Supplement of The Cryosphere, 20, 1025–1046, 2026
https://doi.org/10.5194/tc-20-1025-2026-supplement

The Cryosphere Open Access EGU

Supplement of

Water vapour isotope anomalies during an atmospheric river event at Dome C, East Antarctica

Niels Dutrievoz et al.

Correspondence to: Niels Dutrievoz (niels.dutrievoz@lsce.ipsl.fr)

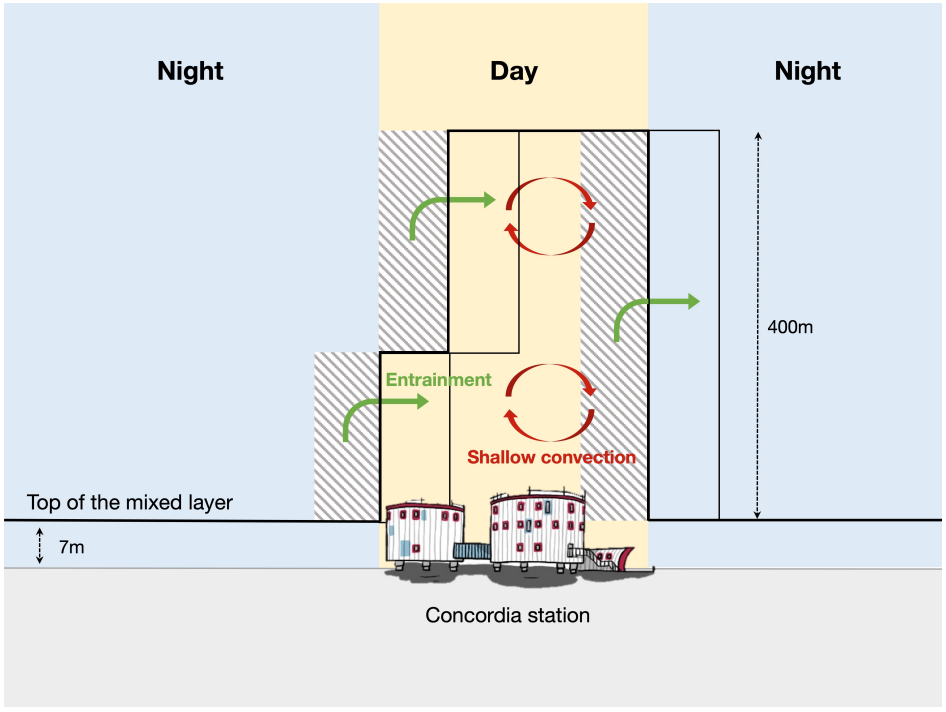

Figure S1. Summary of the entrainment process mechanism, indicated by green arrows. The thick black line represents the variable-height mixed layer, while the red arrows correspond to shallow convection. The blue background indicates nighttime periods, whereas the yellow background represents daytime periods.

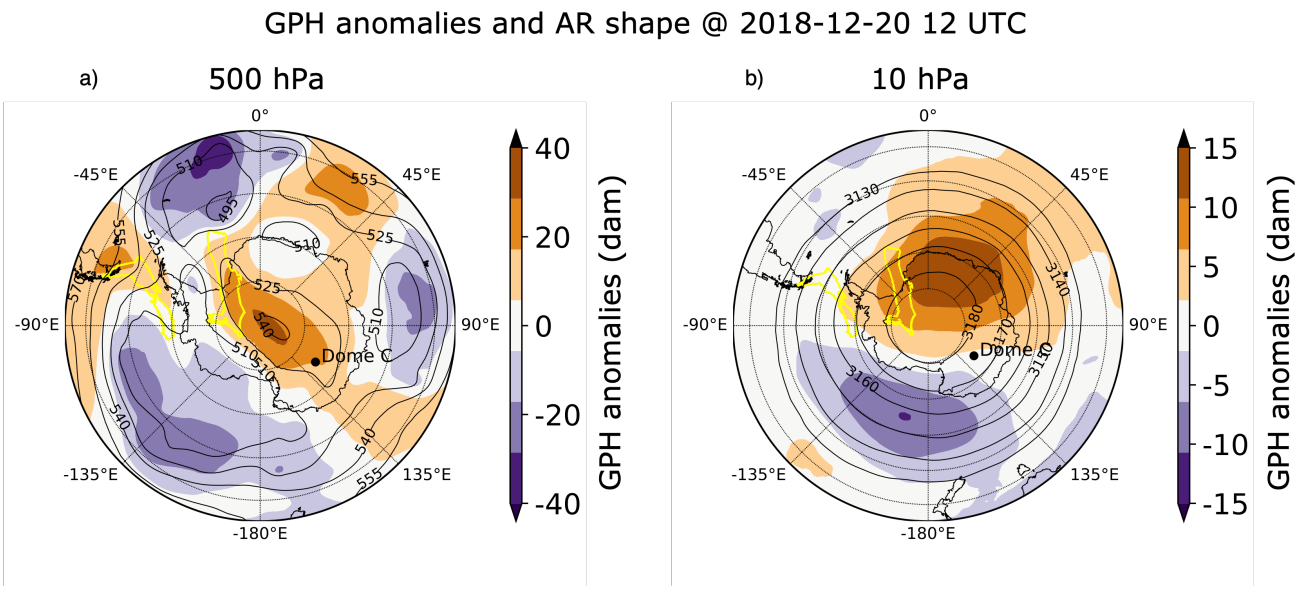

Figure S2. MERRA-2 geopotential height anomalies for 2018-12-20 12:00 UTC at (a) 500 hPa and (b) 10 hPa. Monthly anomalies are with respect to the corresponding 1980-2018 monthly mean. The yellow outlines corresponds with the atmospheric rivers detected using the IWV AR detection scheme.

