Interannual variability of the western boundary current of the Bay of Bengal: 25 years of repeated XBT sections

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XBT – Science Workshop, Tokyo

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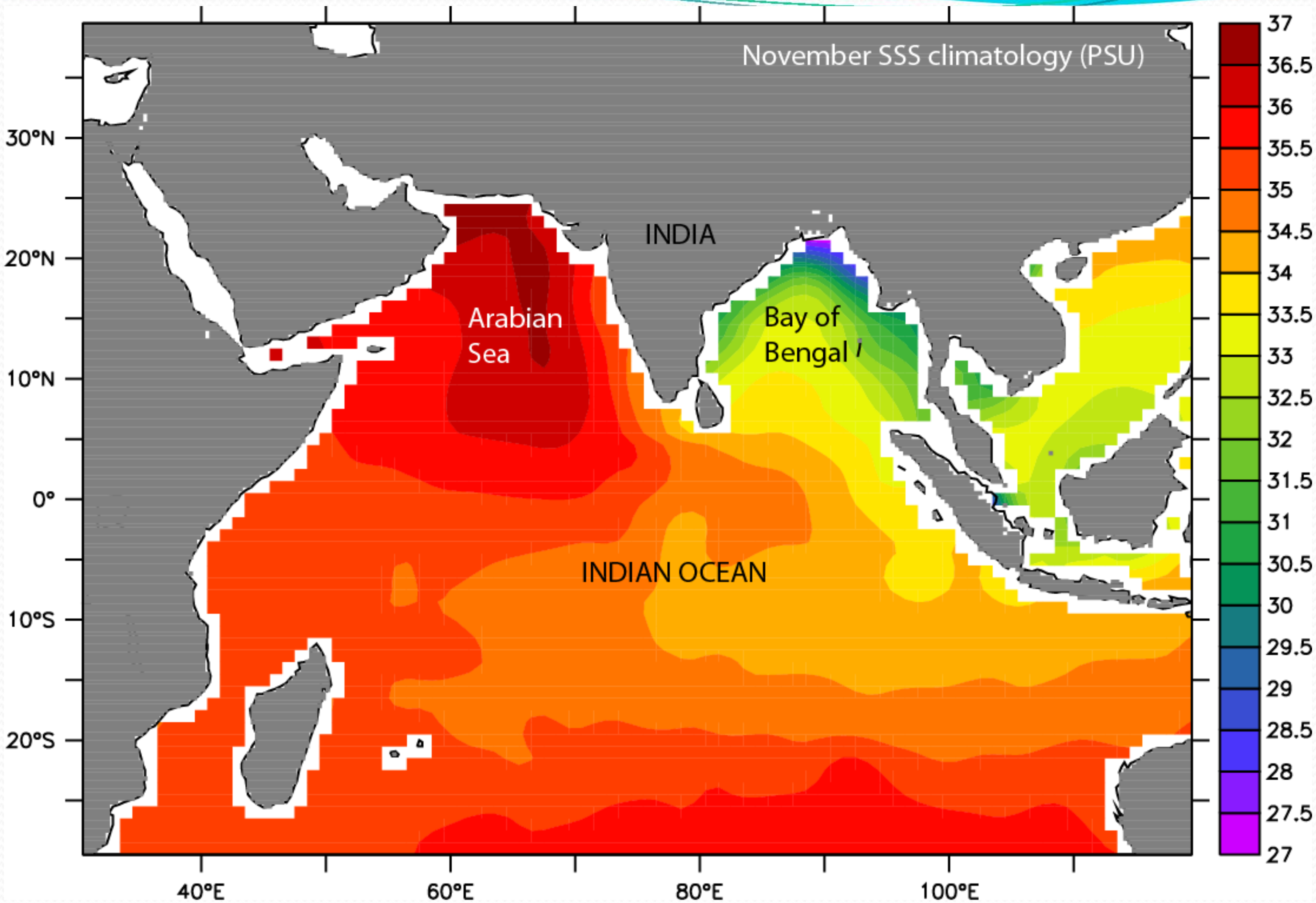
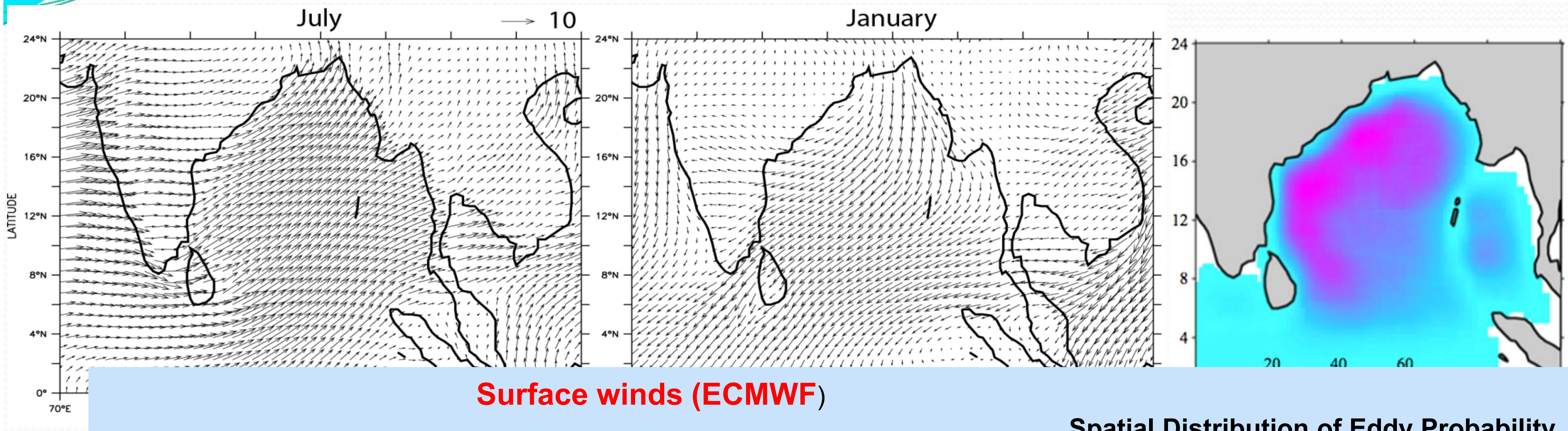
Background of the Study area (Bay of Bengal)



- **Semi - enclosed tropical basin, restricting northward transport of Heat & Mass.**
- **Evaporation – Précipitation is always - ve**
- **Strong haline stratification, shallow mixed layer, 4^0 - 5^0C Temp. Invensions**
- **Devastating Tropical Cyclones**

Background of the study area (Bay of Bengal)



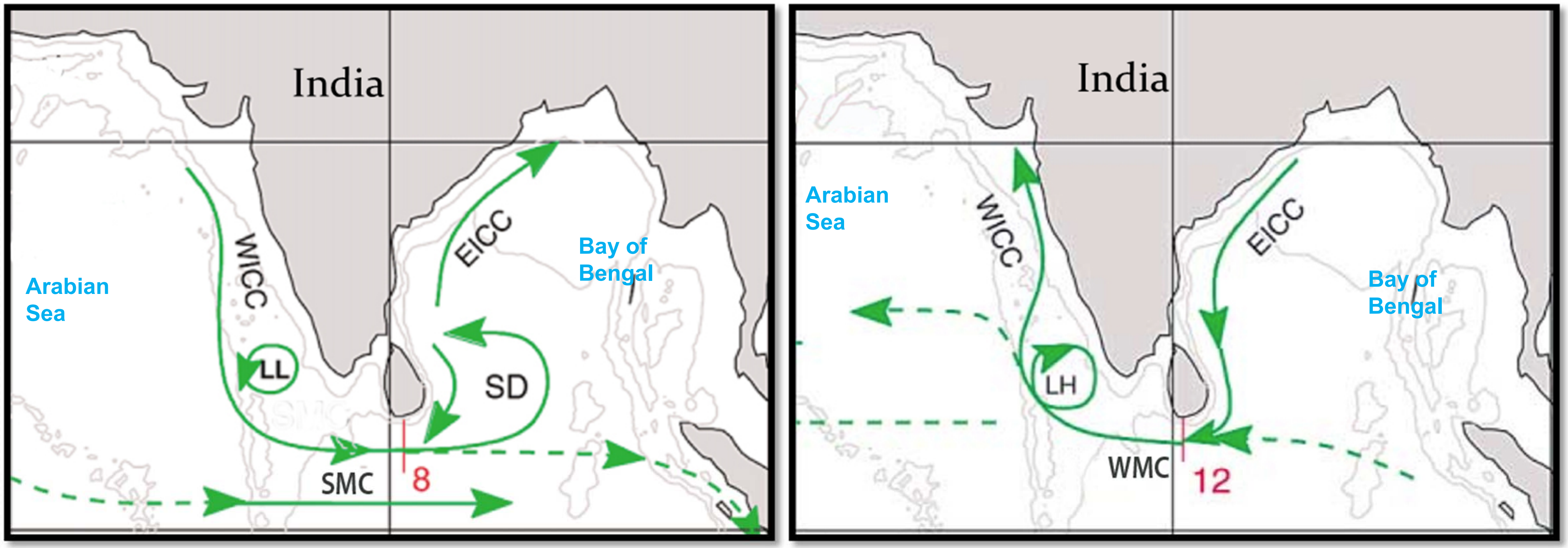
Surface winds (ECMWF)

Spatial Distribution of Eddy Probability (Gengxin Chen et al; 2012)

- Seasonal riversal of monsoonal winds, July (Southwesterlies) & January (Northeasterlies)
- Western BoB is prone to strong mesoscale eddies; influencing the coastal currents.

Background of the study area (Bay of Bengal)

- East India Coastal Current (EICC). Poleward (Feb - Sep) & Equatorward (Oct - Jan)
- EICC participates in the Exchange of Water Masses between basins.



