Chesapeake Bay hypoxia projections are sensitive to model methodology

Kyle Hinson, Marjy Friedrichs, Ray Najjar, Zihao Bian, Maria Herrmann, Pierre St-Laurent, & Hanqin Tian

Hinson et al. (2024) *Scientific Reports*

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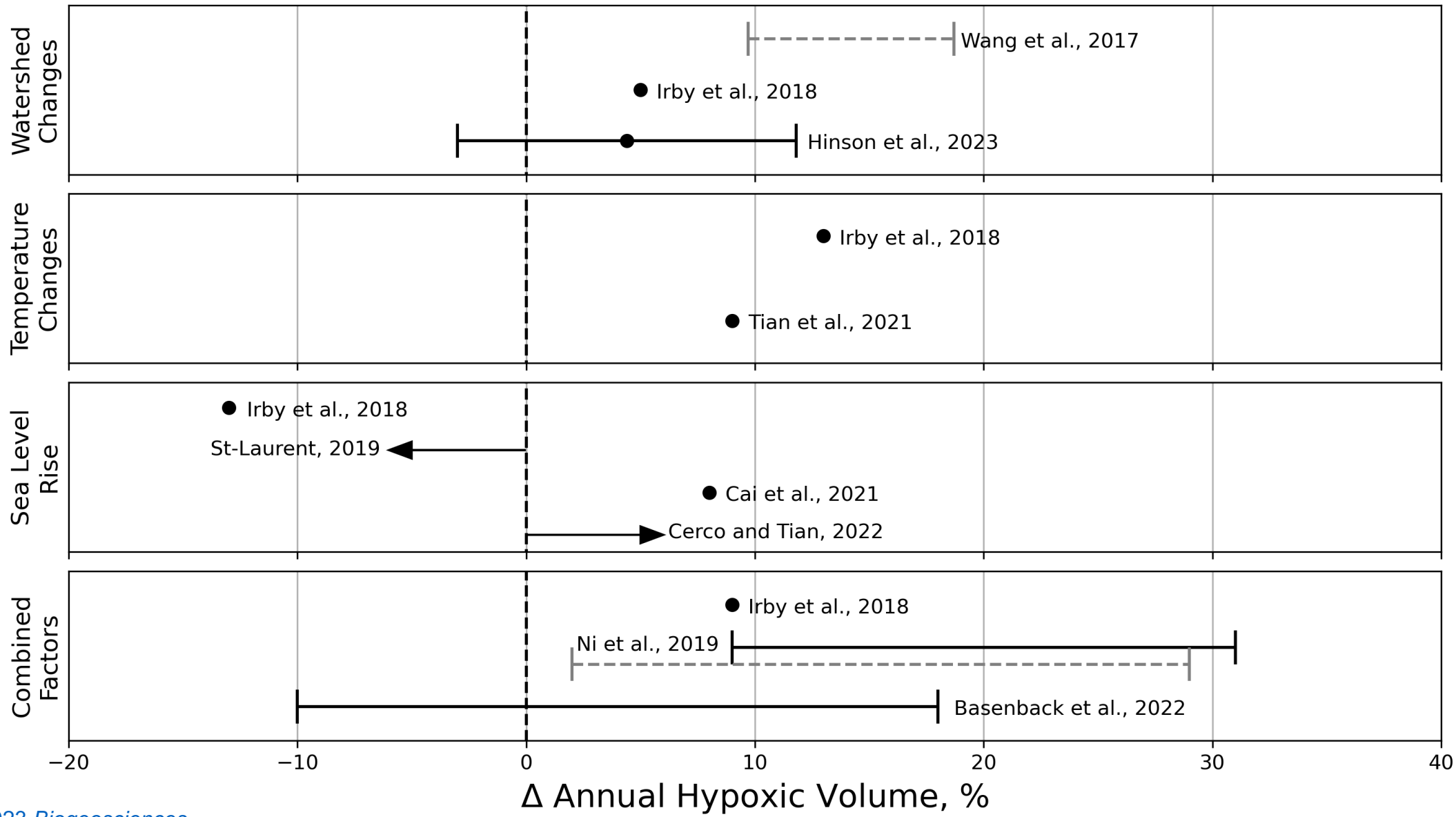
Virginia Institute of Marine Science

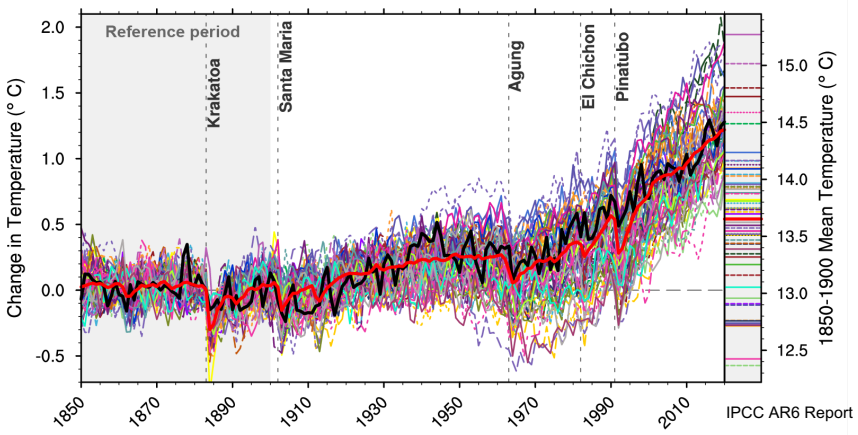
Chesapeake Bay Hypoxia Response to Climate Change



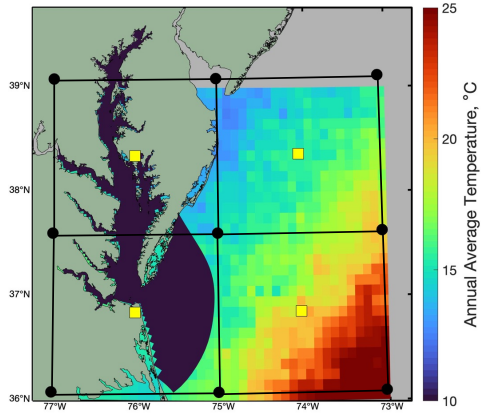
Hinson et al., 2023 *Biogeosciences*

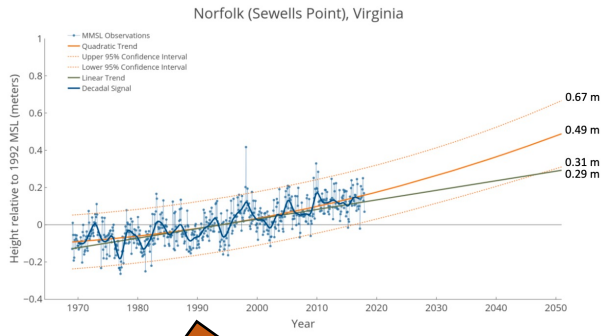
Simulating a Future Chesapeake Climate

Global Climate Models



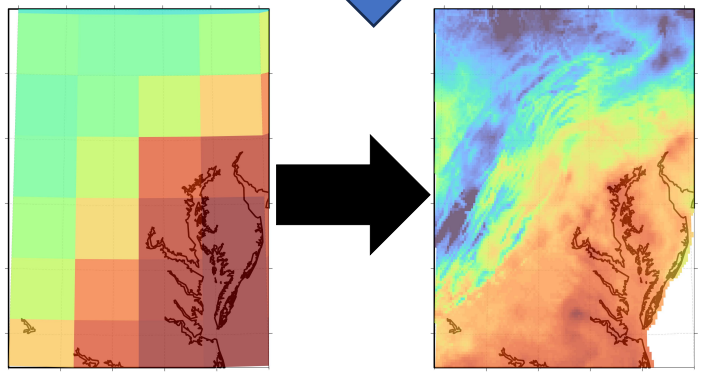
Future Ocean Conditions

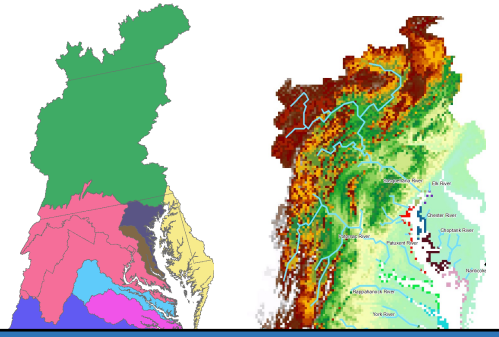




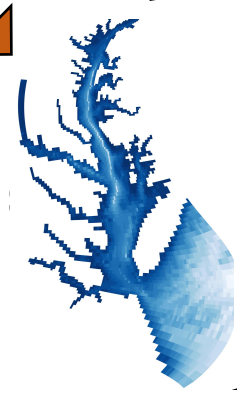
Boon et al., 2018

Downscaling



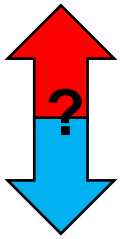


Watershed Model(s)

