Overview of oceanography splinter session:

“Understanding of 2-D sea surface height signals”

Relevant Scientific topics:

1. Meso- and submesoscale dynamics impacting on SSH in the 15-200 km wavelengths: Gerard
2. Relevance and handling of ageostrophic signals: Billy
3. Interaction between submesoscale, mesoscale, and large-scale circulation: Roger
4. Insights from submesoscale-resolving OGCM simulations: Alex
Meso- and submesoscale dynamic from SSH

Impact of submesoscales in terms of the dispersion of pollutants or floats by the surface currents (Finite Size Lyapunov Exponents) [Haza et al. '12]

*No submesoscale*

*With submesoscales*

[From Haza et al., OM 2012]

Fig. 1. FSLE branches from 1/12° (upper panel) and 1/48° (lower panel) HYCOM simulations in the Gulf Stream region. Note the rich submesoscale field in the higher resolution case. The color panels indicate FSLE in 1 days. Blue colors show inflowing/stable LCS from forward in time, and red colors out-flowing/unstable LCS from backward in time particle advection. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this paper.)

When submesoscales are present FSLE have a larger magnitude and involve smaller scales

=> Dispersion by submesoscales is significant
When OFES30 SSHA data is spatially “degraded” (i.e., averaged), the inferred energy fluxes approach those of AVISO.
Figure S2 | Wavenumber spectra of relative vorticity in the north box (150-160°E, 35-45°N) in (a) March and (b) September of 2002. Relative vorticities deduced from SSH (black curve) and from surface velocity (gray curve).
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This new potential has been successfully tested, in particular for …
Diagnosis of the 3D dynamics in the first 500m including within the ML
(Ponte et al.,'13)

Black curve: velocity spectrum from SSH (Ug,Vg)
Red curve: velocity spectrum from
surface currents observed in the model
Thick blue curve: velocity spectrum diagnosed
from SSH using an additional mixing argument
related to the mixed-layer dynamics

-> Mixing argument explains the differences between the black and red curves.
The resulting analytical solution only requires the knowledge of

high resolution SSH and climatological value of the ML depth
In the same way ...

the W field within the ML is diagnosed by considering that it involves a SQG contribution and a mixing contribution (derived from Garrett and Loder, 81): Ponte et al.'13

**Simulated W by an OGCM**

**Diagnosed W from SSH, SST and Kv**

![Diagram](image)

**Figure 6.** Snapshots of the vertical velocity field at 40 m with ML (a) and reconstructed field $w_{sqg} + w_m$ (b). Units are m/day.

$\Rightarrow$ W diagnosis requires the knowledge of, both, HR SSH, HR SST and order of magnitude of the vertical mixing (from Argo floats).

These first diagnosis results seem promising and point out the strong potential of the wide-swath altimeters.
Submesoscale KE is produced by sheared instability in summer and mixed-layer instabilities in winter.
Relevance and handling of ageostrophic signals
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Interactions between submesoscales, mesoscales and large-scale circulation
Interactions between submesoscales, mesoscales and large-scale circulation

Fig. 4. Perturbation power spectral density $E(\kappa)$ for a simulation from Fig. 3 (solid). Spectra are plotted at 2-day intervals from day 1.5 to day 29.5. The linear prediction of the spectrum [$E_\text{lin}(\kappa)$, dashed] is set equal to the nonlinear spectrum on day 1.5 and then evolved at each along-channel wavenumber as predicted by linear theory taking into account the changes in Ri and $U$; that is, $E_\text{lin}(\kappa)$ is evolved using $\tau_\text{lin}(k)$ from (1) based on the instantaneous Ri and $U$ from the nonlinear simulation: $E_\text{lin}(\kappa) = e^{2\tau_\text{lin}(\kappa)}|E|_{t=1.5} (k, l)dl$. The decrease in growth rate with cross-channel wavenumber, $l$, is ignored for simplicity and because low $l$ modes soon dominate.
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Presentations:

1. Roger Samelson: *Effect of mesoscale vs. submesoscales on eddy amplitude time series*
2. Billy Kessler: *Submesoscale jets and squirts observed in Solomon Sea glider data*
3. Alex Kurapov: *Submesoscale features in a 2-km resolution eastern Bering Sea simulation*
4. Gerald Dibarboure: *Short wavelength correlated errors of altimetry: implications for SWOT*