Contribution of large-scale dynamics to recent European temperature extremes

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Introduction

Motivation

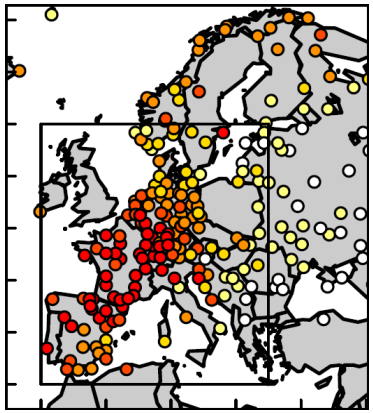
What would have been recent European temperature extremes in the absence of long-term warming?

Methodology & Data

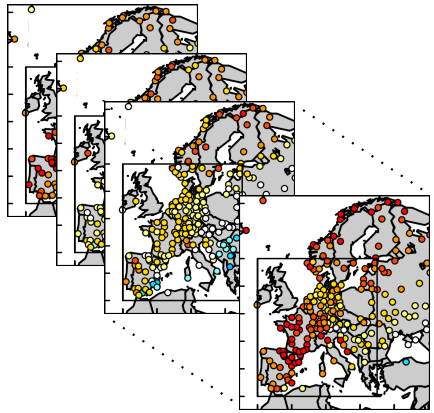
- Estimating temperature anomalies by searching analog synoptic situations in the past.
- Data: ECA&D temperature observations, NCEP/NCAR reanalysis of Z500/SLP.

Flow-analogues: methodology

Temperature of day (d, y)

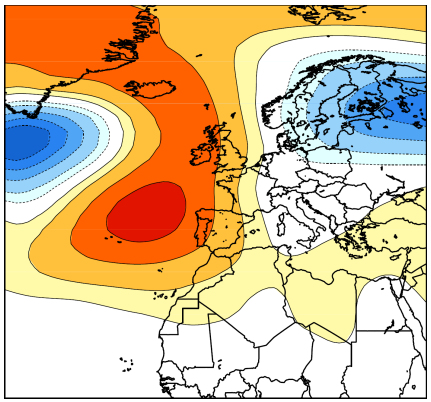


How does it compare?

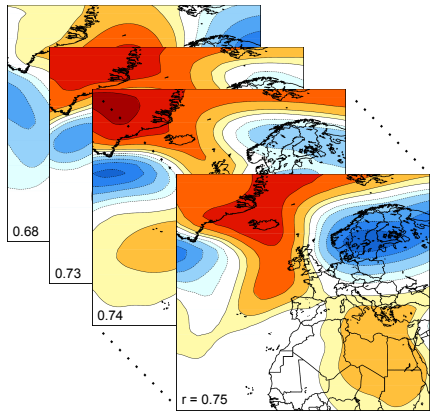


Range of analog temperatures

Circulation of day (d, y)



