Figure S1: Representation of elevation in WRF (a), CCLM (b), and ERA5L (c).
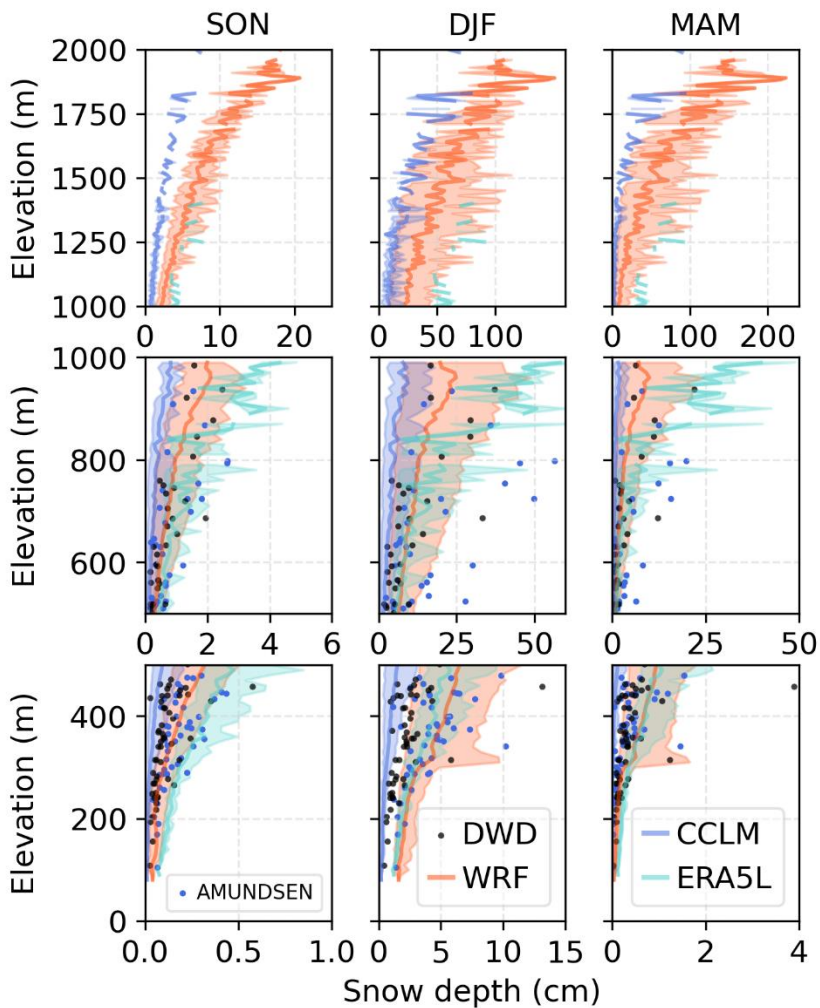
Figure S2: Mean winter snow depth averaged over 1987 – 2018 simulated by the WRF model, CCLM, ERA5L, and AMUNDSEN as well as observations (DWD) compared over the whole range of elevations in the study area. The transparent areas show the ranges of all grid cells at the respective elevation, and the line represents the median. Note the different x-axis scalings.

Table S3: Pearson rank correlation for biases of extreme snow dynamics. Significant correlations at the 95 % (99 %) level are marked with one (two) asterisks. For AMUNDSEN, the elevation, temperature, and precipitation of the driving CCLM climate are shown.

