Multi-decadal Change of the South Pacific Gyre Circulation

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Introduction

In previous work (Roemmich *et al*, JPO, 2007) an increase in South Pacific Gyre (SPG) circulation was described using Argo, altimetry, and WOCE hydrography. Here it is shown that the same trend continues for a second decade in steric height (SH) and sea surface height (SSH), with corresponding 35-year signals seen in sea surface temperature (SST) and sea level pressure (SLP).

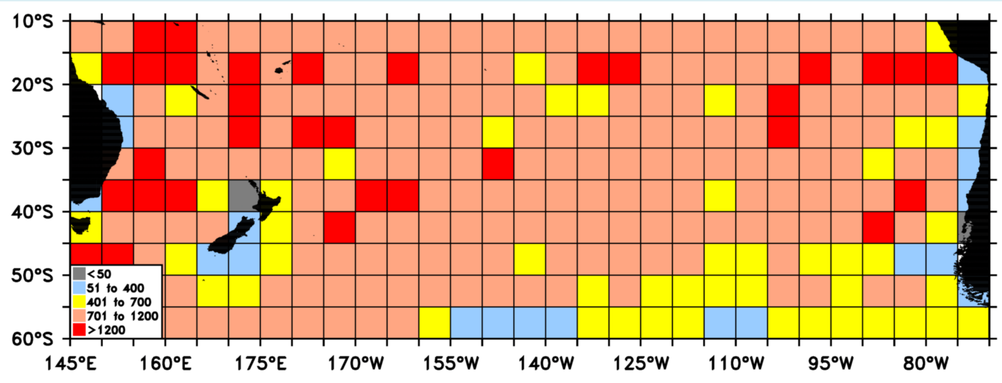

Fig 1: Argo data coverage in 5° squares. About 1000 Argo T,S profiles and trajectory estimates are in each 5° square, increasing by ~100 per year.

