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Combining angular and spatial information from multibeam backscatter data for improved unsupervised acoustic seabed segmentation

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Combining Angular and Spatial Information from Multibeam Backscatter Data for Improved Unsupervised Acoustic Seabed Segmentation

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FONSECA Luciano ^{3,4}, MAYER Larry ³, and IMMENGA Dirk ²

¹ School of Life & Environmental Sciences, Deakin University, Australia

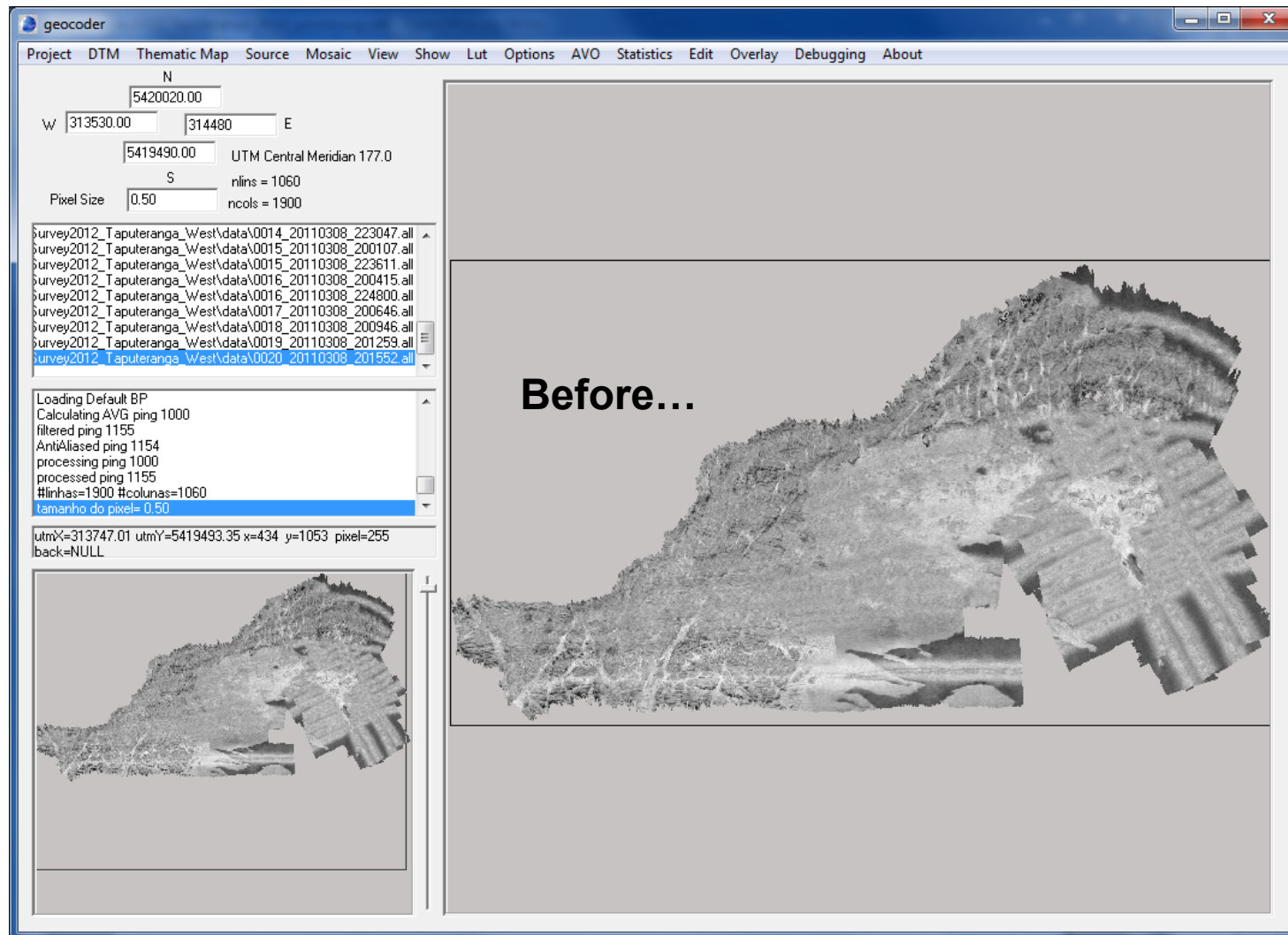
² Department of Earth & Ocean Sciences, University of Waikato, Hamilton, New Zealand

³ Center for Coastal and Ocean Mapping, University of New Hampshire, USA

⁴ Faculty of Engineering at Gama, University of Brasilia, Brazil

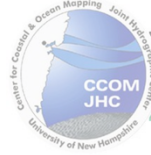
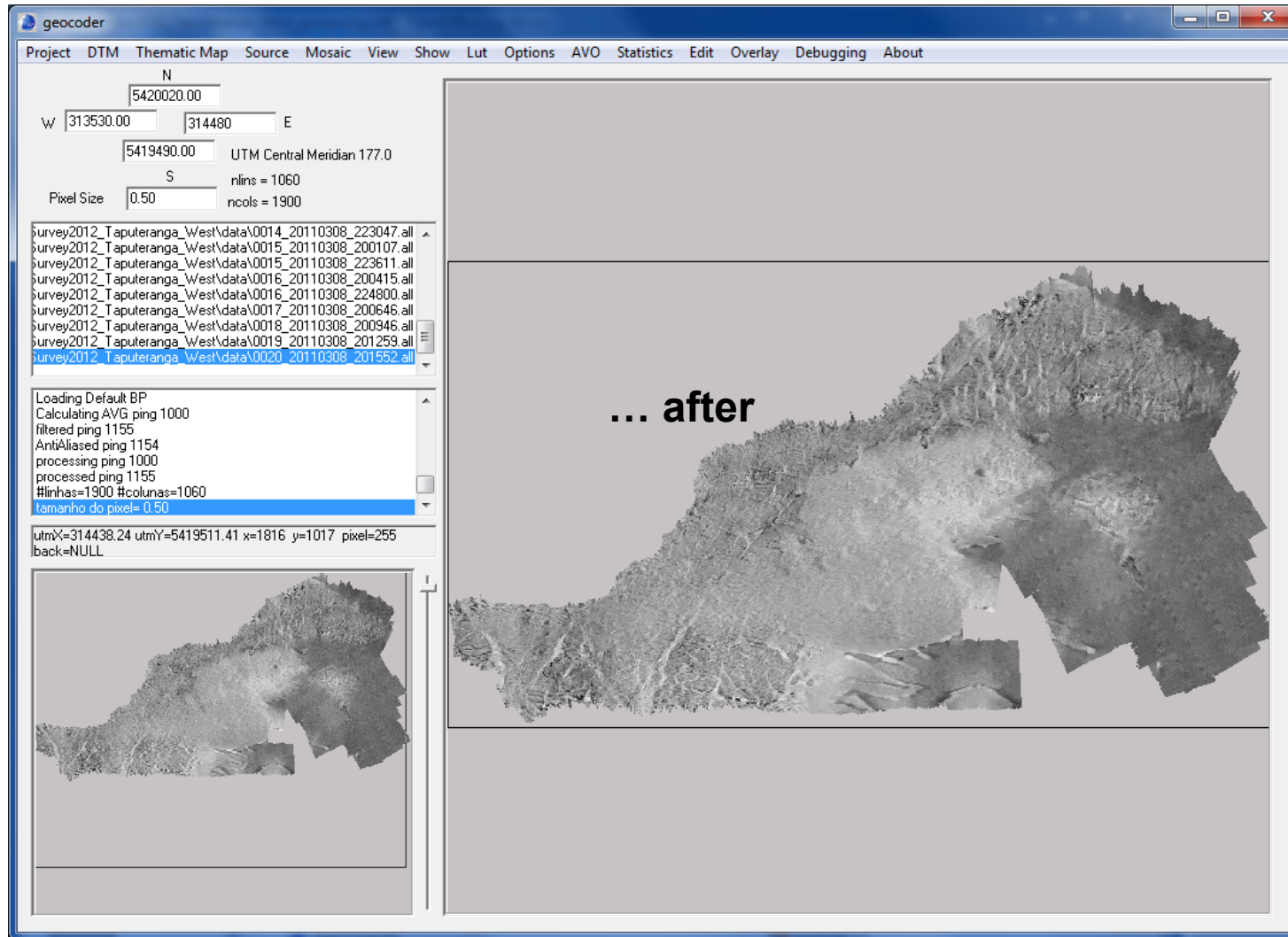
Introduction: Geocoder

A backscatter-data processing software by CCOM-JHC, UNH.



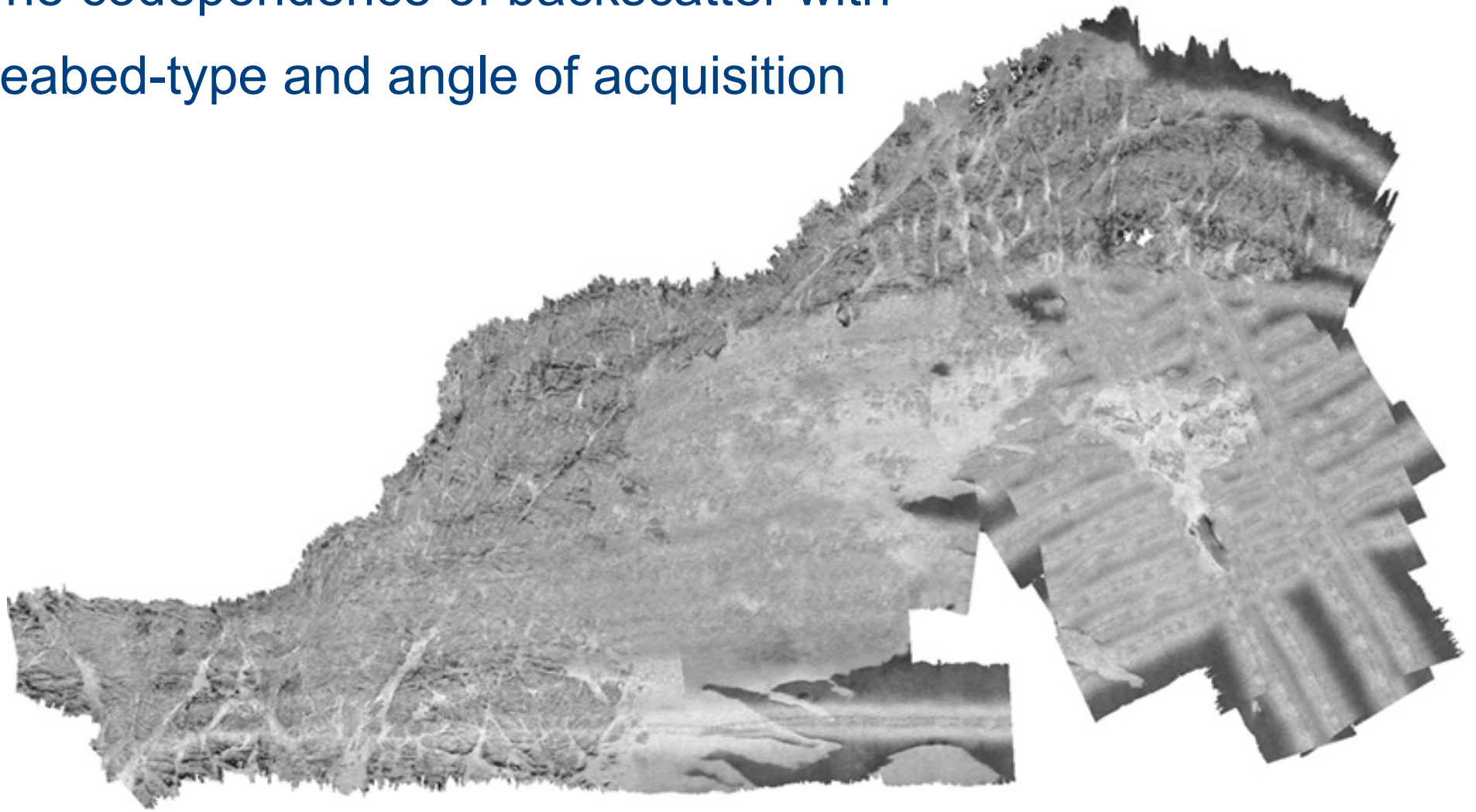
Introduction: Geocoder

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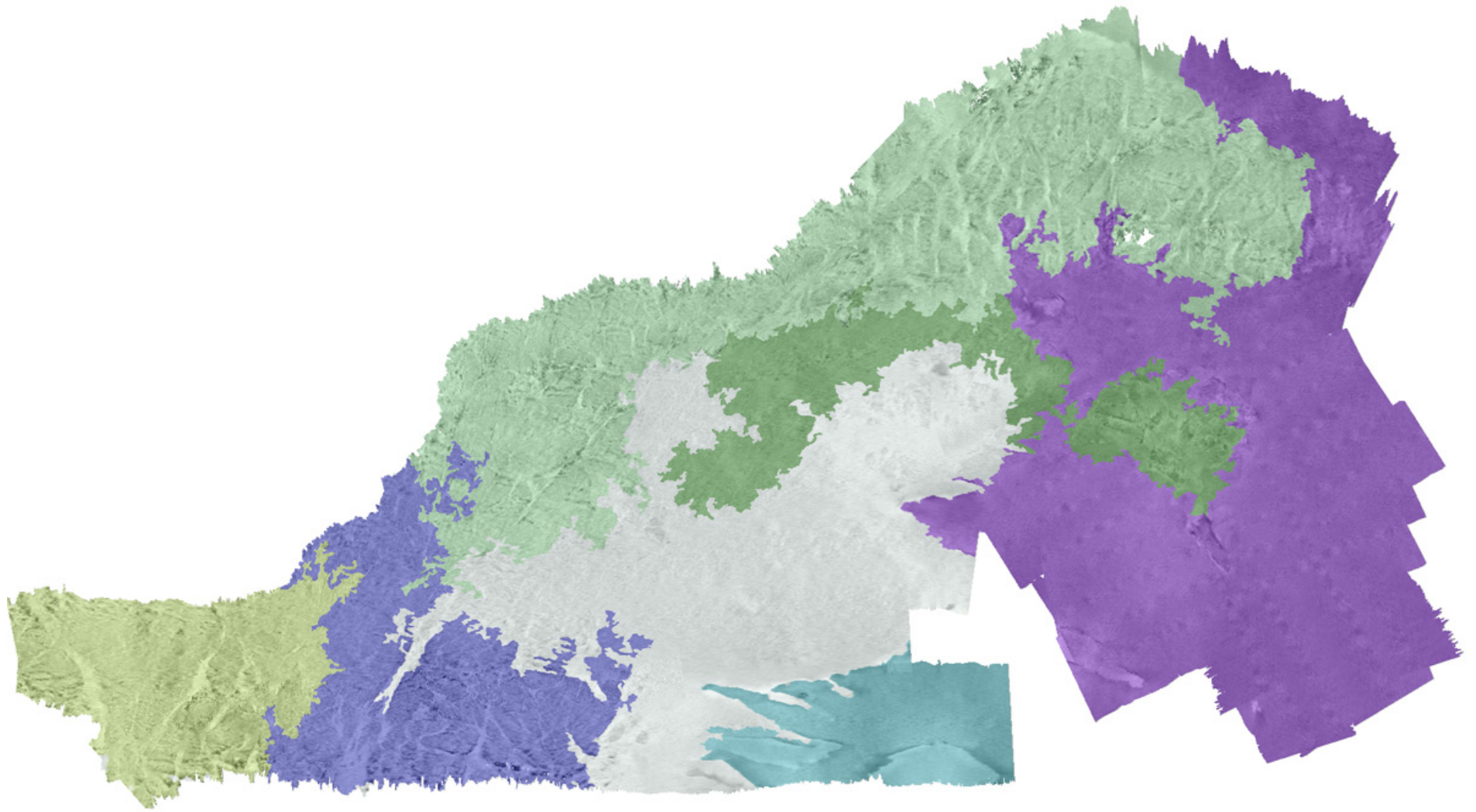


Introduction: main issue

The codependence of backscatter with seabed-type and angle of acquisition



Solution #1: Image-based methodologies



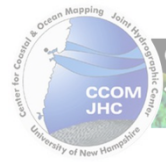
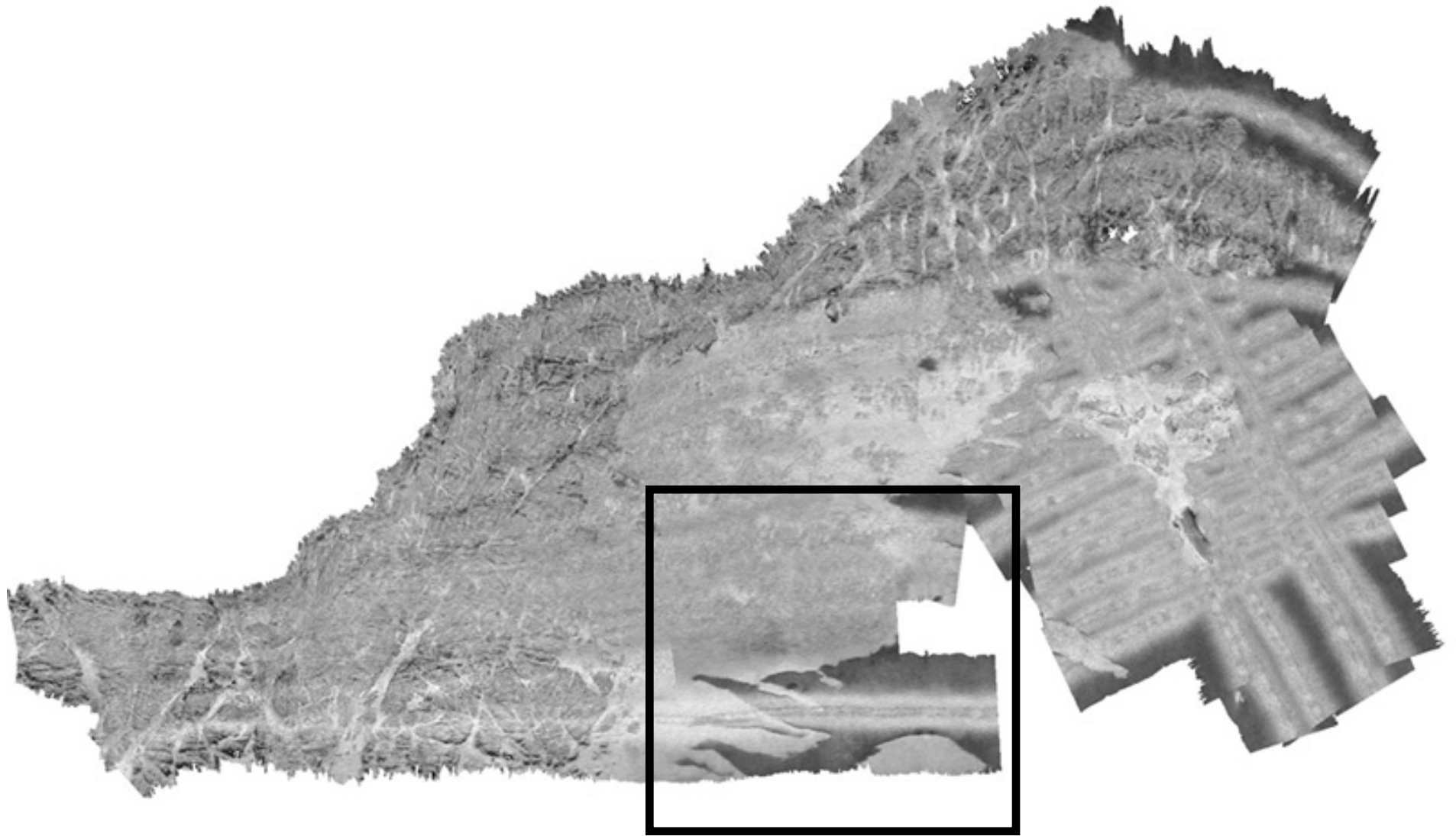
Solution #1: Image-based methodologies

