

Lateral carbon fluxes: shelf-open ocean exchange

Part 1: Numerical model-based approaches

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Part 2: Tracer and data-based approaches

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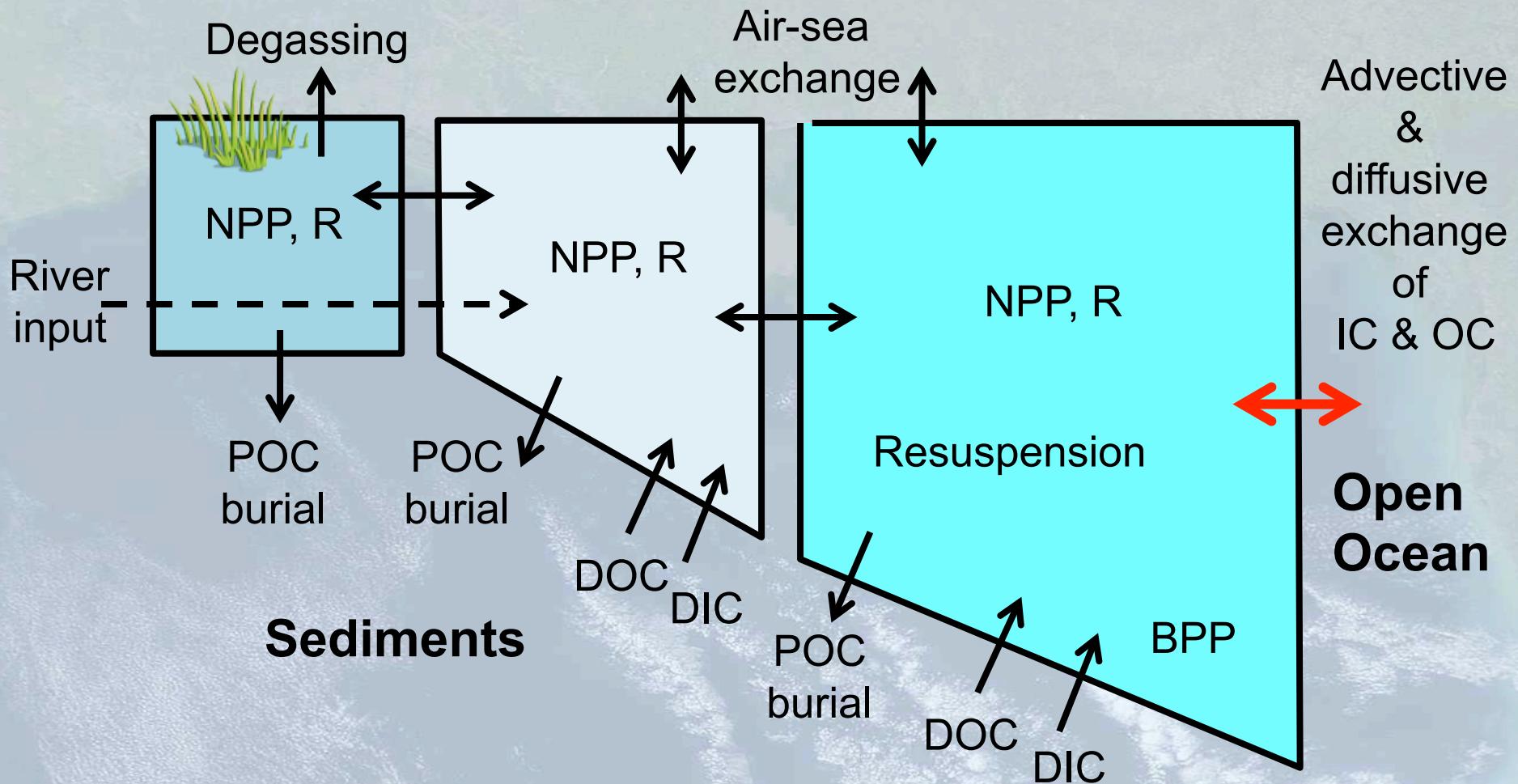
University of Connecticut

CCARS Workshop, Woods Hole, MA
August 19-21, 2014



Coastal Carbon Budget

Tidal wetlands Estuaries Continental shelf



Shelf-open ocean exchange

Why is this flux particularly important?

- One of the largest terms in the coastal carbon budget
- Highly variable in space and on multiple time scales
- Potentially represents a permanent carbon sink

Why is this flux so poorly constrained?

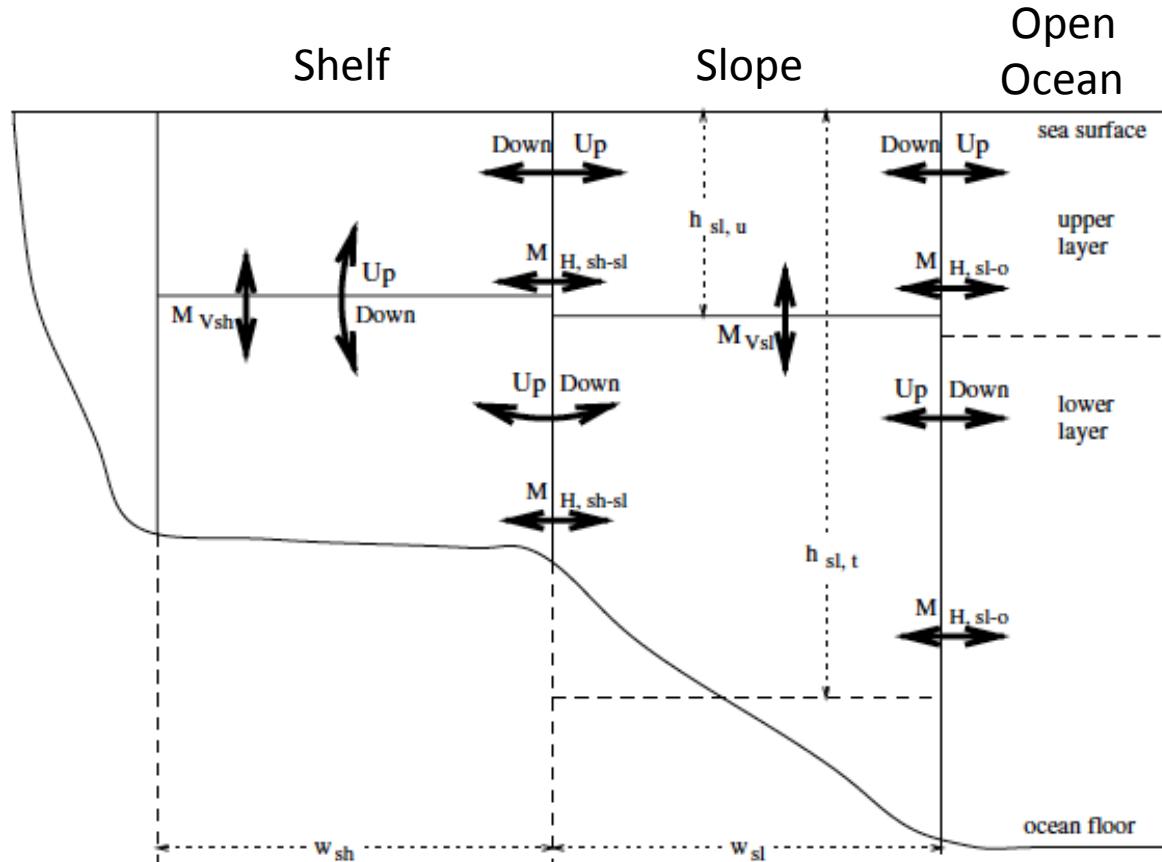
- Often computed with a mass balance approach
- Limited observations on the temporal/spatial scales required
- Difficult to model (need many regional models)