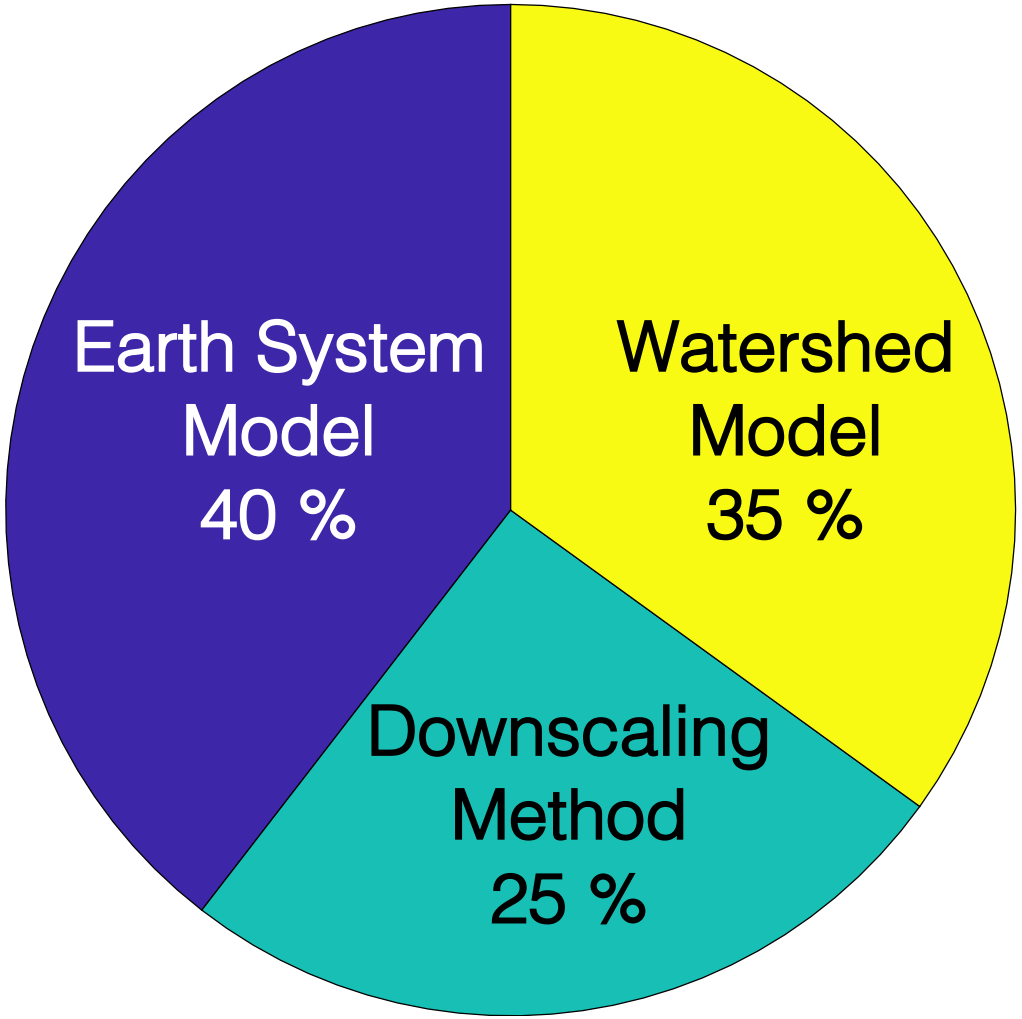


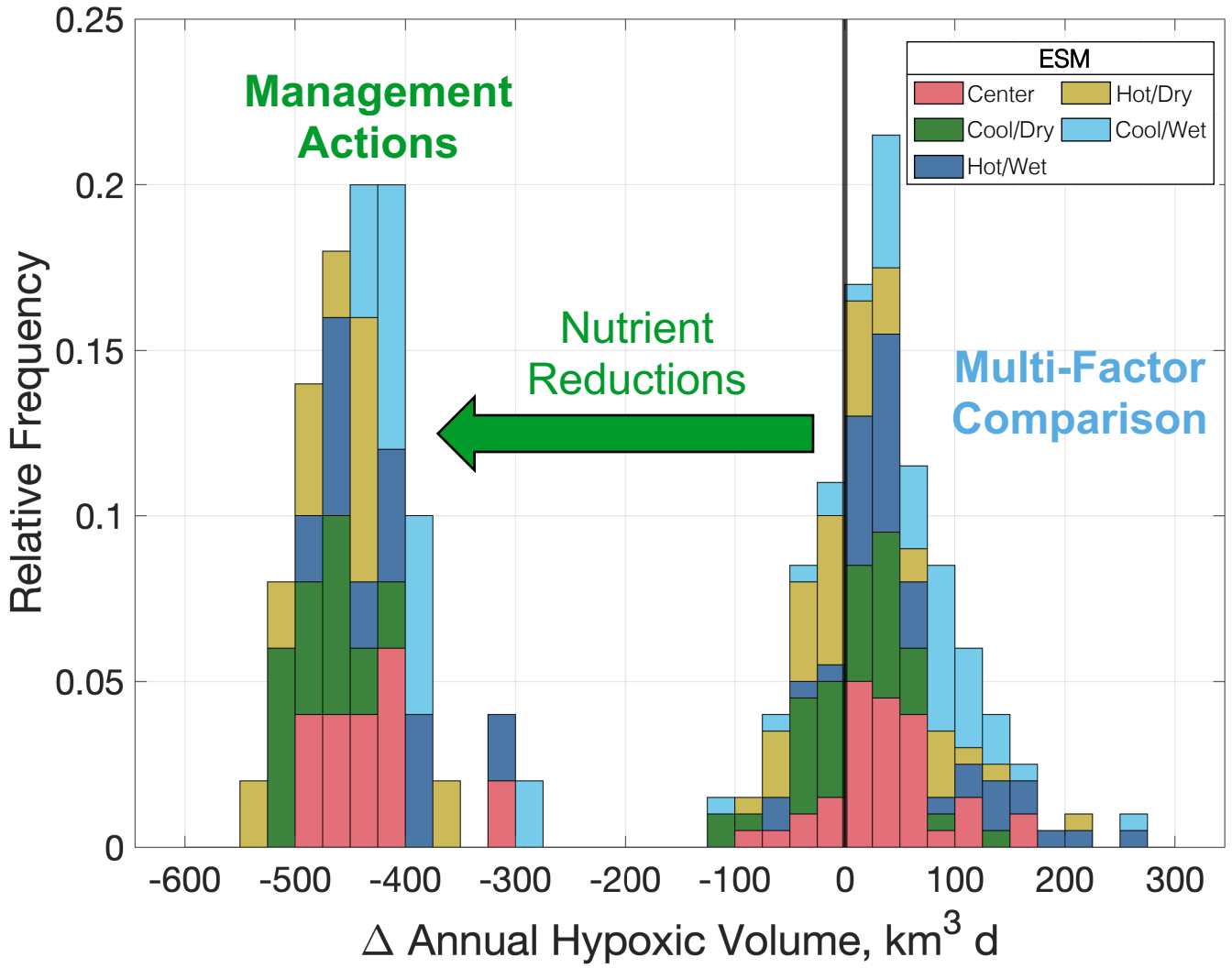
Estuarine Model

Hypoxia



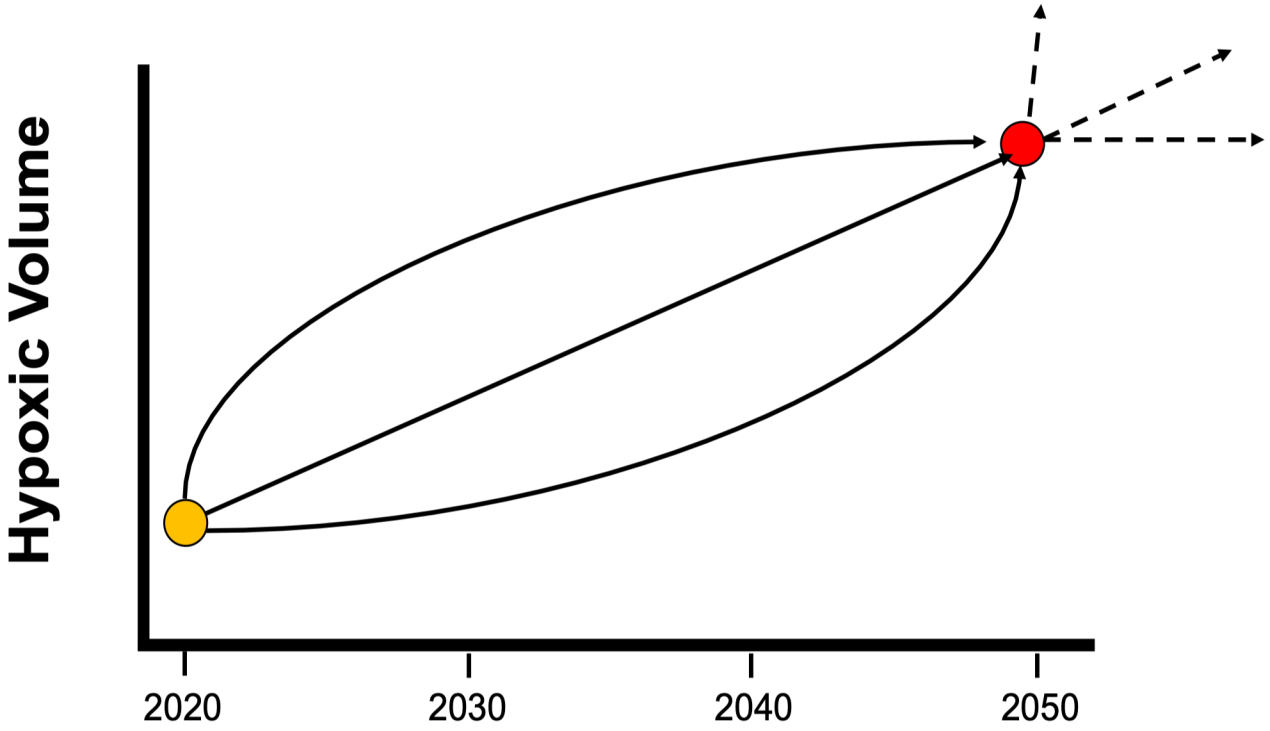
Previous Uncertainty Quantification



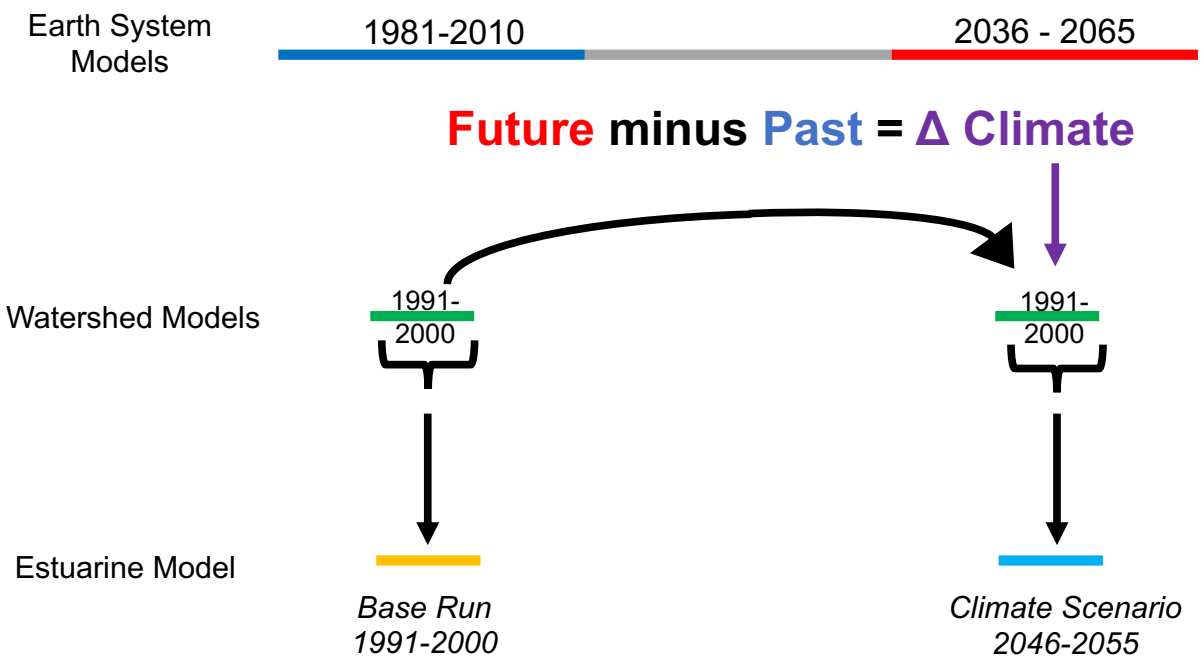


Hinson et al., 2023 *Biogeosciences*

Climate Scenario Methodologies



Continuous Simulation



Delta Simulation

- ***Does the method used have a substantial impact on hypoxia projections?***

Research Question

How does our climate scenario approach affect future uncertainty?

