



**u<sup>b</sup>**

**UNIVERSITÄT  
BERN**

**OESCHGER CENTRE  
CLIMATE CHANGE RESEARCH**

# Simulating climate variability over the last millennium at Climate and Environmental Physics, Bern

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University of Bern, Switzerland

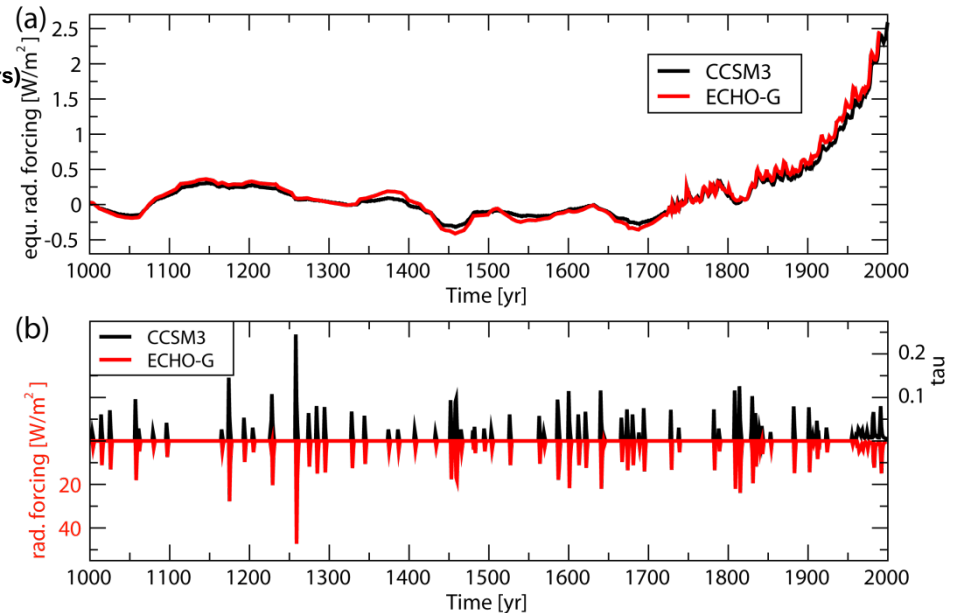
- **Control simulations** (500-1000yrs)

- 1990 AD
- 1500 AD
- 1000 AD
- 850 AD with C-cycle

- **Transient simulations**

- 4 x 1500-2100 AD
- 5 x 1000-1500 AD
- 1 x 1000-2100 AD
- 6 x 1150-1450 AD
- 1 x 850 -2100 AD (in progress) with C-cycle

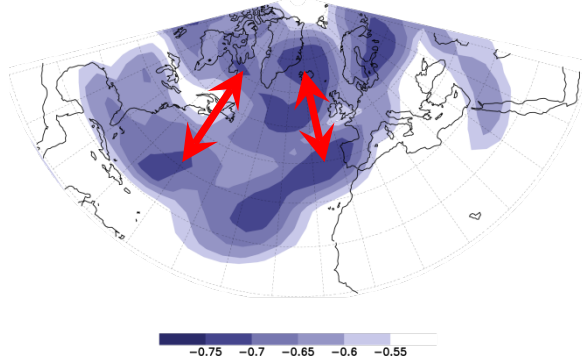
## GHG+Solar (Crowley scaled with Lean)



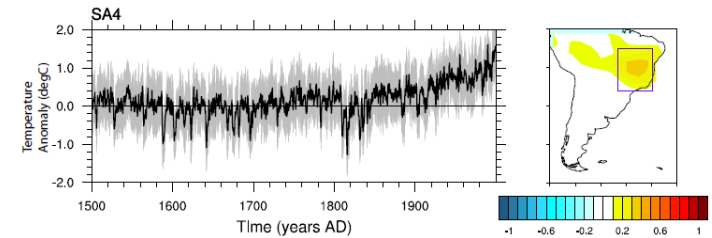
## Volcanoes (Crowley)

# Examples of research activity

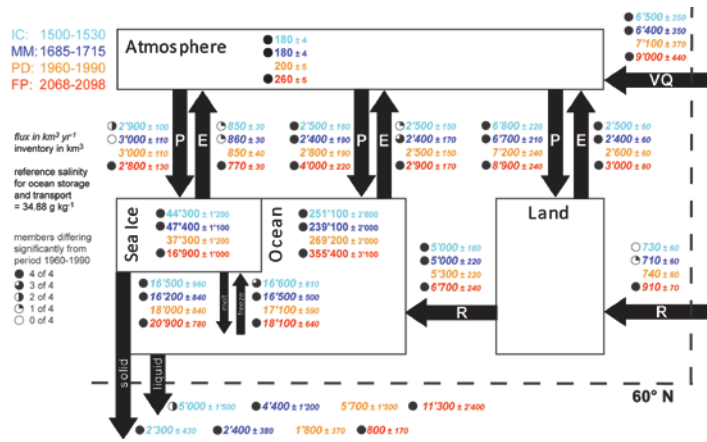
## Teleconnection and modes of variability



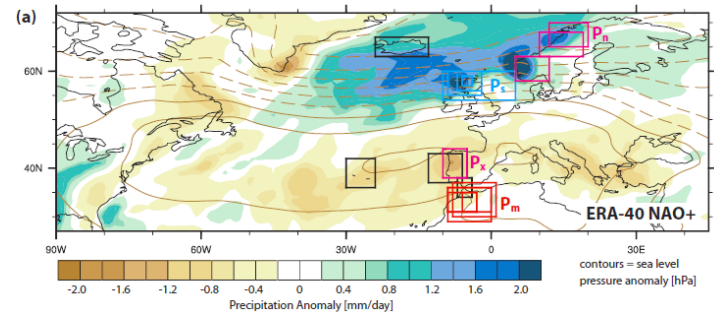
## Southern Hemisphere climate variability



