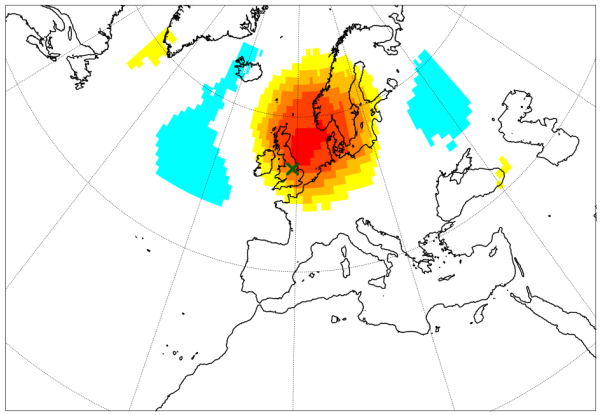
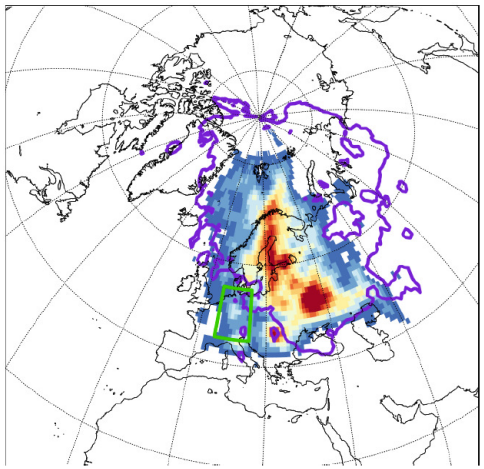
The importance of atmospheric blocking for European temperature extremes





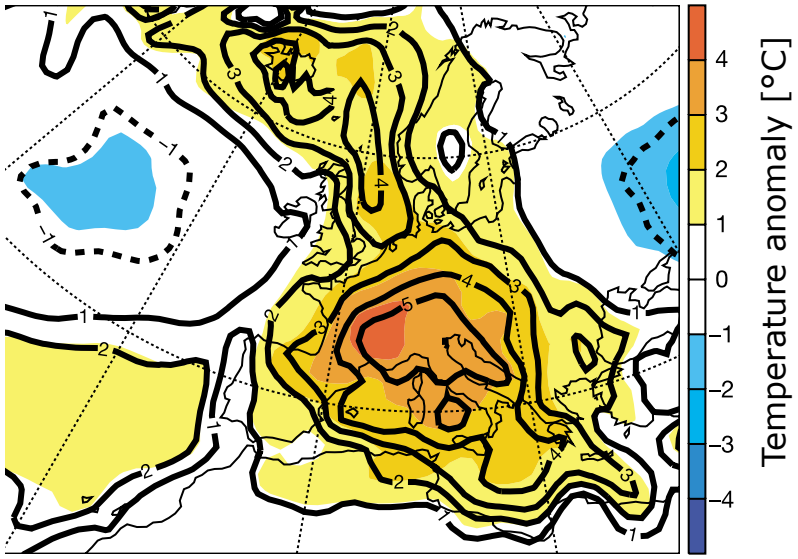
Stephan Pfahl, Melanie Bieli and Heini Wernli

Institute for Atmospheric and Climate Science, ETH Zurich

Example: 2003 heat wave

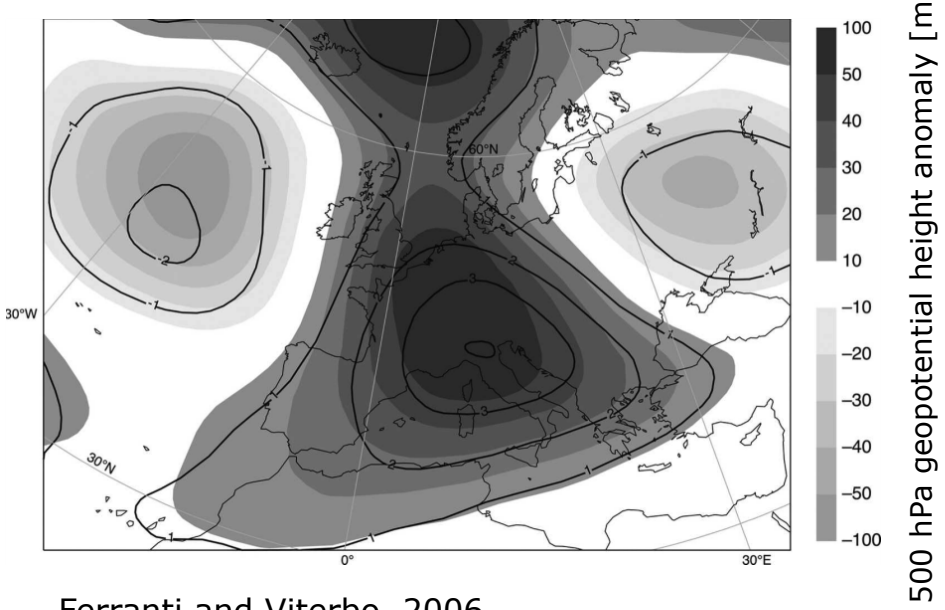
Summer 2003:

