Spatiotemporal variability of air-sea CO2 exchange in the California Current

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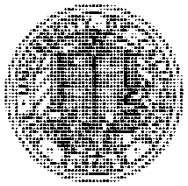

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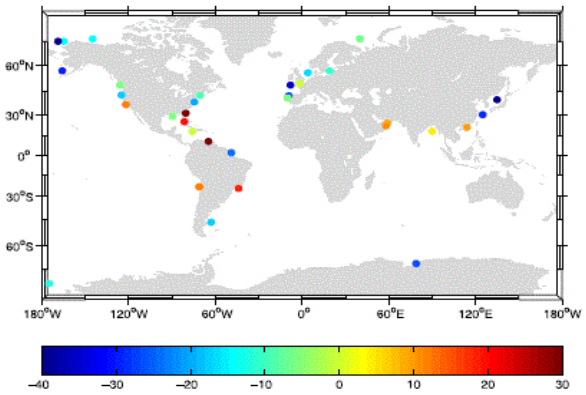
Motivation

Role of EBC regions in global carbon cycle

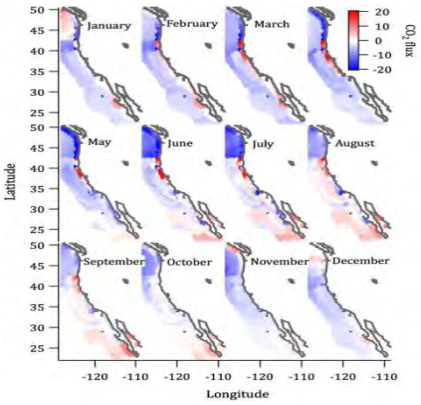
- Carbon exchange difficult to estimate from observations alone.
- Shelf outgassing compensated by primary production offshore.
- Substantial zonal and meridional gradients and variability.

Downscaling from climate to regional models

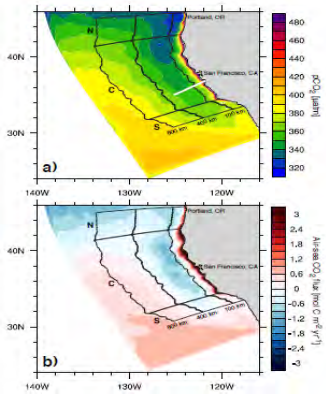
- Impact of horizontal resolution on air-sea CO_2 fluxes
- Implications for estimating net regional carbon budget.



-6 TgC/yr
Cai et al., 2006; Cai, 2011



-14 TgC/yr
Hales et al., 2012



-1 TgC/yr
Turi et al., 2013

Coupled Physical-Biogeochemical Model

Ocean Circulation Model

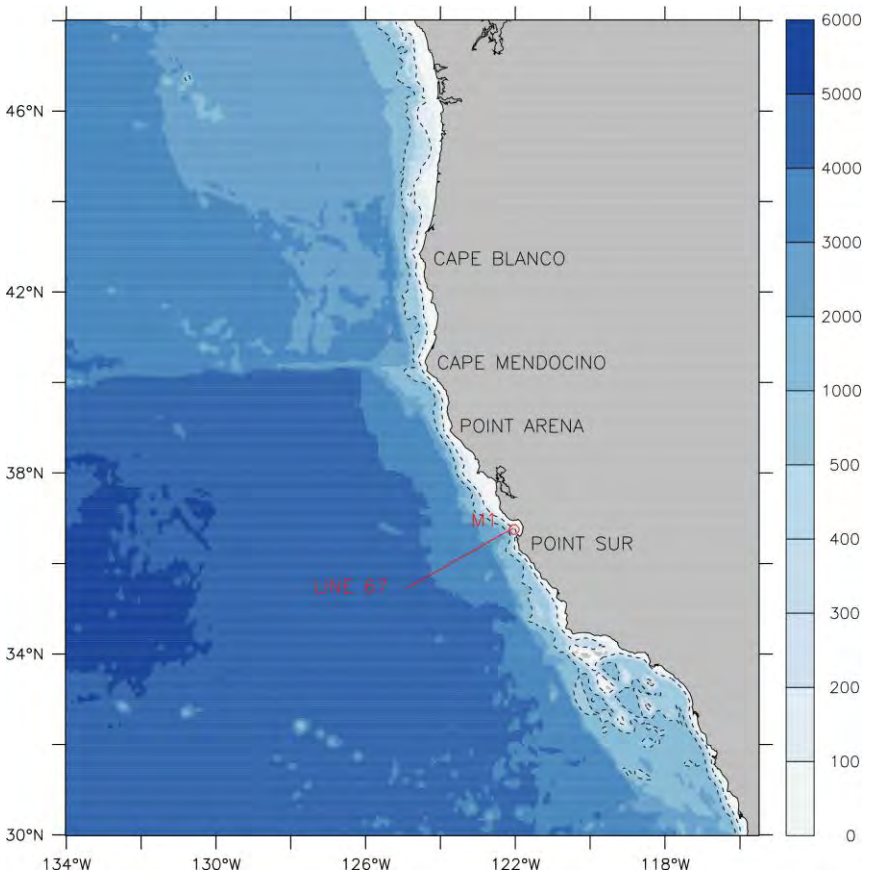
- ROMS
- Resolution: 1/3°, 1/10°, 1/30°
- 42 vertical levels
- BC/IC: SODA, monthly
- Surface: COAMPS, daily

Biogeochemical Model

- NEMURO (3N, 2P, 3Z, 3D)
- DIC, Alkalinity, Carbonate
- OCMIP air-sea CO_2 exchange
- NEMURO BC/IC: WOA, monthly
- Carbon BC/IC: GLODAP, annual

