Zonal currents of the SW tropical Pacific

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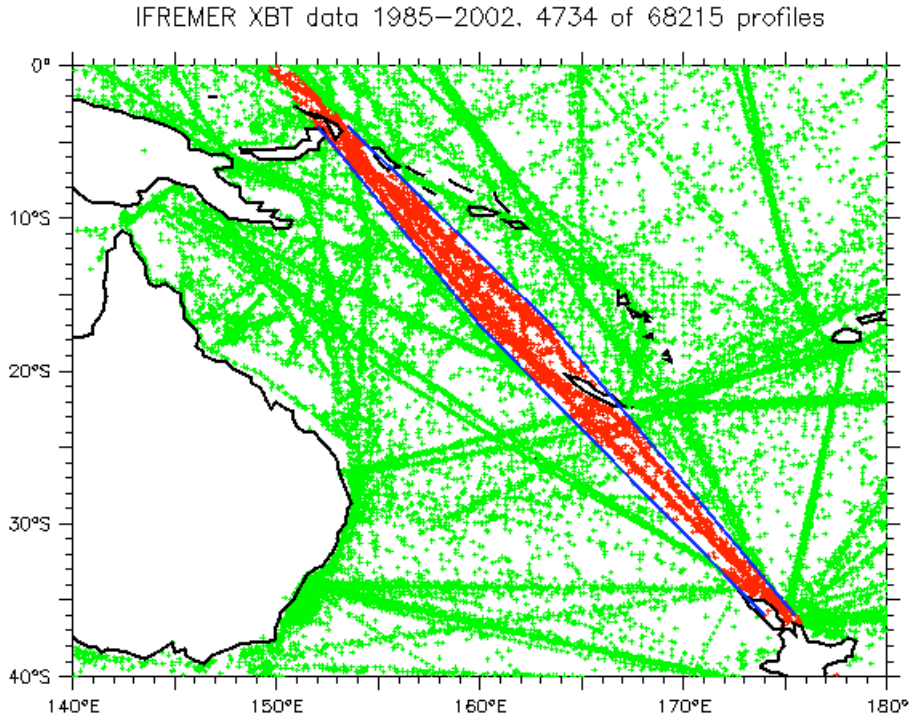
Data/model sources

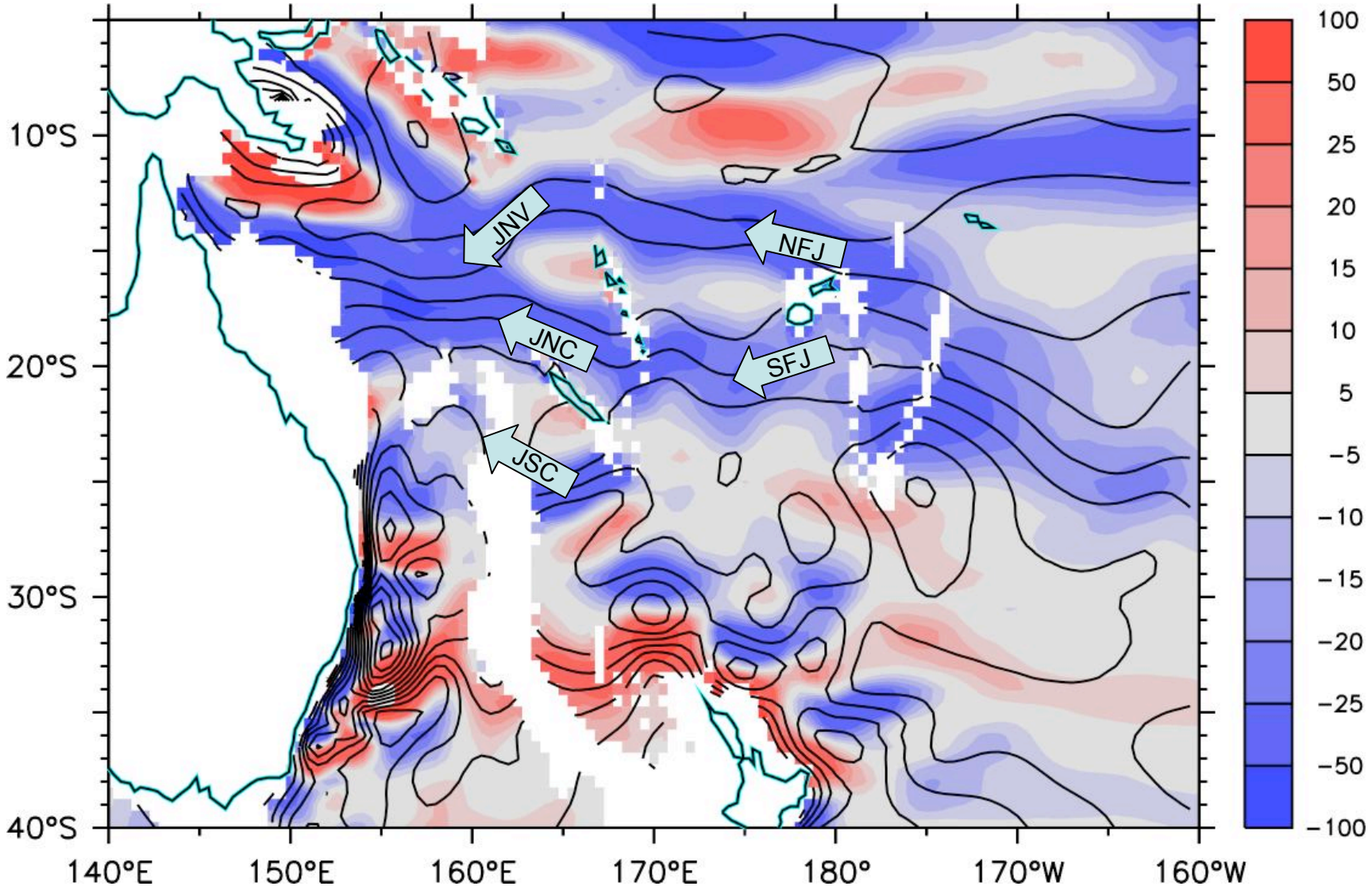
- CARS CTD compilation (Ridgway and Dunn)
- IFREMER XBT data
- Topex/Jason altimetry
- ORCA OGCM
- Linear Rossby model

Auckland-Solomon Strait XBT track



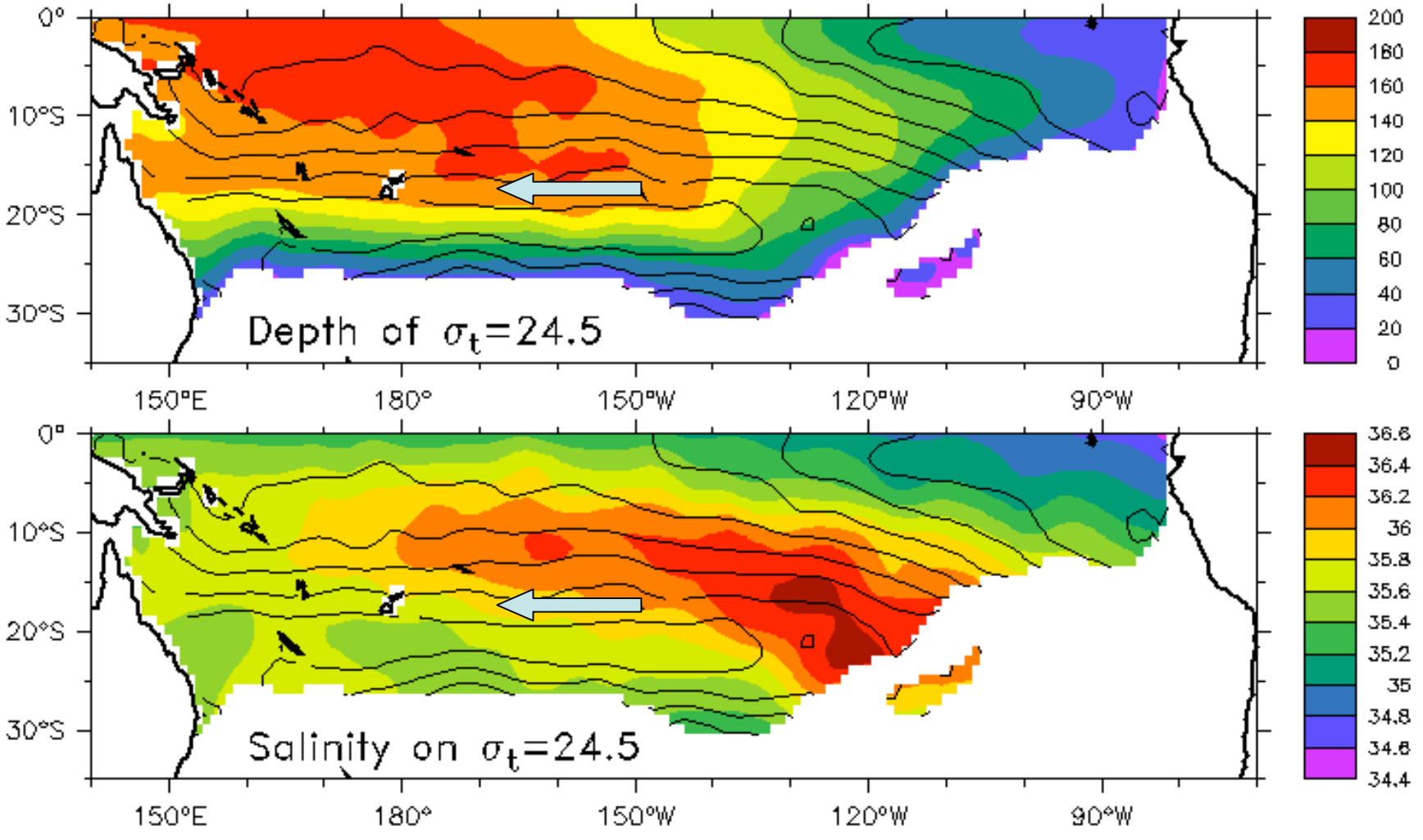
Mean $\int u_g dz$ (colors) , $\int DH dz$ (contours)

Relative to 2000m. CARS data ($m^2 s^{-1}$)