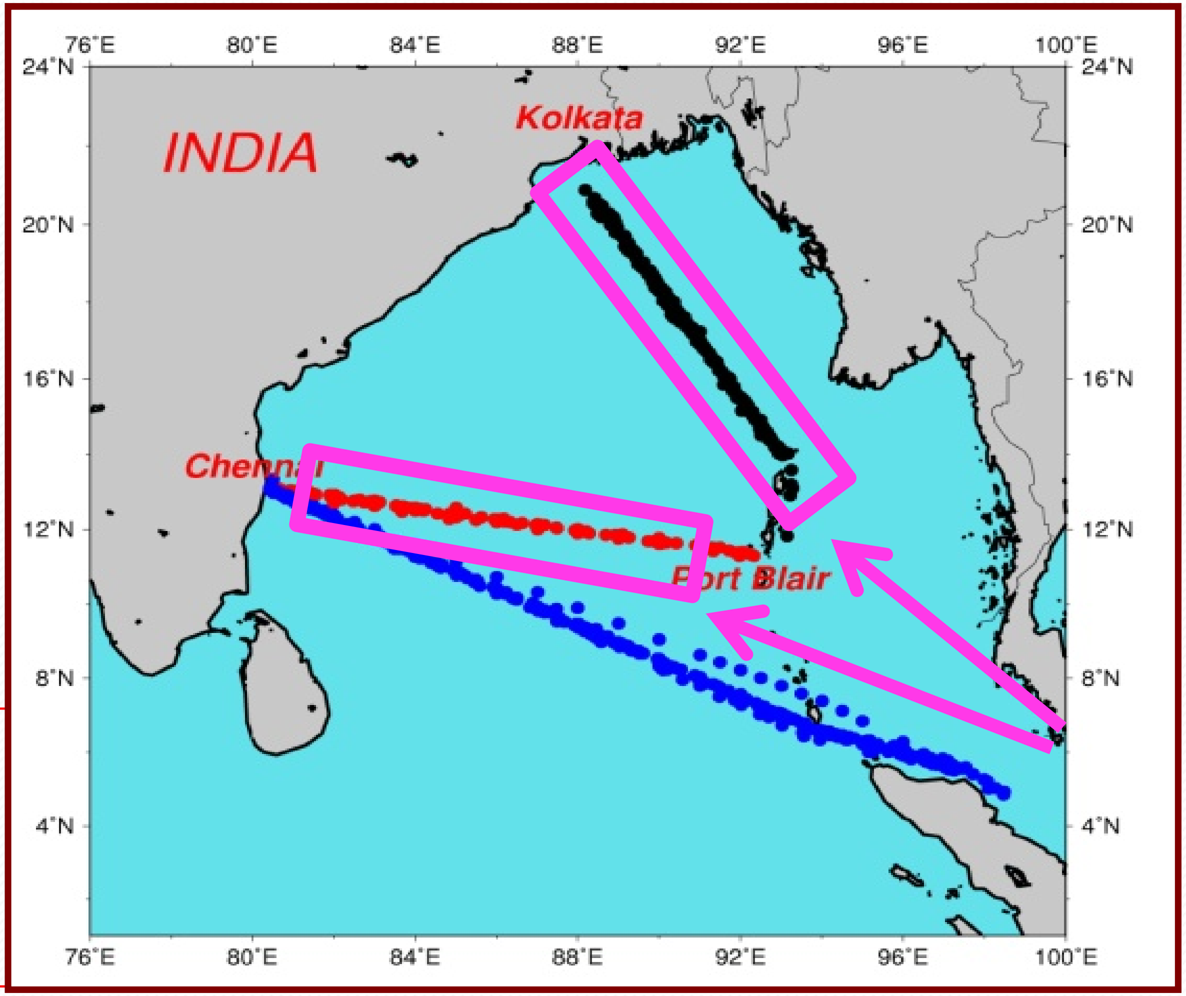
Summer

Winter

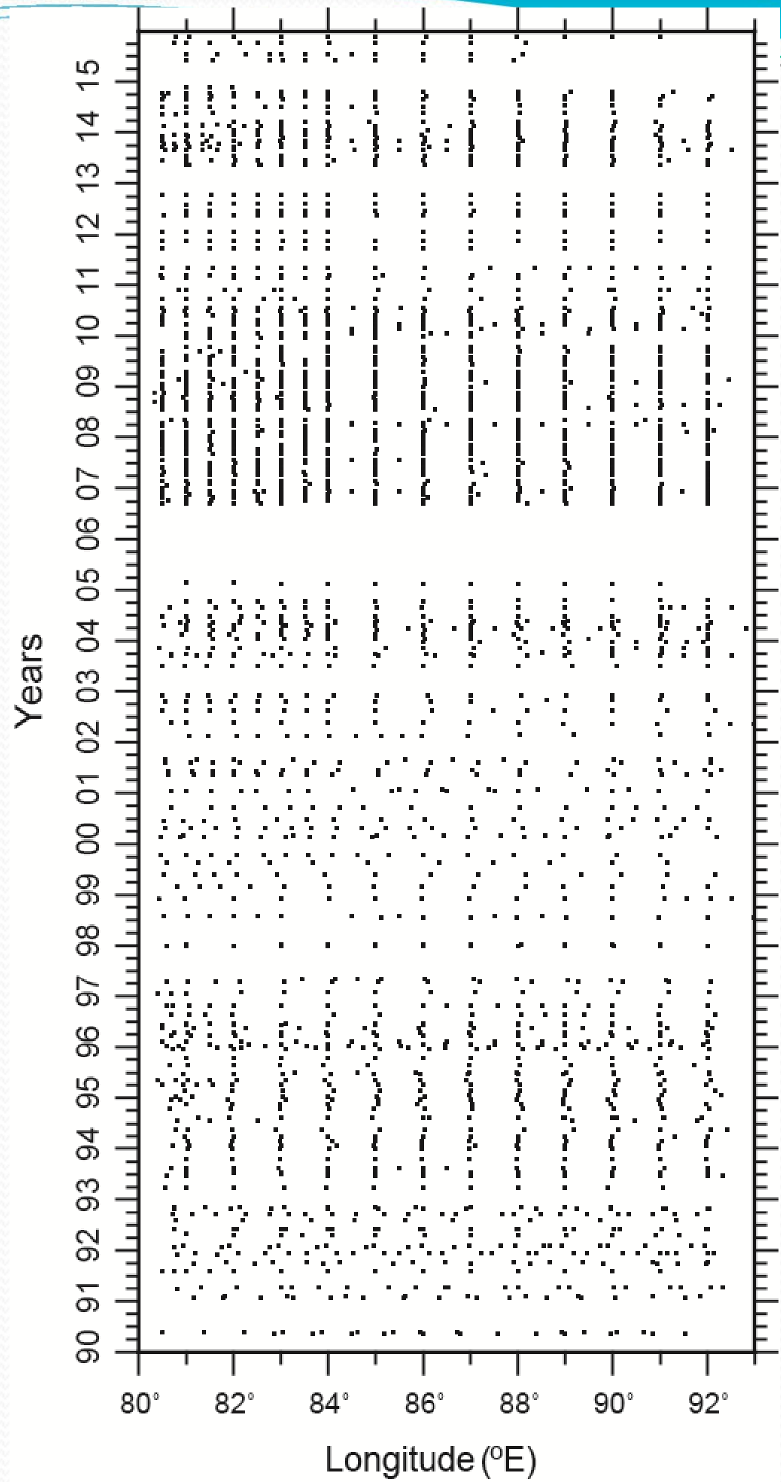
(Schott & McCreary, 2001)

XBT Observations

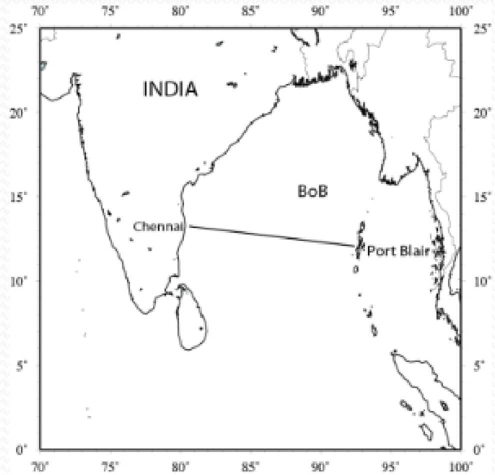
- T-7 XBT probes
- 1990 – continuing (25 years)
- Monthly voyages
- SSS Samples: at all XBT Stations



XBT data density (25 years)



Chennai – Port Blair Transect : 1990 - continuing

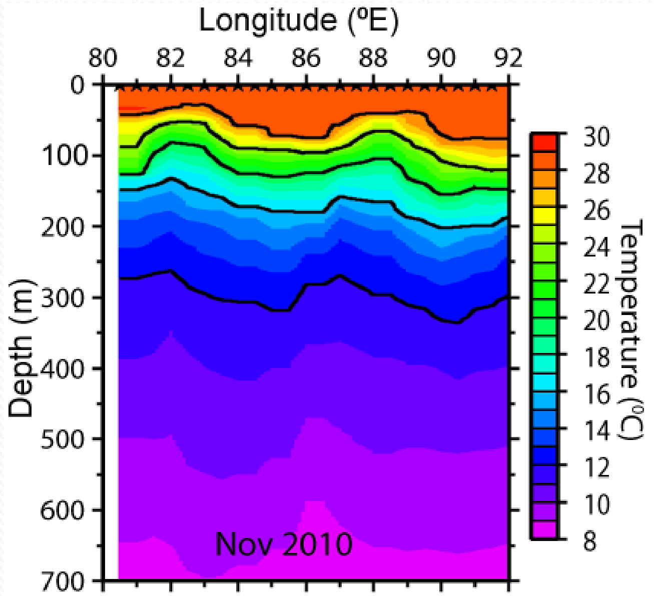


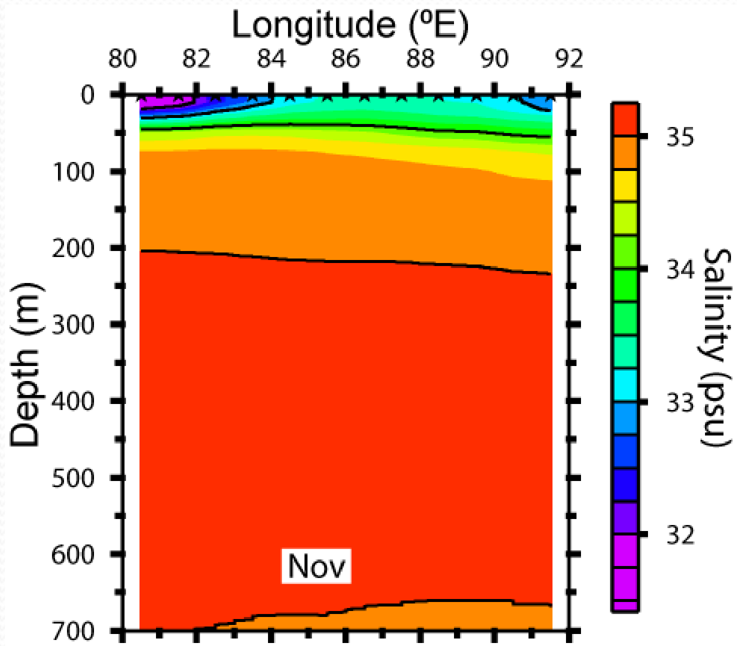
Computational strategy of geostrophic currents

