Salinity Structure of the Indian Ocean Dipole: Perspectives from Aquarius and SMOS satellite missions

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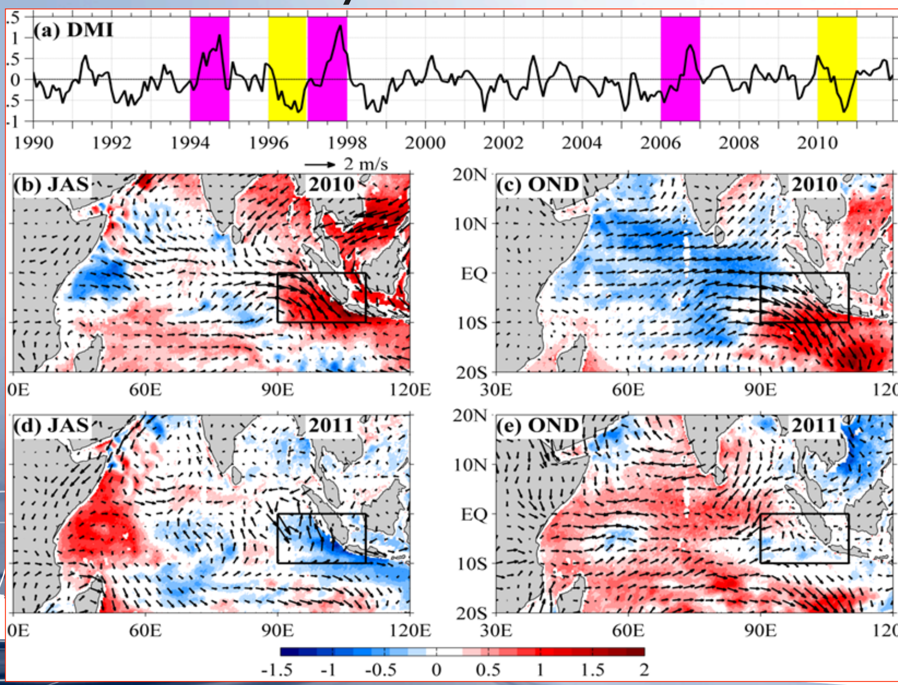
Background:

- ✓ Indian Ocean: least sampled among the world' s oceans
- ✓ Indian Ocean Dipole (IOD): an interannual timescale east–west sea surface temperature (SST) oscillation
- ✓ IOD arises from ocean–atmosphere interactions and affects the regional climate variability

