

# Geophysical Fluid Dynamics Laboratory Review

June 30 - July 2, 2009



# Ocean Processes and Parameterization

Presented by  
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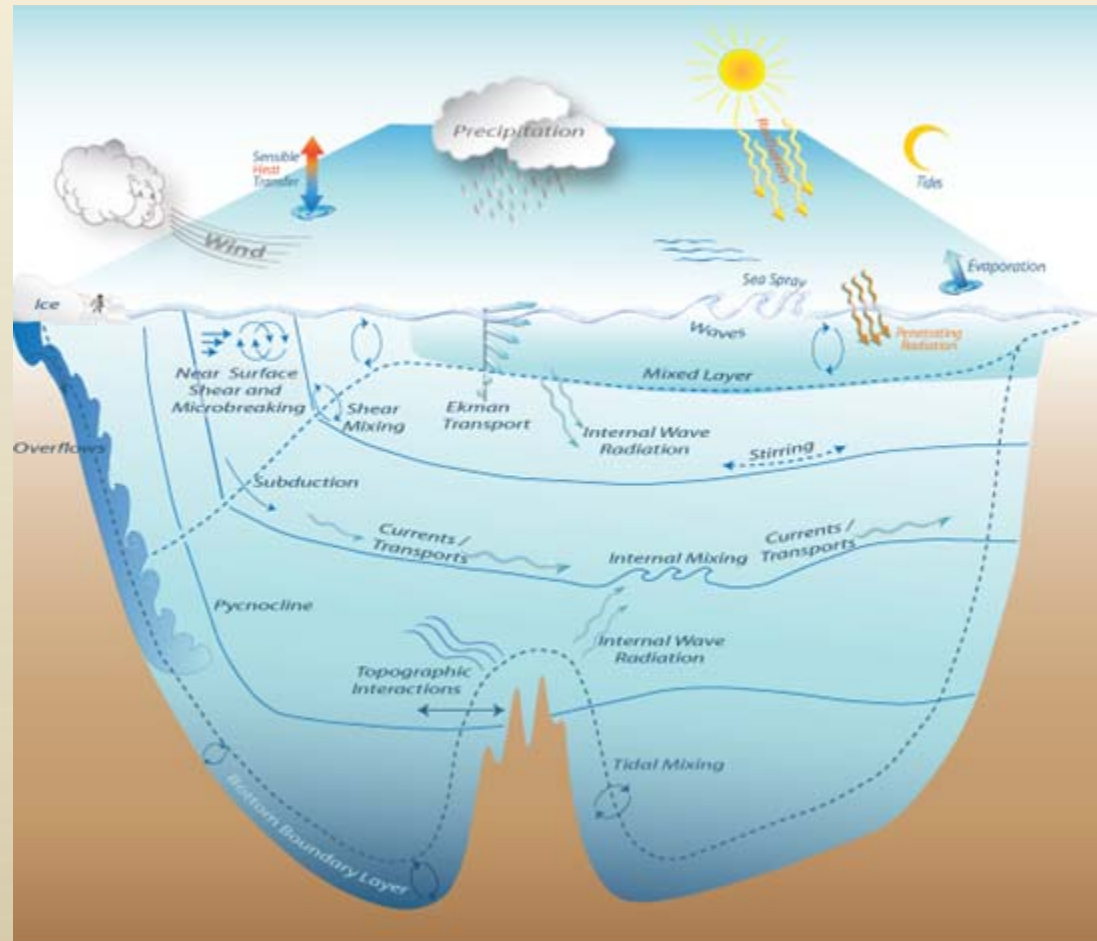
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# Importance of improving ocean process parameterizations

- Ocean climate is strongly affected by processes on scales finer than model grid
- New approach to sub-grid-scale processes: Physically-based, energetically-consistent parameterizations that vary temporally and spatially
- Climate models which allow sub-grid-scale mixing to evolve with time are more credible for climate change projection

