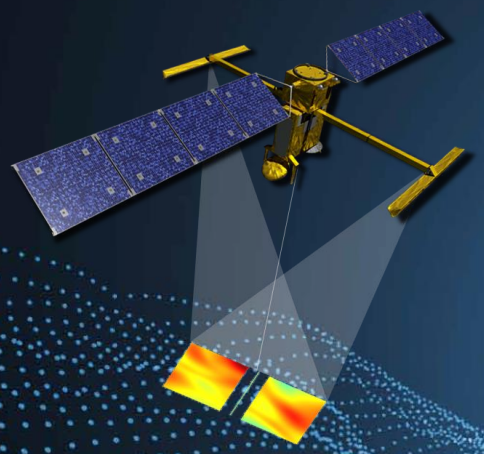

Detection capabilities of a multi-satellite wide-swath altimetry conceptual mission

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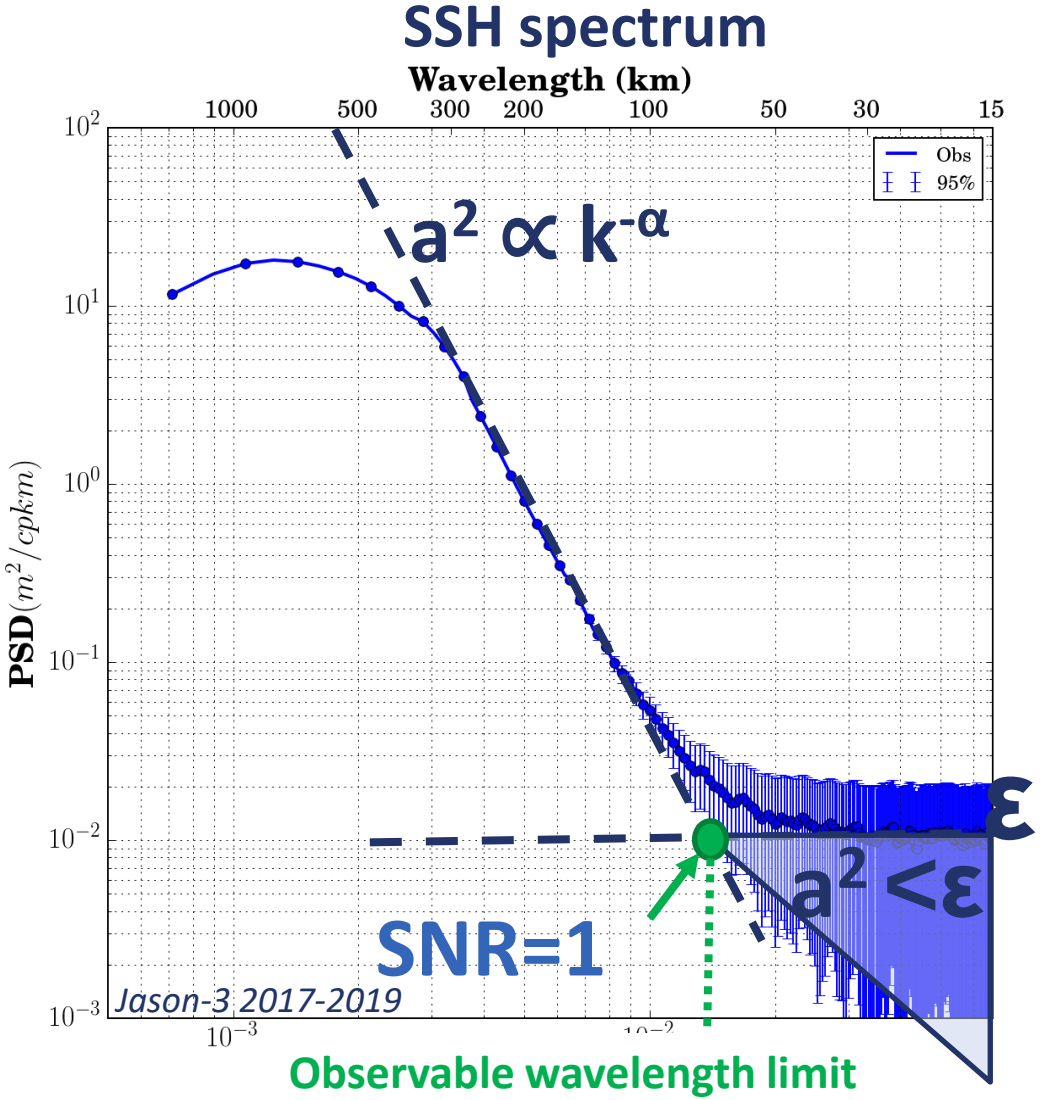
EGU 2023 General Assembly, Vienna, Austria, 23-28 April 2023.

