Impact of Climate Change on Hypoxia in the Chesapeake Bay: Results from ChesROMS-ECB

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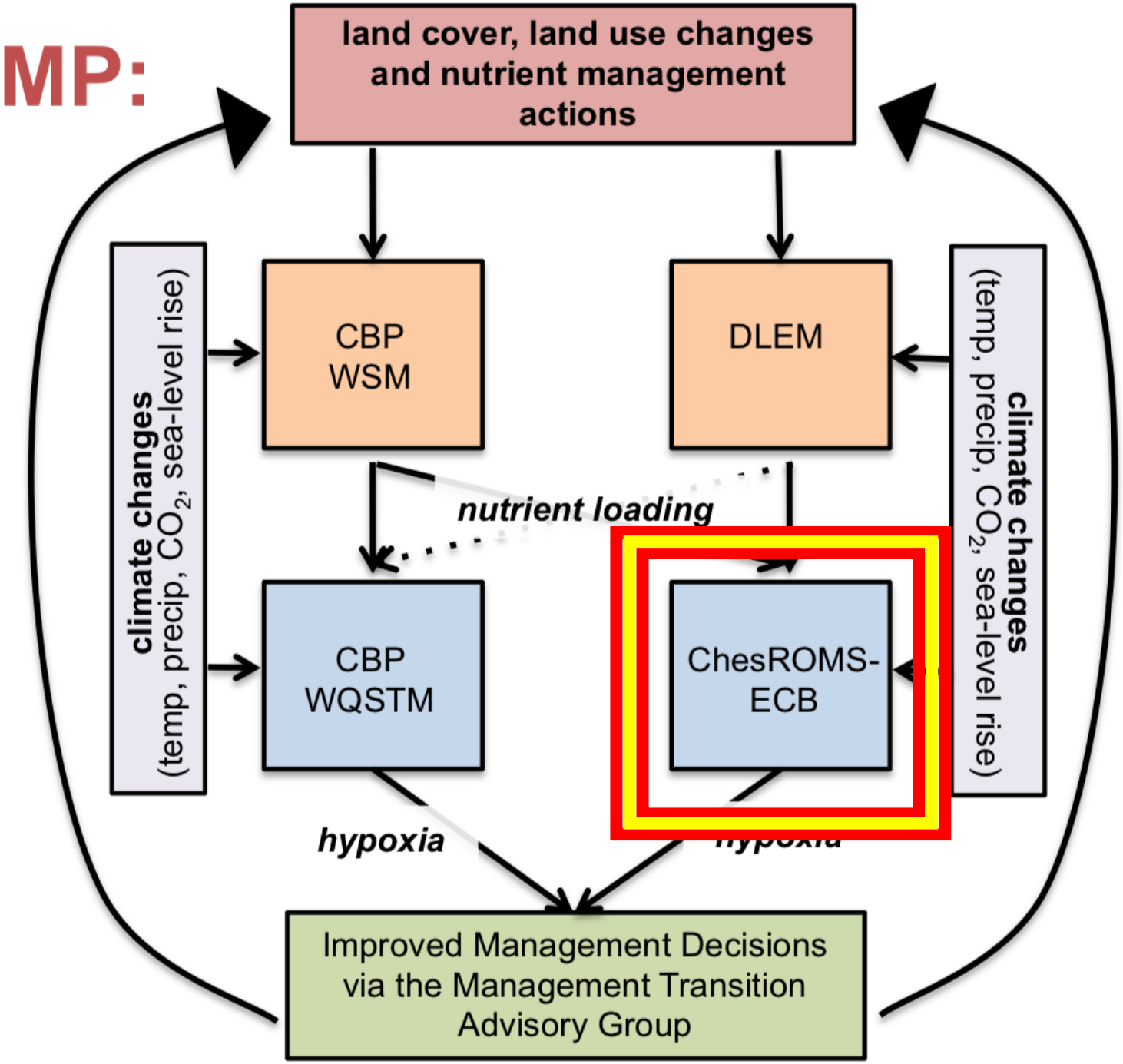
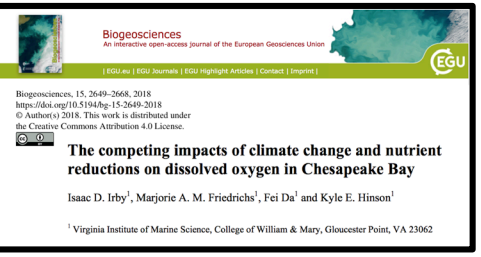
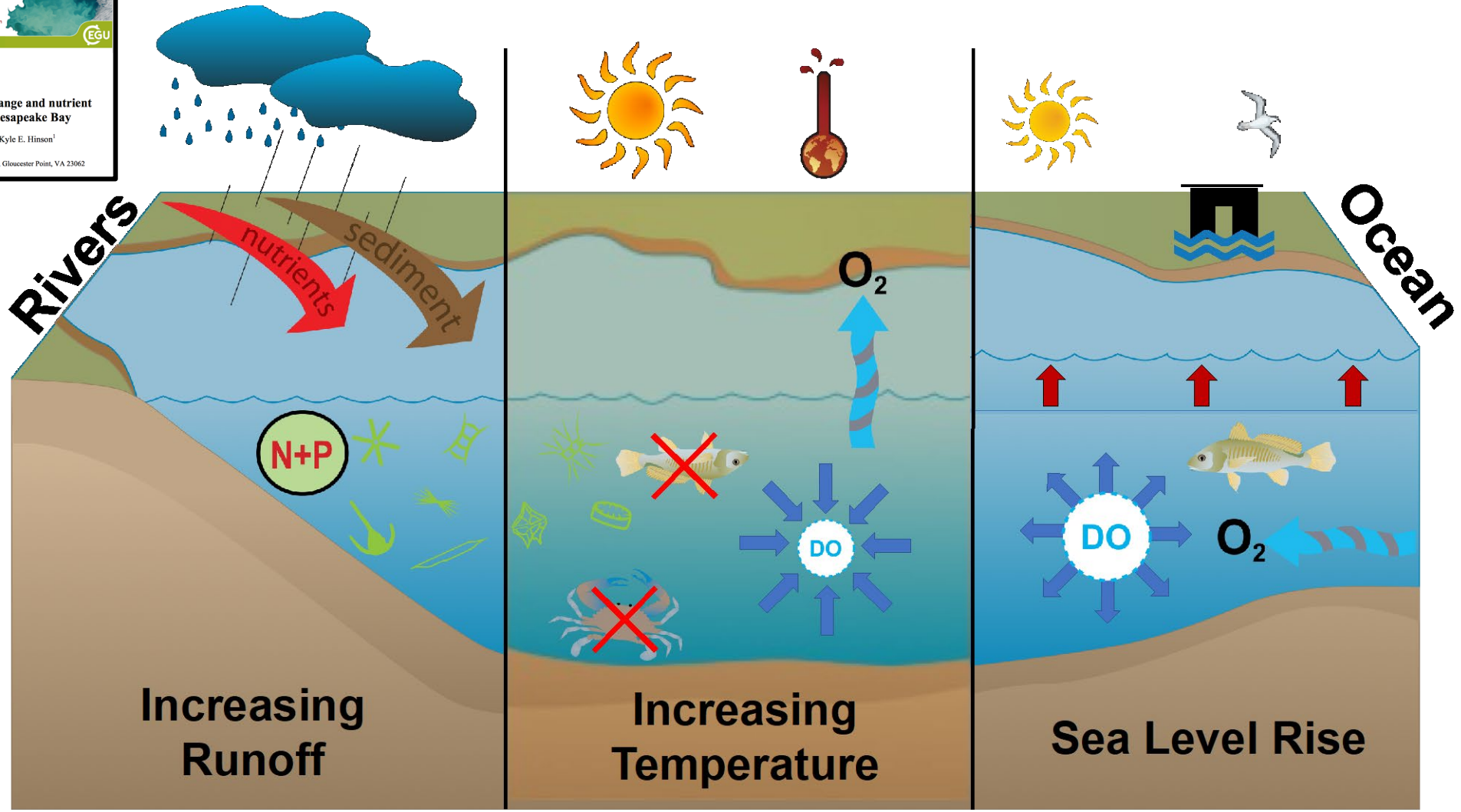
CHAMP:


land cover, land use changes and nutrient management actions
climate changes (temp, precip, CO_2, sea-level rise)
CBP WSM
DLEM
climate changes (temp, precip, CO_2, sea-level rise)
nutrient loading
CBP WQSTM
ChesROMS-ECB
hypoxia
Improved Management Decisions via the Management Transition Advisory Group

