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Moisture sources and dynamics over the Southeast Tibetan Plateau reflected in dual water vapor isotopes

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Table S1. The correlation coefficients between vapor isotopic variables ($\delta^{18}O$ and *d-excess*) and the fraction of within-boundary-layer moisture contribution over land for different seasons between 2015-2017. Values with significance levels ***exceeding 99%***, **between 99% and 95%**, *95% and 90%*, are in bold italic, bold, and italic, respectively.

	2015-2017 All	Nov-Apr	JJAS	May	Oct
$\delta^{18}O$	*-0.07*	***0.47***	0.05	-0.07	**-0.25**
d-excess	***-0.23***	*-0.10*	0.01	0.06	0.05

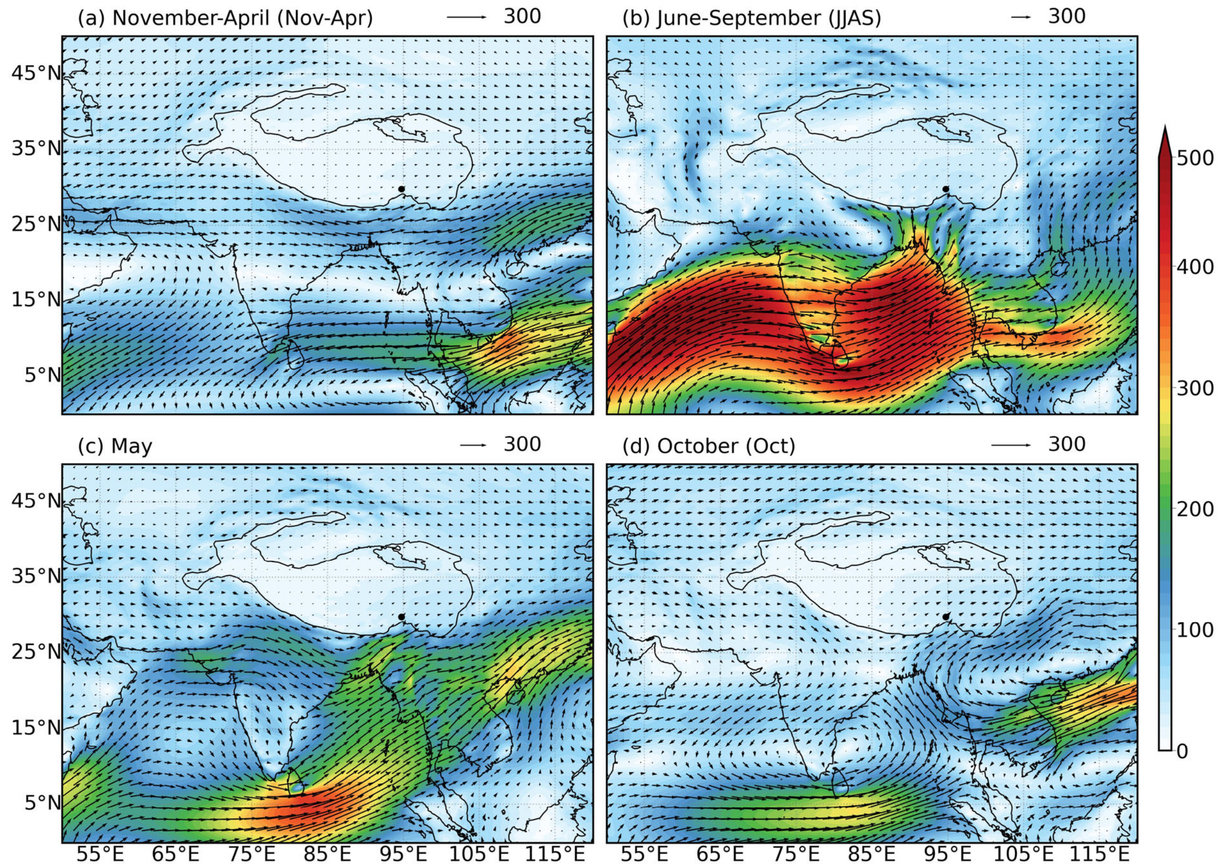

Figure S1. Location of the South-East Tibetan Plateau station (SETP) and the climatological moisture transport pattern during different seasons. (a) climatological mean (1991-2020) vertical integral water vapor transport (vectors and shading, kg m^{-1} s^{-1}) for the non-monsoon season of November-April (Nov-Apr). (b-d) are the same (a), but for the summer monsoon season of June-September (JJAS, b), May (c), and October (d), respectively. The black dots indicate the location of the SETP station. The black solid lines denote the Tibetan Plateau with altitude contour at 3000 m.

