Global assessment of SWOT small-scale performance via synergy with surface chlorophyll observations

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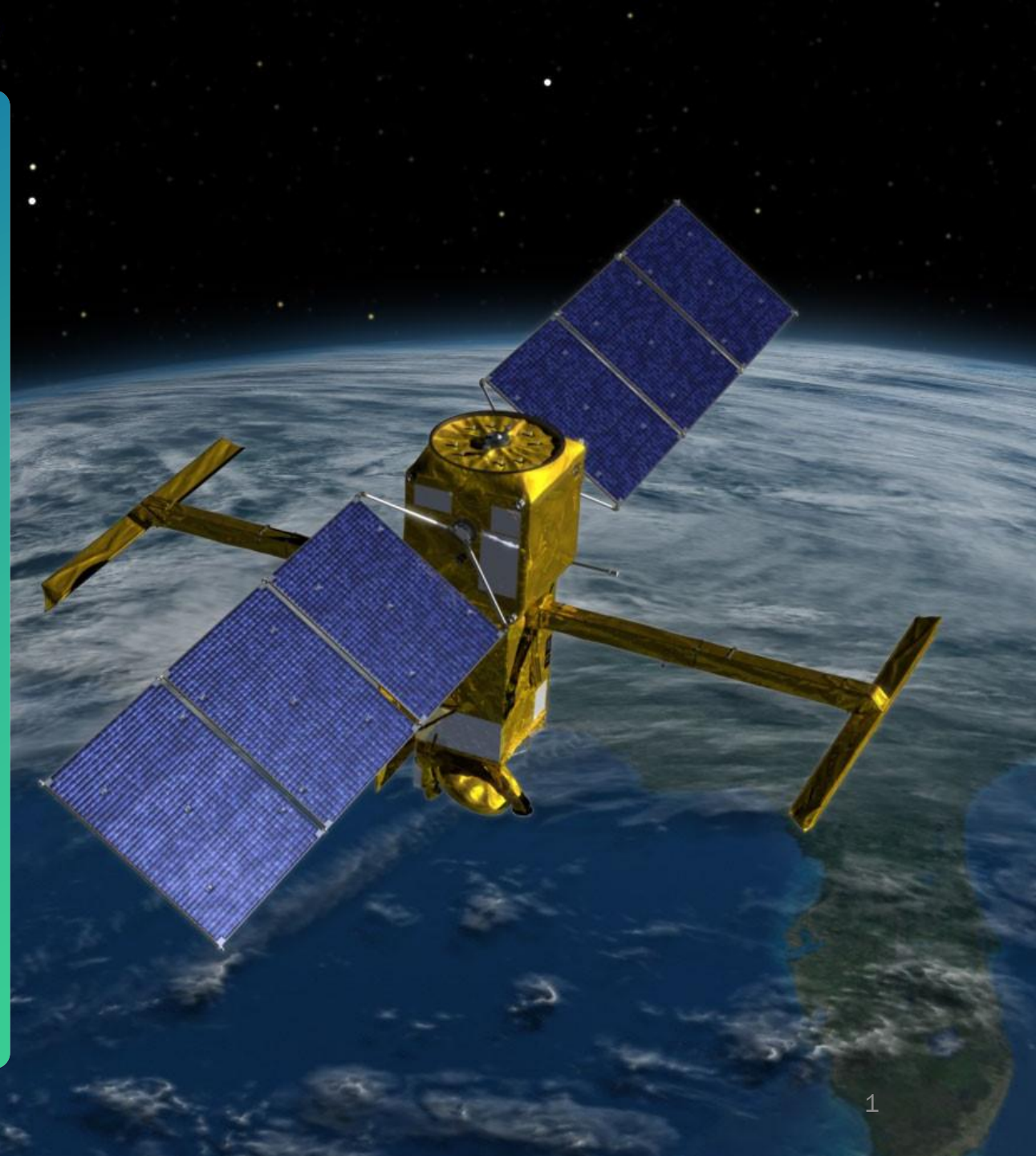
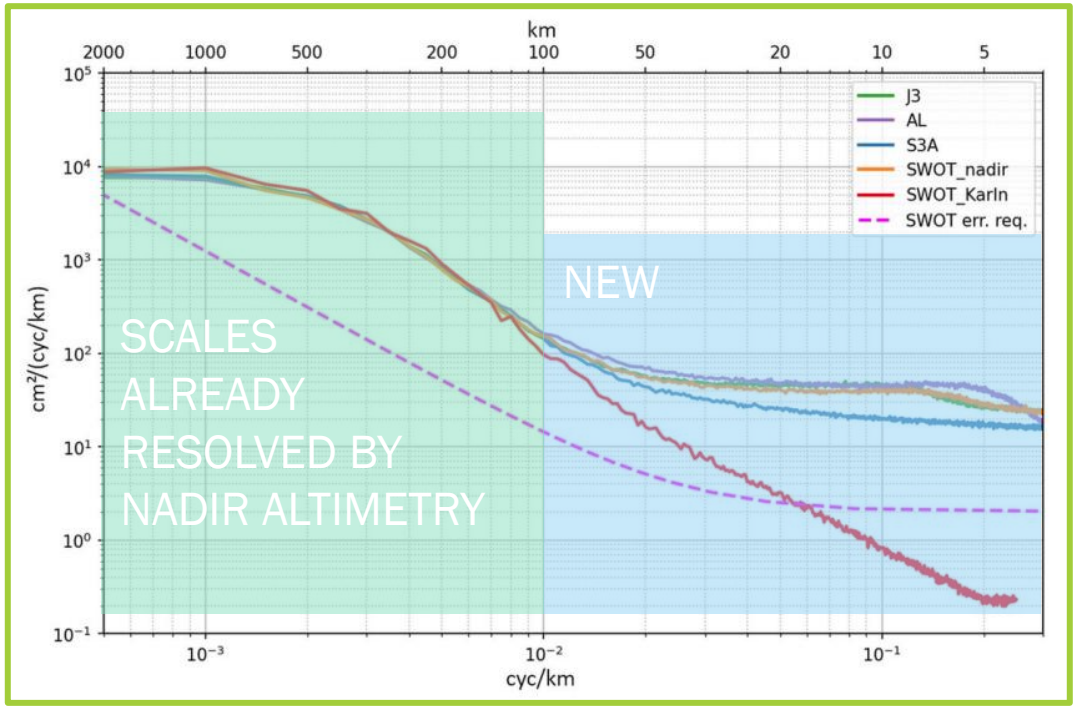


Context

❑ New topography content at scales < 100 km with SWOT KaRIn as showed in Fu et al. (2024)

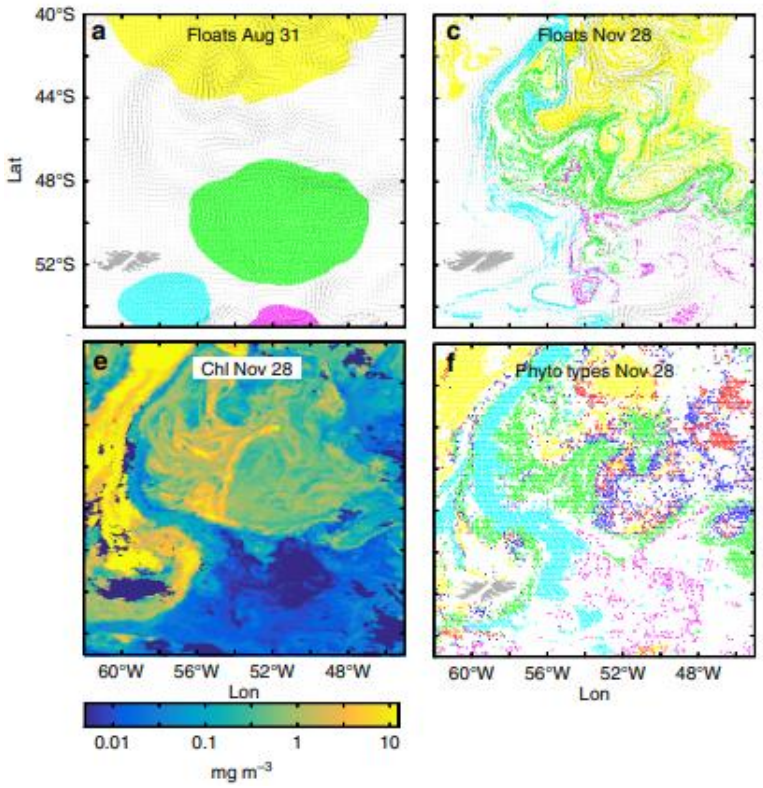


Objective:

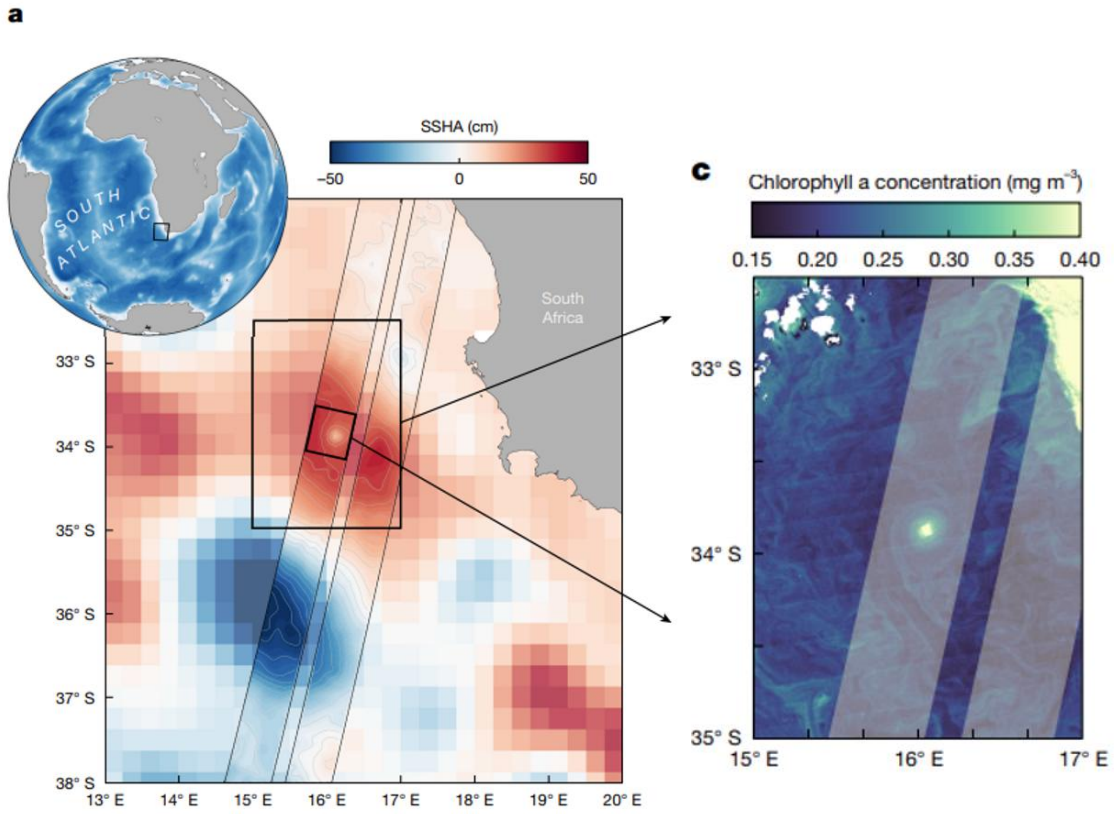
- ➢ Better understand the content of SWOT KaRIn Topography at scales < 100 km
- ➢ Show that KaRIn reflects real oceanic features and is not the result of any instrumental artifacts or other measurement error.

