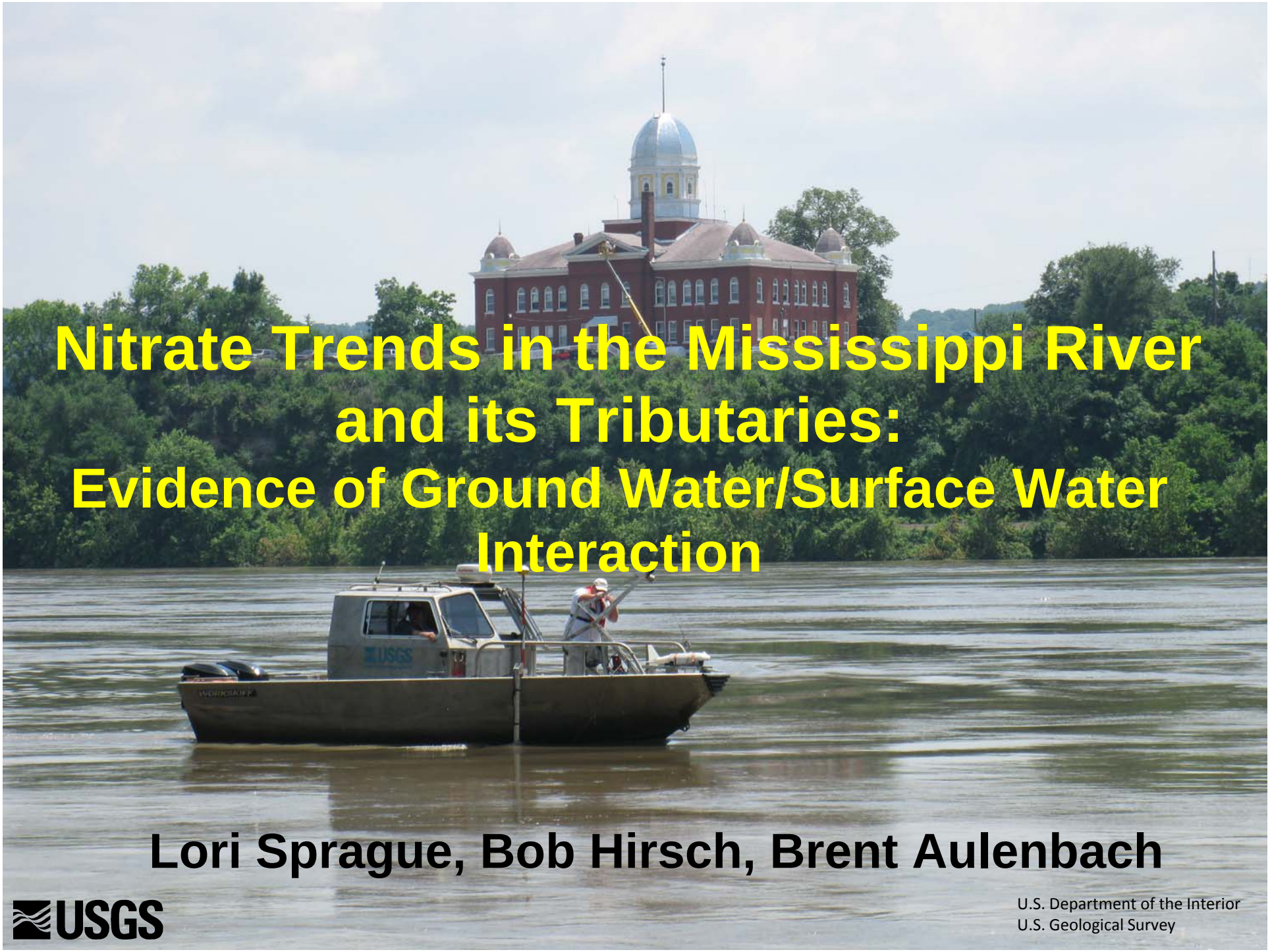

Nitrate Trends in the Mississippi River and its Tributaries: Evidence of Ground Water/Surface Water Interaction

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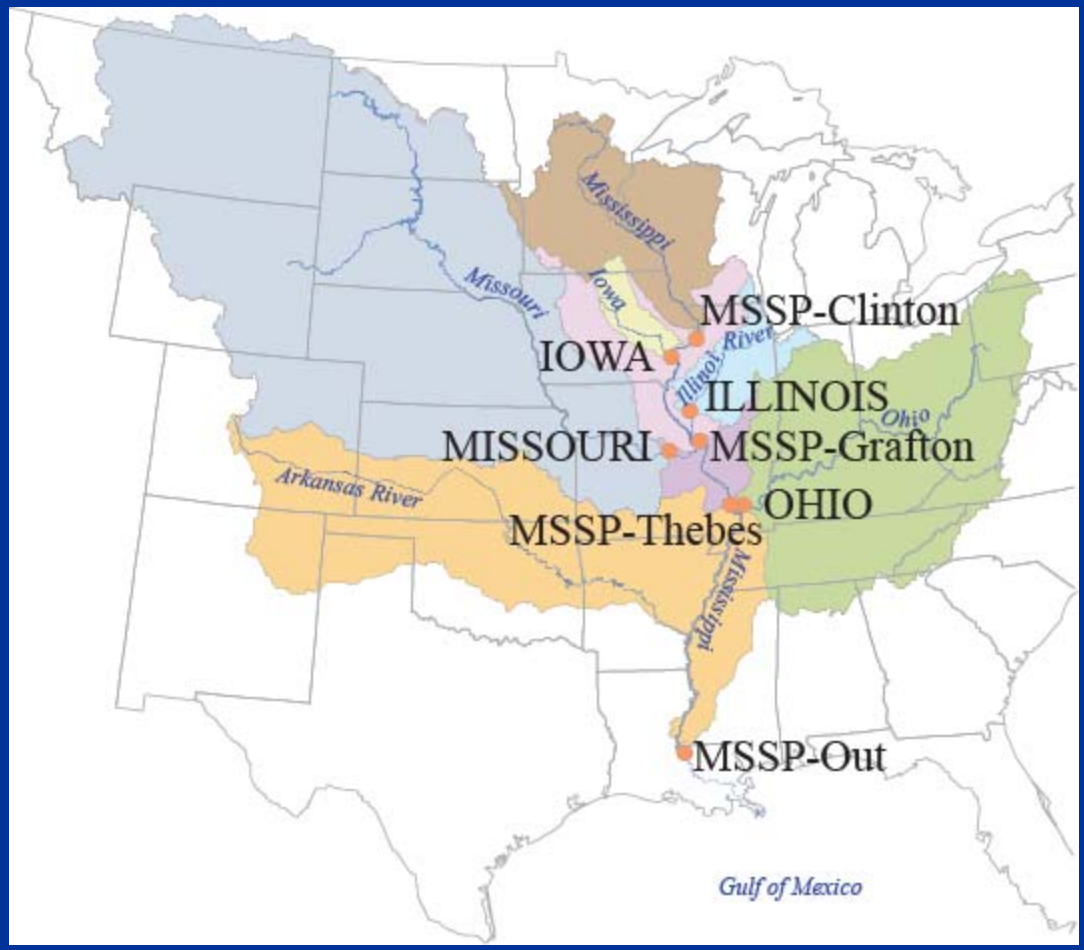
USGS