Overview

- **Previous CHAMP Climate Change Research**
  - Irby, Friedrichs, Da and Hinson, 2018
- **Preliminary Results: Impact of 2025 climate change on future NO_3 loading**
    - Global Climate Models (20+ models)
    - Downscaling Methods (BCSD vs. MACA)
    - Emission Scenarios (RCP 4.5 vs. 8.5)
    - Watershed Models (DLEM vs. CBP-Phase6)
- **PhD Chapters**

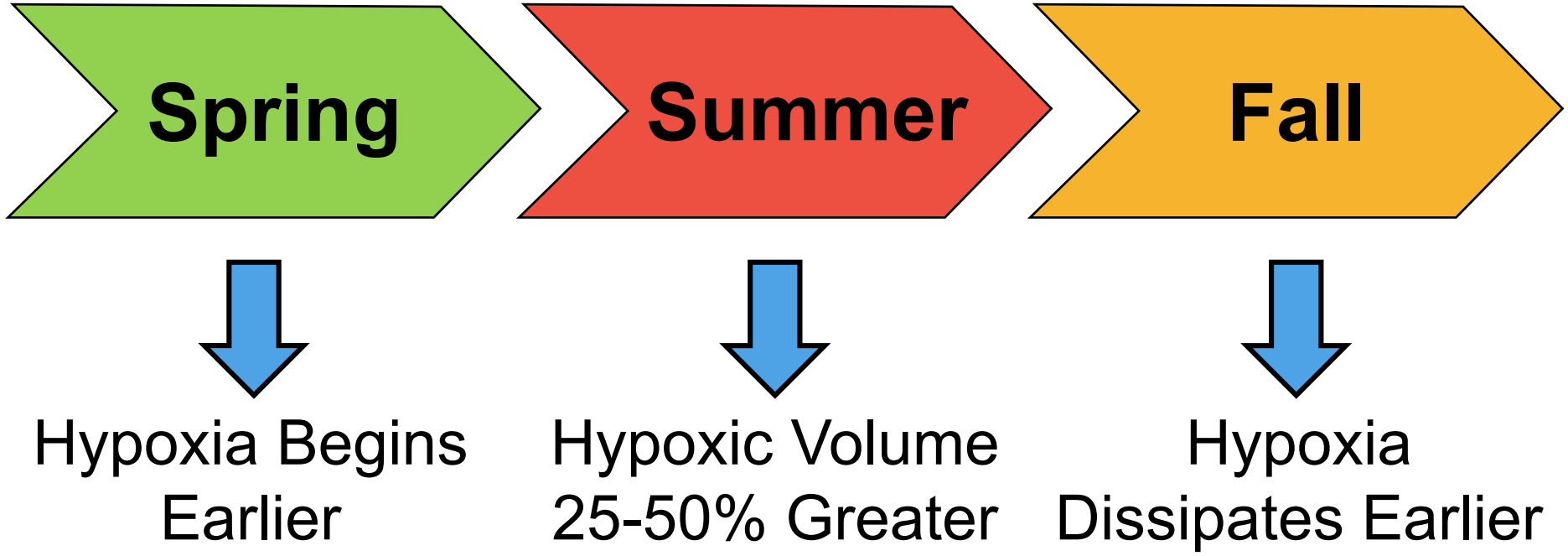




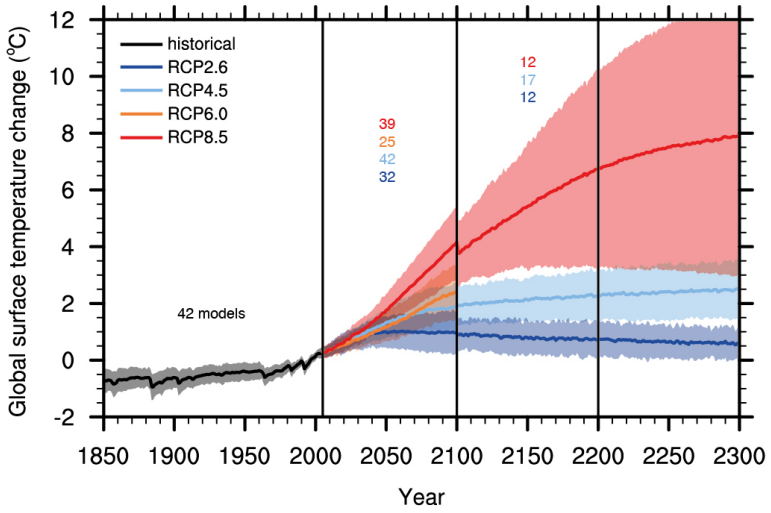
- Rivers/precip have a small negative impact on bottom DO
- Temperature has a large negative impact on bottom DO
- SLR has a small positive impact on bottom DO

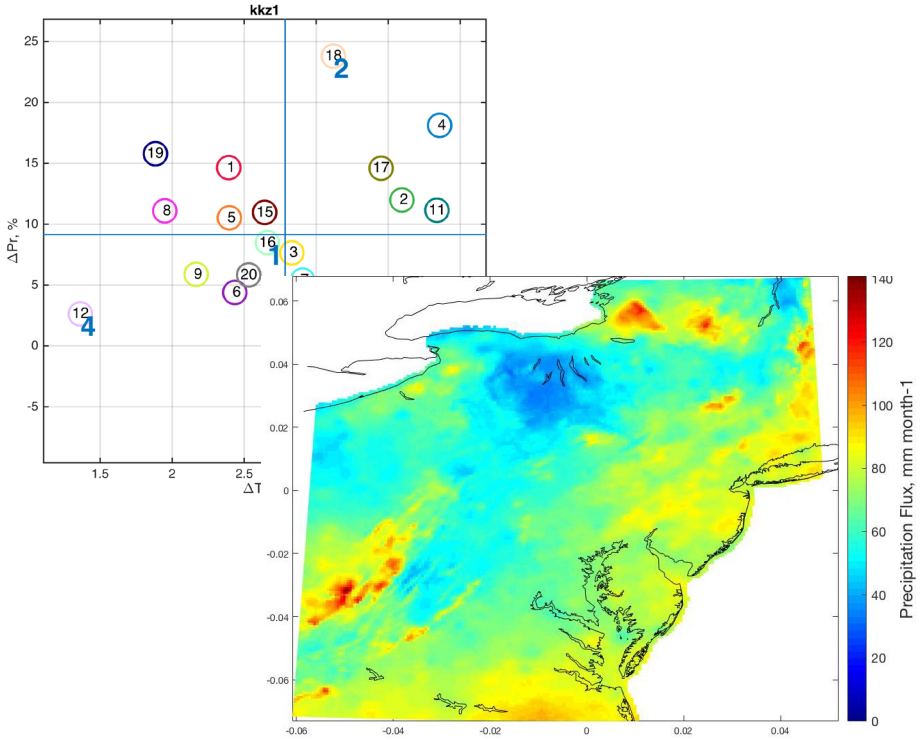
→ Of these three climate impacts, temperature is greatest