Context

- ❑ Chlorophyll (CHL) is driven by several processes, but to a first order its spatial distribution is controlled by surface circulation (left figure).
- ❑ A large component of surface circulation is geostrophic, therefore directly associated with topography gradients.
- ➢ Thus, we can use **correlation between CHL and topography to assess quality of the small-scale detected by KaRIn.**

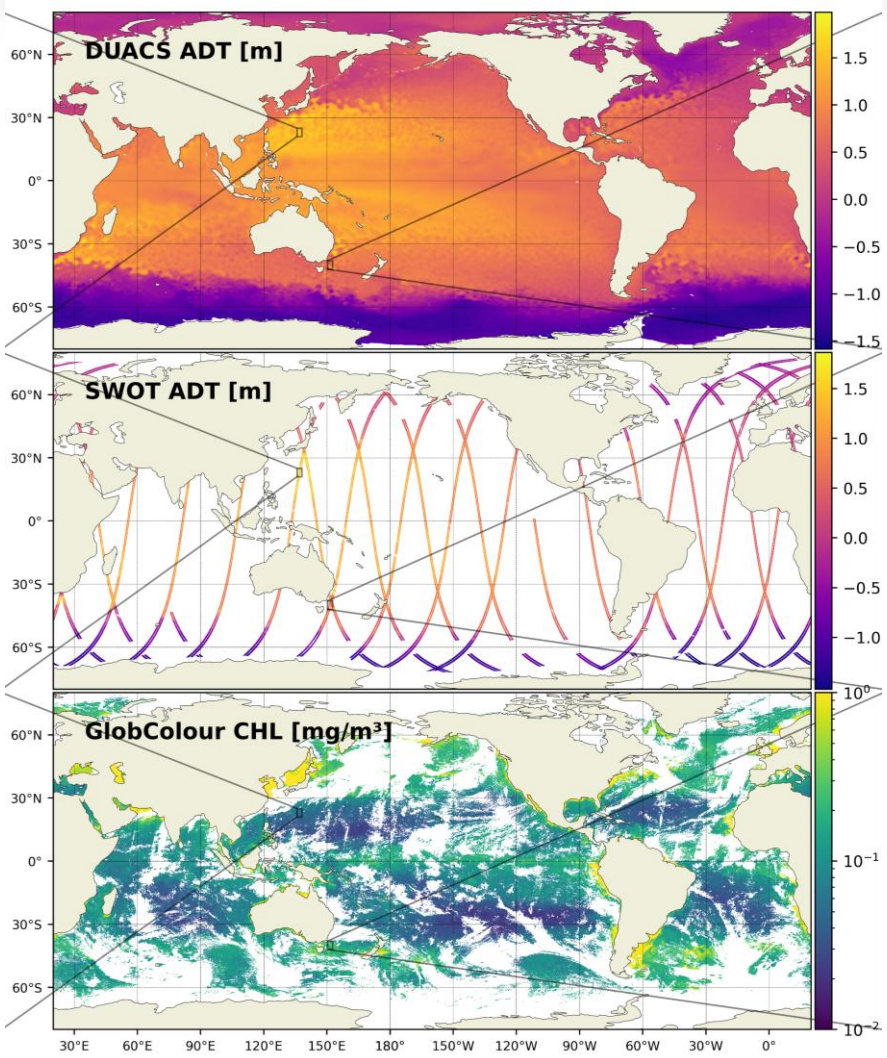


Source: D'Ovidio et al. (2018)



Adapted from Archer et al. (2015)

Data



DUACS grid (MIOST interpolator) from conventional nadir altimetry
→ used as a reference

https://data.marine.copernicus.eu/product/SEALEVEL_GLO_PHY_L4_MY_008_047

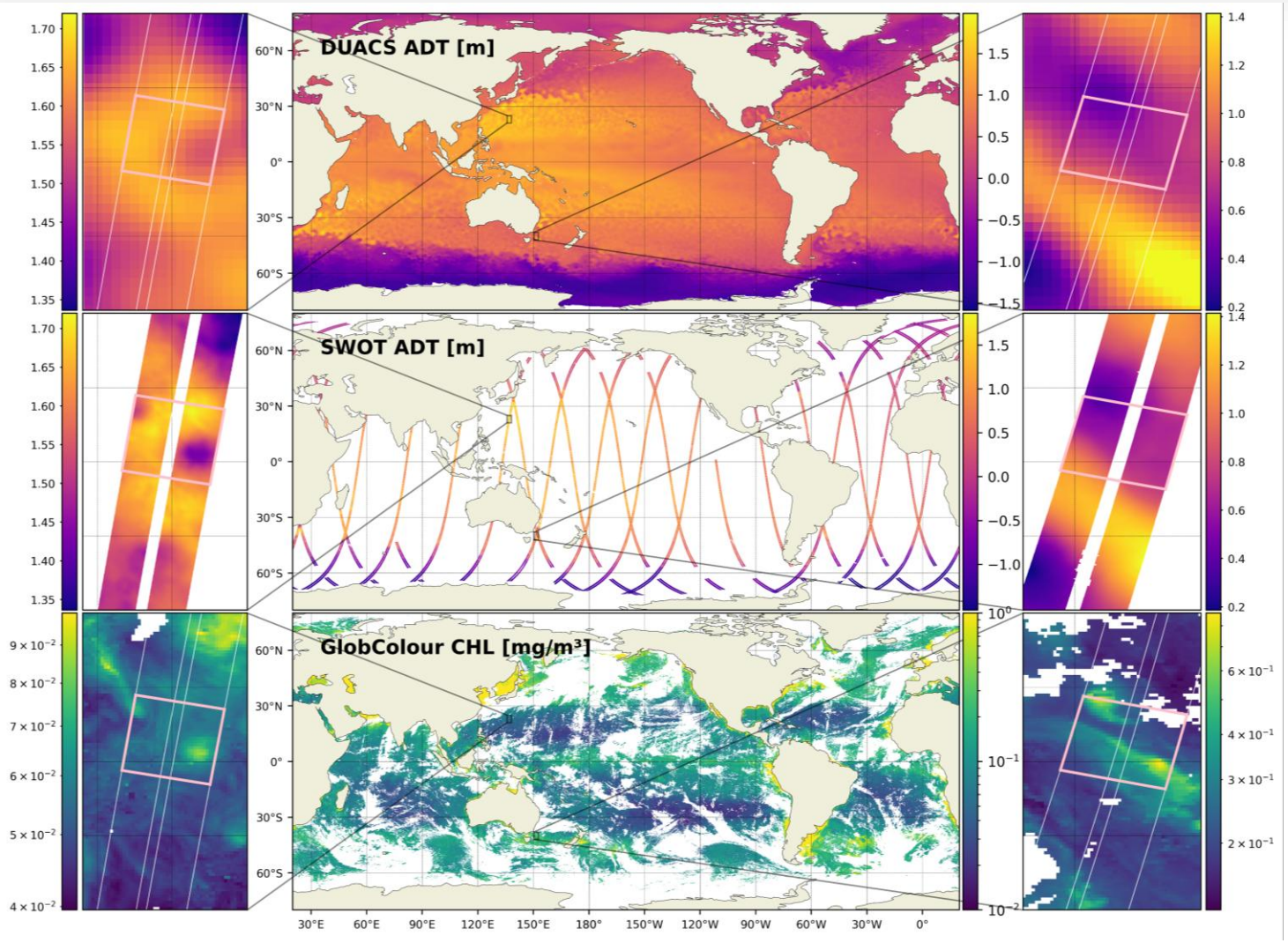
KaRIn Swath :
L3_SWOT_LR_SSH_Basic_V1.0.2
2 km x 2 km grid

https://www.aviso.altimetry.fr/en/data/products/sea-surface-height-products/global/swot-l3-ocean-products.html

