Dependence of seasonal hindcast skill on different mechanisms influencing European summers during the 20th century

Nele-Charlotte Neddermann[1,2], Wolfgang A. Müller[3],
André Düsterhus[1], Holger Pohlmann[3],
and Johanna Baehr[1]

[1] *Institute of Oceanography, Universität Hamburg*
[2] *International Max Planck Research School on Earth System Modelling, Hamburg*
[3] *Max Planck Institute for Meteorology, Hamburg*

Seasonal Summer Hindcast Skill

July-August (JA)
500hPa geopotential height (Z500)
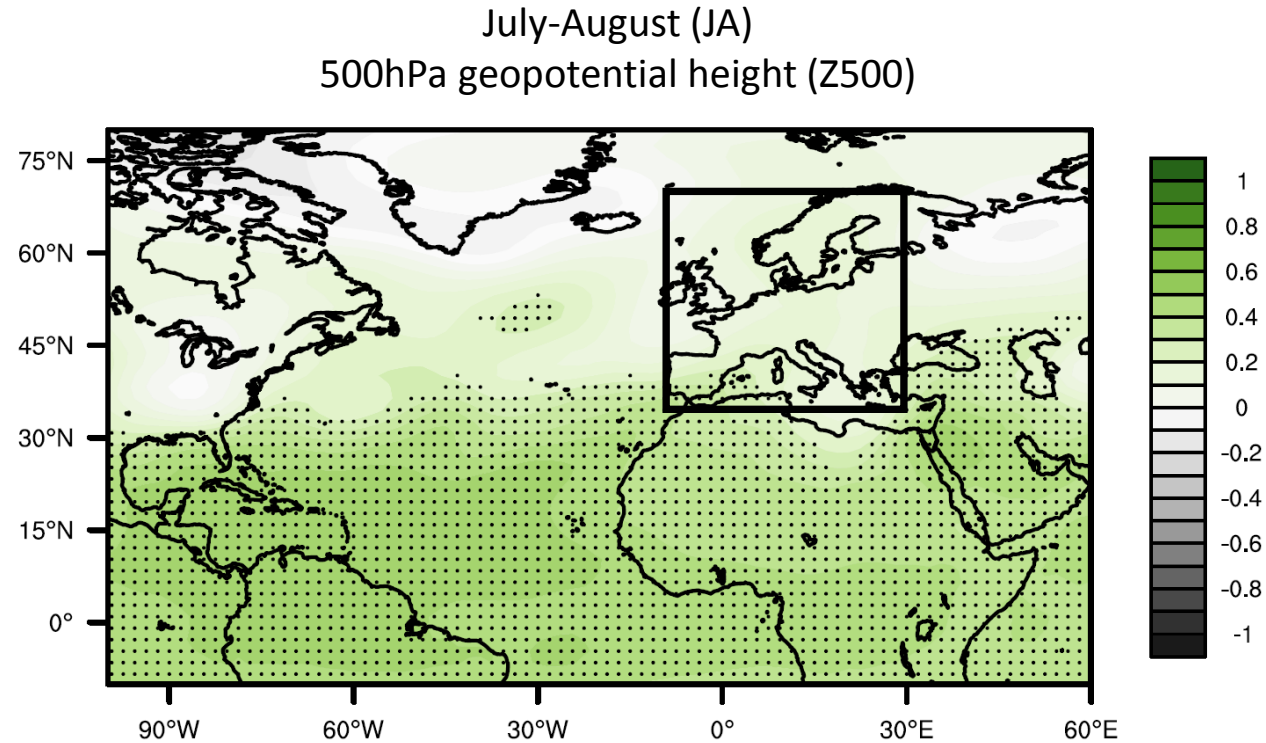
- Anomaly Correlation (ACC) between model (MPI-ESM-MR) and reanalysis (ERA-20C)
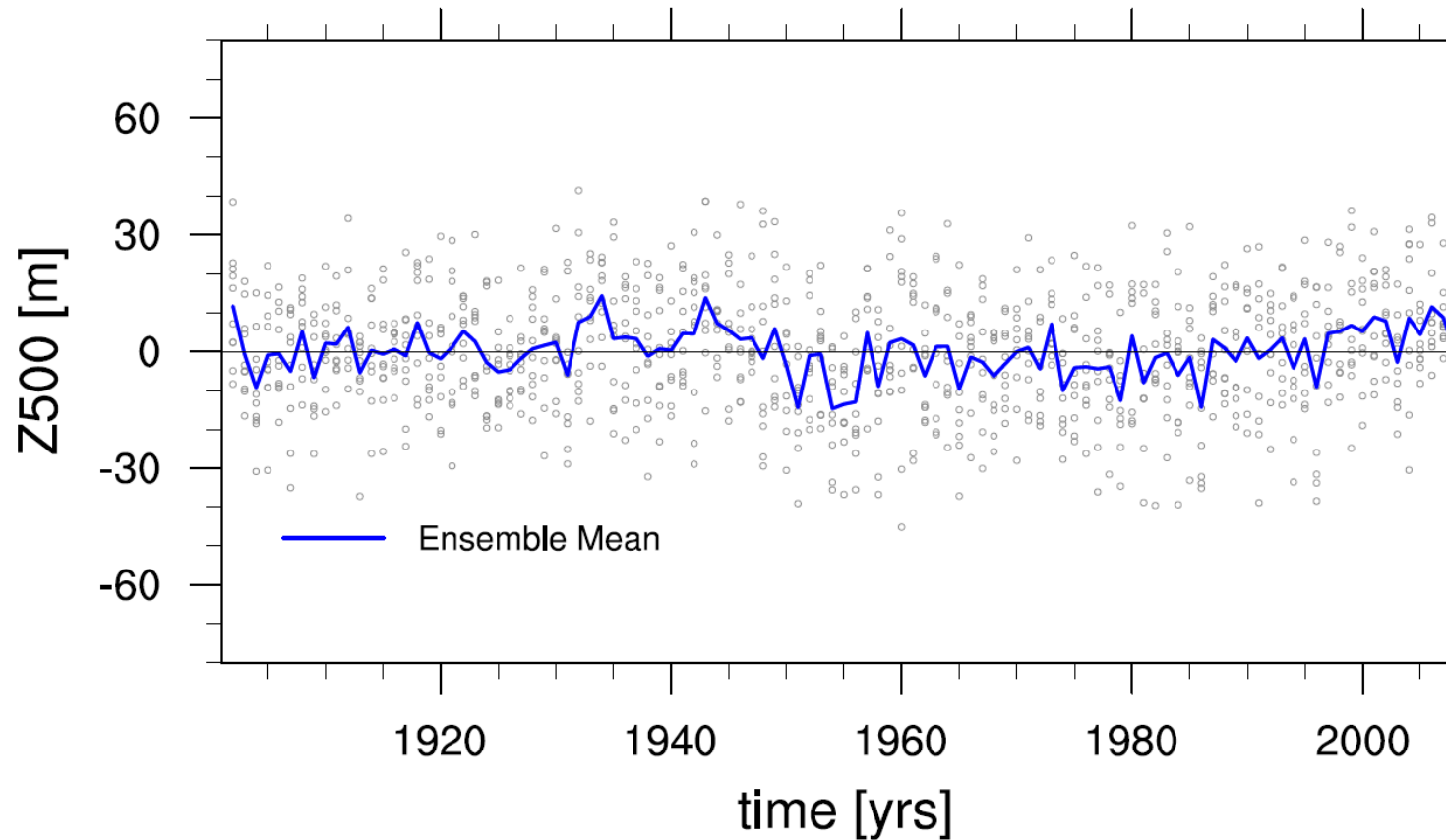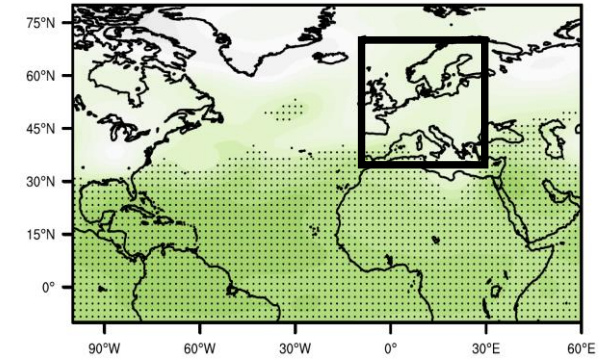- no seasonal prediction skill over Europe