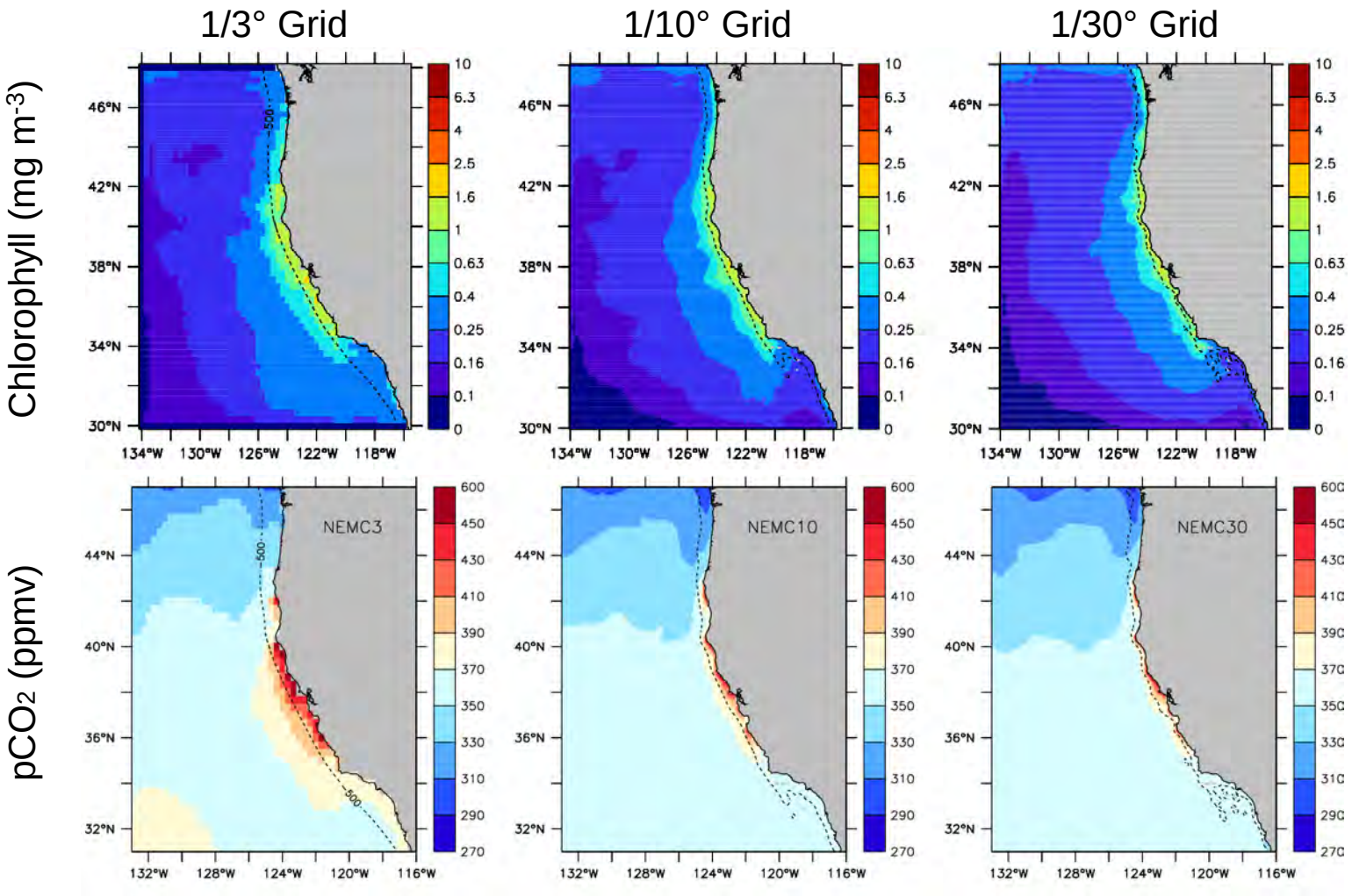
Run duration

- 7 years (1999-2005)



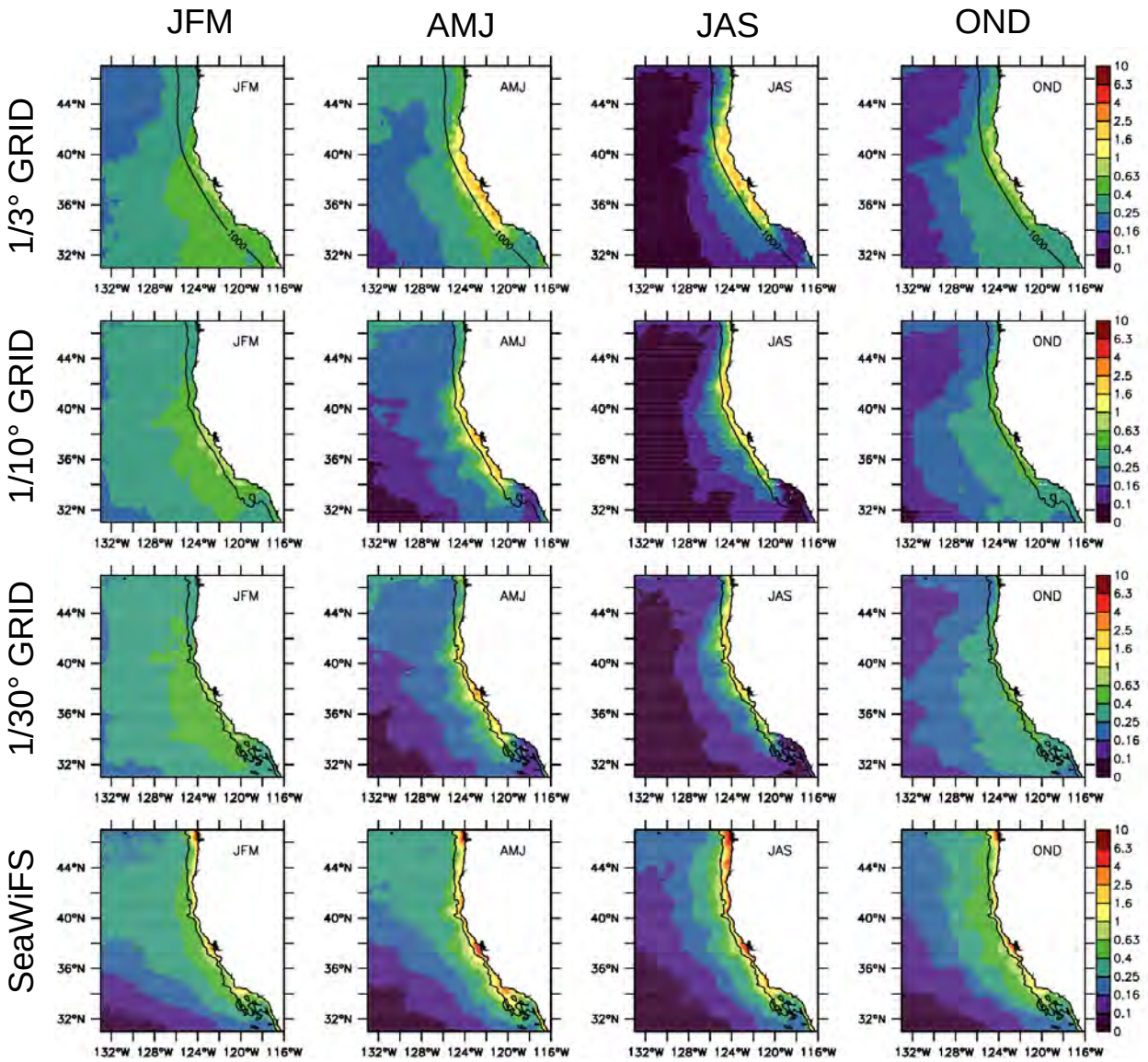
ROMS grid and bottom topography (m)