Grid CHL:
Multi mission product
Daily grid // Res: 4 km x 4 km
Cloud gaps

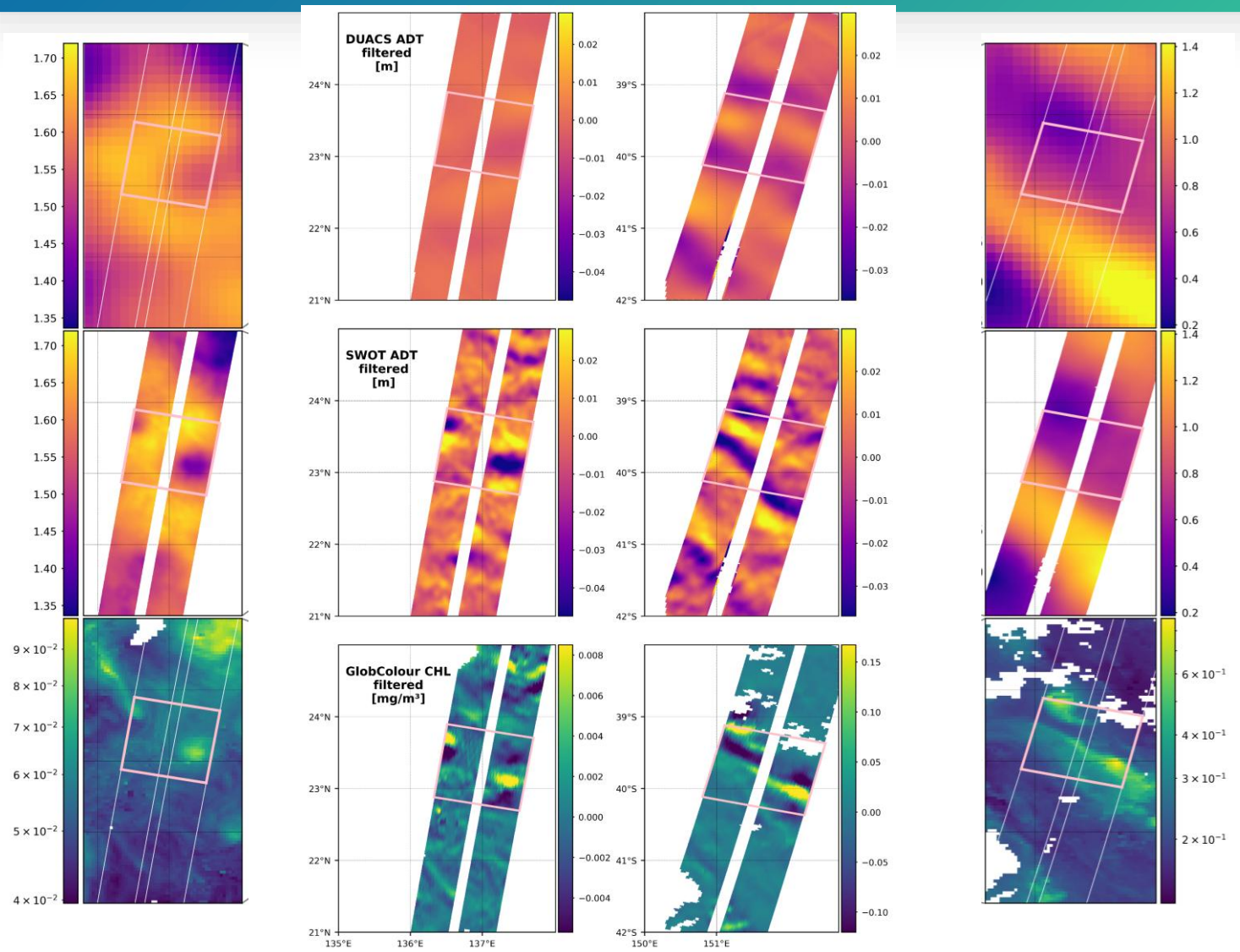
https://data.marine.copernicus.eu/product/OCEANCOLOUR_GLO_BGC_L3_MY_009_103/description

Methods – Interpolation & Filtering



1. **Interpolation :** DUACS grid and CHL grid are interpolated over the SWOT swath

Methods – Interpolation & Filtering



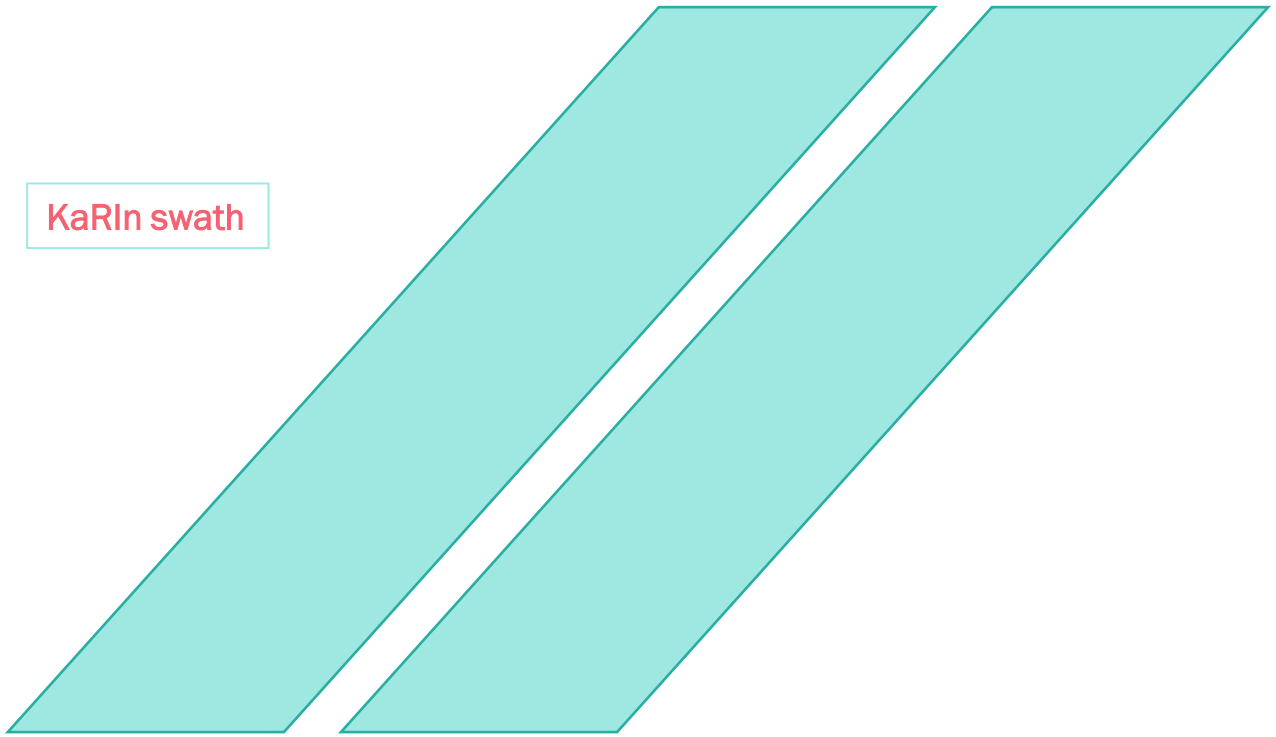
1. **Interpolation :** DUACS grid and CHL grid are interpolated over the SWOT swath

2. **Filtering :** All fields are along-track band-pass filtered between 100km and 15km
   - ➢ Suppress large-scale gradient and speckle-like noise.

Focus on correlation at small scales

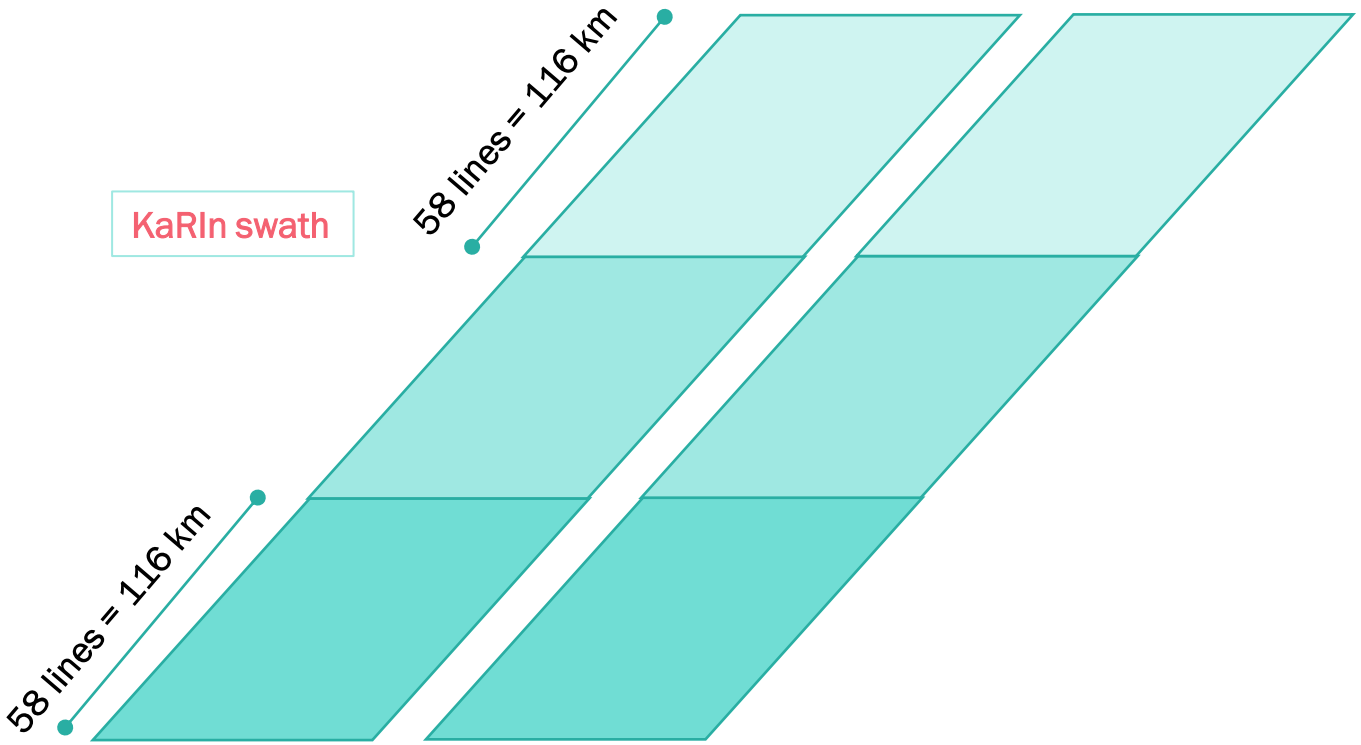
(Implementation of a robust 2D filter not possible due to edge effects at the swath boundaries)

