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*Supplement of*

## **Atmospheric blocking representation in storm-resolving climate models under historical and future forcing**

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## **Abstract**

This document contains supplementary material to “Storm-Resolving Models Advance Atmospheric Blocking Simulations and Climate Change Insights”. This includes additional results that complement the analysis presented in the main text: we display the NH blocking frequency with ABS index, Zonal mean wind against latitude in the North Atlantic and North Pacific, spatial correlation between storm-track biases and blocking biases, and the NH blocking frequency bias in ICON projection runs.

## S1. NH blocking frequency with ABS index

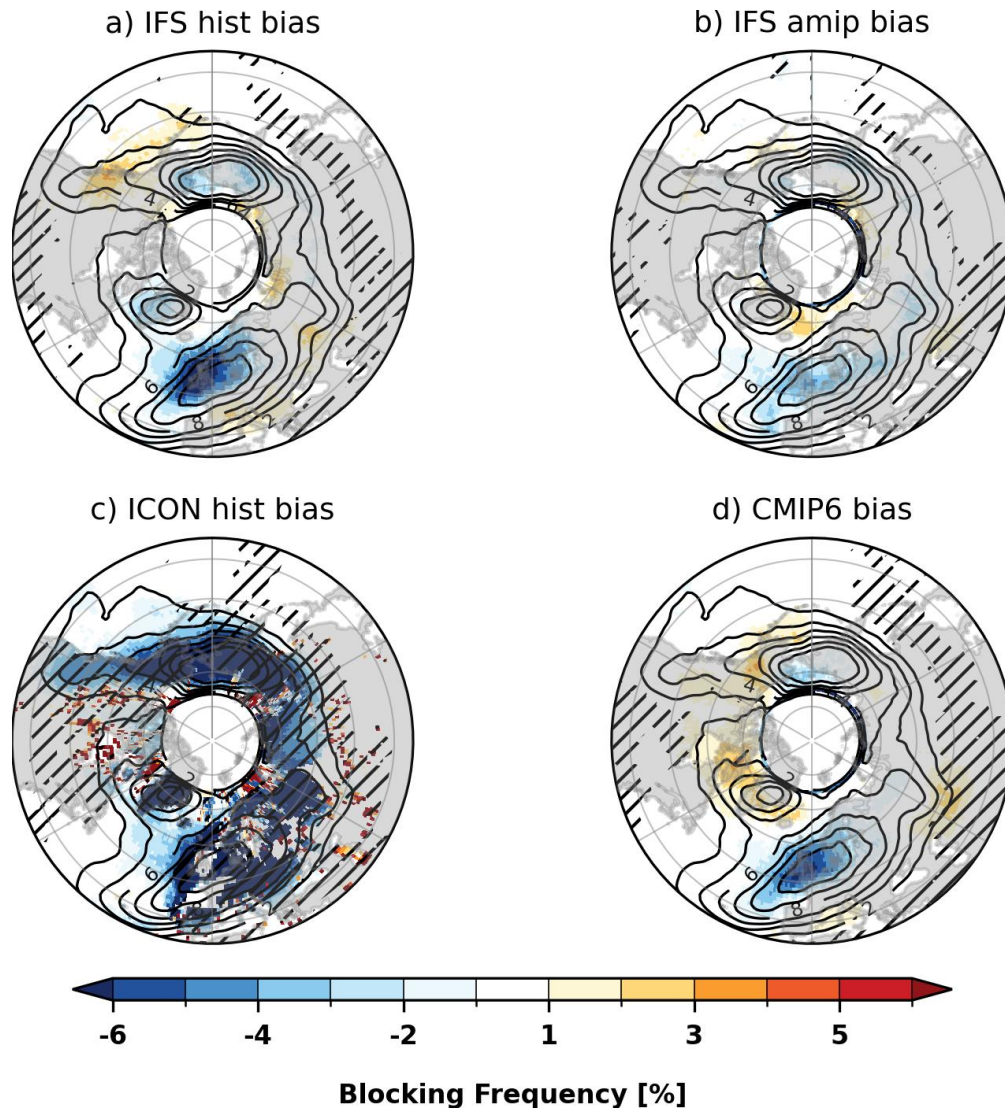


Figure S1: Blocking frequency biases against ERA5 during Northern Hemisphere winter (DJF), based on the ABS index, for (a) IFS historical, (b) IFS atmosphere-only, (c) ICON historical, and (d) the CMIP6 ensemble mean. The ERA5 blocking frequency is indicated by contours. Hatched areas indicate regions where the bias relative to ERA5 exceeds 80%.

