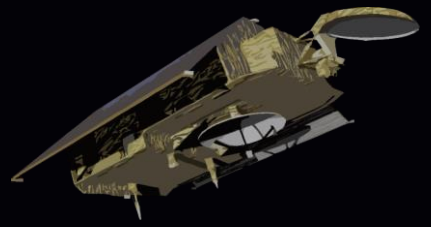


Sentinel-6 Michael Freilich and Jason-3 Tandem Phase Exploitation (S6-JTEX)

T. Moreau[1], E. Cadier[1], L. Amarouche[1], S. Amraoui[1], S. Dinardo[1], A. Guerou[1], A. Mangilli[1], N. Taburet[1], N. Tran[1], M. Vayre[1], M. Ablain[2], R. Jugier[2], M. Passaro[3], D. Dettmering[3], F. Schlembach[3], M. Scagliola[4], D. Giudici[4], J.C.B. da Silva[5], A.M. Santos-Ferreira[5], C. Gommenginger[6], B. Timmermans[6], C. Banks[6], C. Donlon[7]

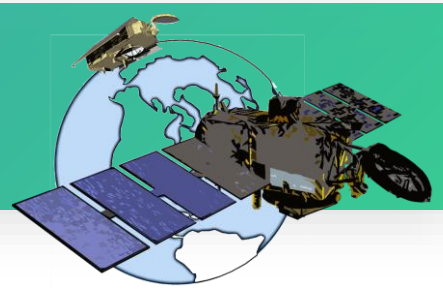
[1] CLS, [2] Magellium, [3] TUM, [4] ARESYS, [5] Univ. Porto, [6] NOC, [7] ESA/ESTEC

Sentinel-6 Mission

Copernicus Sentinel-6 Michael Freilich (S6-MF)

- New reference mission to ensure enhanced continuity of the long-term data record for climate studies
- New sensors: Highly precise radiometer (AMR-C) and new radar altimeter (POS4) with a new architecture and new capabilities currently commissioned to assess:
  - Continuity of LR mode with previous Jason series
  - Consistency between LR and SAR mode data
  - Consistency between SAR RAW and SAR RMC
  - Also analysis of new SAR configurations and processings to better exploit the altimeter performance
    - mitigating any possible GMSL error, sea state effects and mesoscale error
    - benefit of using higher resolution processing over inland waters, cryosphere surfaces but also over ocean

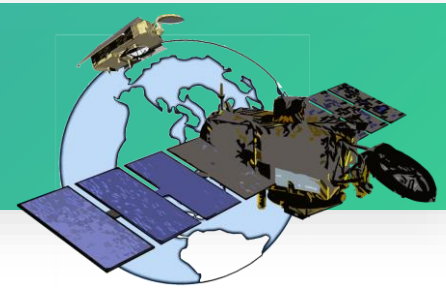
S6-JTEX Science Objectives



Tandem from a Climate perspective

- To perform very accurate calibration of the S6-MF altimeter and radiometer against the reference mission
- To identify discrepancies between missions and different operating modes, but also drifts or periodic signals and establish strategies to correct for these errors
- To produce homogeneous and unbiased time-series observations and allow a precise estimate of uncertainties (with an error on the trend of less than 1mm/year) for long term climate data records and applications
- To also ensure the continuity of the long-term radiometric correction time series

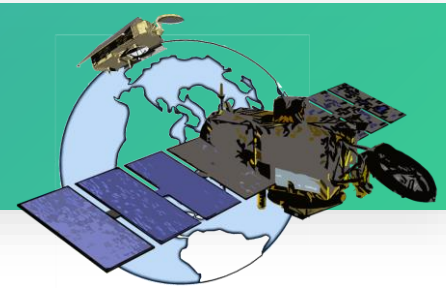
S6-JTEX Science Objectives



Expected impact of the Tandem for sea state

- To provide accurate SWH quantities for marine weather and sea state forecasting but also growing interests in long-term multi-mission altimeter records of sea state
- To gain understanding of the different sea state effects contributing to the sea surface height retrievals uncertainty
  - Increase of measurement noise on SSH with SWH
  - SSH accuracy impacted through SSB
  - Sensitivity to long ocean waves (T02, energy, orientation):
    - High-frequency noise on altimeter estimates
    - Increase of SSH variance at long wavelengths (aliasing)
  - SWH bias due to sea surface motion effect

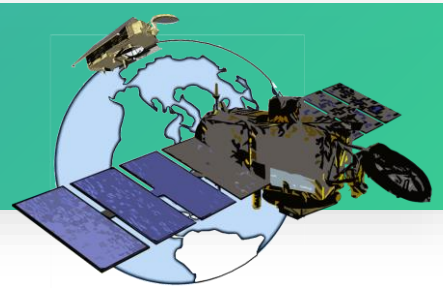
S6-JTEX Science Objectives



Expected benefit from innovative processing and applications

- To make use of innovative algorithms to improve the altimeter performances:
  - SAR processing at higher sampling to mitigate swell-induced aliasing artifacts
  - Benefit of LR-RMC processing at mesoscale, ..
- To assess the enhanced fully focused SAR (FF-SAR) capabilities to better map inland waters (and sea ice leads) but also provide more details of the ocean surface structure

