Is the lady dead, was she killed and by whom? Changing rainfall in the past decades in Europe

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18. Juni 2015 - Abschlussveranstaltung des bilateralen Forschungsprojektes "WETRAX - Veränderung des Risikos von großräumigen Starkniederschlägen im Klimawandel in Mitteleuropa, mit Fokus auf atmosphärische Wetterlagen und Zugbahnen", **Wien**

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

The issue is

deconstructing a given record

with the intention to identify „predictable“ components.

„Predictable“

-- either natural processes, which are known of having limited life times,
-- or man-made processes, which are subject to decisions (e.g., GHG, urban effect)

Differently understood in different social and scientific quarters.

The issue is also to help to discriminate between culturally supported claims and scientifically warranted claims

The issue of deconstructing regional climate change

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We have examined to regions

- the **Baltic Sea region**, and
- the **Med Sea Region**

in the past decades of years, in light of the hypothesis that the changes are related to atmospheric elevated greenhouse gas concentrations.

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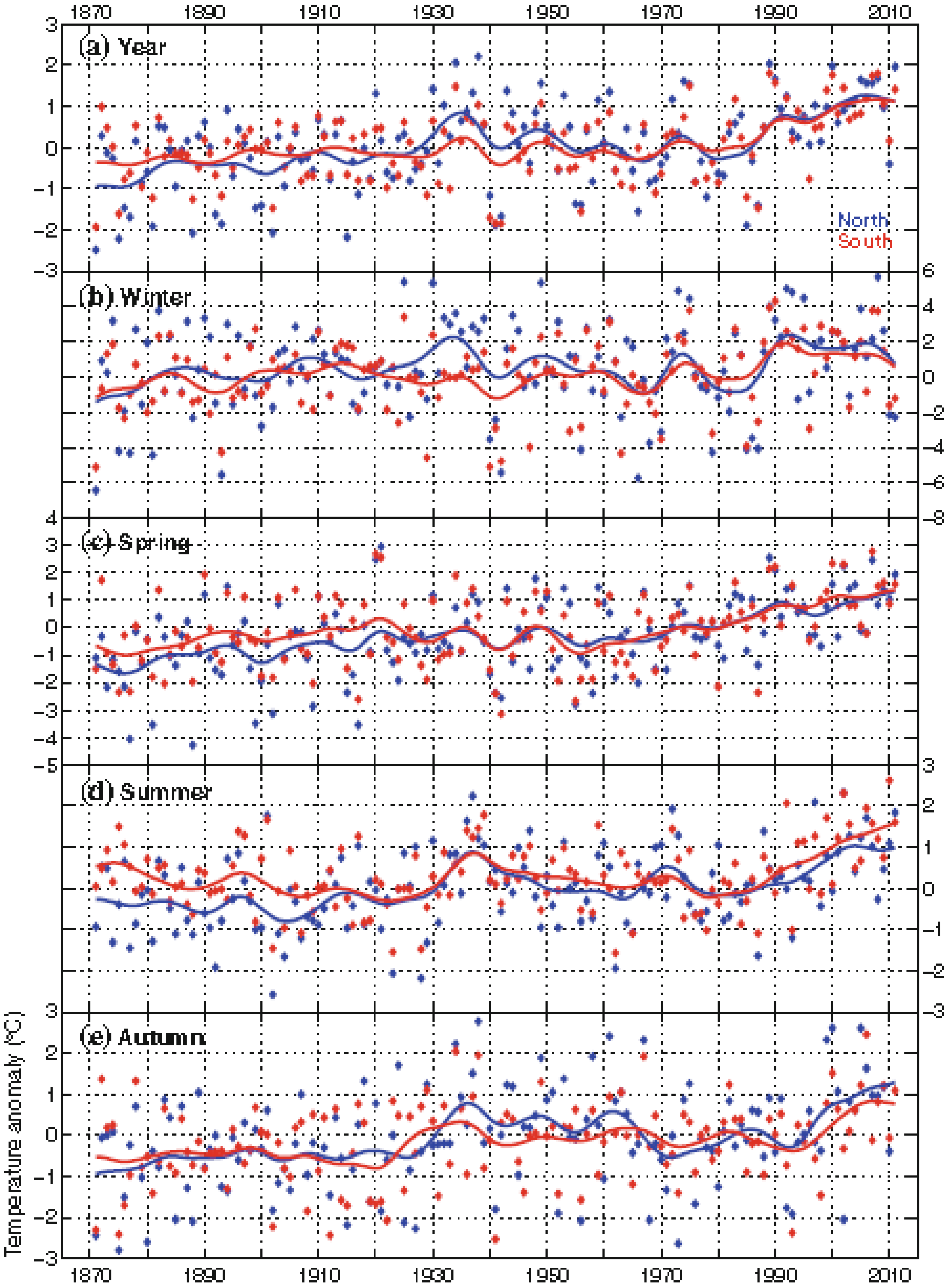
Fig. 4.11 Annual and seasonal mean surface air temperature anomalies (relative to 1960–1991) for the Baltic Sea basin 1871–2011, calculated from 5° by 5° latitude, longitude box average taken from the CRUTEM3v dataset (Brohan et al. 2006) based on land stations (from *top* to *bottom*: **a** annual, **b** winter (*DJF*), **c** spring (*MAM*), **d** summer (*JJA*), **e** autumn (*SON*). *Blue* comprises the Baltic Sea basin north of 60°N and *red* south of 60°N. The dots represent individual years and the smoothed curves (Gaussian filter, σ = 3) highlight variability on timescales longer than 10 years



BACC-II report, 2015

MANIFESTATION

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Observed temperature trends in the Baltic Sea region (1982-2011)

