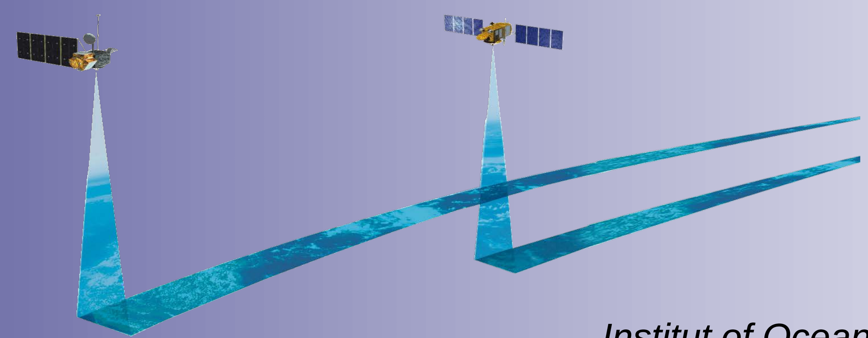
A probabilistic description of the mesoscale Eddy Field of the ocean



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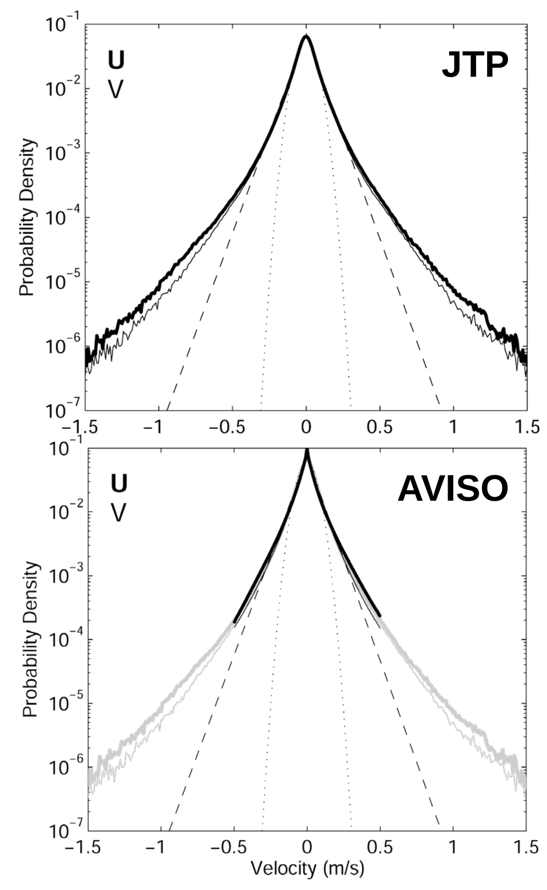
Probability Density Functions (PDF) for both (zonal and meridional) velocity components are presented. They have been inferred from the 3-year long Jason-1 - TOPEX/POSEIDON Tandem Mission (JTP). Results are compared with those obtained form longer time series of geostrophic velocities and SSH inferred form the 19-year 1/3° weekly AVISO SSH anomaly fields from the TOPEX/POSEIDON, Jason-1 and Jason-2 (TPJJ) missions.

The differences in the zonal and meridional components are found to be evident, with a slightly wider shape for the zonal velocity component due to the larger variability in zonal direction. Our results confirm that the exponential shape of the global velocity PDF is a consequence of the spatially inhomogeneous EKE distribution over the global ocean. Hence, the exponential shape is the result of averaging Gaussian PDF with differing PDF-width. As a result, regions that only have a small variance in EKE, have a Gaussian shaped PDF, whereas regions that have a large variance in EKE, show a rather exponential shaped PDF. Accordingly, normalizing any regional velocity PDF with their standard deviation also results in a gaussian PDF independent from the regional extend.

To further describe the behavior of the PDF, skewness and kurtosis is calculated for the first time for both velocity components individually as well as for the underlying SSH. The skewness and kurtosis of the velocity and SSH fields appear to identify the mean path of unstable ocean jets as well as regions dominated by eddies and they complement each other in the description of the actual structure of the eddy field. Using the longer 19-year time series of SSH and velocity results in clearer structures of skewness and kurtosis.

