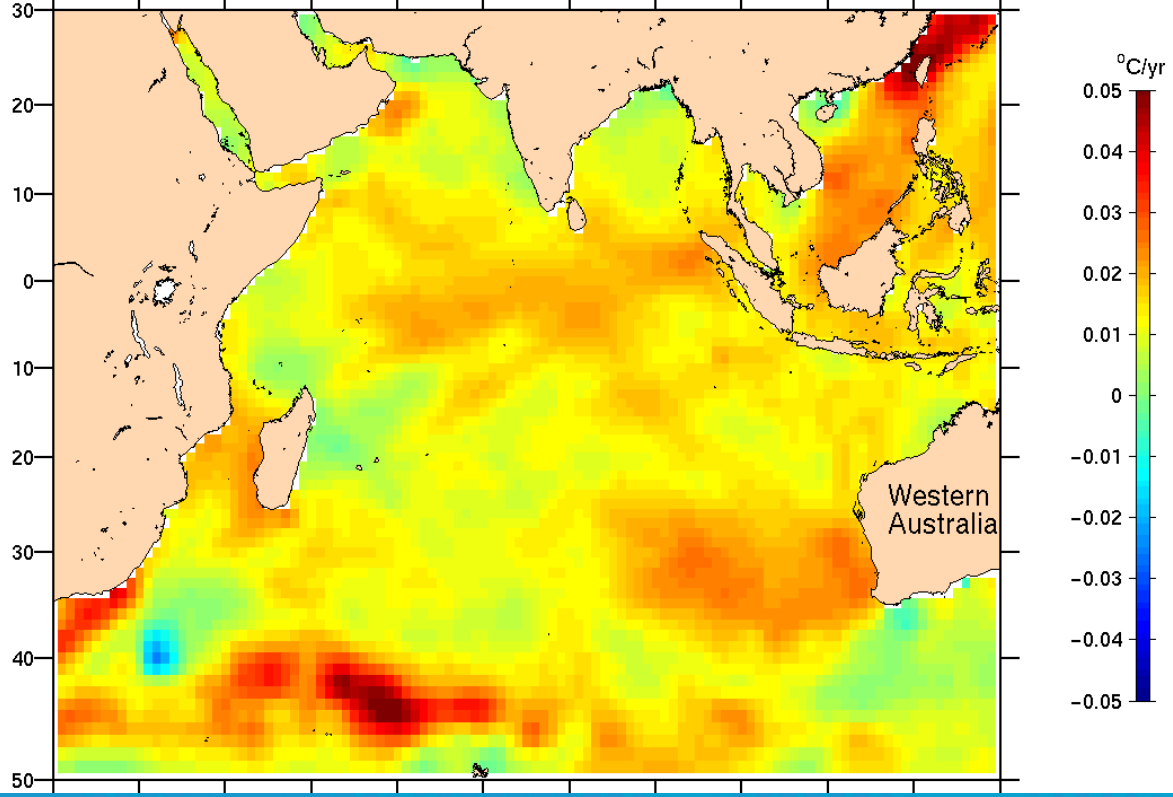


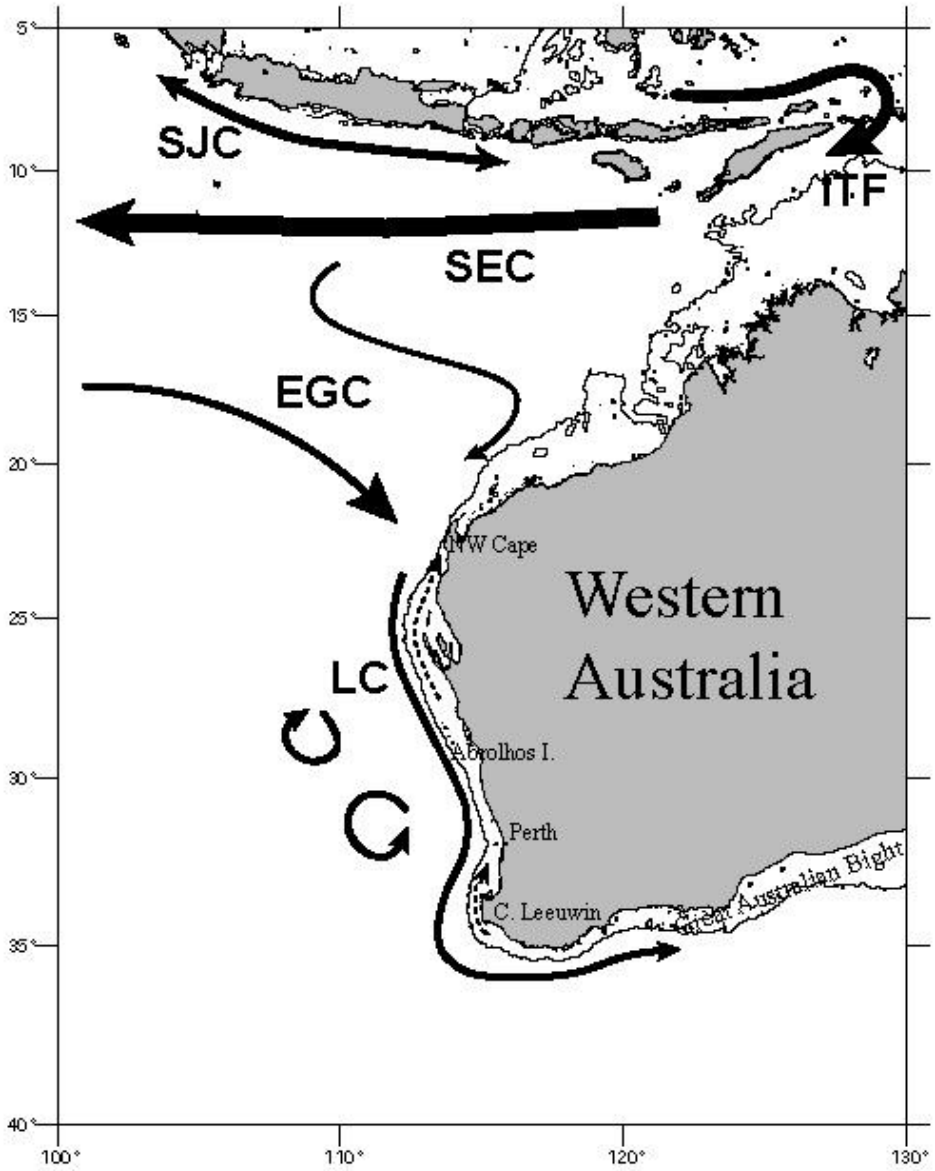
www.csiro.au

Variability and trend of the heat balance in the southeast Indian Ocean

Ming Feng, CSIRO Marine & Atmospheric Research
Arne Biastoch, Claus Böning, Leibniz-Institut für Meeresforschung
Nick Caputi, Department of Fisheries, Western Australia
Gary Meyers, University of Tasmania

