FOCUS : Fine scale Observations in the antarctic circumpolar Current Under SWOT.

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The southern ocean uptakes about 75% of the anthropogenic heat and 43% of the anthropogenic CO2.

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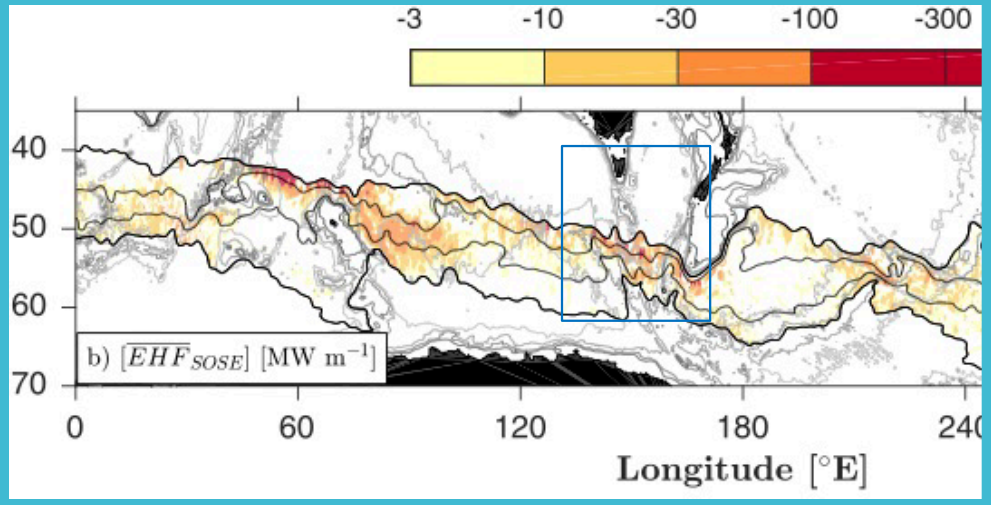
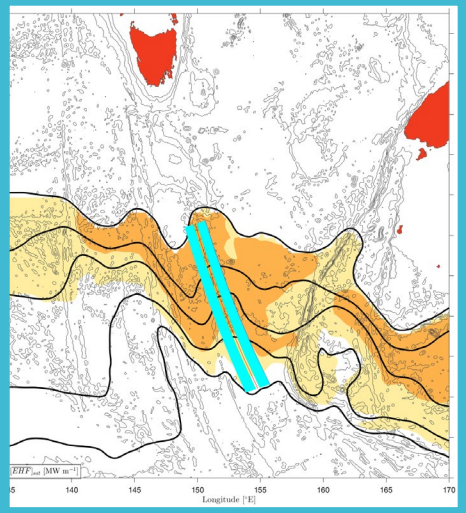
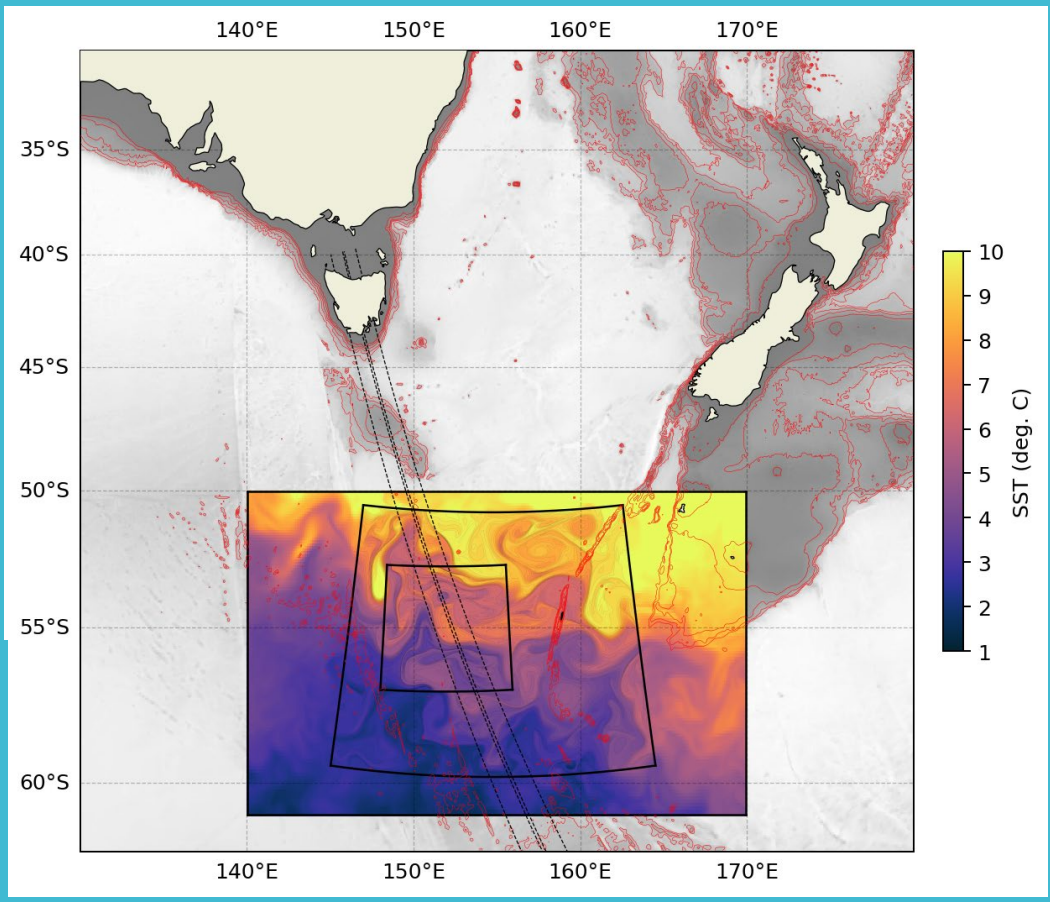
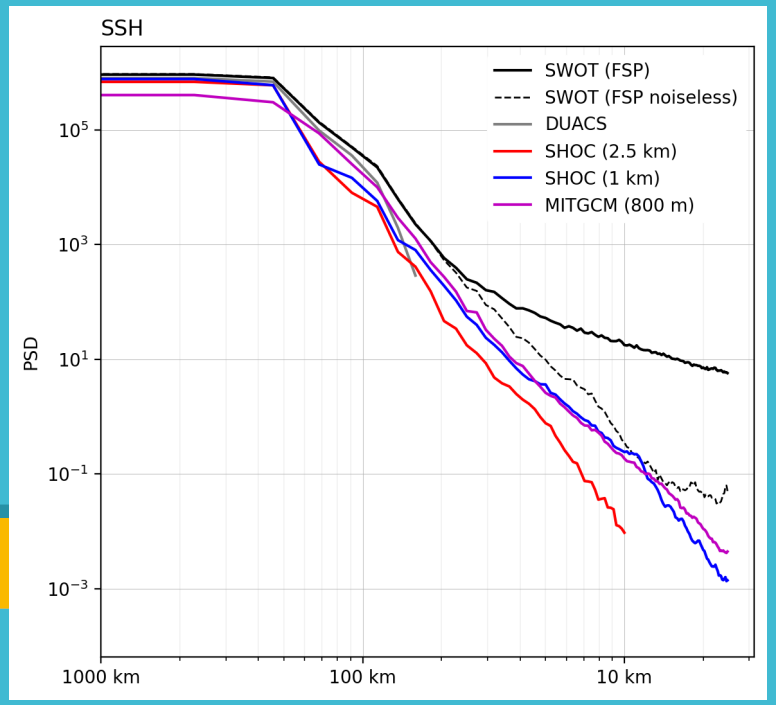
A hotspot for heat transfer









