



Supplement of

Historical droughts manifest an abrupt shift to a wetter Tibetan Plateau

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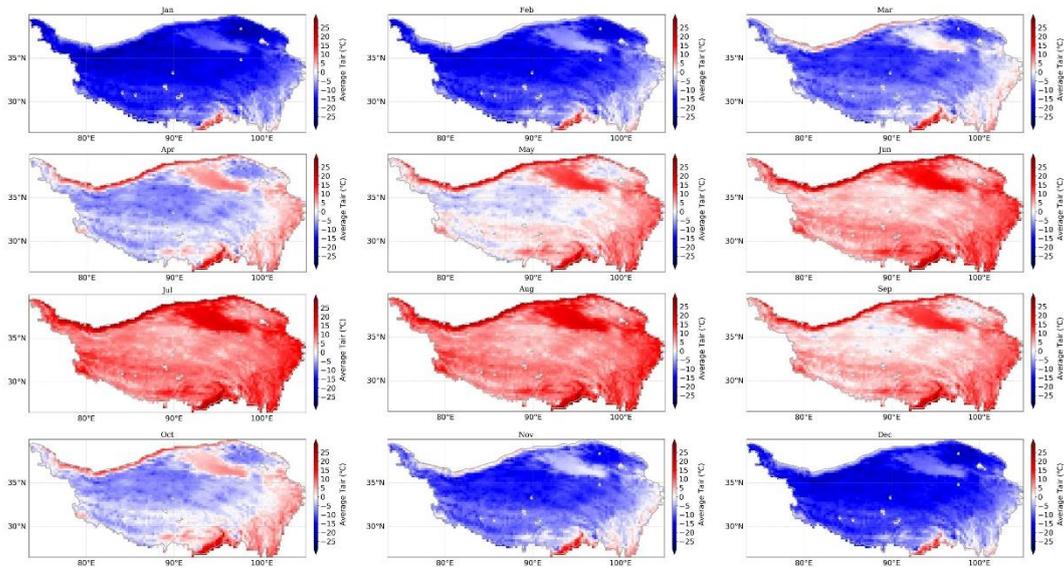


Figure S1. Monthly average air temperature ($T_{air}/Temp$) from January to December over 1961–2014. $T_{air}/Temp$ are based on the gauging interpolation data provided by the Chinese Meteorological Administration (CMA). Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov and Dec are abbreviated for the 12 months from January to December.

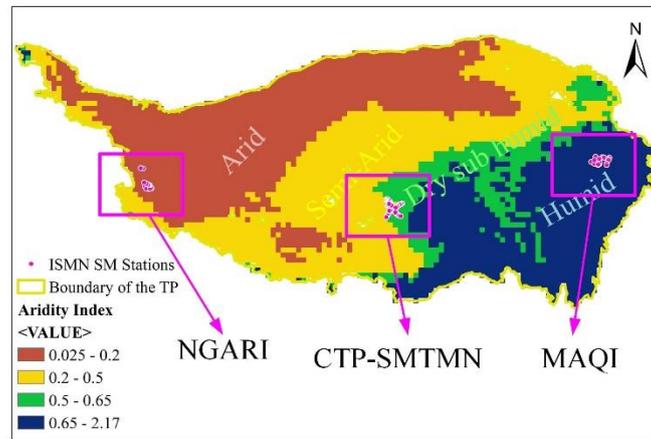


Figure S2. Location of the in situ soil moisture observations from the International Soil Moisture Network and the climate zone of the TP based on the Aridity index (from [http://ref.data.fao.org/map?entryId=221072ae-2090-48a1-be6f5a88f061431a&tab= about](http://ref.data.fao.org/map?entryId=221072ae-2090-48a1-be6f5a88f061431a&tab=about)).

