Supplementary material:
Comparison of high-resolution climate reanalyses datasets for hydro-climatic impact studies

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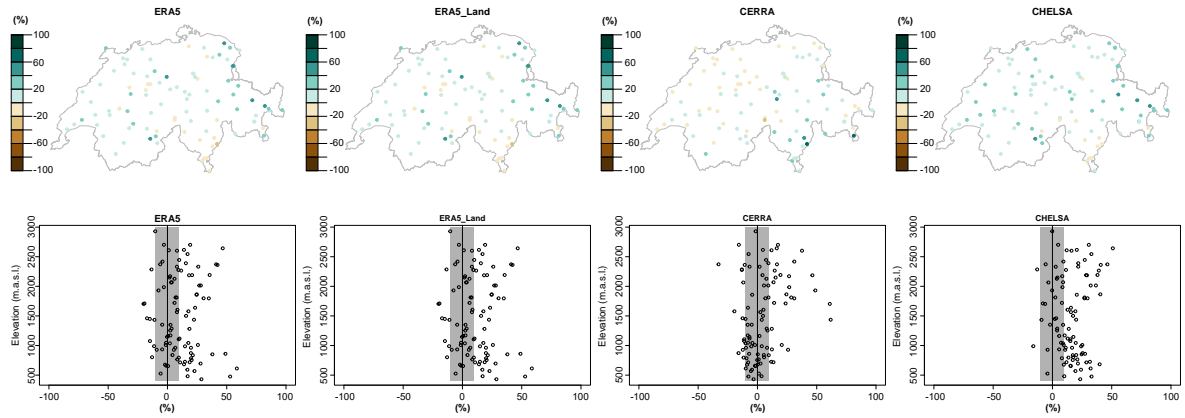
Figure S1: Comparison of the mean daily precipitation at the catchment level of the four reanalysis datasets (ERA5, ERA5-Land, CERRA, and CHELSA) with the gridded observations and elevation dependence of the biases. The first row shows relative biases (in %) at the catchment level for ERA5, ERA5-Land, CERRA, and CHELSA (left to right) compared to observations. The second row shows relative biases (x-axis) sorted by catchment elevation (y-axis); the grey box indicates relative biases within ± 10%.
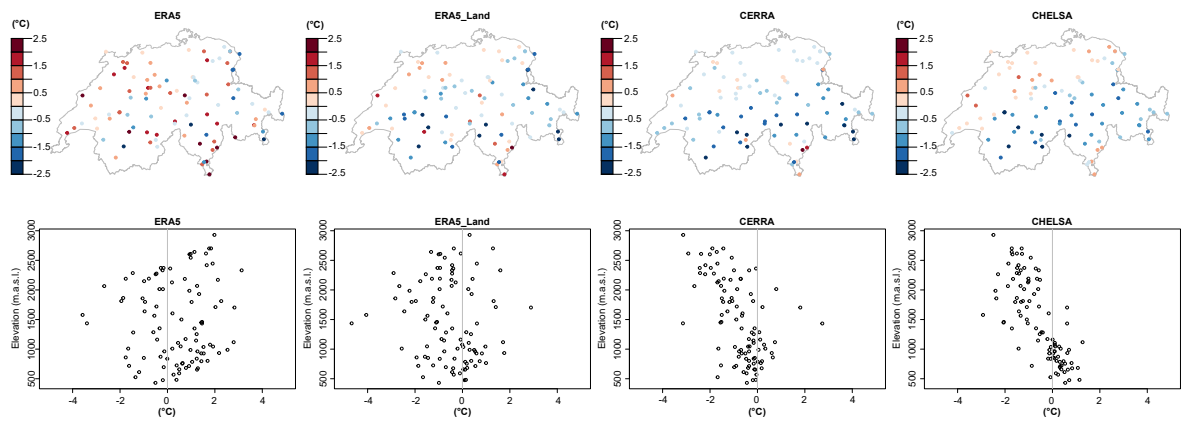
Figure S2: Comparison of the mean daily temperature at the catchment level of the four reanalysis datasets (ERA5, ERA5-Land, CERRA, and CHELSA) with the gridded observations and elevation dependence of the biases. The first row shows absolute biases (in °C) at the catchment level for ERA5, ERA5-Land, CERRA, and CHELSA (left to right) compared to observations. The second row shows absolute biases (x-axis) sorted by catchment elevation (y-axis).