## Freshwater budgets



## Interpretation of proxy data



## Example 1:

# Testing NAO reconstructions

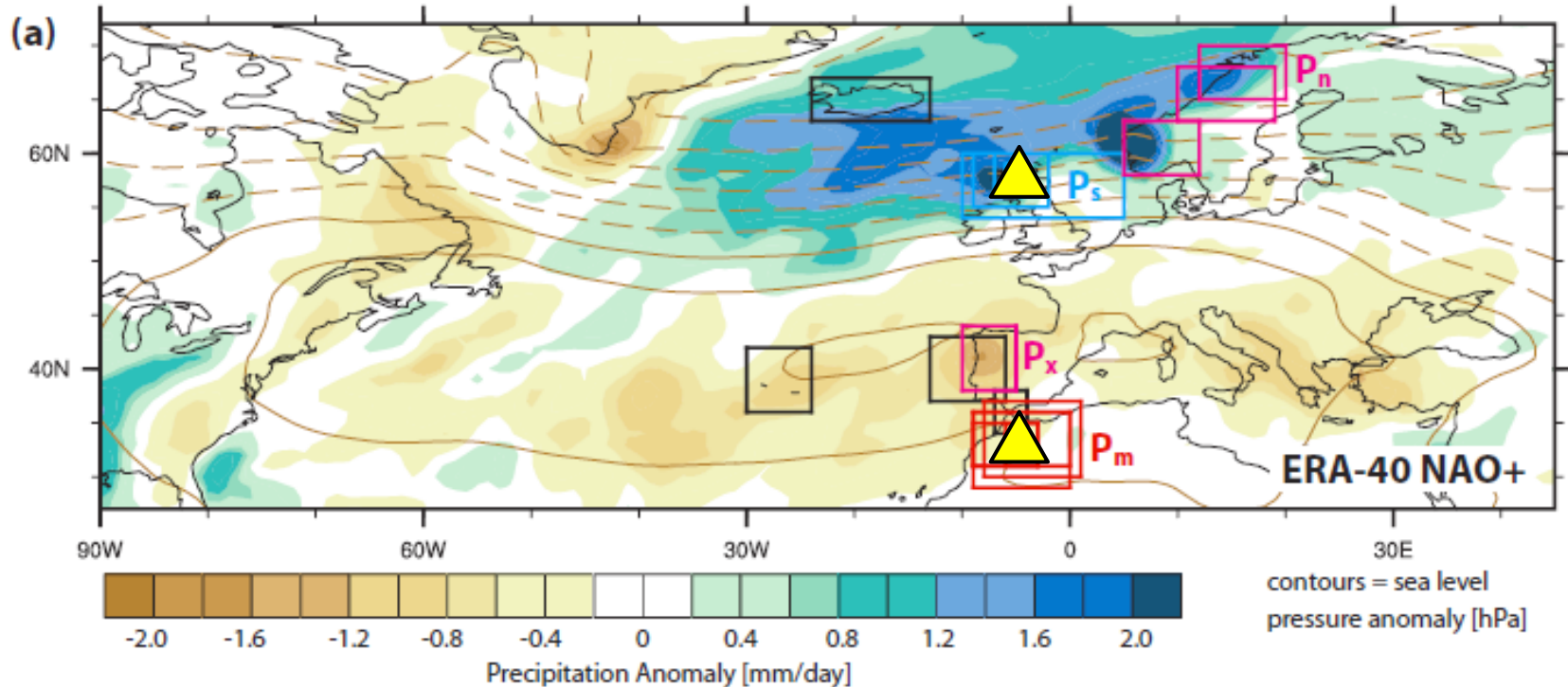
Lehner et al, submitted

## How well can we reconstruct NAO from proxies?

- Trouet et al, 2009: NAO reconstruction based on proxy records from Scotland and Marocco
- Reconstruct NAO from model results using a range of models, reanalysis data and methods
- (Model-based) NAO-indices to be compared:
  - PC-EOF analysis; Iceland-Azore pressure difference
  - Precip at two stations: Marocco-Scotland (Trouet et al)
  - Precip at four stations

# Composite of NAO+ in ERA-40 data

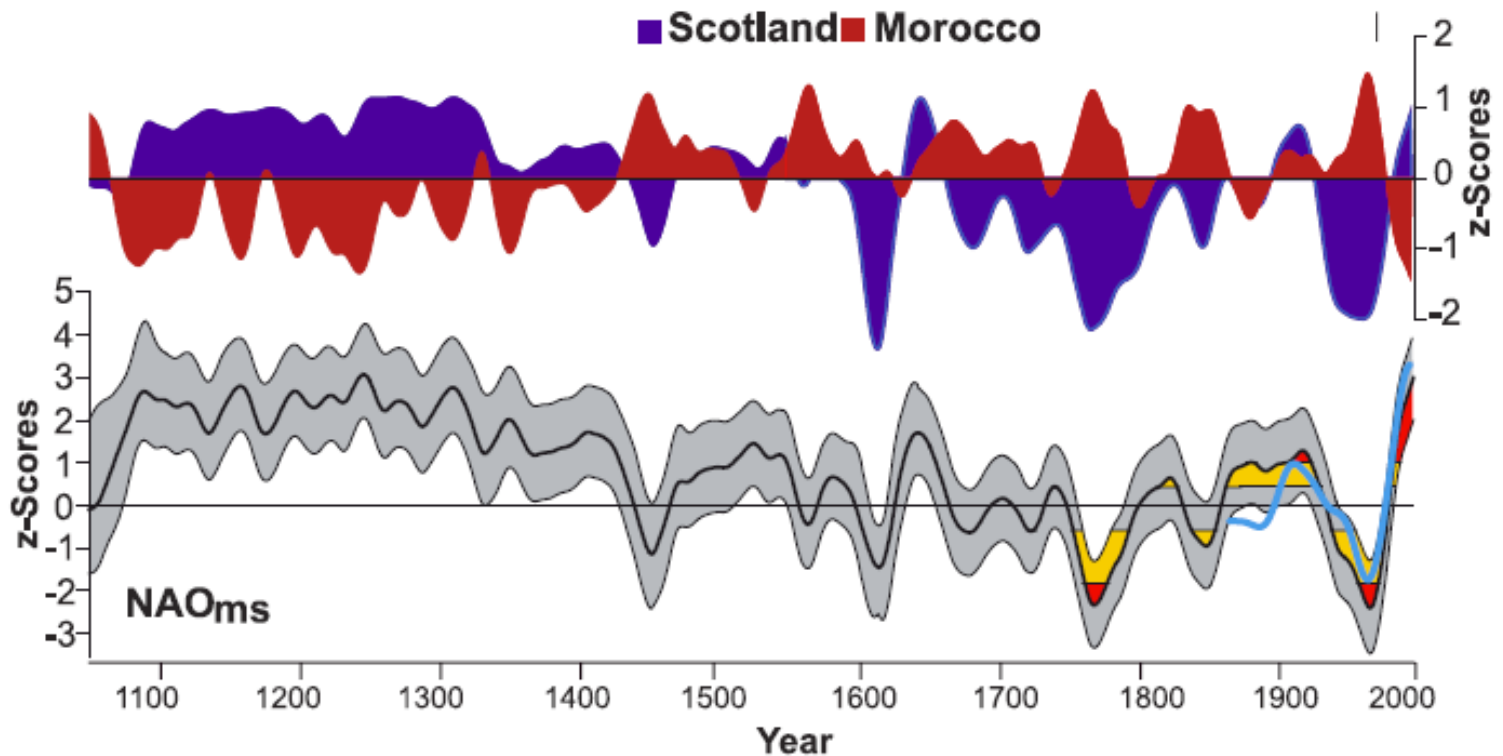
Precipitation (color) and pressure (lines) for NAO+ state



