Decadal variability of East Australian Current transport from high-density XBT transects, and satellite altimetry

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Lisbon
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CSIRO

IMOS Integrated **Marine Observing** System

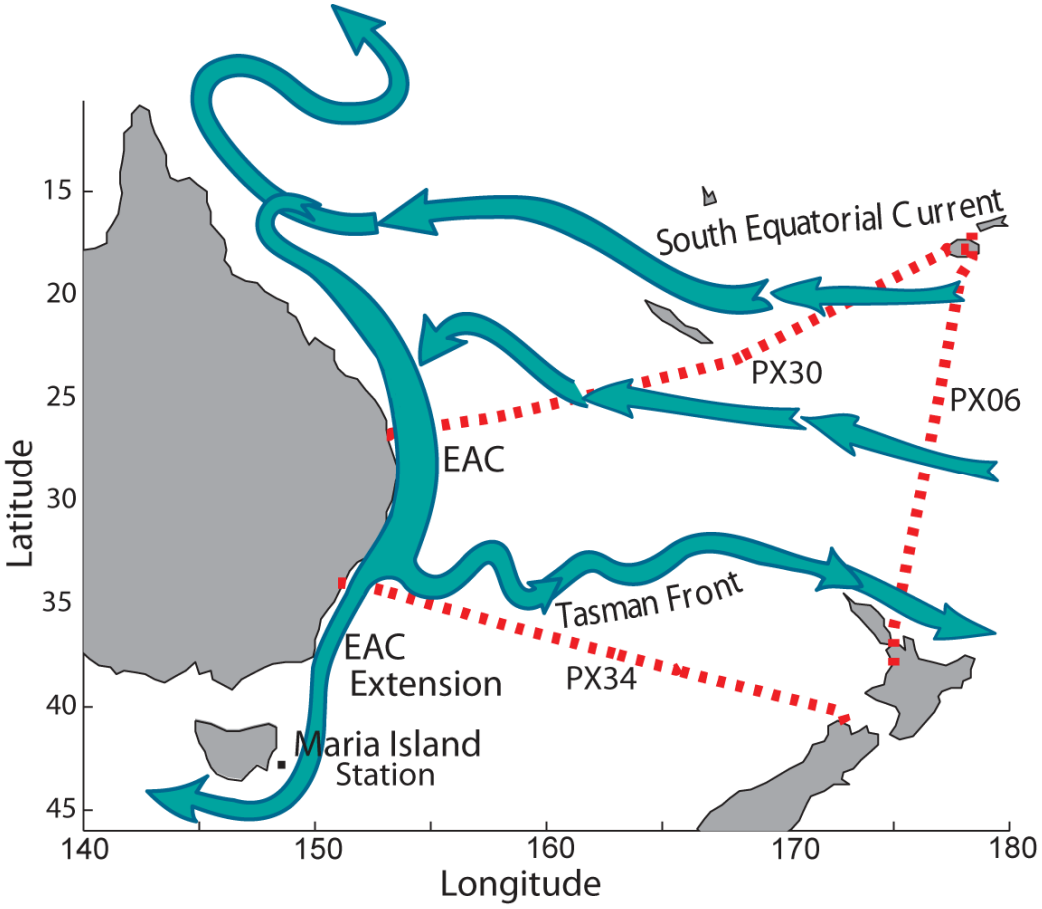
Acknowledgements

- Katy Hill – Integrated Marine Observing System
- Dean Roemmich - Scripps Institution of Oceanography
- Phil Sutton – NIWA

- Ann Gronell – data processing
- Alan Poole – vessel liaison, technical support
  CSIRO Marine & Atmosphere

- Masters and crew of many vessels

Complex Tasman/Coral Sea Current System

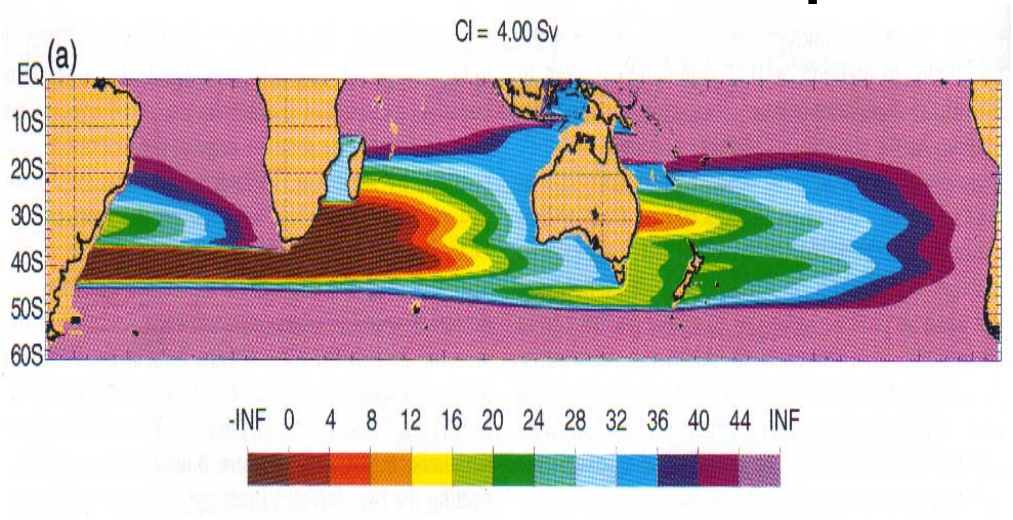


Western boundary current of South Pacific Gyre

SEC feeds EAC

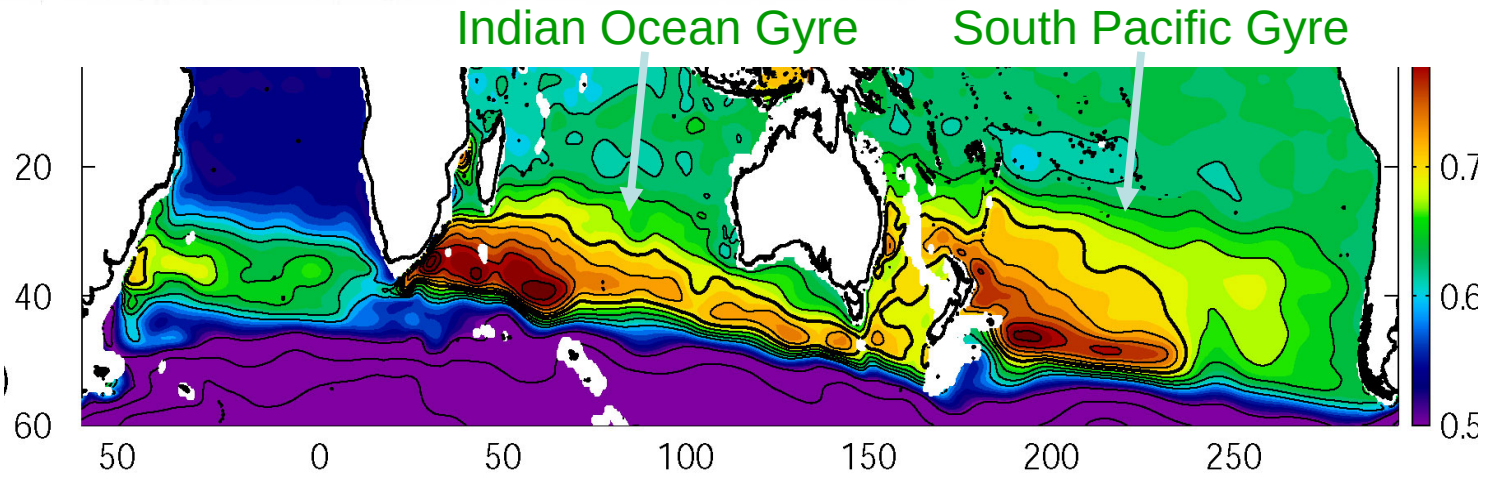
EAC flow partitioned between
-Tasman Front
-EAC Extension

Southern Hemisphere Subtropical ‘Super Gyre’



Three southern gyres connected south of Tasmania and Africa to form ‘Supergyre’

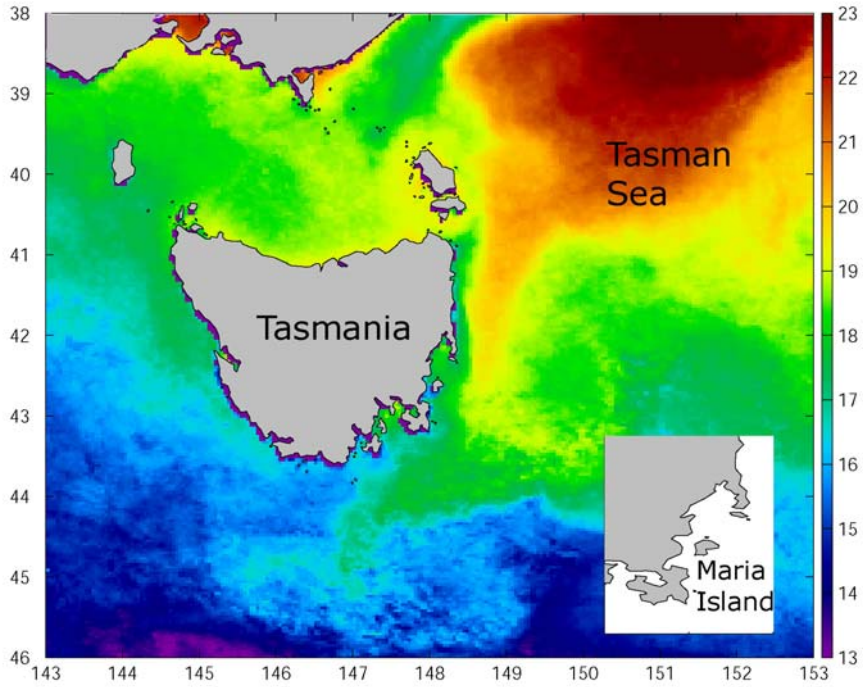
Results from observations confirms results from range of models

