HALO-0215 (15 February 2020)

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1 Objective

This last local research flight from HALO took place as a thick layer of Altostratus was covering all the area extending from Barbados to NTAS. This situation was considered as an opportunity to investigate the radiative impact of upper level clouds on boundary-layer clouds. For this purpose, we flew both above and below the altostratus layer, with the hope that it will allow us to measure the radiative divergence across the upper cloud layer, and to characterize the shallow clouds below it. Our sounding strategy was adapted to the objectives of the mission and to the reduced number of dropsondes available at this stage of the campaign.

Our flight was composed of: 2 circles near Barbados, flown mostly below the altostratus layer; an excursion to NTAS composed of: an outbound leg flown above the altostratus layer, a circle flown below the altostratus layer just before NTAS and a return (inbound) leg to the Barbados area flown below the altostratus layer; and then a series of 3 circles near Barbados: one below and two above the altostratus layer.

2 Crew

Sandrine Bony (Mission PI), Hauke Schulz & Marc Prange (Dropsonde), Martin Hagen (HAMP), Kevin Wolf (SpecMAC & SMART), Andreas Fix (WALES), S. M. Samkeyat Shohan (Velox), Stefan Grillenbeck & Roland Welser (Pilots), Thomas Leder (Engineer)

3 Synoptic Situation

The advection of a moist layer coming from the South led to the presence of a thick and persistent altostratus layer covering the area from Barbados to NTAS (Figures1 and 2). The top of this cloud layer was around 9 km. Its base was clearly above the freezing level, but varied somewhat with space (lower in the NW of the circle than in the SE). During the 2nd circle (17:06-17:36 UTC), some precipitation from this cloud layer was detected by HAMP (Poldirad as well). At the surface, the tradewinds were strong (6-8 m/ s at BCO, about 10 m/s for dropsondes).

Shallow clouds were present below the altostratus, with cloud tops generally around 800 m, sometimes extending to 1.5 to 2 km. Some shallow stratiform layers were also observed around 1.9 to 2 km. Their spatial organization could not be characterized from space because of the presence of the upper cloud layer, and it was difficult to characterize it visually from below the altostratus layer.

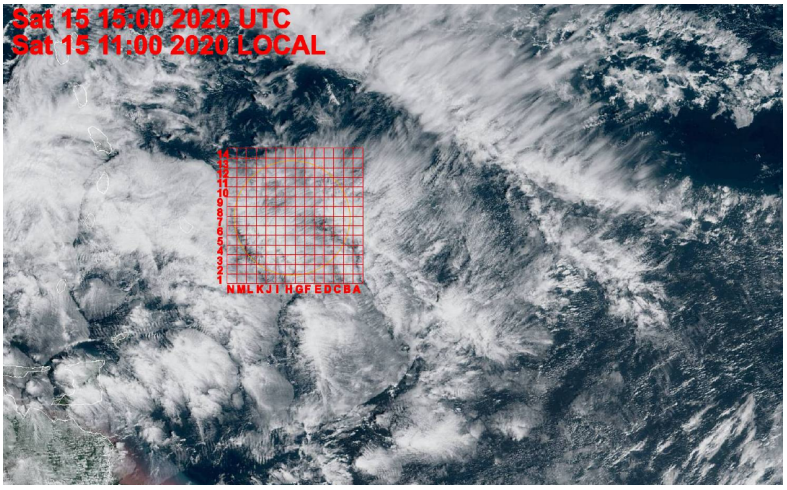

Figure 1: GOES visible imagery at 15:00 UTC (HALO circle under the grid) showing the alto-stratus layer.

During our flight, only one other aircraft, the Twin Otter, was flying in the western side of the circle. A saildrone was also present in the NW part of the Barbados circle (around 10 o' clock).

