# WAVELET-BASED OUTLIER DETECTION AND DENOISING OF AIRBORNE LASER SCANNING DATA

A THESIS SUBMITTED TO
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

TOLGA AKYAY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
GEODETIC AND GEOGRAPHICAL INFORMATION TECHNOLOGIES

DECEMBER 2008

Approval of thesis:

**WAVELET-BASED OUTLIER DETECTION AND DENOISING OF AIRBORNE LASER SCANNER DATA**

submitted by **TOLGA AKYAY** in partial fulfillment of the requirements for the degree of **Master of Science in Geodetic and Geographical Information Technologies Department, Middle East Technical University** by,

Prof. Dr. Canan Özgen _______________
Dean, Graduate School of **Natural and Applied Sciences**

Assoc. Prof. Dr. H. Şebnem Düzgün _______________
Head of Department,
**Geodetic and Geographical Information Technologies**

Assoc. Prof. Dr. Mahmut Onur Karslıoğlu _______________
Supervisor, **Civil Engineering Dept., METU**

**Examining Committee Members:**

Prof. Dr. Vedat Toprak _______________
Geological Engineering Dept., METU

Assoc. Prof. Dr. Mahmut Onur Karslıoğlu _______________
Civil Engineering Dept., METU

Prof. Dr. Kerim Demirbaş _______________
Electrical and Electronics Engineering Dept., METU

Dr. Engin Karaesmen _______________
Civil Engineering Dept., METU

Dr. Uğur Murat Leloğlu _______________
TÜBİTAK-UZAY

**Date:** 01/12/2008

**I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.**

Name, Last name : Tolga AKYAY

Signature :

# ABSTRACT

WAVELET-BASED OUTLIER DETECTION AND DENOISING
OF AIRBORNE LASER SCANNING DATA

AKYAY, Tolga
M.Sc., Department of Geodetic and Geographic Information Technologies
Supervisor: Assoc. Prof. Dr. Mahmut Onur KARSLIOĞLU

December 2008, 115 pages

The method of airborne laser scanning – also named as LIDAR – has recently turned out to be an efficient way for generating high quality digital surface and elevation models. In this work, wavelet-based outlier detection and different wavelet thresholding (wavelet shrinkage) methods for denoising of airborne laser scanning data are discussed. The task is to investigate the effect of wavelet-based outlier detection and find out which wavelet thresholding methods provide best denoising results for post-processing. Data and results are analyzed and visualized by using a MATLAB program which was developed during this work.

Keywords: Outlier detection, wavelet thresholding, image denoising, LIDAR, DEM

# ÖZ

HAVADAN LAZER TARAMA VERİSİNDE DALGACIK TABANLI
AYKIRI DEĞER BELİRLEME VE GÜRÜLTÜ TEMİZLEME

AKYAY, Tolga
Yüksek Lisans, Jeodezi ve Coğrafi Bilgi Teknolojileri Bölümü
Tez Yöneticisi: Doç. Dr. Mahmut Onur KARSLIOĞLU

Aralık 2008, 115 Sayfa

Havadan lazer tarama veya LIDAR olarak da adlandırılan yöntem son yıllarda yüksek kalitede sayısal yüzey ve yükseklik modeli oluşturmada hızlı ve verimli olmuştur. Bu çalışmada, havadan lazer tarama verisinde dalgacık tabanlı aykırı değerlerin belirlenmesi ve değişik dalgacık sıkıştırma yöntemleri kullanılarak havadan lazer tarama verisinde gürültü temizlenmesi tartışılmıştır. Amaç, ileri aşamalardaki çalışmalarda fayda sağlaması için dalgacık tabanlı aykırı değer belirlemenin etkisini araştırmak ve hangi dalgacık sıkıştırma yönteminin gürültü temizlenmesinde daha iyi sonuçlar verdiğini bulmaktır. Veri ve sonuçlar bu çalışmada geliştirilen bir MATLAB uygulaması tarafından analiz edilmiş ve görüntülenmiştir.

Anahtar kelimeler: Aykırı değer belirleme, dalgacık sıkıştırma, görüntülerde gürültü temizleme, LIDAR, DEM

# ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to Assoc. Prof. Dr. Mahmut Onur Karslıoğlu for being a mentor in this field of study and guiding me throughout my research.

I am also grateful to my family for supporting me throughout my educational life.

I would also like to thank MNG Bilgisayar A.Ş. family for their support, understanding and motivation.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# CHAPTER 1

# INTRODUCTION

Airborne laser scanning – also named as LIDAR – technology offers one of the most accurate, expedient and cost-effective ways to capture wide-area elevation information to produce highly detailed digital surface models (DSM) and digital elevation models (DEM). LIDAR data sets contain vast amount of information. Buildings, trees and power lines are individually discernible features. This data are digital and are directly processed to produce detailed bare earth DEMs at vertical accuracies of 0.15 meters to 1 meter. Derived products include contour maps, slope/aspect, 3-D topographic images, virtual reality visualizations and more. LIDAR data can be seamlessly integrated with other data sets, including orthophotos, multispectral, hyperspectral and panchromatic imagery. LIDAR is combined with GIS data and other surveying information to generate complex geomorphic-structure mapping products, building renderings, advanced 3-D modeling/earthworks and many more high quality mapping products.

Despite LIDAR signal contains detailed information, like any other signal, it may also contain outliers and random noise. Outliers should be removed and noise should be filtered out in order to obtain good quality final products. Bilen and Huzubazar proposes a general outlier detection method based on wavelets [22]. Many denoising algorithms have been developed in the spatial and the Fourier domain. In the past two decades, the focus was shifted to wavelet domain due to its properties such as sparsity and multi-resolution structure. Various wavelet thresholding (wavelet shrinkage) methods have been published by researchers. Donoho and Johnstone who intoduced the hard and soft thresholding functions proposes a universal method and an adaptive method based on SURE principle [9]. Kaur, Gupta and Chauhan proposes an adaptive method based on generalized Gaussian distribution [17]. The famous non-linear Bayesian estimator was applied to wavelet domain by Abramovich, Sapatinas and Silverman [19]. Ogden and Parzen established thresholding techniques based on statistical tests of hypotheses [20]. Nason suggests a cross-validation algorithm for wavelet shrinkage [21]. Tuncer investigated the performance of various wavelet thresholding methods on digital and SAR images and compared them with non-wavelet processes [28]. These wavelet thresholding methods are tested on LIDAR data for DSM generation.

Filtering of the LIDAR data is challenging due to the complex distribution of objects on Earth’s surface. This problem has been investigated so far with a variety of algorithms. A filtering based on mathematical morphology called Progressive Morphological Filtering has been developed to enable extraction of ground points from LIDAR measurements with minimum human interaction [26]. Vu and Tokunaga proposes a new method based on multi-resolution analysis enabling the classification of objects based on their size [27].

In this work, the algorithm based on wavelets proposed by Bilen and Huzurbazar is used for outlier detection and removal. For denoising, one universal and five adaptive wavelet thresholding methods are implemented.

Universal method is VisuShrink and adaptive methods include NormalShrink, SureShrink, BayesShrink, Hypthesis Testing and Generalized Cross-validation. Progressive morphological filtering is used for DEM generation. The effect of outlier detection and denoising prior to progressive morphological filtering is also investigated. The program used for analyzing and visualizing the data and results is developed using MATLAB.

This thesis is organized as follows. Chapter 2 and 3 gives brief information about LIDAR and DEMs respectively. In Chapter 4, the concept of image denoising using wavelets is discussed. Chapter 5 covers progressive morphological filtering. Chapter 6 includes information about the test data used in this work. In Chapter 7, the methodology is presented and each step of the algorithm is explained in details. In Chapter 8, the results of wavelet-based outlier detection and denoising is given and discussed. Finally, Chapter 9 covers the conclusions achieved in the scope of this work.

# CHAPTER 2

# LIDAR

## 2.1 General Description

**LIDAR** (**LI**ght **D**etection **A**nd **R**anging) is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target. The well-known method to determine distance to an object or surface is to use laser pulses. Similar to radar technology, the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal [1].

$$dist = \frac{t_{2way} \times c}{2} \qquad (2.1)$$

where $dist$ is the distance measured, $t_{2way}$ is the time elapsed for laser to travel from the sensor to the object and back to the sensor, and $c$ is the speed of light.

The primary difference between LIDAR and radar is that LIDAR uses much shorter wavelengths of the electromagnetic spectrum, typically in the ultraviolet, visible, or near infrared. A laser has a very narrow beam which allows the mapping of physical features with very high resolution compared to radar. In addition, many chemical compounds interact more strongly at visible wavelengths than at microwaves, resulting in a stronger image of these materials [1].

In early stages, LIDAR has been used extensively for atmospheric research and meteorology. With the deployment of the **Global Positioning System** (**GPS**) in the 1980's, precision positioning of aircraft became possible. GPS based surveying technology has made airborne surveying and mapping applications possible and practical. Many have been developed, using downward-looking LIDAR instruments mounted in aircraft or satellites. By merging LIDAR, GPS and inertial attitude technologies, it has become possible to directly measure the shape (elevation) of the earth's surface beneath the aircraft's flight path. This elevation data is generated at the rate of thousands of points per second, with absolute vertical accuracies of up to 15 cm.

When LIDAR data is collected, the instrument also measures the intensity of the returned light which can be used for land-cover classification. The resulting image is a gray-scale measurement of the reflectance amplitude of the light pulse. Intensity data is not concerned in this work. The main focus will be on the elevation data.

## 2.2 System Components

In general, there are two types of LIDAR systems: **micropulse** LIDAR systems and **high energy** systems. Micropulse systems have developed as a result of the ever increasing amount of computer power available combined with advances in laser technology. They use considerably less energy in the laser, typically on the order of one microjoule, and are often "eye-safe", meaning they can be used without safety precautions. High-power systems are common in atmospheric research [1].

There are several major components in a LIDAR system:

- **Laser**: 600-1000 nm lasers are most common for non-scientific applications. They are inexpensive but, since they can be focused and easily absorbed by the eye, the maximum power is limited by the need to make them eye-safe. A common alternative 1550 nm lasers are eye-safe at much higher power levels since this wavelength is not focused by the eye, but the detector technology is less advanced and so these wavelengths are generally used at longer ranges and lower accuracies. They are also used for military applications as 1550 nm is not visible in night vision goggles unlike the shorter 1000 nm infrared laser. Airborne topographic mapping LIDAR systems generally use 1064 nm diode pumped YAG (Yttrium Aluminum Garnet; $Y_3Al_5O_{12}$) lasers, while bathymetric systems generally use 532 nm frequency doubled diode pumped YAG lasers because 532 nm penetrates water with much less attenuation than does 1064 nm. Laser settings include the laser repetition rate (which controls the data collection speed). Pulse length is generally an attribute of the laser cavity length, the number of passes required through the gain material (YAG, YLF, etc.), and Q-switch speed. Better target resolution is achieved with shorter pulses, provided the LIDAR receiver detectors and electronics have sufficient bandwidth [1].

- **Scanner and optics**: How fast images can be developed is also affected by the speed at which it can be scanned into the system. There are several options to scan the azimuth and elevation, including dual oscillating plane mirrors, a combination with a polygon mirror, a dual axis scanner. Optic choices affect the angular resolution and range that can be detected. A hole mirror or a beam splitter are options to collect a return signal.

- **Receiver and receiver electronics**: Receivers are made out of several different materials. Two common ones are Silicon (Si) and Indium Gallium Arsenide (InGaA). They are made in either PIN diode or Avalanche photodiode configurations. The sensitivity of the receiver is another parameter that has to be balanced in a LIDAR design.

- **Position and navigation systems**: LIDAR sensors that are mounted on mobile platforms such as airplanes or satellites require instrumentation to determine the absolute position and orientation of the sensor. Such devices generally include a GPS receiver and an Inertial Measurement Unit (IMU).

The following figure demonstrates typical Airborne LIDAR System (ALS) components:

- Laser Transmitter, Scanner and Receiver
- Aircraft Positioning – Differential GPS (with post-processing)
- Aircraft Attitude – Pitch, Roll, Yaw – Inertial Measurement Unit (GPS-Aided)

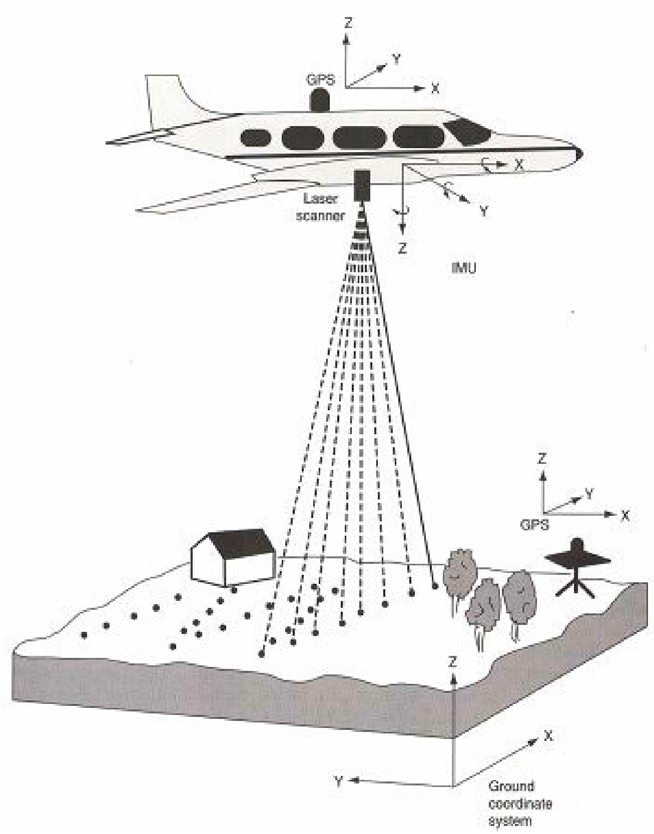



Figure 2.1: Airborne LIDAR System components [2]

## 2.3 Products

Primary products derived from the raw LIDAR data include:

- Digital Elevation Models (DEM)
- Triangular Irregular Networks (TIN)
- 3-D Models
- Intensity Images

# CHAPTER 3

# DIGITAL ELEVATION MODEL

## 3.1 General Description

A **digital elevation model** (**DEM**) is a digital representation of ground surface topography or terrain. A DEM can be represented as a raster (a grid of squares, or an image) or as a **triangular irregular network** (**TIN**). A TIN is a vector based representation of the physical land surface or sea bottom, made up of irregularly distributed nodes and lines with three dimensional coordinates (x, y, z) that are arranged in a network of nonoverlapping triangles.

DEMs are commonly built using remote sensing techniques, however, they may also be built from land surveying. DEMs are used often in geographic information systems, and are the most common basis for digitally-produced relief maps.

A DEM generally refers to a representation of the earth's surface (or subset of this), excluding features such as vegetation, buildings, bridges, etc. The DEM often comprises much of the raw dataset, which may have been acquired through techniques such as photogrammetry, LIDAR, Interferometric Synthetic Aperture Radar (IFSAR), land surveying, etc. A **digital surface model** (**DSM**) on the other hand includes buildings, vegetation, and roads, as well as natural terrain features. The DEM provides a so-called bare-earth model, devoid of landscape features. While a DSM may be useful for landscape modeling, city modeling and visualization applications, a DEM is often required for flood or drainage modeling, land-use studies, geological applications, and much more.

## 3.2 Production

DEMs may be prepared in a number of ways, but they are frequently obtained by remote sensing rather than direct survey.

One powerful technique for generating DEMs is using airborne active sensors. These technologies include LIDAR and IFSAR – also named as INSAR.

LIDAR uses a rapidly pulsed laser rangefinder mounted in a light aircraft with accompanying differential GPS and INS (inertial navigation system) to locate and orient the aircraft. Ten thousand to 30.000 points (x, y, z) are surveyed per second with a spatial precision of a few decimeters, at a cost of a few hundredths of a cent per point. Flying height is on the order of 1.000 meters and airspeeds are on the order of 100 knots. The surveyed points include ground, vegetation, and structures, and require extensive filtering to extract usable terrain models. In heavily vegetated areas LIDAR systems can be challenged to locate the ground surface. Most LIDAR systems use a near-infrared laser that does not penetrate fog or rain [3].

IFSAR bypasses some of these problems. Flying higher and faster than most LIDAR systems, an insar-equipped plane can cover large areas. Longer (cm to m) wavelengths penetrate fog and rain. Extensive development work has resulted in systems that process data almost as rapidly as it is acquired. Unfortunately, there are wave-length related tradeoffs: longer, ~0.5 m (P-band) wavelengths with the potential to penetrate vegetation to the ground of necessity lack high spatial resolution; wavelengths of a few cm (X-band) provide better spatial resolution but image the tree tops [4].

Another powerful technique for generating a DEM is using the digital image correlation (stereo photogrammetry) method. It implies two optical images acquired with different angles taken from an airplane or satellite.

Older methods of generating DEMs often involve interpolating digital contour maps that may have been produced by direct survey of the land surface. This method is still used in mountain areas where airborne scanning is not always satisfactory. The contour data or any other sampled elevation datasets (by GPS or ground survey) are not DEMs, but may be considered DTMs. A DEM implies that elevation is available continuously at each location in the study area.

The quality of a DEM is a measure of how accurate elevation is at each pixel (absolute accuracy) and how accurately is the morphology presented (relative accuracy). Several factors play an important role for quality of DEM-derived products:

- terrain roughness
- sampling density (elevation data collection method)

- grid resolution or pixel size
- interpolation algorithm
- vertical resolution
- terrain analysis algorithm

## 3.3 Uses

Common uses of DEMs include:

- extracting terrain parameters
- modeling water flow or mass movement (for example avalanches)
- creation of relief maps
- rendering of 3D visualizations
- creation of physical models (including raised-relief maps)
- rectification of aerial photography or satellite imagery
- reduction (terrain correction) of gravity measurements (gravimetry, physical geodesy)
- terrain analyses in geomorphology and physical geography

# CHAPTER 4

# IMAGE DENOISING USING WAVELETS

## 4.1 Introduction

Digital images play an important role both in daily applications such as satellite television, magnetic resonance imaging, computer tomography, as well as in research and technology such as geographical information systems and astronomy. Generally, datasets collected by image sensors are contaminated by noise. Imperfect instruments, problems with the data acquisition, and interfering natural phenomena can all degrade the data of interest. Furthermore, noise can be introduced by transmission errors and compression.

There are many different cases of distortions. One of the most prevalent cases is distortion due to additive white Gaussian noise which can be caused by poor image acquisition or by transferring the image data in noisy communication channels. Gaussian noise removal can be effectively done by linear filtering methods. Other types of noises include impulse and speckle noises. Impulse noise is caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware, or transmission in a noisy channel. Two common types of impulse noise are the salt-and-pepper noise and the random-valued noise. For images corrupted by salt-and-pepper noise, the noisy pixels can take only the maximum and the minimum values while in the case of random-valued noise, they can take any random value in the dynamic range.

Speckle is a random, deterministic, interference pattern in an image formed with coherent radiation of a medium containing many sub-resolution scatterers. The texture of the observed speckle pattern does not correspond to underlying structure. The local brightness of the speckle pattern, however, does reflect the local echogenicity of the underlying scatterers.

Therefore, denoising is often a necessary and the first step to be taken before the image data is analyzed. It is necessary to apply an efficient denoising technique to compensate for such data corruption. Image denoising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. Denoising of electronically distorted images is an old but also still a relevant industrial problem. In the past two decades, many methods for denoising have been developed and reported in the literature. There are many works on the restoration of images corrupted by impulse noise. The goal of impulse noise removal is to suppress the noise while preserving the integrity of edge and detail information.

There are two basic approaches to image denoising, spatial filtering methods and transform domain filtering methods [5]. A traditional way to remove noise from image data is to employ spatial filters. Spatial filters employ a low pass filtering on groups of pixels with the assumption that the noise occupies the higher region of frequency spectrum. Low-pass filters will not only smooth away noise but also blur edges in signals and images while the high-pass filters can make edges even sharper and improve the spatial resolution but will also amplify the noisy background [6].

Spatial filters can be classified into non-linear and linear filters. With **non-linear filters**, the noise is removed without any attempts to explicitly identify it. Many non-linear filters fall into the category of order statistic neighbour operators. This means that the local neighbours are sorted into ascending order (according to their value) and this list is processed to give an estimate of the underlying image brightness. The simplest order statistic operator is the median [7], where the central value in the ordered list is used for the new value of the brightness. The median is good at reducing impulse noise (for example salt-and-pepper noise) where the noisy pixels contain no information about their original values. However, when the noise level is over 50%, some details and edges of the original image are smeared by the filter [8]. A mean or average filter is the optimal **linear filter** for Gaussian noise removal in the sense of mean square error. Linear filters too tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal-dependent noise.

Wavelet Analysis, a new form of signal analysis is far more efficient than Fourier analysis wherever a signal is dominated by transient behavior or discontinuities. Engineers and Scientists are now using wavelets to compress digital signals and images, to speed up fundamental scientific problem and to get rid of noise from digital signals [8]. Several investigations have been made into additive noise suppression in signals and images using wavelet transforms. Much of the early work on wavelet noise removal based on thresholding the **Discrete Wavelet Transform** (**DWT**) coefficients of an image and then reconstructing it [9, 10].

This section does not go through the detailed mathematics of the Wavelet Transform. If the reader wishes to get a glance of Wavelet Transform, a suggested reading is *A Really Friendly Guide to Wavelets* by Valens [11].

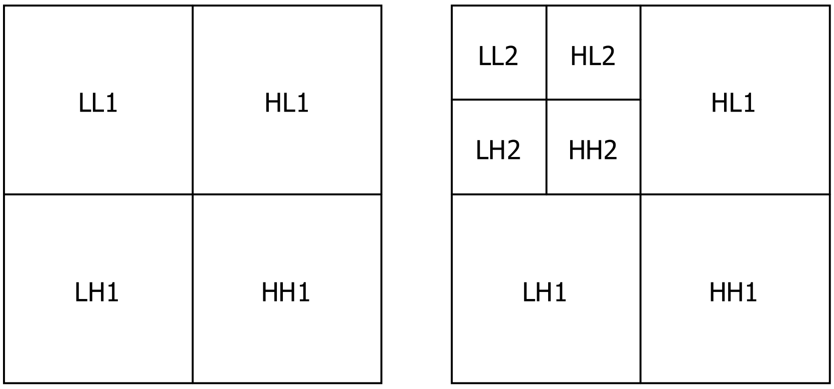
## 4.2 Wavelet Domain Filtering

Working in the wavelet domain is advantageous because the DWT tends to concentrate the energy of the desired signal in a small number of coefficients, hence, the DWT of the noisy image consists of a small number of coefficients with high Signal to Noise Ratio (SNR) and a large number of coefficients with low SNR. After discarding the coefficients with low SNR (i.e. noisy coefficients), the image is reconstructed using inverse DWT. As a result, noise is removed or filtered from the observations.

## 4.3 Discrete Wavelet Transform

Wavelets are functions generated from one single function $\psi$ by dilations and translations [12], where dilation means scaling the wavelet and translation means shifting the wavelet. The basic idea of the wavelet transform is to represent any arbitrary function as a superposition of wavelets. Any such superposition decomposes the given function into different scale levels where each level is further decomposed with a resolution adapted to that level [12].

The DWT is identical to a hierarchical subband system where the subbands are logarithmically spaced in frequency and represent octave-band decomposition. By applying DWT, the image is actually divided i.e. decomposed into four subbands and critically sub sampled as shown in Figure 4.1(a). These four subbands arise from separable applications of vertical and horizontal analysis filters for wavelet decomposition as shown in Figure 4.2(a) [13].




(a) One-Level (b) Two-Level

Figure 4.1: Image Decomposition

The filters $H_0$ and $G_0$ shown in Figure 4.2(a) are one-dimensional Low Pass Filter (LPF) and High Pass Filter (HPF), respectively. Thus, decomposition provides subbands corresponding to different resolution levels and orientation. These subbands labeled LH1, HL1 and HH1 represent the finest scale wavelet coefficients, i.e. detail images while the subband LL1 corresponds to coarse level coefficients, i.e. approximation image. To obtain the next coarse level of wavelet coefficients, the subband LL1 alone is further decomposed and critically sampled using similar filter bank shown in Figure

4.2(a). This results in two-level wavelet decomposition as shown in Figure 4.1(b).

Similarly, to obtain further decomposition, LL2 will be used. This process continues until some final scale is reached [11]. The decomposed image can be reconstructed using a reconstruction (i.e. Inverse DWT) or synthesis filter as shown in Figure 4.2(b). Here, the filters $H_1$ and $G_1$ represents low pass and high pass reconstruction filters respectively.

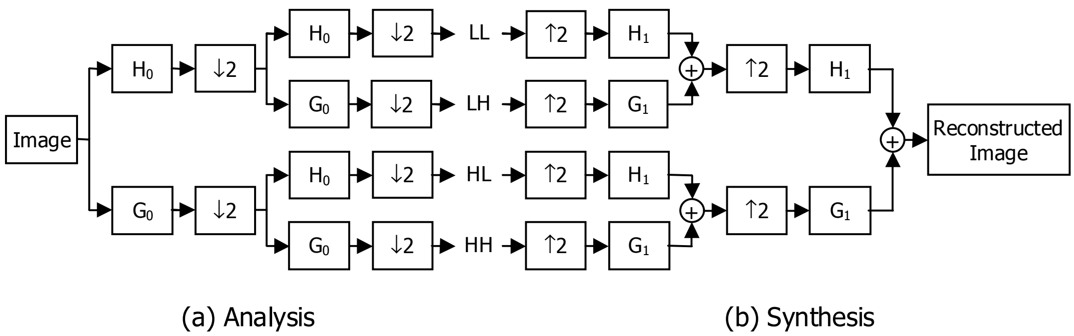



Figure 4.2: One level filter bank for computation of 2-D DWT and Inverse DWT

## 4.4 Wavelet-Based Denoising

Wavelets give a superior performance in image denoising due to properties such as sparsity and multi-resolution structure. With Wavelet Transform gaining popularity in the last two decades, the focus was shifted from the Spatial and Fourier domain to the Wavelet transform domain and various algorithms for denoising in wavelet domain were introduced.

The basic block diagram of wavelet based image denoising system is shown in Fig. 4.3. Wavelet Based Denoising method relies on the fact that noise commonly manifests itself as fine-grained structure in the image and DWT provides a scale based decomposition. Thus, most of the noise tends to be represented by wavelet coefficients at the finer scales. Discarding these coefficients would result in a natural filtering of the noise on the basis of scale. Because the coefficients at such scales also tend to be the primary carriers of edge information, this method sets the DWT coefficients to zero if their values are below a threshold. These coefficients are mostly those corresponding to noise. The edge relating coefficients on the other hand, are usually above the threshold. The Inverse DWT of the thresholded coefficients is the denoised image. It has been found that such denoising is effective in that although noise is suppressed, edge features are retained without much damage [14].

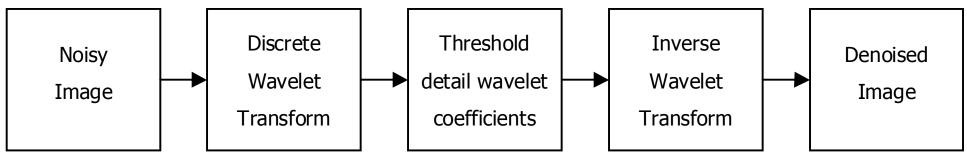



Figure 4.3: Block diagram of wavelet based image denoising system

Researchers published different ways to compute the parameters for the thresholding of wavelet coefficients. Data adaptive thresholds were introduced to achieve optimum value of the threshold. Later efforts found that substantial improvements in perceptual quality could be obtained by translation invariant methods based on thresholding of an Undecimated Wavelet Transform [15]. These thresholding techniques were applied to the non-orthogonal wavelet coefficients to reduce artifacts. Multi-wavelets were also used to achieve similar results.

Wavelet thresholding [9, 10, 16], is a signal estimation technique that exploits the capabilities of wavelet transform for signal denoising. As one may observe, threshold selection is an important question when denoising. A small threshold may yield a result close to the input, but the result may still be noisy. A large threshold on the other hand, produces a signal with a large number of zero coefficients. This leads to a smooth signal. Paying too much attention to smoothness, however, destroys details and in image processing may cause blur and artifacts.

The detail wavelet coefficients (horizontal, vertical and diagonal) are thresholded by the two common thresholding functions:

- **Hard thresholding**

$$f_h(x) = \begin{cases} x & \text{if } |x| \geq \lambda \\ 0 & \text{otherwise} \end{cases} \tag{4.1}$$

- **Soft thresholding**

$$f_s(x) = \begin{cases} x - \lambda & \text{if } x \geq \lambda \\ 0 & \text{if } |\mathrm{x}| < \lambda \\ x + \lambda & \text{if } x \leq \lambda \end{cases} \tag{4.2}$$

where $x$ is the detail wavelet coefficient and $\lambda$ is threshold.

In the scope of this work, six threshold estimation methods are implemented. These are explained in detail in the following sub-sections.

### 4.4.1 VisuShrink

VisuShrink is a non-data dependent method done by applying the Universal Threshold (UT) proposed by Donoho and Johnstone [9]. This threshold is given by

$$T_U = \hat{\sigma}\sqrt{2\log M} \tag{4.3}$$

where $\hat{\sigma}$ is standard deviation and $M$ is the number of pixels in the image.

In practice, we do not know the exact standard deviation. Noise variance is estimated by the robust median estimator:

$$\hat{\sigma} = \frac{\text{median}\left|(Y_{ij})\right|}{0.6745},\ Y_{ij} \in \text{subband HH}_1 \tag{4.4}$$

It is proved that the maximum of any $M$ values are independent and identically distributed as $N(0,\hat{\sigma}^2)$ will be smaller than the UT with high probability. The probability approaches 1 as $M$ increases. Thus, with high probability, a pure noise signal is estimated as being identically zero. However, for denoising images, VisuShrink is found to yield an overly smoothed estimate. This is because the UT is derived under the constraint that with high probability, the estimate should be at least as smooth as the signal. So the UT tends to be high for large values of $M$, killing many signal coefficients along with the noise. Thus, the threshold does not adapt well to discontinuities in the signal.

### 4.4.2 NormalShrink

NormalShrink is an adaptive threshold estimation method based on the generalized Guassian distribution (GGD) modeling of subband coefficients. It is computationally more efficient and adaptive because the parameters required for estimating the threshold value $T_N$ depend on subband data [17].

$$T_N = \frac{\beta \hat{\sigma}^2}{\hat{\sigma}_y} \tag{4.5}$$

where $\hat{\sigma}^2$ is noise variance calculated by (4.4) from subband HH1, $\hat{\sigma}_y$ is the standard deviation of the subband and $\beta$ is the scale parameter computed for each scale:

$$\beta = \sqrt{\log\left(\frac{L_k}{J}\right)} \tag{4.6}$$

where, $L_k$ is the length of the subband at $k^{th}$ scale and $J$ is the total number of decompositions.

### 4.4.3 SureShrink

SureShrink is a thresholding by applying subband adaptive threshold. A separate threshold is computed for each subband based on SURE (Stein's unbiased risk estimator) which is a method for estimating the loss $\|\hat{\mu} - \mu\|^2$ in an unbiased fashion. Let wavelet coefficients in the $j^{th}$ subband be

$\{X_i : i = 1,\ldots,d\}$, $\hat{\mu}$ is the soft threshold estimator $\hat{X}_i = \eta_i(X_i)$, we apply Stein's result [18] to get an unbiased estimate of the risk $E\left\|\hat{\mu}^{(t)}(x) - \mu\right\|^2$:

$$\mathrm{SURE}(t; X) = d - 2 \cdot \#\{i : |X_i| \le t\} + \sum_{i=1}^{d} \min(|X_i|, t)^2 \qquad (4.7)$$

where $\#$ denotes the cardinality of the set.

For an observed vector $x$ (set of noisy wavelet coefficients in a subband), we can find the threshold $T_S$ that minimizes $\mathrm{SURE}(t; X)$:

$$T_S = \mathrm{argmin}_{c \le t \le \sqrt{2 \log d}} \mathrm{SURE}(t; X) \qquad (4.8)$$

Such a method can reasonably be expected to do well in terms of minimizing the risk, since for large sample sizes the Law of Large Numbers will guarantee that the SURE criterion is close to the true risk.

### 4.4.4 BayesShrink

The BayesShrink rule uses a Bayesian mathematical framework for images to derive subband dependent thresholds that are nearly optimal for soft thresholding [19].

Based on the observation that the wavelet coefficients in a subband of a natural image can be summarized adequately by a generalized Guassian distribution (GGD). This observation is well-accepted in the image processing community.

$$t_B = \frac{\hat{\sigma}^2}{\hat{\sigma}_X} \tag{4.9}$$

$$\hat{\sigma}_X = \sqrt{\max\left(\hat{\sigma}_Y^2\right) - \hat{\sigma}^2, 0} \tag{4.10}$$

$$\hat{\sigma}_Y^2 = \frac{1}{N_s}\sum_{n=1}^{N_s} w_n^2 \tag{4.11}$$

where $\hat{\sigma}^2$ is the noise variance calculated by (4.4).

### 4.4.5 Hypothesis Testing

The aim of this approach is to use the data values themselves to separate wavelet coefficients into large coefficients (significant signal) and small coefficients (random noise). This method also operates on a level-by-level basis. At any given level, let $X_1, \ldots, X_d$ be independent with $X_i \sim N(\mu_i, 1)$, $i = 1, \ldots, d$, where $d$ is $2^j$ for level $j$. Let $I_d$ represent a non-empty subset of the indices $\{1, \ldots, d\}$ with $I'_d$ denoting its complement. Then we may consider testing the following hypotheses:

$$\begin{aligned} &H_0 : \mu_1 = \cdots = \mu_d = 0 \\ &H_a : \mu_i = 0 \text{ for } i \in I'_d ; \mu_i \neq 0 \text{ for } i \in I_d \end{aligned} \tag{4.12}$$

where $H_0$ is the null hypothesis and $H_a$ is the alternative hypothesis.

Using the hypotheses in (4.12), we can establish simple thresholding techniques based on statistical tests of hypotheses [20].

If the cardinality of $I_d$ is unknown, the likelihood ratio test reduces simply to:

$$T_{d,*}(X) = \sum_{i=1}^{d} X_i^2 \tag{4.13}$$

which is distributed as a Chi-Square ( $\chi^2$ ) random variable with $d$ degress of freedom under the null hypothesis.

If the cardinality of $I_d$ in (4.12) is known, say $m$, the likelihood ratio test is:

$$T_{d,m}(X) = \sum_{i=d-m+1}^{d} \left(X^2\right)_{(i)} \tag{4.14}$$

where $\left(X^2\right)_{(i)}$ is the i^th^ largest value of $\{X_1^2,\ldots,X_d^2\}$. According to the null hypothesis, the test statistic in (4.14) is a sum of order statistics from an iid sample of $\chi_1^2$ random variables because of the normality of the $X_i$'s.

Testing (4.12) for only one element in $I_d$, the null distribution becomes:

$$P\left[T_{d,1} < x\right] = P\left[\max_{i=1,\ldots,d} |X_i| < \sqrt{x}\right] = \left[\Phi\left(\sqrt{x}\right) - \Phi\left(-\sqrt{x}\right)\right]^d \tag{4.15}$$

Straightforward calculation gives the $(1-\alpha)$ critical point of the distribution in (4.15):

$$x_d^{\alpha} = \left\{\Phi^{-1}\left[\frac{1}{2}\left((1-\alpha)^{1/d} + 1\right)\right]\right\}^2 \tag{4.16}$$

The special case of the hypotheses in (4.12) where $I_d$ has only one element is expressed as:

$$H_0 : \mu_1 = \cdots = \mu_d = 0$$
$$H_a : \exists i \in \{1,\ldots,d\} \text{such that } \mu_i \neq 0 \quad (4.17)$$

The proposed recursive algorithm is as follows:

1. Compute the test statistic $T_{d,1}$ and compare it with the critical value $x_d^{\alpha}$.
2. If the test in step 1 is significant, remove the observation with the greatest value from the dataset, set $d$ to $d-1$, and go to step 1.
3. If the test in step 1 is not significant, set the threshold value to the observation with the greatest absolute value in the current dataset.

The primary goal of this algorithm is to throw out large coefficients until the remaining set of coefficients is believed to be pure noise. Then, all the noise coefficients are shrunk to zero.

The level $\alpha$ of the test of hypotheses can be thought of as being a smoothing parameter. A smaller $\alpha$ value makes it more difficult to include coefficients in the reconstruction and results in a smoother estimator. Since $\alpha$ represents the usual significance level of ordinary test of hypotheses, standard values are $\alpha = .05$ and $\alpha = .01$.

### 4.4.6 Generalized Cross-validation

Cross-validation is widely used as an automatic procedure to choose the smoothing parameter in many statistical applications. The generalized cross-validation (GCV) method is performed by systematically expelling a data point from the construction of an estimate, predicting what the removed value would be and then comparing the prediction with the value of the expelled point [21].

The aim of function estimation in this method is minimizing the mean integrated square error (MISE) between wavelet shrinkage estimator $\hat{f}_t(x)$ and the true function $f(x)$. The threshold $t$ should minimize:

$$M(t) = E\int \left\{ \hat{f}_t(x) - f(x) \right\}^2 dx \tag{4.18}$$

In practice, the function $f$ is not known and so $M$ has to be estimated.

Nason suggests a two-fold cross-validation algorithm that can be used to automatically select a threshold for a wavelet shrinkage estimator based on $2^M$ points. Let $g_1,\ldots,g_n$ represent given data where $n = 2^M$, remove all the odd-indexed $g_i$ from the set. This leaves $2^{M-1}$ evenly indexed $g_j$ which are reindexed from $j = 1,\ldots,2^{M-1}$. A function estimate $\hat{f}_t^E$ is then constructed using a particular threshold $t$ from the re-indexed $g_j$. In order to compare the function estimator with the left-out noisy data an interpolated version of $\hat{f}_t^E$ is formed:

$$\bar{f}_{t,j}^{E} = \frac{1}{2}\left(\hat{f}_{t,j+1}^{E} + \hat{f}_{t,j}^{E}\right), \quad j = 1,\ldots,n/2 \tag{4.19}$$

$\hat{f}_{t,n/2+1}^{E} = \hat{f}_{t,1}^{E}$ because $f$ is assumed to be periodic. The $\hat{f}_t^{O}$ is also computed for the odd indexed points and the interpolant $\bar{f}_t^{O}$ is computed using (4.19). The full estimate for $M(t)$ compares the interpolated wavelet estimators and left-out points:

$$\widehat{M}(t) = \sum_{j=1}^{n/2}\left\{\left(\bar{f}_{t,j}^{E} - g_{2j+1}\right)^2 + \left(\bar{f}_{t,j}^{O} - g_{2j}\right)^2\right\} \tag{4.20}$$

The estimate $\hat{M}$ relies on two estimates of $f_t$ based upon $n/2$ data points. Donoho and Johnstone's [10] universal threshold (4.3) can be used to supply a heuristic method for obtaining a cross-validated threshold for $n$ data points. If the threshold for $n$ points is $T_{UV}(n)$ then the threshold for $n/2$ points will be $T_{UV}(n/2)$ and the relationship between them can be written as:

$$T_{UV}(n) \approx \left(1 - \frac{\log 2}{\log n}\right)^{-1/2} T_{UV}(n/2) \tag{4.21}$$

After the estimate $\hat{M}(t)$ has been minimized, the correction (4.21) is applied to obtain final cross-validated threshold.

This correction can be extended to a $2^k$-fold cross-validation procedure, where $2^k$ estimates $\bar{f}$ are obtained, each based on $n/2^k$ data points selected in a regular way from the original data. Each estimated is interpolated to the original grid and validated by comparing to the remaining $n(1-2^{-k})$ data points. The correction term (4.21) is easily extended to this case and will give the correction factor:

$$\left(1-\frac{k\log 2}{\log n}\right)^{-1/2} \tag{4.22}$$

## 4.5 Wavelet-Based Outlier Detection

Outliers are commonly encountered in data and their presence can seriously distort model identification, parameter estimation and forecasting. Outliers are described as observations which are unusual, but not necessarily errors [22].

Wavelets are fairly new family of basis functions that are used to express and approximate other functions. They combine powerful properties such as orthonormality, different degrees of smoothness, localization in time and scale, compact support and fast implementation. Wavelet coefficients are capable of revealing aspects of the data that other techniques might miss, aspects such as changes in variance, level changes, and discontinuities in functions. Thus, wavelet analysis is well suited for outlier detection [22].

The wavelet-based procedure proposed by Bilen and Huzurbazar [22] is as follows:

1. Apply discrete wavelet transform using Haar wavelet to the observed series $\{Z_t\}$ to obtain the first level of wavelet coefficients $D(J-1)$.

2. Estimate $\hat{\sigma}_1$ from the data by taking the mean absolute deviations (AD) from the median of the wavelet coefficients:

$$\hat{\sigma}_1 = AD(D(J-1)) = \frac{1}{n_1}\sum_{k=1}^{n_1} |d_k(1) - M_1| \tag{4.23}$$

where $d_k(1)$ denotes the wavelet coefficient at location $k$, in the first level of the decomposition and $M_1$ is the median of the level 1 coefficients, $D(J-1)$.

3. Calculate the threshold limit $\tau_1$ using the estimated $\hat{\sigma}_1$:

$$\tau_1 = \hat{\sigma}_1\sqrt{2\log(n)} \tag{4.24}$$

4. Find $S = \{s_1, \ldots, s_m\}$, the set of indices such that $|d_k(1)| > \tau_1$.

5. Use the set of indices $S$ to locate the exact position of outliers: Let $(s_k)$ be the location of the wavelet coefficient such that $|d_k(1)| > \tau_1$. Then the outlier is either in location $(2s_k)$ or $(2s_k - 1)$. To find the exact location, compute the sample mean of the original series $\{Z_t; t = 1, \ldots, n\}$ without observations at locations $(2s_k)$ and $(2s_k - 1)$:

$$\overline{Z}^* = \frac{1}{n-2}\sum_{t \neq 2s_k, 2s_k - 1} Z_t \tag{4.25}$$

The location of the outlier is $(2s_k)$ if $|Z_{2s_k} - \overline{Z}^*| > |Z_{2s_k - 1} - \overline{Z}^*|$; otherwise, the location of the outlier is $(2s_k - 1)$.

# CHAPTER 5

# PROGRESSIVE MORPHOLOGICAL FILTERING

## 5.1 Introduction

High-resolution DEMs are essential for many GIS related analysis and visualization. The airborne LIDAR technology is revolutionizing our way to acquire a high-resolution DEM by allowing rapid and inexpensive measurements of topography over a large area. Airborne LIDAR systems usually obtain measurements for the horizontal coordinates ($x$, $y$) and elevation ($z$) of the reflective objects scanned by the laser beneath the flight path. These measurements generate a 3-dimensional cloud of points with irregular spacing. The laser-scanned objects include buildings, vehicles, vegetation (canopy and understory), and "bare ground". To generate a DEM, measurements from ground and non-ground features have to be identified and classified. Removing non-ground points from LIDAR data sets has proven to be a challenging task.

## 5.2 Morphological Filters

Mathematical morphology composes operations based on set theory to extract features from an image. Two fundamental operations, **dilation** and **erosion**, are commonly employed to enlarge (dilate) or reduce (erode) the size of features in binary images. Dilation and erosion operations may be combined to produce **opening** and **closing** operations. The concept of erosion and dilation has been extended to multi-level (grayscale) images and corresponds to finding the minimum or maximum of the combinations of pixel values and the kernel function, respectively, within a specified neighborhood of each raster [23].

These concepts can also be extended to the analysis of a continuous surface such as a digital surface model as measured by LIDAR data. For a LIDAR measurement $p(x, y, z)$, the dilation of elevation $z$ at $x$ and $y$ is defined as:

$$d_p = \max_{(x_p, y_p) \in w} (z_p) \tag{5.1}$$

where points $(x_p, y_p, z_p)$ represent $p$'s neighbors (coordinates) within a window, $w$. The window can be a onedimensional line or two-dimensional rectangle or other shapes. The dilation output is the maximum elevation value in the neighborhood of $p$. Erosion is a counterpart of dilation and is defined as:

$$e_p = \min_{(x_p, y_p) \in w} (z_p) \tag{5.2}$$

The combination of erosion and dilation generates opening and closing operations that are employed to filter LIDAR data. The opening operation is achieved by performing an erosion of the data set followed by a dilation, while the closing operation is accomplished by carrying out a dilation first and then an erosion. An erosion operation removes objects of sizes smaller than the window size such as trees, while the dilation restores the shapes of large objects such as buildings. The ability of an opening operation to preserve features larger than the window size is very useful in some applications. For example, the measurements of cliff edges can be preserved if the morphological filters are applied to the LIDAR measurements for rocky coasts.

## 5.3 Progressive Morphological Filter

It has been shown that morphological filters can remove measurements for buildings and trees from LIDAR data, but it is difficult to detect all non-ground objects of various sizes using a fixed filtering window size. This problem can be solved by increasing window sizes of morphological filters gradually.

The detailed steps to use the progressive morphological filter to construct the DEMs are given as follows:

1. The irregularly spaced ($x$, $y$, $z$) LIDAR measurements are loaded. A regularly spaced minimum surface grid is constructed by selecting the minimum elevation in each grid cell. Point coordinates ($x$, $y$, $z$) are

stored in each grid cell. If a cell contains no measurements, it is assigned the value of nearest point measurement.

2. The progressive morphological filter whose major component is an opening operation is applied to the grid surface. At the first iteration, the minimum elevation surface together with an initial filtering window size provide the inputs for the filter. In the following iterations, the filtered surface obtained from the previous iteration and an increased window size from Step 3 are used as input for the filter. The output of this step include:
    a. The further smoothed surface from the morphological filter
    b. The detected non-ground points based on the elevation difference threshold

3. The size of the filter window is increased and the elevation difference threshold is calculated. Steps 2 to 3 are repeated until the size of the filter window is greater than a predefined maximum value. This value is usually set to be slightly larger than the maximum building size.

4. The last step is to generate the DEMs based on the data set after non-ground measurements have been removed. Note that each cell of the minimum surface grid generated in Step 1 contains an original or interpolated LIDAR point with elevation representing the cell value. Any filtering operation performed to the grid is actually applied to points in cells. Therefore, the progressive morphological filter classifies the LIDAR measurements at the point level.

## 5.4 Parameters for Progressive Morphological Filter

The selection of the window size and elevation difference threshold is critical to achieve good results when applying the morphological filter. For window size selection, one straight-forward choice is to increase the window size linearly by the following formula:

$$w_k = 2kb + 1 \tag{5.3}$$

where $w_k$ is the full window size, $k = 1,2,\ldots,M$ and $b$ is the initial window size. The maximum window size (number of cells) is equal to $2Mb+1$. Taking $2Mb+1$ as the window size guarantees that the filter window is symmetric around the central point so that the programming of the opening operation is simplified. The advantage of increasing the window size linearly is that gradually changing topographic features are well preserved. However, considerable computing time is needed for an area with large non-ground objects.

Alternatively, the window size can be increased exponentially to reduce the number of iterations used in the filter.

$$w_k = 2b^k + 1 \tag{5.4}$$

where $b$ is the base of an exponential function, $k = 1,2,\ldots,M$ , and again $2b^M + 1$ is equal to the maximum window size.

The elevation difference threshold can be determined based on the slope of topography in the study area. There is a relationship between the maximum elevation difference $dh_{\max(t),k}$ for the terrain, window size $w_k$, and the terrain slope $s$ assuming that the slope is constant.

$$s = \frac{dh_{\max(t),k}}{(w_k - w_{k-1})/2} \tag{5.5}$$

Therefore, the elevation threshold $dh_{T,k}$ is given by

$$dh_{T,k} = \begin{cases} dh_0 & \text{if } w_k \le 3 \\ s(w_k - w_{k-1})c + dh_0 & \text{if } w_k > 3 \\ dh_{\max} & \text{if } dh_{T,k} > dh_{\max} \end{cases} \tag{5.6}$$

where $dh_0$ is the initial elevation difference threshold, $s$ is the slope, $c$ is the cell size, and $dh_{\max}$ is the maximum elevation difference threshold.

In urban areas, primary non-ground objects include cars, trees, and buildings. The sizes of individual cars and trees are much less than that of the buildings, so most of them are often removed in the first several iterations, while the large buildings will be removed last. The maximum elevation difference threshold $dh_{\max}$ can be set to a fixed height (e.g., the lowest building height) to ensure that building complexes are identified. The optimum $s$ is usually achieved by iteratively comparing the filtered and unfiltered data. On the other hand, the non-ground objects in the mountainous areas are primarily vegetation (trees). There is no need to set up a fixed maximum elevation difference threshold to remove trees, and $dh_{max}$ is usually set up as the largest elevation difference in the study area.

# CHAPTER 6

# TEST DATA

The test data is downloaded from ISPRS Test on Extracting DEMs from Point Clouds [24]. Eight sites (Vaihingen/Enz test field and Stuttgart city center) have been chosen for comparing the performance of filters. The areas are originally scanned with an Optech laser scanner. Four represent urban landscapes (City Sites) and the other four represent rural landscapes (Forest Sites). The point density for the City and Forest sites are roughly 0.67 and 0.18 points per square meter, respectively. Each Site is associated with one text file. Each text file represents first and last pulse returns.

Each text file is a space delimited point list. Every record represents two points (first and last return) and four data items are provided for each point in the record:

```
[X1 - First Return] - x coordinate (Easting)
[Y1 - First Return] - y coordinate (Northing)
[Z1 - First Return] - z coordinate (Height)
[I1 - First Return] - Intensity of returned pulse
[X2 - Last  Return] - x coordinate (Easting)
[Y2 - Last  Return] - y coordinate (Northing)
[Z2 - Last  Return] - z coordinate (Height)
[I2 - Last  Return] - Intensity of returned pulse
```

Sample:

```
...
...
...
495246.77 5420160.76 251.33 192 495246.77 5420160.78 251.25 192
495246.73 5420163.65 251.26 193 495246.73 5420163.66 251.20 193
495246.69 5420166.65 251.31 290 495246.69 5420166.65 251.31 290
495246.65 5420169.67 251.32 192 495246.65 5420169.68 251.27 192
495246.61 5420172.70 251.29 290 495246.61 5420172.71 251.23 290
495246.57 5420175.73 251.27 290 495246.57 5420175.73 251.23 290
495246.53 5420178.63 251.22 290 495246.53 5420178.64 251.15 290
495246.49 5420181.52 251.23 319 495246.49 5420181.53 251.18 319
495246.45 5420184.68 251.33 348 495246.45 5420184.68 251.34 348
495246.41 5420187.73 251.31 290 495246.41 5420187.73 251.29 290
...
...
...
```

Table 6.1: Summary of sites

| Location | Site | Planimetric Resolution |
|---|---|---|
| City | Site 1 | 0.67 points per square meter (point spacing: 1.0 – 1.5 m) |
| | Site 2 | |
| | Site 3 | |
| | Site 4 | |
| Forest | Site 5 | 0.18 points per square meter (point spacing: 2.0 – 3.5 m) |
| | Site 6 | |
| | Site 7 | |
| | Site 8 | |

Table 6.2: City sites

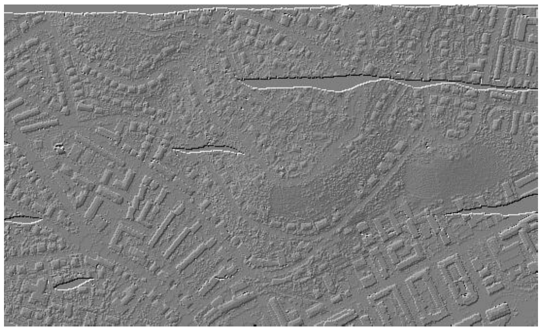
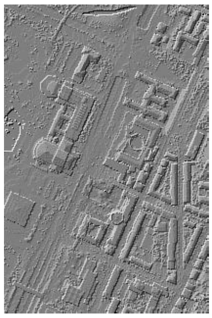
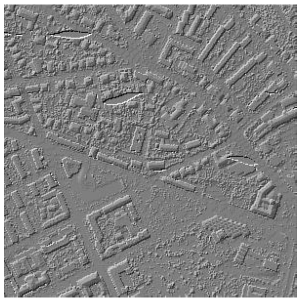
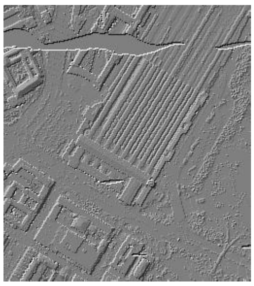
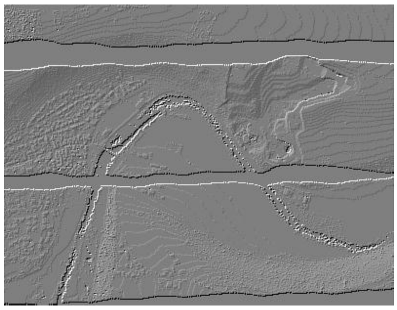
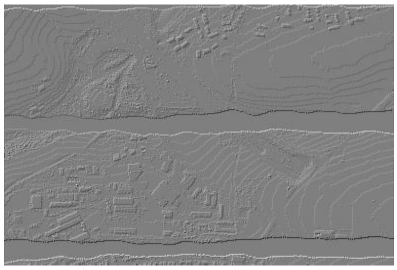
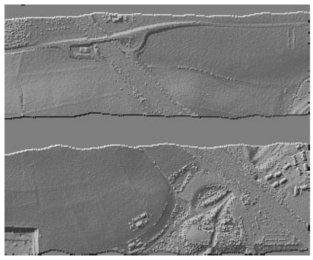
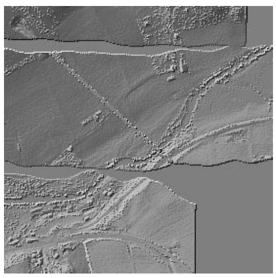
| Site | Data Bounds | | 3-D View |
|---|---|---|---|
| Site 1 | X min | 512050 |  |
| | Y min | 5403440 | |
| | X max | 513150 | |
| | Y max | 5404100 | |
| | Features of interest:<br>• Steep slopes<br>• Mixture of vegetation and buildings on hillside<br>• Buildings on hillside | | |
| Site 2 | X min | 513450 |  |
| | Y min | 5402650 | |
| | X max | 513870 | |
| | Y max | 5403280 | |
| | Features of interest:<br>• Large buildings<br>• Irregularly shaped buildings<br>• Road with bridge and small tunnel | | |
| Site 3 | X min | 512023 |  |
| | Y min | 5403120 | |
| | X max | 512549 | |
| | Y max | 5403500 | |
| | Features of interest:<br>• Densely packed buildings with vegetation between them<br>• Building with eccentric roof (bottom left corner)<br>• Open space with mixture of low and high features | | |
| Site 4 | X min | 513120 |  |
| | Y min | 5403190 | |
| | X max | 513630 | |
| | Y max | 5403760 | |
| | Features of interest:<br>• Railway station with trains (low density of terrain points) | | |

Table 6.3: Forest sites

| **Site** | **Data Bounds** | | **3-D View** |
|---|---|---|---|
| Site 5 | X min | 493650 |  |
| | Y min | 5419770 | |
| | X max | 492250 | |
| | Y max | 5421000 | |
| | Features of interest:<br>• Steep slopes with vegetation<br>• Quarry<br>• Vegetation on river bank | | |
| Site 6 | X min | 496350 |  |
| | Y min | 5420750 | |
| | X max | 497950 | |
| | Y max | 5421817 | |
| | Features of interest:<br>• Large buildings<br>• Road with embankment | | |
| Site 7 | X min | 495950 |  |
| | Y min | 5421350 | |
| | X max | 497200 | |
| | Y max | 5422380 | |
| | Features of interest:<br>• Bridge<br>• Underpass<br>• Road with embankments | | |
| Site 8 | X min | 499450 |  |
| | Y min | 5418330 | |
| | X max | 500550 | |
| | Y max | 5419430 | |
| | Features of interest:<br>• High bridge (diagonal left to right)<br>• Breakline (Bottom center)<br>• Vegetation on river bank | | |

# CHAPTER 7

# METHODOLOGY

## 7.1 Introduction

In this chapter, the wavelet-based outlier detection procedure, obtaining an elevation image from laser points through interpolation, wavelet-based denoising of this elevation image using six wavelet thresholding methods and finally obtaining a DSM or DEM is explained. The complete procedure of the algorithm is shown as a flowchart in Figure 7.1. The step-by-step details of the complete procedure are described in the sub-sections of this chapter. The results are presented in Appendix A and they are discussed in Chapter 8.

The program for analyzing and visualizing the data and results is developed using MATLAB. The key MATLAB functions used and implemented in the algorithm are listed in Appendix B.

