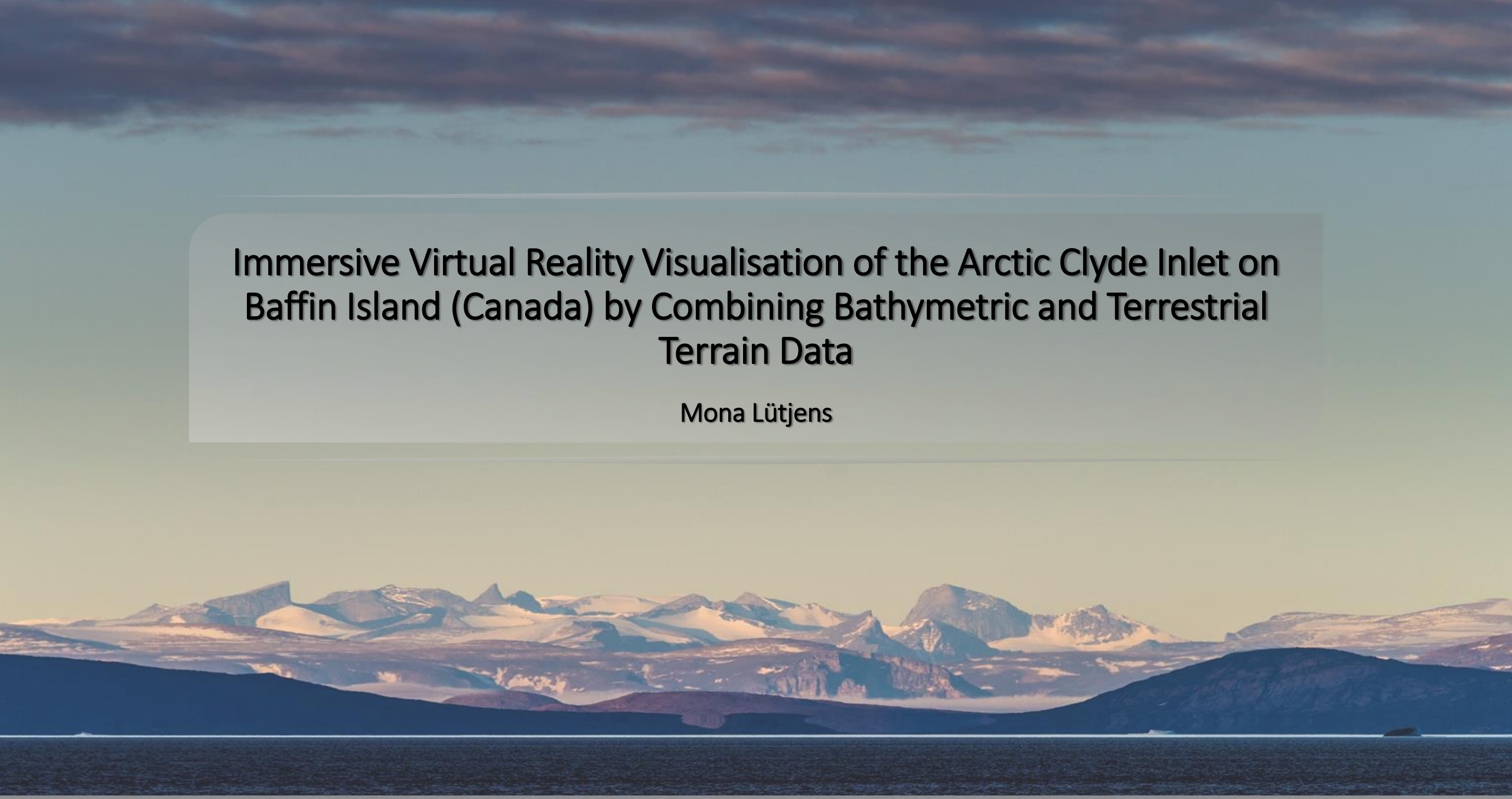
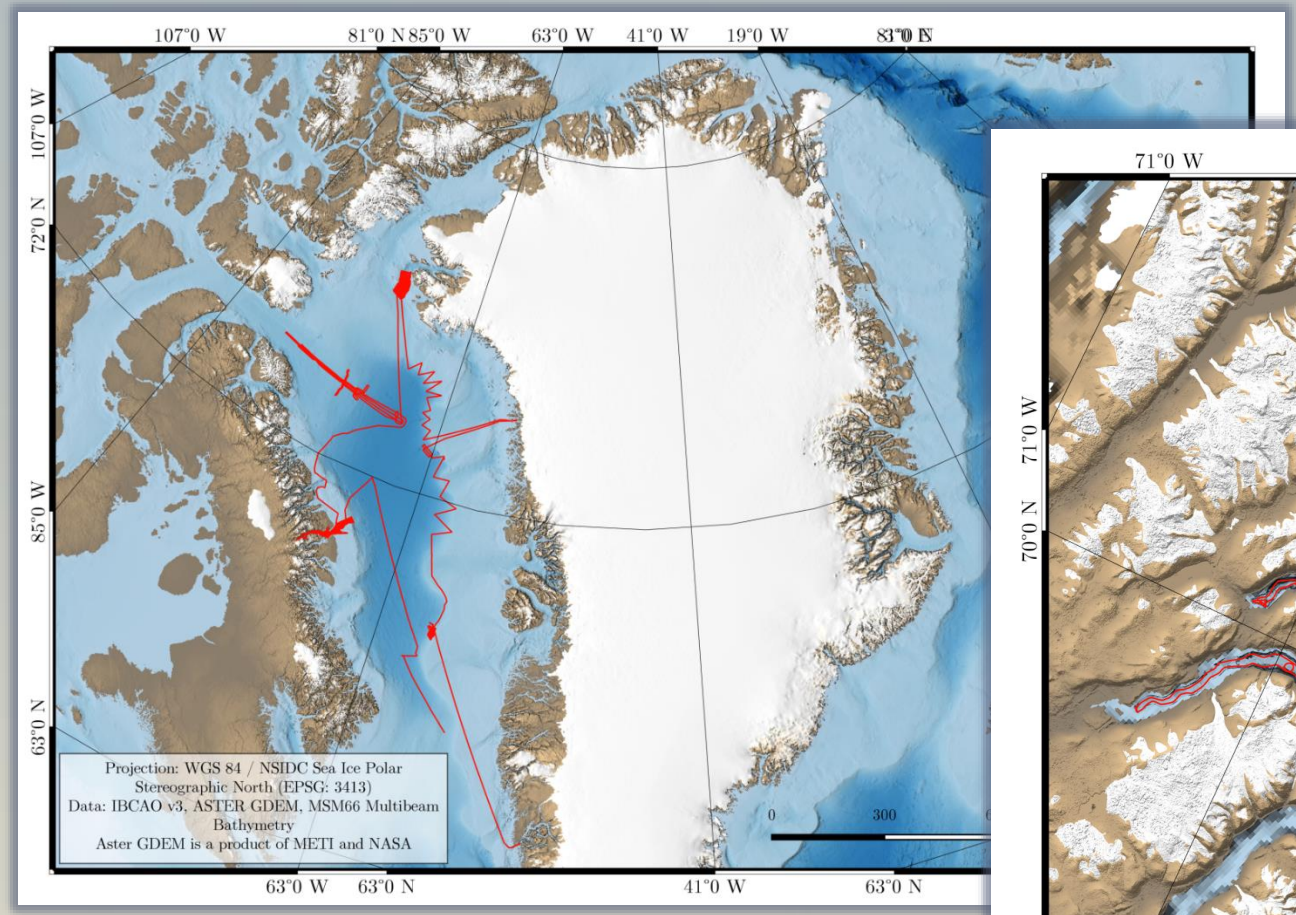
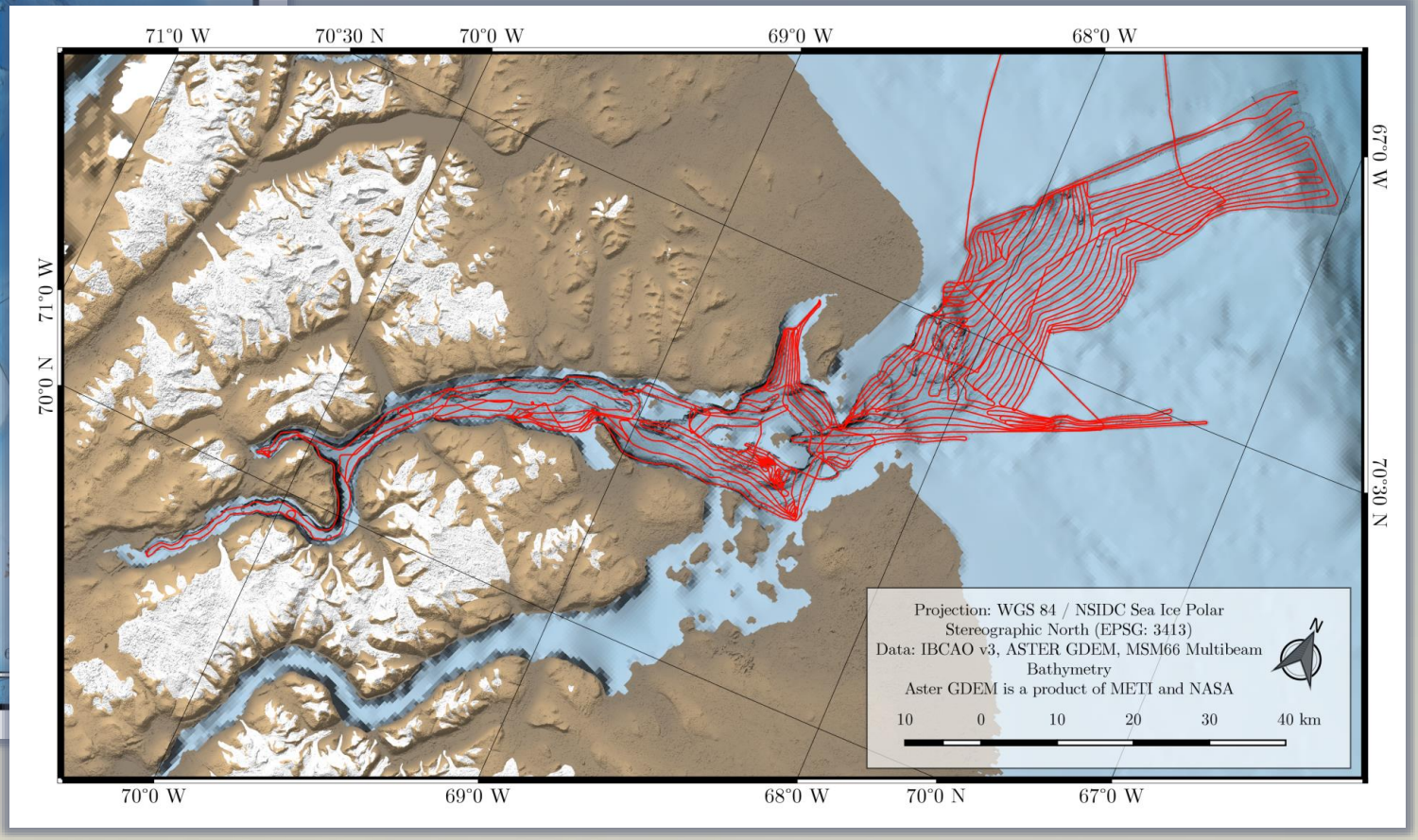
Immersive Virtual Reality Visualisation of the Arctic Clyde Inlet on Baffin Island (Canada) by Combining Bathymetric and Terrestrial Terrain Data