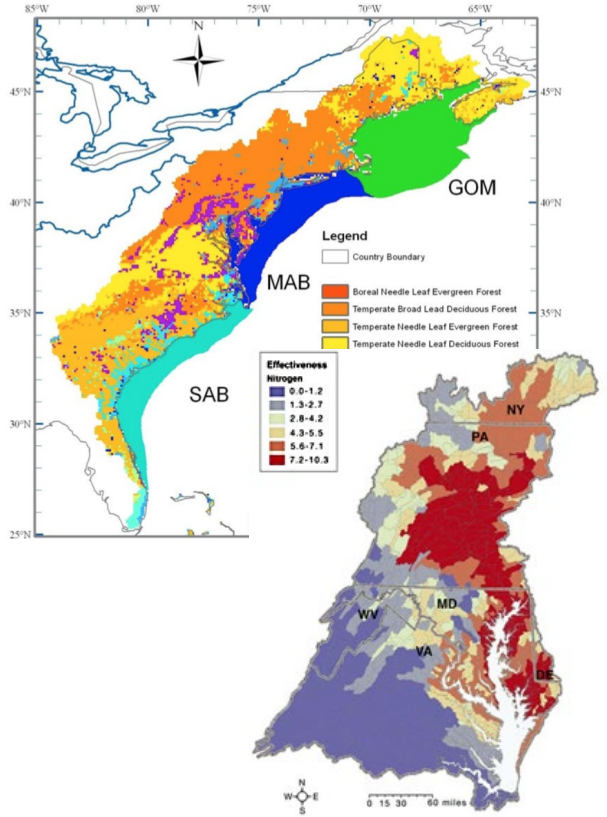
Warmer temperatures (+5°C) cause:



Effects of Climate Watershed Model Forcings on Bay Water Quality







Emissions Scenarios
RCP 4.5 vs RCP 8.5

Downscaling Methodology
BCSD vs MACA

Watershed Model
DLEM vs CBP WSM

Overview

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- **Preliminary Results: Impact of 2025 climate change on future NO_3 loading**
  - Downscaling Methods (BCSD vs. MACA, 20+ GCMs)
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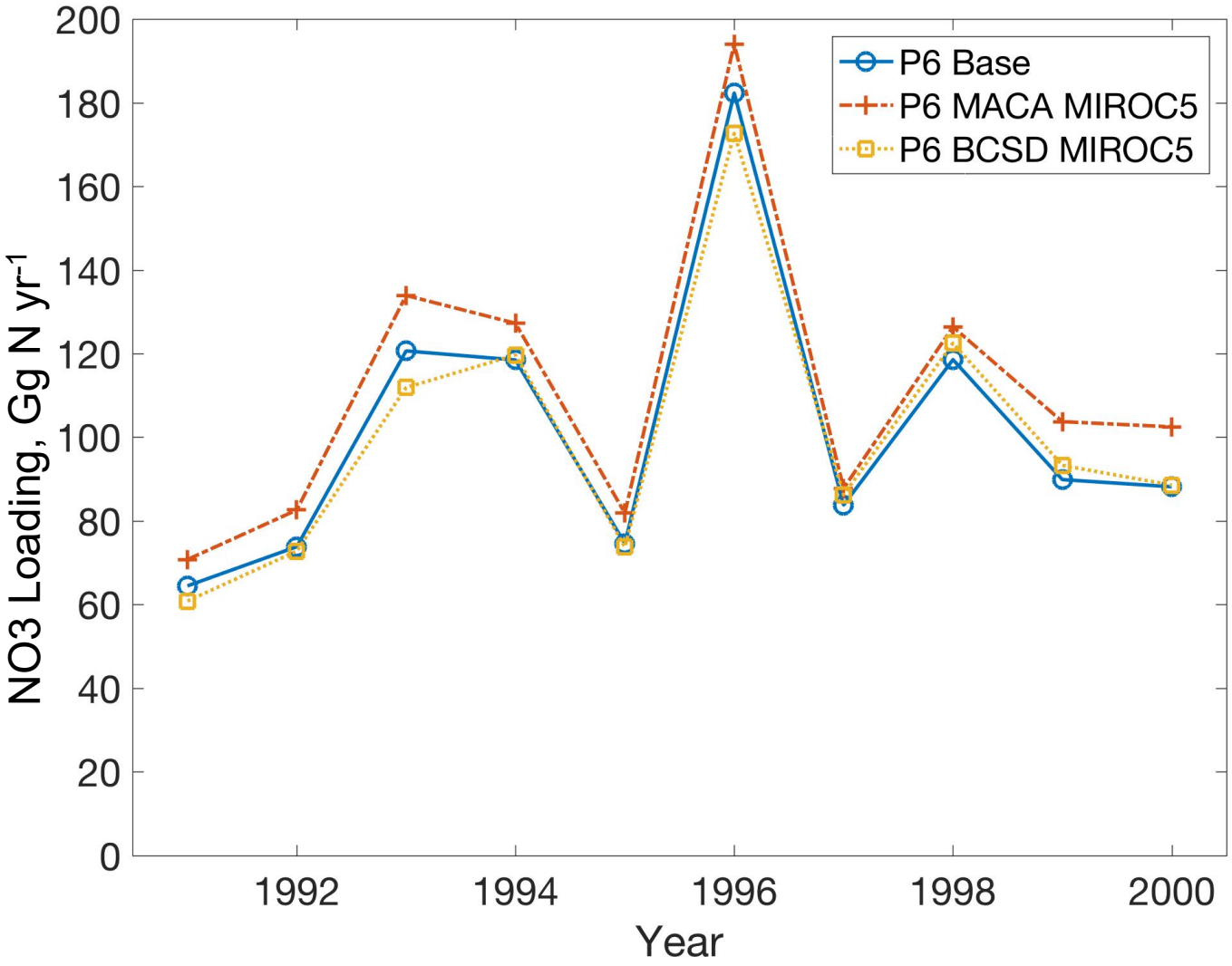
- **PhD Chapters**

Downscaling Effect: MACA vs. BCSD

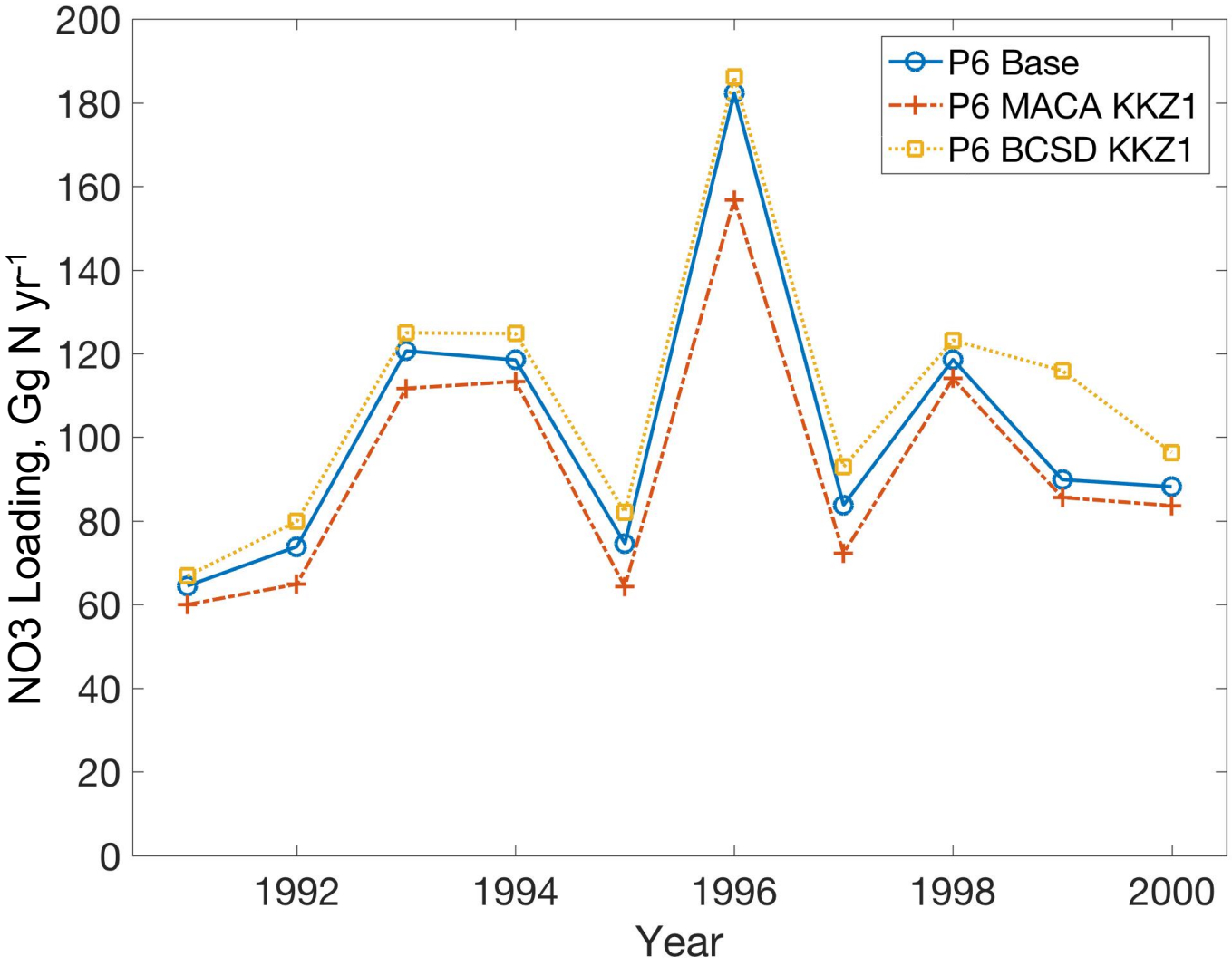
Constants:
- Emissions
- GCM
- Watershed Model



