

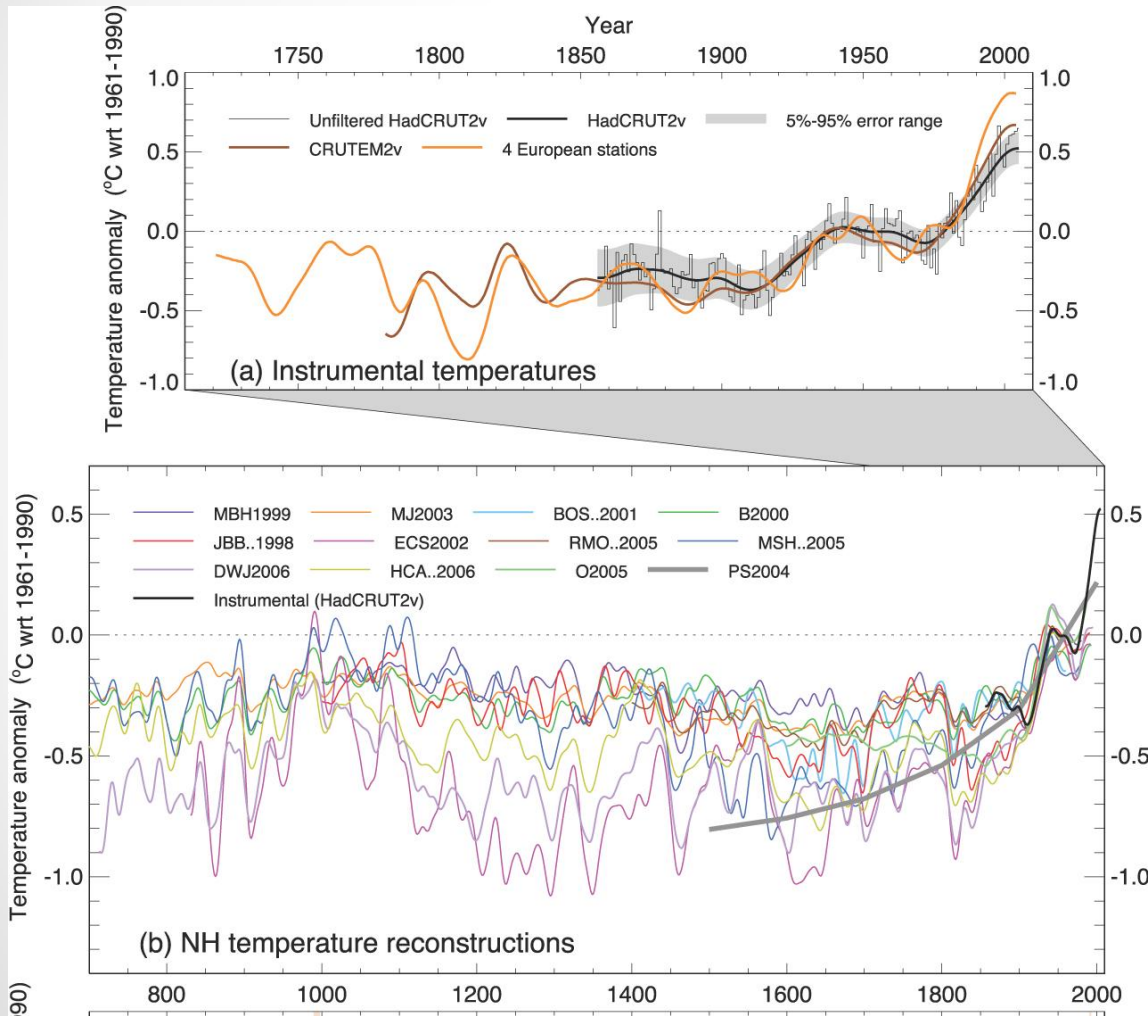


Tree rings, climate and carbon indicators over the past millennium

V. Daux



Is the current climate trend unprecedented?

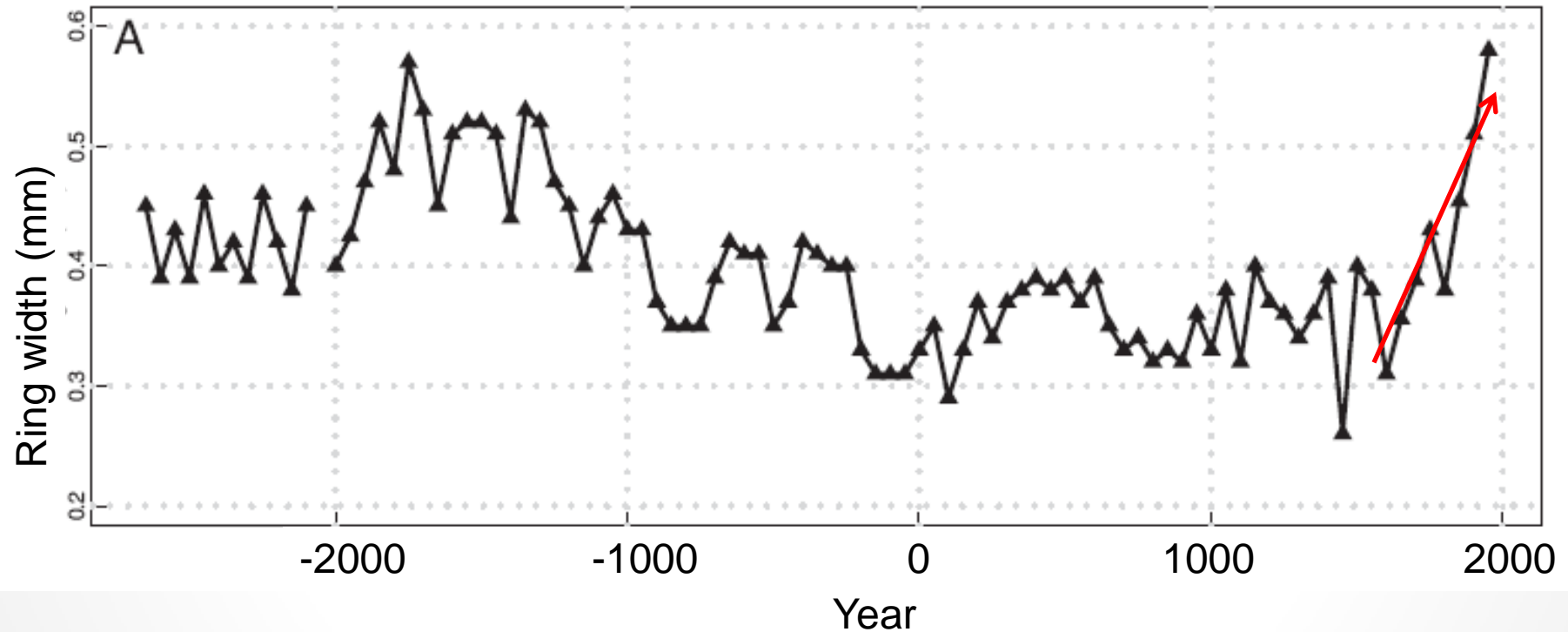


Warming of the climate system is unequivocal at the scale of the last 250 years

Natural/man induced variability?
 → need for several centuries-long high resolution proxy series