Measure of similarity

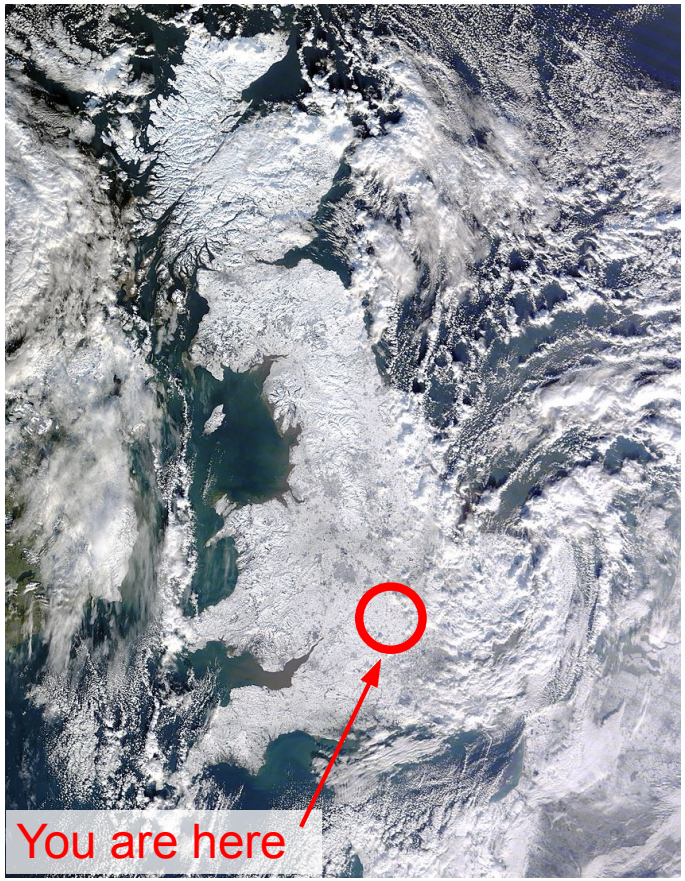


Analogues in $(d \pm 15, y' \neq y)$

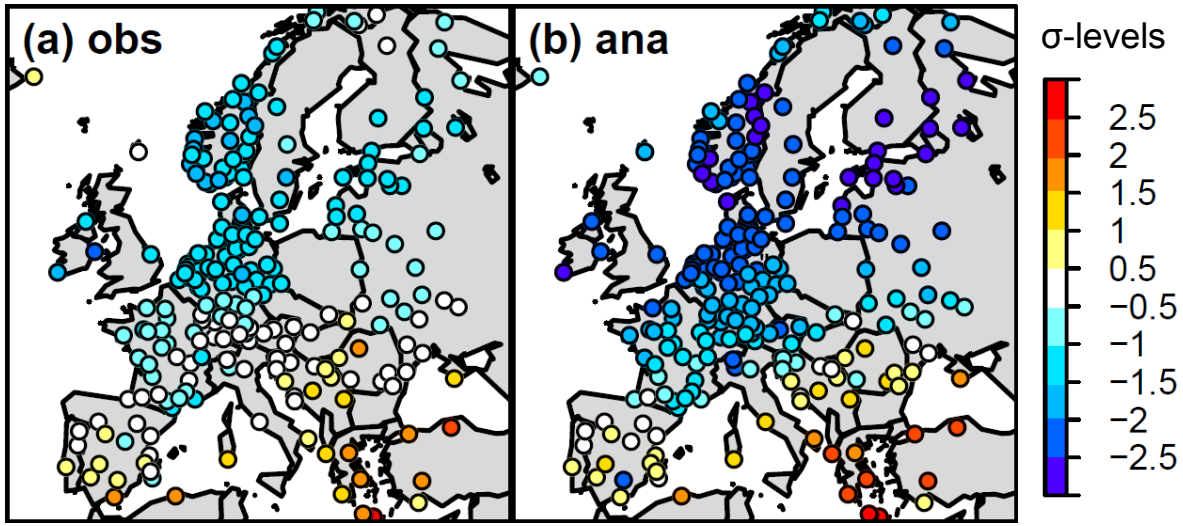
Lorenz, J. Atm. Sci. 1969.

First example — Winter 2009/10

January 7, 2010 (NASA).



DJF 2009/10 temperature anomalies.

