Concurrent development of benthic storm and bottom mixed layer underneath an eddying surface-concentrated zonal jet

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QUESTIONS

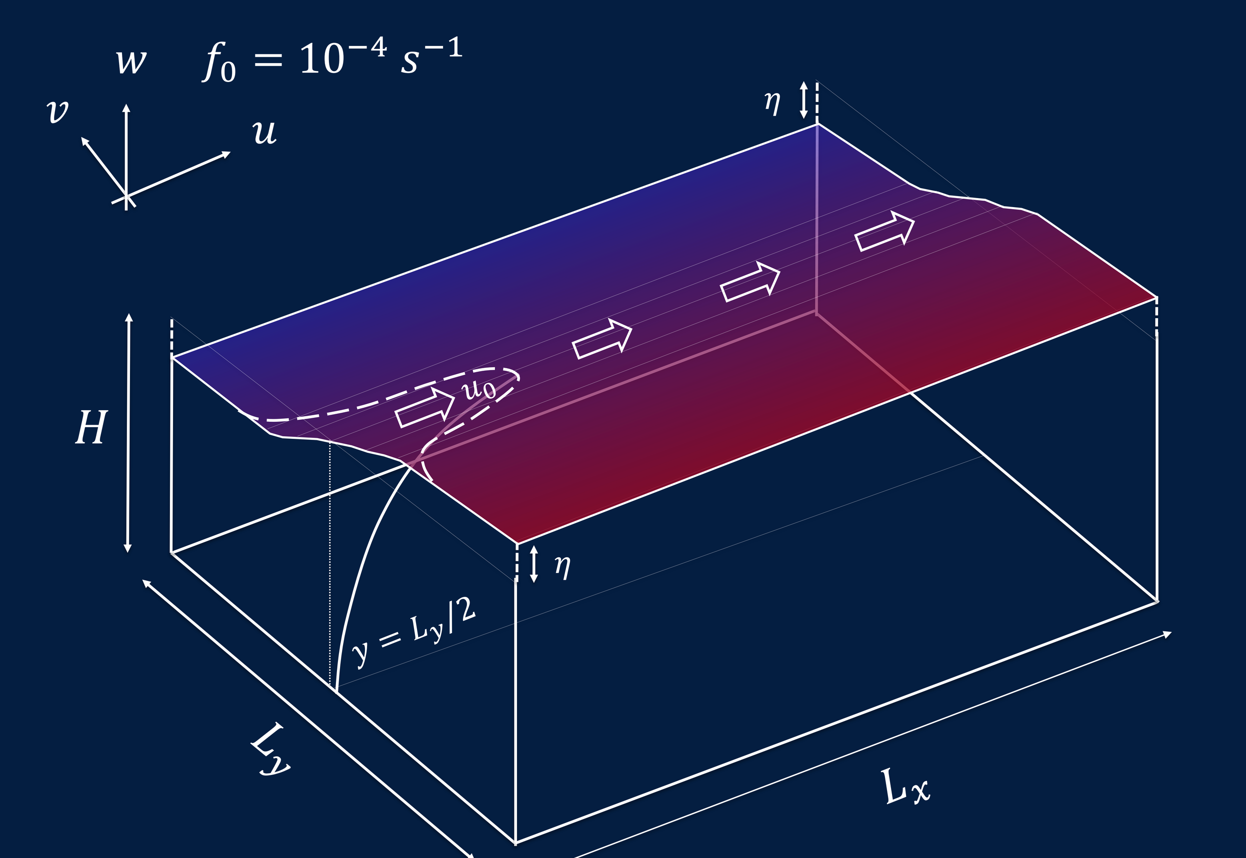
With increased bottom resolution, can an eddying zonal jet induce strong bottom currents (benthic storms) and form a bottom mixed layer? How is energy transferred? What are the characteristics of the resulting bottom boundary layer?

BACKGROUND

Surface current instabilities have been proposed to induce benthic storms via deep cyclogenesis at abyssal depths (e.g. Gardner et al. 2017, Schubert et al. 2018). These features can occur close to the bottom, and it is unclear how strong bottom flows can form underneath an eddying surface current.

