# Weather Systems in GCMs: Blocking, cyclones and airstreams

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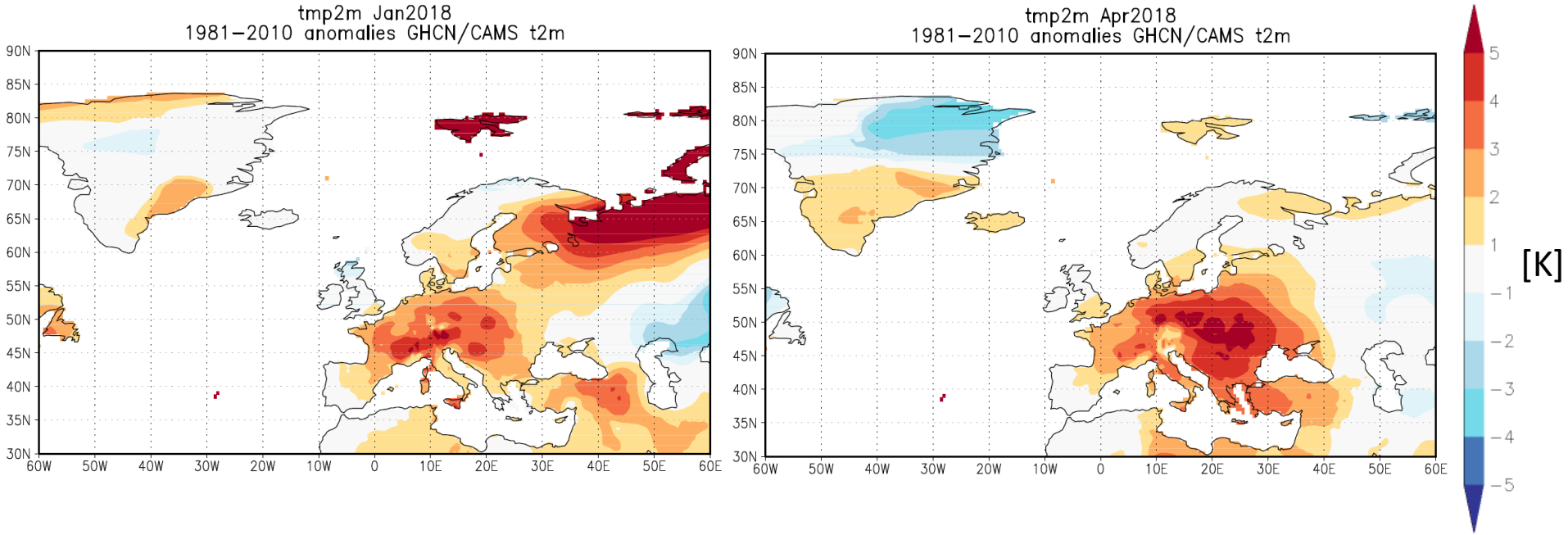
# Introduction

## Wet & mild January vs. dry & warm April 2018 in Europe

T2M anomalies [K] from land surface stations (observations)