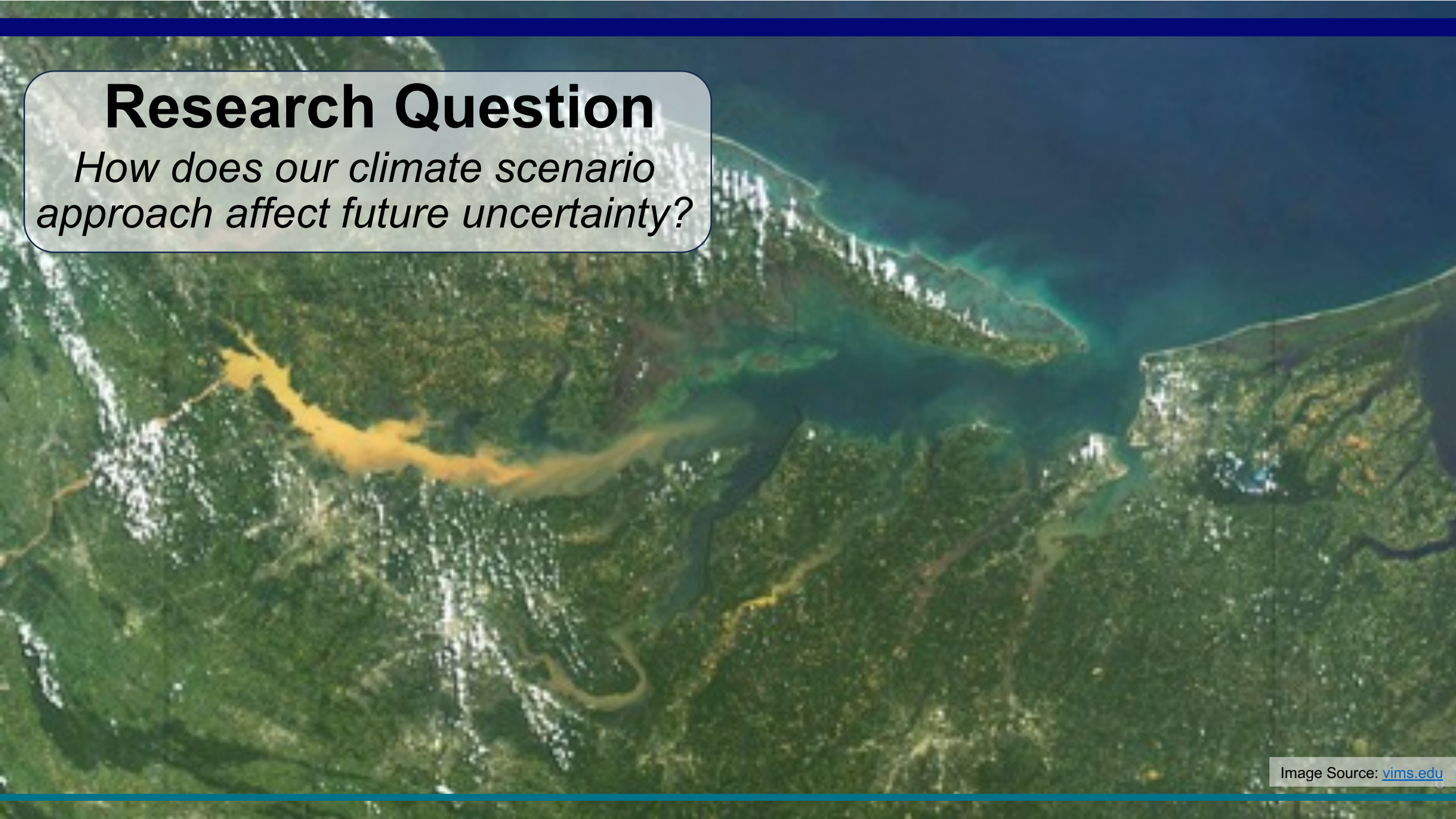


Image Source: vims.edu

ChesROMS-ECB Overview

Atmospheric Inputs

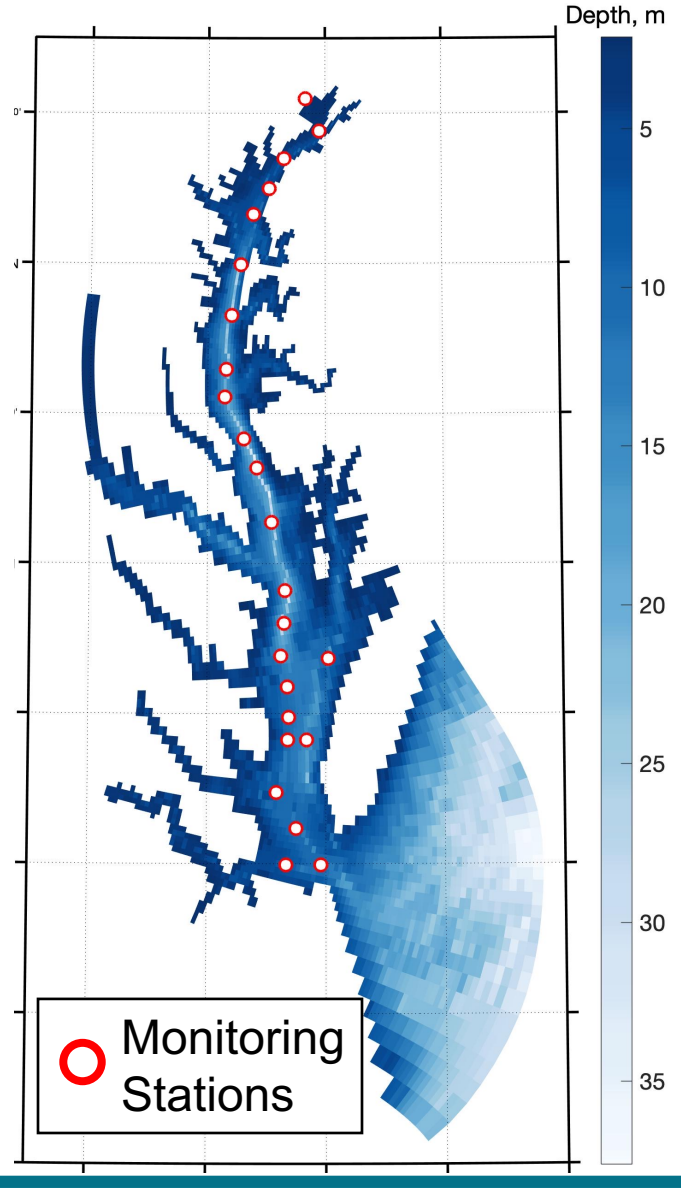
→ Hindcast weather data

Coastal Fluxes

→ Climatological data

Riverine Inputs

→ Watershed Model