The SW Pacific is downstream of a subduction region

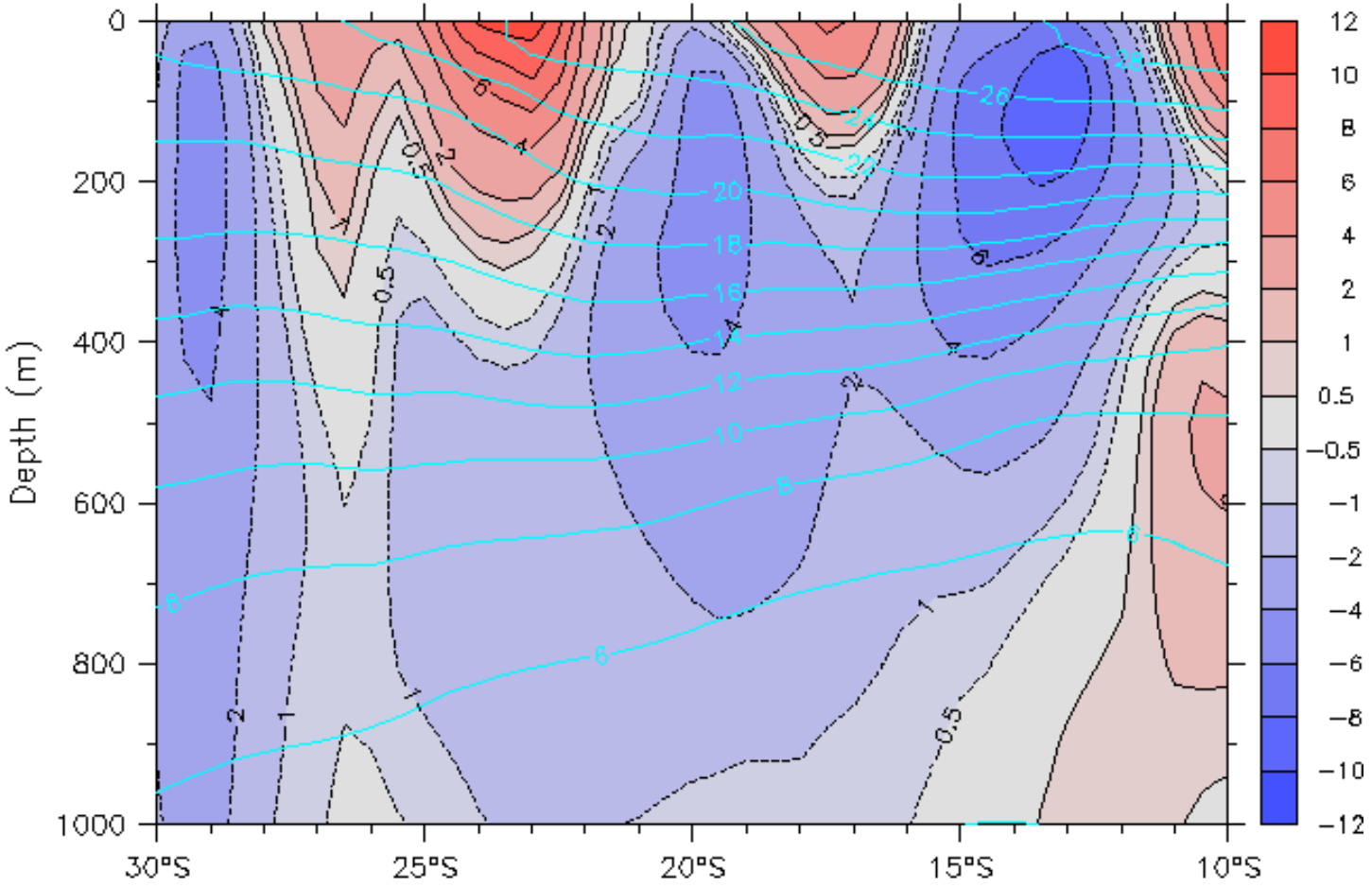
The isopycnal 24.5 in the upper thermocline



Meridional section of u_g shows the SEC broken up into jets

Mean u_g along 170°E

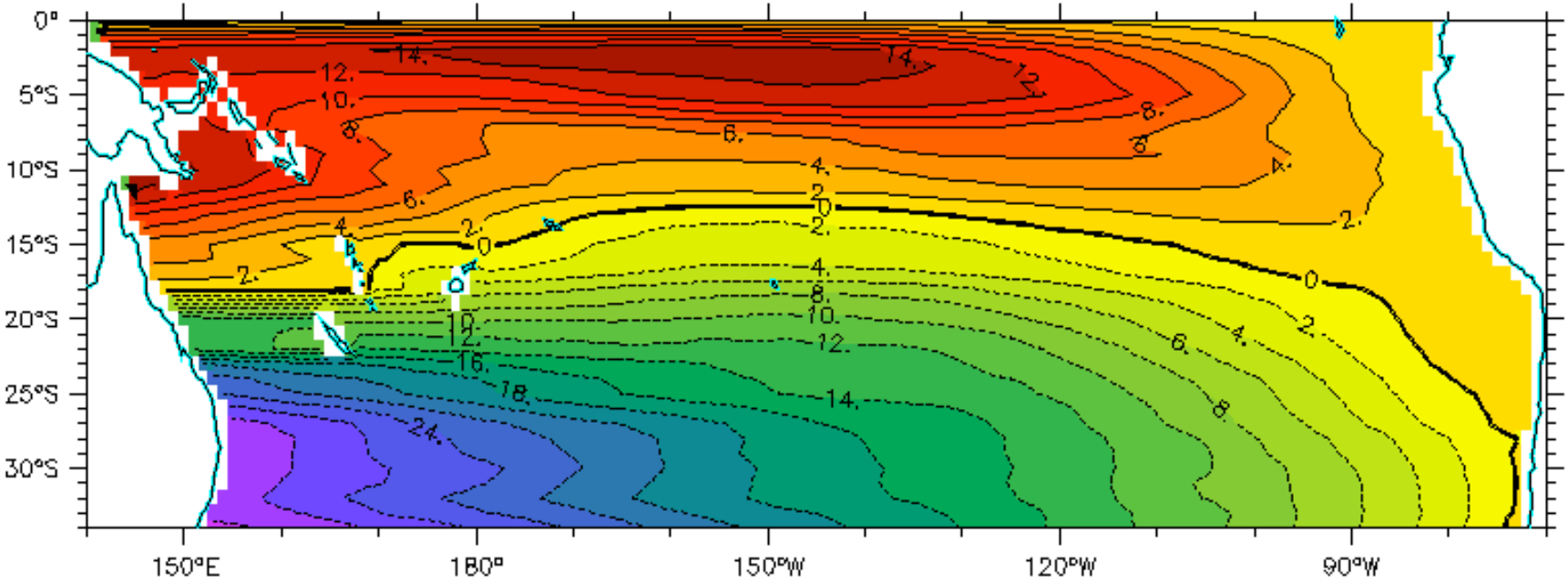
CARS data (rel. 2000m) (cm/s)



Island Rule streamfunction shows jets in the west,
but hides some important details …..

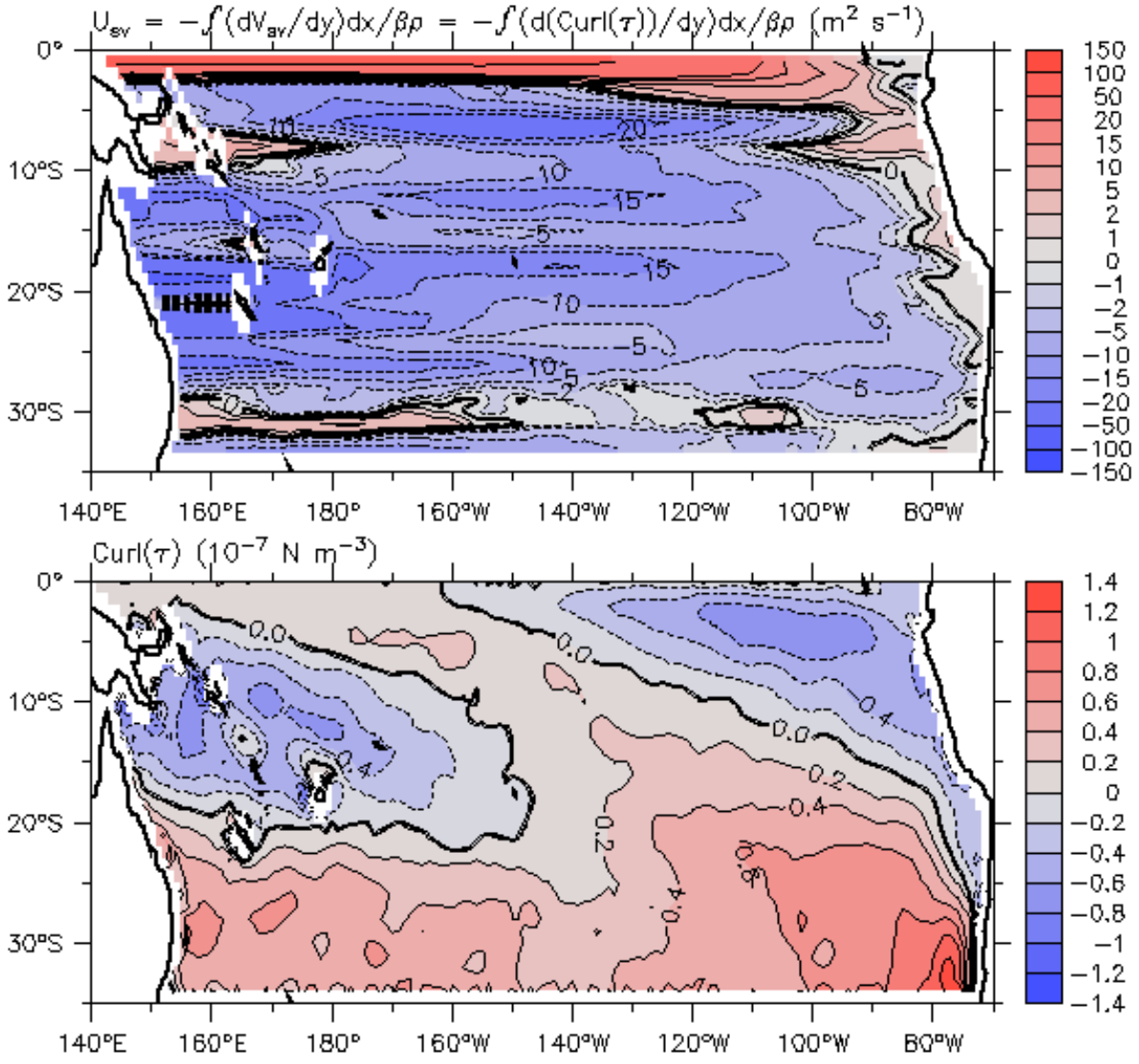
Sverdrup (Island Rule) streamfunction (ERS winds)

Island Rule: Australia = −11.9, NC = −11.9, Fiji = −3.2, Vanuatu = 0.1, Solomons = 11.0



