1 # Supplementary Material

3 # In situ observations of supercooled liquid water clouds over Dome

4 # C, Antarctica by balloon-borne sondes

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25   The information regarding all the flights are presented in this document. This encompasses: 1)

26   the LWP values from HAMSTRAD and the SLW cloud heights from the LIDAR over one day,

27   2) the vertical distributions of temperature, potential temperature and relative humidity

28   measured by the PTU sonde during the flights, and 3) the vertical distribution of the SLWC

29   sonde frequency f, the derivative of the frequency wrt time t (df/dt) and the calculated SLWC

30   during the flights.

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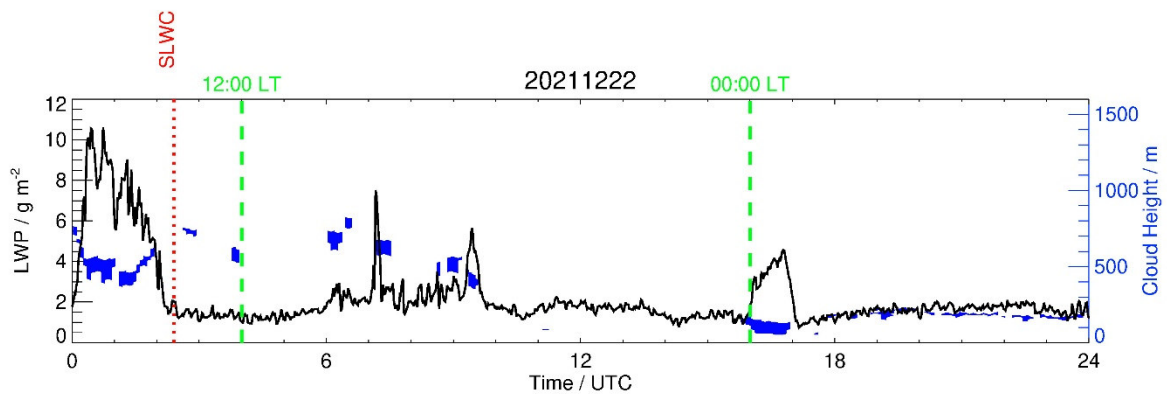
32   **1. LWP vs. SLW clouds**

33

34   **Figure S1:** Diurnal variation of the Liquid Water Path (LWP) measured by HAMSTRAD (g

35   m^{-2}, black solid line) on 22 December 2021 (UTC Time). Superimposed is the SLW cloud

36   thickness (blue area) derived from the LIDAR observations (blue y-axis on the right). Two

37   vertical green dashed lines indicate 12:00 and 00:00 LT. The red vertical dotted line indicates

38   the launch of the SLWC sonde under the meteorological balloon (L01 in ascending phase at

39   about 02:25 UTC).

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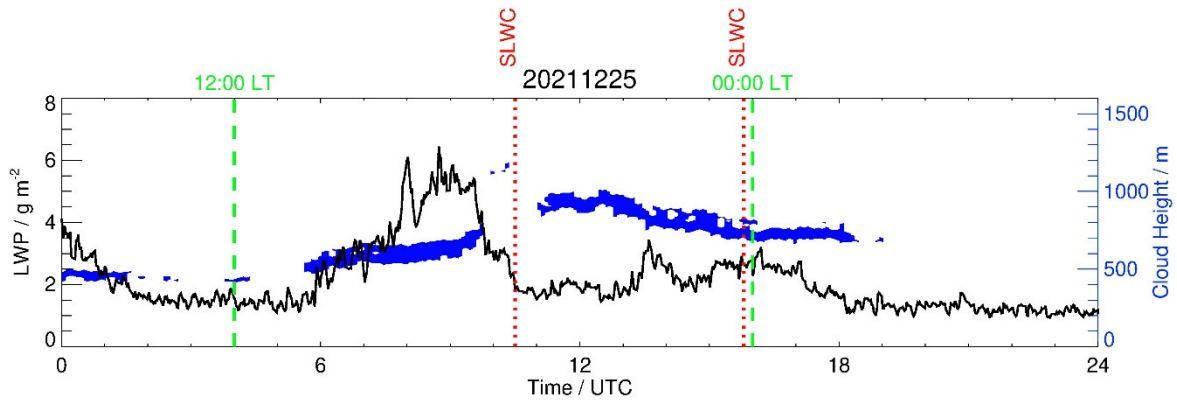
Figure S2: Same as Figure S1 but for 25 December 2021.

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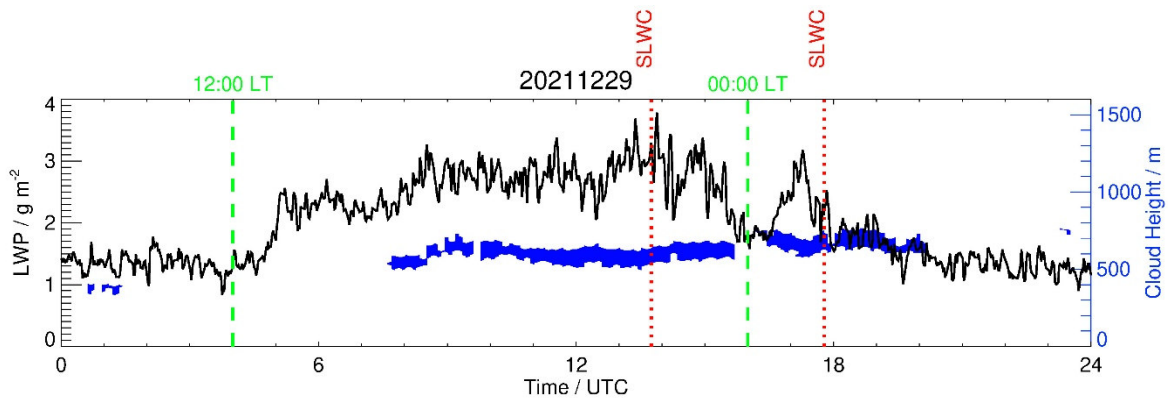
Figure S3: Same as Figure S1, but for 29 December 2021.

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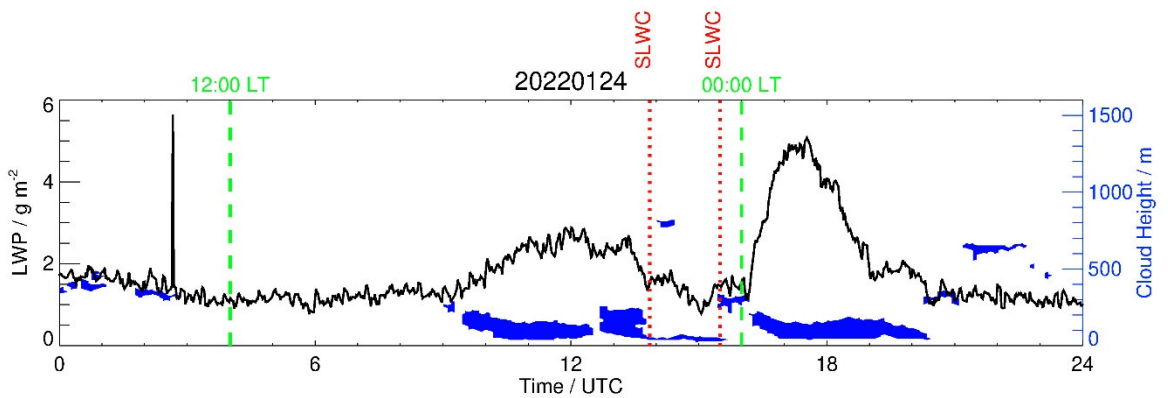
Figure S4: Same as Figure S1, but for 24 January 2022.

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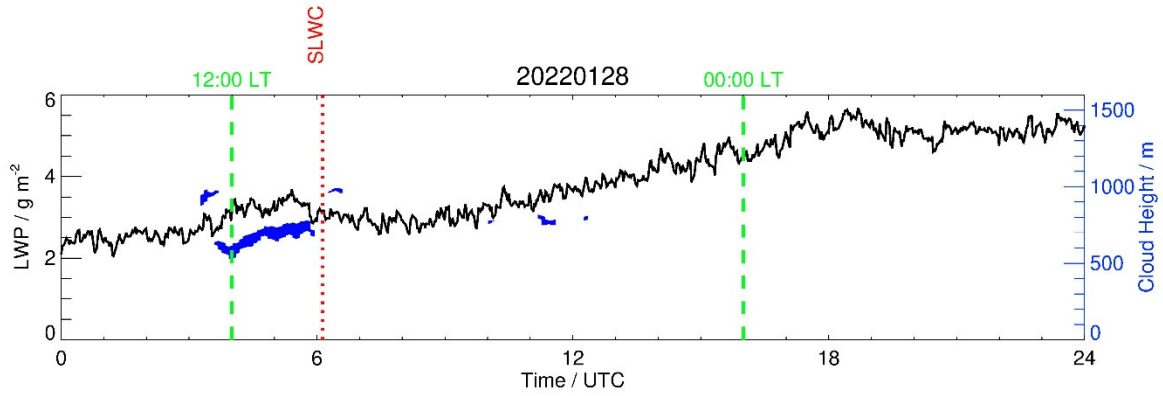
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50   **Figure S5:** Same as Figure S1, but for 28 January 2022.

