Abrupt changes in air temperature and precipitation - do they matter for organic matter?

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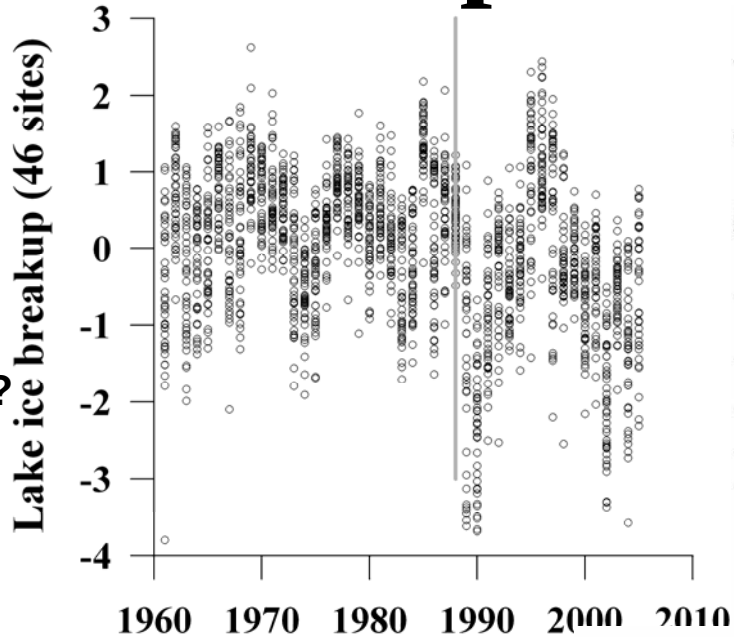
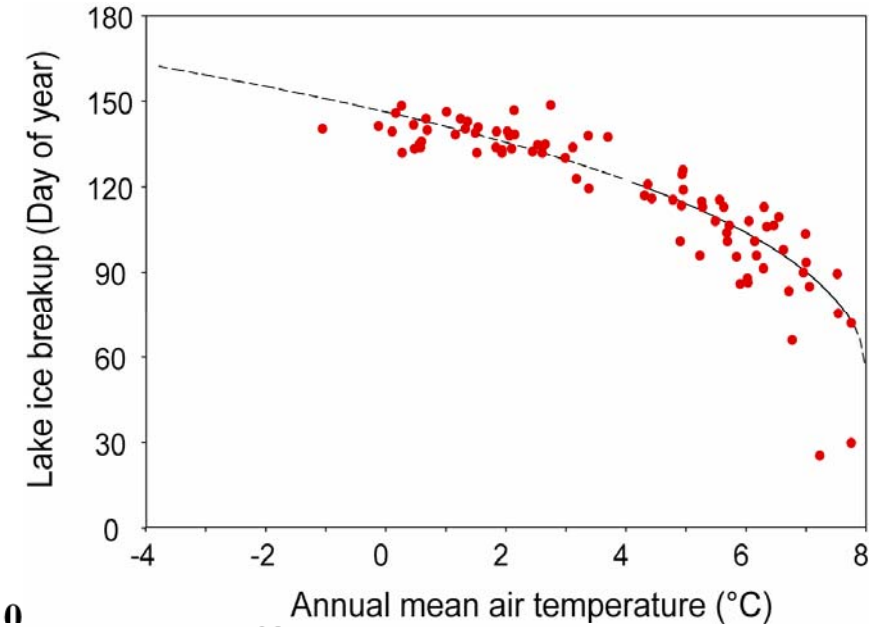
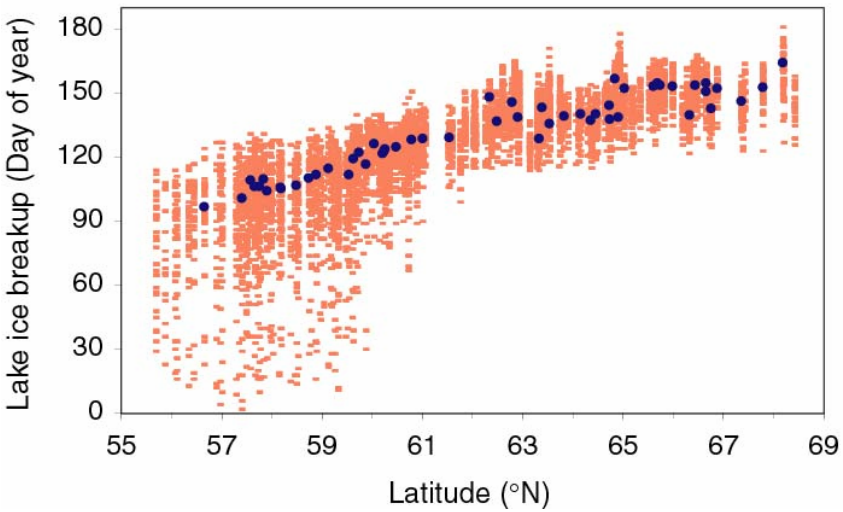
Background of post-doc, lakes...

Abrupt change in ice breakup 1988-89

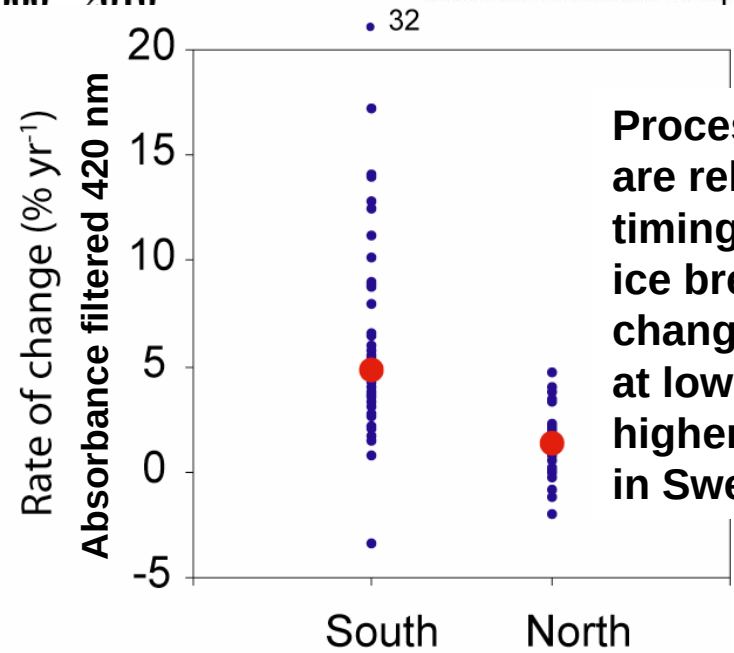
Same in air temperature?







