



Sorbonne Paris Cité



Evidence for significant solar signatures in some 20th century geophysical and climatological time series

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Centenary

Majority (consensus?) views
on recent climate change :

- *carbon dioxide is responsible for global warming (greenhouse effect)*
- *the role of the Sun in such variations is weak or negligible*

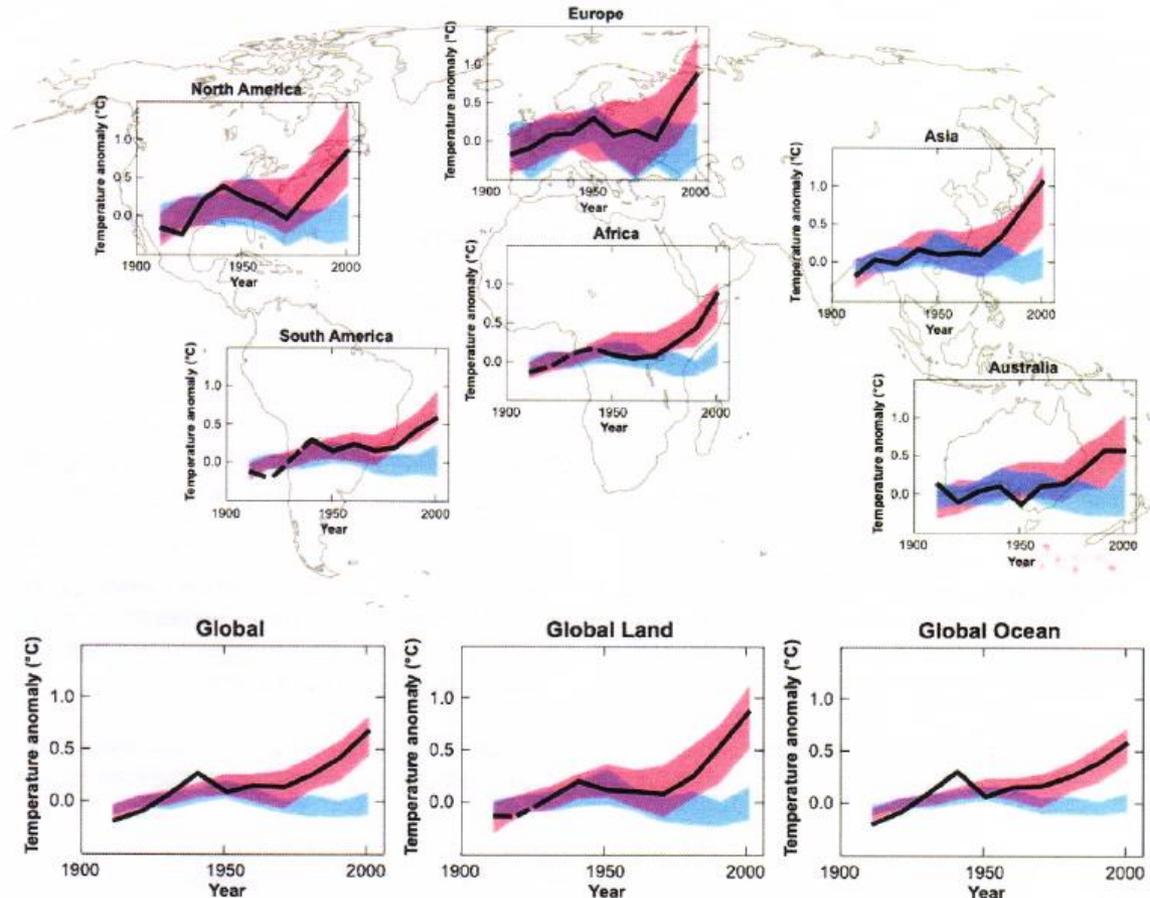
Which observations ?

Global temperature anomalies 1906-2005

Continental
means

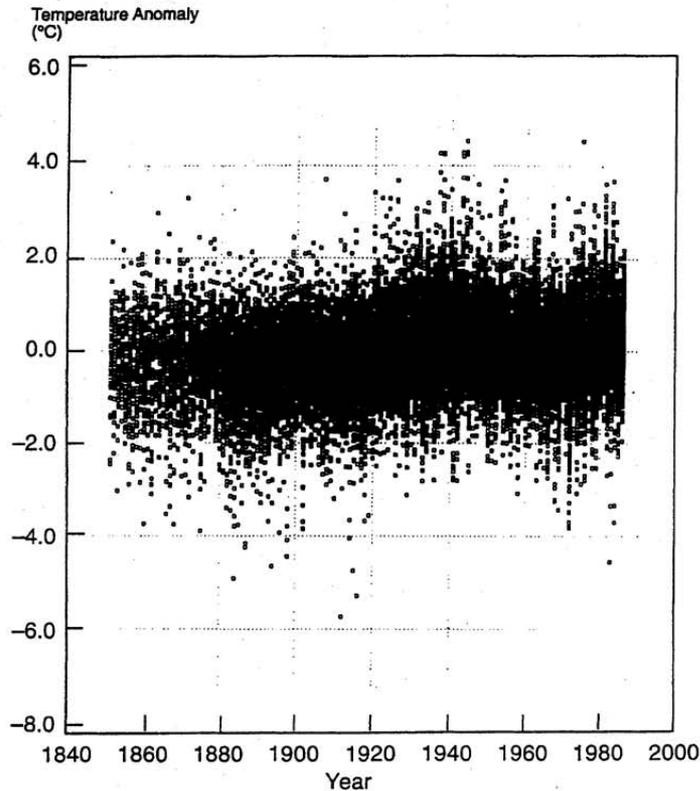
blue = natural
forcings

pink = with
anthropic forcing



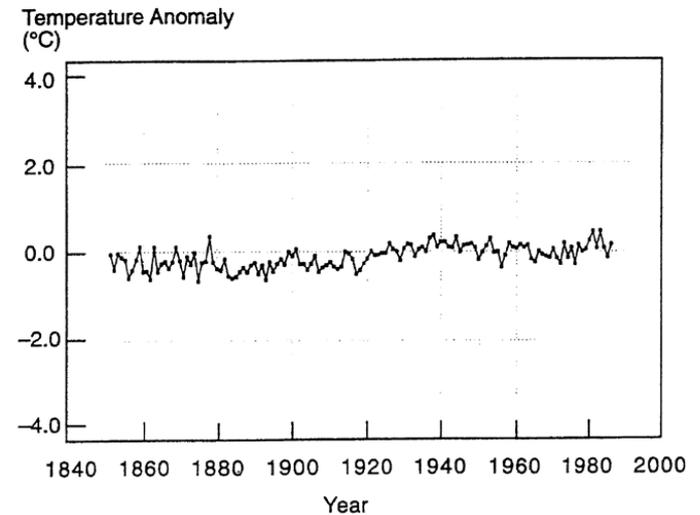
Changes in global surface temperature are very small and quite difficult to determine with certainty

Deviations of Annual Mean Temperature from Long-term Average



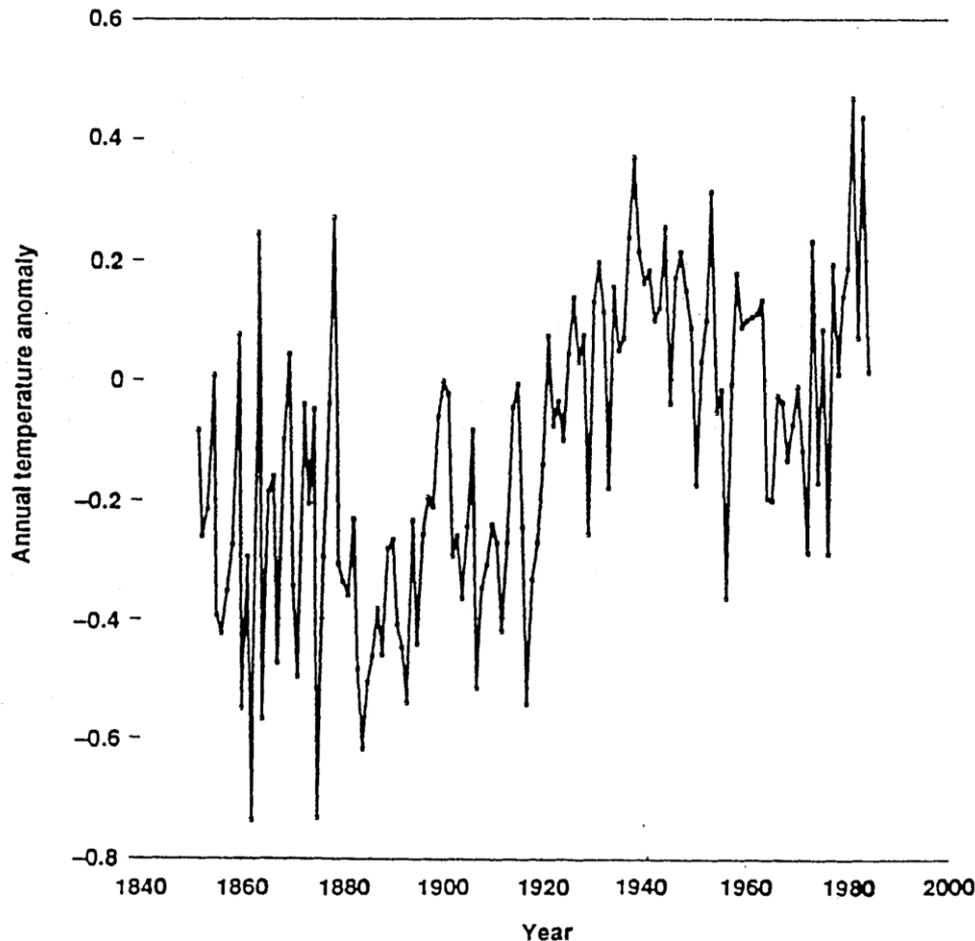
1. Data points averaged to obtain time record of global mean temperature. Note points range from less than -2C to more than +2C.