4 Flight Elements

Table 1: Overview of main elements of flight

Element	(center °N, °W)	Flight Level (FL)	Time (UTC)	Notes
Takeoff & Ferry	GAIA	Ascent to 320	15:06	
Circle 1	(13.3, 57.7)	180	15:35	11 sondes
Circle 2	(13.3, 57.7)	180	16:40	7 sondes
NTAS-leg outbound		370	17:48	Above altostratus
Circle 3	(13.9, 52.1)	180	18:17	12 sondes
NTAS-leg inbound		180	19:23	Below altostratus
Circle 4	(13.3, 57.7)	180	20:00	no sondes
Circle 5	(13.3, 57.7)	350	21:10	12 sondes
Circle 6	(13.3, 57.7)	350	22:30	8 sondes
Ferry		160	23:28	
Landing	GAIA	n/a	24:12	

Circle 1 Dropped 11 sondes with roughly even spacing (30^o), 1^{st} one at 15:38, last one at 16:34. The circle started at FL320, but then the altitude decreased to FL200 (in the SW part of the

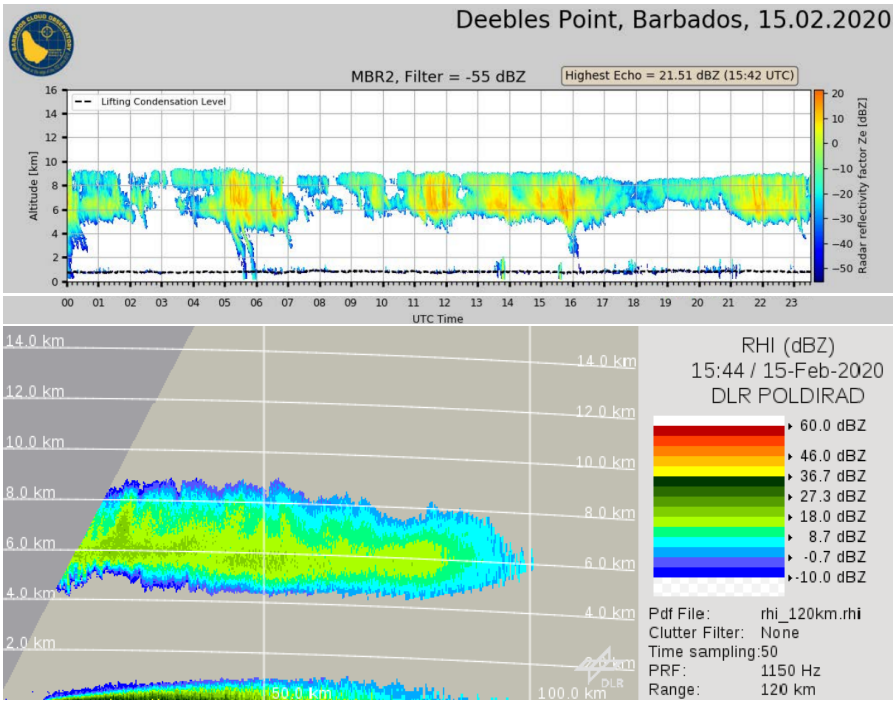

Figure 2: The thick and persistent ice cloud layer in the upper atmosphere observed by the CORAL radar at BCO (time series on top) and by Poldirad (snapshot at 15:44 UTC at the bottom).

circle) and then FL180 (in the northern part of the circle) to remain below the base of the altostratus layer. At the end of the circle (around 16:40), the lidar detects more aerosols and deeper clouds.

Circle 2 Dropped 7 sondes from FL180 with roughly even spacing (45^o), 1^{st} one at 16:41, last one at 17:41. Shallow clouds have cloud tops around 800 m. In the South of this circle, some shallow clouds exhibit stratiform layers. At 17:06 and 17:36, some precipitation from the cloud layer aloft is detected from HAMP (and PoldiRad). Around 17:10, a cold pool is observed.

NTAS-leg outbound Flight above the altostratus layer, which becomes thinner and thinner as we move Eastward.