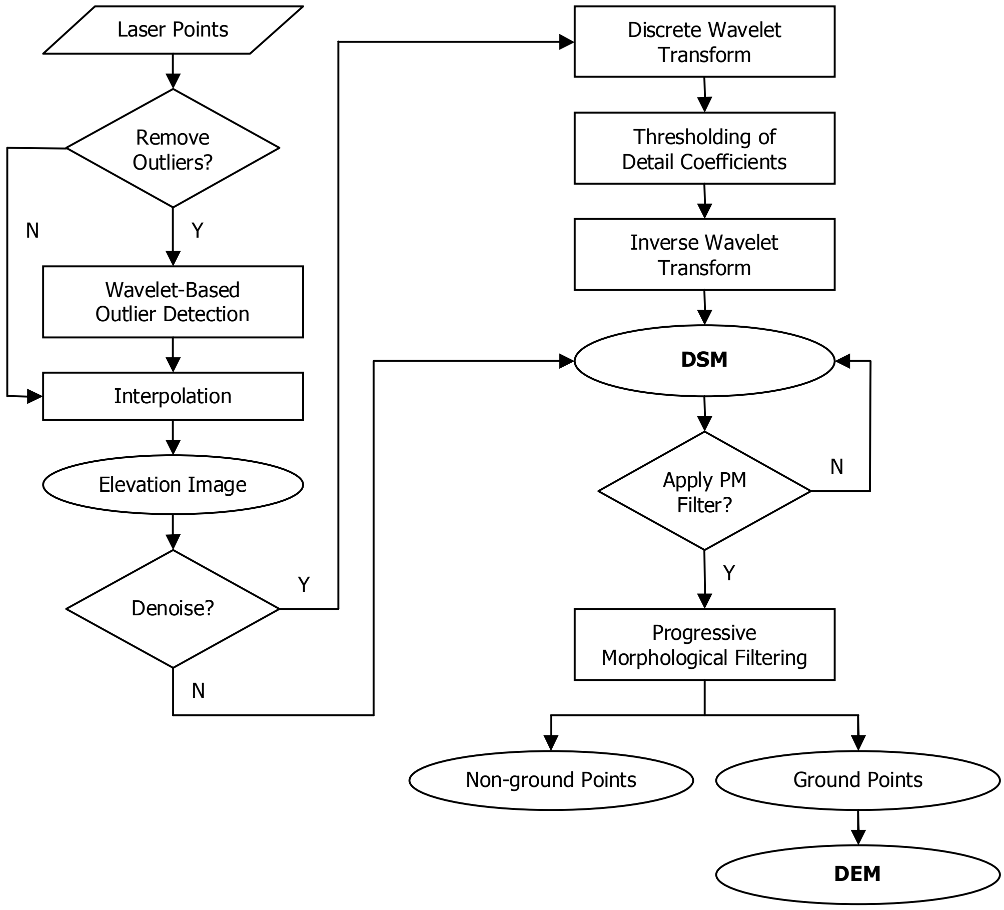



Figure 7.1: Flowchart of algorithm

## 7.2 Wavelet-Based Outlier Detection

The laser points may contain outliers such as spikes, artifacts. These observations should be removed to obtain a smoother elevation image. For this task, the wavelet-based procedure proposed by Bilen and Huzurbazar

[22] as described in Section 4.5 is used. In this procedure, the laser points are considered as time series.

The results for both DSM and DEM generation are tabulated in Tables A.1 and A.2.

## 7.3 Interpolation

In order to apply wavelet-based denoising and progressive morphological filtering on the test data, the nonuniformly spaced laser points must be converted to a uniformly spaced elevation image. There are numerous interpolation methods and determination of the best and suitable interpolation method is beyond the scope of this work. Linear interpolation on the TIN gives the most accurate interpolated image. First return points are used for DSM generation and last return points are used for DEM generation.

TIN is obtained from scattered laser points using **Delaunay triangulation**. In mathematics and computational geometry, a Delaunay triangulation for a set **P** of points in the plane is a triangulation DT(**P**) such that no point in **P** is inside the circumcircle of any triangle in DT(**P**) [25]. TIN is then gridded into a uniformly spaced elevation image through linear interpolation.

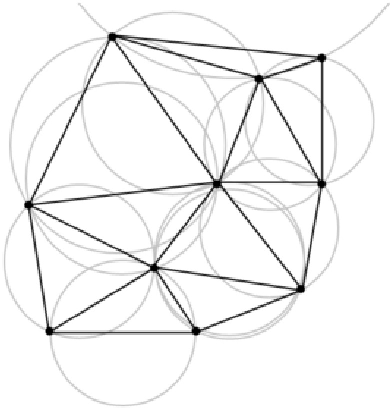


Figure 7.2: Delaunay triangulation in the plane with circumcircles shown

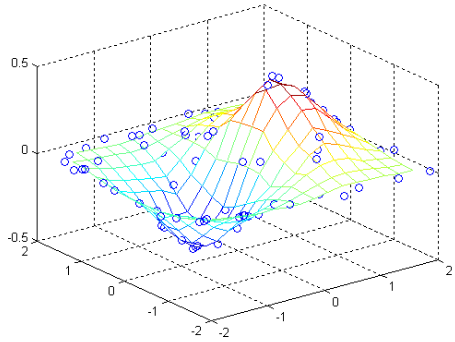



Figure 7.3: Sample gridded data

## 7.4 Wavelet-Based Denoising

After obtaining an elevation image free from outliers, wavelet-based denoising procedure as described in Section 4.4 can be applied. Horizontal, vertical and diagonal detail coefficients are obtained for each desired level using Discrete Wavelet Transform (DWT) with various wavelet models. The wavelet models used in this work are listed in Appendix C. Threshold values for each set of detail coefficients are calculated using six threshold estimation methods and each set is thresholded by both hard (4.1) and soft (4.2) thresholding functions. Finally, inverse wavelet transform is applied using the thresholded detail coefficients to obtain the denoised image.

The following six threshold estimation methods are implemented in this work:

- VisuShrink
- NormalShrink
- SureShrink
- BayesShrink
- Hypothesis Testing
- Generalized Cross-validation

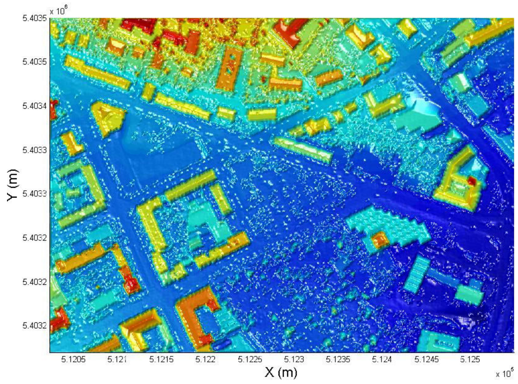
Among these six threshold estimation methods, VisuShrink is a universal method and the other remaining are adaptive methods. The results of each wavelet thresholding method can be found in Tables A.3 to A.50

## 7.5 Progressive Morphological Filtering

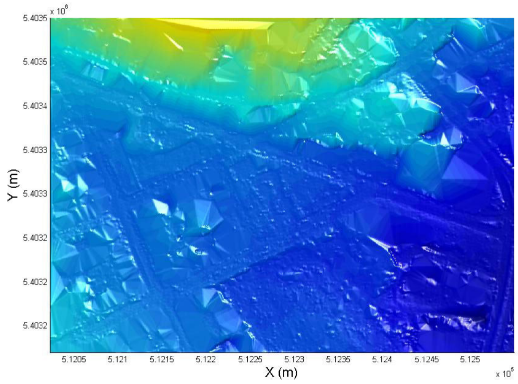
After obtaining a DSM, it may be further decomposed into ground and non-ground points for DEM generation. For this task, progressive morphological filtering explained in Section 5.3 is used. Filter parameters used in this work are listed in Table 7.1 [26]. The plots of City Site 3 with and without filtering are illustrated in Figure 7.4 to demonstrate the effect of progressive morphological filtering.

Table 7.1: Progressive morphological filter parameters

| Location | City Sites | Forest Sites |
|---|---|---|
| Cell size ( $c$ in (5.6)) | 1 | 1 |
| Base of exponential window ( $b$ in (5.4)) | 2 | 2 |
| Increment step for windows ( $k$ in (5.4)) | 0,1,2,...,8 | 0,1,2,...,5 |
| Slope ( $s$ in (5.6)) | 0.08 | 1.2 |
| Initial threshold ( $dh_0$ in (5.6)) | 0.25 | 0.2 |
| Maximum threshold ( $dh_{\max}$ in (5.6)) | 2.5 | 210 |




(a) without filtering




(b) with filtering

Figure 7.4: Plots of City Site 3 with and without progressive morphological filtering

# CHAPTER 8

# RESULTS AND DISCUSSION

## 8.1 Introduction

Test results are obtained according to the methodology described in the previous chapter. In this chapter, the results of wavelet-based outlier detection and denoising are discussed.

The symbols used in the test results are:

$\mu$ Mean

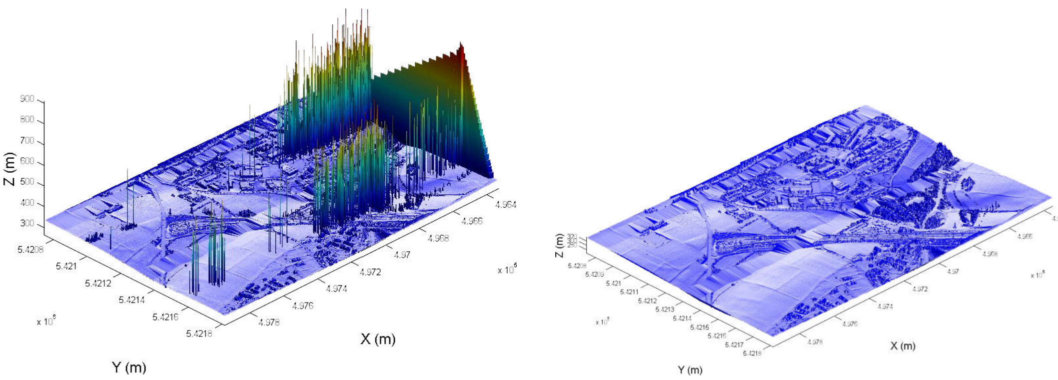
$\sigma$ Standard Deviation

## 8.2 Wavelet-Based Outlier Detection

Outlier detection procedures are usually based on an exact or approximate likelihood ratio test which requires that an initial model fitted to the data. This is a difficult procedure and further complicated in the presence of outliers. The detection procedure based on wavelets proposed by Bilen and Huzurbazar [22] described in Section 4.5 does not require any model fitting.

It is simple, automatable, efficient and practical for large datasets. Here, unusual or inconsistent values (spikes, artifacts) are removed from the dataset in order to obtain a smoother image for better denoising results. The results of wavelet-based outlier detection are given in Table A.1 and A.2.

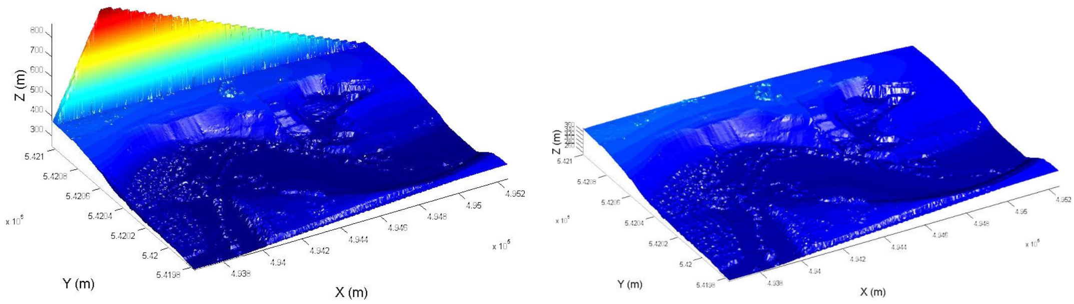
The benefit of the wavelet-based outlier detection on DSM generation can be observed in Table A.1. $\sigma$ decreases while preserving $\mu$. Figure 8.1 clearly visualizes the benefit on DSM generation.




(a) without outlier detection (b) with outlier detection

Figure 8.1: Effect of outlier detection on DSM generation in Forest Site 6

Analyzing Table A.2, the expected benefit is not observed on DEM generation. One reason may be the fact that progressive morphological filtering is already filtering out the outliers. However, in the presence of large artifacts, we observe the improvement as shown in Figure 8.2.




(a) without outlier detection (b) with outlier detection

Figure 8.2: Effect of outlier detection on DEM generation in Forest Site 5

## 8.2 Wavelet-Based Denoising

Wavelet thresholding has been proven to be an effective way of image denoising by many researchers in the literature. It has been found out that adaptive thresholding performs better than universal thresholding. In order to prove these findings in this work, six wavelet thresholding methods, which are described in Section 4.4, were tested on the test data.

The performance of the wavelet thresholding methods are evaluated in Tables A.3 to A.50. $\mu$ and $\sigma$ values are calculated for each method decomposing up to four levels. For better denoising results, one may expect to see decrease in $\sigma$ while $\mu$ remaining constant. Tables 8.1 and 8.2 summarizes the results of wavelet-based denoising.

Table 8.1: Summary of wavelet-based denoising results for DSM generation

| Method | Hard Thresholding | | | | Soft Thresholding | | | |
|---|---|---|---|---|---|---|---|---|
| | including outliers | | excluding outliers | | including outliers | | excluding outliers | |
| | σ | wavelet | σ | wavelet | σ | wavelet | σ | wavelet |
| VisuShrink on City Site 1, σ = 31.1700 | 31.1599 | db20 | 31.0675 | db20 | 31.0829 | rbio3.9 | 30.9951 | rbio3.9 |
| NormalShrink on City Site 2, σ = 11.7044 | 11.7038 | db20 | 11.5640 | db20 | 11.6856 | db20 | 11.5503 | rbio3.9 |
| SureShrink on City Site 3, σ = 9.1404 | 9.1323 | bior2.2 | 9.0300 | db20 | 9.0620 | bior5.5 | 8.9610 | haar bior1.1 |
| BayesShrink on City Site 4, σ = 10.5357 | 10.5357 | N/A | 10.4378 | N/A | 10.5296 | db20 | 10.4328 | rbio3.9 |
| Hypothesis Testing on City Site 2, σ = 11.7044 | 11.4874 | db20 | 11.3555 | bior5.5 | 10.8861 | haar rbio1.1 | 10.7619 | haar bior1.1 |
| GCV on City Site 3, σ = 9.1404 | 8.3856 | rbio1.3 | 8.3117 | bior2.2 | 8.3645 | rbio1.3 | 8.2803 | rbio1.3 |

Table 8.2: Summary of wavelet-based denoising results for DEM generation

| Method | Hard Thresholding | | | | Soft Thresholding | | | |
|---|---|---|---|---|---|---|---|---|
| | including outliers | | excluding outliers | | including outliers | | excluding outliers | |
| | σ | wavelet | σ | wavelet | σ | wavelet | σ | wavelet |
| VisuShrink on City Site 1, σ = 25.6302 | 22.9175 | rbio3.1 | 22.4519 | rbio3.1 | 23.1710 | rbio3.1 | 23.5240 | rbio3.1 |
| NormalShrink on City Site 2, σ = 3.5970 | 3.5625 | db20 | 3.6184 | db20 | 3.5305 | rbio3.1 | 3.5900 | rbio3.9 |
| SureShrink on City Site 3, σ = 4.4727 | 4.3547 | db6 | 4.3456 | bior3.1 | 4.3747 | bior3.1 | 4.3781 | bior3.1 |
| BayesShrink on City Site 4, σ = 3.5185 | 3.5147 | sym20 | 3.5596 | db10 | 3.5098 | rbio2.8 | 3.5540 | rbio2.8 |
| Hypothesis Testing on City Site 2, σ = 3.5970 | 1.9447 | rbio3.5 | 1.9625 | rbio3.5 | 2.1014 | rbio3.3 | 2.0568 | rbio3.3 |
| GCV on City Site 3, σ = 4.4727 | 4.1013 | bior1.5 | 4.1379 | bior1.5 | 4.1071 | bior1.5 | 4.1365 | bior1.5 |

According to Table 8.1, soft thresholding always performs better than hard thresholding for DSM generation. σ always decreases as the level of decomposition increases, i.e. always smoothing the image. However, in some cases, hard thresholding performed better than soft thresholding for DEM generation according to Table 8.2,. This conflict may be due to the mechanism of progressive morphological filtering.

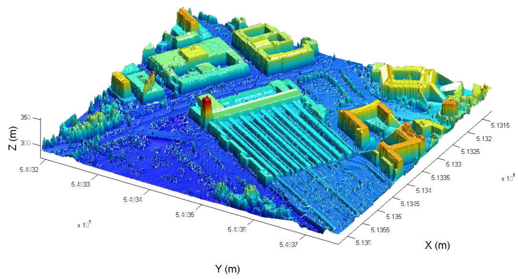
In order to find out the best wavelet thresholding method for DSM generation, each method is applied to City Site 4 with soft thresholding using Daubechies 20 wavelet decomposing up to four levels both including and excluing outliers. The statistical results are presented in Table 8.3 and 8.4 and for comparison, the 3-D DSM plots with two levels of decomposition are illustrated in Figure 8.3.

Table 8.3: Overall denoising performance analysis for DSM generation on City Site 4 including outliers

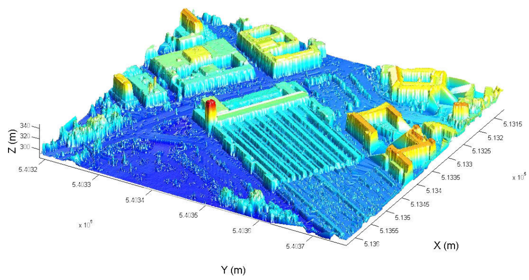
| **City Site 4**, μ = 299.6017, σ = 10.5357 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Method | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| VisuShrink | 299.6019 | 10.5006 | 299.6018 | 10.4587 | 299.6020 | 10.4172 | 299.6022 | 10.3828 |
| NormalShrink | 299.6017 | 10.5238 | 299.6017 | 10.5199 | 299.6017 | 10.5189 | 299.6017 | 10.5187 |
| SureShrink | 299.6018 | 10.5072 | 299.6018 | 10.4906 | 299.6018 | 10.4864 | 299.6018 | 10.4853 |
| BayesShrink | 299.6017 | 10.5314 | 299.6017 | 10.5301 | 299.6017 | 10.5297 | 299.6017 | 10.5296 |
| Hypothesis Testing | 299.6018 | 10.4876 | 299.6011 | 10.4052 | 299.6018 | 10.2409 | 299.6038 | 9.9553 |
| GCV | 299.6018 | 10.5094 | 299.6015 | 10.4648 | 299.6021 | 10.3685 | 299.6037 | 10.1806 |

Table 8.4: Overall denoising performance analysis for DSM generation on City Site 4 excluding outliers

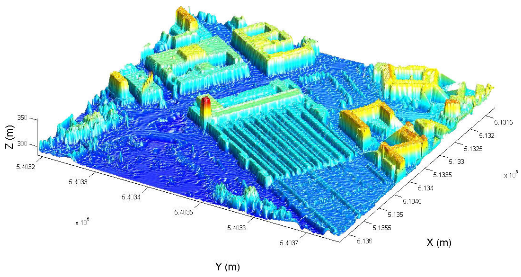
| **City Site 4**, μ = 299.5510, σ = 10.4379 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Method | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| VisuShrink | 299.5511 | 10.4101 | 299.5511 | 10.3740 | 299.5512 | 10.3374 | 299.5513 | 10.3073 |
| NormalShrink | 299.5510 | 10.4286 | 299.5510 | 10.4256 | 299.5510 | 10.4248 | 299.5510 | 10.4247 |
| SureShrink | 299.5511 | 10.4135 | 299.5511 | 10.3969 | 299.5511 | 10.3920 | 299.5511 | 10.3910 |
| BayesShrink | 299.5510 | 10.4345 | 299.5510 | 10.4335 | 299.5510 | 10.4332 | 299.5510 | 10.4331 |
| Hypothesis Testing | 299.5511 | 10.3991 | 299.5503 | 10.3235 | 299.5513 | 10.1622 | 299.5534 | 9.8755 |
| GCV | 299.5511 | 10.4178 | 299.5508 | 10.3794 | 299.5512 | 10.2884 | 299.5533 | 10.1001 |



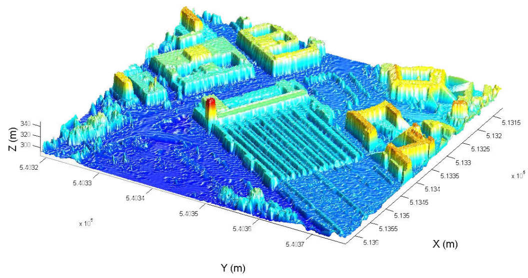

(a) Original including outliers



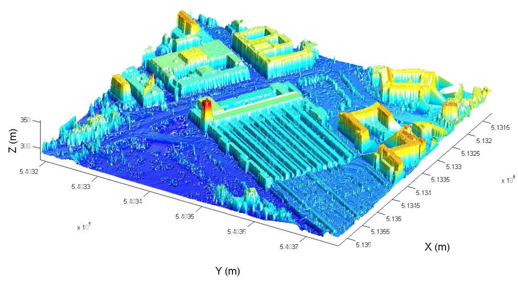

(b) Original excluding outliers



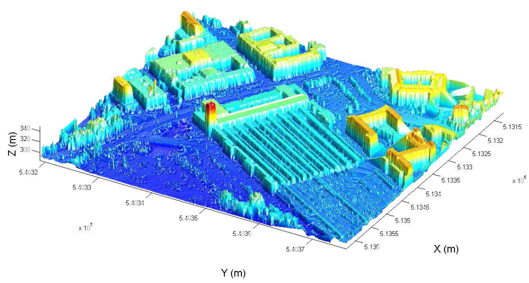

(c) VisuShrink including outliers



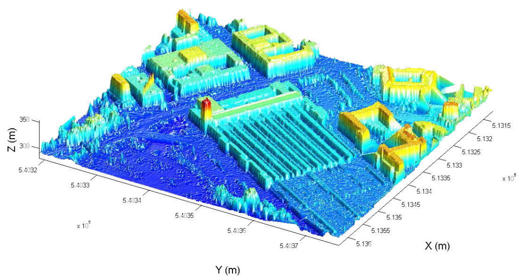

(d) VisuShrink excluding outliers



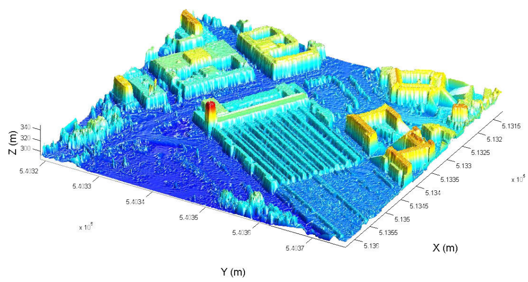

(e) NormalShrink including outliers




(f) NormalShrink excluding outliers

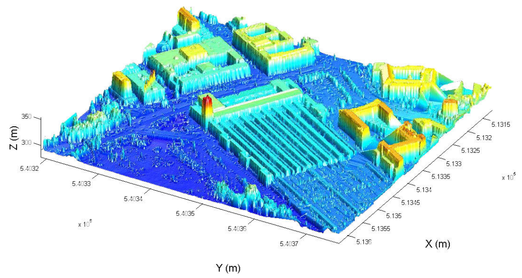



(g) SureShrink including outliers

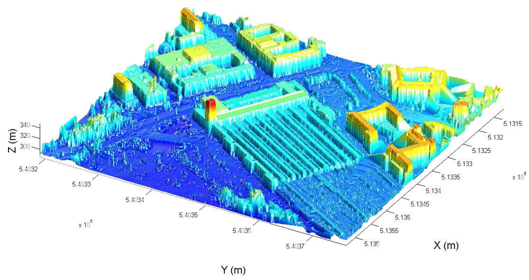



(h) SureShrink excluding outliers

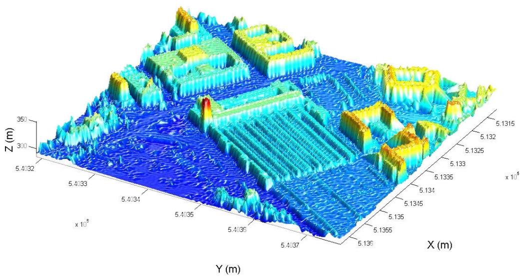
Figure 8.3: 3-D DSM plots of City Site 4



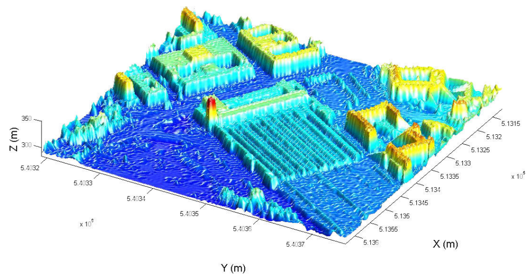

(i) BayesShrink including outliers



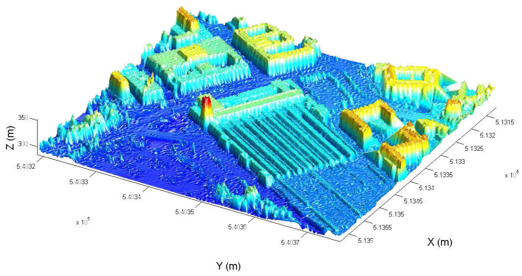

(j) BayesShrink excluding outliers



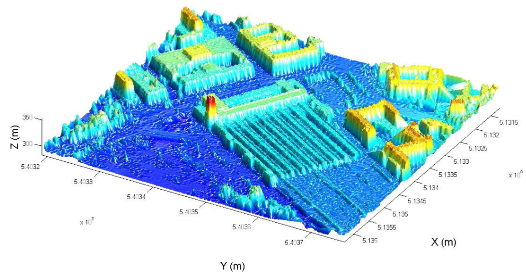

(k) Hypothesis Testing including outliers




(l) Hypothesis Testing excluding outliers




(m) GCV including outliers




(n) GCV excluding outliers

Figure 8.3 (continued)

NormalShrink and BayesShrink are both adaptive thresholding methods based on generalized Gaussian distribution (GGD). Although these two methods are well-accepted in the image processing community, they performed poor in our case which can be verified in Table 8.3 and 8.4. The poor performance may be related to the noise charactestics in the signal. SureShrink, which is an adaptive thresholding method, did not perform as well as the universal method VisuShrink. However, the remaining adaptive methods Hypothesis Testing and Generalized Cross-validation got the best scores, Hypothesis Testing being the winner.

The choice of wavelet model is an important parameter for denoising. Tables 8.1 and 8.2 shows the best performing wavelet models for each case. However, while making the choice, it has to be verified visually. Some wavelets such as Haar and Biorthogonal 1.1 affect the structure of the signal. In our case, Daubechies 20 got reasonable results.

The level decomposition is also an important parameter for denoising. If it is low, the desired denoising performance is not reached. If it is too high, the structure of the actual signal is lost. As an example, for Hypothesis Testing, the original signal is lost after two levels of decomposition.

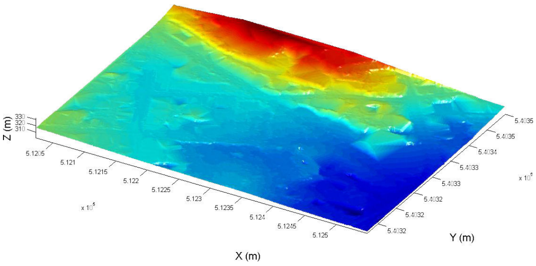
In order to investigate the effect of wavelet-based denoising on DEM generation, each method is applied to City Site 3 with hard thresholding using Daubechies 20 wavelet and decomposing up to four levels both including and excluding outliers. The statistical results are given in Table 8.5 and 8.6 and the 3-D DEM plots with one level of decomposition are illustrated in Figure 8.4.

Table 8.5: Overall denoising performance analysis for DEM generation on City Site 3 including outliers

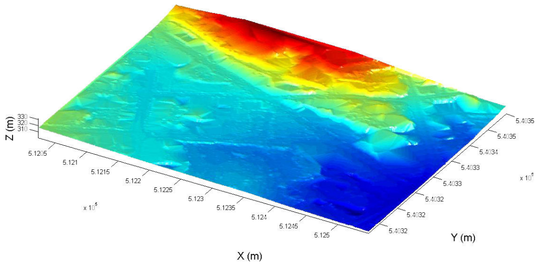
| **City Site 3**, μ = 310.7064, σ = 4.4727 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Method | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| VisuShrink | 310.4581 | 4.3536 | 310.4155 | 4.4541 | 310.4283 | 4.4501 | 310.4339 | 4.4559 |
| NormalShrink | 310.6566 | 4.4470 | 310.6595 | 4.4482 | 310.6586 | 4.4479 | 310.6585 | 4.4480 |
| SureShrink | 310.5053 | 4.3692 | 310.5099 | 4.3705 | 310.5087 | 4.3686 | 310.5084 | 4.3684 |
| BayesShrink | 310.7130 | 4.4703 | 310.7155 | 4.4718 | 310.7154 | 4.4718 | 310.7154 | 4.4718 |
| Hypothesis Testing | 310.4251 | 4.3561 | 310.3158 | 4.4035 | 310.0583 | 4.3888 | 309.7669 | 4.5203 |
| GCV | 310.4813 | 4.3655 | 310.3510 | 4.4060 | 310.0916 | 4.3644 | 309.7193 | 4.3316 |

Table 8.6: Overall denoising performance analysis for DEM generation on City Site 3 excluding outliers

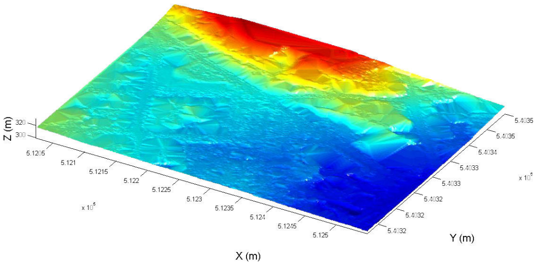
| **City Site 3**, μ = 310.7514, σ = 4.4699 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Method | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| VisuShrink | 310.5955 | 4.3632 | 310.5296 | 4.3639 | 310.5647 | 4.3772 | 310.5706 | 4.3791 |
| NormalShrink | 310.7469 | 4.4730 | 310.7429 | 4.4621 | 310.7428 | 4.4621 | 310.7428 | 4.4621 |
| SureShrink | 310.5889 | 4.3676 | 310.6144 | 4.3945 | 310.6124 | 4.3941 | 310.6135 | 4.3950 |
| BayesShrink | 310.7531 | 4.4653 | 310.7526 | 4.4652 | 310.7526 | 4.4652 | 310.7526 | 4.4652 |
| Hypothesis Testing | 310.5401 | 4.3788 | 310.4285 | 4.3993 | 310.1308 | 4.3724 | 309.9498 | 4.5067 |
| GCV | 310.5778 | 4.3800 | 310.4203 | 4.3679 | 310.1719 | 4.3737 | 309.7653 | 4.3038 |



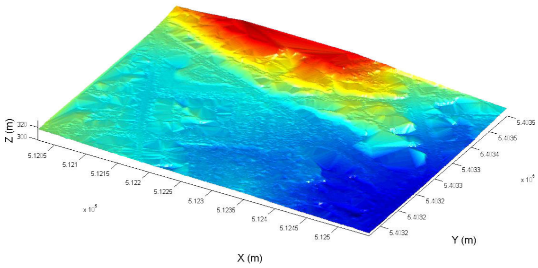

(a) Original including outliers




(b) Original excluding outliers




(c) VisuShrink including outliers




(d) VisuShrink excluding outliers

Figure 8.4: 3-D DEM plots of City Site 3

Although the $\sigma$ values seem to be better after denoising, the plots seem to be noisy compared with originals. The success of wavelet-based denoising on DEM generation with progressive morphological filtering is indeterminate.

# CHAPTER 9

# CONCLUSIONS

The method of airborne laser scanning or LIDAR is one of the most popular methods to produce highly detailed DSMs and DEMs. The primary goal of this thesis is to obtain better final products using wavelet-based techniques. A wavelet-based outlier detection procedure was used to remove outliers. The performance of one universal (VisuShrink) and five adaptive (NormalShrink, SureShrink, BayesShrink, Hypothesis Testing, Generalized Cross-validation) wavelet shrinkage methods were tested for denoising. The conclusions are as follows:

Wavelet-based outlier detection has positive effect on DSM generation. It removes the spikes and artifacts. Although the expected benefit was not observed for DEM generation in every case, it works well in the presence of large artifacts.

Wavelet thresholding is an effect way of image denoising. Soft thresholding performs better than hard thresholding in wavelet-based denosing for DSM generation. Subband adaptive methods are more suitable than the universal method. Hypothesis Testing is a good choice for threshold estimation. The wavelet model used for denoising must be chosen carefully both verifying statistically and visually. The decomposition level is an important parameter in wavelet-based denoising, since desired denoising performance is not reached when low and the actual signal is lost when too high. The effect of wavelet-based denoising on DEM generation is indeterminate. It must be further investigated considering the mechanism of progressive morphological filtering.

Although this study gives a deep understanding of the proposed method, further research is necessary to validate the applicability of the method. The final DSMs and DEMs obtained in this work must be compared with actual ones using known ground control points. This was not possible in this work, since the actual approved DEMs of the test sites were not available.

# REFERENCES

**[1]** Cracknell, A.P. and Hayes, L., *Introduction to Remote Sensing, 2nd Ed.*, Taylor and Francis, London, 2007.

**[2]** Sea Level Rise from ICE in Slavbard – Lidar Data, http://ralph.swan.ac.uk/glaciology/projects/slices/Lidar/index.htm, last access date: 17.07.2008.

**[3]** Fowler, R., *Topographic LIDAR: Digital Elevation Model Technologies and Applications: The DEM Users Manual*, Maune, D.F., Ed., American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland, pp. 207-236, 2001.

**[4]** Hensley, S., Riadh, M., Paul, R., *Interferometric Synthetic Aperture Radar (IFSAR): Digital Elevation Model Technologies and Applications: The DEM Users Manual*, Maune, D.F., Ed., American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland, pp. 142-206., 2001.

**[5]** Motwani., M.C., Gadiya., M.C., Motwani., R.C., Harris Jr., F.C., *Survey of Image Denoising Techniques: Proceedings of GSPx*, Santa Clara, CA, 2004.

**[6]** Arce, G.R., Gallagher, N.C., Nodes, T., *Median Filters: Theory and Applications in Advances in Computer Vision and Image Processing*, Huang, T., Ed., CT: JAI Press, Greenwich, 1986.

**[7]** Tukey, J.W., *Exploratory Data Analysis*, Addison-Wesley, Menlo Park, CA, 1971.

**[8]** Pitas, I., Venetsanopoulos, A.N., *Nonlinear Digital Filters: Principles and Applications*, MA: Kluwer Academic Publishers, Boston, 1990.

**[9]** Donoho, D.L. and Johnstone, I.M., *Ideal Spatial Adaptation by Wavelet Shrinkage*, Biometrika, Vol. 81, No. 3, pp. 425-455, 1994.

**[10]** Donoho, D.L. and Johnstone, I.M., *Adapting to Unknown Smoothness via Wavelet Shrinkage*, Journal of the American Statistical Association, Vol. 90, No. 432, pp. 1200-1224, 1995.

**[11]** Valens, C., *A Really Friendly Guide to Wavelets*, 2004.

**[12]** Antonini, M., Barlaud, M., Mathieu, P., Daubechies, I., *Image Coding using Wavelet Transform*, IEEE Transaction on Image Processing, Vol. 1, No. 2, pp. 205-220, 1992.

**[13]** Shapiro, J.M., *Embedded Image Coding using Zero-tree of Wavelet Coefficients*, IEEE Transactions on Signal Processing, Vol. 41, No. 12, pp 3445–3462, 1993.

**[14]** Rao, R.M, Bobaradikar, A.S., *Wavelet Transforms: Introduction to Theory and Applications*, Addison Wesley Longman Inc., pp. 183-189, 1998.

**[15]** Coifman, R.R., Donoho, D.L., *Translation-Invariant De-noising: Lecture Notes in Statistics: Wavelets and Statistics*, Springer-Verlag, New York, pp. 125-150, 1995.

**[16]** Bruce, A., Donoho, D.L., Yegao, H., *Wavelet Analysis*, IEEE Spectrum, pp. 27-35, 1996.

**[17]** Kaur, L, Gupta, S., Chauhan, R.C., *Image Denoising using Wavelet Thresholding*, Indian Conference on Computer Vision, Graphics and Image Processing, Ahmedabad, 2002.

**[18]** Stein, C., *Estimation of the Mean of a Multivariate Normal Distribution*, The Annals of Statistics, Vol. 9, pp. 1135–1151, 1981.

**[19]** Abramovich, F., Sapatinas, T., Silverman, B.W., *Wavelet Thresholding via a Bayesian Approach*, Journal of the Royal Statistical Society: Series B, Vol. 60, No. 4, pp. 725-749, 1996.

**[20]** Ogden, P., Parzen, E., *Data Dependent Wavelet Thresholding in Nonparametric Regression with Change-point Applications*, Computational Statistics and Data Analysis, Vol. 22, pp. 53-70, 1996.

**[21]** Nason, G.P., *Wavelet Shrinkage using Cross-Validation*, J.R. Statist. Soc., pp. 463-479, 1996.

**[22]** Bilen, C., Huzurbazar, S., *Wavelet-Based Outlier Detection in Time Series*, Journal of Computational & Graphical Statistics, Vol. 11, No. 2, pp. 311-327, 2002.

**[23]** Haralick, R.M., Sternberg, S.R., Zhuang, X., *Image Analysis using Mathematical Morphology*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. PAMI-9, pp. 523-550, 1987.

**[24]** ISPRS Test on Extracting DEMs from Point Clouds, "http://www.itc.nl/isprswgiii-3/filtertest/index.html", last access date: 11.08.2008.

**[25]** Delaunay, B.N., *Sur la sphére vide*, Bulletin of Academy of Sciences of the USSR, No. 6, pp. 793-800, 1934.

**[26]** Zhang, K., Chen, S.C., Whitman, D., Shyu, M.L., Yan, J., Zhang, C., *A Progressive Morphological Filter for Removing Non-Ground Measurements From Airborne LIDAR Data*, Journal of Latex Class Files, Vol. 1, No. 8, 2002.

**[27]** Vu, T.T., Tokunaga, M, *Filtering Airborne Laser Scanner Data: A Wavelet-Based Clustering Method*, Photogrammetric Engineering & Remote Sensing, Vol. 70, No. 11, pp. 1267-1274, 2004.

**[28]** Tuncer, G., *A Java Toolbox for Wavelet Based Image Denoising*, Thesis (M.S.), Middle East Technical University, Ankara, 2006.

# APPENDIX A

# TEST RESULTS

Table A.1: Results of outlier detection for DSM generation

| Site | without outlier detection | | with outlier detection | |
|---|---|---|---|---|
| | μ | σ | μ | σ |
| City Site 1 | 348.3725 | 31.1700 | 348.4279 | 31.0761 |
| City Site 2 | 303.4698 | 11.7044 | 303.4662 | 11.5645 |
| City Site 3 | 318.7184 | 9.1404 | 318.6986 | 9.0395 |
| City Site 4 | 299.6017 | 10.5357 | 299.5510 | 10.4379 |
| Forest Site 5 | 289.3199 | 36.2734 | 289.2938 | 35.9261 |
| Forest Site 6 | 306.0719 | 33.7566 | 302.7327 | 13.2528 |
| Forest Site 7 | 299.8622 | 40.9171 | 298.6160 | 33.9746 |
| Forest Site 8 | 263.0109 | 14.9046 | 262.7298 | 14.4656 |

Table A.2: Results of outlier detection for DEM generation

| Site | without outlier detection | | with outlier detection | |
|---|---|---|---|---|
| | μ | σ | μ | σ |
| City Site 1 | 331.3947 | 25.6302 | 331.5556 | 25.7231 |
| City Site 2 | 292.9100 | 3.5970 | 292.9549 | 3.6377 |
| City Site 3 | 310.7064 | 4.4727 | 310.7514 | 4.4699 |
| City Site 4 | 291.9491 | 3.5185 | 292.0253 | 3.5621 |
| Forest Site 5 | 296.1060 | 57.3415 | 289.6428 | 36.6865 |
| Forest Site 6 | 303.0317 | 13.0421 | 302.9940 | 13.0441 |
| Forest Site 7 | 294.9100 | 9.8161 | 294.9317 | 9.8140 |
| Forest Site 8 | 262.1757 | 15.1136 | 261.9629 | 14.7175 |

Table A.3: Results of VisuShrink with hard thresholding for DSM generation on City Site 1 including outliers

| **City Site 1**, μ = 348.3725, σ = 31.1700 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 348.3725 | 31.1685 | 348.3725 | 31.1681 | 348.3725 | 31.1681 | 348.3725 | 31.1681 |
| db2 | 348.3725 | 31.1675 | 348.3725 | 31.1667 | 348.3726 | 31.1665 | 348.3725 | 31.1666 |
| db4 | 348.3725 | 31.1670 | 348.3725 | 31.1660 | 348.3725 | 31.1659 | 348.3724 | 31.1659 |
| db6 | 348.3726 | 31.1661 | 348.3726 | 31.1649 | 348.3726 | 31.1647 | 348.3726 | 31.1647 |
| db8 | 348.3724 | 31.1657 | 348.3725 | 31.1642 | 348.3725 | 31.1641 | 348.3725 | 31.1641 |
| db10 | 348.3725 | 31.1652 | 348.3724 | 31.1635 | 348.3724 | 31.1632 | 348.3724 | 31.1632 |
| db12 | 348.3725 | 31.1646 | 348.3725 | 31.1626 | 348.3725 | 31.1624 | 348.3725 | 31.1624 |
| db20 | 348.3724 | 31.1630 | 348.3723 | 31.1603 | 348.3724 | 31.1599 | 348.3724 | 31.1599 |
| sym2 | 348.3725 | 31.1675 | 348.3725 | 31.1667 | 348.3726 | 31.1665 | 348.3725 | 31.1666 |
| sym4 | 348.3724 | 31.1674 | 348.3724 | 31.1666 | 348.3724 | 31.1665 | 348.3724 | 31.1665 |
| sym6 | 348.3724 | 31.1672 | 348.3724 | 31.1663 | 348.3724 | 31.1662 | 348.3724 | 31.1661 |
| sym8 | 348.3724 | 31.1669 | 348.3725 | 31.1660 | 348.3725 | 31.1659 | 348.3724 | 31.1659 |
| sym10 | 348.3724 | 31.1668 | 348.3725 | 31.1657 | 348.3725 | 31.1656 | 348.3725 | 31.1656 |
| sym12 | 348.3725 | 31.1667 | 348.3725 | 31.1657 | 348.3725 | 31.1656 | 348.3725 | 31.1656 |
| sym20 | 348.3725 | 31.1663 | 348.3724 | 31.1651 | 348.3724 | 31.1649 | 348.3724 | 31.1649 |
| coif1 | 348.3726 | 31.1674 | 348.3726 | 31.1668 | 348.3725 | 31.1667 | 348.3726 | 31.1667 |
| coif2 | 348.3724 | 31.1675 | 348.3724 | 31.1667 | 348.3724 | 31.1667 | 348.3724 | 31.1666 |
| coif3 | 348.3724 | 31.1672 | 348.3724 | 31.1664 | 348.3724 | 31.1664 | 348.3724 | 31.1664 |
| coif4 | 348.3724 | 31.1670 | 348.3724 | 31.1662 | 348.3724 | 31.1660 | 348.3724 | 31.1660 |
| coif5 | 348.3724 | 31.1669 | 348.3725 | 31.1659 | 348.3724 | 31.1658 | 348.3724 | 31.1658 |
| bior1.1 | 348.3725 | 31.1685 | 348.3725 | 31.1681 | 348.3725 | 31.1681 | 348.3725 | 31.1681 |
| bior1.3 | 348.3725 | 31.1703 | 348.3725 | 31.1703 | 348.3725 | 31.1703 | 348.3725 | 31.1703 |
| bior1.5 | 348.3725 | 31.1706 | 348.3725 | 31.1706 | 348.3725 | 31.1706 | 348.3725 | 31.1706 |
| bior2.2 | 348.3725 | 31.1683 | 348.3724 | 31.1681 | 348.3725 | 31.1681 | 348.3725 | 31.1681 |
| bior2.4 | 348.3725 | 31.1688 | 348.3725 | 31.1687 | 348.3725 | 31.1687 | 348.3725 | 31.1687 |
| bior2.6 | 348.3725 | 31.1690 | 348.3725 | 31.1689 | 348.3725 | 31.1689 | 348.3725 | 31.1689 |
| bior2.8 | 348.3725 | 31.1691 | 348.3725 | 31.1691 | 348.3725 | 31.1691 | 348.3725 | 31.1691 |
| bior3.1 | 348.3725 | 31.1700 | 348.3725 | 31.1701 | 348.3725 | 31.1701 | 348.3725 | 31.1701 |
| bior3.3 | 348.3725 | 31.1692 | 348.3725 | 31.1693 | 348.3725 | 31.1693 | 348.3725 | 31.1693 |
| bior3.5 | 348.3725 | 31.1691 | 348.3725 | 31.1691 | 348.3725 | 31.1691 | 348.3725 | 31.1691 |
| bior3.7 | 348.3725 | 31.1691 | 348.3725 | 31.1692 | 348.3725 | 31.1692 | 348.3725 | 31.1692 |
| bior3.9 | 348.3725 | 31.1692 | 348.3725 | 31.1692 | 348.3725 | 31.1692 | 348.3725 | 31.1692 |
| bior4.4 | 348.3724 | 31.1674 | 348.3725 | 31.1666 | 348.3725 | 31.1665 | 348.3725 | 31.1664 |
| bior5.5 | 348.3725 | 31.1662 | 348.3725 | 31.1634 | 348.3724 | 31.1628 | 348.3724 | 31.1628 |
| bior6.8 | 348.3724 | 31.1674 | 348.3724 | 31.1666 | 348.3724 | 31.1665 | 348.3724 | 31.1665 |
| rbio1.1 | 348.3725 | 31.1685 | 348.3725 | 31.1681 | 348.3725 | 31.1681 | 348.3725 | 31.1681 |
| rbio1.3 | 348.3725 | 31.1678 | 348.3724 | 31.1672 | 348.3725 | 31.1671 | 348.3725 | 31.1671 |
| rbio1.5 | 348.3725 | 31.1679 | 348.3725 | 31.1672 | 348.3724 | 31.1672 | 348.3725 | 31.1672 |
| rbio2.2 | 348.3726 | 31.1684 | 348.3727 | 31.1705 | 348.3727 | 31.1712 | 348.3727 | 31.1713 |
| rbio2.4 | 348.3724 | 31.1666 | 348.3725 | 31.1666 | 348.3726 | 31.1670 | 348.3726 | 31.1670 |
| rbio2.6 | 348.3724 | 31.1663 | 348.3724 | 31.1657 | 348.3723 | 31.1660 | 348.3723 | 31.1660 |
| rbio2.8 | 348.3724 | 31.1661 | 348.3724 | 31.1652 | 348.3724 | 31.1655 | 348.3724 | 31.1655 |
| rbio3.1 | 348.3725 | 31.2194 | 348.3726 | 31.4082 | 348.3723 | 31.6127 | 348.3723 | 31.7357 |
| rbio3.3 | 348.3725 | 31.1720 | 348.3725 | 31.2042 | 348.3726 | 31.2229 | 348.3726 | 31.2263 |
| rbio3.5 | 348.3725 | 31.1674 | 348.3725 | 31.1828 | 348.3726 | 31.1938 | 348.3725 | 31.1961 |
| rbio3.7 | 348.3725 | 31.1660 | 348.3724 | 31.1760 | 348.3725 | 31.1852 | 348.3726 | 31.1868 |
| rbio3.9 | 348.3725 | 31.1654 | 348.3725 | 31.1733 | 348.3727 | 31.1820 | 348.3726 | 31.1832 |
| rbio4.4 | 348.3724 | 31.1679 | 348.3725 | 31.1676 | 348.3725 | 31.1676 | 348.3725 | 31.1676 |
| rbio5.5 | 348.3725 | 31.1688 | 348.3725 | 31.1687 | 348.3725 | 31.1687 | 348.3725 | 31.1687 |
| rbio6.8 | 348.3724 | 31.1670 | 348.3724 | 31.1662 | 348.3725 | 31.1661 | 348.3725 | 31.1661 |
| dmey | 348.3725 | 31.1660 | 348.3725 | 31.1646 | 348.3725 | 31.1645 | 348.3725 | 31.1646 |

Table A.4: Results of VisuShrink with hard thresholding for DEM generation on City Site 1 including outliers

| **City Site 1**, μ = 331.3947, σ = 25.6302 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 330.9192 | 25.3069 | 330.7289 | 25.2312 | 330.6863 | 25.1986 | 330.6730 | 25.1895 |
| db2 | 331.0187 | 25.4384 | 330.6986 | 25.2140 | 330.6446 | 25.1826 | 330.6510 | 25.1671 |
| db4 | 330.8901 | 25.3479 | 330.8893 | 25.2405 | 330.8916 | 25.2683 | 330.9160 | 25.2756 |
| db6 | 331.1053 | 25.4398 | 331.0663 | 25.3099 | 331.1285 | 25.3243 | 331.1223 | 25.2932 |
| db8 | 331.0896 | 25.4199 | 331.2276 | 25.2677 | 331.2633 | 25.2014 | 331.2493 | 25.1781 |
| db10 | 331.3109 | 25.4740 | 331.4933 | 25.2515 | 331.4932 | 25.2344 | 331.4541 | 25.2396 |
| db12 | 331.3456 | 25.4609 | 331.5063 | 25.3027 | 331.5345 | 25.3305 | 331.5699 | 25.3736 |
| db20 | 331.7777 | 25.4669 | 332.3115 | 25.2541 | 332.2805 | 25.1845 | 332.2619 | 25.1999 |
| sym2 | 331.0187 | 25.4384 | 330.6986 | 25.2140 | 330.6446 | 25.1826 | 330.6510 | 25.1671 |
| sym4 | 331.1614 | 25.5016 | 331.1100 | 25.4235 | 331.0741 | 25.4207 | 331.0697 | 25.4219 |
| sym6 | 331.1840 | 25.5113 | 331.1090 | 25.3858 | 331.1239 | 25.3869 | 331.1024 | 25.3719 |
| sym8 | 331.2071 | 25.4839 | 331.2473 | 25.4405 | 331.2648 | 25.3873 | 331.2973 | 25.4397 |
| sym10 | 331.2586 | 25.5183 | 331.2413 | 25.4137 | 331.2540 | 25.4104 | 331.2613 | 25.4261 |
| sym12 | 331.1906 | 25.4921 | 331.2888 | 25.4035 | 331.2872 | 25.3700 | 331.2879 | 25.3607 |
| sym20 | 331.2223 | 25.4765 | 331.4447 | 25.3384 | 331.5070 | 25.3219 | 331.5055 | 25.3181 |
| coif1 | 331.0453 | 25.5215 | 330.8188 | 25.4020 | 330.7698 | 25.4017 | 330.7300 | 25.3935 |
| coif2 | 331.1848 | 25.4997 | 331.0736 | 25.4089 | 331.0428 | 25.3620 | 331.0487 | 25.3701 |
| coif3 | 331.1363 | 25.5040 | 331.0927 | 25.3650 | 331.0815 | 25.3683 | 331.0905 | 25.3813 |
| coif4 | 331.2107 | 25.5109 | 331.1822 | 25.3729 | 331.2434 | 25.3797 | 331.2359 | 25.3638 |
| coif5 | 331.2198 | 25.5137 | 331.1959 | 25.3746 | 331.1688 | 25.3916 | 331.1675 | 25.3987 |
| bior1.1 | 330.9192 | 25.3069 | 330.7289 | 25.2312 | 330.6863 | 25.1986 | 330.6730 | 25.1895 |
| bior1.3 | 331.0050 | 25.3226 | 330.8637 | 25.2045 | 330.8689 | 25.2148 | 330.8652 | 25.2165 |
| bior1.5 | 330.9570 | 25.3344 | 330.8599 | 25.2465 | 330.8777 | 25.2334 | 330.8850 | 25.2386 |
| bior2.2 | 331.2381 | 25.5628 | 331.0744 | 25.4767 | 331.0549 | 25.4549 | 331.0503 | 25.4587 |
| bior2.4 | 331.1799 | 25.5565 | 331.0561 | 25.4998 | 331.0720 | 25.5080 | 331.0734 | 25.5074 |
| bior2.6 | 331.1583 | 25.5434 | 331.0554 | 25.4884 | 331.0336 | 25.4966 | 331.0390 | 25.4976 |
| bior2.8 | 331.1484 | 25.5378 | 331.0401 | 25.4278 | 331.0265 | 25.4401 | 331.0145 | 25.4337 |
| bior3.1 | 331.0584 | 25.5261 | 330.9992 | 25.4805 | 330.9877 | 25.4762 | 330.9891 | 25.4707 |
| bior3.3 | 331.0690 | 25.4742 | 331.0046 | 25.4408 | 330.9859 | 25.4391 | 330.9804 | 25.4387 |
| bior3.5 | 331.0312 | 25.4836 | 330.9622 | 25.4177 | 330.9532 | 25.4130 | 330.9528 | 25.4126 |
| bior3.7 | 331.0426 | 25.4570 | 330.9899 | 25.4442 | 330.9852 | 25.4420 | 330.9867 | 25.4420 |
| bior3.9 | 331.0574 | 25.4216 | 330.9572 | 25.3699 | 330.9493 | 25.3685 | 330.9520 | 25.3694 |
| bior4.4 | 331.1385 | 25.5062 | 331.0586 | 25.4052 | 330.9922 | 25.3828 | 330.9788 | 25.3834 |
| bior5.5 | 331.3303 | 25.5559 | 331.3735 | 25.3783 | 331.6096 | 25.4283 | 331.6332 | 25.4352 |
| bior6.8 | 331.1518 | 25.5199 | 331.1104 | 25.3616 | 331.0835 | 25.3390 | 331.0801 | 25.3451 |
| rbio1.1 | 330.9192 | 25.3069 | 330.7289 | 25.2312 | 330.6863 | 25.1986 | 330.6730 | 25.1895 |
| rbio1.3 | 331.1101 | 25.4896 | 330.8320 | 25.4246 | 330.8127 | 25.4133 | 330.8169 | 25.4130 |
| rbio1.5 | 331.0685 | 25.4747 | 330.9781 | 25.3171 | 331.0388 | 25.3376 | 331.0197 | 25.3317 |
| rbio2.2 | 330.5512 | 25.2897 | 330.0230 | 24.9823 | 330.0827 | 24.8183 | 330.0626 | 24.7798 |
| rbio2.4 | 331.2928 | 25.5172 | 331.2078 | 25.3145 | 331.3317 | 25.2851 | 331.3270 | 25.2324 |
| rbio2.6 | 331.3800 | 25.5475 | 331.6699 | 25.4421 | 331.5562 | 25.2265 | 331.5617 | 25.2155 |
| rbio2.8 | 331.4453 | 25.5766 | 331.7716 | 25.4043 | 331.9640 | 25.3466 | 331.9364 | 25.2801 |
| rbio3.1 | 329.9312 | 25.3845 | 327.2936 | 24.1906 | 328.8109 | 22.8526 | 327.9401 | 22.9175 |
| rbio3.3 | 331.6650 | 25.6827 | 332.3452 | 25.1546 | 332.7569 | 24.1134 | 333.4308 | 24.1909 |
| rbio3.5 | 331.5466 | 25.6643 | 332.6614 | 25.4091 | 333.0631 | 24.9295 | 333.1868 | 24.8064 |
| rbio3.7 | 331.6354 | 25.6281 | 332.9714 | 25.6260 | 333.5057 | 25.0652 | 333.9415 | 25.1541 |
| rbio3.9 | 331.7824 | 25.6530 | 333.0065 | 25.4828 | 333.5559 | 24.7981 | 333.6234 | 24.5606 |
| rbio4.4 | 331.1374 | 25.5108 | 331.0128 | 25.3799 | 331.0251 | 25.3649 | 331.0322 | 25.3637 |
| rbio5.5 | 331.1905 | 25.4622 | 331.0803 | 25.3474 | 331.0672 | 25.3446 | 331.0819 | 25.3530 |
| rbio6.8 | 331.1708 | 25.4930 | 331.1750 | 25.3916 | 331.1825 | 25.3725 | 331.1784 | 25.3639 |
| dmey | 331.5105 | 25.5410 | 331.5353 | 25.3883 | 331.5339 | 25.3256 | 331.5501 | 25.3316 |

