

SWOT – CTOH studies for fine-scale ocean dynamics



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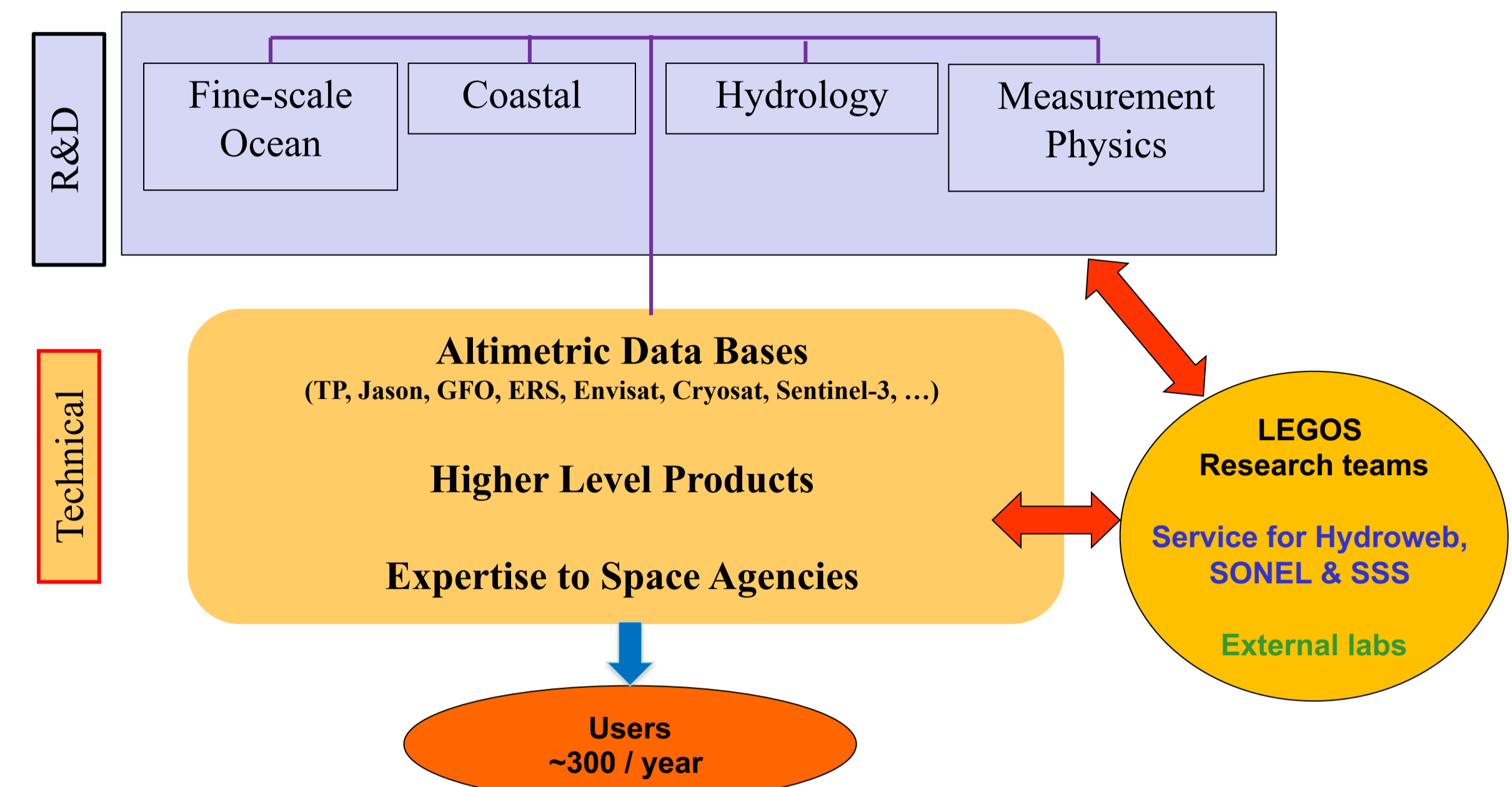
The Center for Topography of the Oceans and Hydrosphere (CTOH) is a French National Observation Service at the LEGOS CNRS Laboratory in Toulouse, created in 1989, dedicated to satellite altimetry studies. We focus on developing new altimetric processing, homogeneous data products and applications for non-standard altimetric research domains (coastal ocean, oceanic fine-scales, hydrology, sea ice, ...). We work in close relationship with space agencies (CNES, ESA) at different levels for satellite altimetry missions: preparation of new missions, definition of the user's needs, CAL/VAL studies, signal analysis & data reprocessing, development of thematic products, teaching and outreach.

