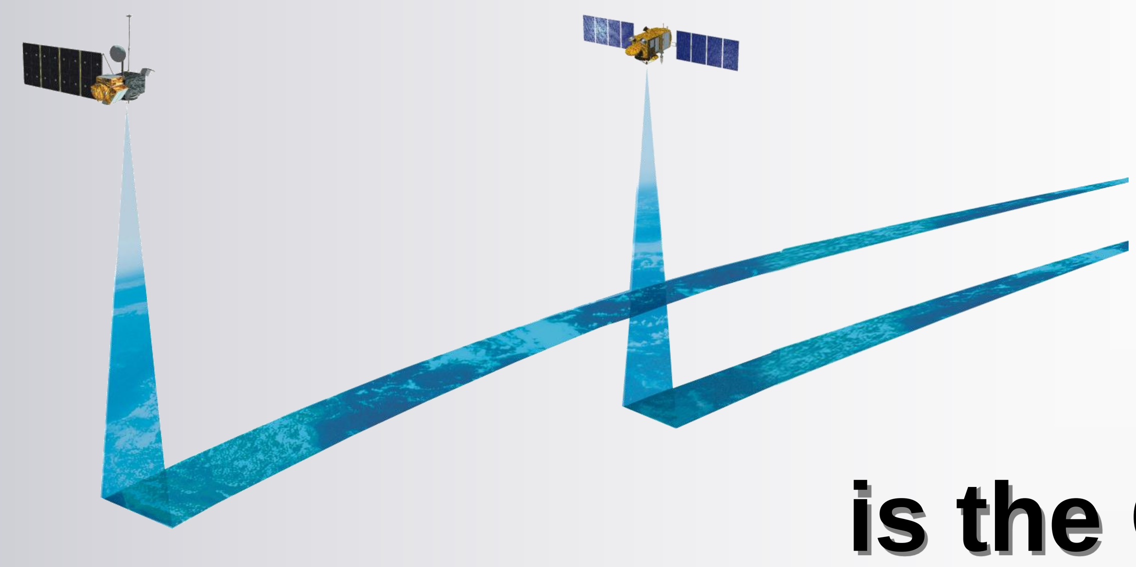
ALTIMETRY FOR OCEANS AND HYDROLOGY, 18-22 October 2010, Lisbon, Portugal
Ocean and hydrology applications workshop

The Large-Scale Geostrophic Flow-Field and Eddy Variability as seen from the TOPEX/Poseidon and Jason-1 Tandem Mission, …



… or is the Ocean Flow-Field isotropic?

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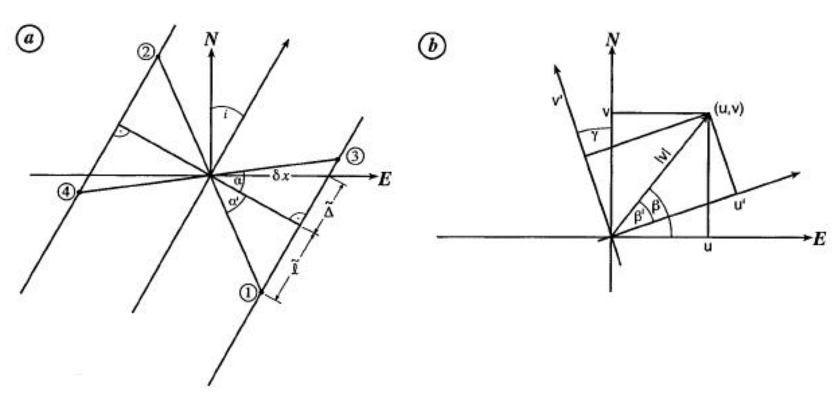
Geostrophic surface velocity anomalies were estimated from the Jason-1-TOPEX/Poseidon (JTP) tandem altimetric Sea Surface Height (SSH) data using the "parallel-track-approach" with a 6.2 *km* along-track resolution from September 2002 to September 2005.

