

# 3D from Skybox video

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Knowledge for Tomorrow



# First experience with 3D from spaceborne video

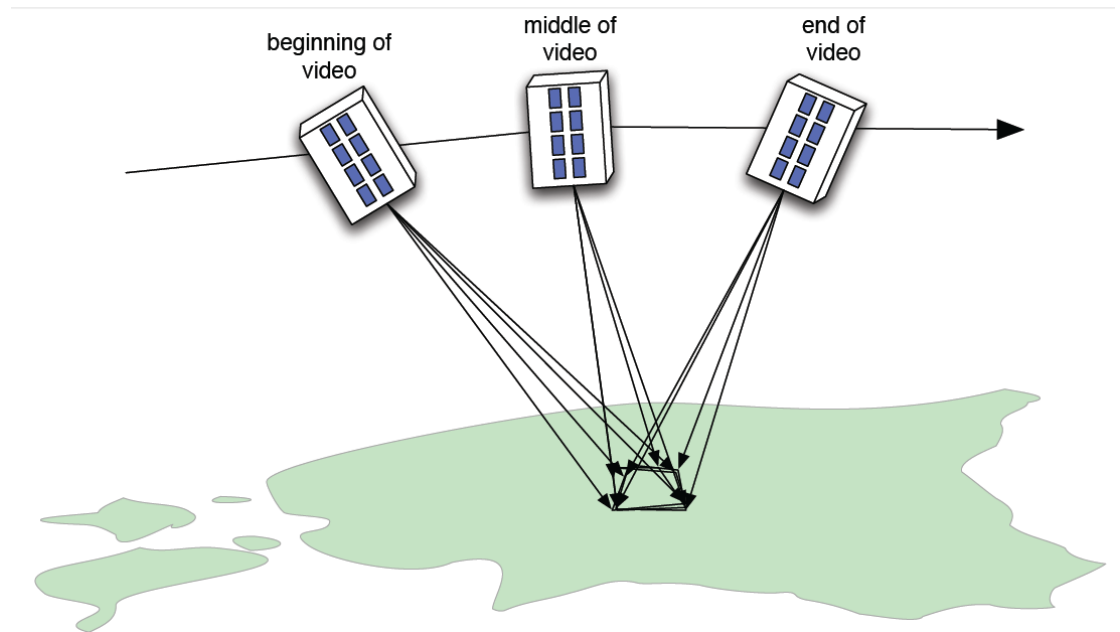


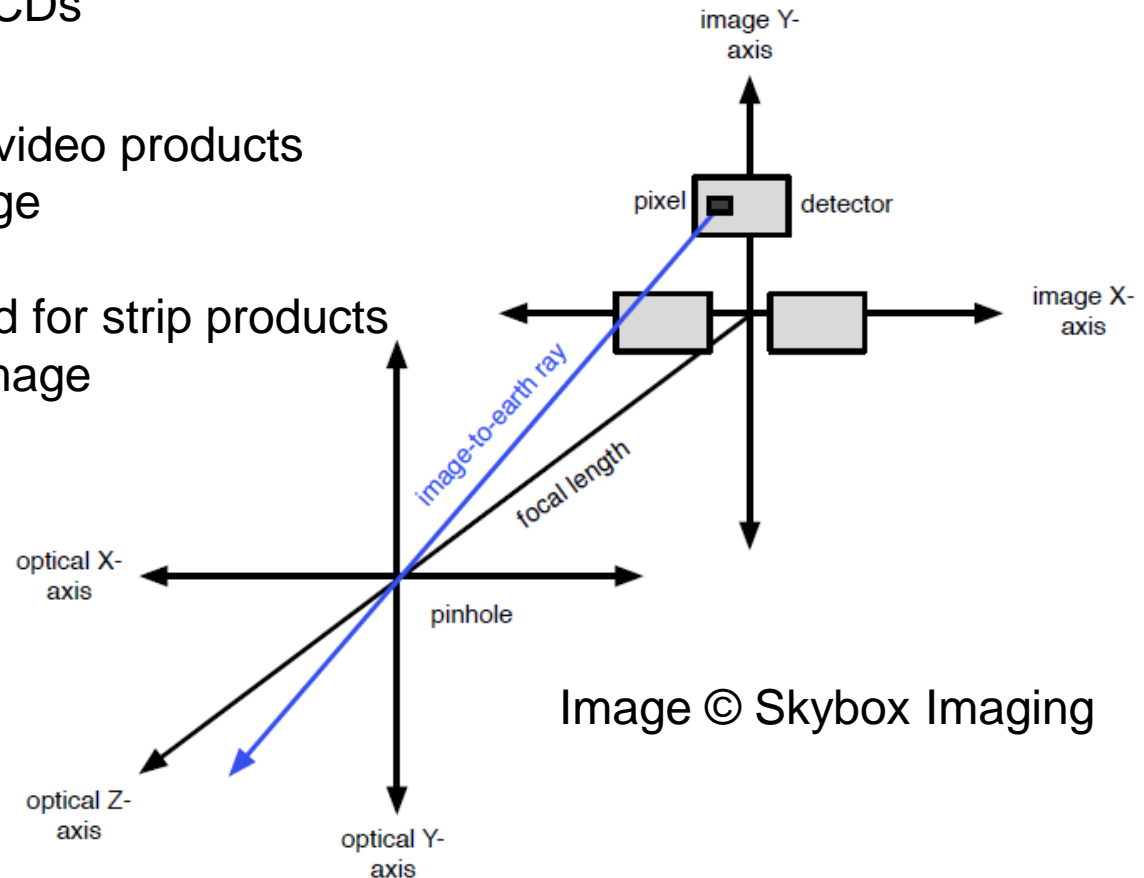
Image © Skybox Imaging



# Skybox camera model

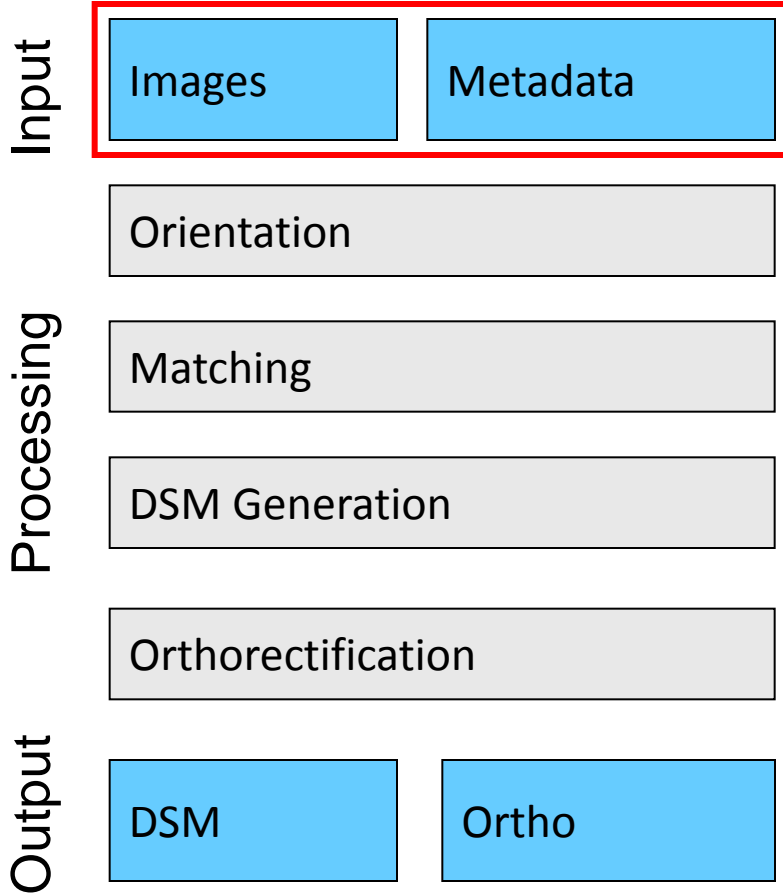


- Frame camera with 3 CCDs
  - One CCD used for video products
    - gray scale image
  - All three CCDs used for strip products
    - Multispectral image



# General Workflow

## Digital Surface Model generation



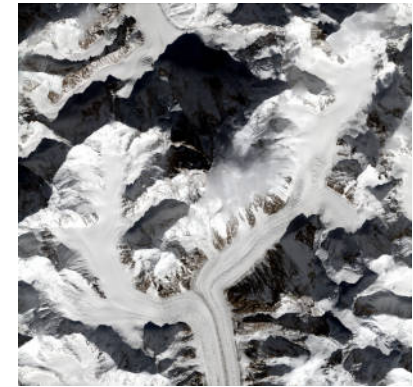
- At least two images, captured on same day.
- Optional: References like Ground control points (GCP), Reference images and DSM.



# K2

## WorldView-2 Triple Stereo

- Very steep terrain
- Very detailed surface model
