RSMAS contribution to MURI August 2012 presentation

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Outline:

1) An ocean dispersion experiment

2) Formation of "star eddies" in the North Atlantic:

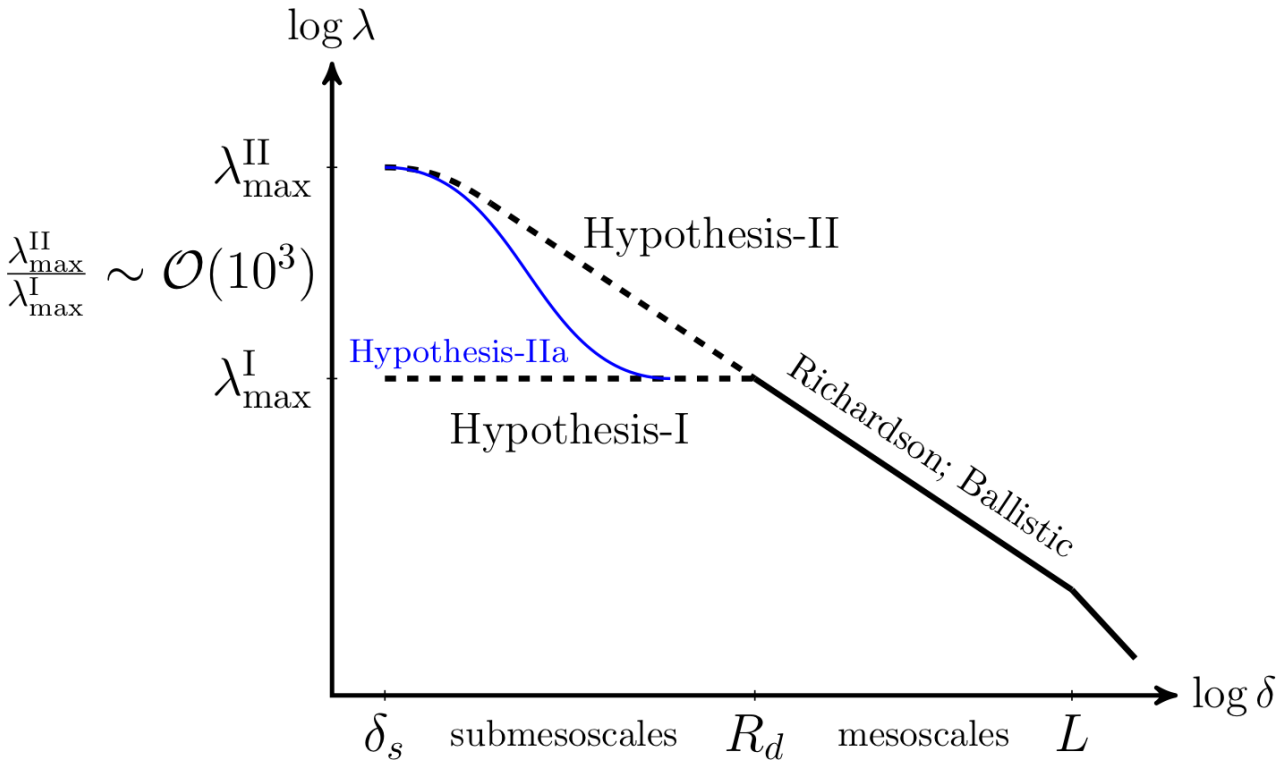
Investigation through LES with emphasis on

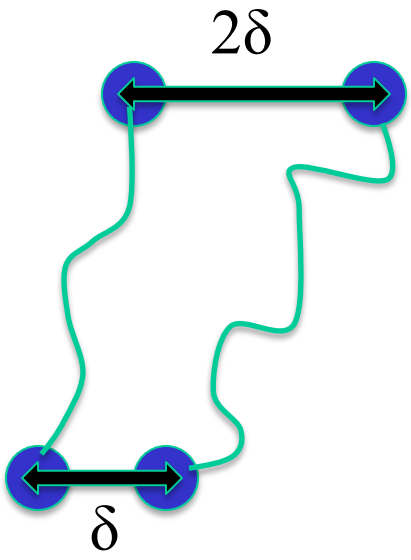
a) their 3D structure visualized using tracer release and FTLE

b) multi-scale (submesoscale-mesoscale) interactions

3) Publication list

Motivation for ocean dispersion experiments
to gain insight into multiscale ocean processes