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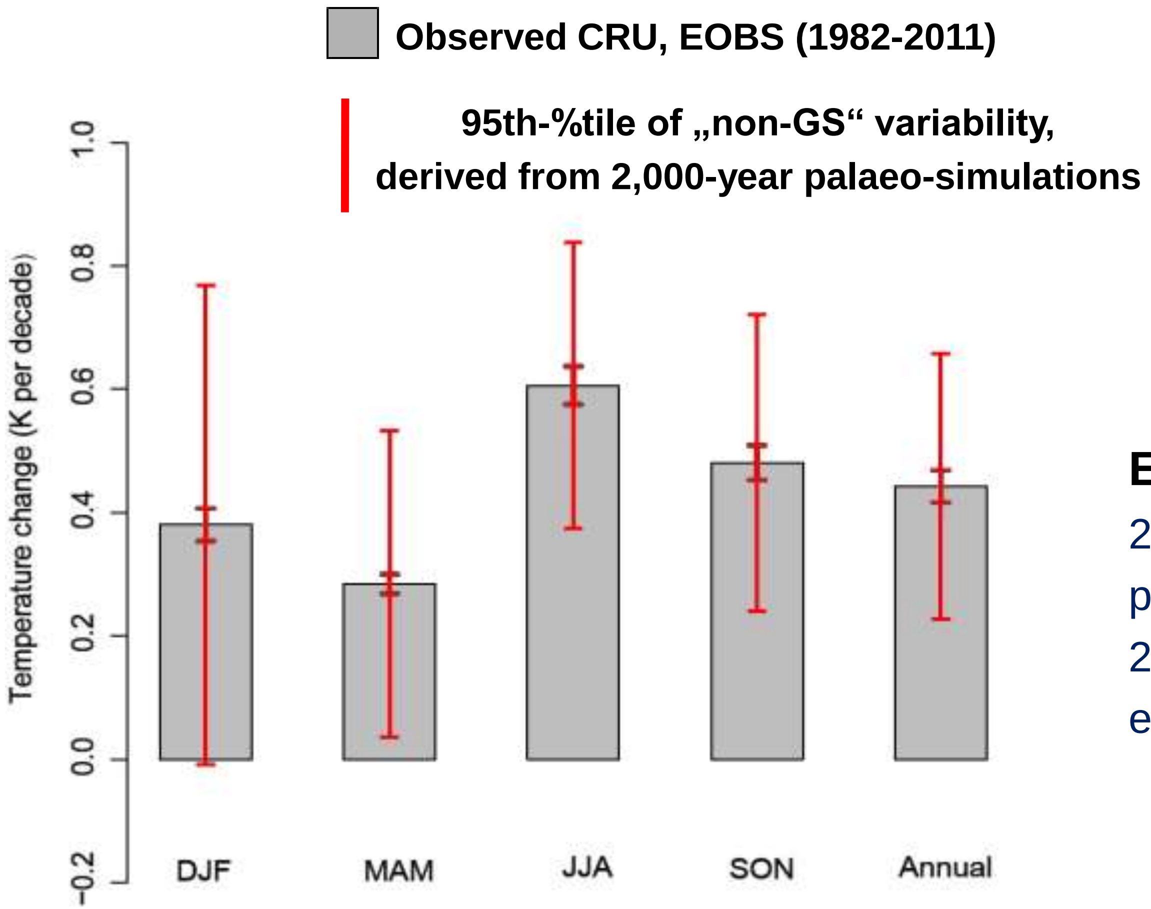

Baltic Sea region

Estimating natural variability:

2,000-year high-resolution regional climate palaeo-simulation (Gómez-Navarro et al, 2013) is used to estimate natural (internal + external) variability.

- **An external cause is needed for explaining the recently observed annual and seasonal warming over the Baltic Sea area, except for winter (with < 2.5% risk of error)**

2m Temperature in the Med Sea Region (1980-2009)

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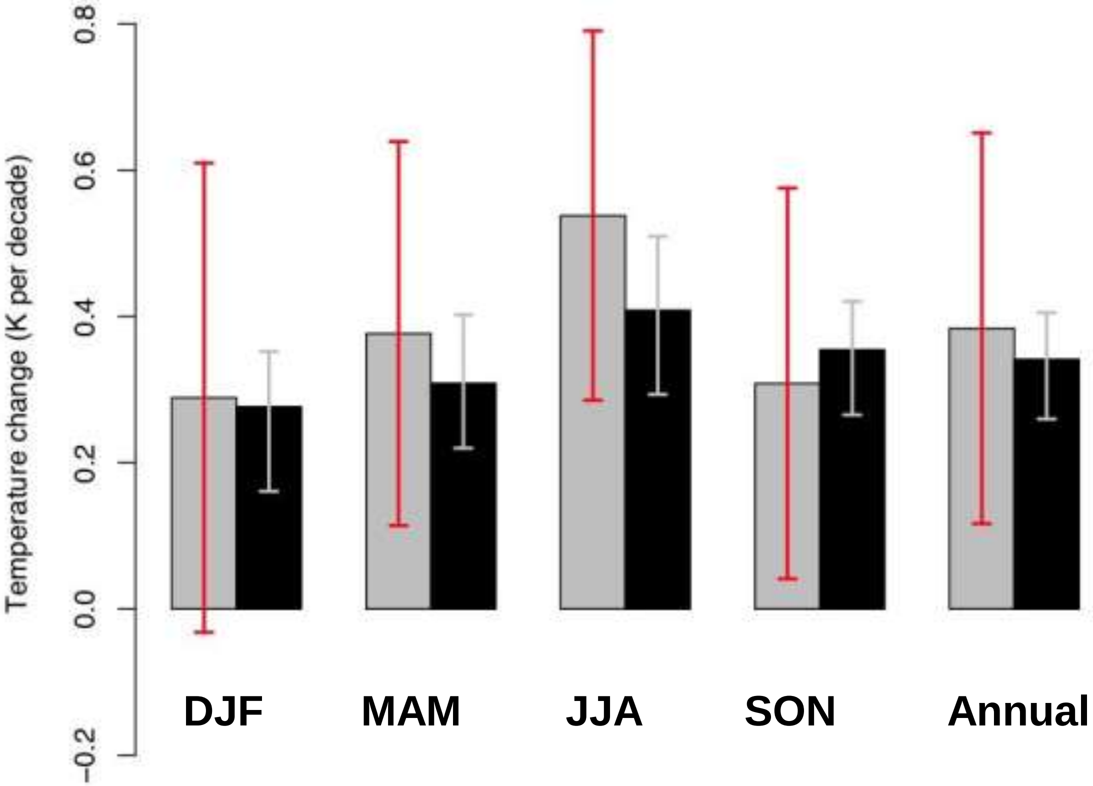
Observed changes of 2m temperature (1980-2009) in comparison with GS signals