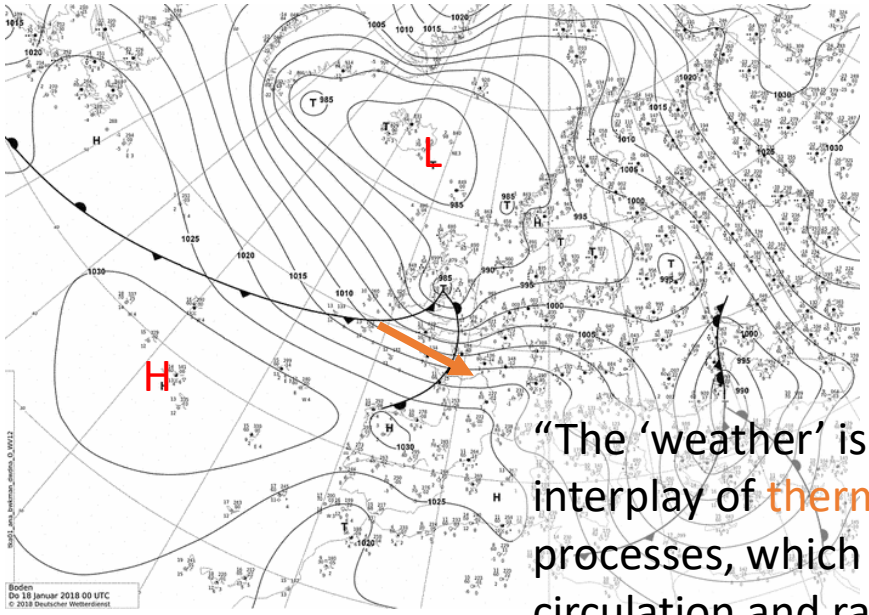


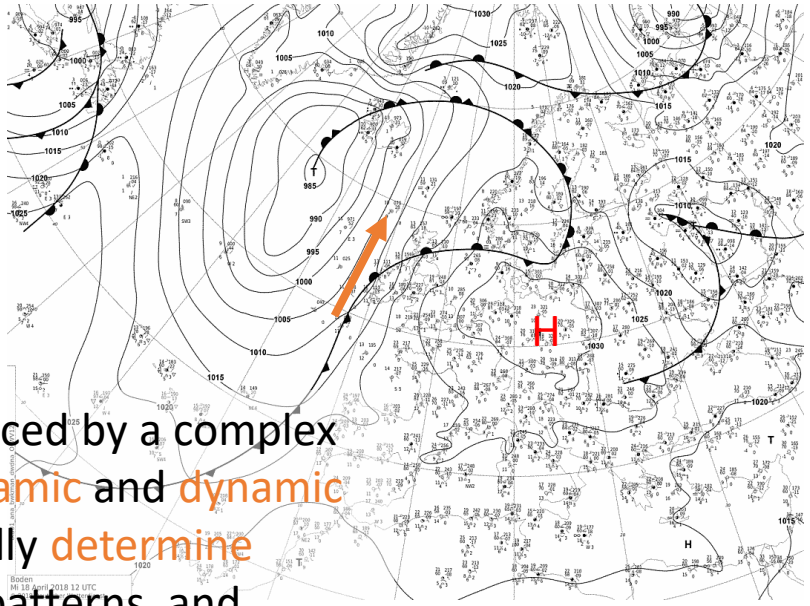

How are synoptic (day-to-day) weather systems linked to climate variability?

Figures created with KMNI Climate Explorer

# Introduction

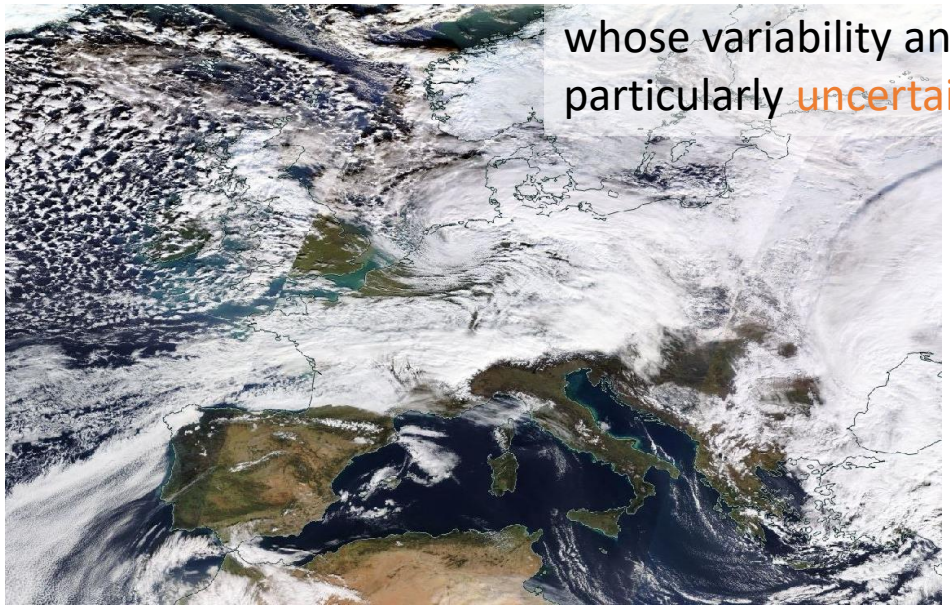
## Wet & mild January vs. dry & warm April 2018 in Europe