- PDF -

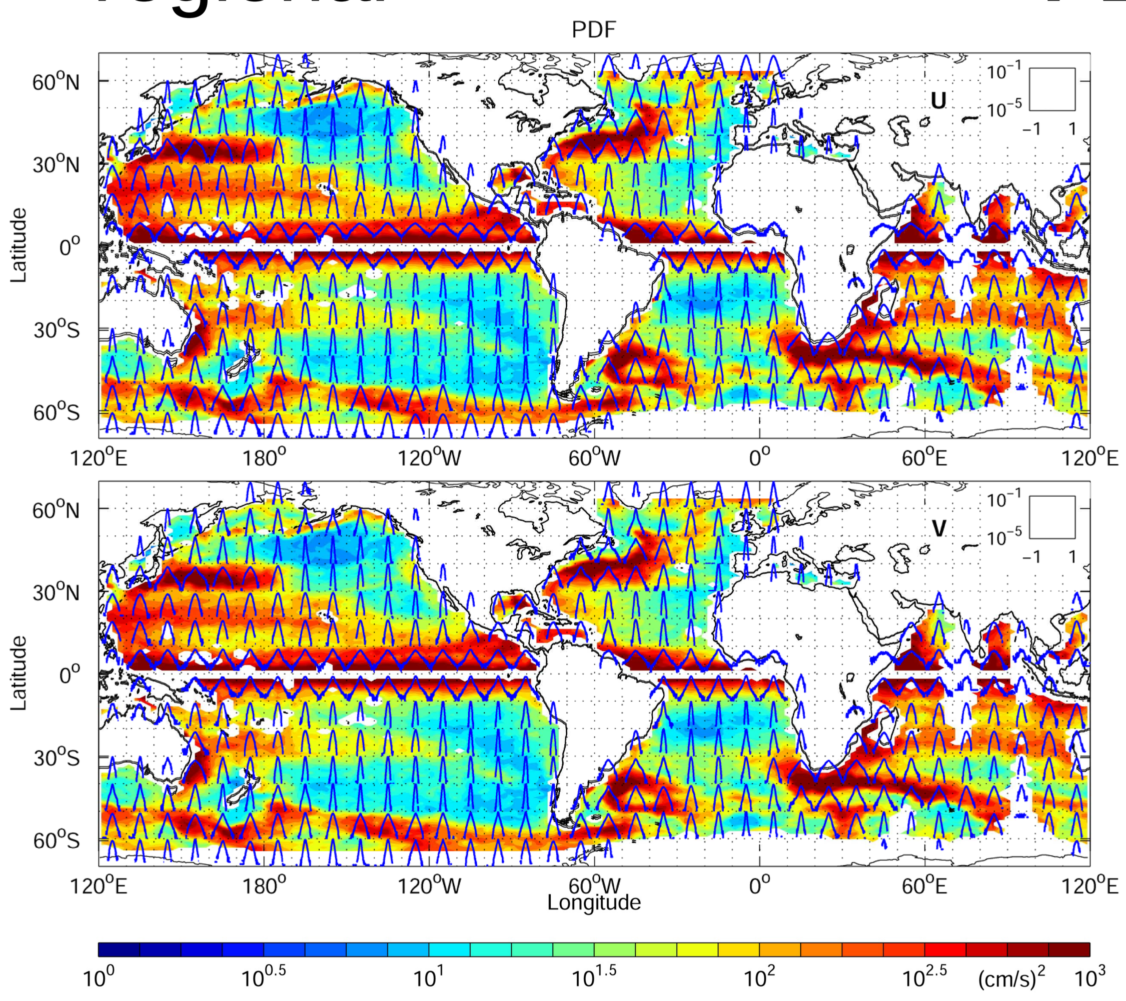
global



TOP Global probability density function distribution of the **zonal** and meridional geostrophic velocity components [*m/s*] from JTP along with the exponential (dashed) and Gaussian fit (dotted) to the zonal PDF.

BOTTOM As above but for the AVISO 1/3° geostrophic velocity components. The JTP distributions are shown in light grey.

