Supporting information

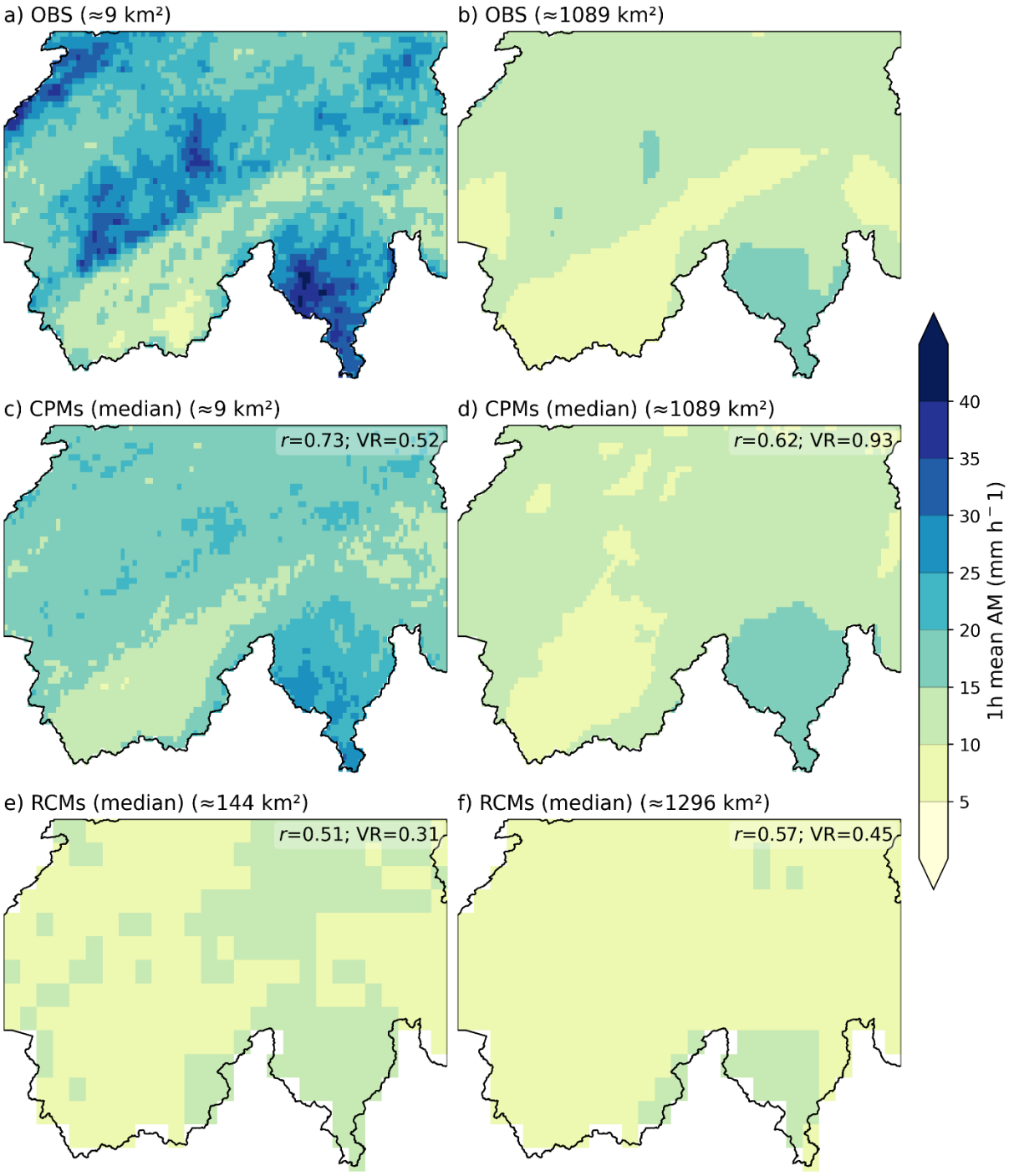


Figure S 1: Spatial distribution of 1h mean annual maximum precipitation over Switzerland for CombiPrecip (OBS) and model ensemble medians at smallest and aggregated spatial scales. (a-b) observational field at ≈9 and ≈1089 km². (c-d) CPM ensemble-median at ≈9 and ≈1089 km². (e-f) RCM ensemble-median at ≈144 and ≈1296 km². In each model panel, r denotes the spatial correlation with OBS and VR the variability ratio (model/OBS; ratio of spatial standard deviations).