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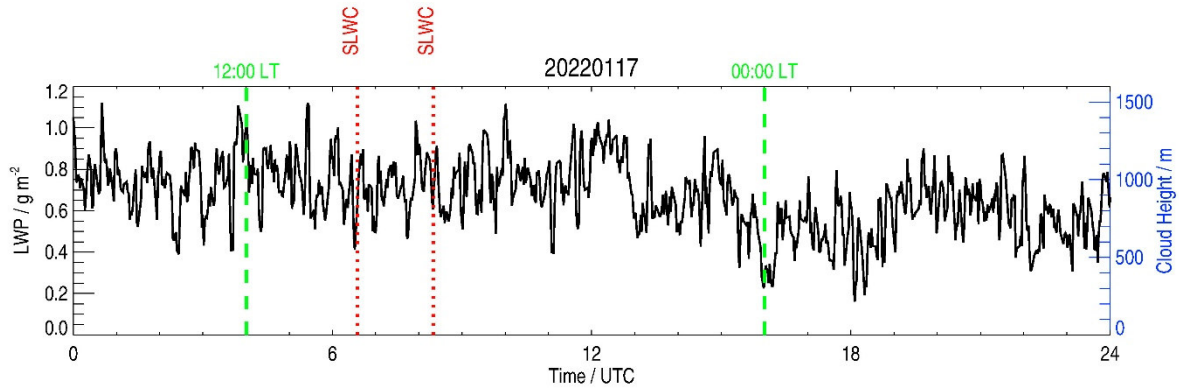
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53   **Figure S6:** Same as Figure S1, but for 17 January 2022, corresponding to a cloud-free condition

54   period.

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56   **2. Temperature, potential temperature and relative humidity**

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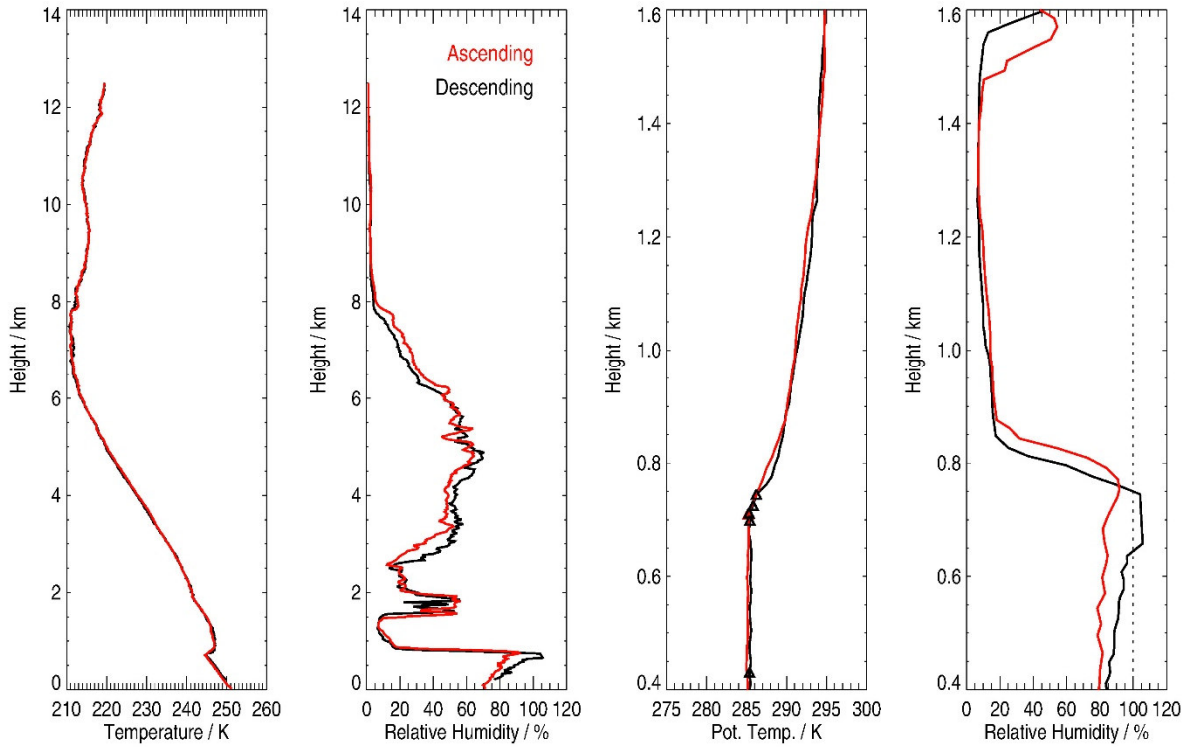
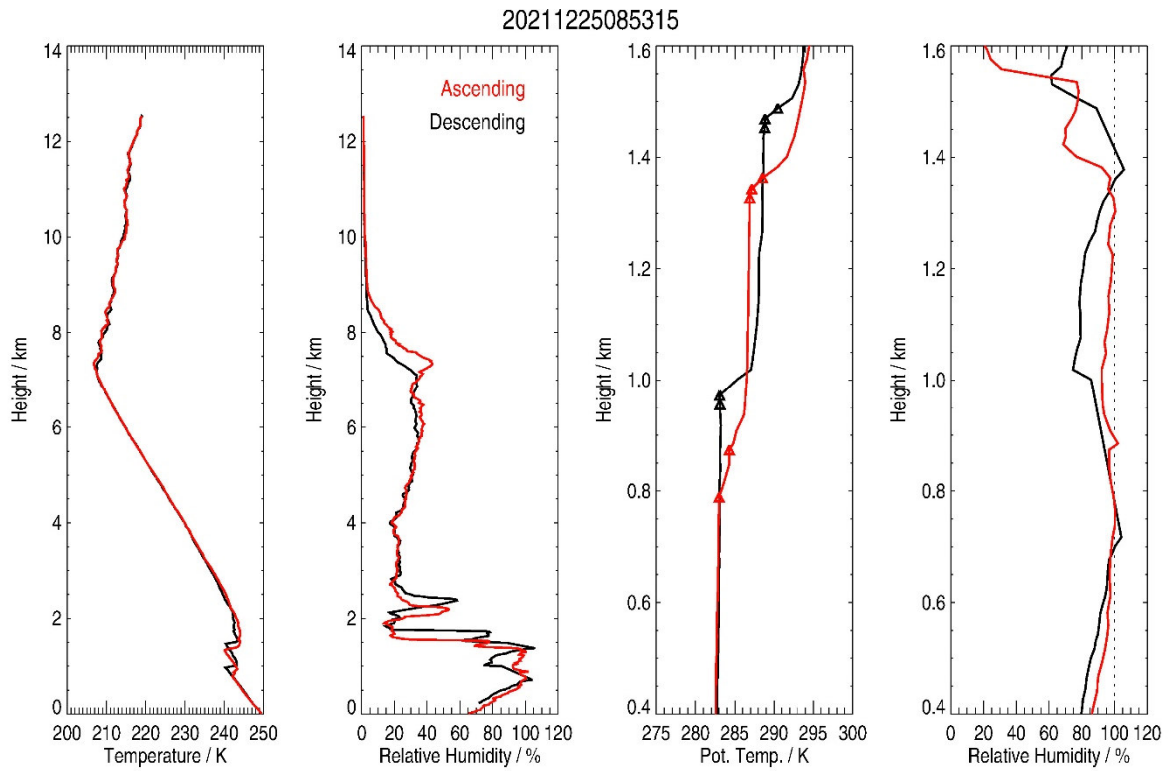


Figure S7: (from left to right) Profiles of: temperature (K), relative humidity (%) observed by the PTU sonde on 22 December 2021 for a launch at 02:24 UTC in ascending (red) and descending (black) phases over the entire vertical range, and potential temperature (K) and relative humidity selected from 400 m agl to 1600 m height. 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.