CTOH has worked on SWOT preparation since 2008, with the two French Science Leads :

- Rosemary Morrow (CNES Ocean Lead, CTOH/LEGOS)
- Jean-Francois Crétaux (CNES Hydrology Lead, CNES/LEGOS)

LEGOS has 9 selected SWOT Science Team projects involving 45 scientists and students

CTOH Activities for SWOT



SWOT preparation activities within the CTOH include

- Early development of the hydrology SWOT simulator,
- Analysing fine-scale ocean signal and noise in alongtrack altimetry
- Improved 2D mapping of ocean fine-scales
- Deriving eddy diagnostics within the SWOT swaths
- User support for the LEGOS SWOT research teams

SWOT – CTOH Fine scale ocean studies

Ocean signal & noise in nadir altimetry

A statistical approach based on the analysis of 1 Hz altimetric SSH wavenumber spectra is used to obtain four geophysical parameters that vary regionally / seasonally:

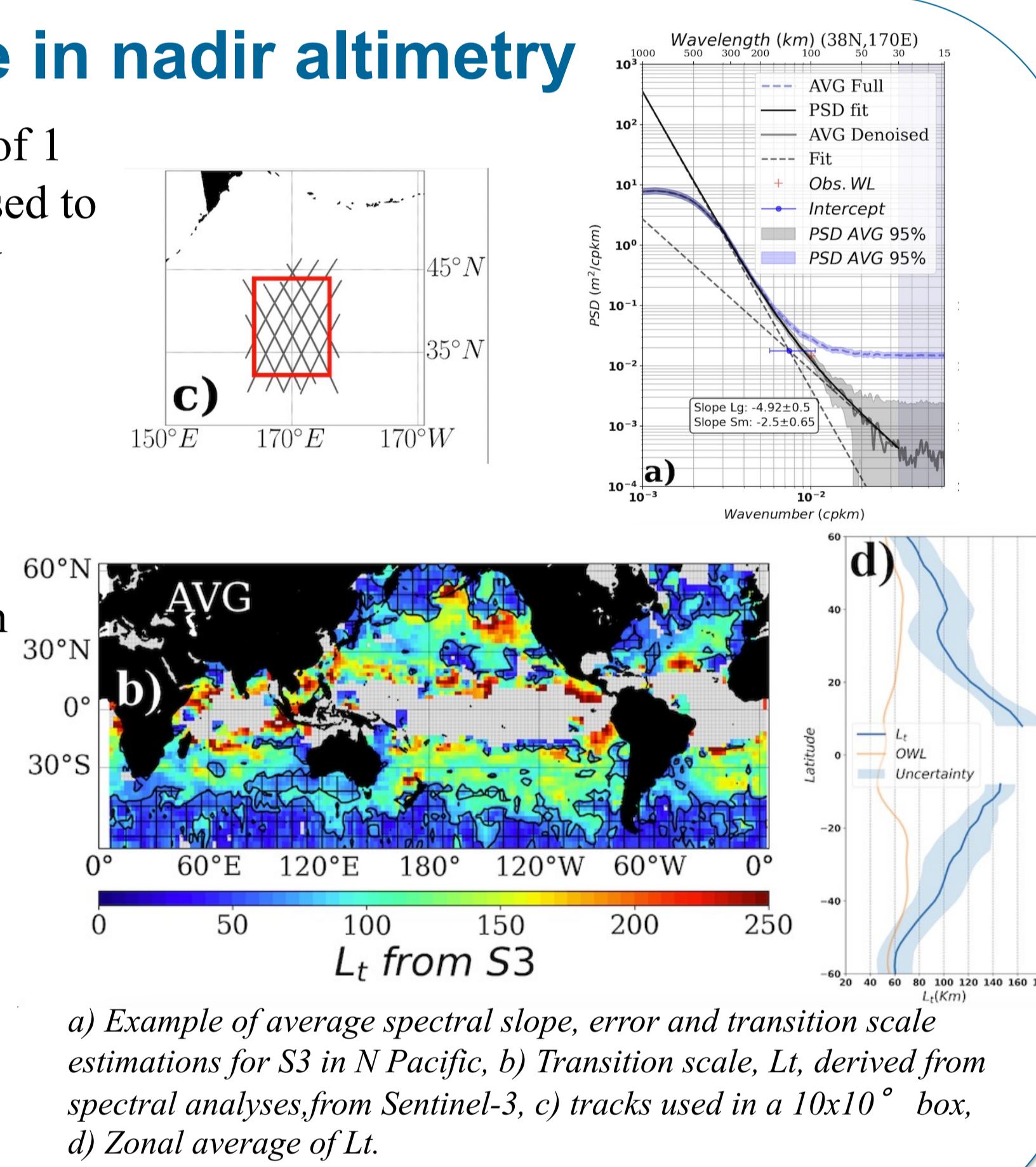
- the background error,
- the spectral slope in the mesoscale range,
- a second spectral slope at smaller scales,
- the transition scale, L_t .