MODEL

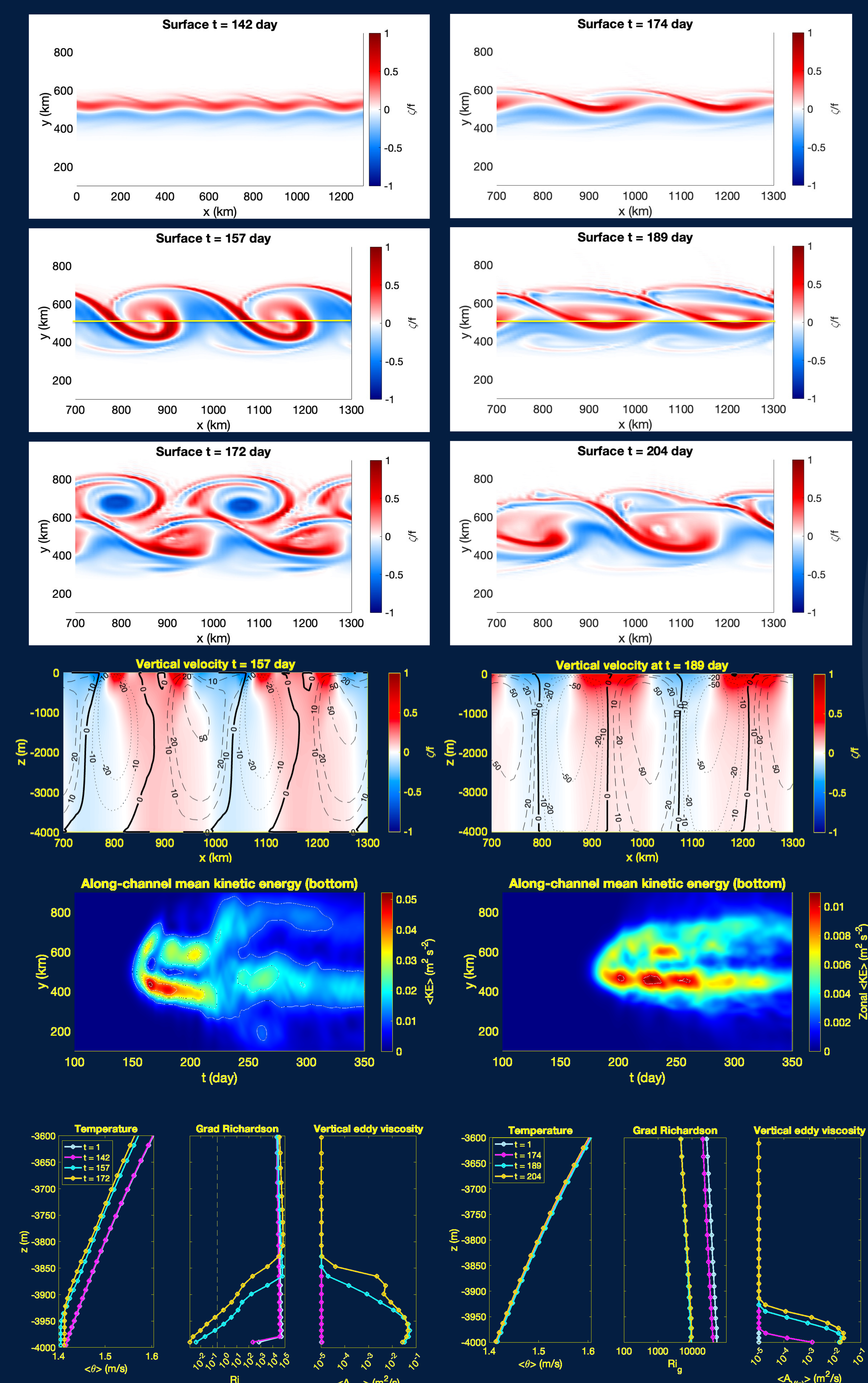
The unforced instability of a surface-intensified zonal jet is simulated using the Regional Ocean Modeling System (ROMS)



