

Estimates of Net Community
Production in the
Upper Delaware Estuary

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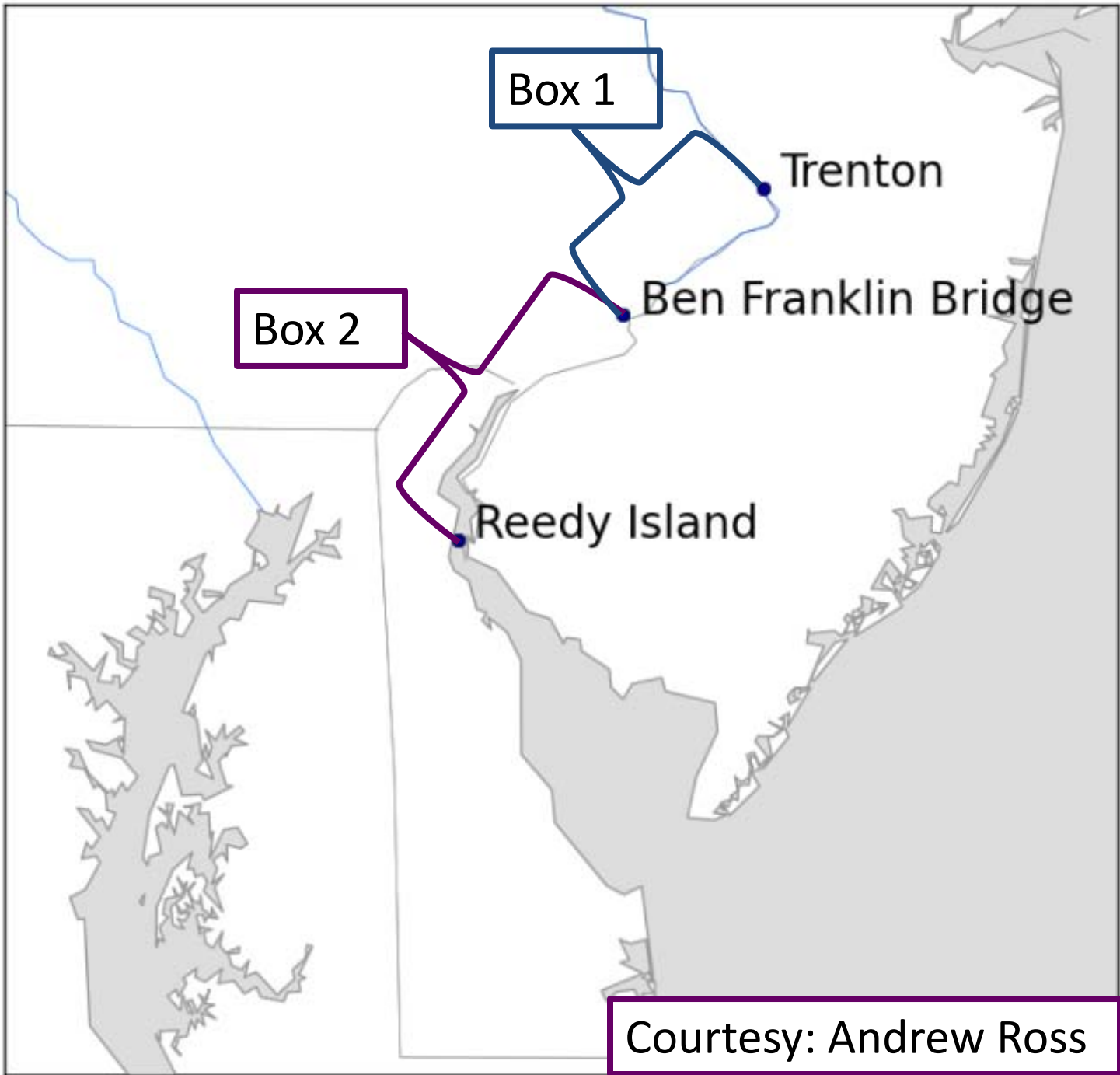
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Motivation

- Oxygen levels have changed in the Delaware Estuary.
- Important to understand the processes that regulate dissolved oxygen in the estuary.
- Net community production is a key process, but poorly constrained.
- Develop a budget based on long-term monitoring of D.O. along the Delaware Estuary.

