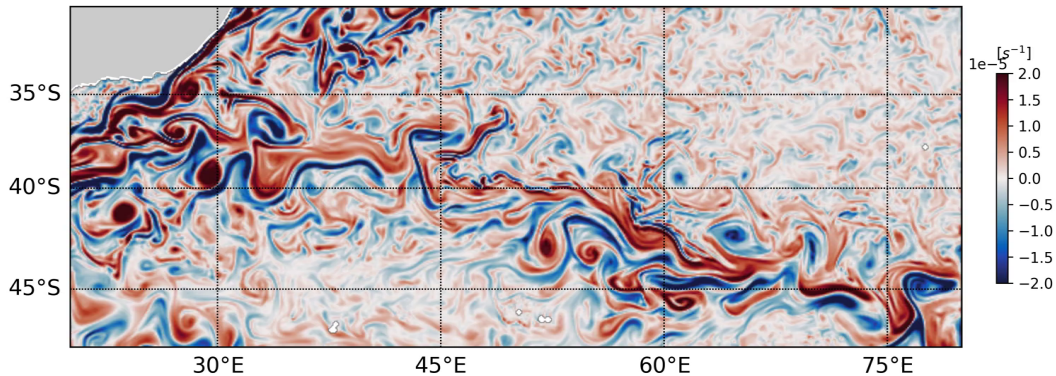


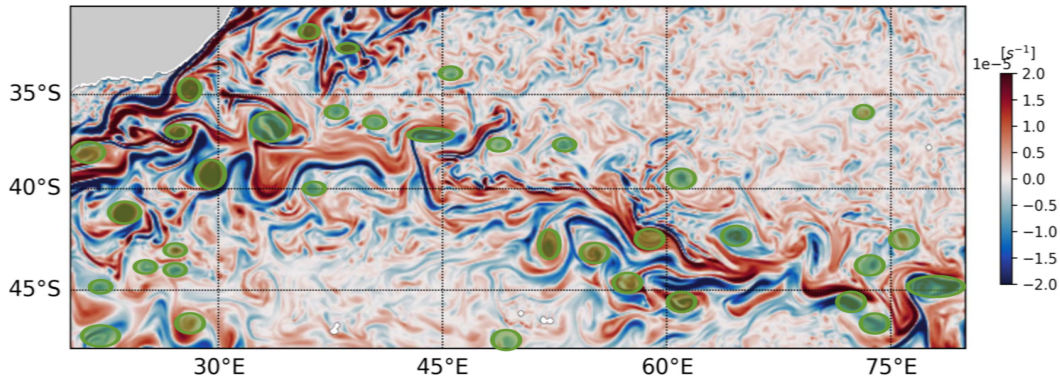
Climate Change Signal in Oceanic Eddies.

Transient



Vorticity in the Agulhas Current Region.

Eddy



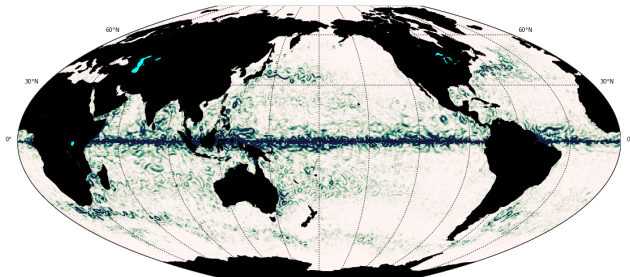
Vorticity in the Agulhas Current Region.

Kinetic Energy has been used to understand temporal and spatial oceanic variability.

(Kang and Curchitser, 2017; White and Heywood, 1995)

The kinetic energy (KE) decomposes into the time-mean (MKE), the time-varying (TKE) and second order terms:

$$\underbrace{\overline{u^2 + v^2}}_{KE} = \underbrace{\overline{u}^2 + \overline{v}^2}_{MKE} + \underbrace{\overline{u'^2 + v'^2}}_{TKE}.$$



