High resolution surface current observations using high-frequency radar network on the U. S. West Coast

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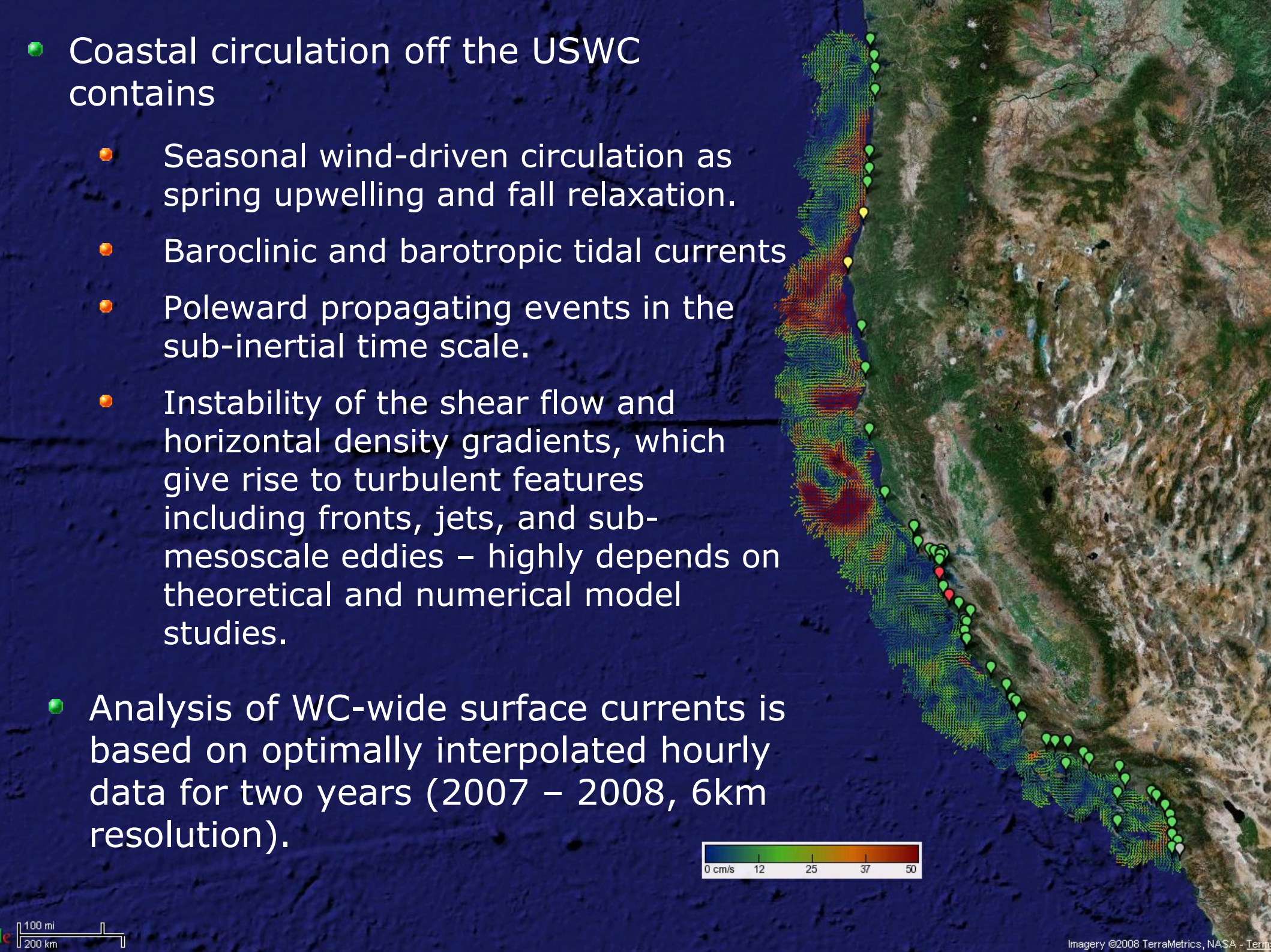
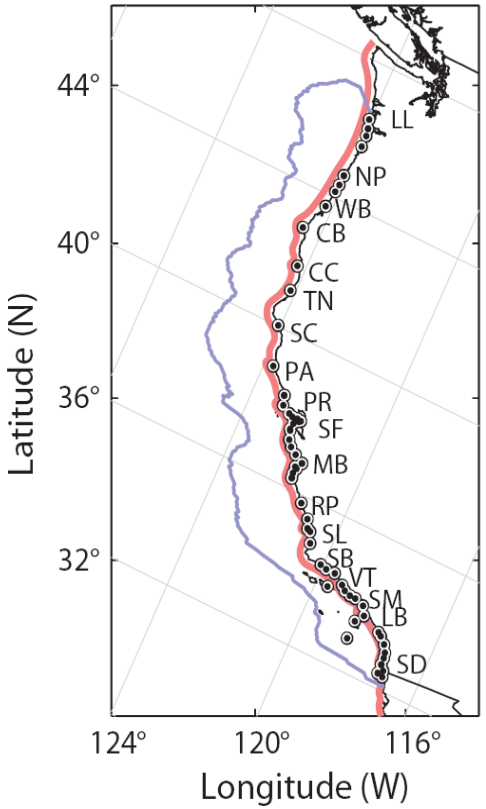
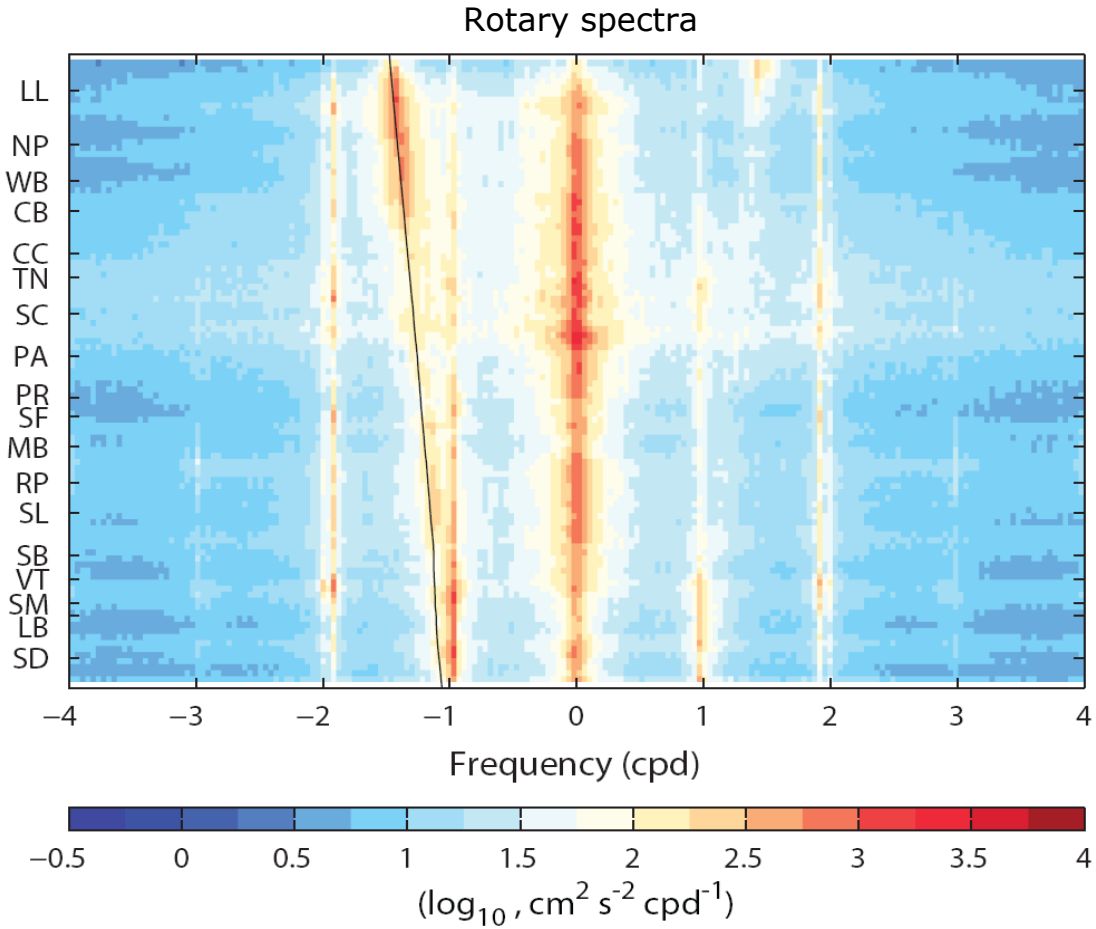
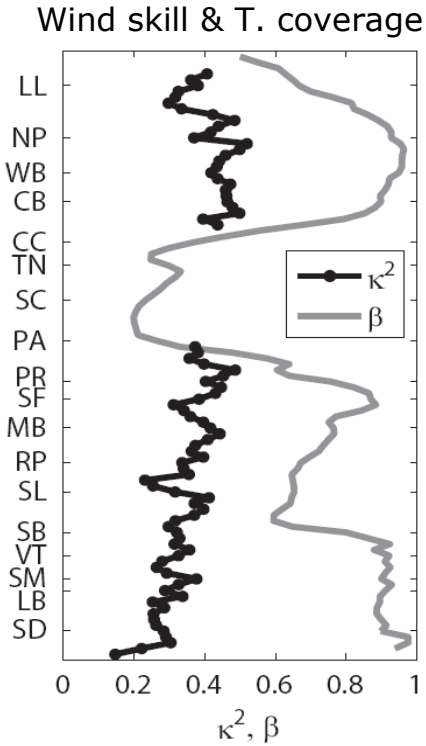
- Coastal circulation off the USWC contains
  - Seasonal wind-driven circulation as spring upwelling and fall relaxation.
  - Baroclinic and barotropic tidal currents
  - Poleward propagating events in the sub-inertial time scale.
  - Instability of the shear flow and horizontal density gradients, which give rise to turbulent features including fronts, jets, and sub-mesoscale eddies – highly depends on theoretical and numerical model studies.
- Analysis of WC-wide surface currents is based on optimally interpolated hourly data for two years (2007 – 2008, 6km resolution).