Mosaic segmentation possibilities:

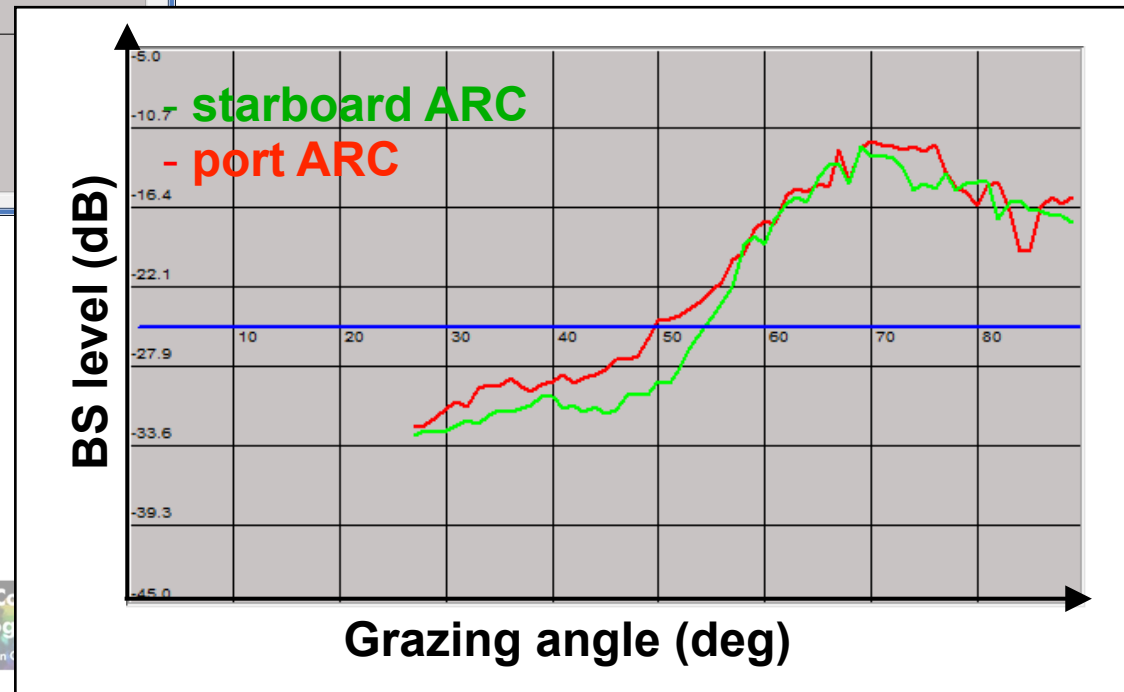
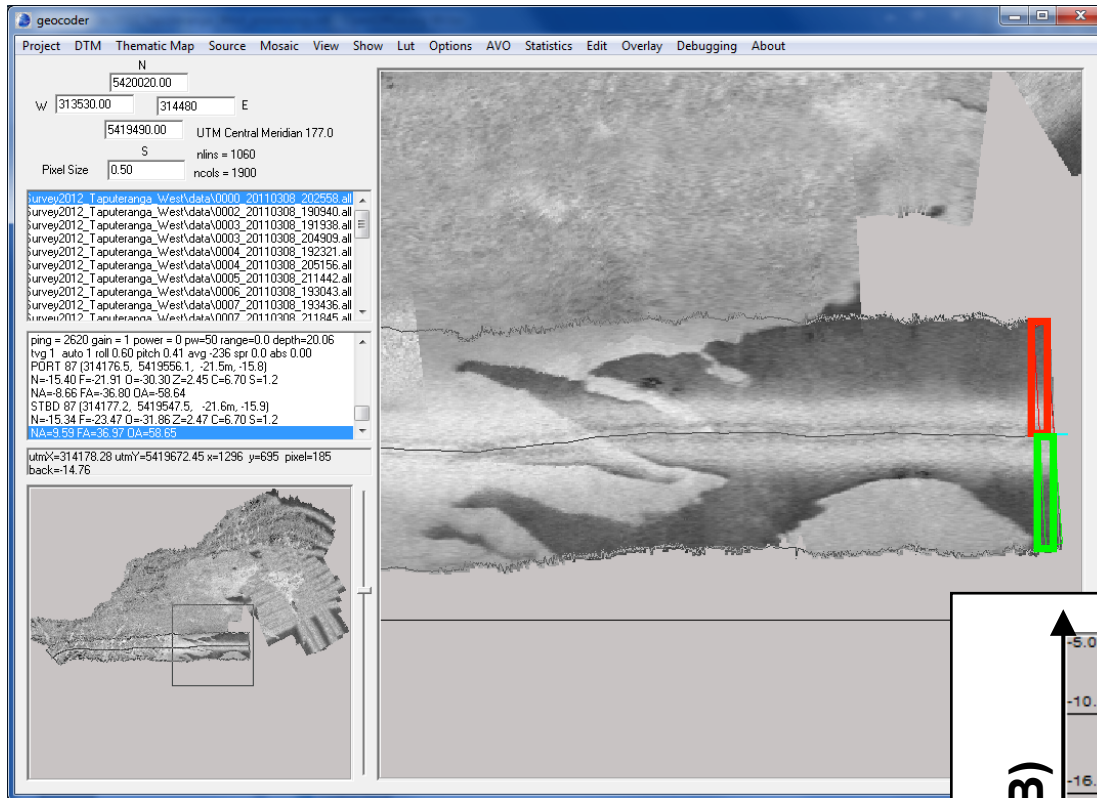
- Manual or Automatic
- Variables:
 - Pixel amplitude
 - Statistics within neighborhood of pixels
 - Textures
 - Power spectra features
 - ...
- Algorithms:
 - k-means clustering
 - Decision trees
 - Neural networks



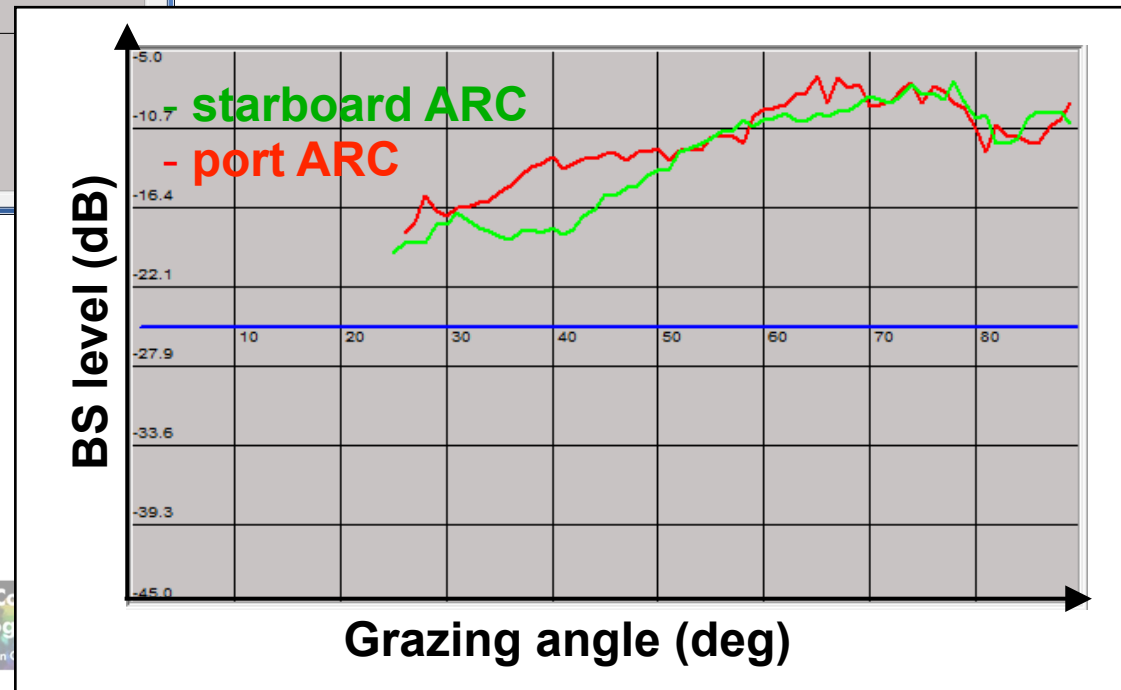
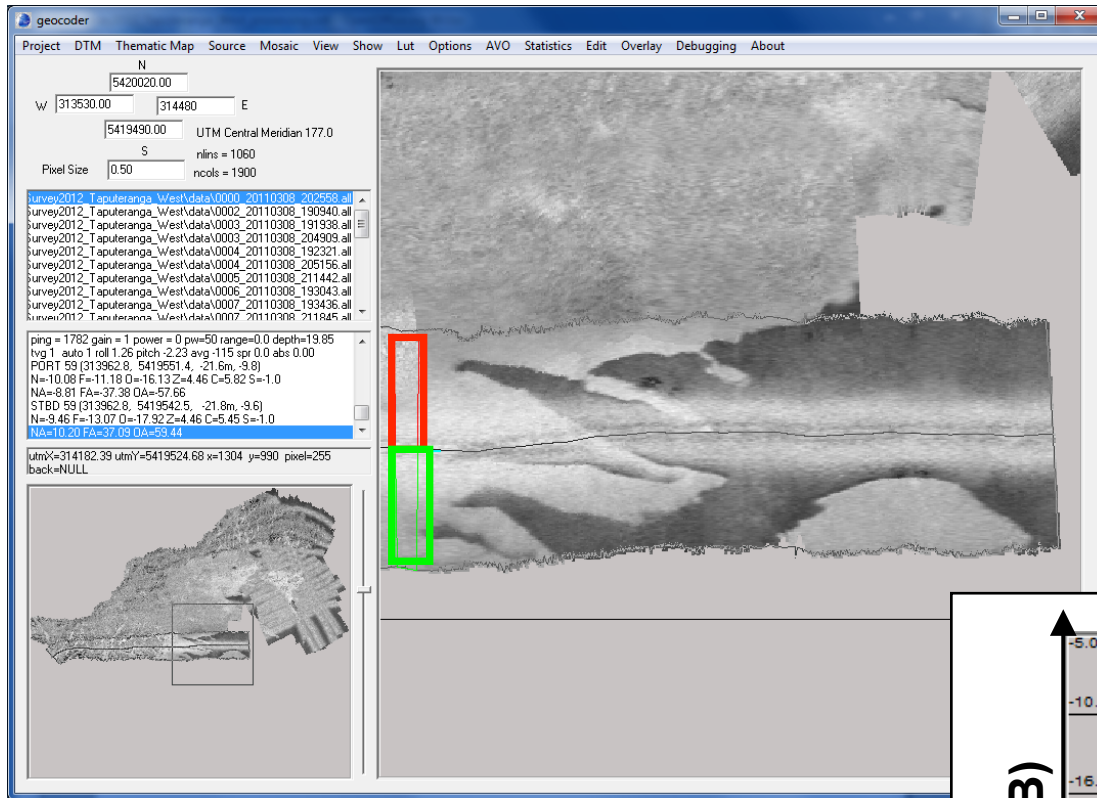
Solution #2: Angular-Response-based methodologies



Solution #2: Angular-Response-based methodologies



Solution #2: Angular-Response-based methodologies



Solution #2: Angular-Response-based methodologies

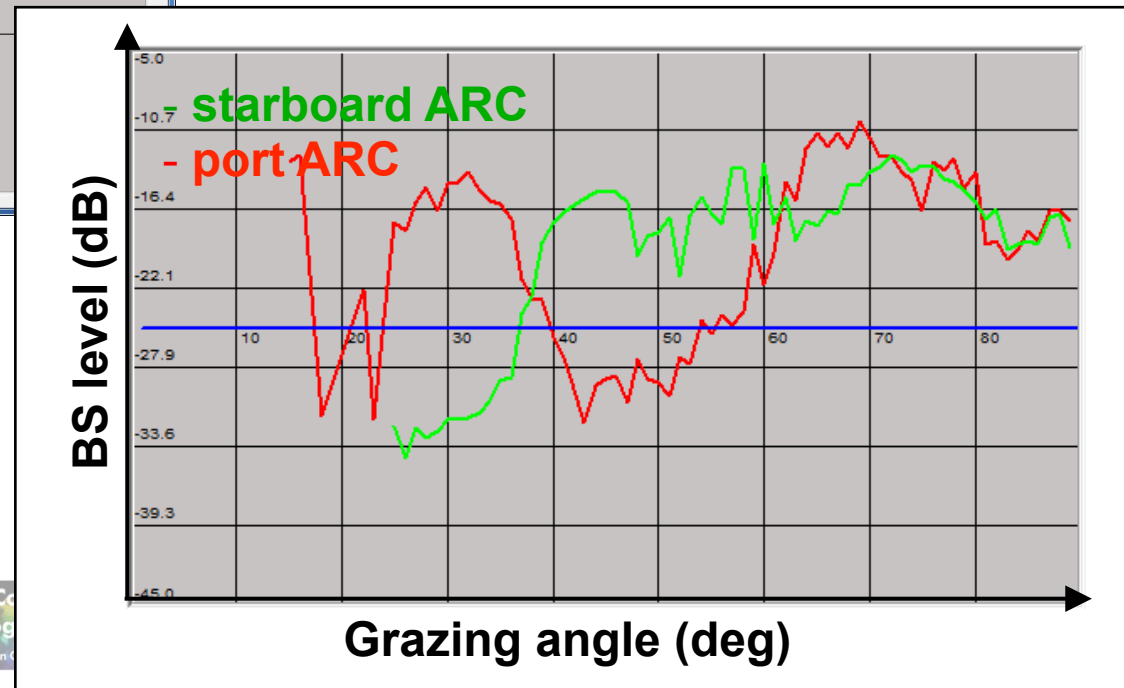
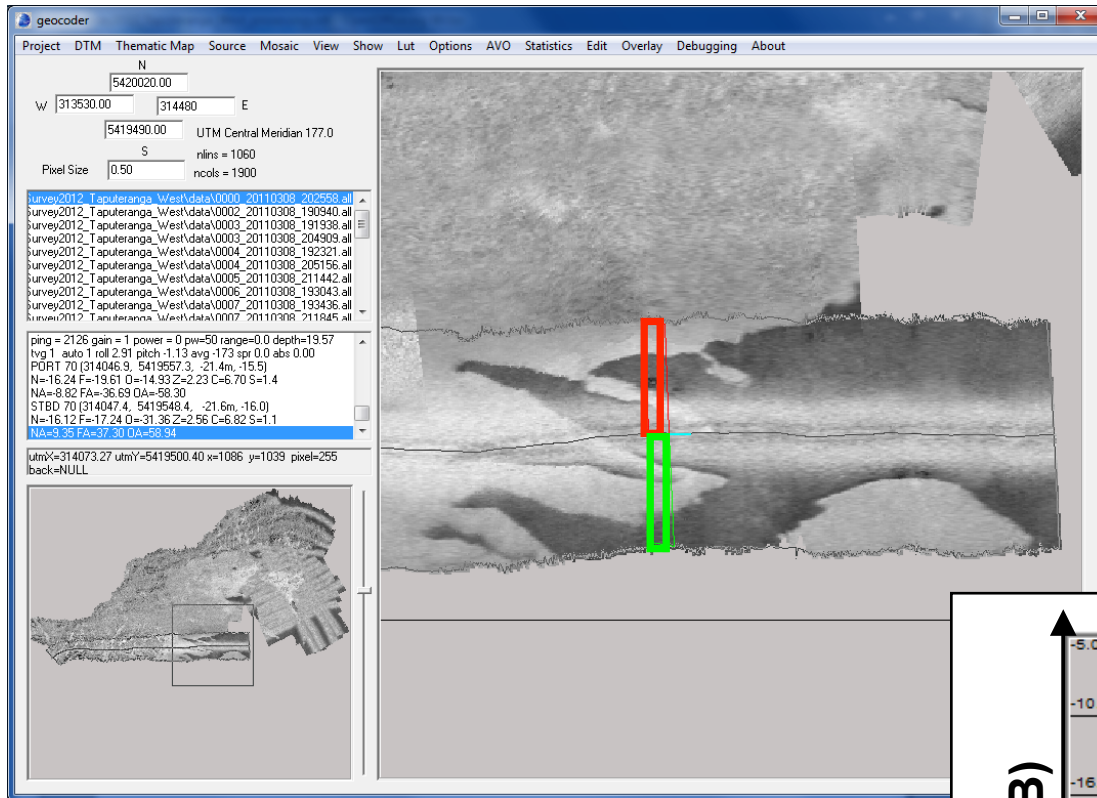


Image-based vs AR-based methodologies

Image-based approach:

To empirically **compensate for angular variation**, so that remaining variations are approximately only due to **change in seabed-type**.