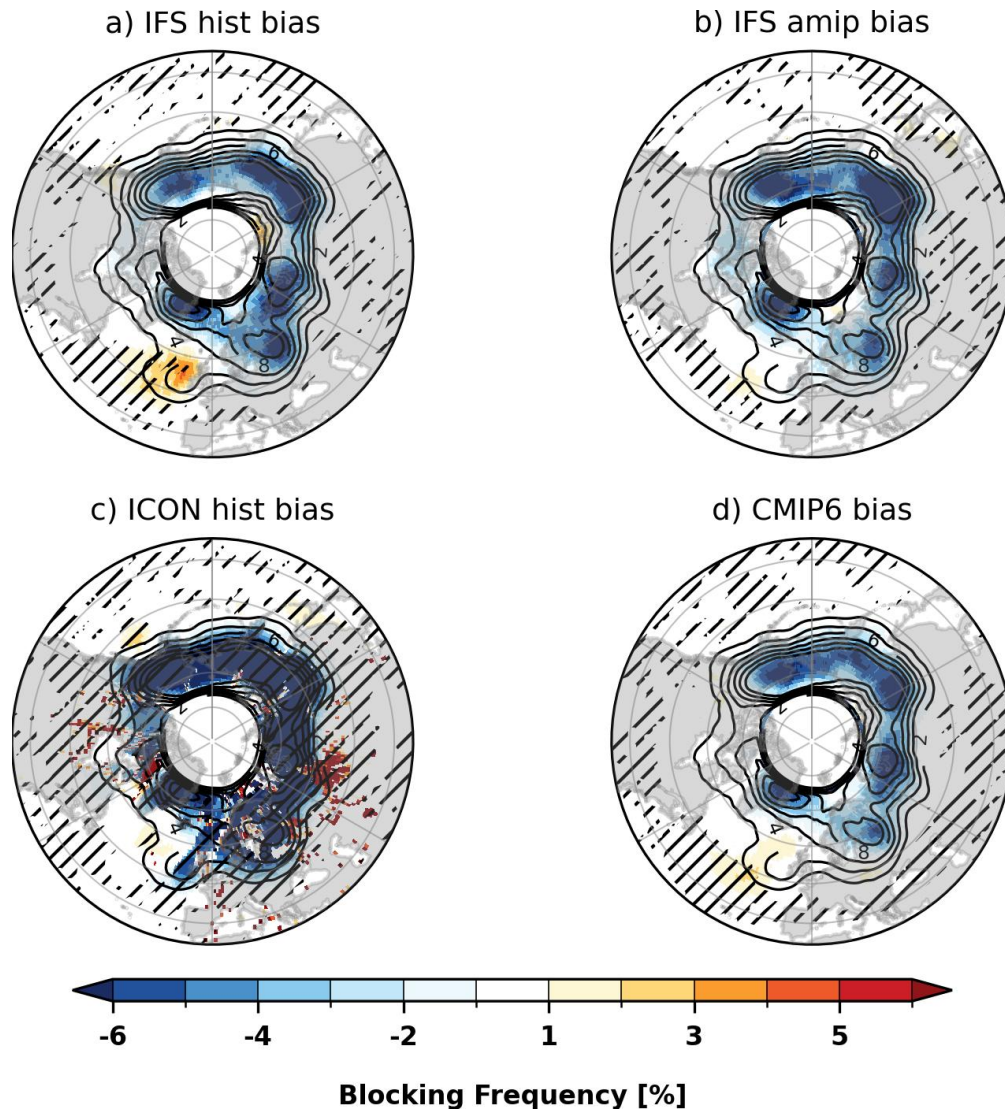


Figure S2: Blocking frequency biases against ERA5 during Northern Hemisphere summer (JJA), based on the ABS index, for (a) IFS historical, (b) IFS atmosphere-only, (c) ICON historical, and (d) the CMIP6 ensemble mean. The ERA5 blocking frequency is indicated by contours. Hatched areas indicate regions where the bias relative to ERA5 exceeds 80%.