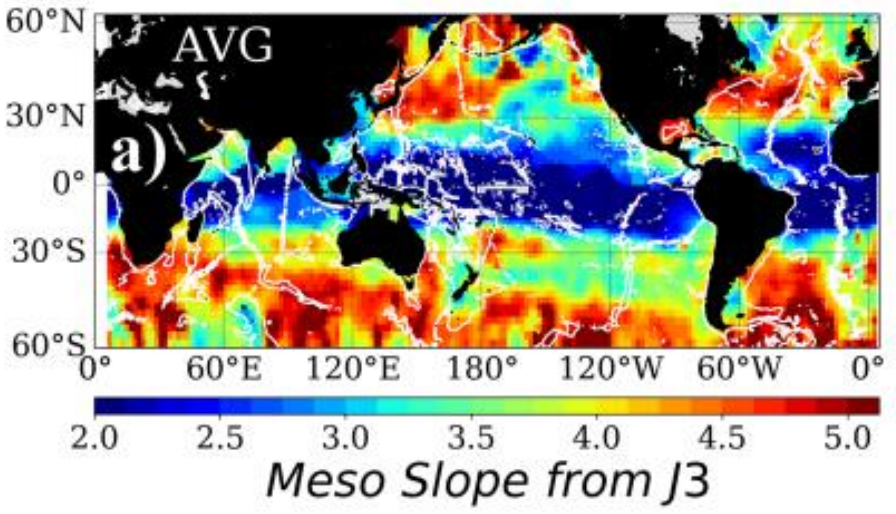
What is the “observable wavelength” ?

- Considering a signal that decreases linearly towards large wavenumbers, following $\mathbf{k^{-\alpha}}$
- Assuming that the altimeter noise level ($\boldsymbol{\varepsilon}$) is known, the observable wavelength can be computed as the intercept of **a** (energy levels) and $\boldsymbol{\varepsilon}$.
- In practice, both terms are modulated by the changes in ocean circulation (**a**) and surface wind wave field ($\boldsymbol{\varepsilon}$).
- **2 ingredients: spectral slope and noise levels.**

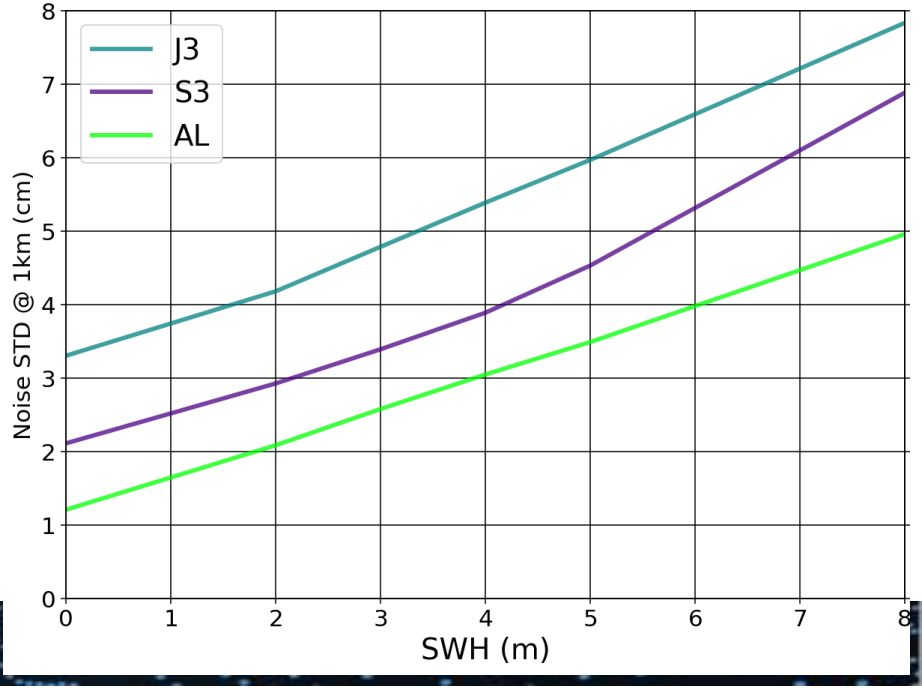


Current knowledge of spectral slopes ($k^{-\alpha}$) and noise levels

- Spectral slope values are modulated by the meso to submesoscale ocean dynamics, highly dependent on local stratification and atmospheric forcing.
- In situ observations are the only source of information available on the variability for wl < 70 km. Swath altimetry is expected to improve the observing capabilities.
- **Noise levels** also vary regionally and seasonally, dependent on the surface wave field.
- This relationship can be approximated as a linear function for conventional altimeters.
- **For a swath altimeter, noise varies as f(cross-track position) and the wave field modulation changes from near to far range.**



