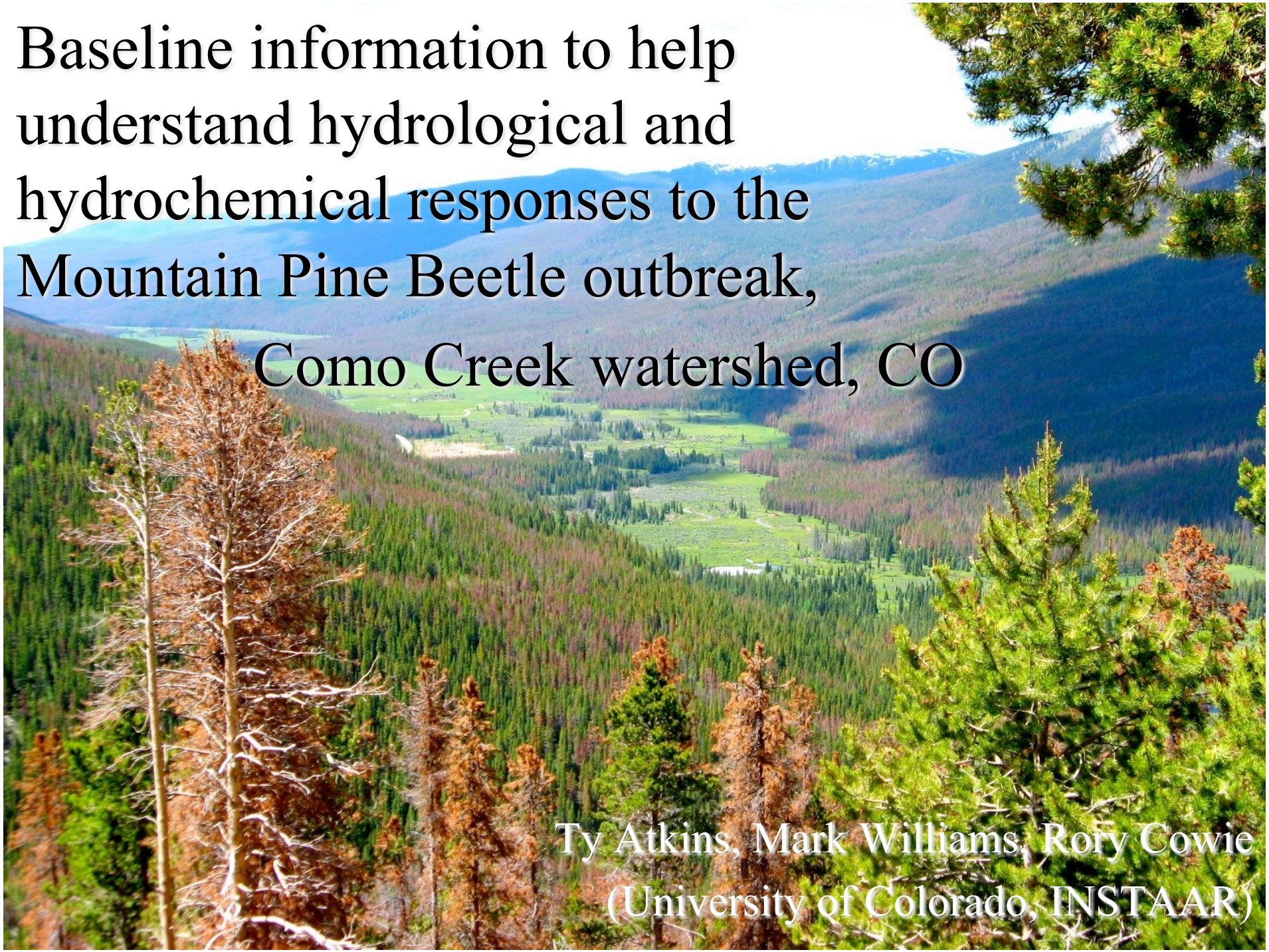
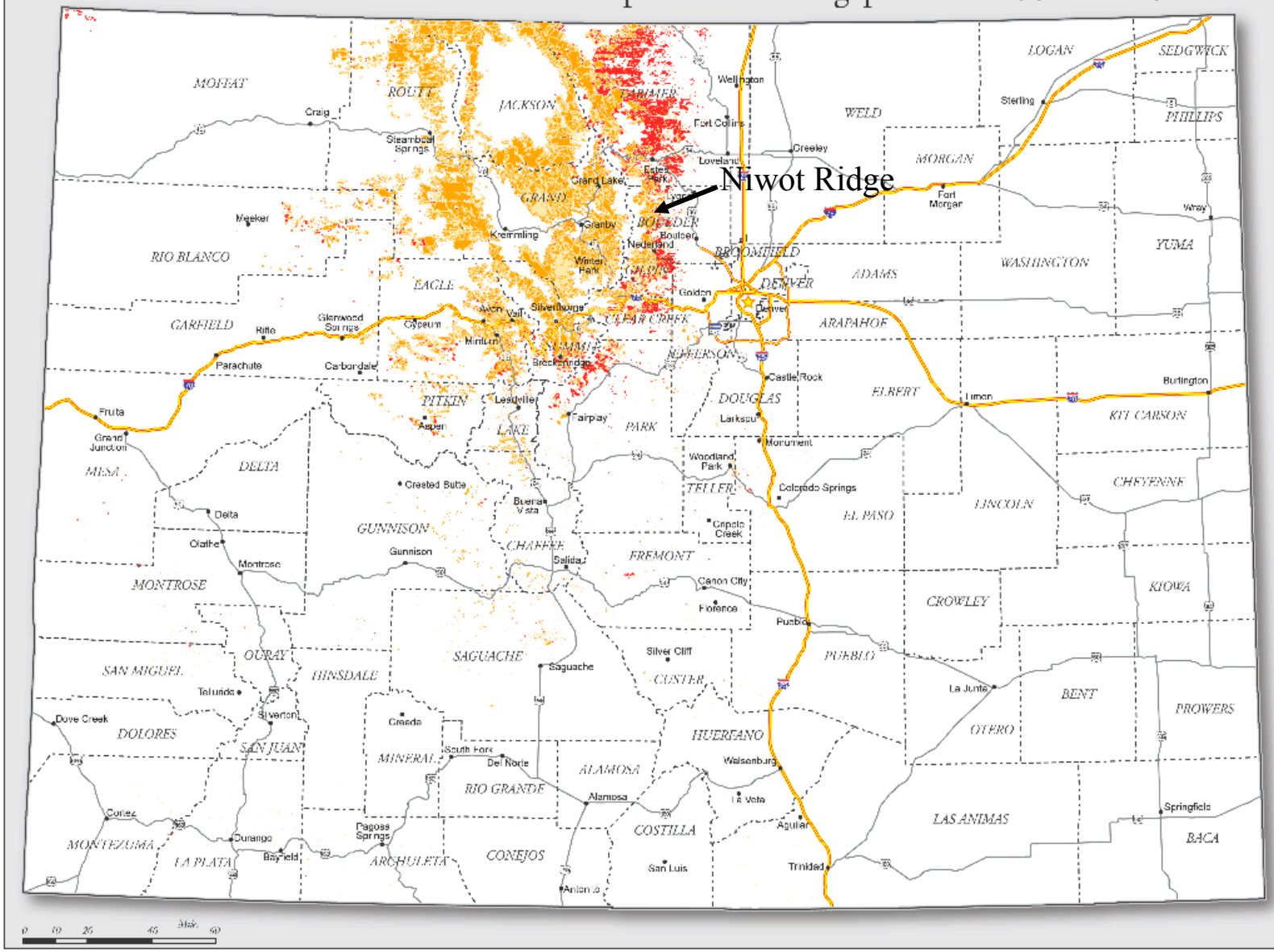
Baseline information to help understand hydrological and hydrochemical responses to the Mountain Pine Beetle outbreak, Como Creek watershed, CO



Ty Atkins, Mark Williams, Rory Cowie
(University of Colorado, INSTAAR)

Colorado's Mountain Pine Beetle Epidemic in Lodgepole Pine 1996 - 2009



Mountain Pine Beetle (New Acres in 2009)

Mountain Pine Beetle (Previously Affected Acres 1996 - 2009)

Interstate

US Highway

County

Cities

Mountain Pine Beetle

The mortality from the current mountain pine beetle infestation is unprecedented in Colorado's recorded history. Since the first infestation began in 1996, approximately 1.5 million acres of lodgepole pine have been infested in Colorado.

Beetle epidemics are a natural part of forest ecosystems, but the old age of many of the state's lodgepole pine forests makes them susceptible to widespread epidemics. Old forests, drought, warm temperatures all have had a role in fueling this epidemic.

At current rates of spread and intensification, it is likely that MPB will kill the majority of Colorado's mature lodgepole pine forests within the next 15 years. However, younger lodgepole pines will survive and seedlings will regenerate naturally.

During the first few years following infestation, needles turn red (red phase) toward the time this occurs is 20 years or more, the dead trees fall over. Wildfire is a real threat in life and presence in beetle-killed areas whether trees are red and dead or years after when they fall over and lie on the ground.

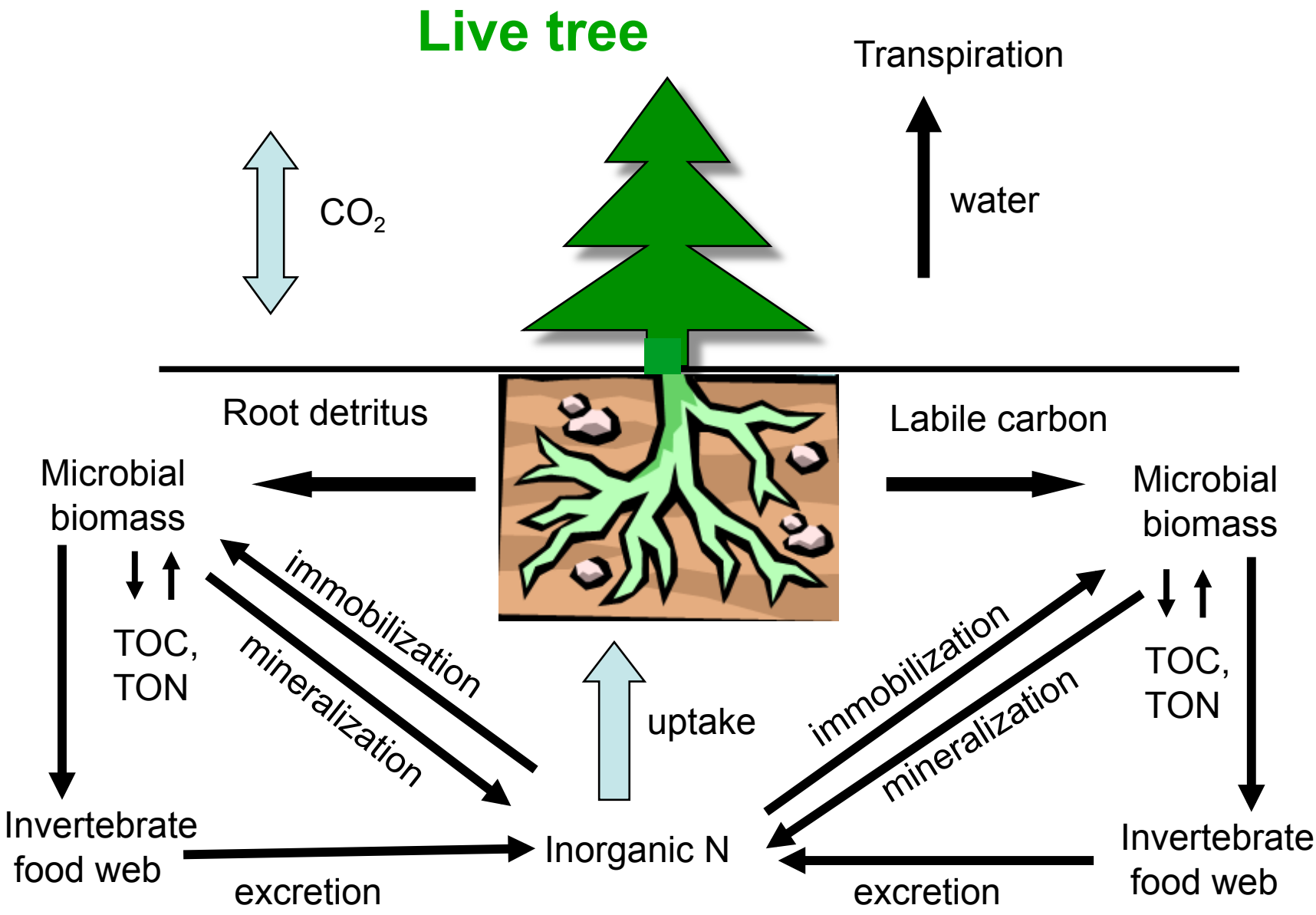
Aerial Survey Data

Due to the nature of aerial surveys, the data on this map will only provide rough estimates of location, intensity and the resulting land information for agents detectable from the air. Many of the most destructive diseases are not represented on this map because these agents are not detectable from aerial surveys. The data presented on this map should only be used as a general indicator of insect and disease activity, and should be validated on the ground for actual location and causal agent. Shaded areas show locations where tree mortality or defoliation was apparent from the air. Tree size of damage is variable and not all trees in shaded areas are dead or defoliated.