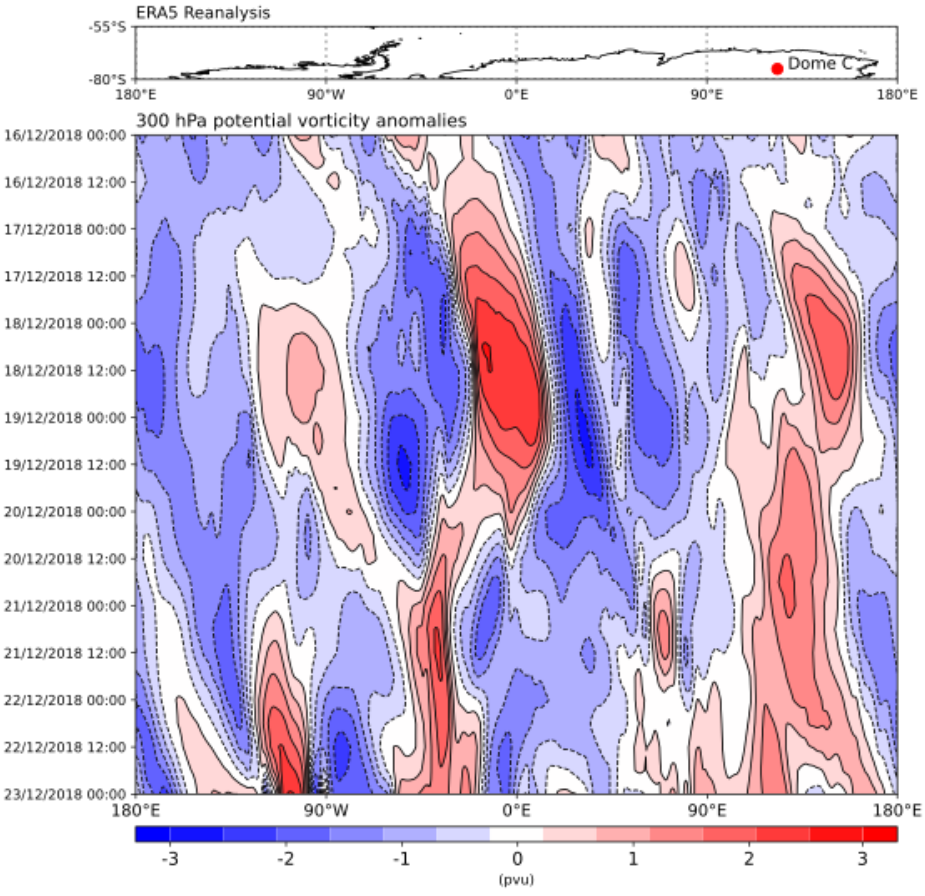

Figure S3. Hovmoller diagram showing 300 hPa potential vorticity anomalies from 2018-12-16 00:00 UTC - 2018-12-23 00:00 UTC with values averaged between 55 °- 80 °S. Monthly anomalies are with respect to the corresponding 1980-2020 monthly mean.