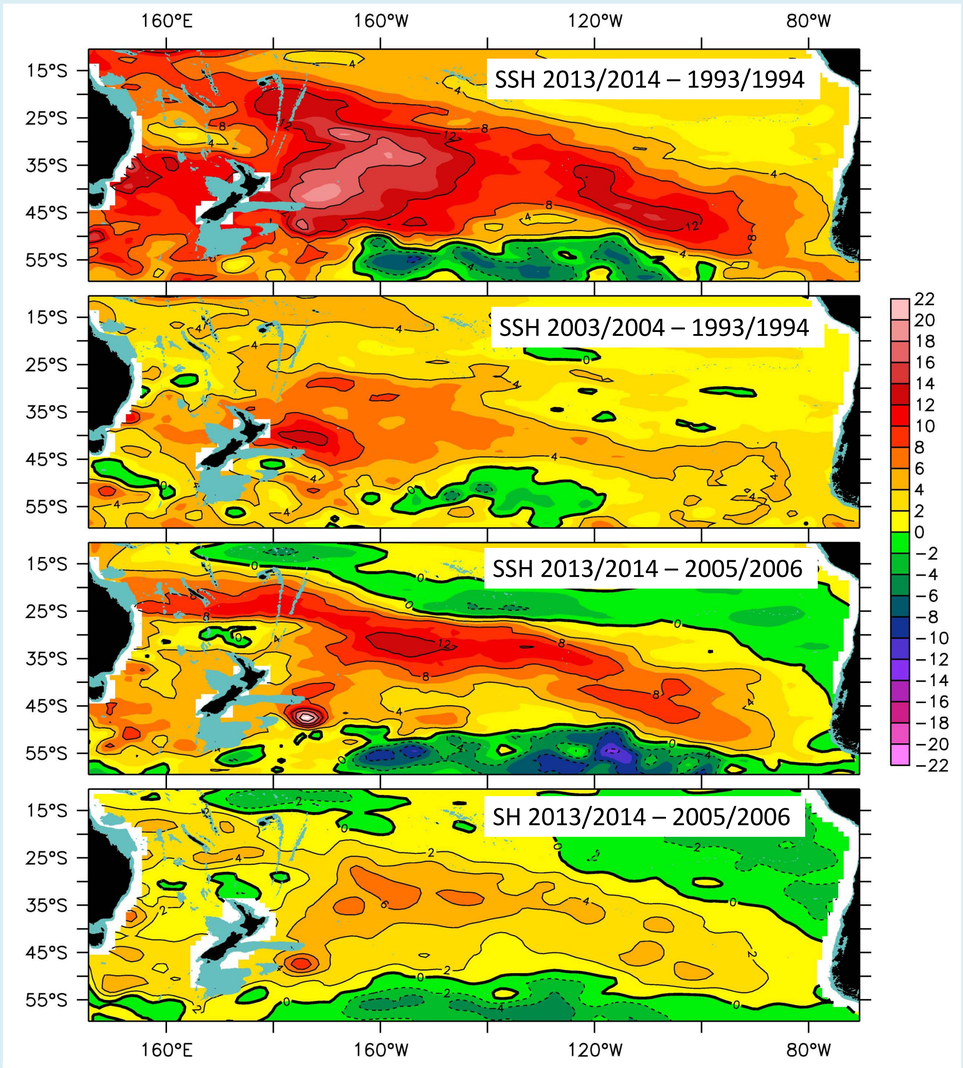

Fig 2: SSH and SH changes.
Panels above show SSH (top 3 panels) and Argo SH changes (bottom, 0/2000) for indicated time periods.

Patterns are similar in SSH and SH and for the two decades of SSH.

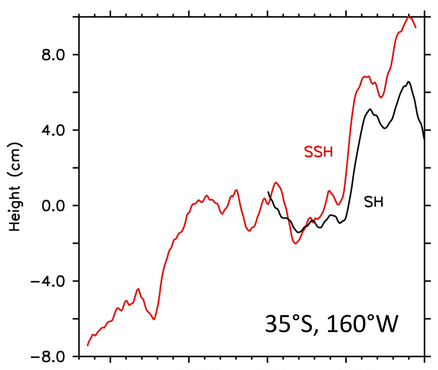

Fig 3: Time-series (right) of SSH and SH, 12-month running mean, at 35°S, 160°W.

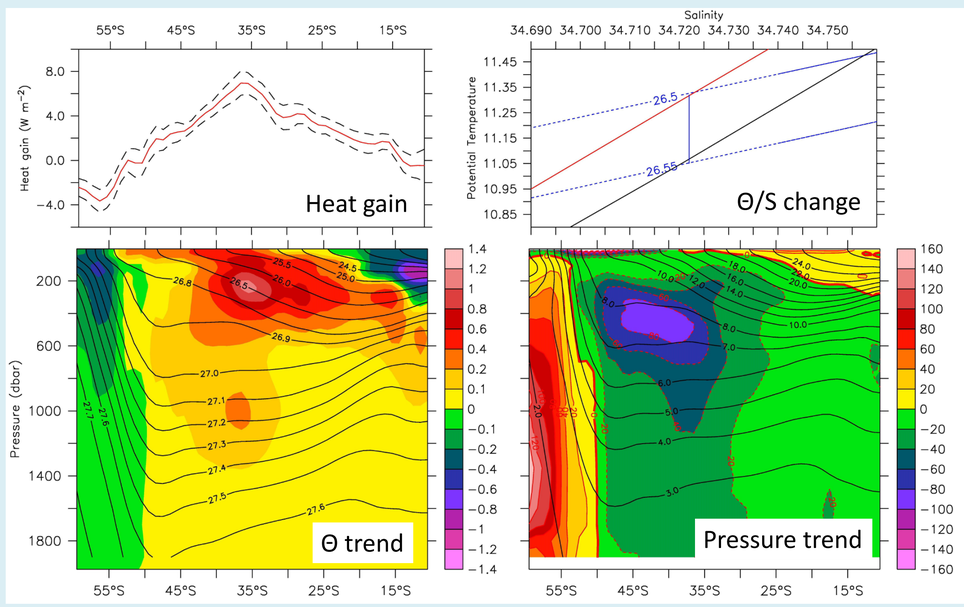

Fig 4: Heat gain; Convergence > A-S flux

(Upper left) Heat gain (W/m^2), 2005 to 2014, 170°W to 130°W. Contours are mean σ_Θ.

(Lower left) Linear trend in Θ (°C/decade).

(Upper right) Θ/S relation, 2005/2006 (black line) and 2013/2014 (red line).

(Lower right) Linear trend in pressure (colors, dbar/decade) on isotherms. Contours are mean Θ.