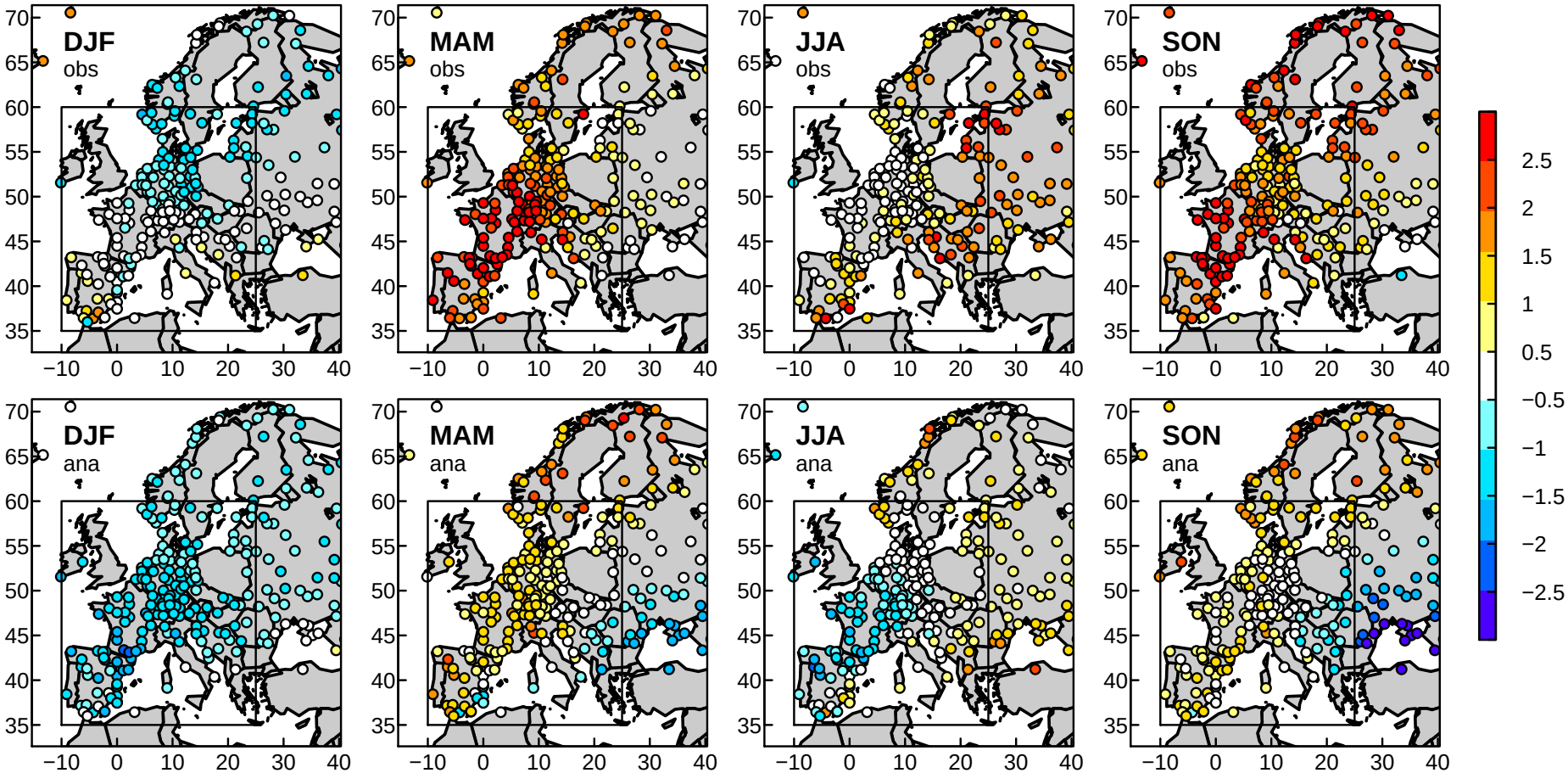


- *Given the record NAO−, winter 2010 is comparable to extremely cold winters of 1940 and 1963.*
- *The 3.3 K difference between 2010 and 1940 cannot be explained without invoking long-term warming.*

Cattiaux et al., GRL 2010 & Ouzeau et al., GRL 2011.

Second example — Record warm year of 2011

Seasonal temperature anomalies in 2011.