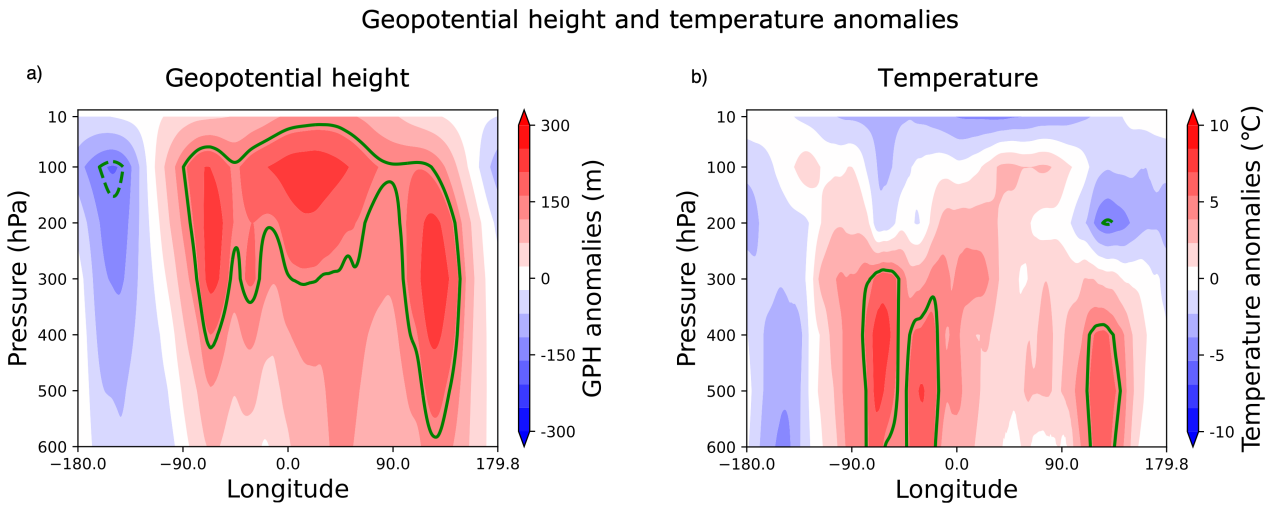

Figure S4. MERRA-2 (a) geopotential height (m) and (b) temperature anomalies (°C) over the Antarctic continent from 10 - 600 hPa averaged between 55 ° - 90 °S. Solid green lines denote anomalies exceeding a) 150 m and b) 5 °C. Monthly anomalies are with respect to the corresponding 1980-2018 monthly mean.

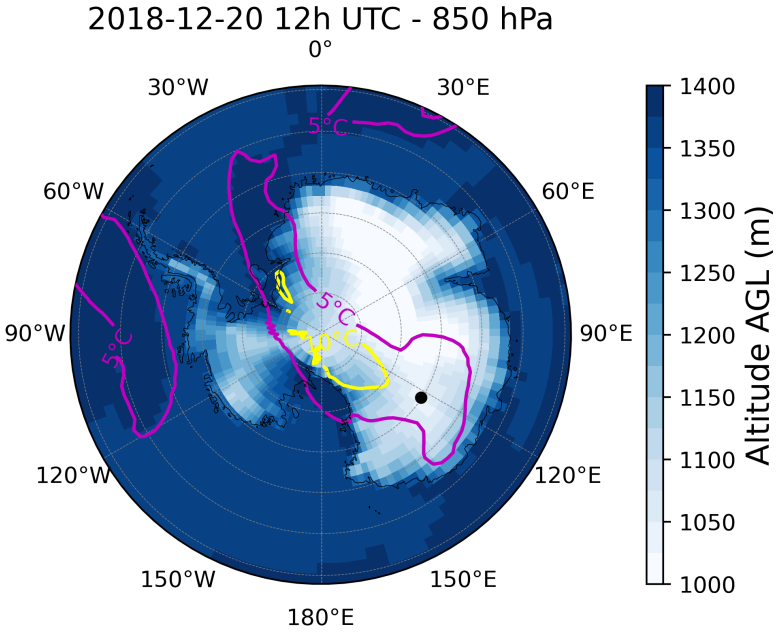

Figure S5. Altitude above the surface (m), corresponding to the model-equivalent 850 hPa level from LMDZ6iso.

