# HALO-0122 (22 January 2020)

Bjorn Stevens

Draft, January 23, 2020

## 1 Objective

First local research flight by HALO. Goal was to fly basic pattern of circles to characterize large scale environment with sondes and clouds with remote sensing. The spur toward NTAS, which is a component of the regular flight plan, was removed in lieu of calibration maneuvers. These included a planned square pattern for BACCARDI calibration, a long leg at standard flight level (FL300) with a return at a lower altitude (FL160) for VELOX, and roles and a pearl for MIRA. Coordination with the Meteor was planned, and joint operations between the L'Atalante, R/V Maria S. Merian, a possible coastguard vessel and the RSS aircraft were designed to deconflict the airspace.

Due to MIRA malfunction the pearl (radar) maneuver was scrapped. This availed us of extra time, and given the presence of cirrus we move the BACCARDI calibration to FL390, which allowed us to get above the cirrus for the BACCARDI square in the south of the flight area. We extended the last (north-west heading) leg of the square for radiation measurements above the cirrus. We then returned under the cirrus as we thought this might add information for SMART and for broadband fluxes. Calibration maneuvers were initially to be coordinated with the R/V Meteor, as sea-state characterization was required for perl maneuver, but not with other aircraft. Due to failure of MIRA we only flew the VELOX and low level lidar legs over the R/V Meteor, with overpasses within $20\,\mathrm{m}$ of its stated position.

## 2 Crew

Bjorn Stevens (Mission PI), Florian Ewald (HAMP Radar), Geet George (Dropsonde), Silke Gross (WALES), Tobias Kölling. (specMACS), Michael Schäfer (VELOX & SMART), Hauke Schulz (Flight Scientist). & Roland Wesler and Marc Puskeiler (Pilots), Alexander Wolf (Engineer)

## 3 Synoptic Situation

The flight started in unusual weather conditions with a a very moist and deep trade-wind layer and convection extending to $4\,\mathrm{km}$ in associated with a 'Fish' pattern that moved across Barbados. Rain started before sunrise and continued through initial flight preparations. The elongated

band of convection had a northwest-southeast orientation that crossed Barbados and the southwest edge of the flight circle. For the most part however the flight pattern circumscribed the exceptionally cloud free region which gives definition to 'Fish'. Cirrus extending to heights of $13.5\,\mathrm{km}$, or even higher, began filling into the domain from the south and west. The base of the cirrus layer seemed to descend through the course of the flight with HALO flying through cirrus even at FL300 (around $9\,\mathrm{km}$) in the western segment of the domain toward the end of the flight. Away from the southwest edge of the track, where we cut across part of the fish, the air was almost entirely cloud free. Toward the R/V Meteor a shallow cumulus field began developing over the course of the flight. Toward the southwest the convective cells substantially overshot the main cloud layer, and moist layers were evident, and should be detectable in the lidar, also in mid levels, around $5\,\mathrm{km}$. Overall the humidity structure was quite complex.

We had many (nine) overpasses of the R/V Meteor, most within a few kilometers, but some within tens of meters. The R/V Metoer was stationary and was launching soundings at its regular times. For the VELOX calibration we flew level legs over clear skies toward and past (to the East) the R/V Meteor at FL300 and then returned at FL160 ($5\,\mathrm{km}$), both of these legs were at night, with our last sounding circle also around sunset.

As luck would have it the composition with the R/V L'Atalante and R/V Maria S. Merian and BCO soundings, as well as the WP-3D flights from Monday provided a very nice sampling of the 'Fish', with the earlier (Monday, WP-3D) measurements, and the surface based measurements to the South and East nicely sampling the body of the 'Fish' and HALO capturing the clear skies to the Northeast. This merits further study, also in the context of the large rain amounts at the BCO and the degree to which this was captured by the forecast models.