U.S. Department of the Interior
U.S. Geological Survey

Study Objectives

- A new method (WRTDS) was used to evaluate changes in nitrate at 8 sites on the Mississippi River and its tributaries from 1980-2008
- Used 3,368 chemical measurements, 110,732 daily streamflow values



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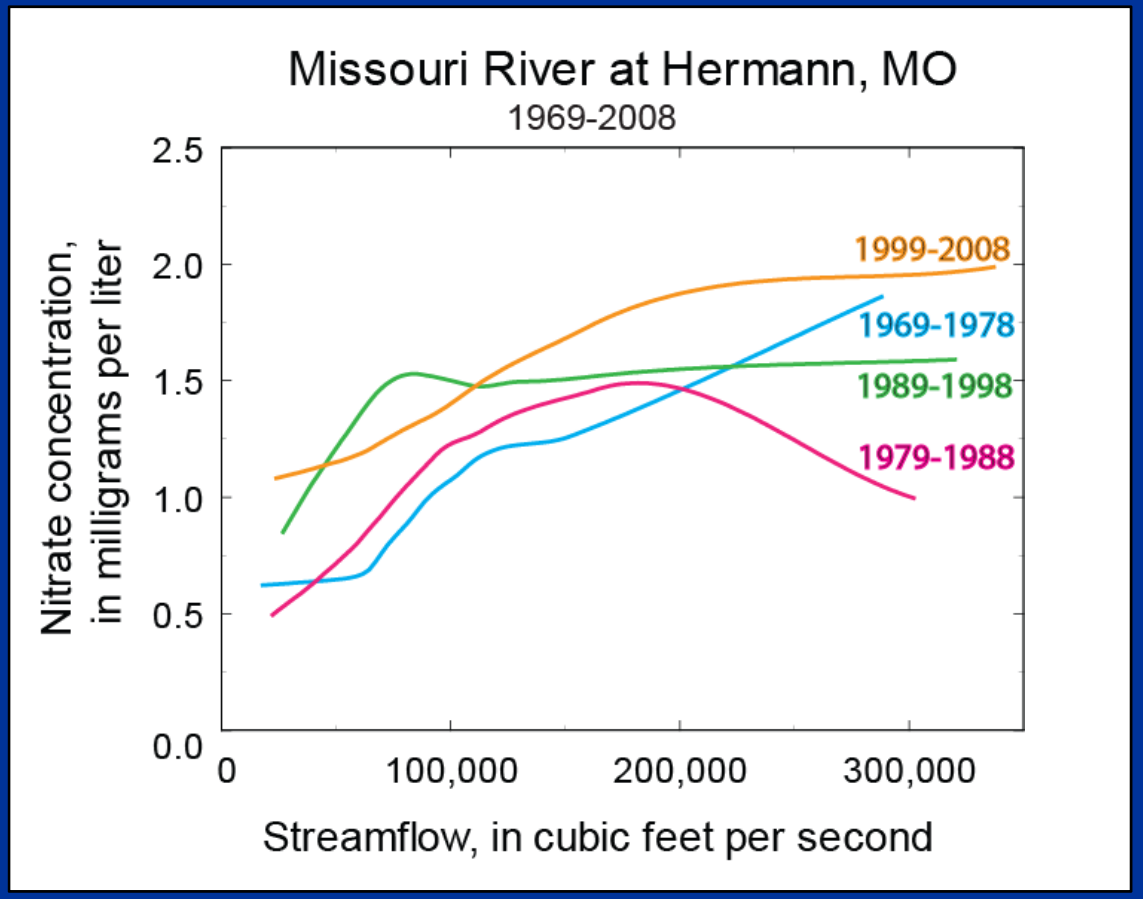
Weighted Regressions on Time, Discharge, and Season (WRTDS)

WRTDS estimates daily flux and concentration

- Modeled using time, season, streamflow
- Accommodates non-stationarity by using a moving-window approach