+ **Full use of data spatial information**

- **Discard angular information**

AR-based approach:

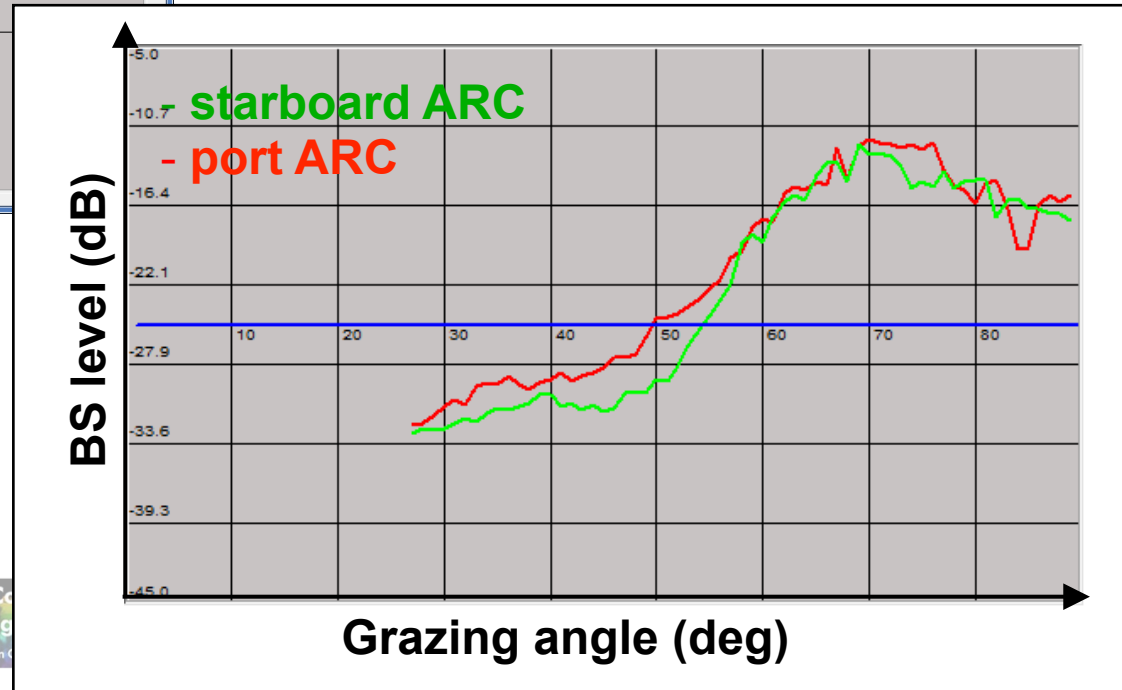
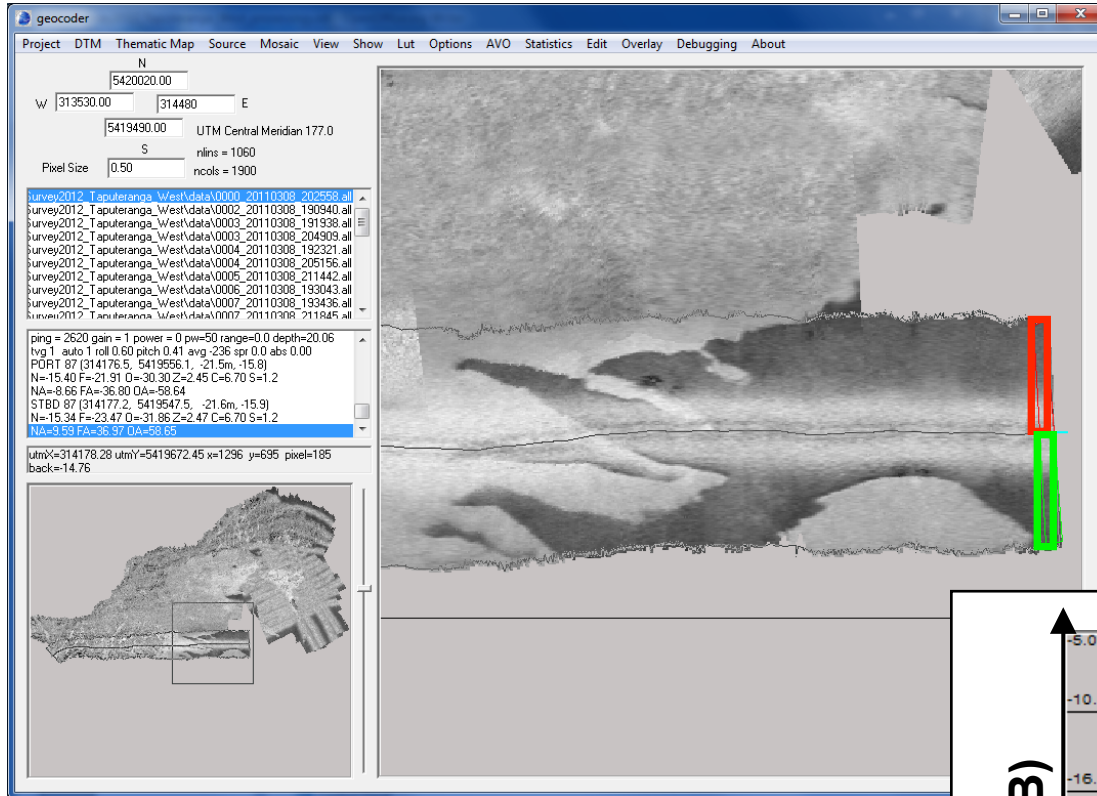
To attempt avoiding **variation in seabed-type**, so that remaining variations are approximately only due to **change with angle**.

+ **Full use of data angular information**

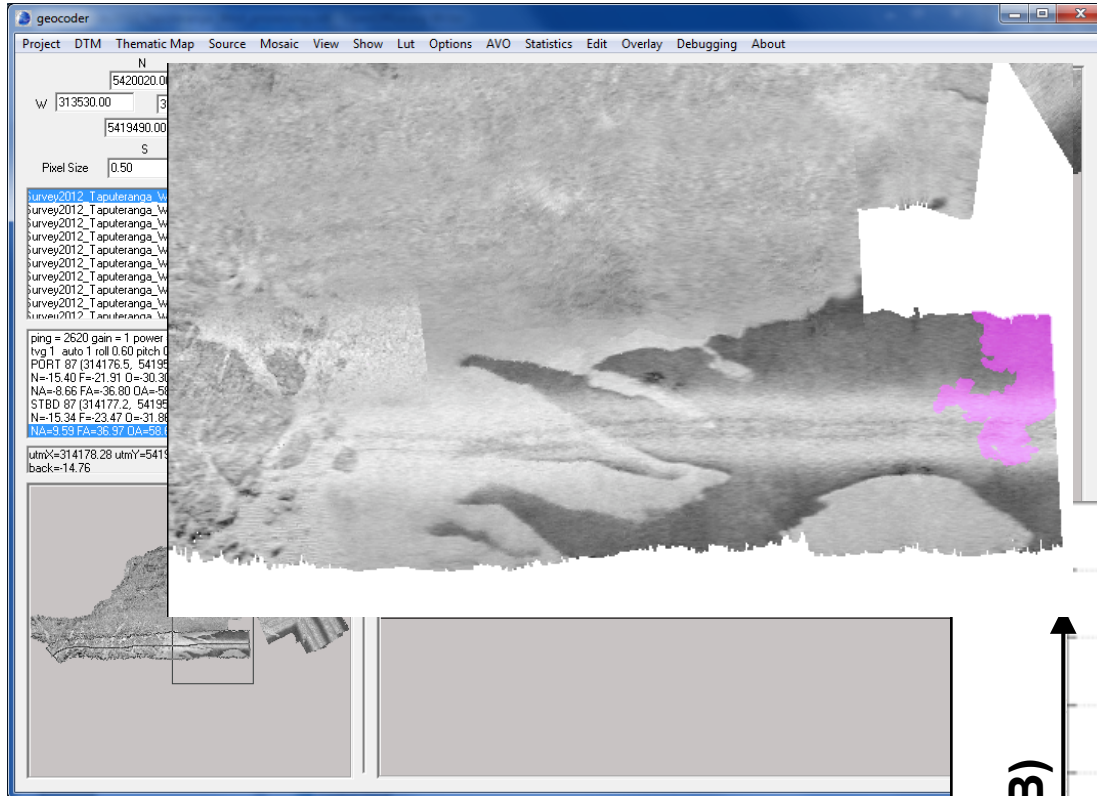
- **Discard data spatial information**



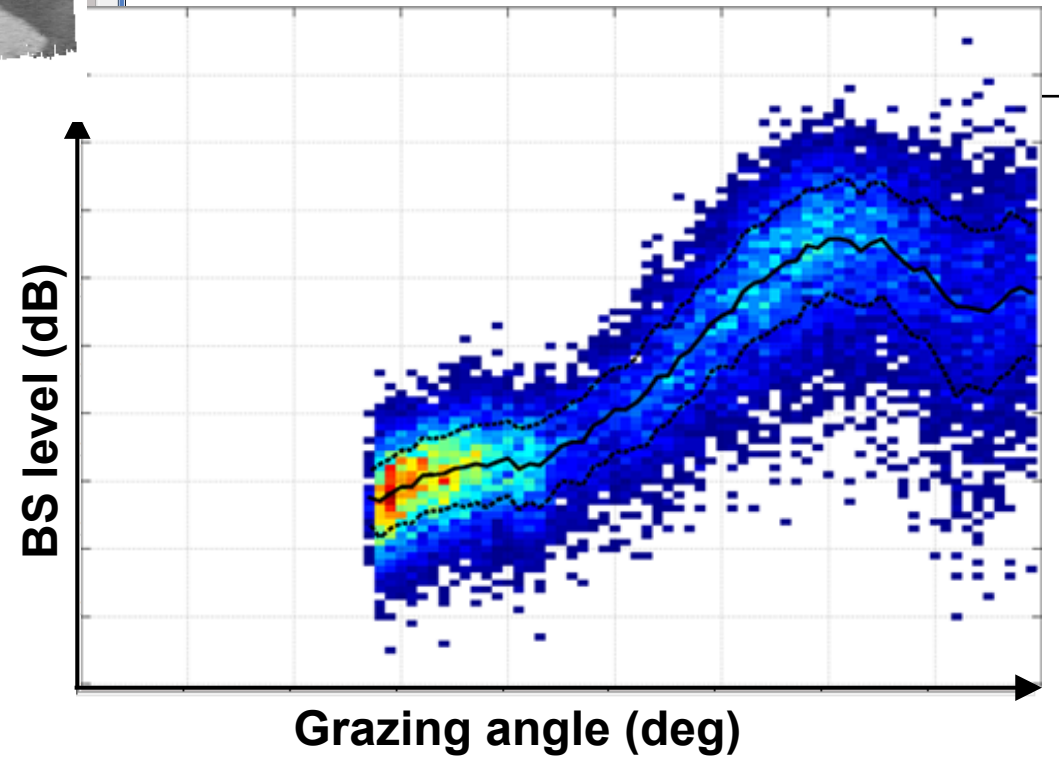
Geocoder improvements:



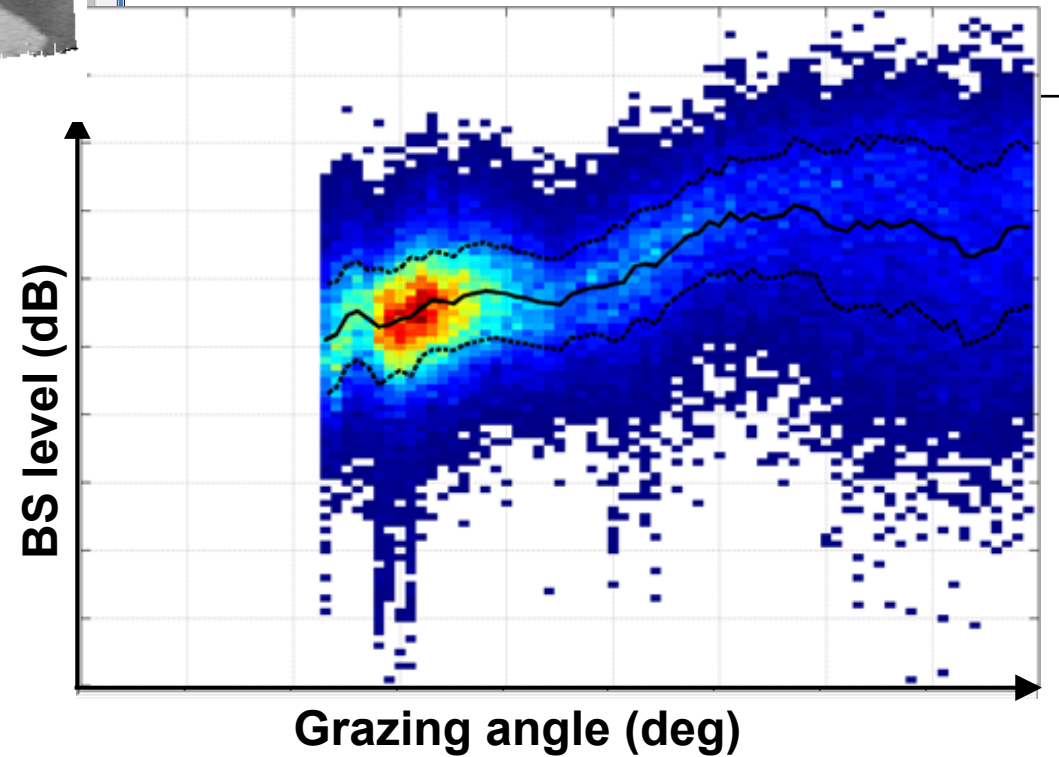
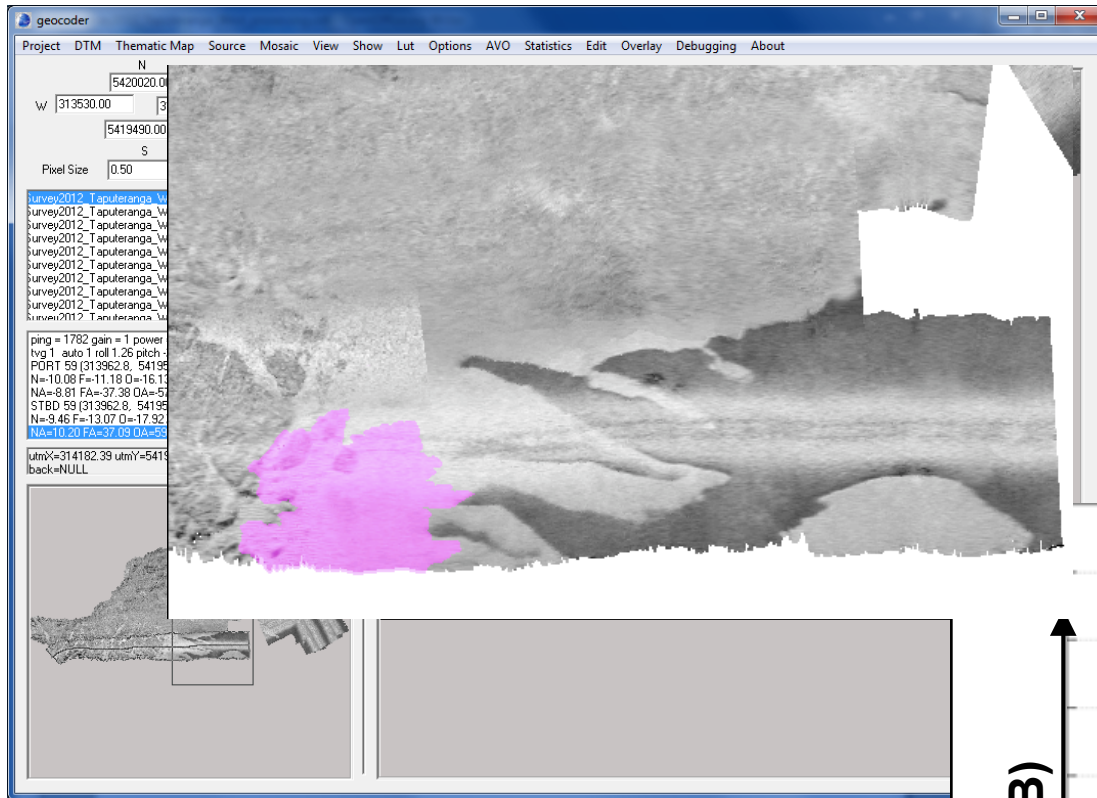
Geocoder improvements:



