# Behaviour of oceanic mesoscale eddies over the Bay of Bengal in contrasting monsoon years

**Subhra Prakash Dey[+], Mihir Kumar Dash[+], and P. C. Pandey***

[+]CORAL, Indian Institute of Technology, Kharagpur
*SEOCS, Indian Institute of Technology, Bhubaneswar

New frontiers of altimetry , Lake Constance – Germany, 27-31 October 2014

# Over view of presentation

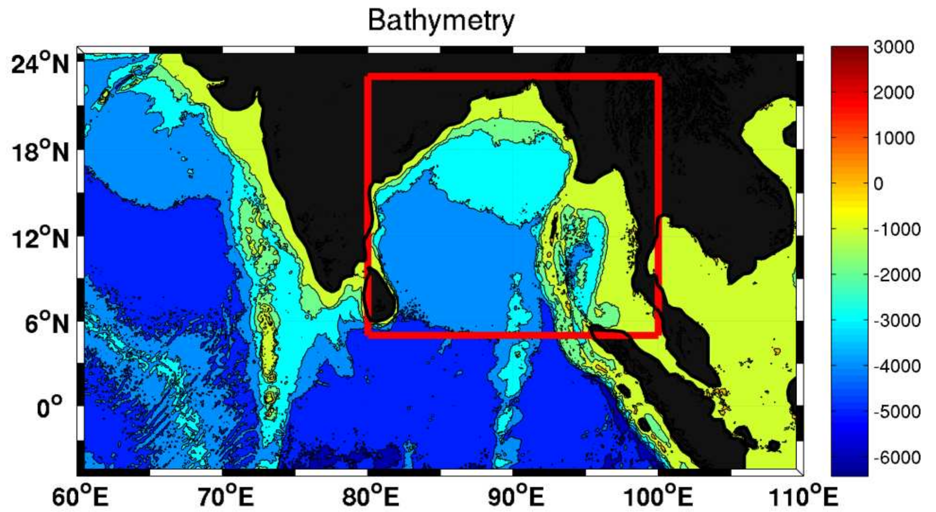
- Introduction
- Variation in coastal kelvin wave in contrasting monsoon years
- Eddy activities in the BoB in contrasting monsoon years
- conclusion

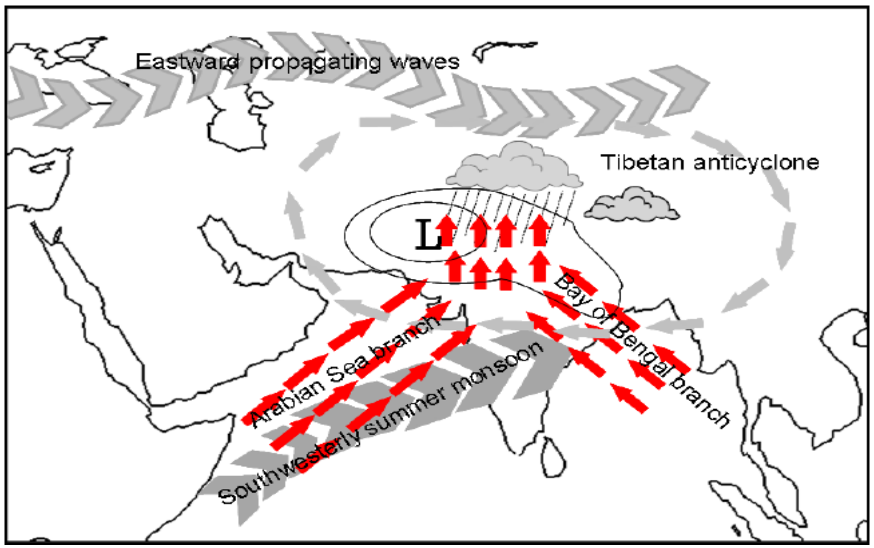
# Introduction

- Upper surface of BoB is affected by fresh water ( EP – PR; River discharge)fluxes, ISO and Remote effects

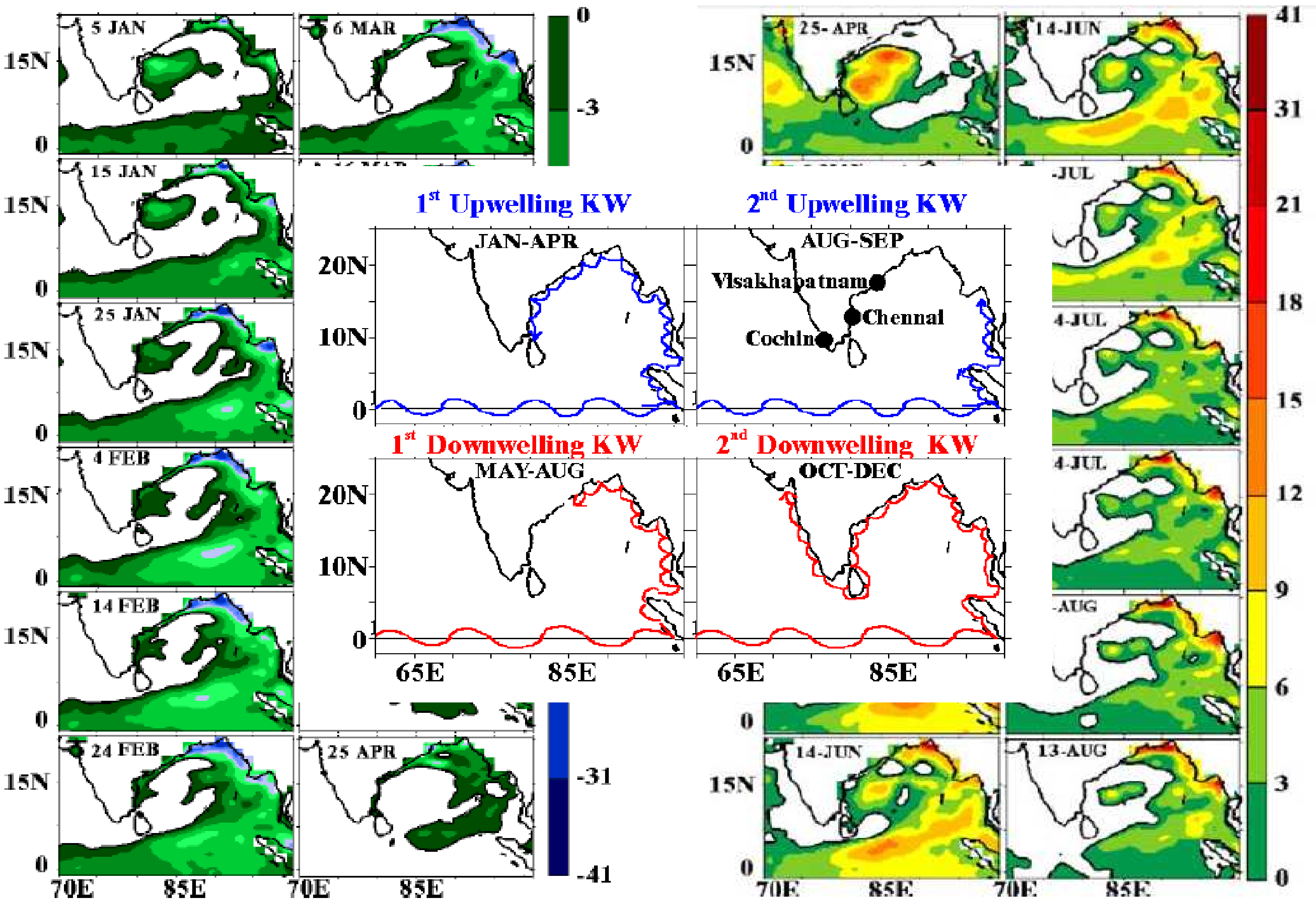
- The near surface circulation in the BoB is driven locally by monsoon winds and remotely by winds over the equatorial Indian Ocean (EIO) [*McCreary et al.*, 1993; *Schott and McCreary*, 2001]