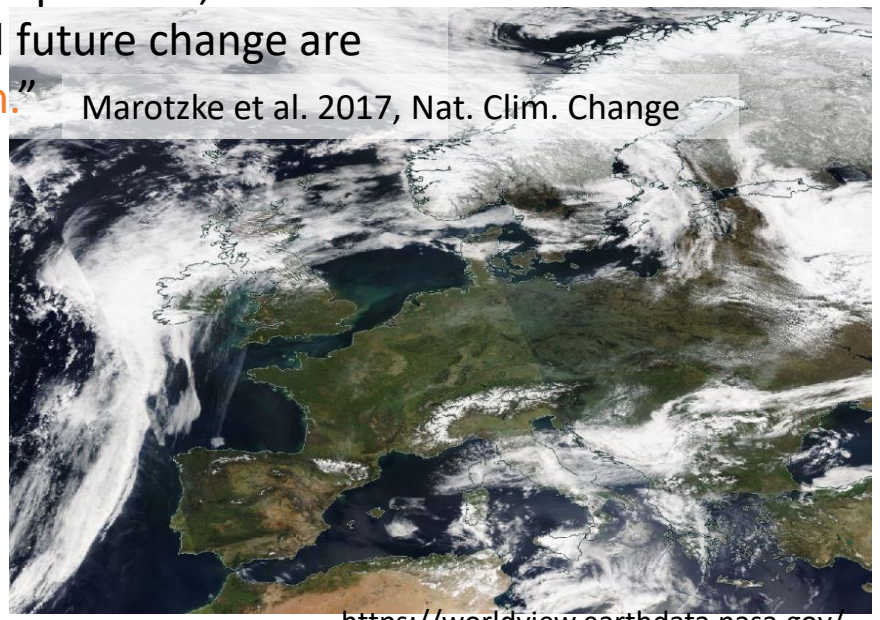



"The 'weather' is produced by a complex interplay of thermodynamic and dynamic processes, which crucially determine circulation and rainfall patterns, and whose variability and future change are particularly uncertain."

