Quantification of physical and numerical mixing using tracer variance dissipation in a coastal ocean model

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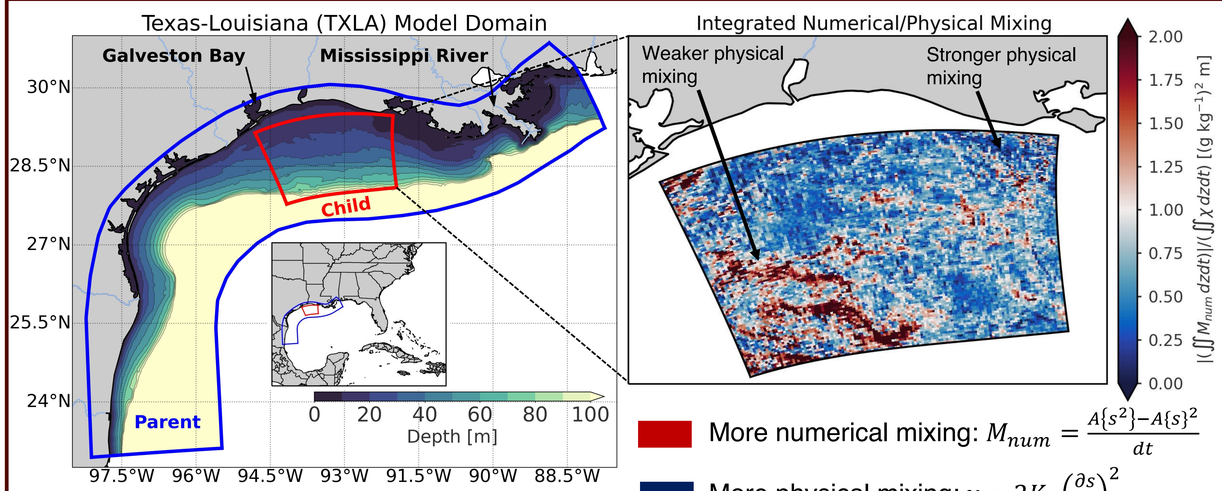
OCEANOGRAPHY

I. Background and motivation



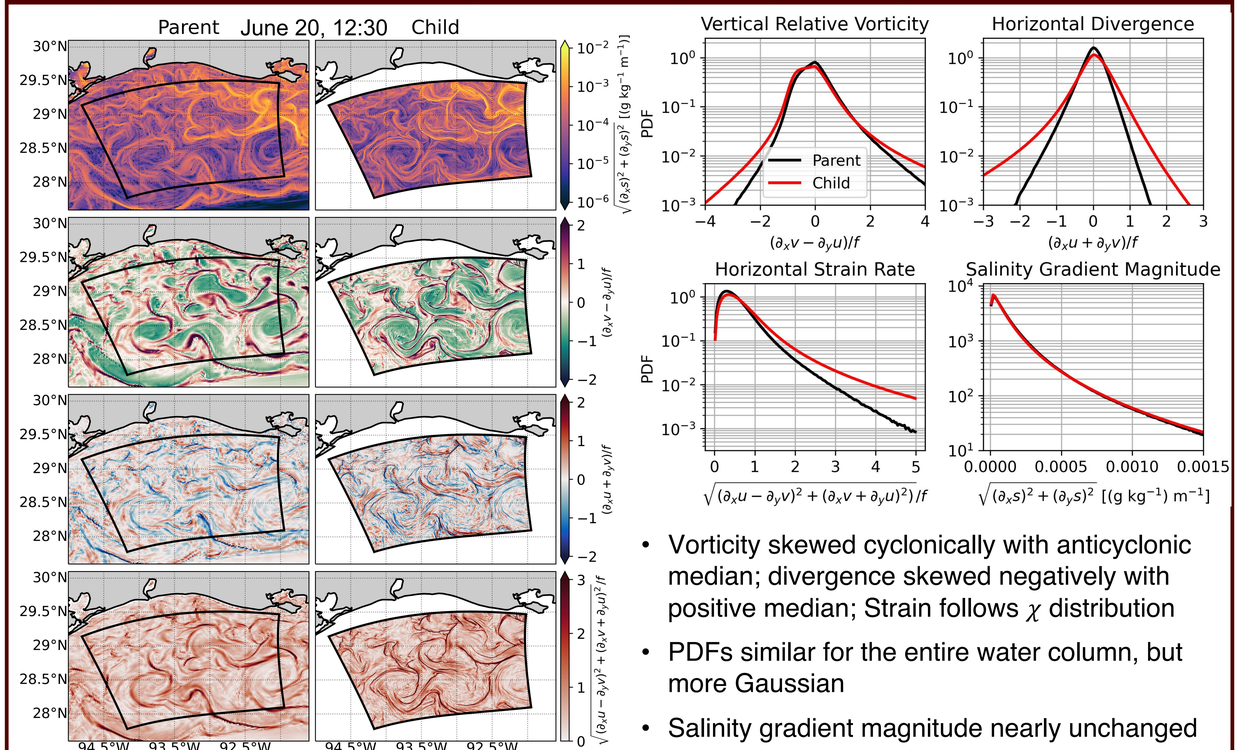
More numerical mixing: $M_{num} = \frac{A\{s^2\} - A\{s\}^2}{dt}$