- 2002 and 2009 are the two strongest rainfall deficit year in the recent decades

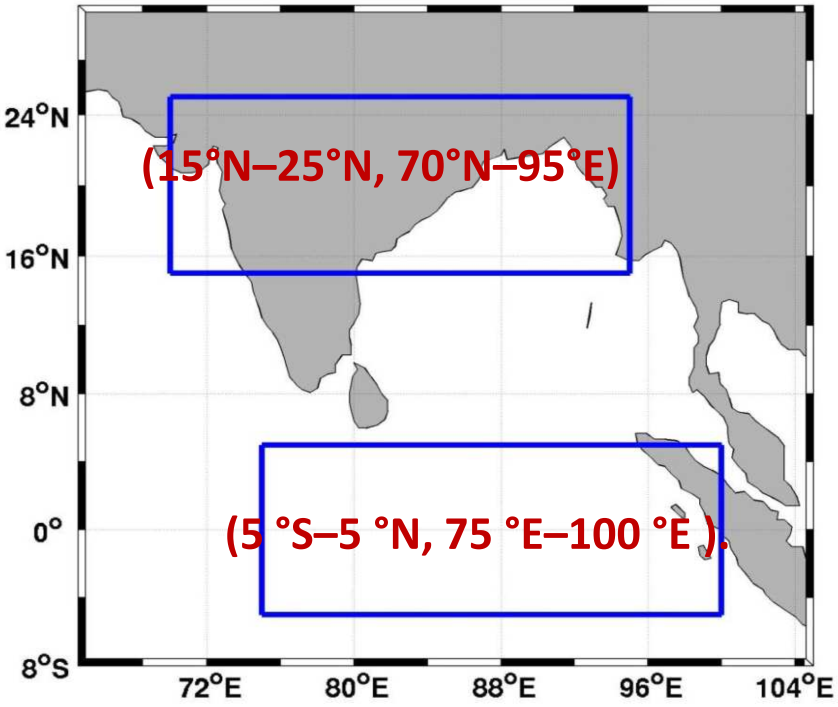



(Adopted from PhD thesis of S. Saeed, Max Plank Research School, 2011)