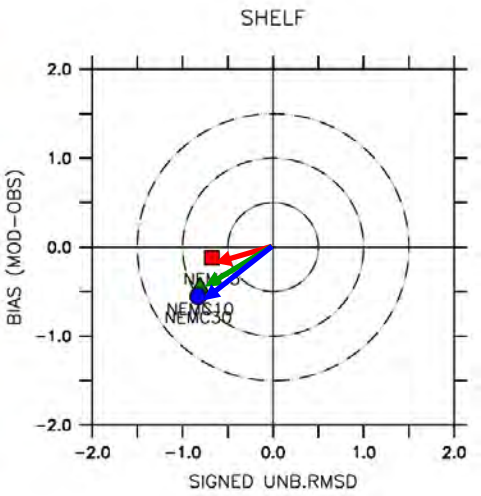
Impact of Horizontal Resolution on Biogeochemistry



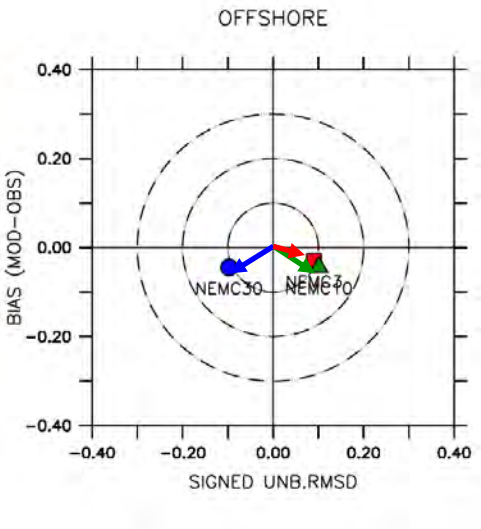
Increasing horizontal resolution decreases width of coastal upwelling and CO_2 outgassing region.

