Intraseasonal variability of the upper ocean in the Seychelles-Chagos thermocline ridge region and its impact on MJO initiation and development

SAULO SOARES, KELVIN RICHARDS AND H. ANNAMALAI

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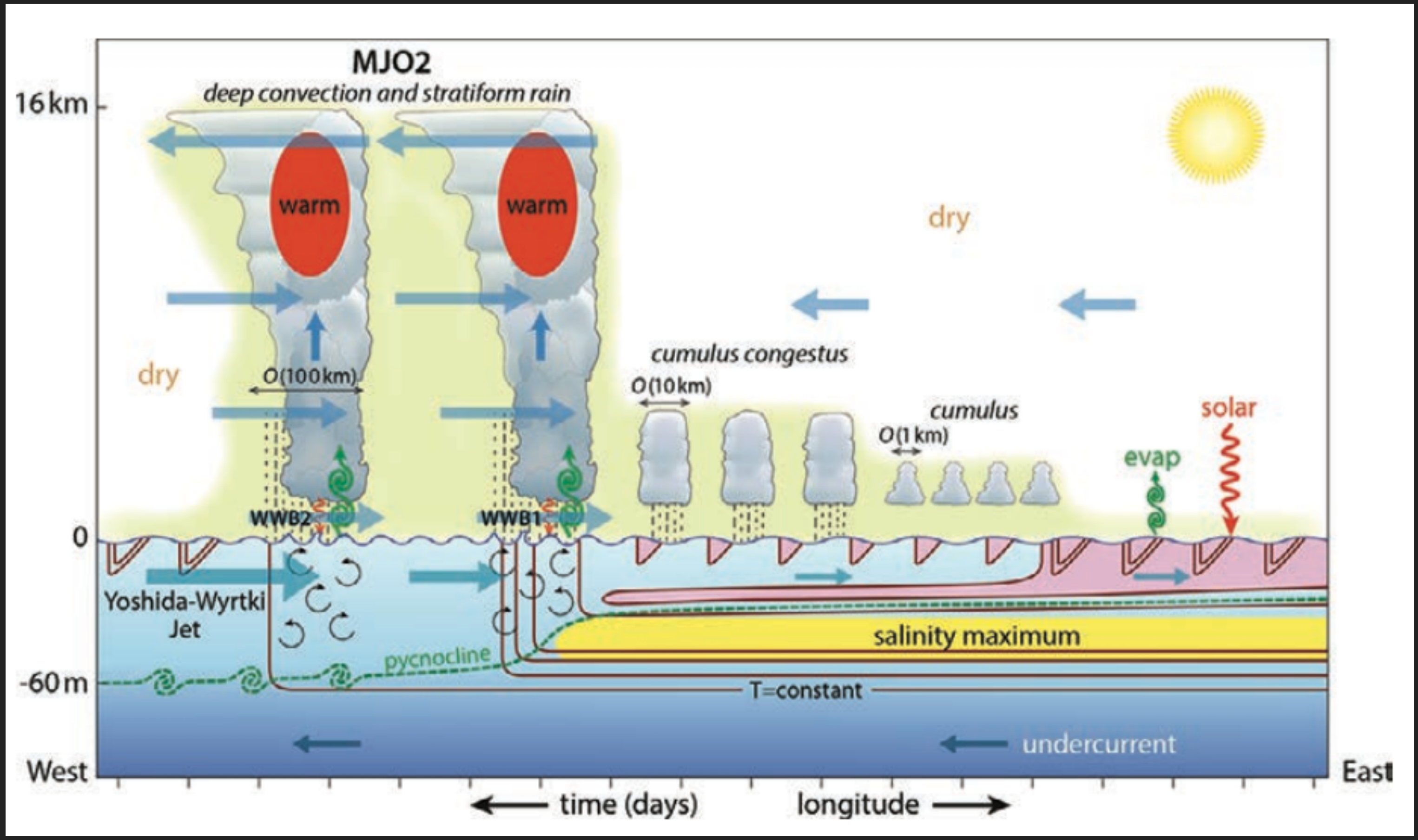
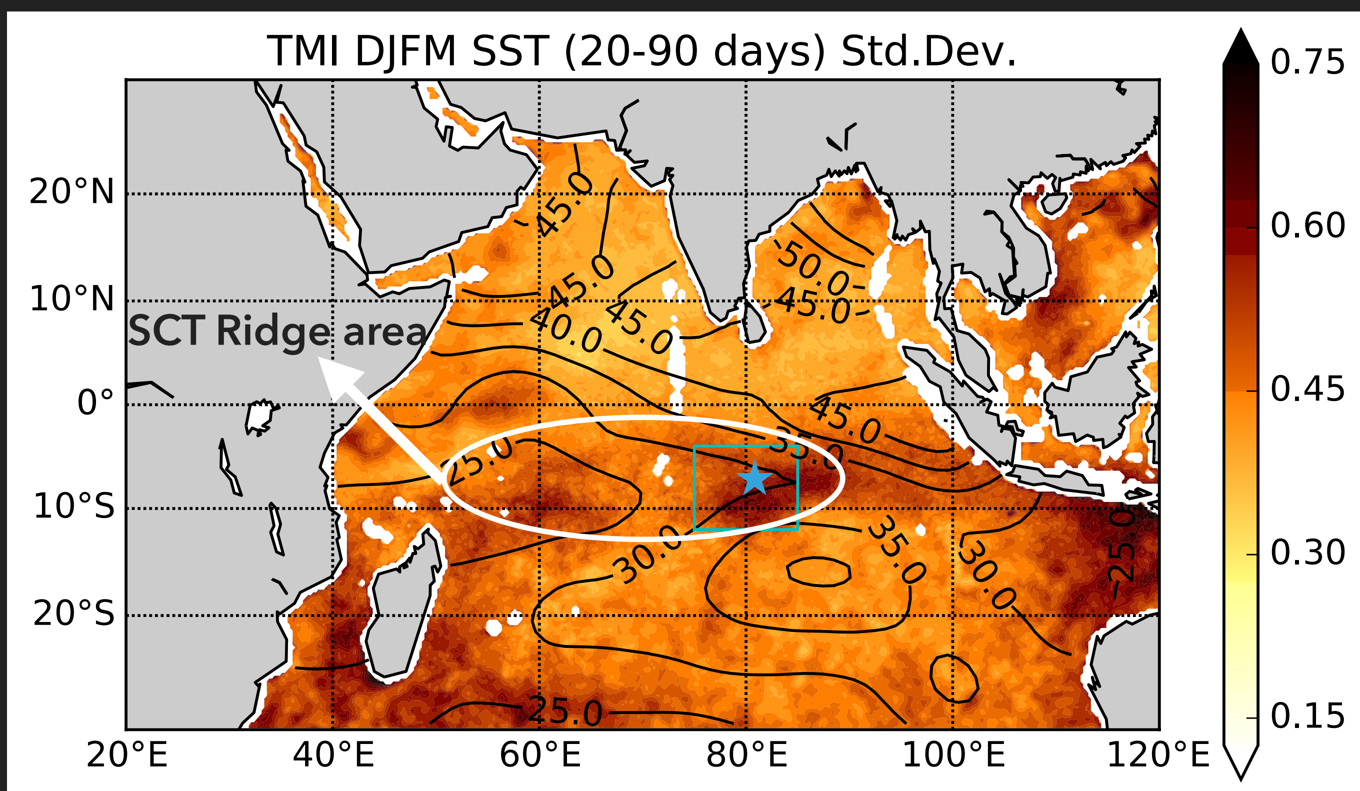
MJO AND THE ROLE OF THE OCEAN



Moum et al., 2013

- MJOs impact weather and precipitation globally: precipitation extremes, monsoon break/active phases, pineapple express, hurricane activity in Atlantic (see Storm King)
- Recent research (e.g. DeMott et al. 2015) points to importance of ocean to MJO dynamics and forecasting
- Whether SSTs play a role via mean/basic state or via feedbacks remains to be ascertained

INTRASEASONAL SST ANOMALIES IN THE RIDGE AREA AND MJOS



Austral Summer instraseasonal SST variability from satellite

Dark contours denote the thermocline depth

★ CINDY cruise station (8 S, 80.5 E)