Marotzke et al. 2017, Nat. Clim. Change





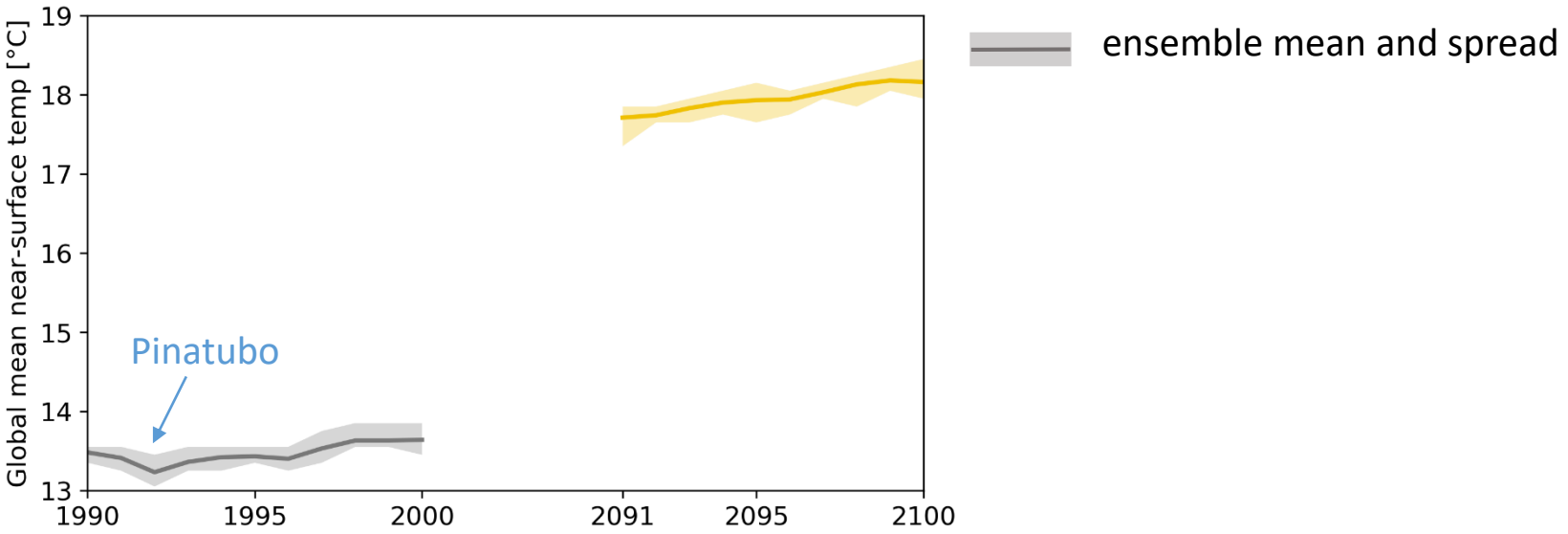
https://worldview.earthdata.nasa.gov/

# Data

Climate model simulations are run by the Climate Physics group

Community Earth System Model version 1 Large Ensemble (CESM1-LE) simulations with 35(?) members Kay et al., 2015

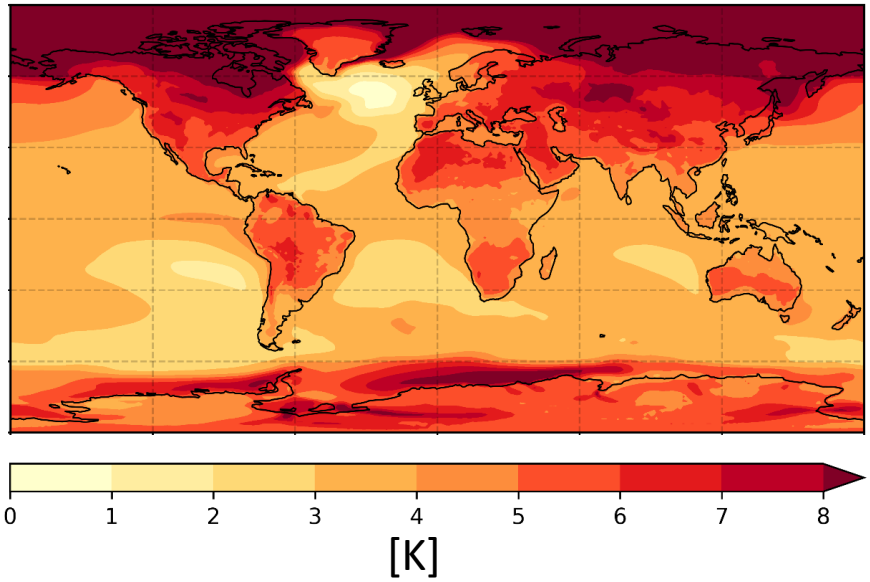
- fully coupled global climate model
- Community Atmospheric Model version 5 (CAM5; Park et al., 2014) with ~ **1°** horizontal resolution, **30** vertical levels and **6**-hourly output
- historical forcing (**B20TR**) for **1990 – 2000**
- RCP8.5 forcing (**BRCP85**) for **2091 – 2100**