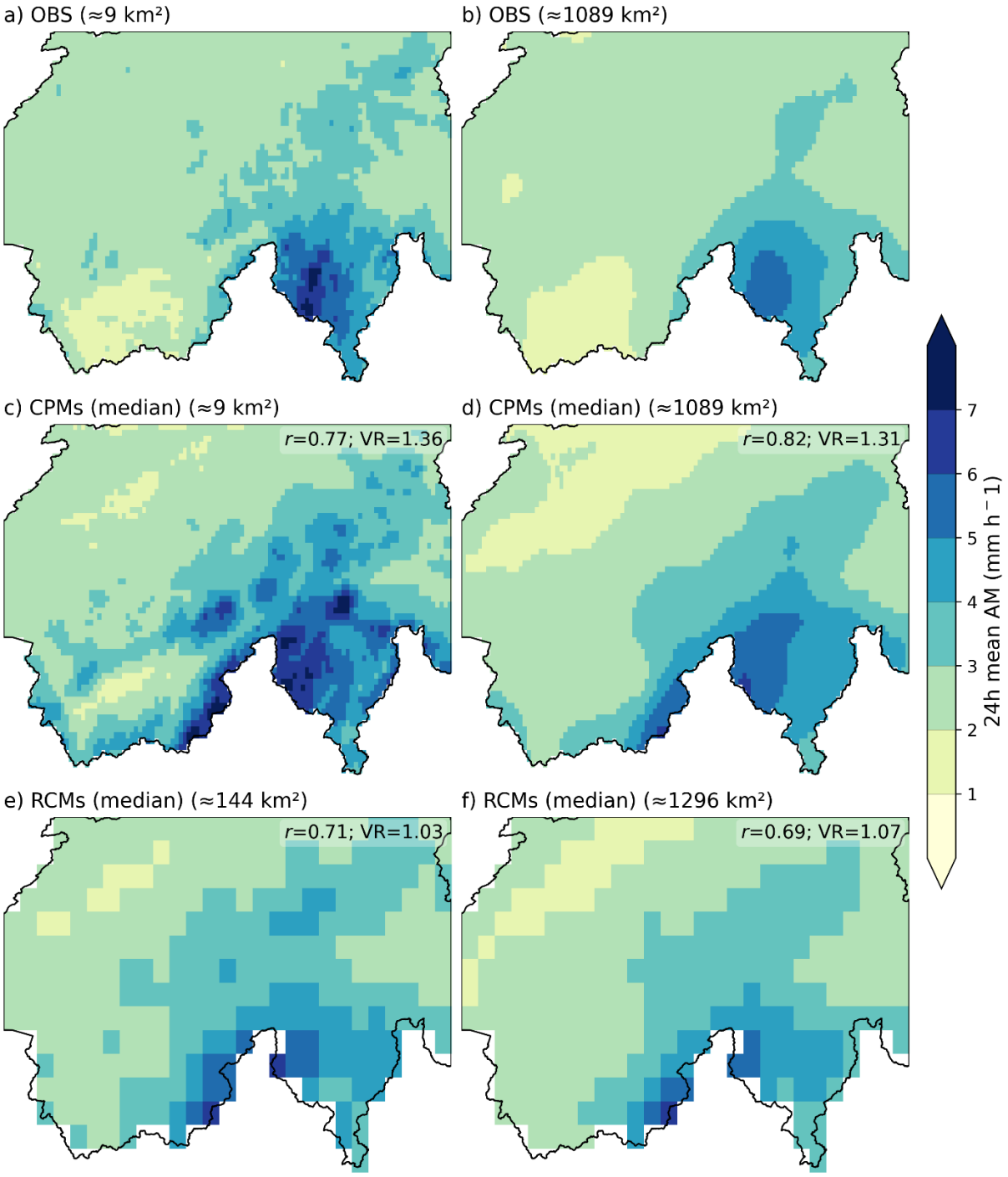


Figure S 2: Spatial distribution of 24h mean annual maximum precipitation over Switzerland for CombiPrecip (OBS) and model ensemble medians at smallest and aggregated spatial scales. (a-b) observational field at ≈9 and ≈1089 km². (c-d) CPM ensemble-median at ≈9 and ≈1089 km². (e-f) RCM ensemble-median at ≈144 and ≈1296 km². In each model panel, r denotes the spatial correlation with OBS and VR the variability ratio (model/OBS; ratio of spatial standard deviations).