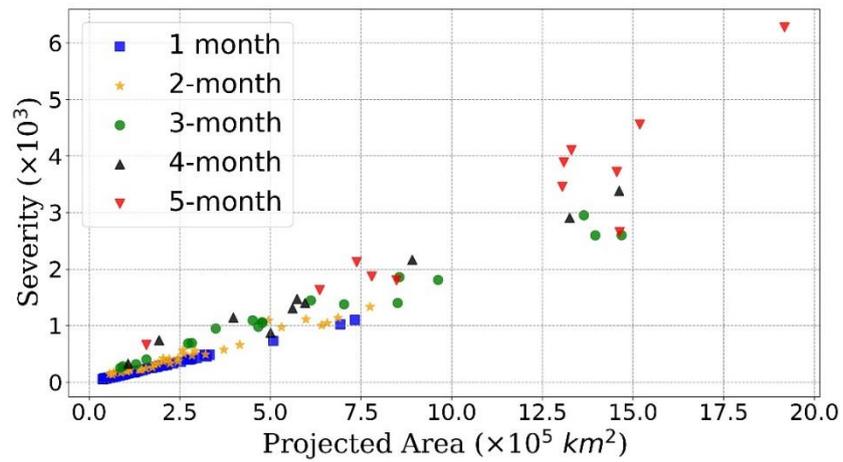


Figure S3. The drought severity and area with different durations for all identified drought events based on GLDAS soil moisture.

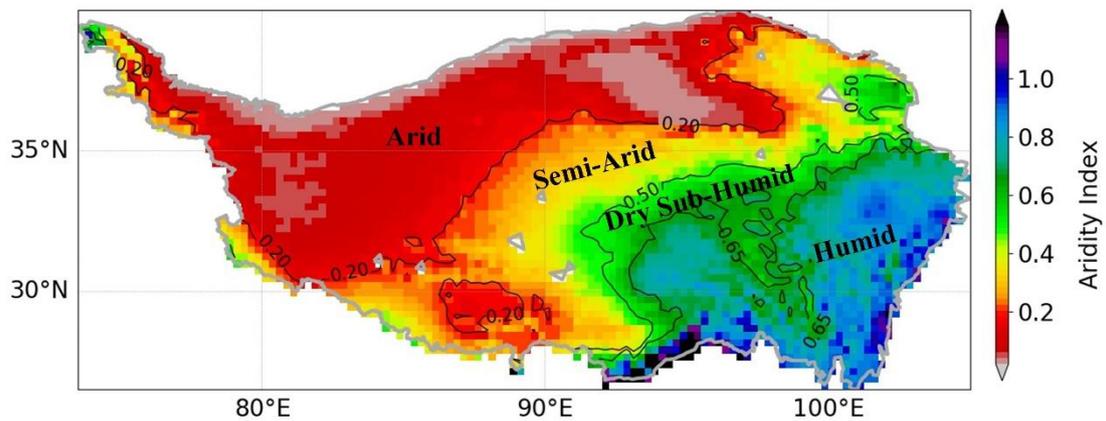


Figure S4. Map of the Aridity index (AI) for the TP (from <http://ref.data.fao.org/map?entryId=221072ae-2090-48a1-be6f5a88f061431a&tab=about>). Aridity index is calculated by dividing the multi-year average precipitation (Prep) using the multi-year average potential evapotranspiration (PET).

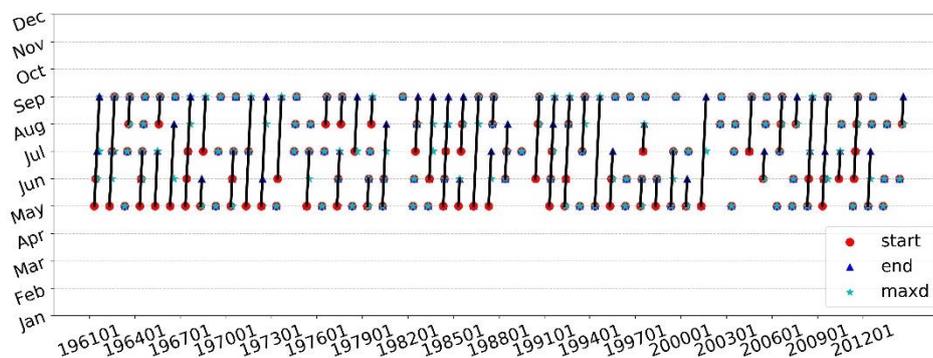


Figure S5. The start, end and maximized (maxd) severity time of the SM drought events based on GLDAS soil moisture

