Pandora cruise provides an unprecedented description of the Solomon Sea

Gérard Eldin [1,2], Alexandre Ganachaud [1,2], Sophie Cravatte [2,3] and Catherine Jeandel [2,4]

1 **Institut de Recherche pour le Développement (IRD)**
2 **Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS) UMR5566, UPS (OMP-PCA), Toulouse, France**
3 **Centre IRD de Nouméa, Nouméa, New Caledonia**
4 **Centre National de la Recherche Scientifique (CNRS)**

Introduction

The climatic variability in the equatorial Pacific at decadal time scales could be linked to water supply from the subtropical gyres toward the equator. Improving our knowledge of water masses transformations and pathways through the South-West Pacific is one of the main objectives of SPICE (Ganachaud et al. this issue). In addition to dynamical transformations, water masses undergo nutrient and micronutrient enrichment when entering into contact with the coasts; impacting the productivity of the Equatorial Pacific Cold Tongue and its climatic role. Quantifying these land/ocean exchanges is a priority of the international GEOTRACES program.

The Pandora Cruise

A multidisciplinary cruise was completed in July 2012 through a France-USA collaboration, to document physical and geochemical water properties in the Solomon Sea and adjacent areas, believed to be a key location for SPICE studies. Data obtained during the cruise and associated mooring deployments are expected to substantially improve our understanding of the area, both in terms of climate and ecosystems.

The main objectives of the cruise were:

- To provide a quasi-synoptic description of surface and subsurface circulation in the Solomon Sea and in the straits connecting it to the equator;
- To deploy a series of moorings in the straits and on both sides of the Solomon Sea, to obtain the temporal variability of the circulation;
- To document water masses transformations and mixing, as well as ocean-margins exchanges, in particular through sampling of Trace Elements and Isotopes (TEI) at selected locations in the area.

Therefore the experimental approach combined physical, chemical and geochemical experiments, to access a wide range of space and time scales of the circulation.

The cruise track included both classical hydrology sections, including macro-nutrients, and 24-48h time-series stations, the latter allowing TEI sampling and providing information on short term hydrology variability, and its impact on geostrophic calculations (Figure 1). The cruise, carried out on French R/V L'Atalante, departed from Nouméa, New Caledonia, on June 28 2012 and ended at the same port on August 6. A first meridional section along 163E documented the incoming flows of the South Equatorial Current. Following sections were obtained across the

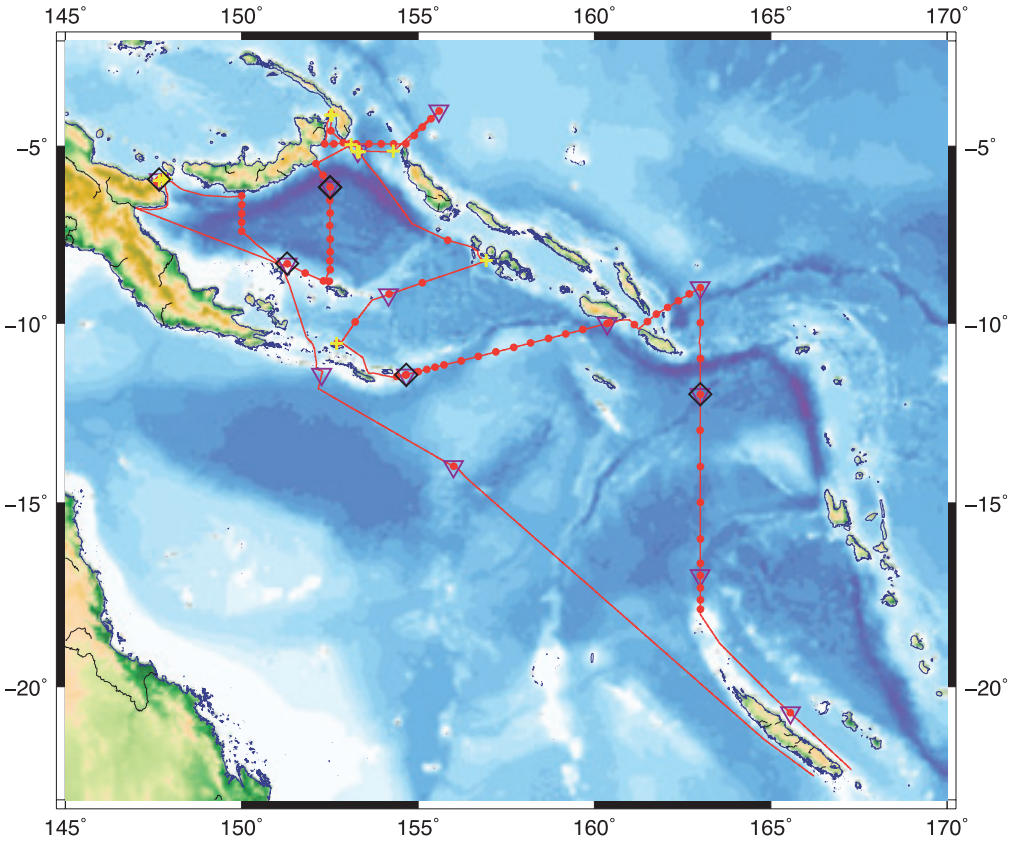

Figure 1. Pandora cruise track. Red dots, CTD stations; triangles, "clean" CTD stations; diamonds, in-situ pumps deployments; yellow crosses, moorings.

southern entrance of the Solomon Sea, in its interior, and across the straits at its northern exit. Two SeaBird CTDO2/Rosette systems were used, comprising a "clean" (titanium structure, Kevlar cable, courtesy of C. Measures, U. of Hawaii) for trace metals sampling and "dirty" system. Overall 83 multiple-cast stations were achieved for a total of 134 casts, most to 2000m or more, including 93 LADCP profiles. During the whole cruise, 2 shipboard RDI ADCPs recorded the current field to 1000-1500m depth. Nine moorings were deployed in the straits, in the frame of a consortium agreement between LEGOS, Scripps Institution of Oceanography (SIO) and University of Papua-New Guinea. Two "end points" moorings were also deployed in the Solomon Sea to monitor total geostrophic flow, as a collaboration between LEGOS and SIO.