Table A.5: Results of VisuShrink with hard thresholding for DSM generation on City Site 1 excluding outliers

| **City Site 1**, μ = 348.4279, σ = 31.0761 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 348.4279 | 31.0745 | 348.4279 | 31.0741 | 348.4279 | 31.0741 | 348.4279 | 31.0741 |
| db2 | 348.4279 | 31.0736 | 348.4279 | 31.0729 | 348.4280 | 31.0728 | 348.4280 | 31.0728 |
| db4 | 348.4279 | 31.0732 | 348.4279 | 31.0724 | 348.4279 | 31.0723 | 348.4279 | 31.0723 |
| db6 | 348.4279 | 31.0726 | 348.4279 | 31.0715 | 348.4279 | 31.0714 | 348.4279 | 31.0714 |
| db8 | 348.4279 | 31.0723 | 348.4279 | 31.0710 | 348.4279 | 31.0709 | 348.4279 | 31.0709 |
| db10 | 348.4279 | 31.0718 | 348.4279 | 31.0703 | 348.4279 | 31.0701 | 348.4279 | 31.0701 |
| db12 | 348.4279 | 31.0713 | 348.4280 | 31.0696 | 348.4279 | 31.0694 | 348.4279 | 31.0694 |
| db20 | 348.4278 | 31.0701 | 348.4278 | 31.0678 | 348.4278 | 31.0675 | 348.4278 | 31.0675 |
| sym2 | 348.4279 | 31.0736 | 348.4279 | 31.0729 | 348.4280 | 31.0728 | 348.4280 | 31.0728 |
| sym4 | 348.4279 | 31.0736 | 348.4278 | 31.0729 | 348.4279 | 31.0728 | 348.4279 | 31.0728 |
| sym6 | 348.4279 | 31.0735 | 348.4278 | 31.0727 | 348.4278 | 31.0726 | 348.4278 | 31.0726 |
| sym8 | 348.4279 | 31.0733 | 348.4279 | 31.0725 | 348.4279 | 31.0724 | 348.4279 | 31.0724 |
| sym10 | 348.4279 | 31.0732 | 348.4279 | 31.0723 | 348.4279 | 31.0722 | 348.4279 | 31.0722 |
| sym12 | 348.4279 | 31.0731 | 348.4279 | 31.0722 | 348.4279 | 31.0721 | 348.4279 | 31.0720 |
| sym20 | 348.4280 | 31.0728 | 348.4279 | 31.0718 | 348.4279 | 31.0716 | 348.4278 | 31.0716 |
| coif1 | 348.4280 | 31.0736 | 348.4280 | 31.0730 | 348.4279 | 31.0729 | 348.4280 | 31.0729 |
| coif2 | 348.4279 | 31.0737 | 348.4278 | 31.0730 | 348.4278 | 31.0730 | 348.4278 | 31.0730 |
| coif3 | 348.4279 | 31.0735 | 348.4279 | 31.0728 | 348.4279 | 31.0727 | 348.4279 | 31.0727 |
| coif4 | 348.4278 | 31.0734 | 348.4278 | 31.0726 | 348.4278 | 31.0725 | 348.4278 | 31.0725 |
| coif5 | 348.4278 | 31.0732 | 348.4279 | 31.0724 | 348.4278 | 31.0723 | 348.4278 | 31.0723 |
| bior1.1 | 348.4279 | 31.0745 | 348.4279 | 31.0741 | 348.4279 | 31.0741 | 348.4279 | 31.0741 |
| bior1.3 | 348.4279 | 31.0763 | 348.4279 | 31.0763 | 348.4279 | 31.0763 | 348.4279 | 31.0763 |
| bior1.5 | 348.4279 | 31.0766 | 348.4279 | 31.0767 | 348.4280 | 31.0767 | 348.4280 | 31.0767 |
| bior2.2 | 348.4279 | 31.0743 | 348.4279 | 31.0742 | 348.4279 | 31.0742 | 348.4279 | 31.0742 |
| bior2.4 | 348.4279 | 31.0749 | 348.4279 | 31.0748 | 348.4279 | 31.0747 | 348.4279 | 31.0747 |
| bior2.6 | 348.4279 | 31.0751 | 348.4279 | 31.0750 | 348.4279 | 31.0750 | 348.4279 | 31.0750 |
| bior2.8 | 348.4279 | 31.0752 | 348.4279 | 31.0751 | 348.4279 | 31.0751 | 348.4279 | 31.0751 |
| bior3.1 | 348.4279 | 31.0759 | 348.4279 | 31.0760 | 348.4279 | 31.0760 | 348.4279 | 31.0760 |
| bior3.3 | 348.4279 | 31.0752 | 348.4279 | 31.0752 | 348.4279 | 31.0752 | 348.4279 | 31.0752 |
| bior3.5 | 348.4279 | 31.0751 | 348.4279 | 31.0752 | 348.4279 | 31.0752 | 348.4279 | 31.0752 |
| bior3.7 | 348.4279 | 31.0752 | 348.4279 | 31.0752 | 348.4279 | 31.0752 | 348.4279 | 31.0752 |
| bior3.9 | 348.4279 | 31.0752 | 348.4279 | 31.0752 | 348.4279 | 31.0752 | 348.4279 | 31.0752 |
| bior4.4 | 348.4279 | 31.0736 | 348.4279 | 31.0729 | 348.4279 | 31.0728 | 348.4279 | 31.0728 |
| bior5.5 | 348.4280 | 31.0725 | 348.4279 | 31.0701 | 348.4279 | 31.0695 | 348.4279 | 31.0695 |
| bior6.8 | 348.4279 | 31.0736 | 348.4279 | 31.0729 | 348.4279 | 31.0729 | 348.4279 | 31.0729 |
| rbio1.1 | 348.4279 | 31.0745 | 348.4279 | 31.0741 | 348.4279 | 31.0741 | 348.4279 | 31.0741 |
| rbio1.3 | 348.4279 | 31.0739 | 348.4279 | 31.0733 | 348.4279 | 31.0732 | 348.4279 | 31.0732 |
| rbio1.5 | 348.4279 | 31.0740 | 348.4279 | 31.0734 | 348.4279 | 31.0733 | 348.4279 | 31.0733 |
| rbio2.2 | 348.4280 | 31.0746 | 348.4281 | 31.0766 | 348.4281 | 31.0772 | 348.4282 | 31.0773 |
| rbio2.4 | 348.4279 | 31.0729 | 348.4279 | 31.0730 | 348.4280 | 31.0734 | 348.4280 | 31.0734 |
| rbio2.6 | 348.4279 | 31.0726 | 348.4279 | 31.0722 | 348.4277 | 31.0724 | 348.4278 | 31.0724 |
| rbio2.8 | 348.4279 | 31.0725 | 348.4278 | 31.0719 | 348.4278 | 31.0721 | 348.4278 | 31.0721 |
| rbio3.1 | 348.4279 | 31.1248 | 348.4280 | 31.3104 | 348.4277 | 31.5110 | 348.4278 | 31.6329 |
| rbio3.3 | 348.4279 | 31.0780 | 348.4279 | 31.1083 | 348.4280 | 31.1254 | 348.4280 | 31.1286 |
| rbio3.5 | 348.4279 | 31.0737 | 348.4280 | 31.0882 | 348.4282 | 31.0977 | 348.4281 | 31.0996 |
| rbio3.7 | 348.4279 | 31.0725 | 348.4278 | 31.0820 | 348.4278 | 31.0903 | 348.4280 | 31.0916 |
| rbio3.9 | 348.4279 | 31.0719 | 348.4279 | 31.0796 | 348.4281 | 31.0872 | 348.4280 | 31.0885 |
| rbio4.4 | 348.4279 | 31.0742 | 348.4279 | 31.0739 | 348.4280 | 31.0739 | 348.4279 | 31.0739 |
| rbio5.5 | 348.4279 | 31.0750 | 348.4279 | 31.0748 | 348.4279 | 31.0748 | 348.4279 | 31.0748 |
| rbio6.8 | 348.4279 | 31.0733 | 348.4279 | 31.0727 | 348.4279 | 31.0726 | 348.4279 | 31.0726 |
| dmey | 348.4279 | 31.0726 | 348.4279 | 31.0715 | 348.4279 | 31.0714 | 348.4279 | 31.0715 |

Table A.6: Results of VisuShrink with hard thresholding for DEM generation on City Site 1 excluding outliers

| **City Site 1**, μ = 331.5556, σ = 25.7231 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 331.1057 | 25.3922 | 330.9123 | 25.3185 | 330.8794 | 25.3041 | 330.8733 | 25.2990 |
| db2 | 331.1994 | 25.6017 | 330.9841 | 25.3731 | 330.9296 | 25.3472 | 330.9116 | 25.3440 |
| db4 | 331.1462 | 25.4487 | 331.1355 | 25.3360 | 331.1161 | 25.3229 | 331.1395 | 25.3202 |
| db6 | 331.3036 | 25.4830 | 331.4507 | 25.3844 | 331.4933 | 25.4383 | 331.5048 | 25.4337 |
| db8 | 331.3329 | 25.5721 | 331.4706 | 25.4485 | 331.4087 | 25.3882 | 331.3953 | 25.3949 |
| db10 | 331.4993 | 25.5383 | 331.8096 | 25.4385 | 331.8448 | 25.3477 | 331.8543 | 25.3343 |
| db12 | 331.5753 | 25.5364 | 331.7041 | 25.3417 | 331.7386 | 25.3516 | 331.7363 | 25.3186 |
| db20 | 331.9425 | 25.5092 | 332.4208 | 25.3179 | 332.4991 | 25.3112 | 332.4536 | 25.2709 |
| sym2 | 331.1994 | 25.6017 | 330.9841 | 25.3731 | 330.9296 | 25.3472 | 330.9116 | 25.3440 |
| sym4 | 331.4580 | 25.6181 | 331.3527 | 25.5133 | 331.3028 | 25.4600 | 331.3125 | 25.4659 |
| sym6 | 331.4032 | 25.5755 | 331.3010 | 25.4509 | 331.3511 | 25.4509 | 331.3528 | 25.4499 |
| sym8 | 331.4360 | 25.5932 | 331.4611 | 25.5123 | 331.4427 | 25.5216 | 331.4630 | 25.5333 |
| sym10 | 331.4360 | 25.5840 | 331.4347 | 25.4396 | 331.4344 | 25.4212 | 331.4290 | 25.4156 |
| sym12 | 331.4622 | 25.6060 | 331.5028 | 25.4510 | 331.4891 | 25.4513 | 331.5025 | 25.4541 |
| sym20 | 331.5031 | 25.5766 | 331.5976 | 25.4126 | 331.6228 | 25.3848 | 331.6102 | 25.3694 |
| coif1 | 331.1982 | 25.5889 | 330.9572 | 25.4197 | 330.9559 | 25.4326 | 330.9377 | 25.4145 |
| coif2 | 331.4519 | 25.6447 | 331.3787 | 25.6047 | 331.3635 | 25.5602 | 331.3566 | 25.5563 |
| coif3 | 331.3813 | 25.6176 | 331.4006 | 25.5135 | 331.4364 | 25.5138 | 331.4497 | 25.5007 |
| coif4 | 331.3811 | 25.5929 | 331.4676 | 25.4799 | 331.4815 | 25.4550 | 331.4958 | 25.4680 |
| coif5 | 331.3852 | 25.5837 | 331.5005 | 25.4500 | 331.5152 | 25.4468 | 331.4946 | 25.4469 |
| bior1.1 | 331.1057 | 25.3922 | 330.9123 | 25.3185 | 330.8794 | 25.3041 | 330.8733 | 25.2990 |
| bior1.3 | 331.1611 | 25.4100 | 331.0049 | 25.2990 | 331.0108 | 25.2757 | 330.9887 | 25.2692 |
| bior1.5 | 331.1507 | 25.4434 | 331.0245 | 25.3207 | 331.0661 | 25.3160 | 331.0672 | 25.3164 |
| bior2.2 | 331.4383 | 25.6762 | 331.3239 | 25.6051 | 331.3313 | 25.6046 | 331.3313 | 25.6084 |
| bior2.4 | 331.3831 | 25.6619 | 331.3009 | 25.6243 | 331.3033 | 25.6274 | 331.3036 | 25.6232 |
| bior2.6 | 331.3599 | 25.6406 | 331.2607 | 25.6218 | 331.2502 | 25.6083 | 331.2483 | 25.6120 |
| bior2.8 | 331.3695 | 25.6431 | 331.2767 | 25.5745 | 331.2600 | 25.5602 | 331.2622 | 25.5602 |
| bior3.1 | 331.3330 | 25.6589 | 331.2893 | 25.6187 | 331.2950 | 25.6159 | 331.2904 | 25.6172 |
| bior3.3 | 331.3068 | 25.6087 | 331.2591 | 25.5777 | 331.2429 | 25.5695 | 331.2425 | 25.5664 |
| bior3.5 | 331.2849 | 25.6024 | 331.2060 | 25.5772 | 331.1885 | 25.5658 | 331.1871 | 25.5621 |
| bior3.7 | 331.3258 | 25.6076 | 331.2613 | 25.5742 | 331.2628 | 25.5843 | 331.2613 | 25.5834 |
| bior3.9 | 331.2926 | 25.5794 | 331.2599 | 25.5839 | 331.2548 | 25.5710 | 331.2534 | 25.5715 |
| bior4.4 | 331.4022 | 25.6082 | 331.2631 | 25.4697 | 331.2364 | 25.4565 | 331.2384 | 25.4543 |
| bior5.5 | 331.5063 | 25.6174 | 331.5760 | 25.4914 | 331.7330 | 25.5502 | 331.6529 | 25.5073 |
| bior6.8 | 331.3830 | 25.6191 | 331.3143 | 25.5259 | 331.3254 | 25.5373 | 331.3175 | 25.5389 |
| rbio1.1 | 331.1057 | 25.3922 | 330.9123 | 25.3185 | 330.8794 | 25.3041 | 330.8733 | 25.2990 |
| rbio1.3 | 331.3552 | 25.6393 | 331.1572 | 25.4897 | 331.1537 | 25.4677 | 331.1452 | 25.4634 |
| rbio1.5 | 331.3046 | 25.6133 | 331.3215 | 25.5497 | 331.2969 | 25.5439 | 331.2834 | 25.5458 |
| rbio2.2 | 330.8154 | 25.4227 | 330.3057 | 25.1660 | 330.4656 | 25.0859 | 330.4582 | 25.0506 |
| rbio2.4 | 331.4765 | 25.6030 | 331.6128 | 25.4834 | 331.6519 | 25.4204 | 331.6745 | 25.4137 |
| rbio2.6 | 331.6229 | 25.6192 | 331.9528 | 25.5181 | 332.0344 | 25.4029 | 332.0692 | 25.3769 |
| rbio2.8 | 331.6834 | 25.6213 | 332.0493 | 25.4635 | 332.2411 | 25.3494 | 332.2747 | 25.3095 |
| rbio3.1 | 330.1956 | 25.7200 | 327.7843 | 24.0520 | 328.6844 | 22.3341 | 328.7546 | 22.4519 |
| rbio3.3 | 332.0012 | 25.7665 | 332.7597 | 25.2089 | 333.2353 | 24.5432 | 333.6295 | 24.4226 |
| rbio3.5 | 331.8024 | 25.7136 | 332.8834 | 25.4035 | 333.2038 | 24.9171 | 333.6252 | 24.9005 |
| rbio3.7 | 331.9021 | 25.7105 | 333.1675 | 25.4100 | 334.1558 | 25.2868 | 334.3885 | 25.2231 |
| rbio3.9 | 332.0018 | 25.6989 | 333.2911 | 25.3701 | 333.5324 | 24.7972 | 333.6871 | 24.6369 |
| rbio4.4 | 331.3944 | 25.6207 | 331.2566 | 25.4896 | 331.2936 | 25.4777 | 331.2891 | 25.4563 |
| rbio5.5 | 331.4003 | 25.5603 | 331.2960 | 25.4850 | 331.3053 | 25.4831 | 331.3000 | 25.4730 |
| rbio6.8 | 331.4689 | 25.6207 | 331.4937 | 25.5074 | 331.4430 | 25.4604 | 331.4648 | 25.4760 |
| dmey | 331.6077 | 25.5550 | 331.7676 | 25.3830 | 331.7547 | 25.3459 | 331.7525 | 25.3263 |

Table A.7: Results of VisuShrink with soft thresholding for DSM generation on City Site 1 including outliers

| **City Site 1**, μ = 348.3725, σ = 31.1700 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 348.3725 | 31.1551 | 348.3725 | 31.1403 | 348.3724 | 31.1274 | 348.3722 | 31.1182 |
| db2 | 348.3724 | 31.1575 | 348.3726 | 31.1425 | 348.3733 | 31.1280 | 348.3736 | 31.1168 |
| db4 | 348.3726 | 31.1585 | 348.3725 | 31.1444 | 348.3725 | 31.1298 | 348.3724 | 31.1180 |
| db6 | 348.3726 | 31.1582 | 348.3727 | 31.1430 | 348.3729 | 31.1267 | 348.3730 | 31.1134 |
| db8 | 348.3724 | 31.1583 | 348.3727 | 31.1421 | 348.3728 | 31.1250 | 348.3731 | 31.1114 |
| db10 | 348.3724 | 31.1579 | 348.3722 | 31.1412 | 348.3724 | 31.1232 | 348.3725 | 31.1082 |
| db12 | 348.3724 | 31.1575 | 348.3728 | 31.1399 | 348.3726 | 31.1210 | 348.3728 | 31.1051 |
| db20 | 348.3723 | 31.1570 | 348.3722 | 31.1379 | 348.3725 | 31.1161 | 348.3732 | 31.0984 |
| sym2 | 348.3724 | 31.1575 | 348.3726 | 31.1425 | 348.3733 | 31.1280 | 348.3736 | 31.1168 |
| sym4 | 348.3724 | 31.1592 | 348.3722 | 31.1462 | 348.3725 | 31.1323 | 348.3727 | 31.1213 |
| sym6 | 348.3724 | 31.1594 | 348.3725 | 31.1459 | 348.3726 | 31.1323 | 348.3727 | 31.1208 |
| sym8 | 348.3724 | 31.1593 | 348.3722 | 31.1458 | 348.3724 | 31.1316 | 348.3726 | 31.1199 |
| sym10 | 348.3724 | 31.1593 | 348.3726 | 31.1454 | 348.3726 | 31.1309 | 348.3726 | 31.1191 |
| sym12 | 348.3726 | 31.1592 | 348.3724 | 31.1453 | 348.3724 | 31.1302 | 348.3727 | 31.1187 |
| sym20 | 348.3726 | 31.1590 | 348.3724 | 31.1445 | 348.3725 | 31.1289 | 348.3726 | 31.1166 |
| coif1 | 348.3727 | 31.1575 | 348.3726 | 31.1432 | 348.3726 | 31.1287 | 348.3732 | 31.1179 |
| coif2 | 348.3724 | 31.1594 | 348.3723 | 31.1466 | 348.3724 | 31.1336 | 348.3725 | 31.1227 |
| coif3 | 348.3724 | 31.1595 | 348.3722 | 31.1464 | 348.3724 | 31.1326 | 348.3724 | 31.1219 |
| coif4 | 348.3724 | 31.1595 | 348.3722 | 31.1461 | 348.3722 | 31.1321 | 348.3725 | 31.1211 |
| coif5 | 348.3724 | 31.1594 | 348.3724 | 31.1458 | 348.3723 | 31.1312 | 348.3726 | 31.1200 |
| bior1.1 | 348.3725 | 31.1551 | 348.3725 | 31.1403 | 348.3724 | 31.1274 | 348.3722 | 31.1182 |
| bior1.3 | 348.3725 | 31.1642 | 348.3725 | 31.1567 | 348.3725 | 31.1484 | 348.3726 | 31.1418 |
| bior1.5 | 348.3725 | 31.1658 | 348.3725 | 31.1596 | 348.3724 | 31.1526 | 348.3724 | 31.1463 |
| bior2.2 | 348.3724 | 31.1593 | 348.3723 | 31.1506 | 348.3724 | 31.1431 | 348.3727 | 31.1381 |
| bior2.4 | 348.3725 | 31.1613 | 348.3727 | 31.1538 | 348.3727 | 31.1475 | 348.3729 | 31.1427 |
| bior2.6 | 348.3725 | 31.1621 | 348.3725 | 31.1553 | 348.3726 | 31.1495 | 348.3726 | 31.1450 |
| bior2.8 | 348.3726 | 31.1626 | 348.3726 | 31.1560 | 348.3727 | 31.1506 | 348.3727 | 31.1463 |
| bior3.1 | 348.3725 | 31.1625 | 348.3725 | 31.1588 | 348.3724 | 31.1563 | 348.3723 | 31.1544 |
| bior3.3 | 348.3725 | 31.1620 | 348.3726 | 31.1579 | 348.3726 | 31.1551 | 348.3727 | 31.1529 |
| bior3.5 | 348.3725 | 31.1624 | 348.3724 | 31.1582 | 348.3724 | 31.1551 | 348.3725 | 31.1530 |
| bior3.7 | 348.3725 | 31.1626 | 348.3726 | 31.1584 | 348.3725 | 31.1552 | 348.3726 | 31.1531 |
| bior3.9 | 348.3725 | 31.1628 | 348.3724 | 31.1587 | 348.3724 | 31.1555 | 348.3725 | 31.1533 |
| bior4.4 | 348.3723 | 31.1593 | 348.3726 | 31.1461 | 348.3728 | 31.1323 | 348.3731 | 31.1208 |
| bior5.5 | 348.3727 | 31.1578 | 348.3726 | 31.1380 | 348.3728 | 31.1124 | 348.3729 | 31.0885 |
| bior6.8 | 348.3724 | 31.1598 | 348.3726 | 31.1475 | 348.3726 | 31.1353 | 348.3727 | 31.1256 |
| rbio1.1 | 348.3725 | 31.1551 | 348.3725 | 31.1403 | 348.3724 | 31.1274 | 348.3722 | 31.1182 |
| rbio1.3 | 348.3725 | 31.1577 | 348.3722 | 31.1431 | 348.3725 | 31.1283 | 348.3724 | 31.1159 |
| rbio1.5 | 348.3725 | 31.1590 | 348.3725 | 31.1447 | 348.3724 | 31.1291 | 348.3725 | 31.1159 |
| rbio2.2 | 348.3729 | 31.1577 | 348.3729 | 31.1436 | 348.3730 | 31.1219 | 348.3741 | 31.1022 |
| rbio2.4 | 348.3725 | 31.1568 | 348.3728 | 31.1386 | 348.3730 | 31.1166 | 348.3734 | 31.0963 |
| rbio2.6 | 348.3723 | 31.1572 | 348.3720 | 31.1386 | 348.3721 | 31.1158 | 348.3721 | 31.0941 |
| rbio2.8 | 348.3722 | 31.1575 | 348.3728 | 31.1382 | 348.3727 | 31.1141 | 348.3725 | 31.0915 |
| rbio3.1 | 348.3725 | 31.2258 | 348.3724 | 31.4841 | 348.3710 | 32.0676 | 348.3707 | 32.9853 |
| rbio3.3 | 348.3725 | 31.1612 | 348.3727 | 31.1679 | 348.3736 | 31.1766 | 348.3730 | 31.1657 |
| rbio3.5 | 348.3725 | 31.1576 | 348.3722 | 31.1445 | 348.3727 | 31.1264 | 348.3725 | 31.1036 |
| rbio3.7 | 348.3725 | 31.1569 | 348.3727 | 31.1385 | 348.3726 | 31.1138 | 348.3737 | 31.0903 |
| rbio3.9 | 348.3725 | 31.1567 | 348.3721 | 31.1368 | 348.3715 | 31.1101 | 348.3726 | 31.0829 |
| rbio4.4 | 348.3725 | 31.1595 | 348.3728 | 31.1469 | 348.3729 | 31.1343 | 348.3731 | 31.1239 |
| rbio5.5 | 348.3724 | 31.1617 | 348.3724 | 31.1534 | 348.3725 | 31.1466 | 348.3726 | 31.1414 |
| rbio6.8 | 348.3724 | 31.1591 | 348.3727 | 31.1450 | 348.3726 | 31.1299 | 348.3726 | 31.1172 |
| dmey | 348.3724 | 31.1590 | 348.3724 | 31.1440 | 348.3724 | 31.1277 | 348.3726 | 31.1150 |

Table A.8: Results of VisuShrink with soft thresholding for DEM generation on City Site 1 including outliers

| **City Site 1**, μ = 331.3947, σ = 25.6302 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 331.1620 | 25.3770 | 331.2460 | 25.3927 | 331.4116 | 25.3883 | 331.4478 | 25.4321 |
| db2 | 331.1018 | 25.5559 | 331.5190 | 25.5941 | 331.8801 | 25.7036 | 331.9928 | 25.6964 |
| db4 | 331.2895 | 25.5475 | 331.9569 | 25.6416 | 332.2851 | 25.7685 | 332.4853 | 25.8405 |
| db6 | 331.3700 | 25.5439 | 332.3088 | 25.7129 | 332.7735 | 25.8286 | 332.9361 | 25.8923 |
| db8 | 331.3224 | 25.4571 | 332.4774 | 25.6665 | 332.9954 | 25.8307 | 333.2184 | 25.8669 |
| db10 | 331.5414 | 25.5817 | 332.6936 | 25.6962 | 333.1989 | 25.8026 | 333.3478 | 25.7920 |
| db12 | 331.5338 | 25.5717 | 332.7144 | 25.7585 | 333.3852 | 25.8735 | 333.5660 | 25.9509 |
| db20 | 331.8167 | 25.5499 | 333.2881 | 25.5567 | 333.8669 | 25.7530 | 334.1658 | 25.8048 |
| sym2 | 331.1018 | 25.5559 | 331.5190 | 25.5941 | 331.8801 | 25.7036 | 331.9928 | 25.6964 |
| sym4 | 331.3863 | 25.5239 | 331.9940 | 25.6756 | 332.2479 | 25.7243 | 332.4724 | 25.7681 |
| sym6 | 331.4260 | 25.4990 | 332.1335 | 25.7197 | 332.4858 | 25.7904 | 332.6569 | 25.8372 |
| sym8 | 331.4018 | 25.4564 | 332.2663 | 25.7240 | 332.7012 | 25.7959 | 332.7639 | 25.8626 |
| sym10 | 331.4626 | 25.4905 | 332.3194 | 25.7116 | 332.6979 | 25.8420 | 332.7971 | 25.8180 |
| sym12 | 331.4818 | 25.5752 | 332.4694 | 25.7368 | 332.7176 | 25.7732 | 332.9277 | 25.8433 |
| sym20 | 331.5671 | 25.5499 | 332.6542 | 25.7545 | 332.9614 | 25.7496 | 333.1413 | 25.8589 |
| coif1 | 331.1841 | 25.5278 | 331.4992 | 25.5963 | 331.8850 | 25.6702 | 332.0504 | 25.7256 |
| coif2 | 331.3976 | 25.5638 | 331.8962 | 25.6346 | 332.3007 | 25.7910 | 332.4316 | 25.8363 |
| coif3 | 331.3993 | 25.5444 | 332.0696 | 25.6527 | 332.4721 | 25.8242 | 332.5371 | 25.8392 |
| coif4 | 331.3791 | 25.5072 | 332.1919 | 25.6893 | 332.6975 | 25.8186 | 332.7654 | 25.8342 |
| coif5 | 331.4189 | 25.5089 | 332.3498 | 25.7388 | 332.7244 | 25.8626 | 332.8824 | 25.9795 |
| bior1.1 | 331.1620 | 25.3770 | 331.2460 | 25.3927 | 331.4116 | 25.3883 | 331.4478 | 25.4321 |
| bior1.3 | 331.1701 | 25.3465 | 331.3118 | 25.3087 | 331.4237 | 25.3171 | 331.5247 | 25.3727 |
| bior1.5 | 331.1820 | 25.3523 | 331.3925 | 25.3627 | 331.6140 | 25.3946 | 331.6096 | 25.3851 |
| bior2.2 | 331.3864 | 25.5967 | 331.5434 | 25.5969 | 331.6403 | 25.6118 | 331.7054 | 25.6518 |
| bior2.4 | 331.2944 | 25.5228 | 331.4803 | 25.5653 | 331.5782 | 25.6240 | 331.5876 | 25.5907 |
| bior2.6 | 331.2799 | 25.5282 | 331.4334 | 25.5488 | 331.5759 | 25.5701 | 331.5543 | 25.5518 |
| bior2.8 | 331.2572 | 25.5142 | 331.4232 | 25.5379 | 331.5055 | 25.5349 | 331.5298 | 25.5434 |
| bior3.1 | 331.2531 | 25.5721 | 331.3101 | 25.5405 | 331.3357 | 25.5413 | 331.3674 | 25.5650 |
| bior3.3 | 331.2497 | 25.5299 | 331.4130 | 25.4959 | 331.4236 | 25.4948 | 331.4885 | 25.5264 |
| bior3.5 | 331.2162 | 25.5159 | 331.3620 | 25.5348 | 331.3534 | 25.5234 | 331.4121 | 25.5590 |
| bior3.7 | 331.2126 | 25.5138 | 331.3924 | 25.5276 | 331.4351 | 25.5601 | 331.4469 | 25.5546 |
| bior3.9 | 331.1874 | 25.4916 | 331.3546 | 25.5324 | 331.3175 | 25.5281 | 331.3645 | 25.5545 |
| bior4.4 | 331.4638 | 25.5632 | 331.8705 | 25.7113 | 332.1896 | 25.7833 | 332.3592 | 25.8264 |
| bior5.5 | 331.4975 | 25.5705 | 332.5129 | 25.7942 | 333.4813 | 26.1098 | 333.8139 | 26.2063 |
| bior6.8 | 331.3680 | 25.5713 | 331.9686 | 25.6858 | 332.2312 | 25.7566 | 332.3684 | 25.7922 |
| rbio1.1 | 331.1620 | 25.3770 | 331.2460 | 25.3927 | 331.4116 | 25.3883 | 331.4478 | 25.4321 |
| rbio1.3 | 331.4976 | 25.5894 | 332.0384 | 25.7040 | 332.3421 | 25.8409 | 332.4838 | 25.8288 |
| rbio1.5 | 331.3884 | 25.5744 | 332.0664 | 25.7221 | 332.5998 | 25.8945 | 332.6456 | 25.9258 |
| rbio2.2 | 330.9737 | 25.4069 | 331.5858 | 25.5249 | 333.6025 | 25.8801 | 334.2578 | 25.9202 |
| rbio2.4 | 331.5045 | 25.5773 | 332.5418 | 25.8202 | 333.5444 | 25.9934 | 333.9156 | 26.1819 |
| rbio2.6 | 331.5977 | 25.5856 | 332.7887 | 25.8196 | 333.8059 | 26.1513 | 334.1549 | 26.2379 |
| rbio2.8 | 331.6664 | 25.5979 | 332.9662 | 25.8749 | 334.0950 | 26.0409 | 334.2945 | 26.1420 |
| rbio3.1 | 330.4510 | 25.7467 | 330.9478 | 24.7275 | 329.8882 | 24.9842 | 326.4562 | 23.1710 |
| rbio3.3 | 332.0752 | 25.7365 | 334.1818 | 25.6901 | 336.4569 | 25.3704 | 337.2574 | 25.2185 |
| rbio3.5 | 331.8410 | 25.6836 | 333.5941 | 25.8464 | 335.6477 | 26.2928 | 336.4555 | 26.2072 |
| rbio3.7 | 331.7296 | 25.6141 | 333.5182 | 25.7755 | 335.6495 | 26.1364 | 336.3138 | 26.2420 |
| rbio3.9 | 331.6960 | 25.6514 | 333.8651 | 25.9569 | 335.5442 | 26.0126 | 336.4774 | 26.1351 |
| rbio4.4 | 331.3487 | 25.5864 | 331.9648 | 25.6396 | 332.4424 | 25.7655 | 332.5892 | 25.8170 |
| rbio5.5 | 331.3865 | 25.6009 | 331.7395 | 25.5982 | 331.9549 | 25.6387 | 332.0150 | 25.6531 |
| rbio6.8 | 331.4311 | 25.5434 | 332.3749 | 25.7718 | 332.8324 | 25.8227 | 332.9605 | 25.8872 |
| dmey | 331.6989 | 25.4810 | 332.9402 | 25.7231 | 333.2973 | 25.8183 | 333.5366 | 25.9365 |

Table A.9: Results of VisuShrink with soft thresholding for DSM generation on City Site 1 excluding outliers

| **City Site 1**, μ = 348.4279, σ = 31.0761 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 348.4279 | 31.0619 | 348.4279 | 31.0473 | 348.4278 | 31.0344 | 348.4277 | 31.0252 |
| db2 | 348.4278 | 31.0649 | 348.4280 | 31.0507 | 348.4286 | 31.0367 | 348.4289 | 31.0259 |
| db4 | 348.4280 | 31.0661 | 348.4279 | 31.0529 | 348.4279 | 31.0390 | 348.4279 | 31.0277 |
| db6 | 348.4280 | 31.0660 | 348.4281 | 31.0519 | 348.4283 | 31.0366 | 348.4284 | 31.0242 |
| db8 | 348.4278 | 31.0661 | 348.4281 | 31.0513 | 348.4282 | 31.0352 | 348.4285 | 31.0226 |
| db10 | 348.4278 | 31.0658 | 348.4277 | 31.0504 | 348.4278 | 31.0334 | 348.4280 | 31.0193 |
| db12 | 348.4279 | 31.0655 | 348.4282 | 31.0494 | 348.4280 | 31.0317 | 348.4282 | 31.0169 |
| db20 | 348.4278 | 31.0652 | 348.4277 | 31.0477 | 348.4279 | 31.0275 | 348.4286 | 31.0112 |
| sym2 | 348.4278 | 31.0649 | 348.4280 | 31.0507 | 348.4286 | 31.0367 | 348.4289 | 31.0259 |
| sym4 | 348.4278 | 31.0667 | 348.4277 | 31.0545 | 348.4279 | 31.0414 | 348.4281 | 31.0310 |
| sym6 | 348.4278 | 31.0669 | 348.4279 | 31.0544 | 348.4280 | 31.0415 | 348.4281 | 31.0307 |
| sym8 | 348.4278 | 31.0670 | 348.4277 | 31.0545 | 348.4279 | 31.0411 | 348.4280 | 31.0301 |
| sym10 | 348.4278 | 31.0670 | 348.4280 | 31.0542 | 348.4280 | 31.0406 | 348.4281 | 31.0296 |
| sym12 | 348.4280 | 31.0669 | 348.4279 | 31.0540 | 348.4278 | 31.0398 | 348.4281 | 31.0290 |
| sym20 | 348.4280 | 31.0668 | 348.4279 | 31.0535 | 348.4279 | 31.0388 | 348.4280 | 31.0274 |
| coif1 | 348.4281 | 31.0649 | 348.4280 | 31.0514 | 348.4281 | 31.0375 | 348.4286 | 31.0270 |
| coif2 | 348.4278 | 31.0669 | 348.4278 | 31.0549 | 348.4279 | 31.0426 | 348.4279 | 31.0323 |
| coif3 | 348.4278 | 31.0670 | 348.4277 | 31.0548 | 348.4278 | 31.0418 | 348.4278 | 31.0317 |
| coif4 | 348.4278 | 31.0671 | 348.4277 | 31.0546 | 348.4277 | 31.0415 | 348.4279 | 31.0312 |
| coif5 | 348.4278 | 31.0670 | 348.4278 | 31.0545 | 348.4278 | 31.0408 | 348.4280 | 31.0302 |
| bior1.1 | 348.4279 | 31.0619 | 348.4279 | 31.0473 | 348.4278 | 31.0344 | 348.4277 | 31.0252 |
| bior1.3 | 348.4279 | 31.0711 | 348.4280 | 31.0638 | 348.4279 | 31.0556 | 348.4280 | 31.0490 |
| bior1.5 | 348.4279 | 31.0727 | 348.4279 | 31.0667 | 348.4279 | 31.0598 | 348.4279 | 31.0535 |
| bior2.2 | 348.4279 | 31.0663 | 348.4278 | 31.0578 | 348.4279 | 31.0505 | 348.4281 | 31.0456 |
| bior2.4 | 348.4279 | 31.0683 | 348.4281 | 31.0610 | 348.4281 | 31.0550 | 348.4283 | 31.0503 |
| bior2.6 | 348.4280 | 31.0691 | 348.4279 | 31.0626 | 348.4280 | 31.0569 | 348.4280 | 31.0525 |
| bior2.8 | 348.4280 | 31.0696 | 348.4280 | 31.0633 | 348.4281 | 31.0579 | 348.4281 | 31.0538 |
| bior3.1 | 348.4279 | 31.0689 | 348.4279 | 31.0653 | 348.4279 | 31.0627 | 348.4278 | 31.0608 |
| bior3.3 | 348.4279 | 31.0688 | 348.4281 | 31.0648 | 348.4281 | 31.0621 | 348.4281 | 31.0601 |
| bior3.5 | 348.4279 | 31.0692 | 348.4278 | 31.0651 | 348.4279 | 31.0621 | 348.4279 | 31.0602 |
| bior3.7 | 348.4279 | 31.0695 | 348.4280 | 31.0654 | 348.4279 | 31.0624 | 348.4280 | 31.0604 |
| bior3.9 | 348.4279 | 31.0697 | 348.4278 | 31.0657 | 348.4278 | 31.0626 | 348.4279 | 31.0604 |
| bior4.4 | 348.4278 | 31.0668 | 348.4280 | 31.0544 | 348.4282 | 31.0414 | 348.4285 | 31.0304 |
| bior5.5 | 348.4281 | 31.0656 | 348.4280 | 31.0472 | 348.4282 | 31.0229 | 348.4283 | 31.0003 |
| bior6.8 | 348.4278 | 31.0673 | 348.4280 | 31.0559 | 348.4280 | 31.0444 | 348.4281 | 31.0352 |
| rbio1.1 | 348.4279 | 31.0619 | 348.4279 | 31.0473 | 348.4278 | 31.0344 | 348.4277 | 31.0252 |
| rbio1.3 | 348.4279 | 31.0650 | 348.4277 | 31.0512 | 348.4281 | 31.0371 | 348.4280 | 31.0252 |
| rbio1.5 | 348.4279 | 31.0664 | 348.4279 | 31.0531 | 348.4279 | 31.0384 | 348.4279 | 31.0260 |
| rbio2.2 | 348.4283 | 31.0655 | 348.4284 | 31.0523 | 348.4284 | 31.0314 | 348.4294 | 31.0126 |
| rbio2.4 | 348.4279 | 31.0647 | 348.4282 | 31.0478 | 348.4283 | 31.0269 | 348.4288 | 31.0077 |
| rbio2.6 | 348.4277 | 31.0651 | 348.4275 | 31.0478 | 348.4276 | 31.0264 | 348.4276 | 31.0059 |
| rbio2.8 | 348.4277 | 31.0654 | 348.4281 | 31.0476 | 348.4281 | 31.0250 | 348.4279 | 31.0037 |
| rbio3.1 | 348.4279 | 31.1327 | 348.4278 | 31.3877 | 348.4265 | 31.9654 | 348.4260 | 32.8670 |
| rbio3.3 | 348.4279 | 31.0689 | 348.4280 | 31.0756 | 348.4290 | 31.0841 | 348.4283 | 31.0732 |
| rbio3.5 | 348.4279 | 31.0656 | 348.4278 | 31.0534 | 348.4282 | 31.0359 | 348.4278 | 31.0139 |
| rbio3.7 | 348.4279 | 31.0650 | 348.4280 | 31.0479 | 348.4280 | 31.0246 | 348.4289 | 31.0020 |
| rbio3.9 | 348.4279 | 31.0648 | 348.4276 | 31.0464 | 348.4271 | 31.0209 | 348.4280 | 30.9951 |
| rbio4.4 | 348.4279 | 31.0671 | 348.4281 | 31.0554 | 348.4283 | 31.0435 | 348.4285 | 31.0336 |
| rbio5.5 | 348.4279 | 31.0689 | 348.4278 | 31.0611 | 348.4280 | 31.0546 | 348.4280 | 31.0496 |
| rbio6.8 | 348.4278 | 31.0668 | 348.4281 | 31.0538 | 348.4281 | 31.0395 | 348.4280 | 31.0274 |
| dmey | 348.4278 | 31.0668 | 348.4279 | 31.0532 | 348.4279 | 31.0381 | 348.4280 | 31.0265 |

Table A.10: Results of VisuShrink with soft thresholding for DEM generation on City Site 1 excluding outliers

| **City Site 1**, μ = 331.5556, σ = 25.7231 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 331.3289 | 25.4801 | 331.4728 | 25.5182 | 331.6406 | 25.5498 | 331.7219 | 25.5882 |
| db2 | 331.3612 | 25.6632 | 331.8500 | 25.6928 | 332.1597 | 25.7923 | 332.3612 | 25.8147 |
| db4 | 331.5888 | 25.6357 | 332.2741 | 25.7151 | 332.6272 | 25.8804 | 332.8051 | 25.9554 |
| db6 | 331.6911 | 25.6448 | 332.5100 | 25.6990 | 333.0460 | 25.8828 | 333.1173 | 25.9105 |
| db8 | 331.6270 | 25.6119 | 332.6003 | 25.7596 | 333.1420 | 25.8856 | 333.3245 | 25.9152 |
| db10 | 331.7261 | 25.6405 | 332.9982 | 25.7931 | 333.5497 | 25.8789 | 333.7052 | 25.9751 |
| db12 | 331.7968 | 25.6194 | 332.9806 | 25.7449 | 333.5389 | 25.9024 | 333.7014 | 25.9123 |
| db20 | 332.0583 | 25.5798 | 333.5385 | 25.7183 | 334.0381 | 25.8690 | 334.2613 | 25.9110 |
| sym2 | 331.3612 | 25.6632 | 331.8500 | 25.6928 | 332.1597 | 25.7923 | 332.3612 | 25.8147 |
| sym4 | 331.5690 | 25.6321 | 332.2494 | 25.7754 | 332.5414 | 25.8220 | 332.6938 | 25.8491 |
| sym6 | 331.6121 | 25.6168 | 332.4200 | 25.8236 | 332.7430 | 25.8820 | 332.9186 | 25.9487 |
| sym8 | 331.6779 | 25.6094 | 332.5994 | 25.8022 | 332.9638 | 25.8989 | 333.0486 | 25.9460 |
| sym10 | 331.7045 | 25.6367 | 332.5913 | 25.7578 | 333.0082 | 25.8728 | 333.0804 | 25.8381 |
| sym12 | 331.6589 | 25.6557 | 332.7941 | 25.8545 | 332.9449 | 25.8192 | 333.1309 | 25.8842 |
| sym20 | 331.7399 | 25.6556 | 332.9674 | 25.8432 | 333.2433 | 25.8377 | 333.3207 | 25.8973 |
| coif1 | 331.4052 | 25.5900 | 331.7997 | 25.7008 | 332.1441 | 25.7999 | 332.2945 | 25.8390 |
| coif2 | 331.6574 | 25.6637 | 332.2142 | 25.7527 | 332.5849 | 25.8872 | 332.6645 | 25.8971 |
| coif3 | 331.6855 | 25.6600 | 332.4144 | 25.7757 | 332.7184 | 25.8868 | 332.7777 | 25.9246 |
| coif4 | 331.7381 | 25.6604 | 332.5354 | 25.7903 | 332.9338 | 25.9159 | 333.1040 | 25.9363 |
| coif5 | 331.7246 | 25.6329 | 332.6690 | 25.8010 | 332.9155 | 25.9323 | 333.1409 | 26.0544 |
| bior1.1 | 331.3289 | 25.4801 | 331.4728 | 25.5182 | 331.6406 | 25.5498 | 331.7219 | 25.5882 |
| bior1.3 | 331.3276 | 25.4348 | 331.5103 | 25.3866 | 331.6421 | 25.4563 | 331.7128 | 25.4903 |
| bior1.5 | 331.3037 | 25.4532 | 331.5056 | 25.4149 | 331.7542 | 25.5005 | 331.7920 | 25.5170 |
| bior2.2 | 331.5638 | 25.7037 | 331.7640 | 25.7111 | 331.8628 | 25.7660 | 331.9363 | 25.7766 |
| bior2.4 | 331.4961 | 25.6602 | 331.6722 | 25.6763 | 331.7949 | 25.7040 | 331.8038 | 25.6998 |
| bior2.6 | 331.4815 | 25.6580 | 331.6361 | 25.6436 | 331.7793 | 25.7182 | 331.7921 | 25.6983 |
| bior2.8 | 331.4666 | 25.6404 | 331.6221 | 25.6377 | 331.7634 | 25.6788 | 331.8130 | 25.6940 |
| bior3.1 | 331.4853 | 25.6751 | 331.6107 | 25.6497 | 331.6952 | 25.7081 | 331.6995 | 25.7139 |
| bior3.3 | 331.5432 | 25.6519 | 331.6609 | 25.6361 | 331.7080 | 25.6621 | 331.7147 | 25.6453 |
| bior3.5 | 331.4895 | 25.6571 | 331.6165 | 25.6746 | 331.6367 | 25.6891 | 331.6903 | 25.6840 |
| bior3.7 | 331.4888 | 25.6439 | 331.6252 | 25.6336 | 331.6580 | 25.6523 | 331.6849 | 25.6326 |
| bior3.9 | 331.4949 | 25.6352 | 331.5693 | 25.6357 | 331.5840 | 25.6378 | 331.6188 | 25.6327 |
| bior4.4 | 331.6941 | 25.6723 | 332.1749 | 25.7692 | 332.5026 | 25.9356 | 332.6424 | 25.9433 |
| bior5.5 | 331.7083 | 25.6878 | 332.8789 | 25.8297 | 333.7189 | 26.2496 | 334.0506 | 26.3744 |
| bior6.8 | 331.6936 | 25.6631 | 332.2811 | 25.7657 | 332.5870 | 25.8986 | 332.6876 | 25.8735 |
| rbio1.1 | 331.3289 | 25.4801 | 331.4728 | 25.5182 | 331.6406 | 25.5498 | 331.7219 | 25.5882 |
| rbio1.3 | 331.6724 | 25.6871 | 332.2485 | 25.8038 | 332.6396 | 25.9386 | 332.8078 | 25.9141 |
| rbio1.5 | 331.6121 | 25.7143 | 332.3865 | 25.8503 | 332.7729 | 26.0064 | 332.9017 | 26.0180 |
| rbio2.2 | 331.2530 | 25.5273 | 331.9855 | 25.6974 | 334.0624 | 26.0355 | 334.7370 | 26.1028 |
| rbio2.4 | 331.7530 | 25.6332 | 332.8848 | 25.8658 | 333.7552 | 26.0787 | 334.0895 | 26.2235 |
| rbio2.6 | 331.9140 | 25.6850 | 333.0953 | 25.8793 | 334.1297 | 26.1576 | 334.3849 | 26.2344 |
| rbio2.8 | 331.9417 | 25.6837 | 333.2100 | 25.8392 | 334.3561 | 26.1508 | 334.5328 | 26.2288 |
| rbio3.1 | 330.4222 | 25.7691 | 331.3314 | 24.9340 | 329.2715 | 25.3244 | 327.8846 | 23.5240 |
| rbio3.3 | 332.4219 | 25.7195 | 334.4707 | 25.8318 | 336.6149 | 25.6123 | 337.4513 | 25.5741 |
| rbio3.5 | 331.9931 | 25.7080 | 333.9525 | 26.0187 | 336.0786 | 26.3272 | 336.7471 | 26.3583 |
| rbio3.7 | 331.9506 | 25.6733 | 333.9858 | 25.9322 | 335.9888 | 26.2981 | 336.7832 | 26.4458 |
| rbio3.9 | 331.9444 | 25.6875 | 334.1808 | 26.0341 | 335.8788 | 26.0038 | 336.5254 | 26.0801 |
| rbio4.4 | 331.5982 | 25.6360 | 332.2954 | 25.7416 | 332.7506 | 25.9231 | 332.8550 | 25.9357 |
| rbio5.5 | 331.6321 | 25.6787 | 332.0596 | 25.6371 | 332.2240 | 25.6922 | 332.2958 | 25.7071 |
| rbio6.8 | 331.7736 | 25.6413 | 332.7148 | 25.8011 | 333.2478 | 25.9451 | 333.3316 | 25.9467 |
| dmey | 331.9355 | 25.6141 | 333.1977 | 25.8084 | 333.4661 | 25.8879 | 333.7343 | 26.0006 |

Table A.11: Results of NormalShrink with hard thresholding for DSM generation on City Site 2 including outliers

| **City Site 2**, μ = 303.4698, σ = 11.7044 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| db2 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| db4 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| db6 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| db8 | 303.4698 | 11.7043 | 303.4698 | 11.7043 | 303.4698 | 11.7043 | 303.4698 | 11.7043 |
| db10 | 303.4698 | 11.7043 | 303.4698 | 11.7043 | 303.4698 | 11.7043 | 303.4698 | 11.7043 |
| db12 | 303.4698 | 11.7042 | 303.4698 | 11.7042 | 303.4698 | 11.7042 | 303.4698 | 11.7042 |
| db20 | 303.4698 | 11.7038 | 303.4698 | 11.7038 | 303.4698 | 11.7038 | 303.4698 | 11.7038 |
| sym2 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| sym4 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| sym6 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| sym8 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| sym10 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| sym12 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| sym20 | 303.4698 | 11.7043 | 303.4698 | 11.7043 | 303.4698 | 11.7043 | 303.4698 | 11.7043 |
| coif1 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| coif2 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| coif3 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| coif4 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| coif5 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior1.1 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior1.3 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior1.5 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior2.2 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior2.4 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior2.6 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior2.8 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior3.1 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior3.3 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior3.5 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior3.7 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior3.9 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior4.4 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior5.5 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| bior6.8 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio1.1 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio1.3 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio1.5 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio2.2 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio2.4 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio2.6 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio2.8 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio3.1 | 303.4698 | 11.7047 | 303.4698 | 11.7047 | 303.4698 | 11.7047 | 303.4698 | 11.7047 |
| rbio3.3 | 303.4698 | 11.7045 | 303.4698 | 11.7046 | 303.4698 | 11.7046 | 303.4698 | 11.7046 |
| rbio3.5 | 303.4698 | 11.7046 | 303.4698 | 11.7046 | 303.4698 | 11.7046 | 303.4698 | 11.7046 |
| rbio3.7 | 303.4698 | 11.7046 | 303.4697 | 11.7047 | 303.4697 | 11.7047 | 303.4697 | 11.7047 |
| rbio3.9 | 303.4698 | 11.7046 | 303.4698 | 11.7047 | 303.4698 | 11.7047 | 303.4698 | 11.7047 |
| rbio4.4 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio5.5 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| rbio6.8 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 | 303.4698 | 11.7044 |
| dmey | 303.4698 | 11.7043 | 303.4698 | 11.7043 | 303.4698 | 11.7044 | 303.4697 | 11.7044 |

Table A.12: Results of NormalShrink with hard thresholding for DEM generation on City Site 2 including outliers

| **City Site 2**, μ = 292.9100, σ = 3.5970 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.9100 | 3.5966 | 292.9100 | 3.5966 | 292.9100 | 3.5966 | 292.9100 | 3.5966 |
| db2 | 292.9083 | 3.5952 | 292.9083 | 3.5952 | 292.9083 | 3.5952 | 292.9083 | 3.5952 |
| db4 | 292.9100 | 3.5958 | 292.9103 | 3.5956 | 292.9103 | 3.5956 | 292.9103 | 3.5956 |
| db6 | 292.9112 | 3.5973 | 292.9103 | 3.5965 | 292.9103 | 3.5965 | 292.9103 | 3.5965 |
| db8 | 292.9075 | 3.5949 | 292.9067 | 3.5950 | 292.9067 | 3.5950 | 292.9067 | 3.5950 |
| db10 | 292.9051 | 3.5915 | 292.9046 | 3.5906 | 292.9045 | 3.5906 | 292.9045 | 3.5906 |
| db12 | 292.9025 | 3.5942 | 292.9024 | 3.5941 | 292.9025 | 3.5941 | 292.9025 | 3.5941 |
| db20 | 292.8798 | 3.5635 | 292.8784 | 3.5628 | 292.8785 | 3.5625 | 292.8785 | 3.5625 |
| sym2 | 292.9083 | 3.5952 | 292.9083 | 3.5952 | 292.9083 | 3.5952 | 292.9083 | 3.5952 |
| sym4 | 292.9094 | 3.5957 | 292.9093 | 3.5955 | 292.9093 | 3.5955 | 292.9093 | 3.5955 |
| sym6 | 292.9094 | 3.5962 | 292.9092 | 3.5959 | 292.9092 | 3.5959 | 292.9092 | 3.5959 |
| sym8 | 292.9098 | 3.5961 | 292.9100 | 3.5959 | 292.9100 | 3.5959 | 292.9100 | 3.5959 |
| sym10 | 292.9103 | 3.5973 | 292.9105 | 3.5974 | 292.9105 | 3.5974 | 292.9105 | 3.5974 |
| sym12 | 292.9121 | 3.6049 | 292.9107 | 3.6030 | 292.9107 | 3.6030 | 292.9107 | 3.6030 |
| sym20 | 292.9072 | 3.5961 | 292.9076 | 3.5967 | 292.9077 | 3.5967 | 292.9077 | 3.5967 |
| coif1 | 292.9096 | 3.5972 | 292.9096 | 3.5972 | 292.9096 | 3.5972 | 292.9096 | 3.5972 |
| coif2 | 292.9108 | 3.5972 | 292.9107 | 3.5971 | 292.9107 | 3.5971 | 292.9107 | 3.5971 |
| coif3 | 292.9095 | 3.5955 | 292.9095 | 3.5955 | 292.9095 | 3.5955 | 292.9095 | 3.5955 |
| coif4 | 292.9080 | 3.5946 | 292.9081 | 3.5946 | 292.9081 | 3.5946 | 292.9081 | 3.5946 |
| coif5 | 292.9097 | 3.5967 | 292.9099 | 3.5968 | 292.9100 | 3.5968 | 292.9100 | 3.5968 |
| bior1.1 | 292.9100 | 3.5966 | 292.9100 | 3.5966 | 292.9100 | 3.5966 | 292.9100 | 3.5966 |
| bior1.3 | 292.9102 | 3.5971 | 292.9102 | 3.5971 | 292.9102 | 3.5971 | 292.9102 | 3.5971 |
| bior1.5 | 292.9089 | 3.5954 | 292.9089 | 3.5954 | 292.9089 | 3.5954 | 292.9089 | 3.5954 |
| bior2.2 | 292.9095 | 3.5958 | 292.9095 | 3.5958 | 292.9095 | 3.5958 | 292.9095 | 3.5958 |
| bior2.4 | 292.9091 | 3.5961 | 292.9091 | 3.5961 | 292.9091 | 3.5961 | 292.9091 | 3.5961 |
| bior2.6 | 292.9092 | 3.5961 | 292.9092 | 3.5961 | 292.9092 | 3.5961 | 292.9092 | 3.5961 |
| bior2.8 | 292.9094 | 3.5964 | 292.9094 | 3.5964 | 292.9094 | 3.5964 | 292.9094 | 3.5964 |
| bior3.1 | 292.9092 | 3.5964 | 292.9092 | 3.5964 | 292.9092 | 3.5964 | 292.9092 | 3.5964 |
| bior3.3 | 292.9073 | 3.5935 | 292.9073 | 3.5935 | 292.9073 | 3.5935 | 292.9073 | 3.5935 |
| bior3.5 | 292.9080 | 3.5944 | 292.9080 | 3.5944 | 292.9080 | 3.5944 | 292.9080 | 3.5944 |
| bior3.7 | 292.9092 | 3.5955 | 292.9092 | 3.5955 | 292.9092 | 3.5955 | 292.9092 | 3.5955 |
| bior3.9 | 292.9080 | 3.5939 | 292.9080 | 3.5939 | 292.9080 | 3.5939 | 292.9080 | 3.5939 |
| bior4.4 | 292.9079 | 3.5941 | 292.9079 | 3.5941 | 292.9079 | 3.5941 | 292.9079 | 3.5941 |
| bior5.5 | 292.9095 | 3.5965 | 292.9098 | 3.5968 | 292.9097 | 3.5971 | 292.9097 | 3.5971 |
| bior6.8 | 292.9111 | 3.5984 | 292.9113 | 3.5987 | 292.9113 | 3.5987 | 292.9113 | 3.5987 |
| rbio1.1 | 292.9100 | 3.5966 | 292.9100 | 3.5966 | 292.9100 | 3.5966 | 292.9100 | 3.5966 |
| rbio1.3 | 292.9101 | 3.5966 | 292.9101 | 3.5966 | 292.9101 | 3.5966 | 292.9101 | 3.5966 |
| rbio1.5 | 292.9076 | 3.5936 | 292.9078 | 3.5941 | 292.9078 | 3.5941 | 292.9078 | 3.5941 |
| rbio2.2 | 292.9082 | 3.5939 | 292.9085 | 3.5941 | 292.9085 | 3.5941 | 292.9085 | 3.5941 |
| rbio2.4 | 292.9088 | 3.5961 | 292.9089 | 3.5954 | 292.9089 | 3.5954 | 292.9089 | 3.5954 |
| rbio2.6 | 292.9081 | 3.5939 | 292.9088 | 3.5957 | 292.9088 | 3.5957 | 292.9088 | 3.5957 |
| rbio2.8 | 292.9148 | 3.6048 | 292.9143 | 3.6045 | 292.9140 | 3.6044 | 292.9140 | 3.6044 |
| rbio3.1 | 292.8969 | 3.5900 | 292.8980 | 3.5910 | 292.8980 | 3.5908 | 292.8980 | 3.5908 |
| rbio3.3 | 292.9049 | 3.6002 | 292.9045 | 3.6004 | 292.9045 | 3.6006 | 292.9045 | 3.6006 |
| rbio3.5 | 292.9062 | 3.6071 | 292.9053 | 3.6006 | 292.9053 | 3.6005 | 292.9053 | 3.6005 |
| rbio3.7 | 292.8922 | 3.5823 | 292.8906 | 3.5813 | 292.8911 | 3.5813 | 292.8911 | 3.5813 |
| rbio3.9 | 292.8889 | 3.5812 | 292.8860 | 3.5790 | 292.8862 | 3.5785 | 292.8861 | 3.5785 |
| rbio4.4 | 292.9102 | 3.5976 | 292.9101 | 3.5977 | 292.9101 | 3.5977 | 292.9101 | 3.5977 |
| rbio5.5 | 292.9099 | 3.5963 | 292.9098 | 3.5963 | 292.9098 | 3.5963 | 292.9098 | 3.5963 |
| rbio6.8 | 292.9089 | 3.5952 | 292.9090 | 3.5959 | 292.9090 | 3.5959 | 292.9090 | 3.5959 |
| dmey | 292.9132 | 3.6010 | 292.9137 | 3.6025 | 292.9137 | 3.6025 | 292.9137 | 3.6026 |