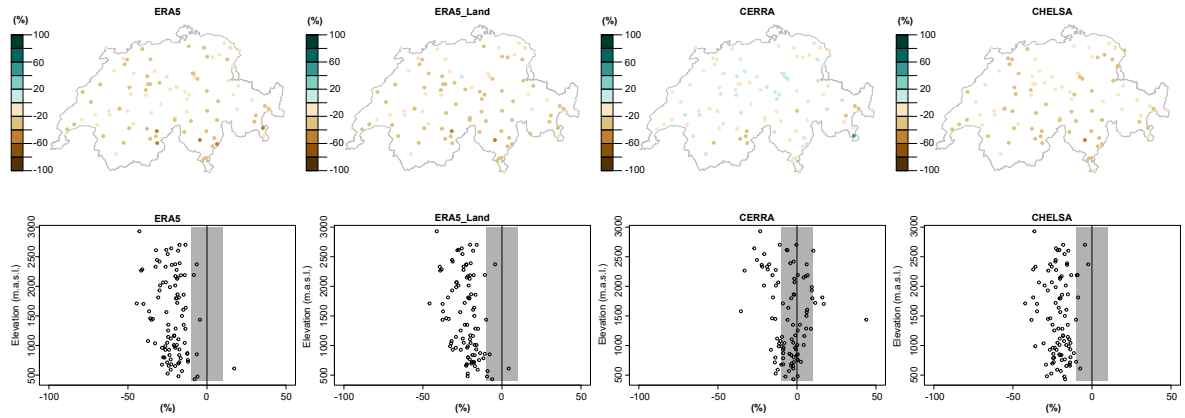
Figure S3: Comparison of the mean annual maximum 1-day precipitation (rx1d) at the catchment level of the four reanalysis datasets (ERA5, ERA5-Land, CERRA, and CHELSA) with the gridded observations and elevation dependence of the biases. The first row shows relative biases (in %) at the catchment location for ERA5, ERA5-Land, CERRA, and CHELSA (left to right) compared to observations. The second row shows relative biases (x-axis) sorted by catchment elevation (y-axis); the grey boxes indicate relative biases within ± 10%.
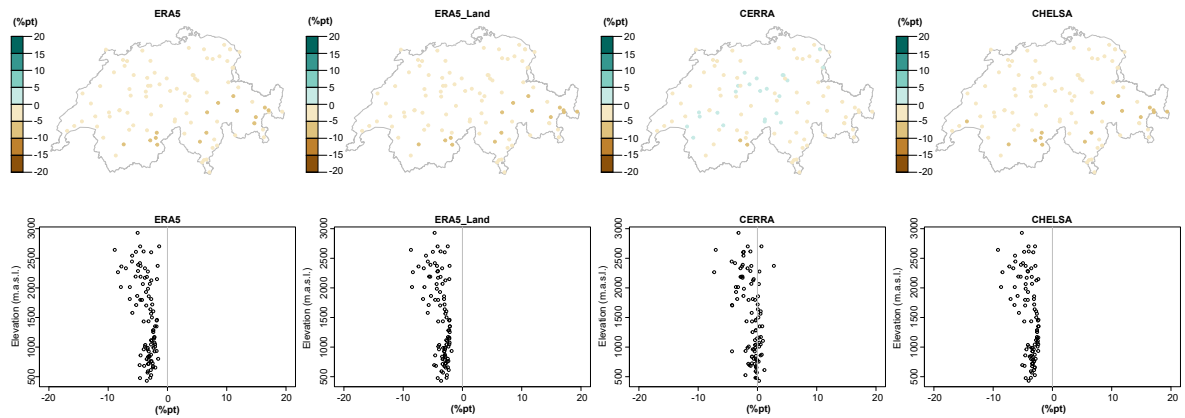
Figure S4: Comparison of the mean fraction of precipitation due to extremely wet days (r99ptot) at the catchment level of the four reanalysis datasets (ERA5, ERA5-Land, CERRA, and CHELSA) with the gridded observations and elevation dependence of the biases. The first row shows absolute biases (in percentage points) at the catchment level for ERA5, ERA5-Land, CERRA, and CHELSA (left to right) compared to observations. The second row shows absolute biases (x-axis) sorted by catchment elevation (y-axis).