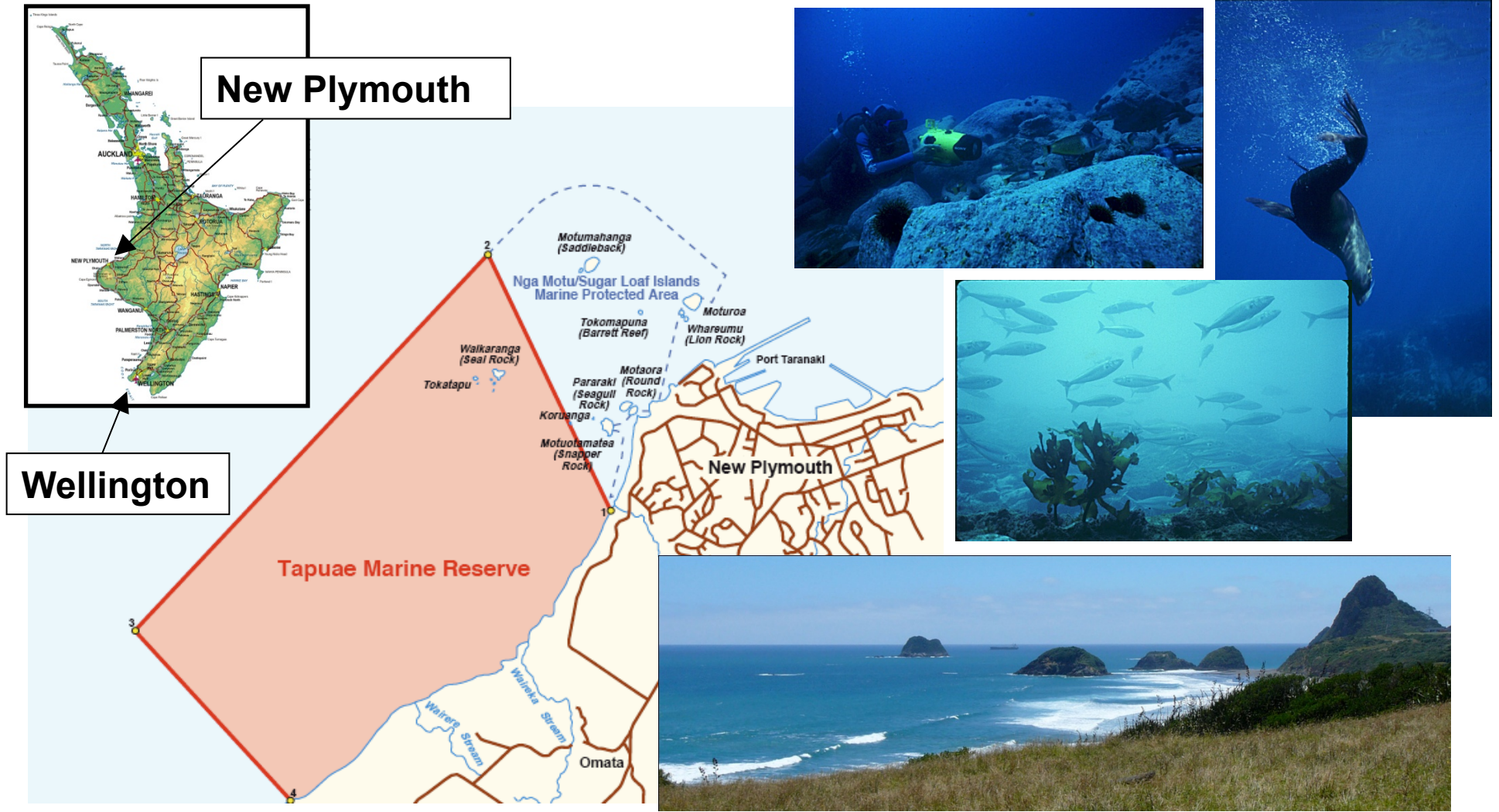
- Themes
- 2D histograms



Geocoder improvements:

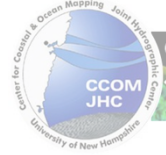
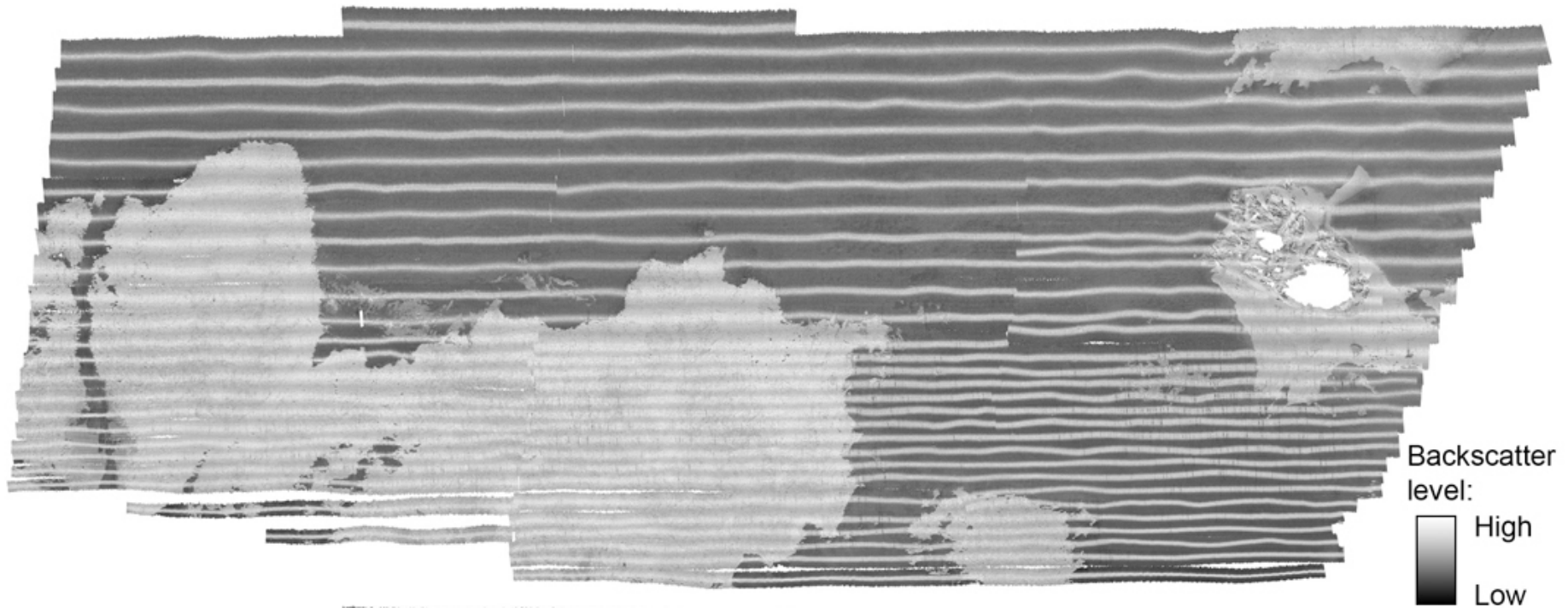


A possible combined approach



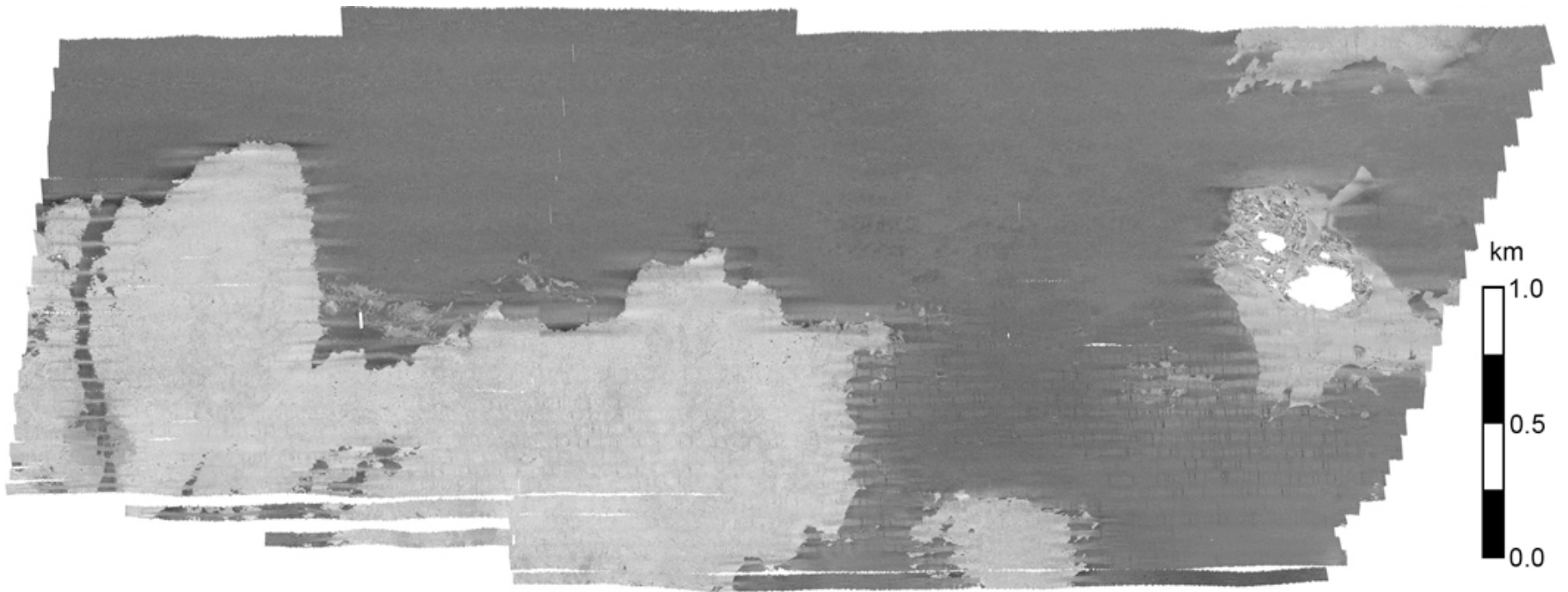
A possible combined approach

Raw backscatter data

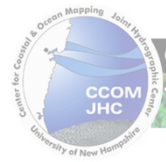


A possible combined approach

Mosaic (AVG flat, 300 pings)



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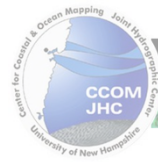
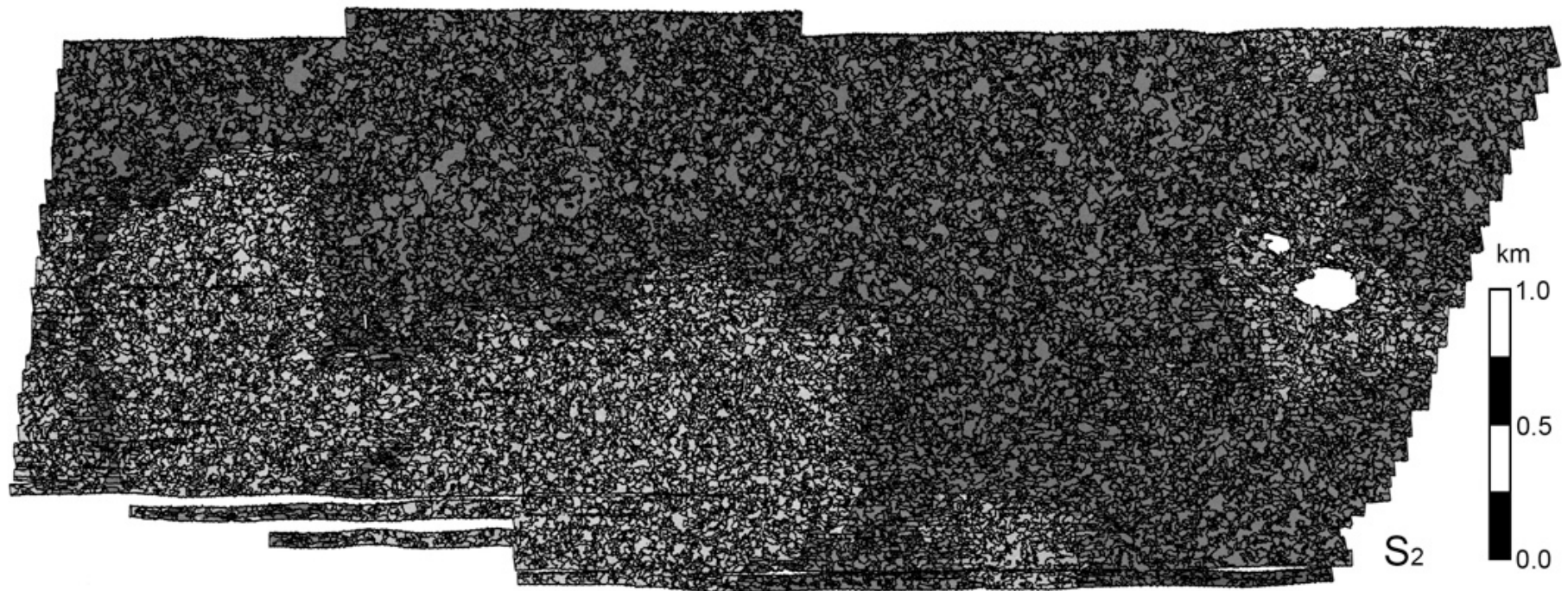
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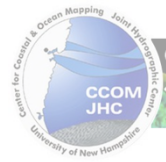
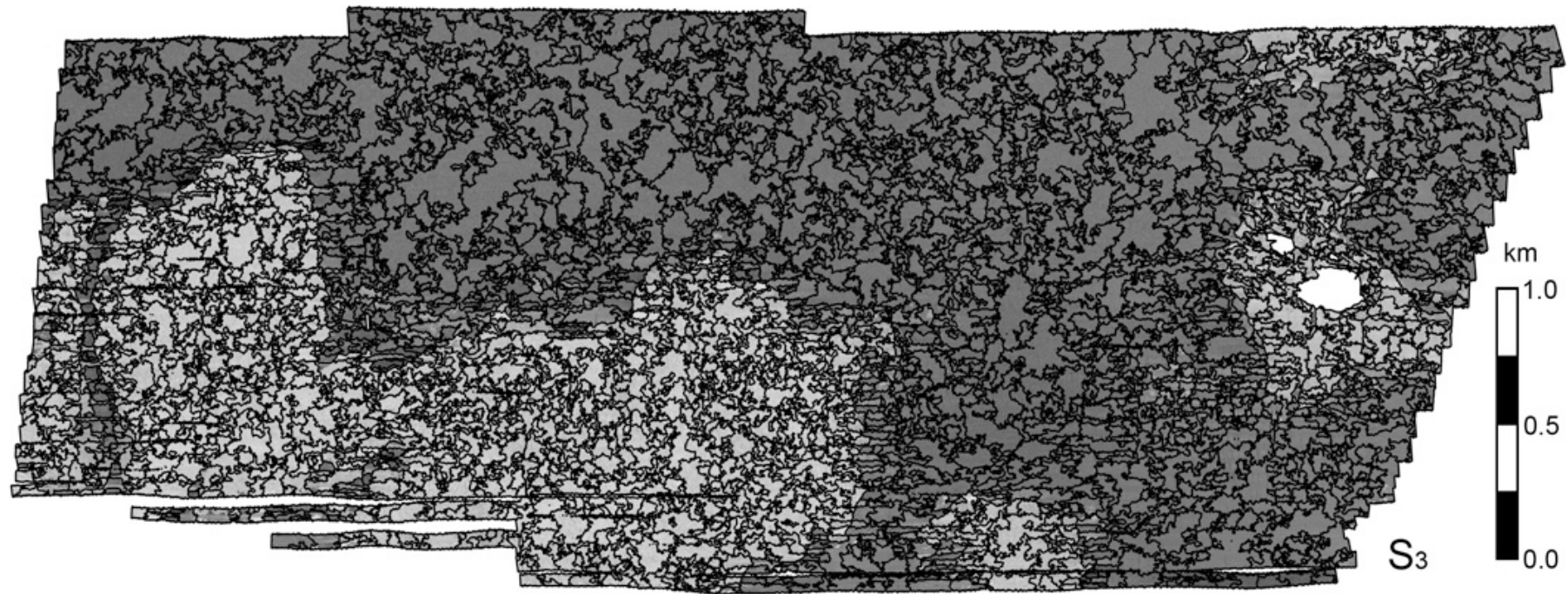
A possible combined approach

Mosaic segmentation through aggregation (level 2)



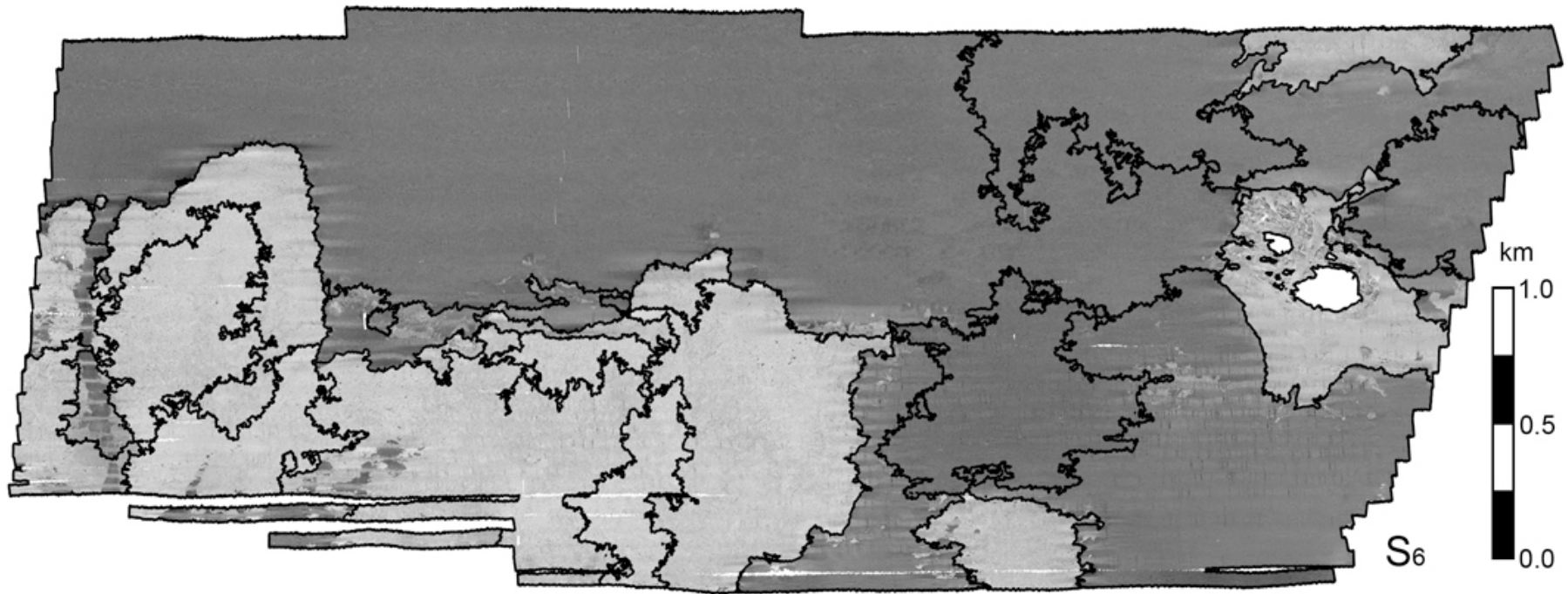
A possible combined approach

Mosaic segmentation through aggregation (level 3)



A possible combined approach

Mosaic segmentation through aggregation (level 6)



