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Supplement of

In situ observations of supercooled liquid water clouds over Dome C, Antarctica, by balloon-borne sondes

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The information regarding all the flights are presented in this document. This encompasses: 1) the LWP values from HAMSTRAD and the SLW cloud heights from the LIDAR over one day, 2) the vertical profiles of temperature, potential temperature and relative humidity measured by the PTU sonde during the flights, and 3) the vertical profiles of the SLWC sonde frequency *f*, the derivative of the frequency with respect to time t (df/dt) and the calculated SLWC during the flights.

1. LWP vs. SLW clouds

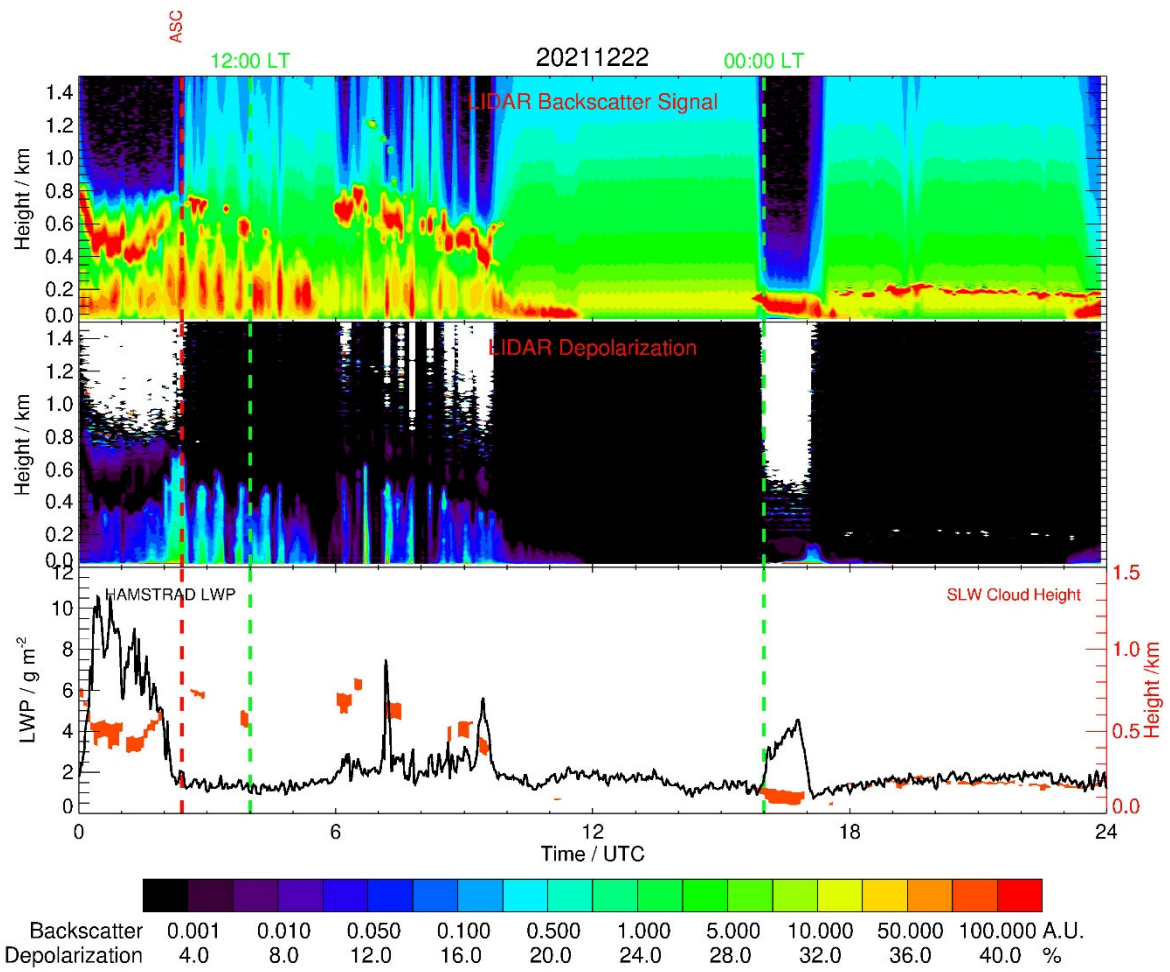

Figure S1: Diurnal variation on 22 December 2021 (UTC Time) of: (Top) the profile of the LIDAR backscatter signal (A.U., Arbitrary Unit); (Center) the profile of the LIDAR depolarization ratio (%); (Bottom) the Liquid Water Path (LWP) measured by HAMSTRAD (g

m^{-2}, black solid line) superimposed with the SLW cloud thickness (red area) derived from the LIDAR observations (red y-axis on the right). Two vertical green dashed lines indicate 12:00 and 00:00 LT. The thick red vertical dashed lines indicate the time when balloon observations with SLWC sondes were performed in ascending (ASC) or descending (DES) phase while the thin red vertical solid line indicates the launch time of the balloon for which observations in the descending phase were performed.

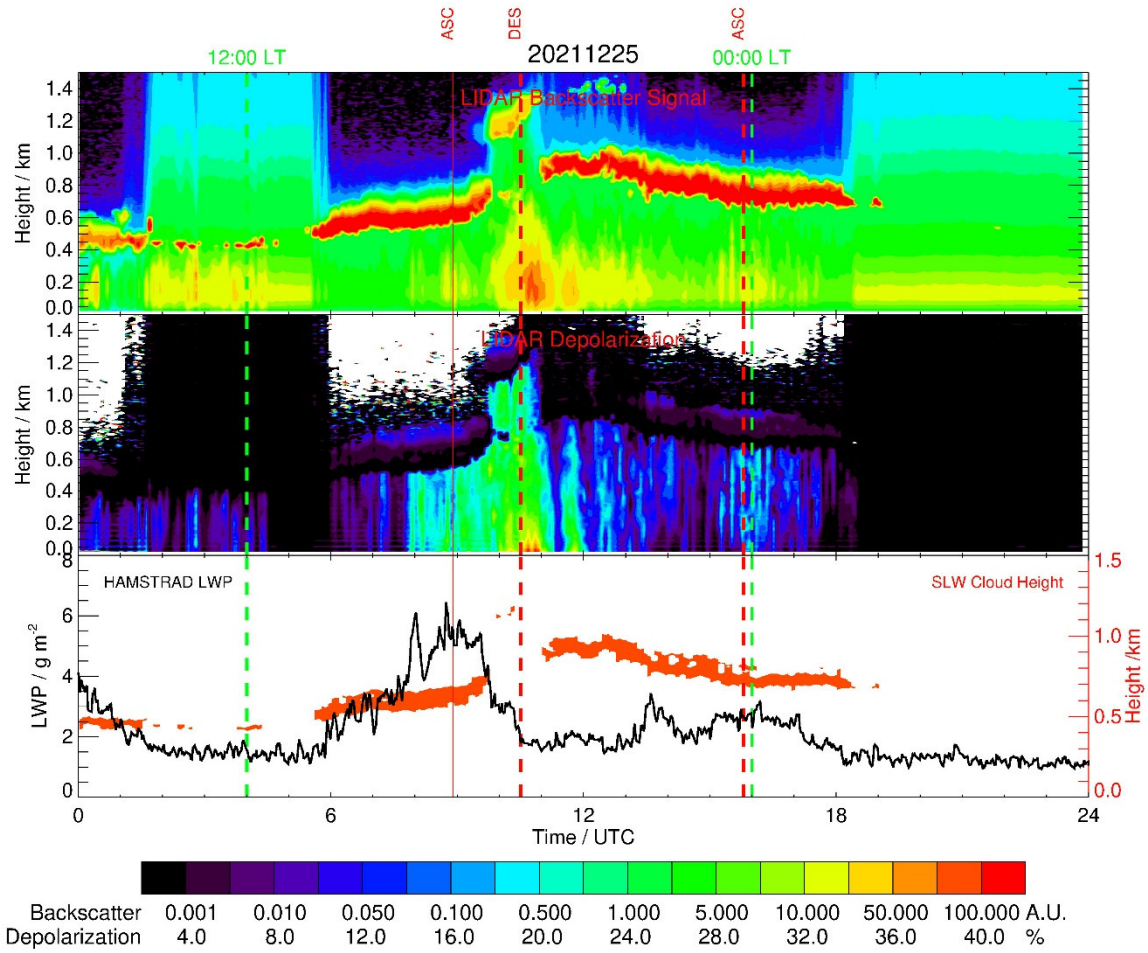

Figure S2: Same as Figure S1 but for 25 December 2021.

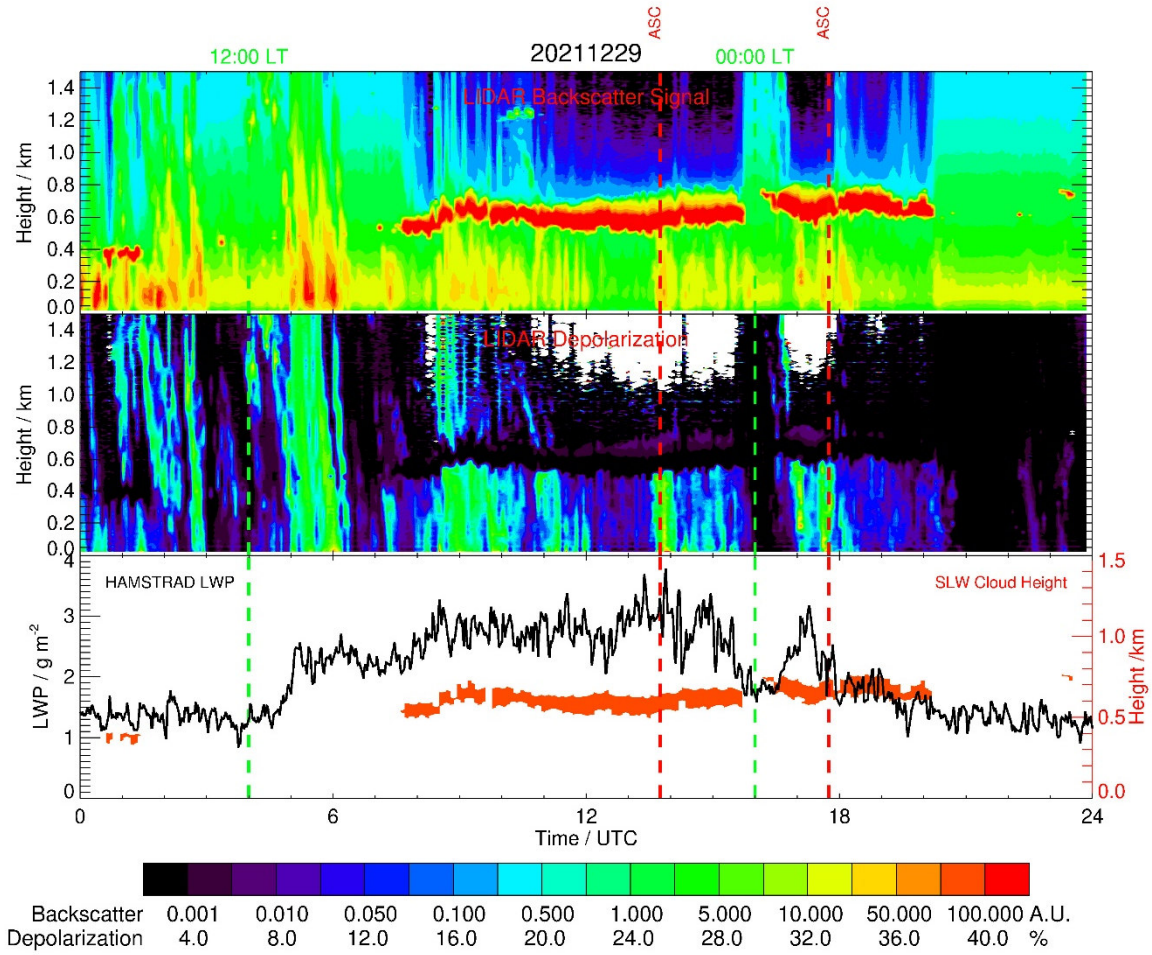

Figure S3: Same as Figure S1, but for 29 December 2021.

