RÉPUBLIQUE FRANÇAISE
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SWOT HR
FLOODPLAIN DEM STATUS AND PLANS

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on behalf of the ADT

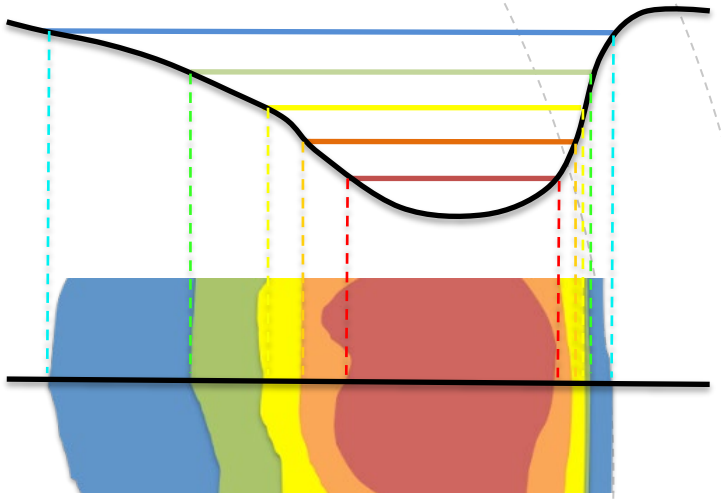
SWOT VALIDATION MEETING, CHAPEL HILL, NC
18 JUNE 2024

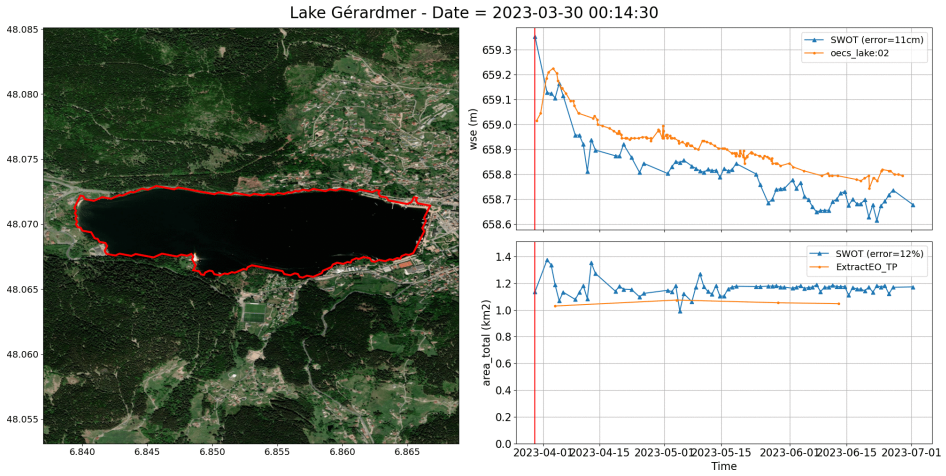
OUTLINE

BATHTUB RING APPROACH

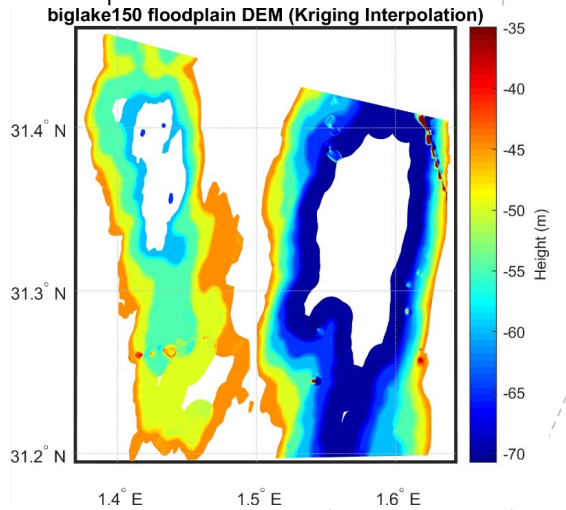
Principle and limitations

- Pre-launch plan was to use the waterbodies' variations in elevation and extent to derive a partial bathymetry based on PIXC/PIXCVec products
  - For each date, the edge pixels of a detected water body form an (iso-) elevation curve (with slope for rivers and big lakes)
  - Between observed min and max water level only
  - Long time series needed (at least one year of data)
- Difficulties: errors and pseudo-random variations in elevation and extent
  - Example: Gerardmer lake (true extent varies very little)
- Promising results obtained on some sites, but also many unsatisfactory cases.