Methods – Correlation calculation



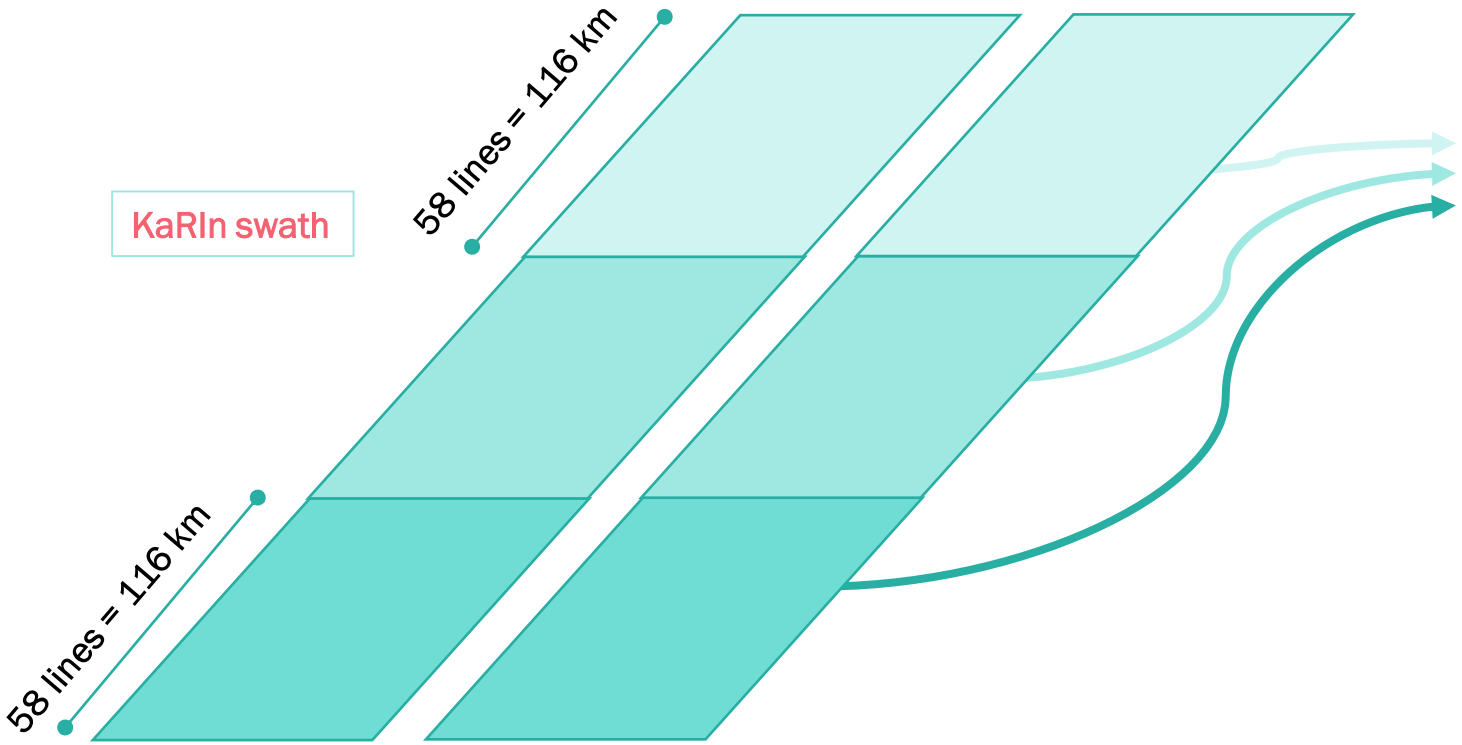
Methods – Correlation calculation

1- Swath is divided into equal sections of 58 lines (116 km – along-track)



Methods – Correlation calculation

2- Calculation of correlation coefficient over each section



Correlation coefficient between ADT (Topography) and CHL

$$Corr = \frac{E((E(ADT) - ADT)(E(CHL) - CHL))}{\sigma(ADT) * \sigma(CHL)}$$

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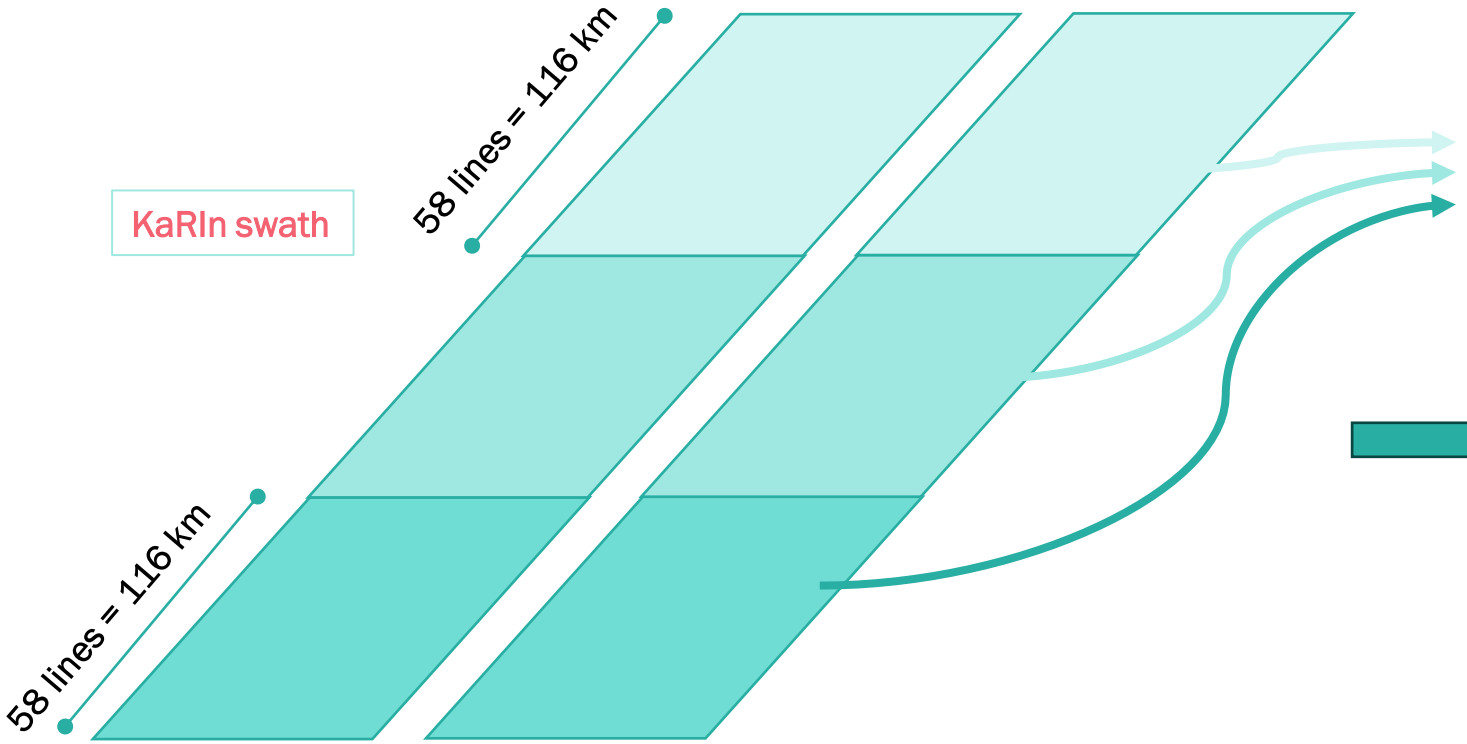

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Calculation of the correlation coefficients over 1 year during the Science Phase.

Methods – Correlation calculation

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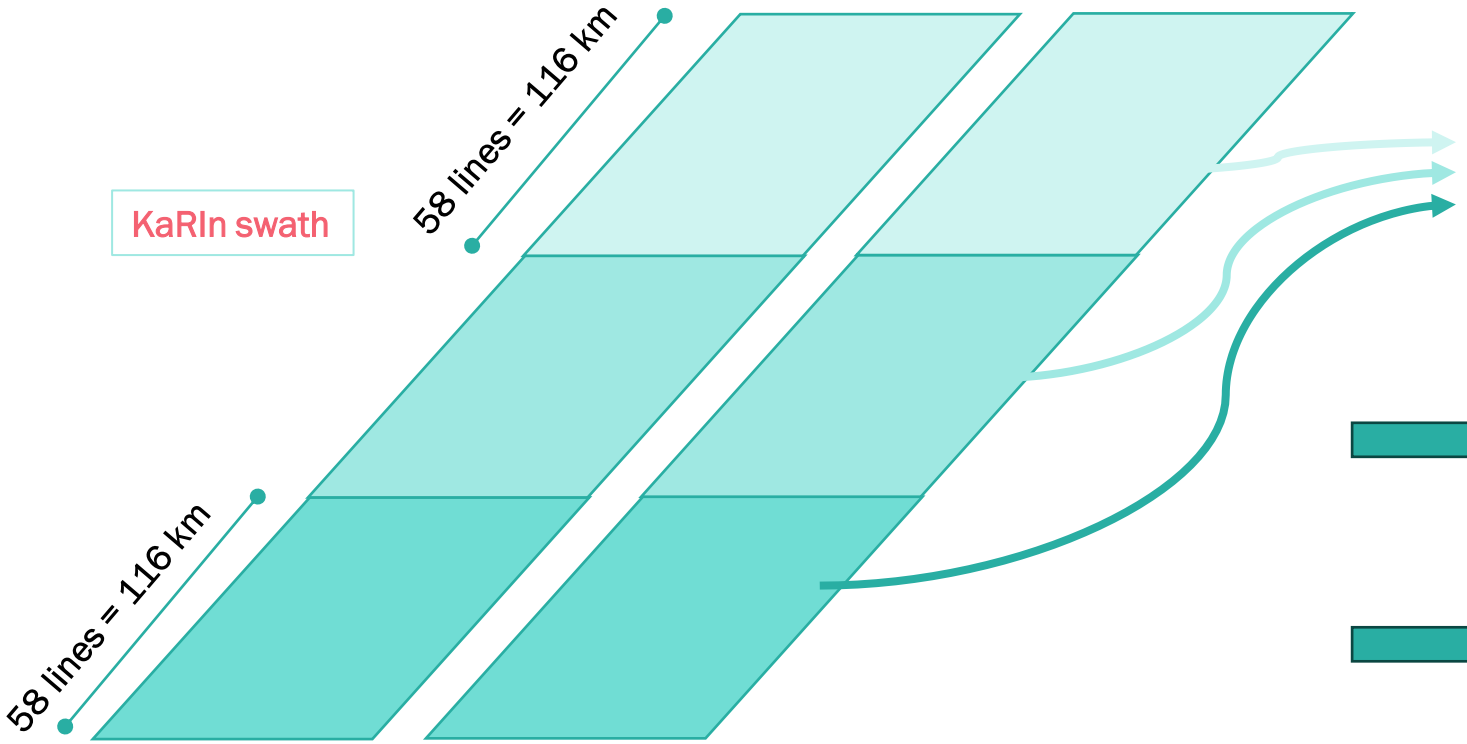