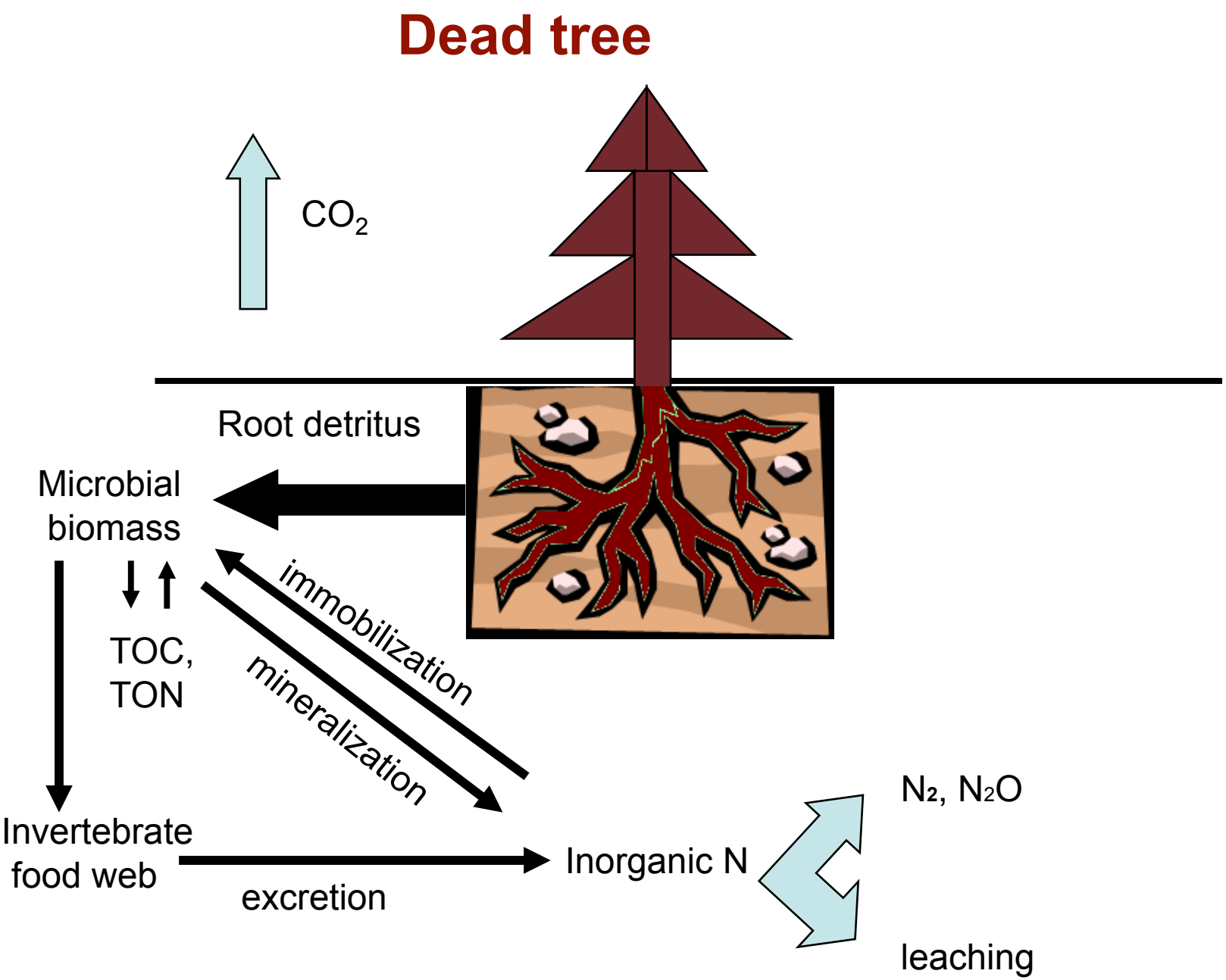
The insect and disease data represented on this map are available digitally from the USDA Forest Service, Region Two Forest Health Management group. The company reserve the right to correct, update, modify or replace GIS products. Using this map for purposes other than those for which it was intended may yield inconsistent or misleading results.

Map created January 2010
For more information:
http://www.fs.fed.us/r2/boulder/

0 10 20 40 60 Miles

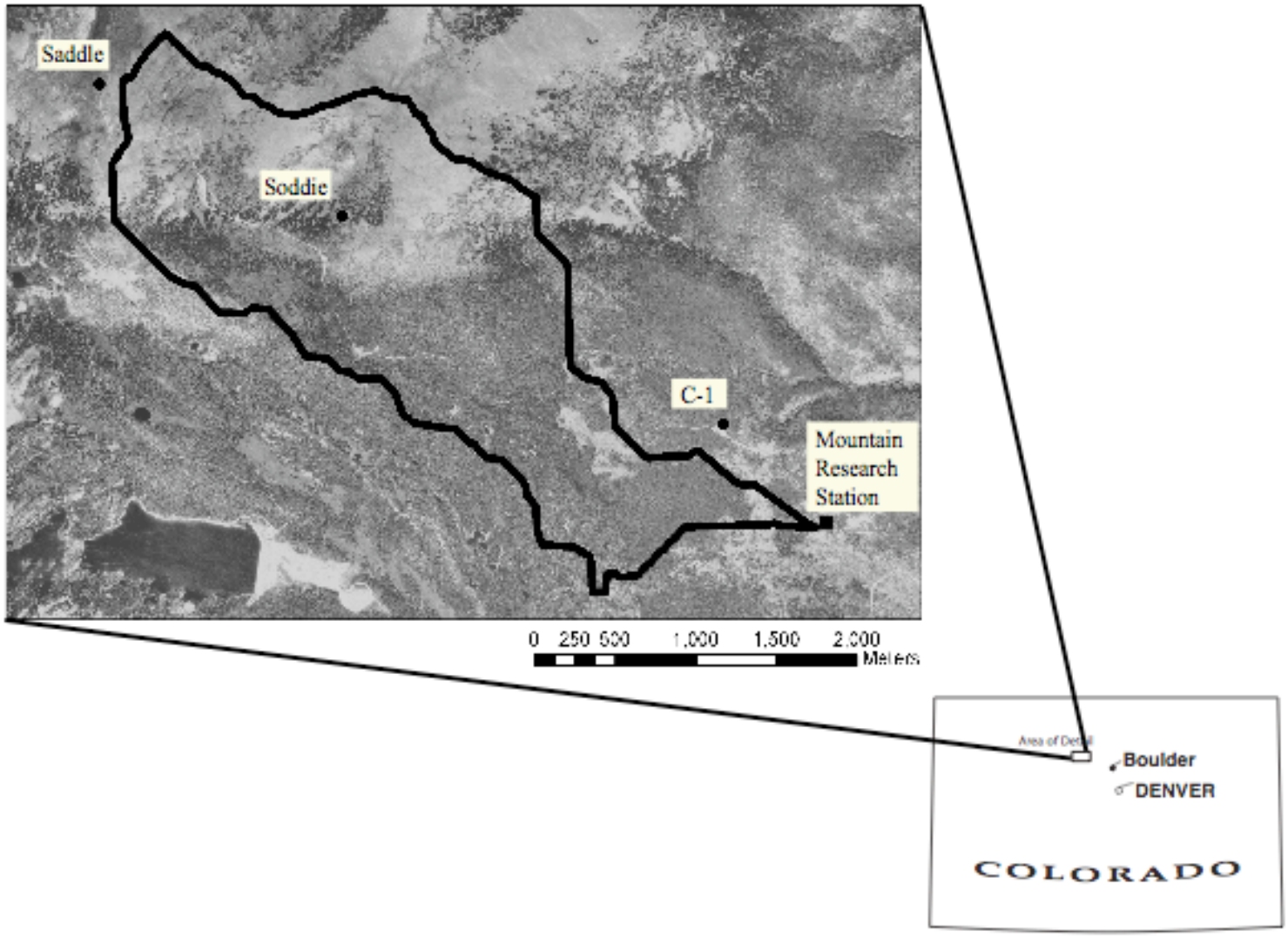


Xiong et al, 2010



Xiong et al, 2010

Como Creek Watershed



Niwot Ridge LTER

C-1 site:

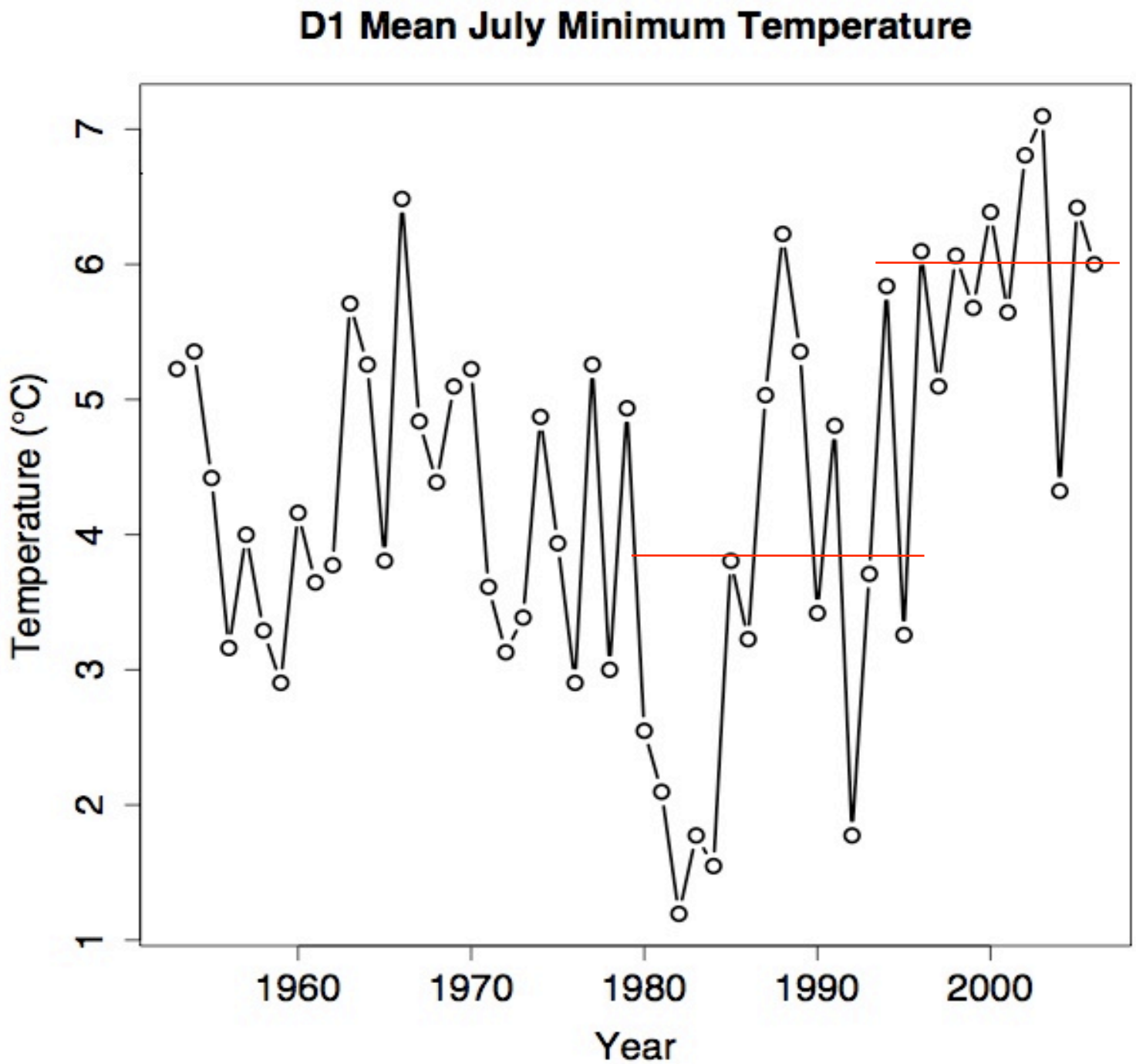
Ameriflux Tower, Soil Moisture Probes, SnoTel, NADP site, Snow Pits