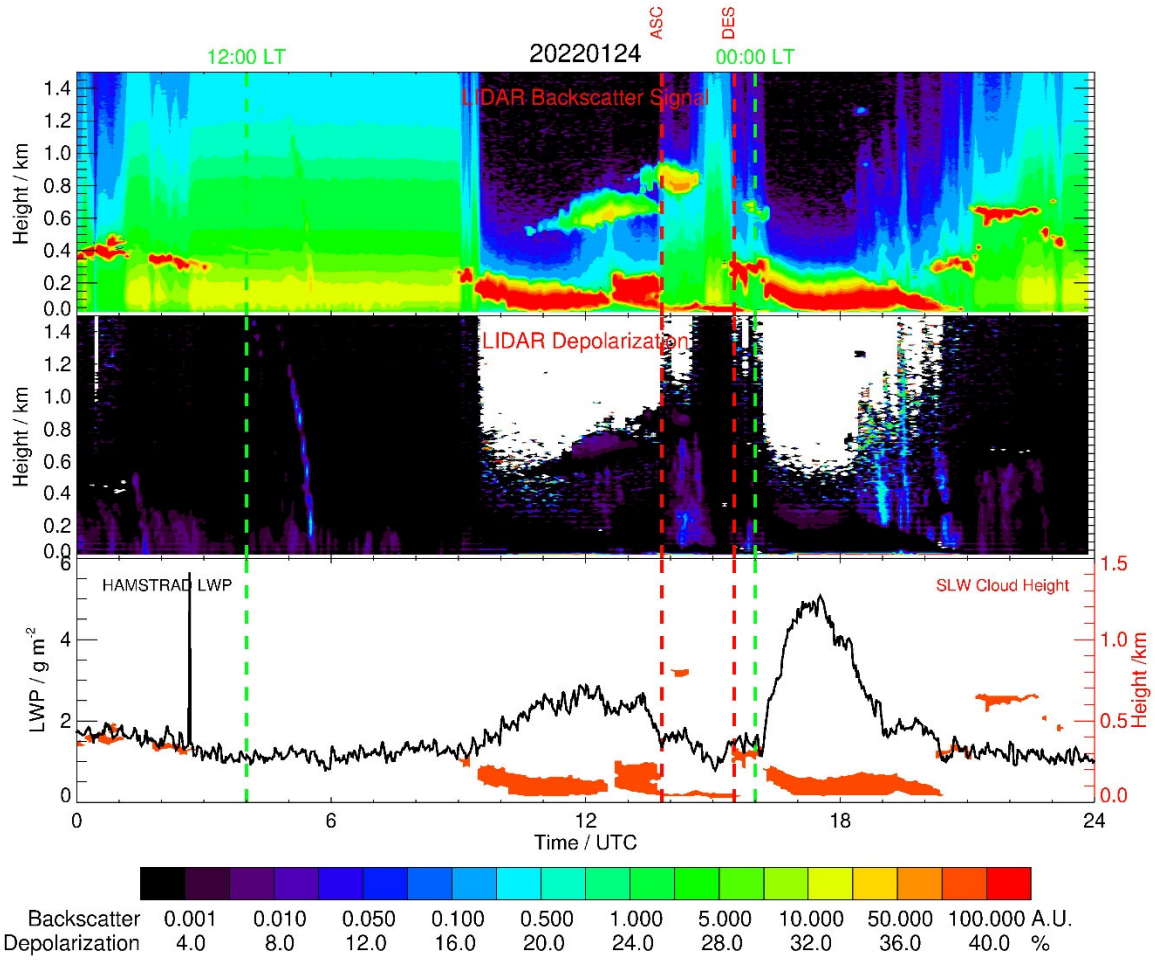

Figure S4: Same as Figure S1, but for 24 January 2022.

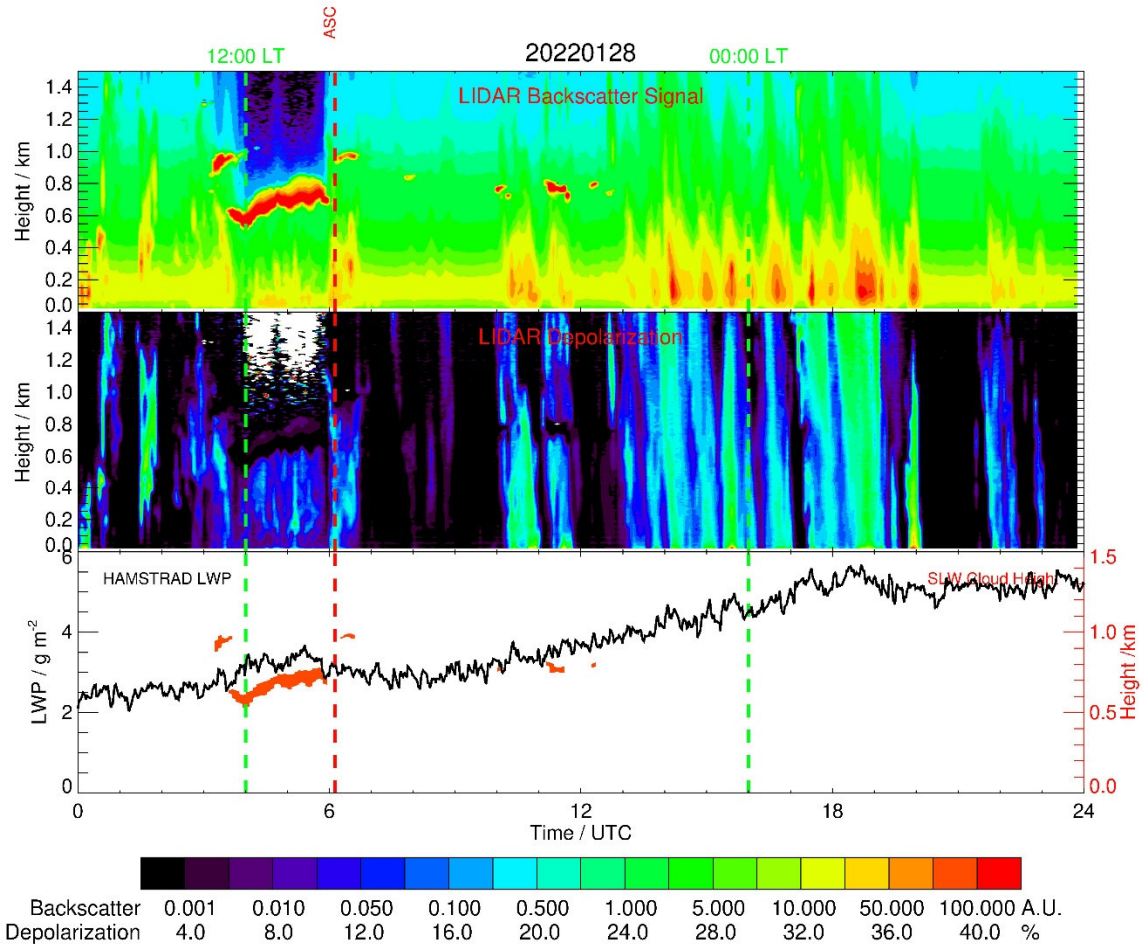

Figure S5: Same as Figure S1, but for 28 January 2022.

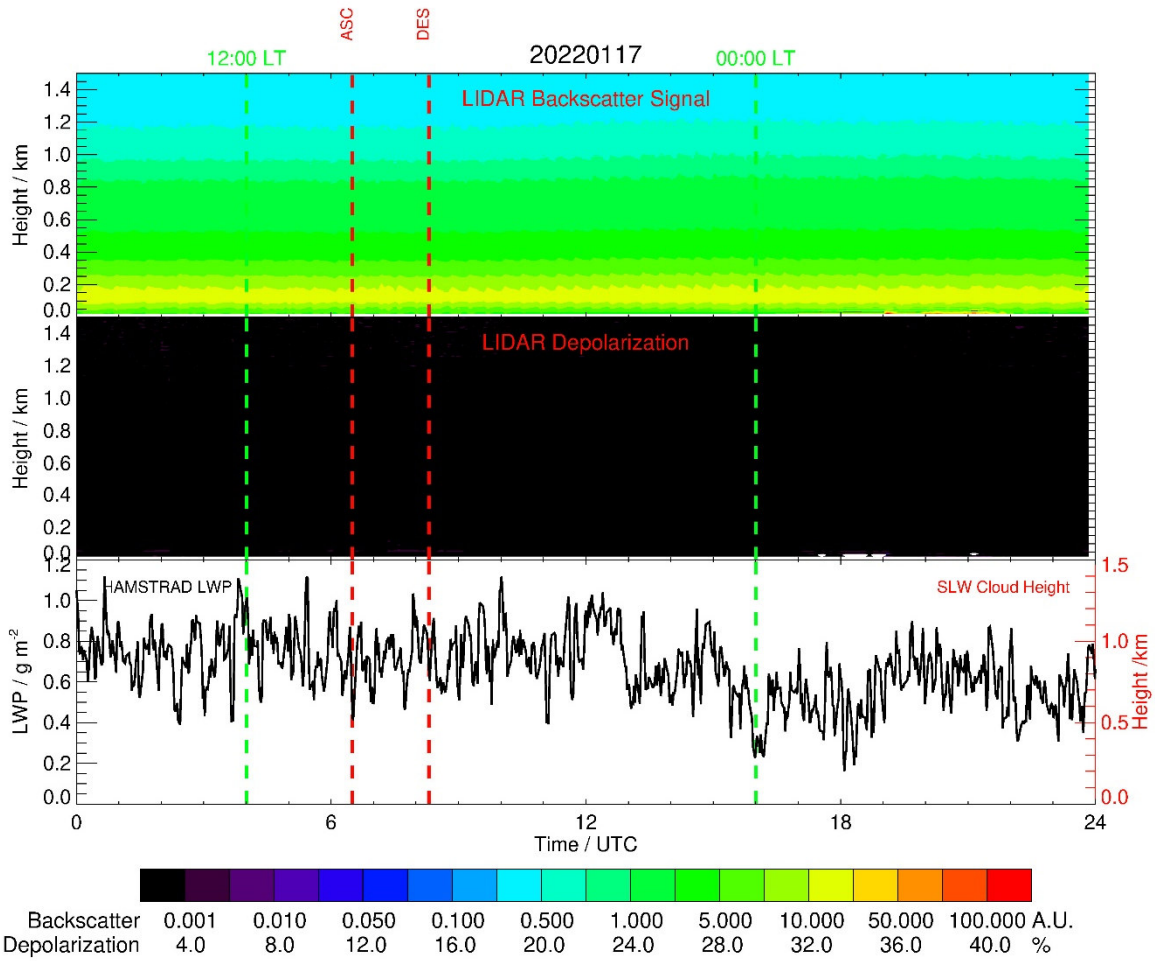

Figure S6: Same as Figure S1, but for 17 January 2022, corresponding to a cloud-free condition period.