## S2. Zonal mean wind against latitude in the North Atlantic and North Pacific

Sectoral zonal wind and blocking frequency (DJF, NH)

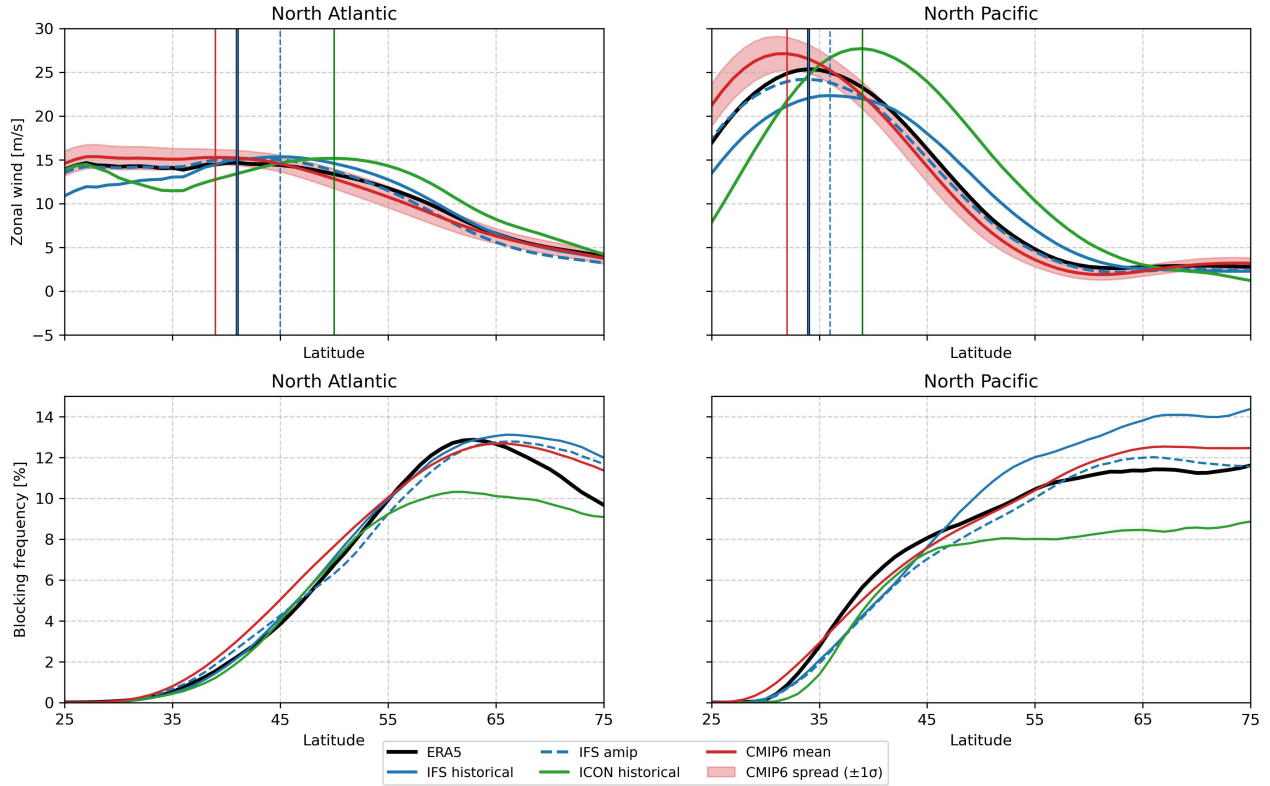


Figure S3: Zonal mean 500 hPa zonal wind ( $\text{m s}^{-1}$ ) and sector-averaged blocking frequency (%) as a function of latitude for the North Atlantic and North Pacific basins during winter (DJF), based on historical simulations. The plots compare ERA5 with IFS, ICON, and the CMIP6 ensemble mean. Shaded areas denote the inter-model spread ( $\pm 1\sigma$ ) for CMIP6. Vertical lines mark the latitude of maximum zonal wind (jet core) for each dataset.