Noise for 1 km resolution

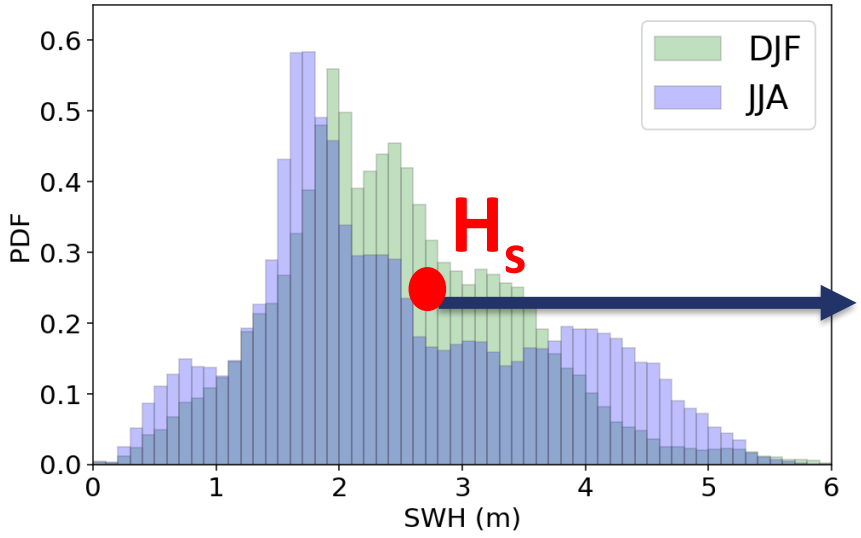


Noise floor estimates as f(SWH)

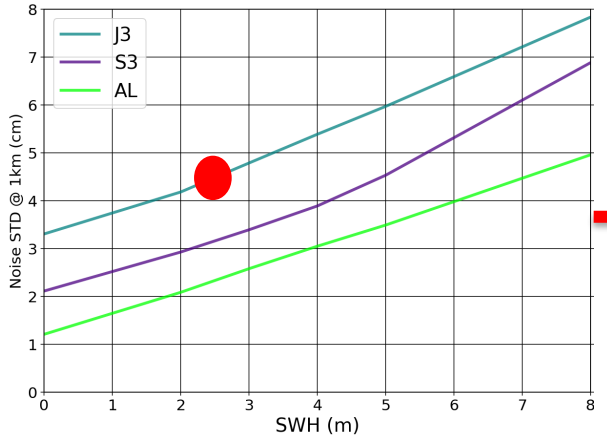
Steps :

1. Climatological SWH observations (median of the observed global distribution). **Representative metric of localSWH (H_s).**
2. Noise floor estimates through the combination of **(1)** instrumental noise as a function of SWH **ε(SWH)** for the observations (currently modelled for the swath instrument).

