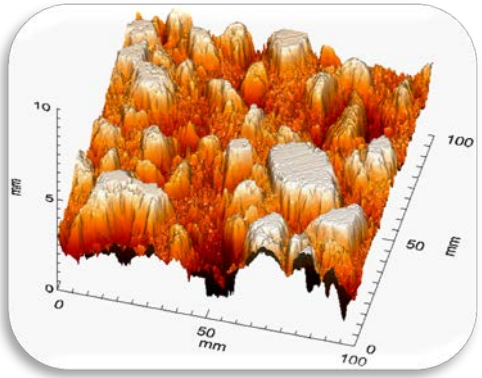
TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

INSTITUTE OF TRANSPORTATION
Research Center of Road Engineering
Group for planning, maintenance and PMS

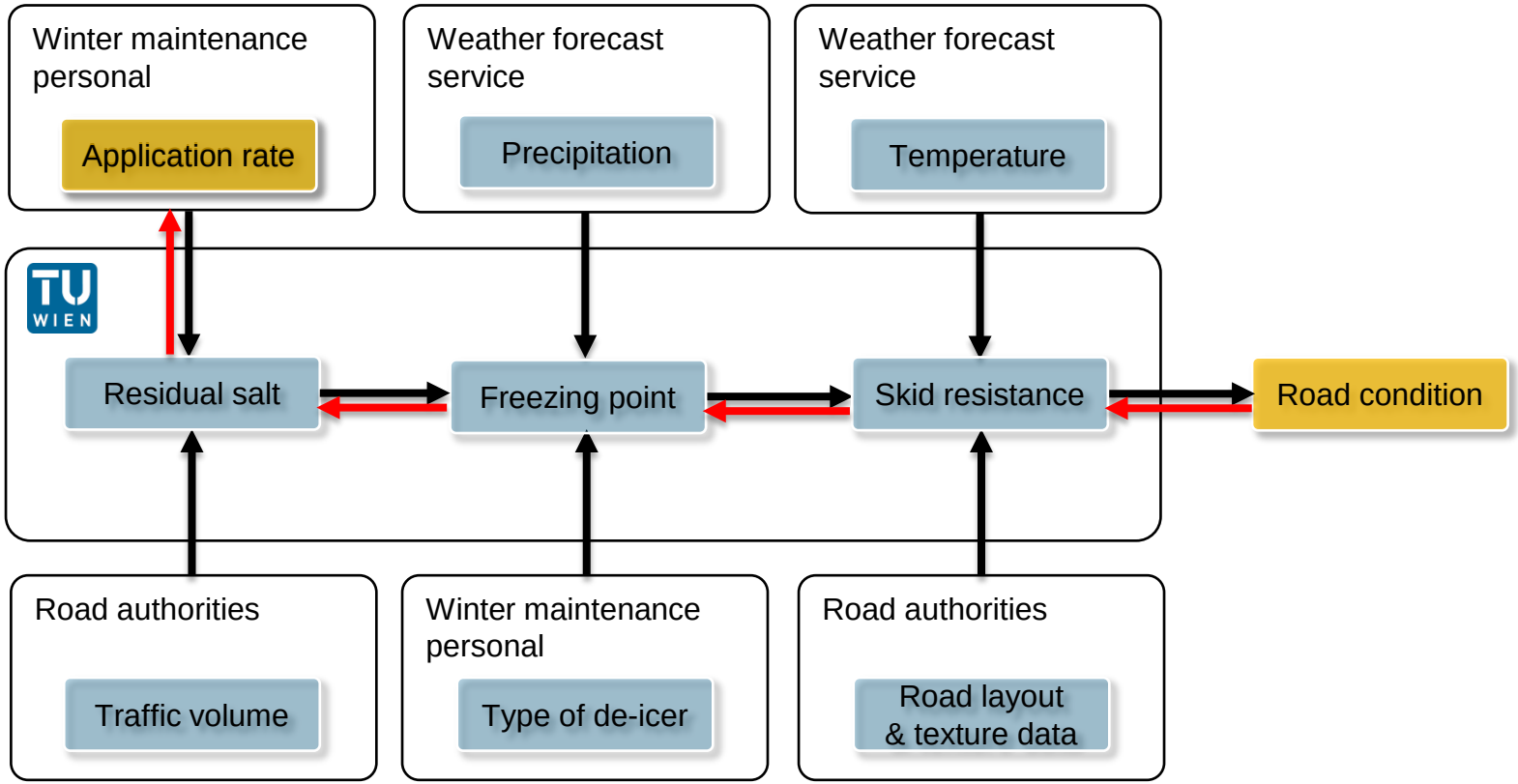
SIRWEC 2012 Paper 0070

„Towards real-time skid resistance forecast“



Nutz, P. - Hoffmann, M.

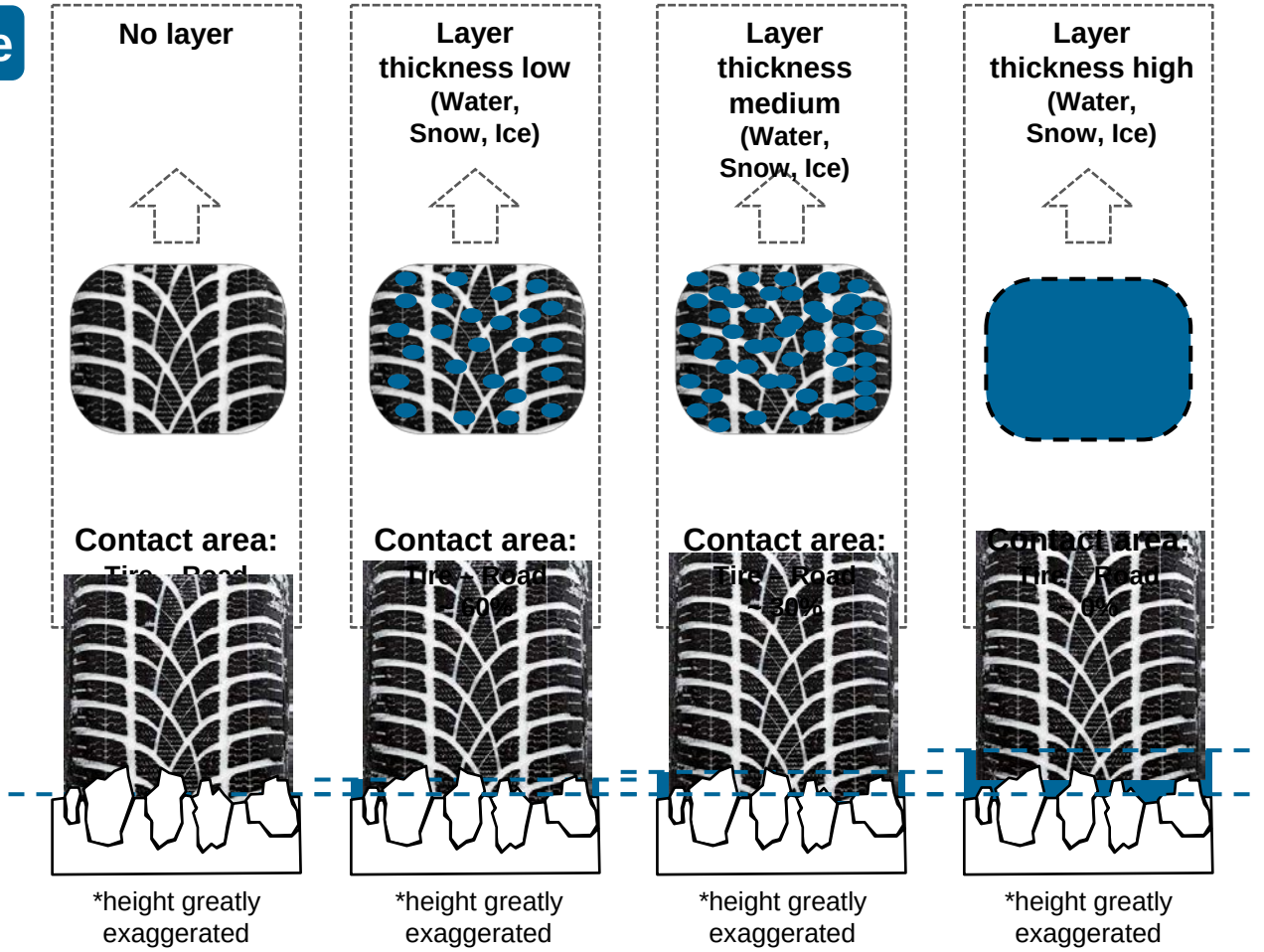
1 Modelling - Salt usage and cost comparison



2 Skid resistance - importance of road surface texture

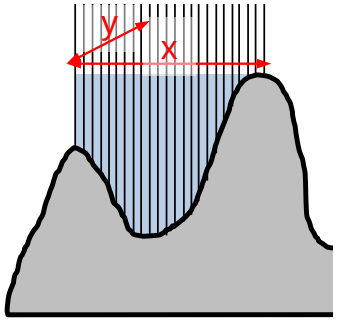
Skid resistance & Texture

- Small amounts of snow or ice have no relevant impact on skid resistance if the mean texture depth is large enough to absorb this amount
- Continuous precipitation results in a filled texture resulting in a decreasing contact area of tire and road surface
- Thus the road texture provides a buffer for small amounts of precipitation
- Furthermore this buffer gives the winter maintenance personal time for preparation



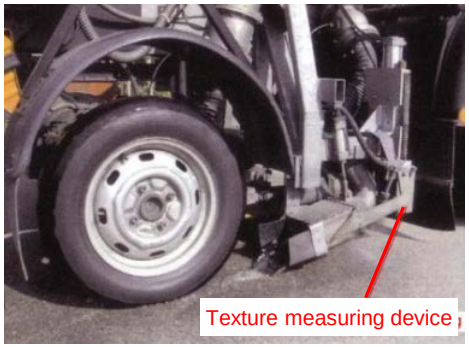
3 Determination of road macro texture

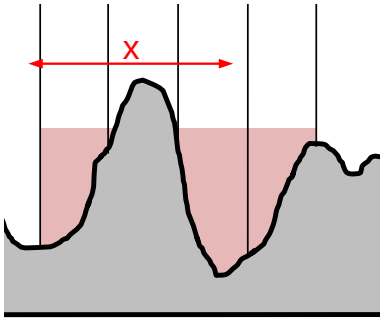
Laser scan (1/10 mm)



- ✓ Very precise
- X Only in laboratory

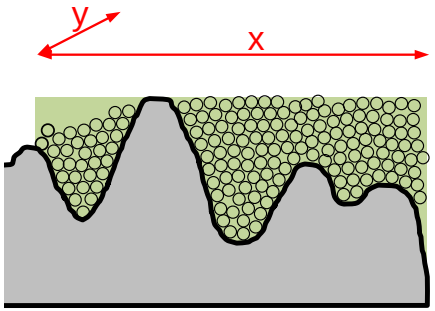
RoadSTAR (1 mm)





- ✓ Whole network scans
- X Moderate precision

Sand patch (Ø 0,18-0,25)



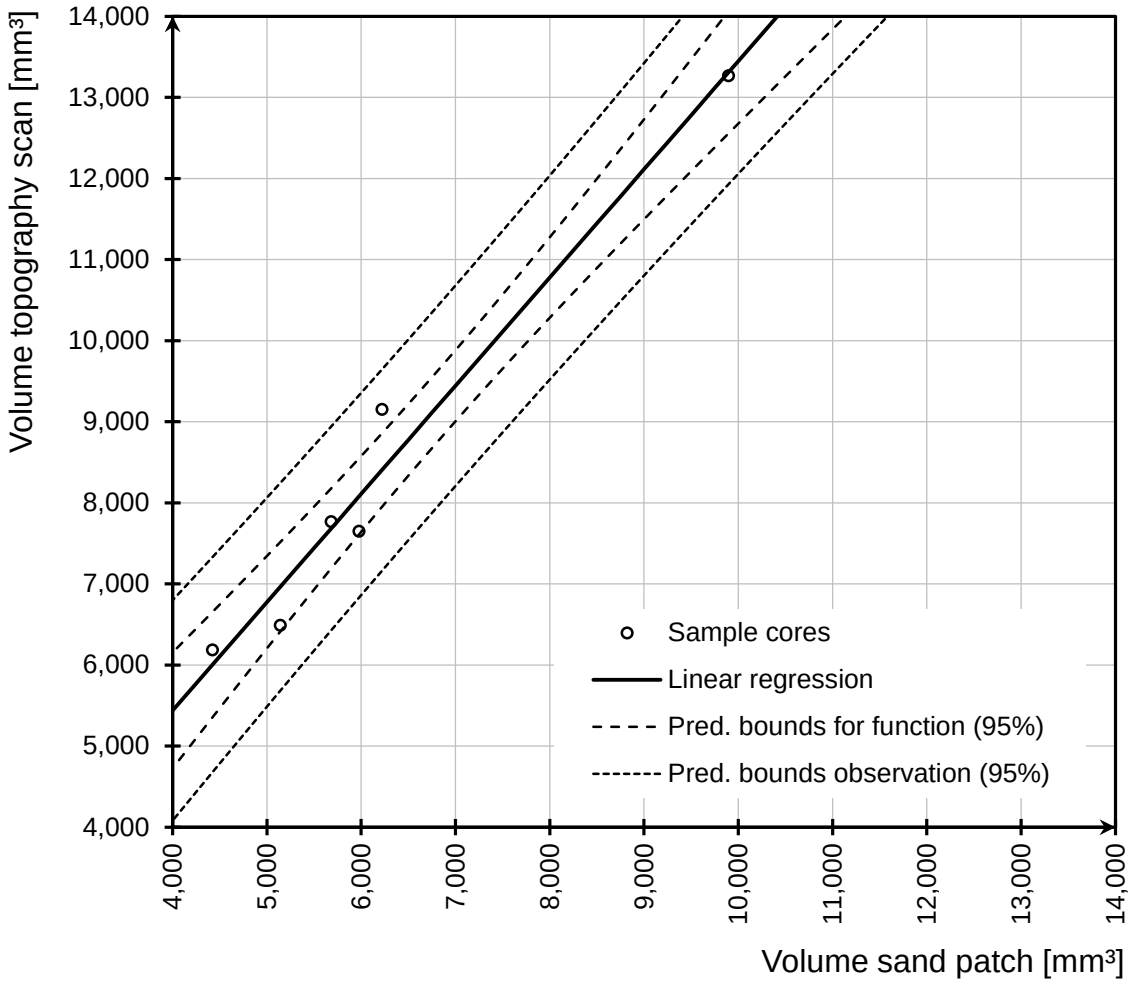
- ✓ Easy & cheap
- X Only single points

4 Correlation between texture determination methods 1/2

Laser scan - Sand patch

- Linear correlation between volumetric and geometric methods with $R^2 = 0.9799$ quiet good
- Offset of ~1500 mm³ with geometric method due to exact determination of the highest peak in surveyed area
- Easy and cheap volumetric sand patch method can be used with only a few exact topography scans in laboratory as background

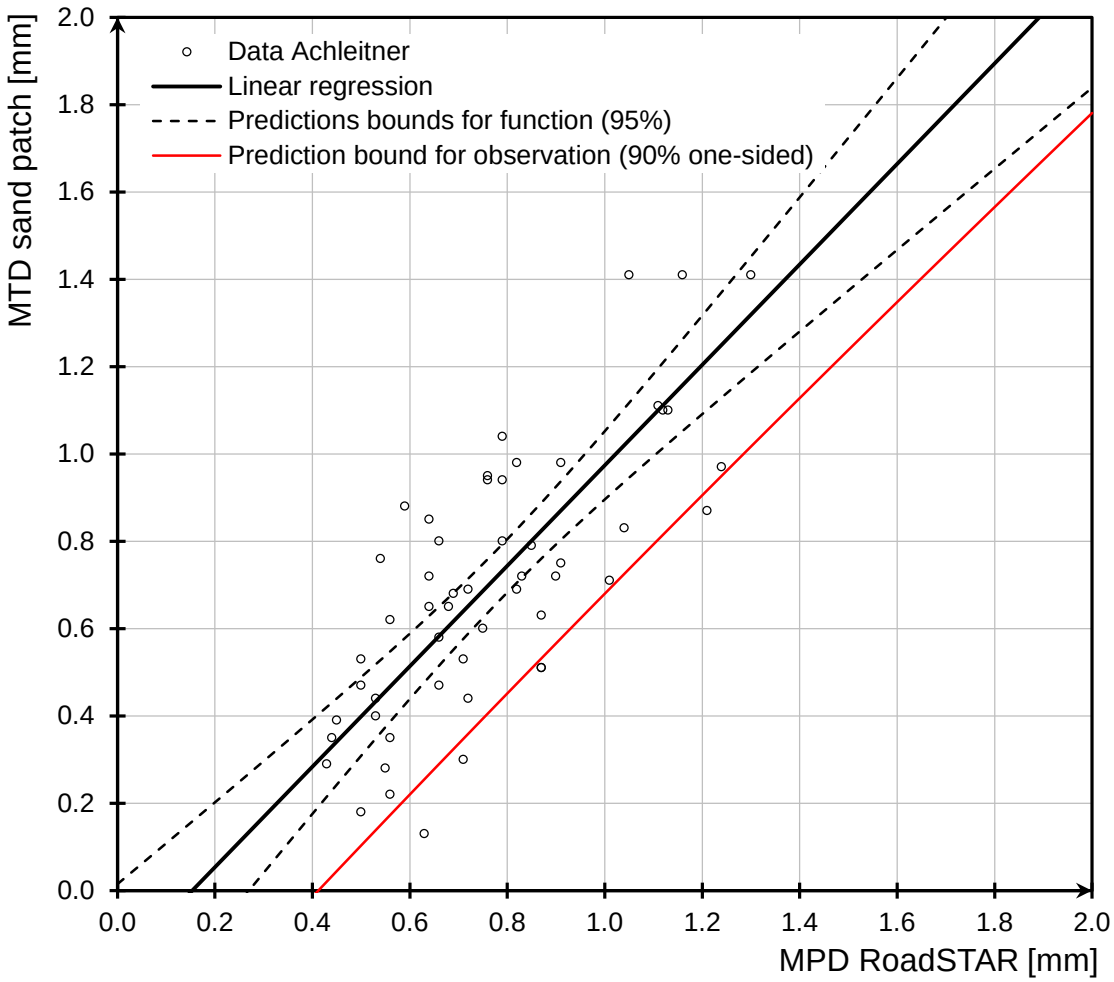
$$V_L = 1.335 * V_{SP} + 101.3$$



4 Correlation between texture determination methods 2/2

Sand patch - RoadSTAR

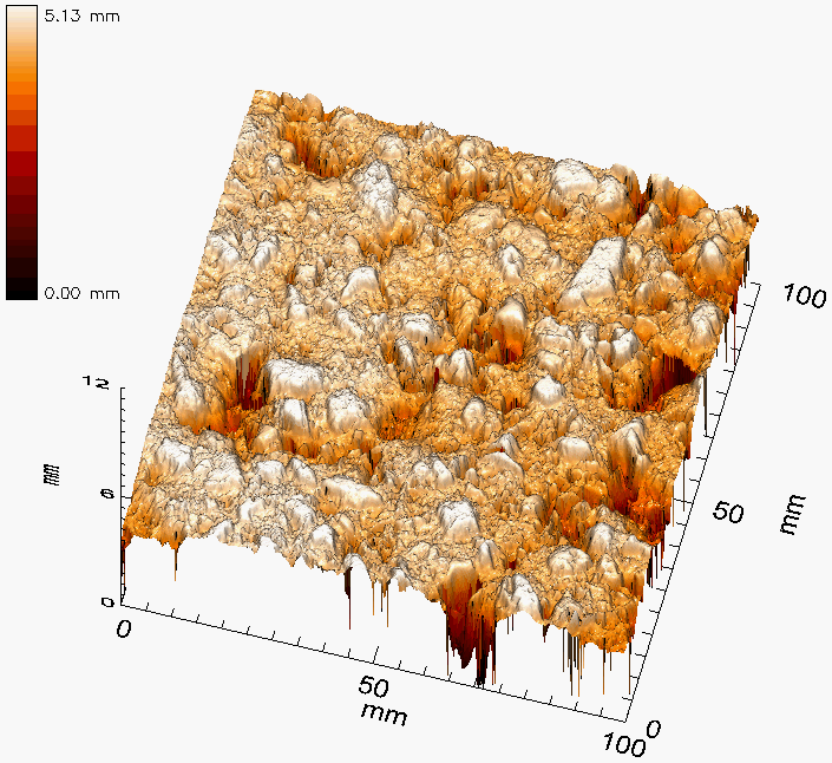
- Correlation between sand patch and RoadSTAR with R^2=0.646 moderate
- One sided 90% prediction bound for new observation used to keep the odds of less road texture volume the measured below 10%
- With improved network scans the safety buffer for texture volume could be reduced



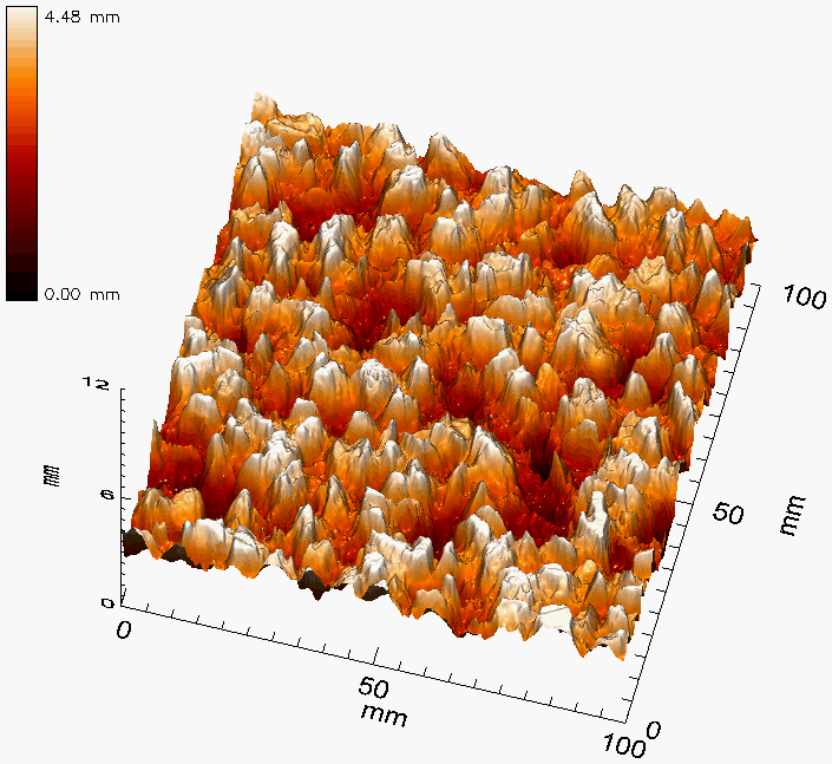
$$MTD = 1.1354 * MPD - 0.4685$$

5 Road surface texture – Difference between pavements

Flexible Pavement (7 years old)