Variance of surface currents







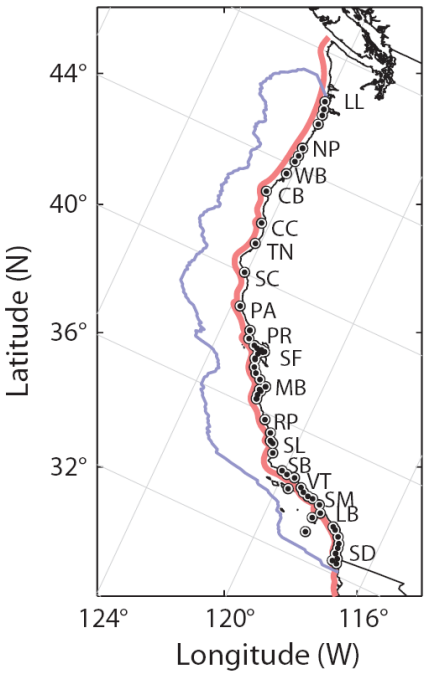
Potential driving forces: wind, tides, low frequency pressure gradients, near-inertial, and non-linear interactions

Wind skill – variance explained by (local) wind

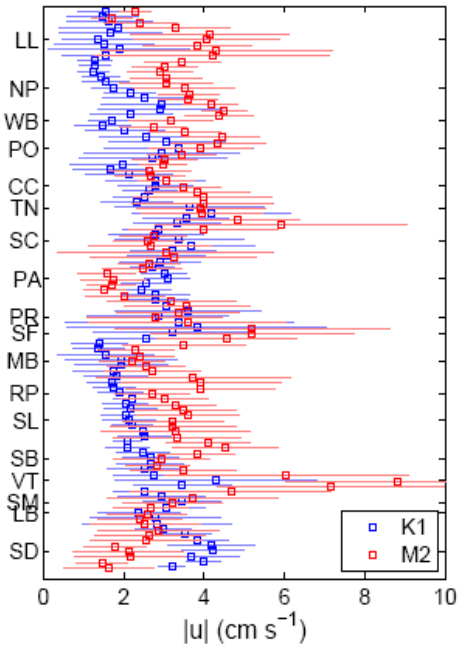
Regression of NDBC winds (14 stations) on surface currents requires concurrnet data sets.

(Kim *et al*, JGR, submitted.)

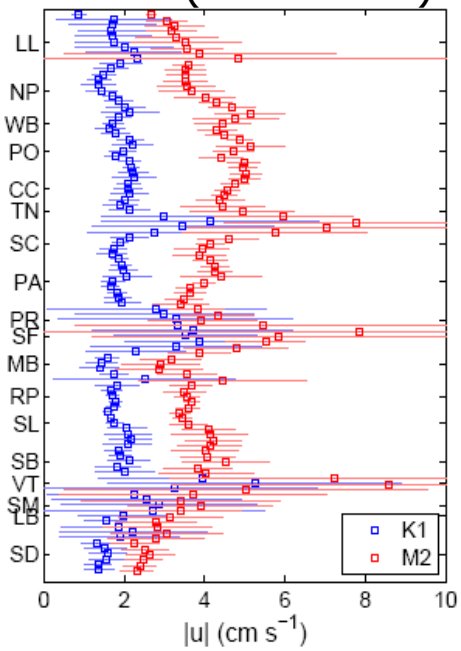
Surface tidal currents



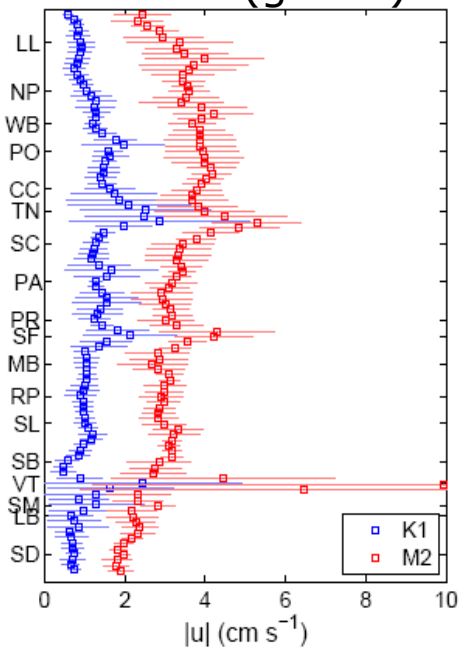
HFR Observation



ENPAC (nearshore)



TPXO (global)



Harmonic analysis at K1 and M2.

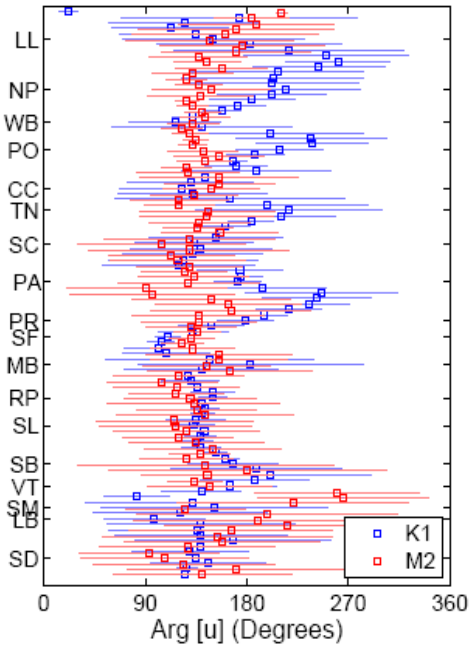
Two barotropic tidal models.

Averaged cross-shore structure.

S1 = 1 cpd
SA1 = 0.0027 cpd
K1 = 1.0027 cpd

Variance at K1 can be shown with variance at S1 + SA1.