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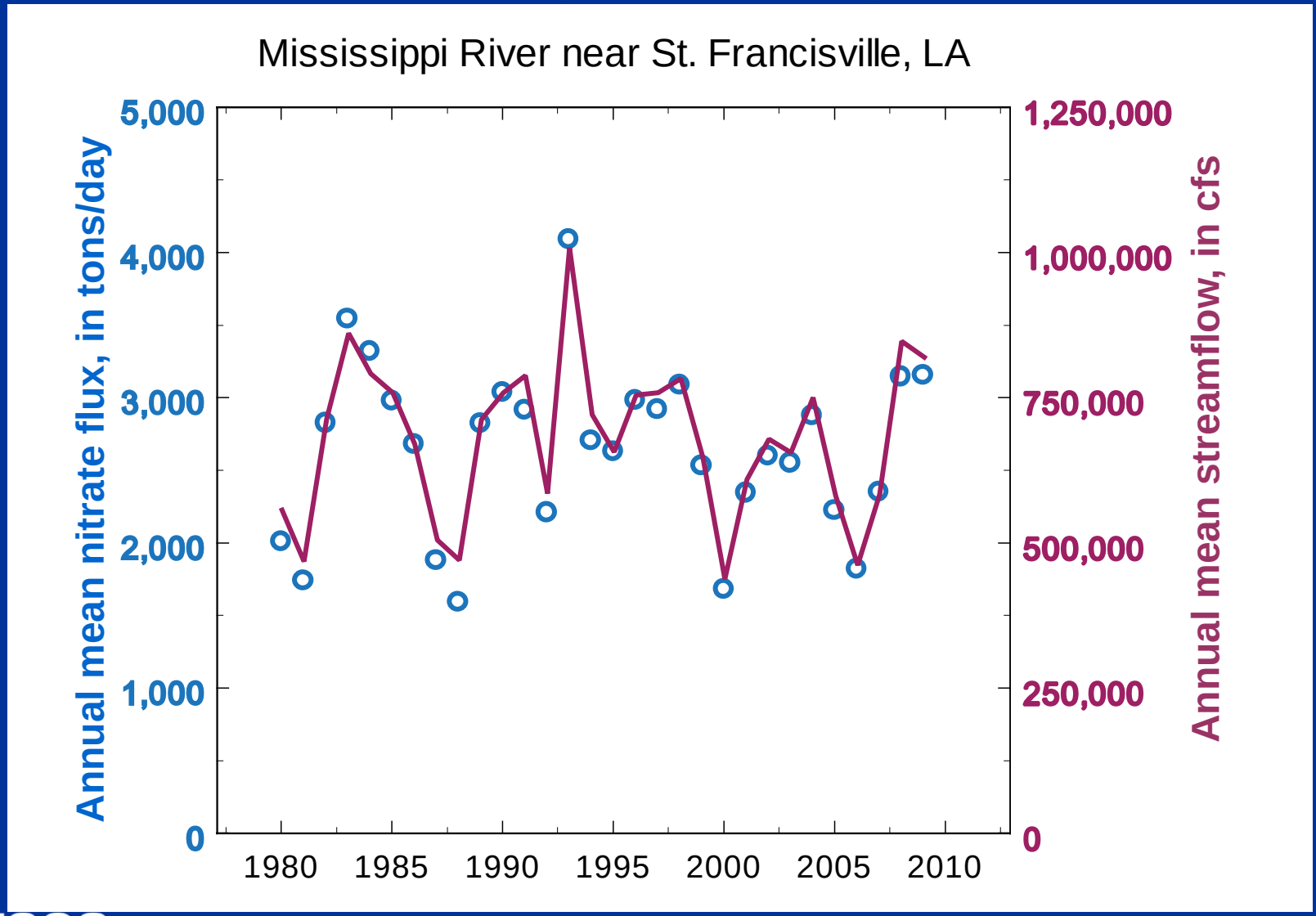
Example Output



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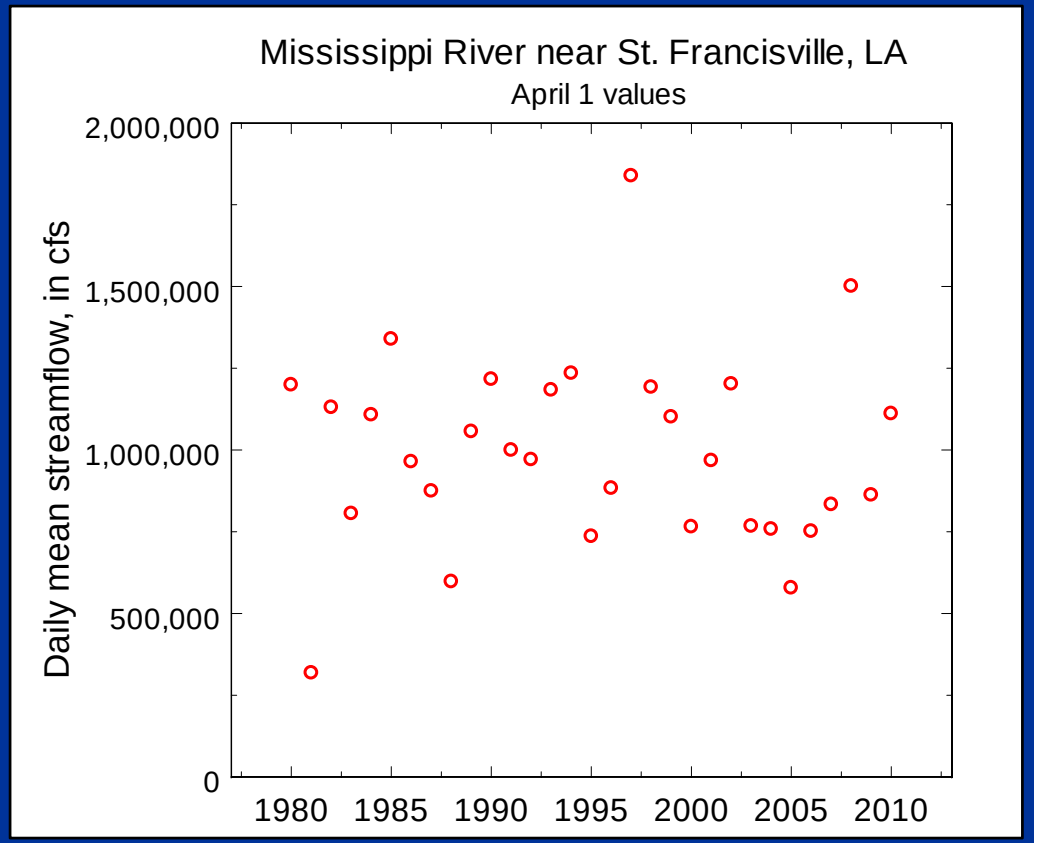
Flow normalization