Mona Lütjens



Area of Investigation





Main Focus

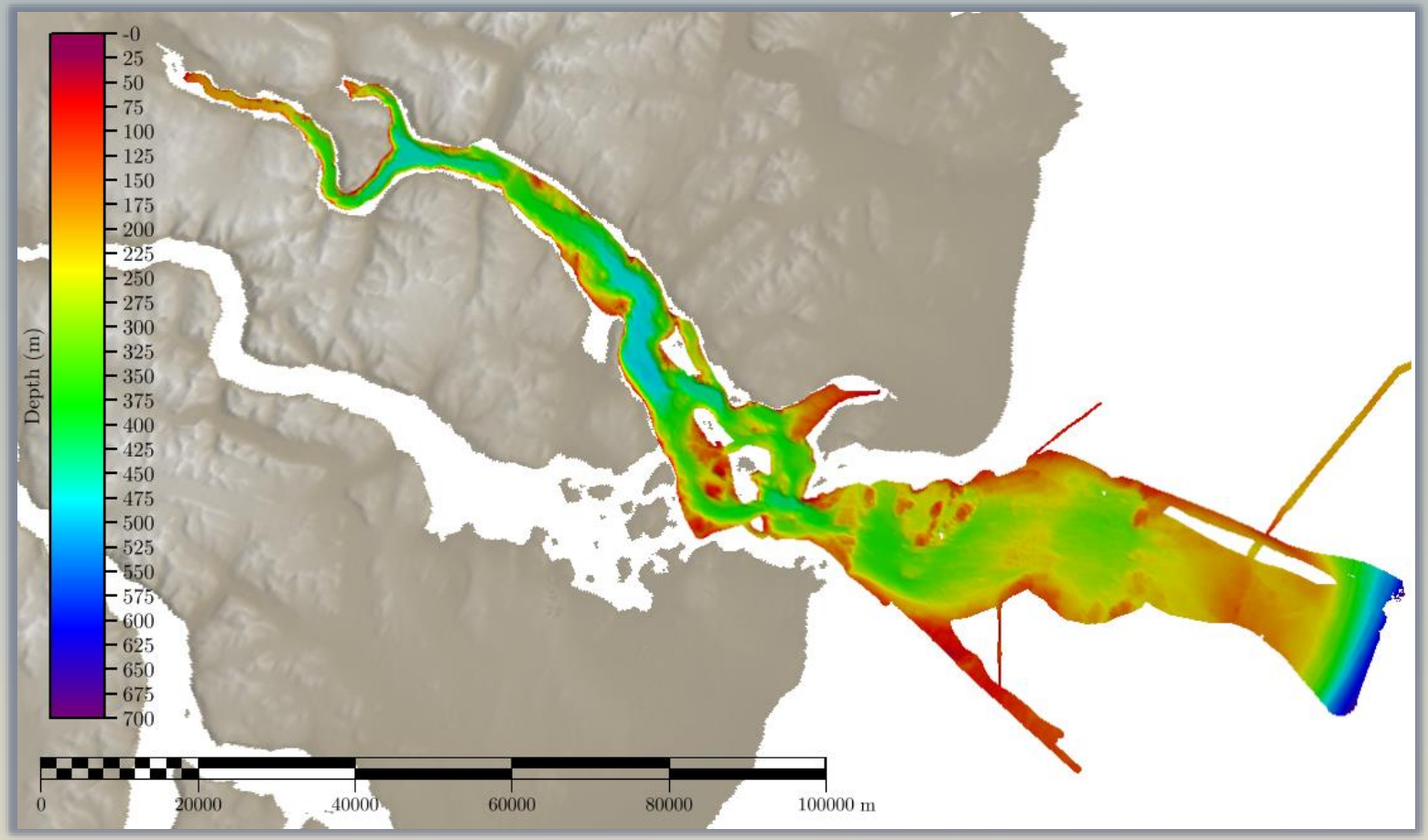
- Creation of the digital elevation model
- Development of virtual reality application
- Advantages and limitations of displaying terrain data in 3D immersive applications

Materials

Dataset	Resolution	EPSG	Type
MSM 66	5 m	32661	Raster
IBCAO	500 m	3996	Raster
ArcticDEM	2 m	3413	Raster
	5 m	3413	Raster
CDEM	~ 20 m	4269	Raster
RGI	varying	4326	Vector