Globally Averaged Deviations from Average Temperature Plotted on a Scale Relevant to the Individual Station Deviations.



2. Average of points in previous figure.

CRU NH Average Annual Anomalies (1851-1984)



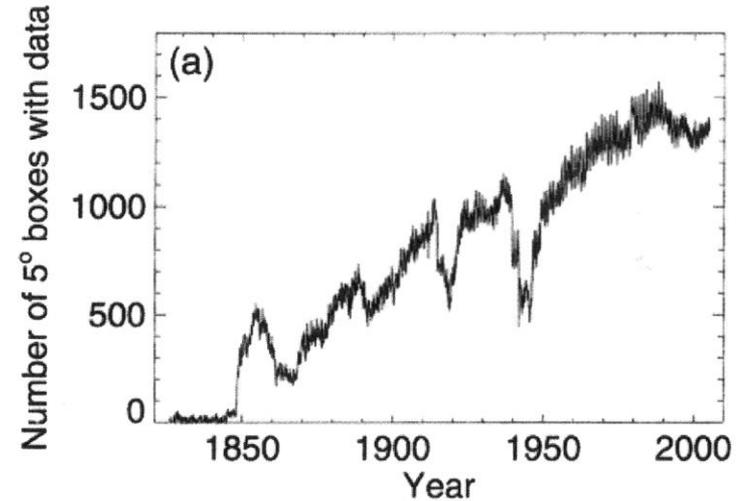
**3. Curve in previous figure stretched to fill graph.
Note that range is now from about -0.6C to +0.3C.**

And the sum of
(average regional)
temperatures is not
(thermodynamically
speaking) a
temperature

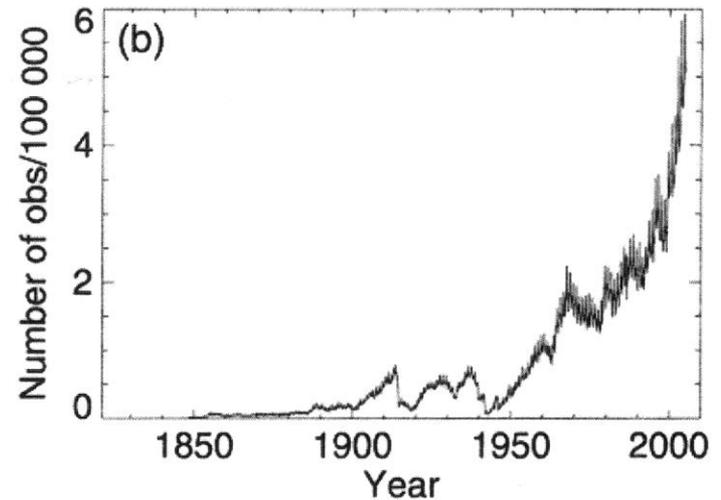
From Lindzen (2006)

Monthly mean temperature anomalies (at sea surface) available from 1826 to 2004

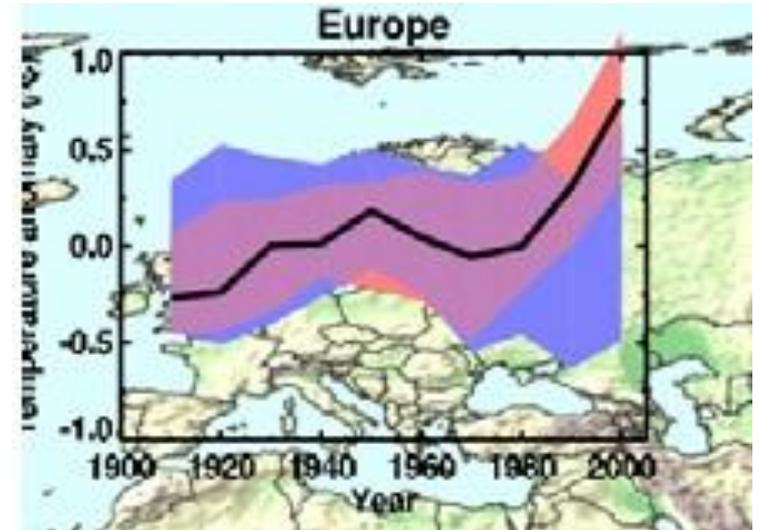
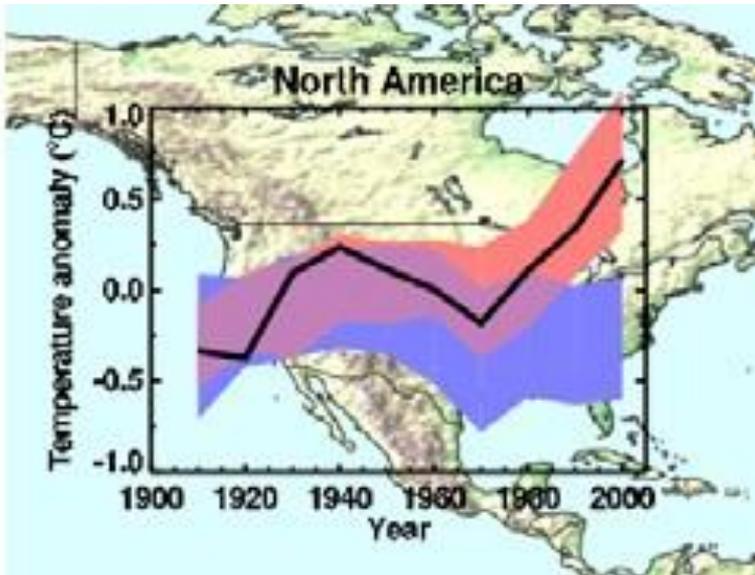
Number of 5° cells with
at least one observation
per month



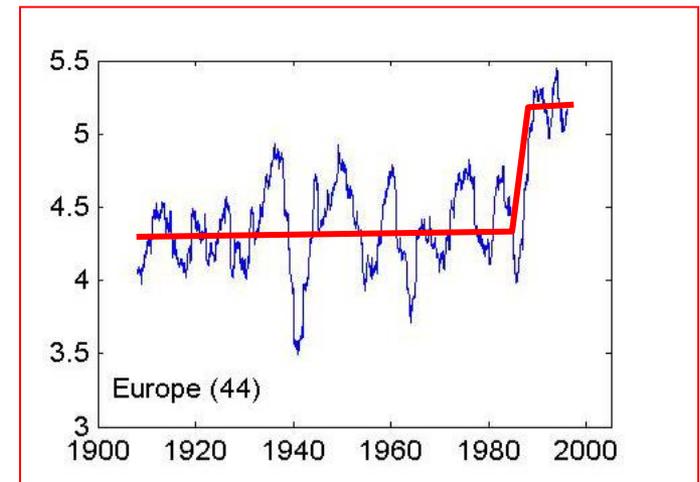
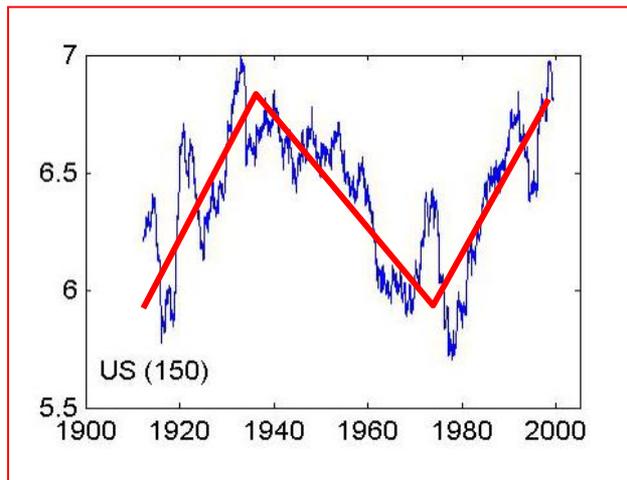
Number of observations



Comparison between IPCC curves and recalculated curves for Europe and the USA



IPCC WG1 Fourth Assessment Report, 2007



Le Mouél et al, 2008, 2009

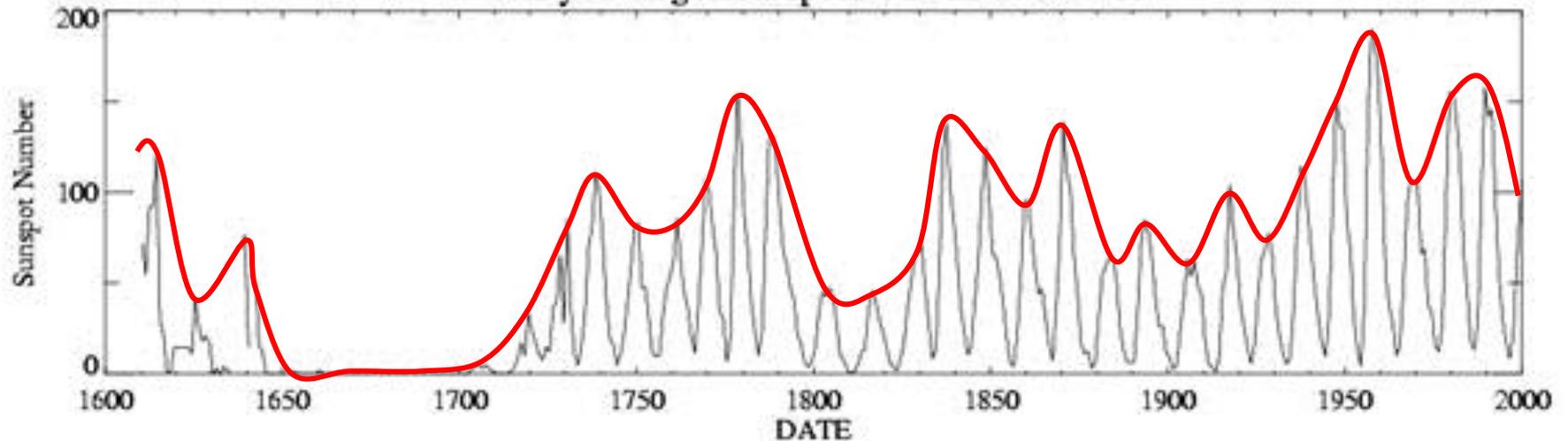
Observations :

could the Sun generate effects that have so far
not been reported?