- **Flow-normalization eliminates the influence of streamflow (Q)**
  - **Q on any given day is a random sample from the probability distribution of Q for that day of the year**
  - **Concentration and flux are estimated for each historical Q value on that day of the year**
    - **Flow-normalized value on that date is the mean of those values**



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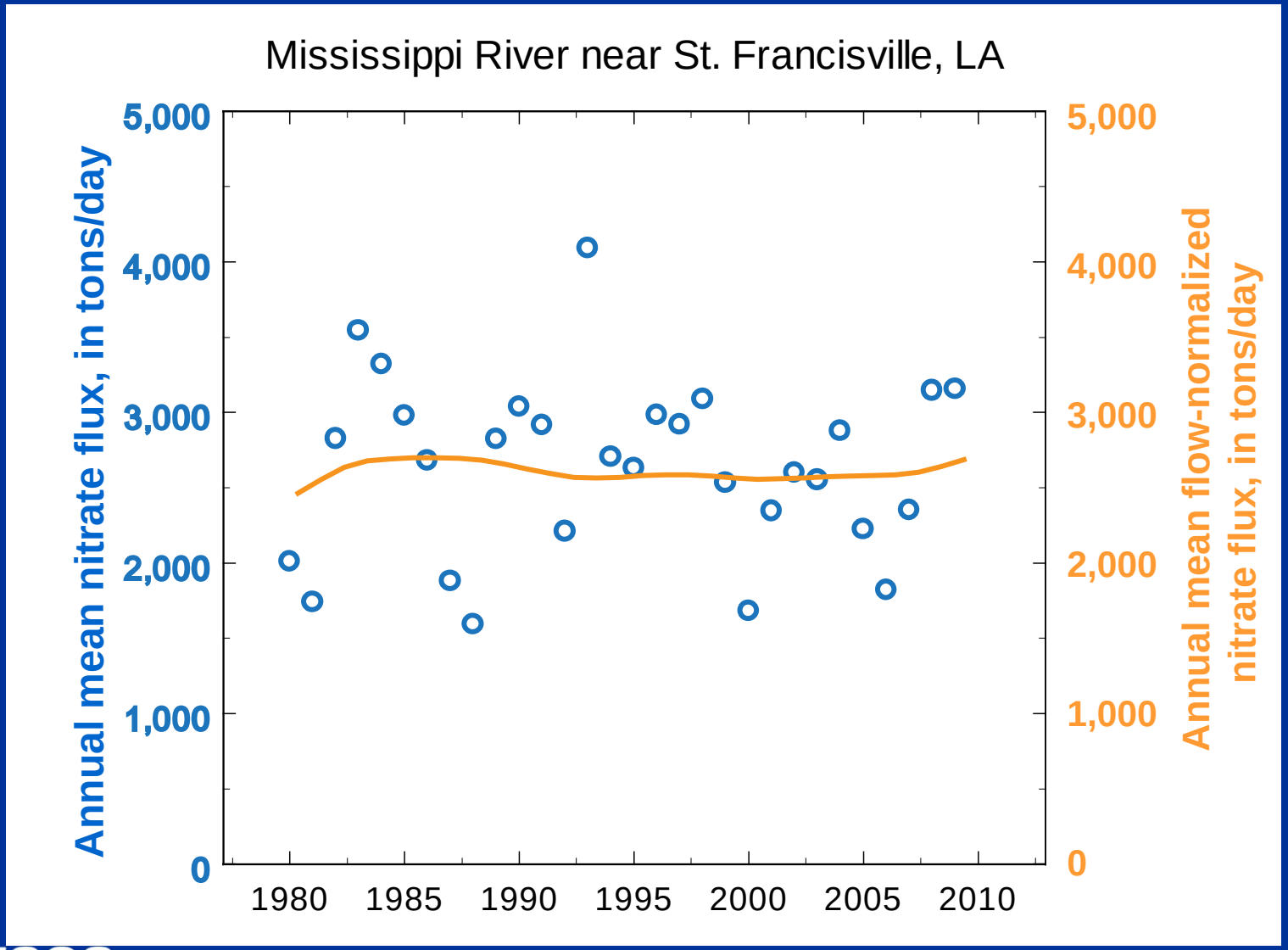
Flow normalization



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Flow-normalized flux

Net change 1980-2008

Site	Total annual flow-normalized yield (flux per unit area) in 1980 ($kg/km^2/yr$)
MSSP-Clinton	297
IOWA	1,813
ILLINOIS	1,433
MSSP-Grafton	751
MISSOURI	67
MSSP-Thebes	257
OHIO	590
MSSP-Out	278

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Flow-normalized flux

Net change 1980-2008

Site	Total annual flow-normalized yield (flux per unit area) in 1980 ($kg/km^2/yr$)	Net change, 1980-2008 (%)
MSSP-Clinton	297	67
IOWA	1,813	-3
ILLINOIS	1,433	-1
MSSP-Grafton	751	14
MISSOURI	67	57
MSSP-Thebes	257	9
OHIO	590	-1
MSSP-Out	278	9

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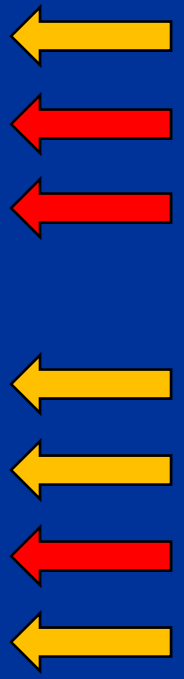
Flow-normalized flux

Comparison of rates of change 1980-2000 and 2000-2008

Site	Rate of change, in %/yr	
	1980-2000	2000-2008
MSSP-Clinton	1.4	3.7
IOWA	0.1	-0.6
ILLINOIS	0.7	-1.7
MSSP-Grafton	0.5	0.4
MISSOURI	1.0	3.9
MSSP-Thebes	0.1	0.9
OHIO	0.1	-0.3
MSSP-Out	0.2	0.5



