Observation and modeling of intermediate zonal jets in the Tropical Pacific Ocean.

**Years 2013-2014 for ZEBRE**

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**Objectives**: At 1000 and 1500m depth in the equatorial Pacific, the presence of alternating zonal jets has been evidenced at the basin scale. The main goal of the ZEBRE project was to better document the characteristics of these deep extra-equatorial jets in the Pacific ocean and in the other tropical oceans. To:

- describe the zonal jets 3D structure, their water masses properties in the Tropical Pacific, and their connection with the western boundary currents from the combined analyses of existing observations (Shipboard ADCP currents, 3-D products of geostrophic velocities, Argo float drifts) and from a dedicated cruise, CASSIOPEE.
- compare them with similar structures in the Atlantic and Indian tropical Oceans
- characterize the jets in existing numerical simulations, test the models ability to realistically simulate such features.

**Main results**:

- The jets vertical structure and their connections with the overlying Tsuchiya jets have been investigated using a compilation of SADCP measurements, and 3-D Argo data. The 1000m jets are far from being barotropic, and appear to be objects dynamically distinct from the Tsuchiya jets.
- Similar jets are observed in the 1000m mean velocities in the Equatorial Atlantic Ocean (with a somewhat larger meridional scale), but surprisingly not revealed by Argo floats drifts in the Indian Ocean, suggesting that they are not an ubiquitous feature of the equatorial oceans.
- Their representation in state-of-the-art ocean model simulations (with different horizontal and vertical resolution, diffusion coefficients and advection schemes) is not realistic. The simulated jets are very weak and not zonally coherent, their meridional scale is not realistic, and they appear to be too strongly constrained by the topography.

Figure 1: CASSIOPEE cruise track (July-August 2015); the white dots show the positions of the CTD casts, the red dots the Argo floats deployed, the white stars the recovered moorings. Colors show bathymetry (m).

Figure 2: Upper panel: tracks of the cruises included in the SADCP database. Colors show the depth of the deepest velocity measurement (m). Lower panel: Vertical-latitudinal structure of the zonal jets, averaged in the...
The CASSIOPEE cruise was carried out on R/V Atalante from July 19 to August 23, 2015 (one year after what was initially planned, and on R/V Atalante instead of R/V Alis). Three meridional sections documented the zonal jets structure and their longitudinal evolution from the surface to the bottom, with 101 classical hydrological casts (white dots in Figure 1), including nutrients, neodymium isotopes, biological sampling as well as LADCP, video-profiler (UVP5) and turbulence (chi-pods) measurements (Figure 1). 4 moorings from SPICEMoor have also been recovered in Solomon and Vitiaz straits (white stars in Figure 1). 9 Argo floats have been deployed (7 Arvor, 2 from CSIRO; red dots in Figure 1).

SADCP direct velocity measurements collected from research vessels during cruises and ship transits in the tropical Pacific since 2004 were analyzed (Figure 2, upper panel). These data reveal a very interesting vertical structure of the zonal currents. Two distinct meridional structures of the zonal currents are observed (Fig 2, lower panel): multiple Tsuchiya jets between the thermocline and 700-800m, in the southern hemisphere, at 2.5°, 5.5°, but also at 9°S, 11.5°S and 14°S, with a core deepening poleward from the equator. In addition, intermediate extra-equatorial intermediate currents appear below 800m and are clearly distinct from the Tsuchiya jets. They appear to be two distinct dynamical « objects » whose dynamics still needs to be studied.

**Future of the project**: Two publications on the vertical structures of the jets and on their characteristics in the three tropical oceans are in progress. The CASSIOPEE cruise data are being analyzed. We are looking for a PhD student to work with us on these data, and to perform idealized numerical simulations to better understand the dynamics of the jets.

**Nombre de publications, de communications et de thèses**  
*(citer au maximum 5 publications en lien direct avec le projet)*


- Cravatte S., F. Marin and W. S. Kessler (2014), Zonal jets at 1000m in the tropics observed from Argo float’s drifts, Mercator-Coriolis Newsletter, Avril-Mai 2014.