CSIRO

Regional Currents in the southeast Indian Ocean



ITF – Indonesian Throughflow

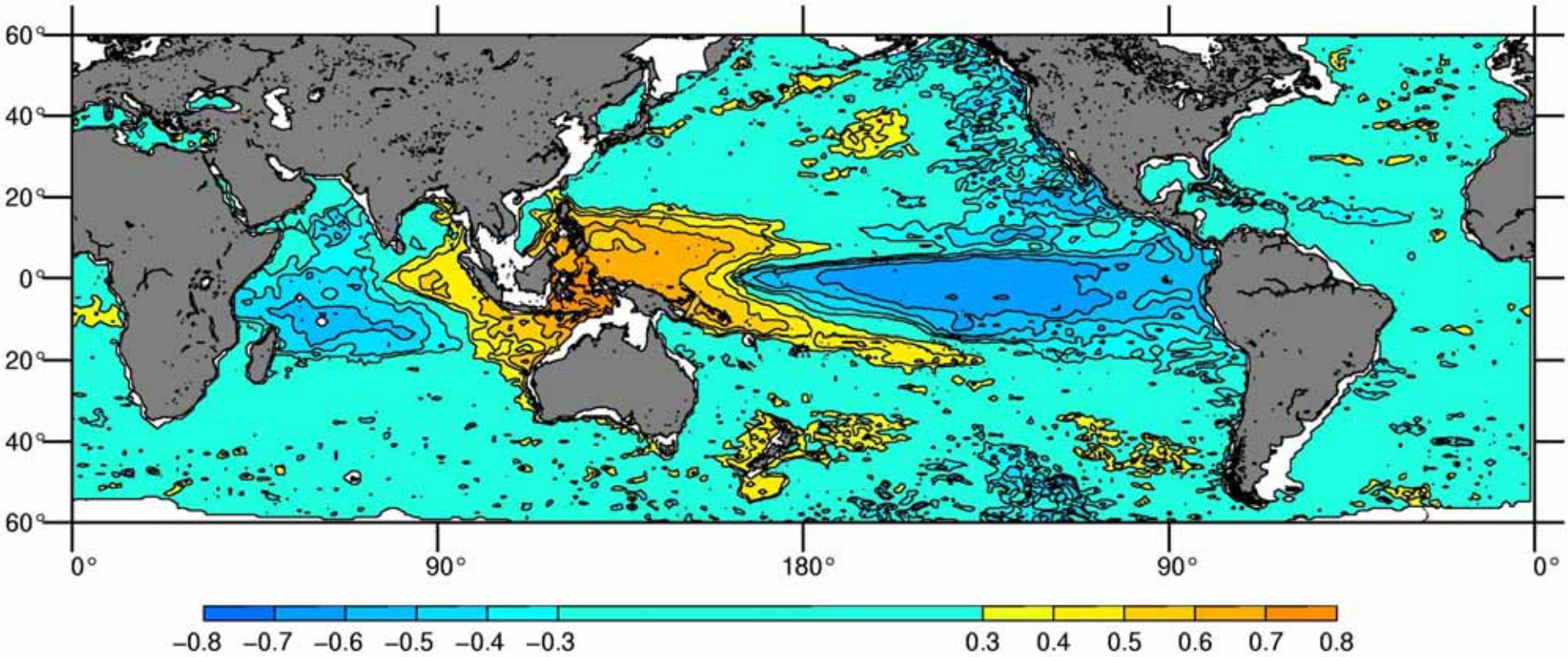
SEC – South Equatorial Current

SJC – South Java Current

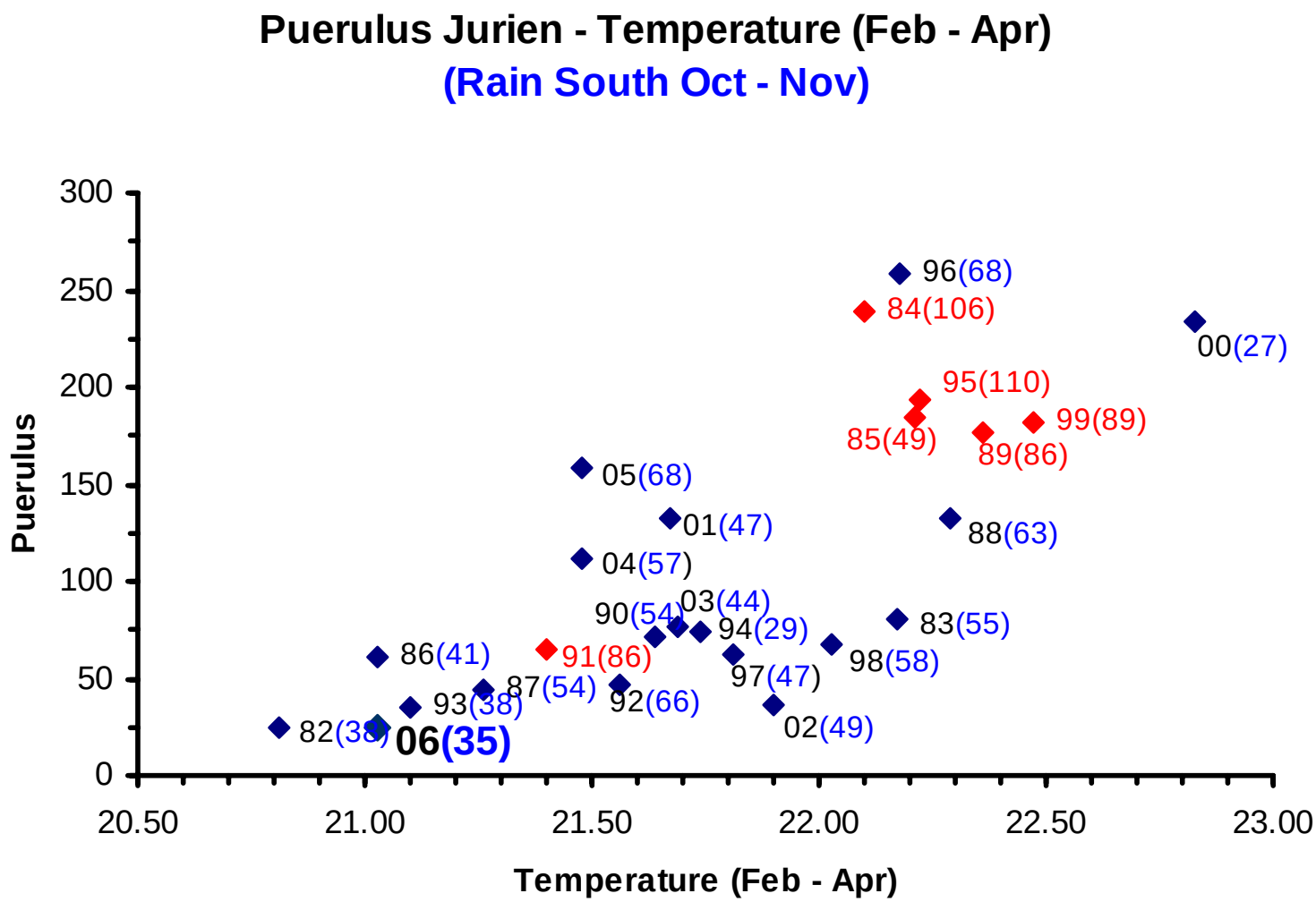
EGC – Eastern Gyral Current

LC – Leeuwin Current

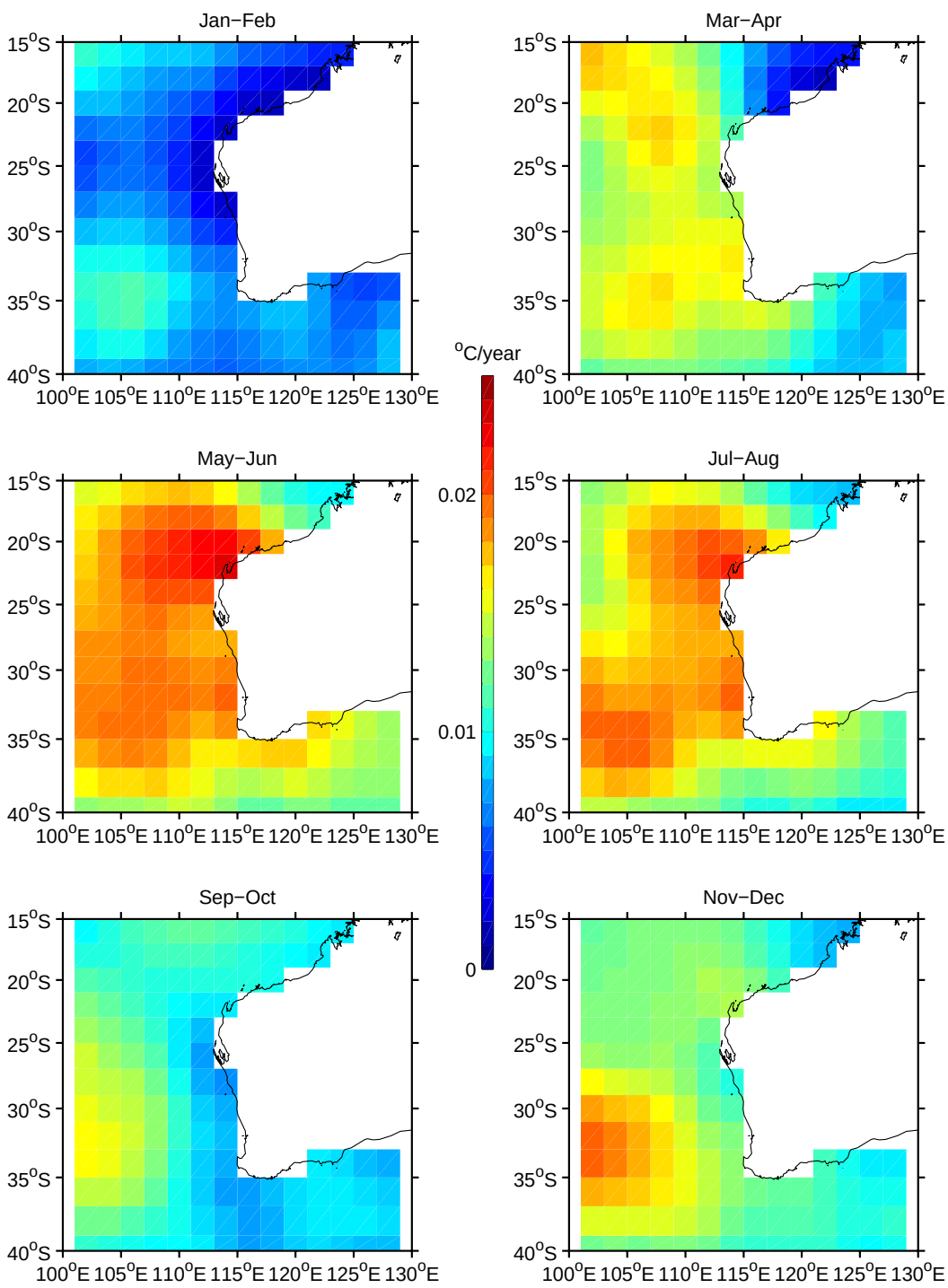
Correlation between SOI and altimeter sea level anomalies