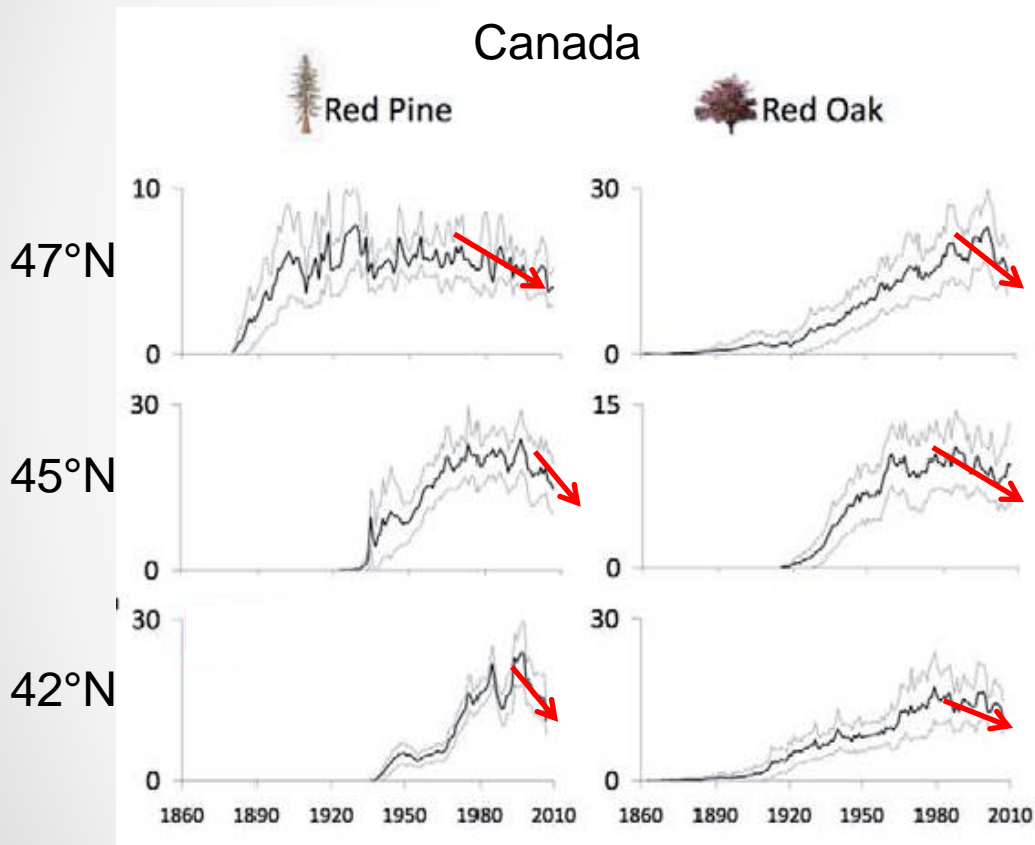
Carbon storage : Are trees growing faster?



Salzer et al., PNAS, 2009



Carbon storage : Are trees growing faster?



Unexpected tree growth decline

→ Divergence between climate and tree-growth

What about carbon stocks under climate change?



Tree-rings parameters
width, wood density, $\delta^{13}\text{C}$, $\delta^{18}\text{O}$

Data  Model

- Long series of climate related proxies
- Forest growth

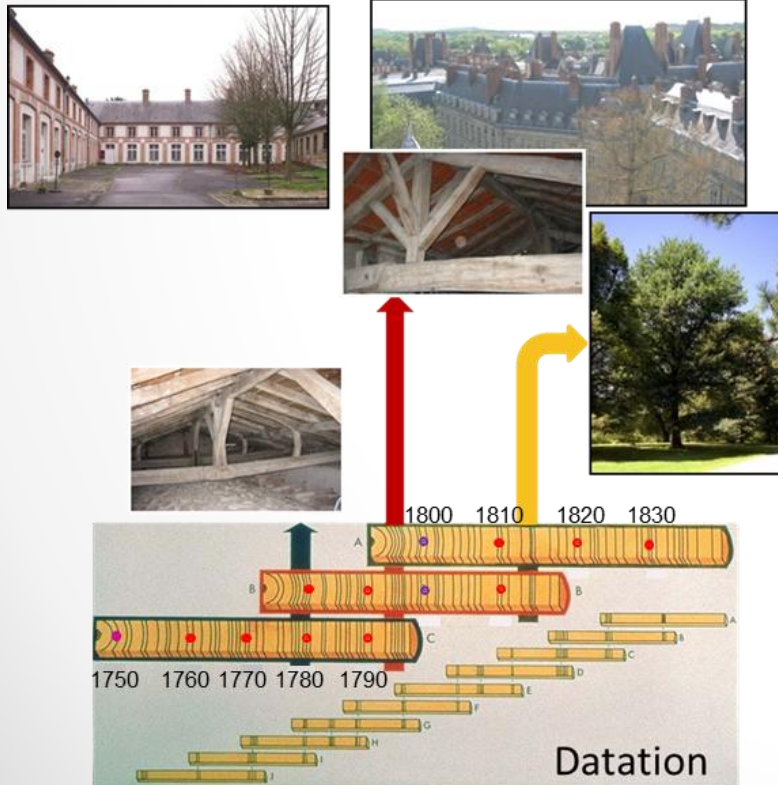
METHODOLOGY



Inter-annual
variation
recorded in rings



Long chronologies at yearly resolution



Cutting +
milling



Cellulose extraction

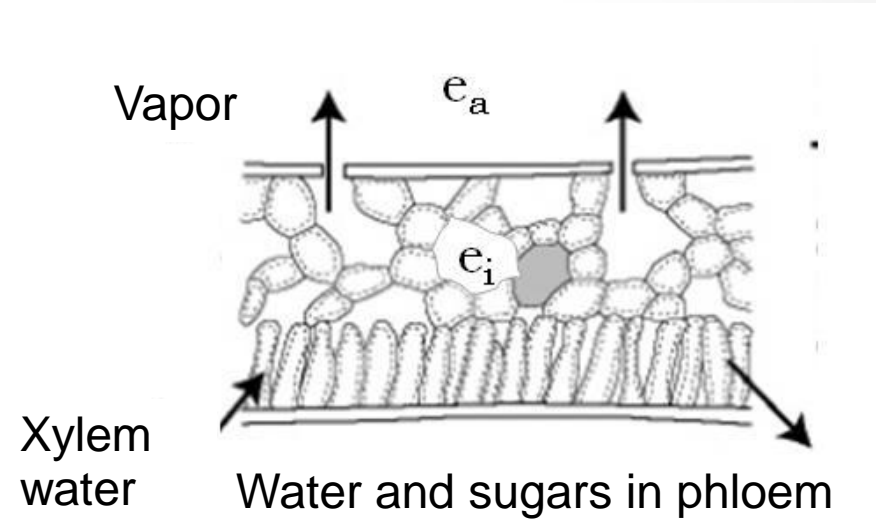
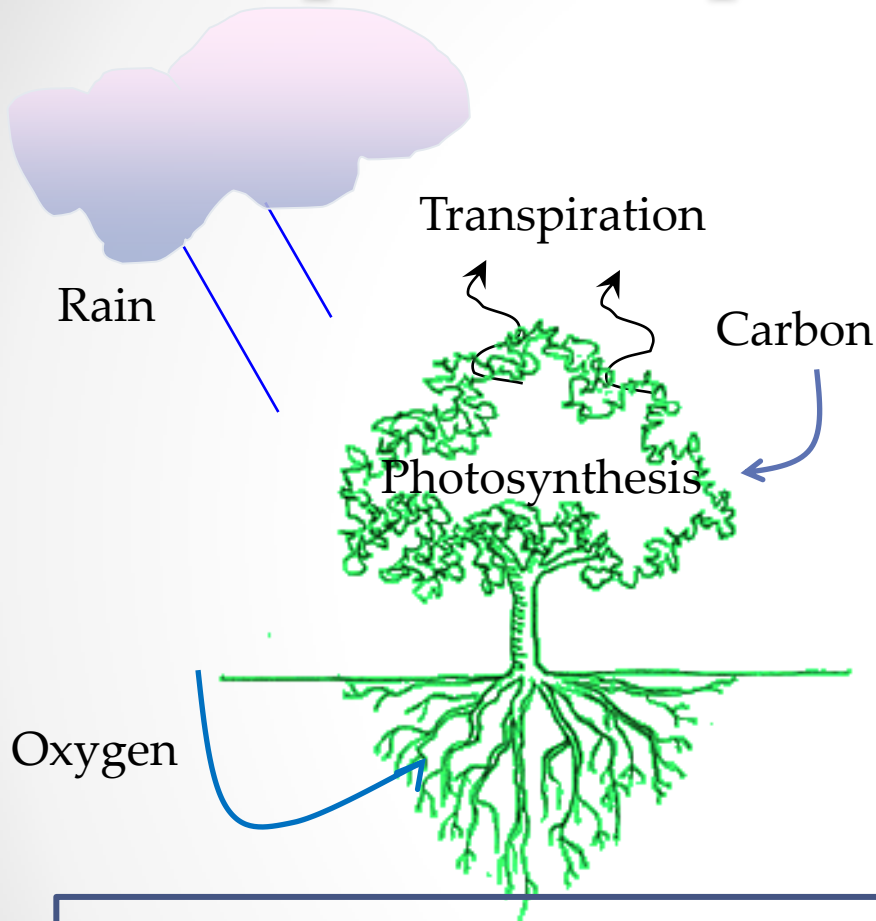


