HALO-0128 (28 January 2020)

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1 Objective

Fourth local research flight by HALO. Goal was to fly basic pattern of circles at FL320, with a late morning 11:00LT take-off. The two $210\,\mathrm{min}$ circle segments were to be flow with a spur toward NTAS between them, each covering 3.5 circles. Sondes were to be dropped based on heading, every 30° and with $90\,$offsets in start of sets of twelve sondes. The plan for the spur was to fly along the line between CC and NTAS, starting at the bisection point near CE, and extend as far as time would allow given the desire for a less than $9\,\mathrm{h}$ flight. The second $210\,\mathrm{min}$ circle pattern would end just upwind of Barbados, and we planned to loop back to descent to FL150 for lidar leg.

Coordination with the ATR-42 and Twin Otter was planned, but not with ships, although the R/V Meteor were operating in the HALO circle.

Because of problems with the ATR-41 inertial navigation system it did not join for the first half of the flight, but rather entered the circle near the end of the day (20:30 UTC). Due to the late start the super-curtain was not flown, as the Twin-Otter requires an earlier take off to get in its two flights. The Meteor was near L1 and cruising on zig-zags to fly its kite. For the spur radar calibration maneuvers were added at the last minute, which shortened the spur. A single sounding was launched near the turn around point of the spur, which is where the radar calibration loop was flown. One of the circle sondes failed, and two sondes were launched near simultaneously at the last launching point with the heading of 0° just upwind of the BCO.

2 Crew

Bjorn Stevens (Mission PI), Kerry Emanuel (Flight Scientist), Marvin Forde (Dropsonde Support), Linda Foster (specMACS/VELOX/SMART), Silke Gross (WALES), Marcus Klingebiel (Ground Support), Marek Jacob (HAMP), Hauke Schulz (Dropsondes).Stefan Grillenbeck and Marc Puskeiler (Pilots), Alexander Wolf (Engineer)

3 Synoptic Situation

At the start of the circle pattern, and perhaps for the first three sets, the interior of the circle was mostly sugar, with clusters here and there, with bands, patches and lines. There were some think

veils, or stratiform remains also evident of deeper convection south of the circle (see first photo showing this convection) Skies aloft were clear. To the south and slowly enchroaching onto the flight track were some stratiform layers with cloud tops near $2.3\,\mathrm{km}$.

On the spur we had even better examples of sugar, with large fields of scattered shallow convection (see flight-deck photo from 19:46:50 UTC), with little evidence of large-scale patterning.

Convection deepened over the second half of the flight and we saw some of our first radar echoes. It seemed to deepen, or fill in from the south (consistent with MODIS presentation in Fig. 1, with stratiform layers encroaching into the circle domain, transitioning to flower-like clouds, with their stratiform layers around $2300\,\mathrm{km}$ by the end of the flight.

Overall this was a very nice sugar flight, filling in, or deepening, toward the end, but well sampled sugar for the most part.

As and aside: We took off with deeper $3\,\mathrm{km}$ to $4\,\mathrm{km}$ convection visible north of Barbados. This appeared to be a remnant of a Northwest-Southeast oriented line of flower-like elements that we had been tracking the following day, hoping they would find their way into our domain. This was associated with a very visible spreading cold pool about $30\,\mathrm{min}$ after take-off but did not affect flight operations. Discussion as to whether Island was a cloud magnet, as it seemed like clouds clustered over the island, particularly downwind of the uwwind shore, as we passed at 12:16 UTC.

4 Flight Elements

Table 1: Overview of main elements of flight, ML denotes 'Meteor Line' at $57.245°$.

Element	Loc.	Alt.	Time (UTC)	Notes
Takeoff	GAIA	↑ 320	15	
Note	n/e		16:12	Last sonde at 330° from first set of twelve
Note	n/e	”	18:38	Turning off circlen
Sonde	n/e	”	19:00	Before turning into radar calibration maneuvers
Note	n/e	”	19:04	Calibration (540°) of heading
Note	n/e	”	21	Pronounced hydrolapze
Note	n/e	”	21:14	Developing stratiform clouds (7Uhr on Circle)
Note	n/e	”	22:40	A little bumpier (12Uhr on Circle)
Note	CW	”	23:00	Nice stratiform layer, also on radar
Landing	GAIA	n/a	24	

Circles (first half) Dropping based on heading worked like clock work. We had one failed sonde. Drop sets at headings of $0°$, $90°$, $180°$.