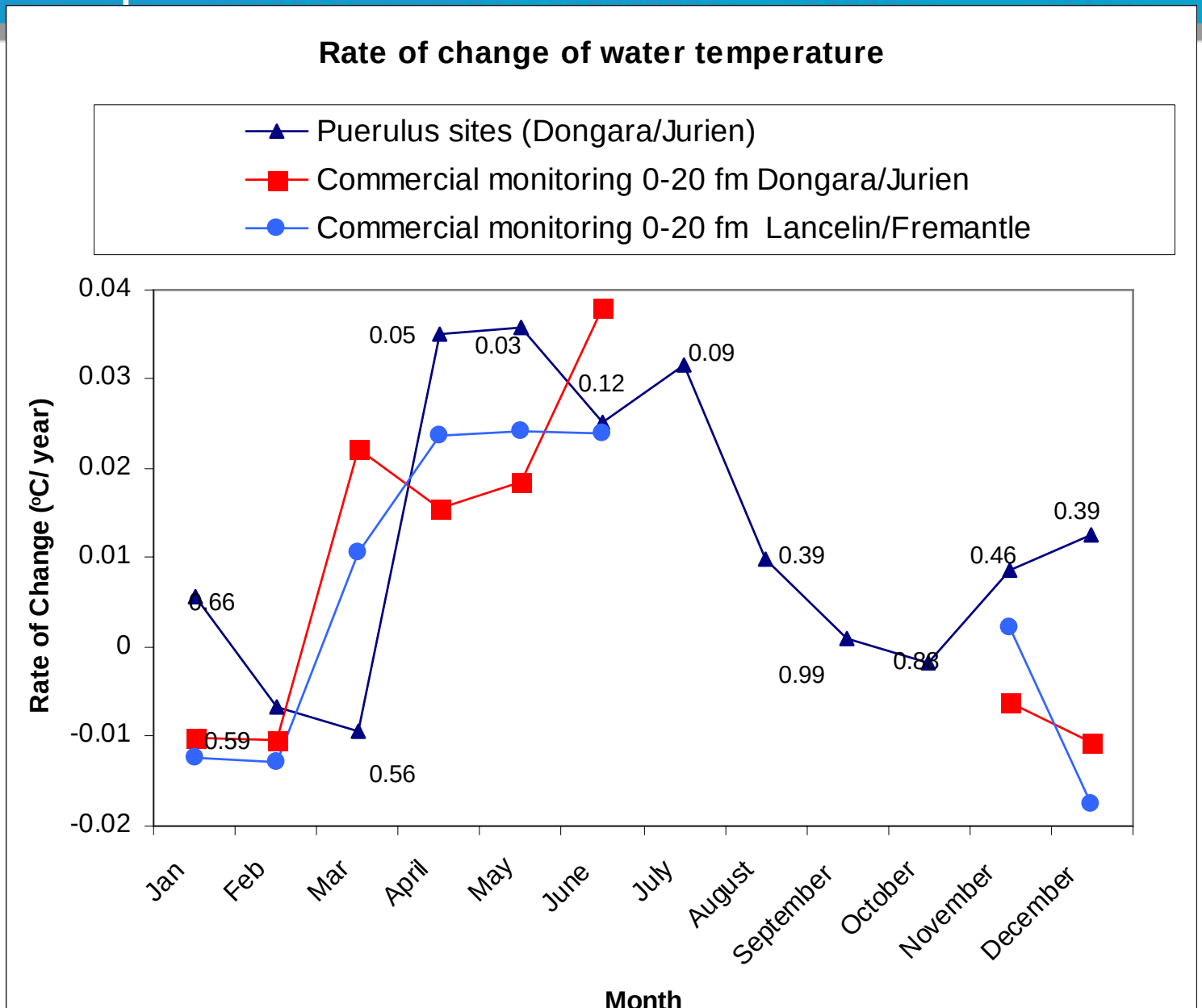
Relationship between rock lobster larvae (Puerulus) settlement and sea surface temperature



Bimonthly trend in ERSST



Temperature trends on the shelf since 1971



ORCA025 model

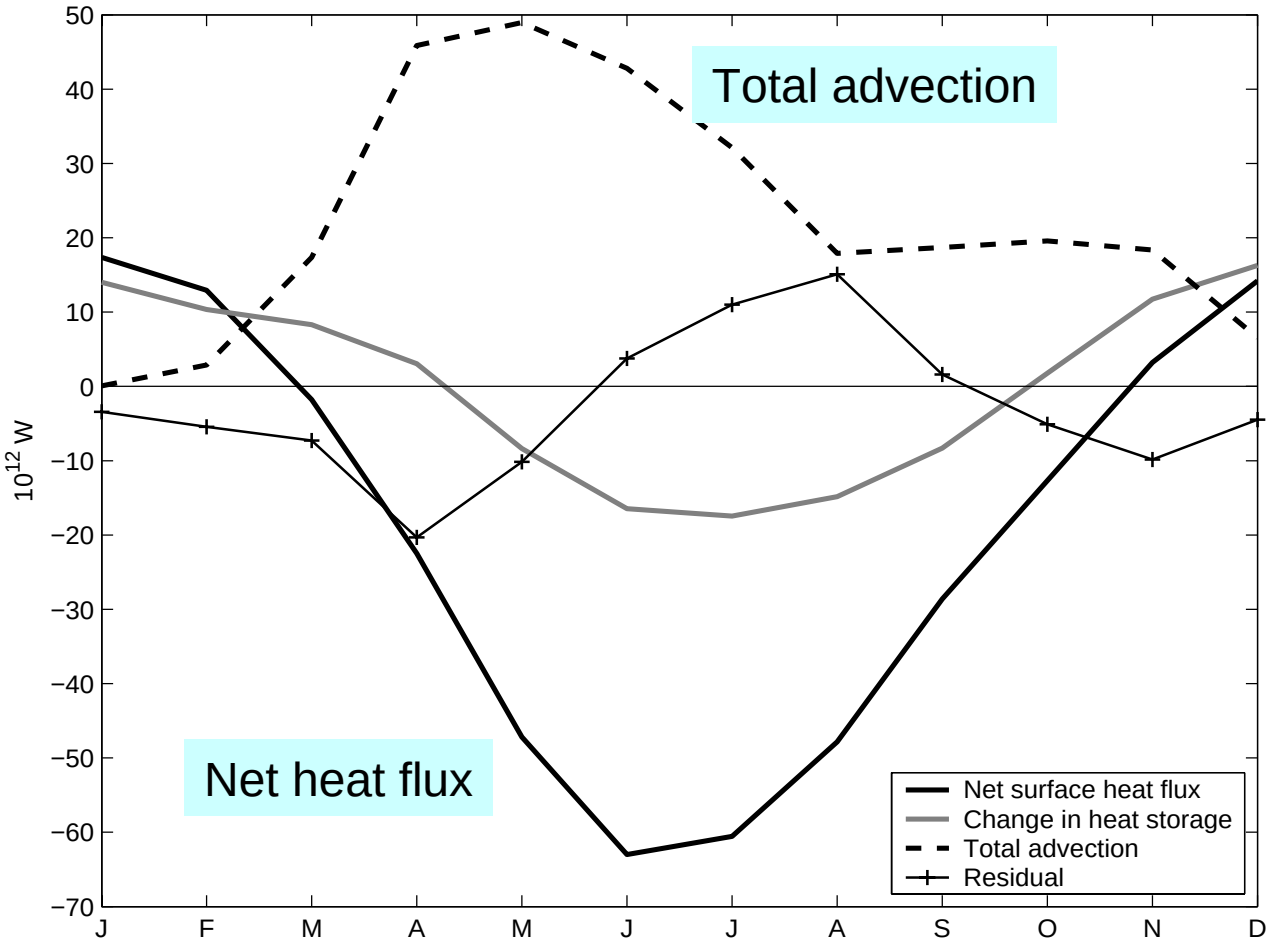
- Global ¼ degree horizontal resolution
- 6 m vertical resolution near surface, 20 layers in the upper 500 m
- Surface forcing based on bulk forcing methodology (Large and Yeager 2004) according to “CORE” protocol