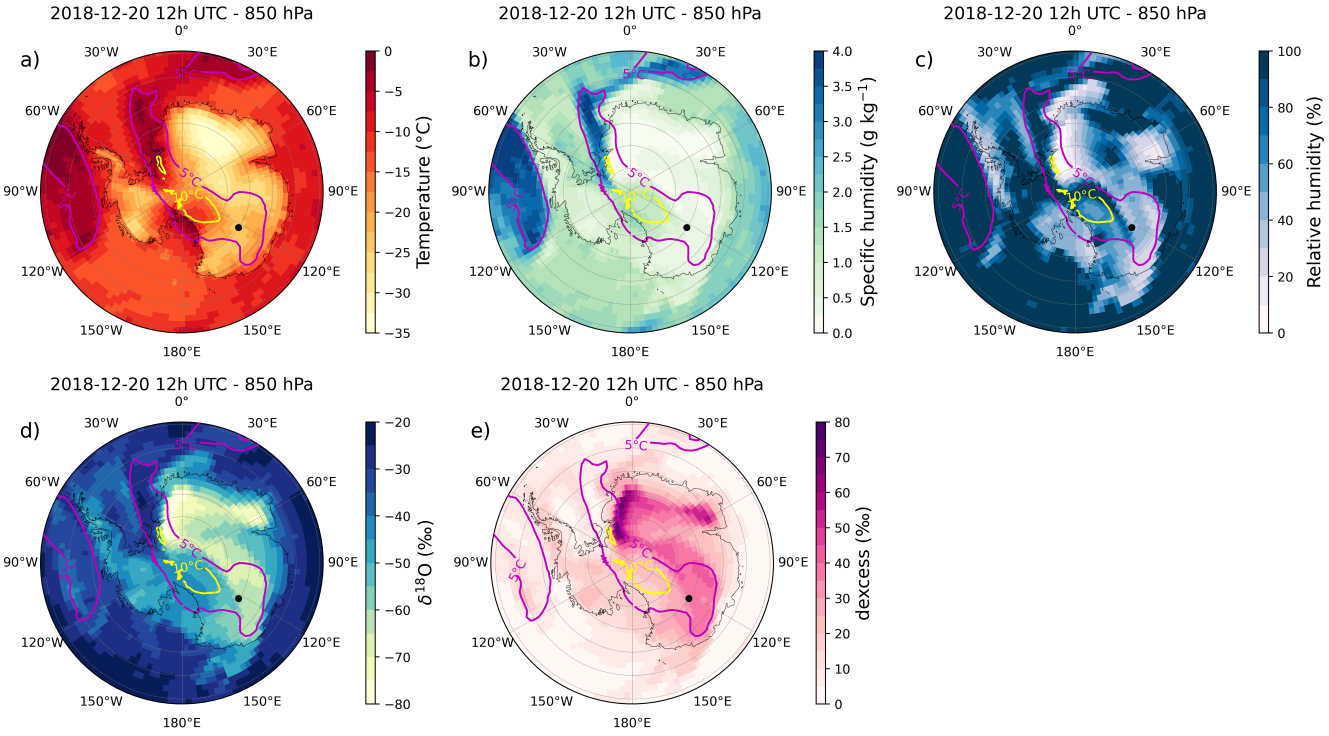

Figure S6. (a) Temperature (°C), (b) specific humidity (g kg^{-1}), (c) relative humidity (%), (d) $\delta^{18}O$ (‰), and (e) d-excess (‰), calculated on 20 December 2018 at 12:00 UTC at the model level equivalent to 850 hPa above sea level. The purple contour represents the 5 °C anomaly boundary, while the yellow contour indicates the 10 °C anomaly boundary. The black dot indicates Concordia station. The altitude above the surface corresponding to the model-equivalent 850 hPa level in LMDZ6iso is shown in Figure S5 (around 1000 m AGL over the ice sheet).

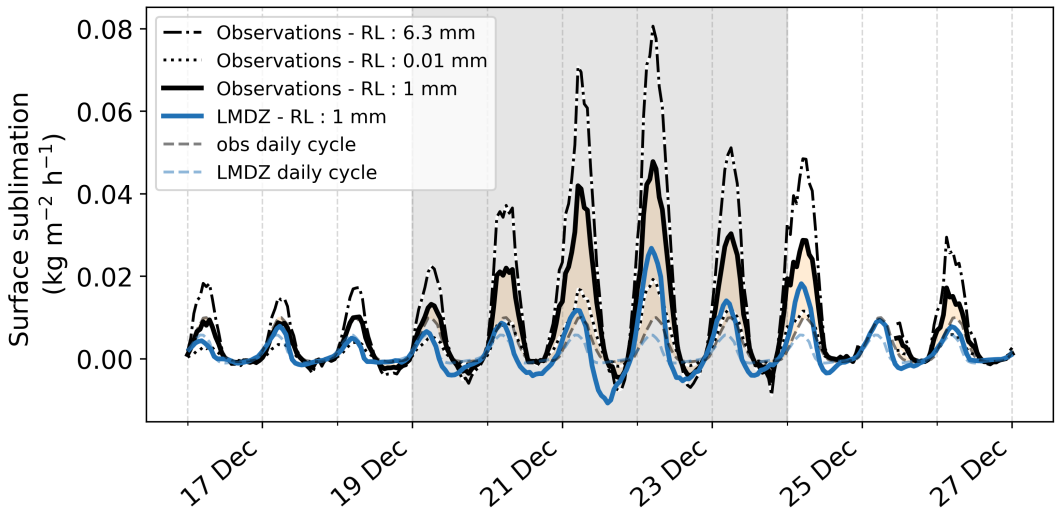

Figure S7. Water vapour flux at Dome C during December 2018 (positive for sublimation, negative for condensation) from observations (black lines) and model simulations (blue line). The solid black line corresponds to the reference configuration, using the H88 stability function with a roughness length $z_0 = 1\,\mathrm{mm}$ (default value in LMDZ). The black broken lines show sensitivity tests with $z_0 = 0.01\,\mathrm{mm}$ (dotted line) and $z_0 = 6.3\,\mathrm{mm}$ (dashdot line). The grey rectangle indicates the period of the AR. The grey and blue dashed lines represent the mean diurnal cycle calculated over the entire month of December 2018 excluding the event (December 19-23), for observations and the model, respectively. The orange shading indicates the difference between the mean clear-sky diurnal cycle and the observations during the event.

