

WAMSI Node 2

Climate Processes, Predictability and Impacts in a Warming Indian Ocean

Bryson Bates

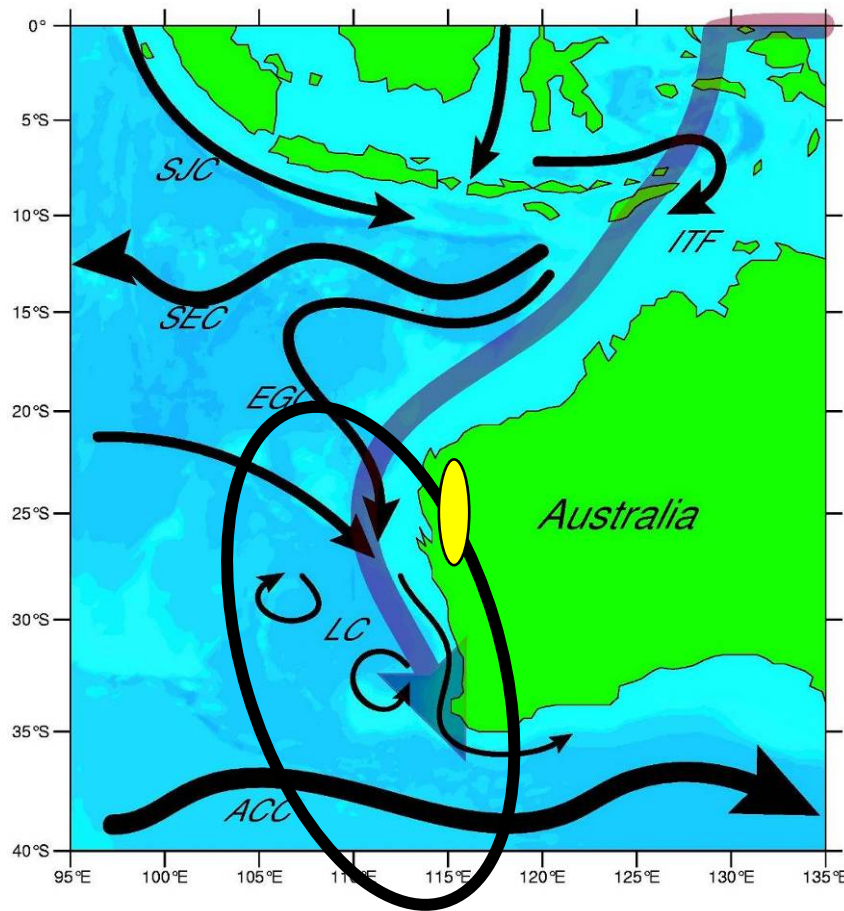
Presentation Outline

- **Background**
- **Major outcomes**
- **Projects underway**
- **Preliminary findings**
- **Implications for management & policy**
- **Future plans**

Three Nested Projects

- **2.1** *Predictability of Indo-Pacific Ocean as a global condition on marine & terrestrial climate impacts in WA (BoM)*
- **2.2** *Dynamics & impact of Leeuwin Current on marine environment off WA (CSIRO)*
- **2.3** *Oceanic conditions at Ningaloo Reef – analysis of downscaling ocean climate into the Ningaloo Reef Tract (AIMS)*

Overall Goals



western australian
marine science institution

- *Understand dynamics of variability & change*
 - Basin-circulation
 - Leeuwin Current
 - Ningaloo Reef
- *Dynamical downscaling*
 - Nested models
 - 1000 to 10 to 1km
- *Assess impact of climate change on the marine environment*

National Research
FLAGSHIPS
Wealth from Oceans



Collaborating Organisations

- **Centre for Australian Weather & Climate Research (CAWCR)**
- **CSIRO / BoM BLUELink project**
- **Department of Fisheries (WA)**
- **University of Western Australia**
- **Murdoch University**