Table A.13: Results of NormalShrink with hard thresholding for DSM generation on City Site 2 excluding outliers

| **City Site 2**, $\mu$ = 303.4662, $\sigma$ = 11.5645 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ |
| haar | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| db2 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| db4 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| db6 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| db8 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| db10 | 303.4662 | 11.5644 | 303.4662 | 11.5644 | 303.4662 | 11.5644 | 303.4662 | 11.5644 |
| db12 | 303.4662 | 11.5644 | 303.4662 | 11.5644 | 303.4662 | 11.5644 | 303.4662 | 11.5644 |
| db20 | 303.4662 | 11.5640 | 303.4662 | 11.5640 | 303.4662 | 11.5640 | 303.4662 | 11.5640 |
| sym2 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| sym4 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| sym6 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| sym8 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| sym10 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| sym12 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| sym20 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| coif1 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| coif2 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| coif3 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| coif4 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| coif5 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior1.1 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior1.3 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior1.5 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior2.2 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior2.4 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior2.6 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior2.8 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior3.1 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior3.3 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior3.5 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior3.7 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior3.9 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior4.4 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior5.5 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| bior6.8 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| rbio1.1 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| rbio1.3 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| rbio1.5 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| rbio2.2 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| rbio2.4 | 303.4662 | 11.5646 | 303.4662 | 11.5646 | 303.4662 | 11.5646 | 303.4662 | 11.5646 |
| rbio2.6 | 303.4662 | 11.5646 | 303.4662 | 11.5646 | 303.4662 | 11.5646 | 303.4662 | 11.5646 |
| rbio2.8 | 303.4662 | 11.5646 | 303.4662 | 11.5646 | 303.4662 | 11.5646 | 303.4662 | 11.5646 |
| rbio3.1 | 303.4662 | 11.5648 | 303.4662 | 11.5649 | 303.4662 | 11.5649 | 303.4662 | 11.5649 |
| rbio3.3 | 303.4662 | 11.5647 | 303.4662 | 11.5647 | 303.4662 | 11.5647 | 303.4662 | 11.5647 |
| rbio3.5 | 303.4662 | 11.5647 | 303.4662 | 11.5648 | 303.4662 | 11.5648 | 303.4662 | 11.5648 |
| rbio3.7 | 303.4662 | 11.5647 | 303.4662 | 11.5648 | 303.4662 | 11.5648 | 303.4662 | 11.5648 |
| rbio3.9 | 303.4662 | 11.5647 | 303.4662 | 11.5648 | 303.4662 | 11.5648 | 303.4662 | 11.5648 |
| rbio4.4 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| rbio5.5 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| rbio6.8 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |
| dmey | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 | 303.4662 | 11.5645 |

Table A.14: Results of NormalShrink with hard thresholding for DEM generation on City Site 2 excluding outliers

| **City Site 2**, μ = 292.9549, σ = 3.6377 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.9549 | 3.6377 | 292.9549 | 3.6377 | 292.9549 | 3.6377 | 292.9549 | 3.6377 |
| db2 | 292.9544 | 3.6389 | 292.9543 | 3.6389 | 292.9543 | 3.6389 | 292.9543 | 3.6389 |
| db4 | 292.9550 | 3.6409 | 292.9551 | 3.6409 | 292.9551 | 3.6409 | 292.9551 | 3.6409 |
| db6 | 292.9556 | 3.6396 | 292.9553 | 3.6391 | 292.9553 | 3.6391 | 292.9553 | 3.6391 |
| db8 | 292.9595 | 3.6501 | 292.9601 | 3.6504 | 292.9600 | 3.6504 | 292.9600 | 3.6504 |
| db10 | 292.9562 | 3.6429 | 292.9565 | 3.6432 | 292.9565 | 3.6432 | 292.9565 | 3.6432 |
| db12 | 292.9530 | 3.6350 | 292.9538 | 3.6365 | 292.9538 | 3.6365 | 292.9538 | 3.6365 |
| db20 | 292.9335 | 3.6172 | 292.9319 | 3.6177 | 292.9319 | 3.6184 | 292.9319 | 3.6184 |
| sym2 | 292.9544 | 3.6389 | 292.9543 | 3.6389 | 292.9543 | 3.6389 | 292.9543 | 3.6389 |
| sym4 | 292.9569 | 3.6404 | 292.9565 | 3.6406 | 292.9565 | 3.6406 | 292.9565 | 3.6406 |
| sym6 | 292.9556 | 3.6396 | 292.9554 | 3.6395 | 292.9555 | 3.6396 | 292.9555 | 3.6396 |
| sym8 | 292.9557 | 3.6401 | 292.9558 | 3.6403 | 292.9558 | 3.6402 | 292.9558 | 3.6402 |
| sym10 | 292.9588 | 3.6438 | 292.9590 | 3.6439 | 292.9590 | 3.6439 | 292.9590 | 3.6439 |
| sym12 | 292.9588 | 3.6440 | 292.9589 | 3.6435 | 292.9589 | 3.6435 | 292.9589 | 3.6435 |
| sym20 | 292.9550 | 3.6419 | 292.9559 | 3.6425 | 292.9559 | 3.6425 | 292.9559 | 3.6425 |
| coif1 | 292.9534 | 3.6375 | 292.9533 | 3.6376 | 292.9533 | 3.6376 | 292.9533 | 3.6376 |
| coif2 | 292.9557 | 3.6402 | 292.9557 | 3.6401 | 292.9557 | 3.6401 | 292.9557 | 3.6401 |
| coif3 | 292.9566 | 3.6399 | 292.9568 | 3.6397 | 292.9568 | 3.6397 | 292.9568 | 3.6397 |
| coif4 | 292.9574 | 3.6440 | 292.9575 | 3.6443 | 292.9575 | 3.6443 | 292.9575 | 3.6443 |
| coif5 | 292.9570 | 3.6439 | 292.9571 | 3.6443 | 292.9571 | 3.6443 | 292.9571 | 3.6443 |
| bior1.1 | 292.9549 | 3.6377 | 292.9549 | 3.6377 | 292.9549 | 3.6377 | 292.9549 | 3.6377 |
| bior1.3 | 292.9548 | 3.6378 | 292.9548 | 3.6378 | 292.9548 | 3.6378 | 292.9548 | 3.6378 |
| bior1.5 | 292.9549 | 3.6379 | 292.9549 | 3.6379 | 292.9549 | 3.6379 | 292.9549 | 3.6379 |
| bior2.2 | 292.9528 | 3.6377 | 292.9529 | 3.6376 | 292.9529 | 3.6376 | 292.9529 | 3.6376 |
| bior2.4 | 292.9541 | 3.6371 | 292.9541 | 3.6371 | 292.9541 | 3.6371 | 292.9541 | 3.6371 |
| bior2.6 | 292.9541 | 3.6371 | 292.9541 | 3.6371 | 292.9541 | 3.6371 | 292.9541 | 3.6371 |
| bior2.8 | 292.9537 | 3.6379 | 292.9537 | 3.6379 | 292.9537 | 3.6379 | 292.9537 | 3.6379 |
| bior3.1 | 292.9552 | 3.6395 | 292.9552 | 3.6395 | 292.9552 | 3.6395 | 292.9552 | 3.6395 |
| bior3.3 | 292.9555 | 3.6399 | 292.9555 | 3.6399 | 292.9555 | 3.6399 | 292.9555 | 3.6399 |
| bior3.5 | 292.9549 | 3.6387 | 292.9549 | 3.6387 | 292.9549 | 3.6387 | 292.9549 | 3.6387 |
| bior3.7 | 292.9551 | 3.6390 | 292.9551 | 3.6390 | 292.9551 | 3.6390 | 292.9551 | 3.6390 |
| bior3.9 | 292.9552 | 3.6387 | 292.9552 | 3.6387 | 292.9552 | 3.6387 | 292.9552 | 3.6387 |
| bior4.4 | 292.9546 | 3.6379 | 292.9546 | 3.6381 | 292.9546 | 3.6381 | 292.9546 | 3.6381 |
| bior5.5 | 292.9558 | 3.6418 | 292.9553 | 3.6410 | 292.9553 | 3.6410 | 292.9553 | 3.6410 |
| bior6.8 | 292.9573 | 3.6403 | 292.9562 | 3.6401 | 292.9562 | 3.6401 | 292.9562 | 3.6401 |
| rbio1.1 | 292.9549 | 3.6377 | 292.9549 | 3.6377 | 292.9549 | 3.6377 | 292.9549 | 3.6377 |
| rbio1.3 | 292.9557 | 3.6395 | 292.9559 | 3.6398 | 292.9559 | 3.6398 | 292.9559 | 3.6398 |
| rbio1.5 | 292.9548 | 3.6388 | 292.9549 | 3.6391 | 292.9548 | 3.6391 | 292.9548 | 3.6391 |
| rbio2.2 | 292.9542 | 3.6365 | 292.9542 | 3.6363 | 292.9542 | 3.6363 | 292.9542 | 3.6363 |
| rbio2.4 | 292.9571 | 3.6421 | 292.9575 | 3.6422 | 292.9575 | 3.6422 | 292.9575 | 3.6422 |
| rbio2.6 | 292.9567 | 3.6418 | 292.9569 | 3.6422 | 292.9569 | 3.6421 | 292.9569 | 3.6421 |
| rbio2.8 | 292.9588 | 3.6474 | 292.9589 | 3.6458 | 292.9589 | 3.6457 | 292.9589 | 3.6457 |
| rbio3.1 | 292.9456 | 3.6352 | 292.9458 | 3.6363 | 292.9457 | 3.6363 | 292.9457 | 3.6363 |
| rbio3.3 | 292.9515 | 3.6419 | 292.9502 | 3.6398 | 292.9502 | 3.6398 | 292.9502 | 3.6398 |
| rbio3.5 | 292.9509 | 3.6414 | 292.9478 | 3.6391 | 292.9476 | 3.6394 | 292.9476 | 3.6394 |
| rbio3.7 | 292.9445 | 3.6374 | 292.9421 | 3.6368 | 292.9423 | 3.6373 | 292.9423 | 3.6373 |
| rbio3.9 | 292.9430 | 3.6321 | 292.9366 | 3.6274 | 292.9366 | 3.6276 | 292.9366 | 3.6276 |
| rbio4.4 | 292.9560 | 3.6419 | 292.9558 | 3.6418 | 292.9558 | 3.6418 | 292.9558 | 3.6418 |
| rbio5.5 | 292.9565 | 3.6393 | 292.9565 | 3.6393 | 292.9565 | 3.6393 | 292.9565 | 3.6393 |
| rbio6.8 | 292.9564 | 3.6409 | 292.9562 | 3.6409 | 292.9562 | 3.6409 | 292.9562 | 3.6409 |
| dmey | 292.9569 | 3.6411 | 292.9566 | 3.6410 | 292.9566 | 3.6410 | 292.9566 | 3.6410 |

Table A.15: Results of NormalShrink with soft thresholding for DSM generation on City Site 2 including outliers

| **City Site 2**, μ = 303.4698, σ = 11.7044 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 303.4698 | 11.7041 | 303.4698 | 11.7040 | 303.4698 | 11.7039 | 303.4698 | 11.7039 |
| db2 | 303.4697 | 11.7029 | 303.4697 | 11.7024 | 303.4697 | 11.7023 | 303.4697 | 11.7023 |
| db4 | 303.4698 | 11.7017 | 303.4698 | 11.7009 | 303.4698 | 11.7007 | 303.4698 | 11.7007 |
| db6 | 303.4698 | 11.7006 | 303.4698 | 11.6994 | 303.4698 | 11.6991 | 303.4698 | 11.6990 |
| db8 | 303.4698 | 11.6991 | 303.4697 | 11.6975 | 303.4697 | 11.6971 | 303.4697 | 11.6970 |
| db10 | 303.4697 | 11.6978 | 303.4697 | 11.6958 | 303.4697 | 11.6952 | 303.4697 | 11.6951 |
| db12 | 303.4698 | 11.6965 | 303.4698 | 11.6940 | 303.4698 | 11.6933 | 303.4698 | 11.6932 |
| db20 | 303.4698 | 11.6914 | 303.4698 | 11.6870 | 303.4698 | 11.6859 | 303.4698 | 11.6856 |
| sym2 | 303.4697 | 11.7029 | 303.4697 | 11.7024 | 303.4697 | 11.7023 | 303.4697 | 11.7023 |
| sym4 | 303.4698 | 11.7024 | 303.4698 | 11.7018 | 303.4698 | 11.7017 | 303.4698 | 11.7016 |
| sym6 | 303.4698 | 11.7019 | 303.4698 | 11.7012 | 303.4698 | 11.7010 | 303.4698 | 11.7010 |
| sym8 | 303.4698 | 11.7014 | 303.4698 | 11.7006 | 303.4698 | 11.7004 | 303.4698 | 11.7003 |
| sym10 | 303.4698 | 11.7011 | 303.4698 | 11.7001 | 303.4698 | 11.6998 | 303.4698 | 11.6998 |
| sym12 | 303.4697 | 11.7006 | 303.4698 | 11.6996 | 303.4698 | 11.6993 | 303.4698 | 11.6992 |
| sym20 | 303.4697 | 11.6995 | 303.4697 | 11.6981 | 303.4697 | 11.6977 | 303.4697 | 11.6976 |
| coif1 | 303.4698 | 11.7028 | 303.4698 | 11.7024 | 303.4698 | 11.7022 | 303.4698 | 11.7022 |
| coif2 | 303.4698 | 11.7024 | 303.4698 | 11.7018 | 303.4698 | 11.7016 | 303.4698 | 11.7016 |
| coif3 | 303.4698 | 11.7018 | 303.4698 | 11.7011 | 303.4698 | 11.7009 | 303.4698 | 11.7008 |
| coif4 | 303.4698 | 11.7013 | 303.4698 | 11.7004 | 303.4698 | 11.7002 | 303.4698 | 11.7001 |
| coif5 | 303.4698 | 11.7009 | 303.4698 | 11.6998 | 303.4698 | 11.6996 | 303.4698 | 11.6995 |
| bior1.1 | 303.4698 | 11.7041 | 303.4698 | 11.7040 | 303.4698 | 11.7039 | 303.4698 | 11.7039 |
| bior1.3 | 303.4698 | 11.7042 | 303.4698 | 11.7042 | 303.4698 | 11.7042 | 303.4698 | 11.7042 |
| bior1.5 | 303.4698 | 11.7042 | 303.4698 | 11.7042 | 303.4698 | 11.7042 | 303.4698 | 11.7042 |
| bior2.2 | 303.4698 | 11.7038 | 303.4698 | 11.7037 | 303.4698 | 11.7037 | 303.4698 | 11.7037 |
| bior2.4 | 303.4698 | 11.7039 | 303.4698 | 11.7038 | 303.4698 | 11.7038 | 303.4698 | 11.7038 |
| bior2.6 | 303.4698 | 11.7039 | 303.4698 | 11.7038 | 303.4698 | 11.7038 | 303.4698 | 11.7038 |
| bior2.8 | 303.4698 | 11.7039 | 303.4698 | 11.7038 | 303.4698 | 11.7038 | 303.4698 | 11.7038 |
| bior3.1 | 303.4698 | 11.7038 | 303.4698 | 11.7038 | 303.4698 | 11.7038 | 303.4698 | 11.7038 |
| bior3.3 | 303.4698 | 11.7038 | 303.4698 | 11.7037 | 303.4698 | 11.7037 | 303.4698 | 11.7037 |
| bior3.5 | 303.4698 | 11.7038 | 303.4698 | 11.7037 | 303.4698 | 11.7037 | 303.4698 | 11.7037 |
| bior3.7 | 303.4698 | 11.7037 | 303.4698 | 11.7037 | 303.4698 | 11.7037 | 303.4698 | 11.7037 |
| bior3.9 | 303.4698 | 11.7037 | 303.4698 | 11.7037 | 303.4698 | 11.7037 | 303.4698 | 11.7037 |
| bior4.4 | 303.4698 | 11.7025 | 303.4698 | 11.7020 | 303.4698 | 11.7018 | 303.4698 | 11.7018 |
| bior5.5 | 303.4698 | 11.7004 | 303.4697 | 11.6983 | 303.4697 | 11.6975 | 303.4697 | 11.6972 |
| bior6.8 | 303.4698 | 11.7022 | 303.4698 | 11.7016 | 303.4698 | 11.7014 | 303.4698 | 11.7014 |
| rbio1.1 | 303.4698 | 11.7041 | 303.4698 | 11.7040 | 303.4698 | 11.7039 | 303.4698 | 11.7039 |
| rbio1.3 | 303.4698 | 11.7026 | 303.4698 | 11.7020 | 303.4698 | 11.7018 | 303.4698 | 11.7018 |
| rbio1.5 | 303.4698 | 11.7021 | 303.4697 | 11.7014 | 303.4698 | 11.7011 | 303.4697 | 11.7010 |
| rbio2.2 | 303.4698 | 11.7011 | 303.4698 | 11.6997 | 303.4698 | 11.6993 | 303.4698 | 11.6992 |
| rbio2.4 | 303.4698 | 11.7004 | 303.4698 | 11.6987 | 303.4698 | 11.6981 | 303.4698 | 11.6979 |
| rbio2.6 | 303.4698 | 11.6997 | 303.4697 | 11.6974 | 303.4697 | 11.6967 | 303.4697 | 11.6964 |
| rbio2.8 | 303.4698 | 11.6991 | 303.4698 | 11.6964 | 303.4698 | 11.6955 | 303.4698 | 11.6952 |
| rbio3.1 | 303.4698 | 11.7036 | 303.4697 | 11.7032 | 303.4697 | 11.7030 | 303.4697 | 11.7028 |
| rbio3.3 | 303.4698 | 11.6991 | 303.4697 | 11.6970 | 303.4696 | 11.6963 | 303.4697 | 11.6961 |
| rbio3.5 | 303.4698 | 11.6974 | 303.4698 | 11.6941 | 303.4697 | 11.6929 | 303.4697 | 11.6925 |
| rbio3.7 | 303.4698 | 11.6960 | 303.4698 | 11.6910 | 303.4698 | 11.6894 | 303.4698 | 11.6889 |
| rbio3.9 | 303.4698 | 11.6950 | 303.4698 | 11.6897 | 303.4698 | 11.6877 | 303.4698 | 11.6871 |
| rbio4.4 | 303.4698 | 11.7021 | 303.4698 | 11.7015 | 303.4698 | 11.7013 | 303.4698 | 11.7013 |
| rbio5.5 | 303.4698 | 11.7030 | 303.4698 | 11.7027 | 303.4698 | 11.7027 | 303.4698 | 11.7027 |
| rbio6.8 | 303.4698 | 11.7011 | 303.4698 | 11.7001 | 303.4698 | 11.6998 | 303.4698 | 11.6997 |
| dmey | 303.4698 | 11.6985 | 303.4698 | 11.6966 | 303.4698 | 11.6961 | 303.4698 | 11.6960 |

Table A.16: Results of NormalShrink with soft thresholding for DEM generation on City Site 2 including outliers

| **City Site 2**, μ = 292.9100, σ = 3.5970 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.9093 | 3.5958 | 292.9098 | 3.5959 | 292.9099 | 3.5962 | 292.9099 | 3.5962 |
| db2 | 292.9117 | 3.5967 | 292.9121 | 3.5966 | 292.9122 | 3.5964 | 292.9121 | 3.5964 |
| db4 | 292.9150 | 3.6000 | 292.9154 | 3.5997 | 292.9155 | 3.6003 | 292.9155 | 3.5999 |
| db6 | 292.9204 | 3.6124 | 292.9255 | 3.6165 | 292.9258 | 3.6167 | 292.9257 | 3.6168 |
| db8 | 292.9145 | 3.6086 | 292.9172 | 3.6092 | 292.9171 | 3.6094 | 292.9170 | 3.6094 |
| db10 | 292.9066 | 3.5895 | 292.9074 | 3.5884 | 292.9065 | 3.5875 | 292.9065 | 3.5875 |
| db12 | 292.9059 | 3.5992 | 292.9050 | 3.5972 | 292.9057 | 3.5971 | 292.9063 | 3.5977 |
| db20 | 292.8462 | 3.5204 | 292.8480 | 3.5172 | 292.8546 | 3.5309 | 292.8552 | 3.5312 |
| sym2 | 292.9117 | 3.5967 | 292.9121 | 3.5966 | 292.9122 | 3.5964 | 292.9121 | 3.5964 |
| sym4 | 292.9152 | 3.6023 | 292.9167 | 3.6004 | 292.9159 | 3.6000 | 292.9163 | 3.6001 |
| sym6 | 292.9139 | 3.5994 | 292.9148 | 3.5992 | 292.9145 | 3.5983 | 292.9146 | 3.5987 |
| sym8 | 292.9154 | 3.6068 | 292.9168 | 3.6069 | 292.9166 | 3.6064 | 292.9170 | 3.6070 |
| sym10 | 292.9149 | 3.6058 | 292.9187 | 3.6129 | 292.9186 | 3.6116 | 292.9186 | 3.6116 |
| sym12 | 292.9172 | 3.6066 | 292.9183 | 3.6057 | 292.9185 | 3.6056 | 292.9183 | 3.6054 |
| sym20 | 292.9065 | 3.5910 | 292.9146 | 3.6019 | 292.9141 | 3.6005 | 292.9142 | 3.6009 |
| coif1 | 292.9134 | 3.5992 | 292.9132 | 3.5982 | 292.9140 | 3.5982 | 292.9140 | 3.5982 |
| coif2 | 292.9139 | 3.5994 | 292.9141 | 3.5993 | 292.9144 | 3.5990 | 292.9145 | 3.5990 |
| coif3 | 292.9128 | 3.5979 | 292.9136 | 3.5972 | 292.9138 | 3.5977 | 292.9136 | 3.5975 |
| coif4 | 292.9144 | 3.6077 | 292.9167 | 3.6073 | 292.9169 | 3.6076 | 292.9168 | 3.6075 |
| coif5 | 292.9183 | 3.6139 | 292.9205 | 3.6141 | 292.9201 | 3.6136 | 292.9202 | 3.6136 |
| bior1.1 | 292.9093 | 3.5958 | 292.9098 | 3.5959 | 292.9099 | 3.5962 | 292.9099 | 3.5962 |
| bior1.3 | 292.9103 | 3.5978 | 292.9094 | 3.5961 | 292.9094 | 3.5961 | 292.9094 | 3.5961 |
| bior1.5 | 292.9096 | 3.5980 | 292.9109 | 3.5979 | 292.9109 | 3.5979 | 292.9109 | 3.5979 |
| bior2.2 | 292.9098 | 3.5981 | 292.9101 | 3.5989 | 292.9103 | 3.5989 | 292.9103 | 3.5989 |
| bior2.4 | 292.9104 | 3.5985 | 292.9104 | 3.5980 | 292.9104 | 3.5981 | 292.9104 | 3.5981 |
| bior2.6 | 292.9111 | 3.5993 | 292.9113 | 3.5998 | 292.9113 | 3.5998 | 292.9113 | 3.5998 |
| bior2.8 | 292.9116 | 3.6003 | 292.9118 | 3.6003 | 292.9118 | 3.6003 | 292.9118 | 3.6003 |
| bior3.1 | 292.9108 | 3.5973 | 292.9116 | 3.5983 | 292.9116 | 3.5983 | 292.9116 | 3.5983 |
| bior3.3 | 292.9122 | 3.5996 | 292.9123 | 3.5996 | 292.9123 | 3.5996 | 292.9123 | 3.5996 |
| bior3.5 | 292.9123 | 3.5996 | 292.9125 | 3.5997 | 292.9123 | 3.5997 | 292.9126 | 3.5997 |
| bior3.7 | 292.9130 | 3.6004 | 292.9126 | 3.5999 | 292.9128 | 3.5999 | 292.9128 | 3.5999 |
| bior3.9 | 292.9129 | 3.6001 | 292.9128 | 3.5999 | 292.9128 | 3.5999 | 292.9128 | 3.5999 |
| bior4.4 | 292.9129 | 3.5989 | 292.9128 | 3.5970 | 292.9130 | 3.5968 | 292.9130 | 3.5968 |
| bior5.5 | 292.9255 | 3.6155 | 292.9301 | 3.6161 | 292.9295 | 3.6144 | 292.9288 | 3.6135 |
| bior6.8 | 292.9138 | 3.6000 | 292.9172 | 3.6057 | 292.9172 | 3.6049 | 292.9172 | 3.6049 |
| rbio1.1 | 292.9093 | 3.5958 | 292.9098 | 3.5959 | 292.9099 | 3.5962 | 292.9099 | 3.5962 |
| rbio1.3 | 292.9124 | 3.5982 | 292.9152 | 3.5993 | 292.9146 | 3.5987 | 292.9147 | 3.5987 |
| rbio1.5 | 292.9169 | 3.6072 | 292.9182 | 3.6079 | 292.9184 | 3.6087 | 292.9186 | 3.6086 |
| rbio2.2 | 292.9150 | 3.5962 | 292.9163 | 3.5969 | 292.9176 | 3.5969 | 292.9180 | 3.5969 |
| rbio2.4 | 292.9188 | 3.5979 | 292.9211 | 3.6022 | 292.9200 | 3.6000 | 292.9204 | 3.6003 |
| rbio2.6 | 292.9166 | 3.5980 | 292.9188 | 3.5992 | 292.9174 | 3.5978 | 292.9167 | 3.5963 |
| rbio2.8 | 292.9133 | 3.5979 | 292.9216 | 3.6043 | 292.9222 | 3.6039 | 292.9227 | 3.6036 |
| rbio3.1 | 292.8606 | 3.5418 | 292.8351 | 3.5267 | 292.8426 | 3.5311 | 292.8414 | 3.5305 |
| rbio3.3 | 292.8976 | 3.5727 | 292.8887 | 3.5764 | 292.8902 | 3.5762 | 292.8897 | 3.5754 |
| rbio3.5 | 292.9046 | 3.5947 | 292.8883 | 3.5692 | 292.8884 | 3.5685 | 292.8886 | 3.5679 |
| rbio3.7 | 292.9043 | 3.5985 | 292.8918 | 3.5752 | 292.8928 | 3.5728 | 292.8943 | 3.5743 |
| rbio3.9 | 292.8890 | 3.5720 | 292.8783 | 3.5535 | 292.8804 | 3.5586 | 292.8809 | 3.5581 |
| rbio4.4 | 292.9179 | 3.6062 | 292.9190 | 3.6070 | 292.9191 | 3.6072 | 292.9192 | 3.6073 |
| rbio5.5 | 292.9110 | 3.5967 | 292.9143 | 3.6031 | 292.9142 | 3.6031 | 292.9142 | 3.6031 |
| rbio6.8 | 292.9157 | 3.6038 | 292.9191 | 3.6064 | 292.9189 | 3.6052 | 292.9187 | 3.6050 |
| dmey | 292.8938 | 3.5741 | 292.8949 | 3.5694 | 292.8945 | 3.5692 | 292.8946 | 3.5695 |

Table A.17: Results of NormalShrink with soft thresholding for DSM generation on City Site 2 excluding outliers

| **City Site 2**, μ = 303.4662, σ = 11.5645 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 303.4662 | 11.5642 | 303.4662 | 11.5640 | 303.4662 | 11.5640 | 303.4662 | 11.5640 |
| db2 | 303.4662 | 11.5630 | 303.4662 | 11.5626 | 303.4662 | 11.5625 | 303.4662 | 11.5625 |
| db4 | 303.4662 | 11.5622 | 303.4662 | 11.5615 | 303.4662 | 11.5613 | 303.4662 | 11.5613 |
| db6 | 303.4662 | 11.5613 | 303.4662 | 11.5603 | 303.4662 | 11.5600 | 303.4662 | 11.5600 |
| db8 | 303.4662 | 11.5601 | 303.4662 | 11.5588 | 303.4662 | 11.5585 | 303.4662 | 11.5584 |
| db10 | 303.4661 | 11.5591 | 303.4661 | 11.5574 | 303.4661 | 11.5570 | 303.4661 | 11.5569 |
| db12 | 303.4662 | 11.5583 | 303.4662 | 11.5562 | 303.4662 | 11.5557 | 303.4662 | 11.5556 |
| db20 | 303.4662 | 11.5550 | 303.4662 | 11.5517 | 303.4662 | 11.5509 | 303.4662 | 11.5507 |
| sym2 | 303.4662 | 11.5630 | 303.4662 | 11.5626 | 303.4662 | 11.5625 | 303.4662 | 11.5625 |
| sym4 | 303.4662 | 11.5628 | 303.4662 | 11.5623 | 303.4662 | 11.5621 | 303.4662 | 11.5621 |
| sym6 | 303.4662 | 11.5624 | 303.4662 | 11.5618 | 303.4662 | 11.5616 | 303.4662 | 11.5616 |
| sym8 | 303.4662 | 11.5621 | 303.4662 | 11.5614 | 303.4662 | 11.5612 | 303.4662 | 11.5611 |
| sym10 | 303.4662 | 11.5617 | 303.4662 | 11.5609 | 303.4662 | 11.5607 | 303.4662 | 11.5607 |
| sym12 | 303.4662 | 11.5613 | 303.4662 | 11.5604 | 303.4662 | 11.5601 | 303.4662 | 11.5601 |
| sym20 | 303.4662 | 11.5605 | 303.4662 | 11.5593 | 303.4662 | 11.5590 | 303.4662 | 11.5589 |
| coif1 | 303.4662 | 11.5631 | 303.4662 | 11.5627 | 303.4662 | 11.5625 | 303.4662 | 11.5625 |
| coif2 | 303.4662 | 11.5628 | 303.4662 | 11.5623 | 303.4662 | 11.5621 | 303.4662 | 11.5621 |
| coif3 | 303.4662 | 11.5623 | 303.4662 | 11.5617 | 303.4662 | 11.5615 | 303.4662 | 11.5615 |
| coif4 | 303.4662 | 11.5619 | 303.4662 | 11.5612 | 303.4662 | 11.5610 | 303.4662 | 11.5609 |
| coif5 | 303.4662 | 11.5616 | 303.4662 | 11.5607 | 303.4662 | 11.5605 | 303.4662 | 11.5604 |
| bior1.1 | 303.4662 | 11.5642 | 303.4662 | 11.5640 | 303.4662 | 11.5640 | 303.4662 | 11.5640 |
| bior1.3 | 303.4662 | 11.5644 | 303.4662 | 11.5643 | 303.4662 | 11.5643 | 303.4662 | 11.5643 |
| bior1.5 | 303.4662 | 11.5644 | 303.4662 | 11.5643 | 303.4662 | 11.5643 | 303.4662 | 11.5643 |
| bior2.2 | 303.4662 | 11.5639 | 303.4662 | 11.5638 | 303.4662 | 11.5638 | 303.4662 | 11.5638 |
| bior2.4 | 303.4662 | 11.5640 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5639 |
| bior2.6 | 303.4662 | 11.5640 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5639 |
| bior2.8 | 303.4662 | 11.5640 | 303.4662 | 11.5640 | 303.4662 | 11.5639 | 303.4662 | 11.5639 |
| bior3.1 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5639 |
| bior3.3 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5638 | 303.4662 | 11.5638 |
| bior3.5 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5638 | 303.4662 | 11.5638 |
| bior3.7 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5639 |
| bior3.9 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5639 | 303.4662 | 11.5638 |
| bior4.4 | 303.4662 | 11.5629 | 303.4662 | 11.5624 | 303.4662 | 11.5623 | 303.4662 | 11.5623 |
| bior5.5 | 303.4662 | 11.5610 | 303.4662 | 11.5592 | 303.4662 | 11.5585 | 303.4662 | 11.5582 |
| bior6.8 | 303.4662 | 11.5626 | 303.4662 | 11.5621 | 303.4662 | 11.5619 | 303.4662 | 11.5619 |
| rbio1.1 | 303.4662 | 11.5642 | 303.4662 | 11.5640 | 303.4662 | 11.5640 | 303.4662 | 11.5640 |
| rbio1.3 | 303.4662 | 11.5629 | 303.4662 | 11.5623 | 303.4662 | 11.5622 | 303.4662 | 11.5621 |
| rbio1.5 | 303.4662 | 11.5625 | 303.4662 | 11.5618 | 303.4662 | 11.5616 | 303.4662 | 11.5615 |
| rbio2.2 | 303.4662 | 11.5616 | 303.4662 | 11.5604 | 303.4662 | 11.5600 | 303.4662 | 11.5599 |
| rbio2.4 | 303.4662 | 11.5612 | 303.4662 | 11.5597 | 303.4662 | 11.5592 | 303.4662 | 11.5591 |
| rbio2.6 | 303.4662 | 11.5606 | 303.4662 | 11.5587 | 303.4662 | 11.5581 | 303.4662 | 11.5579 |
| rbio2.8 | 303.4662 | 11.5602 | 303.4662 | 11.5579 | 303.4662 | 11.5571 | 303.4662 | 11.5569 |
| rbio3.1 | 303.4662 | 11.5642 | 303.4661 | 11.5639 | 303.4661 | 11.5637 | 303.4661 | 11.5636 |
| rbio3.3 | 303.4662 | 11.5601 | 303.4661 | 11.5582 | 303.4661 | 11.5576 | 303.4661 | 11.5574 |
| rbio3.5 | 303.4662 | 11.5588 | 303.4662 | 11.5560 | 303.4662 | 11.5549 | 303.4662 | 11.5546 |
| rbio3.7 | 303.4662 | 11.5577 | 303.4662 | 11.5534 | 303.4662 | 11.5521 | 303.4662 | 11.5516 |
| rbio3.9 | 303.4662 | 11.5569 | 303.4662 | 11.5525 | 303.4662 | 11.5509 | 303.4662 | 11.5503 |
| rbio4.4 | 303.4662 | 11.5626 | 303.4662 | 11.5621 | 303.4662 | 11.5619 | 303.4662 | 11.5619 |
| rbio5.5 | 303.4662 | 11.5632 | 303.4662 | 11.5630 | 303.4662 | 11.5630 | 303.4662 | 11.5630 |
| rbio6.8 | 303.4662 | 11.5618 | 303.4662 | 11.5610 | 303.4662 | 11.5607 | 303.4662 | 11.5607 |
| dmey | 303.4662 | 11.5598 | 303.4662 | 11.5583 | 303.4662 | 11.5579 | 303.4662 | 11.5579 |

Table A.18: Results of NormalShrink with soft thresholding for DEM generation on City Site 2 excluding outliers

| **City Site 2**, μ = 292.9549, σ = 3.6377 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.9558 | 3.6406 | 292.9567 | 3.6413 | 292.9565 | 3.6414 | 292.9566 | 3.6414 |
| db2 | 292.9630 | 3.6495 | 292.9638 | 3.6491 | 292.9636 | 3.6492 | 292.9636 | 3.6492 |
| db4 | 292.9668 | 3.6489 | 292.9670 | 3.6486 | 292.9670 | 3.6487 | 292.9670 | 3.6487 |
| db6 | 292.9627 | 3.6461 | 292.9647 | 3.6433 | 292.9671 | 3.6468 | 292.9671 | 3.6468 |
| db8 | 292.9609 | 3.6485 | 292.9601 | 3.6518 | 292.9600 | 3.6510 | 292.9602 | 3.6512 |
| db10 | 292.9477 | 3.6288 | 292.9423 | 3.6144 | 292.9448 | 3.6175 | 292.9447 | 3.6175 |
| db12 | 292.9423 | 3.6213 | 292.9472 | 3.6248 | 292.9454 | 3.6213 | 292.9457 | 3.6206 |
| db20 | 292.9165 | 3.5936 | 292.9241 | 3.5982 | 292.9241 | 3.5968 | 292.9239 | 3.5966 |
| sym2 | 292.9630 | 3.6495 | 292.9638 | 3.6491 | 292.9636 | 3.6492 | 292.9636 | 3.6492 |
| sym4 | 292.9637 | 3.6497 | 292.9642 | 3.6497 | 292.9644 | 3.6495 | 292.9645 | 3.6496 |
| sym6 | 292.9647 | 3.6501 | 292.9673 | 3.6524 | 292.9673 | 3.6520 | 292.9674 | 3.6519 |
| sym8 | 292.9632 | 3.6482 | 292.9680 | 3.6511 | 292.9677 | 3.6504 | 292.9680 | 3.6504 |
| sym10 | 292.9676 | 3.6539 | 292.9681 | 3.6514 | 292.9683 | 3.6510 | 292.9682 | 3.6509 |
| sym12 | 292.9620 | 3.6497 | 292.9641 | 3.6522 | 292.9646 | 3.6518 | 292.9646 | 3.6518 |
| sym20 | 292.9480 | 3.6244 | 292.9489 | 3.6222 | 292.9493 | 3.6224 | 292.9493 | 3.6223 |
| coif1 | 292.9621 | 3.6455 | 292.9632 | 3.6483 | 292.9636 | 3.6485 | 292.9637 | 3.6486 |
| coif2 | 292.9628 | 3.6462 | 292.9643 | 3.6493 | 292.9644 | 3.6489 | 292.9644 | 3.6489 |
| coif3 | 292.9657 | 3.6494 | 292.9673 | 3.6517 | 292.9682 | 3.6517 | 292.9682 | 3.6517 |
| coif4 | 292.9646 | 3.6480 | 292.9664 | 3.6527 | 292.9667 | 3.6523 | 292.9667 | 3.6522 |
| coif5 | 292.9648 | 3.6493 | 292.9648 | 3.6497 | 292.9651 | 3.6500 | 292.9650 | 3.6497 |
| bior1.1 | 292.9558 | 3.6406 | 292.9567 | 3.6413 | 292.9565 | 3.6414 | 292.9566 | 3.6414 |
| bior1.3 | 292.9566 | 3.6414 | 292.9555 | 3.6395 | 292.9555 | 3.6394 | 292.9554 | 3.6394 |
| bior1.5 | 292.9555 | 3.6410 | 292.9567 | 3.6412 | 292.9569 | 3.6413 | 292.9569 | 3.6413 |
| bior2.2 | 292.9582 | 3.6422 | 292.9584 | 3.6427 | 292.9584 | 3.6427 | 292.9584 | 3.6427 |
| bior2.4 | 292.9585 | 3.6432 | 292.9584 | 3.6426 | 292.9584 | 3.6426 | 292.9584 | 3.6426 |
| bior2.6 | 292.9575 | 3.6410 | 292.9571 | 3.6405 | 292.9571 | 3.6405 | 292.9571 | 3.6405 |
| bior2.8 | 292.9575 | 3.6409 | 292.9576 | 3.6411 | 292.9576 | 3.6411 | 292.9576 | 3.6411 |
| bior3.1 | 292.9589 | 3.6433 | 292.9593 | 3.6436 | 292.9592 | 3.6436 | 292.9592 | 3.6436 |
| bior3.3 | 292.9580 | 3.6409 | 292.9579 | 3.6414 | 292.9578 | 3.6414 | 292.9578 | 3.6414 |
| bior3.5 | 292.9588 | 3.6425 | 292.9590 | 3.6426 | 292.9589 | 3.6426 | 292.9587 | 3.6427 |
| bior3.7 | 292.9589 | 3.6420 | 292.9589 | 3.6418 | 292.9589 | 3.6418 | 292.9589 | 3.6418 |
| bior3.9 | 292.9591 | 3.6422 | 292.9593 | 3.6421 | 292.9593 | 3.6421 | 292.9593 | 3.6421 |
| bior4.4 | 292.9637 | 3.6468 | 292.9639 | 3.6483 | 292.9640 | 3.6482 | 292.9641 | 3.6482 |
| bior5.5 | 292.9736 | 3.6641 | 292.9797 | 3.6679 | 292.9789 | 3.6660 | 292.9792 | 3.6658 |
| bior6.8 | 292.9643 | 3.6505 | 292.9668 | 3.6517 | 292.9674 | 3.6522 | 292.9675 | 3.6523 |
| rbio1.1 | 292.9558 | 3.6406 | 292.9567 | 3.6413 | 292.9565 | 3.6414 | 292.9566 | 3.6414 |
| rbio1.3 | 292.9637 | 3.6511 | 292.9695 | 3.6586 | 292.9696 | 3.6589 | 292.9697 | 3.6589 |
| rbio1.5 | 292.9648 | 3.6528 | 292.9658 | 3.6522 | 292.9660 | 3.6520 | 292.9661 | 3.6521 |
| rbio2.2 | 292.9670 | 3.6472 | 292.9674 | 3.6467 | 292.9670 | 3.6466 | 292.9671 | 3.6465 |
| rbio2.4 | 292.9710 | 3.6582 | 292.9729 | 3.6605 | 292.9760 | 3.6643 | 292.9760 | 3.6643 |
| rbio2.6 | 292.9690 | 3.6553 | 292.9701 | 3.6546 | 292.9685 | 3.6544 | 292.9689 | 3.6547 |
| rbio2.8 | 292.9640 | 3.6506 | 292.9682 | 3.6480 | 292.9695 | 3.6491 | 292.9697 | 3.6491 |
| rbio3.1 | 292.9231 | 3.6101 | 292.8970 | 3.5927 | 292.9022 | 3.5891 | 292.9013 | 3.5922 |
| rbio3.3 | 292.9522 | 3.6389 | 292.9409 | 3.6261 | 292.9428 | 3.6303 | 292.9432 | 3.6313 |
| rbio3.5 | 292.9463 | 3.6261 | 292.9403 | 3.6201 | 292.9416 | 3.6189 | 292.9415 | 3.6187 |
| rbio3.7 | 292.9454 | 3.6195 | 292.9382 | 3.6178 | 292.9380 | 3.6173 | 292.9384 | 3.6182 |
| rbio3.9 | 292.9481 | 3.6321 | 292.9278 | 3.5988 | 292.9215 | 3.5896 | 292.9218 | 3.5900 |
| rbio4.4 | 292.9669 | 3.6545 | 292.9669 | 3.6542 | 292.9671 | 3.6542 | 292.9670 | 3.6542 |
| rbio5.5 | 292.9668 | 3.6533 | 292.9622 | 3.6434 | 292.9622 | 3.6434 | 292.9622 | 3.6434 |
| rbio6.8 | 292.9673 | 3.6494 | 292.9661 | 3.6449 | 292.9667 | 3.6453 | 292.9665 | 3.6453 |
| dmey | 292.9469 | 3.6262 | 292.9482 | 3.6258 | 292.9485 | 3.6258 | 292.9483 | 3.6261 |

Table A.19: Results of SureShrink with hard thresholding for DSM generation on City Site 3 including outliers

| **City Site 3**, μ = 318.7184, σ = 9.1404 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 318.7184 | 9.1382 | 318.7184 | 9.1381 | 318.7184 | 9.1381 | 318.7184 | 9.1381 |
| db2 | 318.7184 | 9.1369 | 318.7184 | 9.1366 | 318.7184 | 9.1366 | 318.7184 | 9.1366 |
| db4 | 318.7184 | 9.1358 | 318.7184 | 9.1355 | 318.7184 | 9.1355 | 318.7184 | 9.1355 |
| db6 | 318.7183 | 9.1352 | 318.7184 | 9.1350 | 318.7183 | 9.1350 | 318.7183 | 9.1350 |
| db8 | 318.7184 | 9.1345 | 318.7184 | 9.1343 | 318.7184 | 9.1343 | 318.7184 | 9.1343 |
| db10 | 318.7183 | 9.1338 | 318.7183 | 9.1336 | 318.7183 | 9.1336 | 318.7183 | 9.1336 |
| db12 | 318.7184 | 9.1340 | 318.7184 | 9.1338 | 318.7184 | 9.1338 | 318.7184 | 9.1338 |
| db20 | 318.7183 | 9.1329 | 318.7183 | 9.1327 | 318.7183 | 9.1327 | 318.7183 | 9.1327 |
| sym2 | 318.7184 | 9.1369 | 318.7184 | 9.1366 | 318.7184 | 9.1366 | 318.7184 | 9.1366 |
| sym4 | 318.7184 | 9.1364 | 318.7184 | 9.1361 | 318.7184 | 9.1361 | 318.7184 | 9.1361 |
| sym6 | 318.7184 | 9.1358 | 318.7184 | 9.1355 | 318.7184 | 9.1355 | 318.7184 | 9.1355 |
| sym8 | 318.7184 | 9.1355 | 318.7184 | 9.1352 | 318.7184 | 9.1352 | 318.7184 | 9.1352 |
| sym10 | 318.7184 | 9.1353 | 318.7184 | 9.1350 | 318.7184 | 9.1350 | 318.7184 | 9.1350 |
| sym12 | 318.7184 | 9.1349 | 318.7184 | 9.1346 | 318.7184 | 9.1346 | 318.7184 | 9.1346 |
| sym20 | 318.7184 | 9.1341 | 318.7184 | 9.1338 | 318.7184 | 9.1338 | 318.7184 | 9.1338 |
| coif1 | 318.7185 | 9.1371 | 318.7185 | 9.1368 | 318.7185 | 9.1368 | 318.7185 | 9.1368 |
| coif2 | 318.7183 | 9.1358 | 318.7183 | 9.1356 | 318.7183 | 9.1355 | 318.7183 | 9.1355 |
| coif3 | 318.7184 | 9.1358 | 318.7184 | 9.1354 | 318.7184 | 9.1354 | 318.7184 | 9.1354 |
| coif4 | 318.7184 | 9.1351 | 318.7184 | 9.1348 | 318.7184 | 9.1348 | 318.7184 | 9.1348 |
| coif5 | 318.7184 | 9.1351 | 318.7184 | 9.1348 | 318.7184 | 9.1348 | 318.7184 | 9.1348 |
| bior1.1 | 318.7184 | 9.1382 | 318.7184 | 9.1381 | 318.7184 | 9.1381 | 318.7184 | 9.1381 |
| bior1.3 | 318.7184 | 9.1407 | 318.7184 | 9.1406 | 318.7184 | 9.1406 | 318.7184 | 9.1406 |
| bior1.5 | 318.7184 | 9.1411 | 318.7184 | 9.1411 | 318.7184 | 9.1411 | 318.7184 | 9.1411 |
| bior2.2 | 318.7184 | 9.1324 | 318.7184 | 9.1323 | 318.7184 | 9.1323 | 318.7184 | 9.1323 |
| bior2.4 | 318.7184 | 9.1340 | 318.7184 | 9.1339 | 318.7184 | 9.1339 | 318.7184 | 9.1339 |
| bior2.6 | 318.7184 | 9.1349 | 318.7184 | 9.1348 | 318.7184 | 9.1348 | 318.7184 | 9.1348 |
| bior2.8 | 318.7184 | 9.1355 | 318.7184 | 9.1355 | 318.7184 | 9.1355 | 318.7184 | 9.1355 |
| bior3.1 | 318.7184 | 9.1396 | 318.7184 | 9.1397 | 318.7184 | 9.1397 | 318.7184 | 9.1397 |
| bior3.3 | 318.7184 | 9.1332 | 318.7184 | 9.1333 | 318.7184 | 9.1333 | 318.7184 | 9.1333 |
| bior3.5 | 318.7184 | 9.1340 | 318.7184 | 9.1341 | 318.7184 | 9.1341 | 318.7184 | 9.1341 |
| bior3.7 | 318.7184 | 9.1340 | 318.7184 | 9.1340 | 318.7184 | 9.1340 | 318.7184 | 9.1340 |
| bior3.9 | 318.7184 | 9.1337 | 318.7184 | 9.1338 | 318.7184 | 9.1338 | 318.7184 | 9.1338 |
| bior4.4 | 318.7183 | 9.1351 | 318.7183 | 9.1347 | 318.7183 | 9.1347 | 318.7183 | 9.1347 |
| bior5.5 | 318.7184 | 9.1380 | 318.7184 | 9.1376 | 318.7184 | 9.1376 | 318.7184 | 9.1376 |
| bior6.8 | 318.7184 | 9.1348 | 318.7184 | 9.1344 | 318.7184 | 9.1344 | 318.7184 | 9.1344 |
| rbio1.1 | 318.7184 | 9.1382 | 318.7184 | 9.1381 | 318.7184 | 9.1381 | 318.7184 | 9.1381 |
| rbio1.3 | 318.7184 | 9.1377 | 318.7184 | 9.1375 | 318.7184 | 9.1375 | 318.7184 | 9.1375 |
| rbio1.5 | 318.7184 | 9.1383 | 318.7184 | 9.1381 | 318.7184 | 9.1381 | 318.7184 | 9.1381 |
| rbio2.2 | 318.7184 | 9.1405 | 318.7184 | 9.1406 | 318.7184 | 9.1406 | 318.7184 | 9.1406 |
| rbio2.4 | 318.7184 | 9.1397 | 318.7184 | 9.1399 | 318.7184 | 9.1399 | 318.7184 | 9.1399 |
| rbio2.6 | 318.7184 | 9.1396 | 318.7184 | 9.1397 | 318.7184 | 9.1397 | 318.7184 | 9.1397 |
| rbio2.8 | 318.7184 | 9.1397 | 318.7184 | 9.1398 | 318.7184 | 9.1398 | 318.7184 | 9.1398 |
| rbio3.1 | 318.7184 | 9.1409 | 318.7184 | 9.1411 | 318.7184 | 9.1411 | 318.7184 | 9.1411 |
| rbio3.3 | 318.7184 | 9.1413 | 318.7184 | 9.1417 | 318.7184 | 9.1417 | 318.7184 | 9.1417 |
| rbio3.5 | 318.7184 | 9.1412 | 318.7184 | 9.1417 | 318.7184 | 9.1417 | 318.7184 | 9.1417 |
| rbio3.7 | 318.7184 | 9.1411 | 318.7184 | 9.1416 | 318.7184 | 9.1416 | 318.7184 | 9.1417 |
| rbio3.9 | 318.7184 | 9.1411 | 318.7184 | 9.1417 | 318.7184 | 9.1417 | 318.7184 | 9.1417 |
| rbio4.4 | 318.7183 | 9.1382 | 318.7183 | 9.1382 | 318.7183 | 9.1382 | 318.7183 | 9.1382 |
| rbio5.5 | 318.7186 | 9.1362 | 318.7186 | 9.1362 | 318.7186 | 9.1362 | 318.7186 | 9.1362 |
| rbio6.8 | 318.7184 | 9.1370 | 318.7184 | 9.1369 | 318.7184 | 9.1369 | 318.7184 | 9.1369 |
| dmey | 318.7184 | 9.1338 | 318.7184 | 9.1335 | 318.7184 | 9.1335 | 318.7184 | 9.1335 |

Table A.20: Results of SureShrink with hard thresholding for DEM generation on City Site 3 including outliers

| **City Site 3**, μ = 310.7064, σ = 4.4727 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 310.7066 | 4.4400 | 310.7275 | 4.4415 | 310.7294 | 4.4446 | 310.7300 | 4.4439 |
| db2 | 310.6330 | 4.3917 | 310.6603 | 4.4045 | 310.6661 | 4.4145 | 310.6666 | 4.4138 |
| db4 | 310.6474 | 4.4423 | 310.6318 | 4.4103 | 310.6372 | 4.4078 | 310.6370 | 4.4079 |
| db6 | 310.5857 | 4.3930 | 310.5698 | 4.3563 | 310.5698 | 4.3547 | 310.5696 | 4.3547 |
| db8 | 310.5885 | 4.3969 | 310.5933 | 4.4045 | 310.5942 | 4.4051 | 310.5941 | 4.4049 |
| db10 | 310.5831 | 4.3948 | 310.5761 | 4.3997 | 310.5768 | 4.3973 | 310.5761 | 4.3971 |
| db12 | 310.5903 | 4.4110 | 310.5791 | 4.4171 | 310.5786 | 4.4183 | 310.5788 | 4.4183 |
| db20 | 310.5053 | 4.3692 | 310.5099 | 4.3705 | 310.5087 | 4.3686 | 310.5084 | 4.3684 |
| sym2 | 310.6330 | 4.3917 | 310.6603 | 4.4045 | 310.6661 | 4.4145 | 310.6666 | 4.4138 |
| sym4 | 310.6429 | 4.4222 | 310.6444 | 4.3970 | 310.6448 | 4.3958 | 310.6439 | 4.3947 |
| sym6 | 310.6324 | 4.4211 | 310.6290 | 4.4125 | 310.6293 | 4.4134 | 310.6297 | 4.4134 |
| sym8 | 310.6024 | 4.3850 | 310.6161 | 4.3918 | 310.6192 | 4.3985 | 310.6202 | 4.3987 |
| sym10 | 310.6033 | 4.4040 | 310.6062 | 4.3938 | 310.6027 | 4.3918 | 310.6016 | 4.3906 |
| sym12 | 310.5680 | 4.3918 | 310.5763 | 4.4068 | 310.5741 | 4.4042 | 310.5740 | 4.4041 |
| sym20 | 310.5412 | 4.3777 | 310.5625 | 4.4042 | 310.5686 | 4.4013 | 310.5681 | 4.4011 |
| coif1 | 310.6204 | 4.3839 | 310.6395 | 4.3822 | 310.6430 | 4.3858 | 310.6429 | 4.3860 |
| coif2 | 310.6466 | 4.4394 | 310.6332 | 4.4002 | 310.6357 | 4.4028 | 310.6359 | 4.4028 |
| coif3 | 310.6244 | 4.4201 | 310.6330 | 4.4276 | 310.6316 | 4.4223 | 310.6318 | 4.4222 |
| coif4 | 310.5848 | 4.3761 | 310.5968 | 4.3758 | 310.5924 | 4.3737 | 310.5930 | 4.3737 |
| coif5 | 310.5588 | 4.3735 | 310.5928 | 4.3975 | 310.5908 | 4.3970 | 310.5908 | 4.3969 |
| bior1.1 | 310.7066 | 4.4400 | 310.7275 | 4.4415 | 310.7294 | 4.4446 | 310.7300 | 4.4439 |
| bior1.3 | 310.6720 | 4.4279 | 310.6724 | 4.4167 | 310.6752 | 4.4244 | 310.6749 | 4.4248 |
| bior1.5 | 310.6542 | 4.4163 | 310.6626 | 4.4378 | 310.6655 | 4.4380 | 310.6648 | 4.4376 |
| bior2.2 | 310.7110 | 4.4784 | 310.6907 | 4.4386 | 310.6947 | 4.4446 | 310.6917 | 4.4446 |
| bior2.4 | 310.7079 | 4.4872 | 310.7049 | 4.4687 | 310.7030 | 4.4681 | 310.7028 | 4.4681 |
| bior2.6 | 310.6708 | 4.4494 | 310.6614 | 4.4206 | 310.6639 | 4.4244 | 310.6639 | 4.4248 |
| bior2.8 | 310.6570 | 4.4466 | 310.6772 | 4.4431 | 310.6741 | 4.4442 | 310.6740 | 4.4444 |
| bior3.1 | 310.5993 | 4.3919 | 310.5937 | 4.3840 | 310.5928 | 4.3833 | 310.5928 | 4.3833 |
| bior3.3 | 310.6154 | 4.3978 | 310.6167 | 4.4060 | 310.6173 | 4.4060 | 310.6173 | 4.4061 |
| bior3.5 | 310.6298 | 4.4228 | 310.6128 | 4.4089 | 310.6127 | 4.4096 | 310.6127 | 4.4095 |
| bior3.7 | 310.6127 | 4.3975 | 310.6131 | 4.3866 | 310.6130 | 4.3863 | 310.6129 | 4.3863 |
| bior3.9 | 310.6266 | 4.4193 | 310.6323 | 4.4308 | 310.6331 | 4.4312 | 310.6331 | 4.4312 |
| bior4.4 | 310.6475 | 4.4291 | 310.6502 | 4.4149 | 310.6569 | 4.4211 | 310.6585 | 4.4219 |
| bior5.5 | 310.6272 | 4.4540 | 310.6276 | 4.4188 | 310.6240 | 4.4212 | 310.6257 | 4.4217 |
| bior6.8 | 310.6012 | 4.4099 | 310.6099 | 4.4052 | 310.6076 | 4.4046 | 310.6072 | 4.4044 |
| rbio1.1 | 310.7066 | 4.4400 | 310.7275 | 4.4415 | 310.7294 | 4.4446 | 310.7300 | 4.4439 |
| rbio1.3 | 310.6554 | 4.4149 | 310.6436 | 4.4270 | 310.6483 | 4.4261 | 310.6477 | 4.4260 |
| rbio1.5 | 310.6558 | 4.4482 | 310.6426 | 4.4317 | 310.6406 | 4.4295 | 310.6418 | 4.4301 |
| rbio2.2 | 310.6125 | 4.3948 | 310.6057 | 4.3671 | 310.6099 | 4.3658 | 310.6076 | 4.3672 |
| rbio2.4 | 310.6019 | 4.3960 | 310.6144 | 4.4346 | 310.6200 | 4.4340 | 310.6202 | 4.4357 |
| rbio2.6 | 310.5881 | 4.3711 | 310.5880 | 4.3721 | 310.5846 | 4.3701 | 310.5873 | 4.3714 |
| rbio2.8 | 310.5939 | 4.3815 | 310.6093 | 4.3974 | 310.6047 | 4.3879 | 310.6041 | 4.3890 |
| rbio3.1 | 310.6024 | 4.4000 | 310.6733 | 4.4615 | 310.6871 | 4.4667 | 310.6871 | 4.4667 |
| rbio3.3 | 310.6177 | 4.4242 | 310.6155 | 4.5236 | 310.6188 | 4.5233 | 310.6231 | 4.5241 |
| rbio3.5 | 310.6399 | 4.4191 | 310.6213 | 4.4471 | 310.6263 | 4.4544 | 310.6218 | 4.4515 |
| rbio3.7 | 310.6028 | 4.3931 | 310.5816 | 4.4258 | 310.5918 | 4.4386 | 310.5906 | 4.4393 |
| rbio3.9 | 310.6017 | 4.4047 | 310.5915 | 4.4249 | 310.5922 | 4.4297 | 310.5922 | 4.4290 |
| rbio4.4 | 310.6171 | 4.4214 | 310.6160 | 4.4114 | 310.6167 | 4.4103 | 310.6163 | 4.4109 |
| rbio5.5 | 310.5859 | 4.3930 | 310.5908 | 4.3874 | 310.5882 | 4.3872 | 310.5876 | 4.3876 |
| rbio6.8 | 310.6021 | 4.3954 | 310.5974 | 4.3887 | 310.6037 | 4.3904 | 310.6035 | 4.3908 |
| dmey | 310.5357 | 4.3695 | 310.5287 | 4.3719 | 310.5274 | 4.3660 | 310.5275 | 4.3661 |

