Supplement of

Modelling the deep convective transport of trace gases (CO, SO_2 and NH_3) from the planetary boundary layer to the Asian summer monsoon anticyclone

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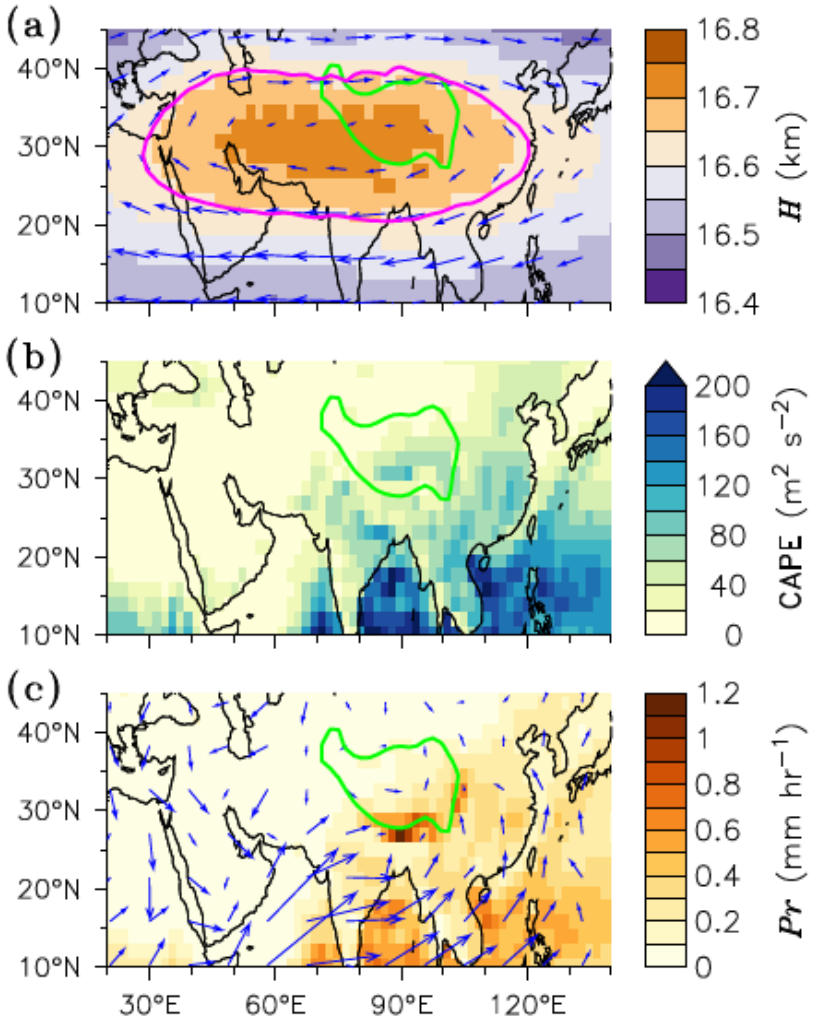

Figure S1. EMAC simulated geopotential height above sea level (*H*) with the wind field overlaid (represented by vectors) at 100 hpa **(a)**, convective available potential energy (CAPE), a metric of the atmospheric instability **(b)**, and precipitation rate (*Pr*) **(c)**, averaged for JJA over the years 2010-2020. The purple line in **(a)** shows the 16.64 km geopotential height contour, highlighting the main anticyclone area. Green lines represent the 3 km terrain-contour height, highlighting the Tibetan Plateau.