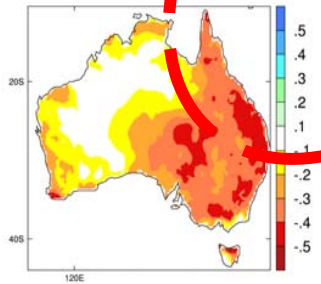
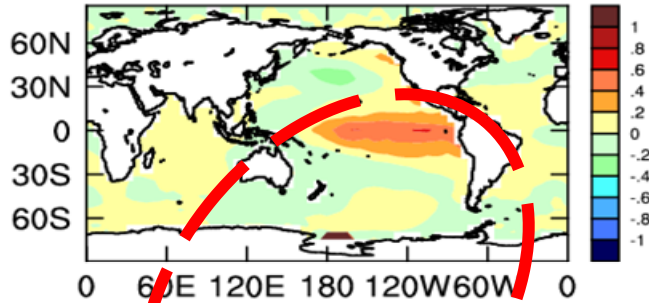
Major Outcomes

- **Assessment of predictability of Leeuwin Current**
- **Reduction in strength of Indonesian throughflow hence Leeuwin Current – impacted by climate regime shift**
- **Enhanced warming off lower west coast of WA**
- **Downscaling workshop 2007 - settling the modelling strategy**

Policy & Management Implications

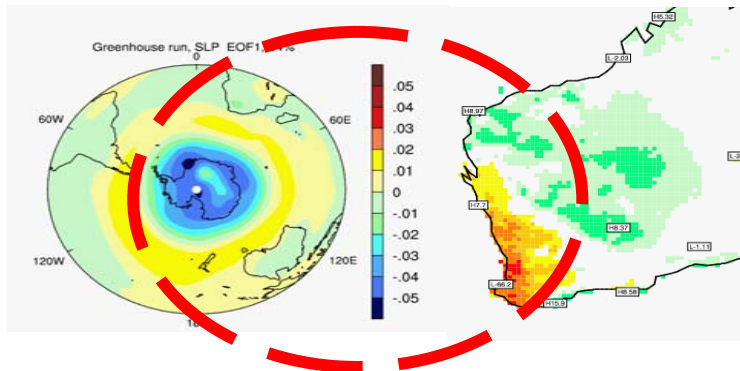
- **Leeuwin Current forecasts – operational decisions (e.g. NW shelf; fisheries)**
- **Warming & reduction of Leeuwin Current transport – impacts on:**
 - **fisheries recruitment (e.g. western rock lobster)**
 - **invasive species (e.g. jellyfish)**
- **Reduction of vulnerability of marine ecosystems to climate change**