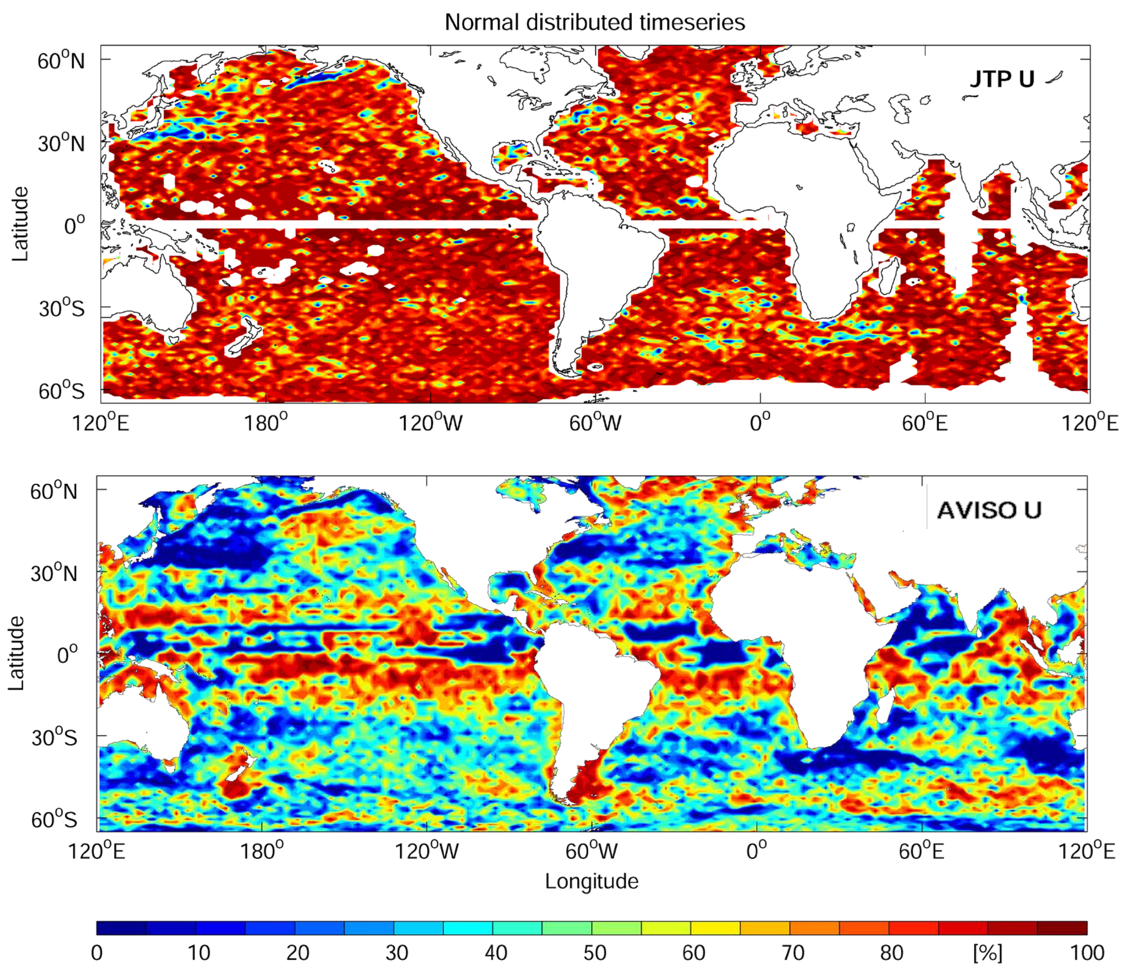
regional



Probability density function distribution of the zonal (top) and meridional (bottom) geostrophic velocity components [*m/s*] calculated along the satellite track and gridded for regions of 10° × 10°. The top right insets give the axis ranges of the displayed PDF. In the back is the 3-year mean EKE (Scharffenberg and Stammer, 2010, their Fig.5a), calculated on the satellite track and gridded on a 2° × 1° grid.

The differences in the zonal and meridional components show a wider shape for the zonal velocity component due to the larger variability in zonal direction.

Lillietest



Percentage of normal distributed time-series for the zonal (top) and meridional (bottom) geostrophic velocity components [*%*]. Each time series was tested (Lillietest) whether it is normal distributed. The results were averaged over 2° × 1° regions.

Our results confirm that the exponential shape of the global velocity PDF is a consequence of the spatially inhomogeneous EKE distribution over the global ocean. Regions that only have a small variance in EKE, have a gaussian shaped PDF. Accordingly, normalizing any regional velocity PDF with their standard deviation also results in a gaussian PDF.

