Long-Range Correlations in Altimetric Sea Level Anomaly Associated With Long-Lived Mesoscale Eddies

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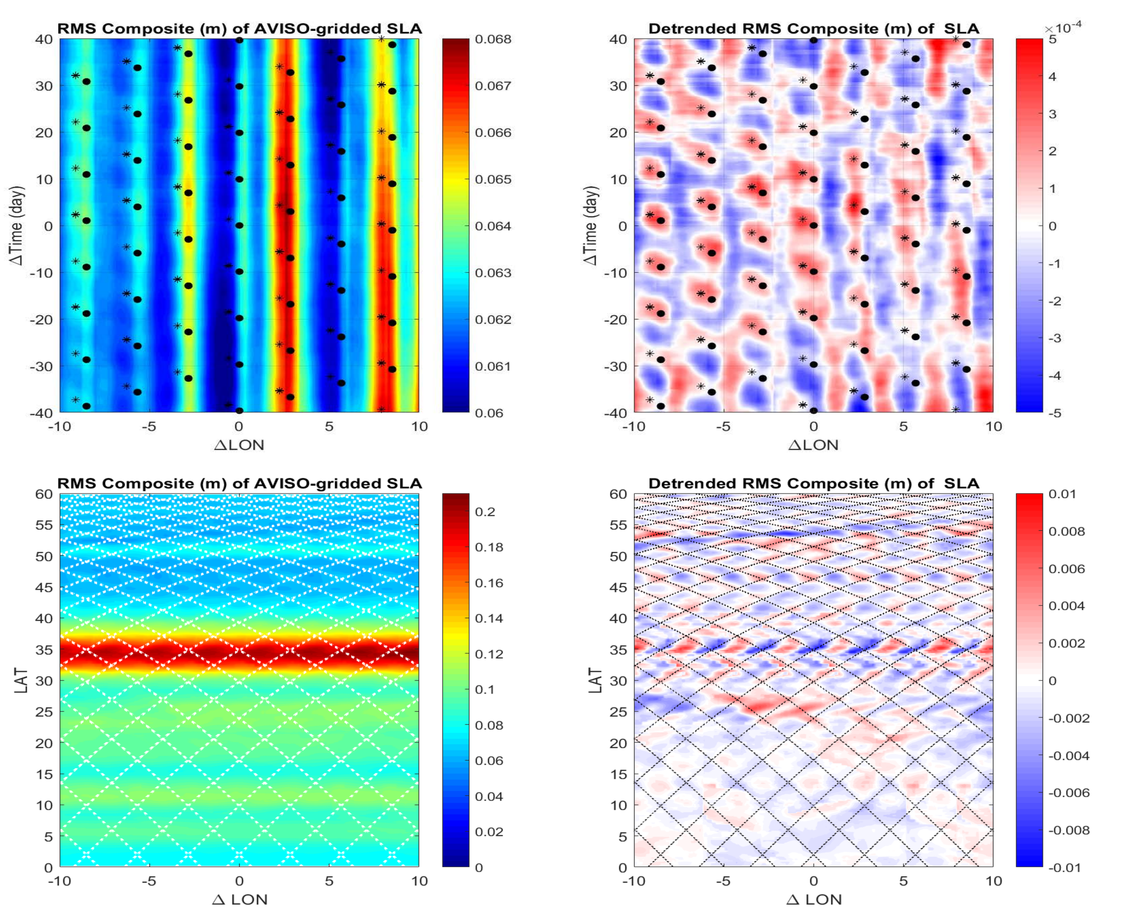
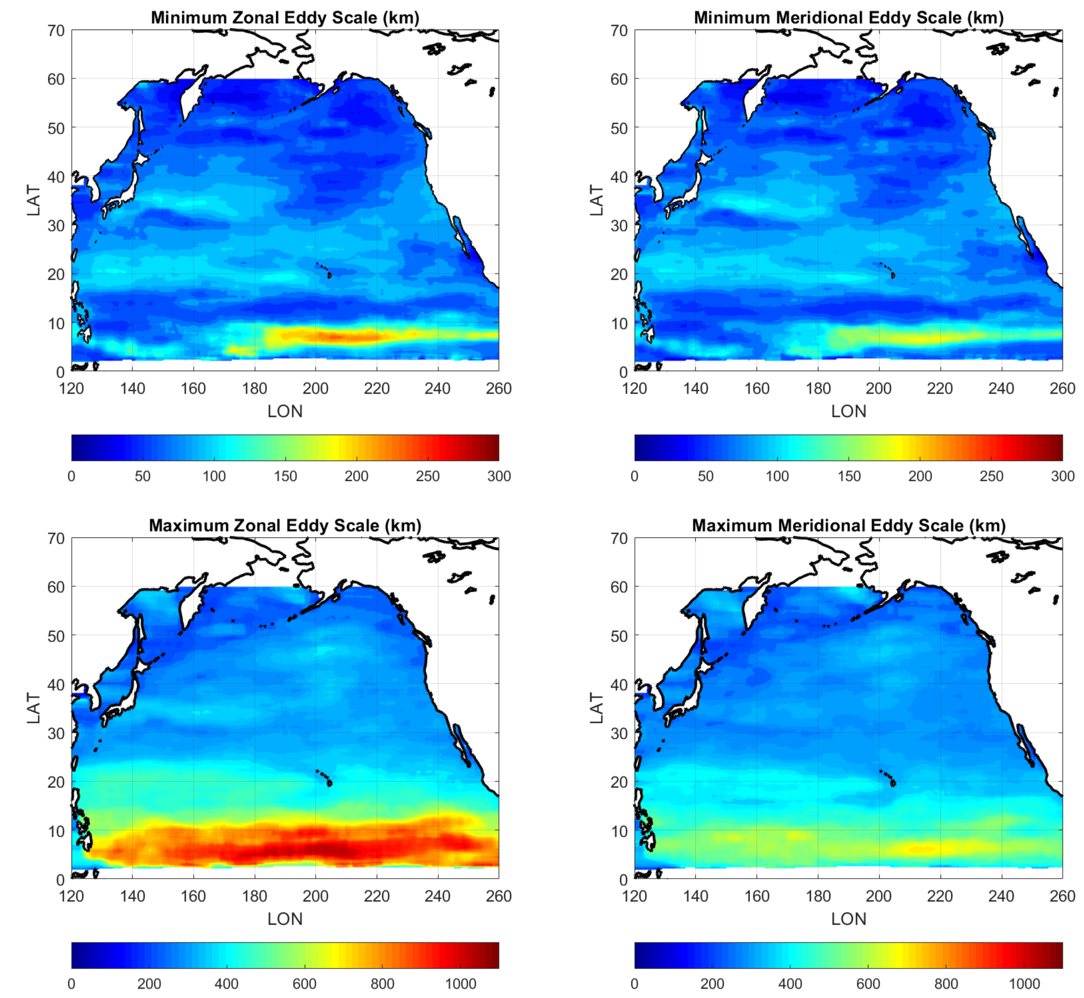
Background