Niwot Ridge LTER

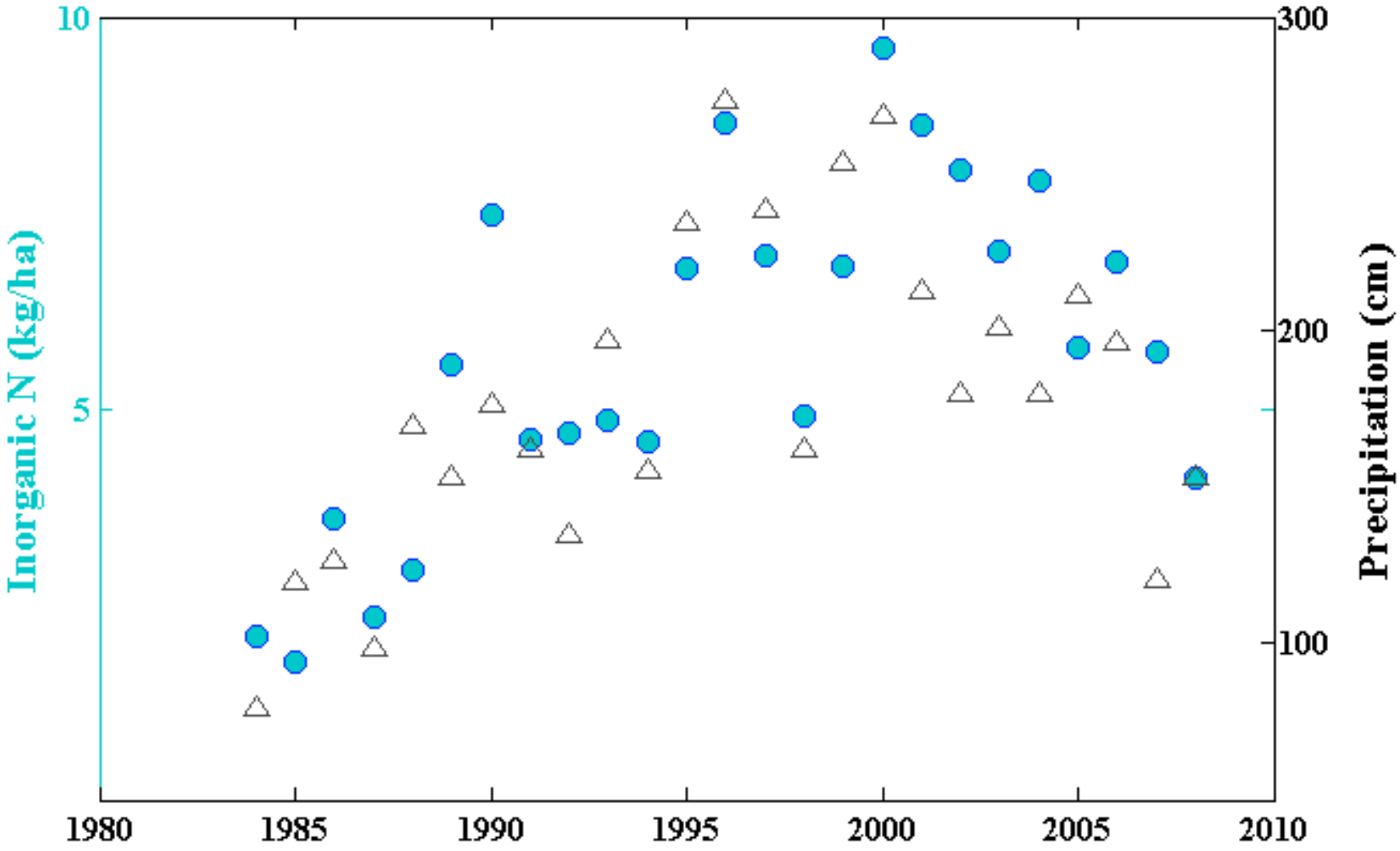
Soddie site:

Snowmelt and Soil Lysimeters, Snow Pits, Meteorological tower

Como Creek

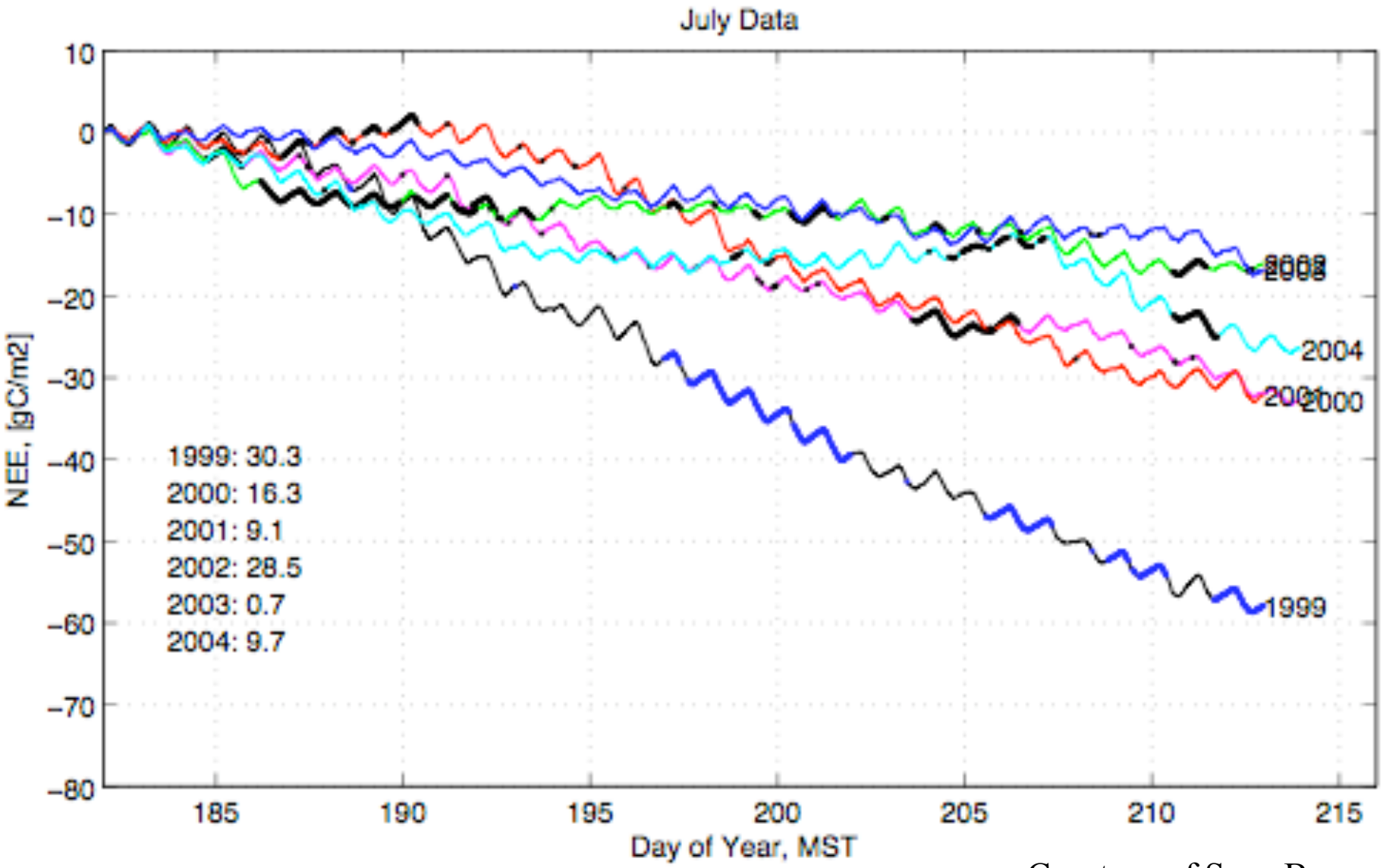

D1 Mean July Minimum Temperature
Temperature (°C)
1
2
3
4
5
6
7
1960
1970
1980
1990
2000
Year

Atmospheric Deposition: C-1 NADP



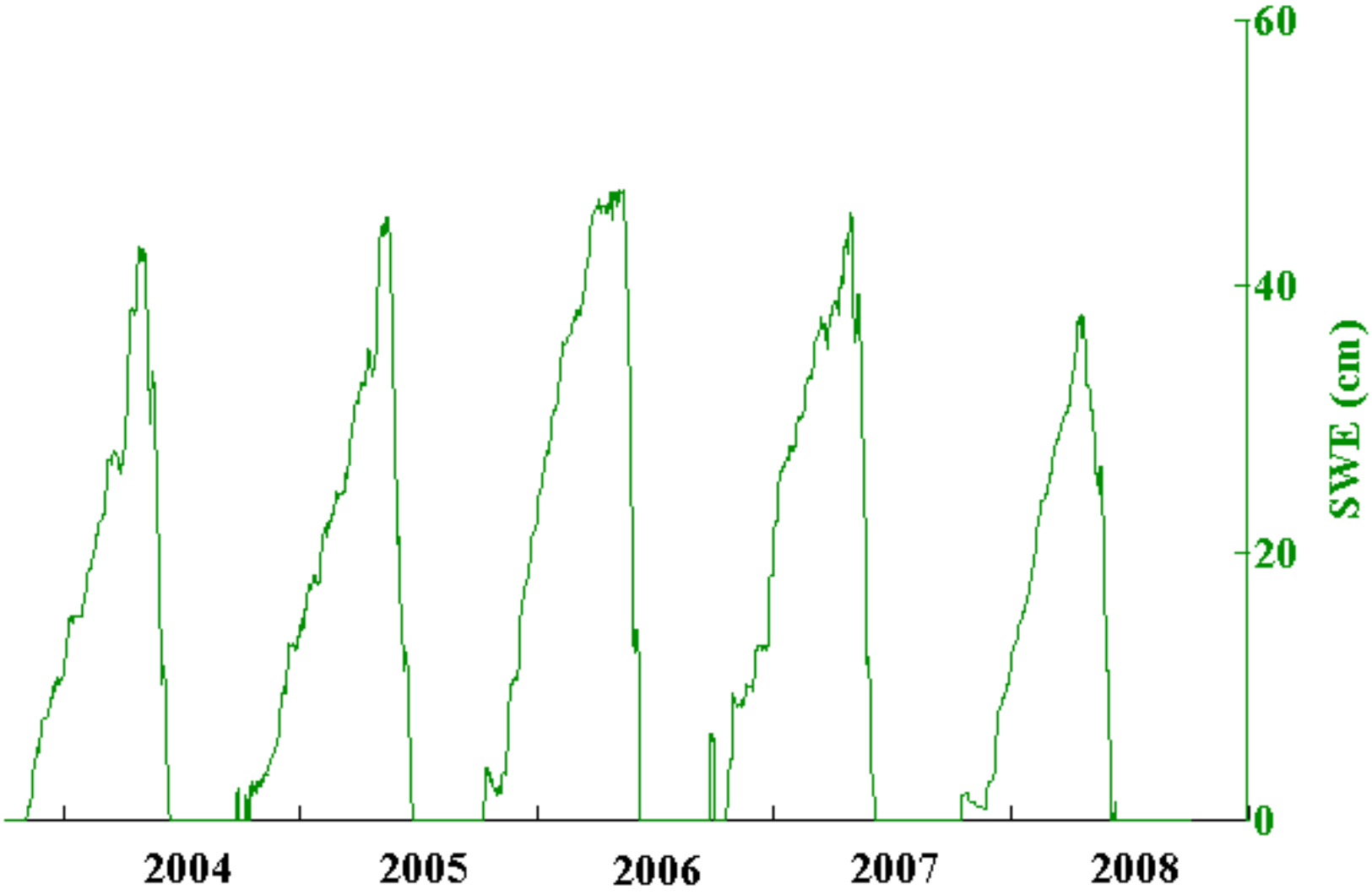
What is a biogeochemical baseline?