Table A.21: Results of SureShrink with hard thresholding for DSM generation on City Site 3 excluding outliers

| **City Site 3**, μ = 318.6986, σ = 9.0395 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 318.6986 | 9.0364 | 318.6986 | 9.0362 | 318.6986 | 9.0362 | 318.6986 | 9.0362 |
| db2 | 318.6986 | 9.0352 | 318.6986 | 9.0350 | 318.6986 | 9.0350 | 318.6986 | 9.0350 |
| db4 | 318.6986 | 9.0335 | 318.6986 | 9.0332 | 318.6987 | 9.0332 | 318.6986 | 9.0332 |
| db6 | 318.6985 | 9.0330 | 318.6985 | 9.0327 | 318.6985 | 9.0327 | 318.6985 | 9.0327 |
| db8 | 318.6986 | 9.0325 | 318.6987 | 9.0323 | 318.6987 | 9.0322 | 318.6987 | 9.0322 |
| db10 | 318.6985 | 9.0318 | 318.6985 | 9.0316 | 318.6985 | 9.0316 | 318.6985 | 9.0316 |
| db12 | 318.6986 | 9.0320 | 318.6986 | 9.0317 | 318.6986 | 9.0317 | 318.6986 | 9.0317 |
| db20 | 318.6985 | 9.0301 | 318.6985 | 9.0300 | 318.6985 | 9.0300 | 318.6985 | 9.0300 |
| sym2 | 318.6986 | 9.0352 | 318.6986 | 9.0350 | 318.6986 | 9.0350 | 318.6986 | 9.0350 |
| sym4 | 318.6986 | 9.0345 | 318.6986 | 9.0341 | 318.6986 | 9.0341 | 318.6986 | 9.0341 |
| sym6 | 318.6986 | 9.0340 | 318.6986 | 9.0338 | 318.6986 | 9.0338 | 318.6986 | 9.0338 |
| sym8 | 318.6986 | 9.0338 | 318.6986 | 9.0334 | 318.6986 | 9.0334 | 318.6986 | 9.0334 |
| sym10 | 318.6985 | 9.0334 | 318.6986 | 9.0332 | 318.6986 | 9.0332 | 318.6986 | 9.0332 |
| sym12 | 318.6986 | 9.0328 | 318.6986 | 9.0325 | 318.6986 | 9.0325 | 318.6986 | 9.0325 |
| sym20 | 318.6986 | 9.0323 | 318.6986 | 9.0320 | 318.6986 | 9.0320 | 318.6986 | 9.0320 |
| coif1 | 318.6986 | 9.0356 | 318.6986 | 9.0353 | 318.6986 | 9.0353 | 318.6986 | 9.0353 |
| coif2 | 318.6985 | 9.0347 | 318.6986 | 9.0344 | 318.6986 | 9.0344 | 318.6986 | 9.0344 |
| coif3 | 318.6986 | 9.0342 | 318.6986 | 9.0338 | 318.6986 | 9.0338 | 318.6986 | 9.0338 |
| coif4 | 318.6986 | 9.0337 | 318.6986 | 9.0334 | 318.6985 | 9.0333 | 318.6985 | 9.0333 |
| coif5 | 318.6986 | 9.0334 | 318.6986 | 9.0330 | 318.6986 | 9.0330 | 318.6986 | 9.0330 |
| bior1.1 | 318.6986 | 9.0364 | 318.6986 | 9.0362 | 318.6986 | 9.0362 | 318.6986 | 9.0362 |
| bior1.3 | 318.6986 | 9.0397 | 318.6986 | 9.0396 | 318.6986 | 9.0396 | 318.6986 | 9.0396 |
| bior1.5 | 318.6986 | 9.0401 | 318.6986 | 9.0401 | 318.6986 | 9.0401 | 318.6986 | 9.0401 |
| bior2.2 | 318.6986 | 9.0303 | 318.6986 | 9.0303 | 318.6986 | 9.0302 | 318.6986 | 9.0302 |
| bior2.4 | 318.6986 | 9.0323 | 318.6986 | 9.0322 | 318.6986 | 9.0322 | 318.6986 | 9.0322 |
| bior2.6 | 318.6986 | 9.0334 | 318.6986 | 9.0334 | 318.6986 | 9.0334 | 318.6986 | 9.0334 |
| bior2.8 | 318.6986 | 9.0341 | 318.6986 | 9.0340 | 318.6986 | 9.0340 | 318.6986 | 9.0340 |
| bior3.1 | 318.6986 | 9.0361 | 318.6986 | 9.0362 | 318.6986 | 9.0362 | 318.6986 | 9.0362 |
| bior3.3 | 318.6986 | 9.0314 | 318.6986 | 9.0315 | 318.6986 | 9.0315 | 318.6986 | 9.0315 |
| bior3.5 | 318.6986 | 9.0311 | 318.6986 | 9.0312 | 318.6986 | 9.0312 | 318.6986 | 9.0312 |
| bior3.7 | 318.6986 | 9.0317 | 318.6986 | 9.0318 | 318.6986 | 9.0318 | 318.6986 | 9.0318 |
| bior3.9 | 318.6986 | 9.0319 | 318.6986 | 9.0320 | 318.6986 | 9.0320 | 318.6986 | 9.0320 |
| bior4.4 | 318.6985 | 9.0325 | 318.6985 | 9.0322 | 318.6985 | 9.0322 | 318.6985 | 9.0322 |
| bior5.5 | 318.6986 | 9.0361 | 318.6986 | 9.0357 | 318.6986 | 9.0357 | 318.6986 | 9.0357 |
| bior6.8 | 318.6985 | 9.0324 | 318.6985 | 9.0320 | 318.6985 | 9.0320 | 318.6985 | 9.0320 |
| rbio1.1 | 318.6986 | 9.0364 | 318.6986 | 9.0362 | 318.6986 | 9.0362 | 318.6986 | 9.0362 |
| rbio1.3 | 318.6986 | 9.0356 | 318.6986 | 9.0354 | 318.6986 | 9.0354 | 318.6986 | 9.0354 |
| rbio1.5 | 318.6986 | 9.0360 | 318.6986 | 9.0358 | 318.6986 | 9.0358 | 318.6986 | 9.0358 |
| rbio2.2 | 318.6986 | 9.0396 | 318.6986 | 9.0397 | 318.6986 | 9.0397 | 318.6986 | 9.0397 |
| rbio2.4 | 318.6986 | 9.0386 | 318.6986 | 9.0388 | 318.6986 | 9.0388 | 318.6986 | 9.0388 |
| rbio2.6 | 318.6986 | 9.0385 | 318.6986 | 9.0386 | 318.6986 | 9.0386 | 318.6986 | 9.0386 |
| rbio2.8 | 318.6986 | 9.0385 | 318.6986 | 9.0387 | 318.6986 | 9.0387 | 318.6986 | 9.0387 |
| rbio3.1 | 318.6986 | 9.0401 | 318.6986 | 9.0403 | 318.6986 | 9.0403 | 318.6986 | 9.0403 |
| rbio3.3 | 318.6986 | 9.0406 | 318.6986 | 9.0409 | 318.6986 | 9.0409 | 318.6986 | 9.0409 |
| rbio3.5 | 318.6986 | 9.0403 | 318.6986 | 9.0408 | 318.6986 | 9.0408 | 318.6986 | 9.0408 |
| rbio3.7 | 318.6986 | 9.0403 | 318.6986 | 9.0408 | 318.6986 | 9.0408 | 318.6986 | 9.0408 |
| rbio3.9 | 318.6986 | 9.0403 | 318.6986 | 9.0409 | 318.6986 | 9.0410 | 318.6986 | 9.0410 |
| rbio4.4 | 318.6985 | 9.0368 | 318.6985 | 9.0368 | 318.6985 | 9.0368 | 318.6985 | 9.0368 |
| rbio5.5 | 318.6987 | 9.0349 | 318.6987 | 9.0349 | 318.6987 | 9.0349 | 318.6987 | 9.0349 |
| rbio6.8 | 318.6986 | 9.0357 | 318.6986 | 9.0355 | 318.6986 | 9.0355 | 318.6986 | 9.0355 |
| dmey | 318.6986 | 9.0319 | 318.6986 | 9.0316 | 318.6986 | 9.0316 | 318.6986 | 9.0317 |

Table A.22: Results of SureShrink with hard thresholding for DEM generation on City Site 3 excluding outliers

| **City Site 3**, $\mu$ = 310.7514, $\sigma$ = 4.4699 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ |
| haar | 310.7710 | 4.4665 | 310.7698 | 4.4491 | 310.7714 | 4.4518 | 310.7713 | 4.4520 |
| db2 | 310.7452 | 4.4547 | 310.7442 | 4.4322 | 310.7459 | 4.4317 | 310.7456 | 4.4312 |
| db4 | 310.7166 | 4.4155 | 310.7197 | 4.4252 | 310.7211 | 4.4249 | 310.7213 | 4.4248 |
| db6 | 310.6540 | 4.3761 | 310.6825 | 4.3911 | 310.6823 | 4.3915 | 310.6815 | 4.3910 |
| db8 | 310.6653 | 4.4057 | 310.6650 | 4.4067 | 310.6663 | 4.4071 | 310.6665 | 4.4076 |
| db10 | 310.6186 | 4.3915 | 310.6427 | 4.4217 | 310.6346 | 4.4190 | 310.6347 | 4.4185 |
| db12 | 310.6277 | 4.4046 | 310.6444 | 4.4209 | 310.6437 | 4.4235 | 310.6432 | 4.4235 |
| db20 | 310.5889 | 4.3676 | 310.6144 | 4.3945 | 310.6124 | 4.3941 | 310.6135 | 4.3950 |
| sym2 | 310.7452 | 4.4547 | 310.7442 | 4.4322 | 310.7459 | 4.4317 | 310.7456 | 4.4312 |
| sym4 | 310.6757 | 4.4181 | 310.6922 | 4.3929 | 310.6964 | 4.3933 | 310.6966 | 4.3933 |
| sym6 | 310.6662 | 4.3876 | 310.6867 | 4.3924 | 310.6898 | 4.3941 | 310.6910 | 4.3936 |
| sym8 | 310.6581 | 4.3898 | 310.6723 | 4.3793 | 310.6709 | 4.3773 | 310.6710 | 4.3771 |
| sym10 | 310.6596 | 4.3928 | 310.6804 | 4.4007 | 310.6797 | 4.3976 | 310.6781 | 4.3974 |
| sym12 | 310.6564 | 4.4100 | 310.6817 | 4.4183 | 310.6844 | 4.4250 | 310.6841 | 4.4243 |
| sym20 | 310.6301 | 4.3988 | 310.6493 | 4.4265 | 310.6514 | 4.4276 | 310.6508 | 4.4275 |
| coif1 | 310.7063 | 4.4325 | 310.7257 | 4.4251 | 310.7311 | 4.4315 | 310.7319 | 4.4325 |
| coif2 | 310.6829 | 4.4189 | 310.7072 | 4.4139 | 310.7076 | 4.4135 | 310.7081 | 4.4127 |
| coif3 | 310.6700 | 4.4012 | 310.6816 | 4.4012 | 310.6858 | 4.4005 | 310.6860 | 4.4001 |
| coif4 | 310.6591 | 4.3791 | 310.6622 | 4.3929 | 310.6615 | 4.3936 | 310.6615 | 4.3939 |
| coif5 | 310.6550 | 4.3844 | 310.6515 | 4.3923 | 310.6577 | 4.3914 | 310.6574 | 4.3916 |
| bior1.1 | 310.7710 | 4.4665 | 310.7698 | 4.4491 | 310.7714 | 4.4518 | 310.7713 | 4.4520 |
| bior1.3 | 310.7305 | 4.4407 | 310.7280 | 4.4293 | 310.7354 | 4.4294 | 310.7355 | 4.4295 |
| bior1.5 | 310.7230 | 4.4488 | 310.7156 | 4.4488 | 310.7156 | 4.4456 | 310.7159 | 4.4454 |
| bior2.2 | 310.7328 | 4.4251 | 310.7268 | 4.4181 | 310.7283 | 4.4159 | 310.7285 | 4.4160 |
| bior2.4 | 310.7181 | 4.4279 | 310.7107 | 4.4126 | 310.7128 | 4.4159 | 310.7125 | 4.4163 |
| bior2.6 | 310.7090 | 4.4300 | 310.7192 | 4.4446 | 310.7252 | 4.4456 | 310.7225 | 4.4451 |
| bior2.8 | 310.7253 | 4.4448 | 310.7038 | 4.4147 | 310.7014 | 4.4142 | 310.7011 | 4.4144 |
| bior3.1 | 310.6692 | 4.3656 | 310.6505 | 4.3455 | 310.6511 | 4.3456 | 310.6511 | 4.3456 |
| bior3.3 | 310.6659 | 4.3663 | 310.6717 | 4.3784 | 310.6711 | 4.3759 | 310.6711 | 4.3759 |
| bior3.5 | 310.6900 | 4.4012 | 310.6937 | 4.4100 | 310.6908 | 4.4087 | 310.6908 | 4.4087 |
| bior3.7 | 310.6689 | 4.3683 | 310.6757 | 4.3702 | 310.6757 | 4.3702 | 310.6757 | 4.3702 |
| bior3.9 | 310.6890 | 4.4123 | 310.6921 | 4.4142 | 310.6942 | 4.4170 | 310.6943 | 4.4170 |
| bior4.4 | 310.6606 | 4.3860 | 310.6775 | 4.3793 | 310.6799 | 4.3837 | 310.6786 | 4.3825 |
| bior5.5 | 310.6917 | 4.4423 | 310.7285 | 4.4419 | 310.7295 | 4.4290 | 310.7303 | 4.4296 |
| bior6.8 | 310.6711 | 4.4008 | 310.6737 | 4.3959 | 310.6769 | 4.3958 | 310.6779 | 4.3965 |
| rbio1.1 | 310.7710 | 4.4665 | 310.7698 | 4.4491 | 310.7714 | 4.4518 | 310.7713 | 4.4520 |
| rbio1.3 | 310.7183 | 4.4050 | 310.7145 | 4.4019 | 310.7192 | 4.4093 | 310.7188 | 4.4091 |
| rbio1.5 | 310.7058 | 4.4138 | 310.7005 | 4.4134 | 310.6916 | 4.4090 | 310.6927 | 4.4090 |
| rbio2.2 | 310.6548 | 4.3641 | 310.6769 | 4.3824 | 310.6782 | 4.3896 | 310.6798 | 4.3897 |
| rbio2.4 | 310.6904 | 4.4233 | 310.6879 | 4.4111 | 310.6896 | 4.4143 | 310.6903 | 4.4142 |
| rbio2.6 | 310.6552 | 4.3816 | 310.6659 | 4.3746 | 310.6714 | 4.3776 | 310.6698 | 4.3757 |
| rbio2.8 | 310.6323 | 4.3619 | 310.6360 | 4.3475 | 310.6354 | 4.3502 | 310.6353 | 4.3530 |
| rbio3.1 | 310.6728 | 4.4231 | 310.7120 | 4.4538 | 310.7116 | 4.4603 | 310.7112 | 4.4604 |
| rbio3.3 | 310.6456 | 4.4027 | 310.6519 | 4.4783 | 310.6608 | 4.4927 | 310.6616 | 4.4911 |
| rbio3.5 | 310.6681 | 4.4273 | 310.6802 | 4.4579 | 310.6964 | 4.4706 | 310.6934 | 4.4632 |
| rbio3.7 | 310.6938 | 4.4489 | 310.6587 | 4.4794 | 310.6617 | 4.4798 | 310.6626 | 4.4816 |
| rbio3.9 | 310.6769 | 4.4239 | 310.6804 | 4.4147 | 310.6887 | 4.4152 | 310.6907 | 4.4173 |
| rbio4.4 | 310.6884 | 4.4216 | 310.7030 | 4.4375 | 310.7089 | 4.4383 | 310.7083 | 4.4360 |
| rbio5.5 | 310.6612 | 4.4205 | 310.6574 | 4.4133 | 310.6583 | 4.4126 | 310.6579 | 4.4128 |
| rbio6.8 | 310.6389 | 4.3733 | 310.6394 | 4.3663 | 310.6444 | 4.3702 | 310.6407 | 4.3692 |
| Dmey | 310.6285 | 4.3795 | 310.6412 | 4.3924 | 310.6436 | 4.3931 | 310.6432 | 4.3931 |

Table A.23: Results of SureShrink with soft thresholding for DSM generation on City Site 3 including outliers

| **City Site 3**, μ = 318.7184, σ = 9.1404 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 318.7184 | 9.0984 | 318.7184 | 9.0776 | 318.7184 | 9.0656 | 318.7184 | 9.0639 |
| db2 | 318.7183 | 9.1037 | 318.7183 | 9.0833 | 318.7184 | 9.0754 | 318.7184 | 9.0739 |
| db4 | 318.7186 | 9.1049 | 318.7185 | 9.0837 | 318.7185 | 9.0767 | 318.7185 | 9.0726 |
| db6 | 318.7181 | 9.1034 | 318.7182 | 9.0838 | 318.7182 | 9.0789 | 318.7182 | 9.0780 |
| db8 | 318.7184 | 9.1029 | 318.7186 | 9.0823 | 318.7186 | 9.0764 | 318.7186 | 9.0745 |
| db10 | 318.7184 | 9.1026 | 318.7183 | 9.0830 | 318.7183 | 9.0795 | 318.7183 | 9.0785 |
| db12 | 318.7183 | 9.1023 | 318.7184 | 9.0846 | 318.7184 | 9.0803 | 318.7184 | 9.0791 |
| db20 | 318.7182 | 9.1003 | 318.7182 | 9.0821 | 318.7182 | 9.0785 | 318.7182 | 9.0773 |
| sym2 | 318.7183 | 9.1037 | 318.7183 | 9.0833 | 318.7184 | 9.0754 | 318.7184 | 9.0739 |
| sym4 | 318.7183 | 9.1055 | 318.7179 | 9.0837 | 318.7180 | 9.0747 | 318.7180 | 9.0721 |
| sym6 | 318.7182 | 9.1053 | 318.7185 | 9.0852 | 318.7184 | 9.0773 | 318.7185 | 9.0741 |
| sym8 | 318.7183 | 9.1049 | 318.7180 | 9.0850 | 318.7180 | 9.0781 | 318.7180 | 9.0761 |
| sym10 | 318.7183 | 9.1052 | 318.7185 | 9.0843 | 318.7186 | 9.0765 | 318.7185 | 9.0746 |
| sym12 | 318.7185 | 9.1049 | 318.7183 | 9.0840 | 318.7183 | 9.0760 | 318.7183 | 9.0746 |
| sym20 | 318.7185 | 9.1038 | 318.7184 | 9.0833 | 318.7184 | 9.0780 | 318.7184 | 9.0763 |
| coif1 | 318.7186 | 9.1040 | 318.7183 | 9.0825 | 318.7184 | 9.0733 | 318.7185 | 9.0687 |
| coif2 | 318.7182 | 9.1043 | 318.7179 | 9.0823 | 318.7178 | 9.0737 | 318.7178 | 9.0701 |
| coif3 | 318.7182 | 9.1052 | 318.7179 | 9.0833 | 318.7180 | 9.0744 | 318.7180 | 9.0724 |
| coif4 | 318.7182 | 9.1041 | 318.7180 | 9.0839 | 318.7179 | 9.0776 | 318.7179 | 9.0759 |
| coif5 | 318.7182 | 9.1040 | 318.7180 | 9.0830 | 318.7180 | 9.0761 | 318.7180 | 9.0743 |
| bior1.1 | 318.7184 | 9.0984 | 318.7184 | 9.0776 | 318.7184 | 9.0656 | 318.7184 | 9.0639 |
| bior1.3 | 318.7184 | 9.1192 | 318.7183 | 9.1053 | 318.7183 | 9.1005 | 318.7183 | 9.0997 |
| bior1.5 | 318.7184 | 9.1236 | 318.7184 | 9.1117 | 318.7183 | 9.1068 | 318.7183 | 9.1044 |
| bior2.2 | 318.7184 | 9.0942 | 318.7182 | 9.0724 | 318.7182 | 9.0644 | 318.7182 | 9.0633 |
| bior2.4 | 318.7184 | 9.1011 | 318.7187 | 9.0848 | 318.7187 | 9.0802 | 318.7187 | 9.0782 |
| bior2.6 | 318.7184 | 9.1045 | 318.7182 | 9.0889 | 318.7182 | 9.0840 | 318.7182 | 9.0819 |
| bior2.8 | 318.7184 | 9.1069 | 318.7186 | 9.0940 | 318.7186 | 9.0903 | 318.7186 | 9.0891 |
| bior3.1 | 318.7184 | 9.1048 | 318.7184 | 9.0969 | 318.7184 | 9.0955 | 318.7184 | 9.0953 |
| bior3.3 | 318.7184 | 9.1000 | 318.7184 | 9.0912 | 318.7184 | 9.0892 | 318.7184 | 9.0889 |
| bior3.5 | 318.7184 | 9.1020 | 318.7183 | 9.0928 | 318.7184 | 9.0915 | 318.7183 | 9.0906 |
| bior3.7 | 318.7184 | 9.1026 | 318.7185 | 9.0943 | 318.7185 | 9.0927 | 318.7185 | 9.0920 |
| bior3.9 | 318.7184 | 9.1024 | 318.7183 | 9.0937 | 318.7183 | 9.0924 | 318.7183 | 9.0919 |
| bior4.4 | 318.7181 | 9.1022 | 318.7185 | 9.0779 | 318.7185 | 9.0673 | 318.7185 | 9.0653 |
| bior5.5 | 318.7186 | 9.1089 | 318.7189 | 9.0811 | 318.7188 | 9.0683 | 318.7188 | 9.0620 |
| bior6.8 | 318.7181 | 9.1042 | 318.7184 | 9.0824 | 318.7184 | 9.0749 | 318.7184 | 9.0724 |
| rbio1.1 | 318.7184 | 9.0984 | 318.7184 | 9.0776 | 318.7184 | 9.0656 | 318.7184 | 9.0639 |
| rbio1.3 | 318.7184 | 9.1026 | 318.7179 | 9.0789 | 318.7178 | 9.0689 | 318.7178 | 9.0671 |
| rbio1.5 | 318.7184 | 9.1076 | 318.7185 | 9.0847 | 318.7183 | 9.0753 | 318.7183 | 9.0711 |
| rbio2.2 | 318.7186 | 9.1164 | 318.7184 | 9.1005 | 318.7185 | 9.0949 | 318.7185 | 9.0918 |
| rbio2.4 | 318.7182 | 9.1106 | 318.7184 | 9.0923 | 318.7184 | 9.0852 | 318.7185 | 9.0807 |
| rbio2.6 | 318.7182 | 9.1108 | 318.7180 | 9.0884 | 318.7179 | 9.0805 | 318.7179 | 9.0743 |
| rbio2.8 | 318.7182 | 9.1114 | 318.7185 | 9.0909 | 318.7184 | 9.0825 | 318.7184 | 9.0749 |
| rbio3.1 | 318.7184 | 9.1389 | 318.7184 | 9.1385 | 318.7183 | 9.1378 | 318.7183 | 9.1374 |
| rbio3.3 | 318.7184 | 9.1263 | 318.7184 | 9.1195 | 318.7184 | 9.1152 | 318.7184 | 9.1147 |
| rbio3.5 | 318.7184 | 9.1223 | 318.7183 | 9.1104 | 318.7183 | 9.1063 | 318.7183 | 9.1032 |
| rbio3.7 | 318.7184 | 9.1205 | 318.7186 | 9.1068 | 318.7186 | 9.1010 | 318.7186 | 9.0980 |
| rbio3.9 | 318.7184 | 9.1198 | 318.7182 | 9.1042 | 318.7182 | 9.0968 | 318.7182 | 9.0944 |
| rbio4.4 | 318.7182 | 9.1096 | 318.7184 | 9.0935 | 318.7184 | 9.0878 | 318.7184 | 9.0850 |
| rbio5.5 | 318.7186 | 9.1085 | 318.7187 | 9.0955 | 318.7187 | 9.0930 | 318.7187 | 9.0903 |
| rbio6.8 | 318.7182 | 9.1071 | 318.7184 | 9.0886 | 318.7184 | 9.0827 | 318.7184 | 9.0782 |
| dmey | 318.7183 | 9.1028 | 318.7181 | 9.0815 | 318.7181 | 9.0763 | 318.7181 | 9.0751 |

Table A.24: Results of SureShrink with soft thresholding for DEM generation on City Site 3 including outliers

| **City Site 3**, μ = 310.7064, σ = 4.4727 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 310.7818 | 4.5063 | 310.8721 | 4.5024 | 310.8814 | 4.5014 | 310.8959 | 4.5157 |
| db2 | 310.6728 | 4.4292 | 310.7617 | 4.4678 | 310.7592 | 4.4460 | 310.7578 | 4.4400 |
| db4 | 310.6228 | 4.4172 | 310.7000 | 4.4426 | 310.7082 | 4.4577 | 310.7228 | 4.4693 |
| db6 | 310.6185 | 4.4291 | 310.6996 | 4.4596 | 310.7112 | 4.4640 | 310.7107 | 4.4608 |
| db8 | 310.5983 | 4.4265 | 310.6689 | 4.4514 | 310.6705 | 4.4538 | 310.6774 | 4.4576 |
| db10 | 310.5331 | 4.3537 | 310.6471 | 4.4562 | 310.6519 | 4.4490 | 310.6532 | 4.4535 |
| db12 | 310.5620 | 4.3973 | 310.6269 | 4.4661 | 310.6458 | 4.4742 | 310.6476 | 4.4756 |
| db20 | 310.5329 | 4.4003 | 310.5939 | 4.4698 | 310.5950 | 4.4619 | 310.5960 | 4.4575 |
| sym2 | 310.6728 | 4.4292 | 310.7617 | 4.4678 | 310.7592 | 4.4460 | 310.7578 | 4.4400 |
| sym4 | 310.6269 | 4.3925 | 310.7174 | 4.4671 | 310.7314 | 4.4751 | 310.7303 | 4.4715 |
| sym6 | 310.6156 | 4.4059 | 310.6893 | 4.4282 | 310.7216 | 4.4574 | 310.7248 | 4.4548 |
| sym8 | 310.6076 | 4.4041 | 310.6887 | 4.4484 | 310.7076 | 4.4434 | 310.7120 | 4.4425 |
| sym10 | 310.5870 | 4.3887 | 310.6744 | 4.4475 | 310.7073 | 4.4805 | 310.7000 | 4.4652 |
| sym12 | 310.5620 | 4.3891 | 310.6226 | 4.4013 | 310.6387 | 4.4080 | 310.6461 | 4.4139 |
| sym20 | 310.5446 | 4.3845 | 310.6158 | 4.4046 | 310.6233 | 4.4080 | 310.6255 | 4.4093 |
| coif1 | 310.6389 | 4.3832 | 310.7263 | 4.4565 | 310.7444 | 4.4571 | 310.7354 | 4.4514 |
| coif2 | 310.6453 | 4.4206 | 310.7209 | 4.4717 | 310.7285 | 4.4764 | 310.7379 | 4.4864 |
| coif3 | 310.6128 | 4.3965 | 310.6961 | 4.4625 | 310.7052 | 4.4631 | 310.7109 | 4.4613 |
| coif4 | 310.5852 | 4.3890 | 310.6698 | 4.4427 | 310.6977 | 4.4709 | 310.6992 | 4.4731 |
| coif5 | 310.5660 | 4.3725 | 310.6856 | 4.4612 | 310.6866 | 4.4743 | 310.6896 | 4.4735 |
| bior1.1 | 310.7818 | 4.5063 | 310.8721 | 4.5024 | 310.8814 | 4.5014 | 310.8959 | 4.5157 |
| bior1.3 | 310.7203 | 4.4728 | 310.7759 | 4.4768 | 310.7954 | 4.4749 | 310.7929 | 4.4670 |
| bior1.5 | 310.6974 | 4.4565 | 310.7733 | 4.4950 | 310.7999 | 4.5046 | 310.7896 | 4.4838 |
| bior2.2 | 310.6874 | 4.4291 | 310.7753 | 4.5043 | 310.7787 | 4.4895 | 310.7851 | 4.4933 |
| bior2.4 | 310.6719 | 4.4291 | 310.7416 | 4.4388 | 310.7541 | 4.4458 | 310.7493 | 4.4349 |
| bior2.6 | 310.6542 | 4.4111 | 310.7188 | 4.4570 | 310.7223 | 4.4612 | 310.7277 | 4.4635 |
| bior2.8 | 310.6406 | 4.3981 | 310.7138 | 4.4315 | 310.7136 | 4.4303 | 310.7169 | 4.4306 |
| bior3.1 | 310.5995 | 4.3930 | 310.6254 | 4.3765 | 310.6240 | 4.3749 | 310.6226 | 4.3747 |
| bior3.3 | 310.5837 | 4.3732 | 310.6484 | 4.4013 | 310.6499 | 4.4077 | 310.6498 | 4.4085 |
| bior3.5 | 310.6000 | 4.4003 | 310.6555 | 4.4201 | 310.6538 | 4.4188 | 310.6504 | 4.4145 |
| bior3.7 | 310.5996 | 4.3930 | 310.6329 | 4.3943 | 310.6319 | 4.3961 | 310.6339 | 4.3998 |
| bior3.9 | 310.6012 | 4.3939 | 310.6420 | 4.4131 | 310.6510 | 4.4156 | 310.6472 | 4.4134 |
| bior4.4 | 310.6403 | 4.4106 | 310.7279 | 4.4464 | 310.7424 | 4.4515 | 310.7501 | 4.4589 |
| bior5.5 | 310.5827 | 4.3997 | 310.6850 | 4.4231 | 310.7216 | 4.4556 | 310.7390 | 4.4729 |
| bior6.8 | 310.6023 | 4.4035 | 310.6902 | 4.4393 | 310.7021 | 4.4423 | 310.7101 | 4.4467 |
| rbio1.1 | 310.7818 | 4.5063 | 310.8721 | 4.5024 | 310.8814 | 4.5014 | 310.8959 | 4.5157 |
| rbio1.3 | 310.6966 | 4.4529 | 310.7616 | 4.4870 | 310.7697 | 4.4786 | 310.7810 | 4.4844 |
| rbio1.5 | 310.6834 | 4.4543 | 310.7398 | 4.4813 | 310.7574 | 4.4924 | 310.7597 | 4.4857 |
| rbio2.2 | 310.5945 | 4.3538 | 310.6234 | 4.3761 | 310.6240 | 4.3862 | 310.6166 | 4.3809 |
| rbio2.4 | 310.6399 | 4.4226 | 310.6880 | 4.4410 | 310.7226 | 4.4606 | 310.7239 | 4.4584 |
| rbio2.6 | 310.6186 | 4.4070 | 310.7029 | 4.4614 | 310.6984 | 4.4730 | 310.7126 | 4.4881 |
| rbio2.8 | 310.5978 | 4.3899 | 310.6783 | 4.4518 | 310.6985 | 4.4546 | 310.7100 | 4.4664 |
| rbio3.1 | 310.5627 | 4.3920 | 310.4950 | 4.3539 | 310.4871 | 4.4137 | 310.4887 | 4.4149 |
| rbio3.3 | 310.6247 | 4.4339 | 310.5686 | 4.4504 | 310.5940 | 4.5147 | 310.6019 | 4.5144 |
| rbio3.5 | 310.6225 | 4.4025 | 310.5927 | 4.4052 | 310.5991 | 4.4269 | 310.6064 | 4.4317 |
| rbio3.7 | 310.6324 | 4.4242 | 310.6113 | 4.4224 | 310.6239 | 4.4558 | 310.6322 | 4.4559 |
| rbio3.9 | 310.6243 | 4.4199 | 310.6074 | 4.3998 | 310.6096 | 4.4192 | 310.6075 | 4.4186 |
| rbio4.4 | 310.6346 | 4.4137 | 310.6927 | 4.4393 | 310.7066 | 4.4432 | 310.7051 | 4.4354 |
| rbio5.5 | 310.6011 | 4.3908 | 310.6545 | 4.4275 | 310.6619 | 4.4287 | 310.6625 | 4.4242 |
| rbio6.8 | 310.5991 | 4.3962 | 310.6890 | 4.4516 | 310.6996 | 4.4542 | 310.7068 | 4.4591 |
| dmey | 310.5404 | 4.3886 | 310.6010 | 4.4244 | 310.5994 | 4.4162 | 310.6057 | 4.4150 |

Table A.25: Results of SureShrink with soft thresholding for DSM generation on City Site 3 excluding outliers

| **City Site 3**, μ = 318.6986, σ = 9.0395 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 318.6986 | 8.9980 | 318.6986 | 8.9759 | 318.6986 | 8.9625 | 318.6986 | 8.9610 |
| db2 | 318.6985 | 9.0047 | 318.6985 | 8.9841 | 318.6985 | 8.9757 | 318.6986 | 8.9734 |
| db4 | 318.6987 | 9.0063 | 318.6987 | 8.9852 | 318.6987 | 8.9783 | 318.6987 | 8.9748 |
| db6 | 318.6983 | 9.0056 | 318.6984 | 8.9841 | 318.6984 | 8.9778 | 318.6984 | 8.9757 |
| db8 | 318.6986 | 9.0057 | 318.6988 | 8.9864 | 318.6987 | 8.9783 | 318.6987 | 8.9774 |
| db10 | 318.6986 | 9.0058 | 318.6985 | 8.9858 | 318.6985 | 8.9806 | 318.6984 | 8.9784 |
| db12 | 318.6984 | 9.0059 | 318.6985 | 8.9882 | 318.6985 | 8.9825 | 318.6985 | 8.9805 |
| db20 | 318.6984 | 9.0035 | 318.6984 | 8.9855 | 318.6984 | 8.9806 | 318.6984 | 8.9796 |
| sym2 | 318.6985 | 9.0047 | 318.6985 | 8.9841 | 318.6985 | 8.9757 | 318.6986 | 8.9734 |
| sym4 | 318.6984 | 9.0072 | 318.6982 | 8.9876 | 318.6982 | 8.9788 | 318.6983 | 8.9753 |
| sym6 | 318.6984 | 9.0076 | 318.6987 | 8.9887 | 318.6987 | 8.9820 | 318.6987 | 8.9784 |
| sym8 | 318.6985 | 9.0074 | 318.6983 | 8.9863 | 318.6982 | 8.9779 | 318.6982 | 8.9757 |
| sym10 | 318.6984 | 9.0076 | 318.6987 | 8.9884 | 318.6987 | 8.9802 | 318.6987 | 8.9781 |
| sym12 | 318.6987 | 9.0077 | 318.6986 | 8.9878 | 318.6986 | 8.9793 | 318.6986 | 8.9764 |
| sym20 | 318.6987 | 9.0071 | 318.6986 | 8.9872 | 318.6986 | 8.9795 | 318.6986 | 8.9776 |
| coif1 | 318.6986 | 9.0060 | 318.6984 | 8.9829 | 318.6985 | 8.9736 | 318.6985 | 8.9708 |
| coif2 | 318.6983 | 9.0080 | 318.6982 | 8.9878 | 318.6981 | 8.9798 | 318.6981 | 8.9746 |
| coif3 | 318.6984 | 9.0081 | 318.6981 | 8.9876 | 318.6982 | 8.9792 | 318.6982 | 8.9773 |
| coif4 | 318.6984 | 9.0076 | 318.6982 | 8.9874 | 318.6981 | 8.9793 | 318.6981 | 8.9756 |
| coif5 | 318.6984 | 9.0074 | 318.6982 | 8.9857 | 318.6982 | 8.9783 | 318.6982 | 8.9757 |
| bior1.1 | 318.6986 | 8.9980 | 318.6986 | 8.9759 | 318.6986 | 8.9625 | 318.6986 | 8.9610 |
| bior1.3 | 318.6986 | 9.0213 | 318.6985 | 9.0078 | 318.6985 | 9.0014 | 318.6985 | 9.0006 |
| bior1.5 | 318.6986 | 9.0255 | 318.6986 | 9.0143 | 318.6985 | 9.0091 | 318.6985 | 9.0068 |
| bior2.2 | 318.6986 | 8.9967 | 318.6985 | 8.9761 | 318.6986 | 8.9691 | 318.6986 | 8.9668 |
| bior2.4 | 318.6986 | 9.0041 | 318.6988 | 8.9873 | 318.6988 | 8.9830 | 318.6989 | 8.9804 |
| bior2.6 | 318.6986 | 9.0078 | 318.6984 | 8.9923 | 318.6983 | 8.9872 | 318.6984 | 8.9855 |
| bior2.8 | 318.6986 | 9.0098 | 318.6988 | 8.9951 | 318.6988 | 8.9910 | 318.6987 | 8.9895 |
| bior3.1 | 318.6986 | 9.0052 | 318.6986 | 8.9974 | 318.6986 | 8.9960 | 318.6986 | 8.9958 |
| bior3.3 | 318.6986 | 9.0022 | 318.6986 | 8.9934 | 318.6986 | 8.9914 | 318.6986 | 8.9913 |
| bior3.5 | 318.6986 | 9.0036 | 318.6985 | 8.9941 | 318.6986 | 8.9927 | 318.6986 | 8.9926 |
| bior3.7 | 318.6986 | 9.0054 | 318.6987 | 8.9969 | 318.6987 | 8.9947 | 318.6987 | 8.9937 |
| bior3.9 | 318.6986 | 9.0063 | 318.6985 | 8.9977 | 318.6985 | 8.9961 | 318.6985 | 8.9959 |
| bior4.4 | 318.6983 | 9.0038 | 318.6986 | 8.9812 | 318.6986 | 8.9725 | 318.6986 | 8.9681 |
| bior5.5 | 318.6988 | 9.0097 | 318.6990 | 8.9825 | 318.6989 | 8.9694 | 318.6990 | 8.9623 |
| bior6.8 | 318.6983 | 9.0056 | 318.6985 | 8.9853 | 318.6986 | 8.9774 | 318.6986 | 8.9744 |
| rbio1.1 | 318.6986 | 8.9980 | 318.6986 | 8.9759 | 318.6986 | 8.9625 | 318.6986 | 8.9610 |
| rbio1.3 | 318.6986 | 9.0022 | 318.6982 | 8.9790 | 318.6981 | 8.9680 | 318.6980 | 8.9654 |
| rbio1.5 | 318.6986 | 9.0071 | 318.6987 | 8.9841 | 318.6985 | 8.9746 | 318.6985 | 8.9709 |
| rbio2.2 | 318.6987 | 9.0177 | 318.6986 | 9.0019 | 318.6986 | 8.9938 | 318.6987 | 8.9911 |
| rbio2.4 | 318.6984 | 9.0130 | 318.6986 | 8.9937 | 318.6986 | 8.9859 | 318.6986 | 8.9818 |
| rbio2.6 | 318.6984 | 9.0135 | 318.6982 | 8.9918 | 318.6981 | 8.9829 | 318.6981 | 8.9769 |
| rbio2.8 | 318.6984 | 9.0136 | 318.6986 | 8.9924 | 318.6986 | 8.9829 | 318.6986 | 8.9777 |
| rbio3.1 | 318.6986 | 9.0390 | 318.6986 | 9.0388 | 318.6986 | 9.0381 | 318.6986 | 9.0381 |
| rbio3.3 | 318.6986 | 9.0267 | 318.6986 | 9.0202 | 318.6986 | 9.0164 | 318.6986 | 9.0163 |
| rbio3.5 | 318.6986 | 9.0227 | 318.6985 | 9.0111 | 318.6985 | 9.0065 | 318.6985 | 9.0039 |
| rbio3.7 | 318.6986 | 9.0212 | 318.6987 | 9.0087 | 318.6988 | 9.0033 | 318.6987 | 8.9993 |
| rbio3.9 | 318.6986 | 9.0205 | 318.6985 | 9.0053 | 318.6985 | 8.9999 | 318.6985 | 8.9963 |
| rbio4.4 | 318.6984 | 9.0112 | 318.6986 | 8.9952 | 318.6986 | 8.9913 | 318.6986 | 8.9881 |
| rbio5.5 | 318.6988 | 9.0117 | 318.6989 | 8.9988 | 318.6989 | 8.9961 | 318.6989 | 8.9942 |
| rbio6.8 | 318.6984 | 9.0101 | 318.6986 | 8.9916 | 318.6986 | 8.9847 | 318.6986 | 8.9810 |
| dmey | 318.6984 | 9.0068 | 318.6983 | 8.9871 | 318.6983 | 8.9825 | 318.6983 | 8.9814 |

Table A.26: Results of SureShrink with soft thresholding for DEM generation on City Site 3 excluding outliers

| **City Site 3**, μ = 310.7514, σ = 4.4699 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 310.8209 | 4.5014 | 310.9333 | 4.5234 | 310.9500 | 4.5097 | 310.9656 | 4.5229 |
| db2 | 310.7306 | 4.4382 | 310.7953 | 4.4542 | 310.8280 | 4.4591 | 310.8283 | 4.4554 |
| db4 | 310.6778 | 4.4113 | 310.7536 | 4.4601 | 310.8019 | 4.5011 | 310.8031 | 4.4910 |
| db6 | 310.6770 | 4.4328 | 310.7901 | 4.4803 | 310.8102 | 4.4968 | 310.8142 | 4.4997 |
| db8 | 310.6253 | 4.3681 | 310.7275 | 4.4305 | 310.7497 | 4.4500 | 310.7546 | 4.4480 |
| db10 | 310.6090 | 4.3859 | 310.7304 | 4.4696 | 310.7614 | 4.4794 | 310.7621 | 4.4790 |
| db12 | 310.6614 | 4.4259 | 310.6912 | 4.4365 | 310.7064 | 4.4455 | 310.7013 | 4.4380 |
| db20 | 310.6226 | 4.4095 | 310.6543 | 4.4384 | 310.6827 | 4.4668 | 310.6834 | 4.4664 |
| sym2 | 310.7306 | 4.4382 | 310.7953 | 4.4542 | 310.8280 | 4.4591 | 310.8283 | 4.4554 |
| sym4 | 310.7165 | 4.4463 | 310.8037 | 4.4768 | 310.8124 | 4.4800 | 310.8181 | 4.4890 |
| sym6 | 310.6923 | 4.4339 | 310.7616 | 4.4528 | 310.7863 | 4.4598 | 310.7926 | 4.4581 |
| sym8 | 310.6724 | 4.4198 | 310.7701 | 4.4589 | 310.7841 | 4.4797 | 310.7931 | 4.4812 |
| sym10 | 310.6668 | 4.4166 | 310.7364 | 4.4524 | 310.7502 | 4.4613 | 310.7539 | 4.4572 |
| sym12 | 310.6299 | 4.3990 | 310.7080 | 4.4192 | 310.7290 | 4.4379 | 310.7340 | 4.4418 |
| sym20 | 310.6097 | 4.3907 | 310.6914 | 4.4114 | 310.6960 | 4.4142 | 310.6965 | 4.4147 |
| coif1 | 310.6885 | 4.3907 | 310.7949 | 4.4648 | 310.8220 | 4.4812 | 310.8259 | 4.4854 |
| coif2 | 310.7217 | 4.4578 | 310.7915 | 4.4771 | 310.8055 | 4.4862 | 310.8183 | 4.4985 |
| coif3 | 310.6842 | 4.4330 | 310.7622 | 4.4522 | 310.7653 | 4.4591 | 310.7645 | 4.4594 |
| coif4 | 310.6791 | 4.4320 | 310.7558 | 4.4576 | 310.7636 | 4.4679 | 310.7642 | 4.4713 |
| coif5 | 310.6758 | 4.4345 | 310.7317 | 4.4417 | 310.7561 | 4.4529 | 310.7540 | 4.4525 |
| bior1.1 | 310.8209 | 4.5014 | 310.9333 | 4.5234 | 310.9500 | 4.5097 | 310.9656 | 4.5229 |
| bior1.3 | 310.7791 | 4.4820 | 310.8436 | 4.4947 | 310.8597 | 4.4761 | 310.8661 | 4.4780 |
| bior1.5 | 310.7593 | 4.4690 | 310.8404 | 4.5079 | 310.8394 | 4.5008 | 310.8425 | 4.4995 |
| bior2.2 | 310.7527 | 4.4491 | 310.8409 | 4.4995 | 310.8545 | 4.5026 | 310.8530 | 4.5022 |
| bior2.4 | 310.7067 | 4.4263 | 310.8050 | 4.4585 | 310.8170 | 4.4664 | 310.8218 | 4.4700 |
| bior2.6 | 310.6986 | 4.4211 | 310.7884 | 4.4653 | 310.7968 | 4.4673 | 310.7991 | 4.4679 |
| bior2.8 | 310.6861 | 4.4104 | 310.7775 | 4.4422 | 310.7819 | 4.4340 | 310.7781 | 4.4316 |
| bior3.1 | 310.6494 | 4.3565 | 310.6863 | 4.3866 | 310.6821 | 4.3781 | 310.6844 | 4.3781 |
| bior3.3 | 310.6627 | 4.3821 | 310.7059 | 4.4081 | 310.6991 | 4.3954 | 310.6989 | 4.3959 |
| bior3.5 | 310.6409 | 4.3747 | 310.7061 | 4.4004 | 310.7179 | 4.4185 | 310.7187 | 4.4182 |
| bior3.7 | 310.6521 | 4.3941 | 310.7029 | 4.4193 | 310.7021 | 4.4077 | 310.7010 | 4.4045 |
| bior3.9 | 310.6409 | 4.3909 | 310.7112 | 4.4107 | 310.7094 | 4.4096 | 310.7112 | 4.4133 |
| bior4.4 | 310.7079 | 4.4430 | 310.7975 | 4.4642 | 310.7995 | 4.4647 | 310.8171 | 4.4778 |
| bior5.5 | 310.6409 | 4.3814 | 310.7595 | 4.4463 | 310.7960 | 4.4748 | 310.8084 | 4.4842 |
| bior6.8 | 310.6748 | 4.4237 | 310.7557 | 4.4470 | 310.7678 | 4.4575 | 310.7738 | 4.4567 |
| rbio1.1 | 310.8209 | 4.5014 | 310.9333 | 4.5234 | 310.9500 | 4.5097 | 310.9656 | 4.5229 |
| rbio1.3 | 310.7393 | 4.4436 | 310.8344 | 4.5123 | 310.8502 | 4.5141 | 310.8627 | 4.5110 |
| rbio1.5 | 310.7090 | 4.4216 | 310.7915 | 4.4724 | 310.8088 | 4.4708 | 310.8126 | 4.4618 |
| rbio2.2 | 310.6630 | 4.3608 | 310.7010 | 4.3788 | 310.6936 | 4.3671 | 310.7009 | 4.3879 |
| rbio2.4 | 310.7476 | 4.4683 | 310.7780 | 4.4675 | 310.7914 | 4.4573 | 310.8013 | 4.4574 |
| rbio2.6 | 310.6927 | 4.4259 | 310.7554 | 4.4394 | 310.7686 | 4.4682 | 310.7891 | 4.4869 |
| rbio2.8 | 310.6816 | 4.4259 | 310.7398 | 4.4419 | 310.7620 | 4.4660 | 310.7752 | 4.4647 |
| rbio3.1 | 310.6098 | 4.3710 | 310.5421 | 4.3344 | 310.5283 | 4.3717 | 310.5445 | 4.3889 |
| rbio3.3 | 310.6670 | 4.4053 | 310.6259 | 4.4364 | 310.6462 | 4.5063 | 310.6331 | 4.4881 |
| rbio3.5 | 310.6697 | 4.3993 | 310.6772 | 4.4337 | 310.6945 | 4.4682 | 310.6927 | 4.4765 |
| rbio3.7 | 310.6849 | 4.4251 | 310.7035 | 4.4425 | 310.6820 | 4.4166 | 310.6914 | 4.4099 |
| rbio3.9 | 310.6788 | 4.4227 | 310.6926 | 4.4132 | 310.6991 | 4.4251 | 310.7131 | 4.4366 |
| rbio4.4 | 310.7005 | 4.4253 | 310.7581 | 4.4480 | 310.7882 | 4.4729 | 310.7864 | 4.4758 |
| rbio5.5 | 310.6575 | 4.3909 | 310.7041 | 4.3944 | 310.7106 | 4.3936 | 310.7093 | 4.3917 |
| rbio6.8 | 310.6842 | 4.4463 | 310.7461 | 4.4579 | 310.7678 | 4.4800 | 310.7644 | 4.4709 |
| dmey | 310.6207 | 4.4110 | 310.6992 | 4.4570 | 310.7019 | 4.4553 | 310.7155 | 4.4637 |

Table A.27: Results of BayesShrink with hard thresholding for DSM generation on City Site 4 including outliers

| **City Site 4**, μ = 299.6017, σ = 10.5357 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| db2 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| db4 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| db6 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| db8 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| db10 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| db12 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| db20 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| sym2 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| sym4 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| sym6 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| sym8 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| sym10 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| sym12 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| sym20 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| coif1 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| coif2 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| coif3 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| coif4 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| coif5 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior1.1 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior1.3 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior1.5 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior2.2 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior2.4 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior2.6 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior2.8 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior3.1 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior3.3 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior3.5 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior3.7 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior3.9 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior4.4 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior5.5 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior6.8 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio1.1 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio1.3 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio1.5 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio2.2 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio2.4 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio2.6 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio2.8 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio3.1 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio3.3 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio3.5 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio3.7 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio3.9 | 299.6017 | 10.5357 | 299.6017 | 10.5358 | 299.6017 | 10.5358 | 299.6017 | 10.5358 |
| rbio4.4 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio5.5 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio6.8 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| dmey | 299.6017 | 10.5357 | 299.6017 | 10.5358 | 299.6017 | 10.5358 | 299.6017 | 10.5358 |

Table A.28: Results of BayesShrink with hard thresholding for DEM generation on City Site 4 including outliers

| **City Site 4**, $\mu$ = 291.9491, $\sigma$ = 3.5185 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ |
| haar | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 |
| db2 | 291.9477 | 3.5176 | 291.9477 | 3.5176 | 291.9477 | 3.5176 | 291.9477 | 3.5176 |
| db4 | 291.9478 | 3.5182 | 291.9478 | 3.5182 | 291.9478 | 3.5182 | 291.9478 | 3.5182 |
| db6 | 291.9479 | 3.5172 | 291.9476 | 3.5172 | 291.9476 | 3.5172 | 291.9476 | 3.5172 |
| db8 | 291.9486 | 3.5158 | 291.9488 | 3.5163 | 291.9488 | 3.5163 | 291.9488 | 3.5163 |
| db10 | 291.9523 | 3.5165 | 291.9524 | 3.5165 | 291.9524 | 3.5165 | 291.9524 | 3.5165 |
| db12 | 291.9481 | 3.5149 | 291.9470 | 3.5148 | 291.9470 | 3.5148 | 291.9470 | 3.5148 |
| db20 | 291.9521 | 3.5162 | 291.9520 | 3.5158 | 291.9521 | 3.5157 | 291.9521 | 3.5157 |
| sym2 | 291.9477 | 3.5176 | 291.9477 | 3.5176 | 291.9477 | 3.5176 | 291.9477 | 3.5176 |
| sym4 | 291.9494 | 3.5181 | 291.9495 | 3.5181 | 291.9495 | 3.5181 | 291.9495 | 3.5181 |
| sym6 | 291.9475 | 3.5166 | 291.9476 | 3.5167 | 291.9476 | 3.5167 | 291.9476 | 3.5167 |
| sym8 | 291.9491 | 3.5173 | 291.9486 | 3.5174 | 291.9486 | 3.5174 | 291.9486 | 3.5174 |
| sym10 | 291.9481 | 3.5172 | 291.9482 | 3.5170 | 291.9482 | 3.5170 | 291.9482 | 3.5170 |
| sym12 | 291.9471 | 3.5164 | 291.9473 | 3.5164 | 291.9473 | 3.5164 | 291.9473 | 3.5164 |
| sym20 | 291.9469 | 3.5148 | 291.9472 | 3.5147 | 291.9472 | 3.5147 | 291.9472 | 3.5147 |
| coif1 | 291.9488 | 3.5189 | 291.9492 | 3.5191 | 291.9492 | 3.5191 | 291.9492 | 3.5191 |
| coif2 | 291.9502 | 3.5175 | 291.9501 | 3.5175 | 291.9501 | 3.5175 | 291.9501 | 3.5175 |
| coif3 | 291.9474 | 3.5173 | 291.9476 | 3.5173 | 291.9476 | 3.5173 | 291.9476 | 3.5173 |
| coif4 | 291.9484 | 3.5172 | 291.9482 | 3.5173 | 291.9482 | 3.5173 | 291.9482 | 3.5173 |
| coif5 | 291.9505 | 3.5183 | 291.9504 | 3.5183 | 291.9504 | 3.5183 | 291.9504 | 3.5183 |
| bior1.1 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 |
| bior1.3 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 |
| bior1.5 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 |
| bior2.2 | 291.9488 | 3.5186 | 291.9488 | 3.5186 | 291.9488 | 3.5186 | 291.9488 | 3.5186 |
| bior2.4 | 291.9490 | 3.5186 | 291.9490 | 3.5186 | 291.9490 | 3.5186 | 291.9490 | 3.5186 |
| bior2.6 | 291.9490 | 3.5186 | 291.9490 | 3.5186 | 291.9490 | 3.5186 | 291.9490 | 3.5186 |
| bior2.8 | 291.9490 | 3.5186 | 291.9490 | 3.5186 | 291.9490 | 3.5186 | 291.9490 | 3.5186 |
| bior3.1 | 291.9493 | 3.5191 | 291.9493 | 3.5191 | 291.9493 | 3.5191 | 291.9493 | 3.5191 |
| bior3.3 | 291.9489 | 3.5188 | 291.9489 | 3.5188 | 291.9489 | 3.5188 | 291.9489 | 3.5188 |
| bior3.5 | 291.9485 | 3.5190 | 291.9485 | 3.5190 | 291.9485 | 3.5190 | 291.9485 | 3.5190 |
| bior3.7 | 291.9485 | 3.5191 | 291.9485 | 3.5191 | 291.9485 | 3.5191 | 291.9485 | 3.5191 |
| bior3.9 | 291.9484 | 3.5190 | 291.9484 | 3.5190 | 291.9484 | 3.5190 | 291.9484 | 3.5190 |
| bior4.4 | 291.9489 | 3.5179 | 291.9489 | 3.5179 | 291.9489 | 3.5179 | 291.9489 | 3.5179 |
| bior5.5 | 291.9458 | 3.5153 | 291.9454 | 3.5155 | 291.9454 | 3.5155 | 291.9454 | 3.5155 |
| bior6.8 | 291.9491 | 3.5174 | 291.9492 | 3.5174 | 291.9492 | 3.5174 | 291.9492 | 3.5174 |
| rbio1.1 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 | 291.9490 | 3.5185 |
| rbio1.3 | 291.9496 | 3.5186 | 291.9496 | 3.5186 | 291.9496 | 3.5186 | 291.9496 | 3.5186 |
| rbio1.5 | 291.9493 | 3.5174 | 291.9497 | 3.5174 | 291.9497 | 3.5174 | 291.9497 | 3.5174 |
| rbio2.2 | 291.9496 | 3.5181 | 291.9500 | 3.5178 | 291.9500 | 3.5178 | 291.9500 | 3.5178 |
| rbio2.4 | 291.9476 | 3.5174 | 291.9473 | 3.5174 | 291.9473 | 3.5174 | 291.9473 | 3.5174 |
| rbio2.6 | 291.9460 | 3.5178 | 291.9451 | 3.5172 | 291.9452 | 3.5172 | 291.9452 | 3.5172 |
| rbio2.8 | 291.9470 | 3.5179 | 291.9475 | 3.5179 | 291.9474 | 3.5179 | 291.9474 | 3.5179 |
| rbio3.1 | 291.9508 | 3.5194 | 291.9506 | 3.5195 | 291.9507 | 3.5195 | 291.9507 | 3.5195 |
| rbio3.3 | 291.9488 | 3.5192 | 291.9494 | 3.5195 | 291.9494 | 3.5195 | 291.9494 | 3.5195 |
| rbio3.5 | 291.9493 | 3.5189 | 291.9488 | 3.5196 | 291.9489 | 3.5197 | 291.9489 | 3.5197 |
| rbio3.7 | 291.9502 | 3.5186 | 291.9512 | 3.5176 | 291.9510 | 3.5176 | 291.9513 | 3.5176 |
| rbio3.9 | 291.9534 | 3.5167 | 291.9546 | 3.5192 | 291.9530 | 3.5195 | 291.9530 | 3.5195 |
| rbio4.4 | 291.9485 | 3.5172 | 291.9486 | 3.5172 | 291.9486 | 3.5172 | 291.9486 | 3.5172 |
| rbio5.5 | 291.9482 | 3.5180 | 291.9482 | 3.5180 | 291.9482 | 3.5180 | 291.9482 | 3.5180 |
| rbio6.8 | 291.9496 | 3.5175 | 291.9489 | 3.5176 | 291.9488 | 3.5176 | 291.9488 | 3.5176 |
| dmey | 291.9484 | 3.5161 | 291.9481 | 3.5161 | 291.9481 | 3.5161 | 291.9481 | 3.5161 |

