Lessons from cross-site studies of forested watersheds: trends in water quality and effects of disturbances

Alba Argerich[1] and Sherri Johnson[2]

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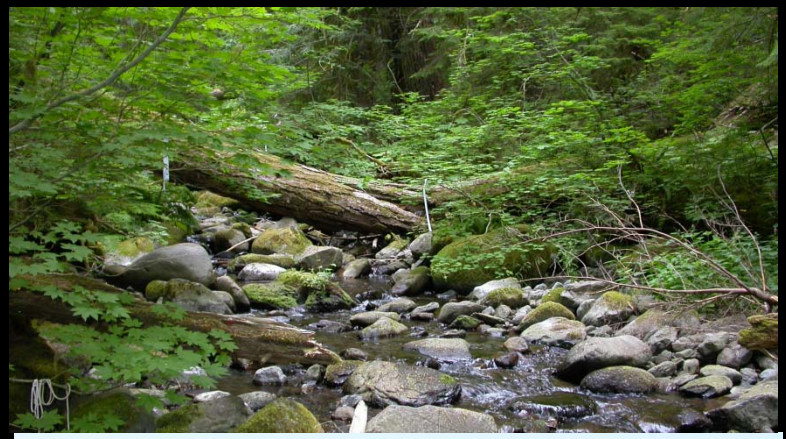
Forested watersheds

80% of our nation's freshwater resources originate from forest watersheds



Forest management

activity in the headwaters has the potential to affect downstream or "WE ALL LIVE DOWNSTREAM"

Nitrogen (N)

essential nutrient

water quality parameter

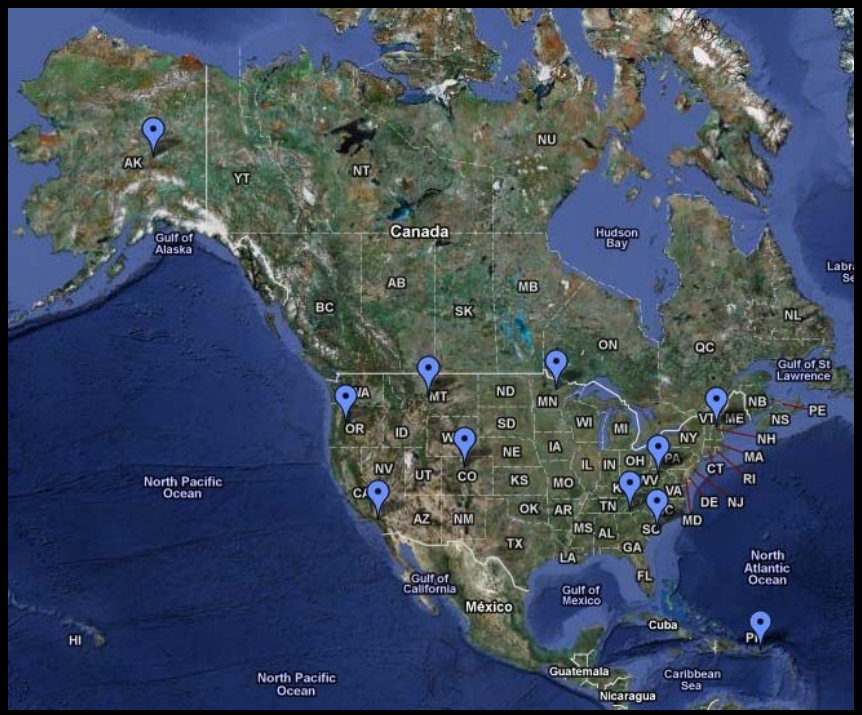
human alteration of the nutrient cycles = eutrophication

Stream Chemistry Synthesis Project

http://web.fsl.orst.edu/streamchem/

Participant sites:

Bonanza Creek /Caribou-Poker, AK
H.J. Andrews, OR
San Dimas, CA
Tenderfoot, MT
Fraser, CO
Marcell, MN
Fernow, WV
Coweeta, NC
Santee, SC
Hubbard Brook, NH
Luquillo, PR



Collaborators:

Mary B. Adams, *Fernow Experimental Forest;* Devendra M. Amatya, *Santee Experimental Forest;* John L. Campbell, *Hubbard Brook Experimental Forest;* George G. Ice, *NCASI, Inc.;* Sherri L. Johnson, *HJ Andrews Experimental Forest;* Jeremy B. Jones, *University of Fairbanks, AK;* Jennifer D. Knoepp, *Coweeta Experimental Forest;* Gene E. Likens, *Cary Institute of Ecosystem Studies;* William H. McDowell, *University of New Hampshire;* Charles C. Rhoades, *Fraser Experimental Forest;* Stephen D. Sebestyen, *Marcell Experimental Forest;* Peter M. Wohlgemuth, *San Dimas Experimental Forest;* David K. Wright, *Tenderfoot Experimental Forest*

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Objectives:

Comparison of long term data across sites. Synthesis papers:

1) Effects of forest disturbance on stream chemistry dynamics, concentrations and fluxes
2) Trends in N concentrations in reference watersheds
3) Influences of sampling strategy and calculation methods on stream solute flux estimates: A comparison of methods used in long-term catchment studies
4) Addressing nutrient criteria using reference basin data

Create a database for stream chemistry data (Standardize units, document analytical and sampling methods)

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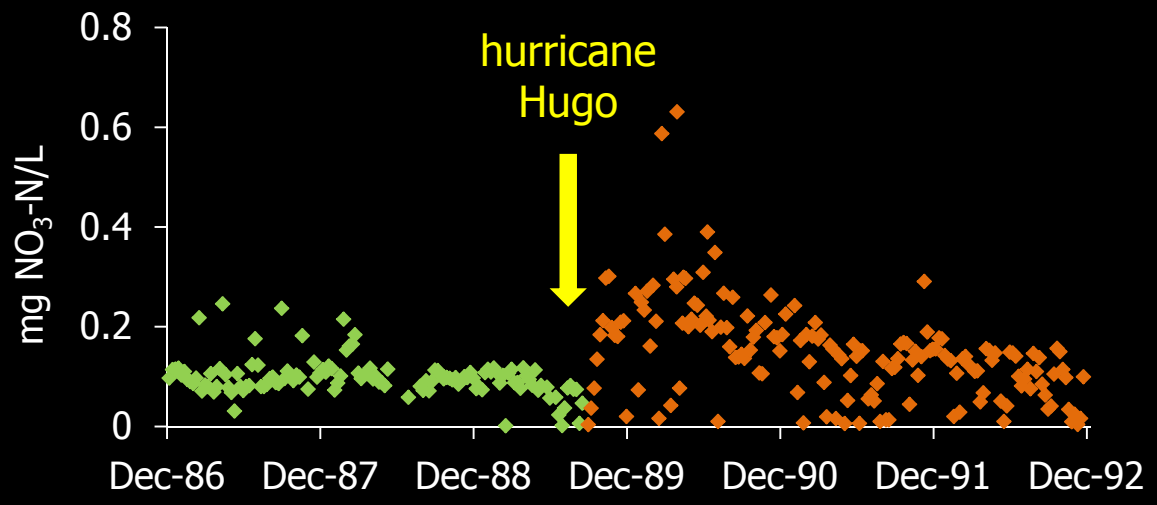
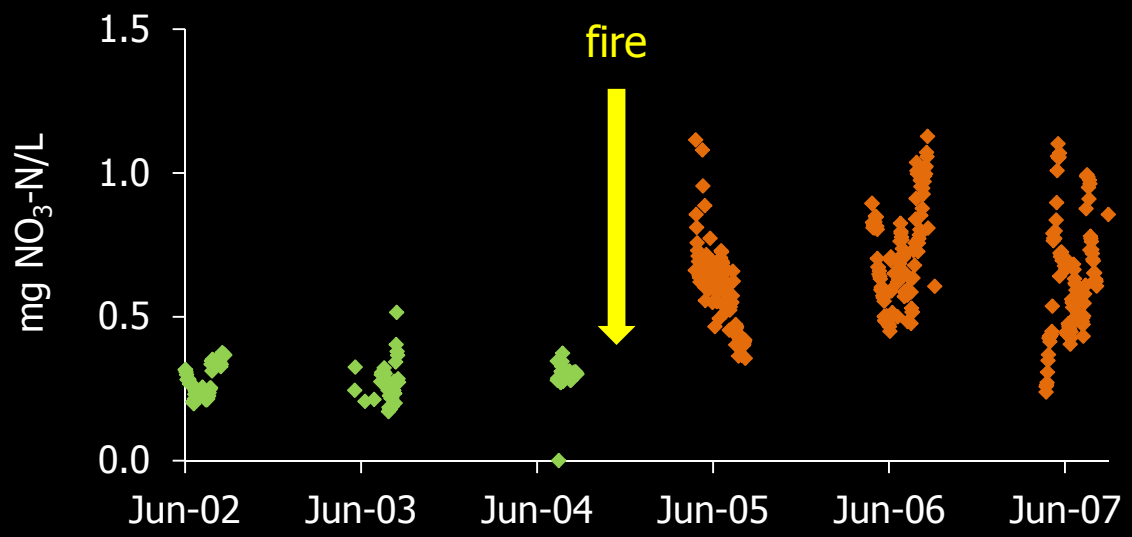
Do NATURAL disturbances lead to similar responses?

