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Impacts of meso- to submeso-scale features on the ocean circulation in the Coral Sea

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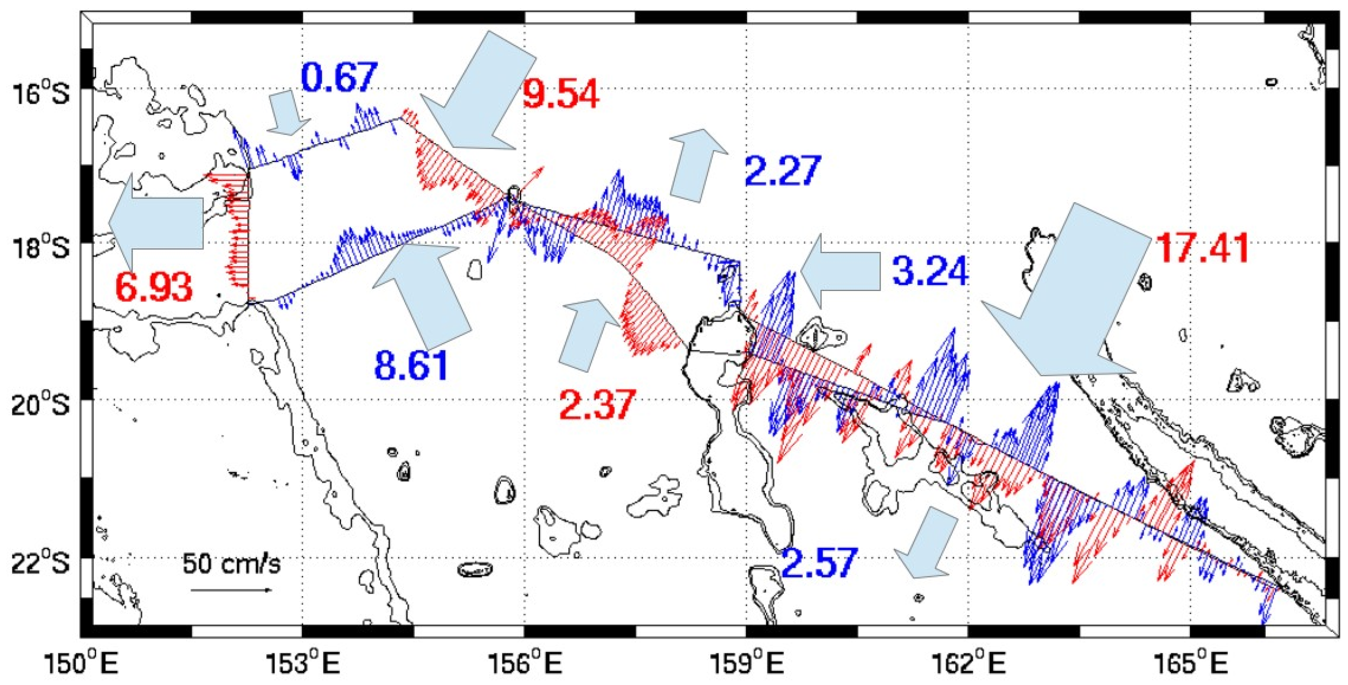
The main objective of this study is to evaluate the impacts of mesoscale activity on transport calculations and water mass exchanges within the Coral Sea. Moreover, we investigate the role of submesoscale activity on the distribution of surface tracers. We use several different data sets and tools : observations during the Bifurcation cruise performed from 1 to 15 Sept. 2012 [*Maes*, 2012], Argo float data, satellite-derived data (AVISO), FSLE calculations [*Nencioli et al.*, 2011] and a Lagrangian toolkit [Ariane, http://www.univ-brest.fr/lpo/ariane] combined with a high-resolution numerical model (NLOM).