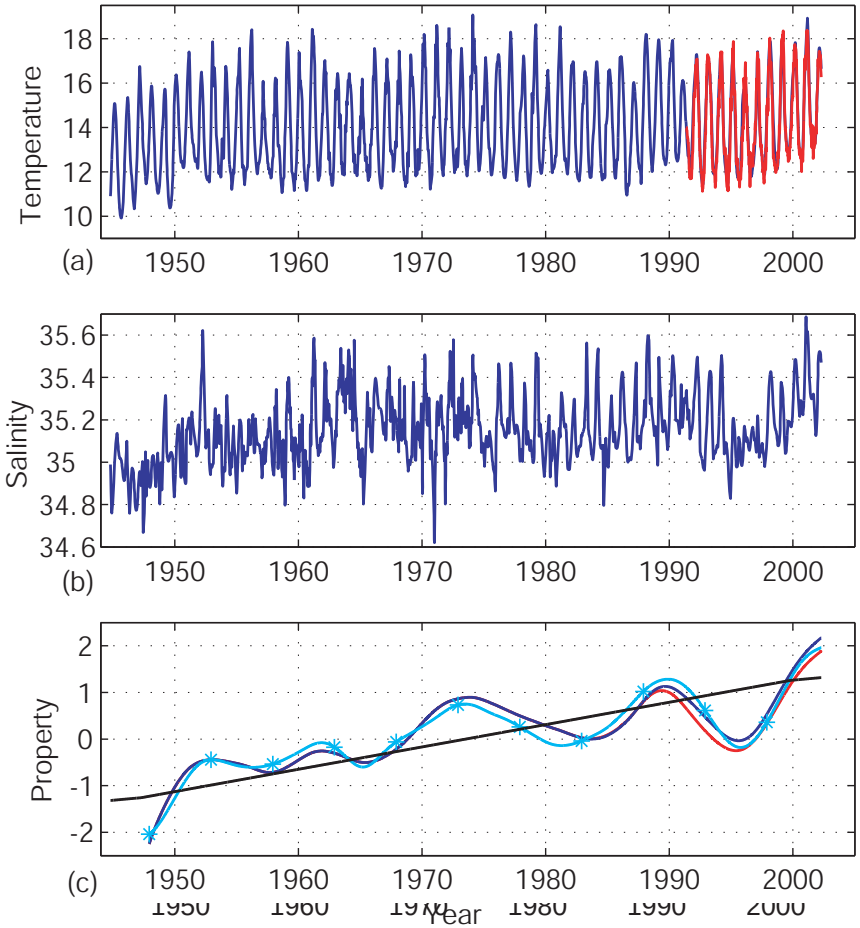


Circulation pattern from CTD casts + Argo profiles CARS climatology

Ridgway, 2007

Longterm Ocean Station



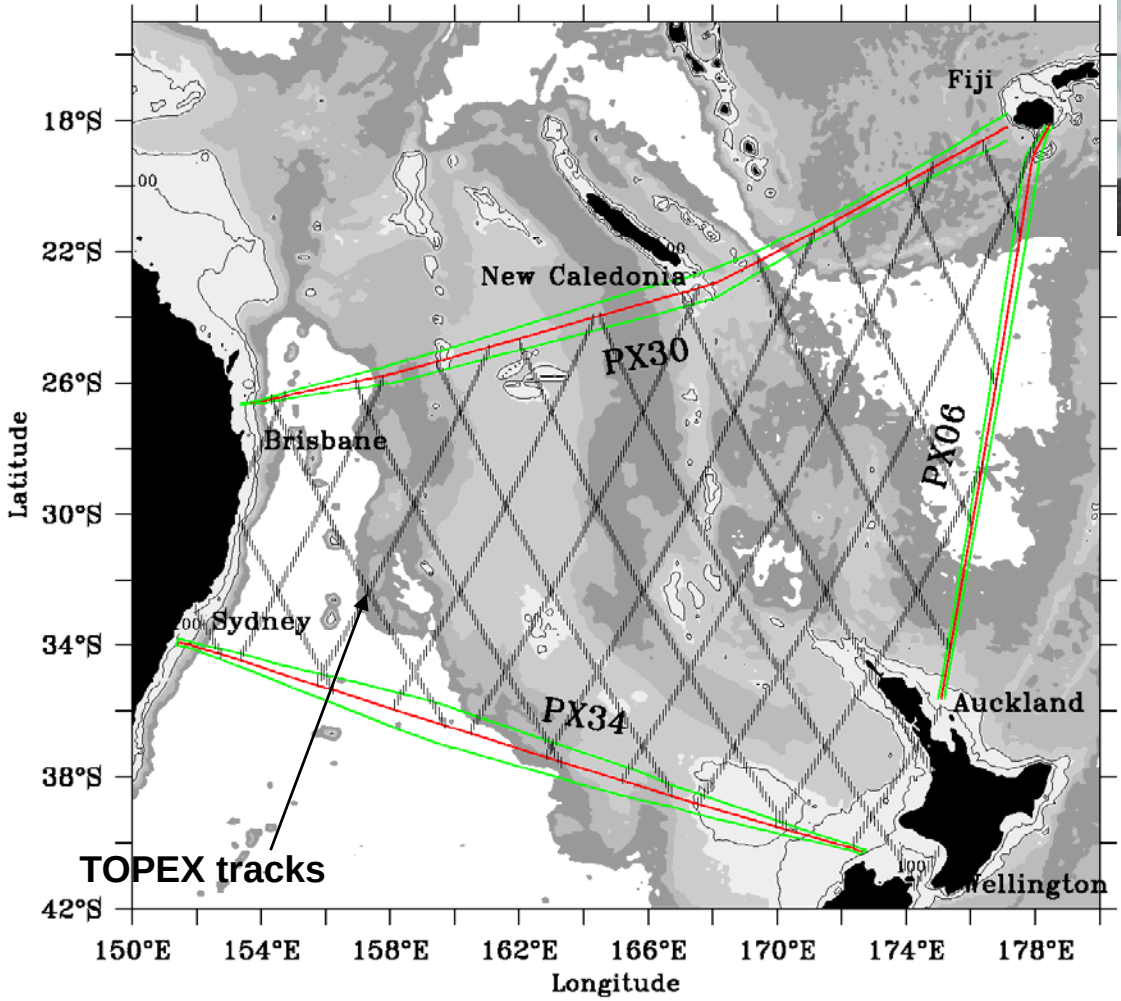


60-year time series at Maria Island

Seasonal to long-term record of EAC flow

Ridgway, 2007

The Tasman Box:



High Resolution XBT lines:

Quarterly sampling
Eddy-resolving
Red: mean track
Green: rms deviation

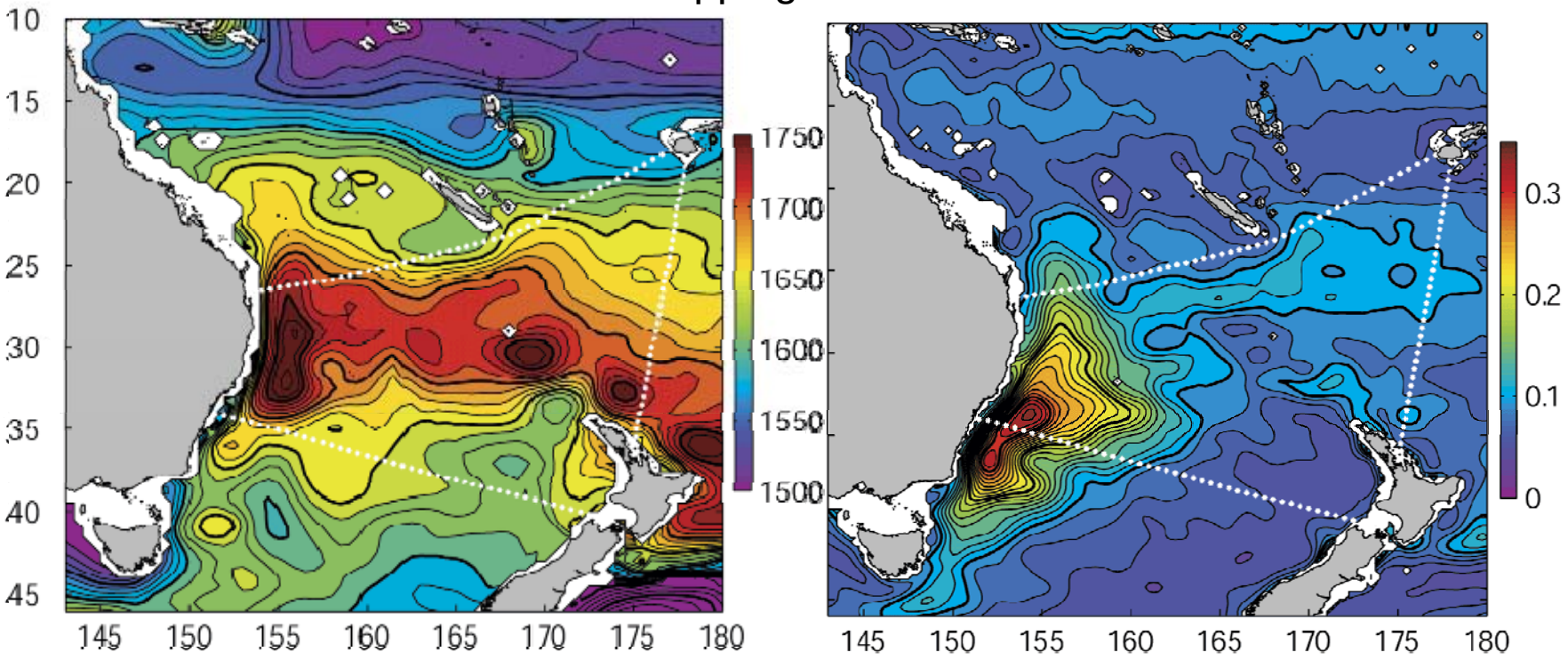
PX06: 1986 - present
PX30: 1991 - present
PX34: 1991 - present

Component of IMOS

Contributes to SPICE

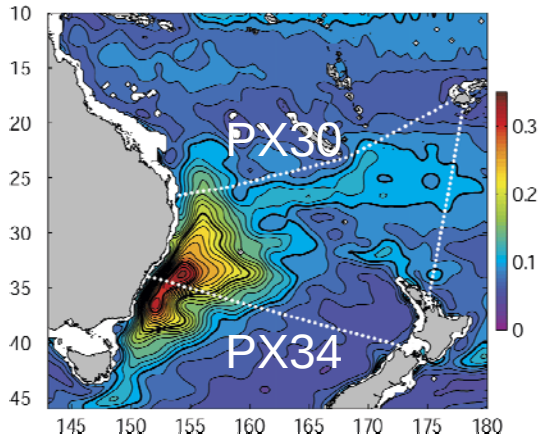
Captures Main Gyre Components

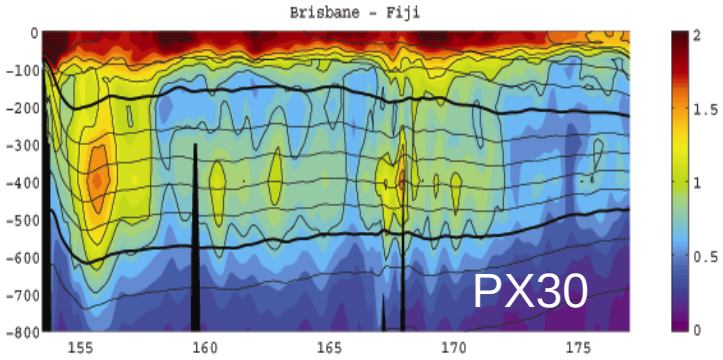
Depth-averaged steric height shows the western end of the gyre circulation – inflows and outflows to the region are captured by the Tasman Box – even though tracks were dictated by available shipping routes

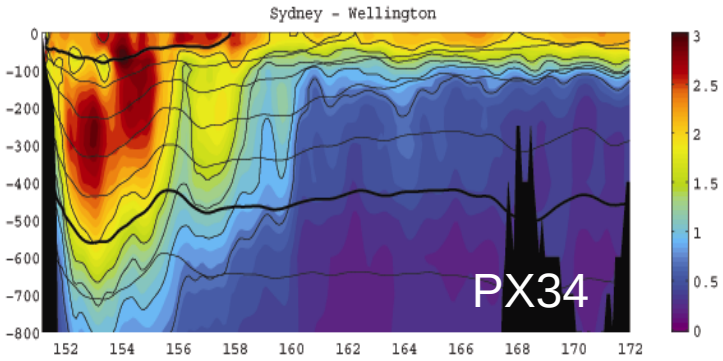


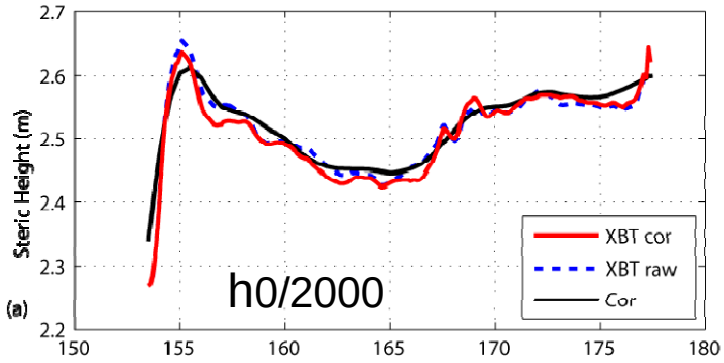
Depth Integrated Steric height (P0/2000)