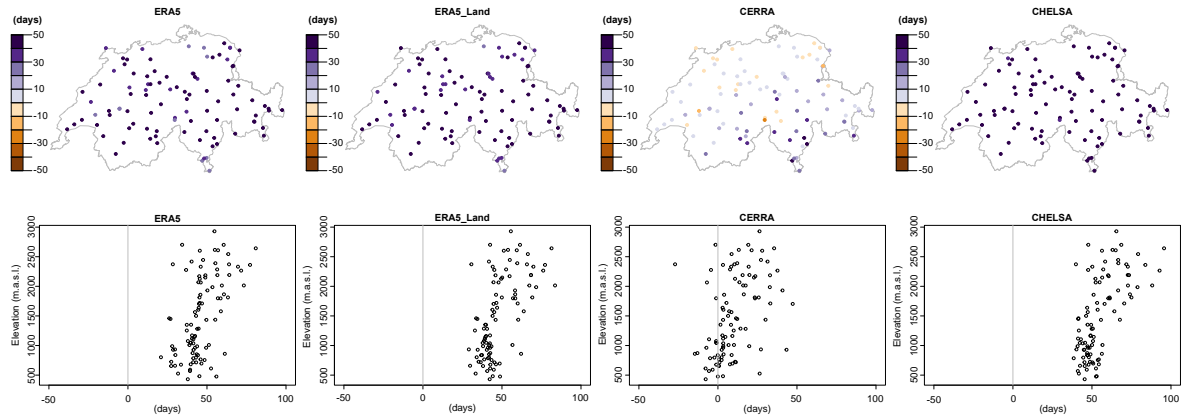
Figure S5: Comparison of the mean number of wet days (wetdays) at the catchment level of the four reanalysis datasets (ERA5, ERA5-Land, CERRA, and CHELSA) with the gridded observations and elevation dependence of the biases. The first row shows absolute biases (in days) at the catchment location for ERA5, ERA5-Land, CERRA, and CHELSA (left to right) compared to observations. The second row shows absolute biases (x-axis) sorted by catchment elevation (y-axis).
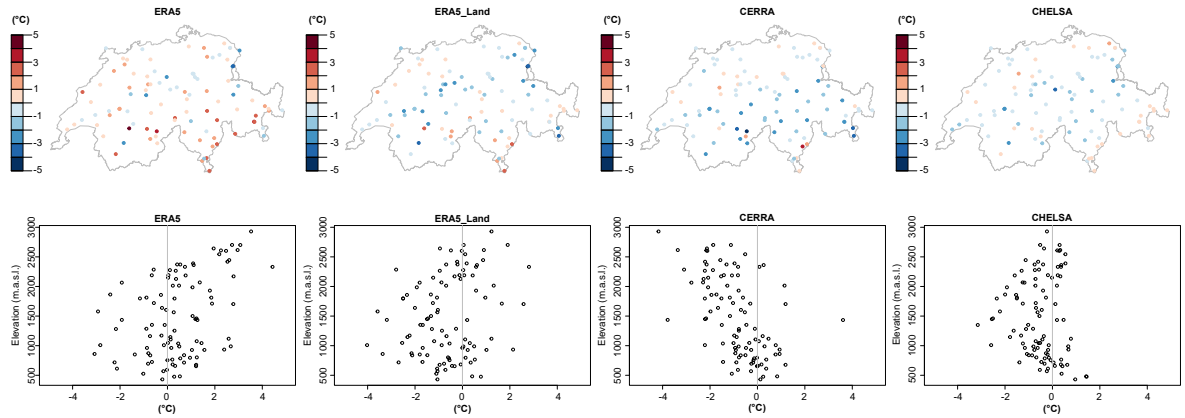
Figure S6: Comparison of the mean annual maximum of daily mean temperature (tg_max) at the catchment level of the four reanalysis datasets (ERA5, ERA5-Land, CERRA, and CHELSA) with the gridded observations and elevation dependence of the biases. The first row shows absolute biases (in °C) at the catchment level for ERA5, ERA5-Land, CERRA, and CHELSA (left to right) compared to observations. The second row shows absolute biases (x-axis) sorted by catchment elevation (y-axis).