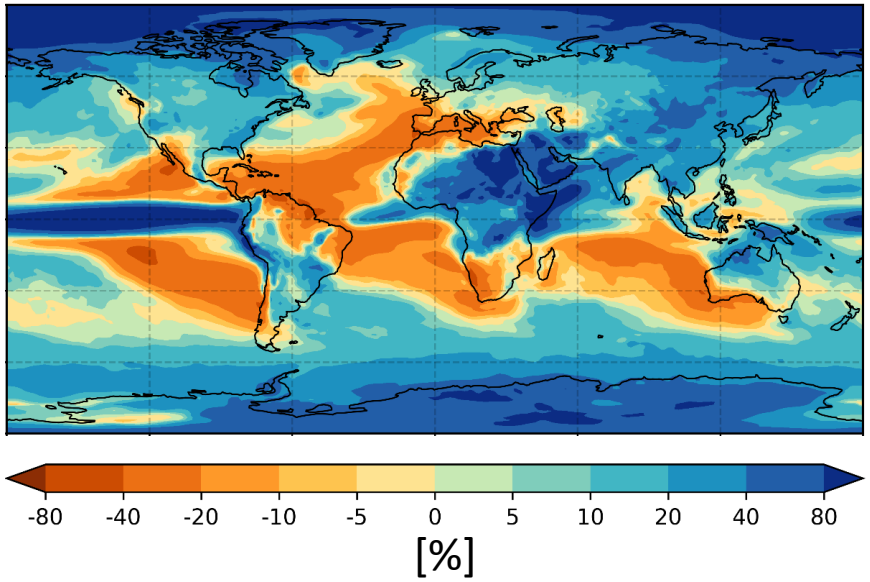
# Data

**Change** between **1990 – 2000** and **2091 – 2100**
**ensemble mean**

Temperature




Precipitation




How does the dynamics of weather systems change with climate?

# Eulerian and Lagrangian diagnostic tools

Tracking of cyclones and anticyclones (based on SLP)

Wernli and Schwierz, 2006; Sprenger et al., 2017

Tracking of blocking

based on upper-level PV Schwierz et al., 2004
based on Z500 Scherrer et al., 2006

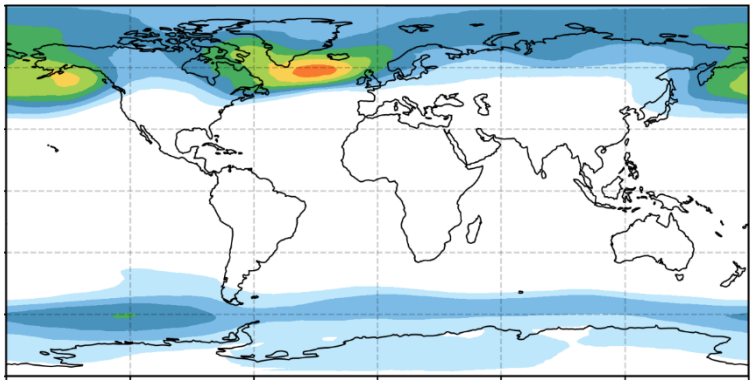
Calculation of air parcel trajectories with Lagranto

Wernli and Davies,1997; Sprenger and Wernli, 2015; Sprenger et al., 2017

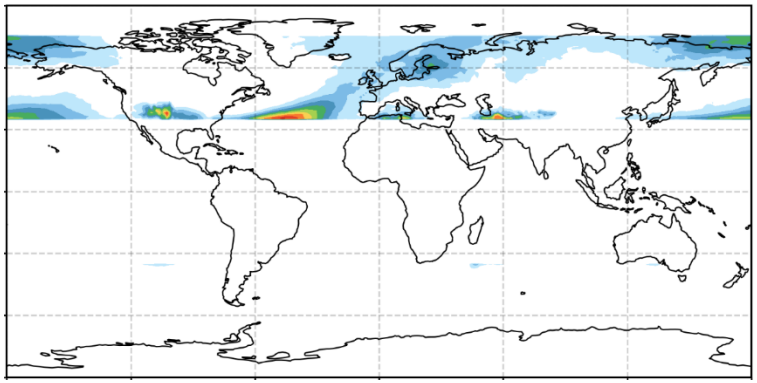
Climatologies have been calculated for ens members 001 – 010