- *Plots of Sea level RMS composites indicate elevated energy in proximity to Jason tracks in both x-y (bottom) and x-t (top, for 45N)*

- These plots both strongly indicate that the energy in present AVISO gridded SLA fields is too tightly confined to close proximity –in both time and space- to satellite observations. By implication **correlation scales used in the present AVISO gridded SLA dataset appear to be inadequate**. This implies a significant risk that long-living mesoscale features including eddies (Chelton et al., 2011) and jets **may be misrepresented in both amplitude and structure** when not in proximity to a recent Jason satellite pass.

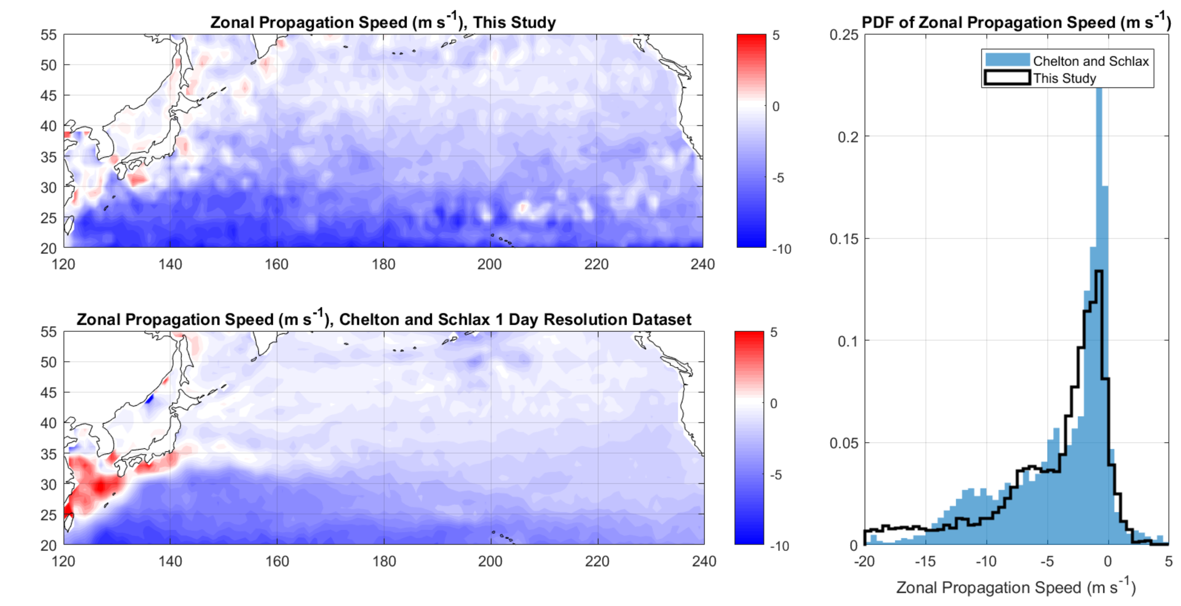
Eddy Scales



Maps of minimum and maximum zonal and meridional eddy scales used to filter along track SLA data.

- Eddy scales were estimated by taking eddy locations identified in the Chelton et al. (2011) eddy dataset (V4, 2017 daily version), smoothing DT-2014 gridded fields (Pujol et al. 2016) with a 20º Gaussian filter to supress large-scale variations before fitting a 2D parabola to each eddy. Eddy scales where then accumulated in regular bins; within each bin the upper most and lower most 5% of eddy scales were discarded.
- Estimated minimum and maximum x and y eddy scales were used to define 2D Gaussian filters we then used to separate along-track SLA into mesoscale eddy, small scale and large scale components.