SWOT shows more energy in the 10-100km scales than was observed or analyzed until now. Our aim is to uncover the corresponding dynamic features and their impact on Heat and Carbon transfers. This has been guiding the design and sampling of the FOCUS experiment. It allies Eulerian and Lagrangian approaches, rapid and slow sampling, physics, chemistry and biology.

Modeling experiments are 2-fold :
- improving regional models with best physical parameterisations, boundary conditions and resolution to represent physical processes (frontal, eddying, internal waves and tides, instabilities, energy cascade…
- Testbed for assimilation and impacts on heat and carbon transfers.

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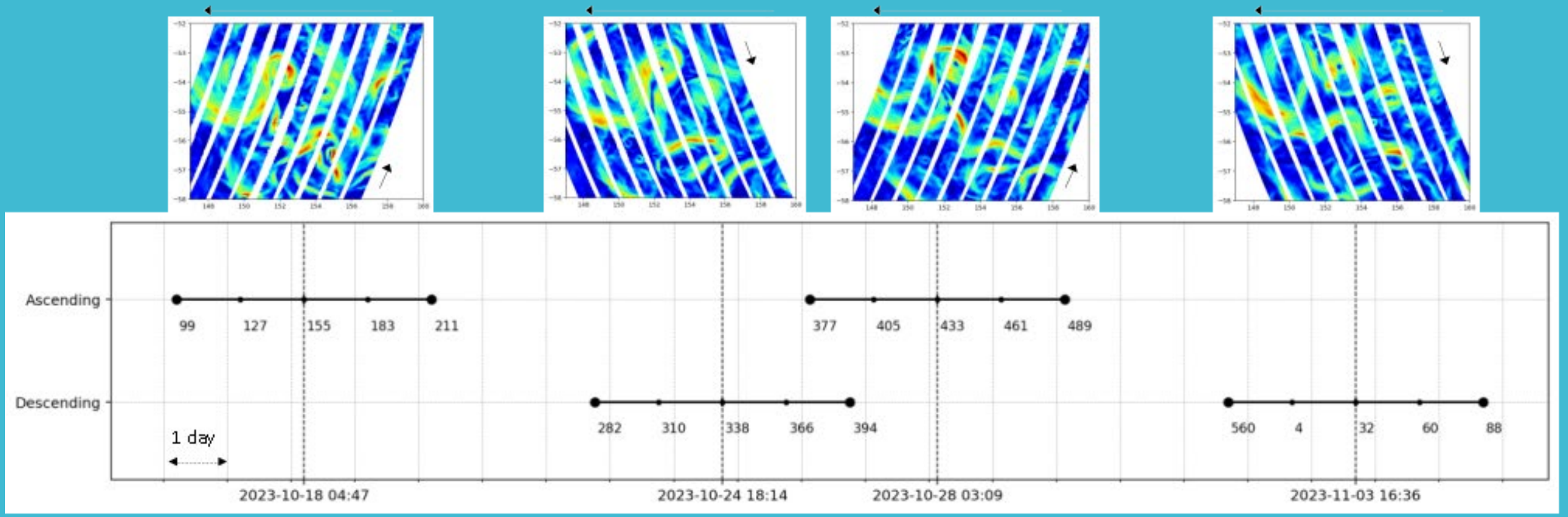
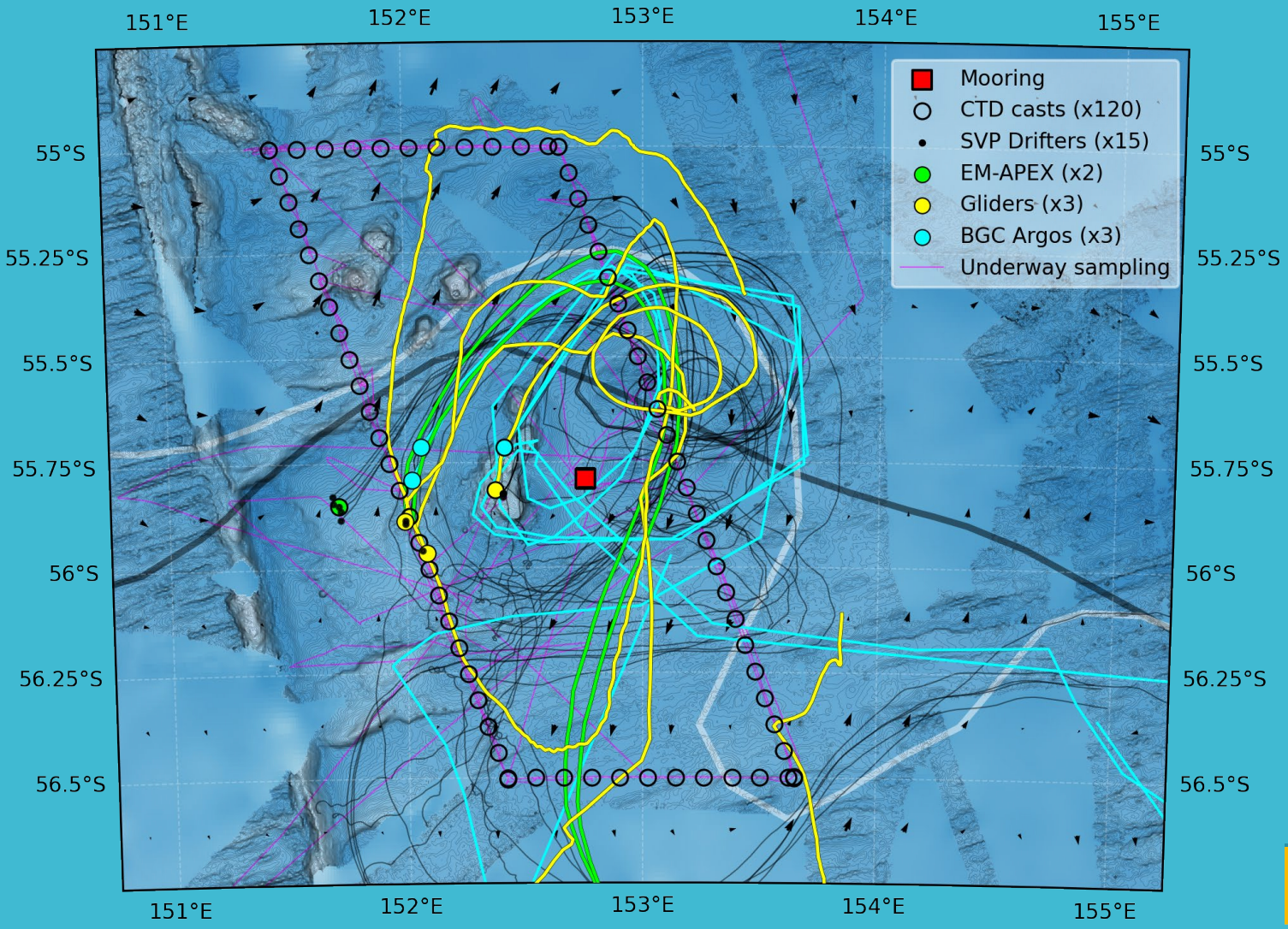
Latitude favors time coverage



The FOCUS campaign with RV Investigator 36d Nov-Dec 2023



The FOCUS (Fine scale Observations of the antarctic circumpolar Current Under Swot) experiment is in an ACC meander south of Tasmania. The voyage involved intense

CTD sections,
triaxus profiling,
underway water sampling, air-sea, SADCP, bathymetry etc.
as well as the deployment of 15x drifters, 3x BGC Argo floats, 2x EM-Apex floats and 3x Gliders
and the deployment of a heavily equipped 50 instruments tall mooring.
The study is also supported by regional models, a range of remote sensing products and SWOT data, from the Fast Sampling Phase and from the science phase.

