River N Export: a Constraint on Mineral N Loss in the CLM-CN?

Cynthia Nevison
University of Colorado/INSTAAR
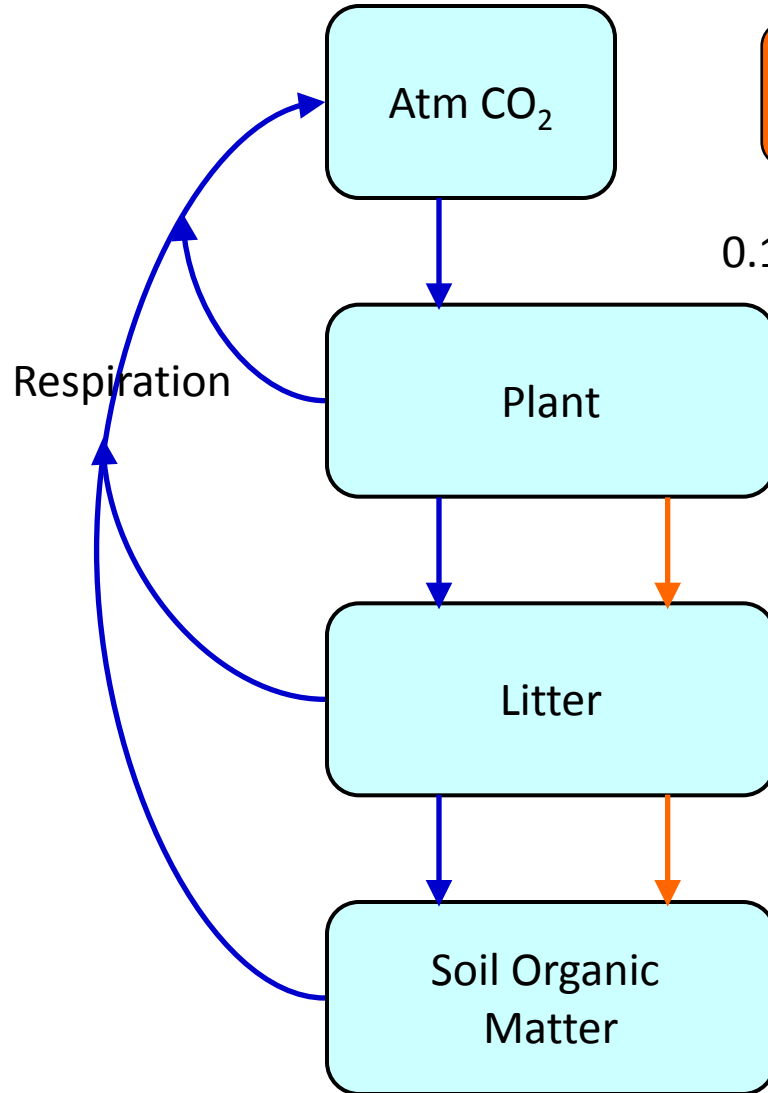
Global Reactive Nitrogen (Nr) Creation by Human Activity 1850 to 2005