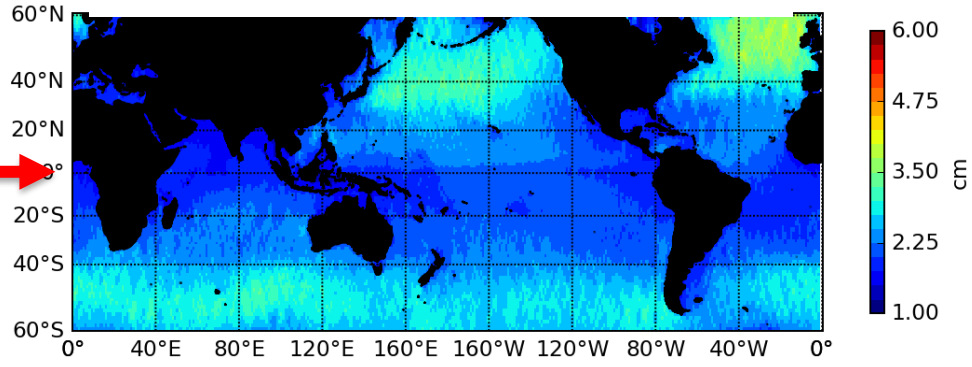
Observed SWH distribution



Relation SWH/Noise levels



Estimated Noise level



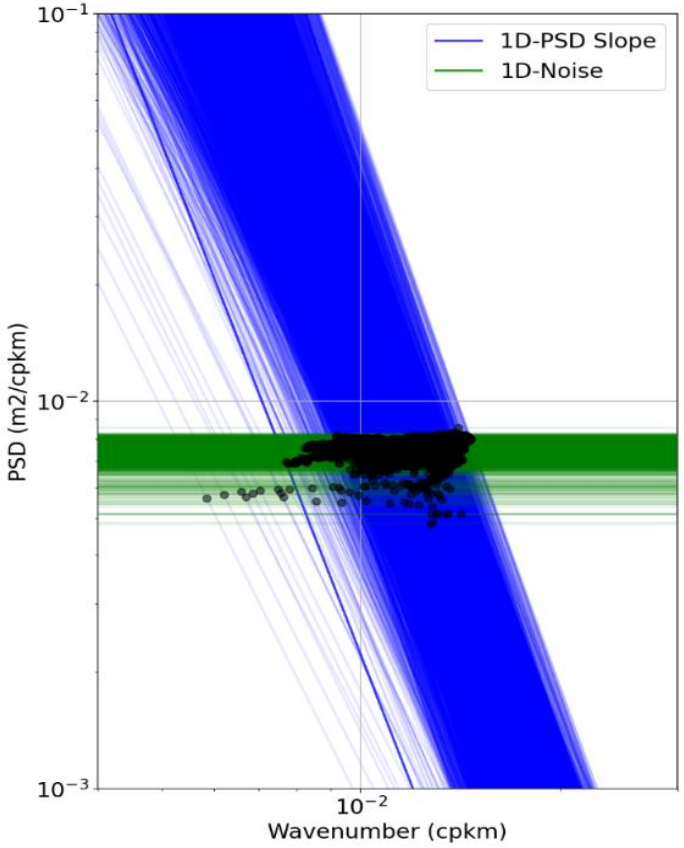
Observable Wavelengths

By combining the estimates of noise floors and the observed spectral slope, we can compute their intercept, and therefore the local observable wavelength.

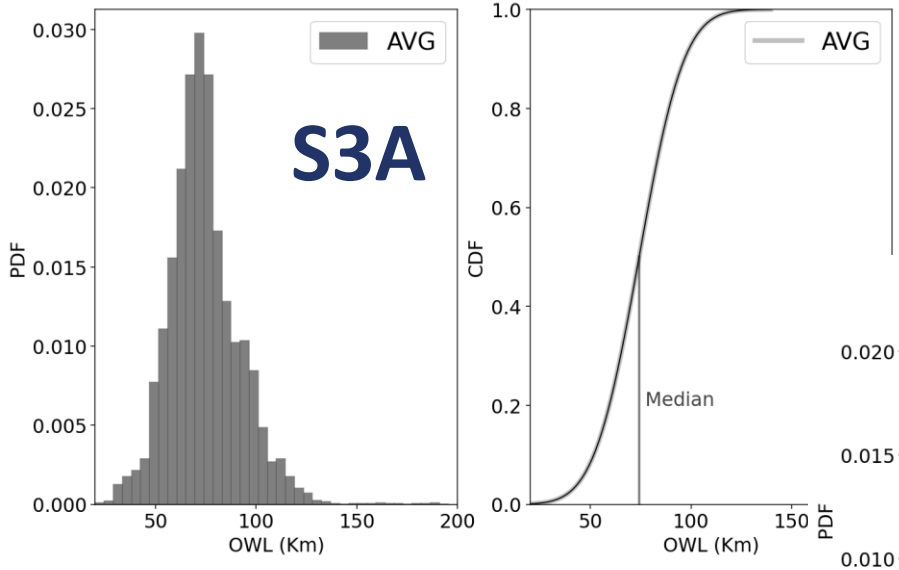
“Best case” estimates for observability wavelength (km)

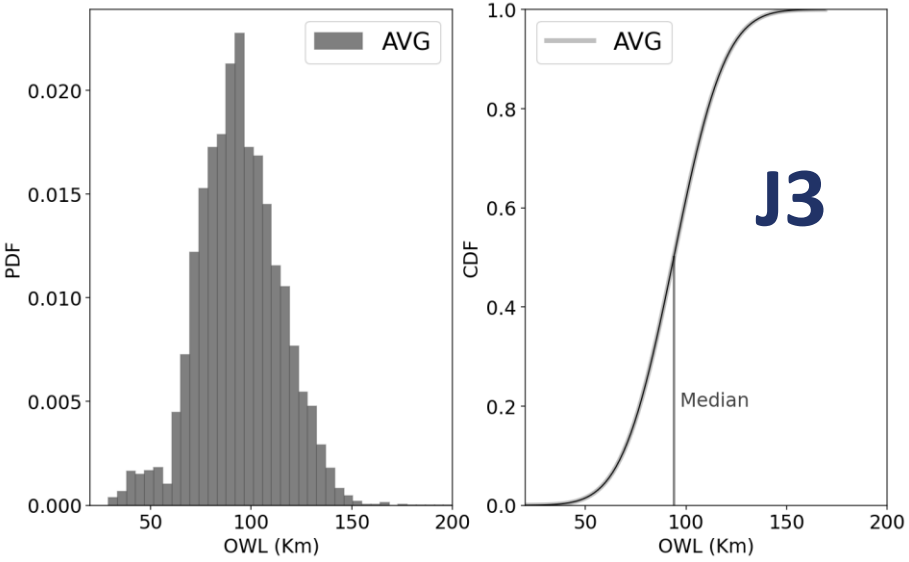
AL	J3	S3A
40-60	70-90	40-60

Global average at 50°S (J3)