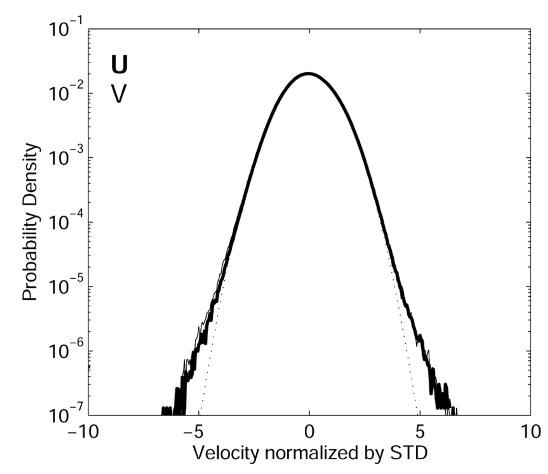
STD-normalized

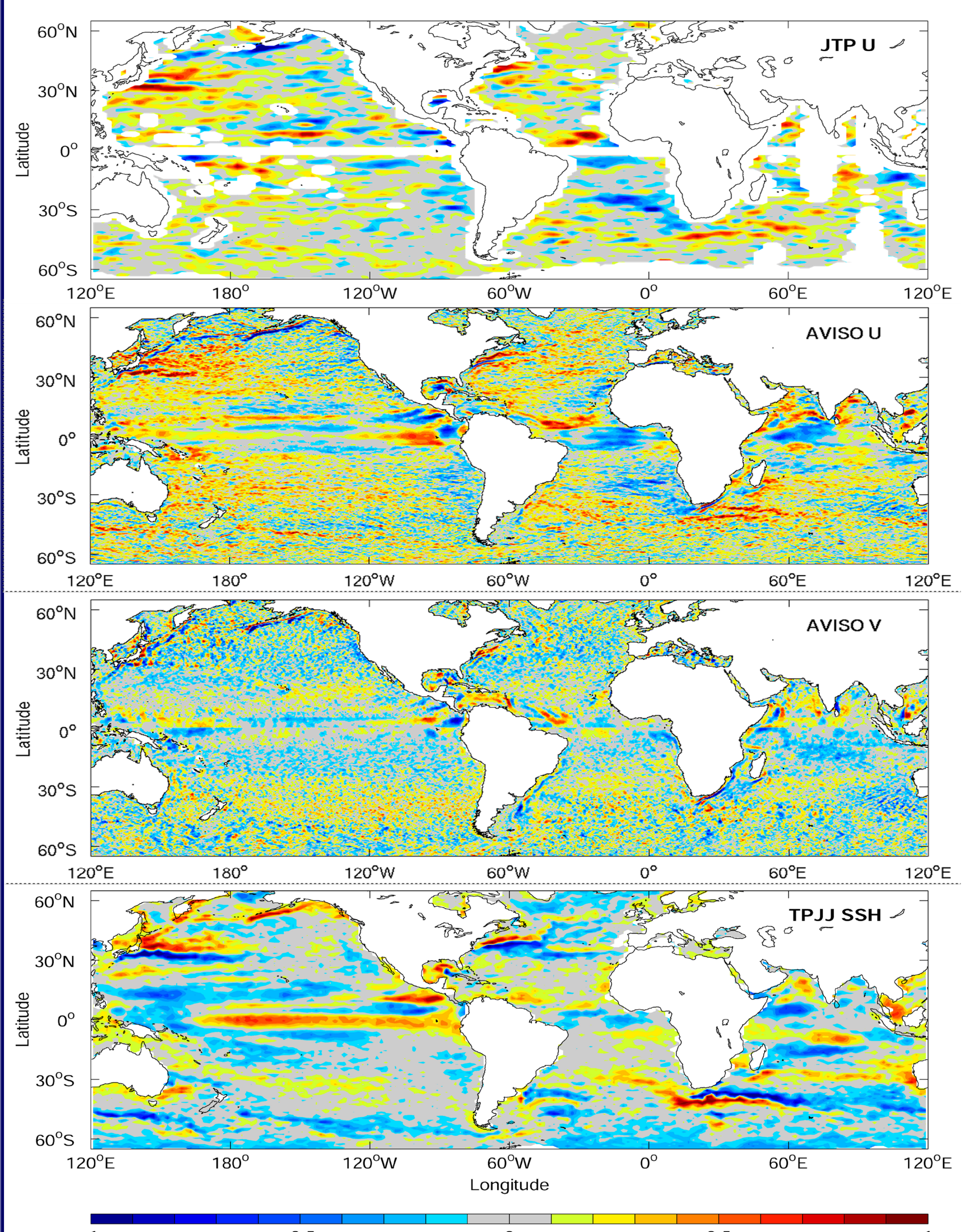
Except for the energetic boundary currents, more than 70% of the individual velocity time-series are Gauss distributed.