Carbon Flux

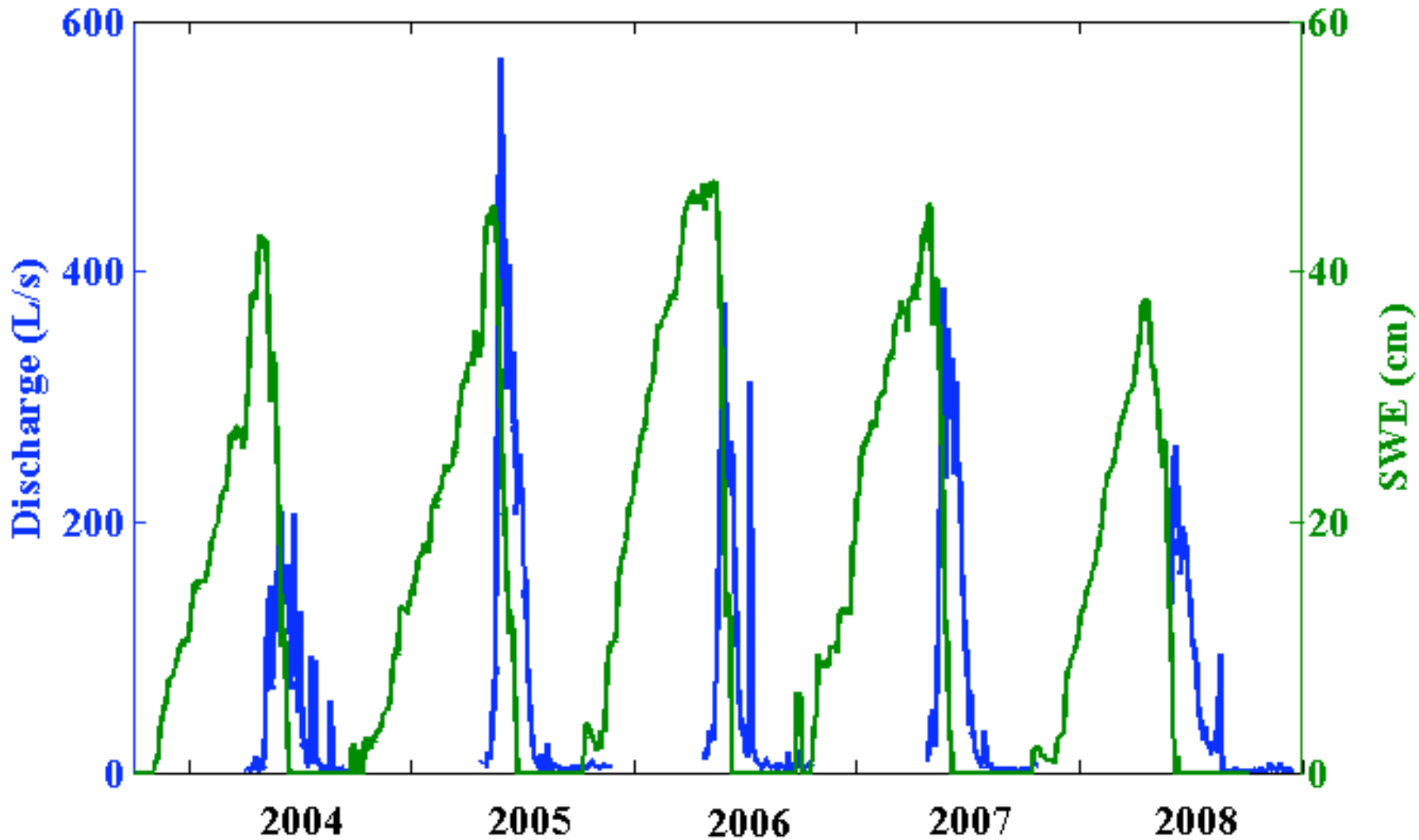


Courtesy of Sean Burns

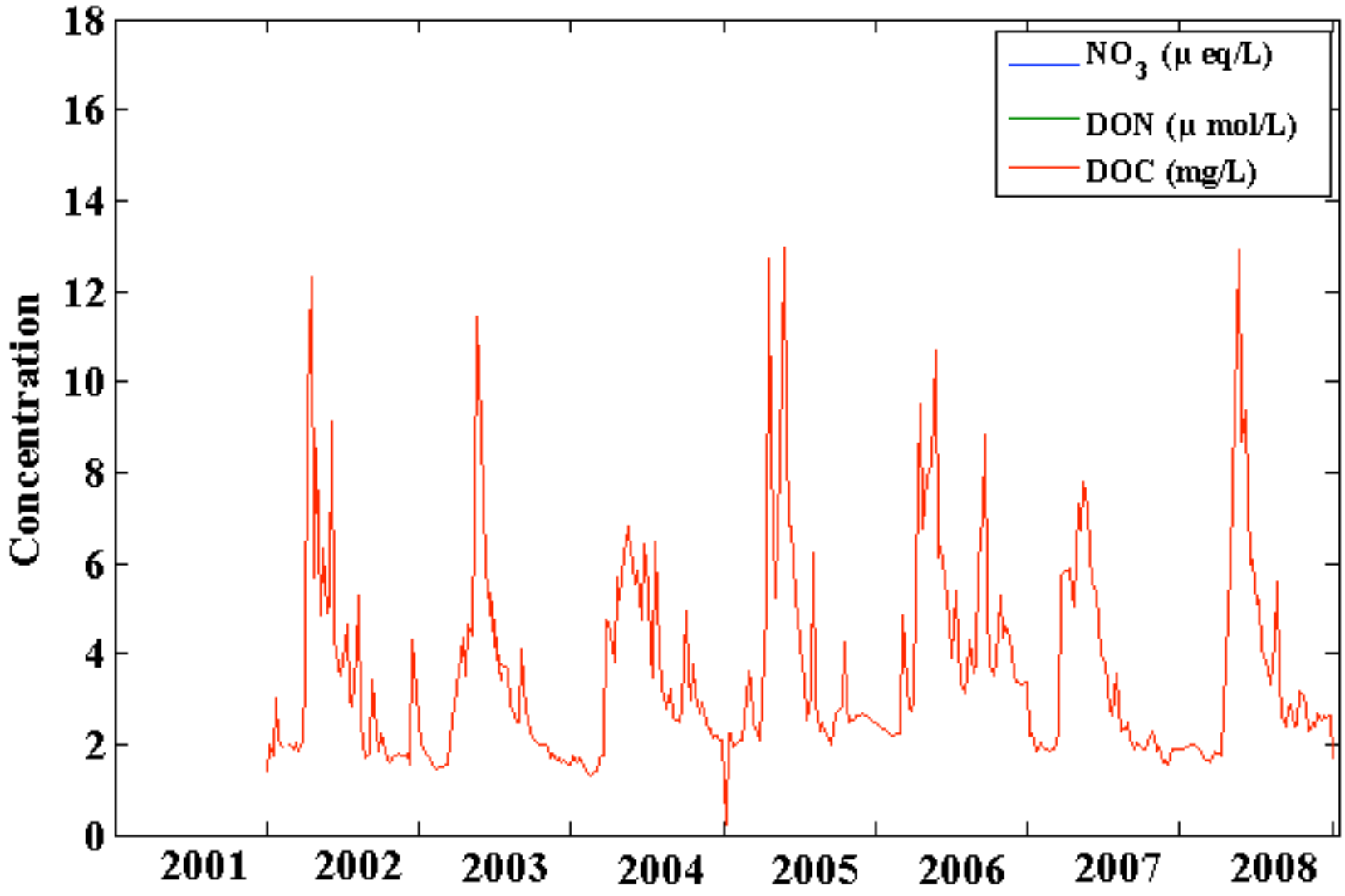
Precipitation



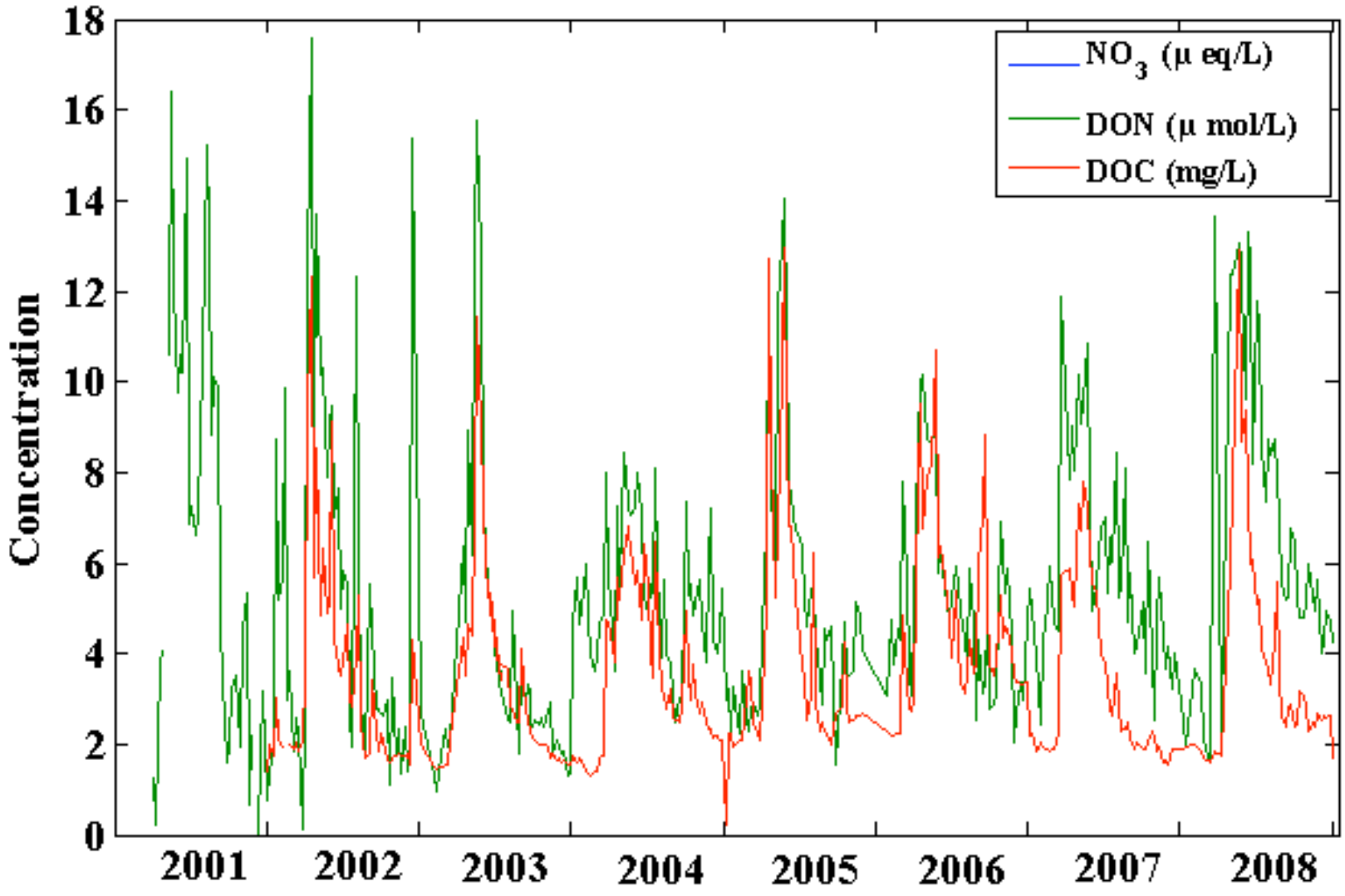
Hydrograph


600
400
200
0
Discharge (L/s)
60
40
20
0
SWE (cm)
2004
2005
2006
2007
2008

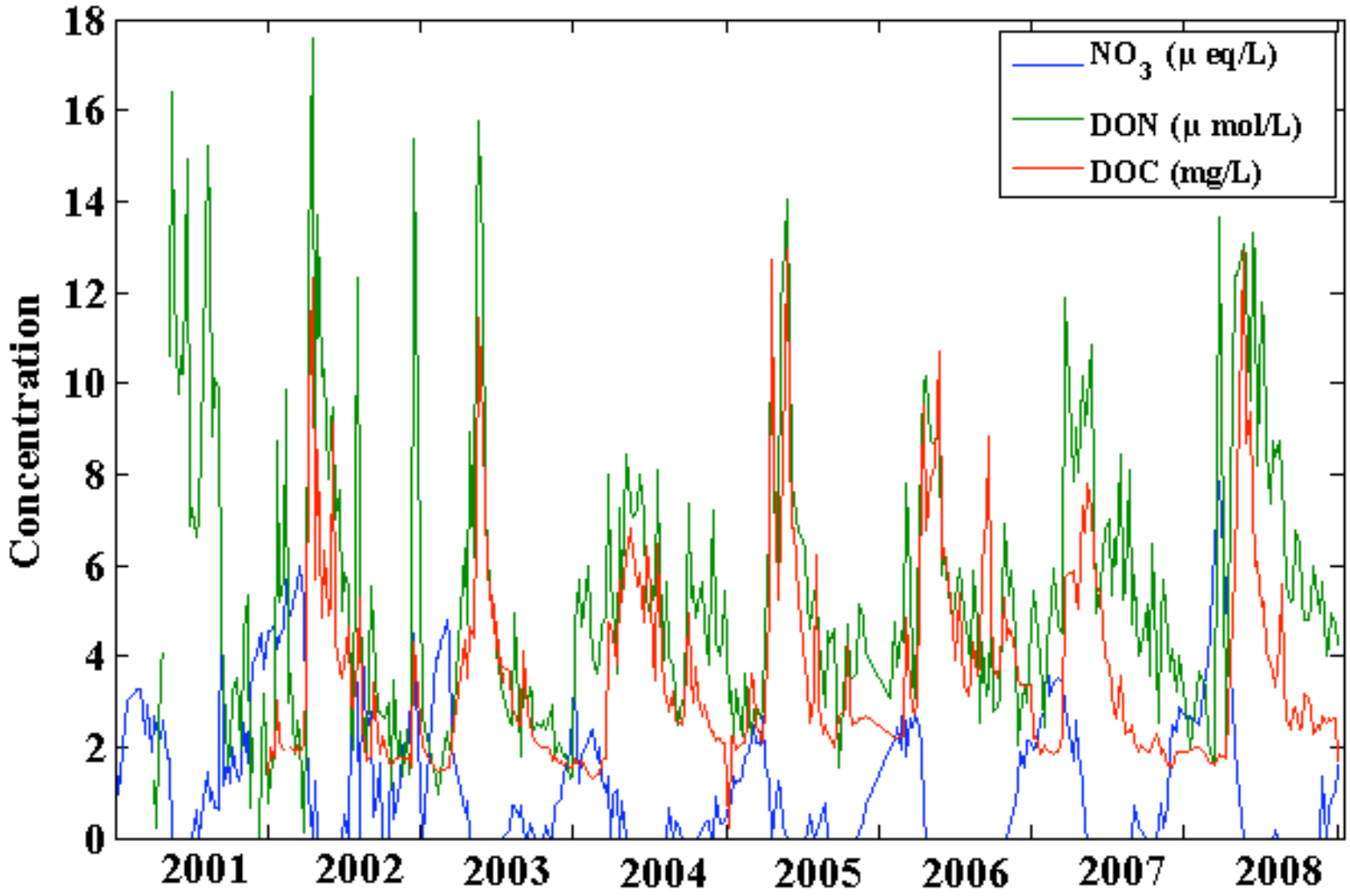
Nutrient Chemistry

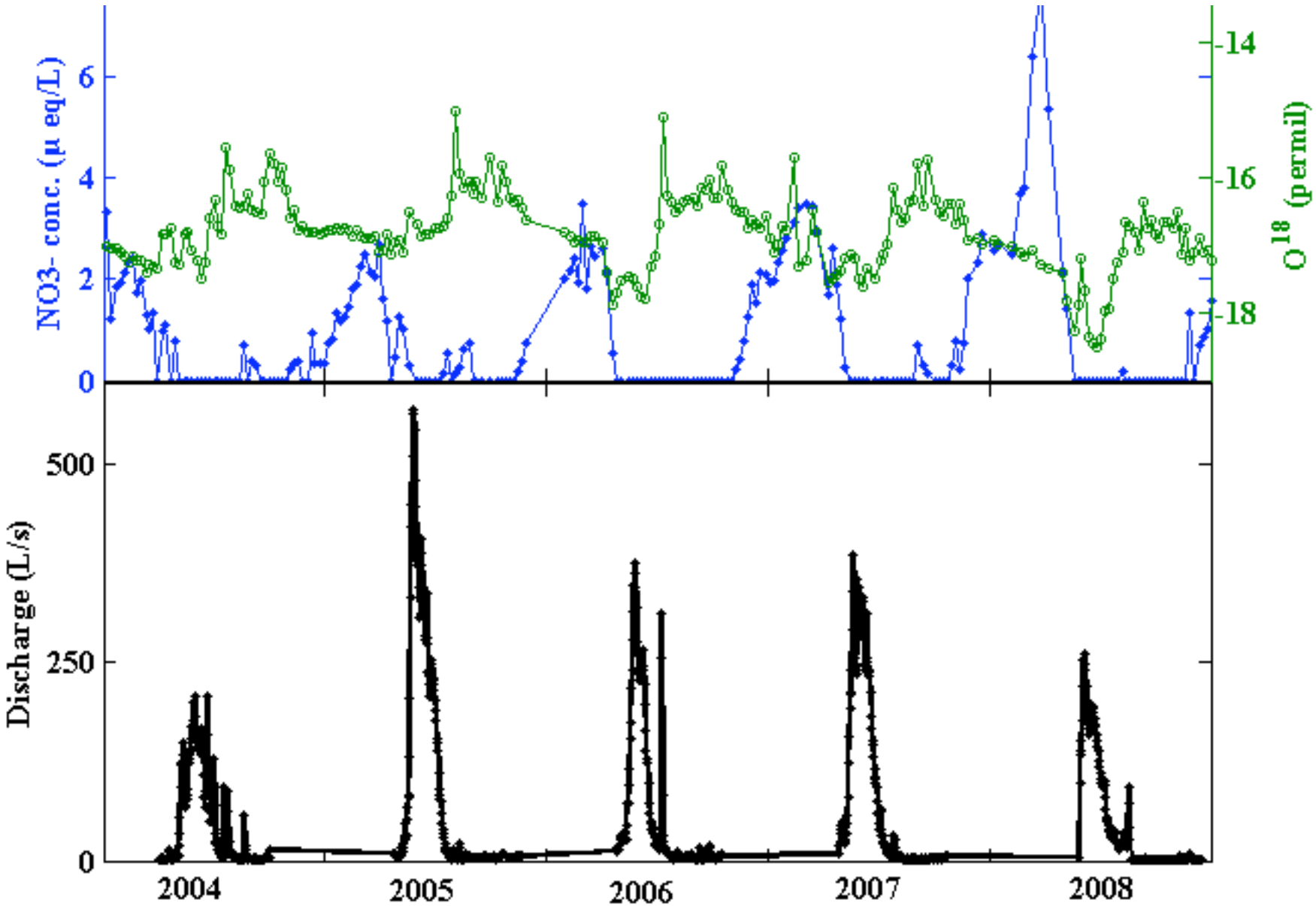