- CORE: Co-ordinated Ocean-Ice Reference Experiments

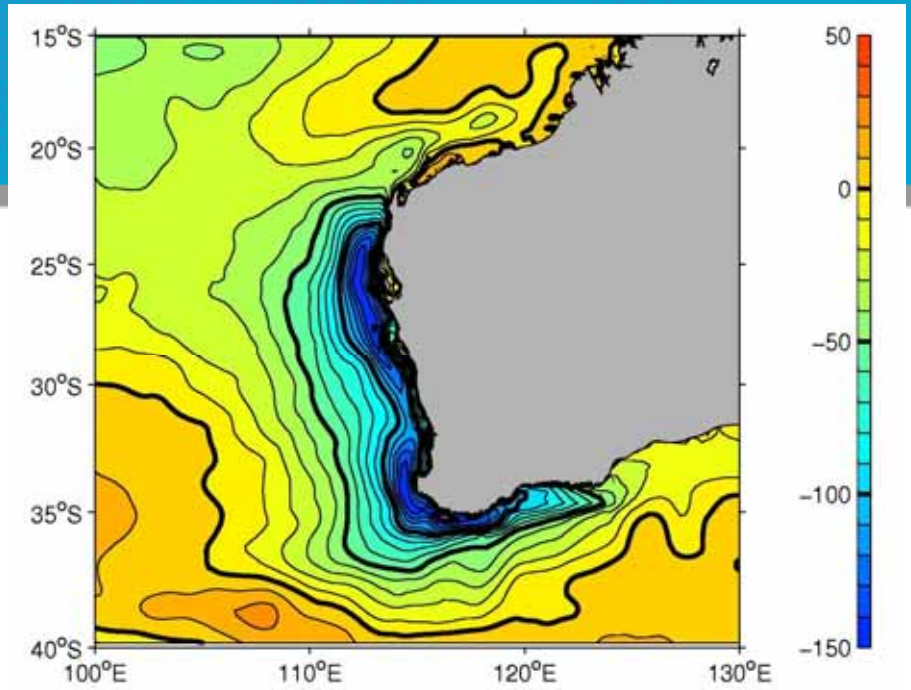
- Monthly output during 1960-2004

Monthly heat balance during 1990-2004

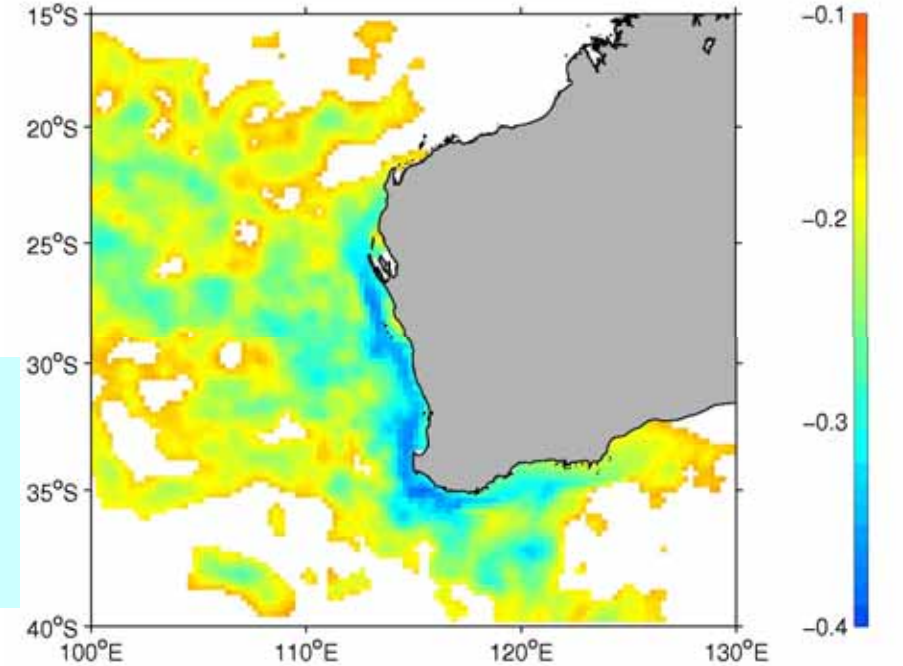
Dominantly balanced by LC advection and surface heat loss



Mean air-sea heat flux

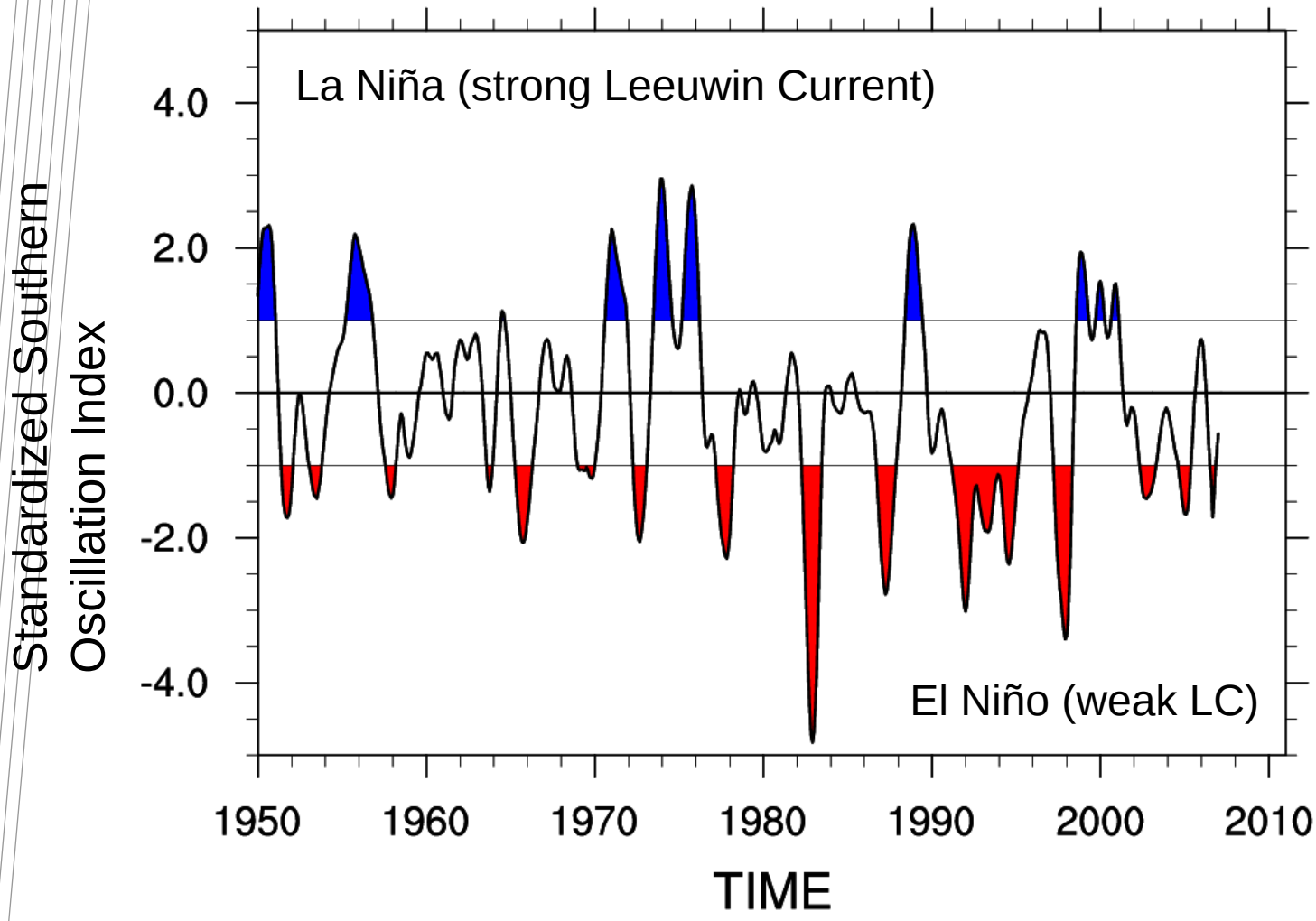


Correlation of heat flux anomaly with SOI



On interannual time scale, variation of heat balance is dominated by the advection and air-sea flux

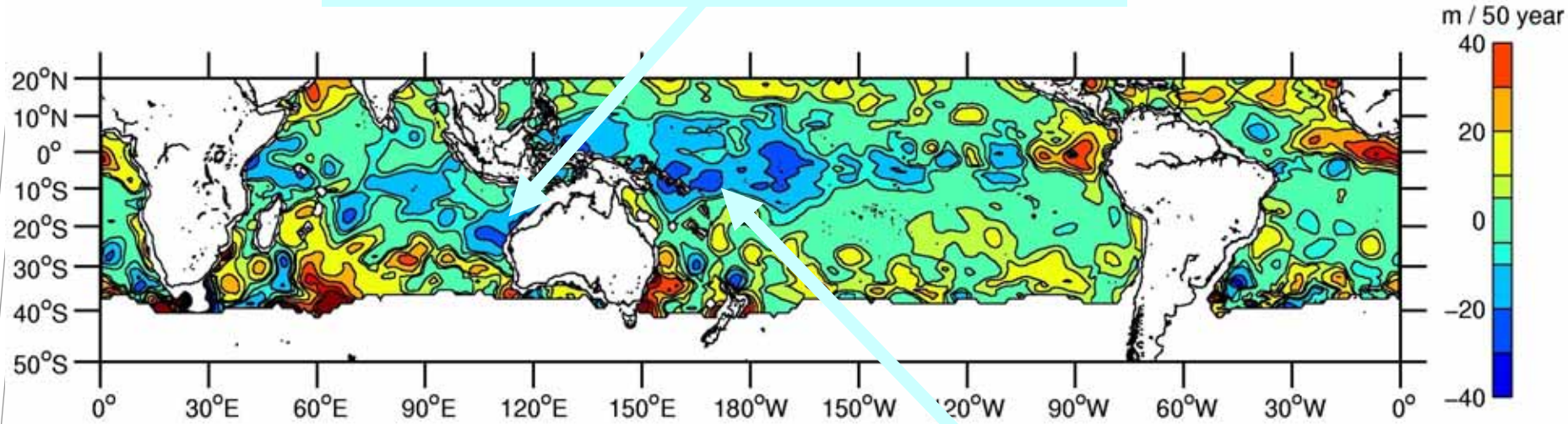
A sudden change in the climate of tropical Pacific during mid-1970s