Three-Headed Dog



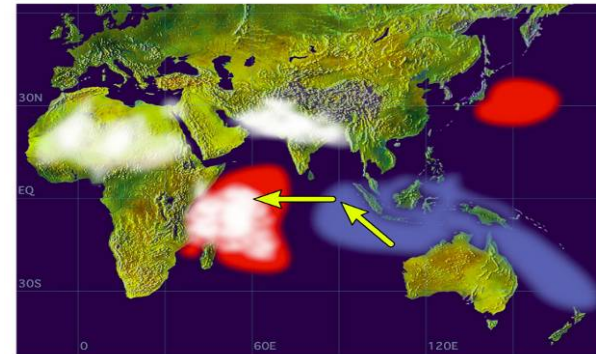
ENSO

Southern Annular Mode

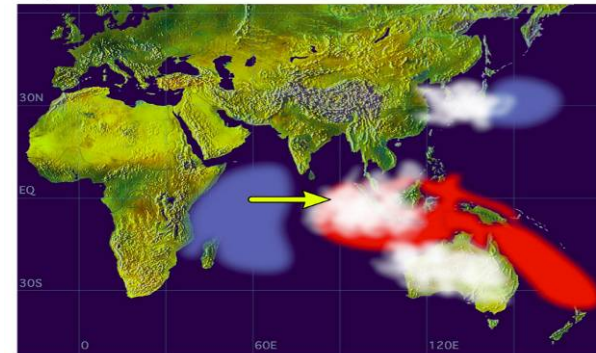


Indian Ocean Dipole