- Movie: [http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10212/332\\_read-921/](http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10212/332_read-921/)



15°



0°



-15°

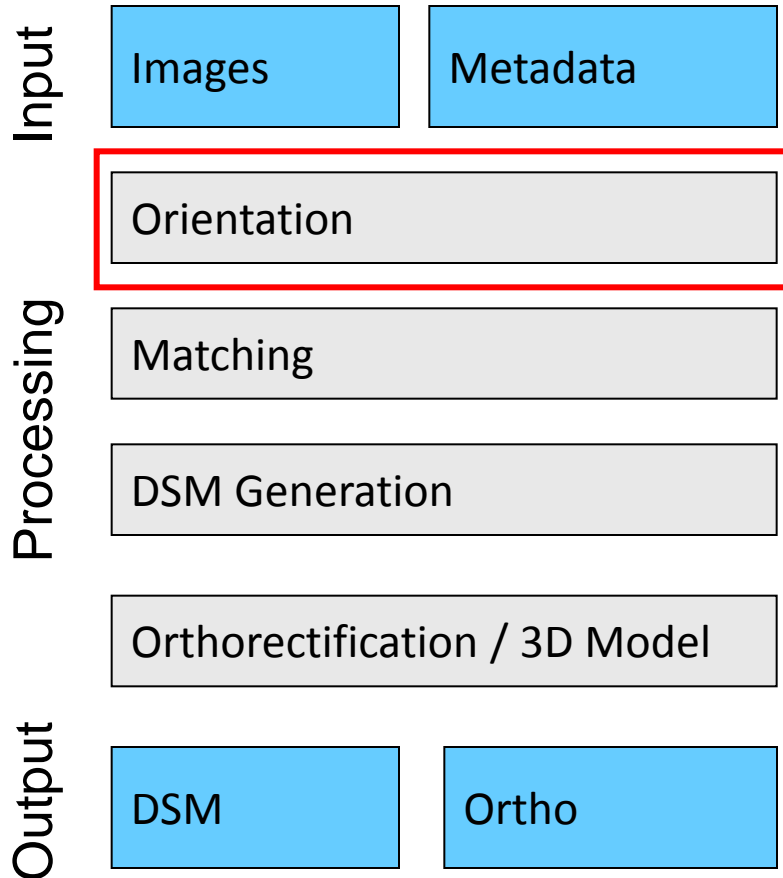




# Skybox Las Vegas sequence



# Workflow Orientation



- Good relative orientation required, error  $< 0.5$  pixel
- Automatic GCP/tie point matching (SIFT and local least squares matching).
- Bundle block adjustment estimates improved orientation parameters
- Automatic process, unless GCPs are required



# Image orientation

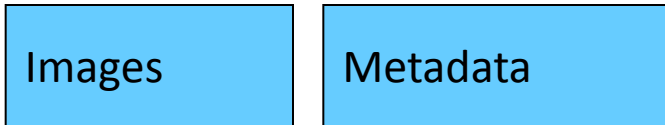
## Las Vegas Skybox video

- Subset of 60 images (1 image per second)
  - Little change between each image
- RPC model + relative corrections in image space
  - Magnitude of corrections ~ 100 pixels.
  - Tie point RMSE 0.3 pix (SIFT tie points).