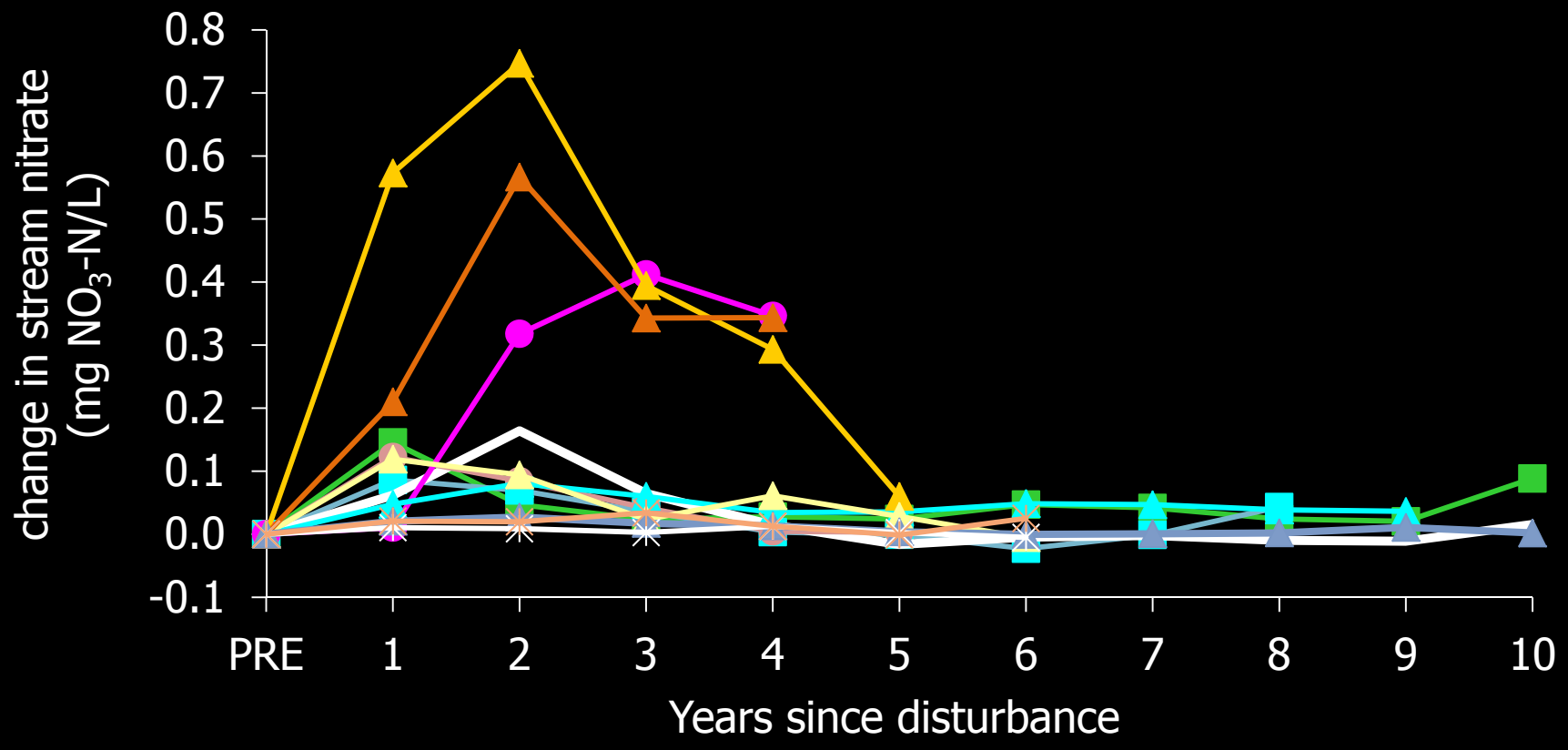


Luquillo Exp. Forest - Quebrada Sonadora Puerto Rico



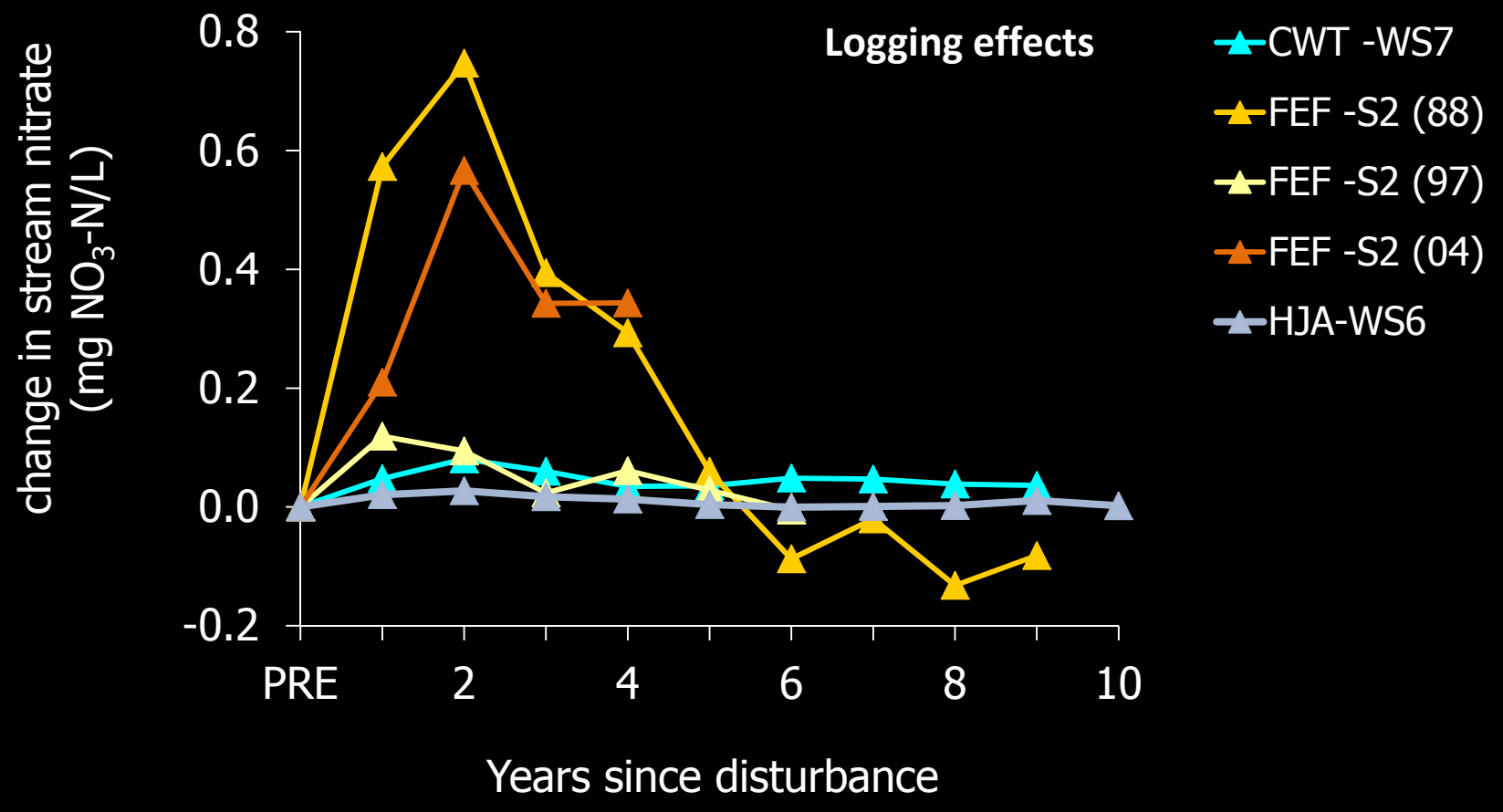
Caribou-Poker Creek – P6 watershed Alaska

Do natural AND ANTHROPOGENIC disturbances lead to similar responses?



- LUQ - QS (hurricane)
- HBEF -W6 (ice storm)
- BNZ -P6 (fire)
- FEF -S2 (logging)
- FEF -S2 (logging)
- CWT -WS36 (insect infestation)
- CWT -WS7 (hurricane)
- SEF-W77 (fire)
- CWT -WS7 (logging)
- FEF -S2 (logging)
- HJA-WS6 (logging)
- FRA- E. St. Louis (insect infestation)

Do same type of disturbances lead to similar responses?



Do same type of disturbances lead to similar responses?

Different magnitude and duration of the responses

Definition of PRE conditions?

Disturbed catchments

vs.

Reference catchments or pre-conditions

non stationary?

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ENVIRONMENTAL RESEARCH LETTERS
Environ. Res. Lett. **8** (2013) 014039 (8pp)
doi:10.1088/1748-9326/8/1/014039

Trends in stream nitrogen concentrations for forested reference catchments across the USA

A Argerich[1], S L Johnson[2], S D Sebestyen[3], C C Rhoades[4], E Greathouse[1], J D Knoepp[5], M B Adams[6], G E Likens[7,8], J L Campbell[9], W H McDowell[10], F N Scatena[11] and G G Ice[12]

http://iopscience.iop.org/1748-9326/8/1/014039

video abstract

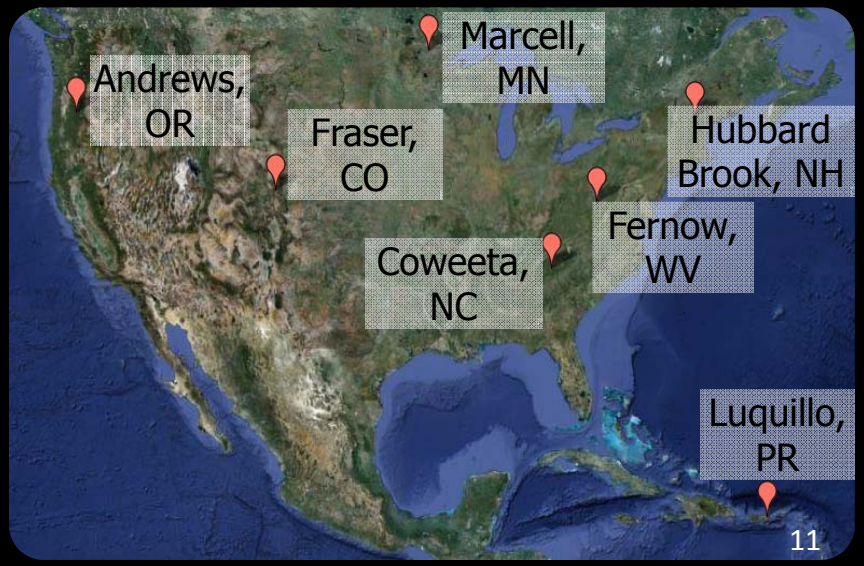
7 sites & 22 reference catchments

without major land use changes in the last 60 years

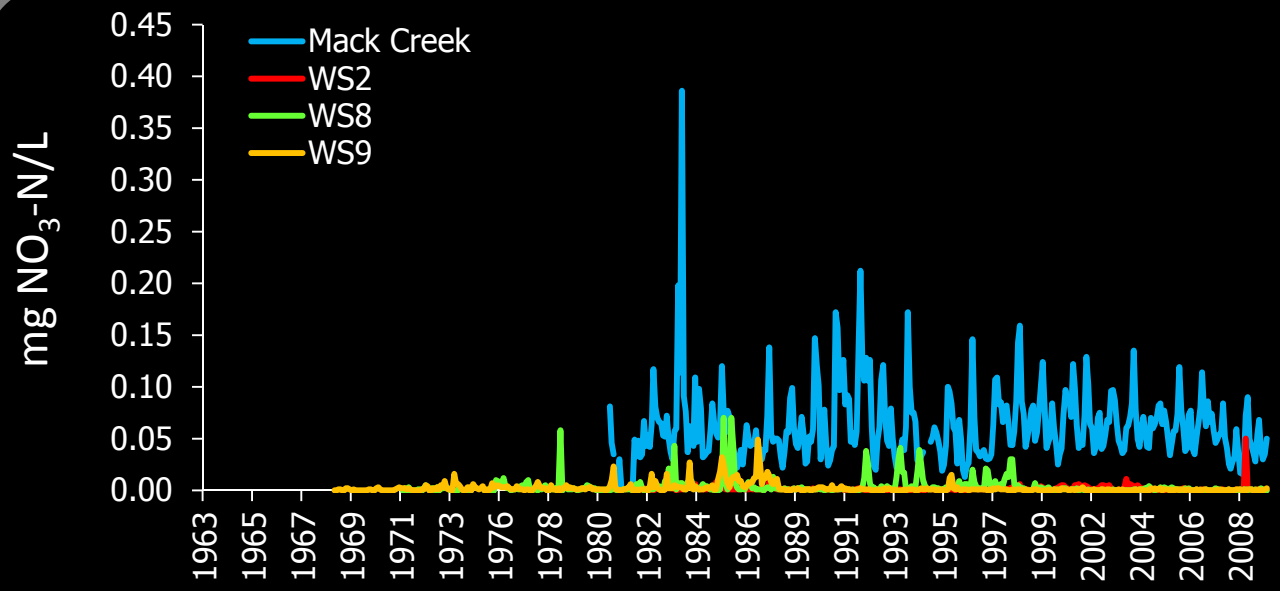
≥ 12 years of data (1996-2007)

chemistry sampling intervals < 3 weeks

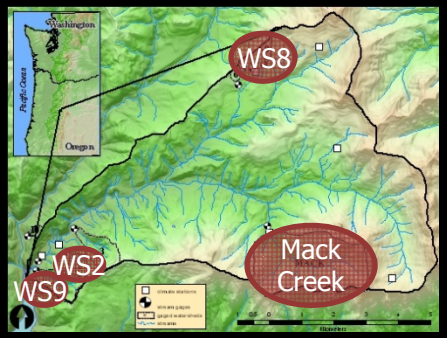
daily Q measurements



Trends in N concentrations: natural variability



H. J. Andrews Exp. Forest



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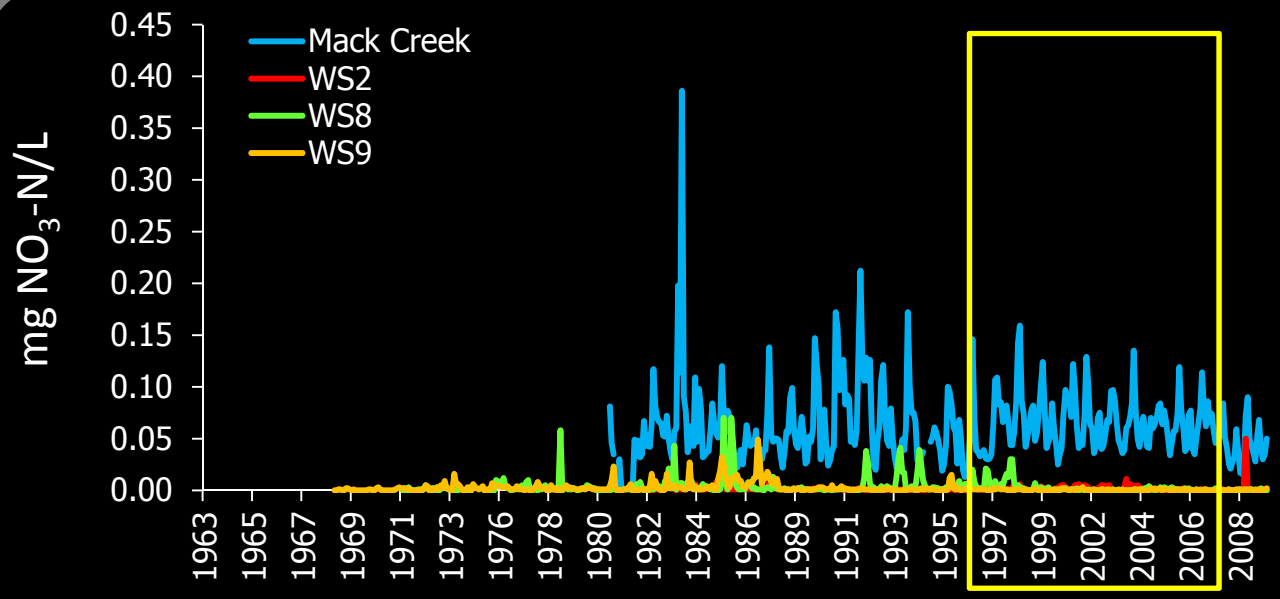

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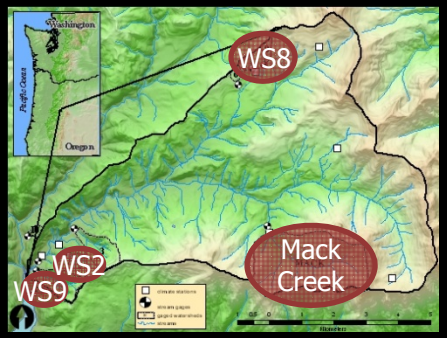

Period of 1996-2007

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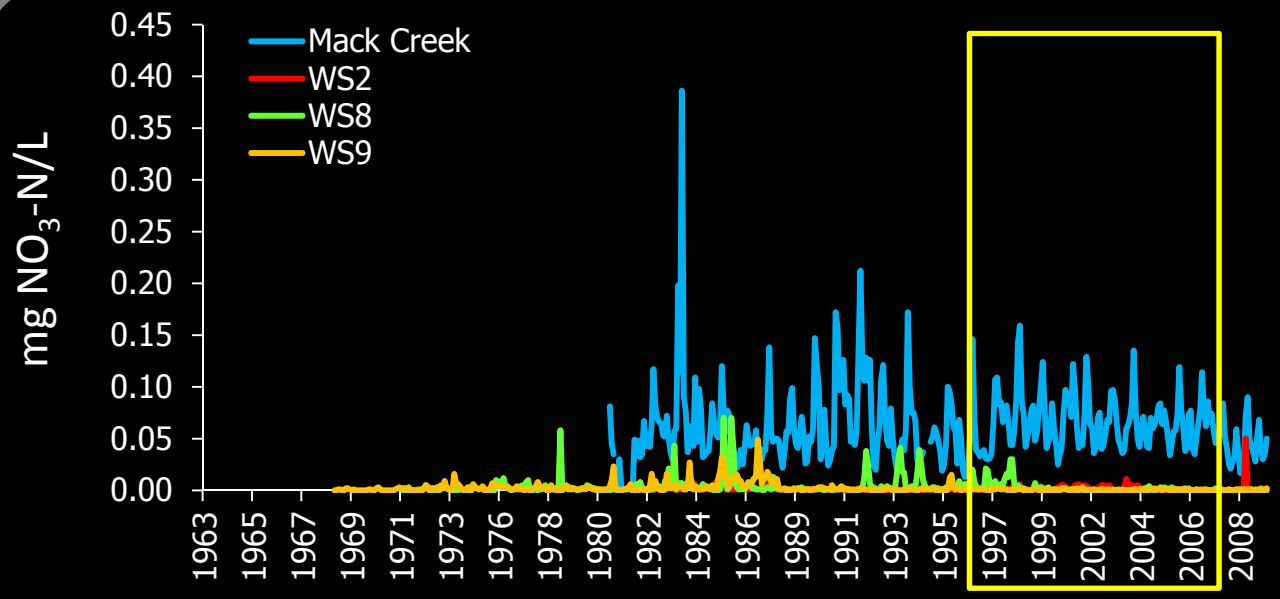

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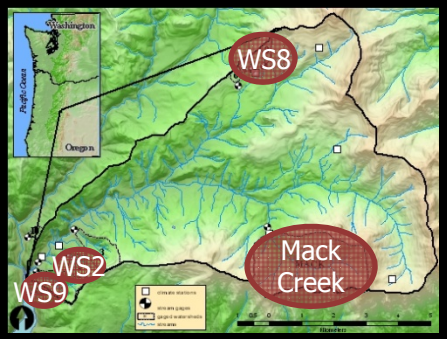