Table A.29: Results of BayesShrink with hard thresholding for DSM generation on City Site 4 excluding outliers

| **City Site 4**, μ = 299.5510, σ = 10.4379 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| db2 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| db4 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| db6 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| db8 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| db10 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| db12 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| db20 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| sym2 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| sym4 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| sym6 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| sym8 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| sym10 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| sym12 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| sym20 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| coif1 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| coif2 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| coif3 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| coif4 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| coif5 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior1.1 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior1.3 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior1.5 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior2.2 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior2.4 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior2.6 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior2.8 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior3.1 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior3.3 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior3.5 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior3.7 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior3.9 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior4.4 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior5.5 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| bior6.8 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio1.1 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio1.3 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio1.5 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio2.2 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio2.4 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio2.6 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio2.8 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio3.1 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio3.3 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio3.5 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio3.7 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio3.9 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio4.4 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio5.5 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| rbio6.8 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |
| dmey | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 | 299.5510 | 10.4379 |

Table A.30: Results of BayesShrink with hard thresholding for DEM generation on City Site 4 excluding outliers

| **City Site 4**, μ = 292.0253, σ = 3.5621 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.0253 | 3.5621 | 292.0253 | 3.5621 | 292.0253 | 3.5621 | 292.0253 | 3.5621 |
| db2 | 292.0230 | 3.5614 | 292.0229 | 3.5614 | 292.0229 | 3.5614 | 292.0229 | 3.5614 |
| db4 | 292.0216 | 3.5615 | 292.0216 | 3.5616 | 292.0216 | 3.5616 | 292.0216 | 3.5616 |
| db6 | 292.0247 | 3.5599 | 292.0245 | 3.5598 | 292.0245 | 3.5598 | 292.0245 | 3.5598 |
| db8 | 292.0252 | 3.5609 | 292.0252 | 3.5609 | 292.0252 | 3.5609 | 292.0252 | 3.5609 |
| db10 | 292.0294 | 3.5595 | 292.0284 | 3.5600 | 292.0289 | 3.5596 | 292.0289 | 3.5596 |
| db12 | 292.0277 | 3.5616 | 292.0279 | 3.5602 | 292.0279 | 3.5602 | 292.0279 | 3.5602 |
| db20 | 292.0260 | 3.5600 | 292.0263 | 3.5611 | 292.0263 | 3.5611 | 292.0263 | 3.5611 |
| sym2 | 292.0230 | 3.5614 | 292.0229 | 3.5614 | 292.0229 | 3.5614 | 292.0229 | 3.5614 |
| sym4 | 292.0257 | 3.5618 | 292.0257 | 3.5618 | 292.0257 | 3.5618 | 292.0257 | 3.5618 |
| sym6 | 292.0278 | 3.5630 | 292.0277 | 3.5630 | 292.0277 | 3.5630 | 292.0277 | 3.5630 |
| sym8 | 292.0272 | 3.5619 | 292.0272 | 3.5619 | 292.0272 | 3.5619 | 292.0272 | 3.5619 |
| sym10 | 292.0258 | 3.5612 | 292.0258 | 3.5614 | 292.0258 | 3.5614 | 292.0258 | 3.5614 |
| sym12 | 292.0255 | 3.5608 | 292.0257 | 3.5609 | 292.0257 | 3.5609 | 292.0257 | 3.5609 |
| sym20 | 292.0273 | 3.5613 | 292.0273 | 3.5613 | 292.0273 | 3.5613 | 292.0273 | 3.5613 |
| coif1 | 292.0248 | 3.5613 | 292.0249 | 3.5613 | 292.0249 | 3.5613 | 292.0249 | 3.5613 |
| coif2 | 292.0260 | 3.5613 | 292.0260 | 3.5613 | 292.0260 | 3.5613 | 292.0260 | 3.5613 |
| coif3 | 292.0262 | 3.5611 | 292.0262 | 3.5612 | 292.0262 | 3.5612 | 292.0262 | 3.5612 |
| coif4 | 292.0253 | 3.5612 | 292.0252 | 3.5610 | 292.0252 | 3.5610 | 292.0252 | 3.5610 |
| coif5 | 292.0250 | 3.5612 | 292.0251 | 3.5612 | 292.0251 | 3.5612 | 292.0251 | 3.5612 |
| bior1.1 | 292.0253 | 3.5621 | 292.0253 | 3.5621 | 292.0253 | 3.5621 | 292.0253 | 3.5621 |
| bior1.3 | 292.0254 | 3.5622 | 292.0254 | 3.5622 | 292.0254 | 3.5622 | 292.0254 | 3.5622 |
| bior1.5 | 292.0255 | 3.5621 | 292.0255 | 3.5621 | 292.0255 | 3.5621 | 292.0255 | 3.5621 |
| bior2.2 | 292.0249 | 3.5622 | 292.0249 | 3.5622 | 292.0249 | 3.5622 | 292.0249 | 3.5622 |
| bior2.4 | 292.0252 | 3.5622 | 292.0252 | 3.5622 | 292.0252 | 3.5622 | 292.0252 | 3.5622 |
| bior2.6 | 292.0253 | 3.5621 | 292.0253 | 3.5621 | 292.0253 | 3.5621 | 292.0253 | 3.5621 |
| bior2.8 | 292.0254 | 3.5622 | 292.0254 | 3.5622 | 292.0254 | 3.5622 | 292.0254 | 3.5622 |
| bior3.1 | 292.0255 | 3.5621 | 292.0255 | 3.5621 | 292.0255 | 3.5621 | 292.0255 | 3.5621 |
| bior3.3 | 292.0251 | 3.5620 | 292.0251 | 3.5620 | 292.0251 | 3.5620 | 292.0251 | 3.5620 |
| bior3.5 | 292.0246 | 3.5623 | 292.0246 | 3.5623 | 292.0246 | 3.5623 | 292.0246 | 3.5623 |
| bior3.7 | 292.0247 | 3.5623 | 292.0247 | 3.5623 | 292.0247 | 3.5623 | 292.0247 | 3.5623 |
| bior3.9 | 292.0246 | 3.5623 | 292.0246 | 3.5623 | 292.0246 | 3.5623 | 292.0246 | 3.5623 |
| bior4.4 | 292.0253 | 3.5619 | 292.0253 | 3.5619 | 292.0253 | 3.5619 | 292.0253 | 3.5619 |
| bior5.5 | 292.0253 | 3.5614 | 292.0254 | 3.5613 | 292.0254 | 3.5613 | 292.0254 | 3.5613 |
| bior6.8 | 292.0250 | 3.5611 | 292.0250 | 3.5612 | 292.0250 | 3.5612 | 292.0250 | 3.5612 |
| rbio1.1 | 292.0253 | 3.5621 | 292.0253 | 3.5621 | 292.0253 | 3.5621 | 292.0253 | 3.5621 |
| rbio1.3 | 292.0259 | 3.5624 | 292.0259 | 3.5625 | 292.0259 | 3.5625 | 292.0259 | 3.5625 |
| rbio1.5 | 292.0240 | 3.5613 | 292.0243 | 3.5613 | 292.0243 | 3.5613 | 292.0243 | 3.5613 |
| rbio2.2 | 292.0251 | 3.5616 | 292.0252 | 3.5619 | 292.0252 | 3.5619 | 292.0252 | 3.5619 |
| rbio2.4 | 292.0253 | 3.5613 | 292.0259 | 3.5621 | 292.0259 | 3.5621 | 292.0259 | 3.5621 |
| rbio2.6 | 292.0262 | 3.5626 | 292.0270 | 3.5629 | 292.0270 | 3.5629 | 292.0270 | 3.5629 |
| rbio2.8 | 292.0263 | 3.5614 | 292.0260 | 3.5611 | 292.0258 | 3.5612 | 292.0258 | 3.5612 |
| rbio3.1 | 292.0272 | 3.5652 | 292.0287 | 3.5655 | 292.0287 | 3.5655 | 292.0287 | 3.5655 |
| rbio3.3 | 292.0234 | 3.5606 | 292.0251 | 3.5608 | 292.0251 | 3.5608 | 292.0251 | 3.5608 |
| rbio3.5 | 292.0265 | 3.5640 | 292.0264 | 3.5639 | 292.0265 | 3.5639 | 292.0265 | 3.5639 |
| rbio3.7 | 292.0287 | 3.5634 | 292.0310 | 3.5631 | 292.0310 | 3.5632 | 292.0310 | 3.5632 |
| rbio3.9 | 292.0302 | 3.5613 | 292.0300 | 3.5602 | 292.0303 | 3.5601 | 292.0303 | 3.5601 |
| rbio4.4 | 292.0237 | 3.5602 | 292.0234 | 3.5603 | 292.0234 | 3.5603 | 292.0234 | 3.5603 |
| rbio5.5 | 292.0248 | 3.5619 | 292.0250 | 3.5621 | 292.0250 | 3.5621 | 292.0250 | 3.5621 |
| rbio6.8 | 292.0264 | 3.5622 | 292.0263 | 3.5622 | 292.0263 | 3.5622 | 292.0263 | 3.5622 |
| dmey | 292.0231 | 3.5600 | 292.0229 | 3.5601 | 292.0229 | 3.5601 | 292.0229 | 3.5601 |

Table A.31: Results of BayesShrink with soft thresholding for DSM generation on City Site 4 including outliers

| **City Site 4**, μ = 299.6017, σ = 10.5357 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| db2 | 299.6017 | 10.5354 | 299.6017 | 10.5353 | 299.6017 | 10.5352 | 299.6017 | 10.5352 |
| db4 | 299.6017 | 10.5350 | 299.6017 | 10.5348 | 299.6017 | 10.5347 | 299.6017 | 10.5347 |
| db6 | 299.6017 | 10.5346 | 299.6017 | 10.5342 | 299.6017 | 10.5341 | 299.6017 | 10.5341 |
| db8 | 299.6017 | 10.5341 | 299.6017 | 10.5336 | 299.6017 | 10.5335 | 299.6017 | 10.5334 |
| db10 | 299.6017 | 10.5336 | 299.6017 | 10.5330 | 299.6017 | 10.5328 | 299.6017 | 10.5327 |
| db12 | 299.6017 | 10.5332 | 299.6017 | 10.5324 | 299.6017 | 10.5322 | 299.6017 | 10.5321 |
| db20 | 299.6017 | 10.5314 | 299.6017 | 10.5301 | 299.6017 | 10.5297 | 299.6017 | 10.5296 |
| sym2 | 299.6017 | 10.5354 | 299.6017 | 10.5353 | 299.6017 | 10.5352 | 299.6017 | 10.5352 |
| sym4 | 299.6017 | 10.5352 | 299.6017 | 10.5350 | 299.6017 | 10.5350 | 299.6017 | 10.5350 |
| sym6 | 299.6017 | 10.5350 | 299.6017 | 10.5348 | 299.6017 | 10.5348 | 299.6017 | 10.5348 |
| sym8 | 299.6017 | 10.5349 | 299.6017 | 10.5346 | 299.6017 | 10.5346 | 299.6017 | 10.5346 |
| sym10 | 299.6017 | 10.5348 | 299.6017 | 10.5345 | 299.6017 | 10.5344 | 299.6017 | 10.5344 |
| sym12 | 299.6017 | 10.5347 | 299.6017 | 10.5343 | 299.6017 | 10.5342 | 299.6017 | 10.5342 |
| sym20 | 299.6017 | 10.5343 | 299.6017 | 10.5339 | 299.6017 | 10.5338 | 299.6017 | 10.5337 |
| coif1 | 299.6017 | 10.5354 | 299.6017 | 10.5353 | 299.6017 | 10.5352 | 299.6017 | 10.5352 |
| coif2 | 299.6017 | 10.5352 | 299.6017 | 10.5351 | 299.6017 | 10.5350 | 299.6017 | 10.5350 |
| coif3 | 299.6017 | 10.5351 | 299.6017 | 10.5349 | 299.6017 | 10.5348 | 299.6017 | 10.5348 |
| coif4 | 299.6017 | 10.5349 | 299.6017 | 10.5347 | 299.6017 | 10.5346 | 299.6017 | 10.5346 |
| coif5 | 299.6017 | 10.5348 | 299.6017 | 10.5345 | 299.6017 | 10.5344 | 299.6017 | 10.5344 |
| bior1.1 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior1.3 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior1.5 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| bior2.2 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior2.4 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior2.6 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior2.8 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior3.1 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior3.3 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior3.5 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior3.7 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior3.9 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 | 299.6017 | 10.5356 |
| bior4.4 | 299.6017 | 10.5353 | 299.6017 | 10.5351 | 299.6017 | 10.5351 | 299.6017 | 10.5351 |
| bior5.5 | 299.6017 | 10.5346 | 299.6017 | 10.5340 | 299.6017 | 10.5337 | 299.6017 | 10.5336 |
| bior6.8 | 299.6017 | 10.5352 | 299.6017 | 10.5350 | 299.6017 | 10.5350 | 299.6017 | 10.5349 |
| rbio1.1 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 | 299.6017 | 10.5357 |
| rbio1.3 | 299.6017 | 10.5352 | 299.6017 | 10.5351 | 299.6017 | 10.5350 | 299.6017 | 10.5350 |
| rbio1.5 | 299.6017 | 10.5351 | 299.6017 | 10.5349 | 299.6017 | 10.5348 | 299.6017 | 10.5348 |
| rbio2.2 | 299.6017 | 10.5348 | 299.6017 | 10.5345 | 299.6017 | 10.5343 | 299.6017 | 10.5343 |
| rbio2.4 | 299.6017 | 10.5347 | 299.6017 | 10.5341 | 299.6017 | 10.5339 | 299.6017 | 10.5339 |
| rbio2.6 | 299.6017 | 10.5344 | 299.6017 | 10.5337 | 299.6017 | 10.5335 | 299.6017 | 10.5334 |
| rbio2.8 | 299.6017 | 10.5342 | 299.6017 | 10.5333 | 299.6017 | 10.5330 | 299.6017 | 10.5329 |
| rbio3.1 | 299.6017 | 10.5352 | 299.6017 | 10.5350 | 299.6017 | 10.5349 | 299.6017 | 10.5349 |
| rbio3.3 | 299.6017 | 10.5339 | 299.6017 | 10.5332 | 299.6017 | 10.5330 | 299.6017 | 10.5329 |
| rbio3.5 | 299.6017 | 10.5334 | 299.6017 | 10.5322 | 299.6017 | 10.5318 | 299.6017 | 10.5316 |
| rbio3.7 | 299.6017 | 10.5329 | 299.6017 | 10.5313 | 299.6017 | 10.5308 | 299.6017 | 10.5306 |
| rbio3.9 | 299.6017 | 10.5325 | 299.6017 | 10.5305 | 299.6017 | 10.5298 | 299.6017 | 10.5296 |
| rbio4.4 | 299.6017 | 10.5351 | 299.6017 | 10.5350 | 299.6017 | 10.5349 | 299.6017 | 10.5349 |
| rbio5.5 | 299.6017 | 10.5354 | 299.6017 | 10.5353 | 299.6017 | 10.5353 | 299.6017 | 10.5353 |
| rbio6.8 | 299.6017 | 10.5348 | 299.6017 | 10.5345 | 299.6017 | 10.5344 | 299.6017 | 10.5344 |
| dmey | 299.6017 | 10.5339 | 299.6017 | 10.5334 | 299.6017 | 10.5333 | 299.6017 | 10.5332 |

Table A.32: Results of BayesShrink with soft thresholding for DEM generation on City Site 4 including outliers

| **City Site 4**, μ = 291.9491, σ = 3.5185 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 291.9498 | 3.5180 | 291.9502 | 3.5179 | 291.9502 | 3.5179 | 291.9502 | 3.5179 |
| db2 | 291.9531 | 3.5161 | 291.9552 | 3.5157 | 291.9553 | 3.5157 | 291.9554 | 3.5157 |
| db4 | 291.9606 | 3.5175 | 291.9617 | 3.5168 | 291.9621 | 3.5167 | 291.9624 | 3.5167 |
| db6 | 291.9572 | 3.5132 | 291.9609 | 3.5132 | 291.9611 | 3.5130 | 291.9608 | 3.5131 |
| db8 | 291.9607 | 3.5173 | 291.9636 | 3.5172 | 291.9638 | 3.5169 | 291.9639 | 3.5170 |
| db10 | 291.9619 | 3.5162 | 291.9660 | 3.5147 | 291.9672 | 3.5146 | 291.9669 | 3.5147 |
| db12 | 291.9638 | 3.5179 | 291.9681 | 3.5166 | 291.9695 | 3.5162 | 291.9693 | 3.5162 |
| db20 | 291.9587 | 3.5126 | 291.9680 | 3.5155 | 291.9697 | 3.5149 | 291.9700 | 3.5148 |
| sym2 | 291.9531 | 3.5161 | 291.9552 | 3.5157 | 291.9553 | 3.5157 | 291.9554 | 3.5157 |
| sym4 | 291.9576 | 3.5167 | 291.9601 | 3.5169 | 291.9609 | 3.5169 | 291.9608 | 3.5167 |
| sym6 | 291.9564 | 3.5147 | 291.9593 | 3.5154 | 291.9593 | 3.5155 | 291.9596 | 3.5155 |
| sym8 | 291.9577 | 3.5156 | 291.9597 | 3.5152 | 291.9602 | 3.5151 | 291.9604 | 3.5152 |
| sym10 | 291.9596 | 3.5159 | 291.9633 | 3.5161 | 291.9636 | 3.5156 | 291.9636 | 3.5155 |
| sym12 | 291.9597 | 3.5169 | 291.9638 | 3.5185 | 291.9637 | 3.5175 | 291.9637 | 3.5177 |
| sym20 | 291.9605 | 3.5158 | 291.9649 | 3.5159 | 291.9671 | 3.5167 | 291.9670 | 3.5168 |
| coif1 | 291.9540 | 3.5158 | 291.9555 | 3.5158 | 291.9557 | 3.5158 | 291.9559 | 3.5157 |
| coif2 | 291.9576 | 3.5174 | 291.9605 | 3.5186 | 291.9605 | 3.5188 | 291.9608 | 3.5187 |
| coif3 | 291.9565 | 3.5167 | 291.9588 | 3.5163 | 291.9592 | 3.5164 | 291.9592 | 3.5164 |
| coif4 | 291.9573 | 3.5153 | 291.9593 | 3.5160 | 291.9598 | 3.5157 | 291.9599 | 3.5157 |
| coif5 | 291.9570 | 3.5157 | 291.9607 | 3.5161 | 291.9613 | 3.5160 | 291.9617 | 3.5160 |
| bior1.1 | 291.9498 | 3.5180 | 291.9502 | 3.5179 | 291.9502 | 3.5179 | 291.9502 | 3.5179 |
| bior1.3 | 291.9478 | 3.5174 | 291.9480 | 3.5174 | 291.9480 | 3.5174 | 291.9480 | 3.5174 |
| bior1.5 | 291.9478 | 3.5174 | 291.9488 | 3.5173 | 291.9489 | 3.5172 | 291.9489 | 3.5172 |
| bior2.2 | 291.9496 | 3.5169 | 291.9497 | 3.5170 | 291.9496 | 3.5170 | 291.9496 | 3.5170 |
| bior2.4 | 291.9509 | 3.5177 | 291.9510 | 3.5174 | 291.9510 | 3.5174 | 291.9510 | 3.5174 |
| bior2.6 | 291.9502 | 3.5176 | 291.9502 | 3.5173 | 291.9502 | 3.5173 | 291.9502 | 3.5173 |
| bior2.8 | 291.9502 | 3.5173 | 291.9503 | 3.5173 | 291.9503 | 3.5173 | 291.9503 | 3.5173 |
| bior3.1 | 291.9515 | 3.5163 | 291.9518 | 3.5163 | 291.9517 | 3.5163 | 291.9517 | 3.5163 |
| bior3.3 | 291.9505 | 3.5163 | 291.9506 | 3.5163 | 291.9506 | 3.5163 | 291.9506 | 3.5163 |
| bior3.5 | 291.9500 | 3.5158 | 291.9501 | 3.5158 | 291.9501 | 3.5158 | 291.9501 | 3.5158 |
| bior3.7 | 291.9503 | 3.5157 | 291.9506 | 3.5156 | 291.9507 | 3.5156 | 291.9507 | 3.5156 |
| bior3.9 | 291.9498 | 3.5152 | 291.9499 | 3.5152 | 291.9499 | 3.5152 | 291.9499 | 3.5152 |
| bior4.4 | 291.9567 | 3.5160 | 291.9561 | 3.5146 | 291.9565 | 3.5146 | 291.9566 | 3.5146 |
| bior5.5 | 291.9633 | 3.5187 | 291.9728 | 3.5180 | 291.9754 | 3.5187 | 291.9750 | 3.5187 |
| bior6.8 | 291.9572 | 3.5169 | 291.9590 | 3.5165 | 291.9583 | 3.5166 | 291.9585 | 3.5165 |
| rbio1.1 | 291.9498 | 3.5180 | 291.9502 | 3.5179 | 291.9502 | 3.5179 | 291.9502 | 3.5179 |
| rbio1.3 | 291.9549 | 3.5185 | 291.9556 | 3.5181 | 291.9561 | 3.5179 | 291.9561 | 3.5179 |
| rbio1.5 | 291.9575 | 3.5171 | 291.9599 | 3.5168 | 291.9603 | 3.5164 | 291.9604 | 3.5164 |
| rbio2.2 | 291.9611 | 3.5143 | 291.9648 | 3.5153 | 291.9654 | 3.5154 | 291.9653 | 3.5152 |
| rbio2.4 | 291.9615 | 3.5166 | 291.9665 | 3.5184 | 291.9678 | 3.5176 | 291.9675 | 3.5179 |
| rbio2.6 | 291.9603 | 3.5140 | 291.9680 | 3.5107 | 291.9683 | 3.5106 | 291.9686 | 3.5106 |
| rbio2.8 | 291.9616 | 3.5136 | 291.9696 | 3.5119 | 291.9707 | 3.5095 | 291.9708 | 3.5098 |
| rbio3.1 | 291.9355 | 3.5154 | 291.9385 | 3.5134 | 291.9388 | 3.5134 | 291.9392 | 3.5142 |
| rbio3.3 | 291.9496 | 3.5180 | 291.9590 | 3.5131 | 291.9597 | 3.5128 | 291.9595 | 3.5127 |
| rbio3.5 | 291.9657 | 3.5162 | 291.9789 | 3.5151 | 291.9839 | 3.5136 | 291.9831 | 3.5135 |
| rbio3.7 | 291.9688 | 3.5154 | 291.9859 | 3.5131 | 291.9867 | 3.5114 | 291.9874 | 3.5116 |
| rbio3.9 | 291.9718 | 3.5158 | 291.9841 | 3.5126 | 291.9890 | 3.5115 | 291.9891 | 3.5117 |
| rbio4.4 | 291.9584 | 3.5158 | 291.9592 | 3.5162 | 291.9592 | 3.5163 | 291.9592 | 3.5163 |
| rbio5.5 | 291.9519 | 3.5151 | 291.9516 | 3.5153 | 291.9516 | 3.5153 | 291.9516 | 3.5153 |
| rbio6.8 | 291.9594 | 3.5165 | 291.9614 | 3.5160 | 291.9620 | 3.5157 | 291.9616 | 3.5158 |
| dmey | 291.9603 | 3.5167 | 291.9617 | 3.5160 | 291.9622 | 3.5158 | 291.9618 | 3.5158 |

Table A.33: Results of BayesShrink with soft thresholding for DSM generation on City Site 4 excluding outliers

| **City Site 4**, $\mu$ = 299.5510, $\sigma$ = 10.4379 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ |
| haar | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| db2 | 299.5510 | 10.4375 | 299.5510 | 10.4374 | 299.5510 | 10.4374 | 299.5510 | 10.4374 |
| db4 | 299.5510 | 10.4372 | 299.5510 | 10.4370 | 299.5510 | 10.4370 | 299.5510 | 10.4370 |
| db6 | 299.5510 | 10.4369 | 299.5510 | 10.4366 | 299.5510 | 10.4365 | 299.5510 | 10.4365 |
| db8 | 299.5510 | 10.4366 | 299.5510 | 10.4361 | 299.5510 | 10.4360 | 299.5510 | 10.4360 |
| db10 | 299.5510 | 10.4362 | 299.5510 | 10.4356 | 299.5510 | 10.4355 | 299.5510 | 10.4354 |
| db12 | 299.5510 | 10.4359 | 299.5510 | 10.4353 | 299.5510 | 10.4351 | 299.5510 | 10.4351 |
| db20 | 299.5510 | 10.4345 | 299.5510 | 10.4335 | 299.5510 | 10.4332 | 299.5510 | 10.4331 |
| sym2 | 299.5510 | 10.4375 | 299.5510 | 10.4374 | 299.5510 | 10.4374 | 299.5510 | 10.4374 |
| sym4 | 299.5510 | 10.4374 | 299.5510 | 10.4372 | 299.5510 | 10.4372 | 299.5510 | 10.4372 |
| sym6 | 299.5510 | 10.4373 | 299.5510 | 10.4371 | 299.5510 | 10.4370 | 299.5510 | 10.4370 |
| sym8 | 299.5510 | 10.4372 | 299.5510 | 10.4369 | 299.5510 | 10.4369 | 299.5510 | 10.4369 |
| sym10 | 299.5510 | 10.4371 | 299.5510 | 10.4368 | 299.5510 | 10.4368 | 299.5510 | 10.4367 |
| sym12 | 299.5510 | 10.4370 | 299.5510 | 10.4367 | 299.5510 | 10.4366 | 299.5510 | 10.4366 |
| sym20 | 299.5510 | 10.4367 | 299.5510 | 10.4364 | 299.5510 | 10.4363 | 299.5510 | 10.4362 |
| coif1 | 299.5510 | 10.4375 | 299.5510 | 10.4374 | 299.5510 | 10.4374 | 299.5510 | 10.4374 |
| coif2 | 299.5510 | 10.4374 | 299.5510 | 10.4373 | 299.5510 | 10.4372 | 299.5510 | 10.4372 |
| coif3 | 299.5510 | 10.4373 | 299.5510 | 10.4371 | 299.5510 | 10.4370 | 299.5510 | 10.4370 |
| coif4 | 299.5510 | 10.4372 | 299.5510 | 10.4370 | 299.5510 | 10.4369 | 299.5510 | 10.4369 |
| coif5 | 299.5510 | 10.4371 | 299.5510 | 10.4368 | 299.5510 | 10.4367 | 299.5510 | 10.4367 |
| bior1.1 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| bior1.3 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| bior1.5 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| bior2.2 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 |
| bior2.4 | 299.5510 | 10.4378 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 |
| bior2.6 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| bior2.8 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| bior3.1 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 |
| bior3.3 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 |
| bior3.5 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 |
| bior3.7 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 |
| bior3.9 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 | 299.5510 | 10.4377 |
| bior4.4 | 299.5510 | 10.4375 | 299.5510 | 10.4373 | 299.5510 | 10.4373 | 299.5510 | 10.4373 |
| bior5.5 | 299.5510 | 10.4369 | 299.5510 | 10.4364 | 299.5510 | 10.4361 | 299.5510 | 10.4361 |
| bior6.8 | 299.5510 | 10.4373 | 299.5510 | 10.4372 | 299.5510 | 10.4372 | 299.5510 | 10.4372 |
| rbio1.1 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 | 299.5510 | 10.4378 |
| rbio1.3 | 299.5510 | 10.4374 | 299.5510 | 10.4373 | 299.5510 | 10.4372 | 299.5510 | 10.4372 |
| rbio1.5 | 299.5510 | 10.4373 | 299.5510 | 10.4371 | 299.5510 | 10.4370 | 299.5510 | 10.4370 |
| rbio2.2 | 299.5510 | 10.4370 | 299.5510 | 10.4367 | 299.5510 | 10.4365 | 299.5510 | 10.4365 |
| rbio2.4 | 299.5510 | 10.4369 | 299.5510 | 10.4365 | 299.5510 | 10.4363 | 299.5510 | 10.4363 |
| rbio2.6 | 299.5510 | 10.4367 | 299.5510 | 10.4361 | 299.5510 | 10.4359 | 299.5510 | 10.4358 |
| rbio2.8 | 299.5510 | 10.4366 | 299.5510 | 10.4358 | 299.5510 | 10.4356 | 299.5510 | 10.4355 |
| rbio3.1 | 299.5510 | 10.4374 | 299.5510 | 10.4372 | 299.5510 | 10.4372 | 299.5510 | 10.4371 |
| rbio3.3 | 299.5510 | 10.4363 | 299.5510 | 10.4357 | 299.5510 | 10.4354 | 299.5510 | 10.4353 |
| rbio3.5 | 299.5510 | 10.4359 | 299.5510 | 10.4348 | 299.5510 | 10.4345 | 299.5510 | 10.4344 |
| rbio3.7 | 299.5510 | 10.4356 | 299.5510 | 10.4342 | 299.5510 | 10.4337 | 299.5510 | 10.4336 |
| rbio3.9 | 299.5510 | 10.4353 | 299.5510 | 10.4336 | 299.5510 | 10.4330 | 299.5510 | 10.4328 |
| rbio4.4 | 299.5510 | 10.4373 | 299.5510 | 10.4372 | 299.5510 | 10.4372 | 299.5510 | 10.4371 |
| rbio5.5 | 299.5510 | 10.4375 | 299.5510 | 10.4375 | 299.5510 | 10.4375 | 299.5510 | 10.4375 |
| rbio6.8 | 299.5510 | 10.4371 | 299.5510 | 10.4368 | 299.5510 | 10.4368 | 299.5510 | 10.4367 |
| dmey | 299.5510 | 10.4364 | 299.5510 | 10.4360 | 299.5510 | 10.4359 | 299.5510 | 10.4359 |

Table A.34: Results of BayesShrink with soft thresholding for DEM generation on City Site 4 excluding outliers

| **City Site 4**, μ = 292.0253, σ = 3.5621 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.0258 | 3.5620 | 292.0260 | 3.5619 | 292.0257 | 3.5619 | 292.0257 | 3.5619 |
| db2 | 292.0277 | 3.5599 | 292.0290 | 3.5599 | 292.0291 | 3.5598 | 292.0291 | 3.5598 |
| db4 | 292.0354 | 3.5619 | 292.0364 | 3.5607 | 292.0368 | 3.5606 | 292.0368 | 3.5606 |
| db6 | 292.0330 | 3.5573 | 292.0349 | 3.5565 | 292.0345 | 3.5570 | 292.0345 | 3.5570 |
| db8 | 292.0366 | 3.5576 | 292.0396 | 3.5564 | 292.0394 | 3.5563 | 292.0394 | 3.5563 |
| db10 | 292.0366 | 3.5604 | 292.0413 | 3.5612 | 292.0416 | 3.5610 | 292.0414 | 3.5610 |
| db12 | 292.0354 | 3.5599 | 292.0366 | 3.5565 | 292.0363 | 3.5575 | 292.0362 | 3.5574 |
| db20 | 292.0395 | 3.5615 | 292.0414 | 3.5629 | 292.0415 | 3.5621 | 292.0416 | 3.5621 |
| sym2 | 292.0277 | 3.5599 | 292.0290 | 3.5599 | 292.0291 | 3.5598 | 292.0291 | 3.5598 |
| sym4 | 292.0305 | 3.5592 | 292.0314 | 3.5593 | 292.0318 | 3.5592 | 292.0319 | 3.5591 |
| sym6 | 292.0301 | 3.5575 | 292.0322 | 3.5585 | 292.0324 | 3.5583 | 292.0326 | 3.5583 |
| sym8 | 292.0313 | 3.5578 | 292.0342 | 3.5577 | 292.0344 | 3.5576 | 292.0344 | 3.5576 |
| sym10 | 292.0326 | 3.5584 | 292.0376 | 3.5599 | 292.0385 | 3.5598 | 292.0384 | 3.5598 |
| sym12 | 292.0404 | 3.5615 | 292.0417 | 3.5608 | 292.0421 | 3.5596 | 292.0425 | 3.5607 |
| sym20 | 292.0407 | 3.5609 | 292.0408 | 3.5601 | 292.0415 | 3.5602 | 292.0412 | 3.5600 |
| coif1 | 292.0285 | 3.5577 | 292.0310 | 3.5584 | 292.0313 | 3.5585 | 292.0313 | 3.5585 |
| coif2 | 292.0316 | 3.5597 | 292.0351 | 3.5612 | 292.0347 | 3.5612 | 292.0347 | 3.5612 |
| coif3 | 292.0325 | 3.5583 | 292.0344 | 3.5583 | 292.0345 | 3.5583 | 292.0346 | 3.5583 |
| coif4 | 292.0322 | 3.5572 | 292.0363 | 3.5579 | 292.0369 | 3.5577 | 292.0368 | 3.5579 |
| coif5 | 292.0322 | 3.5578 | 292.0339 | 3.5570 | 292.0342 | 3.5568 | 292.0343 | 3.5570 |
| bior1.1 | 292.0258 | 3.5620 | 292.0260 | 3.5619 | 292.0257 | 3.5619 | 292.0257 | 3.5619 |
| bior1.3 | 292.0247 | 3.5614 | 292.0248 | 3.5614 | 292.0249 | 3.5614 | 292.0249 | 3.5614 |
| bior1.5 | 292.0246 | 3.5616 | 292.0247 | 3.5616 | 292.0247 | 3.5616 | 292.0247 | 3.5616 |
| bior2.2 | 292.0280 | 3.5609 | 292.0280 | 3.5611 | 292.0280 | 3.5611 | 292.0280 | 3.5611 |
| bior2.4 | 292.0270 | 3.5608 | 292.0274 | 3.5604 | 292.0275 | 3.5604 | 292.0275 | 3.5604 |
| bior2.6 | 292.0268 | 3.5603 | 292.0264 | 3.5607 | 292.0264 | 3.5607 | 292.0264 | 3.5607 |
| bior2.8 | 292.0260 | 3.5604 | 292.0266 | 3.5598 | 292.0265 | 3.5598 | 292.0265 | 3.5598 |
| bior3.1 | 292.0273 | 3.5606 | 292.0270 | 3.5599 | 292.0270 | 3.5599 | 292.0270 | 3.5599 |
| bior3.3 | 292.0250 | 3.5591 | 292.0250 | 3.5590 | 292.0250 | 3.5590 | 292.0250 | 3.5590 |
| bior3.5 | 292.0257 | 3.5589 | 292.0259 | 3.5589 | 292.0259 | 3.5589 | 292.0259 | 3.5589 |
| bior3.7 | 292.0272 | 3.5592 | 292.0269 | 3.5593 | 292.0269 | 3.5593 | 292.0269 | 3.5593 |
| bior3.9 | 292.0271 | 3.5592 | 292.0269 | 3.5592 | 292.0269 | 3.5592 | 292.0269 | 3.5592 |
| bior4.4 | 292.0320 | 3.5604 | 292.0314 | 3.5591 | 292.0340 | 3.5608 | 292.0333 | 3.5604 |
| bior5.5 | 292.0407 | 3.5617 | 292.0491 | 3.5596 | 292.0515 | 3.5597 | 292.0517 | 3.5597 |
| bior6.8 | 292.0318 | 3.5586 | 292.0316 | 3.5582 | 292.0337 | 3.5601 | 292.0338 | 3.5601 |
| rbio1.1 | 292.0258 | 3.5620 | 292.0260 | 3.5619 | 292.0257 | 3.5619 | 292.0257 | 3.5619 |
| rbio1.3 | 292.0318 | 3.5625 | 292.0332 | 3.5624 | 292.0342 | 3.5622 | 292.0341 | 3.5622 |
| rbio1.5 | 292.0315 | 3.5602 | 292.0325 | 3.5595 | 292.0330 | 3.5590 | 292.0331 | 3.5590 |
| rbio2.2 | 292.0338 | 3.5563 | 292.0373 | 3.5583 | 292.0371 | 3.5580 | 292.0371 | 3.5578 |
| rbio2.4 | 292.0357 | 3.5579 | 292.0422 | 3.5570 | 292.0439 | 3.5587 | 292.0439 | 3.5587 |
| rbio2.6 | 292.0359 | 3.5561 | 292.0450 | 3.5581 | 292.0448 | 3.5564 | 292.0447 | 3.5564 |
| rbio2.8 | 292.0354 | 3.5547 | 292.0459 | 3.5546 | 292.0460 | 3.5542 | 292.0467 | 3.5540 |
| rbio3.1 | 292.0165 | 3.5608 | 292.0171 | 3.5603 | 292.0128 | 3.5605 | 292.0129 | 3.5594 |
| rbio3.3 | 292.0283 | 3.5608 | 292.0328 | 3.5546 | 292.0327 | 3.5542 | 292.0325 | 3.5542 |
| rbio3.5 | 292.0392 | 3.5577 | 292.0522 | 3.5580 | 292.0526 | 3.5560 | 292.0528 | 3.5561 |
| rbio3.7 | 292.0447 | 3.5592 | 292.0561 | 3.5560 | 292.0571 | 3.5553 | 292.0582 | 3.5548 |
| rbio3.9 | 292.0419 | 3.5553 | 292.0592 | 3.5549 | 292.0622 | 3.5541 | 292.0632 | 3.5543 |
| rbio4.4 | 292.0297 | 3.5581 | 292.0313 | 3.5575 | 292.0314 | 3.5574 | 292.0314 | 3.5574 |
| rbio5.5 | 292.0302 | 3.5604 | 292.0299 | 3.5603 | 292.0300 | 3.5600 | 292.0300 | 3.5600 |
| rbio6.8 | 292.0317 | 3.5570 | 292.0360 | 3.5579 | 292.0370 | 3.5586 | 292.0368 | 3.5586 |
| dmey | 292.0409 | 3.5608 | 292.0429 | 3.5610 | 292.0431 | 3.5607 | 292.0433 | 3.5606 |

Table A.35: Results of Hypothesis Testing with hard thresholding for DSM generation on City Site 2 including outliers

| **City Site 2**, μ = 303.4698, σ = 11.7044 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 303.4698 | 11.6535 | 303.4698 | 11.5979 | 303.4695 | 11.5425 | 303.4700 | 11.5084 |
| db2 | 303.4687 | 11.6638 | 303.4694 | 11.6127 | 303.4690 | 11.5581 | 303.4698 | 11.5228 |
| db4 | 303.4695 | 11.6699 | 303.4695 | 11.6205 | 303.4690 | 11.5652 | 303.4703 | 11.5224 |
| db6 | 303.4699 | 11.6707 | 303.4697 | 11.6188 | 303.4700 | 11.5614 | 303.4714 | 11.5151 |
| db8 | 303.4692 | 11.6692 | 303.4689 | 11.6152 | 303.4691 | 11.5537 | 303.4680 | 11.5089 |
| db10 | 303.4693 | 11.6679 | 303.4690 | 11.6116 | 303.4669 | 11.5494 | 303.4675 | 11.5034 |
| db12 | 303.4704 | 11.6683 | 303.4697 | 11.6102 | 303.4684 | 11.5456 | 303.4703 | 11.4989 |
| db20 | 303.4702 | 11.6667 | 303.4699 | 11.6061 | 303.4714 | 11.5382 | 303.4739 | 11.4874 |
| sym2 | 303.4687 | 11.6638 | 303.4694 | 11.6127 | 303.4690 | 11.5581 | 303.4698 | 11.5228 |
| sym4 | 303.4703 | 11.6717 | 303.4701 | 11.6239 | 303.4691 | 11.5723 | 303.4688 | 11.5335 |
| sym6 | 303.4700 | 11.6725 | 303.4701 | 11.6253 | 303.4693 | 11.5731 | 303.4643 | 11.5399 |
| sym8 | 303.4698 | 11.6724 | 303.4695 | 11.6234 | 303.4687 | 11.5670 | 303.4697 | 11.5299 |
| sym10 | 303.4698 | 11.6724 | 303.4693 | 11.6246 | 303.4695 | 11.5725 | 303.4700 | 11.5337 |
| sym12 | 303.4698 | 11.6714 | 303.4704 | 11.6220 | 303.4710 | 11.5697 | 303.4693 | 11.5264 |
| sym20 | 303.4699 | 11.6714 | 303.4702 | 11.6215 | 303.4707 | 11.5647 | 303.4744 | 11.5370 |
| coif1 | 303.4706 | 11.6662 | 303.4702 | 11.6136 | 303.4711 | 11.5631 | 303.4748 | 11.5311 |
| coif2 | 303.4703 | 11.6720 | 303.4699 | 11.6247 | 303.4681 | 11.5719 | 303.4658 | 11.5363 |
| coif3 | 303.4701 | 11.6726 | 303.4697 | 11.6245 | 303.4681 | 11.5702 | 303.4681 | 11.5294 |
| coif4 | 303.4700 | 11.6728 | 303.4696 | 11.6243 | 303.4692 | 11.5669 | 303.4678 | 11.5290 |
| coif5 | 303.4699 | 11.6728 | 303.4696 | 11.6240 | 303.4694 | 11.5704 | 303.4680 | 11.5291 |
| bior1.1 | 303.4698 | 11.6535 | 303.4698 | 11.5979 | 303.4695 | 11.5425 | 303.4700 | 11.5084 |
| bior1.3 | 303.4698 | 11.6999 | 303.4698 | 11.6991 | 303.4680 | 11.6957 | 303.4697 | 11.6900 |
| bior1.5 | 303.4698 | 11.7092 | 303.4694 | 11.7199 | 303.4702 | 11.7257 | 303.4683 | 11.7218 |
| bior2.2 | 303.4706 | 11.6591 | 303.4699 | 11.6033 | 303.4726 | 11.5563 | 303.4749 | 11.5338 |
| bior2.4 | 303.4706 | 11.6694 | 303.4725 | 11.6278 | 303.4729 | 11.5914 | 303.4751 | 11.5698 |
| bior2.6 | 303.4706 | 11.6738 | 303.4702 | 11.6354 | 303.4687 | 11.6002 | 303.4681 | 11.5851 |
| bior2.8 | 303.4706 | 11.6764 | 303.4716 | 11.6417 | 303.4716 | 11.6147 | 303.4718 | 11.6001 |
| bior3.1 | 303.4698 | 11.6765 | 303.4697 | 11.7035 | 303.4682 | 11.7847 | 303.4713 | 11.8301 |
| bior3.3 | 303.4698 | 11.6696 | 303.4702 | 11.6616 | 303.4692 | 11.6903 | 303.4641 | 11.7114 |
| bior3.5 | 303.4698 | 11.6703 | 303.4698 | 11.6529 | 303.4721 | 11.6590 | 303.4706 | 11.6675 |
| bior3.7 | 303.4698 | 11.6712 | 303.4695 | 11.6558 | 303.4702 | 11.6604 | 303.4678 | 11.6693 |
| bior3.9 | 303.4698 | 11.6721 | 303.4698 | 11.6546 | 303.4696 | 11.6607 | 303.4689 | 11.6761 |
| bior4.4 | 303.4702 | 11.6698 | 303.4717 | 11.6199 | 303.4716 | 11.5568 | 303.4744 | 11.5073 |
| bior5.5 | 303.4695 | 11.6714 | 303.4688 | 11.6154 | 303.4671 | 11.5389 | 303.4616 | 11.4879 |
| bior6.8 | 303.4701 | 11.6718 | 303.4704 | 11.6237 | 303.4711 | 11.5699 | 303.4706 | 11.5259 |
| rbio1.1 | 303.4698 | 11.6535 | 303.4698 | 11.5979 | 303.4695 | 11.5425 | 303.4700 | 11.5084 |
| rbio1.3 | 303.4698 | 11.6657 | 303.4706 | 11.6147 | 303.4690 | 11.5632 | 303.4692 | 11.5192 |
| rbio1.5 | 303.4698 | 11.6720 | 303.4689 | 11.6273 | 303.4693 | 11.5800 | 303.4656 | 11.5384 |
| rbio2.2 | 303.4704 | 11.6826 | 303.4698 | 11.6931 | 303.4713 | 11.7510 | 303.4749 | 11.8095 |
| rbio2.4 | 303.4702 | 11.6745 | 303.4711 | 11.6420 | 303.4700 | 11.6368 | 303.4732 | 11.6461 |
| rbio2.6 | 303.4702 | 11.6750 | 303.4698 | 11.6352 | 303.4681 | 11.6048 | 303.4667 | 11.5986 |
| rbio2.8 | 303.4700 | 11.6756 | 303.4712 | 11.6348 | 303.4703 | 11.6040 | 303.4684 | 11.6004 |
| rbio3.1 | 303.4698 | 11.8663 | 303.4691 | 13.0826 | 303.4683 | 17.6436 | 303.4682 | 25.4798 |
| rbio3.3 | 303.4698 | 11.7035 | 303.4675 | 11.8878 | 303.4662 | 12.4345 | 303.4686 | 13.0754 |
| rbio3.5 | 303.4698 | 11.6877 | 303.4699 | 11.7391 | 303.4647 | 11.9565 | 303.4662 | 12.2065 |
| rbio3.7 | 303.4698 | 11.6838 | 303.4699 | 11.7003 | 303.4701 | 11.8383 | 303.4646 | 11.9961 |
| rbio3.9 | 303.4698 | 11.6824 | 303.4699 | 11.6778 | 303.4701 | 11.7726 | 303.4681 | 11.8911 |
| rbio4.4 | 303.4703 | 11.6765 | 303.4719 | 11.6464 | 303.4712 | 11.6218 | 303.4748 | 11.6008 |
| rbio5.5 | 303.4691 | 11.6762 | 303.4677 | 11.6439 | 303.4670 | 11.6170 | 303.4652 | 11.6003 |
| rbio6.8 | 303.4700 | 11.6743 | 303.4711 | 11.6327 | 303.4703 | 11.5886 | 303.4691 | 11.5587 |
| dmey | 303.4695 | 11.6721 | 303.4693 | 11.6199 | 303.4684 | 11.5557 | 303.4665 | 11.5142 |

Table A.36: Results of Hypothesis Testing with hard thresholding for DEM generation on City Site 2 including outliers

| **City Site 2**, μ = 292.9100, σ = 3.5970 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.8965 | 3.5635 | 292.8726 | 3.4909 | 292.9627 | 3.5737 | 293.0526 | 3.4500 |
| db2 | 292.7831 | 3.4080 | 292.7675 | 3.2869 | 292.7407 | 3.1920 | 292.6735 | 2.9808 |
| db4 | 292.7222 | 3.3551 | 292.6564 | 3.1830 | 292.5078 | 2.9313 | 292.4836 | 2.8052 |
| db6 | 292.7026 | 3.3310 | 292.6005 | 3.1110 | 292.4917 | 2.8759 | 292.4374 | 2.8167 |
| db8 | 292.6667 | 3.2742 | 292.5206 | 2.9935 | 292.3752 | 2.7326 | 292.2966 | 2.6574 |
| db10 | 292.6845 | 3.3036 | 292.5076 | 2.9913 | 292.3704 | 2.7265 | 292.2463 | 2.6379 |
| db12 | 292.6473 | 3.2542 | 292.4979 | 3.0093 | 292.3194 | 2.6253 | 292.1820 | 2.5936 |
| db20 | 292.6114 | 3.2140 | 292.3783 | 2.7720 | 292.2550 | 2.5935 | 292.1388 | 2.5687 |
| sym2 | 292.7831 | 3.4080 | 292.7675 | 3.2869 | 292.7407 | 3.1920 | 292.6735 | 2.9808 |
| sym4 | 292.7601 | 3.4102 | 292.6841 | 3.2482 | 292.6032 | 2.9386 | 292.5633 | 2.8042 |
| sym6 | 292.7454 | 3.3840 | 292.6331 | 3.1503 | 292.5916 | 2.9747 | 292.5309 | 2.7933 |
| sym8 | 292.7333 | 3.3718 | 292.6269 | 3.1478 | 292.5327 | 2.9283 | 292.5161 | 2.8305 |
| sym10 | 292.7142 | 3.3430 | 292.5958 | 3.1029 | 292.4900 | 2.8270 | 292.4533 | 2.7624 |
| sym12 | 292.6766 | 3.3160 | 292.5791 | 3.1156 | 292.4495 | 2.7561 | 292.3589 | 2.6980 |
| sym20 | 292.6462 | 3.2654 | 292.5332 | 3.0455 | 292.4111 | 2.7182 | 292.3142 | 2.6028 |
| coif1 | 292.7645 | 3.3954 | 292.7324 | 3.2823 | 292.6759 | 3.1064 | 292.6269 | 2.8595 |
| coif2 | 292.7820 | 3.4378 | 292.7274 | 3.2874 | 292.6281 | 3.0419 | 292.6178 | 2.8779 |
| coif3 | 292.7567 | 3.3946 | 292.6785 | 3.2135 | 292.5349 | 2.8641 | 292.4372 | 2.6854 |
| coif4 | 292.7263 | 3.3642 | 292.6474 | 3.1744 | 292.5379 | 2.9237 | 292.4488 | 2.8151 |
| coif5 | 292.7095 | 3.3428 | 292.6153 | 3.1183 | 292.4911 | 2.8163 | 292.3793 | 2.5962 |
| bior1.1 | 292.8965 | 3.5635 | 292.8726 | 3.4909 | 292.9627 | 3.5737 | 293.0526 | 3.4500 |
| bior1.3 | 292.8203 | 3.4918 | 292.7309 | 3.3559 | 292.6346 | 3.0884 | 292.6726 | 3.1817 |
| bior1.5 | 292.7726 | 3.4286 | 292.7108 | 3.3264 | 292.5390 | 3.0596 | 292.4604 | 2.8750 |
| bior2.2 | 292.8645 | 3.5128 | 292.9127 | 3.5001 | 292.8844 | 3.3961 | 292.8375 | 3.2002 |
| bior2.4 | 292.8145 | 3.4471 | 292.8279 | 3.4116 | 292.8063 | 3.2760 | 292.7638 | 3.1481 |
| bior2.6 | 292.7584 | 3.3715 | 292.7843 | 3.3522 | 292.7394 | 3.1759 | 292.7489 | 3.0914 |
| bior2.8 | 292.7381 | 3.3451 | 292.7823 | 3.3409 | 292.6695 | 3.0870 | 292.6657 | 2.9747 |
| bior3.1 | 292.7300 | 3.3614 | 292.6029 | 3.1120 | 292.4114 | 2.8460 | 292.2615 | 2.8954 |
| bior3.3 | 292.7631 | 3.4094 | 292.6995 | 3.2597 | 292.5830 | 2.9145 | 292.5400 | 3.0166 |
| bior3.5 | 292.7456 | 3.3825 | 292.6896 | 3.2188 | 292.5536 | 3.0261 | 292.4778 | 2.9766 |
| bior3.7 | 292.7466 | 3.3846 | 292.6849 | 3.2368 | 292.5182 | 2.8734 | 292.3749 | 2.7354 |
| bior3.9 | 292.7435 | 3.3803 | 292.6458 | 3.1876 | 292.5918 | 2.9401 | 292.4422 | 2.7584 |
| bior4.4 | 292.7957 | 3.4483 | 292.7323 | 3.3059 | 292.7271 | 3.1641 | 292.7048 | 3.0340 |
| bior5.5 | 292.7466 | 3.4070 | 292.6622 | 3.1545 | 292.5123 | 2.9073 | 292.4323 | 2.6875 |
| bior6.8 | 292.7448 | 3.3691 | 292.6637 | 3.2187 | 292.6269 | 3.0413 | 292.5867 | 2.8606 |
| rbio1.1 | 292.8965 | 3.5635 | 292.8726 | 3.4909 | 292.9627 | 3.5737 | 293.0526 | 3.4500 |
| rbio1.3 | 292.7407 | 3.3546 | 292.6823 | 3.2271 | 292.6608 | 3.0724 | 292.6358 | 2.9680 |
| rbio1.5 | 292.7241 | 3.3635 | 292.6693 | 3.1671 | 292.5779 | 2.9715 | 292.5346 | 2.8500 |
| rbio2.2 | 292.6643 | 3.2935 | 292.4153 | 2.9290 | 292.2901 | 2.5588 | 292.0054 | 2.1158 |
| rbio2.4 | 292.7708 | 3.3908 | 292.5518 | 3.0241 | 292.3809 | 2.6627 | 292.1911 | 2.4119 |
| rbio2.6 | 292.7525 | 3.3889 | 292.5876 | 3.0836 | 292.3340 | 2.6198 | 292.2147 | 2.4425 |
| rbio2.8 | 292.7334 | 3.3640 | 292.5267 | 3.0052 | 292.3433 | 2.6237 | 292.1879 | 2.4930 |
| rbio3.1 | 292.1987 | 2.7622 | 291.4852 | 2.0921 | 288.1218 | 7.3238 | 285.7713 | 13.8108 |
| rbio3.3 | 292.5348 | 3.0907 | 292.0263 | 2.4087 | 291.4896 | 2.0606 | 290.8732 | 2.0736 |
| rbio3.5 | 292.6182 | 3.2440 | 292.2692 | 2.7285 | 291.8590 | 2.1693 | 291.4300 | 1.9447 |
| rbio3.7 | 292.6642 | 3.3061 | 292.3714 | 2.7493 | 291.9942 | 2.1710 | 291.6138 | 2.1401 |
| rbio3.9 | 292.6786 | 3.3124 | 292.3879 | 2.8074 | 292.0508 | 2.2694 | 291.5956 | 2.0794 |
| rbio4.4 | 292.7278 | 3.3368 | 292.5908 | 3.1104 | 292.5231 | 2.8901 | 292.5008 | 2.7502 |
| rbio5.5 | 292.7410 | 3.3843 | 292.6198 | 3.1215 | 292.5374 | 2.8682 | 292.5135 | 2.7346 |
| rbio6.8 | 292.7365 | 3.3745 | 292.5833 | 3.0920 | 292.4979 | 2.8935 | 292.4481 | 2.7795 |
| dmey | 292.6335 | 3.2538 | 292.4897 | 2.9237 | 292.4326 | 2.7888 | 292.3312 | 2.6561 |