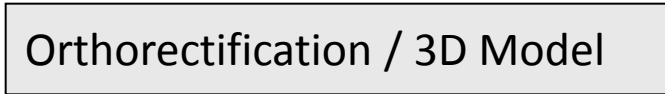
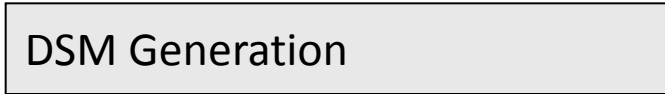
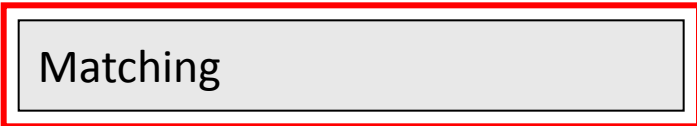


# Workflow Dense Matching

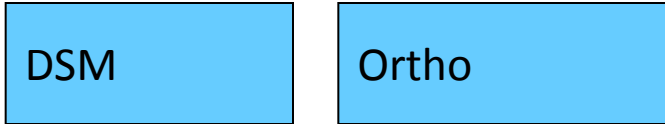
Input



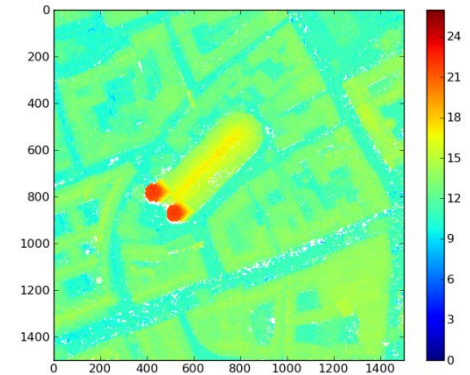
Processing



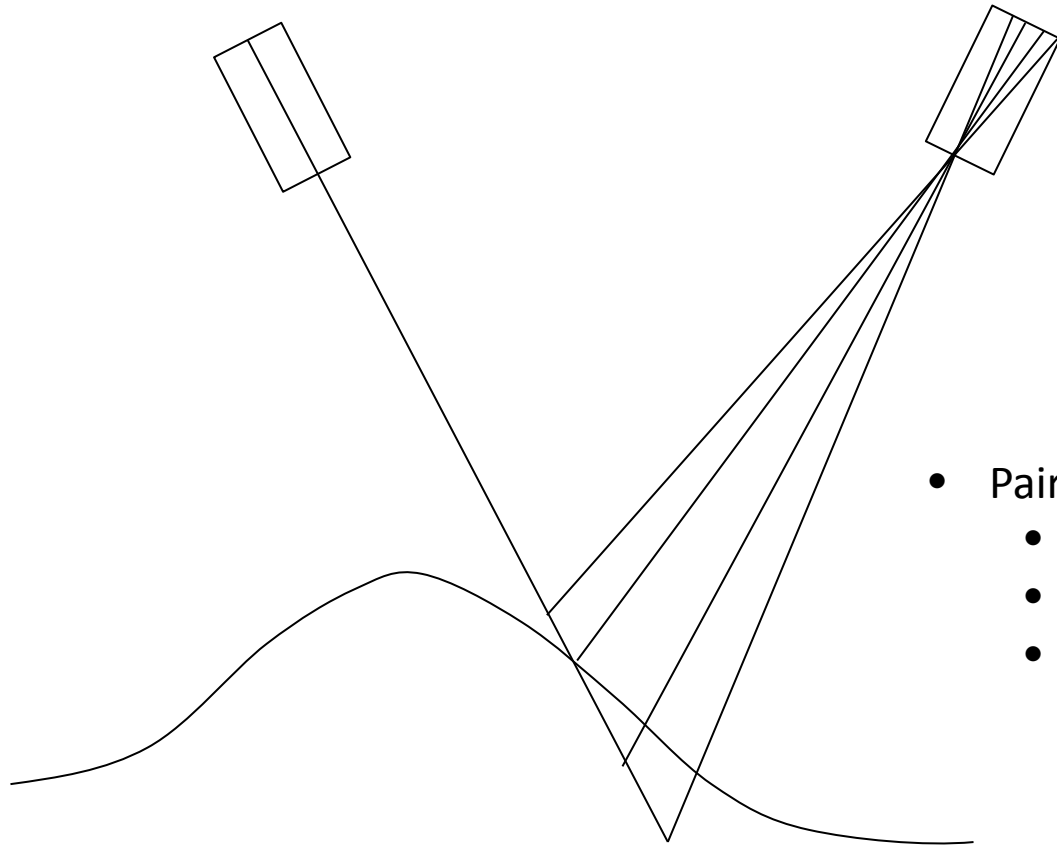
Output



- Find correspondences for each pixel



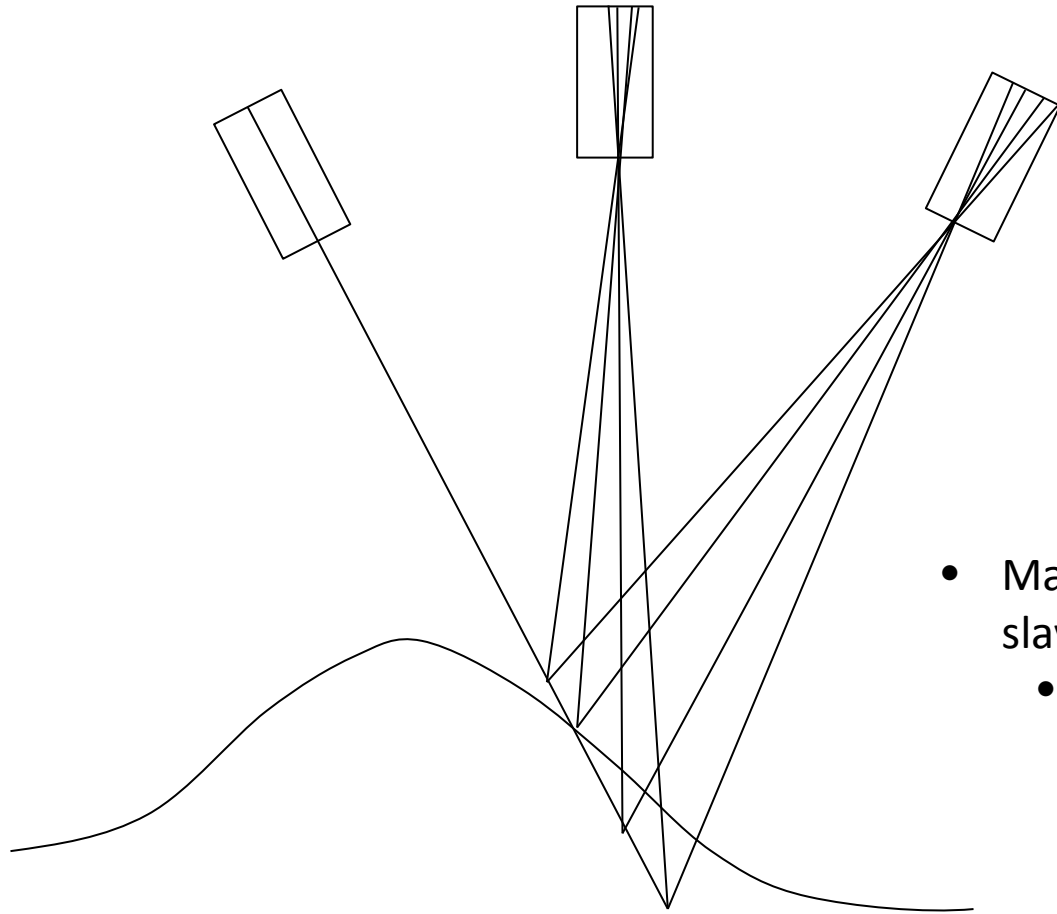
# Pairwise matching



- Pairwise stereo matching + fusion of DSMs
  - merge DSMs with median
  - detect occlusions by left/right check
  - High complexity, early regularisation?