Weyhenmeyer et al. 2004



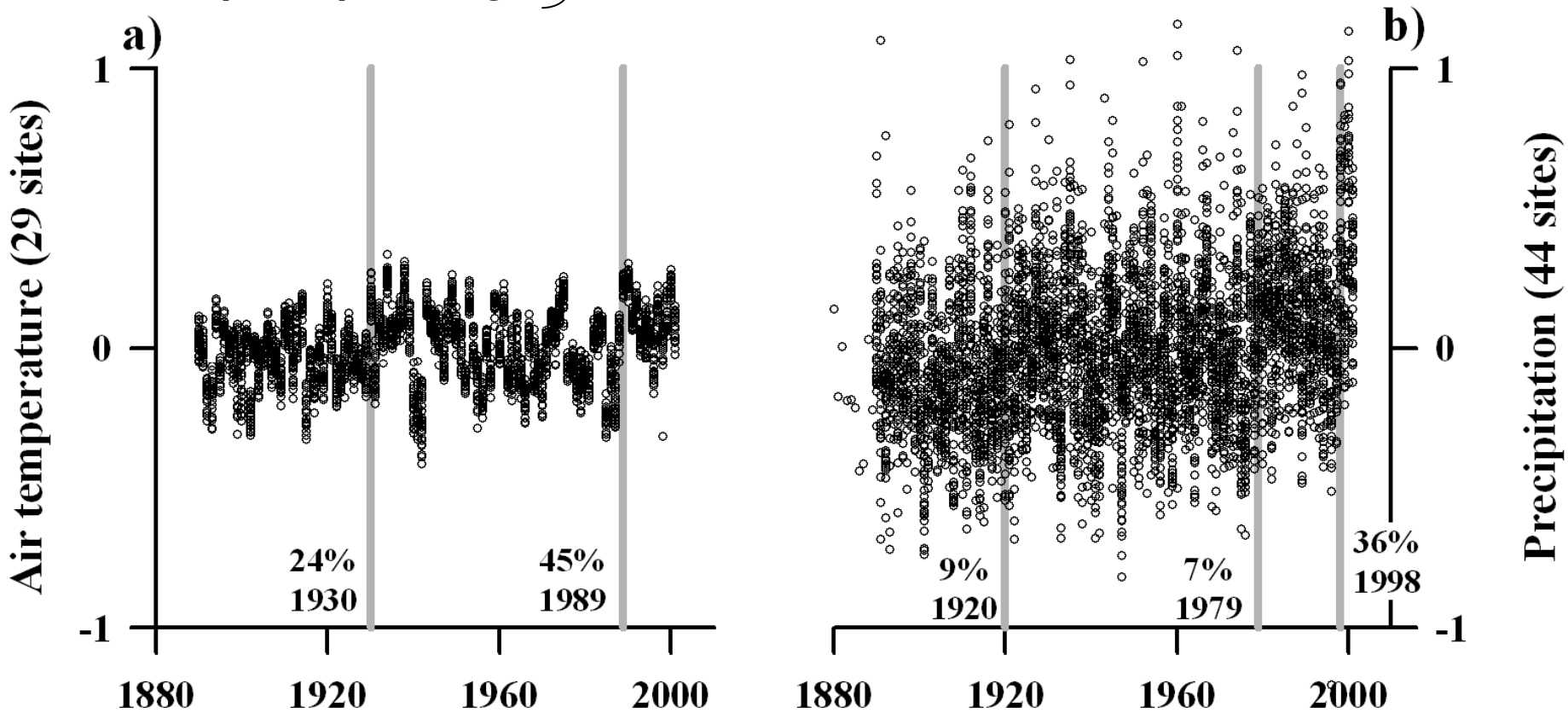
Processes that are related to the timing of lake ice breakup change faster at lower than at higher latitudes, in Sweden

Regime shifts?

Different sources have reported of a:

a) regime shift
b) step trend
c) change-point
d) abrupt change

in air temperature 1988-1989, in northern Europe



All data from Sweden, the NMDTOC database

The aim of this study is to

a) **Compare the possibly regime shift in air temperature 1988-89 with water chemistry at 87 Swedish watercourses**

b) **Evaluate if there is a latitudinal difference in the response**

Using different variations of CUSUM-plots and Pettit-tests

Methods 1- 3 indicate the same years!

1) Cumulative sum of deviations (CUSUM) and Pettitt-test
Tested manually
Lanzante, 1996; Buishand, 1982; Pettitt, 1979

2) Change-Point Analyzer
Software, test period 30 days (80 USD)
www.variation.com

3) Regime Shift Detection
Free Excel add-in
Rodionov, 2004; Rodionov, 2006
www.beringclimate.noaa.gov

Regime Shift Detection

Yearly mean (or quarter)

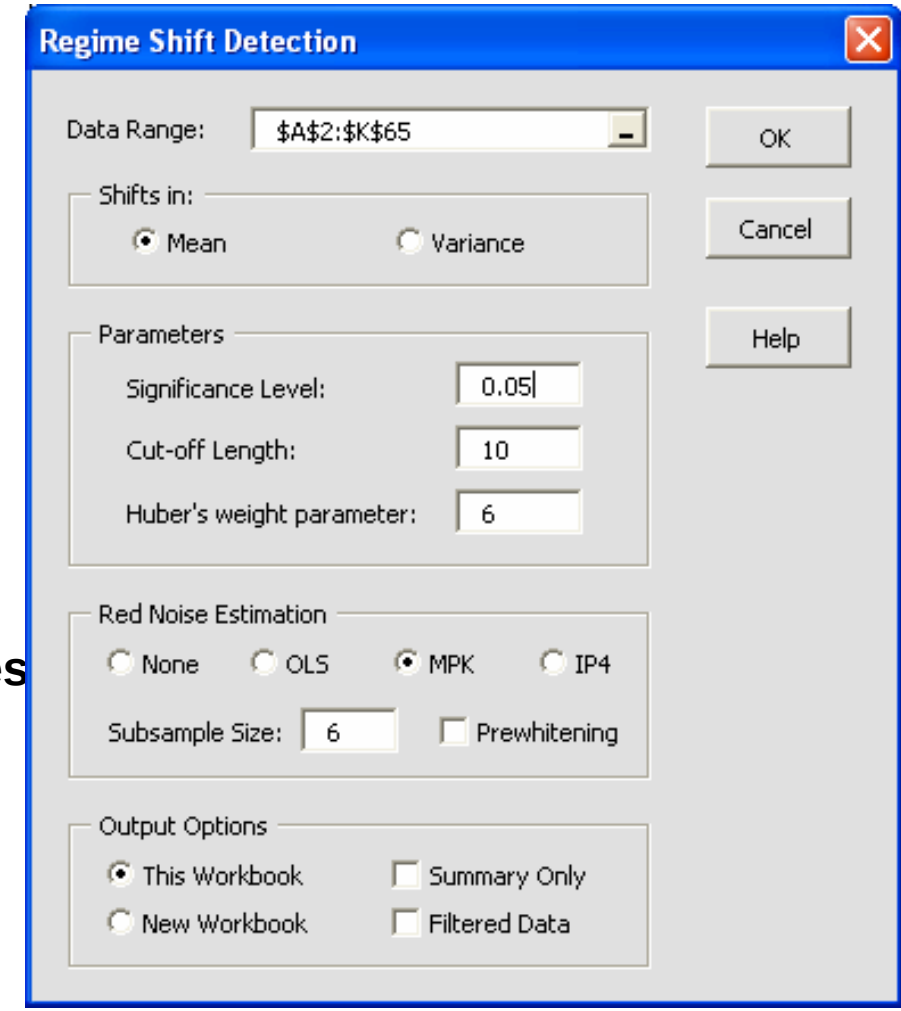
No missing values

Assume no apriori of when the regime shift should accour

Differences tested with Student's t-test

Assumes that the variances for both regimes are the same

Red noise estimation (serial correlation)