- According to Izumo et al. 2010, MJO activity is focused on the ridge zone as austral summer (NDJFM) progresses.
- Ridge area (2-12S, 55-85E) believed a hotspot for air-sea interaction at MJO scale
- Attributed to it's shallow thermocline and mixed-layers (ML)

RESEARCH GOALS

- Determine and Understand the Factors Controlling Instraseasonal SST and upper ocean heat content in the Seychelles-Chagos thermocline ridge (SCTR)
- Evaluate the representativeness of the ocean response to MJO events observed during DYNAMO
- Determine the impact of the thermocline ridge, freshwater fluxes and associated upper ocean variability on the initiation and development of MJO events

This Presentation Will Focus On The First Two

CINDY2011 OBSERVATIONS AND MODELING

- Shipboard observations from R/V Mirai (MJO1 and MJO2)

  Heat and salt budgets; 1D numerical experimentation. Role of mixing/ entrainment vs surface fluxes vs lateral advection; Inertial Oscillations

- Analysis of ARGO and CORA data products

  Seasonal and inter-anual heat and salt budgets

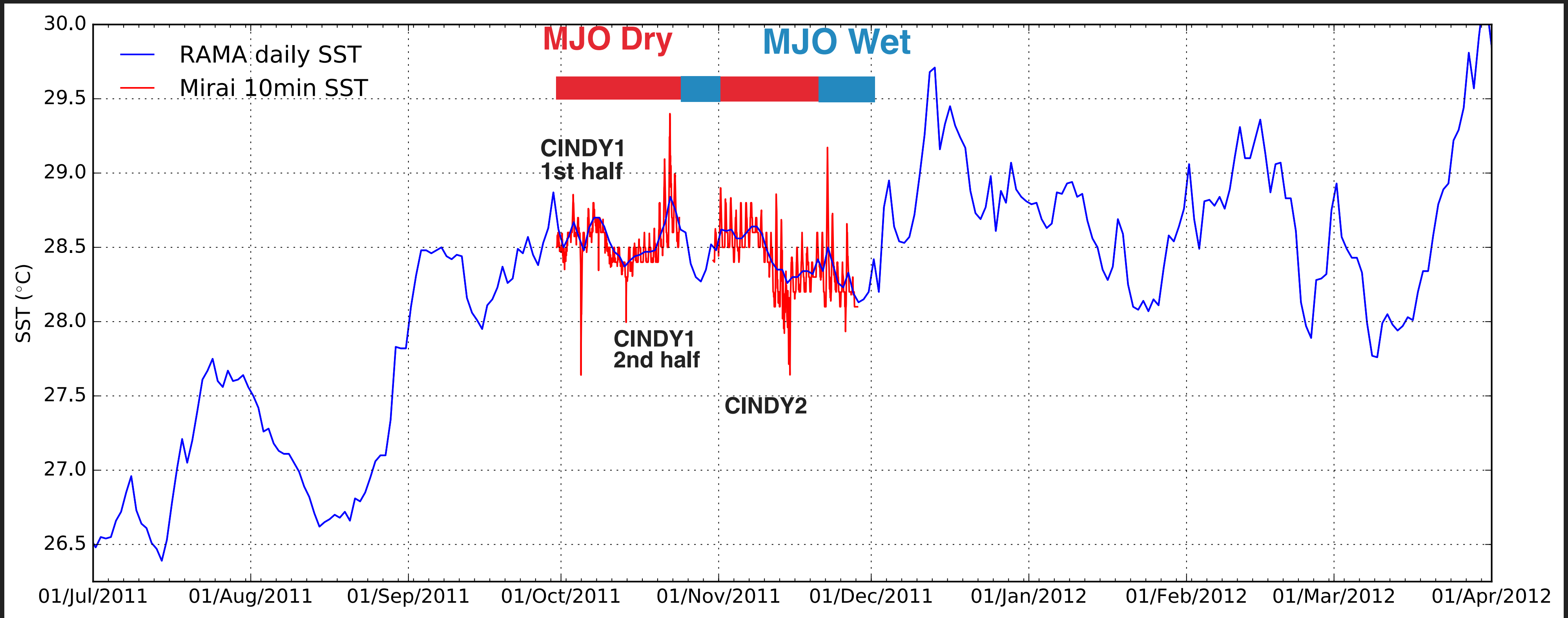
- Analysis of coupled and ocean only model outputs (IPS-NEMO, CESM-POPv2)

  Seasonal heat and salt budget

- Coupled model experimentation (on-going)