Model-Data Comparison: Surface Chlorophyll

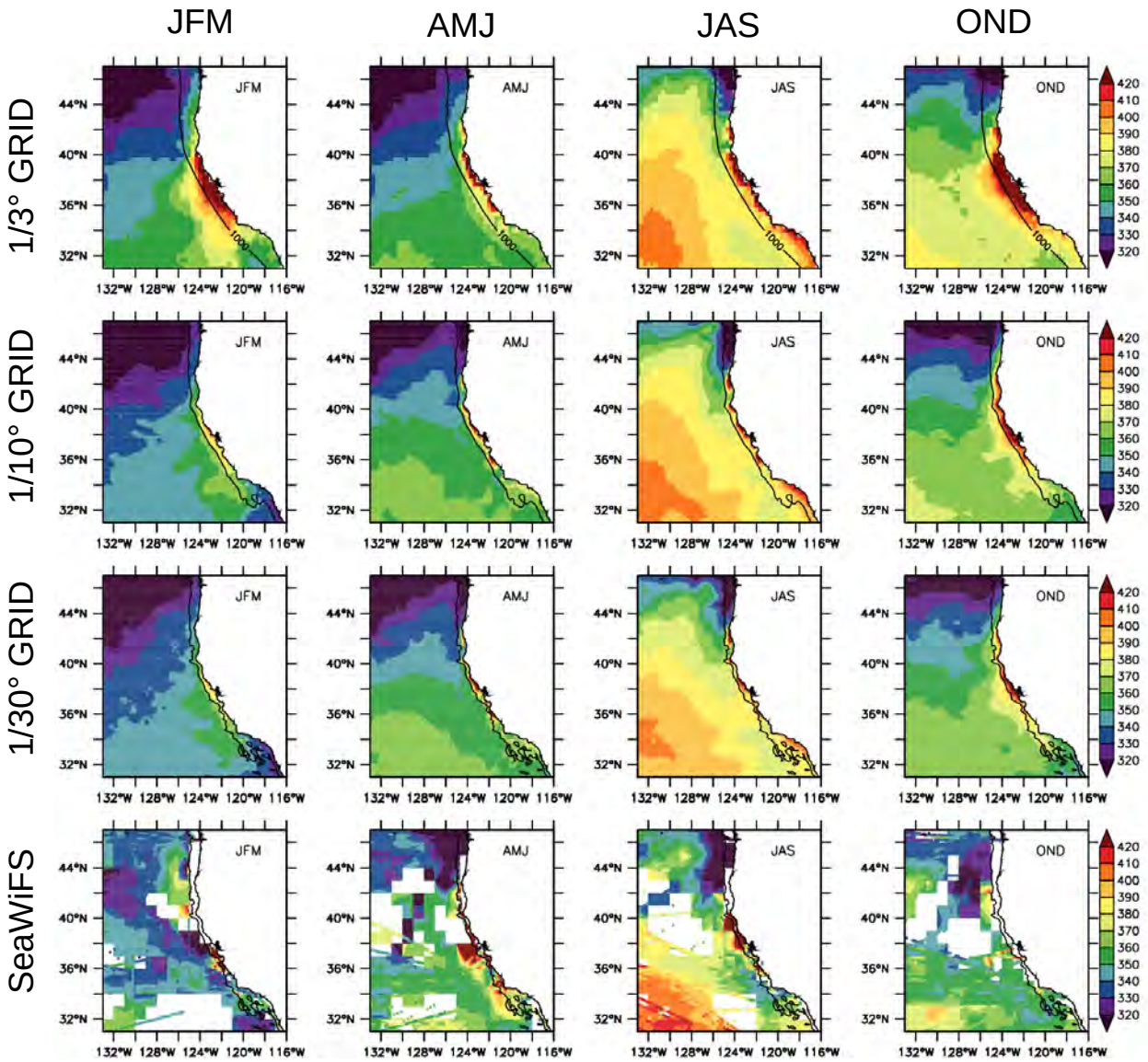


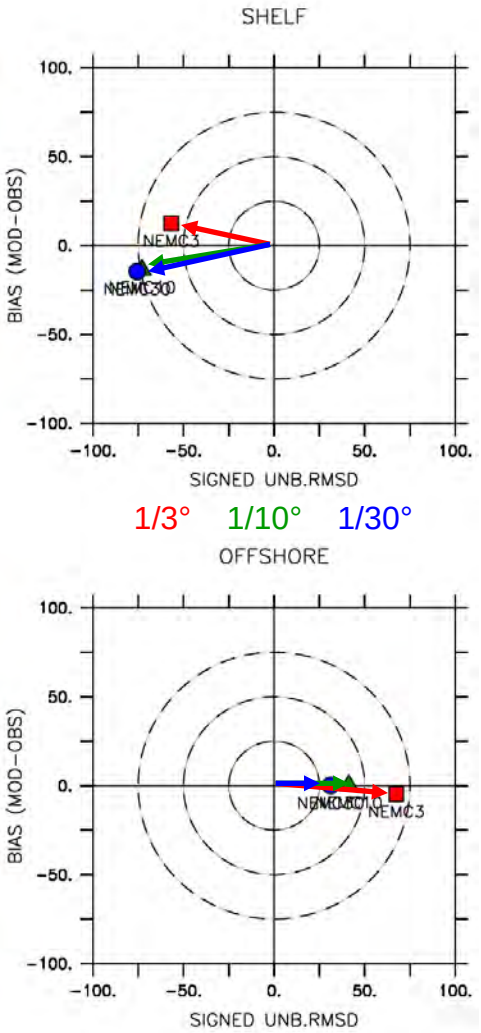


1/3° 1/10° 1/30°

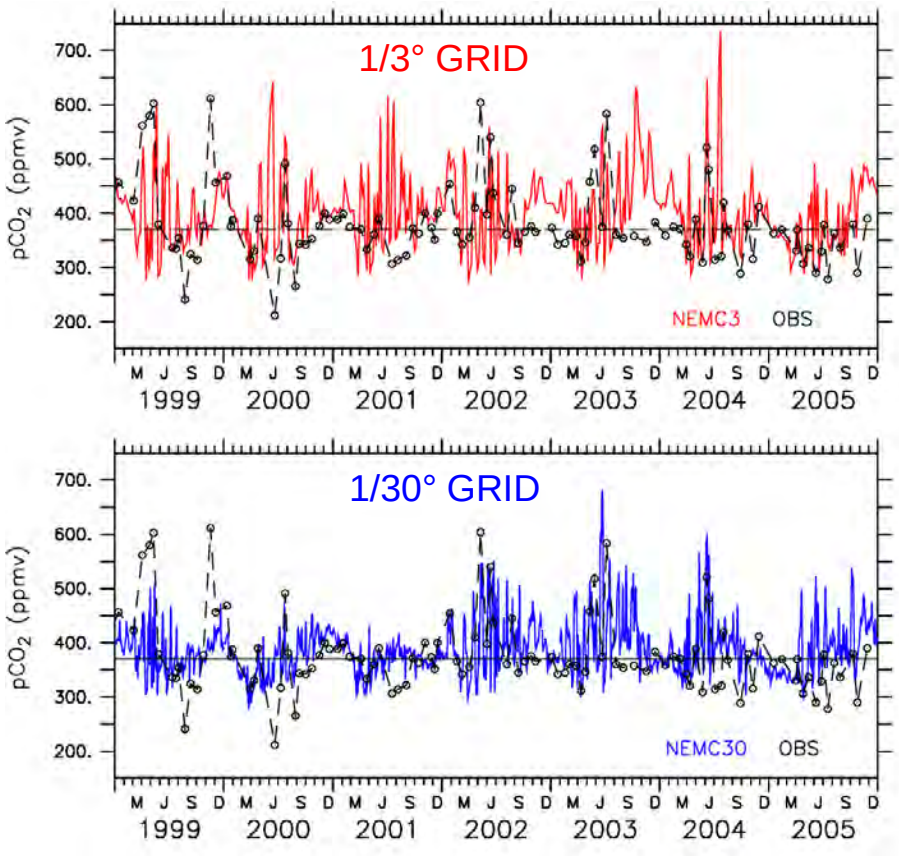


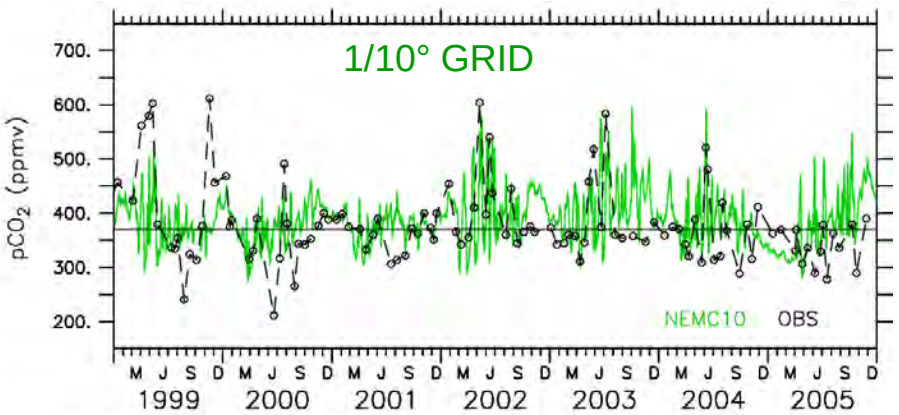
Model-Data Comparison: surface pCO_2