2. Temperature, potential temperature and relative humidity

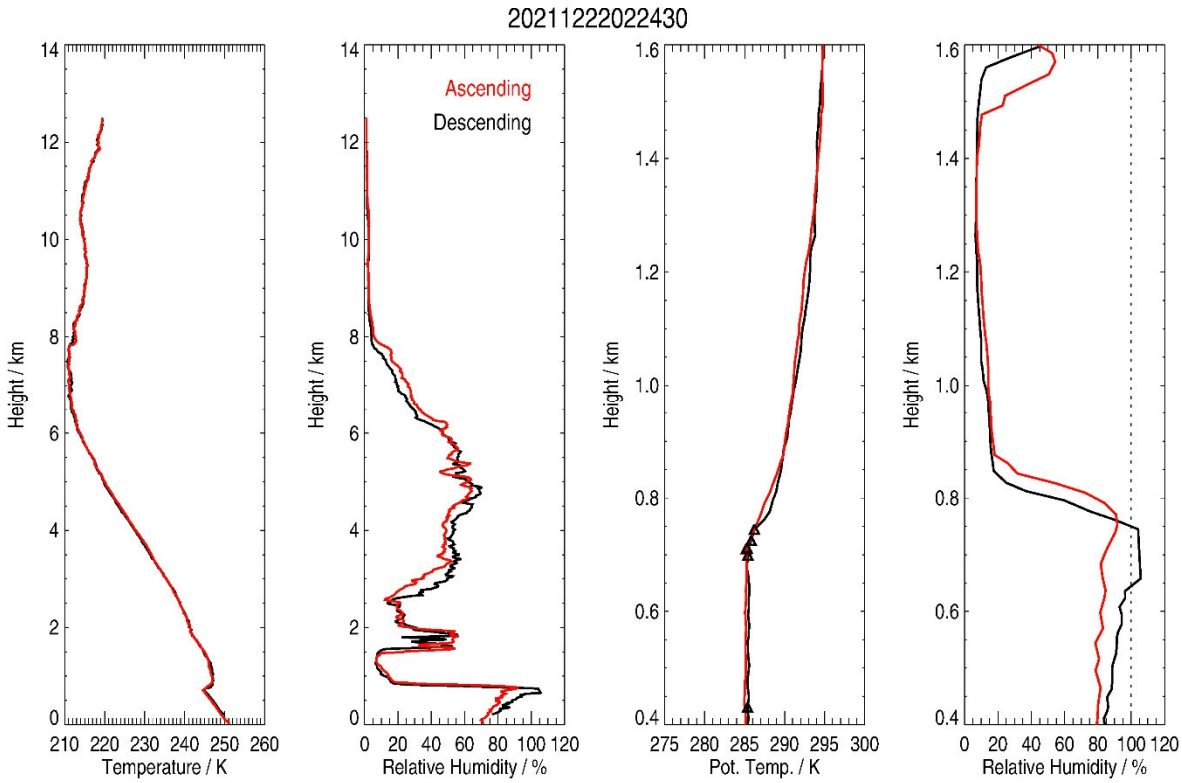

Figure S7: (from left to right) Profiles of: temperature (K), relative humidity (%) observed by the PTU sonde on 22 December 2021 for a launch at 02:24 UTC in ascending (red) and descending (black) phases over the entire vertical range, and potential temperature (K) and relative humidity selected from 400 m to 1600 m agl. Red and black triangles in the vertical profiles of potential temperature highlight the presence of inflection points in the ascending and descending phases, respectively. The vertical dotted line in the right panel indicates the 100% relative humidity.

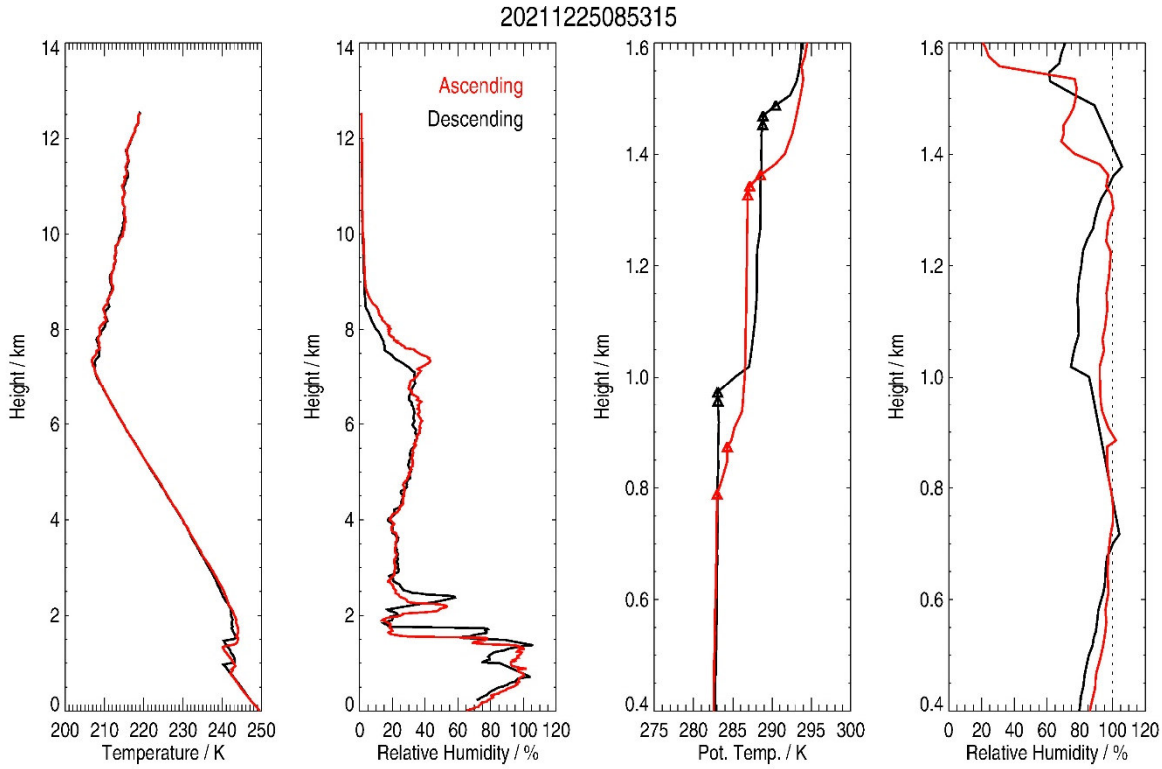

Figure S8: Same as Figure S6 but for 25 December 2021 at 08:53 UTC.

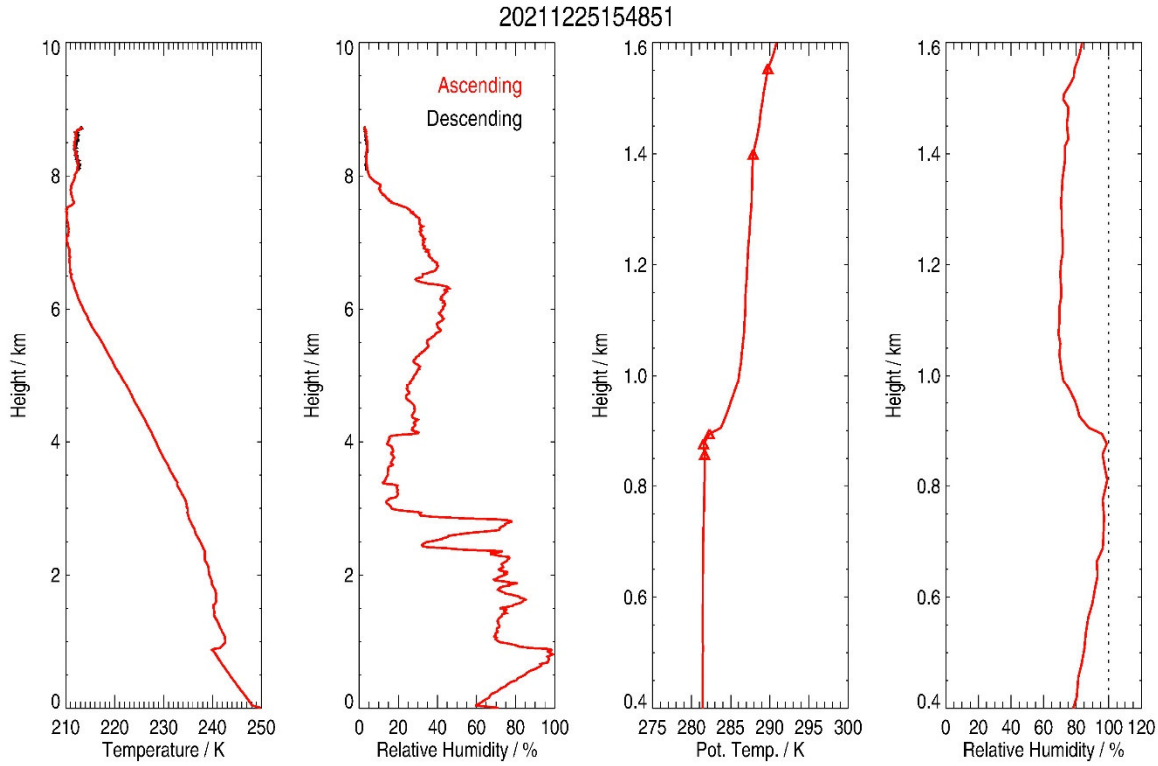

Figure S9: Same as Figure S6 but for 25 December 2021 at 15:48 UTC.