Sectoral zonal wind and blocking frequency (JJA, NH)

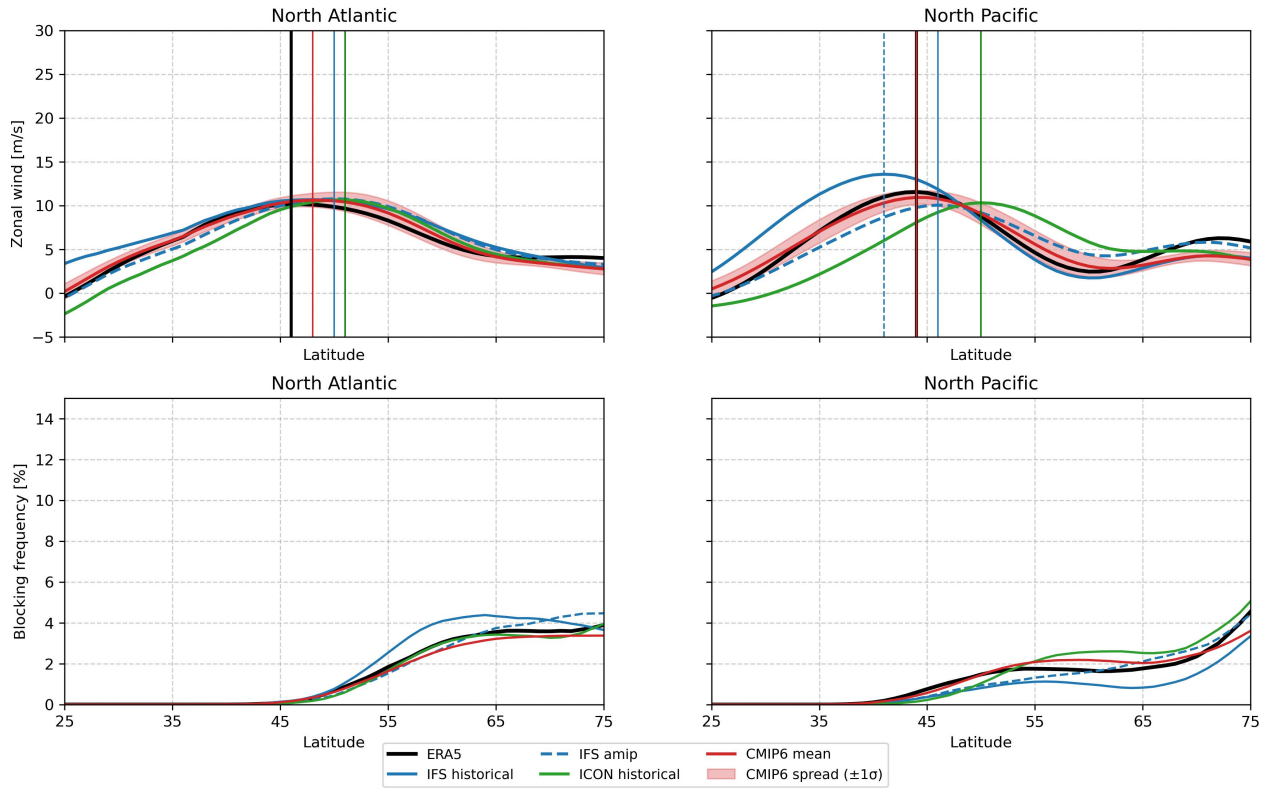


Figure S4: Zonal mean 500 hPa zonal wind ( $\text{m s}^{-1}$ ) and sector-averaged blocking frequency (%) as a function of latitude for the North Atlantic and North Pacific basins during summer (JJA), based on historical simulations. The plots compare ERA5 with IFS, ICON, and the CMIP6 ensemble mean. Shaded areas denote the inter-model spread ( $\pm 1\sigma$ ) for CMIP6. Vertical lines mark the latitude of maximum zonal wind (jet core) for each dataset.

