

Salient results from OSTST 2017-2020: SSH Eddy Identification and Tracking and Modeling the Ocean Mesoscale

R. M. Samelson, D. B. Chelton and L. W. O'Neill

roger.samelson@oregonstate.edu

dudley.chelton@oregonstate.edu

larry.oneill@oregonstate.edu

Ocean Surface Topography Science Team Virtual Meeting
October 2020



Two OSTST-supported results from 2017-2020 are highlighted.

SSH-based Eddy Identification and Tracking: Algorithm transfer to CLS/DUACS AVISO

The Chelton et al. (2011) altimeter SSH-based eddy census and its updates have been widely used. To ensure that this product continues to be available to the community, the algorithm and responsibility for updates was transferred to CLS/DUACS AVISO. The first CLS/DUACS version of the eddy dataset was posted on the AVISO website in 2017.



Chelton, D. B., M. G. Schlax, and R. M. Samelson, 2011. Global observations of nonlinear mesoscale eddies. *Progress in Oceanography*, 91, 167-216, doi:10.1016/j.pocean.2011.01.002.

<https://www.aviso.altimetry.fr/en/data/products/value-added-products/global-mesoscale-eddy-trajectory-product.html>

Modeling the ocean mesoscale:

The ocean mesoscale regime of the reduced-gravity quasi-geostrophic model*

1. **Altimeter SSH wavenumber-frequency power spectra** show evidence of nondispersive propagation, but linear dispersive deviations would only be expected close to resolution limit of AVISO gridded product. **Do these spectra show nonlinearity?**
2. **Eddy identification and tracking** ("nonlinear, adaptive, lossy space-time wavelet transform") provides complementary quantitative description that retains phase information. **What does this description imply when used to constrain a dynamical model?**
3. The simplest **quasigeostrophic models** show a very wide range of quantitative regimes. **Can a regime be identified that is a good representation of the mid-latitude mean mid-ocean mesoscale?**

* Samelson, R. M., D. B. Chelton, and M. G. Schlax, 2019:
<https://doi.org/10.1175/JPO-D-18-0260.1>



This work is described in the following publication:

Samelson, R. M., D. B. Chelton, and M. G. Schlax, 2019. The ocean mesoscale regime of the reduced-gravity quasi-geostrophic model. *J. Phys. Oceanogr.*, 49, 2469–2498, DOI: 10.1175/JPO-D-18-0260.1; see also links to informal errata and source code at

http://www-poa.coas.oregonstate.edu/~rms/ms/jpo2019omrqq_jpo-d-18-0260.1_errata_eqs_26_27_Fig16.pdf

and

https://github.com/rsamelson/quasigeostrophic_spectral_layer_model/tree/master/qg_1layer_dp.

That study built primarily on three previous publications:

Samelson, R. M., M. G. Schlax, and D. B. Chelton, 2016. A linear stochastic field model of mid-latitude mesoscale sea-surface height variability. *J. Phys. Oceanogr.*, 46, 3103–3120, doi: 10.1175/JPO-D-16-0060.1; see also link to informal errata at

http://www-poa.coas.oregonstate.edu/~rms/ms/jpo2016sfm_jpo-d-16-

0060_1_errata_AVISO_Sk_FigA1.pdf.

Samelson, R. M., M. G. Schlax, and D. B. Chelton, 2014. Randomness, symmetry, and scaling of mesoscale eddy lifecycles. *J. Phys. Oceanogr.*, 44, 1012–1029, doi: 10.1175/JPO-D-13-0161.1; corrigendum doi: 10.1175/JPO-D-14-0139.1.

Chelton, D. B., M. G. Schlax, and R. M. Samelson, 2011. Global observations of nonlinear mesoscale eddies. *Progress in Oceanography*, 91, 167-216, doi:10.1016/j.pocean.2011.01.002.

The ocean mesoscale regime

1. Can a regime be identified that is a good representation of the mid-latitude mean mid-ocean mesoscale?

Yes.

2. What does the eddy-based description imply when used to constrain a dynamical model?

Tight constraints on model parameters:

$$\beta \approx 0.6, r_{\psi} \approx 0.02, \tau \approx 1$$

Stochastic forcing amplitude	1/4 cm² day⁻¹
SSH damping rate	1/62 week⁻¹
Stochastic forcing timescale	1 week

3. Do the altimeter wavenumber-frequency spectra show evidence of nonlinearity?

Yes: nonlinearity removes energy along the linear dispersion relation and deposits it elsewhere.

4. The altimeter SSH record likely contains largely unexplored wavenumber-frequency information at high frequencies and wavenumbers, which is apparently affected by the propagating space-time covariance structure in the AVISO objective analysis.



Oregon State University
College of Earth, Ocean,
and Atmospheric Sciences

Samelson, R. M., D. B. Chelton, and M. G. Schlax, 2019:
<https://doi.org/10.1175/JPO-D-18-0280.1>



Conclusion 1: The sought-after regime can be found and fits probability distribution functions as well as mean statistics: it is a remarkably good fit for such a simple model!

Conclusion 2: The corresponding physical constraints or rates implied by the parameter values that define the regime are as indicated on the slide.

Conclusion 3: Additional evidence for nonlinearity of the observed wavenumber-frequency spectra can be extracted from the model comparison through a linear inversion of the observed spectra using the transfer function for the linearized dynamics. This analysis indicates that nonlinearity removes energy along the linear dispersion relation and deposits it elsewhere.

Conclusion 4: The same linear inversion suggests that the propagating space-time covariance structure used to construct the merged, multi-altimeter SSH dataset may leave its imprint on the gridded spectra. This in turn suggests that a refined procedure might be developed that would retain additional information at high frequencies and wavenumbers, which might then be used for further analysis of mesoscale dynamics.