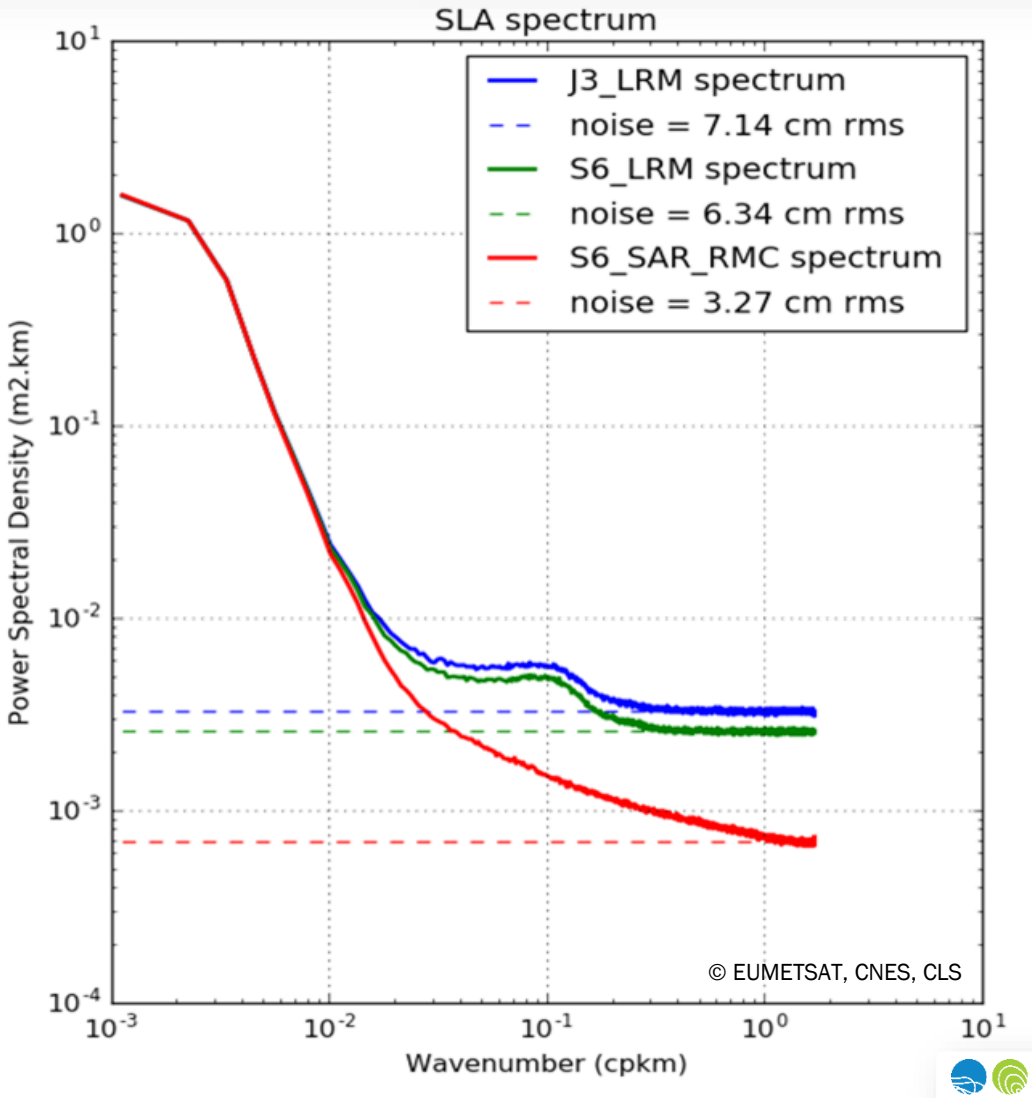
S6-JTEX Science Objectives



- To provide an exhaustive analysis of S6-MF measurements during the tandem flight with Jason-3 that would demonstrate the high benefit of this new altimeter reference mission to extend the legacy of sea-surface height measurements
- To develop a number of scientific studies that fully exploit the S6-MF capabilities and make use of innovative processing to allow for new potential products and applications
- To ensure a full and open sharing of all processed data for the science community, to report the results of these studies in peer-reviewed journal articles, and to operational agencies, S6VT and other relevant bodies and organisations that might be interested in

