

The fate of water vapor over the Atlantic and variations in the AMOC

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Motivation

- Precipitation contributes to buoyancy changes in the upper ocean, leading to variability in the Atlantic Meridional Overturning Circulation (AMOC)
- The AMOC is also linked to SST and atmospheric circulation pattern changes that can influence where water evaporates and precipitation falls.
- “Water-tagging” capability implemented in CAM5.3 allows detailed analysis of the atmospheric water cycle and its relationship with the AMOC.

Data and Methods

47 years of monthly precipitation and AMOC data were obtained from an 1850's control simulation in CESM 1.2 using CAM5.3.

48 tags were enabled to track the source of water in the atmosphere:

- 10° latitude bands in ocean basins (40 tags)
- Approx. 1 tag per continent (8 tags)

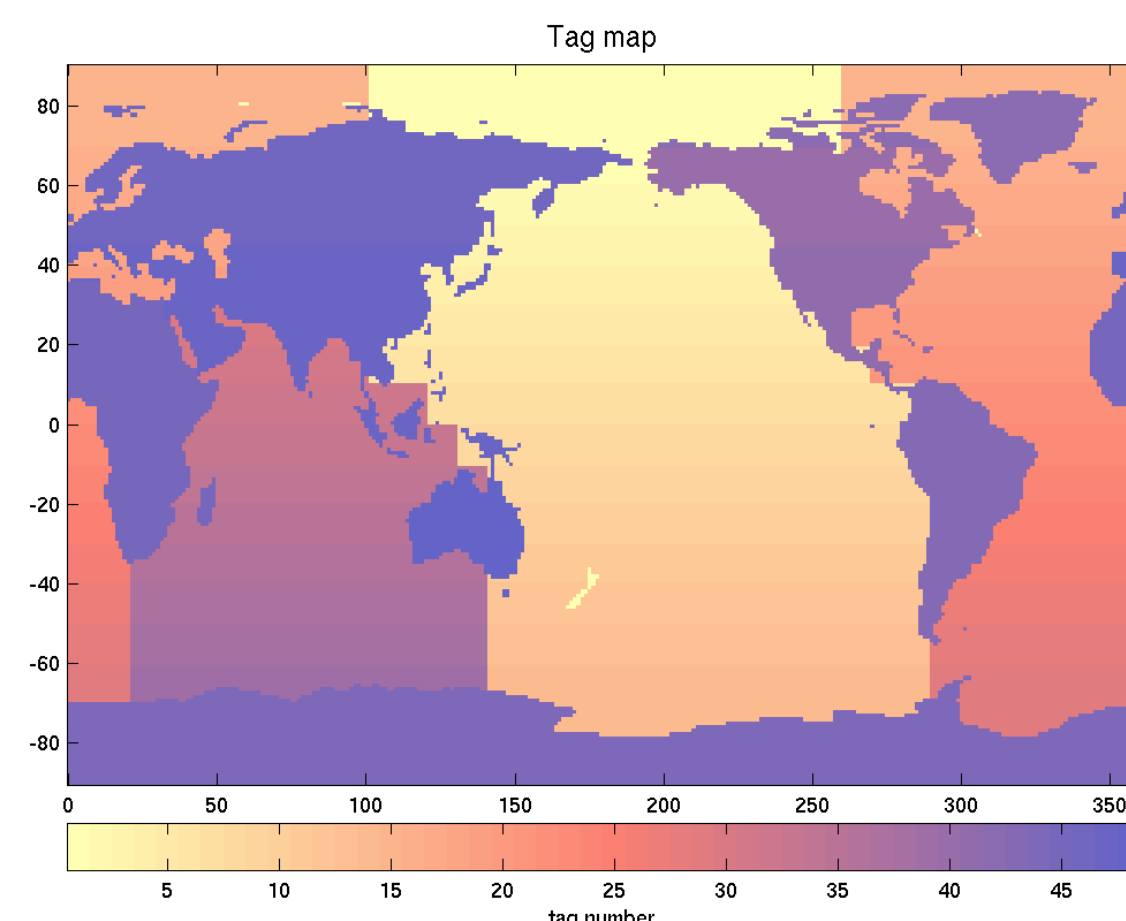


Fig. 1. Shows locations of 48 tagged source regions.