*** One early available output is the high-resolution bathymetry. Covering the FSP pass 6.**

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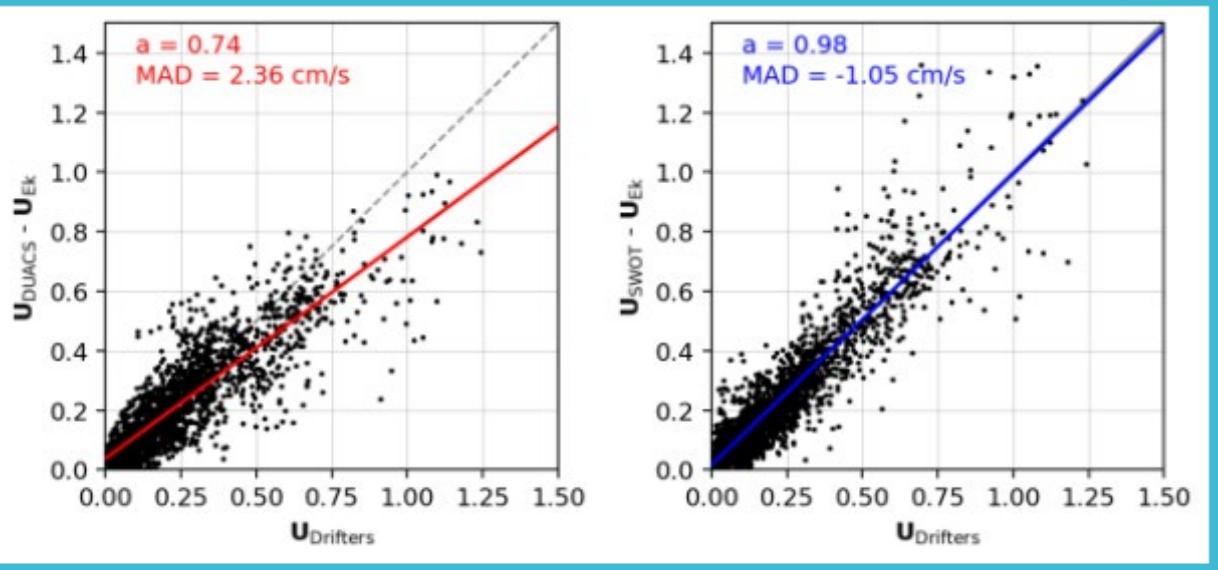
Example of surface currents validation