European Seasonal Summer Hindcast Skill

- MPI-ESM-MR, fully coupled seasonal prediction system
- 10 independent ensemble members, initialised in May
- 1900-2010
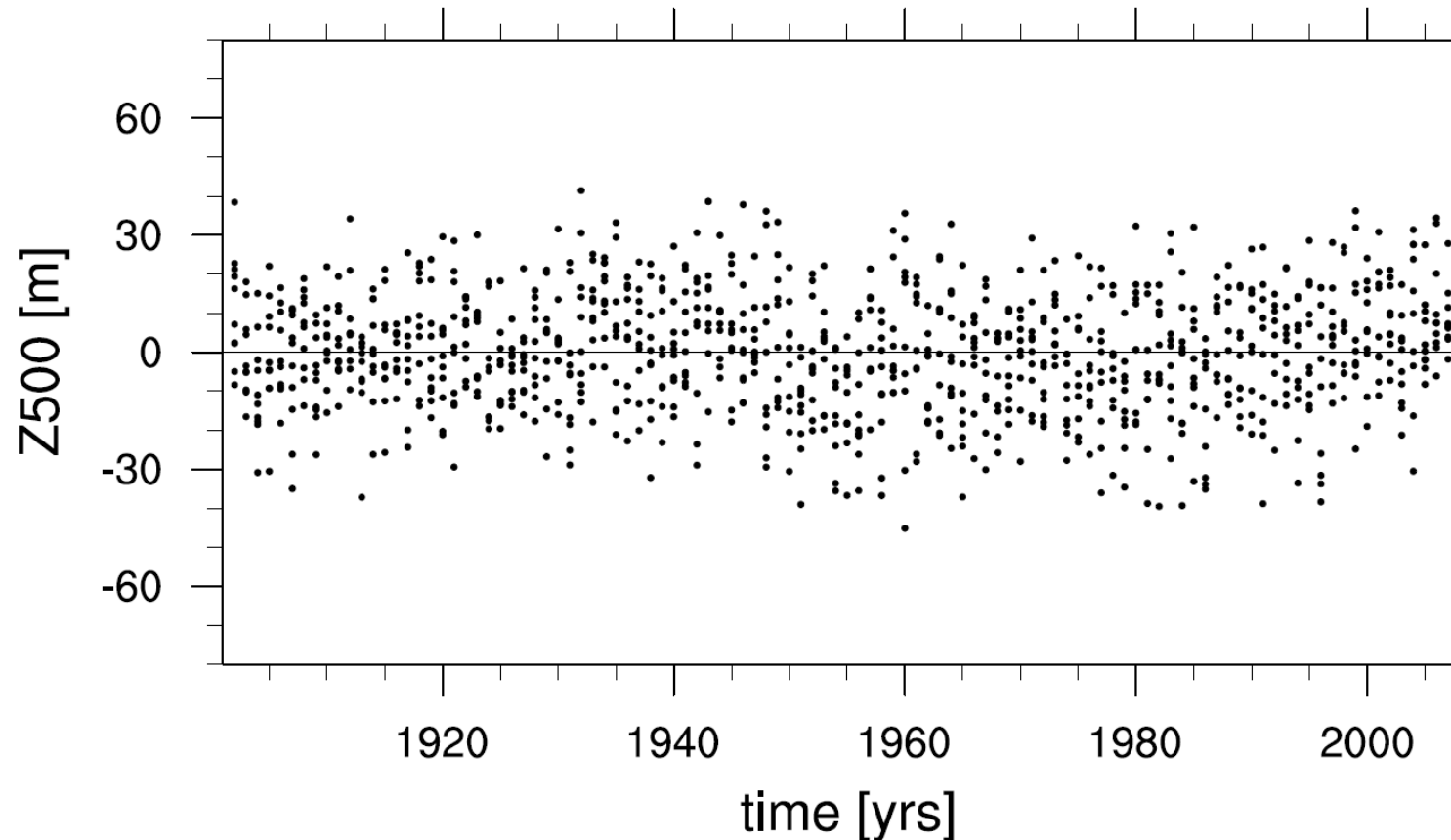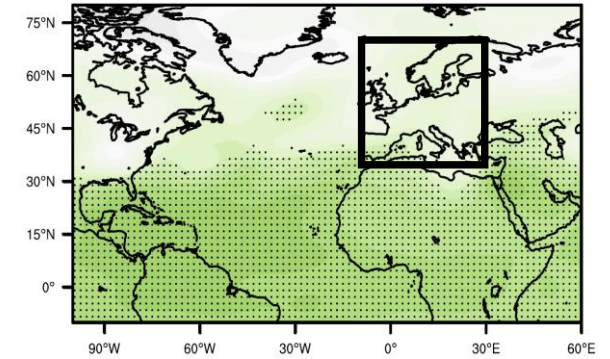
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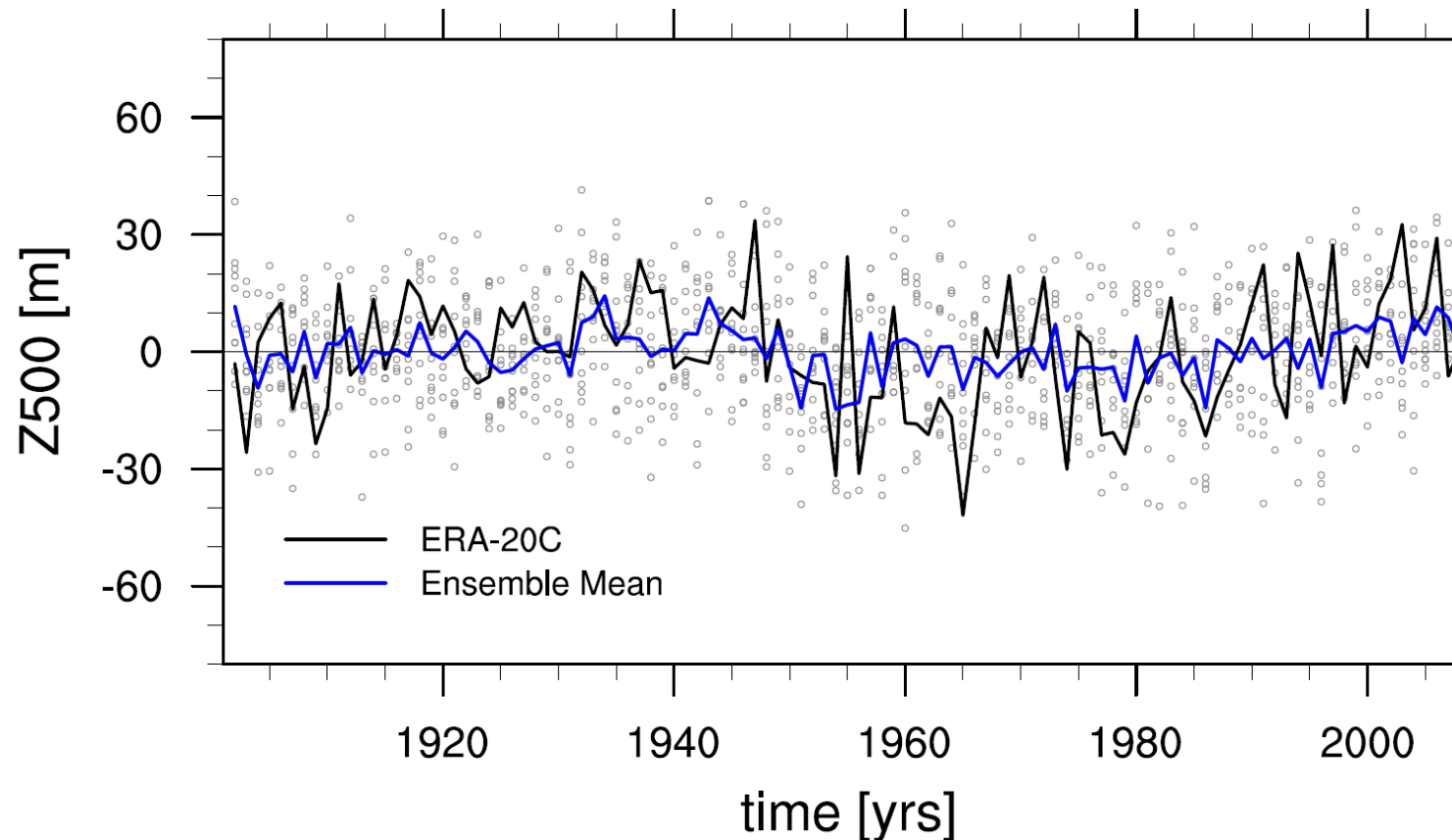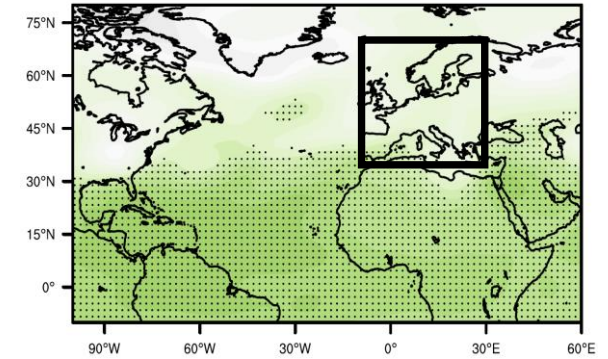- 1900-2010

European Seasonal Summer Hindcast Skill

- MPI-ESM-MR, fully coupled seasonal prediction system
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*Why do ensemble members show such a large spread?*

- various physical mechanisms influence European summers
- Is skill of model influenced by those mechanisms?