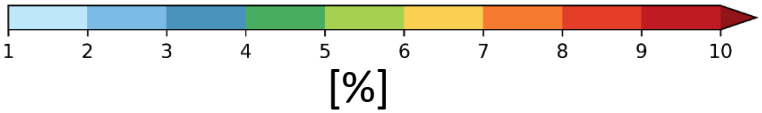
# Climatologies (ensemble mean 1990 – 2000)

PV-blocking



Z500-blocking



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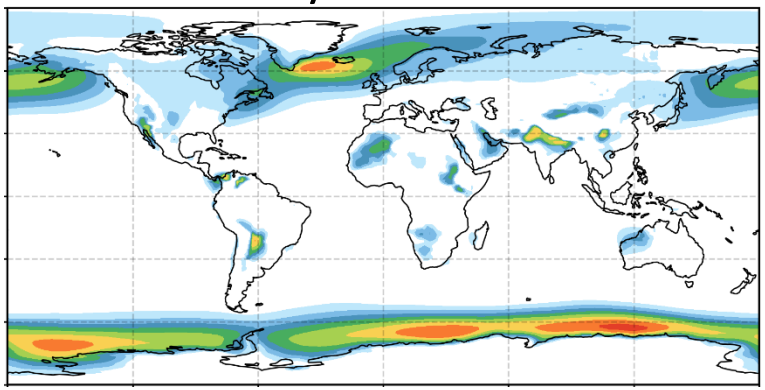
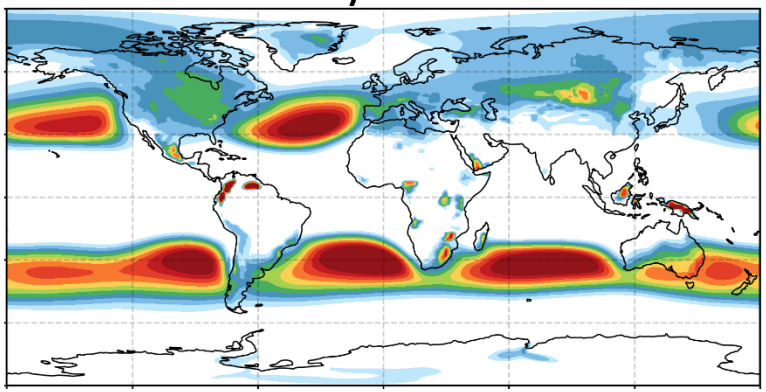
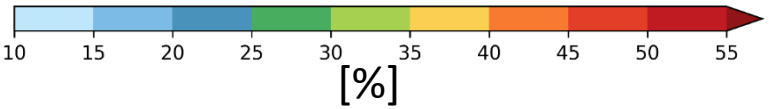
Cyclones



Anticyclones



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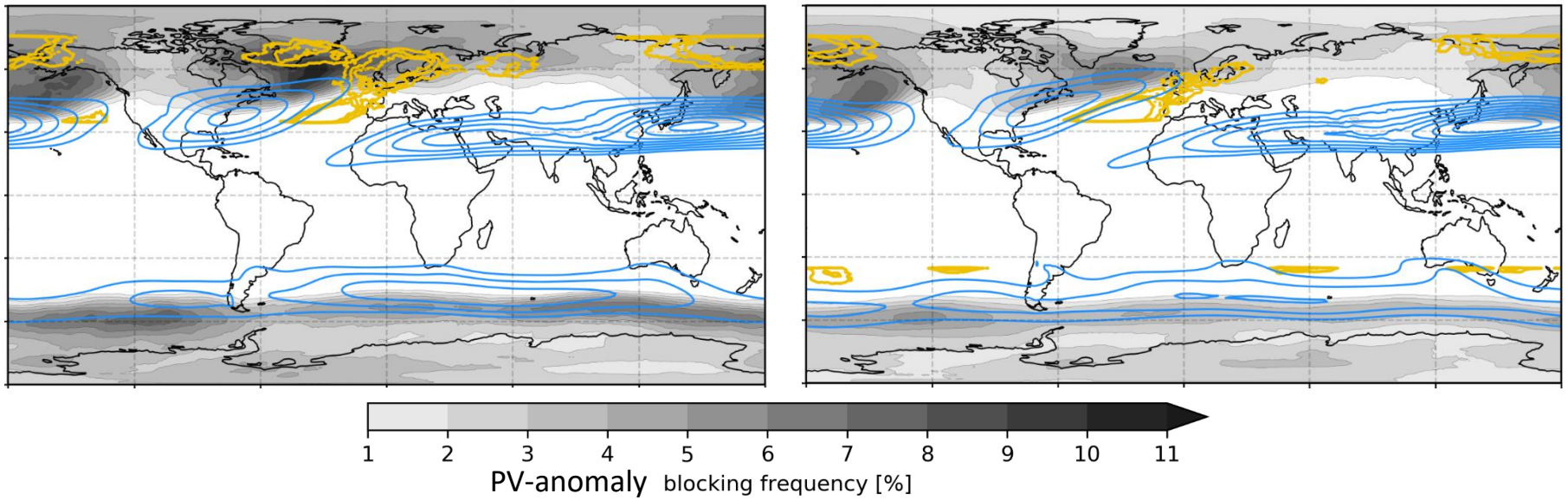
# Climatologies (Reanalyse vs CESM)