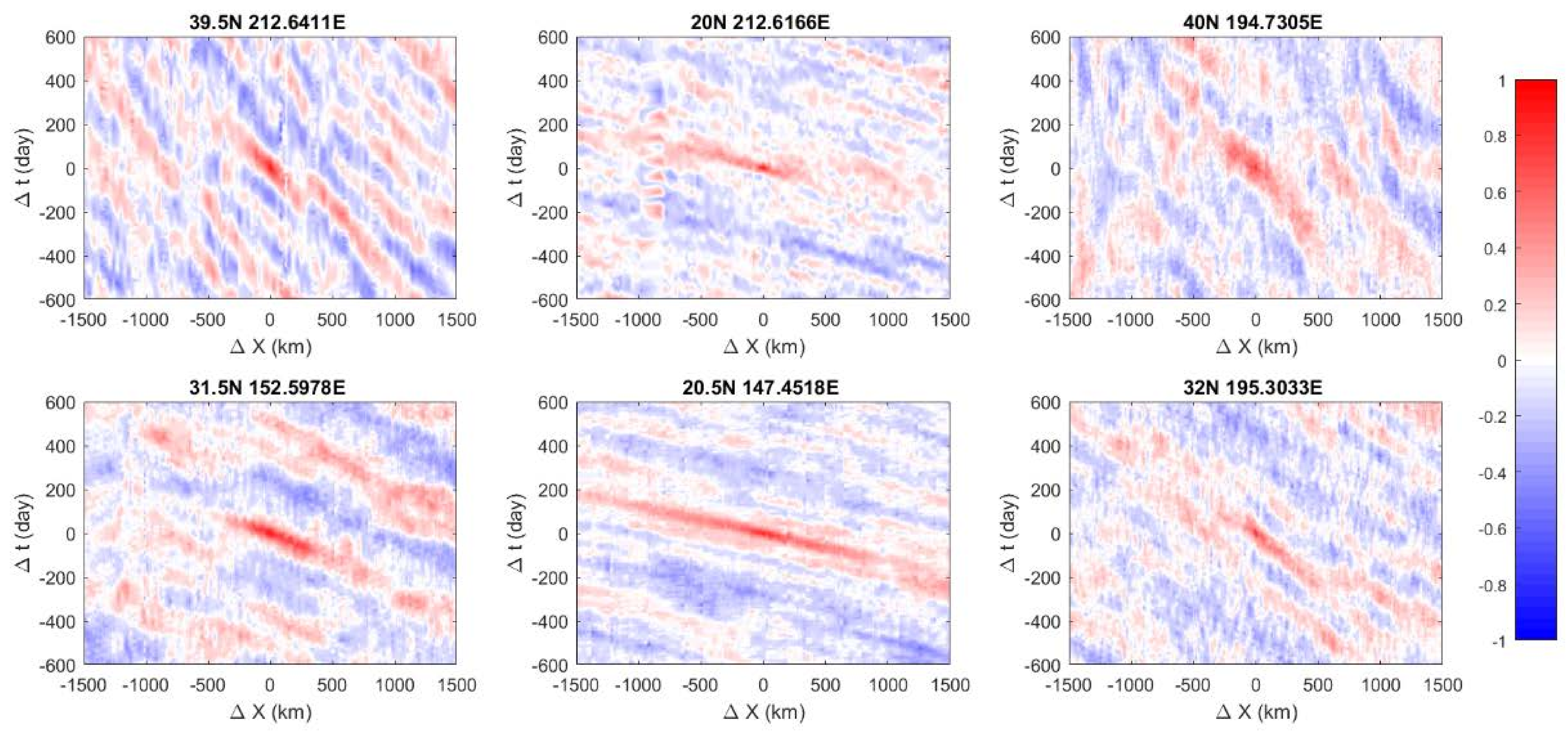
Propagation Velocities



Maps of zonal propagation speed (left, our observations at the top, Chelton and Schlax at the bottom) and PDFs of propagation speed (right).

- Using the mesoscale eddy component of SLA we then computed correlation fields relative to each Jason or ERS satellite track (at 0.5º latitude intervals along each track). Zonal propagation speeds were then estimated by finding a closed contour of correlation enclosing the origin using a principal component based scaling method.
- Our methodology produces propagation velocities in **broad statistical agreement** with propagation speeds from Chelton and Schlax's eddy dataset.
- While **agreeing in general structure** (faster westward propagation in the south, general tendency for propagation speed to reduce towards the east of the basin), our observations display **considerable local disagreement** with Chelton and Schlax.