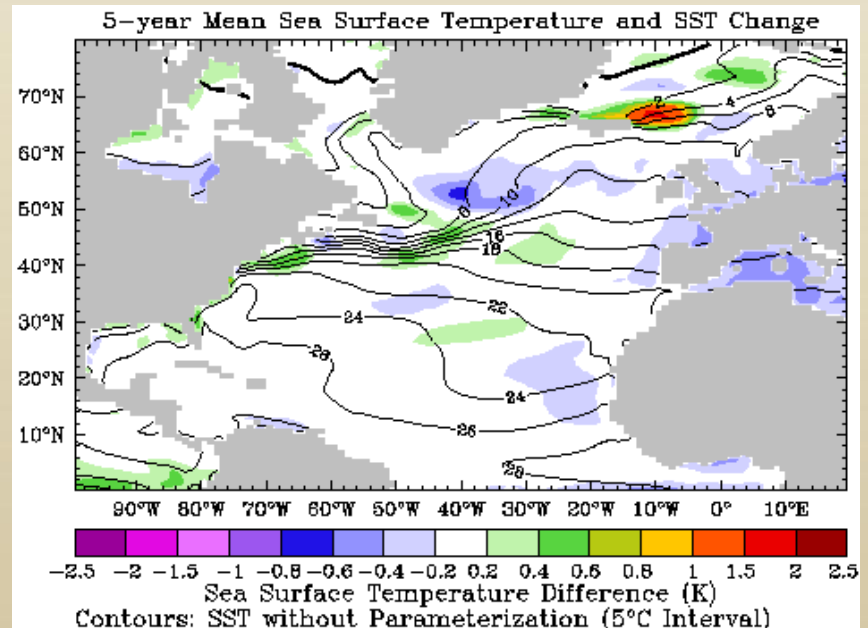
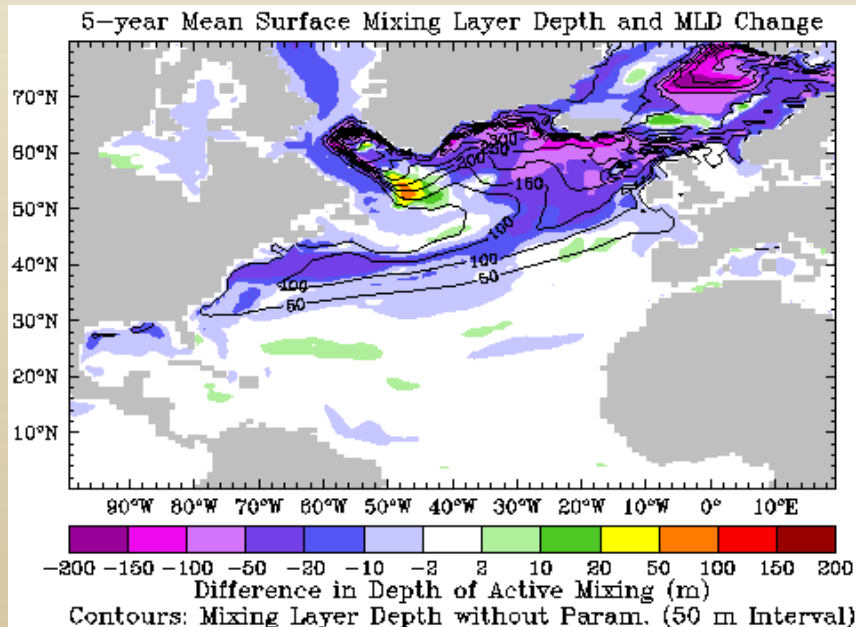


# Mesoscale Eddy-Mixed layer interactions

As a participant in USCLIVAR Eddy-Mixed Layer Interaction Climate Process Team, GFDL improved representation of eddies in the mixed layer

- Surface boundary matching for Gent-McWilliams implemented in CM2M (*Ferrari et al, 2008*)
- Upper ocean submesoscale eddies parameterized in CM2M and CM2G (*Fox-Kemper et al, 2008*)