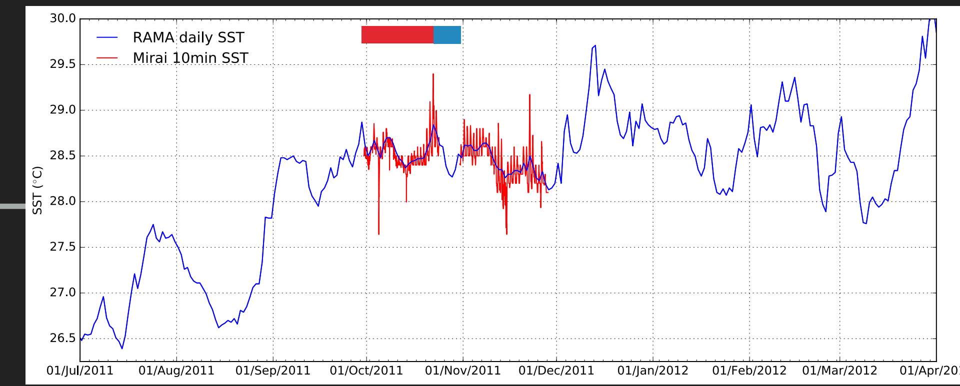
FINDINGS SO FAR

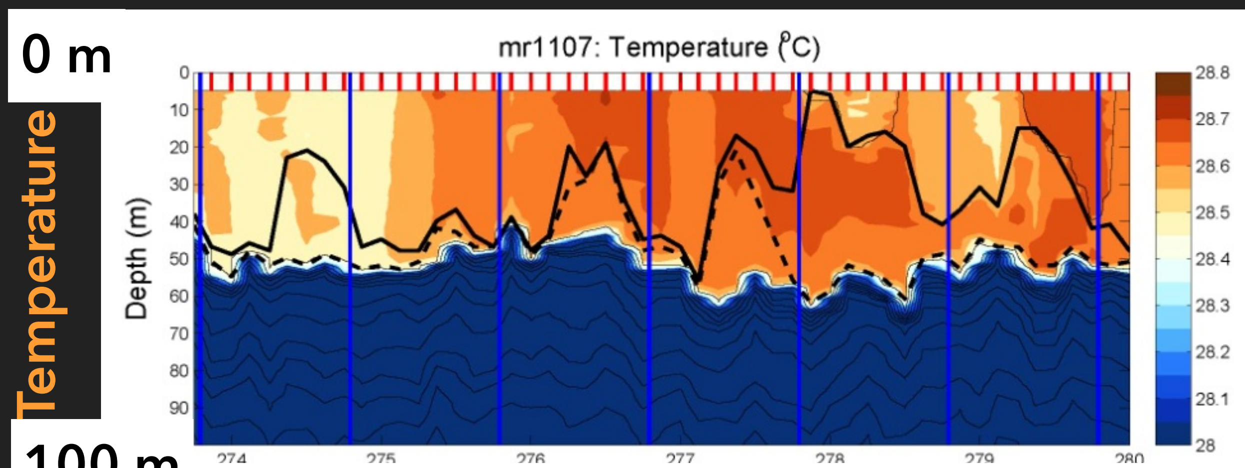
In-situ SST at 8S, 80.5E

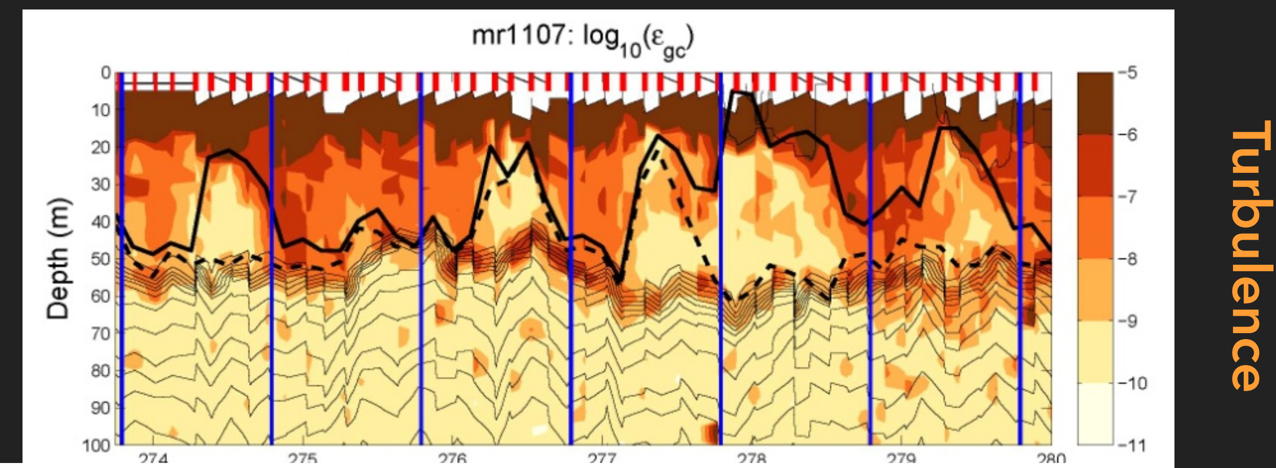


- Ocean response to MJO in the SCTR is impacted by processes operating from daily through to interannual timescales
  - At the daily timescale: Diurnal warm layers, turbulent mixing, near inertial oscillations and precipitation.
  - At the seasonal timescale: Rossby waves, advection.

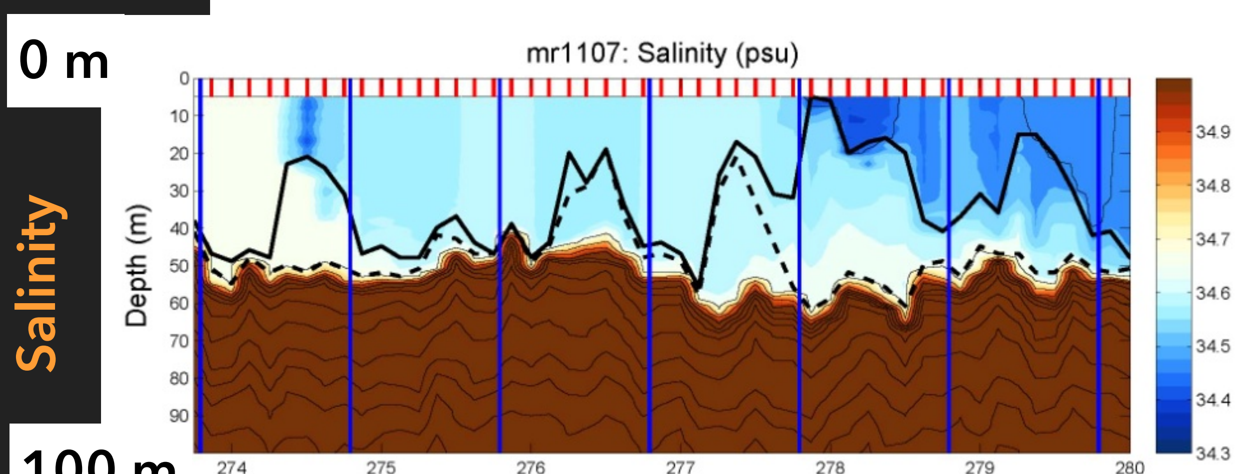
CINDY LEG 1. (FIRST HALF)



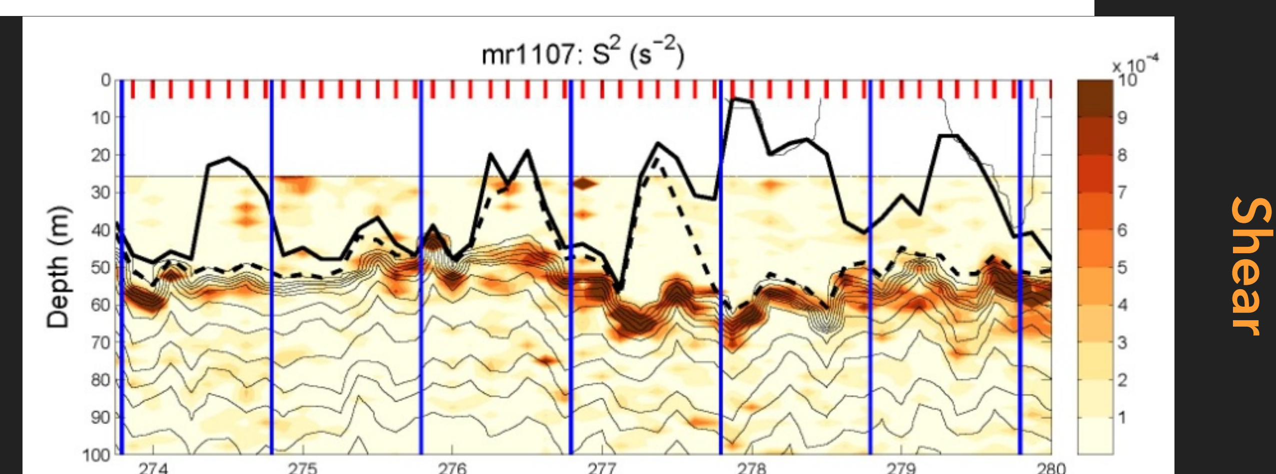




First week of sampling: black line is mixed-layer depth; dashed isothermal layer depth