Some results from our group

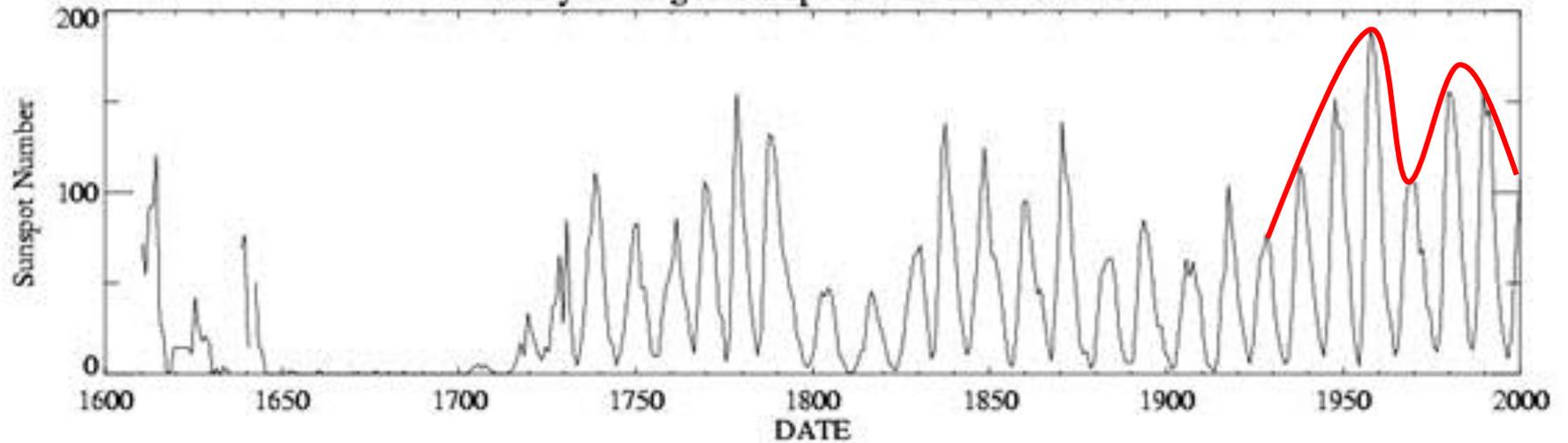
Changes in solar activity in the past four centuries

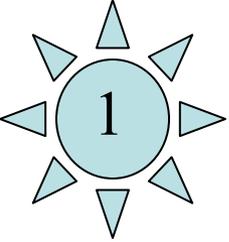
Yearly Averaged Sunspot Numbers 1610-2000



The past century

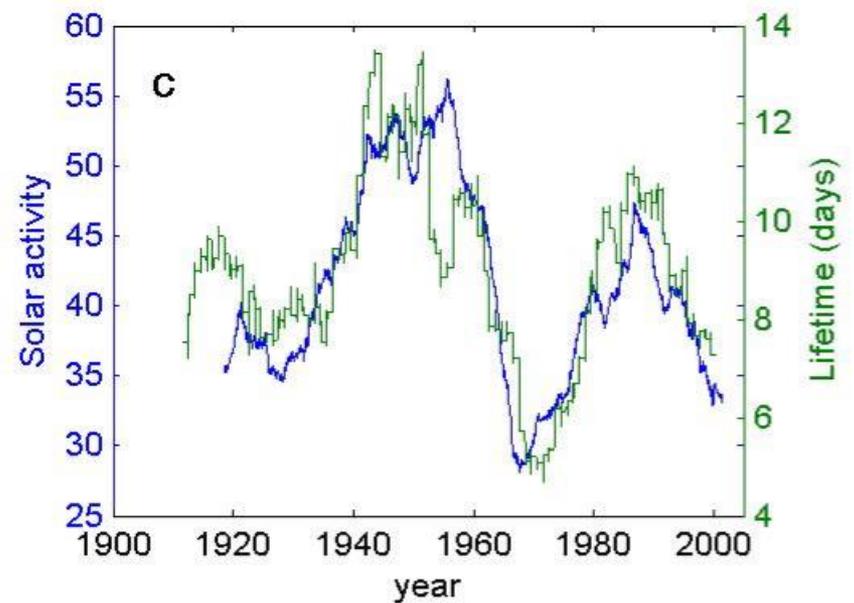
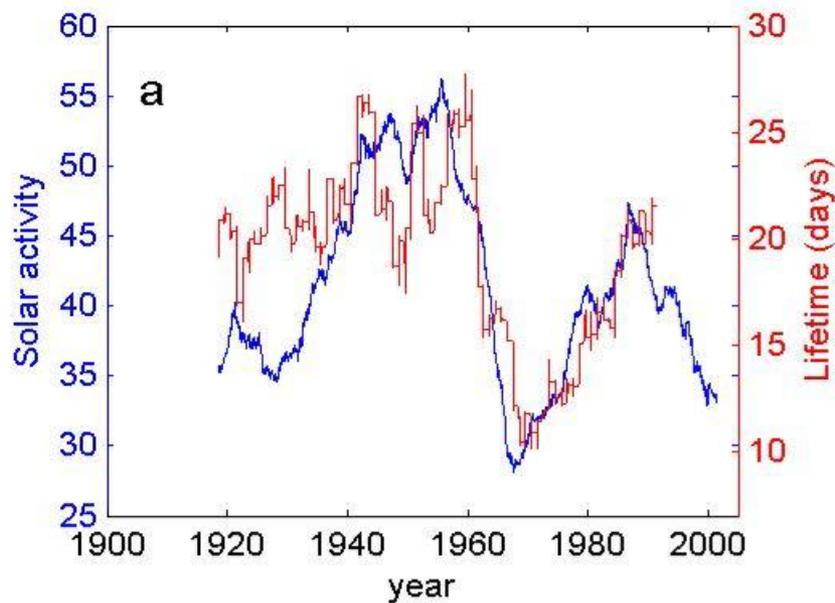
Yearly Averaged Sunspot Numbers 1610-2000

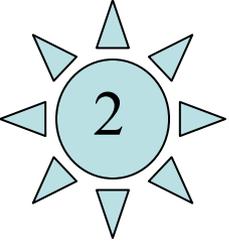




Correlation

between solar activity and variability of temperature
in Europe (left) and Holland (right)

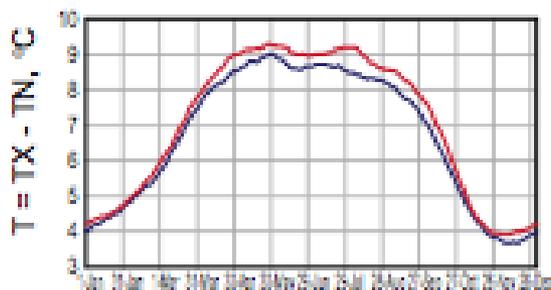




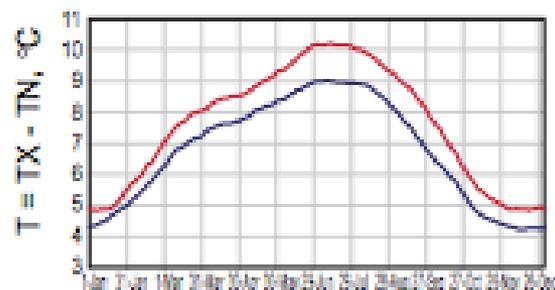
The longest instrumental recordings (250 yrs)

Annual mean variation of daily temperatures
(range)
as a function of intensity of solar cycles

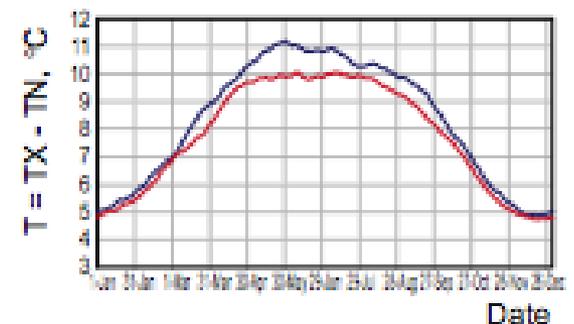
Prague



Bologna



Uccle

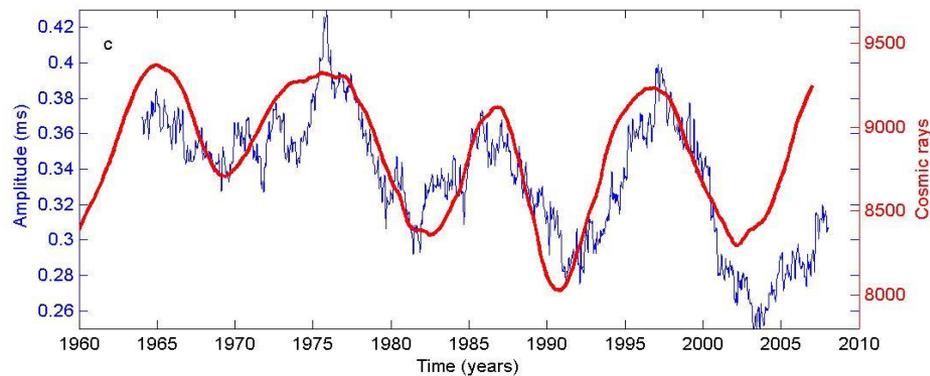
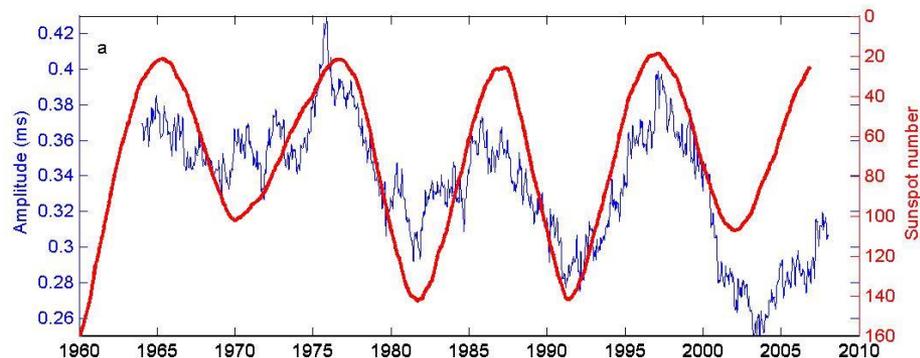