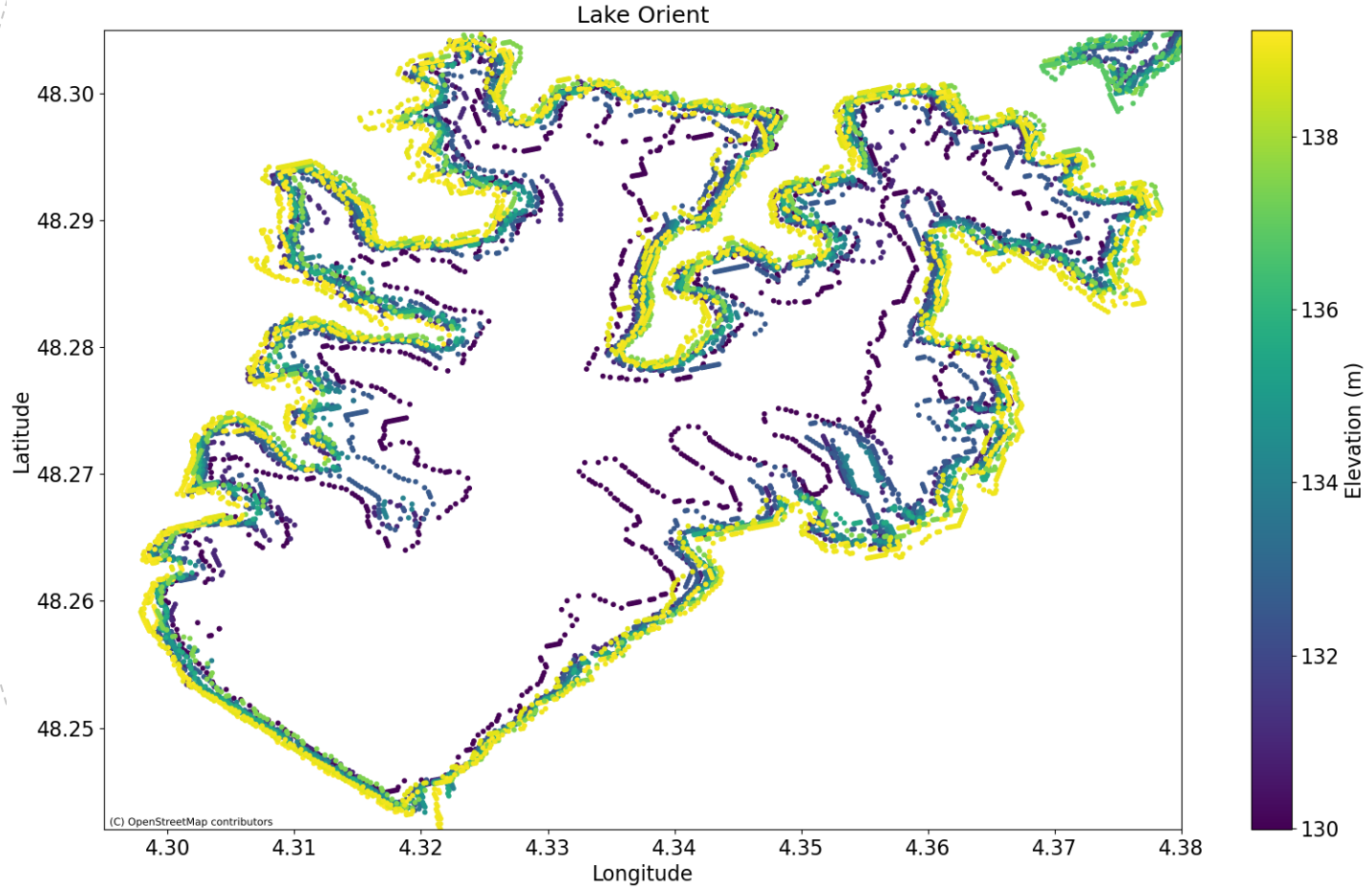


Example based on simulated data



BATHTUB RING APPROACH

Example: Orient Lake in France (geolocated edge pixels)



- Derived from 12 PIXC/PIXCVec products, Dec. 2023 - May 2024 (science orbit)
- Large variations in height and extent in period
- Based on open water (4) and/or water-near-land (3) pixels

BATHTUB RING APPROACH

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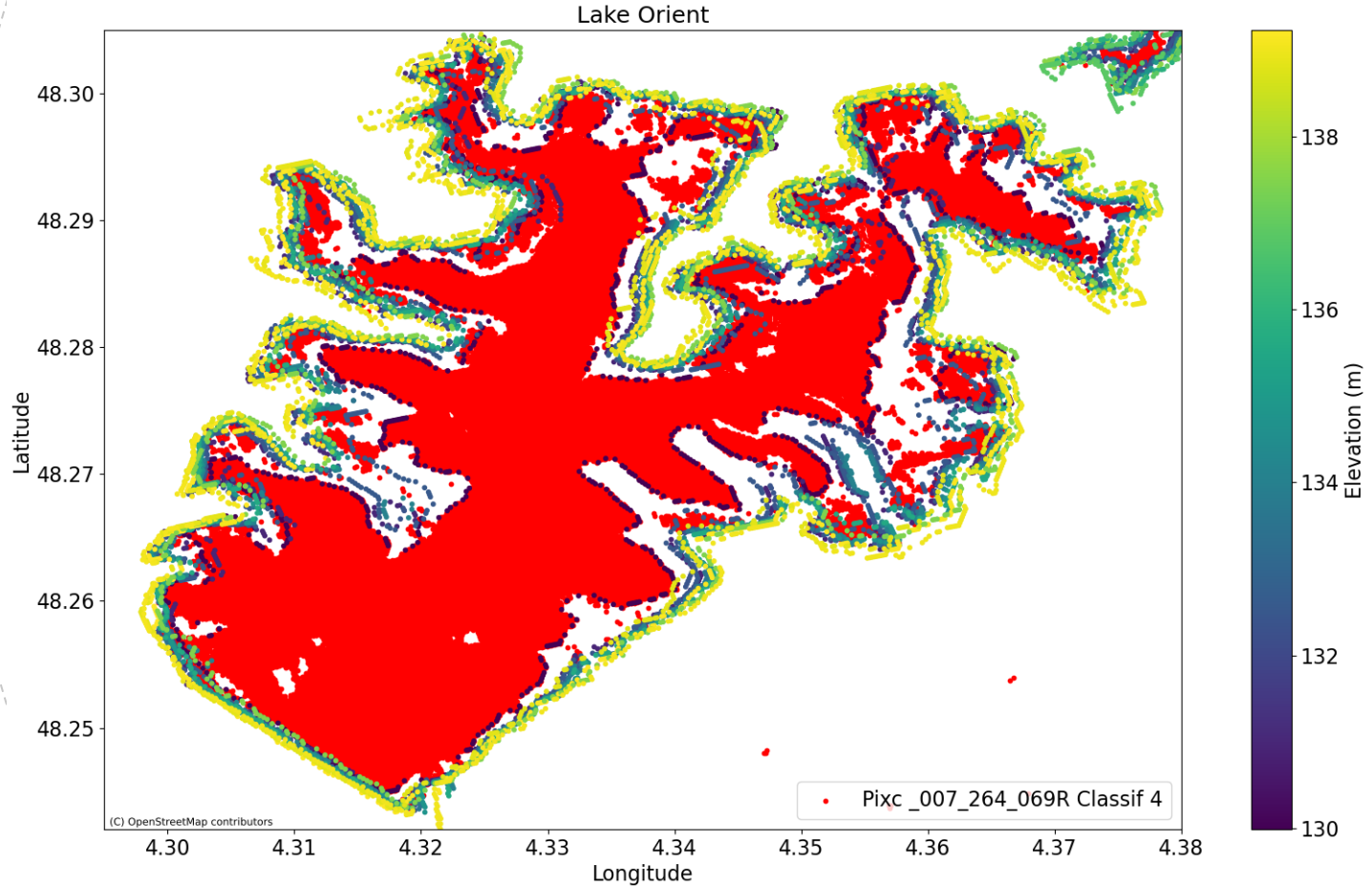