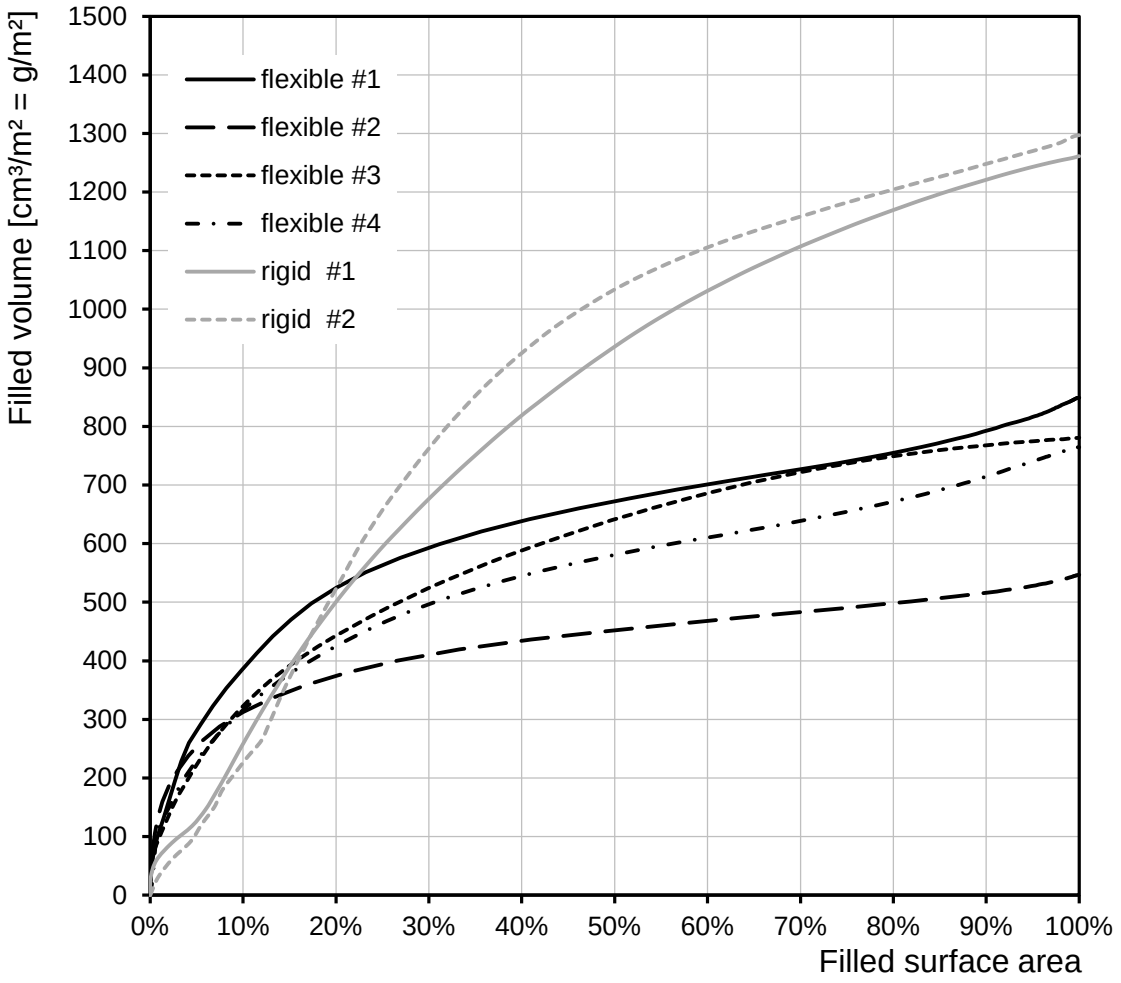
Rigid Pavement (2 months old)



6 Road surface texture and filled surface area

Volume vs. Area

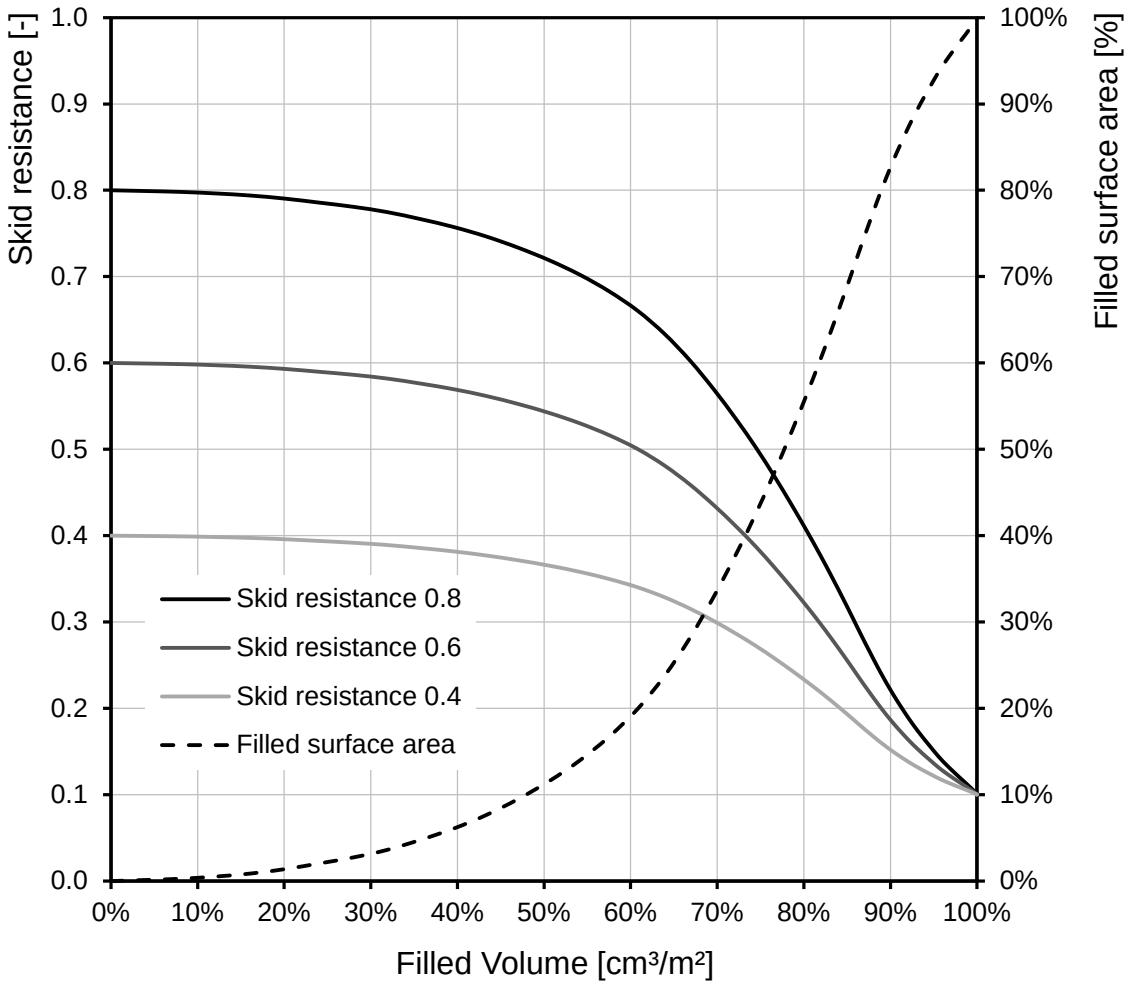
- Filled surface area is the area where precipitation covers the road texture
- 100% filled surface area means no direct contact between tire and road texture
- Tested rigid pavements show more road surface texture than flexible pavements
- With flexible pavement 80% of the available texture volume is filled with only 20% of the surface covered
- Under constant precipitation rate the last 80% surface area are covered rapidly



6 Towards skid resistance prediction

Skid resistance vs. Area

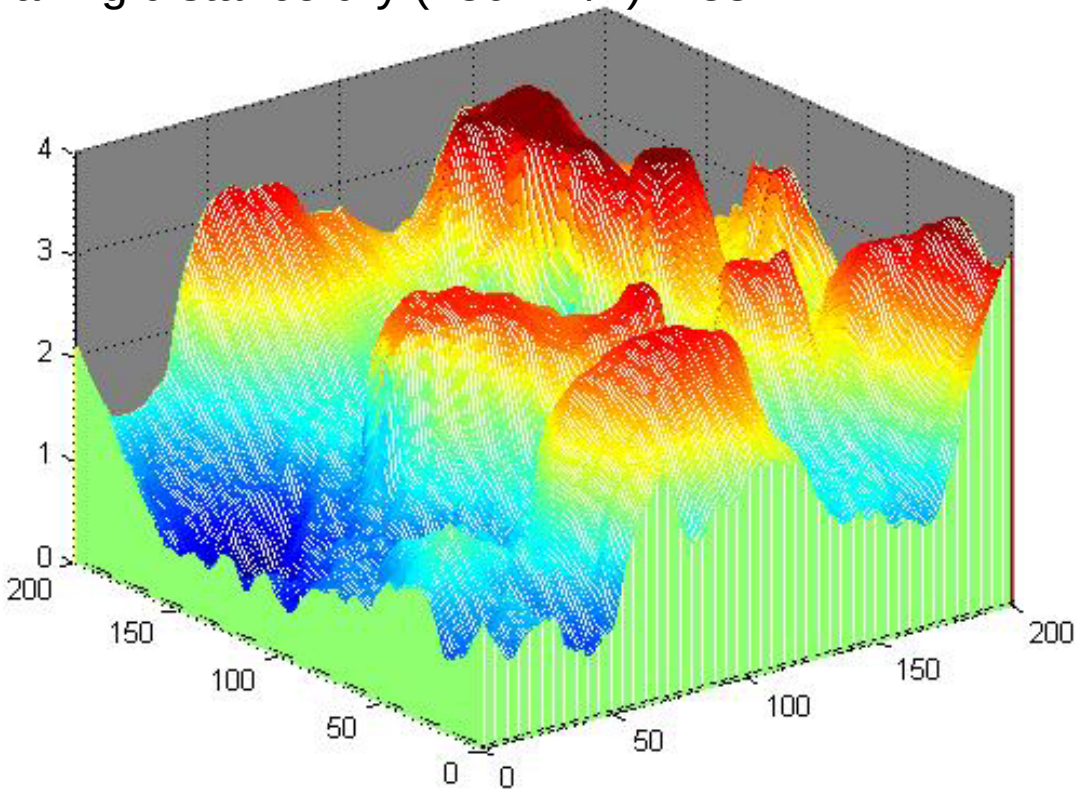
- Based on skid resistance of roads under usual measurement conditions the impact of snow or ice can be predicted depending on filled volume and surface area
- With increasing macro texture filling rate the contact area is gradually covered with snow or ice leading to a sudden drop of skid resistance between 60 to 90% of filled macro texture volume.

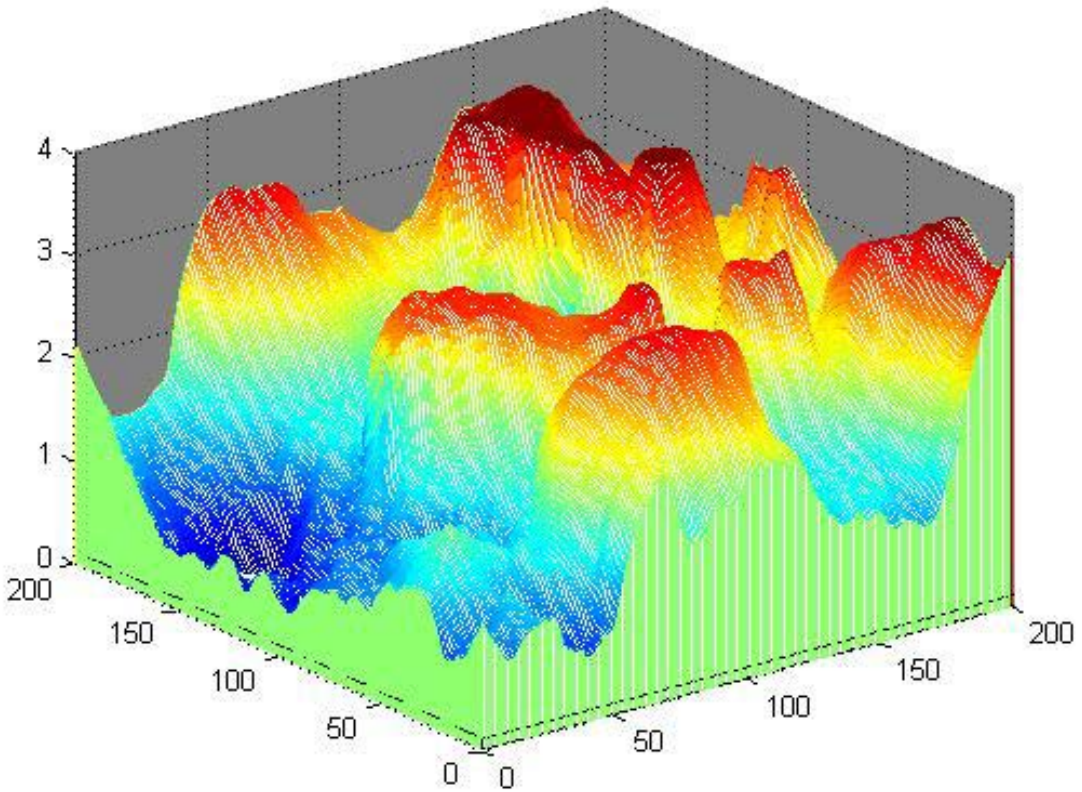


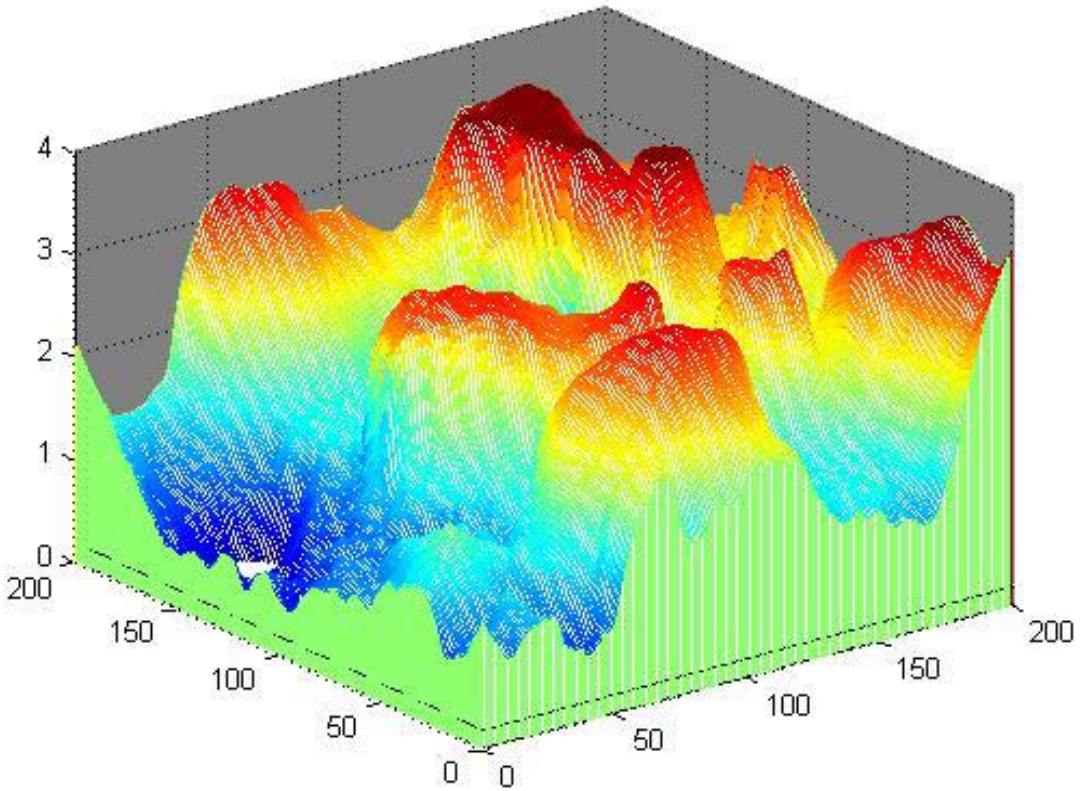
$$SR = SA_{snow} * SR_{snow} + (100\% - SA_{snow}) * SR_{wet}$$

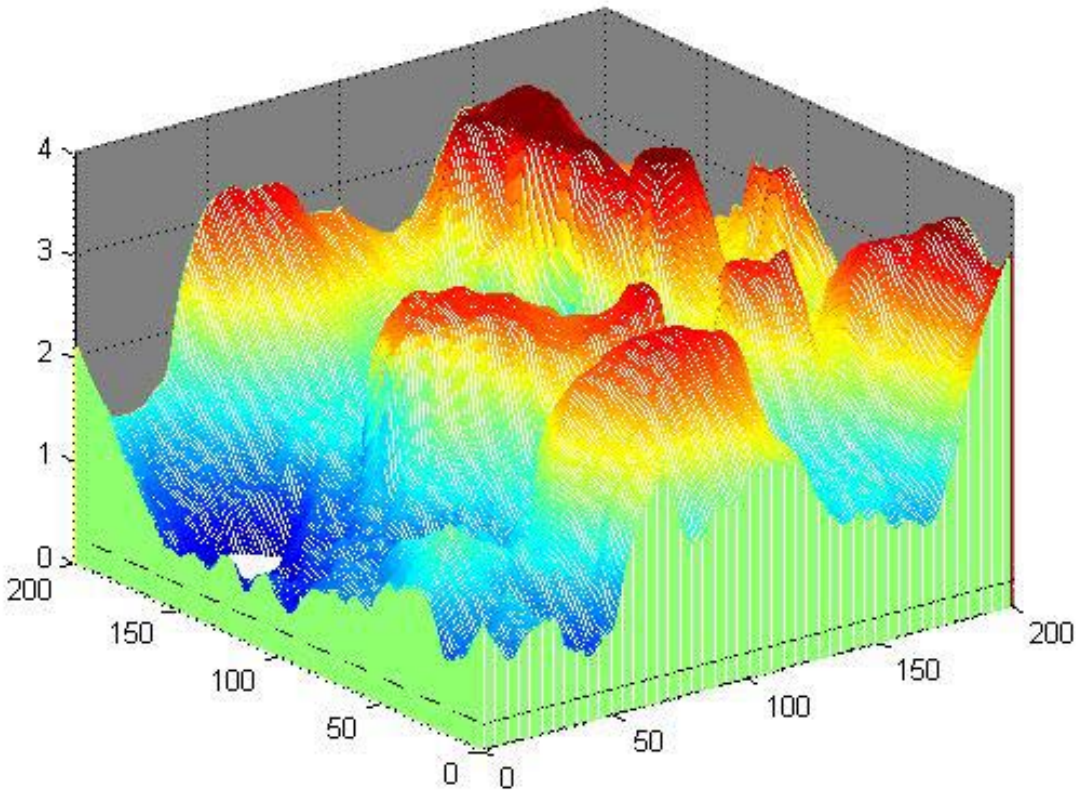
7 Animation - Macro texture and skid resistance

