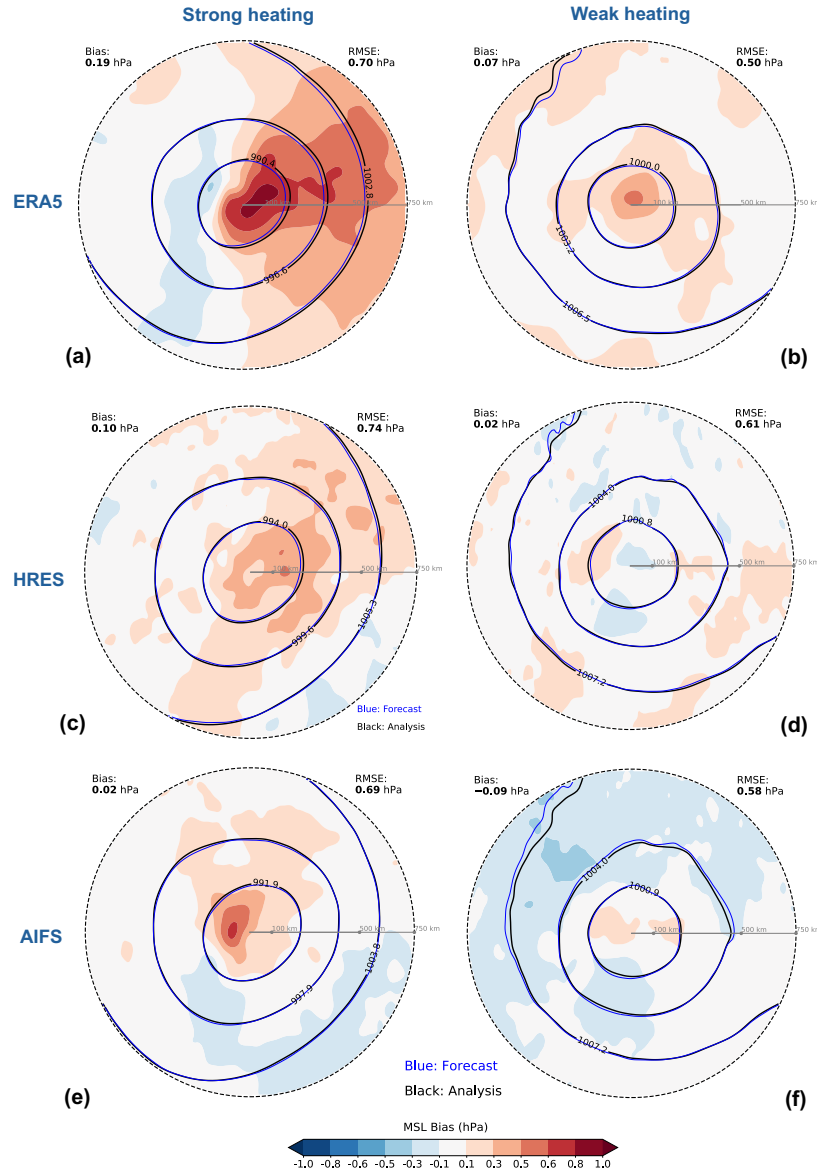