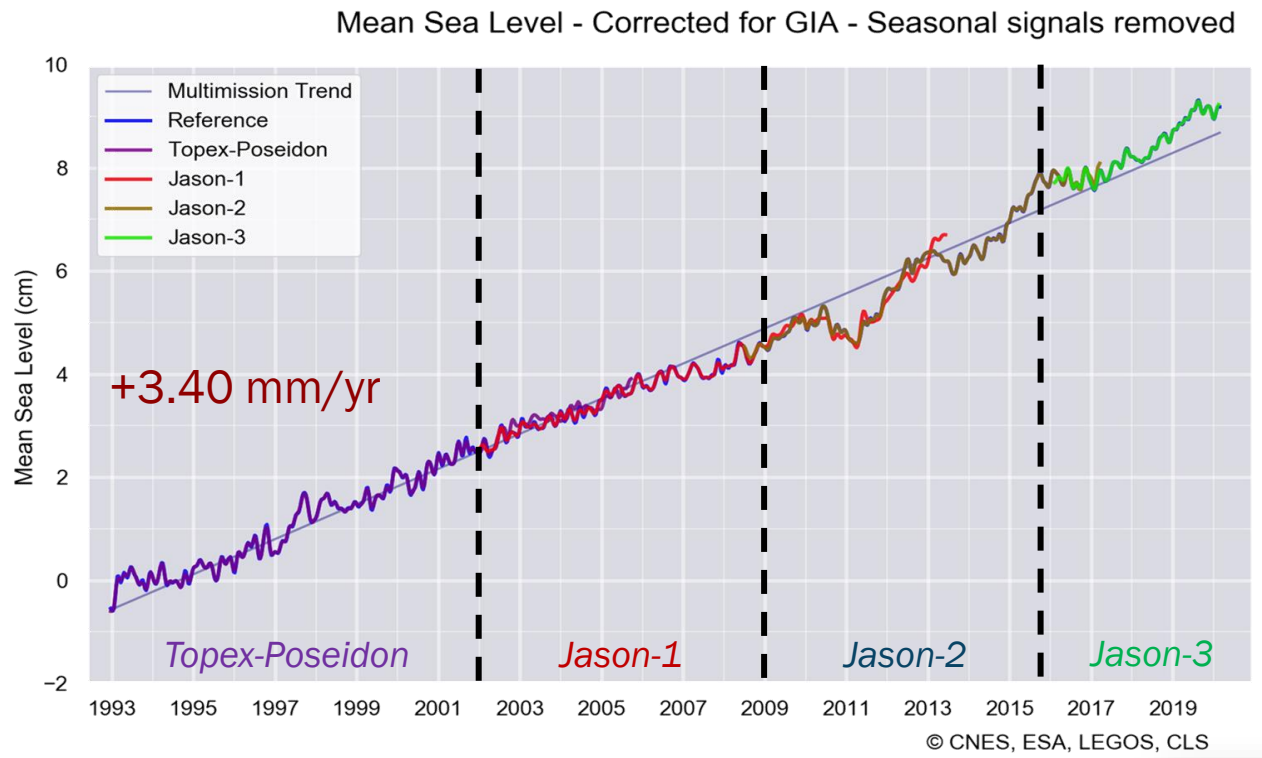
CalVal Ocean

- To compile and summarize the main results obtained during the CNES/EUMETSAT commissioning activities and ESA GPP project, and identify the remaining open questions
- To perform investigations to fully assessed Sentinel-6MF performances and discuss potential processing alternatives (L1B, L2 and post processing) that could allow to mitigate sensitivities and ultimately discrepancies between all acquisition modes of S6 and J3