Courtesy of J. Galloway
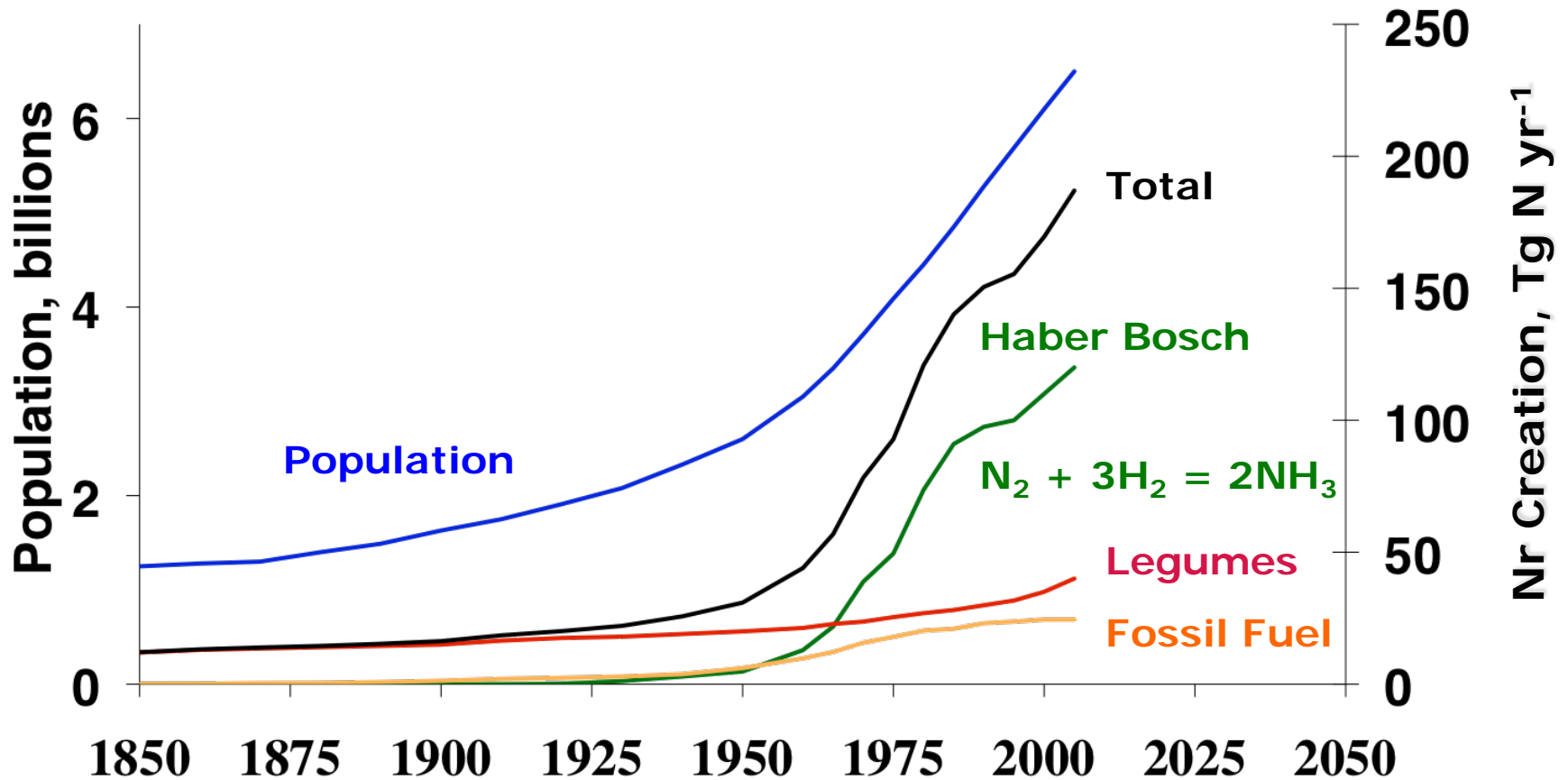
Carbon cycle

Nitrogen cycle

Atm CO_2

$Atm\ N_2O$

$Atm\ N_2$

Respiration

Plant

0.1-0.2%

0.2-5%

Nitrification

Denitrification **(129)**

Litter

Inorganic Soil N

Atmospheric N Deposition **(65)**

Soil Organic Matter

Biological N_2 Fixation **(119)**

Leaching **(0.01   Tg N/yr)**
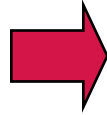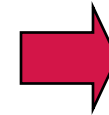
Adapted from Thornton et al., 2009
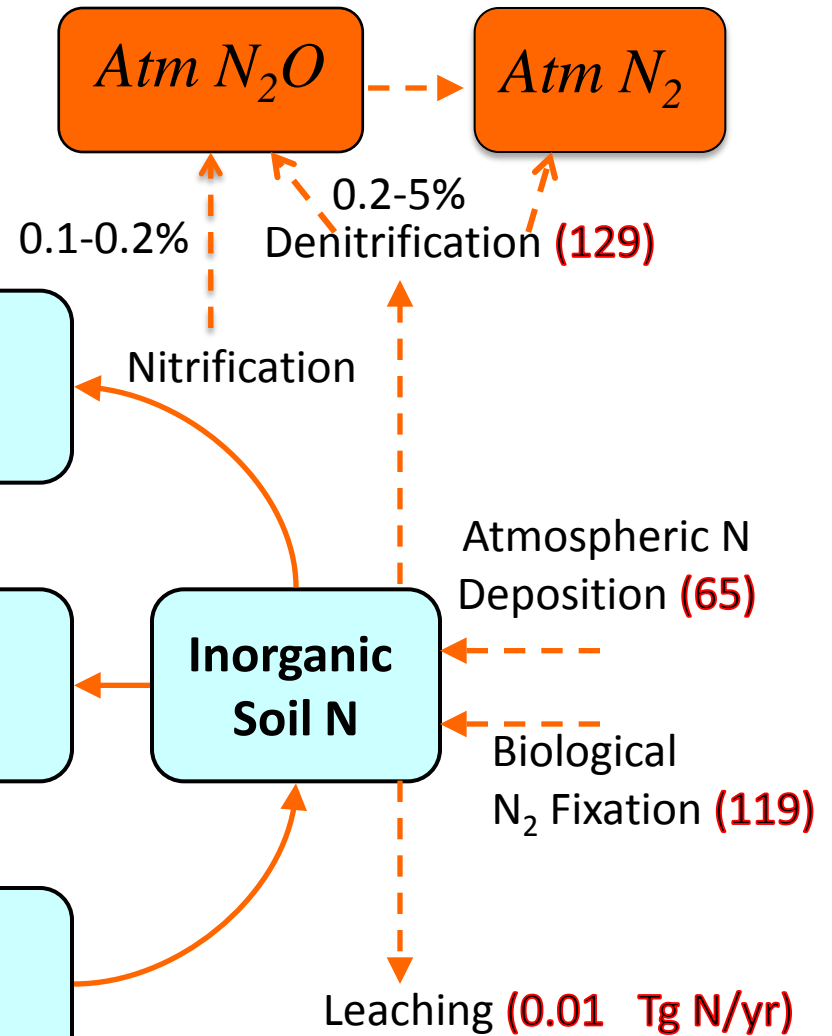
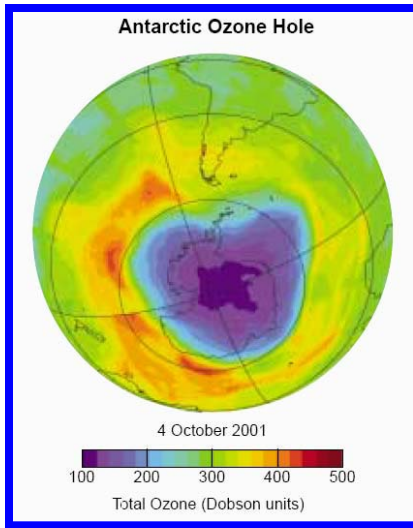# Too Much Nitrogen: A "Cascade" of Consequences

Smog, Haze

Forest Die-back

Acidification

Ozone Depletion

Global Warming

Eutrophication

Courtesy of J. Galloway

Does it matter whether or not CLM-CN correctly partitions mineral N losses between denitrification and leaching?

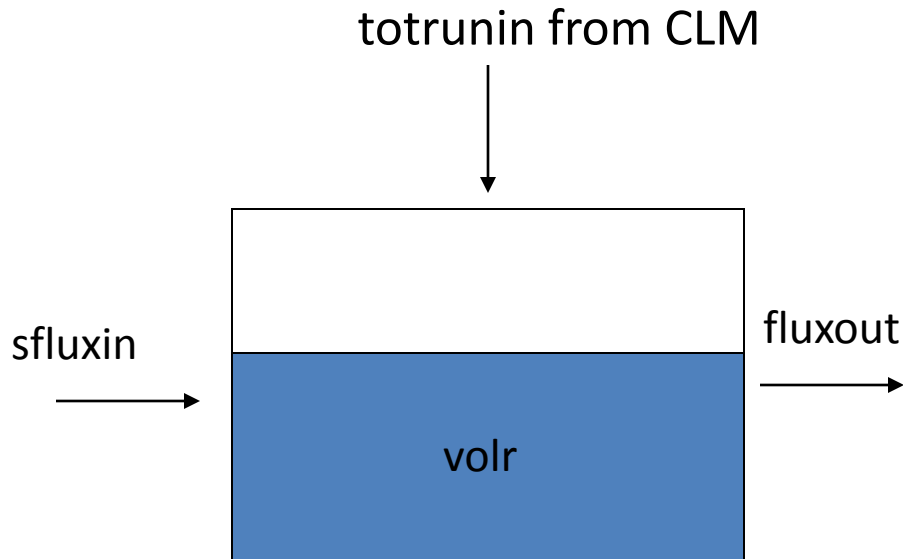Yes, if you want to capture the full nitrogen "cascade."

How will we know if revised versions of CLM-CN are getting mineral N losses right?

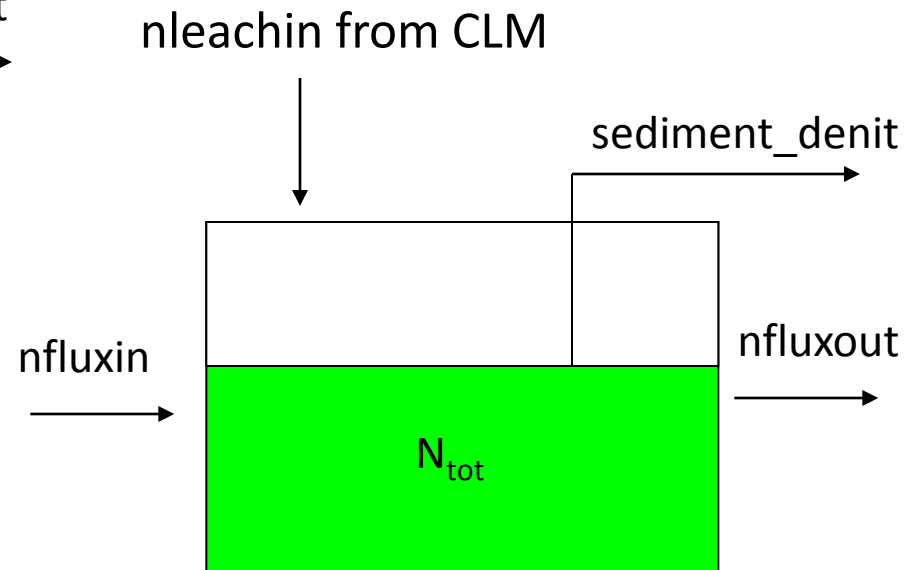Compare results directly to observed leaching or denitrification rates.

Compare to global patterns of river N export.

