Wind-Driven Surface Currents

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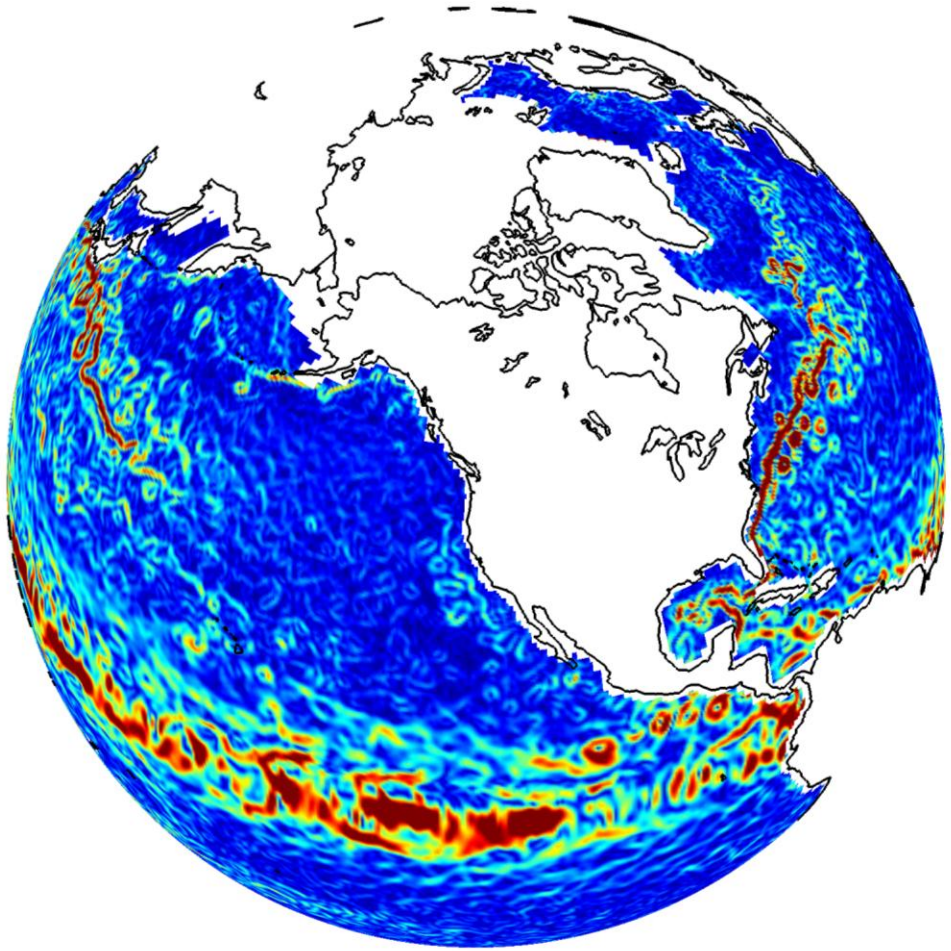
- Updates to OSCAR
- Progress with wind-driven upper ocean mixed layer currents.

- Ocean Surface Currents Analyses-Realtime (OSCAR) is a satellite-derived global surface current product provided in near-real time based on geostrophy, Ekman dynamics, and thermal wind
- Using ERA/I and NCEP winds right now

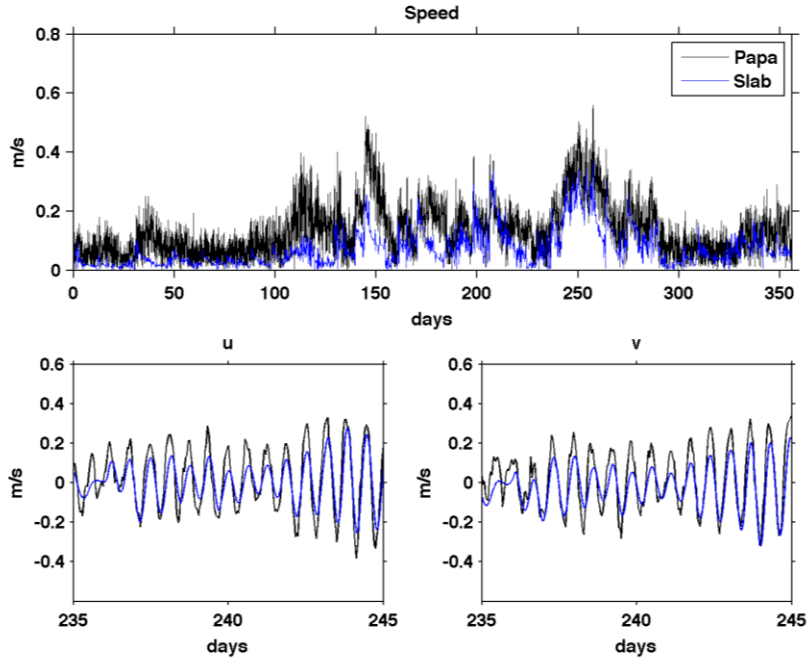


NEW version of OSCAR -- DAILY

- New version getting close
- Daily OSCAR, ¼ degree grid, separate geostrophic, wind-driven components, full currents
- Metadata – David Moroni's talk later in the meeting
  - Spent some time with Jessica Hausman at PO.DAAC in April setting up metadata practices. (This is more involved than I thought… e.g. her sample netcdf header is 6 pages long at 10pt font.)
- Final OSCAR (note: this version will have a DOI) and interim OSCAR
  - Climate OSCAR?
- Large data sets: will be producing daily files
  - Can easily record what data sources went into that day's file
- Hosted at the PO DAAC, http://podaac.jpl.nasa.gov/ Phasing out the NOAA site.
  - Plotting functionality at ESR