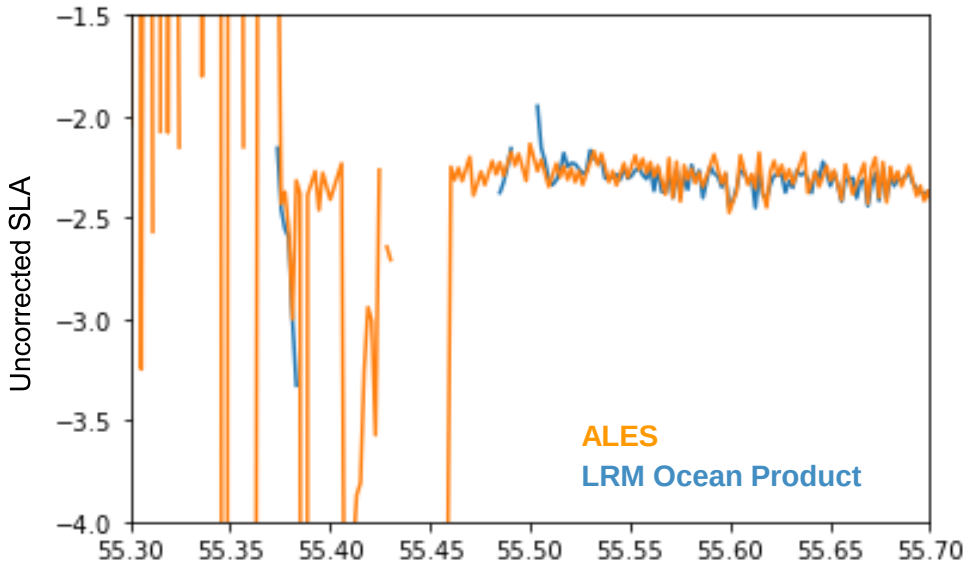
Uncertainties and GMSL

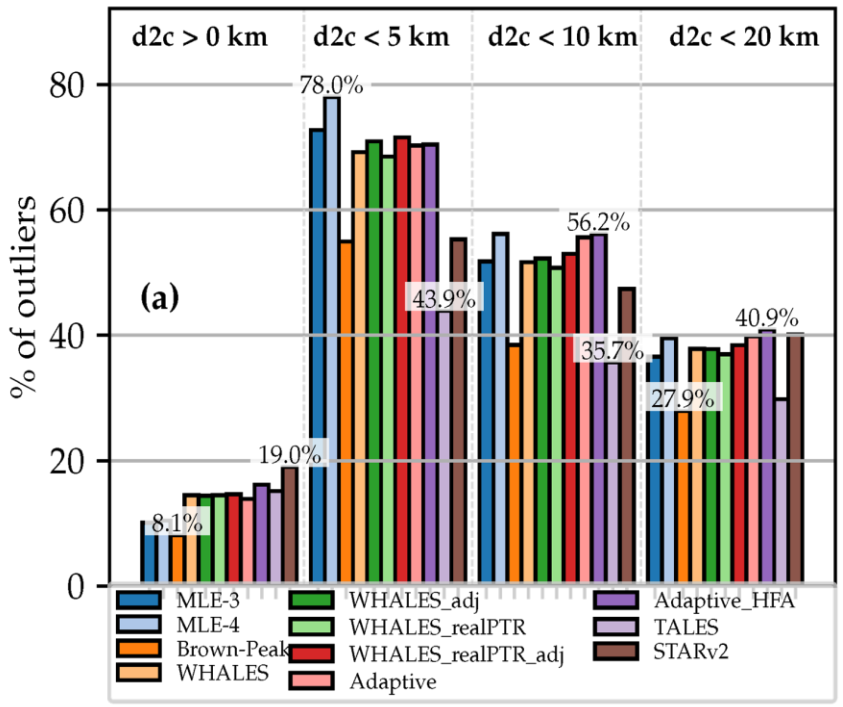
- To homogenize and mitigate MSL discrepancies between S6-MF and Jason-3, with a focus on the SAR data
- Consolidate the current method of bias estimation for “reference” missions, at the global and regional scales
- Explore new methods (multi-mission approach with different orbits and/or use of FRM data) and quantify their accuracy compared to the one used so far
- To specify an alternative intercalibration method between S3 SRAL and S6-MF
- To analyze in depth the level of uncertainty obtained



Coastal Assessment

- Comparison of the coastal performances of S6-MF in its different modes of operation (LRM, SAR-RAW and SAR-RMC) and J3 (making use of specific retrackers: ALES, ..)
- In terms of: range and significant wave height (bias, noise, drift and outliers), consistency of the relevant geophysical correction
- Statistics will be referred to the 20-km limit from the global coastline





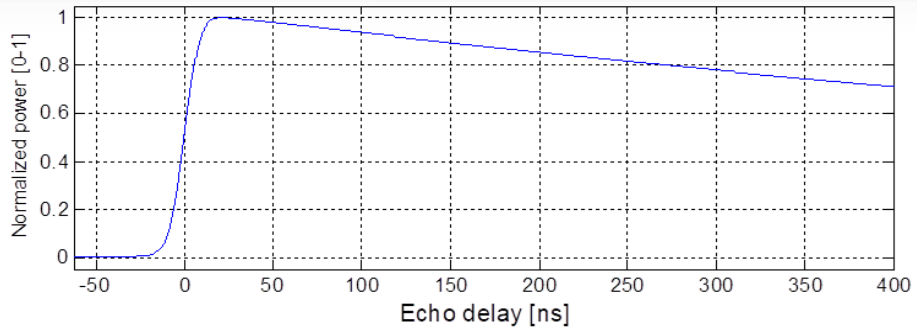
Schlembach et al., 2020