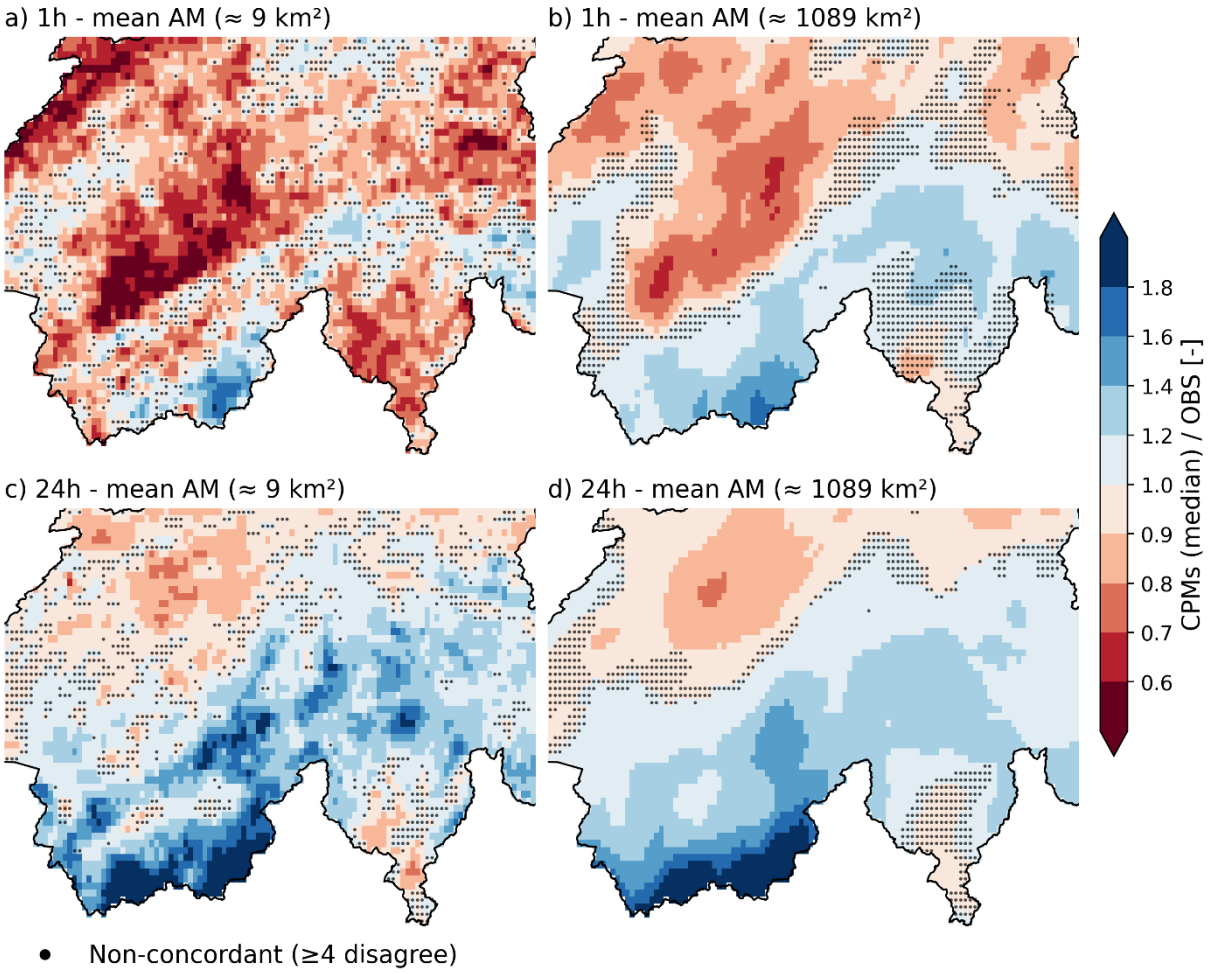


Figure S 3: Spatial patterns of bias of the CPM ensemble median relative to CombiPrecip (OBS) for mean annual maximum precipitation at 1-hour (a, b) and 24-hour (c, d) durations. Panels (a) and (c) show biases at the native CPM resolution (approximately 9 km²), while panels (b) and (d) present results after spatial aggregation to areas of about 1089 km² (11x11 grids). Bias is expressed as the ratio CPM/OBS, where values above 1 indicate overestimation. Black dots mark non-concordant grid cells, defined as locations where four or more CPM members disagree on the sign of the bias.