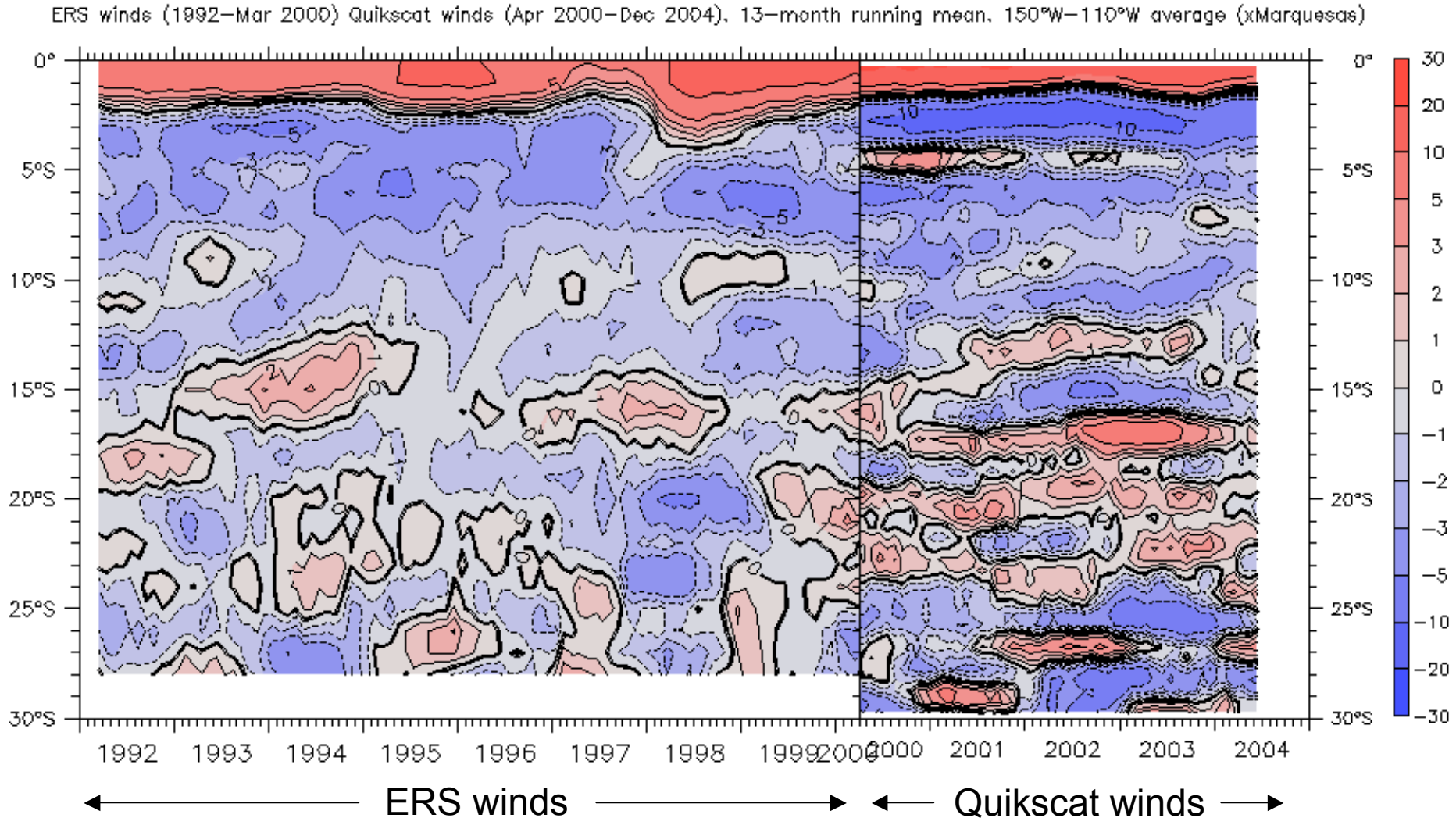
Curl(τ) and zonal Sverdrup transport (Island Rule)

ERS winds (1991-2000)



Sverdrupian filaments persist over years

$$-\frac{dU_{Sv}}{dx} = \frac{dV_{Sv}}{dy} = \boxed{\frac{1}{\beta\rho}\frac{d(Curl(\tau))}{dy}}$$ *in the central Pacific*

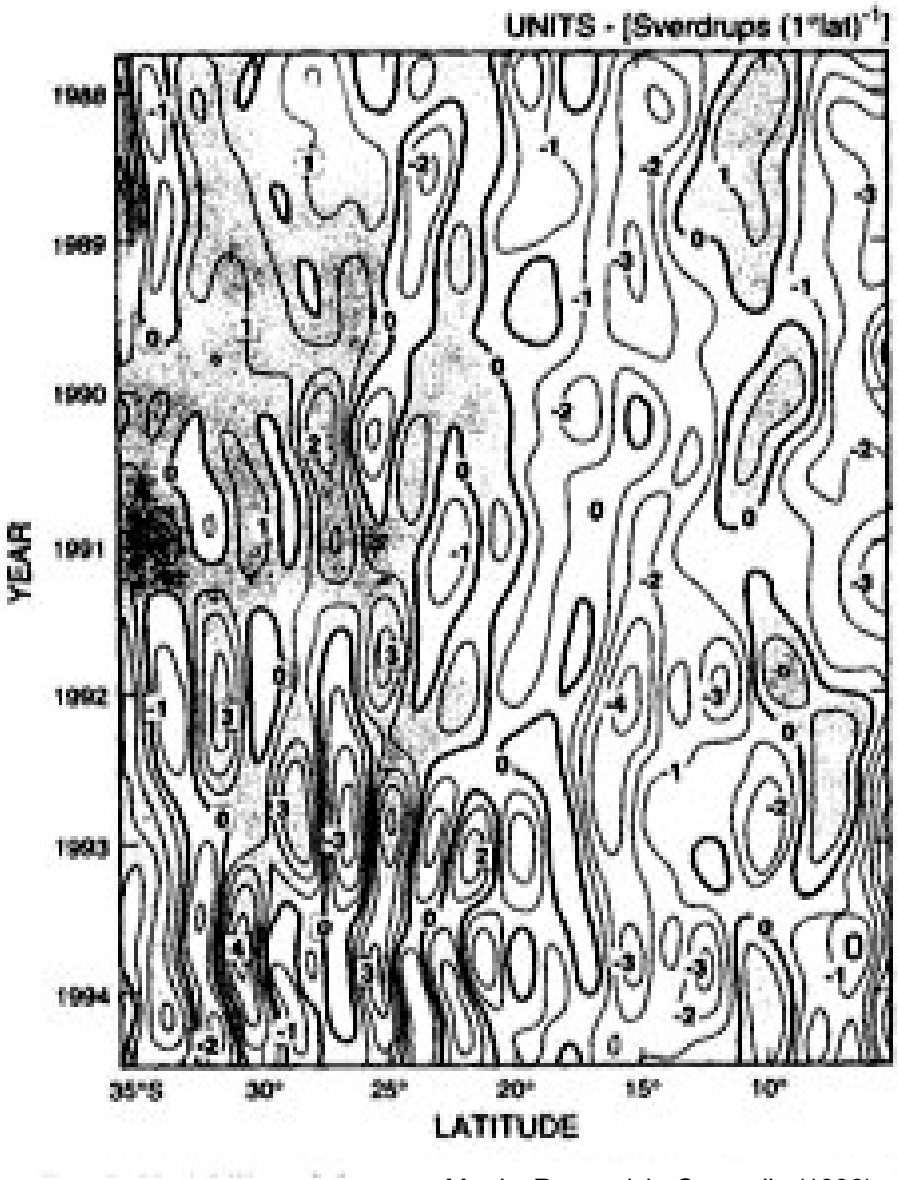


Transport across 180° (Hi-Res XBT line)

The zonal currents are broken up into small-scale filaments, even east of the (large) islands.

The SEC appears to be concentrated in a wavering band near 12°-15°S.

Interannual (?) changes in the intensity of the eddying.



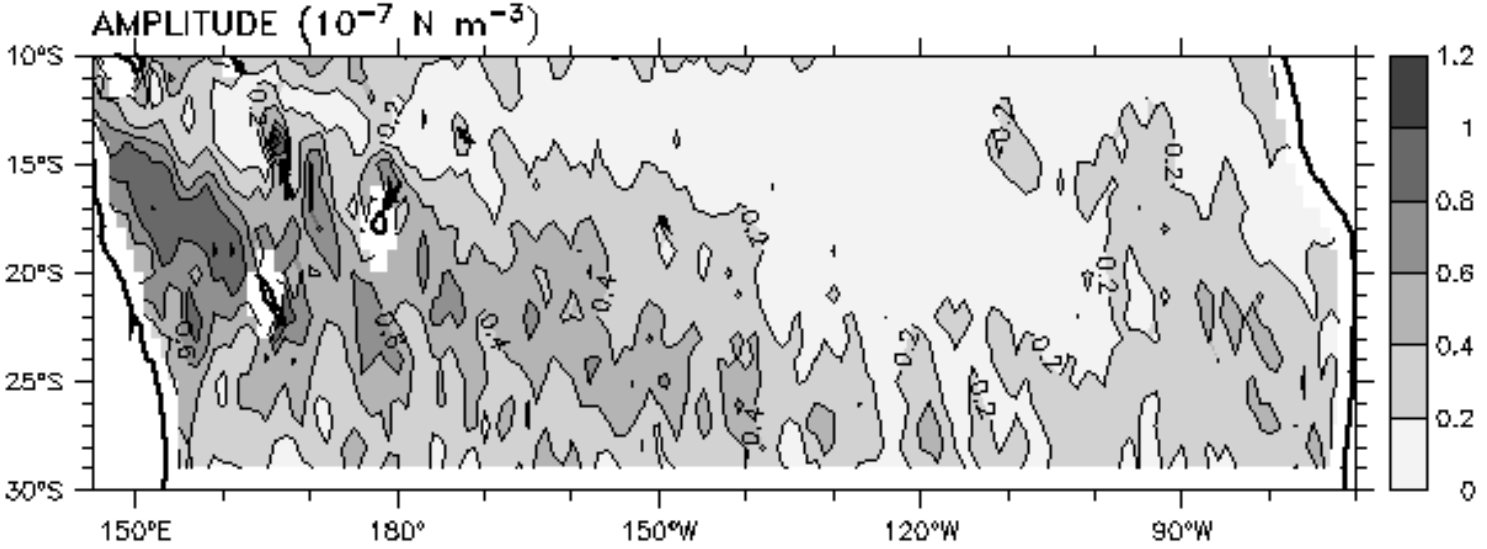
Morris, Roemmich, Cornuelle (1996)

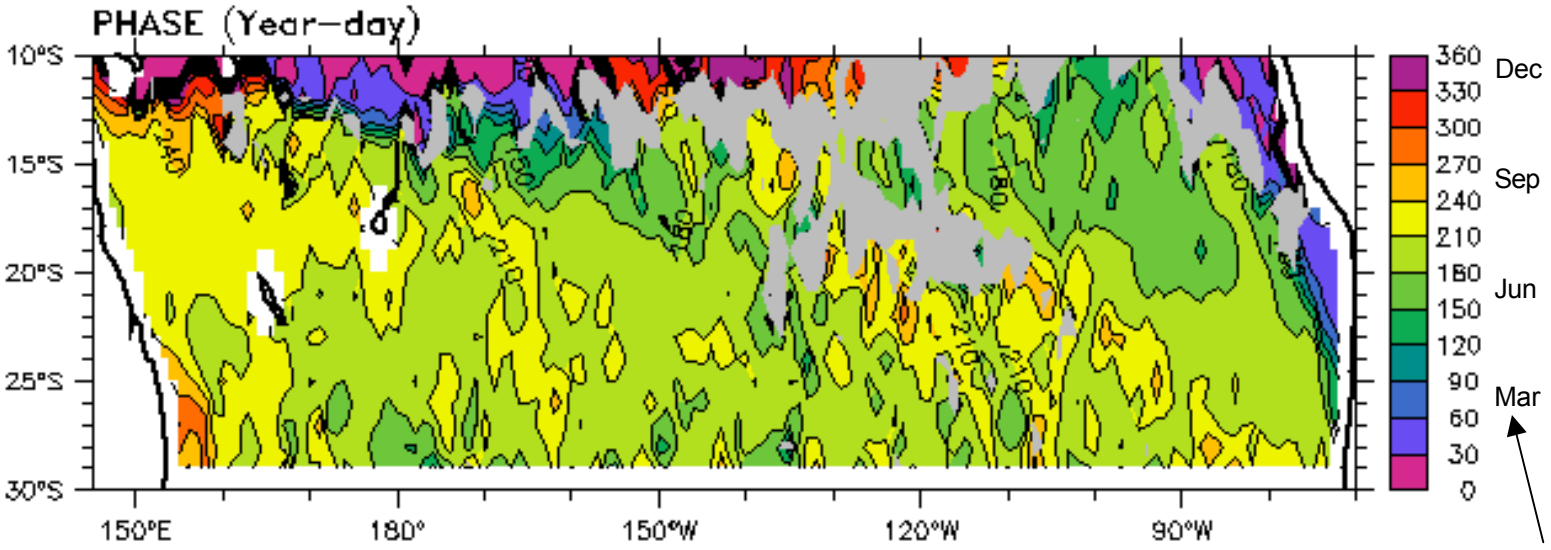
1 cpy harmonic of Curl(τ)