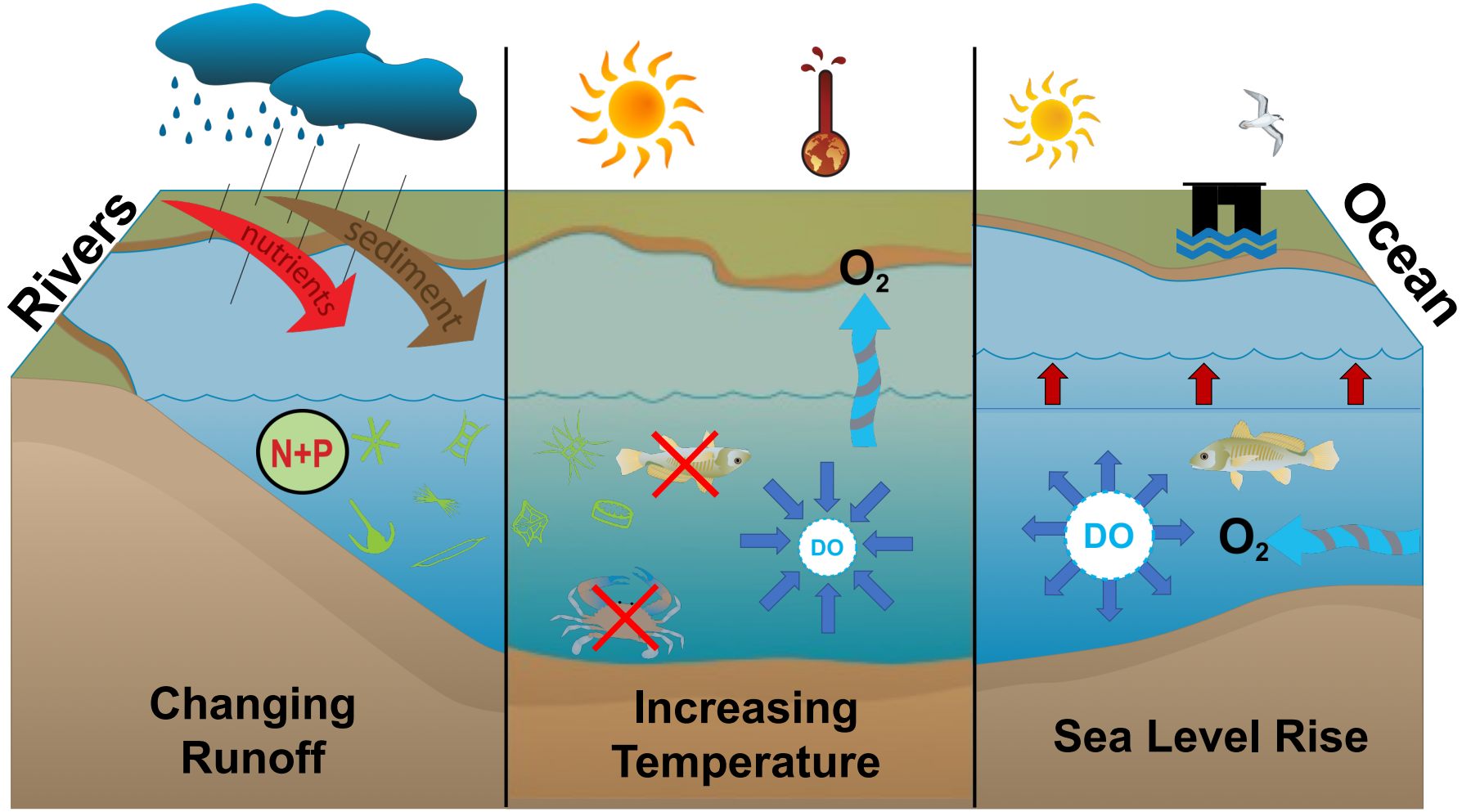
Model Information

3-D model, 20 depth levels
Daily outputs

Model Outputs

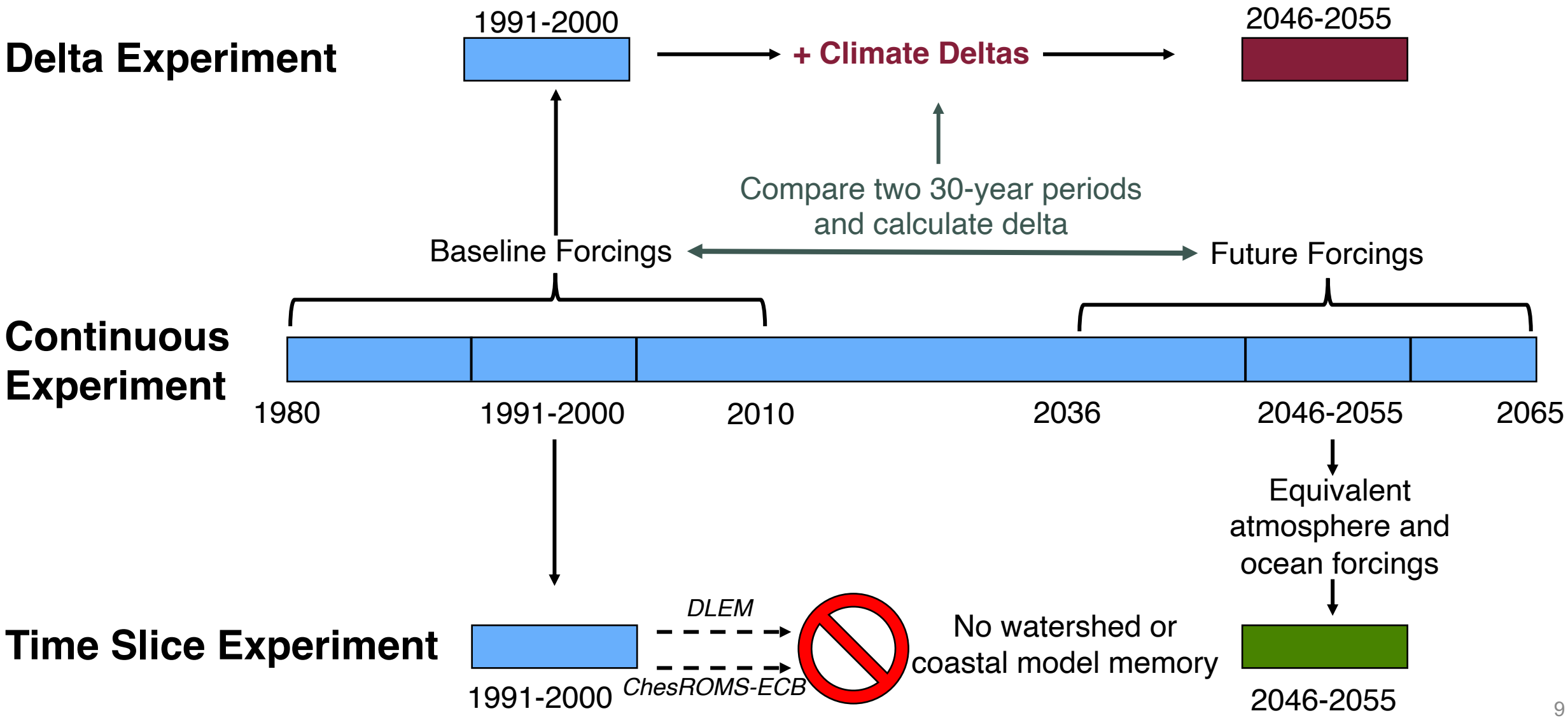
Hydrodynamics and Biogeochemistry

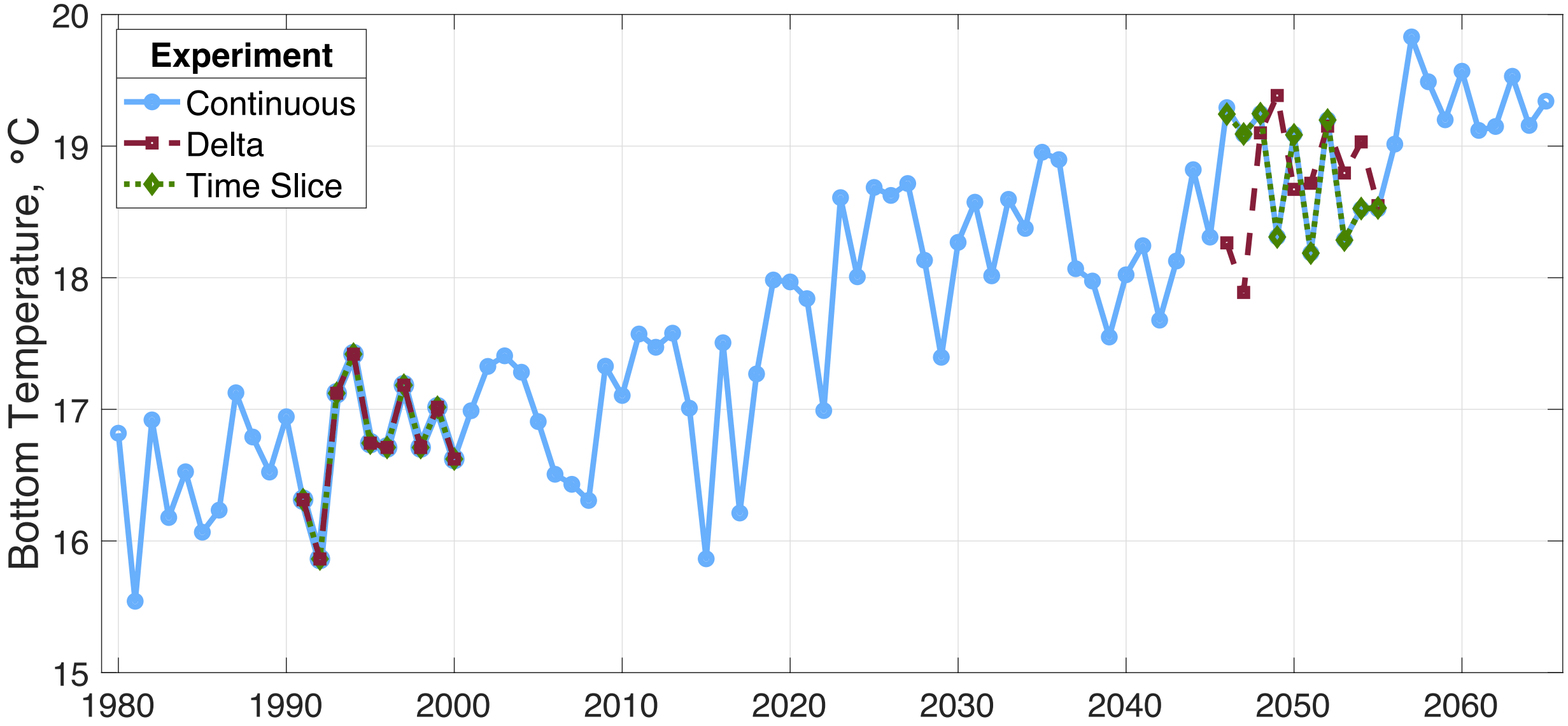
Climate Scenario Method Comparison