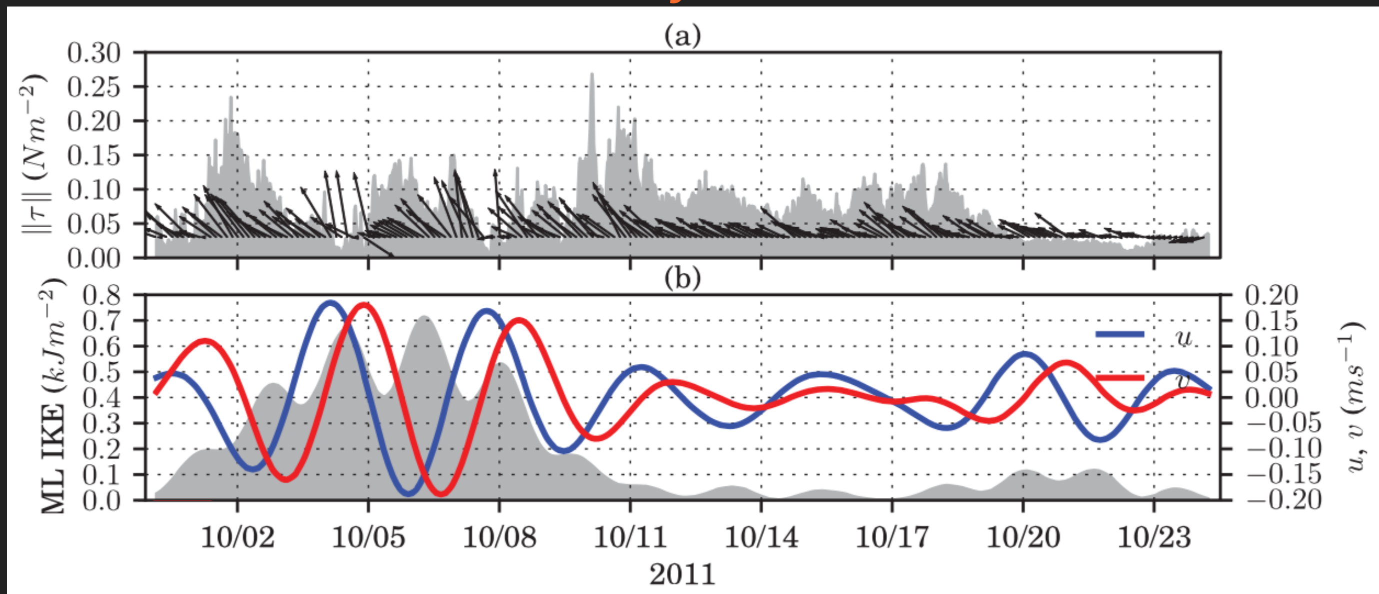
First week of sampling

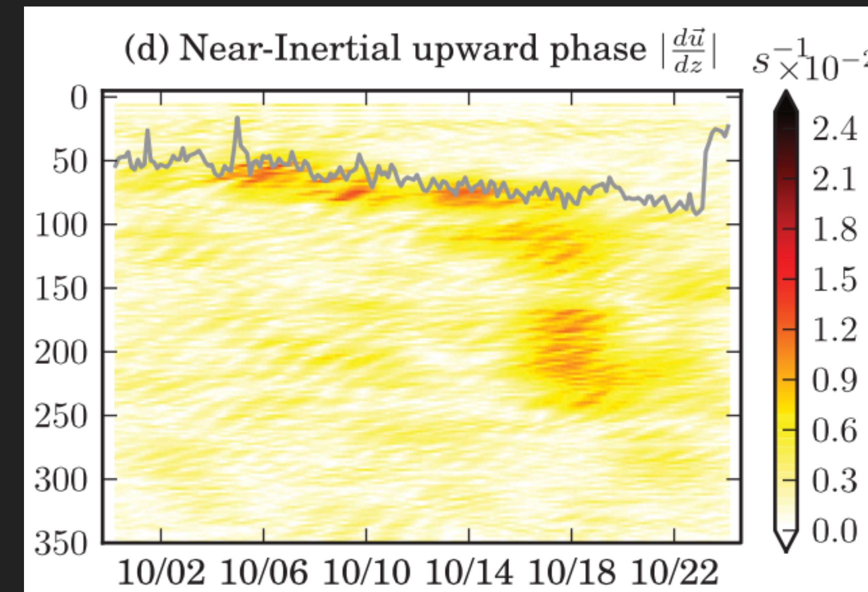


First week of sampling

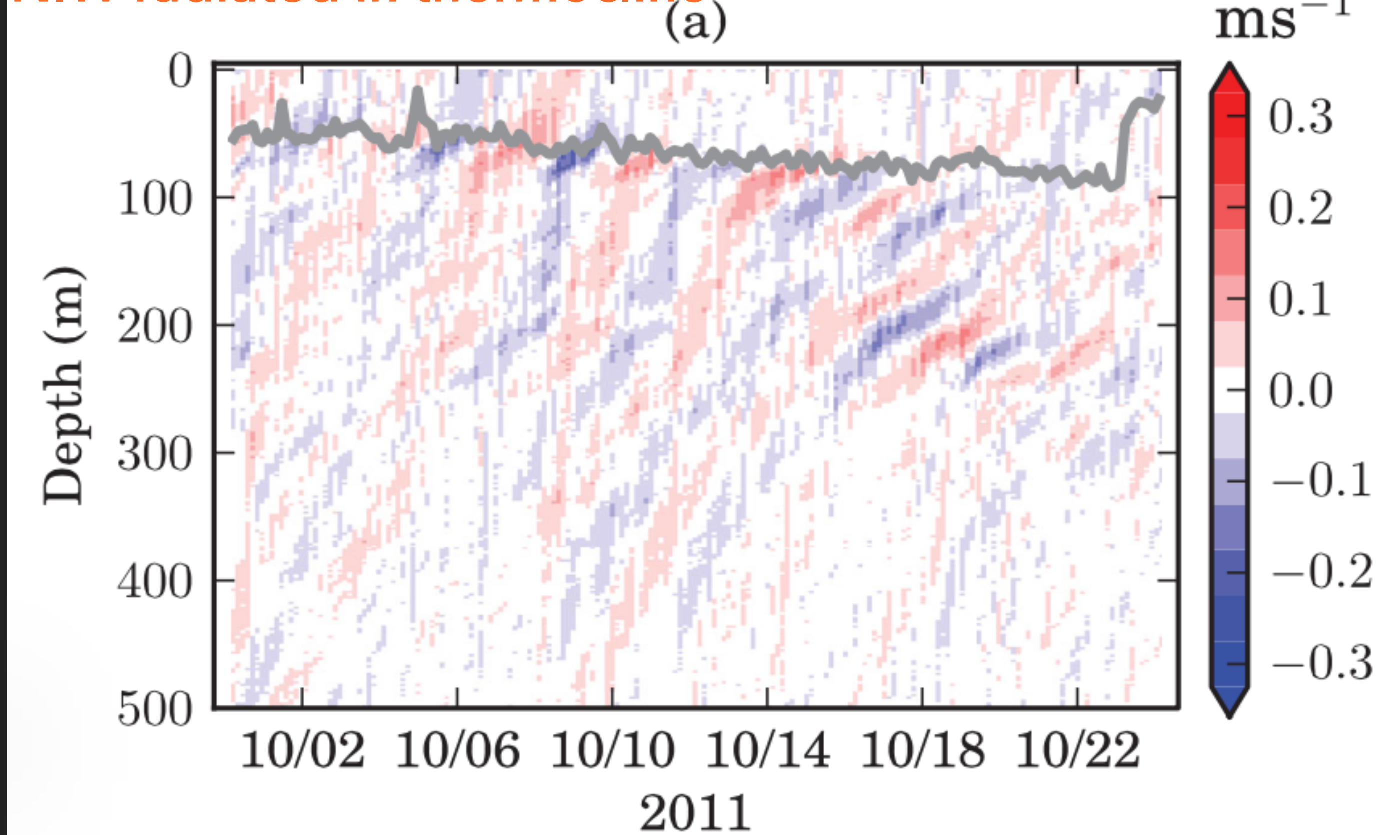
- Daily warm layers suppressed by clouds and turbulent mixing
- Wind generated NIOs : shear at the base of the surface layer
- Precipitation induces salinity variability and stratification

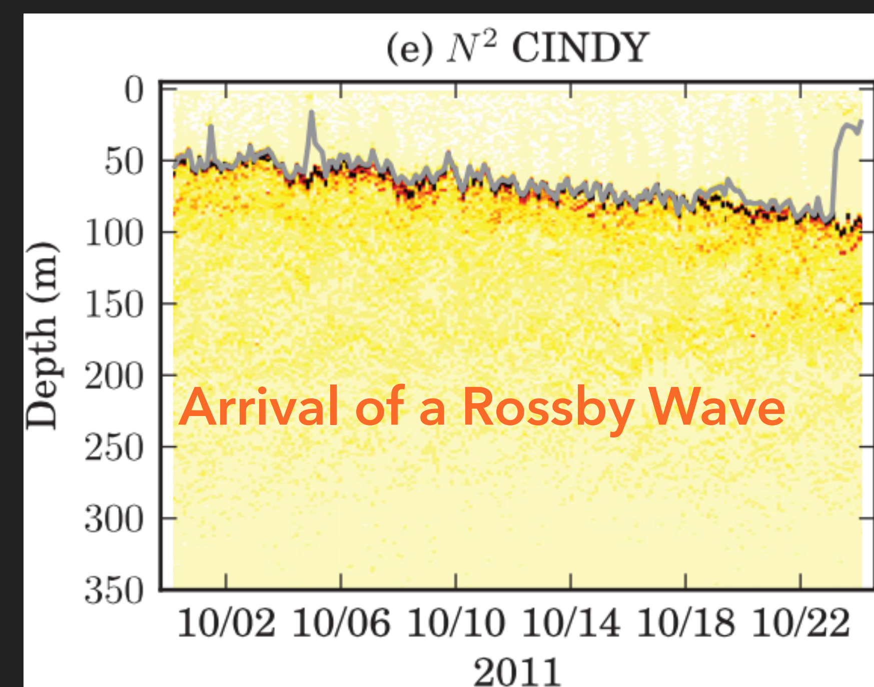
Winds and Mixed Layer Inertial Oscillations