# Multi-image matching

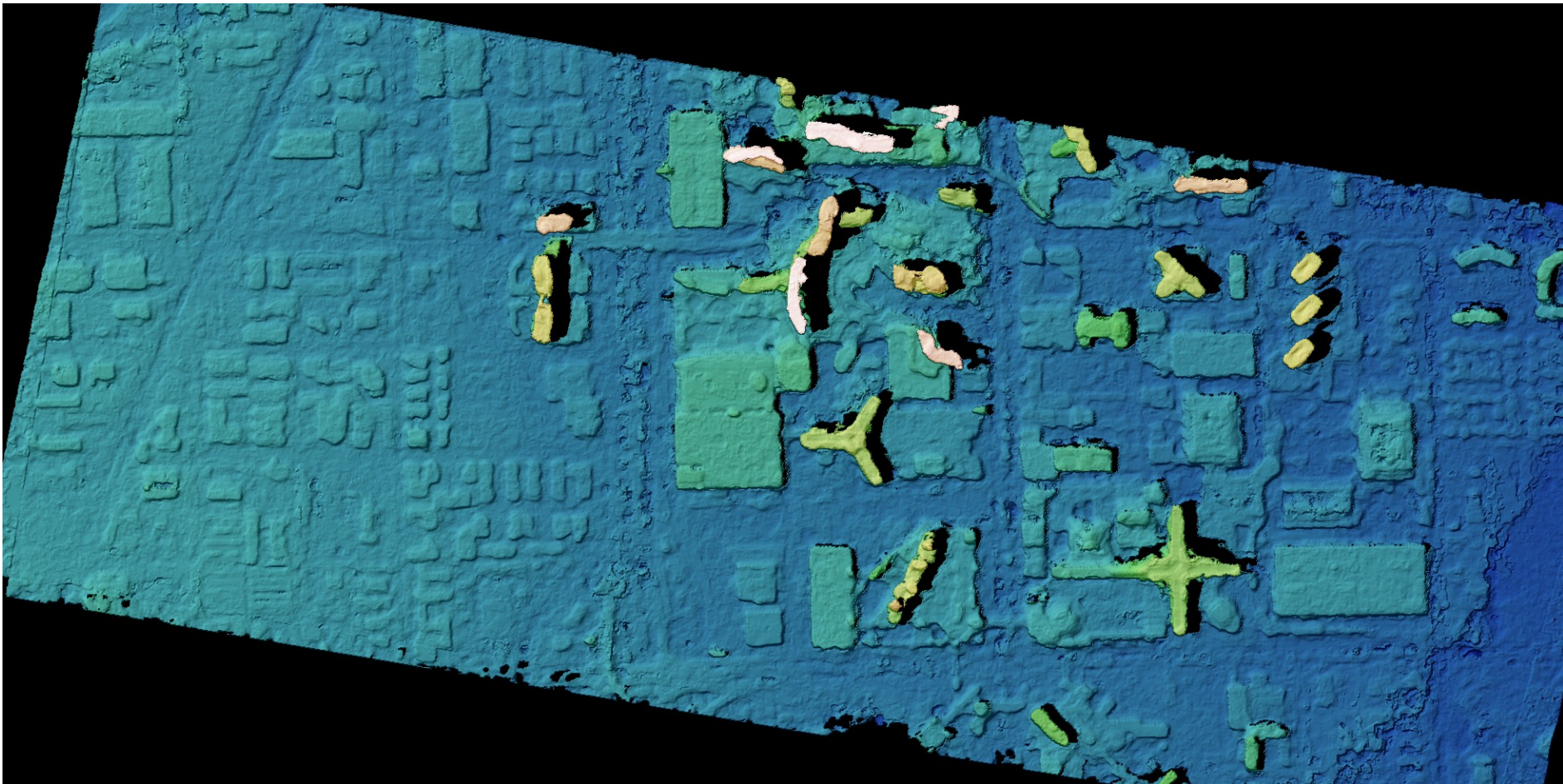


- Matching of master image against multiple slave images.
  - Data cost fusion in image space, before regularization