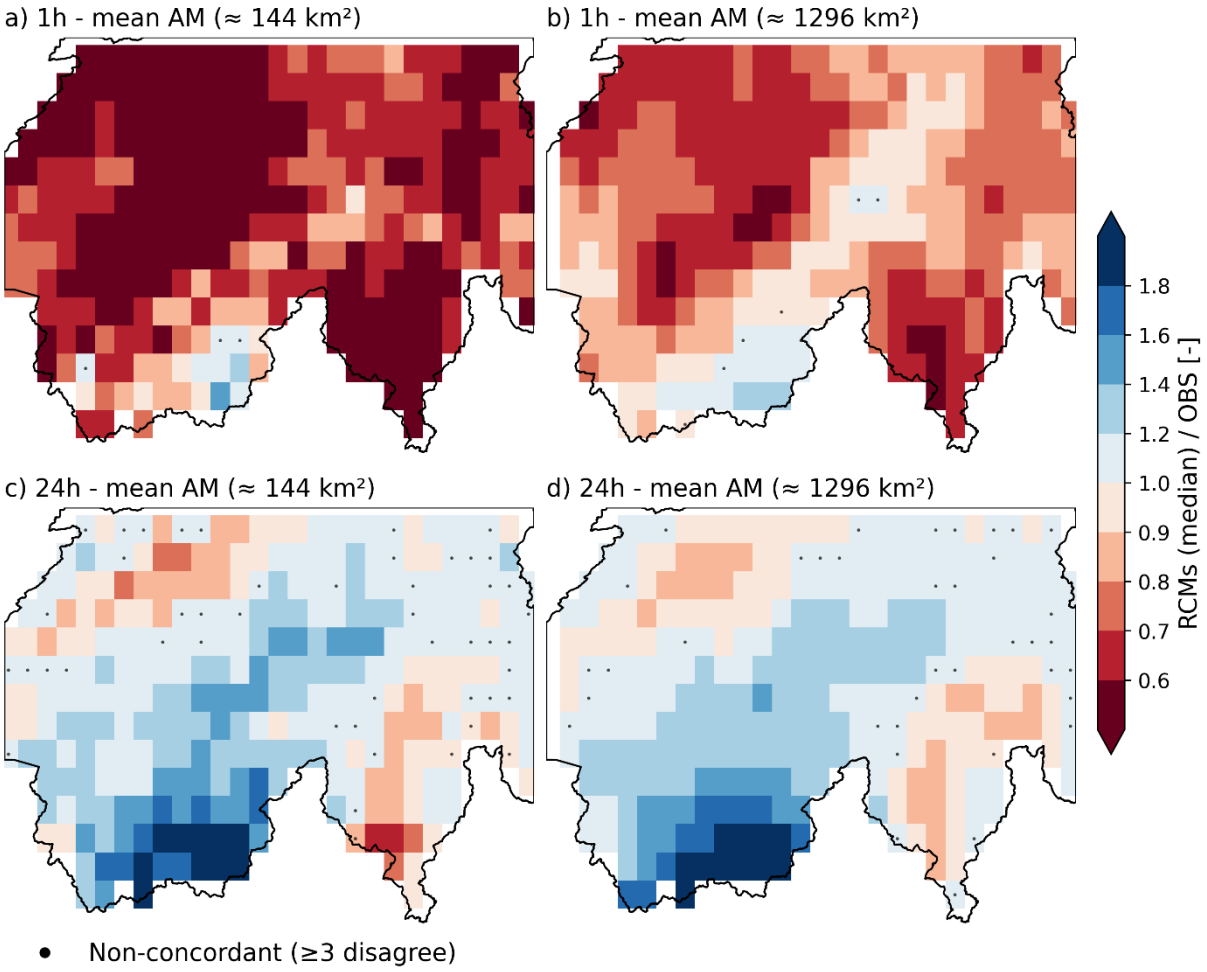
