SEASONAL VARIABILITY OF EDDY KINETIC ENERGY IN SOUTHEASTERN ARABIAN SEA

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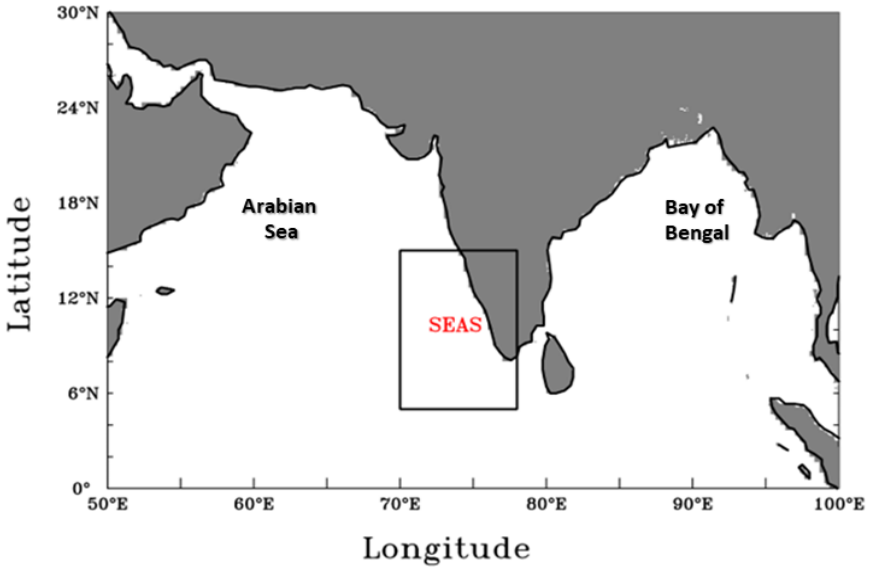
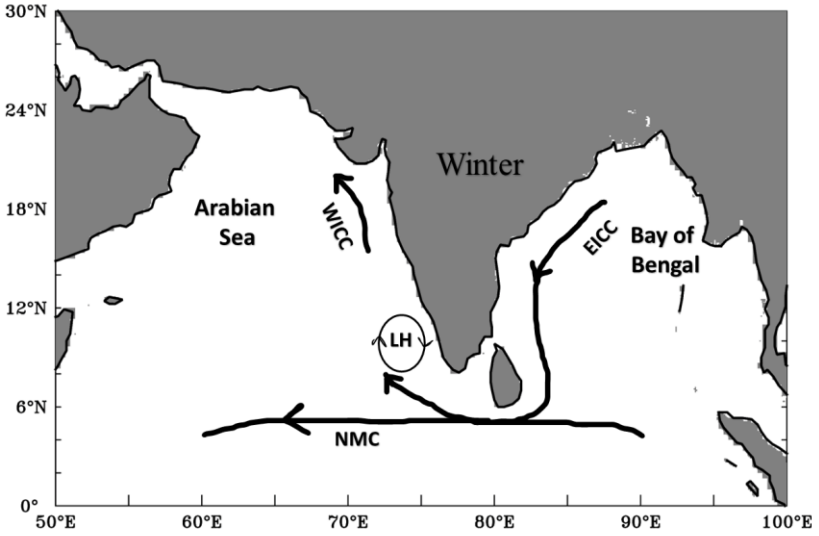
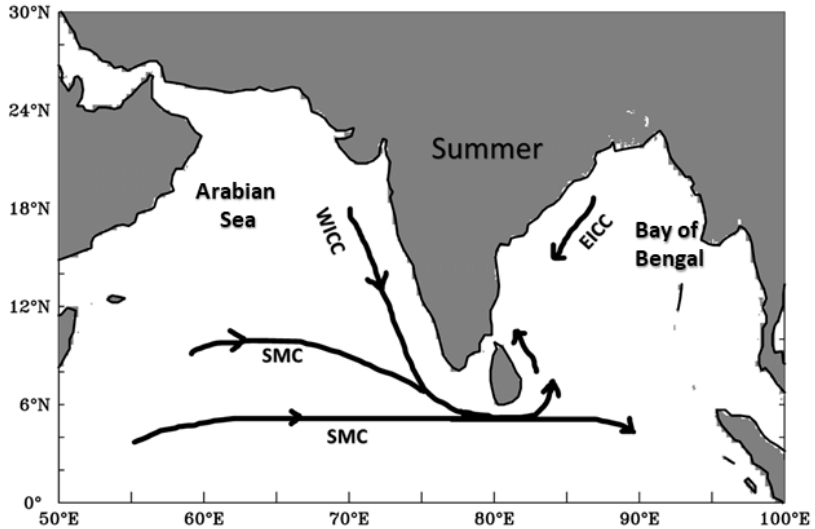
BACKGROUND & OBJECTIVES



