

Amala Mahadevan Woods Hole Oceanographic Institution

Summer Monsoon winds



Air-sea Interaction Regional Initiative in the Northern Indian Ocean

Ocean Currents

Amit Tandon **Tom Farrar Bob Weller** Jennifer MacKinnon Andrew Lucas **Emily Shroyer** Eric D'Asaro Craig Lee Arnold Gordon **Daniel Rudnick Rob Pinkel** Luca Centurioni Karan Venayagamoorthy Sutanu Sarkar Jonathan Nash Harper Simmons Lou St Laurent **SUP** Jinadasa H.J.S. Fernando Hemantha Wijesekera **Tommy Jensen** lossif Lozovatsky **Debasis Sengupta** M. Ravichandran R. Venkatesan Rashmi Sharma

earth.nullschool.net

Source: Twisted sifter

1.5 billion people depend on the Monsoon water, food, economy



There are more people living inside this circle than outside of it.

population vs. longitude

The world's largest populations lie astride the Bay of Bengal

- Seasonal wind reversal changes circulation
- Extremely fresh
- Highly stratified, poorly ventilated
- Warm surface SST responds quickly
- Air-sea fluxes <-> FW runoff
- Oxygen minimum zone



ONSOON WINDS

Bay of Bengal - anomalous ocean



Surface salinity from the Aquarius satellite - Jan 2012



A challenge for prediction

Climate models (dry bias)



Ocean models - Surface too cool Intra-seasonal variability



Large uncertainty in air-sea fluxes - differences amongst flux products

Mean net surface heat flux(1988-2000)









Air-sea interaction regional initiative

Improve monsoonal prediction on sub-seasonal time scales through a better understanding of the upper ocean structure, processes, and ocean-atmosphere exchange.





Building a Partnership

Indian Ministry of Earth Sciences

- Starting with a steering committee 2010 August, white paper, Exploratory meetings with Indian & Sri Lankan Institutions / Ministries
- Several science meetings 2011 (WHOI), 2012 (NRL), 2012 (IISc, India)- Framing of Indian Science plan for OMM. 2013 Monsoon mission mtg. IITM Pune 2013 Hyderabad, Boston/San Diego, 2014, San Diego.

• Cruises :

Nov-Dec 2013 R/V Roger Revelle - 2 Legs from Colombo, Sri Lanka

Dec 2013 Sagar Nidhi from Chennai

June 2014 R/V Revelle - from Chennai

August 2014 Sagar Nidhi

Oct/Nov 2014 Sagar Nidhi - mooring deployment

Summer school in India
2014 July



NARA- Colombo

What sort of program ?

Improve monsoonal prediction on sub-seasonal time scales



fluxes, phenomena

Interpret observations explore parameter dependence

Questions

Air-sea fluxes of heat, moisture and momentum Quantify, test and refine parameterizations

Controls on surface temperature Responds rapidly to incoming solar radiation.

Upper ocean stratification, freshwater, its dispersal How is surface freshwater entering the northern bay get dispersed?





Bay of

Bengal

Ganges

Rive

India

Arabian

Sea

- Challenges Salinity controls surface density influenced by FW discharge
 - Country EEZs
 - Access
 - Sharing of data



NCOM simulated Surface Salinity (30 Oct 2009) from Tommy Jensen, NRL

Research Cruises



R/V Roger Revelle 83.5m, 3180 tons





R/V Sagar Nidhi 103.6m, GRT 4862 Mt

UCTD survey ADCP Turbulence glider Temperature microstructure Gliders Radiometry/ IOP Wire walker



n

Process Study Ocean Model

shows submesoscale eddies and filaments that contribute to lateral and vertical dispersal of fresh water



Bay of Bengal -Air sea flux

Controls on SST: Solar input

Measure: Light, attenuation, properties Spectrally-resolved radiometry Inherent optical properties of water-Absorption, scattering Constituents of water dissolved, particulate organic matter solar input barrier layer advection of heat (fresh) Scattering of light thermocline absorption of light example mixing of heat density profile

Improve estimates of A-S flux Test bulk formulae



Surface meteorology every minute Direct covariance flux.



Expected Outcomes

Scientific

Long term observatory

- Air-sea flux measurements + solar input
- Test bulk formulae, improve models
- Upper ocean vertical structure

Measure mixing rates

- Relate to air-sea fluxes and stratification
- Test and improve parametrizations
- Improve upper ocean vertical structure in models

Process modeling

- Understand freshwater dispersal mechanisms
- Understand mixing processes
- Estimate advection test for seasonal variations

Expected Outcomes

Partnership

Training and Education

- New generation of oceanographers in India
- Use of new instrumentation
- Building a sustainable observation program
- Scientific collaboration > 10 years
- Cooperation on instrumenting the ocean
- Bay of Bengal observatory

Summary

Monsoons an ocean-atmosphere climate phenomenon of high societal relevance. Needing our community's attention.

Large uncertainty in forecast —variability on sub-seasonal time scales and regional spatial scales not captured by models

Northern Indian Ocean - unique region - strong freshwater influence, poorly ventilated to the north.

Specific questions being addressed through ASIRI:

- Atmospheric convection occurs over the ocean -Strong air-sea interaction air-sea fluxes?
- Controls on SST?
- Surface freshwater dispersal and stratification?

Objective : Improve understanding and forecasting of the monsoons