Snapshot of Transient Kinetic Energy

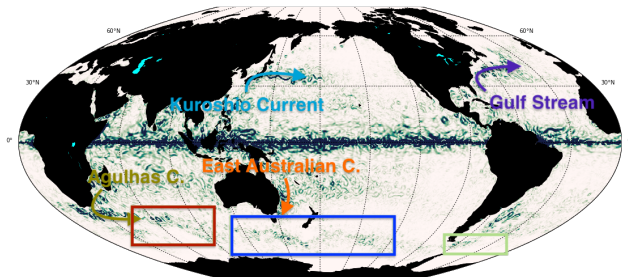
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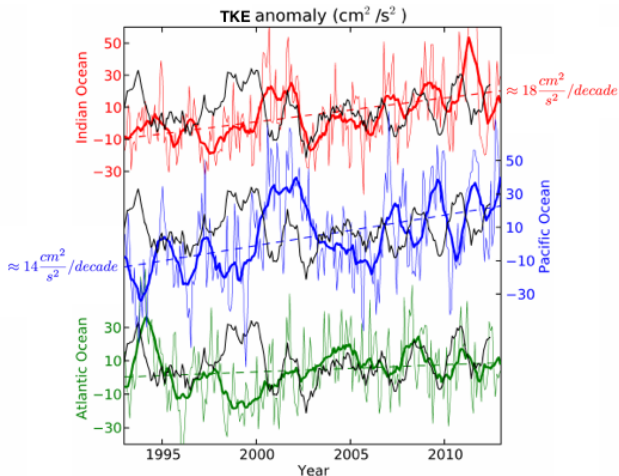
(Chelton et al., 2011; Chelton et al., 2007.)



Snapshot of Transient Kinetic Energy

Southern Ocean TKE trends

These regions located in the Southern Ocean show a significant increase of TKE anomaly over the last two decades. (Hogg et al., 2015)

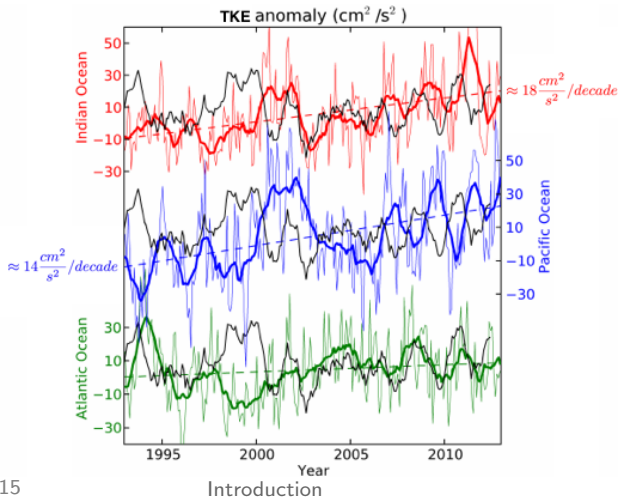


TKE anomaly trend for three Southern Ocean sectors.

How much of this TKE trend is attributed to eddies?

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TKE anomaly trend for three Southern Ocean sectors.

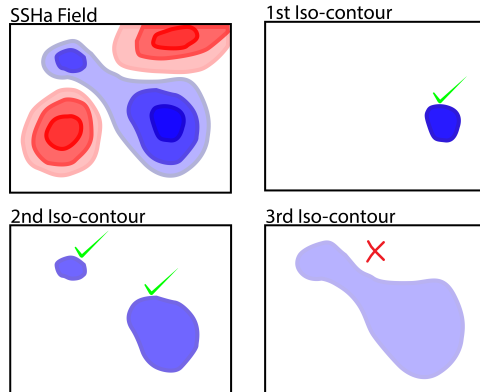
How much of this TKE trend is attributed to eddies?

“TrackEddy” algorithm is an eddy tracking-reconstruction algorithm.

Identification steps:

- ▶ Outer contour of an eddy is roughly elliptical,
- ▶ eddy area limited by the 1st baroclinic Rossby radius of deformation
- ▶ and **eddies can be approximated by Gaussians**.

(Fernandes et al., 2006; Klocker et. al., 2014)



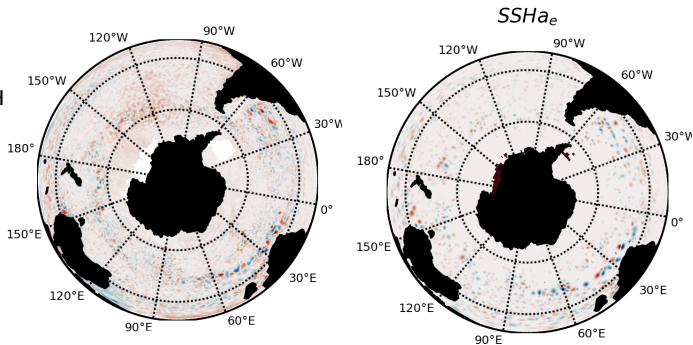
TrackEddy implementation cartoon.