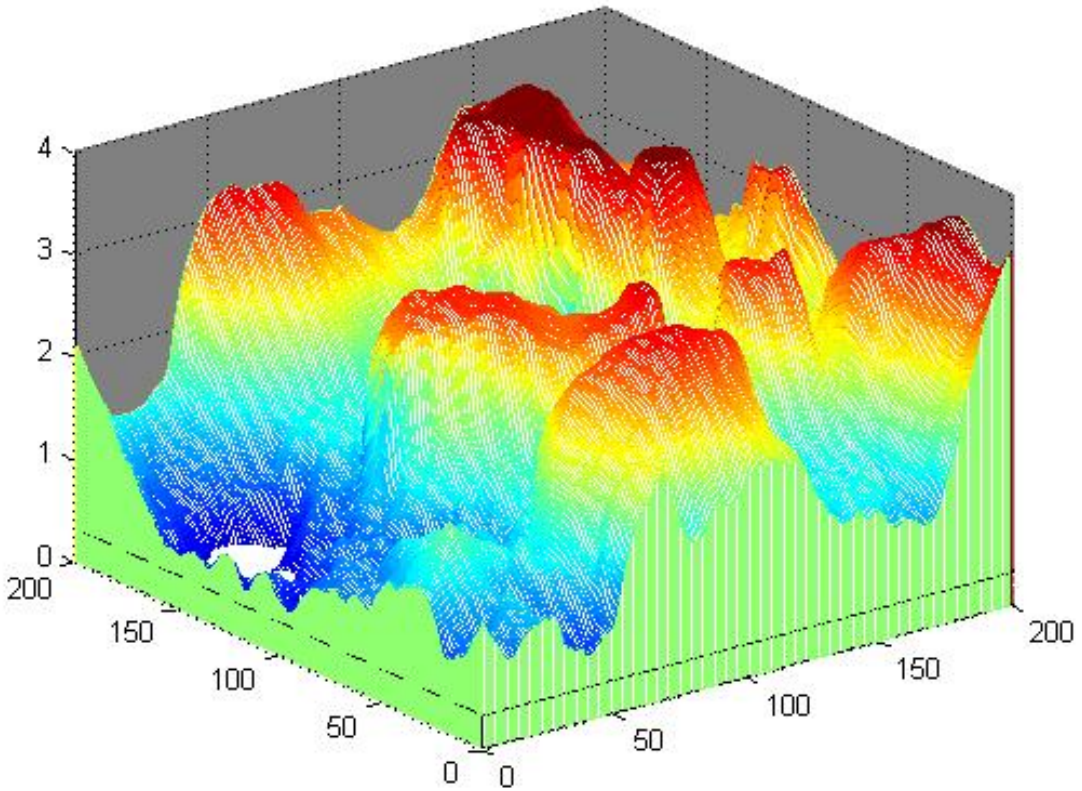
Braking distance dry (130 km/h) = 83 m

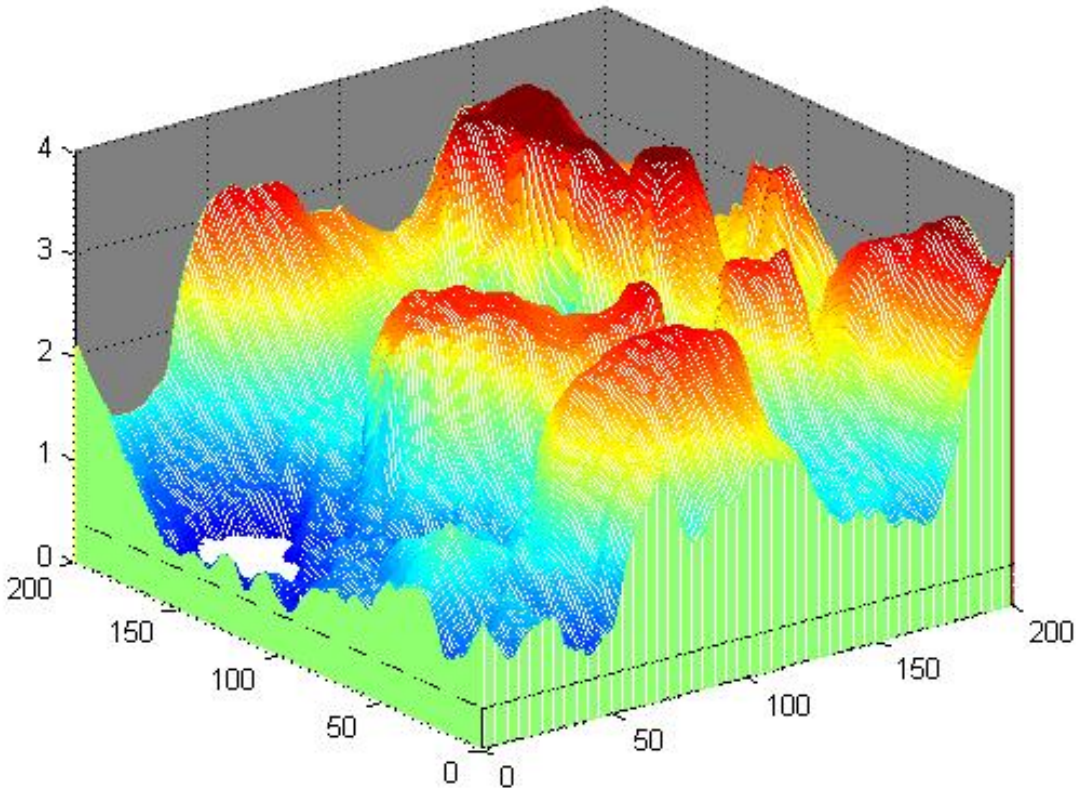


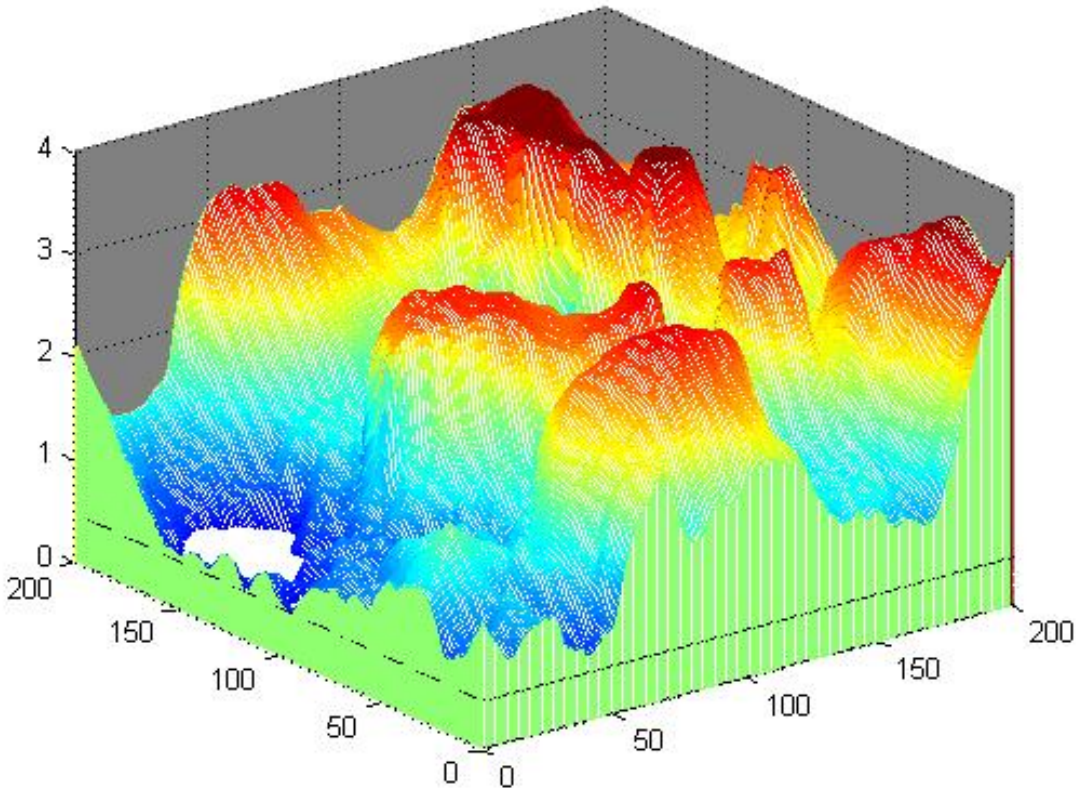


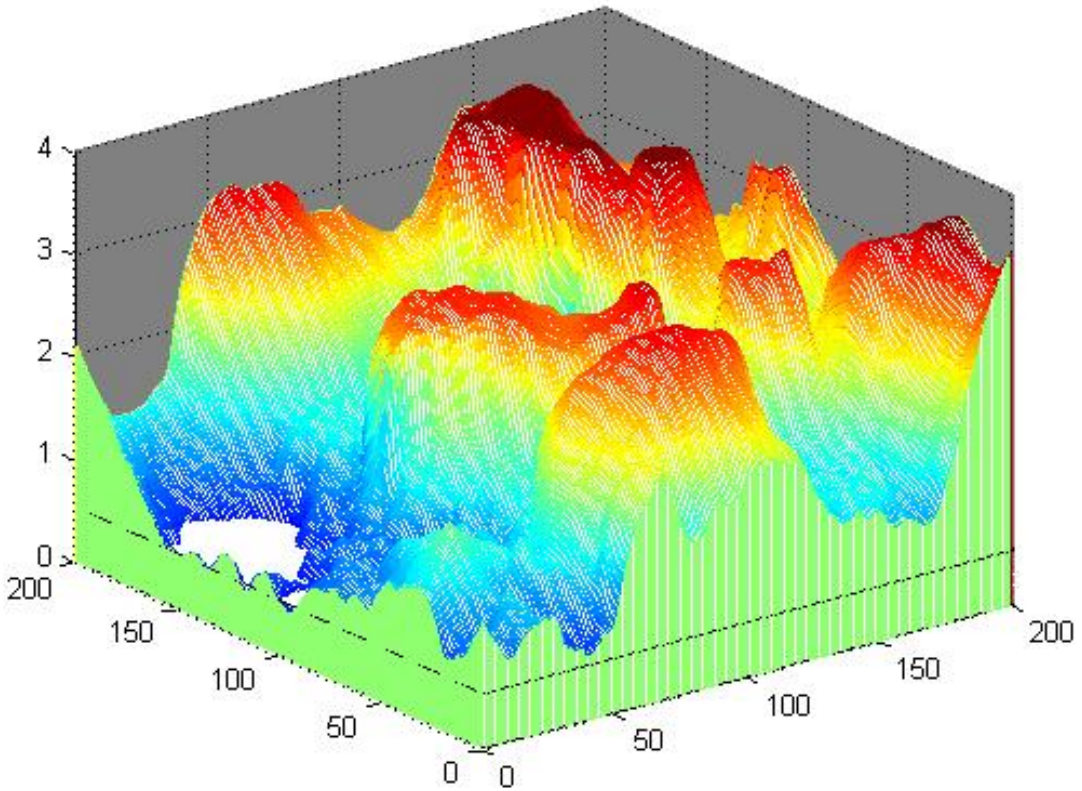


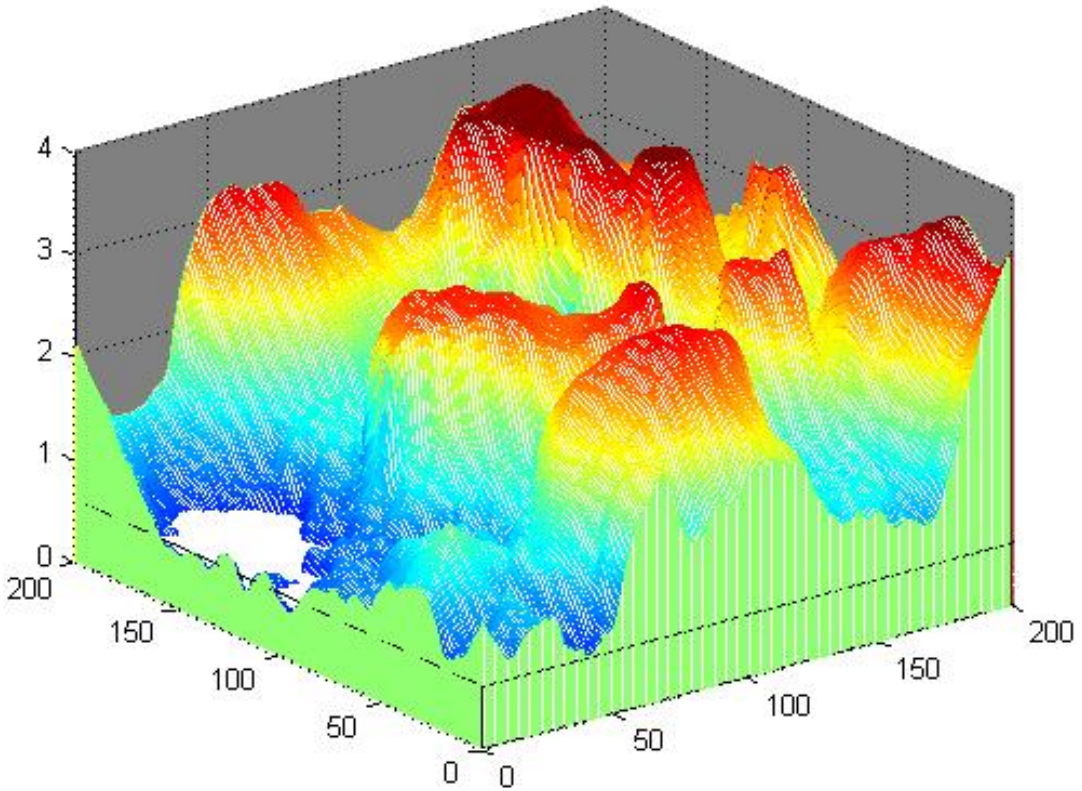


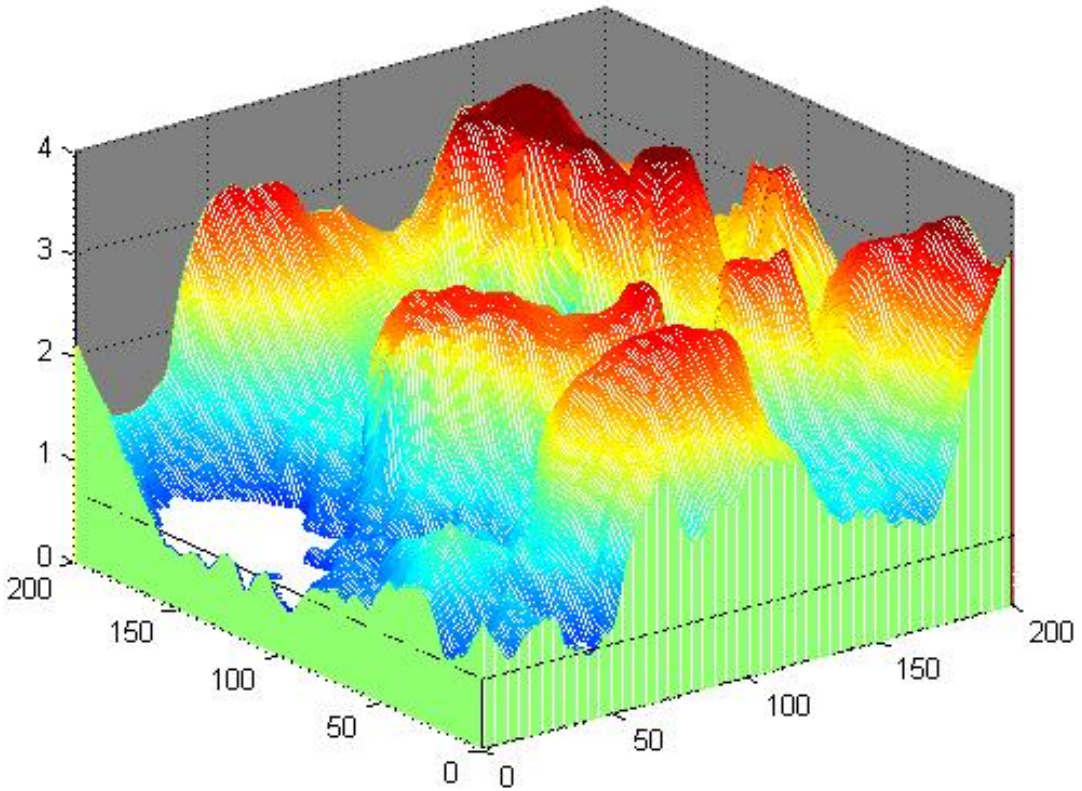


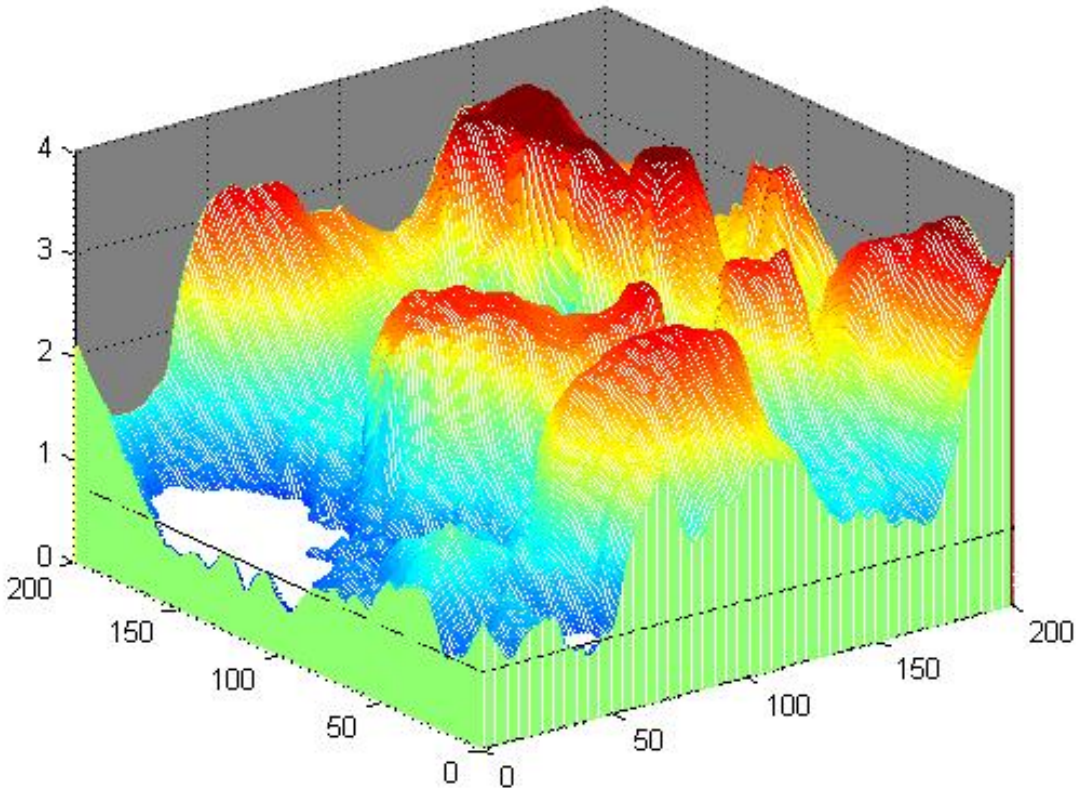


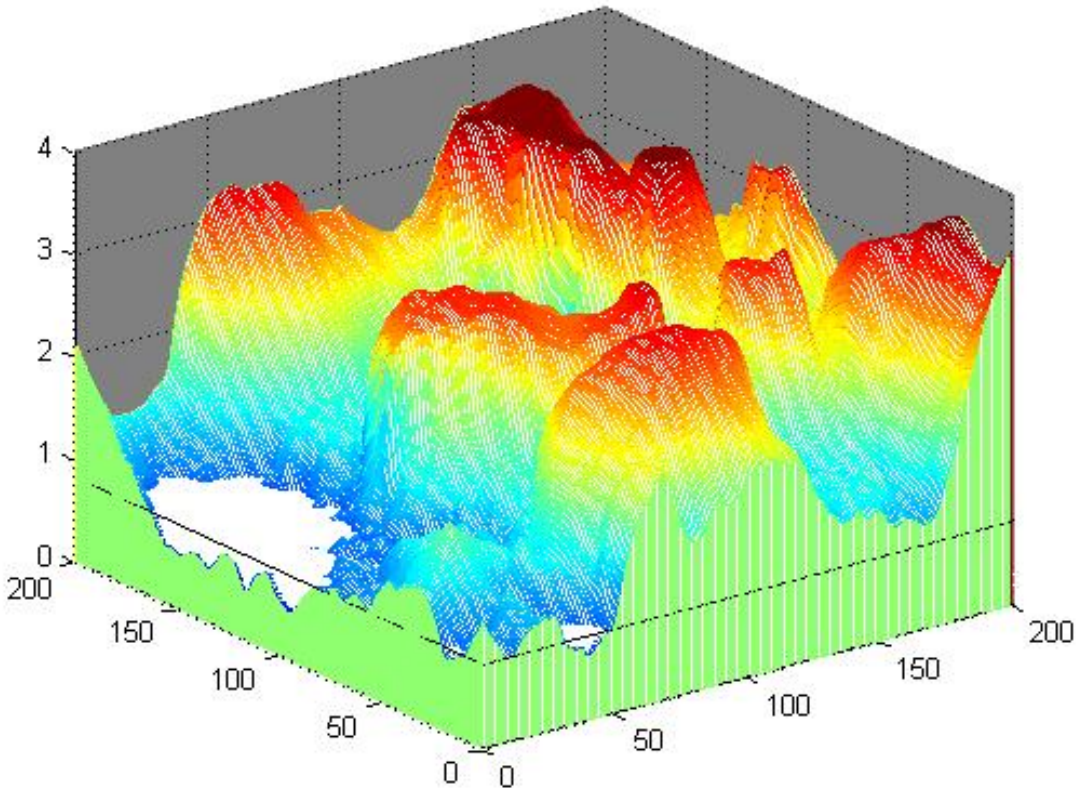


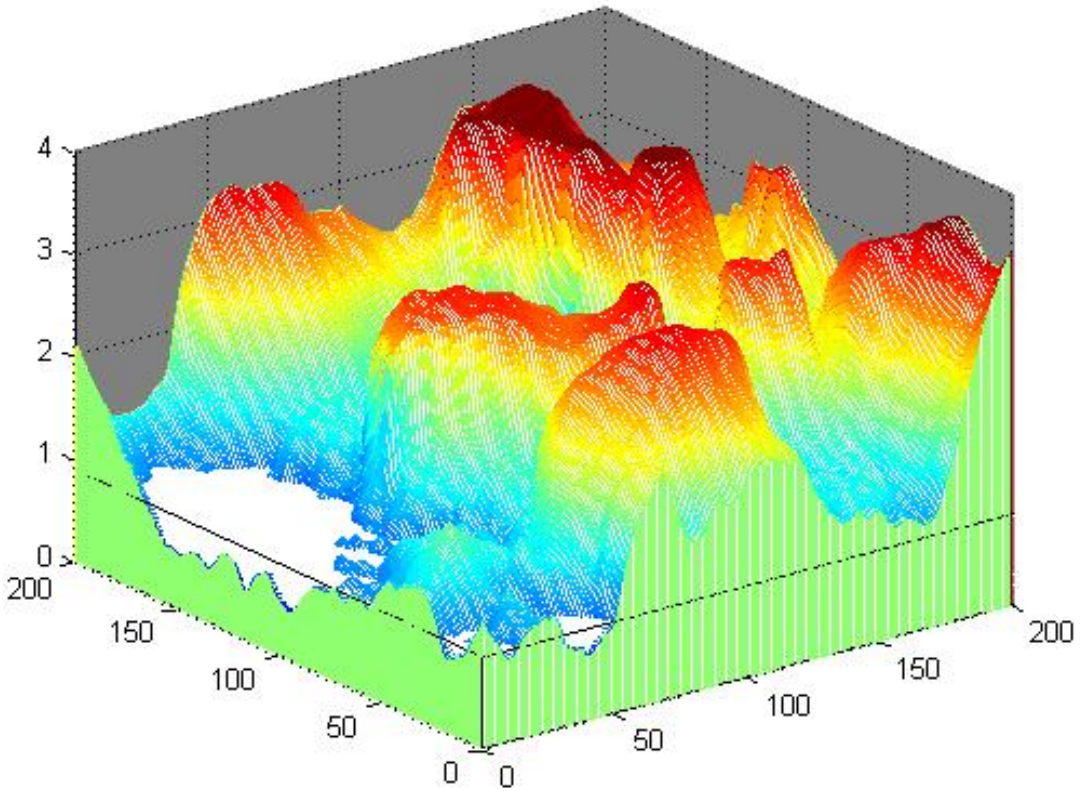


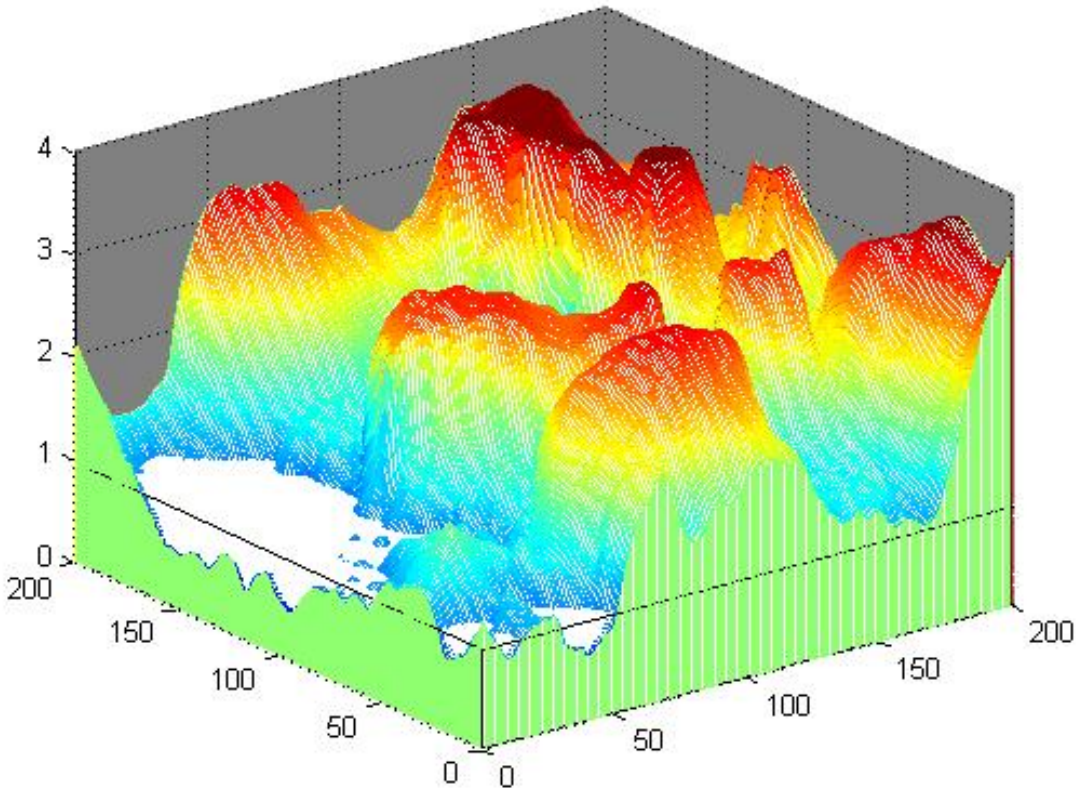


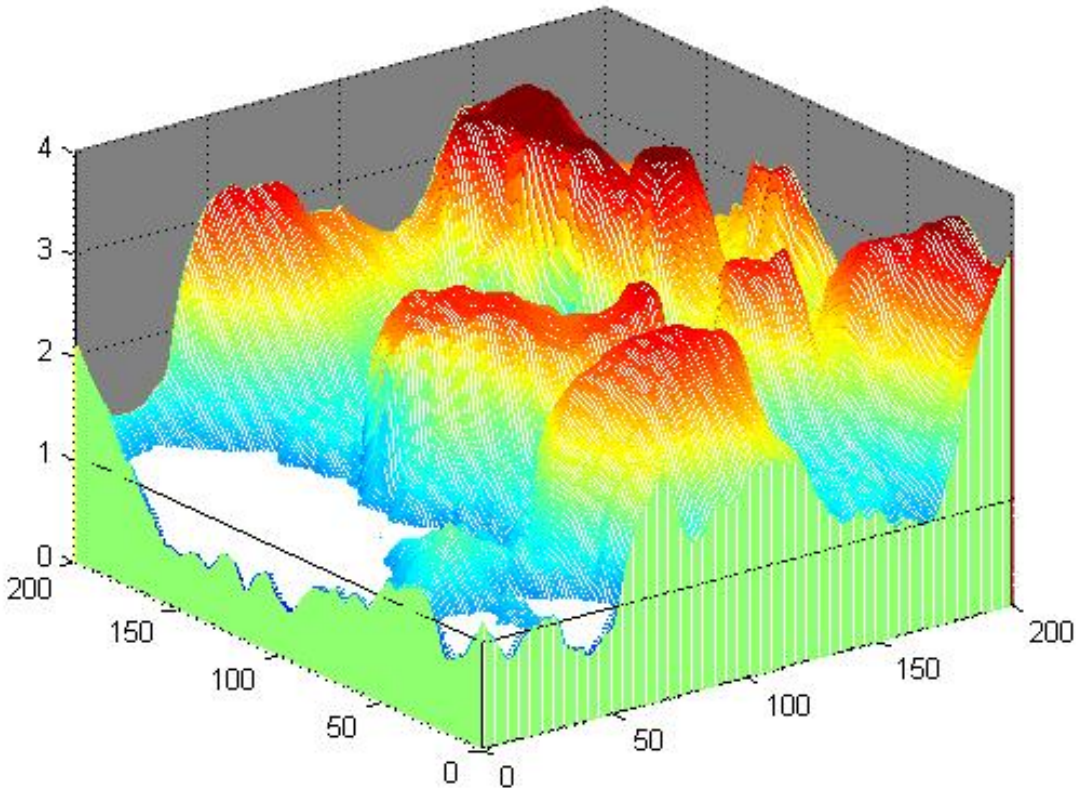


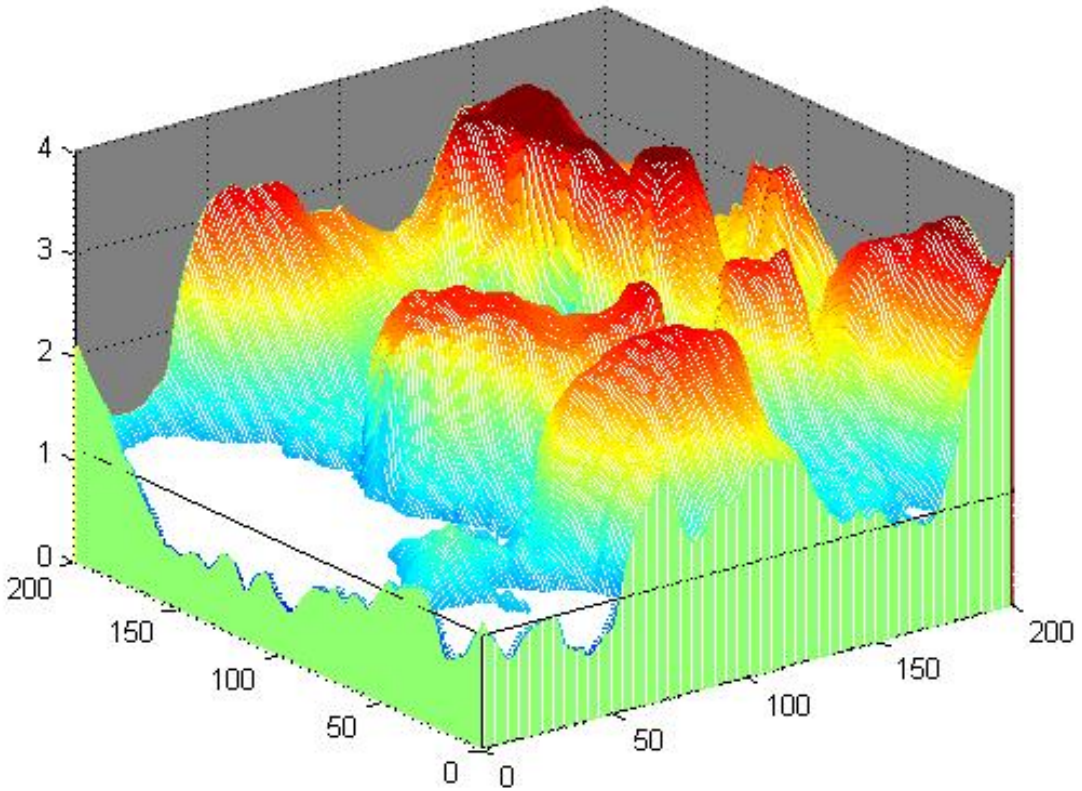


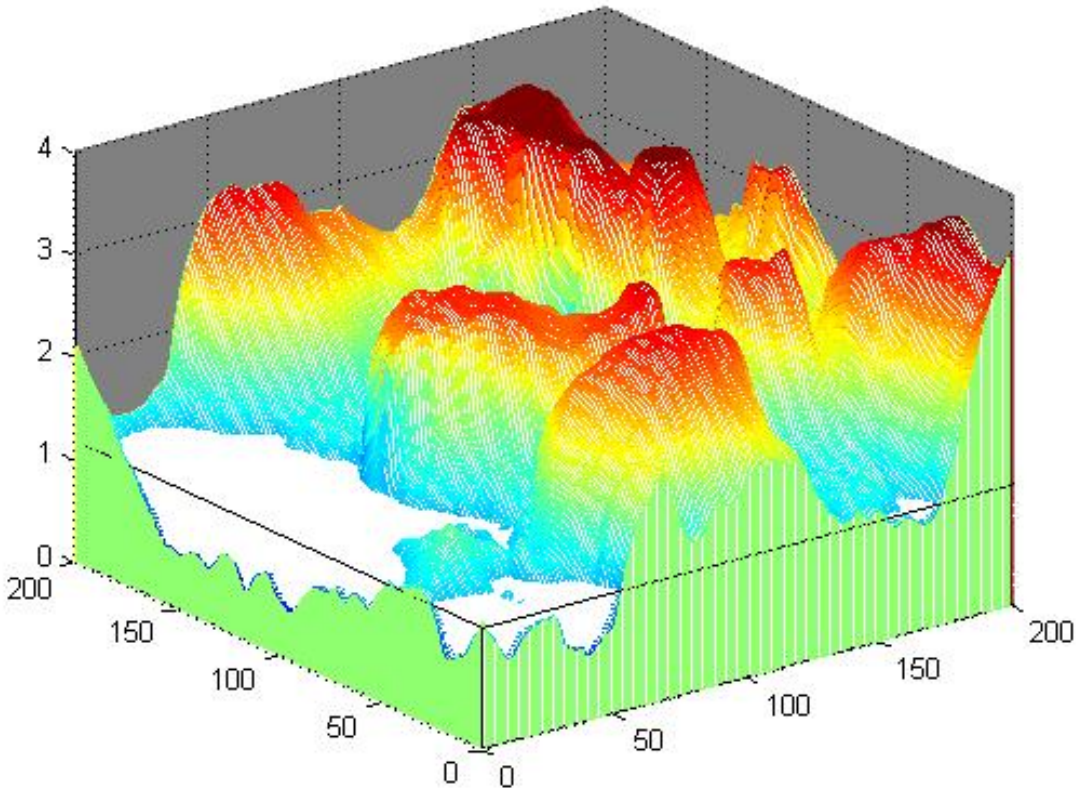


