HALO-0202 (02 February 2020)

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1. Objectives

- Flying seven standard circle patterns (six circles with dropsondes) to extend the EUREC^{4}A statistics by a regular daylight flight.
- Flying under swath of GPM satellite in the eastern part of the circle. GPM covered this region at 12:05 UTC.
- Exploring the potential to observe divergence at multiple scales and characterizing the clouds inside the circle by flying the novel clover pattern as excursion.

2. Crew

Felix Ament (Mission PI), Andreas Fix (WALES), Florian Ewald (HAMP), Veronika Pörtge (SpecMacs), Kevin Wolf (Smart/Velox), Geet George (Dropsondes), Eleni Tetoni (HAMP, dropsonde support); Roland Welser & Marc Puskeiler (Pilots), Sebastian Gerstner (flight engineer)
Contact at ground: Marc Prange & Theresa Lang

3. Synoptic Situation

Easterly surface winds transported relatively dry air with a high load of Saharan dust towards Barbados (Fig. 1). Local weather was controlled by high-pressure ridge. A strong temperature gradient at about 2.8 km height capped the boundary layer. Aerosol and moisture was confined to this layer (Fig. 2a). Surface wind were moderate with ~5 m/s – sea appeared calm without any whitecap. Air aloft was clear and dry. No cirrus was visible throughout the flight.

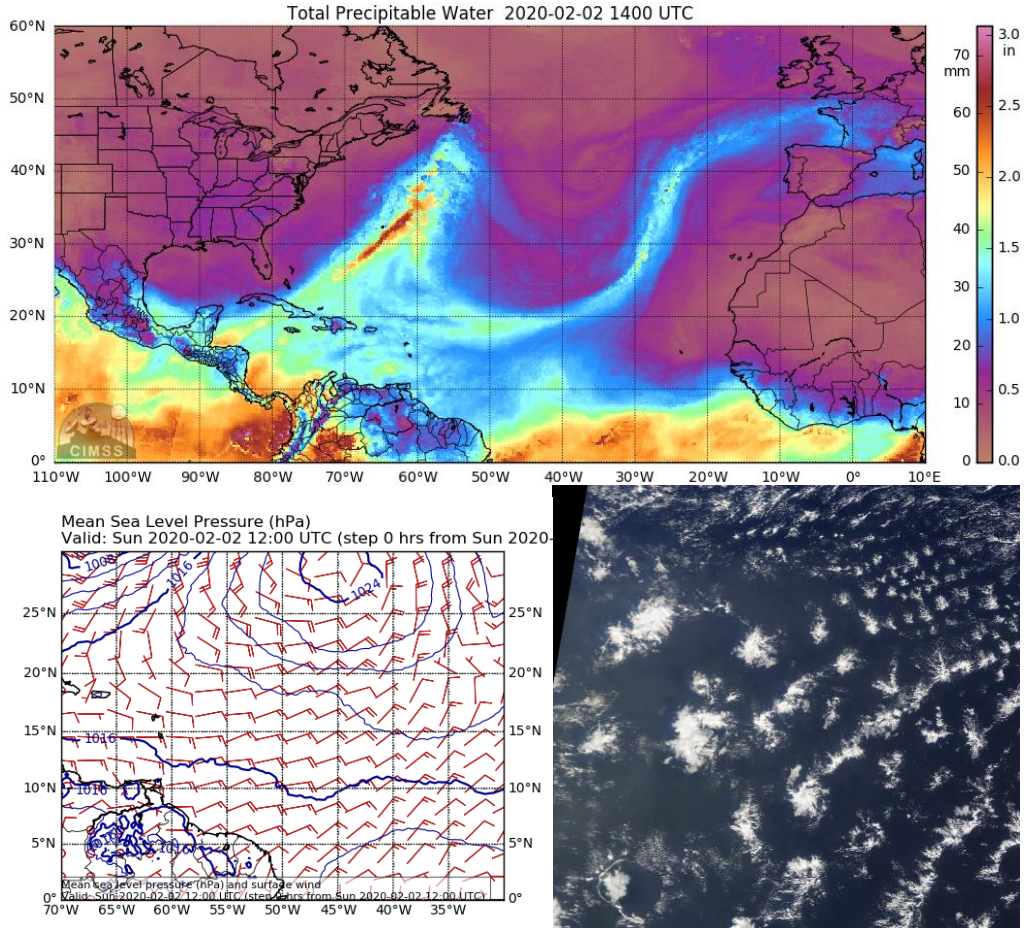

Figure 1: Total precipitable water from MIMIC-TPW Ver.2 (top); surface level pressure and wind analysis by the ICON model (bottom right) and MODIS image from NASA Worldview (bottom left).