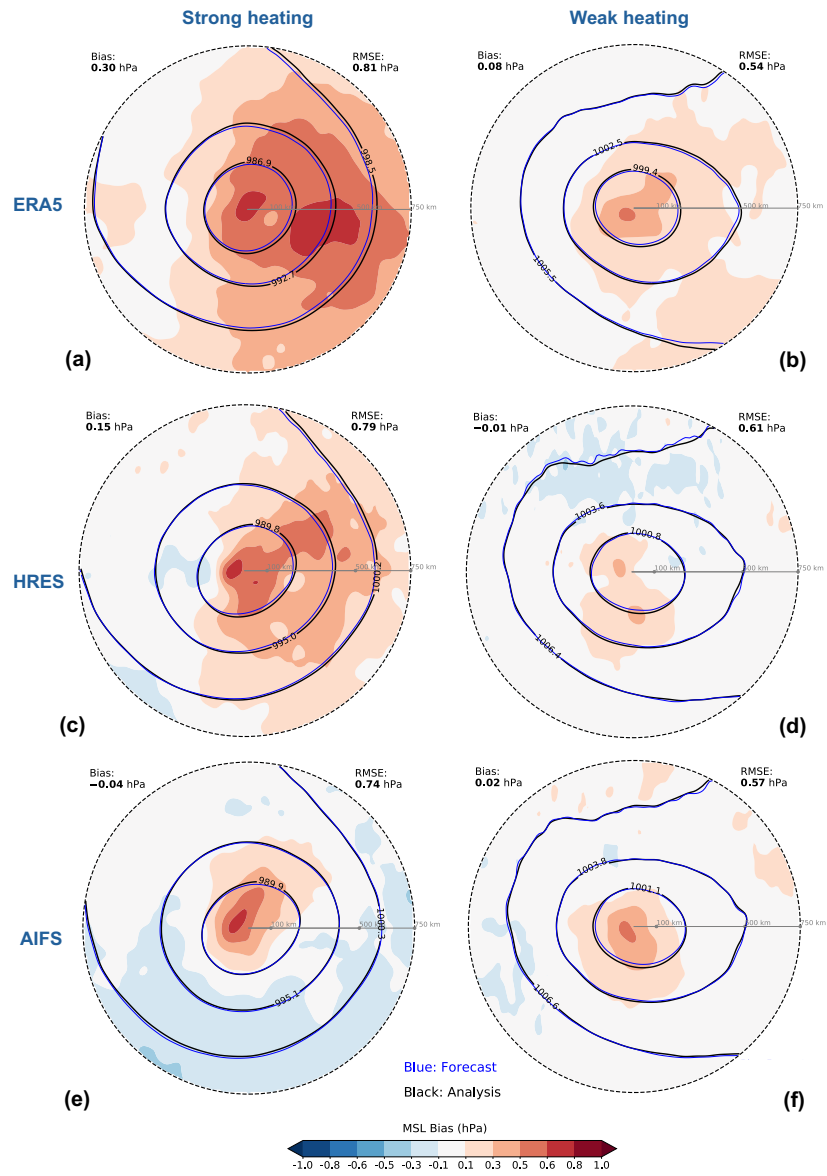