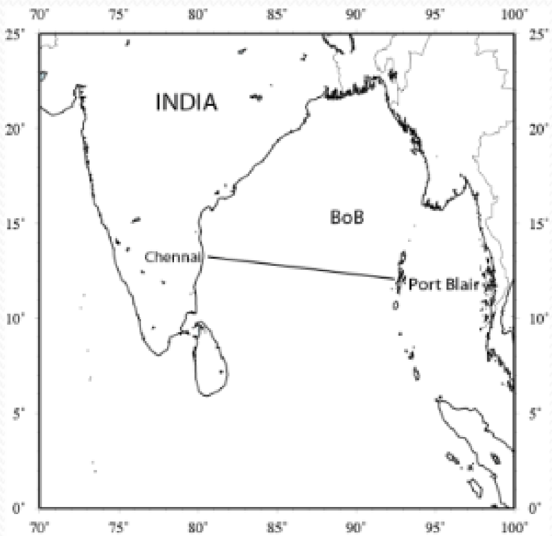
- **Carried out running averages for $1^0 x 1^0$ bin for each XBT transect.**

- **Monthly T-S relationship is developed from NIOA climatology.**

- **Using this T-S relation, salinity values are synthesized for each XBT (t) values.**





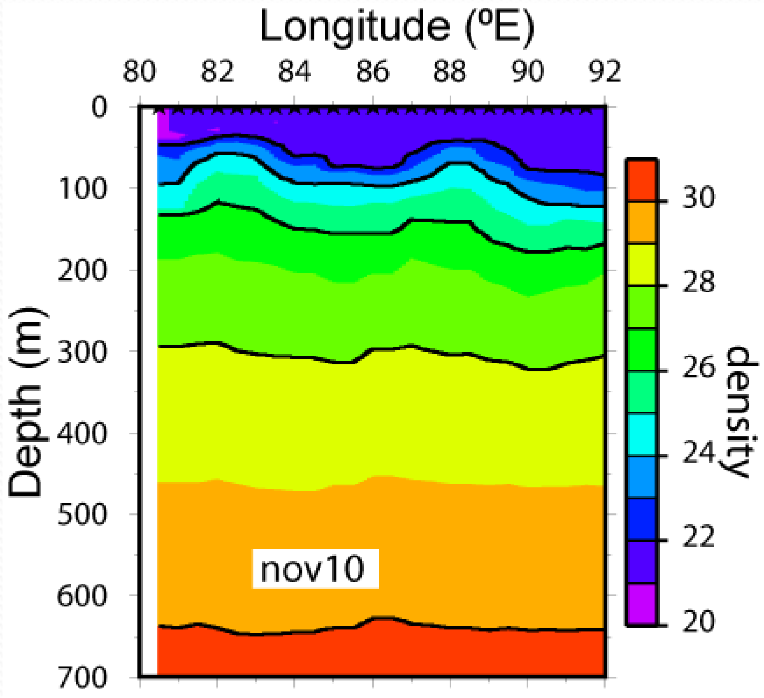


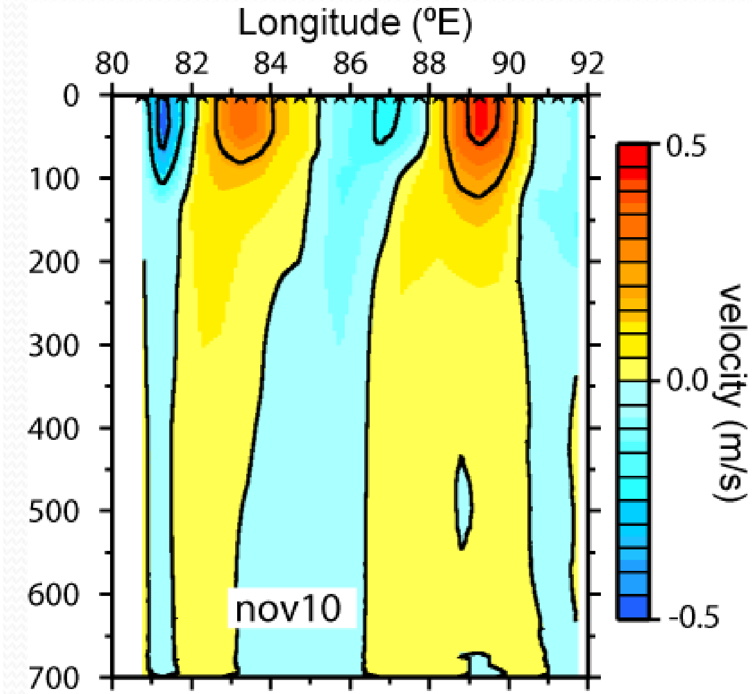
Computational strategy of geostrophic currents

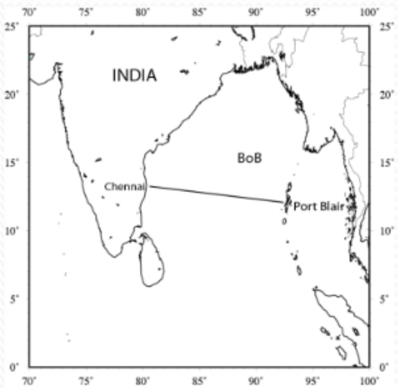
- **Density profiles are computed for each XBT (t) & Synthesized salinity.**
- **Crosstrack geostrophic currents are computed w.r.t 700m reference level**

