ATR-0213 (13 February 2020)

Flight #19 and #20 – as200019 and as200020

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Sandrine Bony, Julien Delanoë, Alfons Schwarzenboeck
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1. Objective

The objective of the 1st flight (Flight #19) was to characterize the clouds and boundary layer properties associated with flowers present within the HALO circle, focusing on the cloud stratiform layer, the cloud base level, the subcloud-layer and the surface layer.
During the second flight, the objective was to fly in the lee of the flowers sampled in the morning (mostly in clear air) as well as sample the conditions associated with 'fish' advecting westward in the HALO circle towards the area of operation of the ATR. The flight focused on the cloud base level, the subcloud layer and the stratiform part of 'fish'. There was an issue with inertial navigation system of the ATR.
HALO and TO flew this day.
A sail drone was also in the area.

2. Crew

Flight A (7:35 – 11:52 UTC):
Cyrille Flamant (Mission PI, Lidar), Julien Delanoë (RASTA), Sandrine Bony (BASTA), Alfons Schwarzenboeck (Microphysics), Leonie Villiger (Picarro), Shalik Small (turbulence), Hubert Bellec (SAFIRE Engineer), Gilles Vergez (SAFIRE Engineer), Dominique Duchanoy (Pilot), Christophe Lendroit (Pilot), Thierry André (Mechanics)
Flight-level support on ground: Raphaela Vogel, Jessica Vial, Nicolas Rochetin, Sandrine Bony

Flight B (13:14 – 17:35 UTC):

Pierre-Etienne Brioulet (Mission PI, turbulence), Christophe Caudoux (RASTA), Kathy-Ann Cesar (BASTA), Julien Totems (Lidar), Pierre Coutris (Microphysique), Franziska Aemisegger (Picarro), Tetyana Jiang (SAFIRE Engineer), Michel Cluzeau (SAFIRE Engineer), Dominique Duchanoy (Pilot), Christian Lendroit (Pilot), Kevin Salaun (Mechanics)
Flight-level support on ground: Raphaela Vogel, Nicolas Rochetin, Sandrine Bony, Jessica Vial

2. Synoptic Situation

A strengthened Atlantic high pressure maintains the ridge over Barbados and the remainder of the Caribbean. A steep pressure gradient continues to induce strong winds from the east to east north east across the area. Moisture at the surface and lower levels give way to partly cloudy to cloudy conditions with stratocumulus and cumulus clouds. Scattered showered and towering cumulus cells also persist. Haze encroaching to the east. Seas are moderate to rough.

Cloud field moving from the west at about 12 m/s was of type flower in during the 1st flight and 'fish' during the second flight. Widespread stratiform clouds were associated with the flowers, but also the,'fish'.

Flight #19
The ATR performed the 1st northernmost half of its 1st rectangle at ~2100 m above sea level, i.e. above the inversion, to quantify the exchanges between the free troposphere and the top of the stratiform cloud layer (particularly using Picarro measurement of water vapour isotopologues). The 2nd half of the 1st rectangle was performed below the inversion, in the stratiform layer (at 1850 m). The ATR then descended to perform 2 rectangles at CBH (790 m on the 2nd rectangle and 855 m on th e3rd). The lidar

sampled plenty of clouds on all 3. CBH was found to be steady at 820 m. The boundary layer appeared to be very hazy below the cloud base, with significant depolarization suggesting that the aerosol load was high and likely a mix of sea salt and dust. The aircraft then descend to 600 and 300 m to perform the L-shape pattern (1st at 600 m). The aircraft then descended to 60 m for 7 min heading northwest from the entry point. It then climbed to FL70, just above the inversion and the stratiform clouds for more Picarro sampling of the exchanges between the free troposphere and the clouds. The lidar provided evidence that there was very little backscatter above the clouds in this region (NE of Barbados). A dust layer was sampled above the clouds and just below the upper level inversion during aircraft soundings after take-off and before landing. A saildrone was operating with the L, and the Ron Brown was seen to approach the Bridgetown harbor shortly before the ATR landed.