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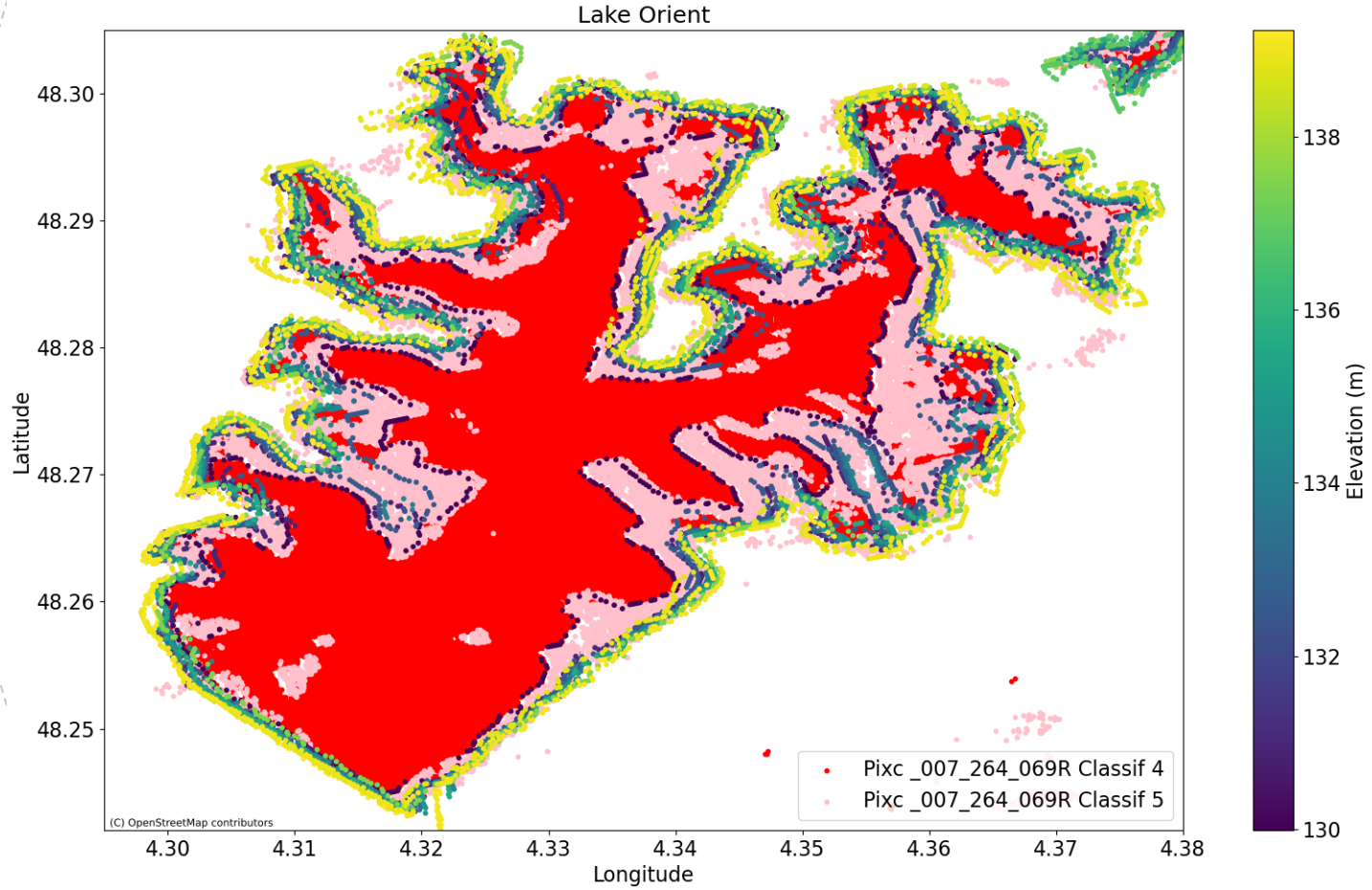
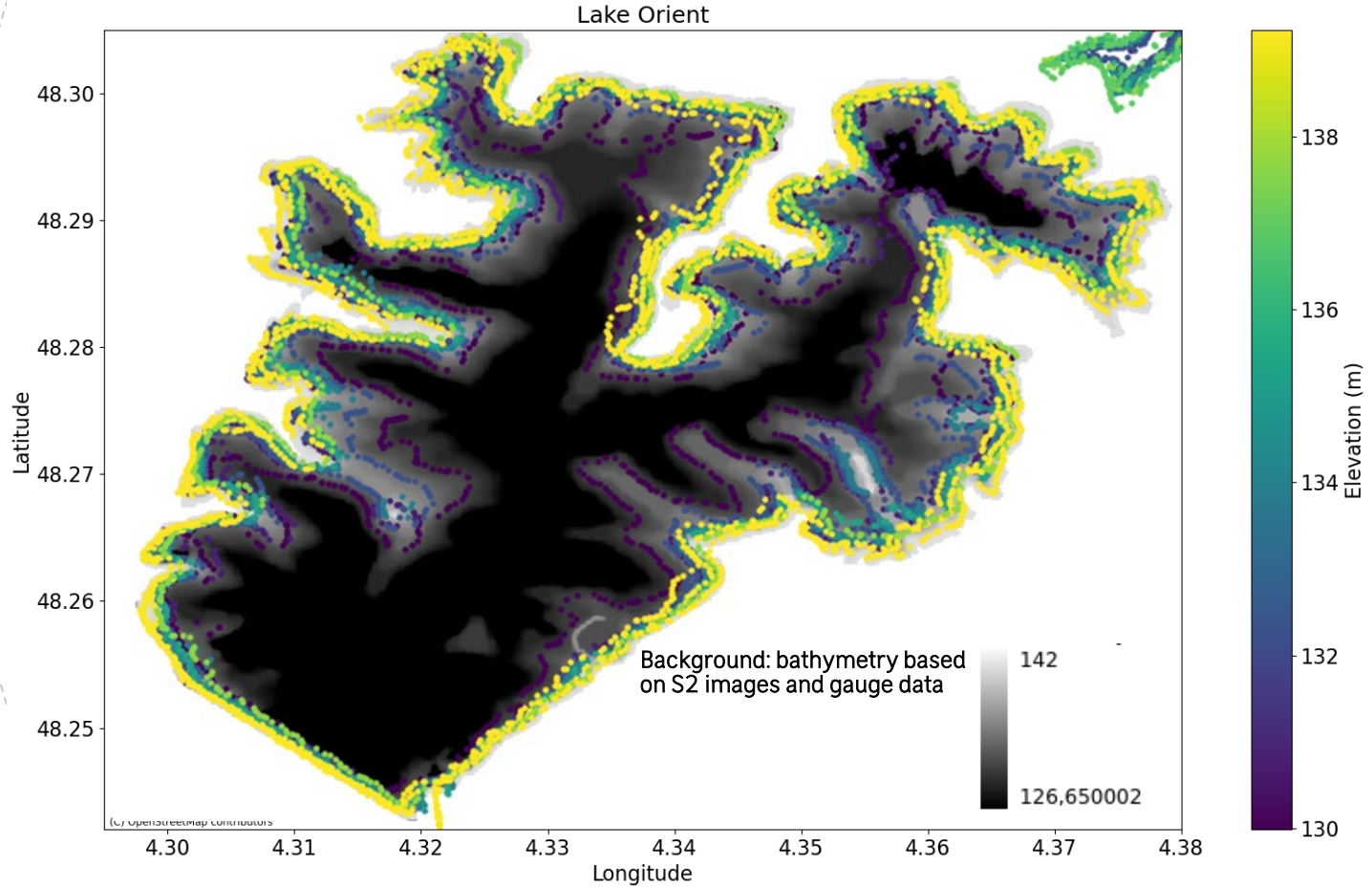