Method

- Diagnostic model for net ecosystem metabolism (NEM)- D.O. Budget
- $NEM = -NCP$
- Divide Delaware Estuary into 2 boxes:
 - Box 1: Trenton to Ben Franklin Bridge
 - Box 2: Ben Franklin Bridge to Reedy Island
- River discharge is held constant from Trenton to Reedy Island (constant for both boxes)



Box 1

Trenton

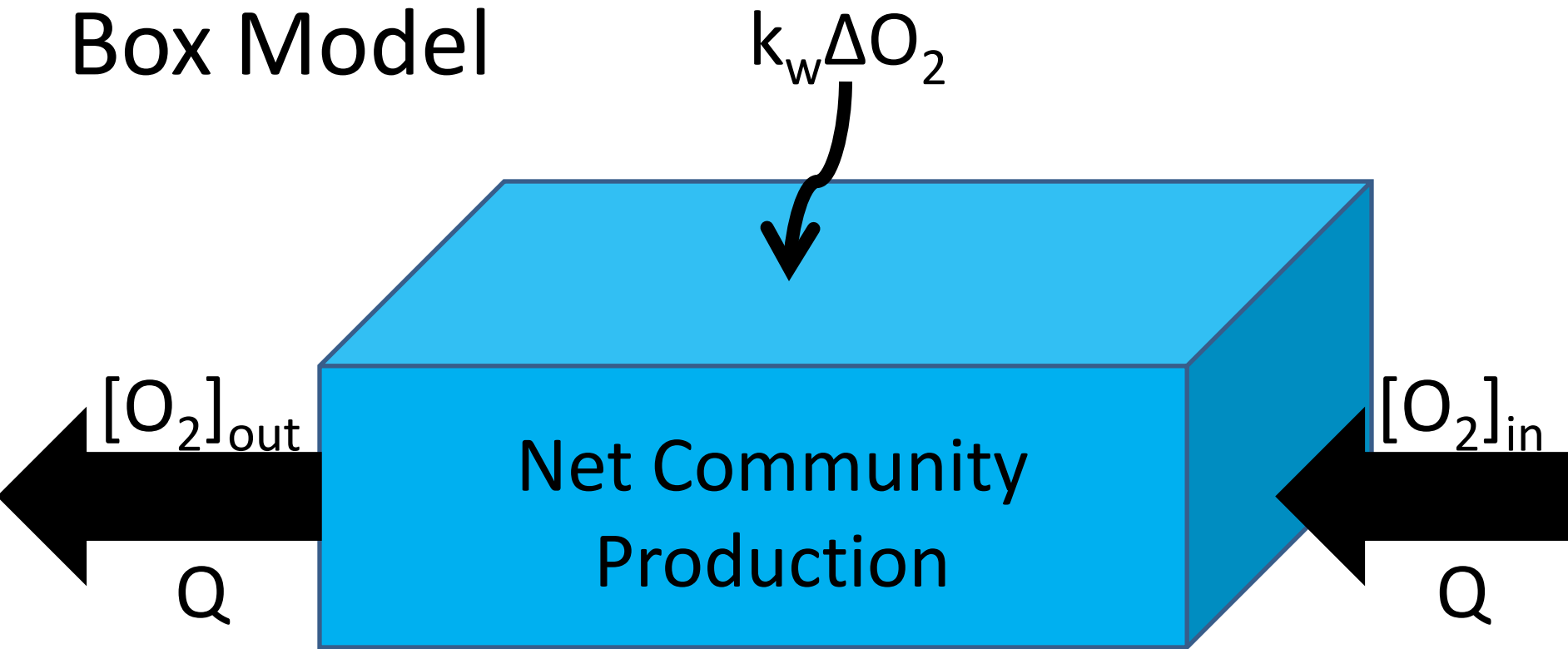
Box 2

Ben Franklin Bridge

Reedy Island

Courtesy: Andrew Ross

Box Model



$$NEM = -NCP = -V \frac{\partial [O_2]}{\partial t} - k_w \Delta [O_2] A + Q \{ [O_2]_{in} - [O_2]_{out} \}$$