# 4 Flight Elements

Table 1: Overview of main elements of flight

| Element | (°N, °W) | Alt. | Time (UTC) | Notes |
|---|---|---|---|---|
| Takeoff & Ferry | GAIA | asc. to 320 | 14:56 | |
| CW Circles | pending | 320 | | |
| Climb for Manuevers | ” | asc. to 430 | 18:38 | RonBrown |
| Start of BACCARDI sqare | ” | 430 | 18:55 | First leg into the sun |
| Leg above cirrus | ” | 430 | 19:08 | Descent and turn-back at end |
| Leg below cirrus | ” | 310 | 19:27 | |
| CW Circles | ” | 300 | 19:34 | |
| VELOX (upper) leg | | 300 | | L R/V Meteor overpass |
| Lidar/VELOX (lower) leg | | 160 | | R/V Meteor overpass |
| Landing | GAIA | n/a | | |

**Inter-calibration** We flew a calibration square of two minute legs, with the first leg into the sun

for BACCARDI calibration. This was done at FL430 to stay above cirrus. VELOX legs wer flown at two heights over the R/V Meteor. Very close overpasses, behavior of remote sensing instrumentation encourages us to avoid direct overpasses, also of BCO.

**Cirrus** Took advantage of the cirrus to fly level legs above and below cirrus both for remote sensing retrieval and radiation budget.

**Circles** These were 210 minutes on continuous circle patterns. Ideally a circle completed in $60\,\mathrm{min}$ but this was difficult because aircraft loading at start of flight required faster flying, but we settled on to pattern later. Sondes were launched in groups of 12 at $5\,\mathrm{min}$ intervals, with $15\,\mathrm{min}$ between groups. Decided at some point to not replace missing sondes. Generally operations worked well. First continuous measurements of divergence through real time analysis.

# 5 Instrument Status

**HAMP Radar** Did not function, no measurements

**HAMP Radiometer** Kv had some problems and required a restart after take off. $90\,\mathrm{GHz}$ to $119\,\mathrm{GHz}$ worked fine. $183\,\mathrm{GHz}$ did not function The Kv showed some some sign of spurious signal and shutdown during direct overpasses of the Meteor during the VELOX legs at FL300 and FL160, this also appeared to cause glitches in the $90\,\mathrm{GHz}$ to $119\,\mathrm{GHz}$ worked fine.

**Sondes** 73 sondes launched, four failures, three due to missing signal, one due to parachute not opening.

**SMART** No problems reported

**specMACS** Worked well. Began loosing spectral signal about $30\,\mathrm{min}$ befor esunset. No icing even at FL450

**VELOX** Quick looks suggested that it worked very well, collected data the whole flight, and detected METEOR, no sign of gradients seen on transfer flights. Short crash of system before calibration legs, but quick recovery so these seem useful seem promising.

**WALES** Some teething problems in the first half of the flight which may compromise water vapor measurements in upper troposphere. Some temperature regulation problems related climbing to FL430, and descent there-after.

# 6 Figures

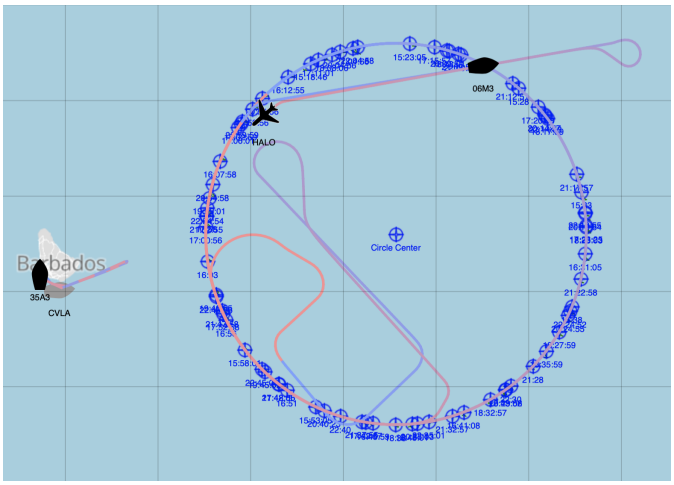


Figure 1: Flight track from PLANET tracking with superimposed dropsondes.