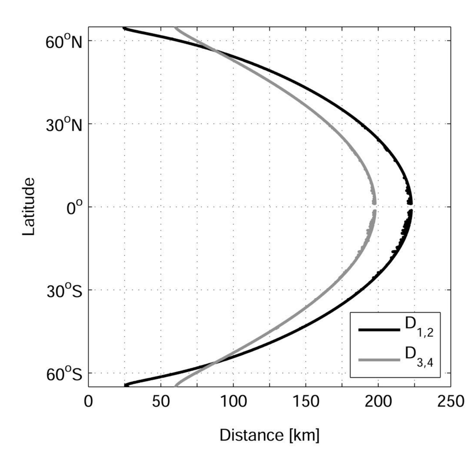
With that method it has been possible for the first time to calculate zonal and meridional geostrophic velocity components separately without the assumption of isotropy, and the resulting EKE subsequently, along the satellite track for each along-track position. The opportunity to study each velocity component on its own yields an important increase in knowledge to the general behavior of the ocean circulation.

Results shown suggest that velocity time series of the JTP tandem mission should be continued through similar constellations, e.g., of Jason-2 and Jason-3.

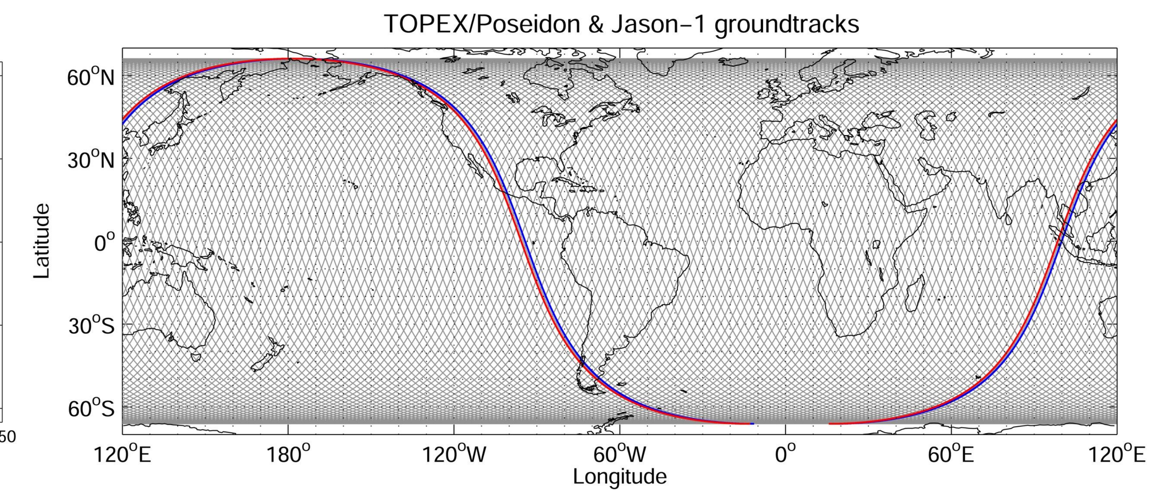
Geostrophic Velocity Calculation



LEFT (a) Schematic of the geometry used to compute orthogonal geostrophic velocity components on the interleaving track from SSH measurements provided along the two tracks to the east and west. (b) Schematic illustrating the orientation of the orthogonal velocity components obtained from the along-track data and their rotation into a local Cartesian coordinate system with zonal/meridional orientation. (Stammer and Dieterich, 1999)