### S3. NH blocking frequency in ICON projection runs

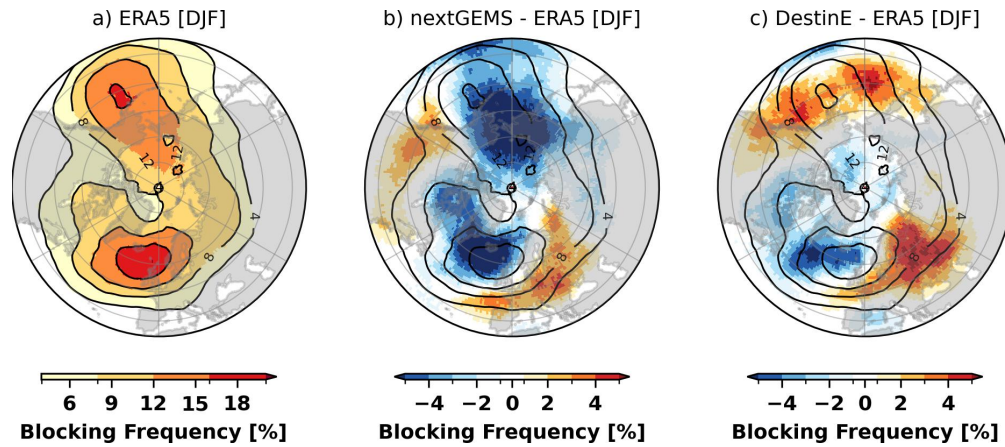


Figure S5: (a) Blocking frequency in ERA5 and corresponding biases relative to ERA5 for (b) ICON SSP3–7.0 nextGEMS and (c) ICON SSP3–7.0 DestinE during Northern Hemisphere winter (DJF), based on the ANO index. Black contours indicate ERA5 blocking frequency. Hatched regions denote areas where the bias relative to ERA5 exceeds 80%. Although SSP3–7.0 simulations are shown, differences are presented relative to ERA5 rather than as SSP3–7.0 minus historical changes, due to differences in model configuration and drift between ICON simulations (see text for details).

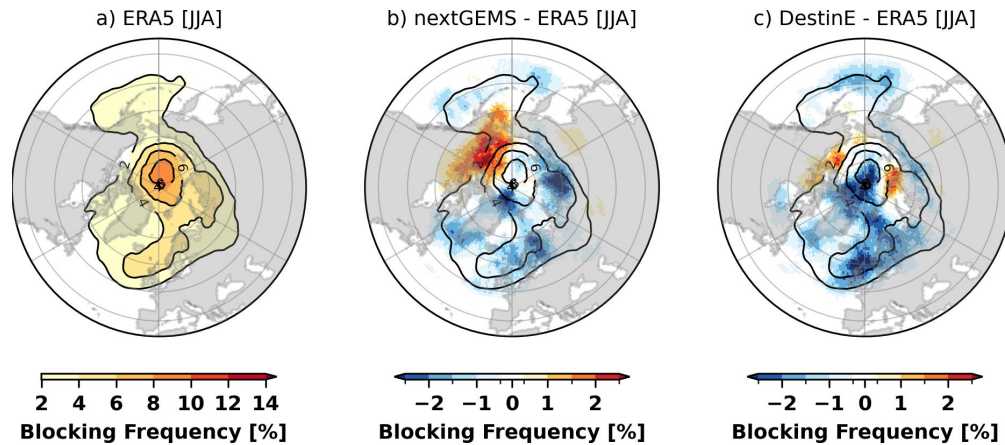


Figure S6: (a) Blocking frequency in ERA5 and corresponding biases relative to ERA5 for (b) ICON SSP3–7.0 nextGEMS and (c) ICON SSP3–7.0 DestinE during Northern Hemisphere summer (JJA), based on the ANO index. Black contours indicate ERA5 blocking frequency. Hatched regions denote areas where the bias relative to ERA5 exceeds 80%. Although SSP3–7.0 simulations are shown, differences are presented relative to ERA5 rather than as SSP3–7.0 minus historical changes, due to differences in model configuration and drift between ICON simulations (see text for details).