NEM = – Time Rate of Change of D.O.
– Gas Transfer + Advection

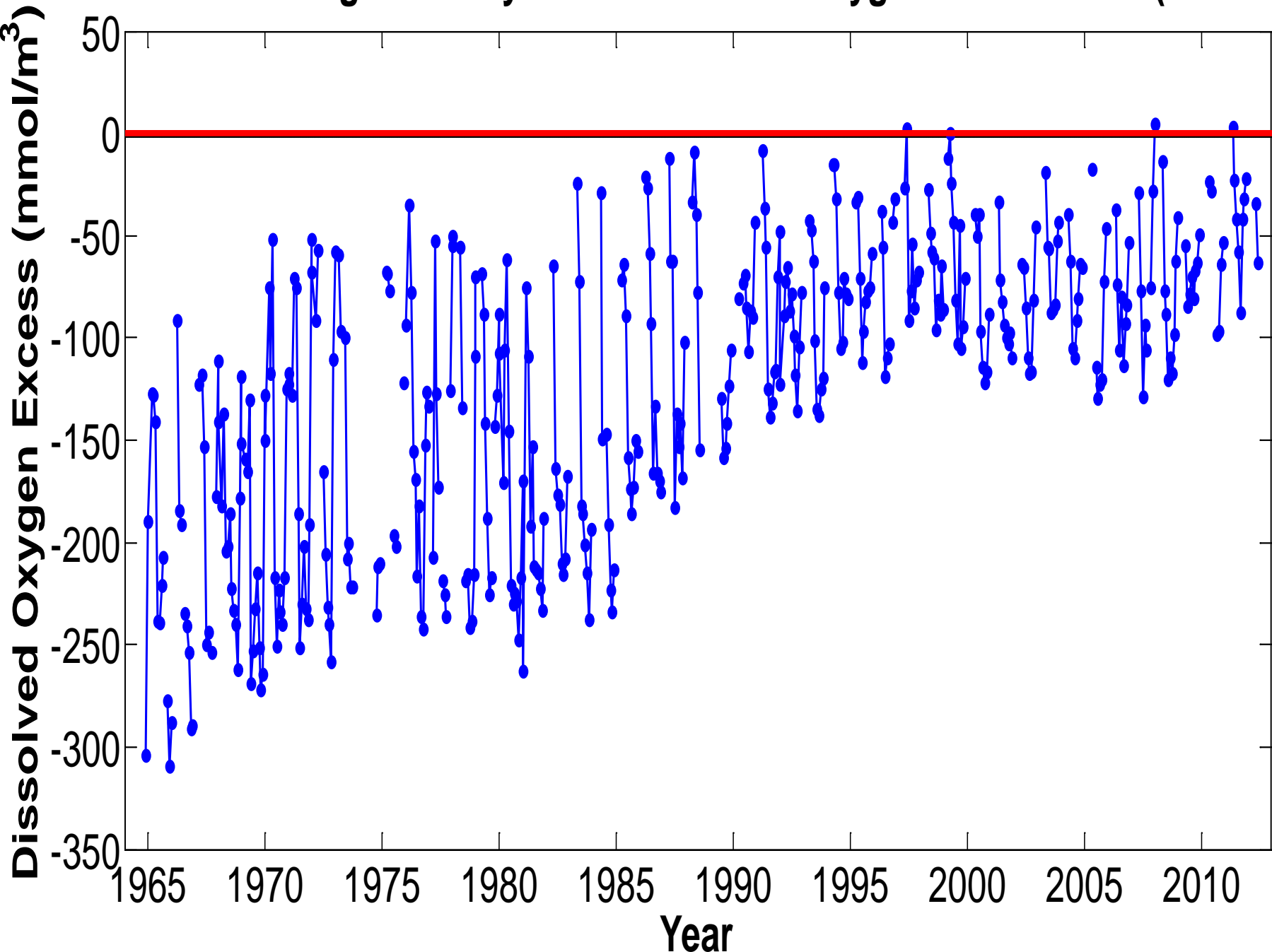
Data (1970-2009)

- 3 USGS locations along the Delaware River:
 - Trenton, New Jersey
 - Ben Franklin Bridge
 - Reedy Island Jetty, Delaware
- USGS dissolved oxygen, temperature, and salinity data
- USGS River discharge data at Trenton
- NCDC wind data from Wilmington, DE

