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**OESCHGER CENTRE
CLIMATE CHANGE RESEARCH**

Influence of solar activity on the occurrence of weather types over Europe from 1763 to 2009

05.10.2016 – SCOSTEP Workshop

Mikhaël Schwander & Stefan Brönnimann
Oeschger Centre for Climate Change Research
Institute of Geography
University of Bern

Outline

- > Motivation & Research Questions
 - > Data & Methods
 - > Results
 - Analysis of the influence of the solar cycle on the frequency of occurrence of weather types (inter-type).
 - Analysis of within-type differences
 - Comparison with FUPSOL simulations
 - > Conclusion
-

Motivation & Research Questions

- > How does the 11-year solar cycle affect the atmospheric circulation over Europe?
- > Can changes be identified through variations in the frequency of occurrence of weather types?
- > Huth et al. (2008)

Ann. Geophys., 26, 1999–2004, 2008
www.ann-geophys.net/26/1999/2008/
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Solar activity affects the occurrence of synoptic types over Europe

R. Huth¹, J. Kyselý¹, J. Bochníček², and P. Hejda²

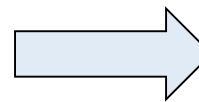
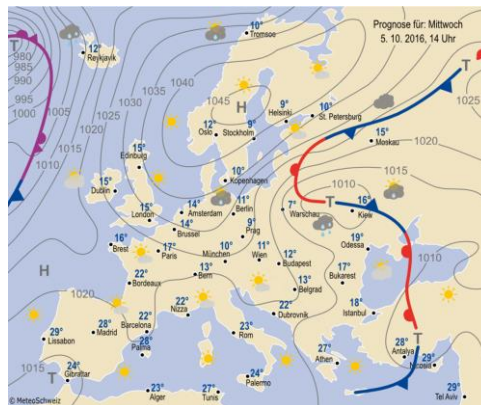
¹Institute of Atmospheric Physics, Boční II 1401, 141 31 Praha 4, Czech Republic

²Institute of Geophysics, Boční II 1401, 141 31 Praha 4, Czech Republic

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Weather Type Classifications (WTCs)

- > WTCs aim at identifying recurrent dynamical patterns for a specific region.
- > Manual or automatic.
- > Many different methods.



Data & Methods - CAP7

- > CAP (Cluster Analysis of Principal Components) is a classification method used by MeteoSwiss.
- > The classification is available with 9, 18 and 27 types.
- > Daily weather types from 1957 computed with ERA-40/-Interim.

=> CAP9 selected as reference

- > Sea level pressure and temperature from 13 European weather stations used to reconstruct the weather types.
- > 7 daily weather types from 1763 to 2009.

=> **CAP7** (Schwander et al., submitted)

Data & Methods - CAP7

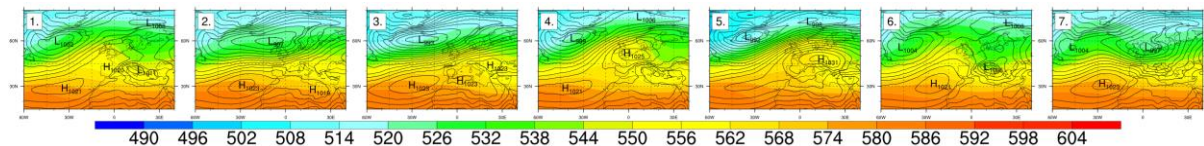
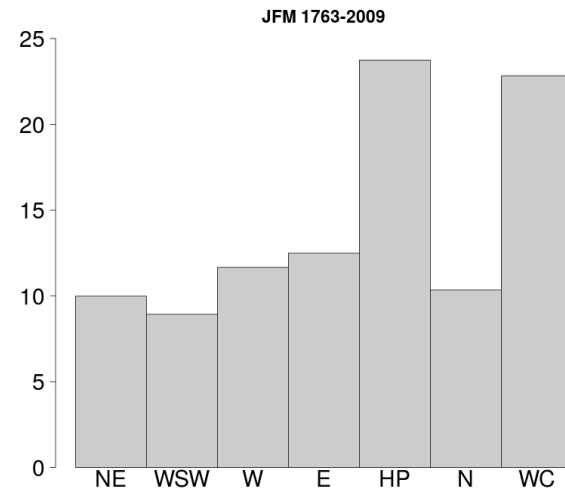
> CAP7

1. (NE) NorthEast
2. (WSW) West-SouthWest
3. (W) Westerly flow over Northern Europe
4. (E) East
5. (HP) High Pressure over Europe
6. (N) North
7. (WC) Westerly flow over Southern Europe