Convection and clouds were organized as flowers moving mostly eastwards with a slight component to the North. Essentially, we tracked three to four flowers named the “Barbados flower”, the “gravel flower twins” and the “Brave Flower” (s. Fig. 1a):
We sampled the Barbados flower throughout the whole flight. During the first circle, it was located in the southeastern part of the circle. At the end of the flight, the Barbados flower had reached Barbados (as documented by nice pictures from BCO and the Poldirad site). The top of the Barabados flower was capped by almost stratiform clouds (s. Fig 2b). Only the trailing edge at northwest featured more vigorous, penetrating convection. In the evening, associated cold pool fronts occurred (Fig. 1b, Fig. 2g).
The Brave Flower (s. Fig 2d) developed in the Northwestern part of the circle. Its tops consisted of many convective cell without any stratiform structure. It moved to Northwestern part of the circle. This region was almost perfectly cloud free (s. Fig 2c). Accordingly, the Brave flower dissipated.
The gravel twins (Fig. 2f) developed from a gravel like line into flowers and entered the circle straight from the eastern side. Like the Brave Flower, clusters of small convective clouds dominate them. They dissipated slowly during the flight day.

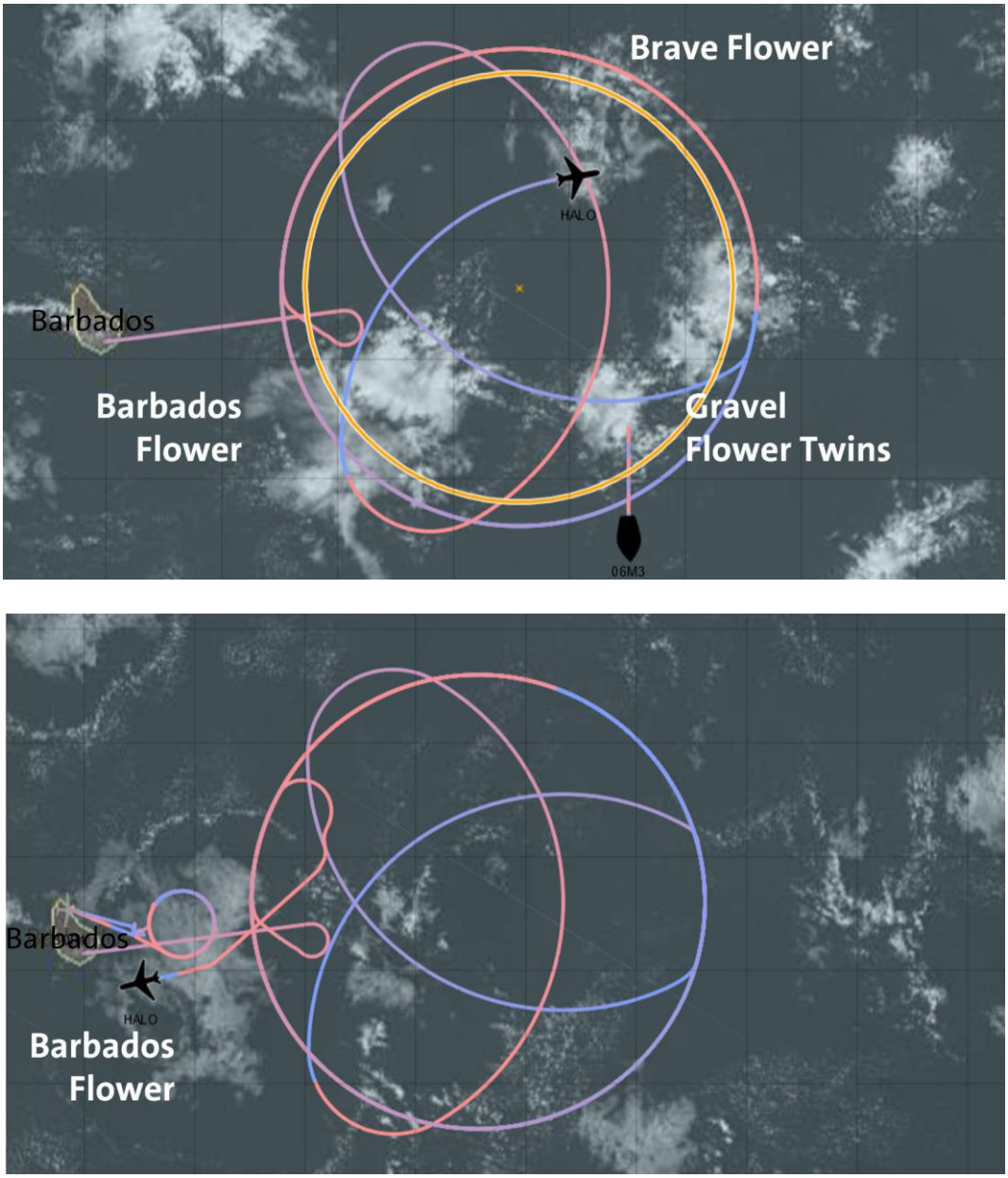

Figure 2: Flight track of HALO on top of GOES visible imagery at 16:15Z (top) and 20:02Z (bottom). (The small circle next to Barbados in the lower figure is the Boreal drone, not HALO).

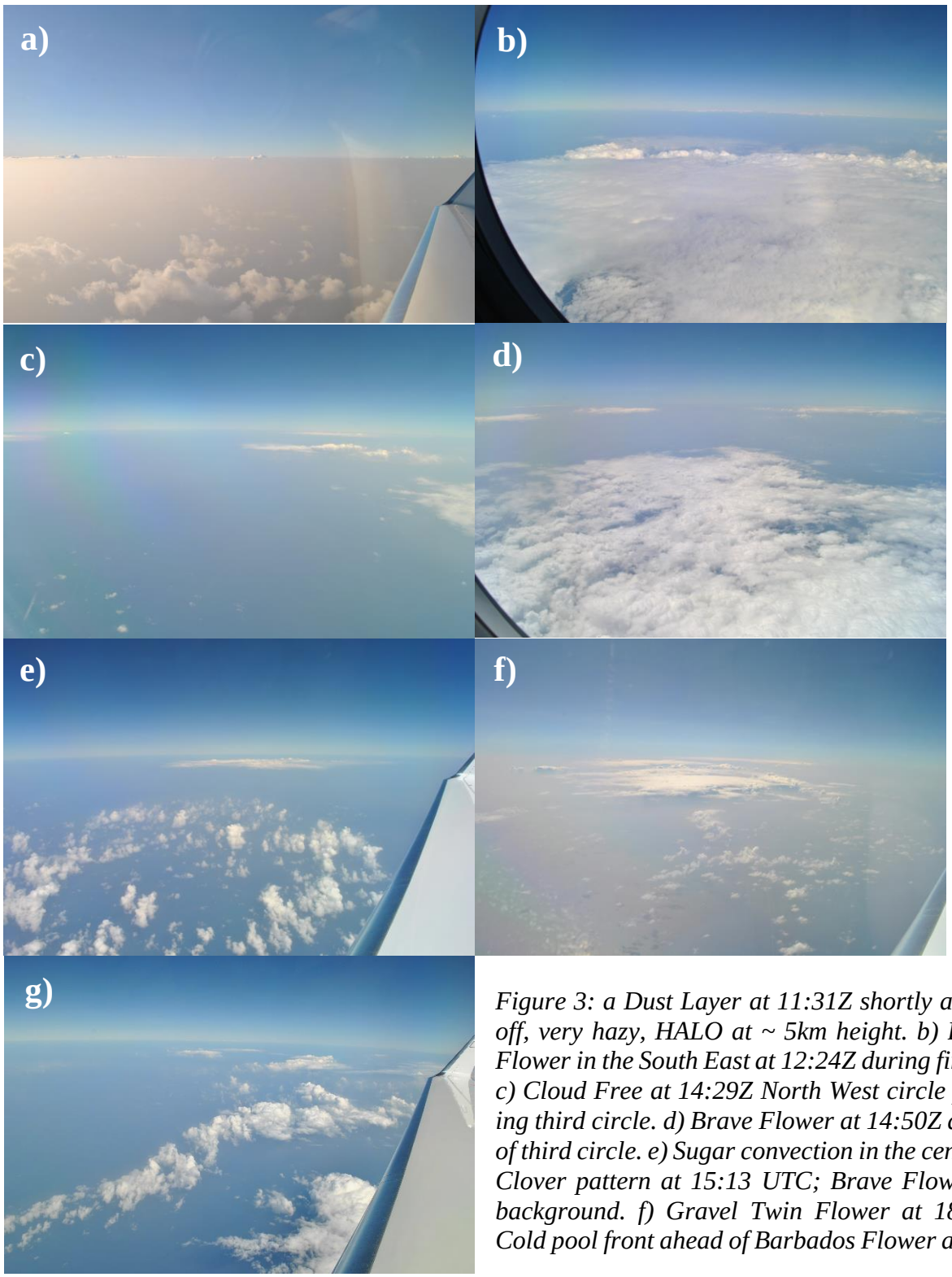

Figure 3: a Dust Layer at 11:31Z shortly after take-off, very hazy, HALO at ~ 5km height. b) Barbados Flower in the South East at 12:24Z during first circle. c) Cloud Free at 14:29Z North West circle part during third circle. d) Brave Flower at 14:50Z at the end of third circle. e) Sugar convection in the center of the Clover pattern at 15:13 UTC; Brave Flower in the background. f) Gravel Twin Flower at 18:11Z. g) Cold pool front ahead of Barbados Flower at 18:45Z.

