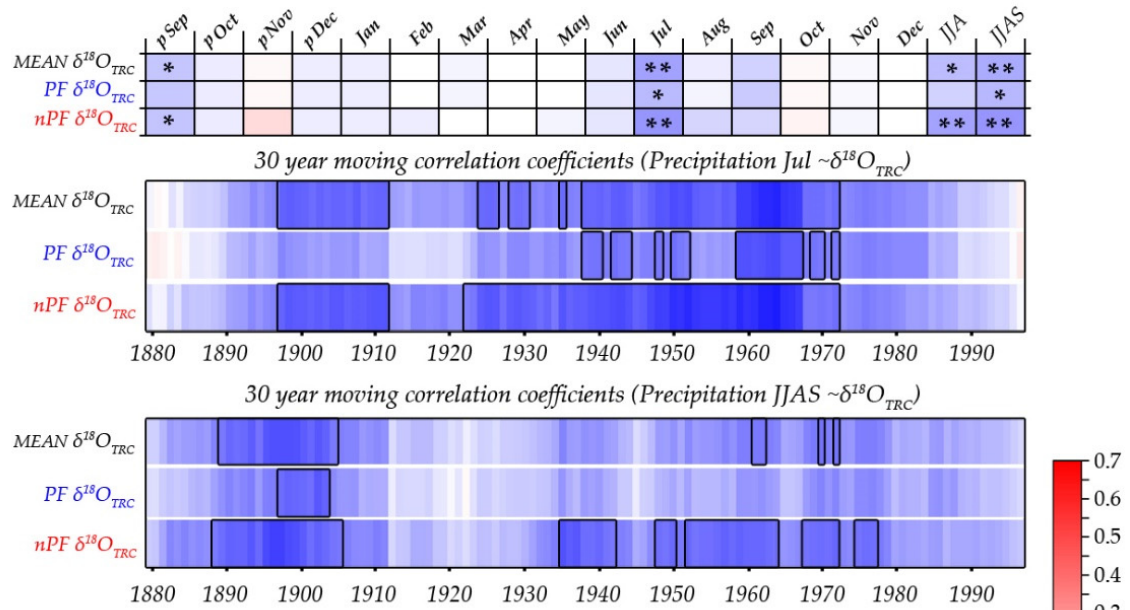
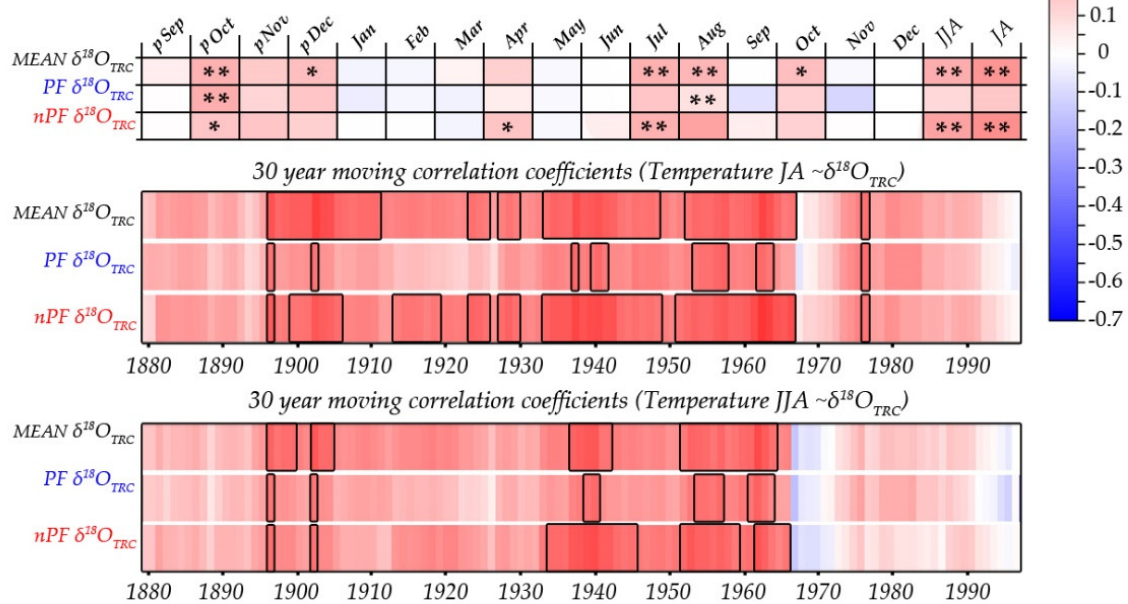