Circle 3 Dropped 12 sondes with roughly even spacing (30^o), 1^{st} one at 18:17 from FL370, last one at 19:16 from FL280. The last 8 sondes of this circle were dropped from FL180. The position of this circle was such that its eastern most side (51 W) was at the edge of the area where sondes could be dropped. Low-level cloudiness below the altostratus layer: none in the North of the circle, sugar clouds in the SE part of the circle, more and deeper clouds in the Southern part of the circle (and a lot of dust), with cloud tops around 800m-1km, sometimes reaching 1.8 km. Around 19:10: precipitation from shallow clouds (up to 1.2

km) is observed from the radar. At cloudbow and a glory were observed at 18:47 UTC.

NTAS-leg inbound Flight below the altostratus layer (FL180). Low-level clouds everywhere, mostly sugar-type, but progressively getting deeper. Some exhibit stratiform layers.

Circle 4 No sondes. FL180. Active shallow convection.

Circle 5 Dropped 12 sondes, 1^{st} one at 21:20, last one at 22:35. The flight level was as high as the ATC did allow us to fly (mostly FL360). After the 1st sonde, a detour from circle was requested by ATC because of air traffic. Return to the circle 20 min later (21:38). Turbulence at the flight level. PoldiRad detects precipitation in the NE and Southern parts of the circle, but no precipitation from shallow clouds. Low clouds mostly aligned along the wind.

Circle 6 Dropped 8 sondes (every 45 ^{o}), 1^{st} one at 22:41, last one at 23:28. Considering circles 5 and 6 together: 12 consecutive sondes (33 to 44, 21:54 to 22:47) have been dropped every 30^o from FL360.

5 Instrument Status

BACARDI No issues reported.

BAHAMAS No issues reported.

Dropsondes 50 sondes were dropped in total. One had data only in the boundary layer.

HAMP radar No issues reported.

HAMP radiometer The 183 GHz channel failed after about one hour.

SMART No issues reported.

SpecMACS No issues reported.

Velox No issues reported.

WALES lidar One of the two lasers was switched off whenever we were flying at low altitude (FL 180).

6 Figures

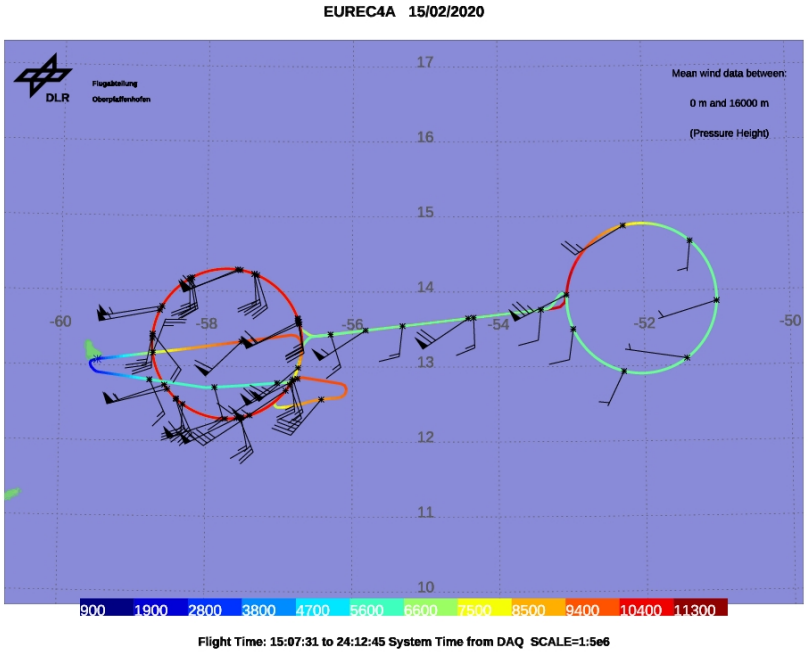

Figure 3: Flight trajectory and position of dropsondes (color indicates the height, in km, of the flight).