ERS winds 1991-2000

Curl has the form:

B $e^{-x/L}$ $e^{i\omega t}$

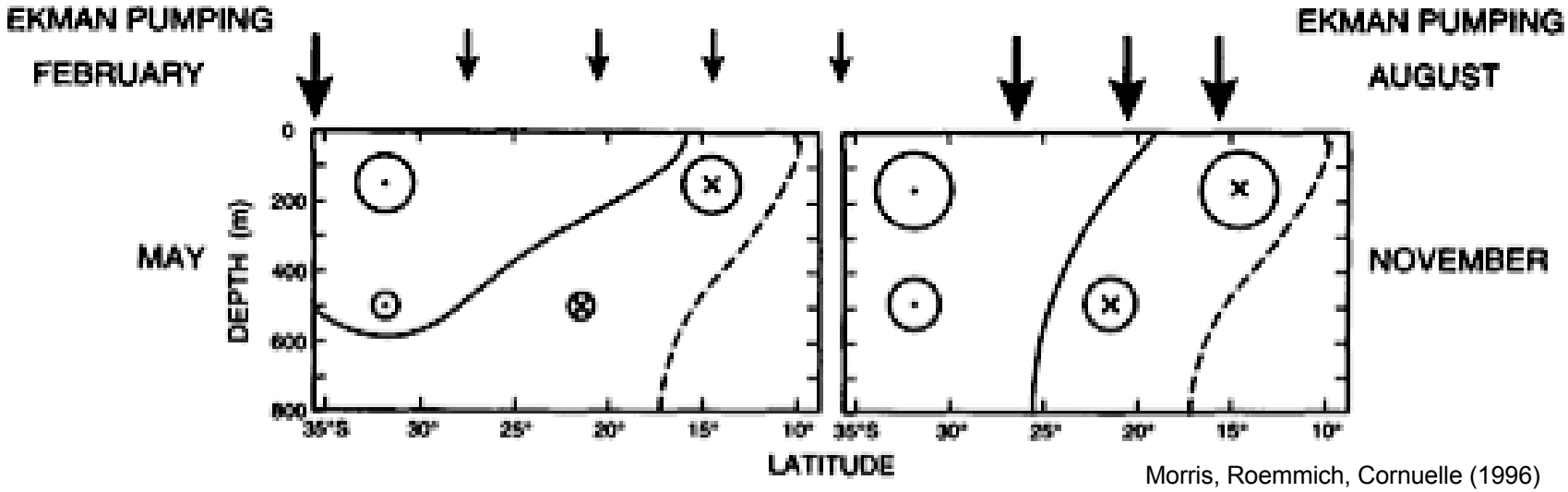




Date of maximum positive Curl

Phase blanked where amplitude is less than 0.1×10^{-7} N m^{-3}

Strong downward Ekman pumping in winter leads to deep thermocline in spring:



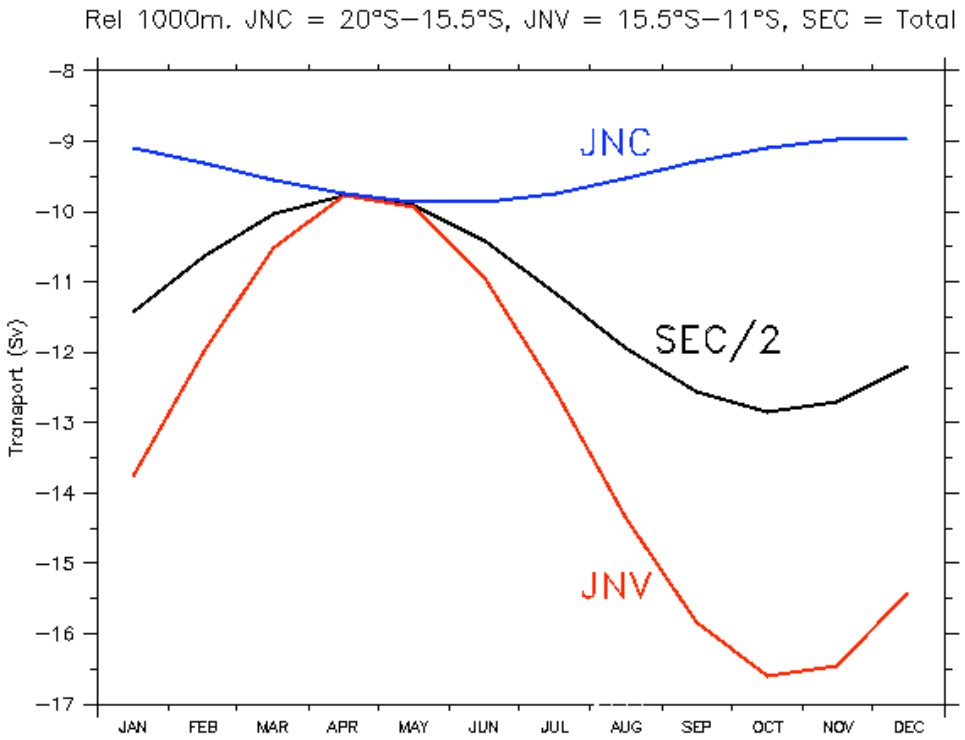
Morris, Roemmich, Cornuelle (1996)

- Morris et al. assumed a local balance, and found agreement between wind forcing and the observed structures.
- Chen and Qiu (2004) solved a reduced gravity Rossby balance simplifying the forcing to an exponential decay eastward (quite like the observed winds).
- For forcing Curl(τ/f) = B $e^{-x/L}$ $e^{i\omega t}$, they found that the Rossby solution is also stationary, with a phase lag.
- For parameters appropriate to the observed winds and latitude 25°S, the lag is 90 days, suggesting that the conclusion that the dynamics are local is incomplete.

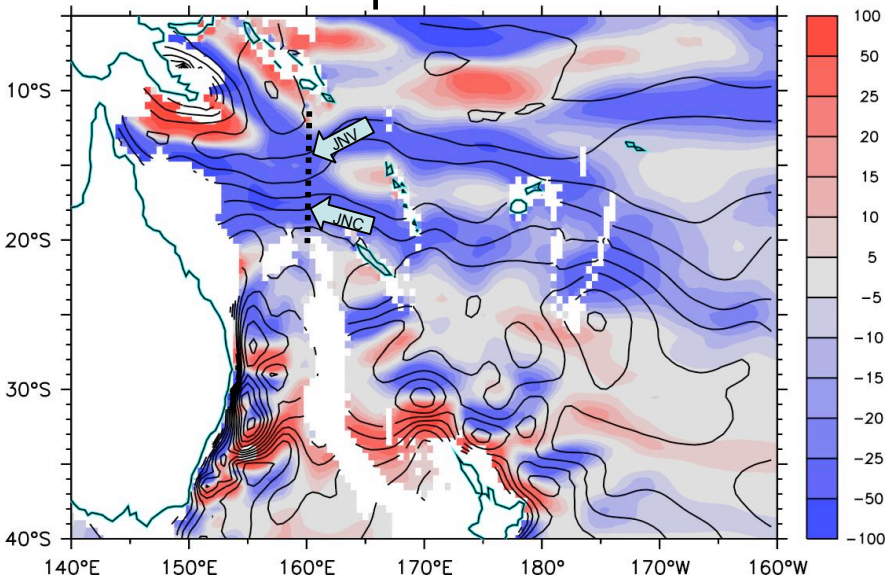
Observed zonal transport across 160°E (CARS)

A phase shift across the SEC between 10°-20°S.

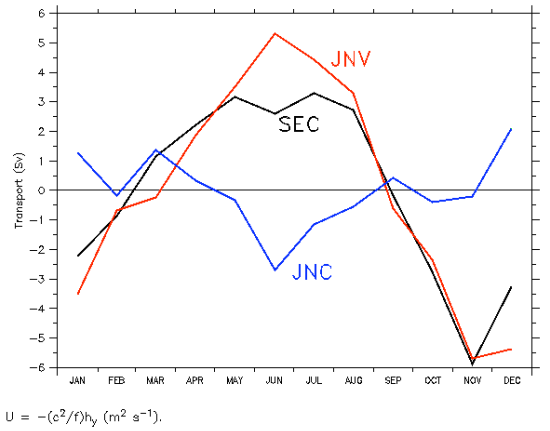
The JNC and JNV fluctuate out of phase.



Mean transport:

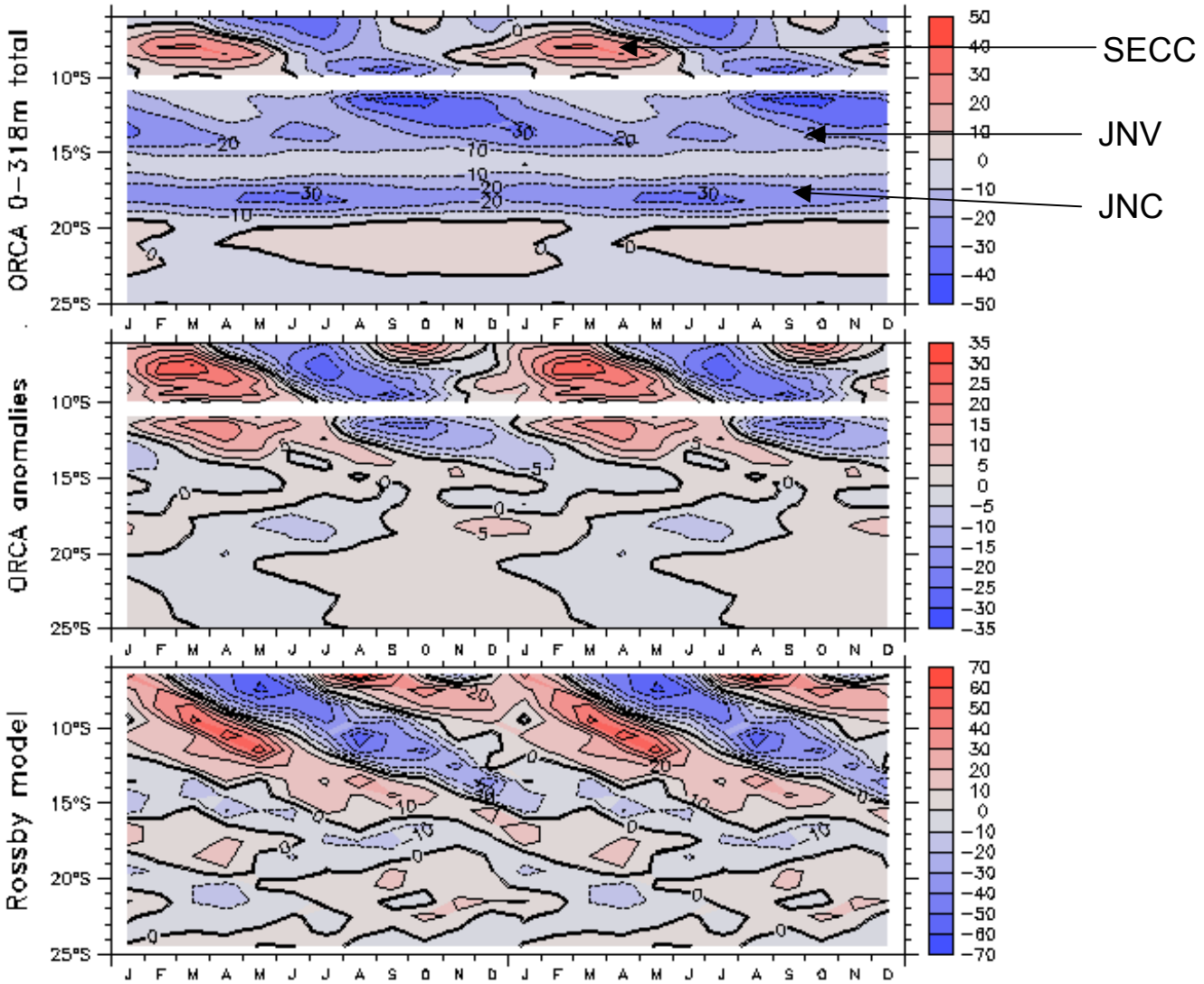


Rossby model (anomalous) transport:



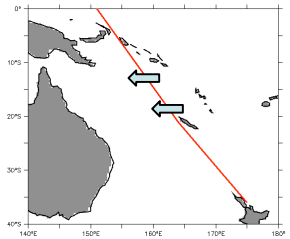
Annual cycle zonal transport across 162°E

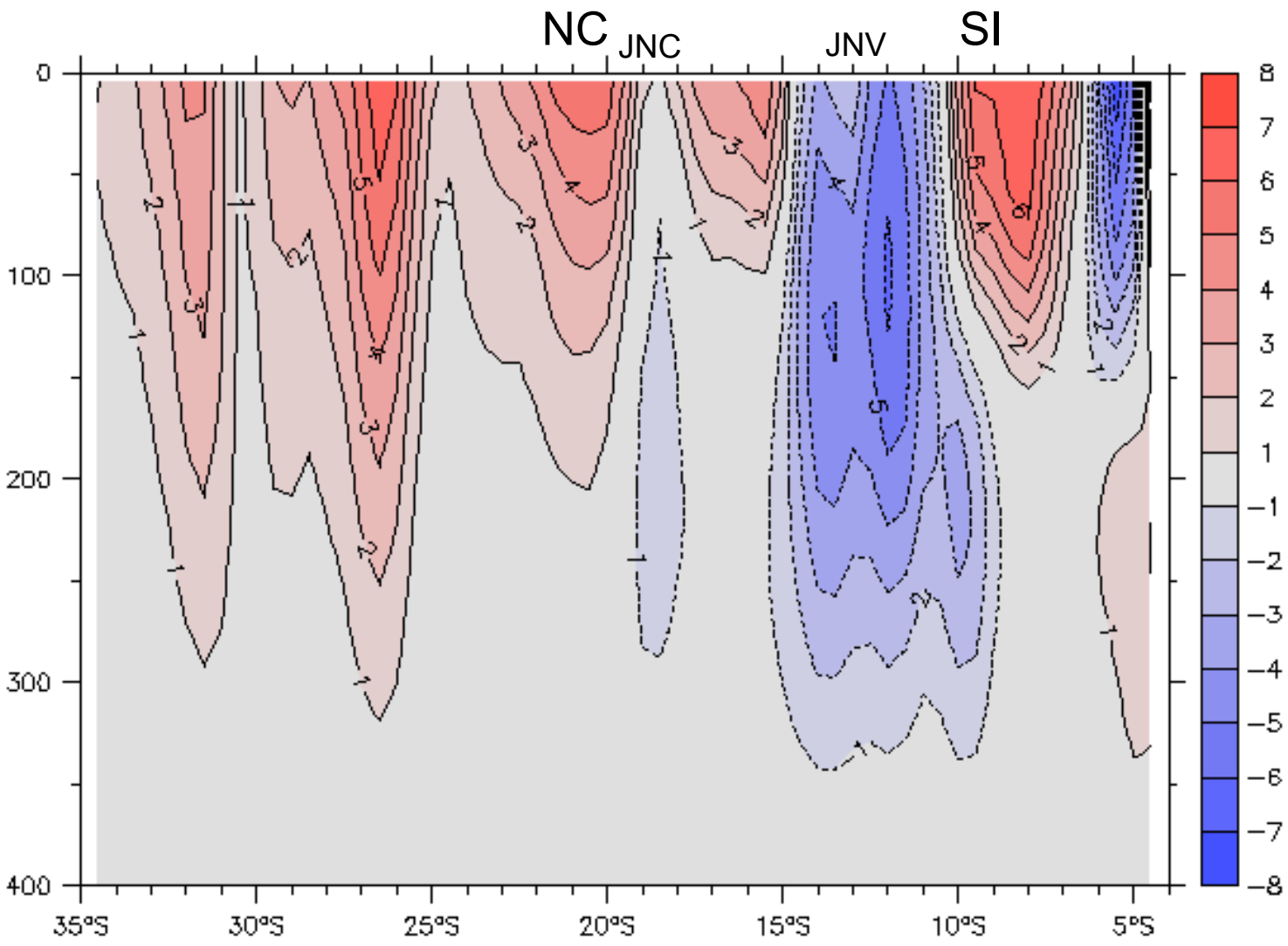
ORCA vs Rossby models (ERS annual cycle forcing, c=3.5 m s^{-1}, D=24 mon)



Mean u_g on the Auckland-Solomon St XBT track

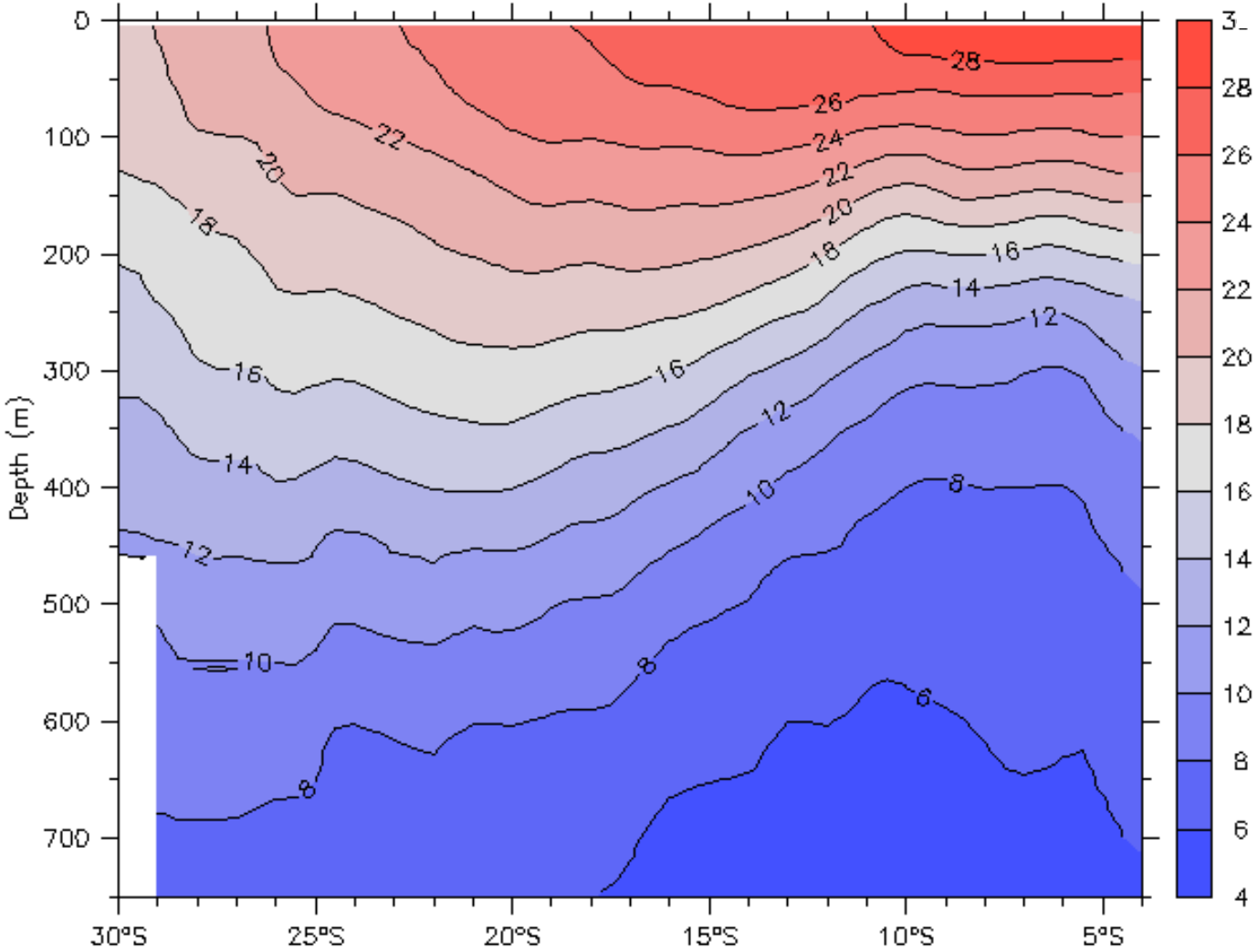
Cross-track velocity relative to 400m





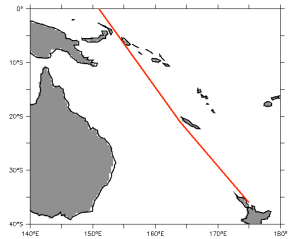
Temperatures on the XBT track during 1992

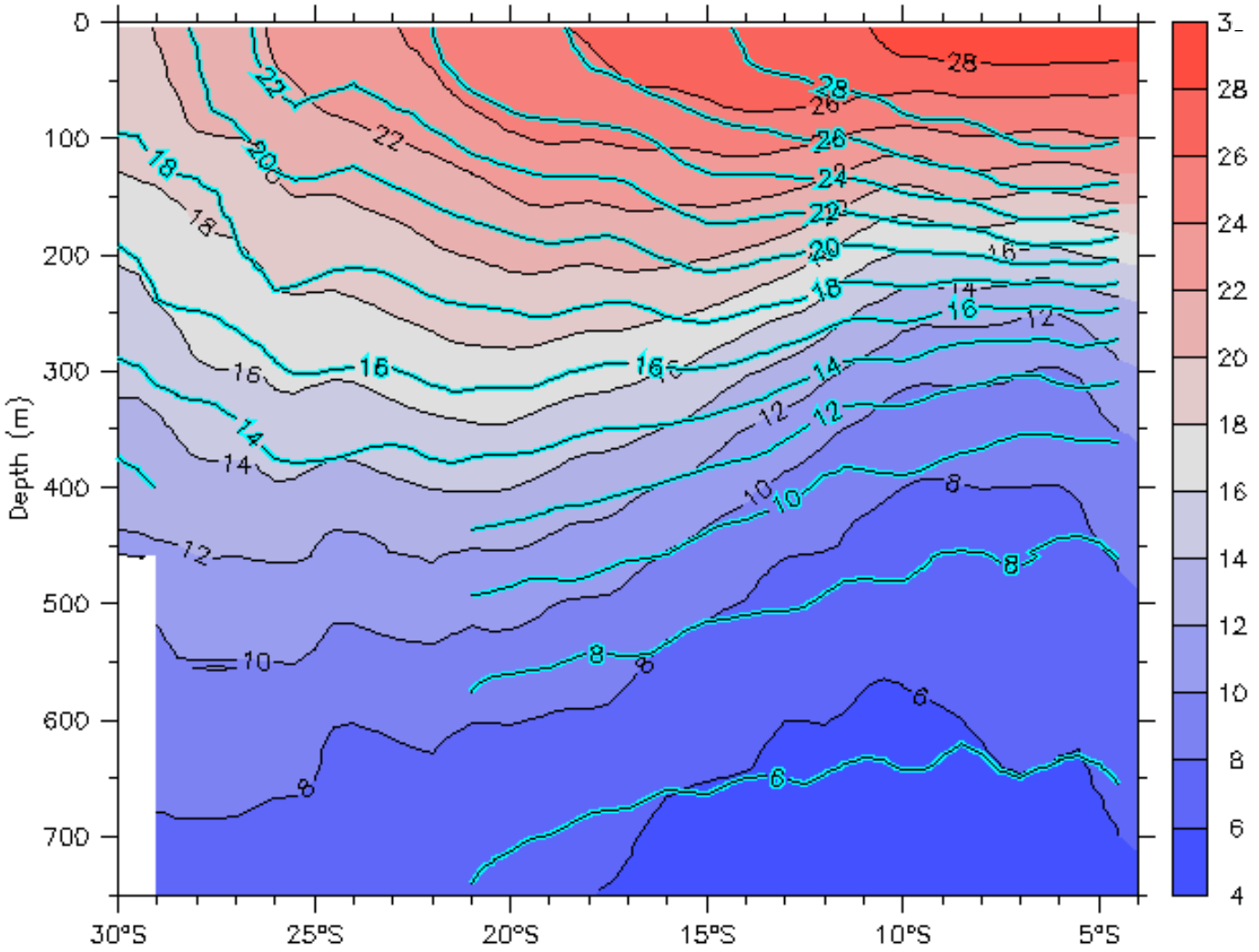
(El Niño)