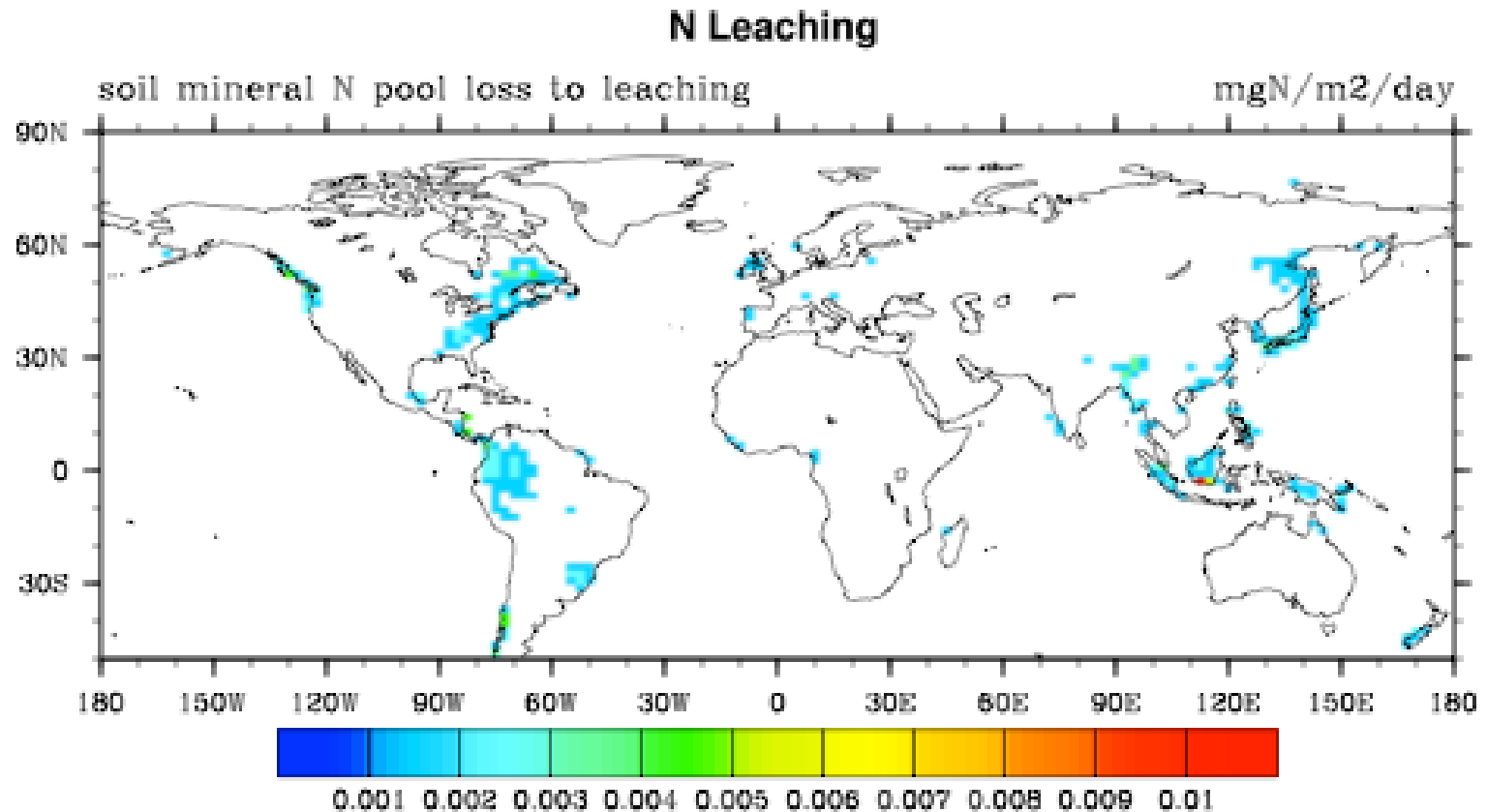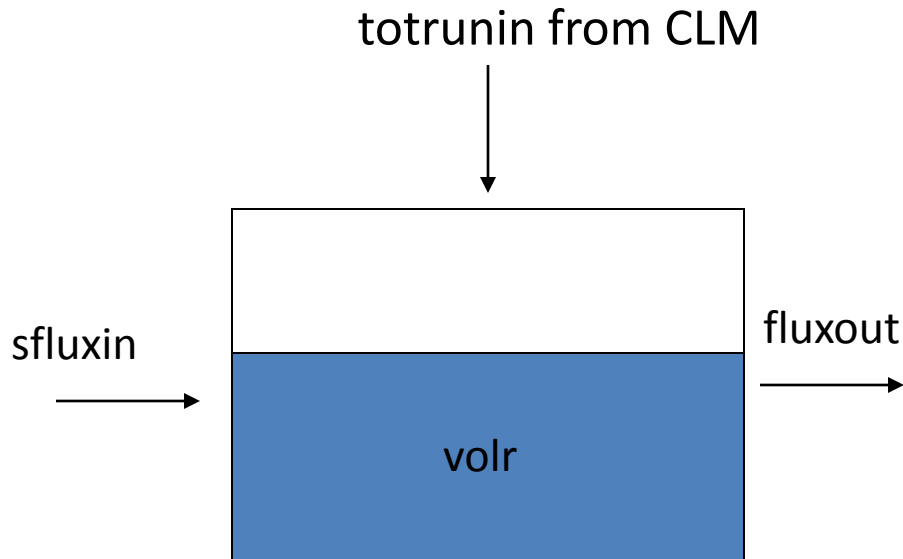# Simulating Nitrogen Transport in the CLM-River Transport Model (RTM)
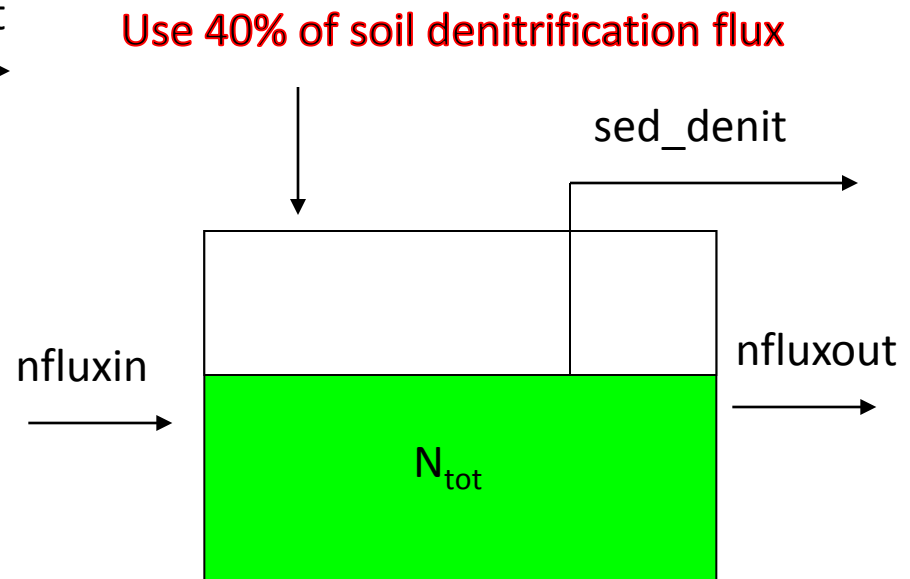
Water Fluxes

totrunin from CLM

N Fluxes

sfluxin

fluxout

volr

nleachin from CLM

sediment_denit

nfluxin

nfluxout

N_{tot}

N Leaching Flux in CLM-CN

N Leaching

soil mineral N pool loss to leaching   mgN/m2/day

Parameterization of Nitrogen Transport in CLM-River Transport Model (RTM)