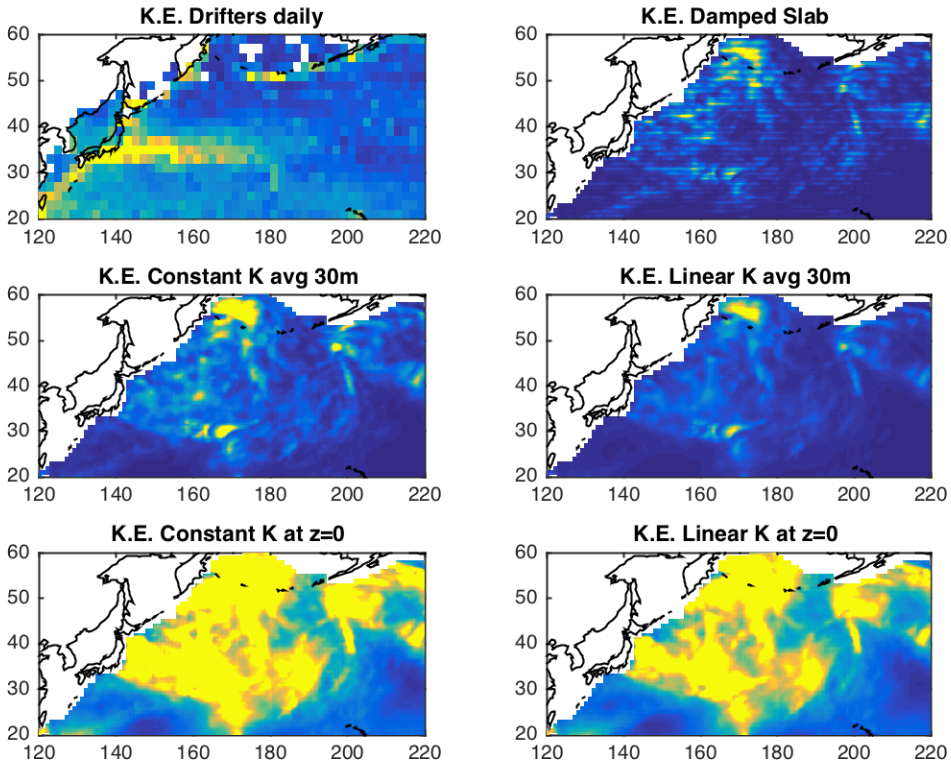
Wind Driven Ocean Mixed Layer (OML) Research with OSCAR

- A hierarchy of increased complexity to the wind-driven component of OSCAR
  - Vertically varying eddy viscosity K(z)
  - d/dt + either Rayleigh damping or K(z)
  - PWP
  - KPP
- For the purposes of surface currents, damped slab performs best so far at Ocean Station Papa
  - Captures amplitude and phase more reliably
  - Vertically uniform
- Much to be learned from the vertical momentum transfer as is varies between models still



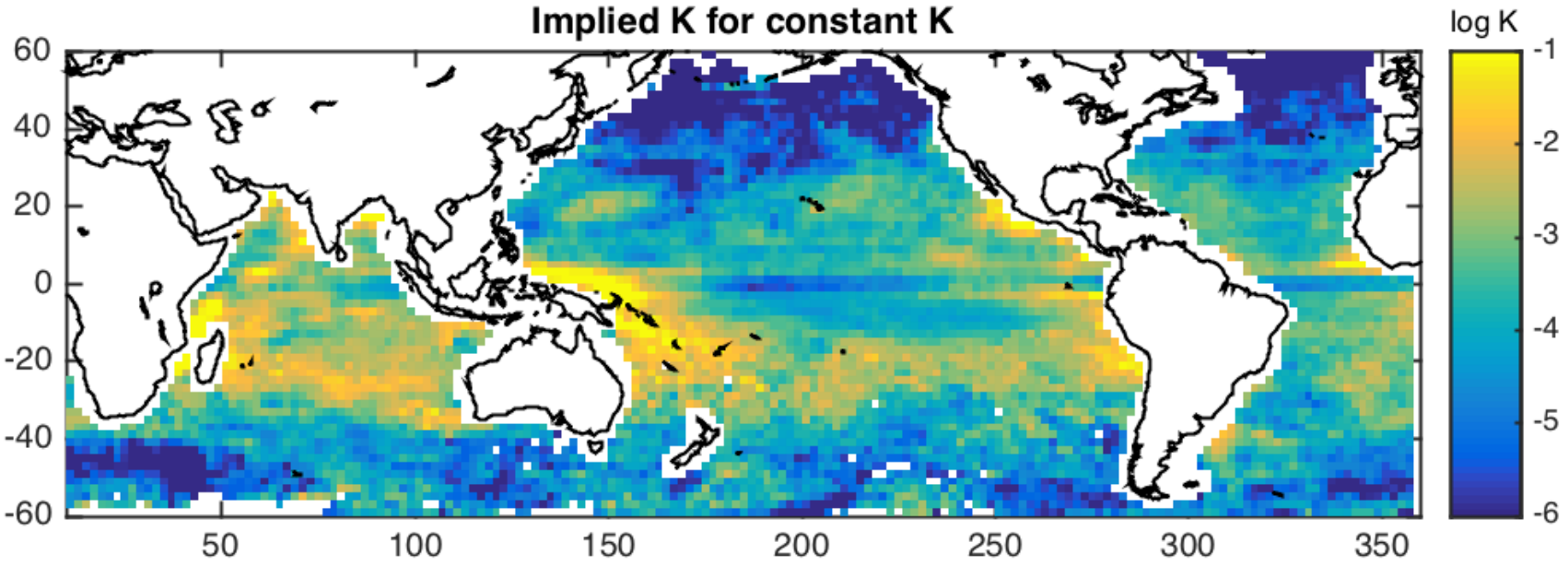
Vertical Dependence: Benefits of DopplerSCAT for OML research