Temperature anomaly



Schär et al., 2004

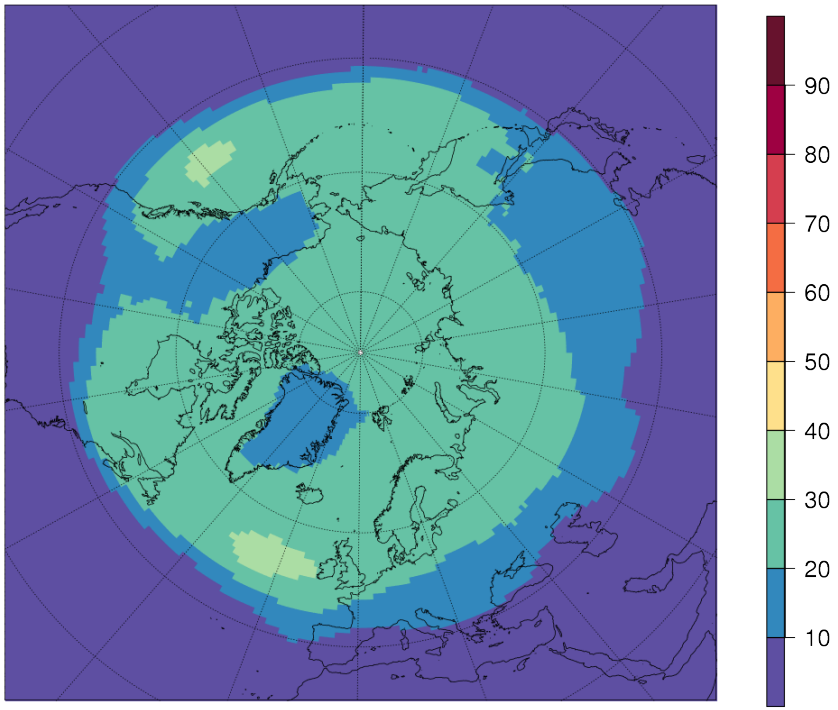
500 hPa geopotential anomaly



Ferranti and Viterbo, 2006

Method

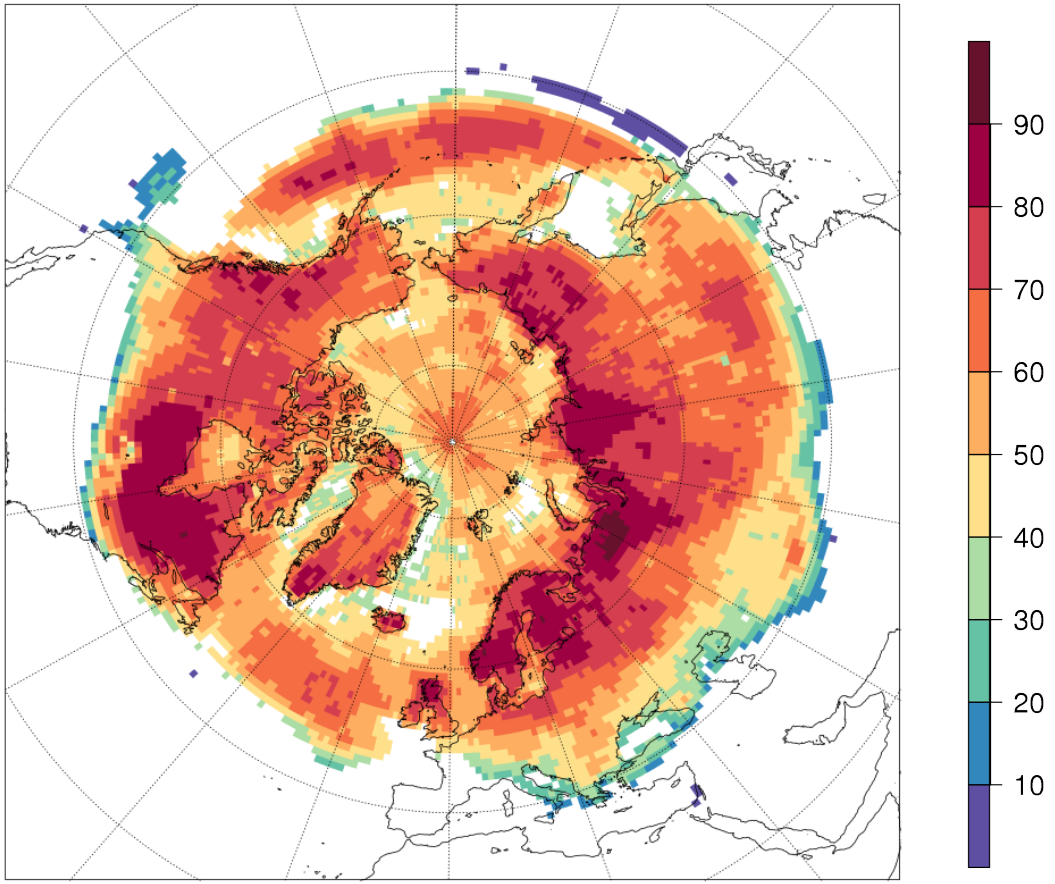
- Identify atmospheric blocking as temporally persistent negative potential vorticity anomalies in the middle/upper troposphere (Schwierz et al., 2004) based on ERA-Interim reanalysis data.