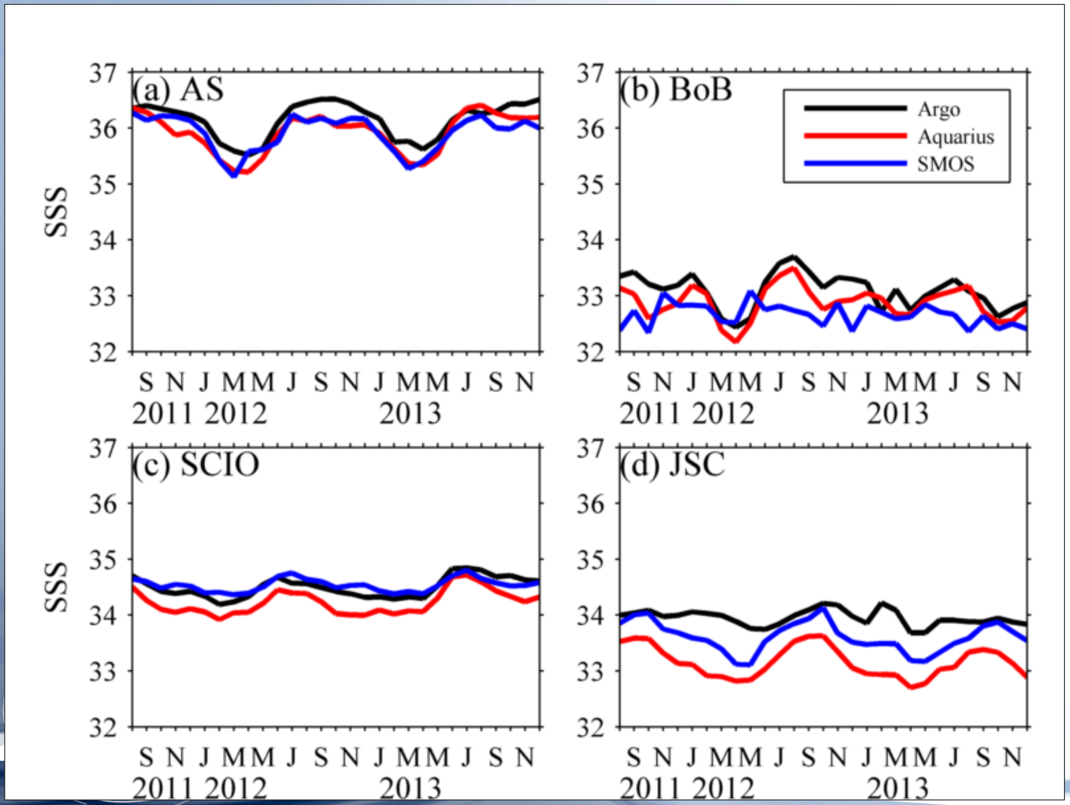


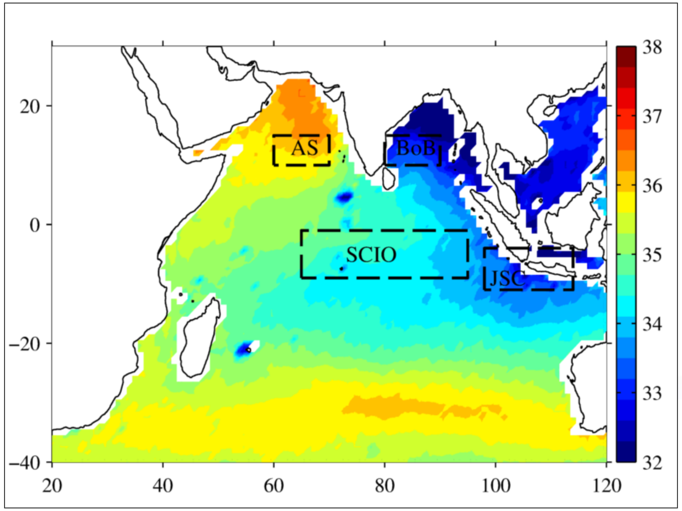
Objectives:

- ✓ Evaluate validity of Aquarius and SMOS SSS in Indian Ocean
- ✓ Assess satellites' observations of SSS during IOD events
- ✓ Quantify the salinity budgets in Central Equatorial and Eastern Indian Ocean regions

Data

- Aquarius (NASA JPL)
- SMOS (IFREMER)
- Argo float data (APDRC)