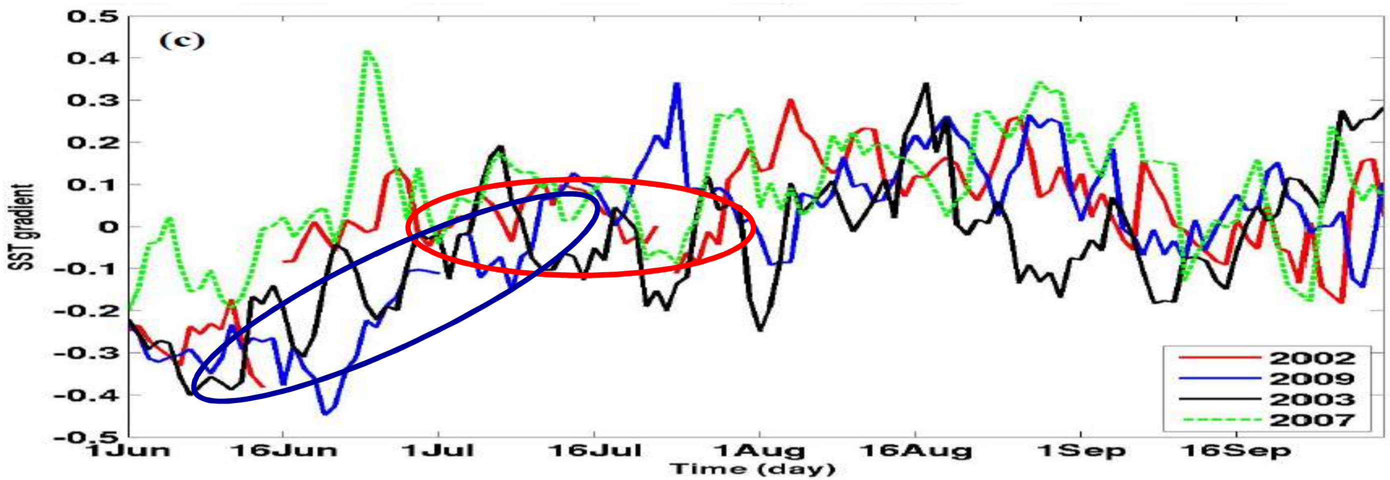



Rao et al. 2010



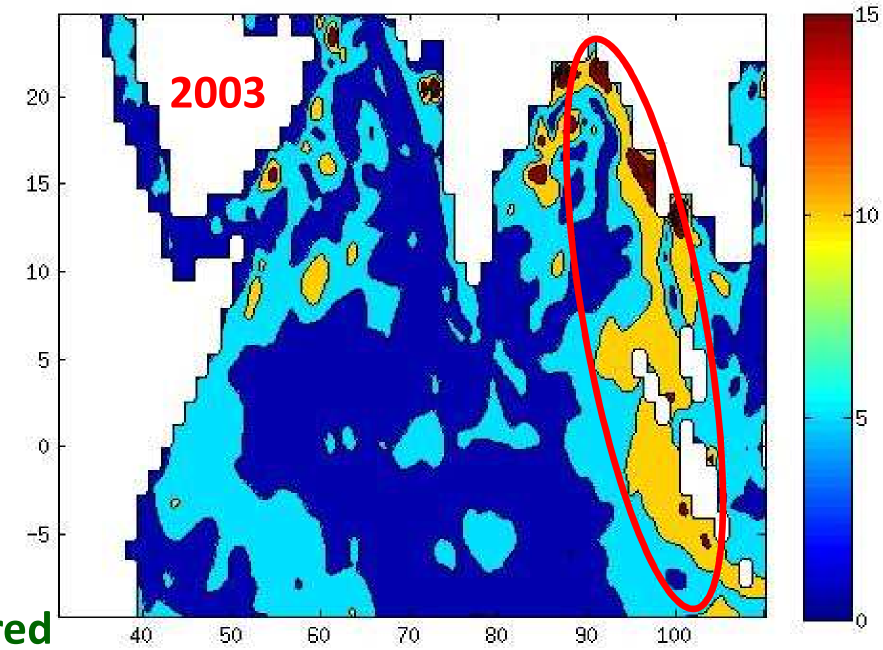

- Act as the source for the convective region (Wang et al. 2005)
- They act as the centre of the ISO (Fu et al. 2008)

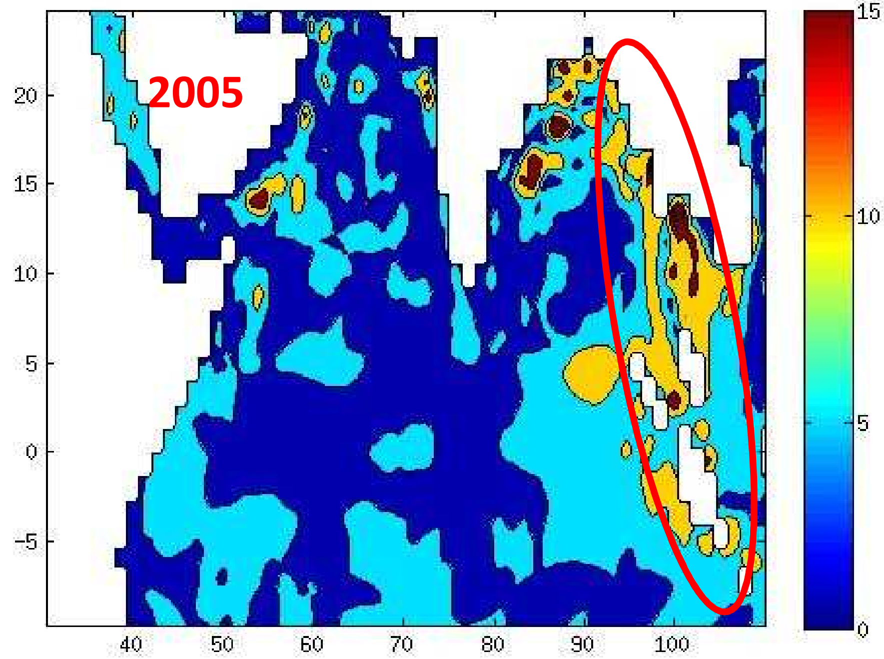
- Northern BoB is warmer than the EIO in June and early July of 2009
- SST gradient is less in July 2002
- Existence of ISO in SST gradient