Correct XBT Mean with Altimetry

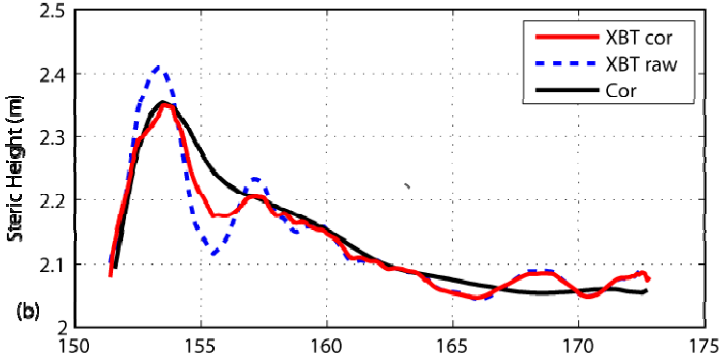




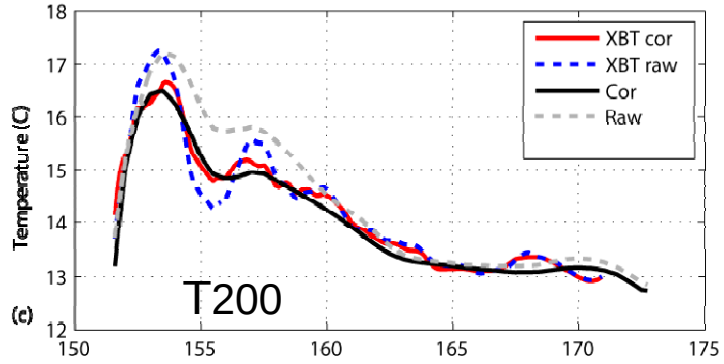




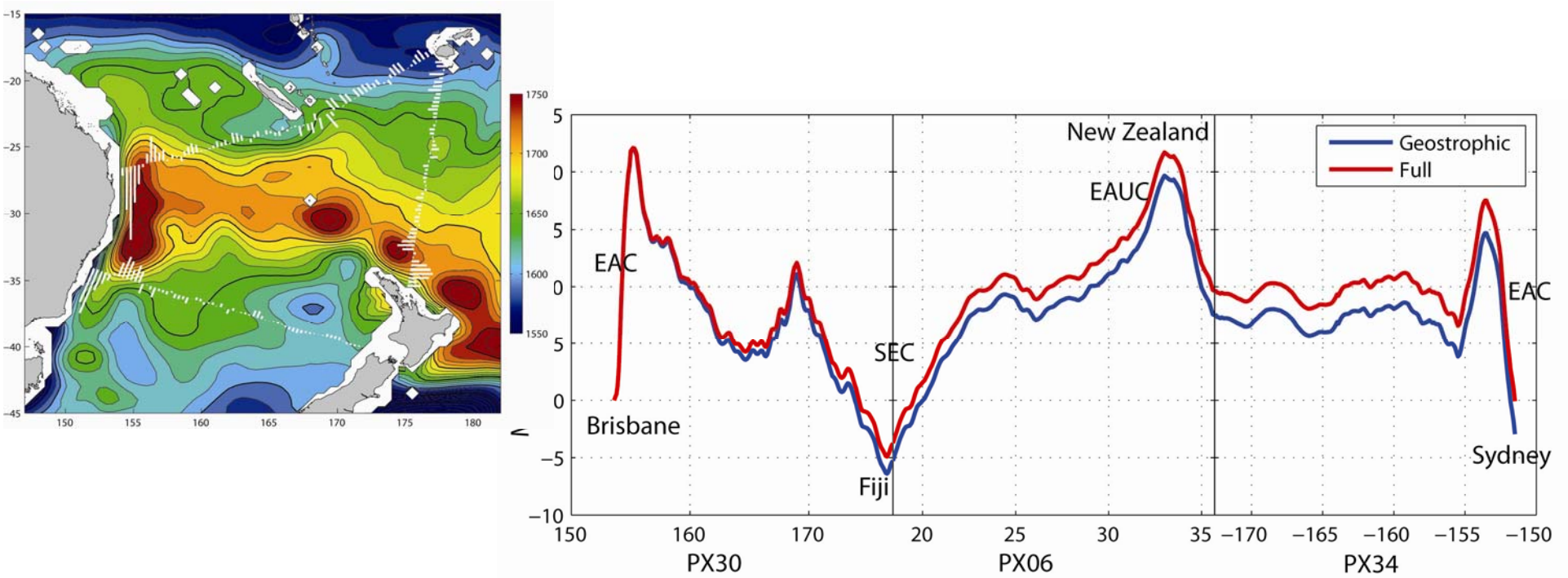
PX30



PX34



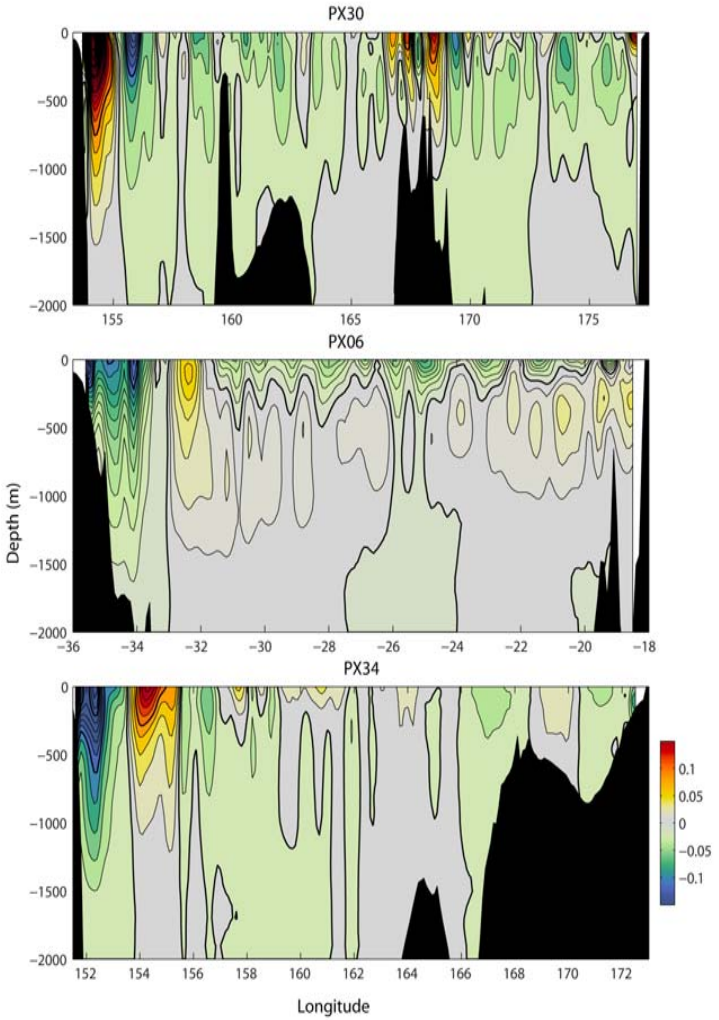
Mean Transport balance in ‘Tasman Box’

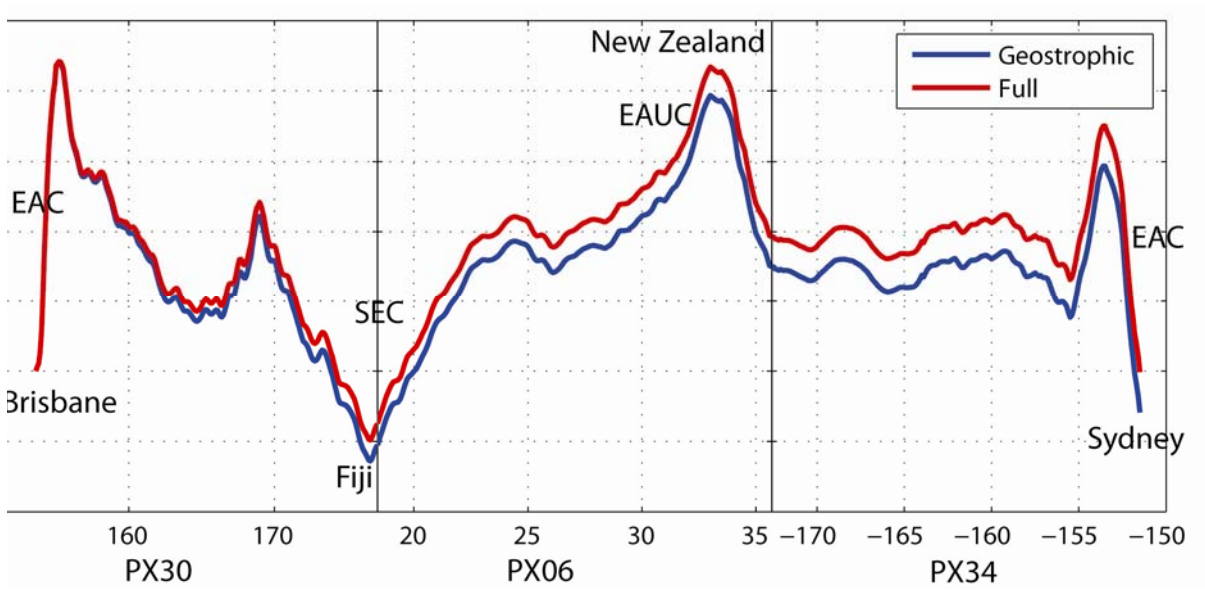


Geostrophic + Ekman = 0

Relative to 2000-m

Mean Transport balance in ‘Tasman Box’

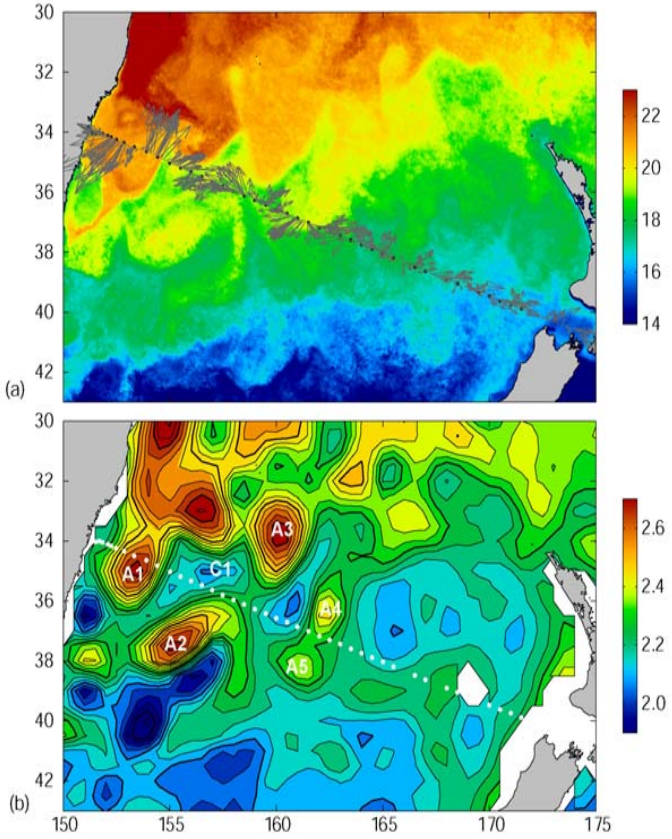




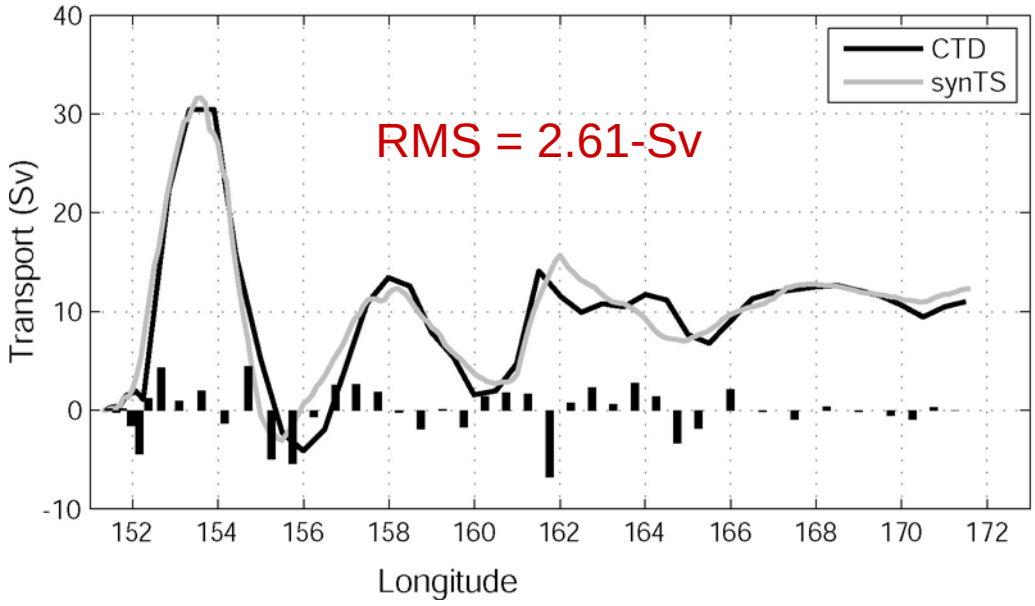
Geostrophic + Ekman = 0

Relative to 2000-m

Transport from surface altimetry



Transport inferred from Satellite properties interpolated along CTD section



46 CTDs along

PX34 section

Comparison of XBT & SynTS Transport

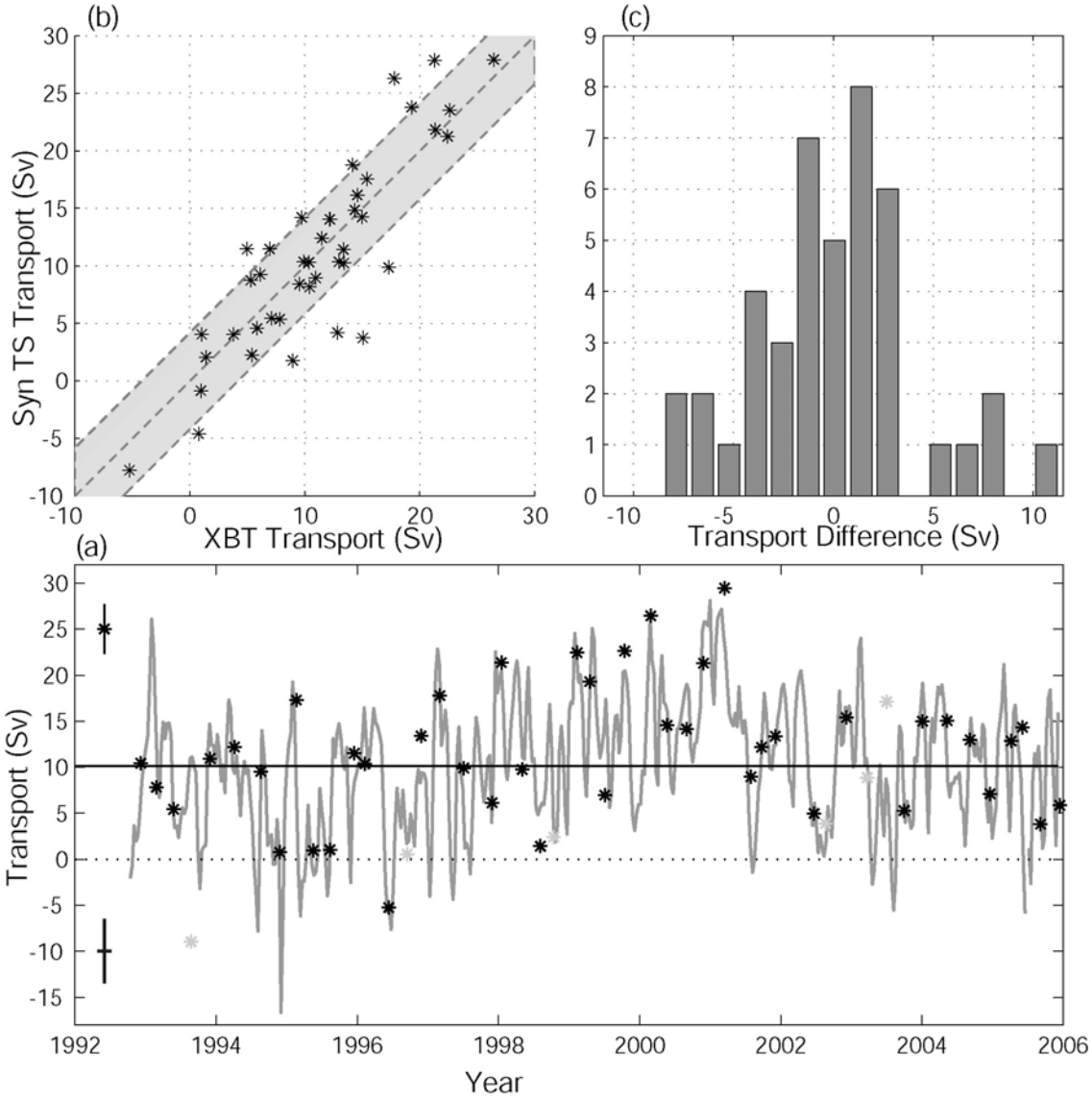
Tr_X and Tr_S transport estimates are strongly correlated