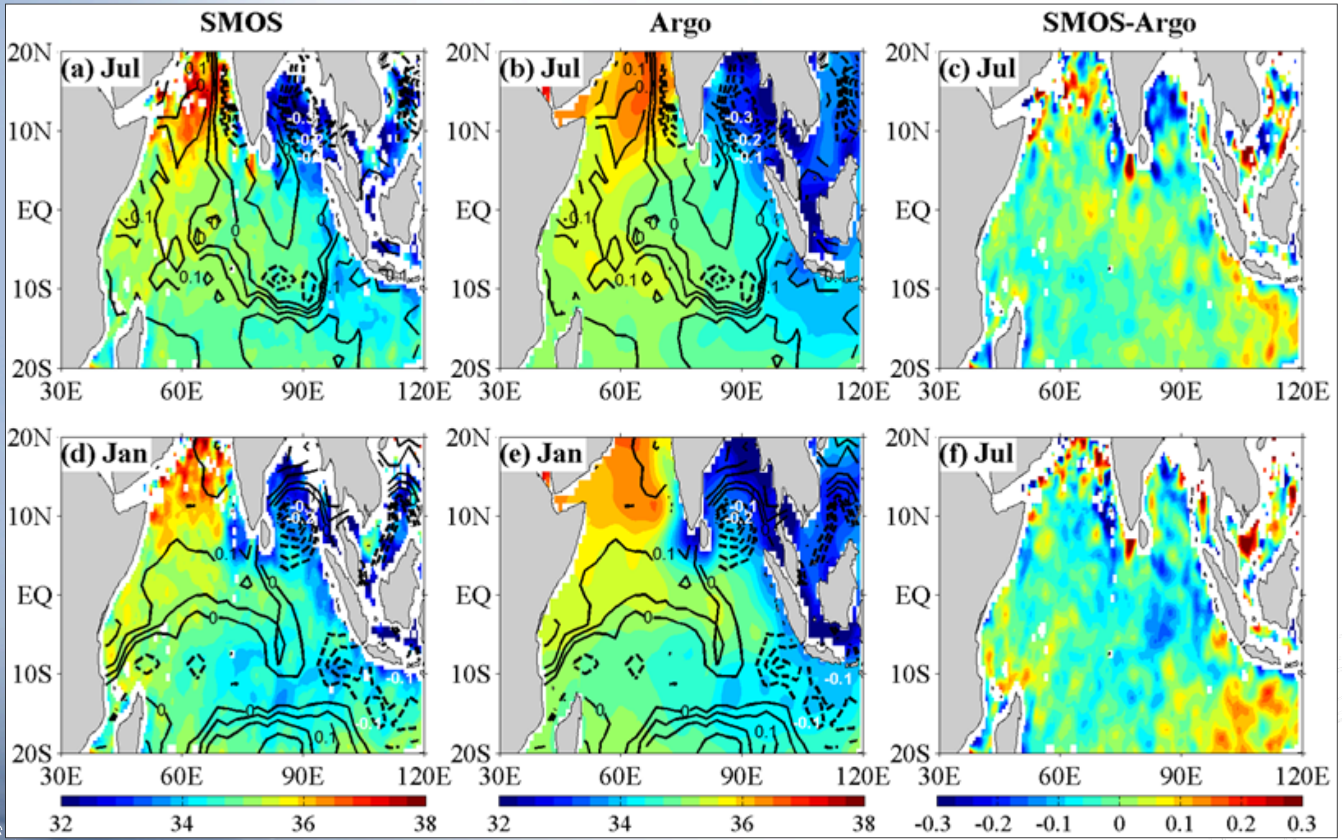




- Relatively good comparison between data sets
- Possible challenges in high precipitation regions

Results:

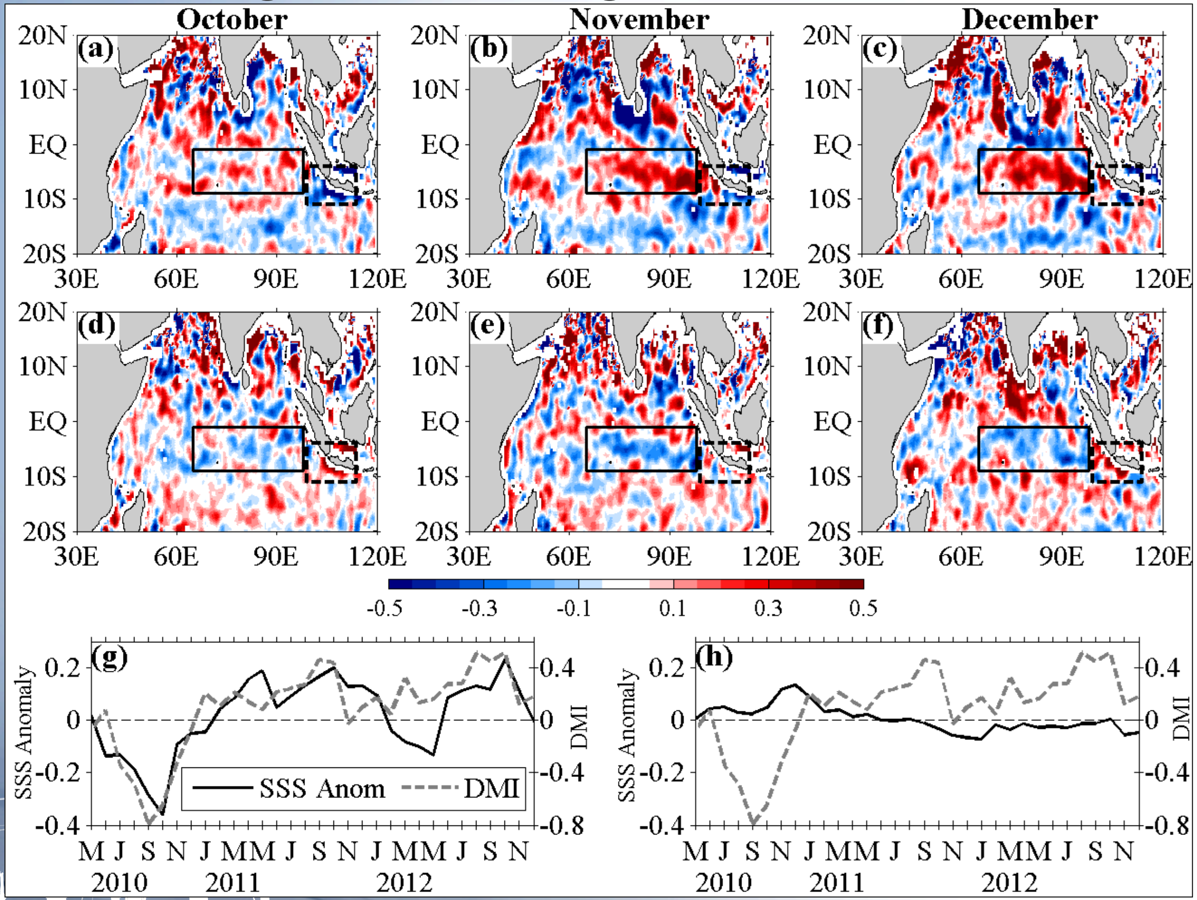
- SSS, E-P



2011 SSS for SMOS and Argo. Contours show evaporation minus precipitation (E-P).

Low SSS around JSC during 2010 NIOD. Absent during 2011

High SSS along SCIO during 2010 NIOD. Absent during 2011



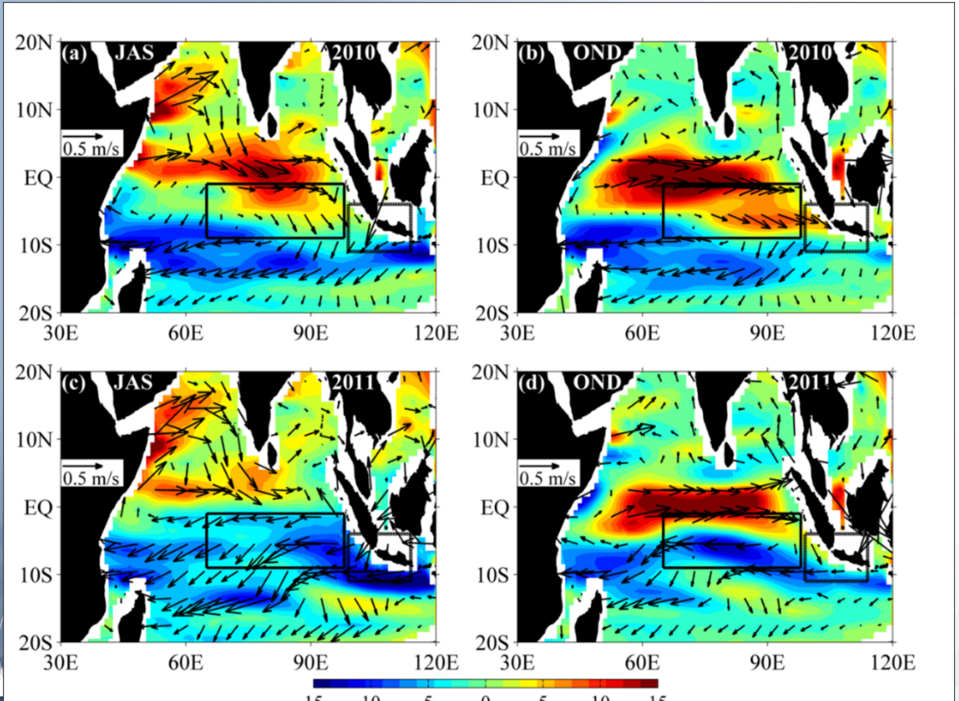
Temporal evolution of box-averaged SSS anomalies shows peak during SON 2010

SMOS SSS anomalies for (top row) 2010 and (middle row) 2011. Temporal evolution of SSS anomalies for JSC (g) and SCIO (h)

Salt flux computed from: $F = \rho u S$

✓ Flux of high-salinity waters from the western Arabian Sea and NE Africa during SW monsoon

✓ By OND, high salinity waters extend into SCIO region and eastern Indian Ocean.