Positive Dipole Mode

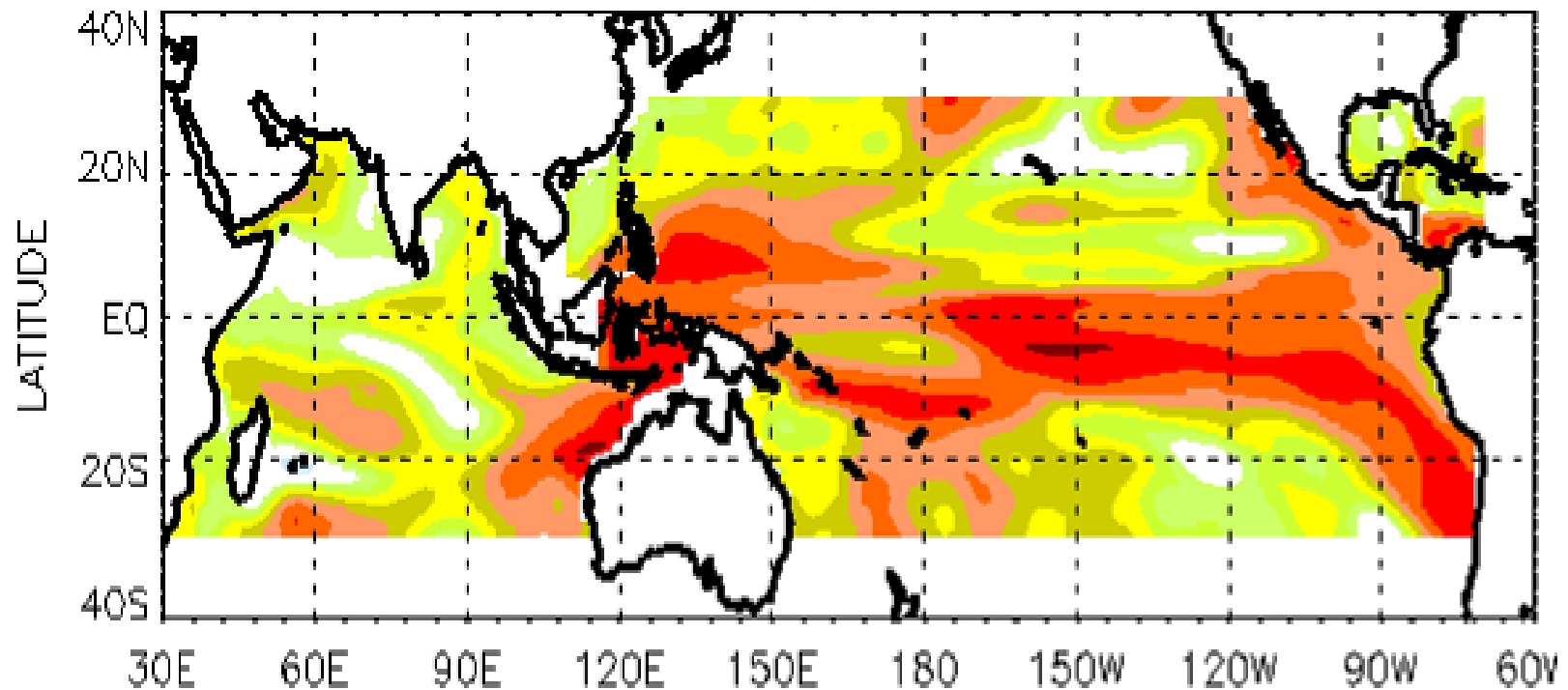


Negative Dipole Mode

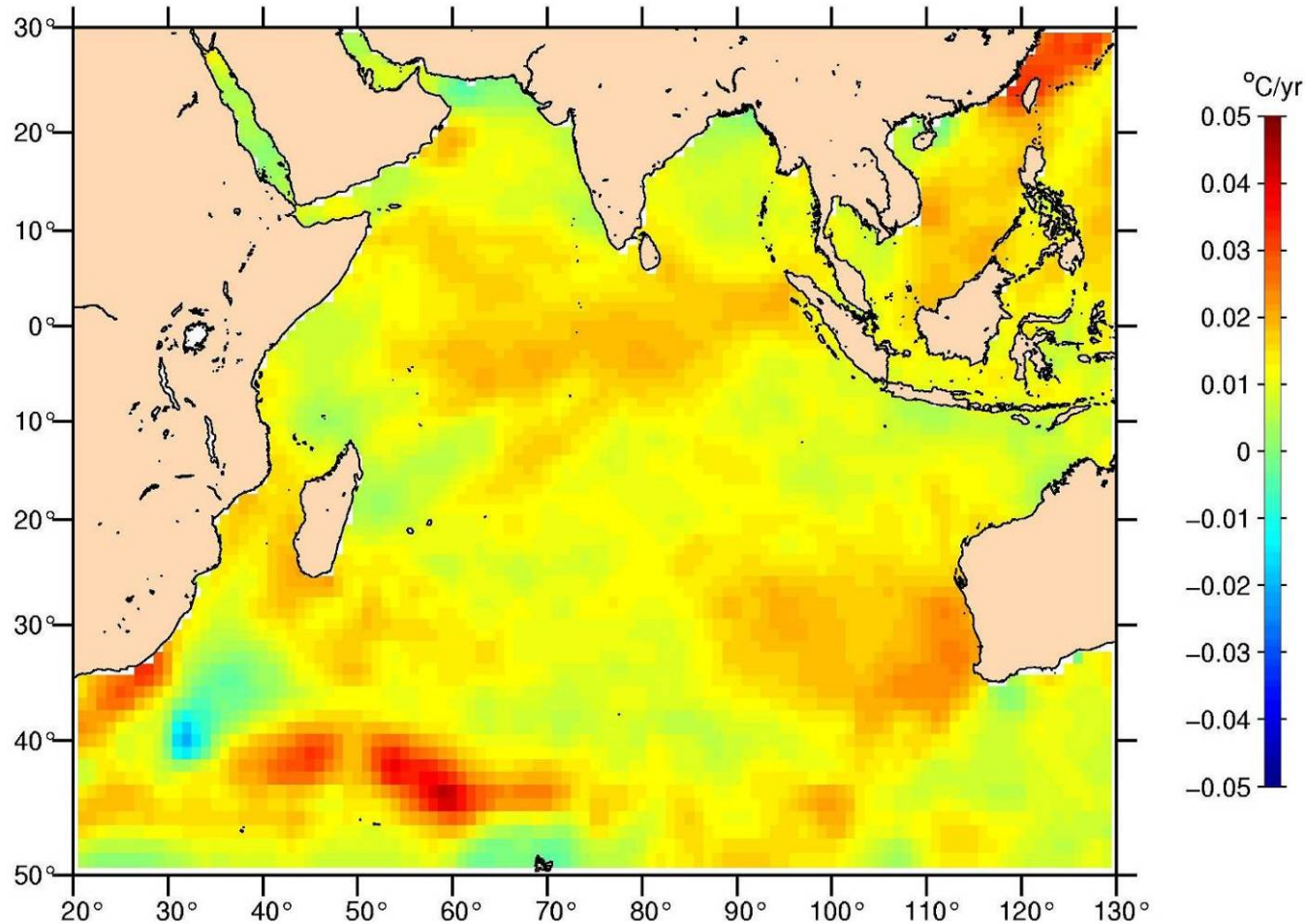


Predicting Heat Content (7 month lead)