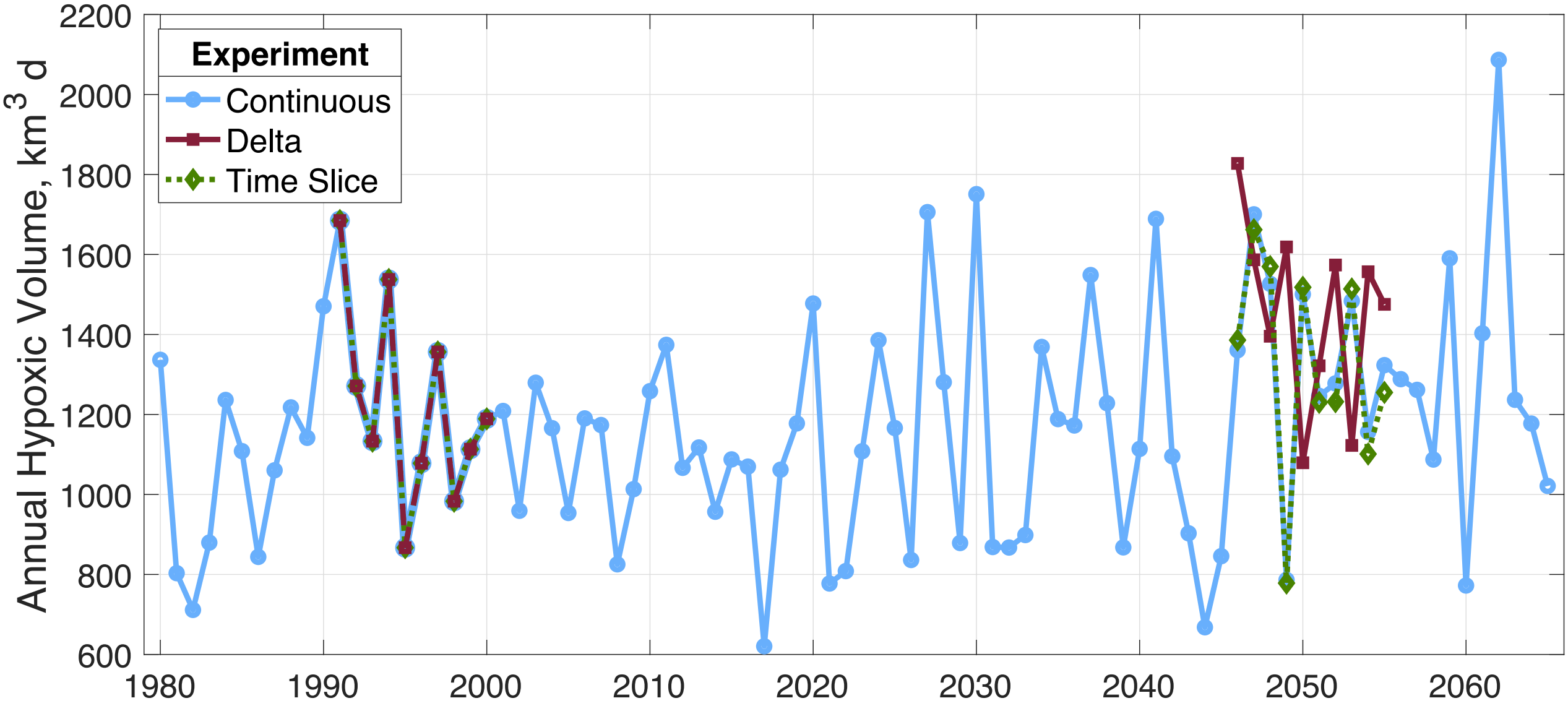
- All climate change impacts applied to future Chesapeake Bay scenarios

Experimental Design

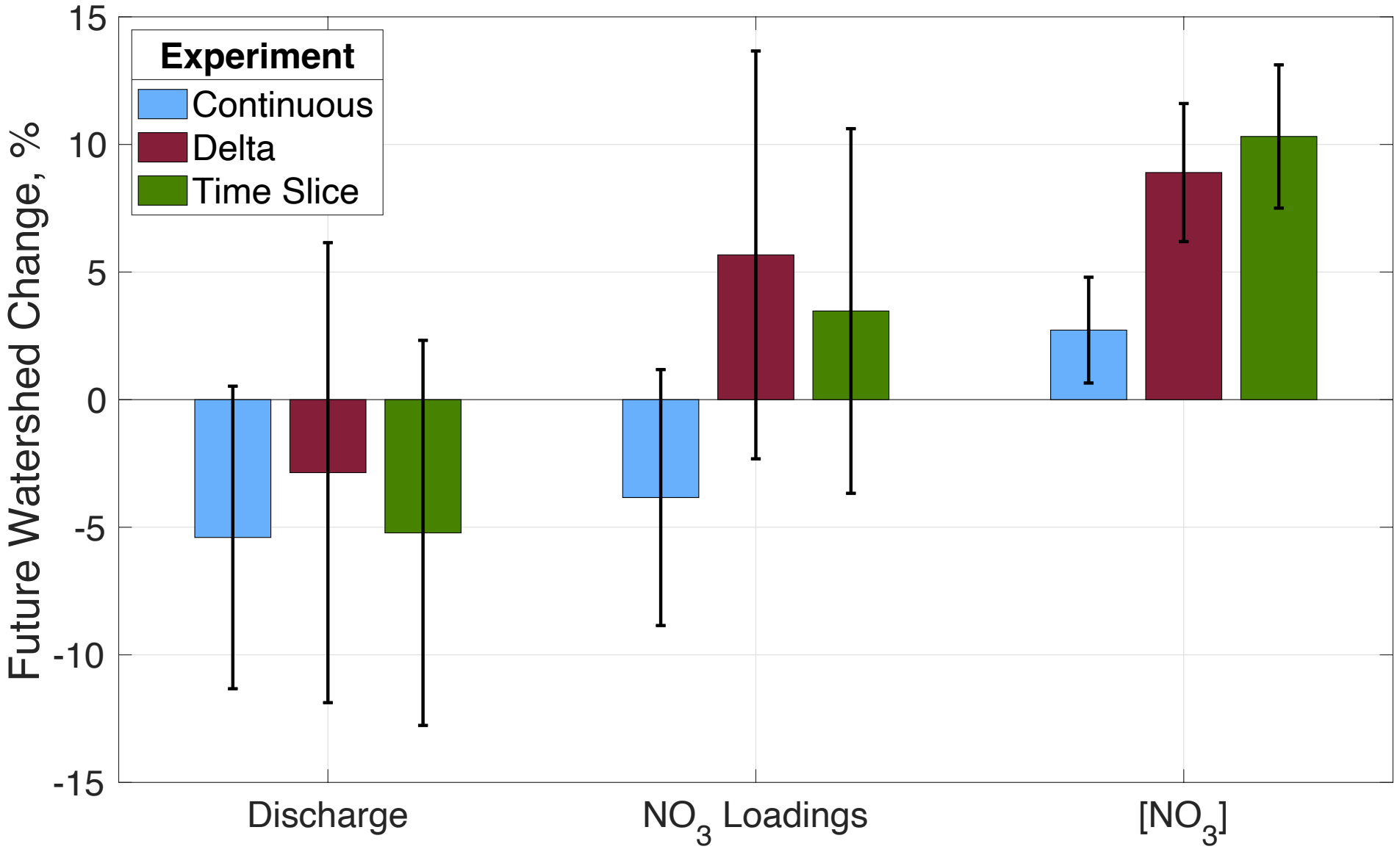




- Equivalent increase in average temperatures for Delta and Time Slice experiments