- Damped slab promising so far, as a very simple model, but there is no vertical dependence. Top surface measurements, such as from DopplerSCAT, will really help with validating models.
- Sample model output for currents averaged over the top 30m vs z=0m.



Implied damping, regional variation

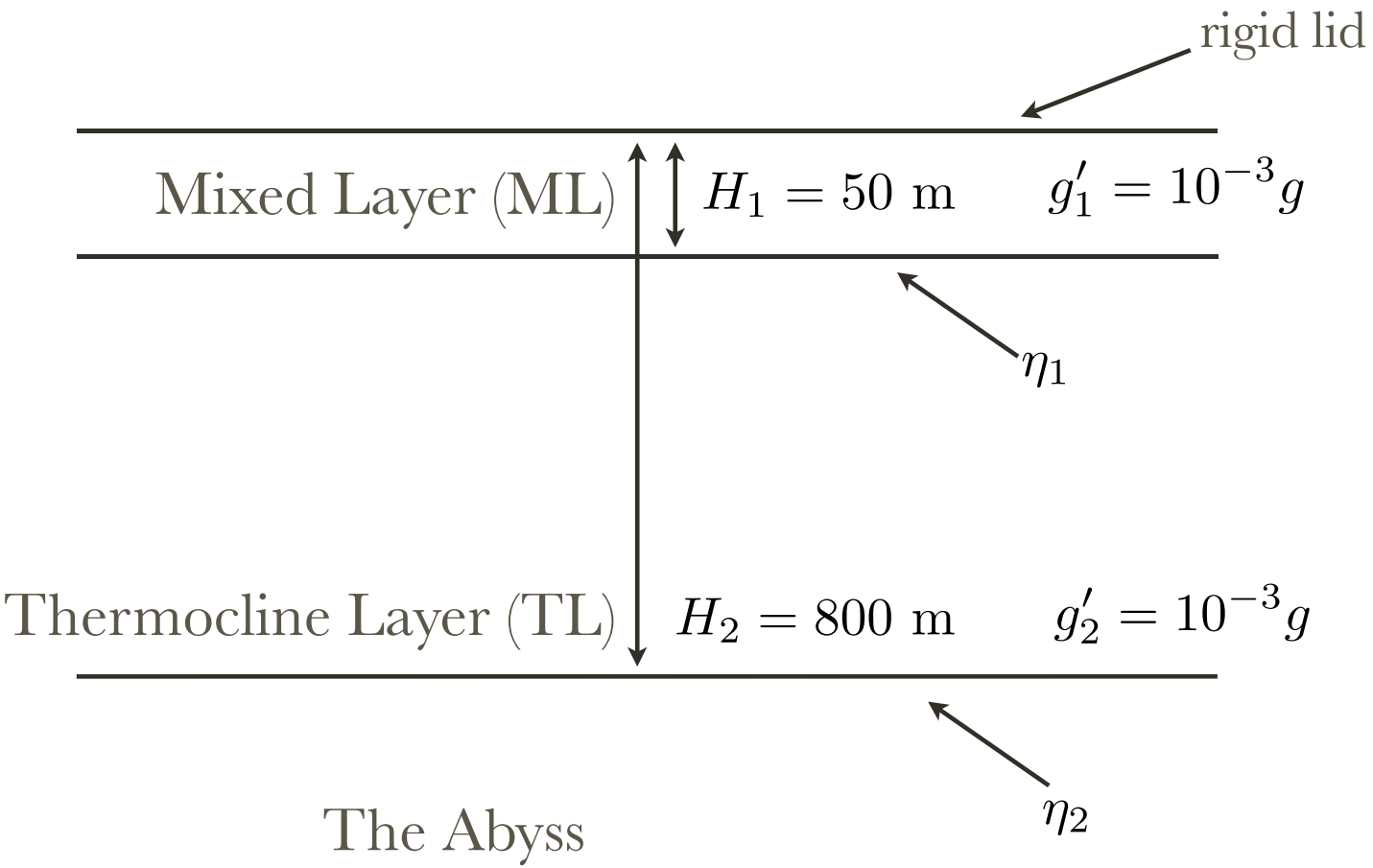
- Map of implied spatial distribution of eddy viscosity, based on drifters vs models