- **Using same GCM, two different downscaling methods often give opposite results.**

Downscaling Effect: MACA vs. BCSD

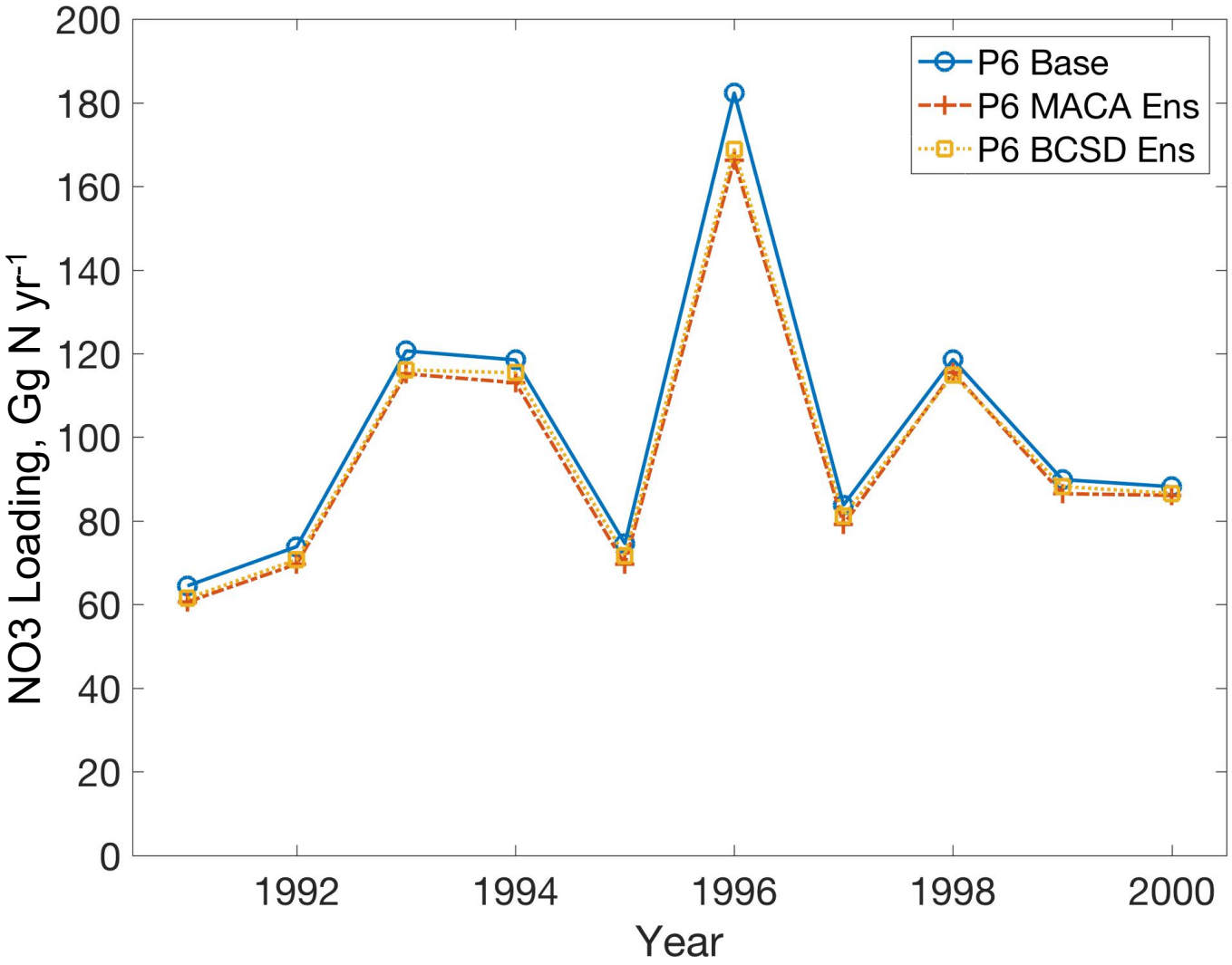
Constants:
- Emissions
- GCM
- Watershed Model



- **Using KKZ method to choose GCM, two different downscaling methods again give opposite results.**

Downscaling Effect: Ensemble GCM

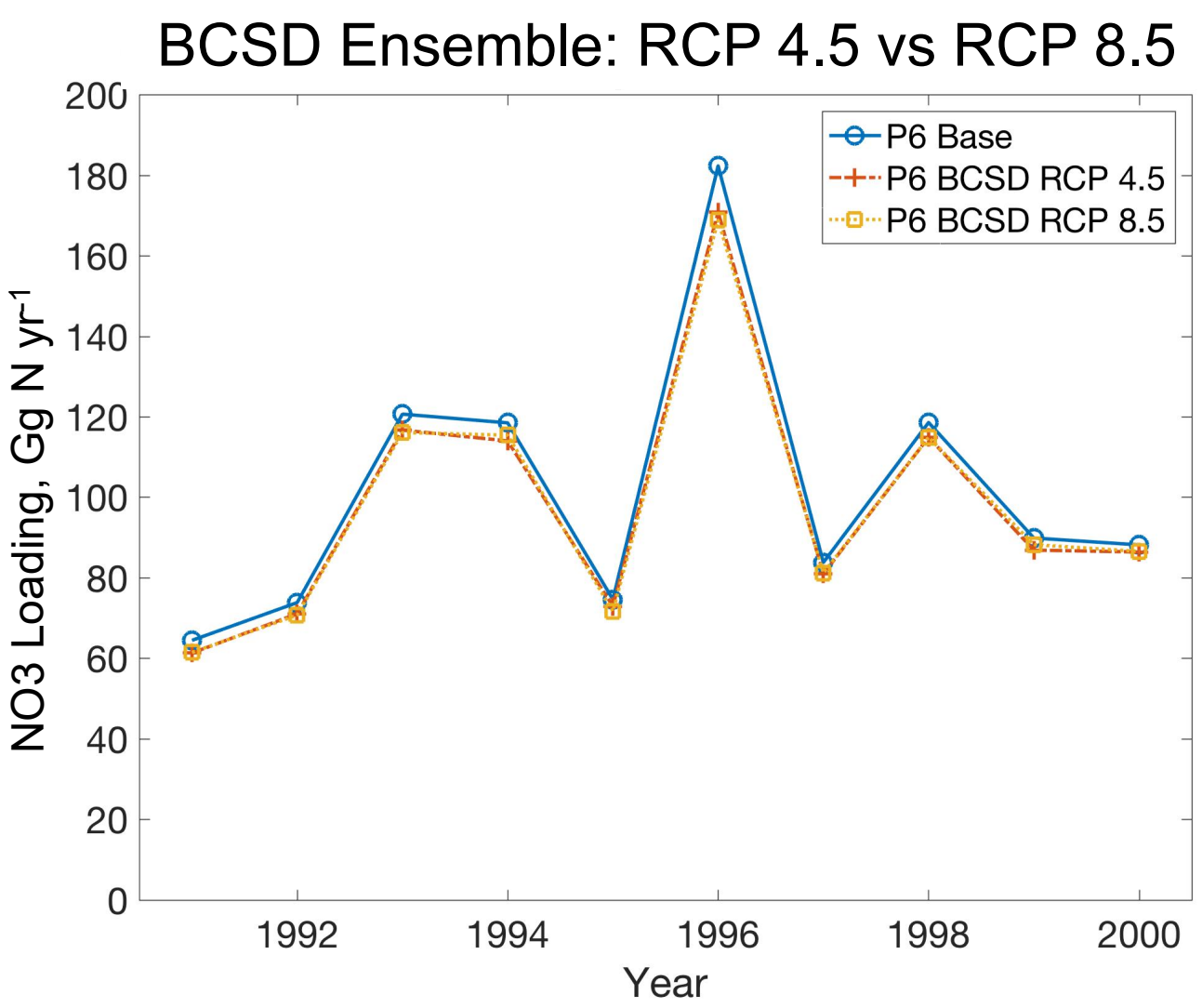
Constants:
- Emissions
- GCM
- Watershed Model