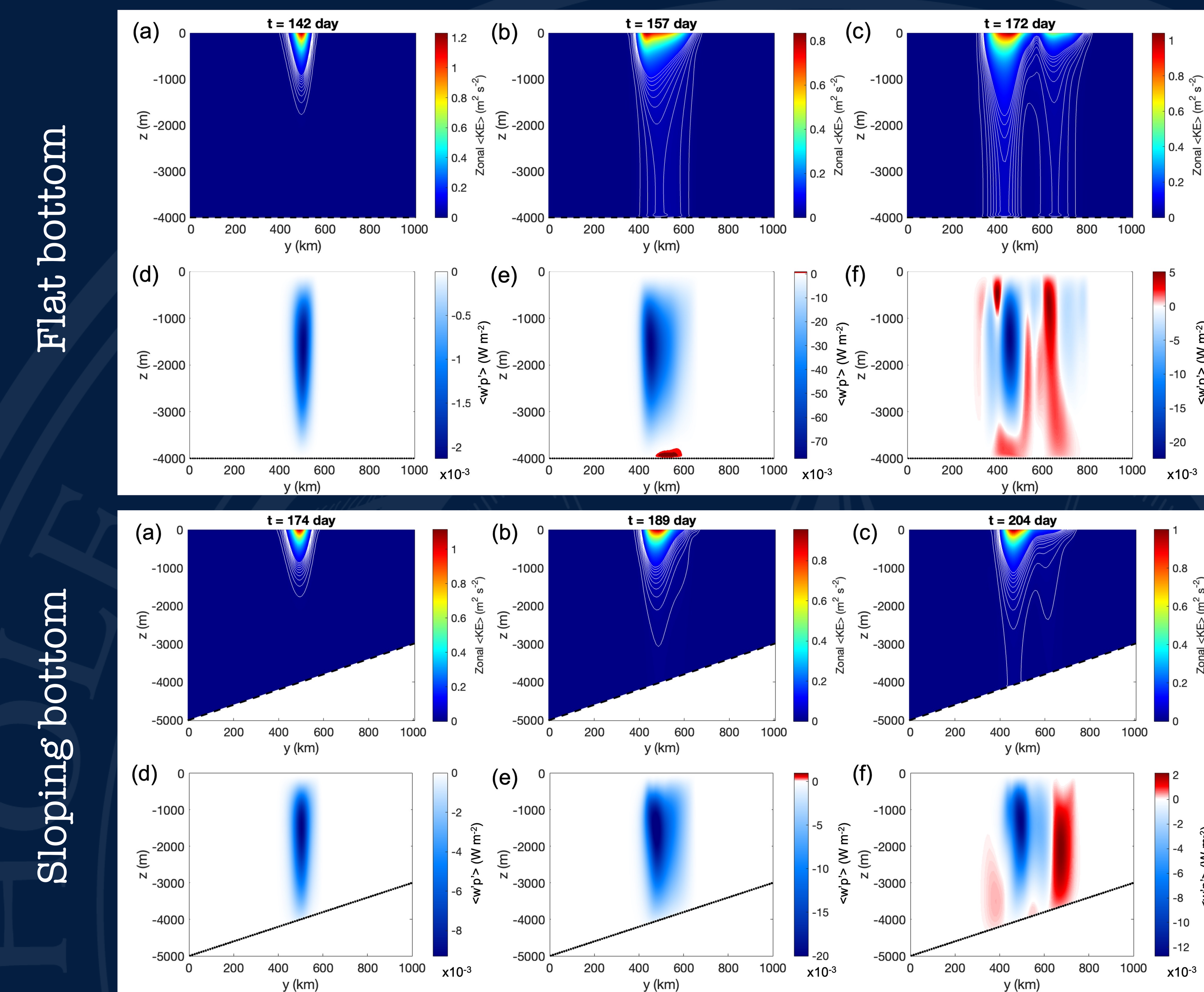
⇒ Configuration: β-plane, flat vs sloping (0.002) topography with 4000 m mean depth, 5 km horizontal grid spacing, 100 vertical levels with increased bottom resolution.

RESULTS

Flat bottom | Sloping bottom



EDDY ENERGY FLUXES



FINDINGS

⇒ Deep vertically coherent vortices form beneath an eddying current as a result of baroclinic instability

⇒ Persistent meanders and deep eddies can induce benthic storms, with stronger horizontal flows on a flat bottom

⇒ An active bottom mixing layer about 50-100 m thick forms underneath with vertical eddy viscosity up to $\mathcal{O}(10^{-2})$ m s^{-2}

⇒ Vertical velocities reach $\mathcal{O}(10)$ m d^{-1} at 5 m.a.b. with a sloping bottom, comparable to sediment particle settling rates

⇒ Downward vertical eddy energy fluxes when surface current is destabilized, with greater fluxes on a flat bottom

ACKNOWLEDGEMENT

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