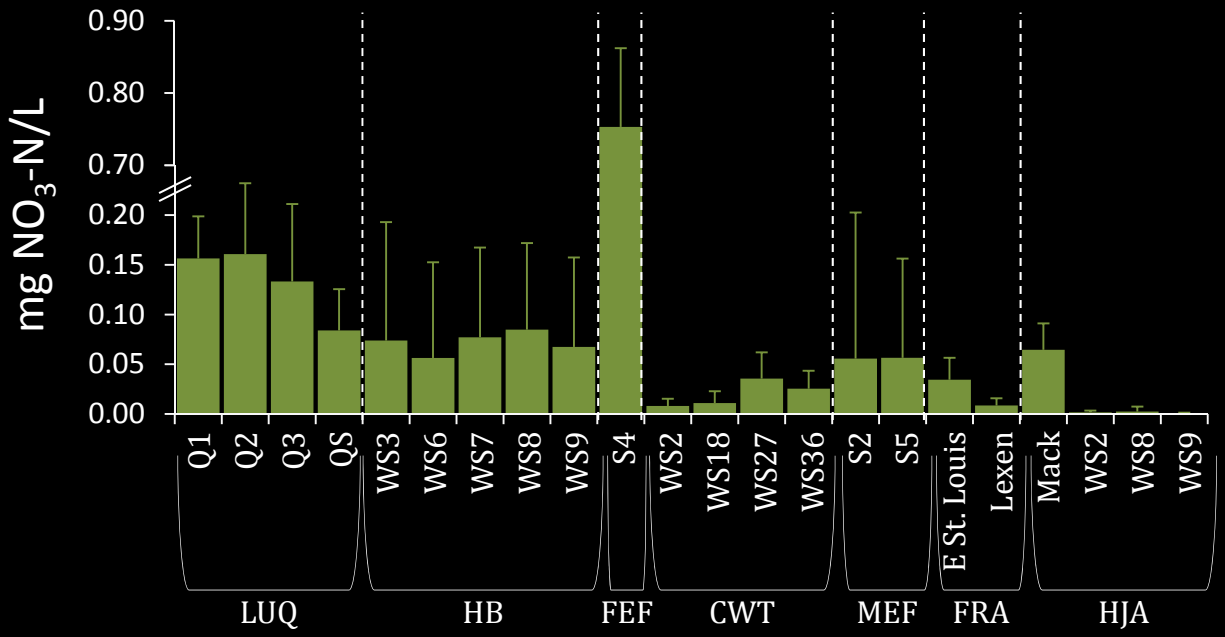

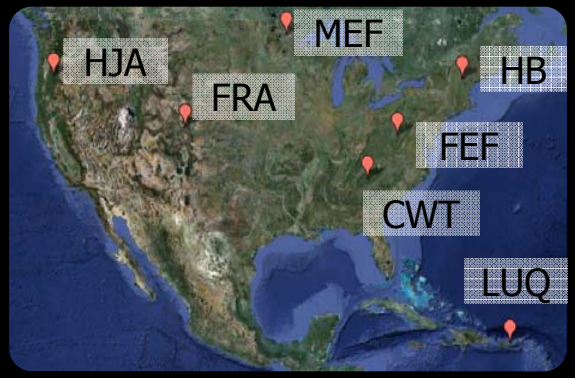

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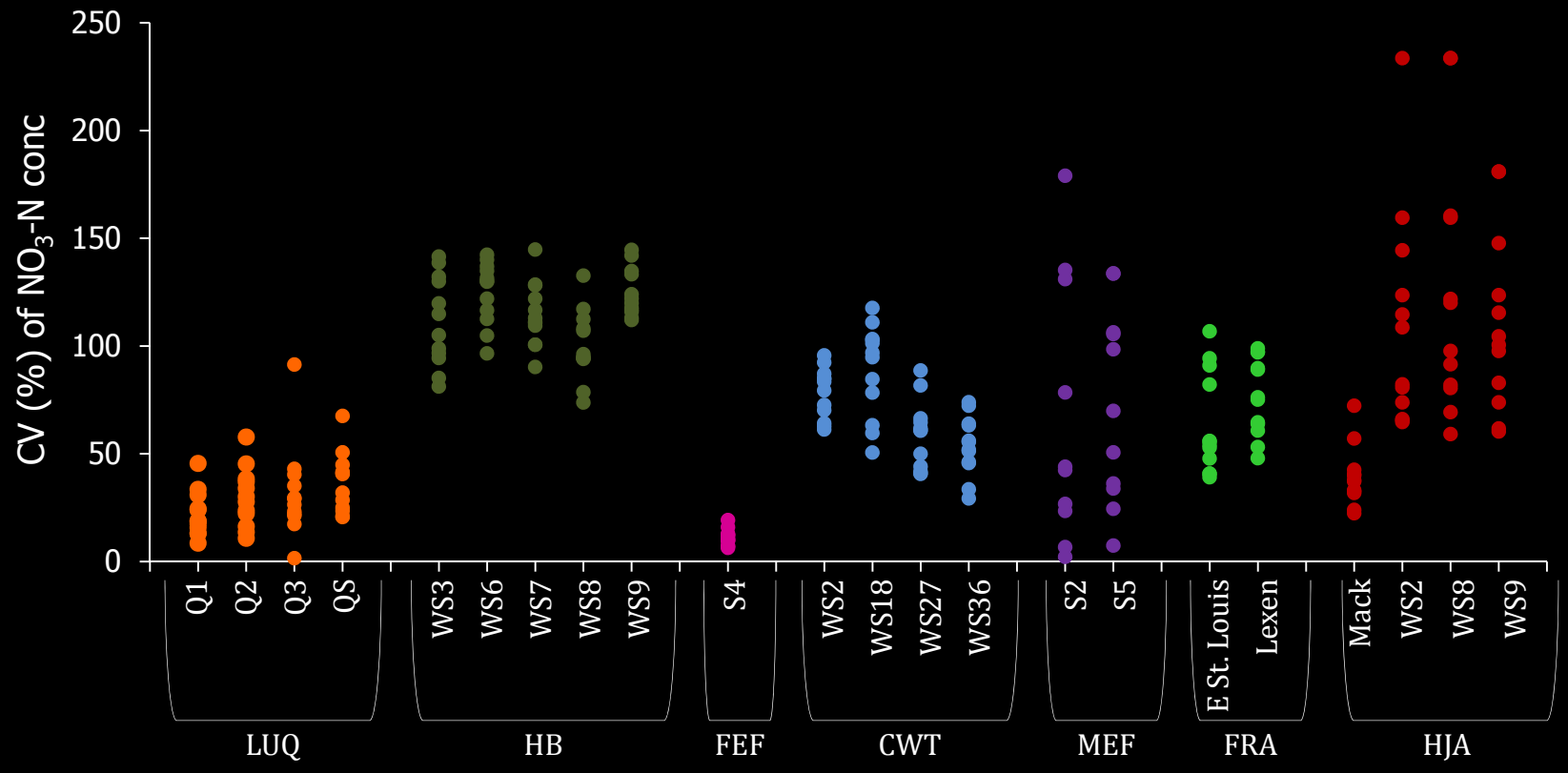

Temporal variation:

- intra-annual

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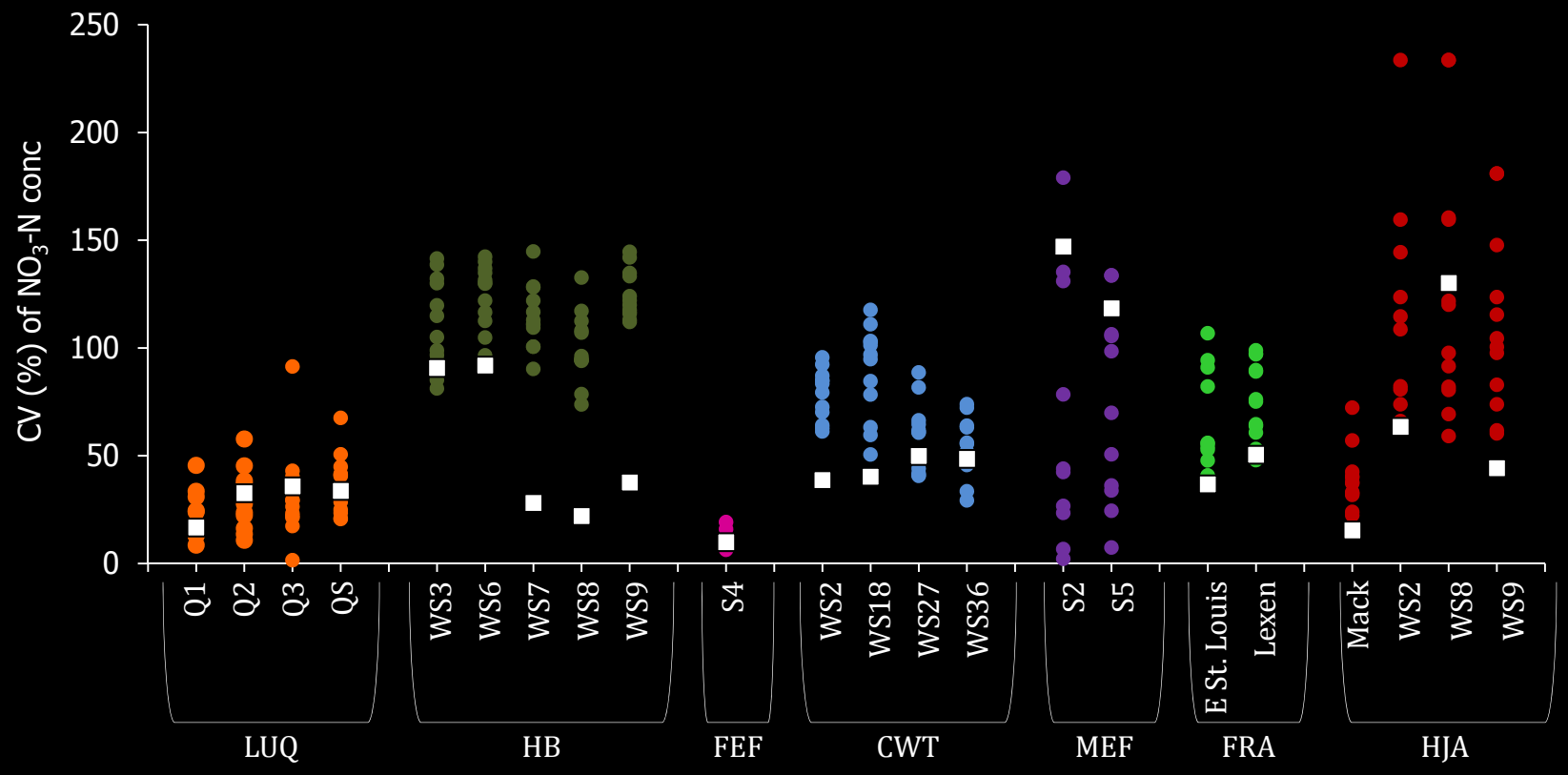

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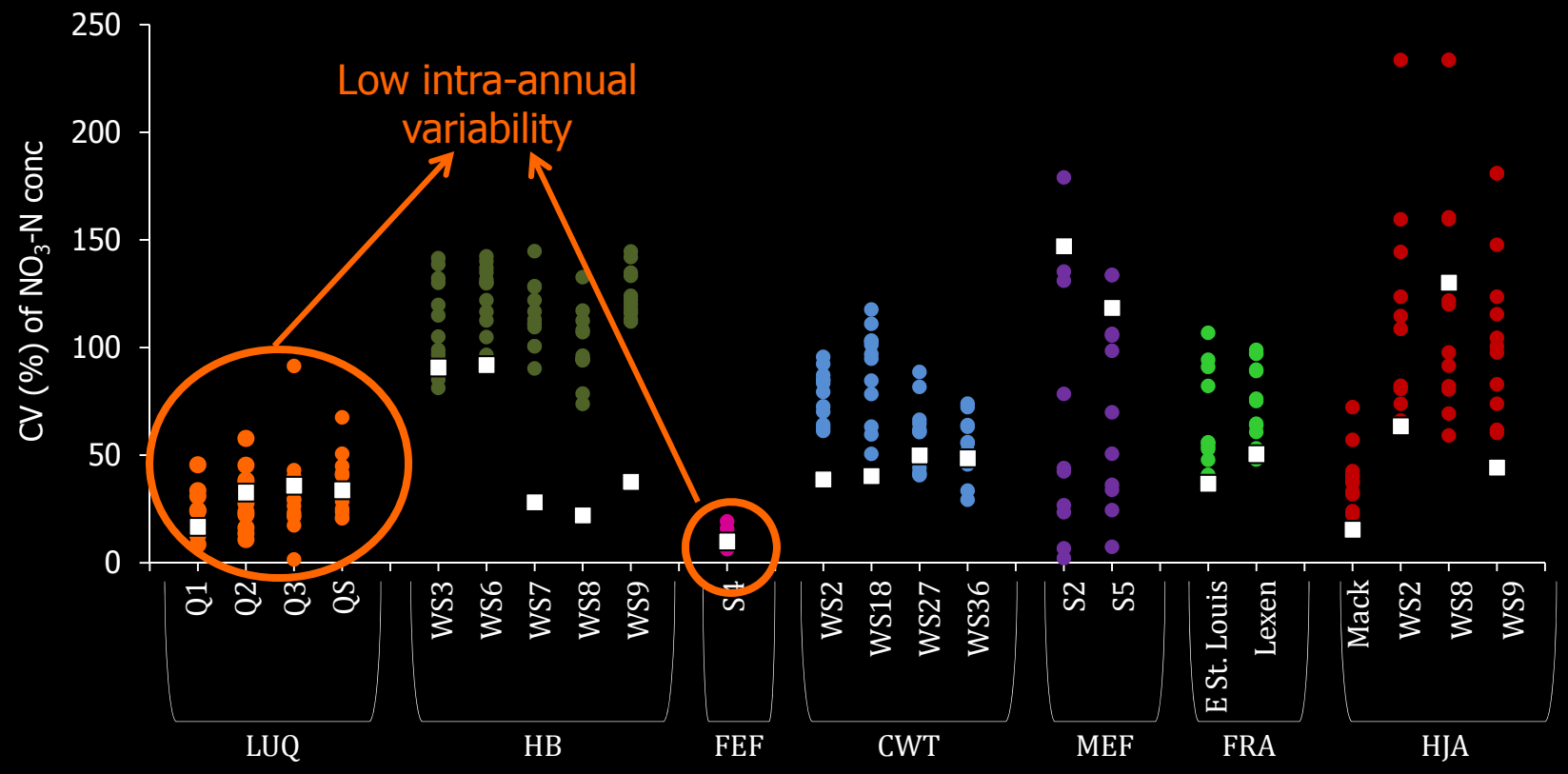