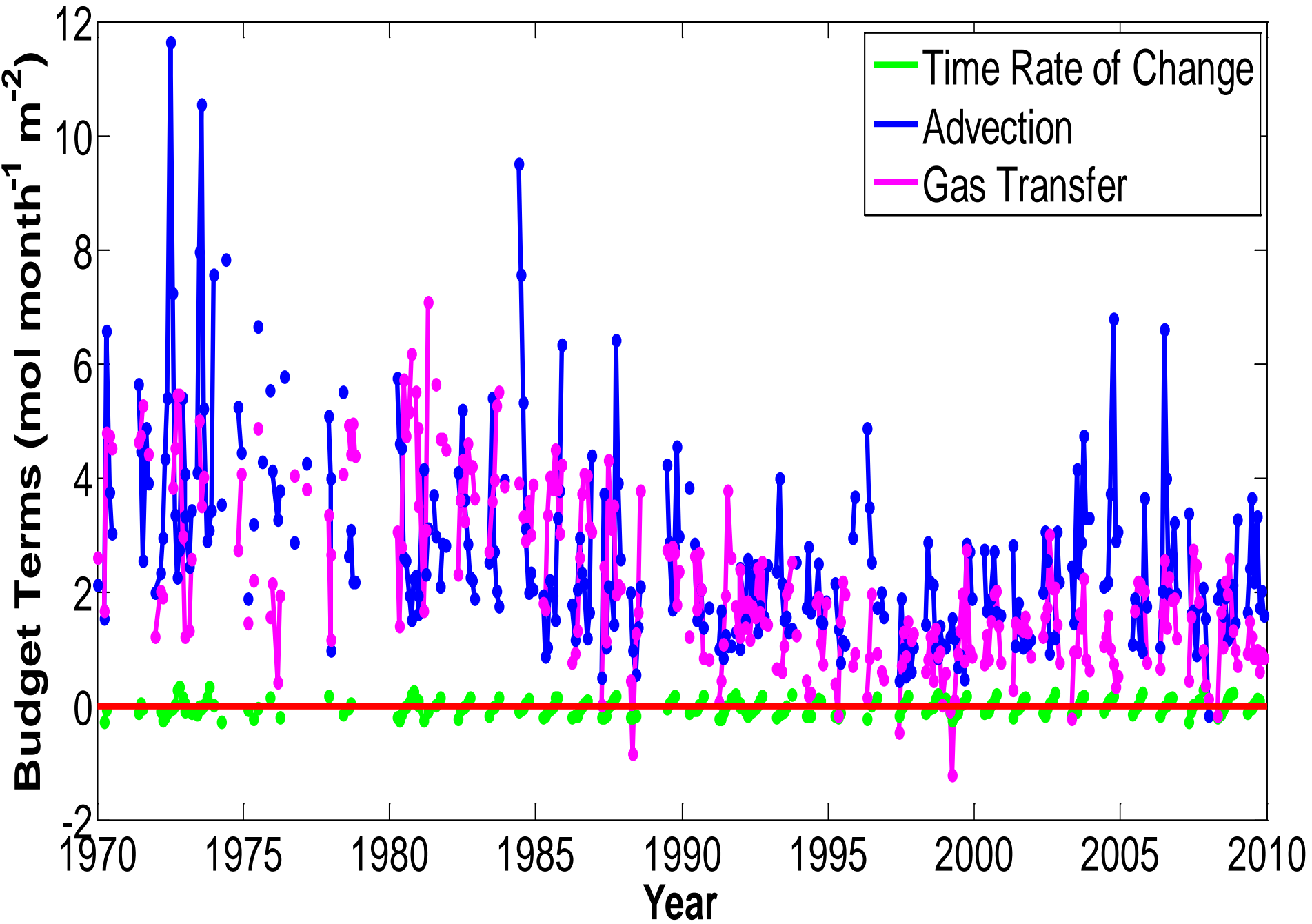
Data (1970-2009)

- Monthly means of data were computed
 - Must have 15 days per month
 - ± 3 S.D. threshold
- Oxygen excess: $\Delta O_2 = [O_2] - [O_2]_{\text{sat}}$
- $[O_2]_{\text{sat}} = f(T, S)$

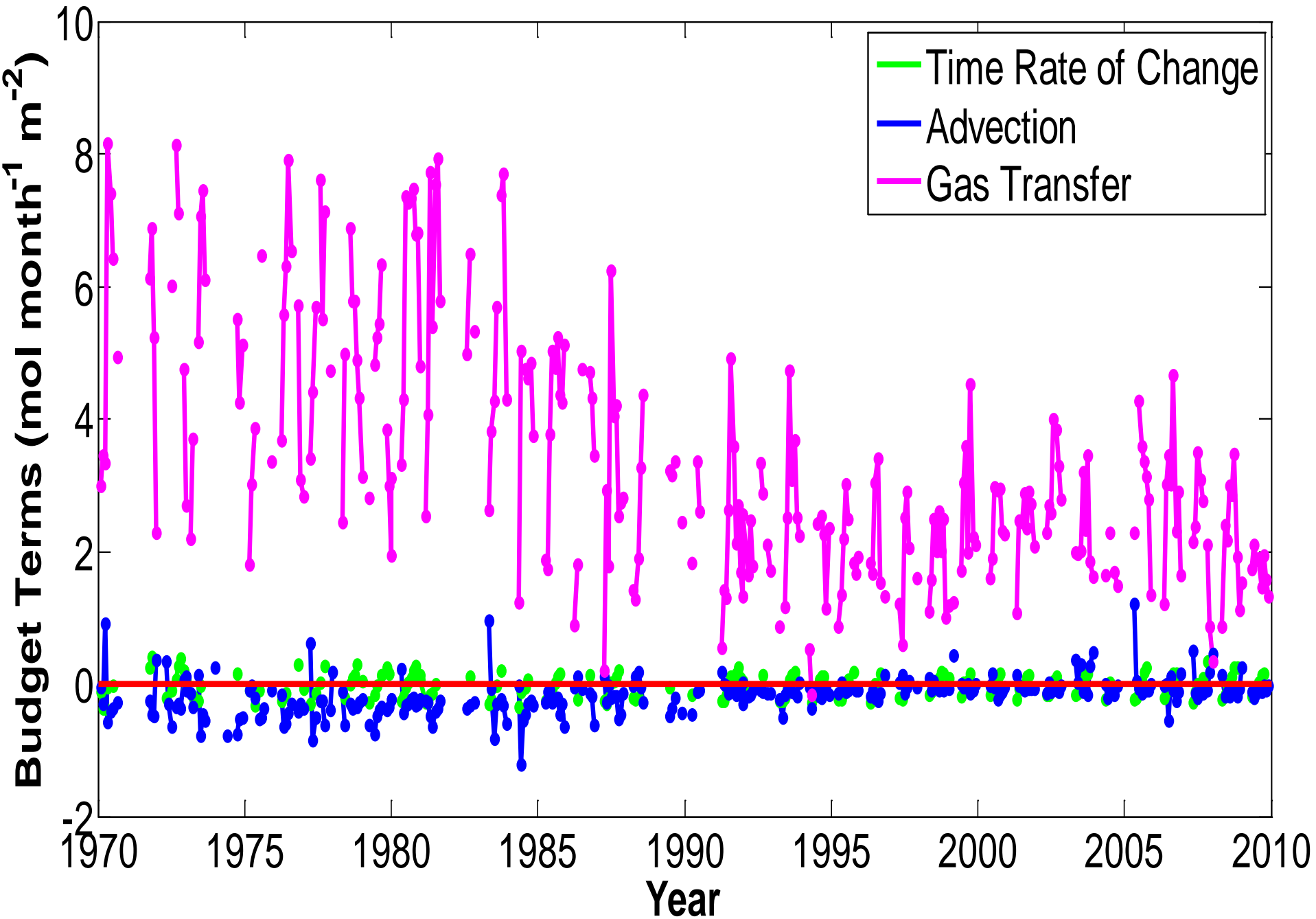
Ben Franklin Bridge Monthly Mean Dissolved Oxygen Excess Data (1964-2012)