Two particle separation

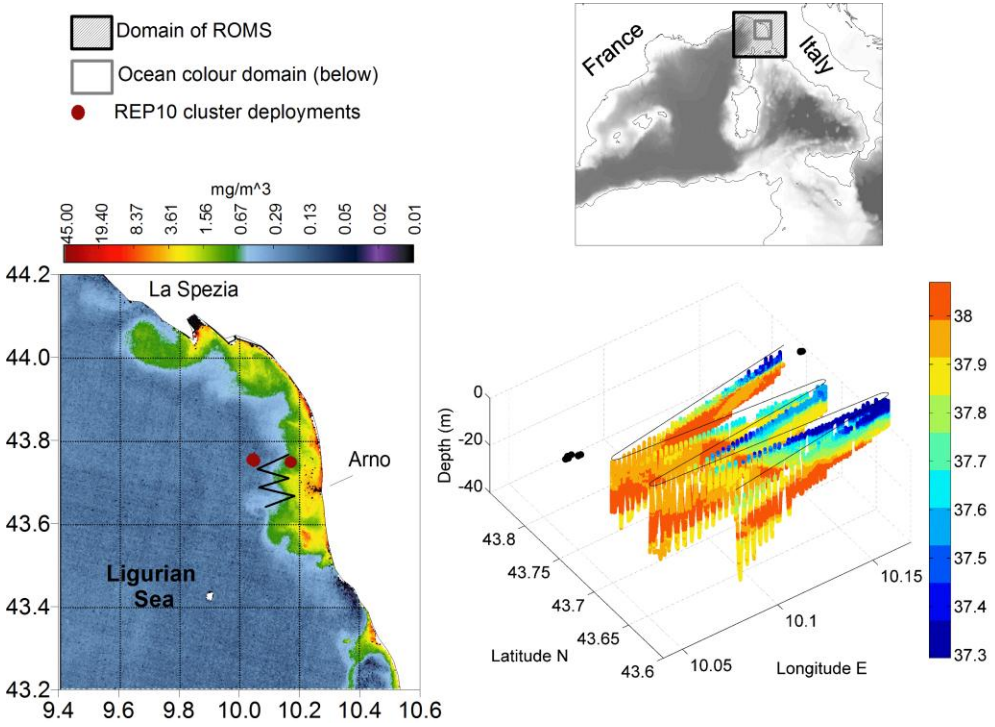
FSLE $\lambda \sim 1/\tau$

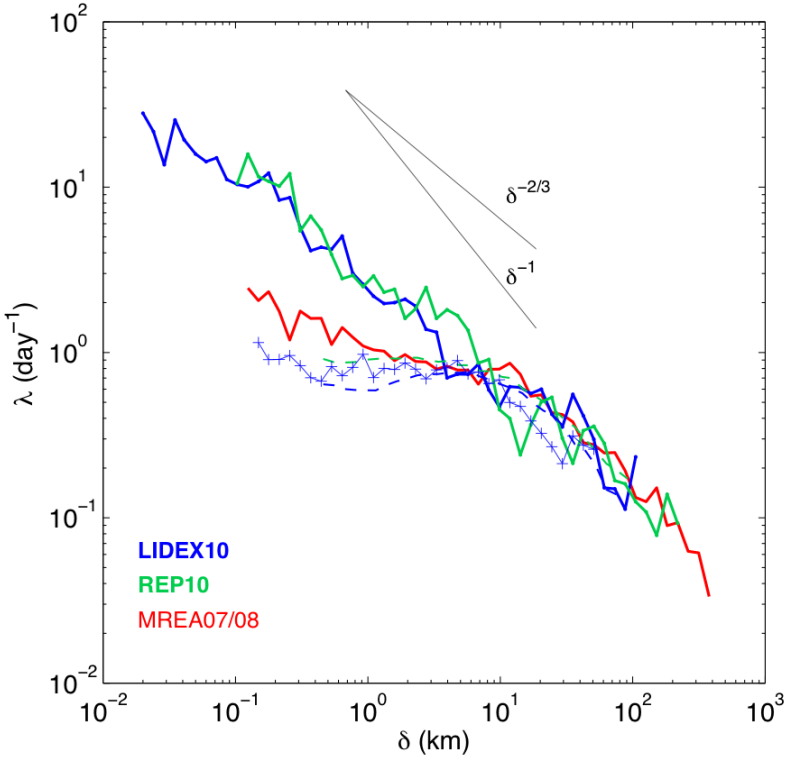
Hypothesis-I : energetic and long-lasting mesoscale features in control (non-local dispersion, Bennett, 1984) ***current data-assimilating OGCMs adequate should give good predictions***