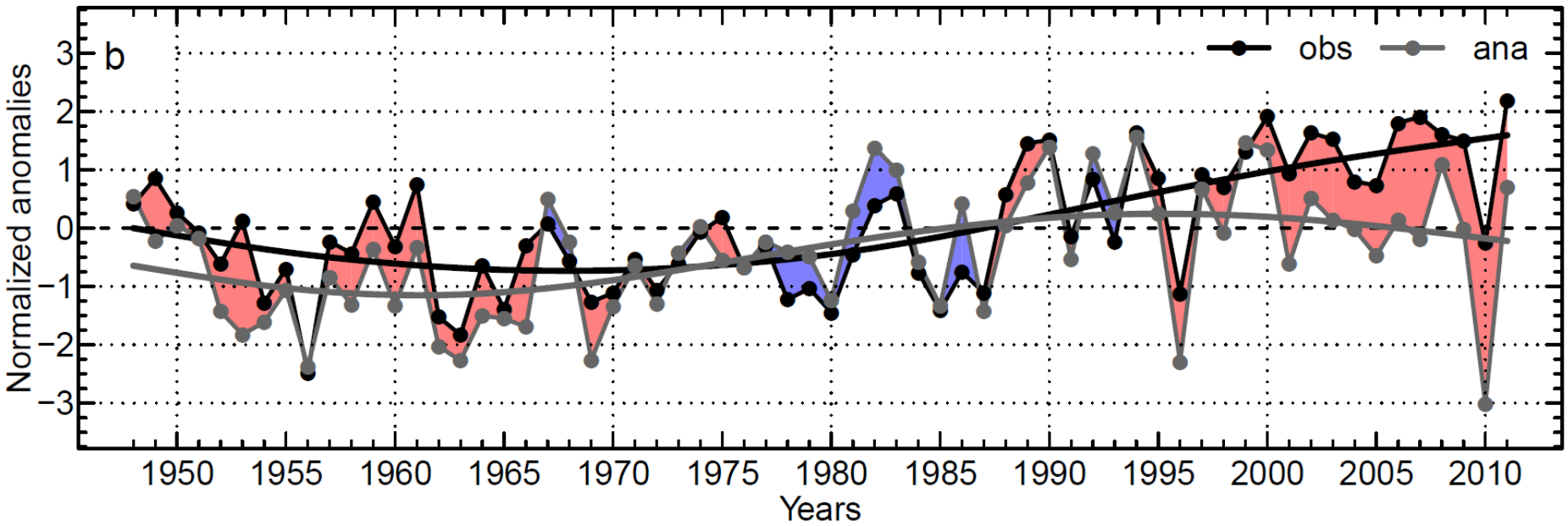


- *2011, warmest year over 1948–2011 (2.1 σ), should have ranked as the 10th (0.7 σ).*

Cattiaux and Yiou, BAMS 2012, *Explaining Extremes of 2011.*

Analogues and climate perspective

Yearly temperature anomalies over Europe (σ-levels).



- *Disentangle low-frequency variability and inter-annual fluctuations.*
- *Inter-annual variability mostly driven by North-Atlantic dynamics.*
- *Low-frequency variability resulting from both North-Atlantic dynamics (e.g., NAO) and background temperature trends (e.g., anthropogenic climate change or Atlantic multi-decadal oscillation).*

Cattiaux and Yiou, BAMS 2012 & Vautard and Yiou, GRL 2009.

Some literature

- J. Cattiaux et al. (2010), Winter 2010 in Europe: A cold extreme in a warming climate, *Geophysical Research Letters*, *37*, pp. L20704. DOI: 10.1029/2010GL044613
- J. Cattiaux and P. Yiou (2012), Contribution of atmospheric circulation to remarkable European temperatures of 2011, in "Explaining Extreme Events of 2011 from a Climate Perspective", *Bulletin of the American Meteorological Society*, *93*, pp. 1041–1067. DOI: 10.1075/BAMS-D-12-00021.1
- E.N. Lorenz (1969), Atmospheric predictability as revealed by naturally occurring analogues, *Journal of the Atmospheric Sciences*, *26* (4), pp. 636–646.
- G. Ouzeau et al. (2011), European cold winter of 2009/10: How unusual in the instrumental record and how reproducible in the Arpege-Climat model?, *Geophysical Research Letters*, *38*, pp. L11706. DOI: 10.1029/2011GL047667
- R. Vautard and P. Yiou (2009), Control of recent European surface climate change by atmospheric flow, *Geophysical Research Letters*, *36* (22), pp. L22702. DOI: 10.1029/2009GL040480
- P. Yiou et al. (2007), Inconsistency between atmospheric dynamics and temperatures during the exceptional 2006/2007 fall/winter and recent warming in Europe, *Geophysical Research Letters*, *34*, pp. L21808. DOI: 10.1029/2007GL031981

Thanks.