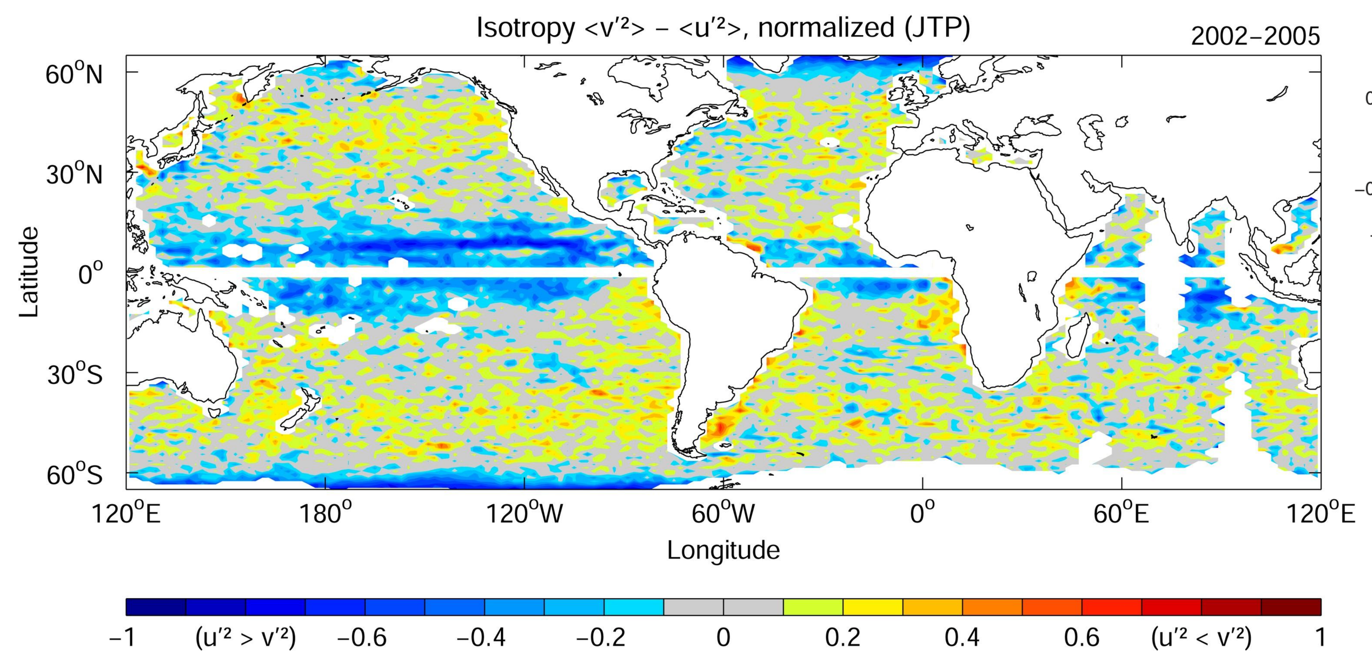


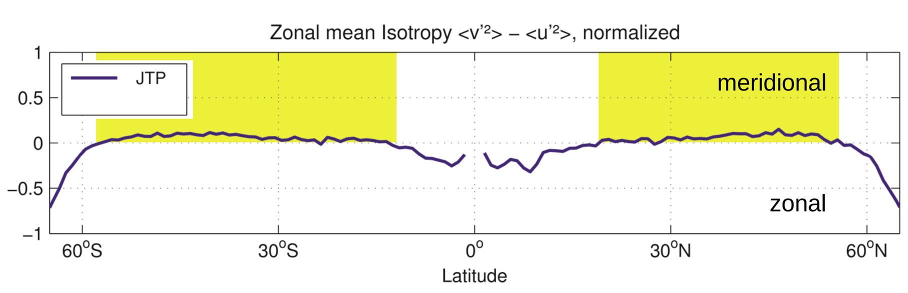
MIDDLE Distances $D_{1;2}$ and $D_{3;4}$ between the SSH measurements (left figure) that are used for the geostrophic velocity calculation as they vary with latitudes.



RIGHT (Top) Virtual ground track (grey) on which the geostrophic velocities were calculated using the SSH data available from the JTP tandem mission. Exemplary the TOPEX/Poseidon (red) and Jason-1 (blue) ground-tracks are shown for ARC 1 and 2.

