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Spring tropical cyclones modulate near-surface isotopic compositions of atmospheric water vapour in Kathmandu, Nepal

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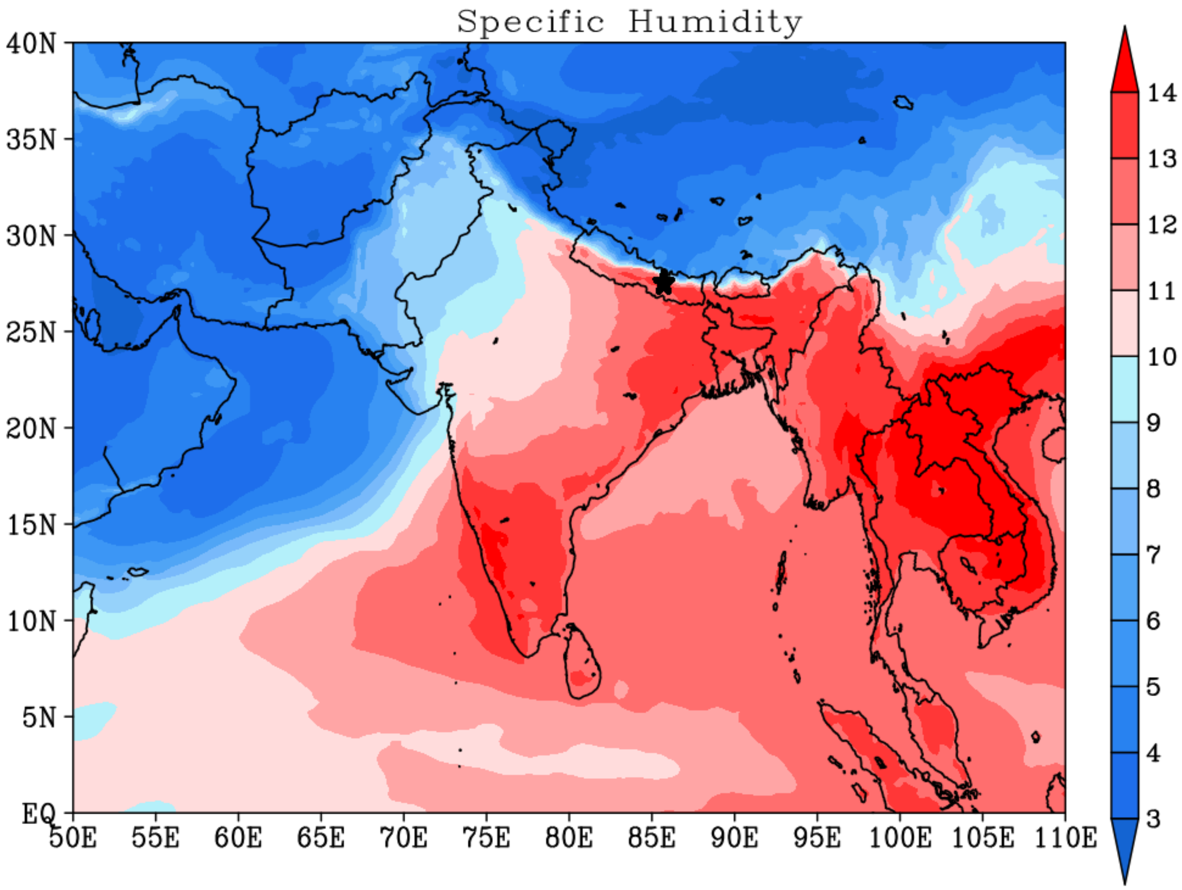

Figure S1 Spatial distribution of specific humidity averaged at 850 hPa (in g kg^{-1}) during the period of study. The black star shows the location of Kathmandu.