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$$Corr = \frac{E((E(ADT) - ADT)(E(CHL) - CHL))}{\sigma(ADT) * \sigma(CHL)}$$

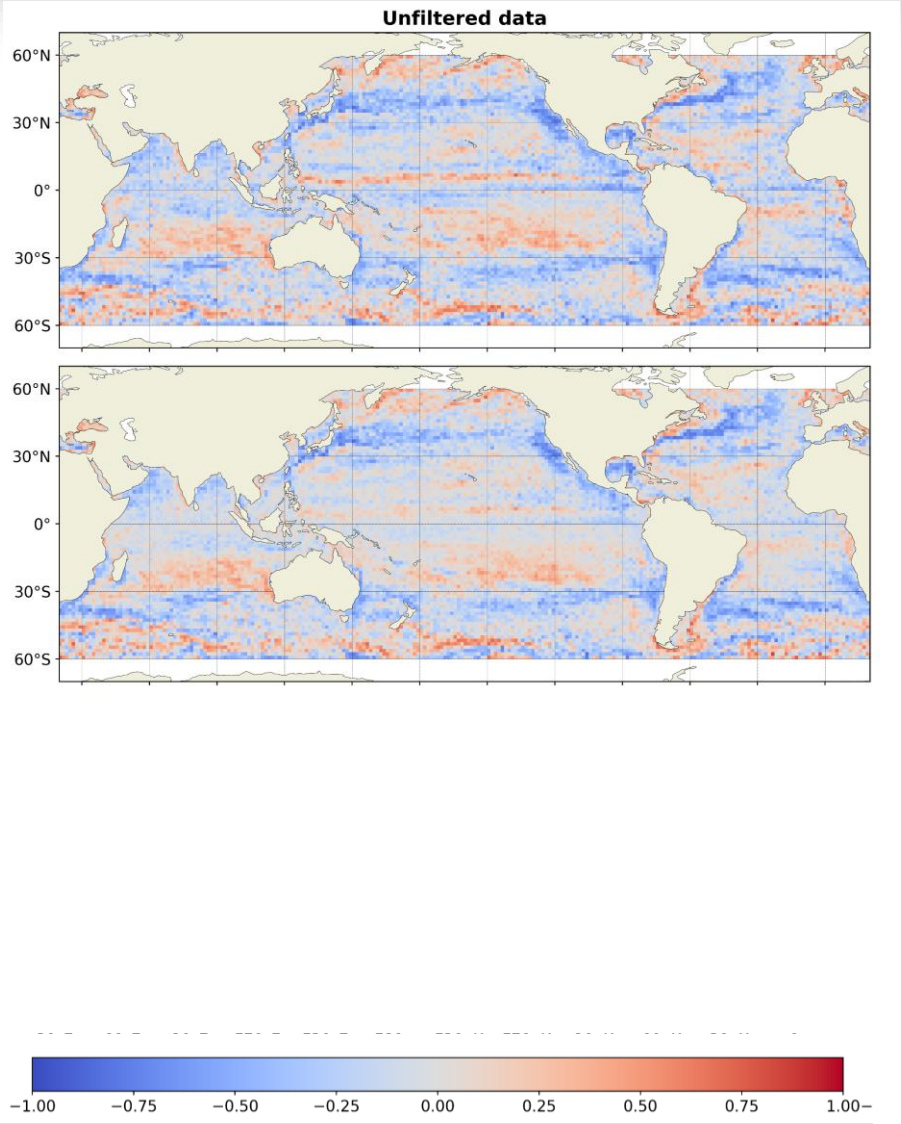
Calculation of the correlation coefficients over 1 year during the Science Phase.

Global binned maps [1.5° x 1.5°] of correlation coefficients are made. The coefficients are binned using the **median**.

Results – All scales (no filtering)

ADT DUACS
correlated with CHL

ADT KaRIn
correlated with CHL



- Regions with strong positive and negative correlations are revealed
- **No major difference between KaRIn and DUACS** (except for the equatorial band)

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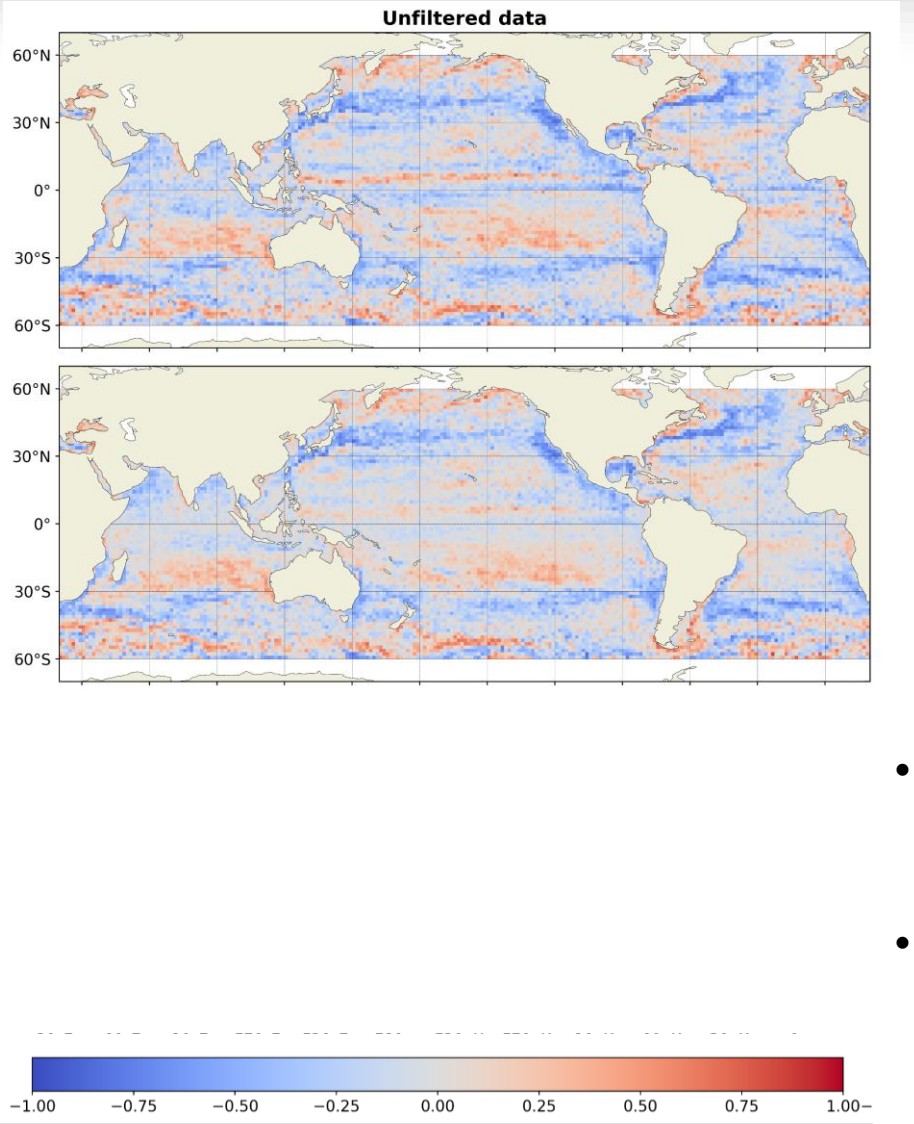

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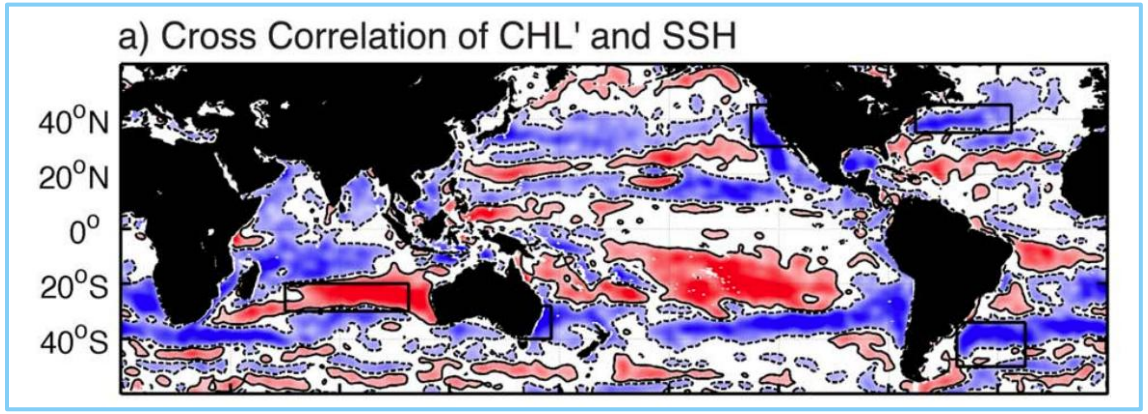


