MPAS-Coastal: A pathway for including coastal ocean dynamics and impacts in ACME V2

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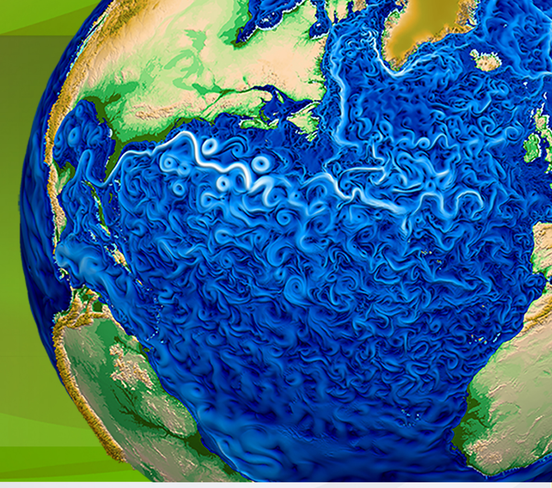
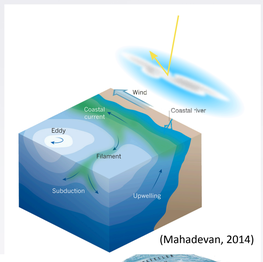


Motivating applications

Coastal California (1000 m scale)

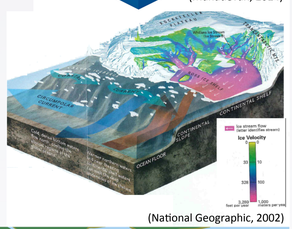
Regional climate on the CA coast is driven by positive feedbacks between surface heat exchanges occurring due to wind-forced coastal upwelling and stratocumulus formation which provides radiative forcing and additional cooling of the atmospheric boundary layer. The ecosystem is dependent upon upwelled nutrients and the ocean-atmosphere coupling.



(Mahadevan, 2014)

Coastal Antarctica (500 m scale)

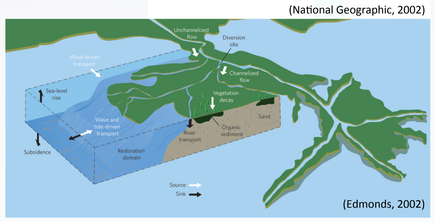
Melt water production in Antarctica is the largest contributor to global sea level rise and is accelerated by small scale, coastal interactions of the land ice sheets and embayment water.



(National Geographic, 2002)

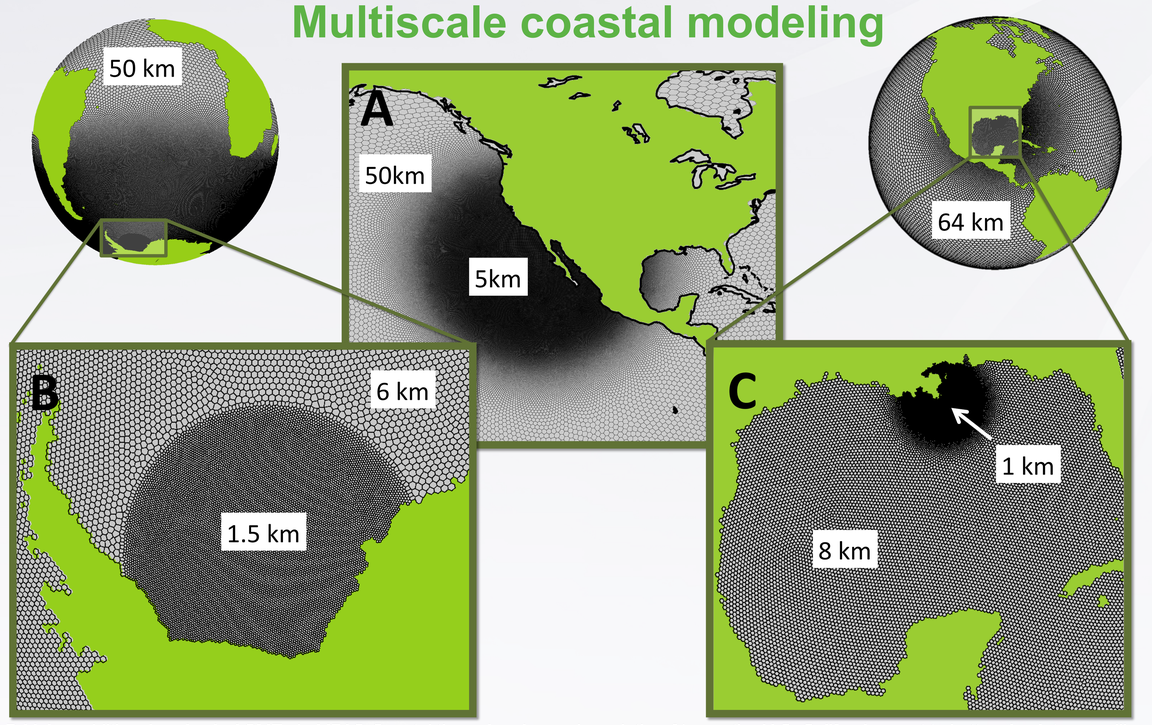
Mississippi River Delta (100 m scale)

Understanding impacts of anthropogenic greenhouse gas emissions and land and river use on coastal biogeochemistry requires a multi-scale, coupled coastal model capable of simulating sea level rise, storm surges, inundation, and sediment transport.