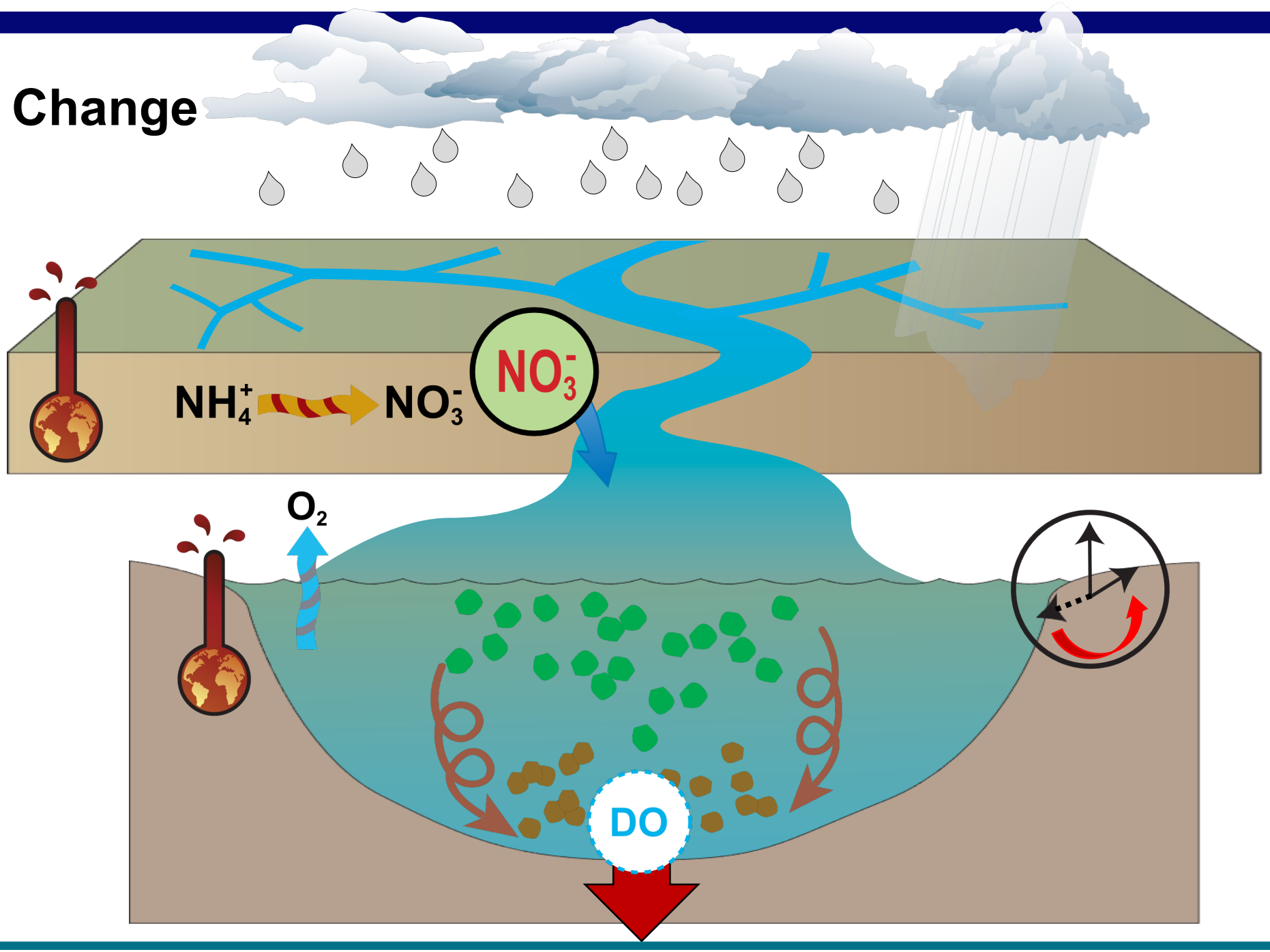


- Nearly equivalent results for Continuous and Time Slice experiments
- Increase in future Delta experiment hypoxia is ~2x greater

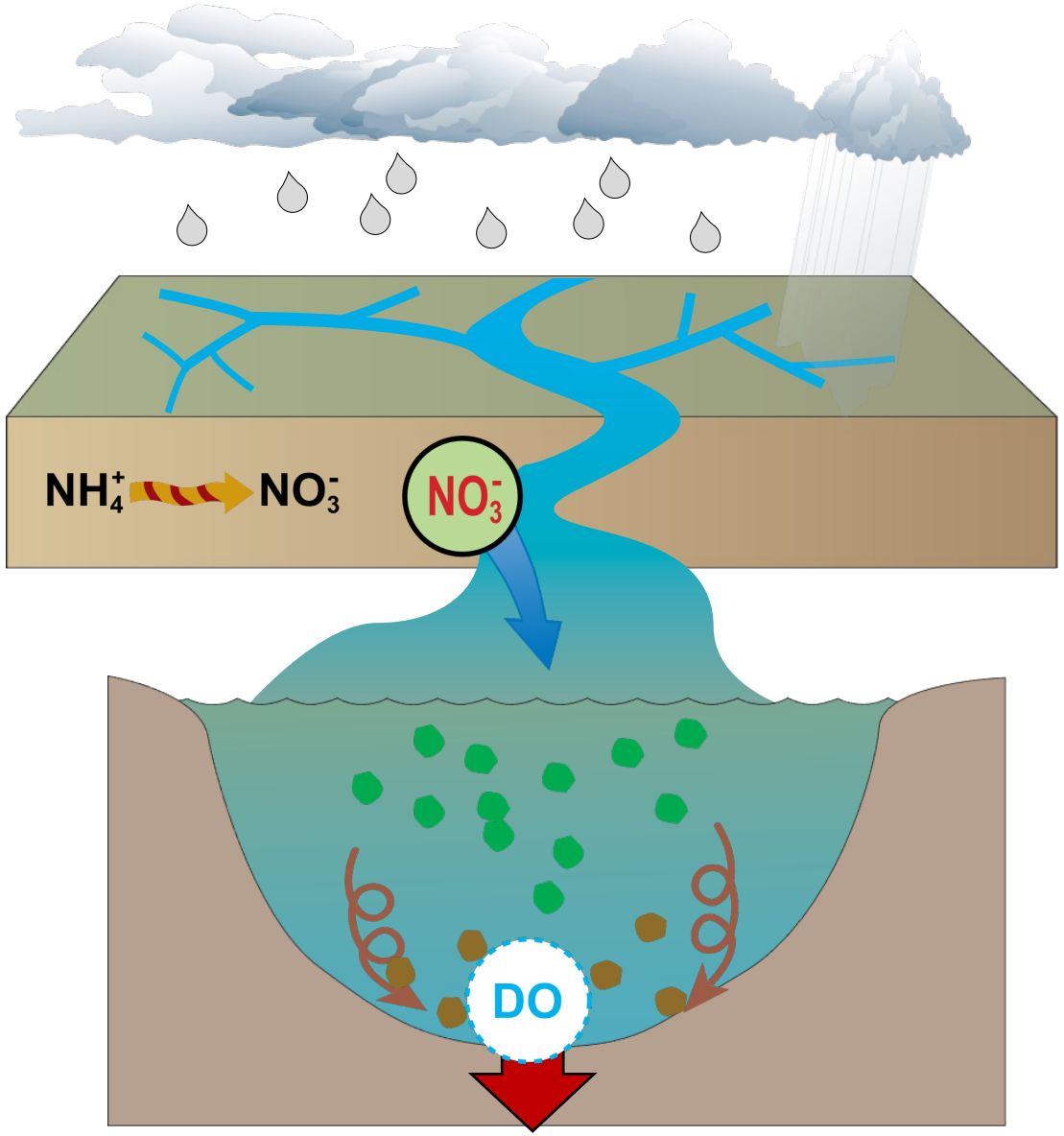


- NO_3 loadings *increase* in Delta and Time Slice, but *decrease* in Continuous
- Difference due to changing discharge and nitrate concentrations

