# A model-data comparison of North Atlantic climate variability and its responses to natural forcing over the last millennium

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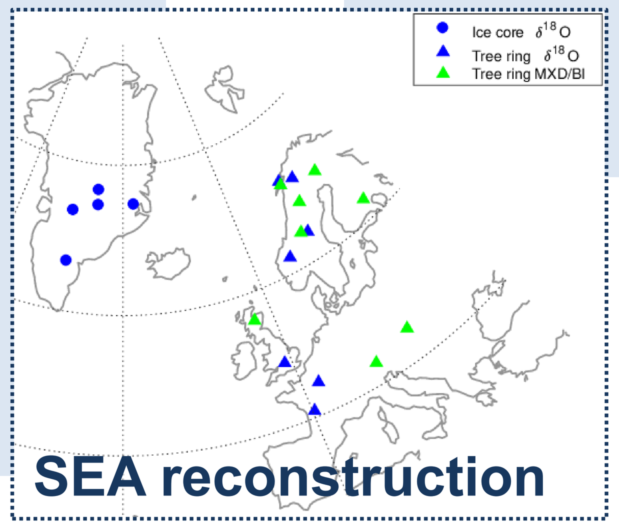
Full abstract

## 1. Introduction

- North Atlantic climate variability is largely governed by the **recurring modes of atmospheric circulation**, also exhibiting impacts of **volcanic and solar forcing**.
- **Gridded reconstructions** of atmospheric circulation over the last millennium offer a unique opportunity for the **paleo-evaluation** of CMIP-PMIP models for the **spatial structure** of climate variability.
- In this study, we perform a data comparison among model-reanalysis-reconstruction in terms of the leading North Atlantic climate variability modes and imprints of major natural forcing.



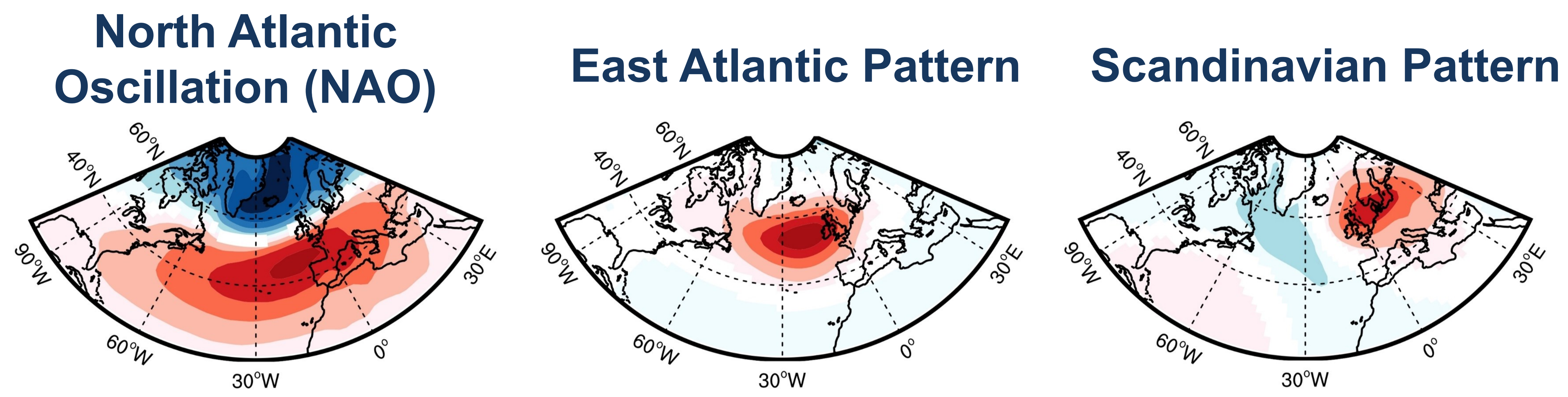




Fig.1 Reconstructed leading EOF modes of winter sea level pressure over the North Atlantic region

## 2. Spatial variability of the NAO

- We compare the 30-year **spatial variability** of modelled North Atlantic climate modes over the years **861-2100** with historical reanalysis and climate field reconstructions.
- The **NAO** in 13 CMIP-PMIP models shows **underestimated spatial variability** compared to historical reanalysis.
- **Future projections** of regional temperature and precipitation may show **biased patterns** due to the underestimated spatial shifts in simulated NAO.