$$V = \frac{g}{f\rho}\frac{\partial}{\partial x}\int_{-h}^{0}\rho(z)\,dz$$

- **A Hanning filter is applied to remove small scale fluctuations**

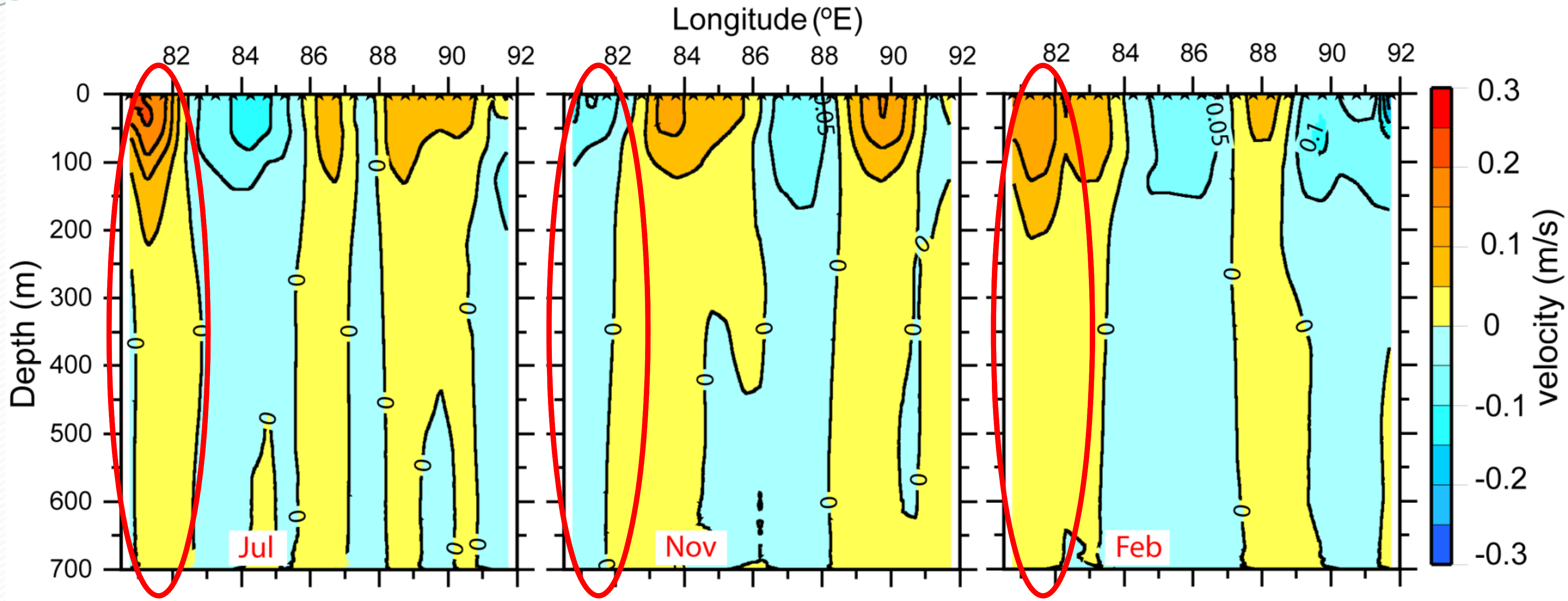




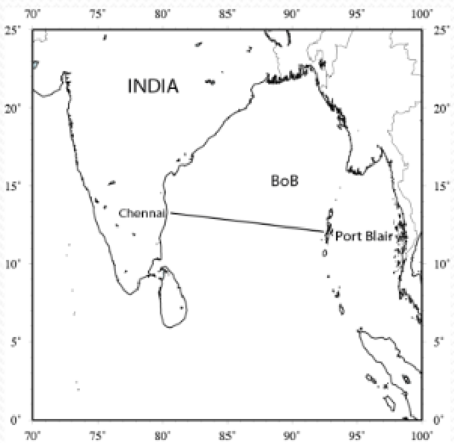


Results

Seasonal climatology of geostrophic currents



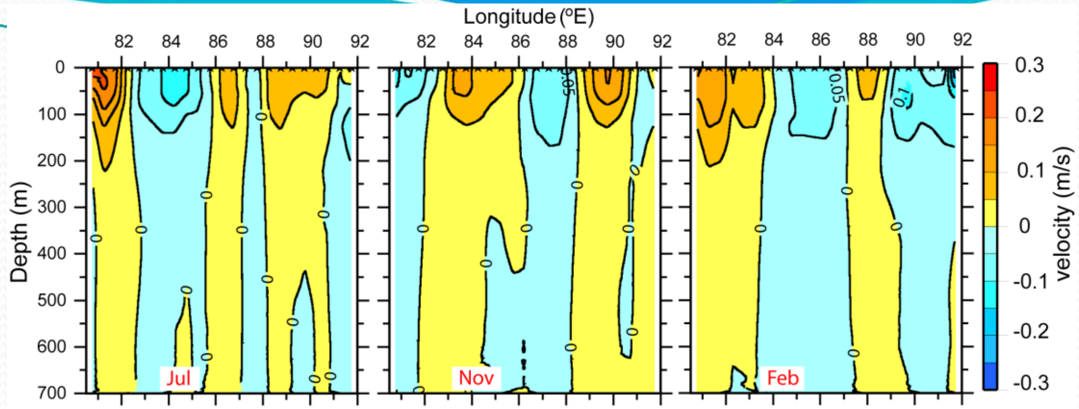
Boundary current is flowing northward during Summer (Dark shade

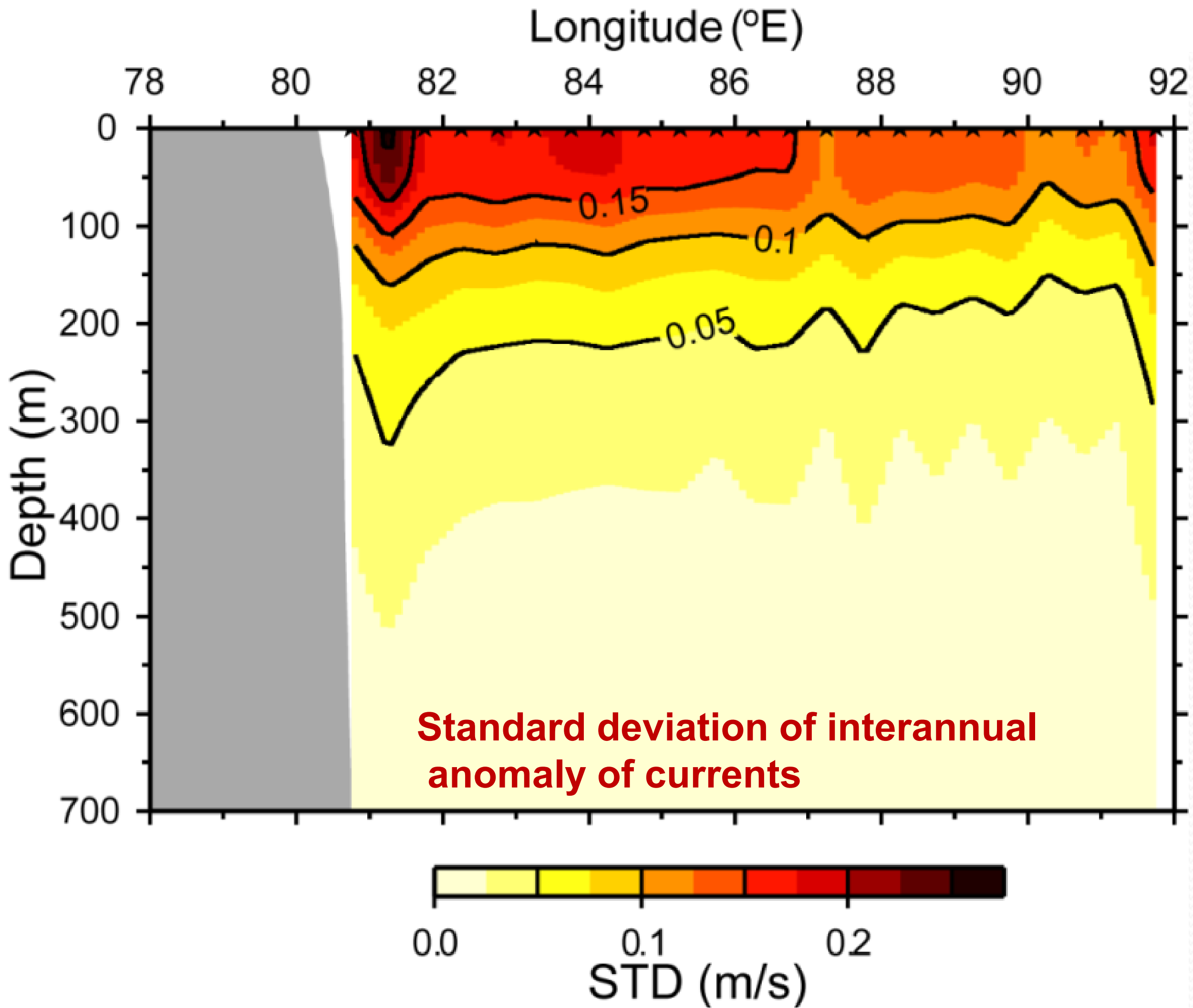


Eequatorward during Winter (Blue shade)

Results

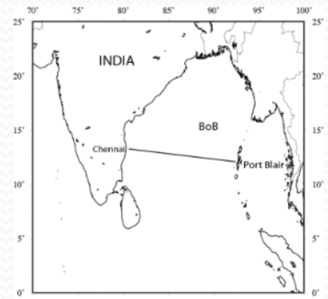
Seasonal climatology of geostrophic currents





Standard deviation of interannual anomaly of currents

- Maximum variability is seen in the west close to the coast & is trapped on the slope region in a narrow band



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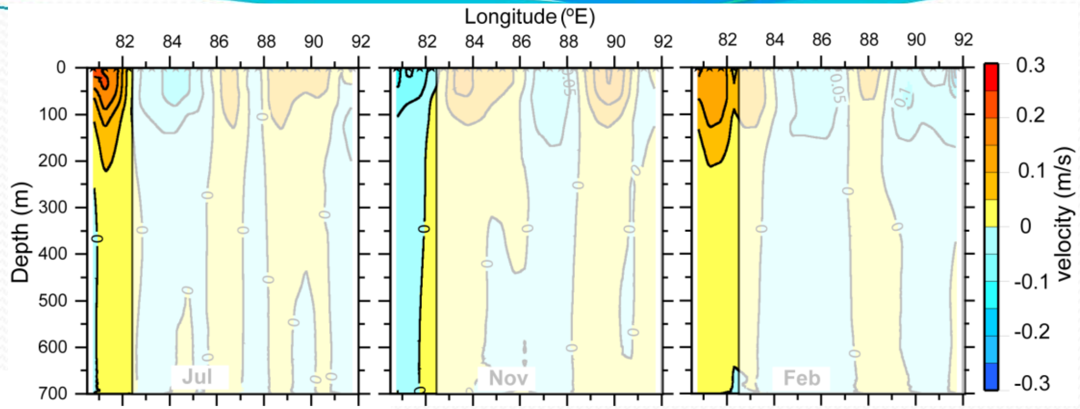
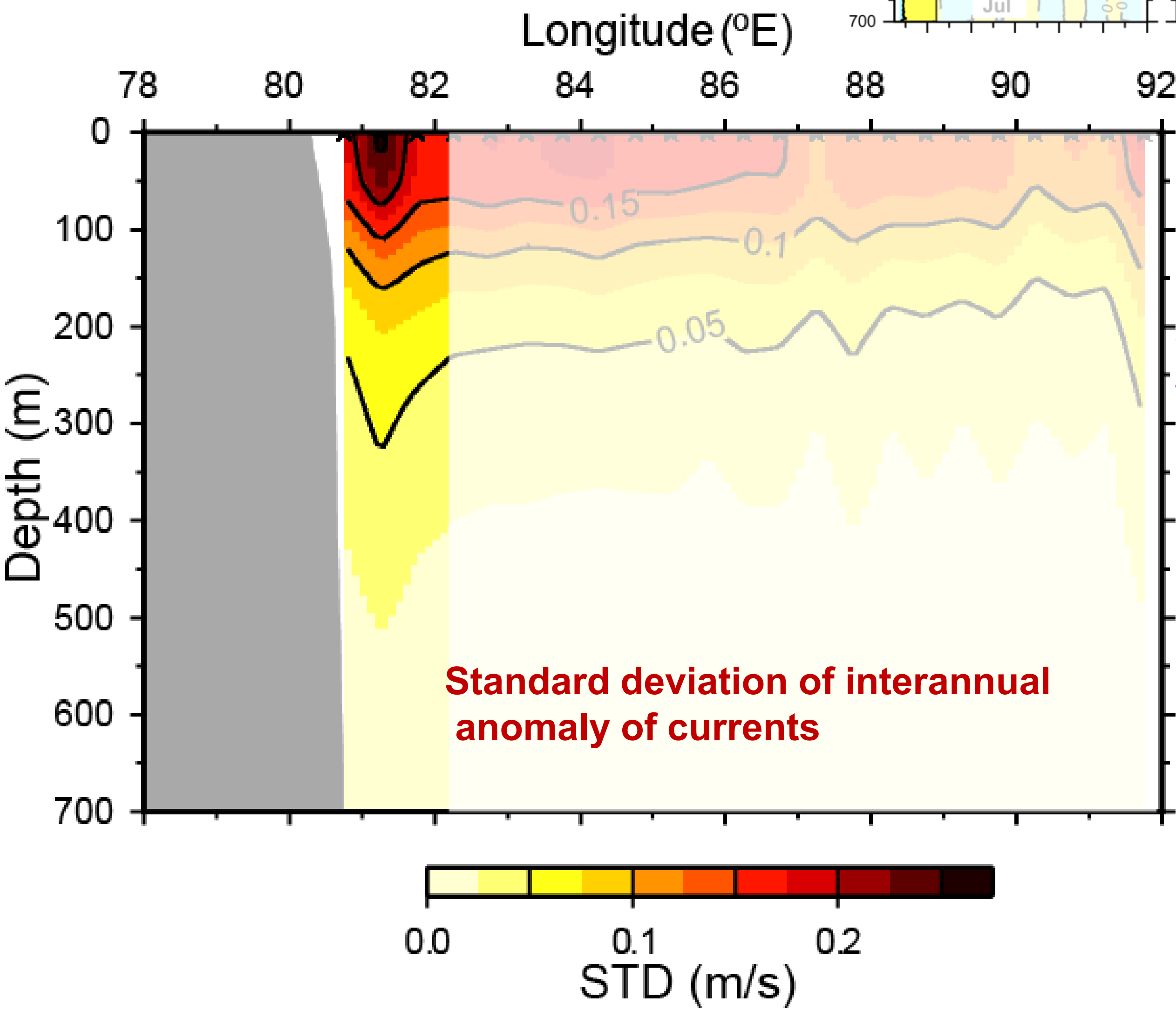
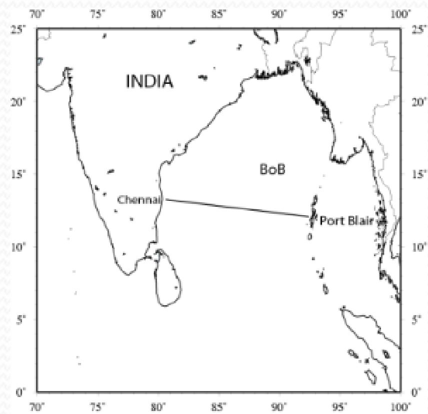




