Does the **Atlantic Meridional Overturning Circulation variability** influence **European cold extremes?**

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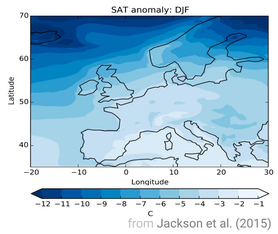
1 What we do & don't know

- The Atlantic Meridional Overturning Circulation (**AMOC**) is a major **system of currents** redistributing heat globally.
- **Idealised large AMOC weakening** experiments, often *hosing*, lead to **cooling NH** (e.g., Bellomo et al., 2023).
- Cooling most pronounced in **winter** & for **northern** latitudes (Jackson et al., 2015).



from Jackson et al. (2015)

- **Effect on cold extreme events** had only been hinted at (Yin & Zhao, 2021)…
  … but now diagnosed over **Europe** for idealised large weakenings (Meccia et al., 2024).
- However, influence of **realistic AMOC variability** on **European cold extremes** has **not been investigated** (only on **mean** climate with limited idealised simulations, Pohlmann et al., 2006).

REASEARCH GAP

How we fill this gap

- Analyse **changing likelihoods** of European variables conditioned on AMOC strengths.
- Use power of **large ensembles of simulations** to better represent **internal variability**:
  - **MPI-ESM-LR, 50 members, historical** (CMIP6).
  - Reference: std (σ) long **pre-industrial** simulation.
- **Detrend**: remove ens. mean trend for each member.
- **Categorise temperatures** based on preceding **interannual AMOC strength:**
  3-year mean AMOC **strength** @ **26.5°N**
  - **Strong**: 1σ or stronger than mean
  - **Weak**: -1σ or weaker than mean

Modelled interannual **AMOC weakenings** were associated with **more severe cold extremes over Europe,** but this **effect has decreased in the recent past**

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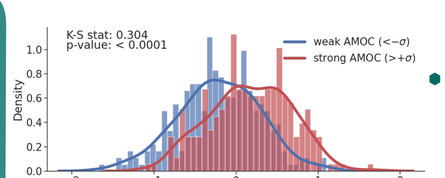
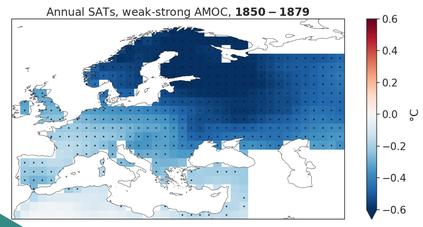
2 Different mean T states



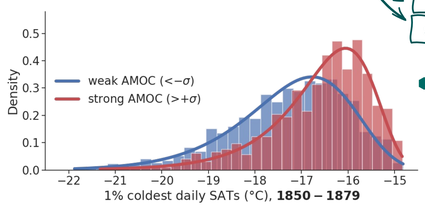
- For **weak AMOC**, distribution of **mean European yearly SATs** shifted to **colder** temperatures.



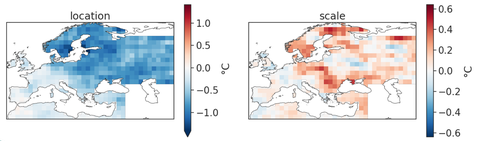
- Spatially, weak AMOC leads to cooling for **all locations,** largest **Scandinavia** & **NE Europe.**

3 Cold extremes also shifted

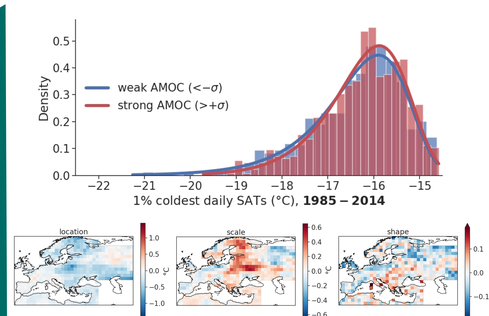
1st percentile daily temperatures
Preceding **3-year AMOC** for year of cold day
weak
strong



- **Colder extremes** for **weak AMOC.** How Generalized Extreme Value (GEV) distribution parameters contribute?



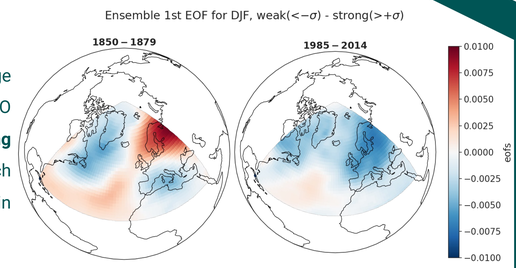
- Largely due to **location shift,** but also some patterns in **scale** parameter.



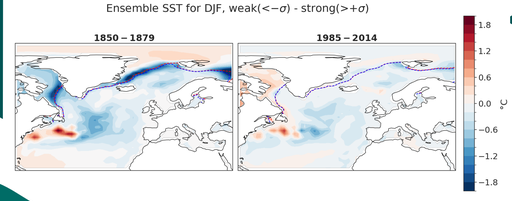
- **Very similar GEVs,** no longer a large shift in location parameter.

1985-2014?

4 Mechanisms



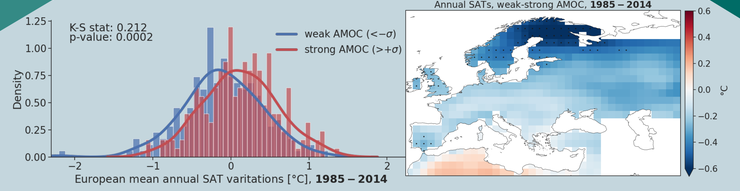
- Pressure patterns change during **weak** AMOC: NAO has **Scandinavian blocking** signal in **1850-1879,** which becomes **Atlantic Ridge** in **1985-2014**.



- Changes could be mediated by **SST** variations, possibly in relation to processes at the **sea-ice edge**.

What about extremes?

Recent period? (1985-2014) → **less pronounced** shift



Why changes weak/strong & early/recent periods?

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