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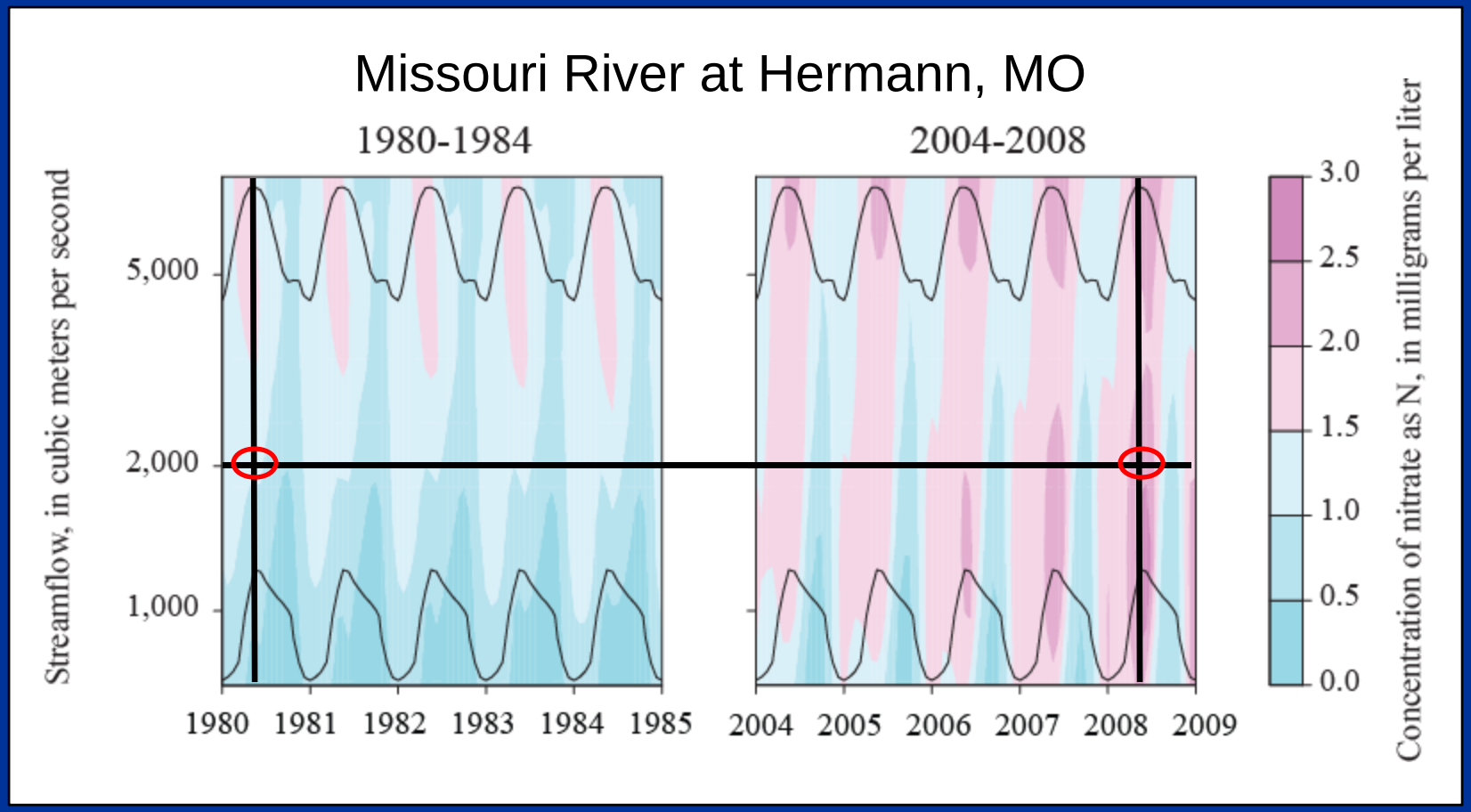
Expected concentration

by streamflow and season



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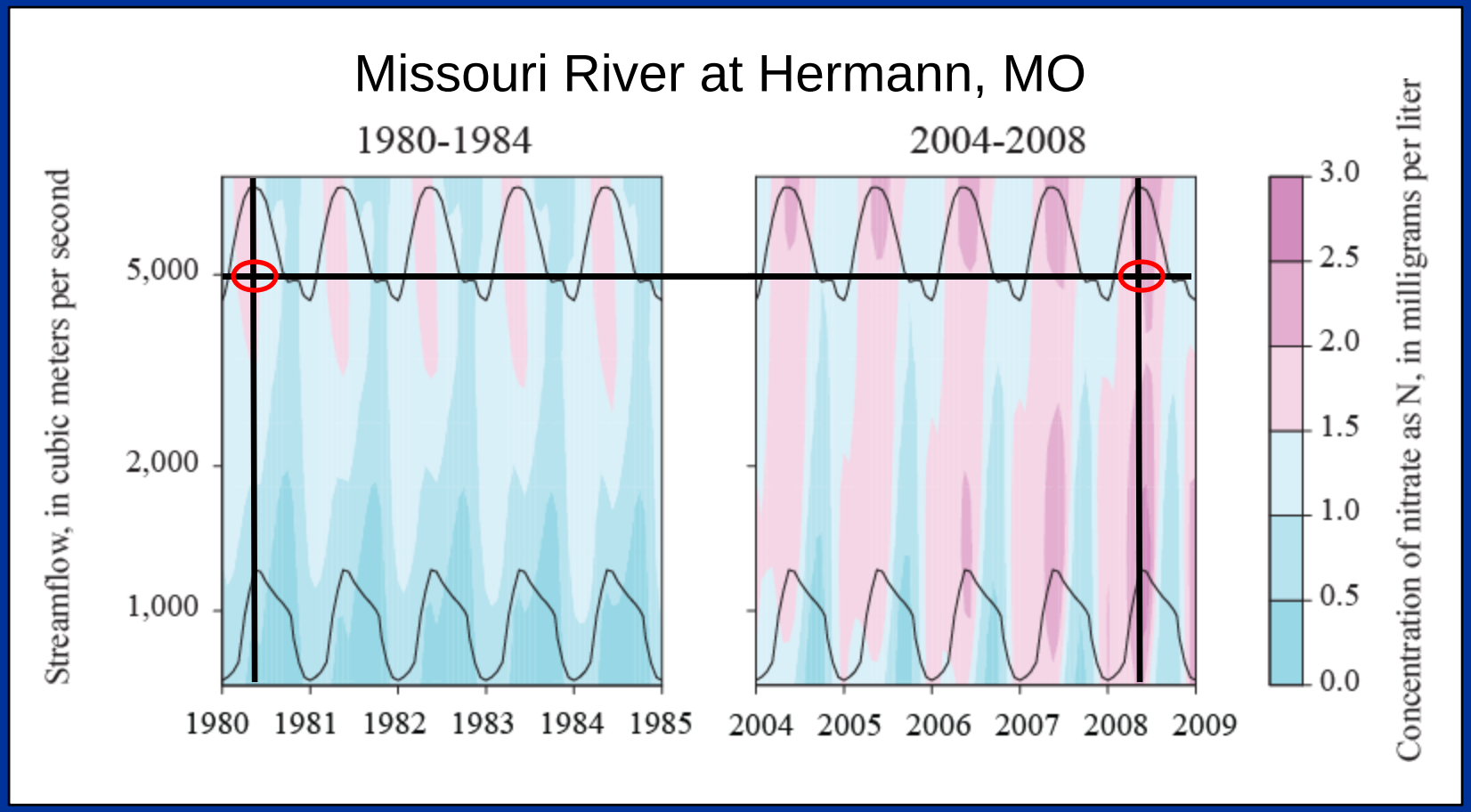
Expected concentration