(d)



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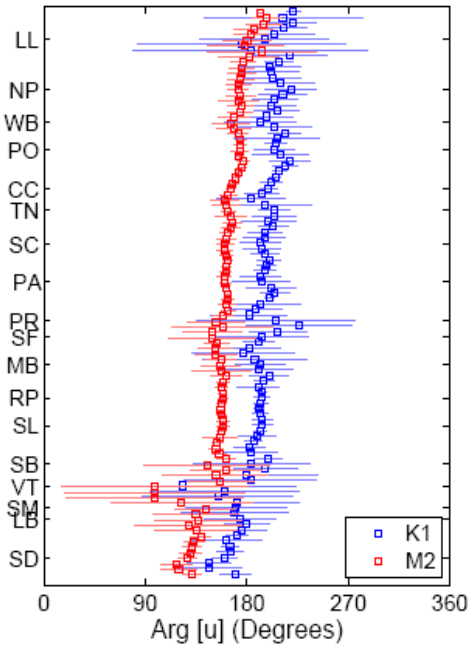

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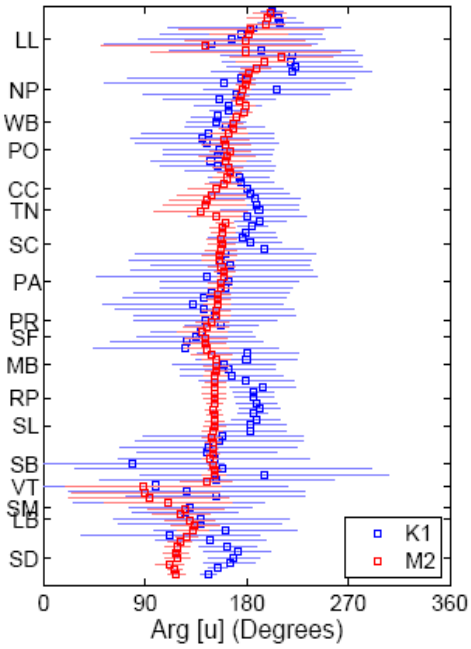
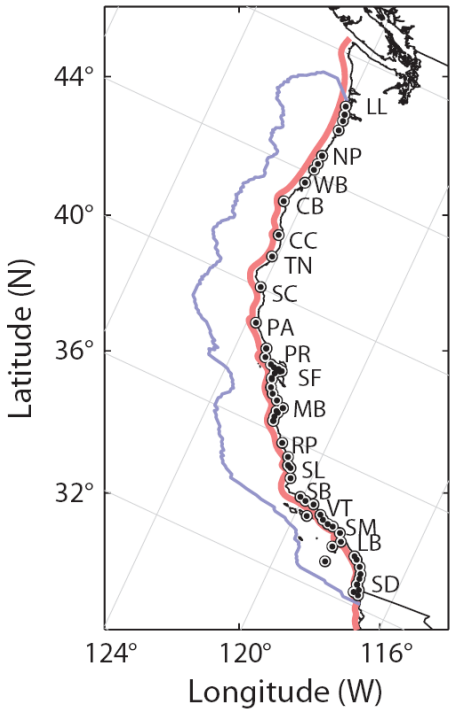
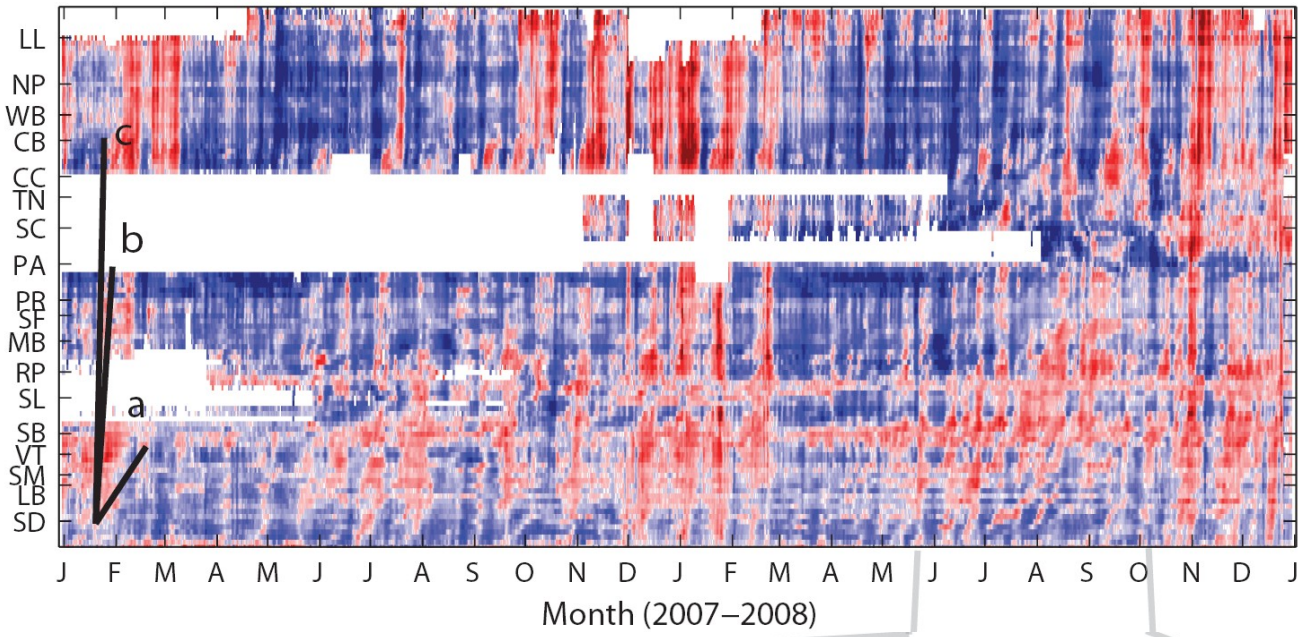