Which mechanisms influence European summers?

- North Atlantic Oscillation (NAO)
- Zonal Pressure Difference (PD)

- Can we identify which mechanism dominates which summer?
  → Cluster analysis
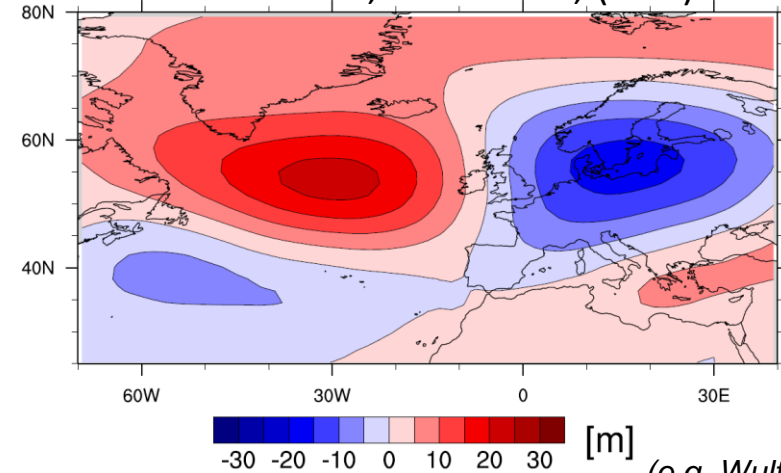
North Atlantic Oscillation (NAO) +
1. EOF of Z500, 1982-2016, (29%)

[m]
-30 -20 -10 0 10 20 30
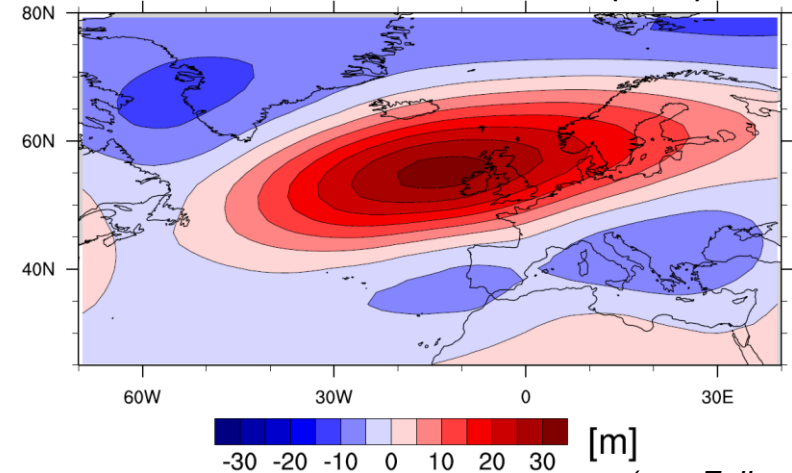
(e.g. Folland et al., 2009)

Zonal Pressure Difference (PD) +
2. EOF of Z500, 1982-2016, (19%)
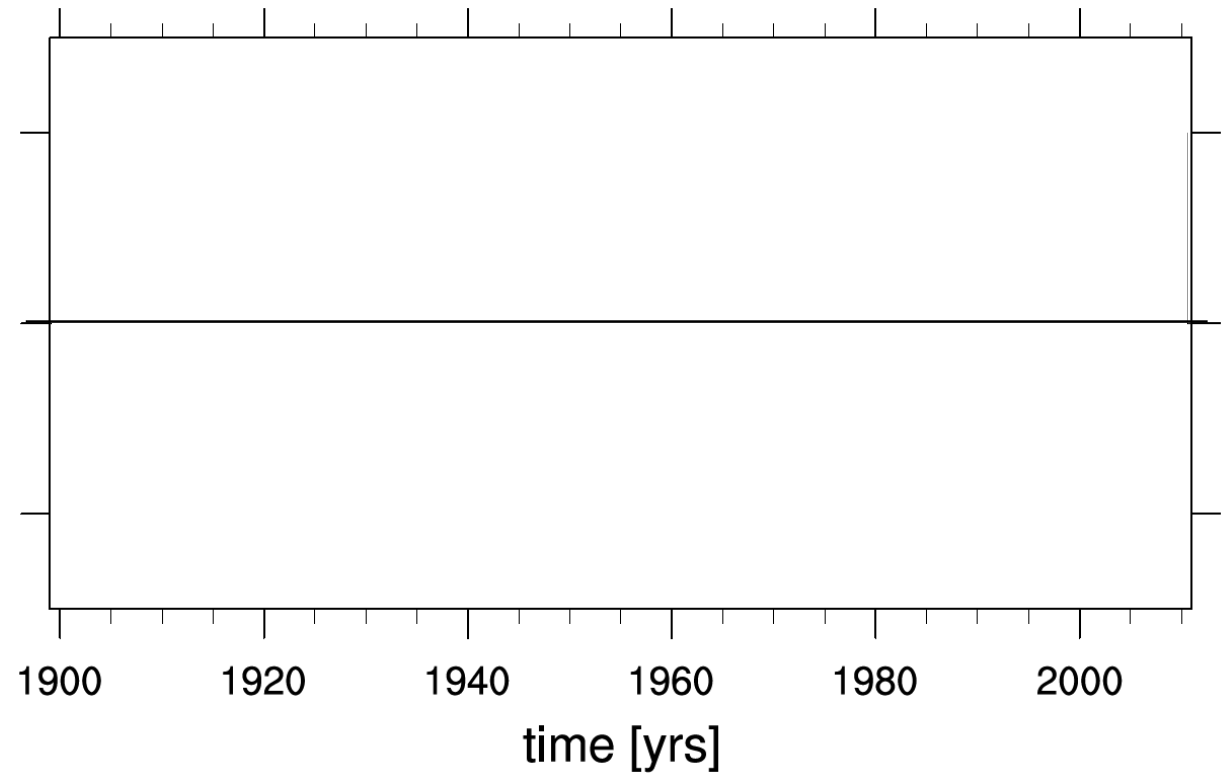

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-30 -20 -10 0 10 20 30

(e.g. Wulff et al., 2017)

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Cluster Analysis
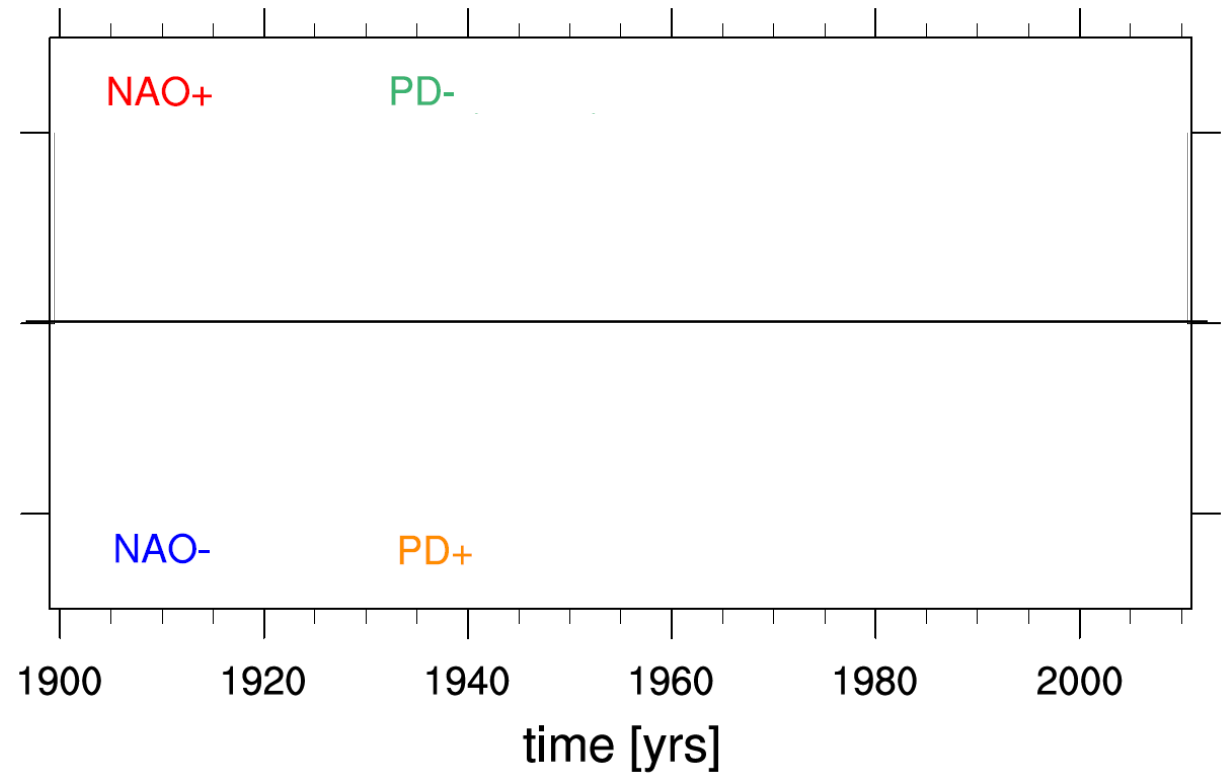
Analyse mechanisms in 1900-2010

