

Impact of Horizontal Model Resolution on Air-Sea CO₂ Exchange in the California Current

**J. Fiechter (UCSC), E. Curchitser (Rutgers), C. Edwards (UCSC),
F. Chai (U. Maine), N. Goebel (UCSC), F. Chavez (MBARI)**

Funding: NSF, NOAA/NMFS

Future Meeting, Hawaii, 15 April 2014

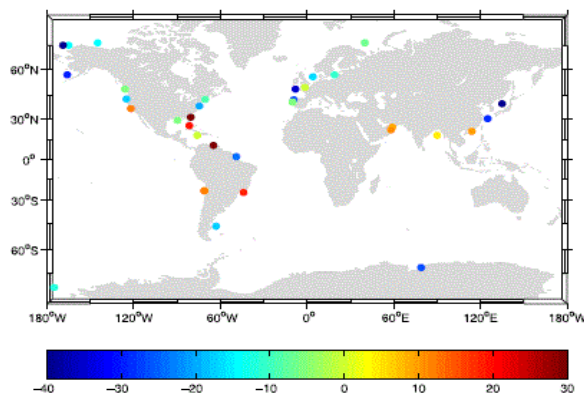
Motivation

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.

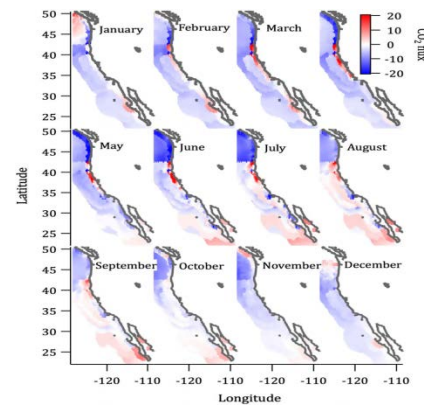
Downscaling from climate to regional models

- Impact of horizontal resolution on air-sea CO₂ fluxes
- Implications for estimating net regional carbon budget.



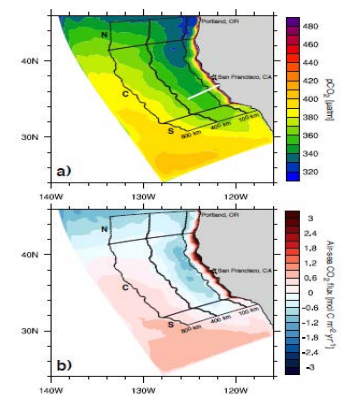
-6 TgC/yr

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

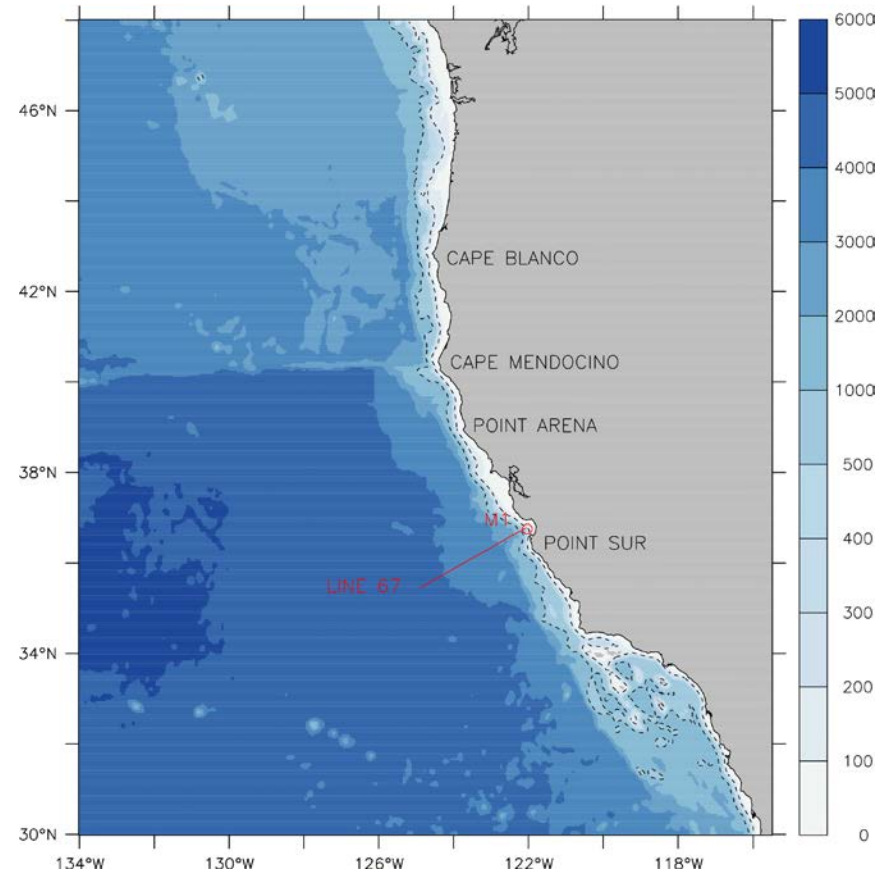
- ROMS
- Resolution: $1/3^\circ$, $1/10^\circ$, $1/30^\circ$
- 42 vertical levels
- BC/IC: SODA, monthly
- Surface: COAMPS, daily