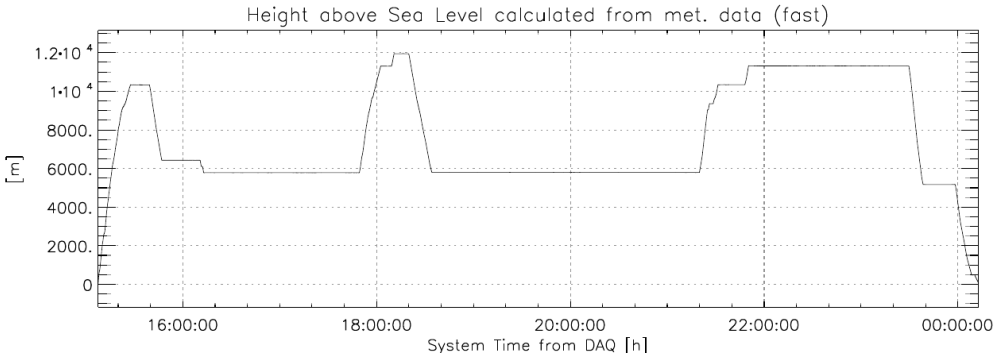

Figure 4: Time series of flight altitude (from BAHAMAS).

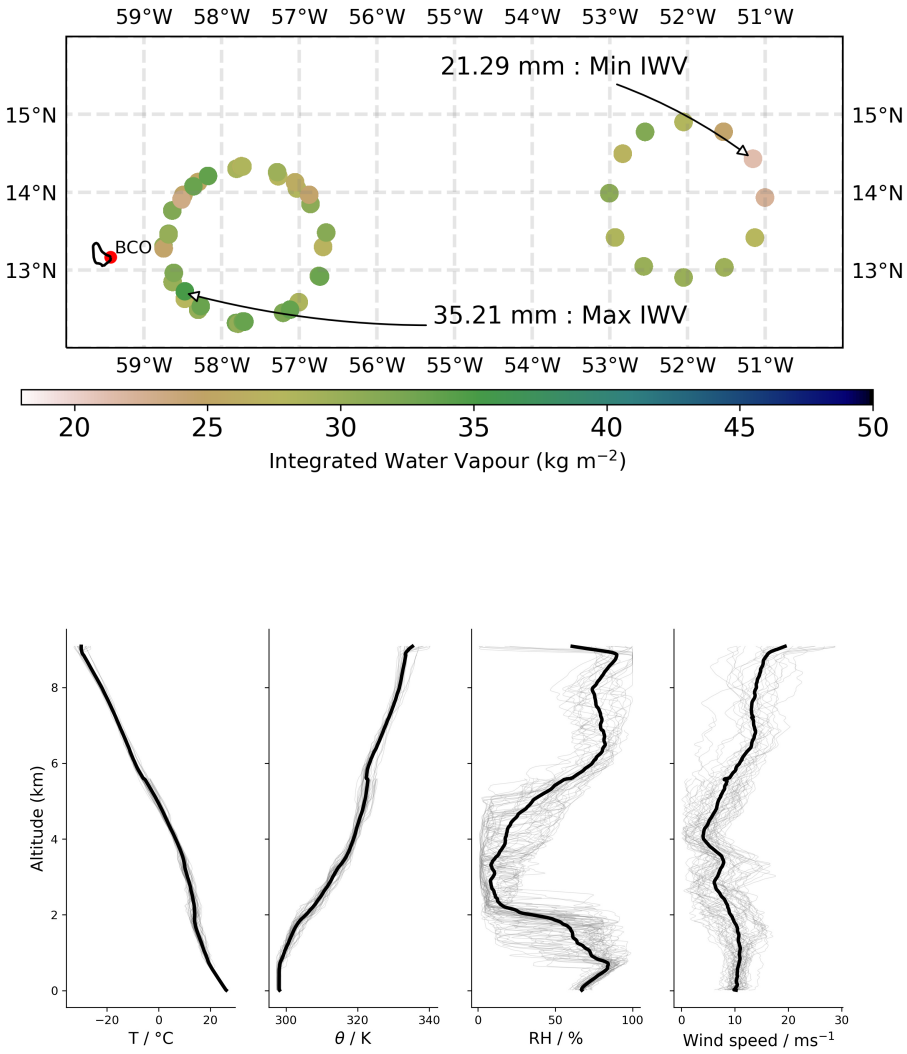

Figure 5: Position of the dropsondes (with the vertically integrated water vapor in color) and vertical profiles derived from the sondes (gray lines represent profiles from individual sondes, the thick line represents the averaged profile).