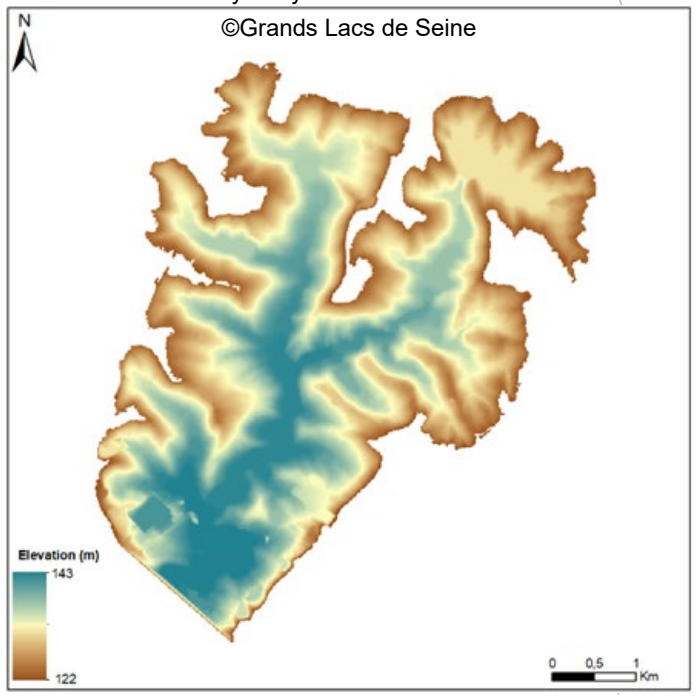
- Derived from 12 PIXC/PIXCVec products, Dec. 2023 - May 2024 (science orbit)
- Large variations in height and extent in period
- Based on open water (4) and/or water-near-land (3) pixels
- Dark water (5) pixels generally should not be used

BATHTUB RING APPROACH

Example: Orient Lake in France (geolocated edge pixels)



Reference bathymetry based on in situ measurements



Good overall agreement between SWOT-derived contour lines and in situ reference bathymetry (above), and partial bathymetry based on S2 images and gauge data (left), but with less detail for this SWOT time series (12 dates only)