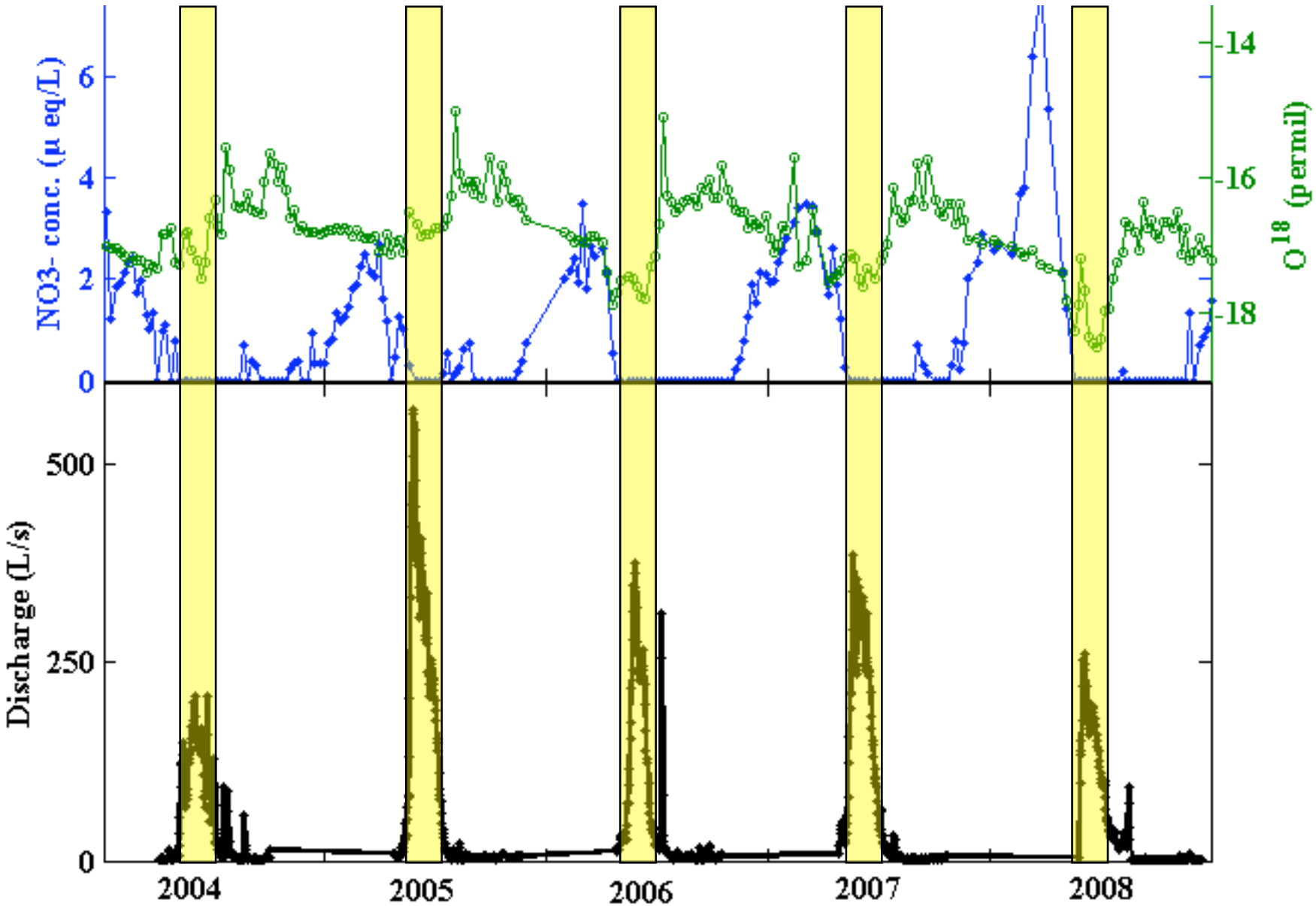
Nutrient Chemistry



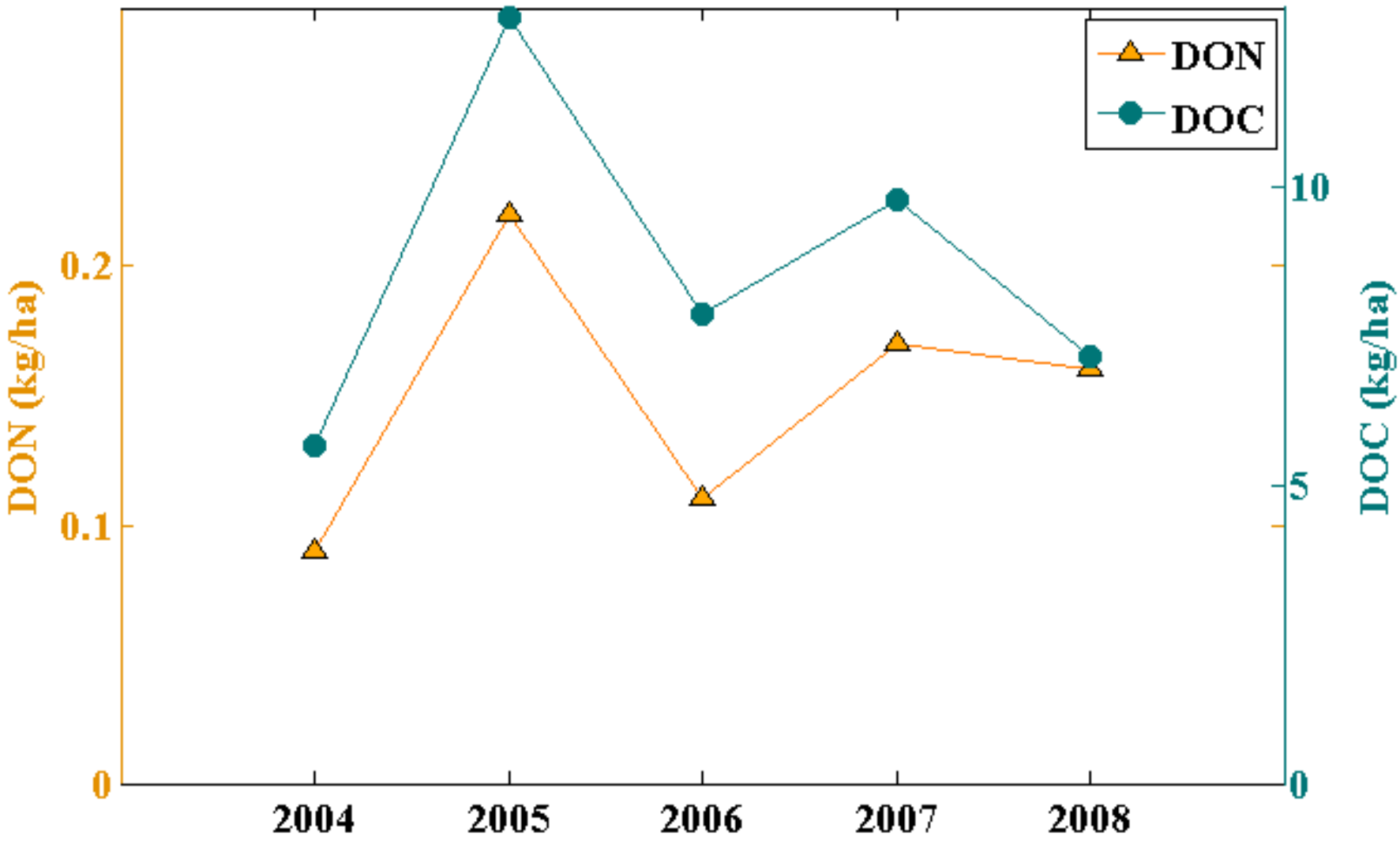
Nutrient Chemistry

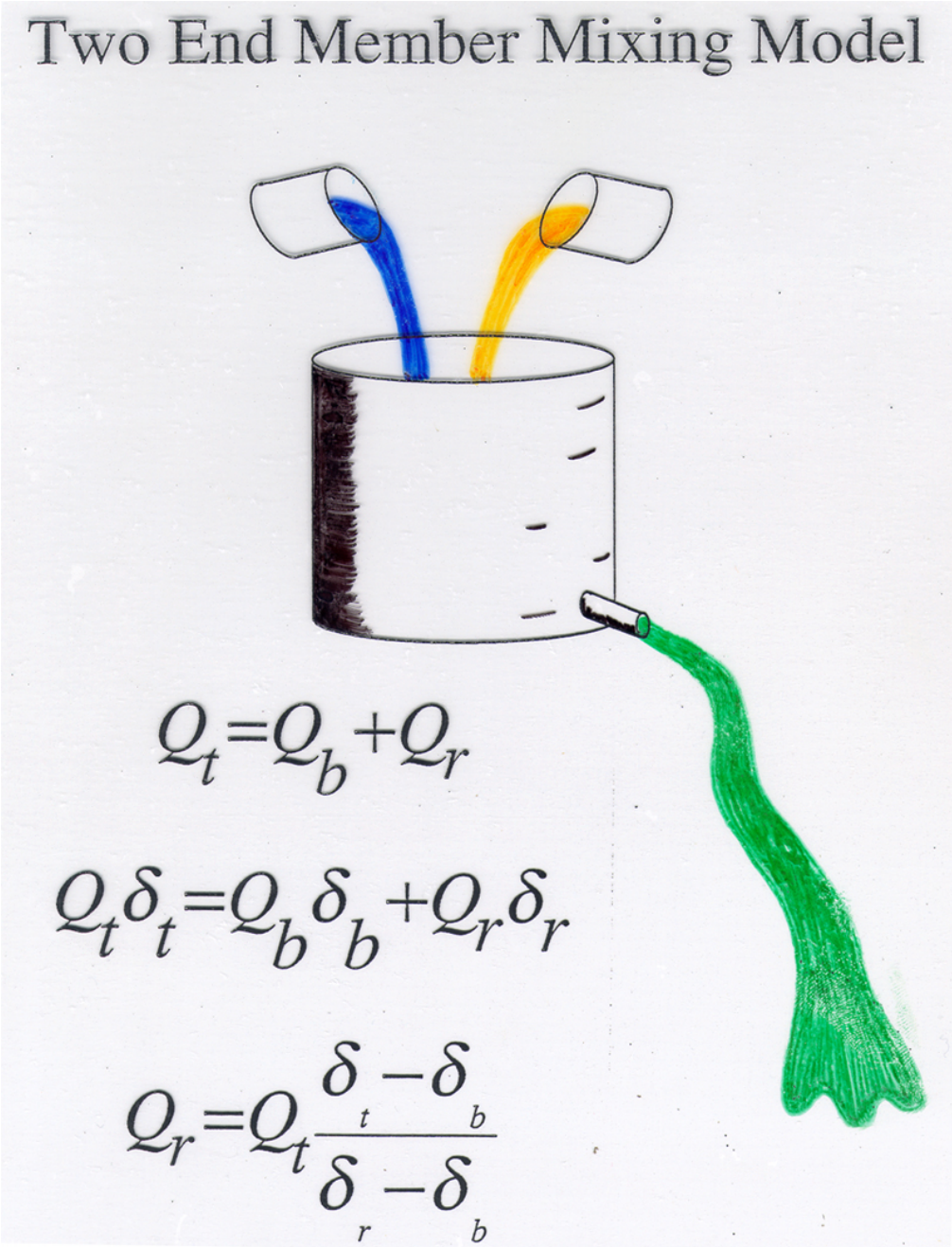



NO3- conc. (µ eq/L)
0
2
4
6
O18 (permil)
-14
-16
-18
Discharge (L/s)
0
250
500
2004
2005
2006
2007
2008


NO3- conc. (µ eq/L)
0
2
4
6
O18 (permil)
-14
-16
-18
Discharge (L/s)
0
250
500
2004
2005
2006
2007
2008