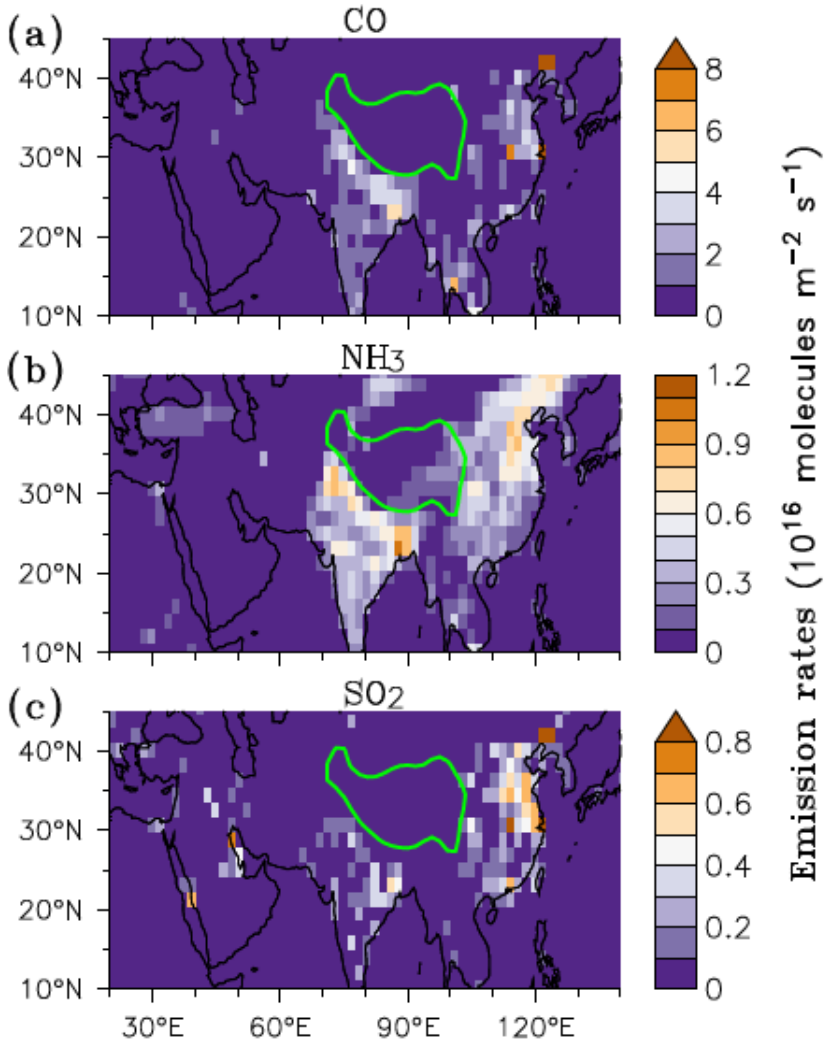

Figure S2. Anthropogenic emission rates of CO **(a)**, NH_3 **(b)** and SO_2 **(c)** near the Earth's surface, averaged for JJA over the years 2010-2020, based on the CAMS emission inventory v4.2 (with a horizontal resolution of 0.5° longitude by 0.5° latitude) and interpolated to the EMAC model grid of T63 (with a horizontal resolution of 1.875° longitude by 1.875° latitude) used for this study. Green lines represent the 3 km terrain contour, highlighting the Tibetan Plateau.