Mass spec.
analysis





Isotopic composition of tree cellulose



$\delta^{18}\text{O}_{\text{rain}}$ (temperature, air mass origin, etc)

Transpiration (temperature, relative humidity, etc)

→ $\delta^{18}\text{O}_{\text{cellulose}}$

Stomatal conductance (water supply, temperature)

Assimilation rate (insolation, temperature)

→ $\delta^{13}\text{C}_{\text{cellulose}}$



Methodology

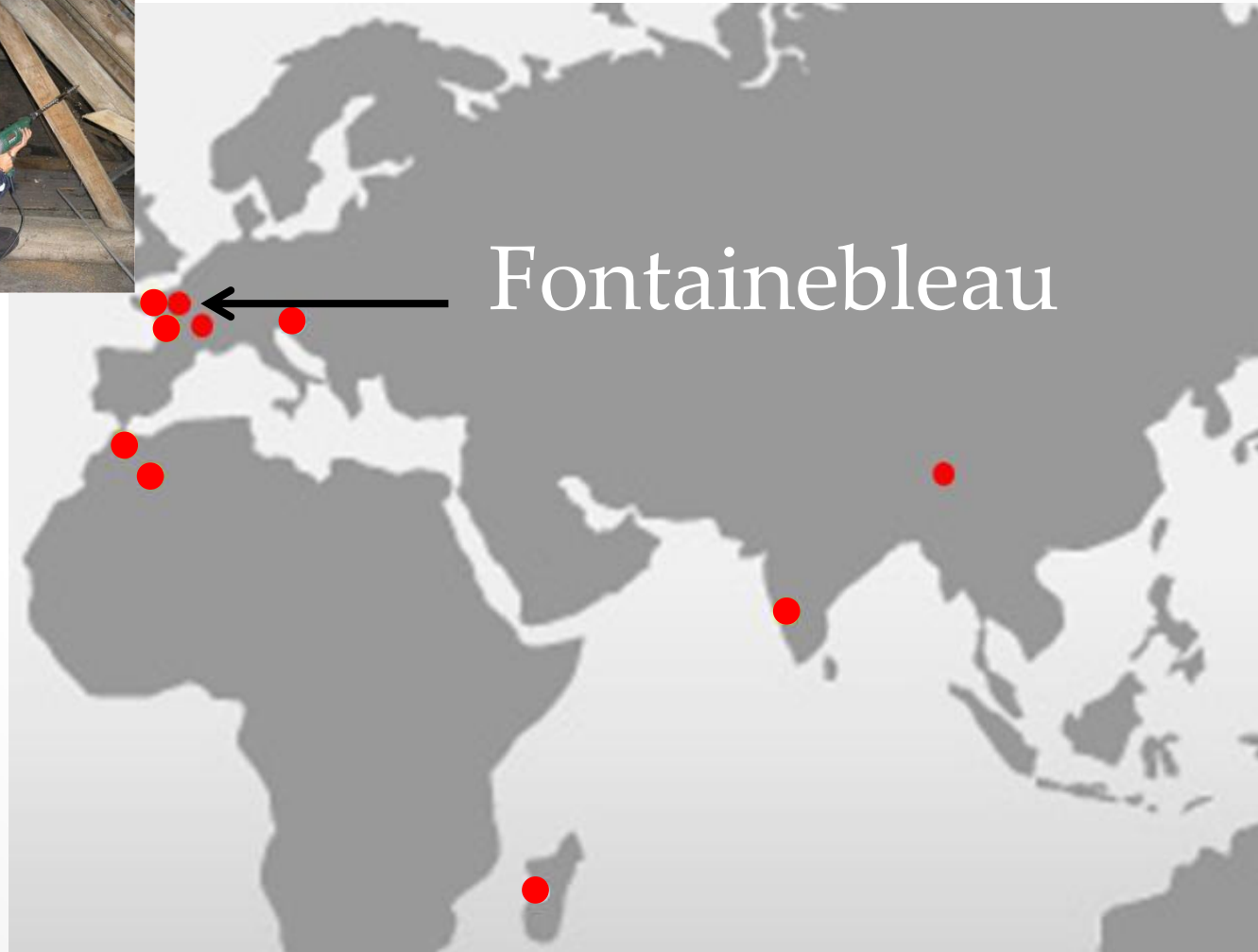


Sites location



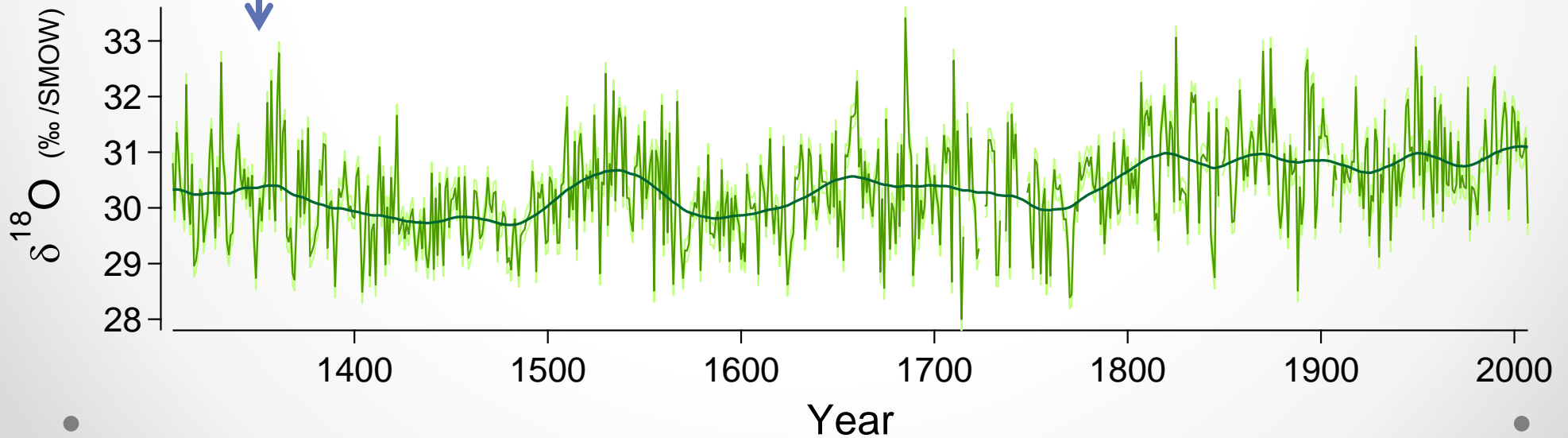
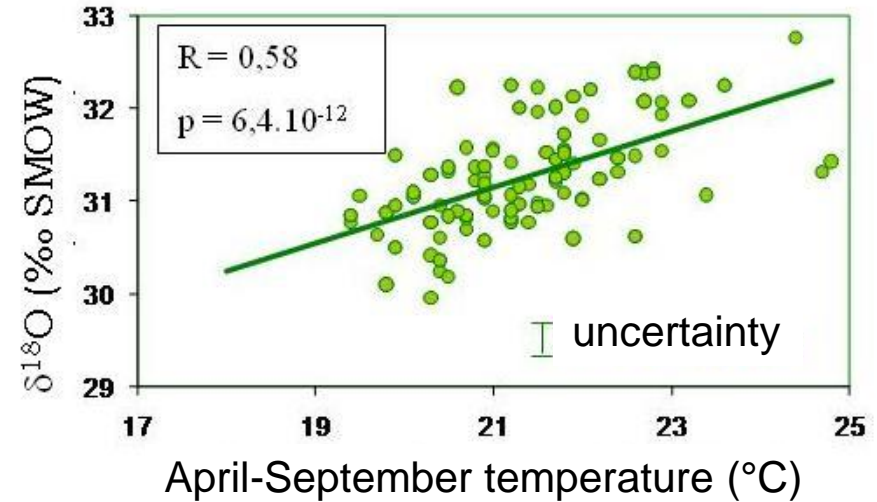