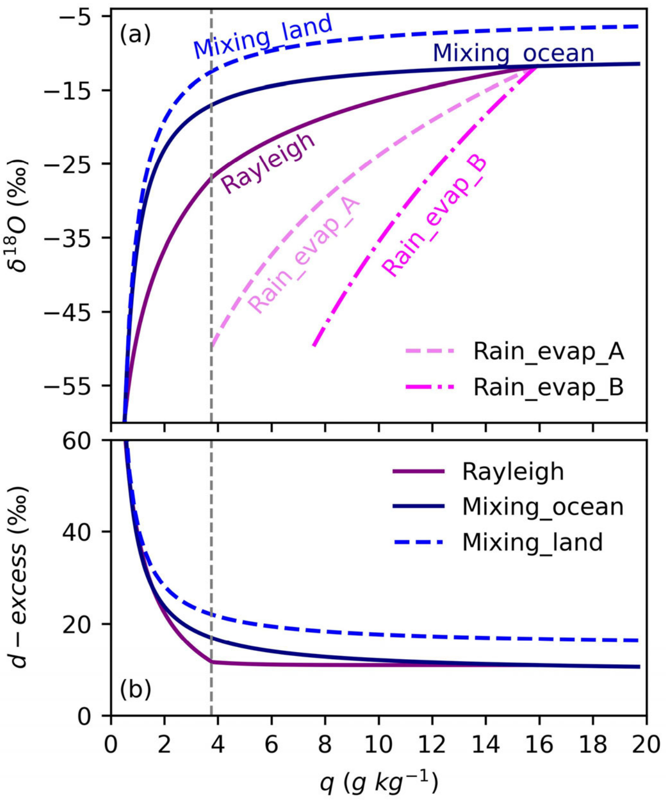

Figure S2. Theoretical pathways of the evolution of water vapor isotope compositions along with specific humidity (*q*). (a) the evolution of $\delta^{18}O$ along with *q*: the solid navy curve (Mixing_ocean) indicate the evolution of $\delta^{18}O$ by the mixing between a wet end member of typical ocean surface water vapor ($\delta^{18}O$ = -11.5‰, $\delta^{2}H$ = -81.0‰, and *q* equals the saturation humidity at 25 °C) with a dry end member with an isotopic signature of ($\delta^{18}O$ = -60.3‰, $\delta^{2}H$ = -418.0‰, and *q* = 0.5 g kg-1). The solid purple curve (Rayleigh) indicates the evolution of $\delta^{18}O$ by the Rayleigh distillation starting with a relative humidity of 80% at ocean surface. The dashed blue curves have the same configuration as the solid blue curve, but the isotopic composition of the wet end member is set to $\delta^{18}O$ = -5‰ and $\delta^{2}H$ = -35‰ to represent vapor dominated by land surface evapotranspiration. The dashed violet and dash-dotted magenta curve represents the super-Rayleigh distillation under two different degrees of rain evaporation (Rain evap A and Rain evap B). A more detailed description of configurations for these reference lines are referred to section 2.3.

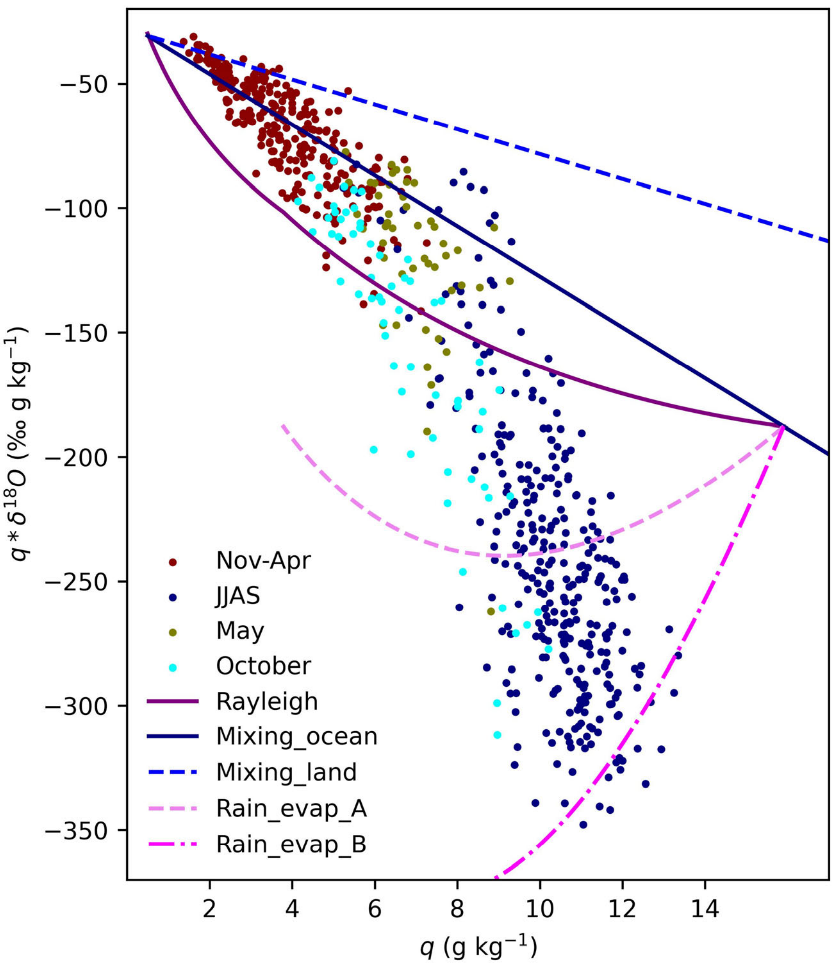

Figure S3. Relationships between specific humidity (q) and the product of q and vapor δ^{18}O ($q \times \delta^{18}O$). Non-monsoon season (Nov-Apr) data are shown as dark red dots, summer monsoon season (JJAS) data as navy dots, data for May as olive dots, and data for October as cyan dots. Settings for reference lines of Rayleigh distillation (the purple solid line), mixing with ocean evaporation (the navy solid line), mixing with land evapotranspiration (the blue dashed line), and partial rain evaporation under two different configurations (the pink dashed and magenta dash-dotted lines) are the same as those in Fig. S2.