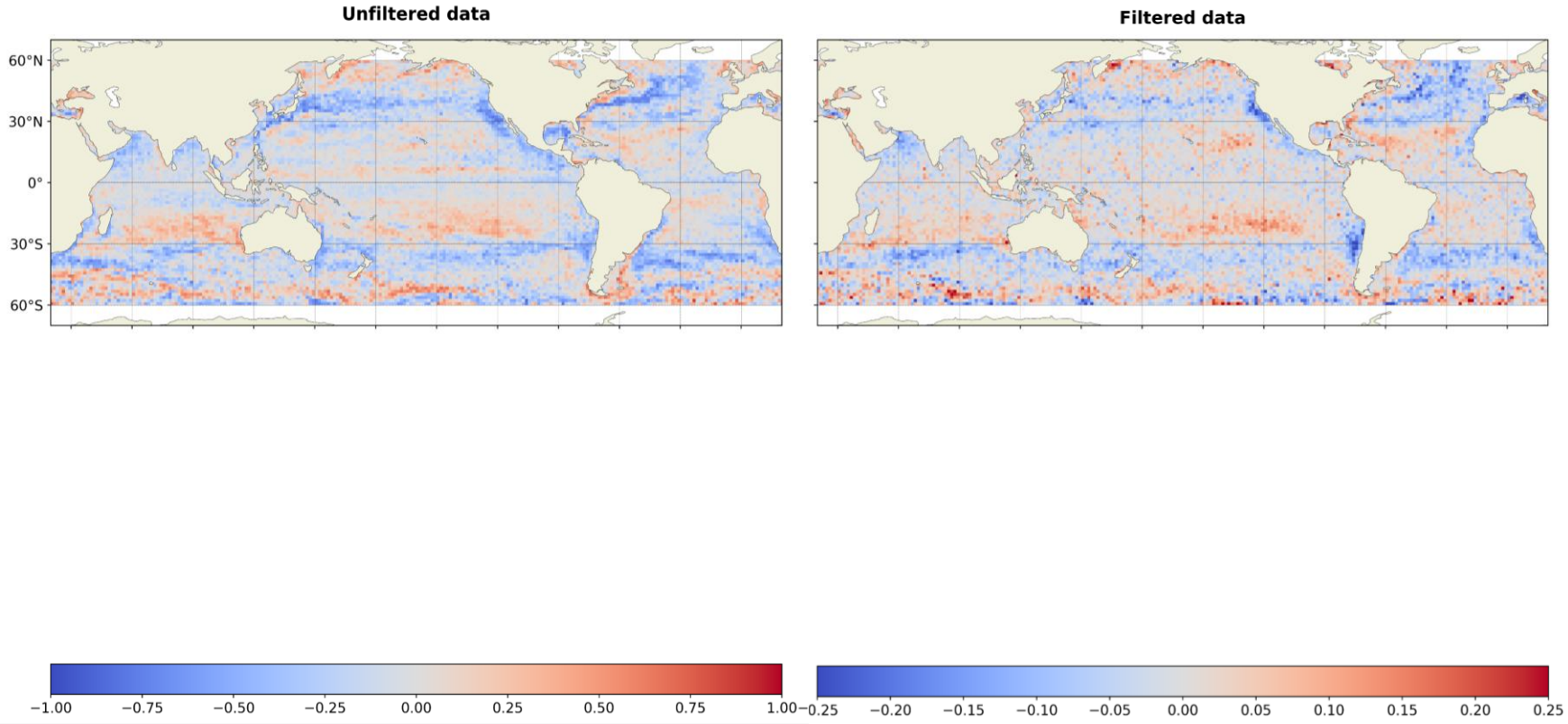
- Regions with strong positive and negative correlations consistent with Gaube et al. (2014)

- Thus, the correlations identified in our analysis are **predominantly associated with retentive structures**

Results – Small scales (< 100 km)

- **Identical regions with strong correlations**
- Lower correlations because of :
  - Difficult exact colocation between ADT and CHL.
  - Small scale CHL patterns not directly controlled by geostrophic velocity.
  - Small scale ADT features not associated with geostrophic current.

ADT KaRIn
correlated with CHL

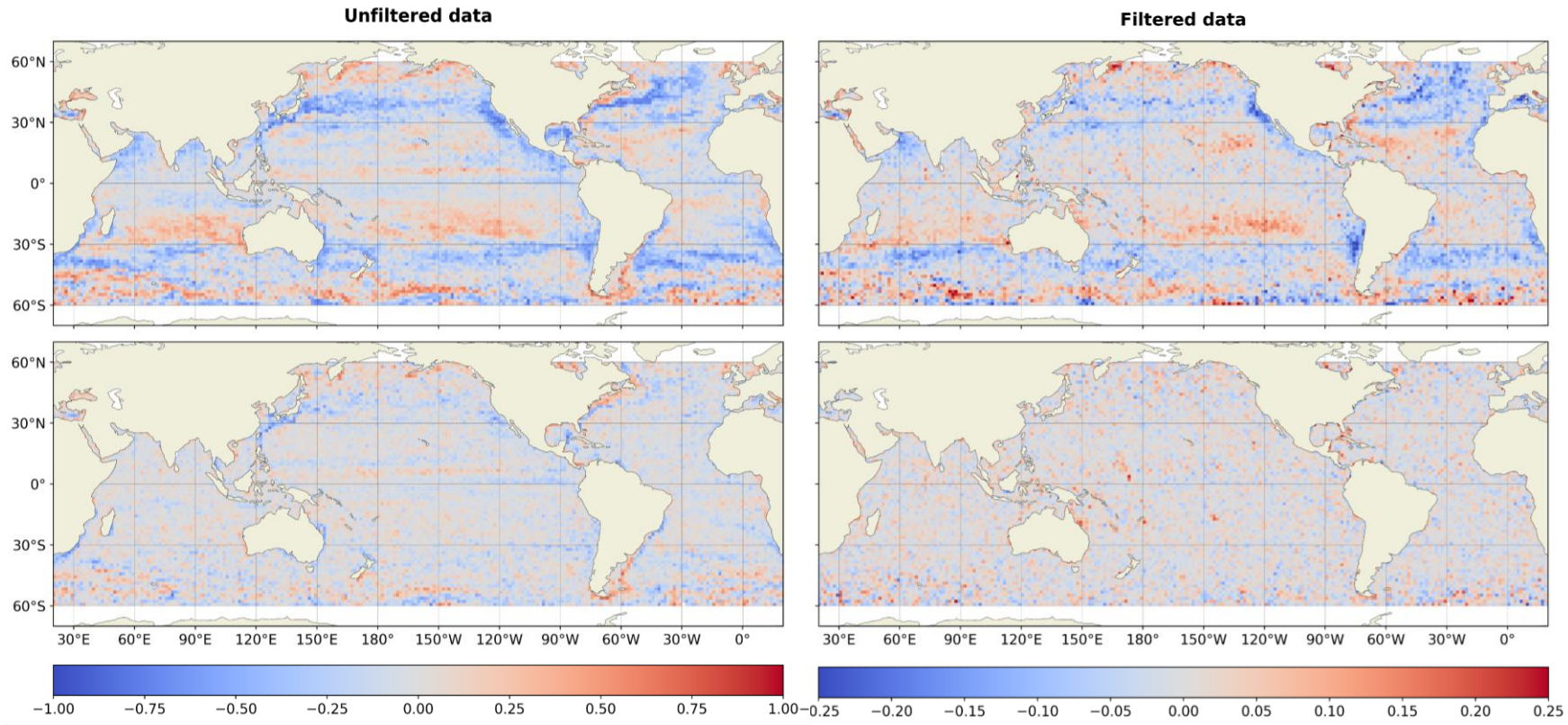


Results – Small scales (< 100 km)

- Analysis repeated with random pairing between ADT and CHL maps.
- No spatial patterns observed in case of random pairing.
- Therefore, the **KaRIn ADT / CHL correlations observed at the small scales are statistically significant.**

ADT KaRIn
correlated with CHL

ADT KaRIn correlated with CHL **"Random"**



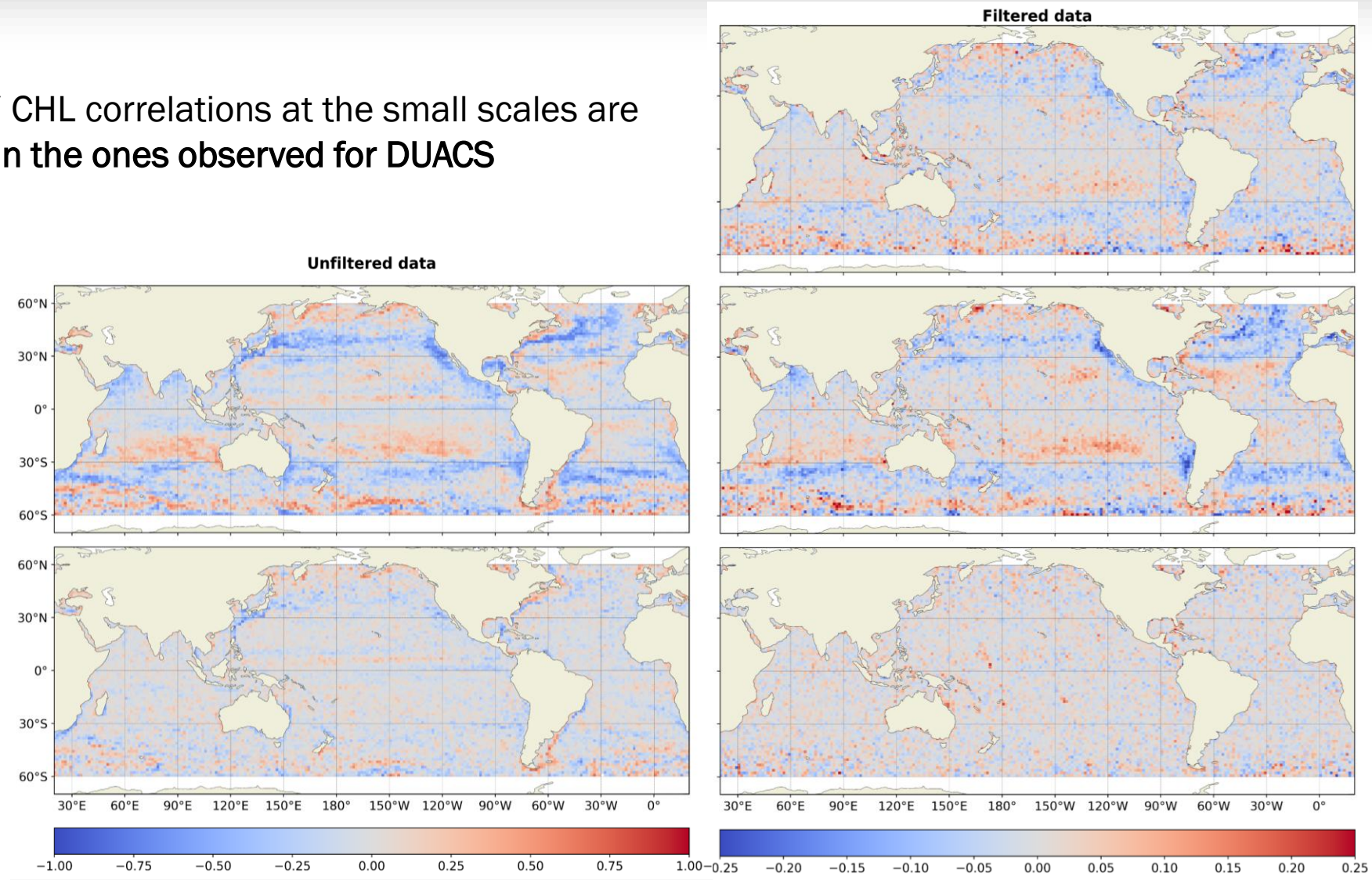
Results – Small scales (< 100 km)

