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

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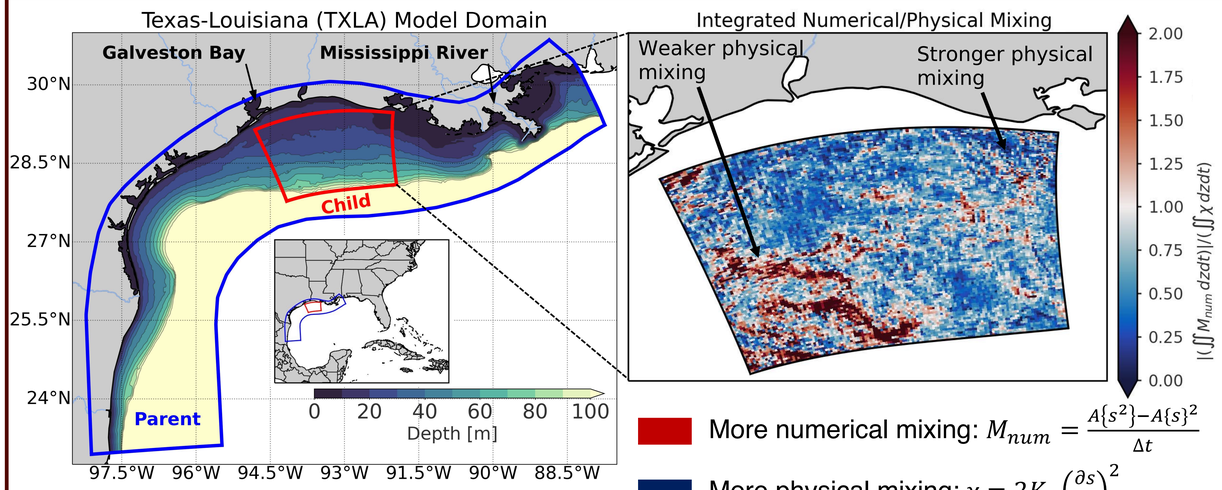
OCEANOGRAPHY

## I. Background and motivation




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

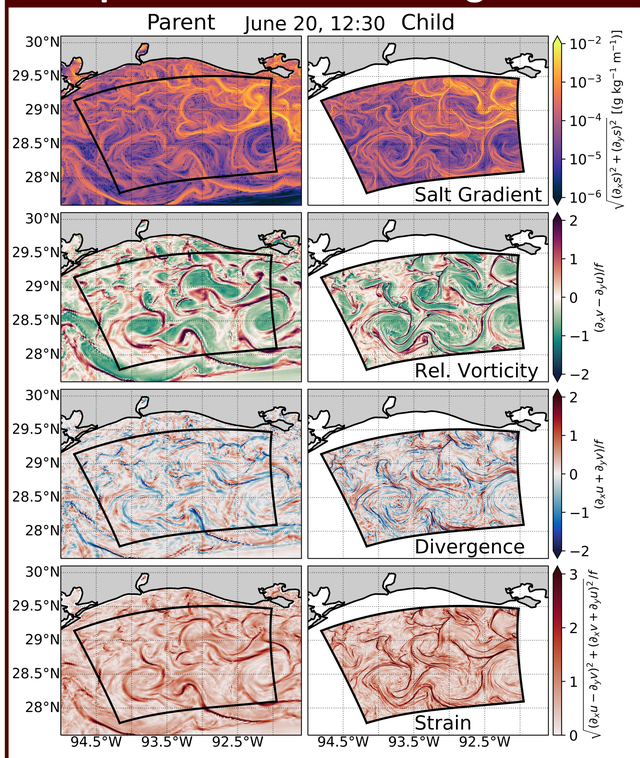
More physical mixing: $\chi = 2K_v \left(\frac{\partial s}{\partial z}\right)^2$

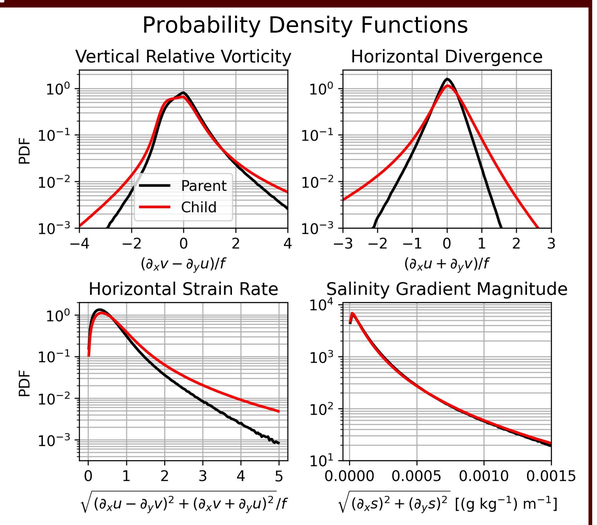
- Realistic ROMS model; two-way nesting
- Parent resolution ~1600 m, child ~300 m
- 41 Day simulation: June 3 – July 14, 2010

- Numerical mixing = mixing generated by the discretization of advection (Burchard & Rennau, 2008)
- Numerical mixing can be as large as physical 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 processes