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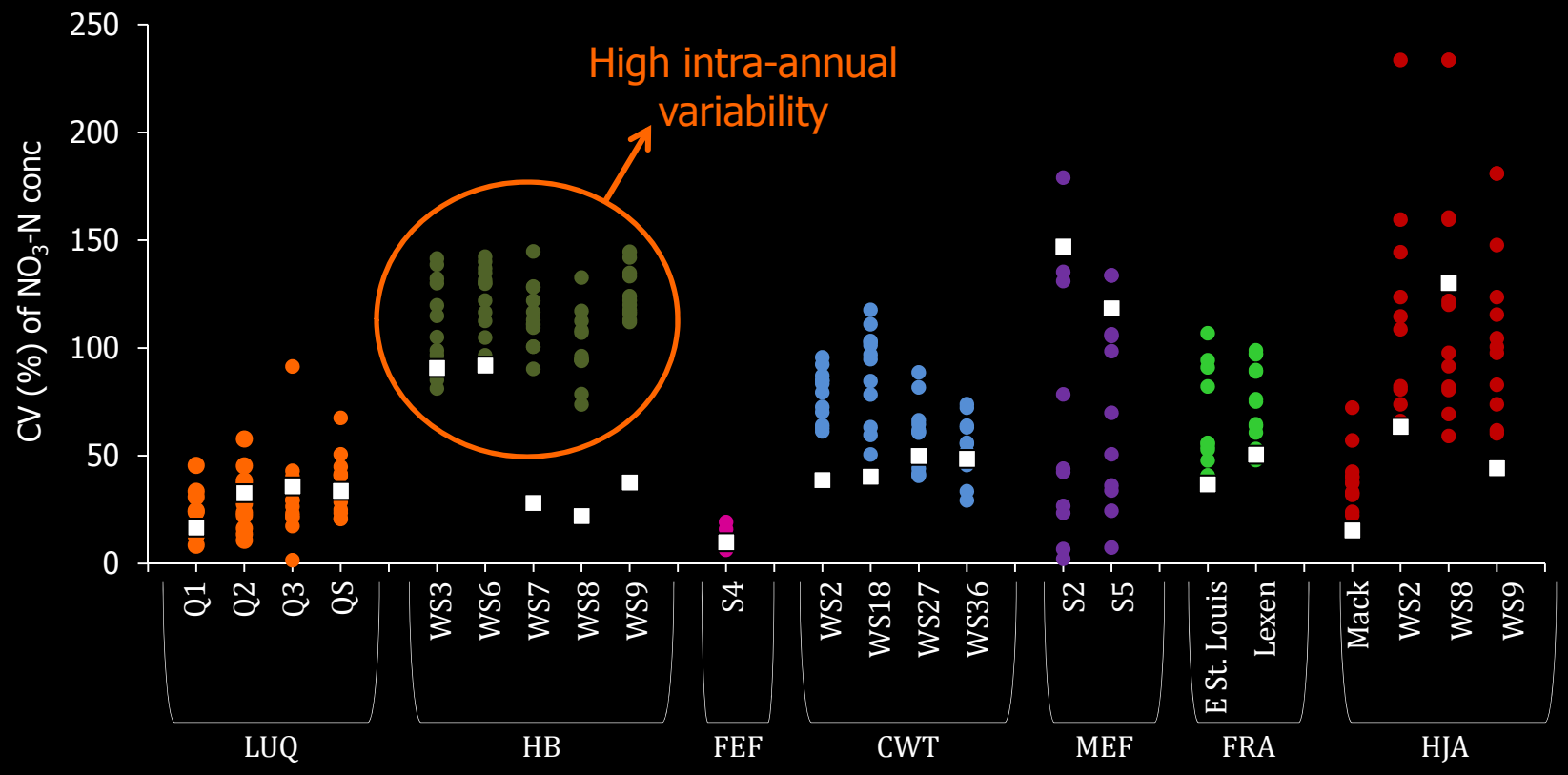

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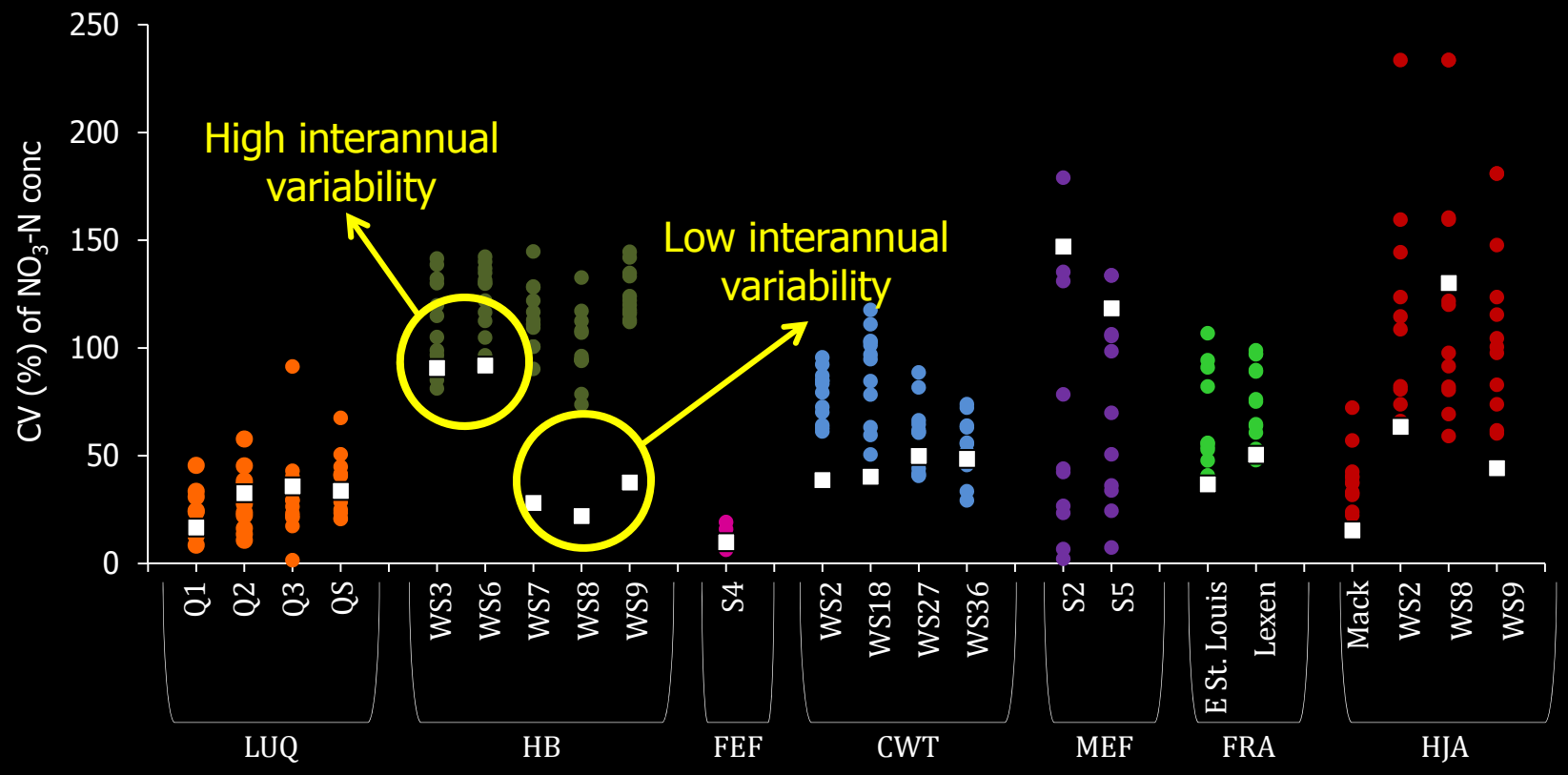

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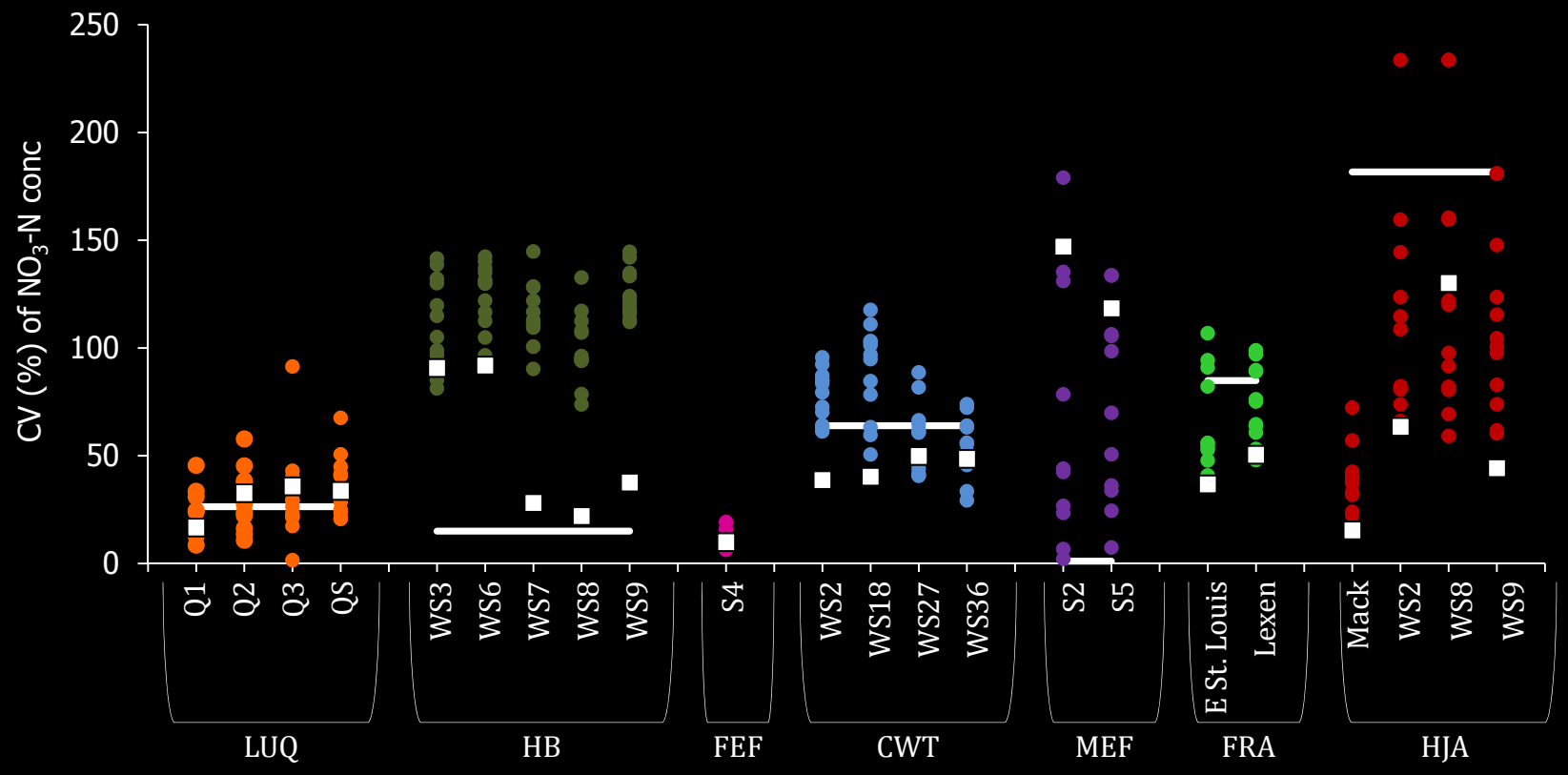

Temporal variation:
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Spatial variation:
- —— within sites

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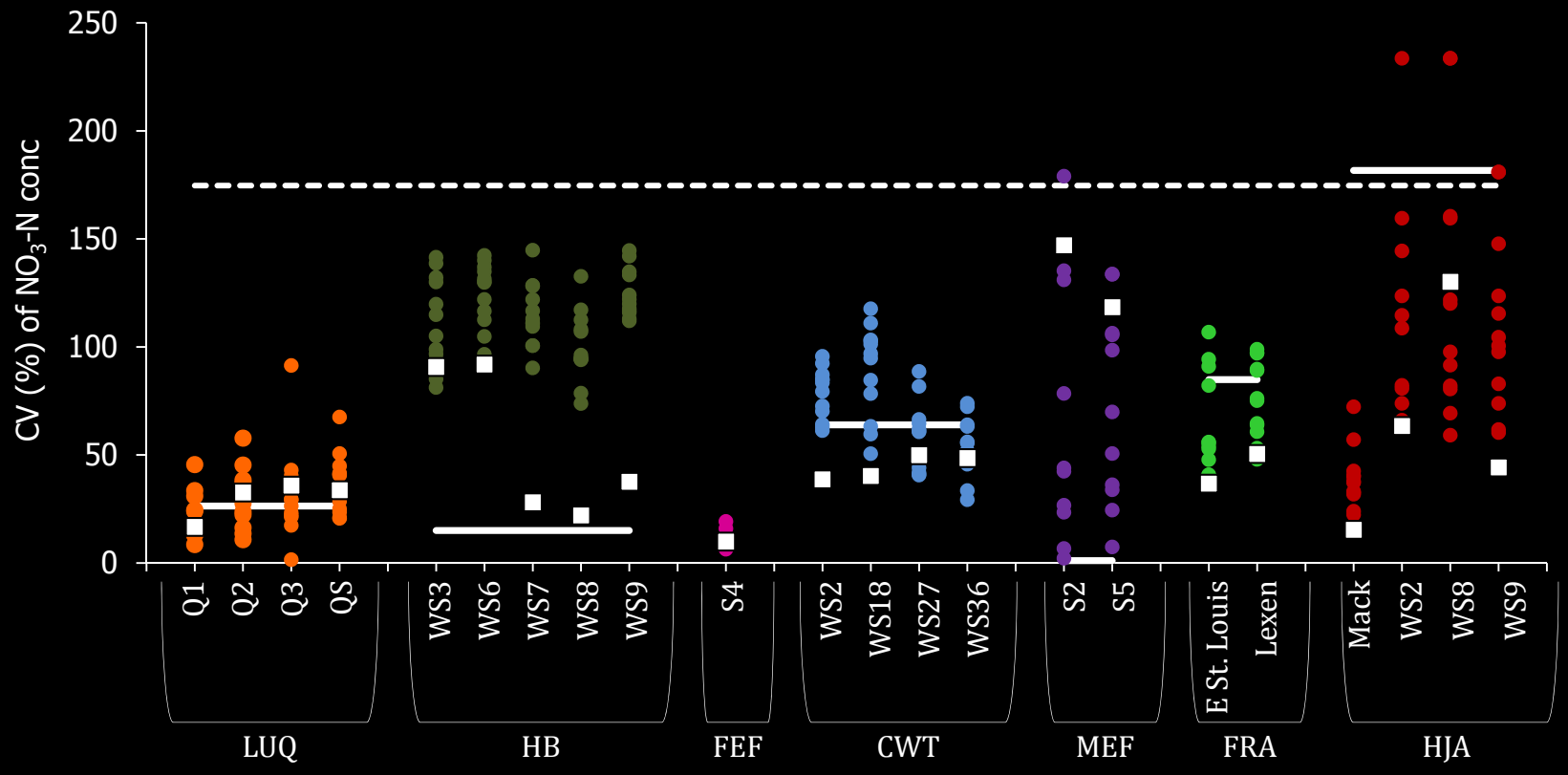