Hydrographic Data Acquisition and Processing

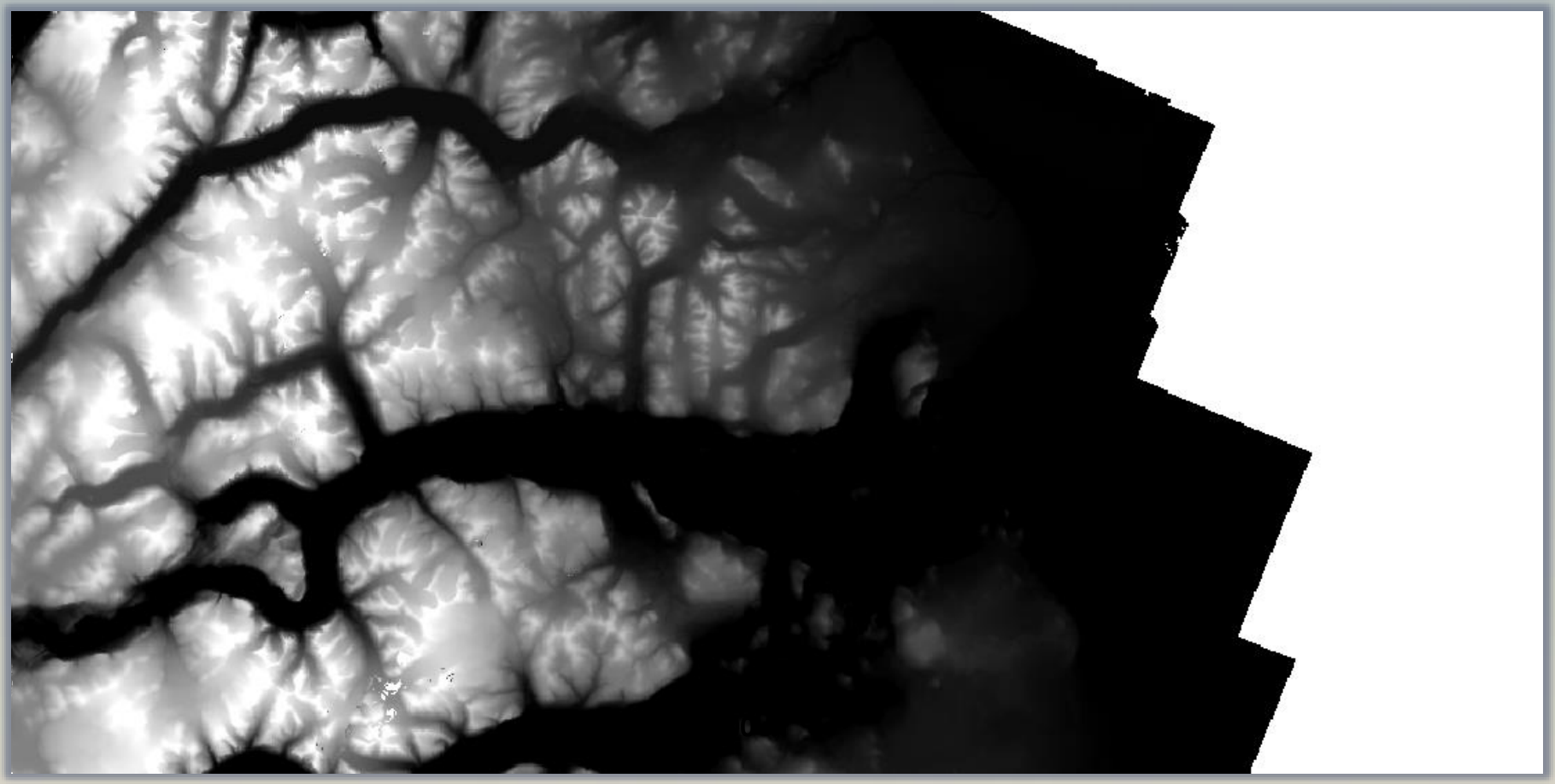
- Kongsberg EM122
- 12 kHz
- 5 m resolution



Data: MSM66 (below surface) und ASTER GDEM (above surface) is a product of METI and NASA