Water Fluxes

totrunin from CLM

sfluxin

fluxout

volr

N Fluxes

Use 40% of soil denitrification flux

sed_denit

nfluxin

nfluxout

N_{tot}

Mineral N Losses and Inputs in CLM-CN

Denitrification + Leaching

Biological N Fixation + Atmospheric Deposition
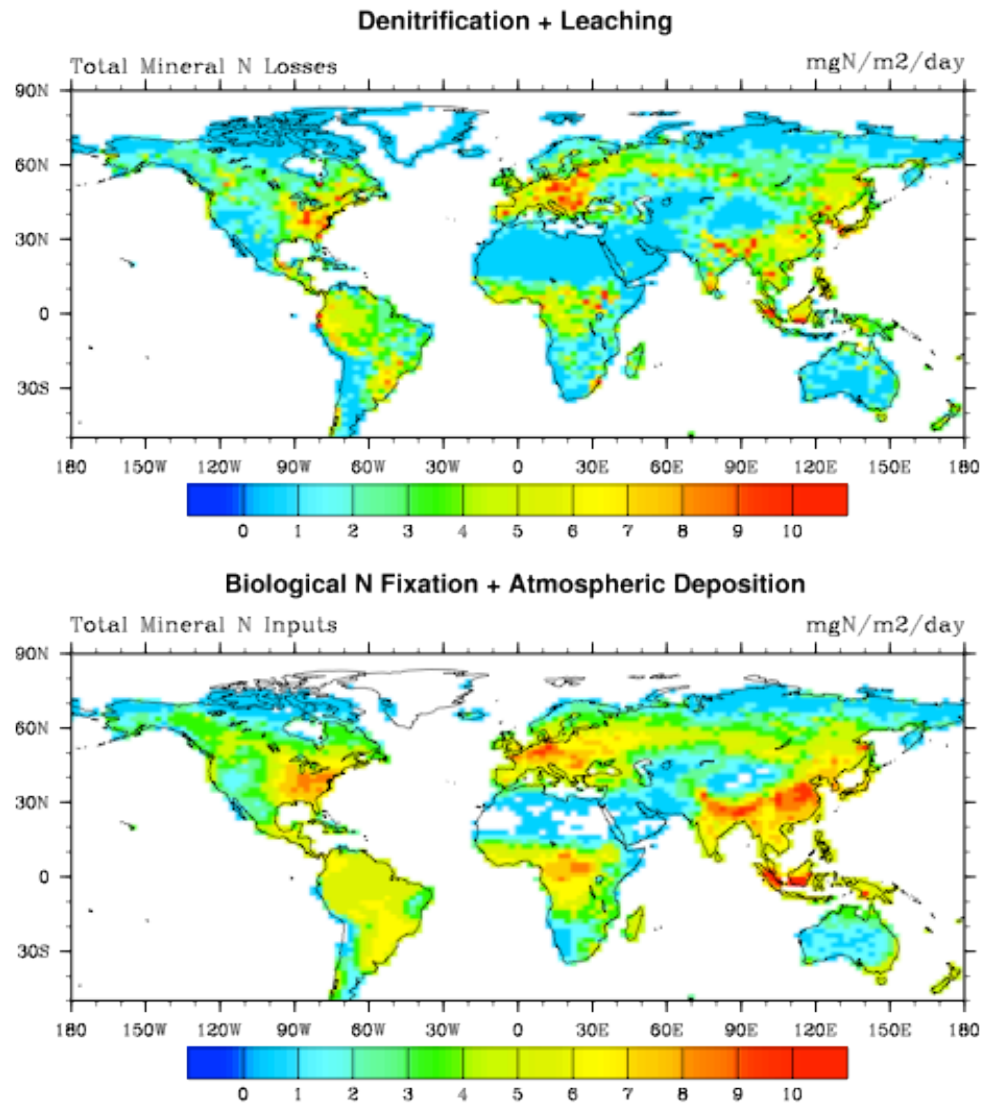
N River Transport in Coupled RTM/CLM-CN
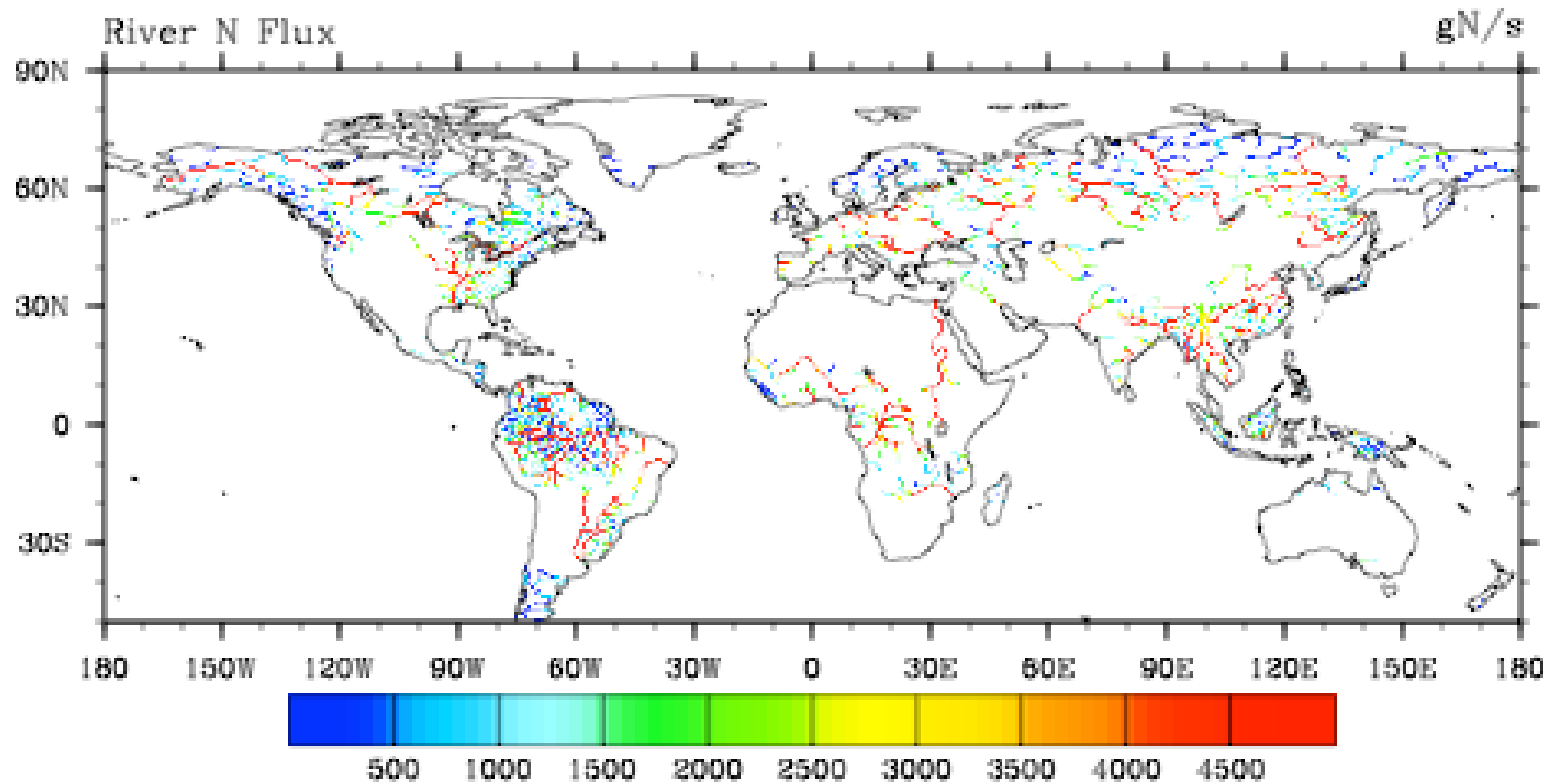
River N Export to the Ocean

Modeled v. Observed Export

R = 0.87

Slope = 0.79

River [N]$_{total}$ Concentration (mg/L)

Modeled v. Observed [N]$_{tot}$
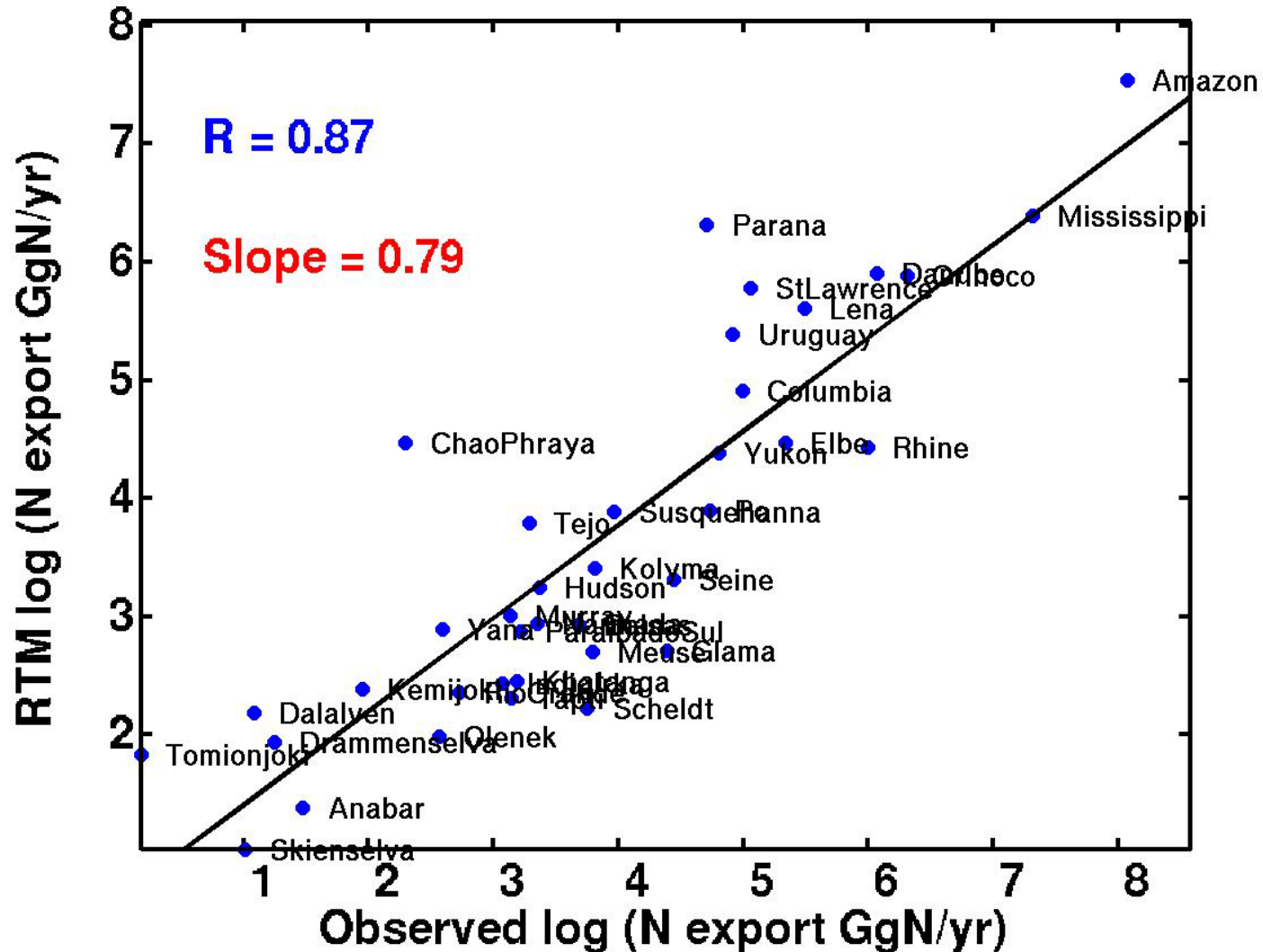
River [N]$_{total}$ "Natural" Rivers Only