## Supplemental Material



**Figure S1:** Mean sea level pressure (MSLP) biases over the North Atlantic, verified against ERA5 reanalysis for (a, c, e) the strong heating group and (b, d, f) the weak heating group. Black contours represent the analysis composite and blue contours the forecast composite. (a,b) ERA5, (c,d) HRES, (e,f) AIFS.



**Figure S2:** As in Figure S1, but for the North Pacific

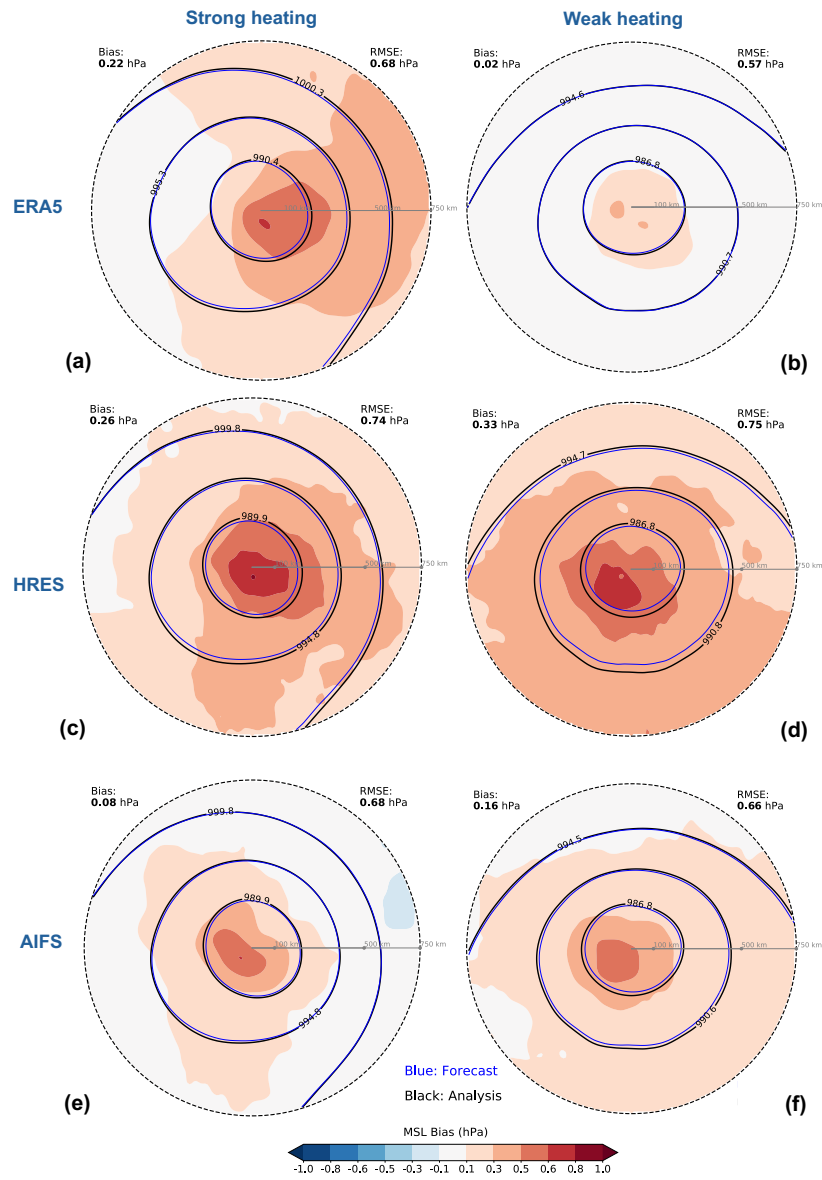
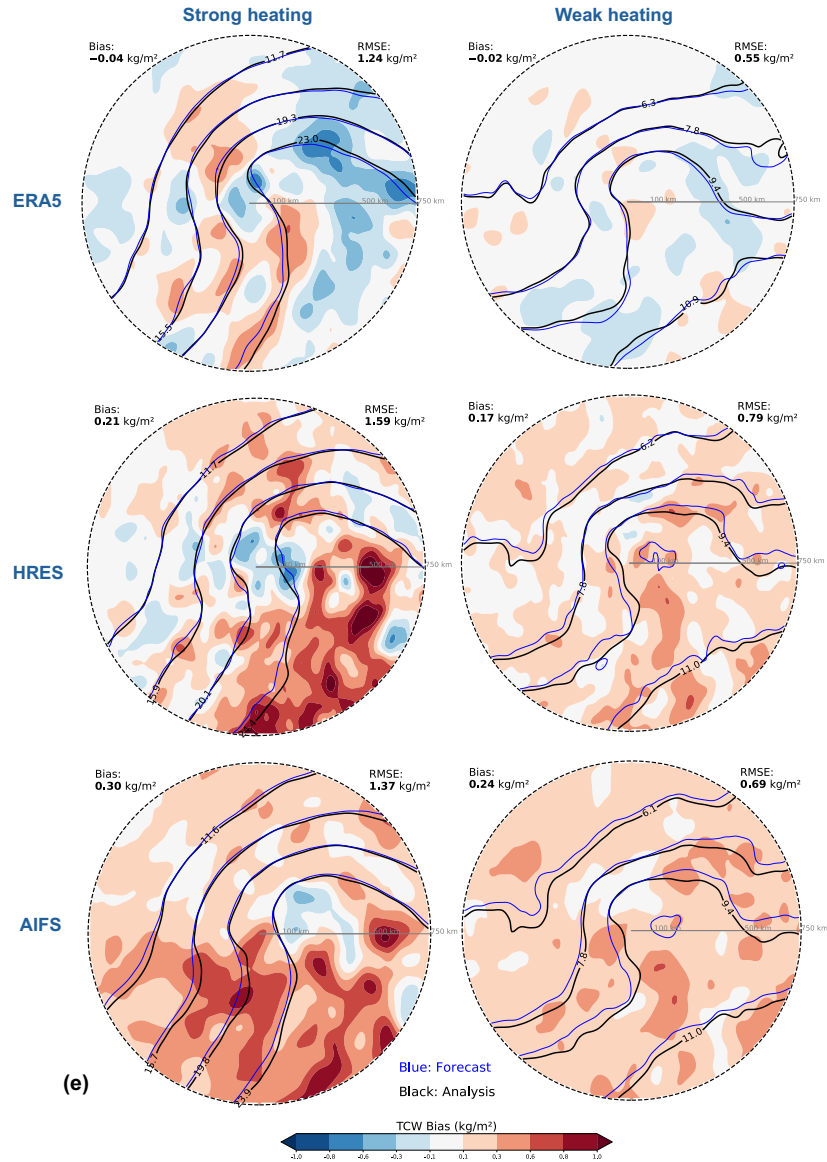
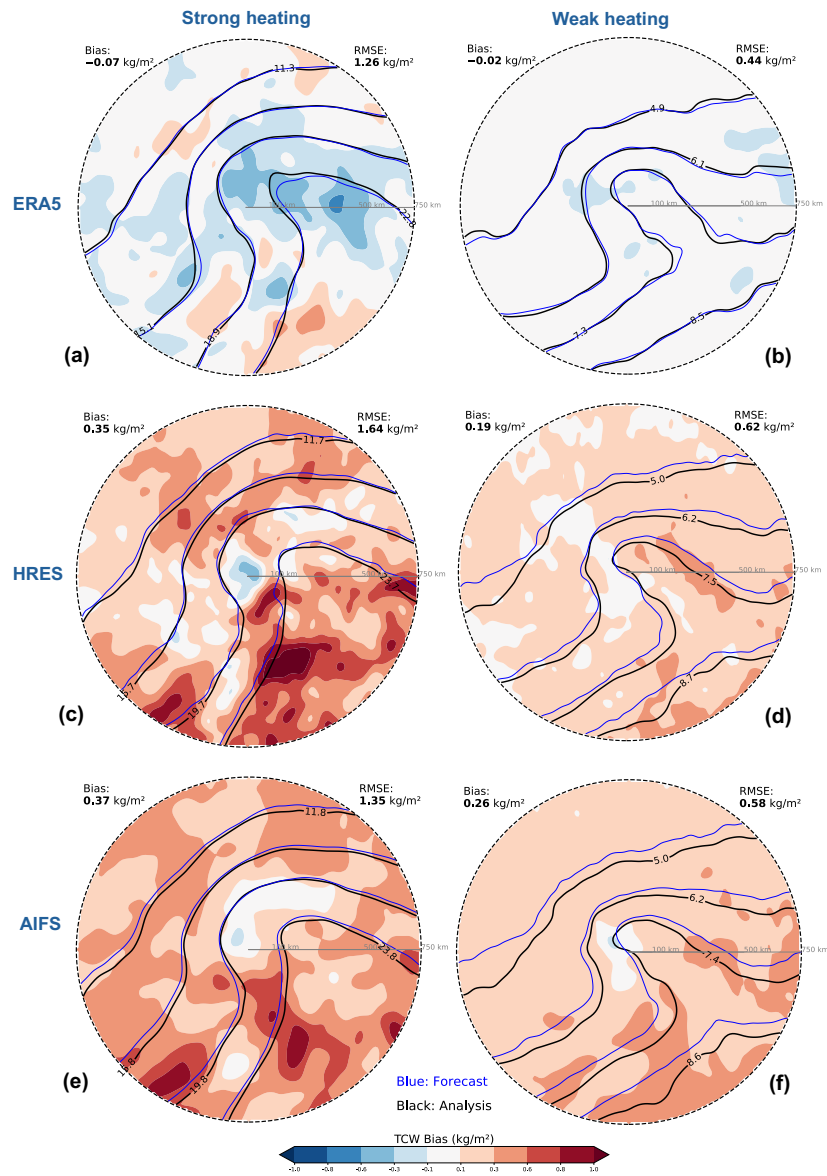