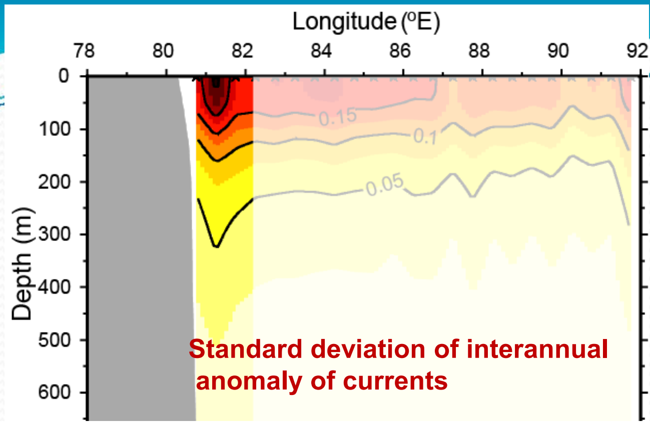
Standard deviation of interannual anomaly of currents

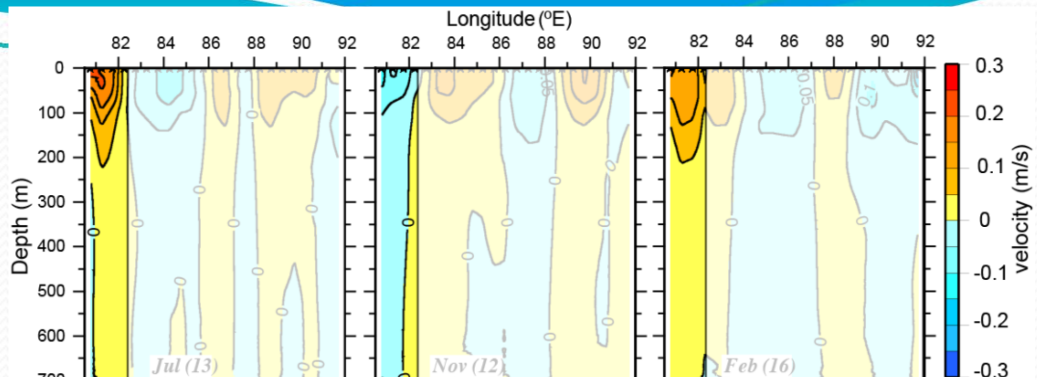
- From the standard deviation variability patterns width of the WBC is fixed up to 82.25E (150 km) In the cross-shore direction.

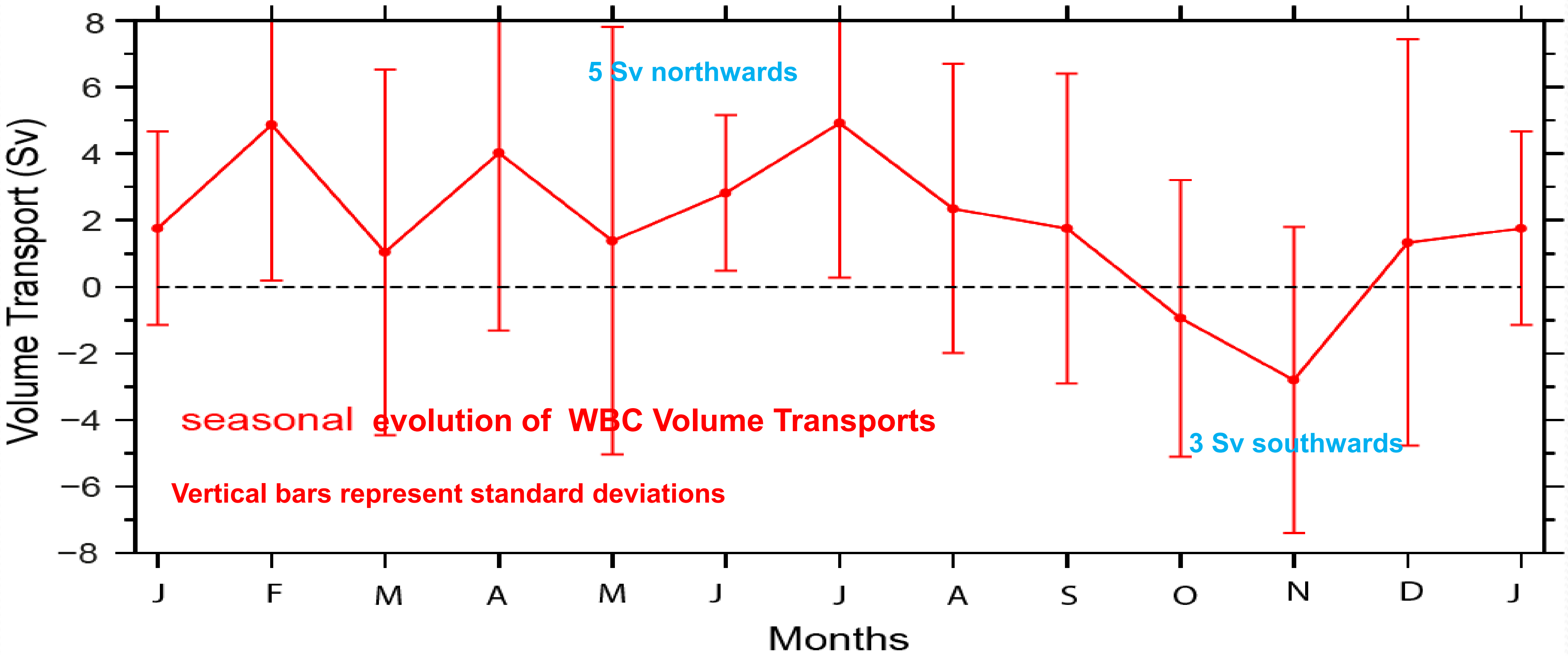


Results

Seasonal climatology of geostrophic currents



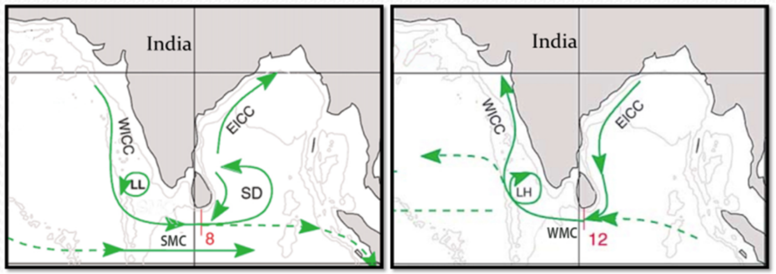




- Volume transport shows seasonal reversal (southward) during post monsoon. Varies between 5Sv northward & 3Sv southward
- Time window of equatorward flow which transports low salinity waters is small.

What drives this Inter- annual Variability of the Western Boundary Current Transports ??

Whether IOD events influence the currents in the Bay of Bengal ??