ERA-Interim DJF

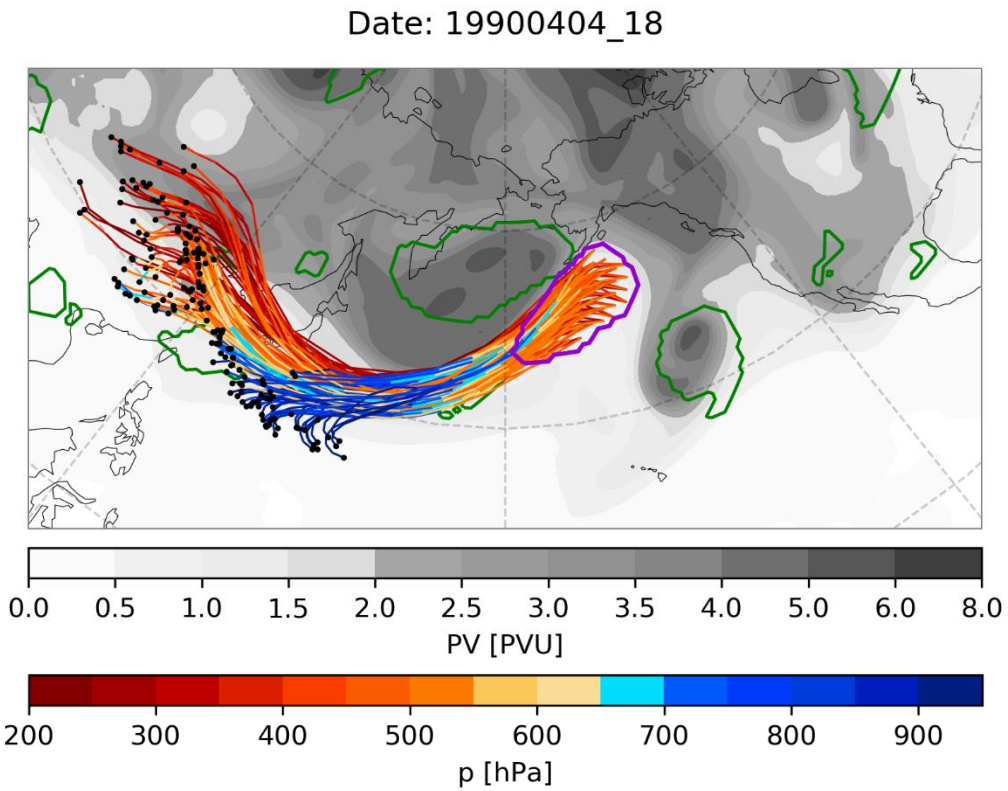
CESM 1990 - 2000 DJF




Z500 reversal blocking frequency (2 and 4%)

Upper-level zonal wind (20,30,40,… m/s)