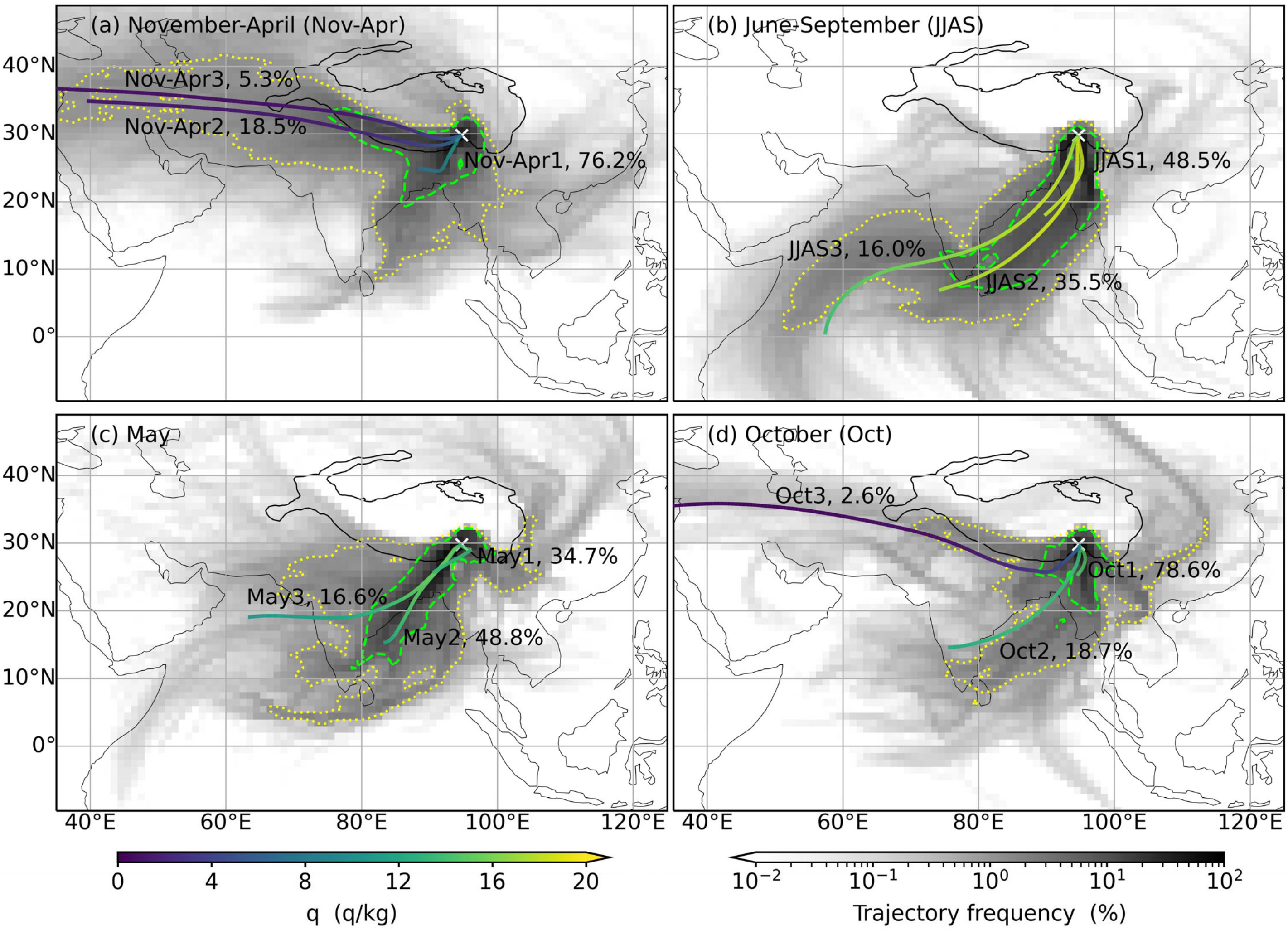

Figure S4. Air mass trajectory frequency and transport pathways during different seasons from 2015-2017. (a) spatial distribution of air mass trajectory frequency over each 1°×1° box (shading) and specific humidity (*q*) along mean trajectories of air parcel transport for the non-monsoon season (November-April). (b-d) are the same as (a), but for the summer monsoon season (b, JJAS), May (c), and October (d). The dotted yellow and dashed green contours indicate the trajectory frequency at 1% and 5%, respectively. The yellow crosses indicate the location of the SETP station. The black solid lines denote the Tibetan Plateau with altitude contour at 3000 m.