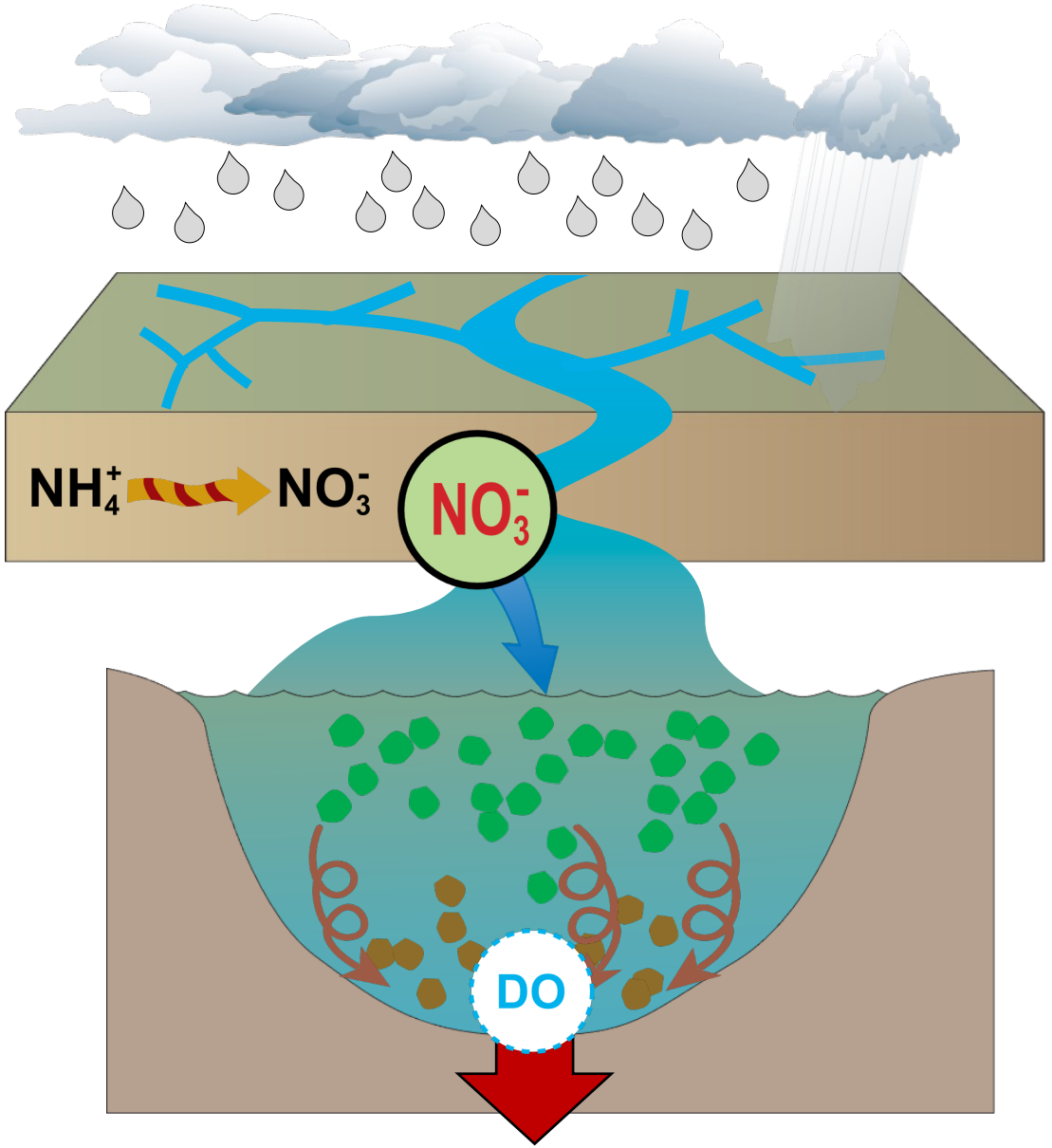
Climate Change



Continuous Experiment



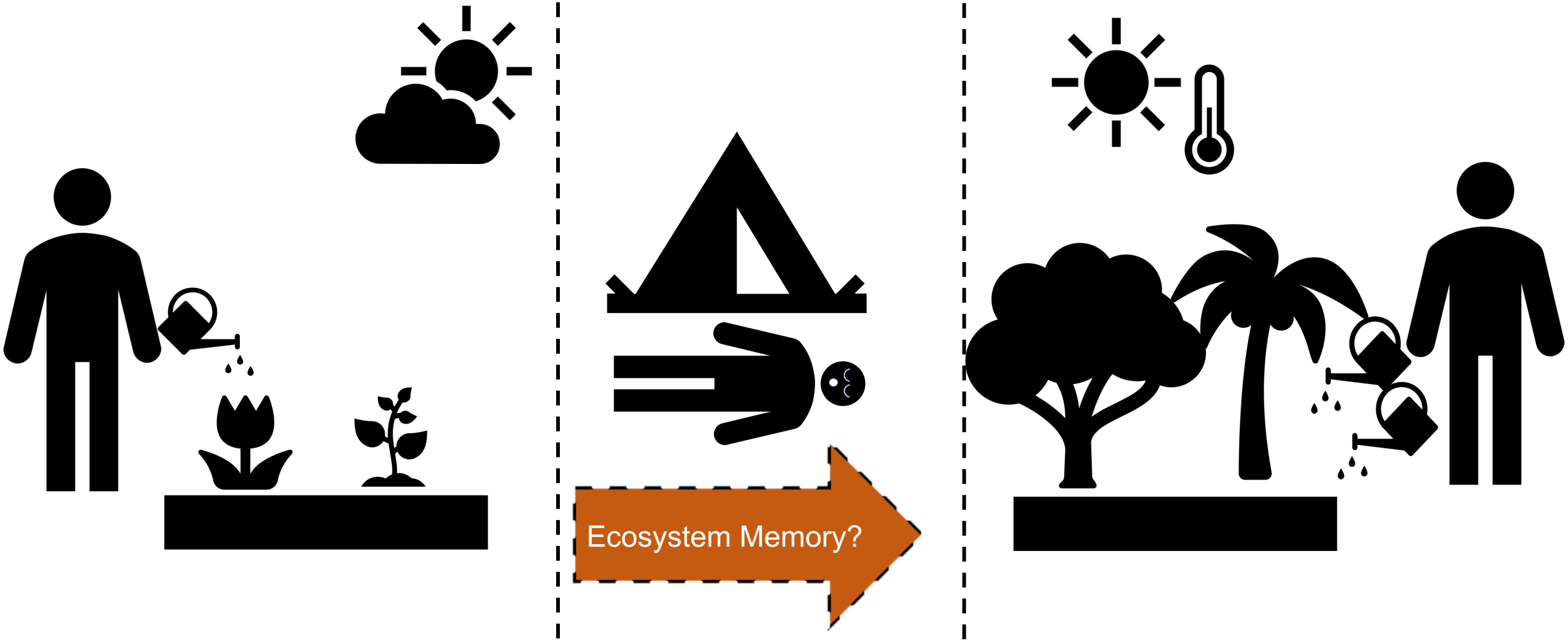
Delta Experiment



Baseline (1990s)

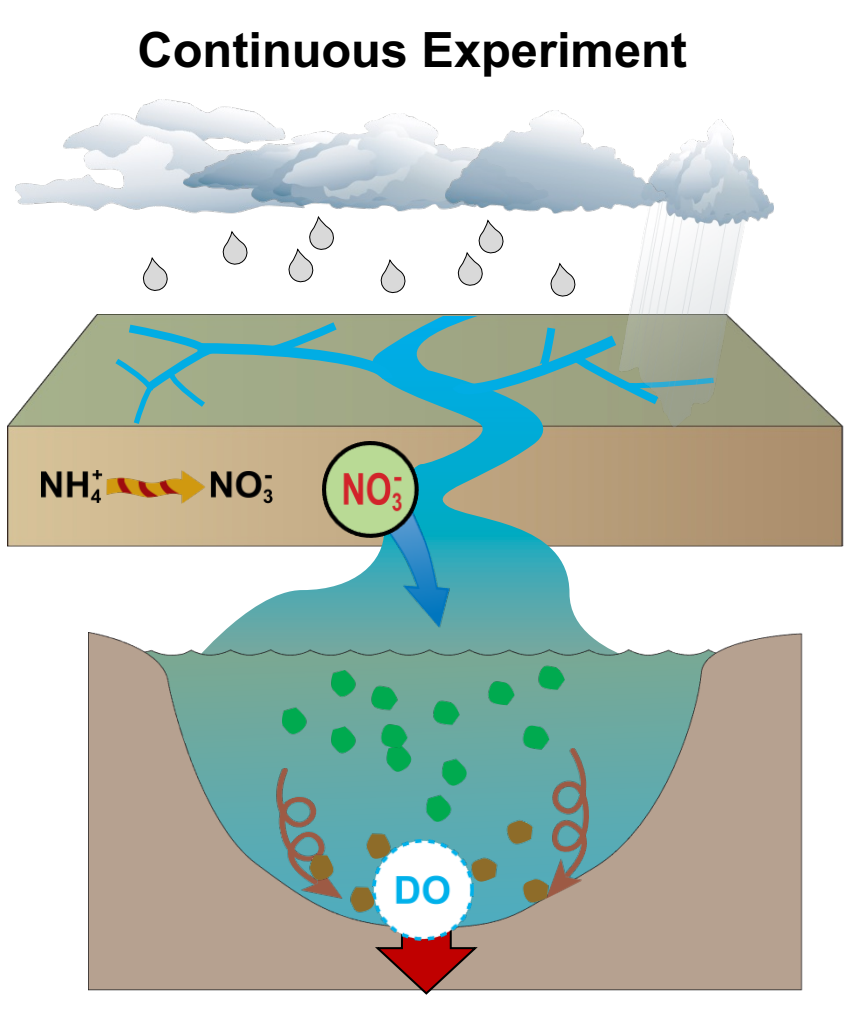
System Evolution

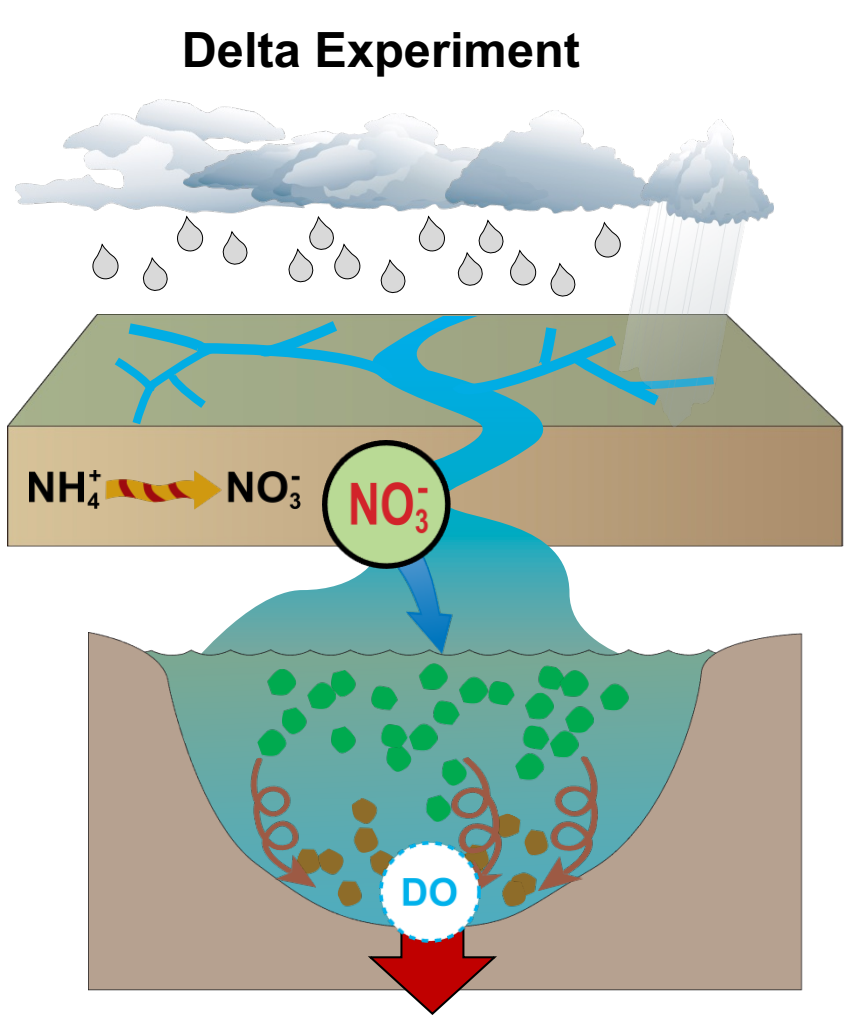
Future (2050s)