- **Ensemble Median estimates are most consistent between downscaling methodologies**
- **Both show small decrease in average annual NO_3 loading in all years**

Effect of Emission Scenario Choice

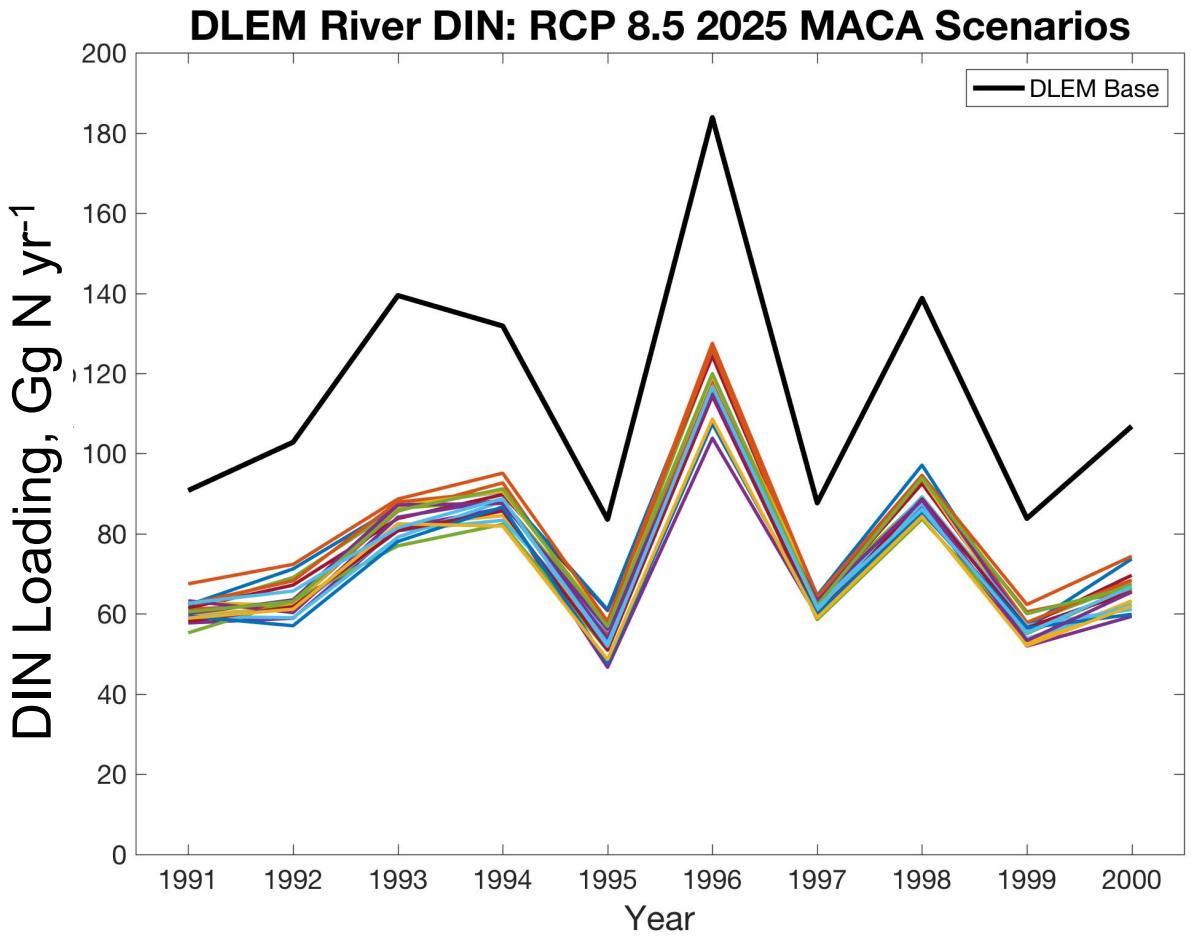
Constants:
- Downscaling
- GCM
- Watershed Model



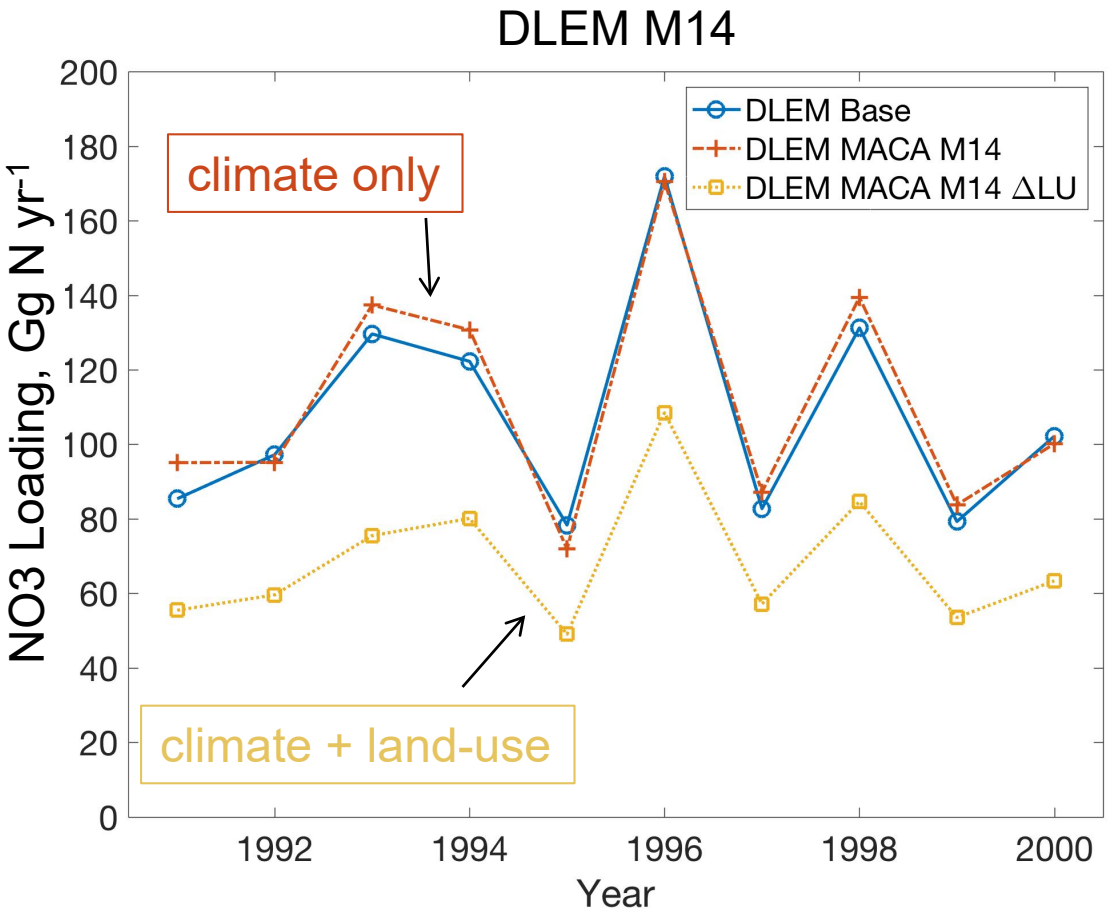
- **Very little difference between RCP4.5 and RCP8.5 in 2025 (BCSD-EnsMed)**