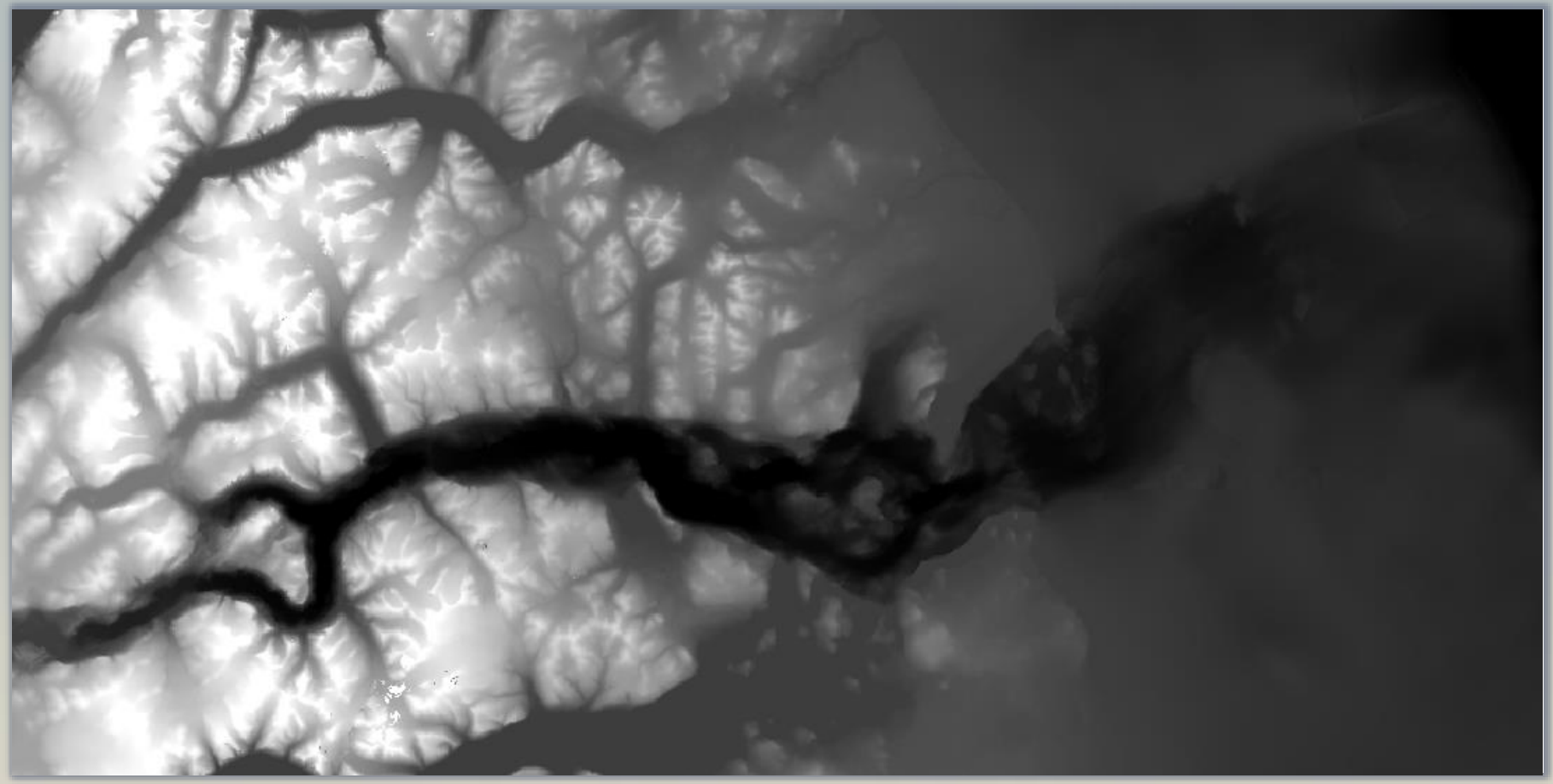
Terrestrial Data Processing

- ArcticDEM 5m
- ArcticDEM 2m
- CDEM



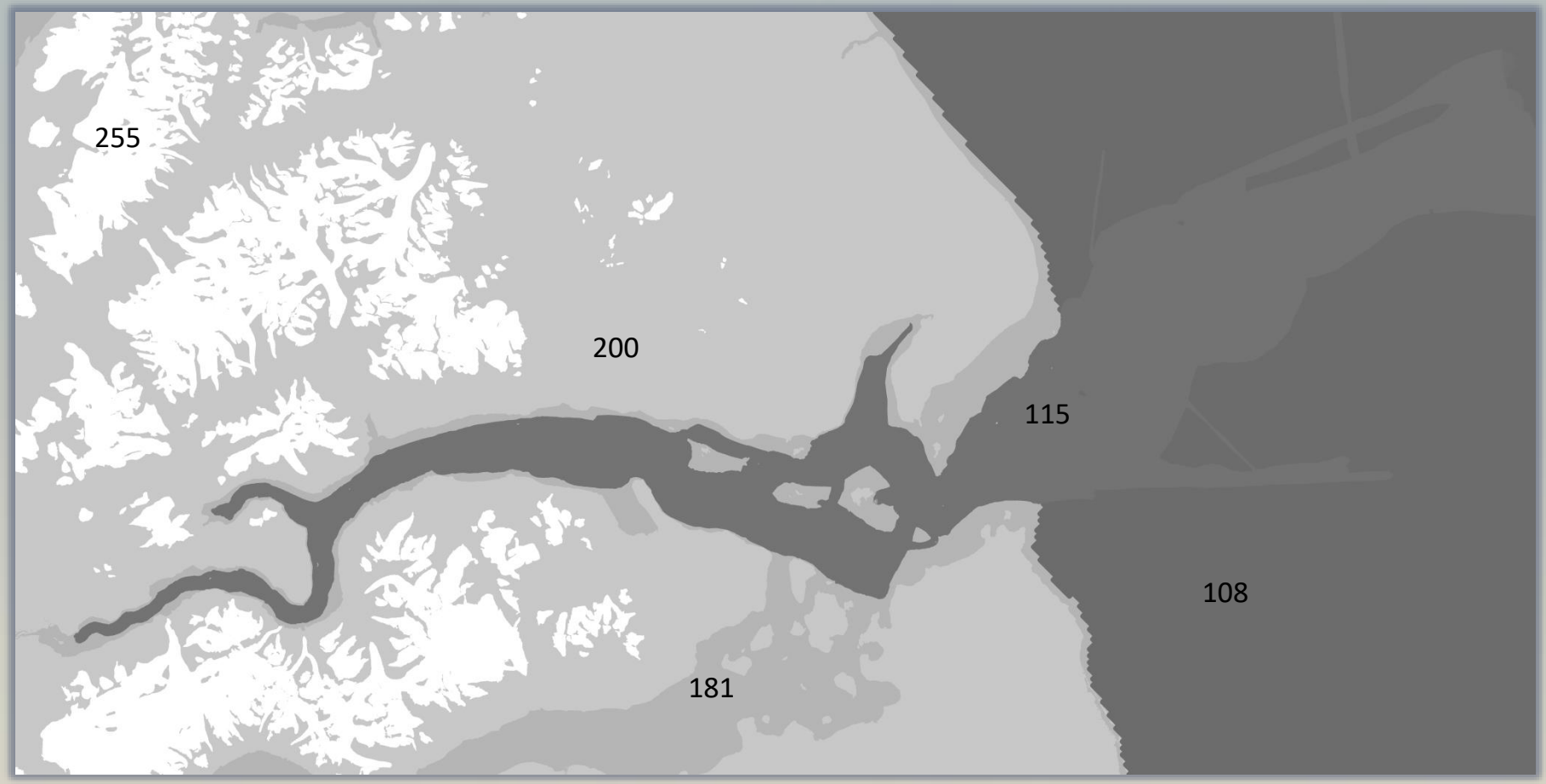
Combining Bathymetric and Terrestrial Data

- Terrestrial DEM
- Extract Fjord (CDEM)
- MSM66
- IBCAO
- Critical locations



Creating the Splat Map

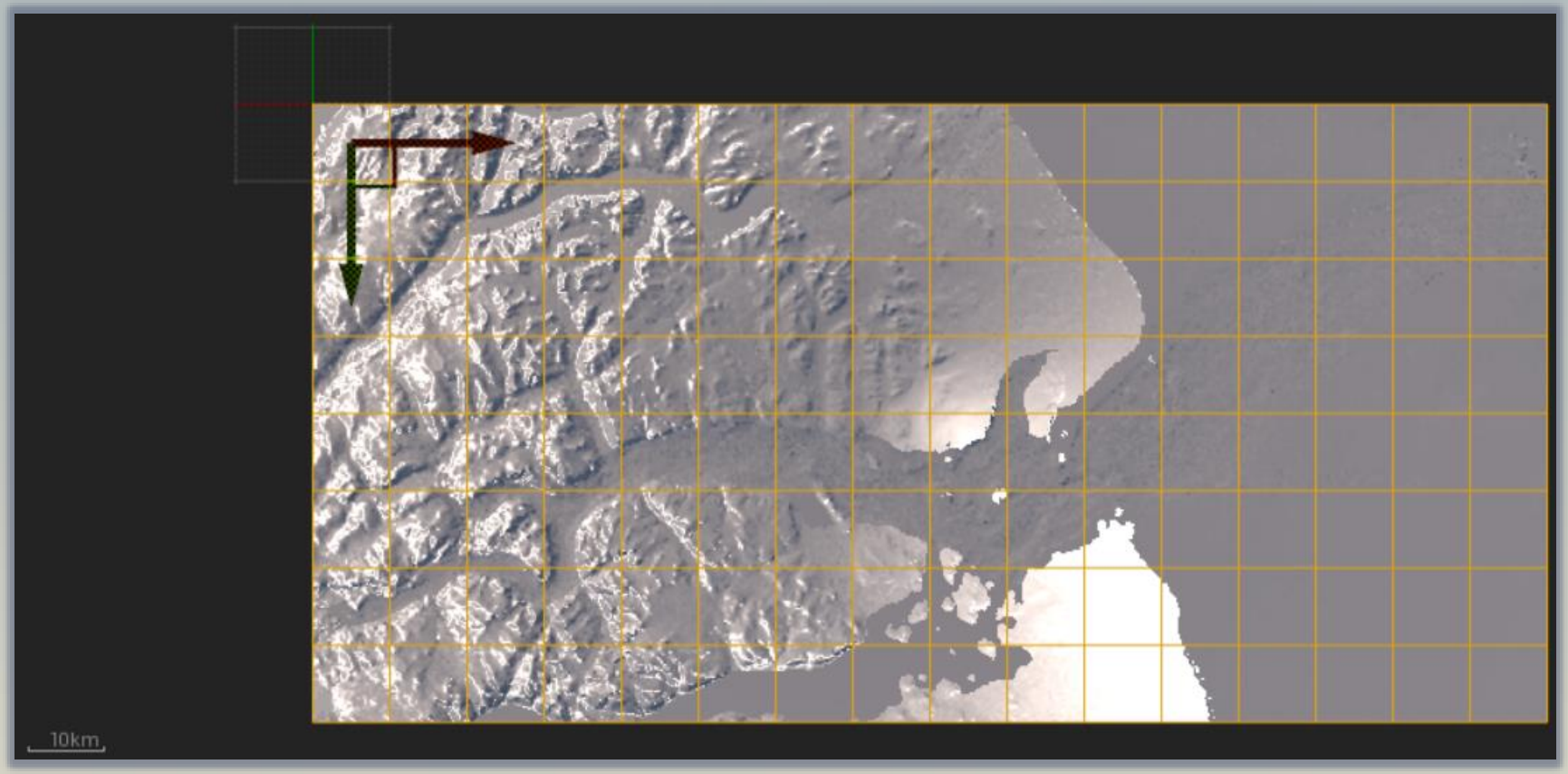
- MSM66
- IBCAO
- Transition
- RGI
- Terrestrial Terrain



Integrating the DEM into VR

Import

- Tiled landscape
- Scaling
- 128 tiles
- Each tile:
  - 2017 x 2017 pixel
  - 10 x 10 km
  - 8 million triangles