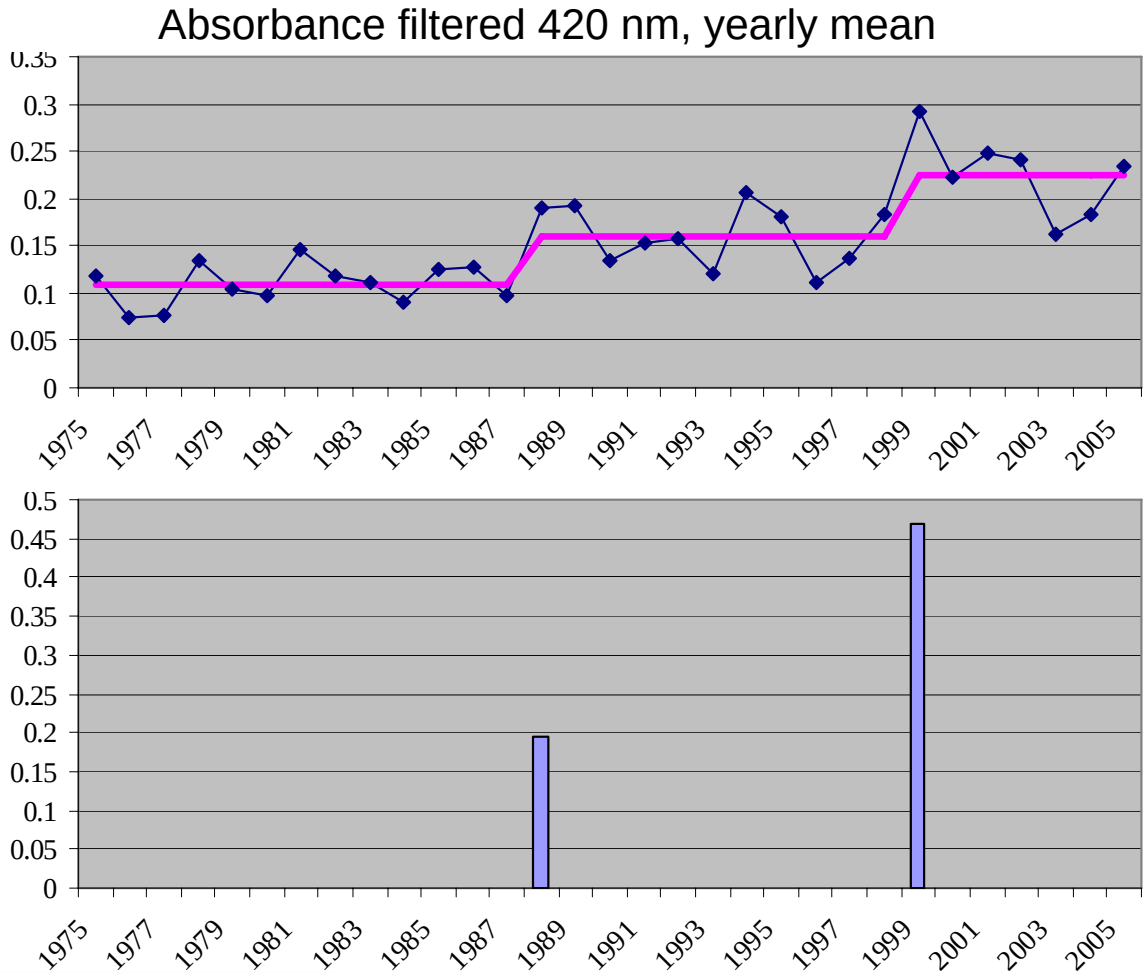


Red Noise Estimation (or serial correlation)

Red noise is modeled by the first order autoregressive model (AR1)

The AR1 coefficient is estimated by MPK (Marriott-Pope and Kendall)

Regime shift index (RSI), which represents a cumulative sum of the normalized anomalies:



$$\mathrm{RSI}_{l,j} = \sum_{i=j}^{j+m} \frac{x_i^*}{l\sigma_l}, m = 0, 1, \ldots, l-1.$$

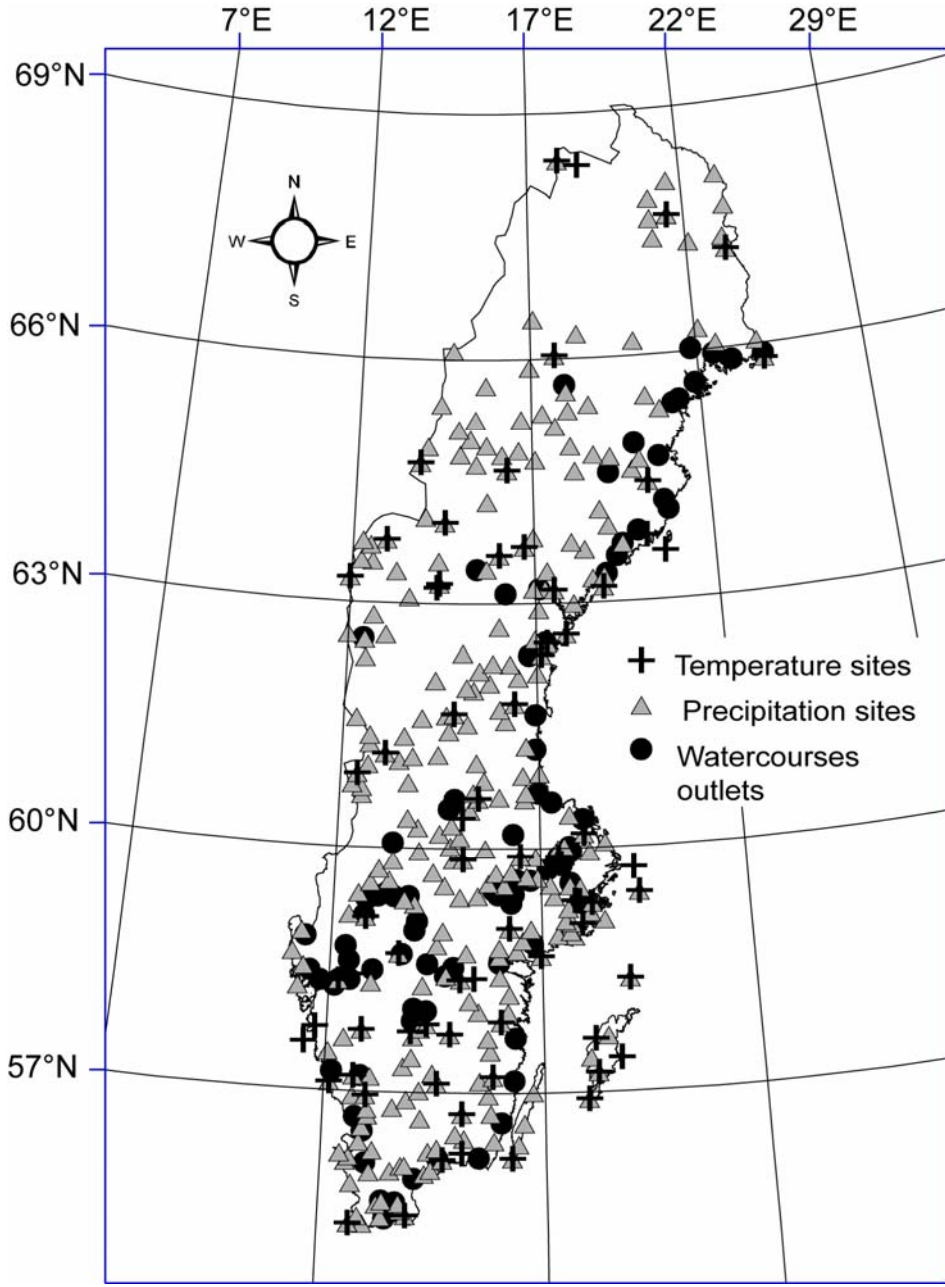
Here $x_i^* = x_i - \bar{x}'_{e2}$ if the shift is up, or $x_i^* = \bar{x}'_{e2} - x_i$