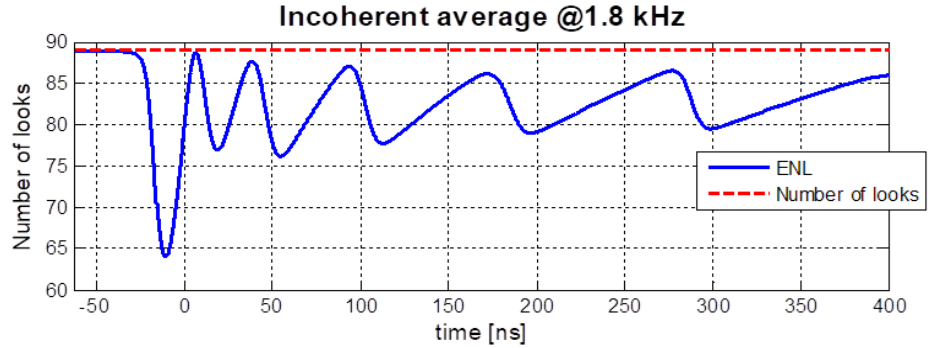
Sea State

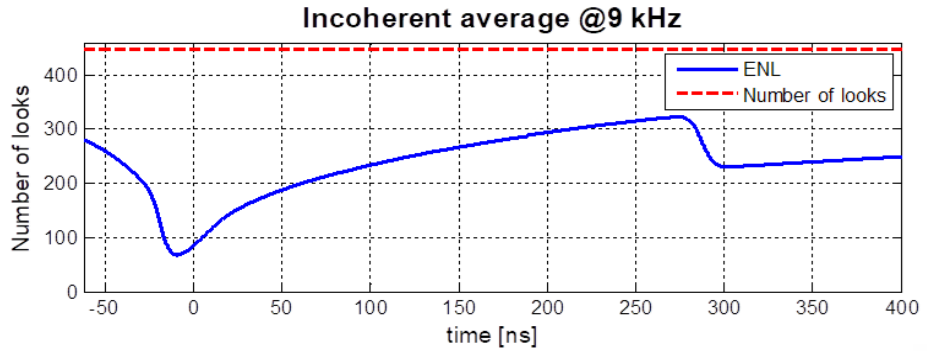
- To evaluate the consistency of S6-MF LRM against Jason-3 (LRM) and buoys
- To examine the uncertainties of S6-MF SAR against Jason-3 and wave buoys, without errors linked to large natural variability of sea state in space and time
- Explore the performance of S6-MF against Jason 3 in different oceanic conditions (e.g. high sea state)
- Other open issues to be addressed:
  - Sea-state impact assessment: Potential impact of ocean wave conditions (wavelength and direction of swell, and wave orbital velocity) on the long-term sea state and sea level time-series?
  - Swell detection: Is it possible to detect swell by combining SAR altimeter data processed in different ways and then to define new products including additional swell information?
  - SSH correction: To propose approaches (empirical correction, increased posting rate) to mitigate negative SSH impacts due to SAR processing and reduce regional biases that would enter into the sea level record?