4. Flight Elements

Element	Time period	Description	Notes
Takeoff at GAIA	11:28:00	ferry to circle entry point, ascend to FL320	
Circle 1	11:47:57 - 12:38:03 (first to last drop)	starting with 0°degree heading (west of circle), dropping every 30° in heading, after last sonde continued to fly circle skipping two sondes	
Circle 2	12:52:26 - 13:43:43 (first to last drop)	starting with 60°degree heading (northwest of circle), dropping every 30, after last sonde continued to fly circle skipping three sondes	
Circle 3	13:57:35 - 14:50:51 (first to last drop)	starting with 150°degree heading (northeast of circle), dropping every 30	Flying almost over Meteor at 14:13; one extra sonde in the center of Barbados flower at 14:18
Clover pattern	15:00:57 -16:16:55 (first to last drop)	Entering clover about 15° after the mots east cirle point; leaving clover about 15° prior to most east circle point. First and last sonde of in total 15 sondes shortly before and after the clover. Dropping sondes every 30° along all three long clover legs.	Roll angle at long legs ~2° (less than 3° of standard circle); roll angle during turns on average little less than 6°.
Circle 4	16:32:45- 17:22:49 (first to last drop)	starting with 240°degree heading (southeast of circle), dropping every 30, after last sonde continued to fly circle skipping two sondes	
Circle 5	17:38:57-18:28:30 (first to last drop)	starting with 300°degree heading (southwest of circle), dropping every 30, after last sonde continued to fly circle skipping two sondes	
Circle 6	18:42:02-19:34:40 (first to last drop)	starting with 0°degree heading (west of circle), dropping every 30, leaving circle after last sonde at 330° heading, descending to FL160	One extra sonde at 18:42:02 in the center of the Barbados flower
Radar circle	19:44-19:49	10° roll angle circle, clockwise, little less 270° turn	
Radar roll maneuver	19:50	Shaking between -20° to 20° roll angles	
Lidar leg	19:50-19.56	Straight leg at FL160; after the leg lidar and radar are switched off	
Landing	20:15	at GAIA	

Some comments on Clover Pattern: Entry and exit of clover were turns from the circle (rotation of 60°) with a maximum roll angle of 30° and about 1min duration to return to bank angles below 10°. The transition between long and short, “steep turning” legs inside the clover was smooth. Roll angle stayed always below 10°. During the first short turn, the roll angle increased from 4° to 8° due to wind. This short leg lasted for only 7 min. The roll angle of the second short turn was constant at 6° with a duration of 8 min.

5. Instrument Status

HAMP: Radar was fully operational; all radiometers in operation at ground including a complete calibration; KV stopped during takeoff but recovered quickly after restarting the computers. 183GHz radiometer hat problems with power supply but came back to operation at about 12:40Z.

SMART & VELOX: fully operational; VELOX windows was wet in the beginning but fully recovered quickly.

WALES: fully operational.

Sondes: 89 sondes released; three with limited radio connection.