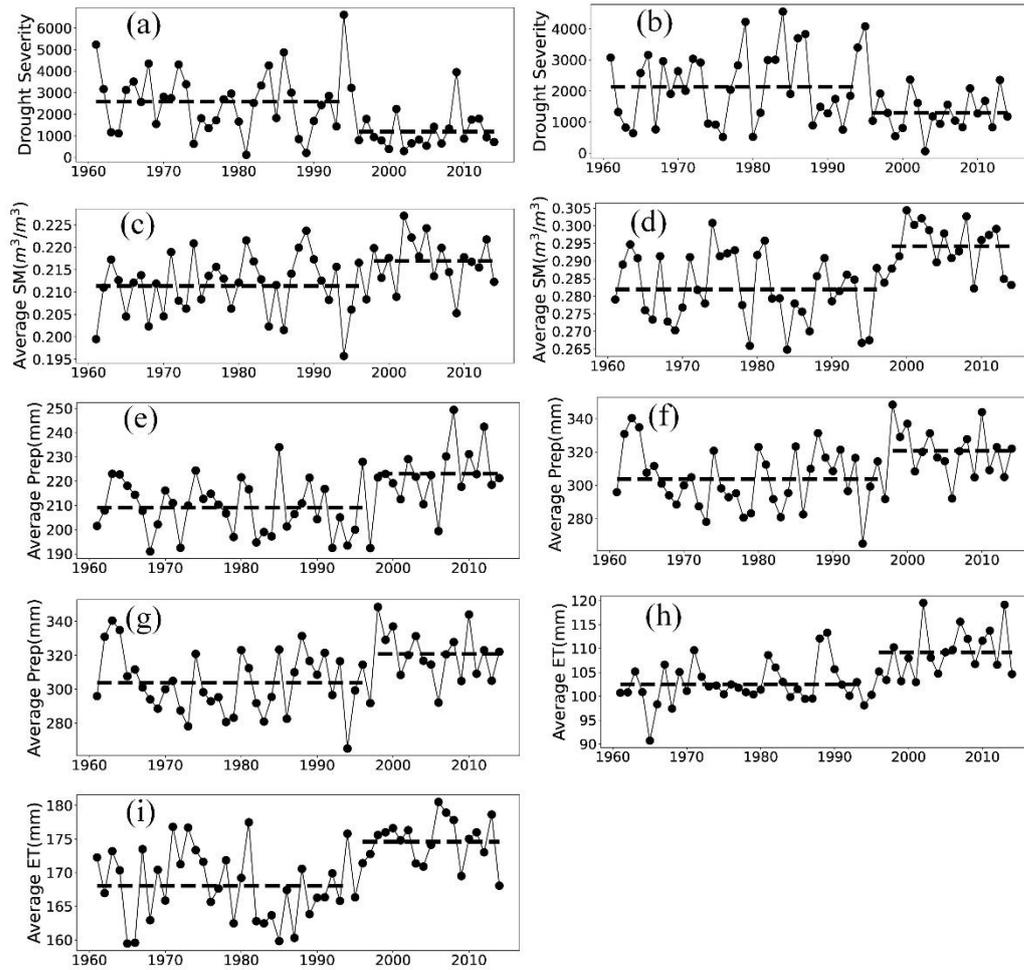


Figure S6. Variations of the total annual soil moisture (SM) drought severity of (a) GLDAS and (b) ERA5, the average SM of (c) GLDAS and (d) ERA5, the yearly average precipitation (Prep) of (e) CMA, (f) GLDAS, and (g) ERA5, and the yearly average actual evapotranspiration (ET) of (h) GLDAS and (i) ERA5 over summer periods (May–September) from 1961 to 2014. The dotted black lines are the mean values over different periods.