- Observed trends of 2m temperature (1980-2009)
- Projected GS signal patterns, A1B scenario
  23 AOGCMs, 49 simulations (CMIP3)
- 90% uncertainty range of observed trends, derived from 10,000-year control simulations
- The spread of trends of 23 climate change projections

➢ **There is less than 5% probability that natural (internal) variability is responsible for the observed annual and seasonal warming in the Med Sea region, except in winter.**

(Barkhordarian et al , Climate Dynamics 2012a)

DETECTION

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?
1
2
3

Observed and projected temperature trends in the Baltic Sea Region (1982-2011)

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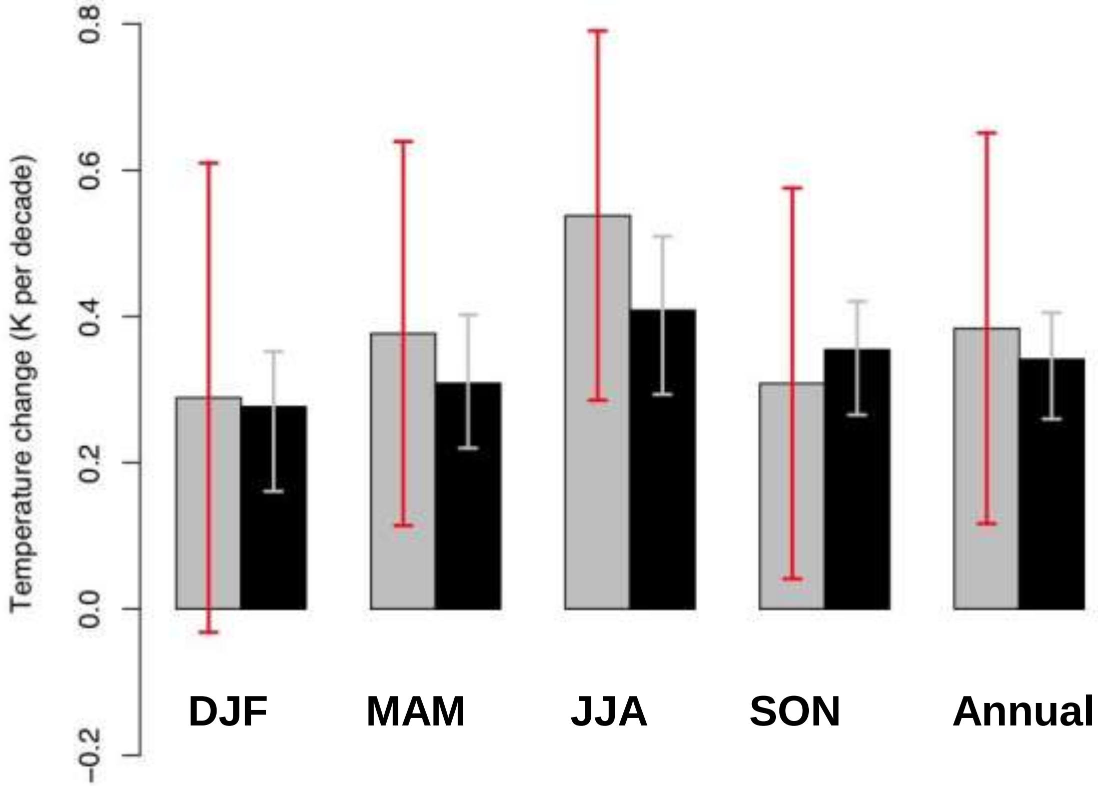
Observed changes of 2m temperature (1980-2009) in comparison with GS signals



- Observed trends of 2m temperature (1980-2009)
- Projected GS signal patterns, A1B scenario
  23 AOGCMs, 49 simulations (CMIP3)
- 90% uncertainty range of observed trends, derived from 10,000-year control simulations
- The spread of trends of 23 climate change projections

➢ **In the Med Sea region, the warming can be explained by the A1B scenario of increased GHGs.**

(Barkhordarian et al , Climate Dynamics 2012a)

Observed and projected temperature trends in the Baltic Sea Region (1982-2011)

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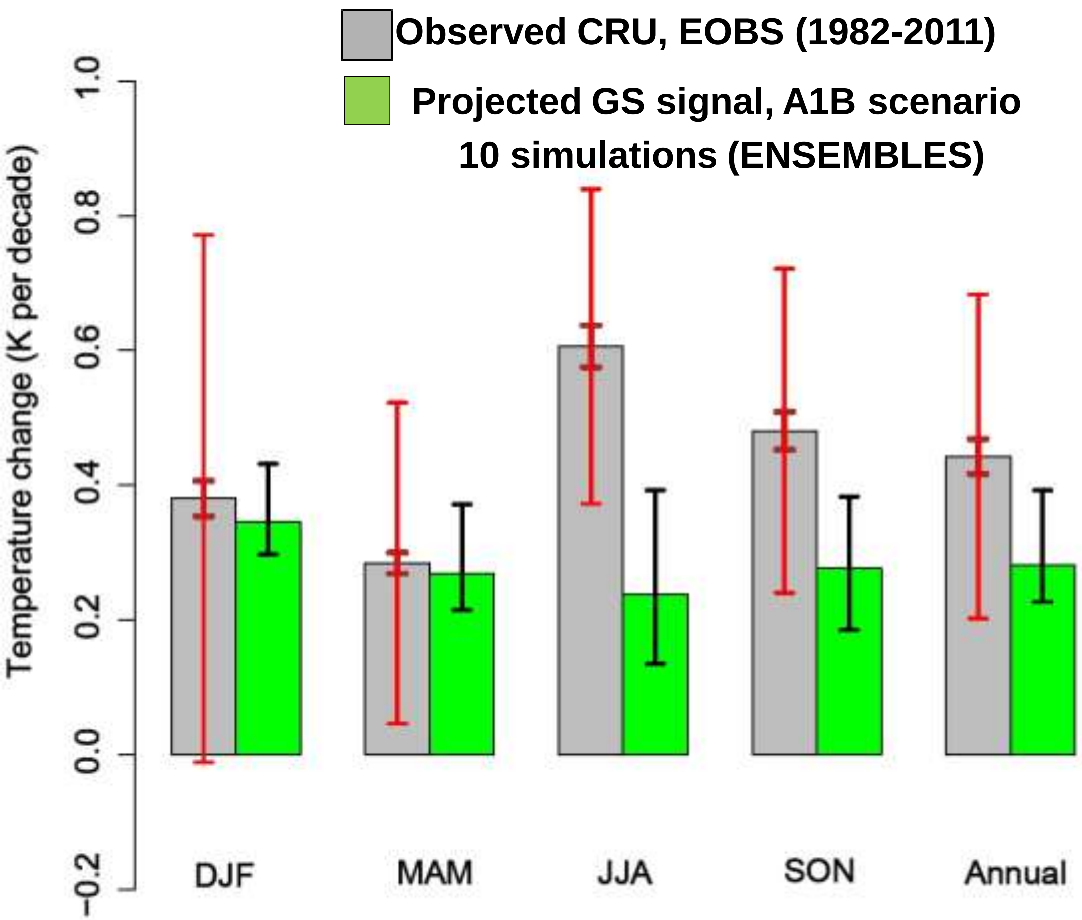