by streamflow and season



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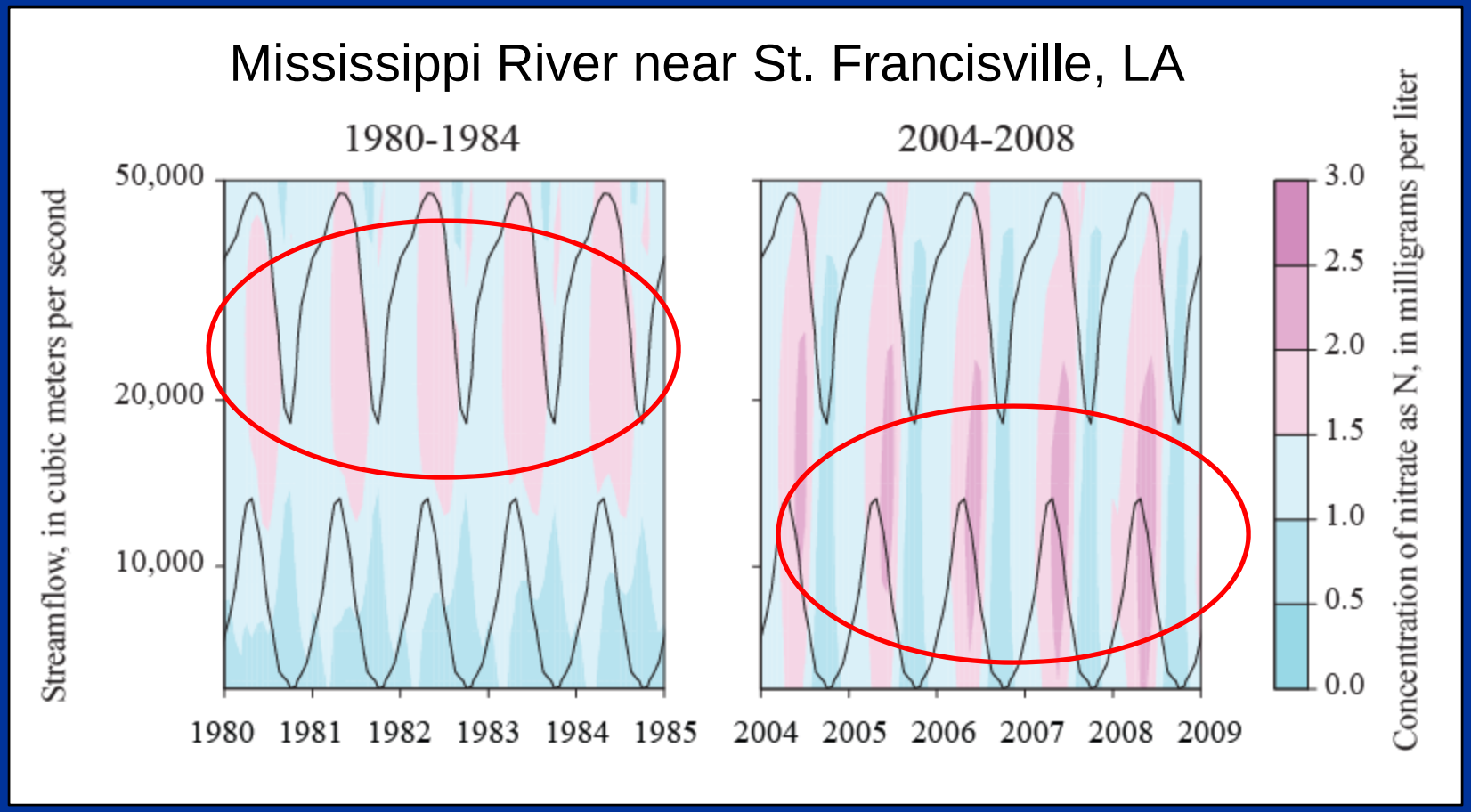
Expected concentration