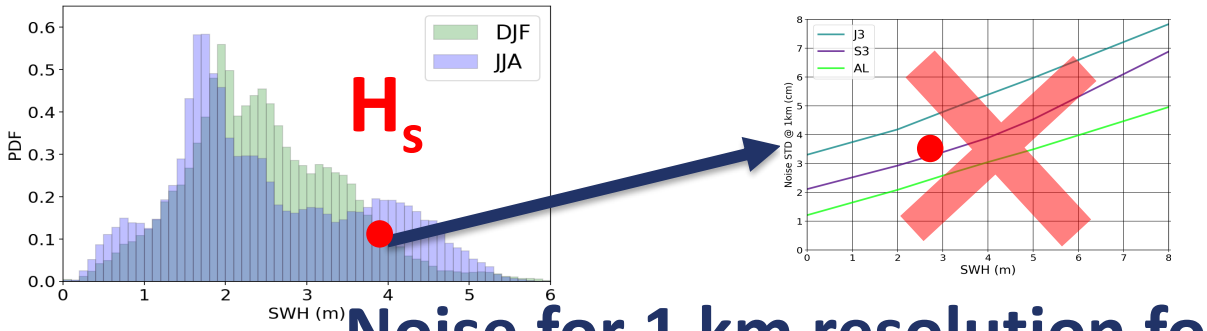


Global estimates of OWL

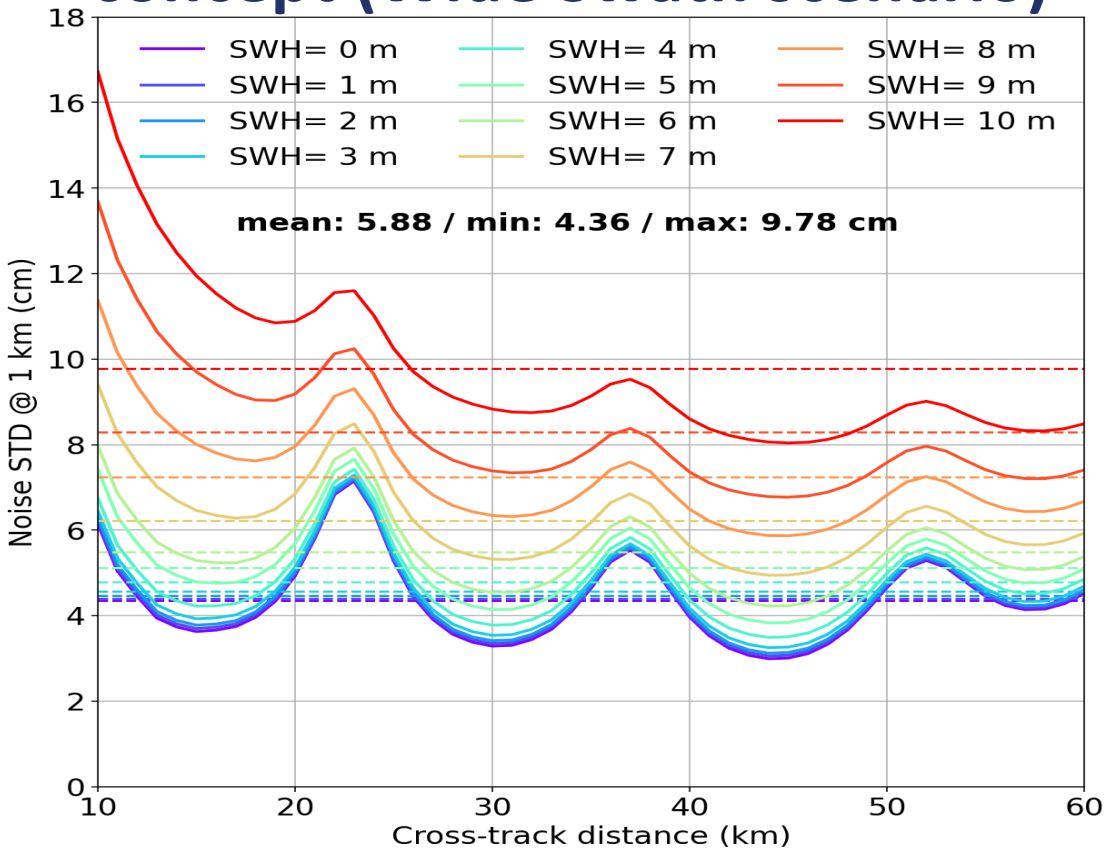


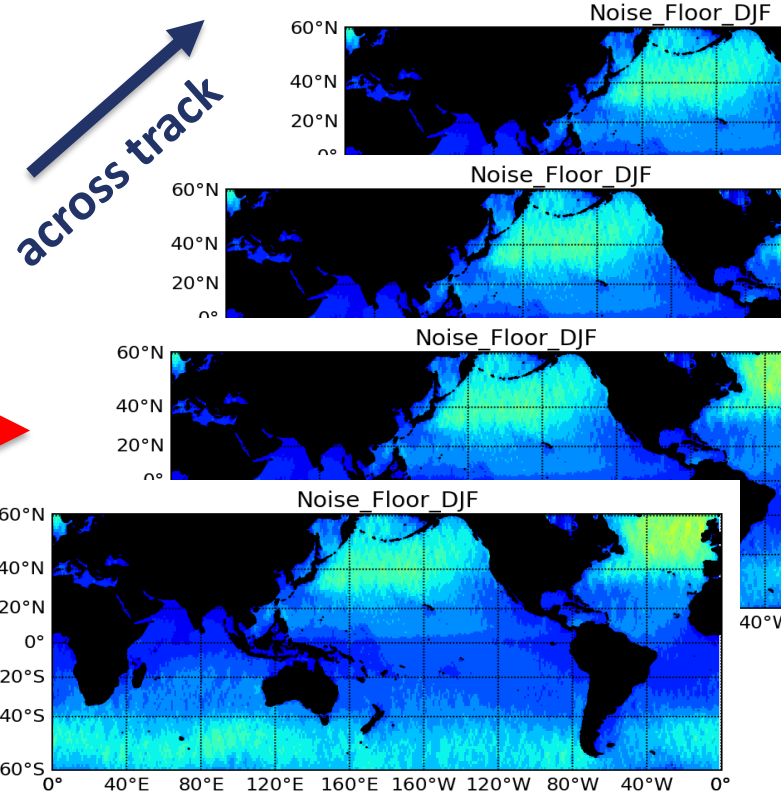