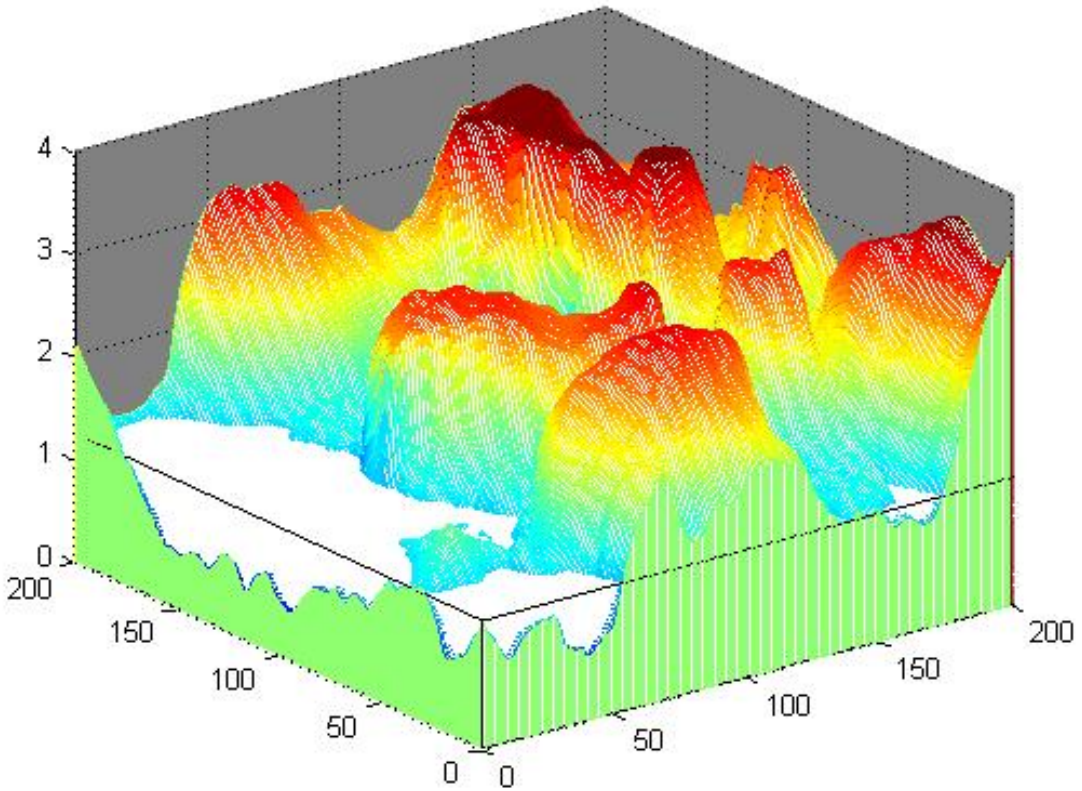


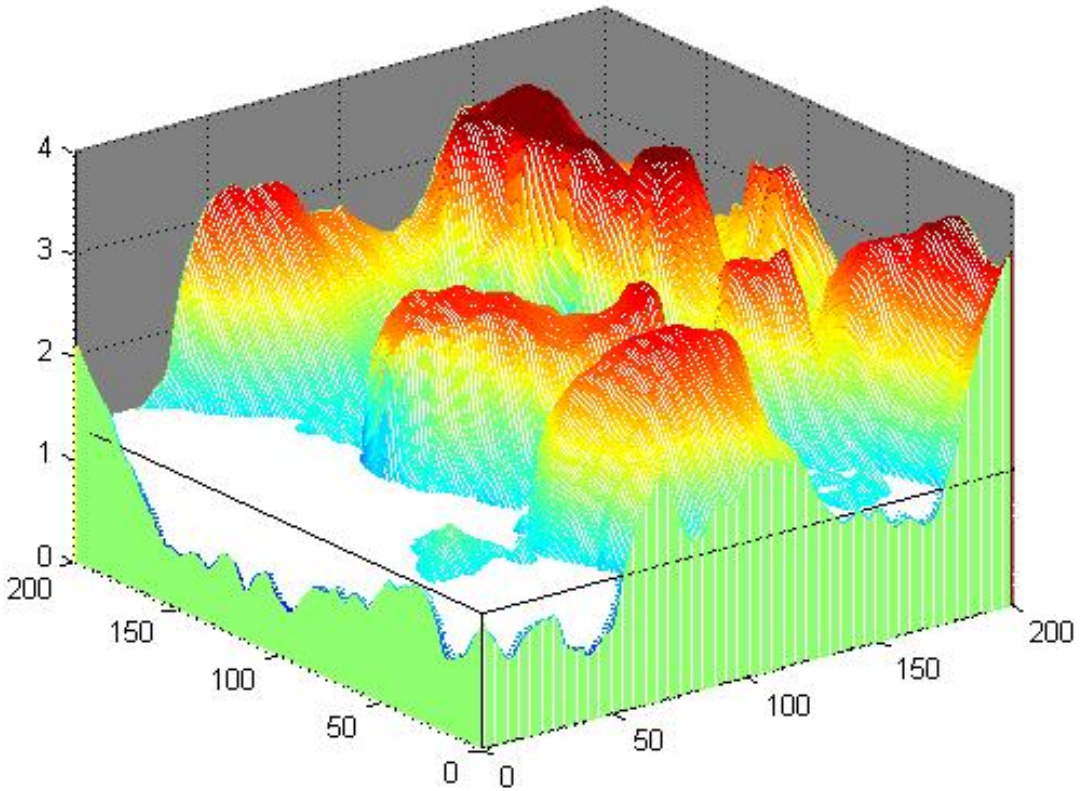


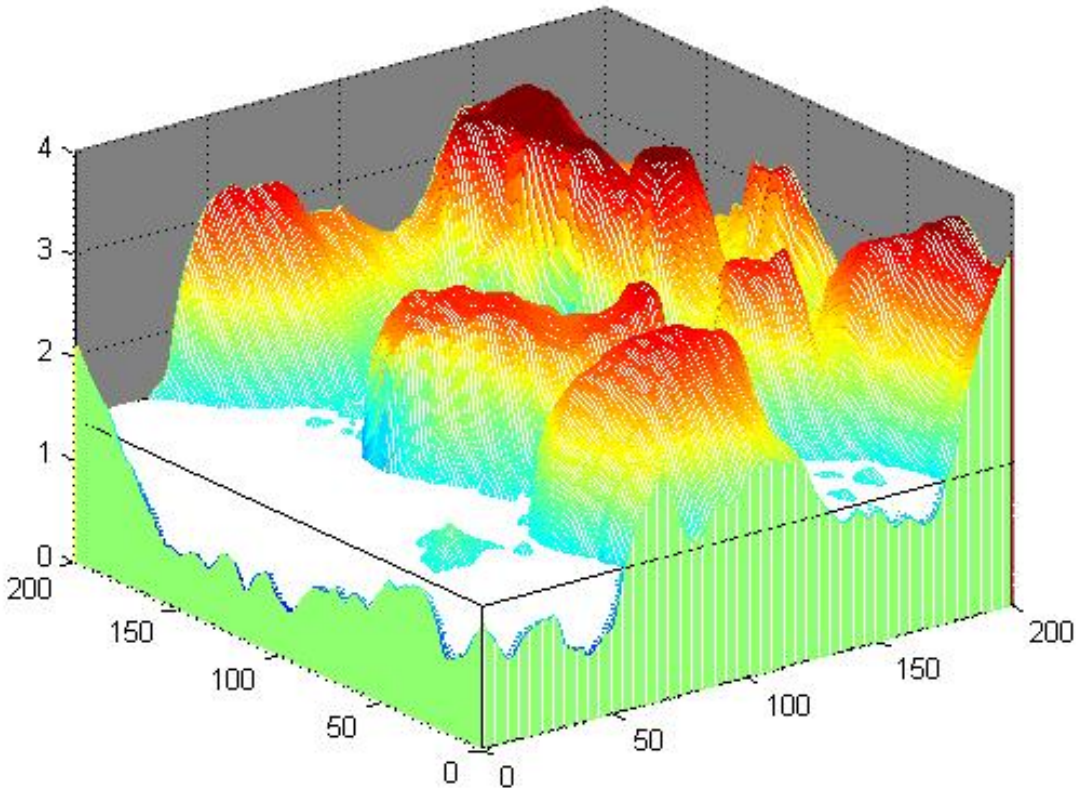


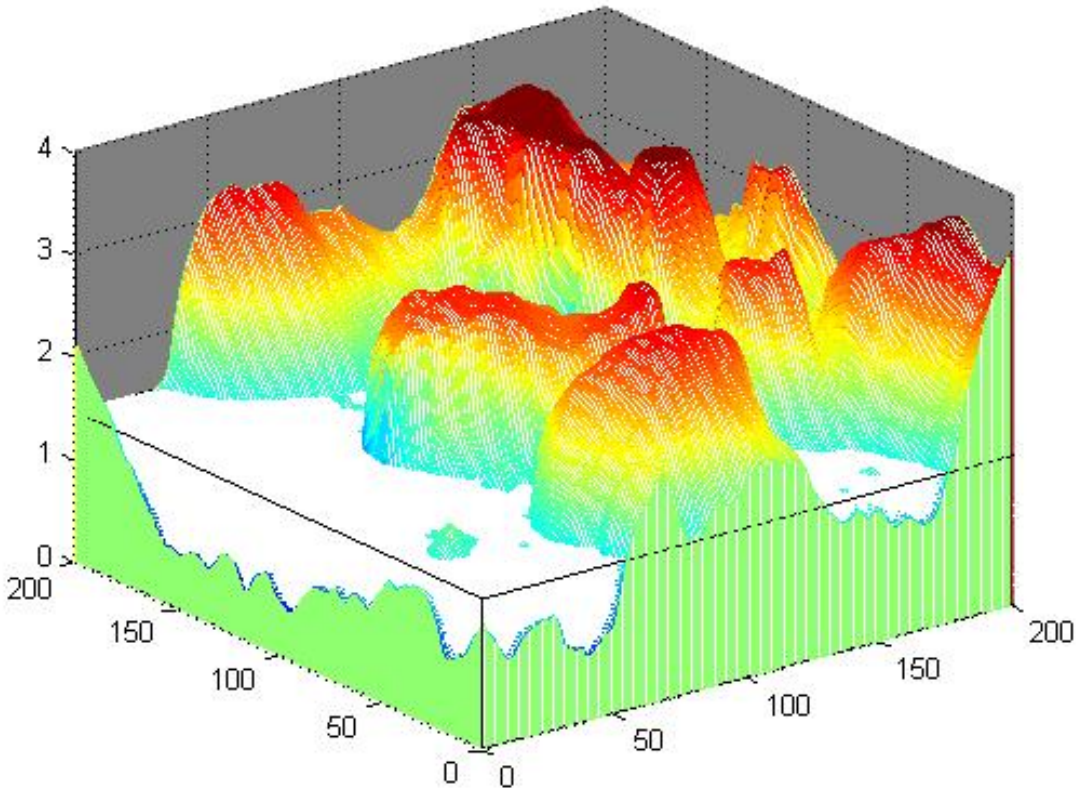


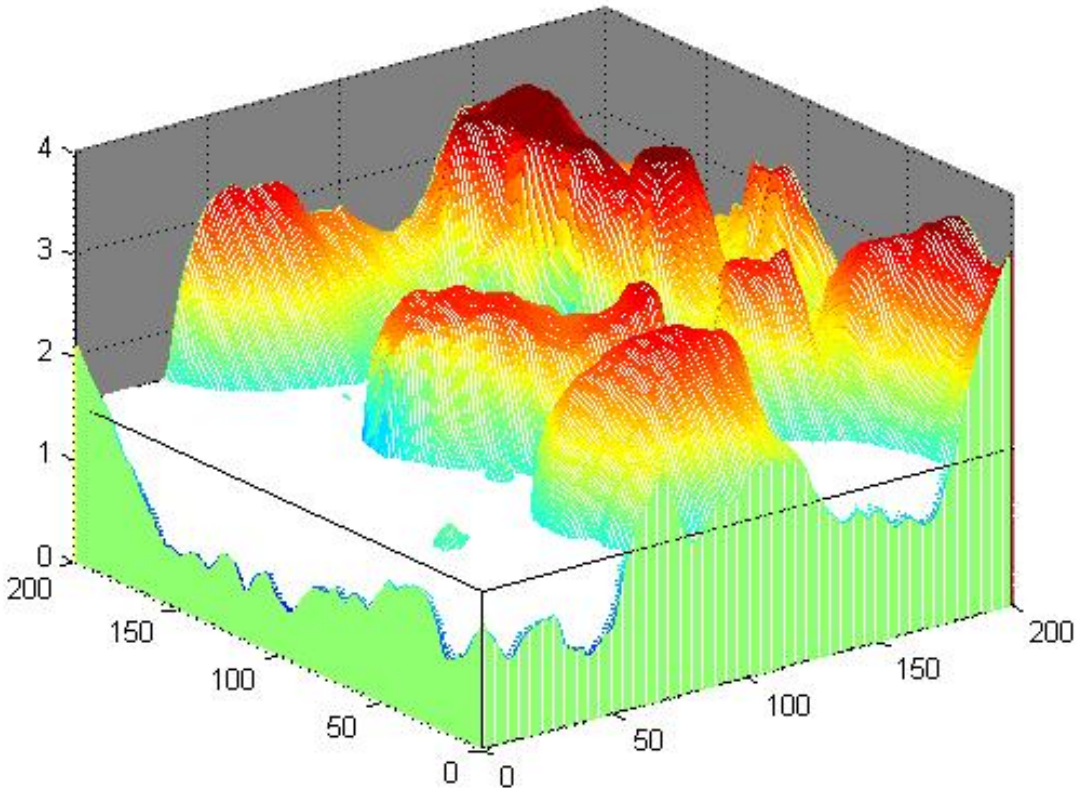


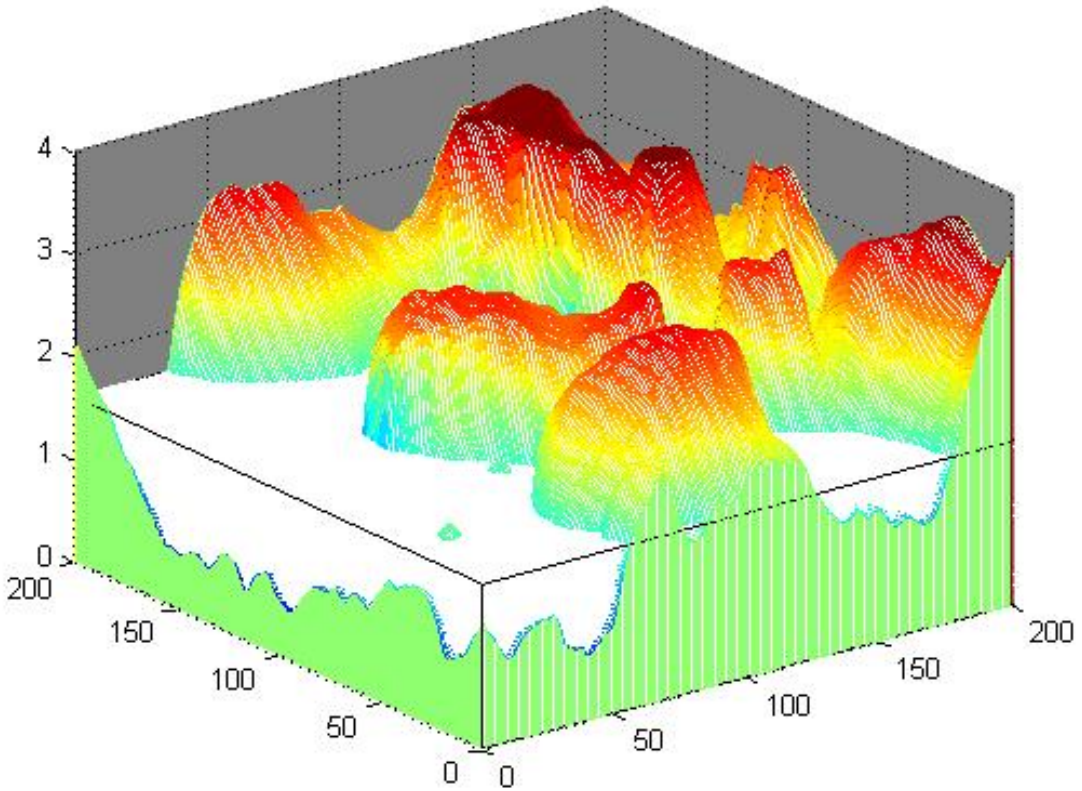


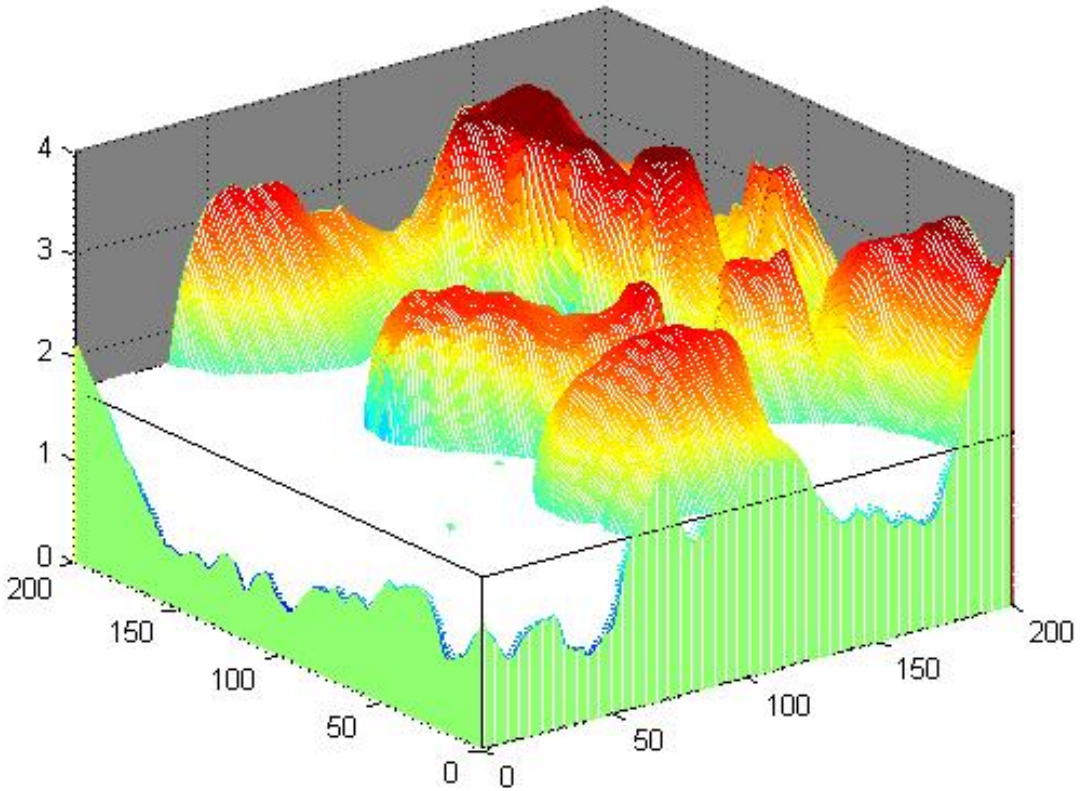


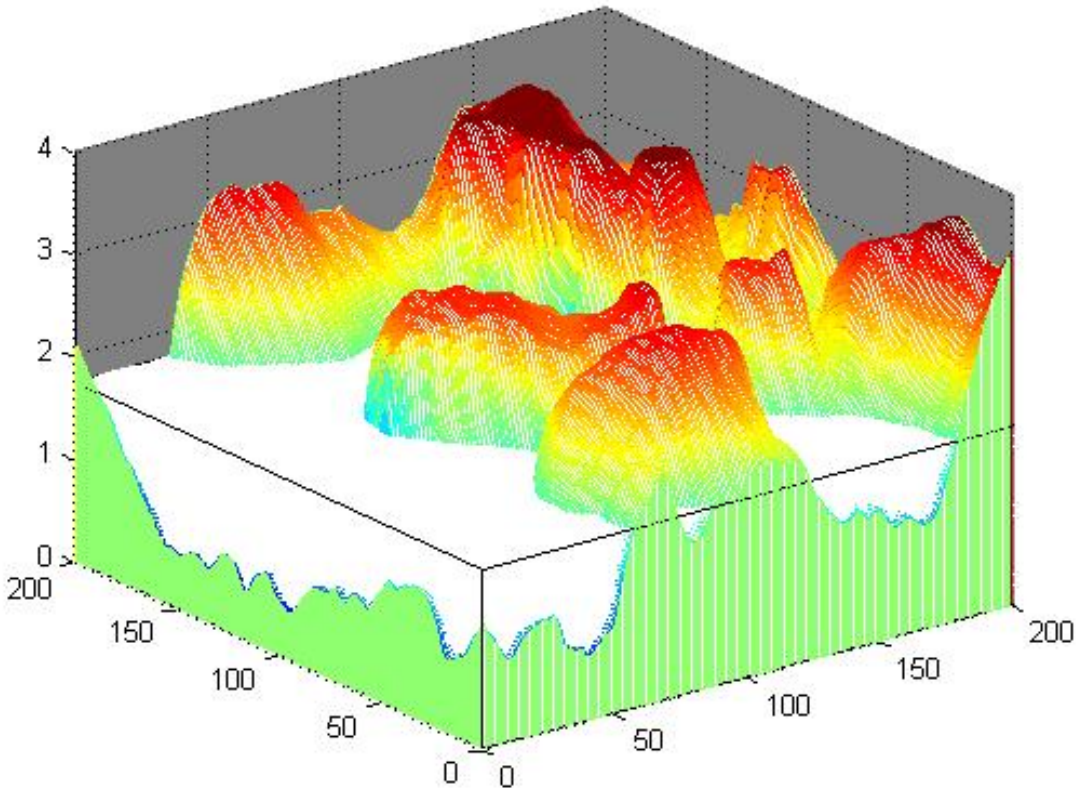


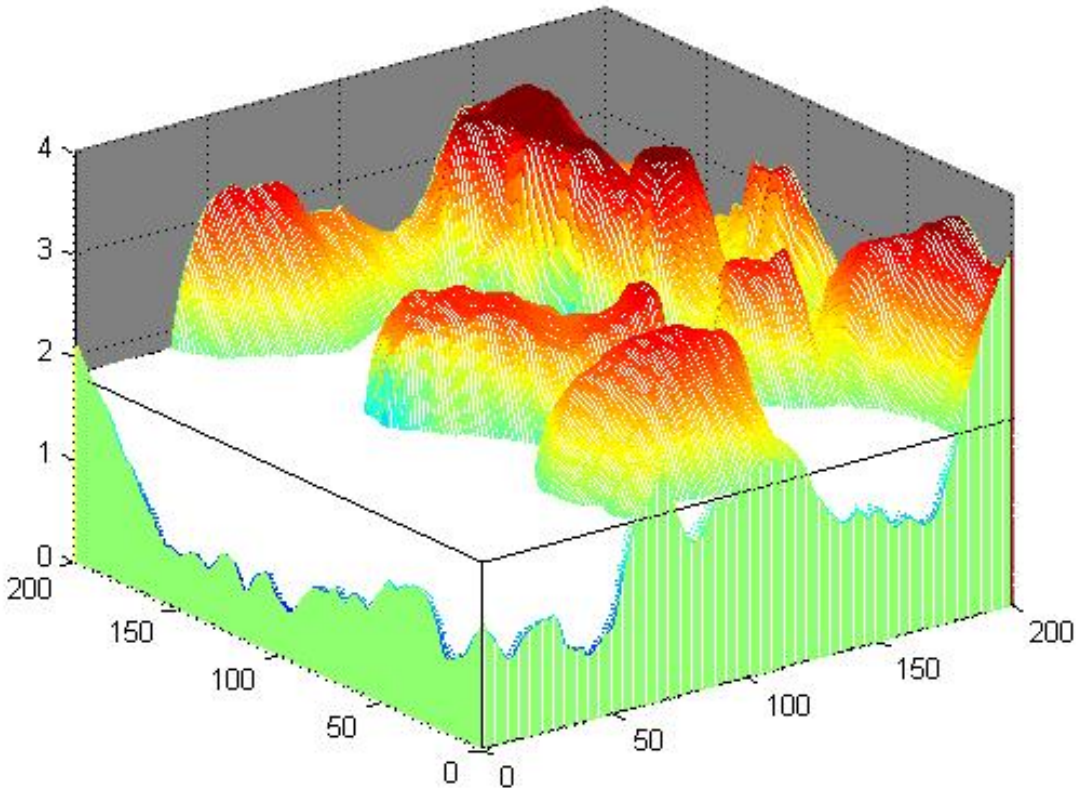


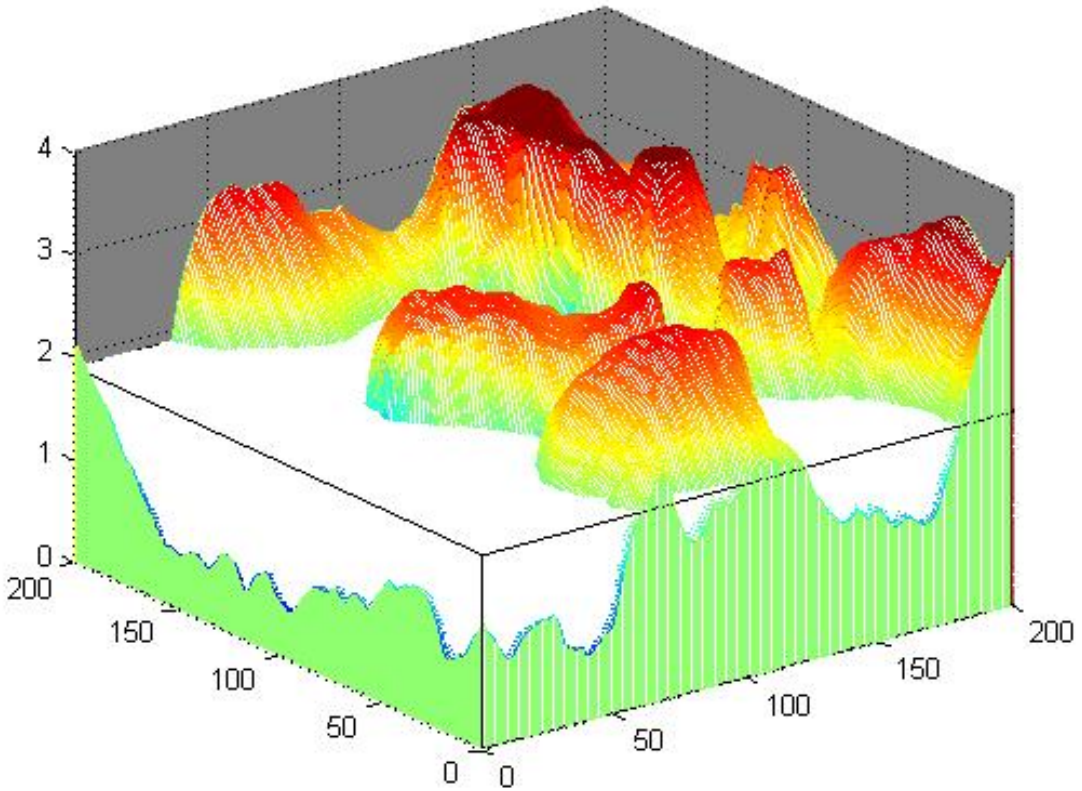


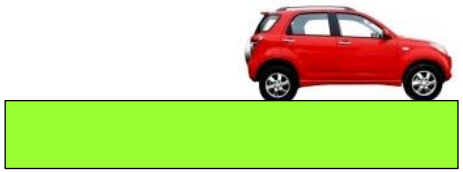


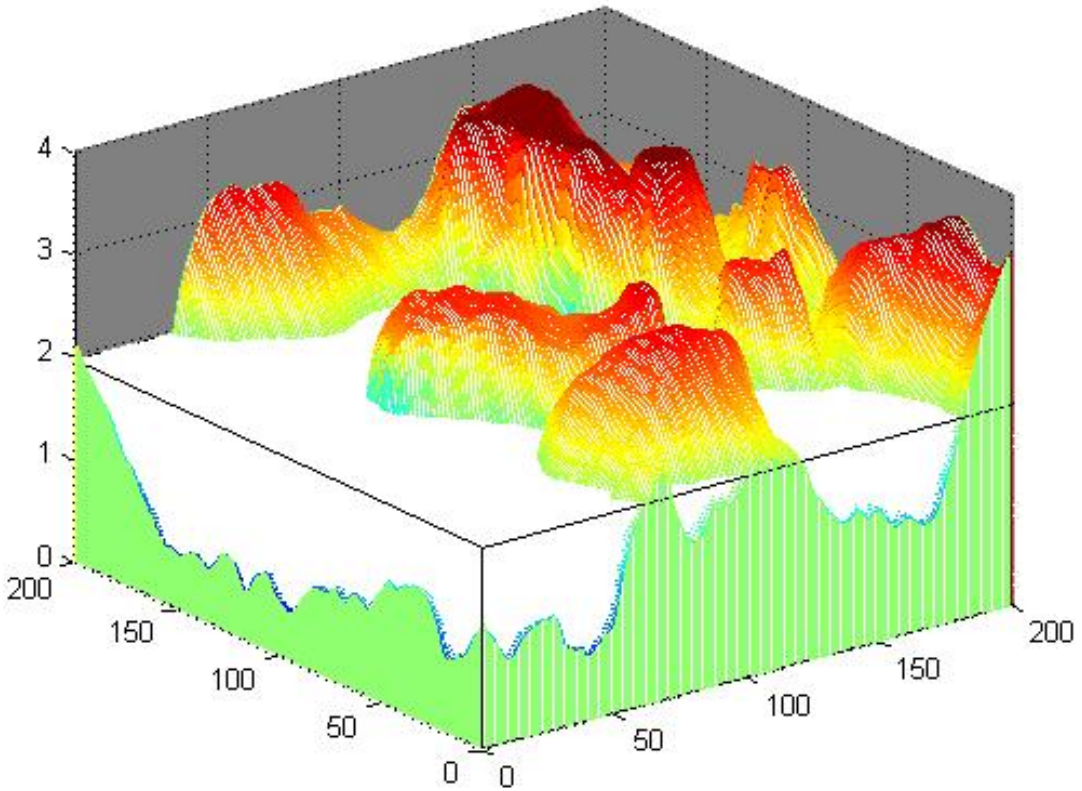


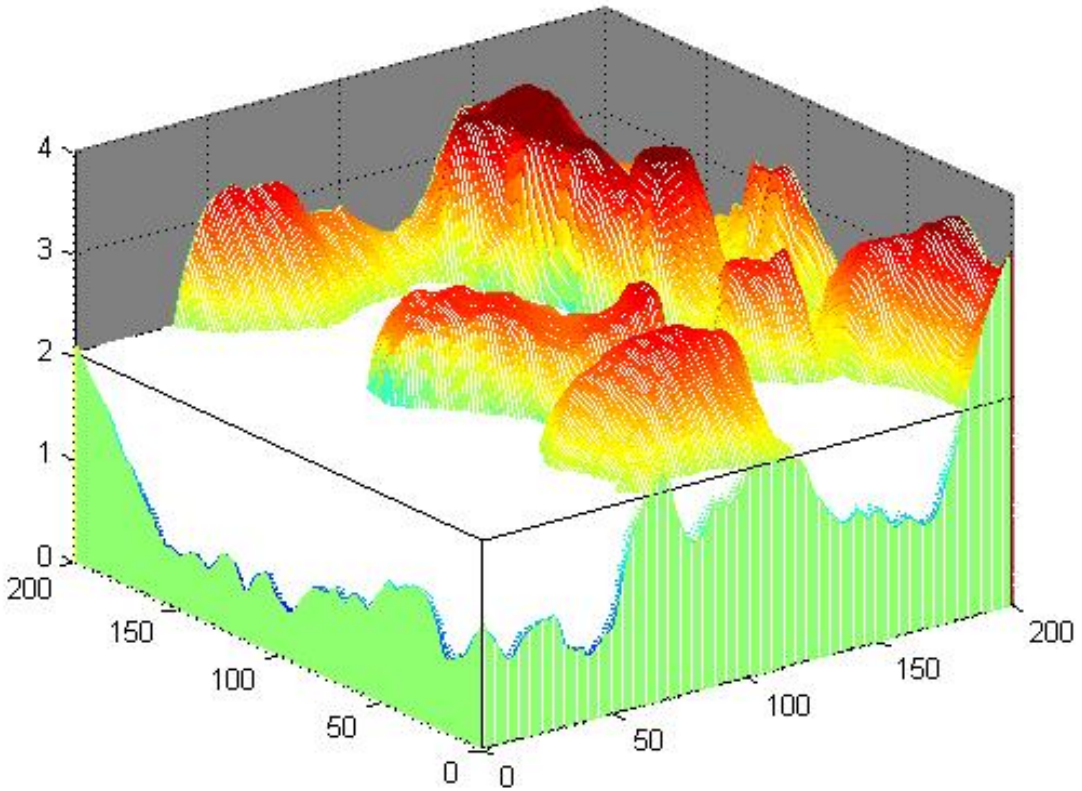