Biogeochemical Model

- NEMURO (3N, 2P, 3Z, 3D)
- DIC, Alkalinity, Ca Carbonate (Hauri et al., 2013)
- OCMIP air-sea CO_2 exchange
- NEMURO BC/IC: WOA, monthly
- Carbon BC/IC: GLODAP, annual

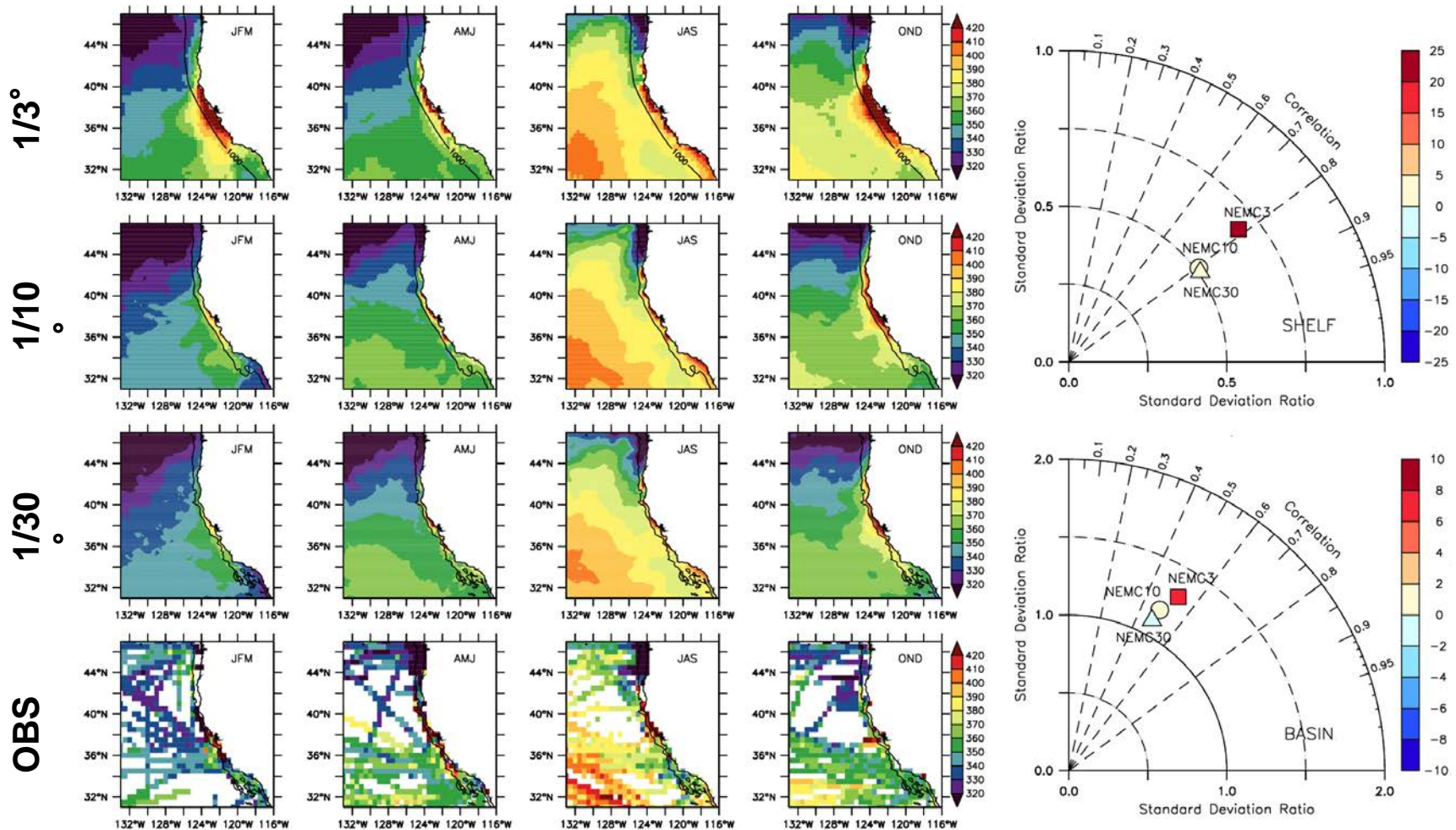