Data

Variables	Explanations	Sites	Time period	Sampling frequency
T_{long}	Air temperature, long time	29	1880-2001	Yearly means
T_{many}	Air temperature, short time	72	1961-2005	Monthly mean
P_{long}	Precipitation, long time	44	1880-2001	Yearly sum
P_{many}	Precipitation, short time	277	1961-2005	Monthly sum
IceBreak	Ice breakup	333	1960-2004	Julian day from 1 Jan
Q	Discharge	87	1965-2004	Monthly mean
AbsF	Absorbance 420 nm, 0.45 µm	87	1975-2005	1 sample per month
AbsF:COD		87	1975-2005	1 sample per month
"Turbidity"	Absorbance unfiltered - AbsF	87	1975-2005	1 sample per month
BC*	Base cations Σ(Ca,Mg,K,Na) - 1.111×Cl	87	1975-2005	1 sample per month
Cl	Chloride	87	1975-2005	1 sample per month
C:N	COD per Organic-N	87	1975-2005	1 sample per month
COD	Chemical oxygen demand determined using $KMnO_4$	87	1975-2005	1 sample per month
Fe	Iron	49	1975-2005	1 sample per month
Mn	Manganese	49	1975-2005	1 sample per month
InorgN	NO_2-N + NO_3-N + NH_4-N	87	1975-2005	1 sample per month
OrgN	Kjeldahl-N - NH_4-N	87	1975-2005	1 sample per month
pH		87	1975-2005	1 sample per month
PO_4	Phosphate-Phosphor	87	1975-2005	1 sample per month
Other-P	Non reactive P: Tot-P - PO_4-P	87	1975-2005	1 sample per month
Si	Silica	87	1975-2005	1 sample per month
SO_4	Sulfate	87	1975-2005	1 sample per month

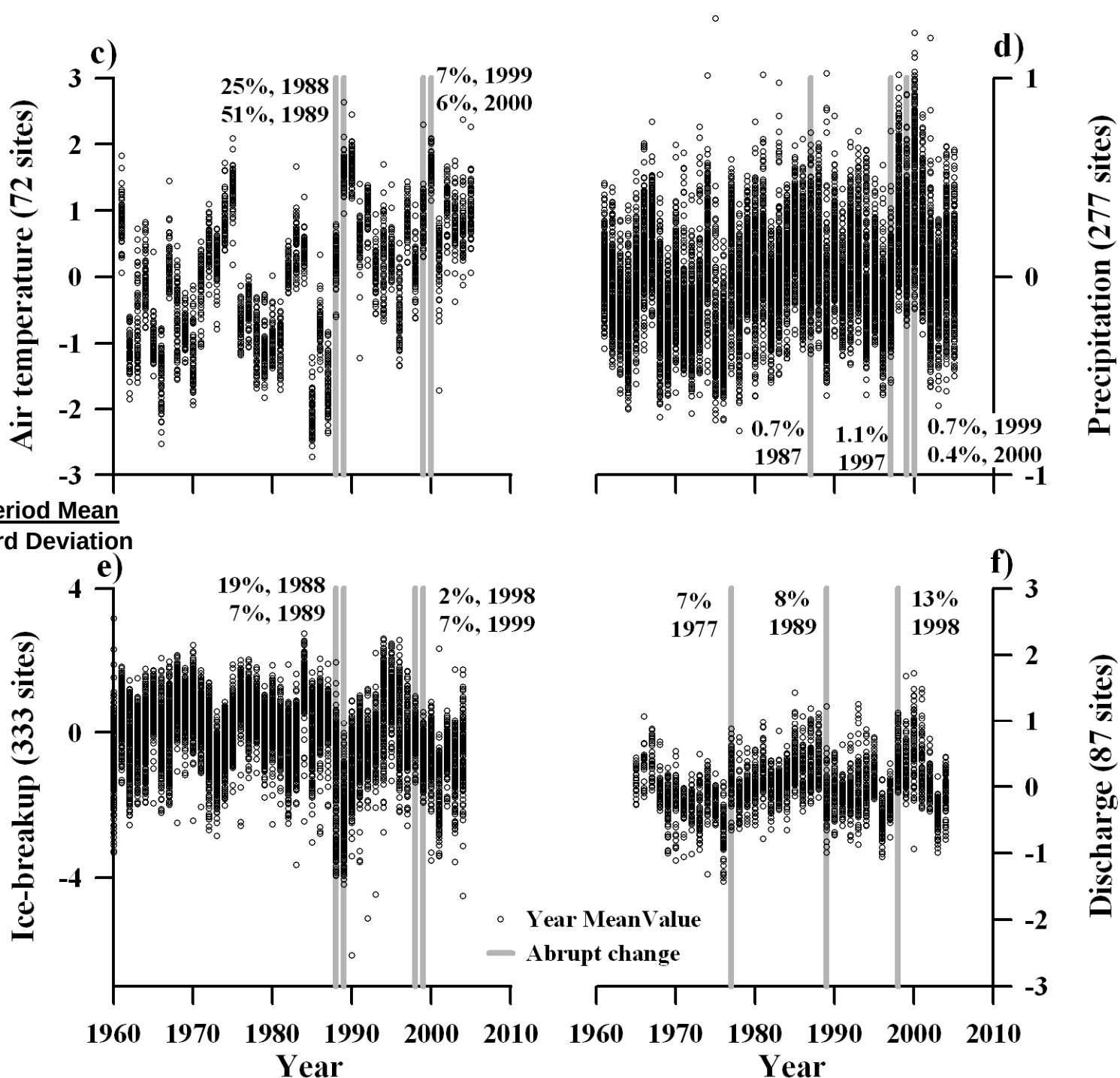
Catchments

Parameter	Median	Max	Min
Latitude, outlet	59°N 55’	66° 27’	55° 47’
Longitude, outlet	16°E 17’	24° 14’	11° 44’
Catchment size	2453	47035	23
Lake surface	6	35	0
Densely built-up area	0	11	0
Forest	61	93	6
Wetland	5	69	0
Open field	4	13	0
Pasture land	1	11	0
Arable field	6	76	0
Mountain	0	47	0
Mountain forest	0	22	0
Glacier	0	1	0