Frequency (%) of weak blocking during summer 1989-2009.

- Determine blocking frequencies during six-hourly near-surface temperature extremes (1% most extreme events).

Summer hot extremes co-located with blocking



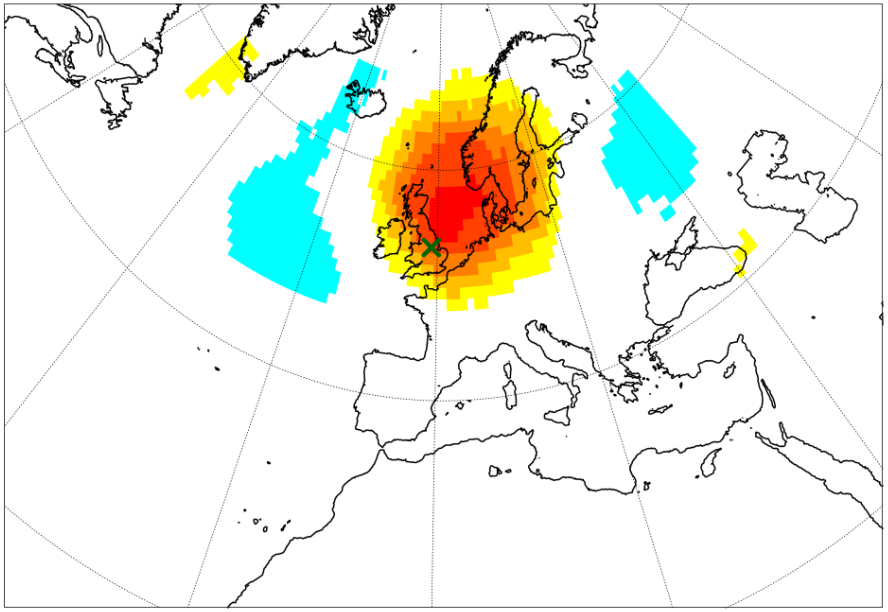
Percentage of hot temperature extremes co-occurring with atmospheric blocking at the same location.

