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Simulations of the Denmark Strait Overflow in Eddy-Permitting and Eddy-Resolving Setups

KEY POINTS

- At the sill section in Denmark Strait, dense water at depth descends down the slope, watermasses further up the water column flow over the **Greenland shelf** and join the overflow further downstream.
- Conventional definition of plume ($\rho \geq 27.8$) ignores the entrained lighter density water, thus underestimates the plume **transport.**
- Eddy kinetic energy (eke) gained through baroclinic instabilities increases rapidly with resolution. Mostly eddies transfer energy to **mean flow.**
- Energy transfers have similar spatial patterns for all simulations, magnitudes **increase** with increasing resolution.

INTRODUCTION

- More than half of the Arctic water flowing into North Atlantic passes through Denmark Strait
  - Important part of the lower limb of Northern part of the AMOC
- Small Rossby radius + localized flow → hard to represent in numerical models with coarse resolution
- In this study, effects of horizontal resolution on representing the overflow is investigated.

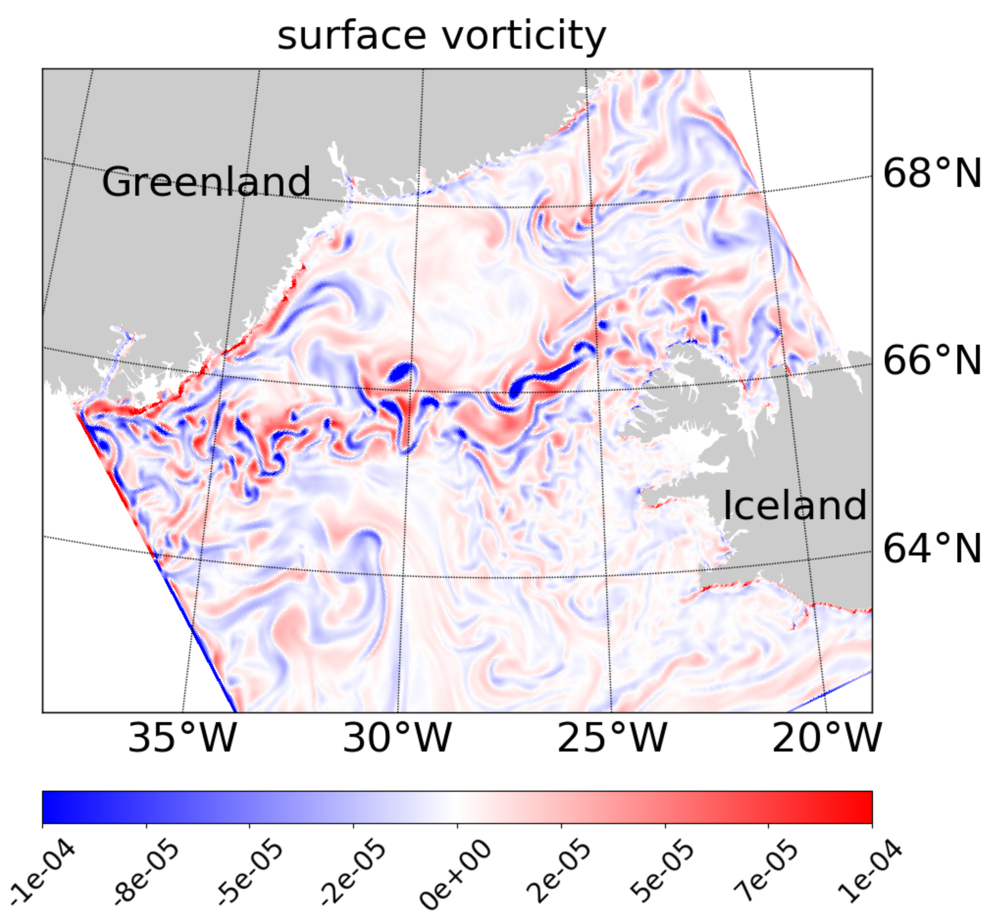


Figure 1: Snapshot of surface vorticity from 2km simulation

METHODOLOGY

Model

- 1 year long simulation in a regional setup (MITgcm)
- Horizontal resolutions: 4km, 2km, 1km
- Vertical resolution is unchanged

Analysis

- Dense water on the sill is marked with passive tracer concentration $\tau = 1$, Plume $= \tau \geq 0.2$
- Energy transfer from mean kinetic energy (mke) to eddy kinetic energy (eke):

$$\overline{u_h' \cdot (u' \cdot \nabla \overline{u_h})}$$ u_h=horizontal velocity