43 transects followed PX34 track

RMS = 4.2-4.8 Sv

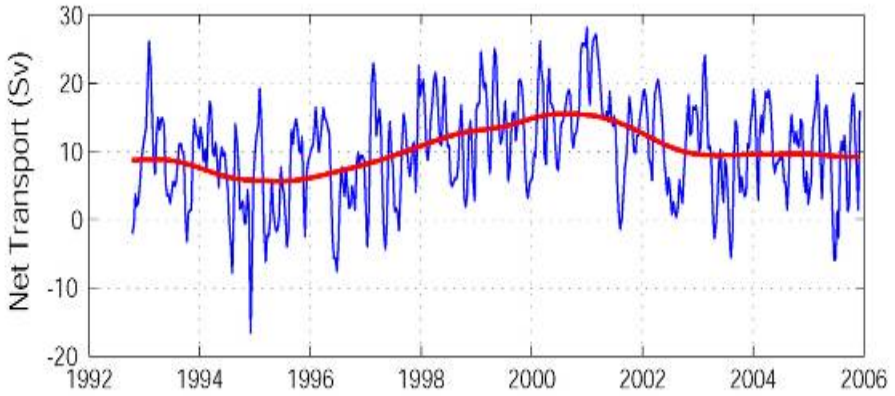
Tr_S obtained every 10 days from altimetry along PX34