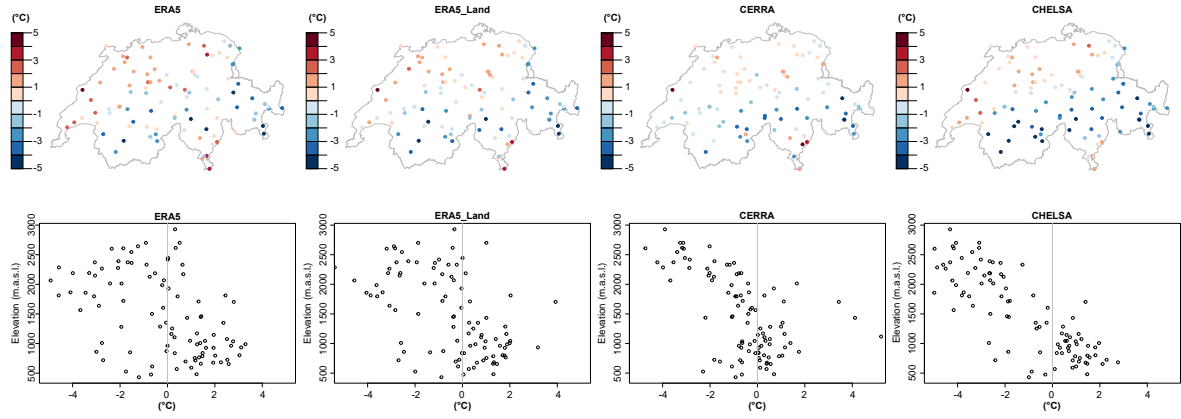
Figure S7: Comparison of the mean annual minimum of daily mean temperature (tg_min) at the catchment level of the four reanalysis datasets (ERA5, ERA5-Land, CERRA, and CHELSA) with the gridded observations and elevation dependence of the biases. The first row shows absolute biases (in °C) at the catchment level for ERA5, ERA5-Land, CERRA, and CHELSA (left to right) compared to observations. The second row shows absolute biases (x-axis) sorted by catchment elevation (y-axis).
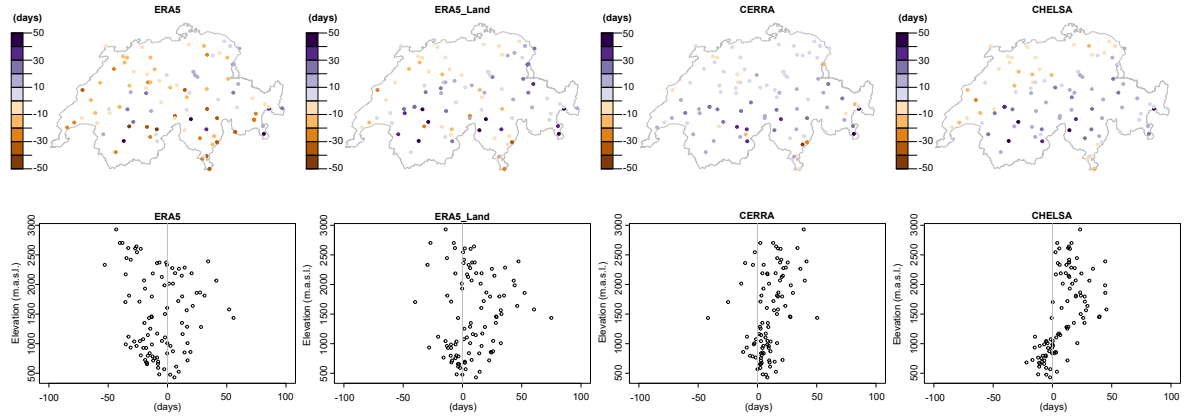
Figure S8: Comparison of the mean number of cold days (colddays) at the catchment level of the four reanalysis datasets (ERA5, ERA5-Land, CERRA, and CHELSA) with the gridded observations and elevation dependence of the biases. The first row shows absolute biases (in days) at the catchment level for ERA5, ERA5-Land, CERRA, and CHELSA (left to right) compared to observations. The second row shows absolute biases (x-axis) sorted by catchment elevation (y-axis).