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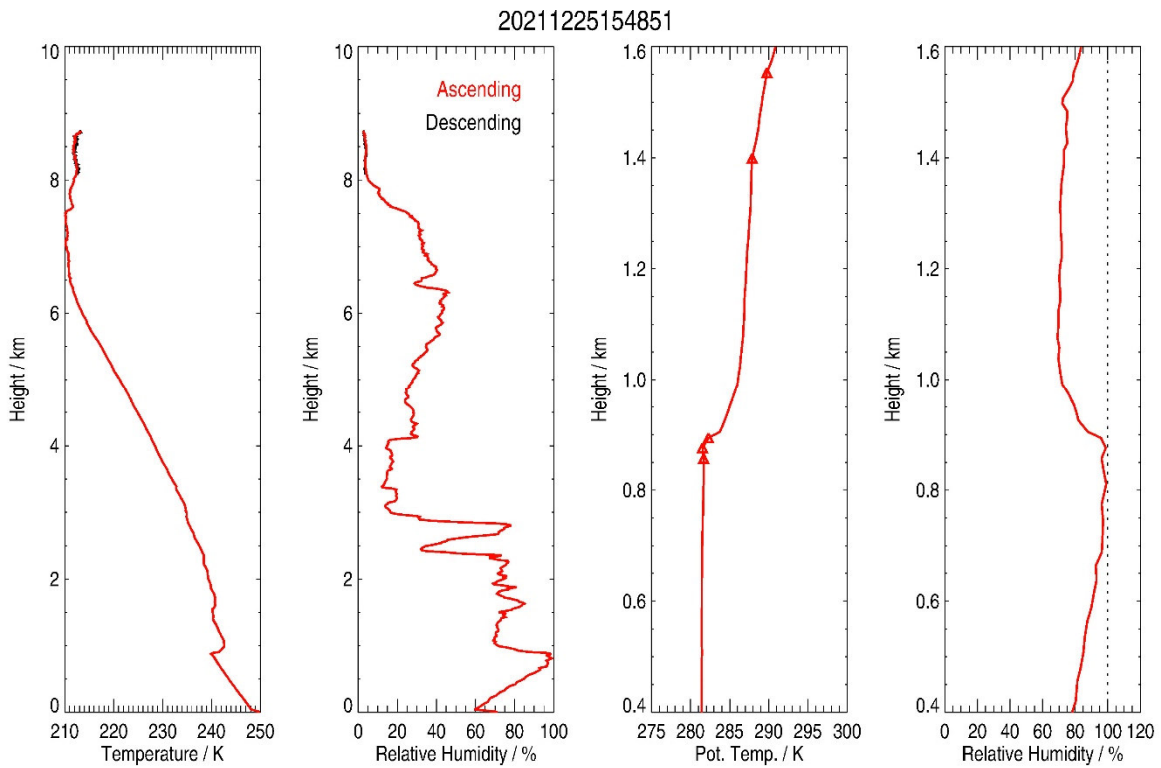
68   **Figure S8:** Same as Figure S6 but for 25 December 2021 at 08:53 UTC.

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

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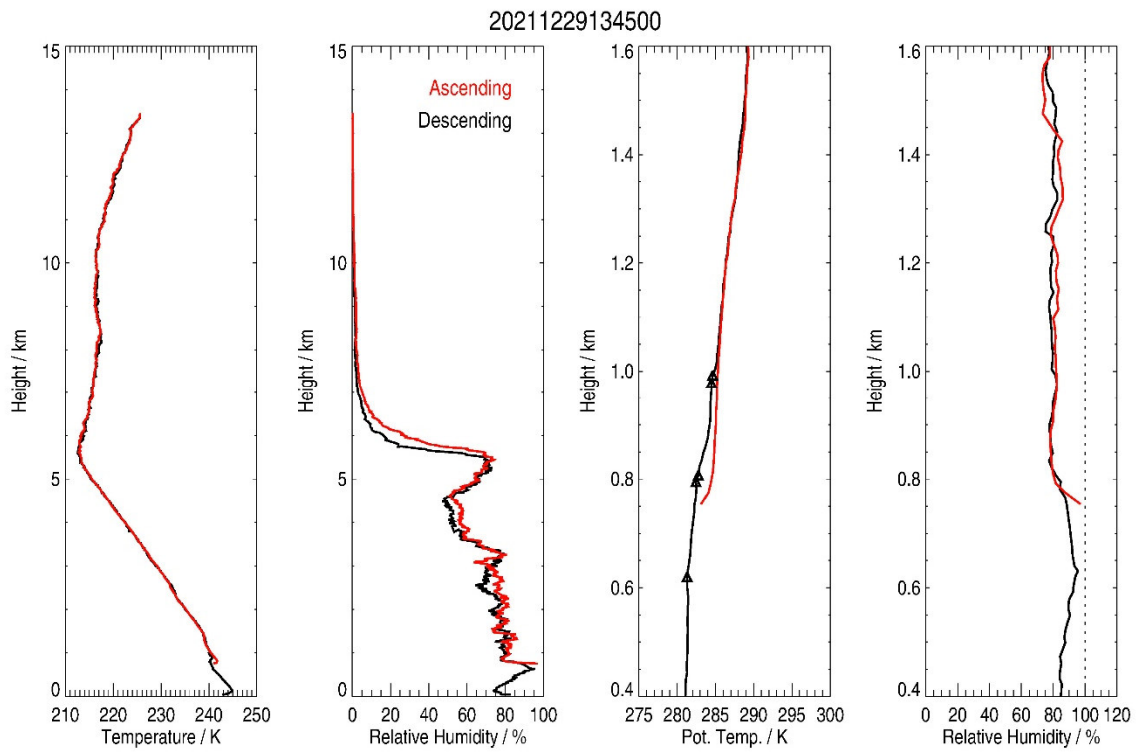
Figure S10: Same as Figure S6 but for 29 December 2021 at 13:45 UTC.

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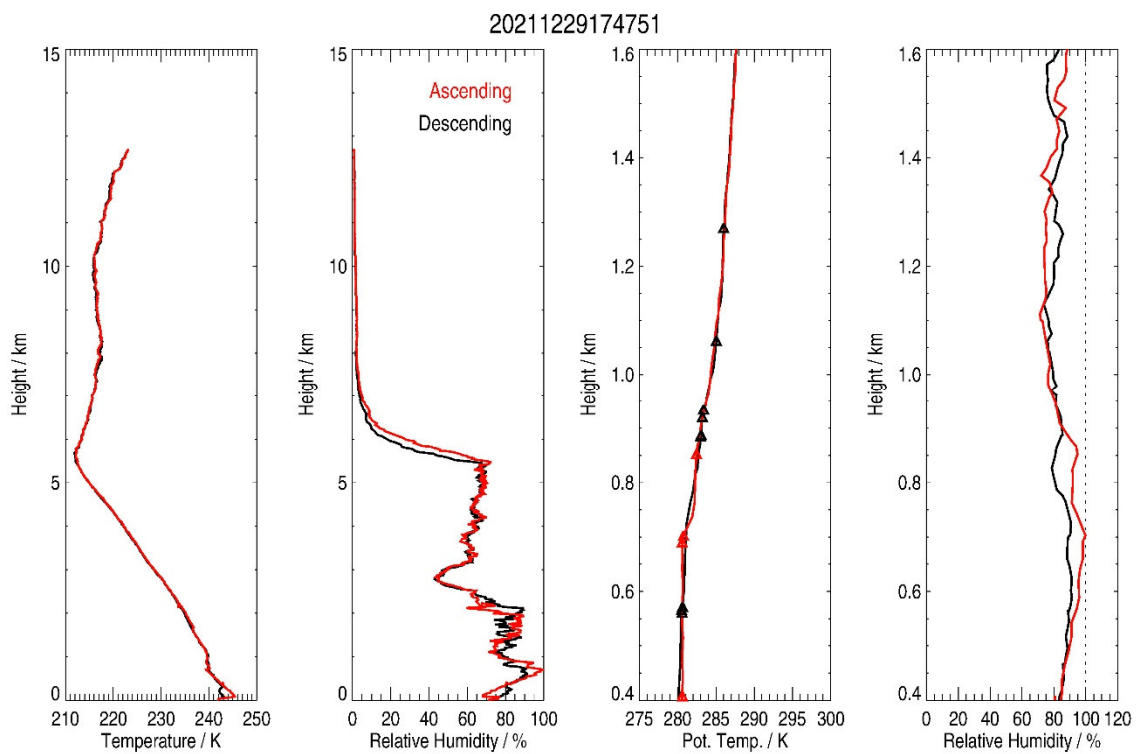
Figure S11: Same as Figure S6 but for 29 December 2021 at 17:47 UTC.