## S4. Spatial correlation between storm-track biases and blocking biases

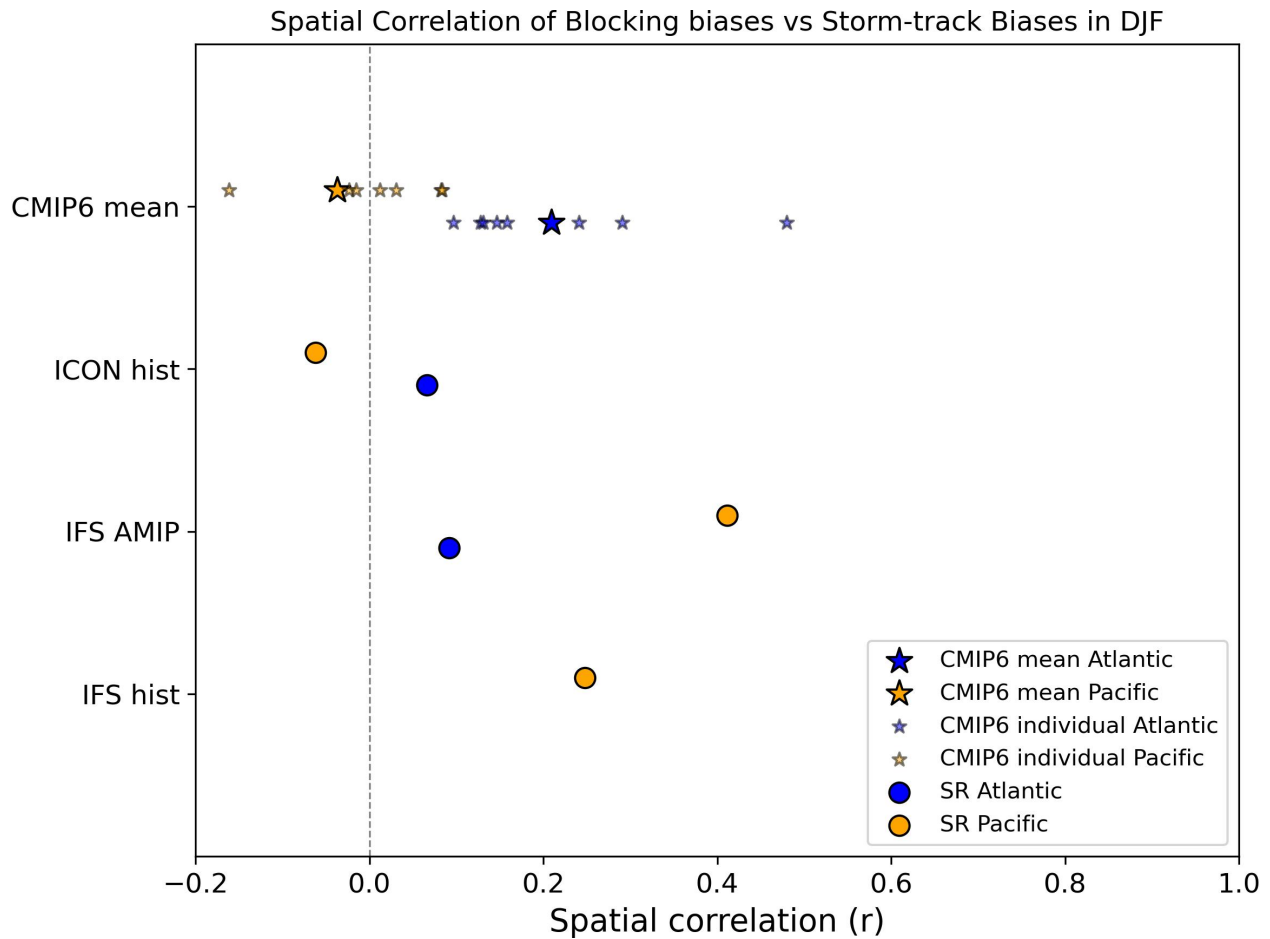


Figure S7: Spatial correlation between storm-track biases and blocking biases in boreal winter (DJF) for the historical simulations analysed in this study, including individual CMIP6 models and storm-resolving (SR) models. Correlations are computed across grid cells within the the ATL 50–90 N, -90–90 E and PAC 40–90 N, 120–240 E.