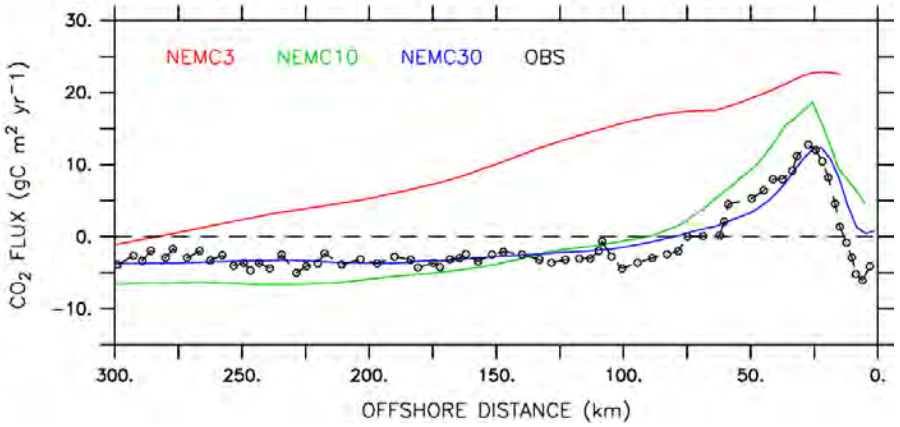




Model-Data Comparison: air-sea CO_2 flux



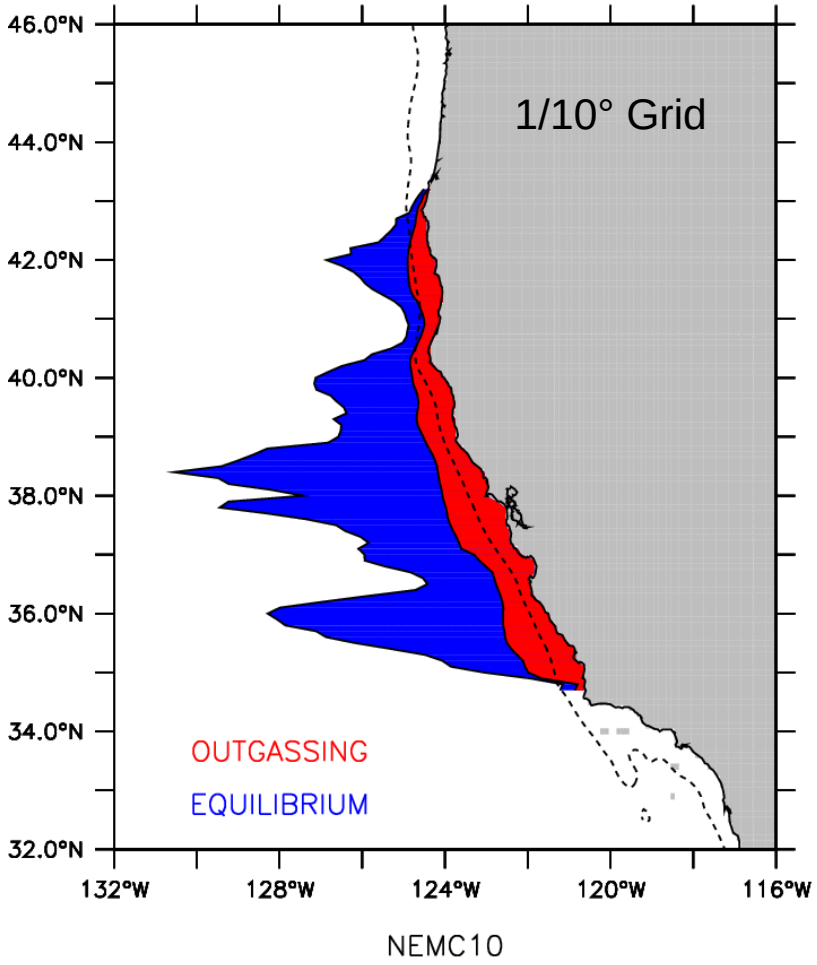


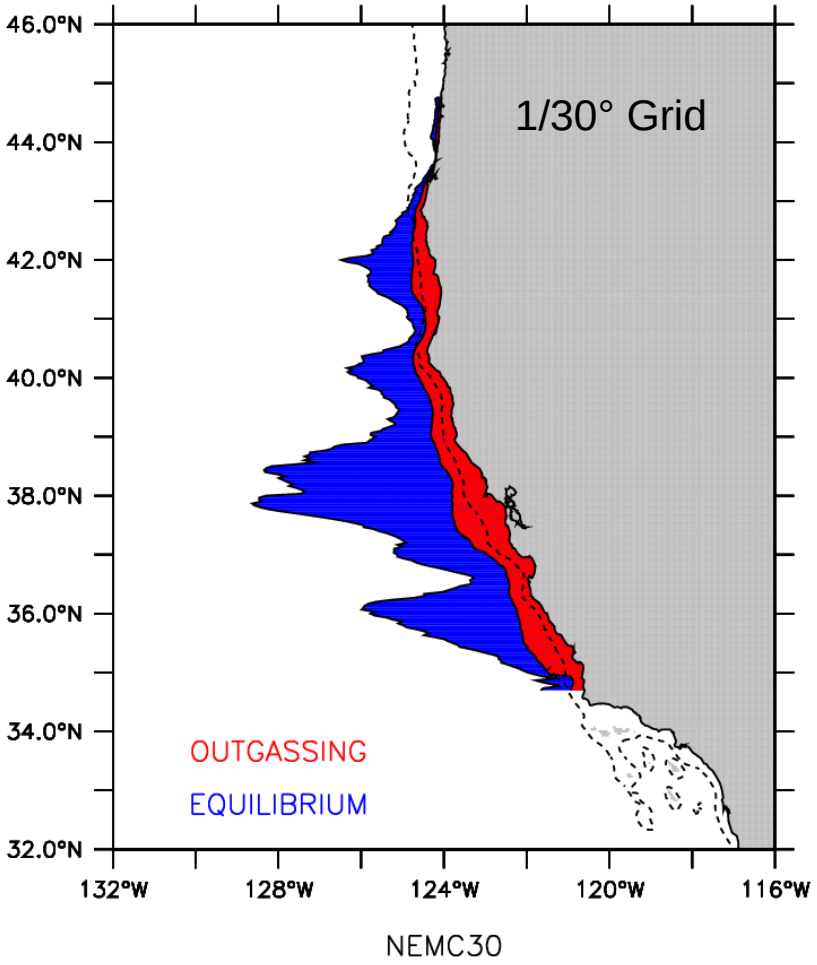


Solutions reproduce daily pCO2 variability at all grid resolutions.