S1 Humidity isotope response calibration

Determining isotopic composition with an analyser based on cavity ring-down spectroscopy (CRDS) can introduce an artificial isotopic signal depending on the humidity of the introduced air samples unless the instruments are properly calibrated for humidity (Steen-Larsen et al., 2013). Even for unknown samples, this effect can be corrected if the correction function is determined using vapour with a known isotopic composition. When conducting our humidity-isotope response calibration, we introduced both standard samples at different humidity levels that covered the full range of atmospheric humidity. The instrument exhibits a transient response when switching between humidity levels. Thus, to obtain a reliable humidity-isotope transfer function the duration of this transient response must be excluded from the actual measurement. For this, the flow rate of dry air was kept constant for 25 min at each humidity level and then changed gradually. To overcome any memory effect, we excluded the first 15 minutes of data acquisition from the calculations of the humidity-isotope response function. We also excluded data if the humidity appeared unstable. To remove analyser drift, we chose a reference humidity level from within typical atmospheric humidity ranges. As mentioned earlier, we performed daily measurements of each standard sample at three water vapour concentration levels, using a humidity value of close to 20,000 ppmv as a constant reference humidity level. The raw data were converted to humidity-corrected values by applying the resulting humidity-isotope response functions (Fig. S2).

Raw data collected between 7 May and 15 May 2021 was calibrated using the humidity-isotope response function obtained on 18 April 2021, and data collected from 15 May onwards was calibrated using the humidity-isotope response function obtained on 15 May 2021.

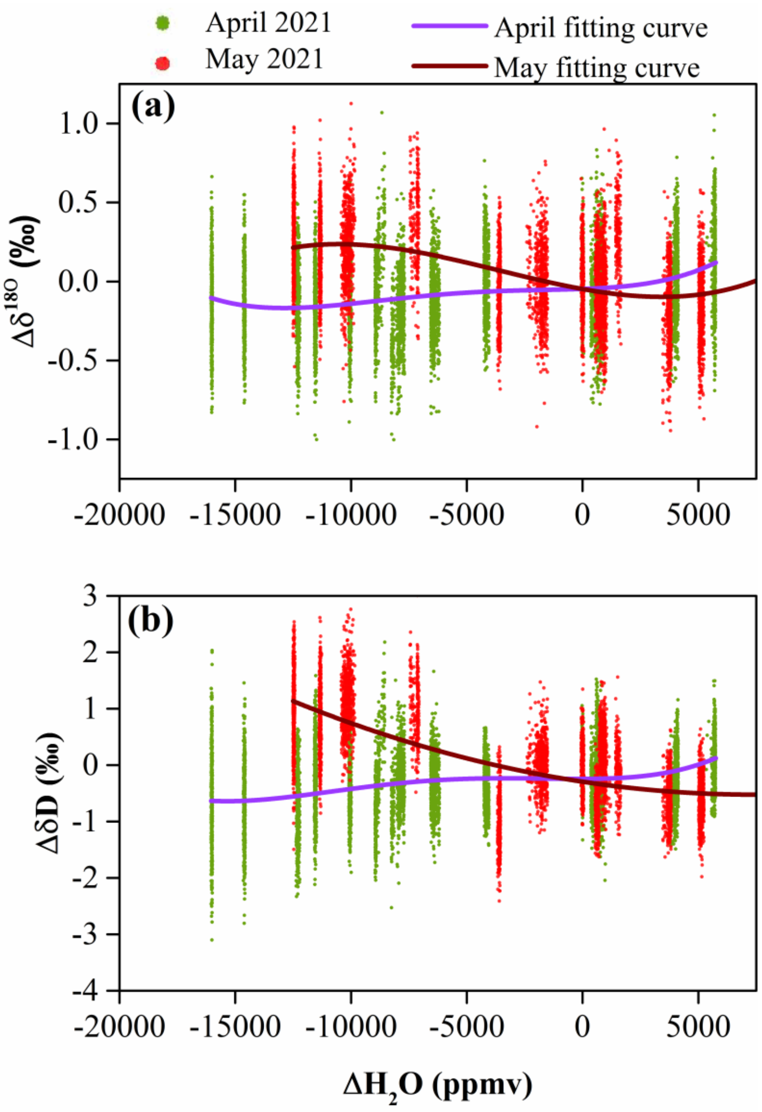

Figure S2 Humidity-isotope response functions of the Picarro analyser for (a) δ^{18}O and (b) δD. The y-axis shows the bias with respect to the mean value measured at the reference humidity level (~20,000 ppmv).

S2 Known standard calibration

To correct instrument bias of measured δ^{18}O and δD values, we used two standards of known isotopic compositions (Std$_1$: δ^{18}O = -29.674 ‰ and δD = -225.827 ‰ and Std$_2$: δ^{18}O = -10.081

‰ and δD = -69.122 ‰) to computed a transfer function and convert the measurement to the international VSMOW scale. Each standard was injected for 25 minutes at three different humidity levels to minimize the memory effect, averaging over the last 15 minutes to obtain the transfer function by applying two-point normalization to the standard and averaged values. The function was assumed to be linear, of the form y=mx+c. We computed the transfer function for each day to convert the humidity-corrected values of $\delta^{18}O$ and δD to VSMOW scale.