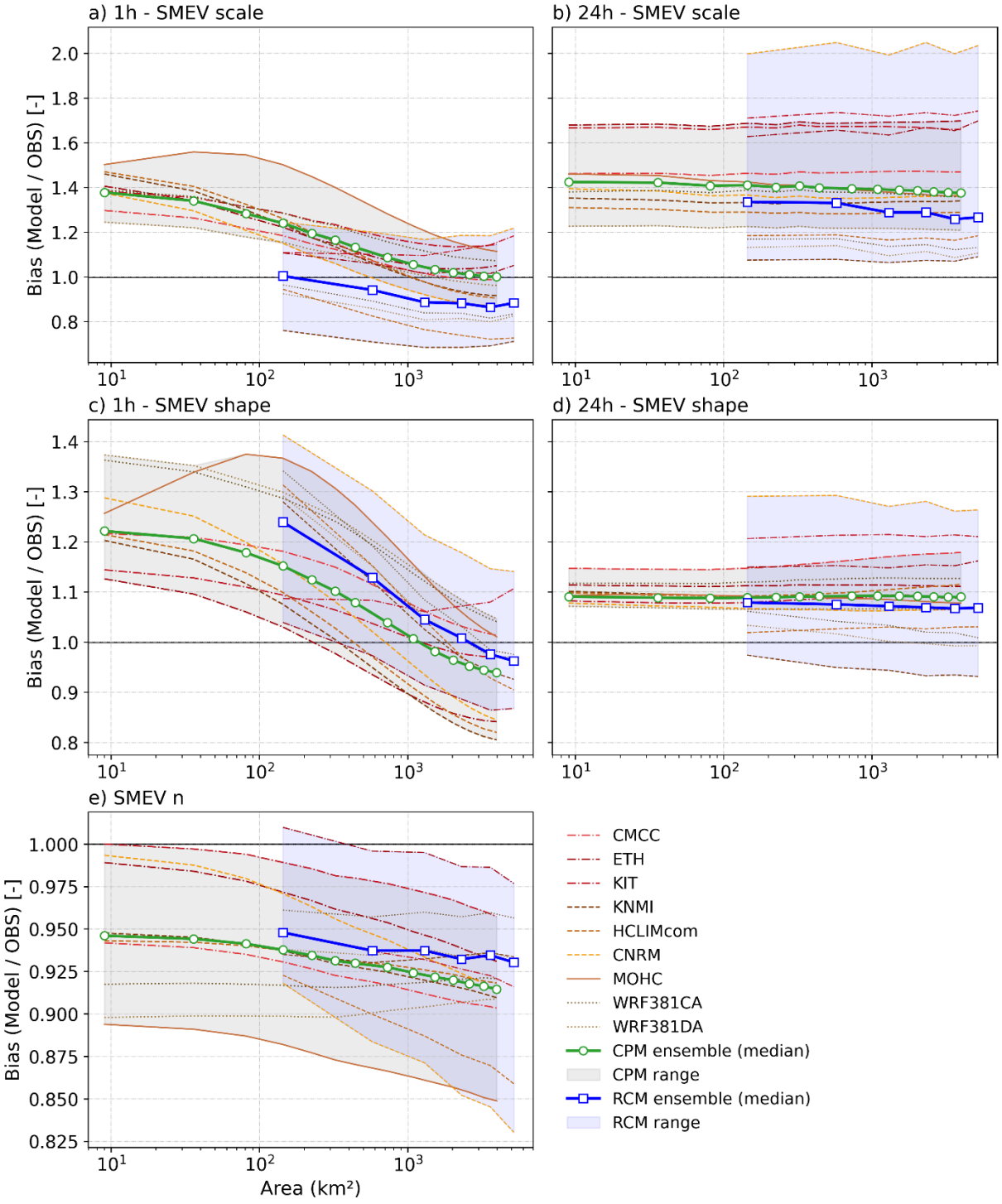