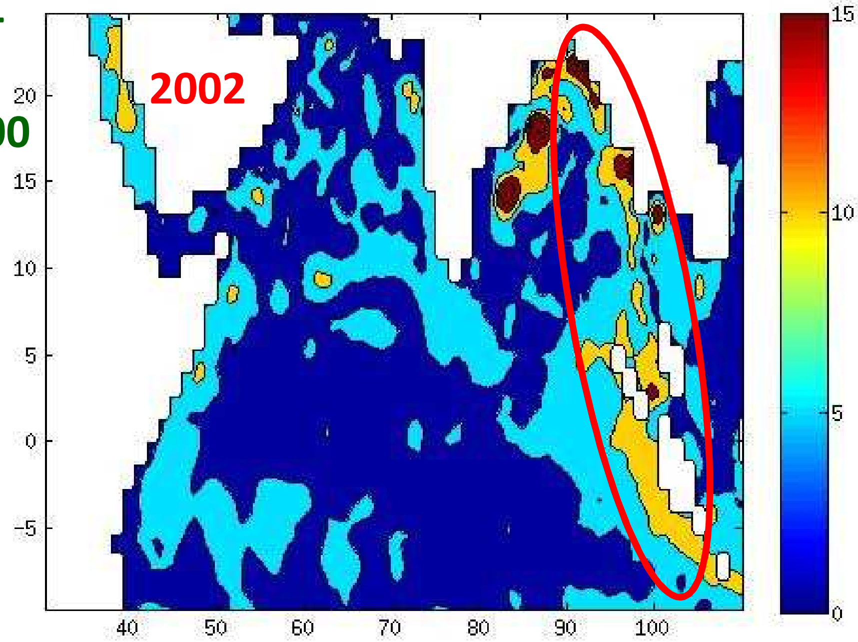

**SST gradient in °C**

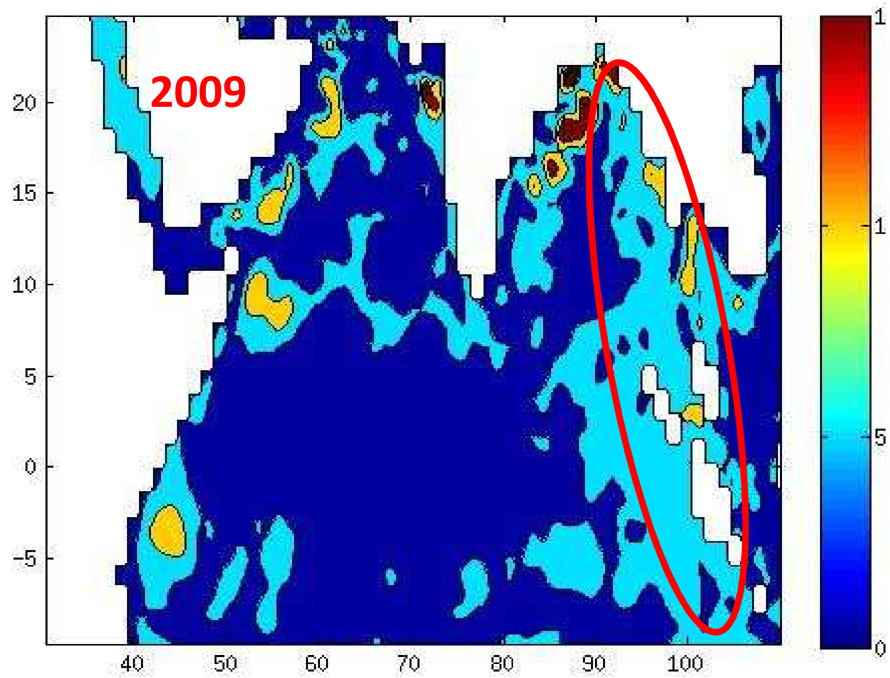
## Standard Deviation of SLA (in cm) for pre-monsoon period (March, April, May)