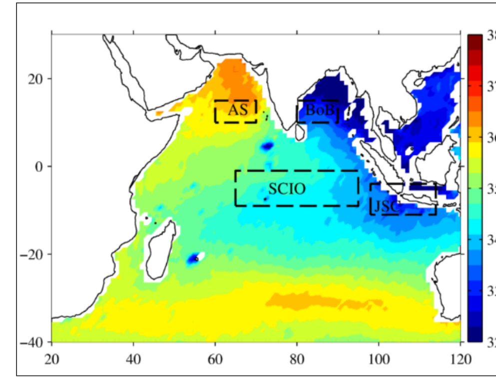


Salt flux(kg m^{-2}s^{-1})for 2010 and 2011. Overlaid are OSCAR currents.

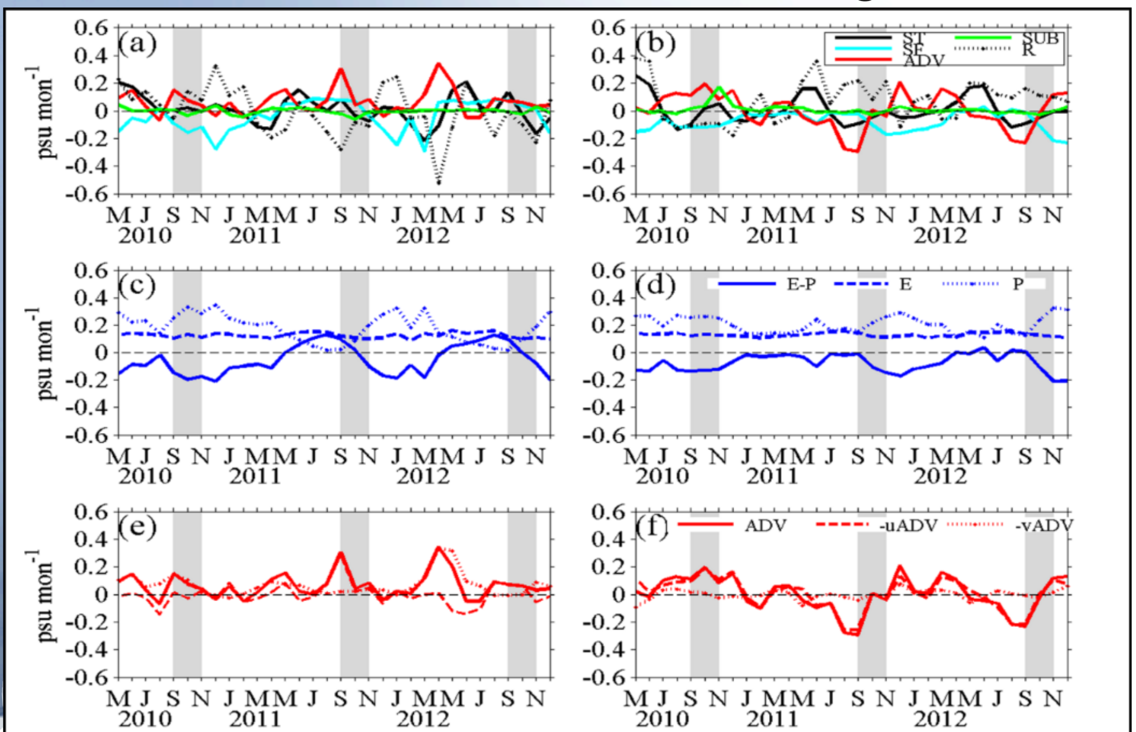
- Eastward flux by Wyrtki Jets; enhanced during NIOD events
- Westward salt flux around 10°S and 15°S by the SEC

Salt budget estimated from:

$$\frac{\partial S}{\partial t} = S\frac{(E-P)}{h} - u\frac{\partial S}{\partial x} - v\frac{\partial S}{\partial y} - w\frac{\partial S}{\partial z} + R$$



JSC region: salinity tendency dominated by advection and surface freshwater forcing terms



Salt budget terms averaged in the boxes for (left panel) JSC and (right panel) SCIO

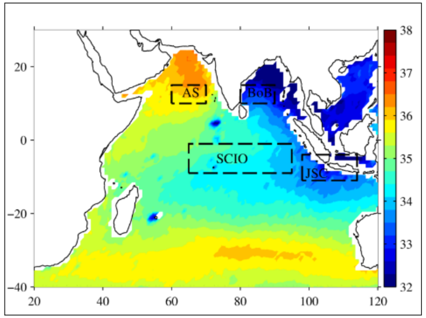
SON 2010: net positive salt advection; negative SSS anomaly however