Methodology





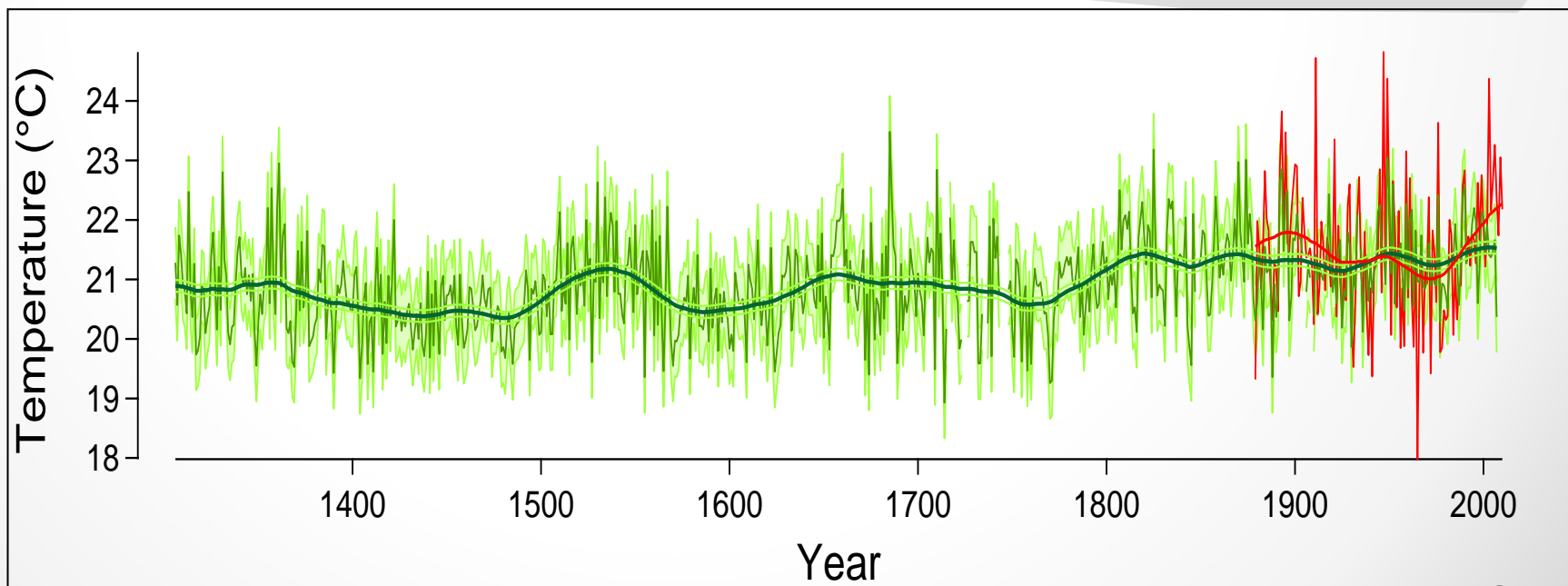
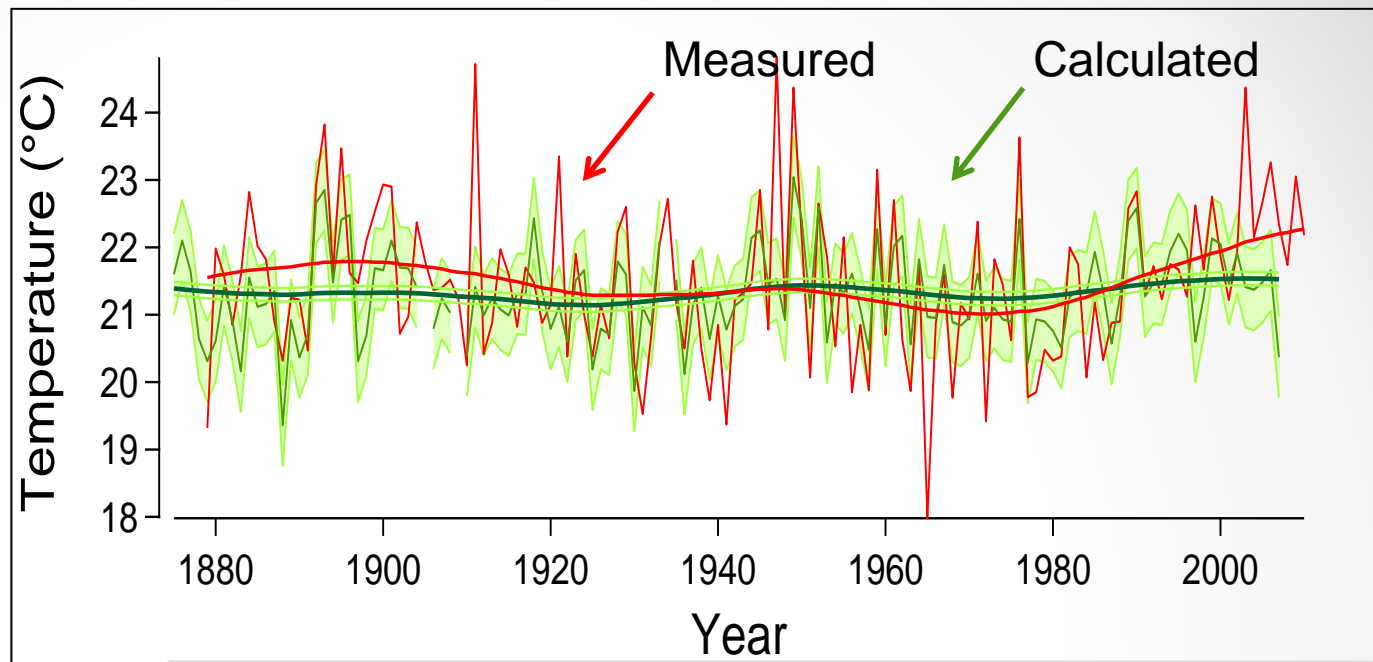
Reconstructing spring-summer temperature in Northern France (Fontainebleau)