Temperatures on the XBT track during 1992

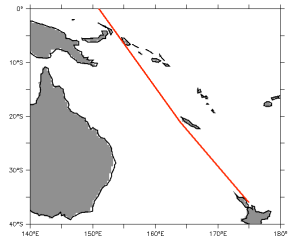
Superimpose 1989 (La Niña)

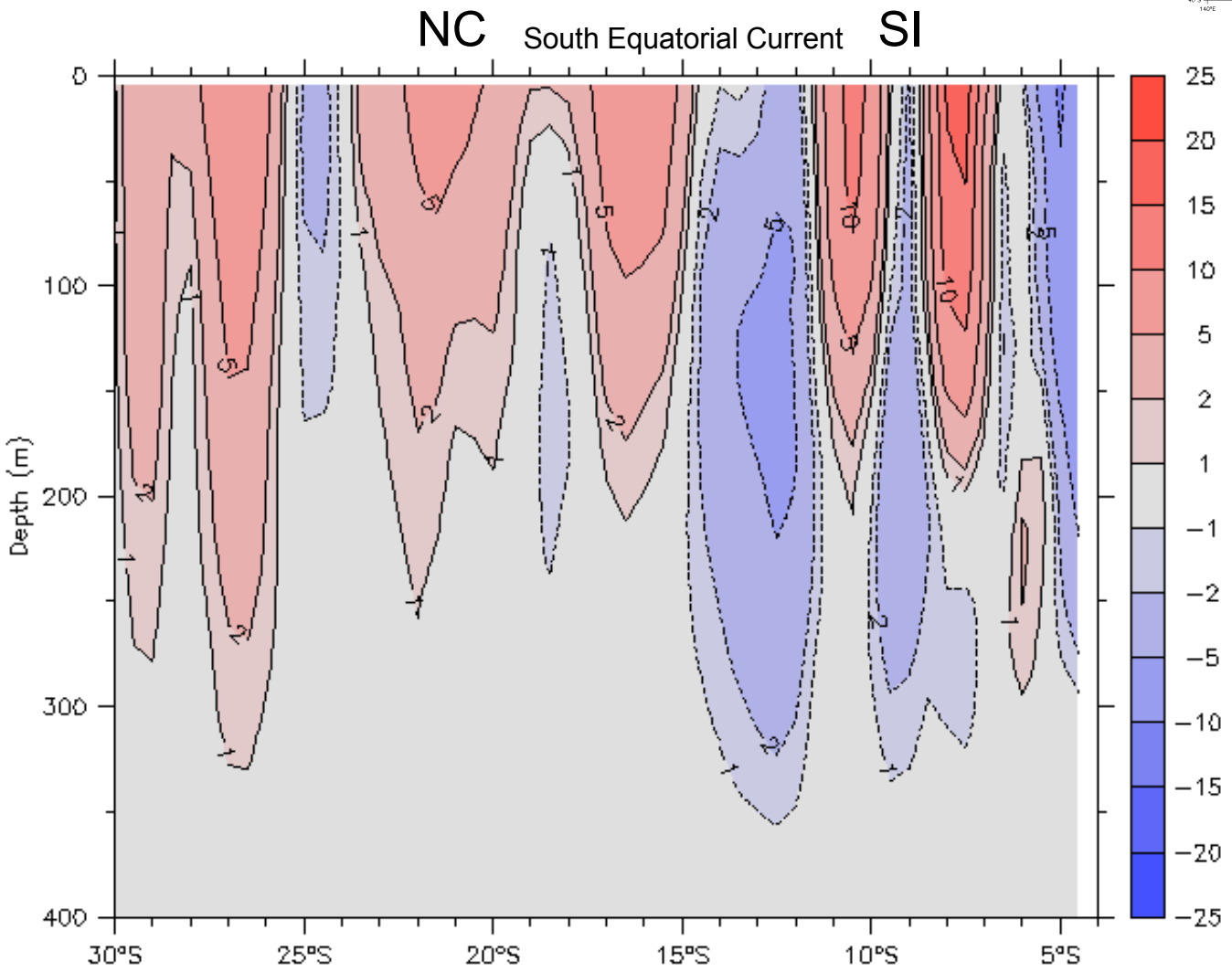




Cross-track velocity during 1989

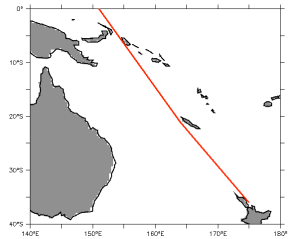
(La Niña)