Sub-inertial alongshore surface currents





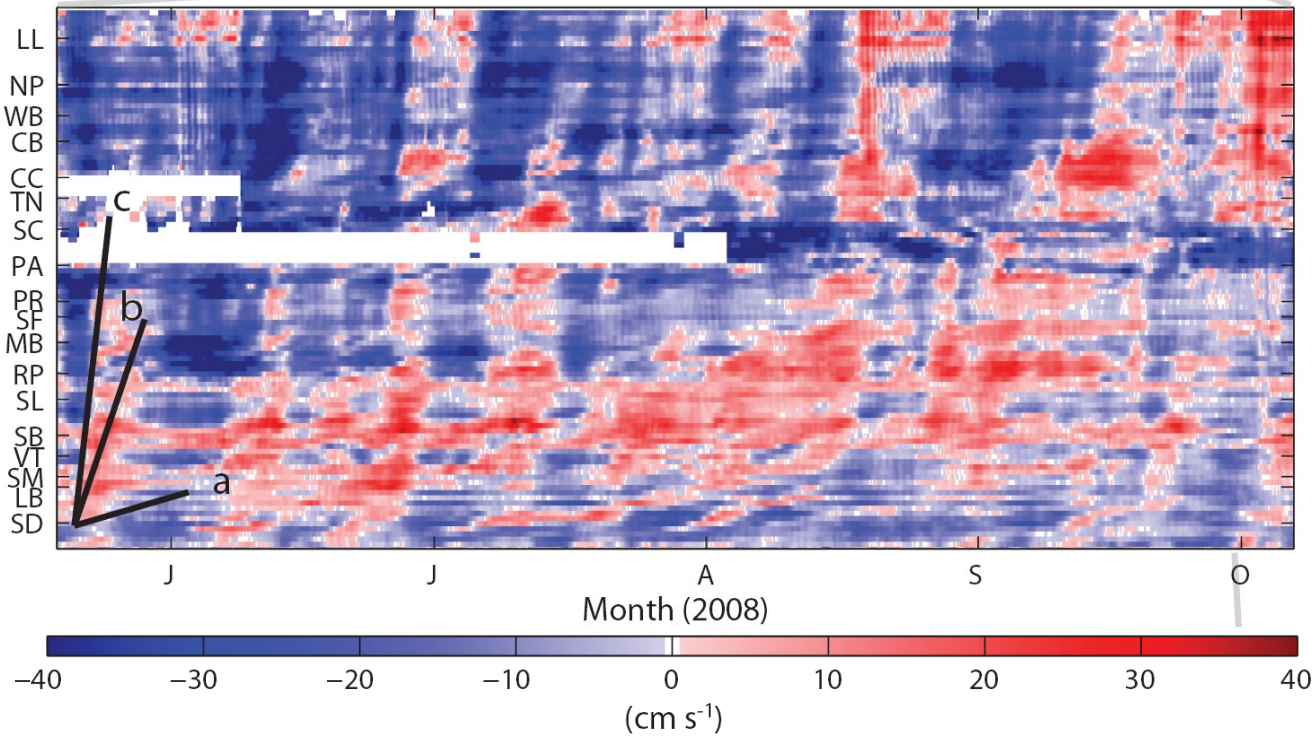
Rotated currents following the shoreline

Daily averaged alongshore surface currents.

Seasonal California Currents.

Phase speeds of 10 and 100 – 300 km/day

Slower mode feature is found in southern CA and (intermittently) north.