- KaRIn ADT / CHL correlations at the small scales are **stronger than the ones observed for DUACS**

ADT DUACS
correlated with CHL

ADT KaRIn
correlated with CHL

ADT KaRIn correlated with CHL
“Random”



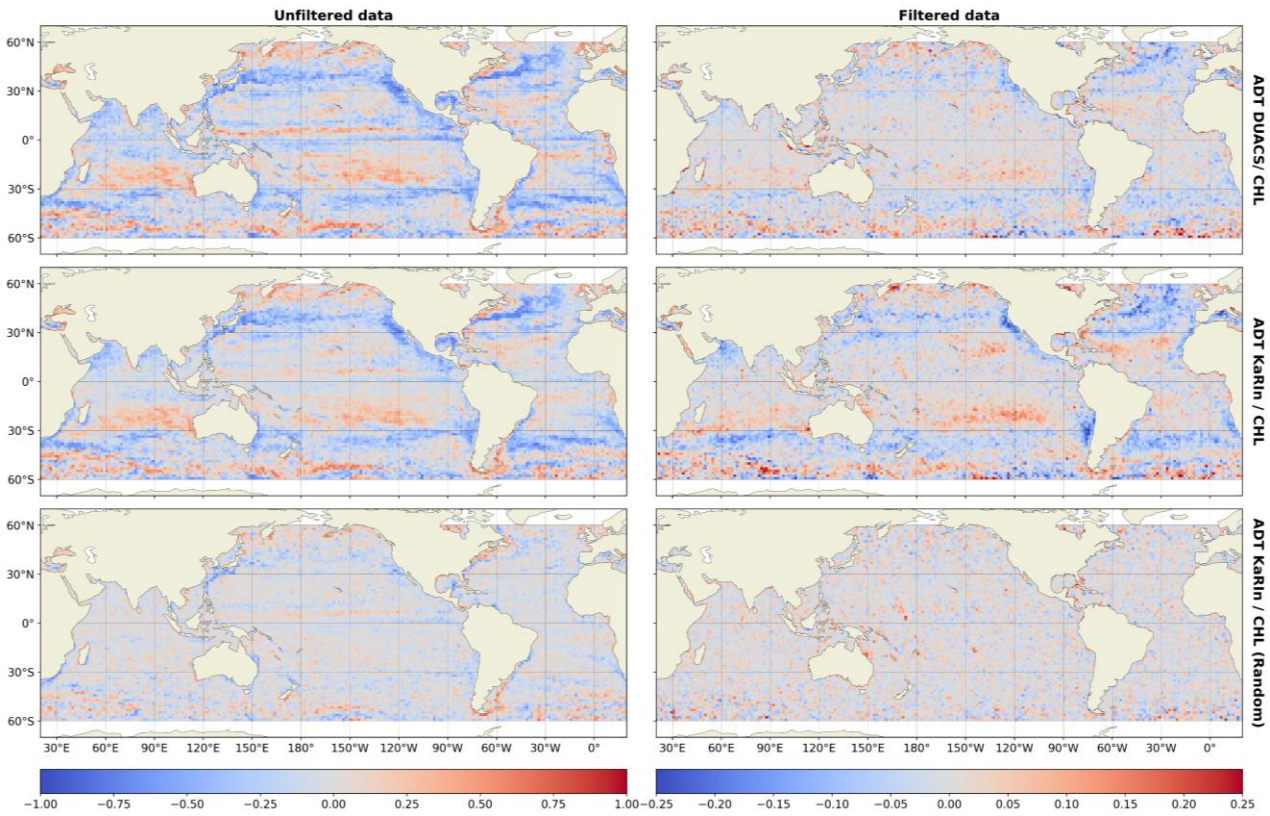
Conclusion

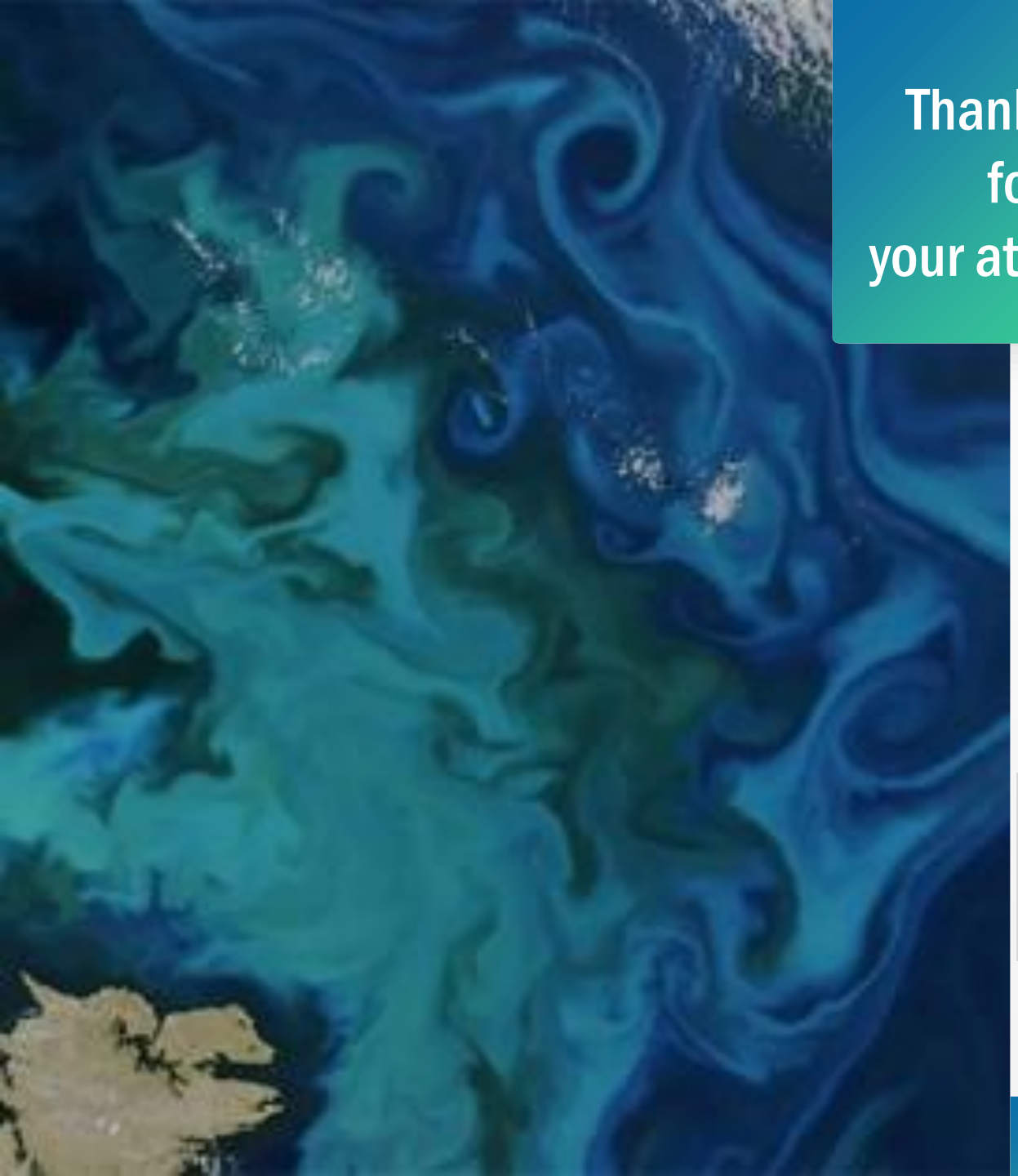
- KaRIn small-scale topography signal is significantly correlated to surface chlorophyll concentration

The topographic signal observed by KaRIn :

→ Can resolve true small-scale (<100 km) oceanic features (i.e. signal not only due to instrumental artifacts or other measurement error).

→ These resolved small-scale geostrophic processes remain inaccessible to current altimetry products across most of the global ocean.





Thank you for your attention

Any questions ?

A. Deniau et al : Global assessment of SWOT performance at the small scale via synergy with surface chlorophyll observations - [Submitted]