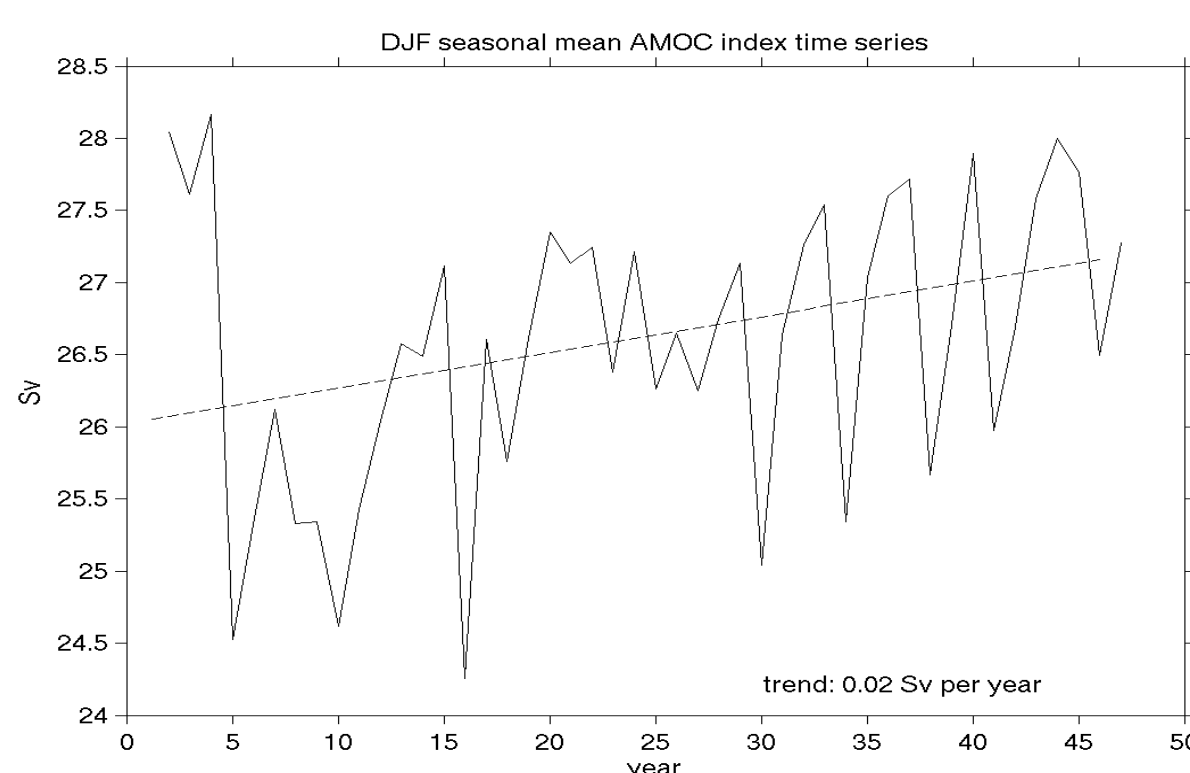


Fig. 2. Time series of seasonal mean DJF AMOC strength

The AMOC index was computed as the maximum value of overturning below 200 m and between 20°-80° N.

Correlation and regression analysis are used to relate the mean precipitation fields with the AMOC index. We also investigate how the AMOC affects the source and rates of precipitation at selected locations over land.