Data & Methods - CAP7

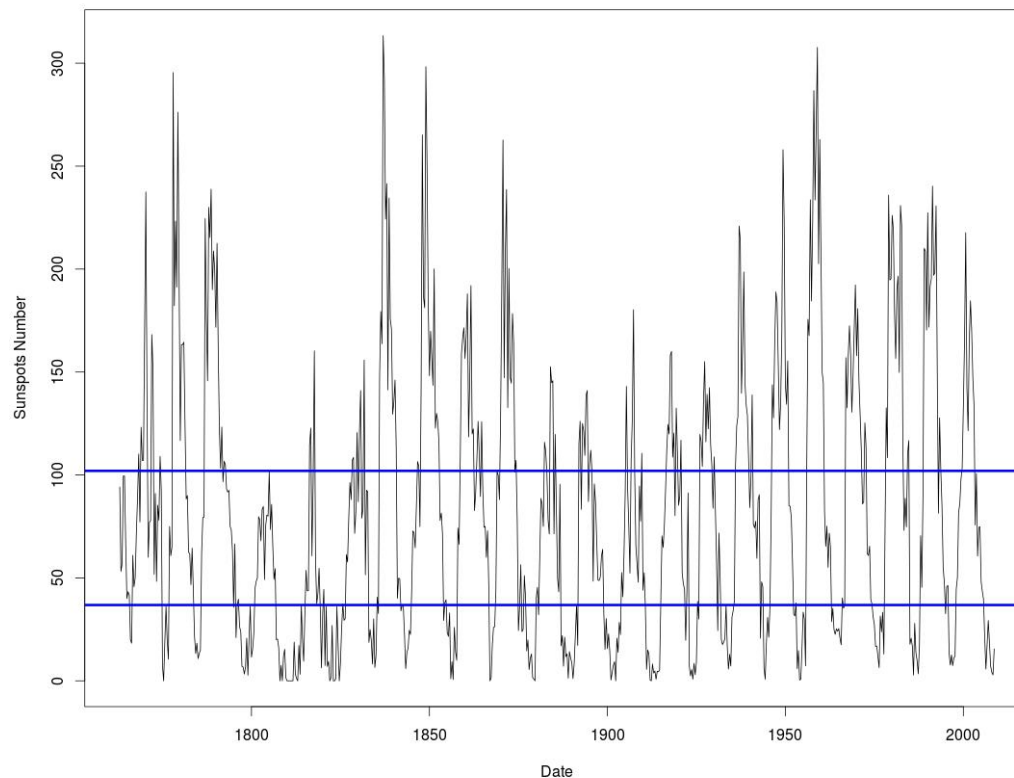
> CAP7

Date	Type	Probability
1921-01-25	5	72.306
1921-01-26	3	81.535
1921-01-27	6	97.773
1921-01-28	5	96.289
1921-01-29	5	91.53
1921-01-30	3	69.781
1921-01-31	7	94.315
1921-02-01	7	99.994
1921-02-02	7	92.813
1921-02-03	2	34.433
1921-02-04	1	98.516
1921-02-05	1	94.175
1921-02-06	4	84.224



Data & Methods - Sunspot

January-February-March (JFM) monthly sunspot number.



High

Moderate

Low

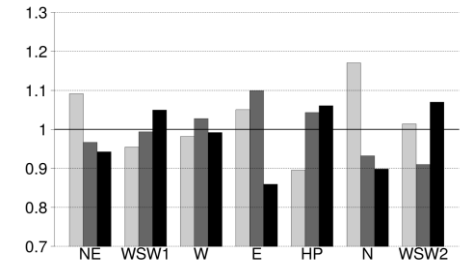
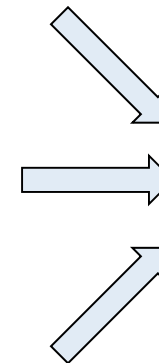
Data & Methods - Classification