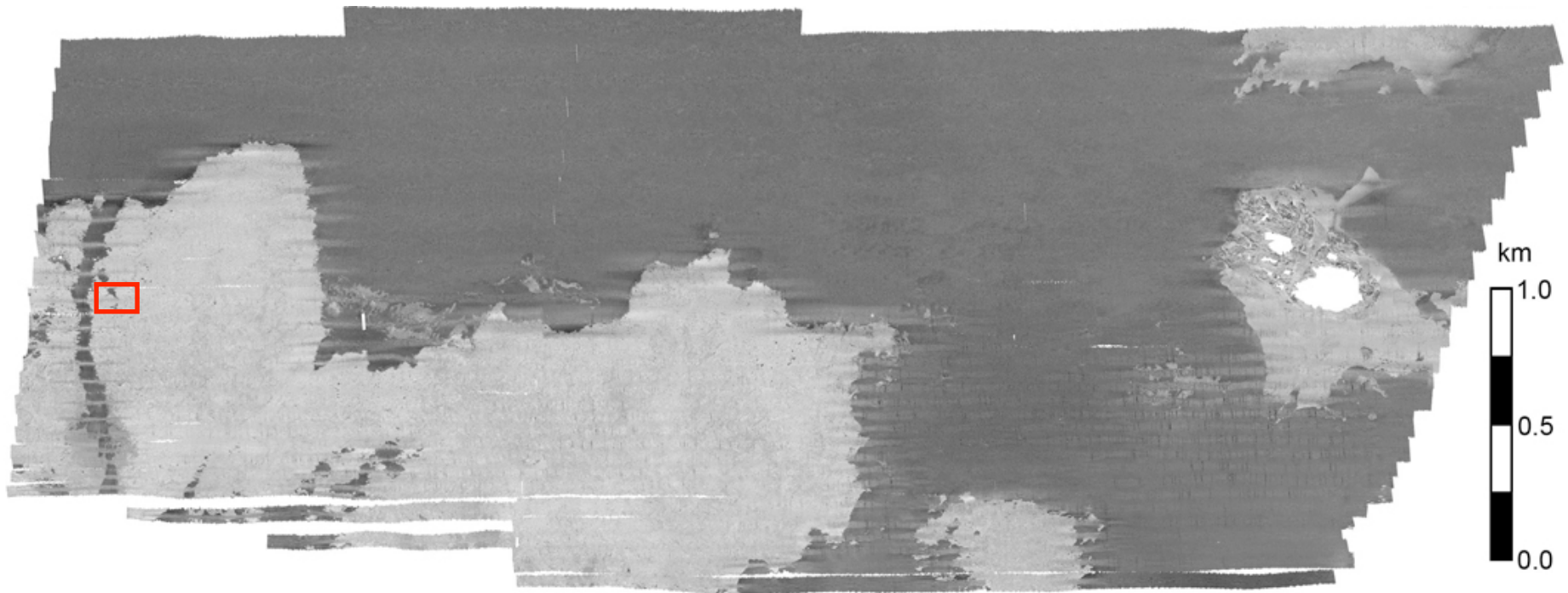
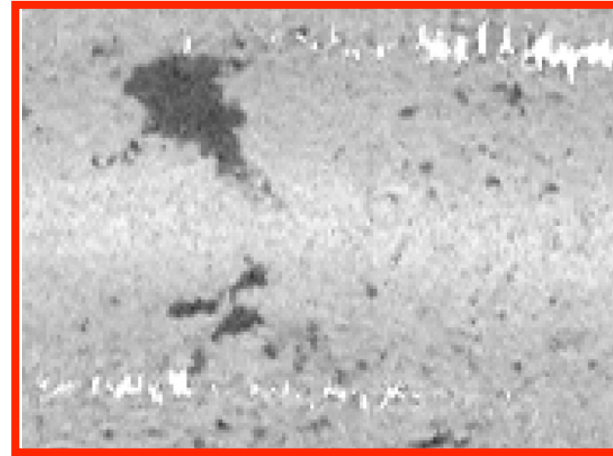
A possible combined approach

Mosaic segmentation through aggregation (level 7)



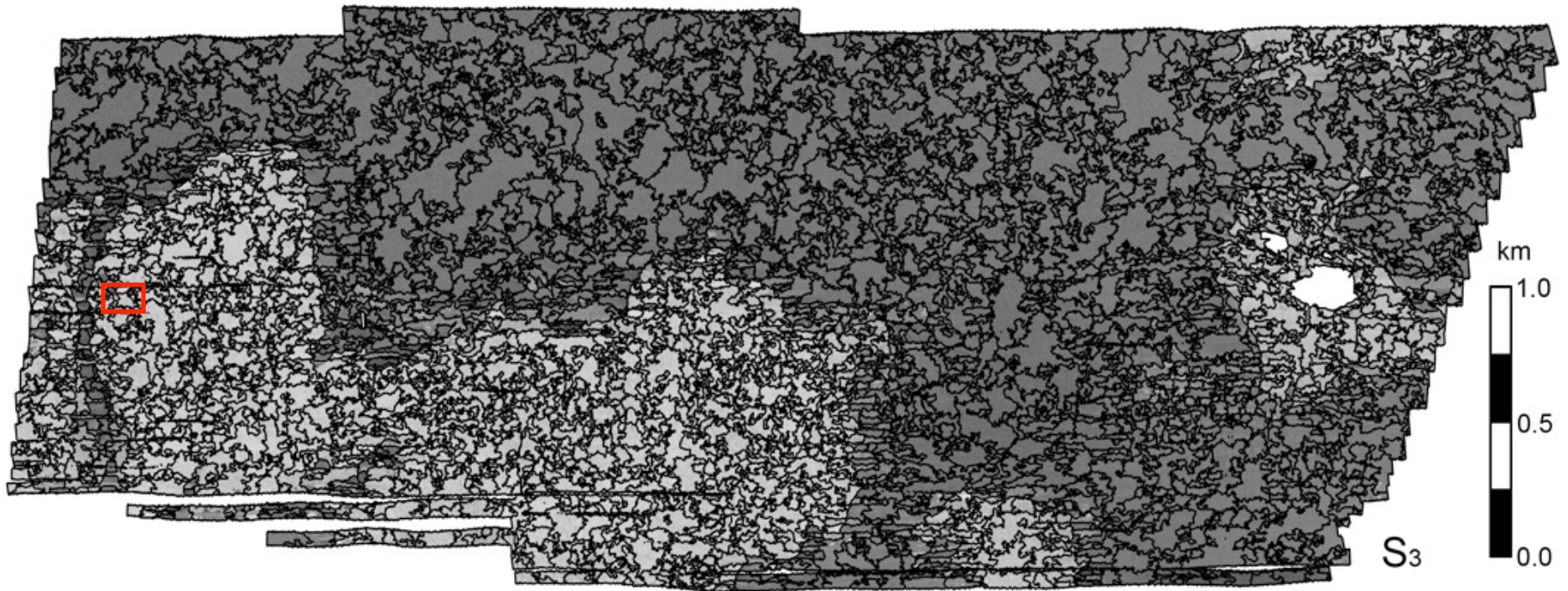
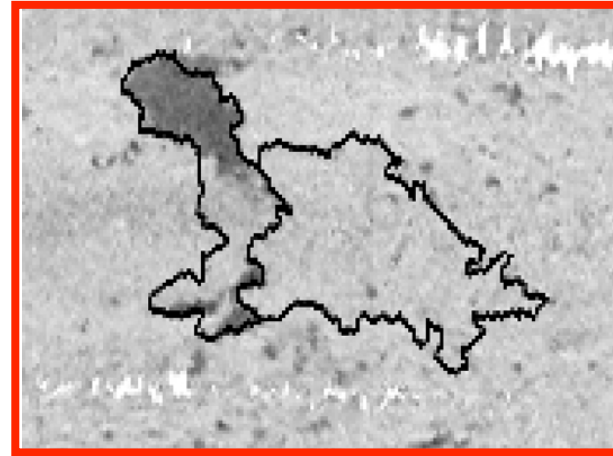
A possible combined approach

Estimating the **homogeneity**
of a given segment



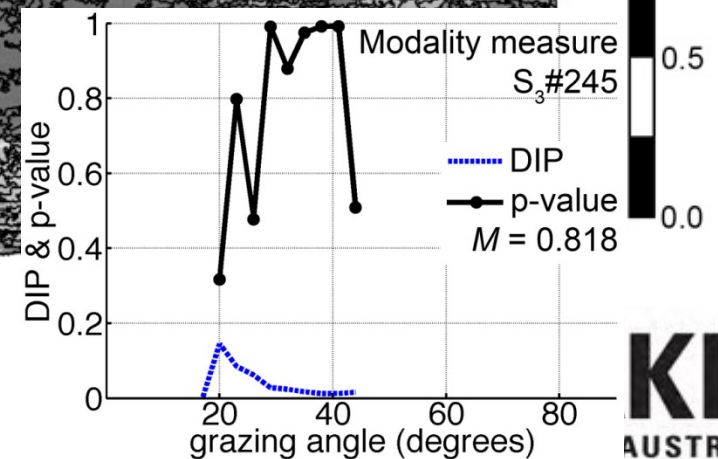
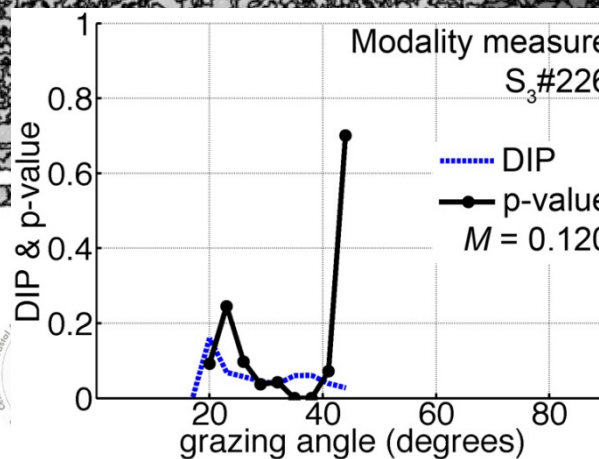
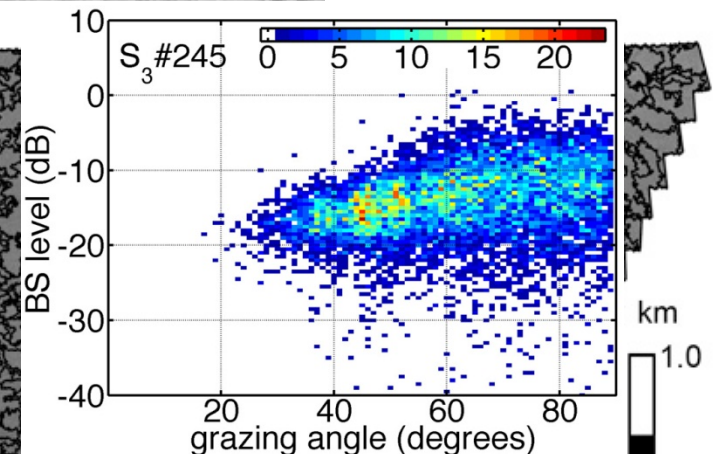
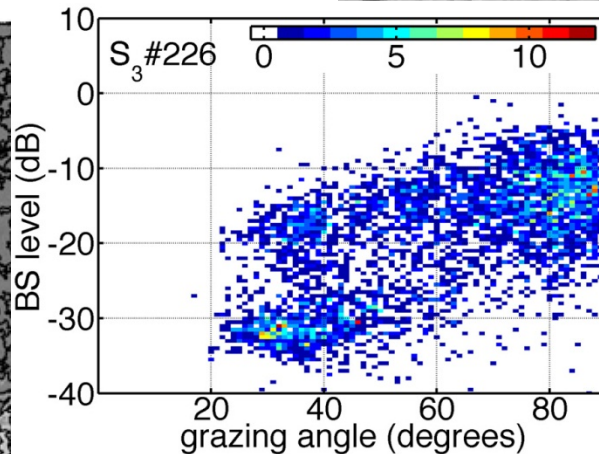
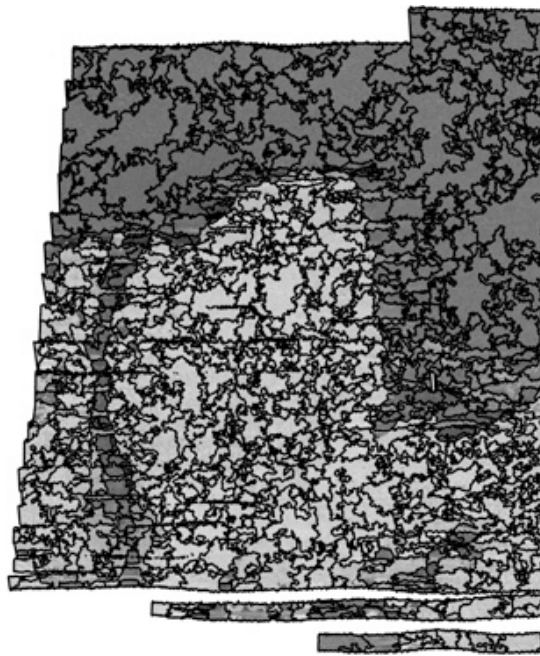
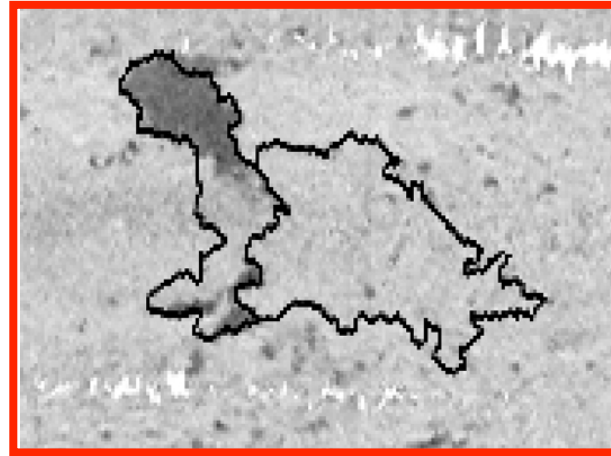
A possible combined approach

Estimating the **homogeneity** of a given segment



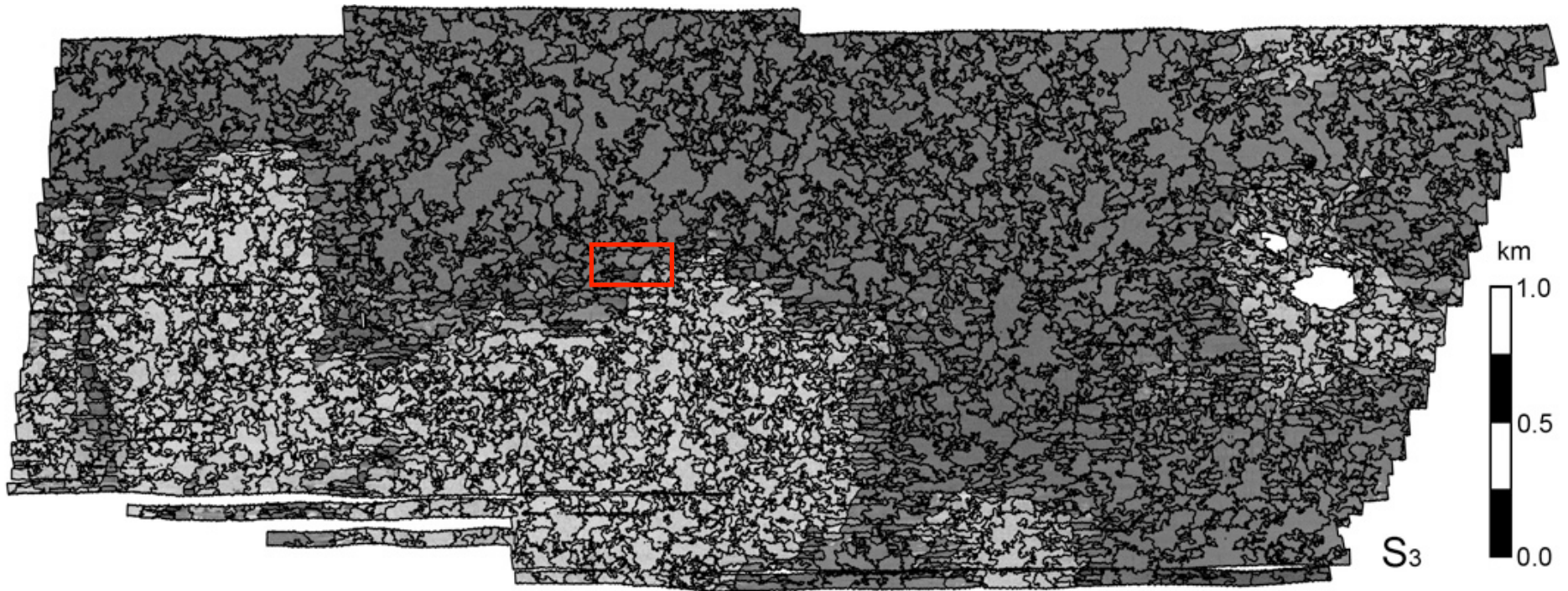
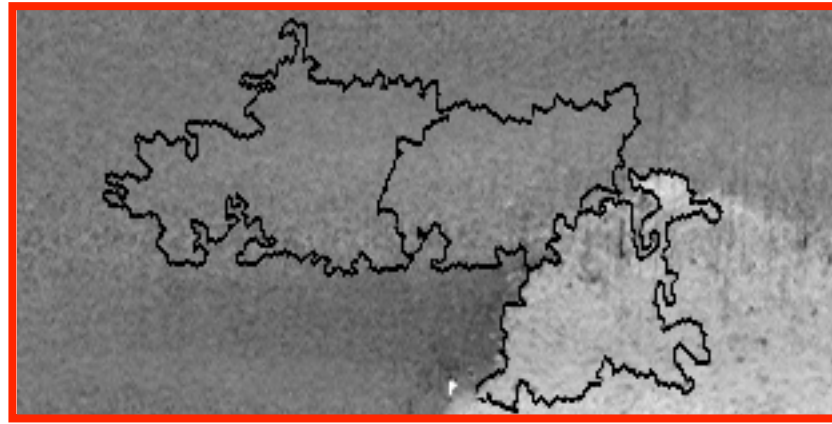
A possible combined approach