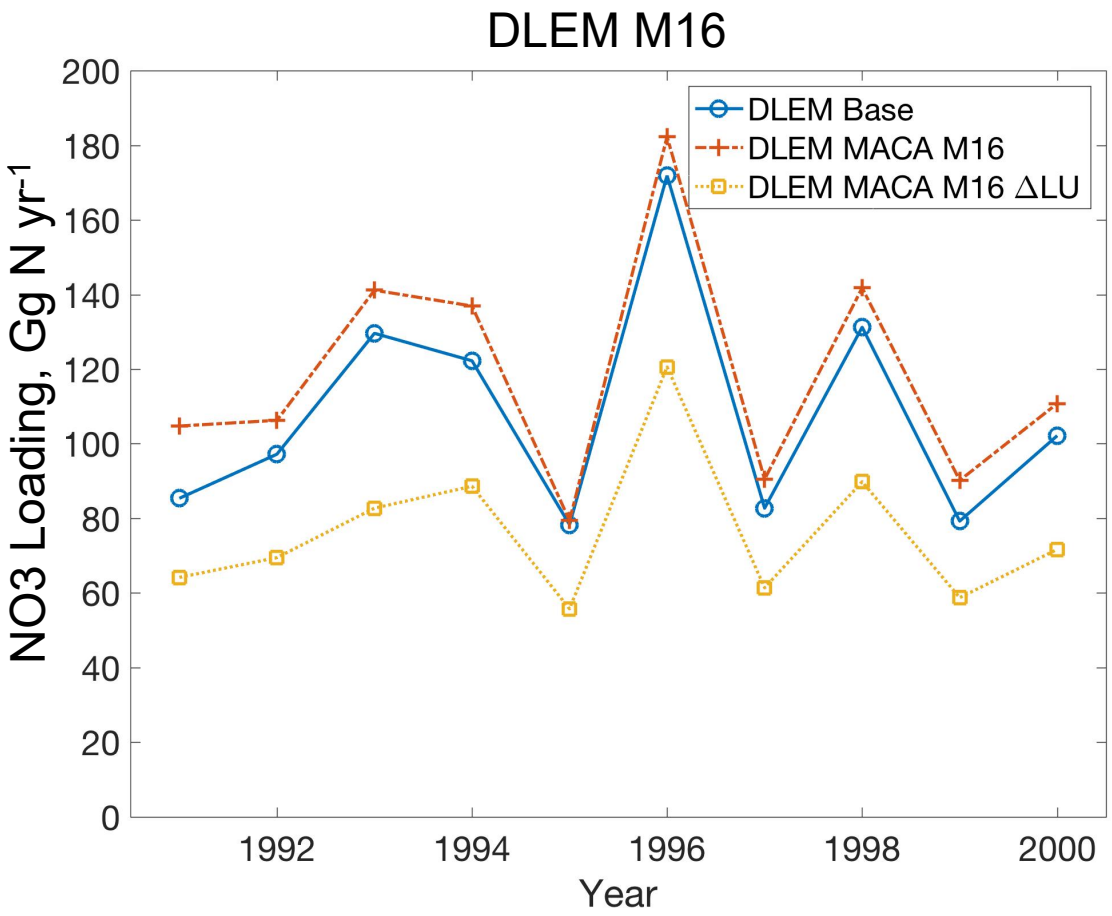
Impact of DLEM Model Selection

- Scenarios include effects of climate change **and** land use change
- Variability among potential future DIN loading
- Overall similar trends due to application of delta approach