Pfahl and Wernli, *Geophys. Res. Lett.*, 2012

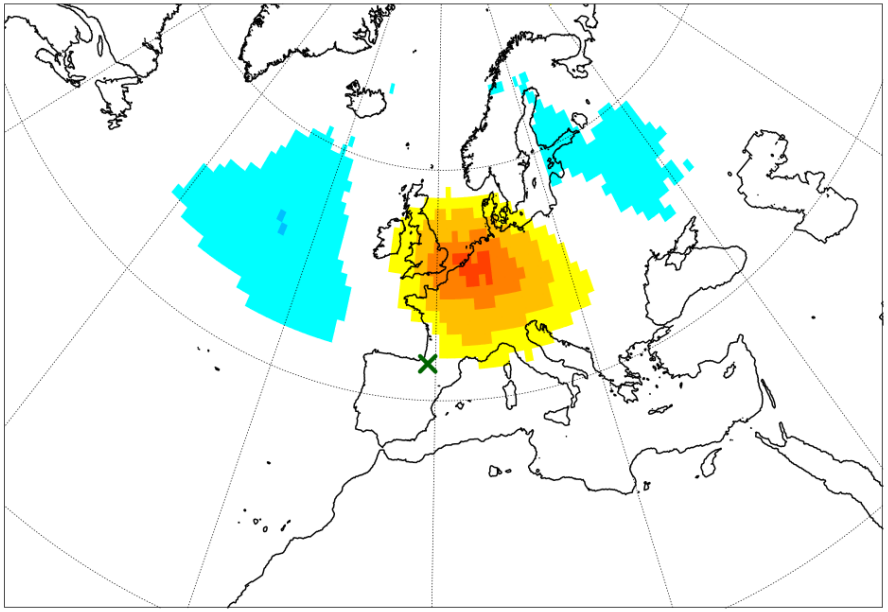
Blocking frequencies during European summer hot extremes

Blocking frequency anomalies (%) during hot extremes at

Nottingham, UK



Pamplona, Spain

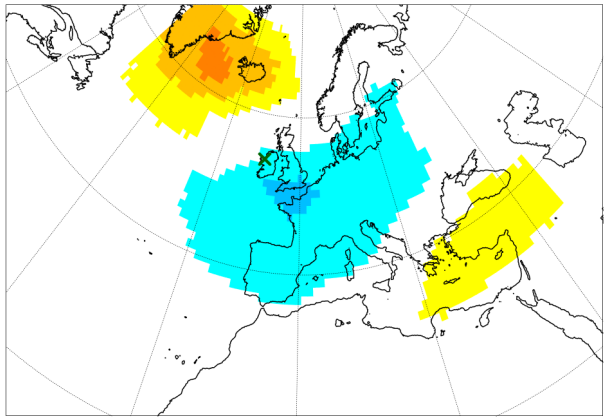


Pfahl, *Nat. Hazards Earth Syst. Sci.*, 2014

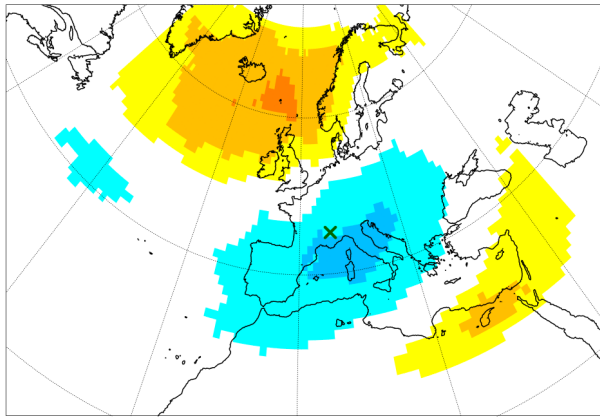
Blocking frequencies during European winter cold extremes