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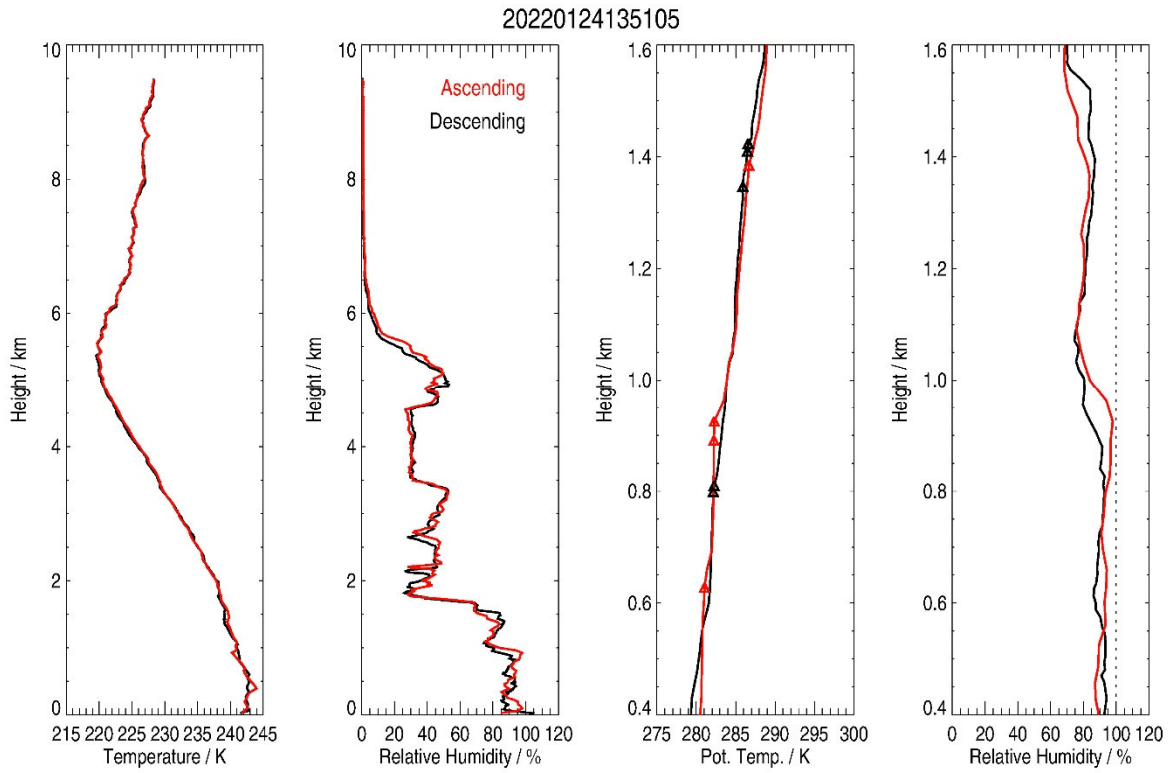
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78 **Figure S12:** Same as Figure S6 but for 24 January 2022 at 13:51 UTC.

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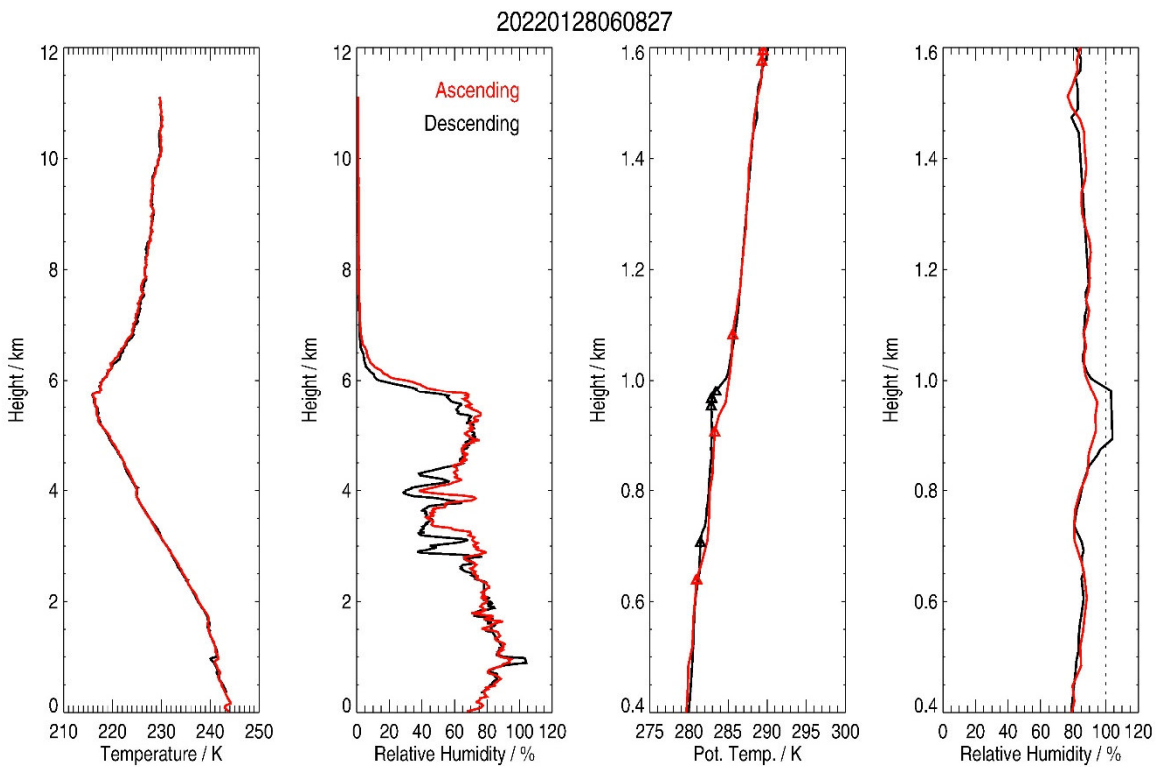
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81 **Figure S13:** Same as Figure S6 but for 28 January 2022 at 06:08 UTC.

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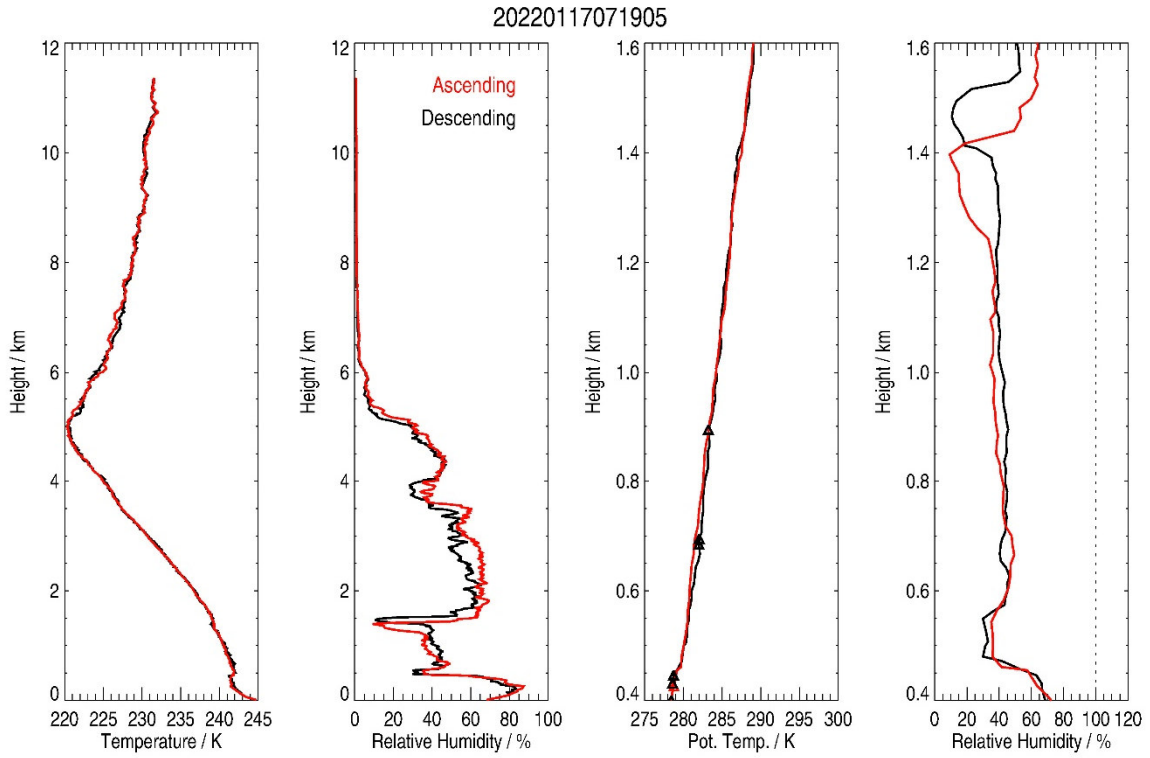
Figure S14: Same as Figure S6 but for 17 January 2022 at 07:19 UTC (cloud-free period).