Figure S3 shows the data used for the calibration and resulting VSMOW slopes ranging from 0.98 to 1.01 for δD and from 0.99 to 1.03 for $\delta^{18}O$.

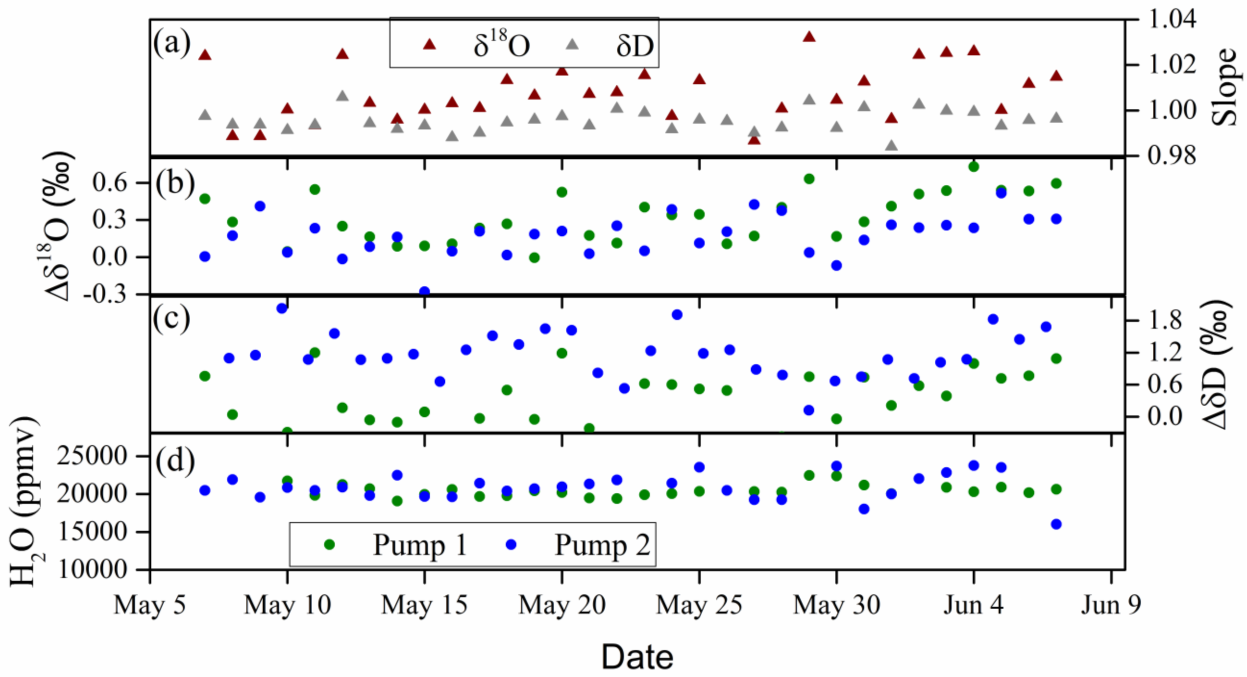

Figure S3 Picarro measurements of known standard samples used for calibration. (a) VSMOW slopes, (b,c) difference between true and measured isotopes ($\delta^{18}O$ and δD) values of standard samples, and (d) reference humidity levels.