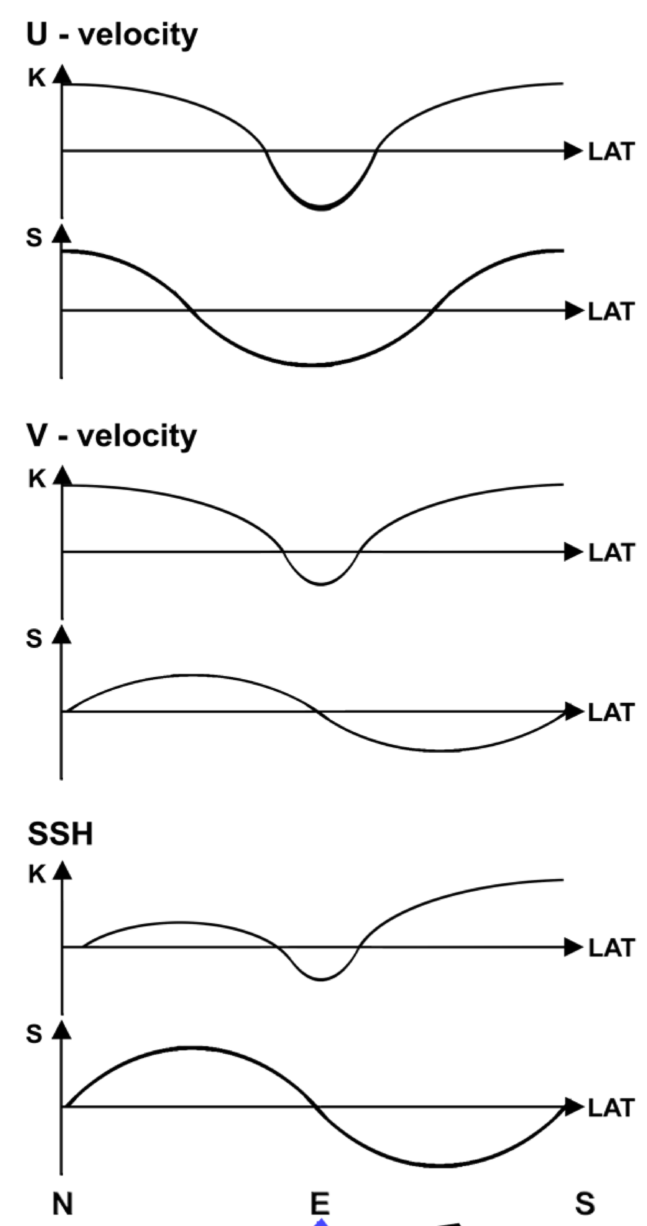
Combining Gauss-distributed time-series that have an equal STD, the resulting PDF will be Gauss-distributed as well. However, if the STD is varying, the resulting PDF will have an exponential shape instead.