# Triplet

Using only 3 images out of 1800



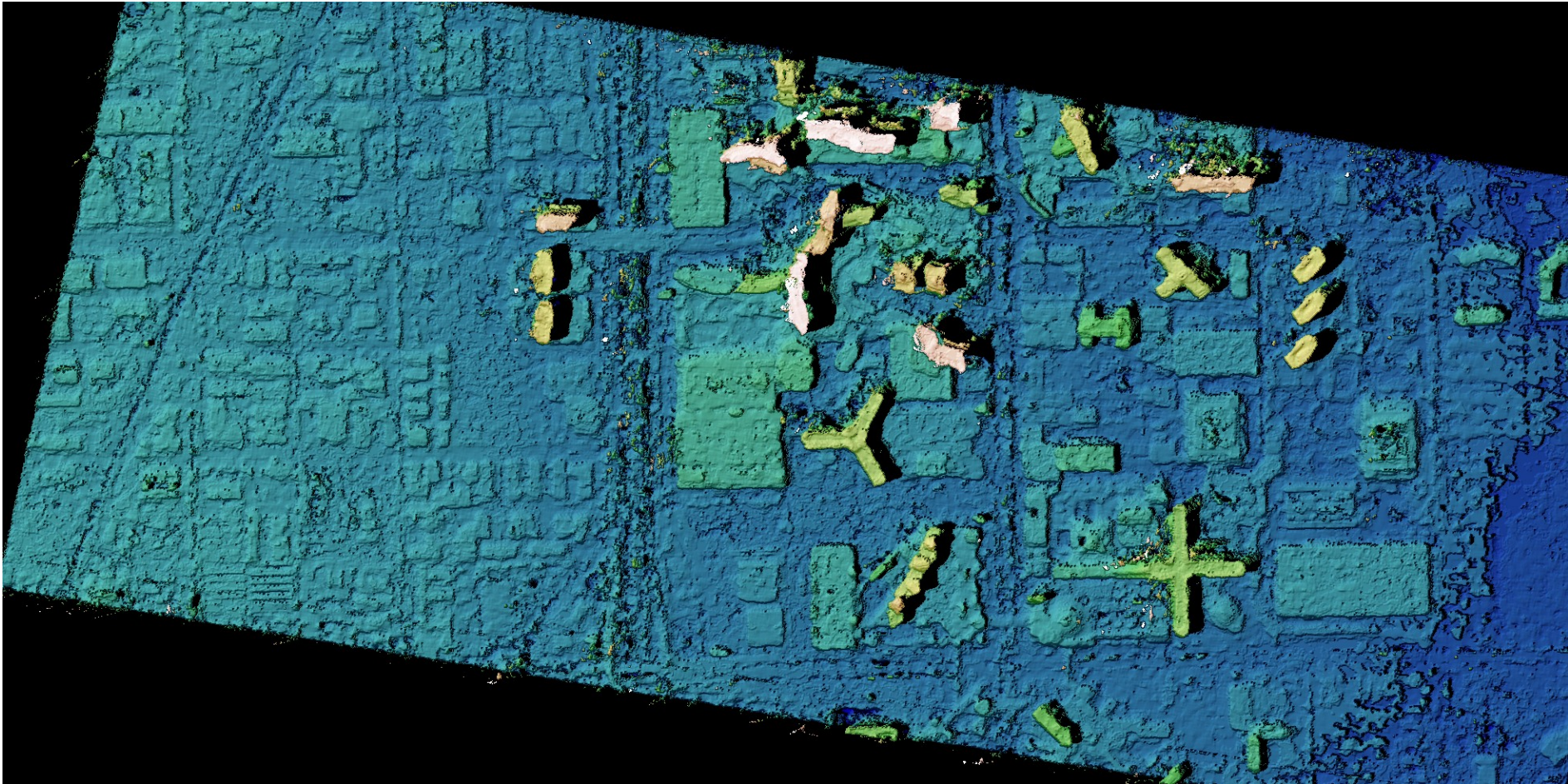
AD+Census, Adaptive Support + TV regularisation + Median/mean fusion of 3 pairs