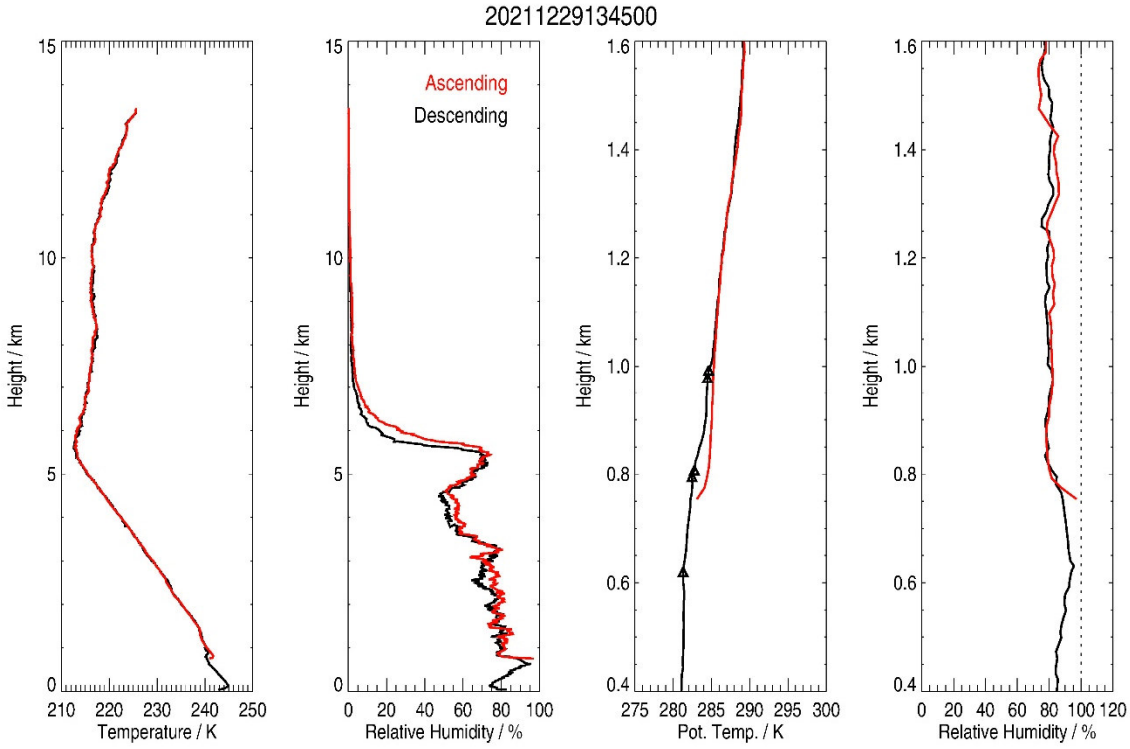

Figure S10: Same as Figure S6 but for 29 December 2021 at 13:45 UTC.

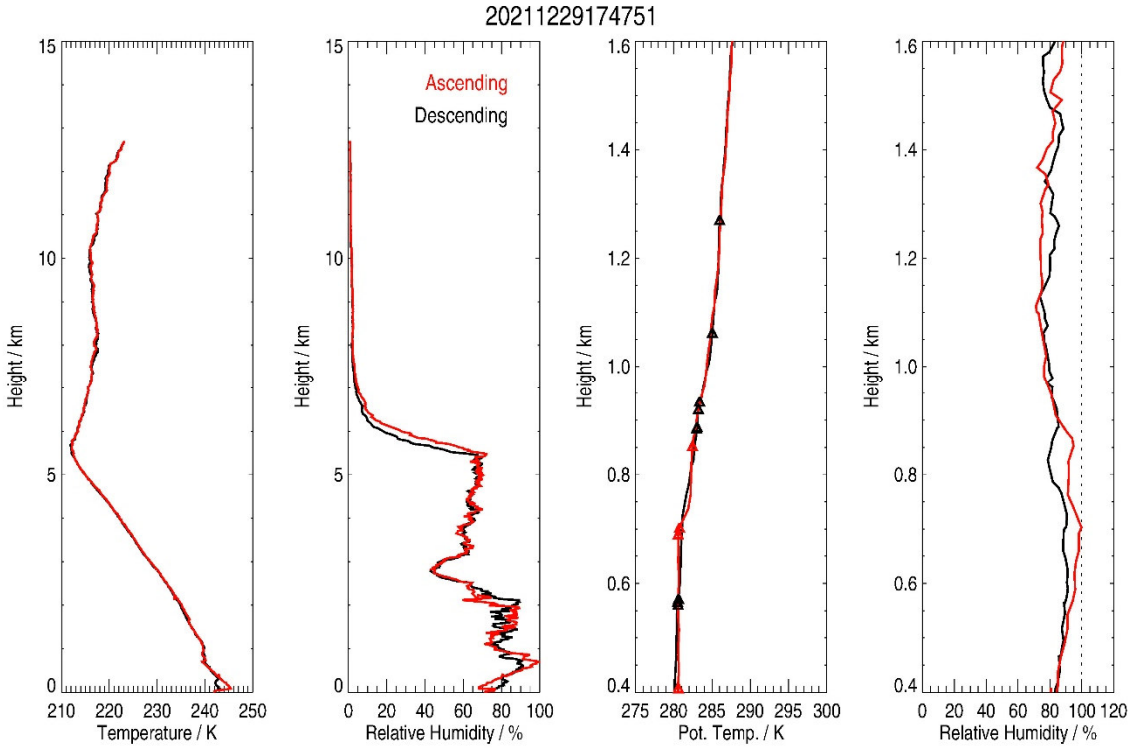

Figure S11: Same as Figure S6 but for 29 December 2021 at 17:47 UTC.

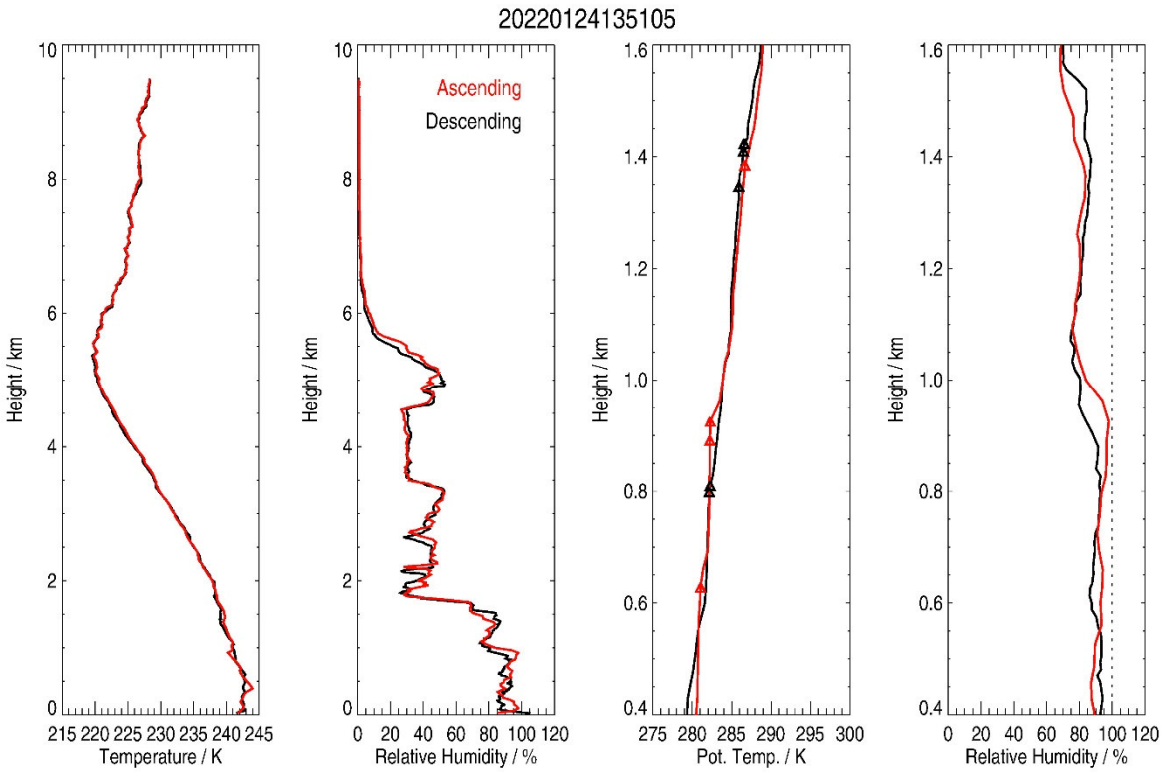

Figure S12: Same as Figure S6 but for 24 January 2022 at 13:51 UTC.

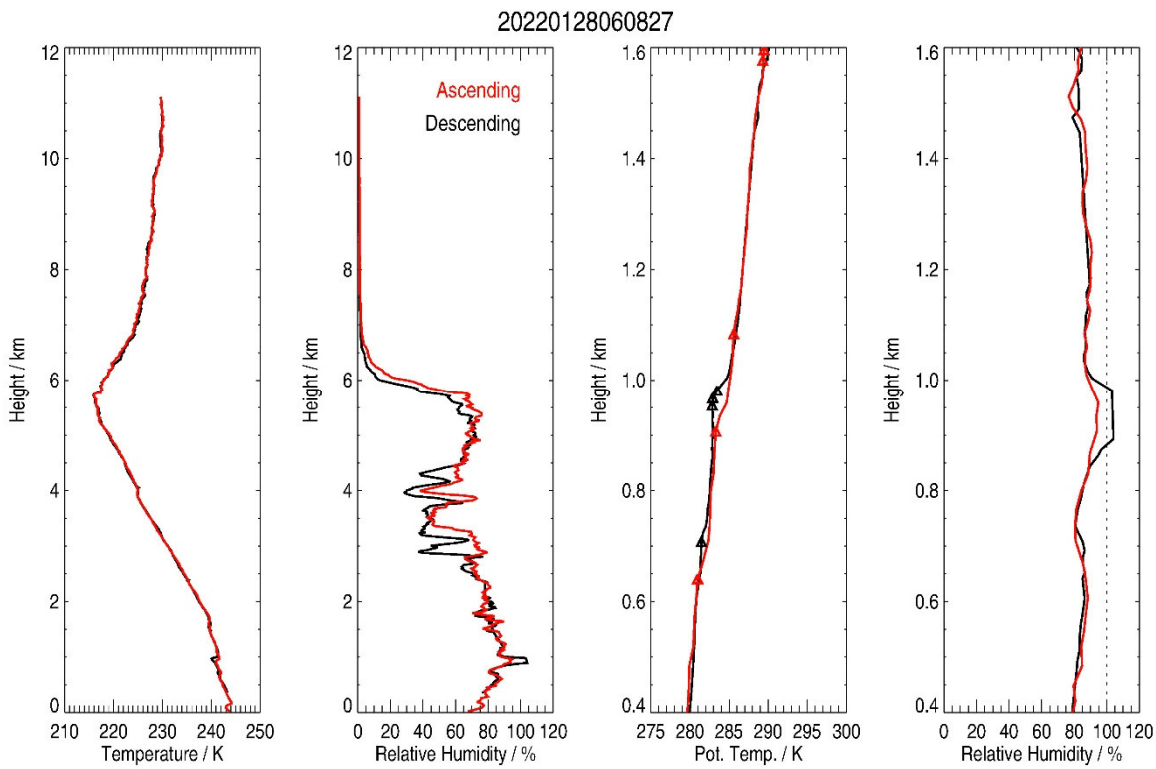

Figure S13: Same as Figure S6 but for 28 January 2022 at 06:08 UTC.