Figure S 4: Spatial patterns of bias of the RCM ensemble median relative to CombiPrecip (OBS) for mean annual maximum precipitation at 1-hour (a, b) and 24-hour (c, d) durations. Panels (a) and (c) show biases at the native RCM resolution (approximately 114 km²), while panels (b) and (d) present results after spatial aggregation to areas of about 1296 km² (3x3 grids). Bias is expressed as the ratio RCM/OBS, where values above 1 indicate overestimation. Black dots mark non-concordant grid cells, defined as locations where 3 or more RCM members disagree on the sign of the bias.



25 **Figure S 5: Scale dependence of biases in SMEV parameters for the CPM and RCM ensembles relative to CombiPrecip (OBS). Panels show the bias (Model/OBS) of the Weibull scale parameter λ for 1 h (a) and 24 h (b), the Weibull shape parameter k for 1 h**

(c) and 24 h (d), and the mean annual number of ordinary events n (e), all as a function of areal extent. Solid green and blue lines denote ensemble-median CPM and RCM biases, respectively; thin lines show individual model members, and shaded bands indicate the corresponding ensemble ranges. Values above (below) 1 indicate overestimation (underestimation) of the SMEV parameters relative to OBS.

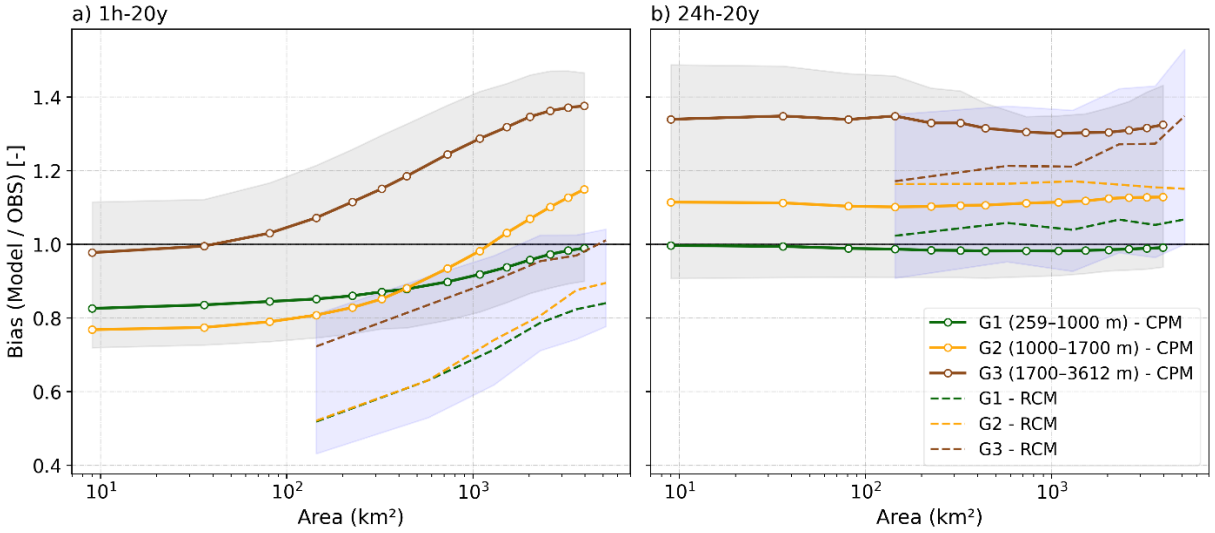


Figure S 6: Scale dependence of CPM and RCM bias in 20-y return levels for durations of (a) 1 h, and (b) 24 h. Bias is expressed as the ratio of CPMs to CombiPrecip (OBS) and RCMs to OBS as a function of areal extent. The biases here are stratified across 3 different elevation groups as indicated in the legend of the figure. Shaded grey and blue bands indicate the corresponding 75th and 25th quartiles for the G3 and G1 in CPMs and RCMs respectively.