Correlation NW shelf ~ 0.7



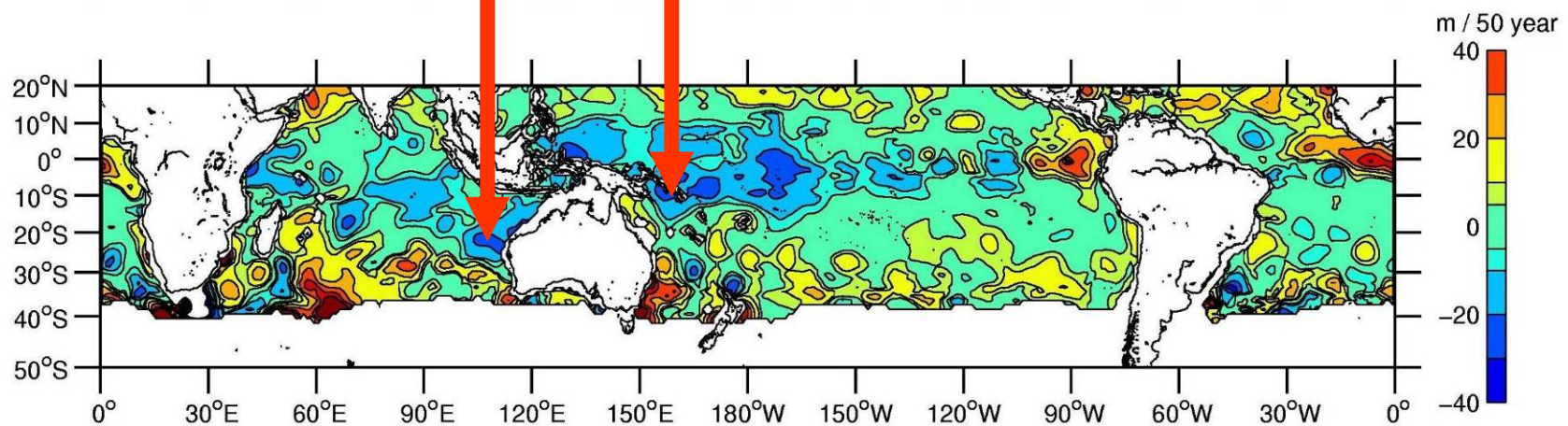
Linear Trends in Sea Surface Temperature



Linear Trends in Thermocline Depths

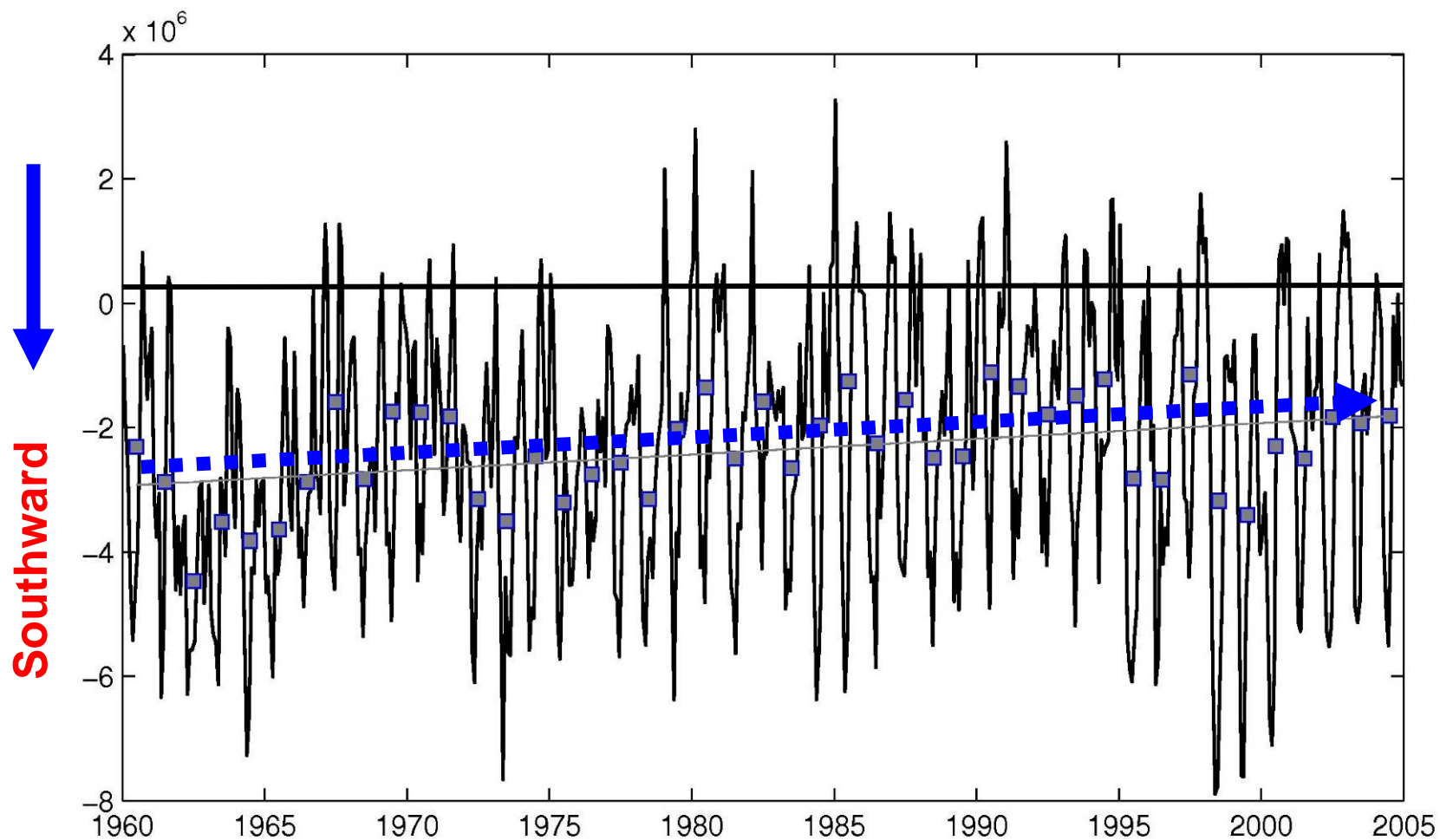
Thermocline shallower in western Pacific & east Indian Oceans