Nutrient Fluxes

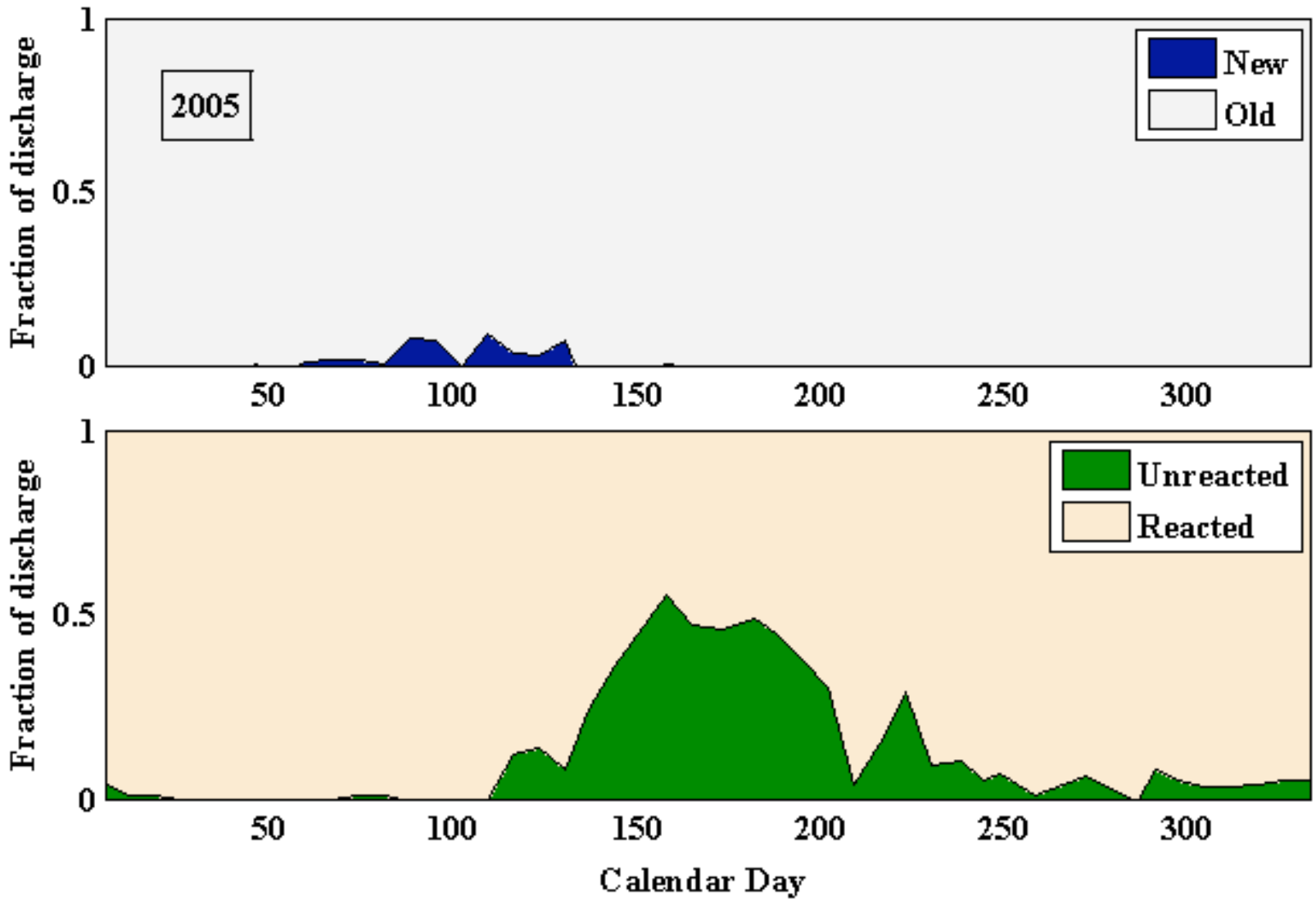




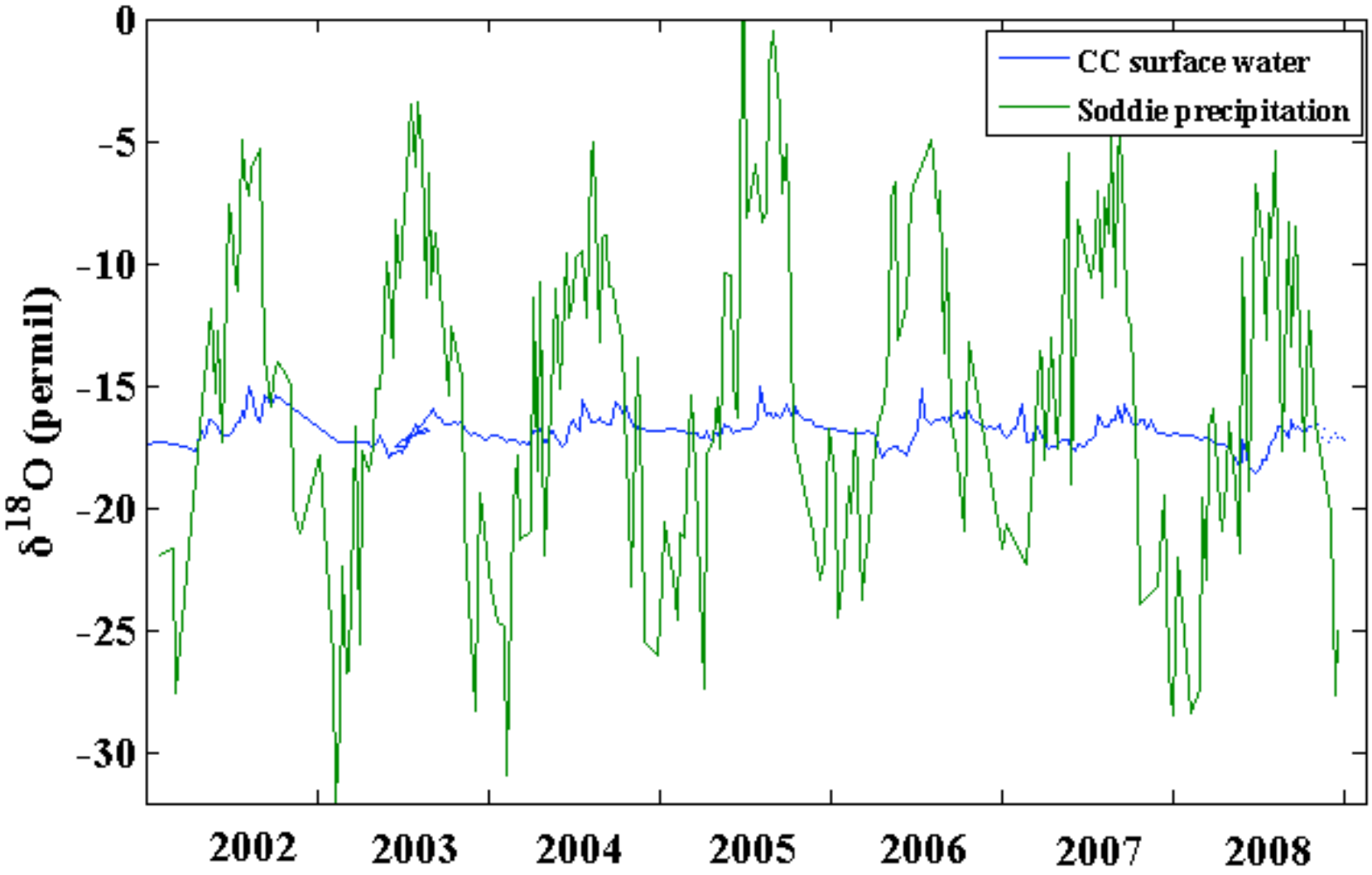
MIXING MODEL: 2 COMPONENTS

- One Conservative Tracer
- Mass Balance Equations for Water and Tracer

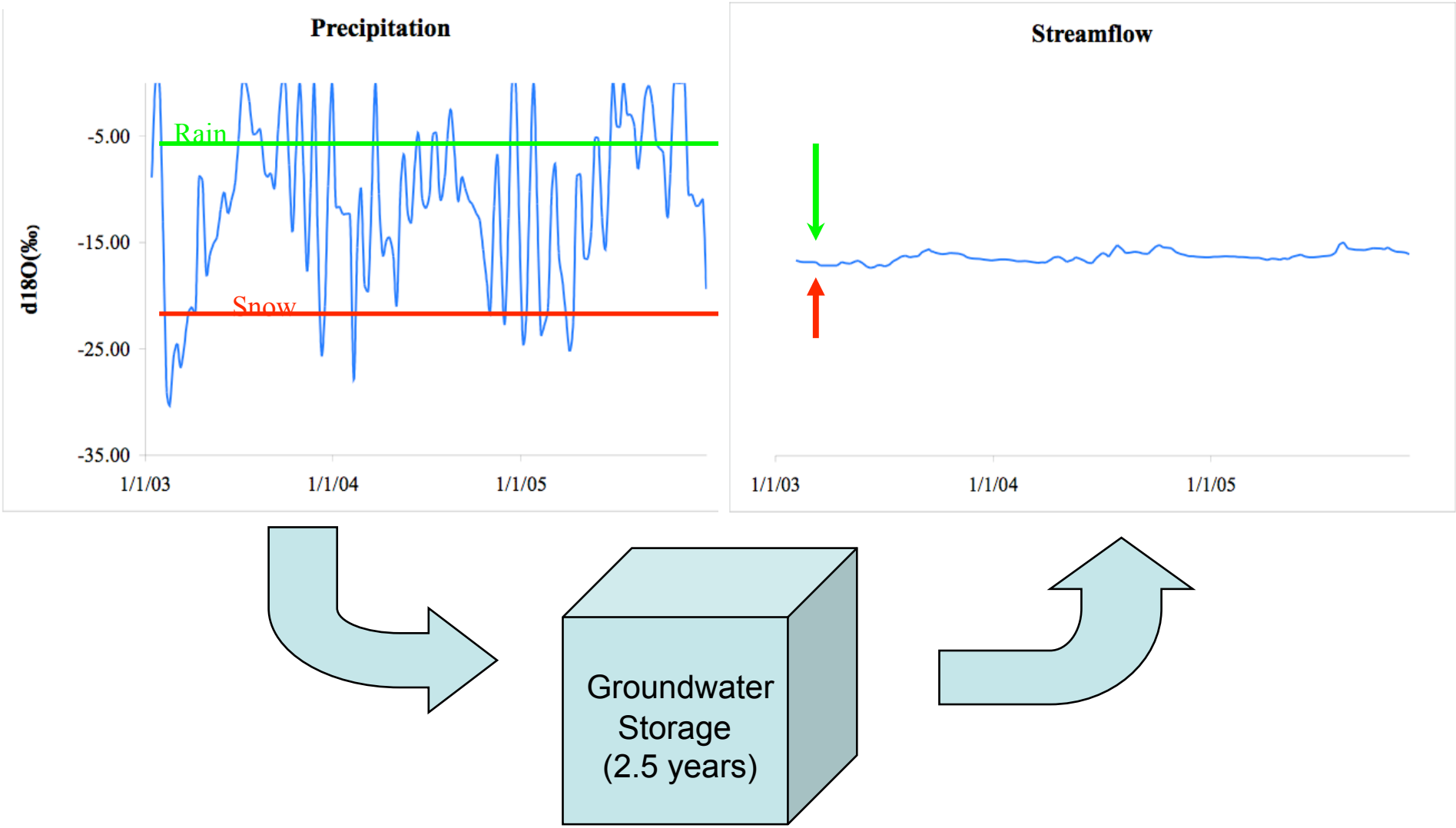
2-component mixing analysis



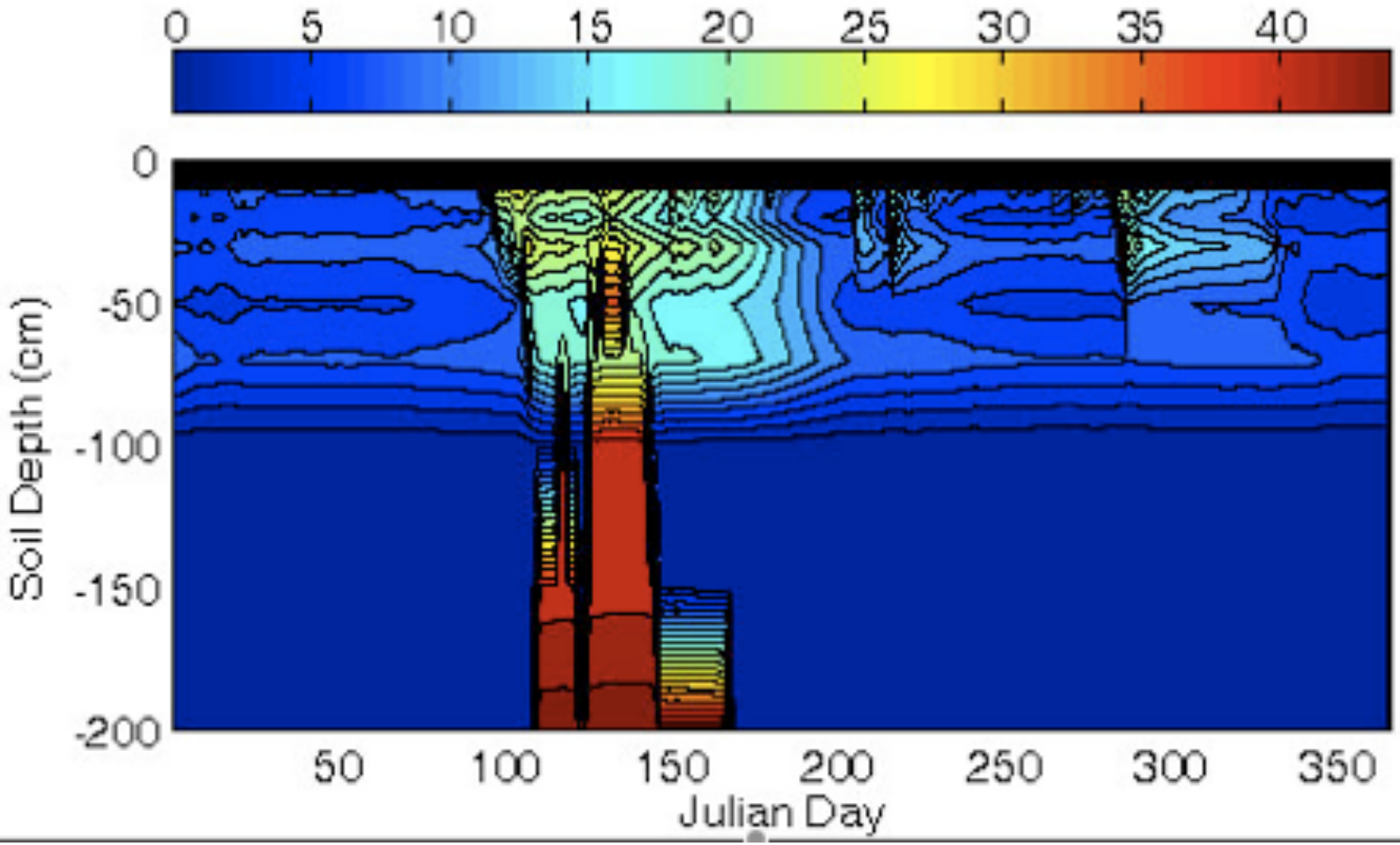
Oxygen isotope cycles



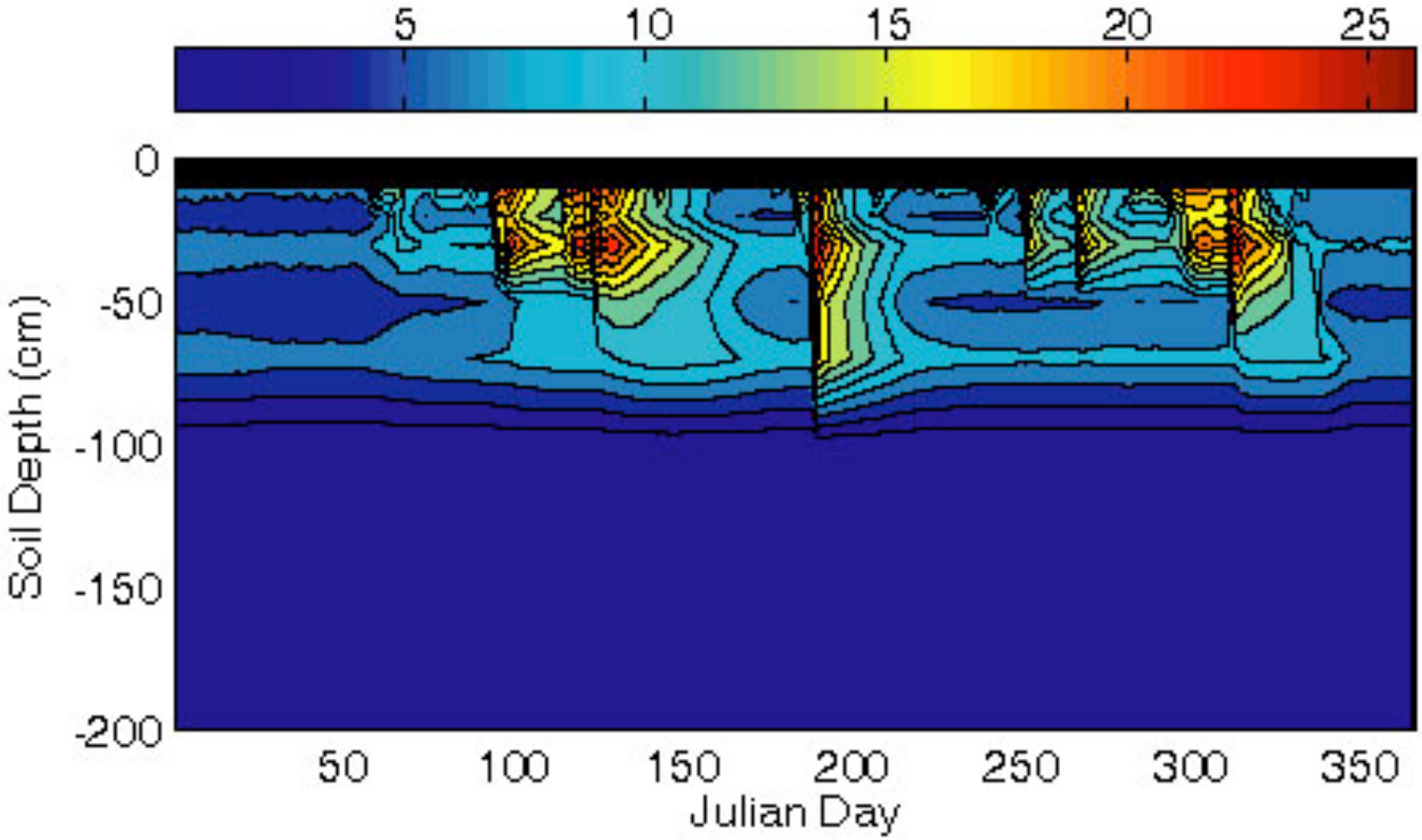
Oxygen Isotope Variation