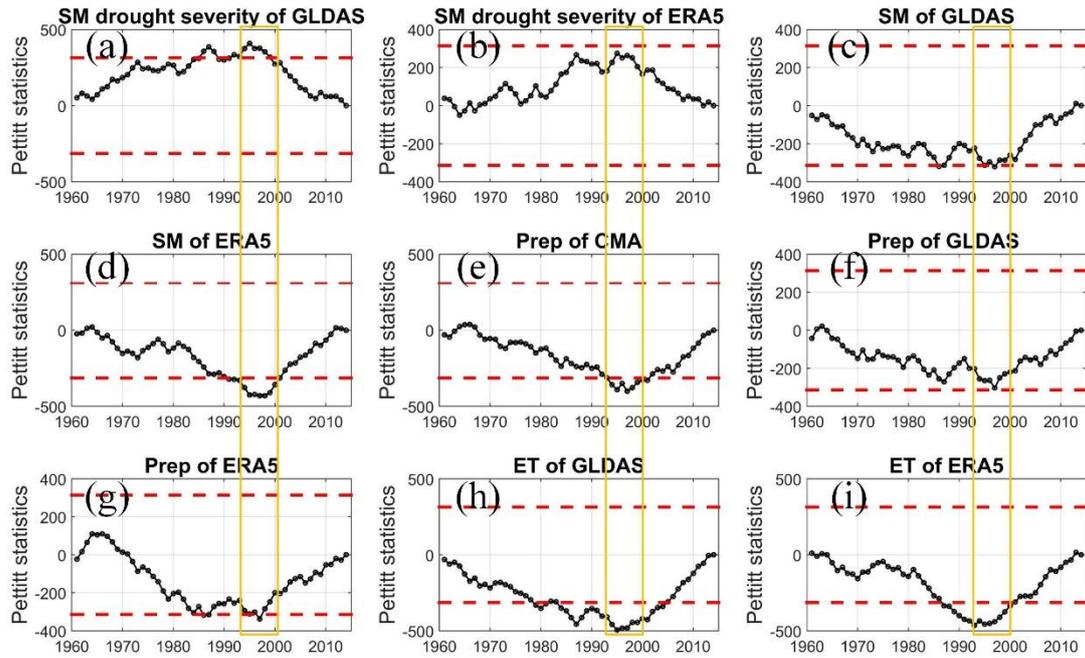


Figure S7. Pettitt statistics for the total annual soil moisture (SM) drought severity of (a) GLDAS and (b) ERA5, the average SM of (c) GLDAS and (d) ERA5, the yearly average precipitation (Prep) of (e) CMA, (f) GLDAS, and (g) ERA5, and the yearly average actual evapotranspiration (ET) of (h) GLDAS and (i) ERA5 over summer periods (May–September) from 1961 to 2014. The red dotted lines represent the statistics at the significance level of $p = 0.05$.