Nonlinear terms. Interactions between eddies and wind-driven motions

- OSCAR: desire as simple model as possible to generate surface currents
- Have been adding in time-dependence, but still keeping geostrophic motions separate from wind-driven motions
- Do we need to include interaction terms?
  - Investigation with **Jeffrey Early at NWRA**
  - QG Damped Slab Model
    - SSH for background mesoscale eddies (QG)
    - Wind for damped slab inertial oscillations in the top surface mixed layer
    - Interaction term between the 2
    - Short story: Geostrophic eddies evolve independent of the inertial motions. Inertial motions couple to the (relatively) slowly varying geostrophic background.

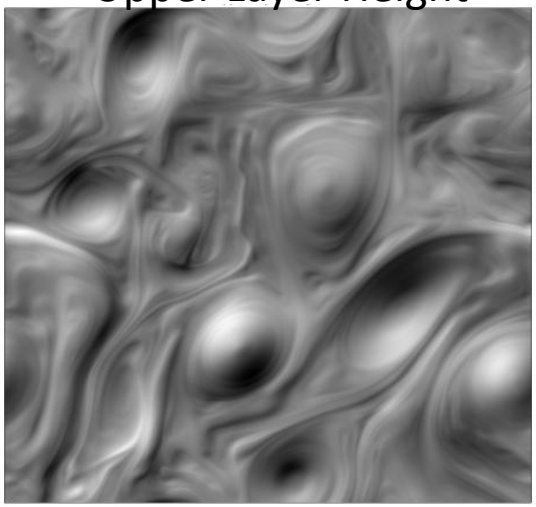
QG Damped Slab 2.5 Layer Model



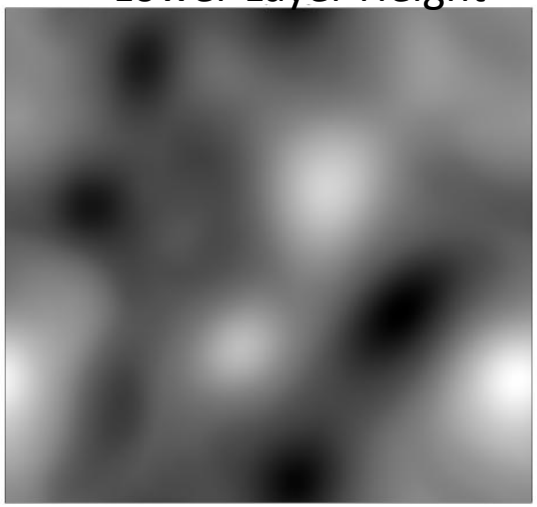
Interactions between eddies and wind-driven motions

- Convergences and divergences in the upper layer due to the coupling terms
- Inertial ringing in the upper layer floats
- Winds horizontally uniform