Flight#20
The large scale conditions of the second flight were drier as the sampling area was localized in the back of the Flower sampled during the first flight. It might be also related to the synoptic scale with extratropical dry air masses. The subsiding conditions thus inhibited the cloud formation and almost clear sky conditions were observed during the flight (see GOES image below). At the beginning of the flight, the inversion was less strong than the other days with few very shallow cumulus. According to the Lidar and the Picarro observations, some vertical structures looking like updrafts or thermals, will be interesting to investigate. As for the other days of flight, the diurnal cycle of clouds in the area is important and during the second flight, the cloud structure is more scattered and heterogeneous. On the two rectangles performed at the cloud base, estimated around 860 m, a strong horizontal variability of the vertical structure of aerosols is noticed on the Lidar. The aerosol concentrations are also very weak compared to the other flights (three time less). The boundary layer appeared also less hazy. As illustrated on the figure below, some measurements can be altered by a plume from a ship in the north-east part of the HALO circle, signals were noticed both on the Lidar, Picarro and temperature fluctuations. After the two rectangles in the cloud base, four L-patterns have been performed in the subcloud layer. The idea was to have an accurate sample of the turbulence structure and investigate the link with the surface through saildrone and ship measurements. More clouds were observed in the south as a Fish pattern was advected with some very sparse rain. More whitecaps were observed in the sea surface.

3. Flight Elements

R: Rectangular (race track) pattern starting at Entry Point, starting with the northward heading leg to the west; L: L-shape pattern round trip (one leg along wind, one crosswind); EP: Entry Point race track (13.25N, 58.41W)

Flight #19:	**(ºN, ºW)**	**Flight Level (FL)**	**Time (UTC)**	**Notes**
Takeoff	GAIA		7:37	
Ferry	To EP	FL100 then FL70	7:47-7:57	Reference for lidar and Picarro, top of stratiform layer
R1		2160 m 1850 m	7:57-8:18 8:20-8:31	Top of stratiform layer then below the inversion in the stratiform clouds
R2		790 m	8:45-9:34	Cloud base
R3		790-855 m	9:34-10:21	Cloud base
L1		600 m	10:24-10:48	Top subcld layer
L2		300 m	10:53-11:14	Mid subcld layer

Flight #19:	(ºN, ºW)	Flight Level (FL)	Time (UTC)	Notes
Low level		200 ft	11:16-11:23	Turbulence
Ferry back	From EP	FL70	11:29-11:39	Just above the inversion and the clouds
Landing	GAIA		11:51	

Flight #20:	(ºN, ºW)	Flight Level (FL)	Time (UTC)	Notes
Takeoff	GAIA		13:14	
Ferry	To EP	2350 m	13:22-13:36	Reference for lidar and Picarro
R1		865 m	13:42-14:40	cloud base
R2		865 m	14:40-15:17	cloud base
L1		600 m	15:21-15:43	top subcld layer
L2		300 m	14:45-16:08	mid subcld layer
L3		150 m	16:14-16:40	subcld layer
L4		60 m	16:47-17:01	Surface layer
NE-SW leg		1500 m		
Ferry back	From EP	2500 m		In the stratiform layer
Landing	GAIA		17:35	

A detailed report of the start time and ending time of all legs is accessible on EUREC4A AERIS website (EUREC4A Operational Center, https://observations.ipsl.fr/aeris/eurec4a/#/)

4. Instrument Status

Radars: RASTA now works well (and concentrated) on the vertical beam. No other beam.
BASTA worked fine.

Lidar: Worked fine.

Picarro: Worked fine.