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Spatial variation:
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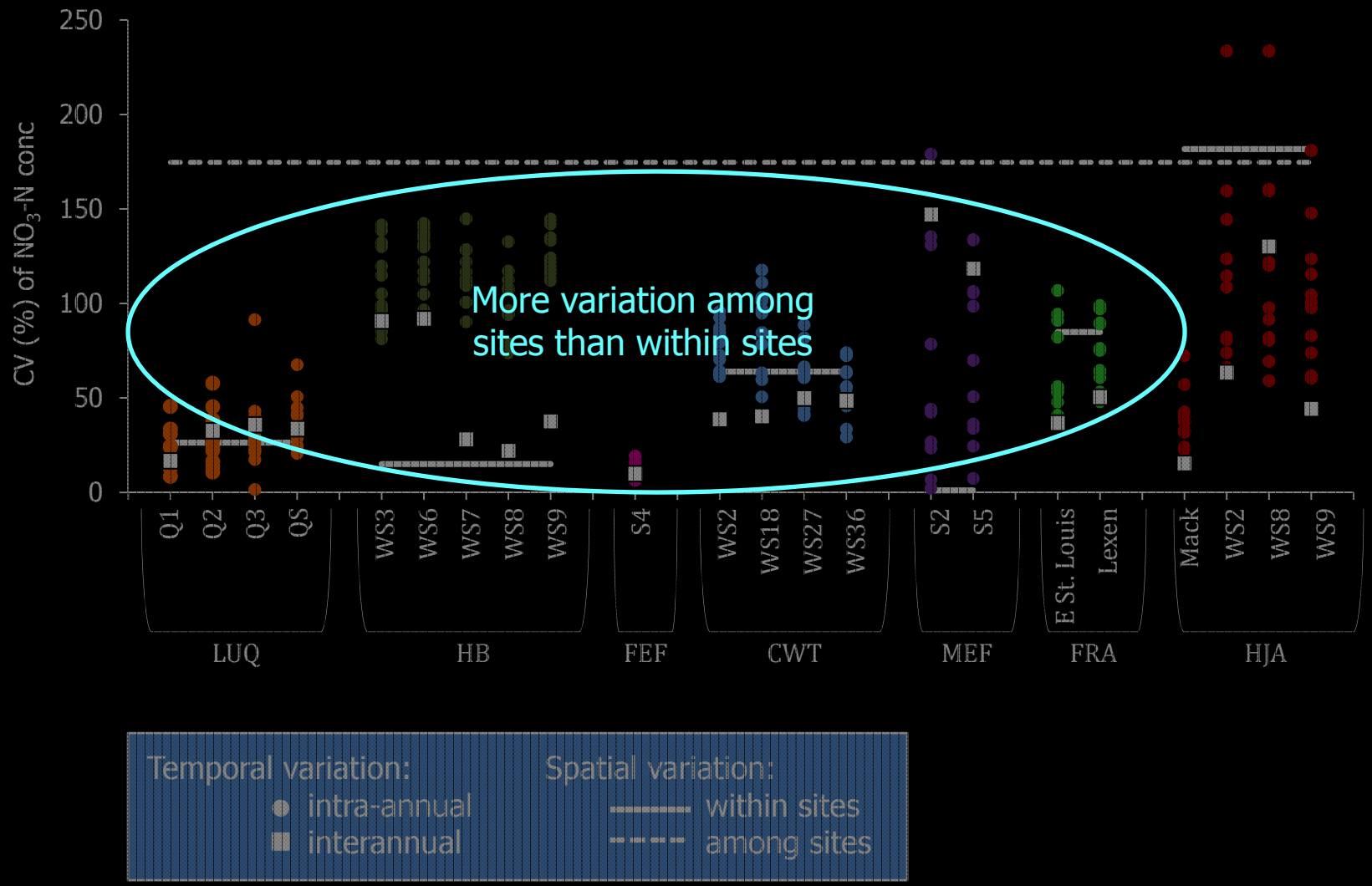

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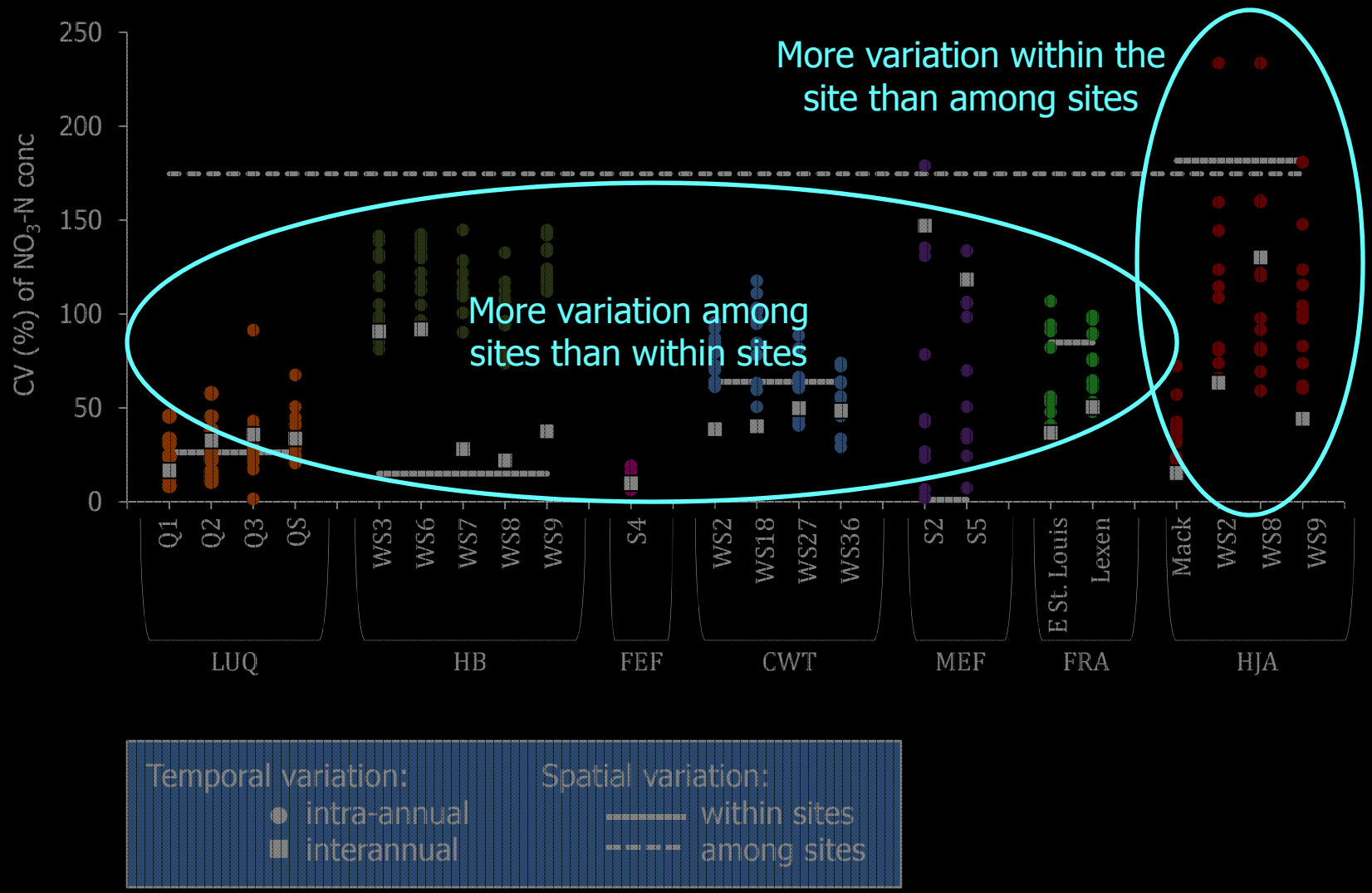
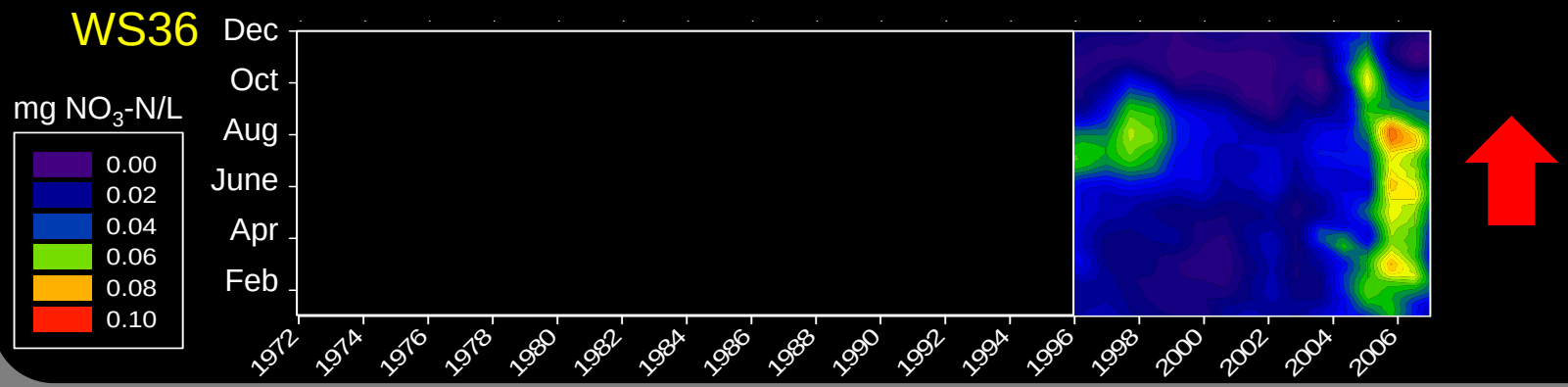


Trends in N concentrations: nitrate in Coweeta



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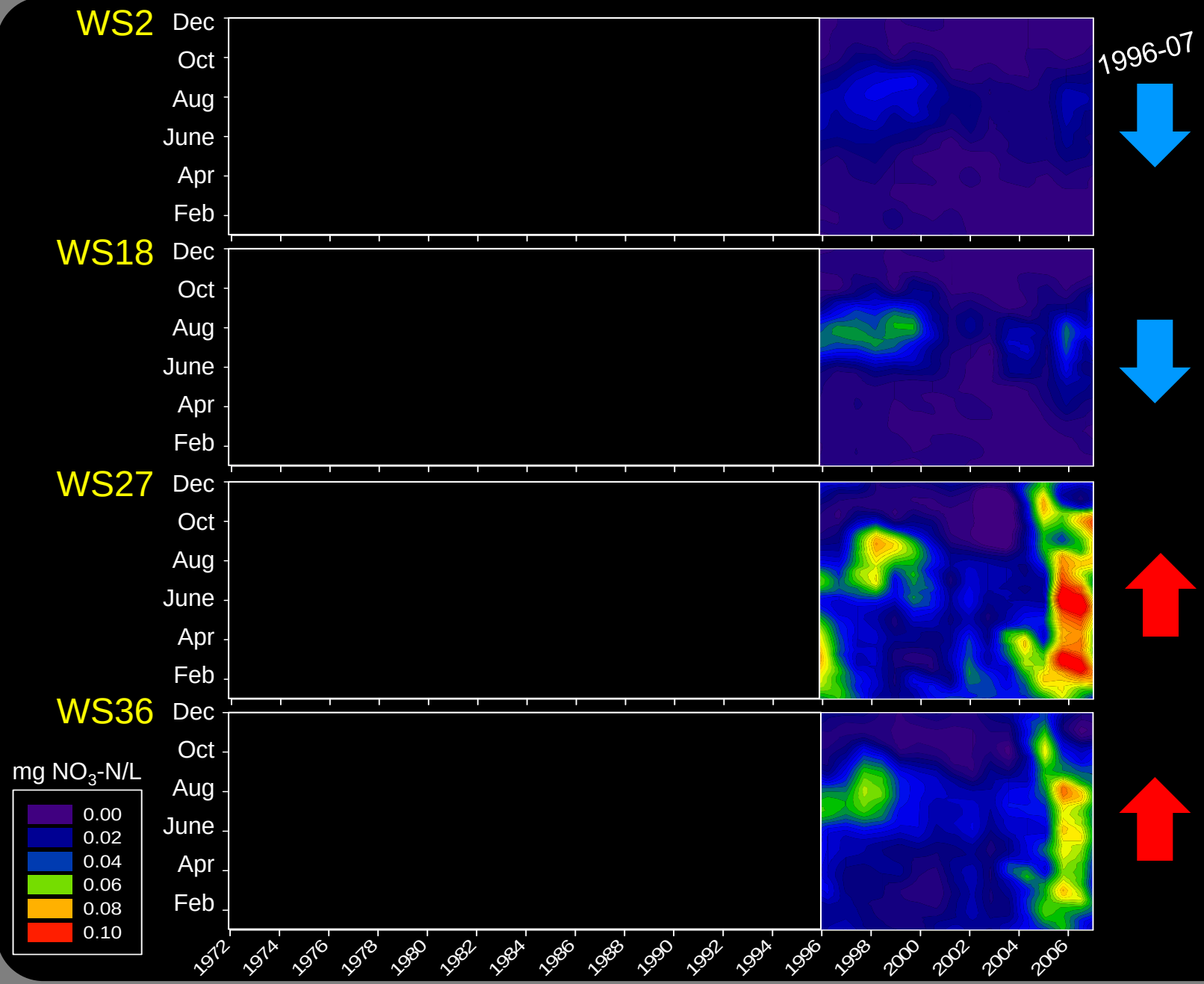