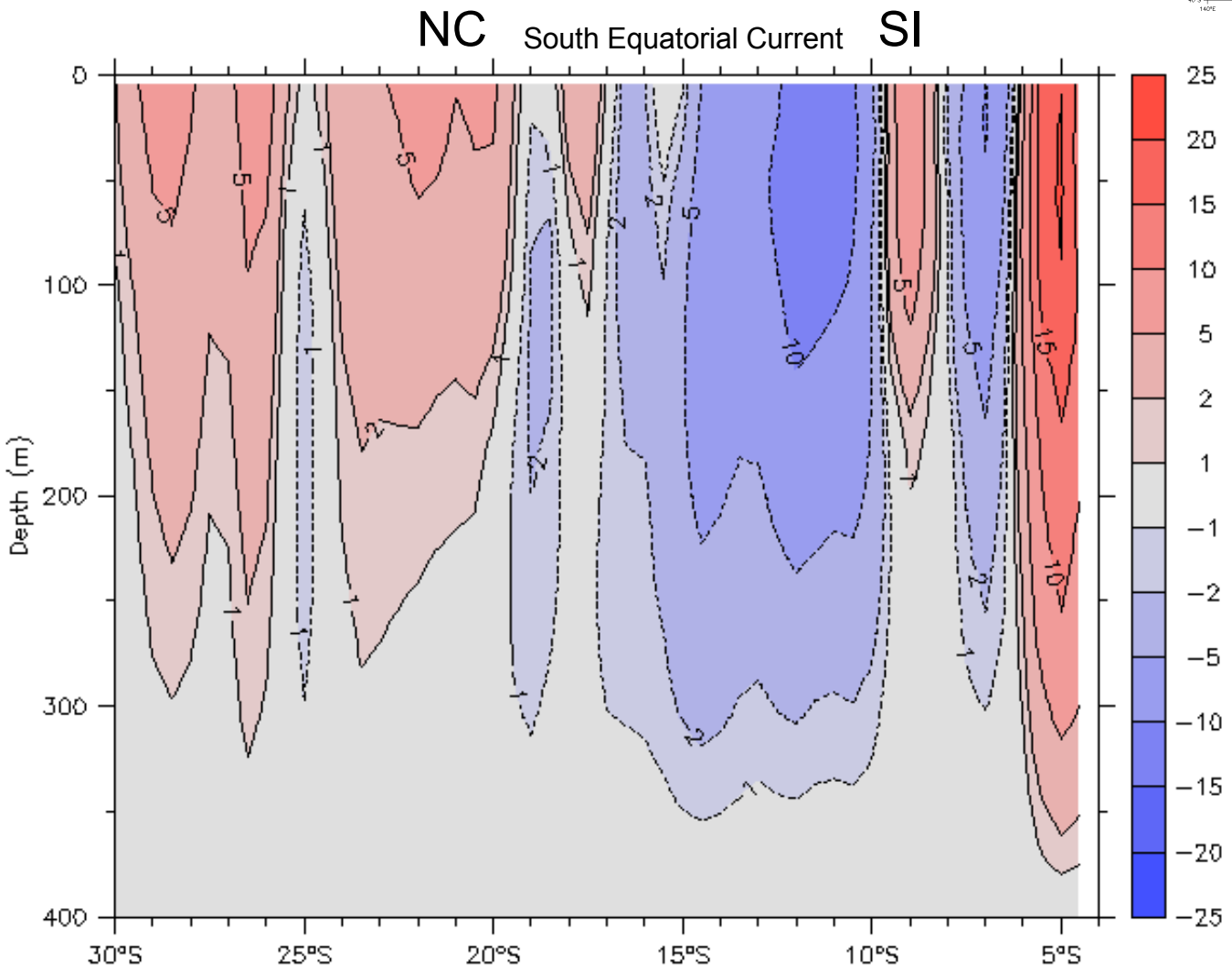




Cross-track velocity during 1992

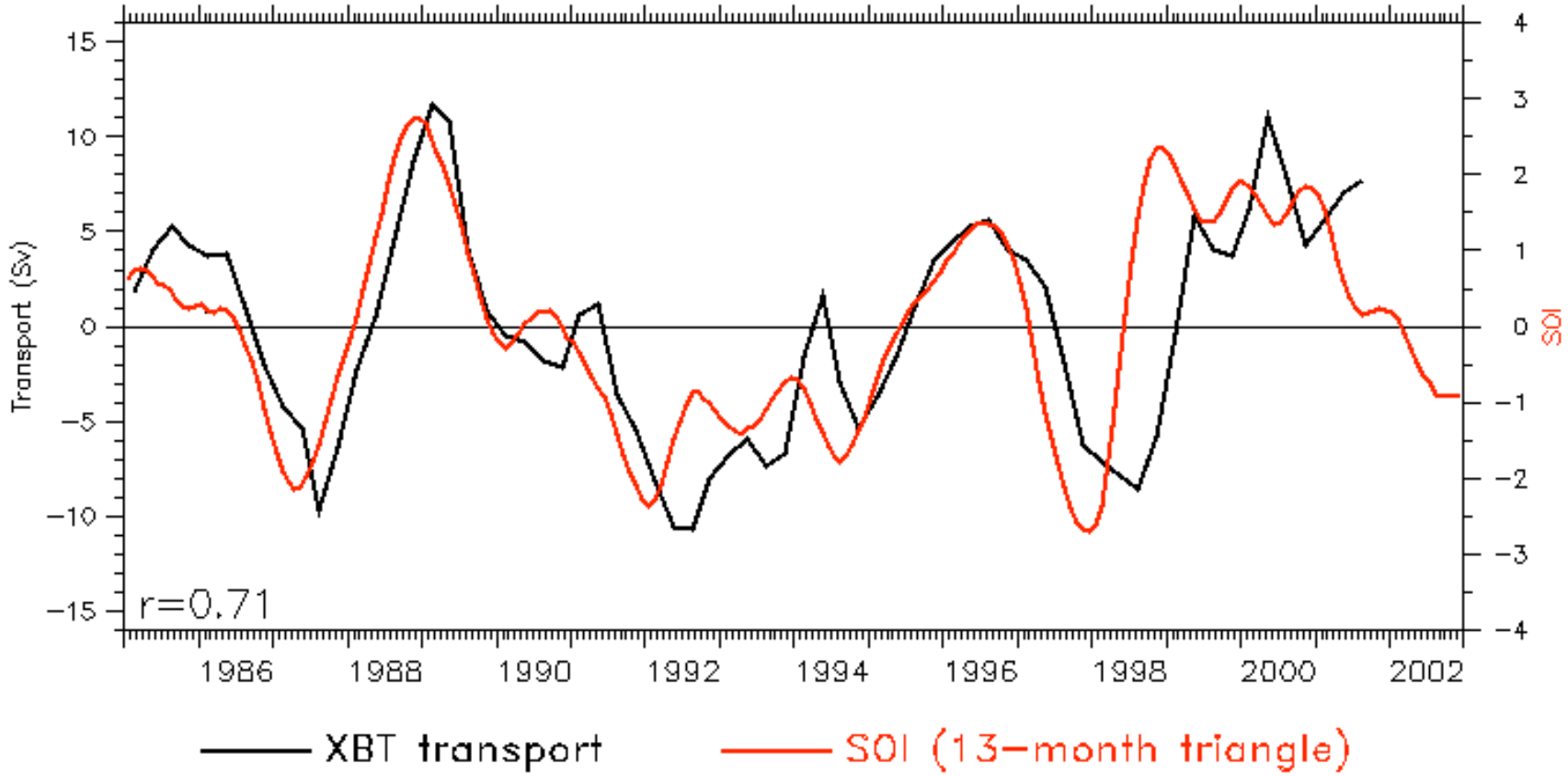
(El Niño)