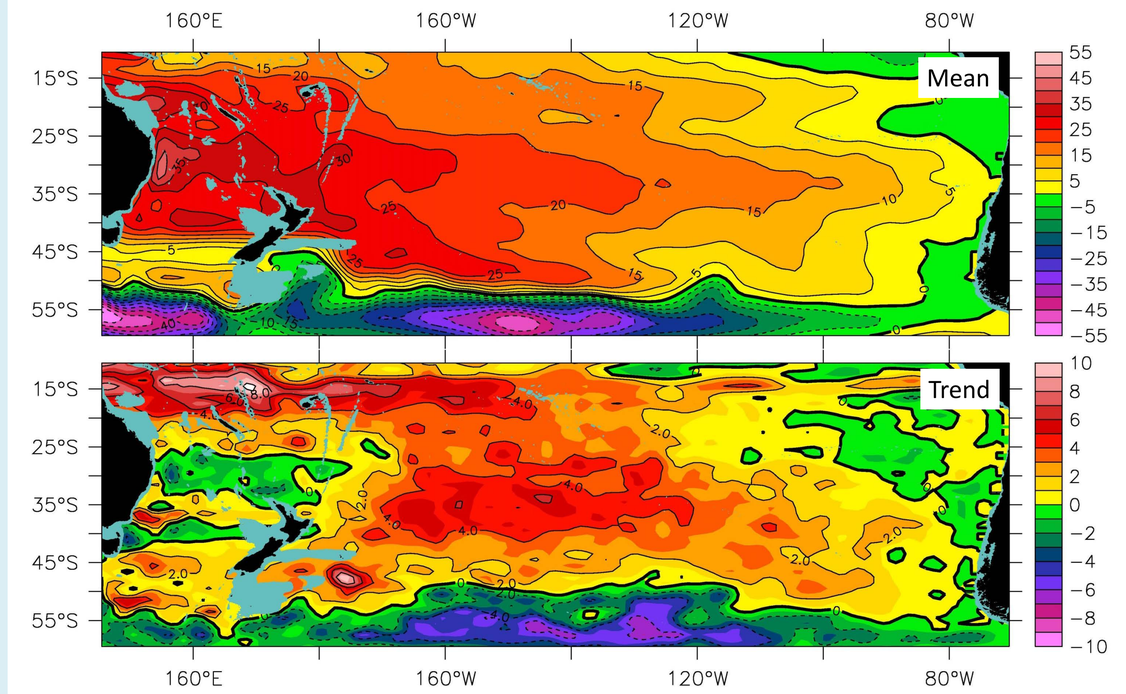

Fig 5: The time mean and trend of geostrophic transport.
The meridional transport (Sv, 0 to 2000 dbar relative to 2000 dbar) based on Argo profile data, is integrated from South America westward. The upper panel is the 2005 to 2014 mean and the lower panel is the linear trend.
The trend in transport is an anti-clockwise circulation centered near 35°S, 140°W (as with SSH, Fig 2, except offset toward the east).

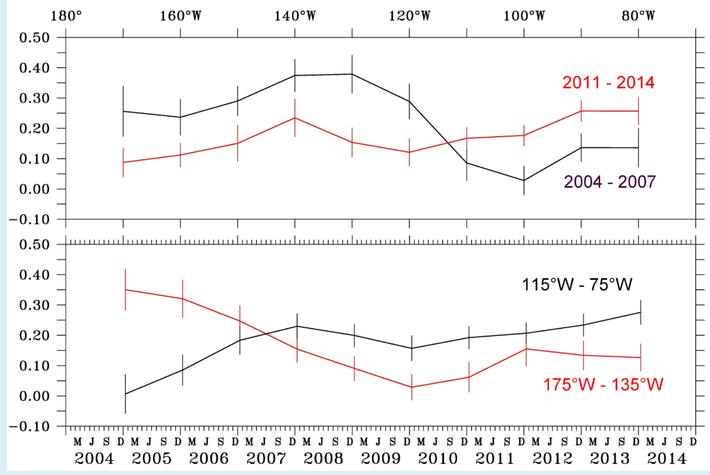

Fig 6: Argo trajectories, V_{1000}.

(top) Bin-average of 1000 dbar meridional velocity (cm s^{-1}) from Argo trajectory data, 40°S to 30°S, in overlapping 20° longitude bins for 2004 to 2007 (black) and 2011 to 2014 (red)

(bottom) Time-series of meridional velocity, 40°S to 30°S, in 2-year time bins for 115°W to 75°W (black) and 175°W to 135°W (red).