Circles (second half) Dropsondes were restarted $30°$ off original plan, at headings of $300°$, $30°$, $120°$. This worked well for last drop being upwind of the BCO and CW.

Spur We stopped sounding near the top of the circle and continued on FL320 along the circle to the Circle East where we turned onto the spur. We increased flight speeds to minimize additional flight time. A sonde was launched before the turn around to minimize distance to the sonde and maximize reception of its signal. The descent began over the lines of deeper convection also being sampled by the WP-3 at the same time, with a near coincident over flight.

5 Instrument Status

BACARDI: No issues reported.

BAHAMAS: No issues reported.

HAMP Radar: Functioned well for entire flight. Calibration loop ($540°$) and roll maneuvers on spur with sounding.

HAMP Radiometer: $183\,\mathrm{GHz}$ bank did not register, 90/$119\,\mathrm{GHz}$ and Kv banks worked well.

Sondes: 74 sondes launched at $30°$ heading offsets, 73 successful launches, two sondes near simultaneous ($15\,\mathrm{s}$ offset) launched on last profile.

SMART: No issues reported.

specMACS: No issues reported.

VELOX: Started late, collected data for whole flight.

WALES: No issues reported.

6 Figures

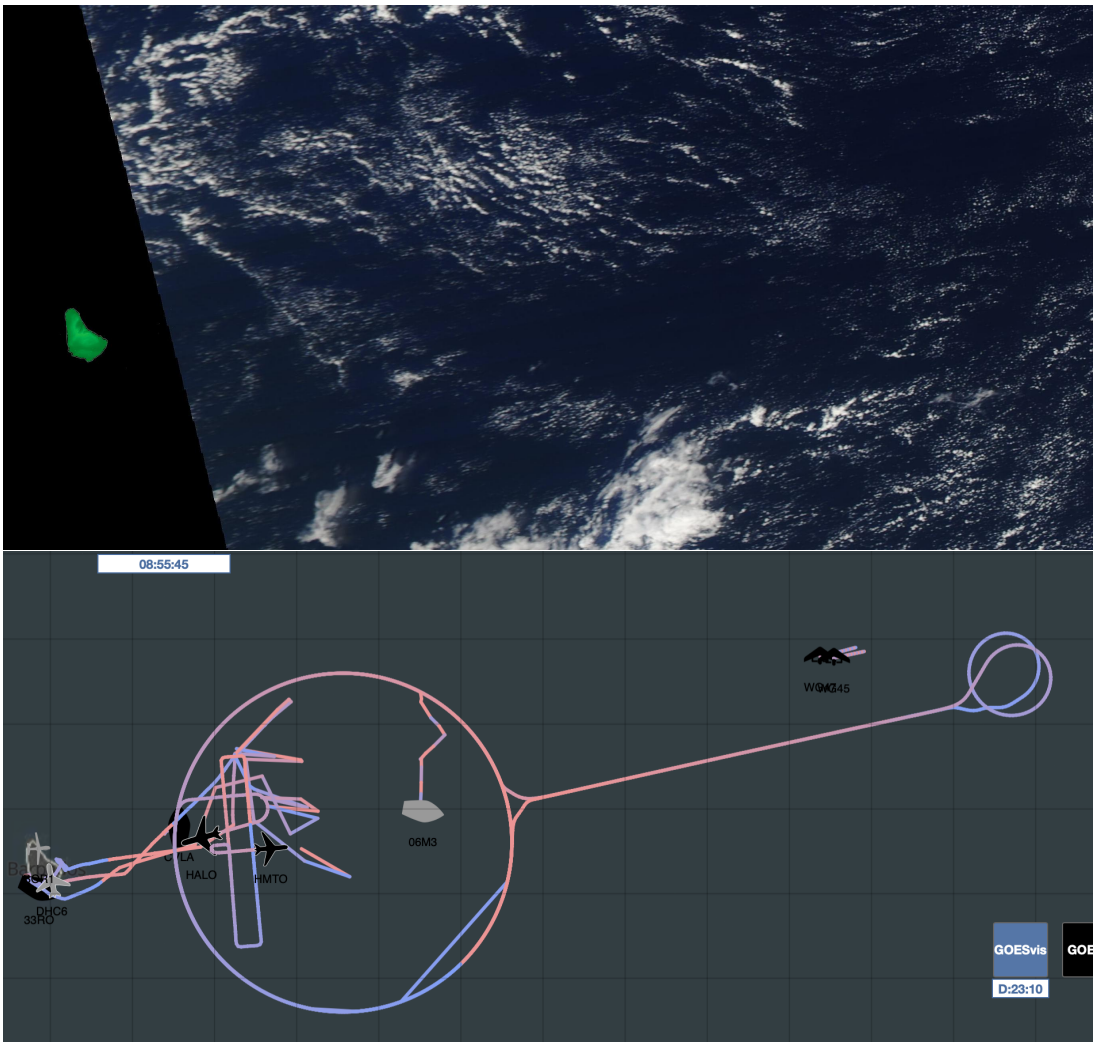

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Figure 1: Upper image is from Modis Aqua showing the area of flight circles 12° to 15° N, and 54° to 60° W. Flight track from PLANET tracking.

Figure 2: Snapshots from flight. From left to right: 17:55, 19:02:30 UTC (top row), 19:46:50UTC (top row), 20:53:51 UTC (middle row), 21:13 UTC , 22:02 UTC (bottom row). 1st, 5th and 6th photo by K. Emanuel.

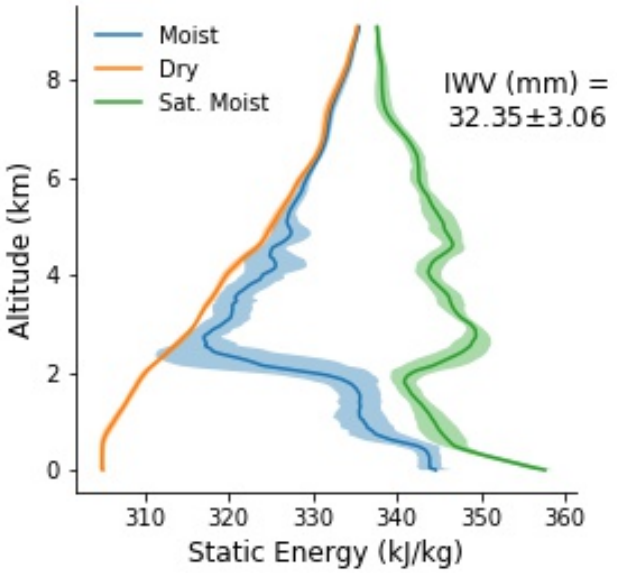

Figure 3: Flight mean dry and moist static energy profiles.