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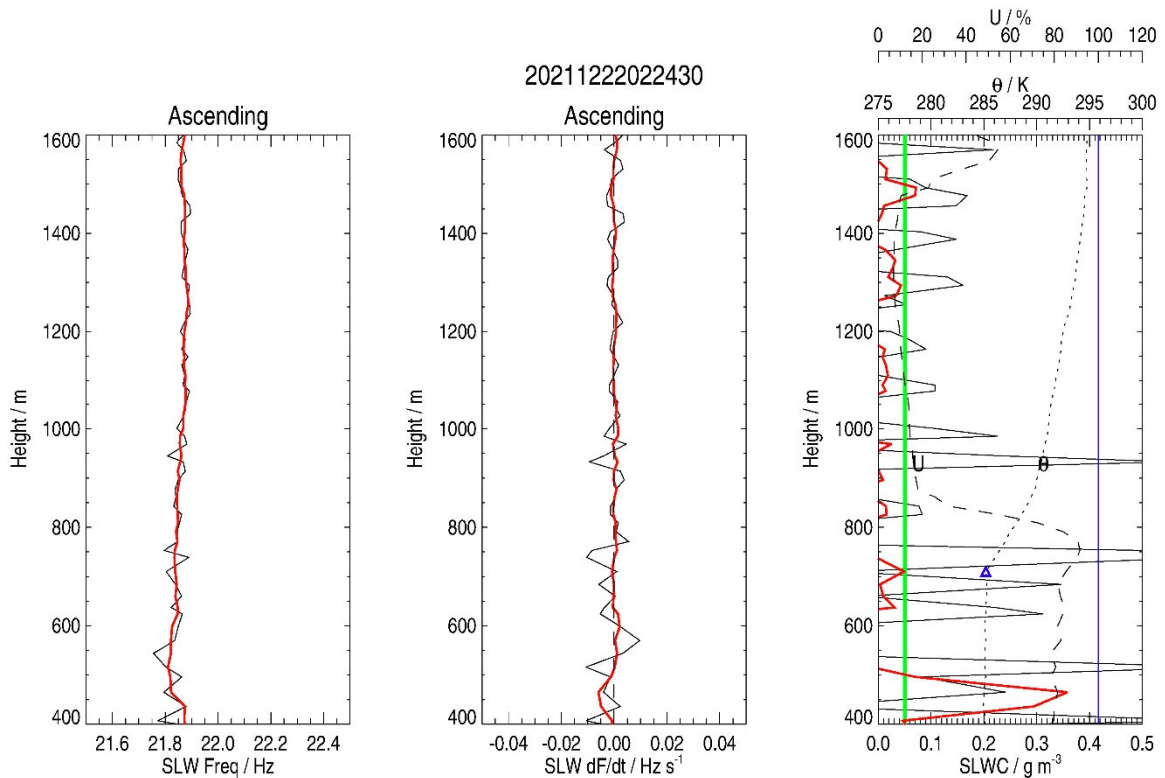
85 **3. SLWC**

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87 **Figure S15:** Profiles of: (left) SLWC sonde frequency f (black; Hz), (middle) df / dt (black;

88 Hz s^{-1}); and (right) SLWC (black; g m^{-3}) observed on 22 December 2021 at 02:24 UTC. 4-point

89 (20 s) running averages are displayed in red. On the right panel, potential temperature (θ, K)

90 and relative humidity (U, %) are shown as dotted and dashed lines, respectively. Blue triangles

91 represent the height of the potential temperature inflection points. The green vertical line

92 represents the estimated one-sigma error (0.05 g m^{-3}) of the SLWC estimates from the SLWC

93 sonde observations. The blue vertical line indicates the 100% relative humidity.

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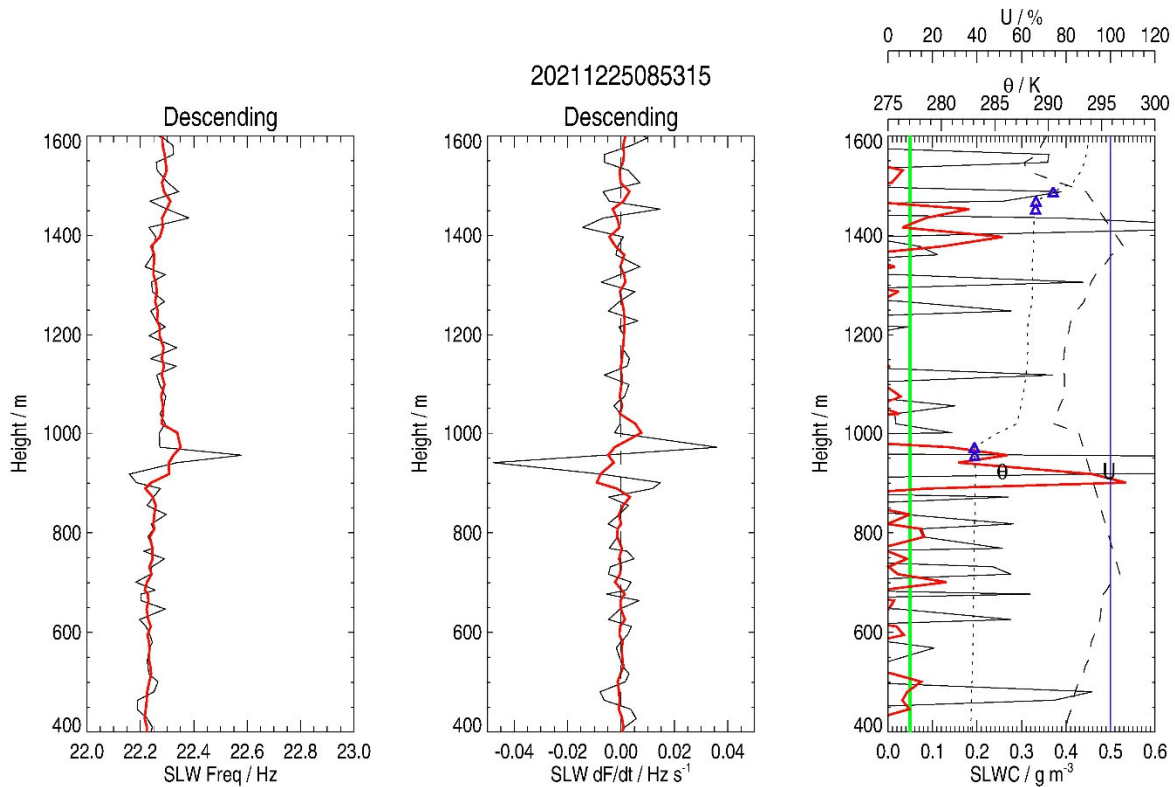
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96 **Figure S16:** Same as Figure S15 but for 25 December 2021 at 08:53 UTC.

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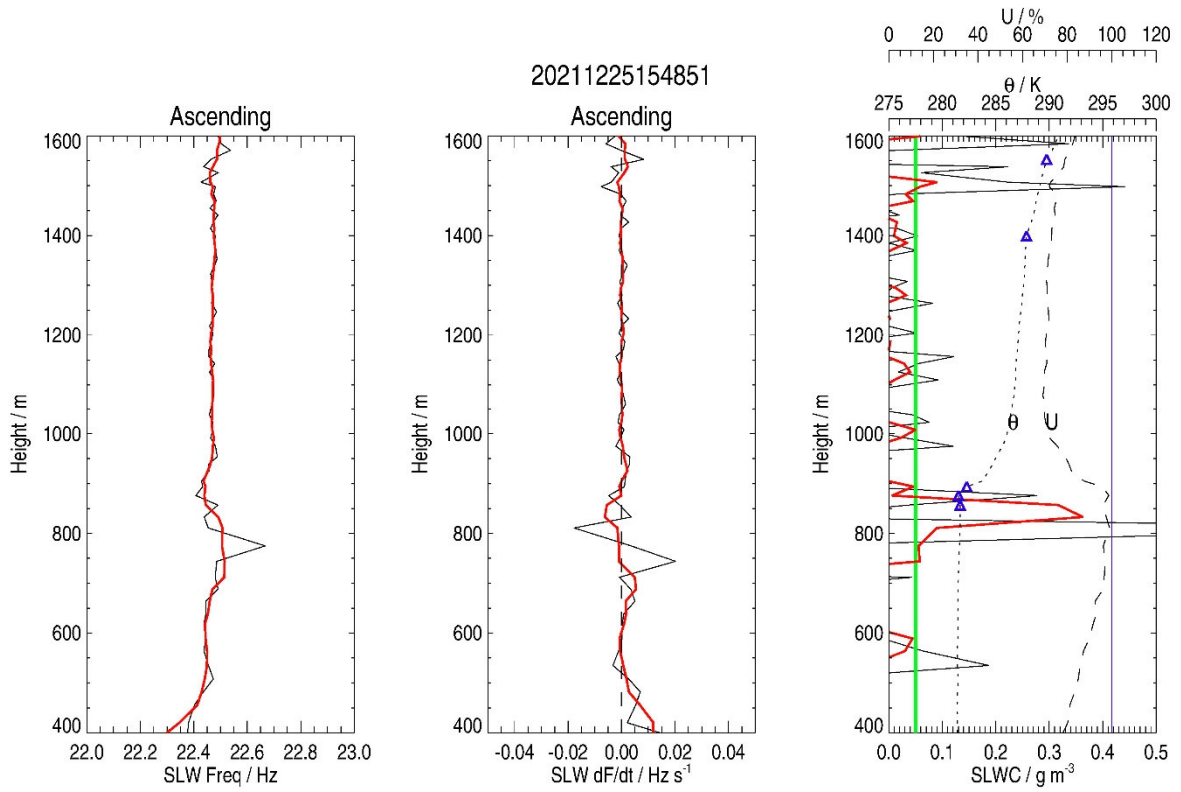
Figure S17: Same as Figure S15 but for 25 December 2021 at 15:48 UTC.

