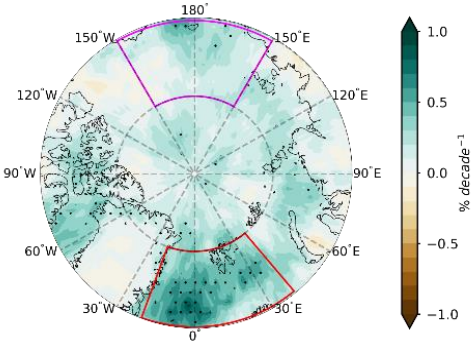
Arctic Atmospheric Rivers: Trends and Impact on Winter Warm Extremes

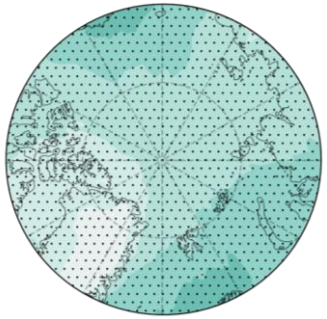
Hailong Wang (PNNL) | HiLAT-RASM

- Observed AR trends is **2x** as much in the Atlantic than the Pacific sector
  - Not captured in CMIP6 and CESM2-LENS coupled experiments but does when SST & sea ice are prescribed
  - Explained by thermodynamical effect of **multidecadal** oscillations (combined negative **IPO** and positive **AMO** during 1981-2021)
  - **E3SM-Arctic** RRM reduces AR bias
- Removing the influence of IPO/AMO can reduce the projection uncertainty in Arctic future AR trends by 24%

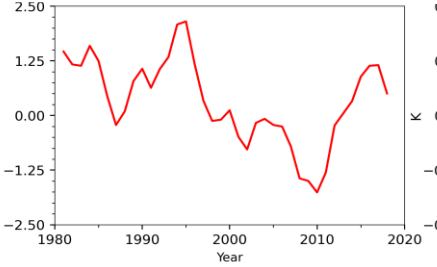
ERA5 AR trends



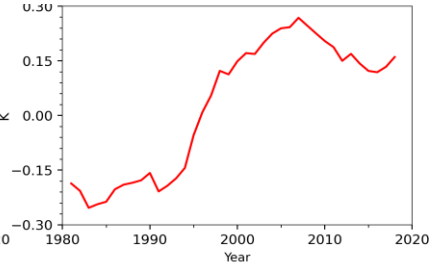
CMIP6 models



IPO index



AMO index



Ma et al. (2024a)

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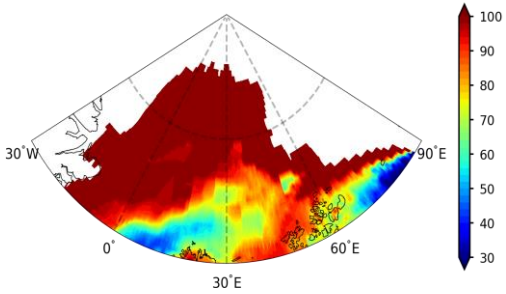
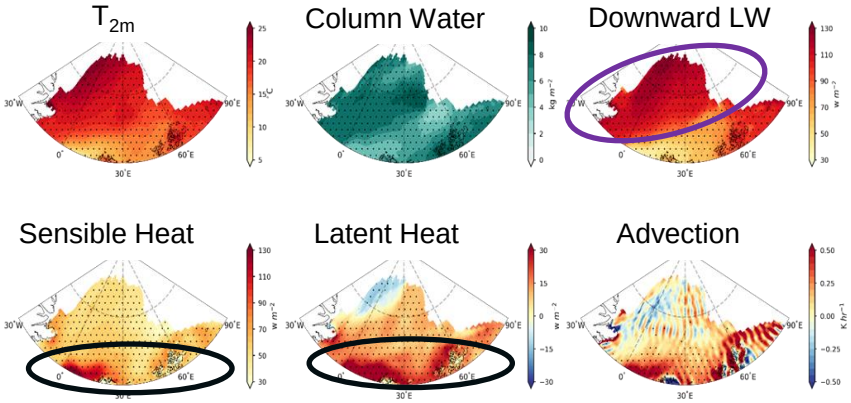
- High Arctic (poleward of 80N) winter warm extremes ($T_{2m} \geq 0$℃) occur rarely, primarily associated with ARs within the **Atlantic** sector (**1980-2021**)
- Huge impact on the surface energy budget
  - Up to **3x** moistening (IWV)
  - DLW dominance transitioning to turbulent heat fluxes dominance (from pole to 80N)
- Frequency, duration and magnitude have been increasing significantly, with implications for Arctic sea ice and ecosystem

% of warm extremes with ARs



Anomalies during the warm extremes



Ma et al. (2024b)