There are more frequent and stronger El Niño events after the mid-1970s

Linear Trends of the Thermocline (14°C isotherm) Depths

Shallow thermocline anomalies are transmitted into the East Indian Ocean

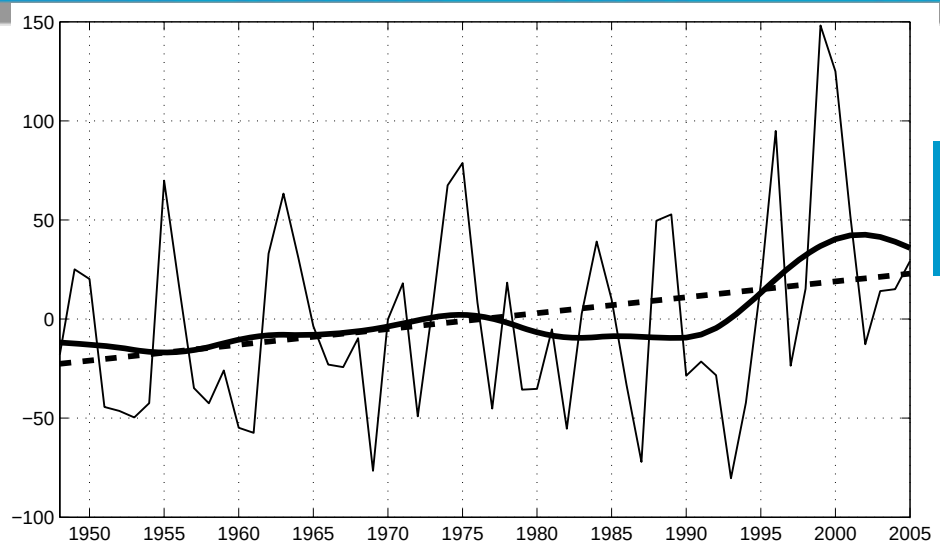


Reduction of meridional pressure gradient, which is the driving force of the Leeuwin Current

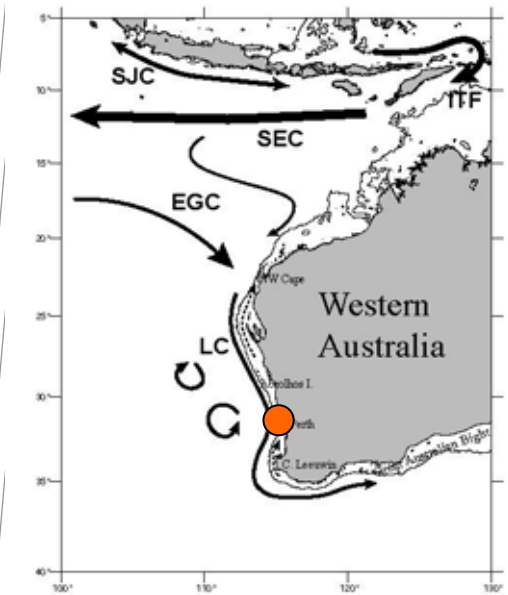
Thermocline becomes shallower in the western Pacific