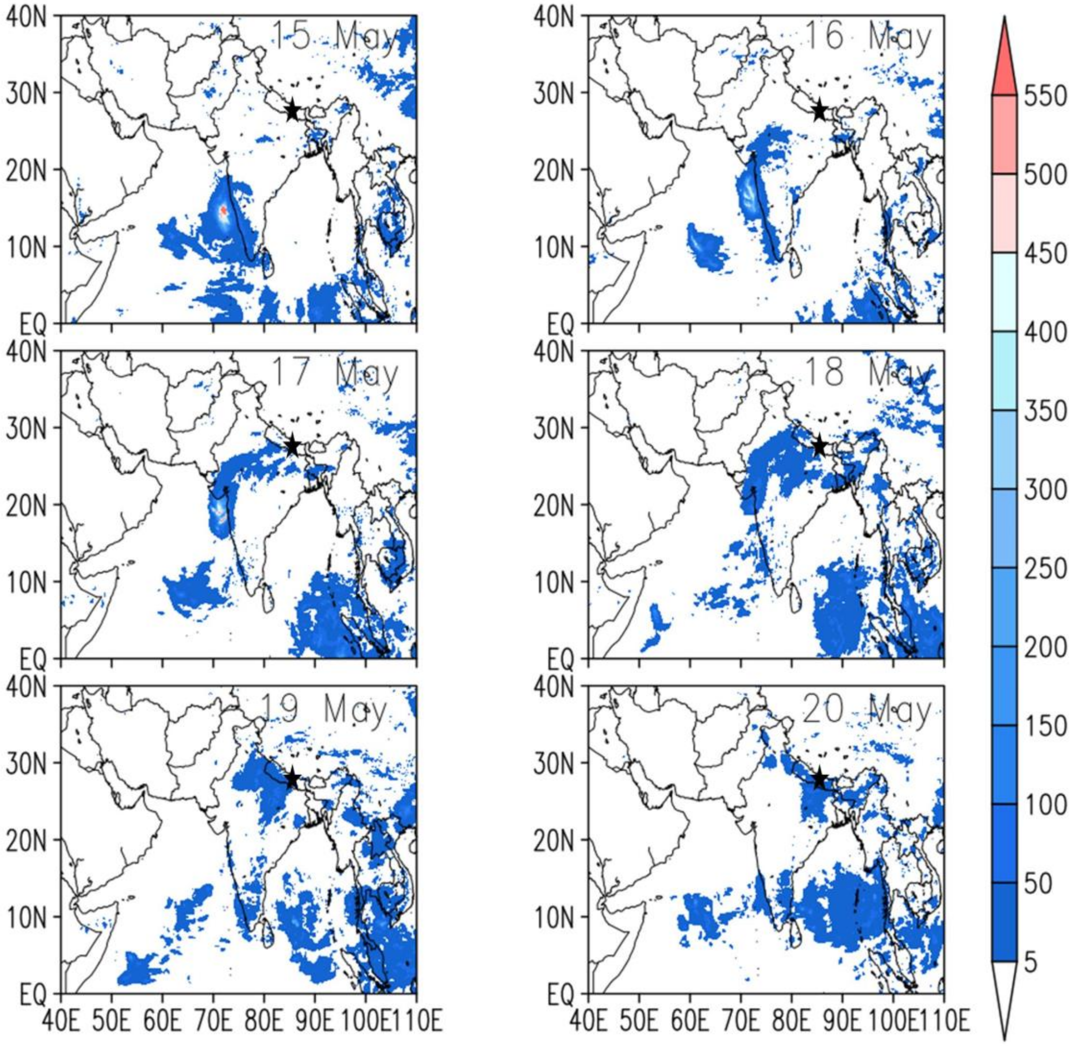

Figure S4 Regional precipitation in millimeters (mm) retrieved from the Integrated Multi-satellite Retrievals for GPM (IMERG) from the Global Precipitation Measurement (GPM) programme during cyclone Tauktae.