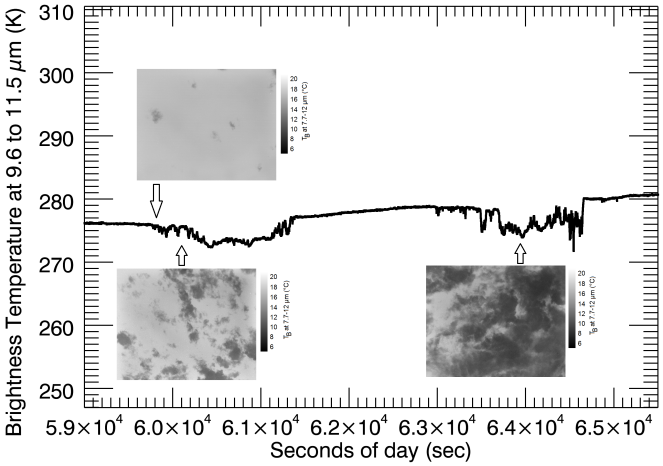


Figure 2: Uncalibrated surface brightness temperature (from KT19) with cloud snapshots from VELOX thermal imager (analysis and figure by Michael Schäfer)

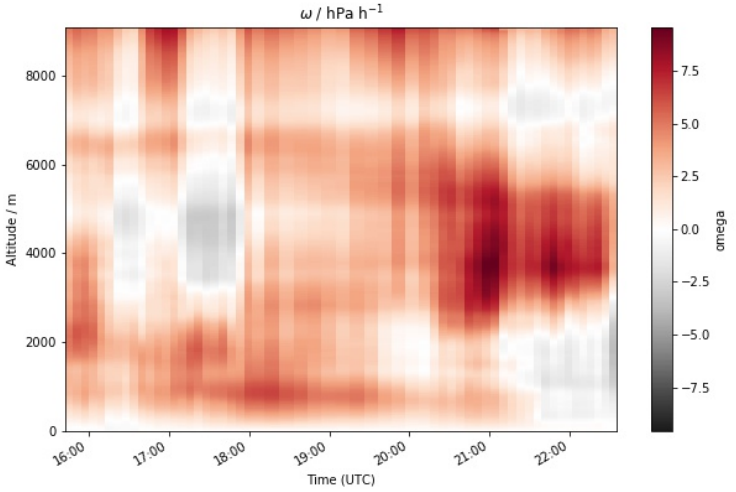


Figure 3: Preliminary estimate of vertical time slice of vertical pressure velocity (analysis and figure by Geet George).

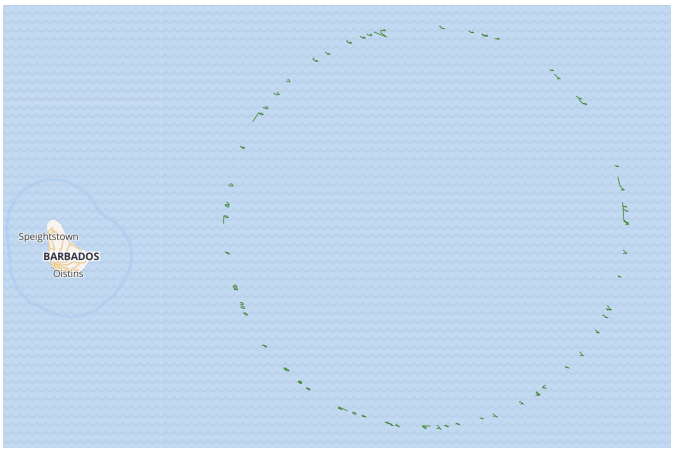


Figure 4: Traces of all the sondes launched during 420 min of HALO circles (composition by Tobias Kölling)