— cycles of high solar activity — cycles of low solar activity



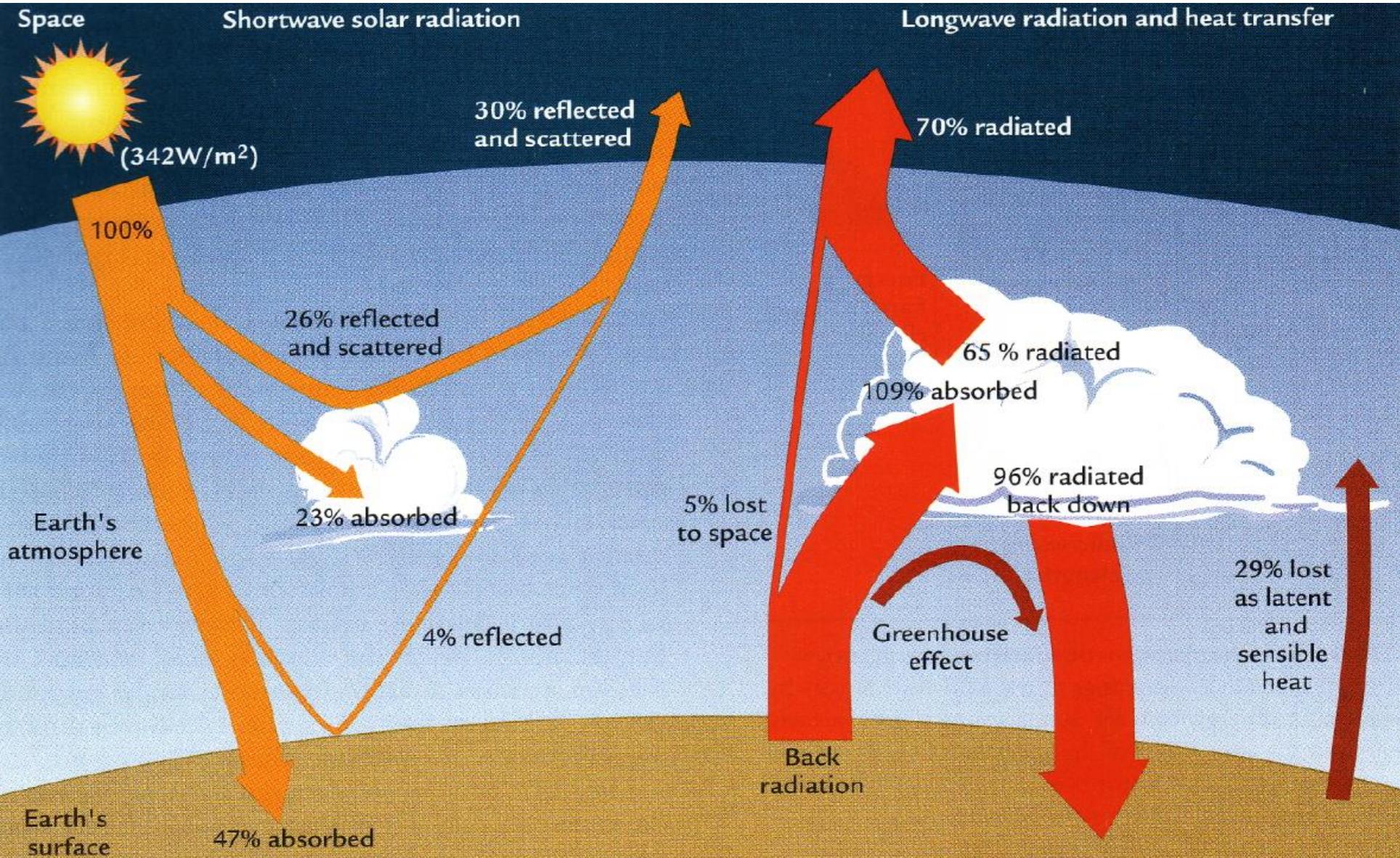
Comparison between
number of sunspots
(red) and amplitude of
6-month spectral line of
length of day (blue)

... and cosmic rays



What about « forcing factors » ?

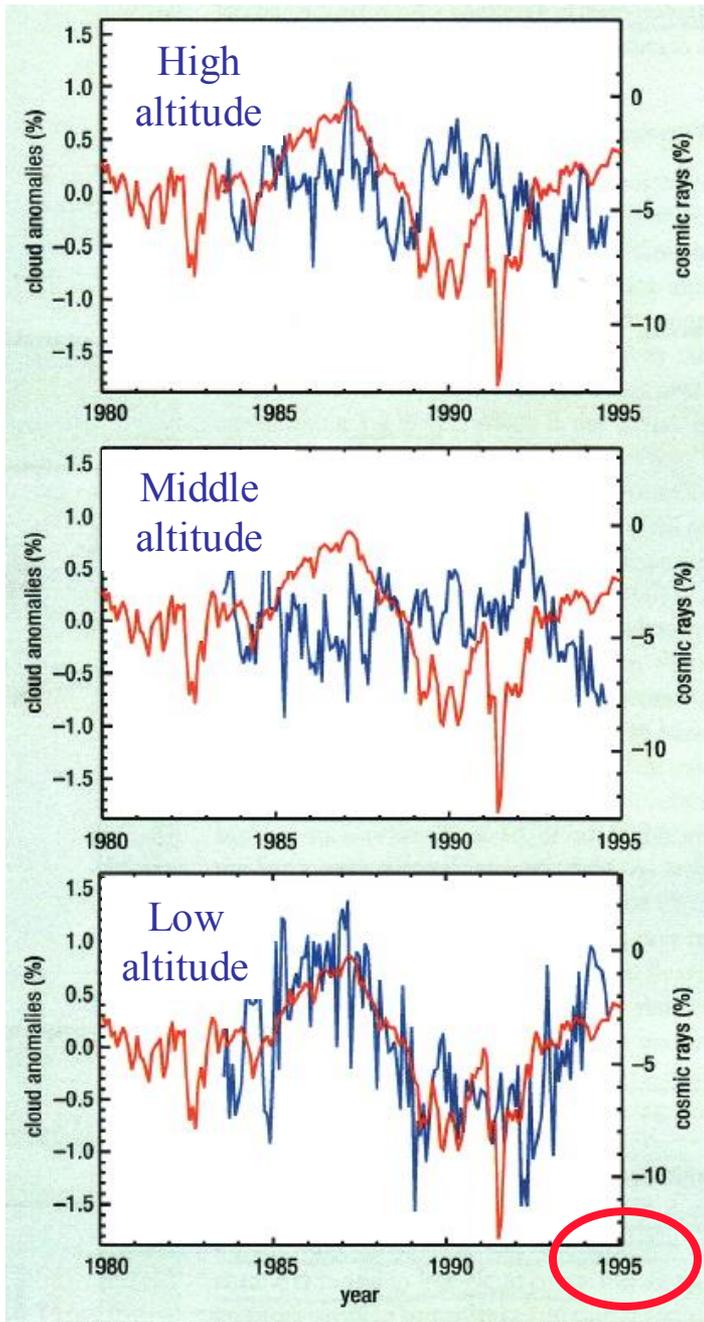
Heat flows in the atmosphere



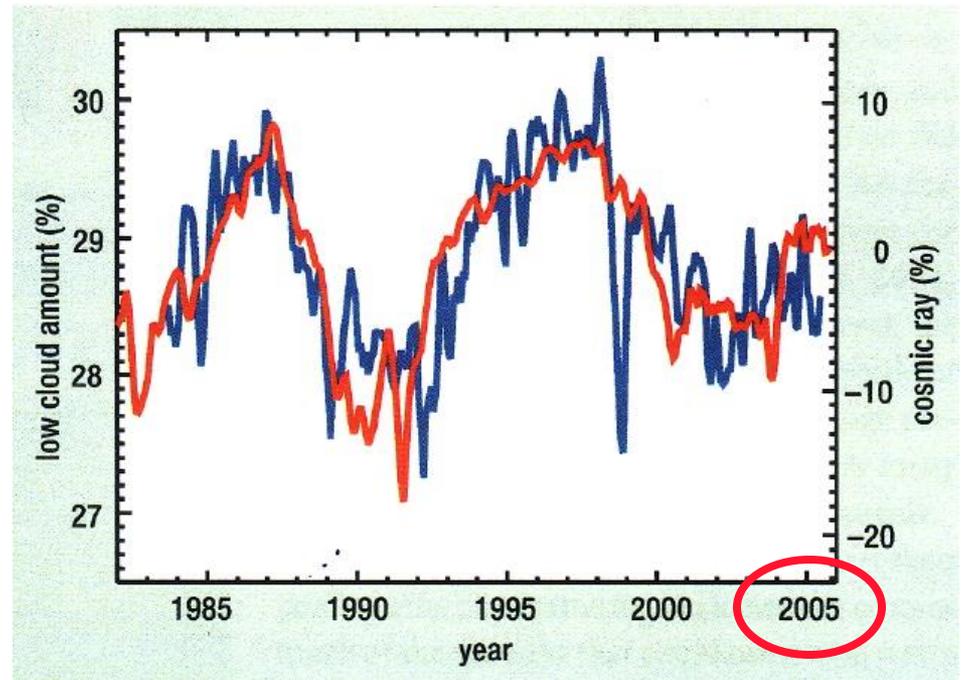
Clouds reflect about 88 Wm^{-2} to space
(out of incoming 342 Wm^{-2} daily average from the Sun)

A change of, say, 10% in cloud cover
would significantly change the « radiative balance »

What could induce such a change ?