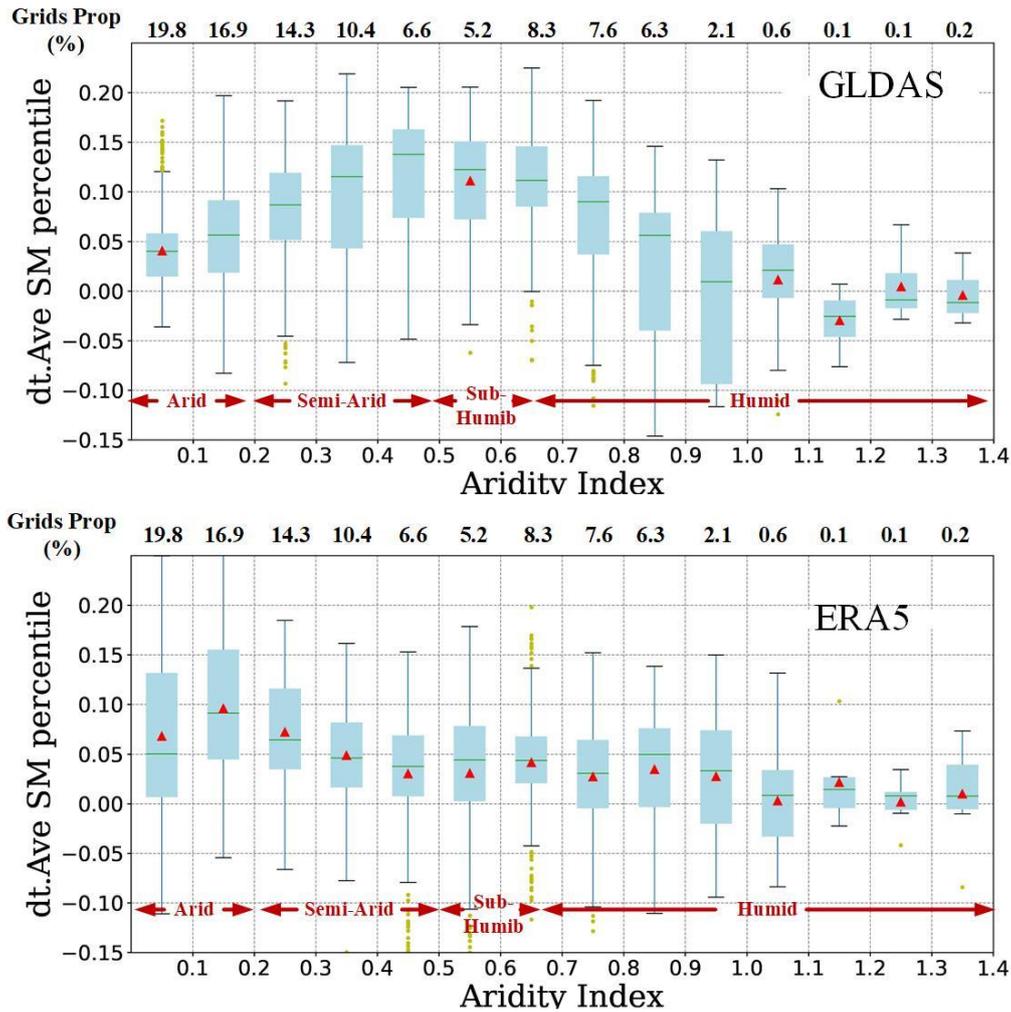


Figure S8. Difference of the average SM percentile (dt.ave SM percentile) over summer periods of May–September between the period after and before the mid to late 1990s based on GLDAS and ERA5 SM. The upper limb, lower limb, blue line and red Δ represent the upper quartile (h1), lower quartile (h2), median and mean value. The whisker ranges from $h1 - 1.5(h2 - h1)$ to $h2 + 1.5(h2 - h1)$. The upper numbers are the proportions (%) of the grid pixels with their Aridity index (Figure S4) falling in the corresponding intervals.

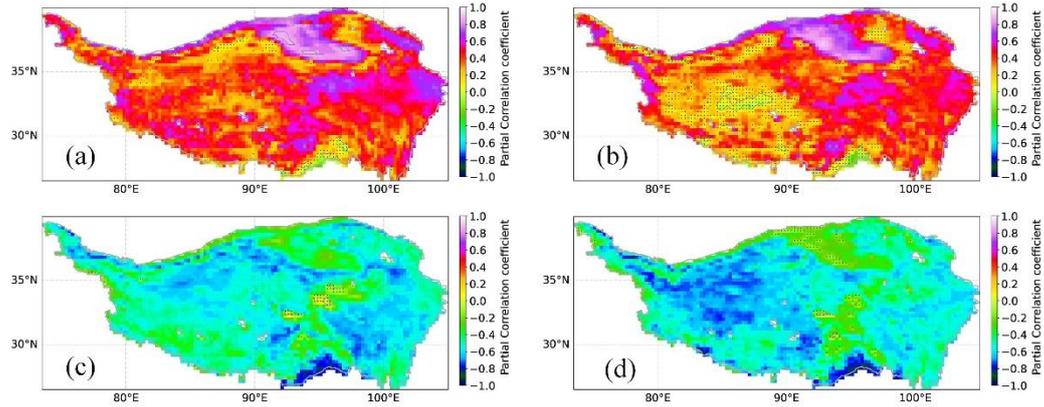


Figure S9. Spatial distribution of the partial correlation coefficient between the soil moisture (SM) percentile and (a)/(b) precipitation (Prep) and (c)/(d) potential evapotranspiration (PET) anomaly over the period before/after the mid to late 1990s based on ERA5 dataset. The black dots denote the un-significant ($p > 0.05$) correlations.