- **DJF and MAM changes can be explained by dominantly GHG driven scenarios**
- **None of the 10 RCM climate projections capture the observed annual and seasonal warming in summer (JJA) and autumn (SON).**

Precipitation trends in the Baltic Sea Region (1979-2008)

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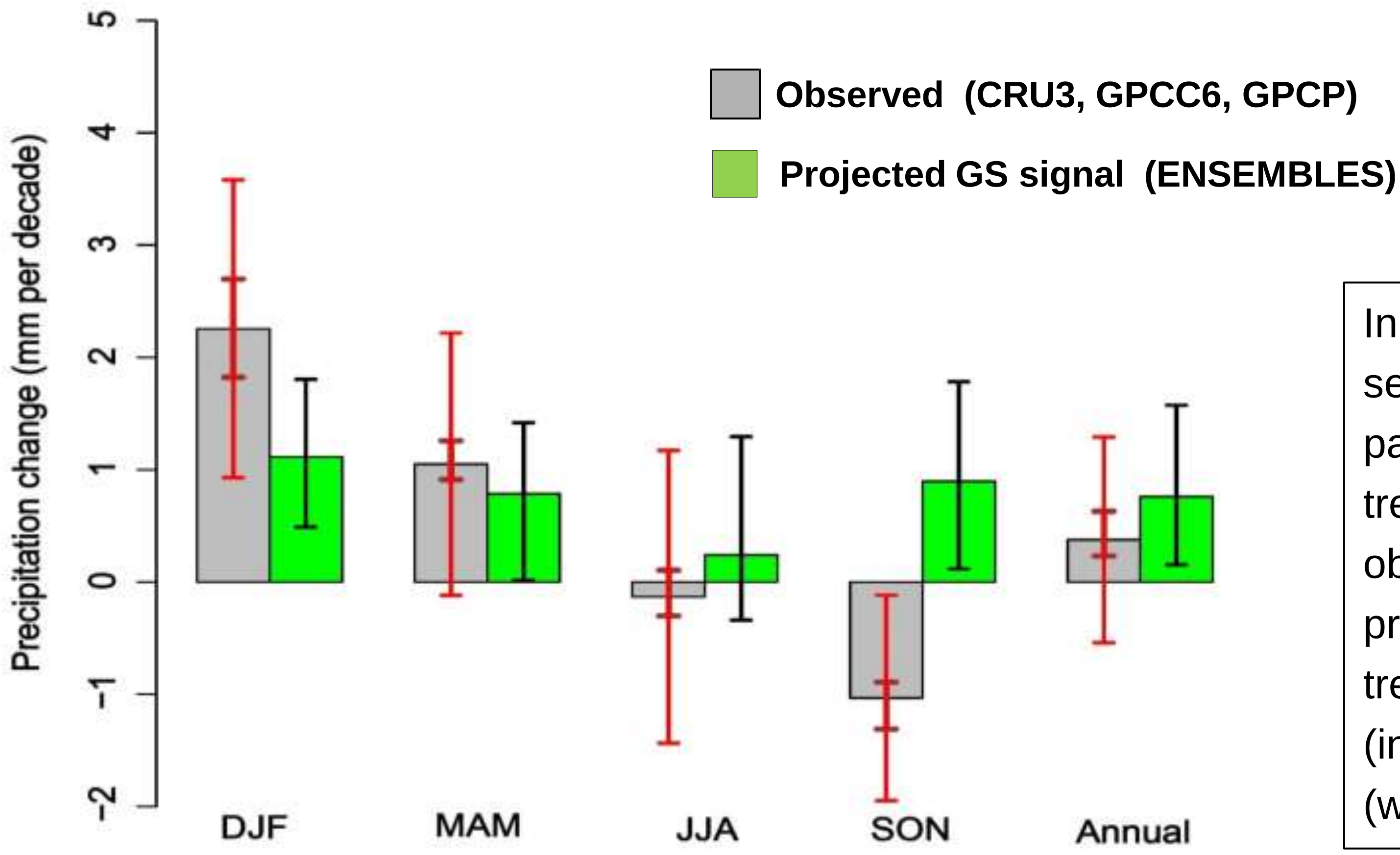

In **winter (DJF)** none of the 59 segments derived from 2,000 year paleo-simulations yield a positive trend of precipitation as strong as that observed. There is less than 5% probability that observed positive trends in winter be due to natural (internal + external) variability alone (with less than 5% risk).

In **spring (MAM)**, **summer (JJA)** and **Annual** trends externally forced changes are not detectable. However observed trends lie within the range of changes described by 10 climate change scenarios, indicating that also in the scenarios a systematic trend reflecting external forcing is not detectable (< 5% risk).

In **autumn (SON)** the observed negative trends of precipitation contradicts the upward trends suggested by 10 climate change scenarios, irrespective of the observed dataset used.