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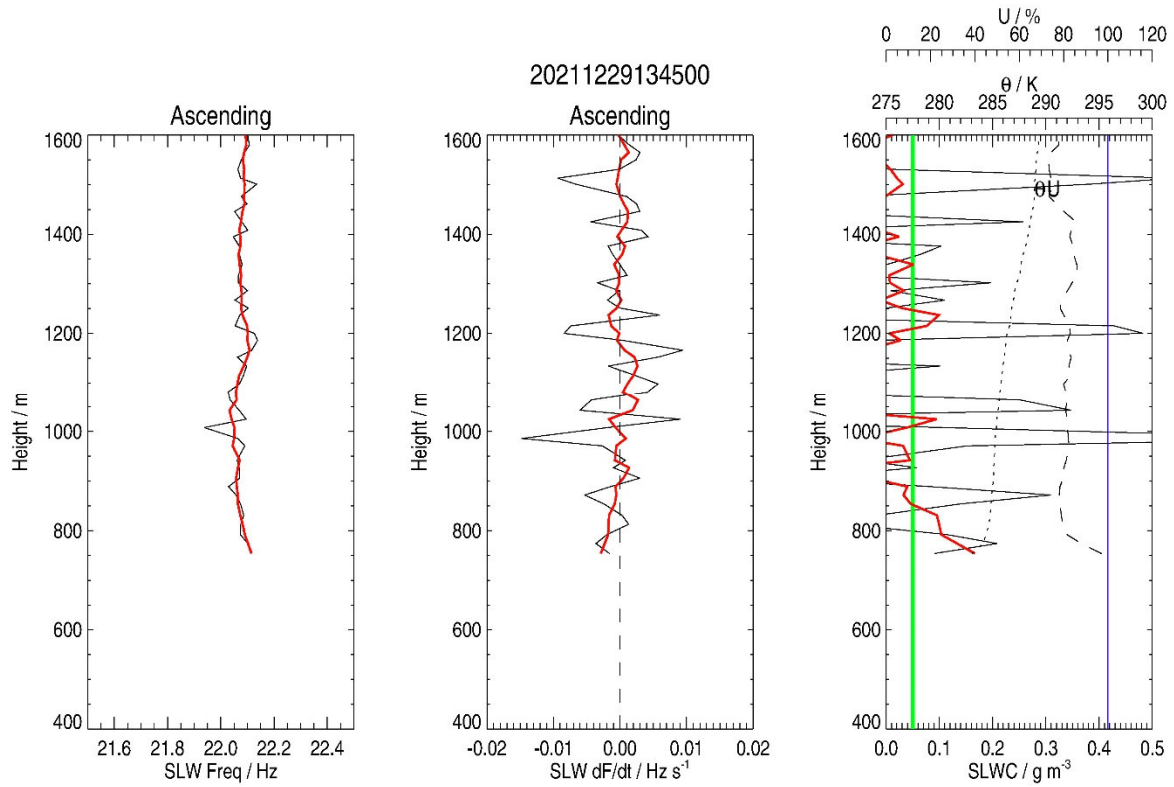
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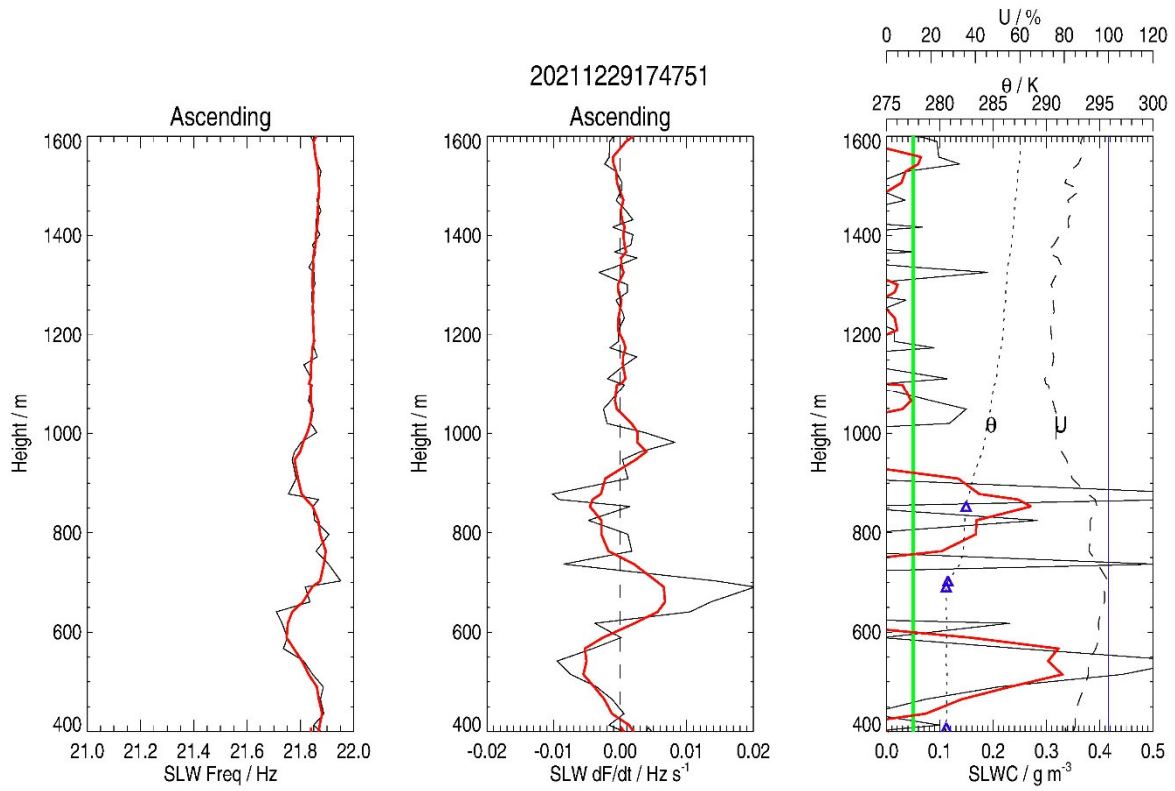
102   **Figure S18:** Same as Figure S15 but for 29 December 2021 at 13:45 UTC.