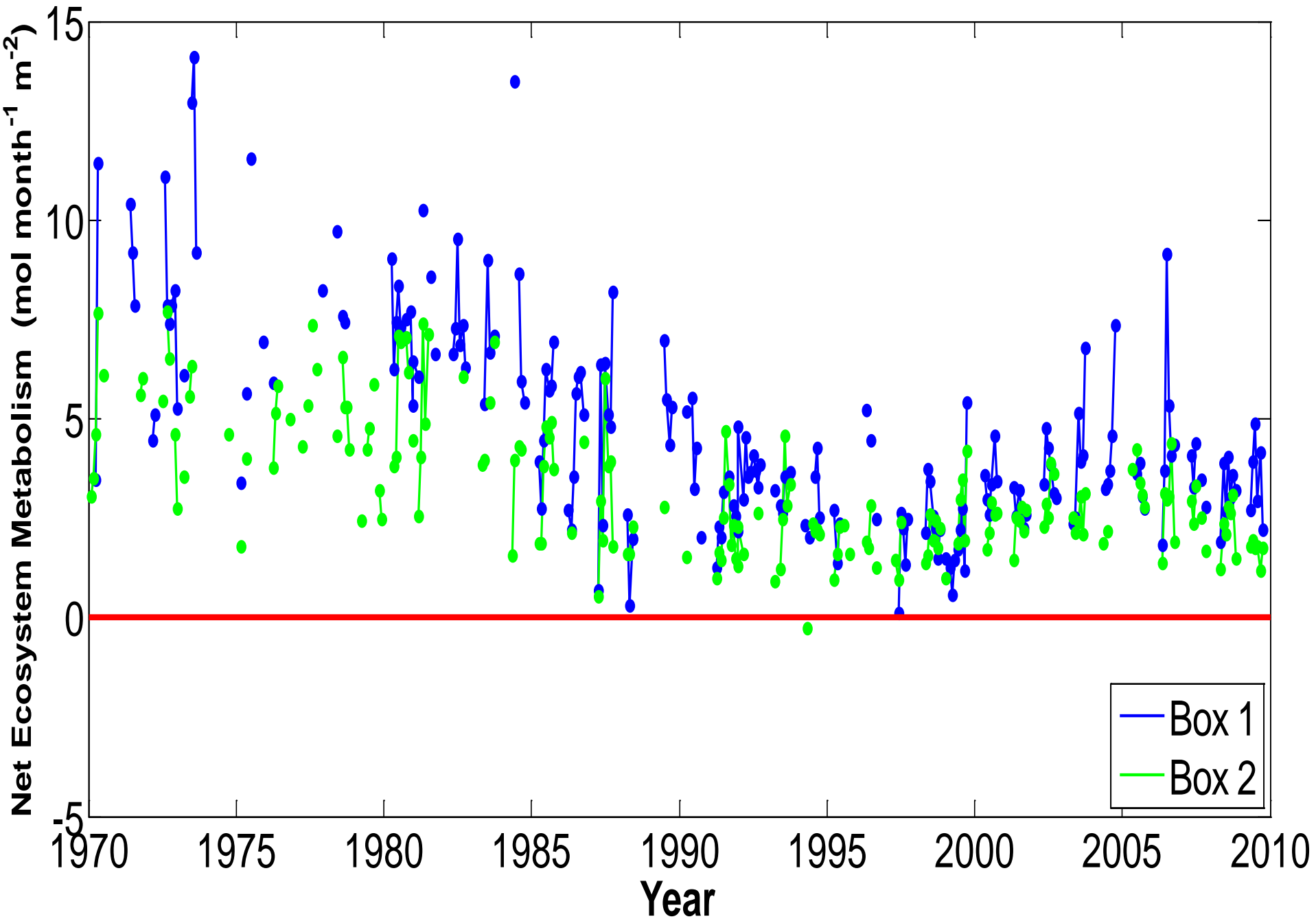
Box 1 Monthly Budget Terms (1970-2009)