- Seasonal analysis of eddy kinetic energy on temporal and spatial scales.
- To investigate the relation of eddy kinetic energy with currents, wind stress curl and chlorophyll-a on seasonal scale.
- To investigate the generating mechanism of eddy kinetic energy over the study region especially on the role of barotropic energy conversion.





WICC - WEST INDIA COASTAL CURRENT

EICC - EAST INDIA COASTAL CURRENT

NMC - NORTH EAST MONSOON CURRENT

SMC - SOUTH WEST MONSOON CURRENT

LH - LACCADIVE HIGH

Figure.1 Study region and circulation maps of North Indian Ocean

Data

- The DUACS multi-mission altimeter products were obtained from **CMEMS** website, consisting **absolute geostrophic current velocity** data of 0.25×0.25 spatial resolution and temporal resolution of three hours.

- **Total current** is obtained from the Globcurrent data repository.Spatial resolution of 25km and temporal resolution of three hours for the combined current velocity data.

- Both the data used covers a period of 24 years from January,1993 to December,2016.

- **10m U and V component of wind data** (0.25° x 0.25°)obtained from ERA-5 reanalysis of ECMWF.(monthly)

- **Chlorophyll_a** concentration data with 4km resolution obtained from ESA OC-CCI(monthly).

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PRELIMINARY RESULTS

Eddy Kinetic Energy

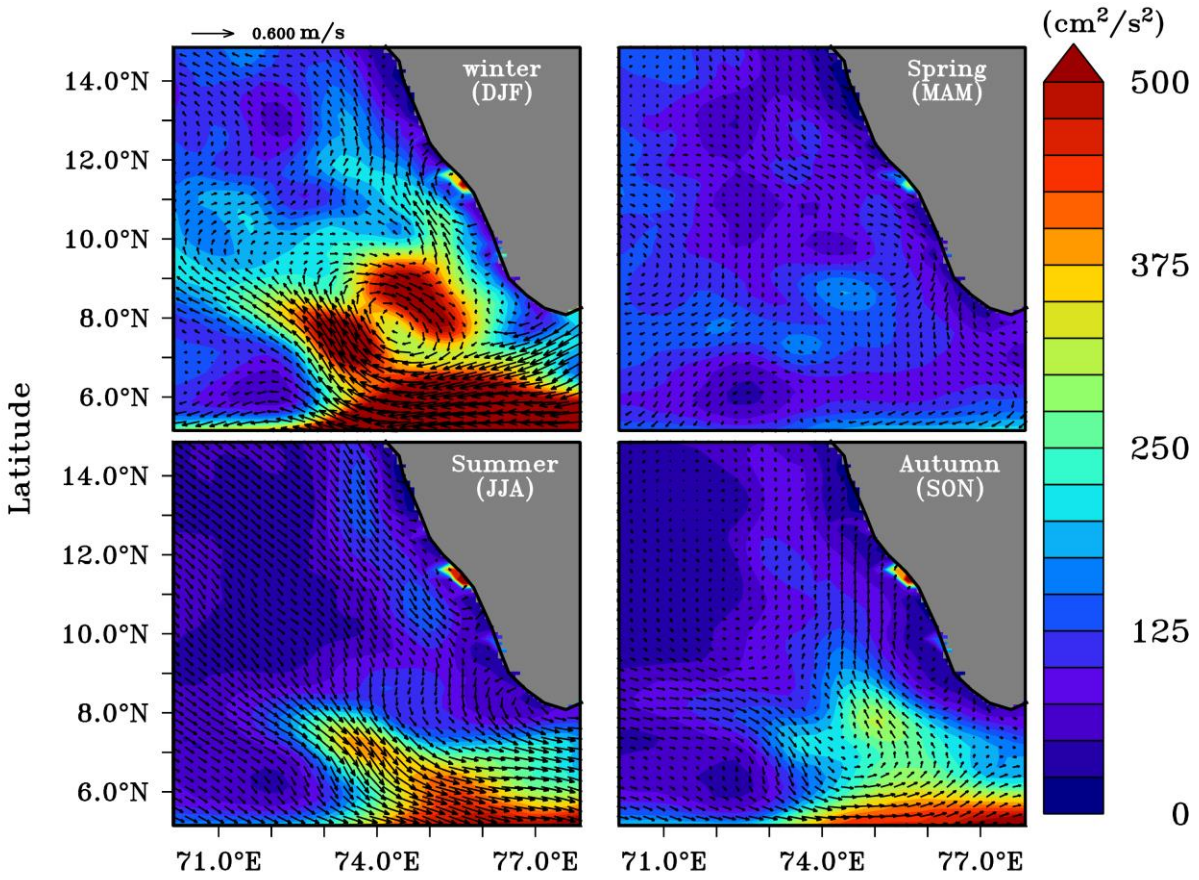

Figure.2 Seasonal spatial map of EKE overlaid by Total Current Vectors.

Correlation for Total Current Magnitude and EKE	
WINTER	r = 0.93
SPRING	r = 0.73
SUMMER	r = 0.60
AUTUMN	r = 0.66

Highest EKE with strong anticyclonic circulation observed during winter.

Barotropic Energy Conversion Rate (BR)

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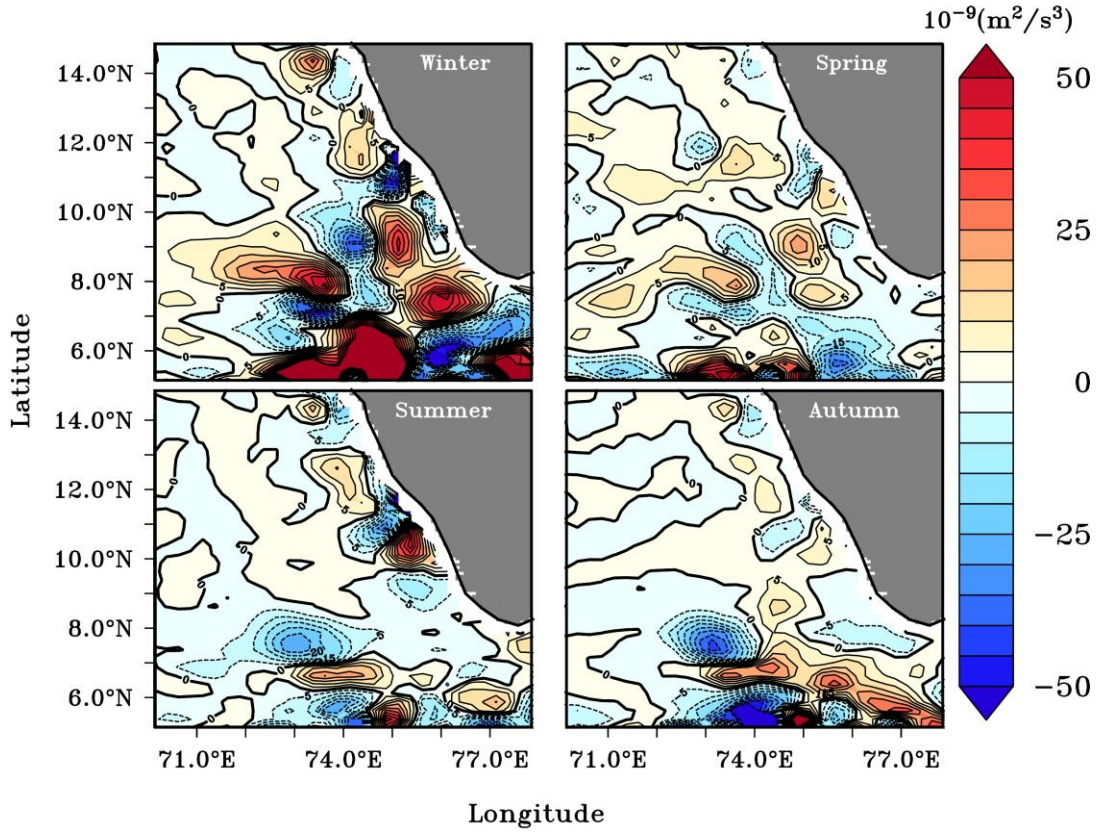
Strong positive value for BR and significant relation between EKE and BR is observed during winter. Thus the winter dominance of EKE could be explained.