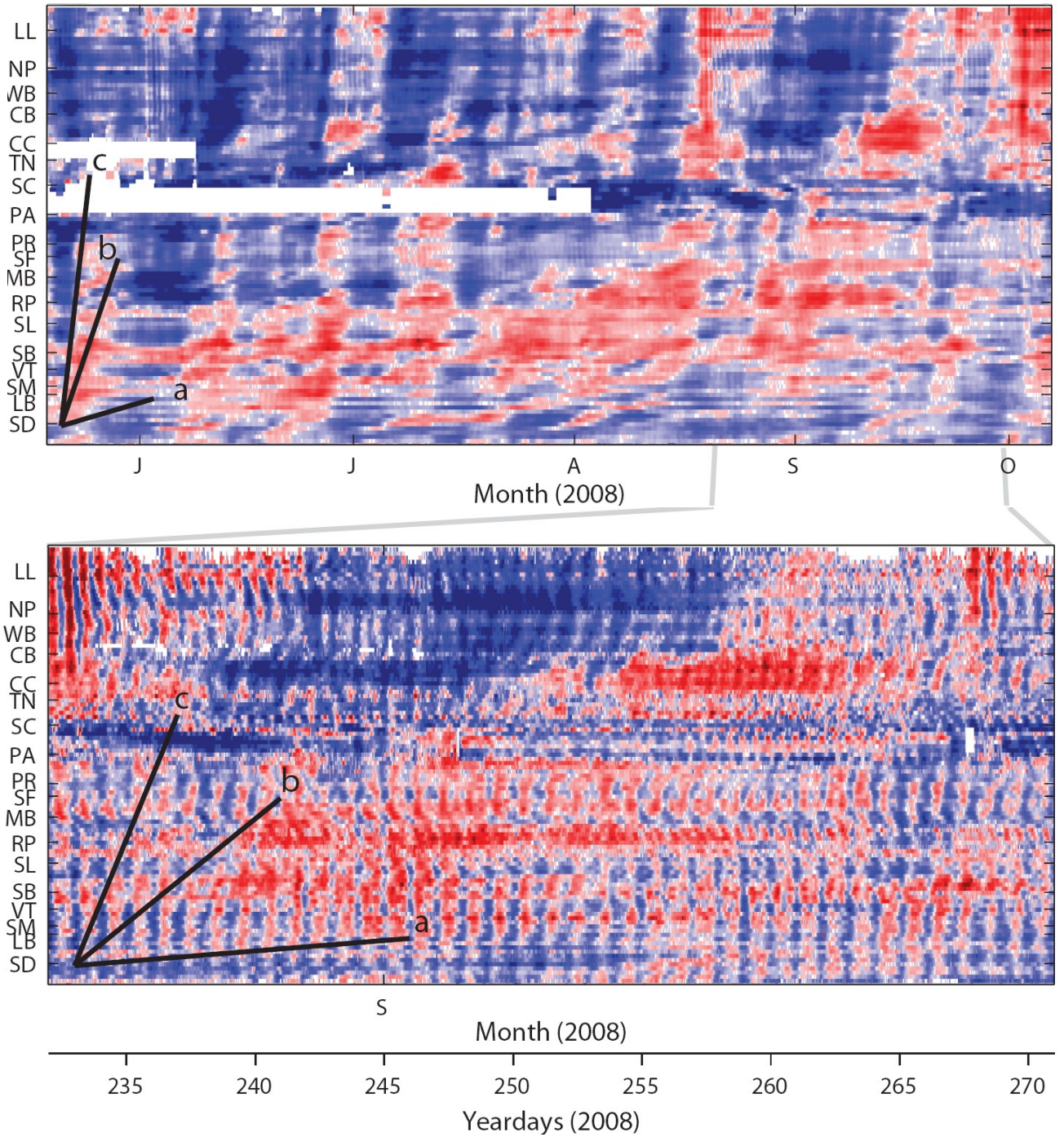


Sub-inertial alongshore surface currents

Hourly alongshore surface currents.

High-frequency structure coherent with diurnal wind and tides.

Poleward progression of convergence front.