Ridgway et al, 2008



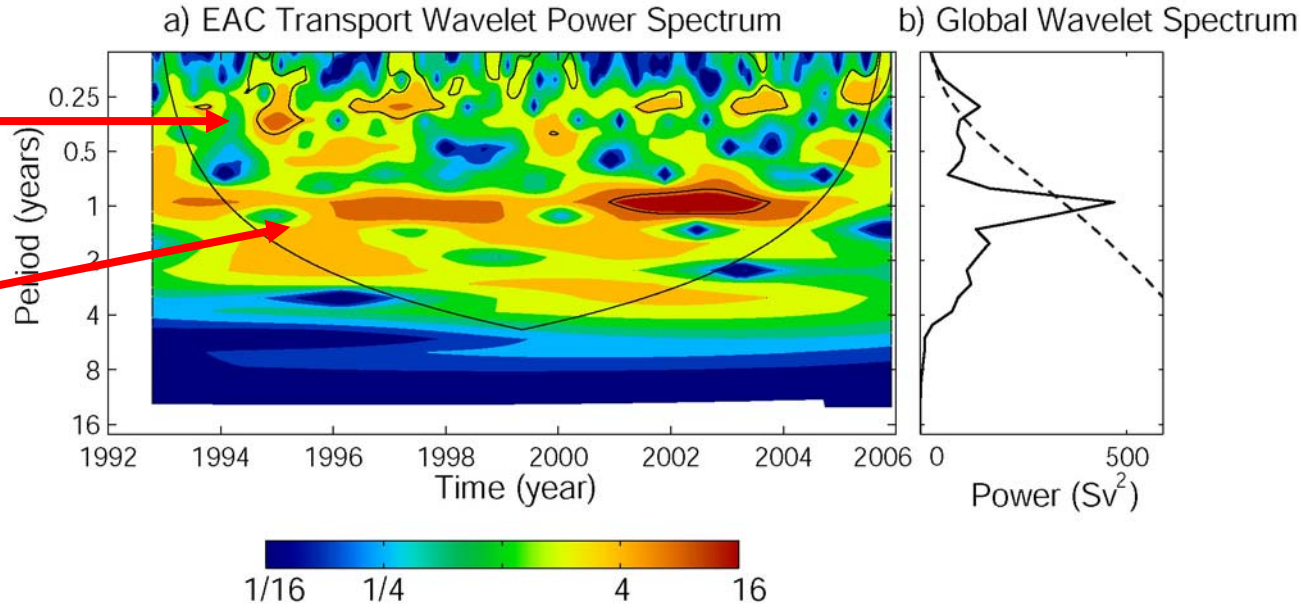
EAC Transport Time Series

Eddyscale, seasonal, interannual and decadal signals

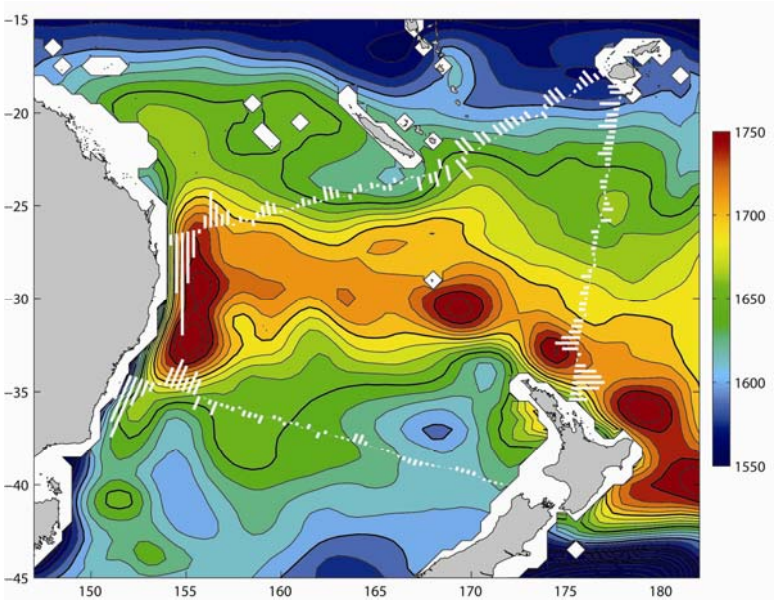


100-day eddy mode

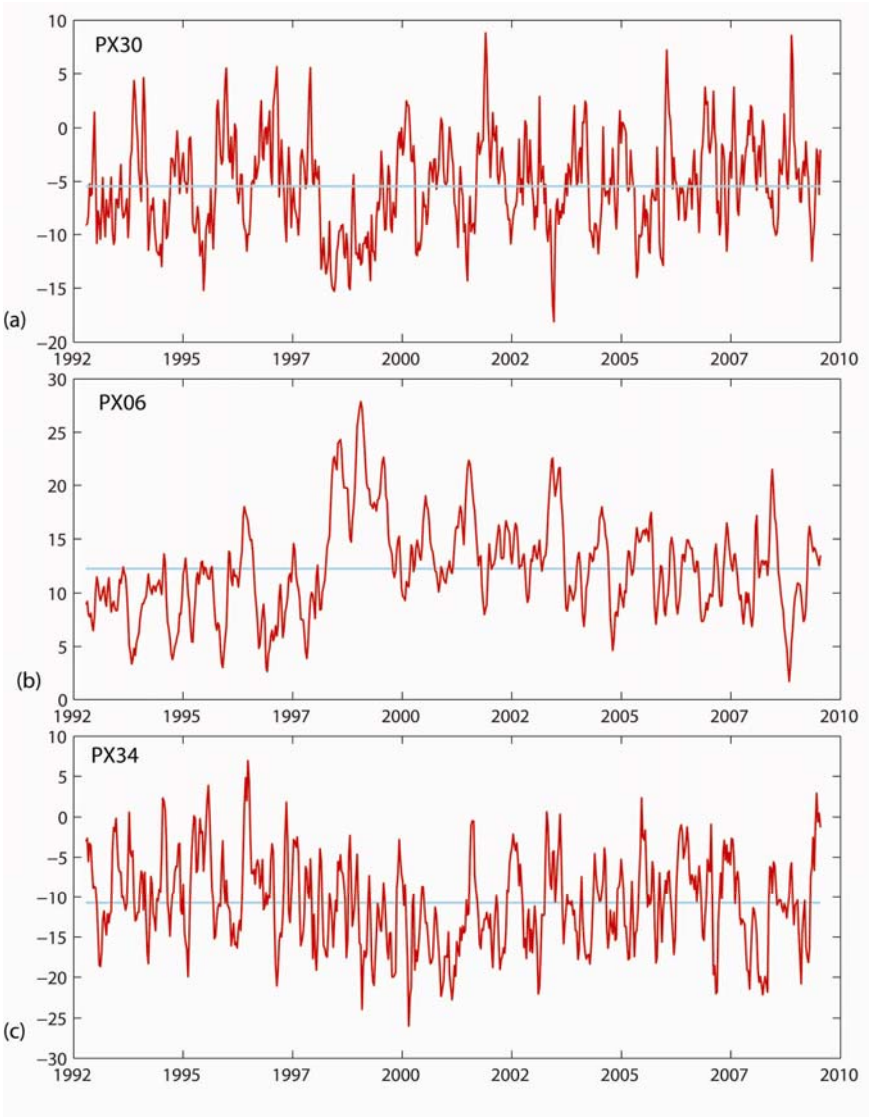
Annual cycle



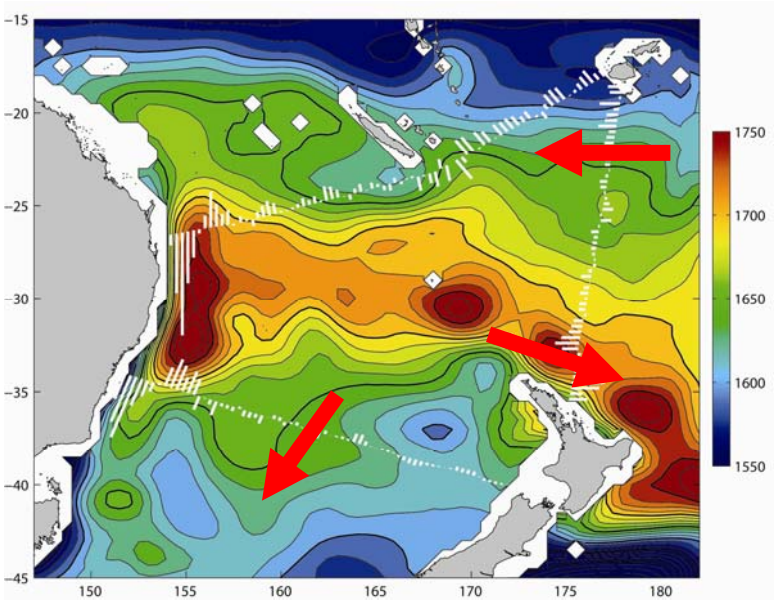
Transport Time Series



Full range of signals observed over 17-year period through each transect

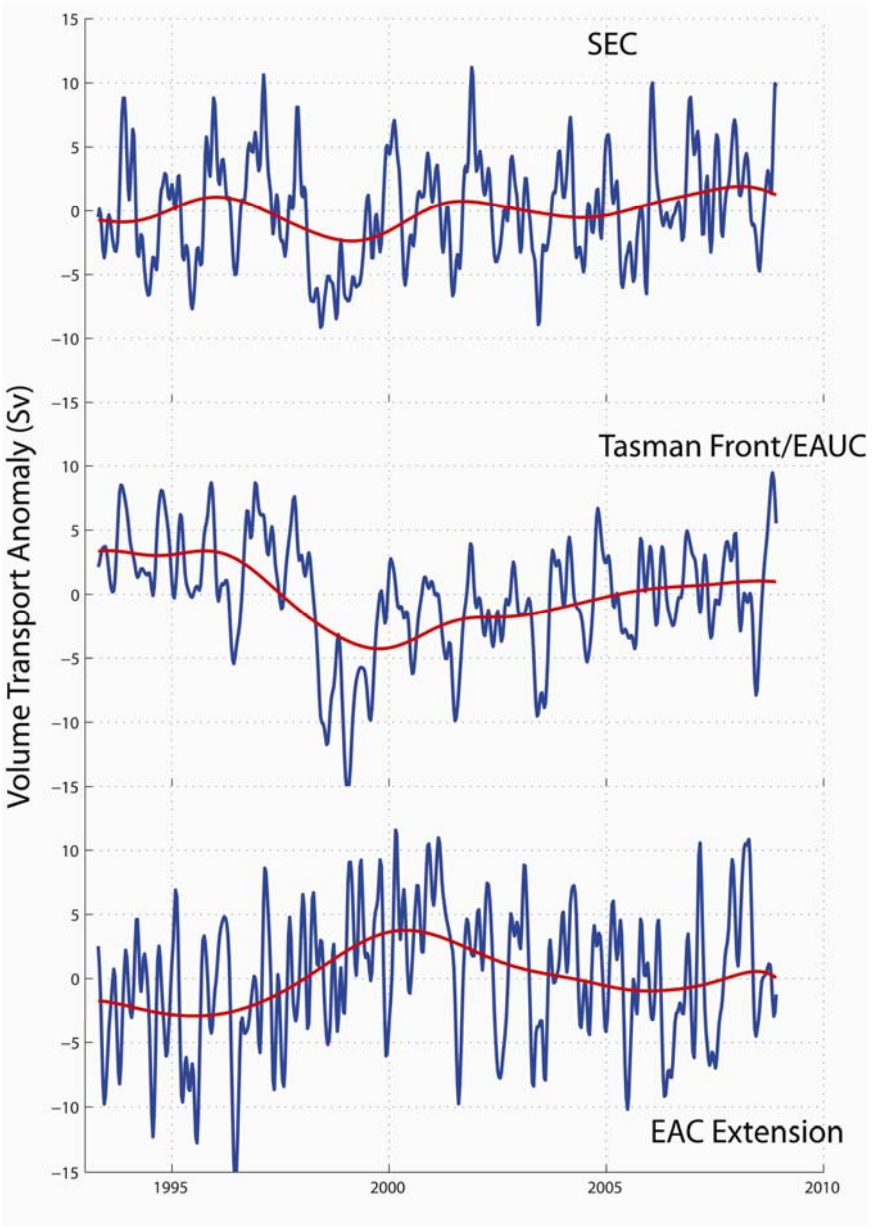


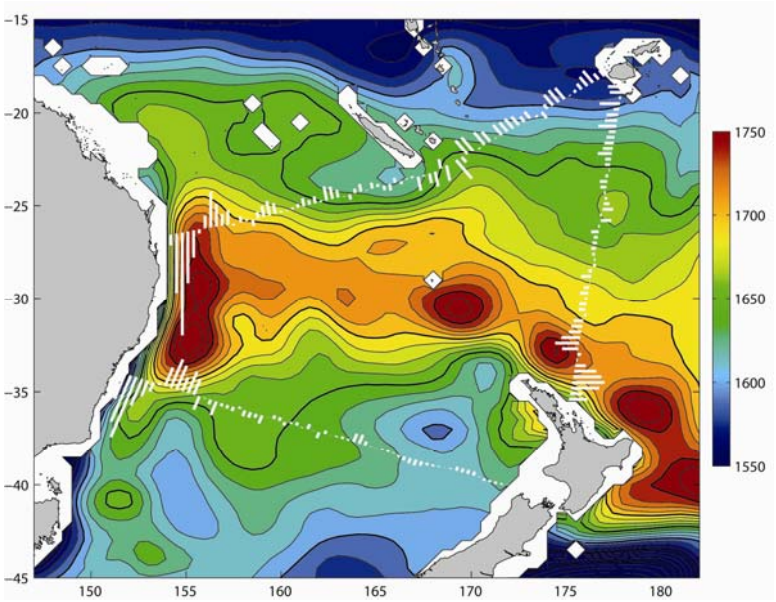
Decadal Signals



Focus on 3 components

‘Decadal’ signal observed in Tasman Front & EAC Extension

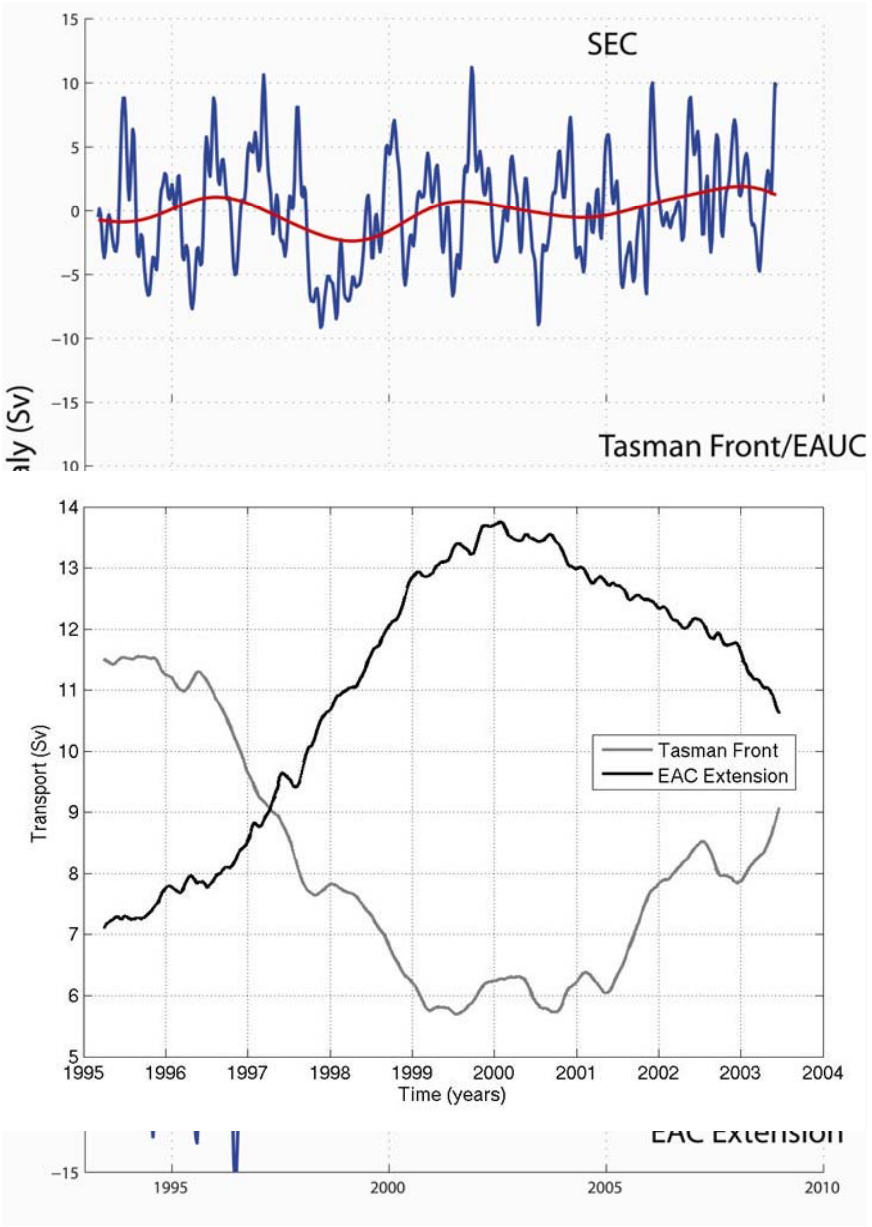




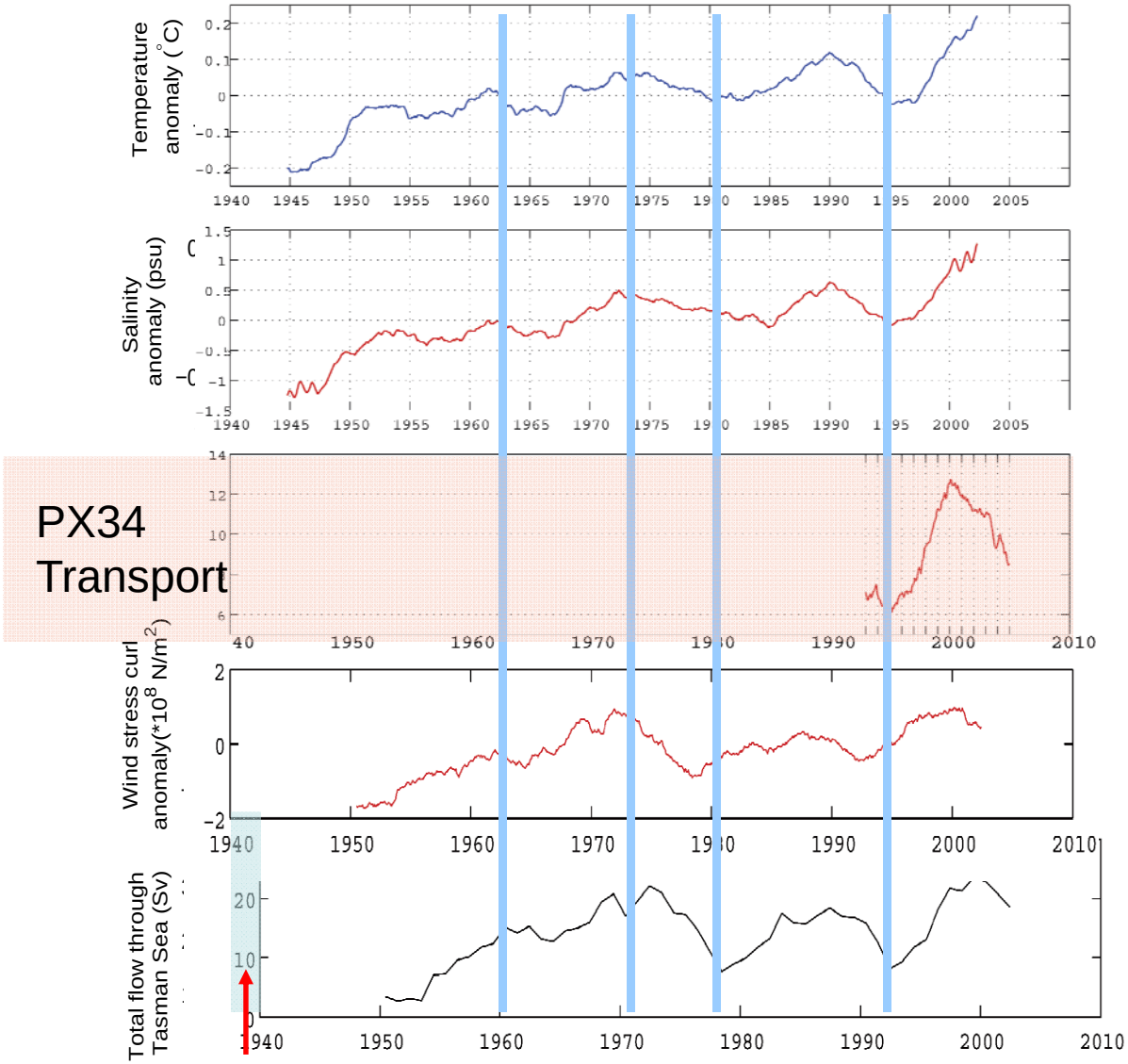
Decadal change in EAC flow opposite in phase to Tasman Front outflow

Increase in EAC

Decrease in Tasman Front



Connected to Basin scale changes



Maria decadal changes and trend forced by EAC flow which in turn responds to gyre adjustment to basin scale wind forcing

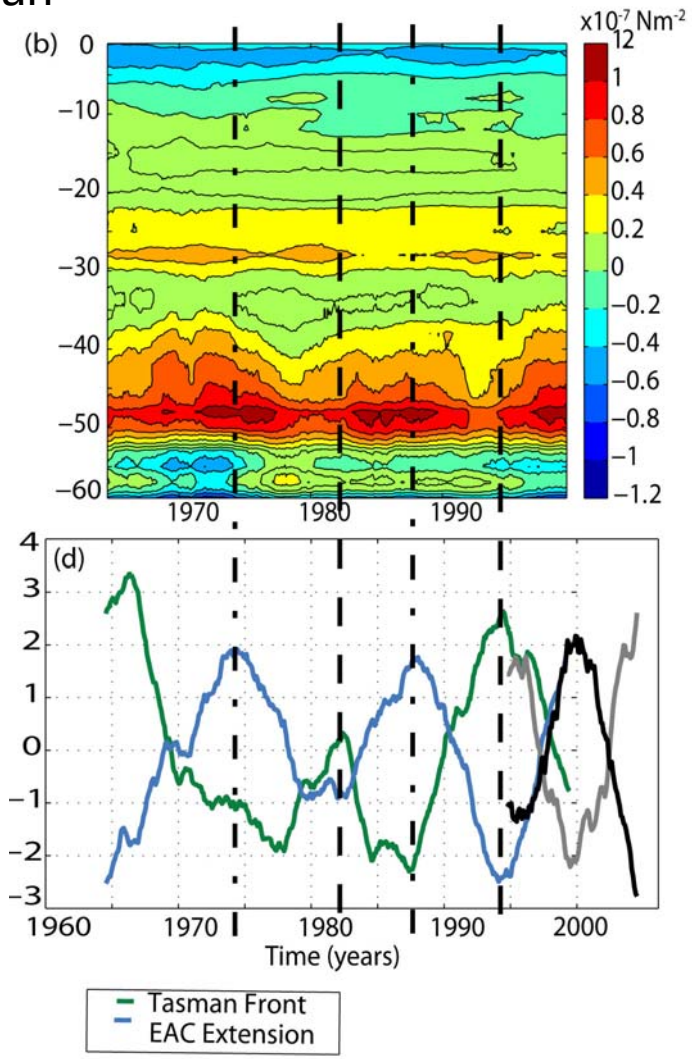
Roemmich et al, 2007

Hill et al., (2008)

3-5-yr lag >>Rossby wave speed @ 40°S

50-year Model Run

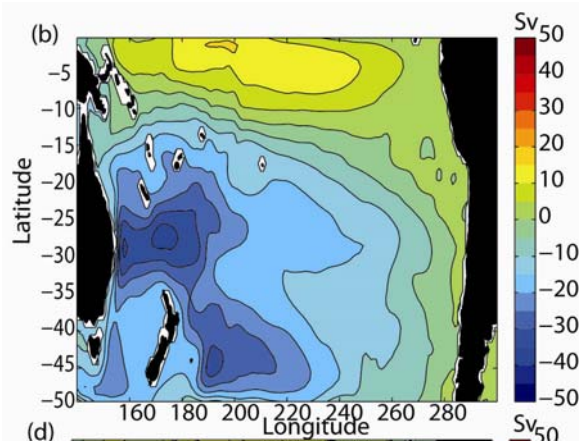
Wind stress curl



Hill et al., 2010

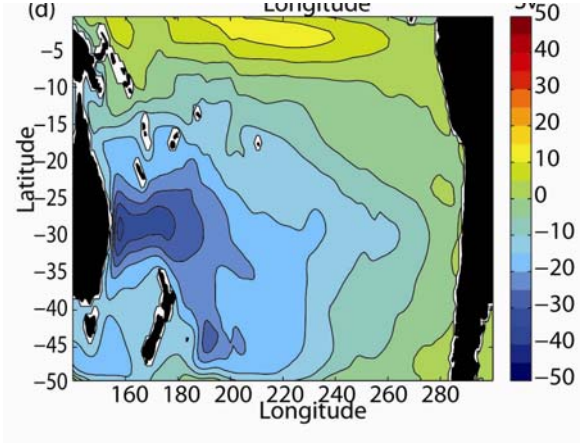
50 year data-assimilating run of GECCO shows similar partitioning of flow between 2 gyre components.