Correlation between EKE and Barotropic energy conversion rate	
WINTER	r = 0.67
SPRING	r = 0.18
SUMMER	r = -0.47
AUTUMN	r = -0.34

Figure.3: Seasonal spatial map of Barotropic energy conversion rate.

Winter Wind Stress Curl

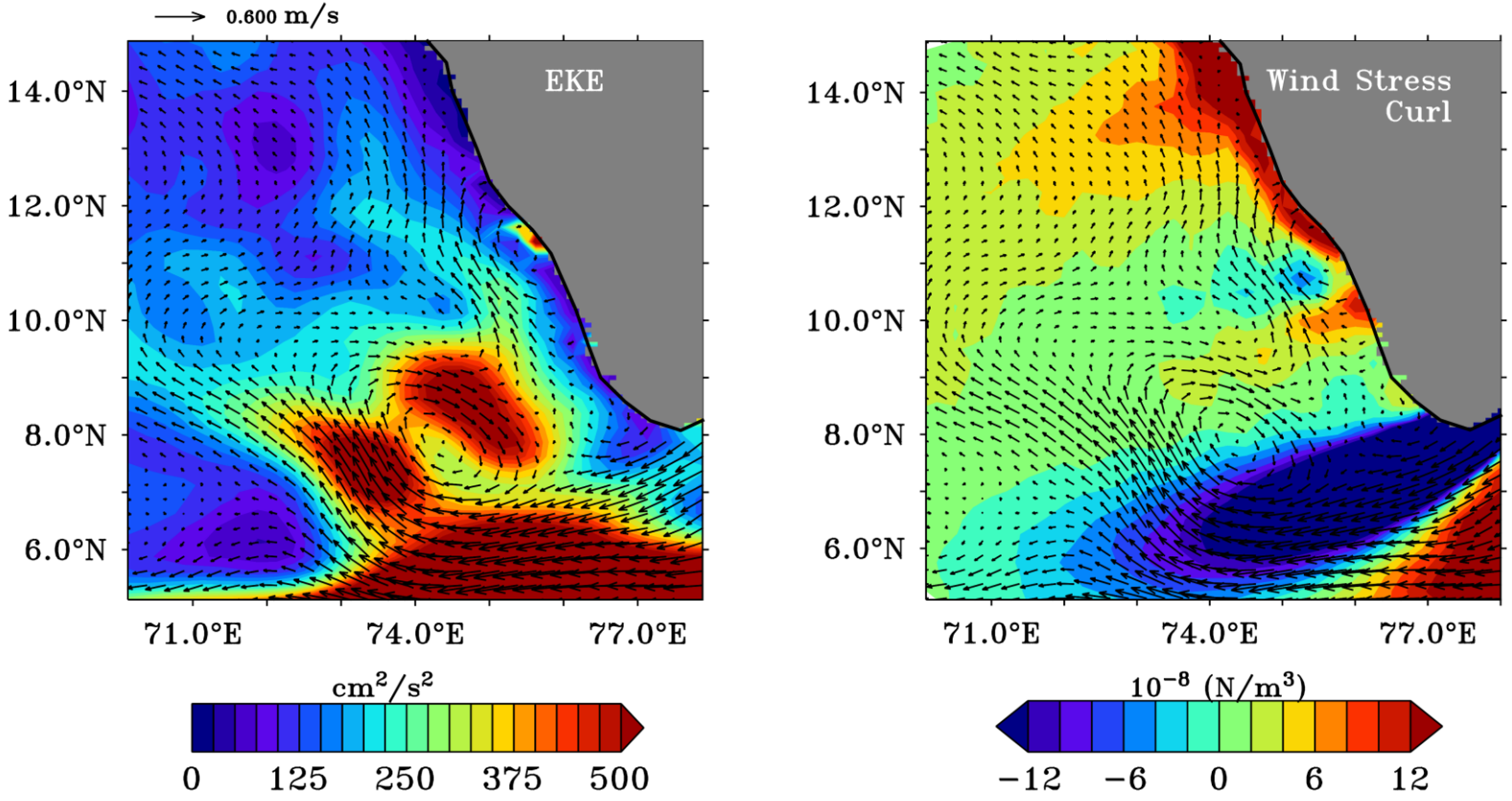


Figure.4 Winter climatological map of EKE and WSC overlaid by the Total current vectors.

- **Strong negative wind stress curl could be observed in the winter over the southern tip of India.**
- **A negative wind stress curl might modify the mean flow of currents.**
- **Thus high EKE during winter could be resulted due to mean flow instability of currents resulting in positive BR, which could be related to the negative WSC.**

Relation of Chlorophyll-a with EKE over SEAS

Correlation between EKE and Chlorophyll-a	
WINTER	0.57
SPRING	-0.20
SUMMER	-0.10
AUTUMN	-0.16

- Significant correlation during winter only.
- Zonal advection from Bay of Bengal provide nutrient-rich water, which is distributed over the entire SEAS by the strong anticyclonic eddy during winter