Part 1: Model based approaches

- West Coast box model approach
- Regional numerical modeling efforts
 - European shelf (carbon)
 - East Coast (carbon)
 - Gulf Coast (nitrogen)
- MAB satellite + neural network approach

(Part 2: Tracer and data-based approaches)

Carbon box model of upwelling region off Vancouver Island

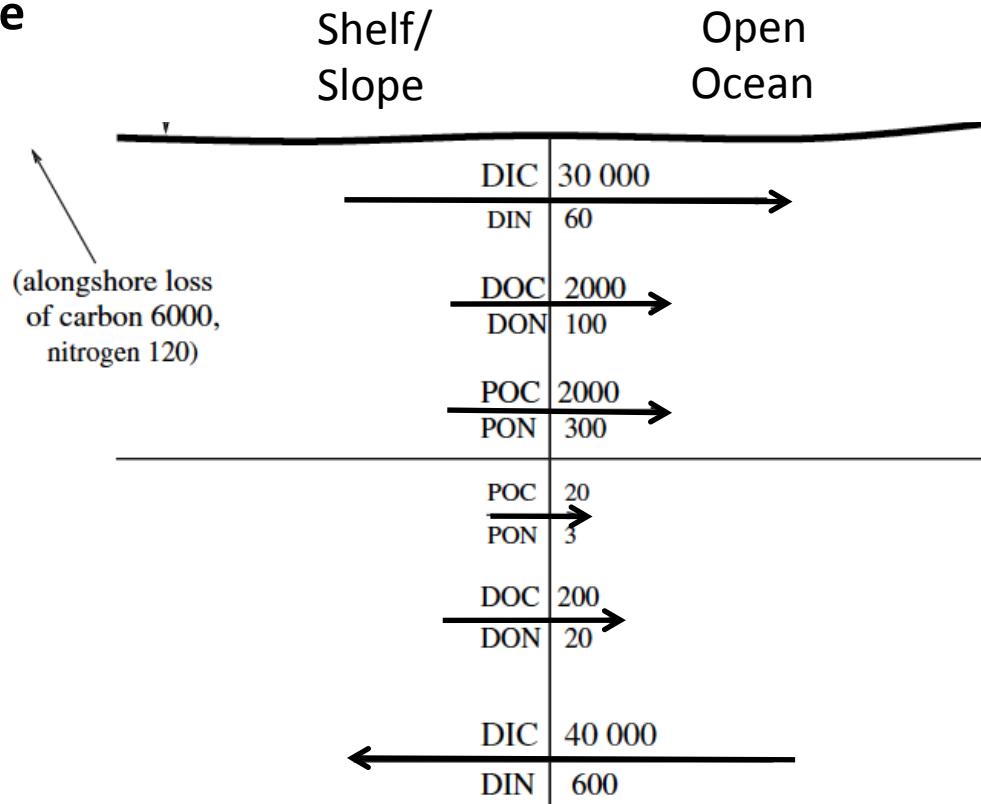


Ianson & Allen, 2002

- 2D box model: vertical, along-shelf

Carbon box model of upwelling region off Vancouver Island

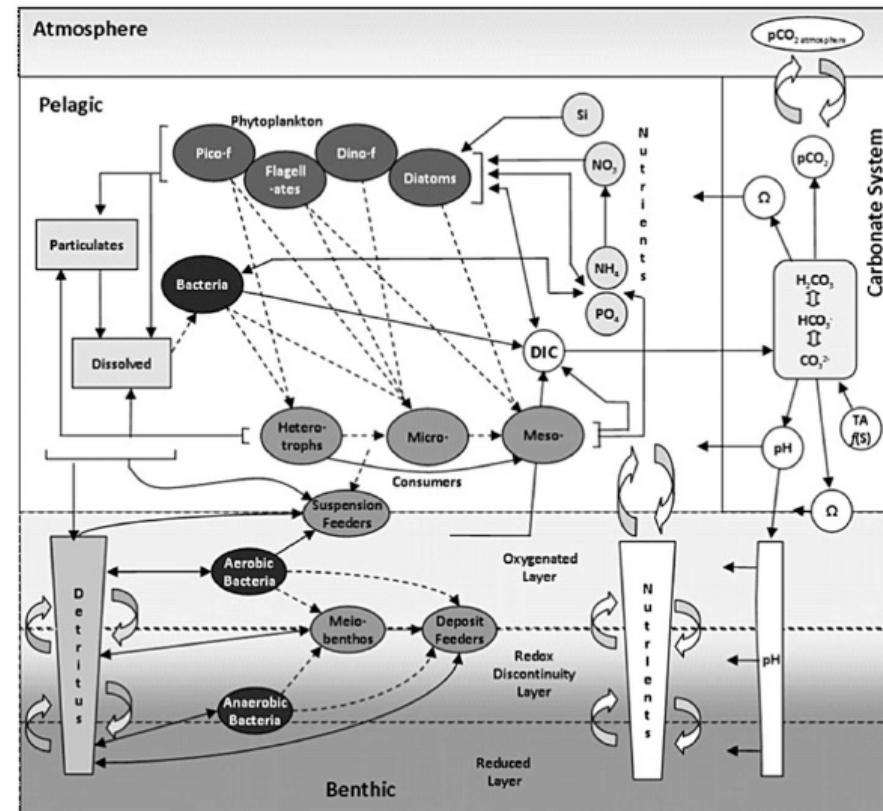
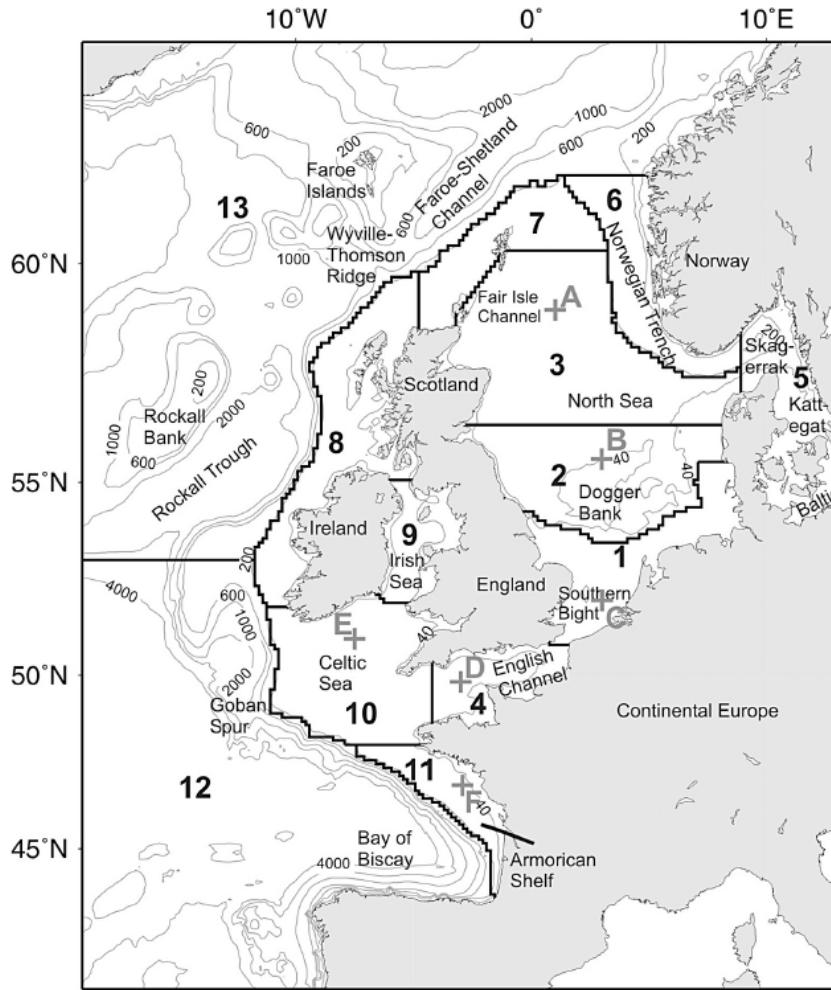
Lateral Advective Fluxes