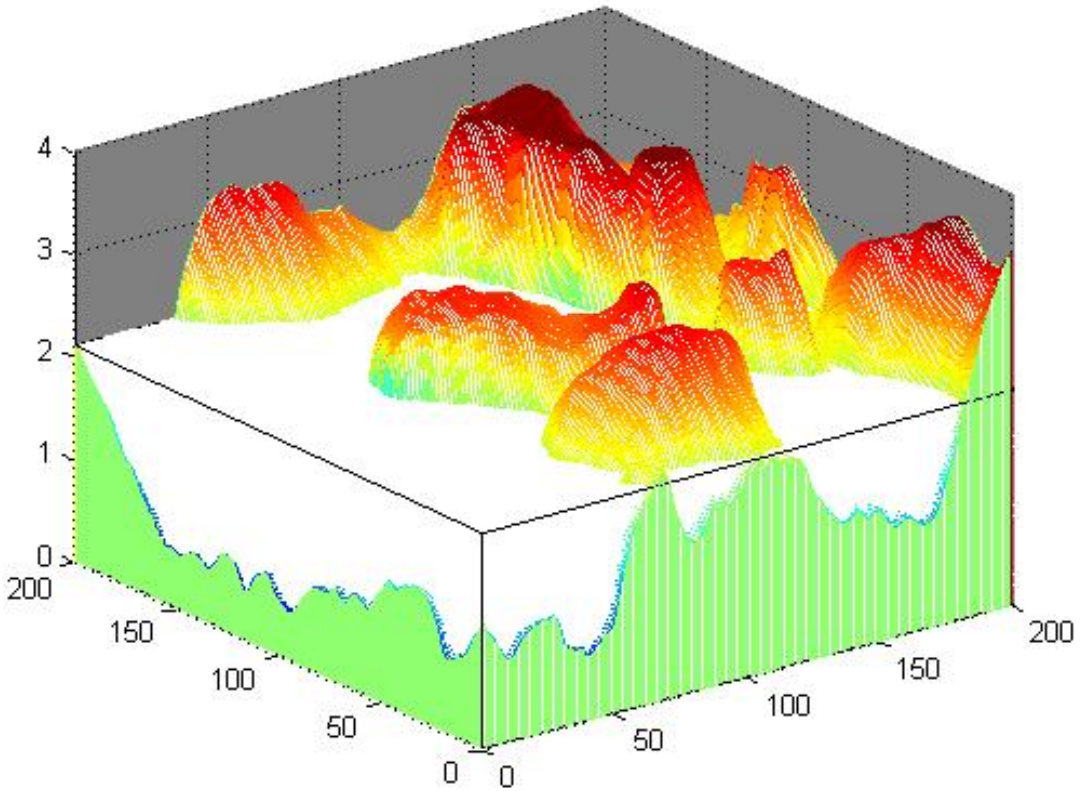


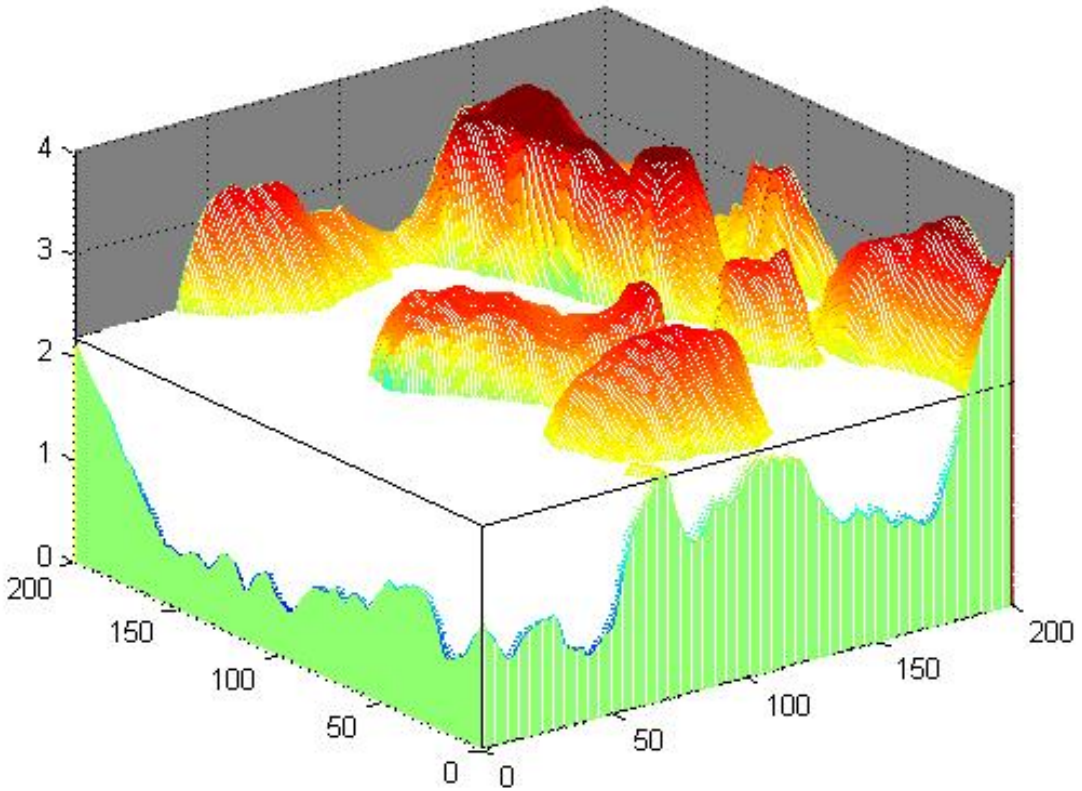


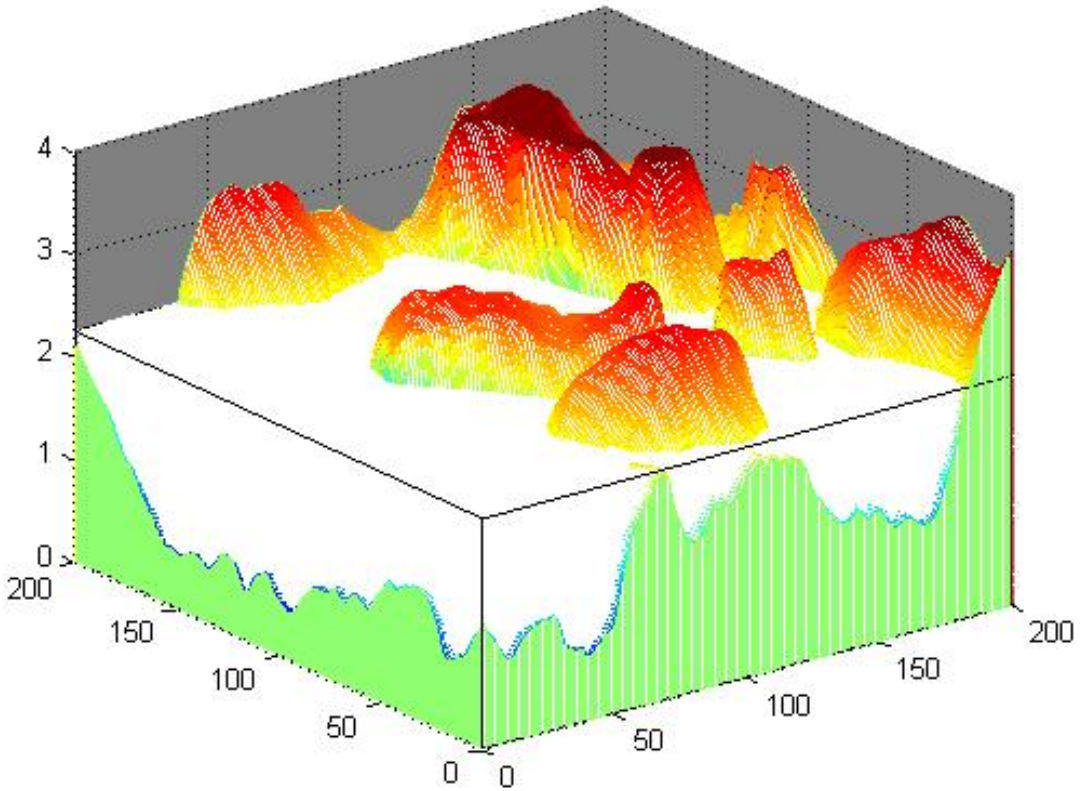


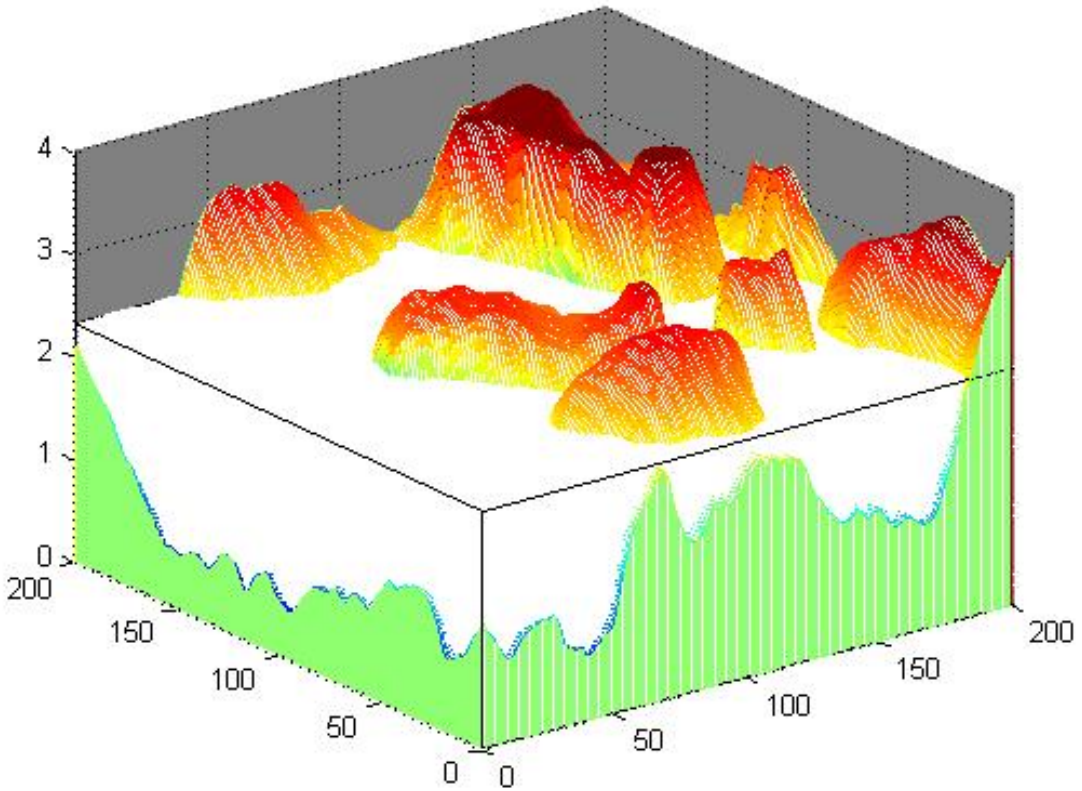


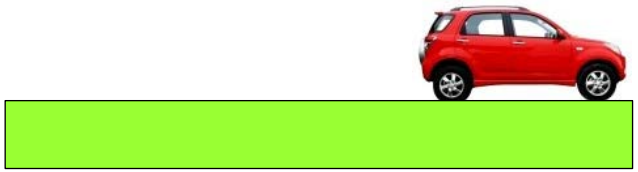


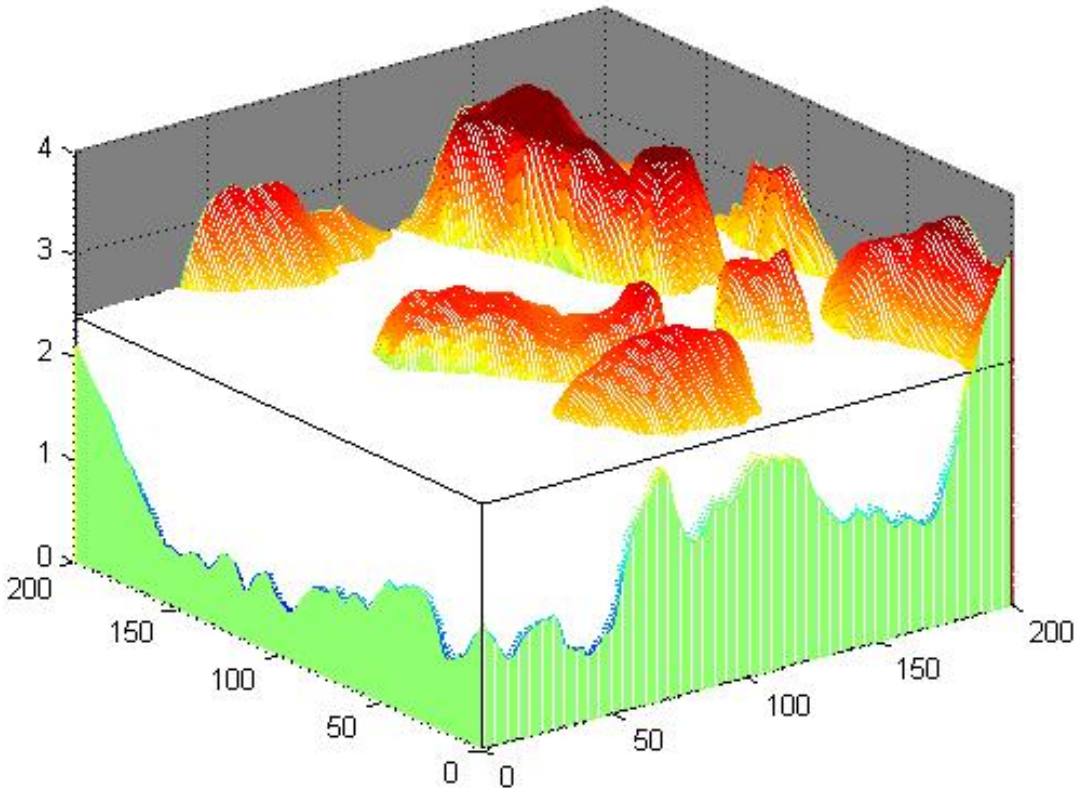


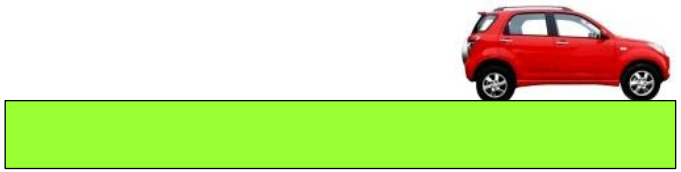


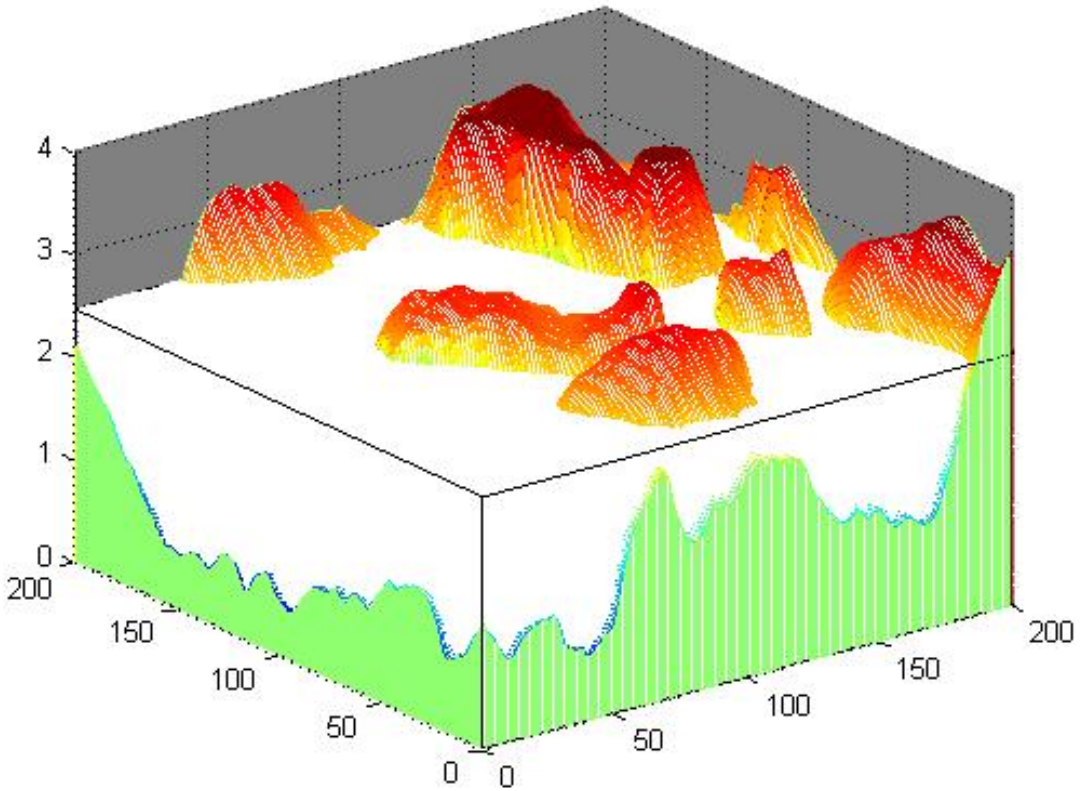


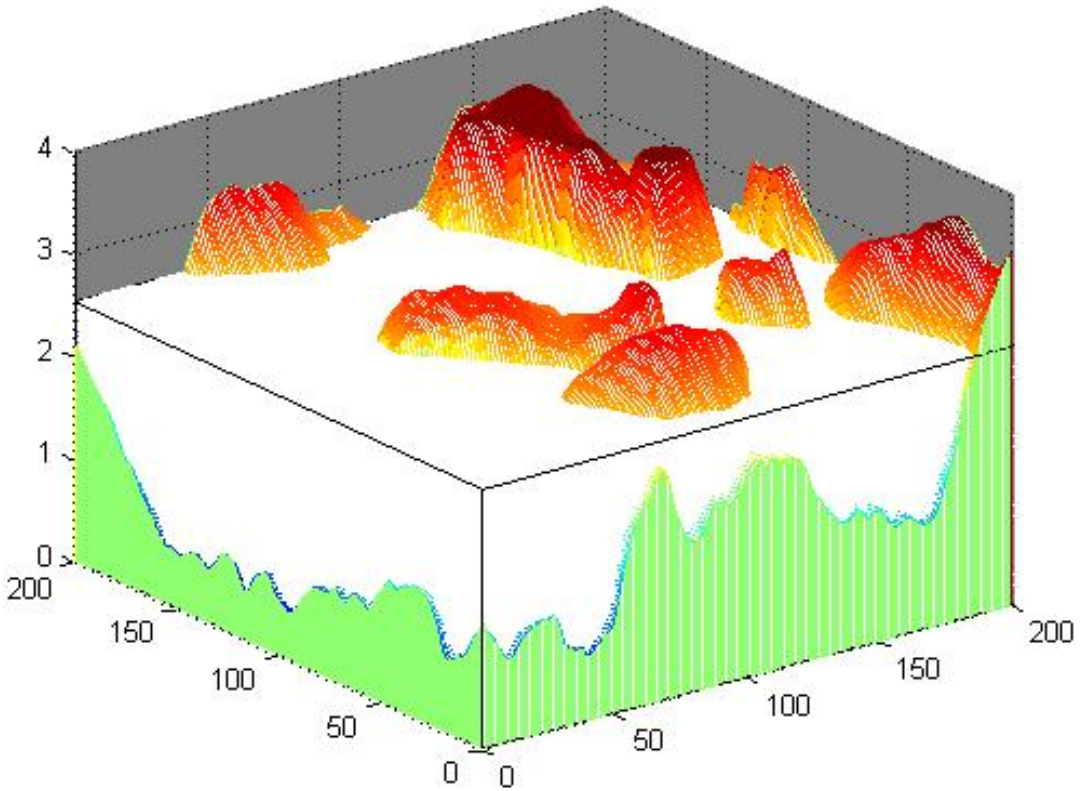


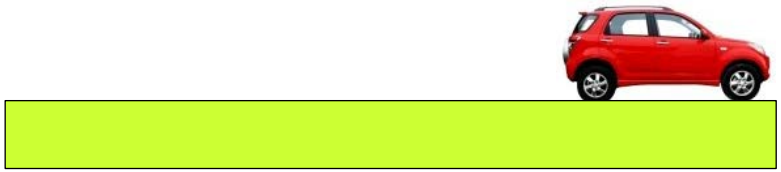


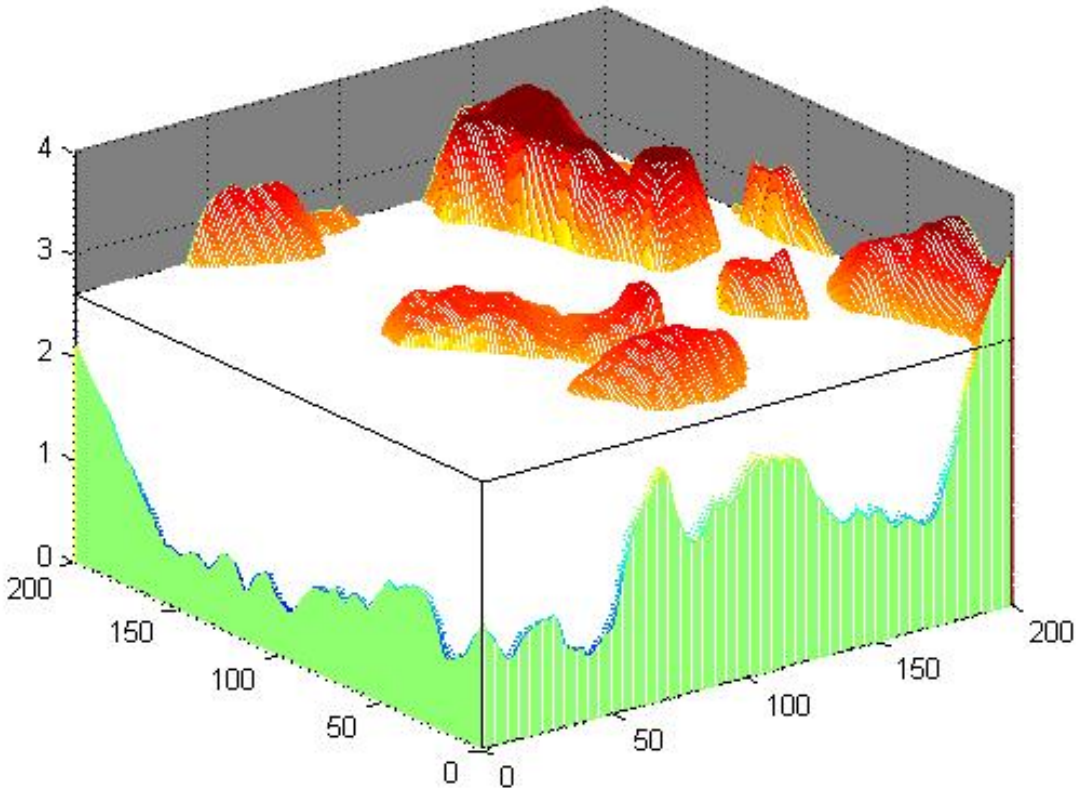


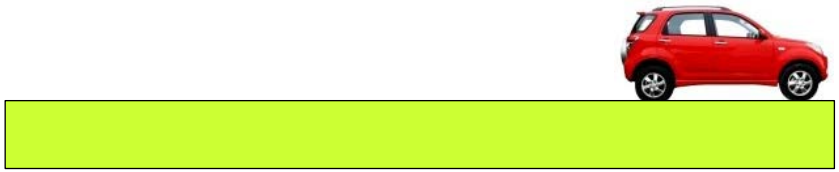


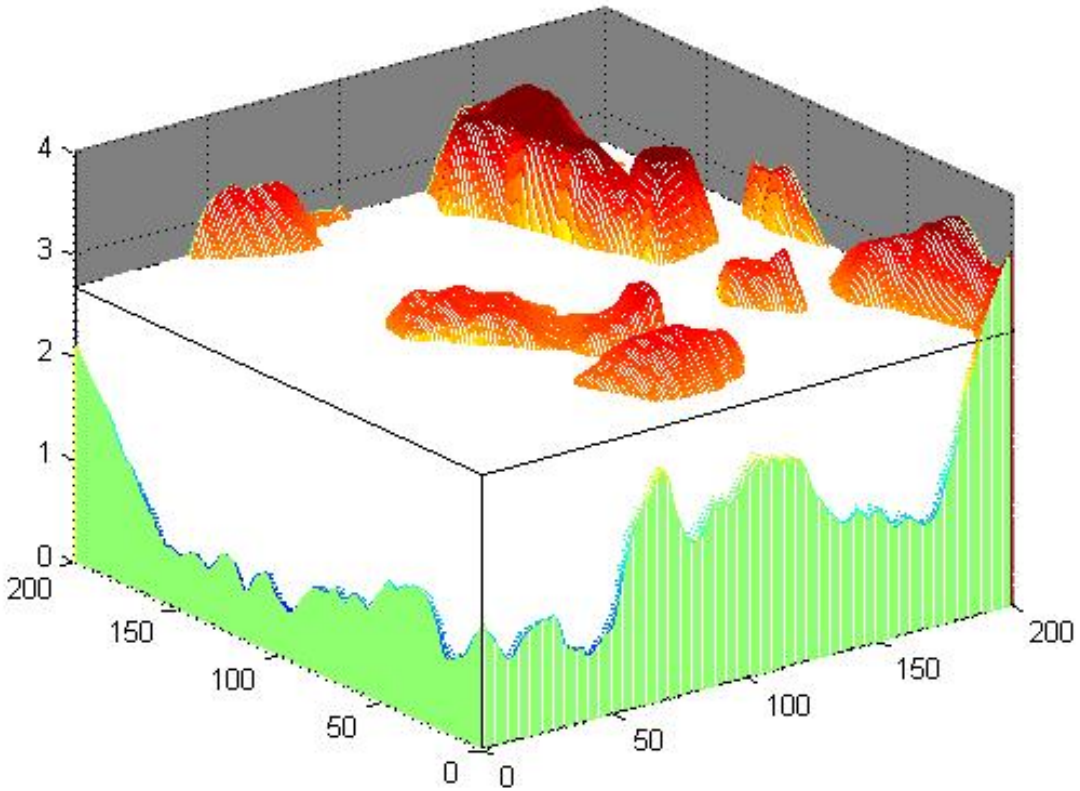