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

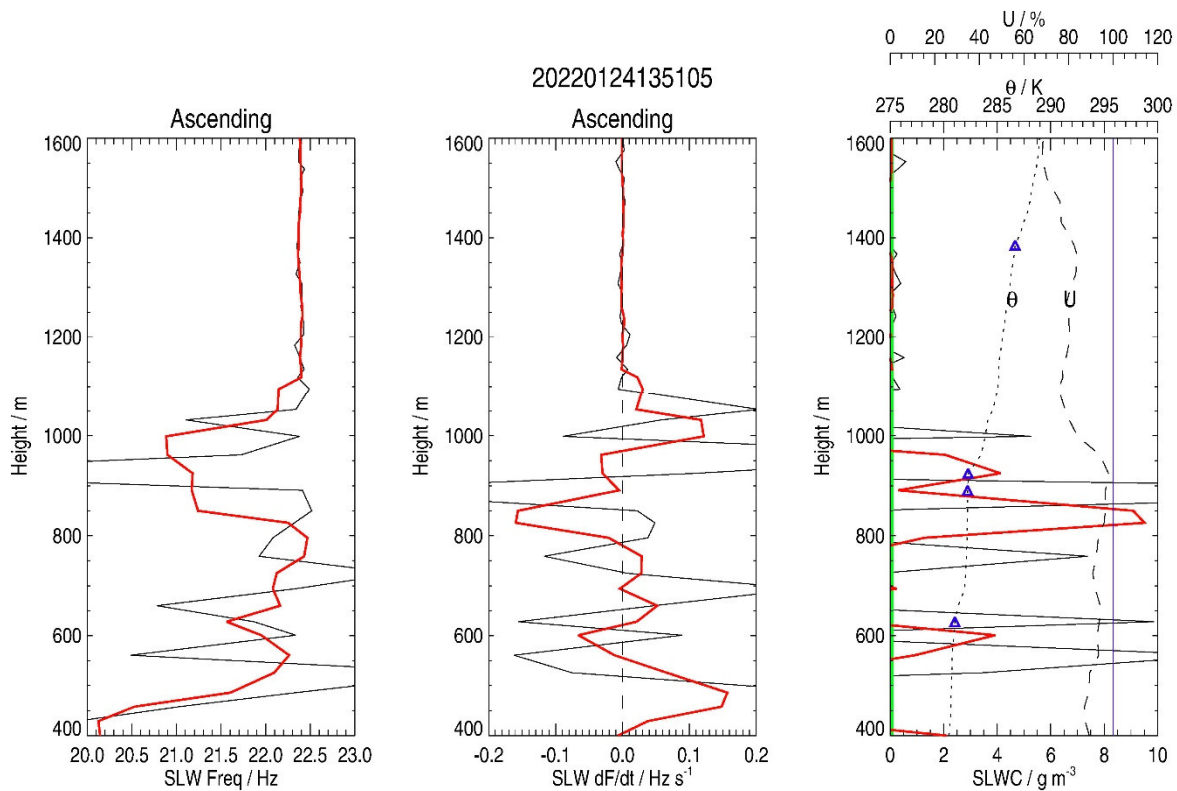



Figure S20: Same as Figure S15 but for 24 January 2022 at 13:51 UTC (ascending phase)

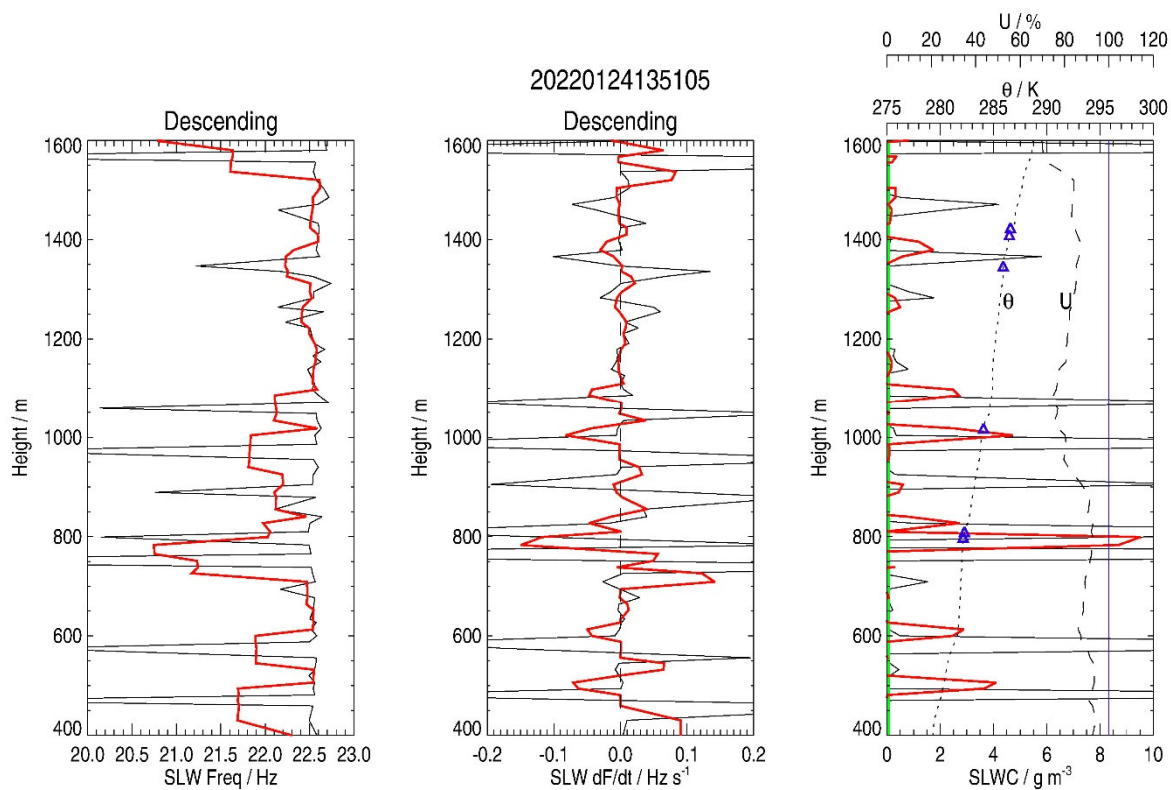
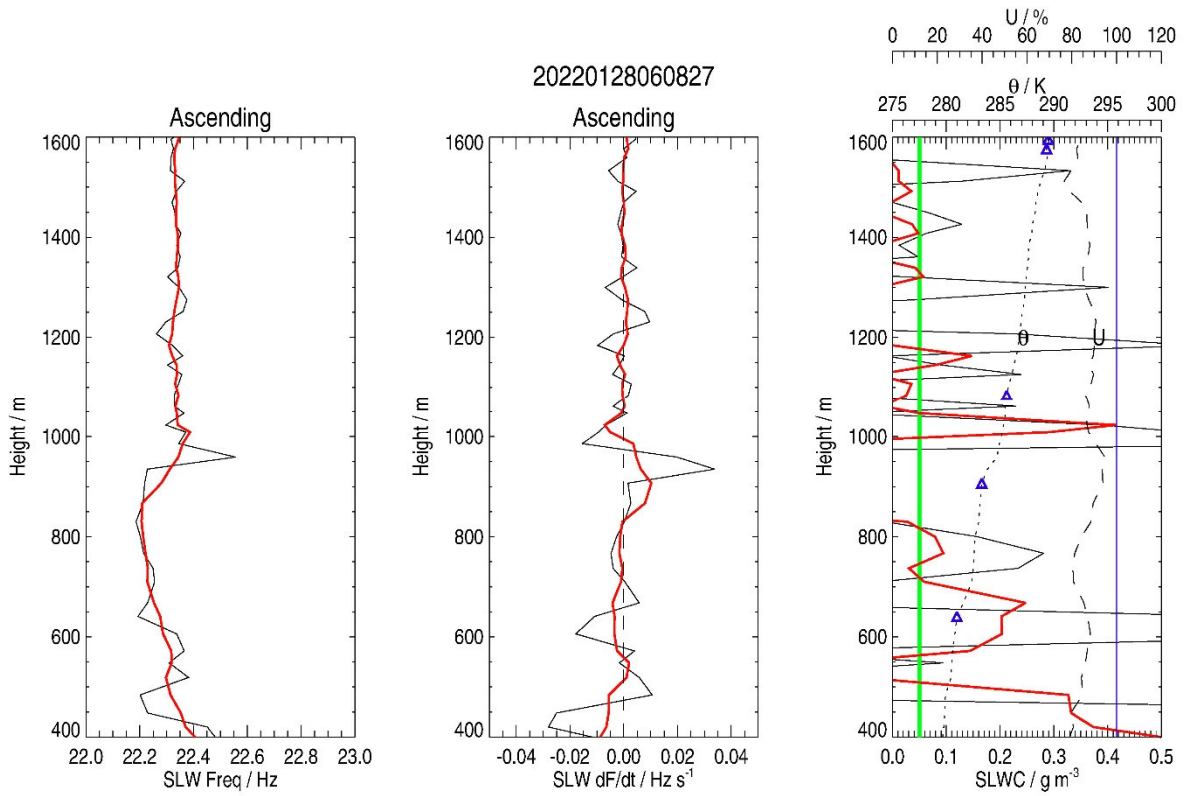



Figure S21: Same as Figure S15 but for 24 January 2022 at 13:51 UTC (descending phase).