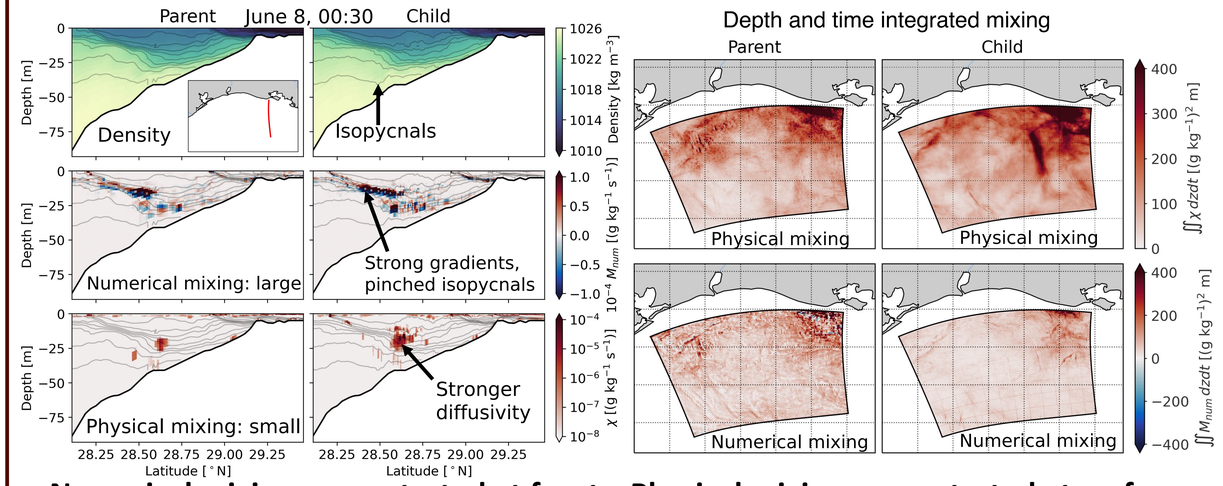



- Vorticity skewed cyclonically with anticyclonic median; divergence skewed negatively with positive median; Strain follows $\chi$ distribution
- PDFs of vorticity and divergence similar for the entire water column, but more Gaussian
- Salinity gradient magnitude nearly unchanged

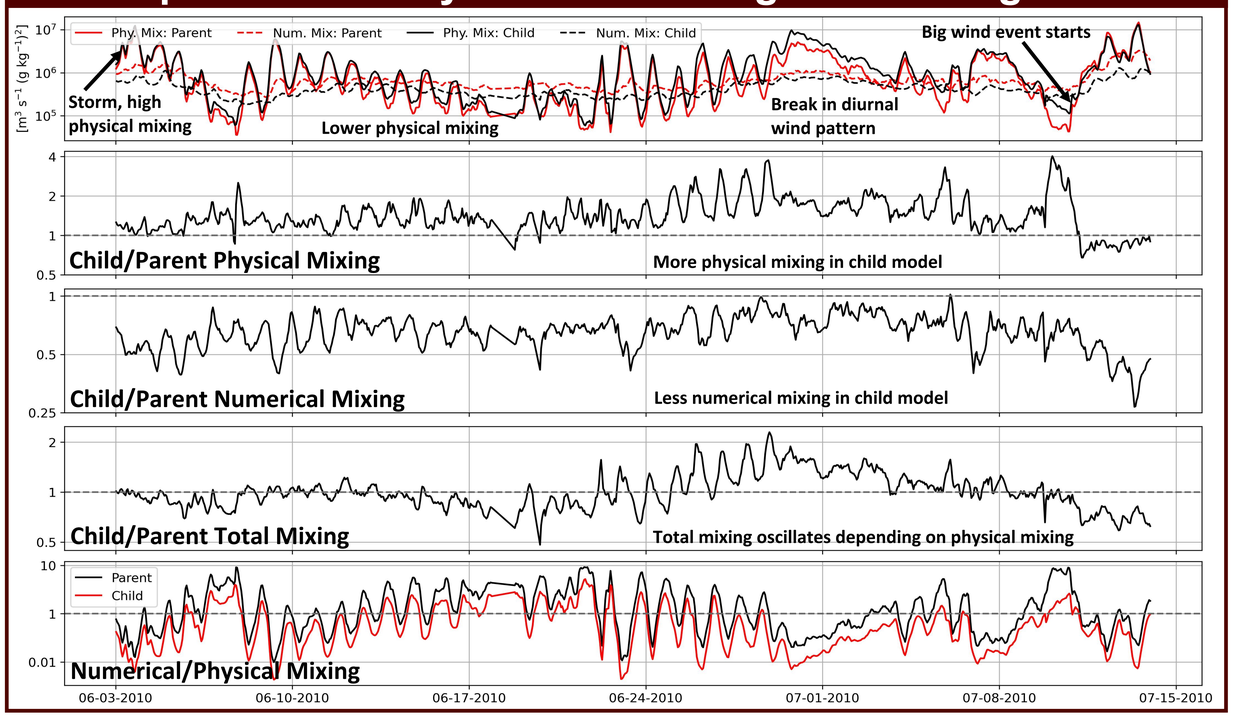
**Nesting sharpens velocity gradients, barely changes salinity gradients**

## 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 in child model
- The decrease in numerical mixing and increase in physical mixing in the child model is caused by better resolution of processes associated with submesoscale fronts

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