Precipitation in the Med Sea Reigon (Over land, 1966-2005, CMIP3)

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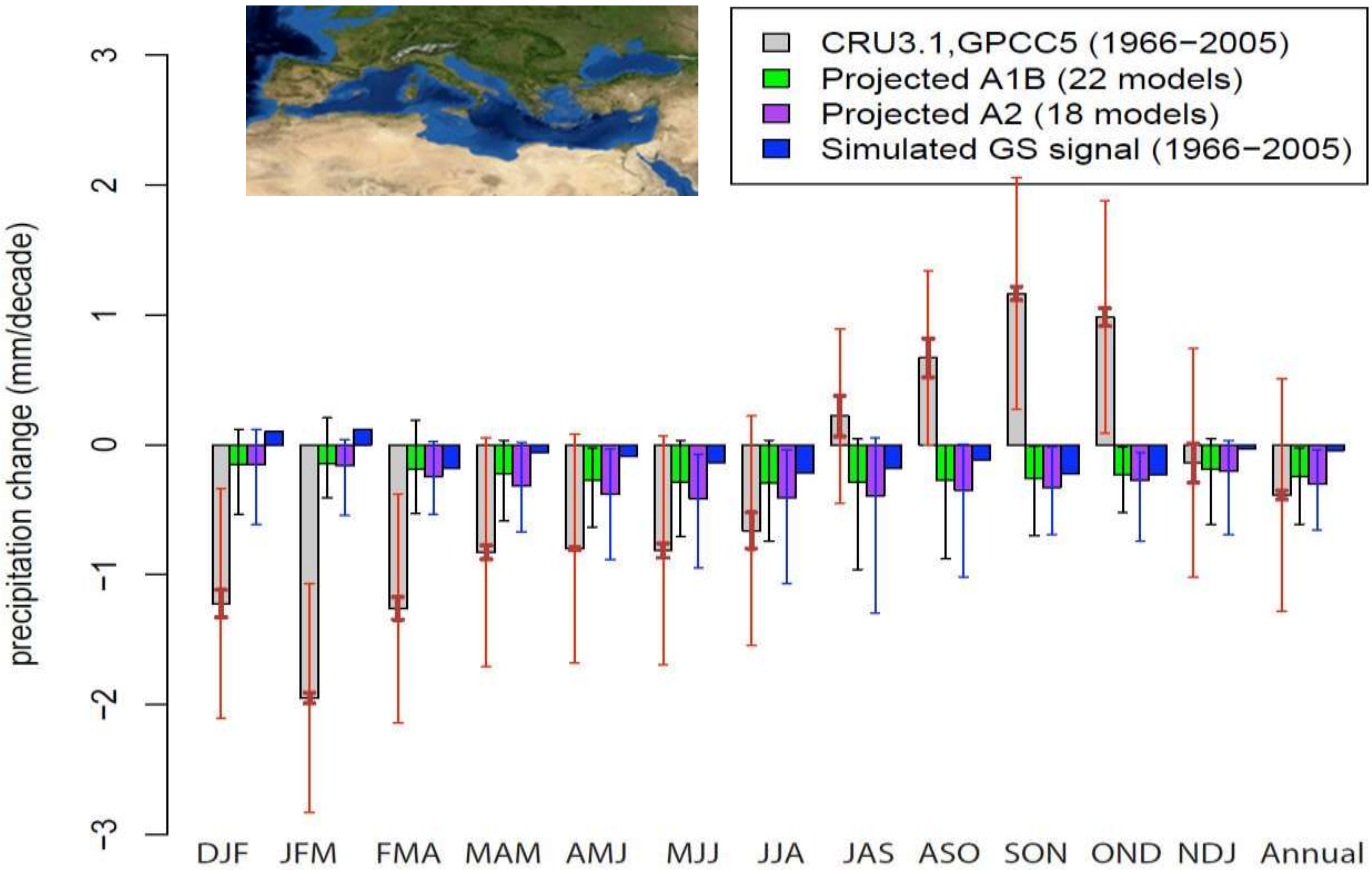

(Barkhordarian et al , Climate Dynamics 2013)

Mean sea-level pressure in the Med Sea Region (SLP)

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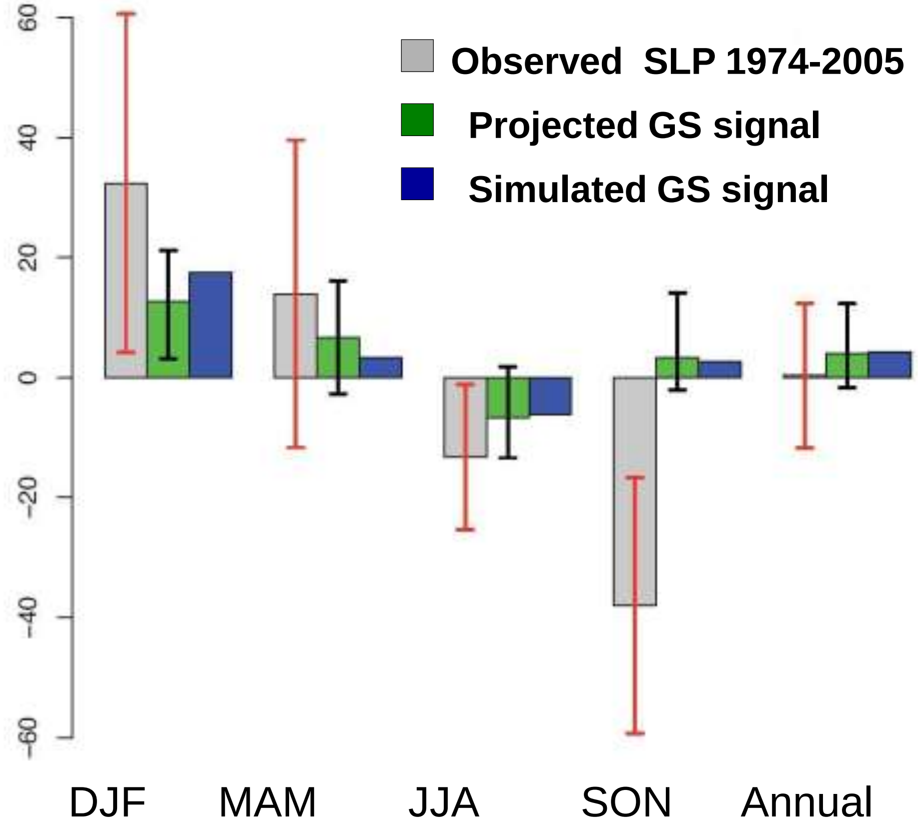