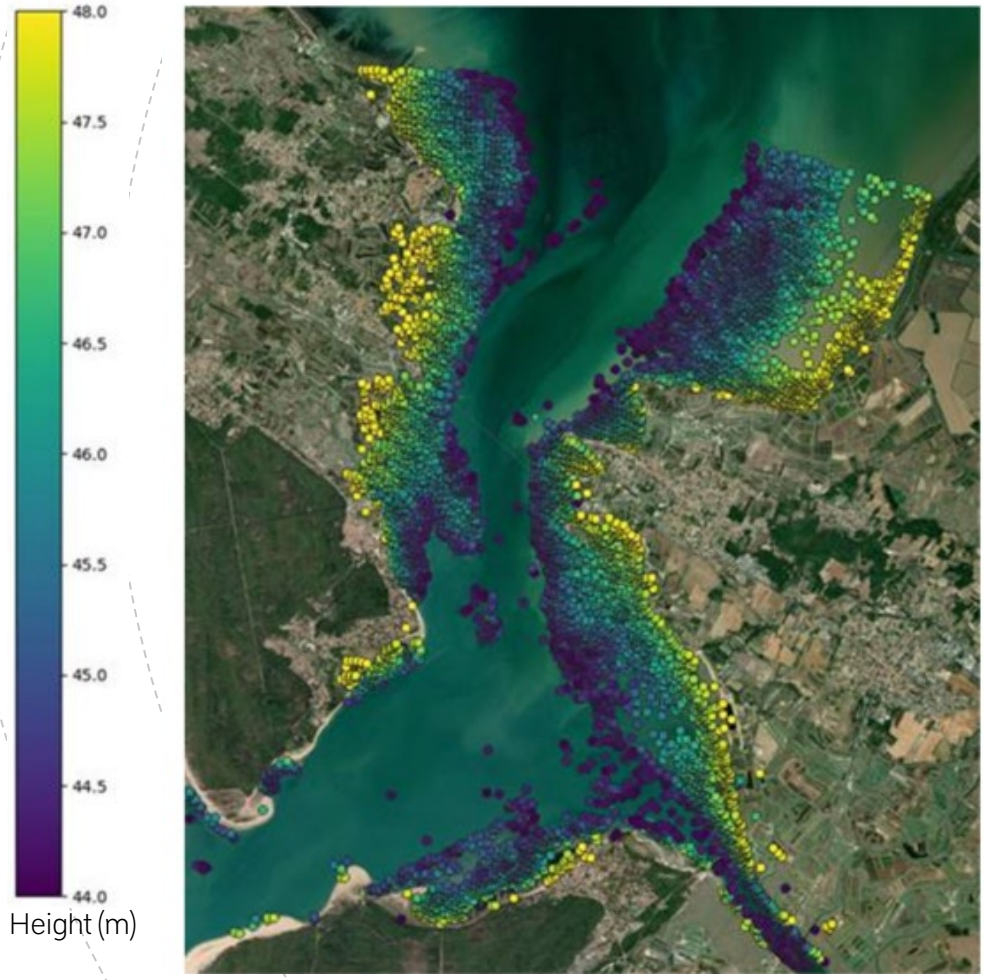
DIRECT HEIGHT EXTRACTION

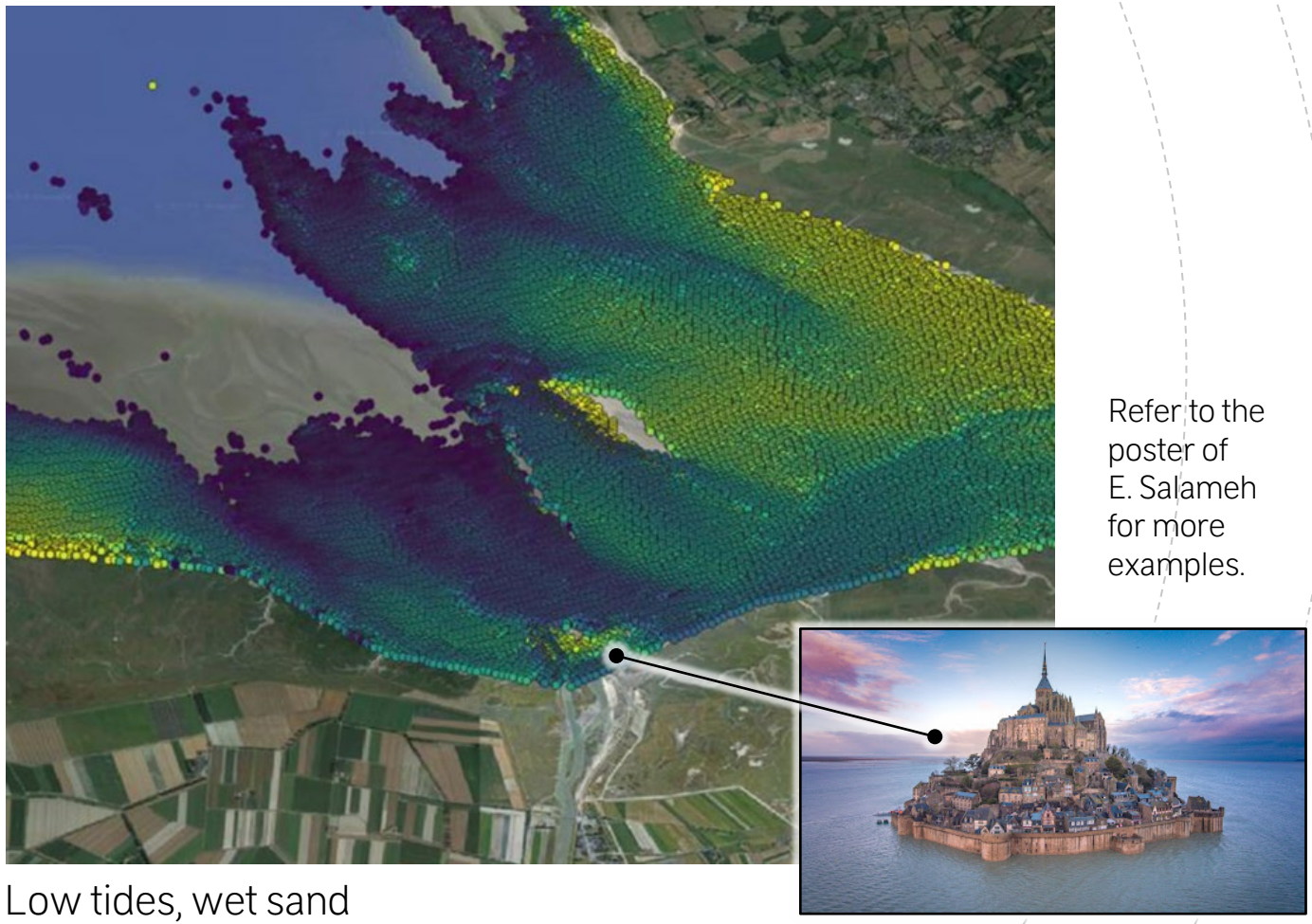
Principle and limitations

- Pre-launch hypothesis was that only water surfaces provide sufficient backscattering to perform interferometric height extraction based on SWOT HR data.
- However, some land surfaces including floodplains and intertidal coastal areas turn out to have sufficient signal to allow direct height extraction based on interferometry.
- With this approach, each acquisition (in favorable conditions) can provide a partial bathymetry, with the possibility to aggregate results over time.
- Limitations and challenges:
  - Layover will deteriorate DEM when the terrain slope exceed SWOT incidence (1°-4°)
  - Acquisitions at low tide / low water level provide the most information
  - Intertidal areas / floodplains not always detected as water (specific tuning would be better)
  - Water areas need to be distinguished and subtracted
  - Between observed min and max water level only (like with bathtub ring approach)
- Promising results obtained in coastal areas (wet sediments) and for certain floodplains (dry sediments)

DIRECT HEIGHT EXTRACTION

Example: Intertidal bathymetry in Moeze Oleron and Mont Saint-Michel Bay (France)