NIW radiated in thermocline





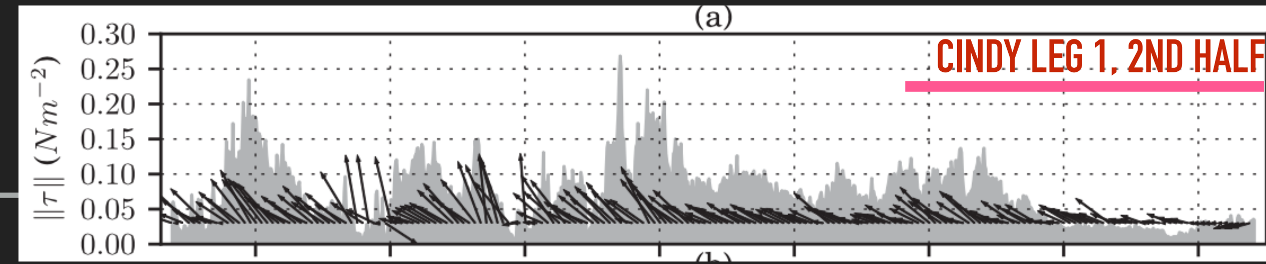
Soares et al, 2016

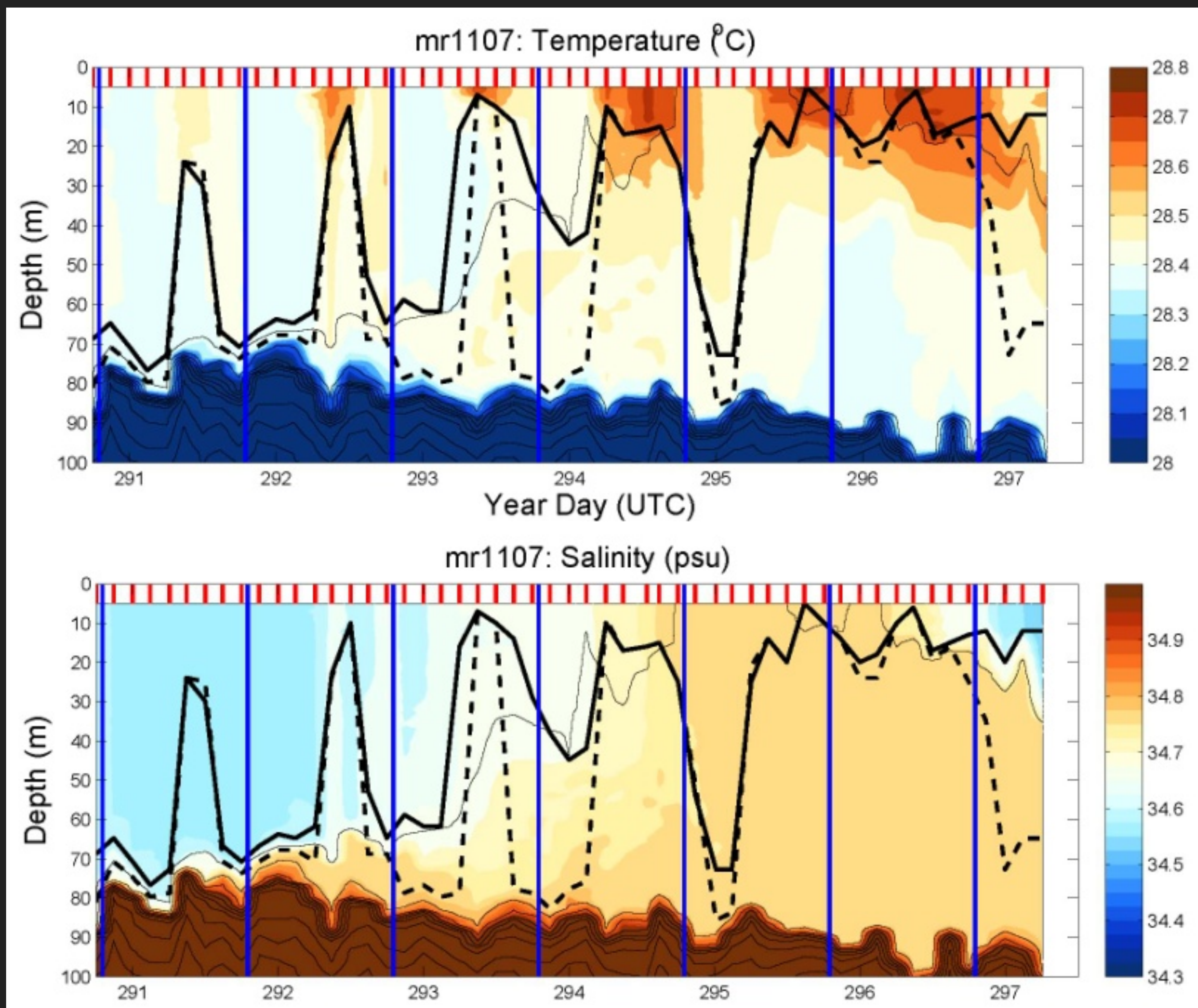
NIOs generated during onset of MJO dry phase

Control shear and mixing at the base of the mixed layer

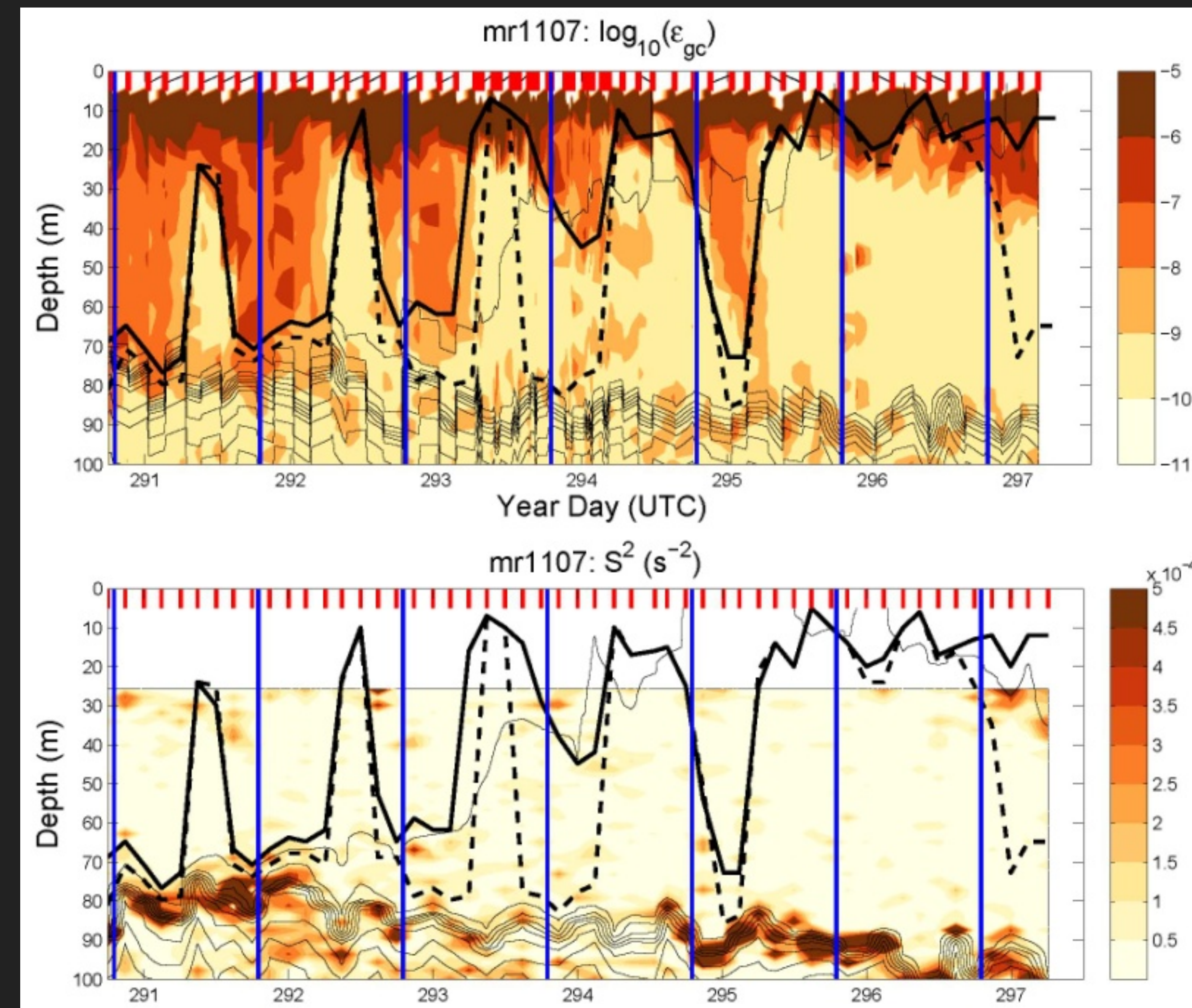
Combine with surface heat fluxes and lead to both suppressed DWL and cooling episode