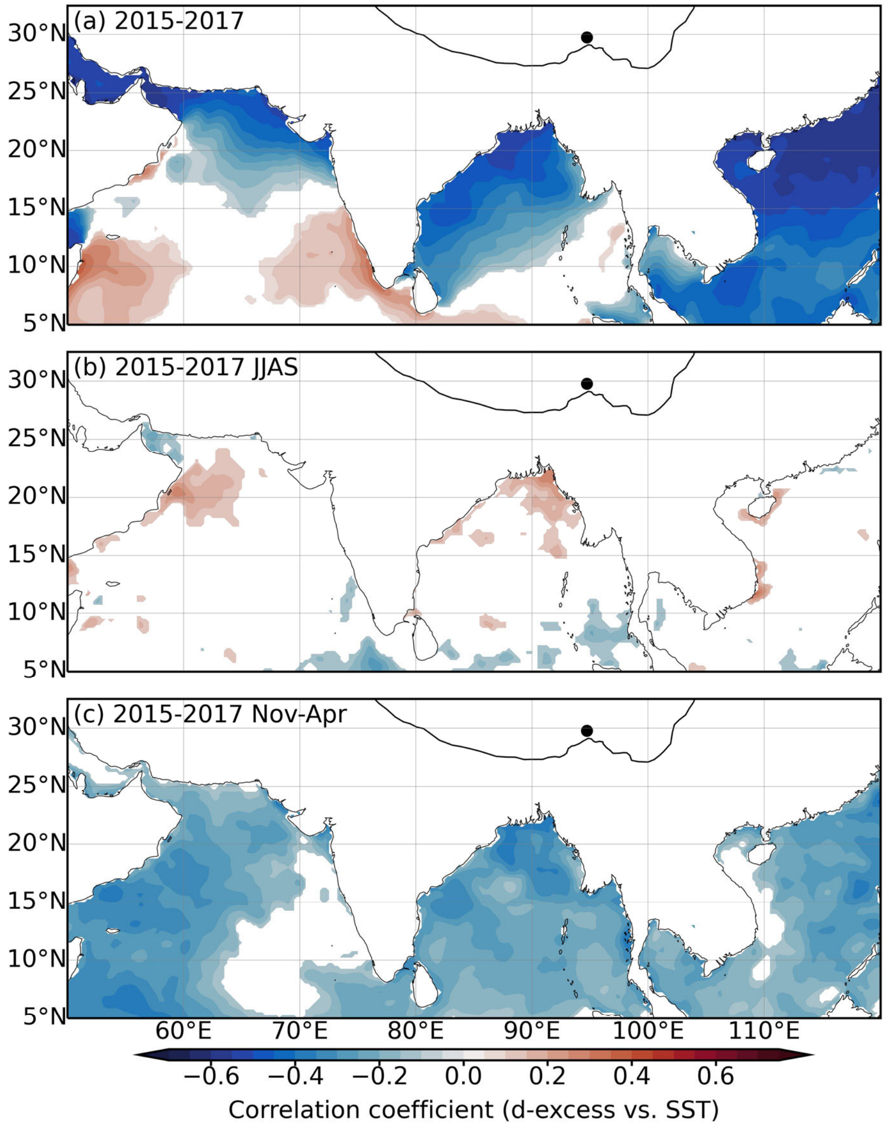

Figure S5. Relationships between water vapor *d*-excess and sea surface temperature (SST). (a) spatial distribution of correlation coefficients between vapor *d*-excess and SST RH_{SST} for all the data from 2015-2017. (b) and (c) are the same as (a) but only for the data within the summer monsoon season (JJAS) or the non-monsoon season (Nov-Apr), respectively. Only values significant at the 95% significance level are shown. The black dots indicate the location of the SETP station. The black solid lines denote the Tibetan Plateau with altitude contour at 3000 m.