6. Figures

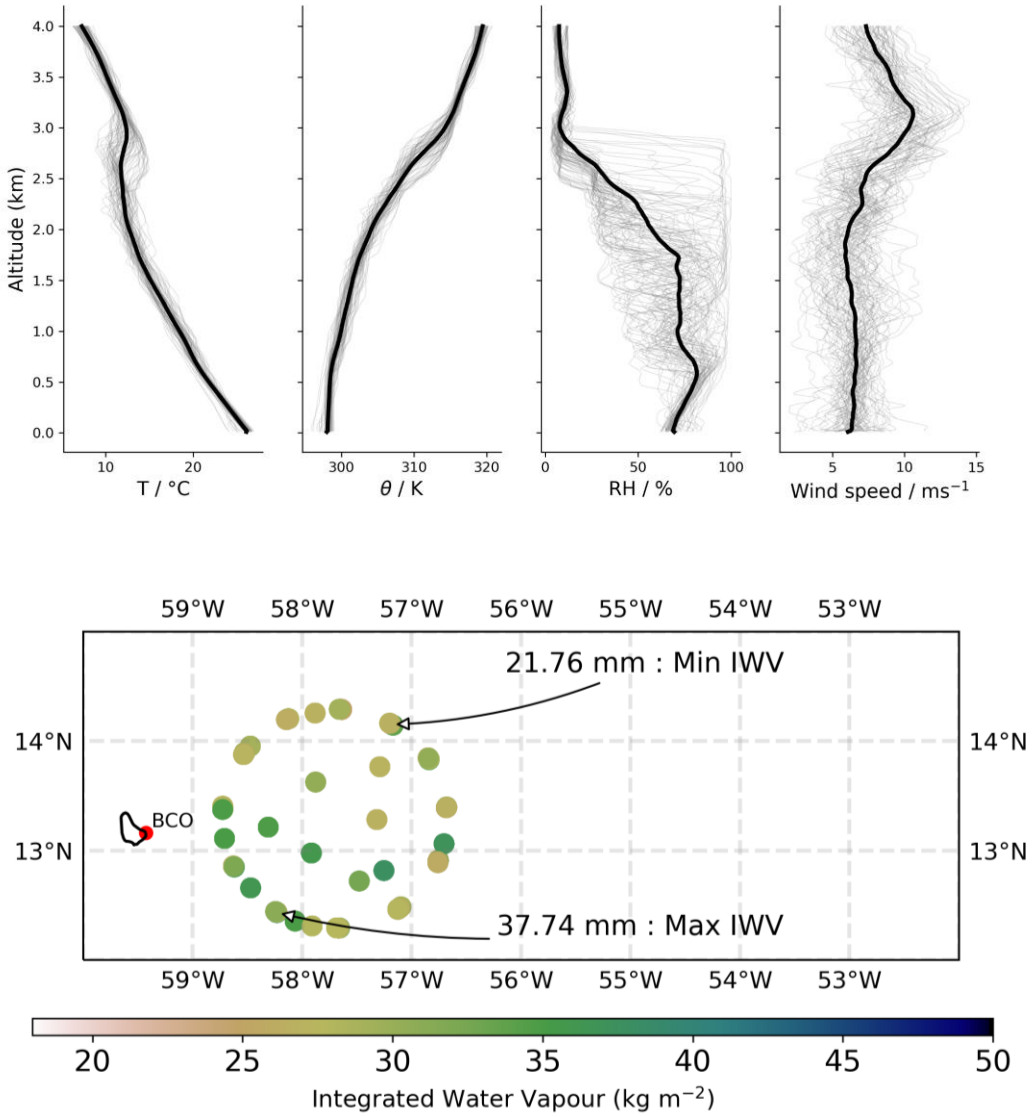

Figure 4: Drop sonde overview: Mean (thick line) and individual profiles (light grey) on top; integrated water vapor from all complete soundings (below). Figure by Geet George.