Mesoscale dynamics

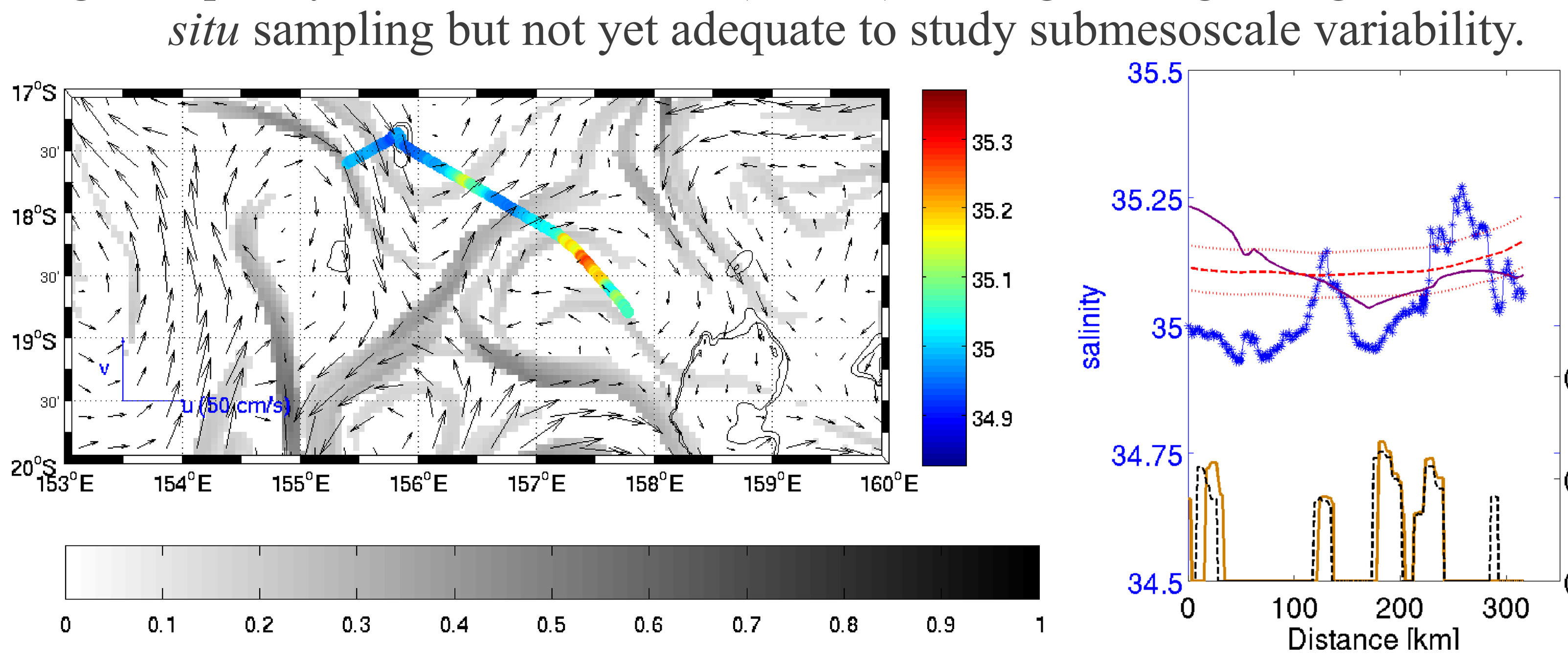
Transport calculations through different sections of the Bifurcation cruise highlight **an eddy-induced aliasing,** estimated in the **order of the intensity of the jets (~15 Sv)**. As a consequence, the main jets are not readily identifiable.