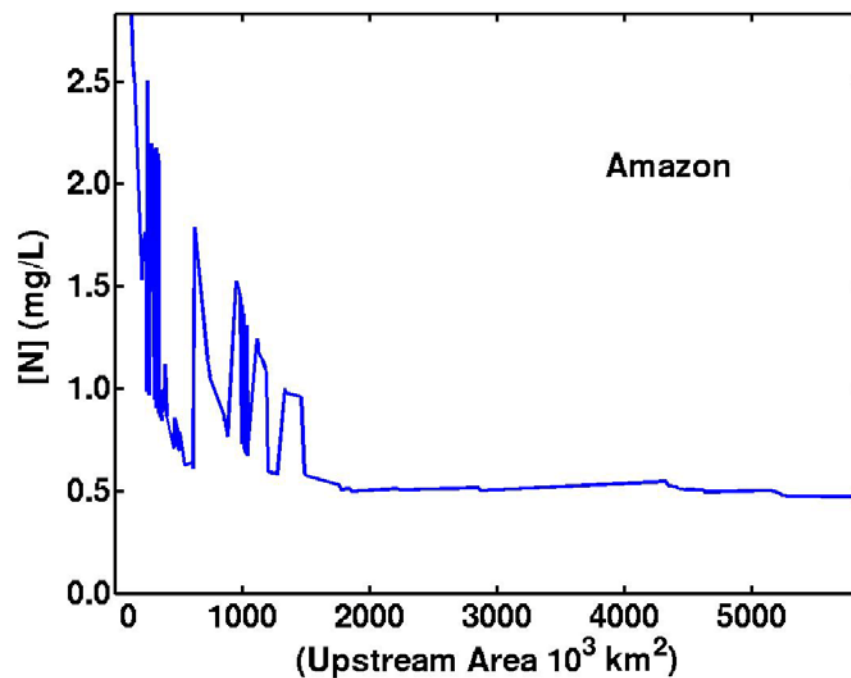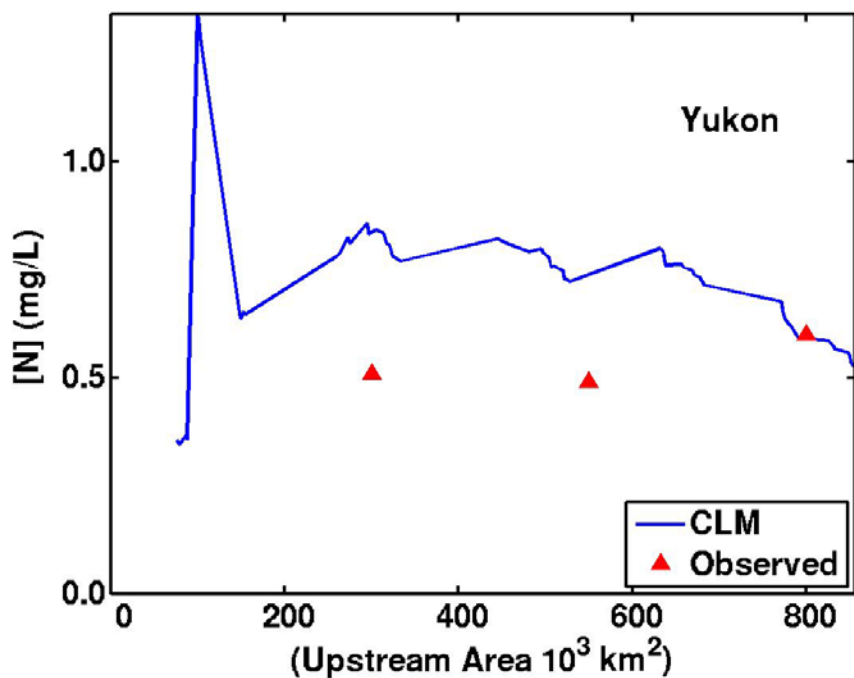Agricultural + Point Sources < 15% of total N inputs
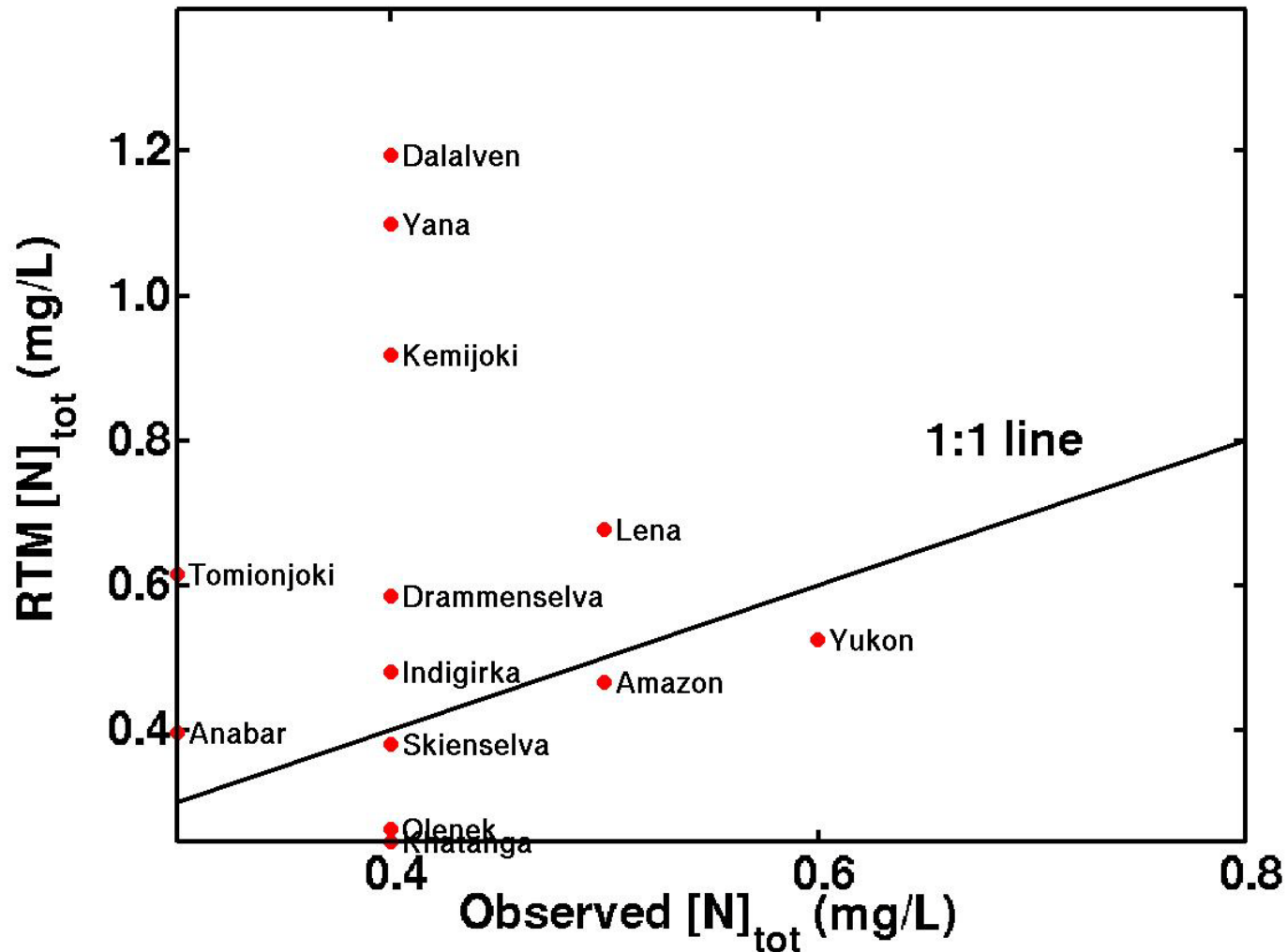
Lena