Fontainebleau

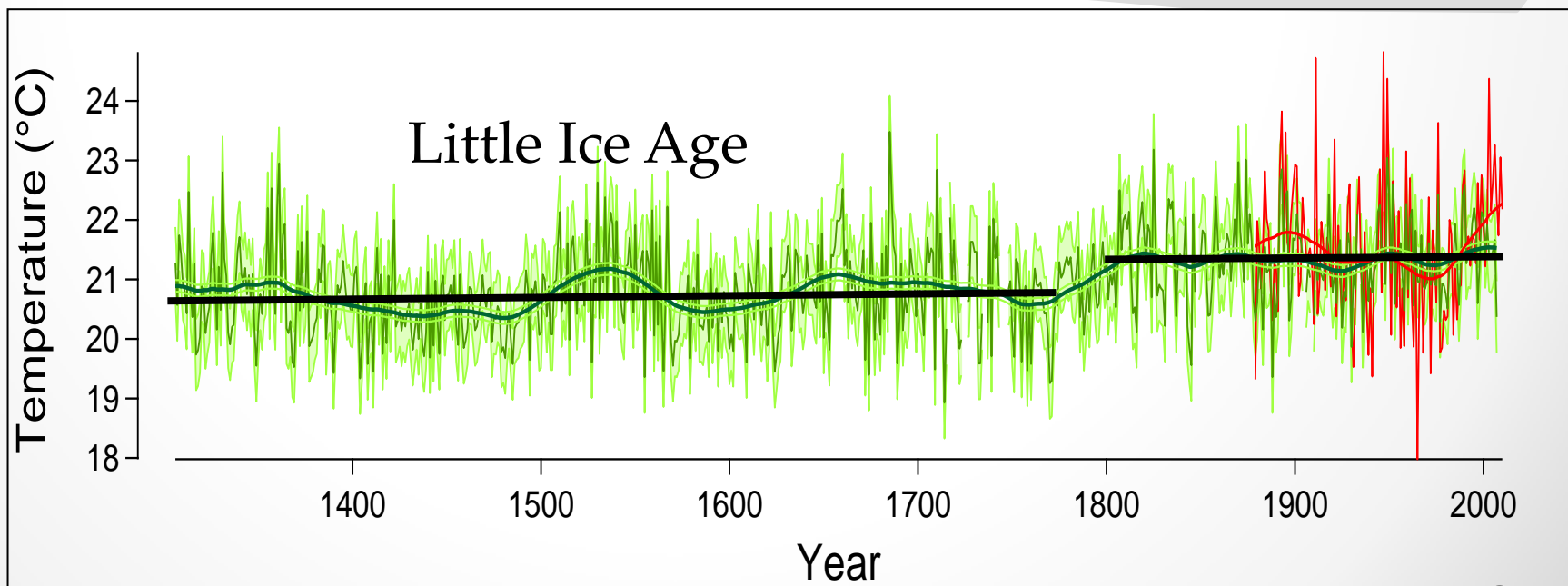
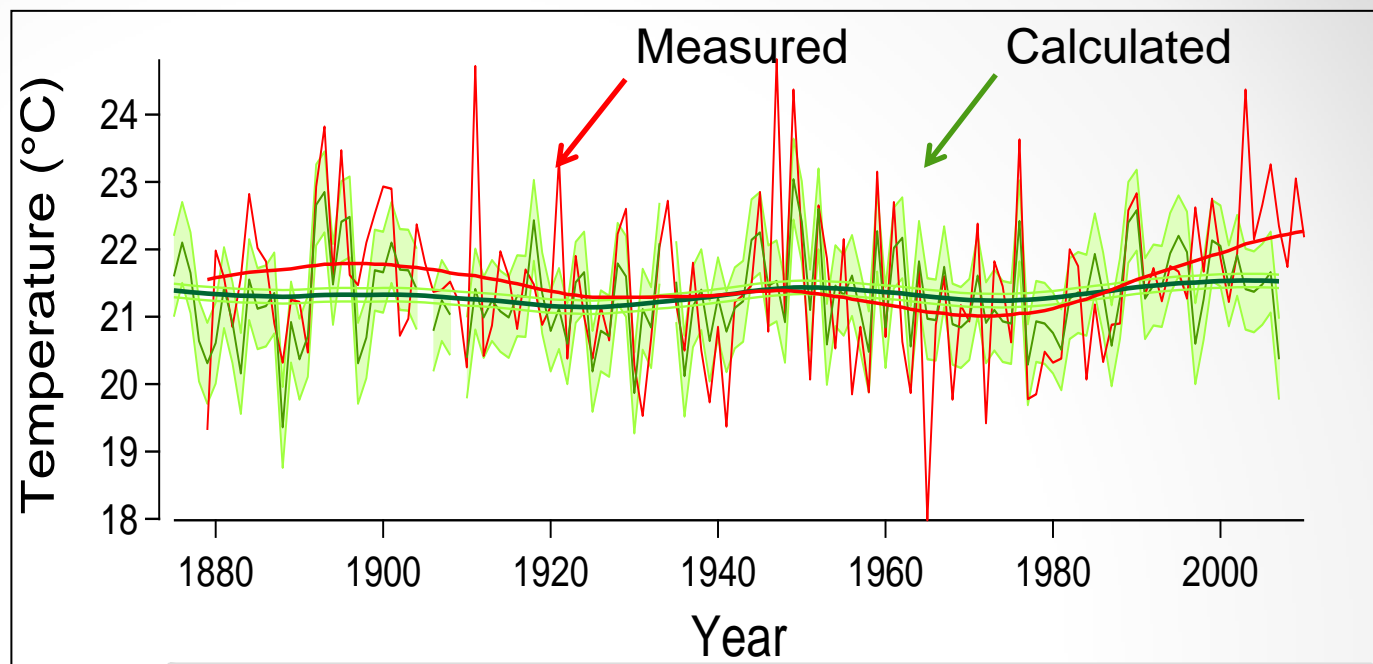
Measured /
reconstructed
temperature :
 $R=0.6$