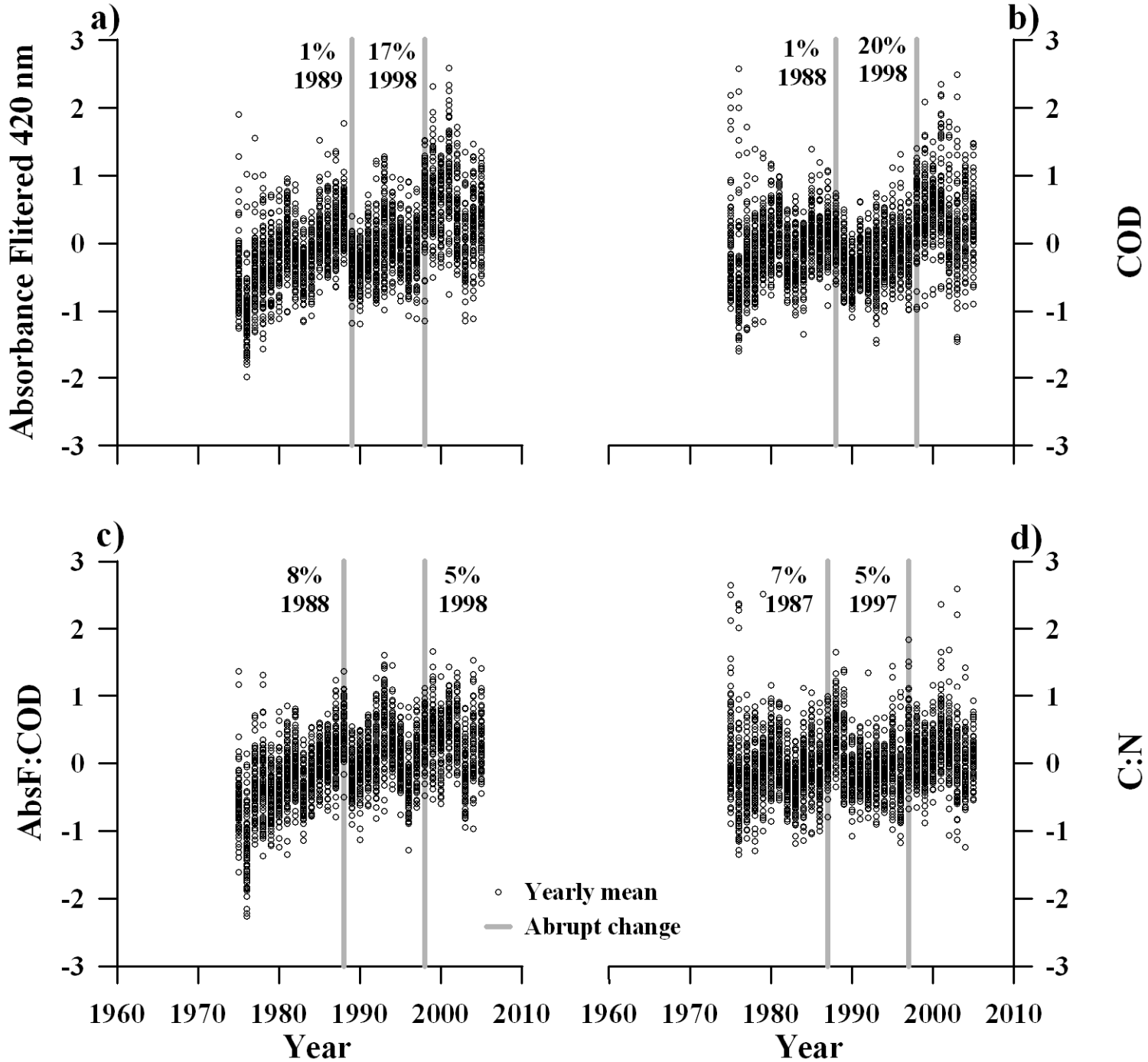


Physical para-meters

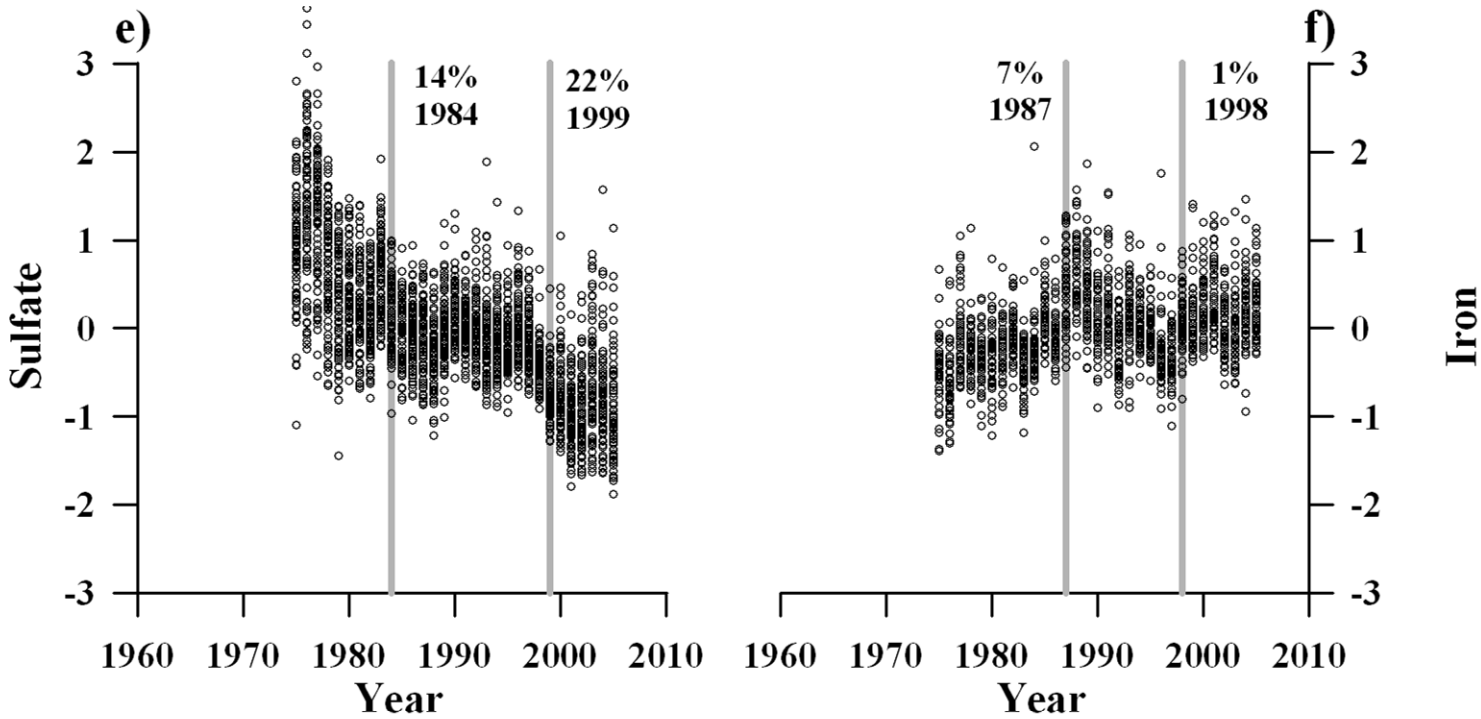
$$Y = \frac{\text{Year Mean - Whole Period Mean}}{\text{Whole Period Standard Deviation}}$$