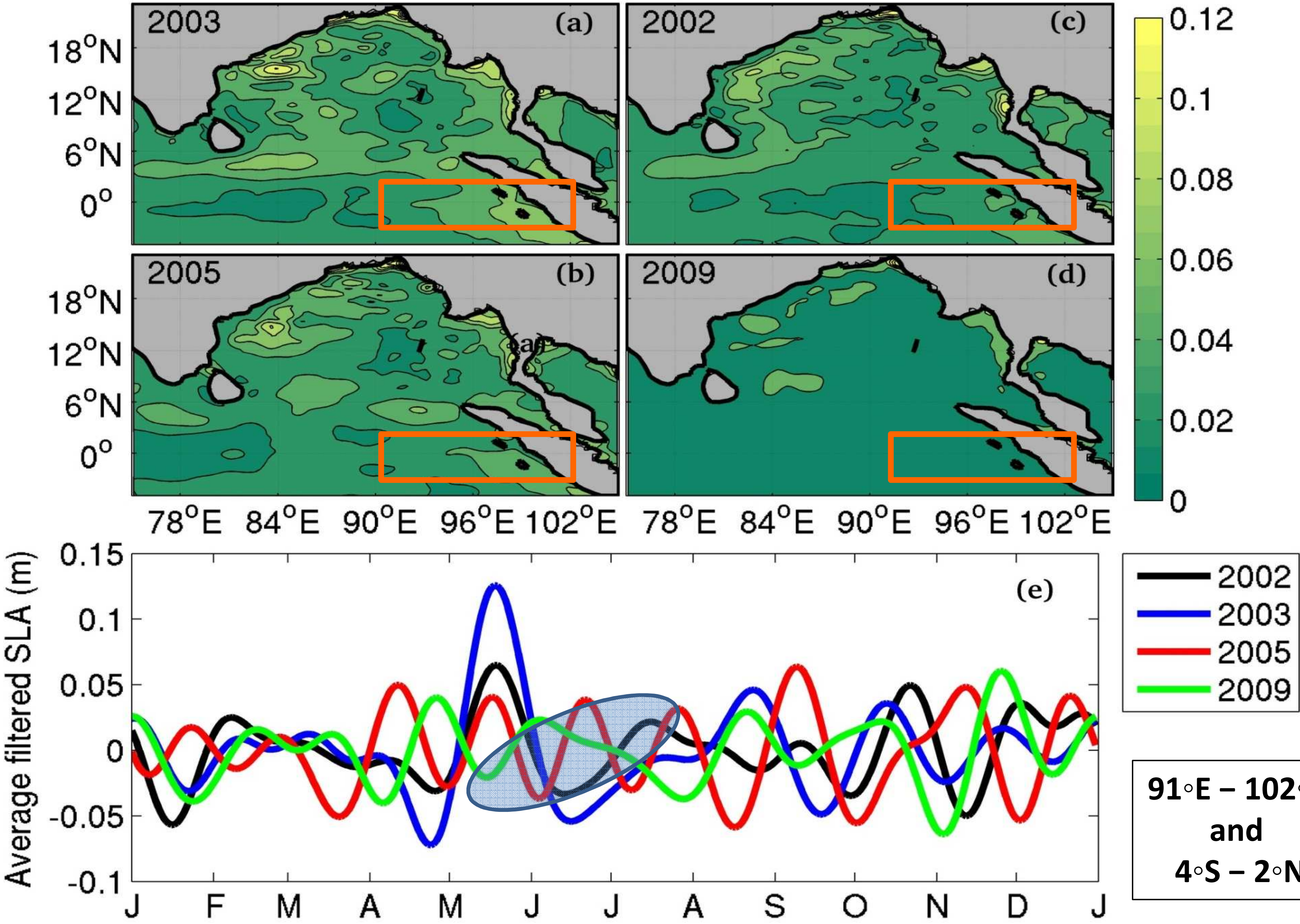




**SLA is filtered using band-pass filter with 30 – 100 days periodicity**



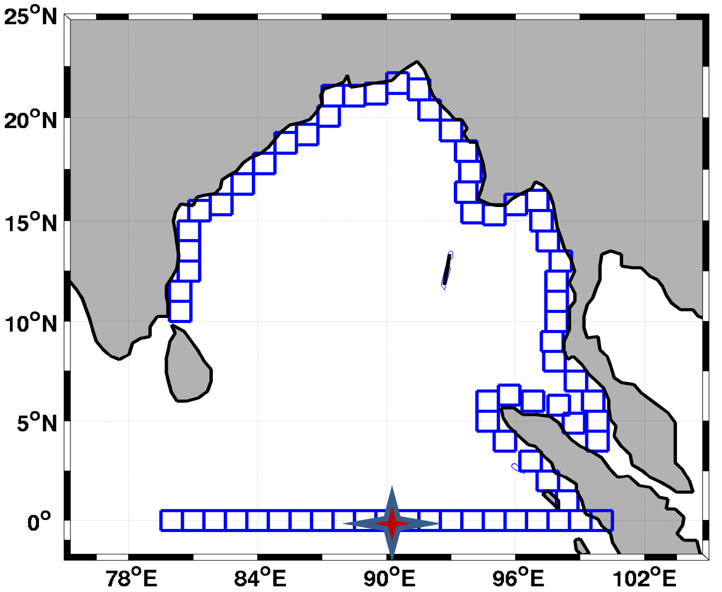



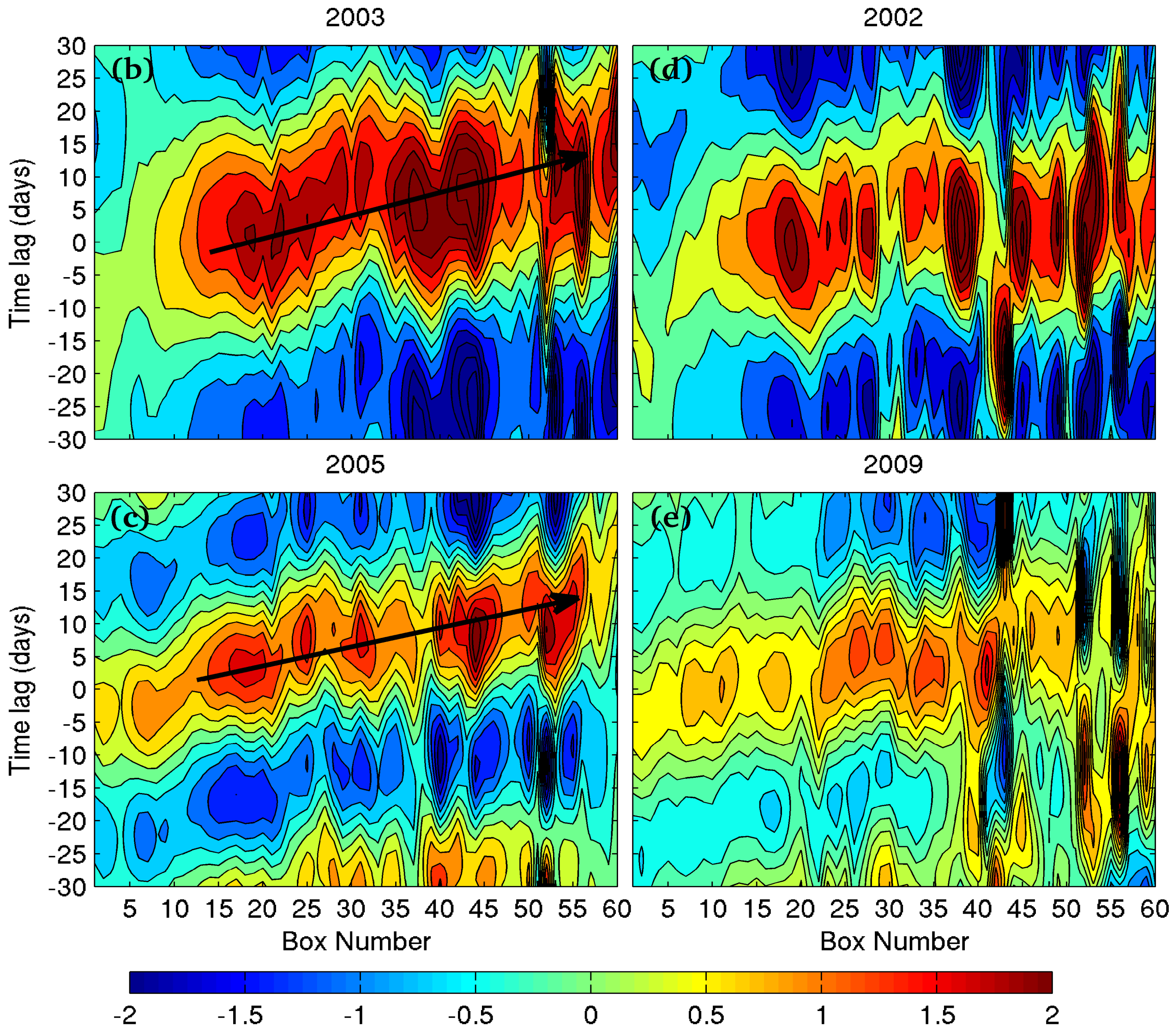
## Standard Deviation of SLA (in m)( combining pre-monsoon and monsoon period (March to Sept.)