Hypothesis-II : rapidly-evolving small scales dictate relative dispersion at submesoscales, ***parameterizations for submesoscale processes would be needed in OGCMs***

Hypothesis-IIa: Large scale separation between submesoscales and mesoscales

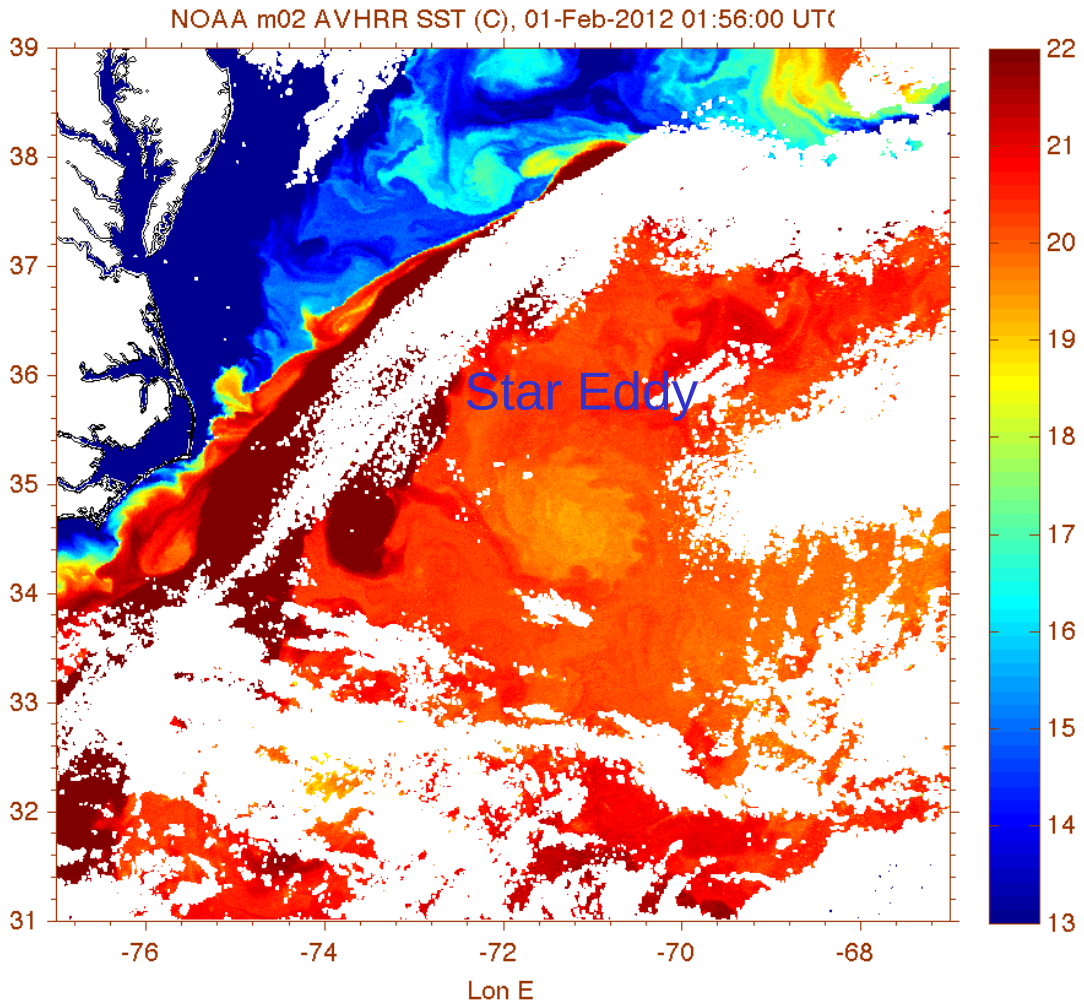
Are the submesoscales important for transport? Results from a recent coastal experiment (Scroeder et al., 2012):