(Edmonds, 2002)

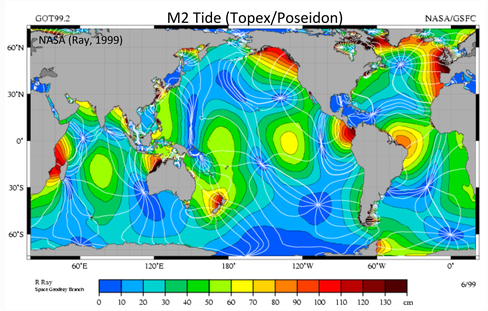
Multiscale coastal modeling



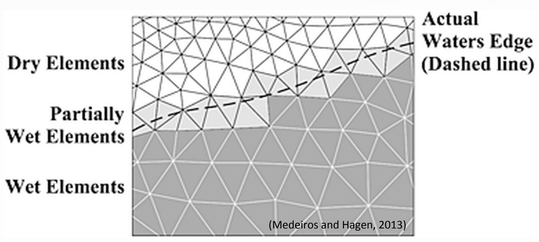
Bridging additional scales in ACME via MPAS-Coastal through enhanced resolution **A**) over the U.S. California coast to better simulate upwelling, stratocumulus cloud formation, and complex eddy-mediated mixing of nutrients, **B**) throughout the Filchner-Ronne region to tightly couple land ice, ocean and sea ice interactions driving ice melting which produces strong sea level rise input, and **C**) within the Mississippi Delta to simulate geomorphology, biogeochemistry, and infrastructure impacts.

Developments Required

Tidal model

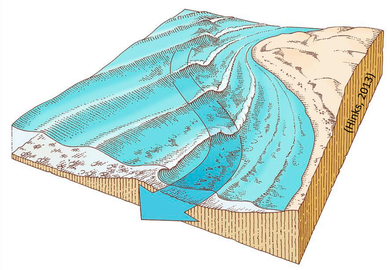


Wetting and drying

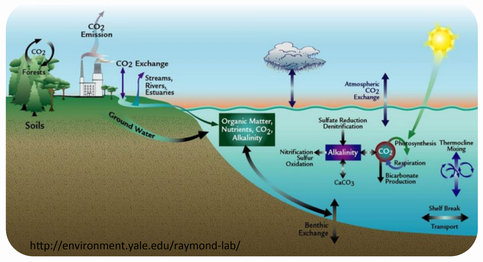


(Medeiros and Hagen, 2013)

Wave model



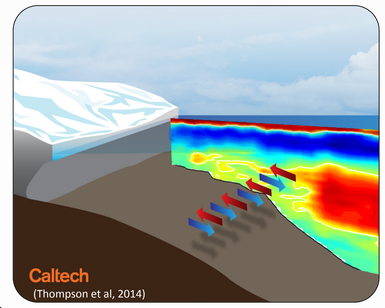
Biogeochemistry



Expected Impact

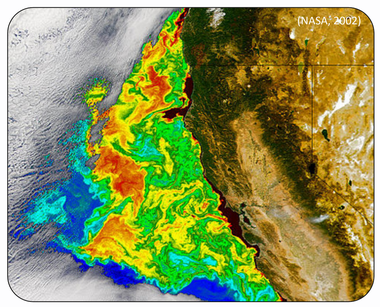
Better representation of global to regional climate via multiscale modeling

Coastal modeling problems fundamentally require a multiscale representation. Large-scales set by the climate system must cascade down to small-scales controlling coastal ecosystems and economies. For example, the biogeochemistry arising from the regional climate on the California coast drives the ecosystem at small-scales, as shown below in chlorophyll concentrations.

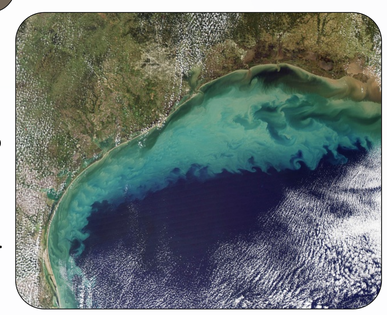


(Thompson et al, 2014)

The Mississippi river delta requires representation of river, delta, coastal, and open ocean scales and their associated feedbacks. Small-scale feedbacks ultimately cascade up to large-scales to set climate forcing via greenhouse gas emissions and freshwater and nutrient fluxes arising from anthropogenic river and land use. Dead zones, shown below, highlight the multiscale nature of coastal modeling.



Ocean - ice sheet interactions, shown above, arise from small-scale regional melting of ice sheets by Southern Ocean waters. Atmospheric feedbacks affect eddy transport and contribute to circulations within Antarctica's embayments. This "heat pump" process depends on mesoscale eddies and requires resolution of small scales. Produced melt water is a substantial contributor to global sea level rise.



ACME Accelerated Climate Modeling for Energy

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