Exploiting the S6-MF ENL

- To evaluate the autocorrelation properties by making use of a theoretical waveform model
- To compare theoretical results with ENL estimated from real S6-MF data
- To verify the effect of the varying ENL on the precision of the retrieval of the geophysical parameters as a function of the multilooking posting rate



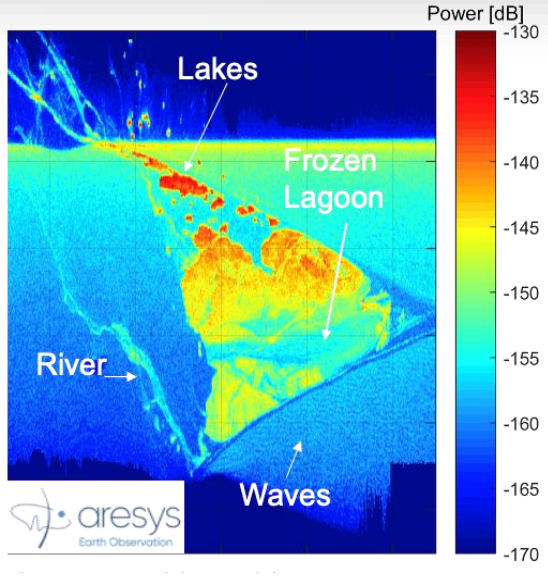


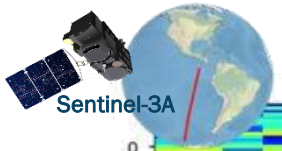


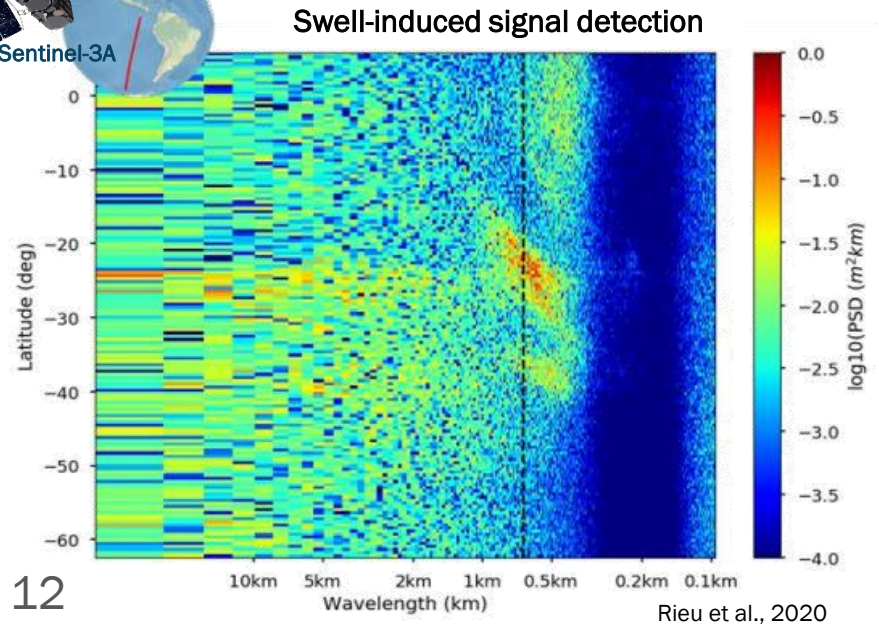
Scagliola et al., 2016

FF-SAR Processing

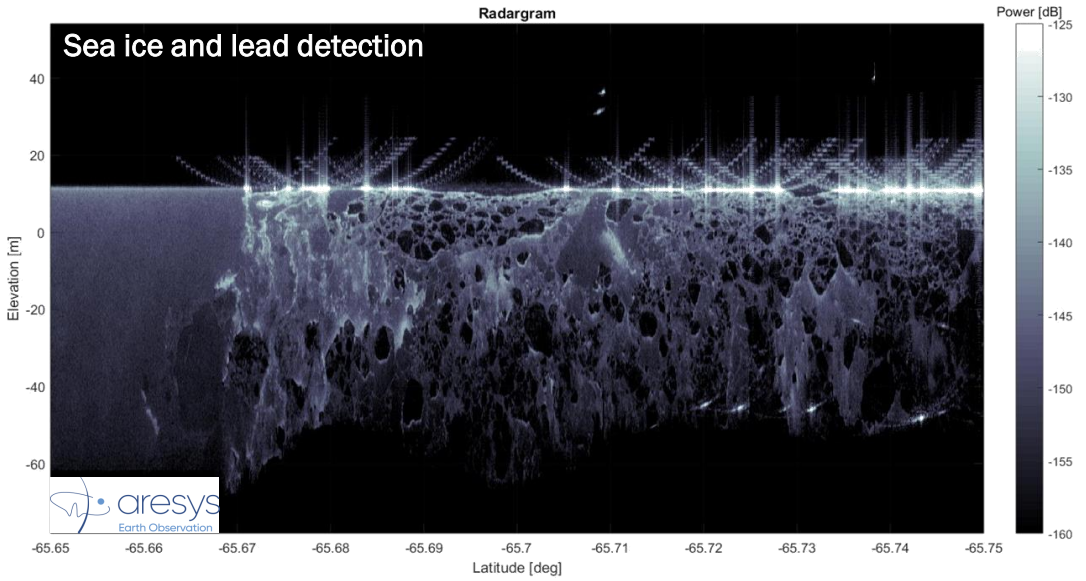
- To identify an optimal configuration for each scenario (open ocean and long ocean waves, sea-ice) tuning the parameters: Doppler processed bandwidth, multilooking, along-track spectrum weighting function
- To process and analyze large data set for each scenario, and assess the interest of FFSAR to be implemented in Sentinel altimeter ground segments