Why is RTM overestimating dissolved [N] ?
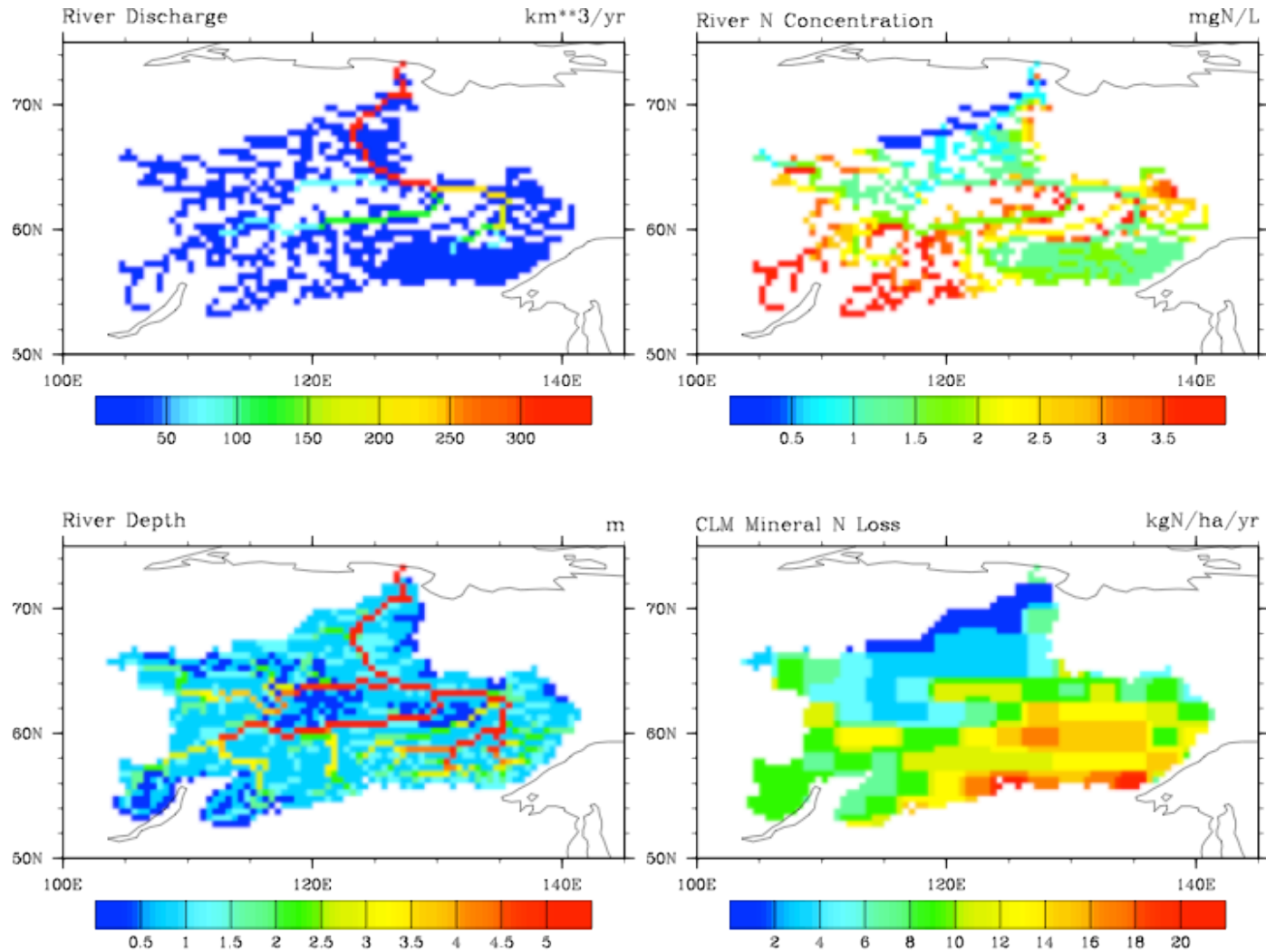
Changes in [N]$_{tot}$ along Longest Main Stem of River

Yukon

Amazon

Summary

1) CLM-CN underestimates mineral N losses due to leaching and may tend to downplay the impact of anthropogenic N additions on the Earth System.

2) Total CLM-CN mineral N losses, when input to the RTM (scaled down by 0.4), produce (somewhat) reasonable patterns of global river N export and dissolved [N] concentration.

    a) Global N export underestimated due to lack of agricultural N inputs.

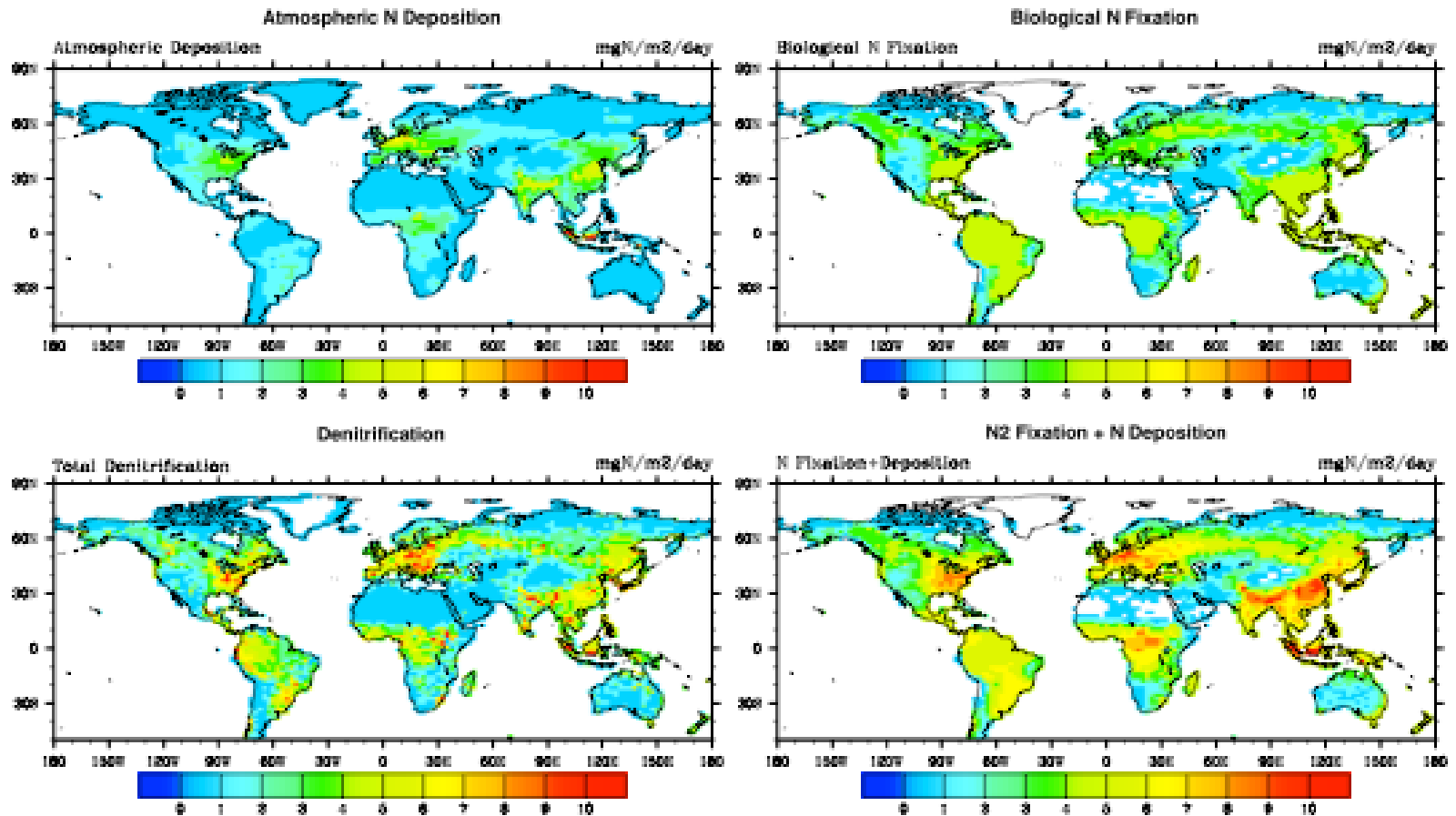   b) [N] tends to be overestimated in "natural" Arctic rivers.