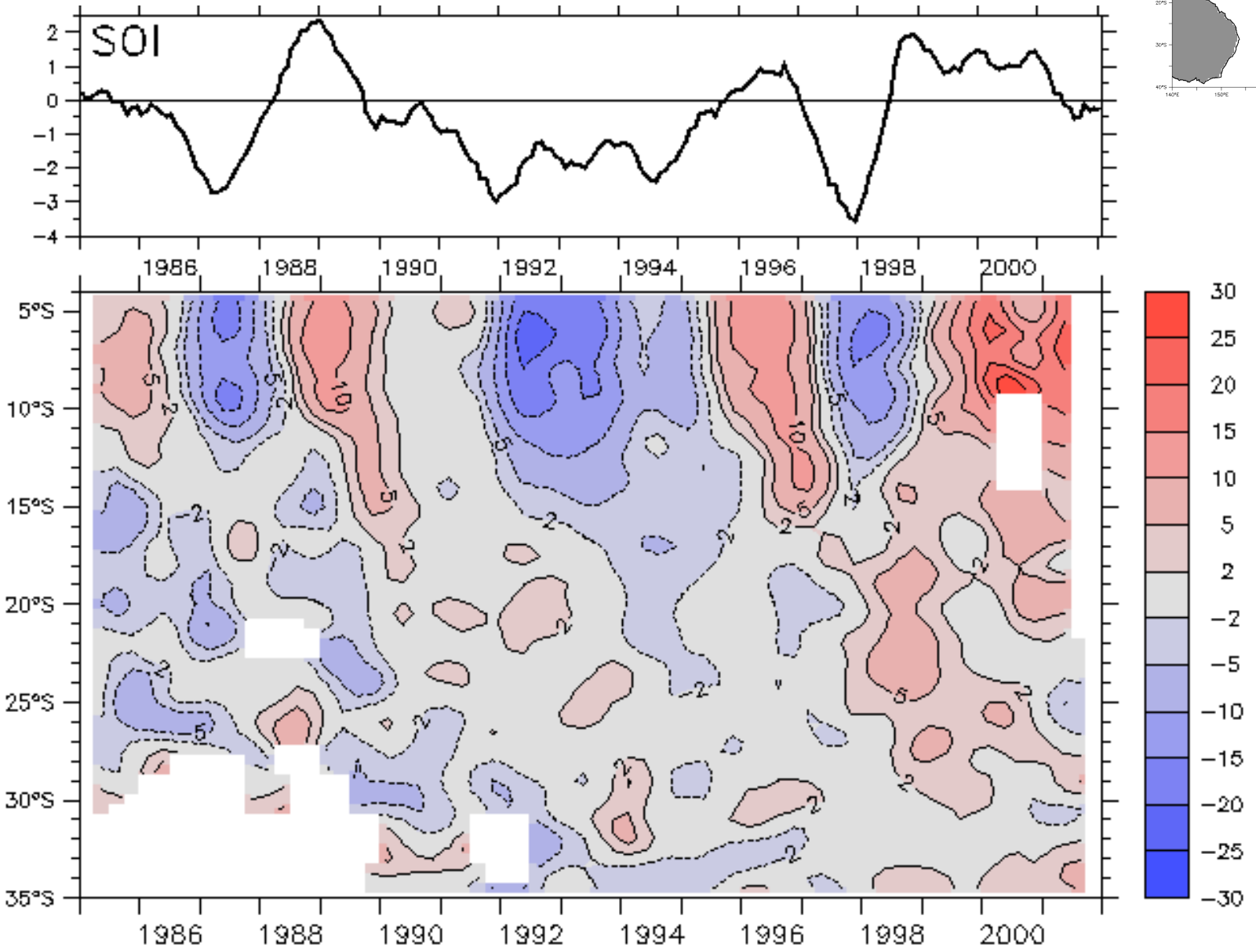


SEC transport and the SOI

Cross-track transport anomalies
on the A-SS XBT track between 10°S-20°S

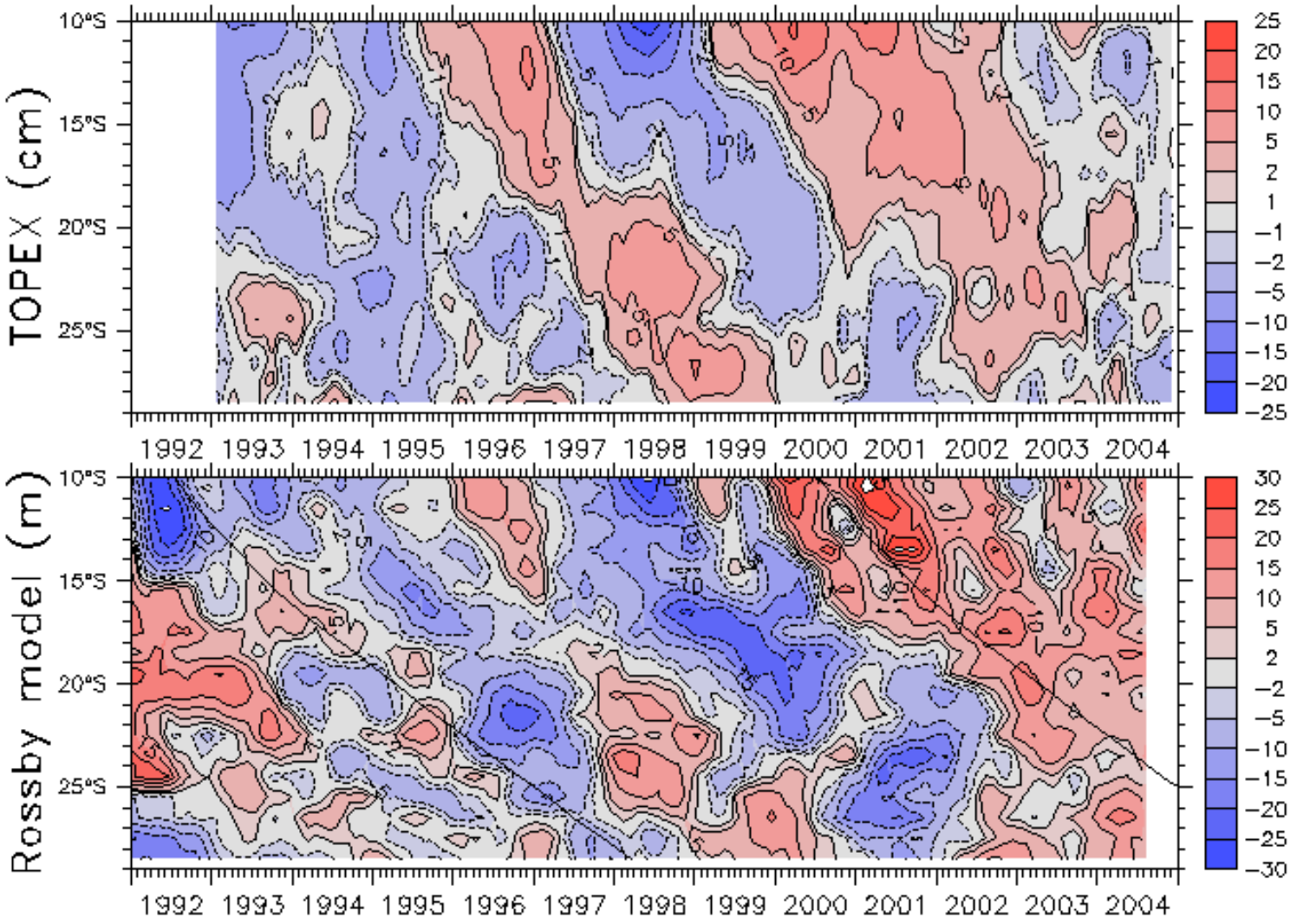


Dynamic Ht anomalies on the Auckland-Solomon St XBT track

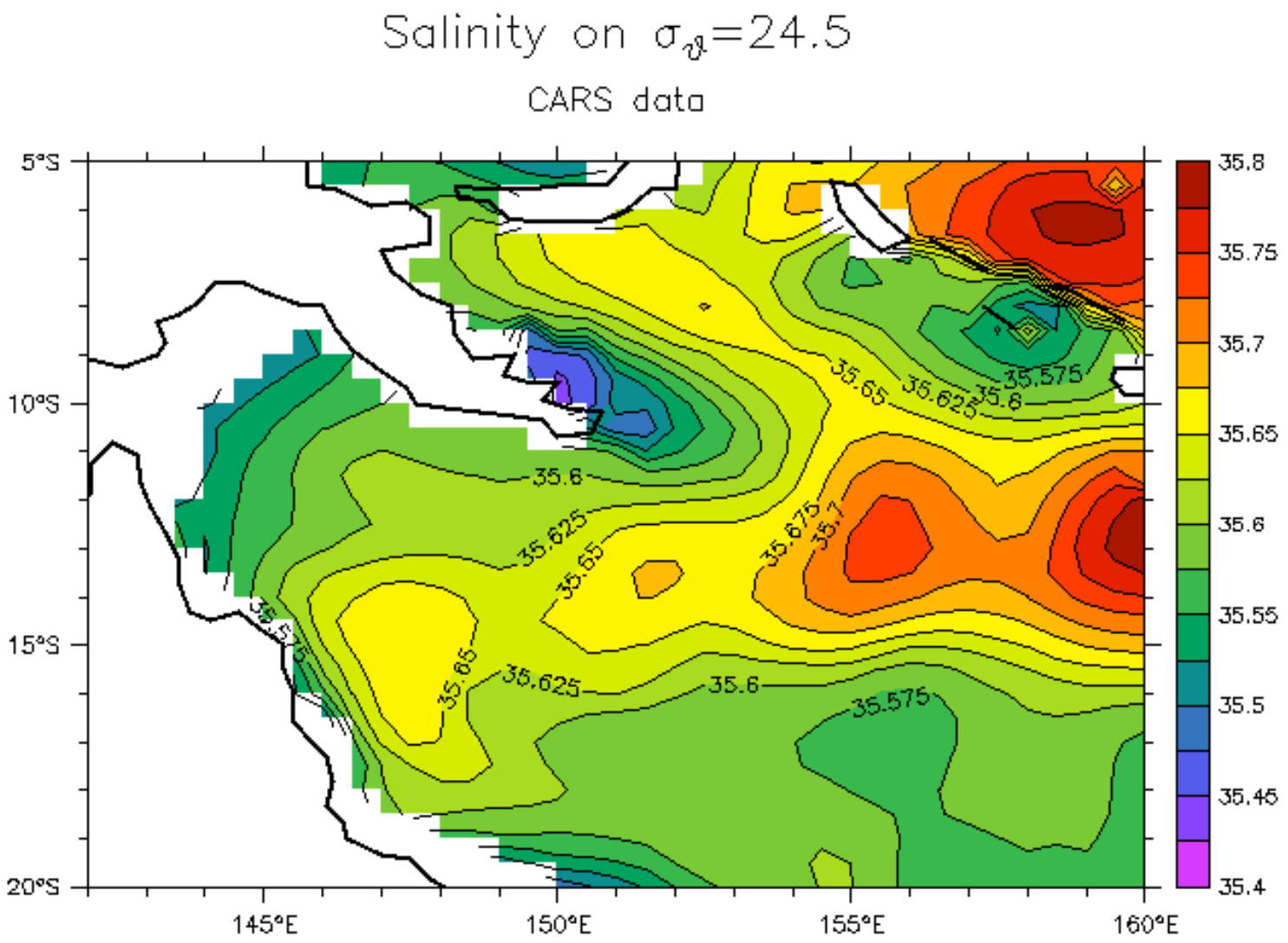


SEC transport anomalies due to Rossby wave phase across 10°S-20°S

Topex and Rossby model SSH along 165°E

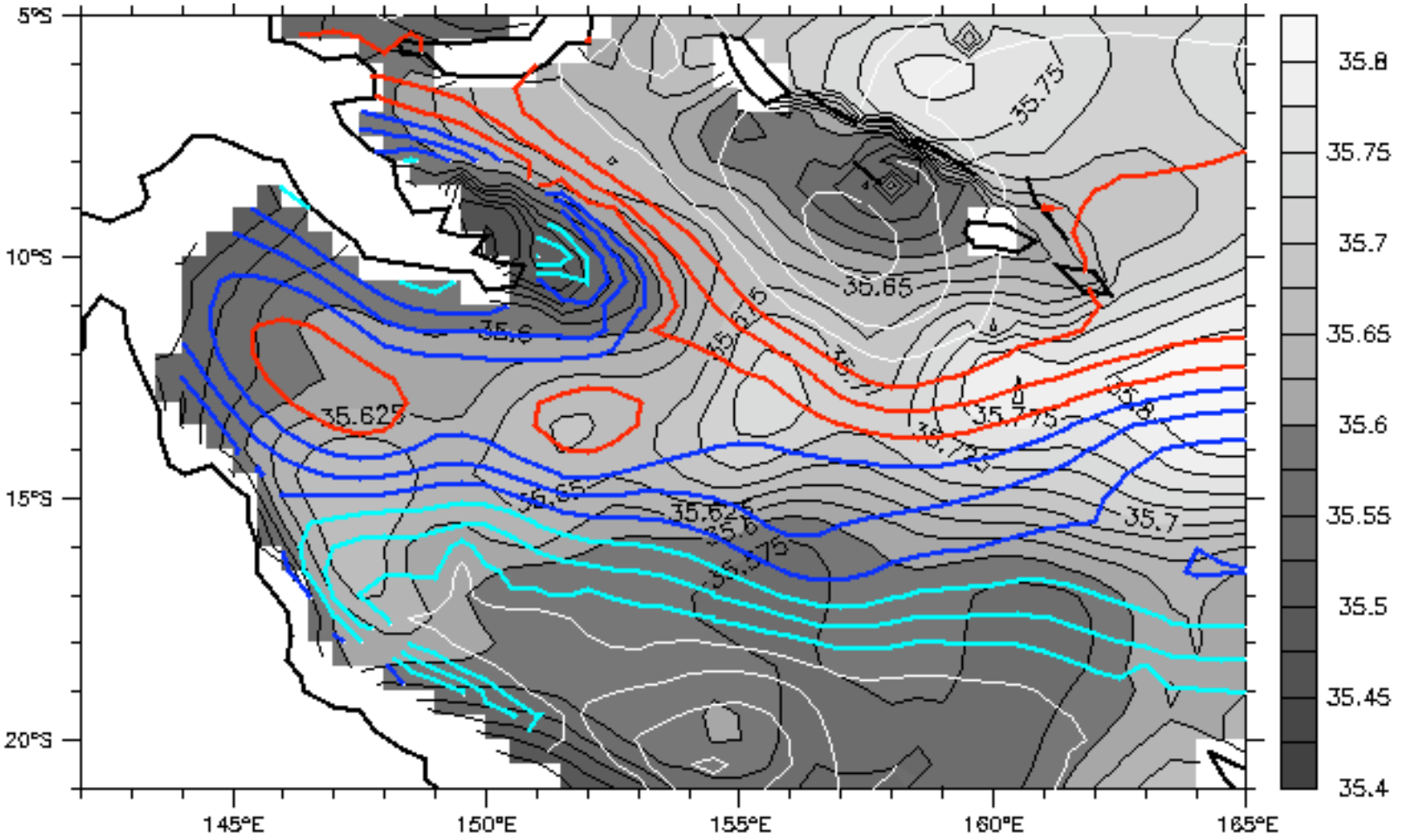


Salinity is a clue to flow directly into the Solomon Sea



Salinity on σ_θ = 24.5

CARS data. Overlay geostrophic streamlines



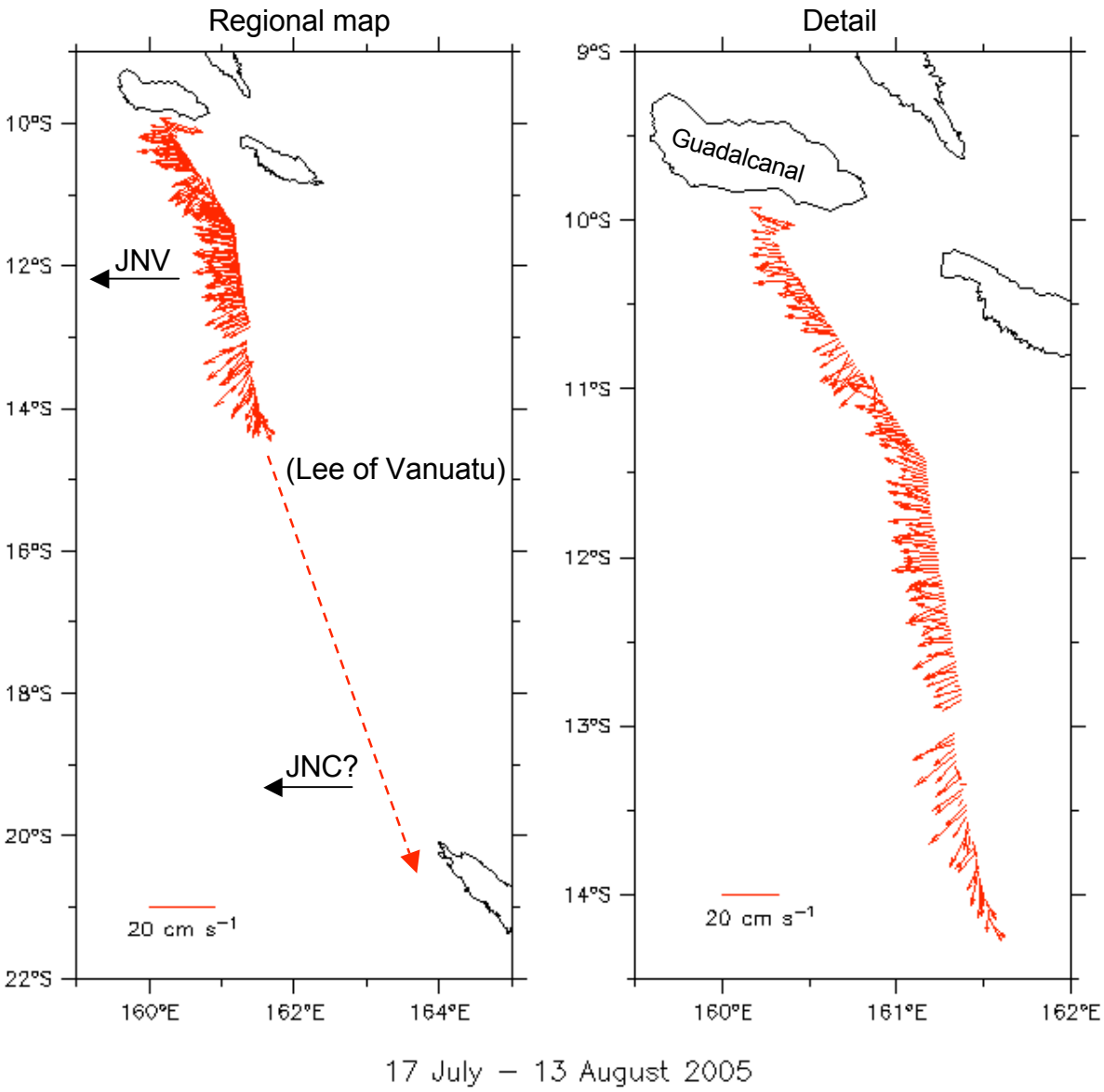
Prospects for progress

- Relation of jets to features in the winds needs exploration (atmos analysis and model experiments).
- Flows into Solomon Sea need explication from models and observations (western boundary influence on Equator is crucial, and we don't know where it originates).
- Relation of sources of subducted water to west Pacific thermocline remains unknown. Are the characteristics of the subducted water a major influence, or do wind-driven dynamics dominate?
- Modal structure of S Pacific thermocline is crucial but remains speculative (theory, models and observations).

- Glider!

0-600m currents along the glider track

Difference between dead reckoning and true position each dive



17 July – 13 August 2005

Spray glider deployed off Guadalcanal on 17 July!

It is making 600m T and S profiles every 3-4 km, on its way to Nouméa.

In collaboration with Davis' group at Scripps, we intend to make regular crossings of the SEC (4 times/yr).

Glider drift is a measure of average current over the upper 600m.