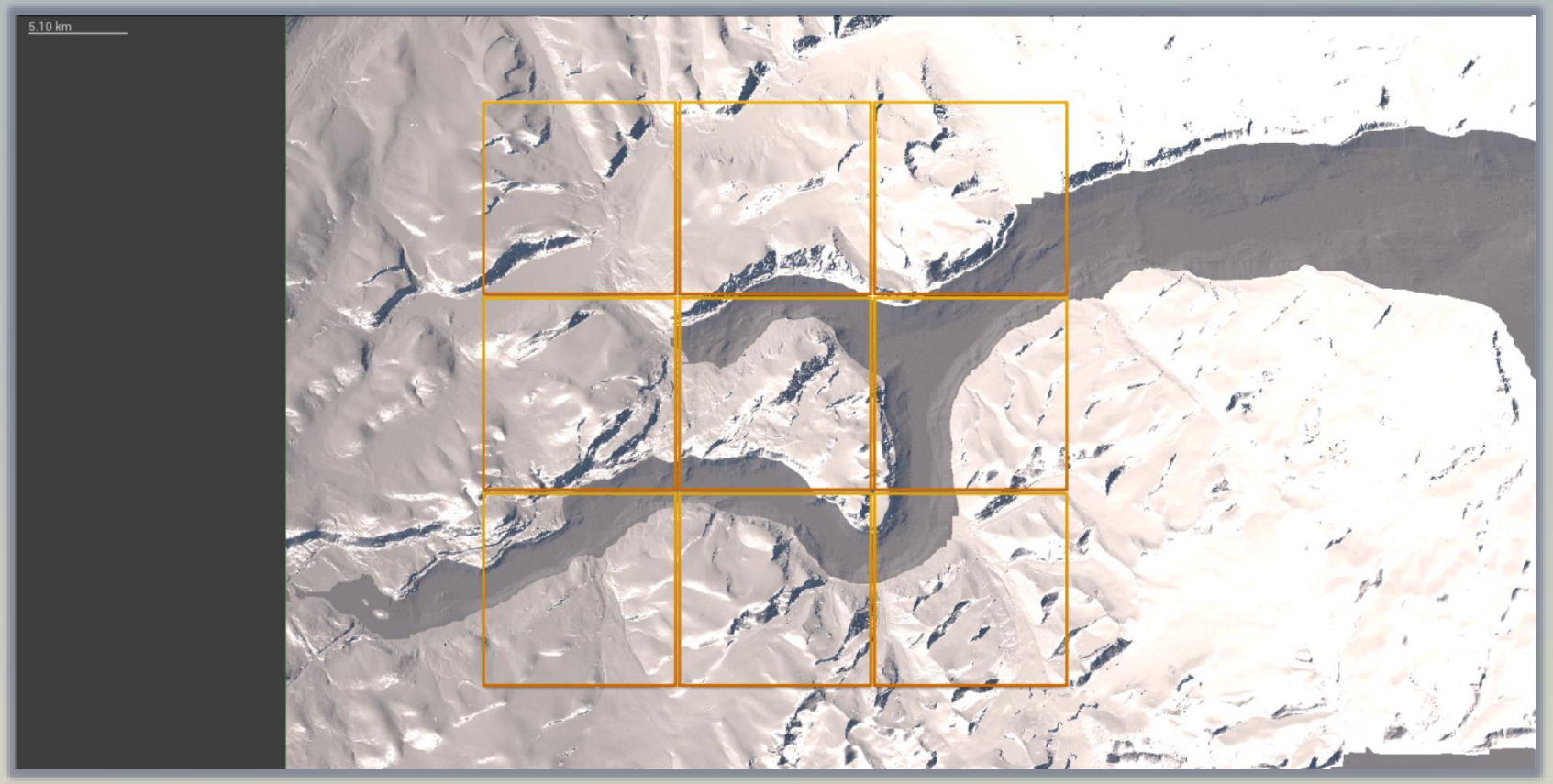
Software: Unreal Engine 4

Integrating the DEM into VR

Import

Level Streaming

- Distance : 10km



Software: Unreal Engine 4

Integrating the DEM into VR

Import

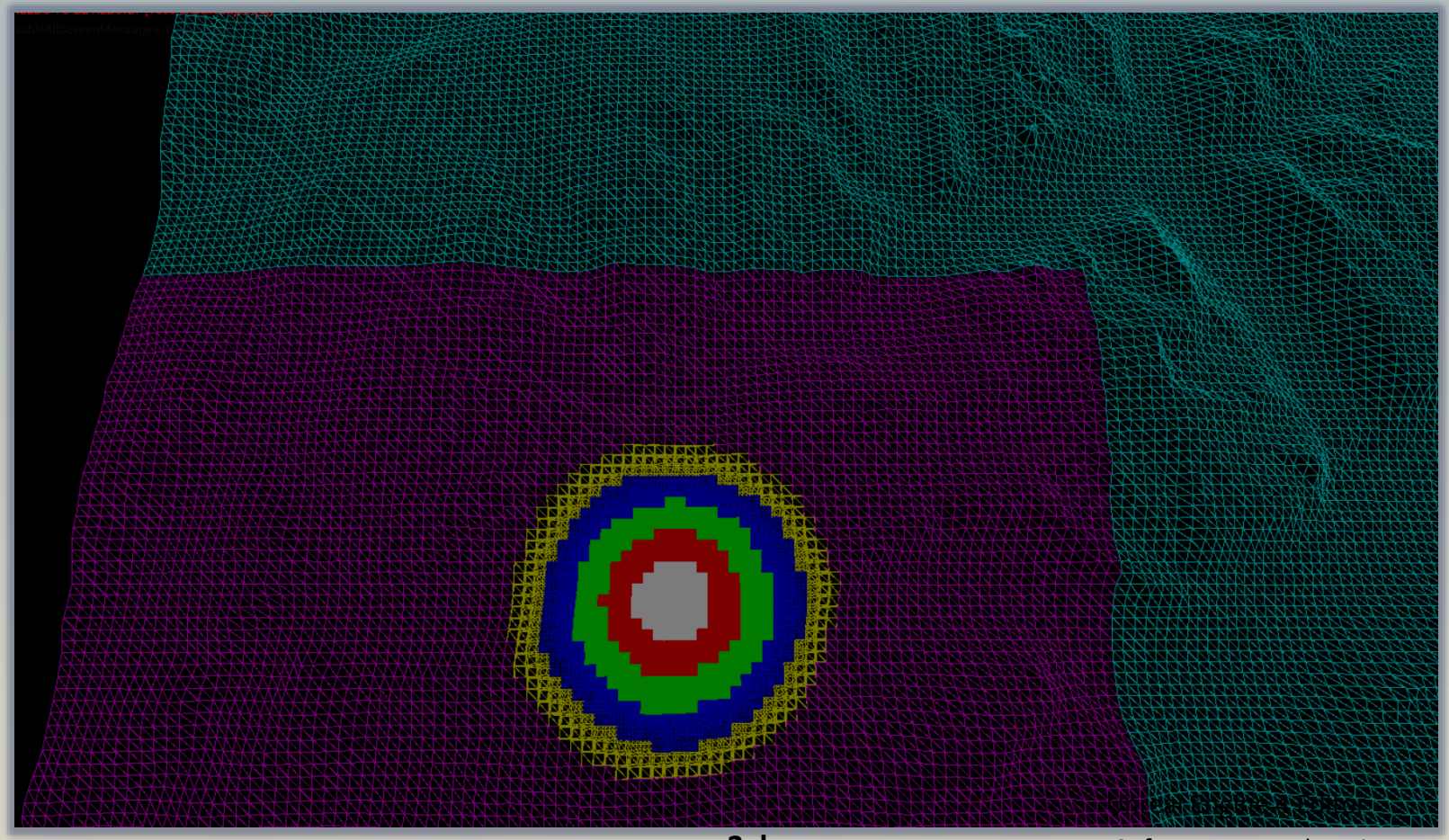
Level Streaming

Level of Detail

- Automatic LOD

- Manual LOD

  - 99.97% triangle reduction

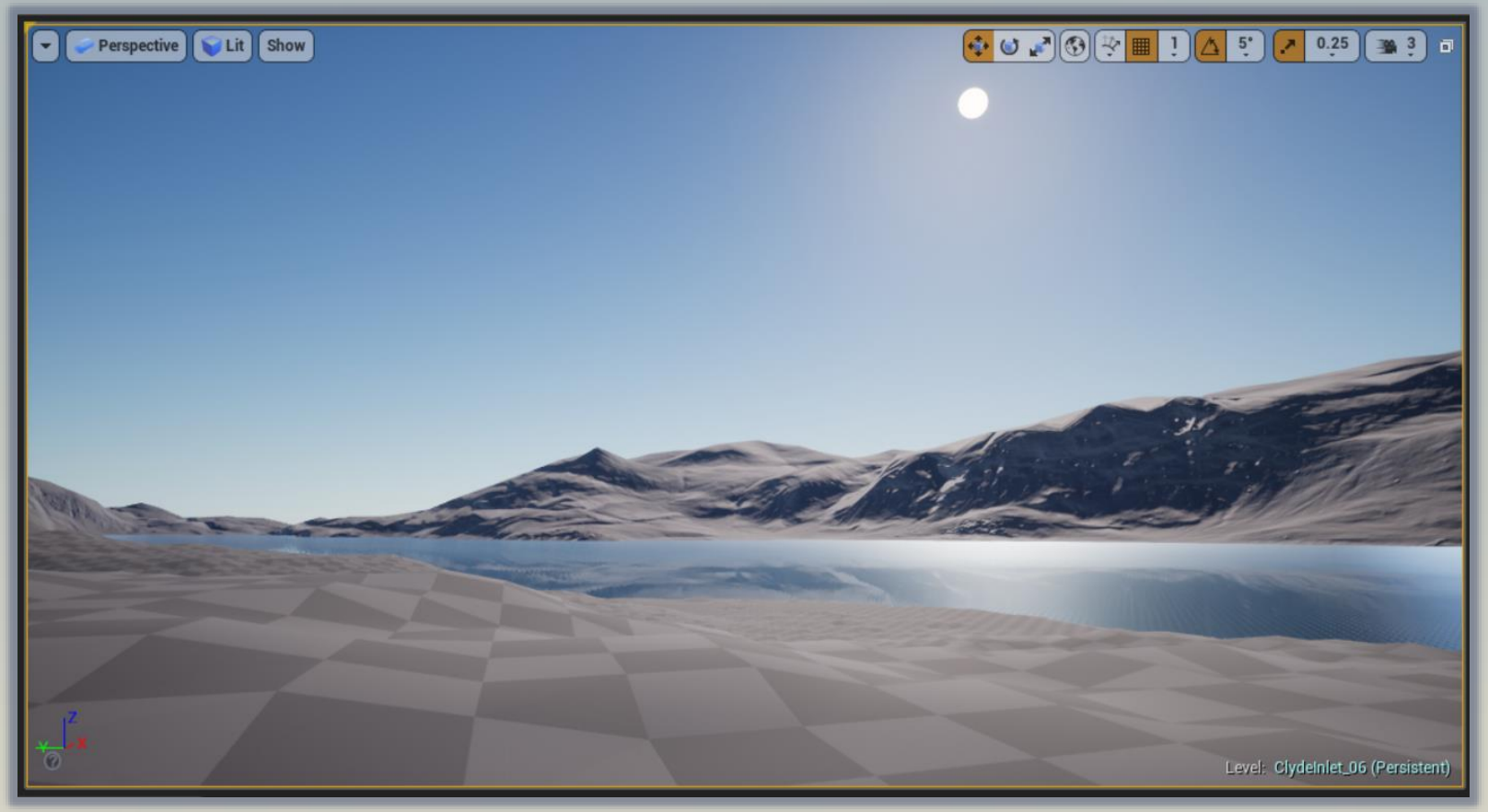


Software: Unreal Engine 4

Environment and Texture in VR

Lightning

- Sky