- *Enhanced dispersion by submesoscale processes from observations*
- *OGCM underestimates of submesoscale dispersion by an order of magnitude*
- *Results stress need of parameterizations for submesoscale Lagrangian dispersion in ocean models (as developed in Haza et al., 2012).*

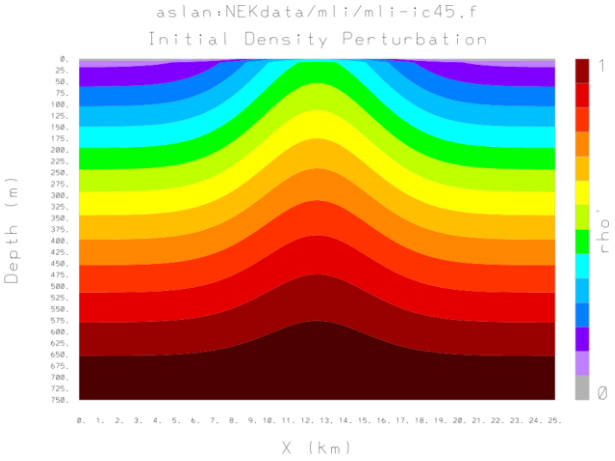
SST in the Gulf Stream Region in February 2012:

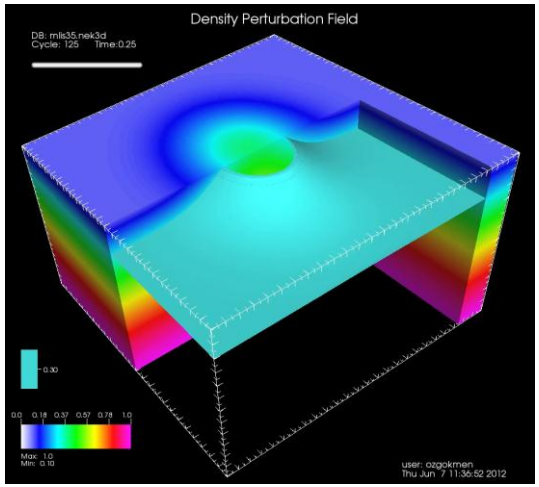


* How do star eddies form?
* What is the role of mixed layer submesoscale processes?
* How do submesoscale and mesoscale instabilities interact?

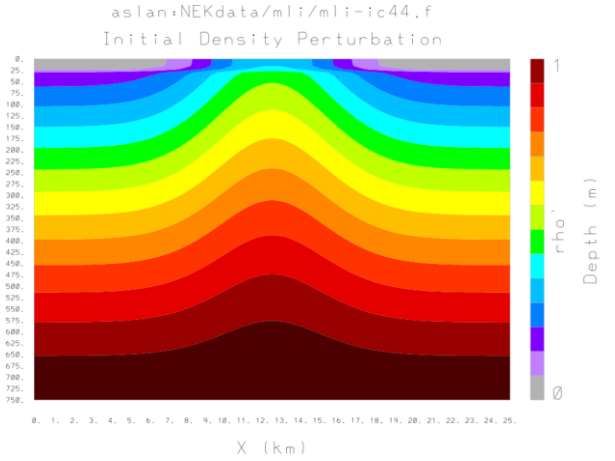
A Cyclone Protruding into the Mixed Layer:

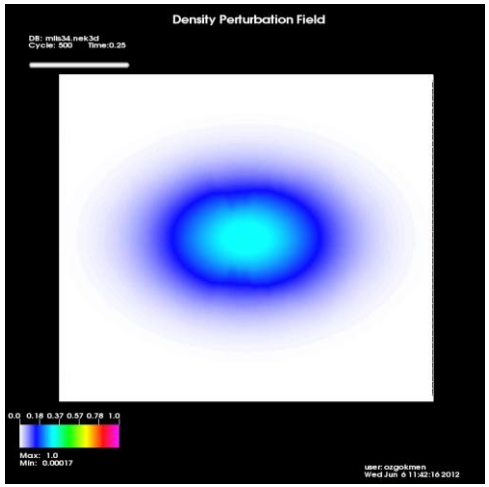
MLD=0 m



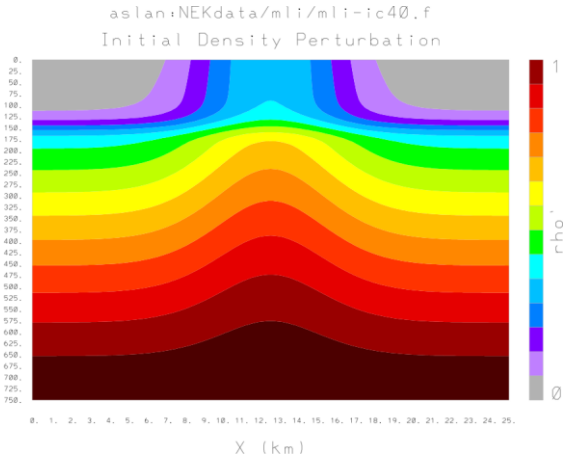


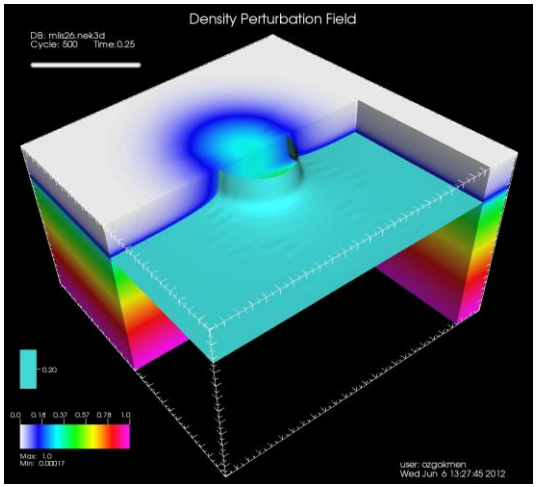
MLD=25 m





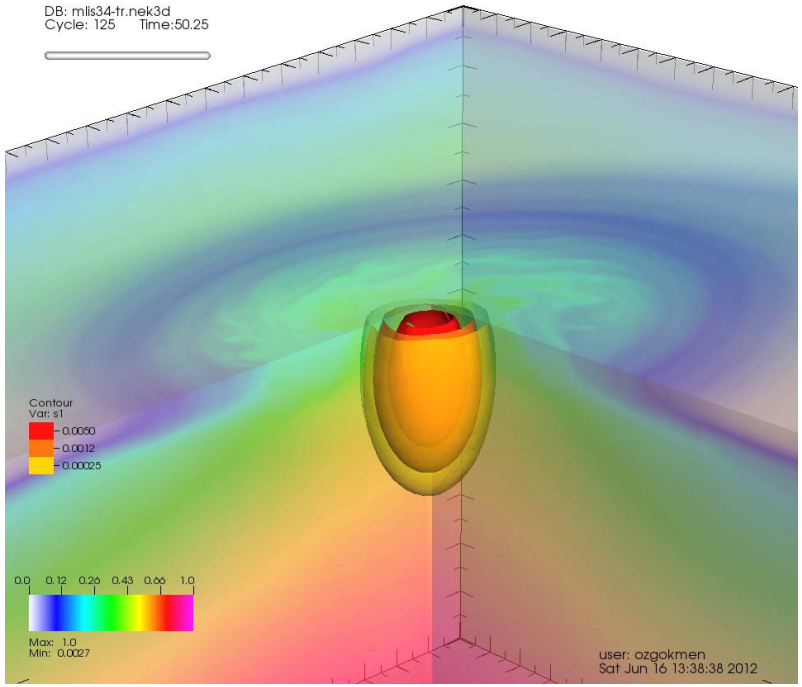
MLD=150 m