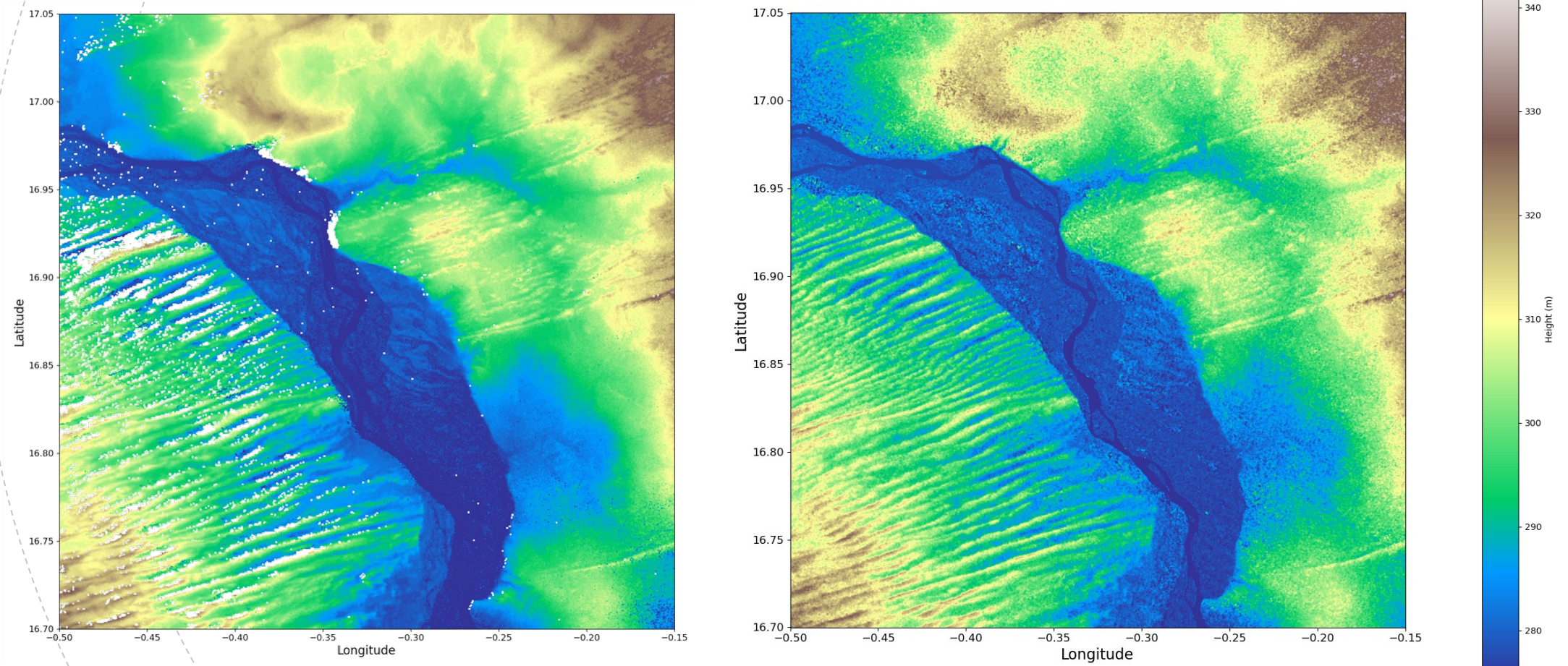


Low tides, wet sand

Refer to the poster of E. Salameh for more examples.

DIRECT HEIGHT EXTRACTION

Example: Niger River – SWOT DEM (left) vs. SRTM (right)



Water detection deactivated (all pixels kept). The main limitation for SWOT DEM is layover (white areas).

SUMMARY AND OUTLOOK

- Despite promising results on some sites, the capacity of the bathtub ring approach to provide a global floodplain DEM based on PIXC/PIXCVec products is uncertain, mainly because of
  - Frequent over-detection of water (bright land)
  - Pseudo-random variations in elevation and extent
- However, direct extraction of bathymetry based on interferometry has proven successful in intertidal areas (mostly wet sediments) and for certain floodplains (may also be dry)
  - Limited to moderate topography because of layover (for slopes > incidence angle of 1°-4°)
  - May need specific PIXC processing (to include more land pixels)
- A large-scale (global) floodplain DEM product only seems possible towards the end of the mission
  - A lot of algorithm development and testing remain
  - A multisensor approach could be an option