Noise level estimates for swath altimetry



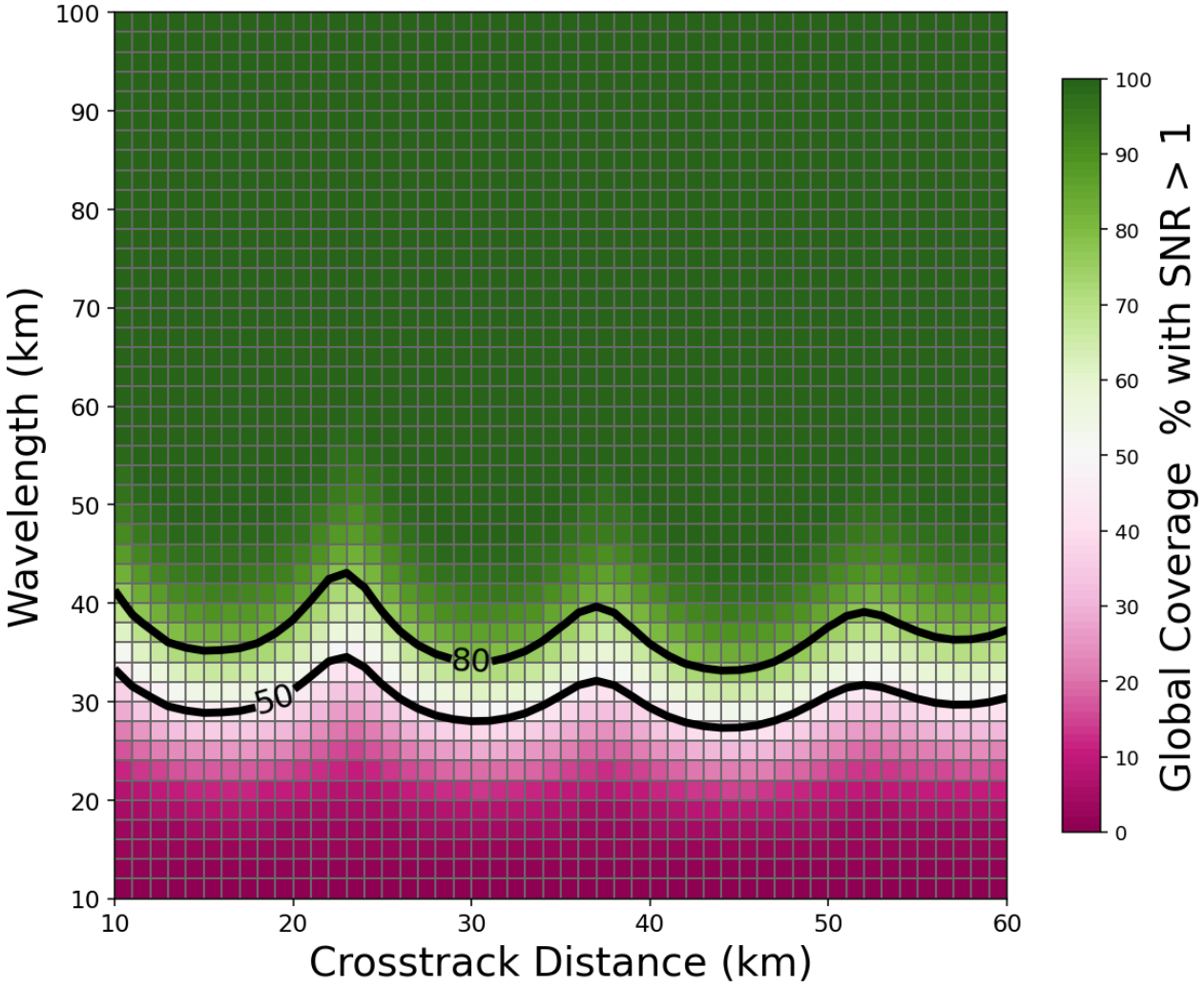
Noise for 1 km resolution for Sentinel-3 NG concept (Wide Swath scenario)