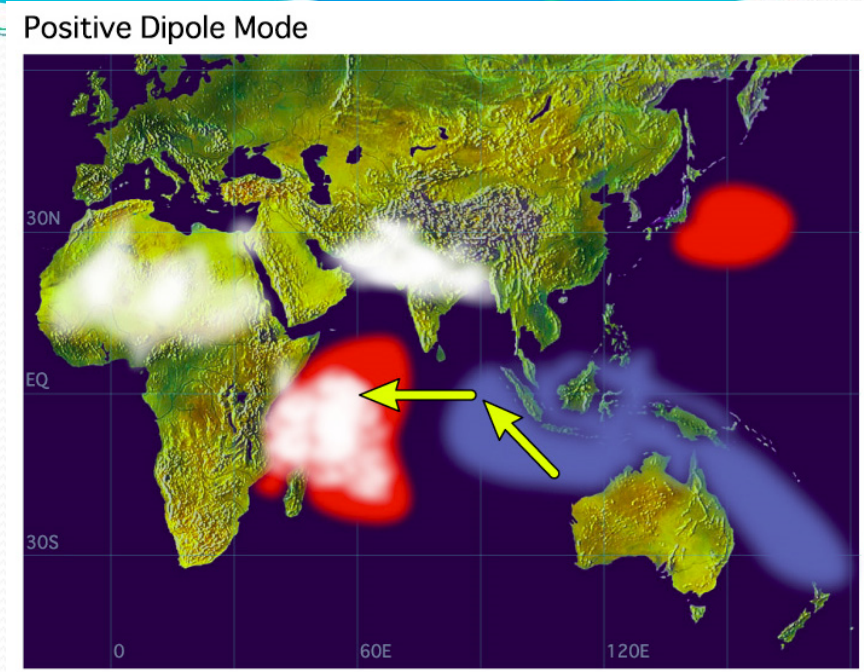
Summer Winter

(Schott & McCreary, 2001)

Results

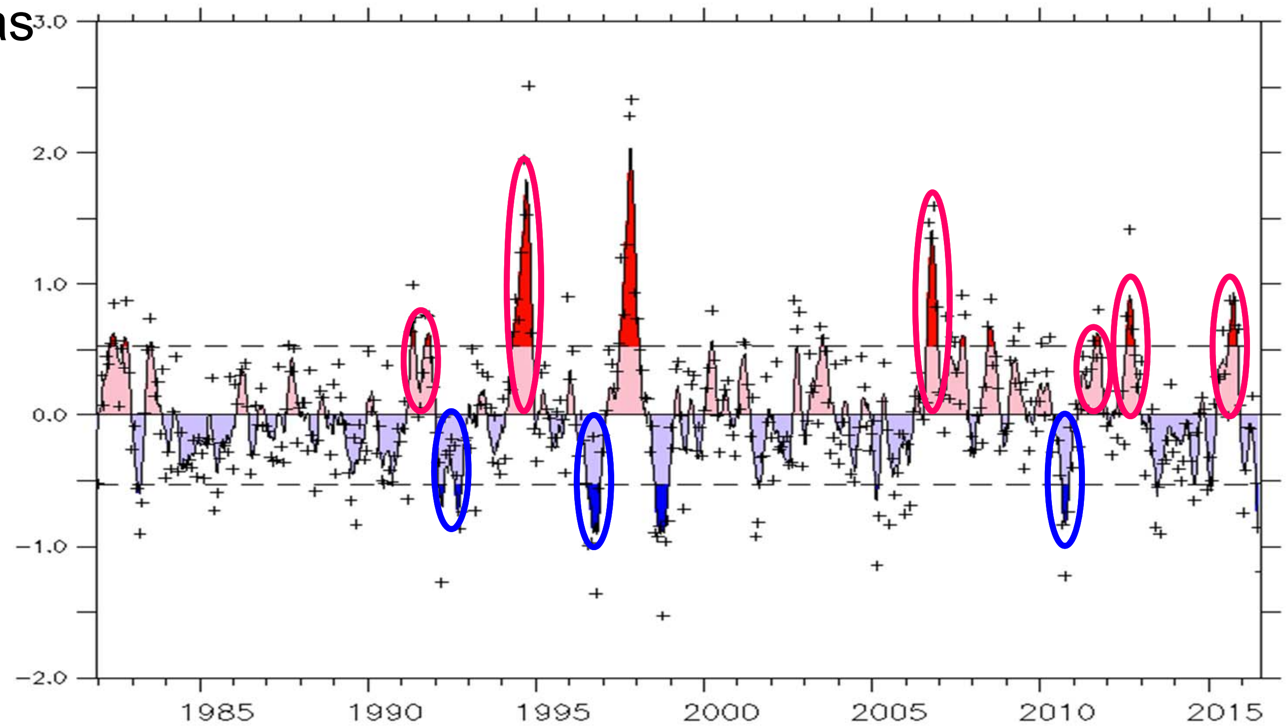
The Dipole Mode Index (DMI)

Saji *et al.* (1999) define DMI as the difference between the SST anomalies in the western equatorial Indian Ocean (50^0E to 70^0E, 10^0S to 10^0N, Western basin) and the southeastern tropical Indian Ocean (90^0E to 110^0E, 10^0S to the Equator, Eastern basin).



As per the above, definition the following years are considered as +ve IOD & -ve IOD years;
1991, 94, 97, 2006,11,12,15.
1992, 96, 98, 2010.

Circles represents IOD years,
Where we have XBT data.



Results

➢Year-to-year modulation of this seasonal pattern: the signature of IOD

MOM2 model (1/3°):

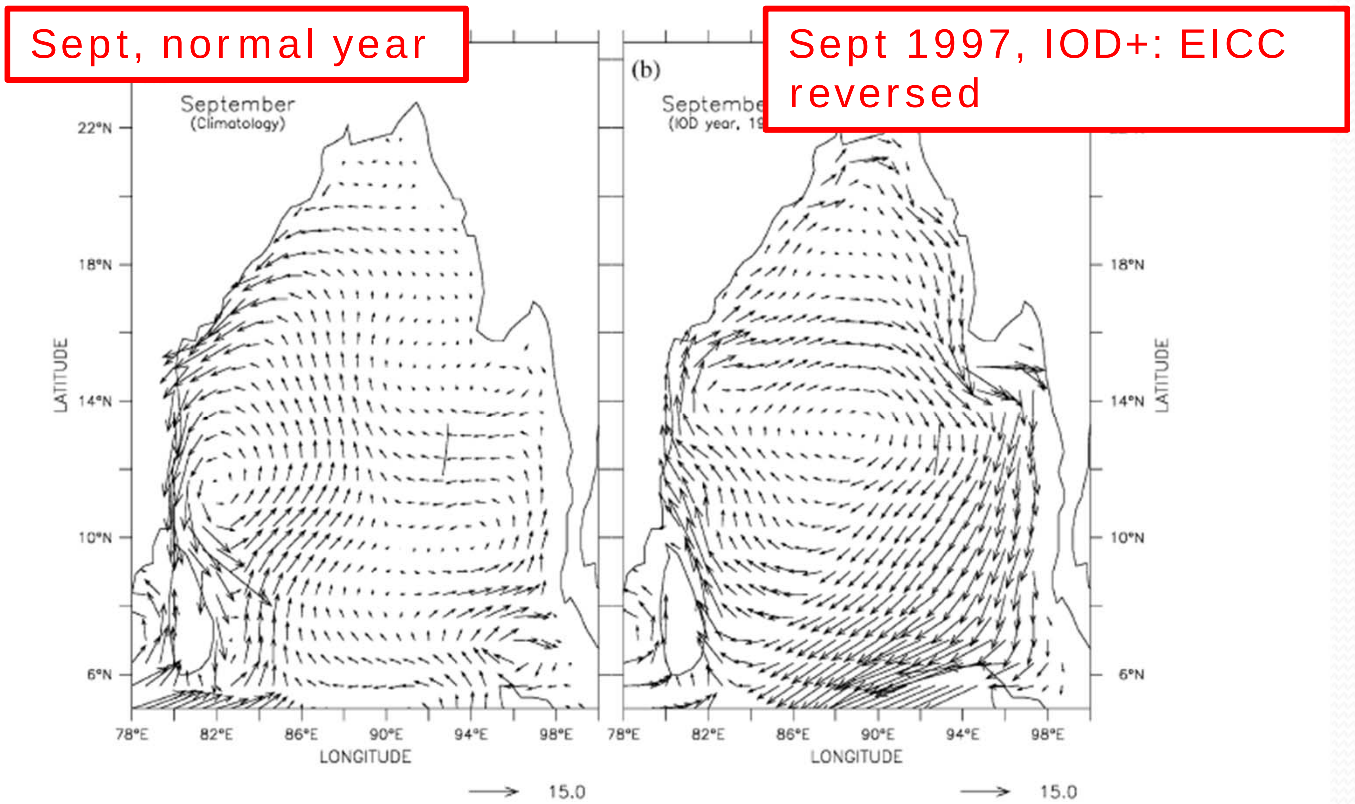
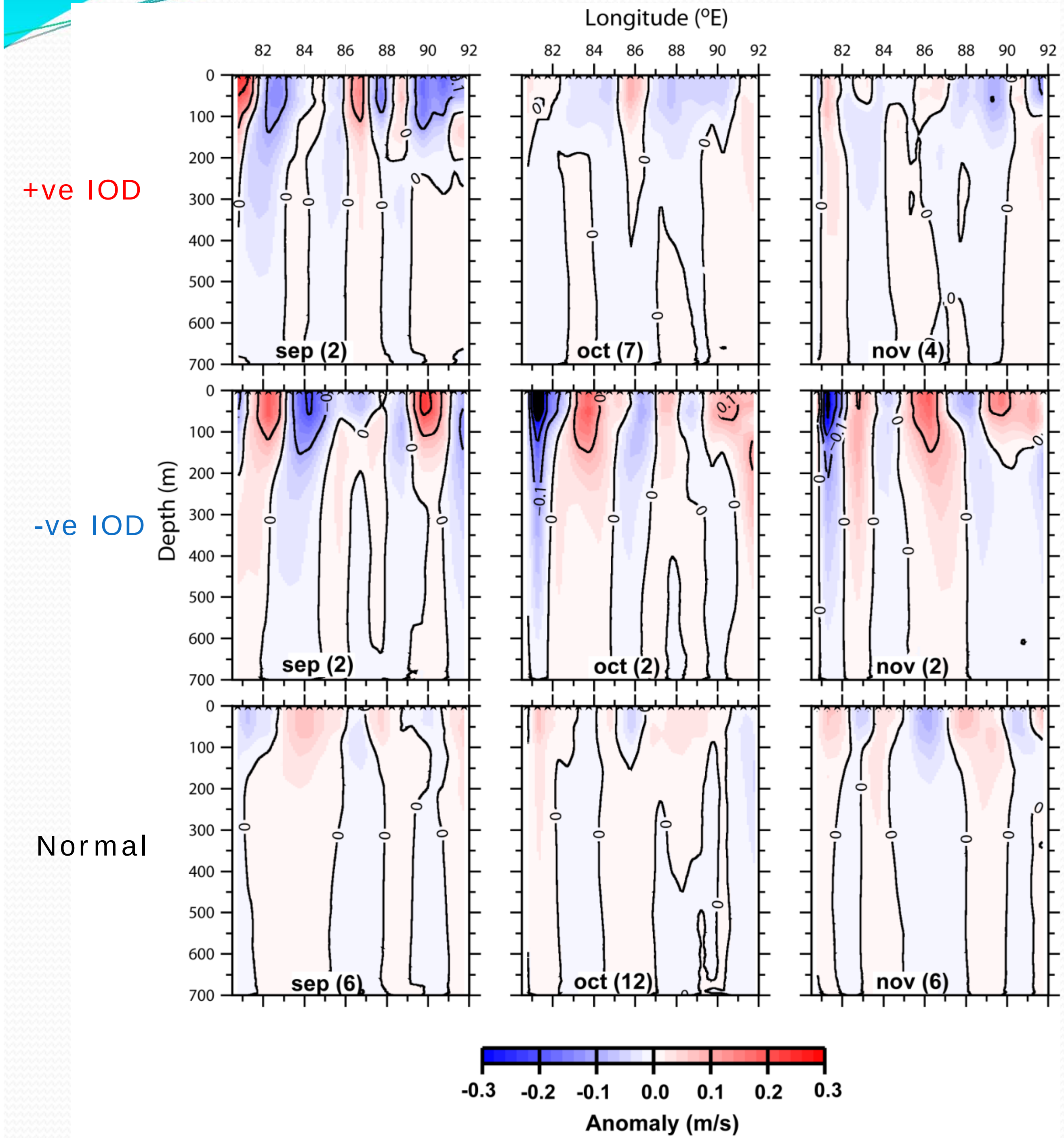