BACK-UP

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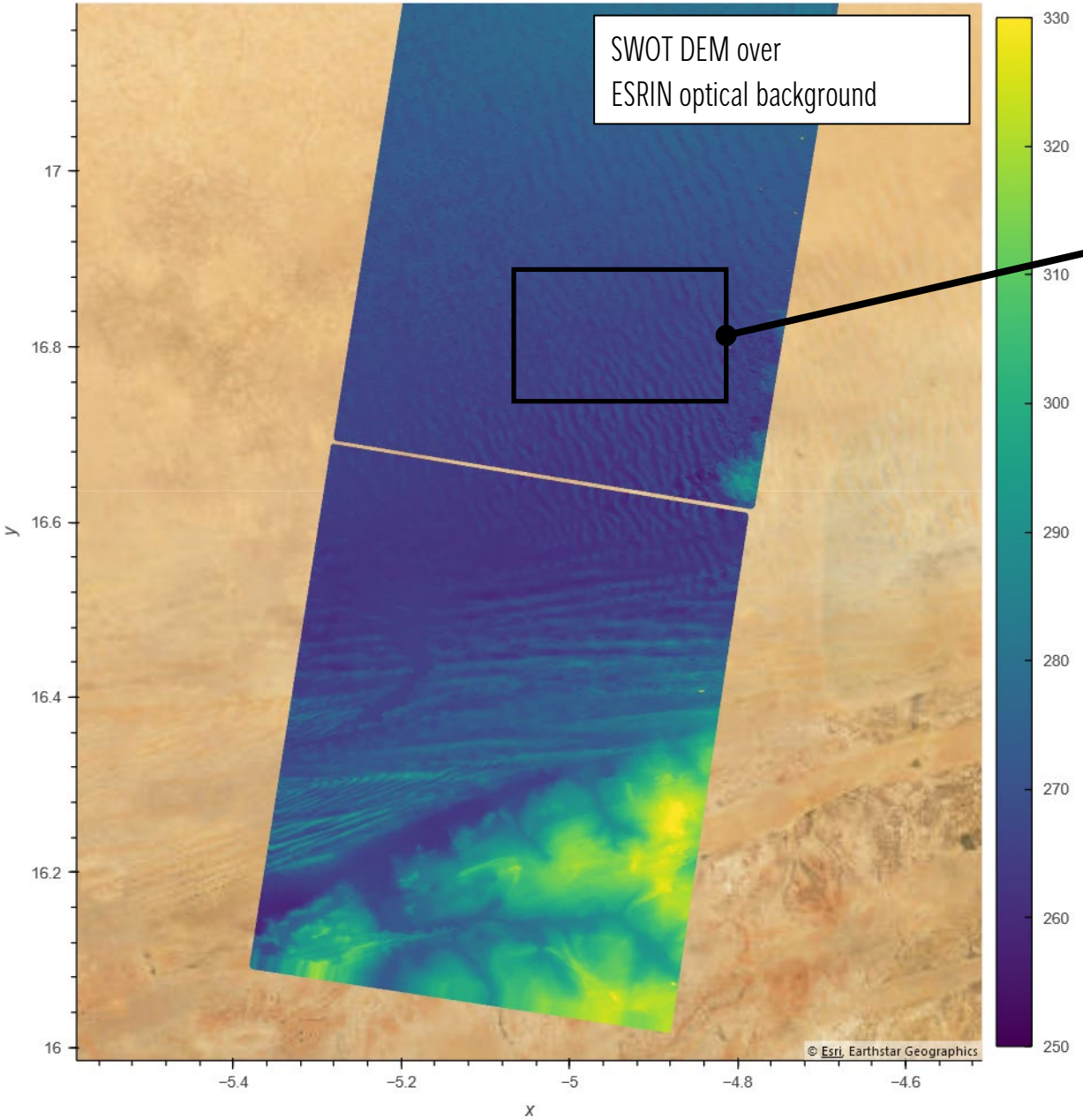
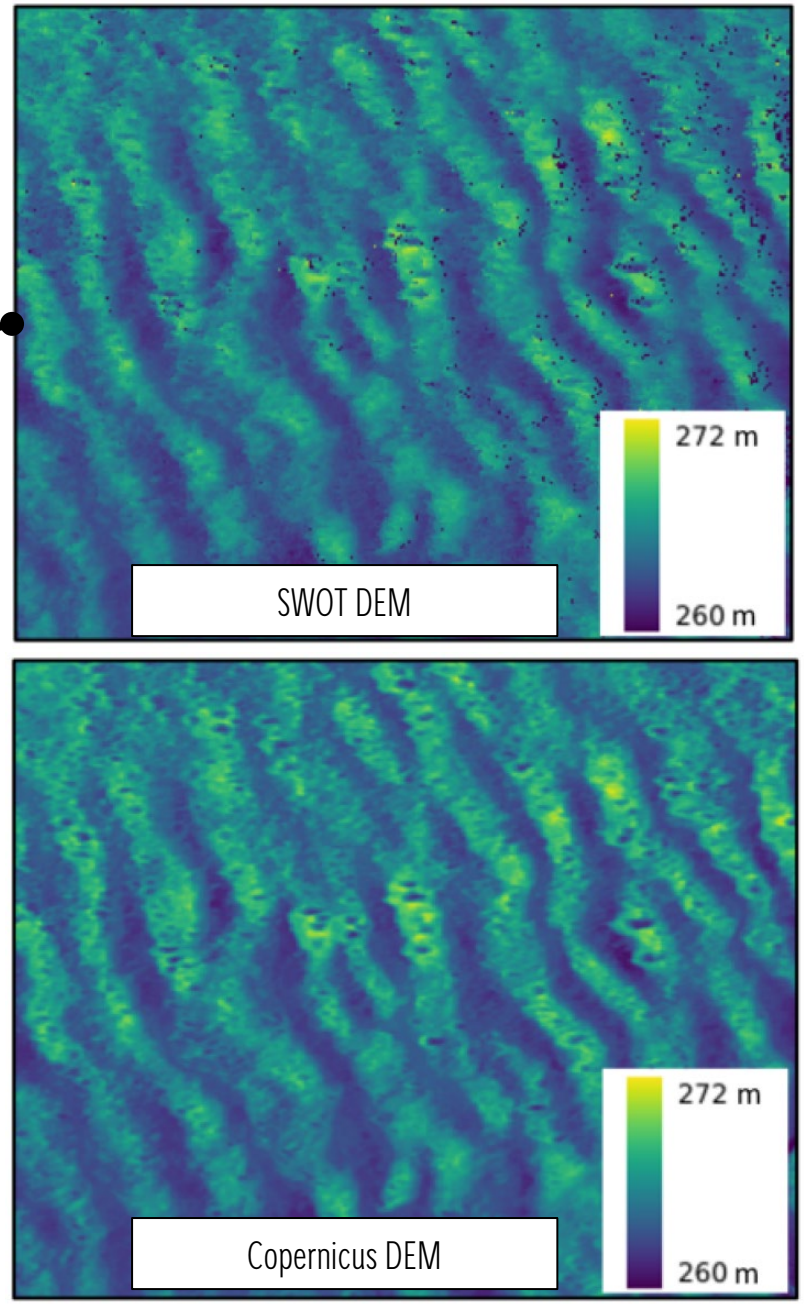
Sahara Dunes & SWOT DEM