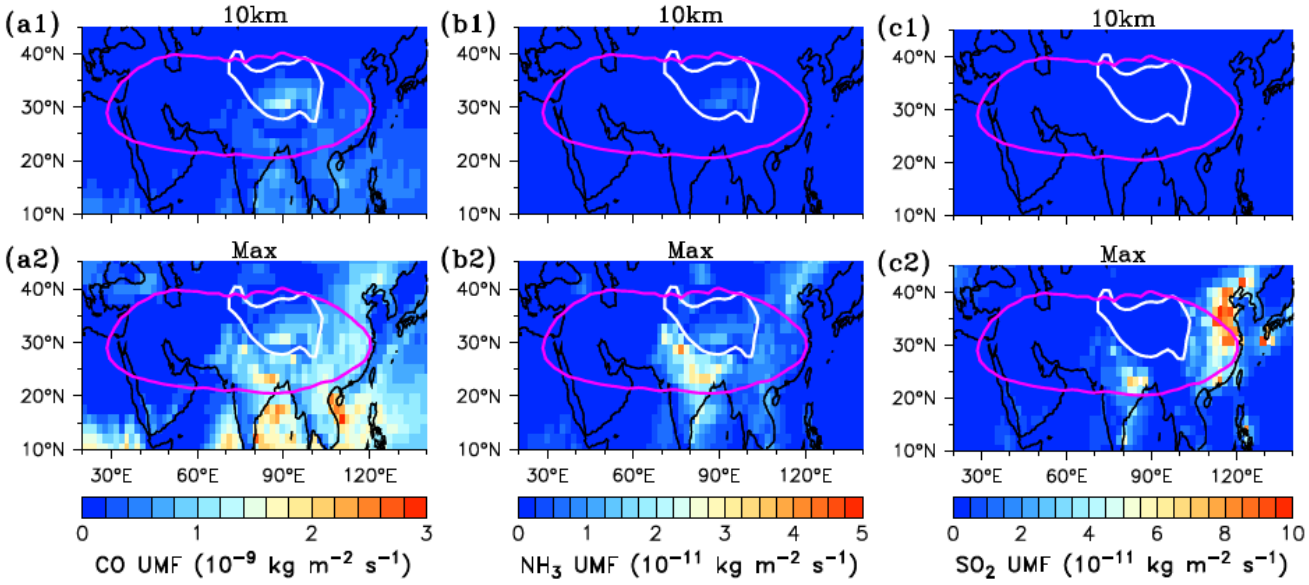

Figure S3. EMAC simulated updraft mass fluxes (UMF) of CO (**a1** and **a2**), NH_3 (**b1** and **b2**) and SO_2 (**c1** and **c2**) at 10 km above the sea level (**a1**, **b1** and **c1**) and their corresponding maximums in the convection column (**a2**, **b2** and **c2**), averaged for JJA over the years 2010-2020. Purple lines are the 16.64 km geopotential height contour at 100 hPa, highlighting the main ASMA area (see Figure S1). White lines represent the 3 km terrain height contour, highlighting the Tibetan Plateau.