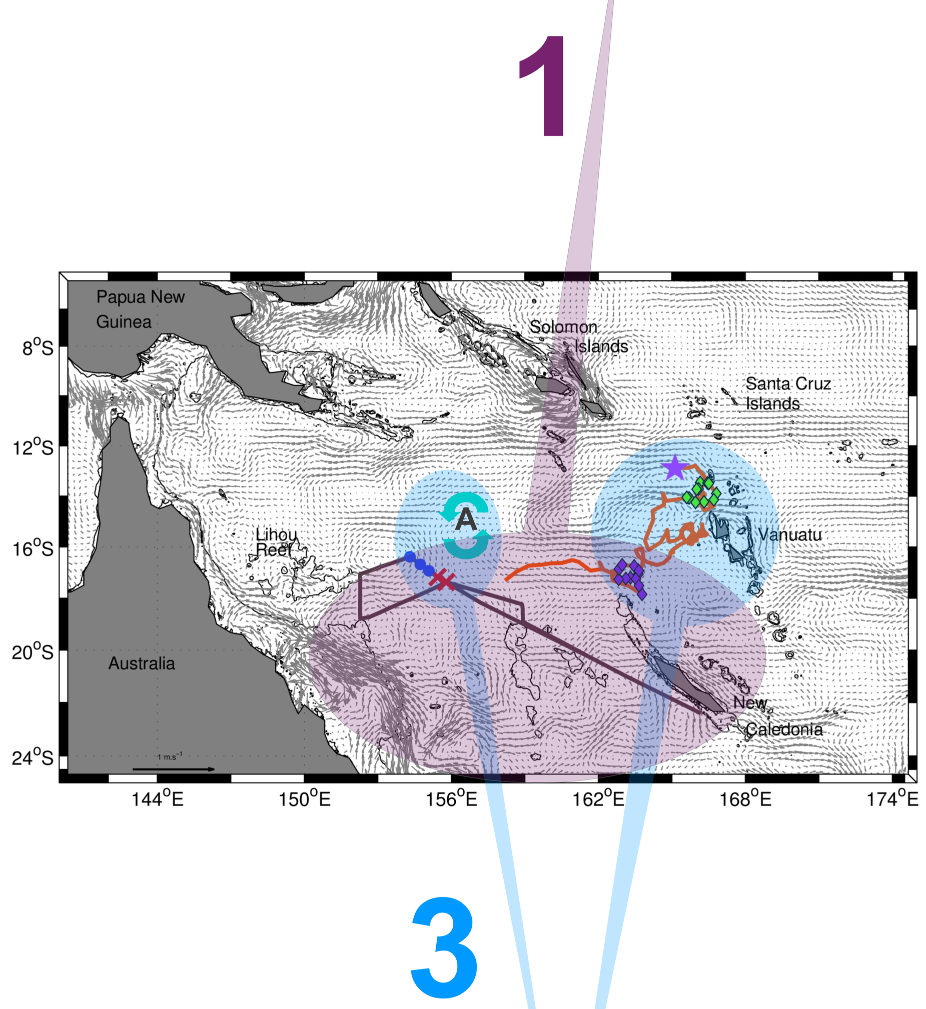
Transports in Sv integrated down to 488 m. Red and blue vectors show the velocity field orthogonal to successive portions of the vessel's track, as measured with the S-ADCP. Big light blue arrows represent qualitatively the direction and the intensity of the full transport field.