Run duration

- 7 years (1999-2005)



Model domain and bottom topography (m)

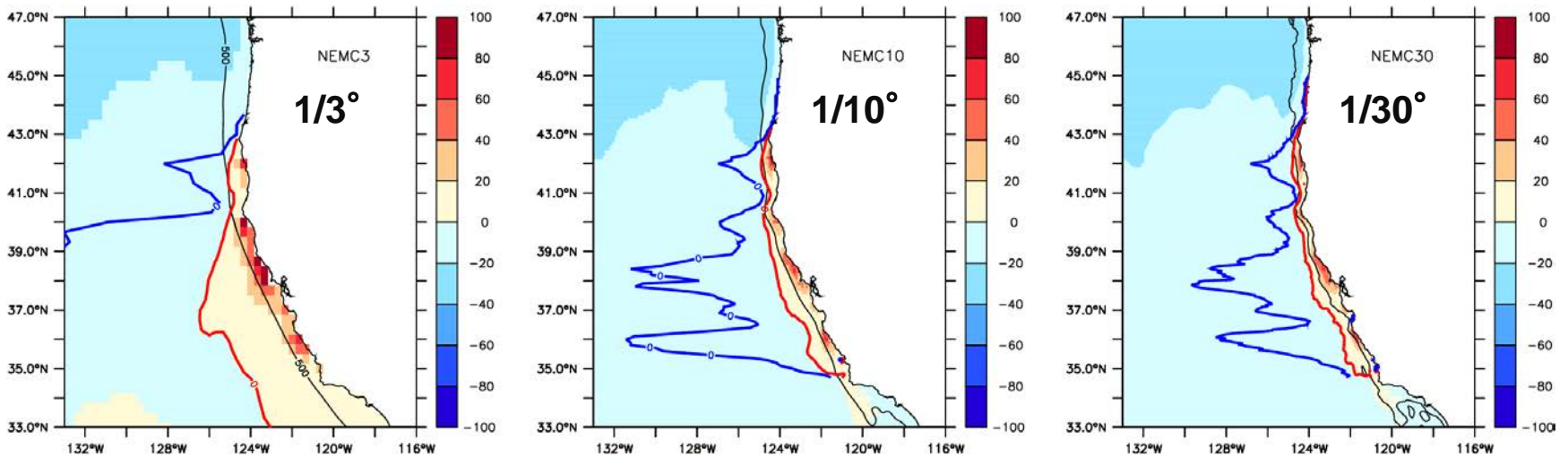
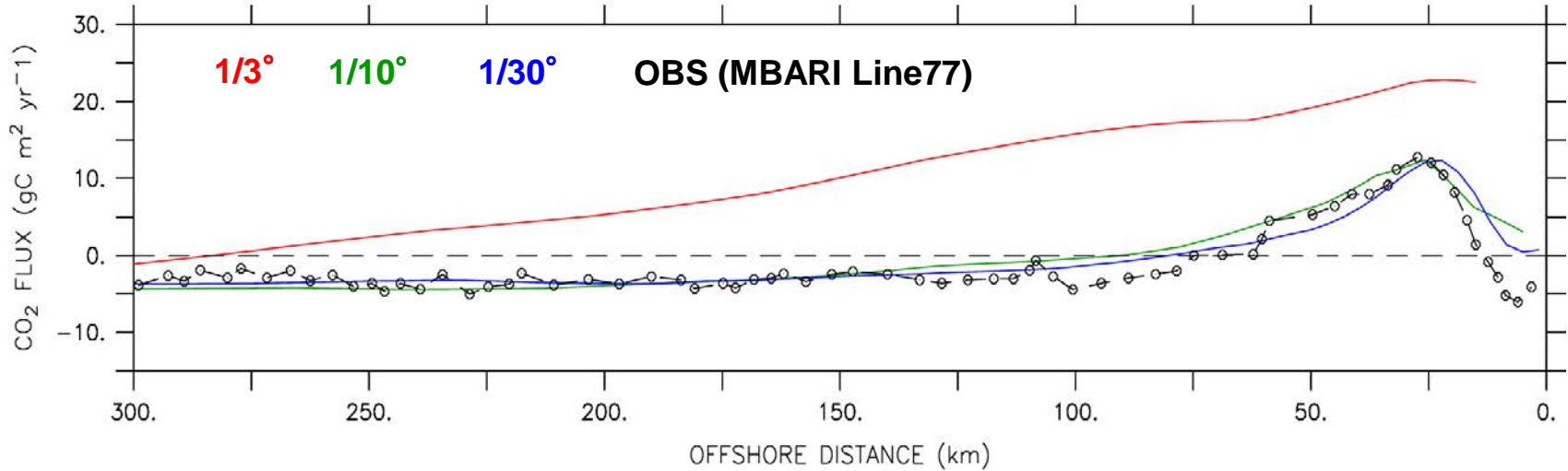
Model-Data Comparison: Seasonal Surface pCO₂