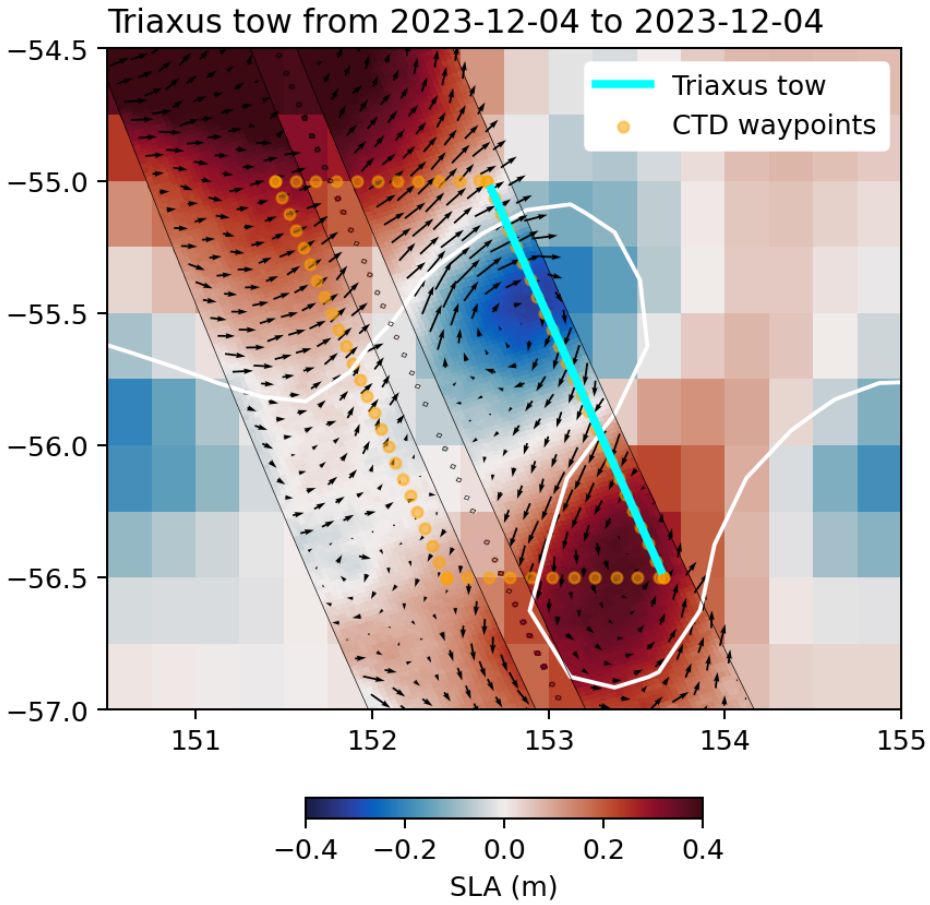


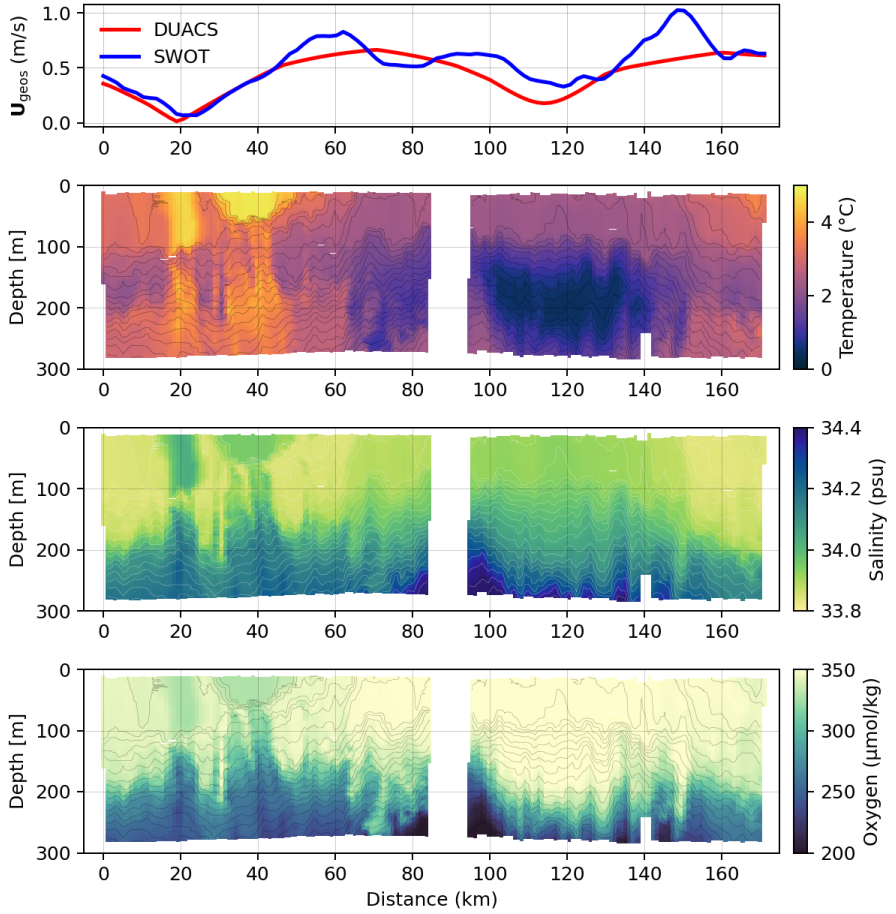
Left (red) = comparison to DUACS, Right =comparison to SWOT
Top = drifters, Bottom = shipborne ADCP

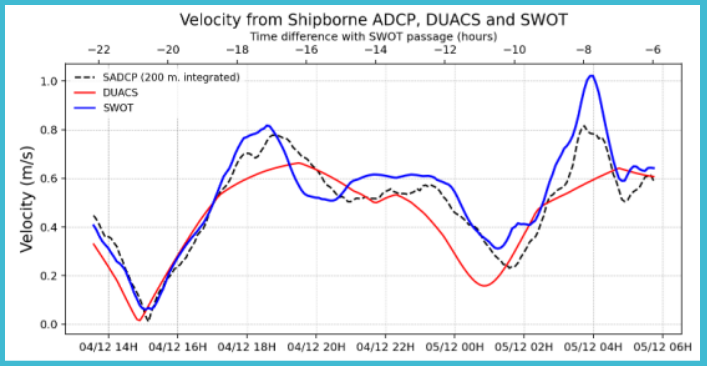
Once filtered for inertial oscillations and corrected for Ekman, the “geostrophic” currents from SWOT match much better.

*** See poster by Tranchant et al. (and upcoming paper) for a more detailed lagrangian study.**

Example of a transect across front and warm-cold eddies







SWOT effectively good at picking sharper fronts which are sampled with the Triaxus vertical profiler.