Also evident in SODA



Strong EAC

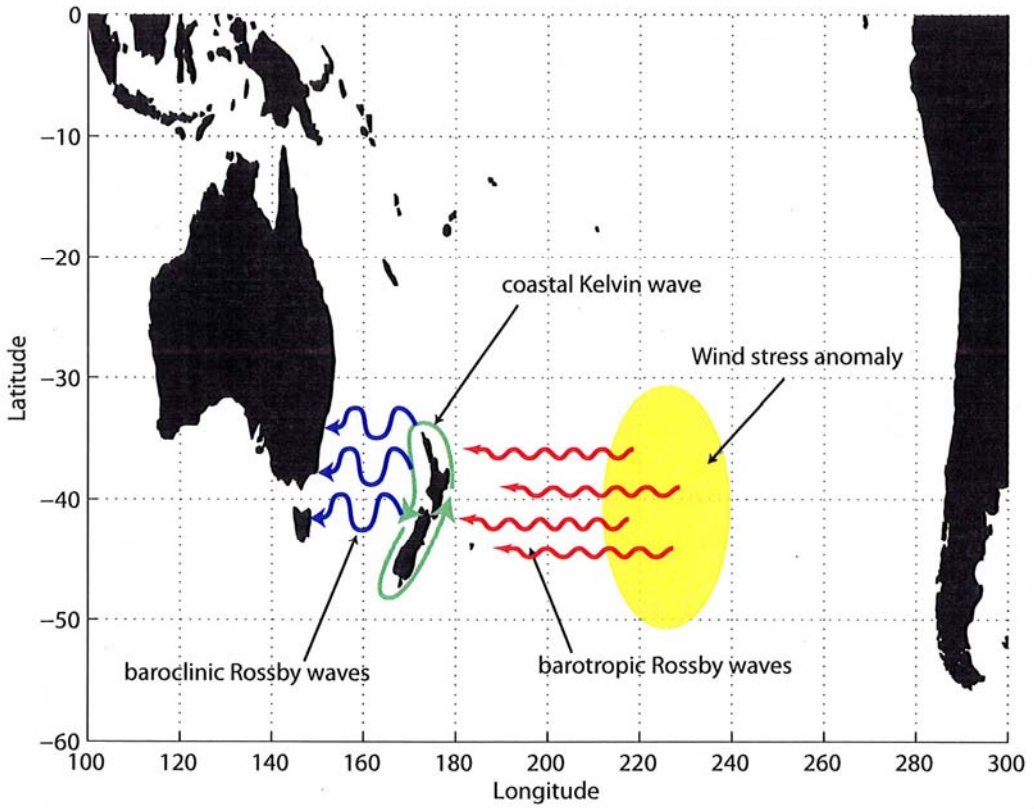
Weak TF



Weak EAC

Strong TF

Barotropic/Baroclinic Mechanism



Potential Barotropic-baroclinic mechanism allowing rapid across basin propagation of signals forced by South Pacific winds

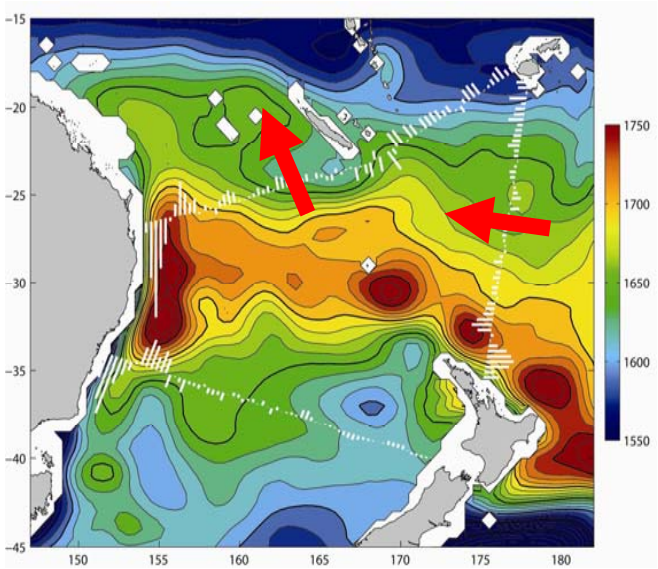
Hill et al, 2010

Other mechanisms

Sasaki et al, 2007

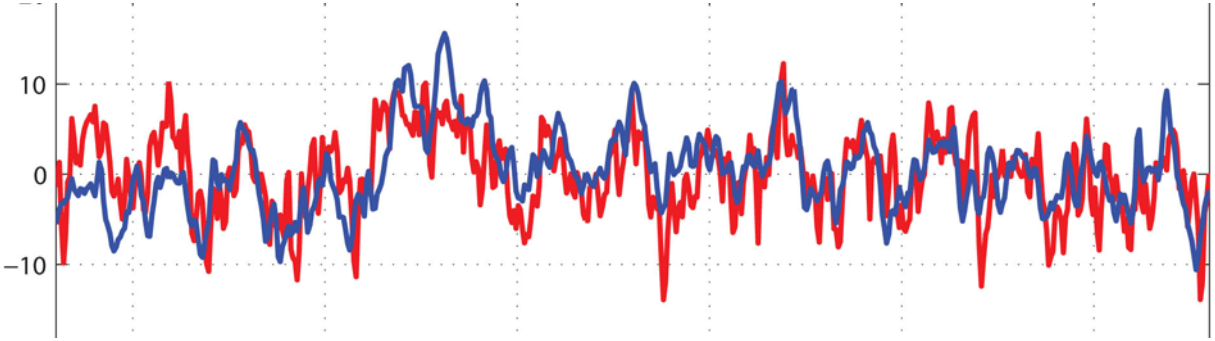
Holbrook et al, 2010

0-5-year signals

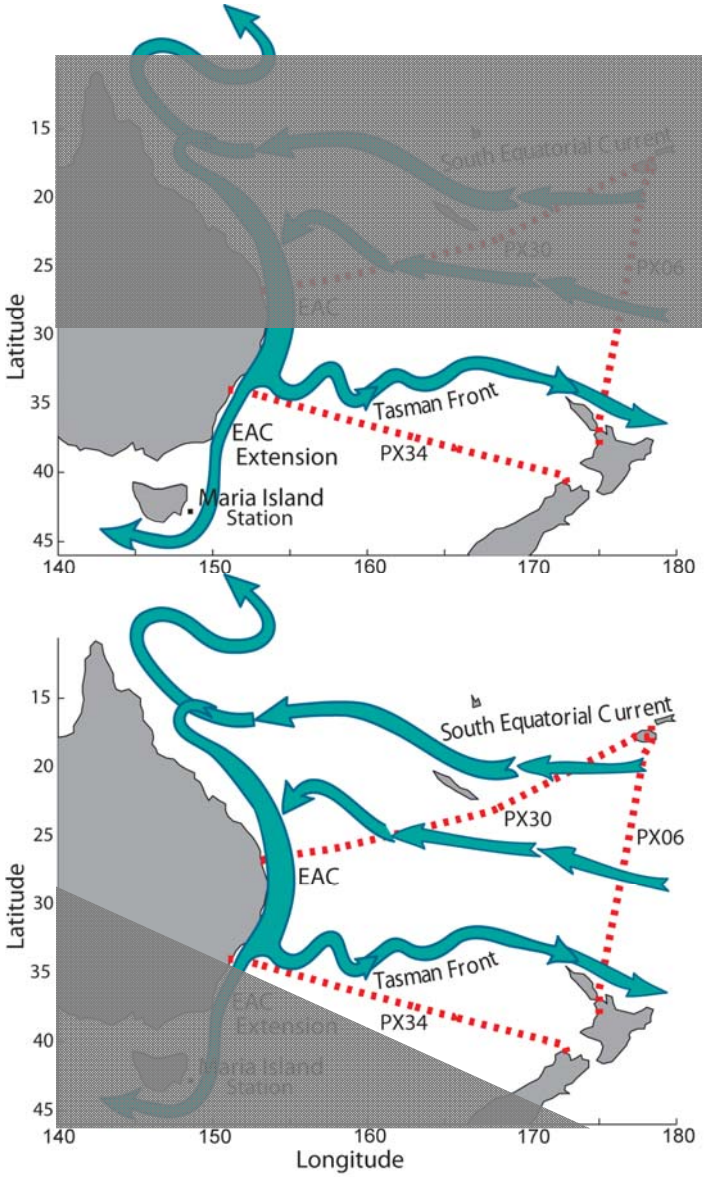


At higher frequencies Tasman Box circulation is predominantly a simple balance between inflow through PX06 and PX30 outflow

- Inner cell of South Pacific Gyre



Summary of Tasman/Coral Sea Current System



> 5 yr
Balance between
EAC Extension & TF

< 5 yr

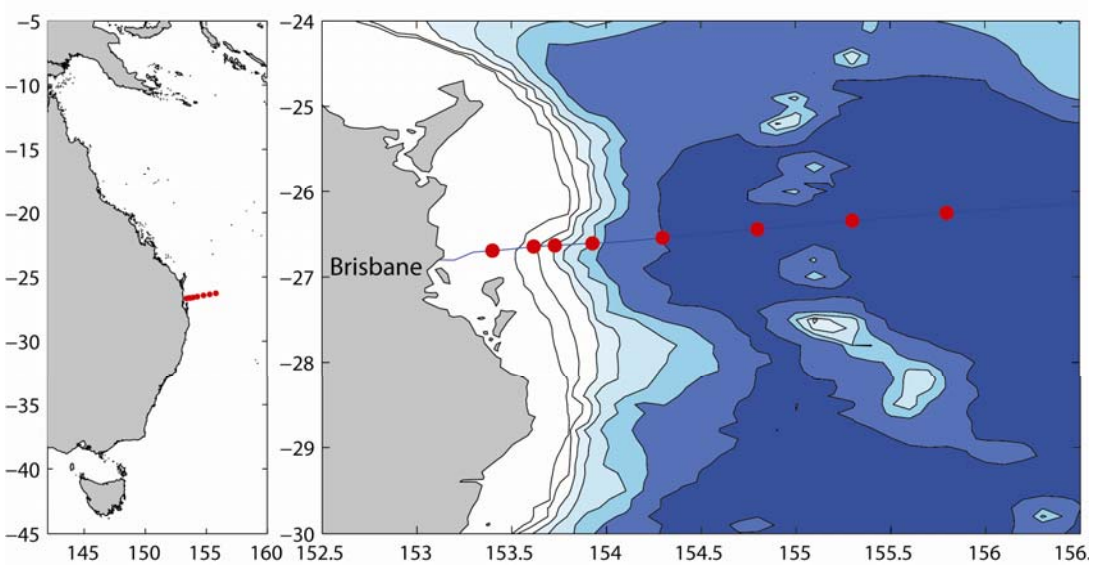
PX06 inflow balances
PX30 outflow
Inner SPG cell

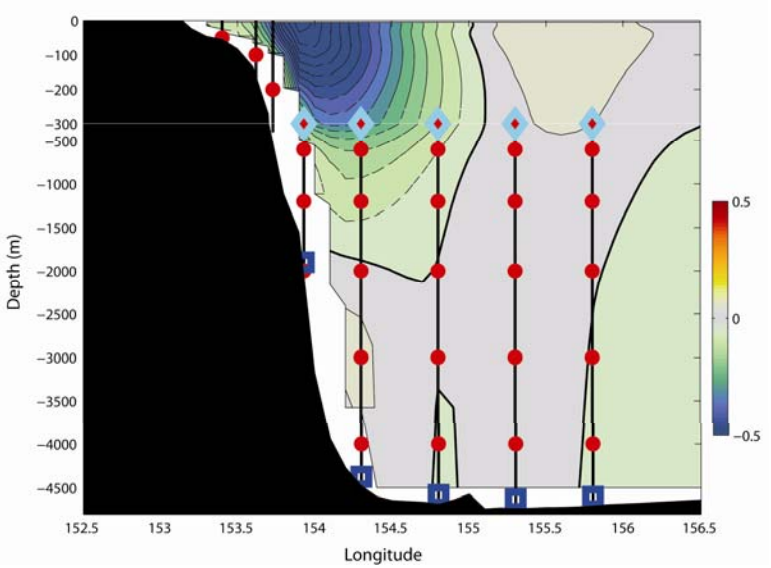
Summary

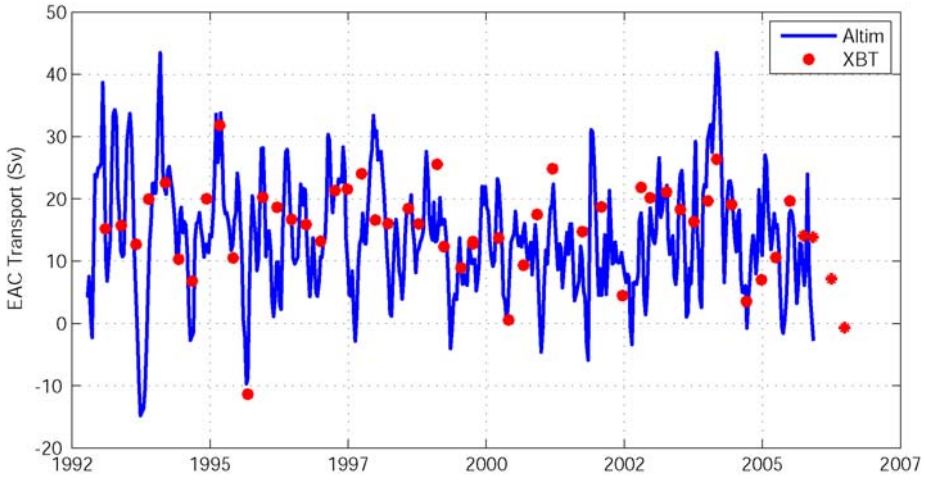
- Combined XBT/Altimetry approach provides 17-year time series of EAC transport
- Tasman Front & EAC Extension are anti-correlated at decadal timescales
- Inner cell of gyre varies at timescales < 5-yrs
- Decadal changes match gyre spin-up and long-term record at Maria Island