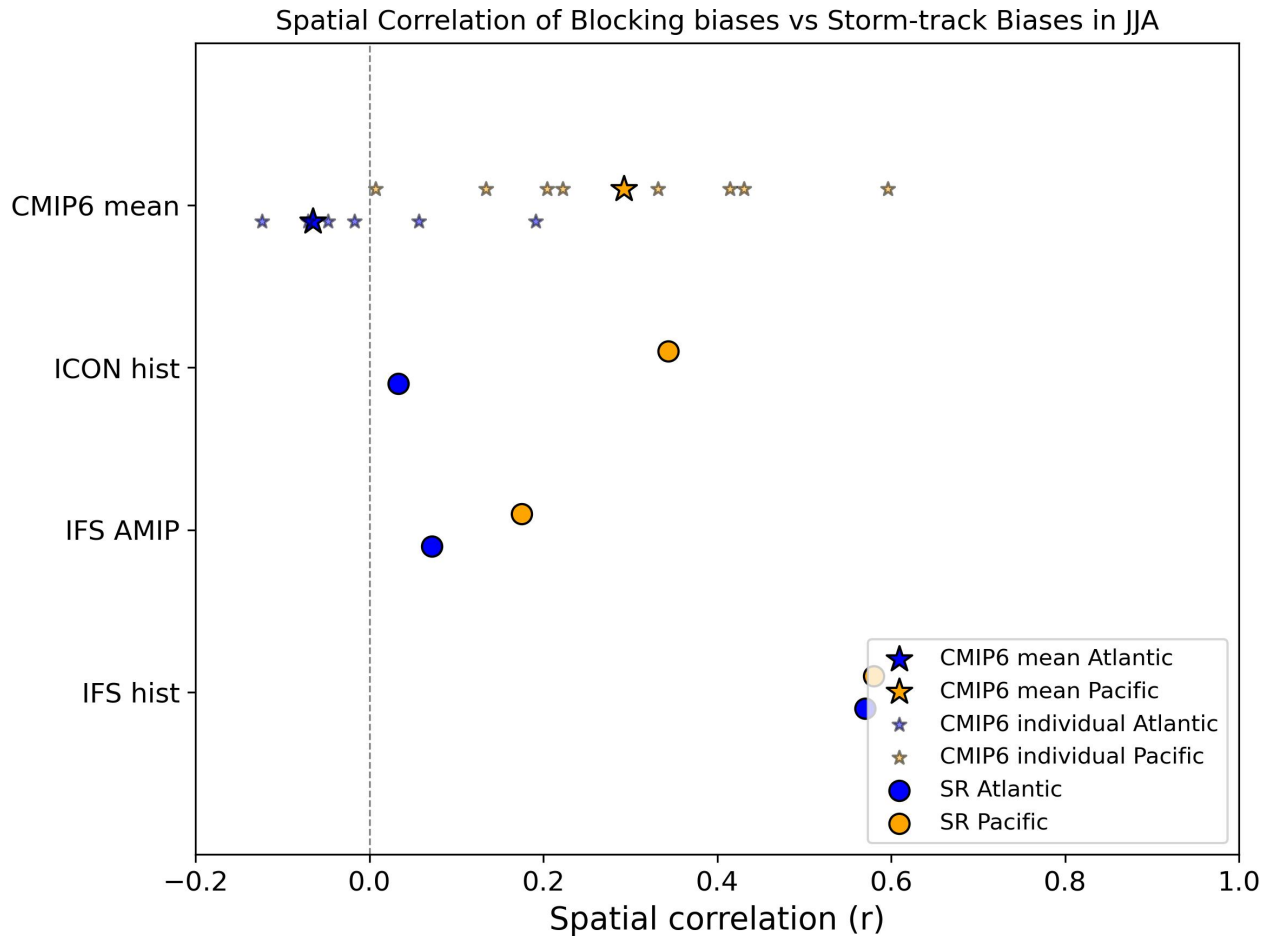


Figure S8: Spatial correlation between storm-track biases and blocking biases in boreal summer (JJA) for the historical simulations analysed in this study, including individual CMIP6 models and storm-resolving (SR) models. Correlations are computed across grid cells within the ATL 50–90 N, -90–90 E and PAC 40–90 N, 120–240 E.