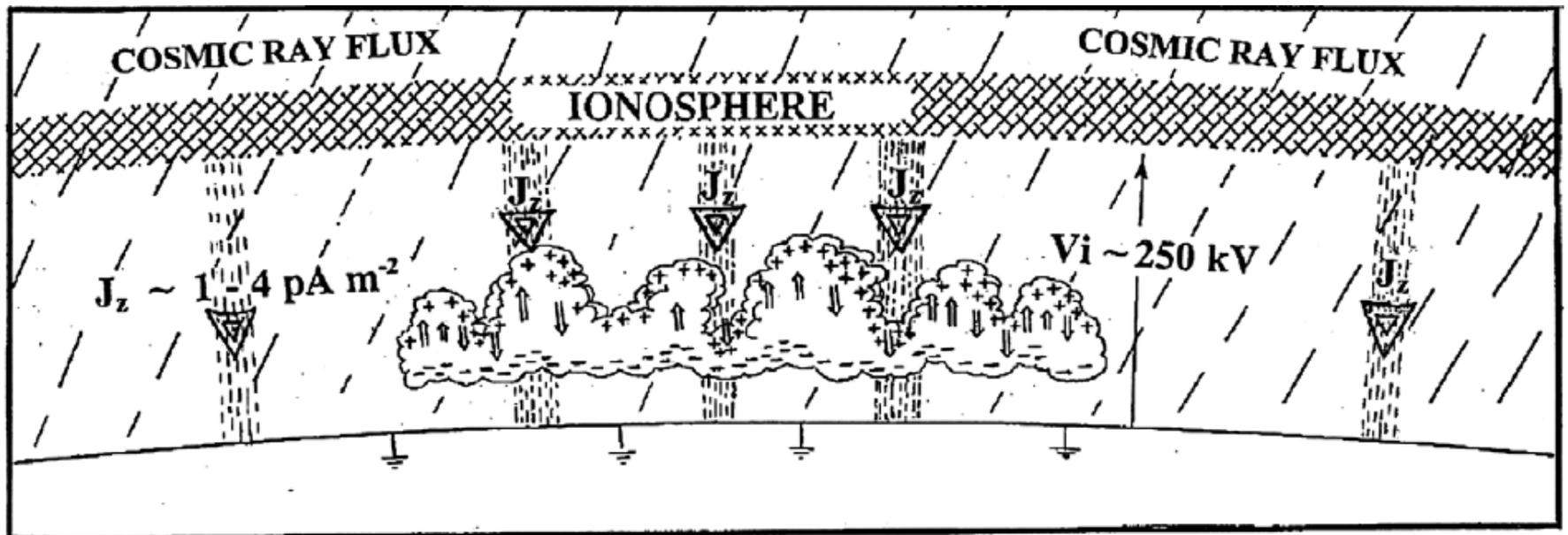
Correlation between cosmic ray flux and lower cloud cover



Accumulation of electric charges at cloud edges due to vertical electric current flowing from ionosphere to surface.

These charges attach to droplets and modify cloud microphysics.

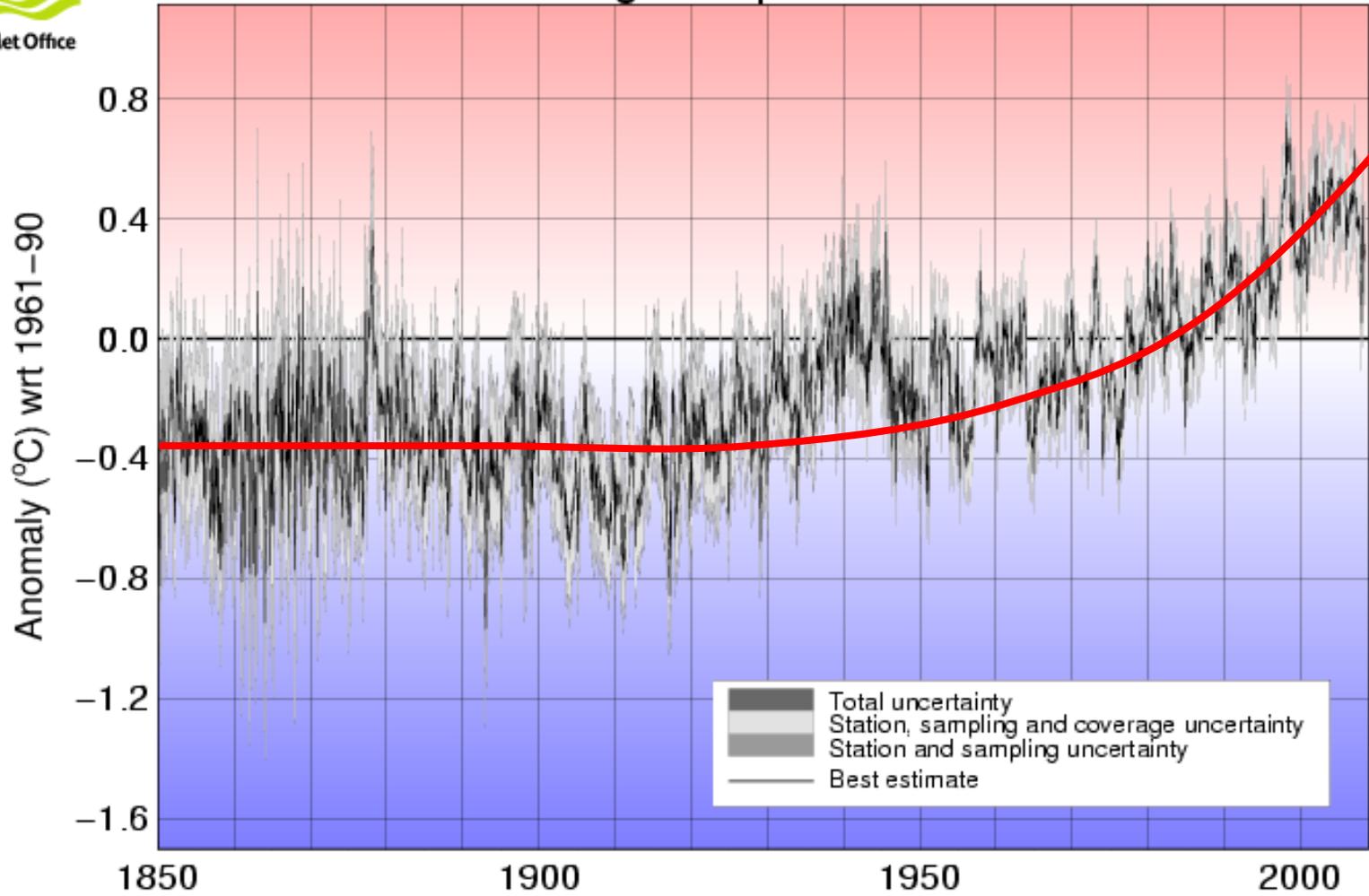
During a solar cycle, some characteristics of the ionosphere vary by tens of percent (not the very small 0.1% of total solar irradiance)