Ianson & Allen, 2002

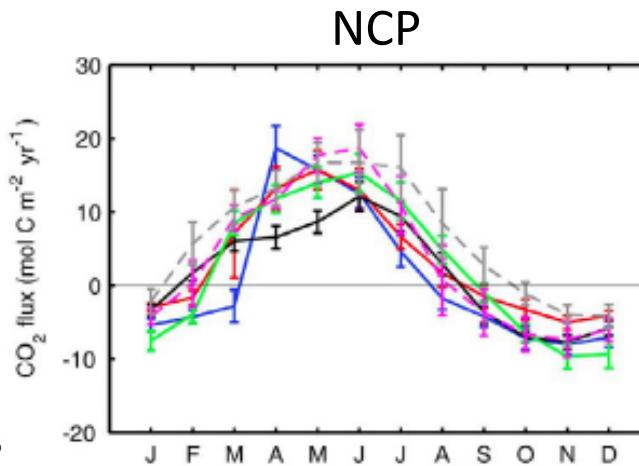
- 2D box model: vertical, along-shelf
- Large flux of DIC from intermediate to shallow depths in coastal region

Lateral carbon fluxes on the northwest European continental shelf

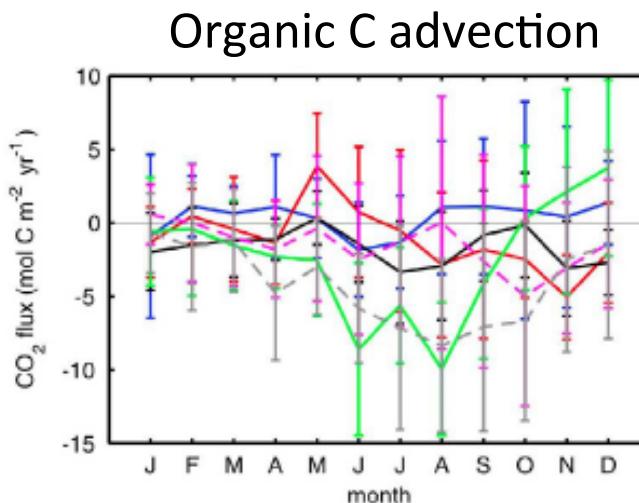
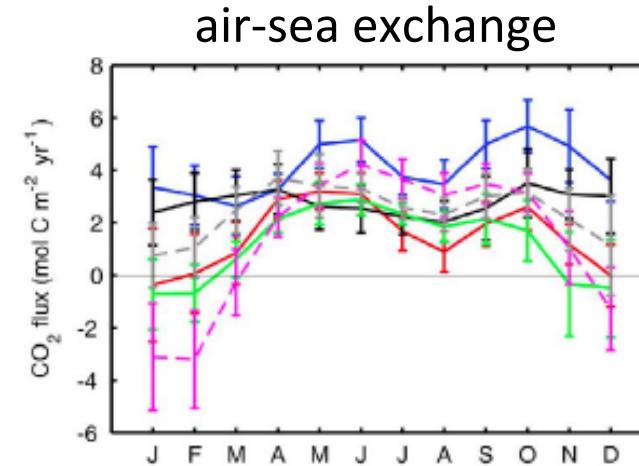


16 year simulation of ERSEM

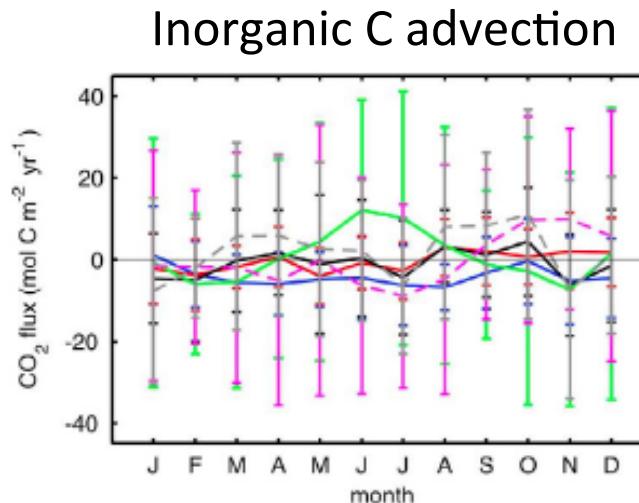
Lateral carbon fluxes on the northwest European continental shelf



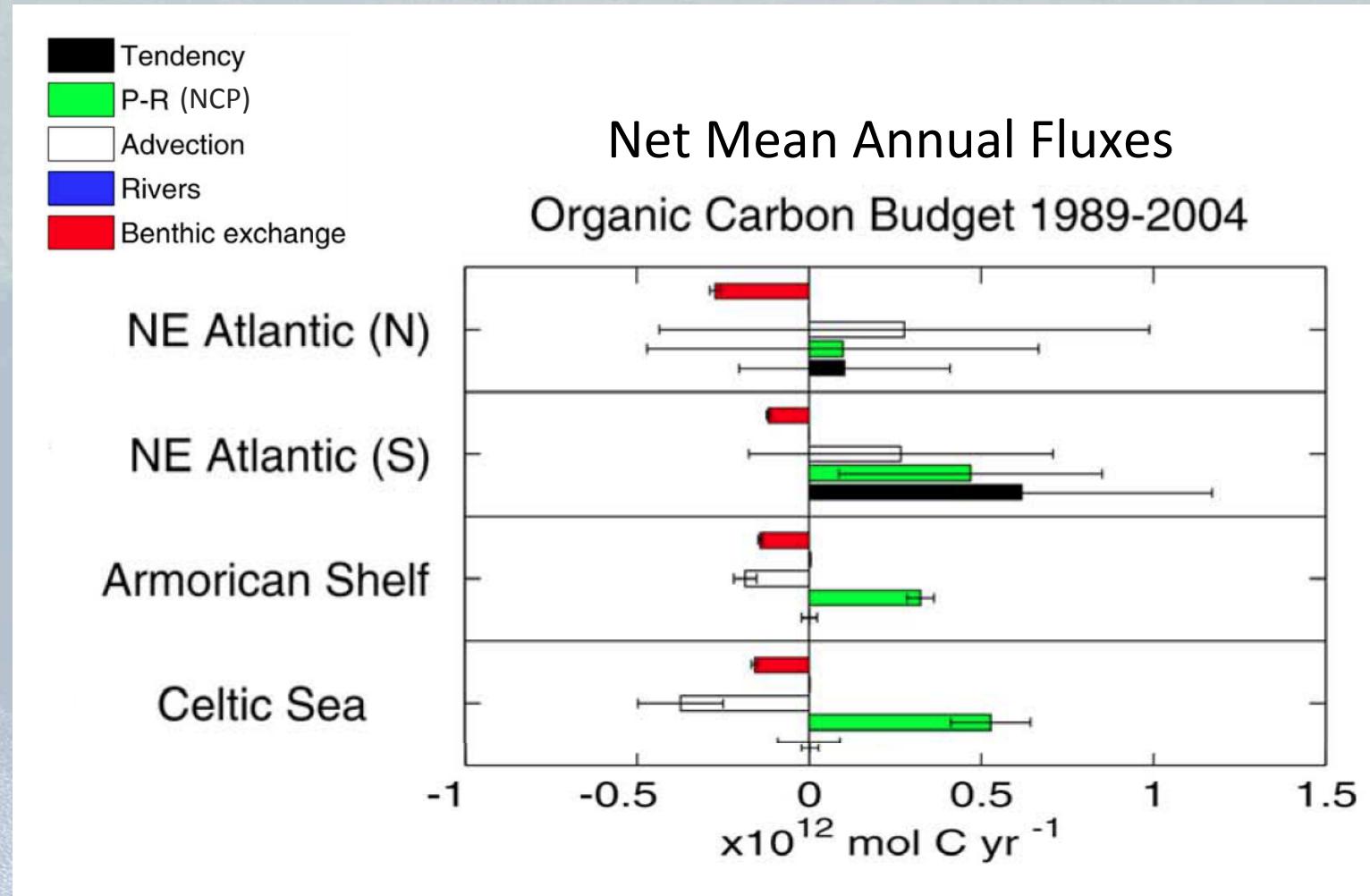
Six colored lines
represent six
subregions