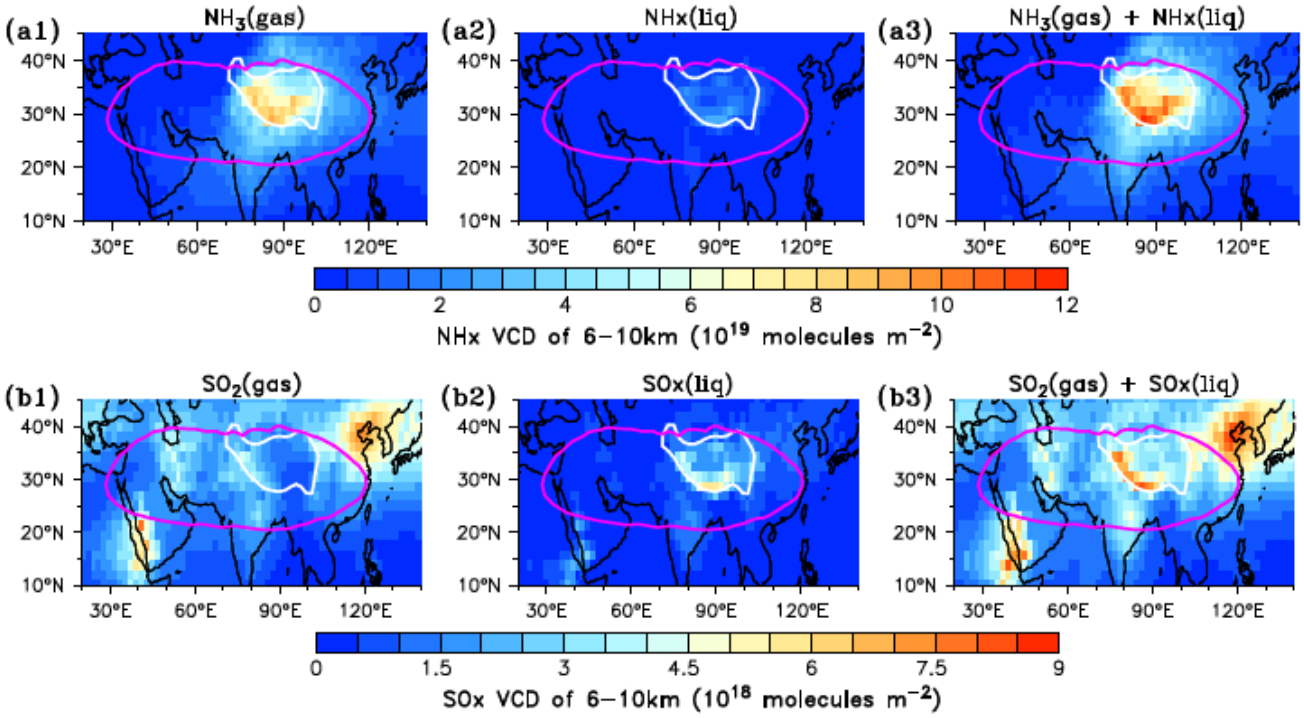

Figure S4. EMAC simulated vertical column densities (VCD) of gas-phase (**a1** and **b1**), liquid-phase (**a2** and **b2**) and gas-plus liquid- phase (**c1** and **c2**) within a height range of 6-10 km above sea level for NH_3 and its reaction products in the clouds (denoted by NHx) (**a1**, **a2** and **a3**) and SO_2 and its reaction products in the clouds (denoted by SOx) (**b1**, **b2** and **b3**), averaged for JJA over the years 2010-2020. Purple lines show the 16.64 km geopotential height contour at 100 hPa, highlighting the main ASMA area (see Figure S1). White lines represent the 3 km terrain height contour, highlighting the Tibetan Plateau. The NHx in the clouds is the sum of liquid ammonia and ammonium, i.e., $NHx(liq) \equiv NH_3(liq) + NH_4^+(liq)$. The SOx in the clouds is the sum of liquid SO_2 and its dissociation and oxidation products (denoted by S(IV, liq) and S(VI, liq)), i.e., $SOx(liq) \equiv S(IV, liq) + S(VI, liq)$, where $S(IV, liq) \equiv SO_2(liq) + HSO_3^-(liq) + SO_3^{2-}(liq)$ and $S(VI, liq) \equiv H_2SO_4(liq) + HSO_4^-(liq) + SO_4^{2-}(liq)$.

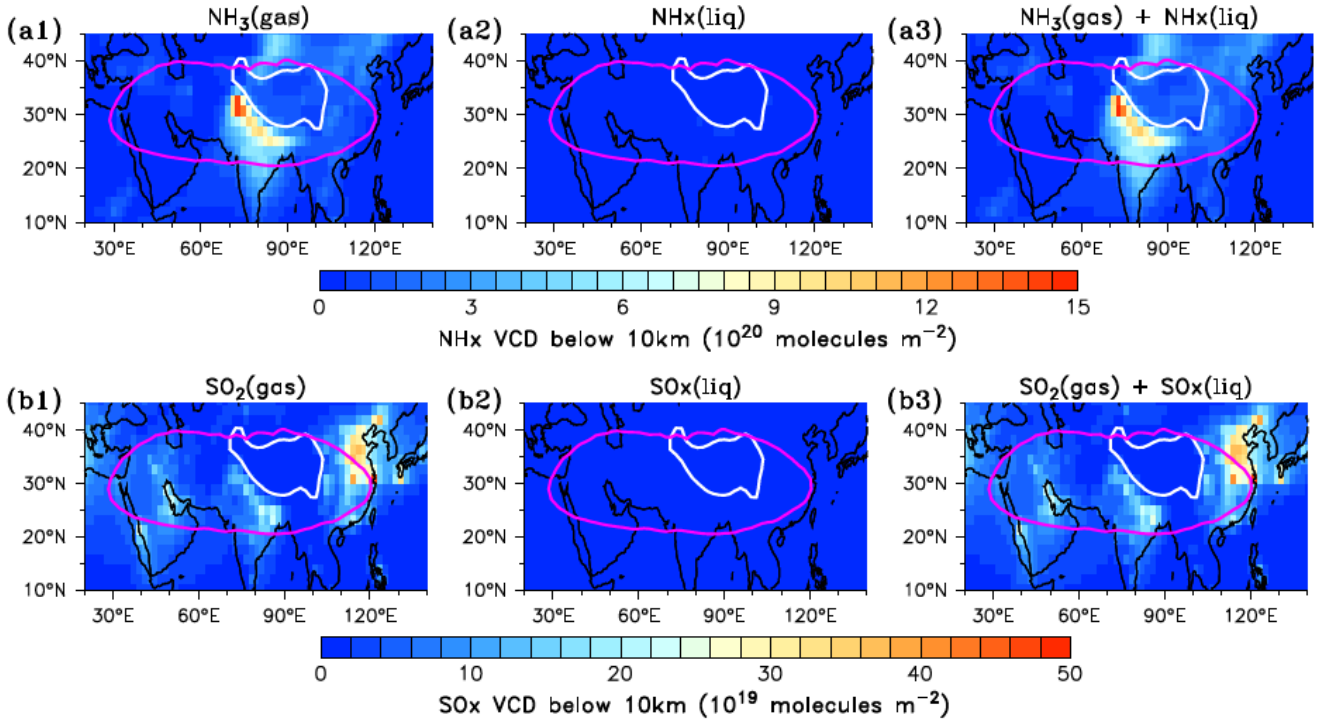

Figure S5. Same as Figure S4, except for a height range from the Earth's surface to 10 km above sea level.