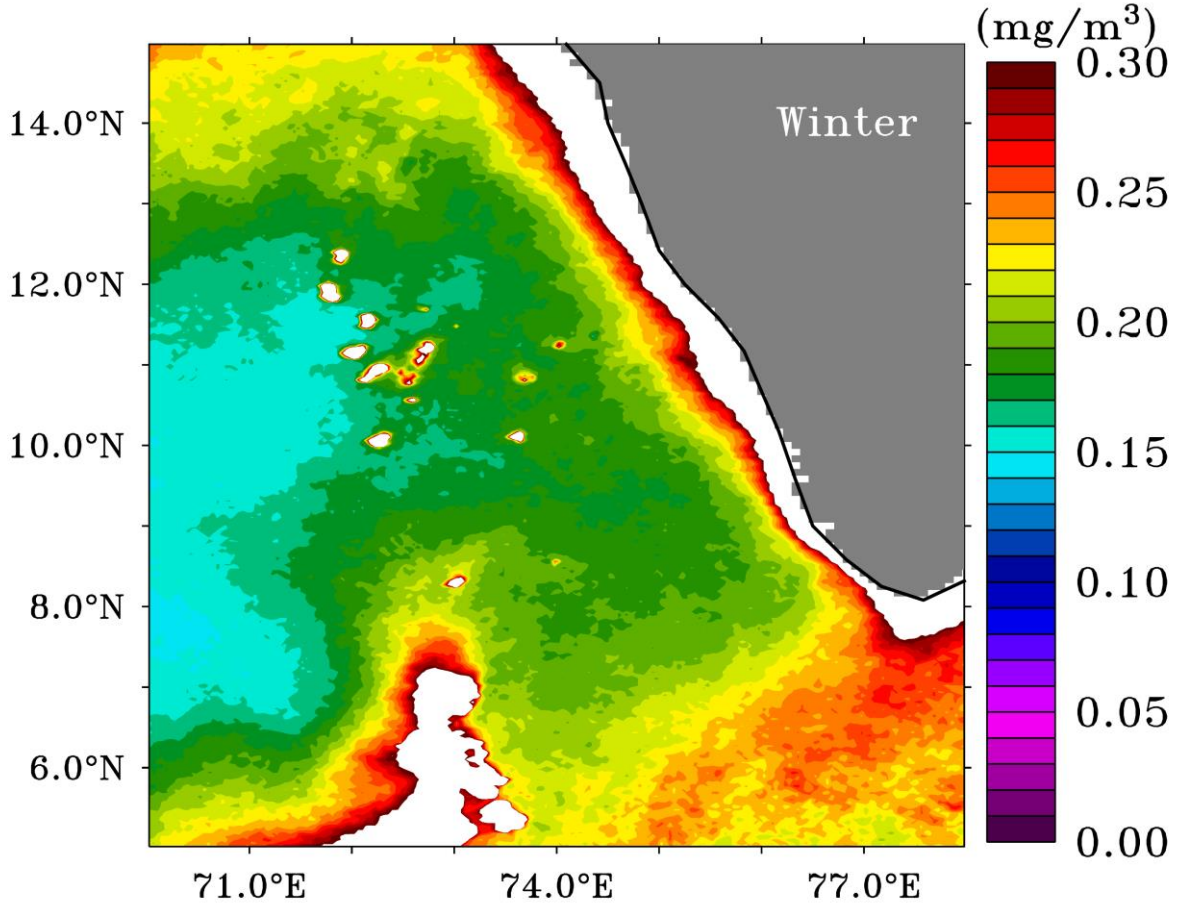


Figure.5 Winter climatology of Chlorophyll-a concentration

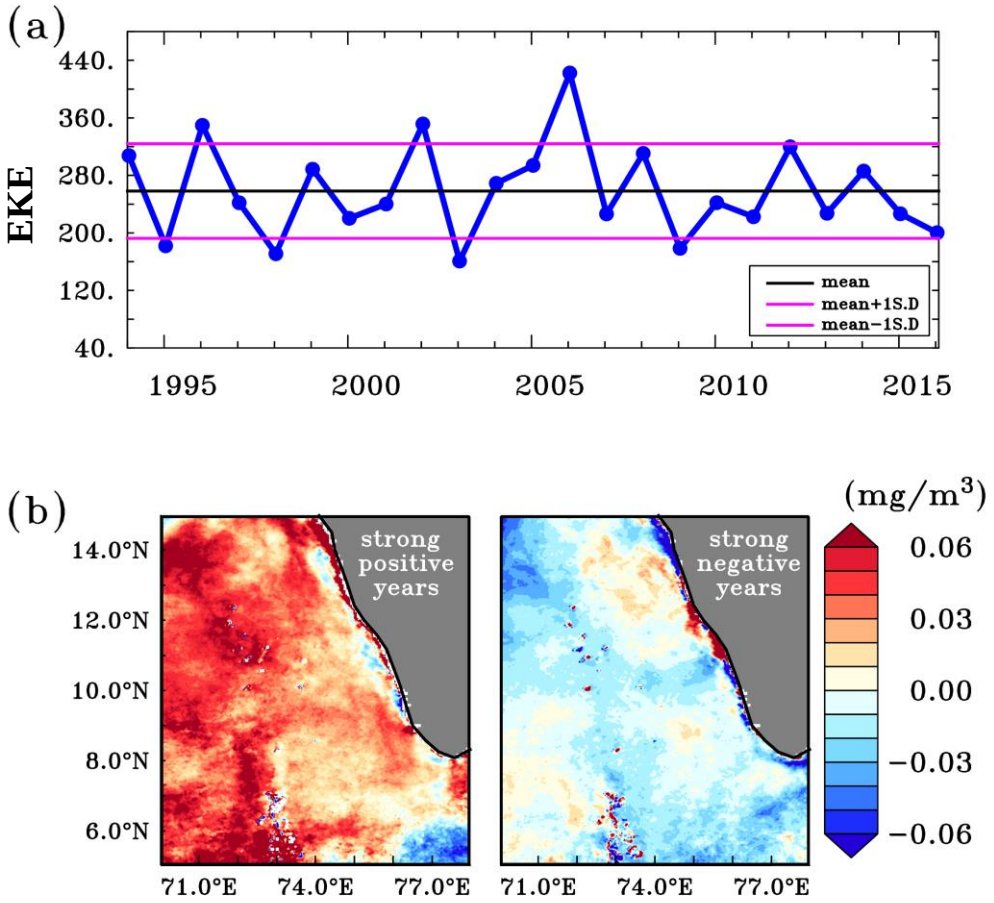


Fig.6 a) Winter Inter-annual variability of EKE cm with respect to the mean and mean ± 1 Standard deviation values **b)** Composite maps of chlorophyll-a anomaly corresponding to the strong positive years and strong negative years of EKE.

- The deviation of chlorophyll-a concentration during strong positive years shows a positive anomaly, whereas the deviation of chlorophyll-a concentration during strong negative years results in negative anomalous chlorophyll-a conditions, indicating that the chlorophyll-a concentration during the winter season over the SEAS is also influenced by Eddy kinetic energy.

PRELIMINARY CONCLUSION

- The highest EKE was observed during the winter.
- The EKE was compared to Total Current Magnitude, and we found a positive correlation between the two for all seasons, and a very strong positive correlation during winter.