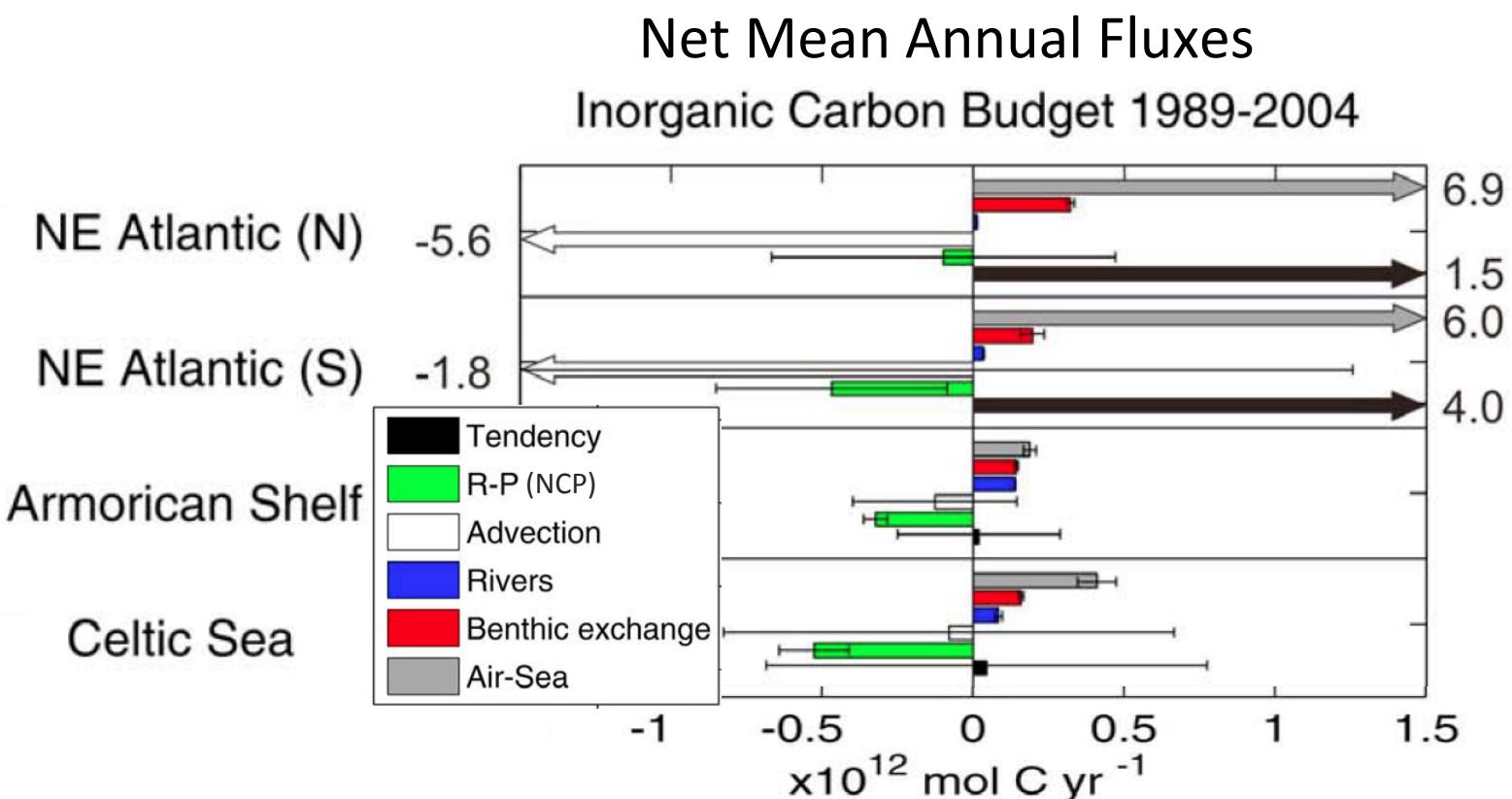
Vertical bars
represent std dev
of 16y of monthly
estimates