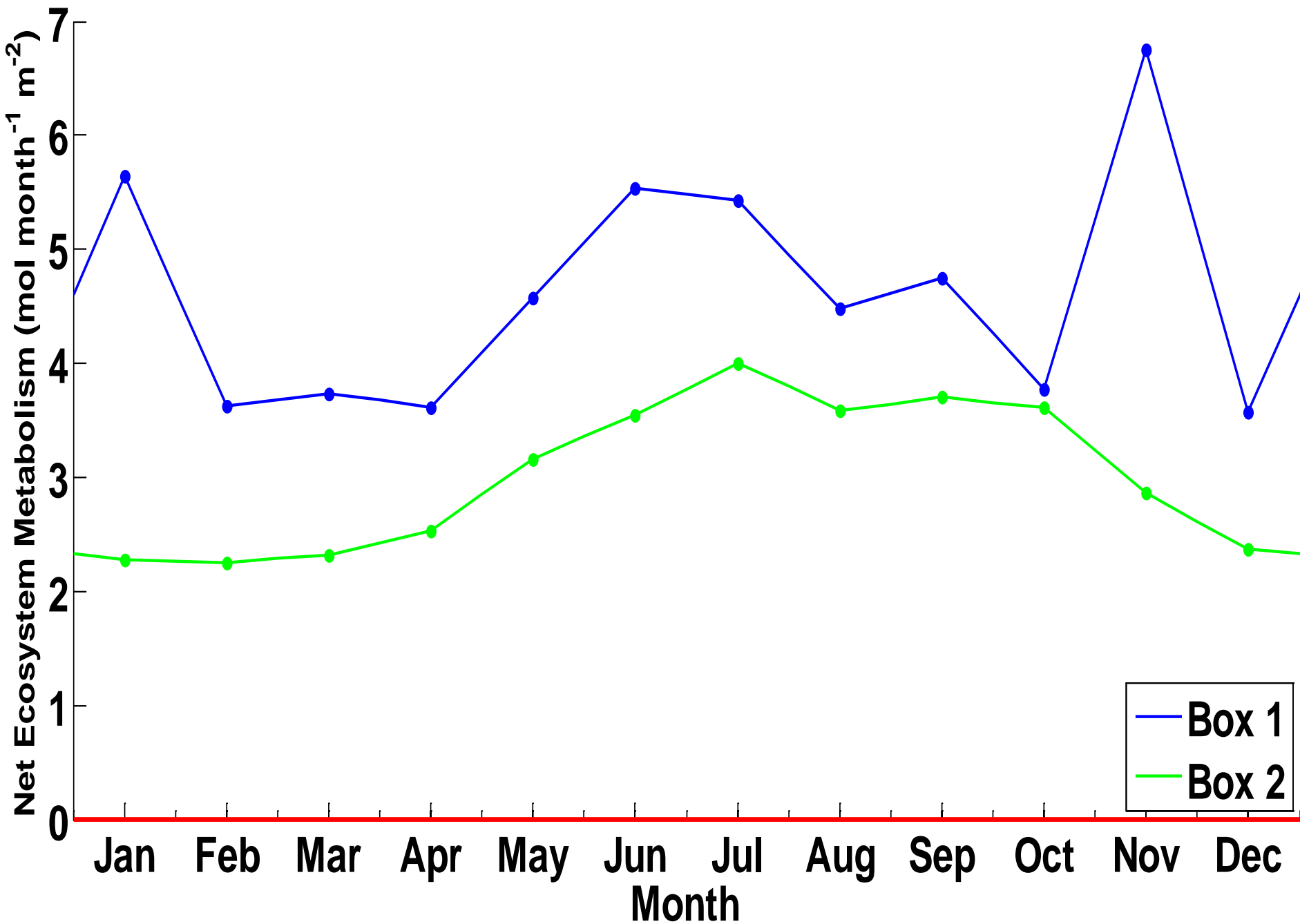
Box 2 Monthly Budget Terms (1970-2009)



