Linking atmospheric blocking to European temperature extremes in spring

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Introduction

The weather in Europe is influenced by dynamical features such as the jet stream and atmospheric blocking. Blocking describes an atmospheric situation in which a stationary high pressure system interrupts the climatological westerly flow for up to several weeks. It can trigger cold and warm spells which is of special relevance in spring because vegetation is particularly vulnerable to extreme temperatures in the early greening phase.

We investigate European cold and warm spells in temperature observations from the E-OBS data set in the period 1979 to 2014 and connect them to blocking derived from geopotential height fields from ERA-Interim.

1. Blocked days and extreme days

A blocked day is defined as day with blocking anywhere in the Euro-Atlantic blocking region. A cold spell day (CSD) or warm spell day (WSD) is identified if T_{min} is below the 10th percentile or T_{max} is above the 90th percentile for at least 6 consecutive days in an area of at least 5°x5° (lon-lat).

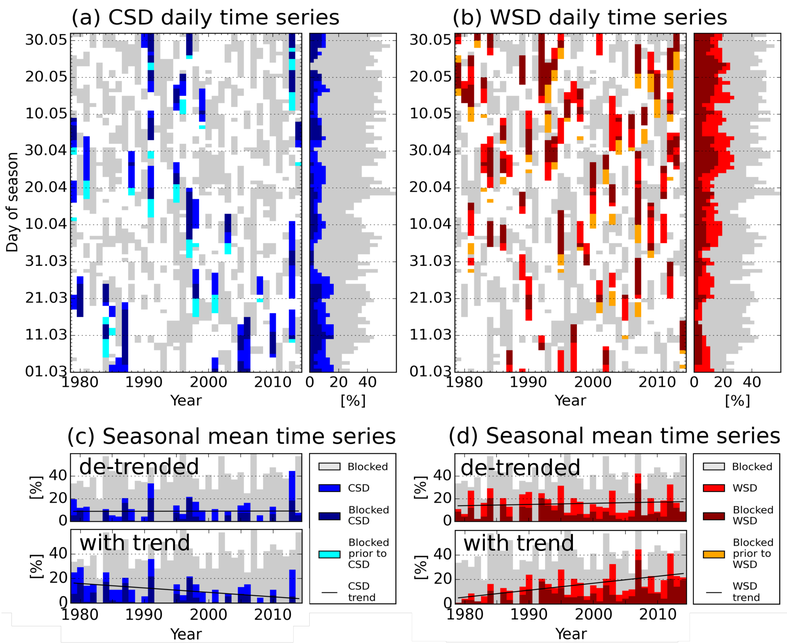

Fig. 1: Time evolution of blocking, (a) CSDs, and (b) WSDs in European spring. Time series (c,d) with the temperature trend removed (top) and not removed (bottom).

References: Brunner, L., G. C. Hegerl, A. K. Steiner (2017): Connecting atmospheric blocking to European temperature extremes in spring. J. Climate 30.2, pp. 585-594, doi:10.1175/JCLI-D-16-0518.1. | AGRI4CAST, 2016: JRC MARS Bulletin - Crop monitoring in Europe, European Commission/Joined Research Centre, URL https://ec.europa.eu/jrc/sites/default/files/jrc-mars/bulletin/vol24-no5.pdf. **Acknowledgments:** This work was funded by the Austrian Science Fund (FWF) under research grant W 1256-G15 (Doctoral Programme Climate Change – Uncertainties, Thresholds and Coping Strategies). L. Brunner was financially supported by a Marietta Blau scholarship by the Austrian Exchange Service (OeAD), financed by funds from the Austrian Federal Ministry of Science, Research and Economy (BMWFW).G. Hegerl was supported by the ERC funded project TITAN (EC-320691), and by the Wolfson Fundation and the Royal Society Wolfson Research Merit Award (WM130060), and by NCAS. We acknowledge the E-OBS dataset from the EU-FP6 project ENSEMBLES (http://ensembles-eu.metoffice.com) and the data providers in the ECA&D project (http://www.ecad.eu), and ECMWF (Reading, UK) for access to its ERA-Interim data set.

2. Blocking frequencies during extreme days

Blocking frequencies during both, CSDs and WSDs differ statistically significant from the climatological mean. During spring the link between blocking and cold conditions weakens while the link between blocking and warm conditions strengthens.