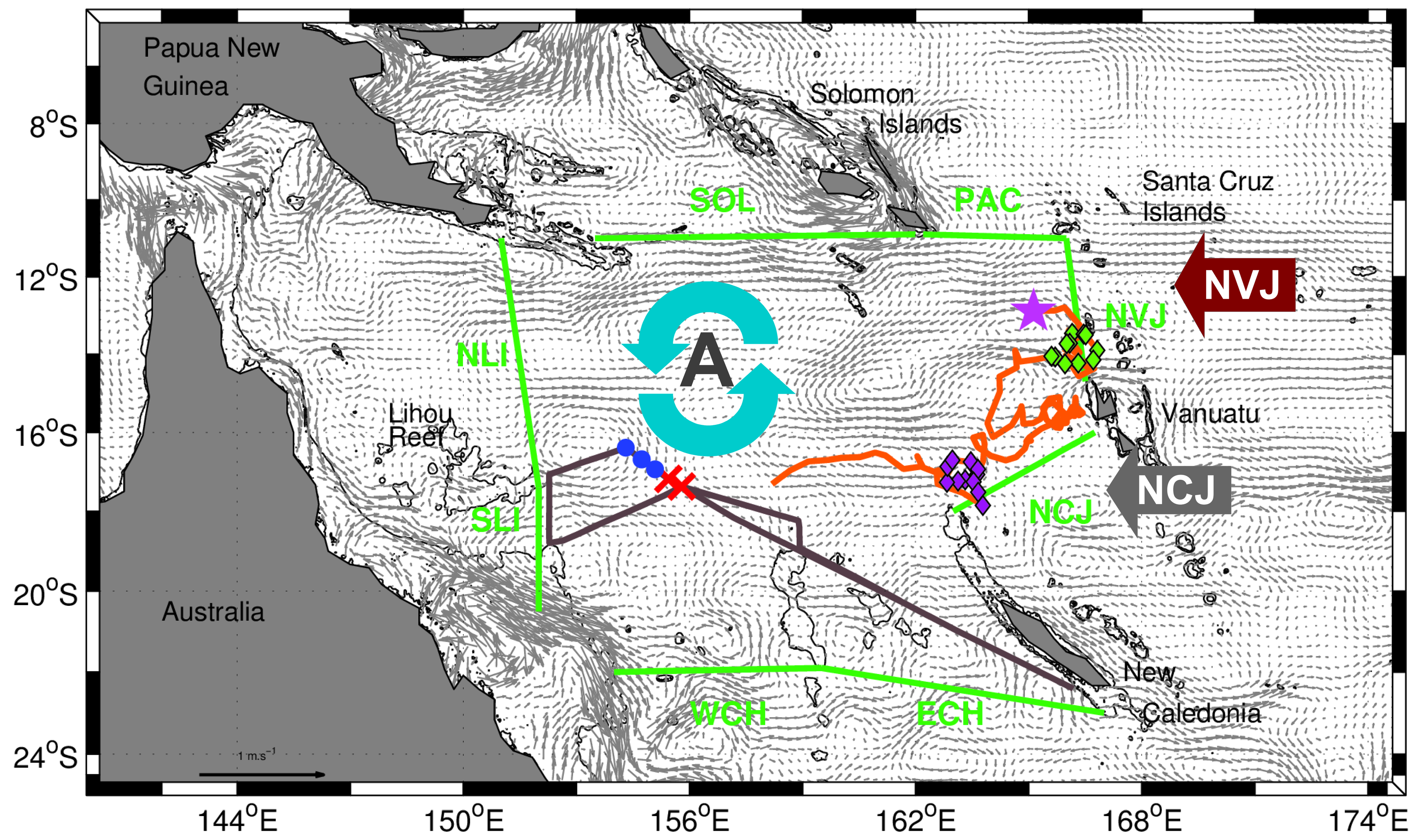
Submesoscale dynamics

Finite Size Lyapunov Exponents (**FSLE**) allow identifying a **link** between **physical fronts** and submesoscale gradients of **surface tracers** (SSS, SST) sampled with a high-frequency TSG. Satellite data (SMOS) are in general good agreement with *in situ* sampling but not yet adequate to study submesoscale variability.