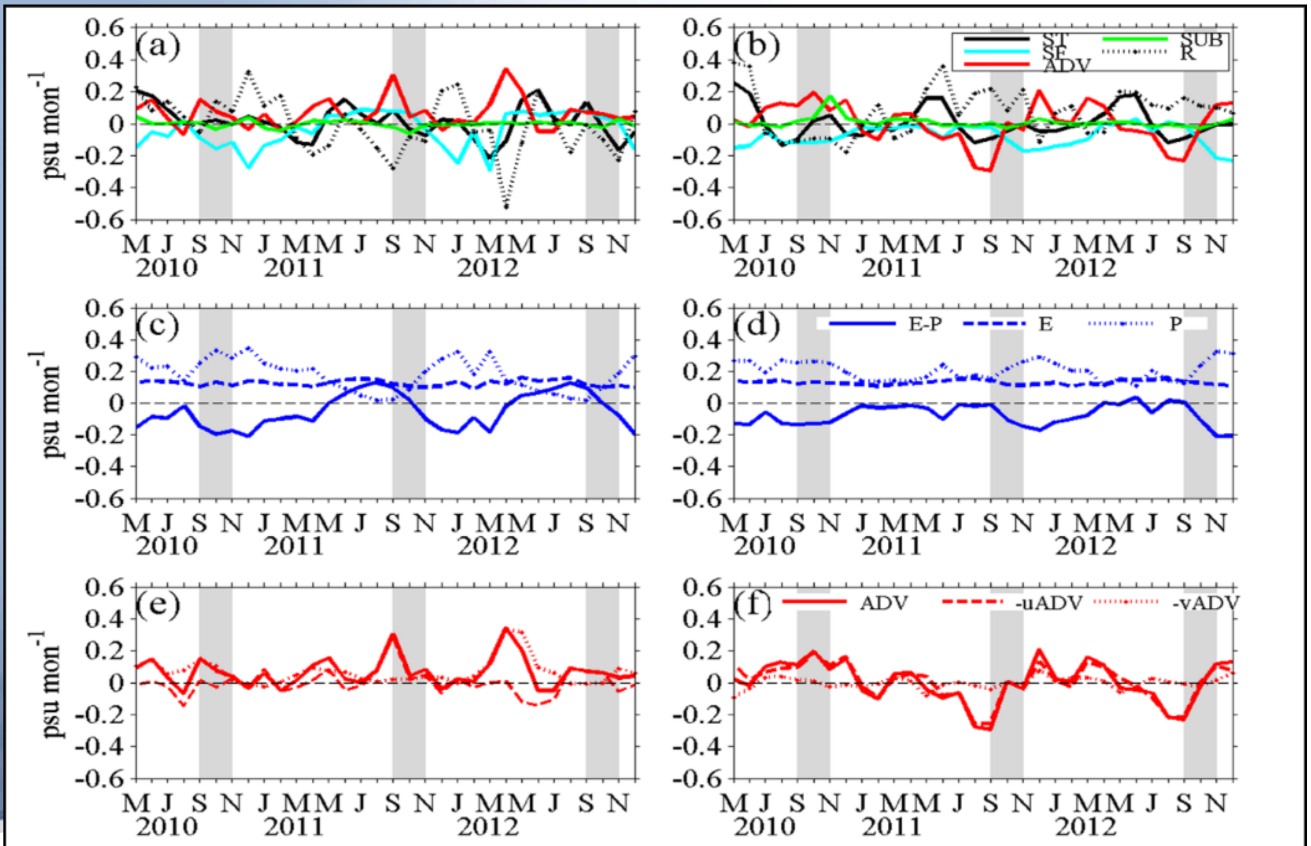
Higher precipitation than evaporation

SON 2011/12: SFW relatively lower; higher SSS anomalies

SCIO region: salinity tendency dominated by advection and surface freshwater forcing terms

Increased zonal advection bring high saline waters from west.