## Impact of submesoscale eddy parameterization in GOLD-SIS

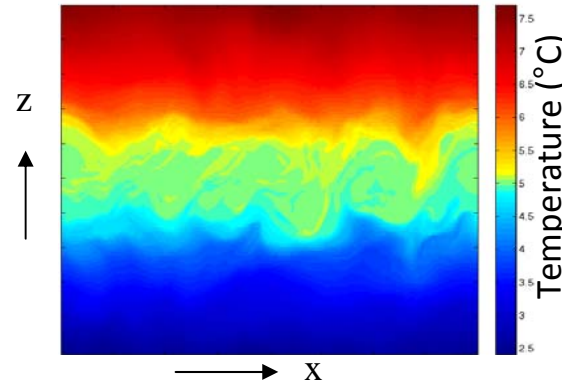




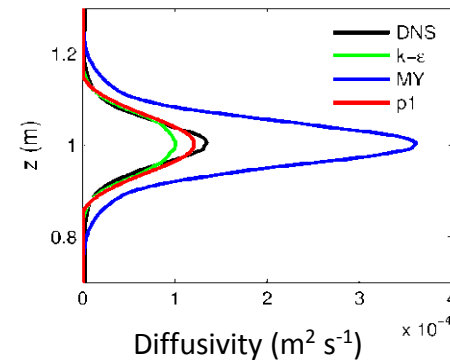
# Improved Overflow Representation

GFDL collaborated in USCLIVAR Gravity Current Entrainment Climate Process Team, leveraging observational and theoretical community expertise

- New representation of flow through narrow straits
- New parameterization of shear driven mixing, in overflows and elsewhere, in CM2G (*Jackson et al, 2008*)

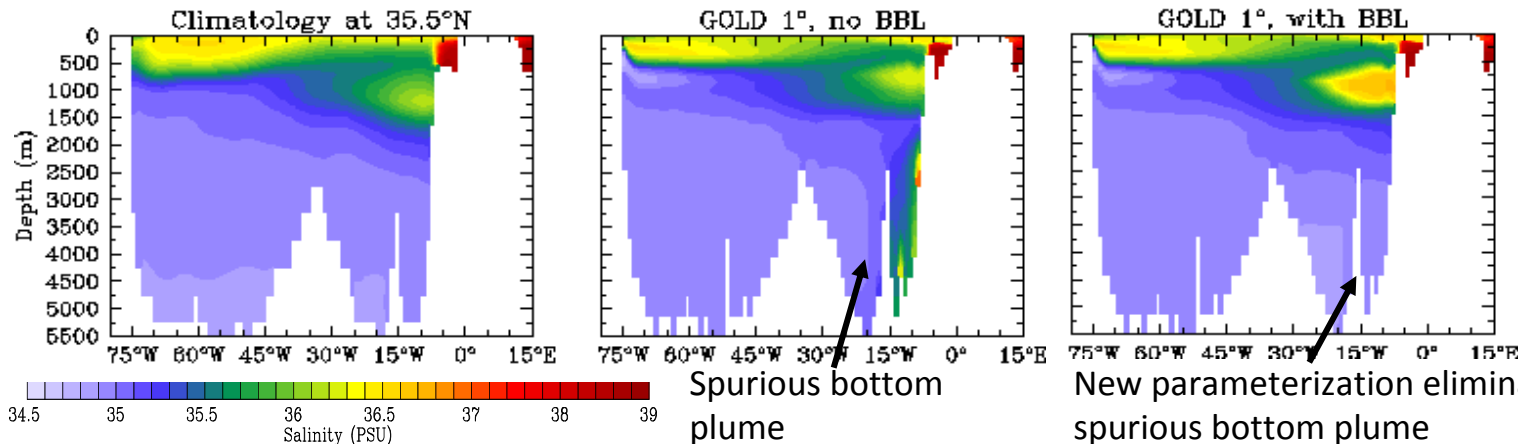


3D high-resolution MITgcm



Diffusivities diagnosed from simulation and predicted by different parameterizations

- New parameterization of frictional bottom boundary layer mixing (*Legg et al, 2006*)