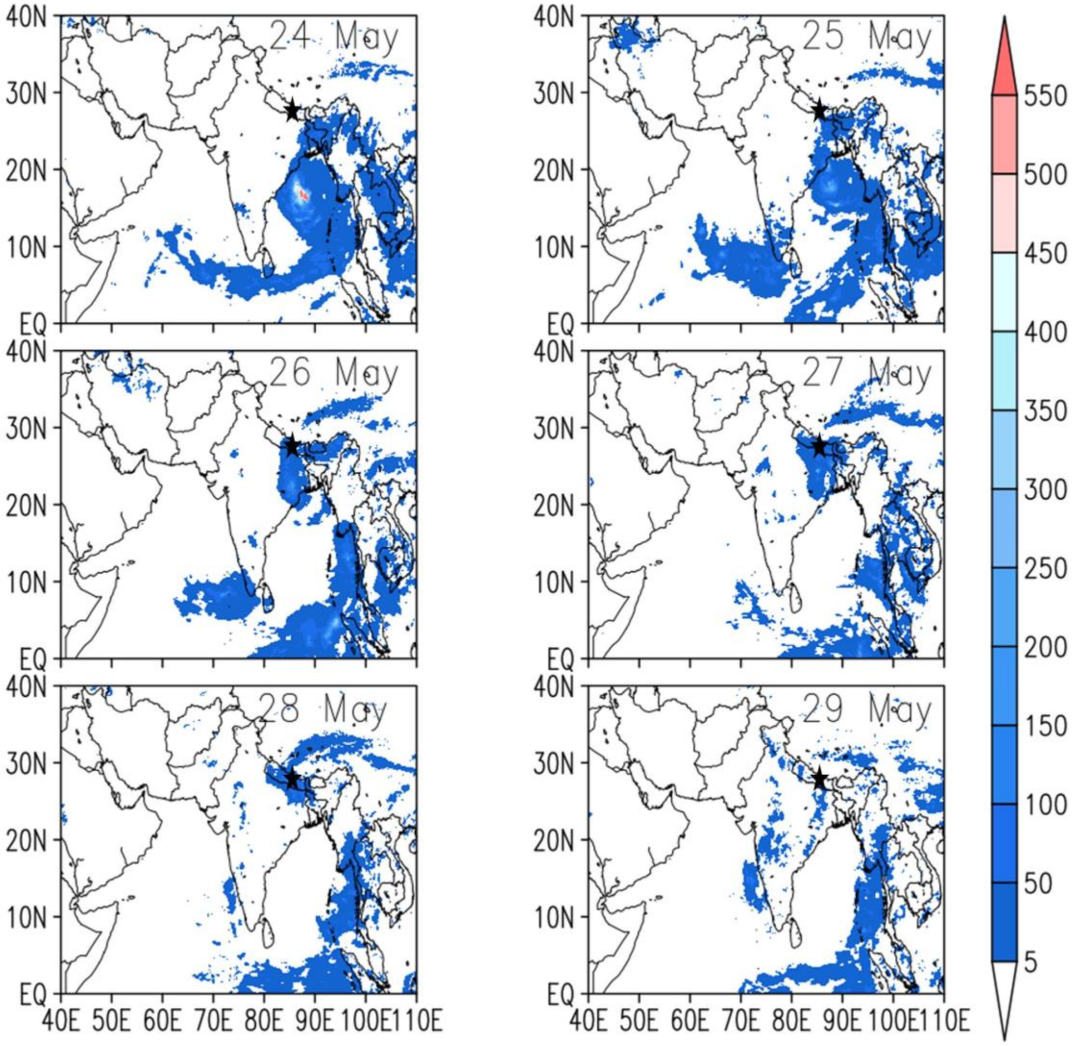

Figure S5 As in Figure S4 but for cyclone Yaas.

