Implementation of Estuary-Shelf Freshwater Exchange Parameterizations in the Community Earth System Model

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• Why?
• Estuary-Shelf Freshwater Exchange Parameterizations
  ➢ Improved “augmented precipitation” scheme
  ➢ Estuary and shelf box models
• Conclusion and Future……

SciDAC: Collaborative project: Improving the Representation of Coastal and Estuarine Processes in Earth System Models
Virtual salt flux: is it correct to consider the global water budget?
Where are the impacts of coastal ocean?
Can we better represent the processes in the ESM (e.g., CESM)?
Improved “augmented precipitation” approach

Empirical method
Tseng et al. (2014 submitted)

Buoyancy-driven plumes

Wind-mixing plumes

Shelf Box

Estuary Box

River

Box Model Approach
- Estuary box
- Shelf box

CECM SURFACE RUNOFF

CESM OCEAN

① Garvine and Whitney (2006); ② Yankovsky and Chapman (1997); ③ Lentz (2004); ④ O’Donnell (1999)
Two-layer Estuary Box Model

- **Methodology**
  - Steady-state Governing Equations:
    - Water mass flux conservation
    - Salt mass flux conservation
    - Potential energy flux (PEF) conservation

![Diagram of the two-layer estuary box model](image)
Off-line Estuary Box Model-validation with observation

Comparison of upper layer outflow salinity between EBM and observations

$R^2 = 63.43\%$
Interactive Estuary Box Model (coupled with POP)

- Apply Box Model in the CESM
  (http://www.cgd.ucar.edu/staff/ytseng/research/Salinity/main.html#ESP)

**CESM surface ocean salinity and velocity vector (annual mean)**

- **no Estuary Box Model output**
- **with Estuary Box Model output**

Columbia River
Summary of the estuary box model

- The estuary Box Model agrees well with observation in the Columbia River estuary.
- Surface salinity distribution at river mouth is obviously improved with estuary Box Model, but we need to introduce the shelf Box Model for more realistic salinity distributions on the shelf ocean.
Off-line Shelf Box Model-validation with ROMS
Conclusion and future......

• The estuary box model is implemented and tested for Amazon and Columbia (offline and online coupled with POP)
• Parameters for different rivers are being estimated and examined (Congo and Mississippi rivers are done!)
• Top 20 rivers will be included and analyzed/compared
• The model framework of shelf box model is completed. It will be included and tested soon after the offline validation is completed (2014 summer)
• Validation/generalization ready for CESM 2 (2014 winter)