CINDY LEG 1, 2ND HALF





Last week of sampling

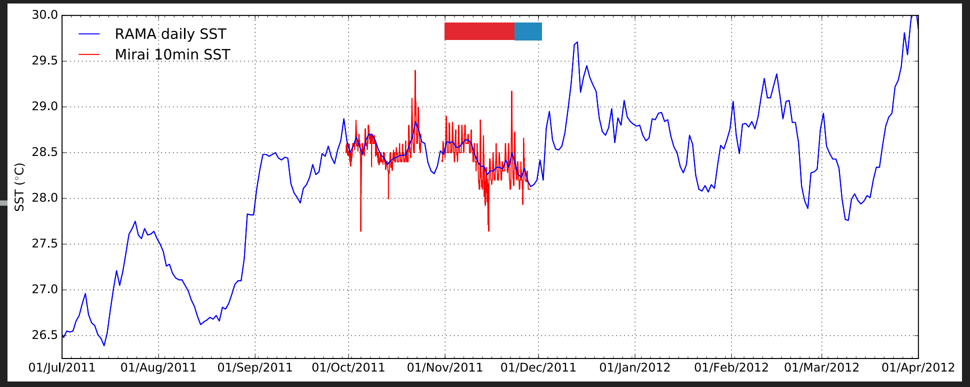


Last week of sampling

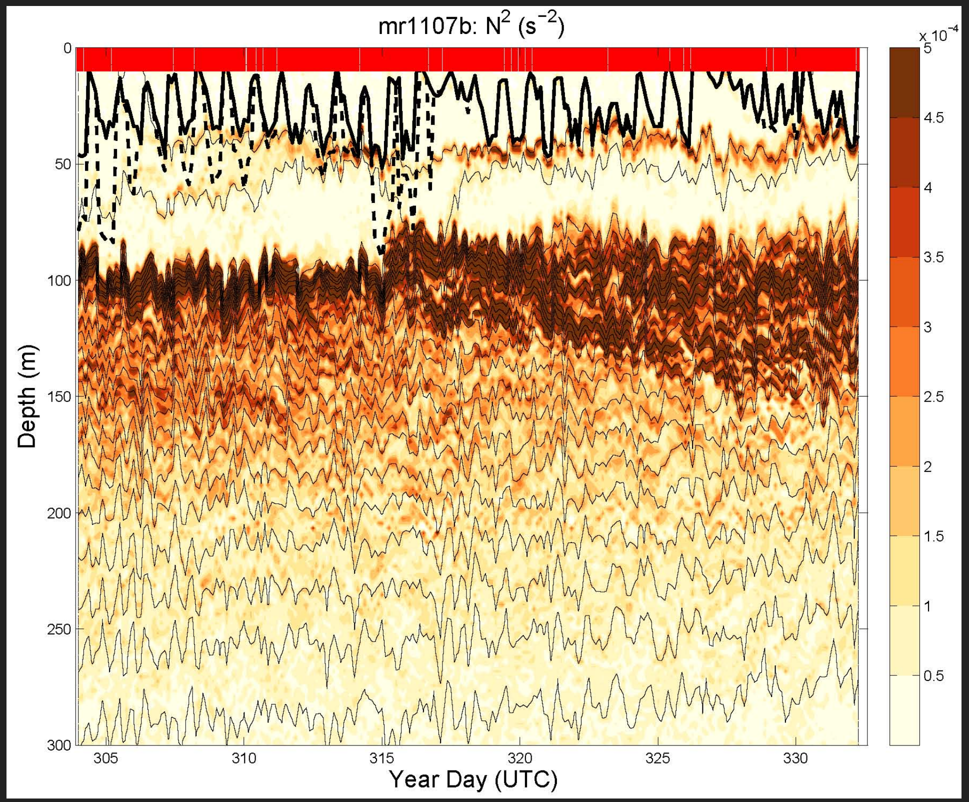
- Calm conditions and dissipation of NIOs allow for DWL to develop
- Salinity stratification also helps in the beginning
- Large stratification around 20m decouples BL from thermocline