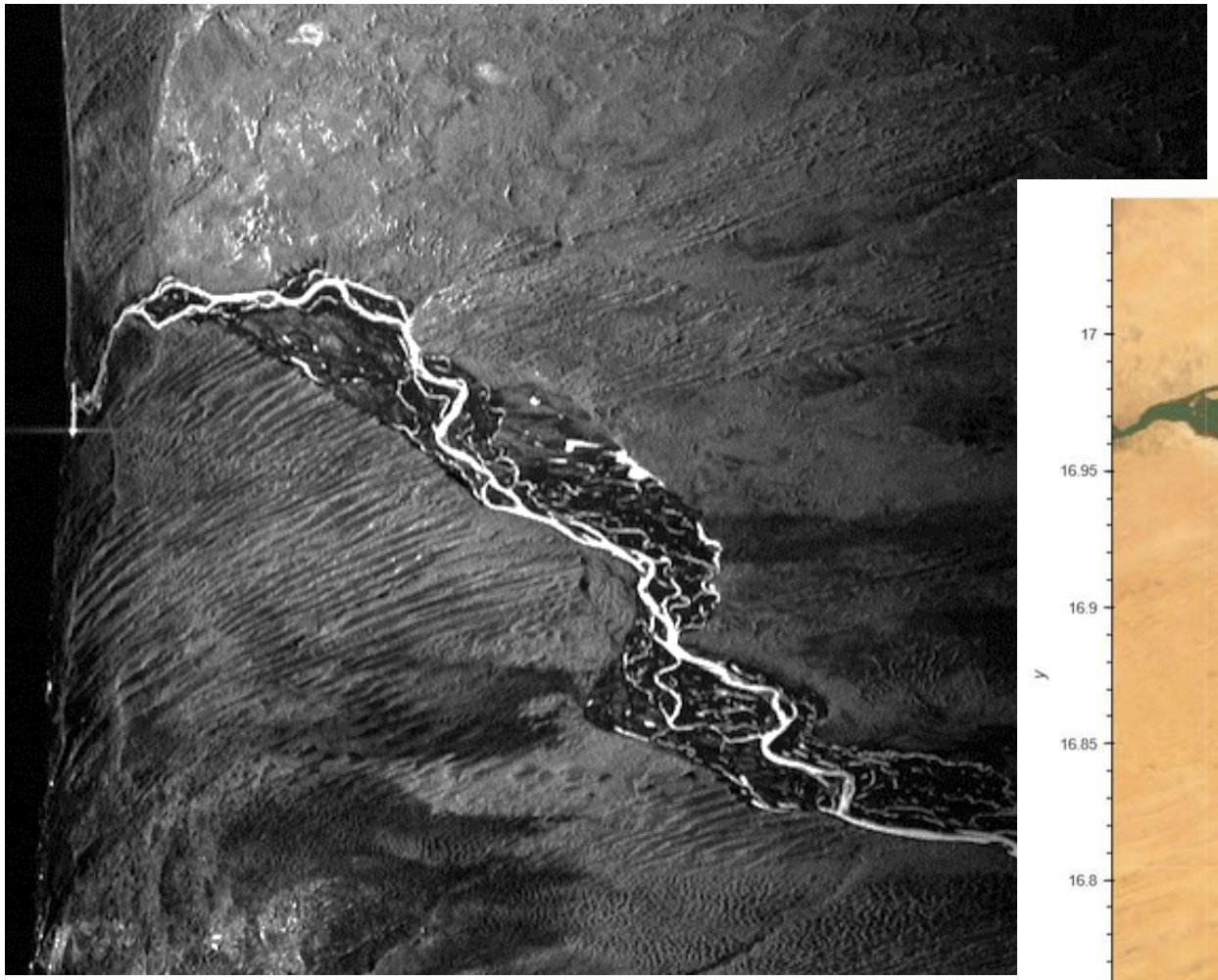
Credits: CNES





NB: The main limitation for SWOT DEM is layover (i.e. precise on relatively flat terrain, e.g. floodplains…)

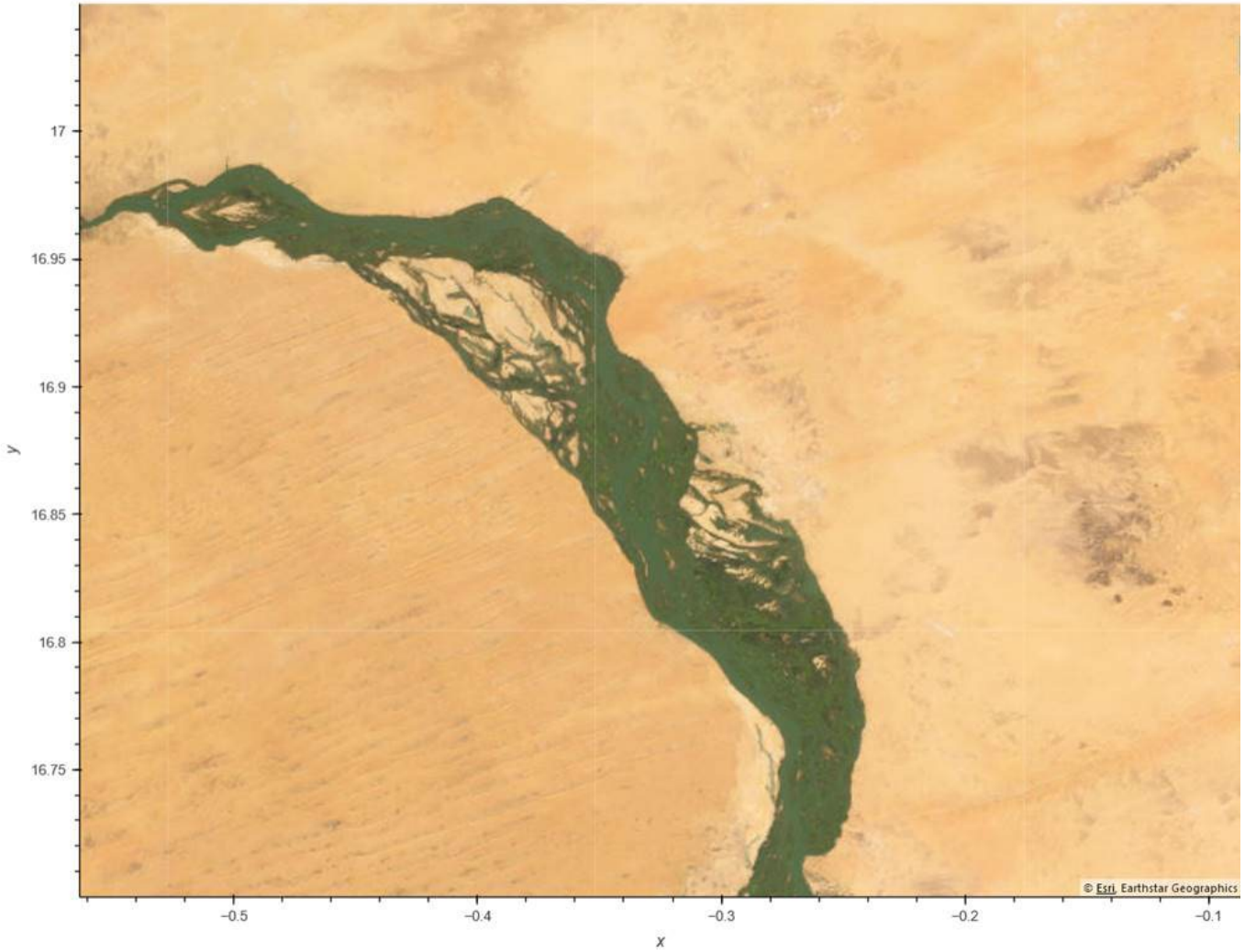
DIGITAL ELEVATION MODEL IN NIGER



KaRIN NRCS

Very bright water as expected

Bright background as well



The water detection (used by default) will keep only water

If it is switched off, SWOT yields a pseudo-DEM

Credits: CNES