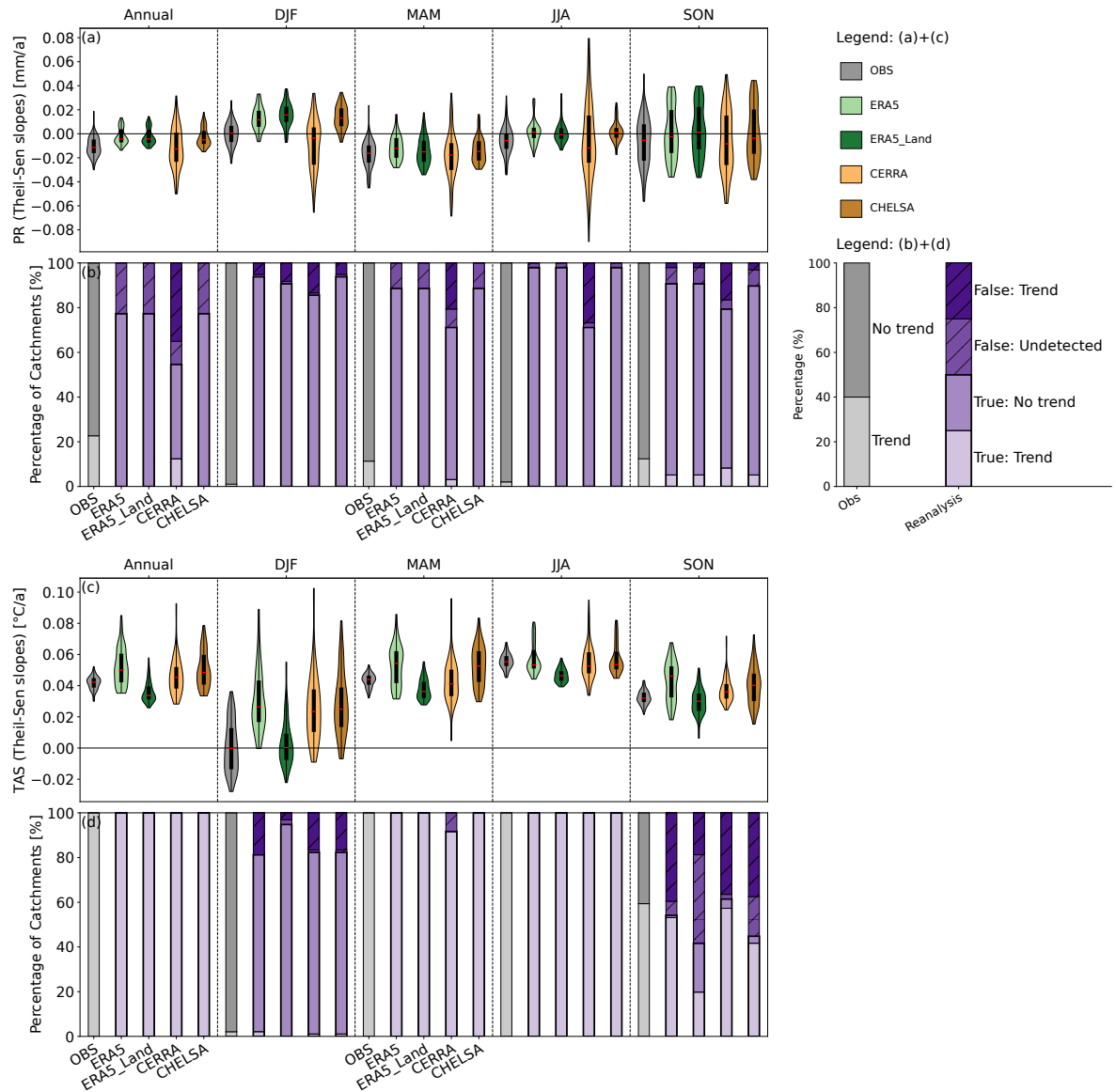
Figure S9: Comparison of trends in precipitation and temperature metrics. Violin plots show trend magnitudes (theil-sen slopes; 1986-2020) in observations (grey) and reanalysis datasets (colors) across all catchments for mean precipitation (a) and temperature (c) at annual and seasonal scales. Stacked barplots show the correct spatial matching of significant trends or no trends in precipitation (b) and temperature (d) by the reanalysis datasets (purple bars) compared to observations. Grey bars show the percentage of catchments with a significant trend (light grey) and no trend (dark grey) in the observations. Purple bars without hatching show the percentage of catchments in the reanalysis datasets with a correct matching of a significant trend (lightest coloring) or no trend (medium light). Hatched bars show the percentage of undetected (medium dark) or false trends (darkest coloring). Each bar represents the respective trends from the aligned violin plots.