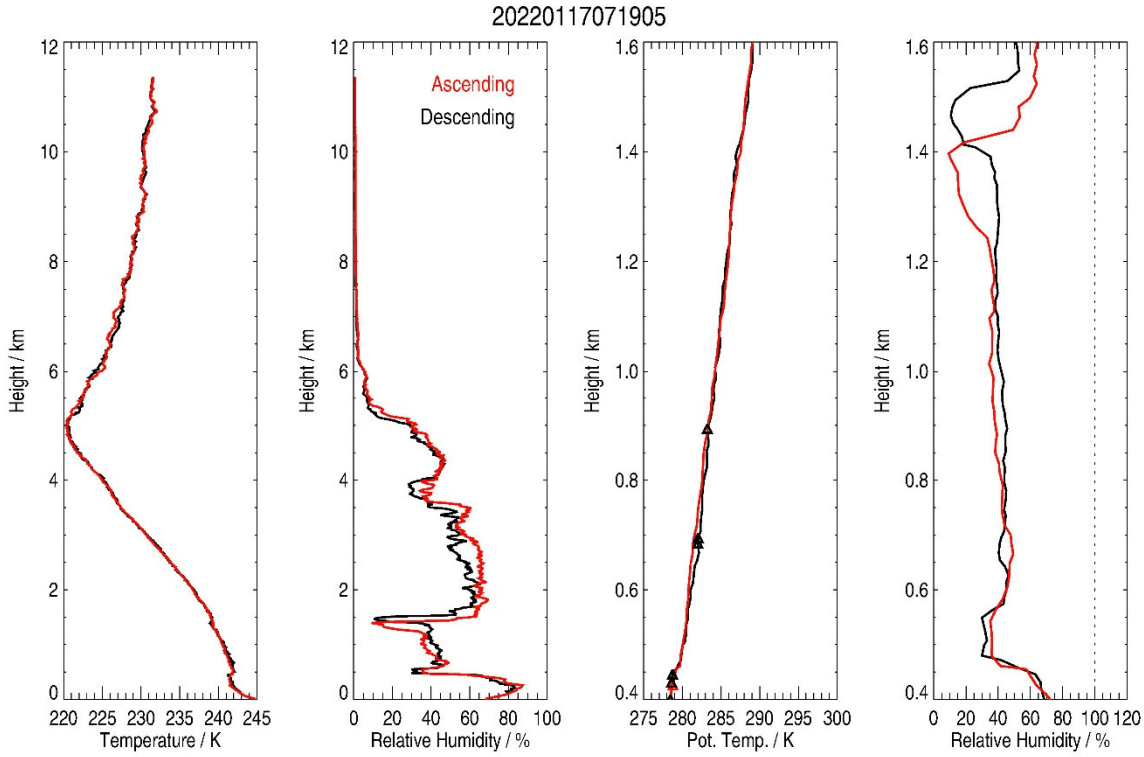

Figure S14: Same as Figure S6 but for 17 January 2022 at 07:19 UTC (cloud-free period).

3. SLWC

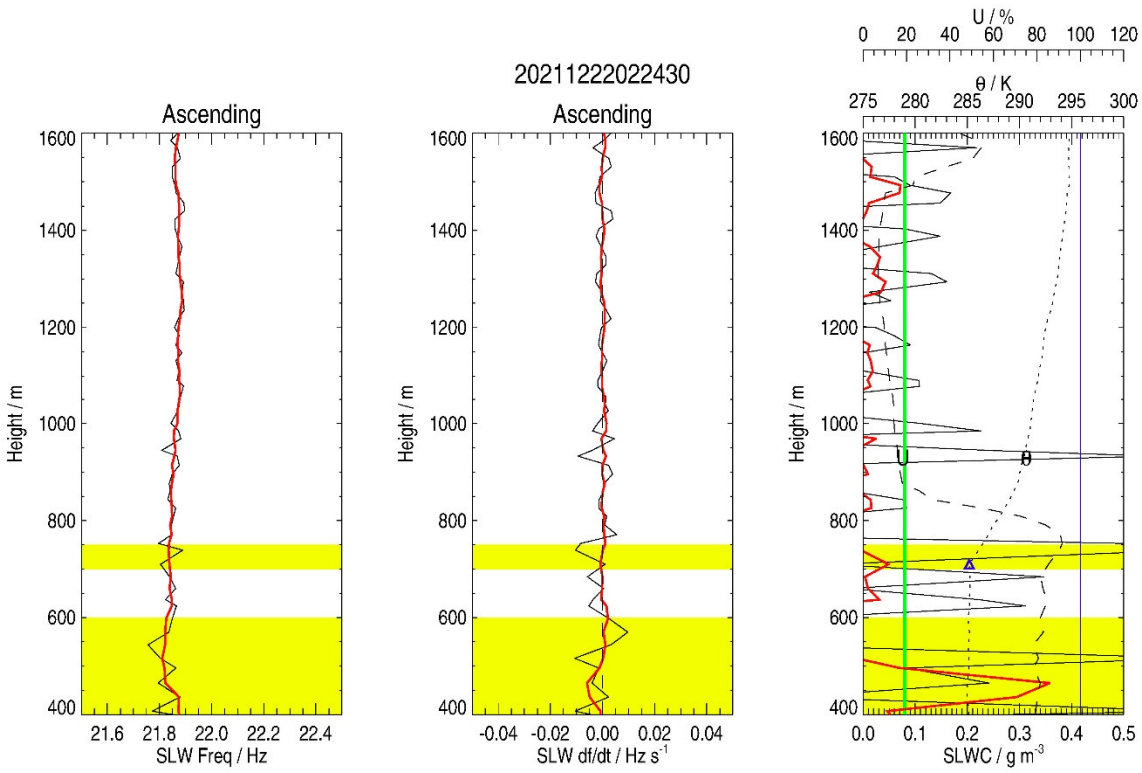

Figure S15: Vertical profiles of: (left) SLWC sonde frequency f (black; Hz), (middle) df/dt (black; Hz s^{-1}); and (right) sonde-calculated SLWC (black; g m^{-3}) on 22 December 2021 at 02:24 UTC. 4-point (20 s) running averages are displayed in red. On the right panel, potential temperature (θ, K) and relative humidity (U, %) are shown as dotted and dashed lines, respectively. Blue triangles represent the height of the potential temperature inflection points. The green vertical line represents the estimated one-sigma error (0.08 g m^{-3}) of the SLWC calculated from the SLWC sonde observations. The blue vertical line indicates the 100% relative humidity. The vertical extensions of the SLW clouds as observed by the LIDAR in a ±1-hour time window centered on the launch time (ascending phase) or on the time of the flight end (descending phase) are highlighted in yellow or orange, respectively.

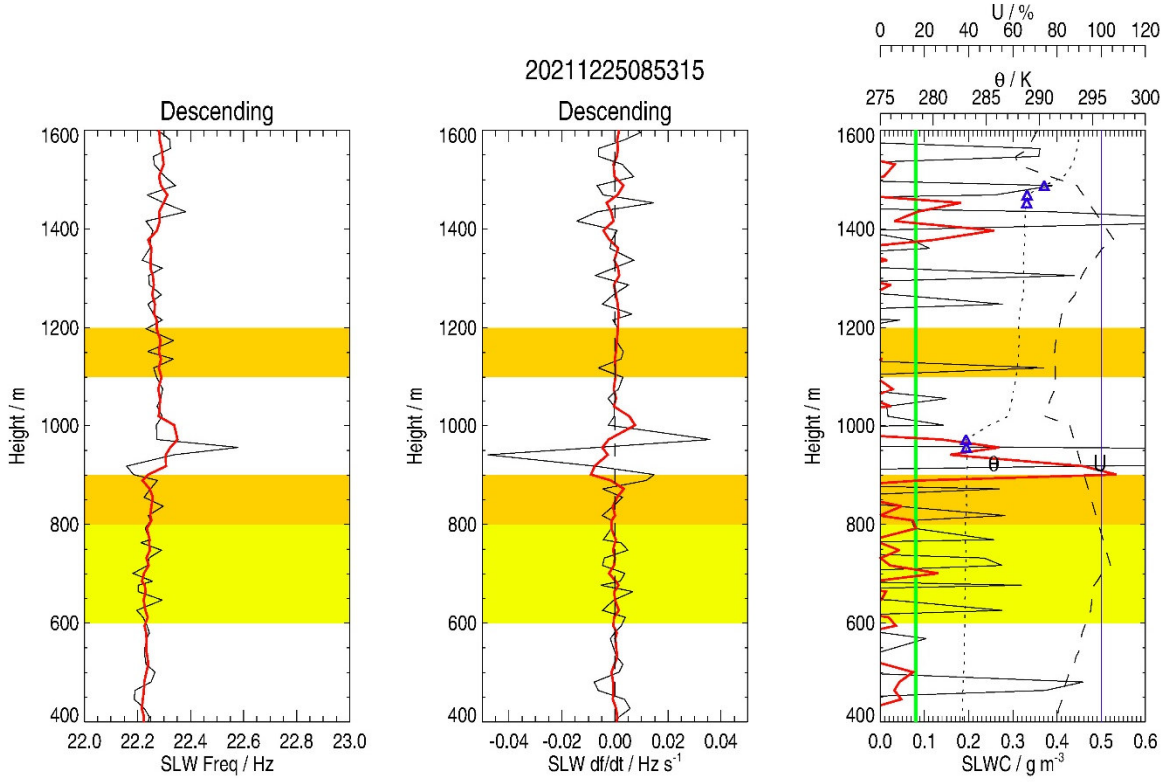

Figure S16: Same as Figure S15 but for 25 December 2021 at 08:53 UTC.