Thank you
CSIRO

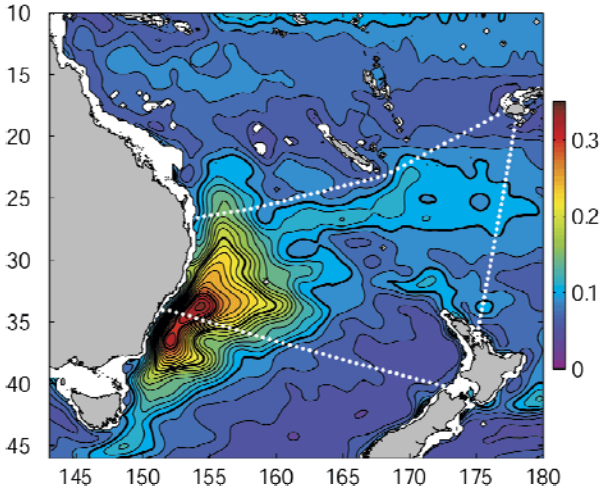
EAC mooring array off Brisbane

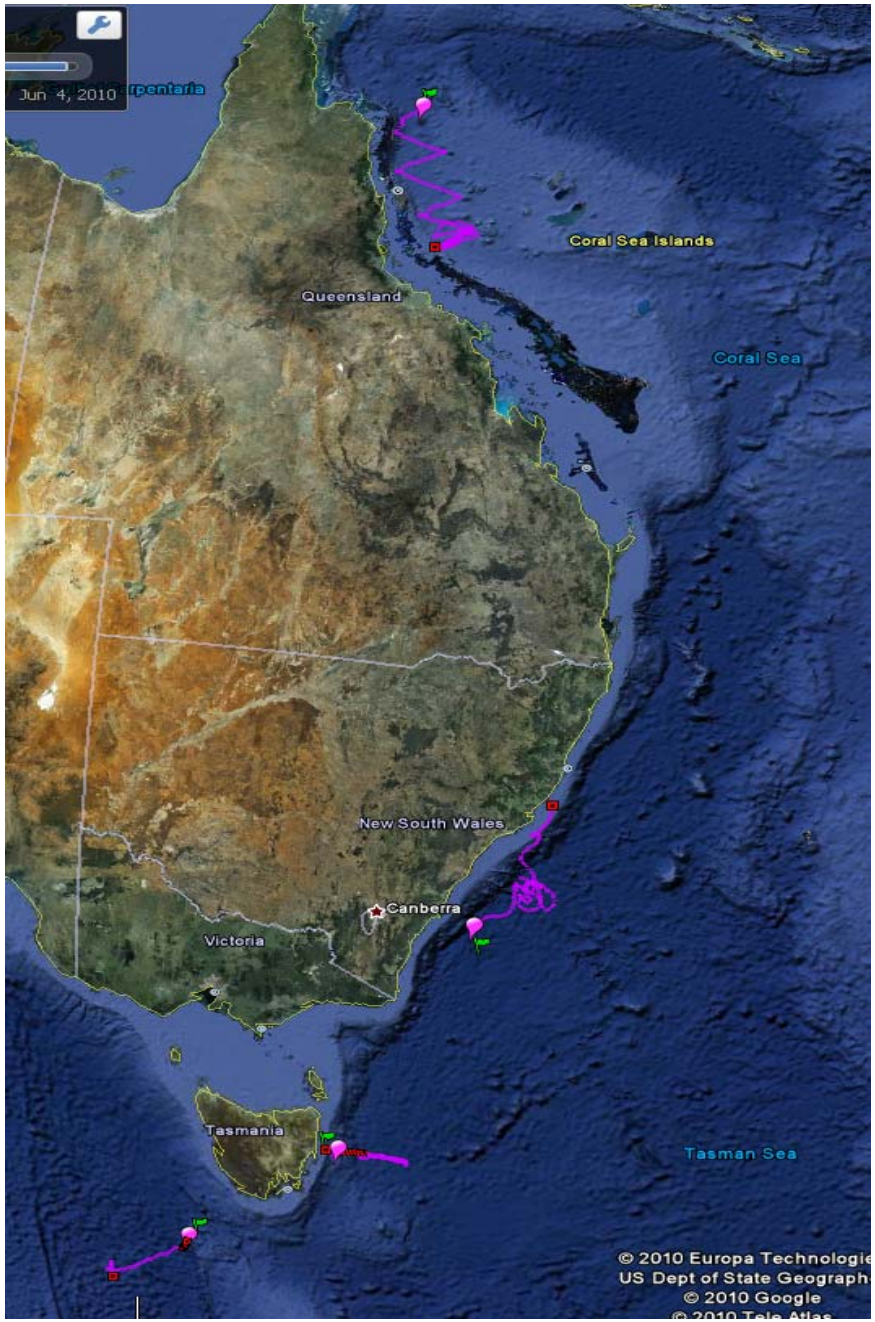






Deployed
April 2012



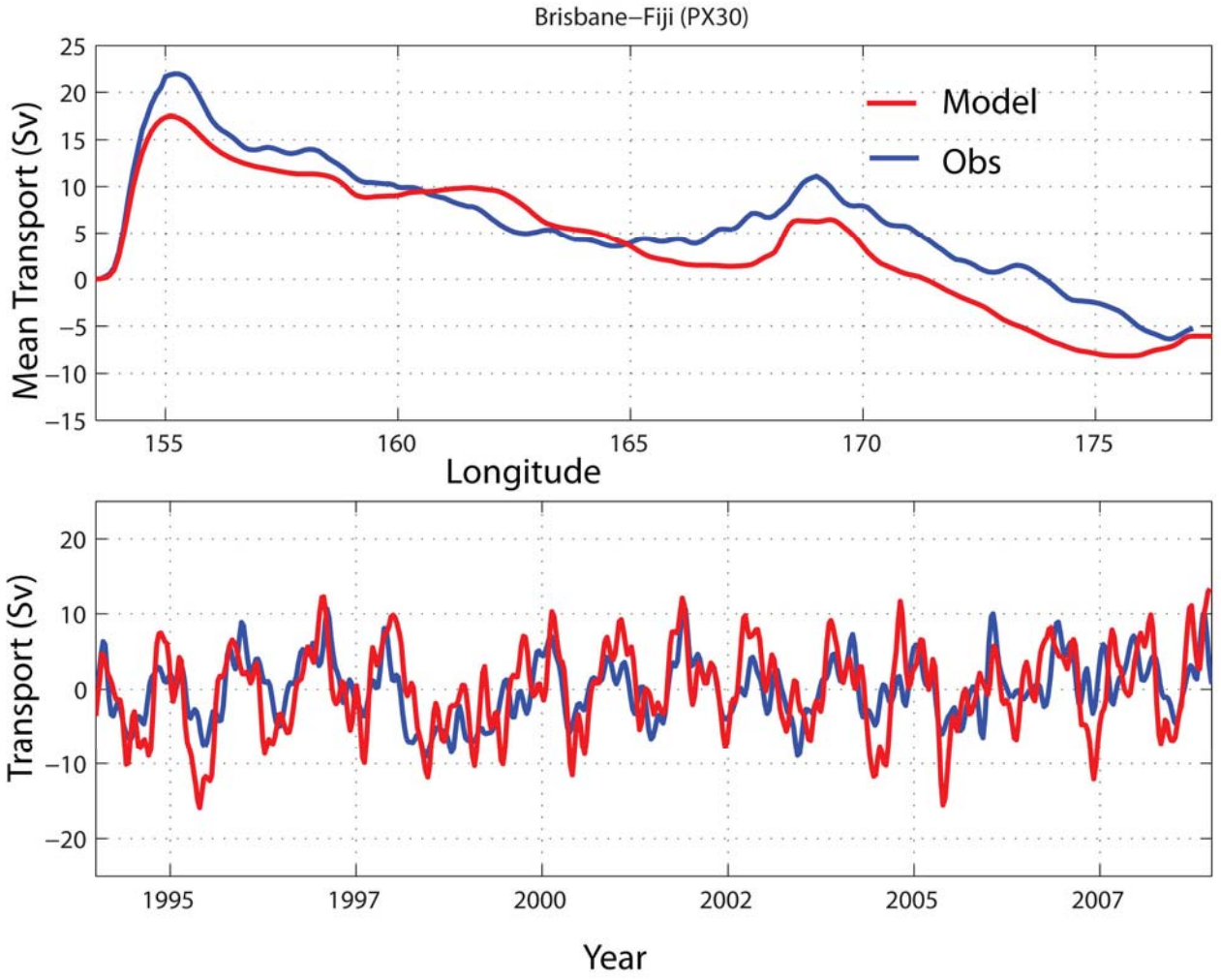


Glider Deployments

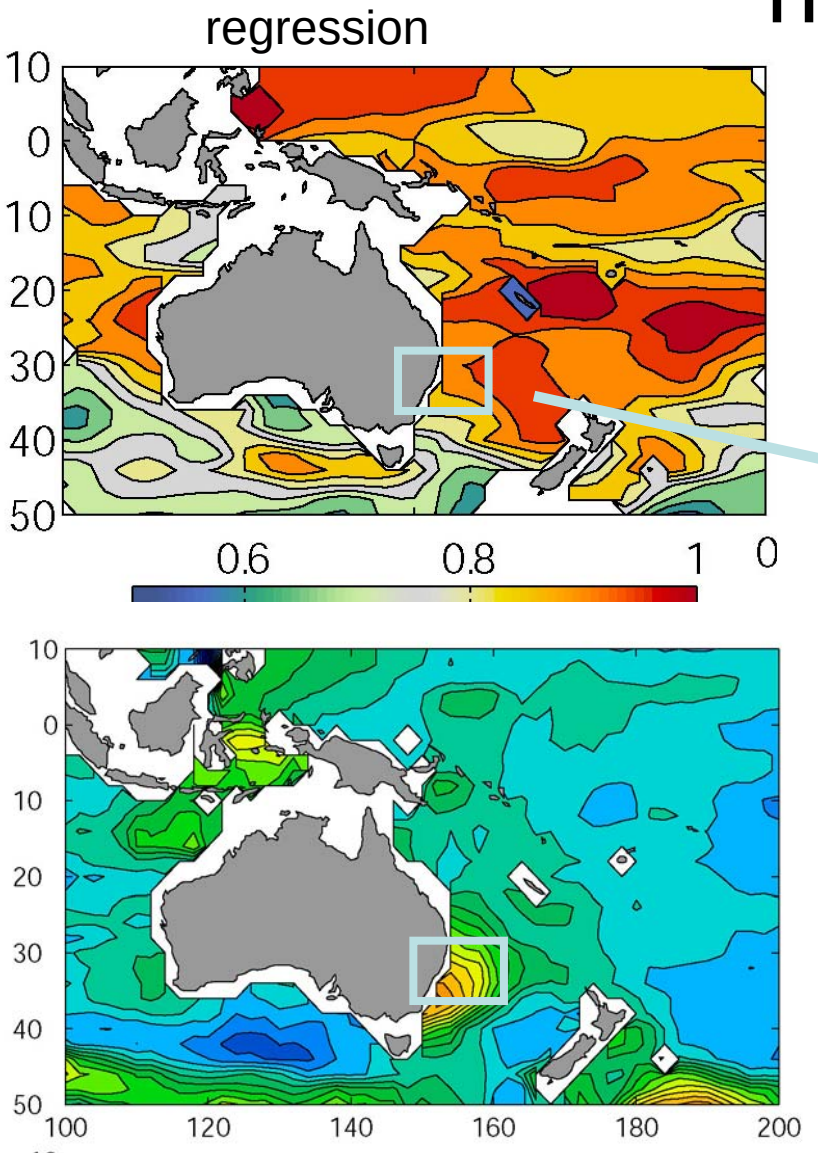
Current Seaglider deployments

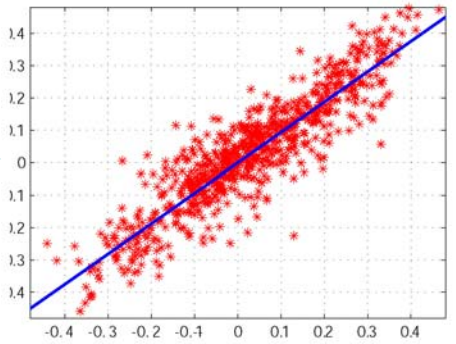
1. Coral Sea – targeting the northward boundary currents (1 deployment)
2. NSW – EAC eddies (4)
3. Eastern Tasmania – EAC Extension (4)
4. Southern Ocean Mooring – Tasman Outflow (2)

http://www2.sese.uwa.edu.au/~hollings/anfog/index.