Significant bias reduction when increasing resolution from 1/3° to 1/10° .

Since CCS is ~neutral, important for correct sign of air-sea exchange.

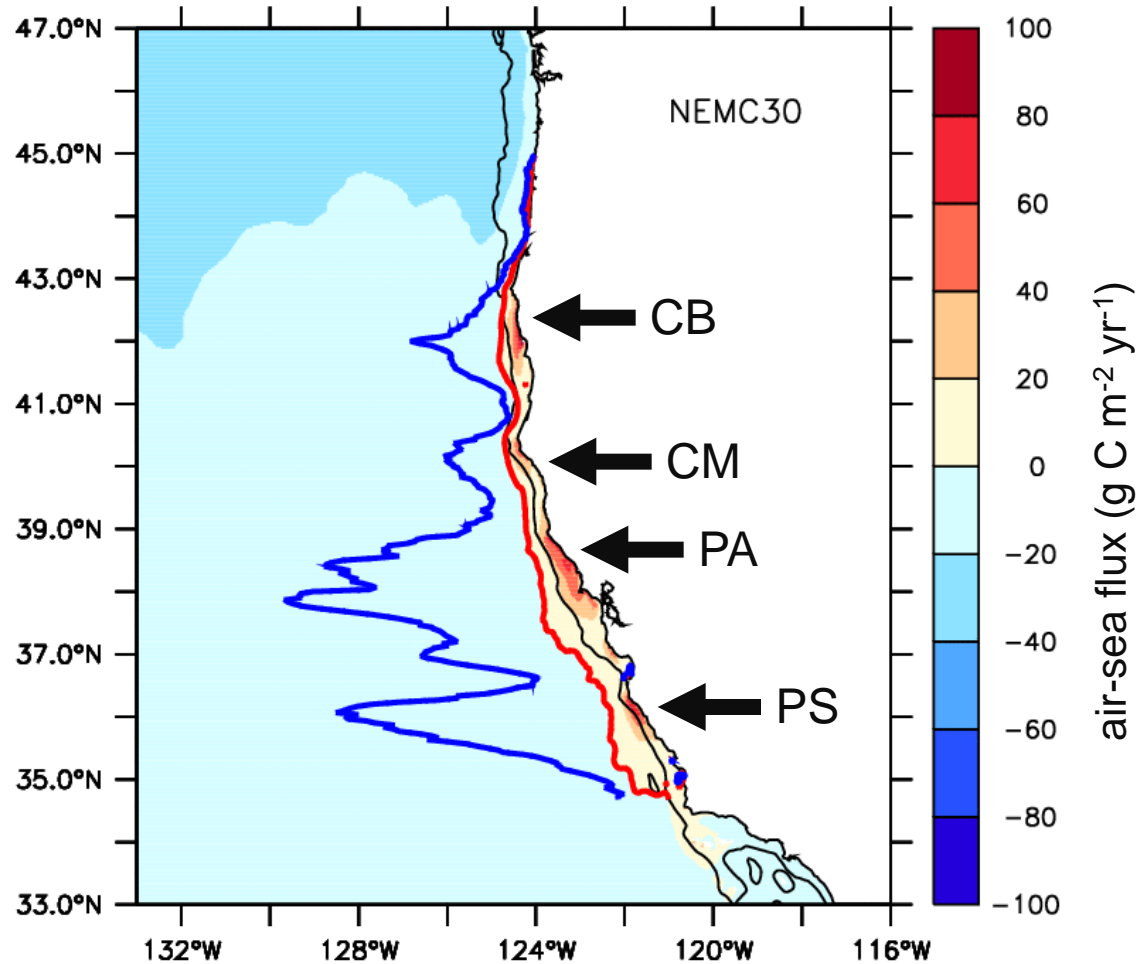
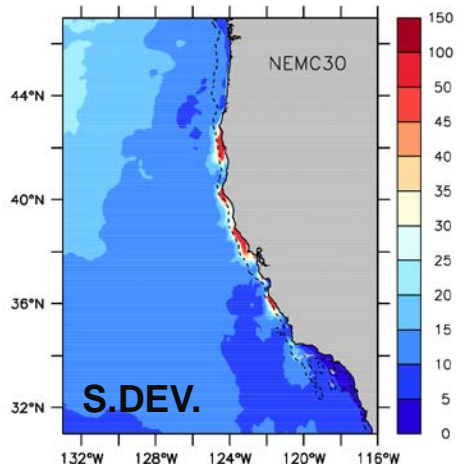
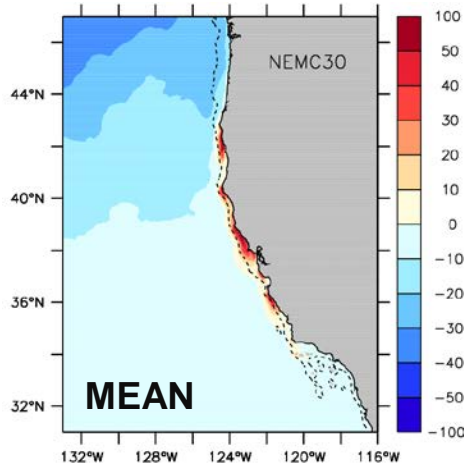
Air-Sea Flux: Impact of Horizontal Model Resolution