□ Classical station to determine NAO (Island-Azores-Portugal)

▲ Location of reconstruction by Trouet (Scotland-Marocco)

# NAO reconstructed from two proxy locations

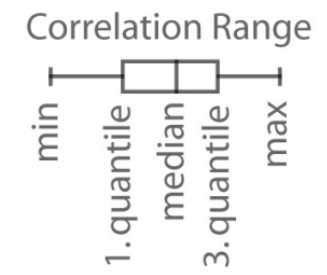
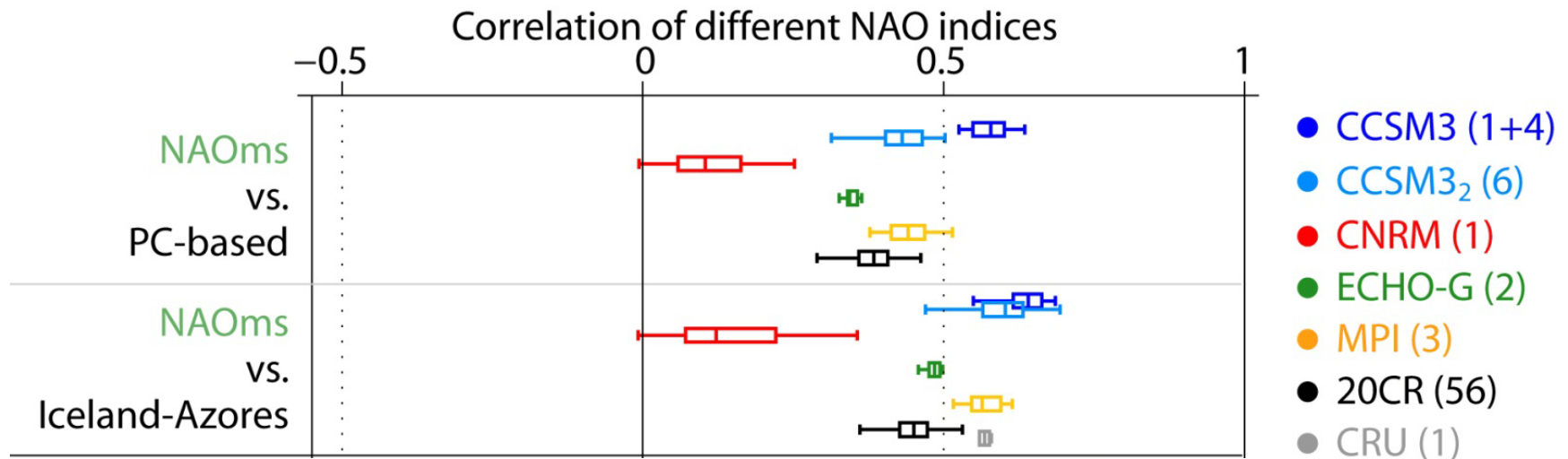


Proxy-based  
Precipitation

Proxy-based  
NAO\_ms

Trouet et al. (2009)

# Correlation between «two location-index» and PC-EOF index or Iceland-Azores index as sampled in a range of models and reanalysis data is only around 0.5