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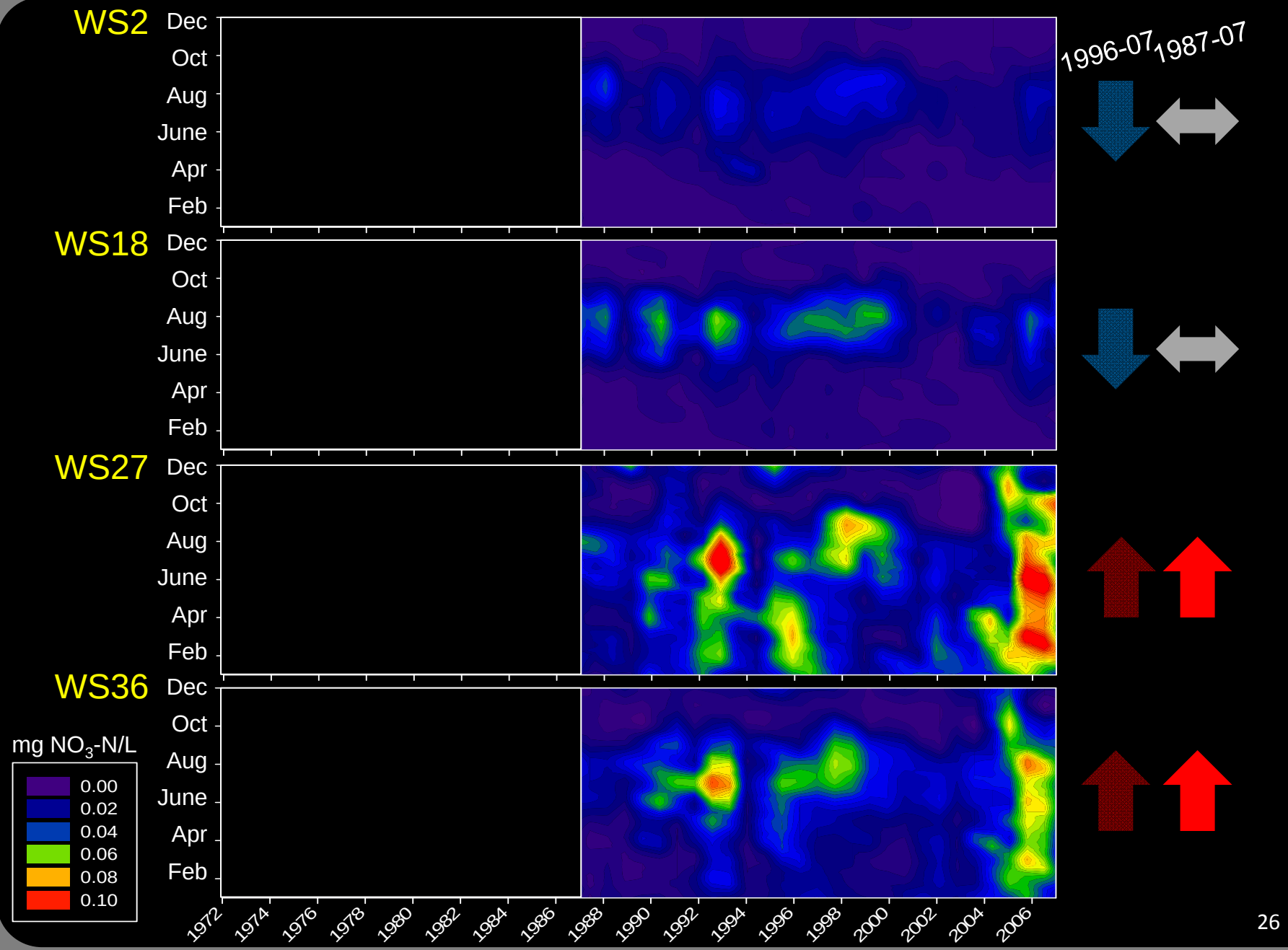

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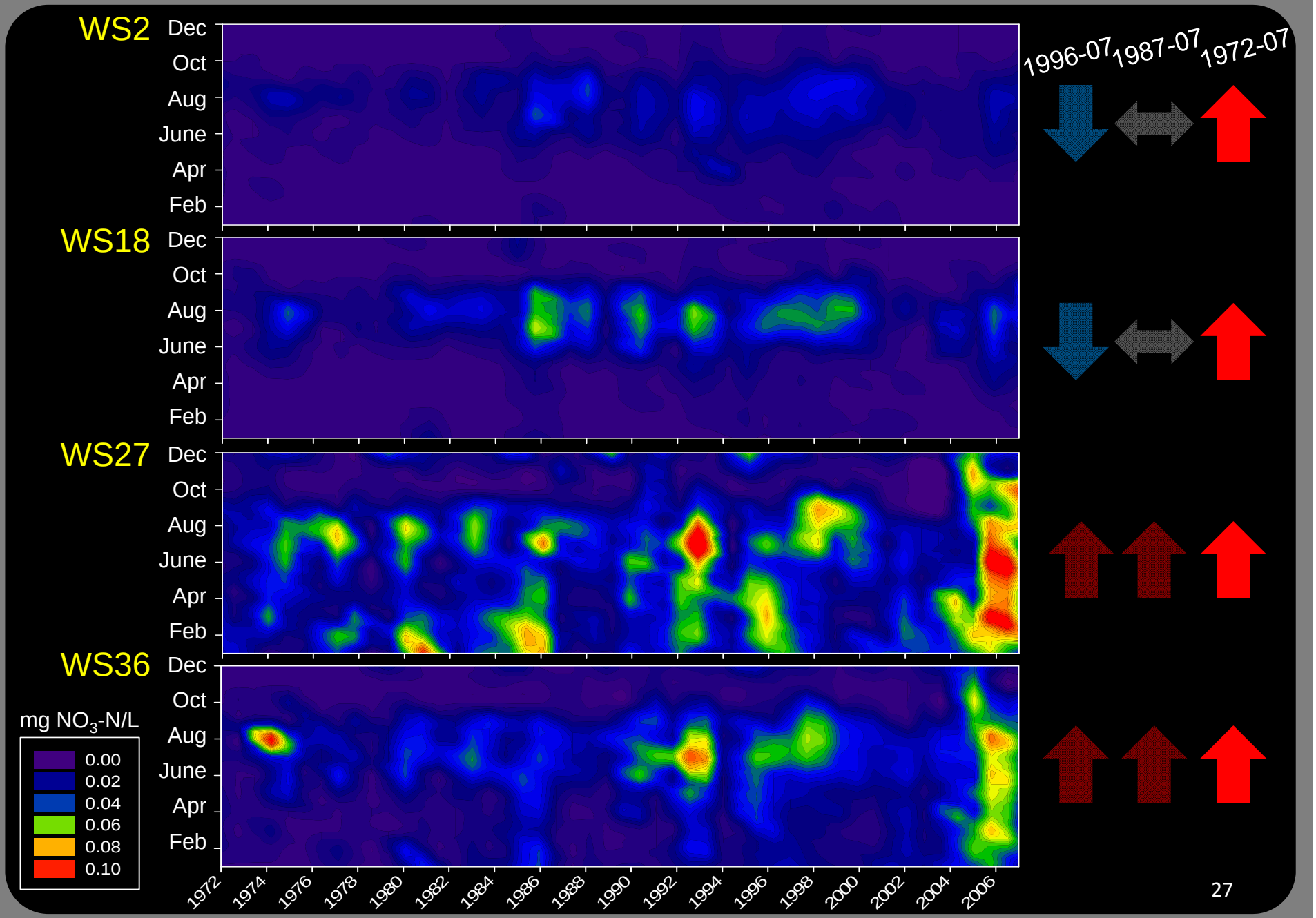
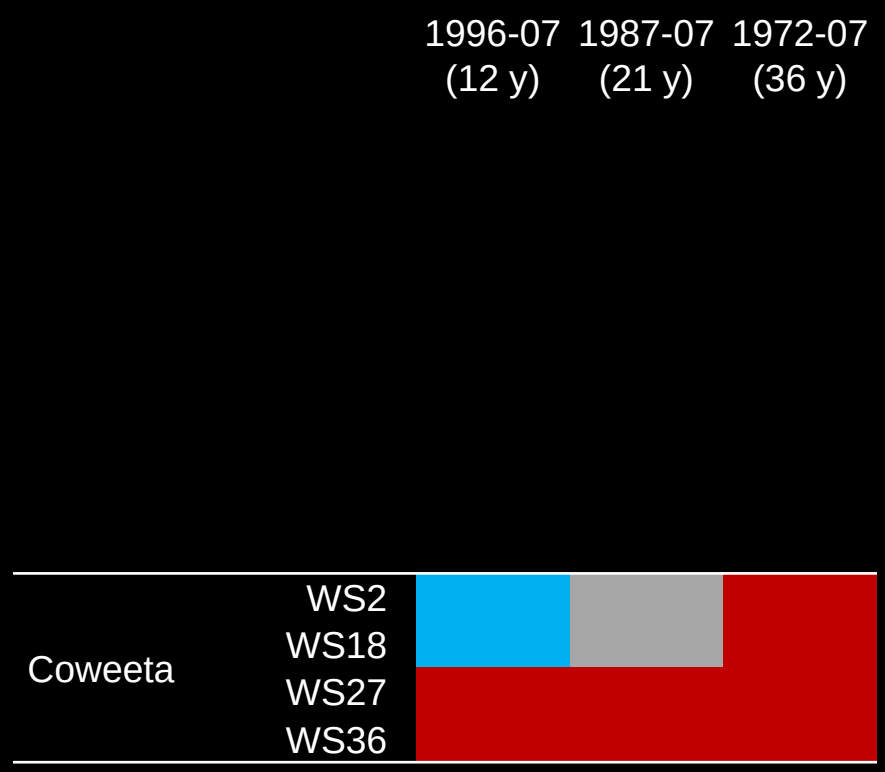