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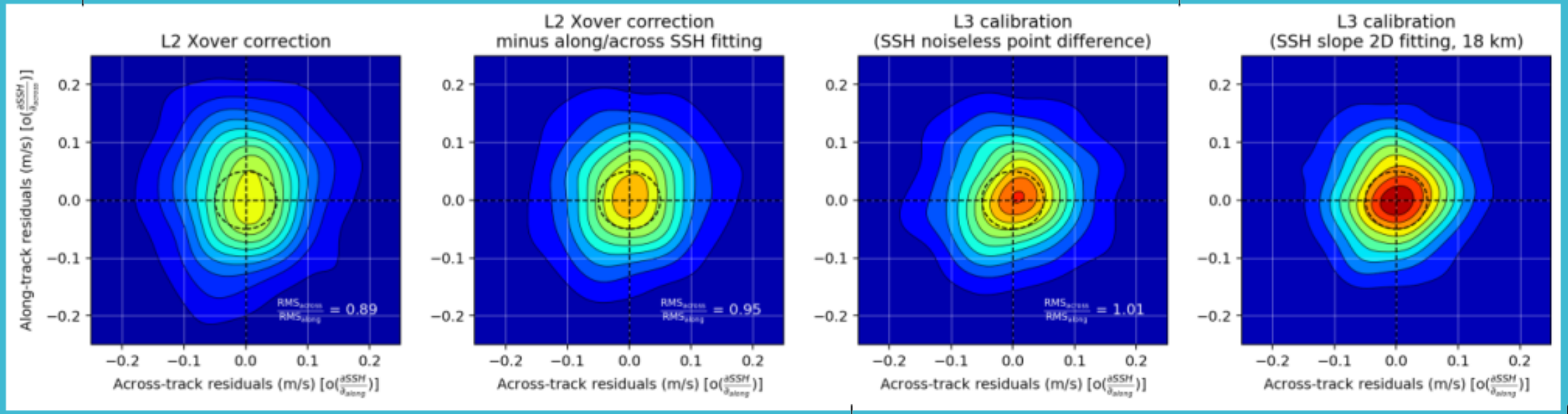
Example of cross track and geostrophic current determination scale testing using drifters