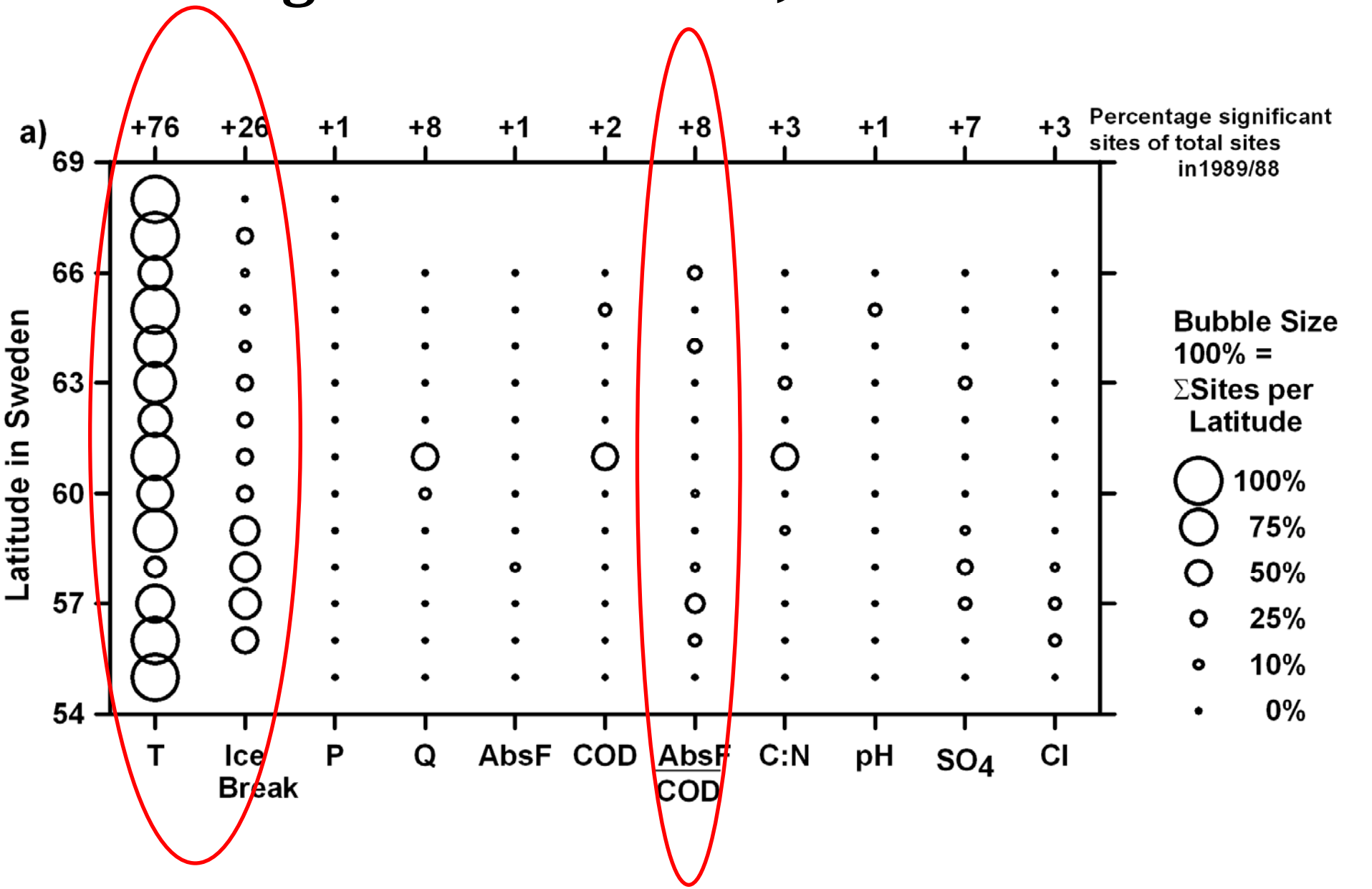
Organic matter, 87 water-courses



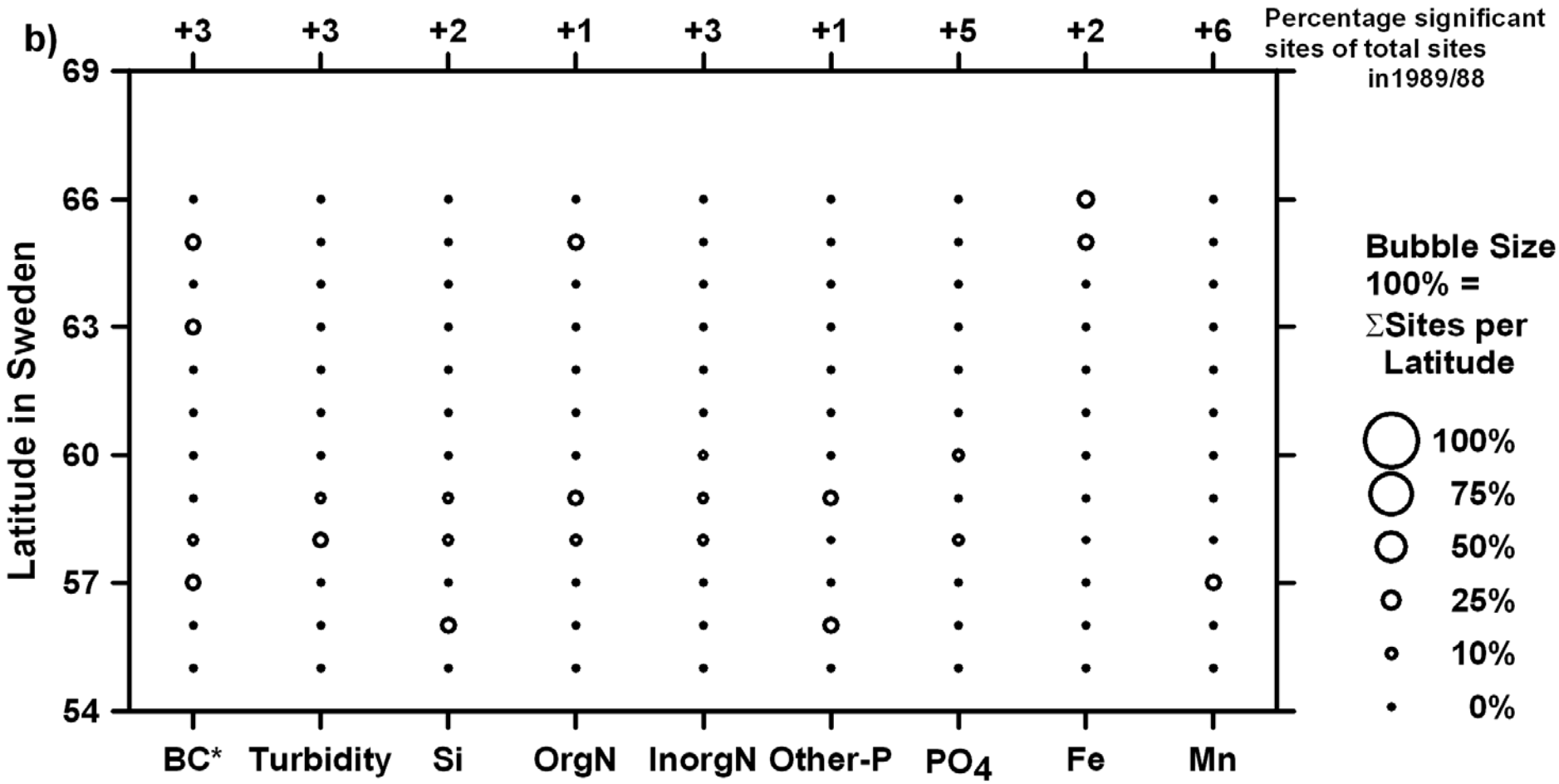
Sulfate & Iron, 87 water-courses



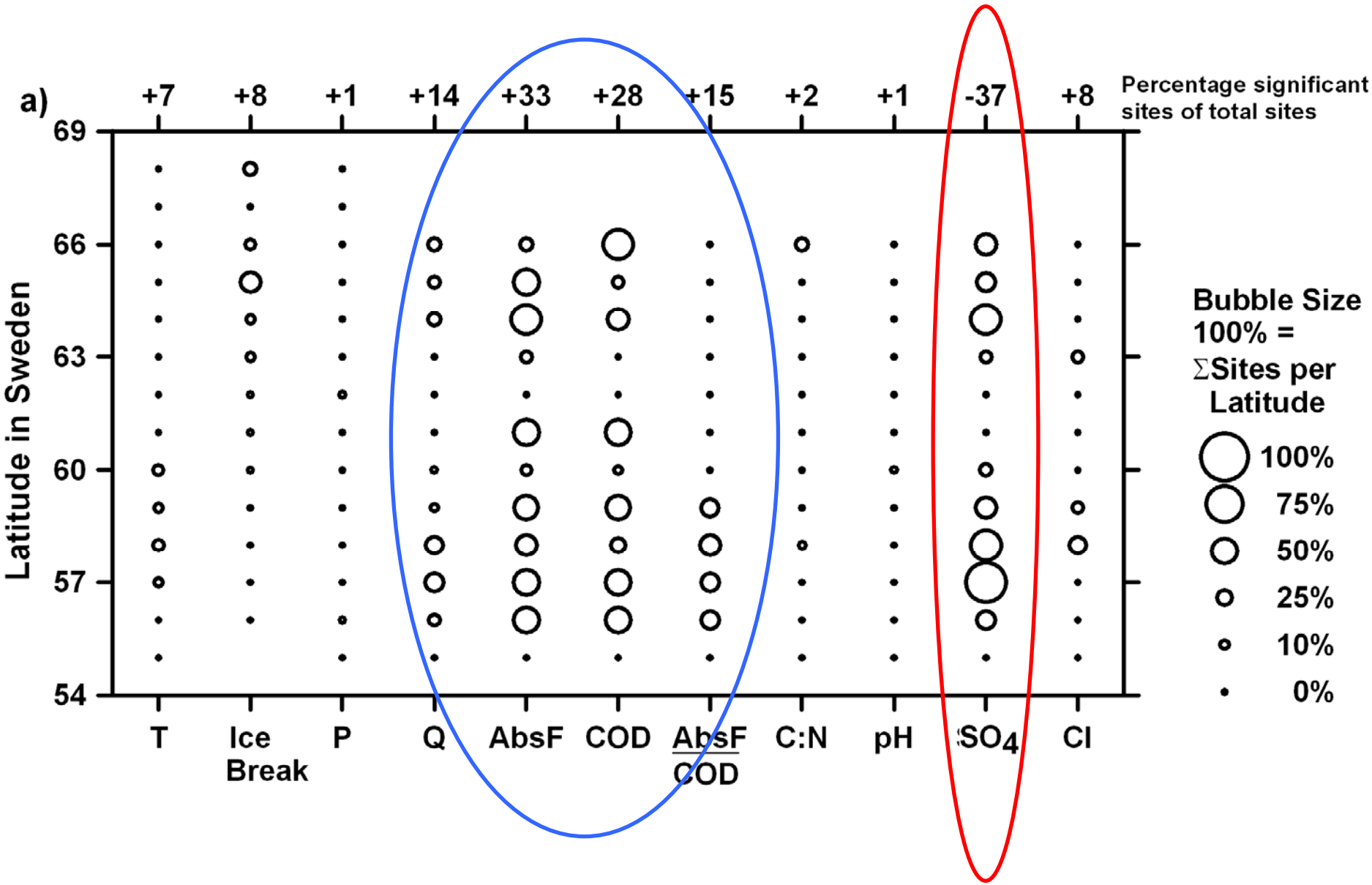
Latitude gradient 1988-89, a



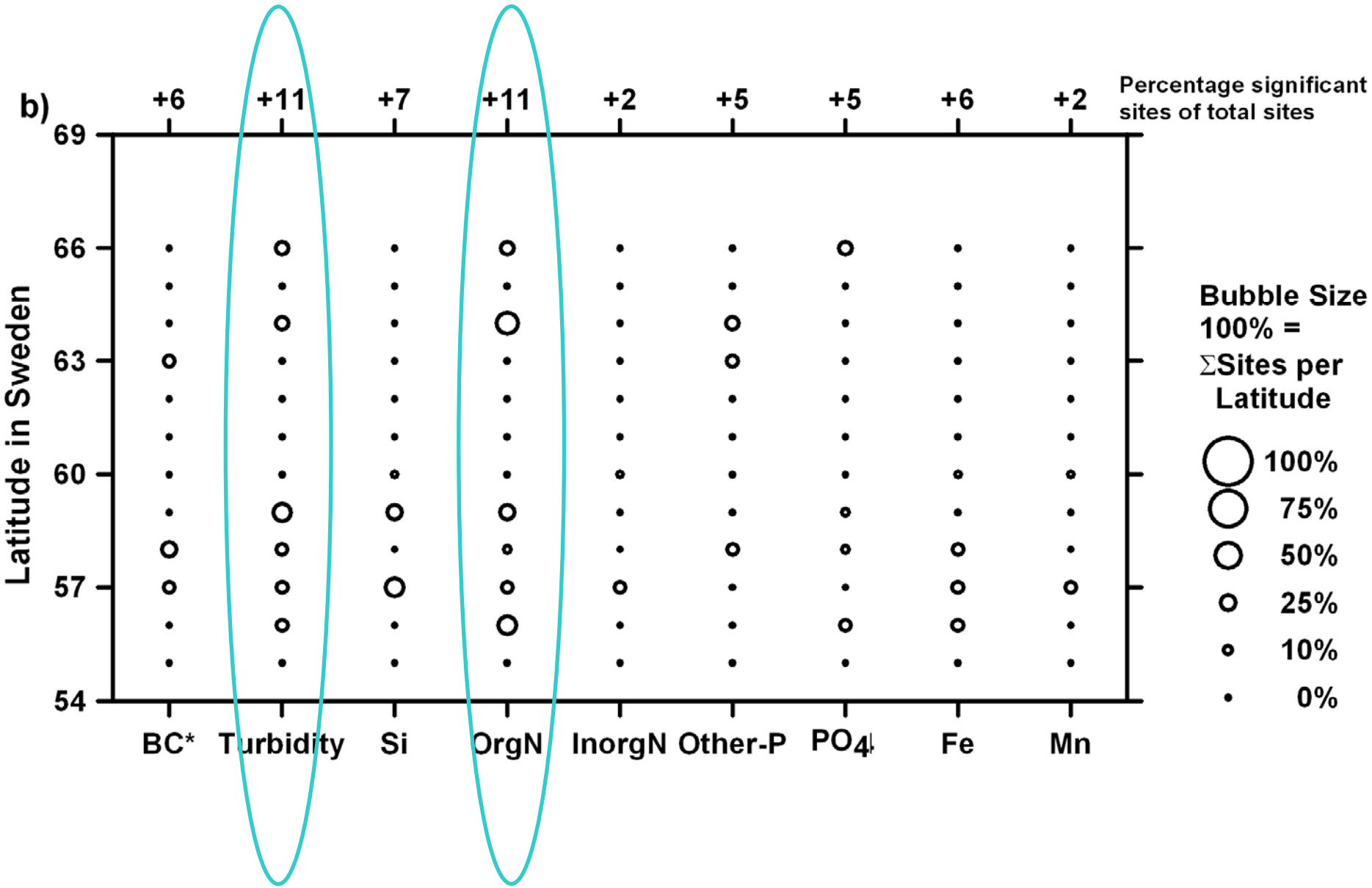
Latitude gradient 1988-89, b