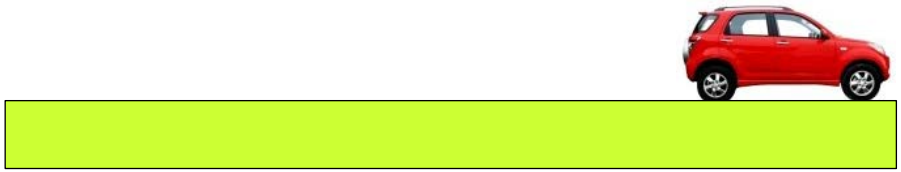


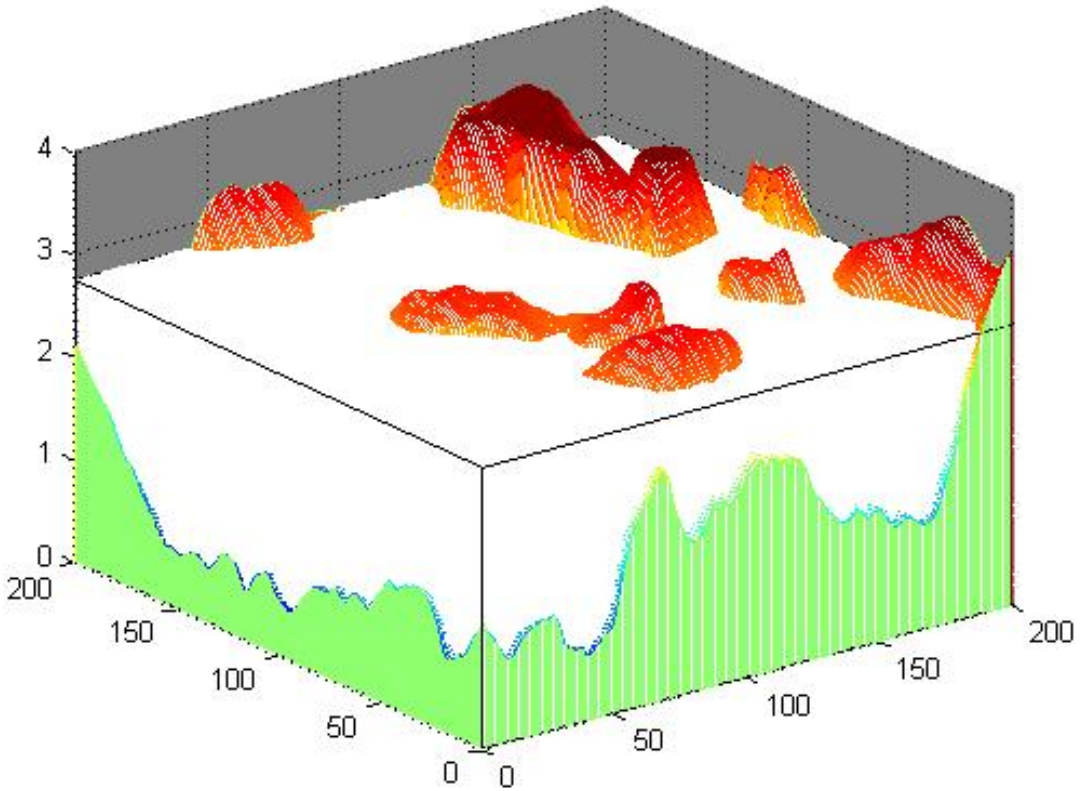


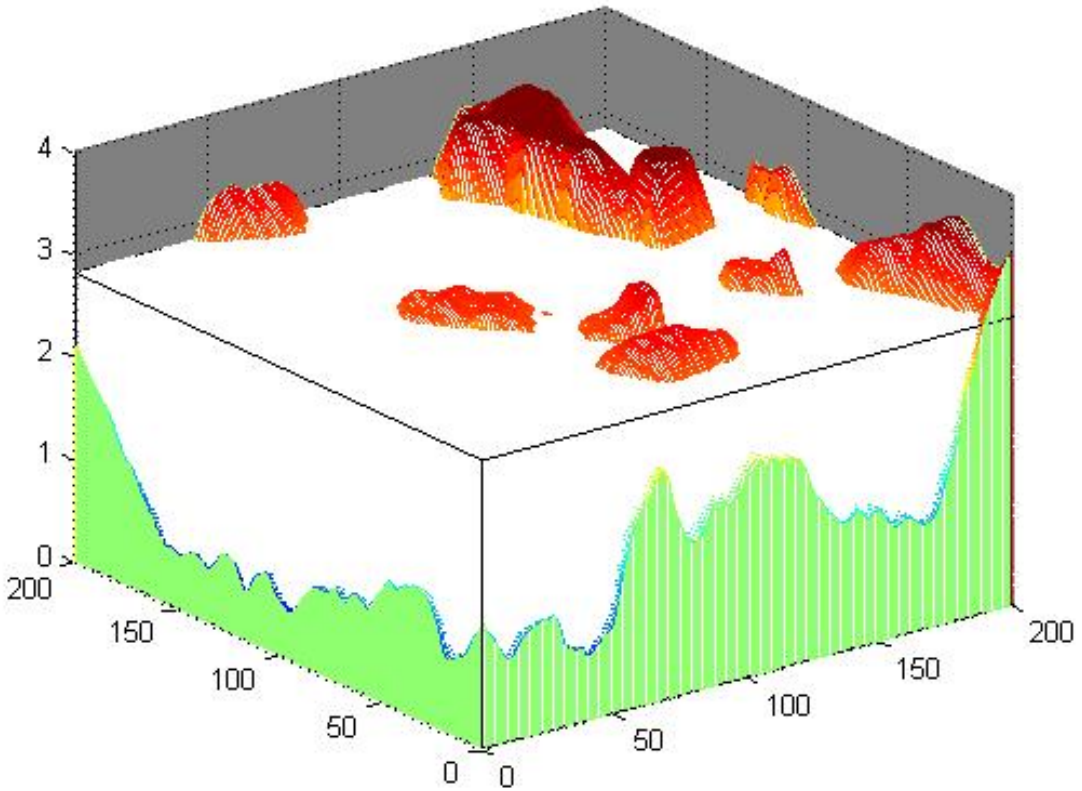


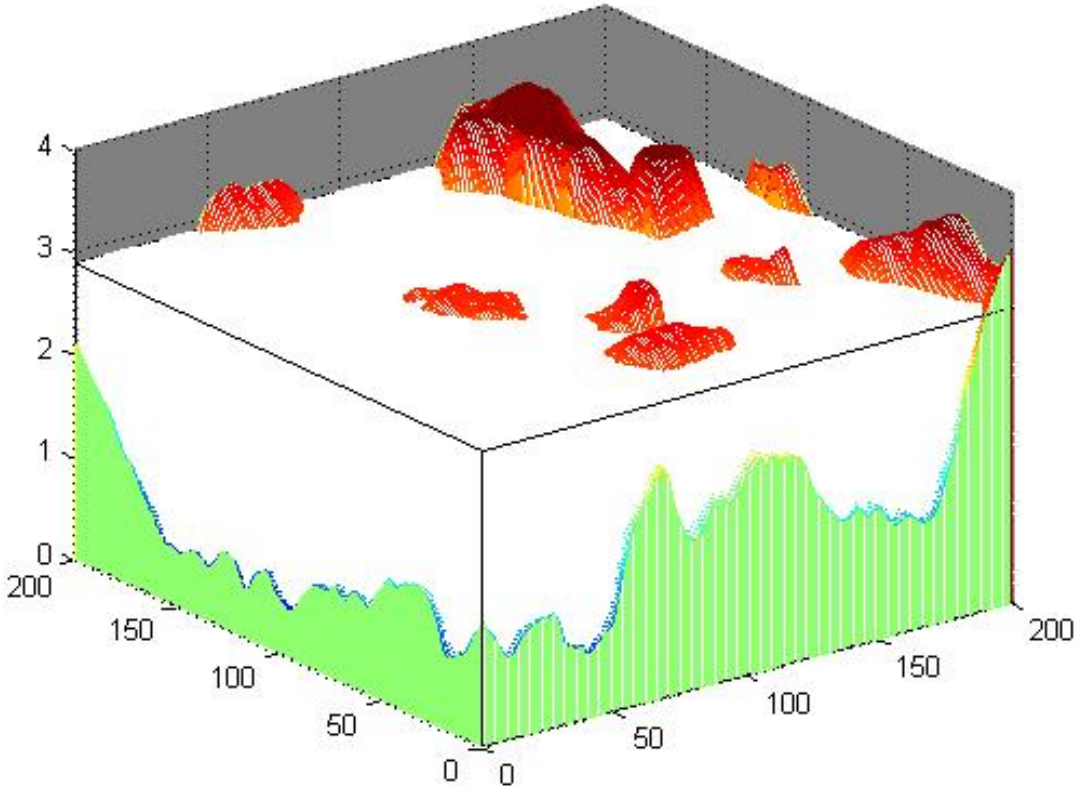


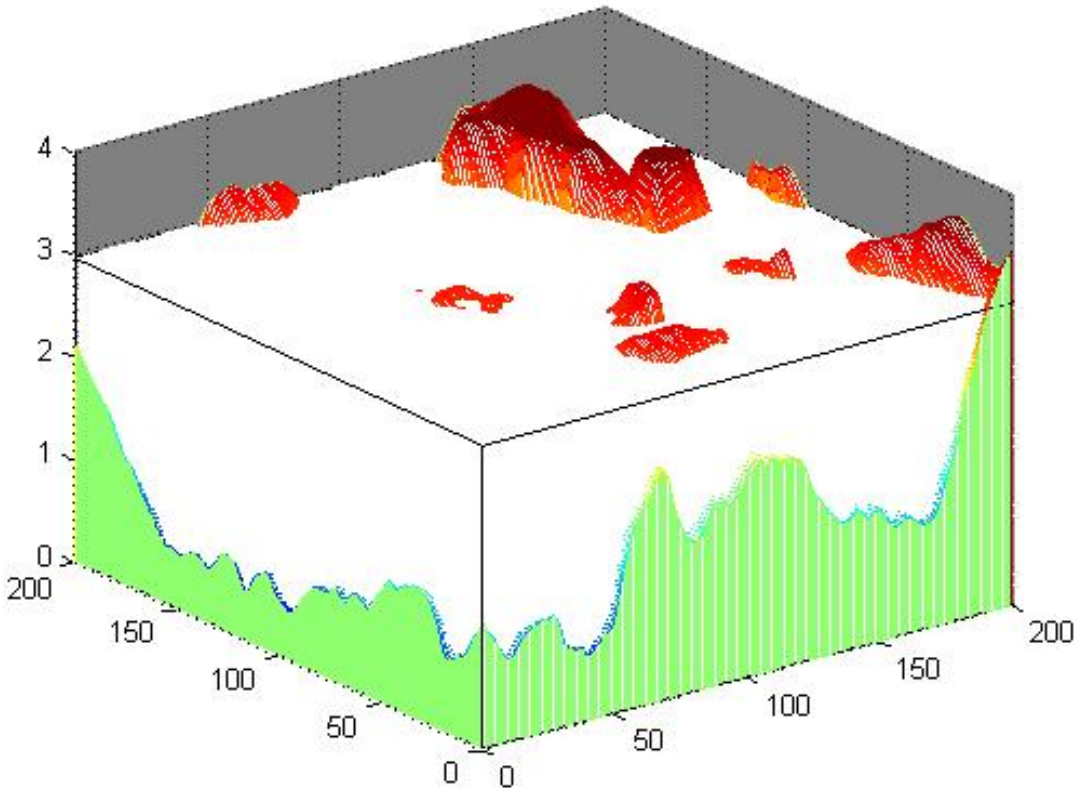


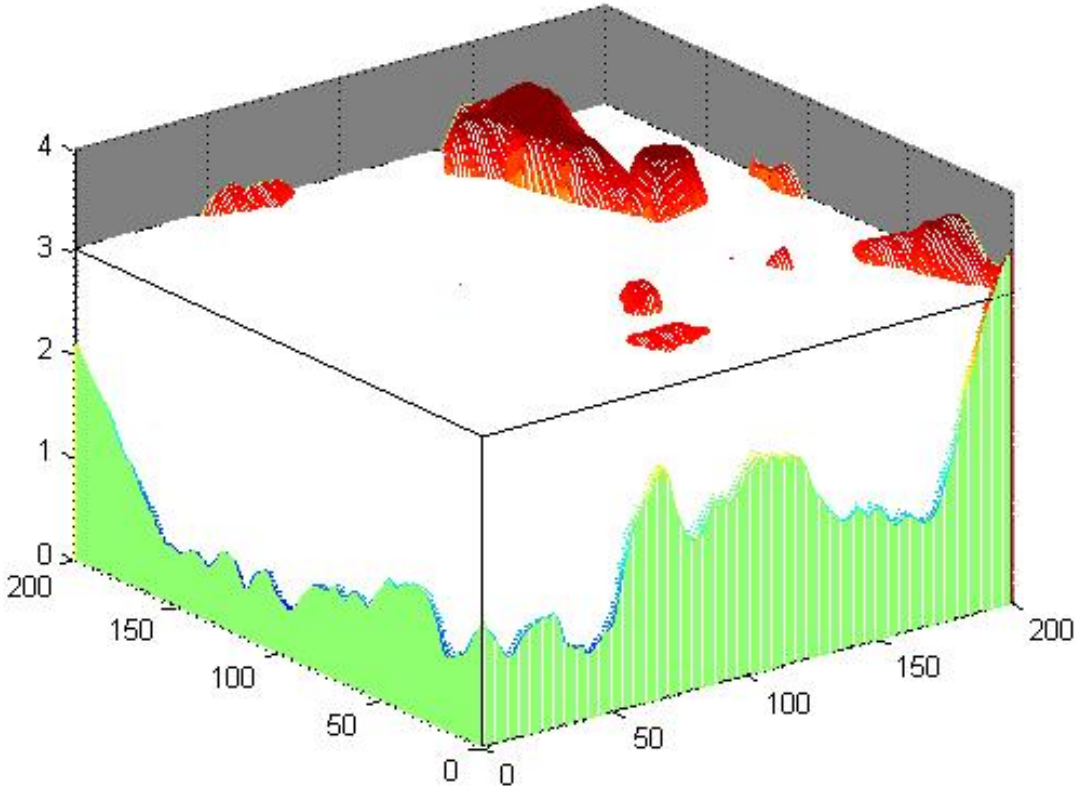


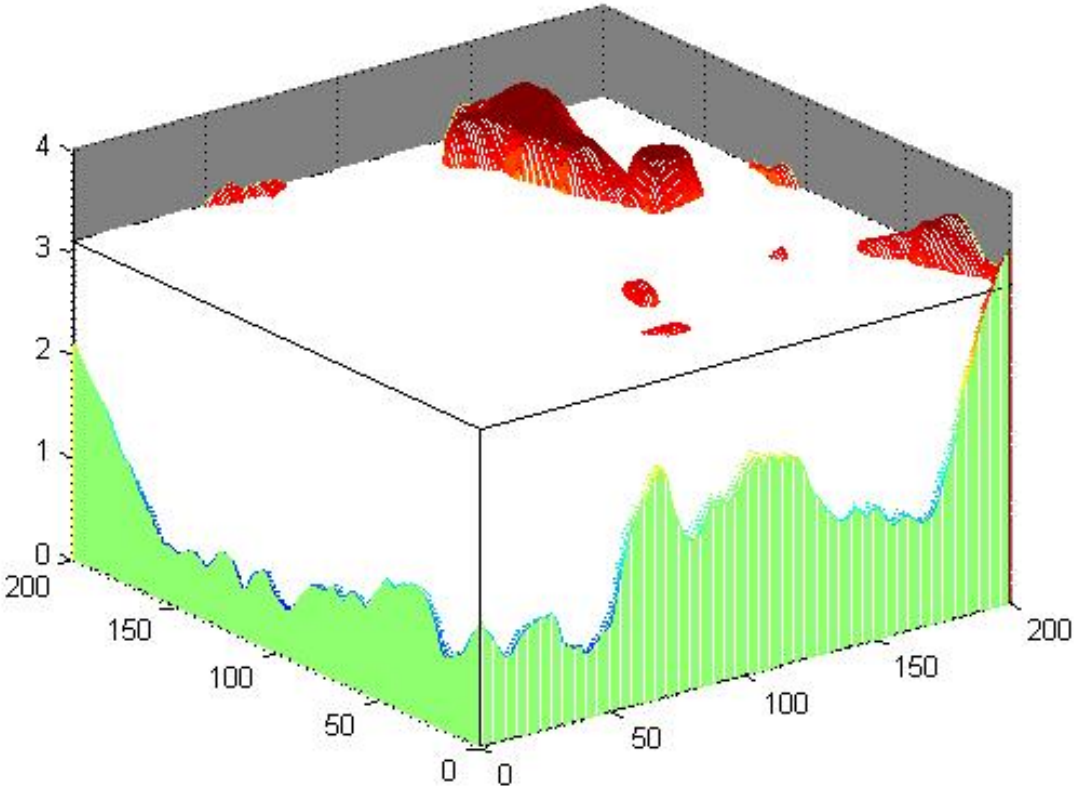


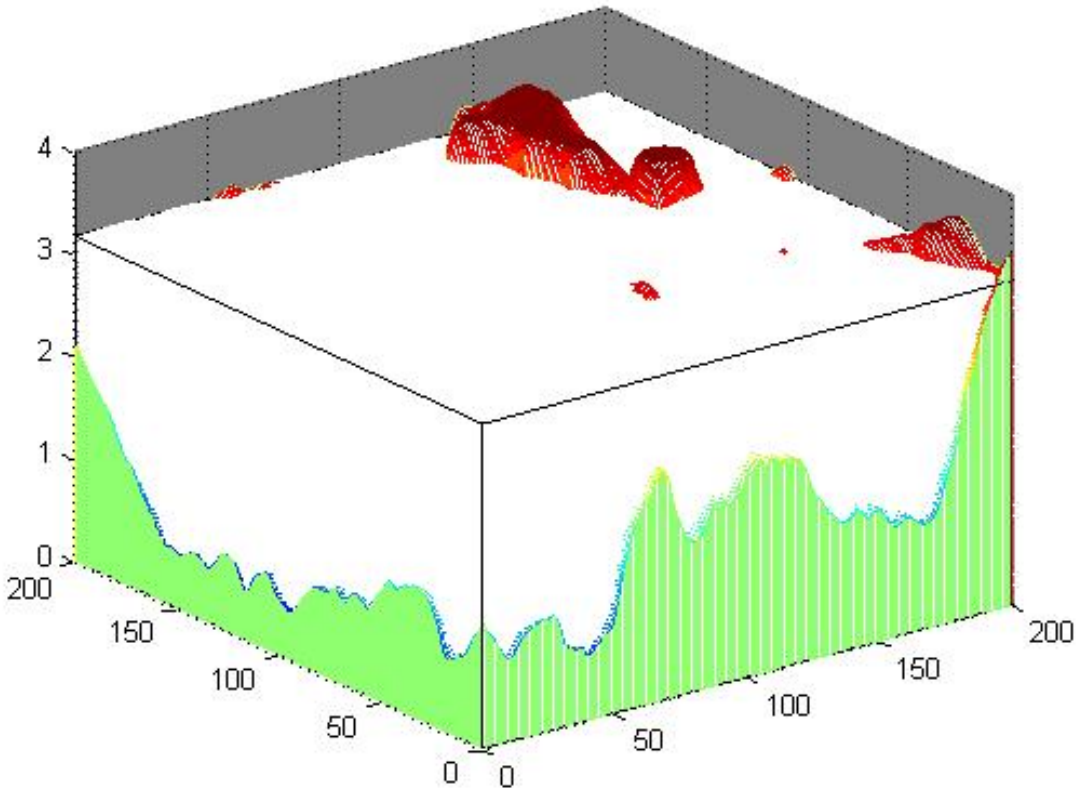


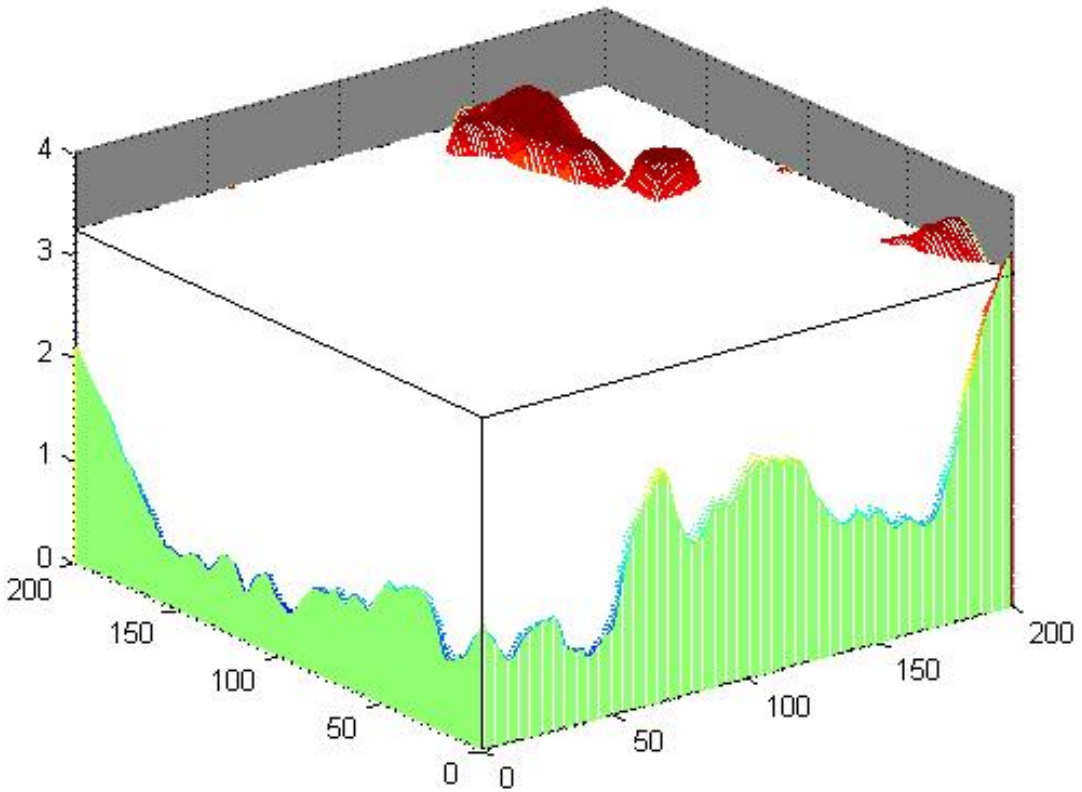


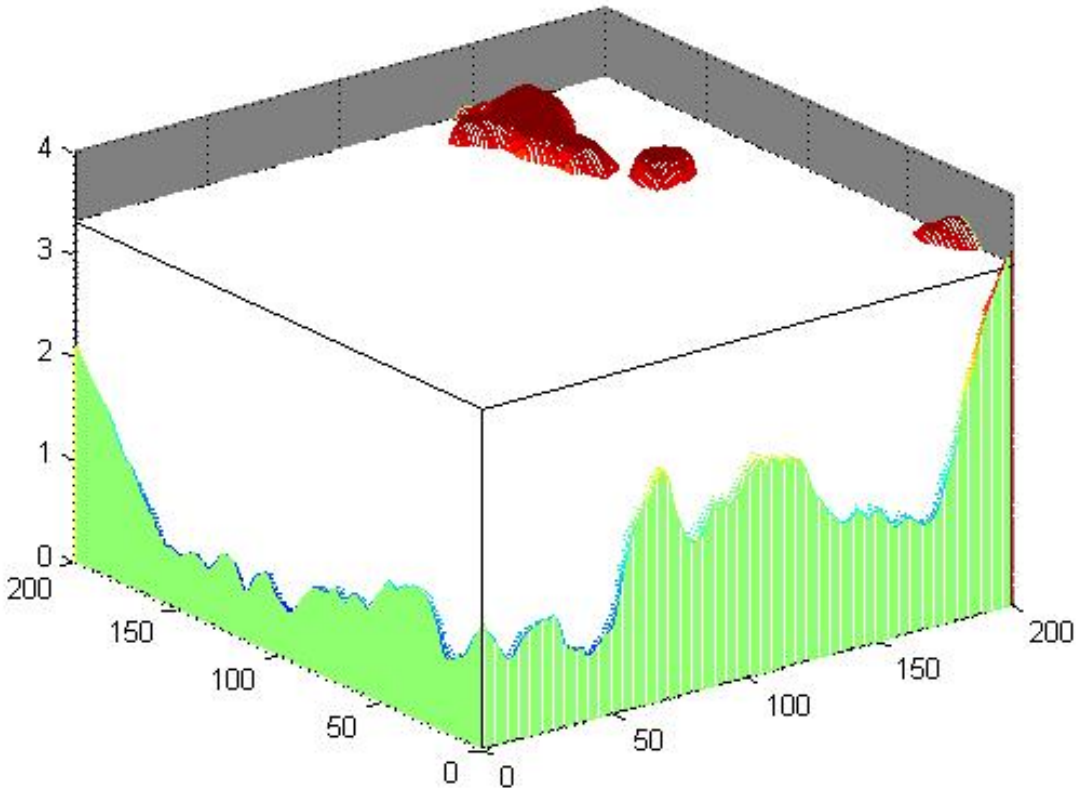


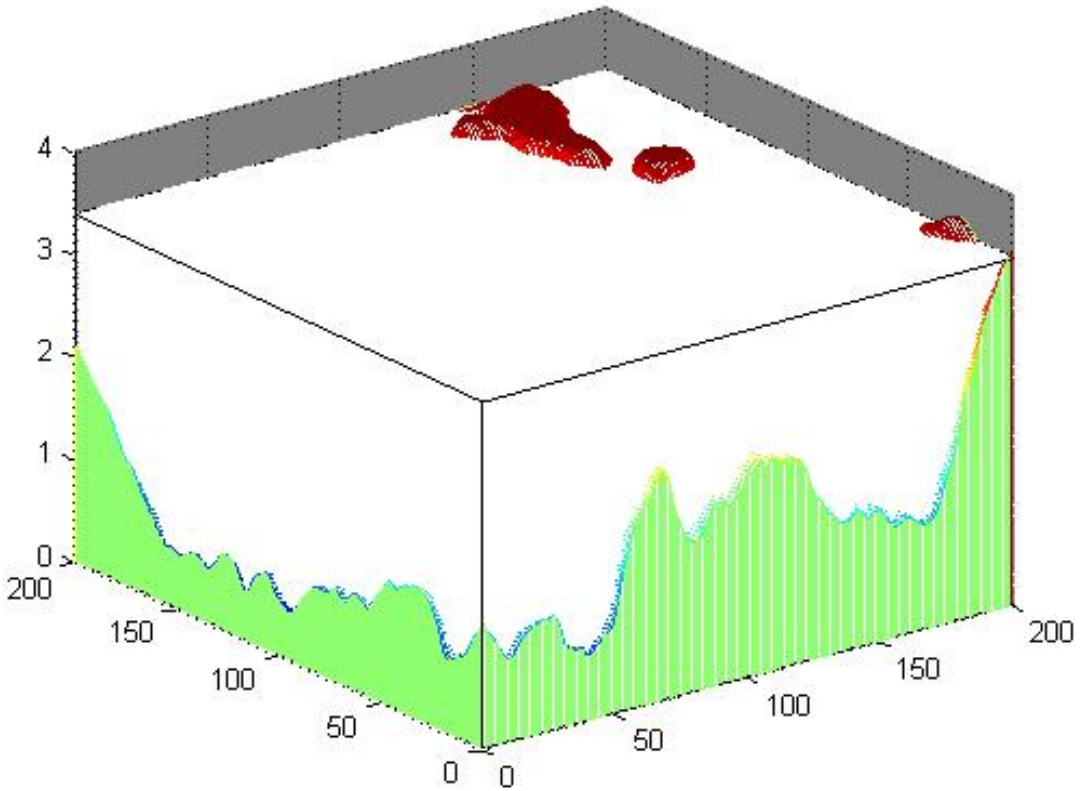


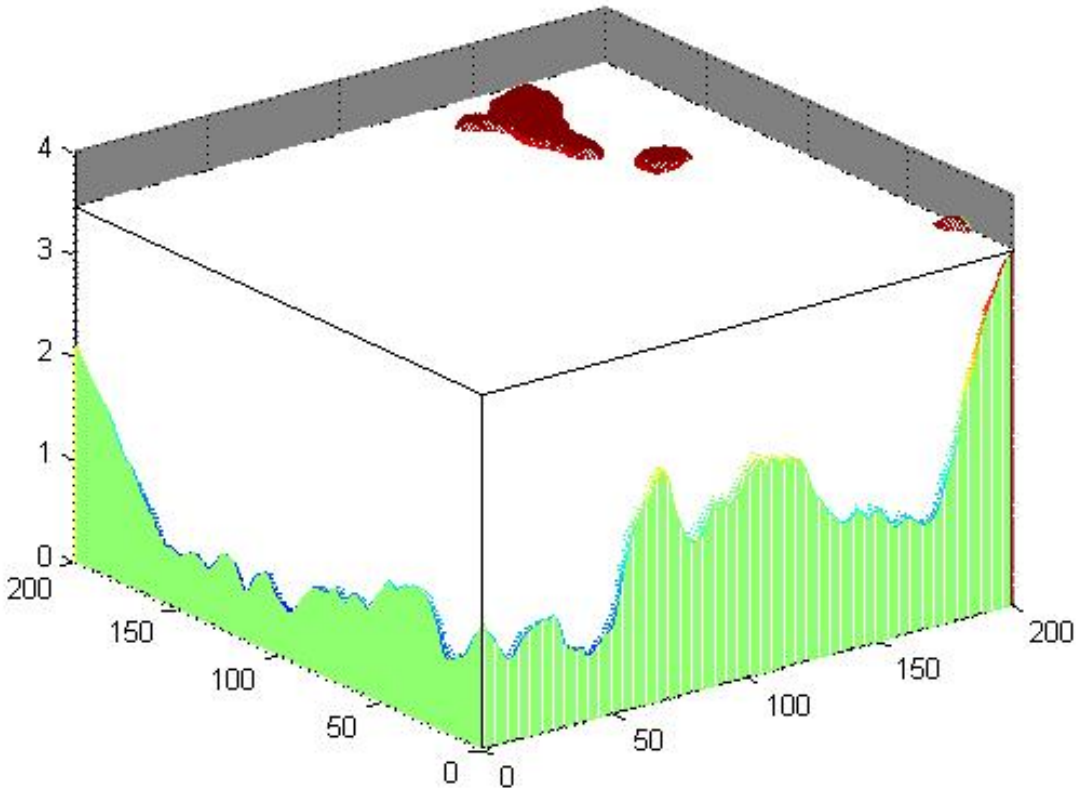


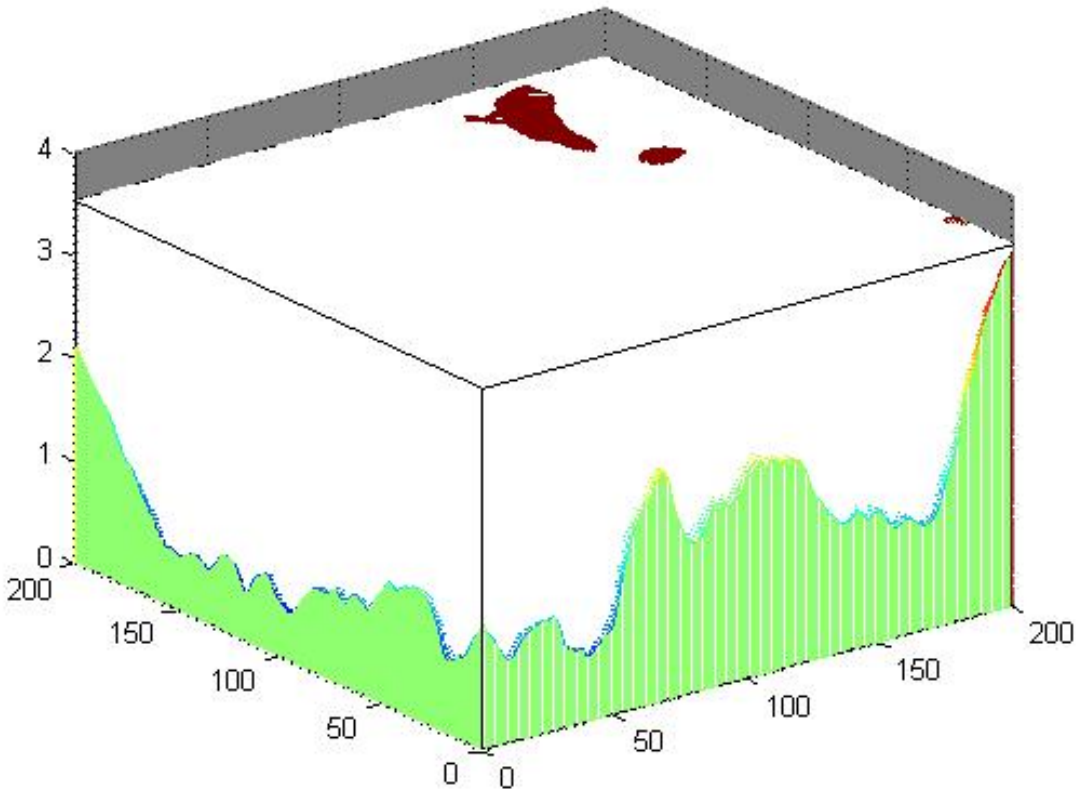




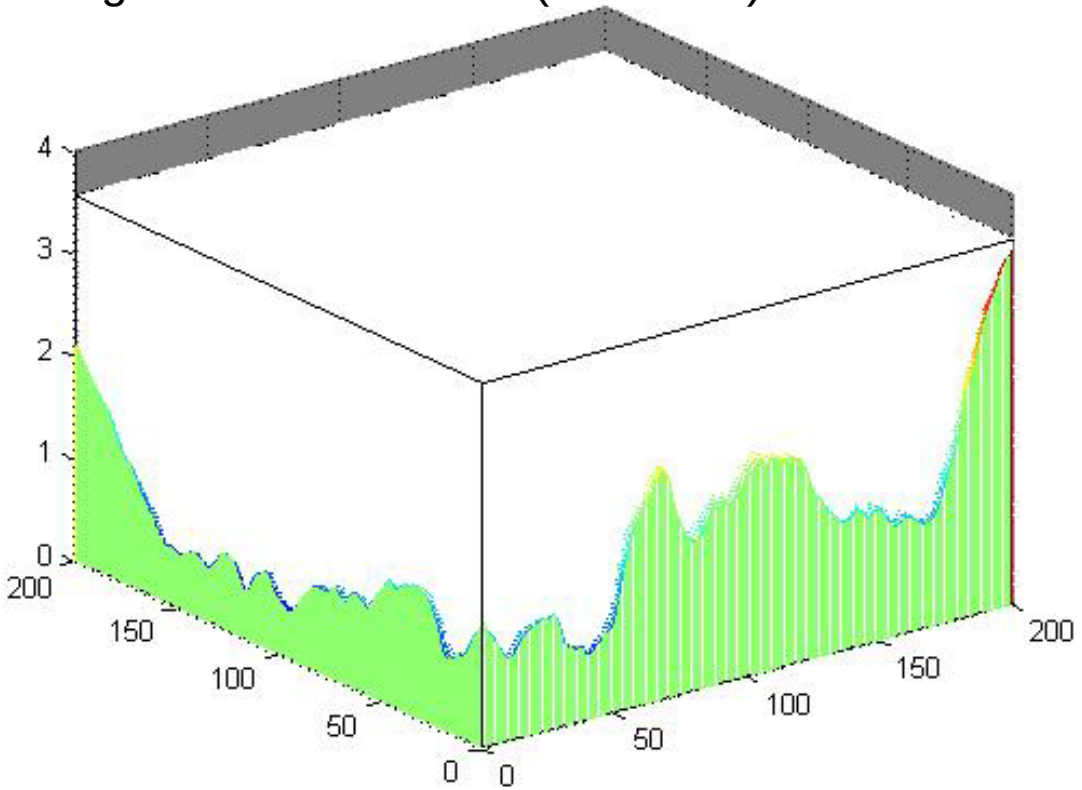