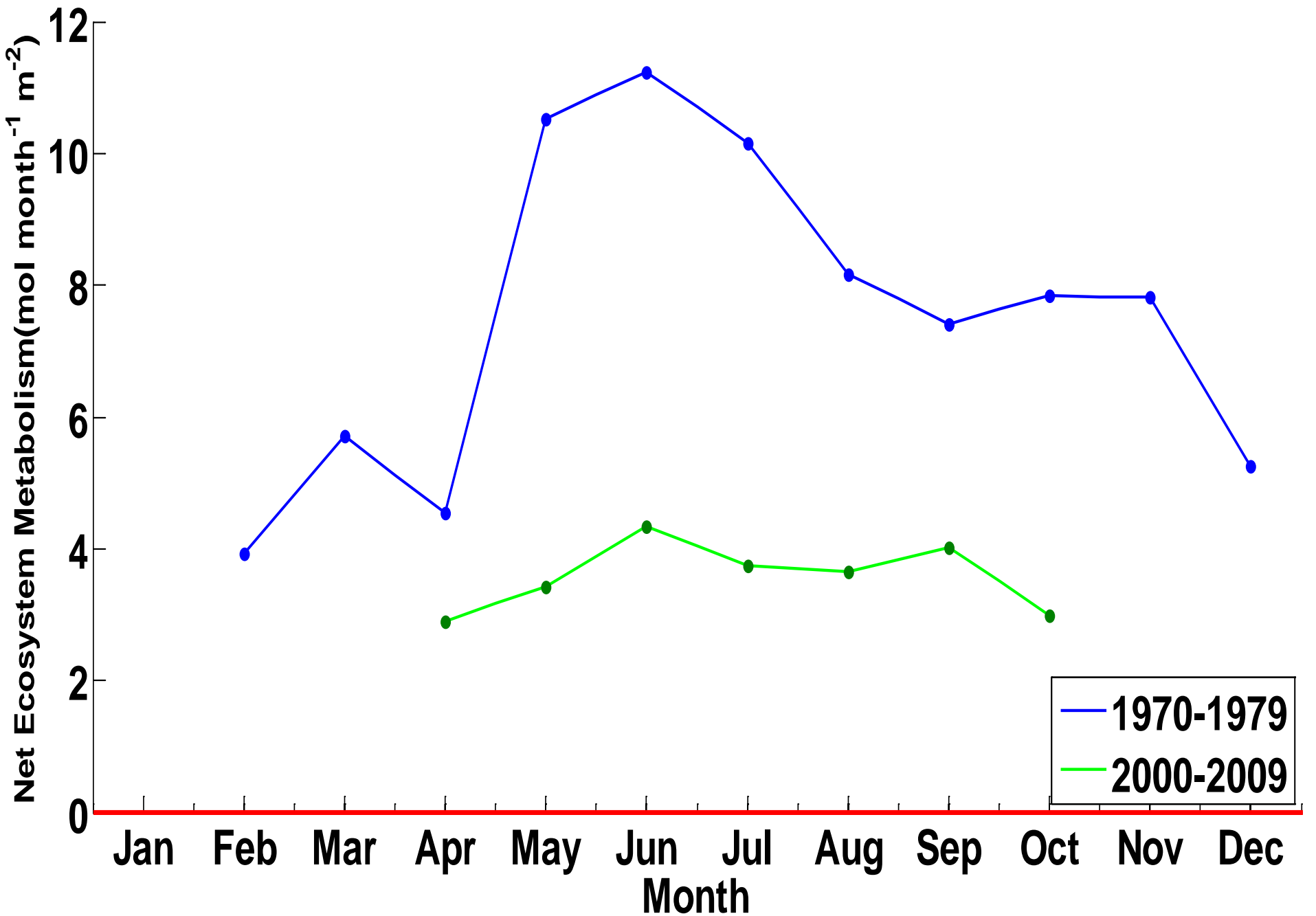
Box 1 and Box 2 Monthly Net Ecosystem Metabolism (1970-2009)