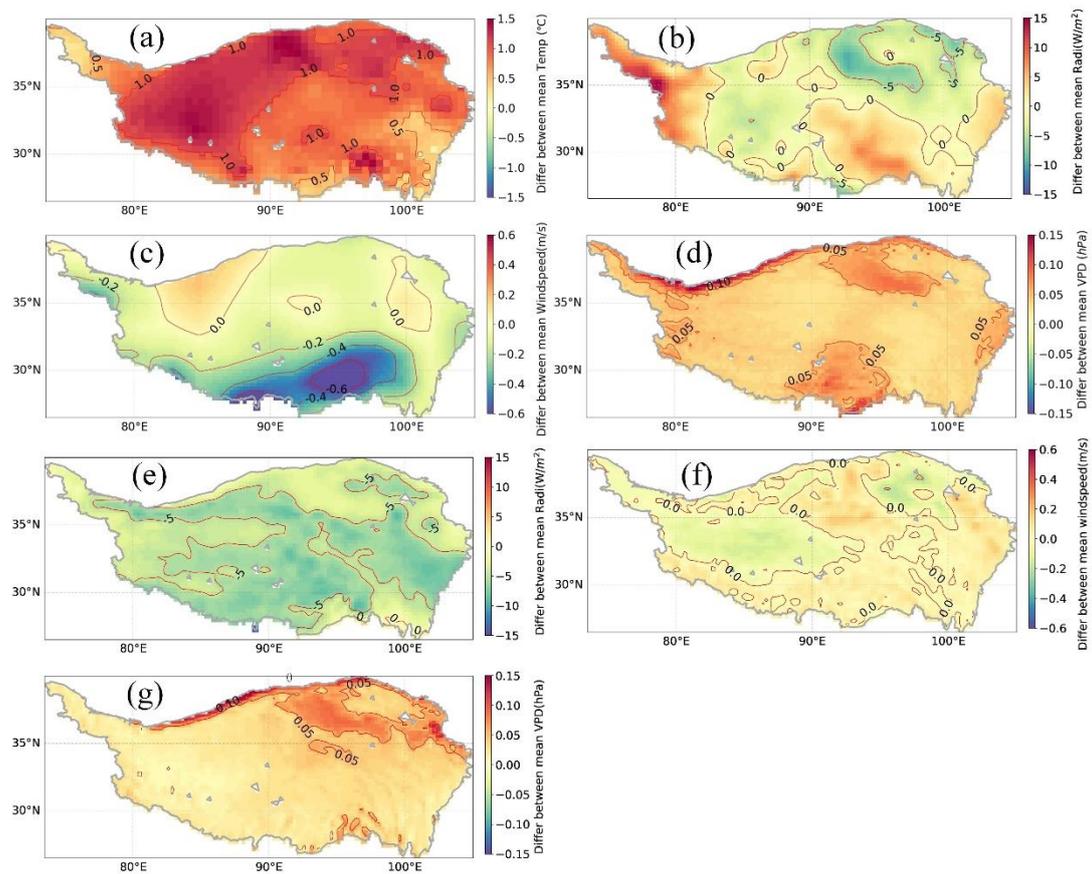


Figure S10. Difference (Differ) between the average state of the air temperature (Temp) (a), radiation (Radi) (b)/(e), Wind speed (Windspeed) (c)/(f) and vapor pressure deficit (VPD) (d)/(g) for GLDAS/ERA5 over the stage of after and before the mid to late 1990s.