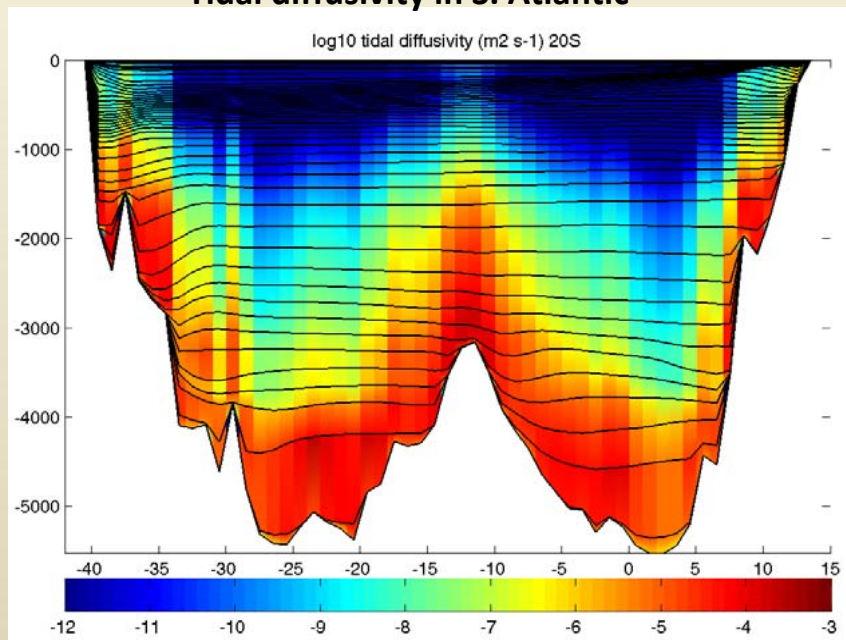


Mediterranean outflow salinity: comparison between CM2G and observed climatology (*Legg et al, 2009*)

# Parameterizing Tidal Mixing

- Tides flow over bottom topography and generate internal waves and mixing

**Tidal diffusivity in S. Atlantic**

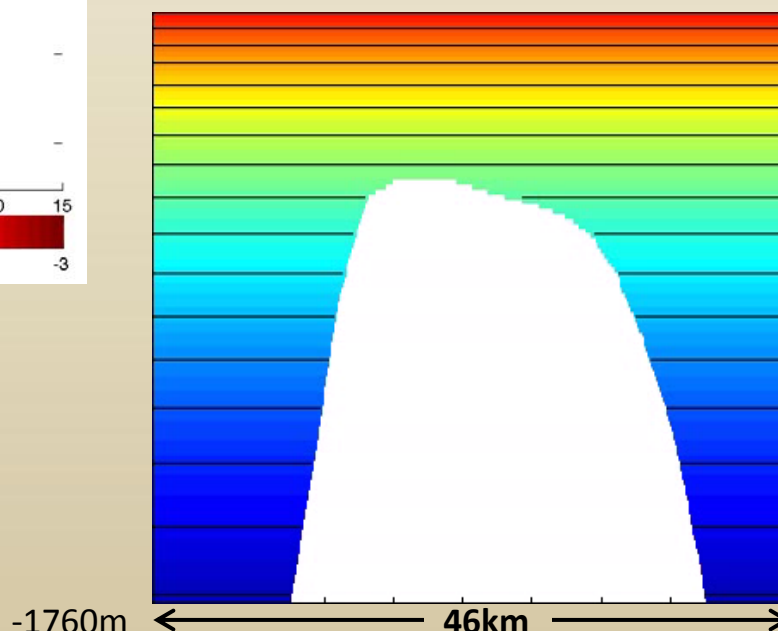


- Ongoing process studies and collaborations aim to extend this parameterization to include:
  - effects of steep slopes
  - nonlinear wave-wave interactions,
  - wave scattering at topography,
  - parametric subharmonic instability.

- A new energetically-consistent parameterization represents localization of tidal mixing at rough topography used in CM2G, CM2M (based on Simmons et al, 2004)

**Buoyancy field from nonhydrostatic**

**-700m simulations of tidal flow over Hawaiian ridge**



Tidal flow over steep ridges leads to internal hydraulic jumps which cause localized mixing (Legg and Klymak, 2008)

# Summary: Processes and parameterization

- **Improved representation of small-scale processes:**  
an important component of GFDL's efforts to develop the world's best ocean climate models
- **Physically-based parameterizations:**  
necessary for credible future climate projections
- **Improvements have recently been made in representation of eddy-mixed layer interaction, overflows, tidal mixing**
- **Outside collaborations, e.g. Climate Process Teams, are vital to this effort:**  
provide understanding of physical processes through observations/process studies

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