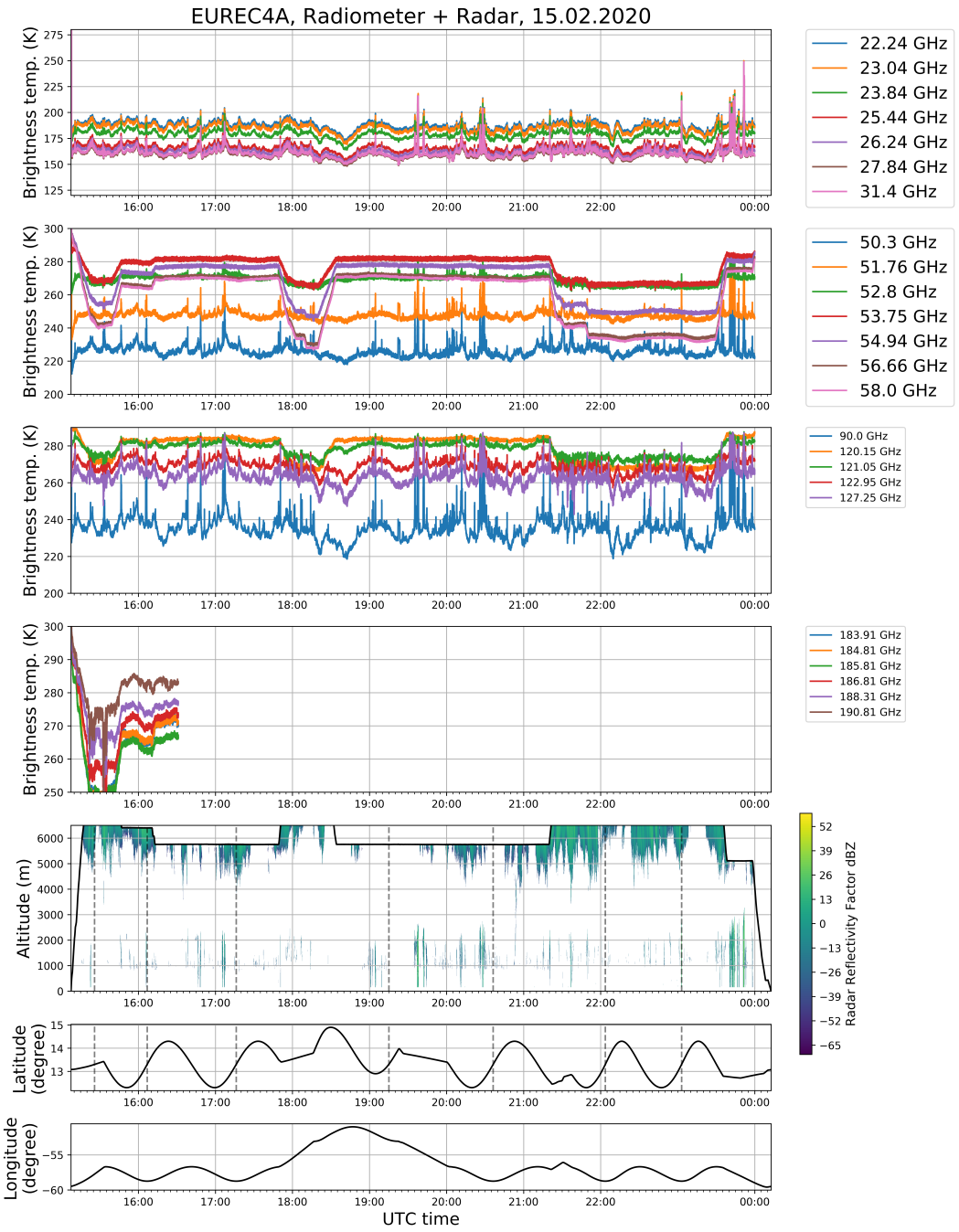

Figure 6: HAMP quicklook.