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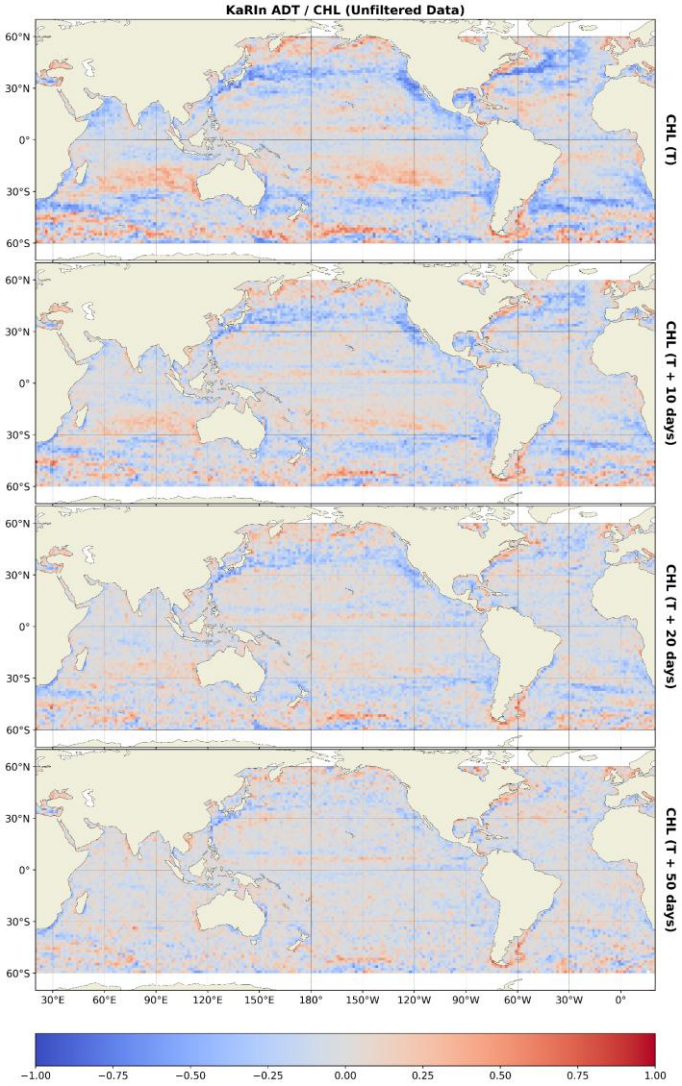
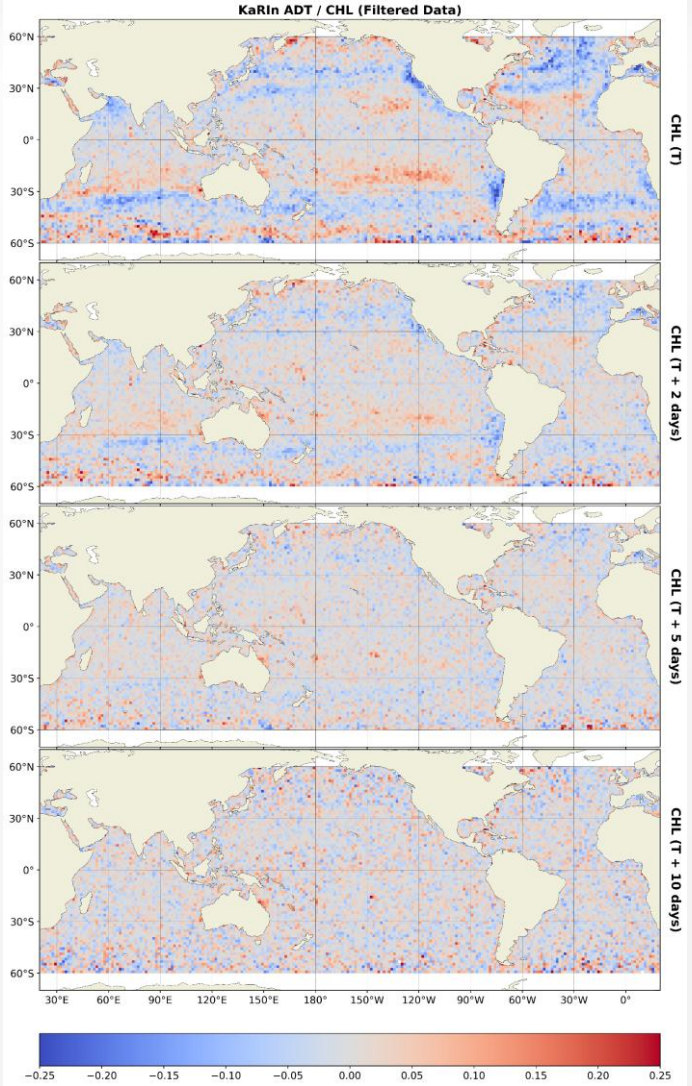
Back-up Slides

Temporal decorrelation Analysis

All scales



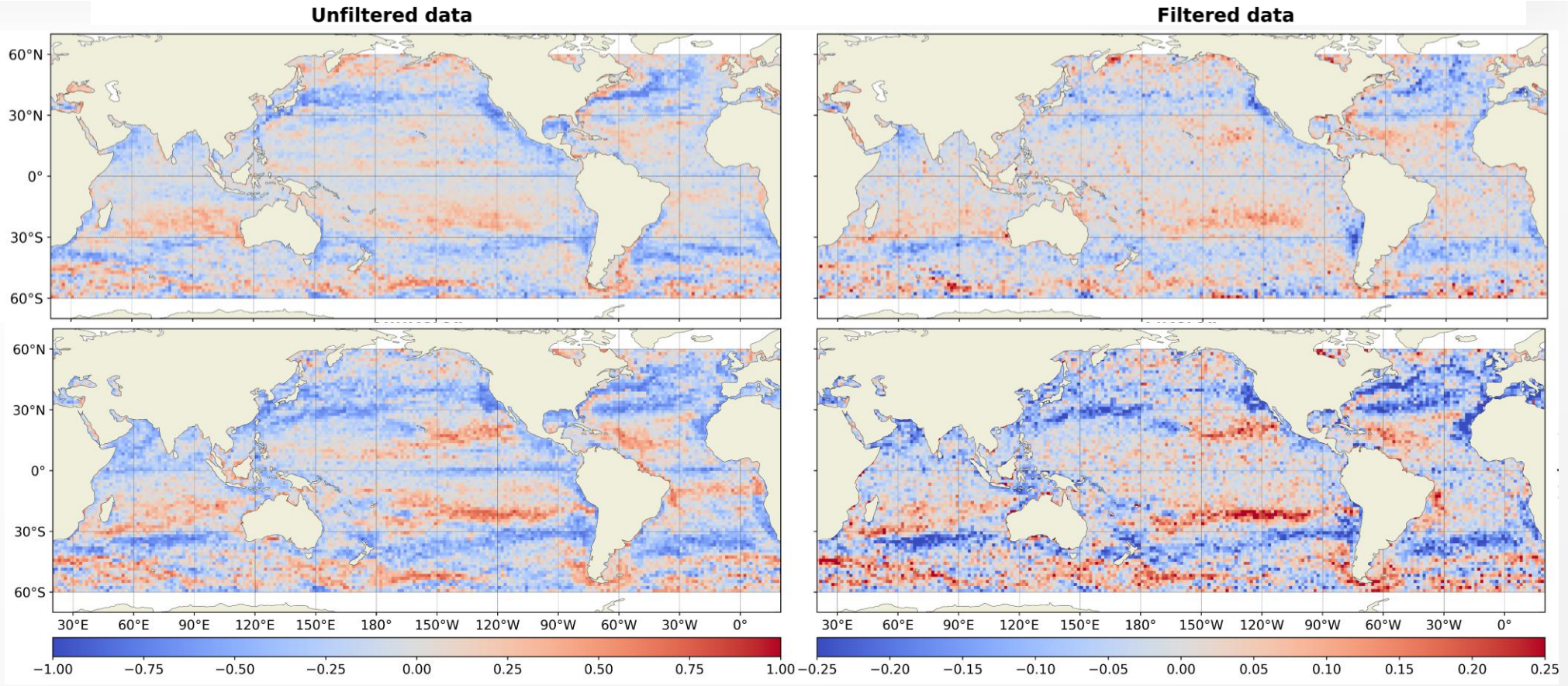


Small scales

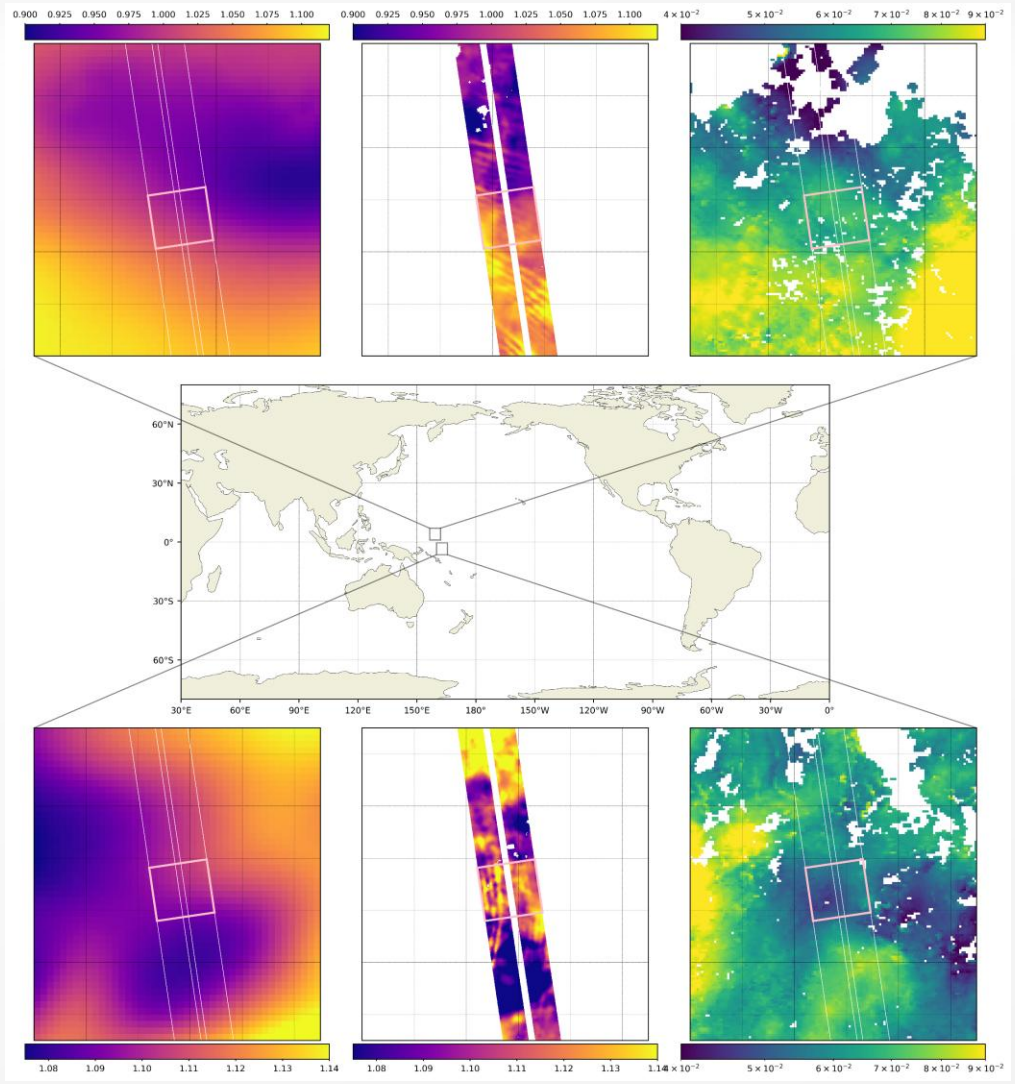
Correlation between CHL and SST

CHL / ADT KaRIn

CHL / SST



Equatorial effects



Spectra Analysis