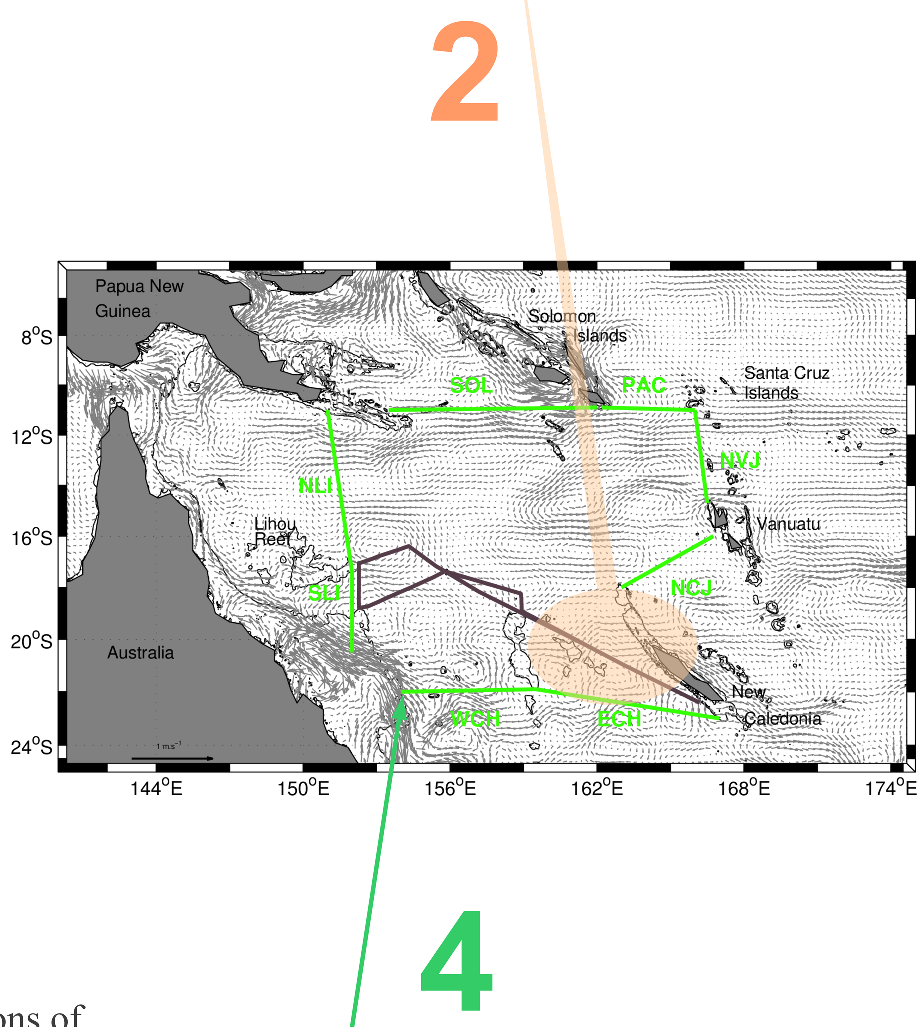


Left : Sea surface salinity (in color) measured by the vessel TSG on 9 Sept. 2012 superimposed on the surface currents and backward FSLE derived from AVISO. Right : Left axis: TSG sea surface salinity (blue) and collocated SMOS (purple) and ISAS-13 (red) salinity data on 9 Sept 2012
Right axis: FSLE calculated on 2 successive days: 9 and 10 Sept 2012.