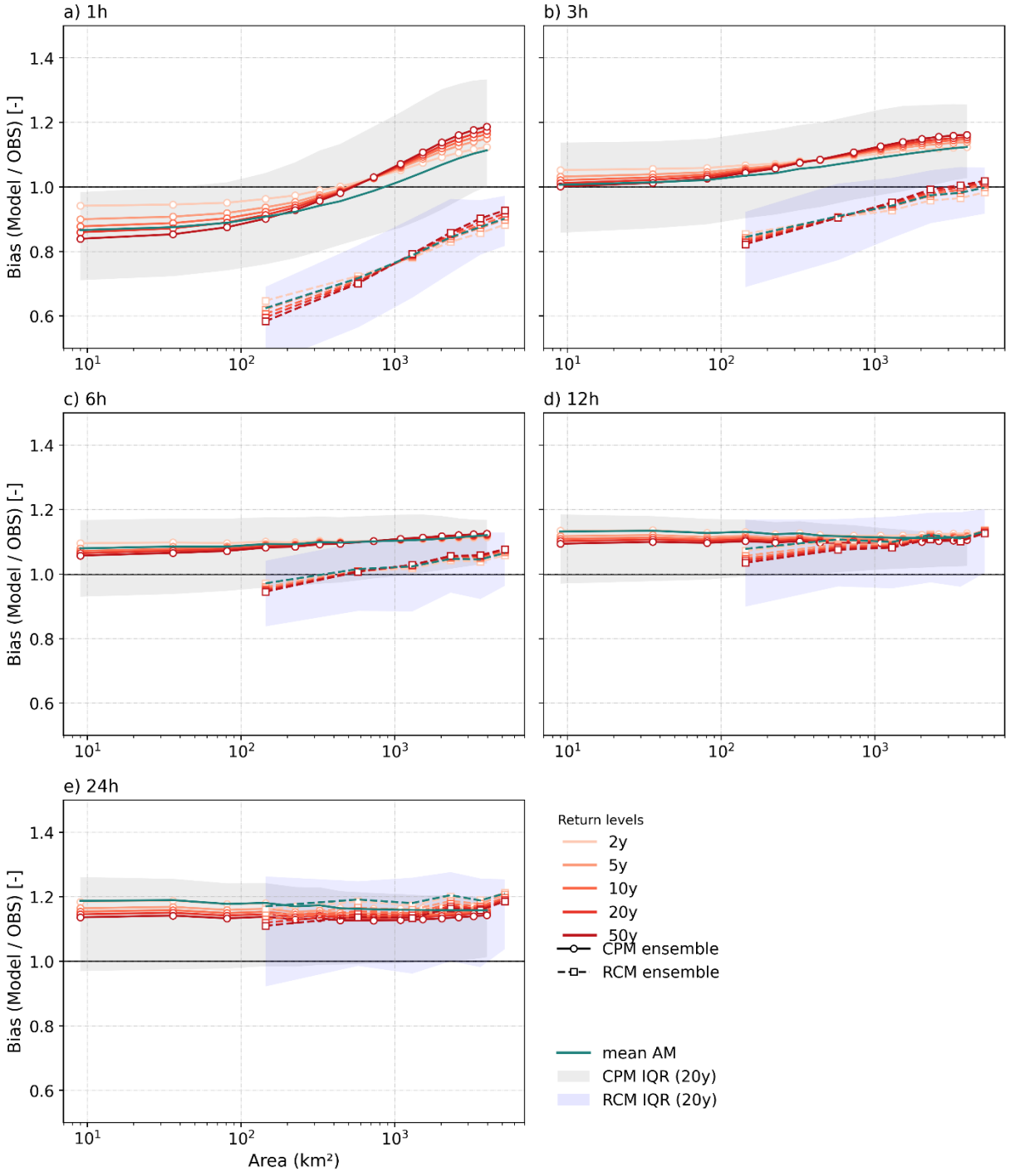


Figure S 7: Scale dependence of CPM and RCM bias relative to CombiPrecip (OBS) shown for multiple event magnitude. Bias (Model/OBS) is plotted against areal extent for mean annual maxima and return levels of 2-, 5-, 10-, 20- and 50-years. Solid lines show ensemble-median biases from moving-window areal aggregation for the CPM and RCM ensembles. Shaded grey and blue bands indicate the corresponding 75th and 25th quartiles for return levels of 20-y return period respectively.

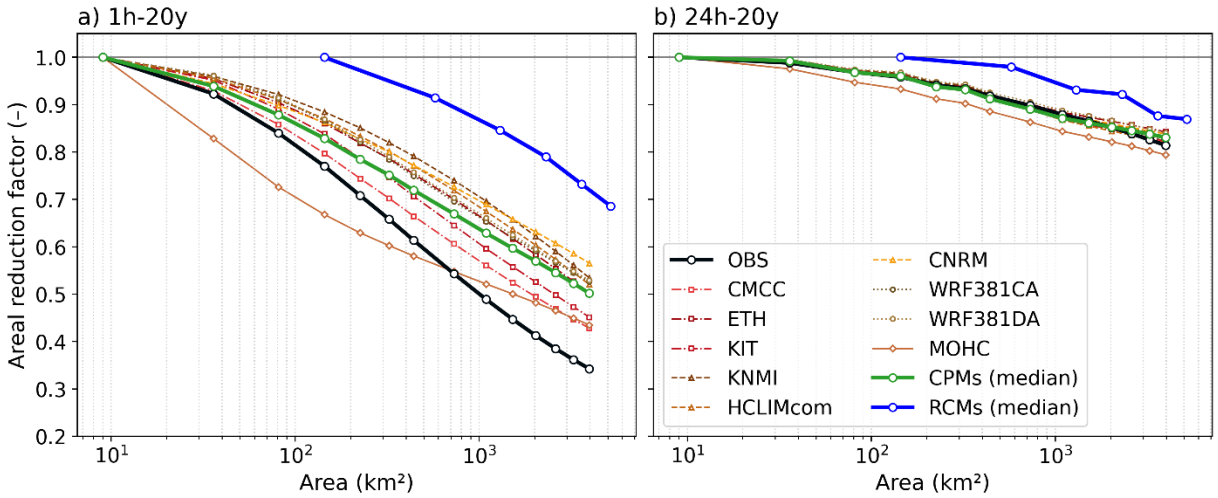


Figure S 8: Areal reduction factor for 1-h (a) and 24-h (b) durations of 20-y return period extreme precipitation. Shown are areal reduction factors (ARF(A) = I(A)/I(Amin)) calculated from CombiPrecip (OBS, black line), individual CPM simulations (thin coloured lines), the CPM ensemble median (green line), and the RCM ensemble median (blue line) as a function of aggregation area. The steeper decline of OBS at 1 h highlights the stronger loss of small-scale extreme intensity in the observations compared with the models, while all datasets exhibit similar reduction rates at 24 h.