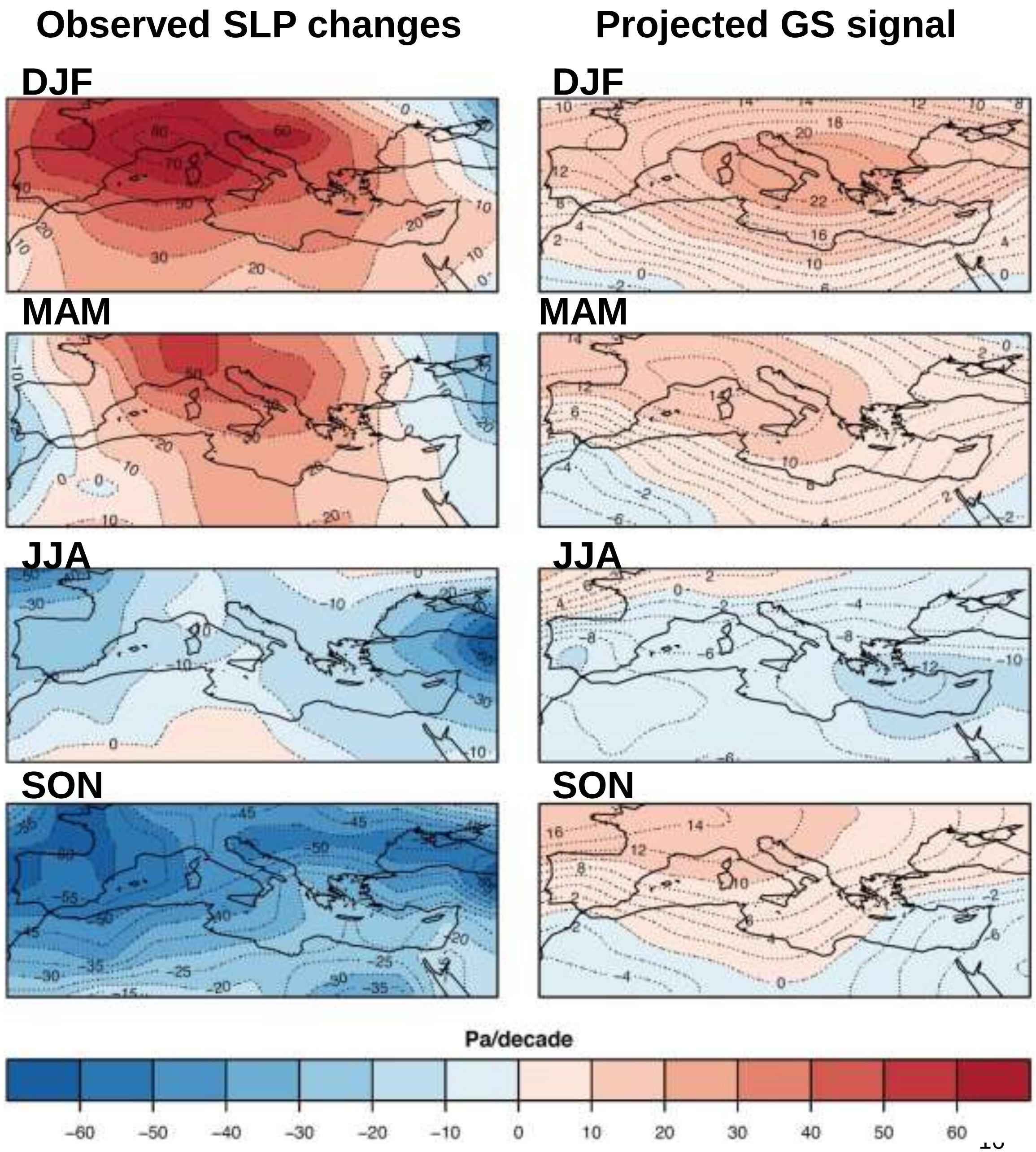

(Barkhordarian A.,2012b)

Surface solar radiation in the Med Sea Region (1985-2004)

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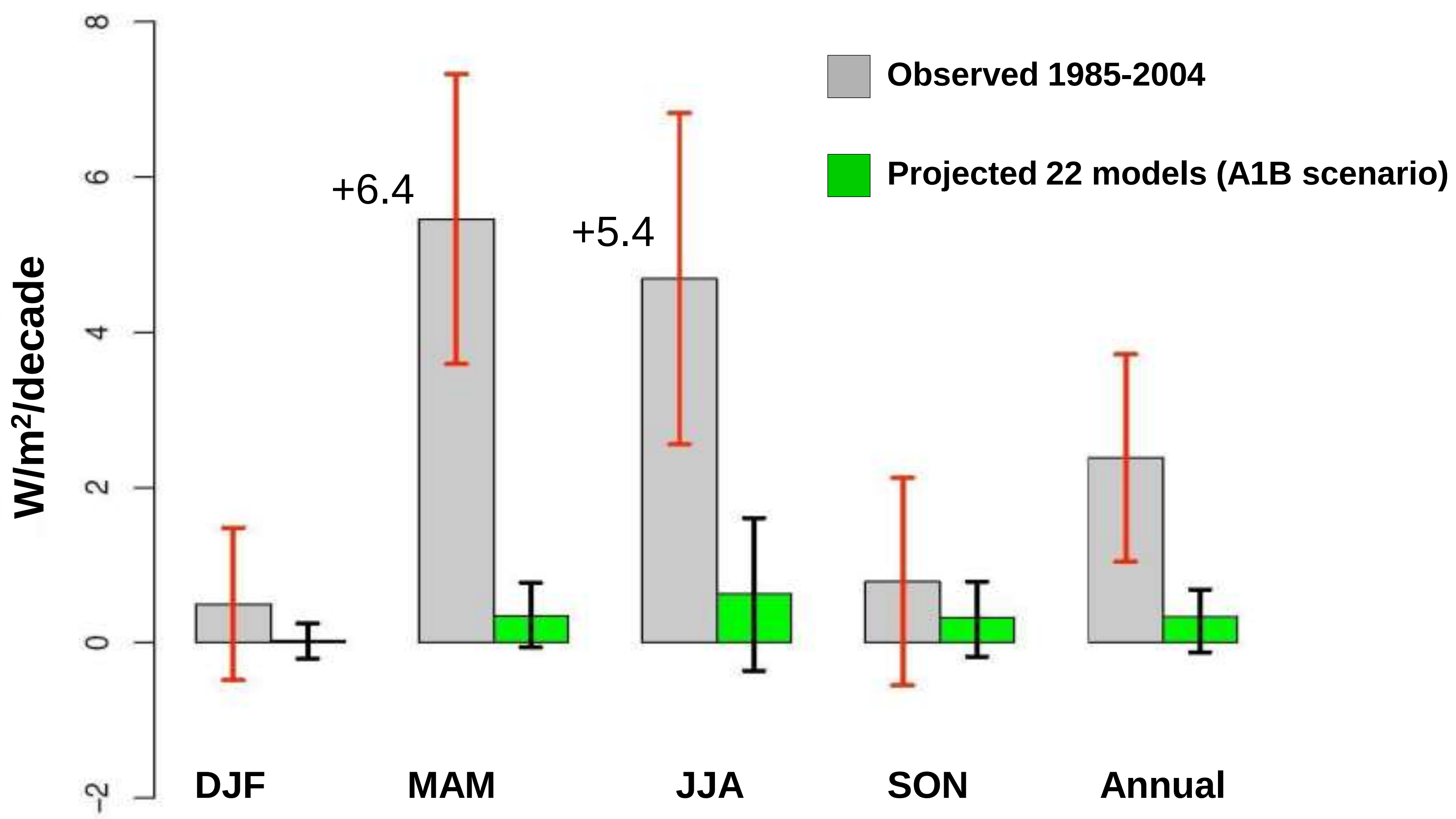