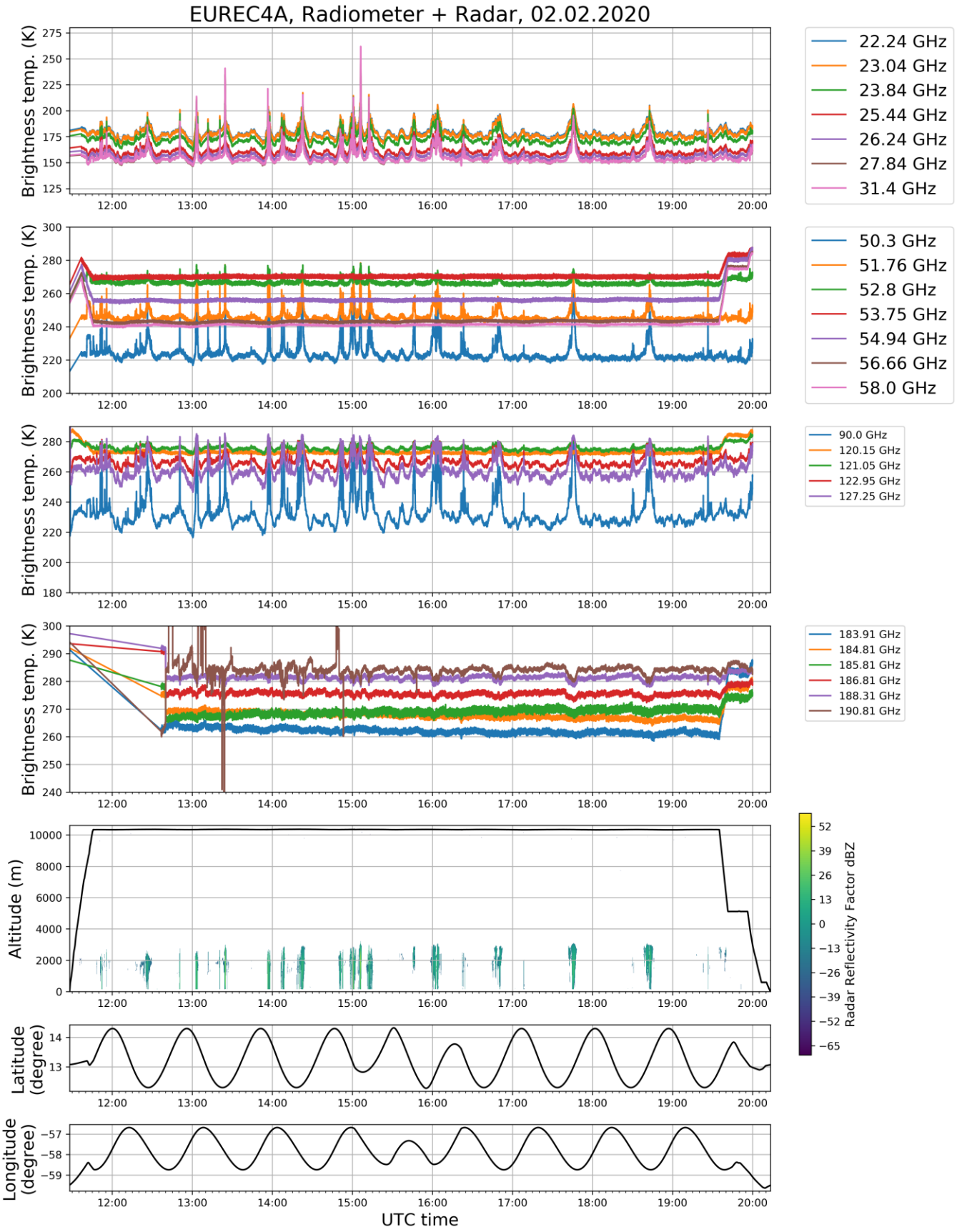

Figure 5: HAMP overview by Marcus Klingebiel.

