Solwara (1)

Oceanic circulation, geochemistry and water masses in the SouthWest Tropical Pacific: Project overview

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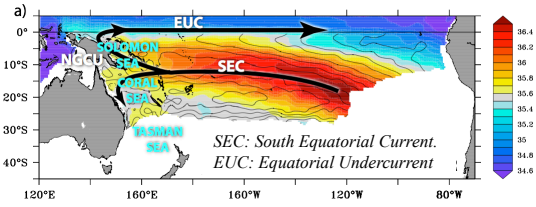
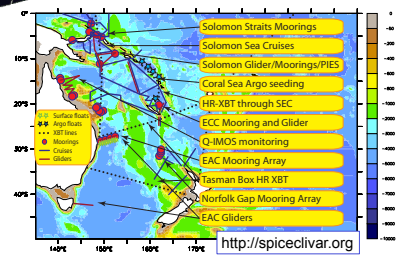
Solwara, French contribution SPICE and GEOTRACES



Schematic circulation of the upper thermocline waters and salinity on sigma 24.5 in the South Pacific.

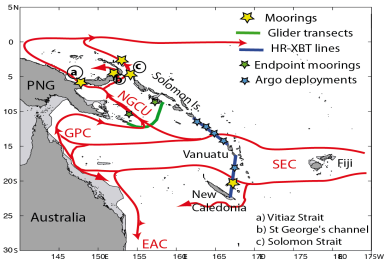
South Pacific thermocline waters are transported by the SEC from the subtropical gyre to the southwest, where they bifurcate poleward and equatorward, supplying the EUC and emerging in the central Pacific cold tongue (left). Changes in either the temperature, trace elements or the amount of water arriving at the equator have the capability to modulate the ENSO cycle and biological activity.

The Solwara/IDAO project is the french contribution to the SPICE international CLIVAR (Ga14, right) and GEOTRACES programmes. Its objective was to determine the characteristics, transports and modifications of the waters transiting through the Coral and Solomon Seas on their route to the equator. The companion Solwara/CYBER project aimed to determine the geochemical enrichment of these waters (Flash presentation by Jeandel et al.)



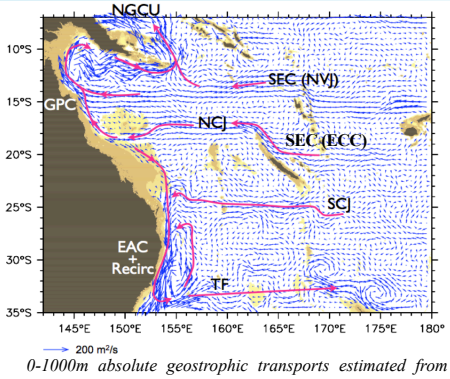
SPICE field experiment. SPICE aims to determine the role of the southwest Pacific in the climate system and to establish a relevant monitoring system.

Dedicated Observations



Numerous observations were made during Solwara, including:
-A high-resolution XBT line (and deployment of Argo floats) to monitor the transport entering into the Coral Sea (SECARGO)
-Repeated gliders transects to monitor the 0-600m transport variability entering the Solomon Sea
-Moorings deployed in the SEC (Sprayalis) and at the exits of the Solomon Sea, to monitor the transport toward the equator.
-Dedicated cruises in the Coral and Solomon Sea (FLUSEC (Ga12), SECARGO (Ga11), BIFURCATION, PANDORA (E13), cf poster 2) documented the currents structure and water properties

Mean circulation in the Coral Sea



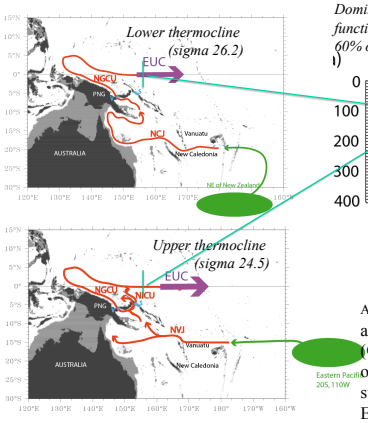
0-1000m absolute geostrophic transports estimated from hydrology and 1000m Argo float drifts. NGCU: New Guinea Coastal Undercurrent; GPC: Gulf of Papua Current; NCJ: North Caledonian Jet; SCJ: South Caledonian Jet; ECC: East Caledonian Current; EAC: East Australian Current; TF: Tasman Front. KC13b

When encountering islands, the SEC forms boundary currents and divide into westward jets (NVJ, NCJ, SCJ) consistently with island rule dynamics.