- Underwater



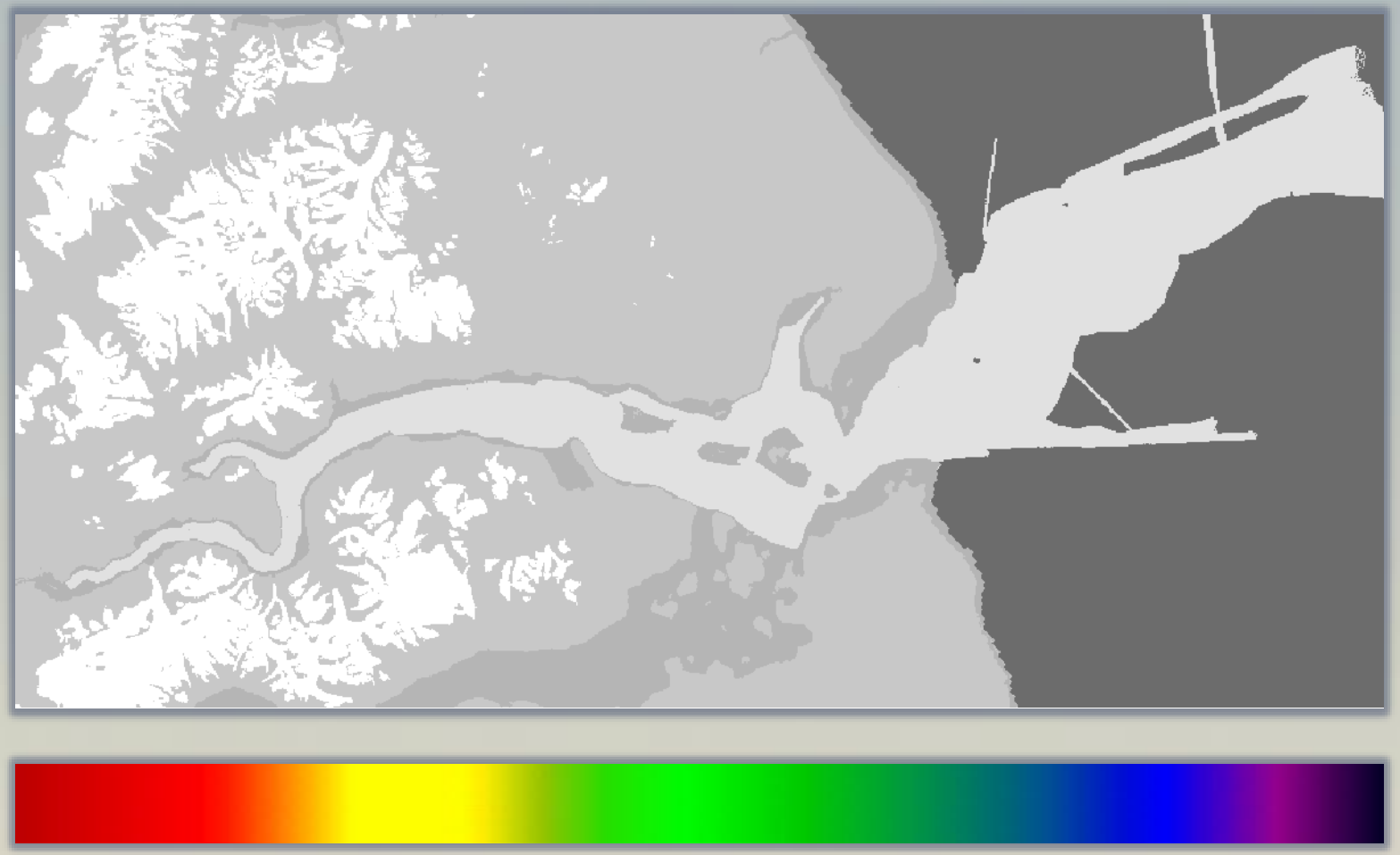
Software: Unreal Engine 4

Environment and Texture in VR

Lightning

Landscape Texture

- Terrestrial Terrain
  - Natural
  - Grey
- MBES Bathymetry
  - Backscatter
  - Rainbow
  - Grey
- Transition + IBCAO
  - Dark grey



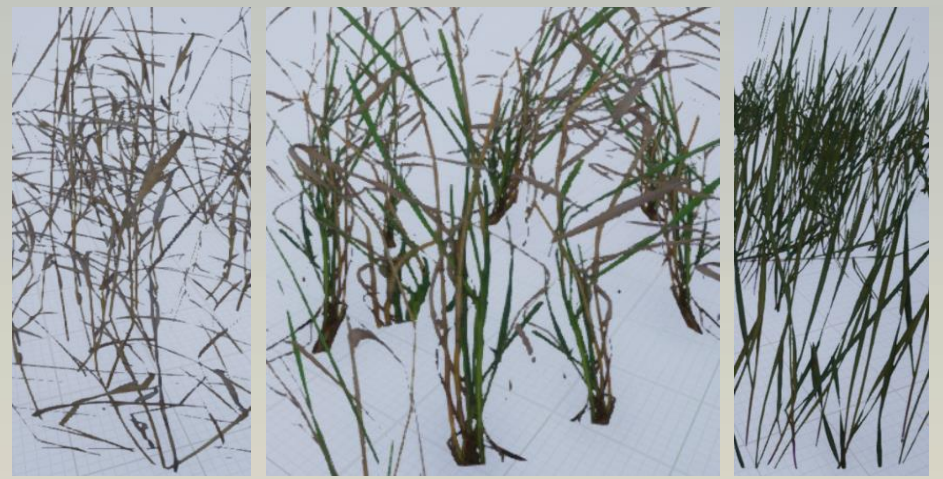
Environment and Texture in VR

Lightning

Landscape Texture

Foliage

- Alpine catchfly
- Heather
- Northern Androsace
- Three grass types



Data:

Photorealistic Landscape Pack 2 - Gokhan Karadayi

Open World Demo Collection – Epic Games

Environment and Texture in VR

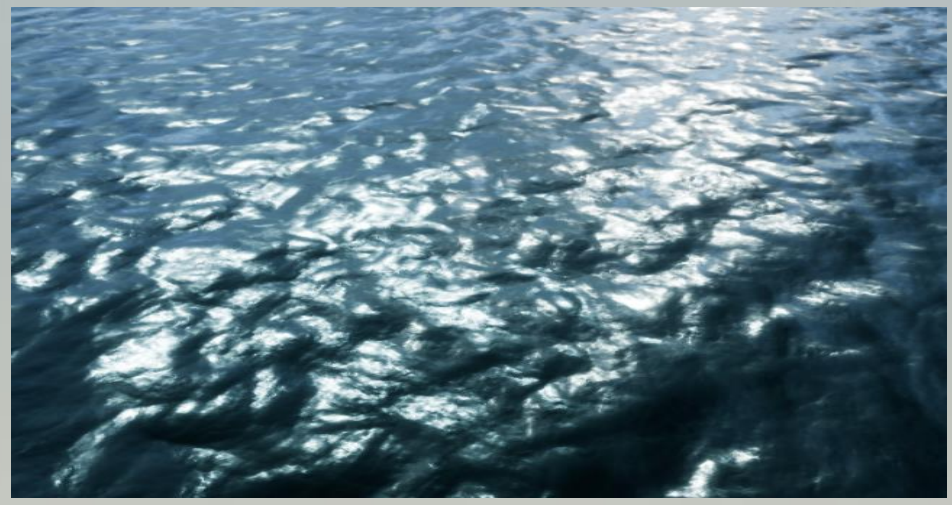
Lightning

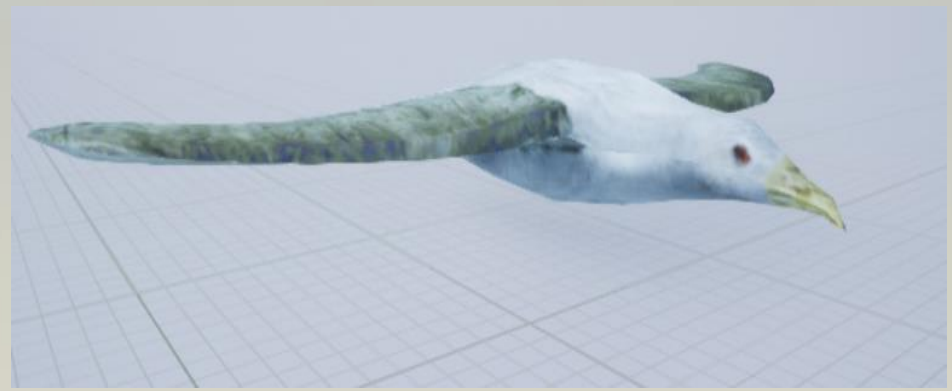
Landscape Texture

Foliage

Water Surface

Seagulls





Data:

Water Planes – Epic Games

Landscape Mountains – Epic Games

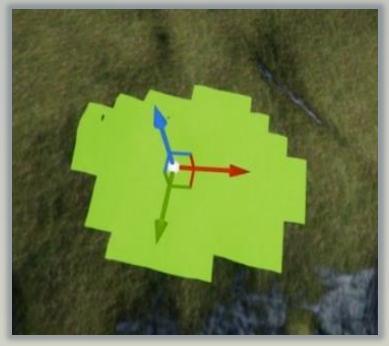
Locomotion in VR

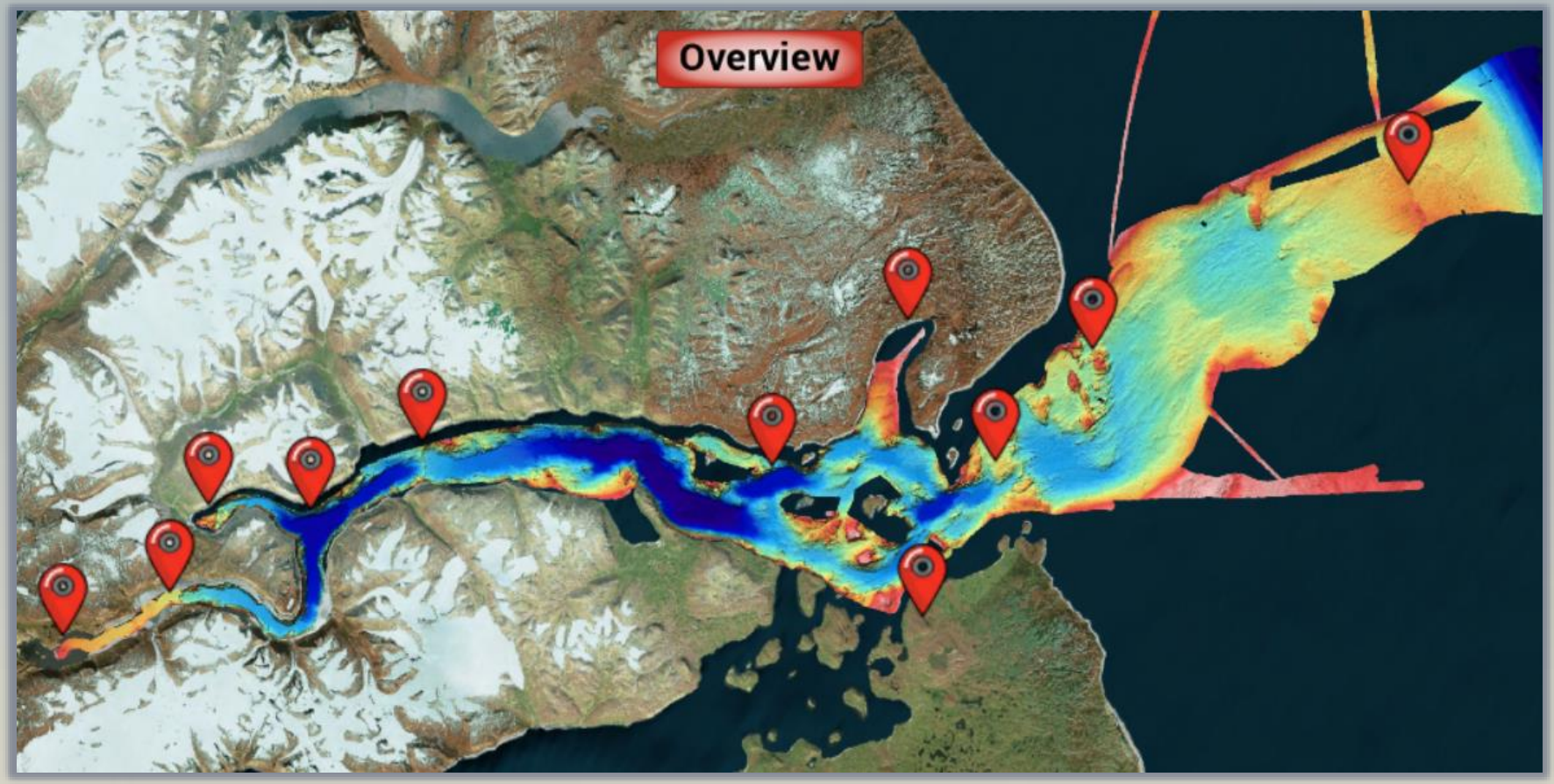
Teleportation

Flying

Fast Travel

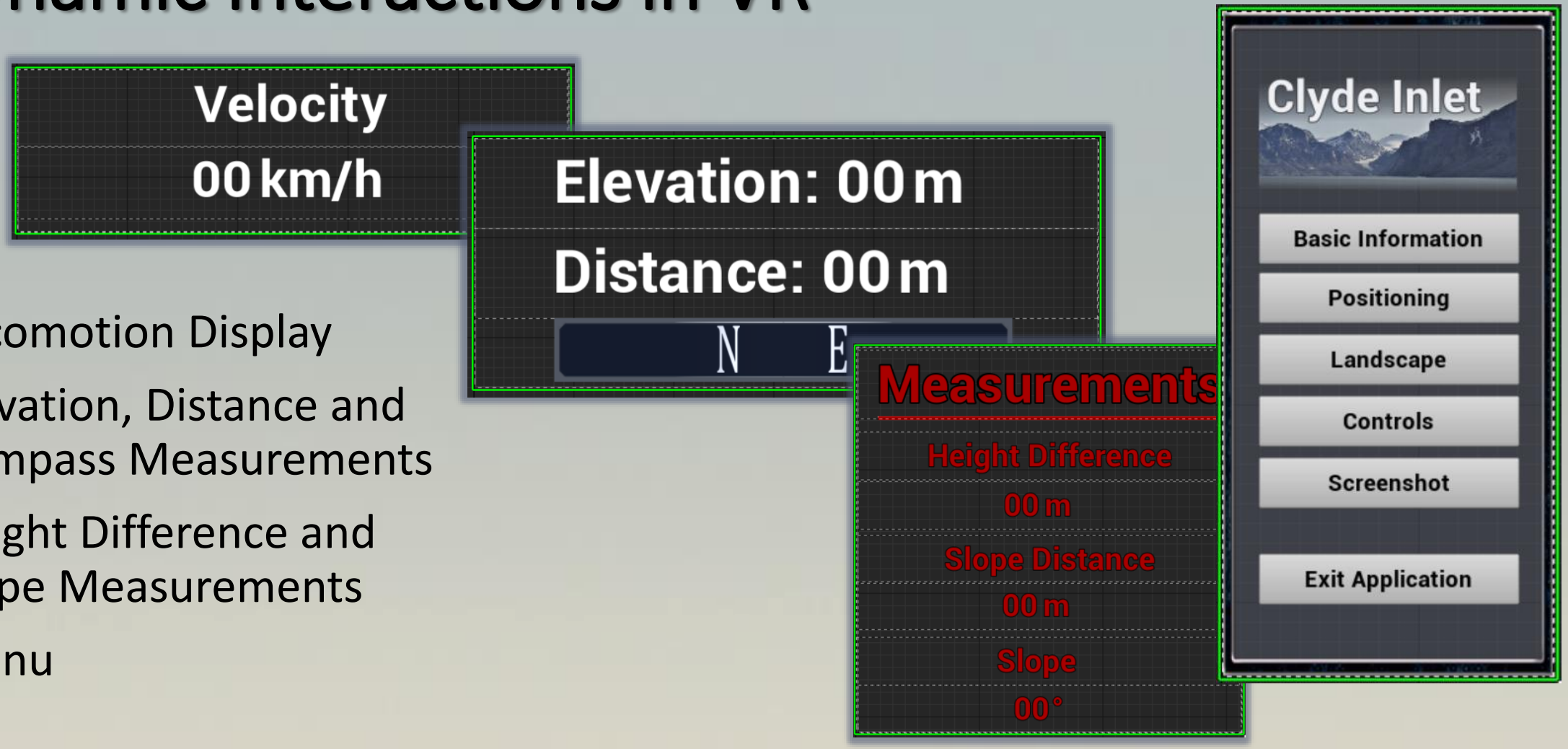
- 12 waypoints





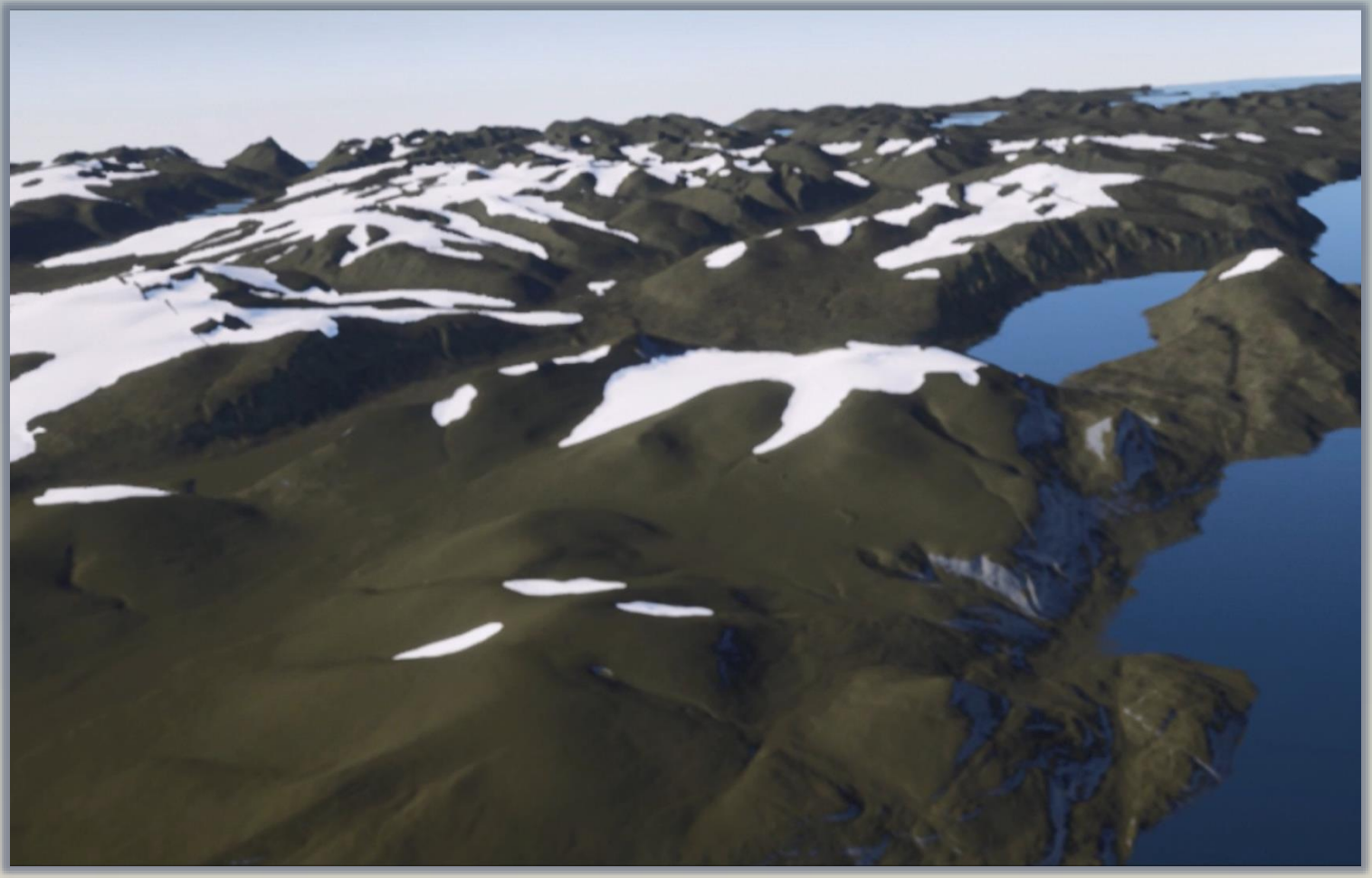
Imagery Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Dynamic Interactions in VR



- Locomotion Display
- Elevation, Distance and Compass Measurements
- Height Difference and Slope Measurements
- Menu

Results: Terrain and Environment



Results: Motion Controller and Locomotion

Results: Measurements

Advantages

- Observation from different perspectives / distances
- Improved perception of the terrain
- Improved interpretation options (e.g. at slopes, visual axes)

Limitations

- Limited possibility to import/export geospatial datasets
  - Compatible with: *.png, *.bmp, *.jpg, *.jpeg, *csv, *.json
- No proper spatial reference
- Time-consuming hardware and project setup

Conclusion

- Method for visualising vast, high resolution terrain in VR
- Combination of bathymetric and terrestrial datasets
- Increased perception of terrain compared to 2D presentations
- Some limitations: import/export, spatial reference system

→ VR has potential for future applications

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Image: Jens Weiser

References

- Epic Games, Inc. (2018). Unreal Engine 4. Retrieved April 05, 2018, from https://www.unrealengine.com/en-US/what-is-unreal-engine-4
- Government of Canada, Natural Resources Canada (2016). Canadian Digital Elevation Model Product Specifications. Retrieved February 19, 2018, from http://ftp.geogratis.gc.ca/pub/nrcan_rncan/elevation/cdem_mnec/doc/CDEM_product_specs.pdf
- Jakobsson, M., Mayer, L., Coakley, B., Dowdeswell, J. A., Forbes, S., Fridman, B., Hodnesdal, H., Noormets, R., Pedersen, R., Rebesco, M., Schenke, H.W., Zarayskaya, Y., Accettella, D., Armstrong, A., Anderson, R.M., Bienhoff, P., Camerlenghi, A., Church, I., Edwards, M., Gardner, J.V., Hall, J.K., Hell, B., Hestvik, O., Kristoffersen, Y., Marcussen, C., Mohammad, R., Mosher, D., Nghiem, S.V., Pedrosa, M.T., Travaglini, P.G., Weatherall, P. (2012). International Bathymetric Chart of the Arctic Ocean (IBCAO) Version 3.0. GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L12609. Retrieved February 19, 2018, from https://doi.org/10.1029/2012GL052219
- Polar Geospatial Center & Regents of the University of Minnesota (2017). Introduction to ArcticDEM. Retrieved February 19, 2018, from https://www.pgc.umn.edu/guides/arcticdem/introduction-to-arcticdem/
- RGI Consortium (2017). Randolph Glacier Inventory – A Dataset of Global Glacier Outlines: Version 6.0: Technical Report, Global Land Ice Measurements from Space. Colorado, USA: Digital Media. Retrieved February 19, 2018, from https://doi.org/10.7265/N5-RGI-60