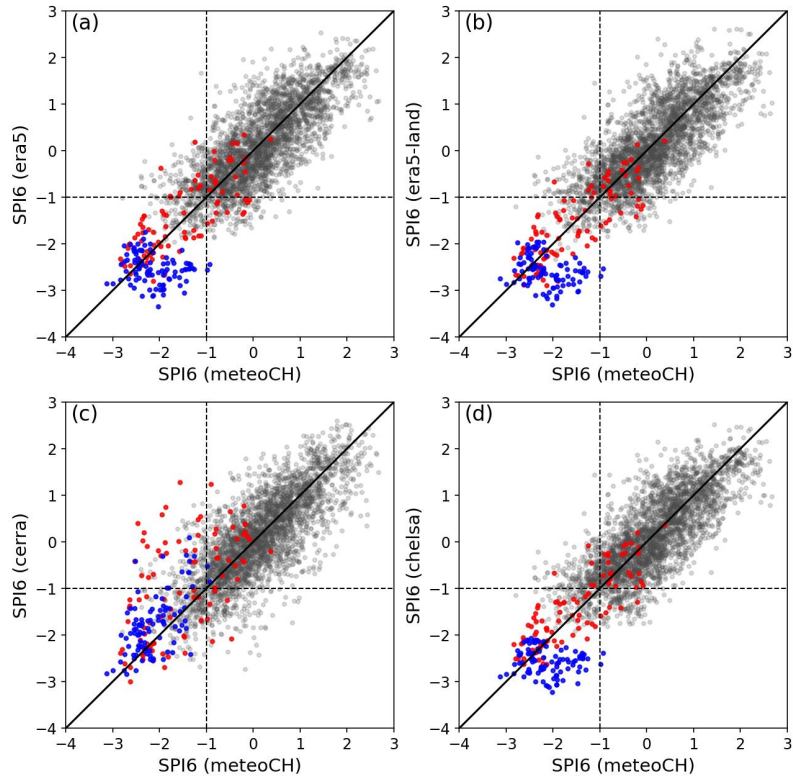
Figure S10: Comparison of SPI6 catchment values (March-August) of all years by the four reanalysis datasets ((a) ERA5, (b) ERA5-Land, (c) CERRA, and (d) CHELSA) compared to gridded observations. Observations on the x-axis and the respective reanalysis dataset on the y-axis. Colored dots show the SPI6 values of the 2003 (blue) and 2018 drought events (red); grey dots all other years. The solid black line indicates the 1:1 line and the dashed lines indicate SPI6 values of -1.
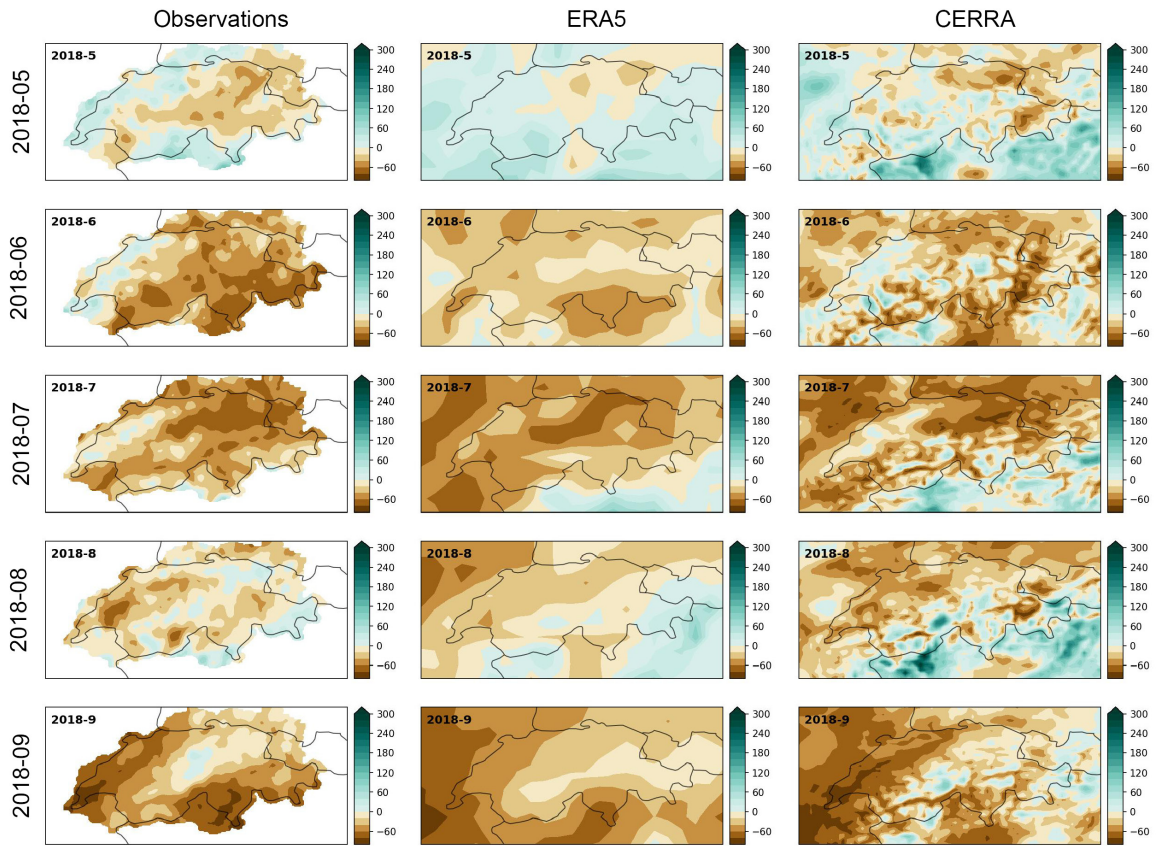
Figure S11: Maps of monthly relative precipitation anomalies (May-September) in observations, ERA5 and CERRA over Switzerland compared to 1986-2020. Observed monthly precipitation anomalies (in %) (left column), ERA5 