Solution at 1/3° grossly overestimates width of outgassing region.

CCS Outgassing and Equilibrium Regions

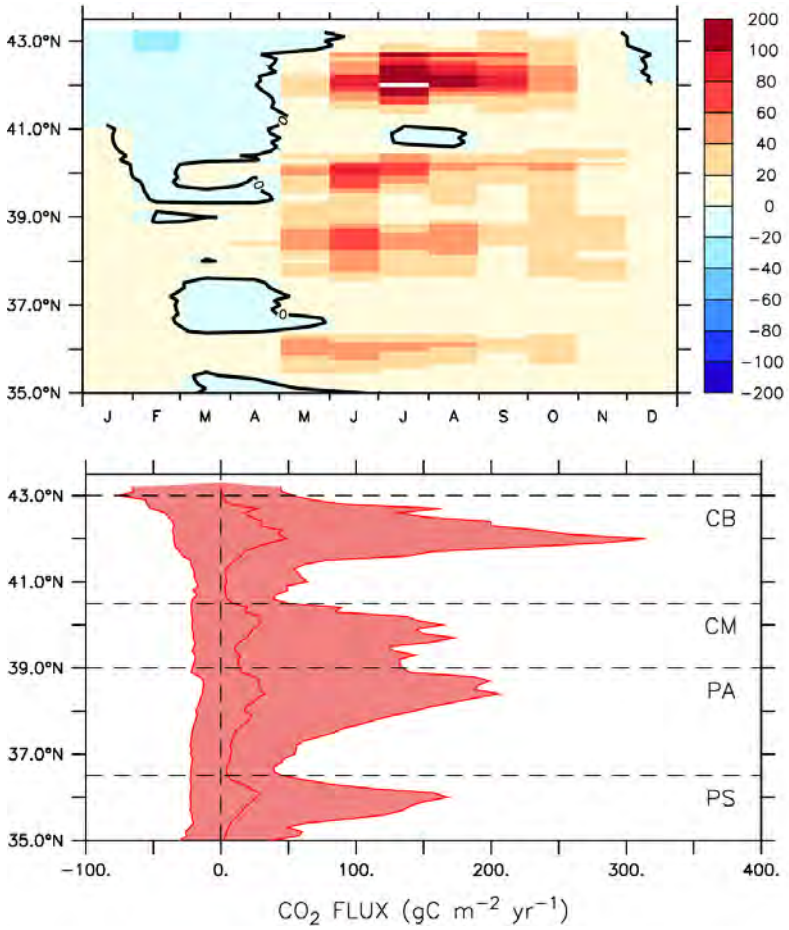




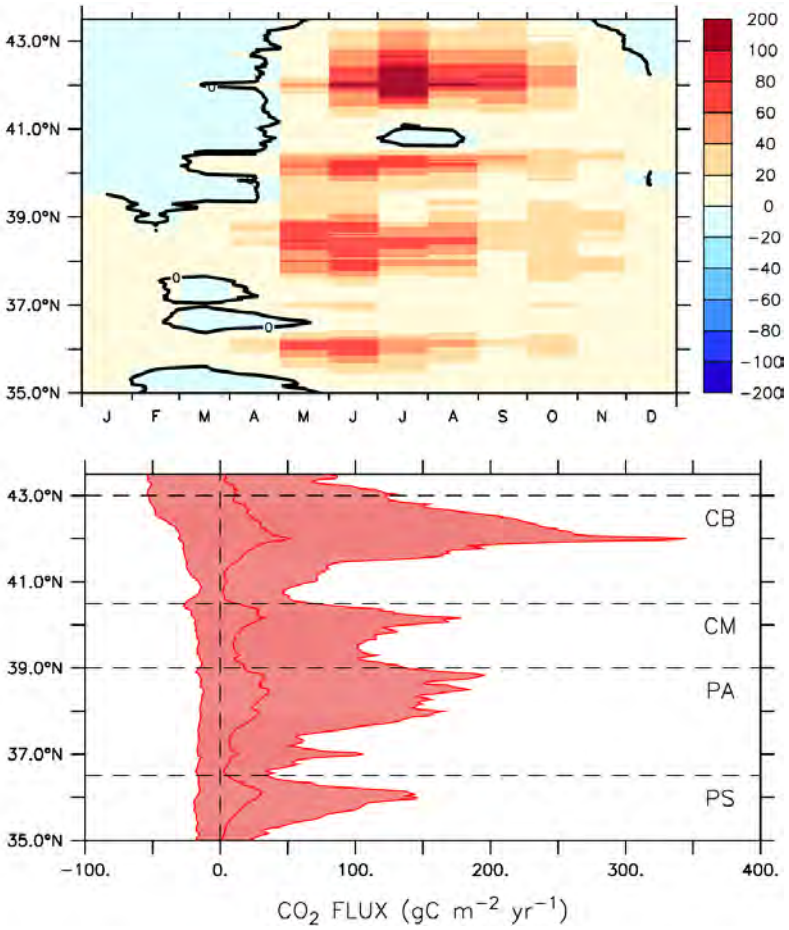
Meridional variability in width of equilibrium region indicates localized enhancement of outgassing condition on the shelf.