Rank correlation between…	WRF	CCLM	ERA5L	AMUNDSEN
Mean annual maximum snow depth bias and model elevation	-0.67**	-0.77**	0.51**	0.06
Mean annual maximum snow depth bias and elevation bias	-0.05	-0.01	0.91**	-0.15
Mean annual maximum snow depth bias and temperature bias	-0.78**	-0.66**	-0.90**	-0.48**
Mean annual maximum snow depth bias and precipitation bias	0.33**	0.02	0.64**	0.43**
Mean annual maximum snow accumulation bias and model elevation	-0.55**	-0.80**	-0.61**	-0.66**
Mean annual maximum snow accumulation bias and elevation bias	-0.22*	-0.21	0.19	-0.28**
Mean annual maximum snow accumulation bias and temperature bias	-0.76**	-0.73**	-0.08	-0.73**
Mean annual maximum snow accumulation bias and precipitation bias	-0.01	0.02	0.71**	0.10
Mean annual maximum snow melt bias and model elevation	0.59*	0.55**	0.67**	0.30**
Mean annual maximum snow melt bias and elevation bias	0.01	0.14	-0.13	0.33**
Mean annual maximum snow melt bias and temperature bias	0.53**	0.61**	-0.02	0.64**
Mean annual maximum snow melt bias and precipitation bias	0.08	-0.18	-0.61**	-0.28**
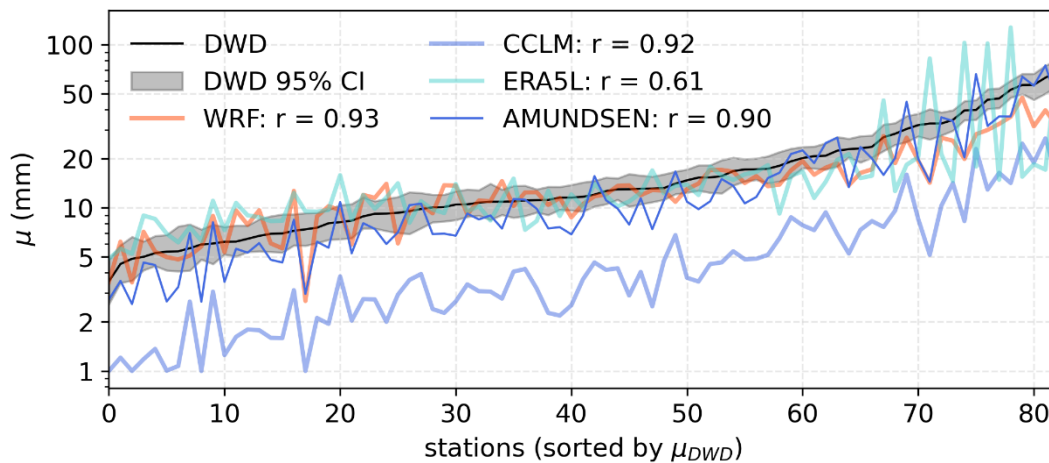
Figure S4: Fitted GEV location parameters for snow depth at each station sorted by the values of the observational location parameter.
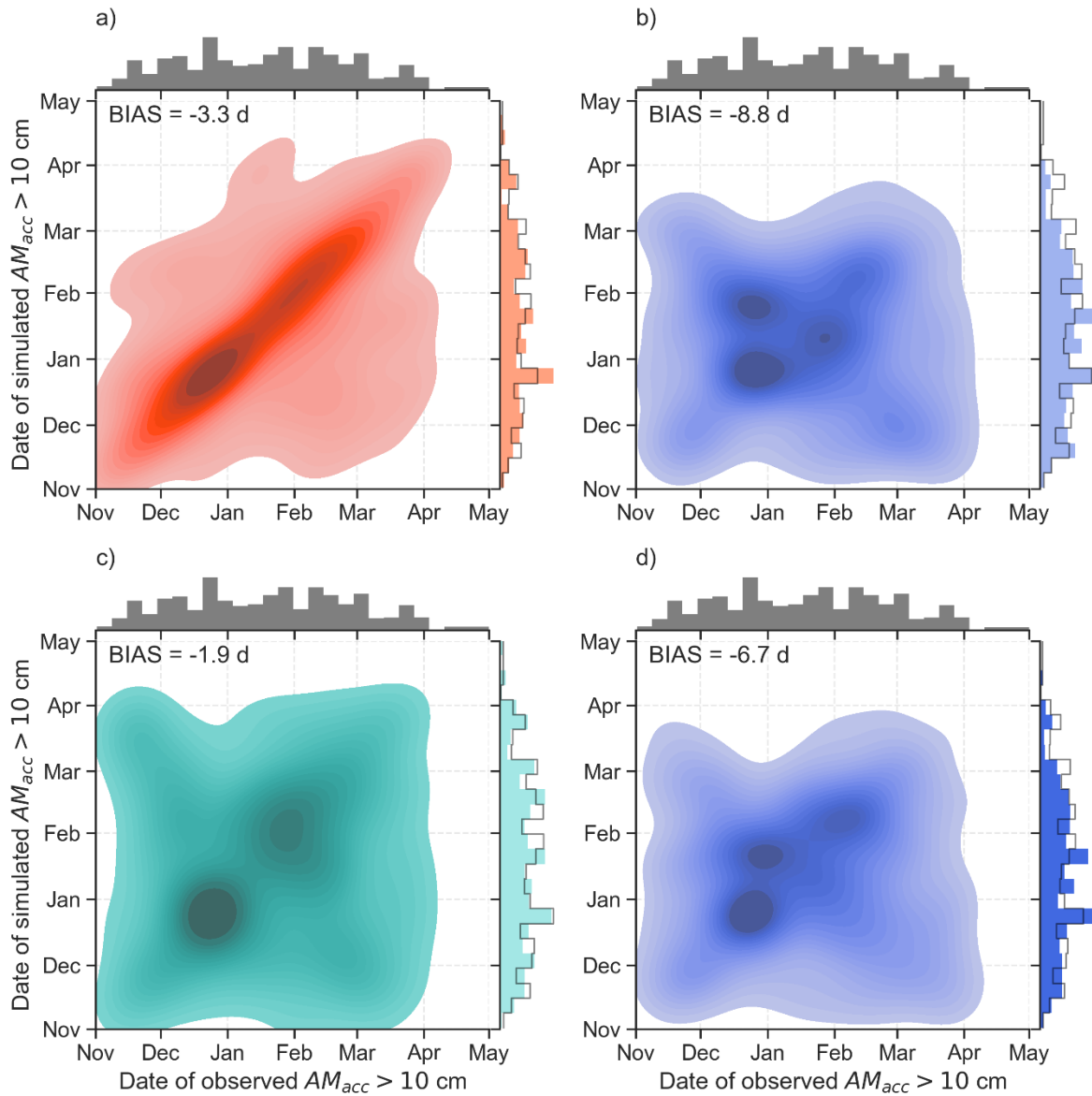
Figure S5: Date of observed and simulated annual maxima of snow depth accumulation above 10 cm for each year and location in 1987 – 2018 simulated by the WRF model (a), CCLM (b), ERA5L (c), and AMUNDSEN (d).
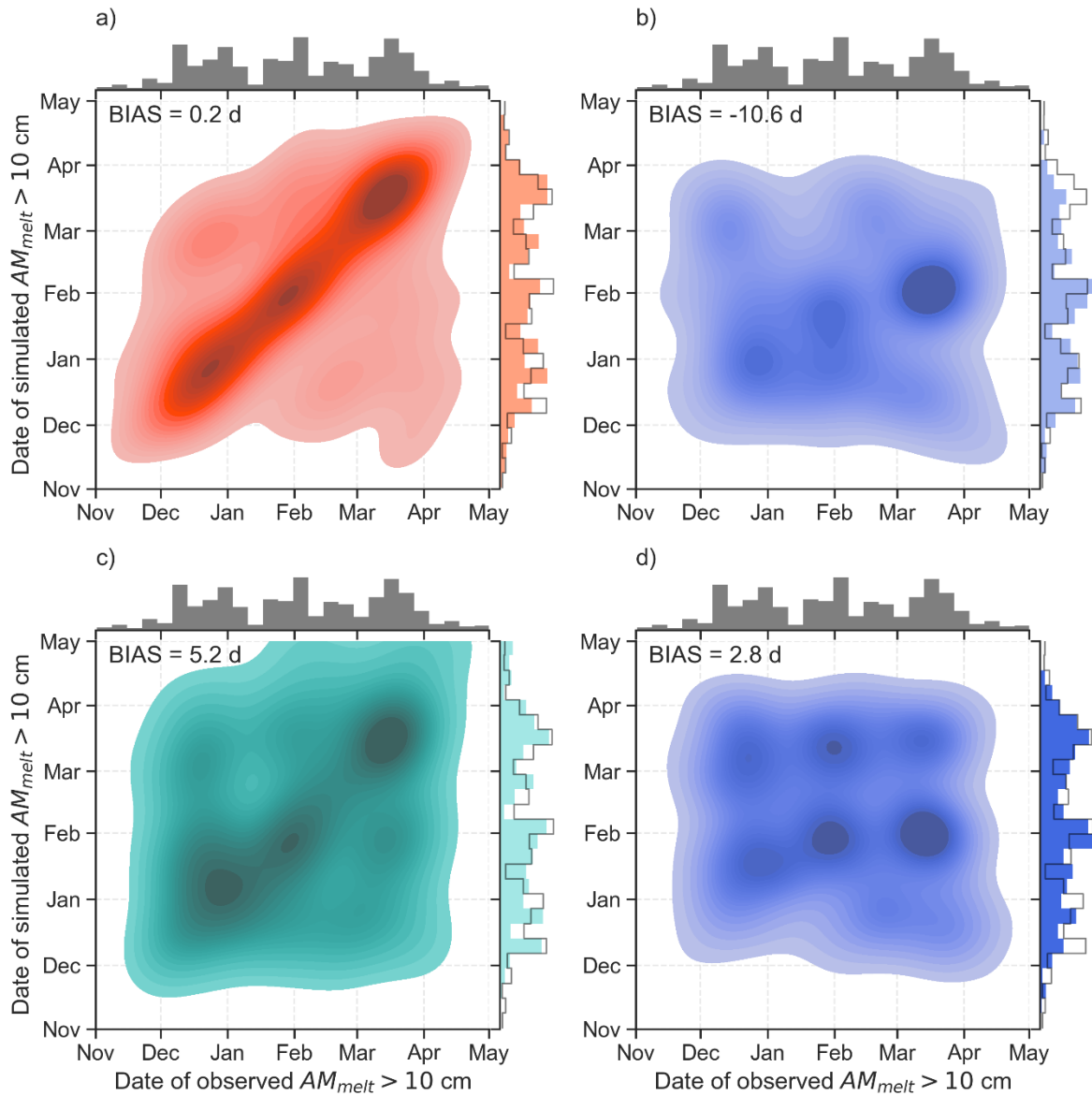