- Energy tansfer from eddy available potential energy (epe) to eke: $\overline{w'b'}$

w=vertical velocity
b=buoyancy

MODIFICATION OF THE PLUME

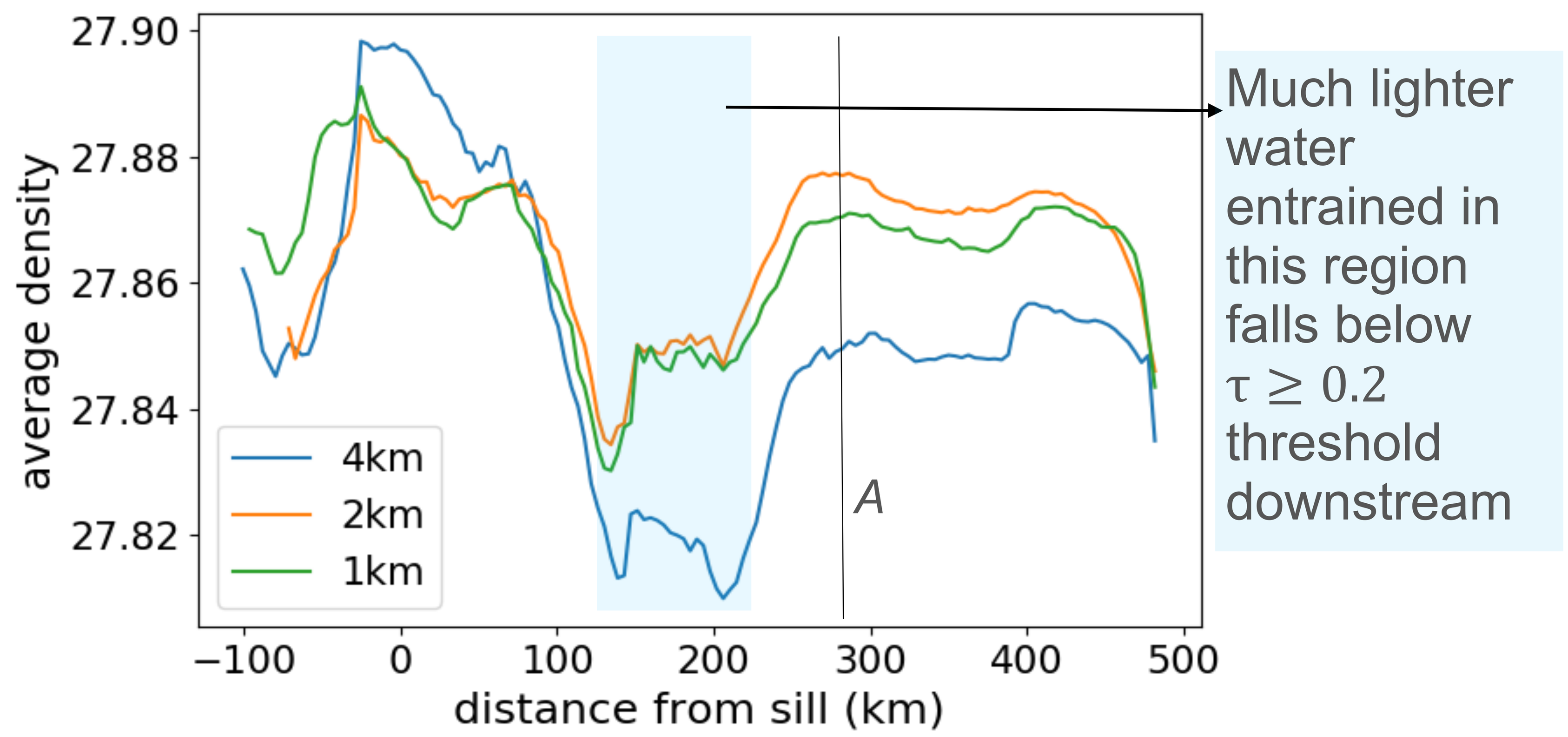
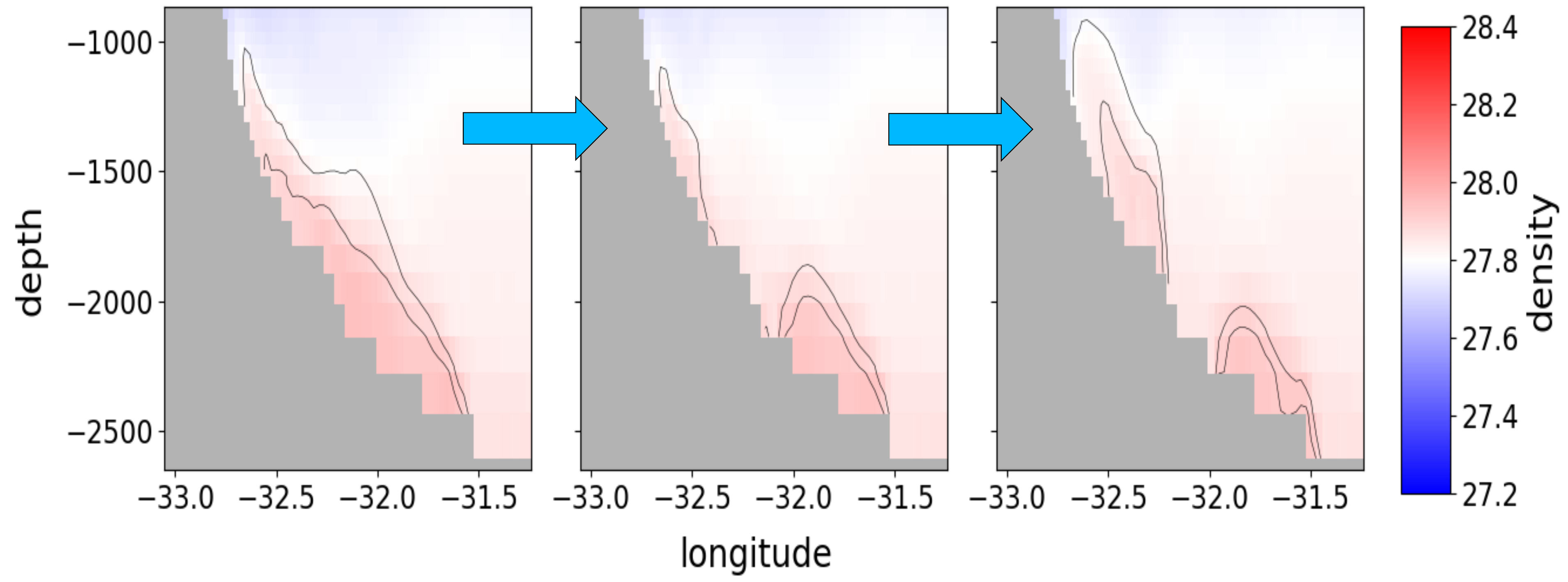