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Low

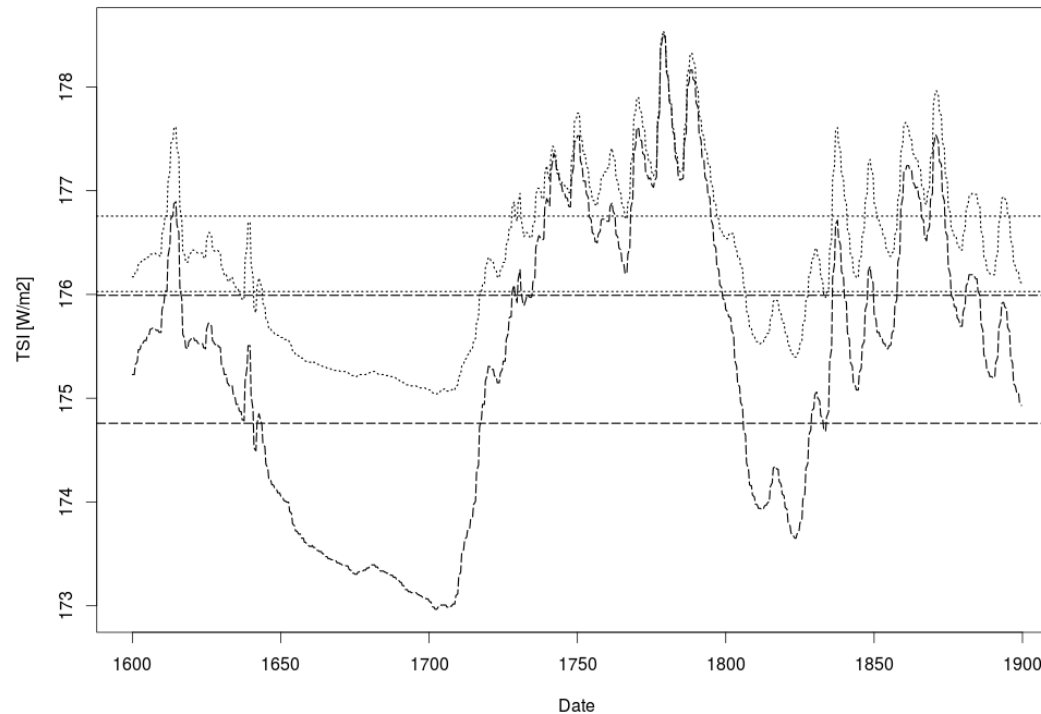
Moderate

High



Data & Methods – Model Simulations

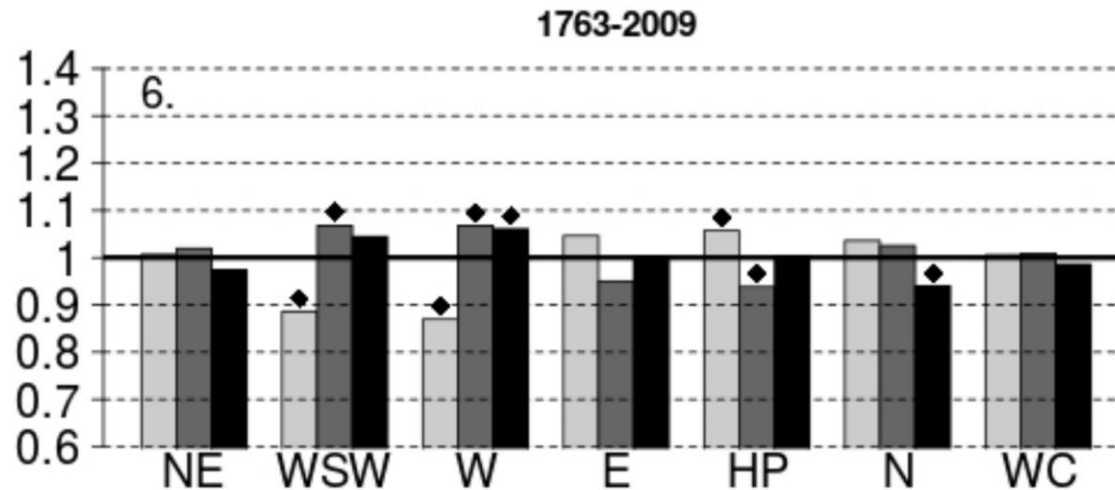
- > 4 model simulations (SOCOL)
- > Large amplitude (L1/L2), Moderate amplitude (M1/M2)



