Coupled ocean-atmosphere dynamics in the eastern Indian Ocean warm pool

Project report

Ming Feng | Principal Research Scientist
3 May 2018
Project staff

Ming Feng
CSIRO
Physical oceanography
Project coordination

Susan Wijffels
CSIRO - WHOI
Physical oceanography
Champion, Profiling floats

Harry Hendon
Bureau of Meteorology
Air-sea coupling
Seasonal prediction

Je-Yuan (Andy) Hsu
CSIRO Postdoc fellow
Physical oceanography
Air-sea coupled modelling
Project staff

Dirk Slawinski, CSIRO, data analyst, data management and QC

Ryan Crossing, CSIRO, mechanical engineer, voyage manager

Craig Hanstein, CSIRO, electronic engineer, float preparation

Other staff members:
Rebecca Cowley, Ian Darby – CSIRO
Alex Ekholm – WHOI
Collaborators

University of New South Wales, **Xiao Hua Wang**, SST diurnal variations
First Institute of Oceanography, **Weidong Yu, Lin Liu**, Bailong buoy
Bureau of Meteorology, **Oscar Alves, Xiaobing Zhou, Maggie Zhao**, ACCESS
Australian Institute of Marine Sciences, **Jessica Benthuysen**, Marine extreme
Geosciences Australia, **Zhi Huang**, Himawari satellite

PhD students:
**Anna Maggiorano**, UNSW, SST diurnal variations
**Ying Zhang**, Chinese Academy of Sciences, Indian Ocean heat balance
**Jie Ma**, Ocean University of China, Indian Ocean meridional overturning
**Maxime Marin**, University of Tasmania, Marine heatwaves
Project objectives

1. Obtain **new insights into air-sea coupling in the east Indian Ocean warm pool** region northwest of Australia, using fast ocean profiling platforms (resolving the very near surface temperature)

2. Understand **coupled model sensitivities** in capturing the scale, strength and atmospheric responses to **diurnal warming events**

3. Quantify the drivers of the decadal variations of the **Indian Ocean heat storage** and the poleward heat transport in the Indian Ocean using numerical model outputs
Achievements and highlights

• Recruitment – Andy Hsu
• Pilot floats deployed and observation strategy assessed
• ACCESS coupled model experiment started
• Indian Ocean and marine heatwave research delivered
Pilot float deployment

Jorge Mckee, RAN
Raw temperature records

Float: 9200, Temperature

9200: Surface "Air" Temperatures
- air temps
- first air temp
- last air temp
- shallowest water

9200: "Air"-Sea Temperature difference
- ALAMO: 2018-Apr-24
Subsampling study on float vertical resolution

1. High resolution of T is more important in the upper 5 m than in the $z = 5-10$ m → Warm layer in the upper 5 m.
2. The current setting of float vertical resolution is 0.1 db at $z < 5$ m and 1 db at $z=5-50$ m → Allowing 0.01 °C RMS
Interaction between surface warm layer and internal tide

Temperature

Salinity

100m
Other highlights:
2016 Marine heatwave across tropical Australia

March 2016

Sea Surface Temperature anomaly

NOAA OISST V2
(daily)

Benthuysen et al. 2018
Strong air-sea heat flux into the ocean

Jan 2016

Feb 2016

ERA-Interim

Shortwave radiation anomaly

Latent heat flux anomaly

Net heat flux anomaly

W/m²
Himawari-8 satellite diurnal SST variation

\[ DSST = \max(SST) - \text{mean}(SST_{2-6am}) \]
MJO event: SST diurnal variation in 16-17 summer

Zhi Huang
Geoscience Australia
Outlook to 2018/19

• Acquisition 5-8 profilers, establish the satellite communication and data handling system; Source a suitably configured platform for the atmospheric surface observations, and arrangements for vessels for deployment and (if needed) recovery

• Run the BoM’s coupled forecast model for the field work periods and analyse model outputs against observations

• Continue assessment of Indian Ocean heat balances associated with warm pool variability

• Model assessment of diurnal upper ocean variations in the coastal regions off northwest Australia
Outlook to 2018/19 – November 2018 field deployment

Australia’s Maritime Jurisdiction off the Northwest Shelf

Dampier

FIO Bailong buoy
ACCESS-S seasonal forecast model

Atmospheric model
Latest UK MetOffice atmospheric model GC2
Horizontal: 60 km in the midlatitudes (N216)
Vertical: 85 levels (extending into the stratosphere)

Ocean model
Latest NEMO model from France which is part of the UK MetOffice coupled model GC2
Horizontal: 25 km
Vertical: 75 levels; level thicknesses range from 1 m near the surface to about 200 m near the bottom (6000m depth)

Model Physics
Latest from UK MetOffice and France
ACCESS model forecast of OLR
January 2010 MJO active phase

SST anomalies prior to onset

Observations

SST, post – prior to MJO onset
Heat balance of the Indian Ocean warm pool

PhD student: Ying Zhang
Decadal variations of southern Indian Ocean heat balance

Reference period

Hiatus – Reference period

Zhang, Feng, Du, Phillips, Bindoff, McPhaden, manuscript

PhD project, Jie Ma
Meridional heat transport of the Indian Ocean
Outlook to 2018/19 – other field works

R/V MIRAI cruise, PI: Y. Masumoto
PhD student: Maxime Marin

MJO, Diurnal variations and ocean mixing

2019: Wheeler, Hendon, Wijffels ...
Modelling study on diurnal SST variations and marine heatwaves – roles of ocean mixing (PhD project, Anna Maggiorano)

Feng et al. 2016
Thank you

CSHOR
Ming Feng
Principal Research Scientist

+61 8 9333 6512
ming.feng@csiro.au
https://cshor.csiro.au/

CSHOR
Presenter Name
Presenter Title

+61 2 9123 4567
firstname.surname@csiro.au
https://cshor.csiro.au/