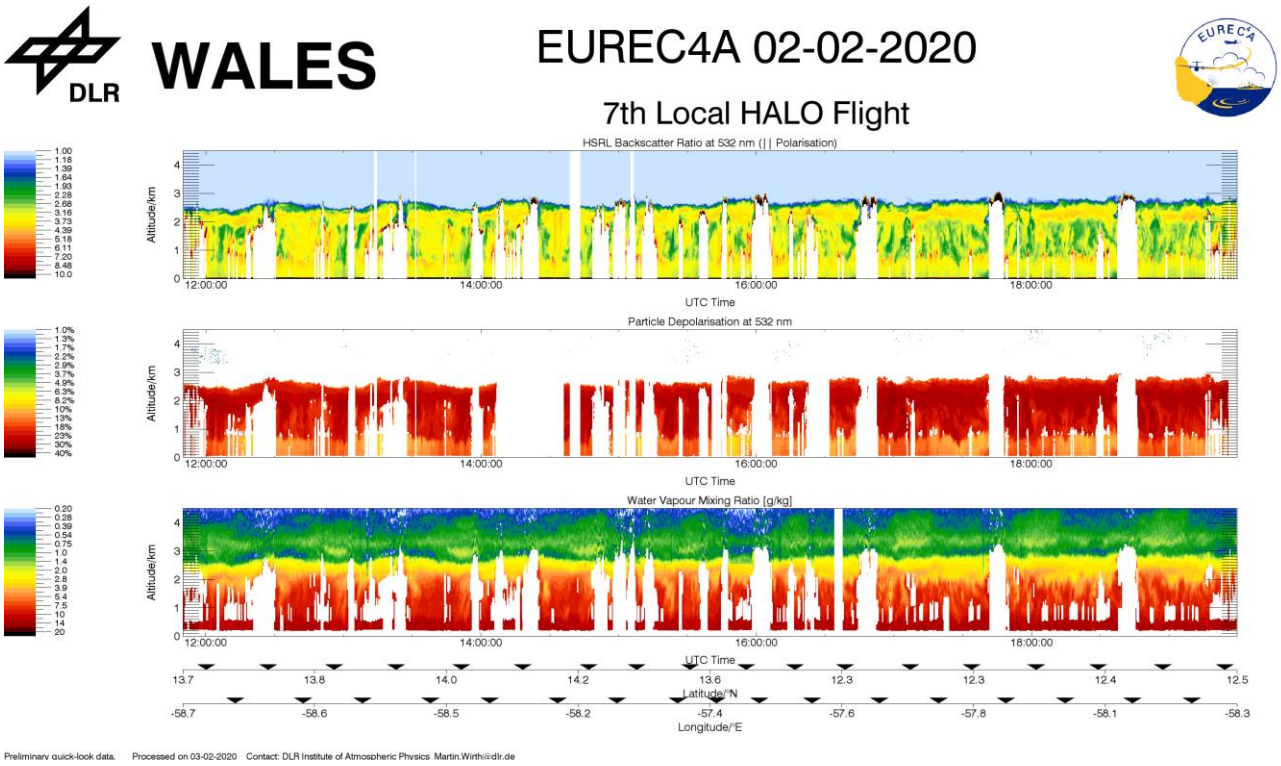

Figure 6: HAMP overview by Martin Wirth.

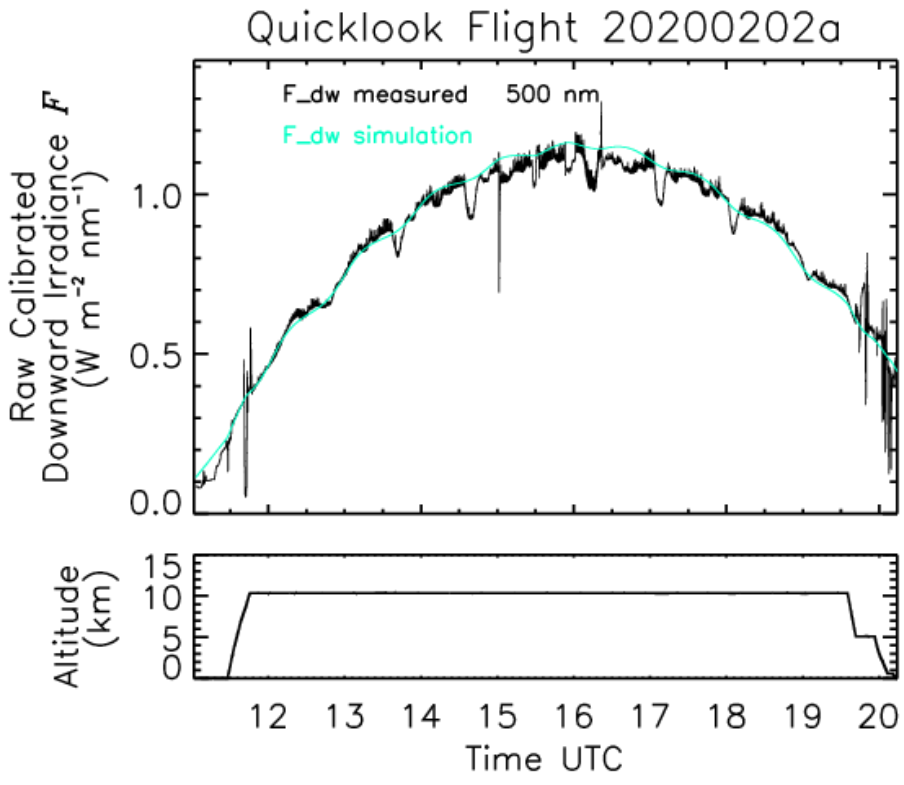

Figure 7: SMART overview by Kevin Wolf. Simulations are based on cloud free atmospheric data.