Impacts in Atlantic and Pacific

Atlantic Ocean

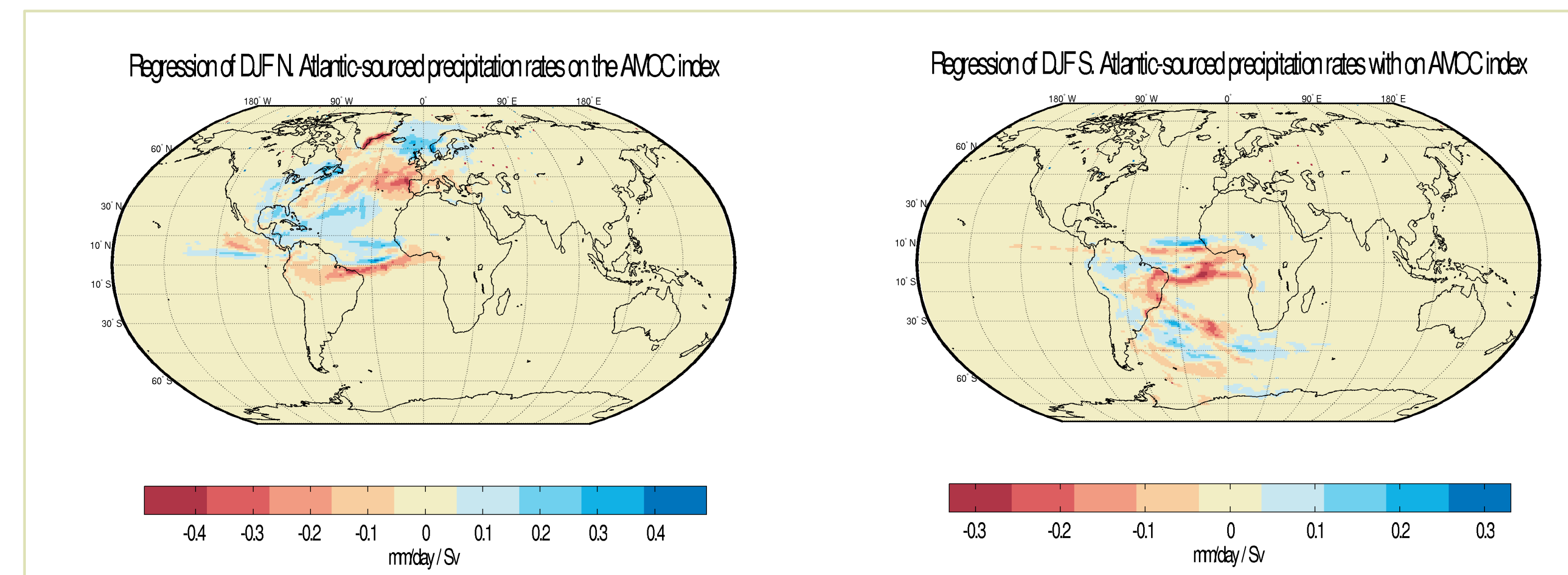
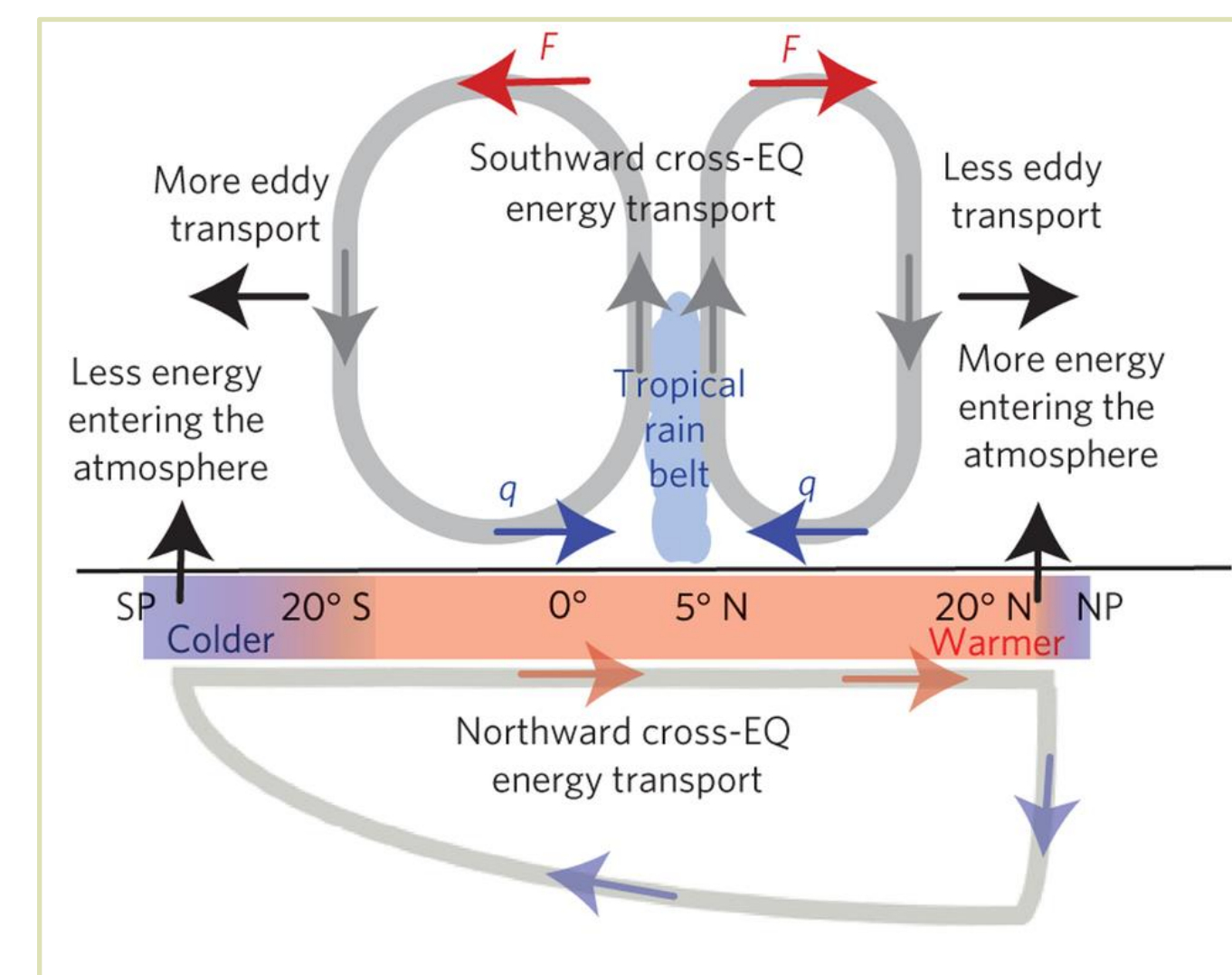