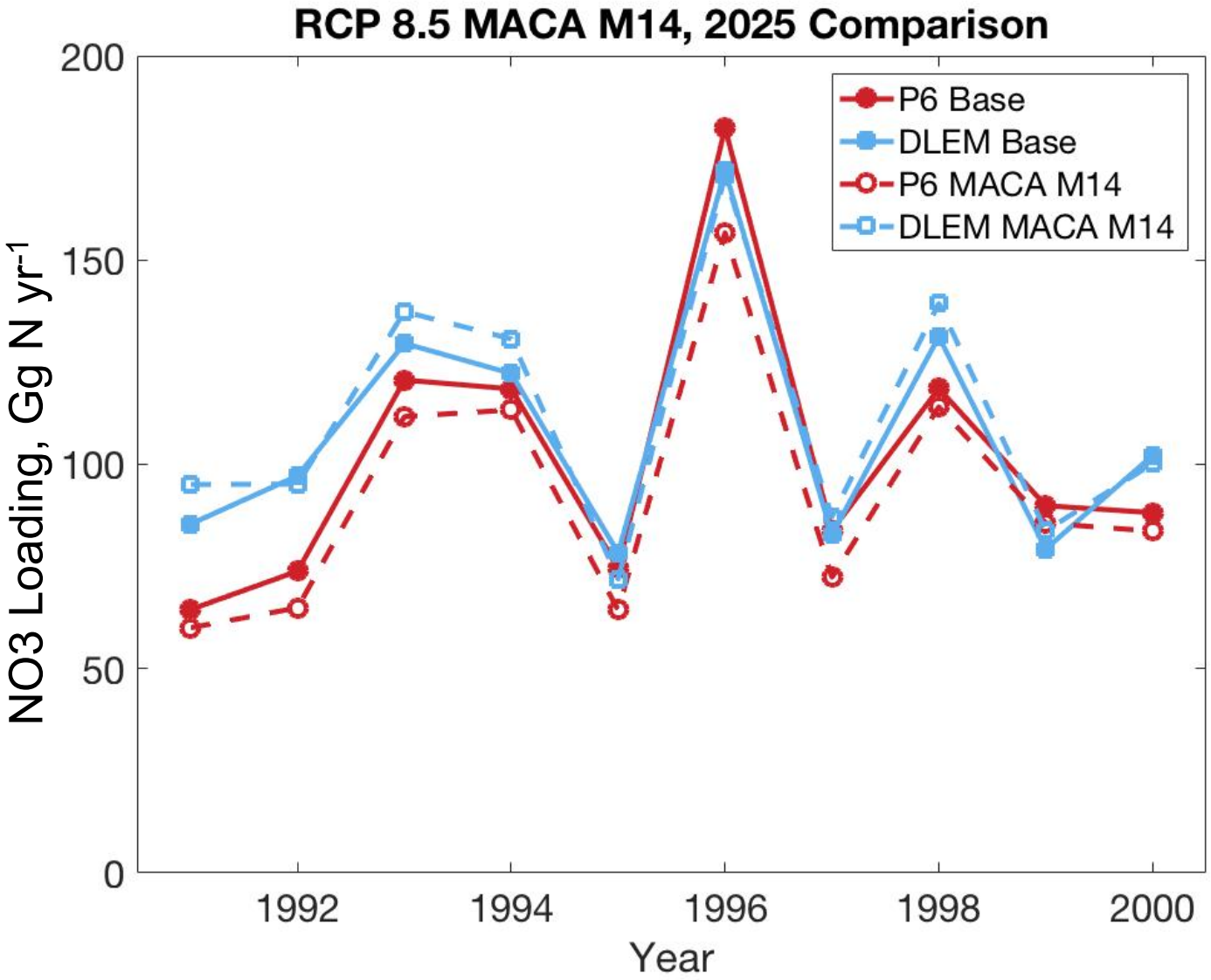
DLEM – Impact of Climate vs Land Use





- **Climate impacts << Land-use impacts on NO_3 loading by 2025**

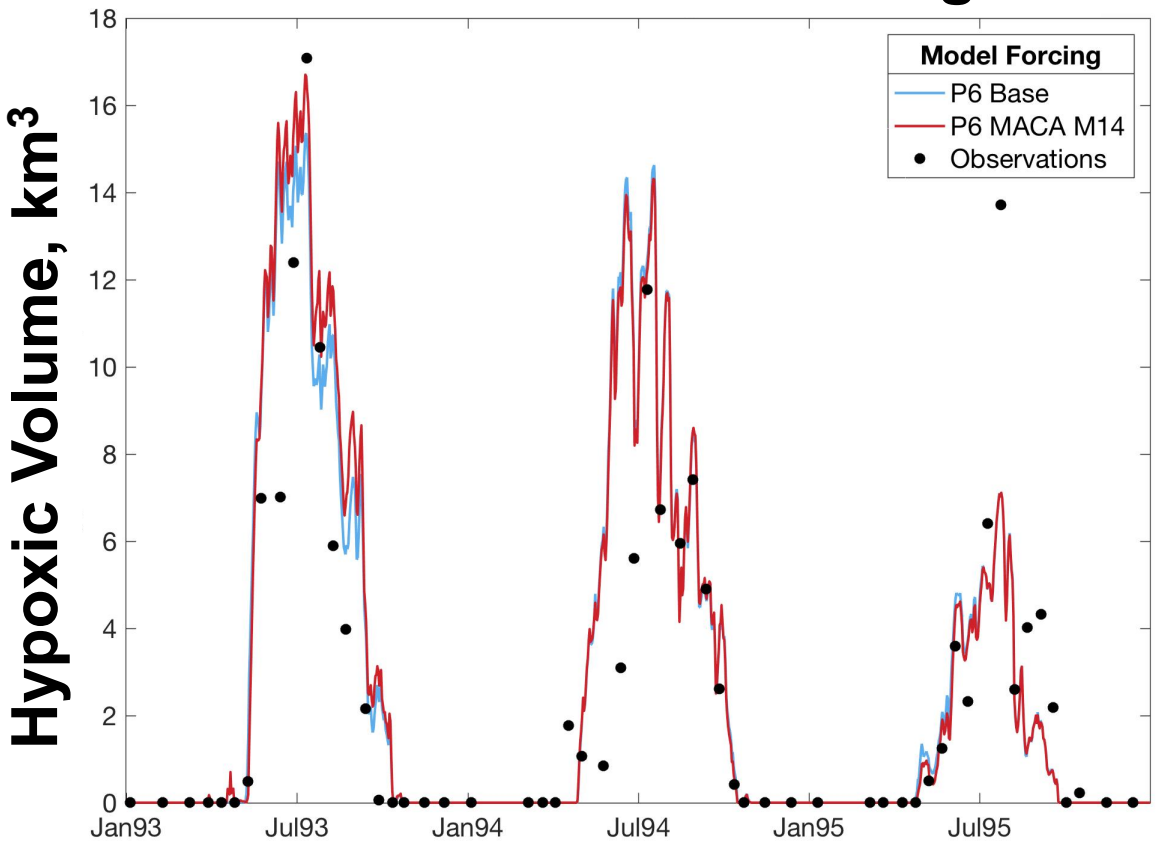
Watershed Model Comparison: DLEM vs. P6



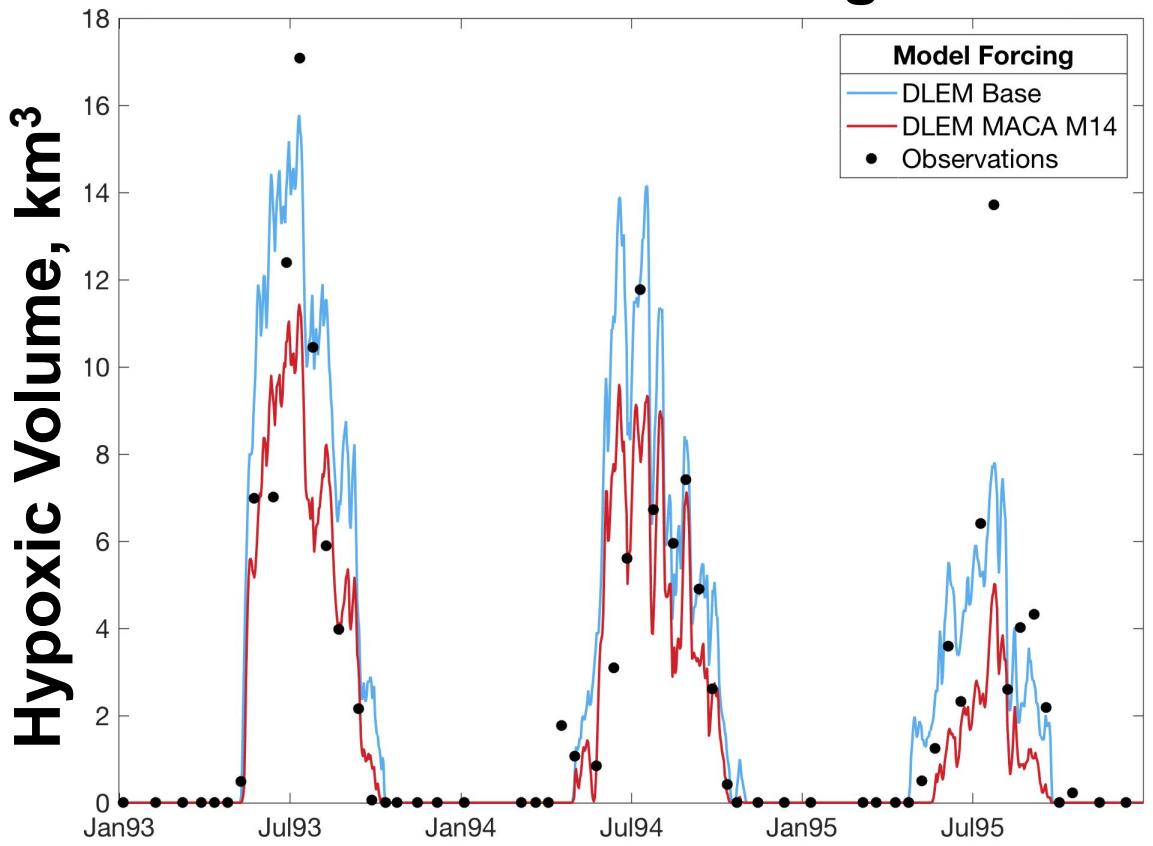
- **Watershed models often show opposite results in terms of climate change impacts on NO3 loading**