Shapiro et al., 2011

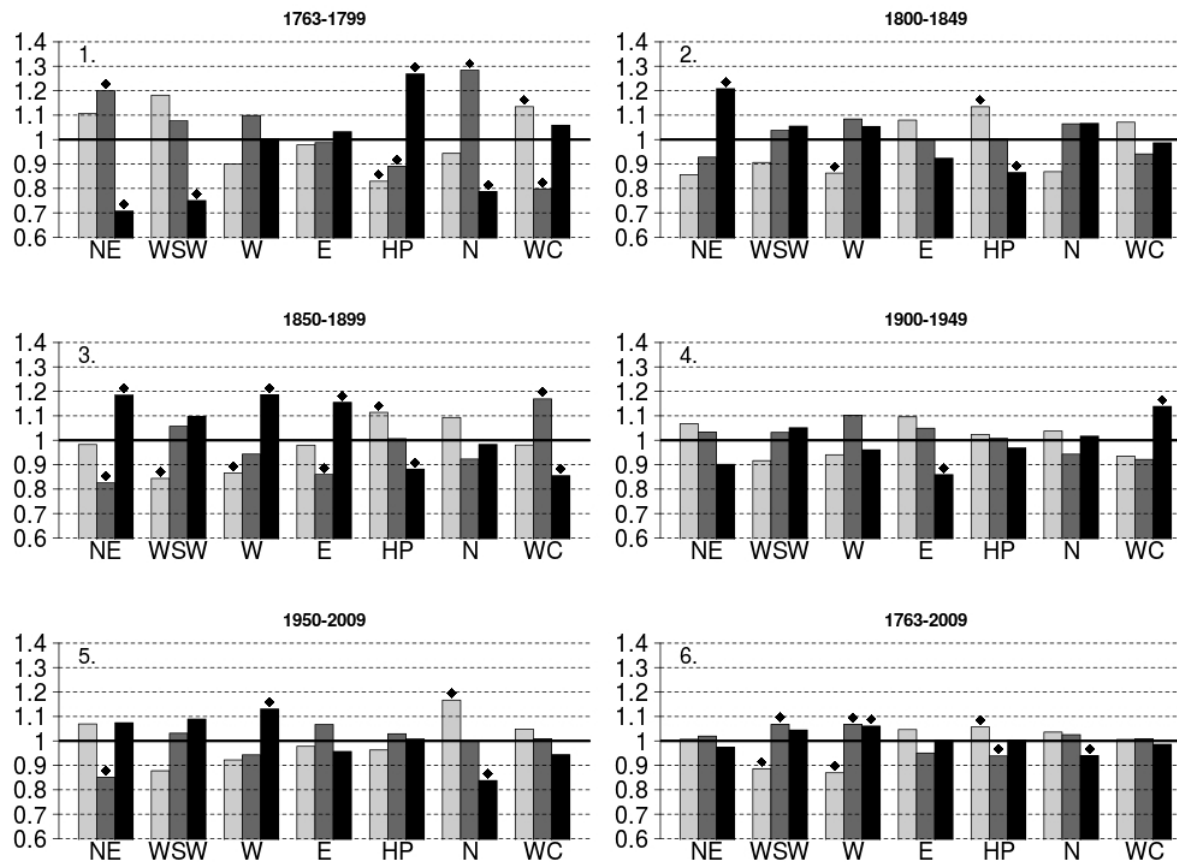
Results – Weather Types Occurrence

1763-2009 CAP 7 low/moderate/high activity frequency of occurrence.



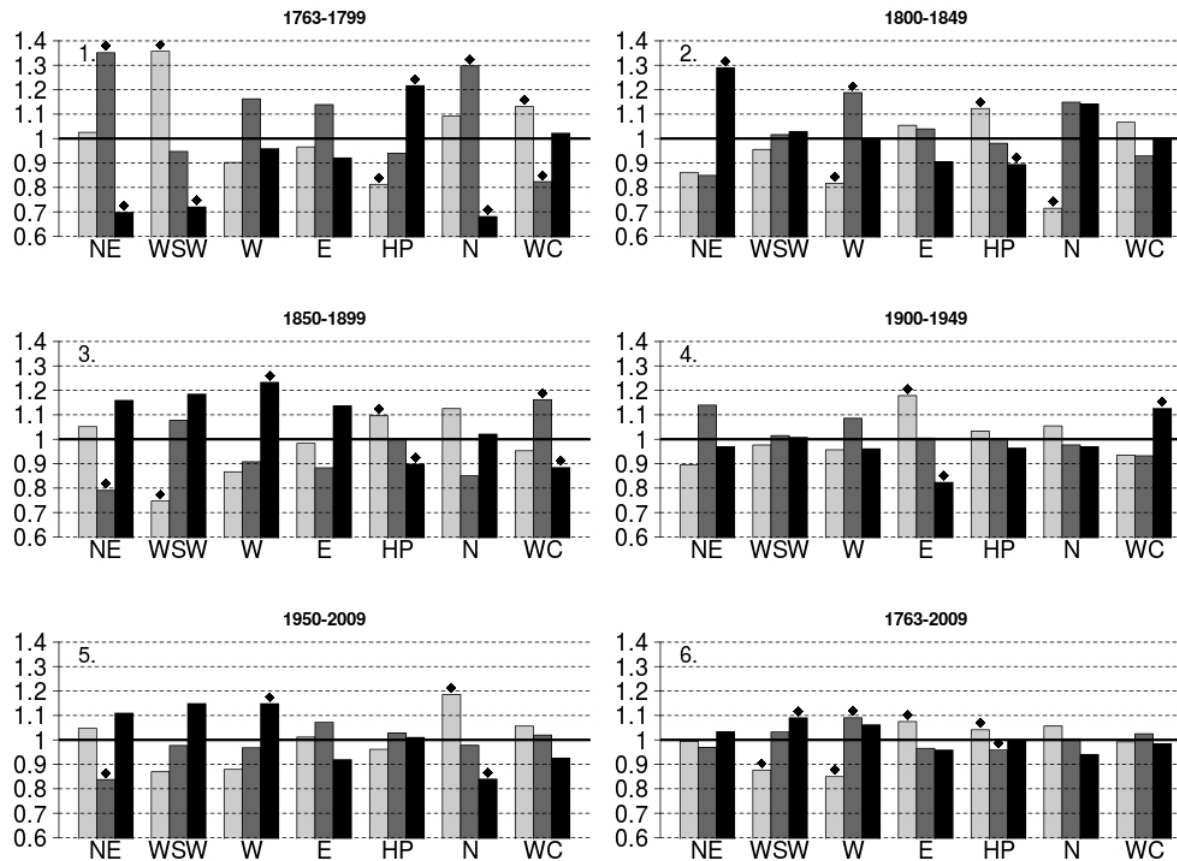
Results – Weather Types Occurrence

1763-2009 CAP 7 low/moderate/high activity frequency of occurrence.