# Example: Blocking dynamics



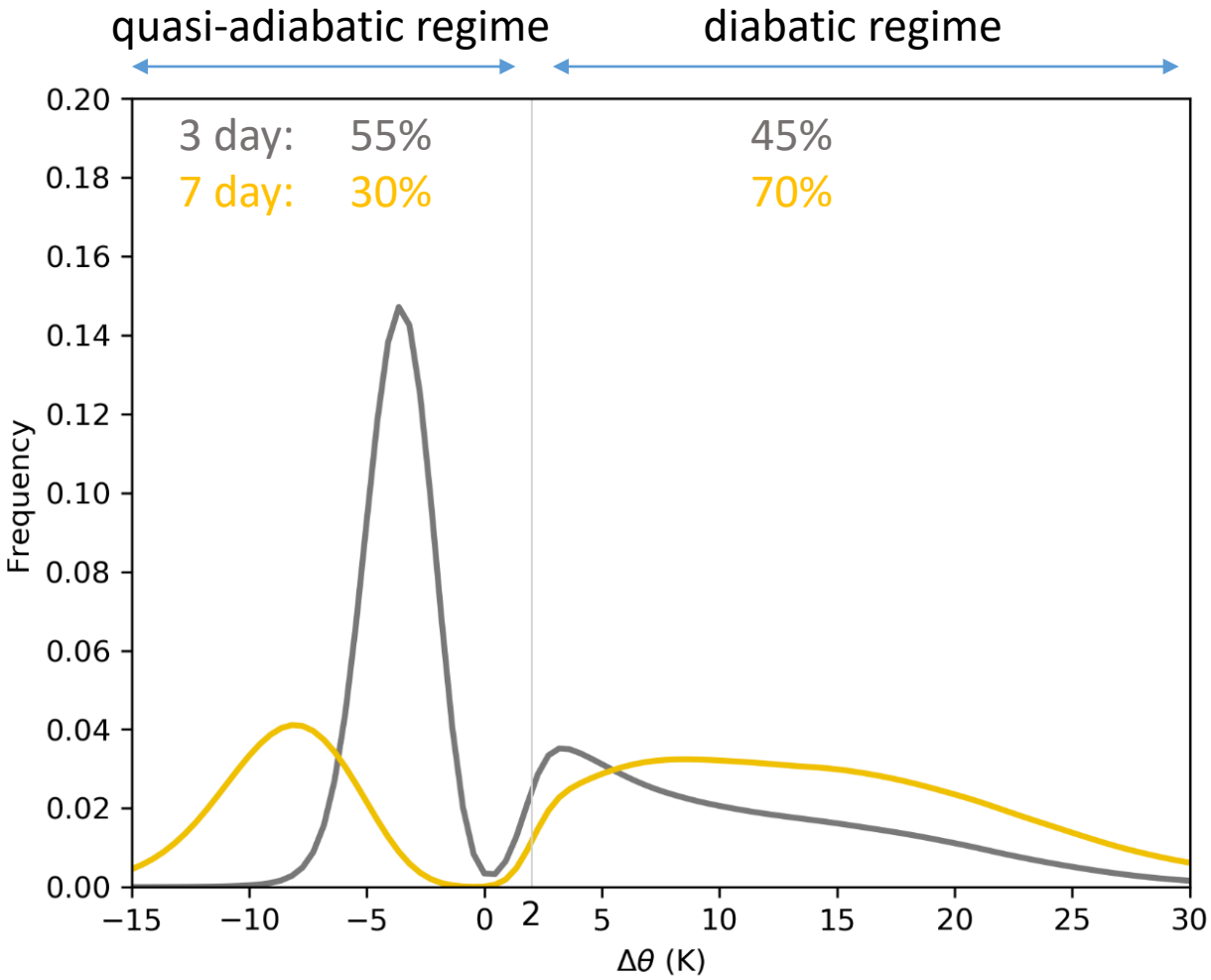

block

cyclone

- Location of blocking air masses at – 3 days before in block

# Example: Blocking dynamics

**ens member 001: ~6 millon blocking air masses**




Diabatic heating/cooling during 3 (7) days before arriving in block