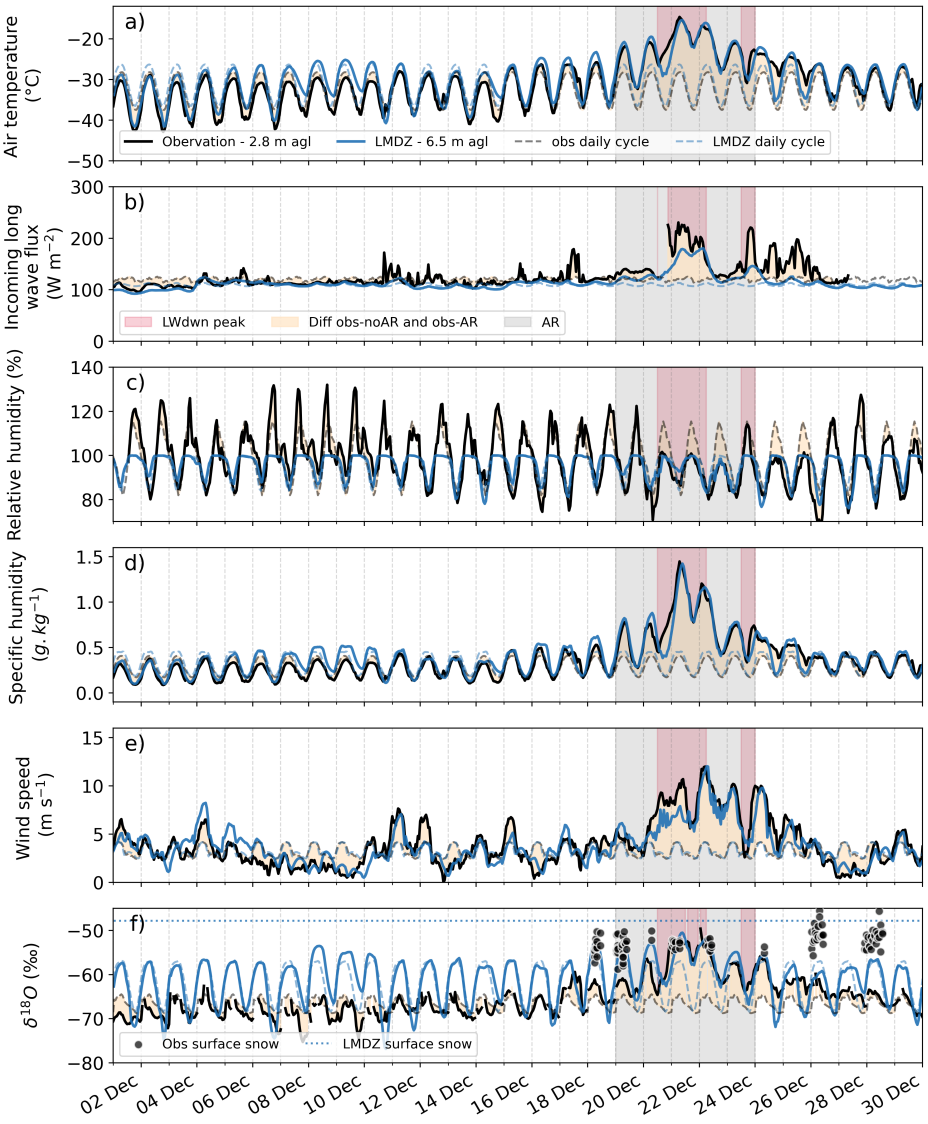

Figure S8. Evolution of (a) air temperature (°C) from the first level of the Concordia meteorological tower (2.8 m AGL), (b) incoming longwave flux from the Baseline Surface Radiation Network, (c) relative humidity with respect to ice (%), (d) specific humidity (g kg^{-1}), (e) wind speed (m s^{-1}) from the first level of the Concordia meteorological tower and (f) $\delta^{18}O$ (‰) from the Concordia Picarro instrument (2.0 m AGL). The grey rectangle indicates the period of the AR. The blue line represents the model output (first level: 6.7 m AGL), while the black line corresponds to the observations. The grey and blue dashed lines represent the mean diurnal cycle calculated over the entire month of December 2018 excluding the event (December 19-23), for observations and the model, respectively. The orange shading indicates the difference between the mean clear-sky diurnal cycle and the observations during the event, while the red shading highlights the peaks in downward longwave radiation. Observed surface snow is shown as black dots, while modelled surface snow is represented by a dashed line.

