Spatio-temporal variability of the SPCZ fresh pool eastern front from coral-derived surface salinity data

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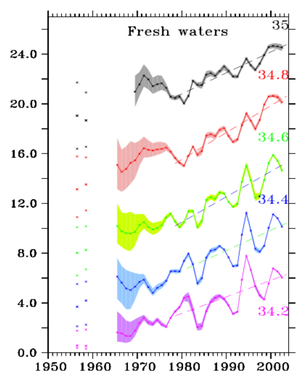
Motivations

The South Pacific Convergence Zone (SPCZ)

- It is one of the major features of the southern hemisphere climate and plays a significant role in global climate.
- It is an area of heavy rainfall that controls the hydrology of many island nations of the South West Pacific .

SPCZ - Oceanic signature = SPCZ freshpool

- Its position is varying with natural climatic modes ENSO – PDO *(e.i. Gouriou and Delcroix, 2002)*.
- Low SSS region expand to the South & East since 1970 *(Terray et al., 2012; Singh et al., 2011; Tchilibou et al., 2015)*.
- Long-term trend modulated by decadal variability (e.i. *Cravatte et al., 2009; Singh et al., 2011; Tchilibou et al., 2015)*.



Cravatte et al., 2009

Is the long-term trend due to anthropogenic forcing ?

-> We need to Increase the length of the SSS back in time

Data

Site

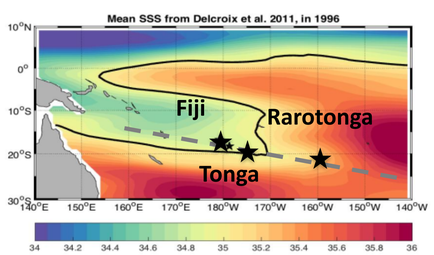


Figure 1: Map of the annual average sea surface salinity for the year 1996. Stars are presenting the three study sites (Fiji, Tonga, and Rarotonga). The Black line represents the 35.2 pss isohaline characterizing the salinity front.

Statistical modelling to predict SSS using coral $\delta^{18}O$

	Fiji	Tonga	Rarotonga
R^2	0.79	0.56	0.37

Table 1: Weights of linear regressions between instrumental SSS and Coral $\delta^{18}O$ over the 1970-1999 time period.

- High % of SSS variance explained by coral $\delta^{18}O$ at each site (Table 1).

Coral $\delta^{18}O$ data *vs.* SSS data

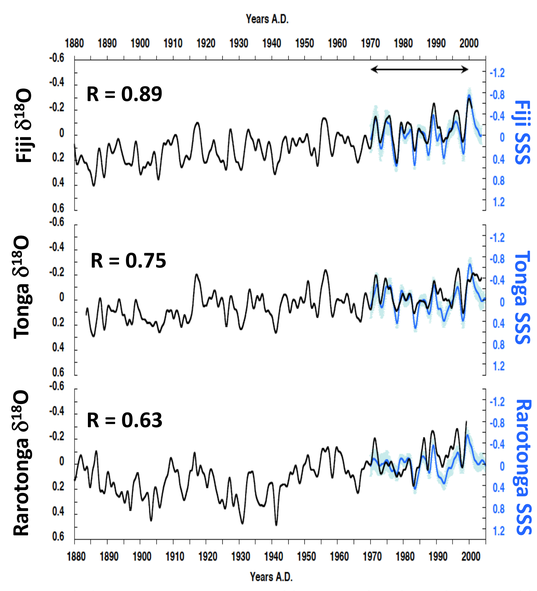


Figure 2: Coral data composites at monthly interpolated resolution in black, monthly instrumental SSS in blue (Delcroix et al., 2011) aand its associated Error Bar (maximal error estimation) in blue shading. Each series filtered with a Hanning filter (25 months). R values are Pearson product moment correlation coefficient for the 1970-2000 time period, all significant at 99%.

- Good correlation between coral $\delta^{18}O$ and SSS - Timing and Amplitude (Figure 2).

Coral-based SSS Spatio-Temporal variability

Interannual Variability

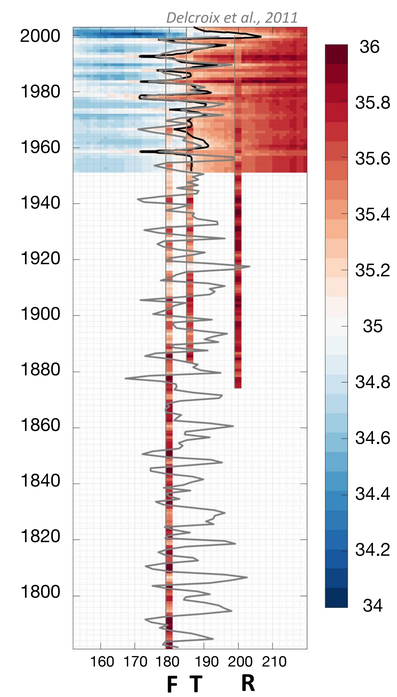


Figure 3: Hovmöllers with on the background instrumental SSS from a 1°*1° box over the F-T-R longitudinal transect (Figure 1, dotted line). On the longitudes corresponding to Fiji (F), Tonga (T), and Rarotonga (R) are coral-derived SSS. The black line corresponds to the 35.2 pss isohaline from instrumental SSS. Predictions of the 35.2 pss isohaline from Fiji interannual variability is presented by the dark and light grey lines, respectively.

- Coral $\delta^{18}O$: good predictor of spatio – temporal SSS variability.
- Salinity front displacements linked to ENSO variability.
- No evidence of significant changes in interannual events frequency before and after 1970.

Long term trend

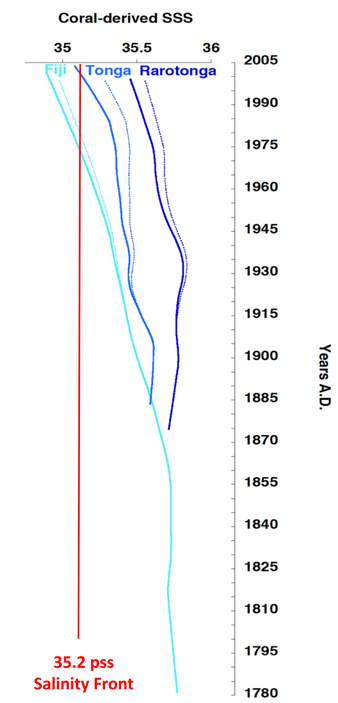


Figure 4: Long term trend coral-derived SSS data from Fiji (light blue), Tonga (medium blue), and Rarotonga (dark blue). The doted lines are the long term trend Fiji, Tonga, and Rarotonga derived SSS once the SST warming trend influence on the coral $\delta^{18}O$ was removed.

- Displacement of the salinity front to the East
- Freshening trend at all 3 sites
- Fiji, freshening breaking point ~ 1870
- Rarotonga, breaking point ~ 1935
- Tonga : hard to define

Summary

- Interannual displacements of the SPCZ salinity front has been modulated by ENSO for the last 200 years without any evidence of frequency changes.
- The long term freshening trend started as early as 1870.
- The recent extreme events in the freshpool displacements are mostly due to transient mean state.