Salt budget terms averaged in the boxes for (left panel) JSC and (right panel) SCIO

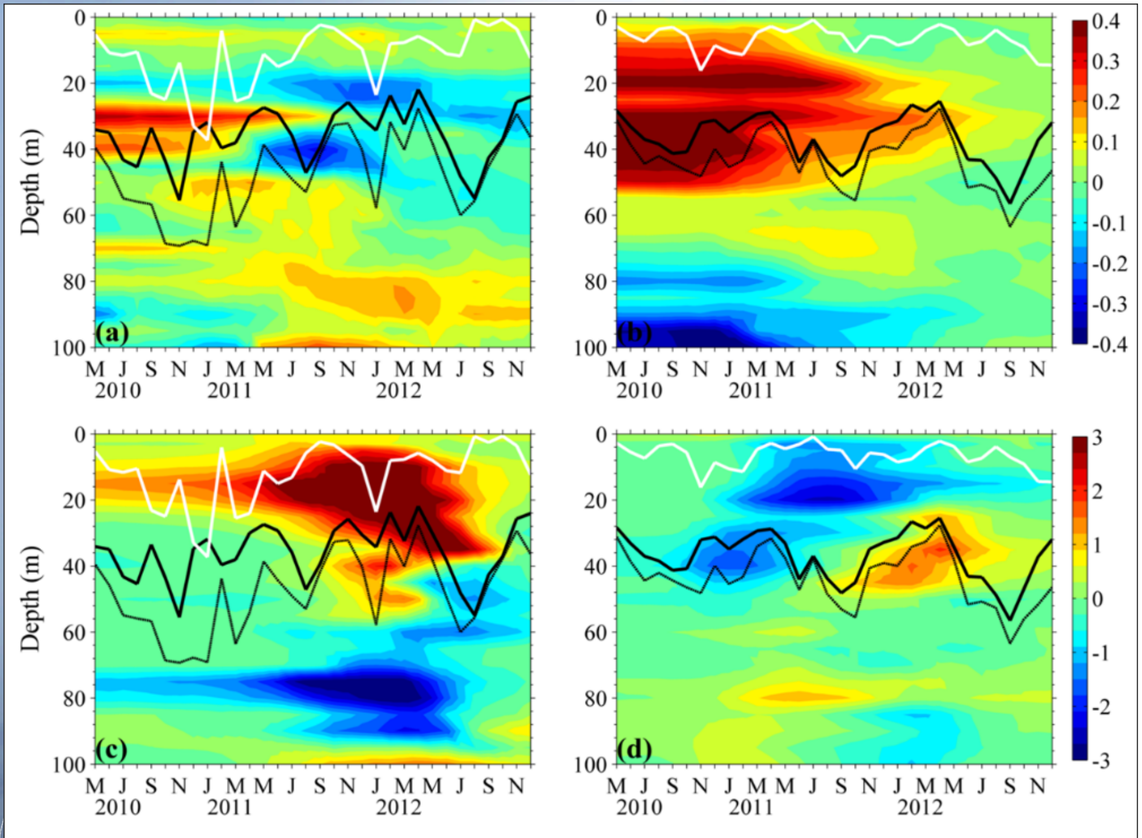
SON 2010: lower ppt; higher *SUB* term

2011/12: advection reverses to be westward;

This brings less saline waters from Pacific Ocean

JSC: during SON 2010, barrier layer thickens; MLD deepens;

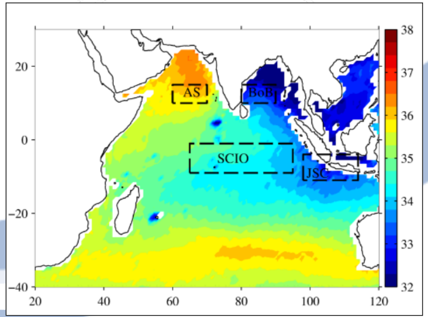
Thermocline however also deepens due to elevated temperatures; suppresses upwelling of subsurface salt



Argo salinity anomalies (a) and (b), Argo temperature anomalies (c) and (d) averaged in the boxes for (left panel) JSC and (right panel) SCIO. Isothermal layer depth (dashed black line), Mixed layer depth (solid black line), and barrier layer thickness (the solid white line); BLT=ILD-MLD

Opposite scenario happens SCIO region: thermocline shoals,

favors upwelling of more saline sub-surface waters into surface waters



Summary:

Satellite-derived SSS compares quite well with Argo data

Java Sumatra Coast:

- ✓ low SSS anomalies during 2010 NIOD event
- ✓ salt tendency is an interplay between the freshwater forcing and horizontal advection terms
- ✓ Increased precipitation more important than zonal advection

South Central Indian Ocean:

- ✓ high SSS anomalies during 2010 NIOD event
- ✓ advection seems to be more important than the freshwater forcing term

Thank you