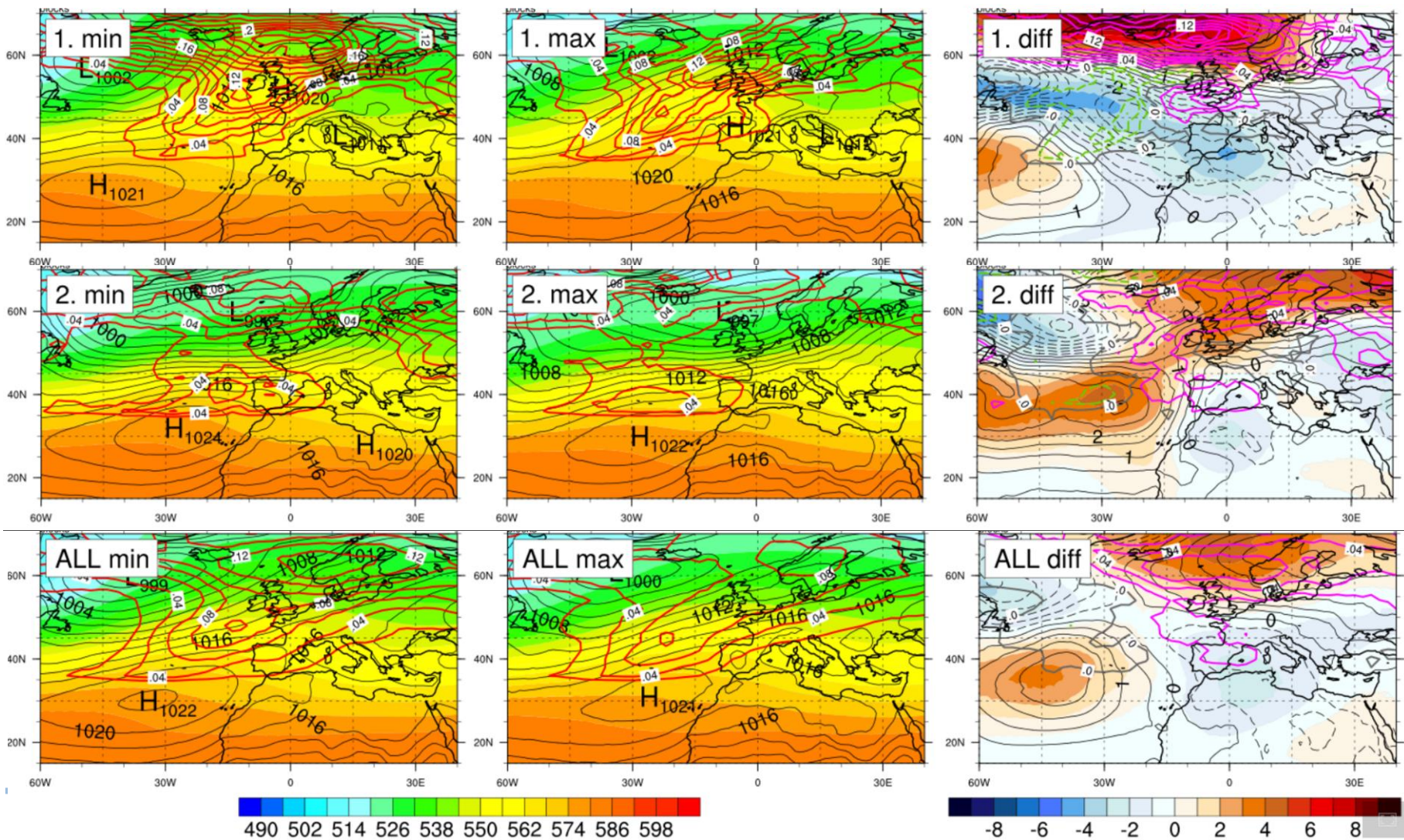


Results – Weather Types Occurrence

1763-2009 CAP 7 (>75%) low/moderate/high activity frequency of occurrence.