- ERA-20C, Z500

Cluster Analysis
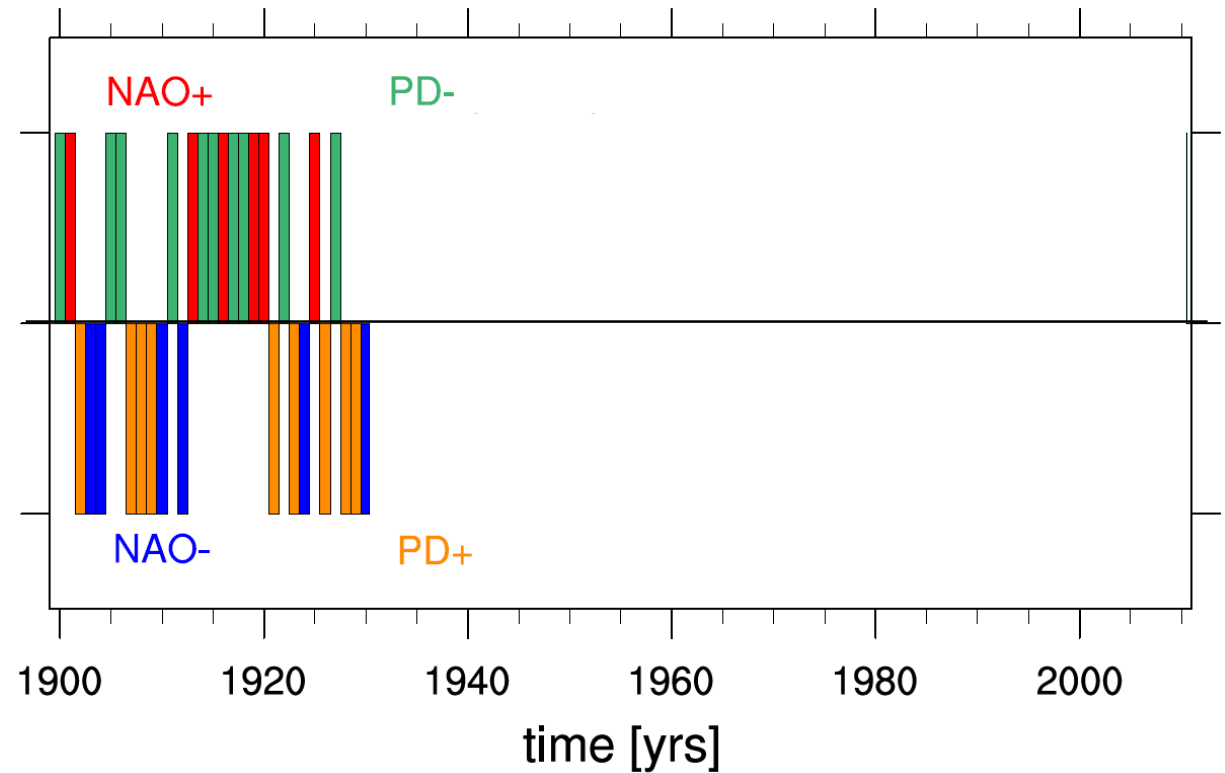
Analyse mechanisms in 1900-2010

- ERA-20C, Z500
- different patterns in positive and negative phase

Cluster Analysis
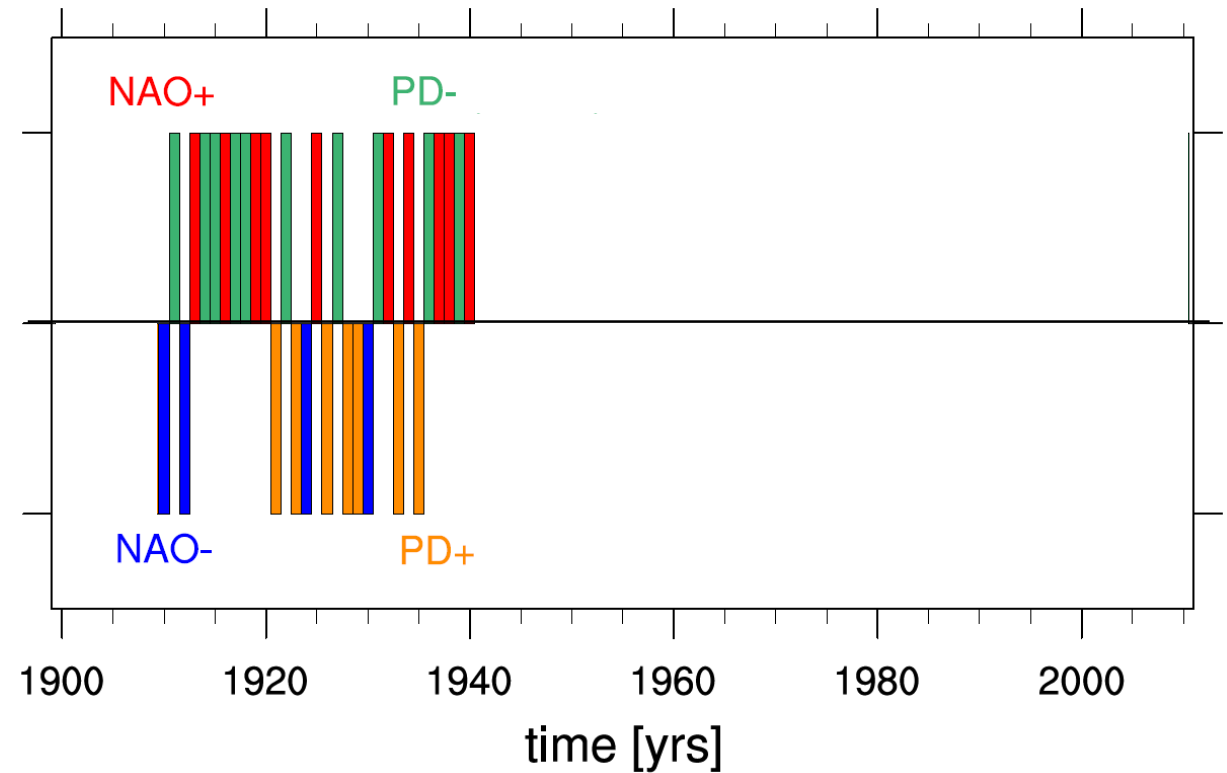
Analyse mechanisms in 1900-2010

- ERA-20C, Z500
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- cluster analysis for first 30 years