Figure S3: As in Figure S1, but for the Southern Ocean.



**Figure S4:** Total column water (TCW) biases over the North Atlantic, verified against ERA5 reanalysis for (a, c, e) the strong heating group and (b, d, f) the weak heating group. Black contours represent the analysis composite and blue contours the forecast composite. (a,b) ERA5, (c,d) HRES, (e,f) AIFS.



**Figure S5:** As in Figure S4, but for the North Pacific

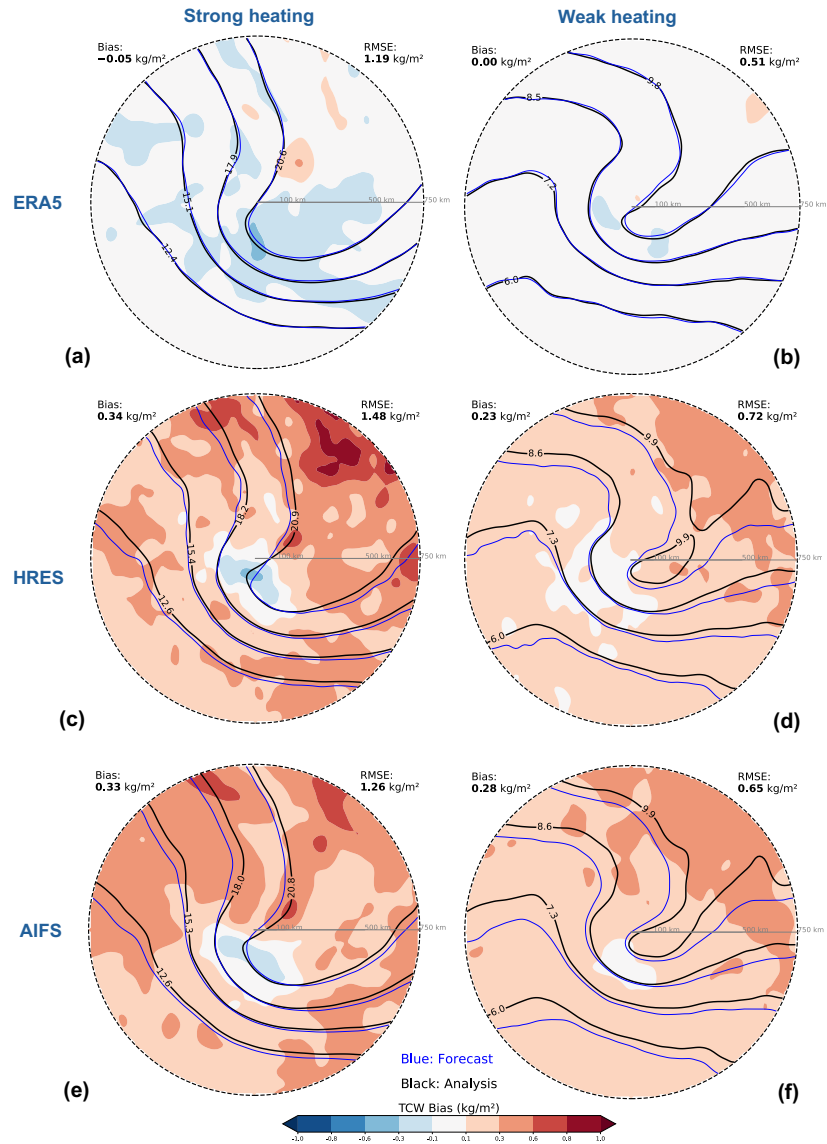
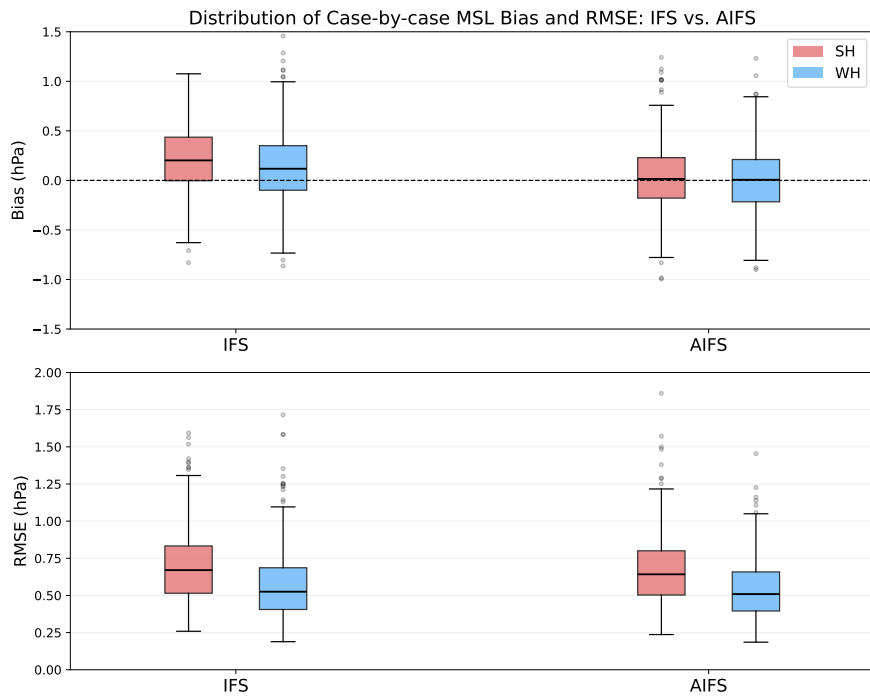
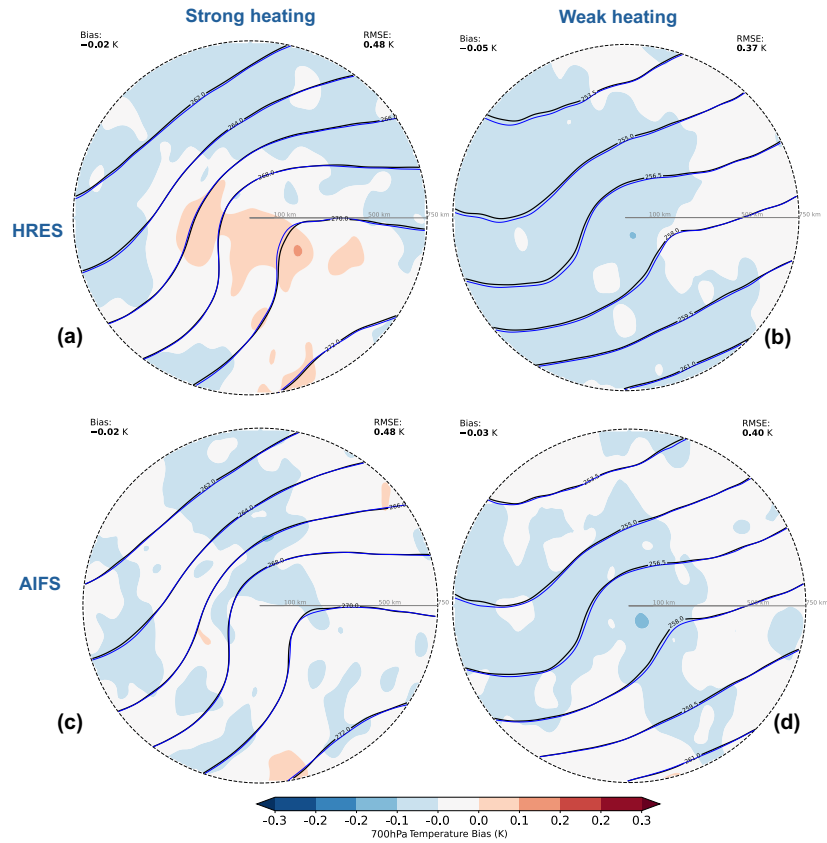