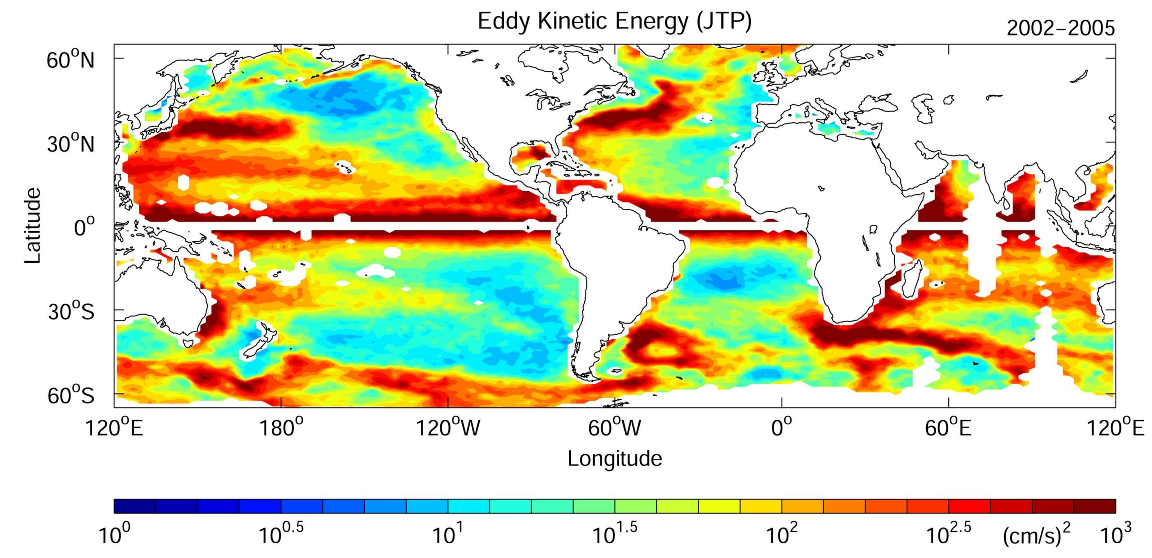
ISOTROPY – 3-year mean – Eddy Kinetic Energy (EKE)





LEFT / TOP 3-year mean isotropy *(v'^2 - u'^2)*, normalized by standard deviation, with *u'* and *v'* the zonal and meridional geostrophic velocity anomalies. Calculated point wise along track and subsequently gridded on a 2° × 1° grid. Over large parts of the world ocean the assumption of isotropy is acceptable but in regions of high EKE the assumption of isotropy leads to an over or rather under estimation of the EKE..

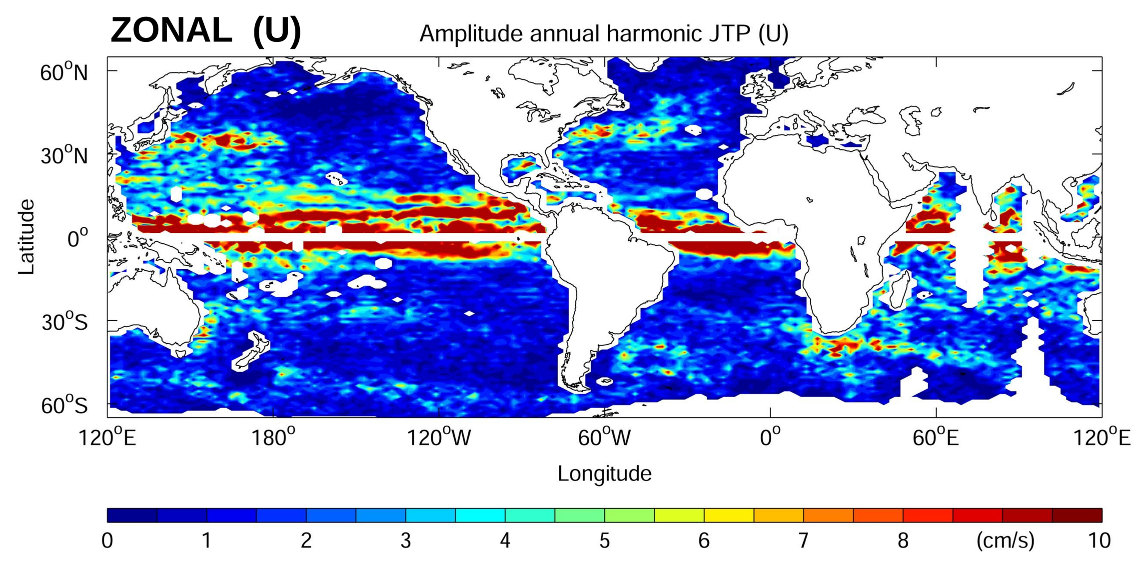
The ocean circulation is shown to have a slightly higher meridional variability by 10 to 20 % in mid latitudes, while in the tropics the EKE field is dominated by variability of the mostly zonal current field which clarifies that in some regions it is important to assume anisotropy.