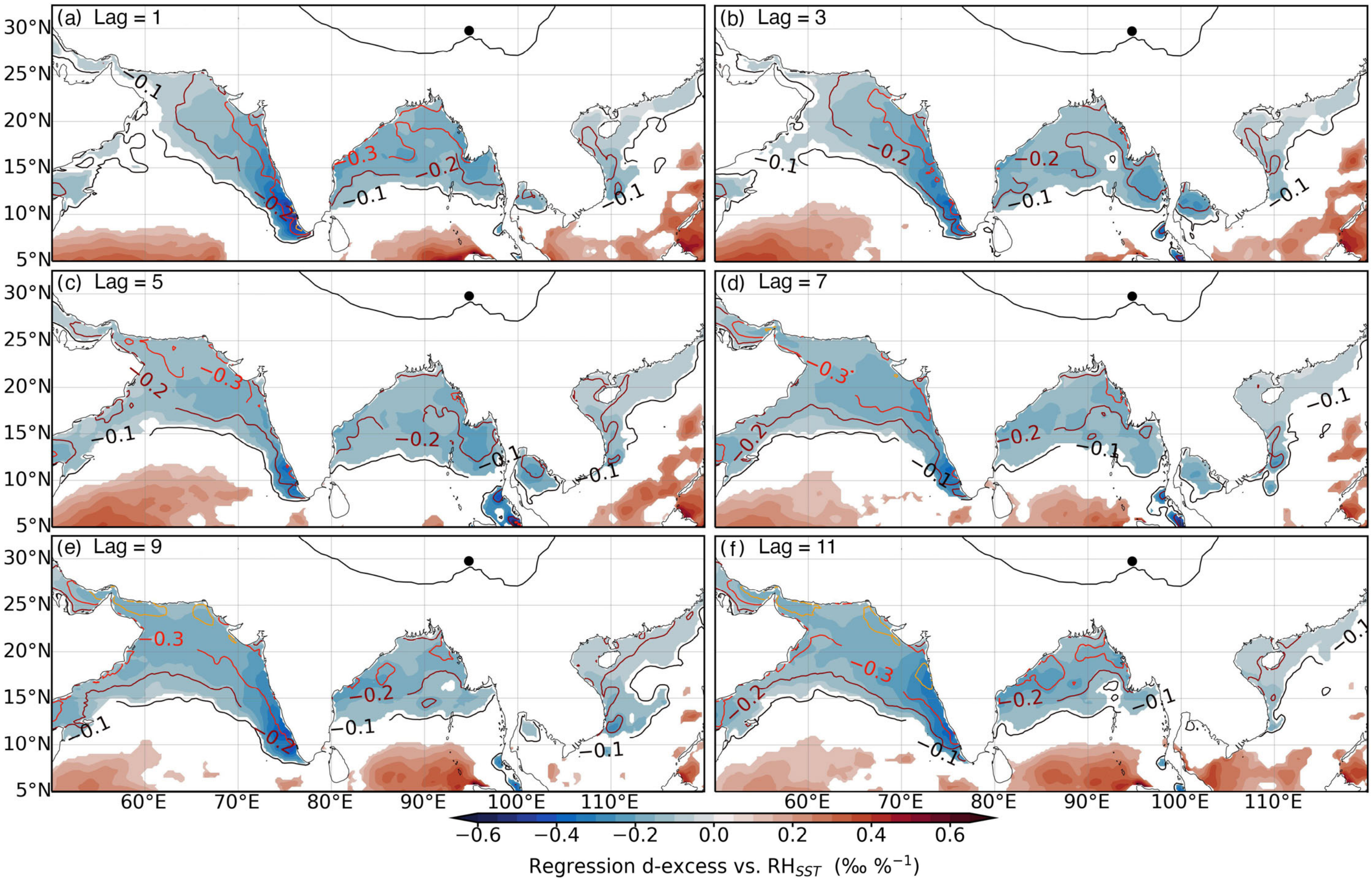

Figure S6. Relationships between vapor *d*-excess and relative humidity scaled to sea surface temperature (RH_{SST}) during (a) 1, (b) 3, (c) 5, (d) 7, (e) 9, and (f) 11 days before the day corresponding to *d*-excess observation dates for the data within the summer monsoon season. Shading represents regressions of *d*-excess against RH_{SST} (only values significant at the 95% significance level are shown). Contours at an interval of 0.1 indicate correlation coefficients between them (only negative correlations are shown). The black dots mark the location of the SETP station. The black solid lines denote the Tibetan Plateau with altitude contour at 3000 m.

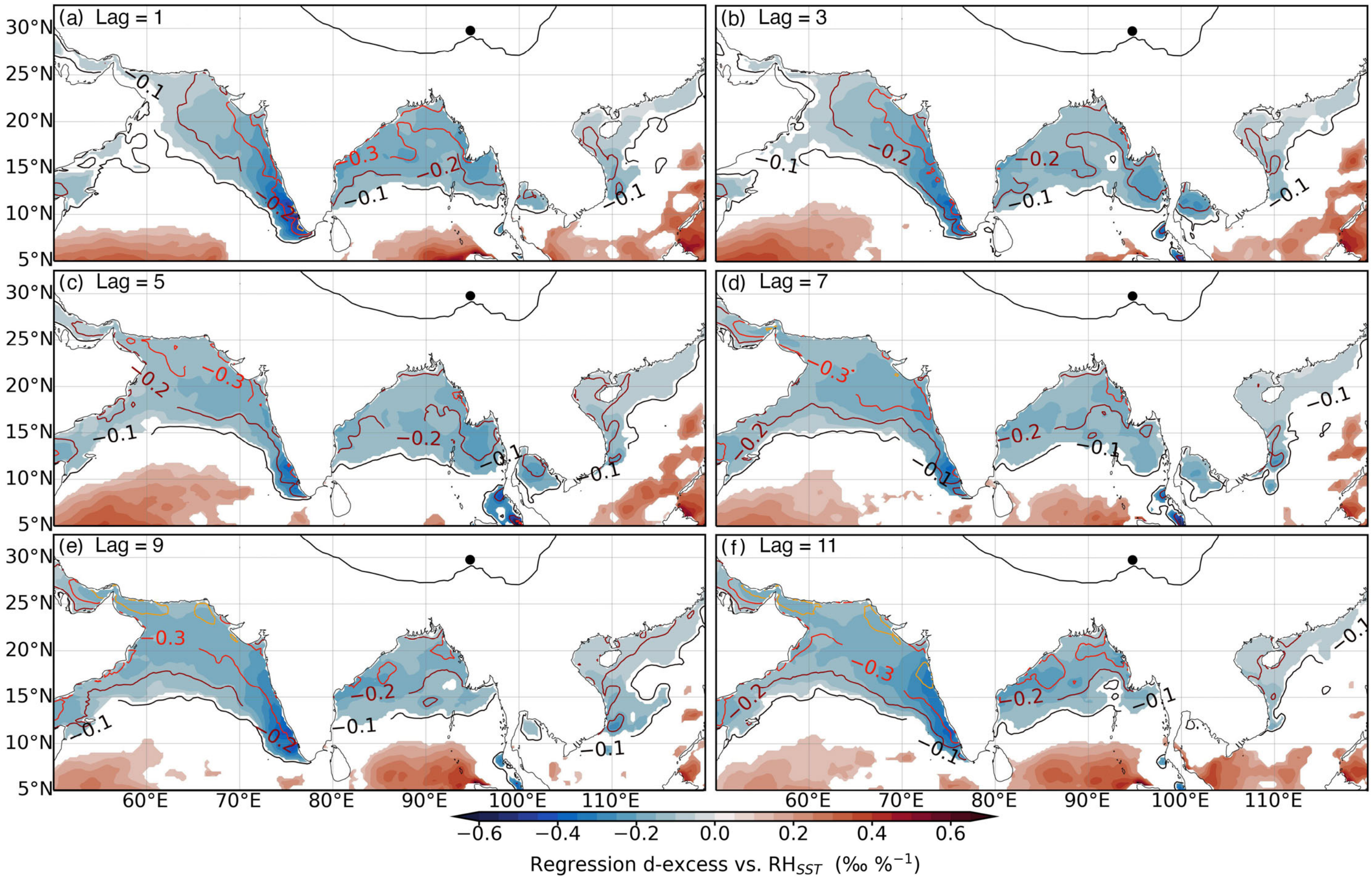

Figure S7. Same as Fig. S6 but for the non-monsoon season.