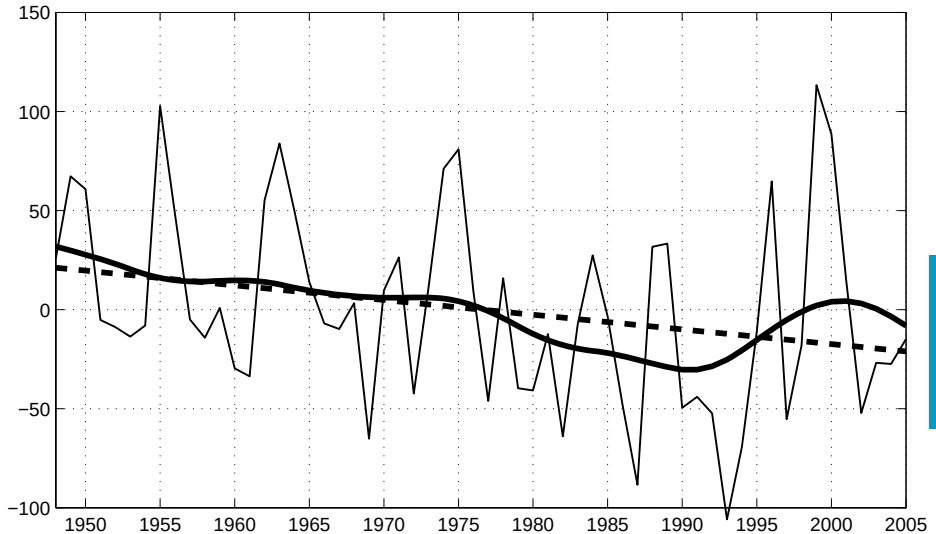
CSIRO

Trends in Fremantle Sea Level during 1948-2005



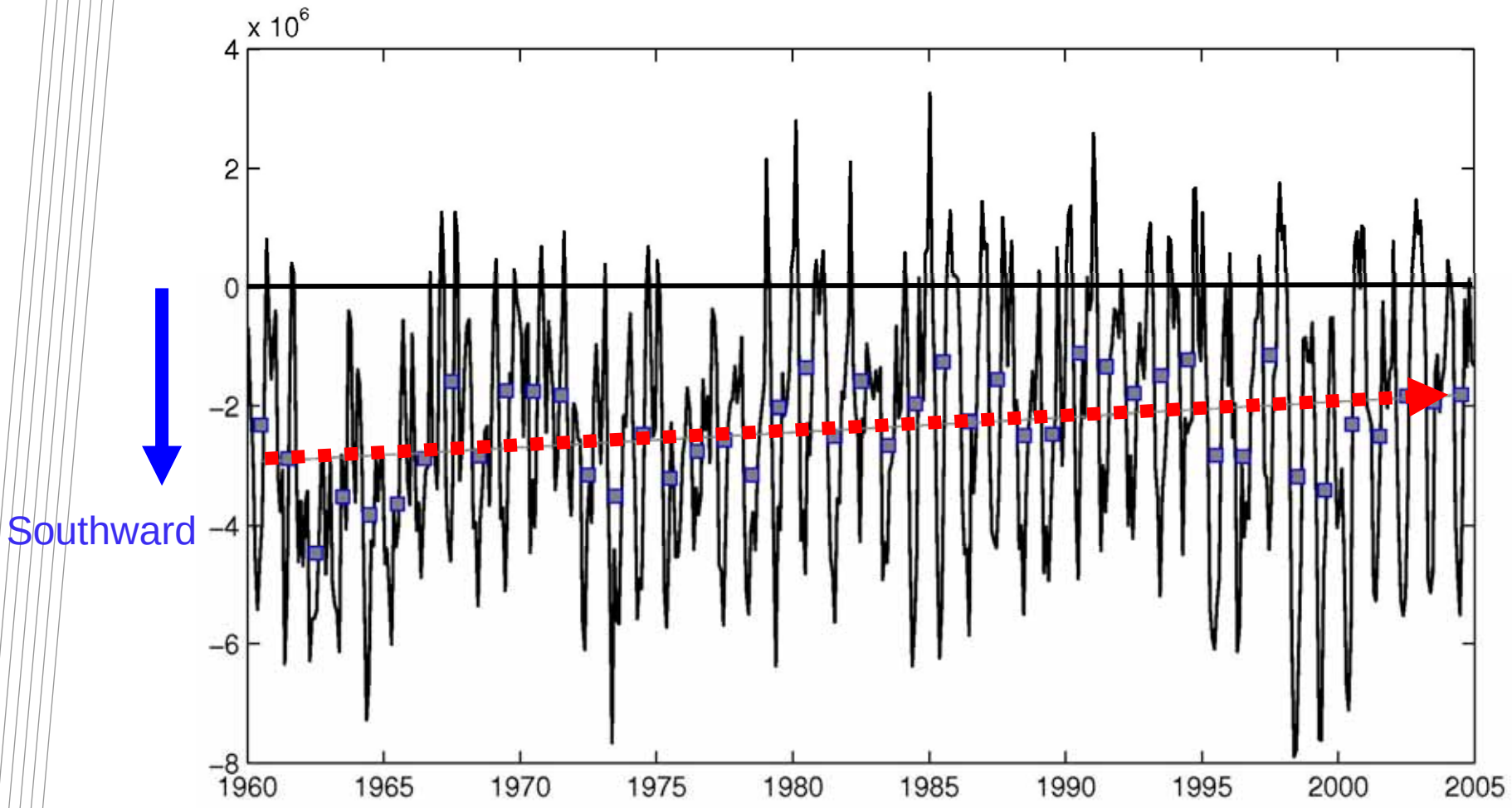
Original data



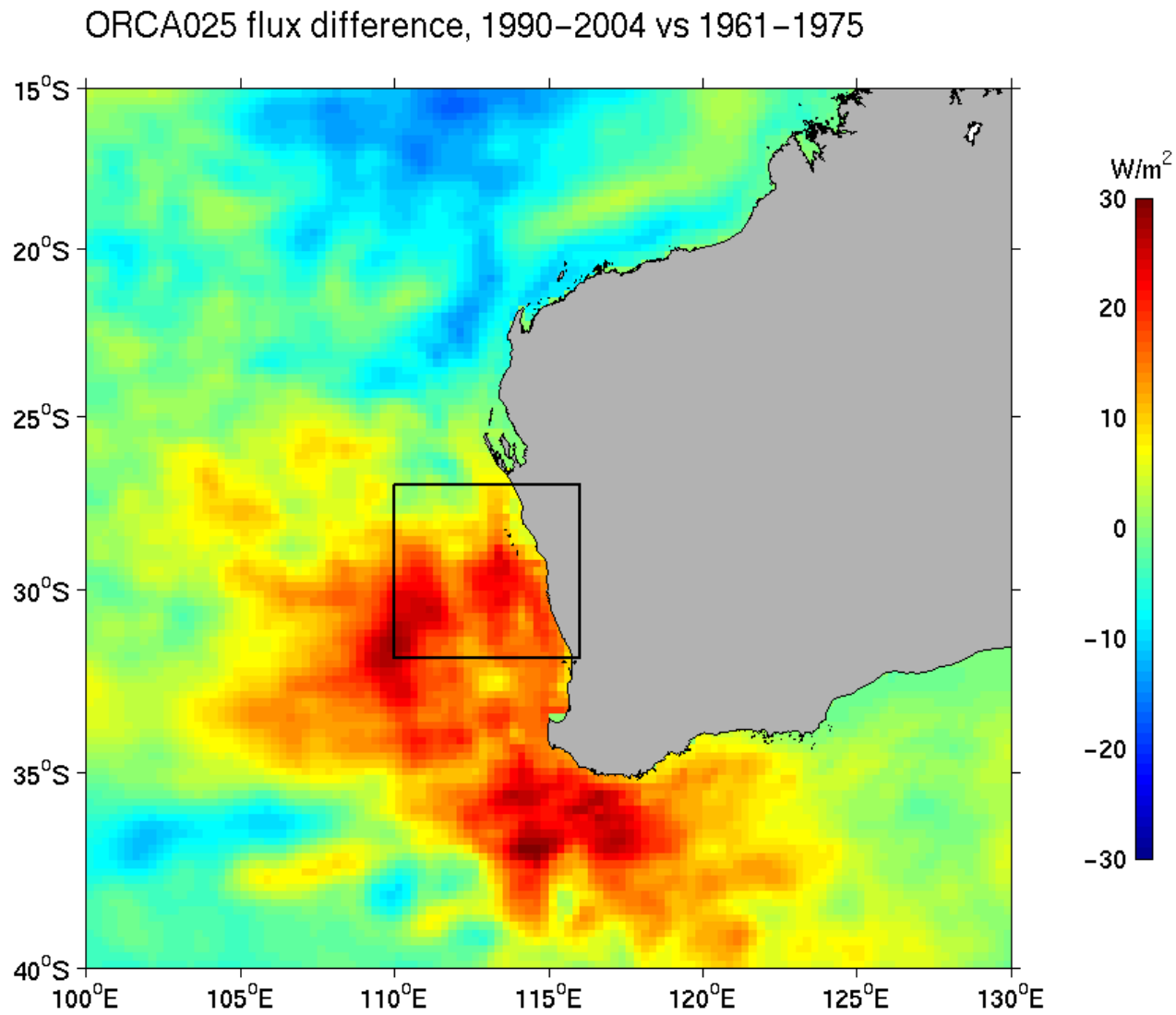


Removing a 1.54 mm/year trend

ORCA025 Modelled volume transport of the Leeuwin Current during 1960-2004 (off Perth)