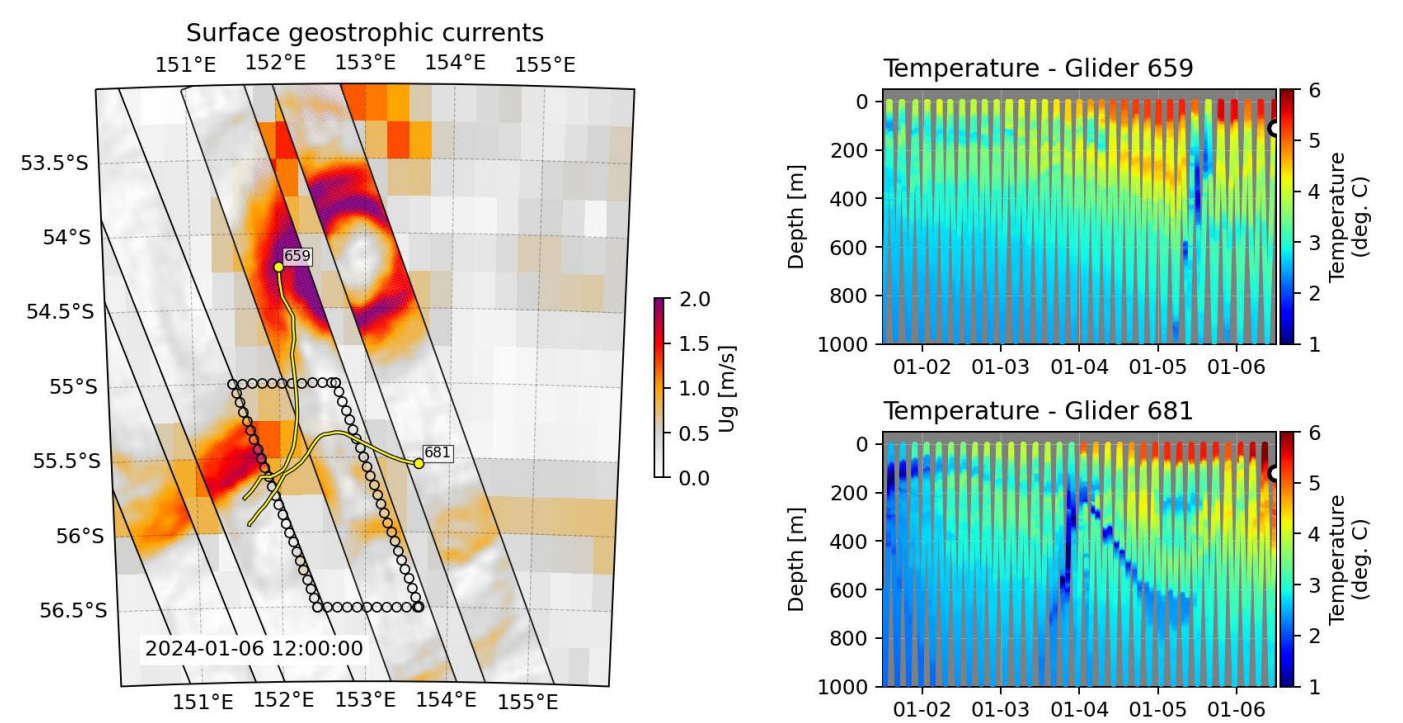
Impact of SWOT cross-track bias

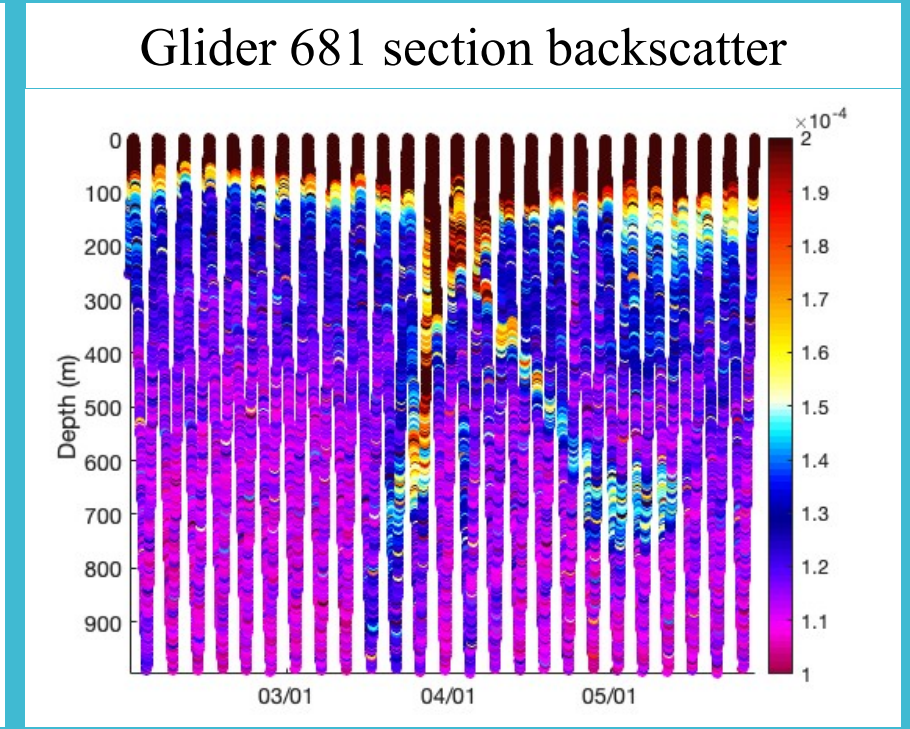


Impact of SSH slope determination

Here we used various version of products and comparison to in situ drifter velocities (once corrected for Ekman, with the inherent limitation).
A larger scale seems needed to compute the geostrophic velocities (or limit the unbalanced impact).

Beyond SWOT : Example of capturing very fine scale very intense anomaly “chimneys” a new way to convey heat and Carbon in and out of the ocean depths.