Estimating the **homogeneity** of a given segment



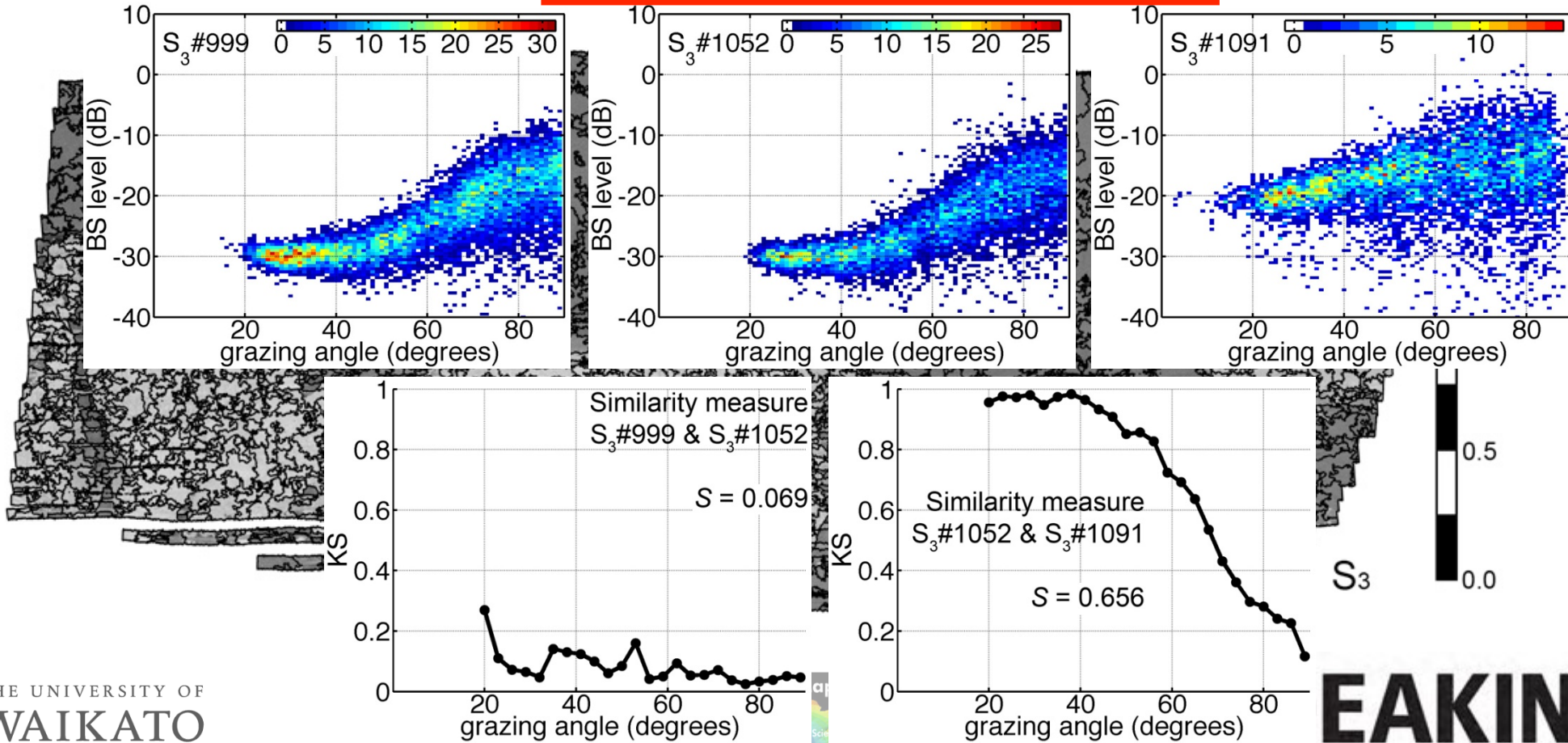
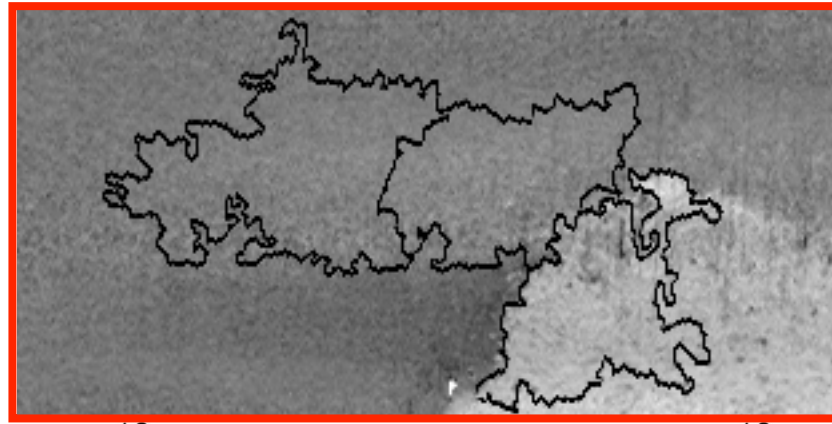
A possible combined approach

Estimating the **similarity** between two segments



A possible combined approach

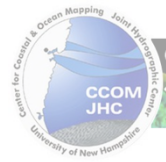
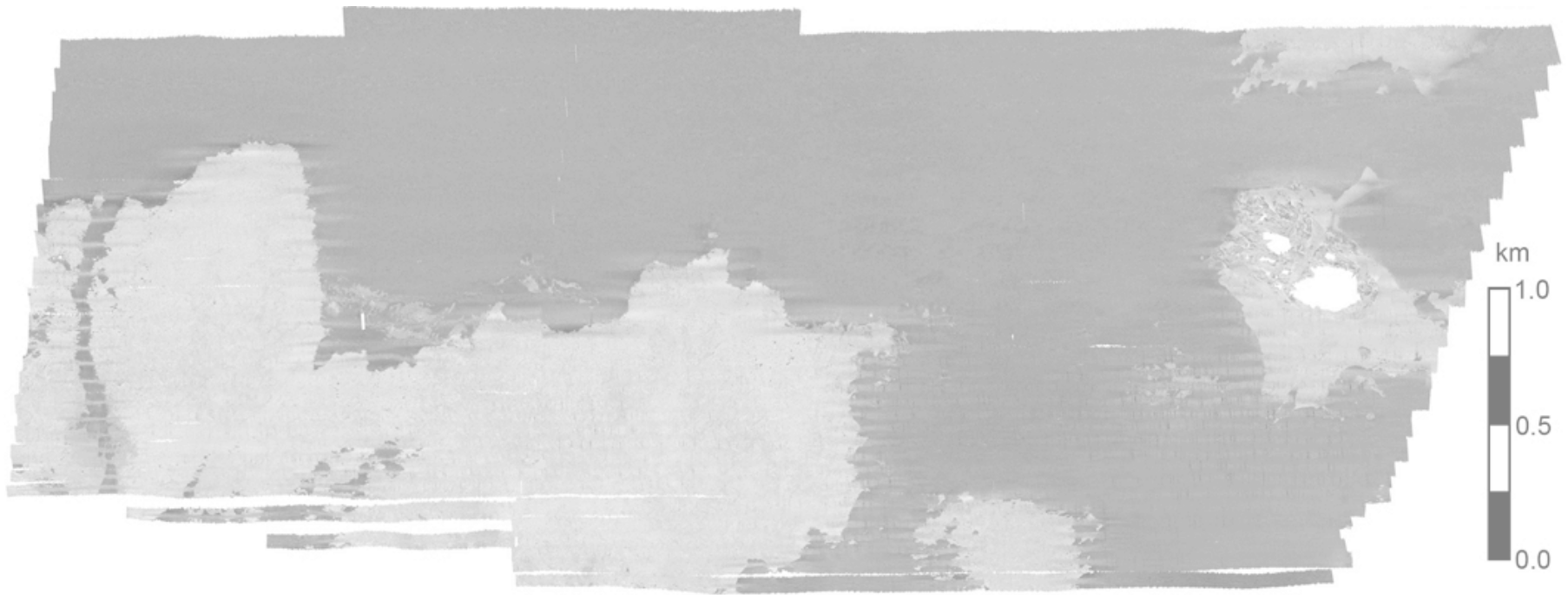
Estimating the **similarity** between two segments



A possible combined approach

Procedure:

Mosaic



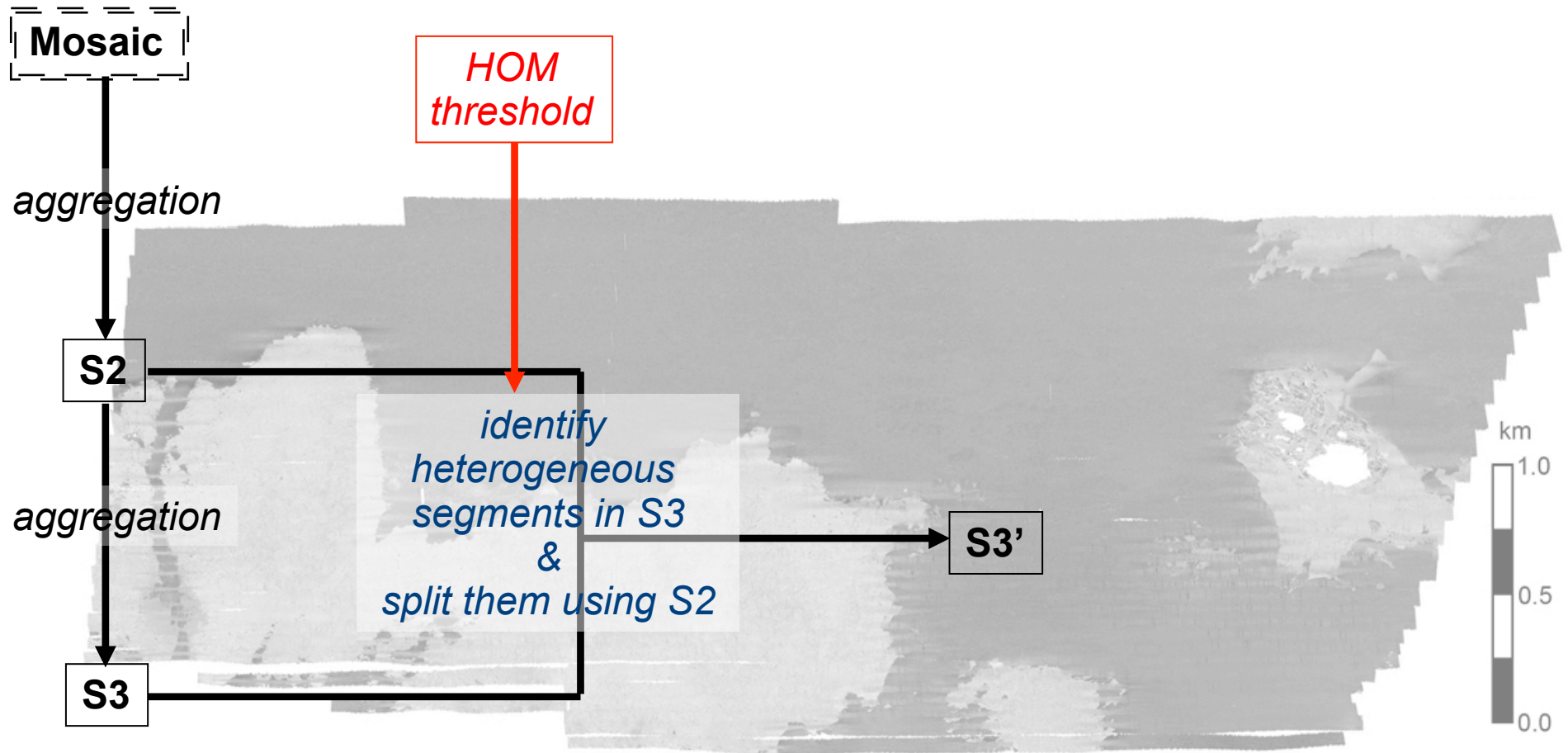
A possible combined approach

Procedure:



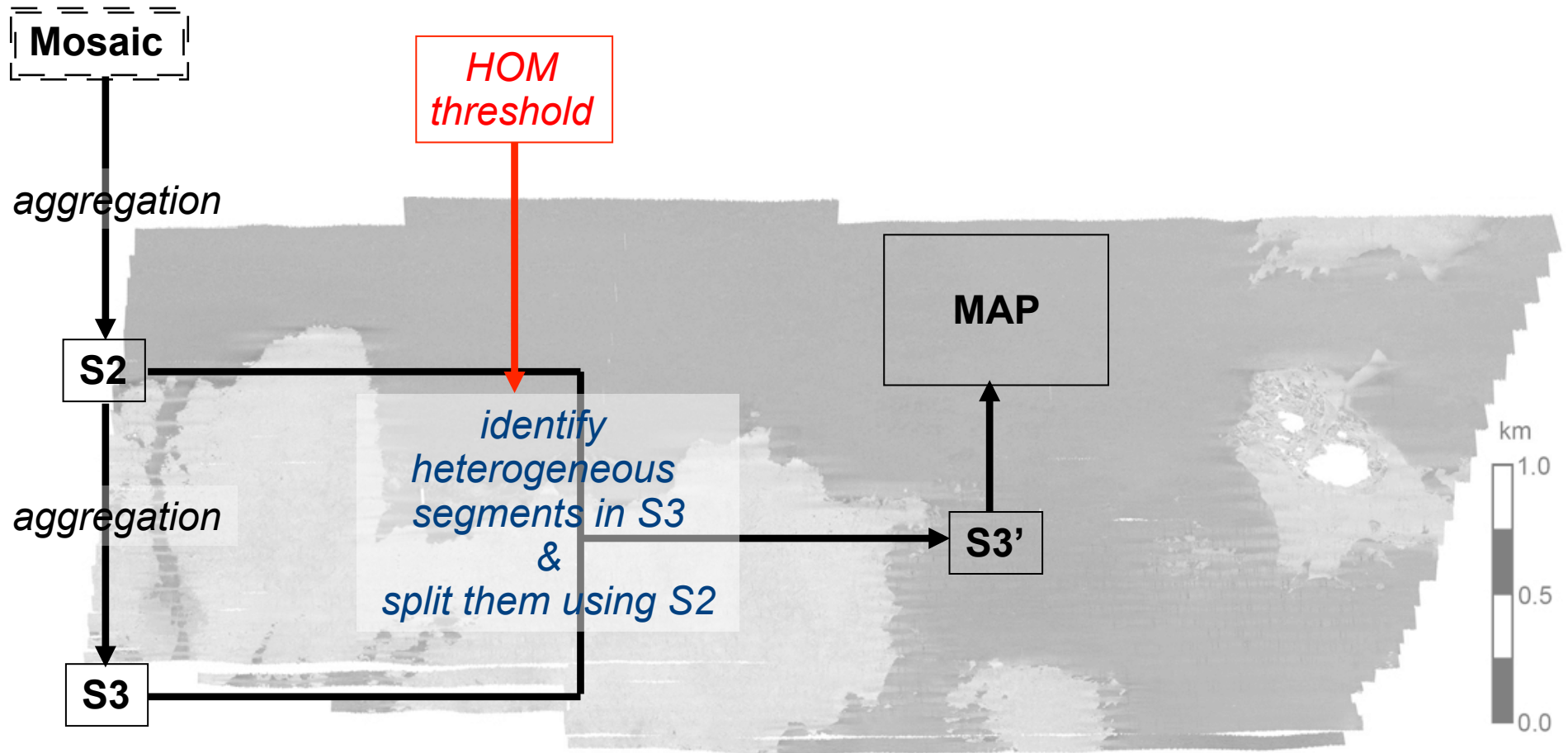
A possible combined approach

Procedure:



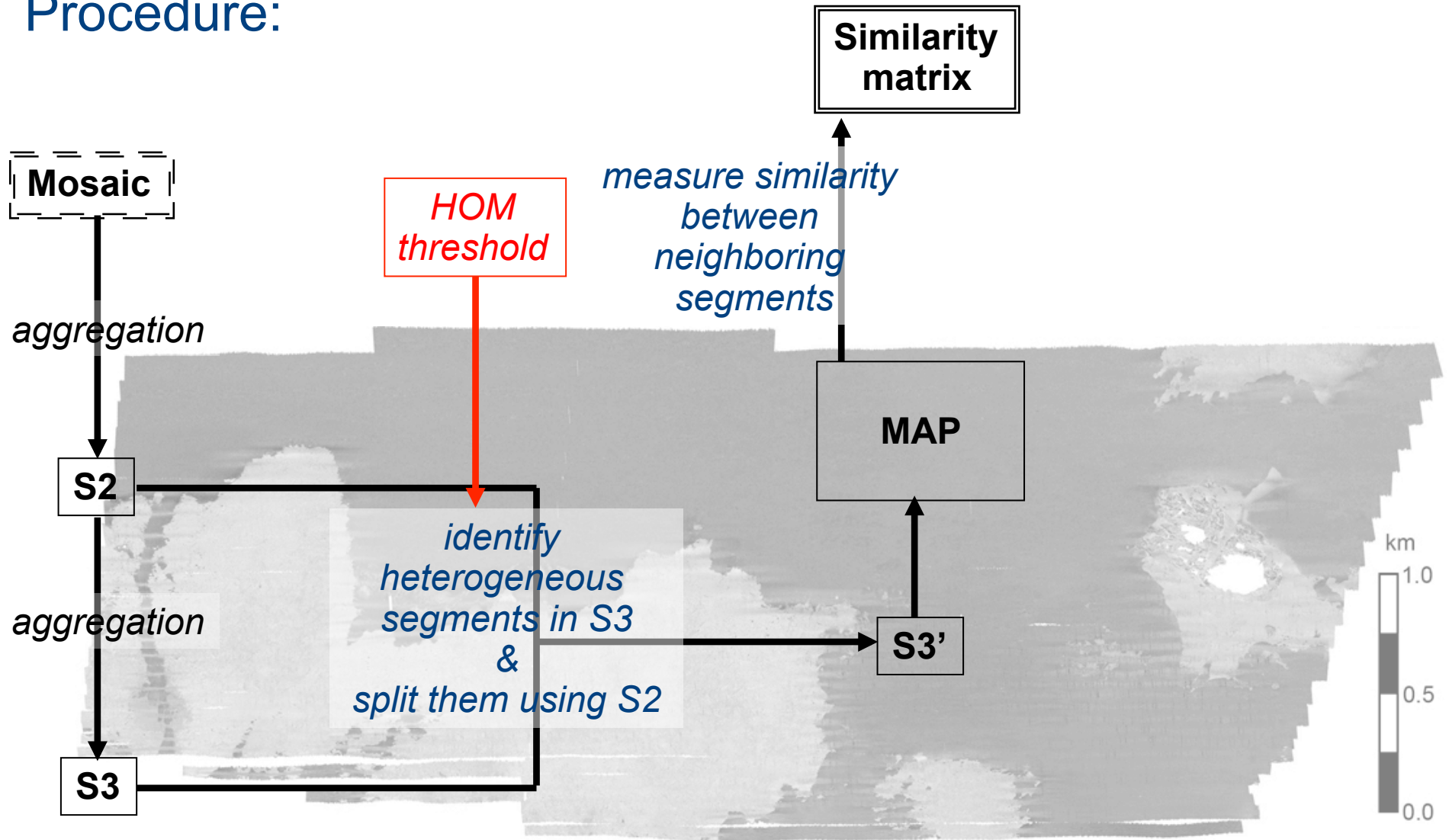
A possible combined approach

Procedure:



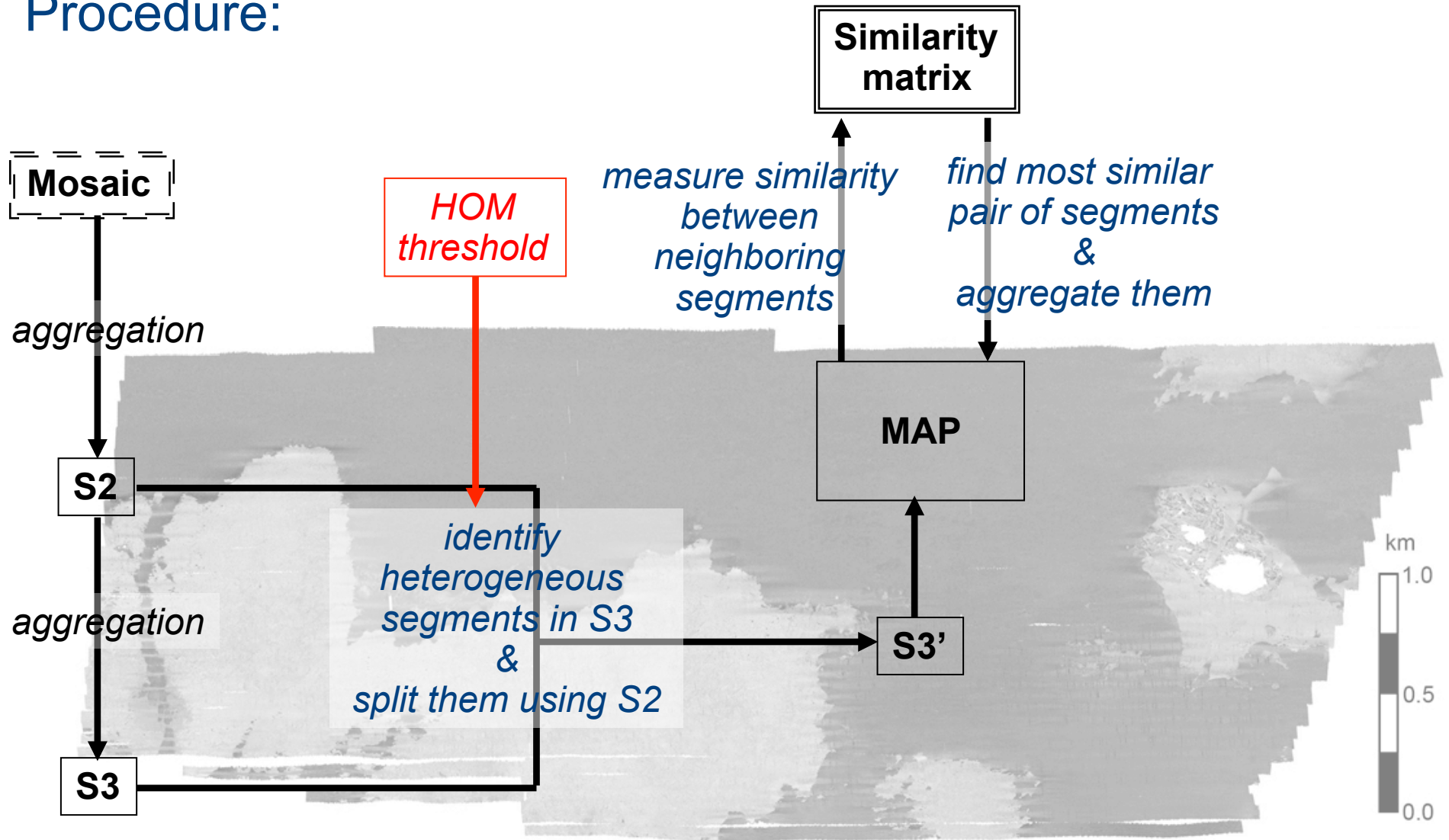
A possible combined approach

Procedure:



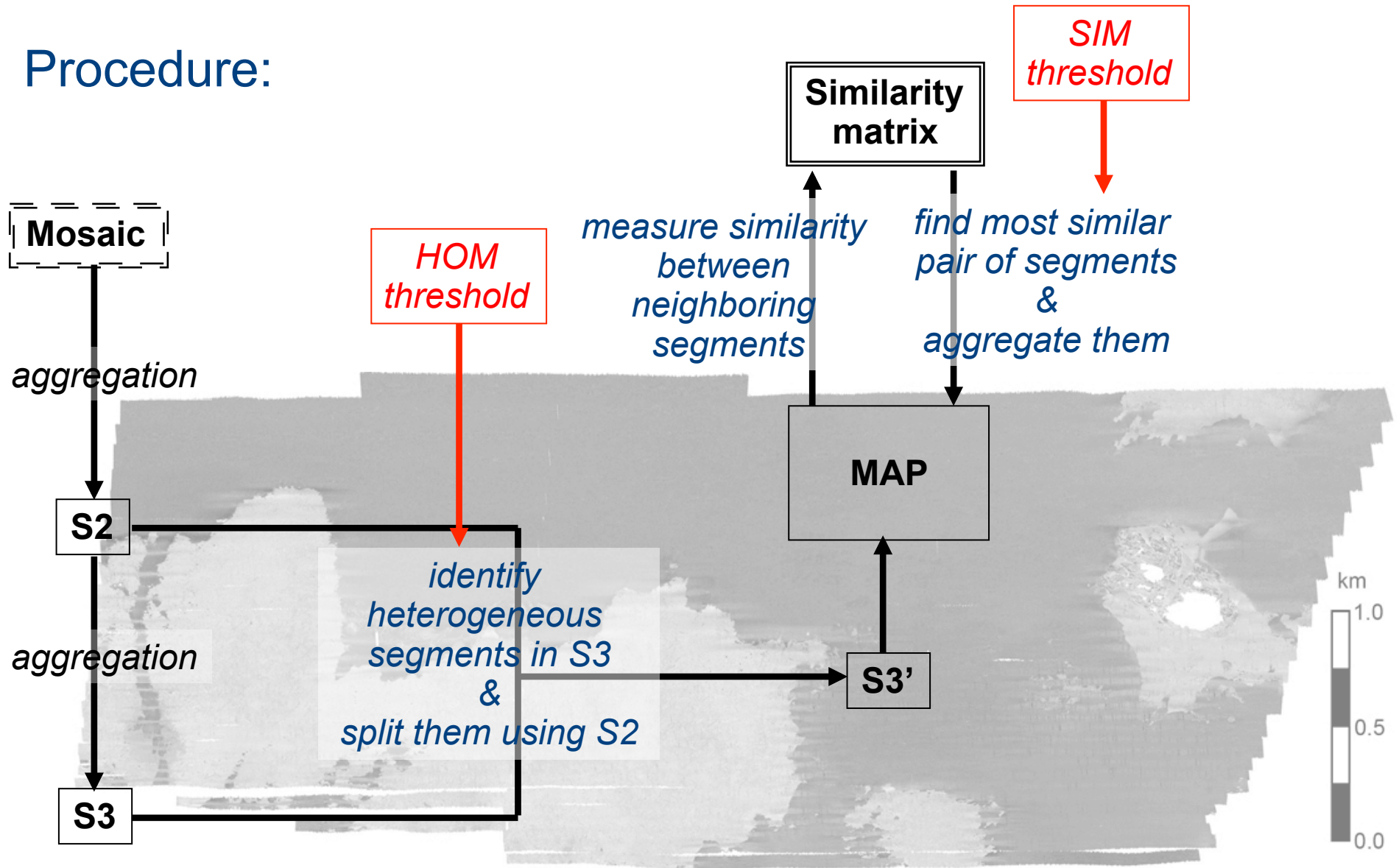
A possible combined approach

Procedure:



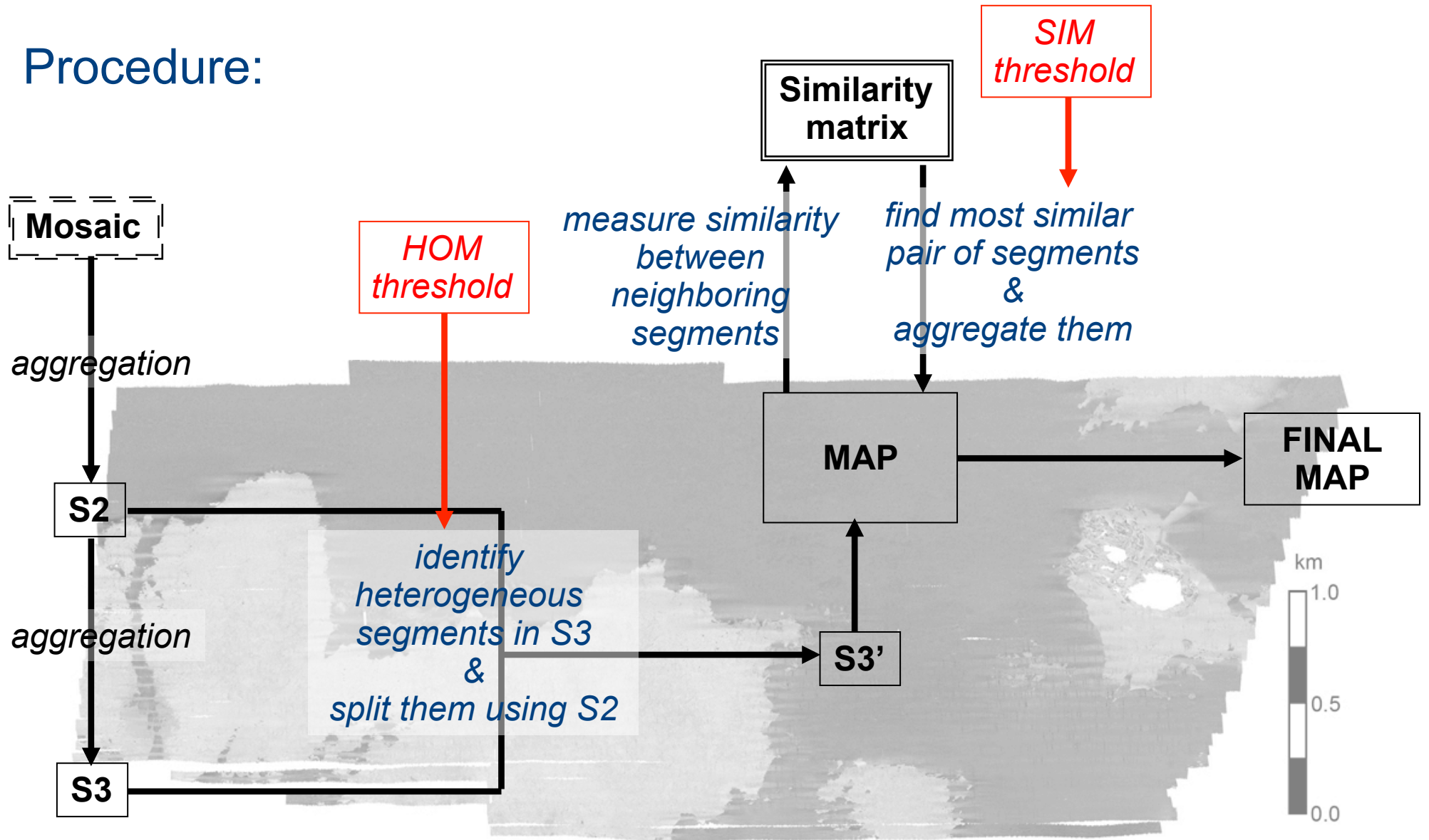
A possible combined approach

Procedure:



A possible combined approach

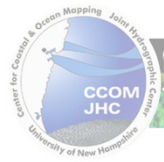
Procedure:



A possible combined approach

Result:

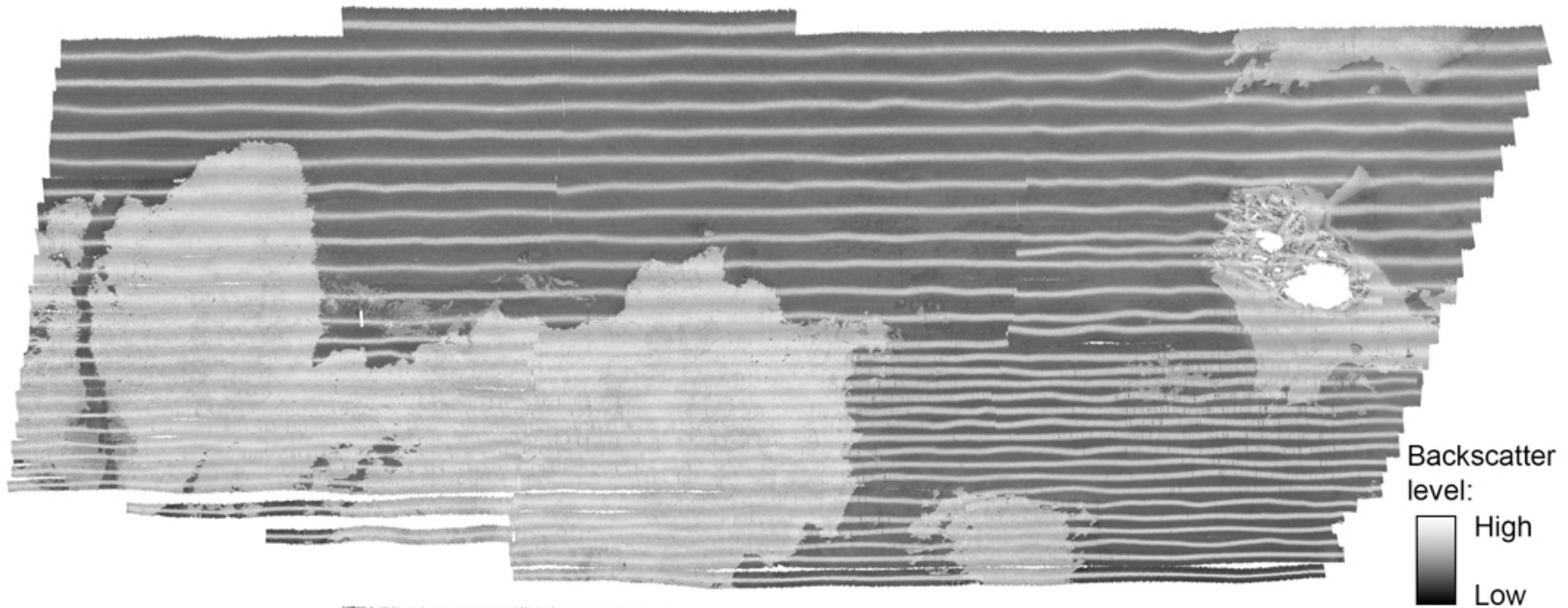
- HOM threshold: 0.5
- SIM threshold: 0.5



A possible combined approach

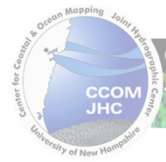
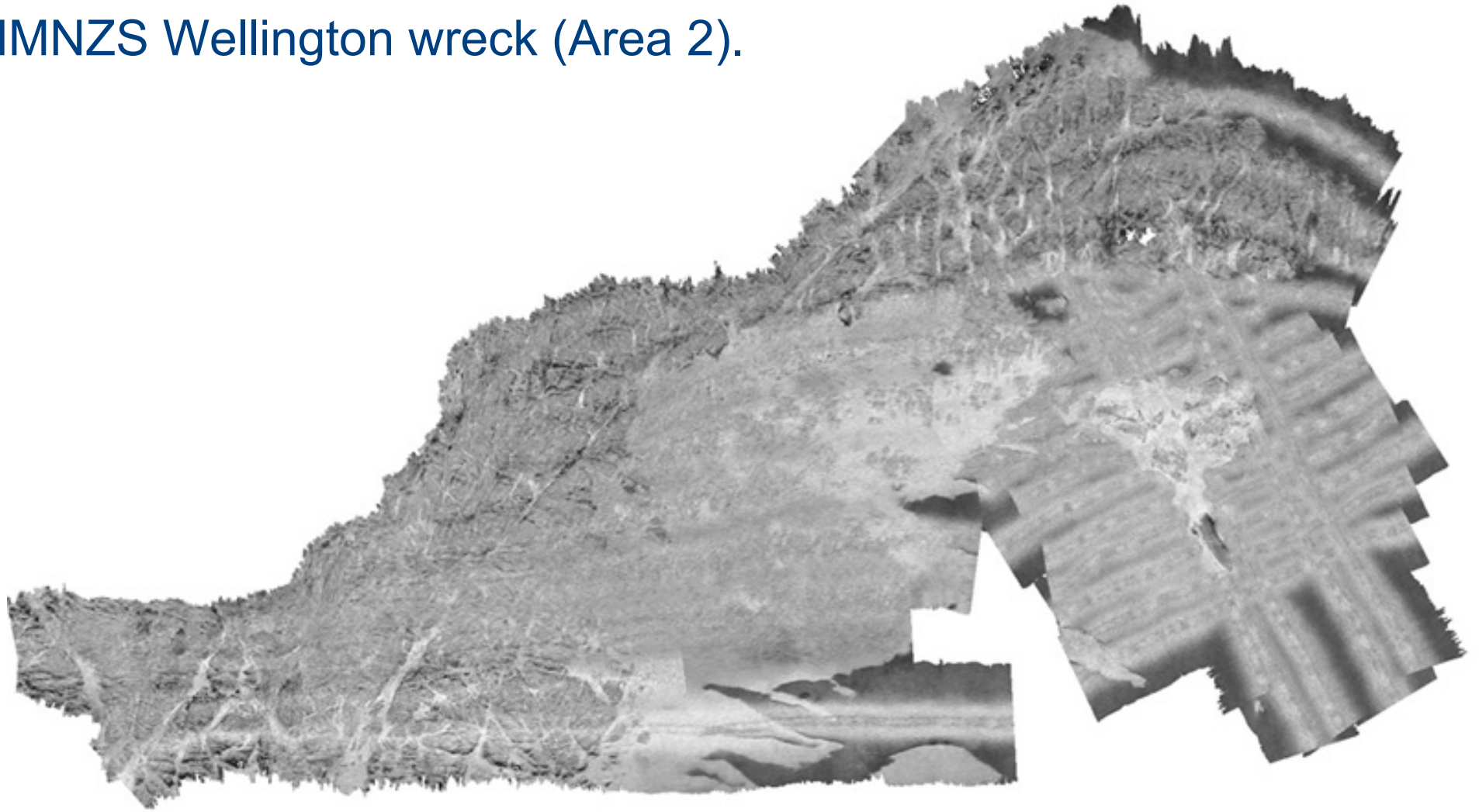
Result:

- HOM threshold: 0.5
- SIM threshold: 0.5



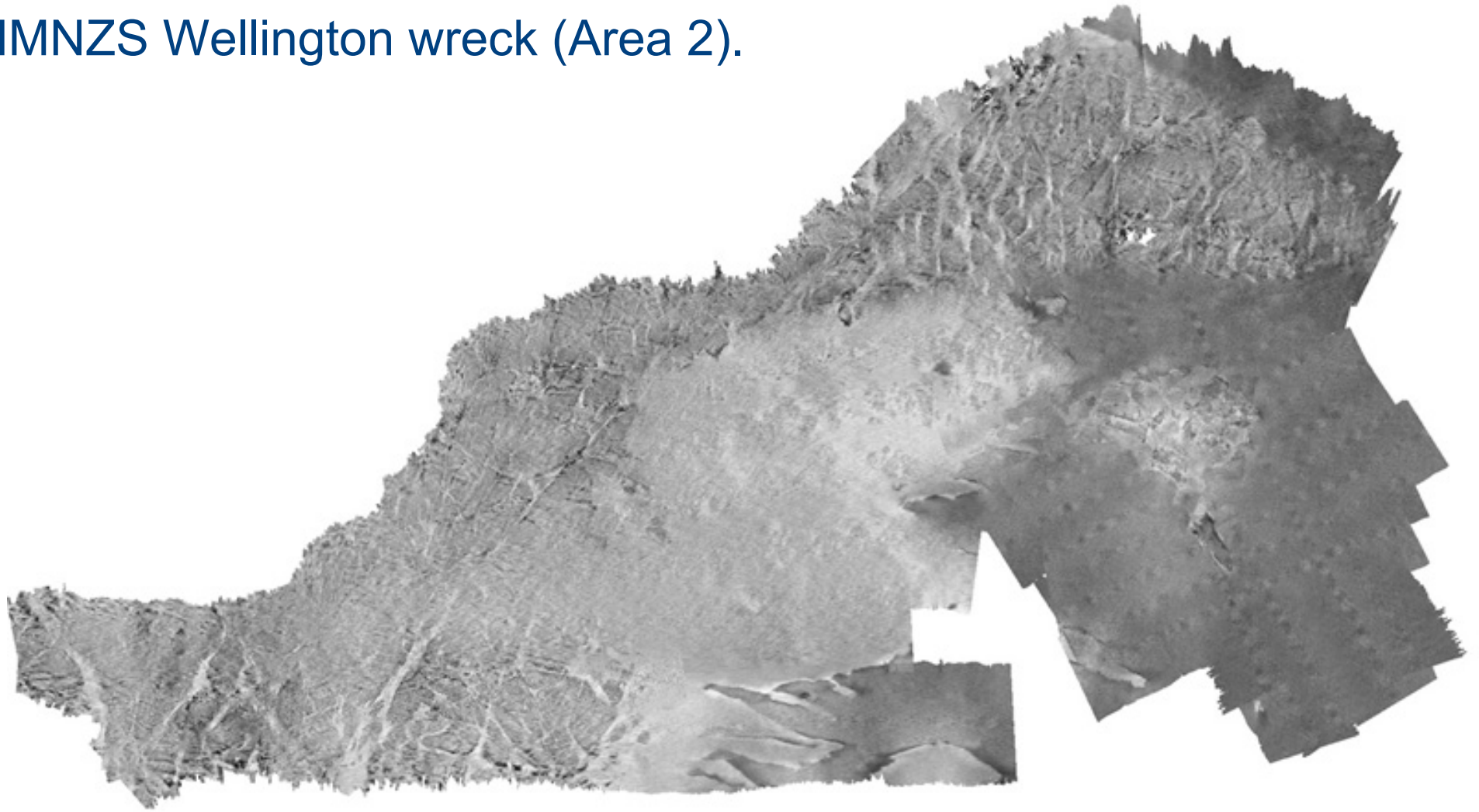
Application to the common dataset

Kongsberg EM2040 data over West Taputeranga (Area 3) + HMNZS Wellington wreck (Area 2).

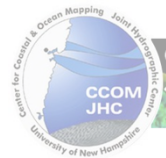


Application to the common dataset

Kongsberg EM2040 data over West Taputeranga (Area 3) + HMNZS Wellington wreck (Area 2).



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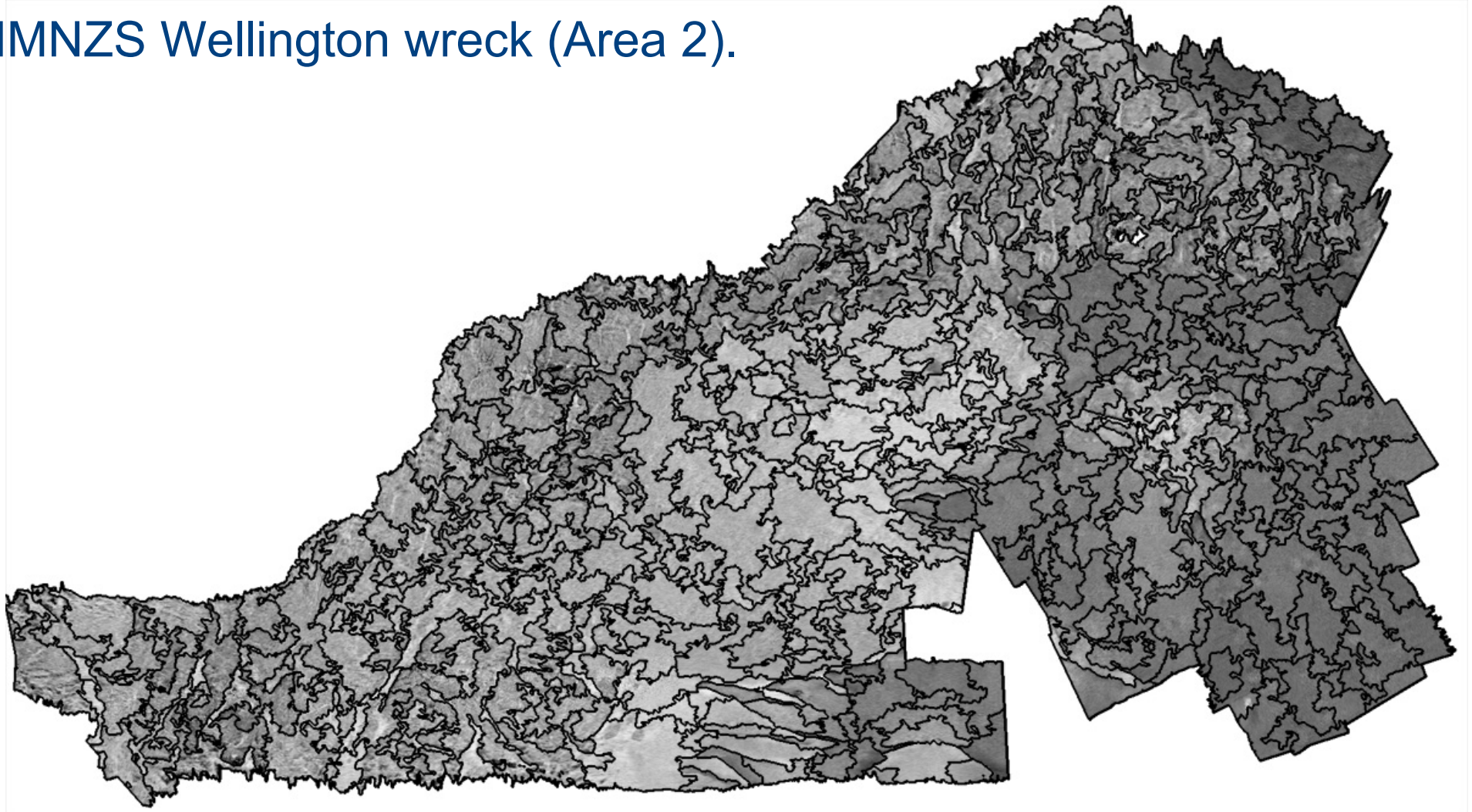
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Application to the common dataset

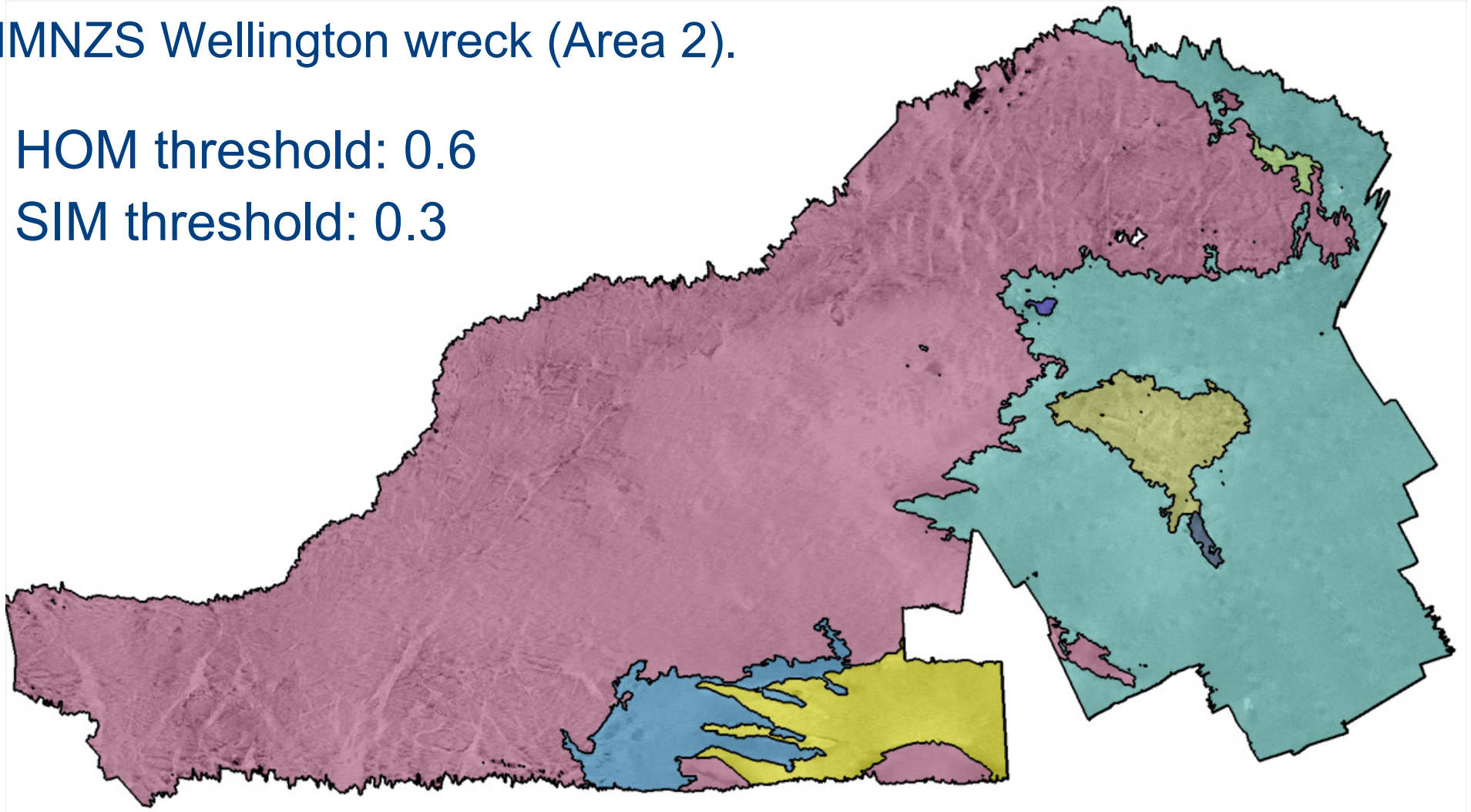
Kongsberg EM2040 data over West Taputeranga (Area 3) + HMNZS Wellington wreck (Area 2).



Application to the common dataset

Kongsberg EM2040 data over West Taputeranga (Area 3) + HMNZS Wellington wreck (Area 2).

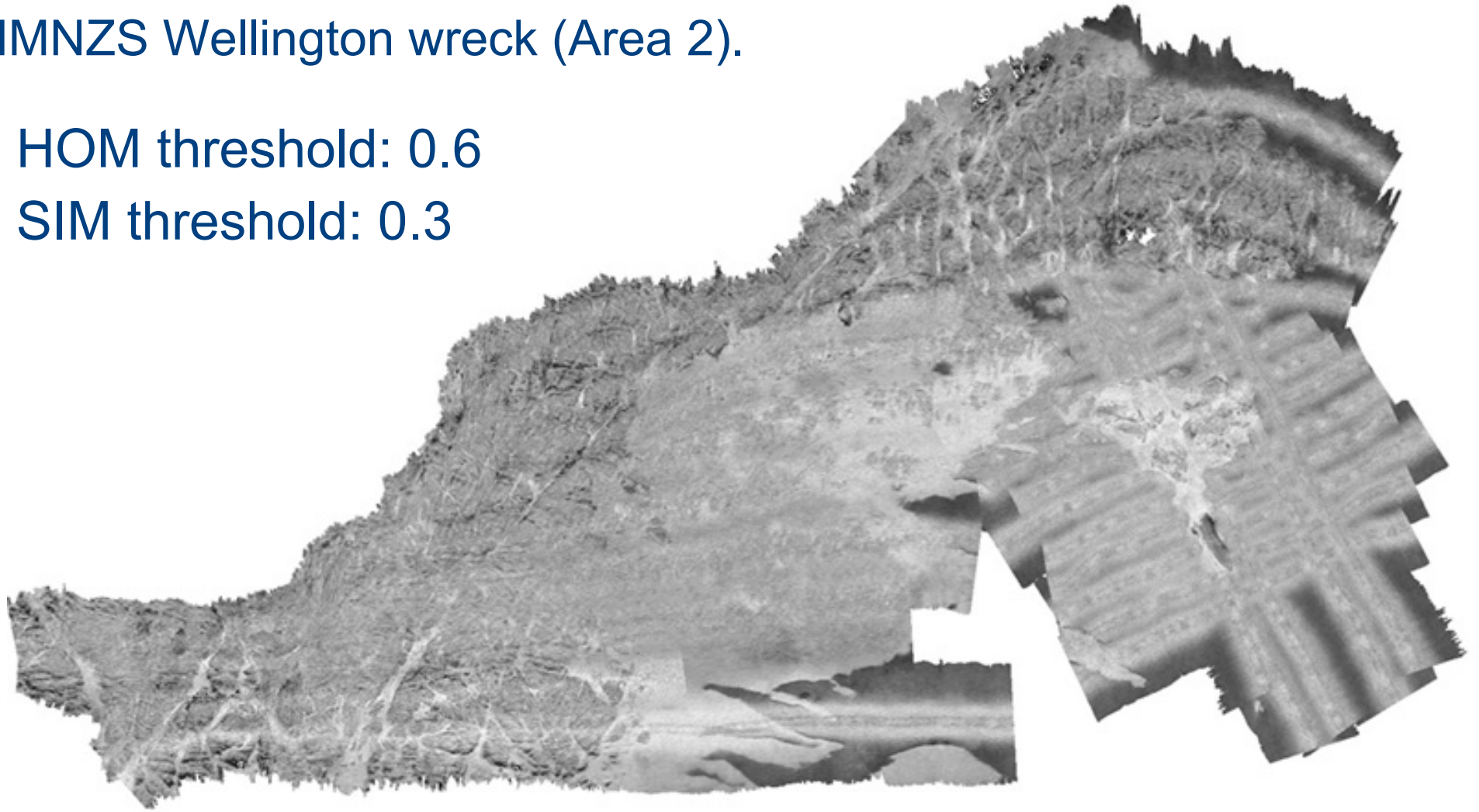
- HOM threshold: 0.6
- SIM threshold: 0.3



Application to the common dataset

Kongsberg EM2040 data over West Taputeranga (Area 3) + HMNZS Wellington wreck (Area 2).

- HOM threshold: 0.6
- SIM threshold: 0.3



Conclusion

“A possible approach”. Work still **in progress**. Other research in development.

- Che-Hasan R., Ierodiaconou D., Laurenson L. 2012. *Combining angular response classification and backscatter imagery segmentation for benthic biological habitat mapping*. Estuarine Coastal and Shelf Science 97, 1-9.
- Rzhanov Y., Fonseca L. & Mayer L. 2012. *Construction of seafloor thematic maps from multibeam acoustic backscatter angular response data*. Computers & Geosciences 41, 181-187
- ...

Looking forward to exploit **frequency information** as well...

Acknowledgments

- The **Foundation for Research, Science and Technology** (Technology in Industry Fellowship, contract number METO0602).
- The **George Mason Charitable Trust**.
- **NOAA Grants** No. NA10NOS4000073 and NA0NOS4001153.
- **Professor Terry Healy** of the University of Waikato department of Earth and Ocean Sciences.