Results : Spatial scale of the transition from geographically balanced to unbalanced motions estimated regionally from satellite altimetry data

- Results agree with in situ observations and predictions from high-resolution models including tidal forcing.
- Expecting SWOT to have lower noise & better L_t resolution at mid to high latitudes

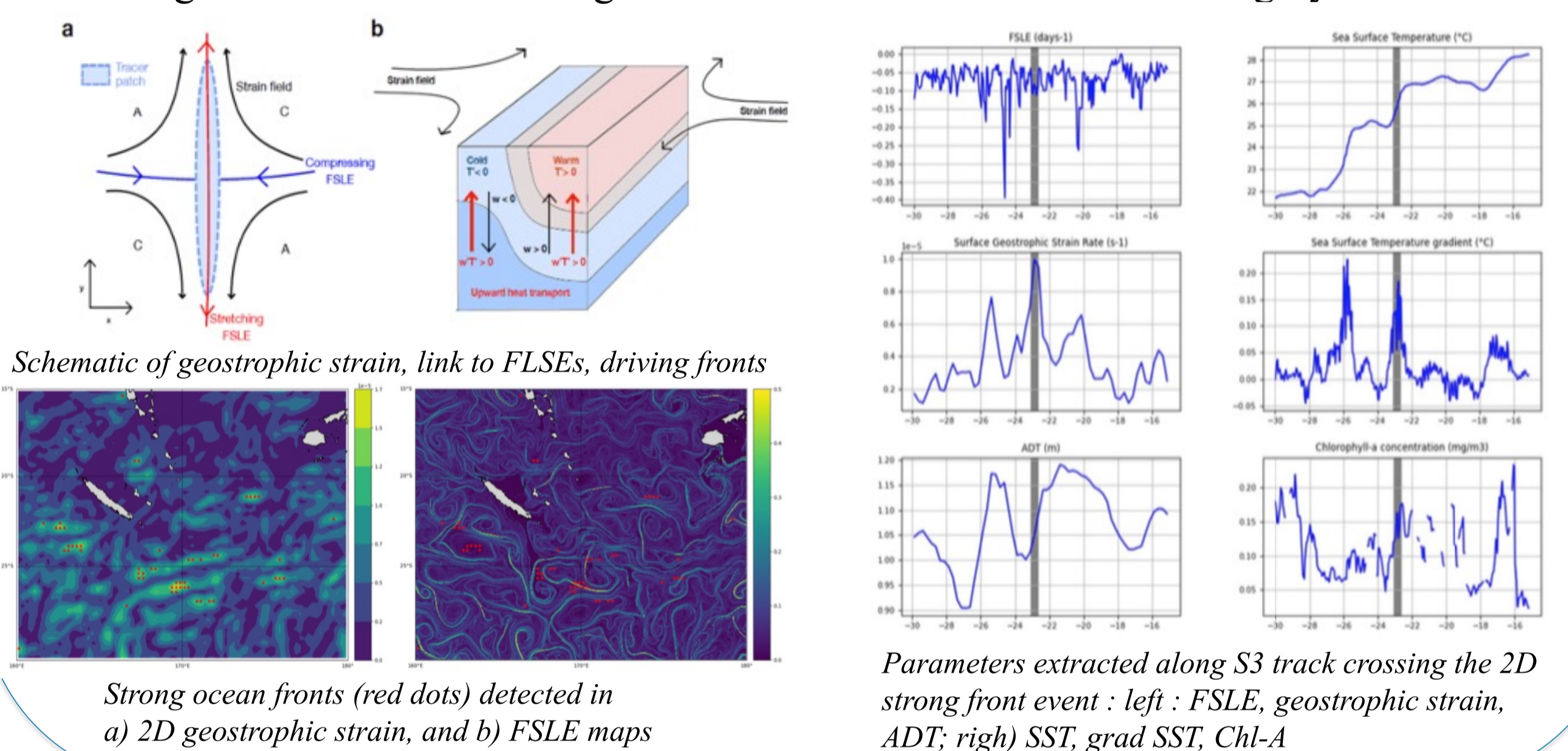
Reference : Vegara, O. et al.; Global submesoscale diagnosis using along-track satellite altimetry Ocean Sci., 2023 doi: /10.5194/os-19-363-2023

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2D Ocean fronts colocated with nadir altimetry

- Dynamical ocean fronts are often detected from 2D gridded maps of altimetry-derived strain or finite-site Lyapunov Exponents (FSLEs).
- Colocalised with Sentinel-3 2D tracer data (SST, ocean color) & 1D nadir altimetry (SSH, wind, waves)
- Strong fronts associated with grad.SST : wind & wave effects are highly variable



Simulating SWOT eddy diagnostics : Agulhas

Different eddy diagnostics (EKE, geostrophic strain, geostrophic energy transfers) have been calculated from the MITGCM model in the Agulhas, to simulate the future SWOT observations, and compared to a pseudo-DUACS product sampled from the same model. The residual represent the smaller scales SWOT should observe.