Scan to read our GRL paper 😊

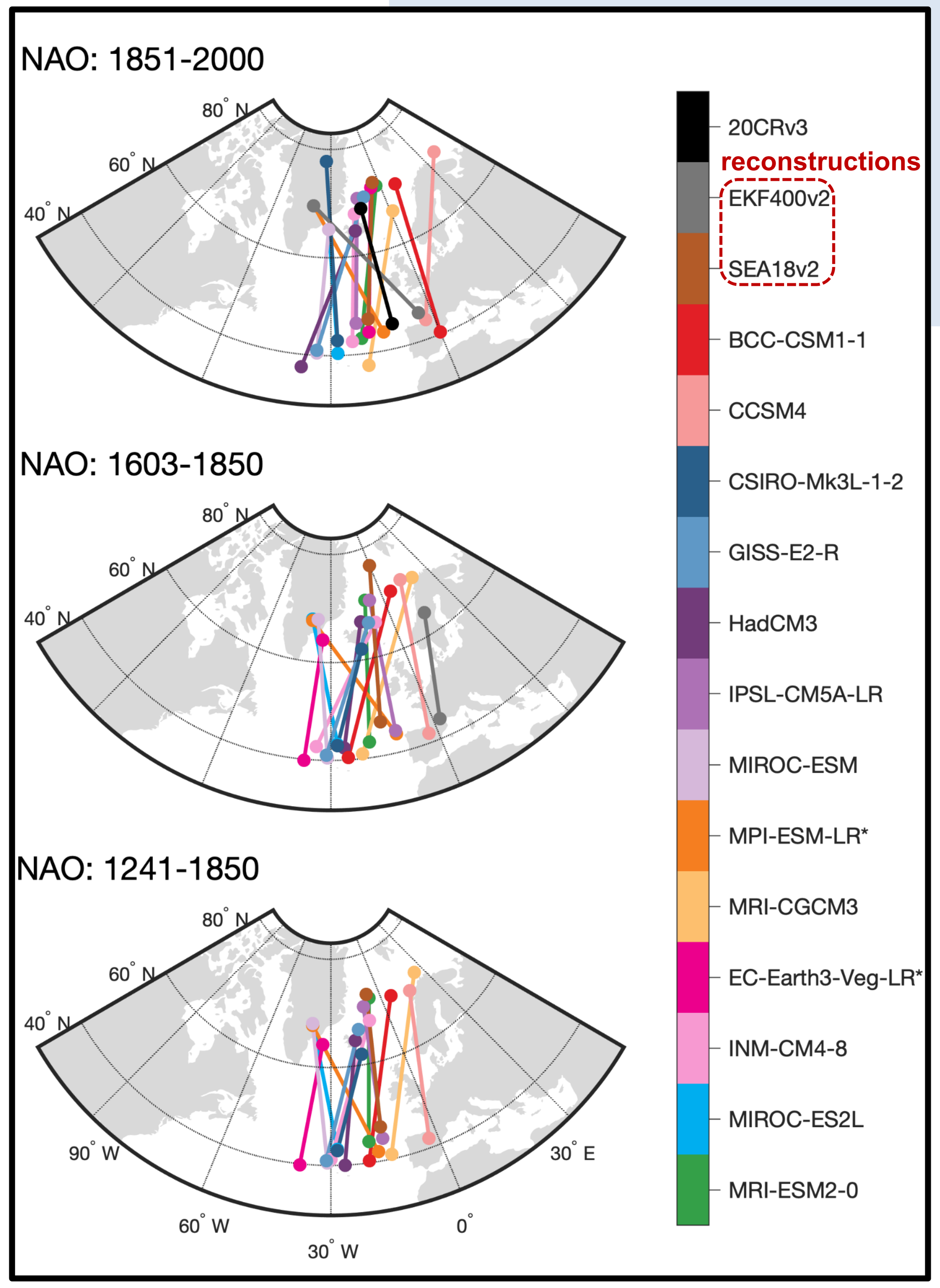



Fig.2 Comparison of the locations of the NAO centers of action (dots) and their tilting features (lines).

## 3. Responses to natural forcing

- Some models can produce similar responses to **volcanic eruptions** to those in reanalysis and reconstructions, showing different processes after **equatorial (EQ) and extratropical Northern Hemisphere (ETNH) eruptions.**
- There are larger discrepancies among the models in the responses to **solar forcing**.