by streamflow and season



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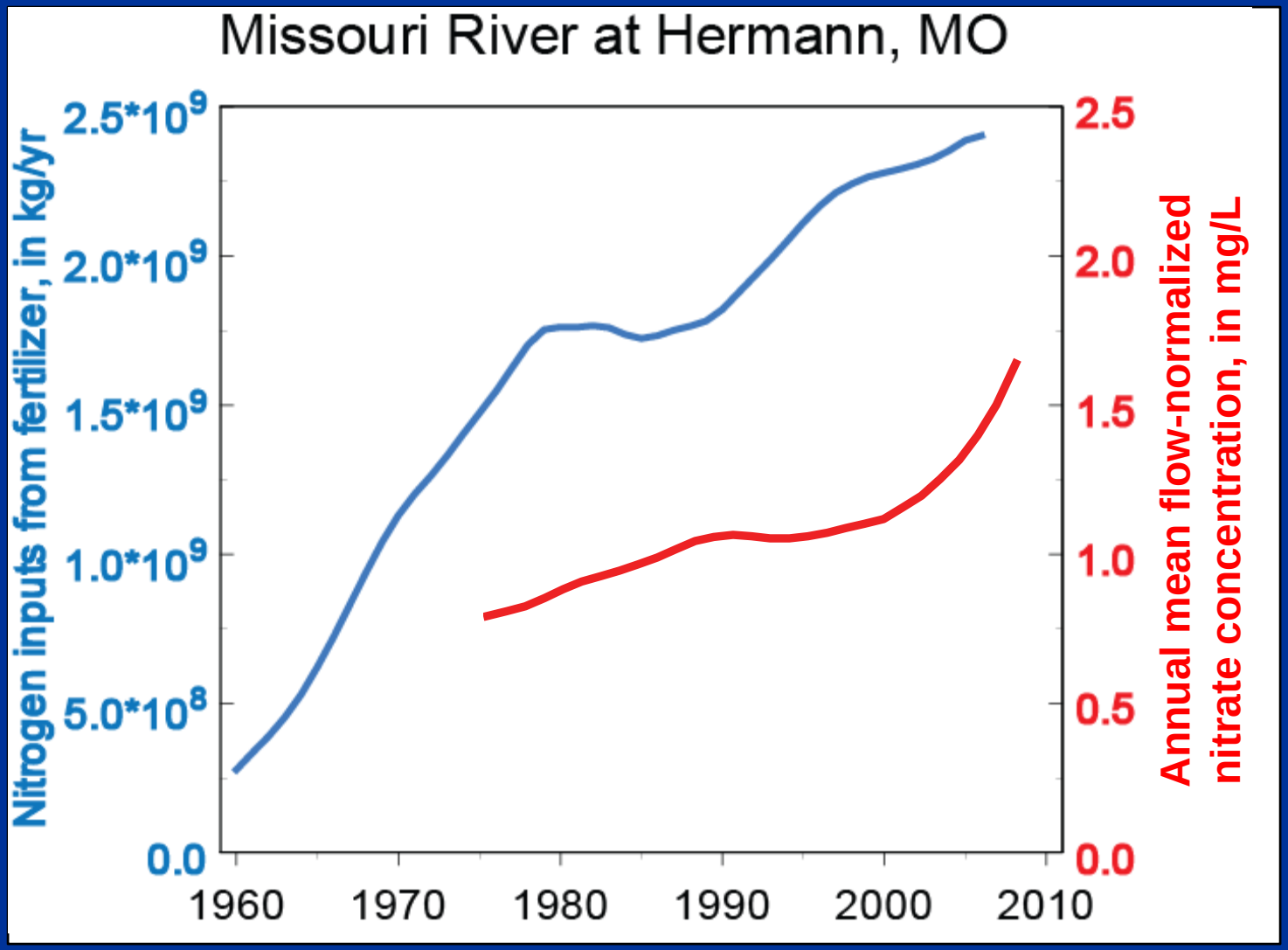
Lag correlation analysis



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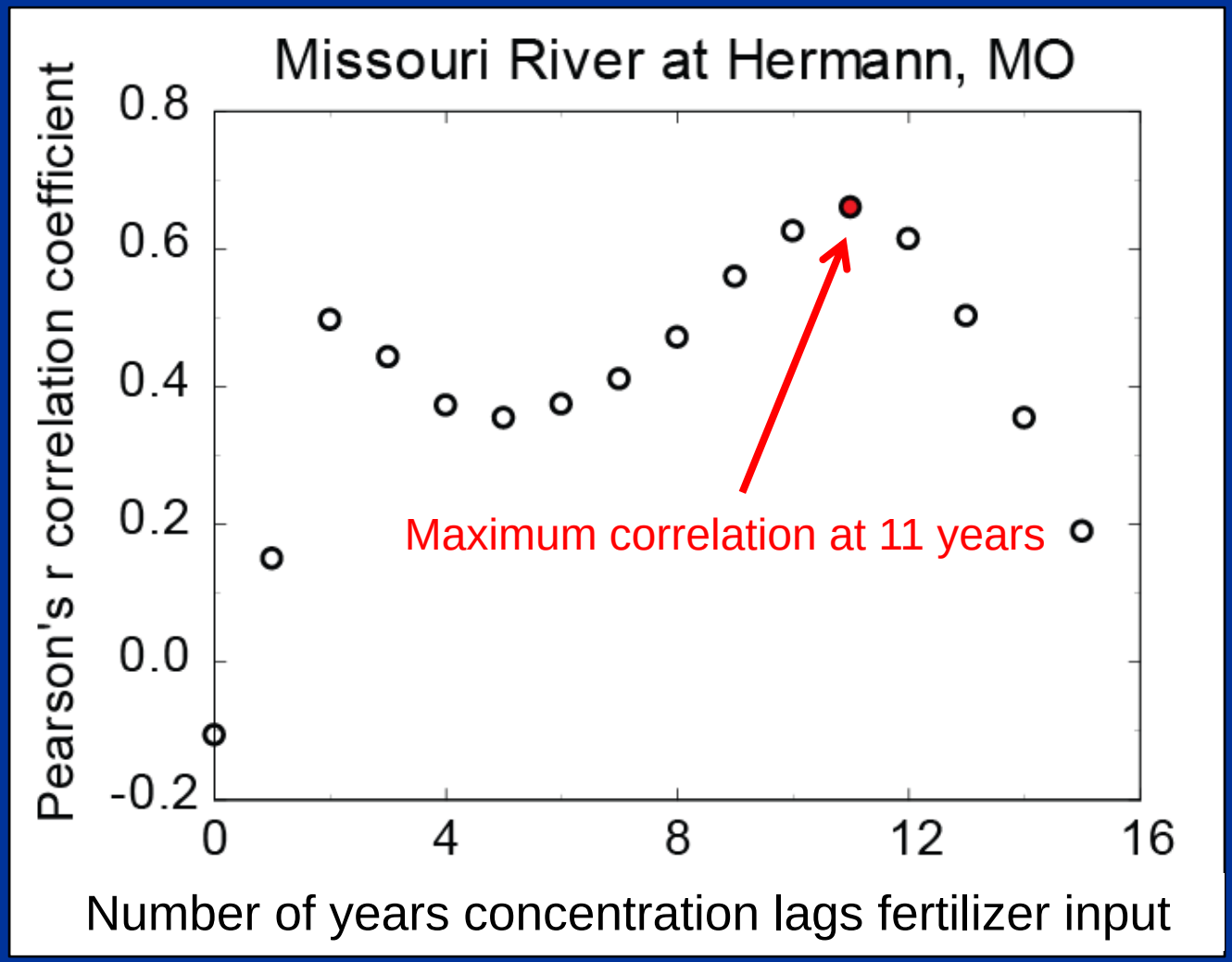
Lag correlation analysis