Figure S6: Date of observed and simulated annual maxima of snow melt above 10 cm for each year and location in 1987 – 2018 simulated by the WRF model (a), CCLM (b), ERA5L (c), and AMUNDSEN (d).
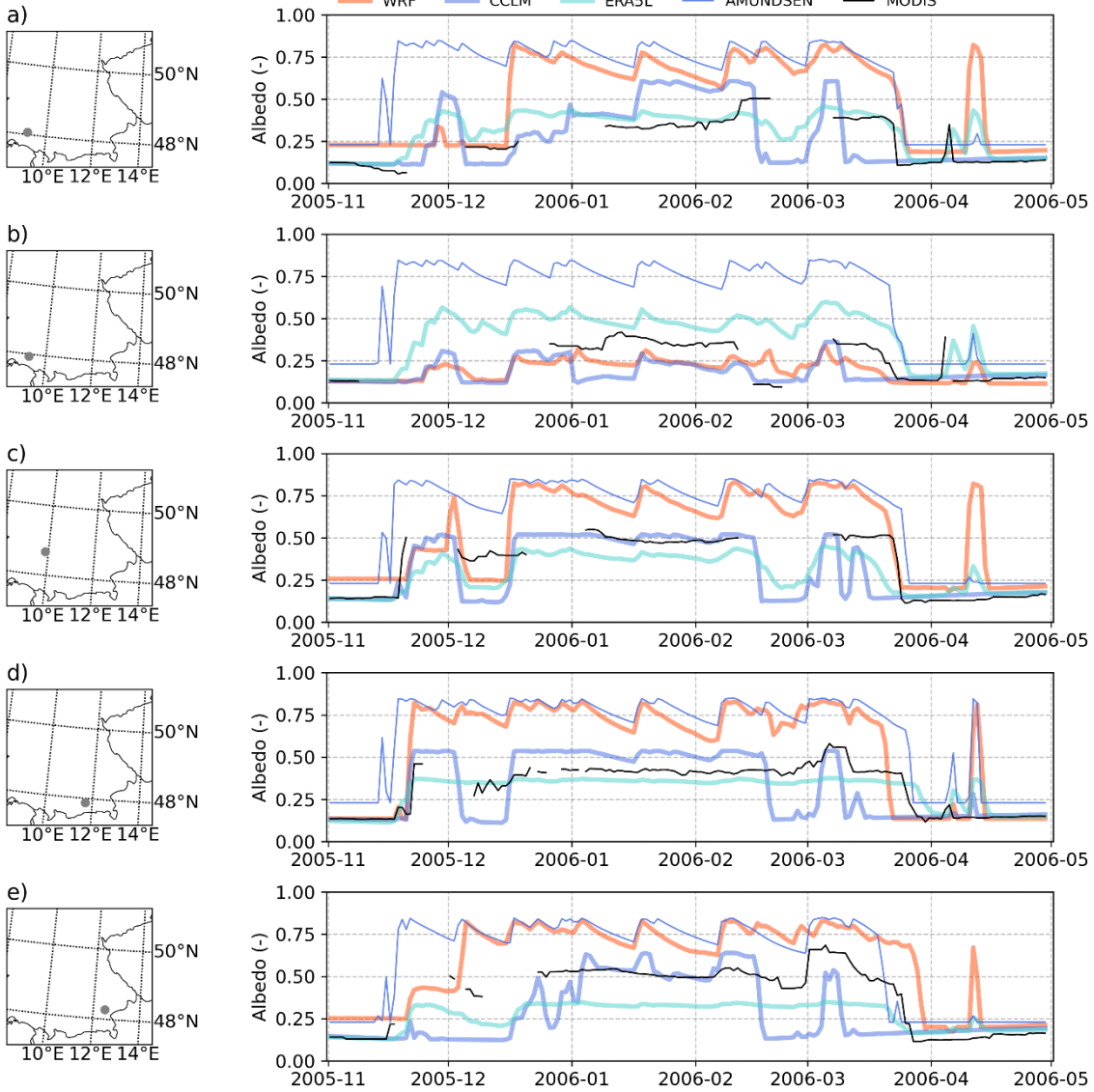
Figure S7: Daily albedo based on remote sensing (MODIS MCD43C3), the WRF, CCLM, and AMUNDSEN simulations over the winter season 2005/2006 at five locations. For the MODIS time series, only data with at least "mixed" or good quality are shown. The second y-axis shows the temperature bias of WRF compared to the weather stations. For the evolution of snow depth during this season, the reader is referred to Figure 5. Land cover information is provided in Table ST2.

Table S8: Land cover information for the sites in Figure 17. The vegetation fraction of the WRF simulation refers to its extent during the vegetation period.