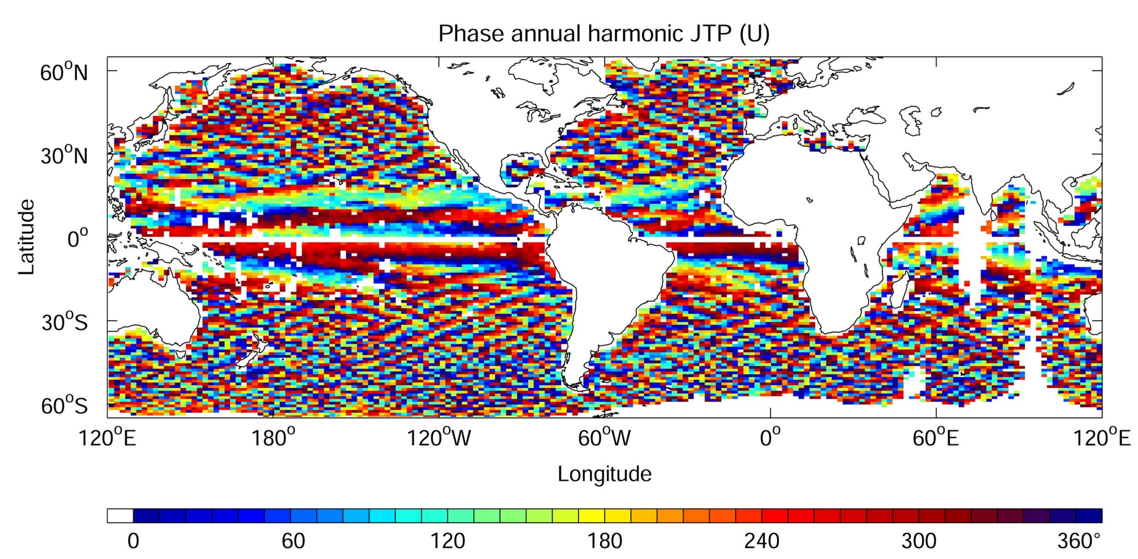


3-year mean EKE calculated point wise along track and gridded on a 2° × 1° grid. The JTP-EKE is comparable to previous estimates, however, regions of known anisotropic conditions can now be displayed with higher accuracy.

Geostrophic Velocities – seasonal– EKE

ZONAL (U)