Red Line: Outgassing Region Blue Line: Equilibrium Region

1/3° solution grossly overestimates near-shore outgassing

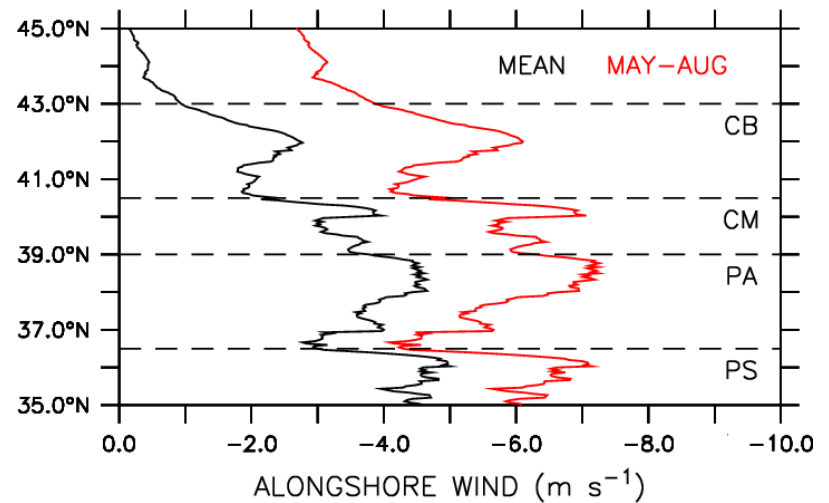
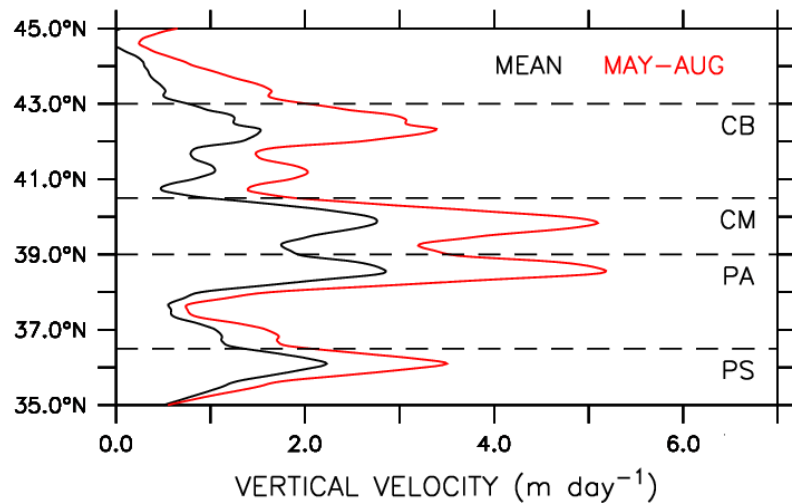
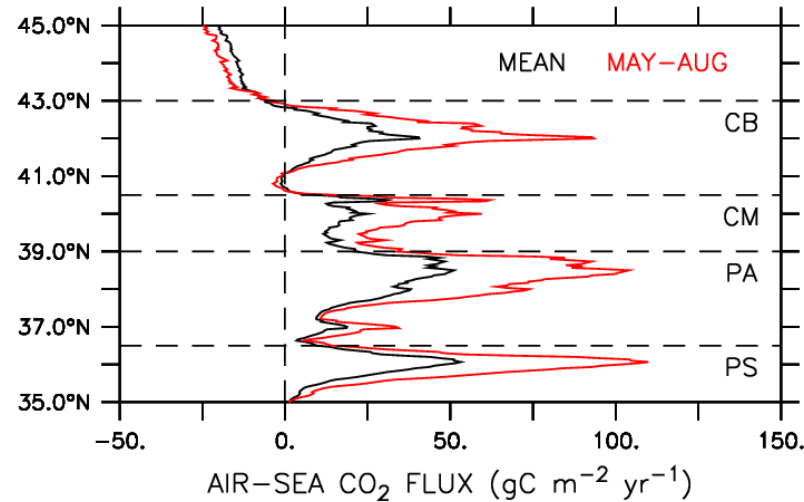
Air-Sea Flux: Outgassing and Equilibrium Regions at 1/30°