Blocking frequency anomalies (%) during cold extremes at

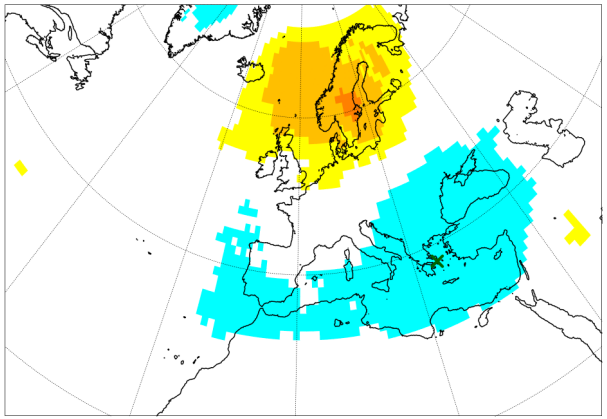
Western Ireland

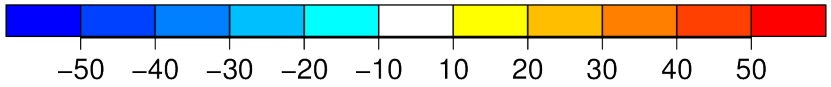


Grenoble, France



Athens, Greece



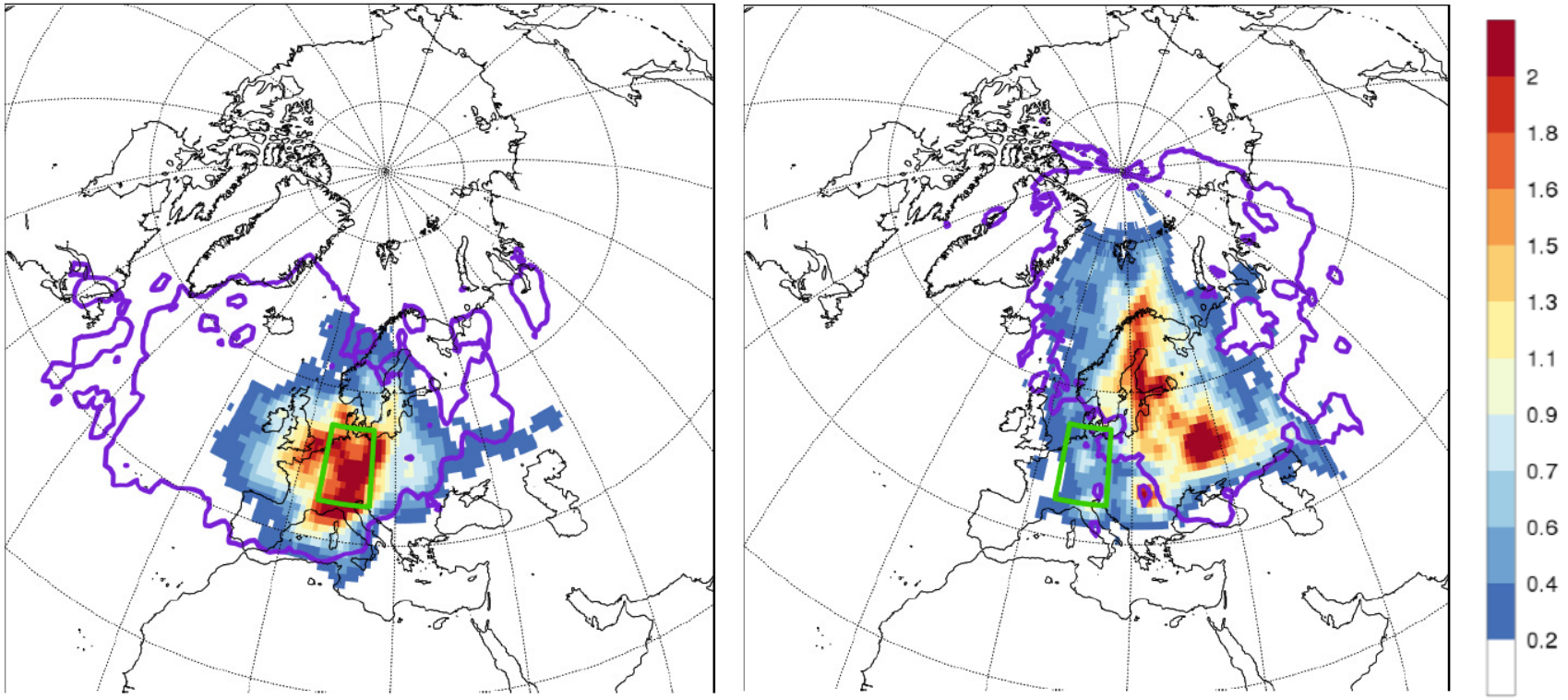


Pfahl, *Nat. Hazards Earth Syst. Sci.*, 2014

Air masses associated with Central European temperature extremes

Hot extremes

Cold extremes

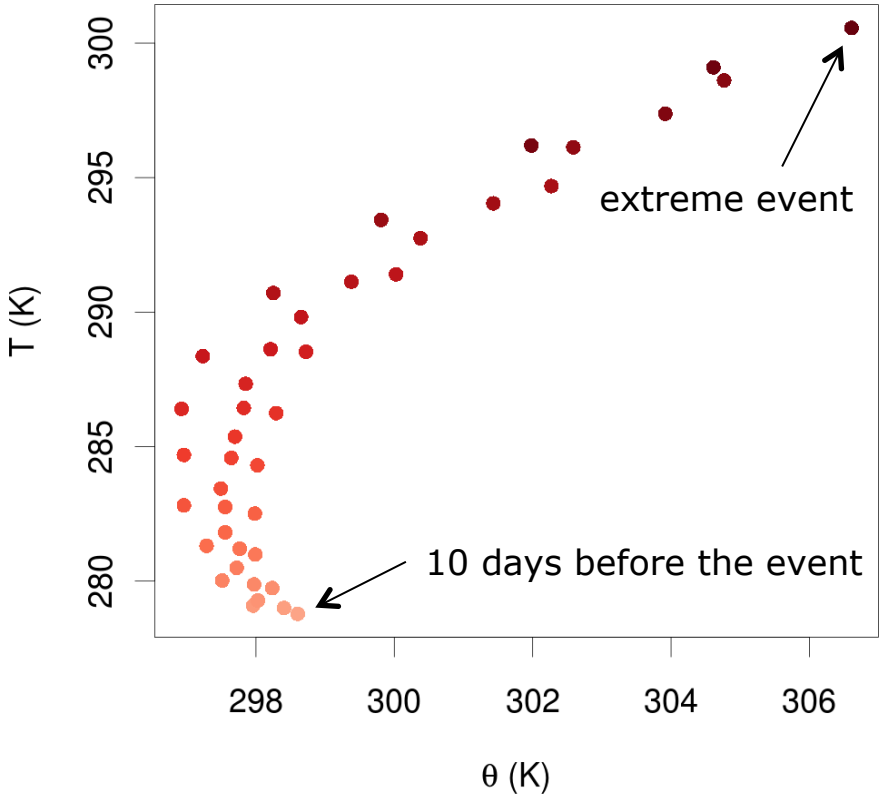


Density of backward trajectories started during temperature extremes in Central Europe (green box) four days before the events.

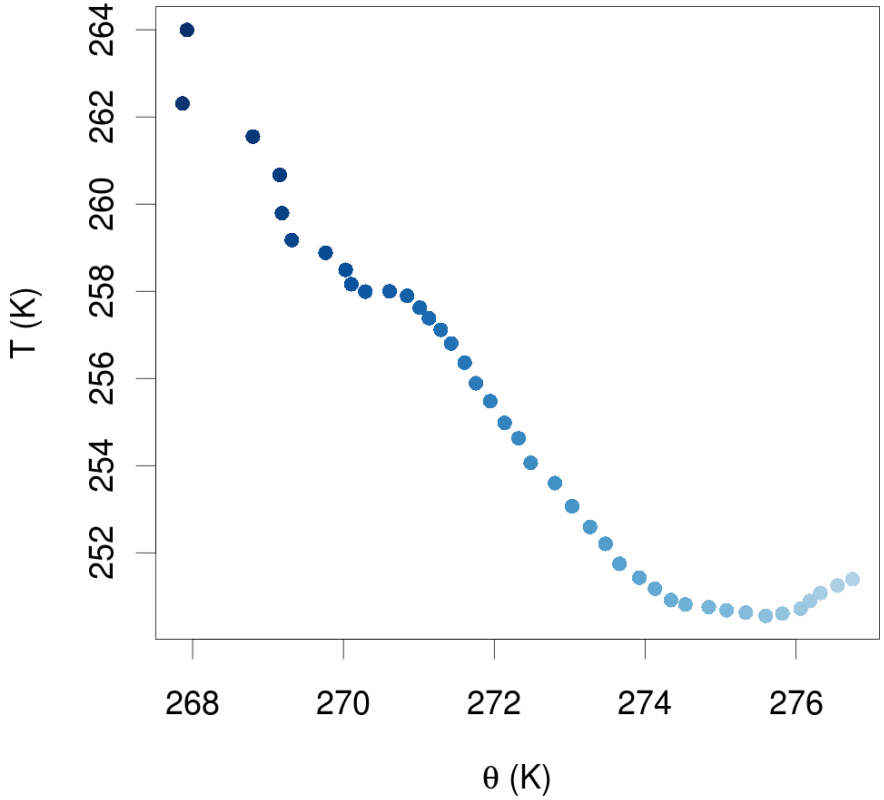
Bieli, Pfahl and Wernli, *Q. J. R. Meteorol. Soc.*, 2015

Air masses associated with Central European temperature extremes

Hot extremes



Cold extremes



Median temperature and potential temperature evolution along trajectories associated with temperature extremes in Central Europe.

Bieli, Pfahl and Wernli, *Q. J. R. Meteorol. Soc.*, 2015

Conclusions

- Hot extremes in summer over the mid- to high-latitude continents occur near the center of blocking anticyclones. High temperatures are due to adiabatic warming in descending air masses as well as diabating heating by radiation and surface fluxes.

- Wintertime cold extremes over the European continent occur downstream of blocking anticyclones over the North Atlantic. They are primarily caused by cold air advection.