Data is still in a preliminary analysis phase. However, some qualitative features seem to already emerge:

- The very deep extension (with a significant speed to more than 1500 m depth) of the western boundary current (New Guinea Coastal Undercurrent, NGCU) at its entrance into the Solomon Sea is confirmed, its core being located at 300-800 m. Its transport during Pandora was probably in the upper range of what was estimated from glider data by Davis et al., (2012); this is consistent with their finding of a stronger flow during El-Niño episodes. However, the slight warming of summer 2012 did not even reach the NOAA definition of El Niño (NOAA/NWS/CPC). It is noteworthy that measured transports through the Solomon Sea and straits were generally stronger than previous observations or model results (Figure 2).
- The existence of a Solomon Island Current (SICU), flowing north-westwards along the eastern coast of the Solomon Islands has been suggested by some modeling studies. During Pandora, only a shallow coastal flow was measured.
- A peculiar increase in dissolved oxygen content, deep into the Solomon Trench (4000-5600m) is currently being investigated.
- Preliminary geochemistry results show that; dissolved iron concentrations only slightly increase across the Solomon Sea transit; radium activities are higher close to the coast; and toxic methyl-mercury can be produced in situ in the open ocean and not only at margins.

A turnover cruise is planned in 2014 to maintain the moorings. The final mooring recovery will take place in 2015, for a total transport time series of 3 years.

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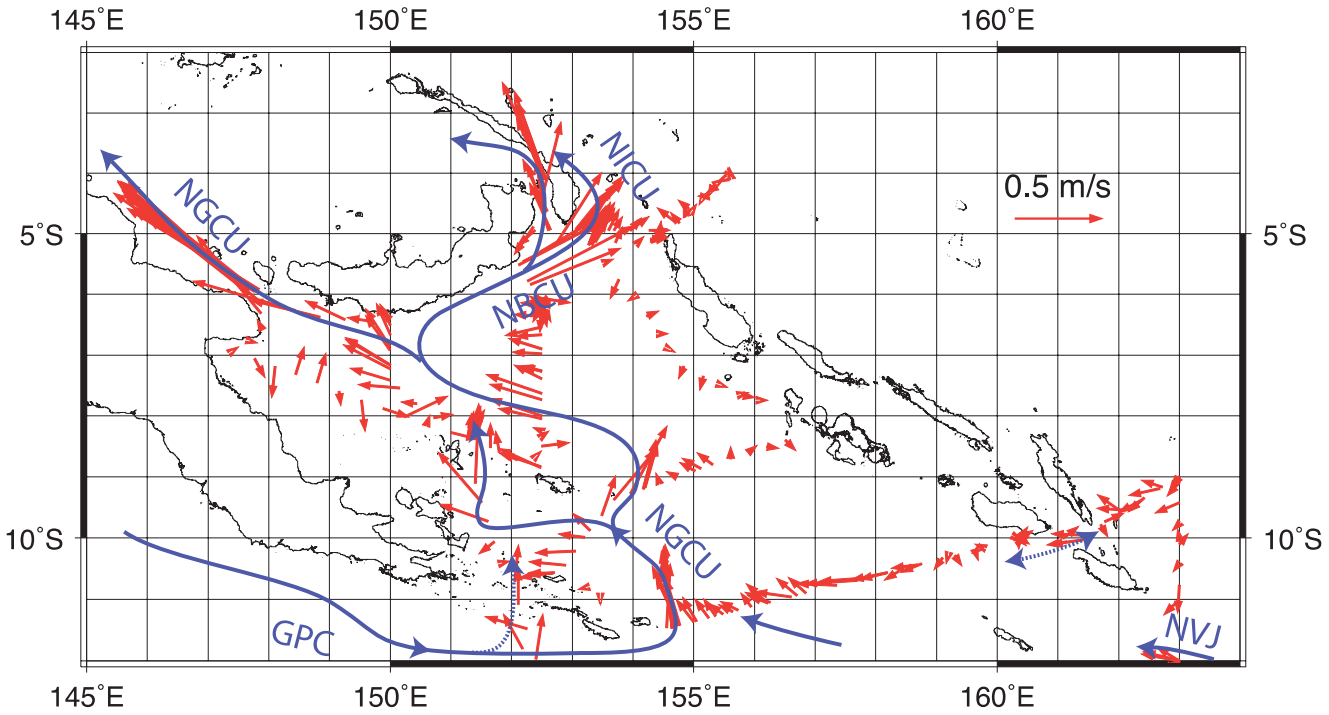

Figure 2. Hourly-averaged, 50-700m depth currents from shipboard ADCP in the Solomon Sea (red arrows), scale is shown on map. Overlayed are the main currents pathways in the Solomon Sea (in blue). GPC: Golf of Papua Current; NVJ: North Vanuatu Jet; NGCU: New Guinea Coastal Undercurrent; NBCU: New Britain Coastal Undercurrent; NICU: New Ireland Coastal Undercurrent.