Fig. 10. Model currents in the Bay of Bengal at a depth of 37.5 m (cm s^{-1})during (a) September (climatological) and (b) September 1997.

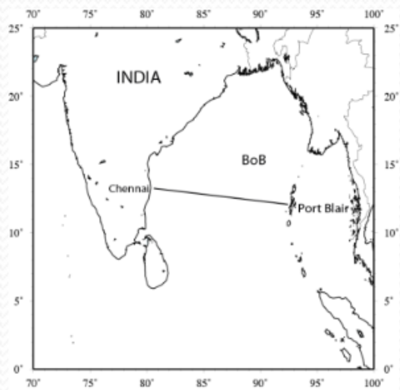
What can 25years of XBT repeated sections tell us ?...

Results

Composites of current anomalies for IOD & Non – IOD years: Sep, Oct, Nov

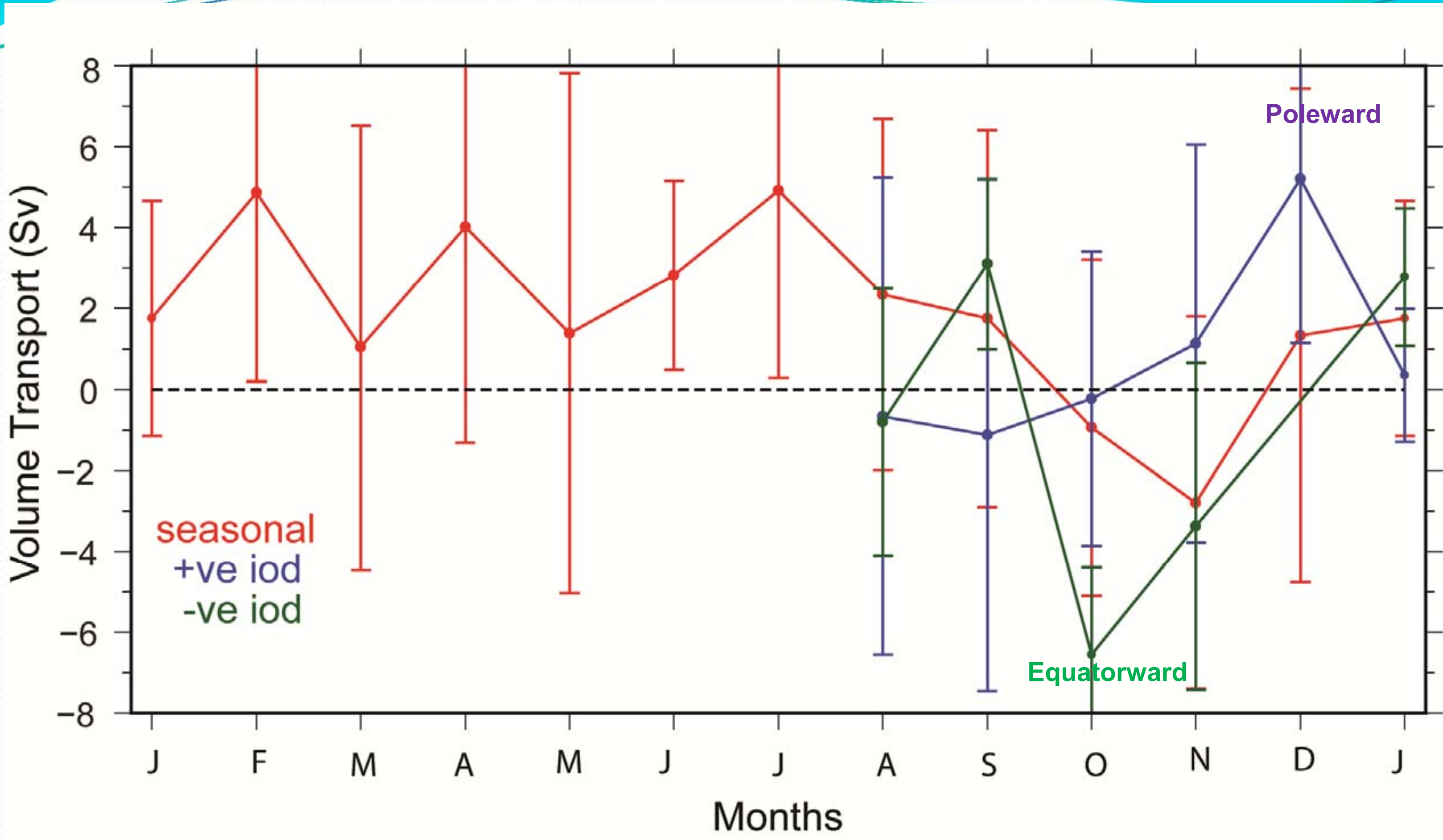


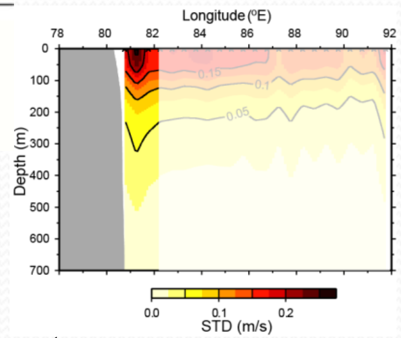
- The anomaly composites shows clear signature of the influence of IOD events in the WBC.
- +ve IOD composite shows northward anomaly & -ve IOD southward anomaly .
- For normal years the anomaly is close to zero.
- The anomalous currents are narrow & at least 700m deep.