1000 dbar equatorward velocity increased east of 115°W and decreased west of 115°W. The anomaly center shifts to the east with depth.

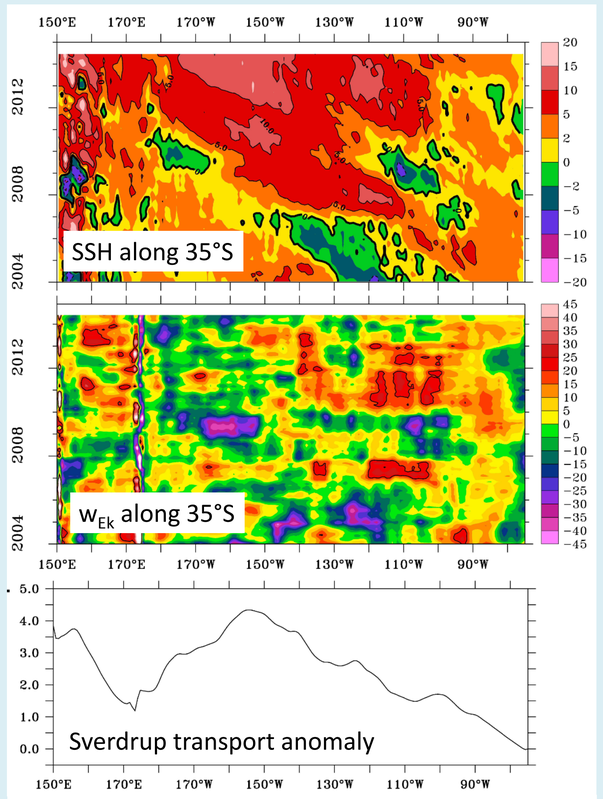

Fig 7: SSH, W_{Ek}, Sverdrup

(top) SSH anomaly along 35°S for 2004 to 2014 relative to the mean of 1993 to 2003.

(middle) Ekman pumping velocity anomaly (m/yr , positive downward).

(bottom) Sverdrup transport anomaly (Sv), from wind stress, integrated westward from South America along 35°S, for 2013 to 2014 relative to the mean of 1993 to 2003.

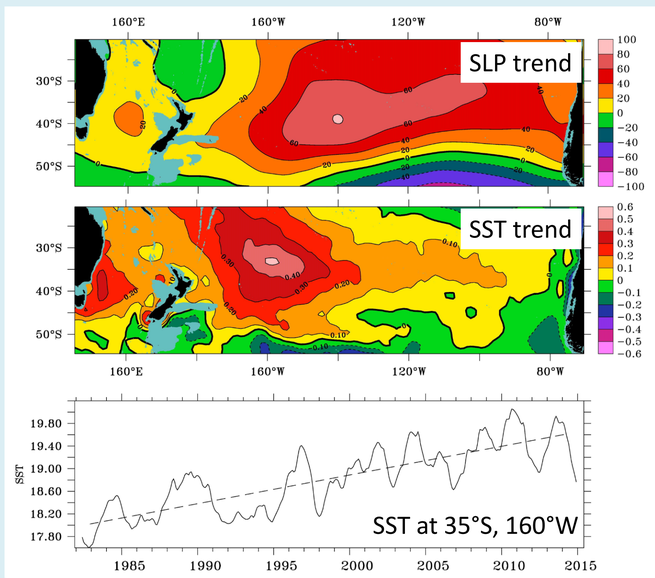

Fig 8: Multi-decadal SLP and SST
Linear trend, 1981 to 2015, in SLP (Pa/decade, ERA-Interim reanalysis), SST (°C/decade, NOAA OI v2 product). Time-series of SST (°C, 12-month running mean) at (35°S, 160°W).

Conclusion:

Argo profile and trajectory data both indicate a decadal increase in the equatorward eastern SPG transport by about 5 Sv between since 2005. The patterns of changes in SSH and SH are similar to that seen in the previous decade (Roemmich *et al*, JPO, 2007). Observed transport changes are consistent with changes in wind stress curl (via the Sverdrup relation), and with 35-year trends in SST and SLP, providing evidence of multi-decadal change in the SPG wind-forcing and circulation.

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