More physical mixing: $\chi = 2K_v \left(\frac{\partial s}{\partial z}\right)^2$

- Realistic ROMS model; two-way nesting
- Parent resolution ~1600 m, child ~300 m
- 40 Day Simulation: June 3 – July 14, 2010
- Numerical mixing = spurious mixing generated by the discretization of advection (Burchard et al. 2008)
- Numerical mixing can be as large as resolved mixing but is rarely quantified (Fringer et al., 2019)

How and why does numerical mixing vary between the parent and child models?

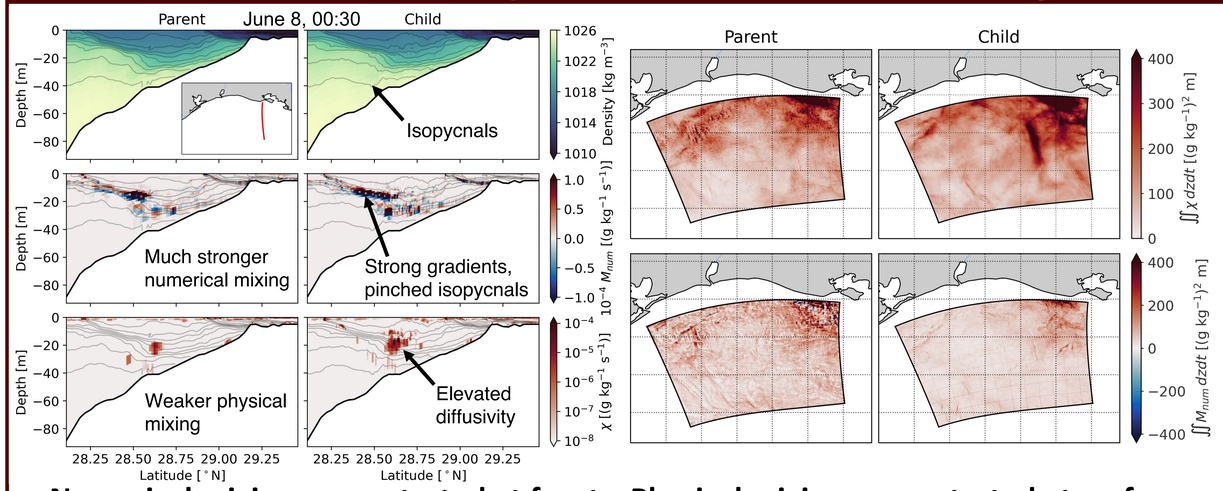
II. Impacts of model nesting: Surface hydrodynamic processes



