Atmospheric signatures of oceanic striations

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Abstract

Zonally oriented features, correlated with stationary oceanic striations, are found in multi-year averages of QuikSCAT wind and other satellite atmospheric data. They are suggested to be induced over the striated pattern of sea surface temperature through the same air-sea interaction mechanism as the one documented earlier over main oceanic fronts. CFES (Coupled GCM For the Earth Simulator) output is used to study the structure of convective cells associated with striations. Implications to the climate system are also discussed.

Question: do weak and ubiquitous oceanic striations have same effect on the atmosphere?

Previous studies revealed the effect of main oceanic SST fronts on near-surface winds and tropospheric circulation
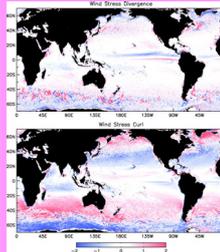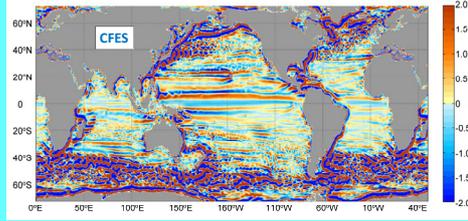

Global 4-year averages (August 1999–July 2003) of the divergence (top) and curl (bottom) of the surface wind stress over the world ocean computed from 25-km-resolution wind measurements by the QuikSCAT scatterometer. (from Chelton et al., 2004)
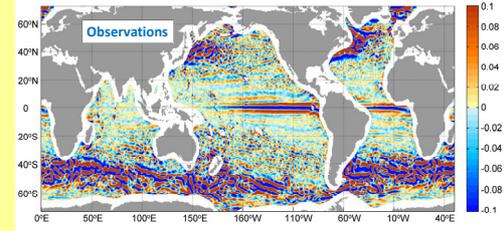
"Influence of the Gulf Stream on the Troposphere" (Minobe et al., 2008)
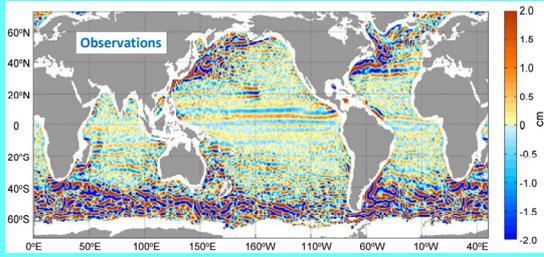
1993-2002 Mean Dynamic Ocean Topography (MDOT) high-pass filtered with 2D Hanning filter of 4° half-width in both longitude and latitude directions.
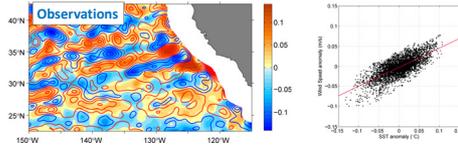

10-year mean Sea Surface Height (SSH) high-pass filtered with a 2D Hanning filter of 4° half-width in both longitude and latitude directions.
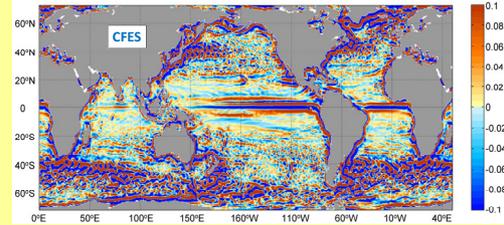

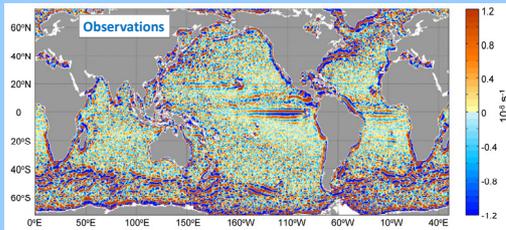2003-2008 mean high-pass filtered AMSR SST
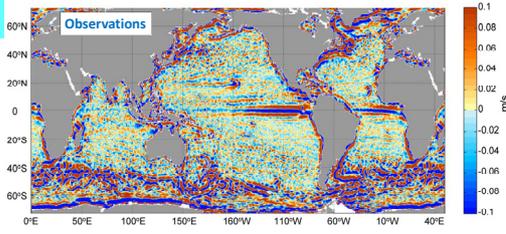
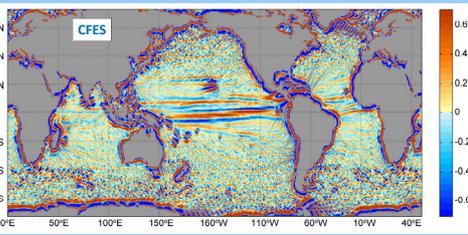2003-2008 average of the QuikSCAT wind speed after high-pass filtering

Left panel: contours of high-pass filtered 2003-2008 mean QuikSCAT wind speed (contour interval is 0.02 m/s) are superimposed on color plot of high-pass filtered 2003-2008 mean AMSR SST. Right panel: scatter plot of SST versus wind speed. The linear correlation coefficient is 0.73.
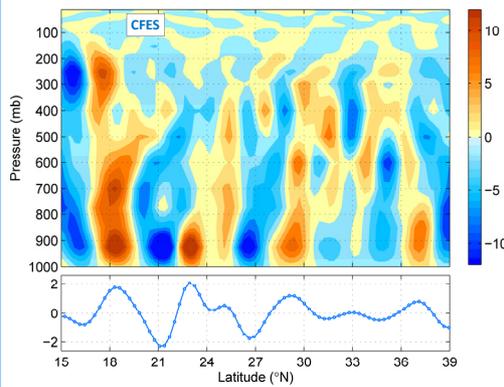