Mississippi River Seasonality in [N] vs. Water Flow

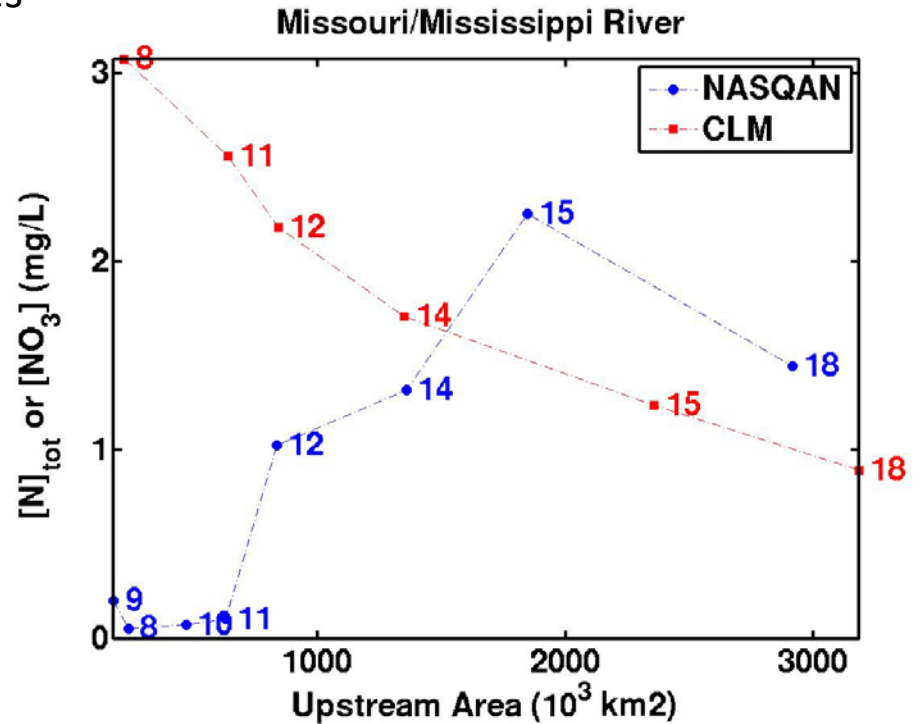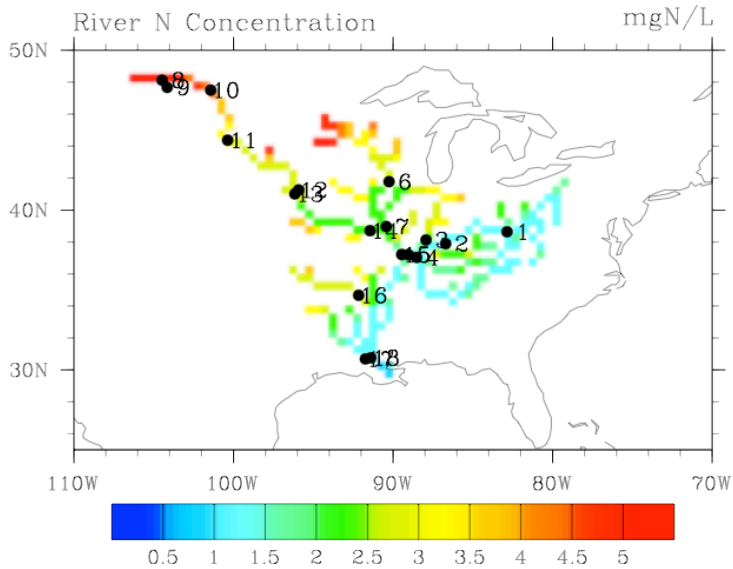Observed (USGS NASQAN)