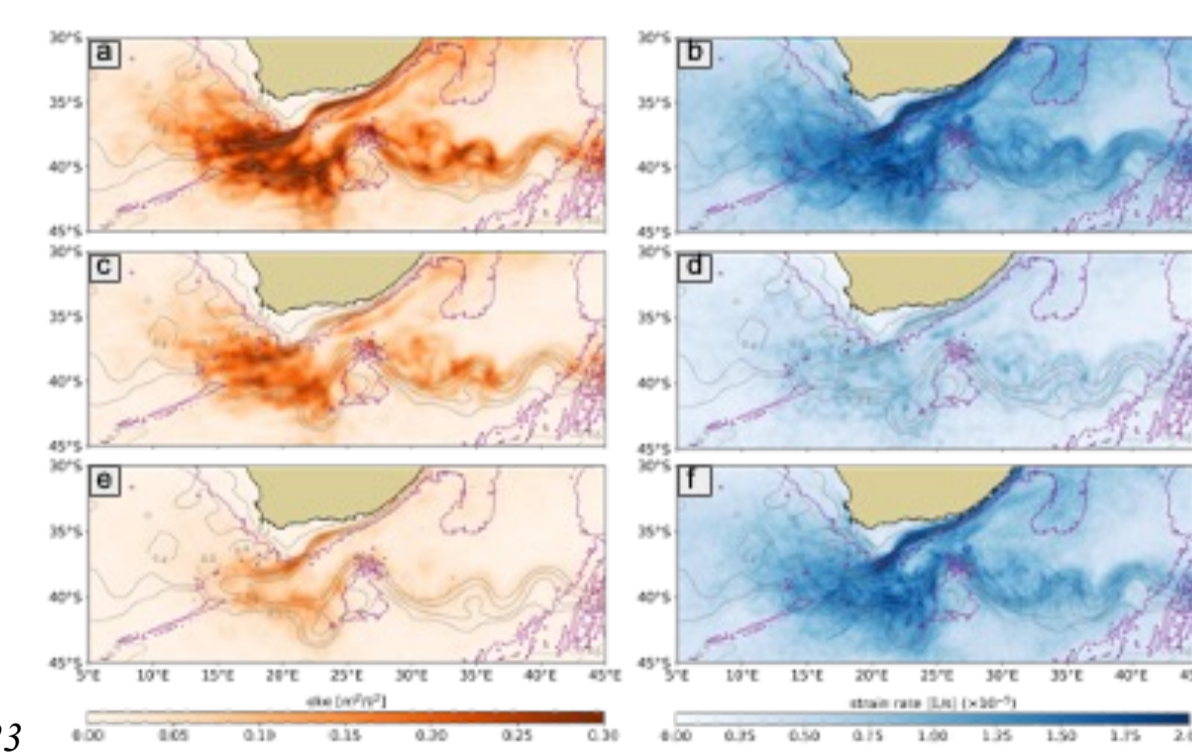
Swath-based eddy diagnostics are also calculated – with simulated random noise, and a neural-network AI filtering applied.

See Young Researcher Poster : Elisa Carli

Average EKE (left) and strain rate standard deviation (right) over the full LLC10 simulation period (Sep 2011 to Nov 2012) (a, b), the pseudo-DUACS product (c, d), and the residuals between the simulation and the pseudo-DUACS product (e, f). The grey contours are the yearly mean current and the purple contours represent the 3000m bathymetry.

Reference : Carli, E et al.; Ocean 2D eddy energy fluxes from small mesoscale processes with SWOT, Ocean Sciences, doi: 10.5194/egusphere-2023-1124, 2023

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X-TRACK: Coastal products & corrections