Example Correlation Plots



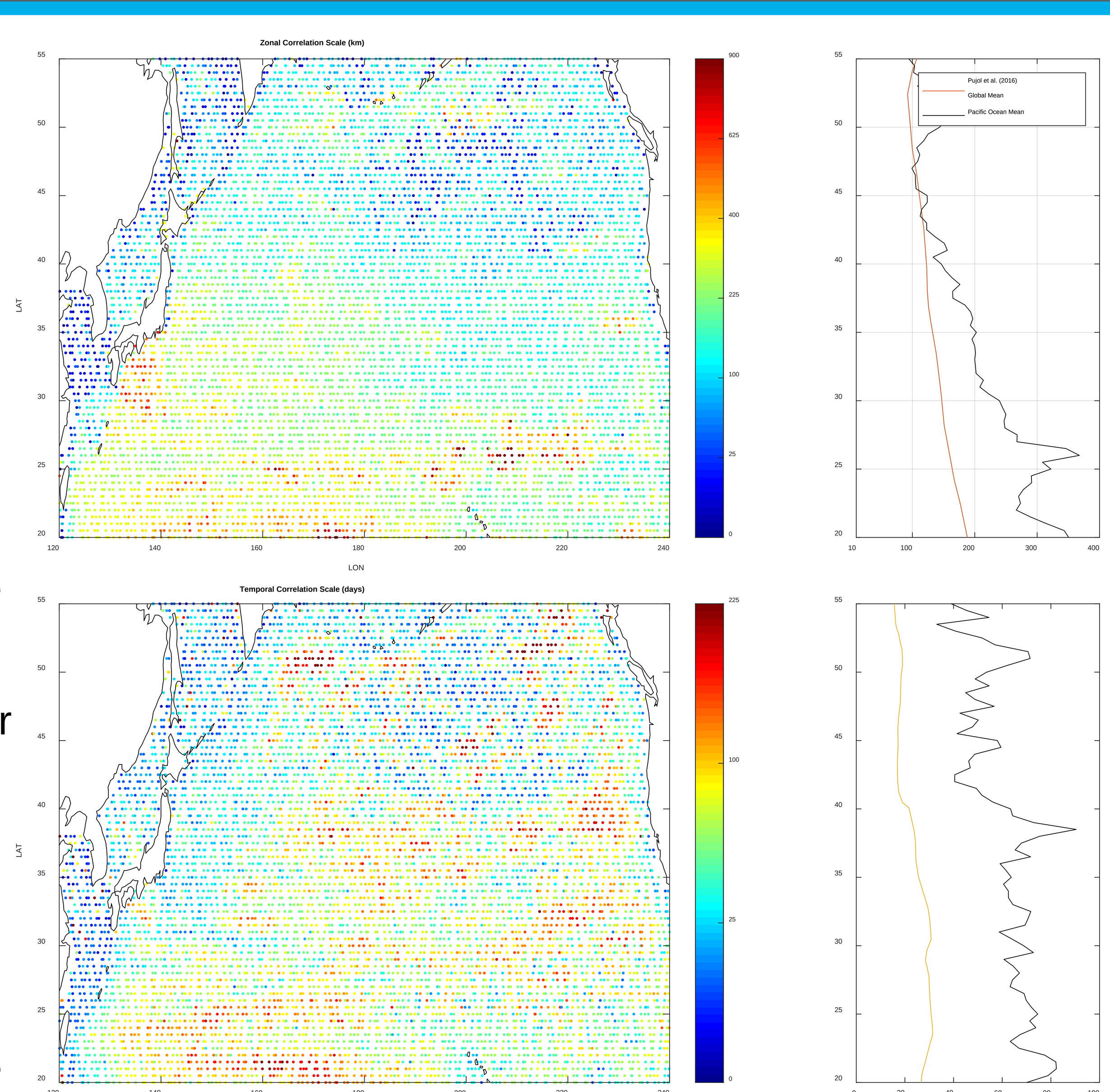
Example longitude-time correlation plots for a variety of latitudes and longitudes.

Conclusion

- We have developed and implemented a methodology to isolate the eddy scale signal in along-track SLA observations, consistent with the data of Chelton & Schlax.
- We have then computed x-y-t correlations of the eddy signal and analysed their parameters by fitting with analytical "propagating" correlation functions.
- We found temporal and zonal decay scales for eddy-scale SLA, which significantly exceed scales assumed in the production of gridded SLA products (Pujol et al. 2016) and reflect importance of long-living eddies.
- Our study suggests that future refinement of SLA products may require **discrimination between signals of different scales and processes and their separate treatment with adequate methods**.

Correlation Scales

- Following Pujol et al. (2016) we fit the following correlation function to our eddy-scale:
- $C(r,t) = \left[1 + ar + \frac{1}{6}(ar)^2 - \frac{1}{6}(ar)^3\right] e^{-ar} e^{\frac{t^2}{T^2}}$
- Where: t denotes time-lag, dx x-lag, T temporal decay scale, L_x longitude decay scale
- A=3.337 and $r = \sqrt{\left(\frac{dx - c_x dt}{L_x}\right)}$
- For each correlation field local optima were found by initializing Nelder-Mead simplex searches at random points in T-L_x state space. T and L_x estimates were then further refined by applying simulated annealing to the best local optimum.
- Zonal means of L_x, T are **generally substantially larger** than mean values of Pujol et al.
- L_x, T **display substantial local variability**. L_x displays a general tendency to decrease with increasing longitude.



Maps of zonal (top left) and temporal (bottom left) correlation scales. Zonal means of zonal (top right) and temporal (bottom right) correlation scales as a function of latitude, our fits indicated in black, Pujol et al's in orange.

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References:

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Pujol, M.-I., Y. Faugère, G. Taburet, S. Dupuy, C. Pelloquin, M. Ablain, and N. Picot, 2016: DUACS DT2014: The new multi-mission altimeter dataset reprocessed over 20 years. Ocean Sci., 12, 1067—1090, doi:10.5194/os-12-1067-2016, 2016.