Table A.37: Results of Hypothesis Testing with hard thresholding for DSM generation on City Site 2 excluding outliers

| **City Site 2**, μ = 303.4662, σ = 11.5645 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 303.4662 | 11.5179 | 303.4662 | 11.4635 | 303.4661 | 11.4097 | 303.4669 | 11.3750 |
| db2 | 303.4653 | 11.5302 | 303.4661 | 11.4821 | 303.4656 | 11.4270 | 303.4673 | 11.3901 |
| db4 | 303.4660 | 11.5363 | 303.4660 | 11.4900 | 303.4650 | 11.4346 | 303.4666 | 11.3914 |
| db6 | 303.4665 | 11.5377 | 303.4664 | 11.4891 | 303.4665 | 11.4331 | 303.4684 | 11.3877 |
| db8 | 303.4658 | 11.5362 | 303.4656 | 11.4849 | 303.4659 | 11.4239 | 303.4648 | 11.3784 |
| db10 | 303.4657 | 11.5352 | 303.4651 | 11.4819 | 303.4627 | 11.4201 | 303.4636 | 11.3733 |
| db12 | 303.4668 | 11.5358 | 303.4659 | 11.4813 | 303.4647 | 11.4187 | 303.4662 | 11.3699 |
| db20 | 303.4665 | 11.5348 | 303.4661 | 11.4784 | 303.4680 | 11.4112 | 303.4705 | 11.3566 |
| sym2 | 303.4653 | 11.5302 | 303.4661 | 11.4821 | 303.4656 | 11.4270 | 303.4673 | 11.3901 |
| sym4 | 303.4667 | 11.5382 | 303.4666 | 11.4940 | 303.4654 | 11.4435 | 303.4650 | 11.4033 |
| sym6 | 303.4664 | 11.5390 | 303.4665 | 11.4946 | 303.4653 | 11.4413 | 303.4612 | 11.4097 |
| sym8 | 303.4662 | 11.5392 | 303.4661 | 11.4934 | 303.4657 | 11.4378 | 303.4667 | 11.3988 |
| sym10 | 303.4662 | 11.5393 | 303.4656 | 11.4936 | 303.4661 | 11.4412 | 303.4663 | 11.4005 |
| sym12 | 303.4663 | 11.5381 | 303.4666 | 11.4924 | 303.4673 | 11.4405 | 303.4653 | 11.3960 |
| sym20 | 303.4663 | 11.5382 | 303.4666 | 11.4915 | 303.4670 | 11.4346 | 303.4703 | 11.4075 |
| coif1 | 303.4669 | 11.5327 | 303.4665 | 11.4831 | 303.4674 | 11.4333 | 303.4708 | 11.4010 |
| coif2 | 303.4666 | 11.5384 | 303.4663 | 11.4937 | 303.4640 | 11.4413 | 303.4626 | 11.4059 |
| coif3 | 303.4664 | 11.5393 | 303.4661 | 11.4942 | 303.4647 | 11.4405 | 303.4628 | 11.3999 |
| coif4 | 303.4663 | 11.5394 | 303.4660 | 11.4939 | 303.4654 | 11.4369 | 303.4634 | 11.3967 |
| coif5 | 303.4662 | 11.5396 | 303.4660 | 11.4937 | 303.4658 | 11.4401 | 303.4649 | 11.3977 |
| bior1.1 | 303.4662 | 11.5179 | 303.4662 | 11.4635 | 303.4661 | 11.4097 | 303.4669 | 11.3750 |
| bior1.3 | 303.4662 | 11.5652 | 303.4662 | 11.5658 | 303.4646 | 11.5642 | 303.4665 | 11.5576 |
| bior1.5 | 303.4662 | 11.5744 | 303.4660 | 11.5879 | 303.4663 | 11.5940 | 303.4649 | 11.5897 |
| bior2.2 | 303.4668 | 11.5260 | 303.4662 | 11.4717 | 303.4688 | 11.4242 | 303.4704 | 11.3969 |
| bior2.4 | 303.4668 | 11.5361 | 303.4685 | 11.4961 | 303.4688 | 11.4582 | 303.4717 | 11.4349 |
| bior2.6 | 303.4668 | 11.5405 | 303.4665 | 11.5042 | 303.4650 | 11.4685 | 303.4639 | 11.4518 |
| bior2.8 | 303.4668 | 11.5429 | 303.4677 | 11.5099 | 303.4676 | 11.4816 | 303.4673 | 11.4645 |
| bior3.1 | 303.4662 | 11.5390 | 303.4661 | 11.5614 | 303.4644 | 11.6170 | 303.4692 | 11.6654 |
| bior3.3 | 303.4662 | 11.5352 | 303.4664 | 11.5234 | 303.4649 | 11.5447 | 303.4591 | 11.5615 |
| bior3.5 | 303.4662 | 11.5365 | 303.4662 | 11.5188 | 303.4676 | 11.5272 | 303.4668 | 11.5367 |
| bior3.7 | 303.4662 | 11.5377 | 303.4660 | 11.5200 | 303.4666 | 11.5249 | 303.4644 | 11.5375 |
| bior3.9 | 303.4662 | 11.5386 | 303.4661 | 11.5199 | 303.4660 | 11.5251 | 303.4662 | 11.5483 |
| bior4.4 | 303.4665 | 11.5364 | 303.4676 | 11.4880 | 303.4678 | 11.4251 | 303.4705 | 11.3746 |
| bior5.5 | 303.4660 | 11.5373 | 303.4653 | 11.4842 | 303.4636 | 11.4080 | 303.4587 | 11.3555 |
| bior6.8 | 303.4663 | 11.5386 | 303.4668 | 11.4932 | 303.4676 | 11.4395 | 303.4676 | 11.3970 |
| rbio1.1 | 303.4662 | 11.5179 | 303.4662 | 11.4635 | 303.4661 | 11.4097 | 303.4669 | 11.3750 |
| rbio1.3 | 303.4662 | 11.5312 | 303.4667 | 11.4814 | 303.4654 | 11.4317 | 303.4649 | 11.3852 |
| rbio1.5 | 303.4662 | 11.5375 | 303.4655 | 11.4962 | 303.4652 | 11.4489 | 303.4611 | 11.4088 |
| rbio2.2 | 303.4668 | 11.5477 | 303.4664 | 11.5607 | 303.4673 | 11.6200 | 303.4717 | 11.6795 |
| rbio2.4 | 303.4666 | 11.5399 | 303.4672 | 11.5093 | 303.4659 | 11.5044 | 303.4685 | 11.5124 |
| rbio2.6 | 303.4664 | 11.5403 | 303.4663 | 11.5031 | 303.4644 | 11.4736 | 303.4636 | 11.4668 |
| rbio2.8 | 303.4664 | 11.5411 | 303.4674 | 11.5022 | 303.4665 | 11.4715 | 303.4637 | 11.4687 |
| rbio3.1 | 303.4662 | 11.7232 | 303.4656 | 12.9197 | 303.4657 | 17.4653 | 303.4648 | 25.6441 |
| rbio3.3 | 303.4662 | 11.5650 | 303.4640 | 11.7449 | 303.4627 | 12.2920 | 303.4643 | 12.9276 |
| rbio3.5 | 303.4662 | 11.5505 | 303.4662 | 11.5989 | 303.4609 | 11.8200 | 303.4627 | 12.0753 |
| rbio3.7 | 303.4662 | 11.5470 | 303.4663 | 11.5617 | 303.4670 | 11.6997 | 303.4615 | 11.8568 |
| rbio3.9 | 303.4662 | 11.5459 | 303.4662 | 11.5413 | 303.4666 | 11.6403 | 303.4659 | 11.7606 |
| rbio4.4 | 303.4666 | 11.5424 | 303.4677 | 11.5135 | 303.4669 | 11.4897 | 303.4704 | 11.4679 |
| rbio5.5 | 303.4656 | 11.5422 | 303.4644 | 11.5119 | 303.4637 | 11.4855 | 303.4645 | 11.4705 |
| rbio6.8 | 303.4664 | 11.5405 | 303.4674 | 11.5010 | 303.4666 | 11.4575 | 303.4651 | 11.4270 |
| dmey | 303.4660 | 11.5395 | 303.4658 | 11.4903 | 303.4649 | 11.4253 | 303.4626 | 11.3851 |

Table A.38: Results of Hypothesis Testing with hard thresholding for DEM generation on City Site 2 excluding outliers

| **City Site 2**, μ = 292.9549, σ = 3.6377 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.9509 | 3.6276 | 292.9235 | 3.5390 | 293.0521 | 3.6321 | 293.1390 | 3.5636 |
| db2 | 292.8669 | 3.5335 | 292.8268 | 3.3242 | 292.7362 | 3.1150 | 292.6964 | 2.9623 |
| db4 | 292.7871 | 3.4104 | 292.6843 | 3.2172 | 292.5367 | 2.9336 | 292.5469 | 2.8513 |
| db6 | 292.7782 | 3.4153 | 292.6667 | 3.2057 | 292.5293 | 2.9116 | 292.4597 | 2.8250 |
| db8 | 292.7231 | 3.3469 | 292.6154 | 3.1176 | 292.4105 | 2.7149 | 292.3659 | 2.6639 |
| db10 | 292.7593 | 3.4060 | 292.6003 | 3.0987 | 292.4107 | 2.6832 | 292.2677 | 2.5558 |
| db12 | 292.7357 | 3.3606 | 292.5542 | 3.0334 | 292.3907 | 2.7159 | 292.2985 | 2.6816 |
| db20 | 292.6883 | 3.2960 | 292.5117 | 2.9624 | 292.2697 | 2.5680 | 292.1683 | 2.6154 |
| sym2 | 292.8669 | 3.5335 | 292.8268 | 3.3242 | 292.7362 | 3.1150 | 292.6964 | 2.9623 |
| sym4 | 292.8227 | 3.4675 | 292.7486 | 3.3243 | 292.6667 | 3.0289 | 292.6169 | 2.8461 |
| sym6 | 292.8098 | 3.4509 | 292.6908 | 3.2167 | 292.5875 | 2.9255 | 292.5543 | 2.7776 |
| sym8 | 292.8012 | 3.4479 | 292.6749 | 3.2003 | 292.5768 | 3.0226 | 292.5149 | 2.7853 |
| sym10 | 292.7946 | 3.4465 | 292.6556 | 3.1923 | 292.6138 | 3.0527 | 292.5553 | 2.8776 |
| sym12 | 292.7306 | 3.3621 | 292.6741 | 3.2355 | 292.5538 | 2.9084 | 292.4290 | 2.7352 |
| sym20 | 292.7064 | 3.3352 | 292.6278 | 3.1788 | 292.4757 | 2.8212 | 292.3329 | 2.5914 |
| coif1 | 292.8415 | 3.4865 | 292.7493 | 3.2651 | 292.7253 | 3.1247 | 292.6870 | 2.9090 |
| coif2 | 292.8347 | 3.4767 | 292.7701 | 3.3310 | 292.6551 | 3.0641 | 292.6926 | 2.9482 |
| coif3 | 292.8037 | 3.4356 | 292.7148 | 3.2660 | 292.6035 | 2.9433 | 292.4894 | 2.7234 |
| coif4 | 292.7927 | 3.4222 | 292.6636 | 3.1922 | 292.5803 | 2.9930 | 292.4914 | 2.8300 |
| coif5 | 292.7820 | 3.4174 | 292.6503 | 3.1682 | 292.5587 | 2.8978 | 292.4283 | 2.6938 |
| bior1.1 | 292.9509 | 3.6276 | 292.9235 | 3.5390 | 293.0521 | 3.6321 | 293.1390 | 3.5636 |
| bior1.3 | 292.8874 | 3.5809 | 292.8274 | 3.5081 | 292.7261 | 3.1824 | 292.7454 | 3.1661 |
| bior1.5 | 292.8538 | 3.5488 | 292.7634 | 3.4066 | 292.5962 | 3.2018 | 292.5341 | 2.9558 |
| bior2.2 | 292.9307 | 3.5942 | 292.9540 | 3.5516 | 292.9069 | 3.3760 | 292.8958 | 3.2237 |
| bior2.4 | 292.8664 | 3.4958 | 292.8950 | 3.4823 | 292.8901 | 3.3845 | 292.8424 | 3.2588 |
| bior2.6 | 292.8272 | 3.4470 | 292.8514 | 3.4150 | 292.7771 | 3.2446 | 292.7874 | 3.1304 |
| bior2.8 | 292.8168 | 3.4225 | 292.8536 | 3.4182 | 292.7524 | 3.2198 | 292.7382 | 3.0171 |
| bior3.1 | 292.8065 | 3.4585 | 292.6930 | 3.2577 | 292.5388 | 3.0484 | 292.4264 | 2.9328 |
| bior3.3 | 292.8155 | 3.4535 | 292.7618 | 3.3117 | 292.6587 | 2.9751 | 292.5267 | 2.9258 |
| bior3.5 | 292.8176 | 3.4626 | 292.7742 | 3.3500 | 292.5664 | 2.9840 | 292.4968 | 2.9360 |
| bior3.7 | 292.8050 | 3.4534 | 292.7669 | 3.3508 | 292.6193 | 3.0027 | 292.5467 | 3.0036 |
| bior3.9 | 292.7958 | 3.4351 | 292.7174 | 3.2658 | 292.6782 | 3.0354 | 292.4716 | 2.7709 |
| bior4.4 | 292.8422 | 3.4859 | 292.8144 | 3.3892 | 292.8169 | 3.2732 | 292.6959 | 2.9923 |
| bior5.5 | 292.8176 | 3.4781 | 292.7373 | 3.2894 | 292.5715 | 2.9459 | 292.4317 | 2.6451 |
| bior6.8 | 292.8086 | 3.4485 | 292.7559 | 3.3309 | 292.6728 | 3.1119 | 292.6461 | 2.9473 |
| rbio1.1 | 292.9509 | 3.6276 | 292.9235 | 3.5390 | 293.0521 | 3.6321 | 293.1390 | 3.5636 |
| rbio1.3 | 292.7809 | 3.3957 | 292.7716 | 3.3701 | 292.7390 | 3.1812 | 292.6910 | 3.0269 |
| rbio1.5 | 292.7630 | 3.3761 | 292.6964 | 3.2123 | 292.6222 | 3.0473 | 292.5746 | 2.9346 |
| rbio2.2 | 292.7252 | 3.3153 | 292.4886 | 2.9339 | 292.3006 | 2.4171 | 292.1047 | 2.2028 |
| rbio2.4 | 292.8242 | 3.4653 | 292.6223 | 3.1284 | 292.4248 | 2.7320 | 292.2973 | 2.4880 |
| rbio2.6 | 292.8021 | 3.4406 | 292.5950 | 3.0829 | 292.3854 | 2.7376 | 292.3279 | 2.5837 |
| rbio2.8 | 292.7826 | 3.4153 | 292.6119 | 3.1444 | 292.4446 | 2.7756 | 292.2853 | 2.5857 |
| rbio3.1 | 292.2128 | 2.7552 | 291.6265 | 2.1082 | 289.3127 | 6.6307 | 276.2405 | 32.5903 |
| rbio3.3 | 292.6169 | 3.1801 | 292.1249 | 2.4885 | 291.7632 | 2.0817 | 291.0589 | 2.1562 |
| rbio3.5 | 292.6905 | 3.2862 | 292.3214 | 2.7800 | 291.8994 | 2.2053 | 291.4673 | 1.9625 |
| rbio3.7 | 292.7274 | 3.3317 | 292.4426 | 2.8139 | 292.1211 | 2.3025 | 291.7332 | 2.1045 |
| rbio3.9 | 292.7539 | 3.3781 | 292.4260 | 2.8932 | 292.0725 | 2.2796 | 291.6382 | 2.1542 |
| rbio4.4 | 292.8126 | 3.4341 | 292.6448 | 3.1967 | 292.5921 | 2.9391 | 292.5490 | 2.7681 |
| rbio5.5 | 292.7807 | 3.4500 | 292.6923 | 3.2104 | 292.5981 | 2.9891 | 292.5875 | 2.8396 |
| rbio6.8 | 292.7811 | 3.4041 | 292.6359 | 3.1415 | 292.5551 | 2.9841 | 292.5508 | 2.9200 |
| dmey | 292.7080 | 3.3285 | 292.5663 | 3.0701 | 292.4691 | 2.8483 | 292.3580 | 2.6583 |

Table A.39: Results of Hypothesis Testing with soft thresholding for DSM generation on City Site 2 including outliers

| **City Site 2**, μ = 303.4698, σ = 11.7044 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 303.4698 | 11.6119 | 303.4698 | 11.4660 | 303.4701 | 11.2185 | 303.4850 | 10.8861 |
| db2 | 303.4685 | 11.6438 | 303.4705 | 11.5432 | 303.4767 | 11.3400 | 303.4722 | 11.0025 |
| db4 | 303.4696 | 11.6546 | 303.4681 | 11.5653 | 303.4743 | 11.3858 | 303.4768 | 11.0673 |
| db6 | 303.4702 | 11.6568 | 303.4686 | 11.5686 | 303.4709 | 11.3923 | 303.4781 | 11.0548 |
| db8 | 303.4695 | 11.6564 | 303.4667 | 11.5691 | 303.4666 | 11.3942 | 303.4706 | 11.0512 |
| db10 | 303.4695 | 11.6563 | 303.4699 | 11.5684 | 303.4653 | 11.3951 | 303.4679 | 11.0679 |
| db12 | 303.4701 | 11.6577 | 303.4697 | 11.5707 | 303.4665 | 11.3968 | 303.4747 | 11.0565 |
| db20 | 303.4701 | 11.6579 | 303.4688 | 11.5696 | 303.4668 | 11.3994 | 303.4683 | 11.0473 |
| sym2 | 303.4685 | 11.6438 | 303.4705 | 11.5432 | 303.4767 | 11.3400 | 303.4722 | 11.0025 |
| sym4 | 303.4704 | 11.6553 | 303.4704 | 11.5639 | 303.4656 | 11.3908 | 303.4666 | 11.0730 |
| sym6 | 303.4702 | 11.6573 | 303.4702 | 11.5727 | 303.4693 | 11.3980 | 303.4601 | 11.0881 |
| sym8 | 303.4701 | 11.6582 | 303.4697 | 11.5707 | 303.4726 | 11.3980 | 303.4651 | 11.0851 |
| sym10 | 303.4701 | 11.6587 | 303.4700 | 11.5743 | 303.4703 | 11.4093 | 303.4638 | 11.0905 |
| sym12 | 303.4695 | 11.6578 | 303.4707 | 11.5720 | 303.4695 | 11.4088 | 303.4667 | 11.0837 |
| sym20 | 303.4695 | 11.6585 | 303.4703 | 11.5732 | 303.4690 | 11.4089 | 303.4755 | 11.1011 |
| coif1 | 303.4709 | 11.6470 | 303.4689 | 11.5427 | 303.4692 | 11.3494 | 303.4771 | 11.0122 |
| coif2 | 303.4704 | 11.6556 | 303.4689 | 11.5652 | 303.4692 | 11.3867 | 303.4670 | 11.0731 |
| coif3 | 303.4703 | 11.6576 | 303.4690 | 11.5696 | 303.4666 | 11.4012 | 303.4630 | 11.0822 |
| coif4 | 303.4702 | 11.6584 | 303.4692 | 11.5715 | 303.4720 | 11.4004 | 303.4655 | 11.0736 |
| coif5 | 303.4701 | 11.6589 | 303.4693 | 11.5725 | 303.4693 | 11.4084 | 303.4669 | 11.0810 |
| bior1.1 | 303.4698 | 11.6119 | 303.4698 | 11.4660 | 303.4701 | 11.2185 | 303.4850 | 10.8861 |
| bior1.3 | 303.4698 | 11.6793 | 303.4713 | 11.6263 | 303.4680 | 11.4875 | 303.4754 | 11.2098 |
| bior1.5 | 303.4698 | 11.6933 | 303.4671 | 11.6618 | 303.4692 | 11.5472 | 303.4641 | 11.2747 |
| bior2.2 | 303.4705 | 11.6406 | 303.4678 | 11.5300 | 303.4705 | 11.3371 | 303.4754 | 11.0205 |
| bior2.4 | 303.4707 | 11.6532 | 303.4738 | 11.5627 | 303.4716 | 11.3889 | 303.4761 | 11.1018 |
| bior2.6 | 303.4708 | 11.6588 | 303.4688 | 11.5706 | 303.4717 | 11.4058 | 303.4676 | 11.1320 |
| bior2.8 | 303.4709 | 11.6621 | 303.4726 | 11.5806 | 303.4733 | 11.4260 | 303.4693 | 11.1474 |
| bior3.1 | 303.4698 | 11.6510 | 303.4733 | 11.5882 | 303.4728 | 11.5391 | 303.4933 | 11.4153 |
| bior3.3 | 303.4698 | 11.6512 | 303.4705 | 11.5797 | 303.4743 | 11.4593 | 303.4598 | 11.2751 |
| bior3.5 | 303.4698 | 11.6538 | 303.4702 | 11.5734 | 303.4691 | 11.4514 | 303.4652 | 11.2294 |
| bior3.7 | 303.4698 | 11.6557 | 303.4693 | 11.5820 | 303.4711 | 11.4552 | 303.4689 | 11.2268 |
| bior3.9 | 303.4698 | 11.6571 | 303.4701 | 11.5783 | 303.4698 | 11.4542 | 303.4698 | 11.2078 |
| bior4.4 | 303.4703 | 11.6535 | 303.4734 | 11.5638 | 303.4702 | 11.3781 | 303.4748 | 11.0402 |
| bior5.5 | 303.4694 | 11.6550 | 303.4675 | 11.5668 | 303.4665 | 11.3734 | 303.4595 | 11.0172 |
| bior6.8 | 303.4702 | 11.6574 | 303.4713 | 11.5716 | 303.4725 | 11.4034 | 303.4670 | 11.0859 |
| rbio1.1 | 303.4698 | 11.6119 | 303.4698 | 11.4660 | 303.4701 | 11.2185 | 303.4850 | 10.8861 |
| rbio1.3 | 303.4698 | 11.6413 | 303.4731 | 11.5327 | 303.4735 | 11.3300 | 303.4734 | 11.0056 |
| rbio1.5 | 303.4698 | 11.6507 | 303.4664 | 11.5607 | 303.4728 | 11.3761 | 303.4625 | 11.0537 |
| rbio2.2 | 303.4711 | 11.6594 | 303.4684 | 11.6043 | 303.4694 | 11.5071 | 303.4803 | 11.2452 |
| rbio2.4 | 303.4705 | 11.6534 | 303.4736 | 11.5683 | 303.4686 | 11.3953 | 303.4756 | 11.0851 |
| rbio2.6 | 303.4702 | 11.6548 | 303.4687 | 11.5655 | 303.4700 | 11.3828 | 303.4606 | 11.0739 |
| rbio2.8 | 303.4701 | 11.6562 | 303.4719 | 11.5692 | 303.4725 | 11.3948 | 303.4625 | 11.0776 |
| rbio3.1 | 303.4698 | 11.8808 | 303.4640 | 13.2833 | 303.4576 | 18.7554 | 303.4882 | 30.9390 |
| rbio3.3 | 303.4698 | 11.6726 | 303.4674 | 11.6957 | 303.4654 | 11.8781 | 303.4687 | 12.0860 |
| rbio3.5 | 303.4698 | 11.6615 | 303.4703 | 11.6023 | 303.4652 | 11.5254 | 303.4603 | 11.3464 |
| rbio3.7 | 303.4698 | 11.6596 | 303.4696 | 11.5888 | 303.4683 | 11.4610 | 303.4643 | 11.2091 |
| rbio3.9 | 303.4698 | 11.6593 | 303.4701 | 11.5793 | 303.4711 | 11.4357 | 303.4702 | 11.1565 |
| rbio4.4 | 303.4707 | 11.6592 | 303.4739 | 11.5802 | 303.4694 | 11.4175 | 303.4747 | 11.1230 |
| rbio5.5 | 303.4687 | 11.6605 | 303.4667 | 11.5821 | 303.4664 | 11.4270 | 303.4612 | 11.1714 |
| rbio6.8 | 303.4703 | 11.6586 | 303.4716 | 11.5745 | 303.4723 | 11.4079 | 303.4652 | 11.0981 |
| dmey | 303.4699 | 11.6598 | 303.4696 | 11.5741 | 303.4687 | 11.4051 | 303.4696 | 11.0694 |

Table A.40: Results of Hypothesis Testing with soft thresholding for DEM generation on City Site 2 including outliers

| **City Site 2**, μ = 292.9100, σ = 3.5970 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.9308 | 3.6244 | 292.9611 | 3.6340 | 293.1880 | 3.8402 | 293.3343 | 3.8016 |
| db2 | 292.7699 | 3.4011 | 292.7922 | 3.3170 | 292.7658 | 3.2653 | 292.7456 | 3.1713 |
| db4 | 292.7181 | 3.3513 | 292.6711 | 3.2109 | 292.6225 | 3.1102 | 292.6608 | 3.0171 |
| db6 | 292.7311 | 3.3848 | 292.6606 | 3.2151 | 292.6028 | 3.0575 | 292.6315 | 3.0045 |
| db8 | 292.6623 | 3.2685 | 292.5901 | 3.1097 | 292.5574 | 3.0329 | 292.5907 | 2.9465 |
| db10 | 292.6969 | 3.3332 | 292.6079 | 3.1340 | 292.5712 | 3.0317 | 292.5838 | 2.9823 |
| db12 | 292.6738 | 3.3047 | 292.6059 | 3.1553 | 292.5487 | 2.9541 | 292.5907 | 3.0052 |
| db20 | 292.6558 | 3.3036 | 292.5335 | 2.9995 | 292.5026 | 2.9052 | 292.5097 | 2.8605 |
| sym2 | 292.7699 | 3.4011 | 292.7922 | 3.3170 | 292.7658 | 3.2653 | 292.7456 | 3.1713 |
| sym4 | 292.7318 | 3.3653 | 292.6637 | 3.2200 | 292.6878 | 3.1141 | 292.7561 | 3.1073 |
| sym6 | 292.7418 | 3.3777 | 292.6443 | 3.1750 | 292.6326 | 3.0707 | 292.7066 | 3.0490 |
| sym8 | 292.7318 | 3.3784 | 292.6546 | 3.1910 | 292.6229 | 3.1138 | 292.6992 | 3.0654 |
| sym10 | 292.7106 | 3.3464 | 292.6360 | 3.1963 | 292.6433 | 3.1329 | 292.7127 | 3.1150 |
| sym12 | 292.6768 | 3.3113 | 292.6430 | 3.2262 | 292.6096 | 2.9991 | 292.6442 | 3.1037 |
| sym20 | 292.6653 | 3.3167 | 292.6022 | 3.1475 | 292.5857 | 2.9898 | 292.6095 | 2.9690 |
| coif1 | 292.7499 | 3.3828 | 292.6771 | 3.2080 | 292.5944 | 3.0031 | 292.5776 | 2.8667 |
| coif2 | 292.7825 | 3.4381 | 292.7200 | 3.2712 | 292.6872 | 3.1792 | 292.7707 | 3.1378 |
| coif3 | 292.7415 | 3.3797 | 292.6885 | 3.2281 | 292.6597 | 3.0918 | 292.6658 | 3.0245 |
| coif4 | 292.7297 | 3.3811 | 292.6534 | 3.1771 | 292.6276 | 3.1091 | 292.6760 | 3.0838 |
| coif5 | 292.7188 | 3.3650 | 292.6289 | 3.1372 | 292.6259 | 3.0568 | 292.6055 | 2.9517 |
| bior1.1 | 292.9308 | 3.6244 | 292.9611 | 3.6340 | 293.1880 | 3.8402 | 293.3343 | 3.8016 |
| bior1.3 | 292.8572 | 3.5730 | 292.7872 | 3.4651 | 292.8241 | 3.4116 | 292.9288 | 3.4862 |
| bior1.5 | 292.8000 | 3.5056 | 292.7440 | 3.3982 | 292.7205 | 3.3721 | 292.8242 | 3.3667 |
| bior2.2 | 292.8444 | 3.4937 | 292.9084 | 3.5220 | 292.9316 | 3.4636 | 292.9689 | 3.3301 |
| bior2.4 | 292.7809 | 3.4140 | 292.7722 | 3.3428 | 292.9062 | 3.4352 | 293.0240 | 3.4407 |
| bior2.6 | 292.7389 | 3.3647 | 292.7788 | 3.3418 | 292.8278 | 3.3634 | 292.9531 | 3.3716 |
| bior2.8 | 292.7239 | 3.3539 | 292.7443 | 3.3391 | 292.8109 | 3.3282 | 292.8301 | 3.1500 |
| bior3.1 | 292.7399 | 3.3738 | 292.6528 | 3.2403 | 292.5403 | 3.0323 | 292.5232 | 3.1854 |
| bior3.3 | 292.7676 | 3.4330 | 292.7210 | 3.2498 | 292.7242 | 3.1458 | 292.7899 | 3.2014 |
| bior3.5 | 292.7506 | 3.4086 | 292.7646 | 3.3458 | 292.8512 | 3.4170 | 292.8277 | 3.2906 |
| bior3.7 | 292.7397 | 3.3946 | 292.7223 | 3.2526 | 292.7534 | 3.1935 | 292.7652 | 3.1783 |
| bior3.9 | 292.7337 | 3.3862 | 292.7706 | 3.3471 | 292.8476 | 3.3518 | 292.8199 | 3.2668 |
| bior4.4 | 292.7916 | 3.4394 | 292.6930 | 3.2395 | 292.7365 | 3.1931 | 292.7998 | 3.1386 |
| bior5.5 | 292.7334 | 3.3810 | 292.6720 | 3.1848 | 292.6070 | 3.0389 | 292.6525 | 2.9706 |
| bior6.8 | 292.7520 | 3.3968 | 292.6540 | 3.2027 | 292.6726 | 3.1668 | 292.7918 | 3.1961 |
| rbio1.1 | 292.9308 | 3.6244 | 292.9611 | 3.6340 | 293.1880 | 3.8402 | 293.3343 | 3.8016 |
| rbio1.3 | 292.7595 | 3.3846 | 292.6982 | 3.2733 | 292.7076 | 3.2123 | 292.8261 | 3.2677 |
| rbio1.5 | 292.7509 | 3.3844 | 292.6846 | 3.1899 | 292.6604 | 3.1605 | 292.7199 | 3.1288 |
| rbio2.2 | 292.6176 | 3.2204 | 292.4256 | 2.9010 | 292.1100 | 2.2309 | 291.8830 | 2.1156 |
| rbio2.4 | 292.7825 | 3.4104 | 292.6117 | 3.1296 | 292.4961 | 2.8895 | 292.5010 | 2.8520 |
| rbio2.6 | 292.7867 | 3.4488 | 292.6769 | 3.2196 | 292.5445 | 2.9888 | 292.5118 | 2.8307 |
| rbio2.8 | 292.7653 | 3.4195 | 292.6117 | 3.1367 | 292.5830 | 3.0493 | 292.6077 | 3.0484 |
| rbio3.1 | 292.1269 | 2.6589 | 291.4159 | 2.0987 | 290.0385 | 5.6931 | 252.6760 | 68.3568 |
| rbio3.3 | 292.5644 | 3.1552 | 292.2000 | 2.6807 | 291.6852 | 2.2374 | 291.1953 | 2.1014 |
| rbio3.5 | 292.6501 | 3.2794 | 292.4385 | 2.9449 | 292.0538 | 2.4256 | 291.8567 | 2.2337 |
| rbio3.7 | 292.6975 | 3.3430 | 292.5016 | 2.9664 | 292.2827 | 2.6211 | 292.0965 | 2.4853 |
| rbio3.9 | 292.6971 | 3.3362 | 292.5915 | 3.1642 | 292.3924 | 2.8058 | 292.1805 | 2.5398 |
| rbio4.4 | 292.7209 | 3.3325 | 292.6137 | 3.1320 | 292.5924 | 3.0282 | 292.6584 | 3.0348 |
| rbio5.5 | 292.7201 | 3.3535 | 292.6423 | 3.1358 | 292.6326 | 3.0927 | 292.7507 | 3.1362 |
| rbio6.8 | 292.7430 | 3.3893 | 292.6225 | 3.1628 | 292.6129 | 3.0925 | 292.6730 | 3.0907 |
| dmey | 292.6427 | 3.2782 | 292.5399 | 3.0024 | 292.5816 | 3.0389 | 292.5559 | 2.9529 |

Table A.41: Results of Hypothesis Testing with soft thresholding for DSM generation on City Site 2 excluding outliers

| **City Site 2**, μ = 303.4662, σ = 11.5645 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 303.4662 | 11.4839 | 303.4662 | 11.3442 | 303.4665 | 11.0979 | 303.4811 | 10.7619 |
| db2 | 303.4650 | 11.5153 | 303.4669 | 11.4217 | 303.4729 | 11.2199 | 303.4688 | 10.8789 |
| db4 | 303.4660 | 11.5257 | 303.4646 | 11.4435 | 303.4702 | 11.2674 | 303.4723 | 10.9459 |
| db6 | 303.4666 | 11.5282 | 303.4651 | 11.4479 | 303.4674 | 11.2749 | 303.4741 | 10.9360 |
| db8 | 303.4659 | 11.5278 | 303.4635 | 11.4484 | 303.4633 | 11.2777 | 303.4672 | 10.9317 |
| db10 | 303.4658 | 11.5277 | 303.4662 | 11.4478 | 303.4616 | 11.2794 | 303.4640 | 10.9486 |
| db12 | 303.4665 | 11.5291 | 303.4661 | 11.4507 | 303.4630 | 11.2818 | 303.4707 | 10.9394 |
| db20 | 303.4665 | 11.5295 | 303.4653 | 11.4498 | 303.4636 | 11.2846 | 303.4651 | 10.9307 |
| sym2 | 303.4650 | 11.5153 | 303.4669 | 11.4217 | 303.4729 | 11.2199 | 303.4688 | 10.8789 |
| sym4 | 303.4668 | 11.5267 | 303.4667 | 11.4424 | 303.4622 | 11.2722 | 303.4638 | 10.9514 |
| sym6 | 303.4667 | 11.5286 | 303.4667 | 11.4512 | 303.4656 | 11.2797 | 303.4572 | 10.9683 |
| sym8 | 303.4666 | 11.5295 | 303.4661 | 11.4495 | 303.4687 | 11.2803 | 303.4615 | 10.9645 |
| sym10 | 303.4665 | 11.5299 | 303.4664 | 11.4529 | 303.4667 | 11.2910 | 303.4602 | 10.9684 |
| sym12 | 303.4659 | 11.5286 | 303.4670 | 11.4507 | 303.4659 | 11.2911 | 303.4629 | 10.9614 |
| sym20 | 303.4660 | 11.5294 | 303.4666 | 11.4521 | 303.4653 | 11.2910 | 303.4718 | 10.9797 |
| coif1 | 303.4672 | 11.5187 | 303.4653 | 11.4210 | 303.4658 | 11.2299 | 303.4743 | 10.8892 |
| coif2 | 303.4668 | 11.5270 | 303.4654 | 11.4437 | 303.4654 | 11.2686 | 303.4636 | 10.9534 |
| coif3 | 303.4667 | 11.5289 | 303.4655 | 11.4482 | 303.4632 | 11.2831 | 303.4595 | 10.9614 |
| coif4 | 303.4666 | 11.5297 | 303.4656 | 11.4502 | 303.4681 | 11.2827 | 303.4618 | 10.9516 |
| coif5 | 303.4666 | 11.5301 | 303.4658 | 11.4513 | 303.4657 | 11.2902 | 303.4636 | 10.9584 |
| bior1.1 | 303.4662 | 11.4839 | 303.4662 | 11.3442 | 303.4665 | 11.0979 | 303.4811 | 10.7619 |
| bior1.3 | 303.4662 | 11.5501 | 303.4677 | 11.5044 | 303.4644 | 11.3686 | 303.4712 | 11.0867 |
| bior1.5 | 303.4662 | 11.5635 | 303.4637 | 11.5397 | 303.4656 | 11.4296 | 303.4608 | 11.1534 |
| bior2.2 | 303.4669 | 11.5127 | 303.4643 | 11.4072 | 303.4671 | 11.2151 | 303.4728 | 10.8946 |
| bior2.4 | 303.4672 | 11.5248 | 303.4701 | 11.4404 | 303.4680 | 11.2689 | 303.4729 | 10.9799 |
| bior2.6 | 303.4672 | 11.5300 | 303.4653 | 11.4483 | 303.4676 | 11.2850 | 303.4639 | 11.0104 |
| bior2.8 | 303.4673 | 11.5330 | 303.4690 | 11.4582 | 303.4697 | 11.3054 | 303.4654 | 11.0243 |
| bior3.1 | 303.4662 | 11.5198 | 303.4694 | 11.4600 | 303.4686 | 11.3993 | 303.4878 | 11.2753 |
| bior3.3 | 303.4662 | 11.5219 | 303.4670 | 11.4550 | 303.4694 | 11.3370 | 303.4551 | 11.1507 |
| bior3.5 | 303.4662 | 11.5247 | 303.4666 | 11.4488 | 303.4659 | 11.3290 | 303.4623 | 11.1048 |
| bior3.7 | 303.4662 | 11.5266 | 303.4659 | 11.4577 | 303.4677 | 11.3329 | 303.4655 | 11.0995 |
| bior3.9 | 303.4662 | 11.5279 | 303.4664 | 11.4543 | 303.4664 | 11.3327 | 303.4667 | 11.0818 |
| bior4.4 | 303.4667 | 11.5249 | 303.4697 | 11.4423 | 303.4665 | 11.2604 | 303.4714 | 10.9193 |
| bior5.5 | 303.4659 | 11.5256 | 303.4642 | 11.4457 | 303.4629 | 11.2563 | 303.4565 | 10.8989 |
| bior6.8 | 303.4667 | 11.5287 | 303.4677 | 11.4503 | 303.4688 | 11.2850 | 303.4633 | 10.9651 |
| rbio1.1 | 303.4662 | 11.4839 | 303.4662 | 11.3442 | 303.4665 | 11.0979 | 303.4811 | 10.7619 |
| rbio1.3 | 303.4662 | 11.5126 | 303.4692 | 11.4103 | 303.4693 | 11.2102 | 303.4688 | 10.8831 |
| rbio1.5 | 303.4662 | 11.5216 | 303.4630 | 11.4382 | 303.4688 | 11.2561 | 303.4586 | 10.9307 |
| rbio2.2 | 303.4675 | 11.5302 | 303.4649 | 11.4817 | 303.4660 | 11.3871 | 303.4774 | 11.1242 |
| rbio2.4 | 303.4669 | 11.5246 | 303.4698 | 11.4459 | 303.4650 | 11.2765 | 303.4723 | 10.9634 |
| rbio2.6 | 303.4666 | 11.5260 | 303.4652 | 11.4437 | 303.4660 | 11.2640 | 303.4574 | 10.9534 |
| rbio2.8 | 303.4665 | 11.5273 | 303.4682 | 11.4471 | 303.4689 | 11.2754 | 303.4587 | 10.9563 |
| rbio3.1 | 303.4662 | 11.7460 | 303.4608 | 13.1483 | 303.4542 | 18.6120 | 303.4843 | 30.8285 |
| rbio3.3 | 303.4662 | 11.5418 | 303.4640 | 11.5685 | 303.4619 | 11.7537 | 303.4649 | 11.9667 |
| rbio3.5 | 303.4662 | 11.5315 | 303.4666 | 11.4786 | 303.4618 | 11.4052 | 303.4571 | 11.2263 |
| rbio3.7 | 303.4662 | 11.5298 | 303.4662 | 11.4655 | 303.4650 | 11.3393 | 303.4609 | 11.0848 |
| rbio3.9 | 303.4662 | 11.5296 | 303.4664 | 11.4566 | 303.4672 | 11.3157 | 303.4667 | 11.0345 |
| rbio4.4 | 303.4671 | 11.5302 | 303.4701 | 11.4577 | 303.4657 | 11.2987 | 303.4714 | 11.0011 |
| rbio5.5 | 303.4651 | 11.5309 | 303.4633 | 11.4599 | 303.4626 | 11.3074 | 303.4583 | 11.0504 |
| rbio6.8 | 303.4667 | 11.5297 | 303.4680 | 11.4528 | 303.4687 | 11.2894 | 303.4615 | 10.9772 |
| dmey | 303.4664 | 11.5311 | 303.4660 | 11.4532 | 303.4651 | 11.2879 | 303.4658 | 10.9498 |

Table A.42: Results of Hypothesis Testing with soft thresholding for DEM generation on City Site 2 excluding outliers

| **City Site 2**, μ = 292.9549, σ = 3.6377 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 292.9681 | 3.6575 | 292.9708 | 3.6086 | 293.1985 | 3.7922 | 293.3196 | 3.7433 |
| db2 | 292.8281 | 3.4679 | 292.8121 | 3.3213 | 292.7822 | 3.2419 | 292.7572 | 3.1600 |
| db4 | 292.7708 | 3.3691 | 292.6808 | 3.2020 | 292.6373 | 3.1108 | 292.6913 | 3.0444 |
| db6 | 292.7800 | 3.4235 | 292.7139 | 3.2701 | 292.6479 | 3.1226 | 292.6166 | 2.9927 |
| db8 | 292.7277 | 3.3469 | 292.6334 | 3.1273 | 292.6097 | 3.1299 | 292.5962 | 2.9483 |
| db10 | 292.7490 | 3.3671 | 292.6639 | 3.2130 | 292.6015 | 3.0428 | 292.6409 | 3.0469 |
| db12 | 292.7520 | 3.3726 | 292.6147 | 3.1143 | 292.5772 | 2.9995 | 292.6130 | 3.0269 |
| db20 | 292.7118 | 3.3306 | 292.5847 | 3.0796 | 292.5386 | 2.9612 | 292.5276 | 2.8773 |
| sym2 | 292.8281 | 3.4679 | 292.8121 | 3.3213 | 292.7822 | 3.2419 | 292.7572 | 3.1600 |
| sym4 | 292.8106 | 3.4542 | 292.7211 | 3.3002 | 292.7254 | 3.1546 | 292.7684 | 3.1107 |
| sym6 | 292.8077 | 3.4506 | 292.6750 | 3.1972 | 292.6624 | 3.1087 | 292.6813 | 3.0077 |
| sym8 | 292.8027 | 3.4457 | 292.7030 | 3.2538 | 292.6771 | 3.1763 | 292.6989 | 3.0752 |
| sym10 | 292.7941 | 3.4345 | 292.6674 | 3.2038 | 292.6916 | 3.1887 | 292.6944 | 3.0615 |
| sym12 | 292.7407 | 3.3840 | 292.6876 | 3.2637 | 292.6374 | 3.0368 | 292.6728 | 3.1181 |
| sym20 | 292.7183 | 3.3509 | 292.6439 | 3.1967 | 292.6156 | 3.0425 | 292.6156 | 2.9500 |
| coif1 | 292.8228 | 3.4881 | 292.6994 | 3.2176 | 292.6406 | 3.0639 | 292.5895 | 2.8574 |
| coif2 | 292.8391 | 3.4895 | 292.7654 | 3.3331 | 292.7035 | 3.1753 | 292.7809 | 3.1361 |
| coif3 | 292.8238 | 3.4729 | 292.7160 | 3.2532 | 292.6940 | 3.1335 | 292.6875 | 3.0563 |
| coif4 | 292.8006 | 3.4366 | 292.6857 | 3.2082 | 292.6521 | 3.1402 | 292.6865 | 3.0915 |
| coif5 | 292.7872 | 3.4210 | 292.6658 | 3.1790 | 292.6565 | 3.0973 | 292.6122 | 2.9476 |
| bior1.1 | 292.9681 | 3.6575 | 292.9708 | 3.6086 | 293.1985 | 3.7922 | 293.3196 | 3.7433 |
| bior1.3 | 292.9026 | 3.6117 | 292.8802 | 3.5652 | 292.8785 | 3.5052 | 292.9828 | 3.5099 |
| bior1.5 | 292.8351 | 3.5387 | 292.7922 | 3.4354 | 292.7882 | 3.4863 | 292.8694 | 3.4288 |
| bior2.2 | 292.8983 | 3.5527 | 292.9571 | 3.5707 | 292.9728 | 3.4855 | 293.0130 | 3.3655 |
| bior2.4 | 292.8372 | 3.4774 | 292.8235 | 3.3816 | 292.9767 | 3.5168 | 293.0103 | 3.3757 |
| bior2.6 | 292.8023 | 3.4462 | 292.8147 | 3.3693 | 292.8486 | 3.3565 | 292.9724 | 3.3732 |
| bior2.8 | 292.7777 | 3.4093 | 292.7652 | 3.3065 | 292.8488 | 3.3727 | 292.8704 | 3.1880 |
| bior3.1 | 292.8093 | 3.4602 | 292.7148 | 3.3142 | 292.6892 | 3.1779 | 292.6371 | 3.2458 |
| bior3.3 | 292.8068 | 3.4264 | 292.7880 | 3.3514 | 292.7628 | 3.1964 | 292.8119 | 3.1842 |
| bior3.5 | 292.8077 | 3.4305 | 292.8410 | 3.4564 | 292.8417 | 3.3520 | 292.8600 | 3.3053 |
| bior3.7 | 292.7992 | 3.4172 | 292.7895 | 3.3429 | 292.8241 | 3.2886 | 292.8472 | 3.3036 |
| bior3.9 | 292.7910 | 3.4145 | 292.8338 | 3.4326 | 292.8638 | 3.3724 | 292.8178 | 3.2530 |
| bior4.4 | 292.8382 | 3.4770 | 292.7528 | 3.2893 | 292.7790 | 3.2355 | 292.8106 | 3.1338 |
| bior5.5 | 292.8106 | 3.4505 | 292.7269 | 3.2408 | 292.6477 | 3.0738 | 292.6520 | 2.9633 |
| bior6.8 | 292.8157 | 3.4570 | 292.7093 | 3.2506 | 292.7231 | 3.2123 | 292.7983 | 3.1940 |
| rbio1.1 | 292.9681 | 3.6575 | 292.9708 | 3.6086 | 293.1985 | 3.7922 | 293.3196 | 3.7433 |
| rbio1.3 | 292.7889 | 3.3998 | 292.7523 | 3.3116 | 292.7572 | 3.2661 | 292.8616 | 3.2914 |
| rbio1.5 | 292.7972 | 3.4255 | 292.7108 | 3.2290 | 292.6626 | 3.1271 | 292.7515 | 3.1410 |
| rbio2.2 | 292.6599 | 3.2587 | 292.4574 | 2.8978 | 292.1183 | 2.1923 | 291.8772 | 2.0887 |
| rbio2.4 | 292.8399 | 3.4918 | 292.6619 | 3.1964 | 292.5646 | 2.9816 | 292.5048 | 2.8381 |
| rbio2.6 | 292.8335 | 3.4763 | 292.7202 | 3.2747 | 292.5762 | 3.0135 | 292.5165 | 2.8484 |
| rbio2.8 | 292.8054 | 3.4369 | 292.6817 | 3.2224 | 292.6225 | 3.0703 | 292.6253 | 3.0335 |
| rbio3.1 | 292.1741 | 2.7057 | 291.5302 | 2.1029 | 290.1170 | 5.7876 | 249.0670 | 71.4461 |
| rbio3.3 | 292.6467 | 3.2561 | 292.2583 | 2.7069 | 291.7678 | 2.2585 | 291.2041 | 2.0568 |
| rbio3.5 | 292.7106 | 3.3098 | 292.4946 | 3.0229 | 292.0820 | 2.4576 | 291.8638 | 2.2135 |
| rbio3.7 | 292.7416 | 3.3547 | 292.5520 | 3.0237 | 292.3263 | 2.7164 | 292.1350 | 2.5202 |
| rbio3.9 | 292.7646 | 3.3924 | 292.6315 | 3.1853 | 292.4149 | 2.8082 | 292.2000 | 2.5243 |
| rbio4.4 | 292.8164 | 3.4591 | 292.6458 | 3.1751 | 292.6292 | 3.0623 | 292.6729 | 3.0364 |
| rbio5.5 | 292.7650 | 3.4149 | 292.6814 | 3.1898 | 292.6712 | 3.1331 | 292.7309 | 3.0853 |
| rbio6.8 | 292.8086 | 3.4500 | 292.6577 | 3.1836 | 292.6686 | 3.1626 | 292.6948 | 3.1015 |
| dmey | 292.7324 | 3.3707 | 292.5904 | 3.0929 | 292.5995 | 3.0551 | 292.5437 | 2.9385 |

Table A.43: Results of GCV with hard thresholding for DSM generation on City Site 3 including outliers

| **City Site 3**, μ = 318.7184, σ = 9.1404 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 318.7184 | 9.1402 | 318.7184 | 9.0094 | 318.7184 | 8.7767 | 318.7184 | 8.4141 |
| db2 | 318.7185 | 9.0948 | 318.7204 | 9.0130 | 318.7250 | 8.8158 | 318.7418 | 8.4321 |
| db4 | 318.7186 | 9.1023 | 318.7159 | 9.0242 | 318.7125 | 8.8454 | 318.7113 | 8.4716 |
| db6 | 318.7178 | 9.1030 | 318.7189 | 9.0362 | 318.7163 | 8.8617 | 318.7236 | 8.5149 |
| db8 | 318.7185 | 9.1042 | 318.7208 | 9.0364 | 318.7141 | 8.8599 | 318.7205 | 8.6966 |
| db10 | 318.7189 | 9.1058 | 318.7158 | 9.0327 | 318.7136 | 8.8615 | 318.7109 | 8.6662 |
| db12 | 318.7182 | 9.1056 | 318.7197 | 9.0397 | 318.7146 | 8.8639 | 318.7210 | 8.5118 |
| db20 | 318.7181 | 9.1063 | 318.7176 | 9.0368 | 318.7221 | 8.8765 | 318.7238 | 8.5052 |
| sym2 | 318.7185 | 9.0948 | 318.7204 | 9.0130 | 318.7250 | 8.8158 | 318.7418 | 8.4321 |
| sym4 | 318.7180 | 9.1013 | 318.7129 | 9.0208 | 318.7167 | 8.8473 | 318.7315 | 8.4889 |
| sym6 | 318.7179 | 9.1029 | 318.7243 | 9.0401 | 318.7121 | 8.8554 | 318.7178 | 8.5088 |
| sym8 | 318.7179 | 9.1037 | 318.7152 | 9.0294 | 318.7082 | 8.8530 | 318.7136 | 8.5054 |
| sym10 | 318.7179 | 9.1041 | 318.7215 | 9.0410 | 318.7267 | 8.8719 | 318.7115 | 8.4835 |
| sym12 | 318.7188 | 9.1053 | 318.7159 | 9.0328 | 318.7186 | 8.8636 | 318.7107 | 8.4611 |
| sym20 | 318.7188 | 9.1058 | 318.7164 | 9.0351 | 318.7204 | 8.8677 | 318.7268 | 8.6030 |
| coif1 | 318.7182 | 9.0942 | 318.7146 | 9.0022 | 318.7218 | 8.8123 | 318.7432 | 8.4522 |
| coif2 | 318.7179 | 9.1013 | 318.7146 | 9.0220 | 318.7064 | 8.8440 | 318.7156 | 8.4951 |
| coif3 | 318.7179 | 9.1034 | 318.7154 | 9.0287 | 318.7239 | 8.8587 | 318.7105 | 8.4669 |
| coif4 | 318.7179 | 9.1040 | 318.7158 | 9.0306 | 318.7118 | 8.8568 | 318.7139 | 8.4779 |
| coif5 | 318.7179 | 9.1045 | 318.7160 | 9.0323 | 318.7235 | 8.8665 | 318.7302 | 8.5112 |
| bior1.1 | 318.7184 | 9.1402 | 318.7184 | 9.0094 | 318.7184 | 8.7767 | 318.7184 | 8.4141 |
| bior1.3 | 318.7184 | 9.1235 | 318.7170 | 9.0916 | 318.7164 | 8.9857 | 318.7155 | 8.7014 |
| bior1.5 | 318.7184 | 9.1362 | 318.7193 | 9.1296 | 318.7161 | 9.0521 | 318.7178 | 8.7652 |
| bior2.2 | 318.7179 | 9.0896 | 318.7156 | 8.9860 | 318.7237 | 8.7780 | 318.7491 | 8.3962 |
| bior2.4 | 318.7181 | 9.0997 | 318.7240 | 9.0277 | 318.7163 | 8.8313 | 318.7219 | 8.4742 |
| bior2.6 | 318.7182 | 9.1042 | 318.7150 | 9.0257 | 318.7058 | 8.8448 | 318.7164 | 8.4992 |
| bior2.8 | 318.7183 | 9.1068 | 318.7225 | 9.0452 | 318.7247 | 8.8705 | 318.7124 | 8.4846 |
| bior3.1 | 318.7184 | 9.0973 | 318.7202 | 9.0136 | 318.7224 | 8.9262 | 318.7251 | 8.9295 |
| bior3.3 | 318.7184 | 9.0983 | 318.7205 | 9.0325 | 318.7068 | 8.8538 | 318.7072 | 8.5207 |
| bior3.5 | 318.7184 | 9.1010 | 318.7154 | 9.0216 | 318.7153 | 8.8499 | 318.7126 | 8.5219 |
| bior3.7 | 318.7184 | 9.1029 | 318.7226 | 9.0368 | 318.7276 | 8.8601 | 318.7187 | 8.5513 |
| bior3.9 | 318.7184 | 9.1044 | 318.7147 | 9.0278 | 318.7124 | 8.8507 | 318.7148 | 8.5071 |
| bior4.4 | 318.7178 | 9.0999 | 318.7239 | 9.0314 | 318.7160 | 8.8428 | 318.7225 | 8.4960 |
| bior5.5 | 318.7191 | 9.1030 | 318.7220 | 9.0330 | 318.7099 | 8.8493 | 318.7133 | 8.4970 |
| bior6.8 | 318.7178 | 9.1032 | 318.7213 | 9.0380 | 318.7247 | 8.8628 | 318.7124 | 8.4800 |
| rbio1.1 | 318.7184 | 9.1402 | 318.7184 | 9.0094 | 318.7184 | 8.7767 | 318.7184 | 8.4141 |
| rbio1.3 | 318.7184 | 9.0892 | 318.7146 | 8.9932 | 318.7099 | 8.7809 | 318.7061 | 8.3856 |
| rbio1.5 | 318.7184 | 9.0974 | 318.7188 | 9.0120 | 318.7126 | 8.8222 | 318.7062 | 8.4353 |
| rbio2.2 | 318.7187 | 9.1041 | 318.7142 | 9.0610 | 318.7233 | 8.9966 | 318.7441 | 8.8259 |
| rbio2.4 | 318.7179 | 9.0988 | 318.7238 | 9.0359 | 318.7144 | 8.8615 | 318.7239 | 8.5277 |
| rbio2.6 | 318.7177 | 9.1001 | 318.7148 | 9.0223 | 318.7067 | 8.8438 | 318.7160 | 8.5090 |
| rbio2.8 | 318.7177 | 9.1016 | 318.7216 | 9.0349 | 318.7242 | 8.8677 | 318.7144 | 8.4919 |
| rbio3.1 | 318.7184 | 9.3179 | 318.7152 | 10.7668 | 318.7013 | 16.9273 | 318.6637 | 37.0375 |
| rbio3.3 | 318.7184 | 9.1173 | 318.7195 | 9.1556 | 318.7164 | 9.3645 | 318.7172 | 9.8874 |
| rbio3.5 | 318.7184 | 9.1066 | 318.7136 | 9.0566 | 318.7164 | 8.9947 | 318.7148 | 9.1102 |
| rbio3.7 | 318.7184 | 9.1050 | 318.7222 | 9.0494 | 318.7271 | 8.9324 | 318.7146 | 8.7961 |
| rbio3.9 | 318.7184 | 9.1043 | 318.7147 | 9.0344 | 318.7126 | 8.9095 | 318.7150 | 8.6511 |
| rbio4.4 | 318.7180 | 9.1044 | 318.7239 | 9.0479 | 318.7138 | 8.8756 | 318.7224 | 8.5527 |
| rbio5.5 | 318.7187 | 9.1091 | 318.7226 | 9.0514 | 318.7108 | 8.8722 | 318.7149 | 8.5260 |
| rbio6.8 | 318.7179 | 9.1039 | 318.7213 | 9.0408 | 318.7244 | 8.8720 | 318.7124 | 8.4951 |
| dmey | 318.7180 | 9.1059 | 318.7172 | 9.0365 | 318.7214 | 8.8715 | 318.7235 | 8.5190 |