TrackEddy implementation-reconstruction from AVISO+ SSHa dataset.

TrackEddy steps:

- ▶ Identify each eddy-like feature from SSH
- ▶ Fit an optimal Gaussian to each feature
- ▶ Reconstruct the perturbation field
- ▶ Calculate geostrophic velocities
- ▶ Calculate KE

(Fernandes et al., 2006; Klocker et. al., 2014)



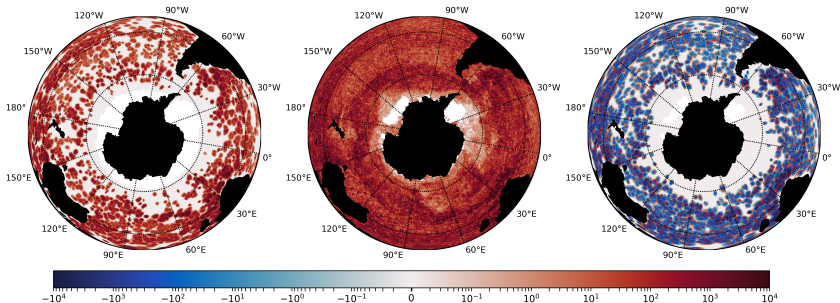
SSHa & TrackEddy reconstruction.

Kinetic energy (KE) decomposes into the time-mean (MKE), the time-varying (TKE):

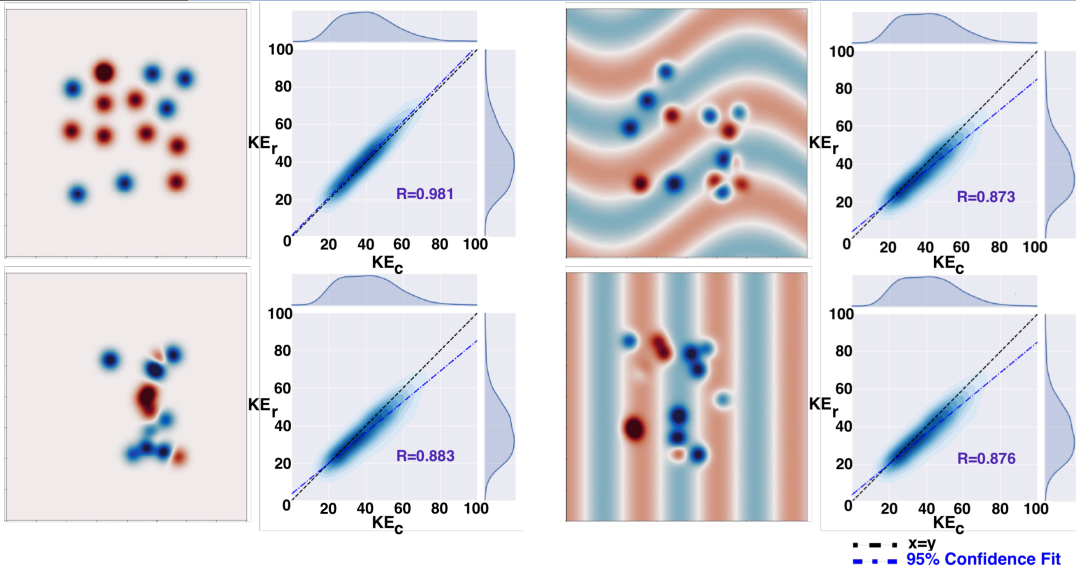
$$\underbrace{\overline{u^2 + v^2}}_{KE} = \underbrace{\bar{u}^2 + \bar{v}^2}_{MKE} + \underbrace{\overline{u'^2 + v'^2}}_{TKE}.$$

We define $u' = u_{eddy} + u_{res}$, then:

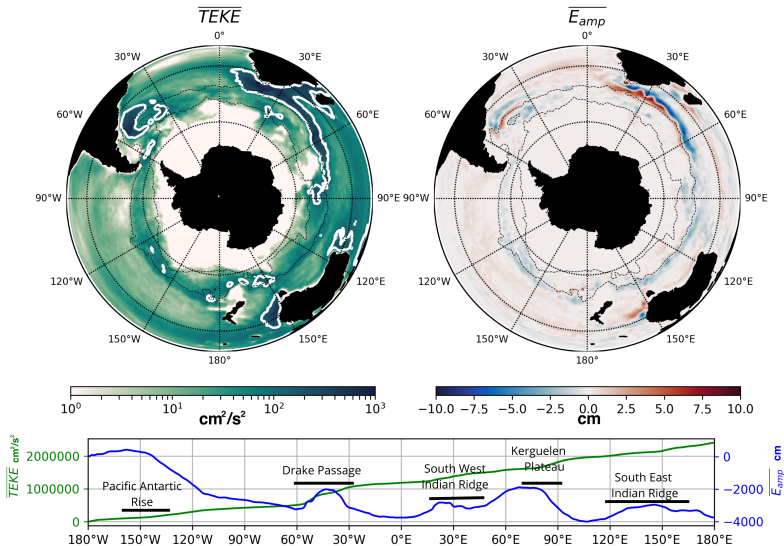
$$\underbrace{u'^2 + v'^2}_{TKE} = \underbrace{u_{eddy}^2 + v_{eddy}^2}_{TEKE} + \underbrace{u_{res}^2 + v_{res}^2}_{TRKE} + \underbrace{2(u_{eddy}u_{res} + v_{eddy}v_{res})}_{TRKE}$$