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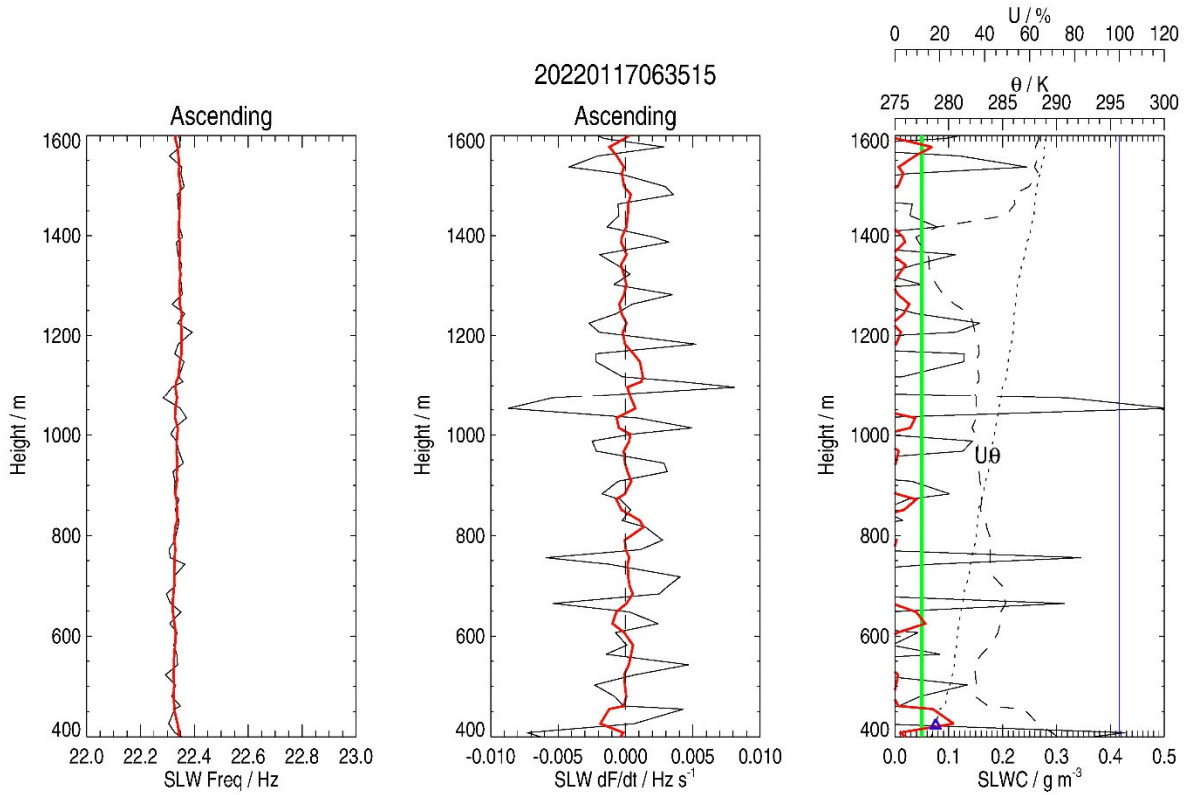
110   **Figure S22:** Same as Figure S15 but for 28 January 2022 at 06:08 UTC.

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112 **Figure S23:** Same as Figure S15 but for 17 January 2022 at 06:35 UTC (ascending phase) in

113 cloud-free conditions.

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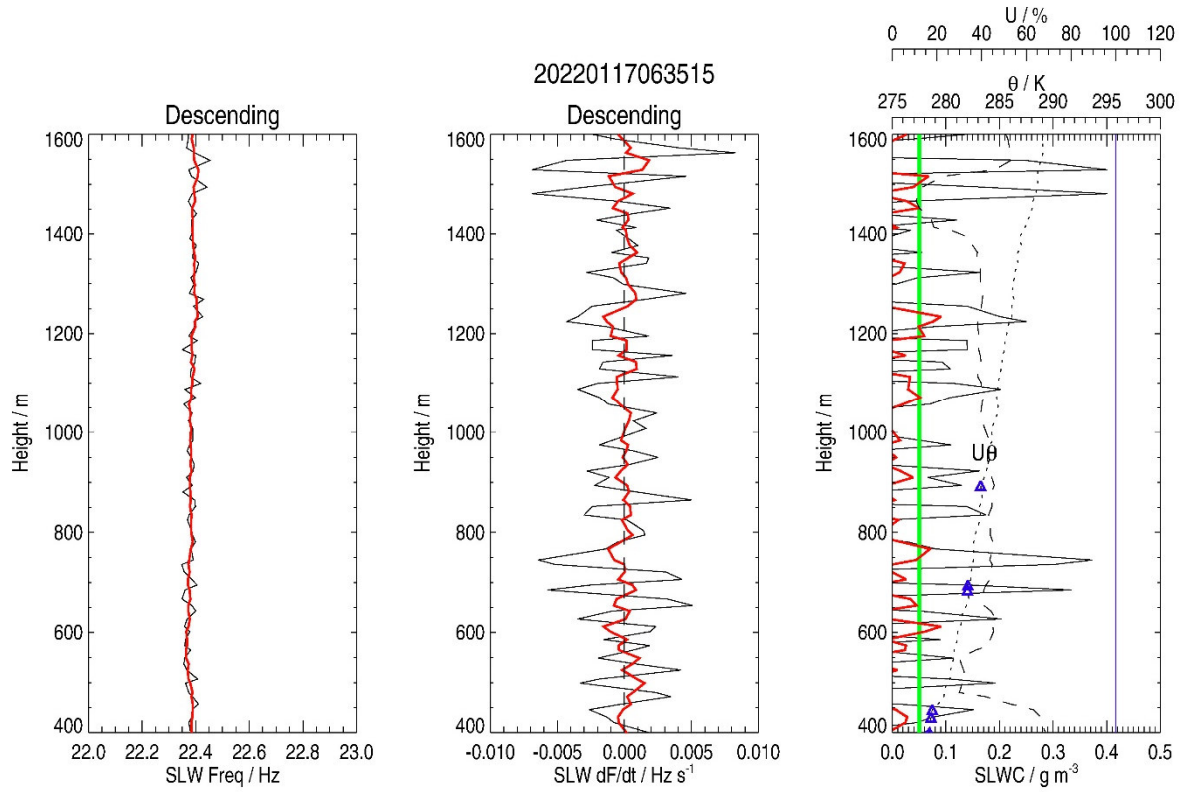
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116 **Figure S24:** Same as Figure S15 but for 17 January 2022 at 06:35 UTC (descending phase) in

117 cloud-free conditions.

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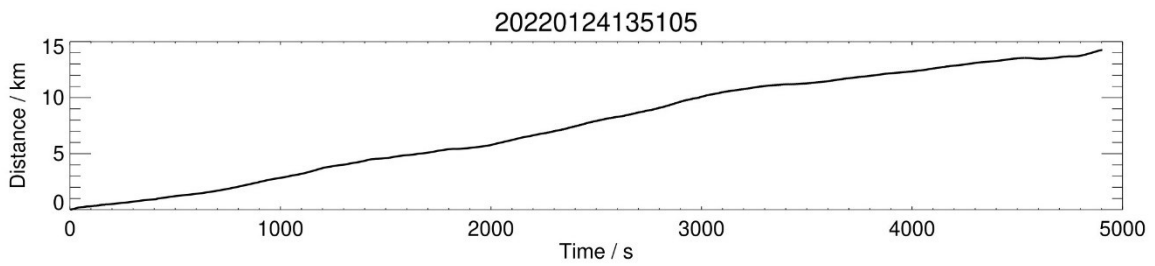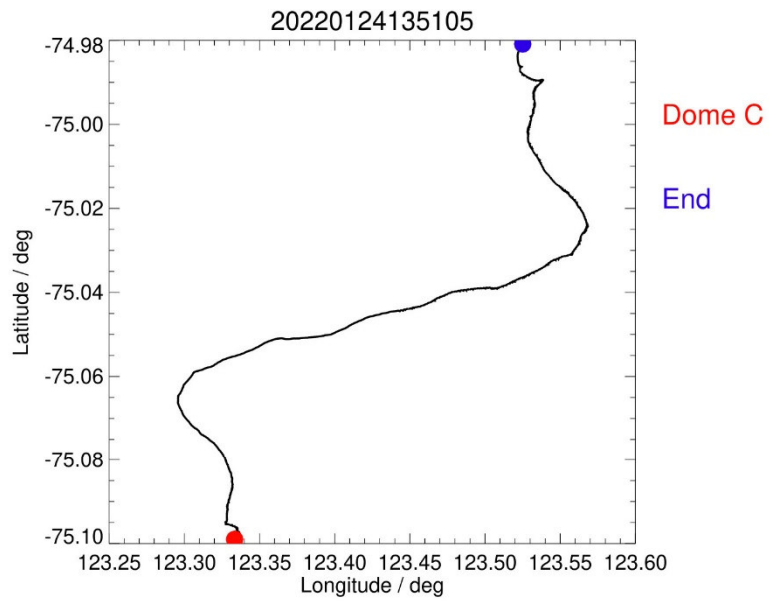
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120 **Figure S25:** (Top) Path followed by the meteorological balloon launched on 24 January 2022

121 at 13:51:05 UTC (L14) (red circle) up to the end of the flight (blue circle). (Bottom) Distance

122 travelled (km) as a function of time since launch.

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