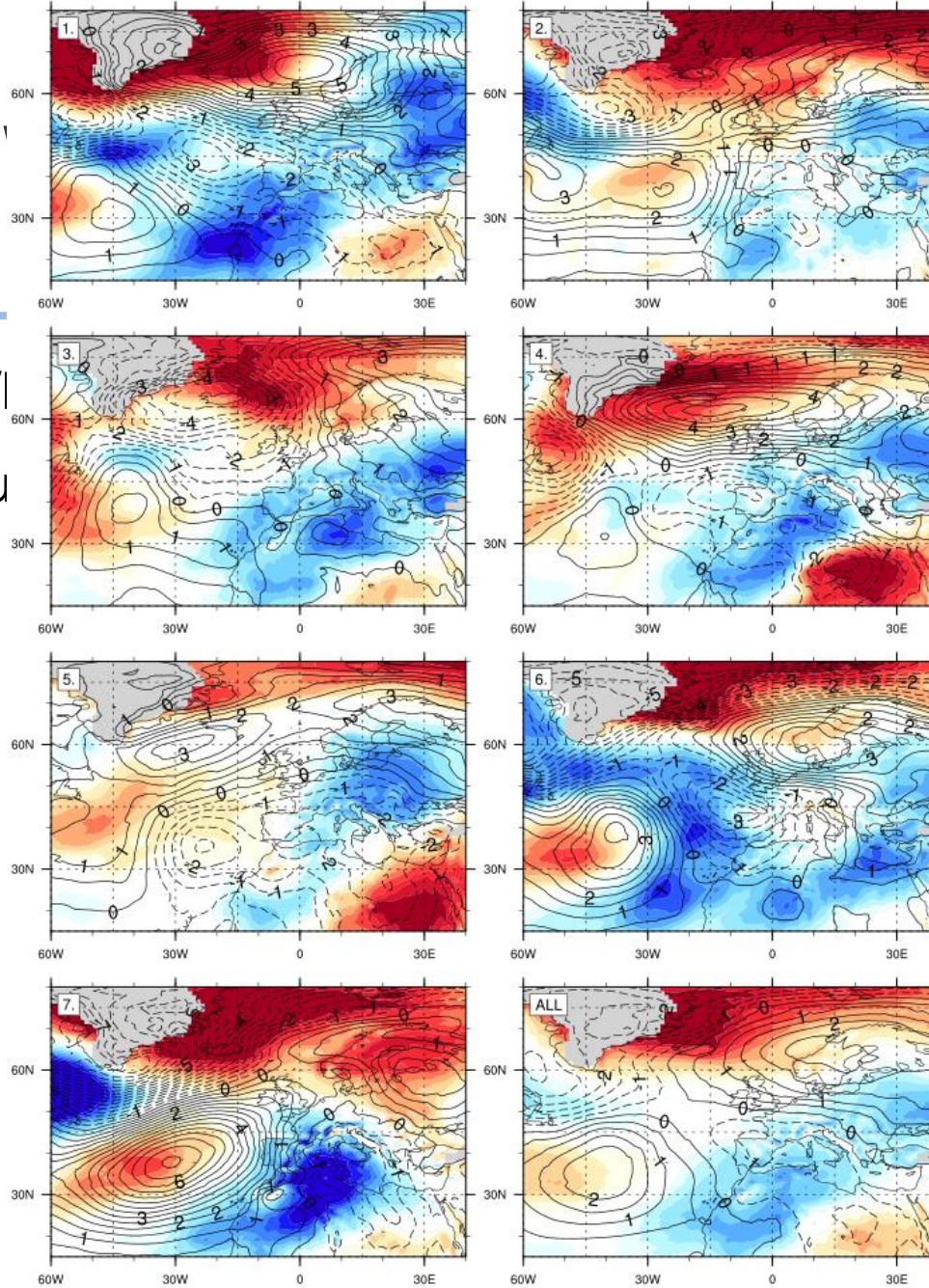


Results – Within-Types Differences



Results –

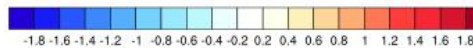
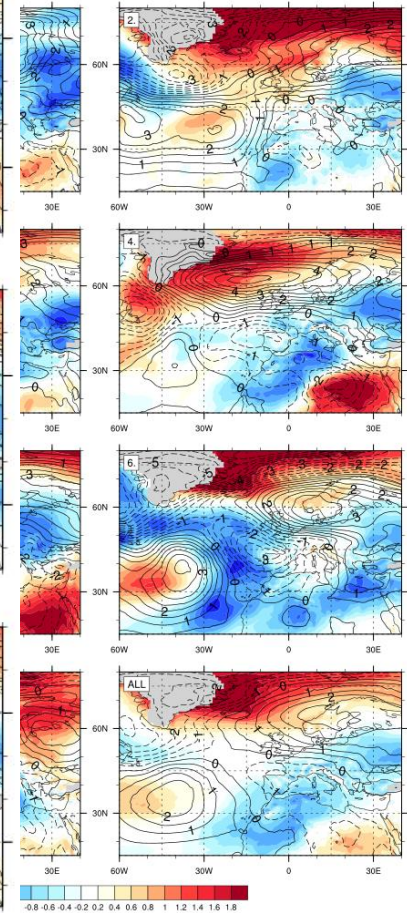
1958-2009 Low/
Sea level pressu



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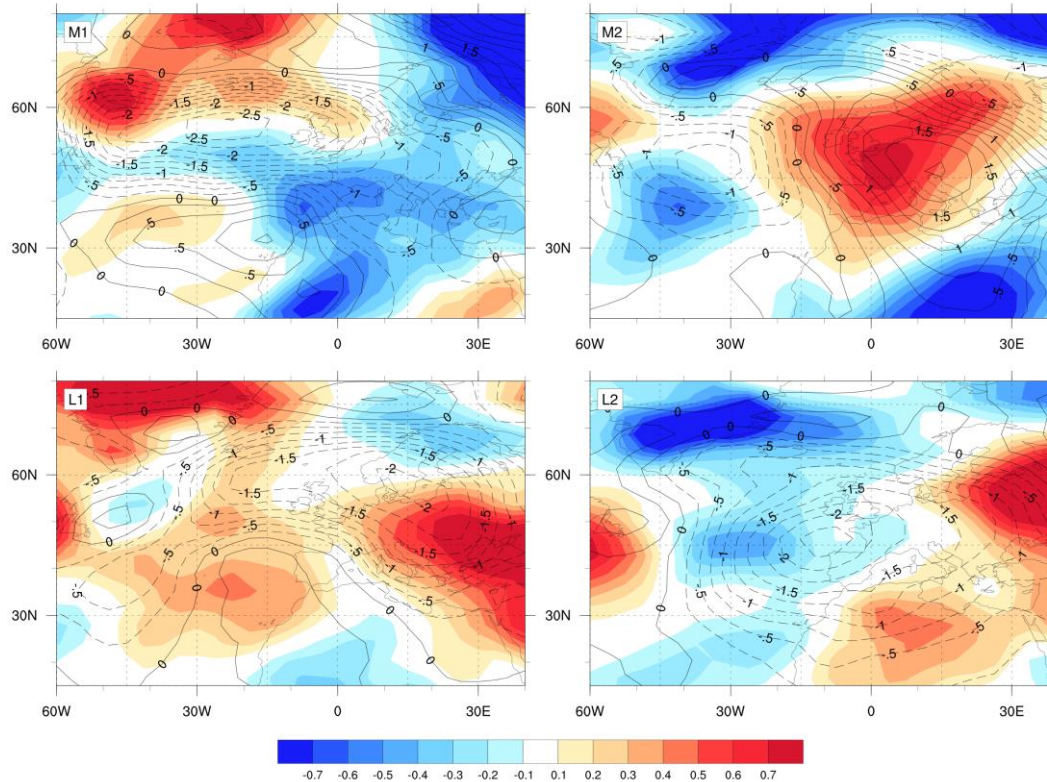
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Results – Model Simulations