Decrease of anthropogenic aerosols due to:

✓ **more effective clean-air regulations, energy consumption**

✓ **decline in the Eastern European economy in the late 1980s, closure of dirty factories**

Solar surface radiation in the Baltic Sea Region, 1984-2005

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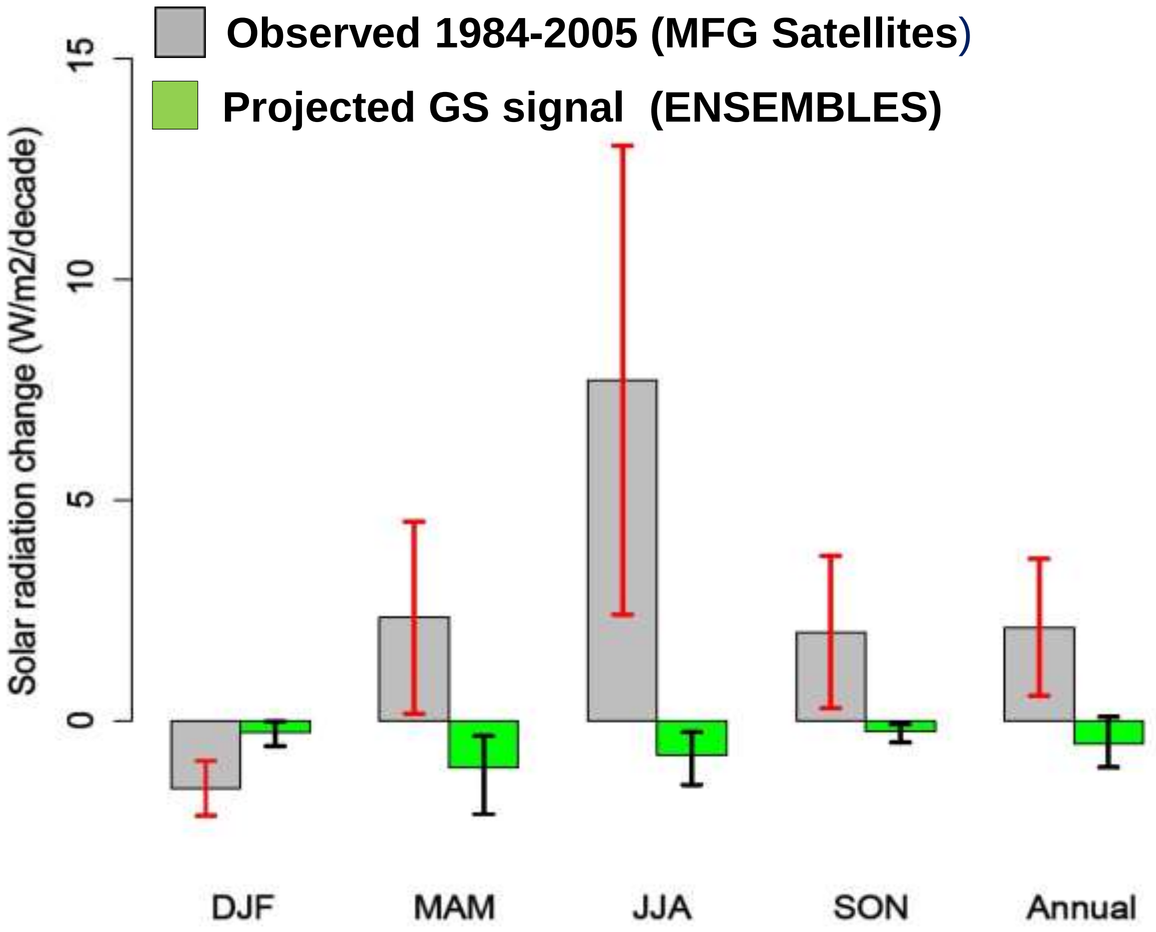
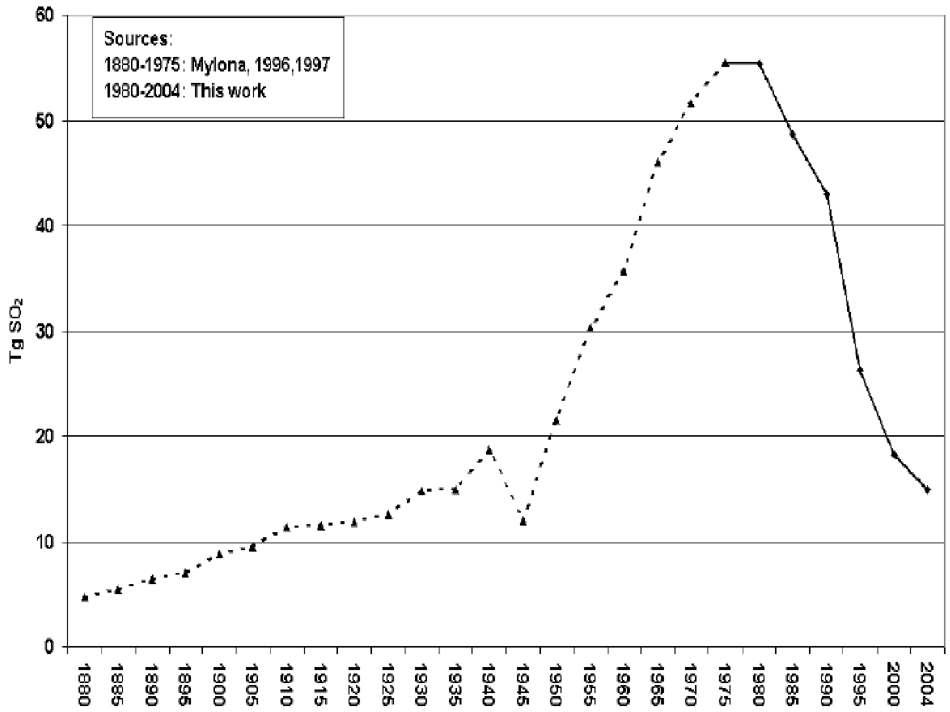