Hypoxic Volume

CBP WSM HV: DO < 2 mg L^{-1}



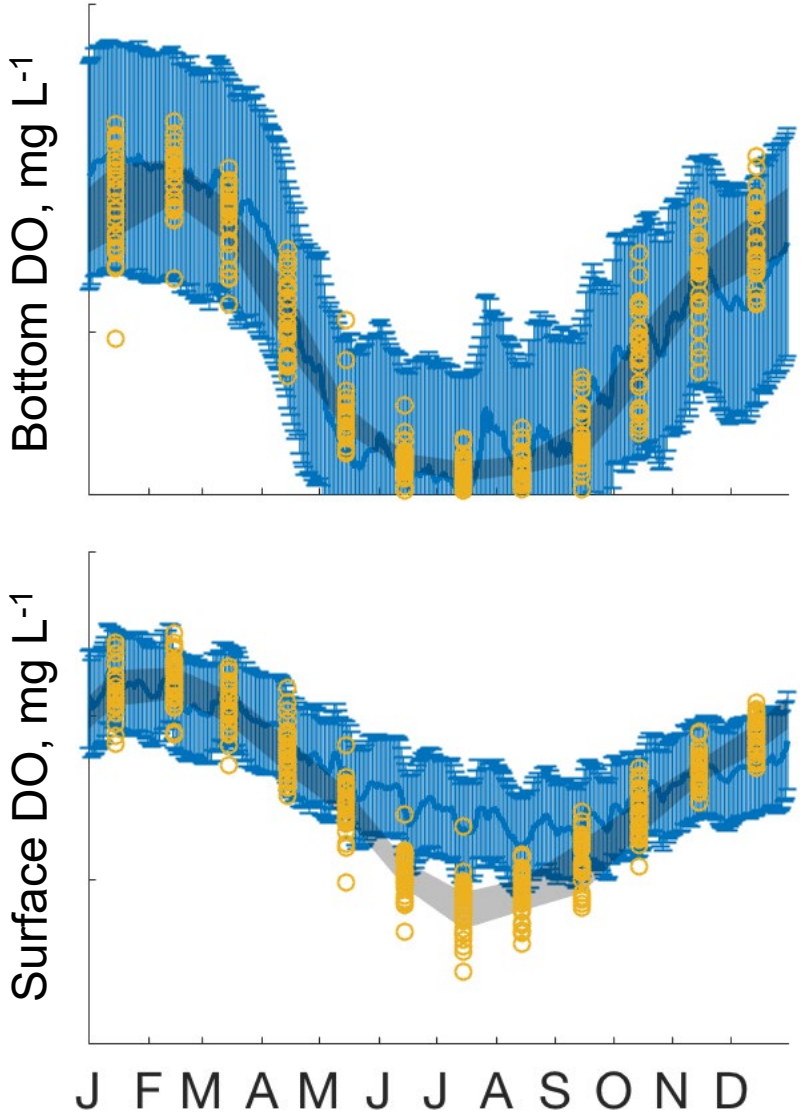
DLEM HV: DO < 2 mg L^{-1}



- **Different effects in hypoxia response for the two watershed models**

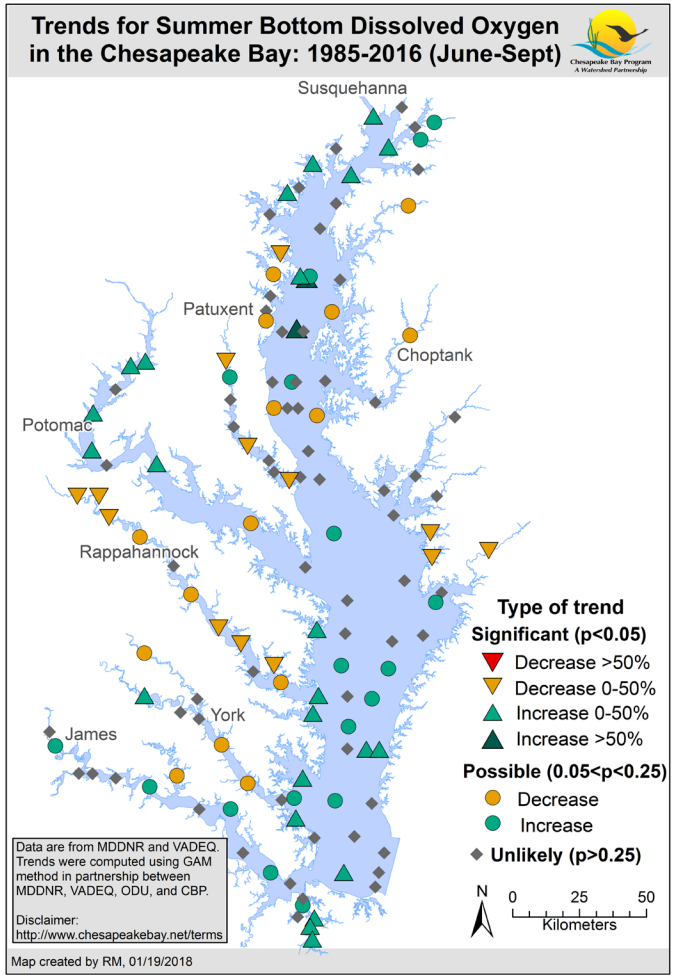
Chapter 1 – Long Term Model Comparison

- Model(s) vs Observations
  - 30 year record of CBP mainstem data (1985-2014)
  - ChesROMS, WQSTM, & SCHISM simulations over 30 years
    - Watershed forcings from CBP WSM
    - Watershed forcings from DLEM
- How well do models reproduce historical long-term change?



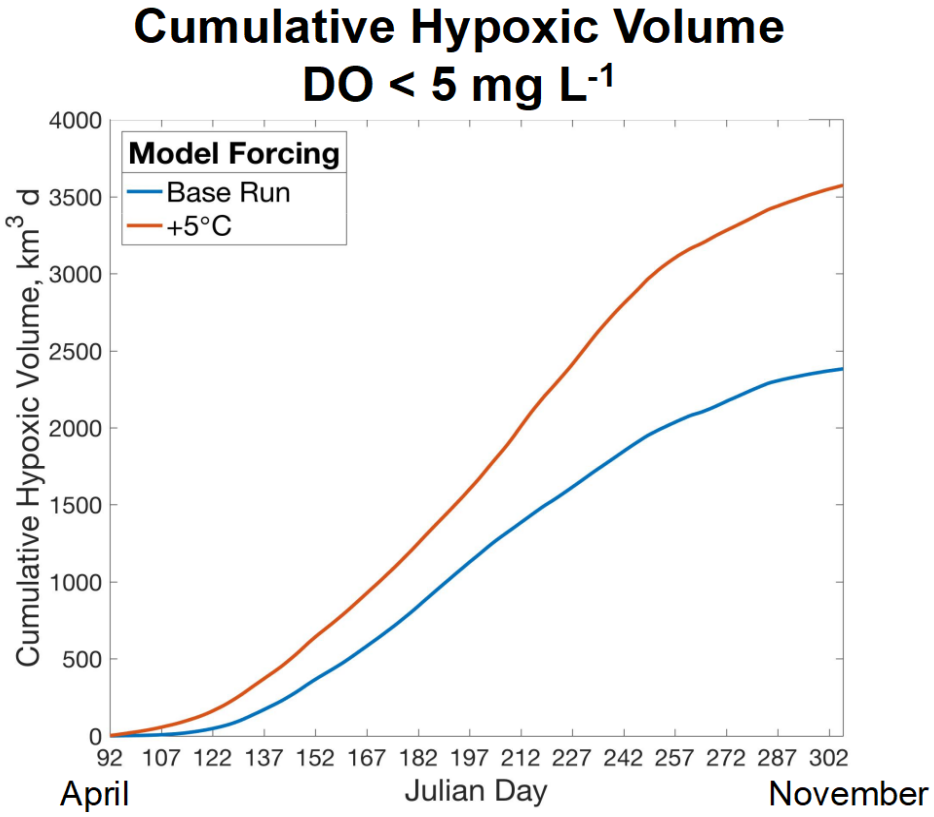
Chapter 2 – Isolating Climate Effects

- Can climate effects on the past 30 years of conditions in the Chesapeake Bay be isolated from local anthropogenic impacts?
- By what amount has climate change made Bay water quality restoration efforts more difficult?



Chapter 3 – The future of climate change in the Chesapeake Bay

- How might Chesapeake Bay hypoxia change with projected climate impacts?
- How certain are we when using global climate model outputs?
    - How much error is due to different downscaling techniques?
    - How much error is due to different emissions scenarios?



Questions?