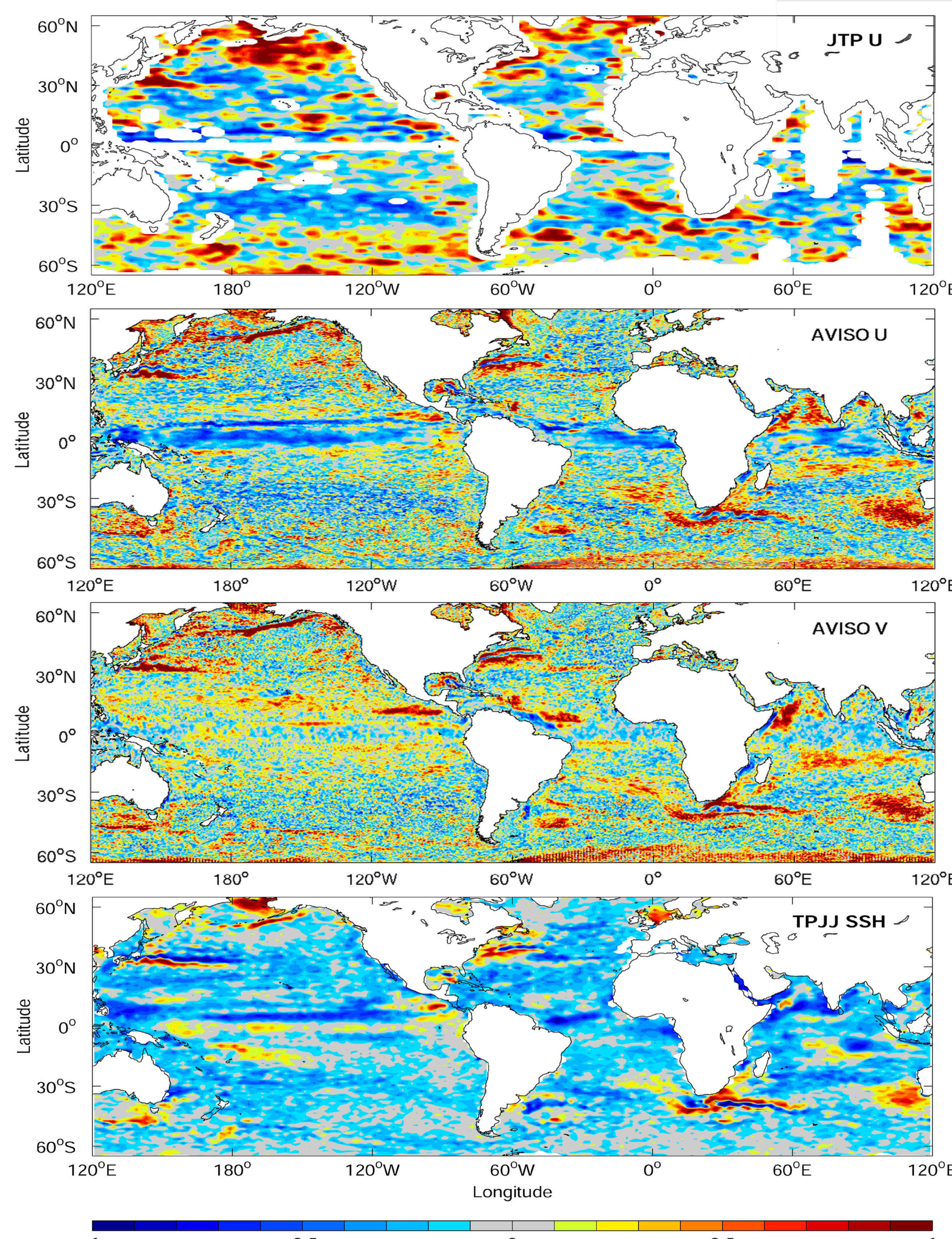
Accordingly, normalizing any regional velocity PDF with their standard deviation also results in a gaussian PDF.

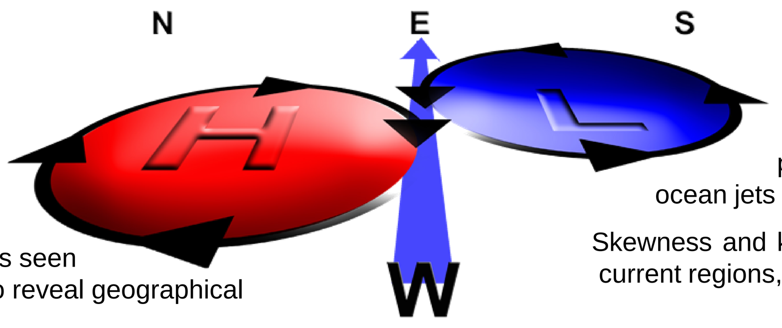
BOTTOM Same global probability density function distribution as LEFT, but the time series were normalized by their standard deviation (Scharffenberg and Stammer, 2010, their Fig.4) along with the Gaussian fit to the **zonal** PDF (dotted).











Skewness

To further describe the behavior of the PDF, the skewness and kurtosis are calculated for the first time for both velocity components and for the SSH. Skewness and kurtosis are statistical parameters that can be used to infer the deviation of a distribution from the Gaussian, as seen in recent studies (e.g. Gille and Llewellyn, 2006). Also, it is a mean to reveal geographical pattern of the eddies in the global oceans, e.g. identify the mean path of unstable ocean jets (Thompson and Demirov, 2006) as well as regions dominated by eddies.

Skewness and kurtosis have significant pattern for both velocity components, eg, in the boundary current regions, in the Agullhas-ring corridor and in the Aleuten current.

Kurtosis

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