Location (Fig. S6)	WRF	CCLM	ERA5L	AMUNDSEN
a)	grassland with 62% vegetation fraction	9% deciduous forest and 10% evergreen forest	87% deciduous broadleaf trees and 10% crops / mixed farming	grassland (point scale)
b)	evergreen needleleaf forest with 90% vegetation fraction	55% deciduous forest and 12% evergreen forest	41% interrupted forest and 59% crops / mixed farming	grassland (point scale)
c)	grassland with 80% vegetation fraction	36% deciduous forest	81% Interrupted forest and 17% crops / mixed farming	grassland (point scale)
d)	urban and built-up land with 0% vegetation fraction	6% deciduous forest and 27% evergreen forest	100% deciduous broadleaf trees	grassland (point scale)
e)	grassland with 78% vegetation fraction	12% deciduous forest	100% interrupted forest	grassland (point scale)
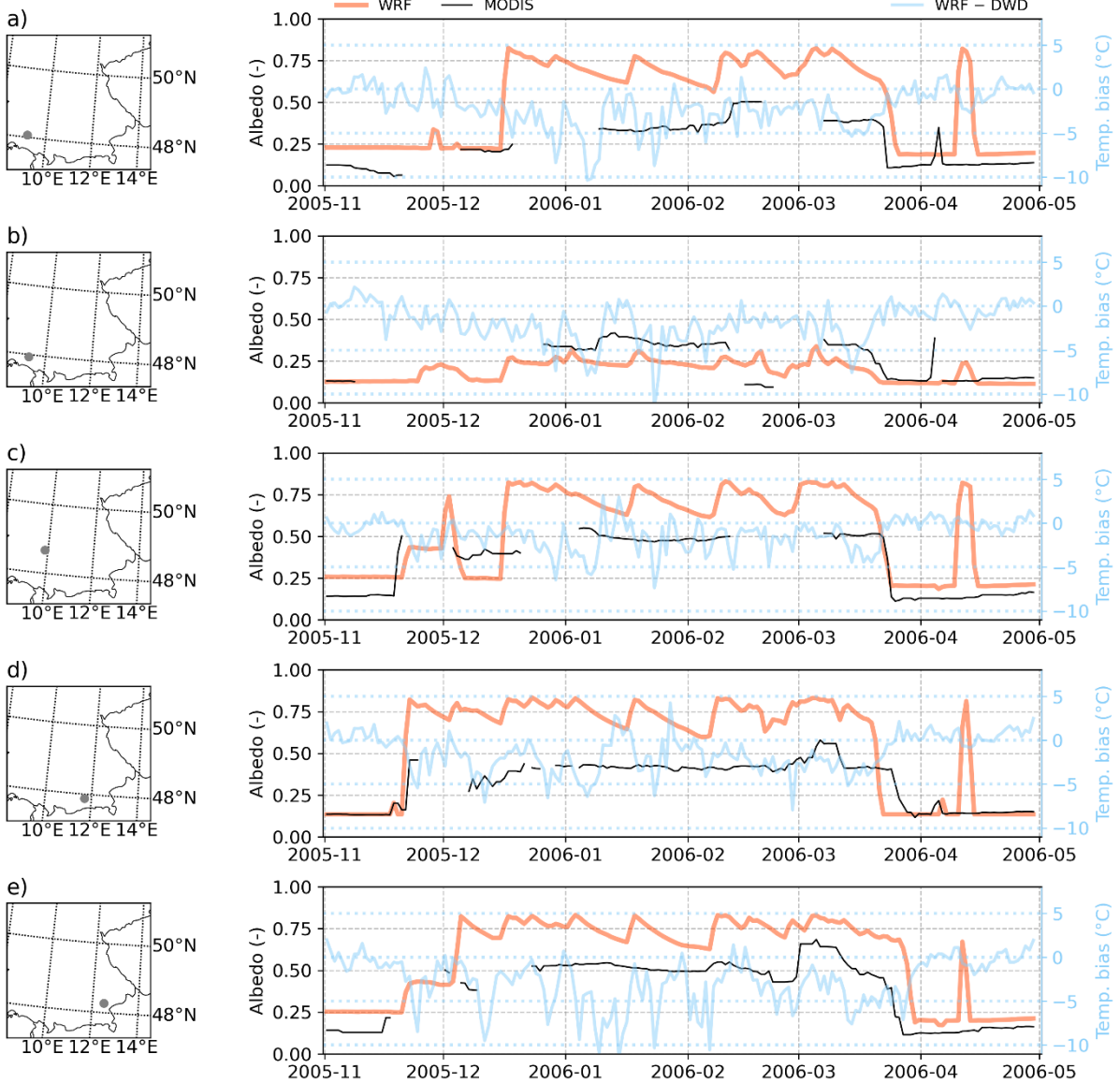
Figure S9: Daily albedo based on remote sensing (MODIS MCD43C3) and the WRF simulation over the winter season 2005/2006 at five locations. For the MODIS time series, only data with at least "mixed" or good quality are shown. The second y-axis shows the temperature bias of WRF compared to the weather stations. The vegetation type of the respective WRF grid cell is grassland (a, c, e), evergreen needleleaf forest (b), and urban and built-up land (d) affecting the simulated albedo.
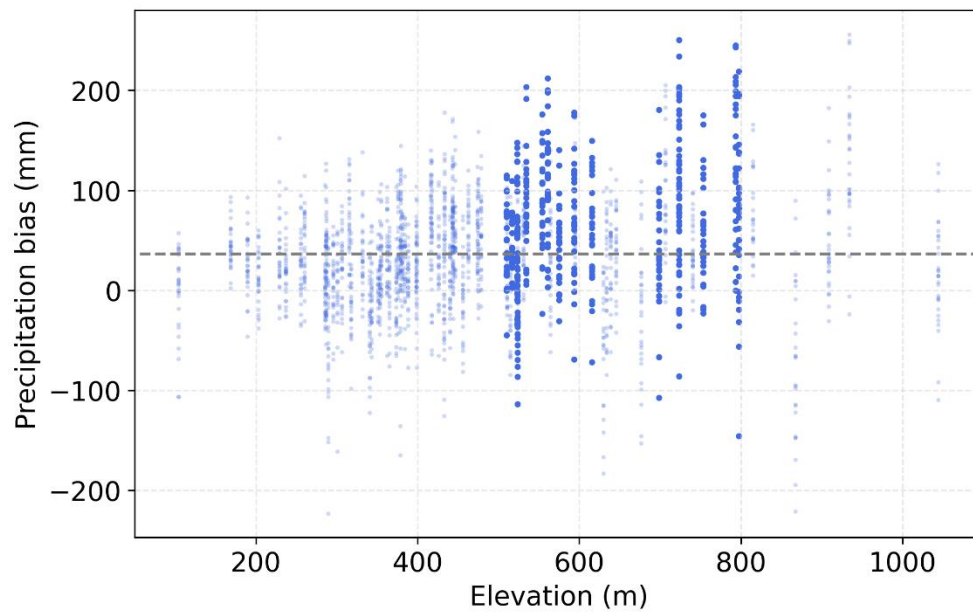
Figure S10: Annual winter precipitation biases of the CCLM minus observations is plotted against the model elevation. Locations north of 48.5° N and above 500 m are marked opaque. The grey dashed line shows the mean precipitation bias.