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Lag correlation analysis

1. **Changes in flow-normalized nitrate lagged changes in fertilizer inputs**
    - **0 to 3 years at IOWA and MSSP-Grafton – large % of tile drains**
    - **7 to 12 years at OHIO, MISSOURI, MSSP-Thebes, and MSSP-Out – small % of tile drains, larger watersheds**
2. **Correlations were significant, but low**
    - **Other factors are also affecting nitrate at these sites**

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Conclusions

1. Flow-normalized concentration and flux of nitrate increased at MISSOURI and the mainstem sites since 1980. No substantial decreases at any other sites.

2. Concentrations decreased in the spring at high flows at MSSP-Thebes, OHIO, and MSSP-Out.

3. At MSSP-Out, the highest concentrations occurred at high flows in 1980 but at low to moderate flows in 2008.

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Conclusions – continued

4. Increases in concentration at low to moderate flows were greater than or comparable to changes at high flows.

5. Changes in concentration and flux appear to lag changes in fertilizer inputs.

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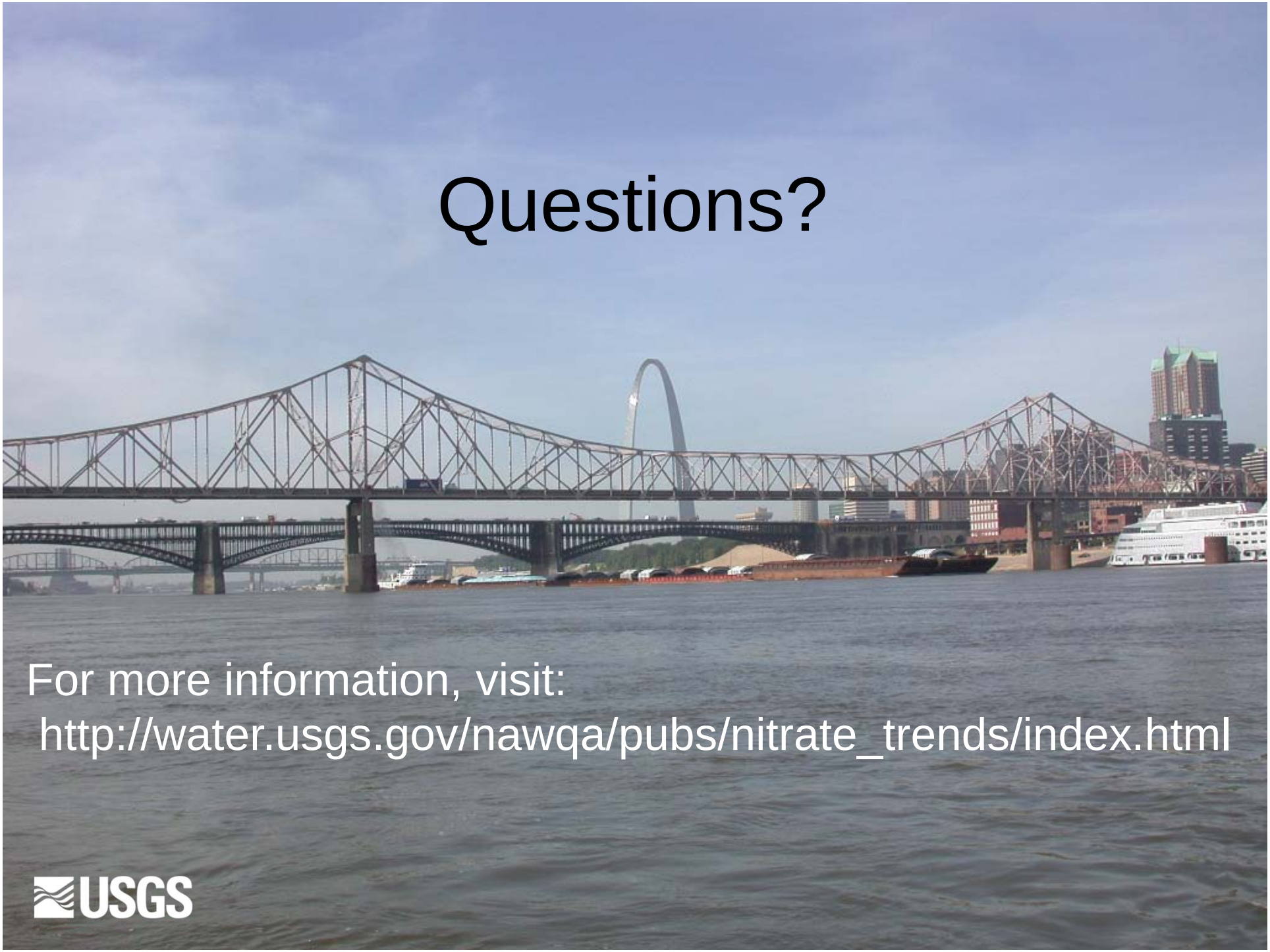
Questions?
For more information, visit:
http://water.usgs.gov/nawqa/pubs/nitrate_trends/index.html
USGS