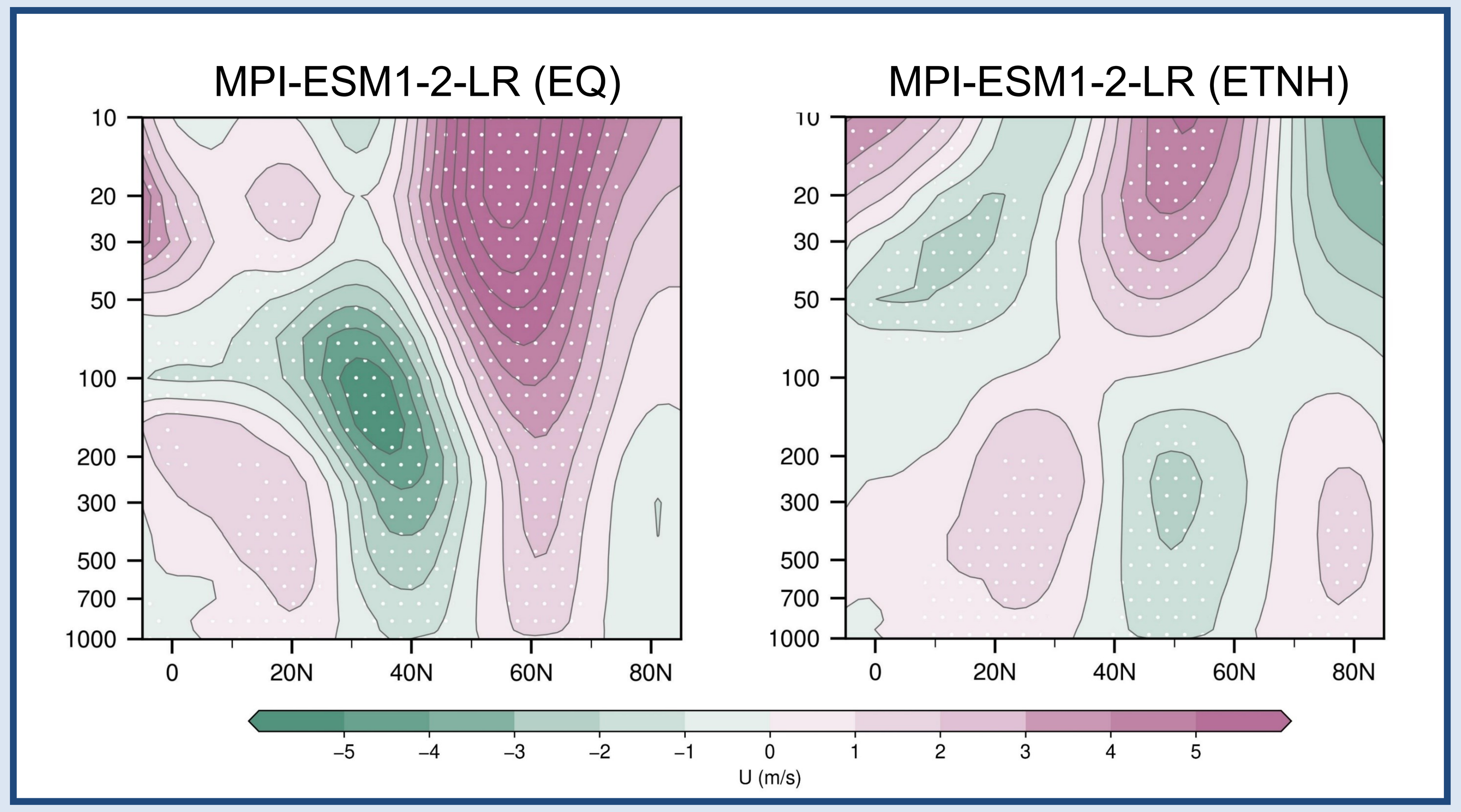



Fig.3 Zonal wind anomalies in the winter of years with peak volcanic forcing with respect to the 5 years before the peak.

## 4. Implications for further application

- Seek better future projections of wind strength and directions in the North Atlantic sector.
- Investigate the variability of Scandinavian heatwaves over the last millennium.

## ❖ Take-home message

- The underestimated spatial variability of the NAO in models highlights a concern for the reliability of regional climate predictions.
- Some models exhibit the ability to reproduce the climate responses to large tropical and extratropical volcanic eruptions.
- **Will the better-performing models in the past also be the better ones in the future?**

### Key references

- Sjolte et al. (2018 & 2020). *Climate of the Past.*
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### Acknowledgements

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