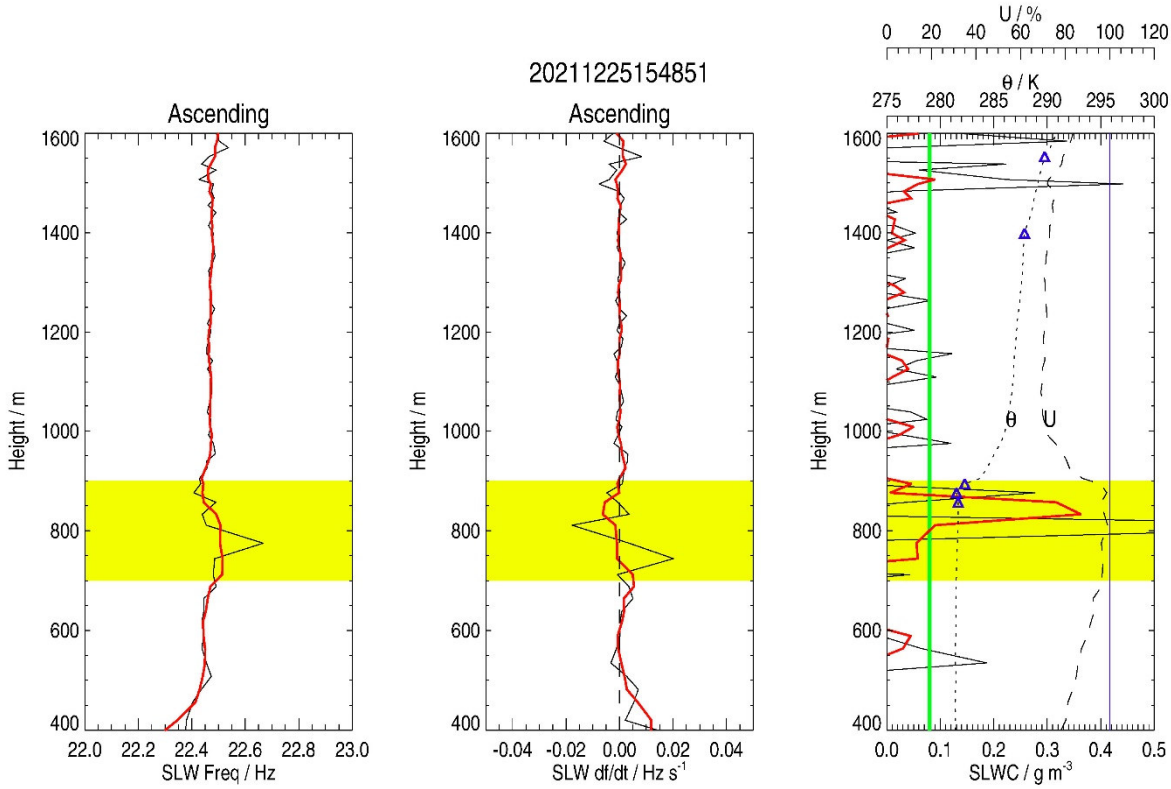

Figure S17: Same as Figure S15 but for 25 December 2021 at 15:48 UTC.

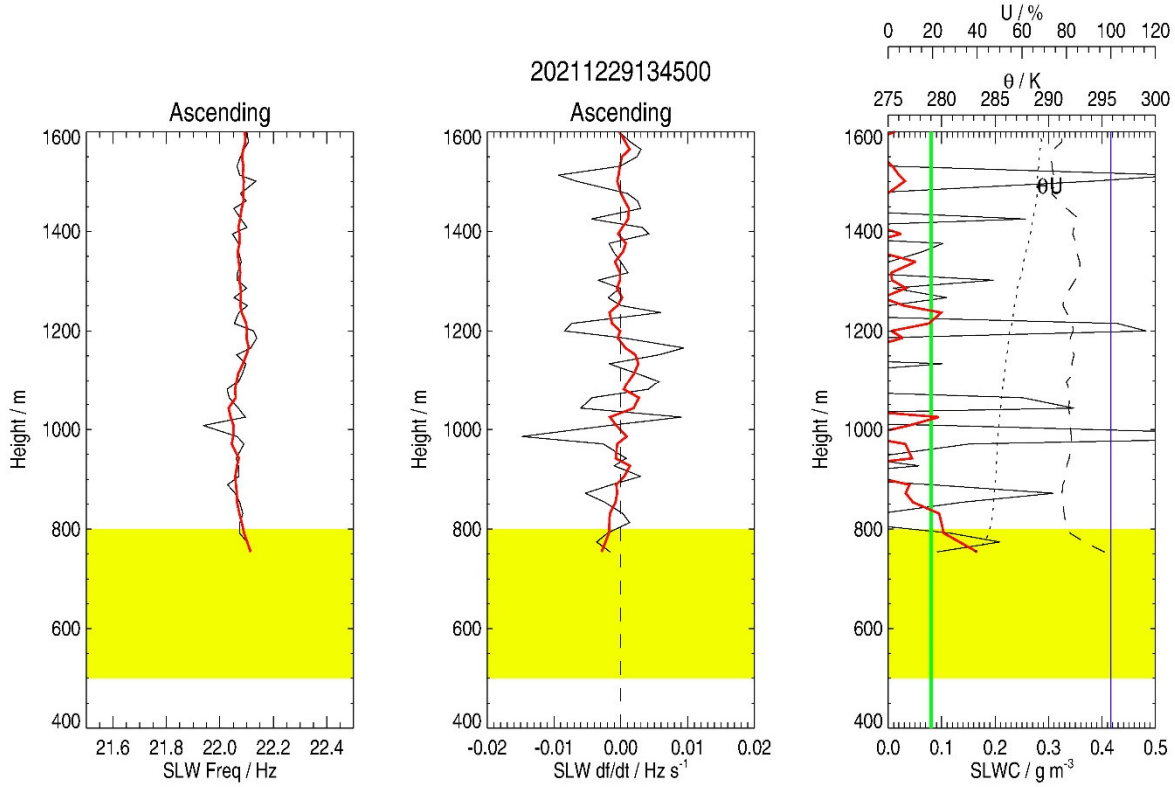

Figure S18: Same as Figure S15 but for 29 December 2021 at 13:45 UTC.

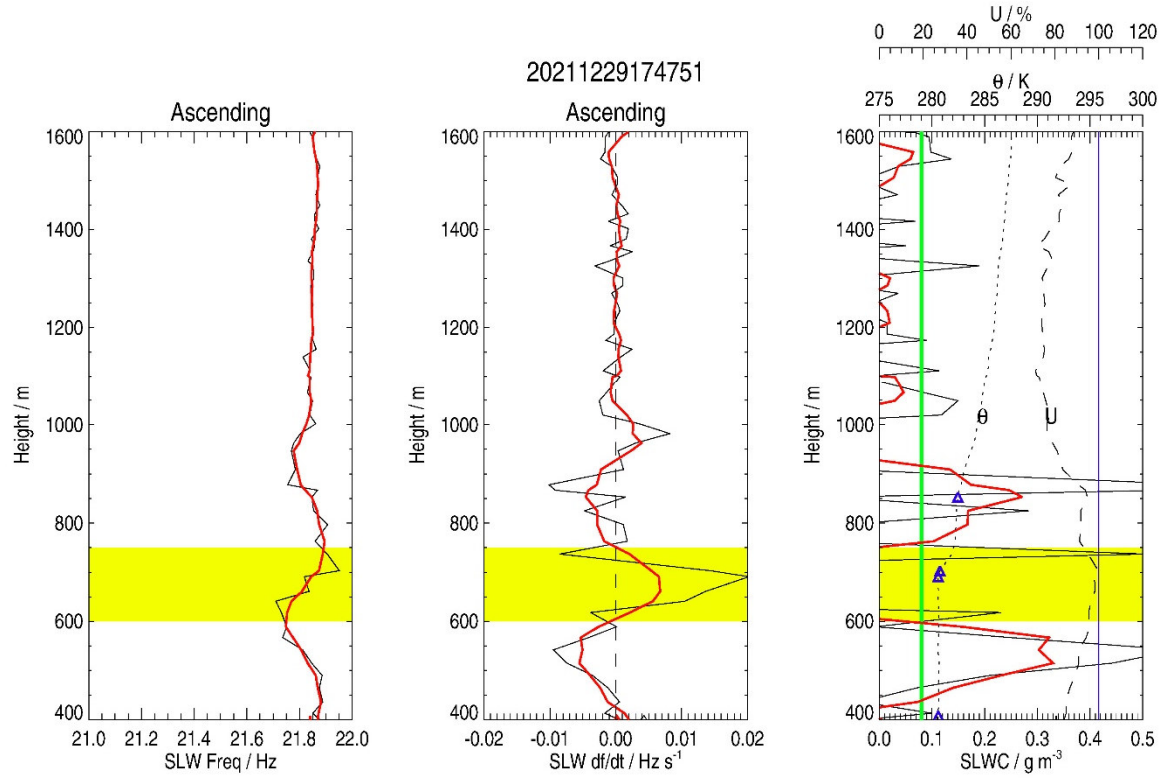

Figure S19: Same as Figure S15 but for 29 December 2021 at 17:47 UTC.

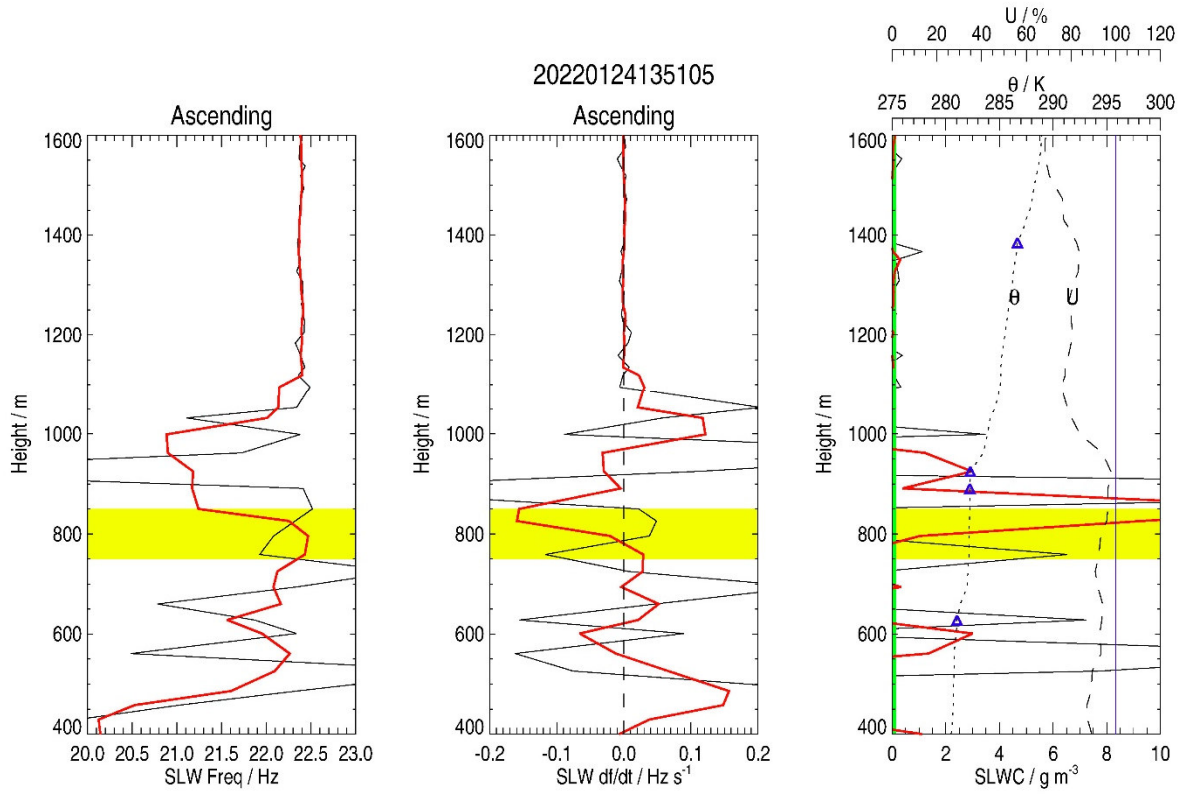

Figure S20: Same as Figure S15 but for 24 January 2022 at 13:51 UTC (ascending phase)