Red Line: Outgassing Region Blue Line: Equilibrium Region

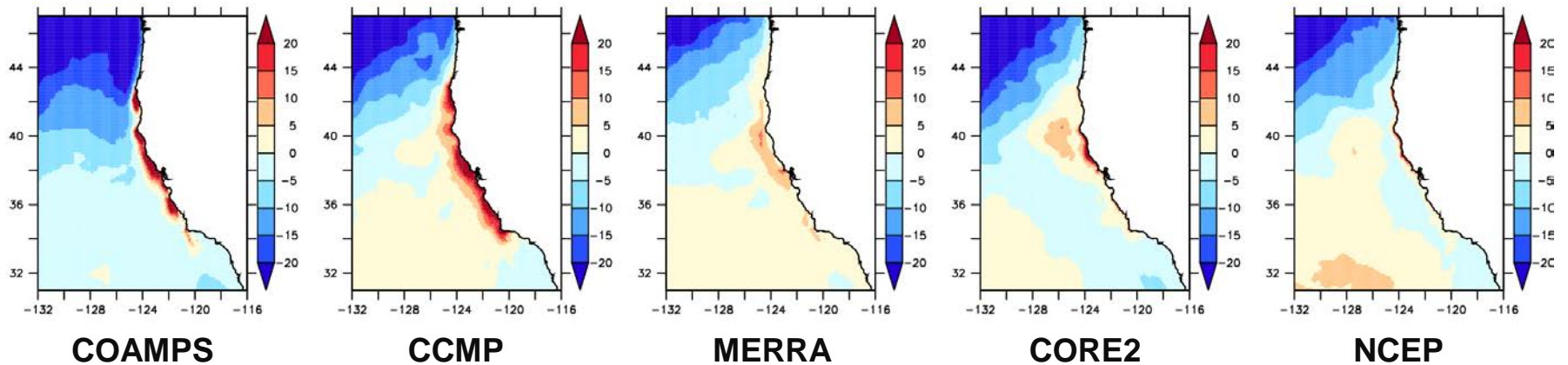
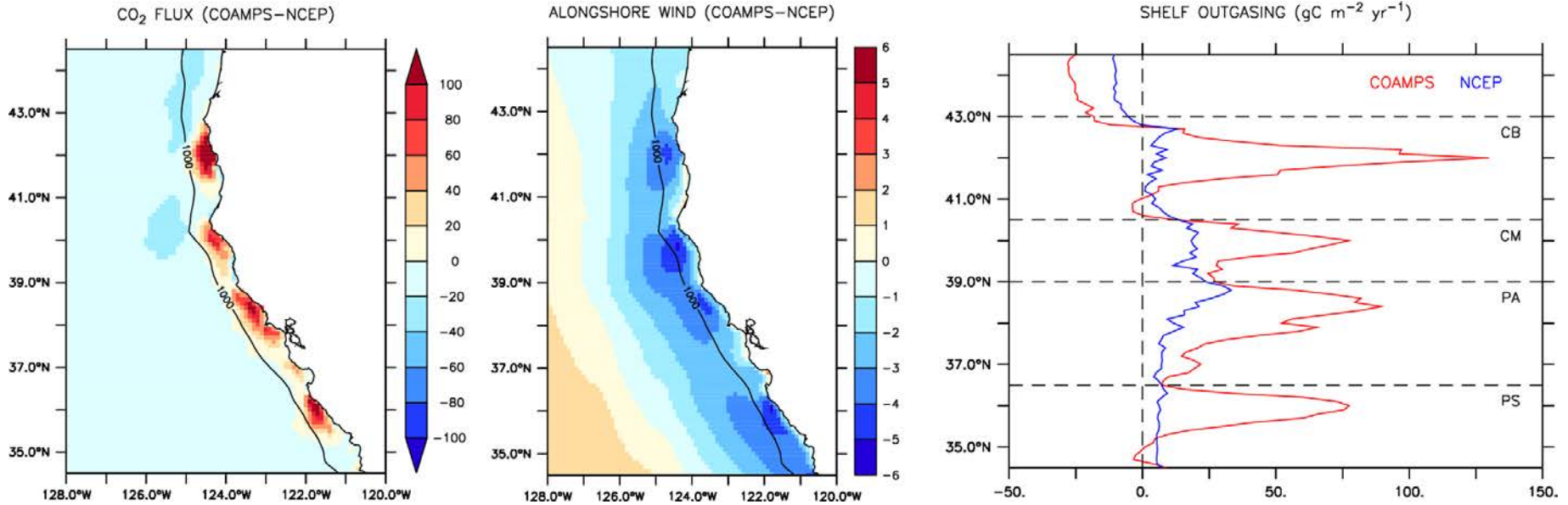
Equilibrium distance indicates local strengthening in outgassing