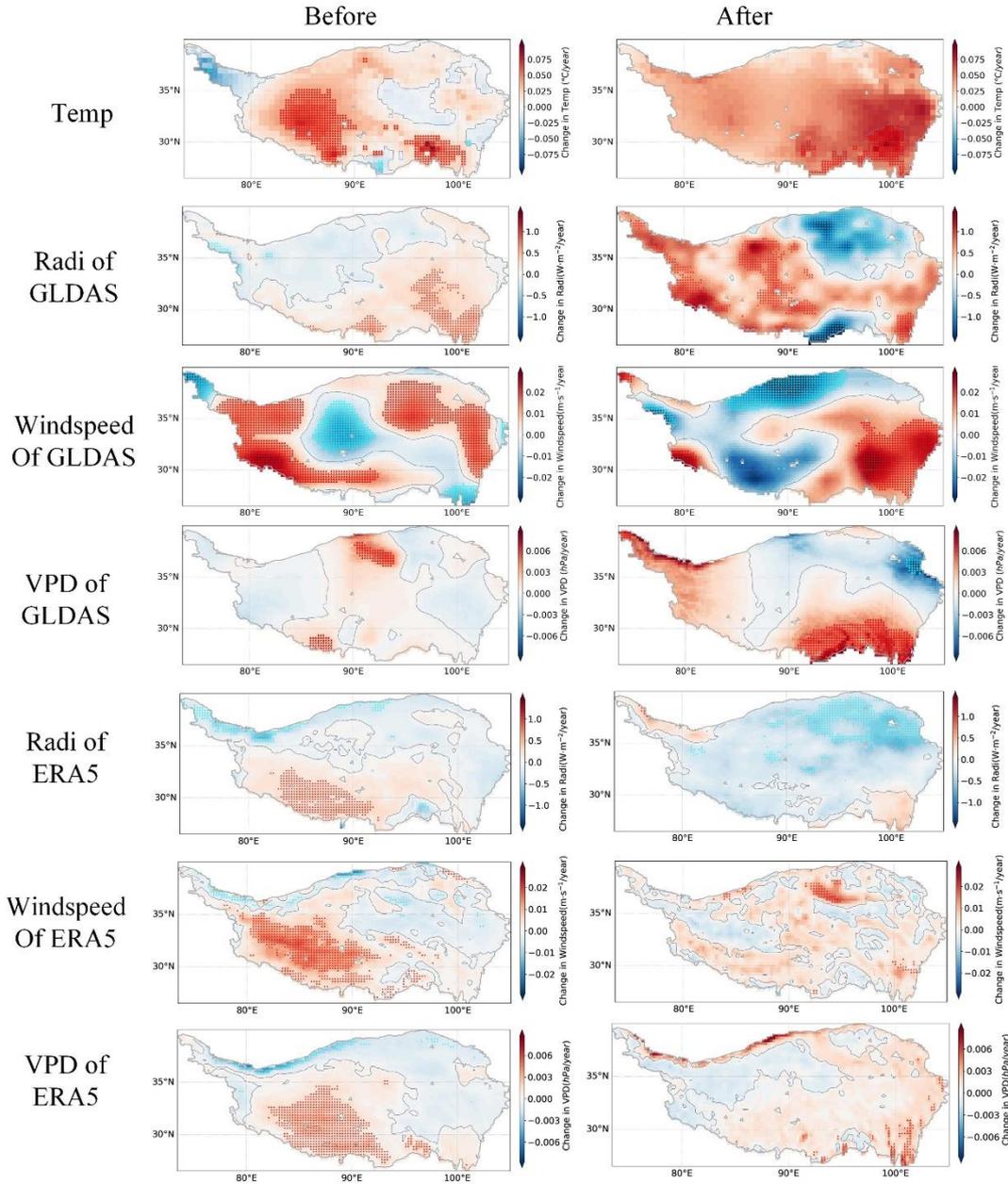


Figure S11. Spatial distribution of the trends in air temperature (Temp), downward radiation (Radi), wind speed (Windspeed) and vapor pressure deficit (VPD) over the stage of after and before the mid to late 1990s based on GLDAS and ERA5. The Δ/∇ with cyan/red denote the significant ($p < 0.05$) increasing/decreasing trends.