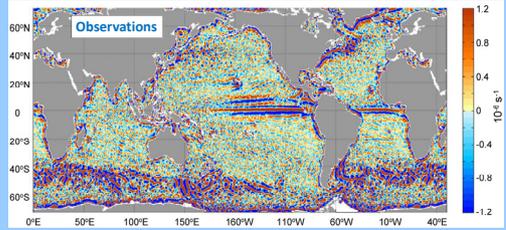
10-year mean high-pass filtered Sea Surface Temperature

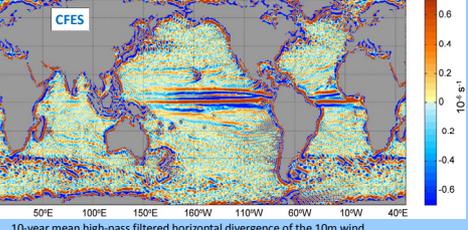2003-2008 average of the QuikSCAT wind curl after high-pass filtering.

10-year mean high-pass filtered curl of the 10m wind.

2003-2008 average of the QuikSCAT wind divergence after high-pass filtering.

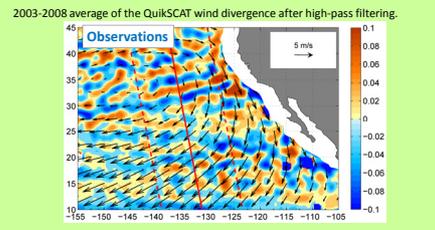10-year mean high-pass filtered horizontal divergence of the 10m wind.

High-pass filtered vertical wind velocity (downward positive) and surface wind divergence (blue curve), both averaged in the along-striation direction.
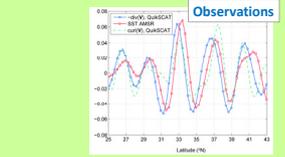

Vectors of the 2003-2008 mean QuikSCAT wind are superimposed on color plot of high-pass filtered 2003-2008 mean AMSR SST in the eastern North Pacific. Red dashed lines show boundaries of the swath within which the high-pass filtered fields were averaged in the along-striation direction.

Vectors of 10-year mean wind (10m) are superimposed on color plot of high-pass filtered SST in the eastern North Pacific. Red dashed lines show boundaries of the swath within which the high-pass filtered fields were averaged in the along-striation direction.
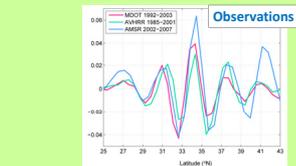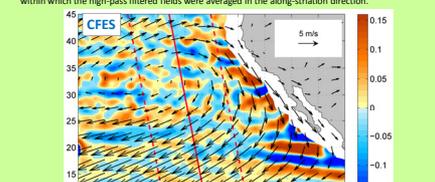

Cross-striation distributions of high-pass filtered 2002-2007 mean AMSR SST (blue curve [°C]), high-pass filtered 1985-2001 mean AVHRR SST (green curve [°C]), and high-pass filtered MDOT (red curve [10 cm]). All fields were averaged along the direction of the striations within a 1600-km swath. Positive (negative) SST anomalies are aligned with crests (troughs) in MDOT. Note that AMSR and AVHRR SSTs are averaged over non-overlapping time periods.

Cross-striation distributions of high-pass filtered SST (red curve [°C]) and high-pass filtered SSH (blue curve [10 cm]). Both fields were averaged along the direction of the striations within a 1600-km swath. The phase shift between the two curves is about 82°; positive (negative) SST anomalies are aligned with positive (negative) zonal velocity. This estimate is also in a good correspondence with that from the joint 2D spectral analysis.
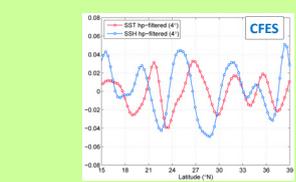

Cross-striation distributions of high-pass filtered AMSR SST (red curve [°C]), high-pass filtered AMSR wind speed (blue curve [m/s]), and high-pass filtered QuikSCAT wind speed (green curve [m/s]). All fields were averaged along the direction of the striations within a 1600-km swath.

Cross-striation distributions of sign-reversed SST laplacian (green curve), high-pass filtered SST (red curve) and high-pass filtered sea level pressure (blue curve). All fields were averaged along the direction of the striations within a 1600-km swath. All curves except for the SST are scaled to fit the plot.
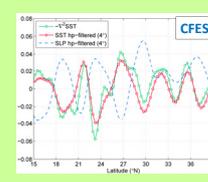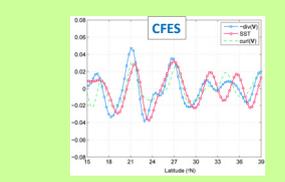

Cross-striation distributions of sign-reversed high-pass filtered divergence of the QuikSCAT wind (blue curve), high-pass filtered curl of the QuikSCAT wind (green curve) and high-pass filtered AMSR SST (red curve). All fields were averaged along the direction of the striations within a 1600-km swath. All curves except for the SST are scaled to fit the plot. The phase shift between the cross-striation distribution of SST and that of the surface wind divergence is about 55°.

Cross-striation distributions of sign-reversed high-pass filtered divergence of the 10m wind (blue curve), high-pass filtered curl of the 10m wind (green curve) and high-pass filtered SST (red curve). All fields were averaged along the direction of the striations within a 1600-km swath. The phase shift between the cross-striation distribution of SST and that of the surface wind divergence is about 65°.