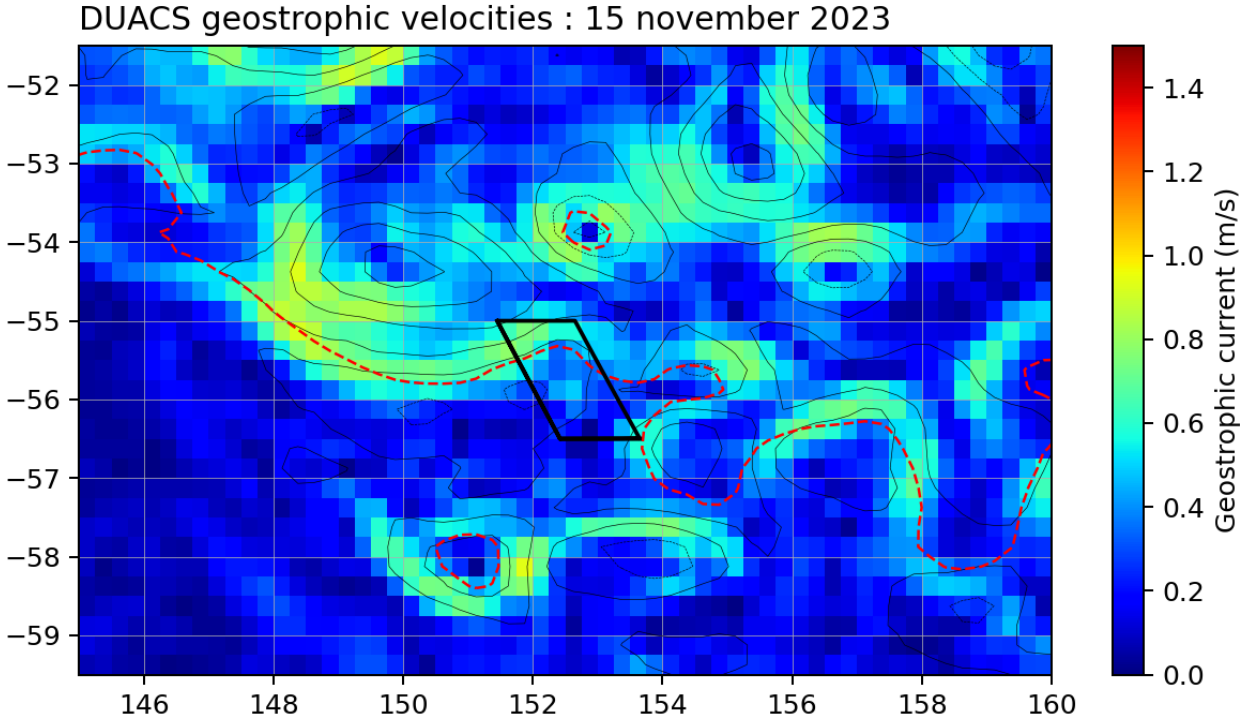


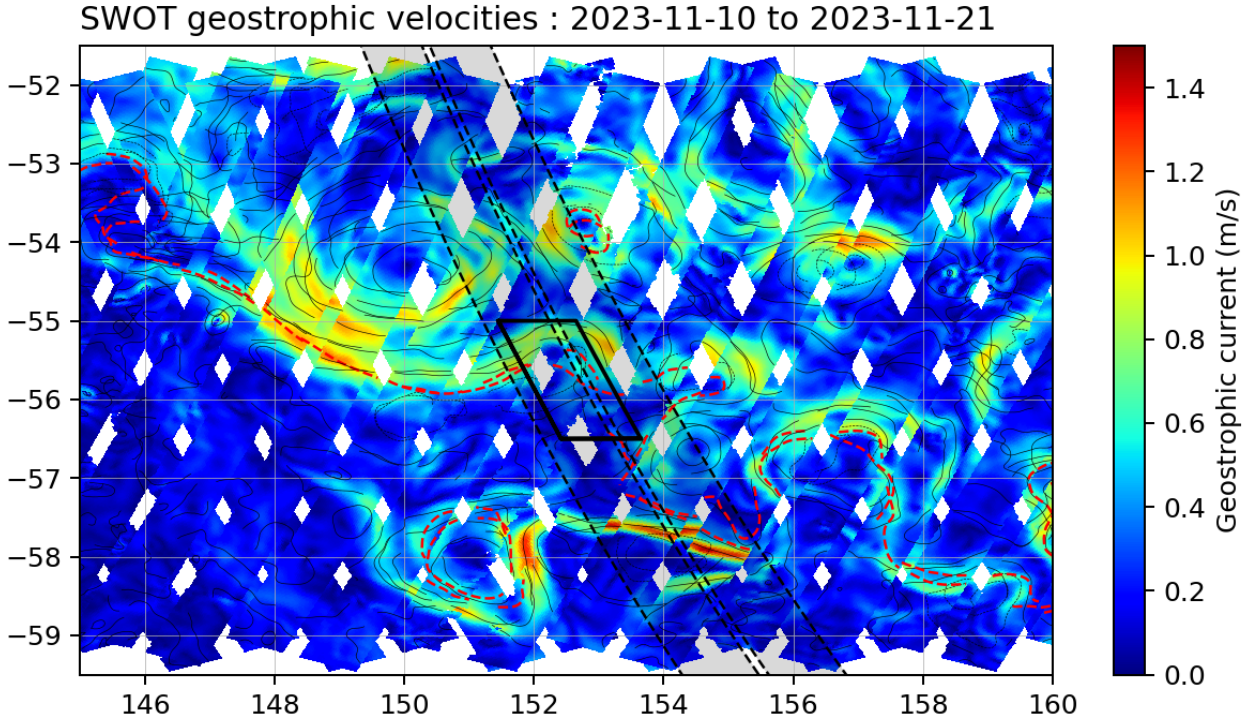


Despite travelling very close to each other, the 2 gliders got different sections as [681] crossed coherent very fine structures of deep reaching colder anomaly illustrating very strong vertical exchange. The higher backscatter in the anomaly points to transport of particles during the event. (Pena-Molino et al. in prep.)

*** At these small scales the surface anomaly alone might not link easily to the vertical movements.**

Yes SWOT is fantastically revealing sharper ocean features and separating what was time and space smeared.
But DUACS always shows those features.
i.e. SWOT validates 30years of DUACS grids.





- FOCUS campaign in the Antarctic Circumpolar Current acquired and is still acquiring a vast in-situ dataset
- Model developments point to the finer scale dynamics and yet to show the impact of SWOT assimilation… beyond the "normal" improvement of mesoscale.
- Higher latitudes have a better time/space luck
- With SWOT currents become comparable to in-situ (ADCP, drifters) for the benefit of chasing unbalanced flow.
- In-situ currents measurements can be used to evaluate (constrain?) Xtrack corrections…
- **Xtrack will be a limitant (as in regionally biasing currents) and need continued attention.**
- The diversity of observing systems leads to un(?)expected features being uncovered. i.e. the ADAC approach led to amazing different observation sets that have potential to lead to transformative change in oceanography.
- Small scale features in corrections (wet and dry tropo, SSB, DAC, tides …) that cannot be represented with existing products with resolution limitations are a limitant that need to be acknowledged. **There's a whole scary/fantastic world to explore where there are cool signals and artefacts co-existing.**
- SWOT validates 30years of DUACS grids. **Recommend DUACS teams to validate : there's probably some to learn and retro improve…**

Looking Forward SWOT-ST project :

- **Analysing the campaign data and SWOT data and modeling efforts will extend over the next 2 years with the Australian Antarctic Program. Nature and change of the Southern Ocean.**
  - **P15 and SR3 go-ship lines with RV-Investigator**

- **How the heat reach the Antarctic continental Shelf Field campaign Dec 2025-Jan2026**
  - **CSEACOM voyage with icebreaker RV Nuyina.**

- **How the warmer waters reach and interact with sensitive Antarctic glaciers**
  - **Denman Marine Voyage with icebreaker RV Nuyina.**

- **Inland waters in Australia.**
  - **Water management reservoirs surveys with SWOT and other remote sensing.**
  - **Lakes monitoring with in situ.**