Brisbane–Fiji (PX30)
Mean Transport (Sv)
25
20
15
10
5
0
−5
−10
−15
155
160
165
170
175
Longitude
Model
Obs
Transport (Sv)
20
10
0
−10
−20
1995
1997
2000
2002
2005
2007
Year

Relationship between in situ & altimeter height

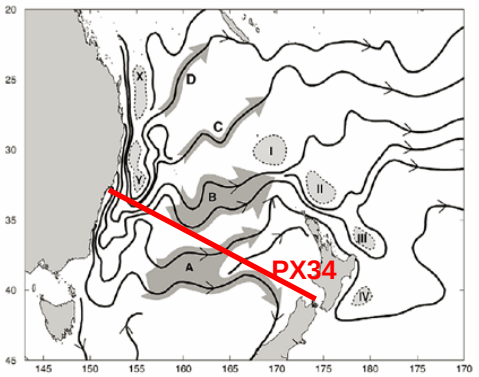


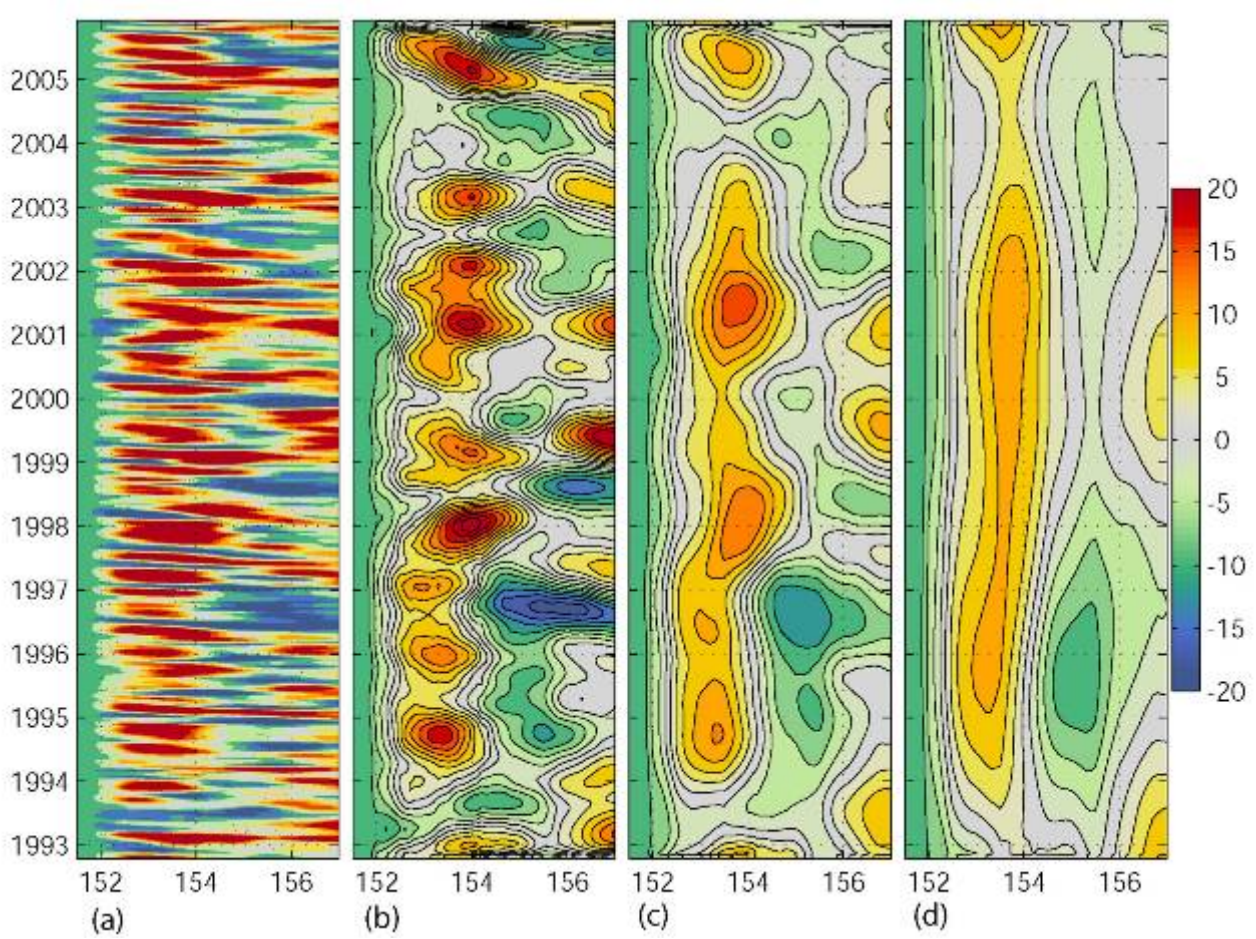


α = 0.934

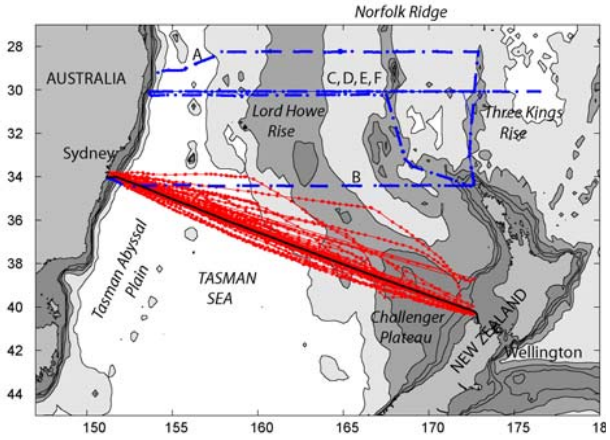
RMS = 0.079-m

Evolution of Mean EAC Flow



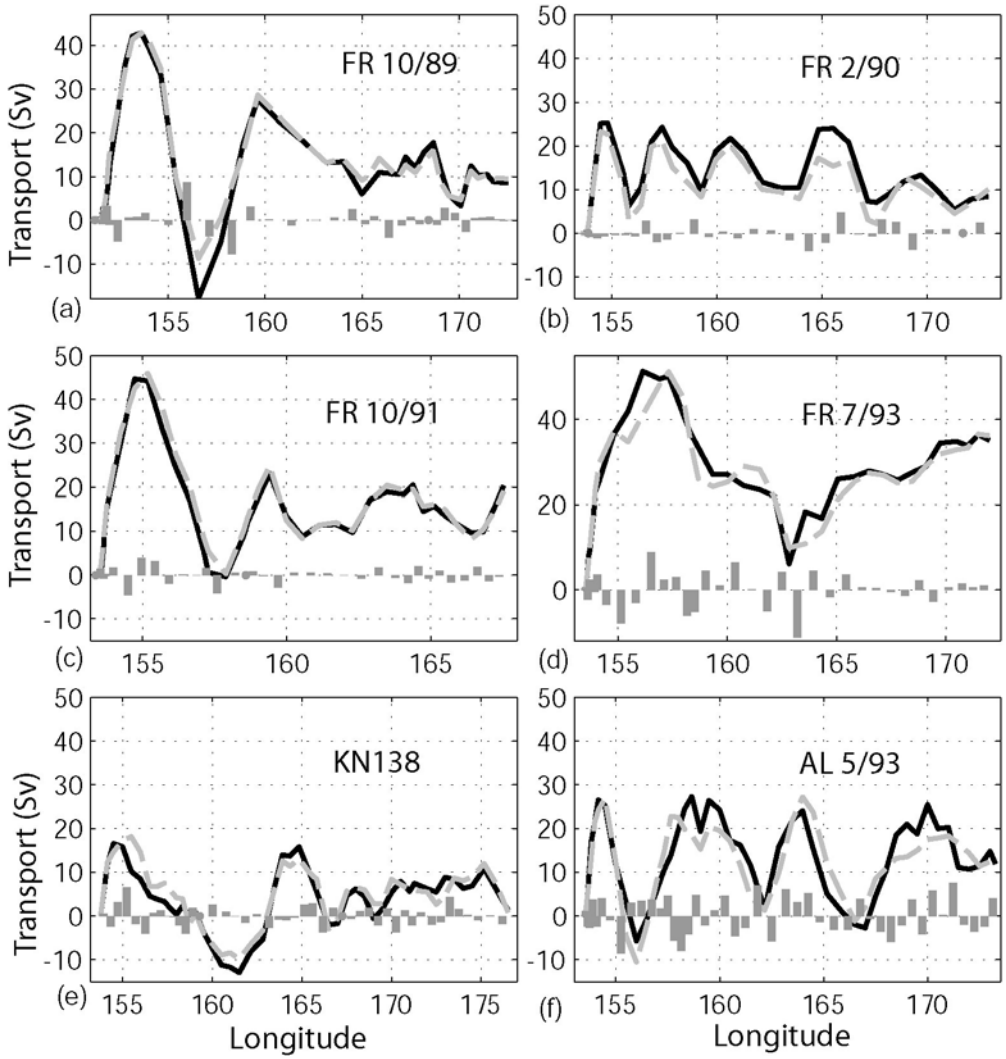


Further comparisons

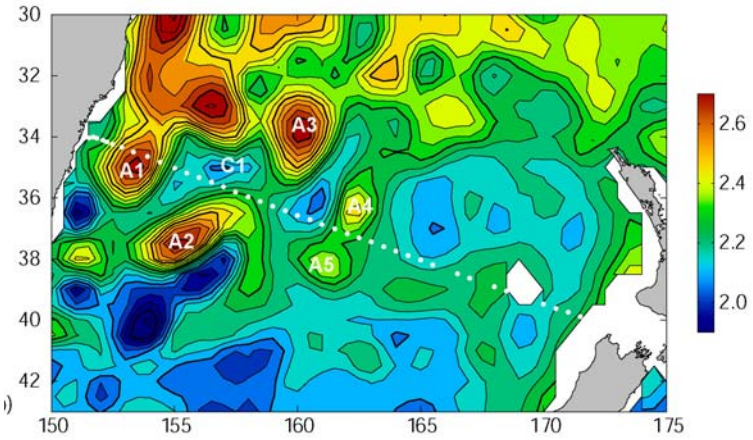


Transport estimated from satellite surface properties alone

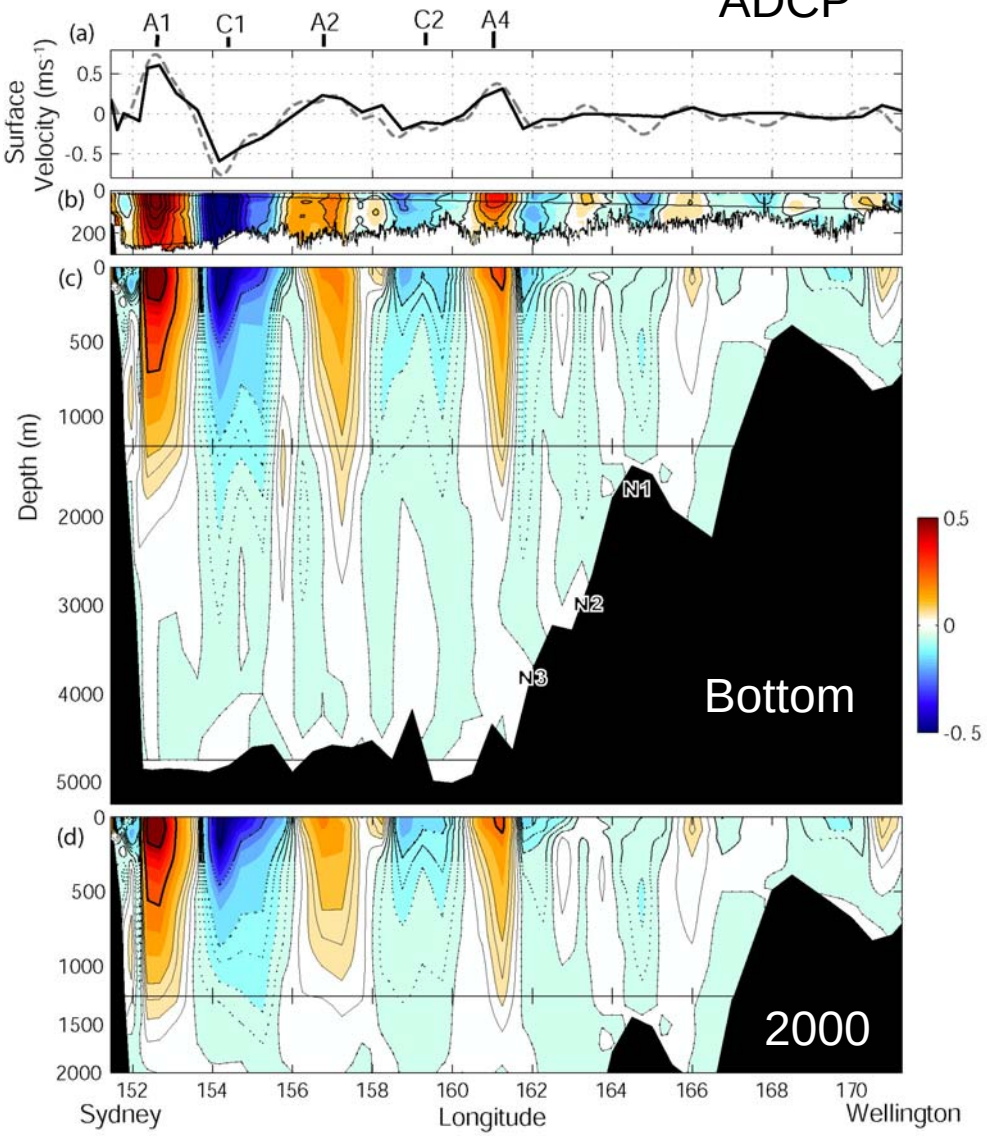
RMS = 4.1-Sv



Geostrophic Velocity Section



ADCP



Eddies resolved using 2000-m reference

Current filaments on LHR are missed