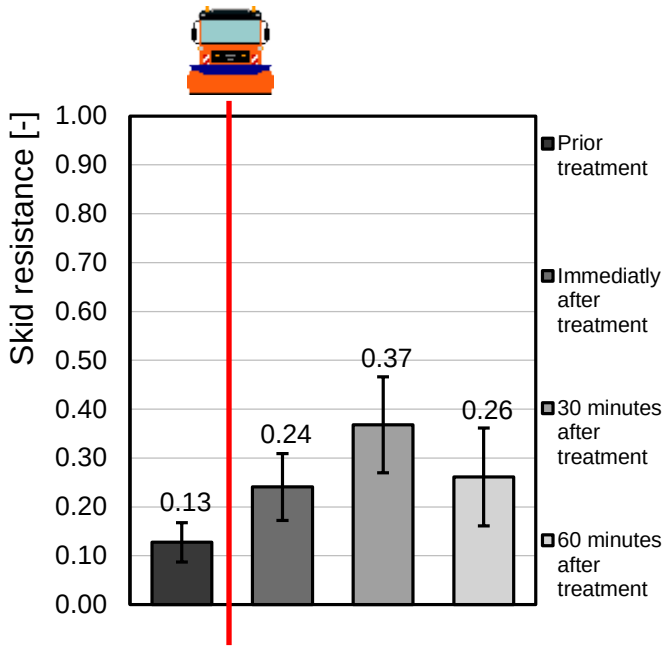


Braking distance snow/ice (130 km/h) = 665 m



8 Skid resistance and precipitation film measurements

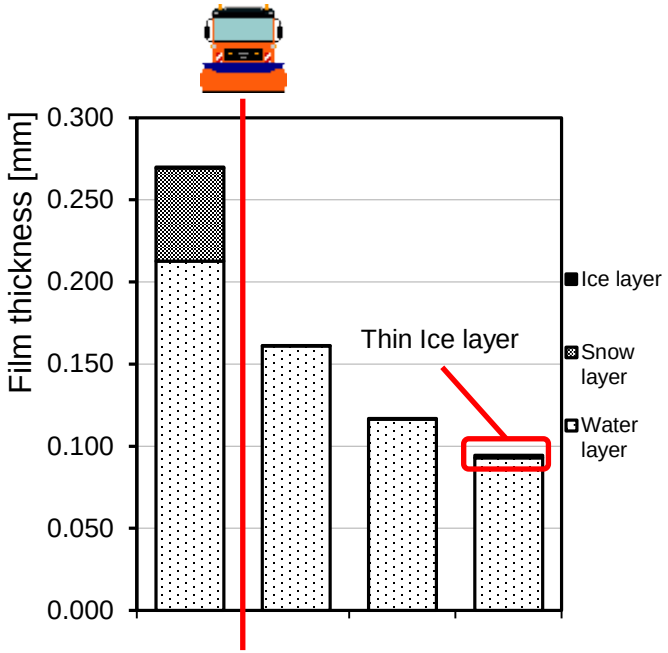
Skid resistance



✓ **Treatment raises skid resistance level for ~ 60 Minutes**

X **Continuous precipitation lowers skid resistance again**

Precipitation film



✓ **Snow has been removed with treatment**

X **Formation of ice Layer 60 Minutes after treatment**

9 Conclusions and Outlook

Outlook and further application

- Correlations between accurate laboratory measurements and available MPD – measures on network level have been established .
- Relation between macro texture volume and filled surface area can be used as indicator of reduced skid resistance based on contact area of road surface - tire
- Established correlation of this sudden drop of skid resistance in line with observed data between 60% to 90% of filled macro texture volume
- Based on further extensive research in field and laboratory measurements during the next 3 years the presented findings and approaches will be sharpened and verified

Thank you for your attention!