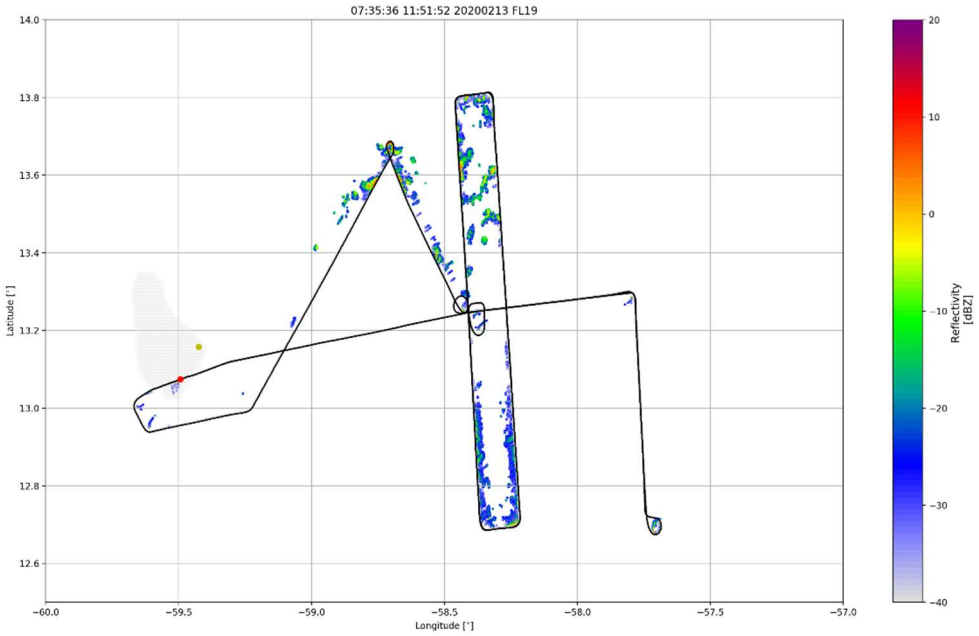
Microphysics: CDP-2, 2DS and FCDP worked well.

Base:

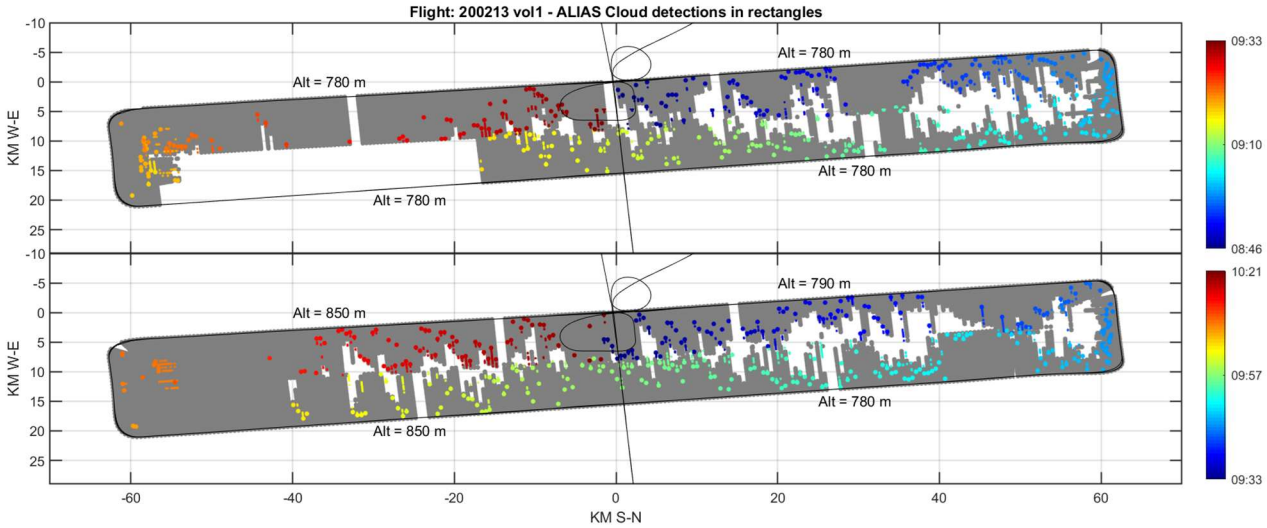
INS degraded to 50Hz instead of 100Hz normally for Flight #19.
Fast wind: OK.
Water vapour: some uncertainties on the KH20 after the calibration.
Temperature: OK.
PVM, LWC-300, Aerosol, microphysics: OK except Nevzorov (LWC).
Uncalibrated LWV Gerber and LWC300

INS data was not recorded during Flight #20. Some of variables above will be affected.