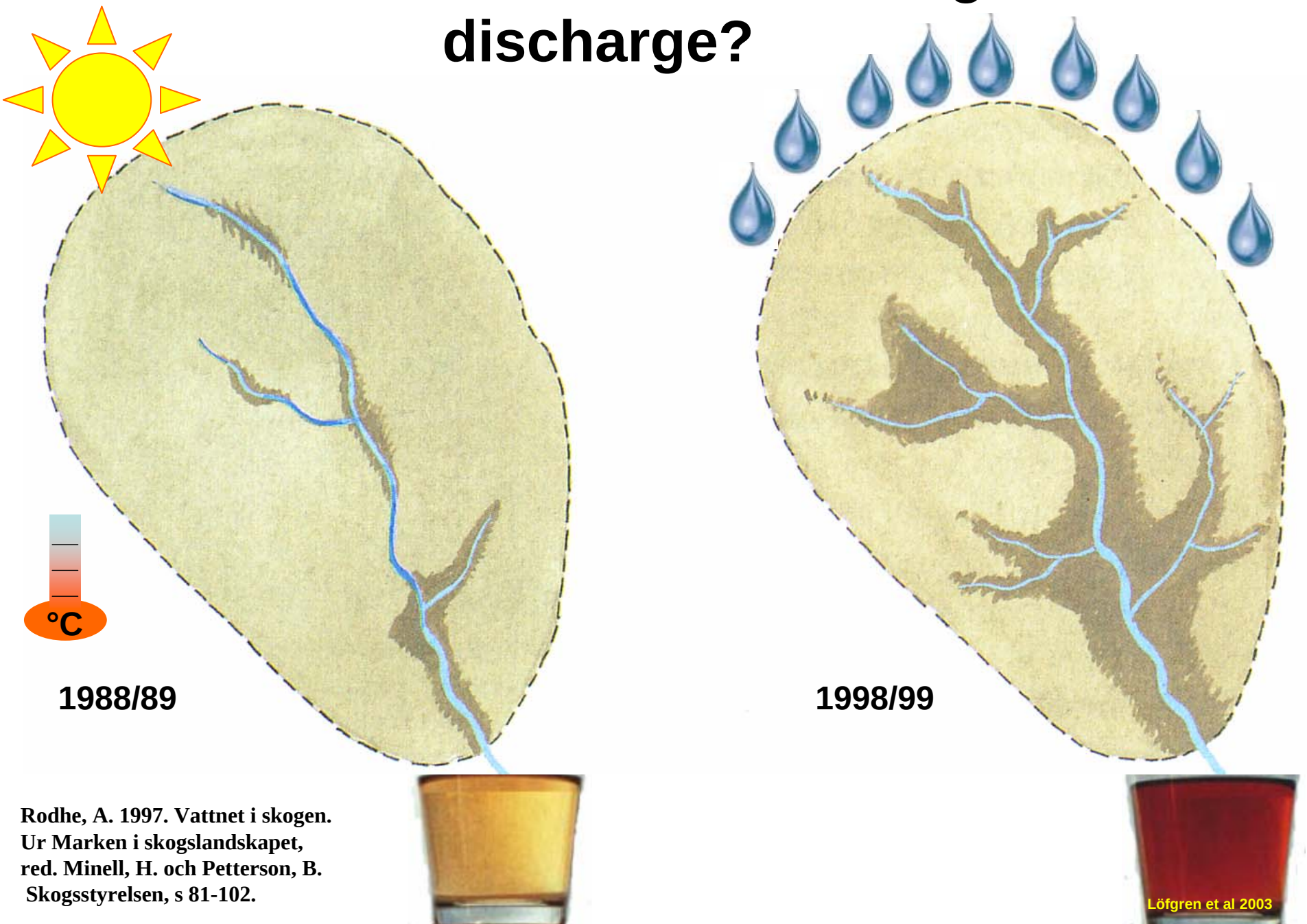
Latitude gradient 1998-99, a



Latitude gradient 1998-99, b

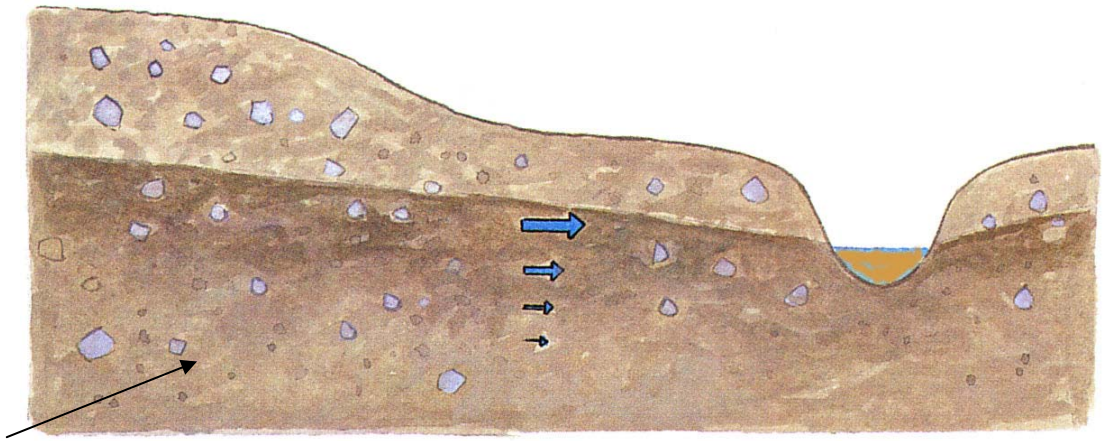


Hotter - more sensitive for changes in discharge?



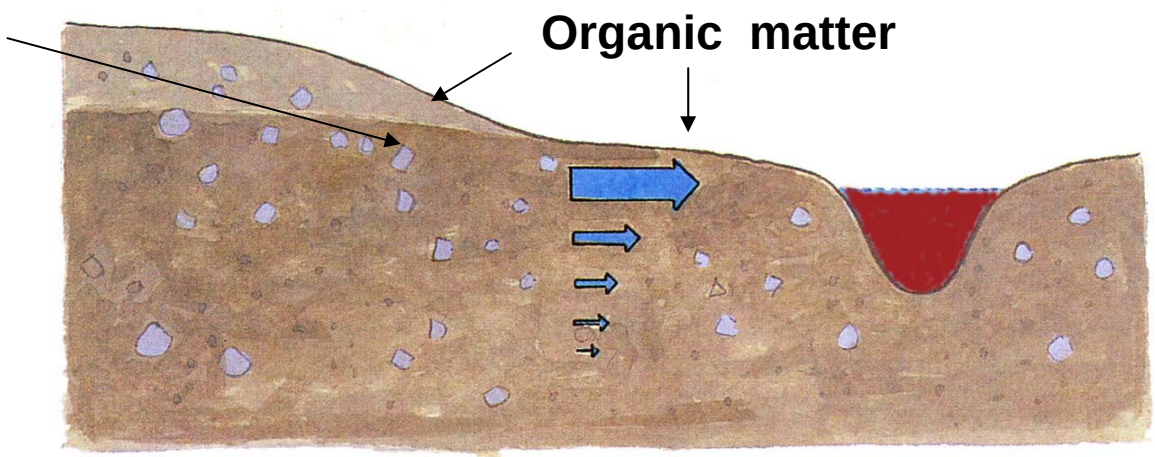
Rodhe, A. 1997. Vattnet i skogen. Ur Marken i skogslandskapet, red. Minell, H. och Petterson, B. Skogsstyrelsen, s 81-102.

Higher groundwater table



Older groundwater:
higher ionic strength,
higher pH,
lower organic matter

Younger groundwater:
higher organic matter,
more coloured per
organic matter



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Thank you for your attention!