DLR



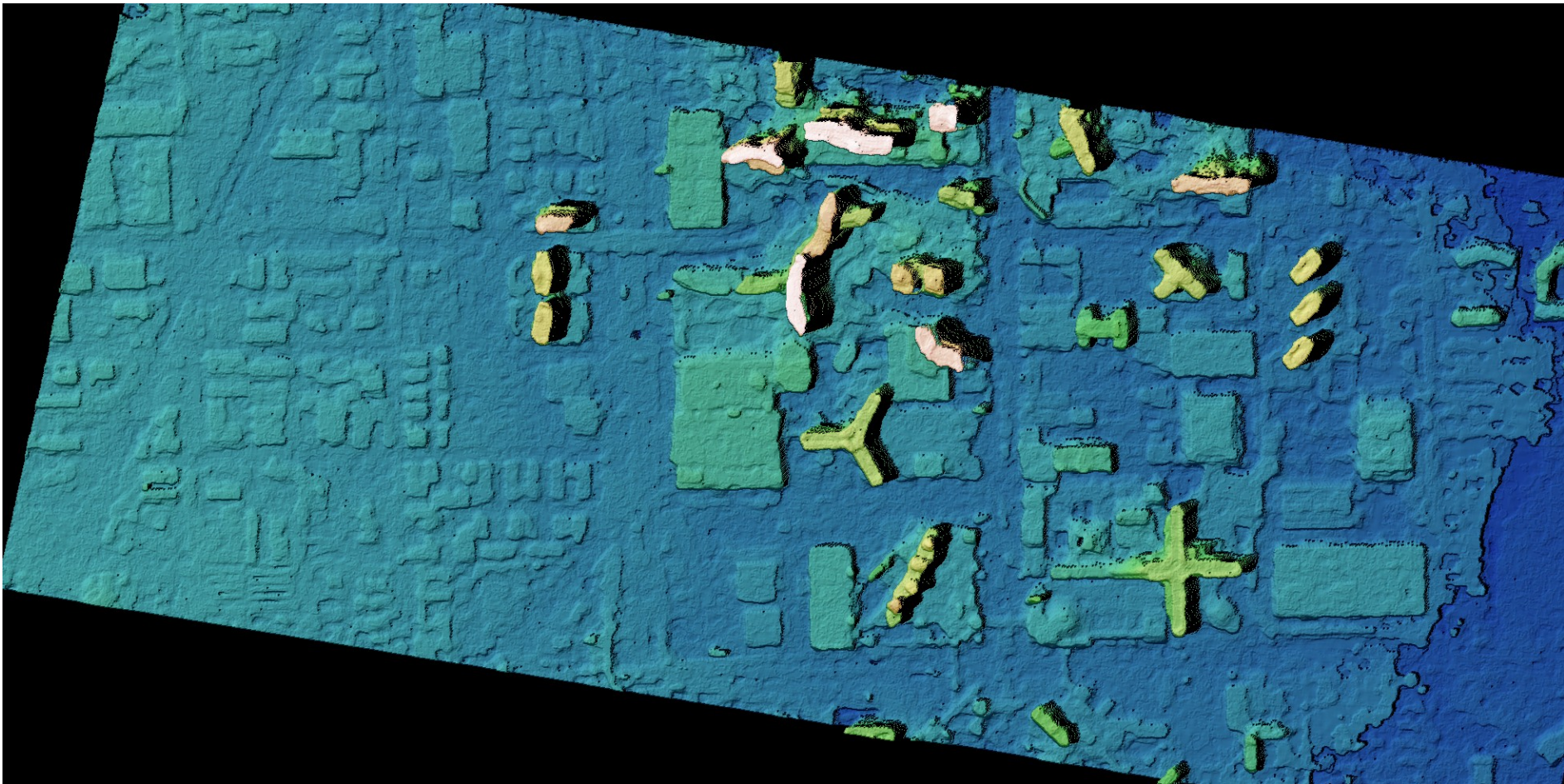
# One Master image, 20 Slave images No regularization



AD+Census, Small Adaptive Support Regions



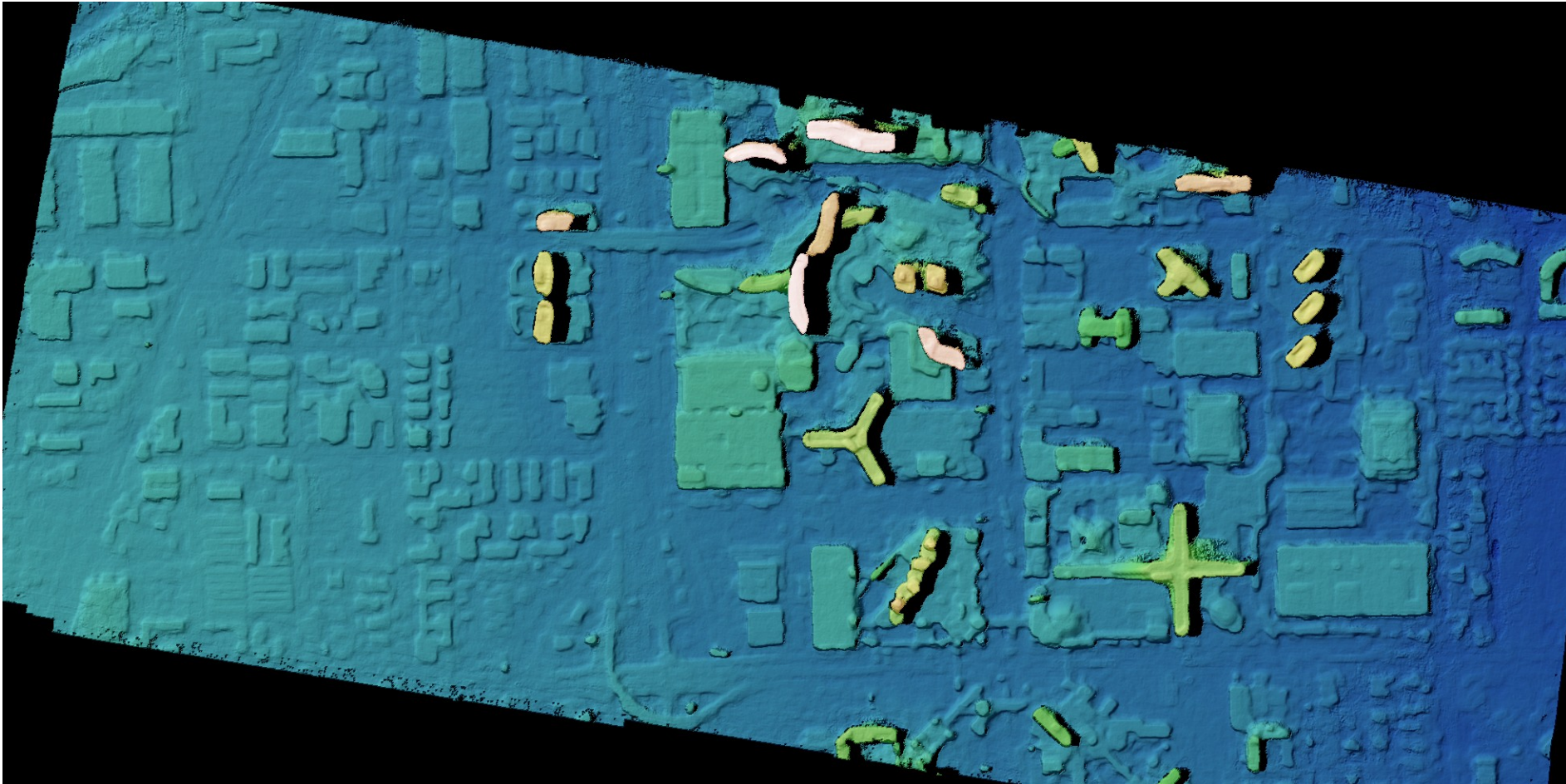
# One Master image, 20 Slave images Total variation regularization