Cluster Analysis

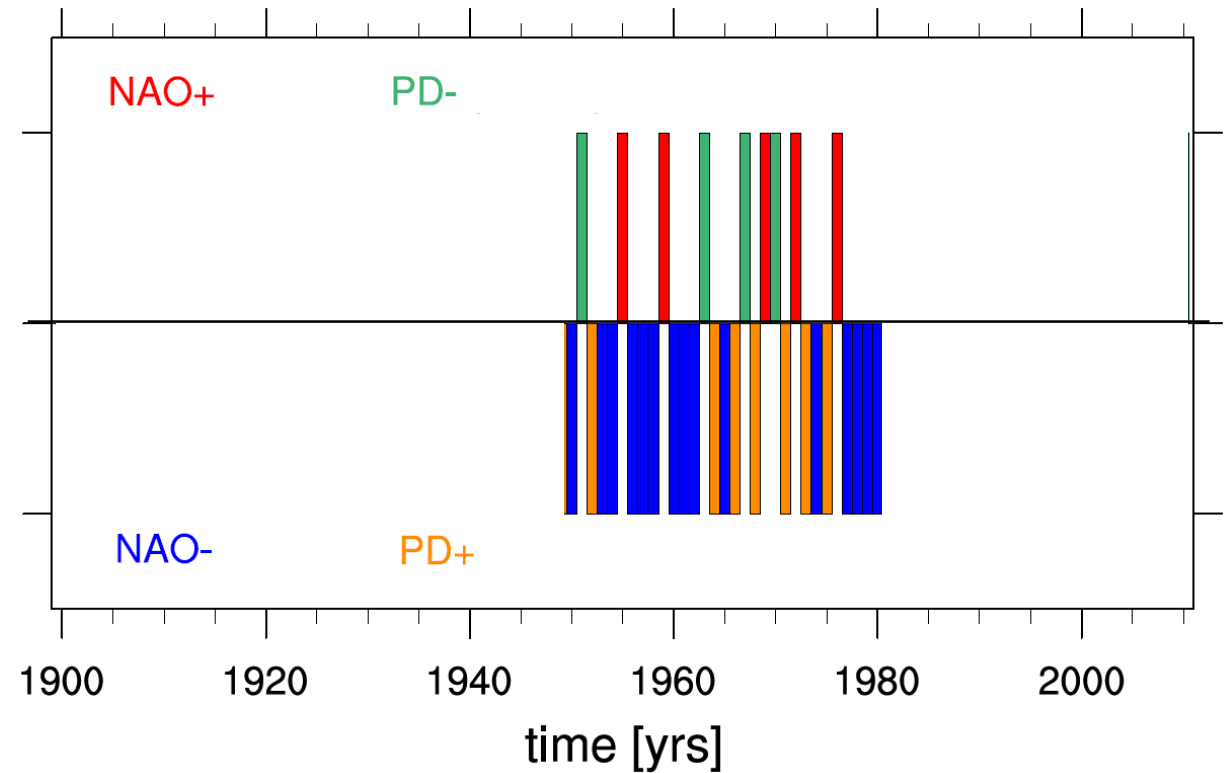Analyse mechanisms in 1900-2010

- ERA-20C, Z500
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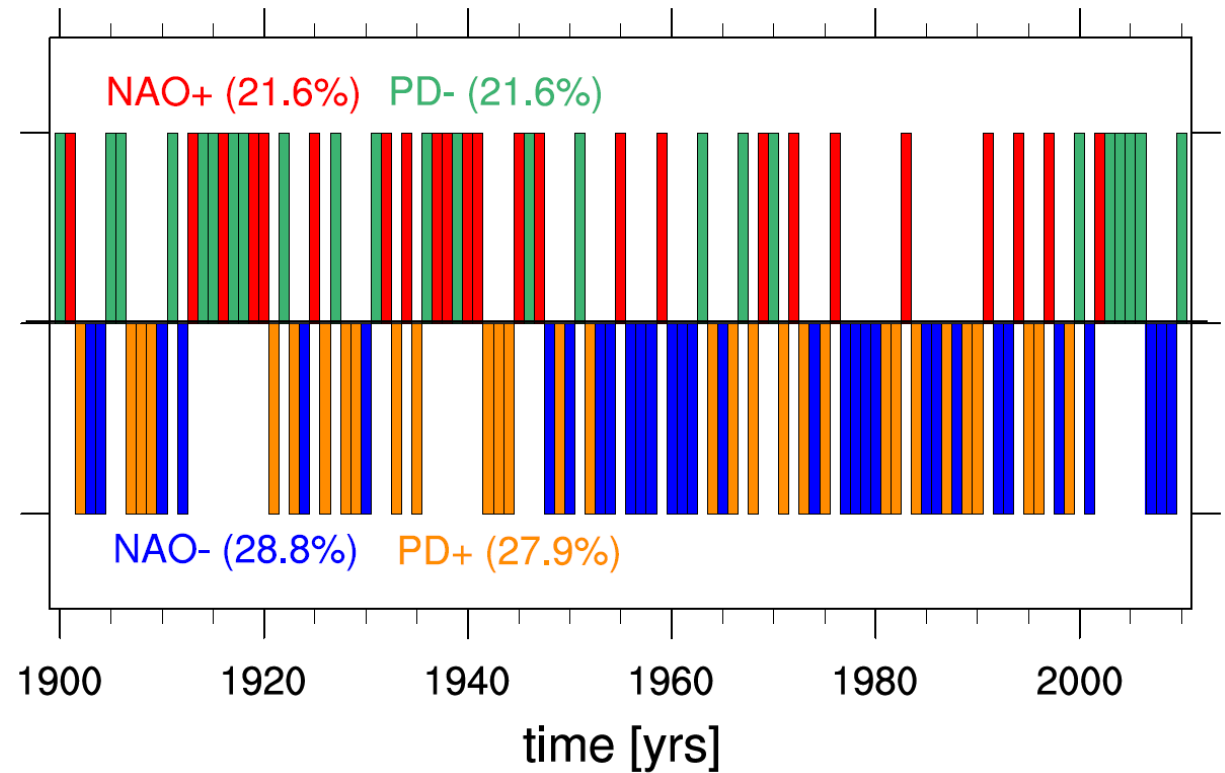- identified cluster in each year is based on clusters of last 30 years

Cluster Analysis

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Cluster Analysis

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→ identify which mechanism dominates each year

Cluster Analysis

Analyse mechanisms in 1900-2010

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→ allow for pattern to change over time

→ identify which mechanism
   dominates each year

NAO+ (21.6%)   PD- (21.6%)

NAO- (28.8%)   PD+ (27.9%)
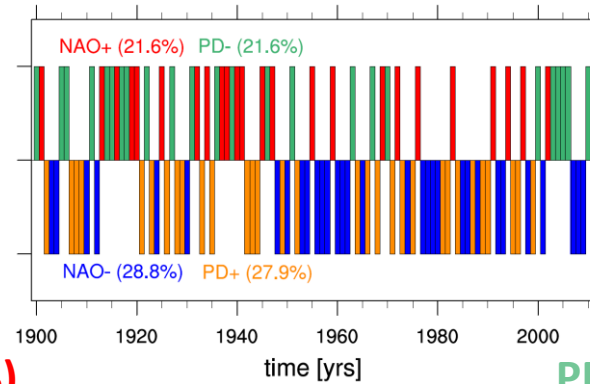
Z500 [m]