Takeaways

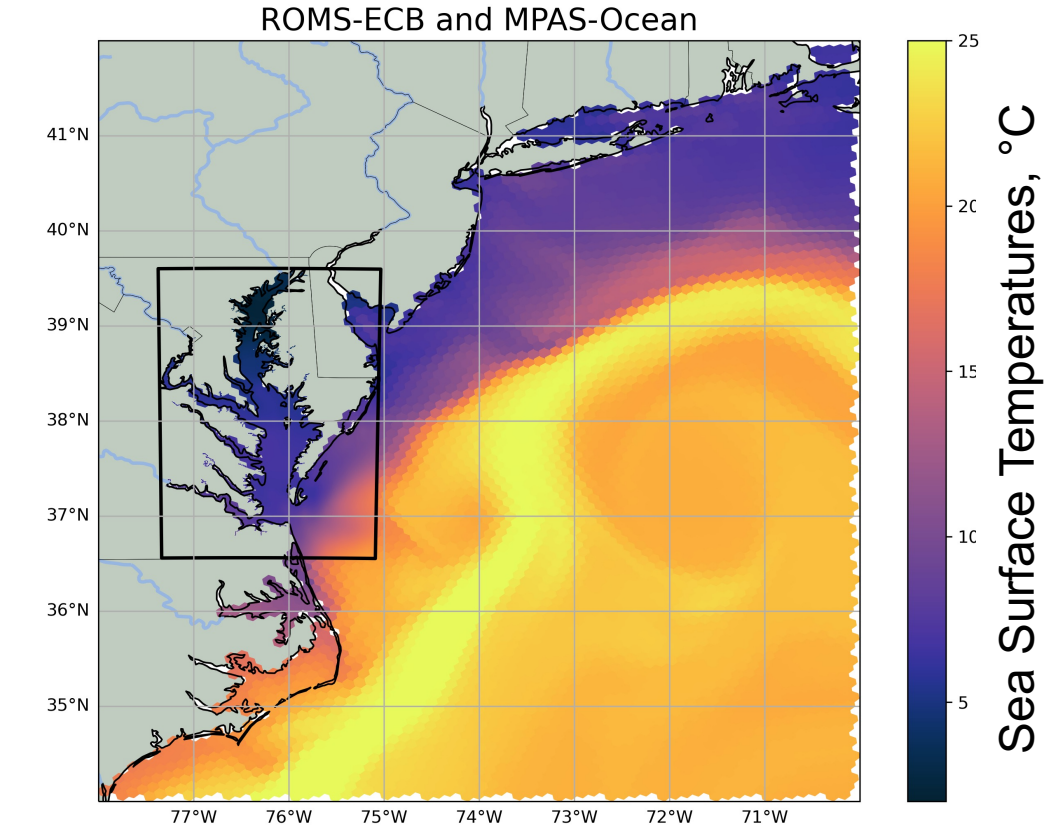
- Future hypoxia affected by biogeochemical changes in Chesapeake Bay *and* its watershed
- Choice of method strongly affects O_2 projections
- Role of ecosystem memory should also be explored further

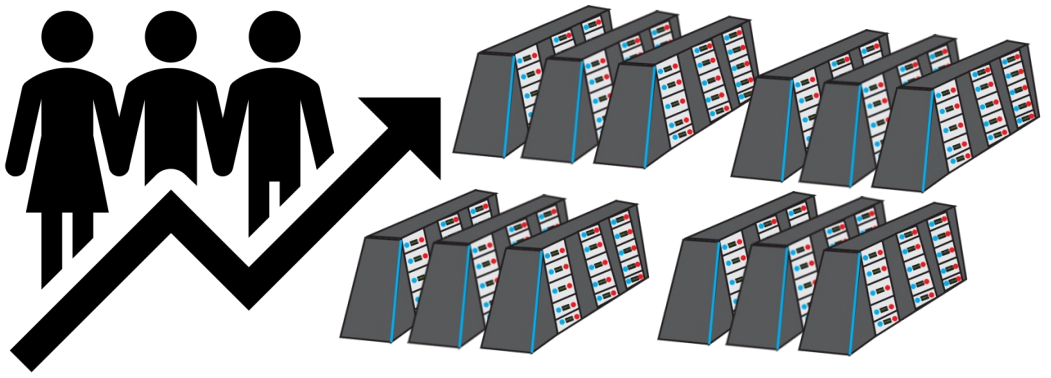




Future Directions

- Consideration of possible feedbacks with larger-scale climate modeling
- Multi-institution effort to simulate future scenarios (previously done in Baltic Sea)
- Evaluate future trends with possible ecosystem shocks





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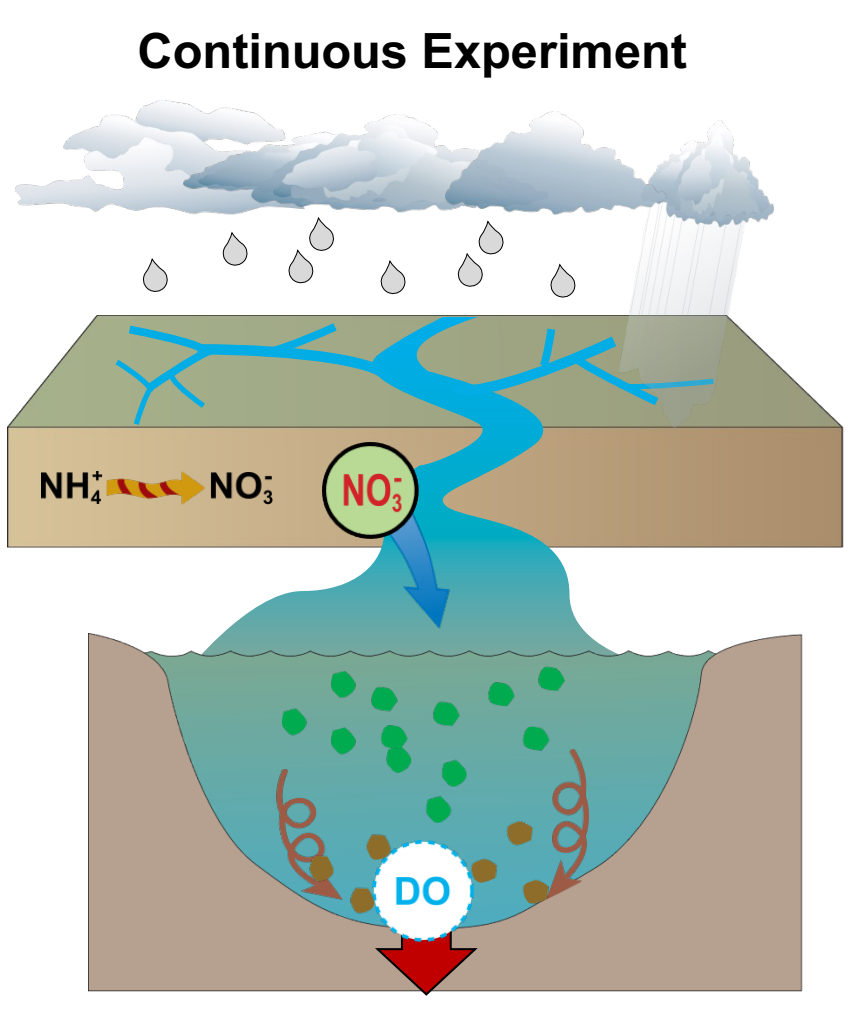

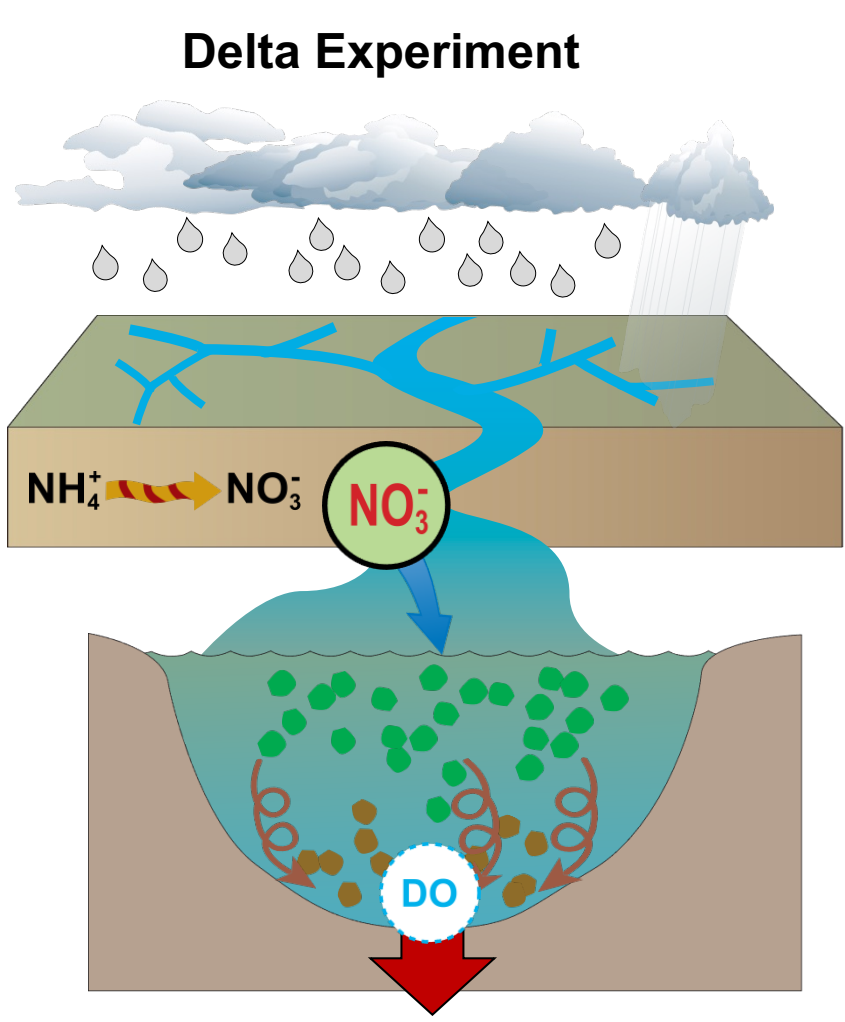

Questions?

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marjy@vims.edu