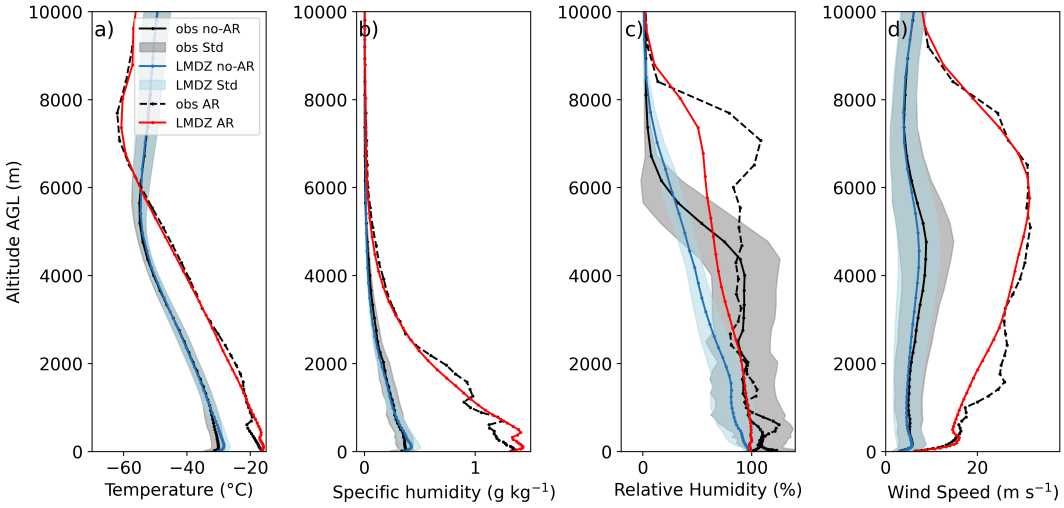

Figure S9. Vertical profiles of (a) temperature (°C), (b) specific humidity (g kg^{-1}), (c) relative humidity with respect to ice (%) and (d) wind speed (m s^{-1}) from the surface to 10 000 m AGL, based on average radiosonde measurements at the Concordia station during December 2018 (twice per day, black solid lines) and during the AR event (21 December 2018 at 11:00 UTC, black dashed lines). Corresponding LMDZ model output at the nearest grid point for the same times are shown in blue lines (December averages) and red lines (AR event). The standard deviation is shown in gray for observations and in blue for LMDZ for 52 radiosondes during December 2018 outside the AR event.

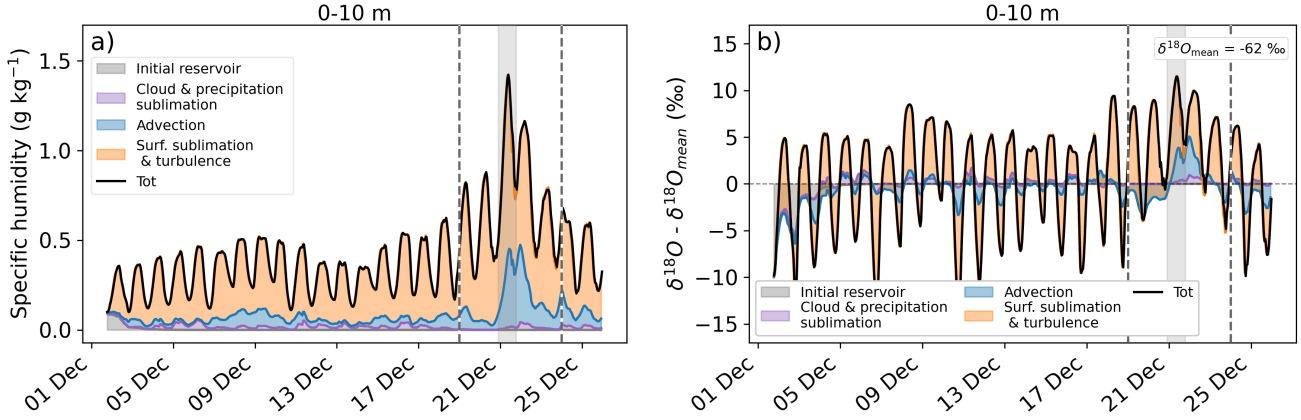

Figure S10. (a) Temporal evolution of the positive contributions of different processes to the surface specific humidity (6.7 m AGL) during December 2018. (b) Anomaly of the positive contributions of different processes to the surface δ^{18}O signal relative to the mean δ^{18}O during the diurnal cycle during December 2018 ($\delta^{18}O_{mean}$ = -62 ‰). The black line represents the signal obtained from total specific humidity and δ^{18}O. Individual contributions to specific humidity and δ^{18}O are shown in colour: orange for surface sublimation and vertical turbulent diffusion, blue for advection, and purple for cloud and precipitation sublimation. Vertical dashed lines mark the AR period (December 19-23), while the shaded area highlights the peak of the event, reached on December 21 at 09:30 UTC.