OBSERVATION OUTCOMES

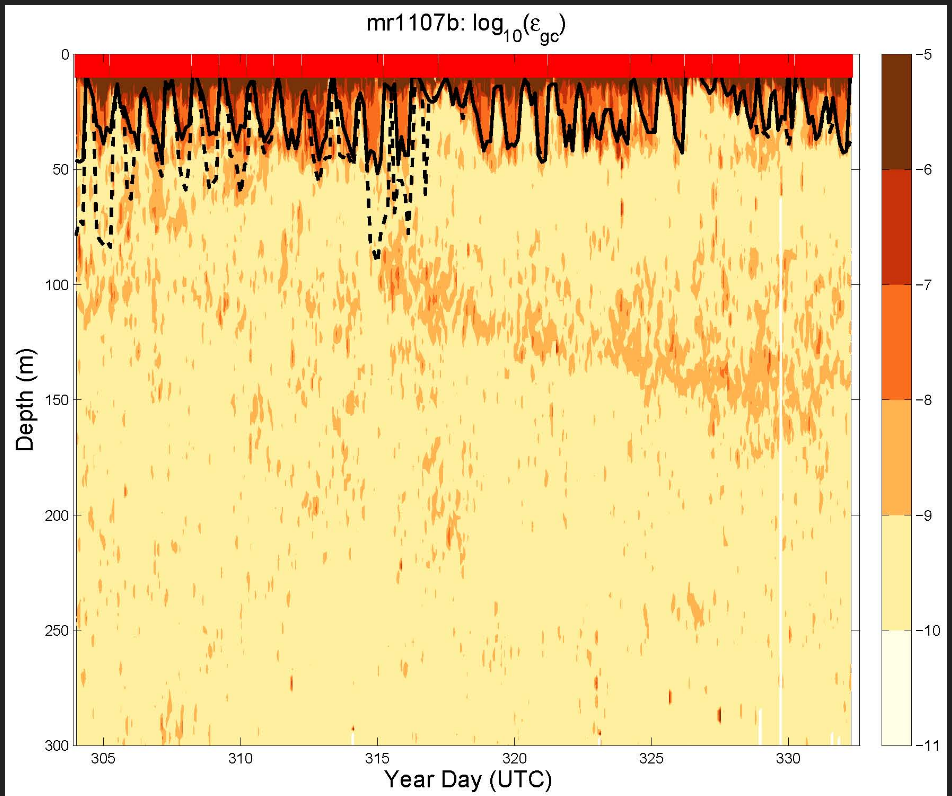
CINDY LEG 2, ANOTHER DRY PHASE



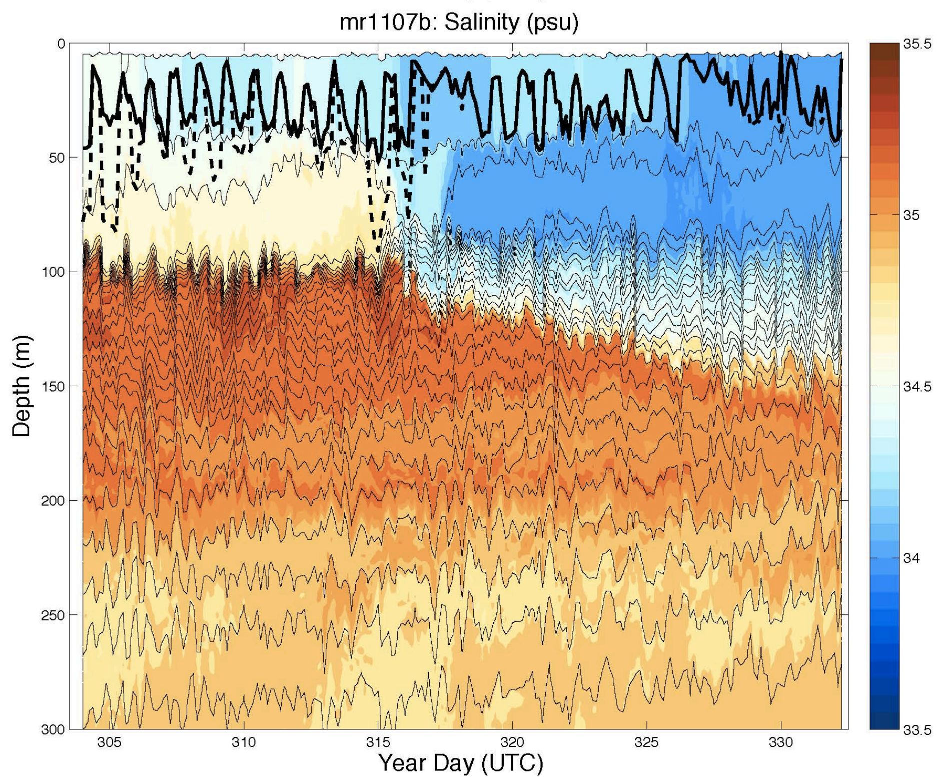
Stratification



Turbulence



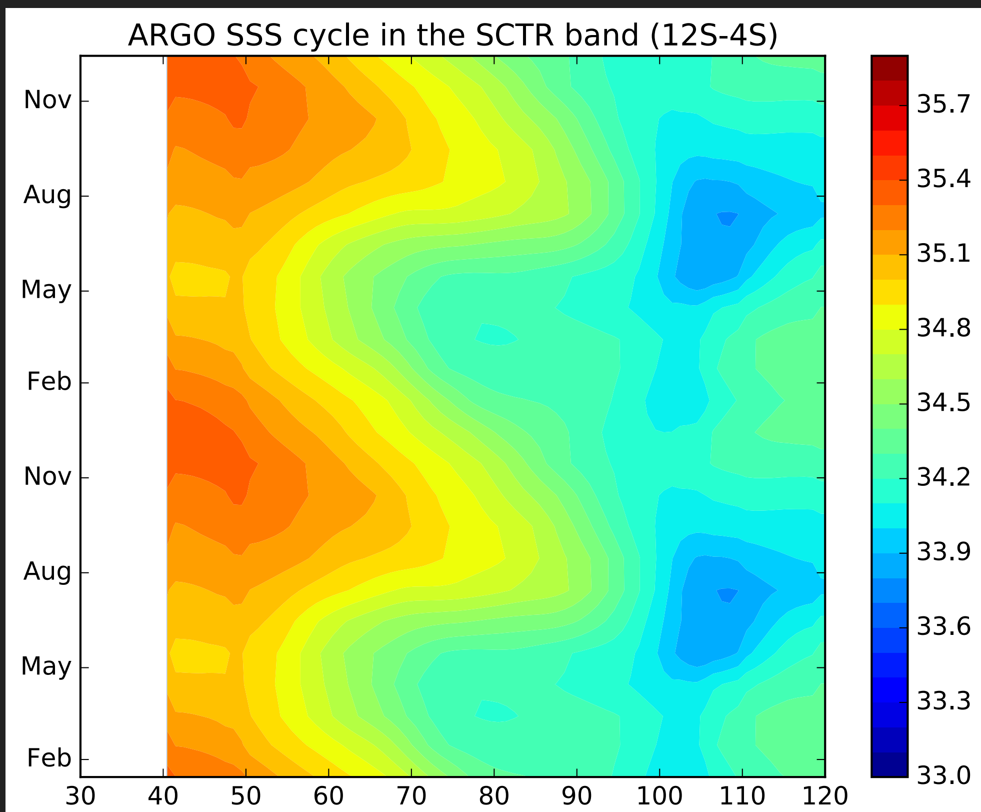
Salinity

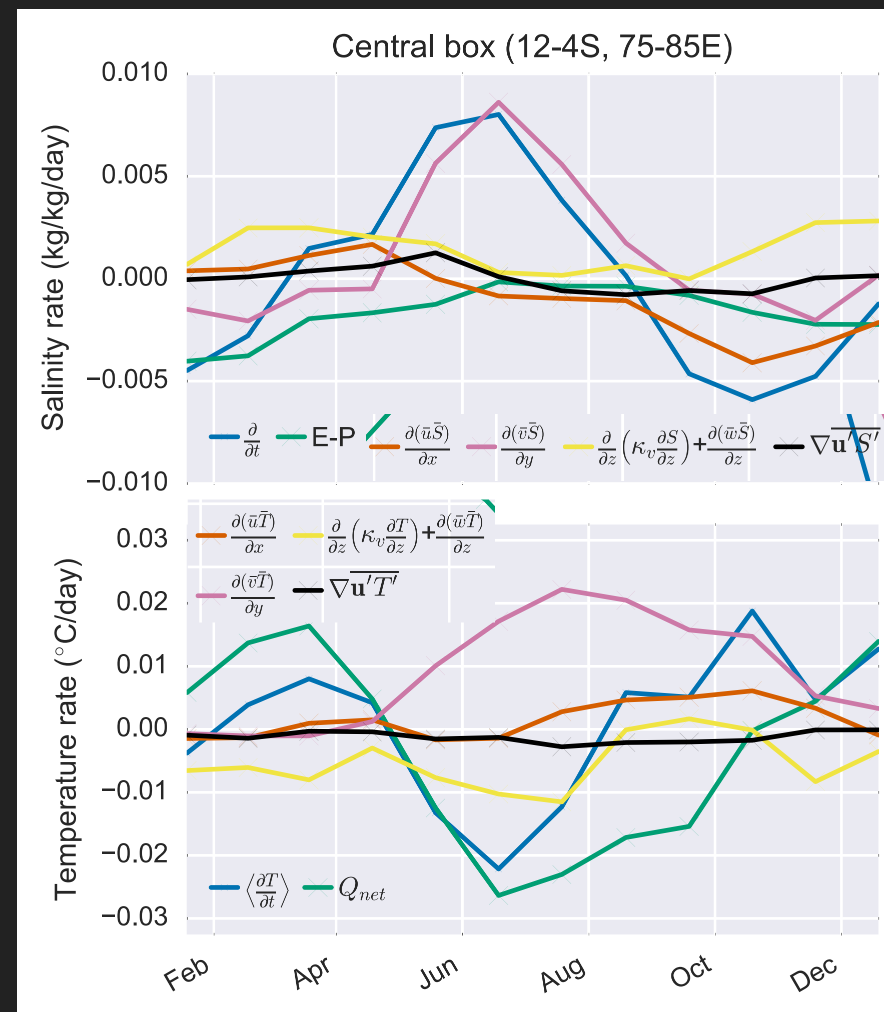


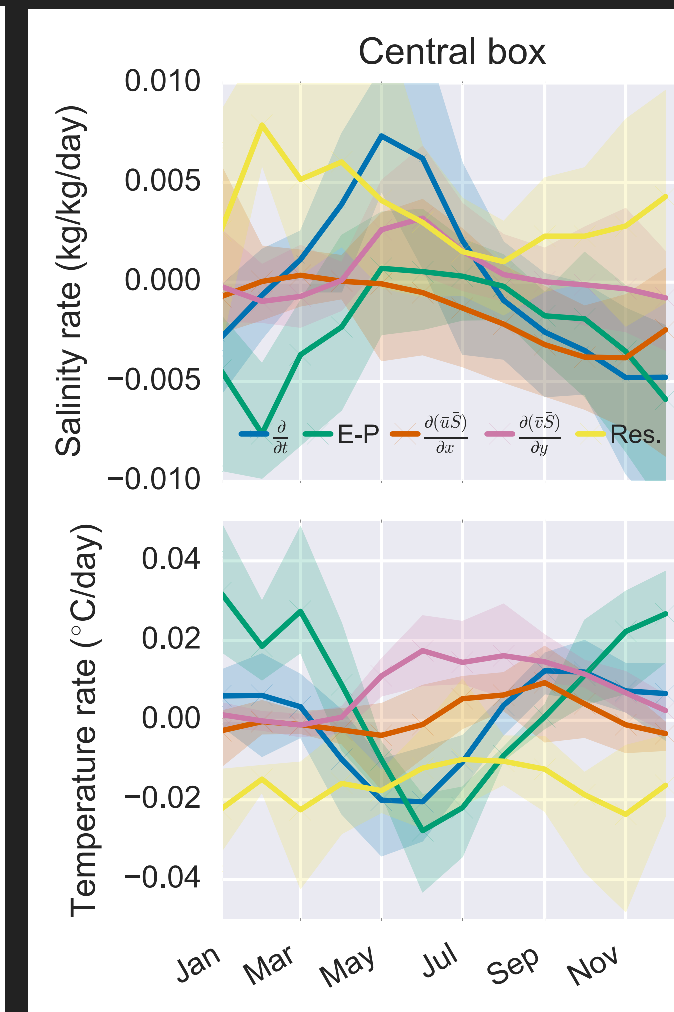
SST cooling in sync with wide-spread freshening of the upper 100 m (intrusion)