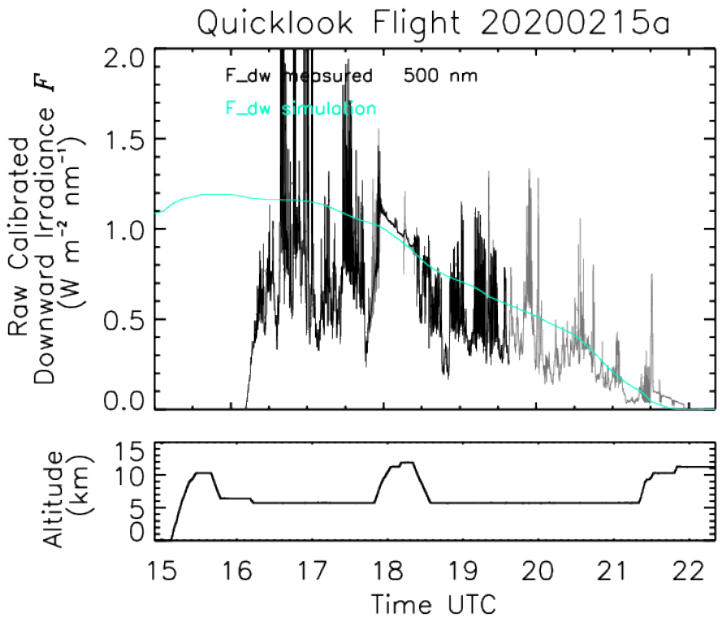

Figure 7: SMART irradiance.

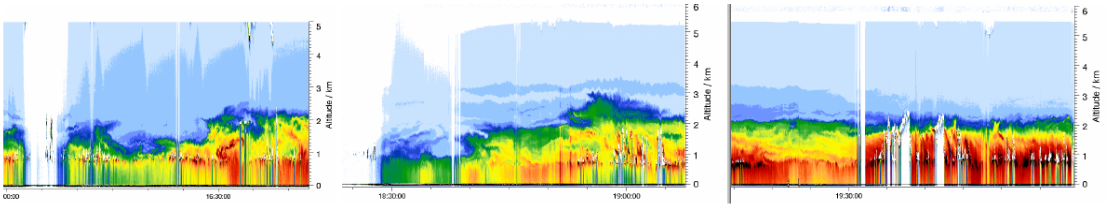

Figure 8: WALES quicklooks (top left) near the end of Circle 2 (16:43 UTC), (top right) during Circle 3 (19:08 UTC) and (bottom) at the beginning of Circle 4 (20:00 UTC).