- Vorticity skewed cyclonically with anticyclonic median; divergence skewed negatively with positive median; Strain follows χ distribution
- PDFs similar for the entire water column, but more Gaussian
- Salinity gradient magnitude nearly unchanged

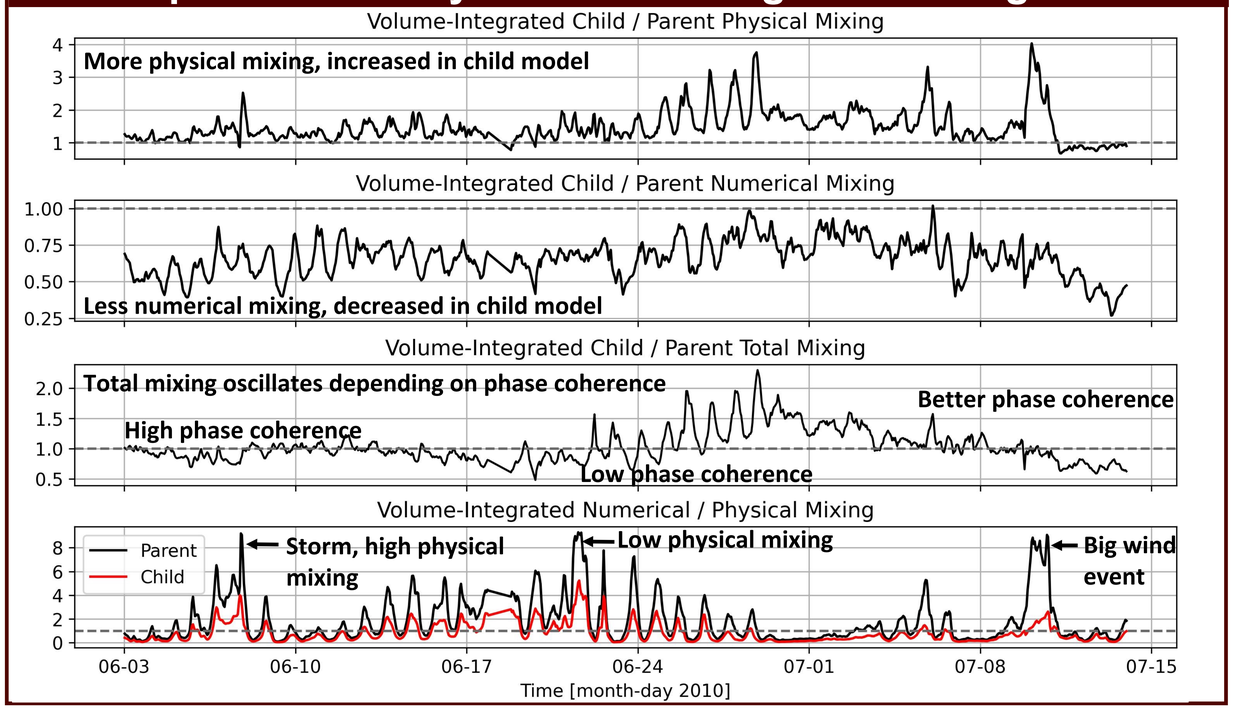
Nesting sharpens velocity gradients, reduces size of frontal eddy filaments

III. Spatial structure of physical and numerical mixing



Numerical mixing concentrated at fronts; Physical mixing concentrated at surface

IV. Temporal variability of volume integrated mixing



V. Conclusions

- We use a realistic, submesoscale resolving, two-way nested model of the TXLA shelf to characterize physical and numerical mixing online
- Numerical mixing exceeds the physical mixing for much of the simulation in the parent model and is concentrated near strong salinity fronts, reduced greatly in child model
- The decrease in numerical mixing is caused by a reduction in size of frontal filaments that have strong horizontal salinity gradients

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