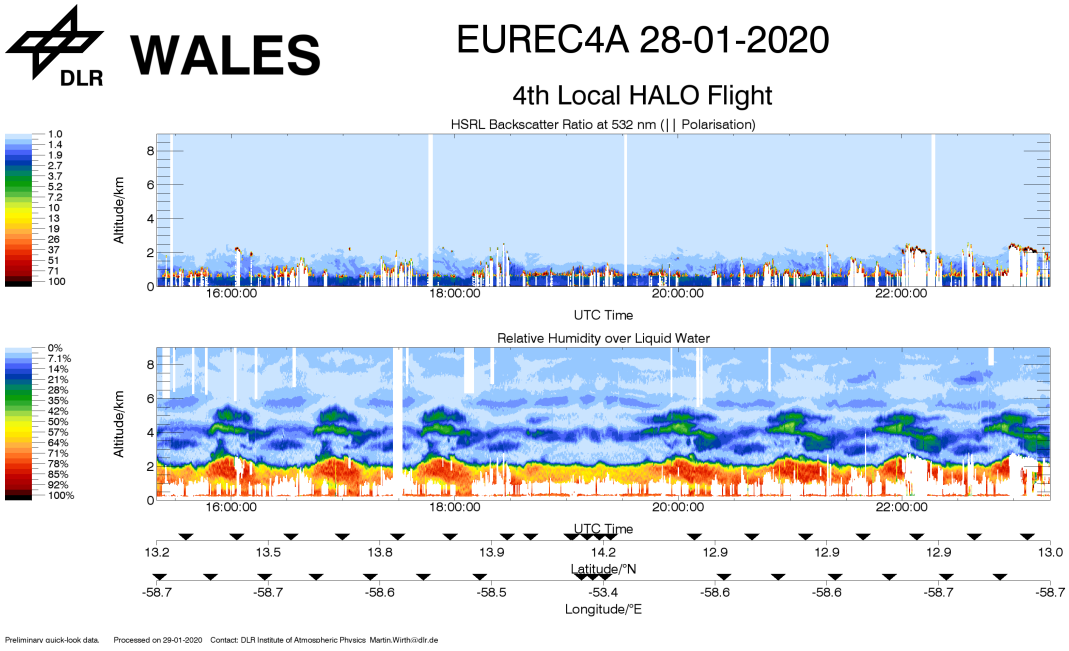

Figure 4: Lidar quick look of entire flight, showing backscatter and humidity.

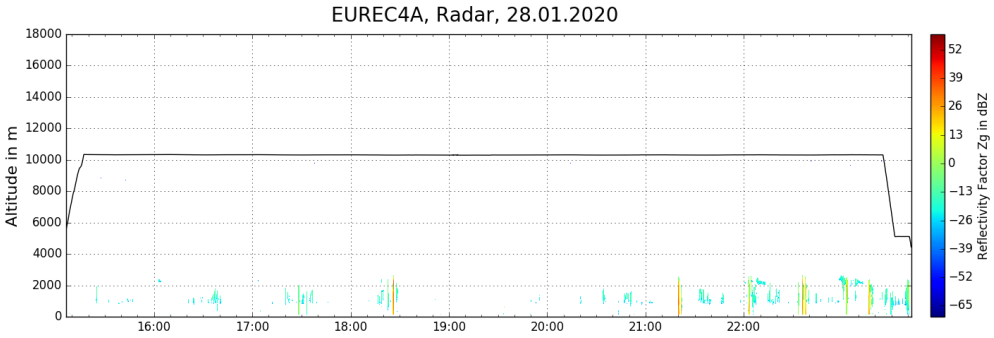

Figure 5: HAMP radar reflectivity quick look of entire flight, showing backscatter and humidity.

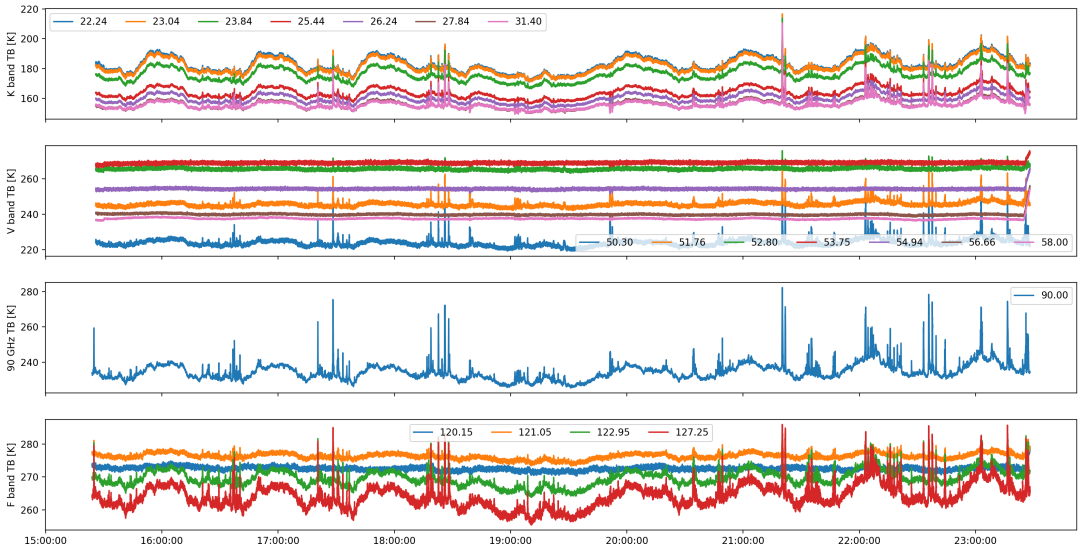

Figure 6: HAMP brightness temperature quick look of entire flight, showing backscatter and humidity.