CCS Outgassing and Coastal Topography

1/10° GRID

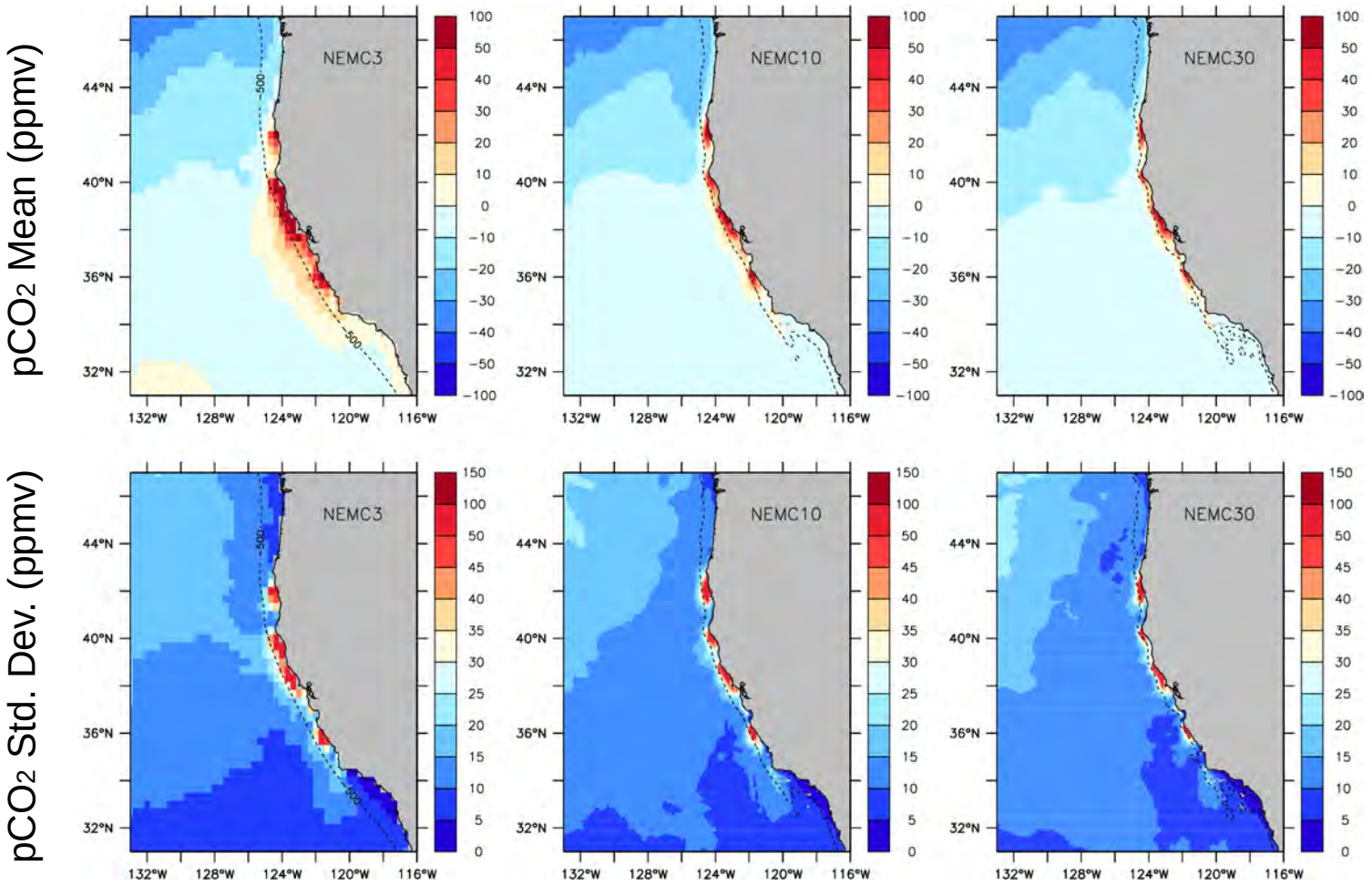


1/30° GRID



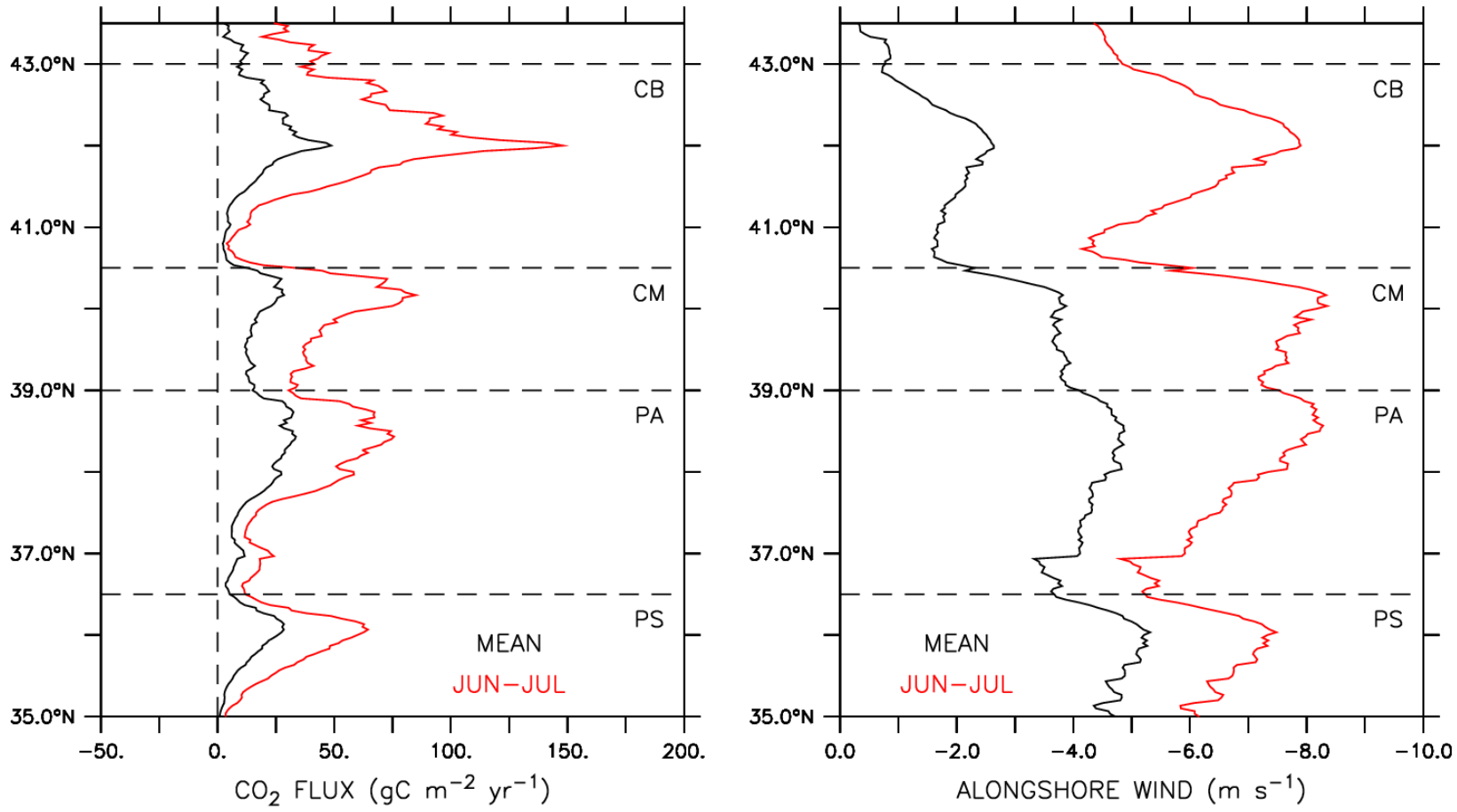
Localized enhancement of shelf outgassing associated with coastline topography (capes).