- Strong positive Barotropic Energy Conversion (BR) was detected for the winter season, indicating that energy conversion from mean current flow may result in generation of EKE.
- The instability of currents is induced by the strong negative wind stress curl over the southern tip of India. Thus, the generation of EKE and its high value during winter could be explained.
- During winter, the eddy kinetic energy had a substantial positive correlation with Chlorophyll-a concentration implying that eddies during the winter influences the distribution of chlorophyll-a concentration over the South-eastern Arabian Sea. Thus the significance of Eddy over fisheries in SEAS during winter could be explored.

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THANK YOU

BASIC EQUATIONS USED

- **Eddy kinetic energy (EKE)** = $\frac{(u'^2)+(v'^2)}{2}$ .....(1)

  where, u' and v' are the Eastward and Northward absolute geostrophic current anomalies.

- **Total Velocity** = $\sqrt{u_{tot_{hs}}^2 + v_{tot_{hs}}^2}$ .....(2)

  Where $u_{tot_{hs}}$ and $v_{tot_{hs}}$ are the Eastward and Northward Eulerian current velocities.

- **Wind Stress Curl (WSC)** = $\nabla \times \tau = \frac{\partial \tau_y}{\partial x} - \frac{\partial \tau_x}{\partial y}$ .....(3)

  where $\tau_x = \rho_a c_d W u$ and $\tau_y = \rho_a c_d W v$; ρ_a is the density of air; c_d is the drag coefficient; W is the magnitude of 10m u and v component of wind

- **Barotropic Energy Conversion Rate Equation (*BR*)** = $-\overline{u'u'}\frac{\partial \bar{u}}{\partial x} - \overline{u'v'}\frac{\partial \bar{u}}{\partial y} - \overline{u'v'}\frac{\partial \bar{v}}{\partial x} - \overline{v'v'}\frac{\partial \bar{v}}{\partial y}$ .....(4)

  where u', v' are the geostrophic velocity anomaly and $\bar{u}, \bar{v}$ are the mean geostrophic velocity.