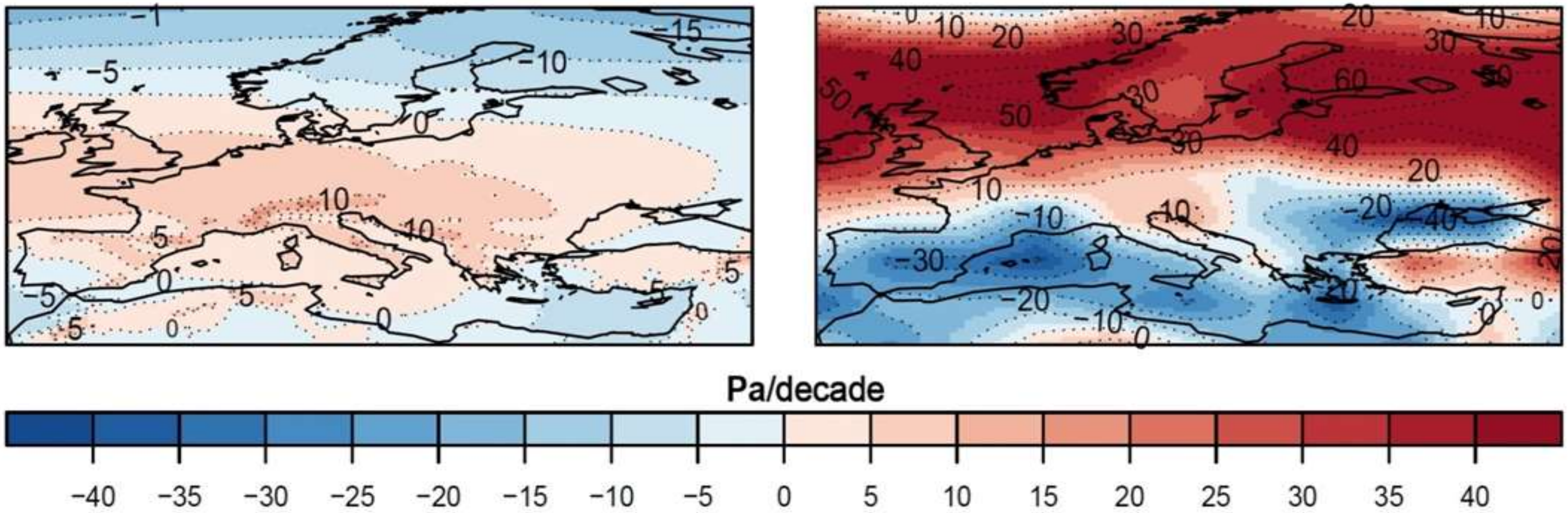
1880-2004 development of sulphur dioxide emissions in Europe (Unit: Tg SO2). (after Vestreng et al., 2007 in BACC-2 report, Sec 6.3 by HC Hansson

- **A possible candidate to explain the observed deviations of the trends in summer and autumn, which are not captured by 10 RCMs, is the effect of changing regional aerosol loads**

Changes in Large-scale circulation (SON) in terms of sea level pressure

Projected GS signal pattern (RCMs)

Observed trend pattern (1978-2009)



- Observed trend pattern shows areas of decrease in SLP over the Med. Sea and areas of increase in SLP over the northern Europe. Observed trend pattern of SLP in SON contradicts regional climate projections.

- **The mismatch between projected and observed precipitation in autumn is already present in the atmospheric circulation.**

Conclusions

Precipitation:

- ✓ An influence of GS signal is detectable in winter and early spring, observed precipitation changes are several times larger than the projected response to GS forcing. The most striking inconsistency, however, is the contradiction between projected drying and the observed increase in precipitation in late summer and autumn

- ✓ Obtained results are insensitive to the removal of NAO fingerprint. And are robust against using a high resolution climate model.

- ✓ The analysis of large-scale circulation patterns, in terms of mean and extreme sea-level pressure and Geopotential height at 500 hPa, confirms the inconsistency detected for precipitation.

Conclusion

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Our analysis indicates that the recent regional climate change in Europe cannot be explained, in the framework of our present knowledge, <u>without</u> reference to elevated greenhouse gases. However, in summer and fall, the river „GHGs" is <u>insufficient</u> in explaining the recent change.

Possible causes:

a) **Suggestion for response to GHG driver by climate model is inaccurate.**
b) **Other drivers are significant, in particular the non-maintenance of the earlier atmospheric aerosol-load (Problem; we have no regional quantified guess patterns)**
c) **Natural variability is underestimated by historical simulation with climate model - the change is still within the range of natural variability.**

Some science is settled, but lots of science is not settled.


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ATTRIBUTION

ATTRIBUTION