anomalies (middle), and CERRA anomalies (right) compared to the long-term average monthly precipitation sums for the months May (top) to September (bottom). Green shading indicates above normal and brown colors below normal monthly precipitation.
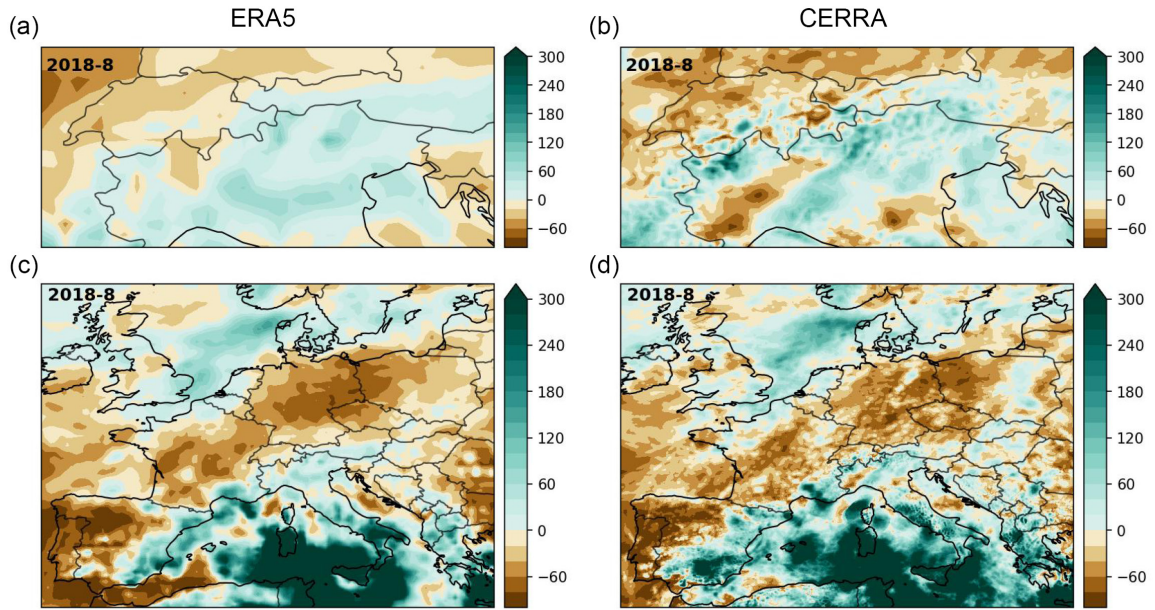
Figure S12: Maps of August precipitation anomalies in ERA5 and CERRA over the Alps and Europe. (a) ERA5 precipitation anomalies (%) over the Alps; (b) CERRA precipitation anomalies (%) over the Alps; (c) ERA5 precipitation anomalies (%) over Europe; (b) CERRA precipitation anomalies (%) over Europe. Relative anomalies compared to the long-term average monthly precipitation sums (1986-2020). Green shading indicates above normal and brown colors below normal monthly precipitation.