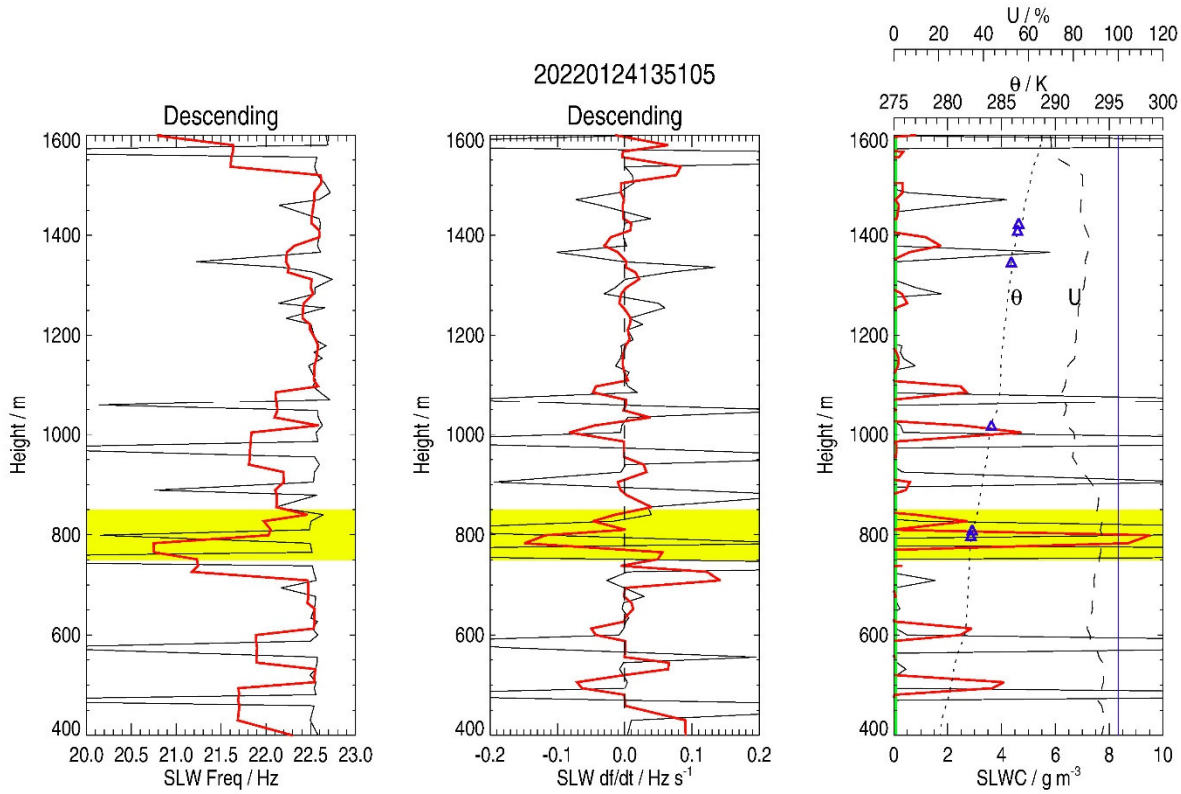

Figure S21: Same as Figure S15 but for 24 January 2022 at 13:51 UTC (descending phase).

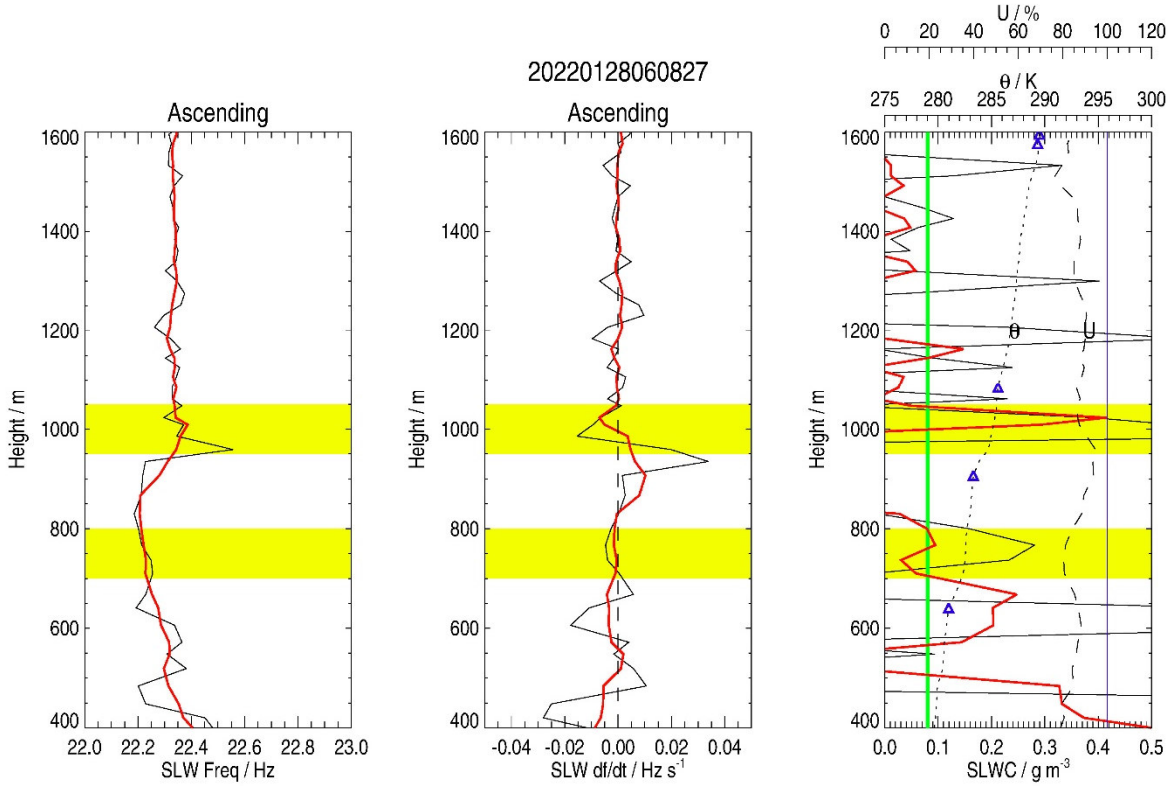

Figure S22: Same as Figure S15 but for 28 January 2022 at 06:08 UTC.

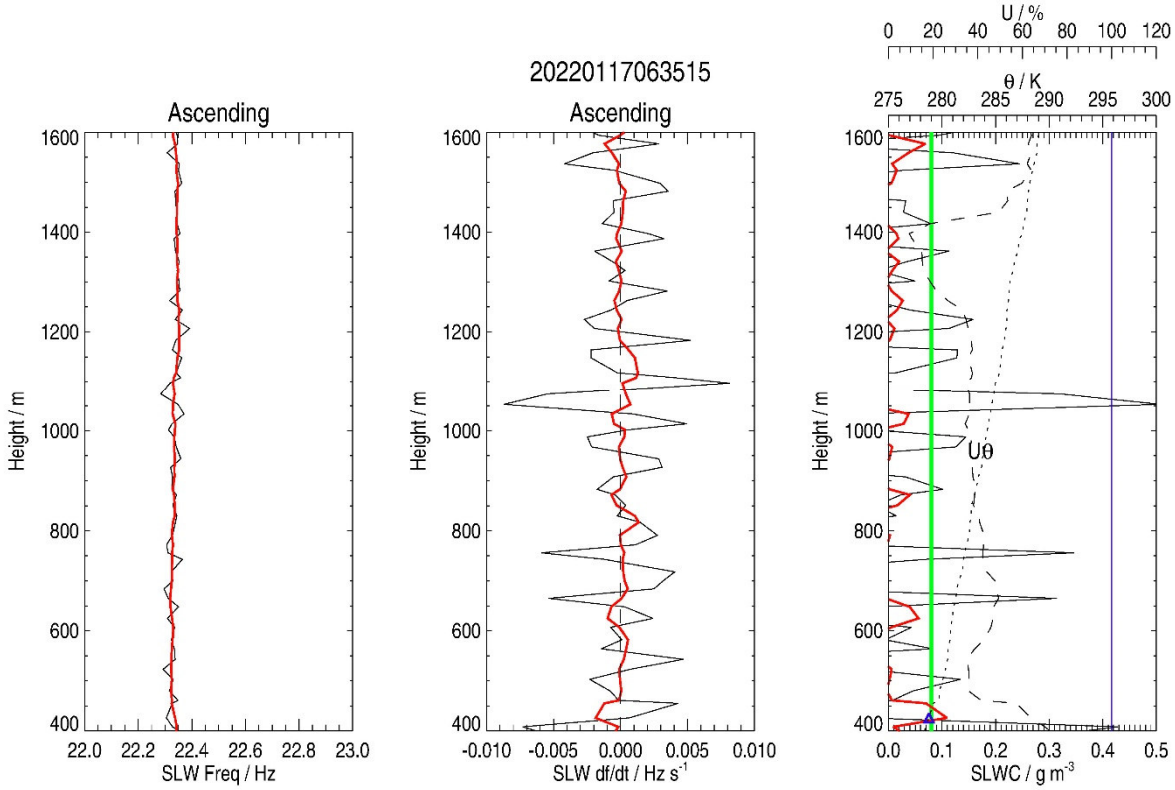

Figure S23: Same as Figure S15 but for 17 January 2022 at 06:35 UTC (ascending phase) in cloud-free conditions.