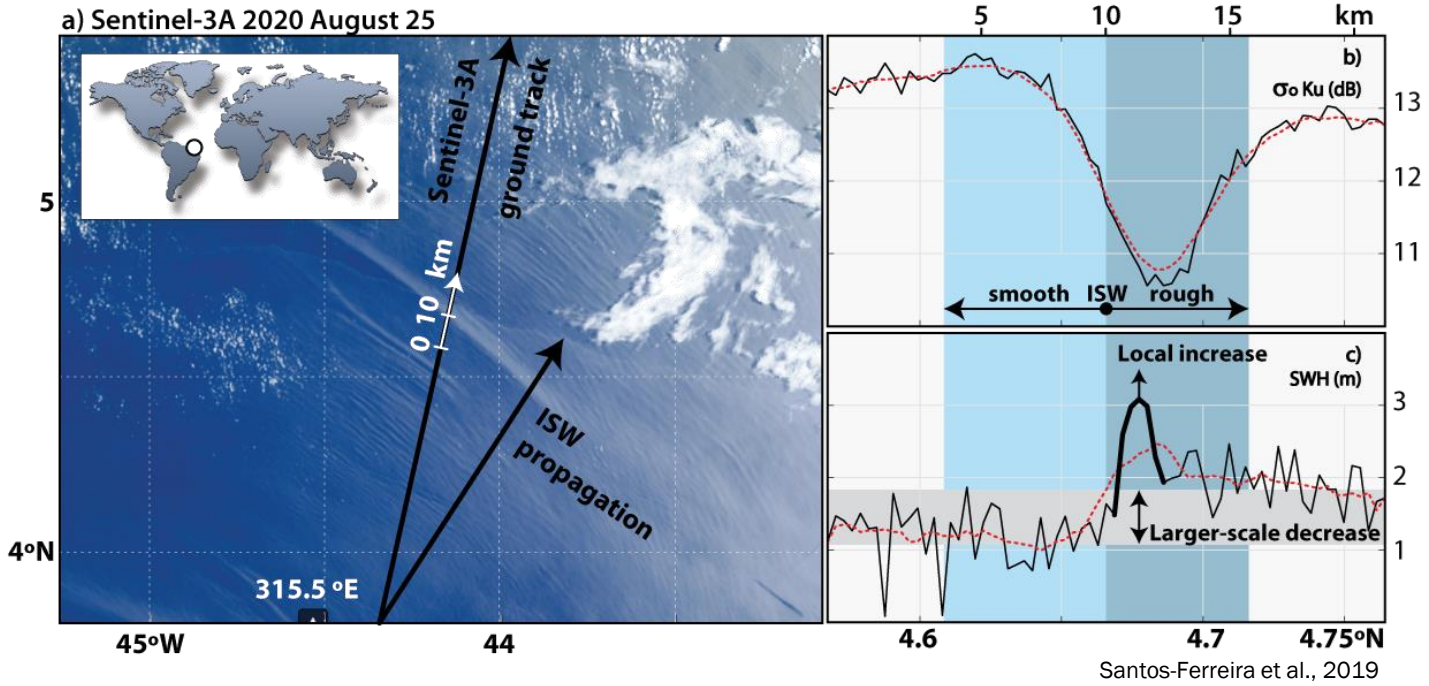


Rieu et al., 2020



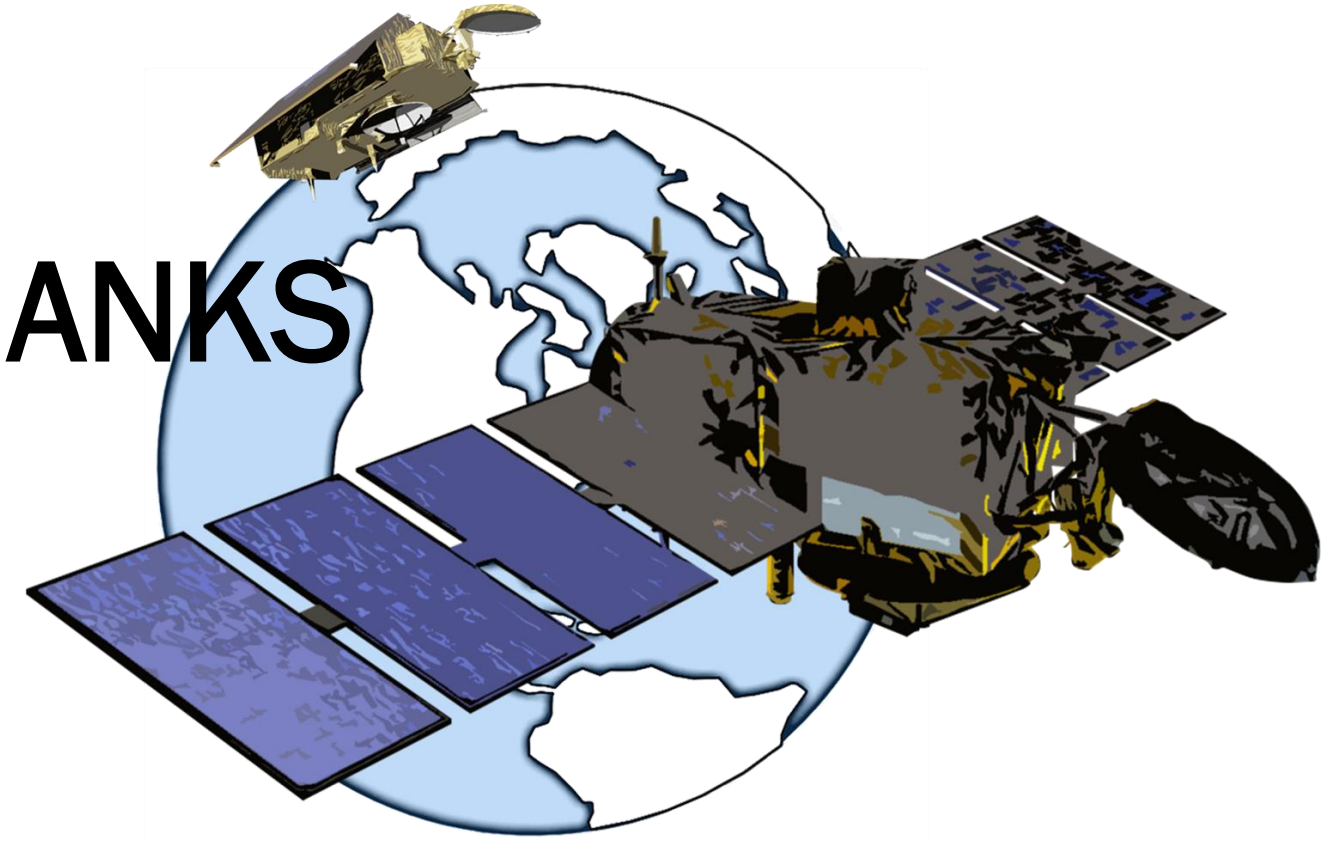
Internal Waves Detection

- To apply automatic detection method in Santos-Ferreira et al. (2019) to detect internal solitary waves (ISWs) in S6-MF SAR data and,
- To analyse signatures owing to large ISWs that cause intense wave breaking at the surface
- Compare sensitivity of signatures, specially SWHs, with J3 and S6-MF SAR