Fig. 3. Regression maps of precipitation rates with the AMOC index using DJF seasonal means. Precipitating water originated from the north Atlantic (left) or the south Atlantic (right).



- DJF chosen as time when AMOC has most variability
- Strongest effects in north and tropical south Atlantic
- ITCZ appears to move northward during strong AMOC

Fig. 4. Relationship of AMOC strength and location of ITCZ. From Frierson et al (2013)

Pacific Ocean

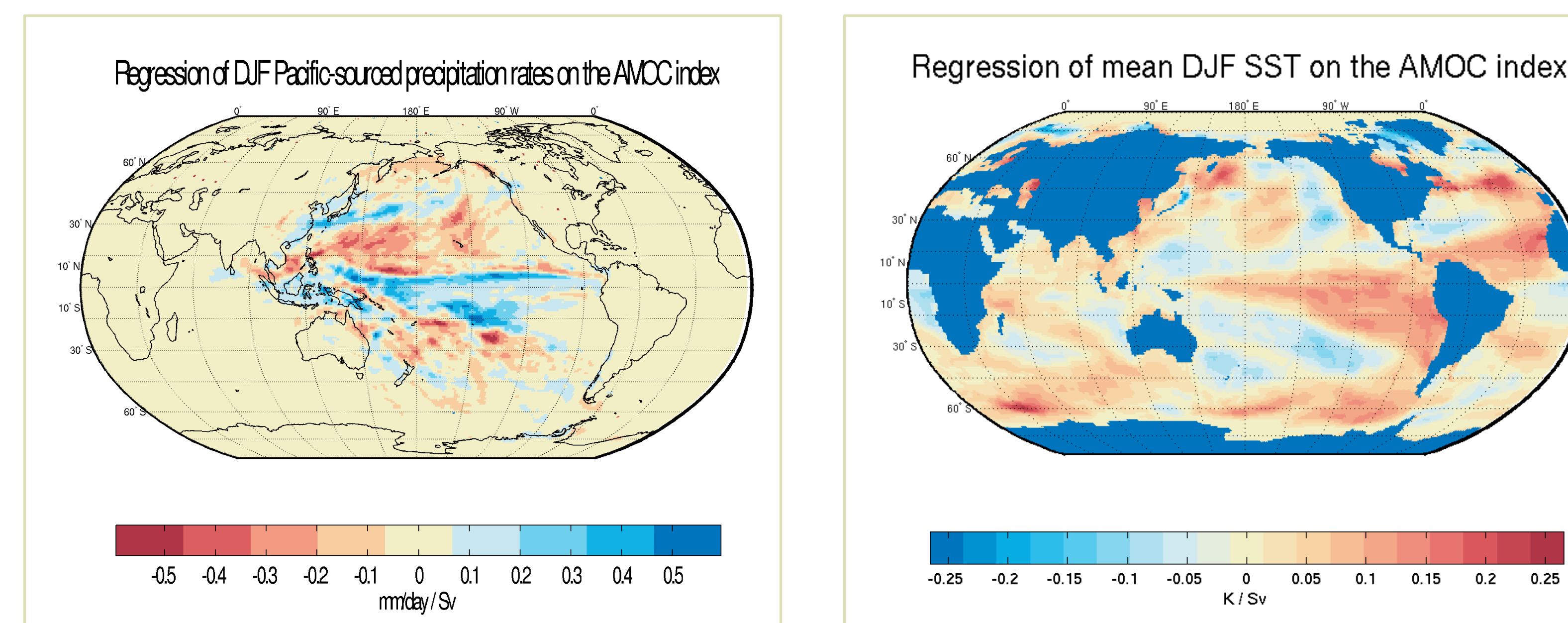


Fig. 5. Left: Regression maps of Pacific-sourced precipitation rates with the AMOC index using DJF seasonal means. Right: Regression map of the DJF mean SST on the AMOC index

- During strong AMOC, wet areas get wetter while dry areas get drier.
- Similar patterns for both precipitation and SST relationships with the AMOC. We speculate teleconnections are due to changes in atmospheric circulation, possibly through zonal winds.