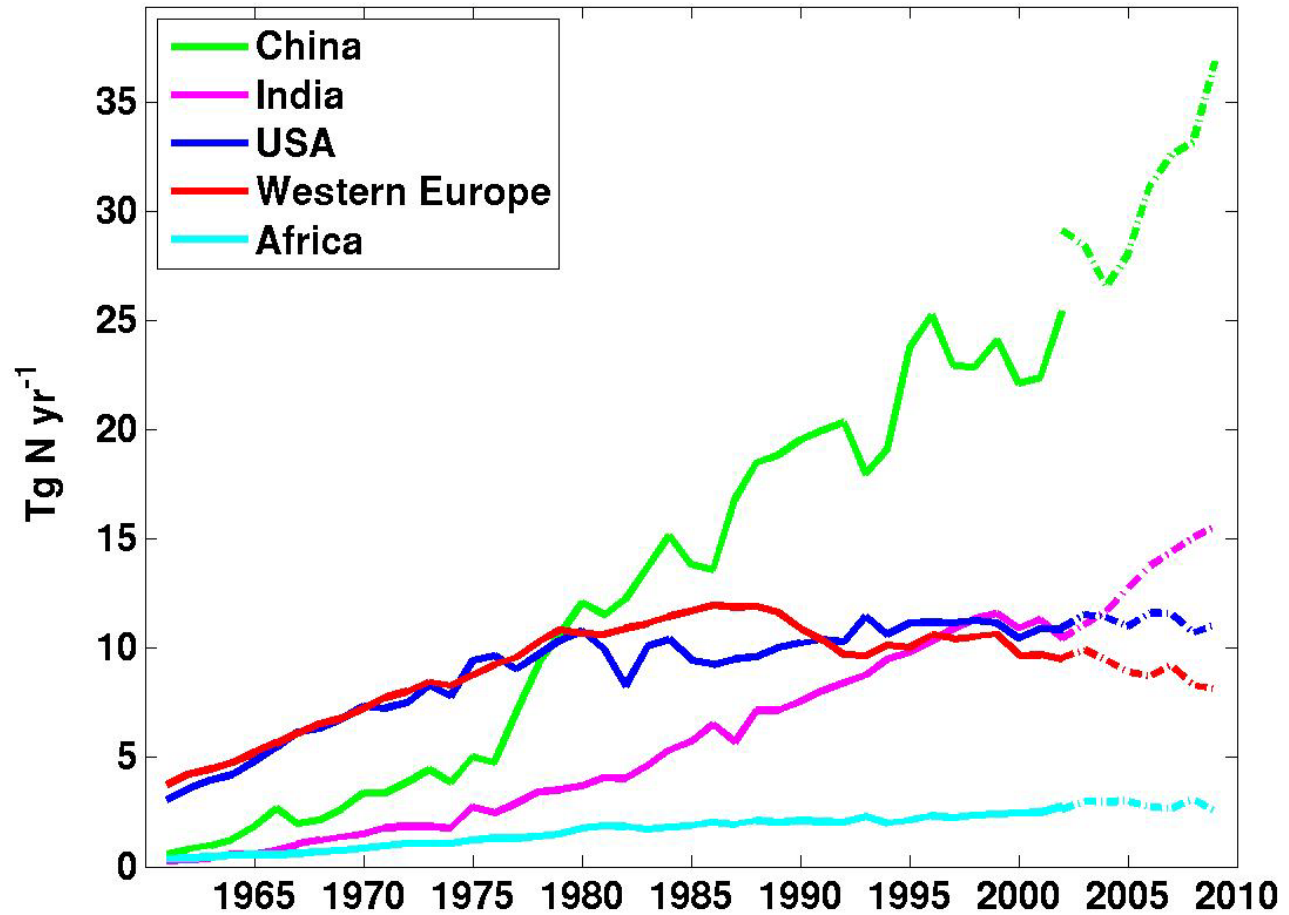CLM-RTM
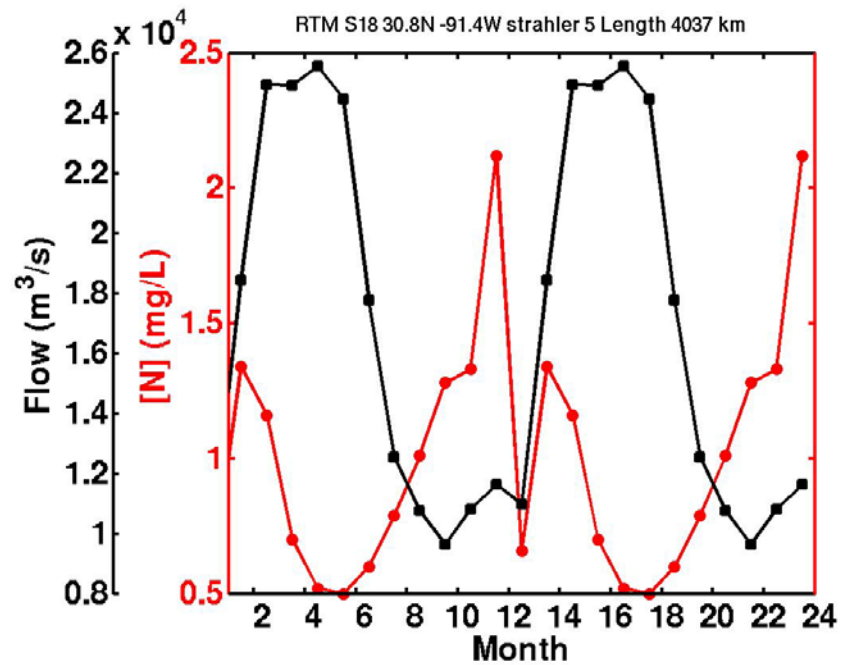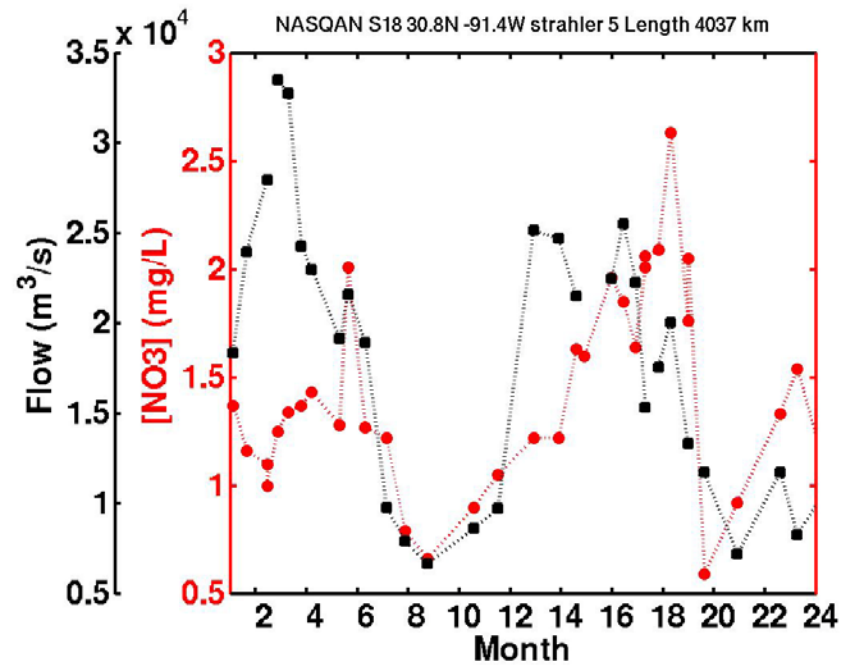
N Inputs and Outputs in CLM-CN

Missouri/Mississippi River

RTM results in Mississippi River Basin
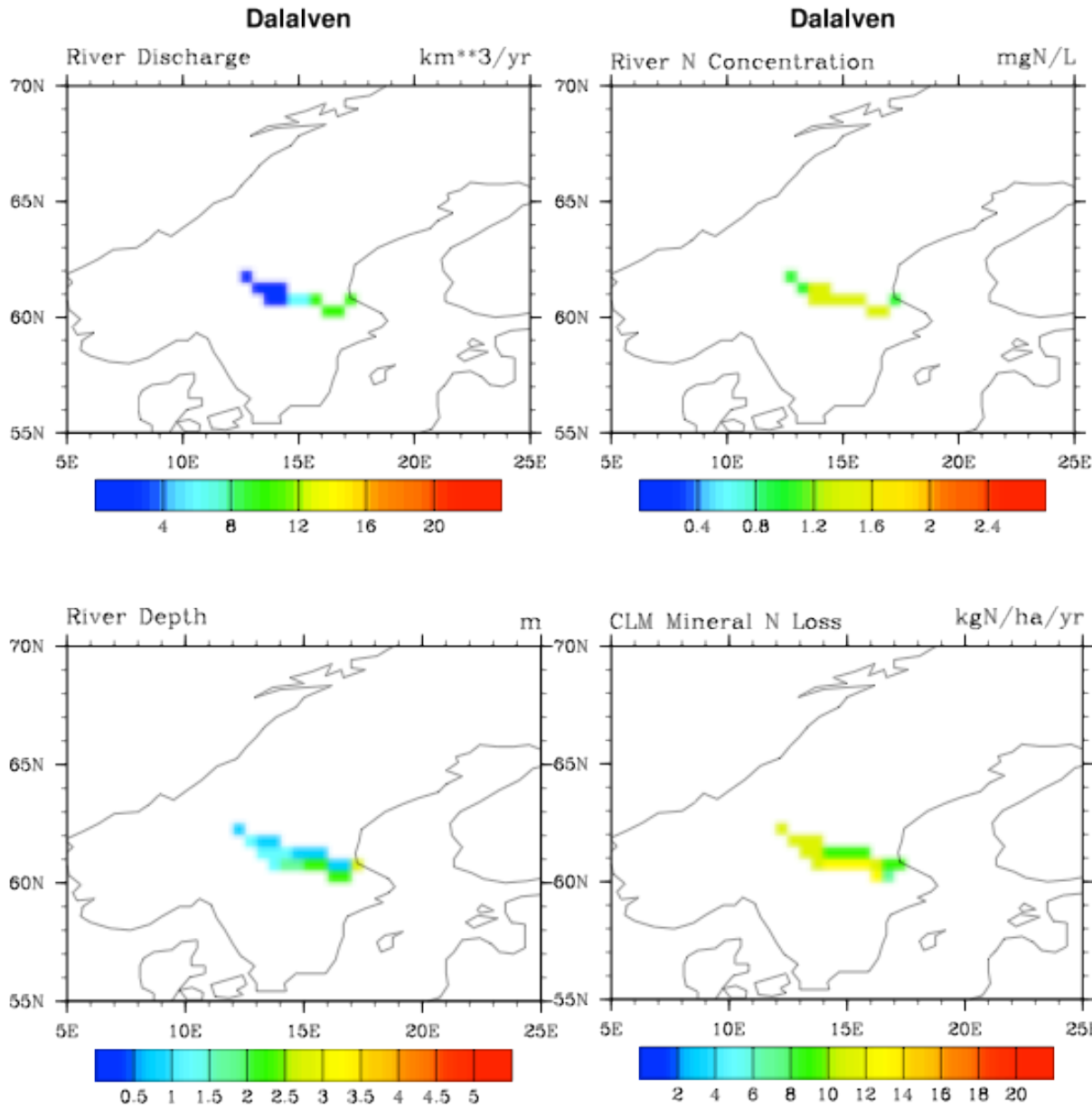showing USGS NASQAN Monitoring Sites

Remove 17 and 13

N Fertilizer Consumption Trends 1961-2009

Data from FAOSTAT

Dalalven

Why is RTM overestimating dissolved [N] ?