AD+Census, Small Adaptive Support Regions + Total Variation (Huber) regularization



# 15 Master image, 20 Slave images Median/Mean fusion



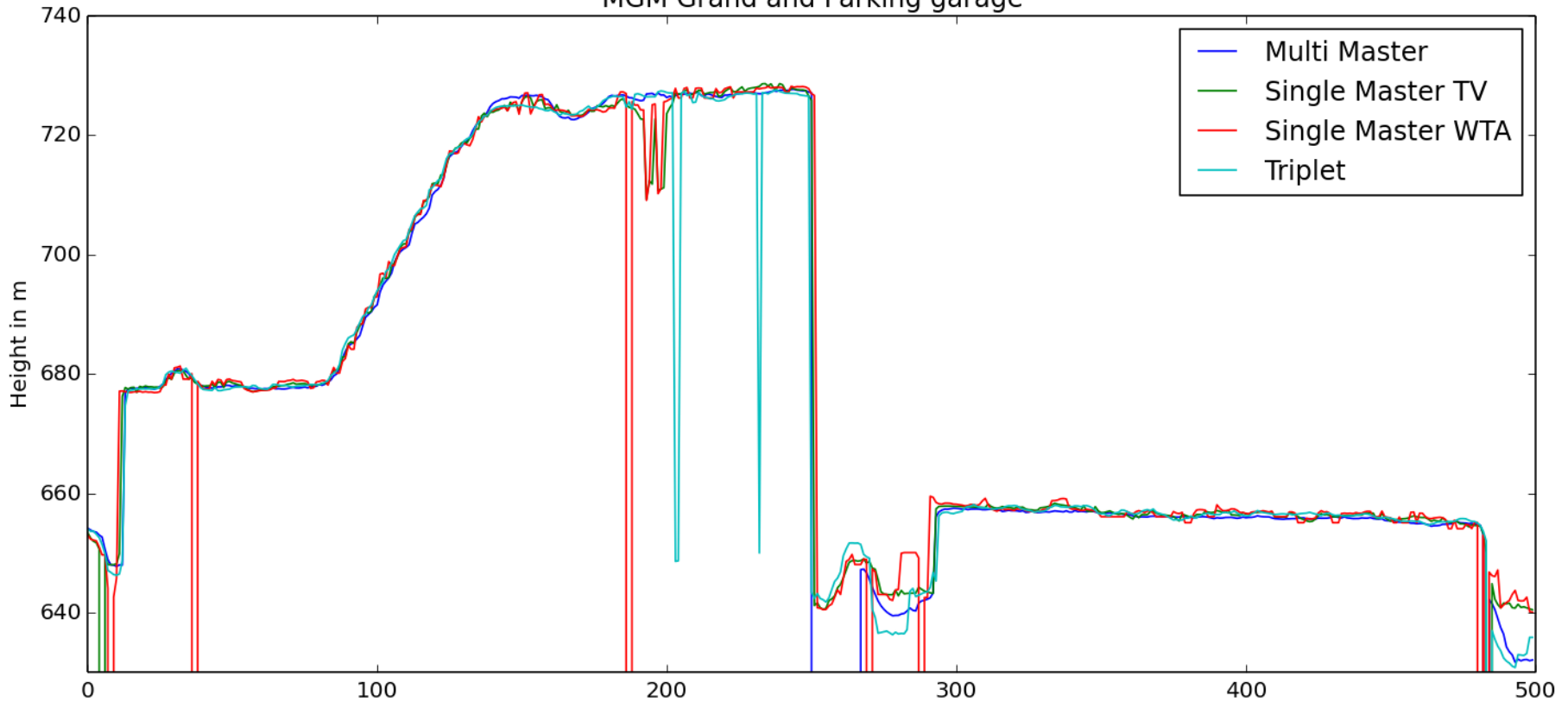
AD+Census, Small Adaptive Support Regions + Total Variation (Huber) regularization