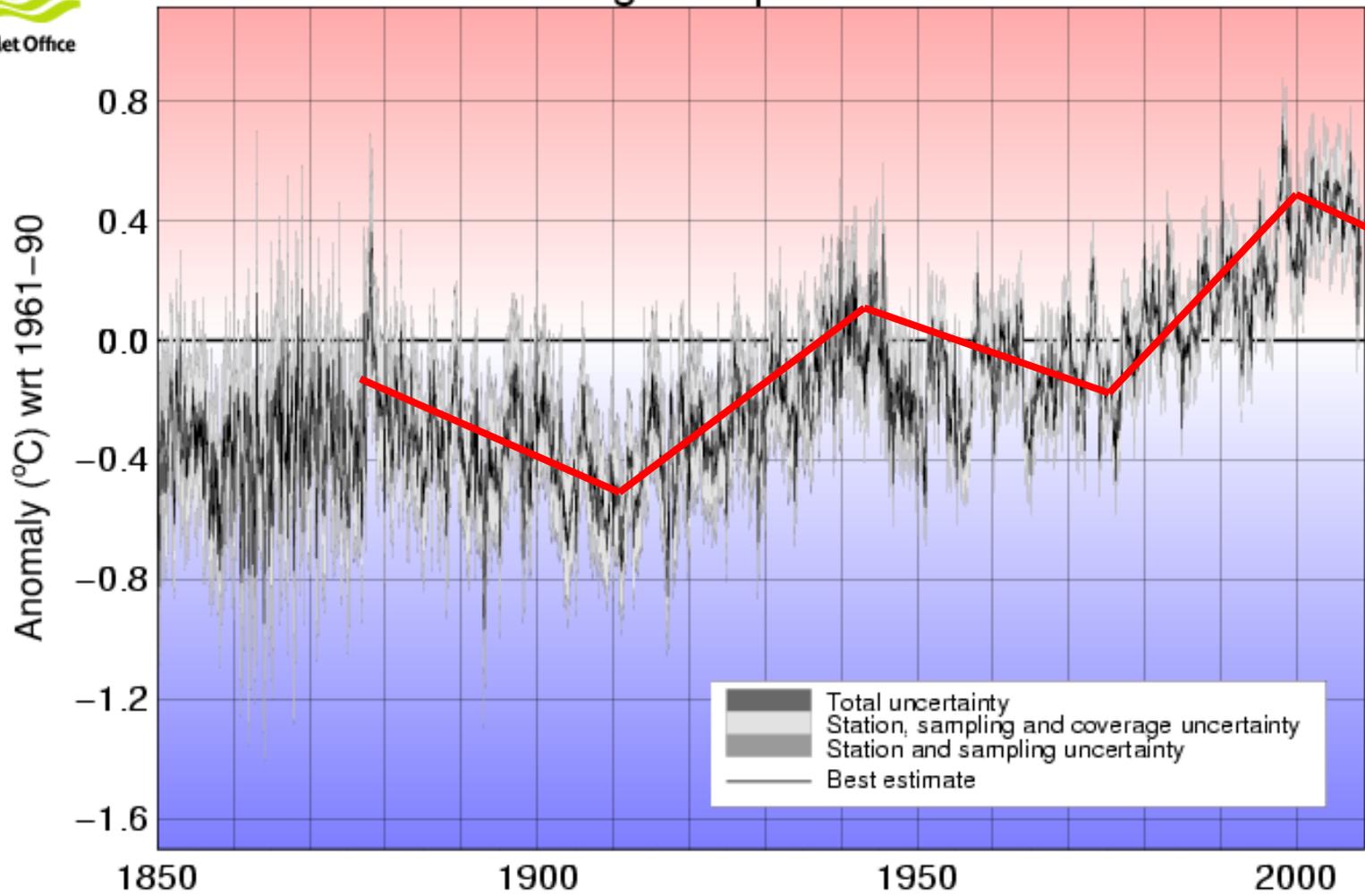
Global average temperature 1850–2007

IPCC ?



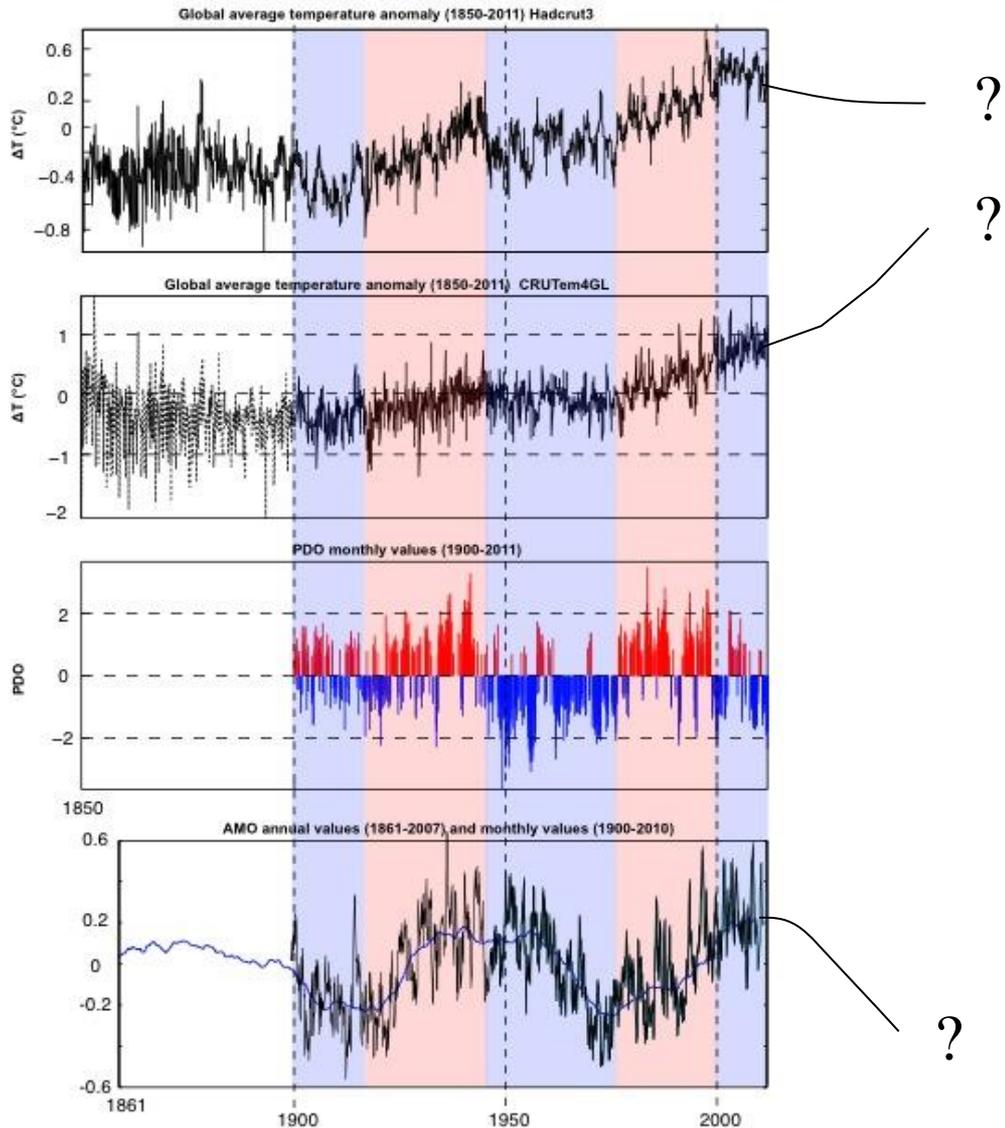


Global average temperature 1850–2007



Or... ?

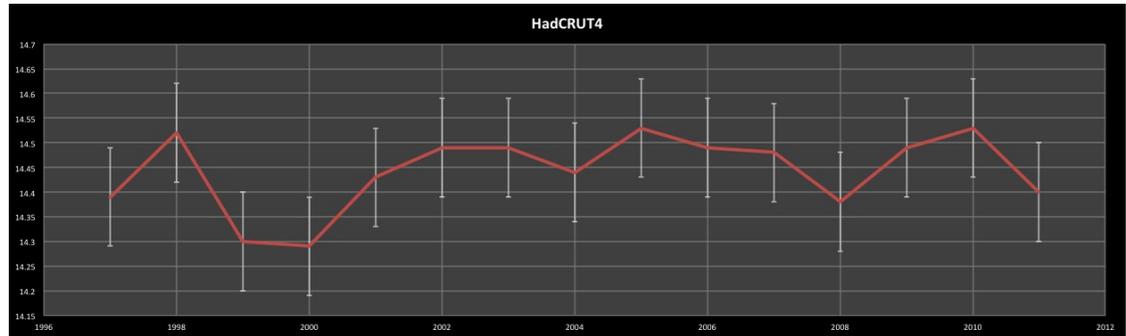
Changes in slope of global mean surface temperature segments correlate with changes in sign of the PDO and changes in slope of the AMO : a non-linear dynamical system? (see Tsonis et al, GRL, 2007)



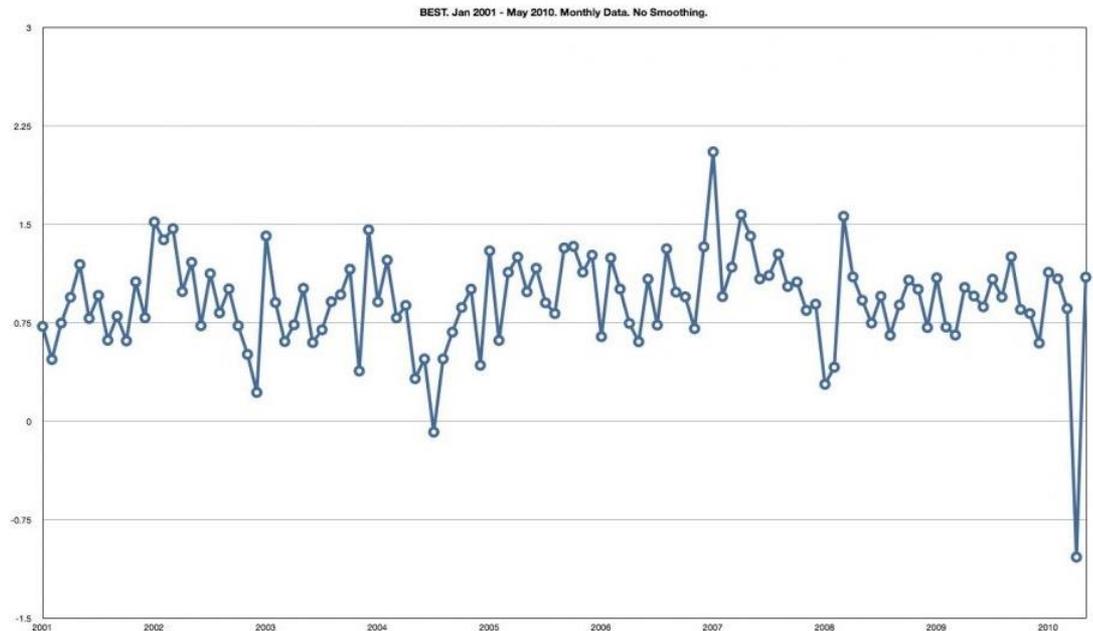
A recent switch to a new cooling regime ?