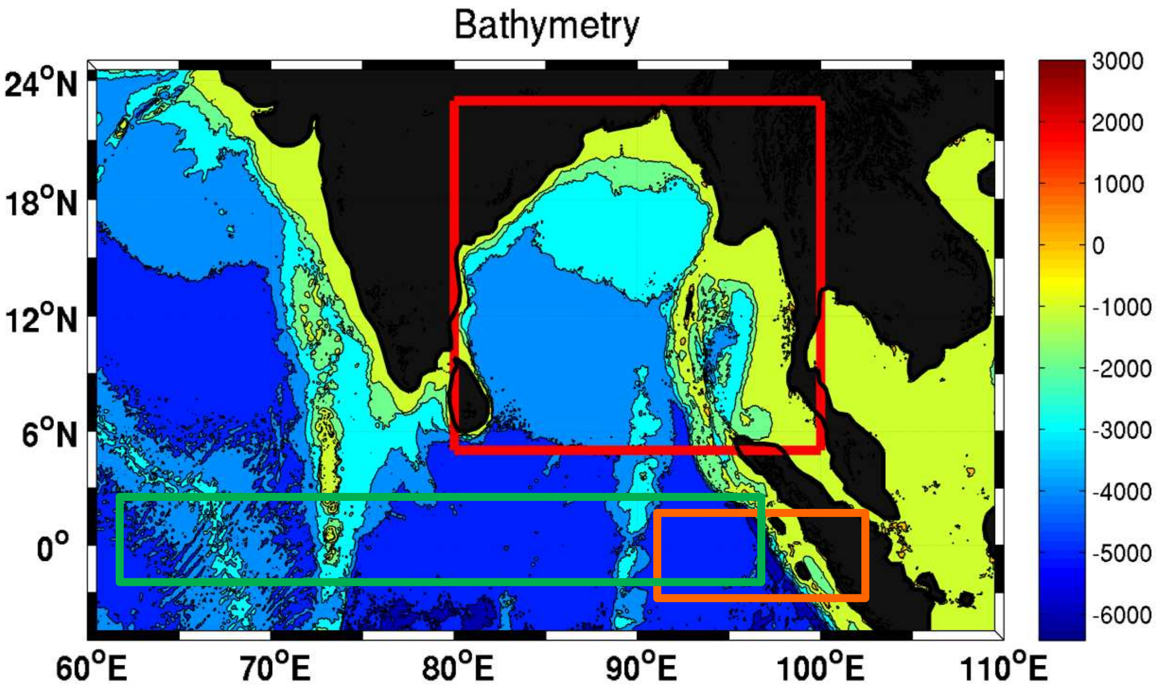

**91°E – 102°E and 4°S – 2°N**

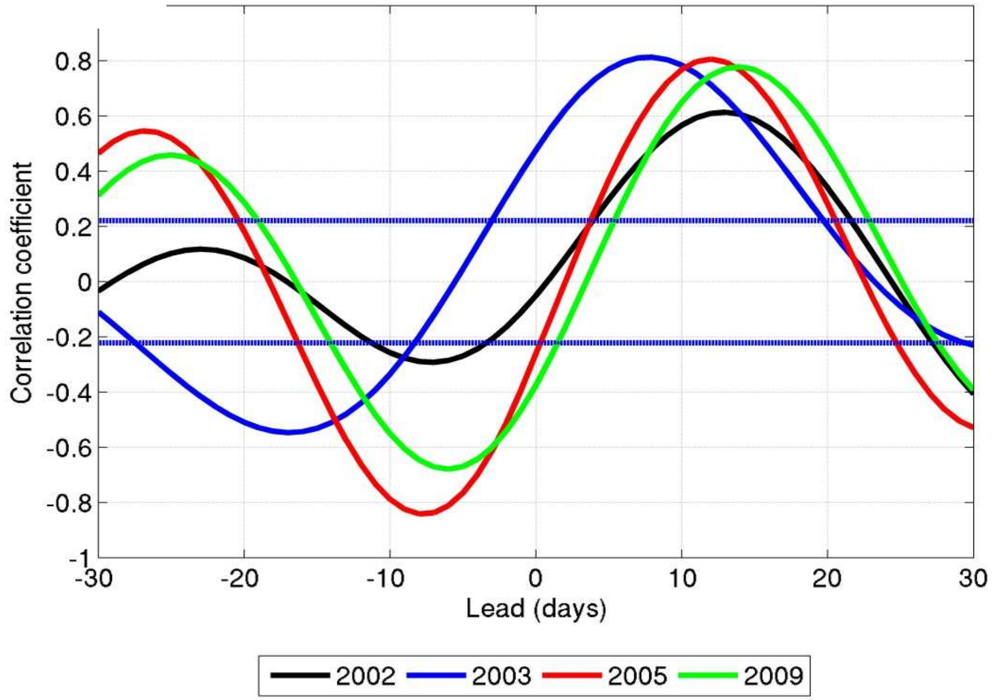
# Time-station lag regression of the observed intra-seasonal MSLA w.r.t Intra-seasonal MSLA at 90E (red star)