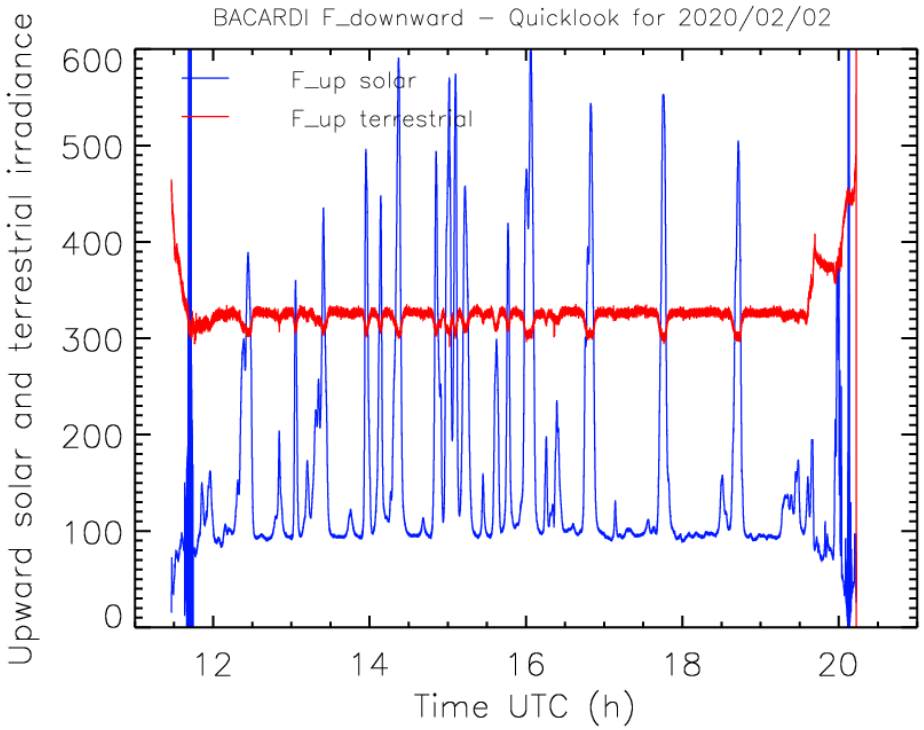

Figure 8: BARCADI (broadband radiation) overview by Andre Ehrlich et al.

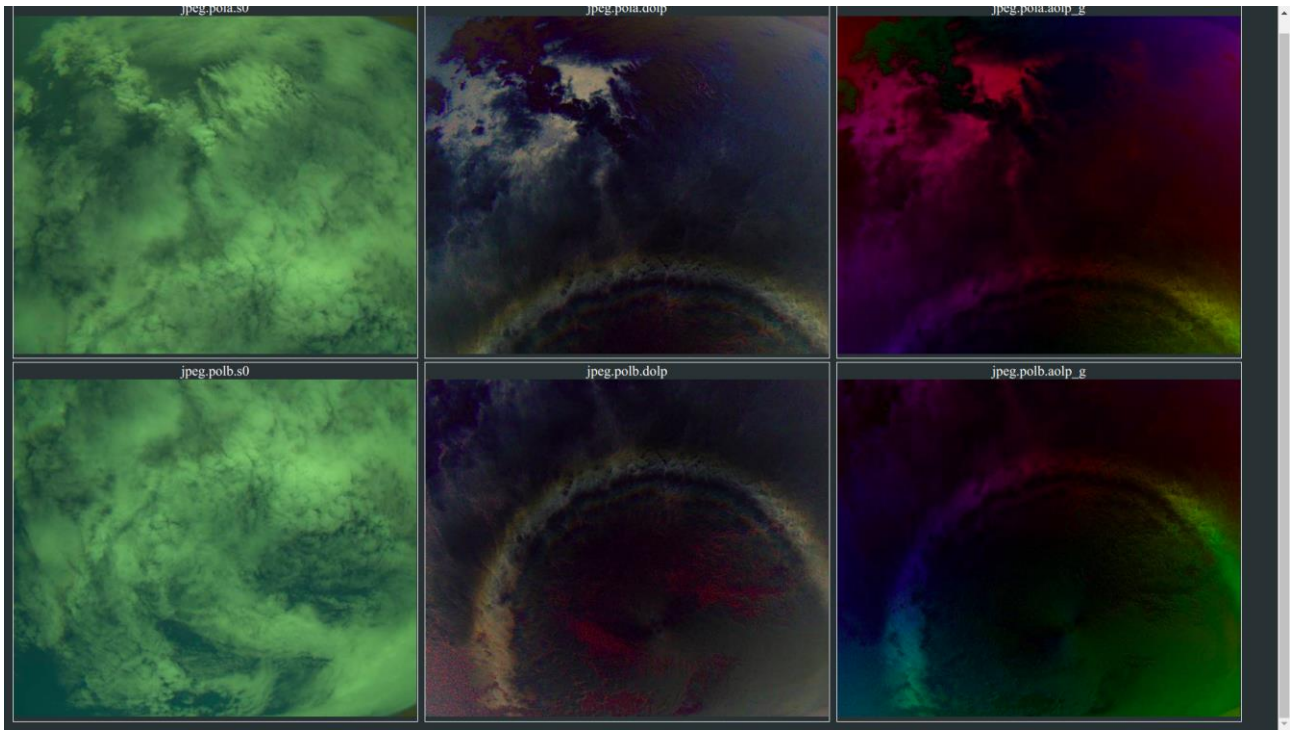

Figure 9: Highlight of specMACS depicting a cloud bow at 13:41:58Z. Figure by Veronika Prötge.