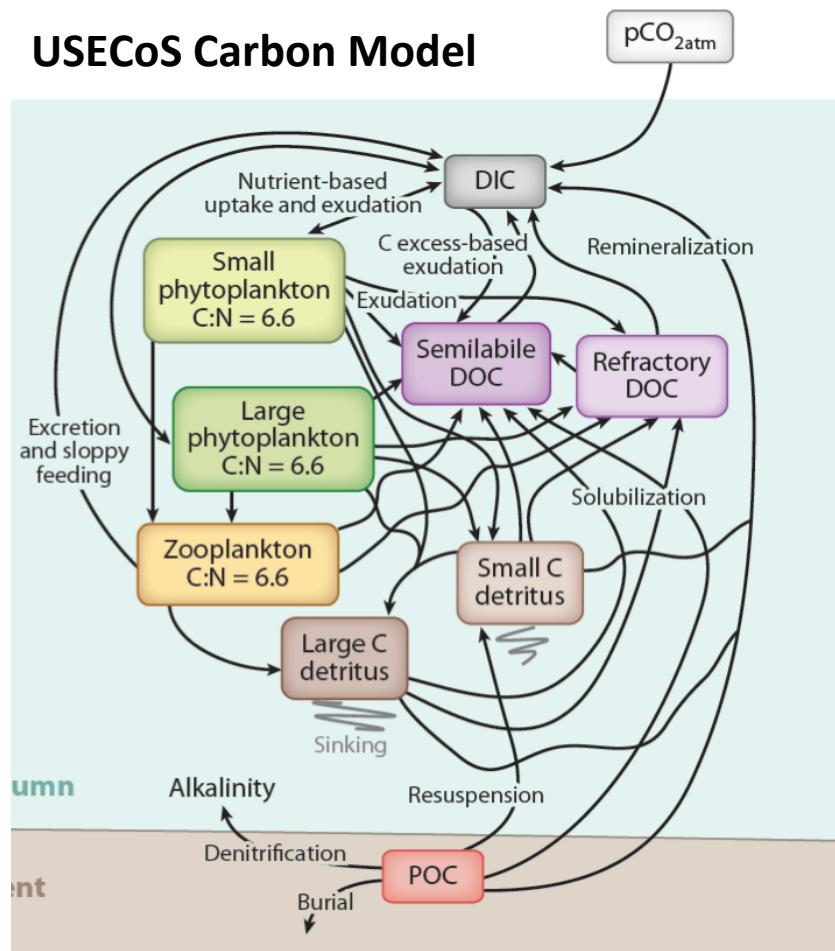
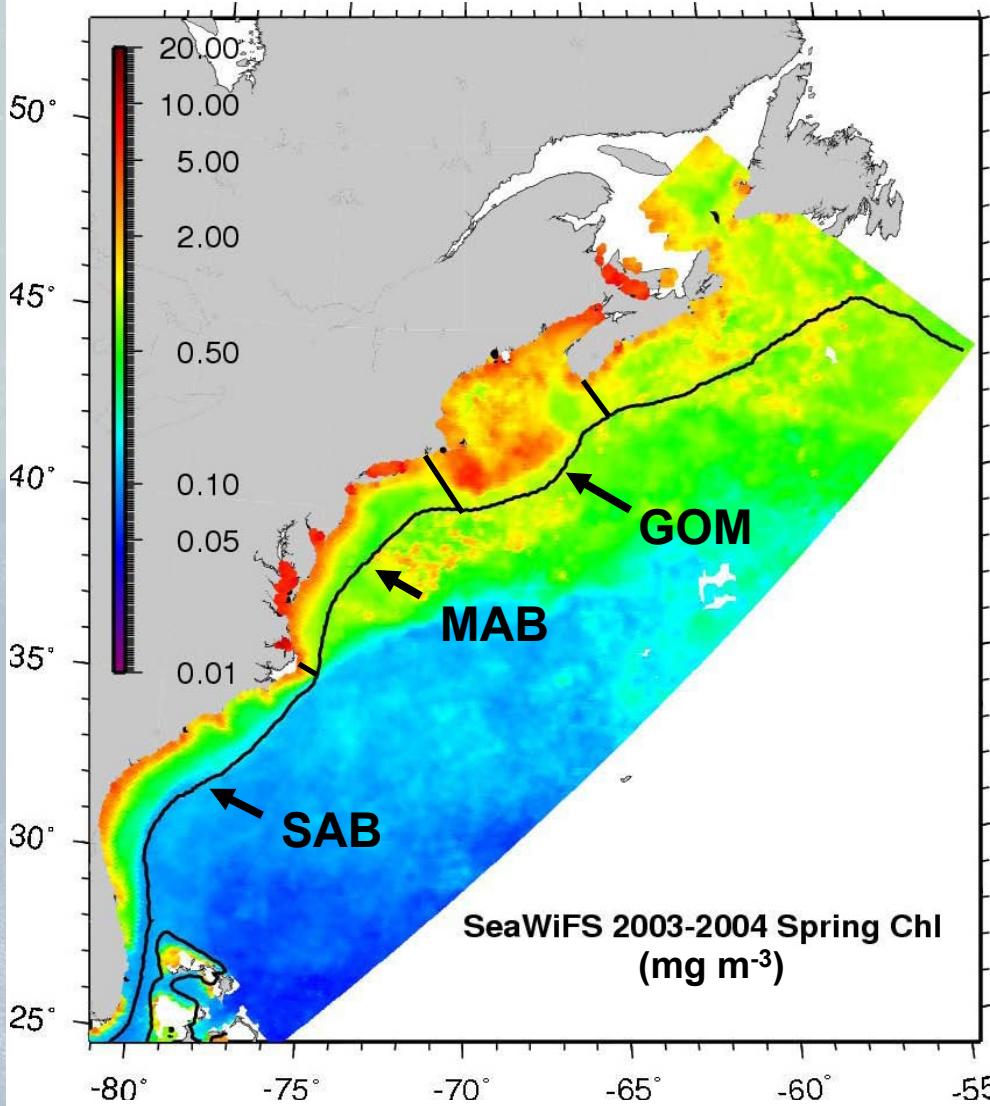
Lateral organic carbon fluxes on the northwest European continental shelf



Lateral inorganic carbon fluxes on the northwest European continental shelf



USECoS: Carbon-Biogeochemical Circulation Model for the US Eastern Continental Shelf

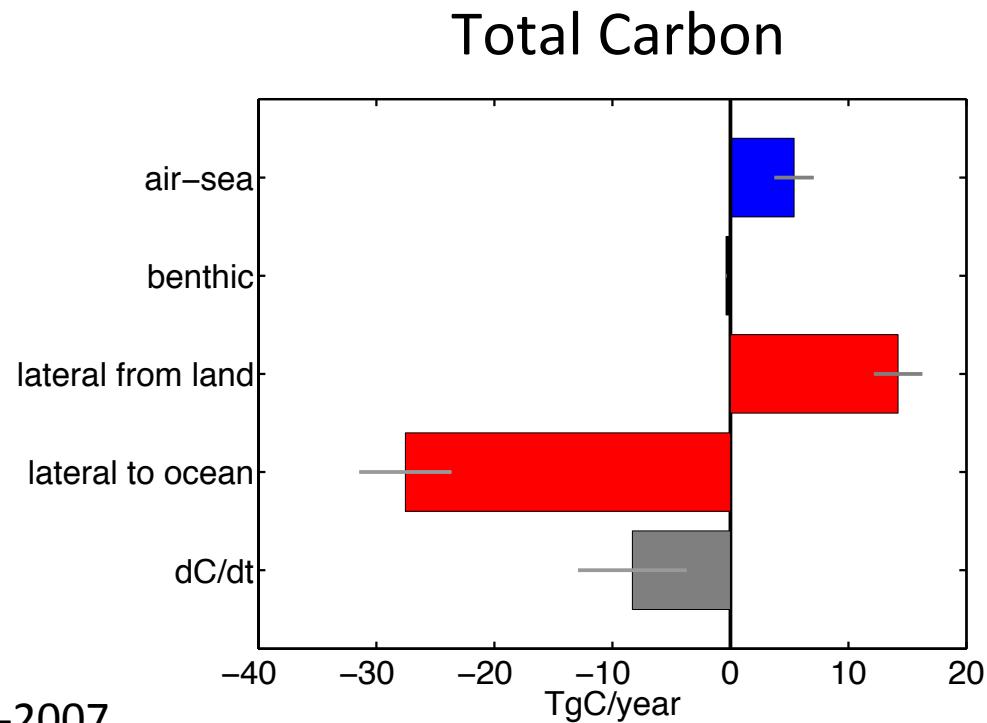


Burial (Druon et al., 2010)

DOC dynamics (Druon et al., 2010)

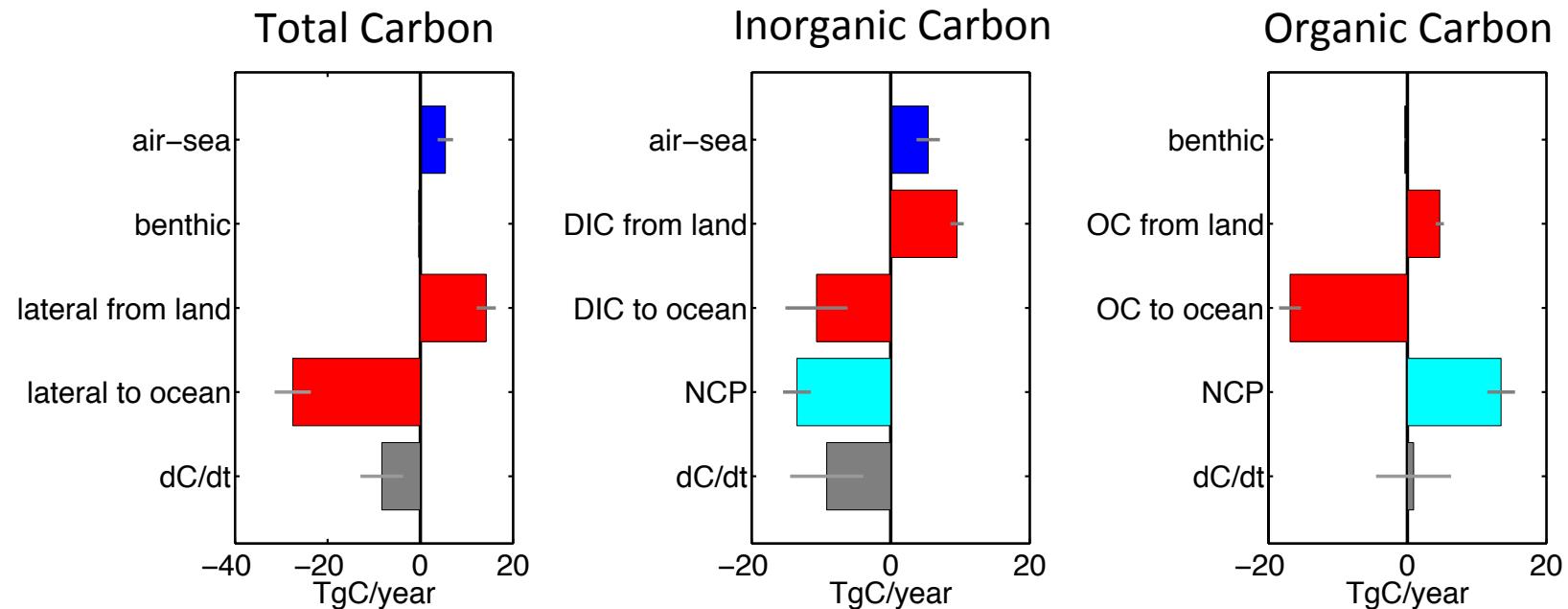
Multiple plankton components (Xiao & Friedrichs, 2014)