CCS Outgassing and Coastal Topography

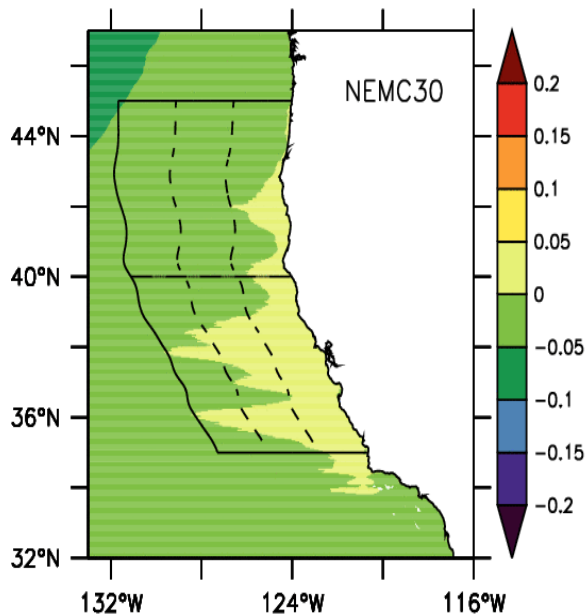


Outgassing enhancement equatorward of topographic features associated with intensification of upwelling-favorable winds