## Supplementary Materials:

### A) Precipitation (Samedan meteo-station: 1864-2011)



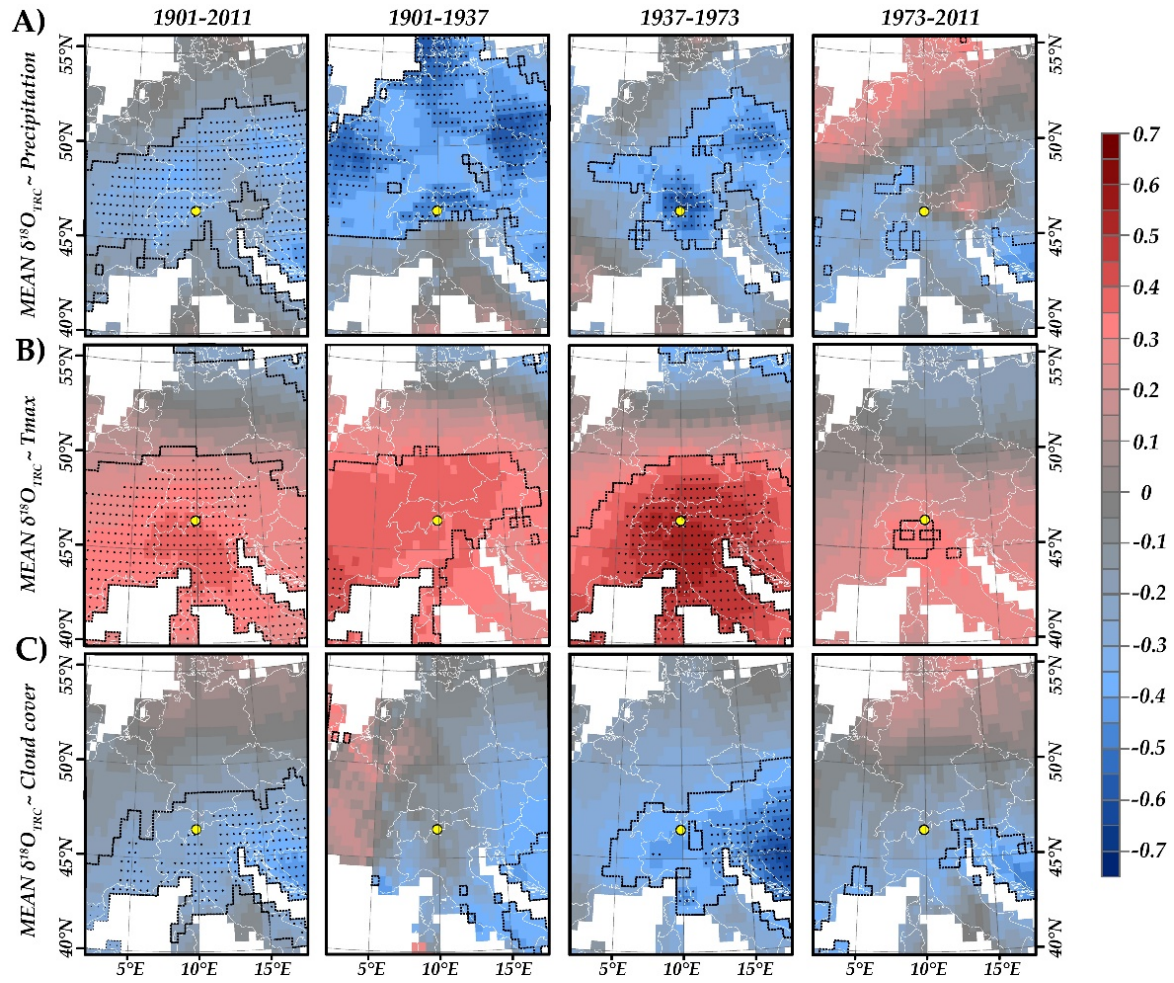
### B) Temperature (Samedan meteo-station 1864-2011)



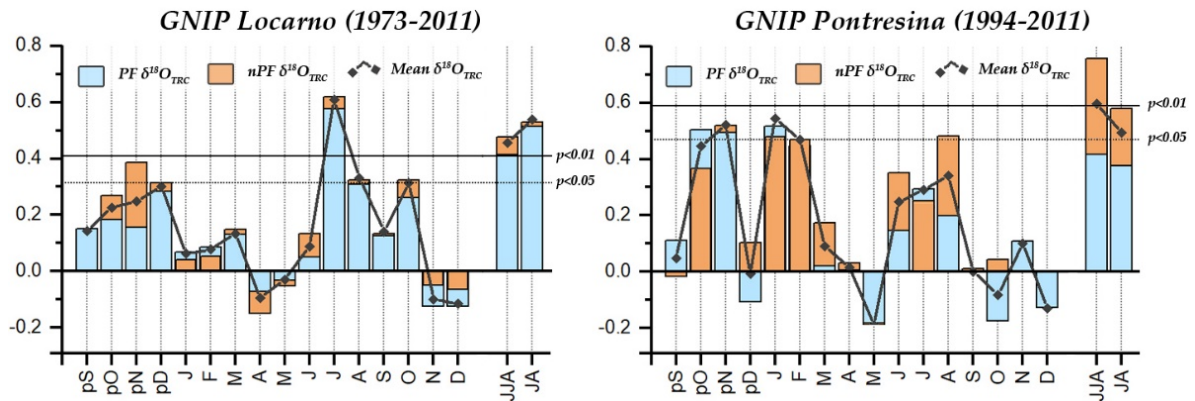
### C) Cloud Cover (Samedan meteo-station: 1980-2011)



**Figure 1.** Climate sensitivities derived for the MEAN- $\delta^{18}O_{TRC}$  chronology and from tree stands growing on permafrost (PF) and non-permafrost (nPF) sites for monthly precipitation (A) and temperature (B). For the monthly correlation analysis, one or two asterisks mark the level of significance of  $p < 0.05$  and  $p < 0.01$ , respectively. For the moving correlations, significant periods ( $p < 0.05$ ) are marked by a black frame. The abscissas axis represents the mid-year of the 30 years moving window. Samedan meteorological station data (1864-2020) are provided by the Federal Office of Meteorology and Climatology/MeteoSwiss.



**Figure S2.** Spatial correlations between CRU TS v 4.04 and the MEAN- $\delta^{18}\text{O}_{\text{TRC}}$  for **A)** precipitation (July), **B)** maximum temperature (July-August), and **C)** cloud cover (July) for the whole observation period (1901-2011) and intervals of 37 years. Dashed black polygons and black points indicate 95% and 99% level of significance, respectively. The yellow dot marks the Val Bever study site.



**Figure S3.** Correlation patterns between the three isotope time series and the adjacent Global Network of Isotopes in Precipitation (GNIP) stations Locarno (1973-2011) and Pontresina (1994-2011). Solid and dashed horizontal lines represent the 99% and 95% level of significance, respectively.