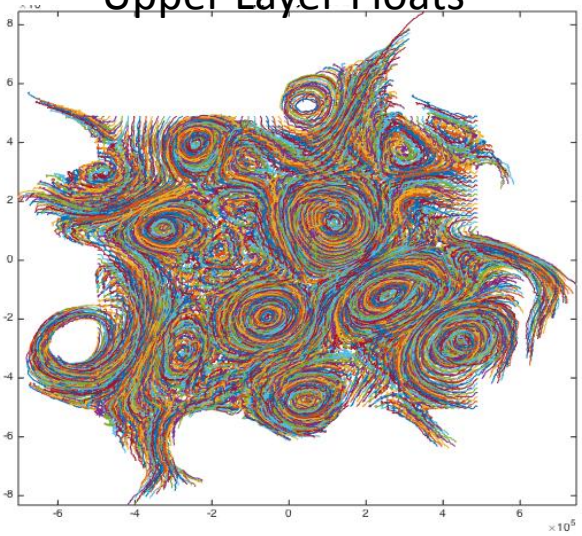
Upper Layer Height



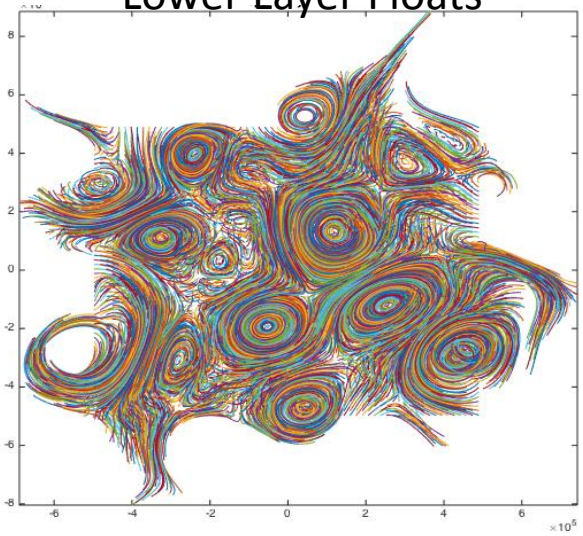
Lower Layer Height



Upper Layer Floats

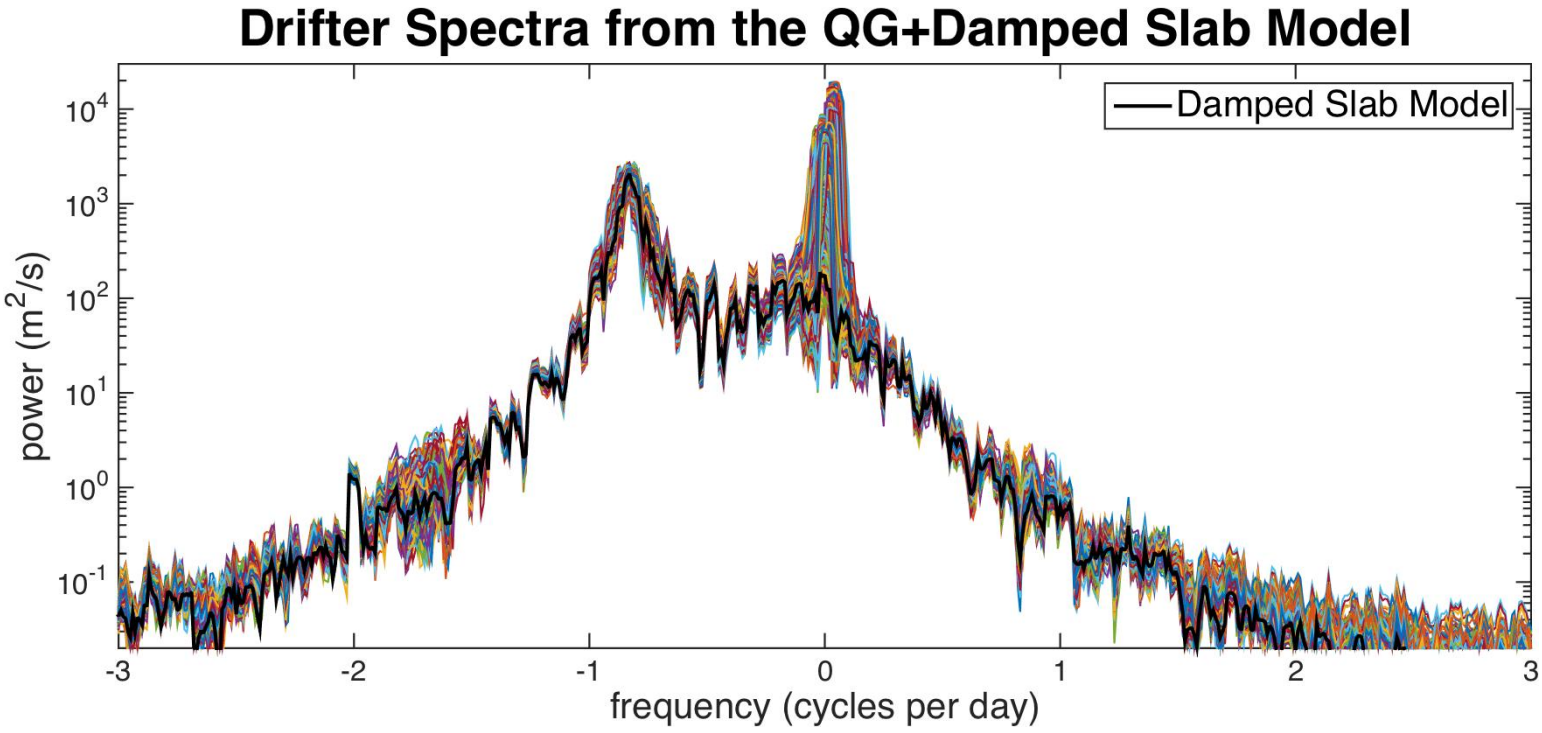


Lower Layer Floats



Interactions between eddies and wind-driven motions

- Black line = the straight damped slab model.
- Colored lines = the individual drifter spectra (low frequency component=the eddies)
- ALL the variability at higher frequencies is due to the nonlinear feedback on the upper layer, otherwise it would match the damped slab model exactly.
  - Note: log plot. Energy spread +/- 20% at inertial, up to +/- 50% at higher