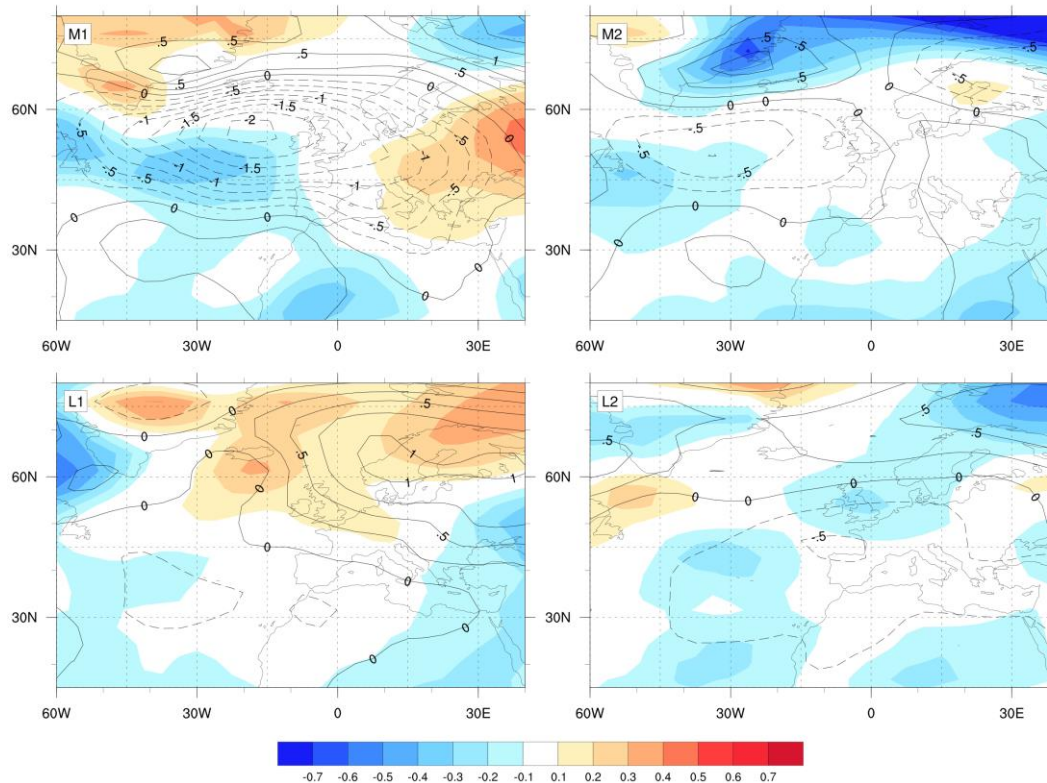
1958-2009 Low/High 11-year cycle solar activity difference
Sea level pressure and 850 hPa temperature