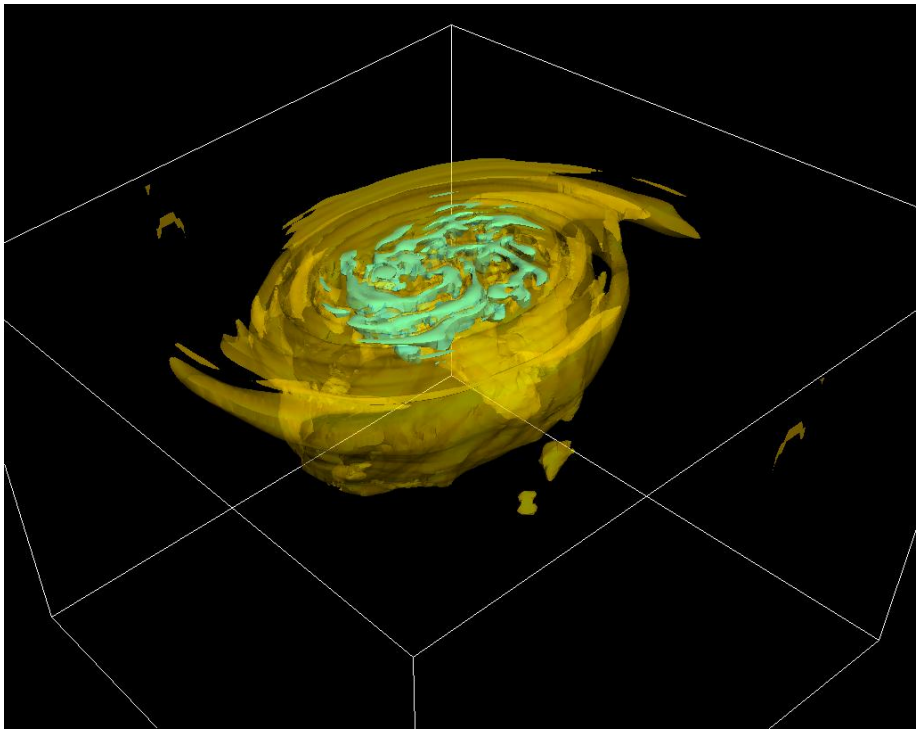


Do Upper-Ocean Star Features Influence Transport?

Passive Tracer Release:

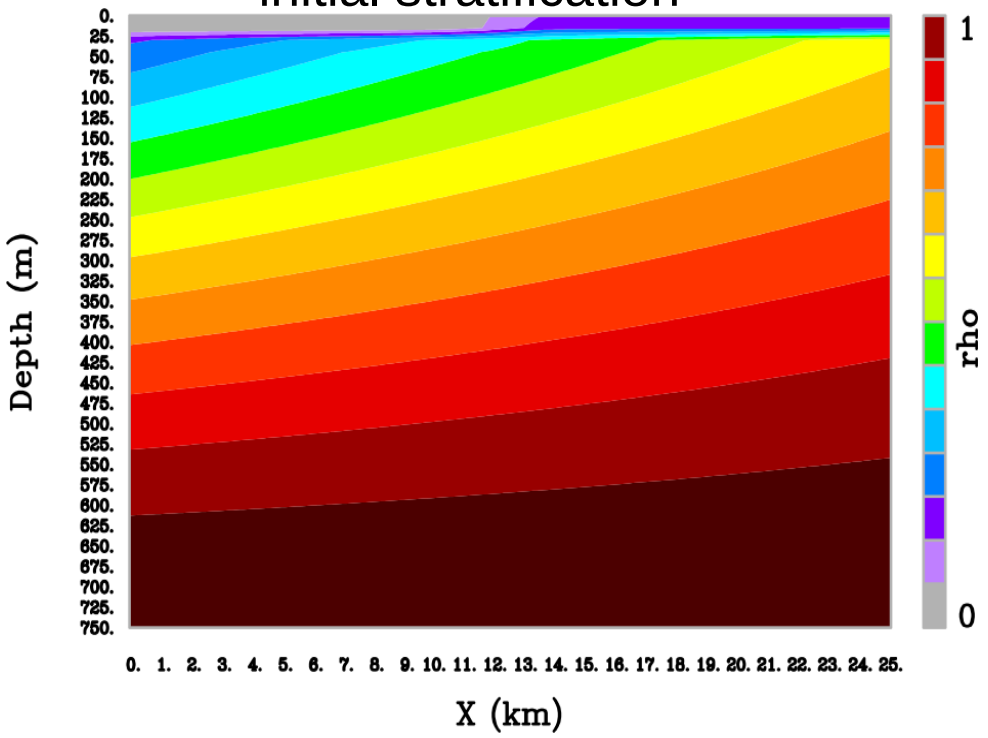


FTLE From 10 Million Particles:

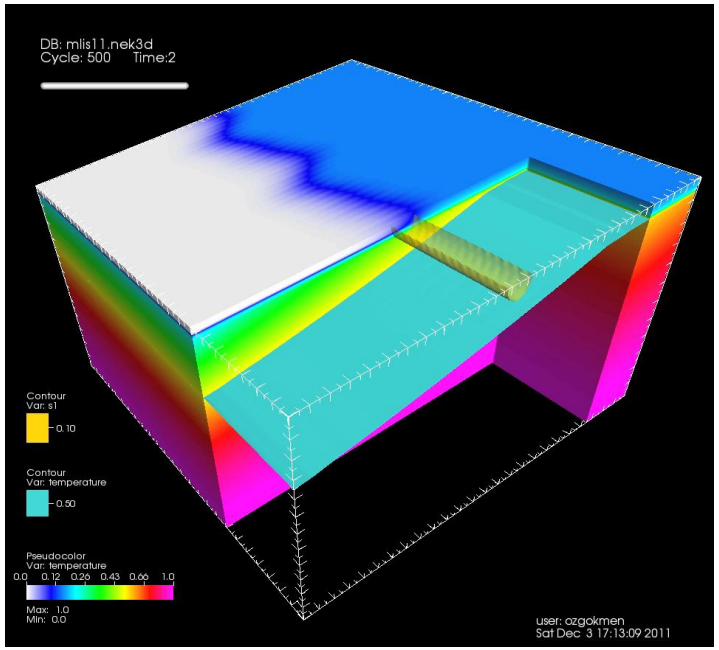


LES model setting for multi-scale interactions:

initial stratification



model animation



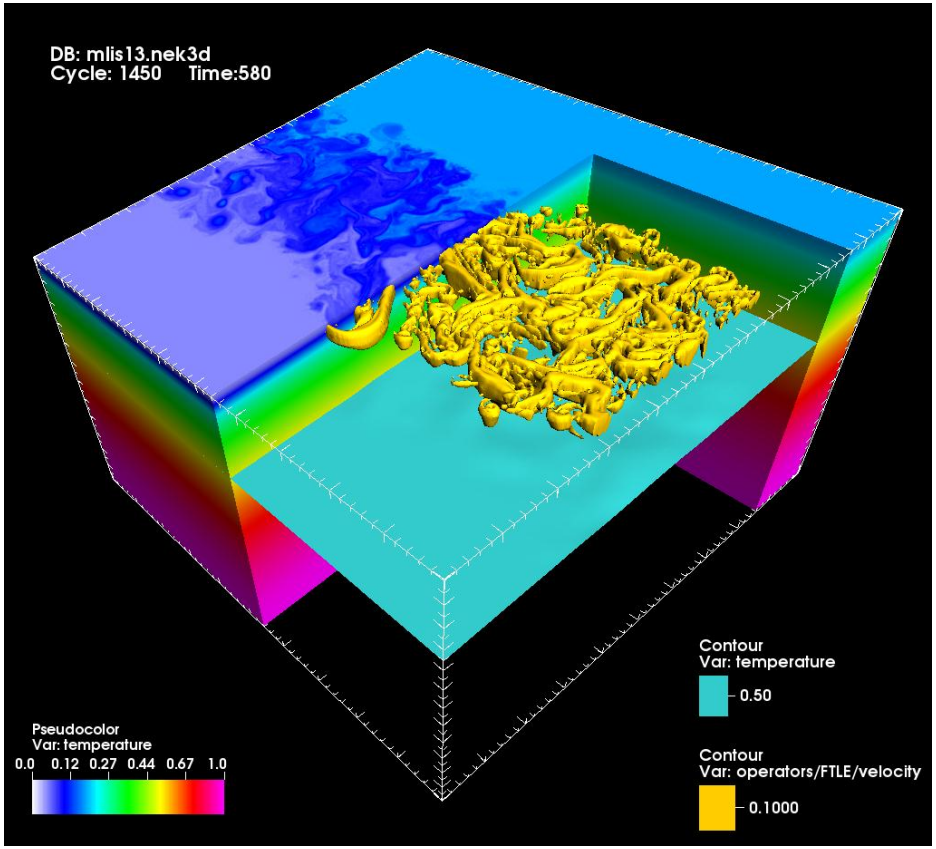
* Domain: 25 km x 25 km x 0.75 km

* Shallow (25 m) weak ML front to get 10x scale separation between MLI and deep baroclinic eddies; no winds or other forcing