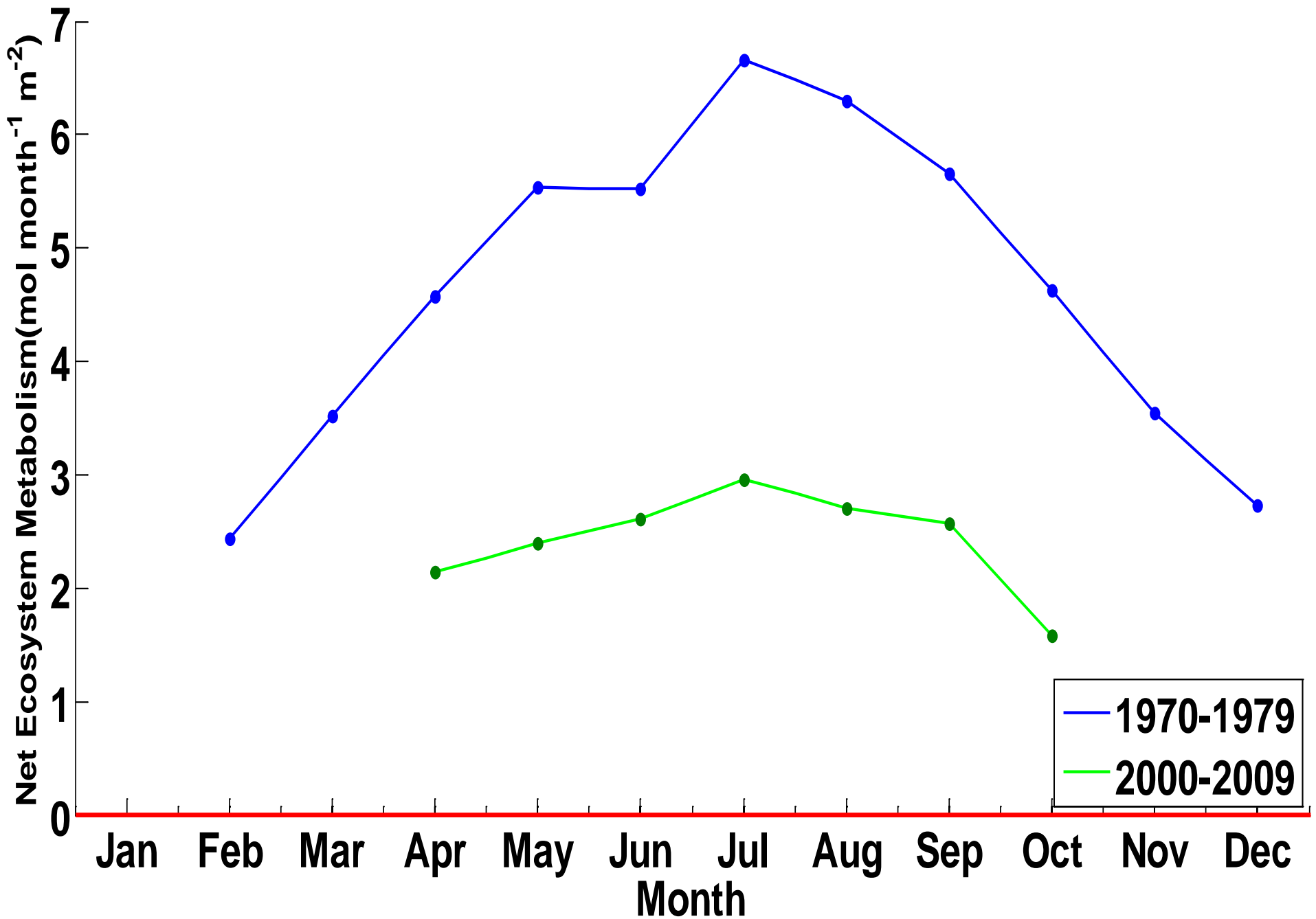
Box 1 and Box 2 Annual Net Ecosystem Metabolism (1970-2009)



Box 1 Annual Net Ecosystem Metabolism



Box 2 Annual Net Ecosystem Metabolism



Comparison with In-Situ Measurements: Water Column NEM Estimates (Preen & Kirchman 2004)

Box 1 (mol m ⁻² month ⁻¹)	Preen & Kirchman	This Study
June	4	3.2
August	10	2.2

Box 2 (mol m ⁻² month ⁻¹)	Preen & Kirchman	This Study
June	0	2.5
August	4	2.2

1980-1985 Rates

	Box 1 (mol C m ⁻² yr ⁻¹)	Box 2 (mol C m ⁻² yr ⁻¹)	Data Source
NEM	57	40	This Study
Primary Production	12	7	Pennock & Sharp (1986)
Respiration	69	47	NEM + Primary Production

Respiration >> Primary Production

**Therefore the region is strongly heterotrophic

Summary

- Consumption of oxygen is highest in summer for both boxes
 - November peak for box 1 may be due to lack of data
- NEM has an overall decreasing trend since 1970 as D.O. levels increase
 - 1970s to 2000s:
 - 52% decrease in Box 1
 - 48% decrease in Box 2
- Gas transfer and advection declining due to rise of D.O. at Ben Franklin Bridge
- Results are same order of magnitude of previous work (Preen & Kirchman 2004)

Limitations

- A linear relationship of D.O. between the three sites is assumed
 - Underestimates the variability
 - Chester may be added
- Diffusion was ignored
- Missing data for some months
 - May use a mean annual cycle to fill in blanks