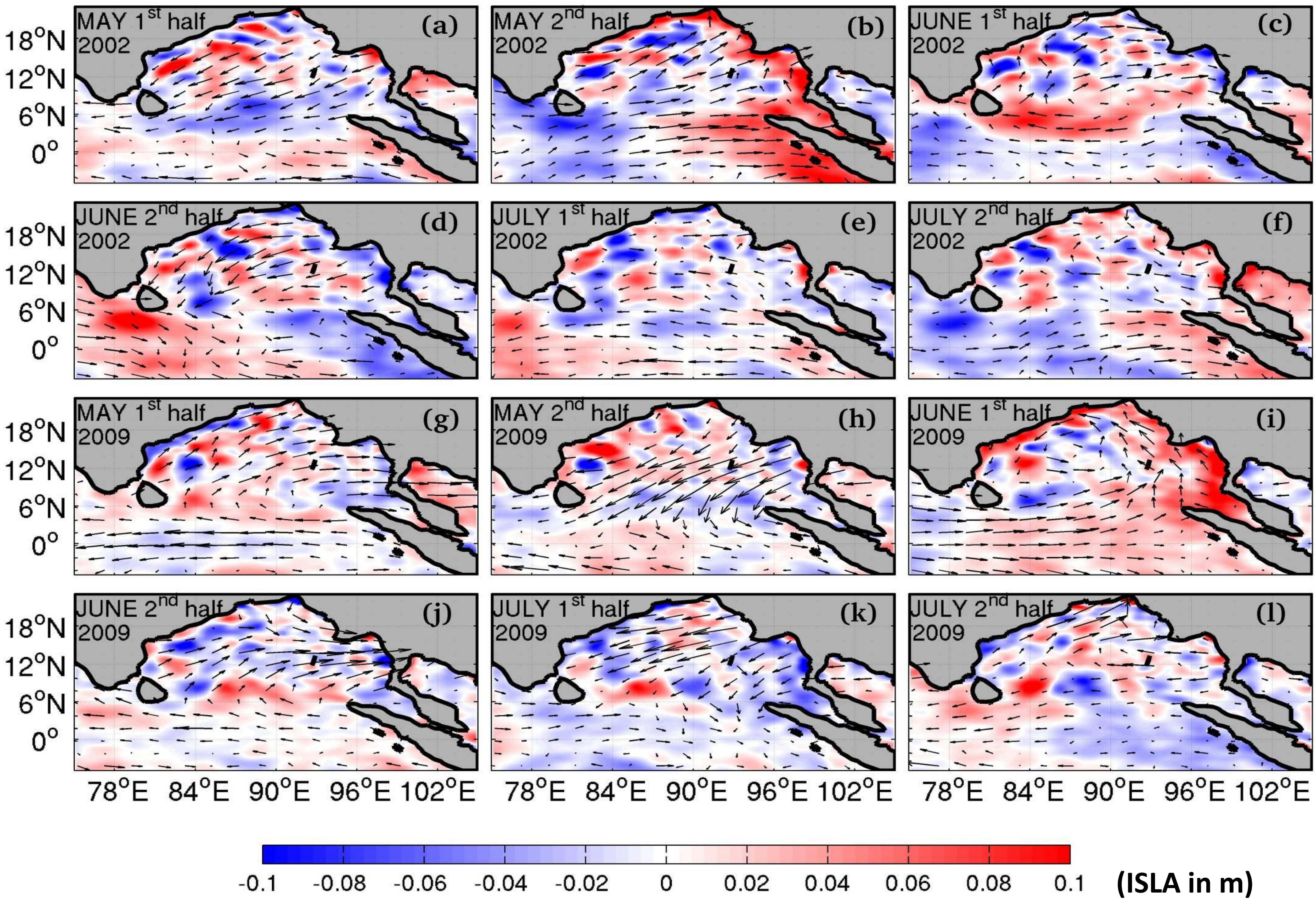




**The SLA is filtered using Lanczos band pass filter with 30 – 100 days periodicity**




**Lag cross-correlation between filtered wind stress and SLA**



MAY 1st half 2002 (a)
MAY 2nd half 2002 (b)
JUNE 1st half 2002 (c)
JUNE 2nd half 2002 (d)
JULY 1st half 2002 (e)
JULY 2nd half 2002 (f)
MAY 1st half 2009 (g)
MAY 2nd half 2009 (h)
JUNE 1st half 2009 (i)
JUNE 2nd half 2009 (j)
JULY 1st half 2009 (k)
JULY 2nd half 2009 (l)
18°N
12°N
6°N
0°
78°E 84°E 90°E 96°E 102°E
-0.1 -0.08 -0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1
(ISLA in m)

# Okubo-Weiss Method for Eddy Detection

- The Okubo-Weiss parameter mainly separates the vorticity dominated domains and the strain dominated domains from the velocity field.

- Okubo-Weiss parameter is defined as

$$W = S_n^2 + S_s^2 - \omega^2$$

Where normal strain rate $S_n = \frac{\partial u}{\partial x} - \frac{\partial v}{\partial y}$

shearing strain rate $S_s = \frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}$

and vorticity $\omega = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$

- By definition eddies are vorticity dominated region. So for eddy region $W<0$.

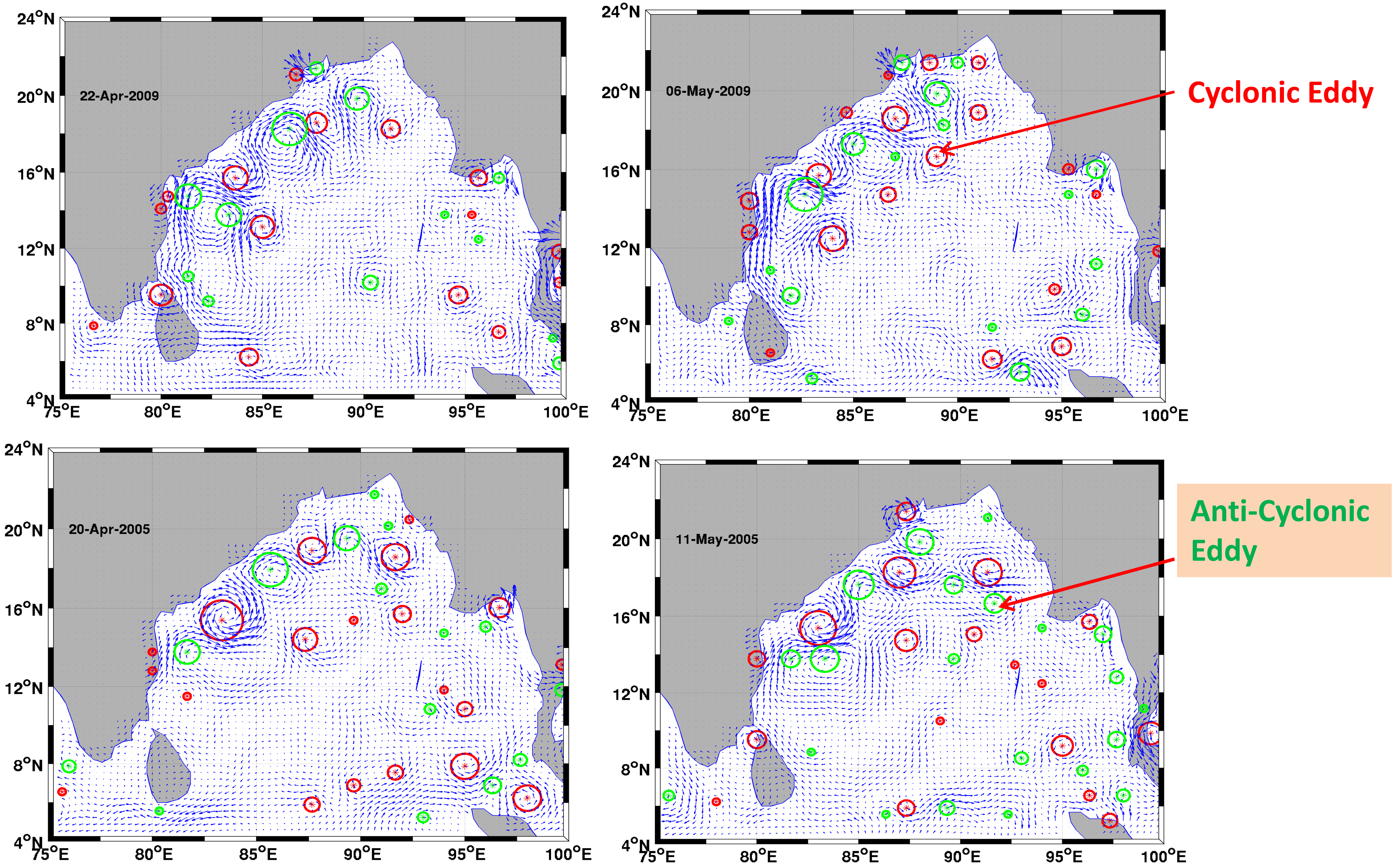
- We separate the coherent vortices by the criteria $W< -0.2\sigma_W$ ,where $\sigma_W$ is the standard deviation of the W having same sign of the vorticity.