CCS Outgassing and Coastal Topography



Regions directly equatorward of capes exhibit higher and more variable air-sea CO_2 fluxes.

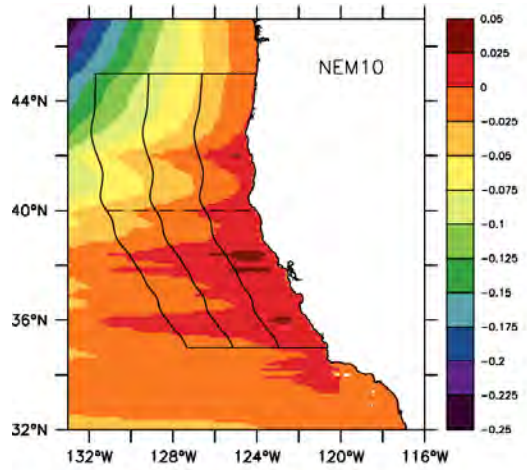
CCS Outgassing and Upwelling Intensification



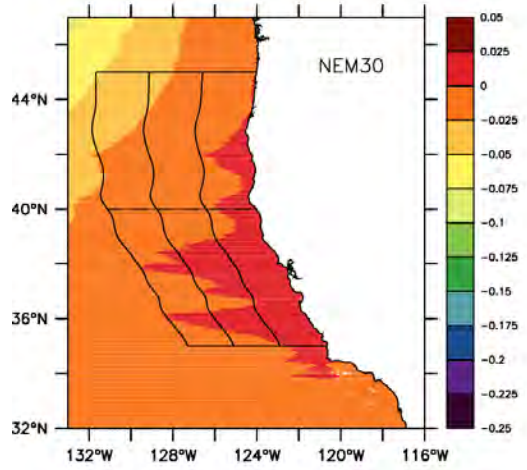
Localized enhancement of shelf outgassing is associated with an intensification of upwelling favorable winds equatorward of capes.

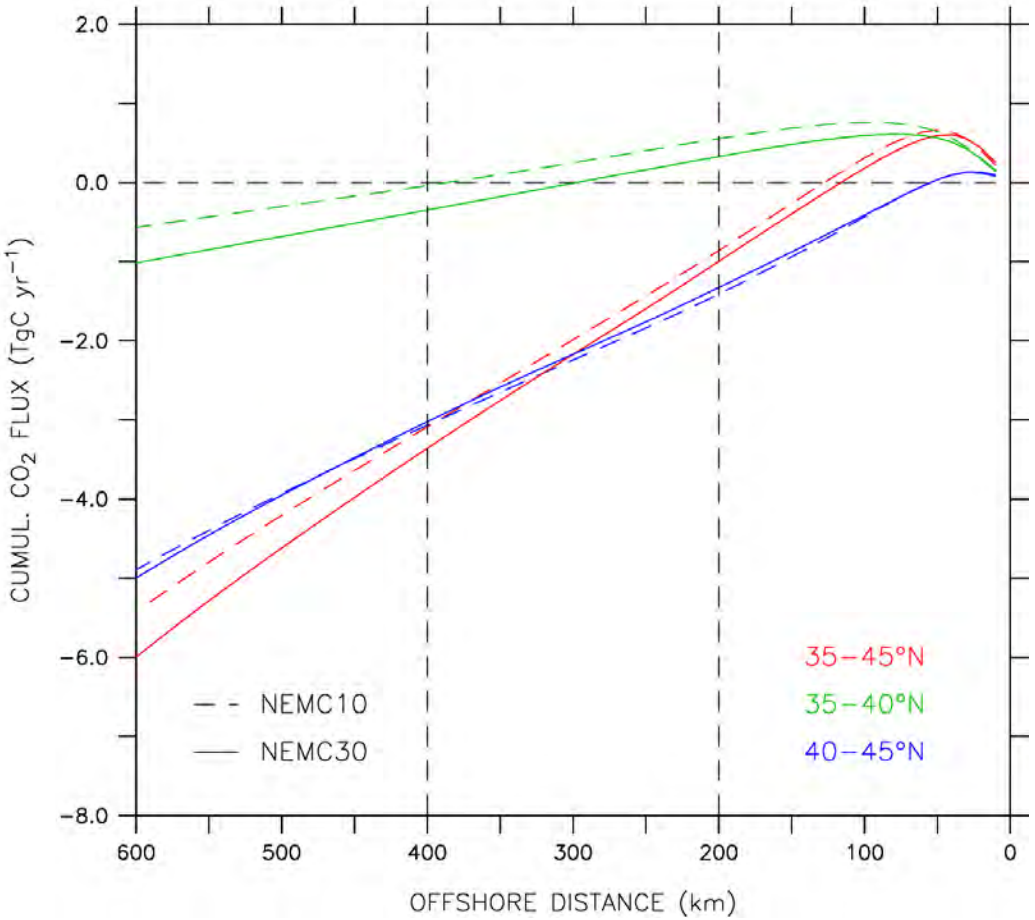
CCS Net Carbon Budget

1/10°



1/30°





Resolution impact most important in southern CCS (35-40°N).

Net carbon budget (600km): sink of 5.4 vs. 6.0 TgC/yr (~10%).

Summary

Role of EBC regions in global carbon cycle

- CO_2 outgassing on the shelf and absorption offshore.
- Equilibrium distance decreases with latitude.

  (35-45N: ~125 km; 35-40N: ~300 km; 40-45N: ~50 km)
- At 600km offshore, CCS is net CO_2 sink of 6.0 TgC/yr.
- Net sink contribution: 20% SoCCS and 80% NoCCS.

Downscaling from climate to regional models

- Zonal resolution important for source-sink transition.
- Meridional resolution important for coastal topography.
- Enhanced localized outgassing equatorward of capes.
- Net carbon exchange at 1/10° is 10% larger than at 1/30°.