Swath Observable Wavelengths

Global Observability for the S3NG swath altimetry concept



- Observability over the global ocean reaches 50% coverage at 30 km wavelength on average (less in the ACC and over rough sea states). This values are valid for over 60% of the swath width. 100% of usable swath is attained at 40km wavelength everywhere.
- 80% of the global ocean is observed with 37 km wavelength on average.

	World ocean coverage (50%)	68%	80%
Observability wavelengths (km)	27 - **30** – 35	31 - **34** – 39	33 - **37** – 43

Conclusions & perspectives

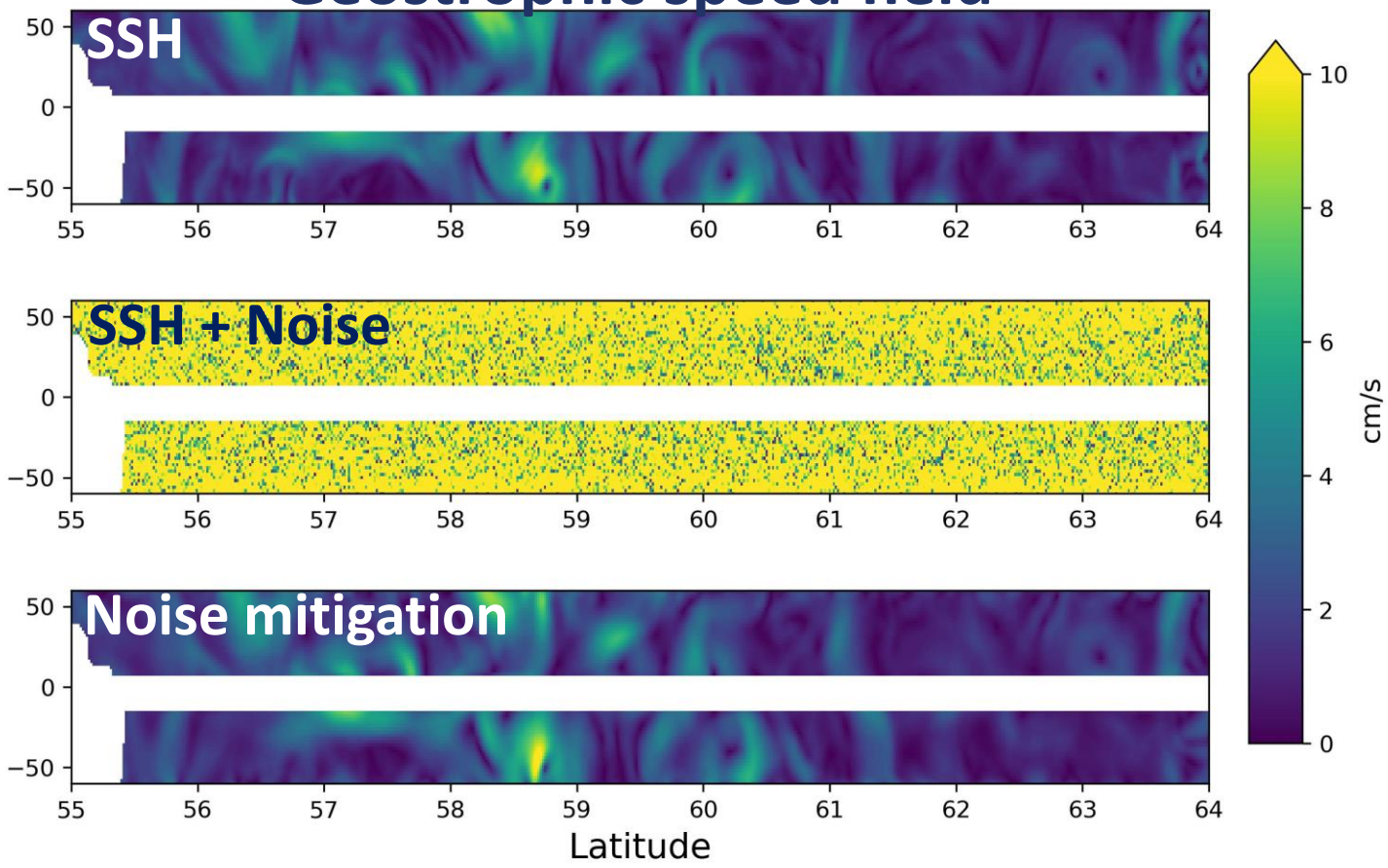
- Although the instrumental performance is lower than for SWOT, **SAOOH** (**Swath Altimeter for Operational Oceanography and hydrology**) instrument performance is on-par: **34km for 68% coverage for SAOOH vs 29 km for SWOT**.
- Statistically, a 2m homogeneous SWH field appears to be as representative as a realistic SWH field for globally averaged analyses (space and time). This approach will not be appropriate for local/seasonal analyses. **Main contribution of the SWH determining the noise levels is observed for SWH values in [1m- 3 m] interval.**