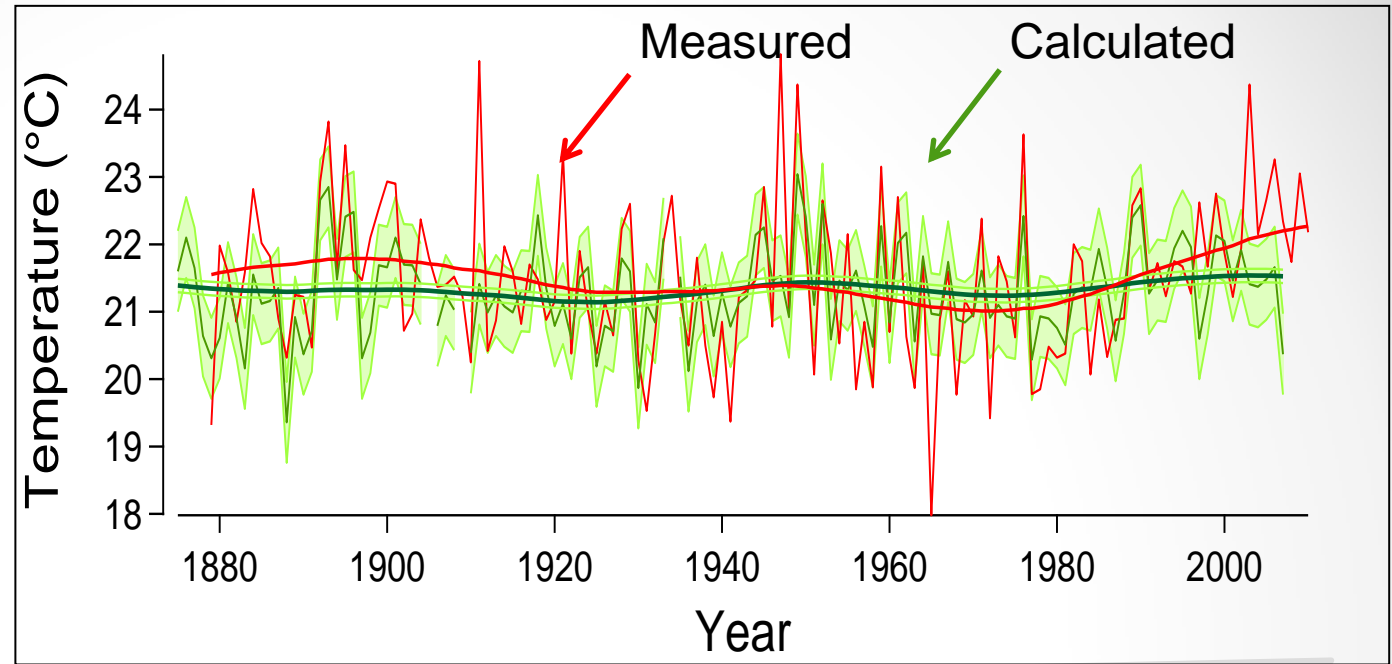
Fontainebleau

Measured /
reconstructed
temperature :
 $R=0.6$

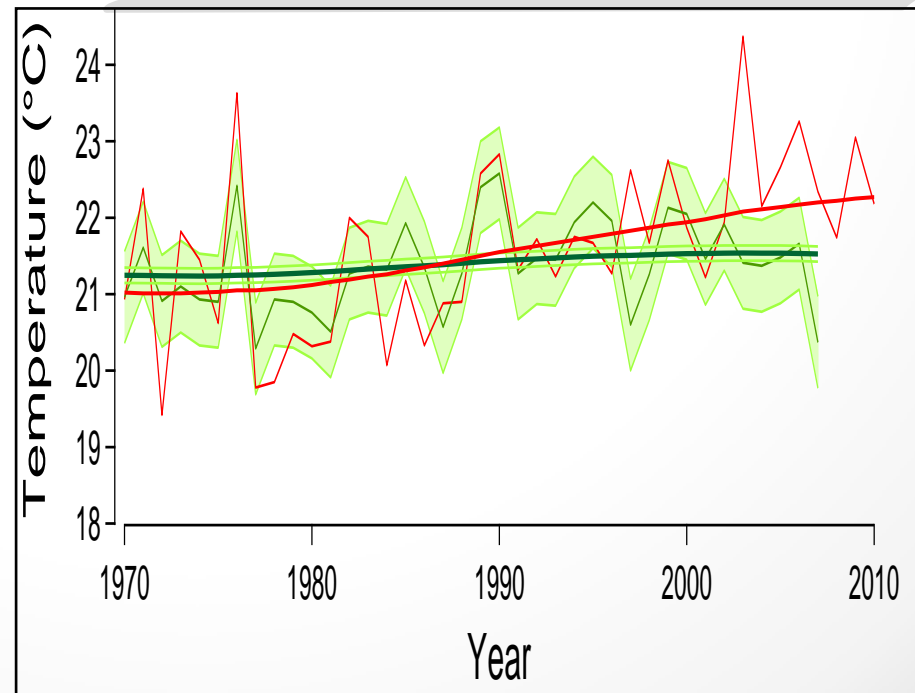




Fontainebleau



Divergence between isotopic signature and climate in recent decades





Orchidee Model: General Structure

Meteorological forcing

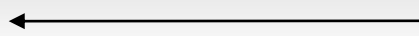
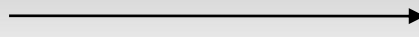
(rain, T°, humidity, CO₂,
incoming radiation...)
+ $\delta^{18}\text{O}$ precipitation
+ $\delta^{18}\text{O}$ water vapor
+ $\delta^{13}\text{C}$ atmospheric

Prescribed vegetation

SECHIBA

Energy & Water cycles,
photosynthesis

Soil water, GPP,
Surface temperature



LAI, albedo,
Roughness

STOMATE

Vegetation & Soil carbon
Cycles (phenology, allocation)

Output variables

Sensible & latent heat fluxes,
CO₂ flux, net radiation...

+ Oxygen discrimination
+ Carbon discrimination
+ tree-rings width

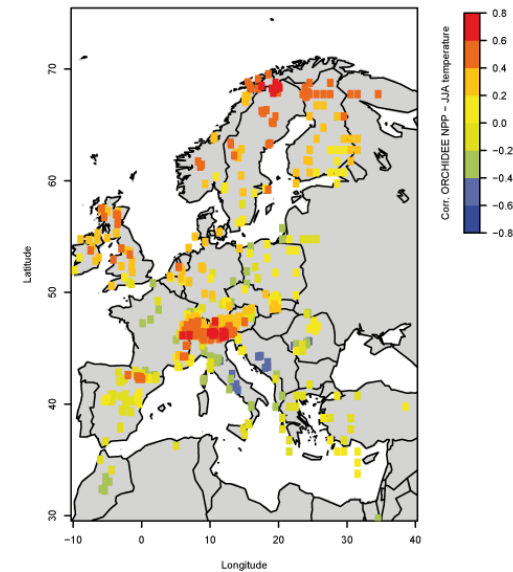
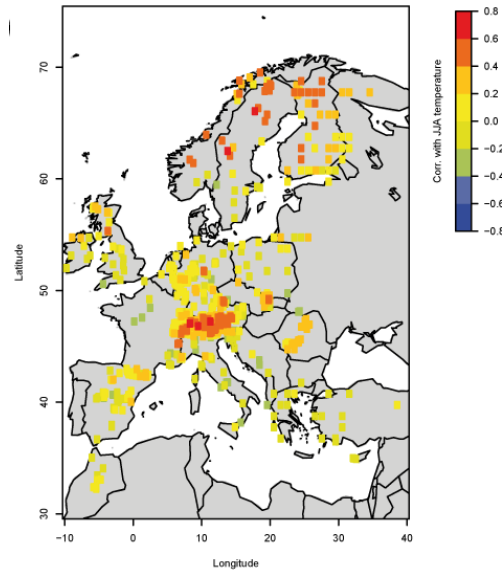


Correlations with climate : similar spatial patterns

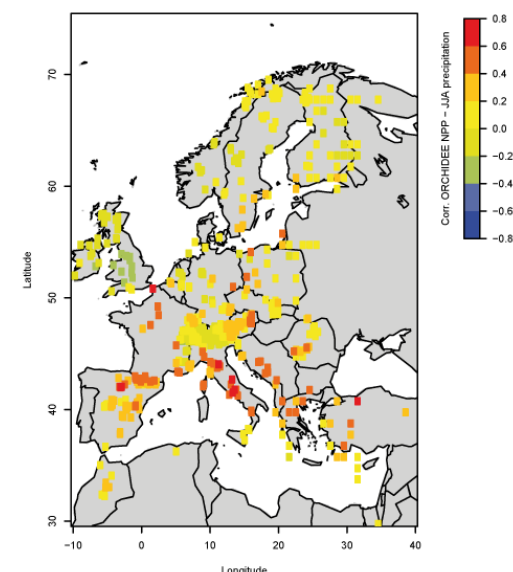
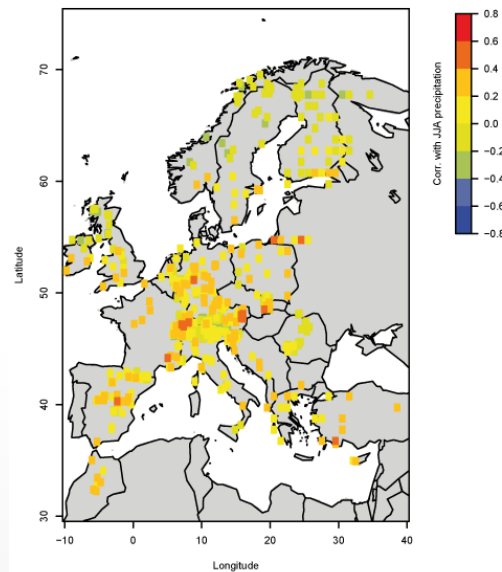
Tree-ring width