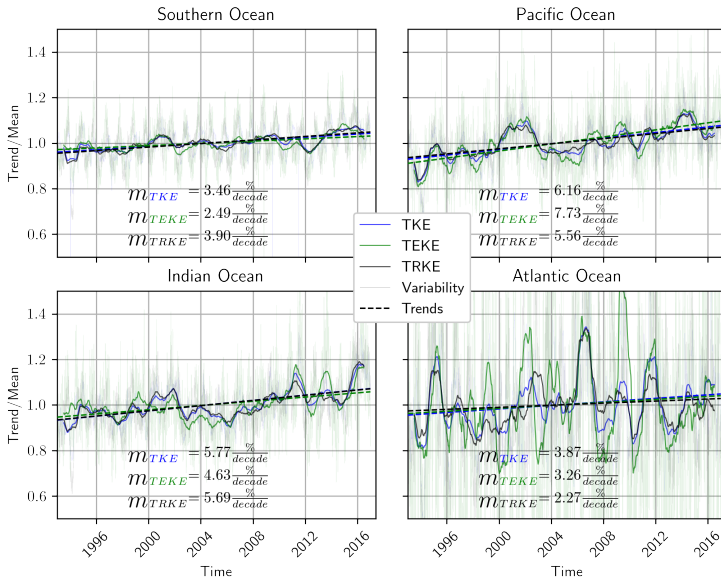
Validation with synthetic data

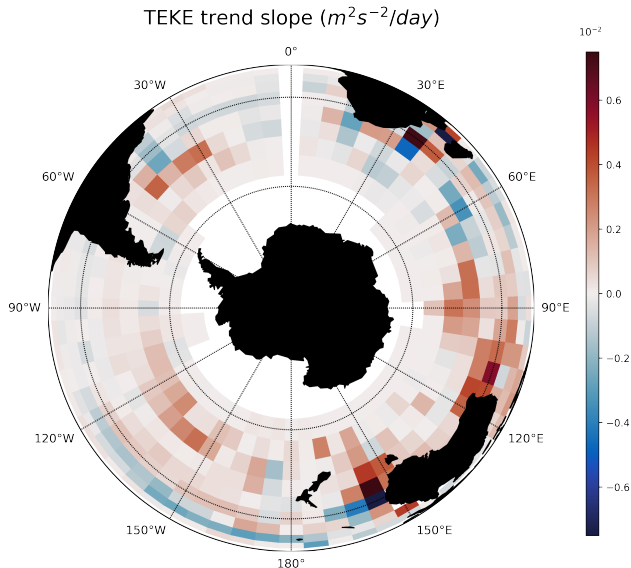


Hotspots identified in AVISO+ SSHa

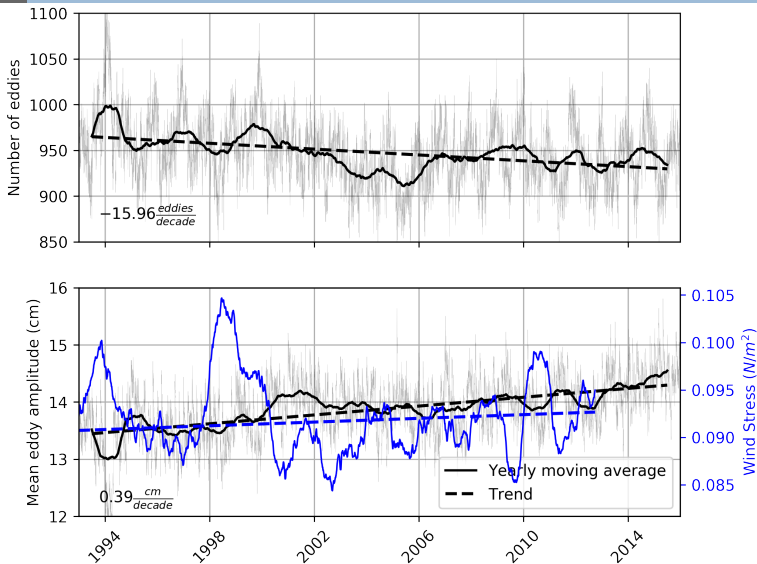


Southern Ocean Trends in AVISO+ SSHa

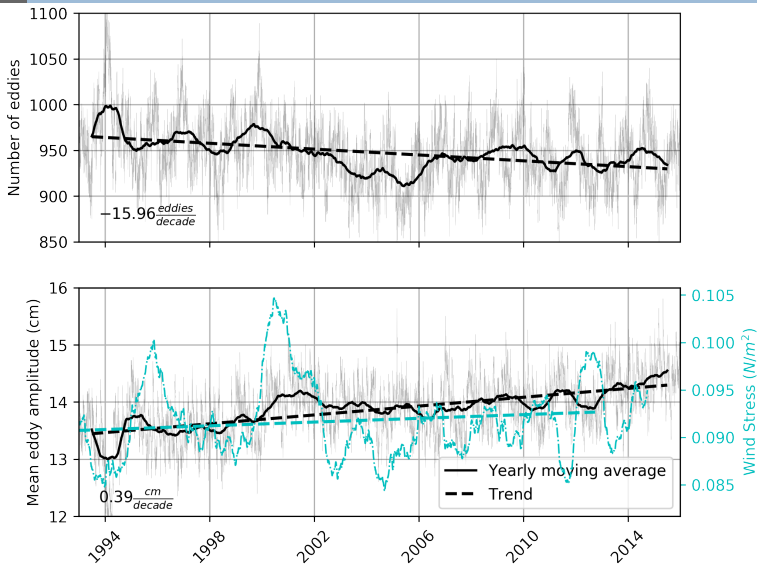




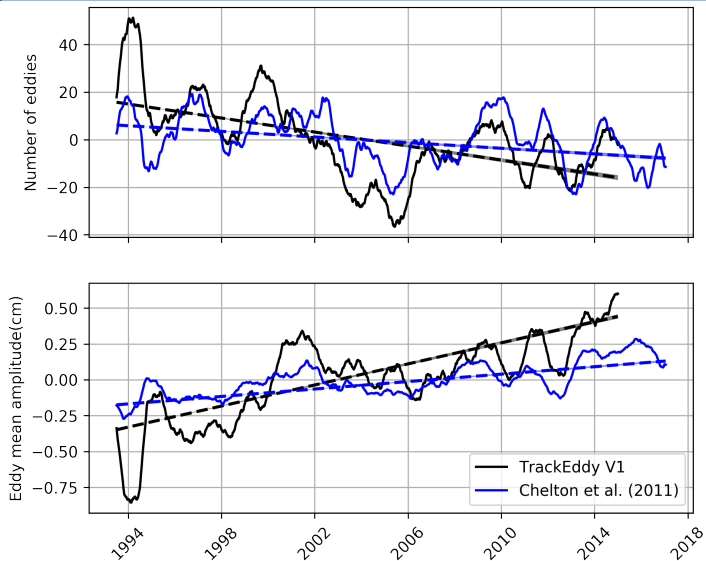
Eddy Intensification



Eddy Intensification in AVISO+ SSHa



Previous studies comparison



- ▶ Development of TrackEddy a reconstruction eddy field algorithm.
- ▶ Validation of TrackEddy.
- ▶ TEKE trends follow the TKE trends.
- ▶ Southern Ocean TEKE & TKE hotspots have a positive slope.
- ▶ EKE trends associated with eddy amplitude, not with an increase on the number of features.

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Thank you!