USECoS: Lateral carbon fluxes on the U.S. eastern continental shelf



- Lateral exchange is large term in the US East Coast carbon budgets

USECoS: Lateral carbon fluxes on the U.S. eastern continental shelf

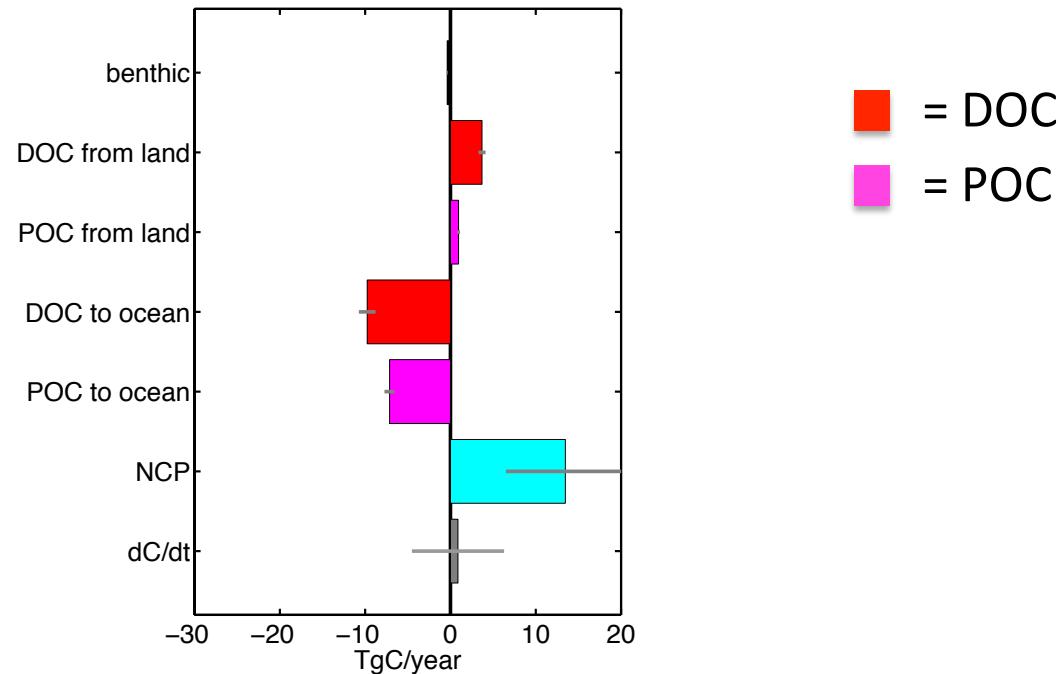


mean over 2004-2007

- Lateral exchange is large term in the US East Coast carbon budgets
- Large interannual variability of lateral DIC flux

USECoS: Lateral carbon fluxes on the U.S. eastern continental shelf

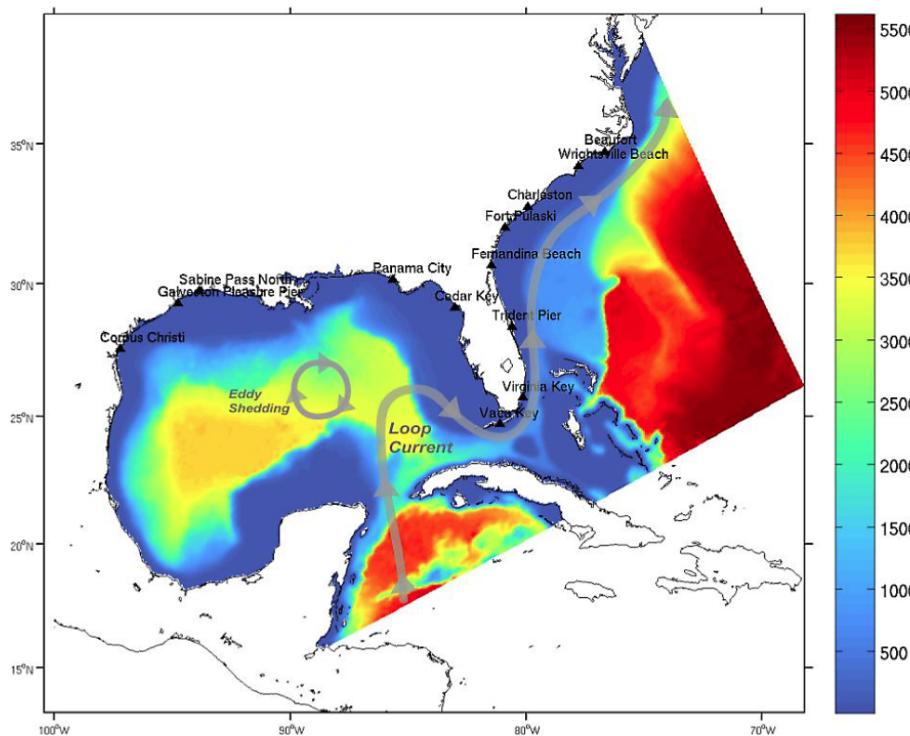
Total Organic Carbon: POC vs. DOC



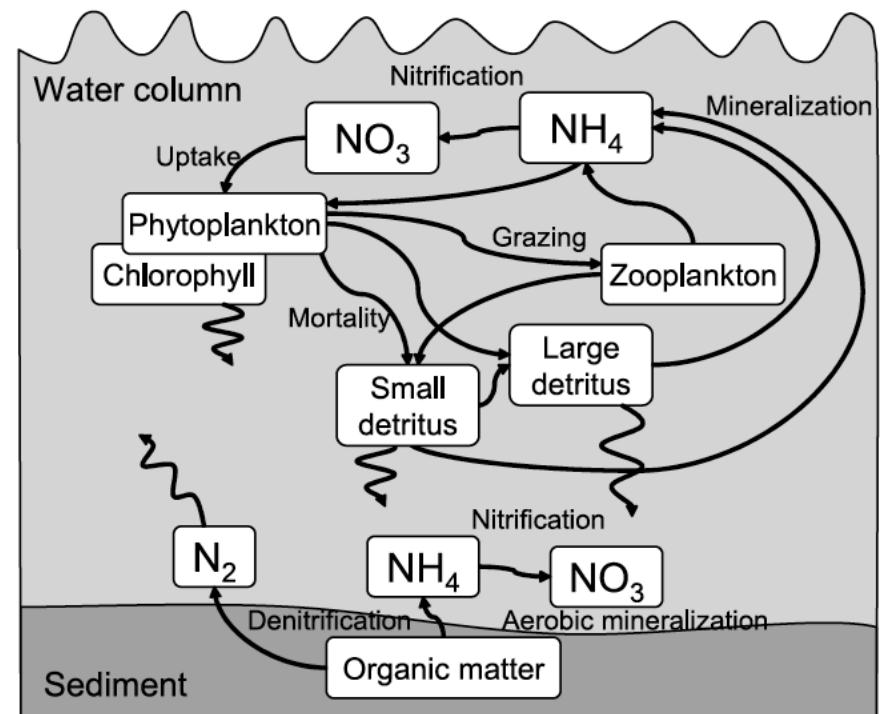
mean over 2004-2007

- DOC input from land >>> POC input from land
- DOC export to shelf > POC export to shelf