Results – Model Simulations

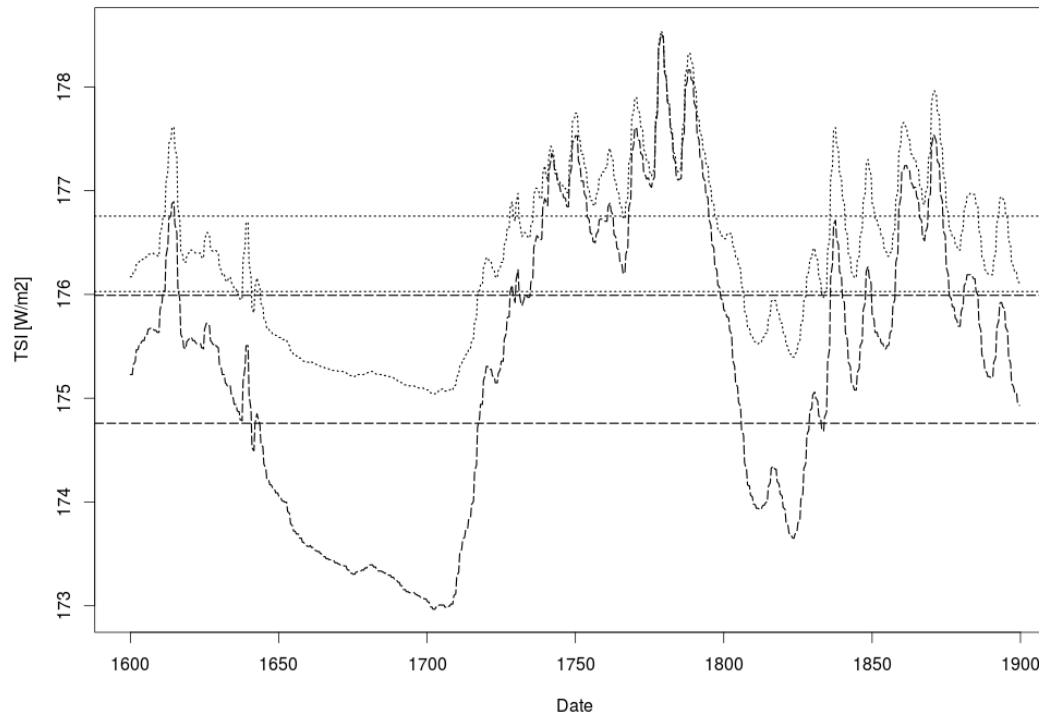
1763-2009 Low/High 11-year cycle solar activity difference

Sea level pressure and 850 hPa temperature



Results – Model Simulations

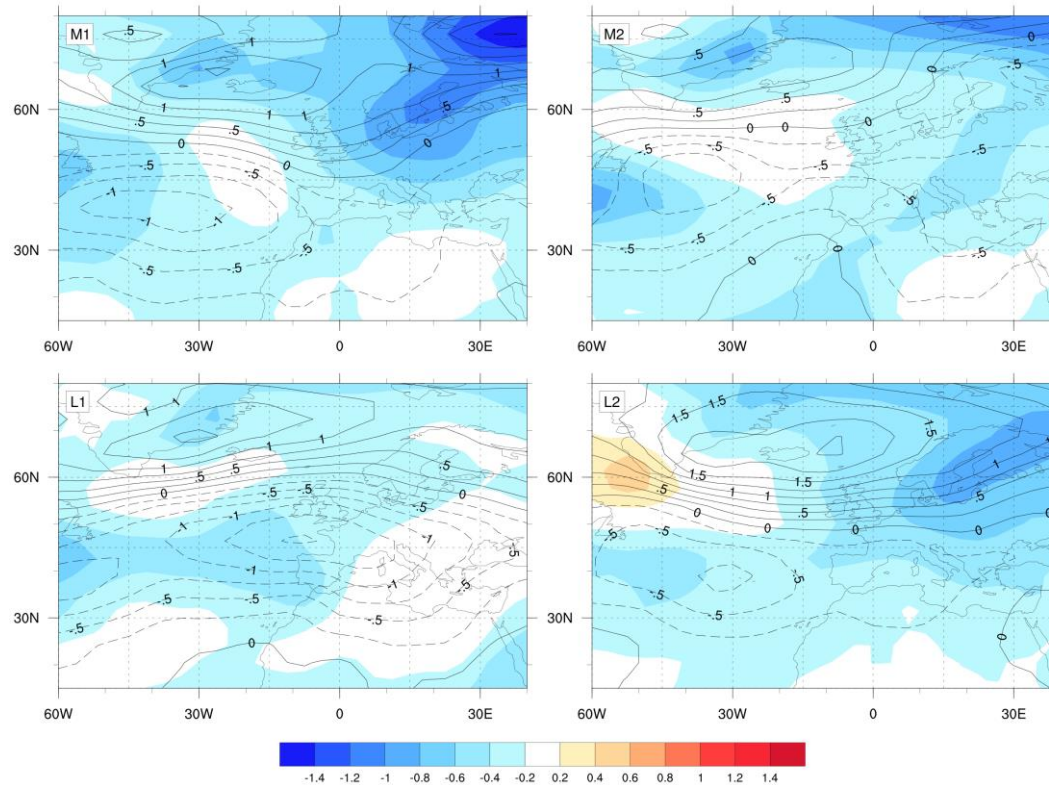
1600-1899 Low/High solar activity difference



Results – Model Simulations

1600-1899 Low/High solar activity difference

Sea level pressure and 850 hPa temperature



Summary

- > Reduction in the occurrence of westerly types under low solar activity.
 - > Increase in the occurrence of easterly types under low solar activity.
 - > Weaker westerly flow under low solar activity and higher pressure over Scandinavia.
 - > Not confirmed by model simulations.
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Thank You
for your Attention!

References

Huth, R., Kyselý, J., Bochníček, J., & Hejda, P. (2008). Solar activity affects the occurrence of synoptic types over Europe. In *Annales Geophysicae* (Vol. 26, No. 7, pp. 1999-2004). Copernicus GmbH.

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Schwander, M., Brönnimann, S., Delaygue, G., (submitted) Rohrer M., Auchmann, R., Brugnara Y. Reconstruction of central European weather types back to 1763. In *International Journal of Climatology*.

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