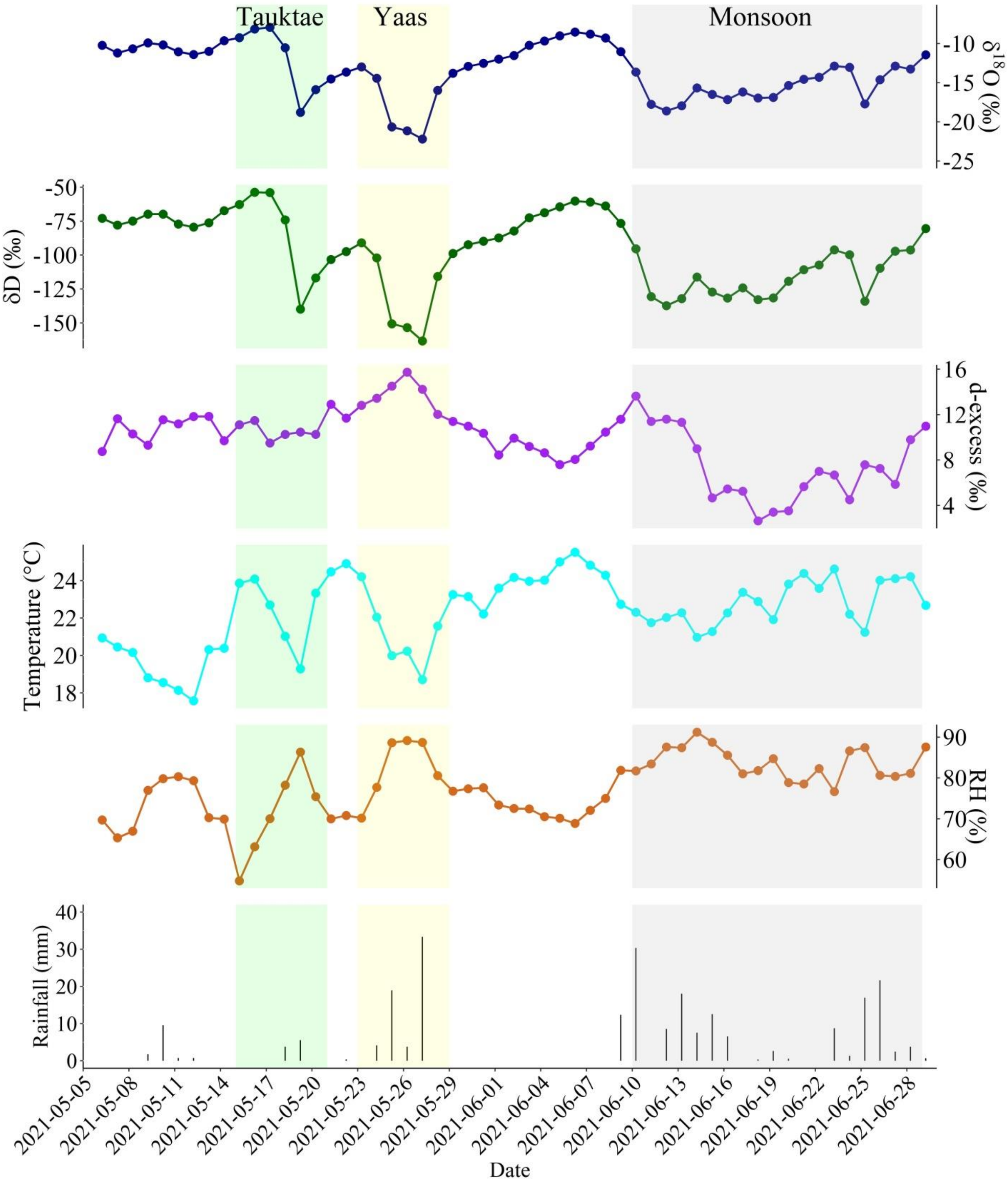

Figure S6 Complete time series of daily average $\delta^{18}O_v$, δD_v, and d-excess$_v$ observed at Kathmandu site from May 07 to June 30 together with surface air temperature, relative humidity, and rainfall amount.