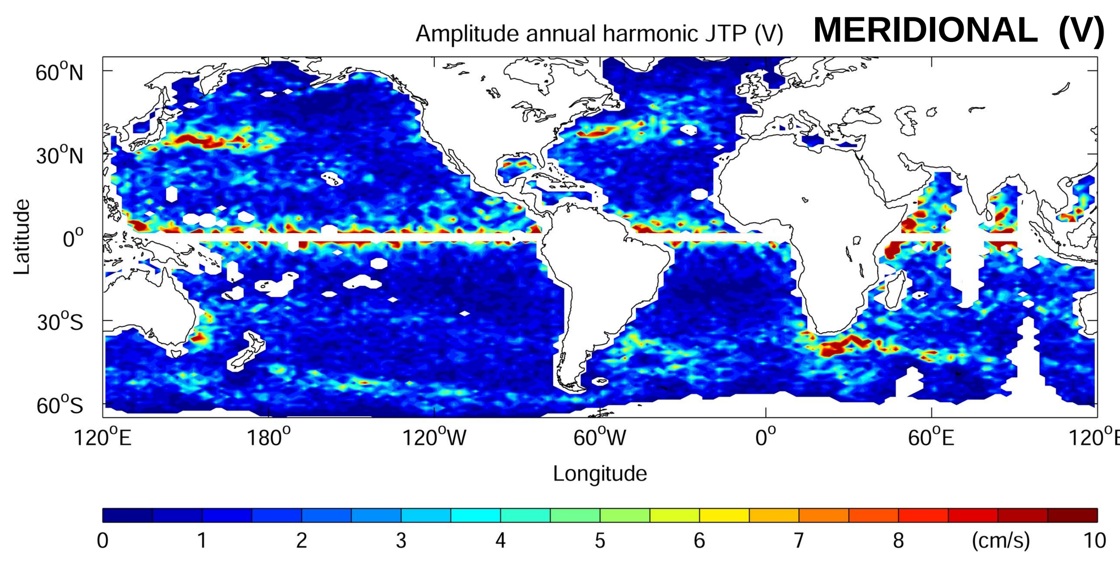


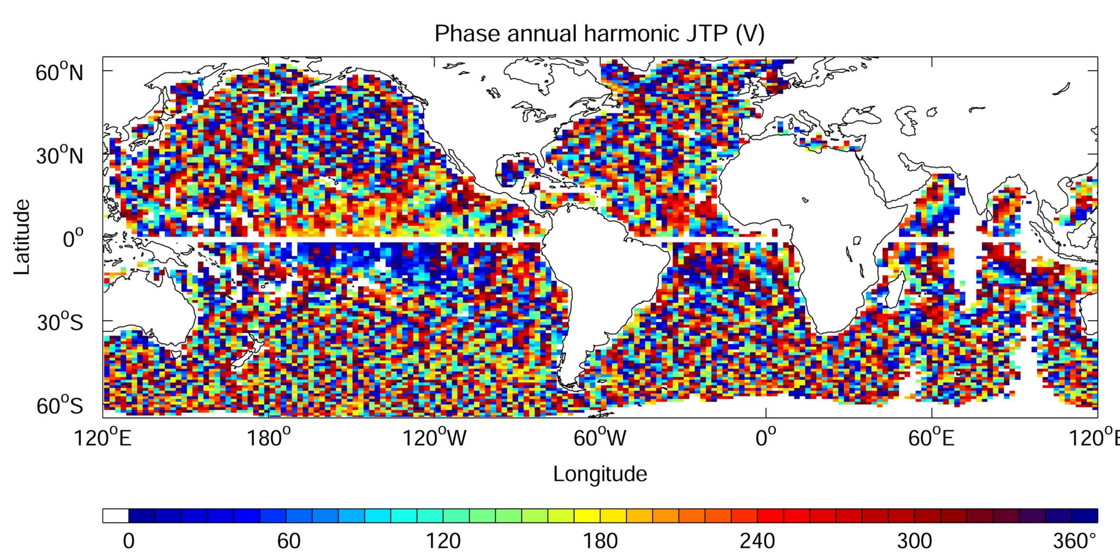
Amplitudes (top) of the annual signal of the *u*- and *v*-velocity-components and (bottom) their phases respectively. The amplitudes and phases are calculated for the mean of each 2° × 1° grid box. The origin of the phases is January 1st.

The annual **amplitudes** reach values bigger than 10 cm/s in the equatorial Pacific, the Kuroshio and Agulhas current for the *u*- and in the Kuroshio and Agulhas current for the *v*-component.

In the western Pacific, for instance, the complex structures of the seasonally changing flow-field appear as zonally coherent jet-like structures.

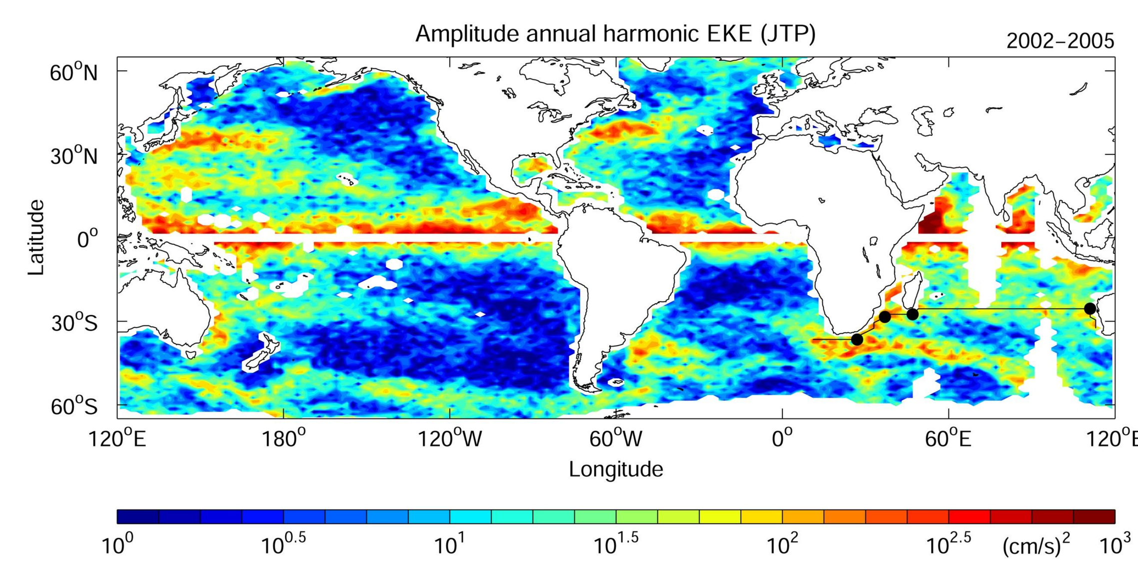
MERIDIONAL (V)