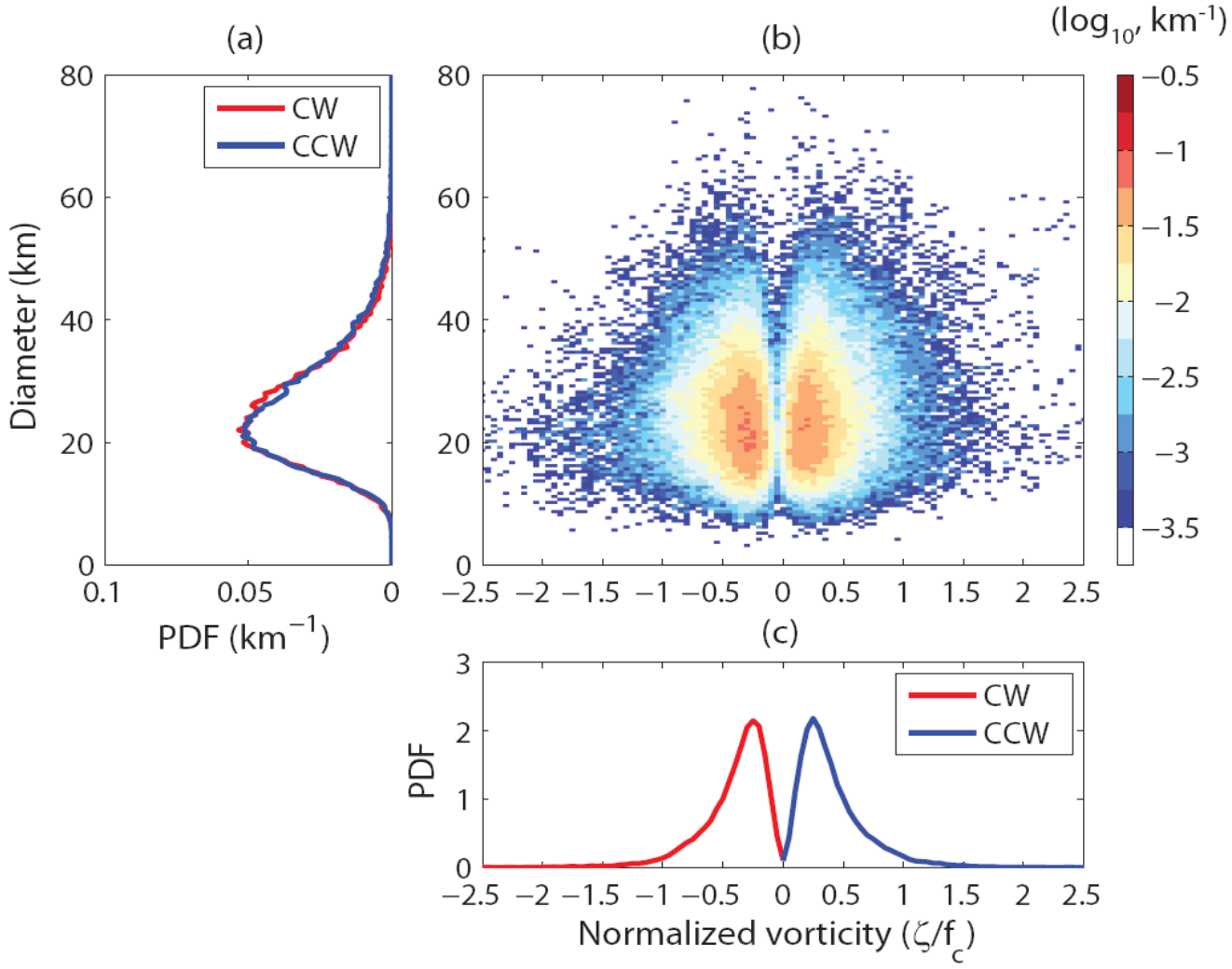
Demography of sub-mesoscale eddies

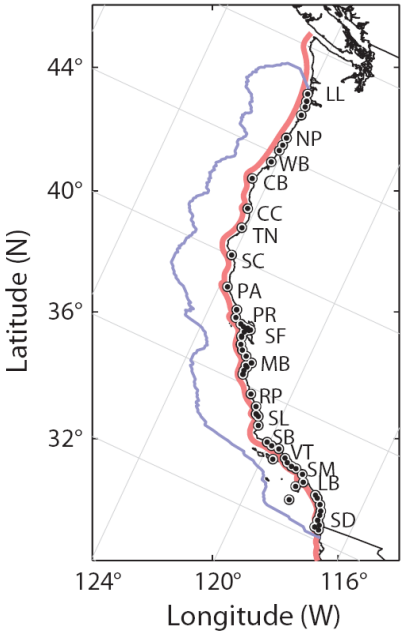
Using flow geometry of the stream functions.

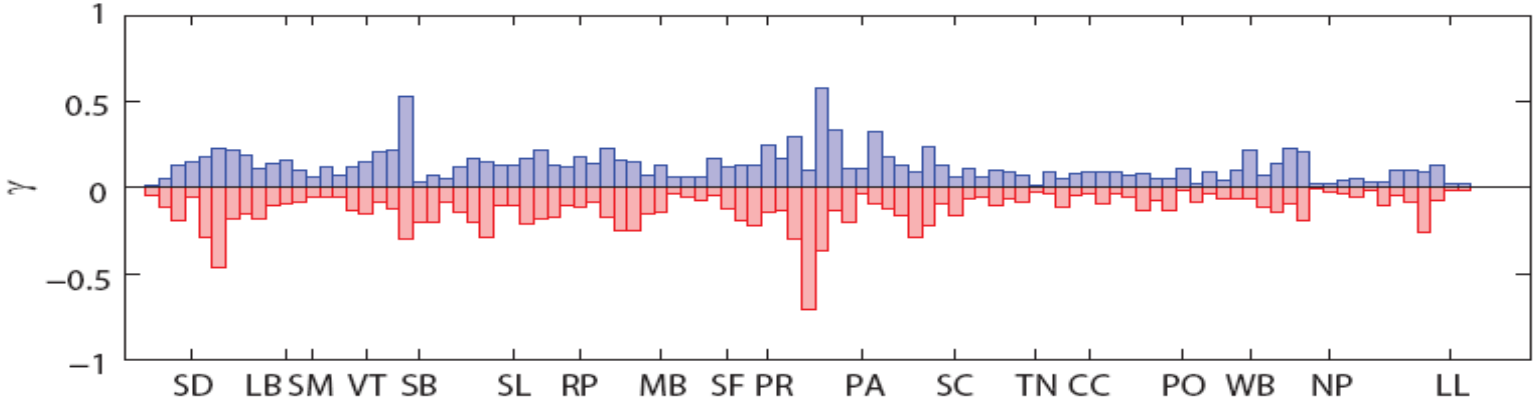
A cluster of streamlines is fitted with an ellipse. (Kim CSR, 2010)

Vorticity at the center of eddies.