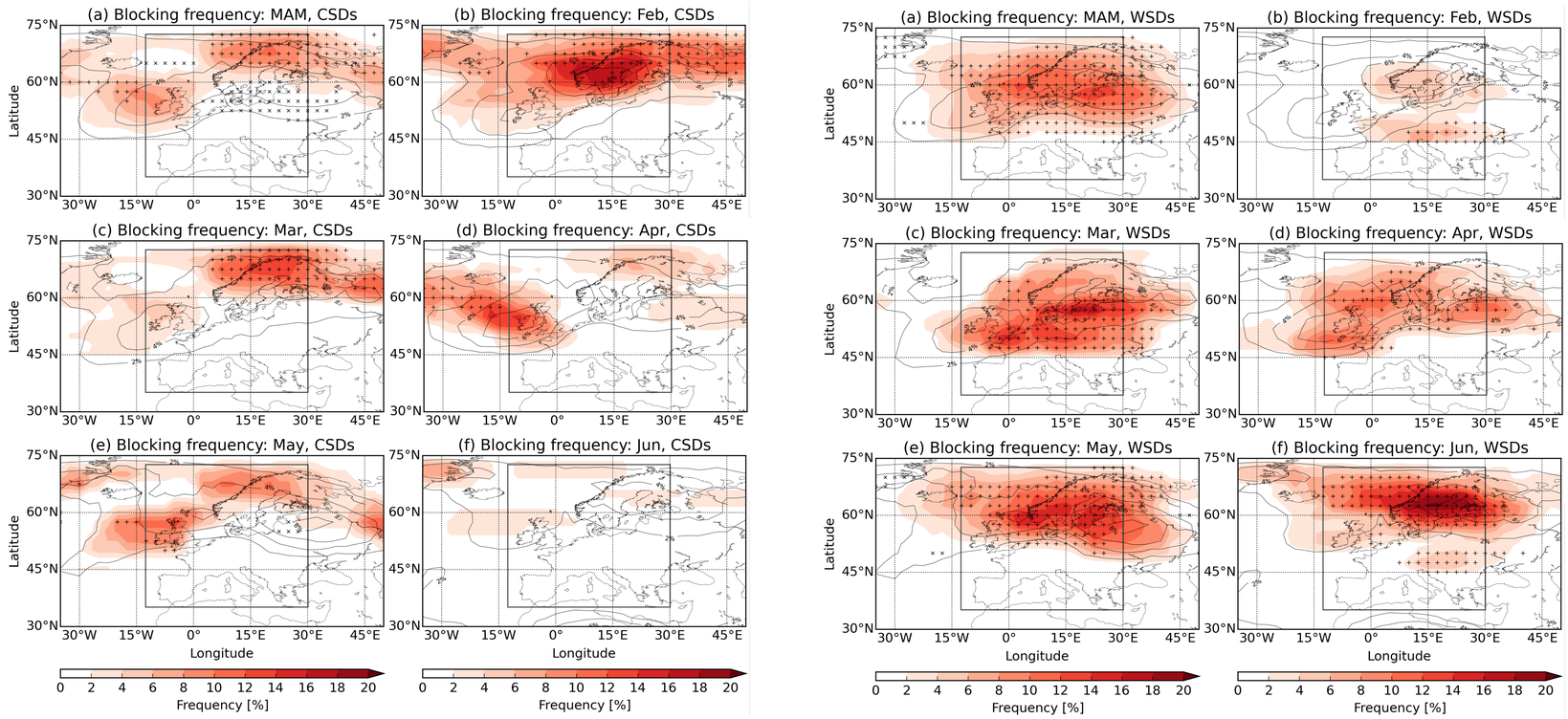

Fig. 2: Blocking frequency over Europe during (left) CSDs and (right) WSDs in (a) March-April-May (MAM) and (b-f) for each month from February to June. Statistically significant values are marked with + (>95th percentile) or x (<5th percentile).

3. Extreme occurance during blocked days

A north-south pattern of the temperature response to blocking shows that CSDs in south-east Europe are caused by cold advection on the eastern and southern flanks of the block. WSDs in northern Europe are due to radiative forcing in the center of the block.

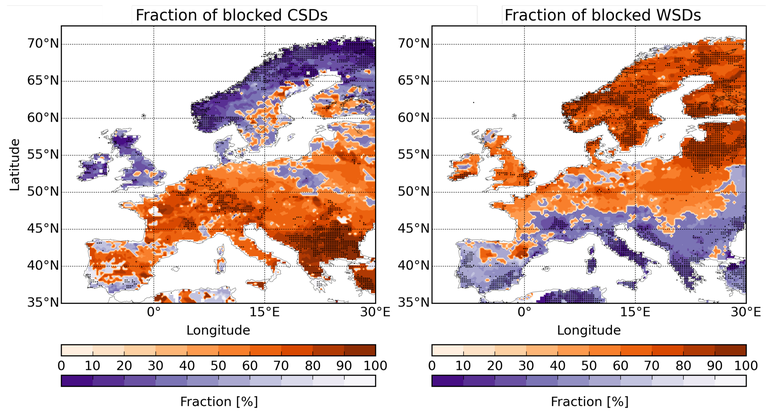

Fig. 3: Fraction of (left) CSDs and (right) WSDs during blocking.

Summary and Conclusions

Our results show statistically significant correlations of blocking frequency and the occurrence of cold spells and warm spells throughout the spring season in Europe (Brunner et al. 2017). We find blocking in winter and early spring to be stronger connected to cold conditions while blocking in late spring and summer is stronger connected to warm conditions. More than 80% of cold spells in south-eastern Europe occur during blocking events situated over the north-eastern Atlantic and northern Scandinavia, whereas warm spells in northern Europe are correlated to blocking over Scandinavia. In the analysis period 1979-2014, substantial interannual variability is found but also a decrease in cold spells and an increase in warm spells over the last 15 years. In such a shifted seasonal environment the occurrence of late spring (blocking connected) cold spells becomes even more critical and detrimental to vegetation as happened in central Europe in April 2016 (AGRI4CAST 2016).