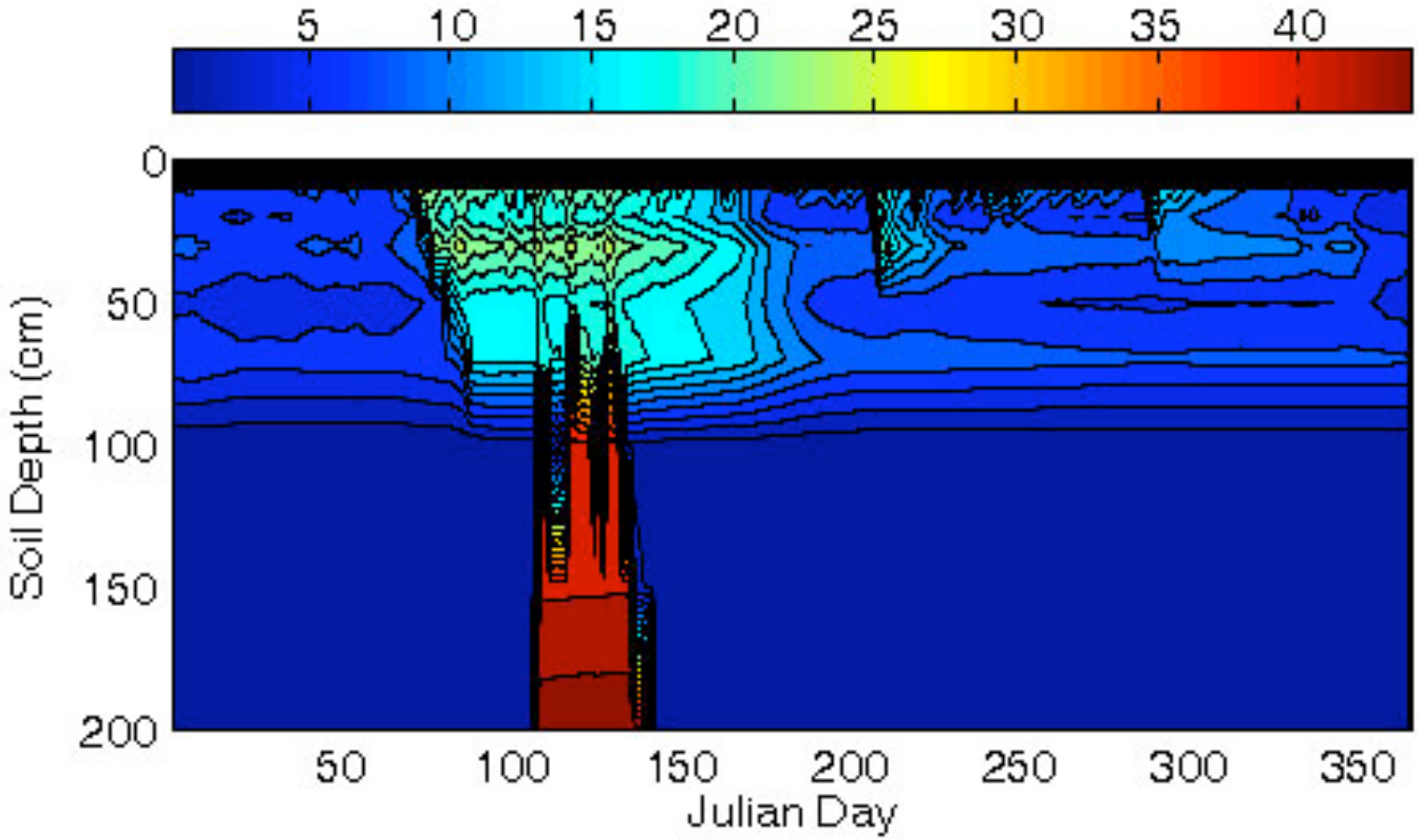
2005 Soil Moisture: C-1



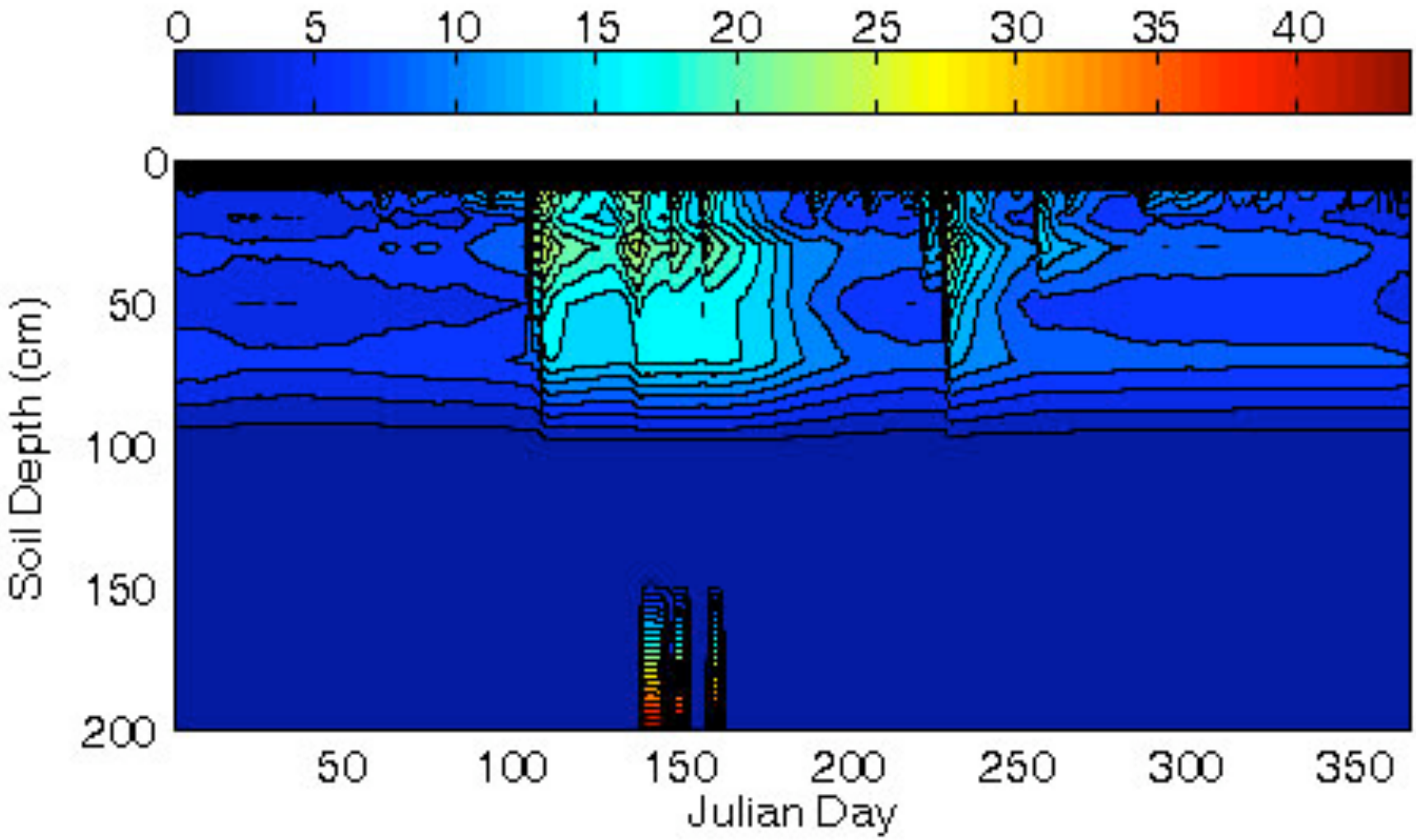
2006 Soil Moisture: C-1



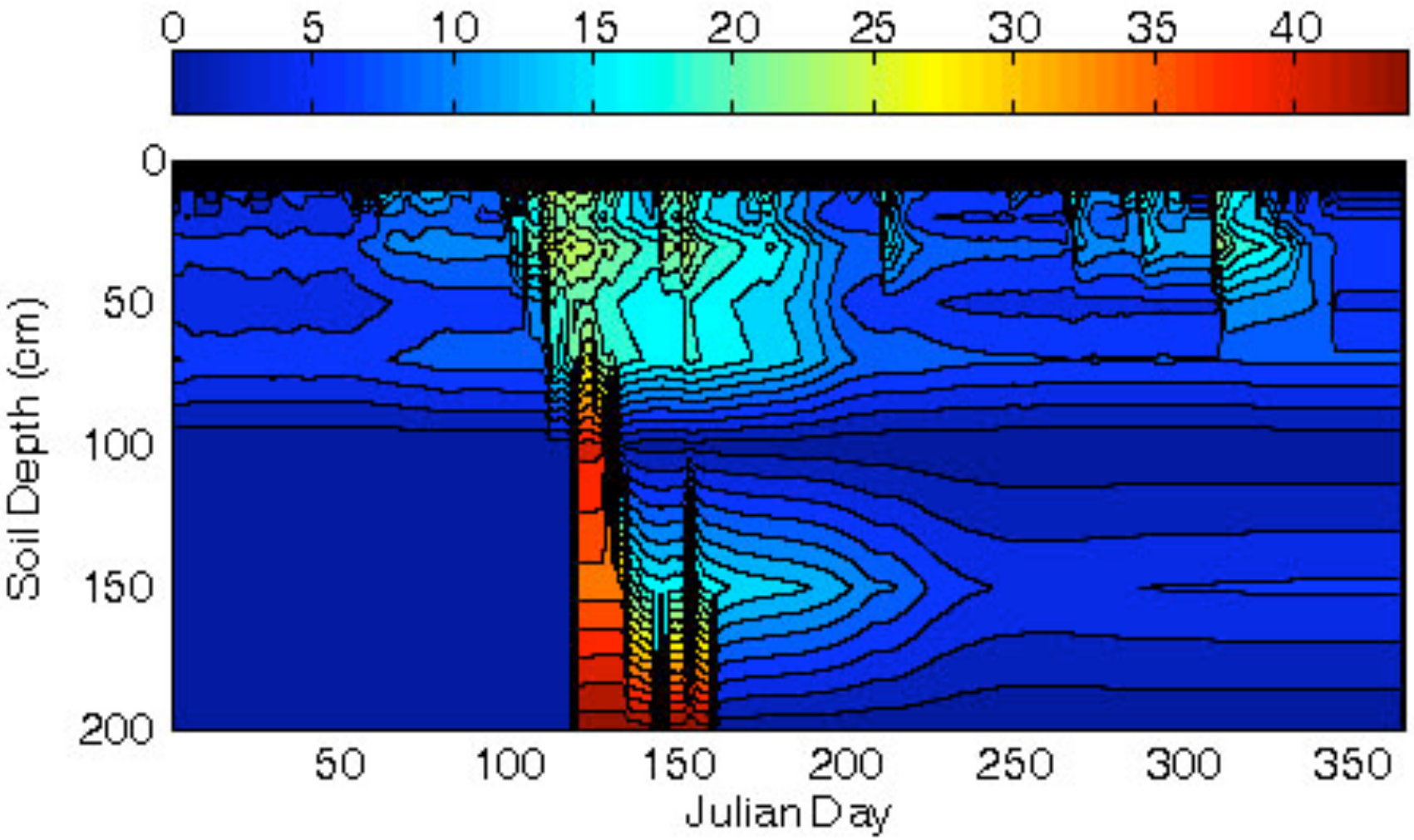
2007 Soil Moisture: C-1

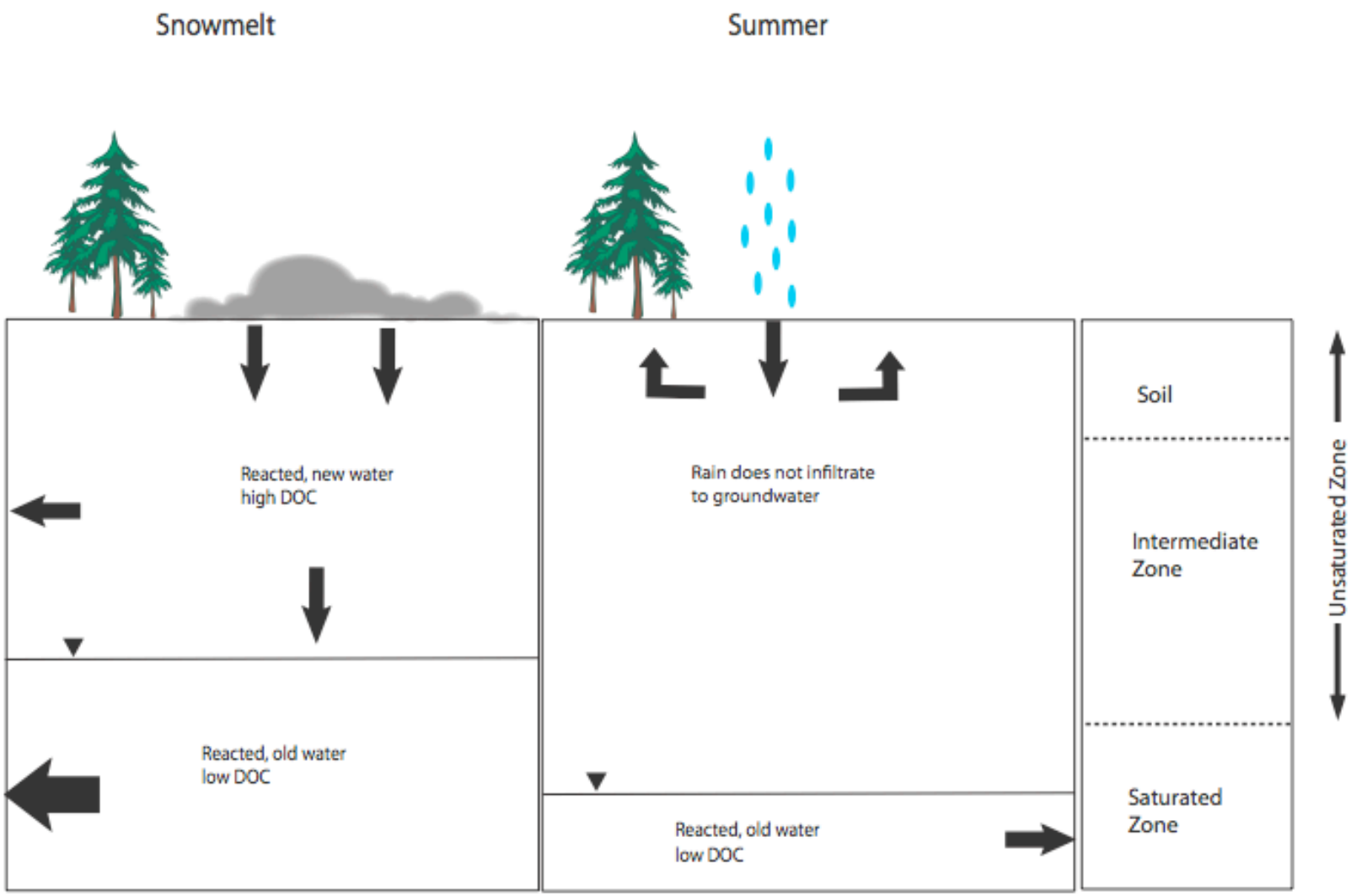


2008 Soil Moisture: C-1



2009 Soil Moisture: C-1




Snowmelt
Summer
Reacted, new water
high DOC
Reacted, old water
low DOC
Rain does not infiltrate
to groundwater
Reacted, old water
low DOC
Soil
Intermediate
Zone
Saturated
Zone
Unsaturated Zone

Message to Stakeholders

- Como Creek will serve as an important indicator of ecosystem and hydrologic change from MPB as we are uniquely poised to capture both before and after conditions.
- Quantifying changes in subsurface flowpaths are key to understanding changes in streamflow generation and biogeochemical reactions