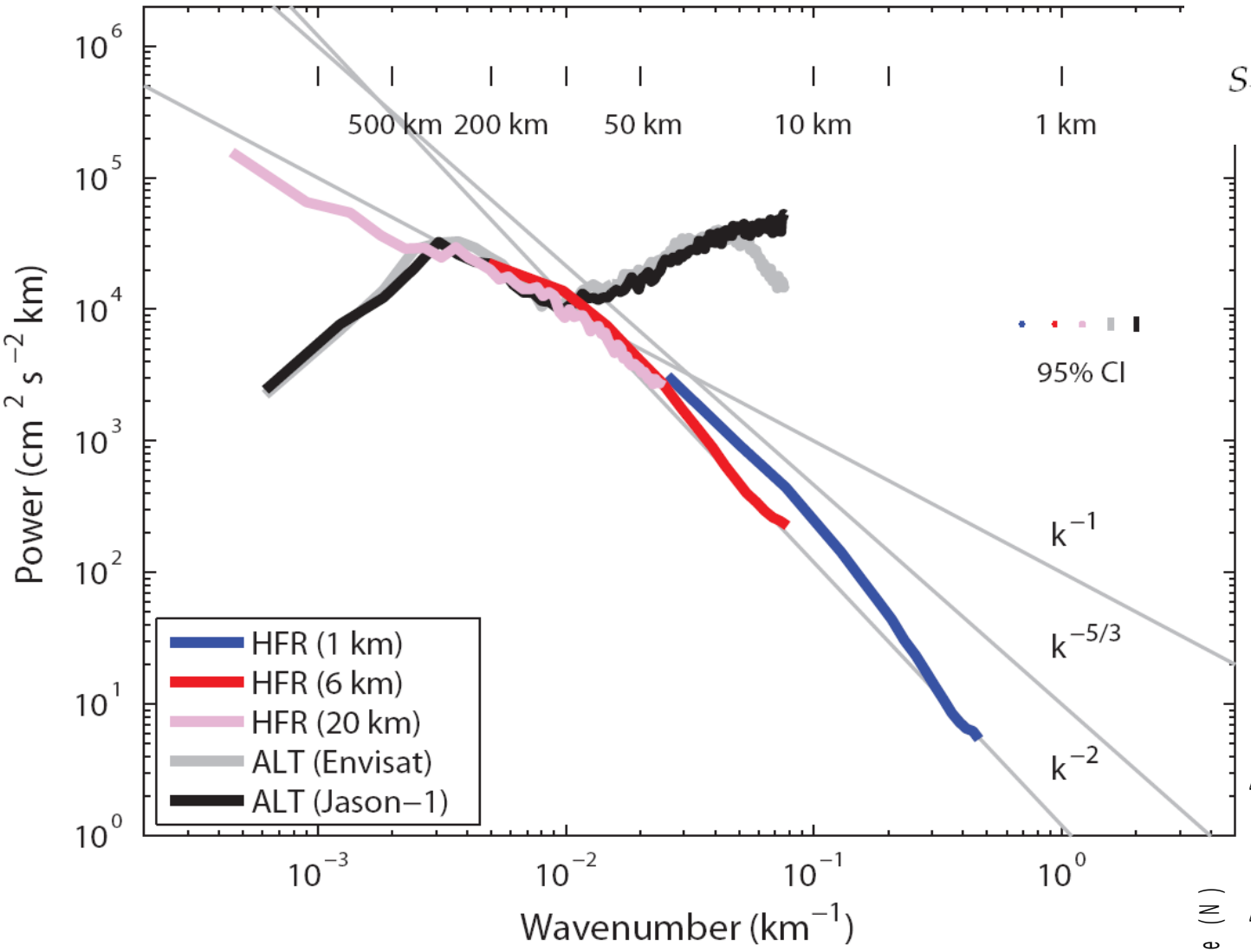
About 2200 eddies for each rotation are identified (at least two days persistence).







Mesoscale to sub-mesoscale?

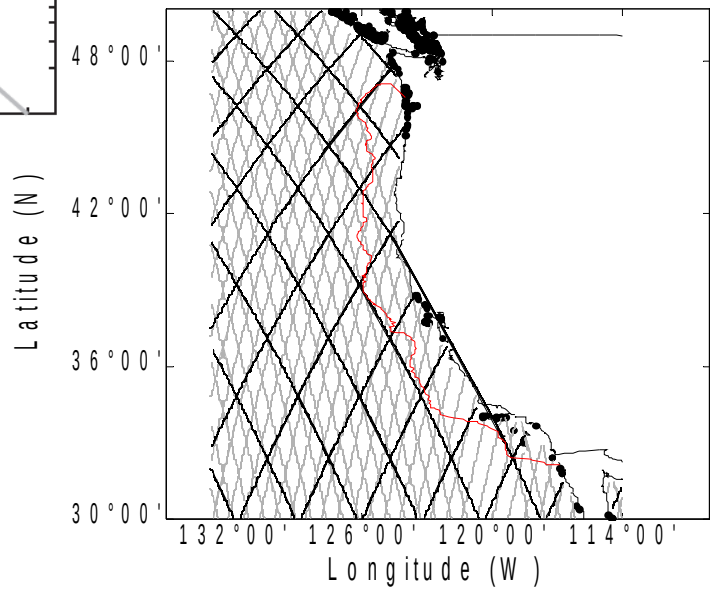


$$S_{\mathbf{u}_\perp}(k_\parallel) = \left(\frac{g}{f_c}\right)^2 \left(2\pi k_\parallel\right)^2 S_{\boldsymbol{\eta}_\parallel}(k_\parallel),$$

Power spectrum of Cross-track geostropic currents from along-track SSHAs

K^{-2} power law related to sub-mesoscale.

Robust estimate on k-2 spectra with data in other regions.



Two kinds of ALT data: Envisat and Jason-1

HFR data with three resolutions:

1 and 6 km data are sampled from SoCAL,
because minimum ageostropic components are expected.
20 km data are from the coastline axis.

Summary and future work

- Potential driving forces and variance of surface circulation off the USWC: wind, tides, low frequency pressure gradients, near-inertial motions, and non-linear interactions.
- Wind skill varies 0.2 – 0.4, aligned with alongshore wind.
- Barotropic currents consistent with tidal models and baroclinic components are captured.
- Poleward propagating alongshore surface currents have a similar feature and phase speed of coastally trapped waves.
- Sub-mesoscale eddies off the USWC:
  Rossby number of O(0.1-2) and 5-80 km diameter
- Scale continuity between sub-mesoscale and mesoscale.
- Lagrangian analysis using gridded surface currents can be used for ASBS, MPAs, and near-real time oil spill model.