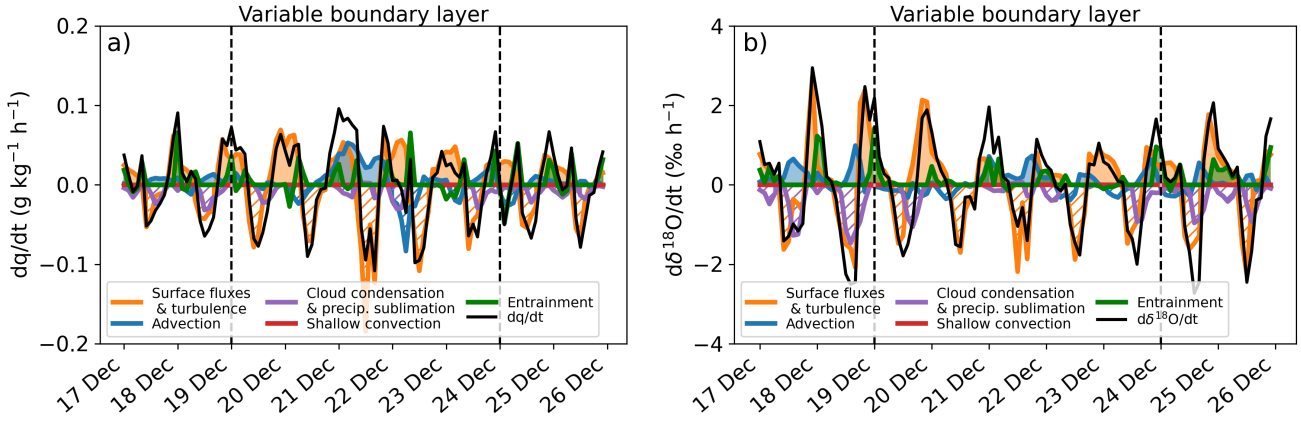

Figure S11. Rate of temporal change of the different processes contributing to the (a) specific humidity tendency (g kg^{-1} h^{-1}) and (b) vapour δ^{18}O tendency (‰ h^{-1}) in the mixed layer at Concordia station. The black line represents the signal obtained from the model output. The individual contributions to the rate of change of humidity and δ^{18}O are shown in colour: orange for vertical turbulent diffusion and surface sublimation, blue for advection, purple for cloud condensation and precipitation sublimation, red for shallow convection and green for mixing. Processes with positive contributions are shown in solid colours, whereas processes with negative contributions are shown using hatched shading. It should be noted that the sign of changes is relative to water vapour so the surface sublimation is positive (increase in water vapour) and the cloud condensation is negative (decrease in water vapour).

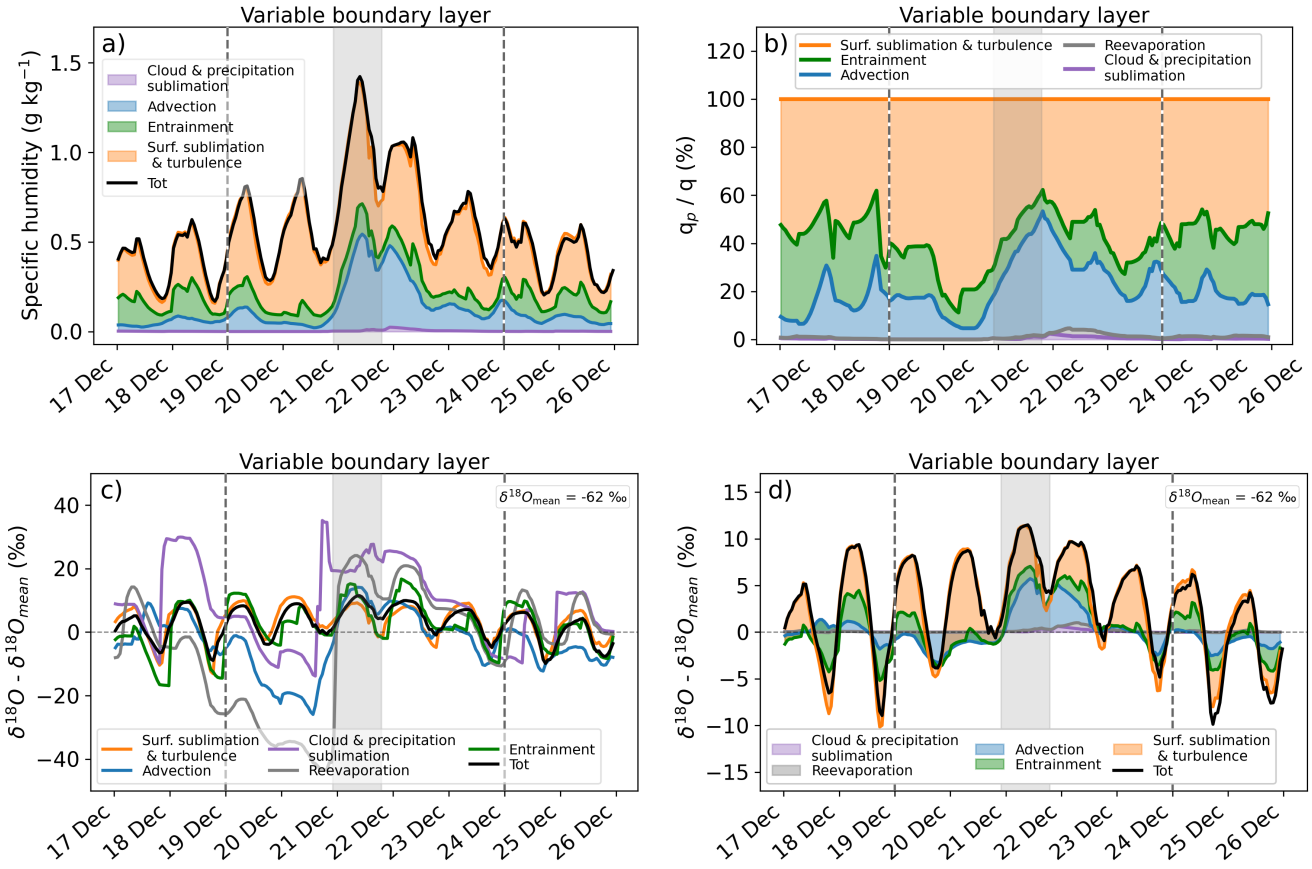

Figure S12. (a) Temporal evolution of the positive contributions of different processes to the specific humidity in the mixed layer and (b) their respective percentages. (c) Evolution of the δ^{18}O anomaly relative to the mean clear-sky diurnal cycle value ($\delta^{18}O_{mean}$ = –62 ‰), associated with different processes. (d) Positive contributions of different processes to the surface δ^{18}O anomaly relative to this mean diurnal value (d). The black line represents the signal obtained from the model output. Individual contributions to specific humidity and δ^{18}O are shown in colour: orange for vertical turbulent diffusion and surface sublimation, blue for advection, and purple for cloud condensation and precipitation sublimation. Vertical dashed lines mark the AR period (December 19-23), while the shaded area highlights the peak of the event, reached on December 21 at 09:30 UTC.