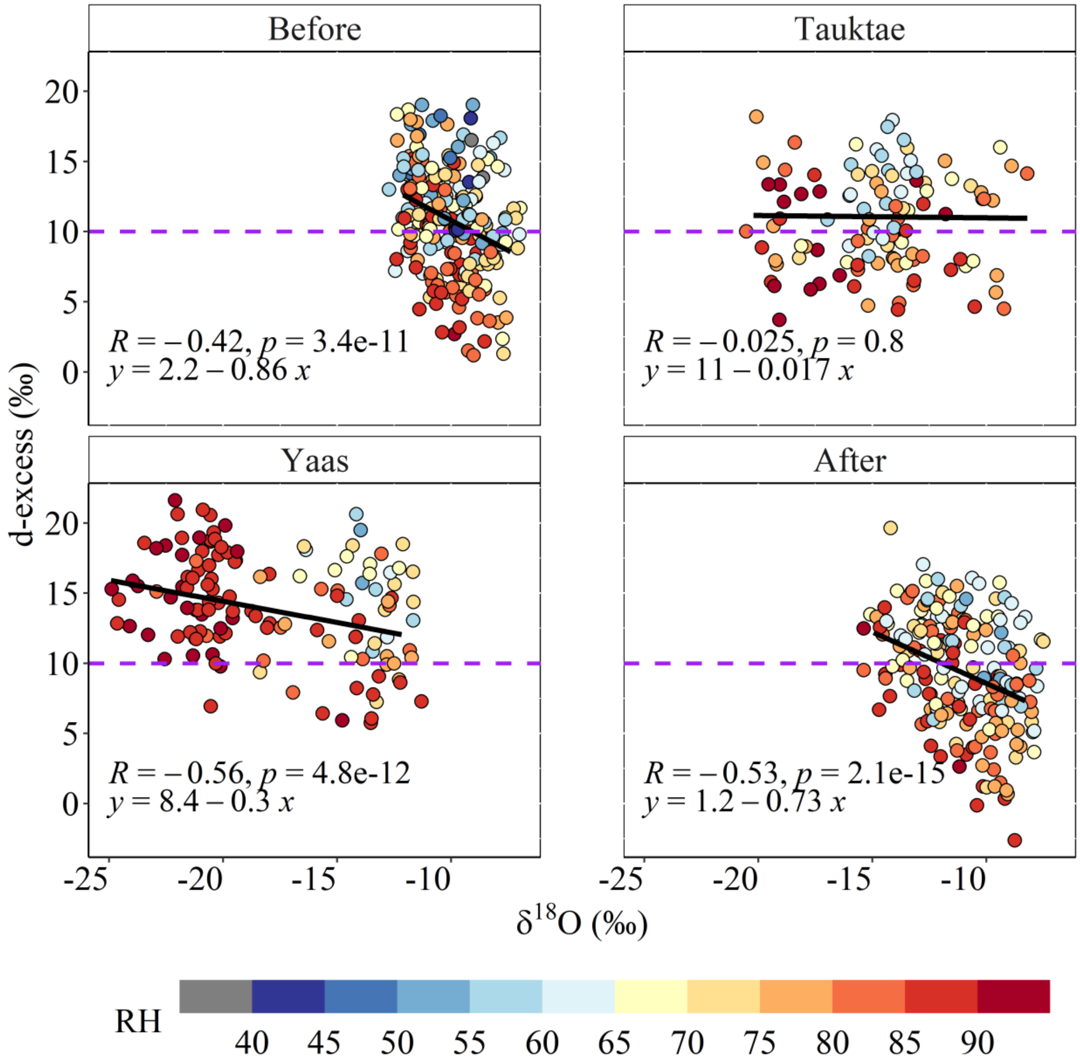

Figure S7 Scatter plots of d-excess$_v$ vs. δ^{18}O$_v$ before, during, and after the cyclone events. The colour represents RH (in %) and the horizontal dashed purple lines represent the global average d-excess value (10 ‰).