Results

Composites of Transport for IOD Years

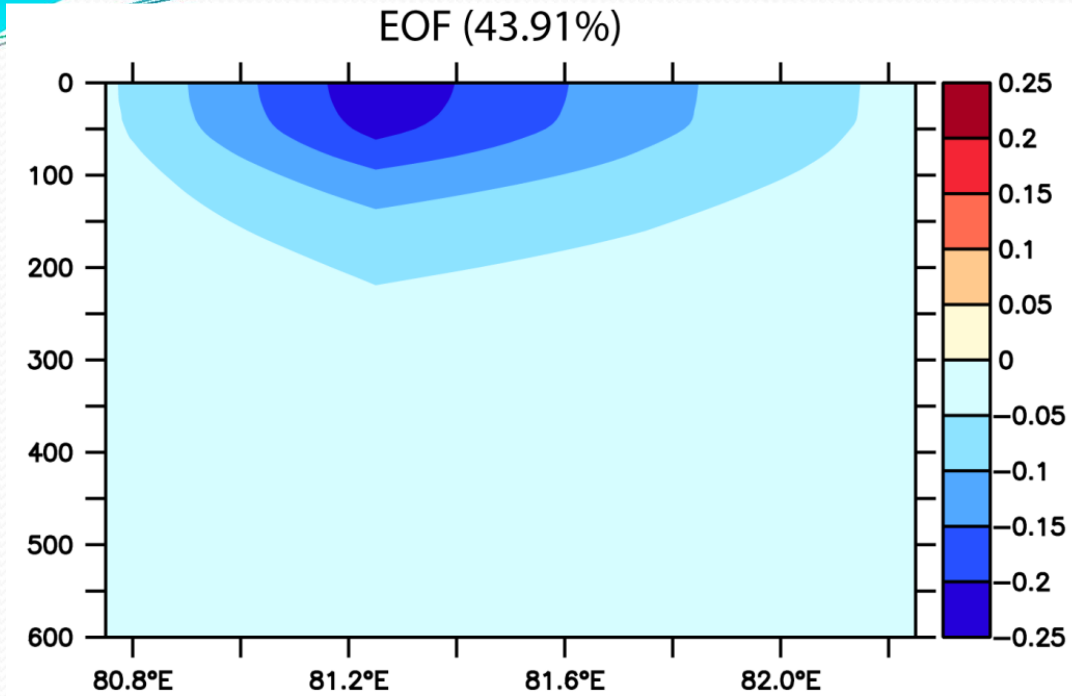




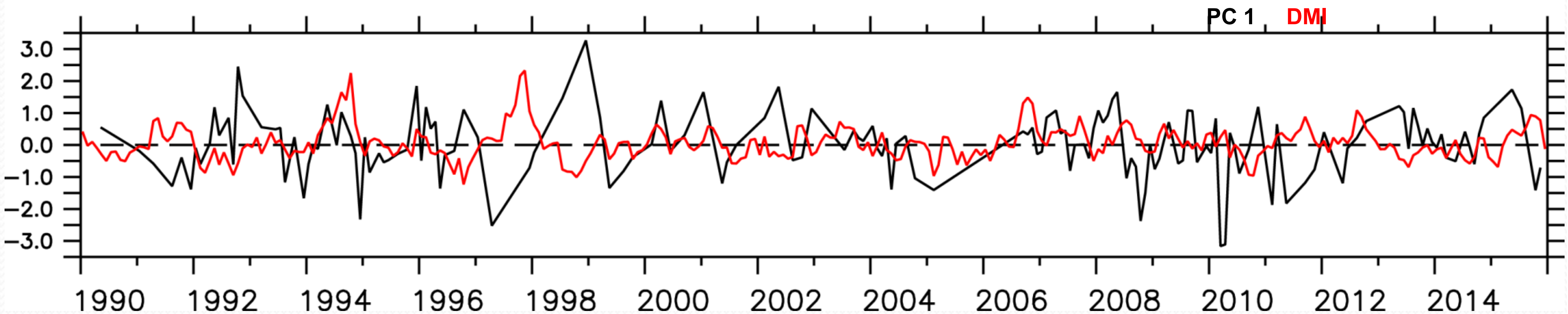
•The influence of IOD in the WBC is manifested by anomalous poleward transport (5.21 Sv, +ve IOD) & anomalous equatorward transport (6.56 Sv, -ve IOD).

• The transport anomaly for +ve IOD and –ve IOD are distinct from each other after accounting for the standard deviations.

Results



- EOF analysis done for the WBC domain.
- The first EOF mode accounts only 43.91% of total variability of XBT data.
- Correlation of DMI time series with principle component of first EOF mode for October is 0.24.
- Indicates IOD event accounts for 25% of Inter annual variations of currents.



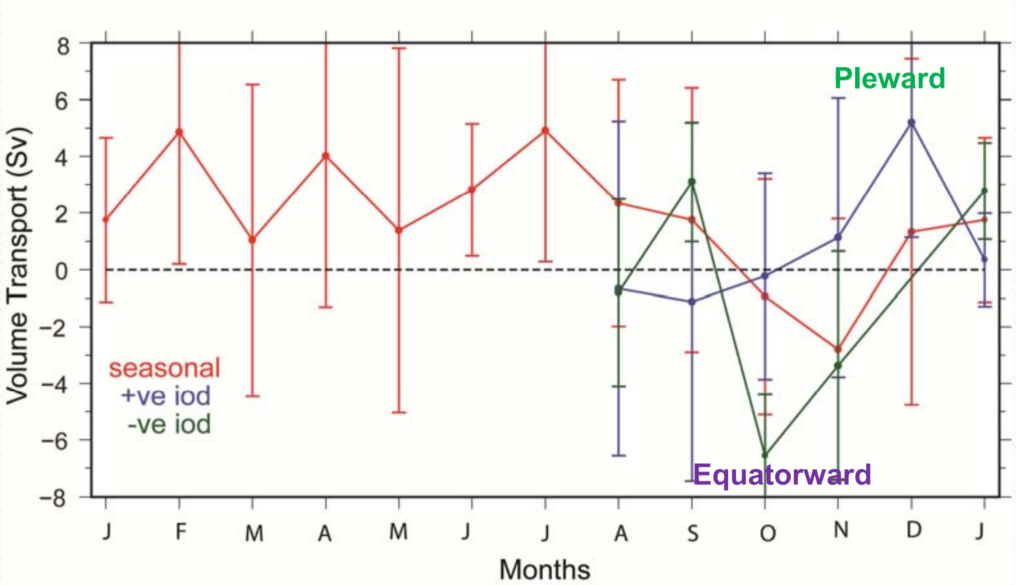
Low correlation (0.24) between DMI time Series & WBC Variability indicates that, although Western Boundary Current transports showed distinct signature of + ve IOD & - ve IOD events, it appears that most of the Year-to-Year variability is not related to IOD events.

- **<u>Other factors contributing to the Variability looks to be;</u>**

➢ **Mesoscale Turbulence**

➢ **Instabilites of the WBC**

➢ **Local Winds**



Summary

- The western boundary of the BoB: a key region of the tropical climate variability.

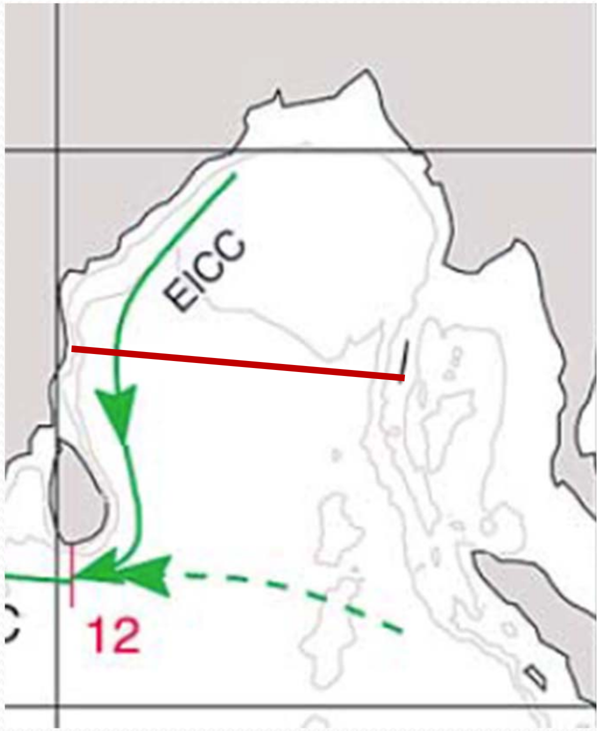
- 25 years of repeat XBT sections: an unprecedented coverage in a data-sparse region.

- The variability of the WBC is dominated by remote forcing from equatorial ocean, during IOD years.

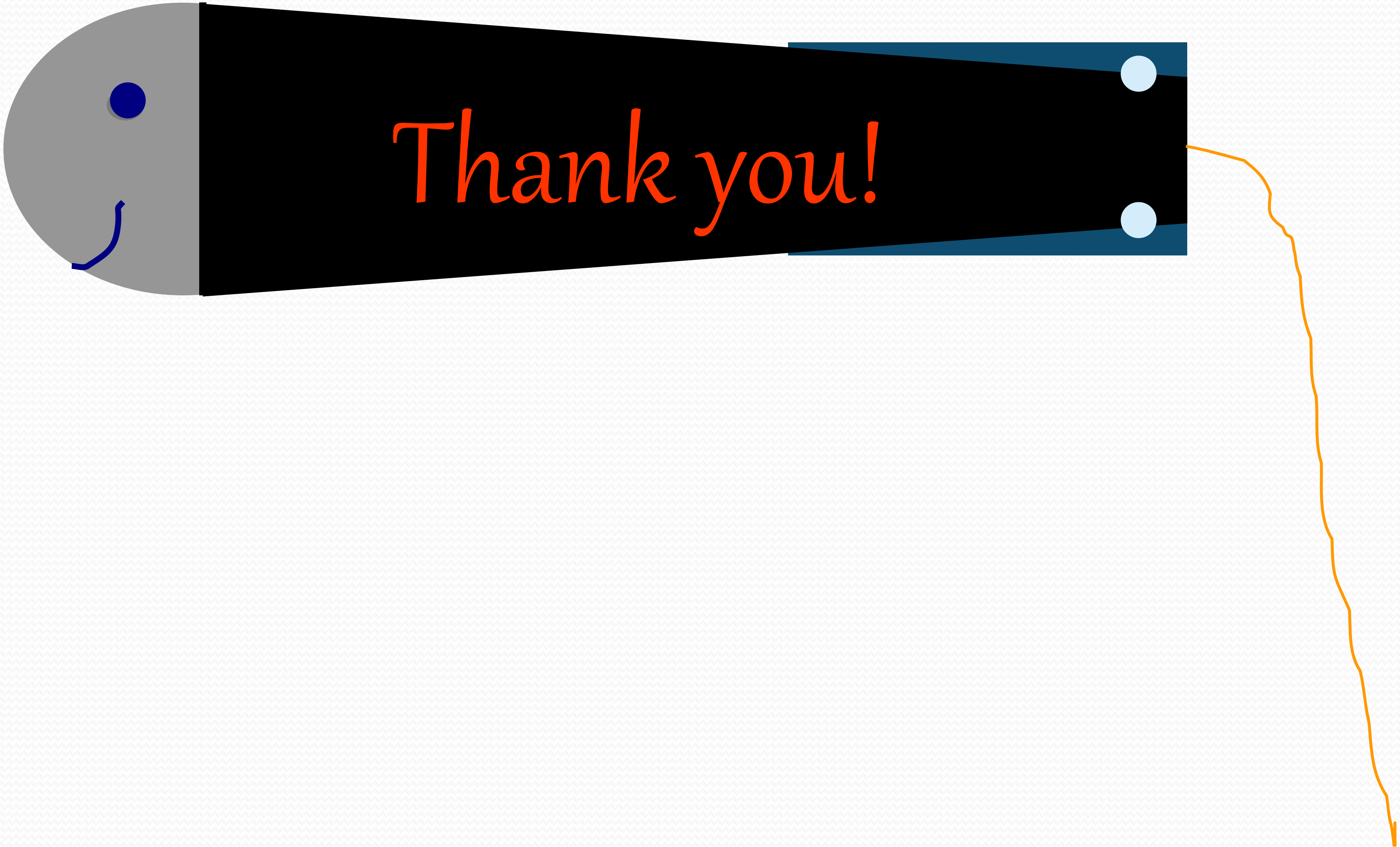
- This manifests as narrow, deep (700m) anomalous transport

- WBC Location: off the shelf break – slope region.

- We must have Pluri - Annual monitoring of WBC transport



- Aside from remote forcing, local forcing (turbulence / local winds) apparently prominent in WBC modulation.


Thank you!