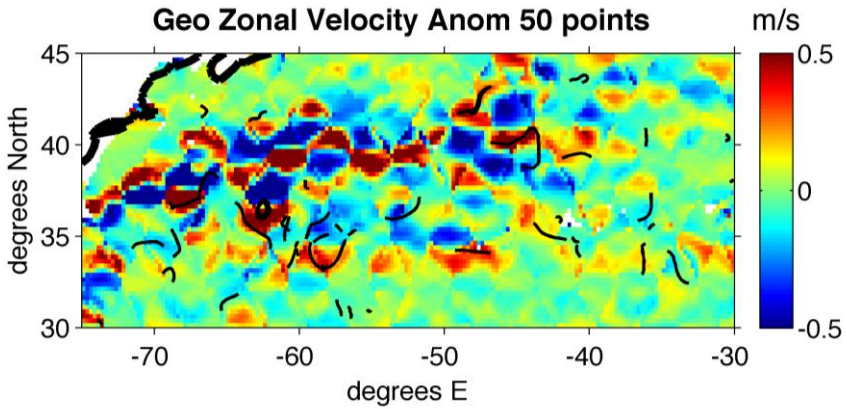
Interactions between eddies and wind-driven motions

- Still preliminary, but interesting that 20-50% difference in energies due to nonlinear terms.
- Note: only get frequency shifting of inertial motions (feff = f +zeta/2) if the density difference between the layers is sufficiently weak – still looking into this and the assumptions used.
- Will need to perform some data assimilation techniques/ inverse solutions to actually implement this for real SSH.

Next Steps

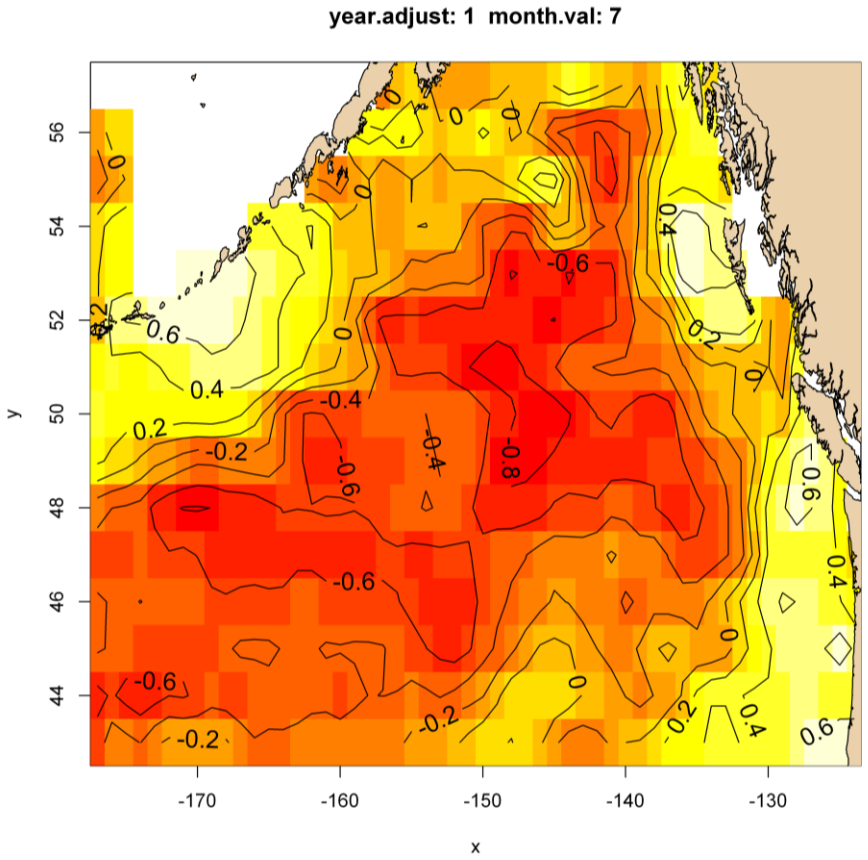
- Continued investigation of time-dependence, explicit vertical variation, and nonlinear versions of OSCAR, while still continuing to develop OSCAR quasi-steady.

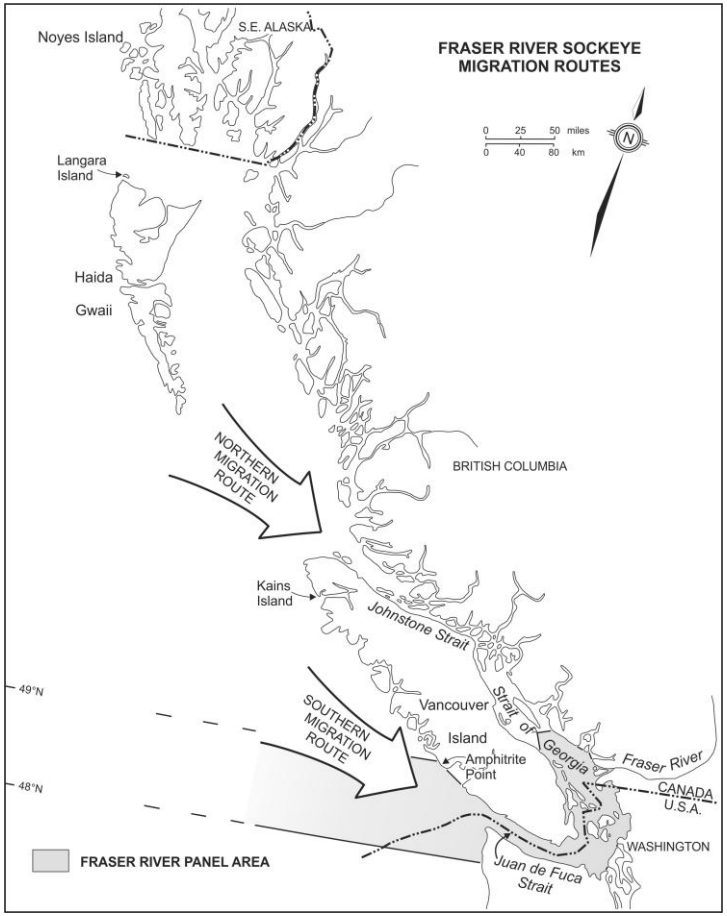
- **Main next direction**: look at level 2 fields
  - Started with SSH
  - Small-scale Ekman pumping
    - Dudley Chelton's talk