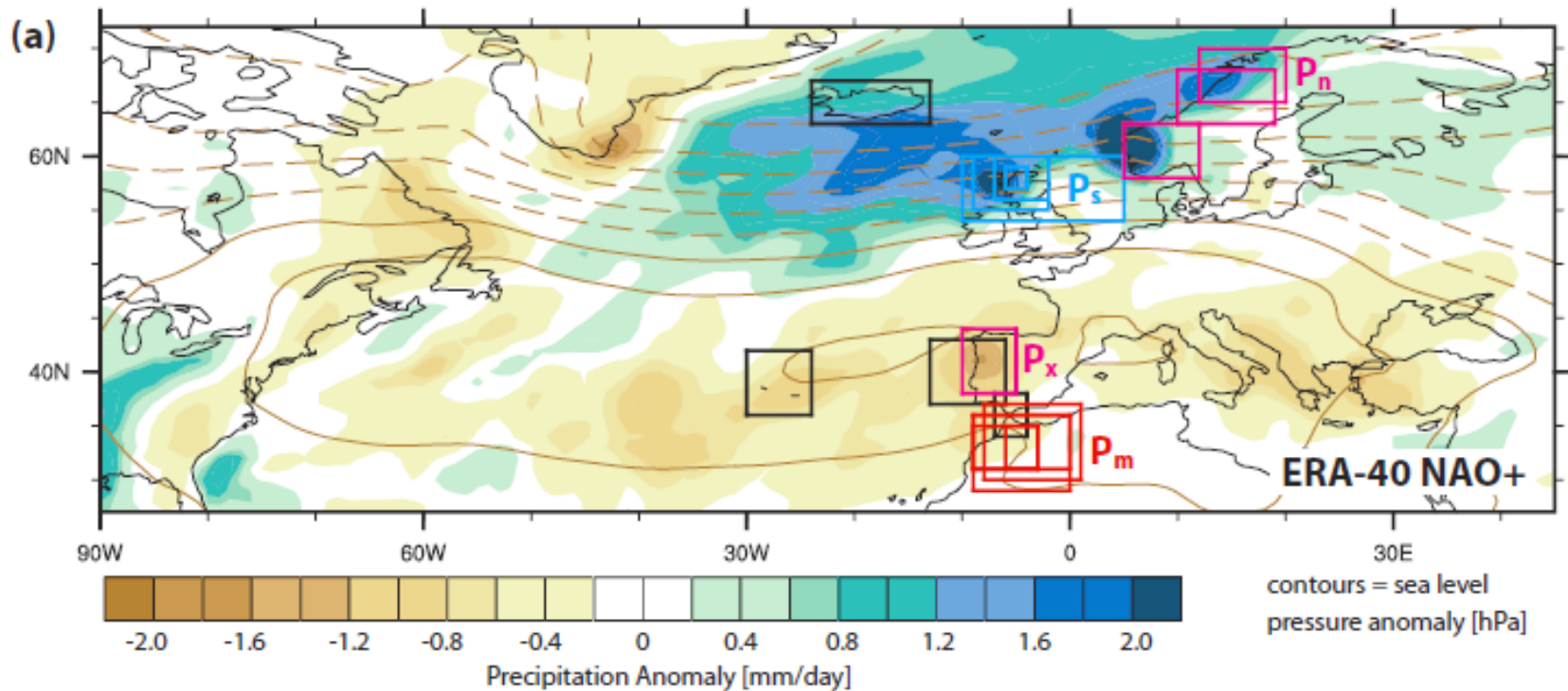




# Adding more proxy locations

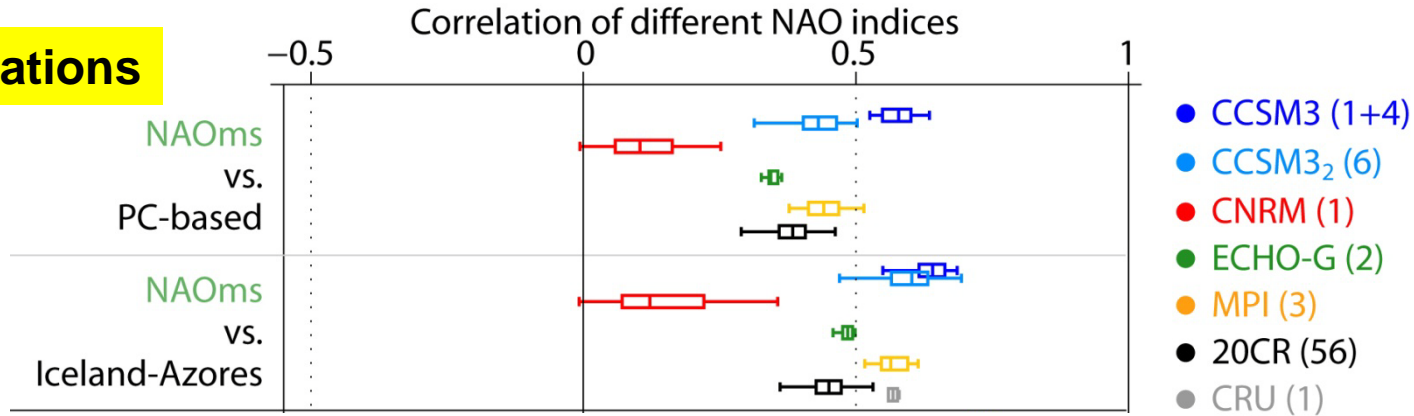
+ Scandinavia

+ Portugal

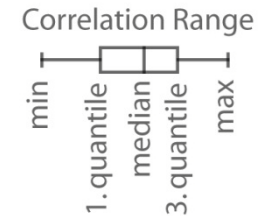


# Adding more proxy locations helps

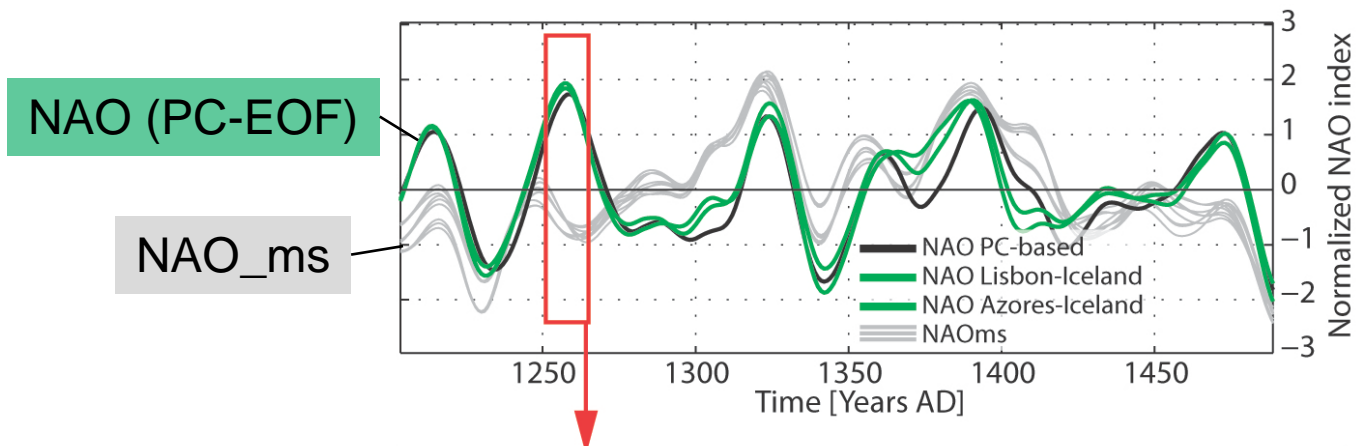
## Two locations



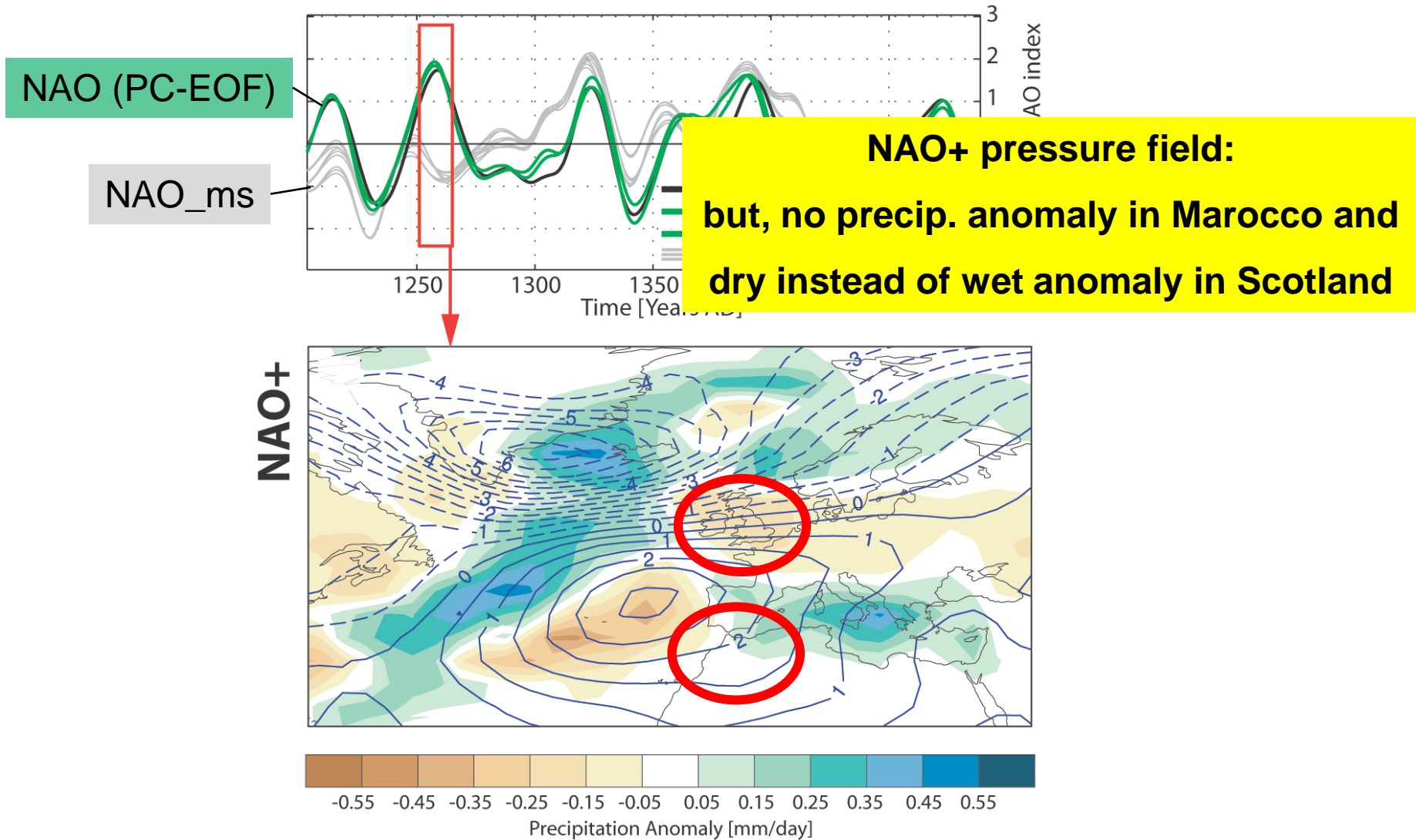