Completely decouples mixing layer from thermocline. (Very shallow ML)

SEASONAL CYCLE OF SALINITY AND TEMPERATURE





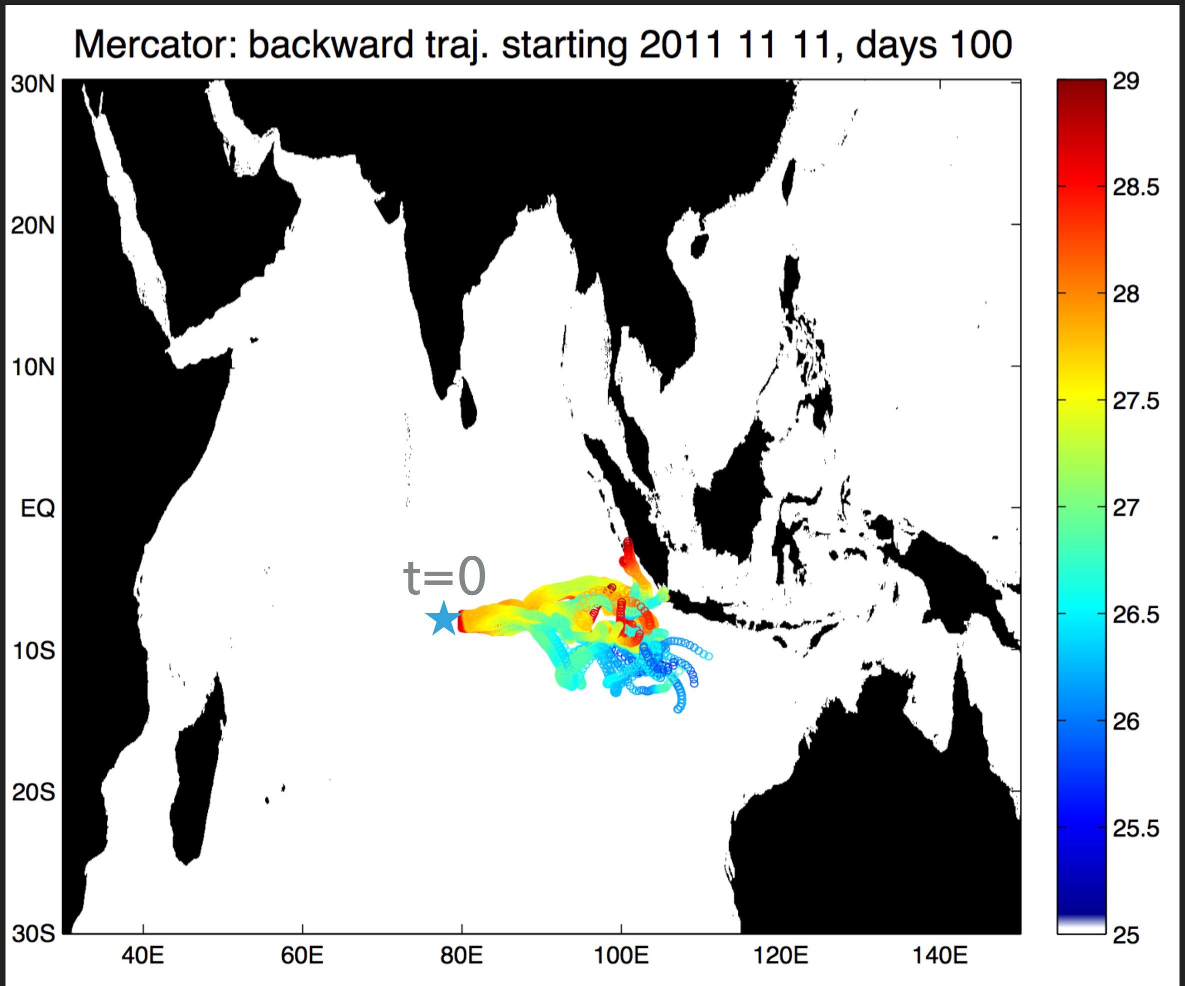


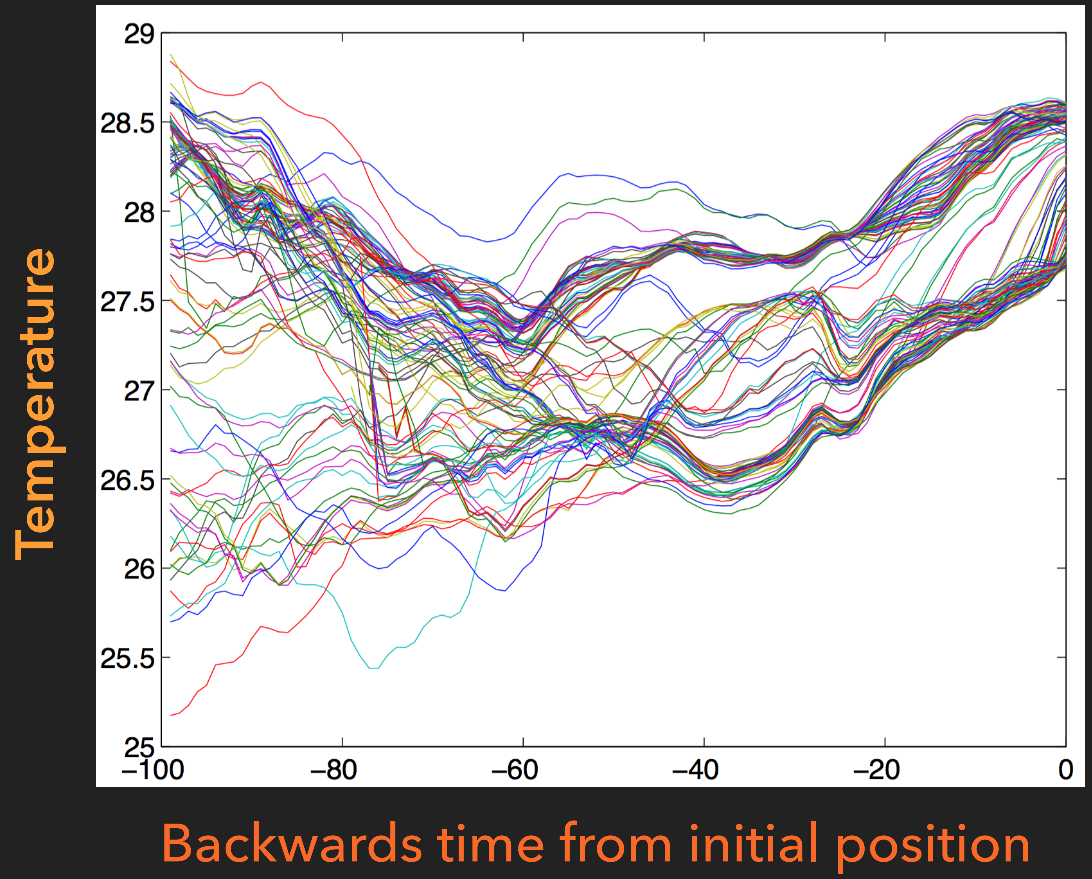
Fresh water is part of the seasonal cycle of the the tropical indian ocean

Controlled by zonal advection of fresher and warmer waters from the east

This fresher east Indian Ocean water stratifies upper most layer and separates BL from thermocline

ORIGIN OF ADVECTED WATERS





The SST cooling in CINDY2 is cold advection by the annual Rossby Wave (e.g. Seike et al. 2013)

Surface waters travel a great distance, warming along the way due to surface forcing and mixing

Implications for MJO air-sea interactions and forecast

- A fair assessment of the ocean role in initiation and development of MJOs in coupled models requires to determine how well the ocean component of the coupled system is capturing the ocean state
  - Small scales processes that depend on vertical resolution and frequent coupling
  - Remote influences and long seasonal time-scales
  - Salinity variations due to local precipitation and advection
  - Thermocline ridge appears less important than previously thought

TOPICS TO BE EXPLORED

- Numerical experimentation with CGCM to address MJO sensitivity to the processes identified here
- Sensitivity to vertical resolution
- Need to expand understanding of SST to other regions: Western sector of SCTR and Maritime Continent.
- Need to investigate further the event to event variability (weak/strong, non-propagating/propagating events)

QUESTIONS?