Figure 4

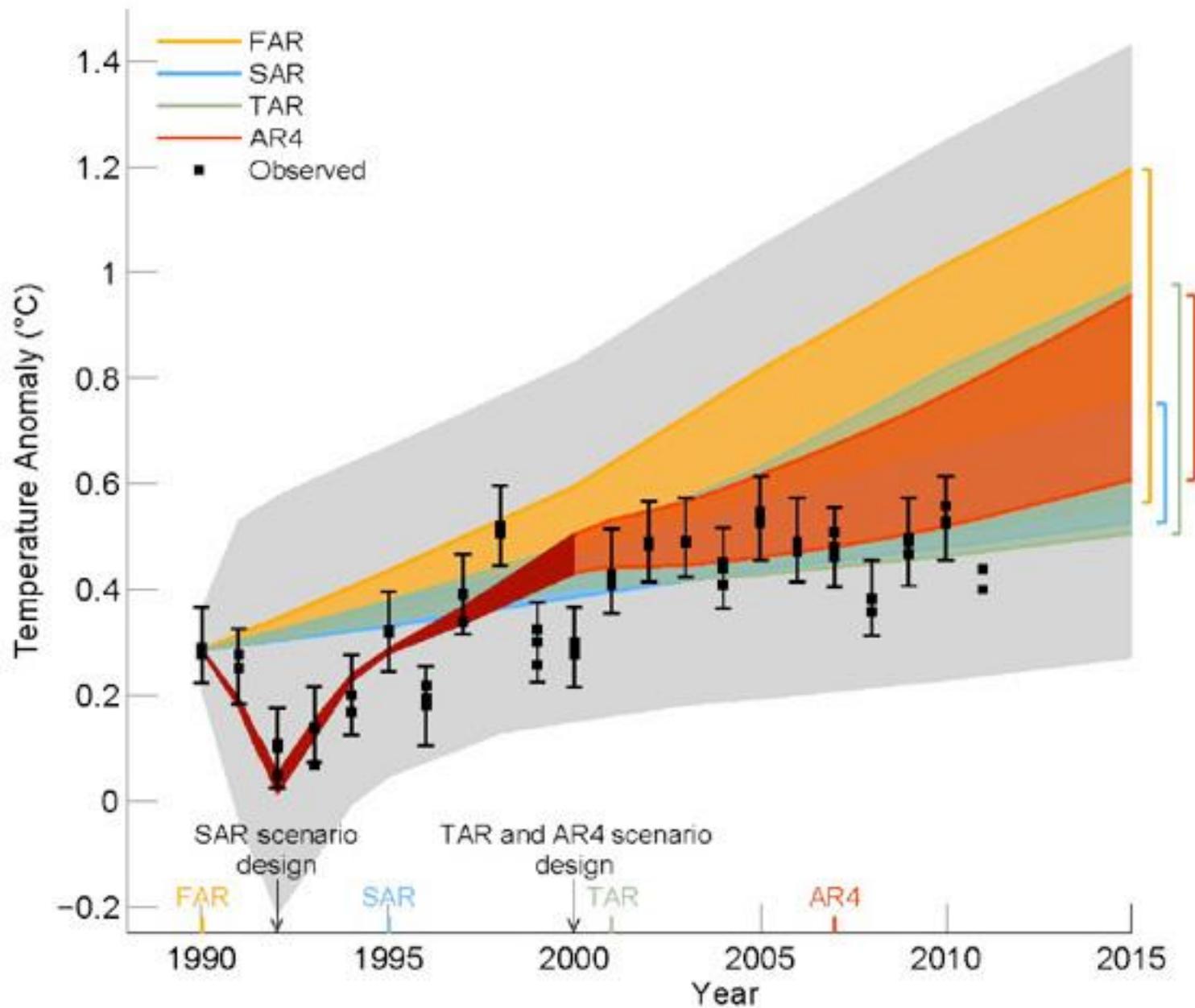
A temperature plateau
over the past
15 years: unexplained
by models



Données de Hadrut4 depuis 1997



Données de BEST depuis 2001



IPCC paradigm in crisis as climate predictions fail

Ross McKittrick, 17/09/13

The figure nearby is from the draft version that underwent expert review last winter. It compares climate model simulations of the global average temperature to observations over the post-1990 interval. During this time atmospheric carbon dioxide rose by 12%, from 355 to 396 ppm. **The IPCC graph shows that climate models predicted temperatures should have responded by rising somewhere between about 0.2 and 0.9 degrees C over the same period. But the actual temperature change was only about 0.1 degrees, and was within the margin of error around zero. In other words, models significantly over-predicted the warming effect of CO2 emissions for the past 22 years. (...)**

What's more, the **U.K.'s main climate modeling lab just this summer revised its long-term weather forecasts to show it now expects there to be no warming for at least another five years.** Ironically, if its model is right, it will have proven itself and all others like it to be fundamentally wrong.

Can climate models explain the recent stagnation in global warming?

Hans von Storch, Armineh Barkhordarian, Klaus Hasselmann and Eduardo Zorita

In recent years, the increase in near-surface global annual mean temperatures has emerged as considerably smaller than many had expected. We investigate whether this can be explained by contemporary climate change scenarios. In contrast to earlier analyses for a ten-year period that indicated consistency between models and observations at the 5% confidence level, **we find that the continued warming stagnation over fifteen years, from 1998 -2012, is no longer consistent with model projections even at the 2% confidence level. Of the possible causes of the inconsistency, the underestimation of internal natural climate variability on decadal time scales is a plausible candidate, but the influence of unaccounted external forcing factors or an overestimation of the model sensitivity to elevated greenhouse gas concentrations cannot be ruled out.** The first cause would have little impact of the expectations of longer term anthropogenic climate change, but the second and particularly the third would.

Discussion and concluding remarks (1):

- * The « golden triangle » :
 - observation
 - physical mechanisms (« theory »)
 - numerical models

- * A falsifiable model ?
(« with checkable predictions »)

Discussion and concluding remarks (2):

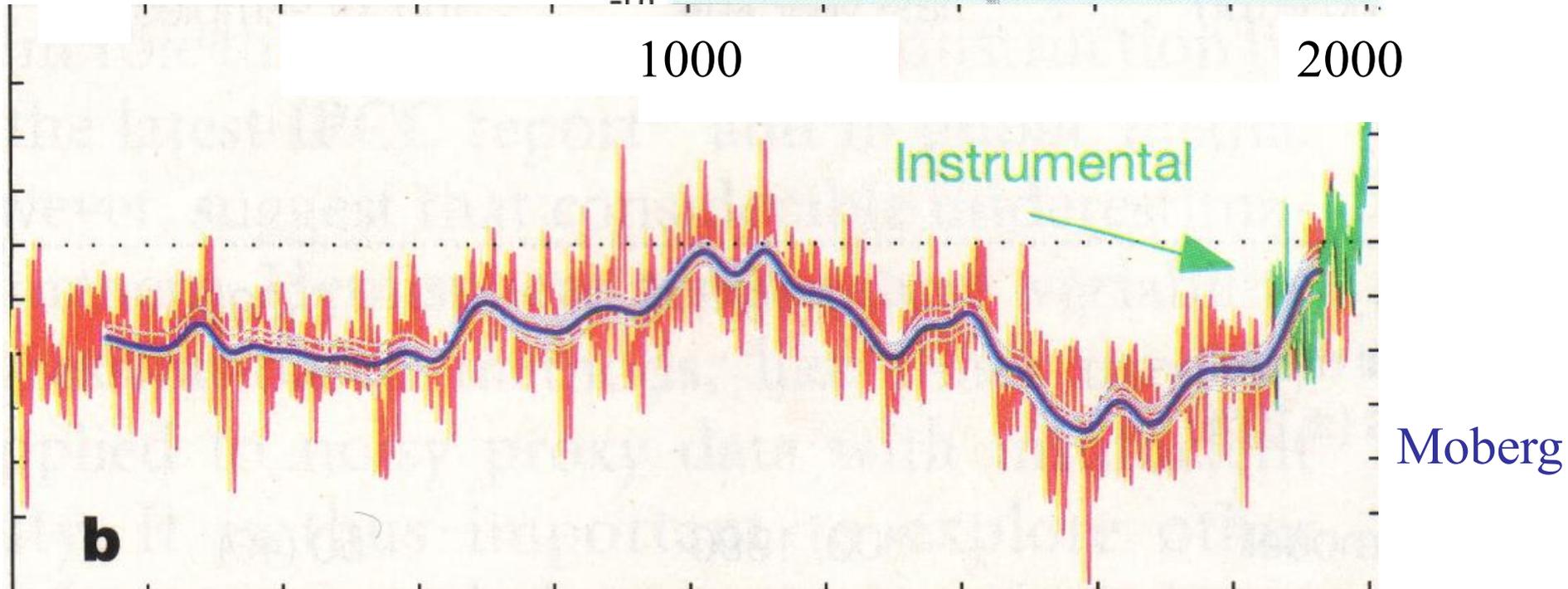
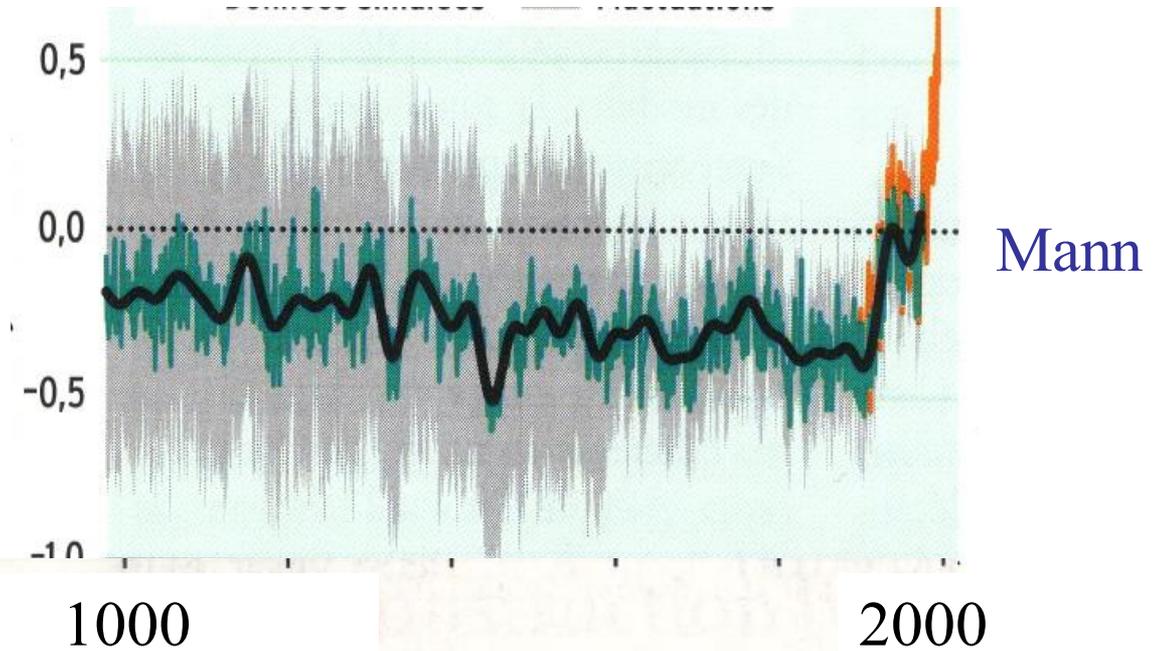
Global warming?