Trends in N concentrations: all sites

NO_3-N

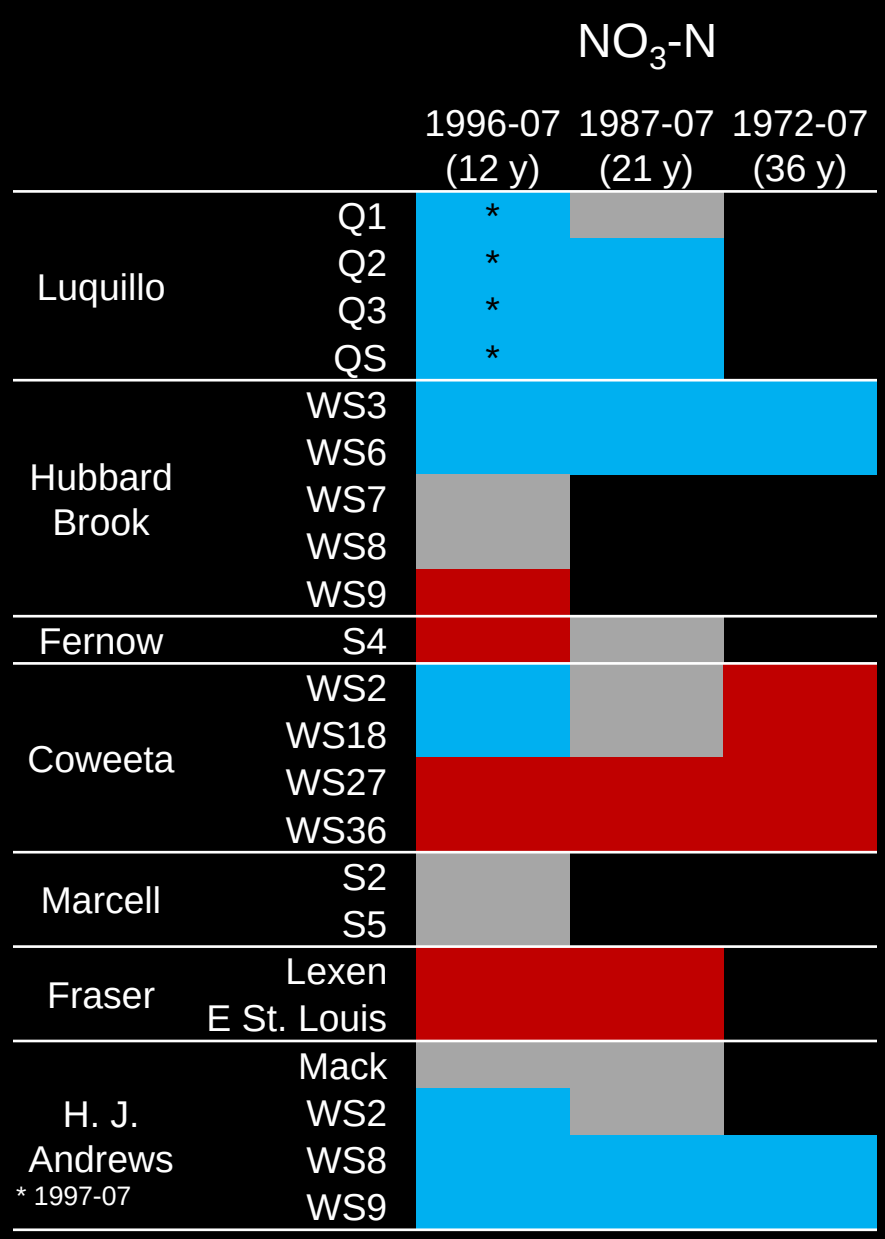


decreasing trend

no significant trend

increasing trend

Trends in N concentrations: all sites



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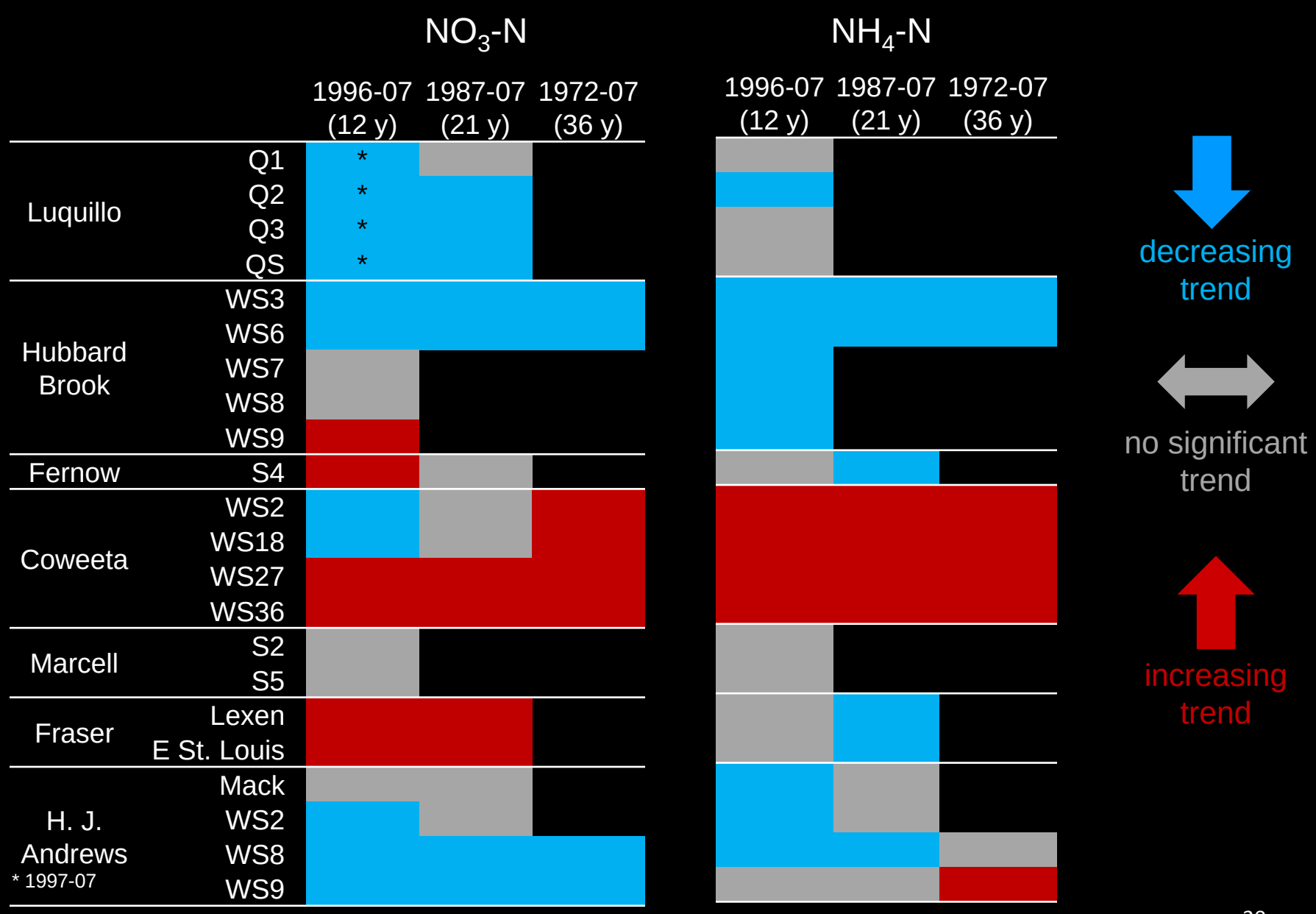

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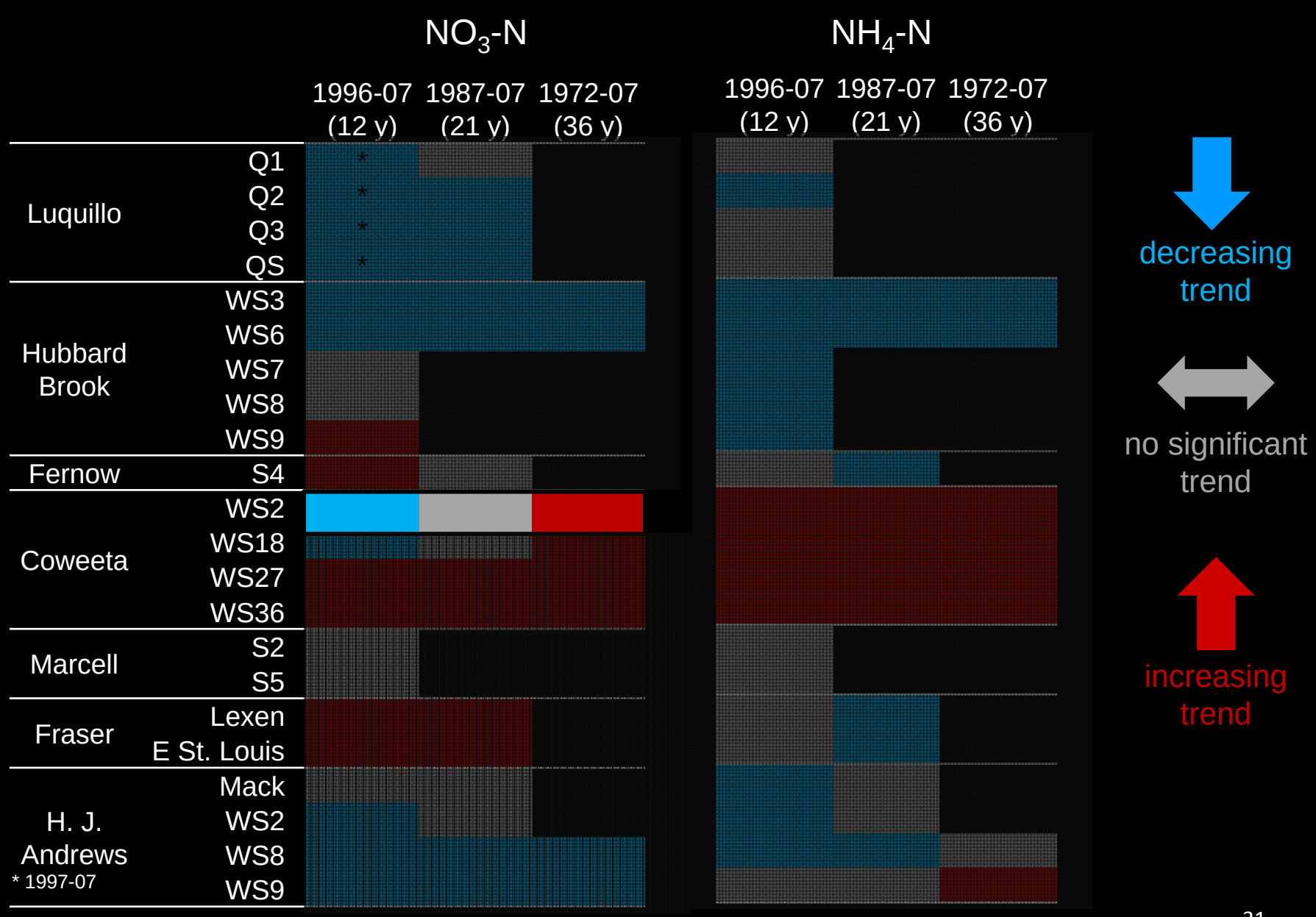

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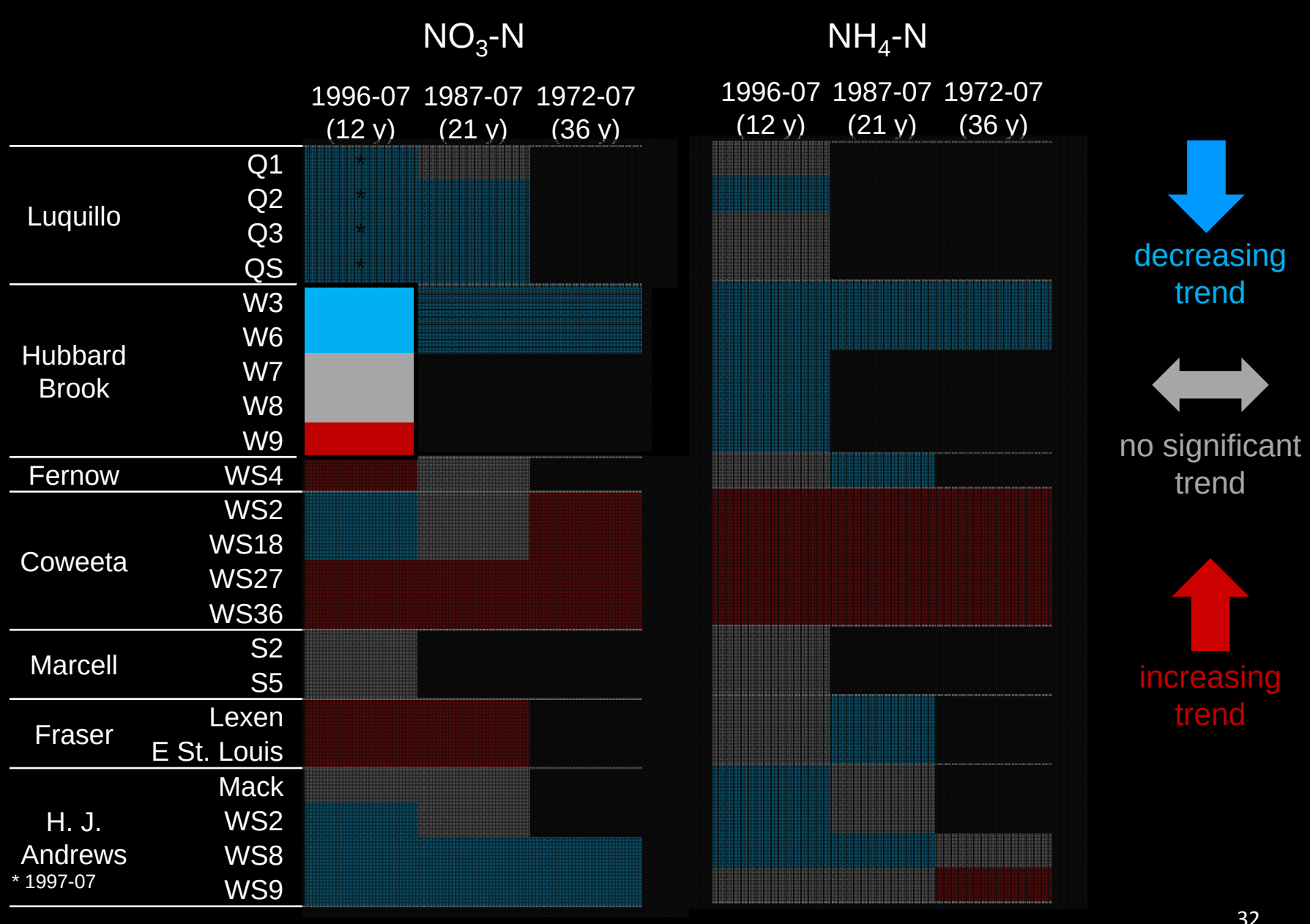

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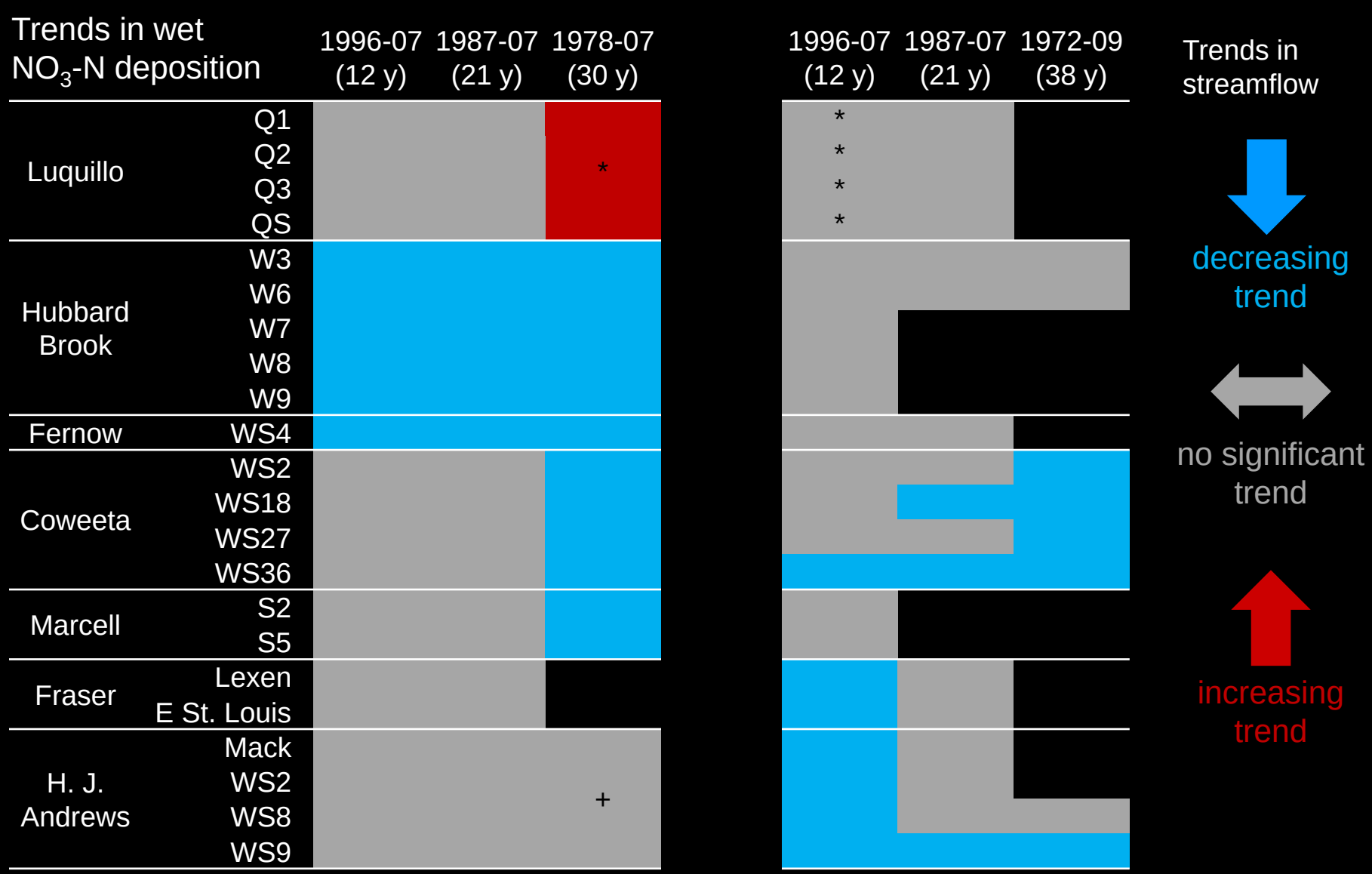

*1985-2007 +1980-2007

Trends in N concentrations in reference catchments across US

Is there more variation among sites than among basins within a site?

Yes, except at HJA. Stream nitrate and ammonium in reference catchments show great temporal and spatial variabilities that must be considered when evaluating loads and establishing nutrient criteria.

Are there generalized long term trends in stream NO_3 and NH_4?

No, forested reference catchments across the country show both increasing and decreasing trends in stream nitrogen.

Catchments within a site do not necessarily present the same trends.

The length of record examined can result in differing trends which highlights the importance of long-term studies.

Are trends associated with changing deposition or discharge?

Stream nitrate and ammonium increase when streamflow decreases.
Stream ammonium increases when atmospheric ammonium wet deposition increases.