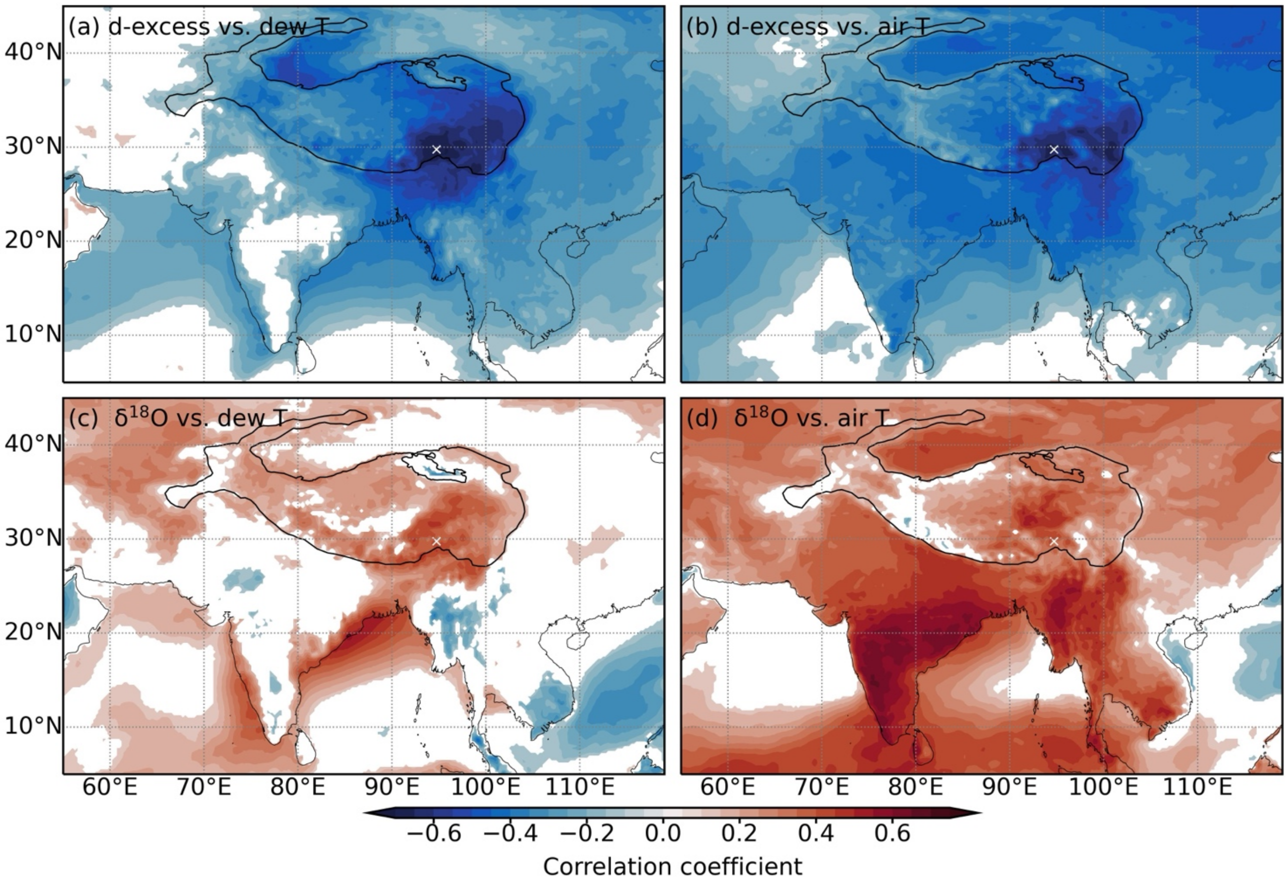

Figure S8. Spatial distribution of correlation coefficients among water vapor isotope compositions, dew point temperature, and air temperature during the non-monsoon season of November-April. (a) spatial distribution of correlation coefficients between SETP vapor *d*-excess and 2-meter dew point temperature. (b) the same as (a) but with 2-meter air temperature. (c) the same as (a) but between $\delta^{18}O$ and 2-meter dew point temperature. (d) the same as (c) but with 2-meter air temperature. Only values significant at the 95% significance level are shown. The white crosses indicate the location of the SETP station. The black solid lines denote the Tibetan Plateau with altitude contour at 3000 m.

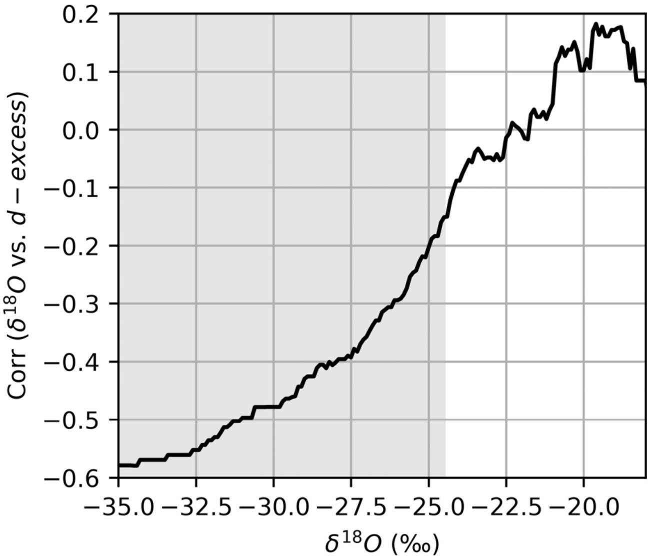

Figure S9. Correlation coefficients between vapor δ^{18}O and *d*-excess for subsets of data that have δ^{18}O values higher than certain levels during the summer monsoon season. The gray shading indicates where correlations pass the 95% significance test.