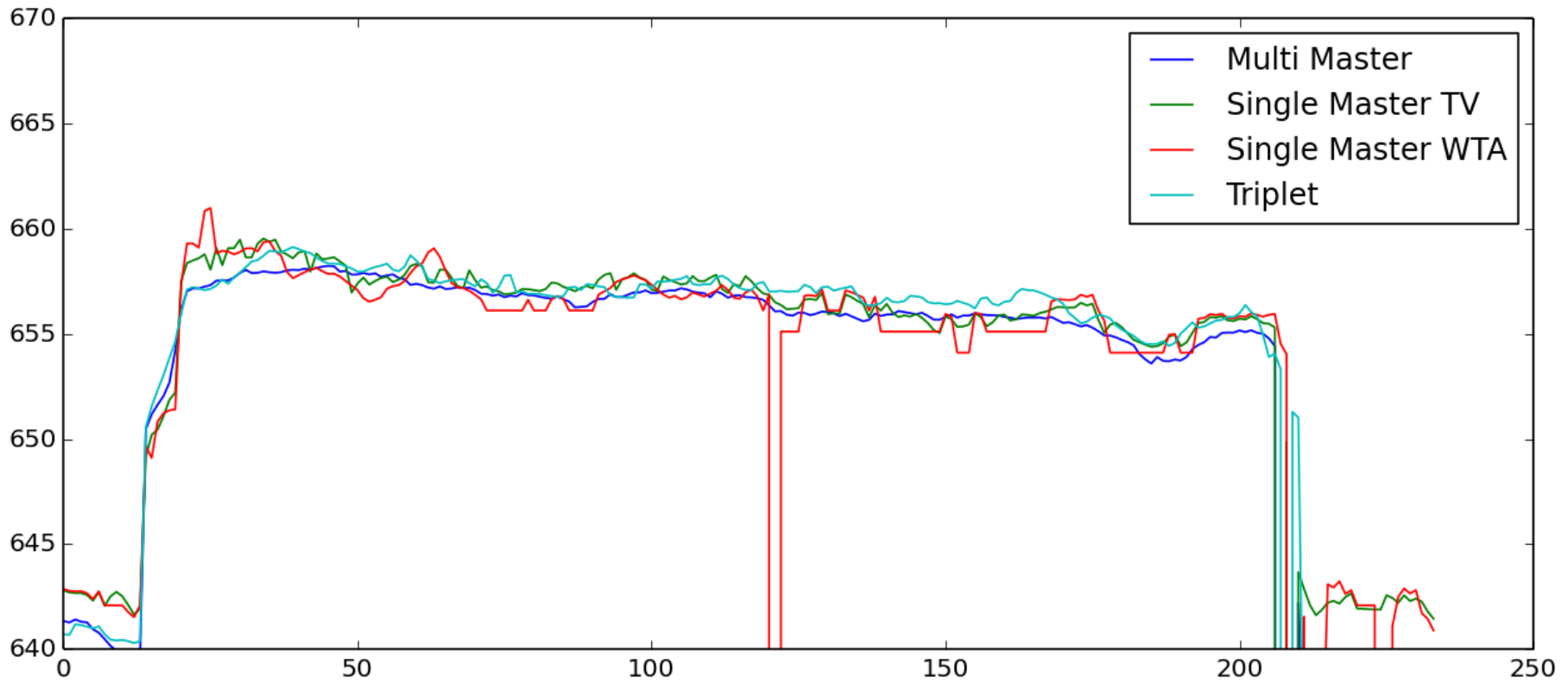
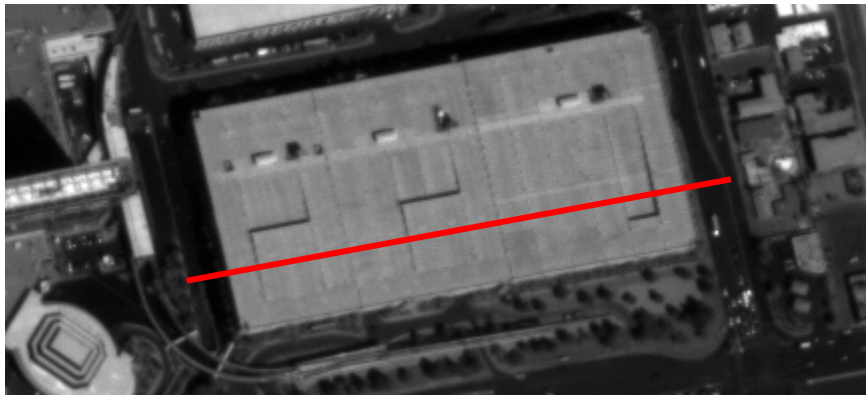


# Profiles



MGM Grand and Parking garage



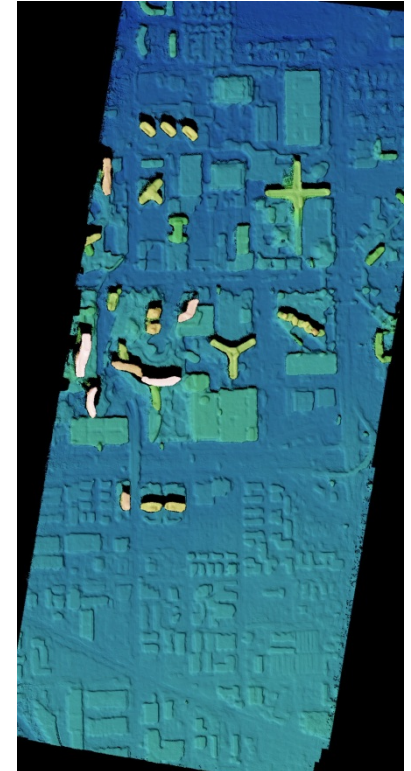


# Conclusions



Preliminary results

- Skybox video is well suited for 3D reconstruction
  - DSM generation at sensor GSD possible.
- Open question: How to best exploit the redundancy?
  - Tailored matching strategy
  - SNR improvement(improve matching in shadows)
  - DSM super-resolution?
- Practical applications
  - High resolution DSMs. 1..2 m ground sampling.
  - Good for complex terrain/urban environments.
  - Small area compared to VHR  
(2x1 km vs 16x16 km)



# Profiles