Net Primary Prod.
ORCHIDEE

JJA
Temperature



JJA
Precipitation

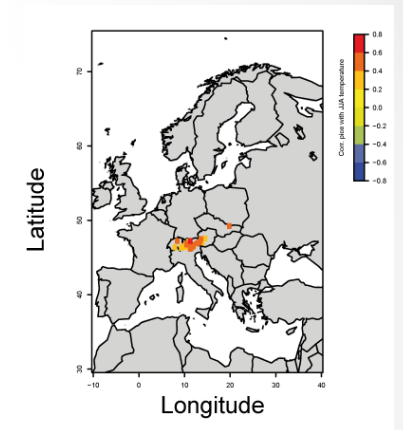
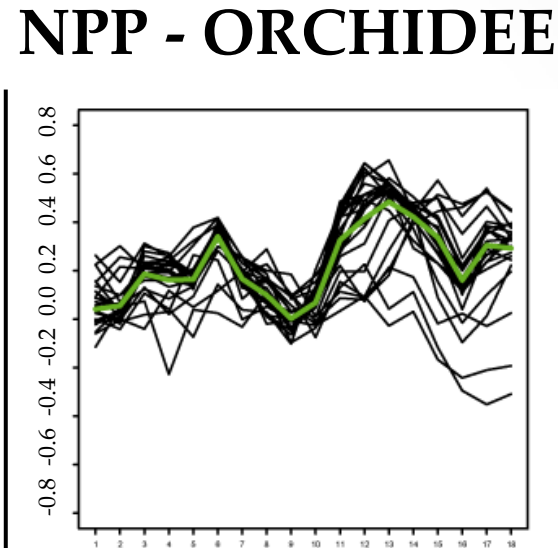
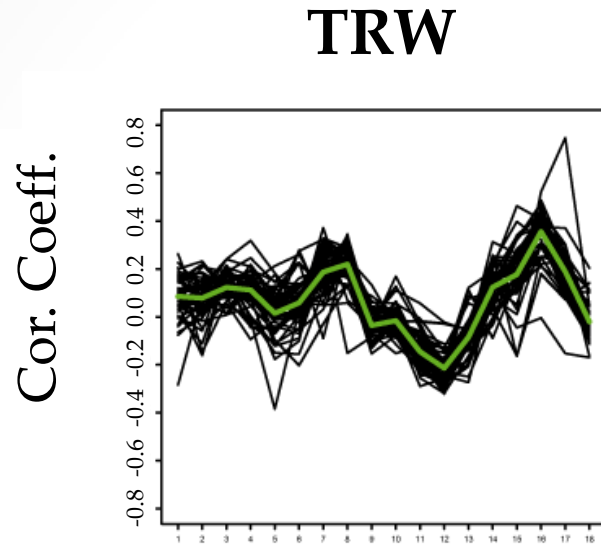


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T. Kun,
O. Bourriaud,
B. Poulter,
D. Frank*

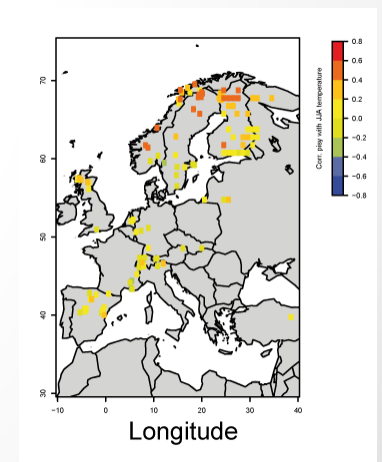
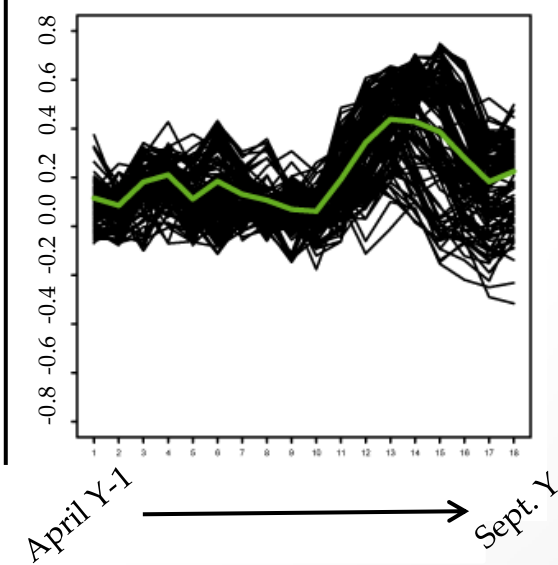
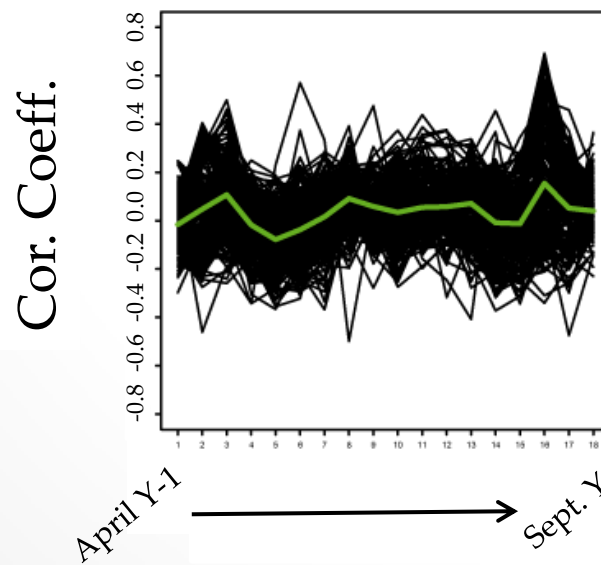