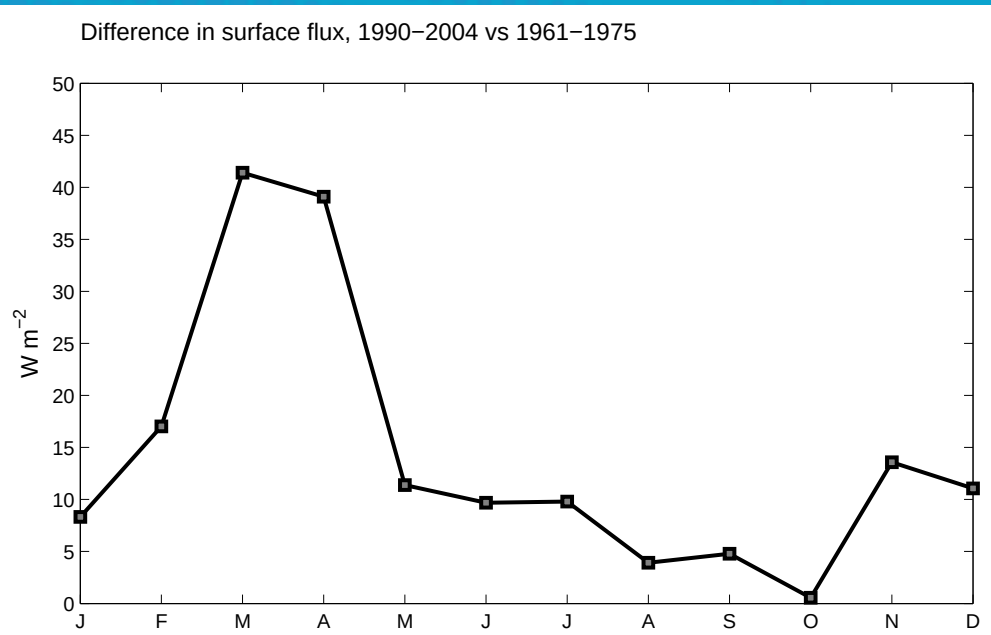


Difference in next heat flux 1990-2004 vs 1961-1975 in ORCA 025

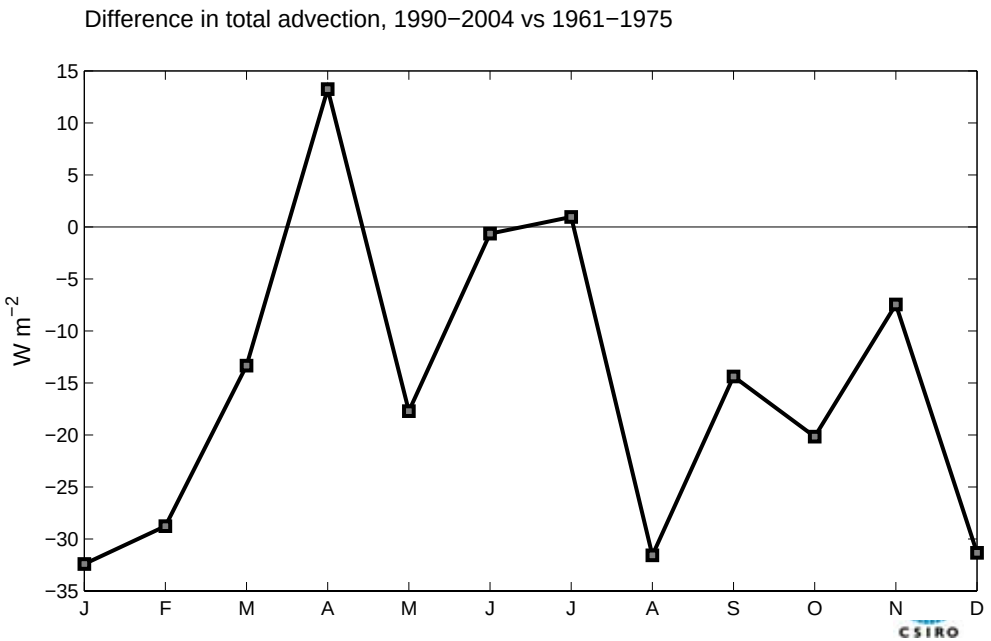


Differences in heat balance 1990-2004 vs 1961-1975

- Net surface heat flux



- Total advection



Summary

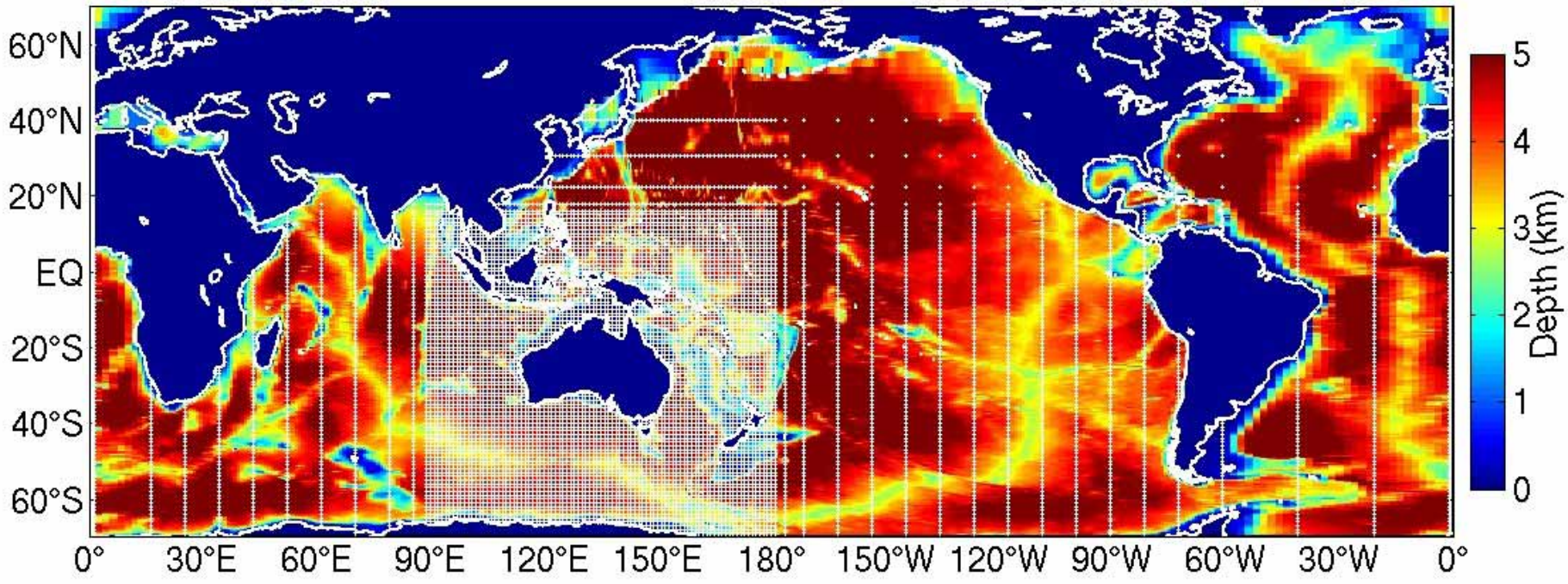
- Enhanced surface warming trend off lower west coast of WA, with the largest warming trend occurring during the austral winter

- The heat budget in the Leeuwin Current is mainly balanced by the two dominant terms: the Leeuwin advection and air-sea heat loss

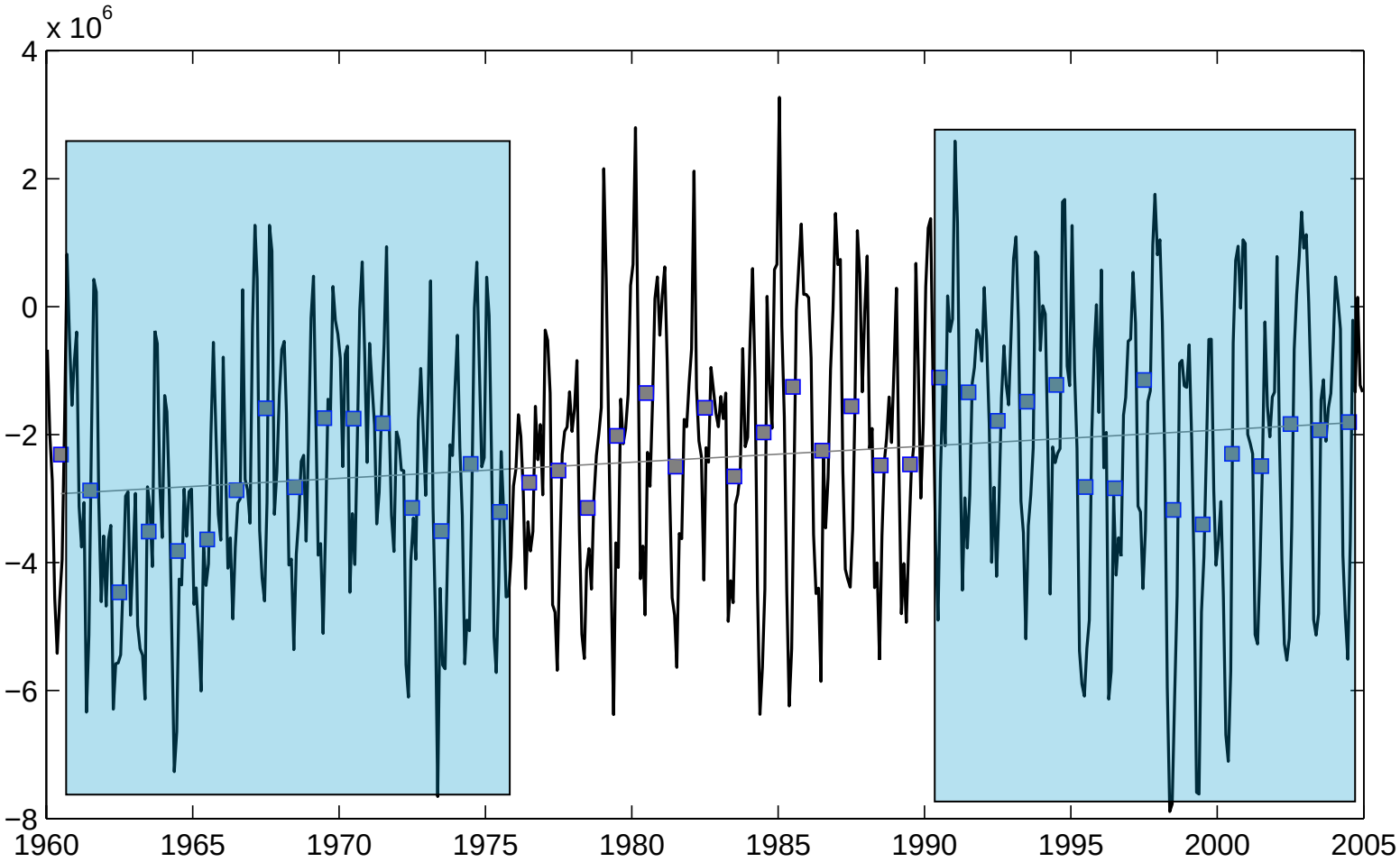
- Reduction of the Leeuwin Current transport, as derived from the ORCA025 model simulation, is responsible for the seasonal changes in the warming trend

- Predict the future changes in the ENSO characteristics is crucial to downscale the climate change impact in the region

Ocean Forecast Australia Model (OFAM) domain (10 km resolution around Australia)

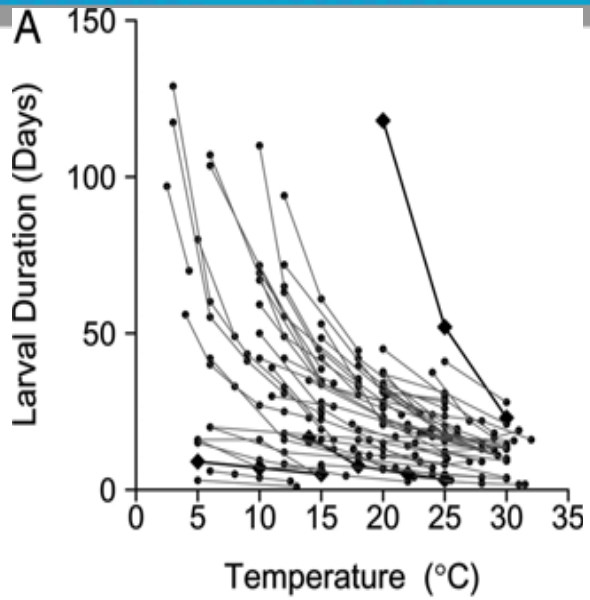


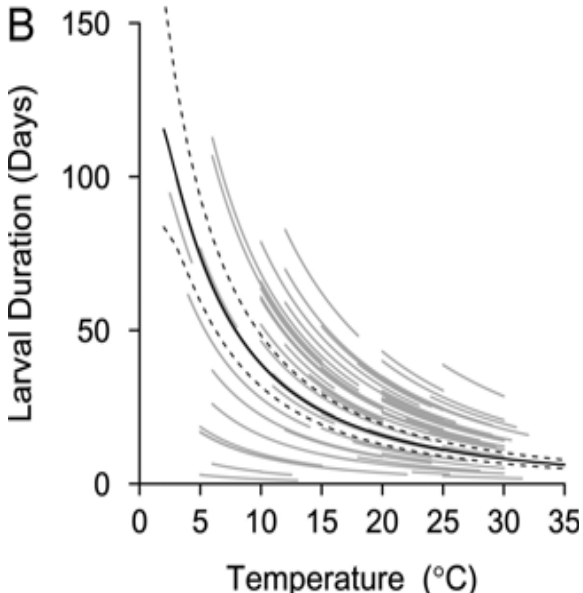
Volume transport of the Leeuwin Current from ORCA025 during 1960-2004



Potential impact: increased temperature

Shortened larval duration and increased survival rate?