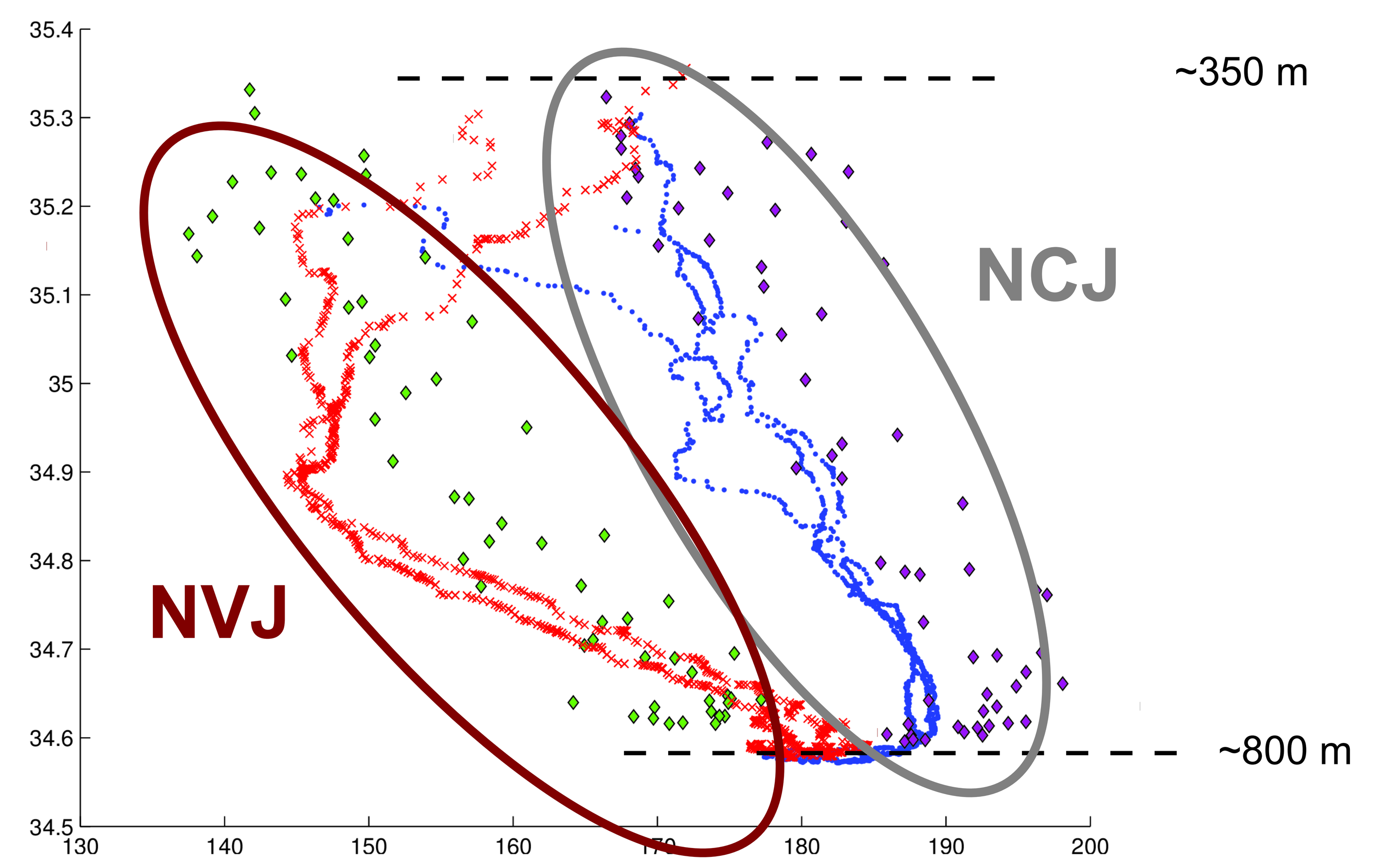




Annual average of the AVISO velocity field in the Coral Sea (arrows). Route of the Bifurcation cruise (brown). Positions of CTD stations (blue and red). Trajectory and positions of Argo profiles (orange line and diamonds). The approximate position of anticyclonic eddy A is shown with bold blue arrows. The geographical limits of the Lagrangian integrations made with Ariane are drawn in green. **NVJ : North Vanuatu Jet ; NCJ : North Caledonian Jet.**