Figure 2: Average density along the plume path, vertical line indicates the section for figure 3

Figure 3: Consecutive snapshots of density fields and passive tracer contours ($\tau = 0.6, 0.3$) for 4km simulation along the section A



plume arrives at the section, deeper part of the dense water has lower velocities

plume is divided; the dense part starts to sink while the rest of the plume masses is transported downstrream

New dense water masses arrive, total amount of dense water is increased, average density increases

ENERGY TRANSFERS

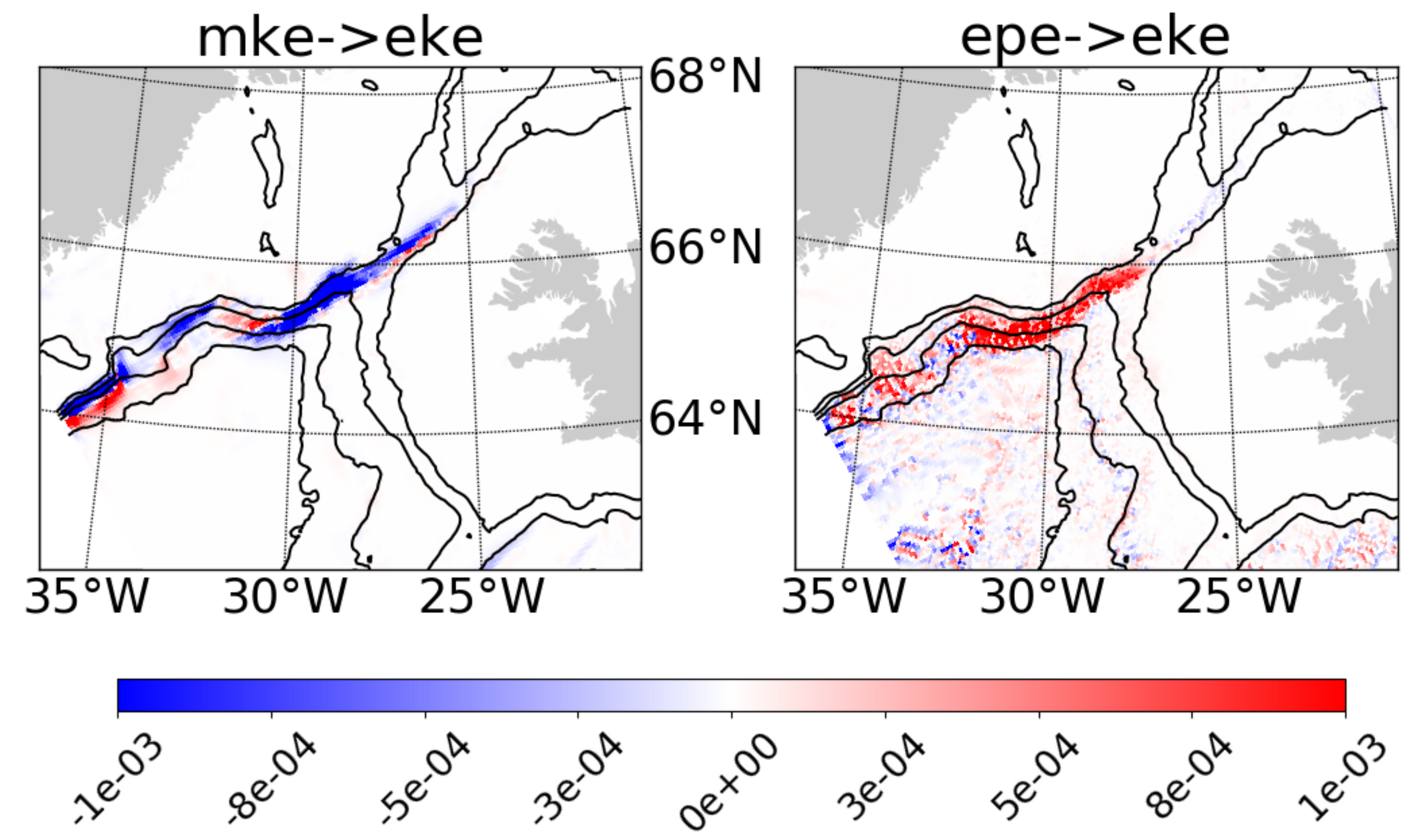


Figure 4: Depth integrated energy transfers for 4km simulation averaged over 1 year

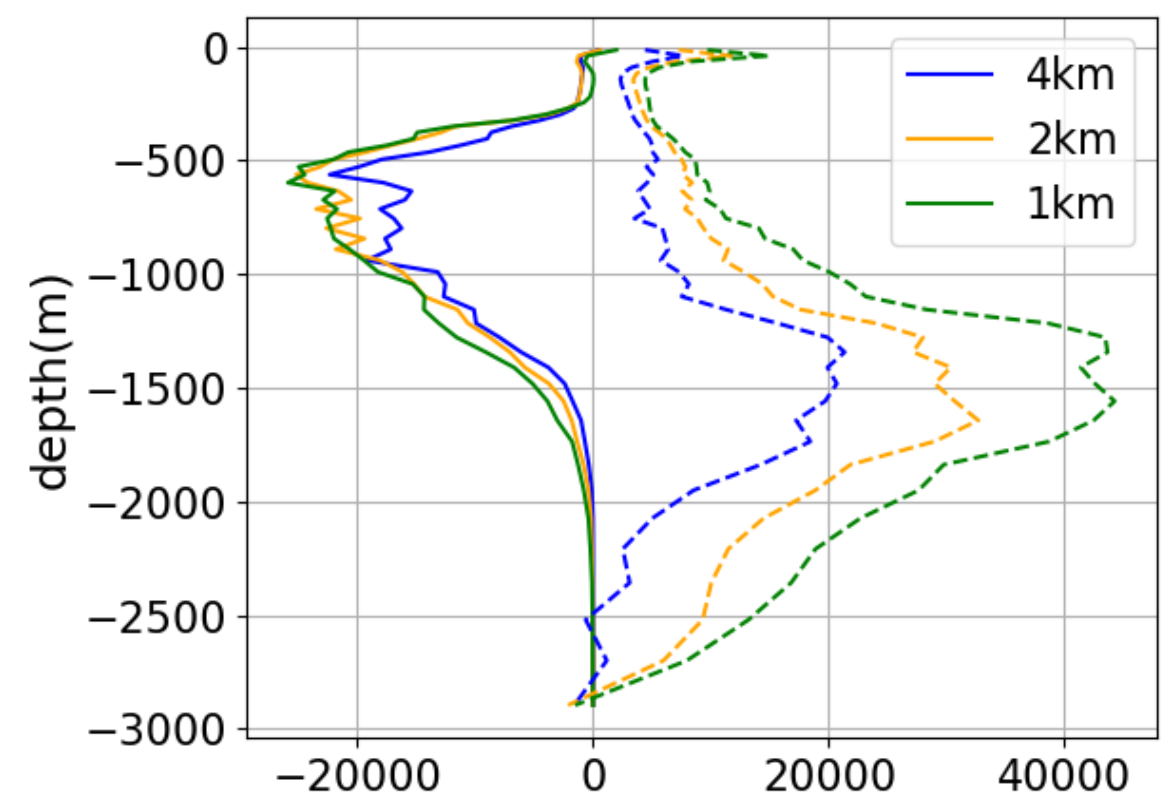


Figure 5: horizontally integrated profiles of energy transfer for mke →eke (solid lines) and epe→eke (dashed lines) averaged over 1 year

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