O'Connor, 2007

CSIRO Marine & Atmospheric Research
Western Australian Marine Science Institution

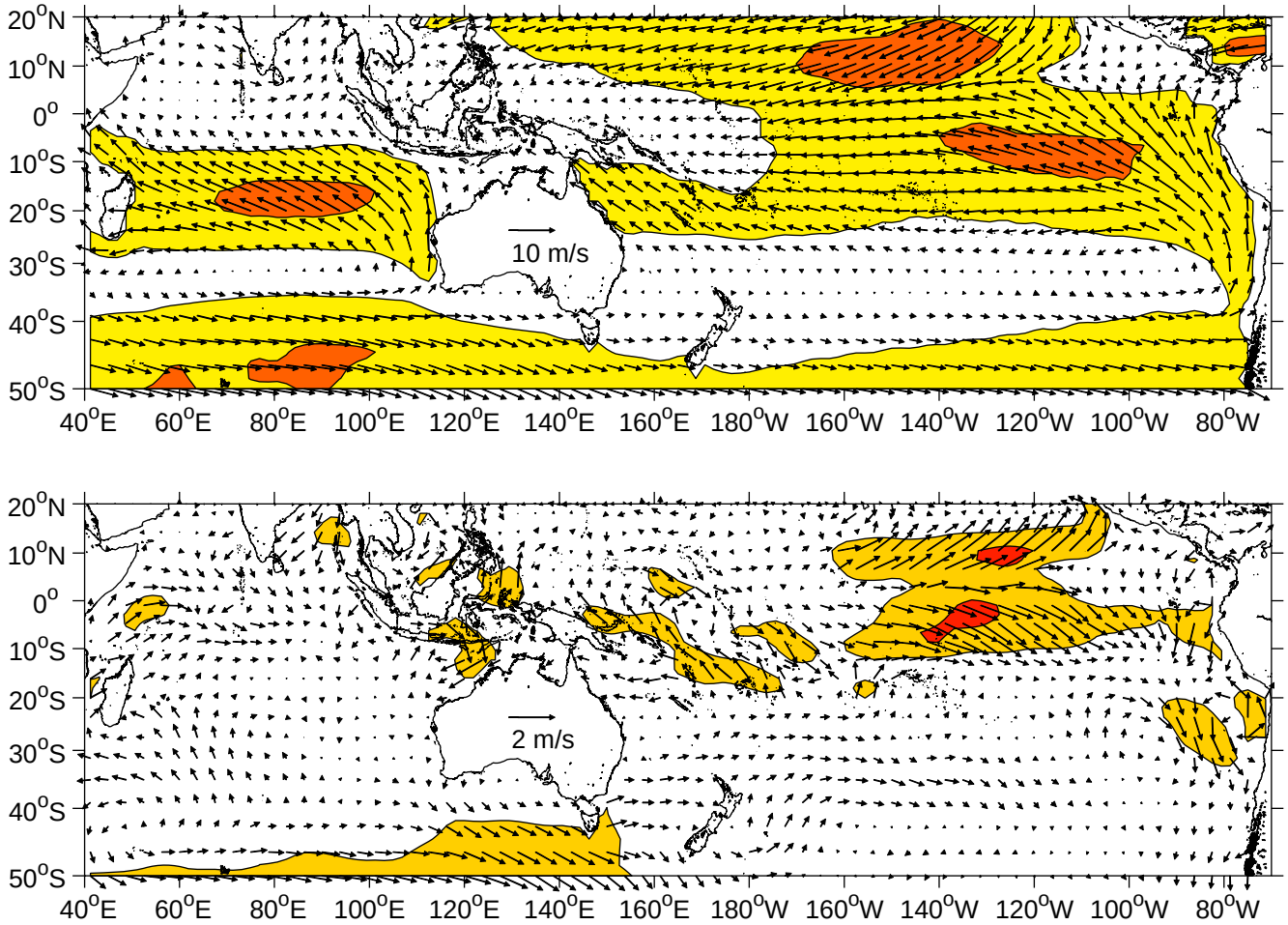
Ming Feng
Email: ming.feng@csiro.au

www.csiro.au

Thank you

CSIRO

Changes in surface wind fields



ORCA025 model

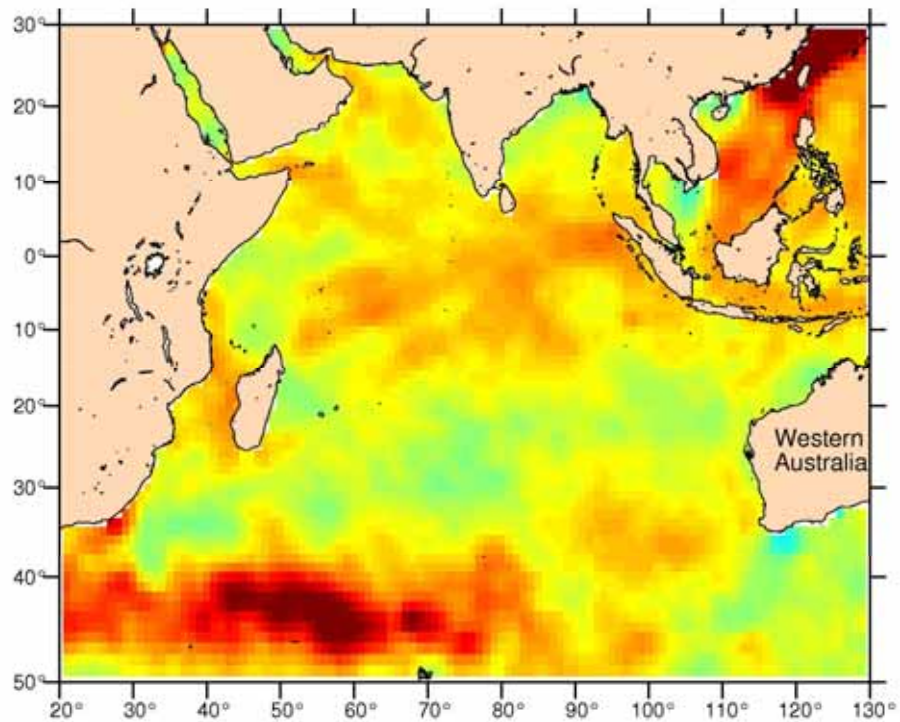
- Global ¼ degree horizontal resolution
- 6 m vertical resolution near surface, 20 layers in the upper 500 m
- Surface forcing based on bulk forcing methodology (Large and Yeager 2004) according to “CORE” protocol

- CORE: Co-ordinated Ocean-Ice Reference Experiments

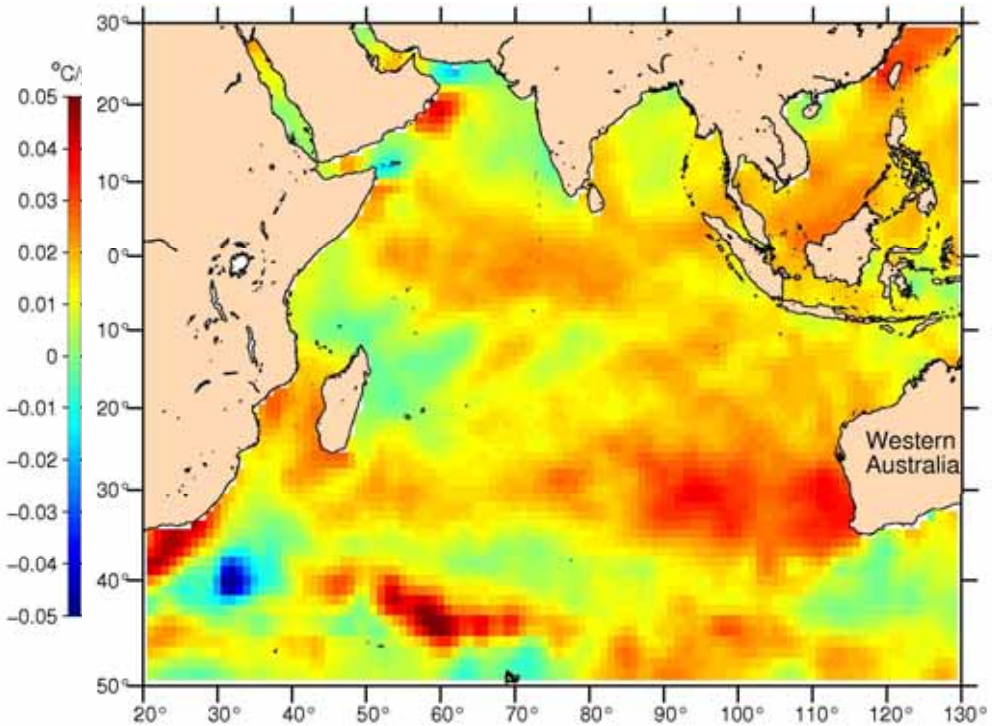
- Monthly output during 1960-2004

Temperature trends in different seasons

December - February



June - August



Correlation of Altimeter Sea Level and SOI