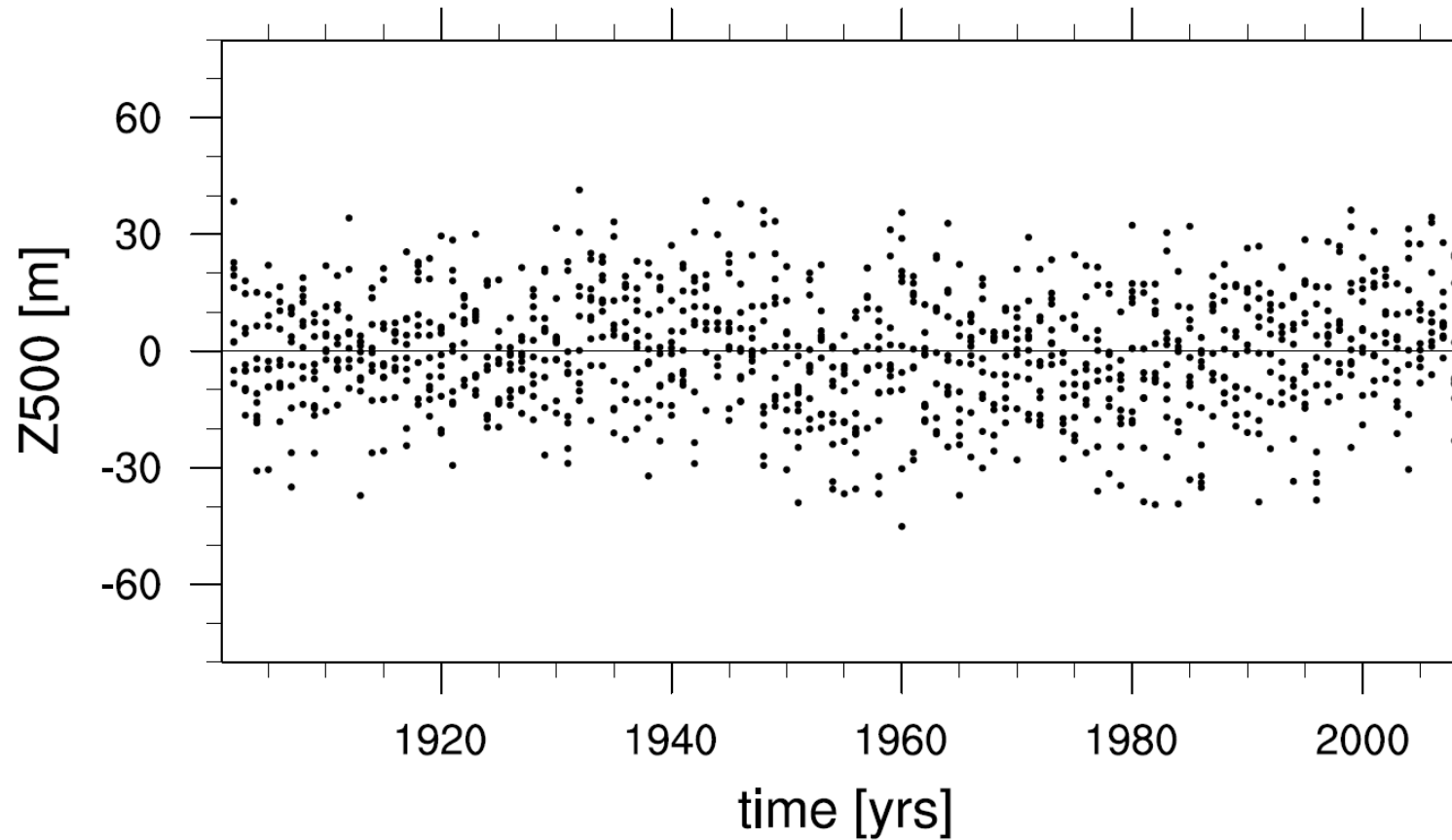time [yrs]
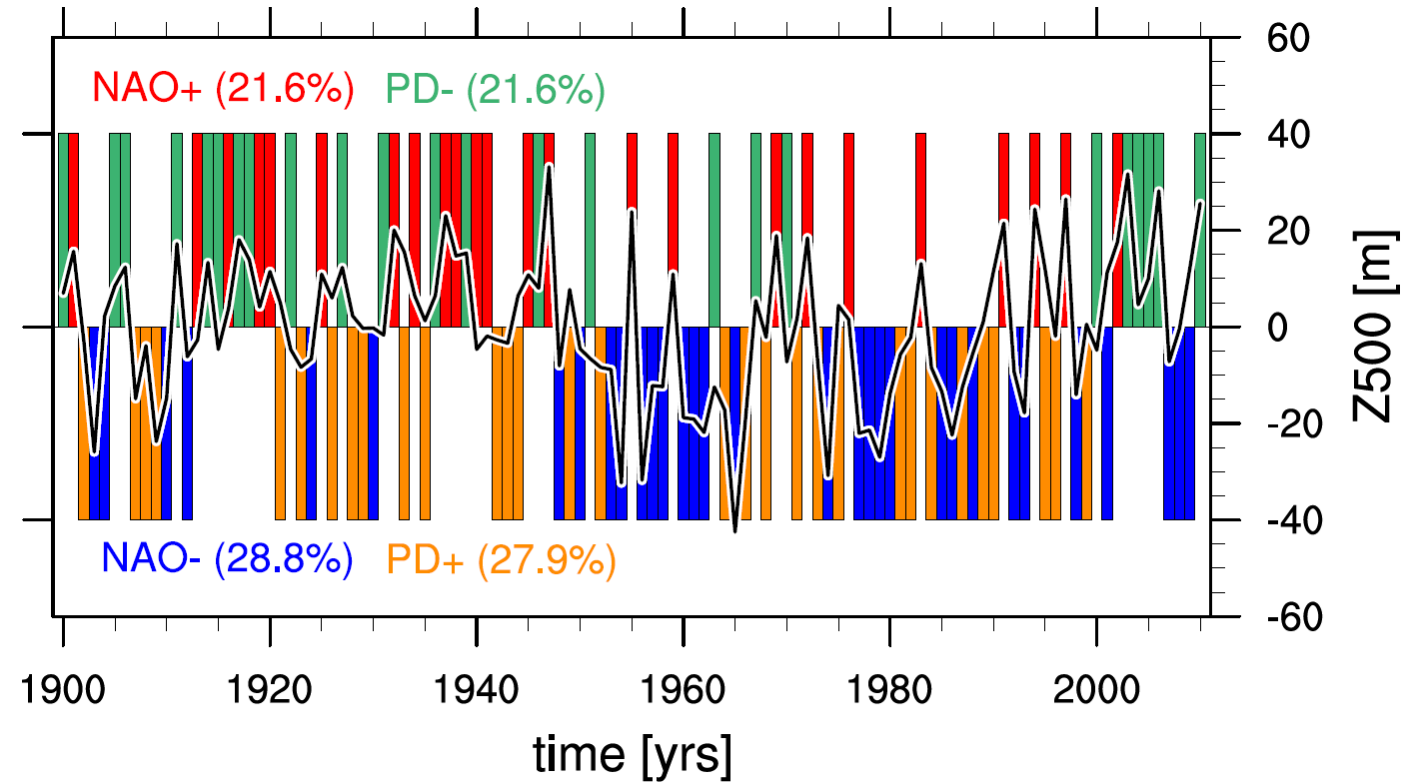
Cluster Analysis

Is skill of model influenced by mechanisms?

- each ensemble member can be assigned to one mechanisms with pattern matching algorithm

- in each year several mechanisms are predicted, but only one is dominant

→ *How would skill be influenced if we select ensemble members for dominant mechanism?*
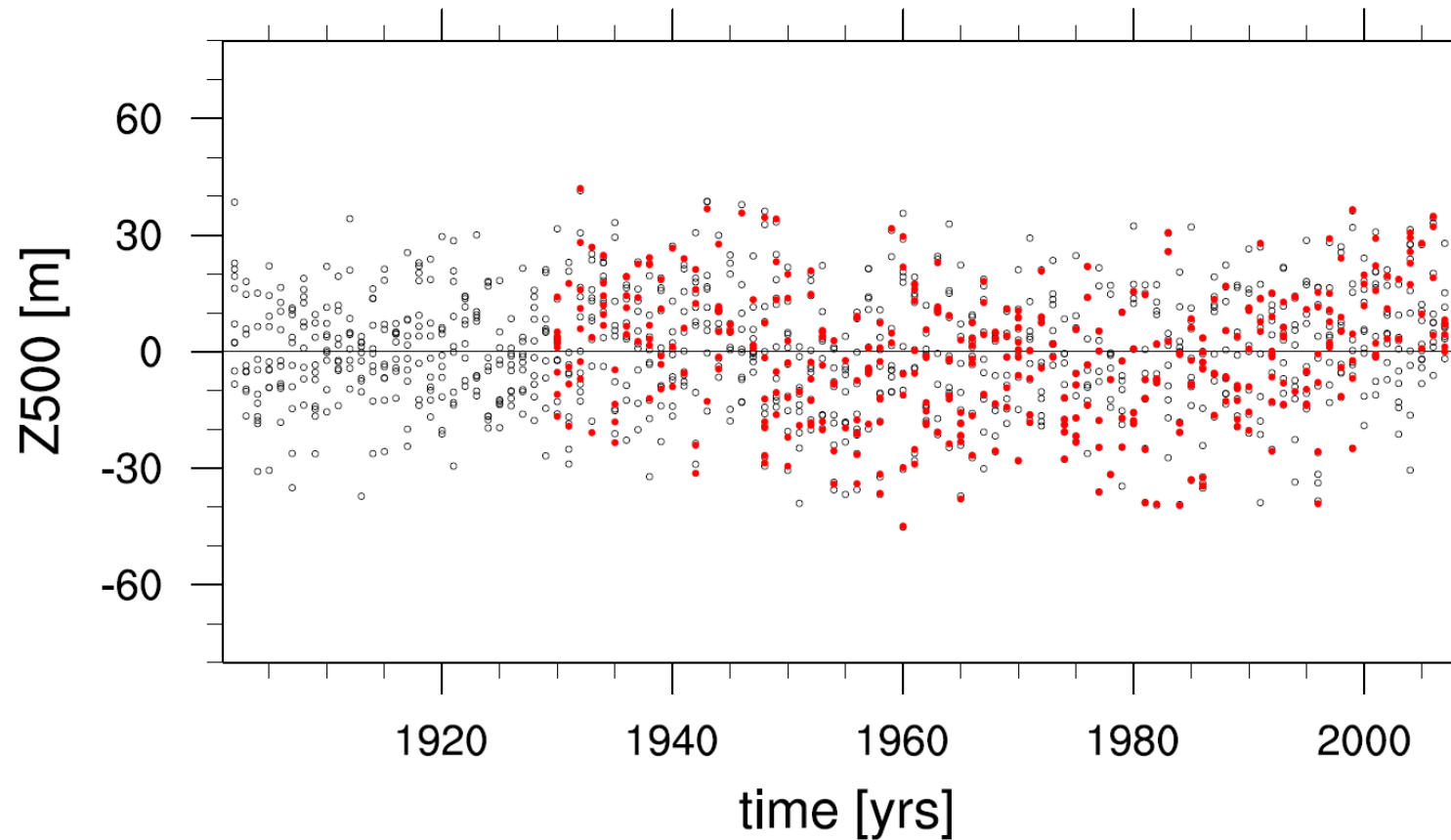
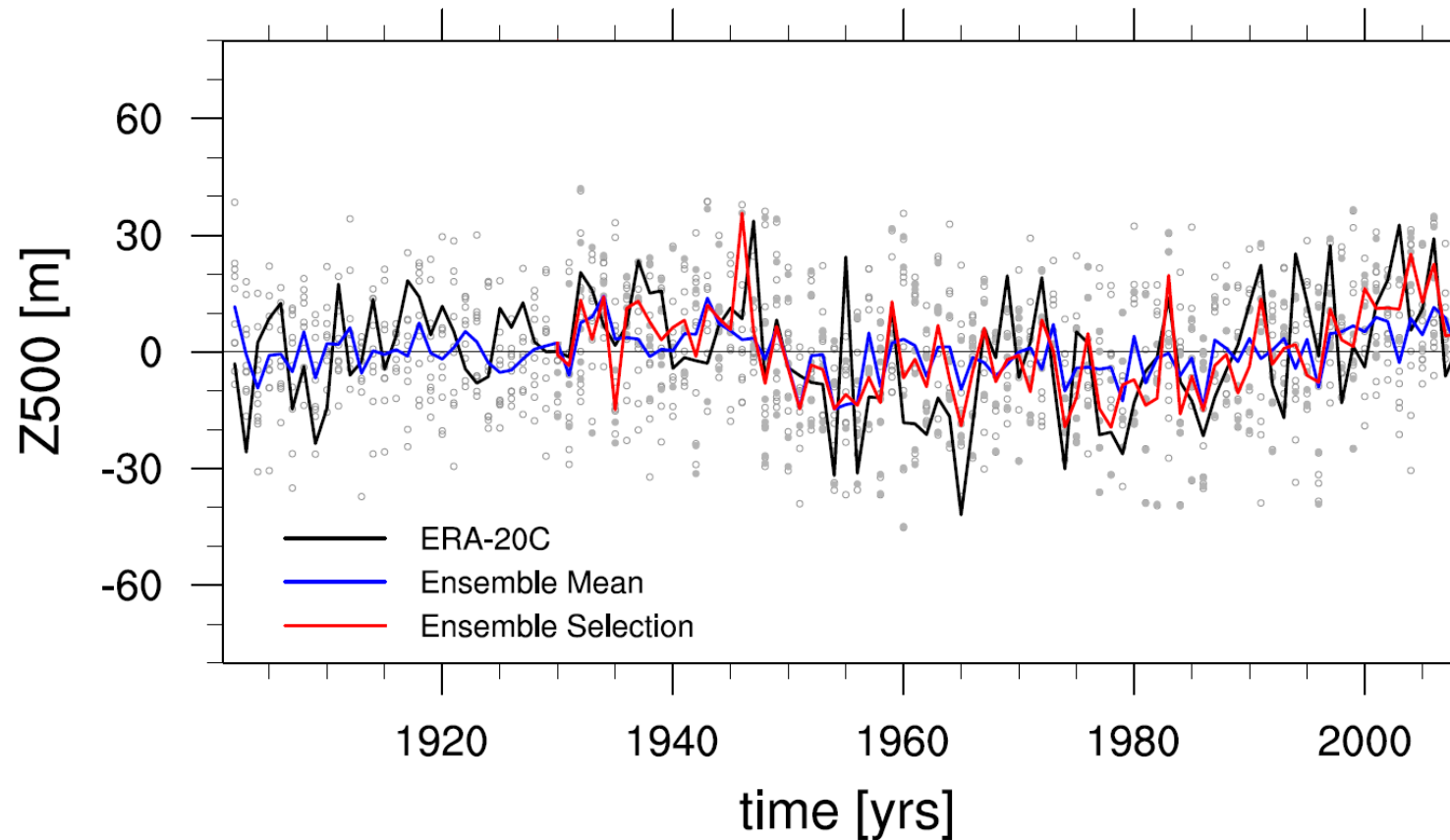