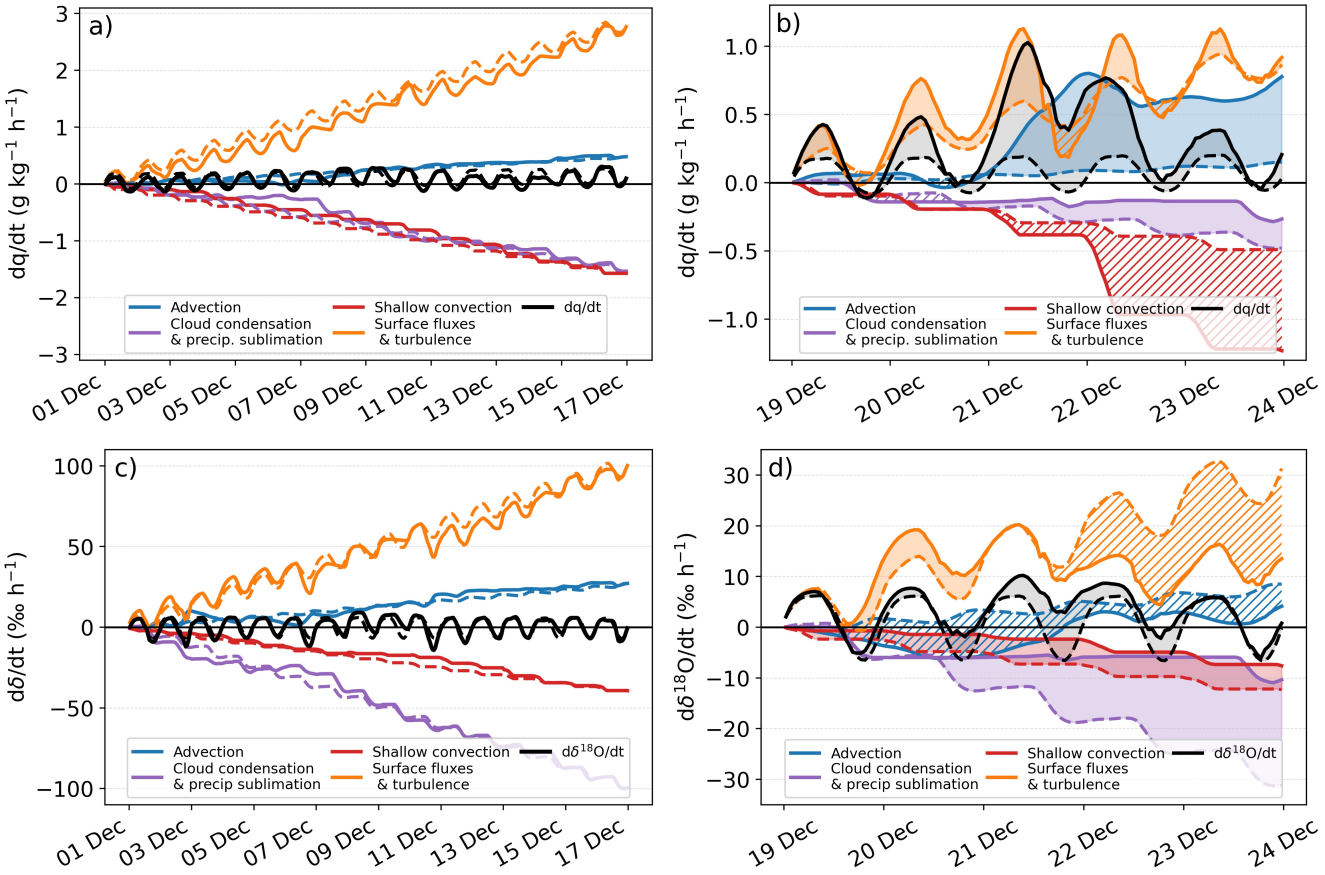

Figure S13. Temporal evolution of (a) water vapour tendency (g kg^{-1} h^{-1}) and (c) δ^{18}O tendency (‰ h^{-1}), each associated with their respective contributing processes at the surface during the unperturbed diurnal cycle (1-17 December). Temporal evolution of (b) the water vapour anomaly and (d) the δ^{18}O anomaly, each associated with their respective contributing processes during the AR event (19-24 December), relative to the unperturbed period. Individual contributions to specific humidity and δ^{18}O are shown in colour: orange for vertical turbulent diffusion and surface sublimation, blue for advection, red for shallow convection, and purple for cloud condensation and precipitation sublimation. Dashed curves represent the mean cumulative diurnal cycles. Uniformly coloured areas indicate periods of positive process anomalies relative to the mean diurnal cycle, while hatched areas indicate periods of negative anomalies.