- * Yes in the past 150 yrs,
weak and irregular (both in space and time)...

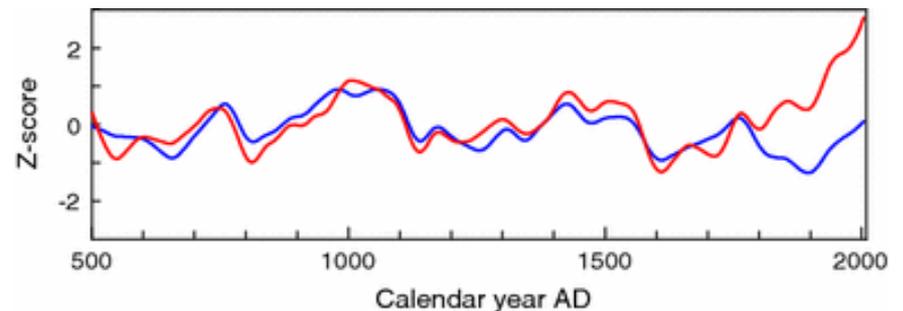
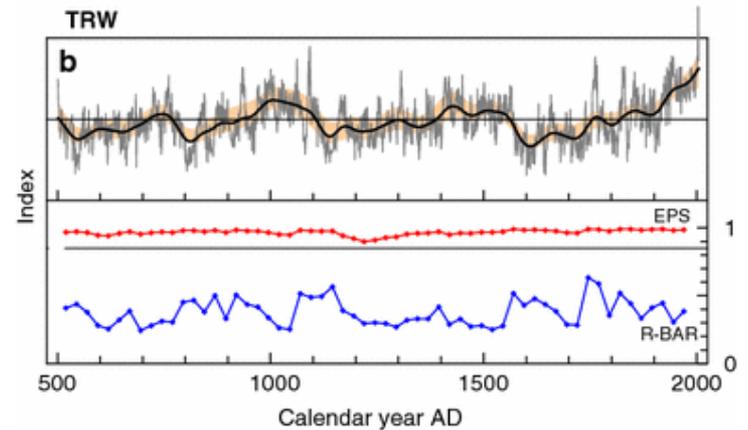
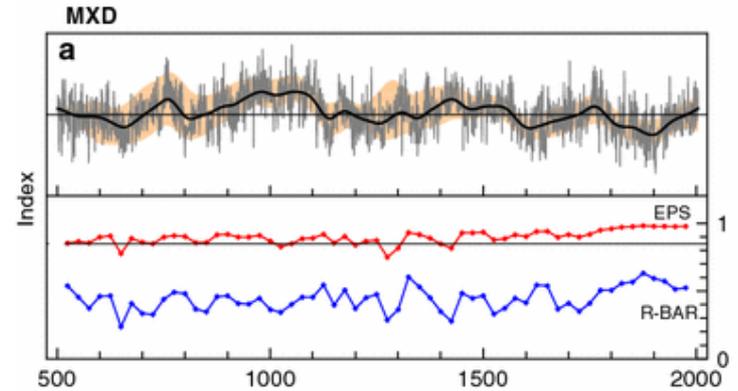
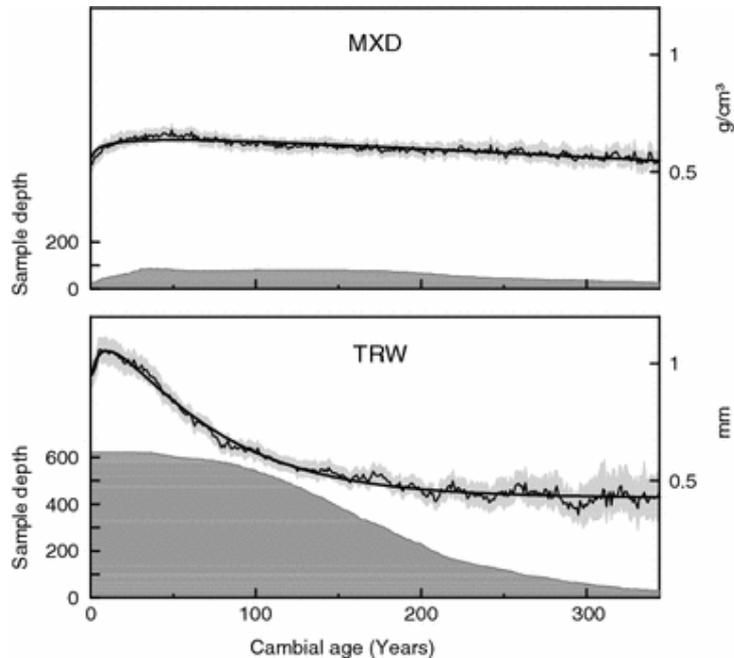
- * Not without precedent in the past 2 millenia...

- * With complex and multiple sources,
some still ill-understood and not taken into account in
models ...

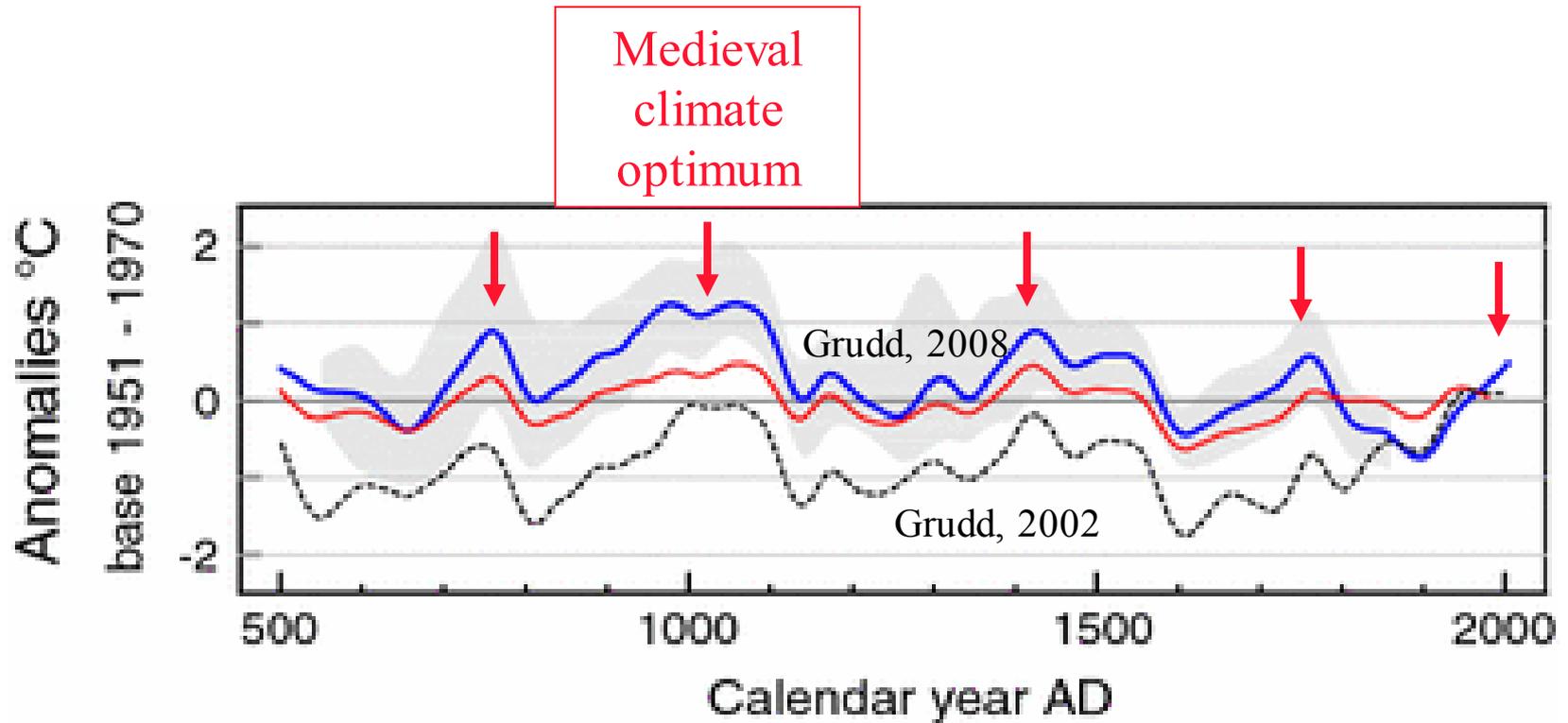
Observations
at the time scale
of the past
millenia...



Annual tree ring width (TRW)
and wood density (MXD) :
a function of cambial age,
hence a significant artefact



Recent warming may have had precedents
Around 750, 1000, 1400 and 1750
(at least in Northern Europe)



Discussion and concluding remarks (3):

- Several recent lines of observation demonstrate an influence of variations in solar activity on time scales going from decades to millenia (with amplitudes much larger than the 1/1000 of solar irradiance).
- Physical mechanisms could involve cosmic rays, ionospheric currents and their action on cloud cover (CLOUD experiment at CERN).

Be alert when one says:

« The problem is settled »,

particularly if it is a very complex problem involving a very complex system, with vastly different time and space scales and only partly understood non-linear phenomena involved...

Thank you