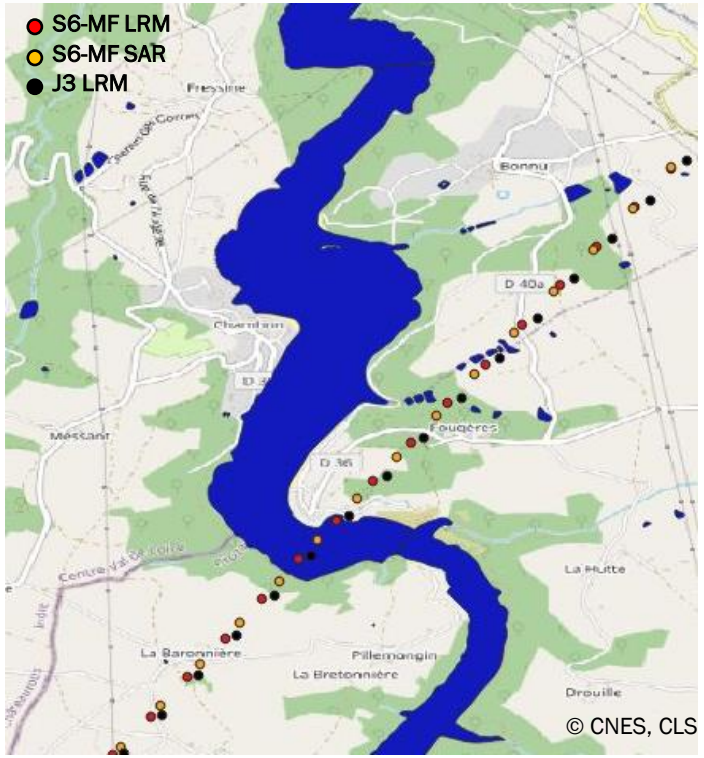
Santos-Ferreira et al., 2019

THANKS



Inland Water Analysis

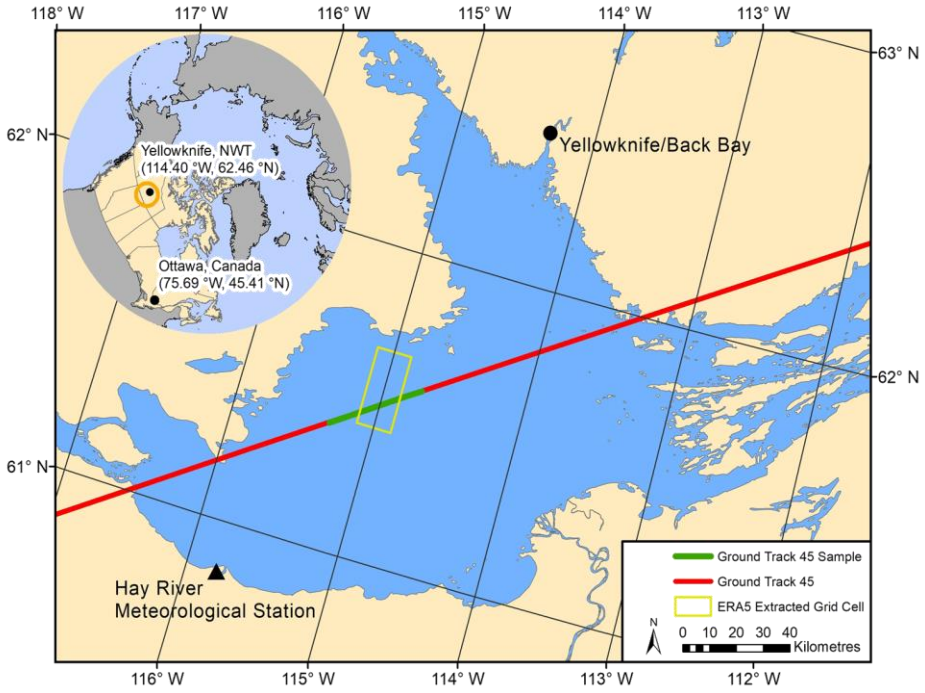
- To determine biases between S6-MF and J3 over a large number of targets (~1000 S6-MF/S3A-B virtual stations) making use of CNES commissioning activity results
- To evaluate S6-MF (LRM, SAR RAW and SAR RMC) performances over inland waters in terms of: missing data, high frequency noise and WSH standard deviation per transect



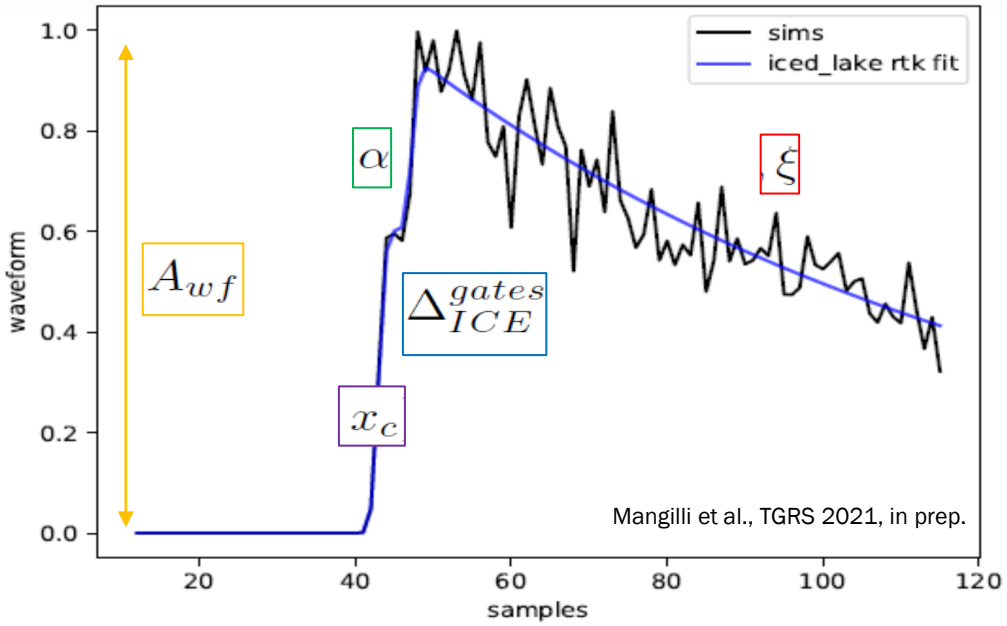
- To characterize the performances of the FF-SAR processing by comparison with UF-SAR, and against in-situ and IceSat-2 data

Lake Ice Thickness (LIT)

- To assess the accuracy of the LIT retrieval (developed in ESA CCI-LAKES project) with S6-MF LRM data and continuity with Jason series



Mangilli et al., TGRS 2021, in prep.



- To develop the SAR LIT estimation over iced covered lakes and compare LRM LIT (J3 and S6) and SAR LIT retrievals over a target lake (e.g. Great Slave Lake)