Feng, Wijffels & Meyers 2007

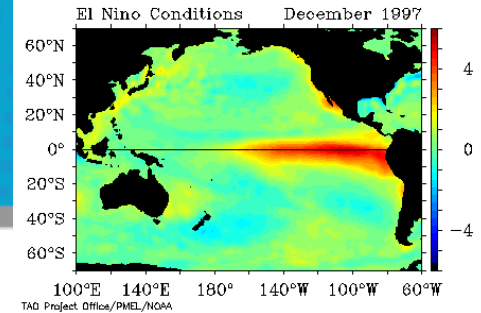


Leeuwin Current weakening – reduced storm activity??

Modelled Volume Transport of Leeuwin Current 1960-2004 (off Perth)

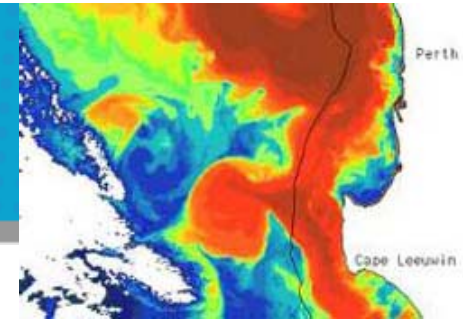


Preliminary Findings Project 2.1 (BoM)



- **Good skill in predicting El Niño & its teleconnection to WA coast (6 – 9 month lead)**
- **Lead time for Indian Ocean Dipole limited to three months**
- **Investigating whether poor predictions for Indian Ocean Dipole stem from model error, poor initial conditions, or inherently low predictability**
- **Large-scale proxy for Leeuwin Current found (upper ocean heat content on NW shelf)**

Preliminary Work Project 2.2 (CSIRO)