- $\omega>0$ for cyclonic eddies and $\omega<0$ for anticyclonic eddies.

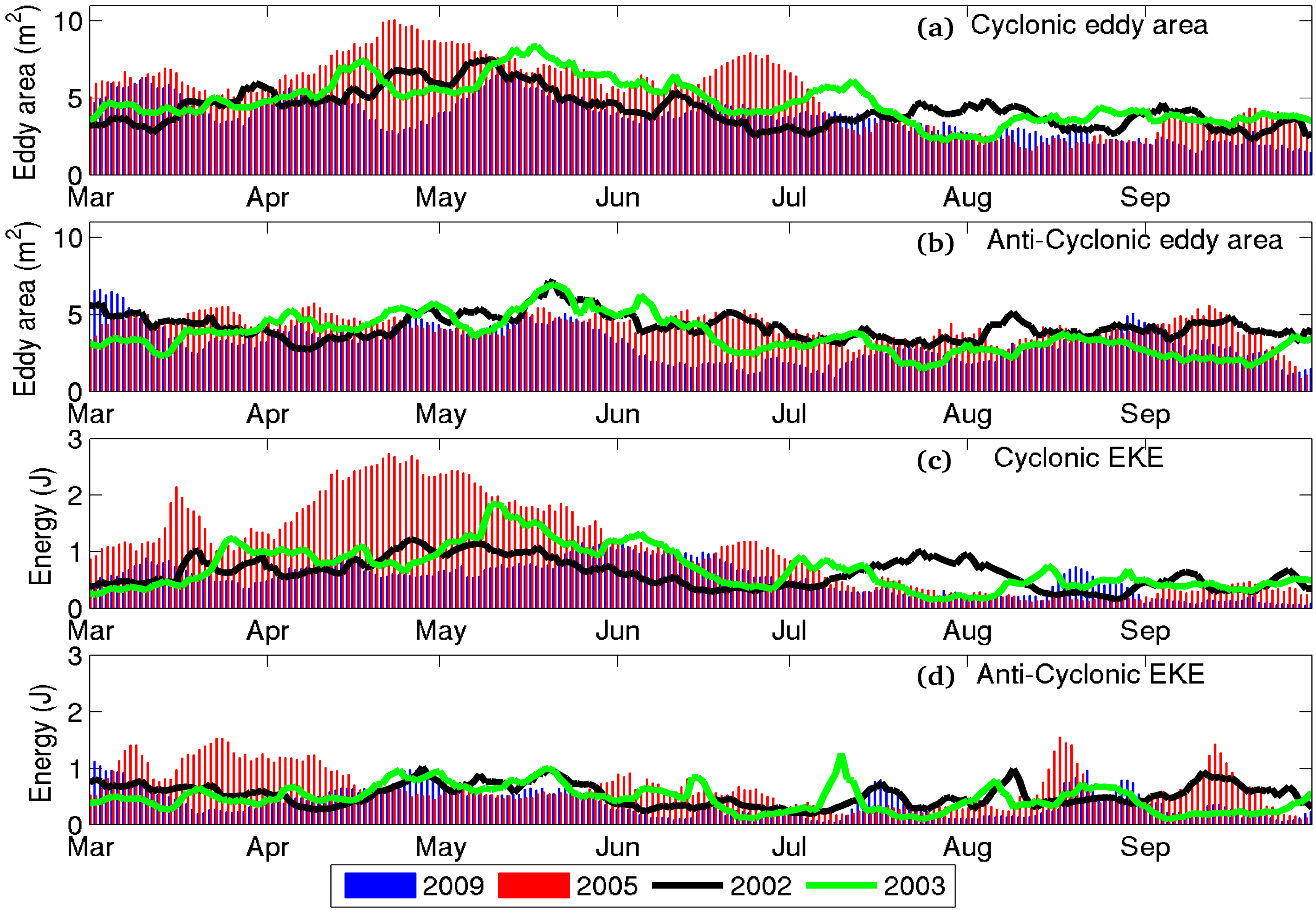
- Eddy centres are decided as the points of maximum vorticity

- Effective radius of an eddy is calculated using the following formula

$R_e = R_T\sqrt{\left(\frac{N_{gp}}{\pi}\, \Delta\varphi\, \Delta\lambda\, cos\varphi_0\right)}$ where $\Delta\varphi = \Delta\lambda = 0.33^o$ and $\varphi_0$ *is* the reference latitude.


22-Apr-2009
06-May-2009
20-Apr-2005
11-May-2005
Cyclonic Eddy
Anti-Cyclonic Eddy
24°N
20°N
16°N
12°N
8°N
4°N
75°E
80°E
85°E
90°E
95°E
100°E

# Total eddy area (in unit of $10^{10} m^2$) and KE (in unit of $10^{-7}$J) in the Northern BoB (78°E – 99°E and 14°N – 23°N)



# Conclusions

- **The propagation of Kelvin wave was reduced in the EIO, Sumatra coast and east coast of the BoB during pre-monsoon and monsoon time of deficit ISM years (e.g. 2002 and 2009) compared to that of normal years (e.g. 2003 and 2005)**

- **The major factor account for the reduction in the strength propagation of wave is weak intra-seasonal wind stress over the EEIO as well as along-shore component over the BoB.**

- **The reduced kelvin wave activities also reduces the radiation of Rossby waves in the region hence reducing the eddy activities in the region**

- **The reduction in wave activities reduces the ILD, may be a cause for increasing the surface temperature (SST)**

# THANK YOU