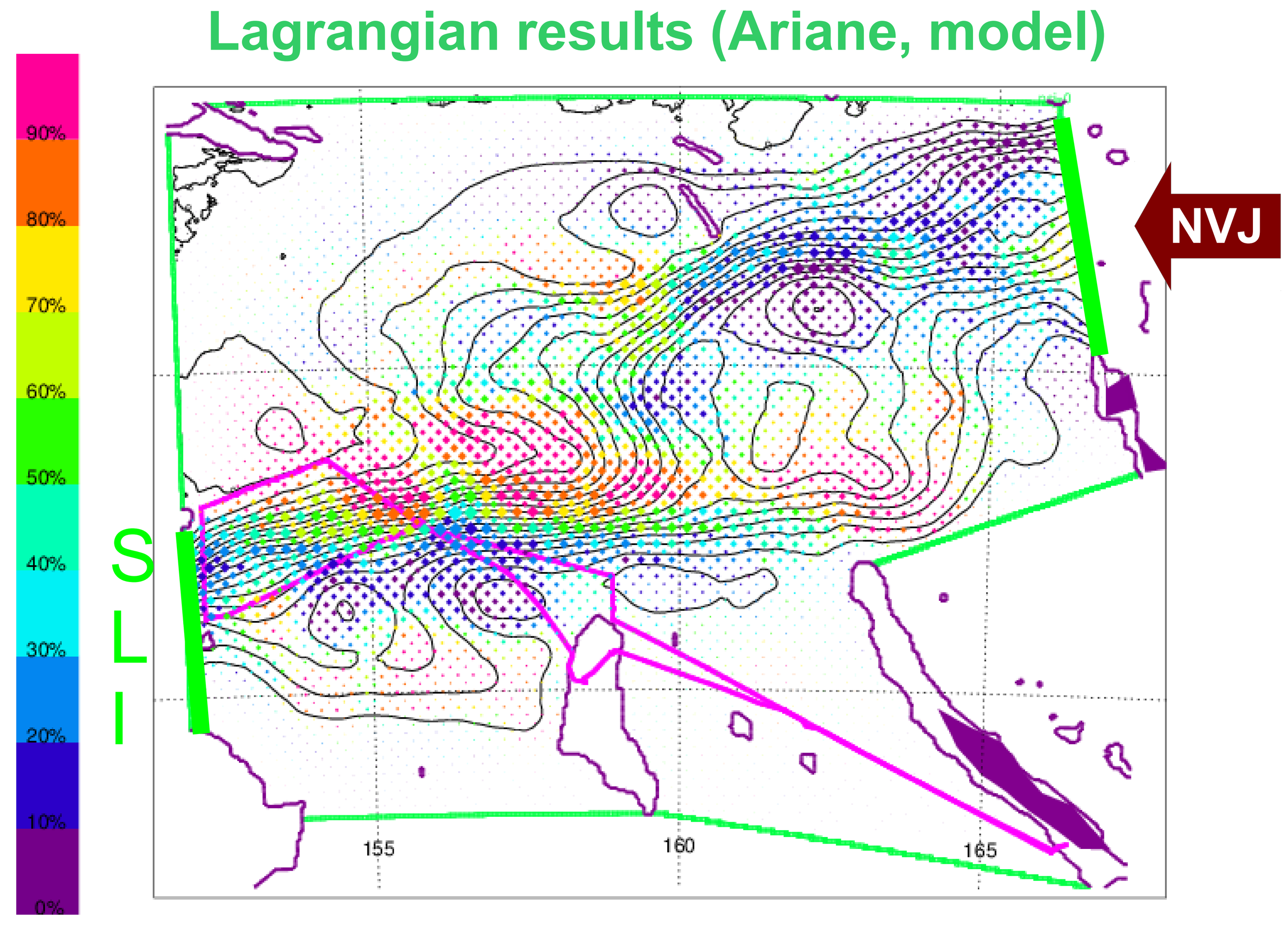
Hydrology (CTD, Argo)



S-O2 diagram zoom on lower thermocline waters for 5 CTD profiles (red and blue) and two groups of Argo profiles from the NVJ (green) and the NCJ (purple diamonds).

The combined analysis of CTD data and Argo profiles shows **NVJ-like water masses in the pathway of the NCJ.** We assume that one **anticyclonic eddy** depicted from satellite observations (AVISO) is responsible for that **cross-jet water mass transport** contributing to a **NVJ-NCJ connection** [*Rousselet et al*, in preparation].

Lagrangian results (Ariane, model)



Black lines : stream function showing the full surface circulation that connects the NVJ and SLI sections. A fraction of this connection is achieved by eddies (not shown), and the diamonds show the contribution of anticyclonic eddies to this fraction (colorbar in %).

A Lagrangian analysis using the daily surface velocity from the NLOM model (1/32°) highlights the **transfer of particles from the NVJ to the NCJ through eddy circulation** (3 % of the flow crossing the SLI section). The contribution of anticyclonic eddies to this eddy-induced leakage can reach up to 70-90 %.

Conclusions

Observations from the *in situ* Bifurcation cruise combined with satellite derived data are considered to illustrate the influence of meso- and submeso- scales on the Coral Sea circulation. Indeed, FSLE are identified as a good tool to explain the distribution of surface tracers. However satellite data are not yet able to detect submesoscale surface gradients. Moreover, the aliasing caused by eddies on transport estimates can reach the intensity of the jets (15 Sv). We also identified a dynamic connection between the NVJ and the NCJ due to mesoscale activity. This preliminary work will be extended thanks to the new set of data collected during the OUTPACE cruise [*Moutin and Bonnet*, 2015] that took place in Feb-March 2015 in the South West Pacific.

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Nencioli, F., d'Ovidio, F., Doglioli, A. M., & Petrenko, A. A. (2011). Surface coastal circulation patterns by in-situ detection of Lagrangian coherent structures. Geophysical Research Letters, 38(17).
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