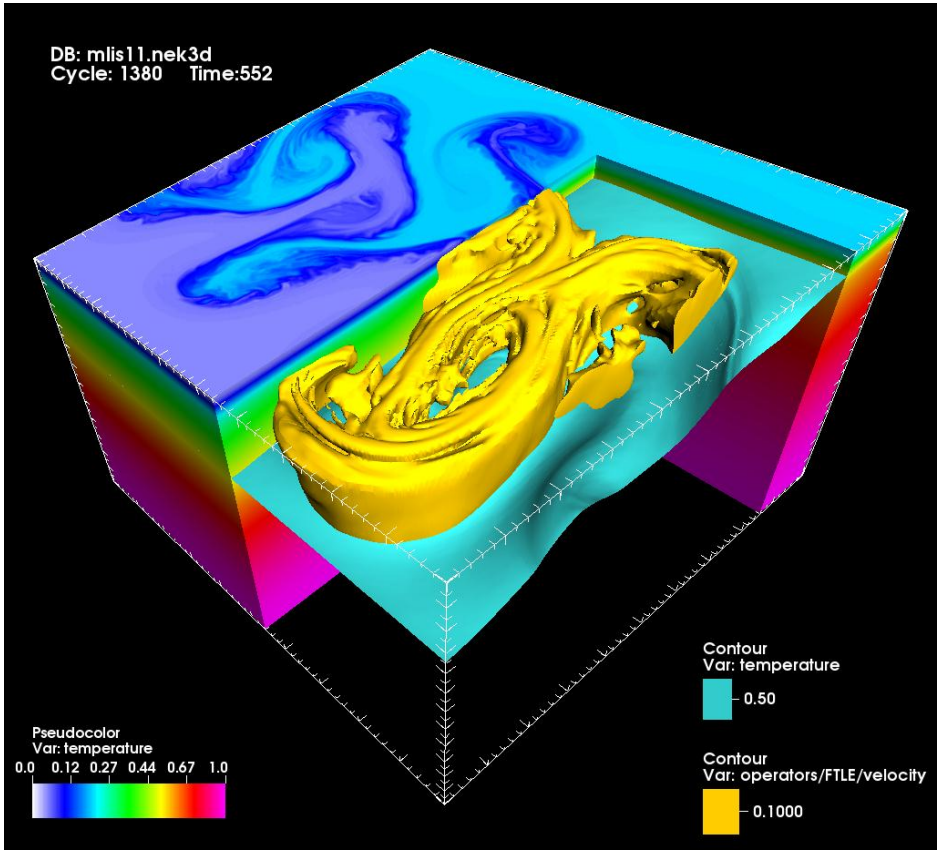
* Spectral element code Nek5000; 22×10^6 points (dx=17 m, dz=0.75 m)

Visualization of Coherent Structures Controlling The Flow
3D FTLEs (7 million particles, full 3D advection)

Phase 1: upper ocean instability only



Phase II – after onset of deep instability



Clearly different turbulent coherent structures in Exp-I vs Exp-II,
shallow submesoscale eddies vs deep mesoscale features…

RSMAS Publications Fully or Partially Supported by 3D+1 MURI:

- Haza, A.C., Özgökmen, T.M., A. Griffa, Z. D. Garraffo and L. Piterbarg, 2012: Parameterization of particle transport at submesoscales in the Gulf Stream region using Lagrangian subgridscale models. Ocean Modelling, 42, 31-49. Ocean Modelling, 42, 31-49.

- Schroeder, K., Chiggiato, J., Haza, A.C., A. Griffa, Özgökmen, T.M., P. Zanasca, A. Molcard, M. Borghini, P.M. Poulain, R. Gerin, Z. Zambianchi, P. Falco and C. Trees, 2012: Targeted Lagrangian sampling of submesoscale dispersion at a coastal frontal zone. Geophys. Res. Lett., 39, L11608, doi.10.1029/2012GL051879.

- Griffa, A., Haza A.C., Özgökmen, T.M., A. Molcard, V. Taillandier, K. Schroeder, Y. Chang and P.M. Poulain: Investigating transport pathways in the ocean. Deep Sea Research II, in press (8 December 2011).

- Özgökmen, T.M., A.C. Poje, P.F. Fischer, H. Childs, H. Krishnan, C. Garth, A. Haza and E. Ryan: On multi-scale dispersion under the influence of surface mixed layer instabilities and deep flows. Ocean Modelling, in press (27 July 2012).

- Haza, A.C., Özgökmen, T.M. and A. Griffa: Impact of noise and sampling on relative dispersion estimates at oceanic submesoscales. Third draft (July 2012).