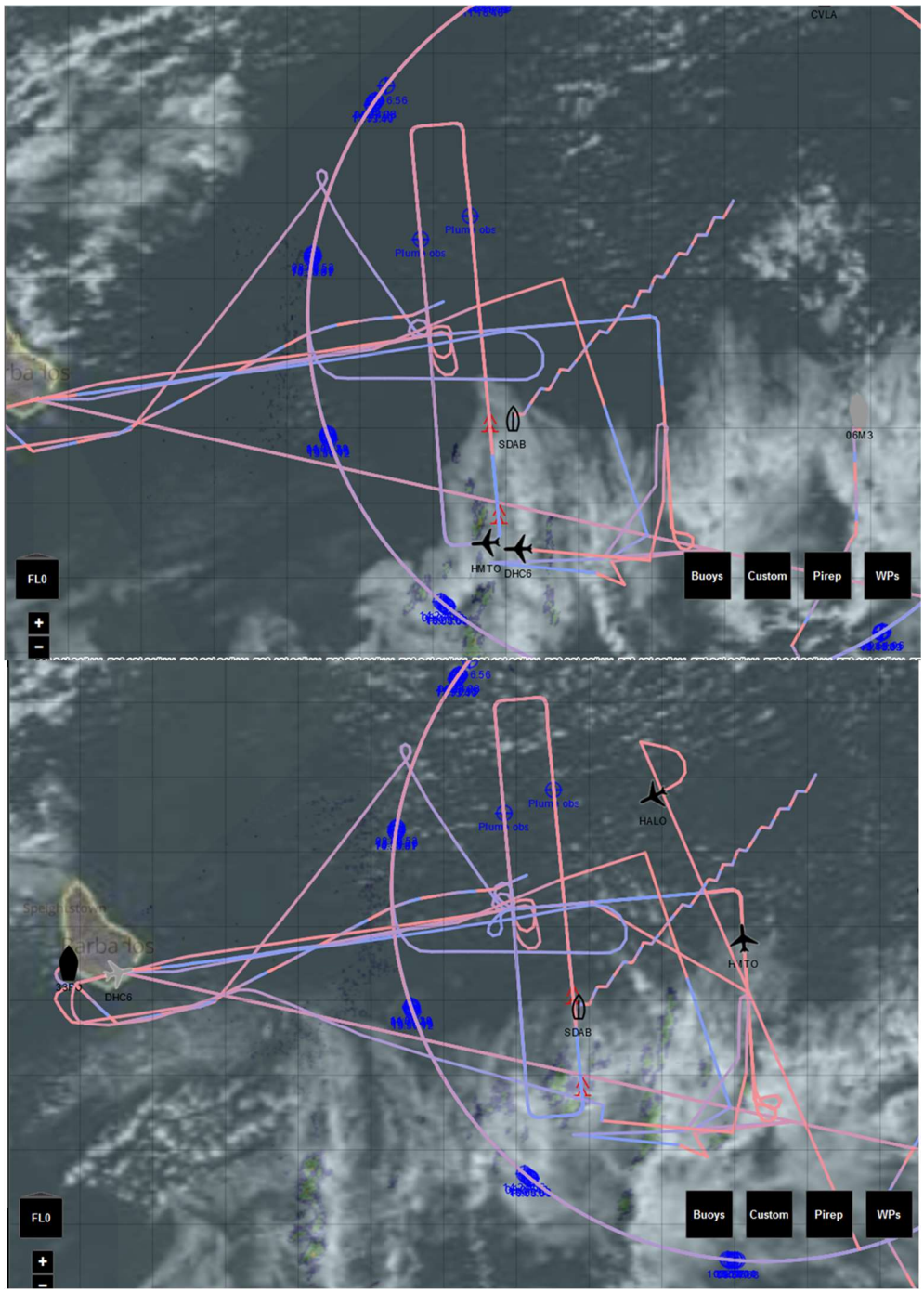
Figures



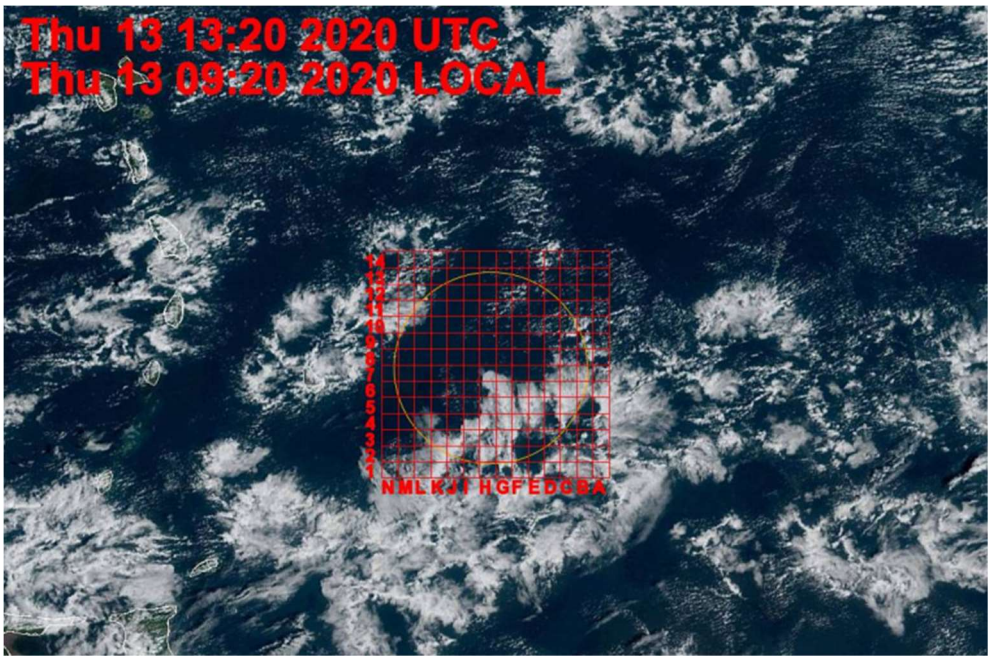
BASTA reflectivity acquired during Flight #19.



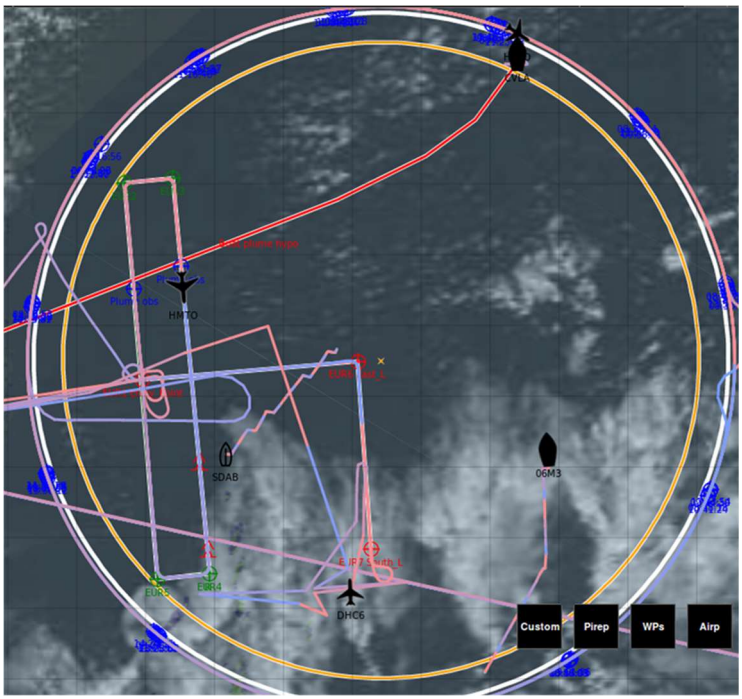
Cloud mask based on ALIAS data for rectangles R2 and R3 during Flight #19. The grey areas correspond to the areas of the rectangle where the lidar signal-to-noise ratio allows cloud detection. Color dots represent the location of the clouds detected at CBH for data acquired in each rectangle. Dots are color-coded according to time (see scale).



Flight tracks of the ATR, the HALO and the TO at 1505 UTC (top) and 1649 UTC (bottom) during Flight #20. At 1505 UTC, the ATR was flying on R2 at CBH in the ‘fish’, while the TO was sampling the clouds above. At 1649 UTC, the ATR was flying at 60 m along L4.



GOES picture of the large scale conditions at the beginning of the second flight.



During the second flight, retro-trajectory of a plume from a ship in the north-east part of the HALO circle. A Fish-like pattern is also advected in the south part of the L.