• SWOT will demonstrate a transition from conventional pulse-limited nadir altimetry to interferometric wide-swath altimetry.

• Simultaneous measurements of the sea surface by both techniques will provide cross calibration and validation.

• Observations from conventional altimetry have exhibited unexplained SSH features at wavelengths shorter than 100 km.

• The two independent measurements might shed light on these features that are of great importance to the SWOT oceanographic objectives.
Global variability of the SSH wavenumber spectral slope

\[ P(k) = a k^b \]

Xu and Fu (2011)
Comparison of kinetic energy spectra from altimetry with high-frequency coastal radar observations

Discrepancies at wavelengths smaller than 100 km are drastic.

Kim et al. (2011)
Wavenumber spectra of SSH and measurement errors

- Media errors and sea-state errors have scales larger than 100 km.
- Do we miss something in conventional altimetry?
- The new approach of SWOT may shed lights on the problem?

*Xu and Fu (2011)*
Nadir provides « heritage » & risk reduction

- Calibration/checkout for traditional J1-J2 altimetry ~months

- Calibration/checkout for new technology … (~ 1 year) (eg., CR2, SMOS, …)

- Heritage from nadir (& AltiKa) will allow faster cross-calibration & error reduction of Karin obs

=> faster product availability
Needed to constrain errors in mesoscale 100-300 km band

Mapped data from the 2 mission (J2-ENV) time series vs. 3-4 mission time series

Missing structures: ~150 km
- Missing up to 25% of total RMS in energetic currents

- Large-scale low frequency motion will be constrained by nadir constellation (J3 / J-CS; Sentinel-3?, HY-2A?)

- Nadir altimetry at same space & time reduces 3-10 cm error in mesoscale (100-300 km) field & in « weather » long wavelength high-frequency band

- If SWOT data have any errors in 100-300 km band (xtrack or alongtrack) – cannot be relied on to constrain mesoscale field
Nadir Provides additional calibration

+ additional spatial coverage

+ larger mesoscales needed to collocate adjoining images

SWOT x SWOT
Along-track cross-calibration window (L)

SWOT x SWOT
4 crosscalibration diamonds
obs = roll signal difference

SWOT x Nadir
4 crosscalibration segments
obs = roll signal

Nadir x Nadir
1 crosscalibration point
obs = orbit error

Along-track cross-calibration window (L’)

+ larger mesoscales needed to collocate adjoining images
Ensure that the error spectrum is guaranteed

- 1km – 10 km – 100 km – 300 km -1000 km

Nadir altimeter provides \textbf{SWH}, while this is only a goal for KaRIN. To have good sea state bias corrections and a guaranteed SWH product requires a nadir altimeter

\ldots Today’s nadir choices \ldots
Ku/C Altimeter (baseline)

- Well-known and mastered solution
- High heritage of developed and on-going altimeters (Poseidon/JASON, SRAL/Sentinel-3, Jason-CS…)
- Performances fully compatible with science requirements
- Very high availability (Ku band less sensitive than Ka band)
- Facilitate fusion between SWOT products and conventional altimeters for ocean better temporal resolution
- KaRin Nadir demonstrator could easily be cross-calibrated

Considered as the mission baseline:
- Benefit from the large ‘Ku/C’ altimeter heritage (SWOT altimeter would inherit from JASON-CS state of the art design)
- Well-known instrument and associated ground processing, which facilitate the comparison with current nadir altimeter reference products (on a new orbit) and on board KaRin Nadir demonstrator.
- Can be considered as an independent reference for KaRIn measurements
This demonstrator consists of adding a nadir channel to the microwave radiometer antenna to implement both a nadir altimeter and a near-nadir interferometer:

- The signal strength is sufficient to perform \textit{conventional} altimetry.
- Very compact (mass/ power/ volume) solution: only one antenna for radiometer and altimeter; RF and digital units will be integrated in KaRIn and may benefit from duplication.
- The performances need to be further validated but link budget and azimuth SAR mode are favorable, may provide better nadir altimeter resolution along track.
- Will require other in flight altimeters data for range calibration if no conventional altimeter on board.
- Retracking efficiency is not fully demonstrated as we cannot benefit from an analytical model of the waveform, but have to develop a numerical retracking procedure.
- Reduced availability w.r.t. Ku/C-band solution (by around 5%) due to the high sensitivity of Ka band attenuation to precipitation.
- Will be implemented on SWOT as a demonstrator for future swath altimeters/ interferometers.
We maintain the baseline as in the Science Requirements Document …

⇒ The combination of Karin with a separate nadir altimeter is the best tool we have at present to link submesoscale to the larger-scale ocean circulation 150-300 km (precise sub-mesoscale observations could be interpreted with respect to the evolving meso-scale circulation, measured AT THE SAME TIME.)

⇒ Impact studied for altimeter constellation, mais impact for Karin TBD

• SWOT can only rely on other altimeter data on different orbits for cross calibration purposes which affect calibration errors → impact TBD

• Risk – if no conventional Nadir Alt on Board and KaRin Nadir Altimeter demonstrator doesn’t work properly. → KaRin nadir altimeter performance TBD – AirSWOT can help!