Fisheries Application

- Michael Folkes, Salmon Stock Assessment, Canadian Dept Fisheries and Oceans
  - Fishery on Fraser sockeye is managed jointly by Canada and the USA: Pacific Salmon Treaty
- Sockeye salmon returning from high seas: proportion returning via Johnstone Strait is called the Diversion Rate. Fish migration is highly influenced by SST and currents.
- Correlation coefficient between OSCAR U during July of the year prior to salmon return and diversion rate
- Central location of -80% is located where we'd generally expect Fraser sockeye to be one year prior to return .





Capital Weather Gang

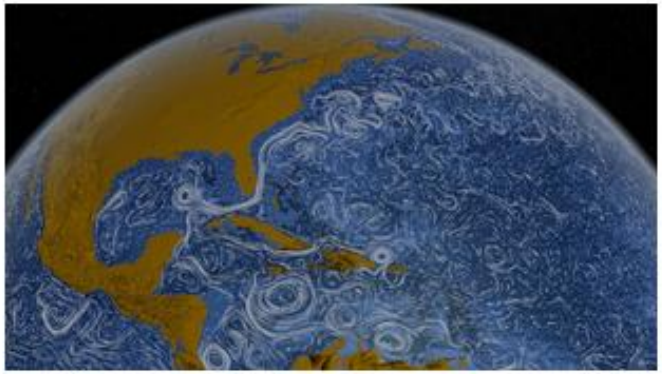
Massive cuts proposed to NASA earth science budget draw protest

By Jason Samenow May 1

Update/clarification at 9:50 a.m. Friday: The Planetary Society, which the House Science Committee press release suggests supports the bill (and we reported as such at the bottom of this post), has submitted clarifying information that it actually does not.

"The Society supported language related to Planetary Science funding contained in the bill, not the full bill itself," said Casey Dreier, director of advocacy for the Planetary Society, in an email. "This was a subtlety expressed in the press release that we want to reiterate. The Earth Science cuts prevent us from supporting the full bill." (For more information, see: Good Planetary Support in A Flawed NASA Bill)

Original post from 4 p.m. Thursday



NASA visualization of ocean currents (NASA)

nd, OR, 19-21 May 2014

Questions for the group

- Pseudo-Operational OSCAR
  - Apparently hundreds of sailors get OSCAR from a couple of different sites that serve it in more navigation-friendly formats, particularly for races.
  - Users like Michael Folkes, Salmon Stock Assessment
  - I'm using NCEP winds. Any other choice?
- Blending between source datasets? We've been doing a linear blend (e.g. between QuikSCAT and ERA/I) over 20 days, and nothing between NCEP and ERA/I. Any better suggestion?
- Serving the data? I'm assuming we're not capable of serving out the data to the general public. What about dynamic plotting? Reduce some of the functionality (like user defined means). But does anyone have any experience in public access and the toll it will take on our system?
- Error/reliability documentation. Anyone set up a standard?

Wind Driven Mixed Layer Research in OSCAR

- Last year: Adding time dependence to the OSCAR equations. Considered KPP, PWP. Arguments for the damped slab.
- The simplest progressions from the existing model are:
  - **VERTICAL VARIATION OF EDDY VISCOSITY**: Generalized Ekman, which has b.c. such that stress goes to zero at depth and a vertically varying eddy viscosity but no time dependence
  - **TIME DEPENDENCE**: Damped slab model which has time dependence but assumes all properties are uniform throughout the mixed layer and uses a Rayleigh drag to treat the damping effects of turbulence
  - **BOTH**: Time dependence and varying forms of the eddy viscosity and boundary conditions, two samples of which are shown below.