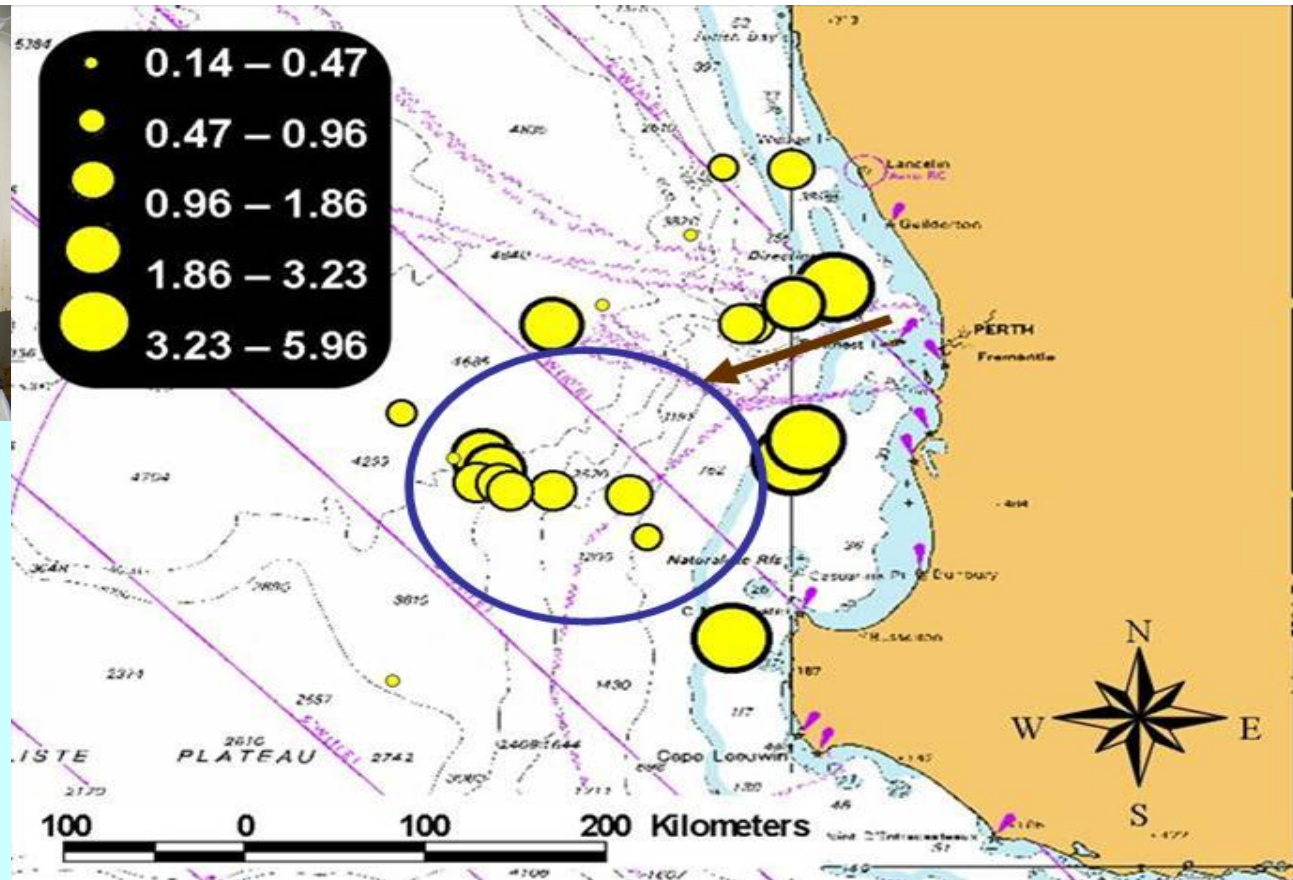
- Preliminary study of ocean heat budget within tropical Indian Ocean in order to understand SST warming trend observed over last four decades
- Reduction of trade winds in equatorial Pacific has induced shallow thermocline anomalies & reduced transport of Indonesian Throughflow
- Long-term trend in the Leeuwin Current identified from historical data & numerical modelling

Cross-shelf Transport of Fish Larvae

PhD project: Murdoch-CSIRO, Candidate: David Holliday



**Spatial
distribution of
fish larvae
concentration
during 2006
eddy cruise**



Preliminary Work Project 2.3 (AIMS)



- **Contributed to analysis & interpretation of in-situ oceanographic data from small section of Ningaloo Marine Park**
- **Provided observational data for development & validation of bathymetric maps**

Future Plans

- **Operational seasonal forecasts of the Leeuwin Current**
- **Characterisation of physical environment of Leeuwin Current under different climate change scenarios (~ 2050)**
- **Plausible changes in the Ningaloo Reef region under climate scenarios**