## Four locations



# Problem from precipitation anomalies



# Problem from precipitation anomalies



## Examples:

- NAO reconstruction based on two proxy locations is not very robust
- Improvements require additional proxy locations
- But, problem remain as precipitation proxies is not pressure field

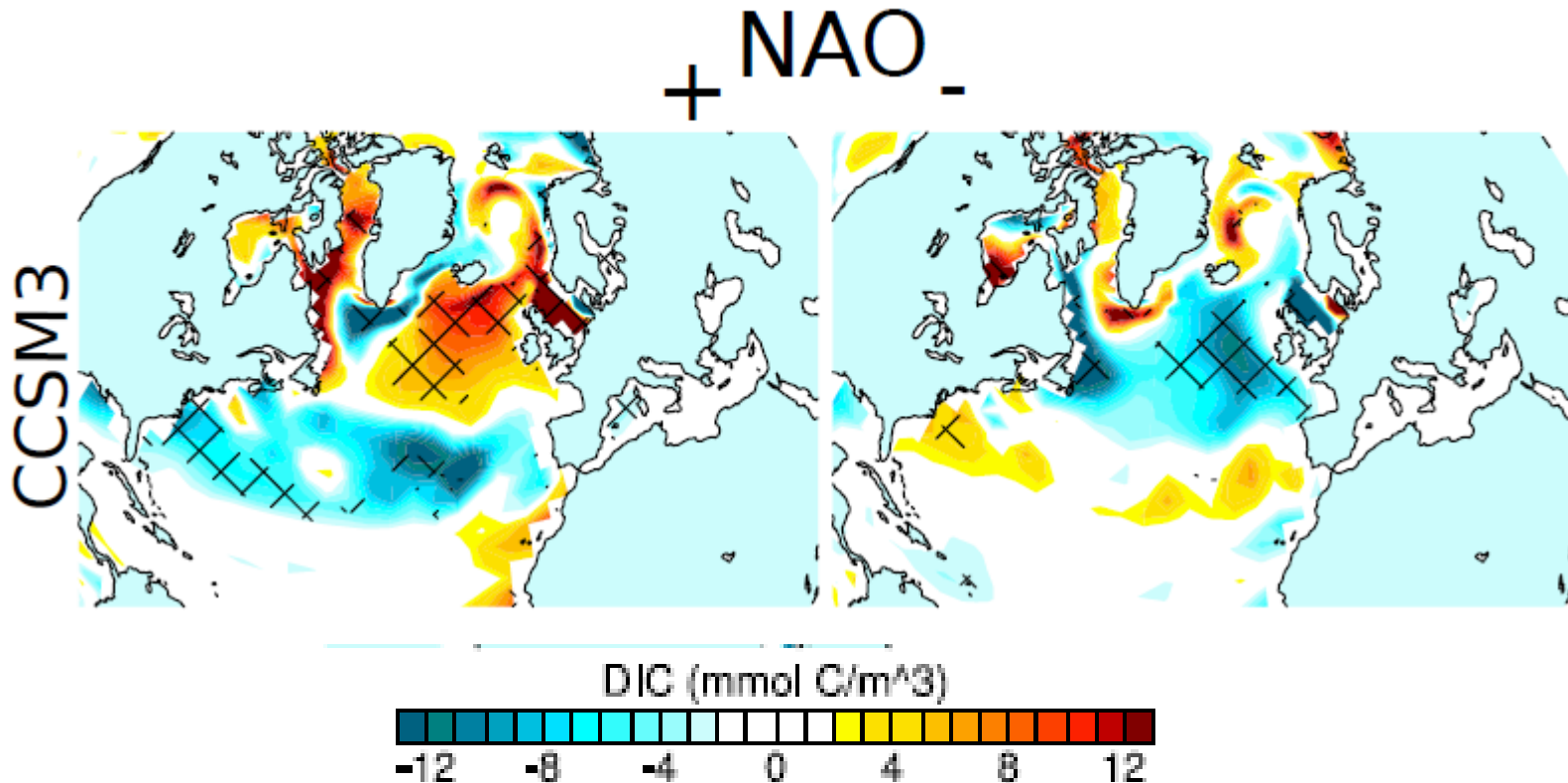
## Example 2:

# NAO and biogeochemical cycles

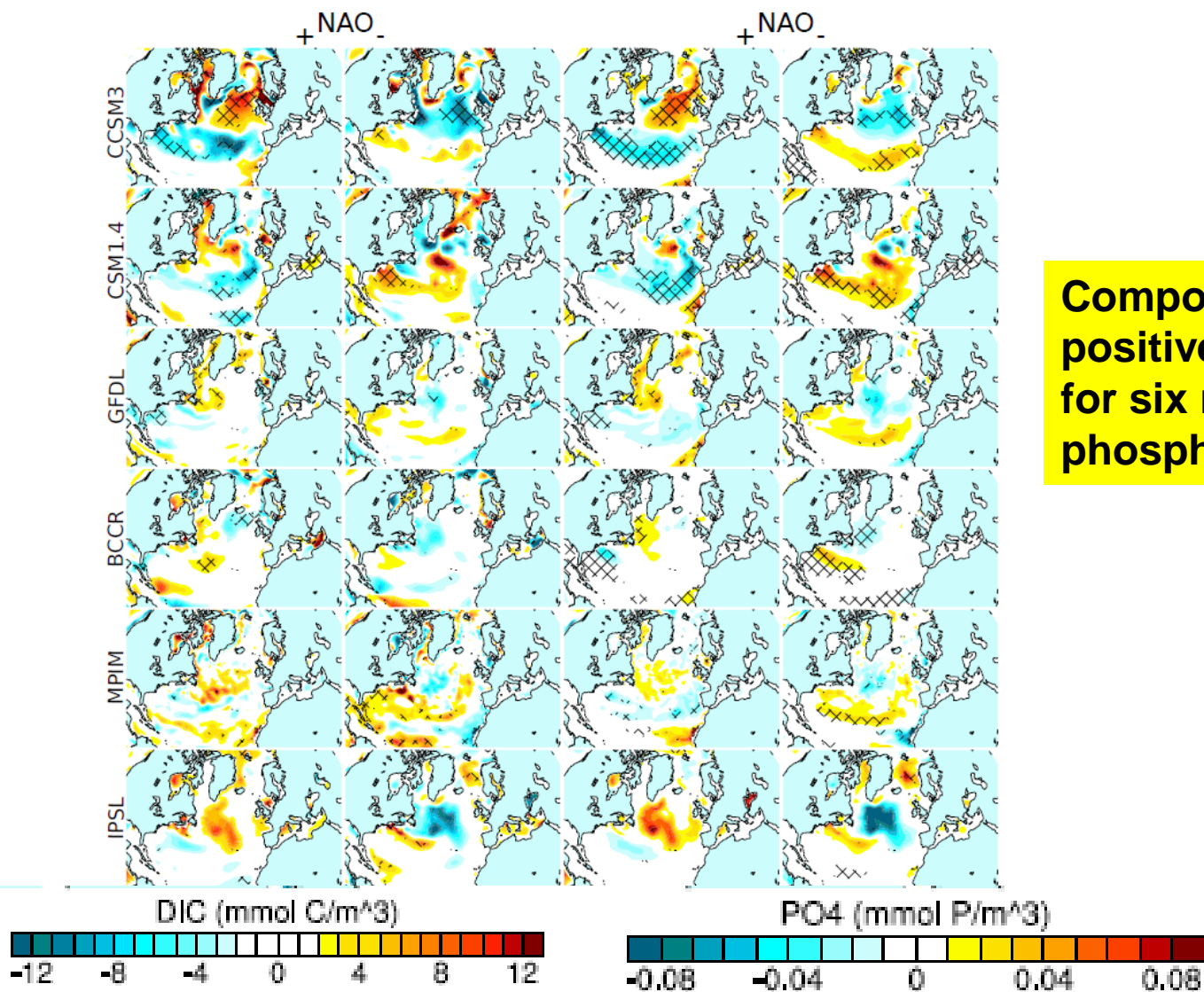
Keller et al, in prep.