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Effects of sampling strategy and calculation methods on solute flux estimates

Flux= mass of N that passes a given point on the river over a given period of time

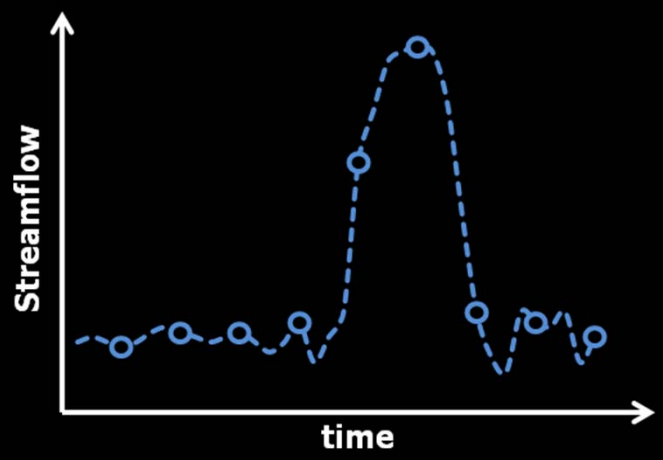
$\Sigma(Q \times conc)$

(kg N/year)

Effects of sampling strategy and calculation methods on solute flux estimates

Period-weighted methods

Grab samples, fixed sampling intervals



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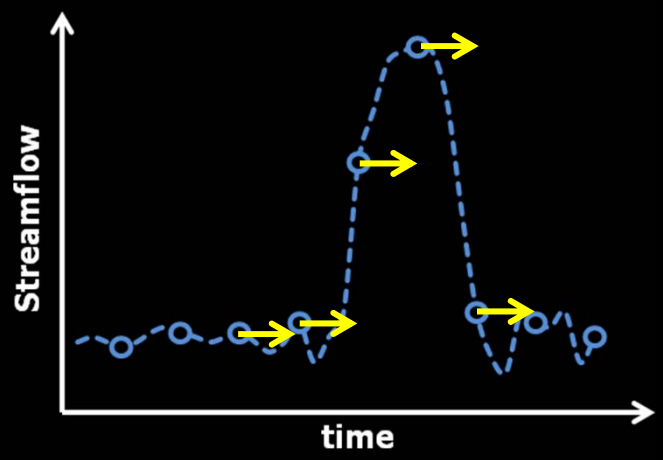

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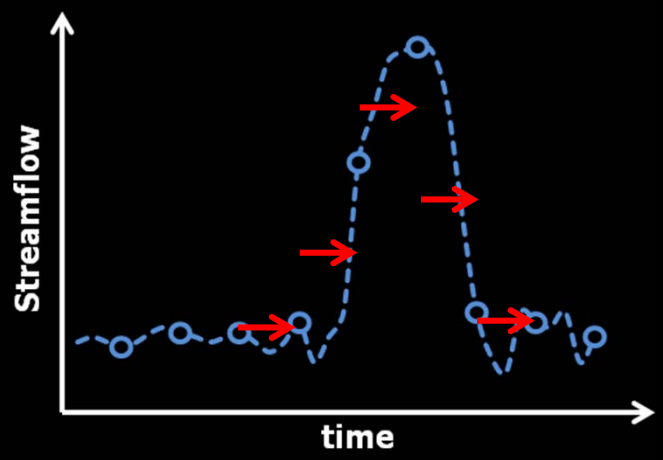

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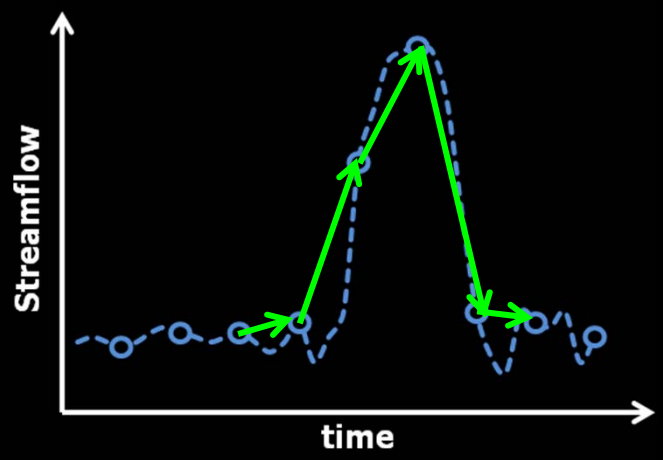

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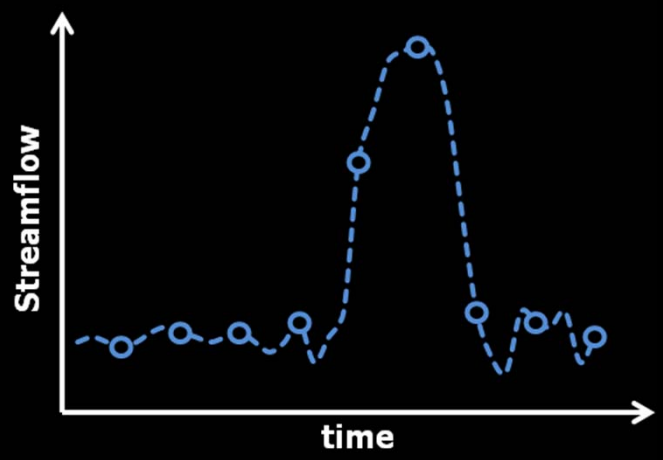
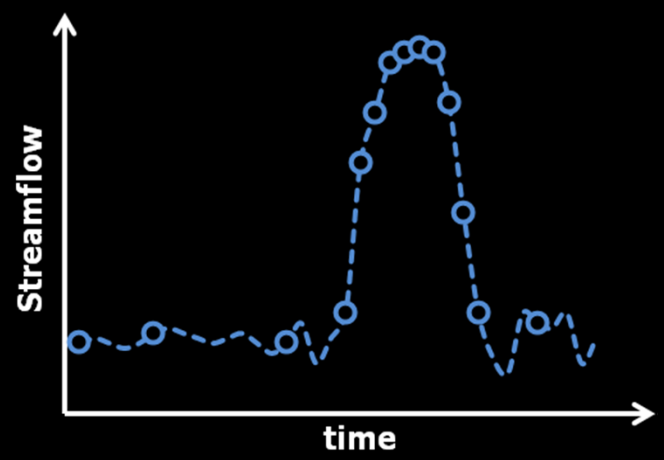


Composite samples



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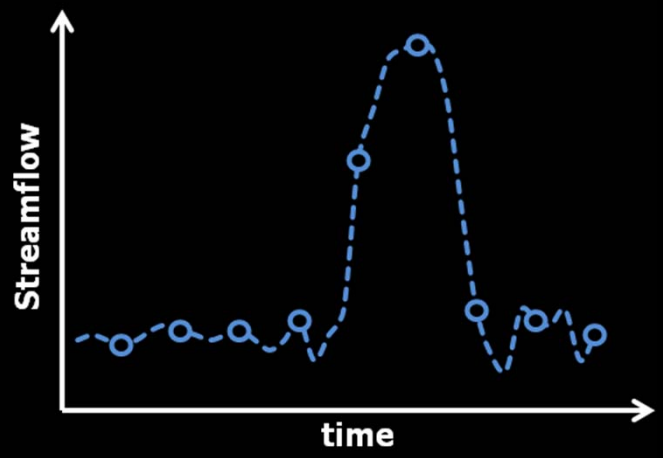

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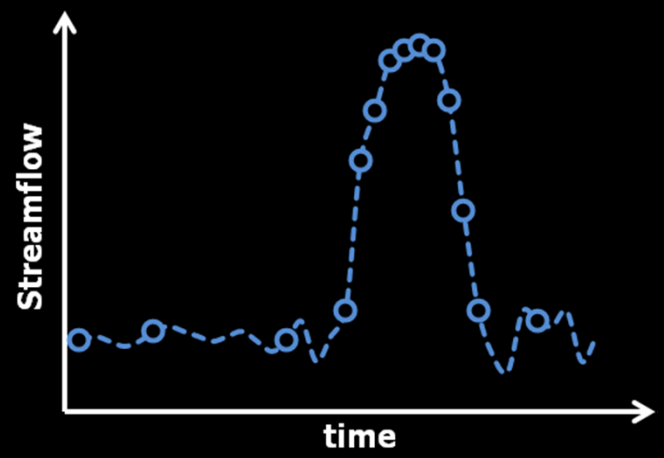
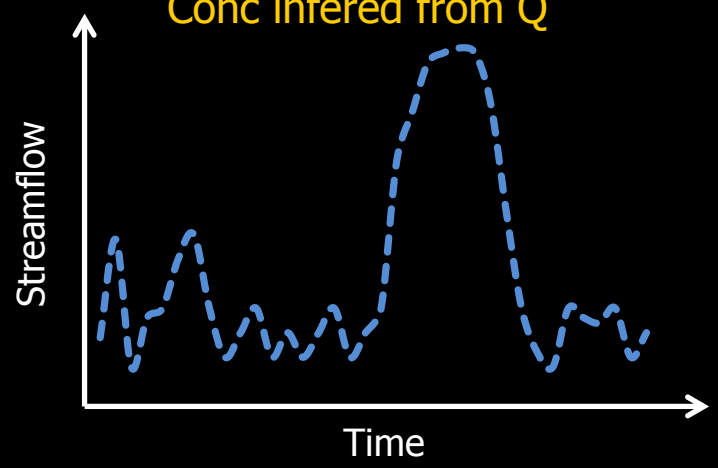


Regression methods

Conc infered from Q



Flux= mass of N that passes a given point on the river over a given period of time

$\Sigma(Q \times conc)$

(kg N/year)

Stream Chemistry Synthesis Project

http://web.fsl.orst.edu/streamchem/

Objectives:

Comparison of long term data across sites. Synthesis papers:

1) Effects of forest disturbance on stream chemistry dynamics, concentrations and fluxes
2) Trends in N concentrations in reference watersheds
3) Influences of sampling strategy and calculation methods on stream solute flux estimates: A comparison of methods used in long-term catchment studies
4) Addressing nutrient criteria using reference basin data

Create a database for stream chemistry data (Standardize units, document analytical and sampling methods)

StreamChemDB http://web.fsl.orst.edu/streamchem/database

Database | Stream Chemistry Synthesis Project (StreamChemDB) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

web.fsl.orst.edu/streamchem/database

Database | Stream Chemistry Synthesis P...

StreamChemDB

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- Presentations
- Who we are
- Documents
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- Database

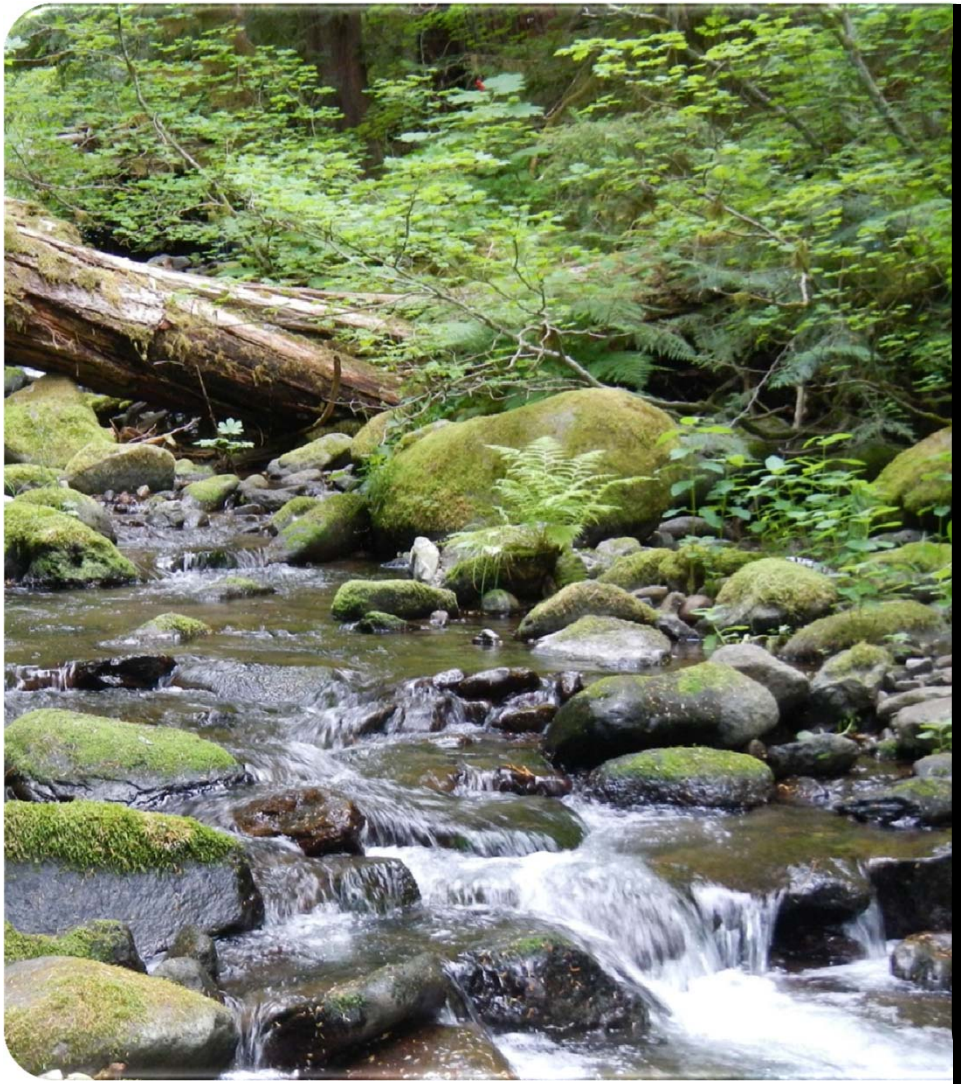
Database Main | Database Design | Download Data | Fluxes | Upload Data

Database

StreamChemDB aims to provide one-stop access to long-term stream chemistry data records and associated metadata for two national networks: the U.S. Forest Service Experimental Forests and Range (EFR) system and the National Science Foundation's Long-term Ecological Research (LTER) sites. This proposed database builds on former LTER-EFR cyberinfrastructure projects ClimDB and HydroDB (http://www.fsl.orst.edu/climhy/), which similarly provide one-stop access to climate and hydrology data across 45 EFRs and LTERs. The project combines data sets that are currently unavailable on the web or are only accessible on disparate web sites in a variety of formats.

To use the prototype database, please select from the following or use the menu above:

- Database Design
- Download Data
- Upload Data (requires login)



For more information:
web.fsl.orst.edu/streamchem/

alba.argerich@oregonstate.edu

Questions?