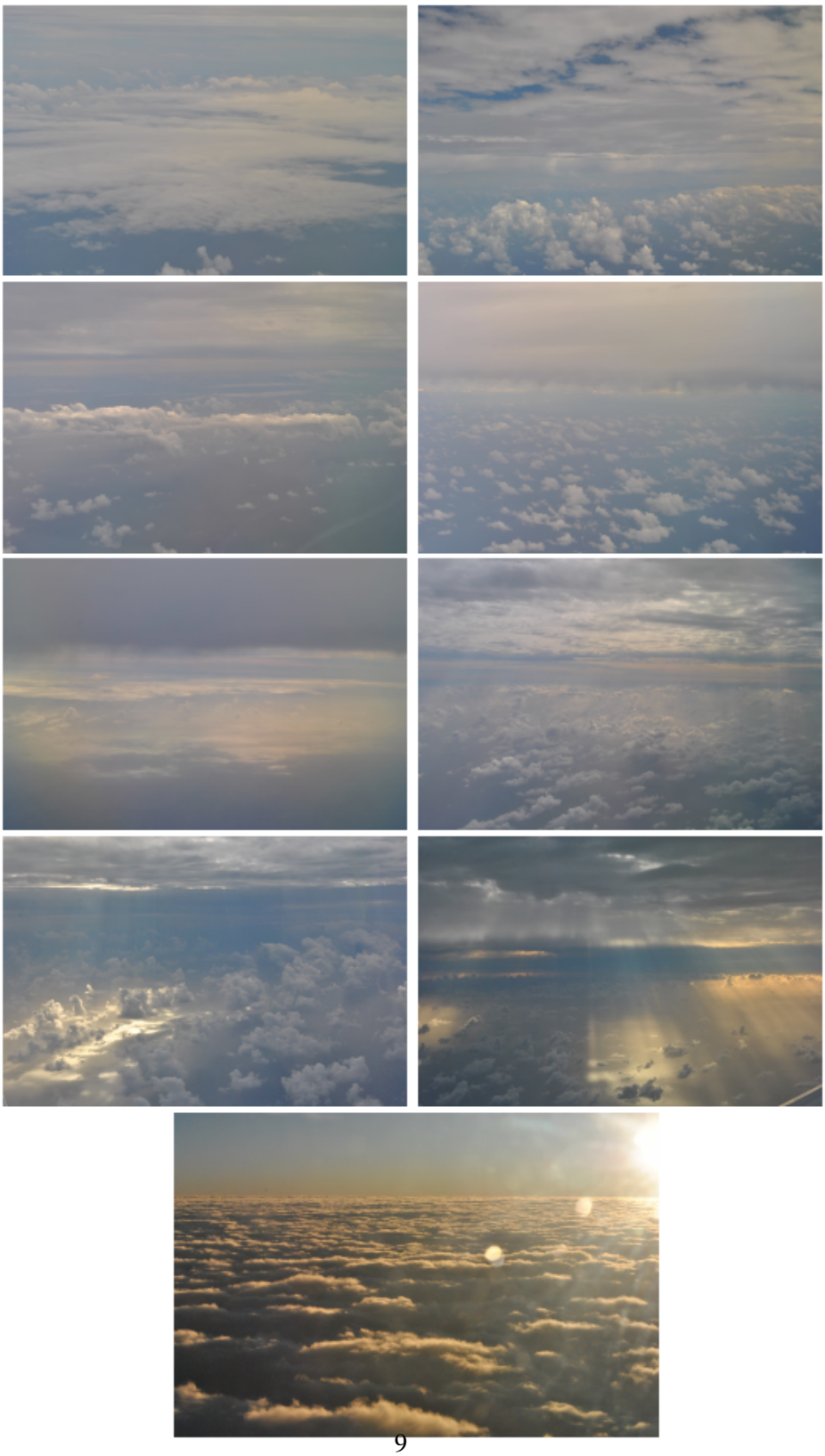

Figure 9: Snapshots from flight. From left to right, 1st row (C1): 15:51 UTC (shallow stratiform layers), 16:40 UTC (shallow cumuli under altostratus). 2nd row (C2): 17:00 UTC (stratiform layers forming at the top of shallow Cu), 17:34 UTC (shallow Cu under precipitating altostratus). 3rd row (C3): 18:48 UTC and 19:07 UTC. 4th row (C4): 20:35 UTC and 21:08 UTC (active low clouds under altostratus). 5th row (C5): 21:55 UTC (top of the altostratus layer at sunset).

Figure 10: Right before the departure (doors were closed), the crew discovered that one instrument was missing: the HALO camera! Thanks to Thomas' reactivity, Nicolas' sporty drive and Geet's heroic run, HALO could finaly take off for its last local research flight with its full instrumentation! (Photos: Marek Jacob)

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