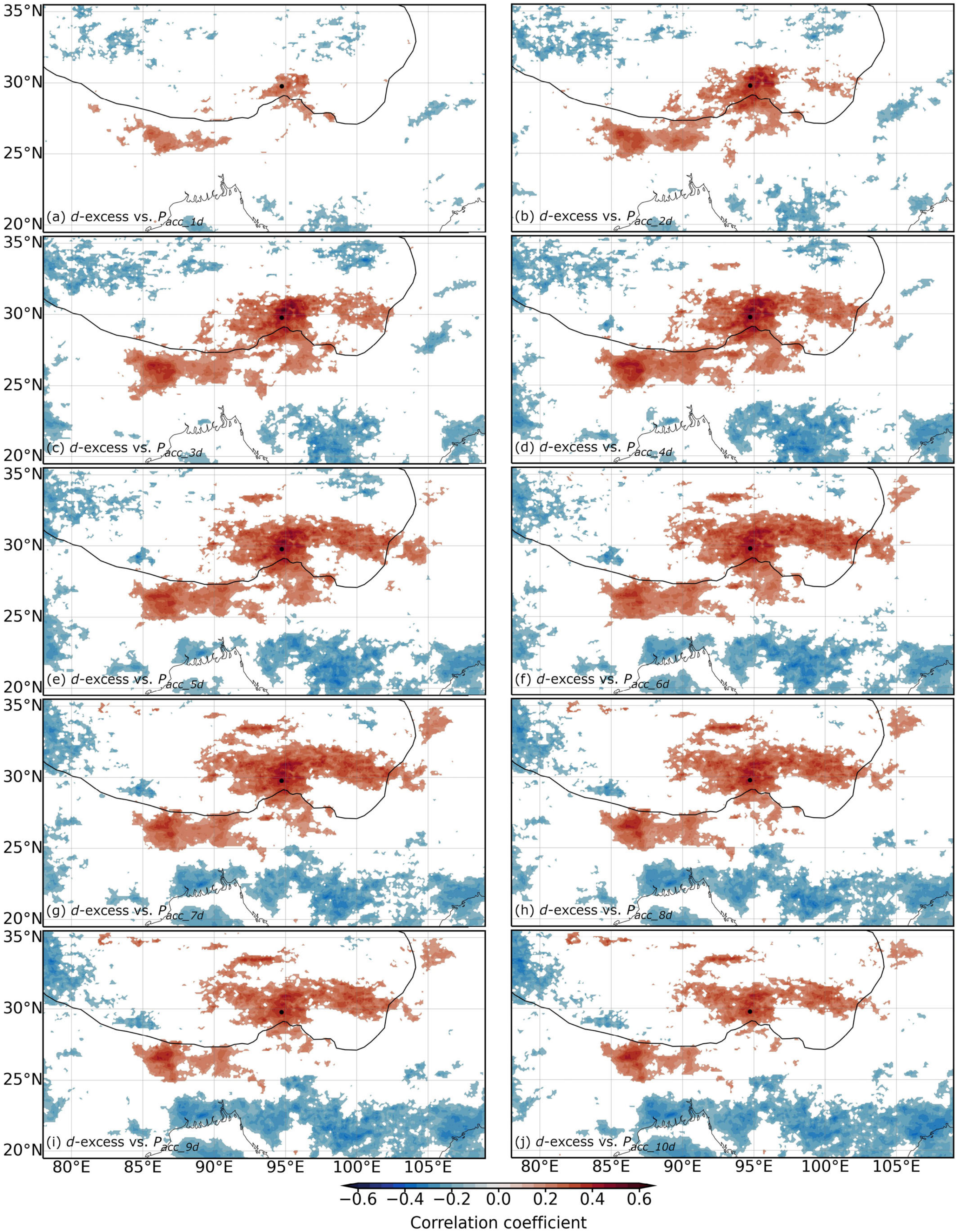

Figure S10. (a) spatial distribution of correlation coefficients between vapor *d*-excess and total precipitation amount during 1-day prior sampling (P_{acc_1d}). (b-j) are the same as (a) but for total precipitation amount during 2-10 days prior sampling. Only values significant at the 95% significance level are shown.