# NAO affects Biogeochemical Cycles

**Composite anomaly patterns  
of DIC for positive/negative  
NAO (DJF)**



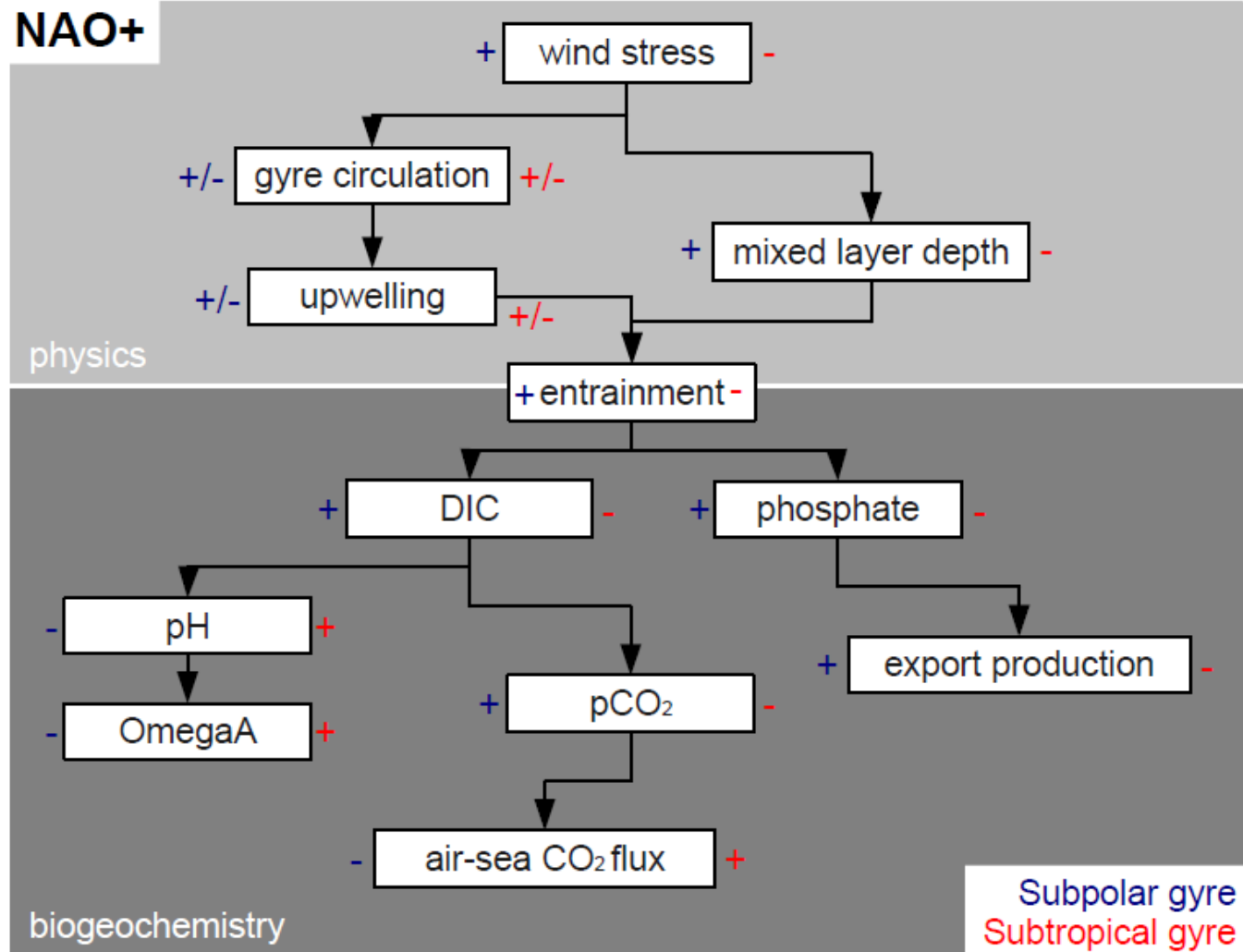
# NAO affects Biogeochemical Cycles



**Composite pattern for positive/negative NAO (DJF) for six models and DIC and phosphate**



# Mechanisms for positive phase



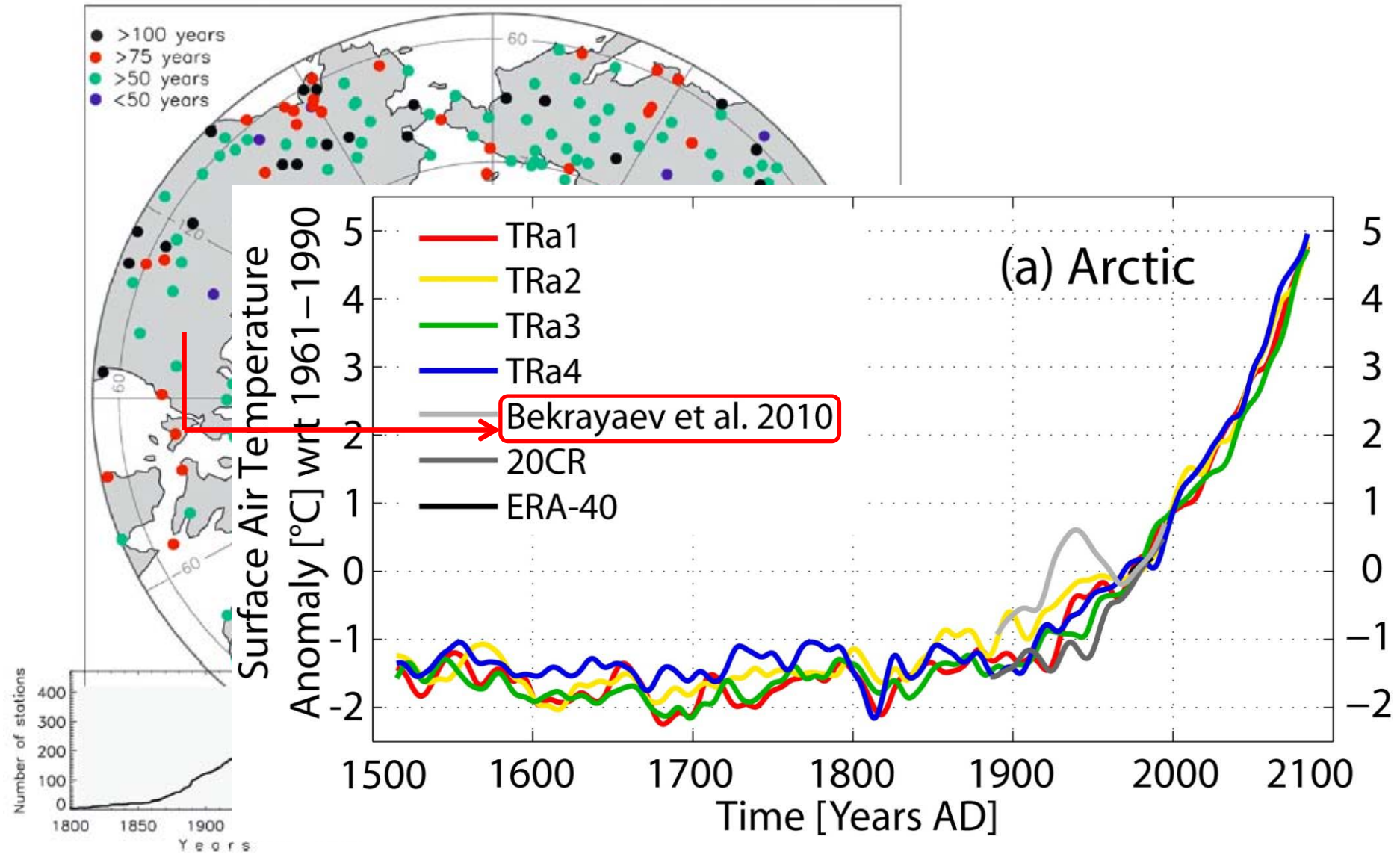
- NAO causes substantial variability in biogeochemistry
- Response in the model is driven by local changes in wind stress – upwelling – nutrient entrainment
- Large scale horizontal transport appears to play little role for NAO associated anomalies

## Outlook:

- CESM simulation from 850-2100 AD; all components in  $\sim 1^\circ \times 1^\circ$  resolution and interactive carbon cycle

Thank you

# Example 1: polar regions, temperature



# Example 1: polar regions, freshwater

Arctic Basin Freshwater Budget  
 (units: km<sup>3</sup>)