Impact of Surface Atmospheric Forcing on Air-Sea Flux



Net Air-Sea Carbon Exchange in CCS

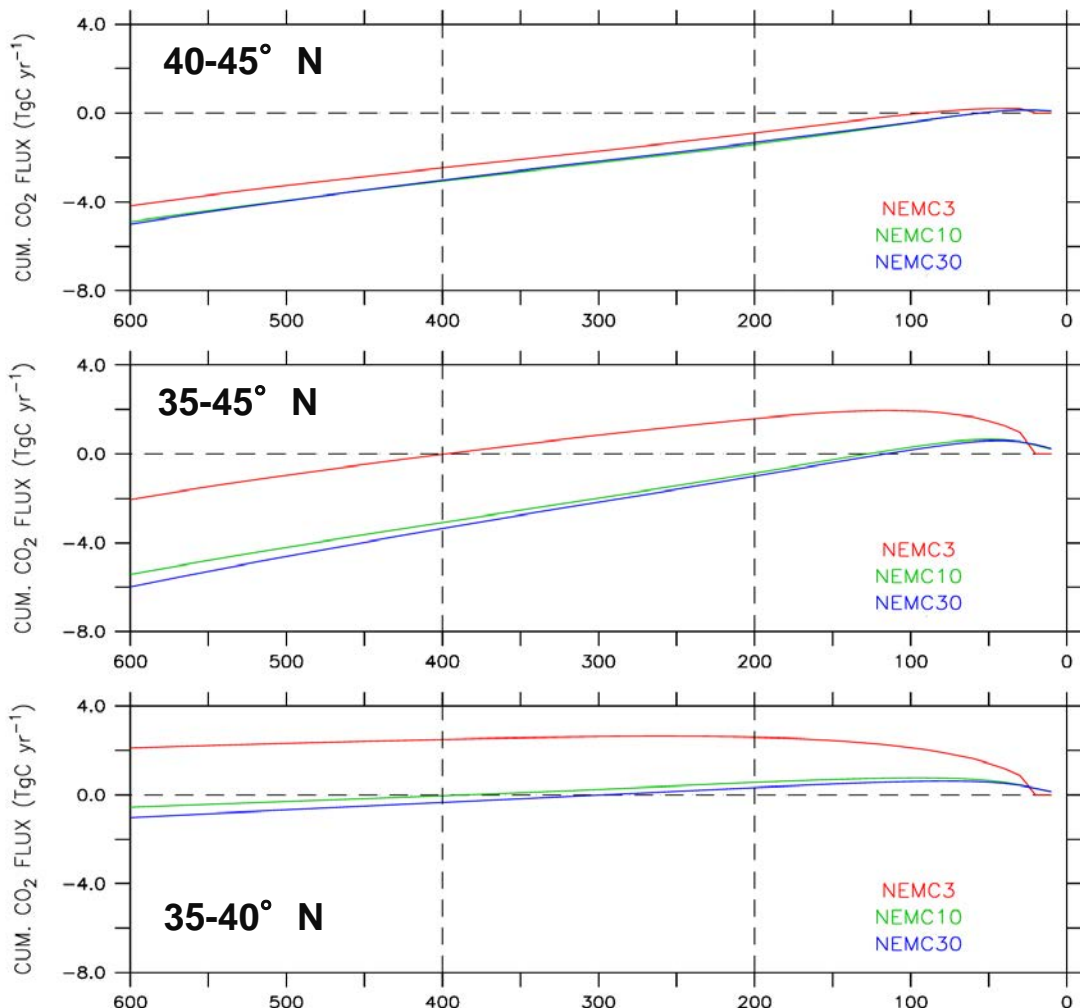


For 35-45° N out to 600 km

1/3° : ~2.0 TgC/yr

1/10° : ~5.4 TgC/yr

1/30° : ~6.0 TgC/yr



At 600km offshore, CCS is net CO₂ sink of ~6.0 TgC/yr

Net sink contribution: 20% SoCCS and 80% NoCCS

Summary

Role of EBC regions in global carbon cycle

- CO₂ outgassing on the shelf and absorption offshore.
- At 600km offshore, CCS is net CO₂ sink of 6.0 TgC/yr.
- Net sink contribution: 20% SoCCS and 80% NoCCS.
- Net carbon exchange at 1/10° is 10% larger than at 1/30° .

Downscaling from climate to regional models

- 1/3° vs. 1/10° : mesoscale eddy activity (Gruber et al., 2011).
- 1/10° vs. 1/30° : shelf slope accuracy (Estrade et al., 2010).
- Enhanced localized outgassing equatorward of capes.
- Wind forcing resolution important to resolve expansion fans.