Figure S6: As in Figure S4, but for the Southern Ocean.



**Figure S7:** Distribution of case-by-case MSL forecast bias (top) and RMSE (bottom) for HRES vs. AIFS.



**Figure S8:** Composite temperature at 700 hPa biases (shading) over the North Atlantic, North Pacific, and Southern Ocean, verified against HRES analysis for the (a, c) strong heating and (b, d) weak heating groups. Black (blue) contours indicate the analysis (forecast) composite. Panels (a, b) show results for HRES and (c, d) for AIFS.

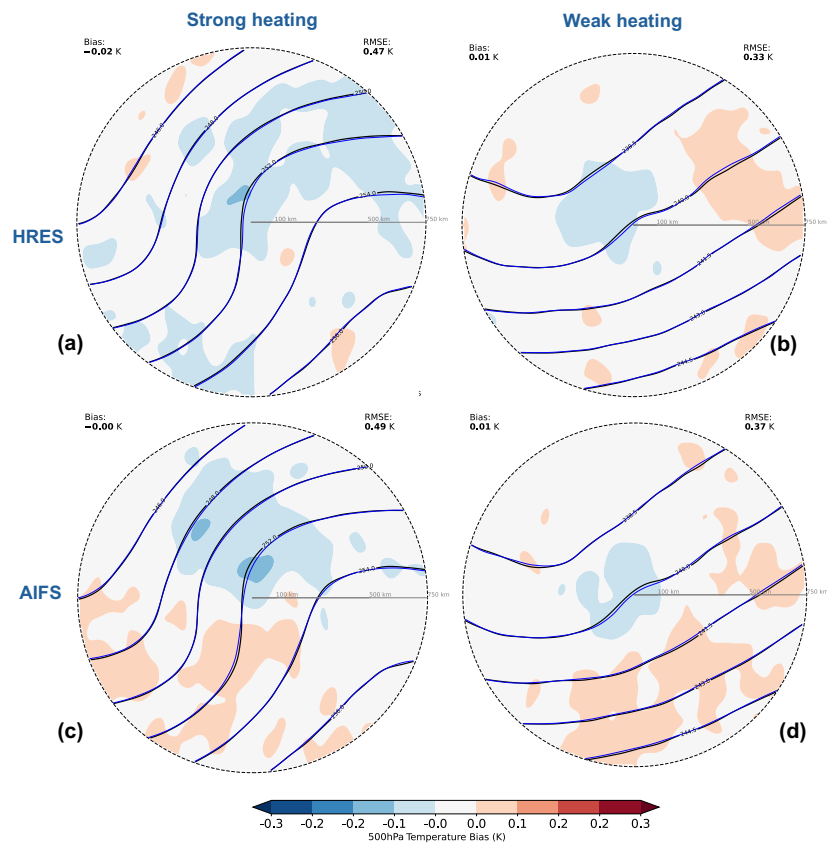


Figure S9: As in Figure S8, but at 500 hPa.