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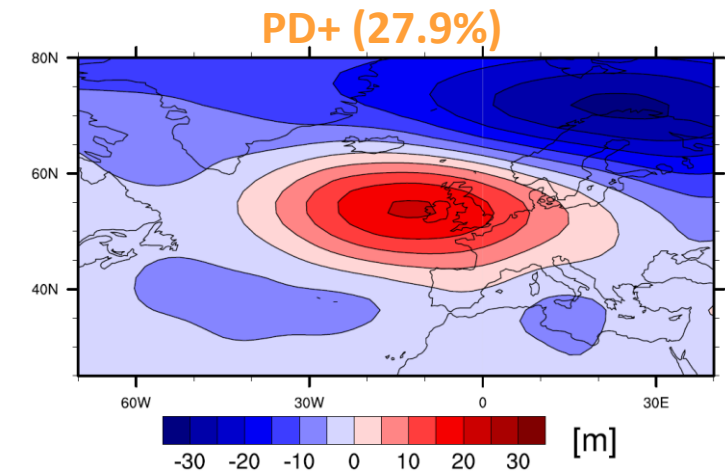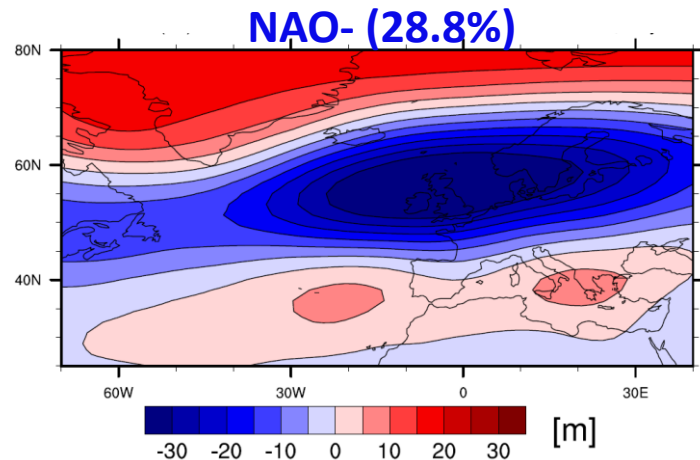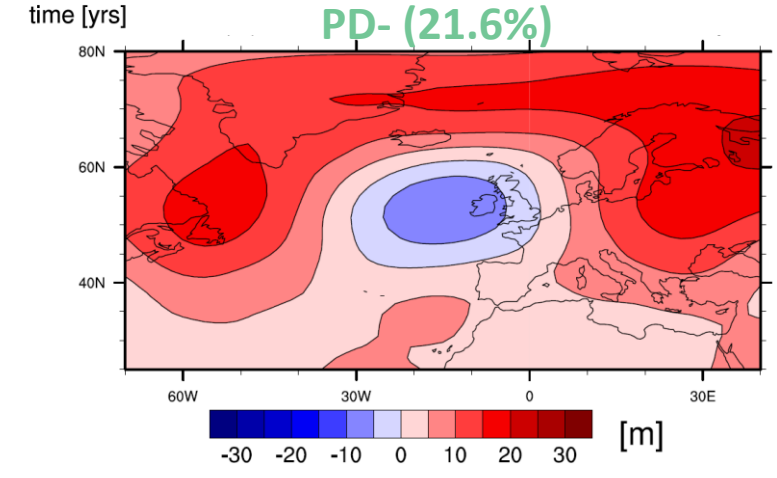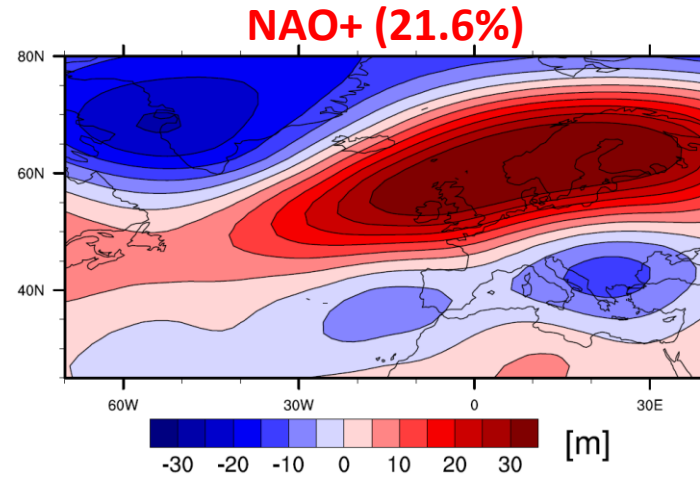
Ensemble Selection