Present results are an idealized case: lack of realistic circulation and idealization of the 2D turbulent field (isotropy is a strong assumption).

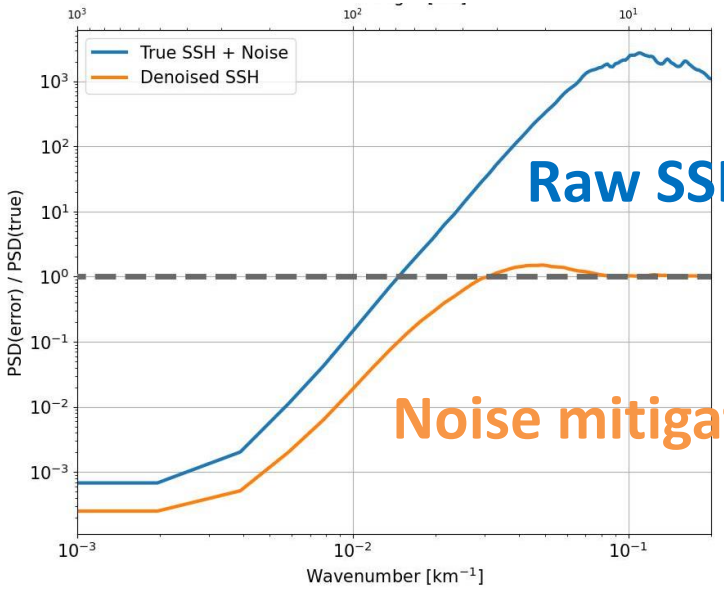
Conclusions & perspectives

A.I. 2D noise mitigation technique* developed for SWOT's KaRIn is evaluated for the S3-NG scenario over the North Atlantic (favorable signal but also important SWH). Computed SNR reaches **32 km** vs 64 km for the non-treated case. A step forward will be to tailor the AI algorithm specifically for the SAOOH instrumental noise function.

Geostrophic speed field



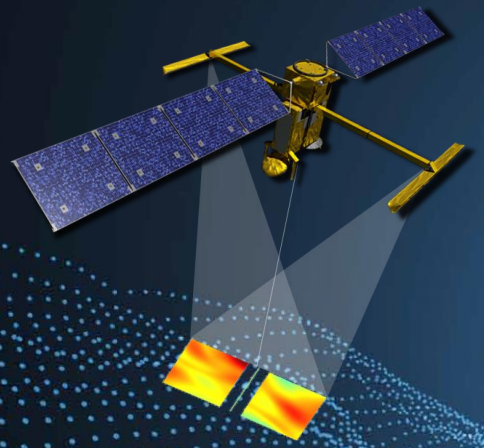
NSR



Raw SSH (64 km)

Noise mitigation (32 km)

*Treboutte et al., 2023, Rem. Sens., doi:10.3390/rs15082183



Thank you!