Table A.44: Results of GCV with hard thresholding for DEM generation on City Site 3 including outliers

| **City Site 3**, μ = 310.7064, σ = 4.4727 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 310.3806 | 4.2154 | 310.3216 | 4.2734 | 310.2930 | 4.1597 | 310.1231 | 4.2033 |
| db2 | 310.5776 | 4.4141 | 310.5003 | 4.3762 | 310.3258 | 4.3236 | 310.2078 | 4.4595 |
| db4 | 310.5688 | 4.4220 | 310.4459 | 4.3900 | 310.1605 | 4.2799 | 309.7788 | 4.3614 |
| db6 | 310.5126 | 4.3541 | 310.3941 | 4.3103 | 310.1339 | 4.2914 | 309.7674 | 4.2326 |
| db8 | 310.5281 | 4.3729 | 310.3992 | 4.3626 | 310.1032 | 4.3198 | 309.9121 | 4.3897 |
| db10 | 310.5044 | 4.3908 | 310.3703 | 4.3608 | 310.0778 | 4.3255 | 309.6880 | 4.3862 |
| db12 | 310.5159 | 4.3709 | 310.3499 | 4.3185 | 310.0604 | 4.3392 | 309.5500 | 4.2874 |
| db20 | 310.4813 | 4.3655 | 310.3510 | 4.4060 | 310.0916 | 4.3644 | 309.7193 | 4.3316 |
| sym2 | 310.5776 | 4.4141 | 310.5003 | 4.3762 | 310.3258 | 4.3236 | 310.2078 | 4.4595 |
| sym4 | 310.5493 | 4.3808 | 310.4420 | 4.3501 | 310.2880 | 4.3483 | 309.8500 | 4.2103 |
| sym6 | 310.5293 | 4.3616 | 310.4025 | 4.3299 | 310.1658 | 4.3188 | 309.7085 | 4.2191 |
| sym8 | 310.5111 | 4.3524 | 310.3977 | 4.3524 | 310.2097 | 4.3710 | 309.7668 | 4.3187 |
| sym10 | 310.4920 | 4.3459 | 310.3604 | 4.3349 | 310.1373 | 4.2557 | 309.7182 | 4.2586 |
| sym12 | 310.4913 | 4.3683 | 310.3649 | 4.3038 | 310.1669 | 4.2868 | 309.7226 | 4.2896 |
| sym20 | 310.4754 | 4.3556 | 310.3353 | 4.3046 | 310.1326 | 4.2937 | 309.6879 | 4.2520 |
| coif1 | 310.5397 | 4.3557 | 310.4971 | 4.3963 | 310.3446 | 4.3727 | 310.0725 | 4.4018 |
| coif2 | 310.5244 | 4.3556 | 310.4276 | 4.3668 | 310.2384 | 4.3448 | 309.8083 | 4.2808 |
| coif3 | 310.5102 | 4.3470 | 310.4145 | 4.3781 | 310.2211 | 4.3133 | 309.8678 | 4.3495 |
| coif4 | 310.4963 | 4.3423 | 310.4152 | 4.3858 | 310.1986 | 4.3610 | 310.0255 | 4.4234 |
| coif5 | 310.4817 | 4.3273 | 310.4051 | 4.3645 | 310.2090 | 4.3039 | 309.7445 | 4.1979 |
| bior1.1 | 310.3806 | 4.2154 | 310.3216 | 4.2734 | 310.2930 | 4.1597 | 310.1231 | 4.2033 |
| bior1.3 | 310.6115 | 4.4219 | 310.4778 | 4.3590 | 310.1769 | 4.2519 | 309.8689 | 4.1464 |
| bior1.5 | 310.5488 | 4.3760 | 310.3096 | 4.2864 | 309.8271 | 4.1444 | 309.5190 | 4.1013 |
| bior2.2 | 310.5734 | 4.3745 | 310.5071 | 4.3833 | 310.3737 | 4.3703 | 310.1504 | 4.3570 |
| bior2.4 | 310.5355 | 4.3579 | 310.4375 | 4.3435 | 310.2679 | 4.3200 | 309.8767 | 4.2461 |
| bior2.6 | 310.5101 | 4.3320 | 310.4284 | 4.3828 | 310.2649 | 4.3663 | 309.8767 | 4.2893 |
| bior2.8 | 310.5038 | 4.3397 | 310.3821 | 4.3380 | 310.2193 | 4.3378 | 309.8178 | 4.2330 |
| bior3.1 | 310.5248 | 4.3697 | 310.2688 | 4.3297 | 309.9286 | 4.3485 | 309.1803 | 4.4102 |
| bior3.3 | 310.5766 | 4.4123 | 310.4080 | 4.3267 | 310.1651 | 4.2740 | 309.7611 | 4.2895 |
| bior3.5 | 310.5703 | 4.4049 | 310.4485 | 4.3521 | 310.2559 | 4.3416 | 309.9996 | 4.4344 |
| bior3.7 | 310.5552 | 4.3884 | 310.4093 | 4.3117 | 310.1949 | 4.2861 | 309.8955 | 4.3404 |
| bior3.9 | 310.5483 | 4.3912 | 310.4540 | 4.3633 | 310.2641 | 4.3320 | 309.8877 | 4.2994 |
| bior4.4 | 310.5423 | 4.3613 | 310.4216 | 4.3108 | 310.2549 | 4.3215 | 309.8422 | 4.2077 |
| bior5.5 | 310.5409 | 4.3884 | 310.4051 | 4.3405 | 310.2689 | 4.3773 | 309.7991 | 4.2197 |
| bior6.8 | 310.5121 | 4.3518 | 310.3872 | 4.3210 | 310.2318 | 4.3286 | 309.7783 | 4.2906 |
| rbio1.1 | 310.3806 | 4.2154 | 310.3216 | 4.2734 | 310.2930 | 4.1597 | 310.1231 | 4.2033 |
| rbio1.3 | 310.6419 | 4.4661 | 310.5419 | 4.3933 | 310.4408 | 4.3924 | 310.1559 | 4.3161 |
| rbio1.5 | 310.5889 | 4.4223 | 310.4786 | 4.3944 | 310.2468 | 4.2745 | 310.0991 | 4.4160 |
| rbio2.2 | 310.5067 | 4.3535 | 310.4731 | 4.4227 | 310.2652 | 4.4180 | 309.9006 | 4.3748 |
| rbio2.4 | 310.5449 | 4.3553 | 310.4182 | 4.3663 | 310.2223 | 4.3858 | 309.8101 | 4.3873 |
| rbio2.6 | 310.5386 | 4.3568 | 310.4325 | 4.3786 | 310.2313 | 4.3390 | 309.8248 | 4.3117 |
| rbio2.8 | 310.5258 | 4.3603 | 310.4148 | 4.3389 | 310.2114 | 4.3087 | 309.8172 | 4.2812 |
| rbio3.1 | 310.1313 | 4.2563 | 308.6466 | 4.3858 | 303.2783 | 10.9602 | 223.5093 | 168.1689 |
| rbio3.3 | 310.5426 | 4.4236 | 310.1821 | 4.3721 | 309.2593 | 4.3769 | 308.3751 | 4.4574 |
| rbio3.5 | 310.5457 | 4.4136 | 310.3497 | 4.3528 | 309.9434 | 4.3377 | 309.6900 | 4.3161 |
| rbio3.7 | 310.5573 | 4.4077 | 310.3338 | 4.3041 | 310.1022 | 4.3290 | 309.7902 | 4.4739 |
| rbio3.9 | 310.5342 | 4.3783 | 310.4233 | 4.3565 | 310.2114 | 4.3792 | 309.7873 | 4.3217 |
| rbio4.4 | 310.5140 | 4.3308 | 310.3763 | 4.3522 | 310.1727 | 4.3554 | 309.7857 | 4.3095 |
| rbio5.5 | 310.5119 | 4.3759 | 310.3793 | 4.3546 | 310.1729 | 4.3765 | 309.7358 | 4.2784 |
| rbio6.8 | 310.5080 | 4.3496 | 310.3698 | 4.3200 | 310.1707 | 4.3049 | 309.7406 | 4.3198 |
| dmey | 310.4705 | 4.3425 | 310.3268 | 4.3379 | 310.1496 | 4.2947 | 309.6759 | 4.2153 |

Table A.45: Results of GCV with hard thresholding for DSM generation on City Site 3 excluding outliers

| **City Site 3**, μ = 318.6986, σ = 9.0395 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 318.6986 | 9.0419 | 318.6986 | 8.9188 | 318.6986 | 8.6899 | 318.6986 | 8.3209 |
| db2 | 318.6987 | 9.0022 | 318.7002 | 8.9289 | 318.7043 | 8.7362 | 318.7206 | 8.3546 |
| db4 | 318.6988 | 9.0105 | 318.6966 | 8.9384 | 318.6932 | 8.7649 | 318.6918 | 8.3900 |
| db6 | 318.6979 | 9.0106 | 318.6990 | 8.9498 | 318.6966 | 8.7813 | 318.7039 | 8.4315 |
| db8 | 318.6987 | 9.0114 | 318.7006 | 8.9517 | 318.6944 | 8.7803 | 318.7008 | 8.6110 |
| db10 | 318.6992 | 9.0132 | 318.6963 | 8.9468 | 318.6939 | 8.7797 | 318.6914 | 8.5775 |
| db12 | 318.6983 | 9.0136 | 318.6996 | 8.9551 | 318.6946 | 8.7855 | 318.7010 | 8.4265 |
| db20 | 318.6982 | 9.0137 | 318.6978 | 8.9513 | 318.7020 | 8.7972 | 318.7037 | 8.4213 |
| sym2 | 318.6987 | 9.0022 | 318.7002 | 8.9289 | 318.7043 | 8.7362 | 318.7206 | 8.3546 |
| sym4 | 318.6981 | 9.0088 | 318.6937 | 8.9346 | 318.6969 | 8.7662 | 318.7107 | 8.4072 |
| sym6 | 318.6980 | 9.0103 | 318.7038 | 8.9559 | 318.6924 | 8.7751 | 318.6979 | 8.4291 |
| sym8 | 318.6980 | 9.0110 | 318.6958 | 8.9445 | 318.6890 | 8.7735 | 318.6935 | 8.4136 |
| sym10 | 318.6980 | 9.0115 | 318.7013 | 8.9565 | 318.7067 | 8.7929 | 318.6916 | 8.4001 |
| sym12 | 318.6991 | 9.0128 | 318.6964 | 8.9474 | 318.6987 | 8.7850 | 318.6908 | 8.3751 |
| sym20 | 318.6991 | 9.0135 | 318.6968 | 8.9500 | 318.7005 | 8.7905 | 318.7069 | 8.5243 |
| coif1 | 318.6984 | 9.0027 | 318.6955 | 8.9187 | 318.7021 | 8.7328 | 318.7223 | 8.3708 |
| coif2 | 318.6980 | 9.0092 | 318.6952 | 8.9371 | 318.6870 | 8.7615 | 318.6956 | 8.4052 |
| coif3 | 318.6979 | 9.0106 | 318.6960 | 8.9434 | 318.7037 | 8.7782 | 318.6907 | 8.3740 |
| coif4 | 318.6979 | 9.0114 | 318.6963 | 8.9459 | 318.6925 | 8.7770 | 318.6940 | 8.3923 |
| coif5 | 318.6979 | 9.0118 | 318.6965 | 8.9474 | 318.7036 | 8.7874 | 318.7095 | 8.4270 |
| bior1.1 | 318.6986 | 9.0419 | 318.6986 | 8.9188 | 318.6986 | 8.6899 | 318.6986 | 8.3209 |
| bior1.3 | 318.6986 | 9.0299 | 318.6971 | 9.0053 | 318.6961 | 8.8968 | 318.6934 | 8.5836 |
| bior1.5 | 318.6986 | 9.0419 | 318.6993 | 9.0436 | 318.6966 | 8.9747 | 318.6983 | 8.6836 |
| bior2.2 | 318.6982 | 8.9985 | 318.6968 | 8.9017 | 318.7045 | 8.6969 | 318.7282 | 8.3117 |
| bior2.4 | 318.6982 | 9.0077 | 318.7035 | 8.9427 | 318.6963 | 8.7504 | 318.7018 | 8.3938 |
| bior2.6 | 318.6982 | 9.0116 | 318.6956 | 8.9412 | 318.6866 | 8.7620 | 318.6963 | 8.4121 |
| bior2.8 | 318.6982 | 9.0138 | 318.7023 | 8.9602 | 318.7042 | 8.7912 | 318.6917 | 8.3981 |
| bior3.1 | 318.6986 | 9.0039 | 318.6999 | 8.9216 | 318.7034 | 8.8324 | 318.7110 | 8.8365 |
| bior3.3 | 318.6986 | 9.0068 | 318.6994 | 8.9463 | 318.6887 | 8.7707 | 318.6867 | 8.4374 |
| bior3.5 | 318.6986 | 9.0093 | 318.6962 | 8.9362 | 318.6958 | 8.7685 | 318.6932 | 8.4249 |
| bior3.7 | 318.6986 | 9.0110 | 318.7022 | 8.9511 | 318.7071 | 8.7782 | 318.6953 | 8.4191 |
| bior3.9 | 318.6986 | 9.0122 | 318.6954 | 8.9410 | 318.6929 | 8.7677 | 318.6948 | 8.4320 |
| bior4.4 | 318.6979 | 9.0079 | 318.7035 | 8.9468 | 318.6960 | 8.7594 | 318.7024 | 8.4067 |
| bior5.5 | 318.6993 | 9.0103 | 318.7016 | 8.9498 | 318.6903 | 8.7663 | 318.6937 | 8.4089 |
| bior6.8 | 318.6979 | 9.0107 | 318.7012 | 8.9534 | 318.7050 | 8.7836 | 318.6925 | 8.3926 |
| rbio1.1 | 318.6986 | 9.0419 | 318.6986 | 8.9188 | 318.6986 | 8.6899 | 318.6986 | 8.3209 |
| rbio1.3 | 318.6986 | 8.9963 | 318.6953 | 8.9070 | 318.6909 | 8.6975 | 318.6881 | 8.3258 |
| rbio1.5 | 318.6986 | 9.0043 | 318.6989 | 8.9276 | 318.6930 | 8.7400 | 318.6870 | 8.3557 |
| rbio2.2 | 318.6987 | 9.0118 | 318.6949 | 8.9765 | 318.7033 | 8.9223 | 318.7230 | 8.7499 |
| rbio2.4 | 318.6981 | 9.0072 | 318.7035 | 8.9517 | 318.6946 | 8.7792 | 318.7037 | 8.4415 |
| rbio2.6 | 318.6979 | 9.0084 | 318.6956 | 8.9380 | 318.6874 | 8.7624 | 318.6959 | 8.4228 |
| rbio2.8 | 318.6979 | 9.0096 | 318.7015 | 8.9508 | 318.7043 | 8.7769 | 318.6944 | 8.4084 |
| rbio3.1 | 318.6986 | 9.2188 | 318.6954 | 10.7404 | 318.6817 | 17.3525 | 318.6444 | 37.2154 |
| rbio3.3 | 318.6986 | 9.0241 | 318.6994 | 9.0689 | 318.6965 | 9.3068 | 318.6969 | 9.7775 |
| rbio3.5 | 318.6986 | 9.0143 | 318.6942 | 8.9768 | 318.6966 | 8.9267 | 318.6952 | 9.0426 |
| rbio3.7 | 318.6986 | 9.0130 | 318.7020 | 8.9672 | 318.7067 | 8.8506 | 318.6949 | 8.7111 |
| rbio3.9 | 318.6986 | 9.0128 | 318.6953 | 8.9513 | 318.6930 | 8.8427 | 318.6951 | 8.6029 |
| rbio4.4 | 318.6980 | 9.0116 | 318.7035 | 8.9622 | 318.6940 | 8.7946 | 318.7024 | 8.4485 |
| rbio5.5 | 318.6991 | 9.0162 | 318.7025 | 8.9654 | 318.6912 | 8.7906 | 318.6951 | 8.4392 |
| rbio6.8 | 318.6979 | 9.0114 | 318.7012 | 8.9560 | 318.7045 | 8.7901 | 318.6923 | 8.4053 |
| dmey | 318.6982 | 9.0131 | 318.6976 | 8.9516 | 318.7014 | 8.7922 | 318.7037 | 8.4352 |

Table A.46: Results of GCV with hard thresholding for DEM generation on City Site 3 excluding outliers

| **City Site 3**, μ = 310.7514, σ = 4.4699 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 310.4289 | 4.1786 | 310.4549 | 4.2912 | 310.4135 | 4.1922 | 310.2033 | 4.2079 |
| db2 | 310.6425 | 4.4233 | 310.5988 | 4.4266 | 310.4200 | 4.3536 | 310.3141 | 4.5001 |
| db4 | 310.6190 | 4.4129 | 310.5306 | 4.3960 | 310.2545 | 4.2639 | 309.8756 | 4.3389 |
| db6 | 310.5981 | 4.3767 | 310.5010 | 4.3372 | 310.2588 | 4.3340 | 309.8821 | 4.3013 |
| db8 | 310.6016 | 4.4048 | 310.4909 | 4.3795 | 310.2115 | 4.3337 | 310.0185 | 4.3965 |
| db10 | 310.5811 | 4.3912 | 310.4545 | 4.3699 | 310.2313 | 4.3517 | 309.7863 | 4.3959 |
| db12 | 310.5885 | 4.3749 | 310.4435 | 4.3388 | 310.1648 | 4.3355 | 309.6595 | 4.3295 |
| db20 | 310.5778 | 4.3800 | 310.4203 | 4.3679 | 310.1719 | 4.3737 | 309.7653 | 4.3038 |
| sym2 | 310.6425 | 4.4233 | 310.5988 | 4.4266 | 310.4200 | 4.3536 | 310.3141 | 4.5001 |
| sym4 | 310.6237 | 4.3959 | 310.5016 | 4.3617 | 310.3653 | 4.3685 | 309.9619 | 4.2671 |
| sym6 | 310.5941 | 4.3666 | 310.4823 | 4.3322 | 310.2696 | 4.3598 | 309.8513 | 4.2857 |
| sym8 | 310.5855 | 4.3533 | 310.4816 | 4.3575 | 310.3110 | 4.3750 | 309.8631 | 4.3717 |
| sym10 | 310.6041 | 4.3775 | 310.4621 | 4.3297 | 310.2596 | 4.2776 | 309.8386 | 4.2949 |
| sym12 | 310.5808 | 4.3990 | 310.4522 | 4.3137 | 310.2641 | 4.3070 | 309.8163 | 4.3689 |
| sym20 | 310.5881 | 4.3984 | 310.4219 | 4.3113 | 310.2372 | 4.3011 | 309.7696 | 4.2745 |
| coif1 | 310.6227 | 4.3819 | 310.5636 | 4.4002 | 310.4421 | 4.3800 | 310.1723 | 4.3817 |
| coif2 | 310.6017 | 4.3590 | 310.5130 | 4.3889 | 310.3477 | 4.3856 | 309.9386 | 4.3262 |
| coif3 | 310.5953 | 4.3623 | 310.4844 | 4.3757 | 310.3229 | 4.3411 | 309.9157 | 4.3831 |
| coif4 | 310.5835 | 4.3597 | 310.4712 | 4.3603 | 310.2828 | 4.3593 | 310.0947 | 4.4247 |
| coif5 | 310.5837 | 4.3624 | 310.4509 | 4.3502 | 310.3144 | 4.3248 | 309.8498 | 4.2124 |
| bior1.1 | 310.4289 | 4.1786 | 310.4549 | 4.2912 | 310.4135 | 4.1922 | 310.2033 | 4.2079 |
| bior1.3 | 310.6862 | 4.4134 | 310.5424 | 4.3490 | 310.2678 | 4.2484 | 309.9953 | 4.1921 |
| bior1.5 | 310.6452 | 4.3976 | 310.4074 | 4.3108 | 310.0119 | 4.1918 | 309.6184 | 4.1379 |
| bior2.2 | 310.6646 | 4.4182 | 310.5813 | 4.3949 | 310.4635 | 4.3912 | 310.1961 | 4.3092 |
| bior2.4 | 310.6207 | 4.3892 | 310.5074 | 4.3249 | 310.3580 | 4.3497 | 309.9834 | 4.2673 |
| bior2.6 | 310.5945 | 4.3743 | 310.5143 | 4.3992 | 310.3604 | 4.3881 | 309.9179 | 4.2527 |
| bior2.8 | 310.5889 | 4.3754 | 310.4837 | 4.3448 | 310.3198 | 4.3597 | 309.8951 | 4.2507 |
| bior3.1 | 310.6209 | 4.4284 | 310.4185 | 4.3057 | 310.1583 | 4.3184 | 309.3659 | 4.1768 |
| bior3.3 | 310.6406 | 4.4217 | 310.5078 | 4.3543 | 310.2939 | 4.3291 | 309.9739 | 4.3879 |
| bior3.5 | 310.6266 | 4.4182 | 310.5440 | 4.3740 | 310.3416 | 4.3527 | 310.0509 | 4.4579 |
| bior3.7 | 310.6183 | 4.4120 | 310.5100 | 4.3525 | 310.3019 | 4.3116 | 309.9672 | 4.3274 |
| bior3.9 | 310.6258 | 4.4219 | 310.5367 | 4.3772 | 310.3238 | 4.3156 | 309.9730 | 4.3290 |
| bior4.4 | 310.6276 | 4.3945 | 310.5140 | 4.3275 | 310.3419 | 4.3261 | 309.9638 | 4.2617 |
| bior5.5 | 310.6188 | 4.4035 | 310.5294 | 4.4010 | 310.3681 | 4.4154 | 309.9047 | 4.2174 |
| bior6.8 | 310.5975 | 4.3762 | 310.4701 | 4.3234 | 310.3039 | 4.3346 | 309.8873 | 4.3199 |
| rbio1.1 | 310.4289 | 4.1786 | 310.4549 | 4.2912 | 310.4135 | 4.1922 | 310.2033 | 4.2079 |
| rbio1.3 | 310.6657 | 4.4296 | 310.6177 | 4.4080 | 310.5227 | 4.4253 | 310.3072 | 4.3779 |
| rbio1.5 | 310.6337 | 4.4175 | 310.5468 | 4.3971 | 310.3493 | 4.2974 | 310.2229 | 4.4599 |
| rbio2.2 | 310.5713 | 4.3528 | 310.5321 | 4.4487 | 310.3310 | 4.4328 | 310.0195 | 4.4340 |
| rbio2.4 | 310.6326 | 4.3958 | 310.4987 | 4.3543 | 310.3077 | 4.3767 | 309.9221 | 4.4071 |
| rbio2.6 | 310.6126 | 4.3790 | 310.5100 | 4.3836 | 310.3220 | 4.3858 | 309.9209 | 4.3561 |
| rbio2.8 | 310.6089 | 4.3876 | 310.5054 | 4.3474 | 310.3088 | 4.3492 | 309.9451 | 4.3175 |
| rbio3.1 | 310.2557 | 4.3153 | 308.7915 | 4.3504 | 302.8888 | 11.2175 | 251.6966 | 144.0014 |
| rbio3.3 | 310.6041 | 4.4215 | 310.3202 | 4.3756 | 309.4661 | 4.3666 | 308.5255 | 4.5333 |
| rbio3.5 | 310.6230 | 4.4389 | 310.4225 | 4.3622 | 310.0545 | 4.3960 | 309.7486 | 4.3491 |
| rbio3.7 | 310.6214 | 4.4390 | 310.4581 | 4.3473 | 310.1667 | 4.3048 | 309.8164 | 4.4293 |
| rbio3.9 | 310.6110 | 4.4166 | 310.4928 | 4.3947 | 310.3095 | 4.3773 | 309.8764 | 4.3483 |
| rbio4.4 | 310.5953 | 4.3725 | 310.4789 | 4.3472 | 310.2633 | 4.3605 | 309.8841 | 4.3595 |
| rbio5.5 | 310.6081 | 4.4175 | 310.4954 | 4.3944 | 310.2367 | 4.3733 | 309.8144 | 4.3008 |
| rbio6.8 | 310.5974 | 4.3727 | 310.4506 | 4.3163 | 310.2473 | 4.3146 | 309.8620 | 4.3300 |
| dmey | 310.5482 | 4.3598 | 310.4002 | 4.3448 | 310.2867 | 4.3466 | 309.8005 | 4.2545 |

Table A.47: Results of GCV with soft thresholding for DSM generation on City Site 3 including outliers

| **City Site 3**, μ = 318.7184, σ = 9.1404 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 318.7184 | 9.1402 | 318.7184 | 9.0088 | 318.7184 | 8.7703 | 318.7184 | 8.3790 |
| db2 | 318.7185 | 9.0947 | 318.7204 | 9.0122 | 318.7250 | 8.8098 | 318.7418 | 8.4169 |
| db4 | 318.7186 | 9.1020 | 318.7160 | 9.0229 | 318.7126 | 8.8414 | 318.7113 | 8.4529 |
| db6 | 318.7178 | 9.1028 | 318.7189 | 9.0347 | 318.7163 | 8.8564 | 318.7236 | 8.4960 |
| db8 | 318.7185 | 9.1040 | 318.7208 | 9.0357 | 318.7141 | 8.8568 | 318.7202 | 8.6616 |
| db10 | 318.7189 | 9.1052 | 318.7158 | 9.0314 | 318.7136 | 8.8568 | 318.7109 | 8.6577 |
| db12 | 318.7182 | 9.1052 | 318.7197 | 9.0390 | 318.7145 | 8.8607 | 318.7210 | 8.4996 |
| db20 | 318.7181 | 9.1058 | 318.7175 | 9.0352 | 318.7220 | 8.8679 | 318.7237 | 8.4954 |
| sym2 | 318.7185 | 9.0947 | 318.7204 | 9.0122 | 318.7250 | 8.8098 | 318.7418 | 8.4169 |
| sym4 | 318.7180 | 9.1008 | 318.7129 | 9.0195 | 318.7162 | 8.8431 | 318.7311 | 8.4673 |
| sym6 | 318.7179 | 9.1026 | 318.7243 | 9.0394 | 318.7121 | 8.8510 | 318.7178 | 8.4827 |
| sym8 | 318.7179 | 9.1035 | 318.7152 | 9.0288 | 318.7082 | 8.8500 | 318.7136 | 8.4816 |
| sym10 | 318.7179 | 9.1039 | 318.7215 | 9.0405 | 318.7267 | 8.8690 | 318.7115 | 8.4694 |
| sym12 | 318.7188 | 9.1052 | 318.7159 | 9.0326 | 318.7188 | 8.8629 | 318.7108 | 8.4537 |
| sym20 | 318.7188 | 9.1056 | 318.7164 | 9.0346 | 318.7205 | 8.8660 | 318.7267 | 8.5908 |
| coif1 | 318.7182 | 9.0939 | 318.7146 | 9.0015 | 318.7221 | 8.8089 | 318.7435 | 8.4305 |
| coif2 | 318.7179 | 9.1011 | 318.7146 | 9.0212 | 318.7064 | 8.8387 | 318.7156 | 8.4674 |
| coif3 | 318.7179 | 9.1029 | 318.7154 | 9.0278 | 318.7239 | 8.8554 | 318.7105 | 8.4458 |
| coif4 | 318.7179 | 9.1038 | 318.7158 | 9.0298 | 318.7118 | 8.8531 | 318.7139 | 8.4651 |
| coif5 | 318.7179 | 9.1042 | 318.7160 | 9.0314 | 318.7235 | 8.8642 | 318.7296 | 8.4976 |
| bior1.1 | 318.7184 | 9.1402 | 318.7184 | 9.0088 | 318.7184 | 8.7703 | 318.7184 | 8.3790 |
| bior1.3 | 318.7184 | 9.1232 | 318.7170 | 9.0908 | 318.7164 | 8.9744 | 318.7143 | 8.6458 |
| bior1.5 | 318.7184 | 9.1359 | 318.7193 | 9.1284 | 318.7161 | 9.0453 | 318.7176 | 8.7447 |
| bior2.2 | 318.7179 | 9.0893 | 318.7156 | 8.9851 | 318.7237 | 8.7751 | 318.7491 | 8.3858 |
| bior2.4 | 318.7181 | 9.0993 | 318.7240 | 9.0265 | 318.7164 | 8.8237 | 318.7220 | 8.4454 |
| bior2.6 | 318.7182 | 9.1038 | 318.7150 | 9.0250 | 318.7058 | 8.8399 | 318.7164 | 8.4683 |
| bior2.8 | 318.7183 | 9.1064 | 318.7225 | 9.0444 | 318.7249 | 8.8662 | 318.7126 | 8.4721 |
| bior3.1 | 318.7184 | 9.0960 | 318.7202 | 9.0095 | 318.7201 | 8.9004 | 318.7126 | 8.8171 |
| bior3.3 | 318.7184 | 9.0980 | 318.7205 | 9.0276 | 318.7068 | 8.8433 | 318.7072 | 8.4869 |
| bior3.5 | 318.7184 | 9.1006 | 318.7155 | 9.0184 | 318.7154 | 8.8428 | 318.7126 | 8.4543 |
| bior3.7 | 318.7184 | 9.1025 | 318.7226 | 9.0336 | 318.7276 | 8.8466 | 318.7153 | 8.4662 |
| bior3.9 | 318.7184 | 9.1039 | 318.7147 | 9.0251 | 318.7125 | 8.8451 | 318.7148 | 8.4811 |
| bior4.4 | 318.7178 | 9.0997 | 318.7239 | 9.0309 | 318.7161 | 8.8368 | 318.7226 | 8.4629 |
| bior5.5 | 318.7191 | 9.1028 | 318.7220 | 9.0316 | 318.7100 | 8.8395 | 318.7133 | 8.4731 |
| bior6.8 | 318.7178 | 9.1030 | 318.7213 | 9.0376 | 318.7248 | 8.8593 | 318.7125 | 8.4639 |
| rbio1.1 | 318.7184 | 9.1402 | 318.7184 | 9.0088 | 318.7184 | 8.7703 | 318.7184 | 8.3790 |
| rbio1.3 | 318.7184 | 9.0888 | 318.7146 | 8.9922 | 318.7099 | 8.7767 | 318.7061 | 8.3645 |
| rbio1.5 | 318.7184 | 9.0972 | 318.7188 | 9.0114 | 318.7126 | 8.8175 | 318.7065 | 8.4144 |
| rbio2.2 | 318.7187 | 9.1036 | 318.7142 | 9.0596 | 318.7235 | 8.9852 | 318.7442 | 8.7514 |
| rbio2.4 | 318.7179 | 9.0985 | 318.7238 | 9.0343 | 318.7144 | 8.8521 | 318.7239 | 8.4968 |
| rbio2.6 | 318.7177 | 9.0999 | 318.7148 | 9.0204 | 318.7067 | 8.8362 | 318.7160 | 8.4684 |
| rbio2.8 | 318.7177 | 9.1012 | 318.7216 | 9.0343 | 318.7242 | 8.8512 | 318.7144 | 8.4519 |
| rbio3.1 | 318.7184 | 9.3133 | 318.7152 | 10.6897 | 318.7013 | 16.0640 | 318.6637 | 31.2036 |
| rbio3.3 | 318.7184 | 9.1155 | 318.7195 | 9.1467 | 318.7164 | 9.2922 | 318.7172 | 9.4185 |
| rbio3.5 | 318.7184 | 9.1056 | 318.7136 | 9.0498 | 318.7164 | 8.9396 | 318.7148 | 8.6327 |
| rbio3.7 | 318.7184 | 9.1040 | 318.7222 | 9.0465 | 318.7271 | 8.8864 | 318.7146 | 8.5266 |
| rbio3.9 | 318.7184 | 9.1039 | 318.7147 | 9.0304 | 318.7126 | 8.8627 | 318.7150 | 8.5021 |
| rbio4.4 | 318.7180 | 9.1038 | 318.7239 | 9.0464 | 318.7139 | 8.8686 | 318.7224 | 8.5110 |
| rbio5.5 | 318.7187 | 9.1088 | 318.7226 | 9.0486 | 318.7110 | 8.8663 | 318.7151 | 8.5100 |
| rbio6.8 | 318.7179 | 9.1037 | 318.7213 | 9.0400 | 318.7244 | 8.8649 | 318.7124 | 8.4733 |
| dmey | 318.7181 | 9.1057 | 318.7172 | 9.0361 | 318.7217 | 8.8693 | 318.7237 | 8.5149 |

Table A.48: Results of GCV with soft thresholding for DEM generation on City Site 3 including outliers

| **City Site 3**, μ = 310.7064, σ = 4.4727 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 310.3806 | 4.2154 | 310.3280 | 4.2709 | 310.2983 | 4.1536 | 310.1407 | 4.1619 |
| db2 | 310.5782 | 4.4139 | 310.5001 | 4.3696 | 310.3254 | 4.3054 | 310.2168 | 4.4534 |
| db4 | 310.5699 | 4.4172 | 310.4475 | 4.3867 | 310.1921 | 4.2863 | 309.9021 | 4.3530 |
| db6 | 310.5149 | 4.3520 | 310.3946 | 4.3116 | 310.1350 | 4.2890 | 309.7873 | 4.2247 |
| db8 | 310.5317 | 4.3685 | 310.4042 | 4.3592 | 310.1312 | 4.3288 | 309.8979 | 4.3605 |
| db10 | 310.5052 | 4.3890 | 310.3754 | 4.3544 | 310.0974 | 4.3146 | 309.6929 | 4.3793 |
| db12 | 310.5184 | 4.3677 | 310.3541 | 4.3112 | 310.0783 | 4.3399 | 309.6009 | 4.2524 |
| db20 | 310.4858 | 4.3522 | 310.3571 | 4.3913 | 310.1844 | 4.3535 | 309.7647 | 4.3131 |
| sym2 | 310.5782 | 4.4139 | 310.5001 | 4.3696 | 310.3254 | 4.3054 | 310.2168 | 4.4534 |
| sym4 | 310.5502 | 4.3774 | 310.4479 | 4.3463 | 310.2953 | 4.3394 | 309.8529 | 4.1890 |
| sym6 | 310.5277 | 4.3564 | 310.4054 | 4.3298 | 310.1712 | 4.3134 | 309.7218 | 4.1948 |
| sym8 | 310.5082 | 4.3457 | 310.4033 | 4.3474 | 310.2112 | 4.3568 | 309.7785 | 4.3014 |
| sym10 | 310.4908 | 4.3396 | 310.3618 | 4.3337 | 310.1375 | 4.2523 | 309.7262 | 4.2619 |
| sym12 | 310.4906 | 4.3662 | 310.3643 | 4.3014 | 310.1695 | 4.2843 | 309.7209 | 4.2889 |
| sym20 | 310.4759 | 4.3536 | 310.3376 | 4.3033 | 310.1367 | 4.2909 | 309.7035 | 4.2459 |
| coif1 | 310.5359 | 4.3525 | 310.4981 | 4.3944 | 310.3534 | 4.3668 | 310.1001 | 4.3924 |
| coif2 | 310.5260 | 4.3487 | 310.4316 | 4.3648 | 310.2351 | 4.3304 | 309.8332 | 4.2473 |
| coif3 | 310.5113 | 4.3427 | 310.4159 | 4.3770 | 310.2227 | 4.3143 | 309.8766 | 4.3426 |
| coif4 | 310.4976 | 4.3436 | 310.4152 | 4.3859 | 310.1914 | 4.3513 | 310.0268 | 4.4125 |
| coif5 | 310.4832 | 4.3277 | 310.4072 | 4.3626 | 310.2113 | 4.3037 | 309.7652 | 4.1934 |
| bior1.1 | 310.3806 | 4.2154 | 310.3280 | 4.2709 | 310.2983 | 4.1536 | 310.1407 | 4.1619 |
| bior1.3 | 310.6124 | 4.4231 | 310.4830 | 4.3592 | 310.1727 | 4.2409 | 309.9048 | 4.1293 |
| bior1.5 | 310.5498 | 4.3773 | 310.3101 | 4.2822 | 309.8235 | 4.1033 | 309.5484 | 4.1071 |
| bior2.2 | 310.5734 | 4.3710 | 310.5090 | 4.3796 | 310.3847 | 4.3662 | 310.1589 | 4.3528 |
| bior2.4 | 310.5366 | 4.3540 | 310.4372 | 4.3424 | 310.2715 | 4.3101 | 309.9029 | 4.2183 |
| bior2.6 | 310.5111 | 4.3277 | 310.4320 | 4.3772 | 310.2622 | 4.3501 | 309.8836 | 4.2697 |
| bior2.8 | 310.5056 | 4.3371 | 310.3827 | 4.3327 | 310.2155 | 4.3290 | 309.8122 | 4.2310 |
| bior3.1 | 310.5237 | 4.3708 | 310.2747 | 4.3224 | 309.9307 | 4.3609 | 309.1725 | 4.3696 |
| bior3.3 | 310.5751 | 4.4110 | 310.4145 | 4.3234 | 310.1890 | 4.2933 | 309.8175 | 4.3420 |
| bior3.5 | 310.5692 | 4.4064 | 310.4458 | 4.3518 | 310.2534 | 4.3367 | 310.0130 | 4.4270 |
| bior3.7 | 310.5542 | 4.3905 | 310.4126 | 4.3109 | 310.2202 | 4.2753 | 309.9304 | 4.2955 |
| bior3.9 | 310.5475 | 4.3938 | 310.4567 | 4.3564 | 310.2664 | 4.3260 | 309.9038 | 4.2796 |
| bior4.4 | 310.5433 | 4.3575 | 310.4215 | 4.3113 | 310.2685 | 4.3143 | 309.8617 | 4.1996 |
| bior5.5 | 310.5401 | 4.3867 | 310.4047 | 4.3383 | 310.2715 | 4.3766 | 309.8275 | 4.2068 |
| bior6.8 | 310.5129 | 4.3493 | 310.3873 | 4.3172 | 310.2284 | 4.3219 | 309.7833 | 4.2661 |
| rbio1.1 | 310.3806 | 4.2154 | 310.3280 | 4.2709 | 310.2983 | 4.1536 | 310.1407 | 4.1619 |
| rbio1.3 | 310.6413 | 4.4651 | 310.5415 | 4.3914 | 310.4459 | 4.3834 | 310.1829 | 4.2987 |
| rbio1.5 | 310.5890 | 4.4206 | 310.4824 | 4.3877 | 310.2856 | 4.3012 | 310.1079 | 4.4108 |
| rbio2.2 | 310.5043 | 4.3512 | 310.4726 | 4.4183 | 310.2671 | 4.4054 | 309.9229 | 4.3510 |
| rbio2.4 | 310.5435 | 4.3520 | 310.4180 | 4.3601 | 310.2356 | 4.3645 | 309.8090 | 4.3384 |
| rbio2.6 | 310.5399 | 4.3553 | 310.4347 | 4.3752 | 310.2356 | 4.3332 | 309.8304 | 4.2642 |
| rbio2.8 | 310.5262 | 4.3574 | 310.4165 | 4.3325 | 310.2060 | 4.2953 | 309.8494 | 4.2457 |
| rbio3.1 | 310.1399 | 4.2462 | 308.6776 | 4.3910 | 303.4611 | 10.6199 | 281.7410 | 51.1837 |
| rbio3.3 | 310.5453 | 4.4234 | 310.2078 | 4.3509 | 309.3167 | 4.2812 | 308.5138 | 4.3969 |
| rbio3.5 | 310.5471 | 4.4142 | 310.3537 | 4.3409 | 309.9613 | 4.3012 | 309.5969 | 4.2667 |
| rbio3.7 | 310.5575 | 4.4087 | 310.3470 | 4.2923 | 310.0973 | 4.2933 | 309.8269 | 4.3865 |
| rbio3.9 | 310.5352 | 4.3788 | 310.4243 | 4.3528 | 310.2085 | 4.3632 | 309.8025 | 4.2815 |
| rbio4.4 | 310.5119 | 4.3295 | 310.3778 | 4.3474 | 310.1813 | 4.3481 | 309.7908 | 4.2938 |
| rbio5.5 | 310.5120 | 4.3759 | 310.3761 | 4.3507 | 310.1727 | 4.3642 | 309.7423 | 4.2568 |
| rbio6.8 | 310.5083 | 4.3494 | 310.3701 | 4.3168 | 310.1698 | 4.2982 | 309.7657 | 4.2922 |
| dmey | 310.4714 | 4.3431 | 310.3288 | 4.3346 | 310.1617 | 4.2934 | 309.6745 | 4.2157 |

Table A.49: Results of GCV with soft thresholding for DSM generation on City Site 3 excluding outliers

| **City Site 3**, μ = 318.6986, σ = 9.0395 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 318.6986 | 9.0419 | 318.6986 | 8.9183 | 318.6986 | 8.6827 | 318.6986 | 8.2848 |
| db2 | 318.6987 | 9.0021 | 318.7002 | 8.9281 | 318.7043 | 8.7292 | 318.7206 | 8.3366 |
| db4 | 318.6988 | 9.0103 | 318.6966 | 8.9378 | 318.6932 | 8.7602 | 318.6917 | 8.3672 |
| db6 | 318.6979 | 9.0103 | 318.6990 | 8.9492 | 318.6966 | 8.7764 | 318.7039 | 8.4106 |
| db8 | 318.6987 | 9.0111 | 318.7006 | 8.9513 | 318.6944 | 8.7772 | 318.7004 | 8.5743 |
| db10 | 318.6992 | 9.0129 | 318.6963 | 8.9458 | 318.6939 | 8.7769 | 318.6918 | 8.5488 |
| db12 | 318.6983 | 9.0130 | 318.6996 | 8.9541 | 318.6947 | 8.7811 | 318.7011 | 8.4153 |
| db20 | 318.6982 | 9.0133 | 318.6978 | 8.9501 | 318.7020 | 8.7898 | 318.7037 | 8.4135 |
| sym2 | 318.6987 | 9.0021 | 318.7002 | 8.9281 | 318.7043 | 8.7292 | 318.7206 | 8.3366 |
| sym4 | 318.6981 | 9.0083 | 318.6937 | 8.9337 | 318.6965 | 8.7627 | 318.7103 | 8.3817 |
| sym6 | 318.6980 | 9.0100 | 318.7038 | 8.9551 | 318.6924 | 8.7703 | 318.6979 | 8.3968 |
| sym8 | 318.6980 | 9.0108 | 318.6958 | 8.9434 | 318.6890 | 8.7693 | 318.6935 | 8.3951 |
| sym10 | 318.6980 | 9.0112 | 318.7013 | 8.9558 | 318.7067 | 8.7915 | 318.6916 | 8.3835 |
| sym12 | 318.6991 | 9.0125 | 318.6964 | 8.9470 | 318.6989 | 8.7840 | 318.6910 | 8.3681 |
| sym20 | 318.6991 | 9.0130 | 318.6968 | 8.9491 | 318.7005 | 8.7876 | 318.7067 | 8.5209 |
| coif1 | 318.6984 | 9.0023 | 318.6955 | 8.9166 | 318.7024 | 8.7284 | 318.7225 | 8.3460 |
| coif2 | 318.6980 | 9.0089 | 318.6952 | 8.9360 | 318.6870 | 8.7571 | 318.6956 | 8.3806 |
| coif3 | 318.6979 | 9.0105 | 318.6960 | 8.9426 | 318.7037 | 8.7766 | 318.6907 | 8.3595 |
| coif4 | 318.6979 | 9.0112 | 318.6963 | 8.9445 | 318.6925 | 8.7733 | 318.6940 | 8.3809 |
| coif5 | 318.6979 | 9.0116 | 318.6965 | 8.9462 | 318.7036 | 8.7858 | 318.7092 | 8.4151 |
| bior1.1 | 318.6986 | 9.0419 | 318.6986 | 8.9183 | 318.6986 | 8.6827 | 318.6986 | 8.2848 |
| bior1.3 | 318.6986 | 9.0298 | 318.6971 | 9.0046 | 318.6961 | 8.8929 | 318.6934 | 8.5607 |
| bior1.5 | 318.6986 | 9.0417 | 318.6993 | 9.0429 | 318.6966 | 8.9672 | 318.6981 | 8.6663 |
| bior2.2 | 318.6982 | 8.9981 | 318.6968 | 8.9006 | 318.7045 | 8.6936 | 318.7282 | 8.3001 |
| bior2.4 | 318.6982 | 9.0073 | 318.7035 | 8.9418 | 318.6964 | 8.7415 | 318.7019 | 8.3586 |
| bior2.6 | 318.6982 | 9.0113 | 318.6956 | 8.9398 | 318.6866 | 8.7581 | 318.6962 | 8.3810 |
| bior2.8 | 318.6982 | 9.0136 | 318.7023 | 8.9594 | 318.7050 | 8.7875 | 318.6925 | 8.3850 |
| bior3.1 | 318.6986 | 9.0036 | 318.7005 | 8.9146 | 318.7013 | 8.8075 | 318.6986 | 8.7193 |
| bior3.3 | 318.6986 | 9.0065 | 318.6994 | 8.9425 | 318.6887 | 8.7591 | 318.6867 | 8.4043 |
| bior3.5 | 318.6986 | 9.0091 | 318.6962 | 8.9327 | 318.6958 | 8.7613 | 318.6932 | 8.3713 |
| bior3.7 | 318.6986 | 9.0107 | 318.7022 | 8.9493 | 318.7070 | 8.7671 | 318.6952 | 8.3790 |
| bior3.9 | 318.6986 | 9.0119 | 318.6954 | 8.9395 | 318.6929 | 8.7643 | 318.6948 | 8.3963 |
| bior4.4 | 318.6979 | 9.0077 | 318.7035 | 8.9461 | 318.6961 | 8.7551 | 318.7025 | 8.3763 |
| bior5.5 | 318.6993 | 9.0100 | 318.7016 | 8.9471 | 318.6903 | 8.7576 | 318.6937 | 8.3861 |
| bior6.8 | 318.6979 | 9.0106 | 318.7012 | 8.9527 | 318.7050 | 8.7812 | 318.6925 | 8.3772 |
| rbio1.1 | 318.6986 | 9.0419 | 318.6986 | 8.9183 | 318.6986 | 8.6827 | 318.6986 | 8.2848 |
| rbio1.3 | 318.6986 | 8.9960 | 318.6953 | 8.9062 | 318.6909 | 8.6934 | 318.6873 | 8.2803 |
| rbio1.5 | 318.6986 | 9.0039 | 318.6989 | 8.9268 | 318.6930 | 8.7348 | 318.6874 | 8.3310 |
| rbio2.2 | 318.6987 | 9.0113 | 318.6949 | 8.9739 | 318.7035 | 8.9065 | 318.7232 | 8.6721 |
| rbio2.4 | 318.6981 | 9.0066 | 318.7035 | 8.9497 | 318.6946 | 8.7707 | 318.7037 | 8.4113 |
| rbio2.6 | 318.6979 | 9.0079 | 318.6956 | 8.9355 | 318.6874 | 8.7548 | 318.6959 | 8.3817 |
| rbio2.8 | 318.6979 | 9.0091 | 318.7015 | 8.9495 | 318.7043 | 8.7725 | 318.6944 | 8.3649 |
| rbio3.1 | 318.6986 | 9.2164 | 318.6954 | 10.6058 | 318.6817 | 16.0351 | 318.6444 | 31.2853 |
| rbio3.3 | 318.6986 | 9.0226 | 318.6994 | 9.0596 | 318.6965 | 9.2160 | 318.6969 | 9.3464 |
| rbio3.5 | 318.6986 | 9.0135 | 318.6942 | 8.9634 | 318.6966 | 8.8603 | 318.6952 | 8.5497 |
| rbio3.7 | 318.6986 | 9.0121 | 318.7020 | 8.9621 | 318.7067 | 8.8086 | 318.6949 | 8.4422 |
| rbio3.9 | 318.6986 | 9.0120 | 318.6953 | 8.9448 | 318.6930 | 8.7843 | 318.6951 | 8.4200 |
| rbio4.4 | 318.6980 | 9.0112 | 318.7035 | 8.9613 | 318.6940 | 8.7876 | 318.7025 | 8.4251 |
| rbio5.5 | 318.6991 | 9.0160 | 318.7025 | 8.9642 | 318.6913 | 8.7856 | 318.6952 | 8.4243 |
| rbio6.8 | 318.6979 | 9.0111 | 318.7012 | 8.9550 | 318.7045 | 8.7868 | 318.6923 | 8.3868 |
| dmey | 318.6982 | 9.0130 | 318.6976 | 8.9509 | 318.7017 | 8.7910 | 318.7040 | 8.4318 |

Table A.50: Results of GCV with soft thresholding for DEM generation on City Site 3 excluding outliers

| **City Site 3**, μ = 310.7514, σ = 4.4699 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wavelet | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| haar | 310.4289 | 4.1786 | 310.4584 | 4.2841 | 310.4201 | 4.1816 | 310.2256 | 4.1611 |
| db2 | 310.6425 | 4.4233 | 310.5958 | 4.4228 | 310.4120 | 4.3277 | 310.3143 | 4.4917 |
| db4 | 310.6189 | 4.4085 | 310.5307 | 4.3950 | 310.2768 | 4.2830 | 309.9798 | 4.3308 |
| db6 | 310.5981 | 4.3767 | 310.5018 | 4.3365 | 310.2604 | 4.3336 | 309.8830 | 4.2683 |
| db8 | 310.6023 | 4.4048 | 310.4876 | 4.3796 | 310.2556 | 4.3562 | 309.9883 | 4.3439 |
| db10 | 310.5821 | 4.3908 | 310.4582 | 4.3646 | 310.2371 | 4.3512 | 309.7921 | 4.3965 |
| db12 | 310.5882 | 4.3725 | 310.4430 | 4.3361 | 310.1778 | 4.3361 | 309.7113 | 4.2843 |
| db20 | 310.5797 | 4.3758 | 310.4207 | 4.3655 | 310.2605 | 4.3687 | 309.8030 | 4.2910 |
| sym2 | 310.6425 | 4.4233 | 310.5958 | 4.4228 | 310.4120 | 4.3277 | 310.3143 | 4.4917 |
| sym4 | 310.6223 | 4.3946 | 310.5072 | 4.3578 | 310.3691 | 4.3606 | 309.9547 | 4.2392 |
| sym6 | 310.5929 | 4.3653 | 310.4853 | 4.3319 | 310.2758 | 4.3578 | 309.8633 | 4.2596 |
| sym8 | 310.5858 | 4.3531 | 310.4861 | 4.3508 | 310.3078 | 4.3641 | 309.8853 | 4.3358 |
| sym10 | 310.6045 | 4.3774 | 310.4608 | 4.3284 | 310.2618 | 4.2778 | 309.8709 | 4.3068 |
| sym12 | 310.5808 | 4.3992 | 310.4520 | 4.3141 | 310.2677 | 4.3069 | 309.8112 | 4.3670 |
| sym20 | 310.5880 | 4.3983 | 310.4221 | 4.3113 | 310.2440 | 4.3014 | 309.7966 | 4.2627 |
| coif1 | 310.6217 | 4.3799 | 310.5612 | 4.3978 | 310.4461 | 4.3796 | 310.1747 | 4.3702 |
| coif2 | 310.6010 | 4.3553 | 310.5119 | 4.3838 | 310.3480 | 4.3719 | 309.9595 | 4.3030 |
| coif3 | 310.5945 | 4.3587 | 310.4838 | 4.3751 | 310.3242 | 4.3410 | 309.9214 | 4.3827 |
| coif4 | 310.5828 | 4.3596 | 310.4705 | 4.3600 | 310.2765 | 4.3477 | 310.0924 | 4.4184 |
| coif5 | 310.5837 | 4.3624 | 310.4512 | 4.3494 | 310.3150 | 4.3243 | 309.8618 | 4.2112 |
| bior1.1 | 310.4289 | 4.1786 | 310.4584 | 4.2841 | 310.4201 | 4.1816 | 310.2256 | 4.1611 |
| bior1.3 | 310.6851 | 4.4134 | 310.5456 | 4.3418 | 310.2664 | 4.2407 | 310.0153 | 4.1676 |
| bior1.5 | 310.6441 | 4.3976 | 310.4049 | 4.3006 | 310.0104 | 4.1801 | 309.6356 | 4.1365 |
| bior2.2 | 310.6630 | 4.4162 | 310.5828 | 4.3926 | 310.4682 | 4.3834 | 310.2115 | 4.3100 |
| bior2.4 | 310.6192 | 4.3872 | 310.5075 | 4.3261 | 310.3617 | 4.3461 | 310.0177 | 4.2338 |
| bior2.6 | 310.5972 | 4.3740 | 310.5119 | 4.3959 | 310.3620 | 4.3788 | 309.9474 | 4.2614 |
| bior2.8 | 310.5916 | 4.3752 | 310.4828 | 4.3451 | 310.3200 | 4.3570 | 309.9236 | 4.2631 |
| bior3.1 | 310.6218 | 4.4231 | 310.4256 | 4.3031 | 310.1334 | 4.3195 | 309.3179 | 4.2218 |
| bior3.3 | 310.6424 | 4.4184 | 310.5197 | 4.3495 | 310.3131 | 4.3277 | 310.0312 | 4.4144 |
| bior3.5 | 310.6287 | 4.4146 | 310.5436 | 4.3716 | 310.3324 | 4.3337 | 310.0796 | 4.4265 |
| bior3.7 | 310.6203 | 4.4085 | 310.5082 | 4.3400 | 310.3042 | 4.3009 | 310.0083 | 4.3188 |
| bior3.9 | 310.6282 | 4.4178 | 310.5374 | 4.3716 | 310.3258 | 4.3080 | 309.9869 | 4.3038 |
| bior4.4 | 310.6263 | 4.3926 | 310.5155 | 4.3271 | 310.3376 | 4.3269 | 309.9838 | 4.2475 |
| bior5.5 | 310.6189 | 4.4036 | 310.5313 | 4.4001 | 310.3721 | 4.4135 | 309.9277 | 4.2060 |
| bior6.8 | 310.5995 | 4.3748 | 310.4699 | 4.3218 | 310.2977 | 4.3229 | 309.9352 | 4.3262 |
| rbio1.1 | 310.4289 | 4.1786 | 310.4584 | 4.2841 | 310.4201 | 4.1816 | 310.2256 | 4.1611 |
| rbio1.3 | 310.6657 | 4.4296 | 310.6201 | 4.4032 | 310.5253 | 4.4227 | 310.3200 | 4.3552 |
| rbio1.5 | 310.6335 | 4.4174 | 310.5476 | 4.3892 | 310.3378 | 4.2878 | 310.2260 | 4.4579 |
| rbio2.2 | 310.5740 | 4.3510 | 310.5325 | 4.4448 | 310.3376 | 4.4165 | 310.0302 | 4.4082 |
| rbio2.4 | 310.6356 | 4.3955 | 310.4999 | 4.3514 | 310.3081 | 4.3606 | 309.9237 | 4.3591 |
| rbio2.6 | 310.6150 | 4.3768 | 310.5071 | 4.3768 | 310.3373 | 4.3584 | 309.9346 | 4.3040 |
| rbio2.8 | 310.6111 | 4.3855 | 310.5069 | 4.3472 | 310.3169 | 4.3414 | 309.9637 | 4.2852 |
| rbio3.1 | 310.2669 | 4.3069 | 308.8096 | 4.3463 | 303.2456 | 10.7965 | 286.0772 | 48.3183 |
| rbio3.3 | 310.6075 | 4.4172 | 310.3192 | 4.3559 | 309.4708 | 4.2861 | 308.6524 | 4.4075 |
| rbio3.5 | 310.6268 | 4.4312 | 310.4287 | 4.3486 | 310.0840 | 4.3286 | 309.7243 | 4.3149 |
| rbio3.7 | 310.6246 | 4.4315 | 310.4687 | 4.3293 | 310.1625 | 4.2801 | 309.8429 | 4.3761 |
| rbio3.9 | 310.6162 | 4.4072 | 310.4956 | 4.3835 | 310.3023 | 4.3541 | 309.8933 | 4.2969 |
| rbio4.4 | 310.5987 | 4.3724 | 310.4792 | 4.3446 | 310.2685 | 4.3470 | 309.8884 | 4.3339 |
| rbio5.5 | 310.6091 | 4.4152 | 310.4974 | 4.3943 | 310.2363 | 4.3700 | 309.8480 | 4.2864 |
| rbio6.8 | 310.5999 | 4.3711 | 310.4514 | 4.3146 | 310.2471 | 4.3030 | 309.8959 | 4.2968 |
| dmey | 310.5522 | 4.3579 | 310.4029 | 4.3424 | 310.2941 | 4.3460 | 309.8009 | 4.2492 |

# APPENDIX B

# KEY FUNCTIONS USED AND IMPLEMENTED IN MATLAB

Key built-in functions used:

- dwt
- meshgrid
- griddata
- wavedec2
- waverec2
- wthresh
- mean
- std
- surf

Key functions implemented:

- outlier
- denoise2
- pmfilter

# APPENDIX C

# IMPLEMENTED WAVELET MODELS

The following wavelet models are implemented in this work:

- Haar
- Daubechies (2, 4, 6, 8, 10, 12, 20)
- Symlets (2, 4, 6, 8, 10, 12, 20 )
- Coiflets (1-5)
- Biorthogonal (1.1, 1.3, 1.5, 2.2, 2.4, 2.6, 2.8, 3.1, 3.3, 3.5, 3.7, 3.9, 4.4, 5.5, 6.8)
- Reverse Biorthogonal (1.1, 1.3, 1.5, 2.2, 2.4, 2.6, 2.8, 3.1, 3.3, 3.5, 3.7, 3.9, 4.4, 5.5, 6.8)
- Discrete Meyer