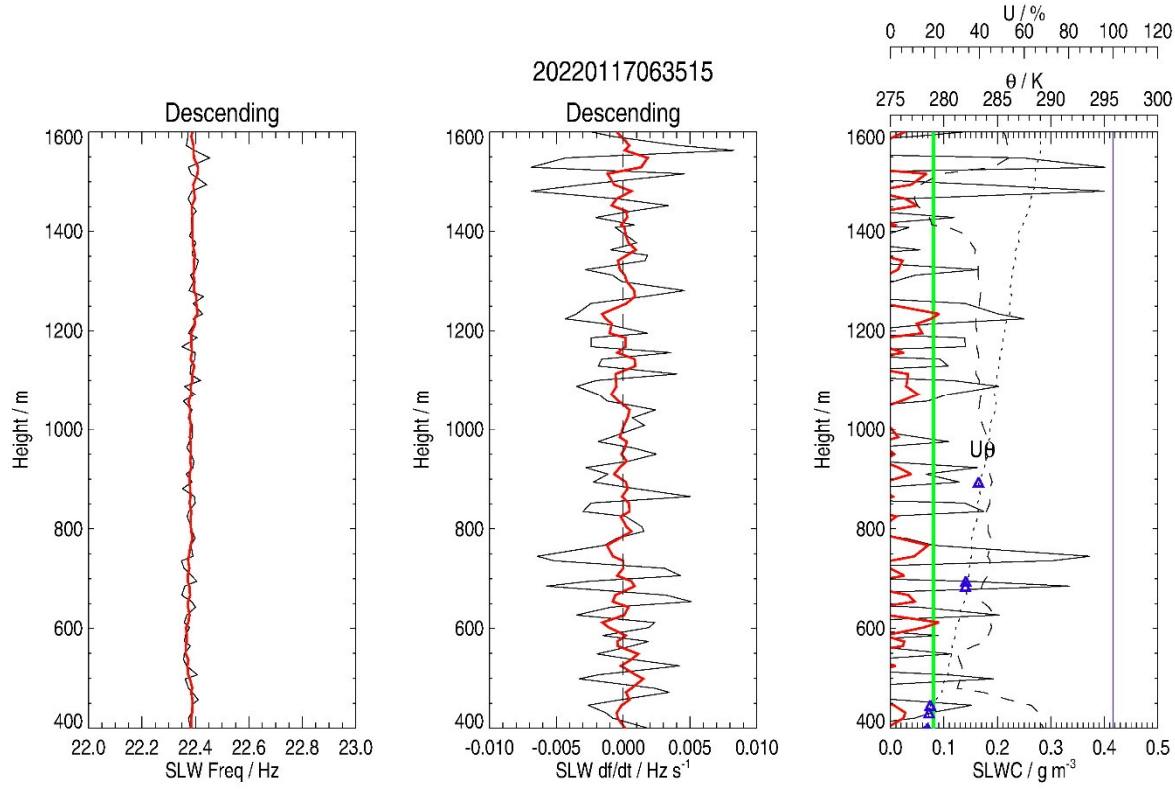

Figure S24: Same as Figure S15 but for 17 January 2022 at 06:35 UTC (descending phase) in cloud-free conditions.

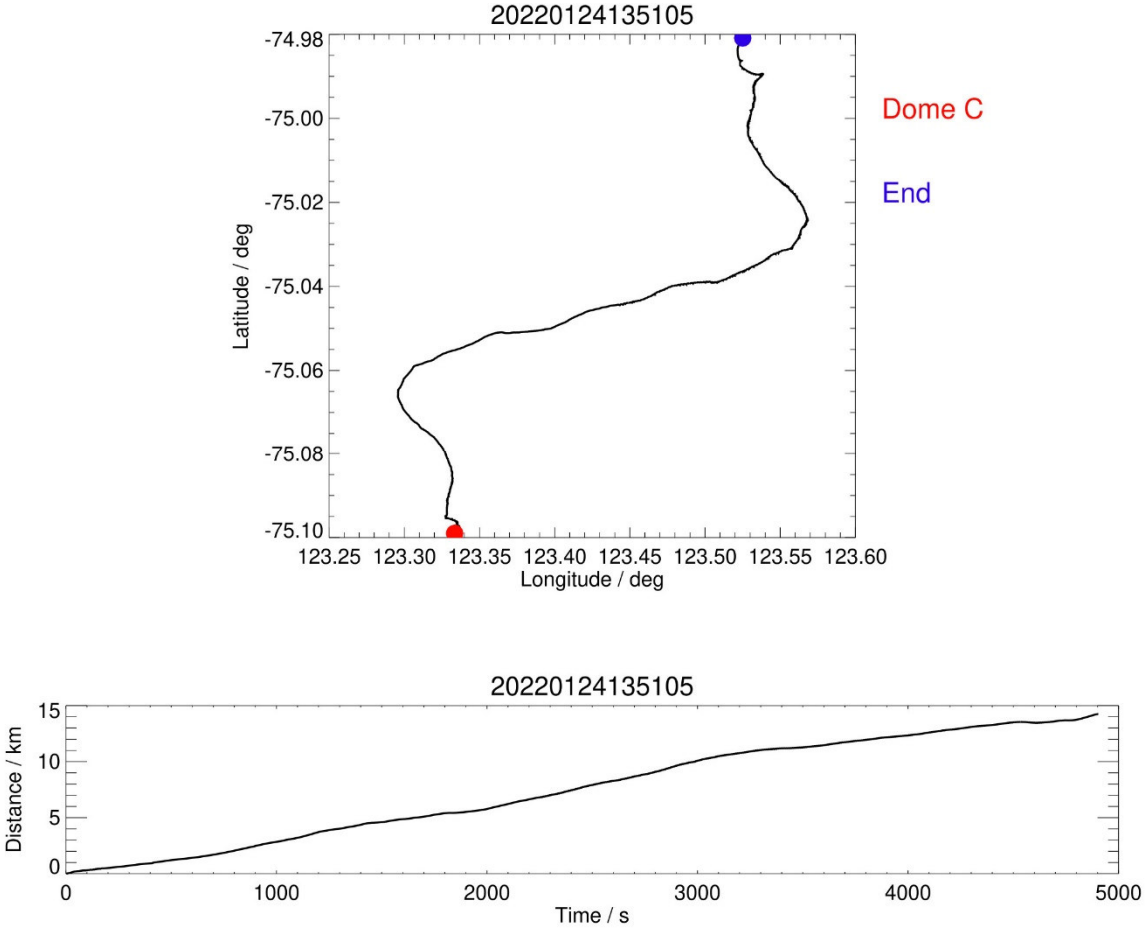

Figure S25: (Top) Path followed by the meteorological balloon launched on 24 January 2022 at 13:51:05 UTC (L14) (red circle) up to the end of the flight (blue circle). (Bottom) Distance travelled (km) as a function of time since launch.

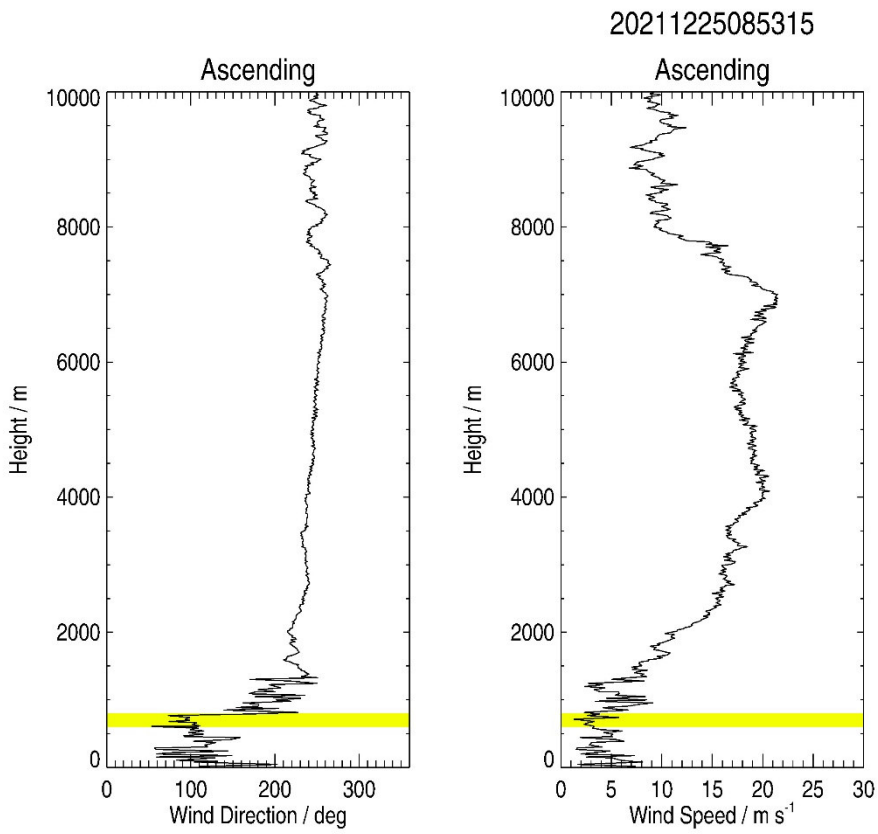

Figure S26: Vertical profiles of the wind direction (left, deg.) and speed (right, m s^{-1}) observed by the PTU sonde during the flight L03 launched on 25 December 2021 at 08:53:15 UTC in the ascending phase. The vertical extensions of the SLW clouds as observed by the LIDAR in a ±1-hour time window centered on the launch time (ascending phase) are highlighted in yellow.

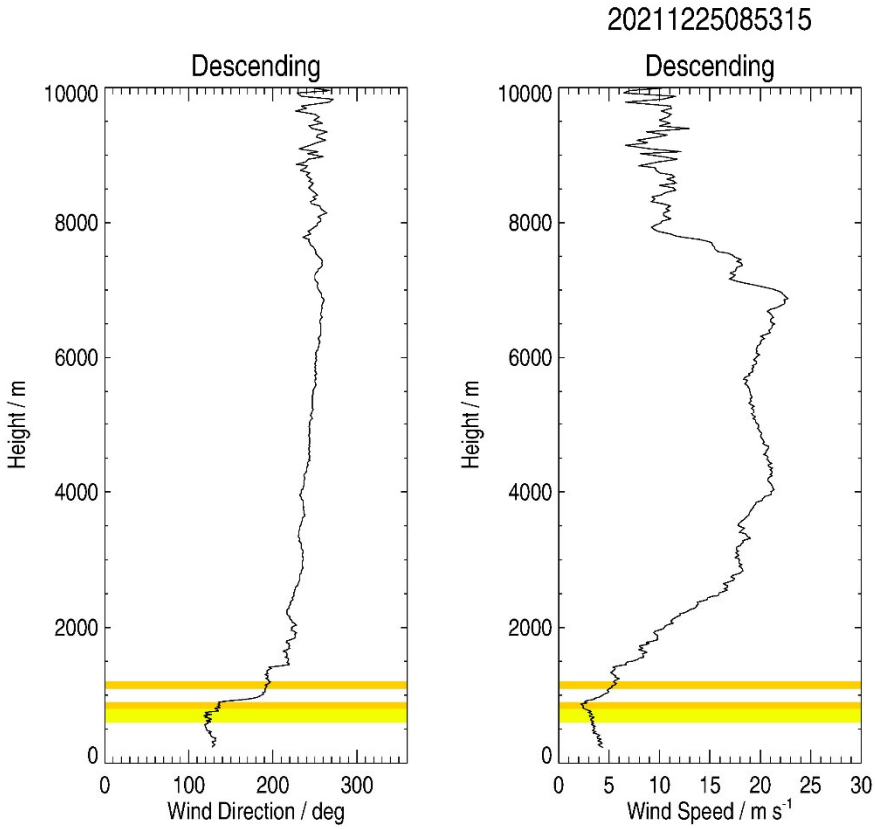

Figure S27: Vertical profiles of the wind direction (left, deg.) and speed (right, m s^{-1}) observed by the PTU sonde during the flight L03 launched on 25 December 2021 at 08:53:15 UTC in the descending phase. The vertical extensions of the SLW clouds as observed by the LIDAR in a ±1-hour time window centered on the launch time (ascending phase) or on the time of the flight end (descending phase) are highlighted in yellow or orange, respectively.