Correlation with monthly temperature

**Pinus
Cembra**



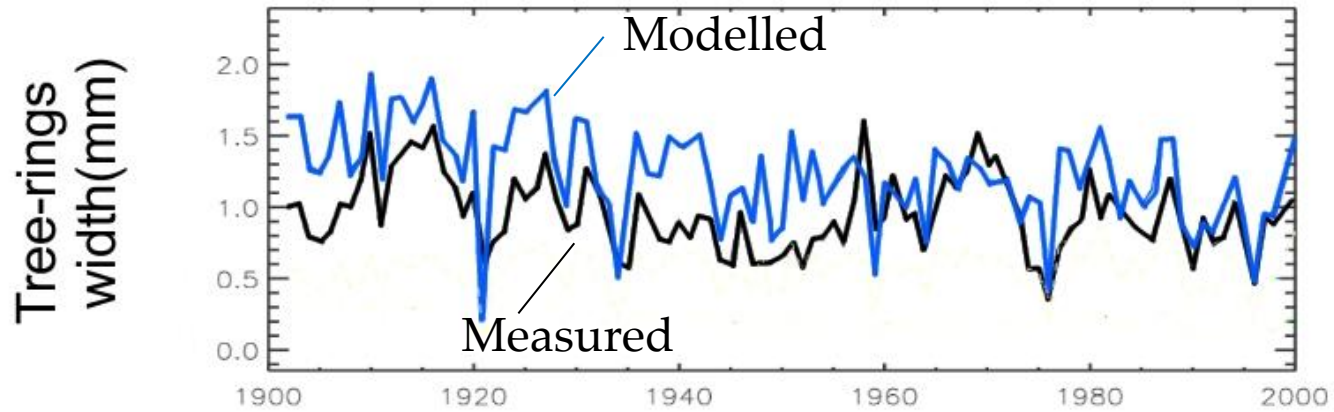
**Pinus
Sylvestris**



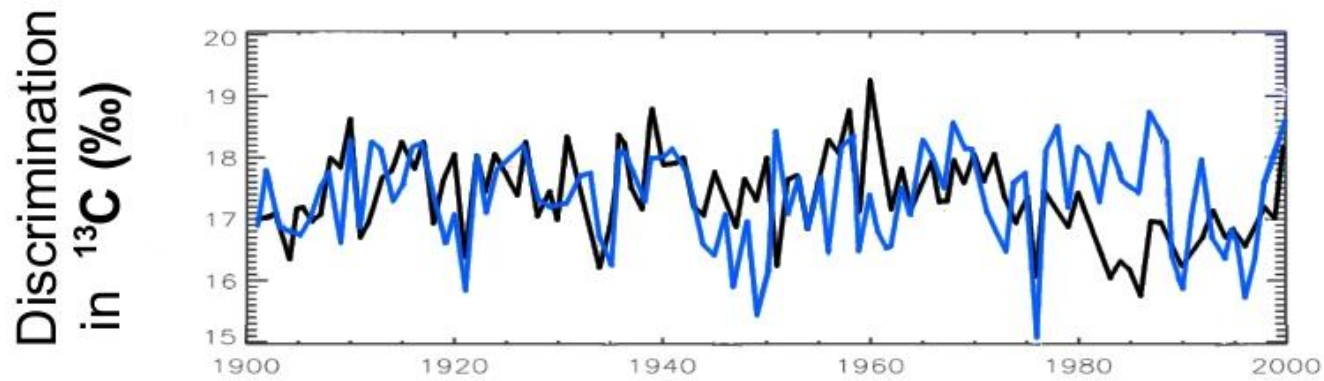
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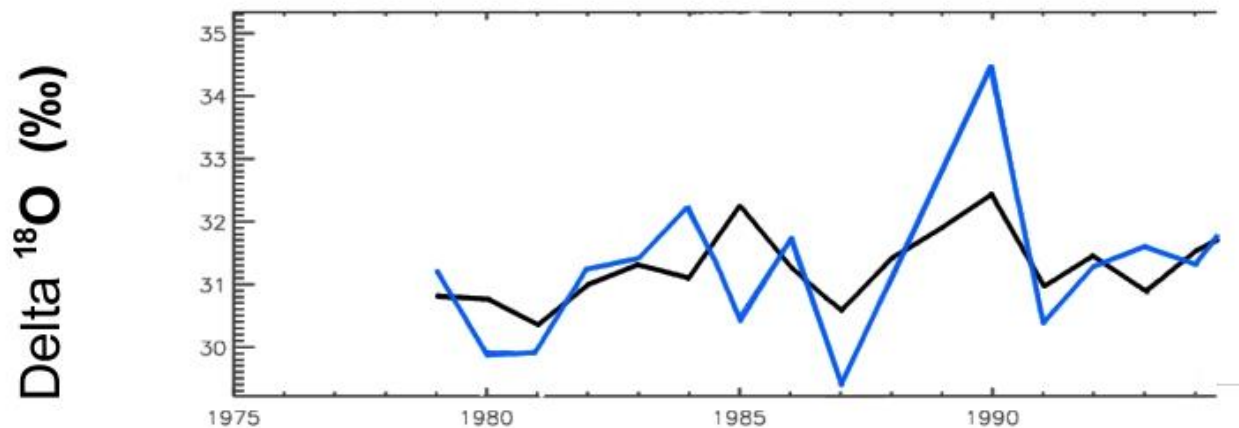
Fontainebleau forest



TRW
 $R=0.62$
 $NSD = 1.28$

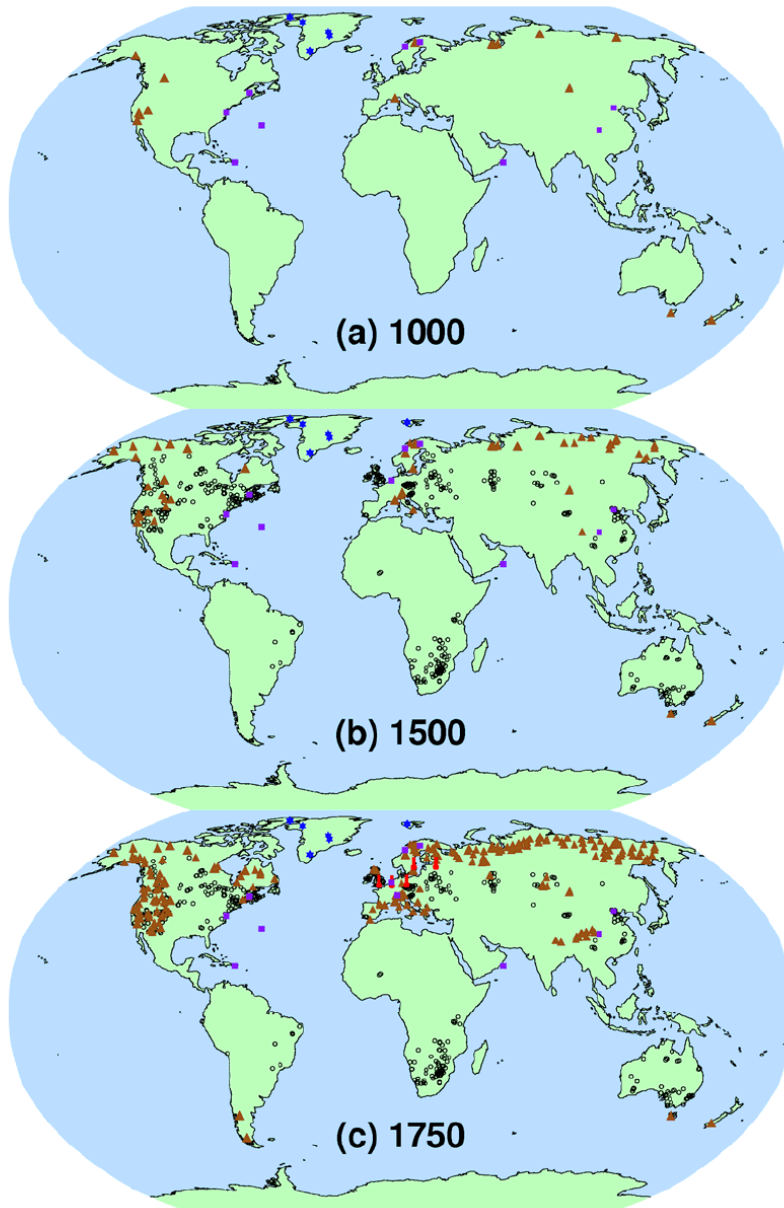


$\delta^{13}C$
 $R=0.35$
 $NSD=1.37$



$\delta^{18}O$
 $R=0.67$
 $NSD=1.44$





Locations of proxy records
with data back to AD 1000,
1500 and 1750

Instrumental: red thermometers
Tree ring: brown triangles
Borehole: black circles
Ice core/ice borehole: blue stars
Other including low-resolution
records: purple squares



Comparison with solar irradiance

49-year running means