Observations and analyses during Solwara revealed:
-the continuity in water properties of the northward western boundary current along Australia; a new current name was proposed, the GPC (Gulf of Papua Current) (SPC12)
-the existence of a direct inflow from the NVJ into the Solomon Sea, in the upper thermocline (Ga12, KC13b)
-that currents south of Vanuatu extend very deep, to at least 1000-1500m (Go08); the NCJ, GPC and NGCU are transporting waters lower thermocline and Antarctic Intermediate waters around sigma 25.5-27.2.

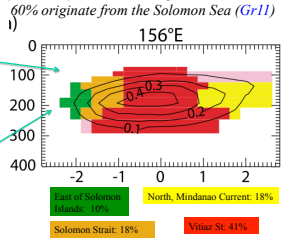
Progress made on the circulation and water masses in the Solomon Sea are described in poster 2.

Pathways to the EUC



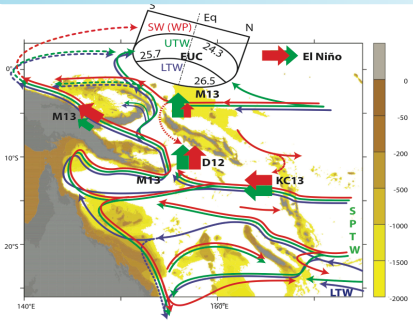
Schematic of the main water pathways from their subduction zones (in green) to the EUC. The actual circulation is obviously more complex.
V: Vitiaz Strait; S: Solomon Strait

Dominant origin of the EUC waters at 156°E as a function of latitude and depth:
60% originate from the Solomon Sea (Gr11)



A numerical simulation (ORCA ¼°) was analyzed using a Lagrangian framework (Gr11,Gr14). This allowed a fine description of the pathways of the waters from their subduction zones to the Coral Sea, and to the EUC. In the model, the lower layer of the EUC is mainly composed of Vitiaz Strait waters (NGCU). Waters originating from Solomon Strait and Mindanao Current mostly remain in the hemisphere from which they originate

Interannual variability



Water pathways and interannual variations for the Surface Water (SW, red), Upper Thermocline Water (UTW, green) and Lower Thermocline Water (LTW, blue) Large arrows indicate the main anomalies generated during El Niño events (Ga14)

XBT observations, repeated gliders transects and high resolution models (ORCA 1/12°) all agree to show that upper thermocline transports are strongly varying interannually. During an El Nino, the SEC north of Vanuatu increase (KC13a). This increased transport enters directly the Solomon Sea (D12); UTW transport mostly increases in the Solomon Strait due to the limited flow though Vitiaz Strait (M13). South of Vanuatu, and deeper, transports are weakly correlated to ENSO.

Conclusions

The project lead to important new results on the circulation in the Coral and Solomon Sea, and on the water pathways toward the equatorial Undercurrent. All the measurements, analyses and modeling studies planned in the funded project were succesfully achieved. 3 theses have been defended; 4 are ongoing. The team published a total of 32 peer-reviewed papers since 2006.

Selected References

D12: Davis, R. E., et al. (2012), Gliders measure western boundary current transport from the south pacific to the equator, JPO
E13: Eldin, G., et al. (2013), Pandora cruise provides an unprecedented description of the solomon sea, CLIVAR Newsletter Exchanges
Ga14: Ganachaud, A., Cravatte C., and Coauthors, 2014: Ocean circulation of the Southwest Pacific: new insights from the Southwest Pacific Ocean and Climate Experiment (SPICE). *JGR.*, **SUBMITTED**
Ga11: Gasparin, F., et al. (2011), A western boundary current east of new caledonia: Observed characteristics, DSR
Ga12: Gasparin, F., et al. (2012), Oceanic transports through the solomon sea: The bend of the new guinea coastal undercurrent, GRL
Go08: Gourdeau, L., et al. (2008), Zonal jets entering the coral sea, JPO.
Gr11: Grenier, M., et al. (2011), From the western boundary currents to the pacific equatorial undercurrent: Modeled pathways and water mass evolutions, JGR.
Gr14: Grenier, M., et al. (2014), From the subtropicss to the equator in the southwest pacific: Continental material fluxes quantified using neodymium parameters along modeled thermocline water pathways, JGR., **SUBMITTED**
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KC13a: Kessler, W. S., and S. Cravatte (2013b), ENSO and short-term variability of the south equatorial current entering the coral sea, JPO
M13: Melet, A., et al. (2013), Solomon sea circulation and water mass modifications: response at ENSO timescales, OD.
SPC12: SPICE, C. (2012), Naming a western boundary current from australia to the solomon sea, CLIVAR Newsletter Exchanges

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Project site: http://solomonseaoceanography.org