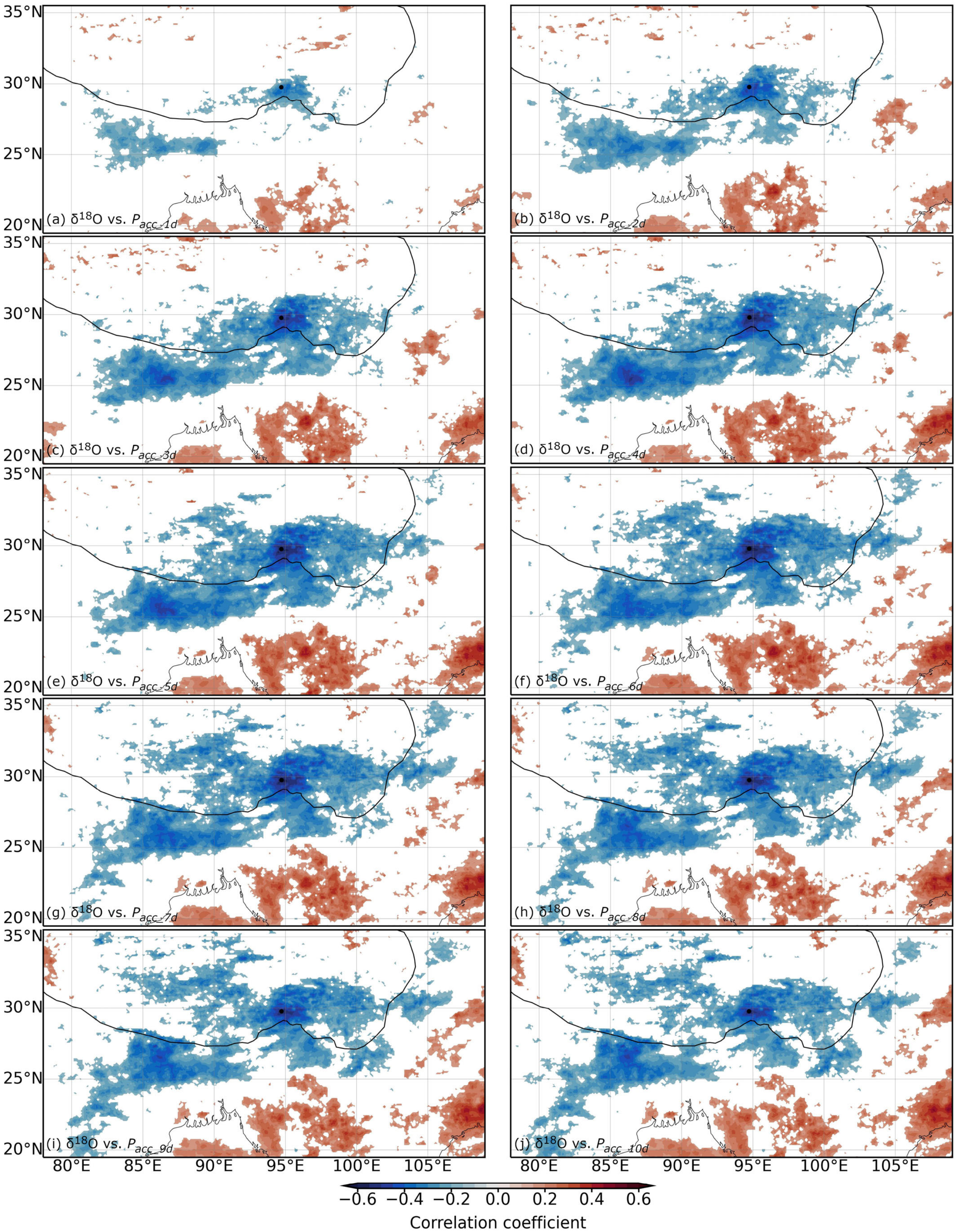

Figure S11. Same as Fig. S8 but for vapor $\delta^{18}O$.

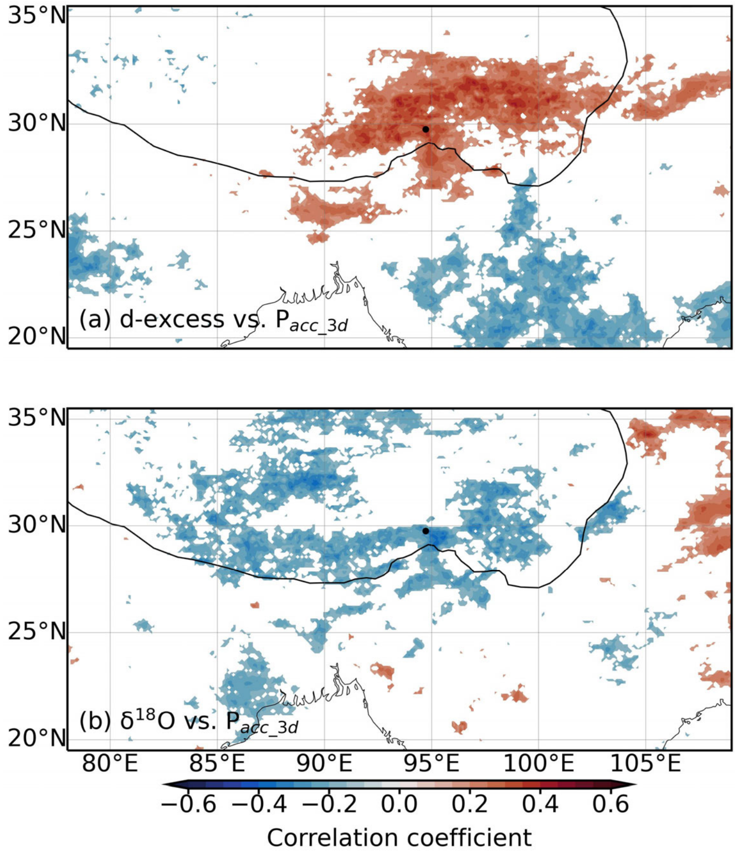

Figure S12. Relationships between SETP vapor isotope compositions for non-rainy days (local daily precipitation amount less than 2 mm) and total precipitation amount at the regional scale during the summer monsoon season. (a) spatial distribution of correlation coefficients between vapor *d*-excess and total precipitation amount during the 3 days prior sampling (P_{acc_3d}). (b) is the same as (a) but for δ^{18}O. Only values significant at the 95% significance level are shown.