Lateral fluxes on Gulf of Mexico shelf



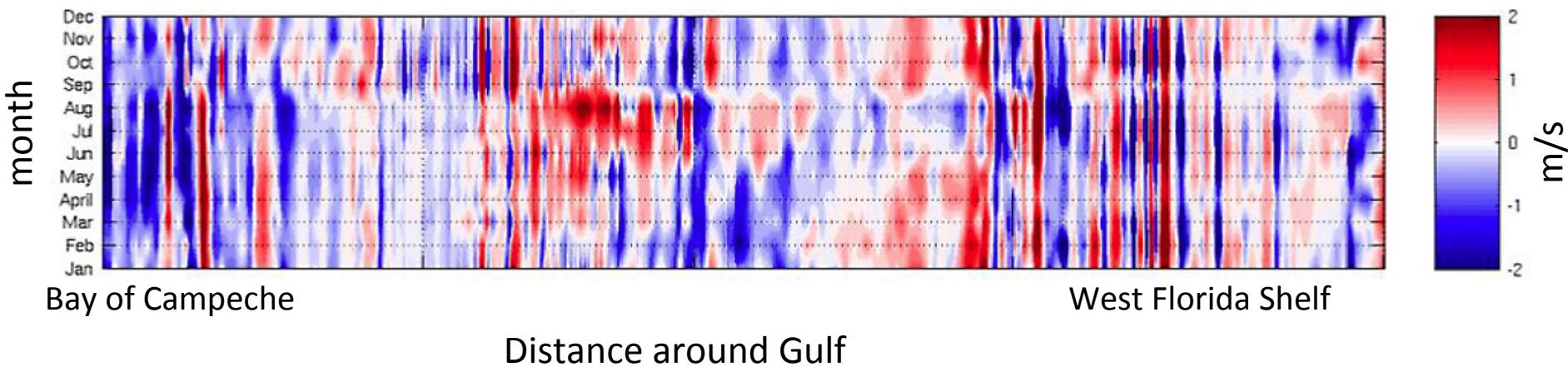
Xue et al., 2014
2005-2010 simulation



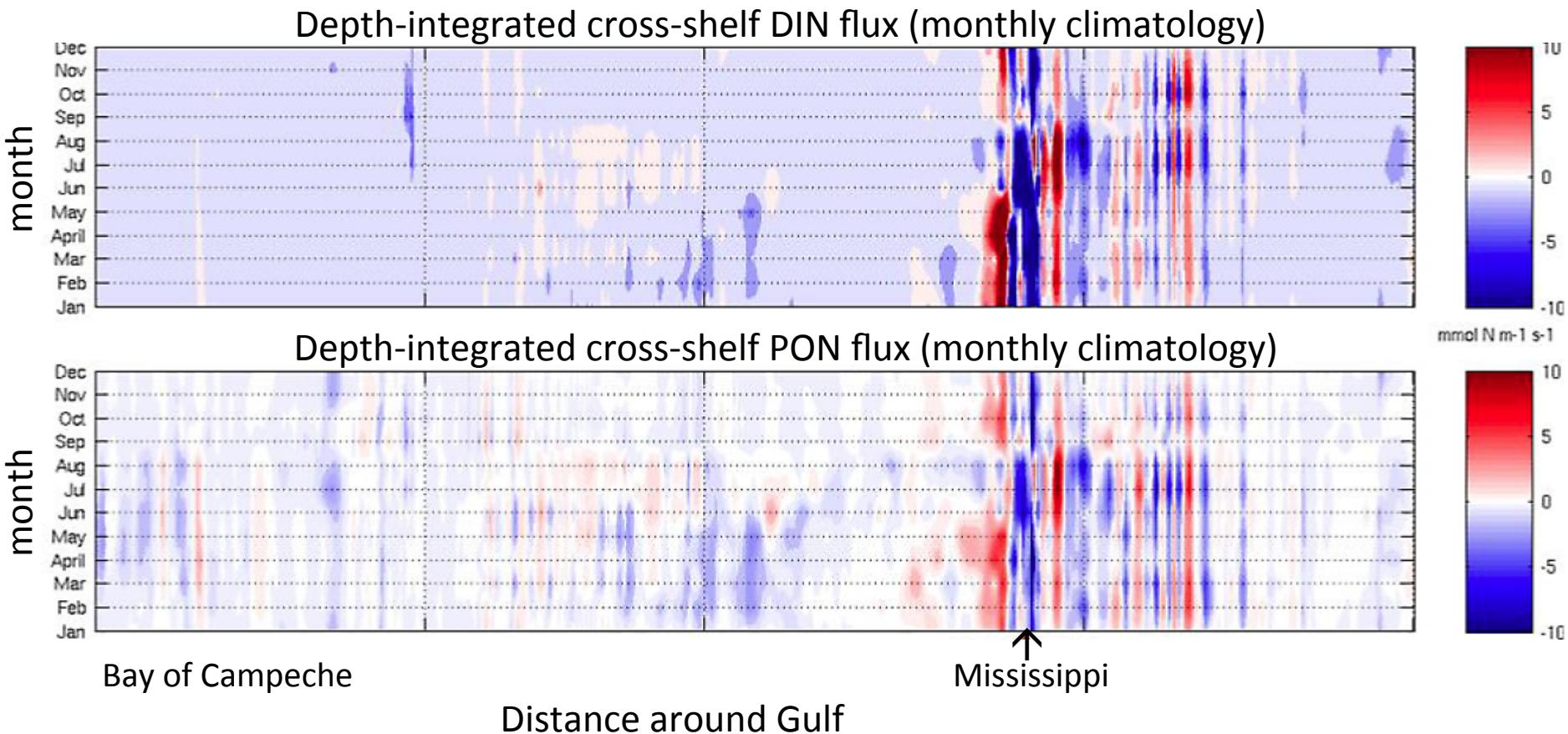
Nitrogen model of
Fennel et al., 2006

Lateral fluxes on Gulf of Mexico shelf

Depth-integrated cross-shelf velocity (monthly climatology)