Impacts on land

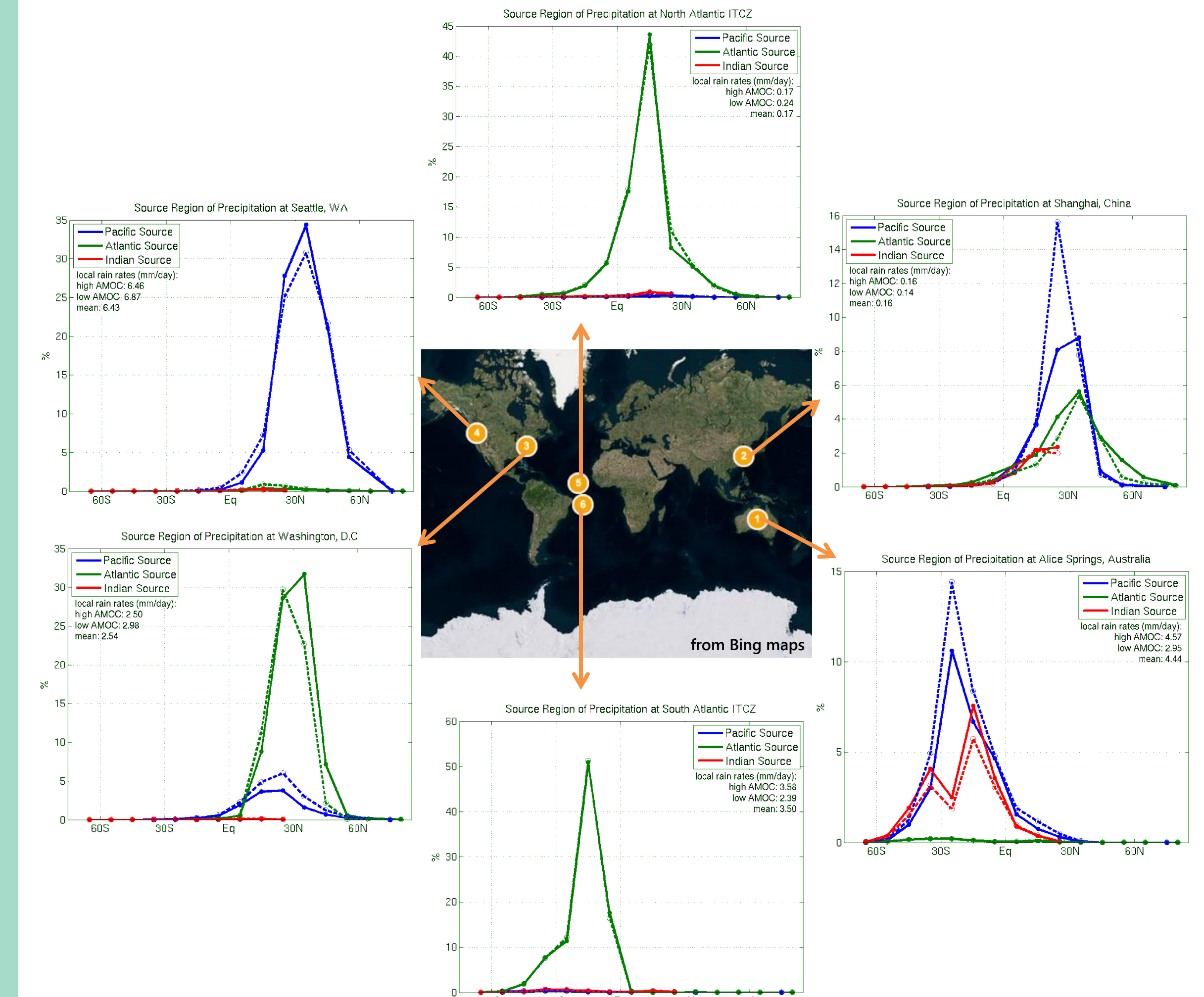


Fig. 6. DJF precipitation rates at Seattle, Washington D.C., Shanghai, Alice Springs, and the North and South Atlantic ITCZ displayed by percent of total precipitation from each source region (basin and latitude band). Solid lines indicate years when the AMOC was in the top 5% of its strength, while dashed lines represent years when the AMOC was at its lowest 5%.

- Examined precipitation-AMOC link for selected locations on land, particularly where strong links existed (e.g. figs. 3,5).
- Composited seasonal rainfall percentages during periods of highest and lowest 5% of AMOC strength.

Acknowledgements

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