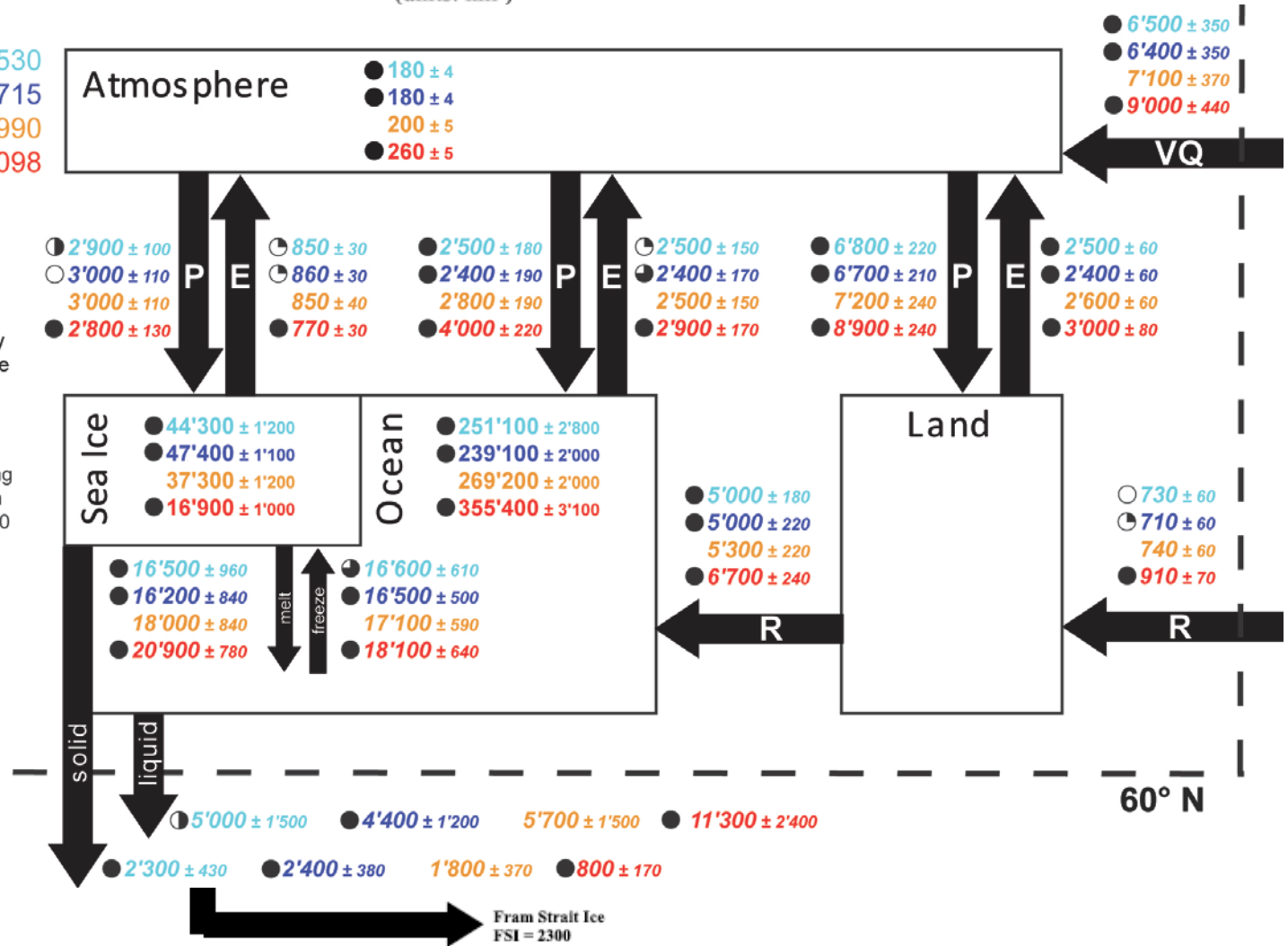
IC: 1500-1530  
 MM: 1685-1715  
 PD: 1960-1990  
 FP: 2068-2098

flux in km<sup>3</sup> yr<sup>-1</sup>  
 inventory in km<sup>3</sup>

reference salinity  
 for ocean storage  
 and transport  
 = 34.88 g kg<sup>-1</sup>

members differing  
 significantly  
 from period 1960-1990

- 4 of 4
- 3 of 4
- 2 of 4
- 1 of 4
- 0 of 4



# Example 1: polar regions, freshwater

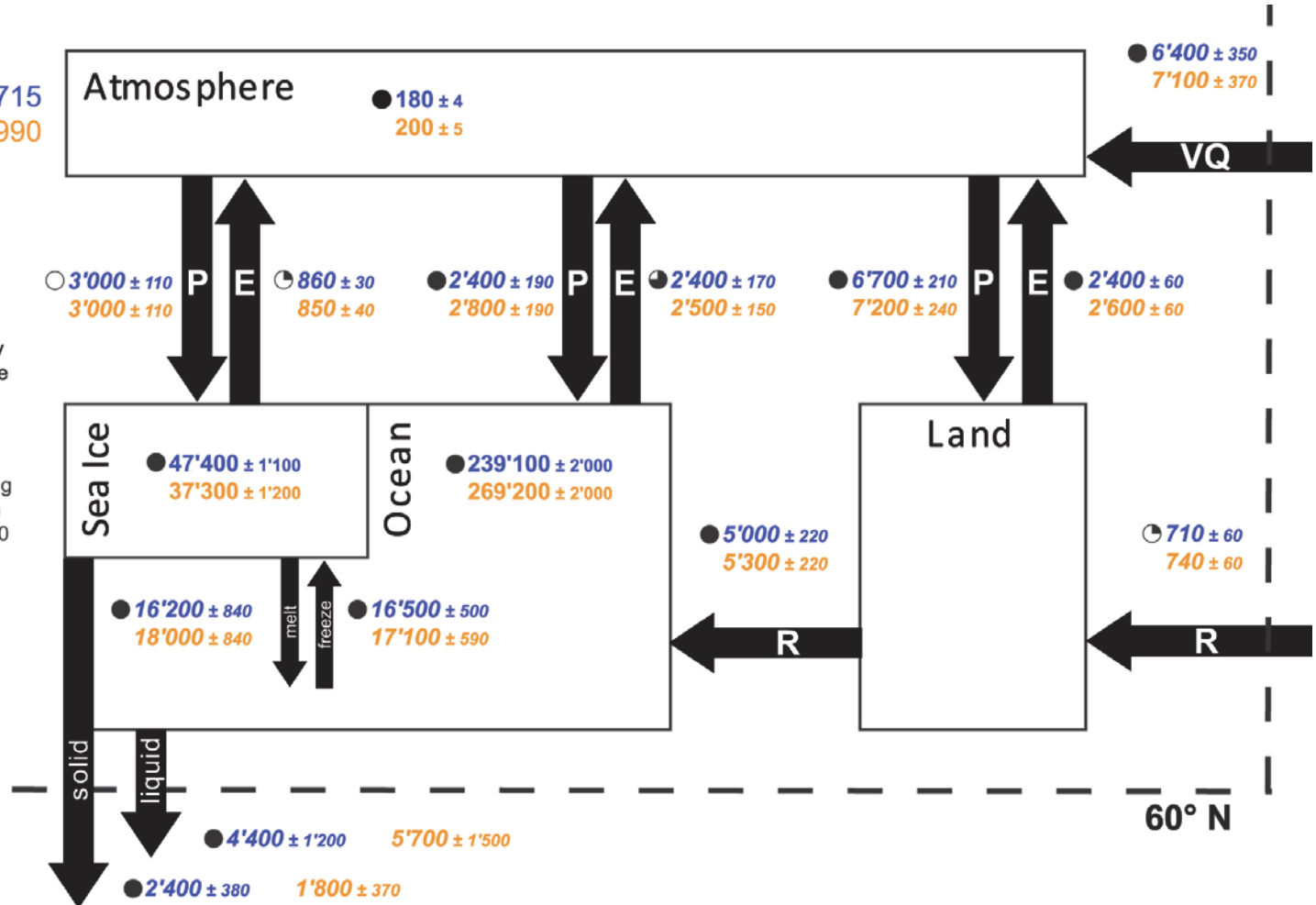
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