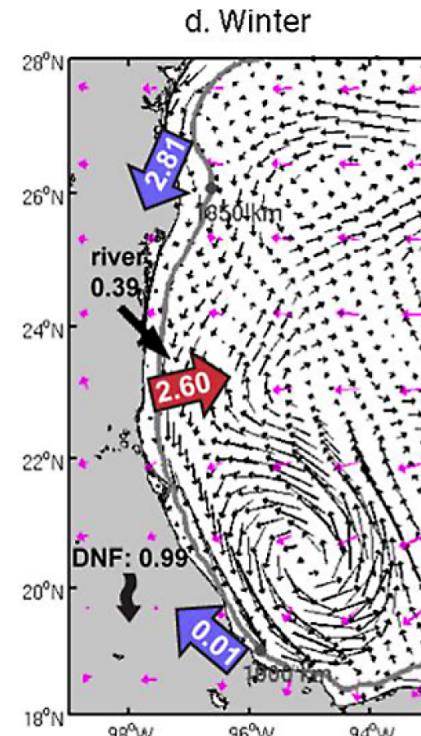
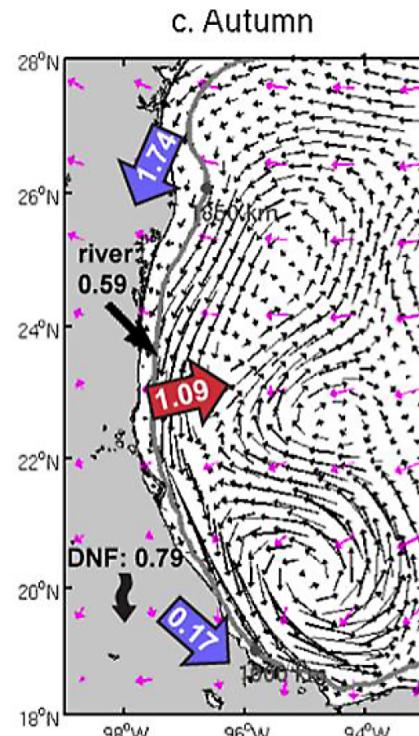
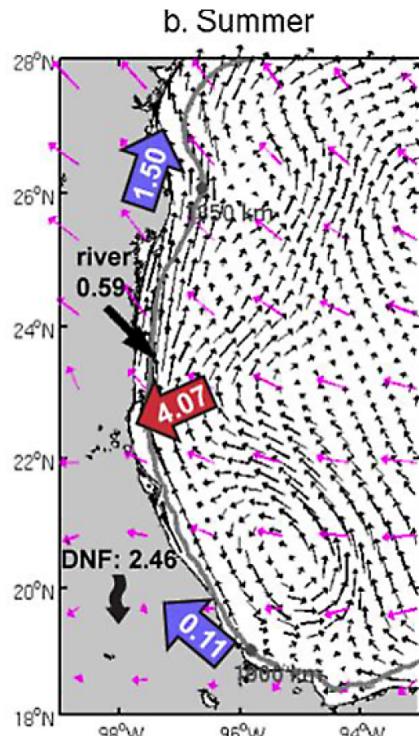
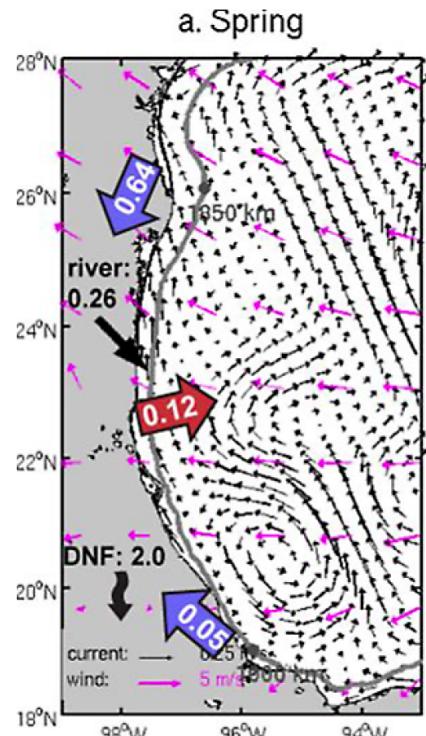


Lateral fluxes on Gulf of Mexico shelf



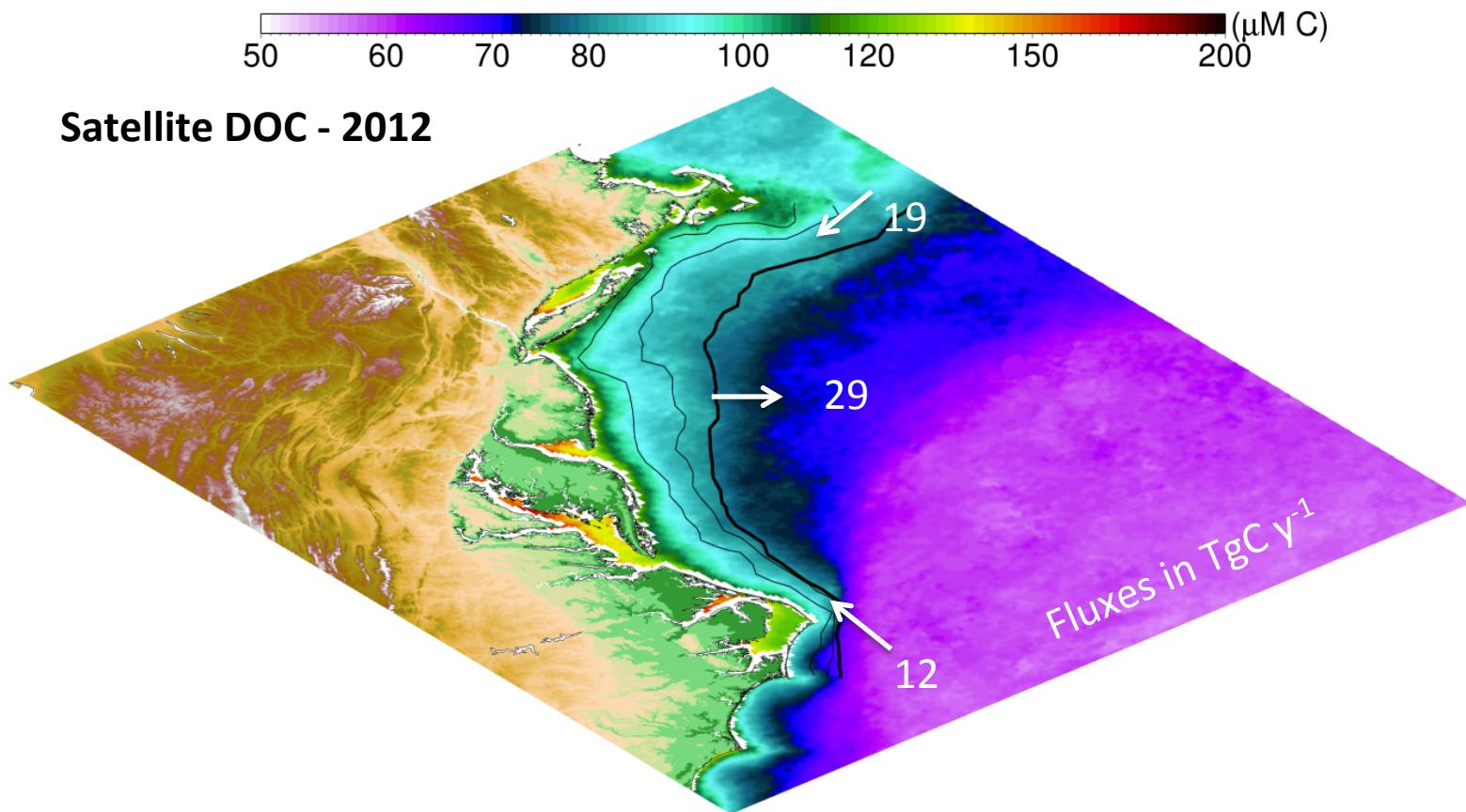
Lateral fluxes on Gulf of Mexico shelf

DIN+PON fluxes



Near zero annual cross-shelf N flux, near constant local riverine N inflow
Lateral exchange with open ocean has large seasonal cycle

Lateral fluxes of DOC in MAB: Satellite + NN analysis



- Develop neural network (NN) model based on observed T, S, DOC, and apply NN model to modeled T, S and satellite DOC to get DOC profiles
- Combine DOC profiles with modeled velocities to get lateral flux of DOC from shelf to open ocean

Shelf-open ocean exchange

Shelf-open ocean exchange is a key component of the coastal carbon balance

- One of the largest terms in the coastal carbon budget
- Highly variable in space and on multiple time scales
- Potentially represents a permanent carbon sink

Shelf-open ocean exchange is still poorly constrained along most of the North American coasts

- Often computed as a mass balance approach
- Limited observations on the temporal/spatial scales required
- Difficult to model (need many regional models)

Additional Slides