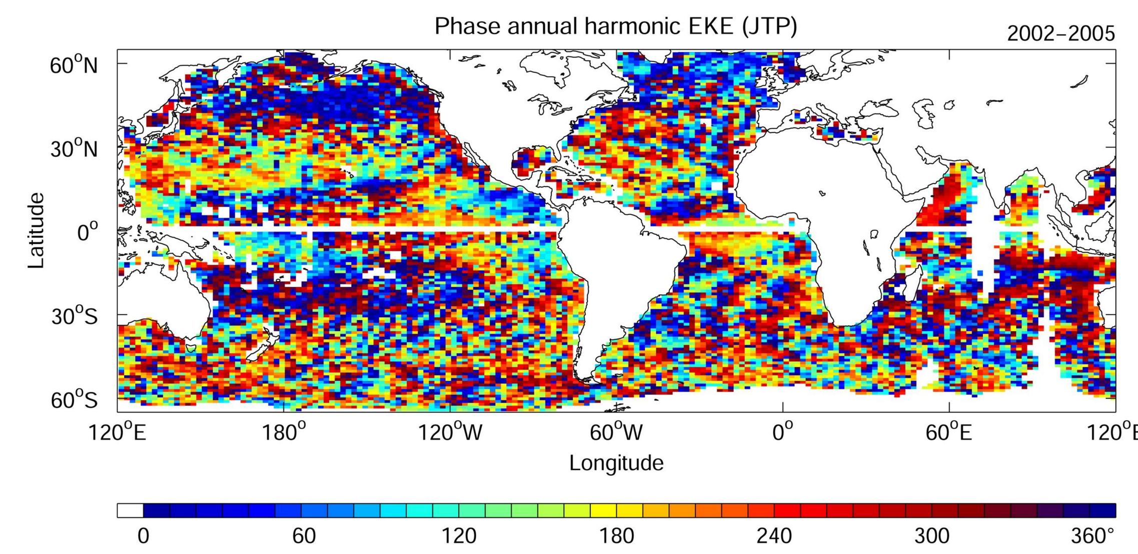




Over most parts of the world ocean the **phase signal** is noisy. In the equatorial Pacific, Atlantic and Indian ocean the areas with large amplitudes show propagating signals visible through the slightly changing colors.

Complex Phase structures are found in mid and high latitudes. To what extend all of those structures represent the ocean still has to be investigated, however, it is reassuring, that first preliminary results of a 1/10° global ocean circulation model also seem to reproduce the complex phase structures from altimeter data.





Annual amplitude (top) of the Eddy Kinetic Energy. Note the logarithmic scale. All major current systems stay out in magnitude. The largest values can be found in the Great Whirl region with up to 870 (cm/s)² . (Bottom) Annual phase of the Eddy Kinetic Energy. The colors denote days starting from January 1st.

In March strong EKE values emerge in the Bay of Tehuantepec, following very strong winds through the isthmus of Tehuantepec. They have a seasonal signal with max in Dec-Jan (Romero-Centeno, 2003). During the summer monsoon about September one can clearly identify the maximum of the Great Whirl (Shankar, 2002).

Conclusion

1) There is a slight excess of meridional eddy variability over most parts of the mid latitudes, whereas from previous studies (Wunsch, 1997) an isotropic eddy field was expected. However the results agree with a publication by Scott et al., (2008) who found the excess in meridional eddy variability in a numerical simulation of the mesoscale eddy field.

2) We demonstrated the importance of the JTP velocity estimates for the understanding of the spatial structures of flow changes on the annual period (Scharffenberg and Stammer, 2010).

3) Conclusions from regional studies could be reproduced and extended to the basin-scale and into a global context.

4) Complex structures of the seasonally changing flow-field reveal, as coherent jet-like structures in the western Pacific.

References

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