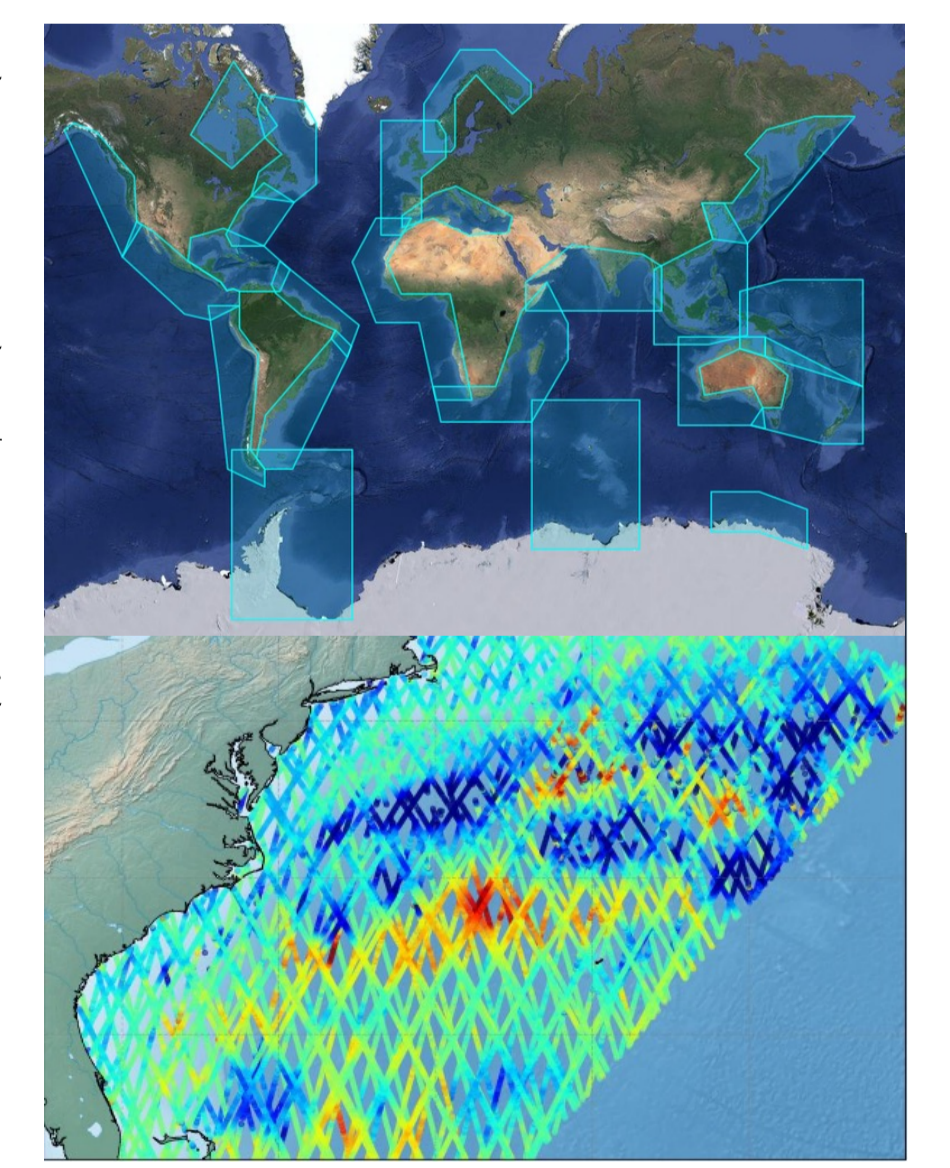
CTOH released a new coastal along track product : XTRACK-L2P Sea Level Anomalies products for coastal applications : version 2022.

Along-track Sea Level Anomalies are projected onto the reference tracks with a spatial interval of about 6-7 km between points. The Sea Level Anomaly time series have been computed with the X-TRACK processing system (developed at LEGOS) starting from the Level 2 Plus (L2P) products distributed by Aviso+.

A Round Robin exercise compared the impact of different altimetric corrections and reprocessing on 1D coastal nadir altimetry Results important for 2D SWOT coastal altimetry.

Map of the 23 zones covered by X-TRACK/L2P product (top), Mean Sea Level Anomaly over the period January to March 2004 using ERS1+ERS2+ENV+SRL, GFO and TP+J1+J2+J3 missions in the Gulfstream region (bottom)

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CTOH and SWOT training and Data Access

The CTOH holds teaching courses on alongtrack altimetry (university training, workshop, individual request), with a focus on emerging applications. These training courses are created for showing users how to handle altimetry data in real cases using Jupyter notebooks in Python. The course topics cover a wide spectrum: principles of ocean and coastal altimetry, reading and using products, computation of derived parameters (series of sea or water levels, currents), comparison with in-situ data, among others.

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For SWOT Ocean Data Access, the CTOH works in close relation with the CNES to establish a service hosting SWOT-related project on its HPC platform. This includes providing computational resources and support for accessing and processing SWOT data. LEGOS users serve as beta-testers for this service prior to its opening to national and international users.

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