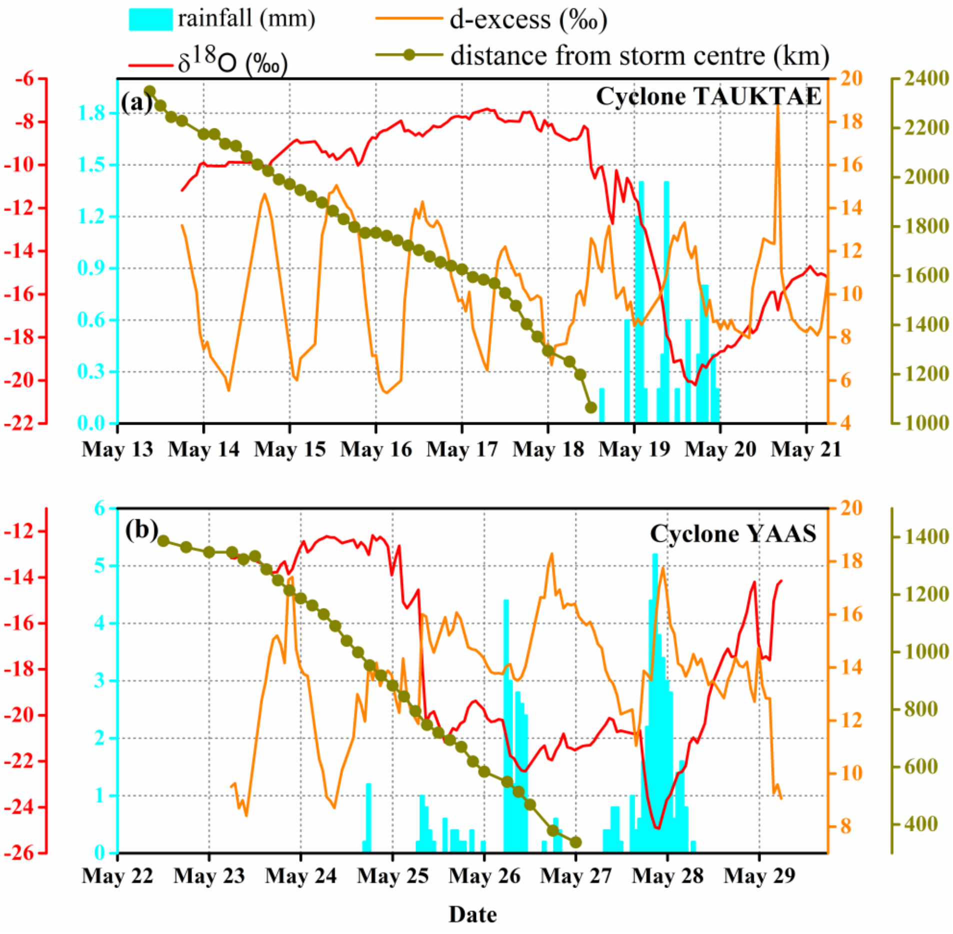

Figure S8 Observed isotopic contents, distance between cyclone eye and sampling site, and related rainfall amount during cyclones Tauktae (a) and Yaas (b).

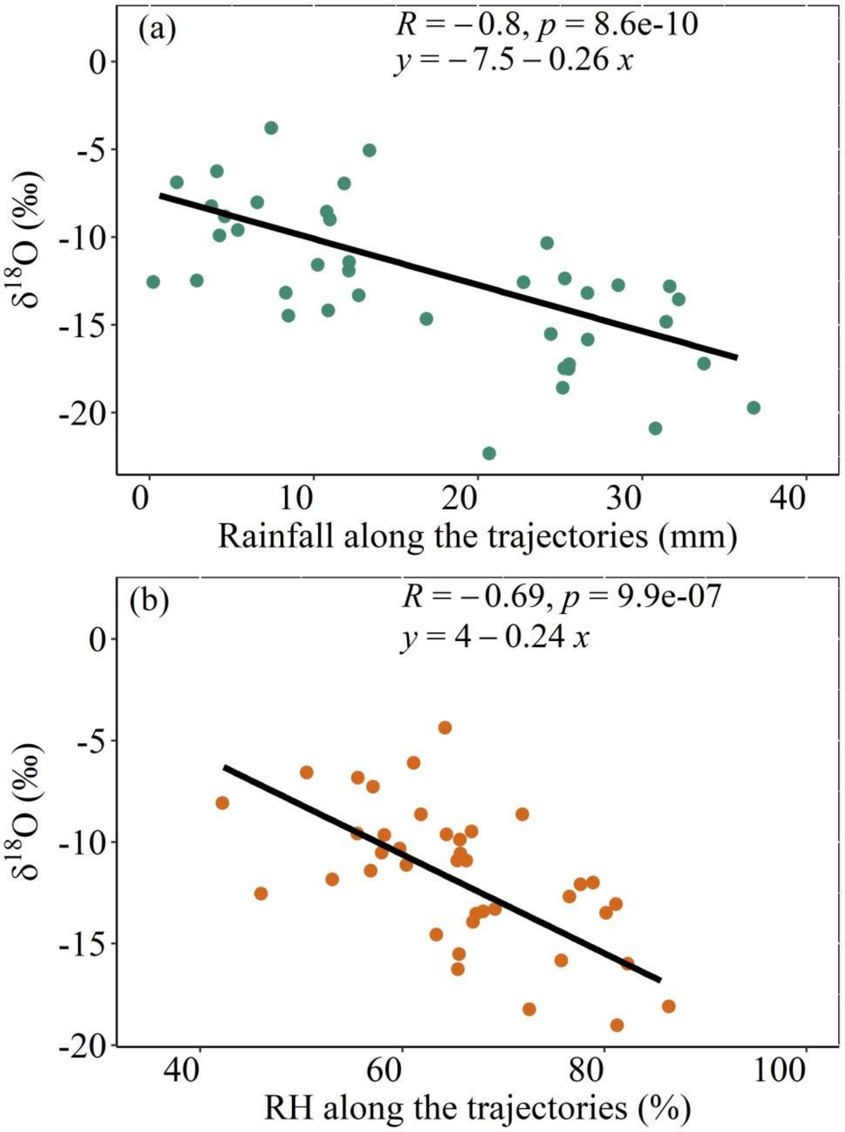

Figure S9 (a) Scatter plots of $\delta^{18}O_v$ vs upstream rainout and (b) average relative humidity (RH) along the moisture trajectories during the cyclone Tauktae.