Ensemble Selection

- selection of ensemble members based on known dominant mechanism
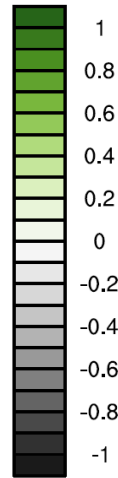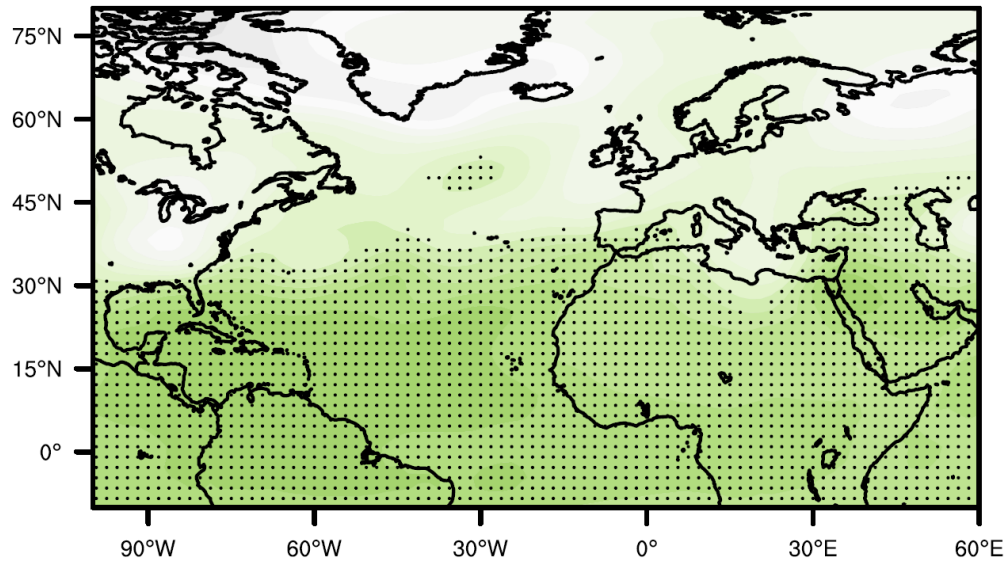
Ensemble Selection

- selection of ensemble members based on known dominant mechanism
- new ensemble mean over selected members
- higher variability
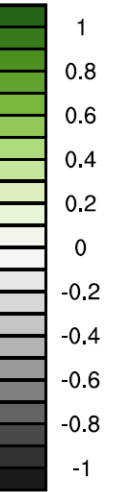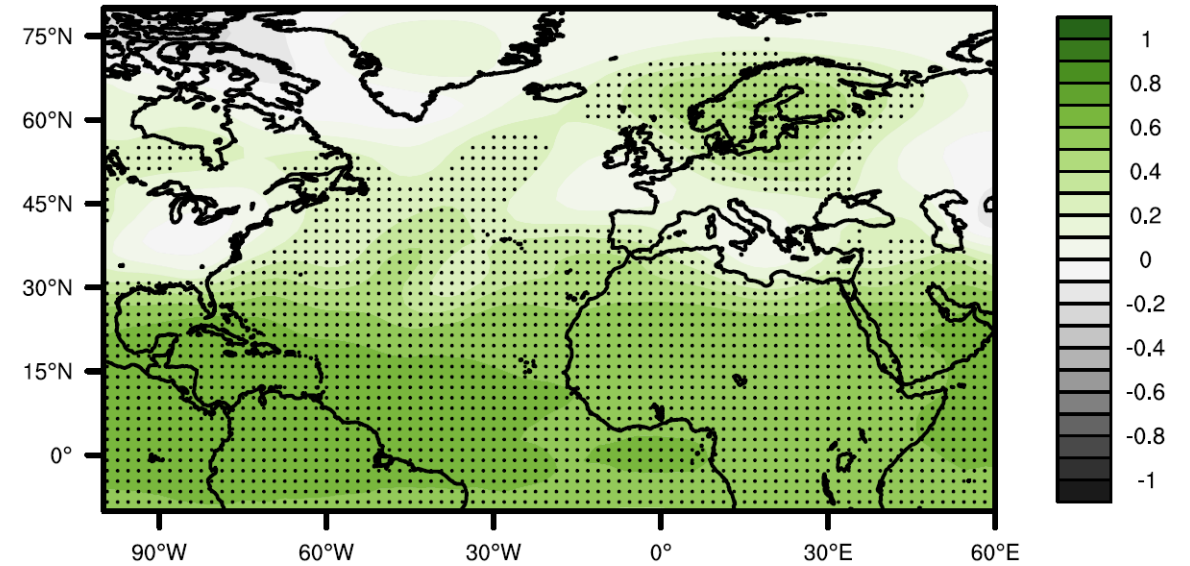
Seasonal Summer Hindcast Skill

Ensemble Mean

July-August (JA)
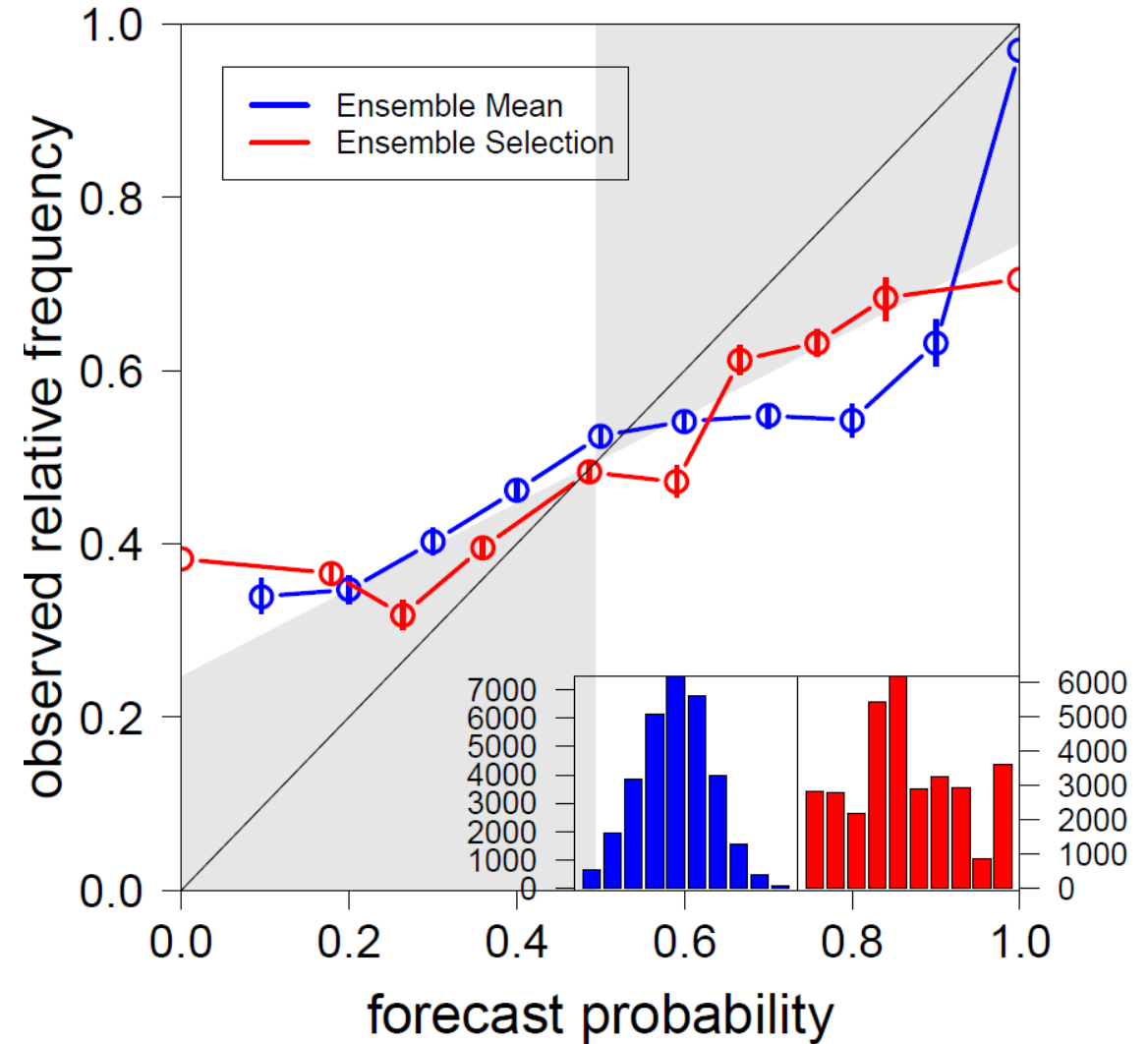500hPa geopotential height (Z500)

Ensemble Selection

July-August (JA)
500hPa geopotential height (Z500)

Reliability

- comparison of probability of forecast to actually observed frequency
- Z500 over Europe

→ improved reliability

→ improved distribution of forecasts

Summary

- we apply cluster analysis to ERA-20C
- identify which mechanisms dominate European summer climate in individual years by analysing
  - North Atlantic Oscillation +/-
  - Zonal Pressure Difference +/-

- model is able to represent these mechanisms
- if known mechanism is considered in hindcast analysis, hindcast skill is improved

→ predictors for mechanisms needed to use method in real forecast set up