OSCAR Equations

$$
\begin{aligned}
if\mathbf{u} &= -\frac{1}{\rho}\nabla p + \frac{1}{\rho}\frac{\partial \tau}{\partial z} \\
\tau &= K\frac{\partial \mathbf{u}}{\partial z} \\
\frac{\partial p}{\partial z} &= -\rho g
\end{aligned}
$$

$$
\frac{\partial \mathbf{u}}{\partial z}(z=0) = \frac{1}{\rho_0 K}\tau_0 \qquad \frac{\partial \mathbf{u}}{\partial z}(z=-H) = 0
$$

$$
K = a\left(\frac{|\mathbf{W}|}{W_0}\right)^b
$$

Modifications to OSCAR Equations

Time and Vertical Dependence: Linear Unsteady Ekman

$$
\frac{\partial \mathbf{u}(t,z)}{\partial t} + if\mathbf{u}(t,z) = \frac{1}{\rho}\frac{\partial \tau(t,z)}{\partial z}
$$

Turbulence parameterized by an Eddy Viscosity

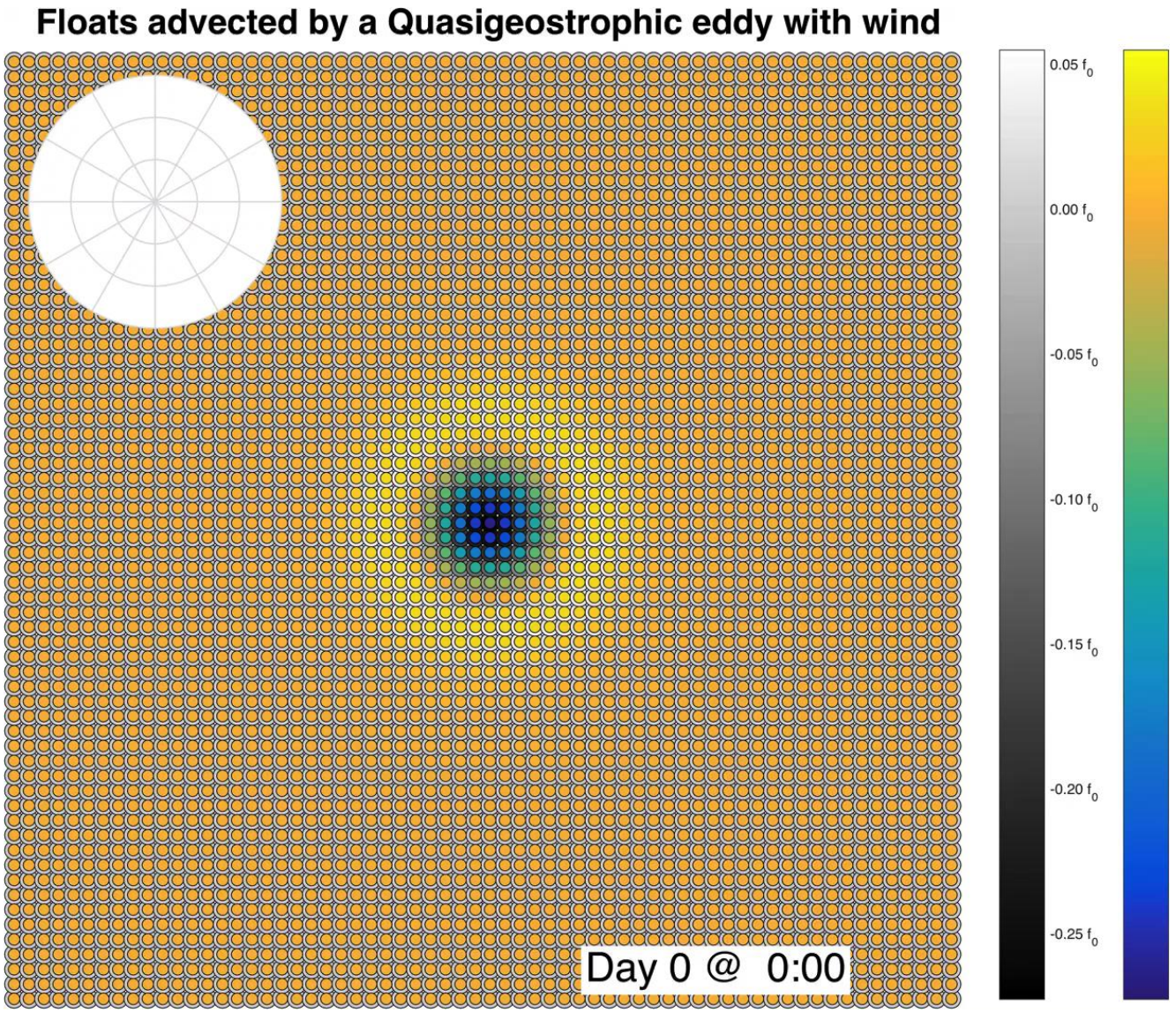
$$
\tau = -K(z)\frac{\partial \mathbf{u}}{\partial z}
$$

$$
\frac{\partial \mathbf{u}(t,z)}{\partial t} + if\mathbf{u}(t,z) = \frac{1}{\rho}\frac{\partial}{\partial z}\left(K(z)\frac{\partial \mathbf{u}(t,z)}{\partial t}\right)
$$

Damped Slab with turbulence as a Rayleigh drag

$$
\frac{d\mathbf{U}(t)}{dt} + if\mathbf{U}(t) = \frac{\tau(t)}{\rho MLD} - r\mathbf{U}(t)
$$

Interactions between eddies and wind-driven motions



Vertical Dependence: Benefits of DopplerSCAT for OML research

- Mean angle of surface currents, averaged over 2008 for the models, 1992:2014 for the drifters
- Angle of “residual” currents = Currents minus the band around the local inertial frequency (inertial motions dominate the signal)