Twin Otter Flight Debrief: Flight TO334 TO335 (28th January 2020)

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TO334 and TO335 double flight

Flight 1: 1335 UTC → 1723 UTC 3 hr 55 min [0935 Local to 1323 Local]

Flight 2: 1834 UTC → 2118 UTC 3 hr 44 min [1434 Local to 1818 Local]

1. Objective

Sample cumulus "sugar" clouds and make measurements of clouds and precipitation along with subcloud aerosol properties in the EUREC4A Joint Operations Area (JOA) in the tropical ocean trade wind region to the east of Barbados, coordinated with the DLR HALO G-V and Saphire ATR42 research sorties. Passes through clouds at all levels. The objective of both flights is the same.

2. Crew:

Pilot: Andy Vidamour
Mission Scientist: Paul Barrett
Instrument operations - BAS equipment: Tom Lachlan-Cope
Instrument operations - Manchester/NCAS equipment: James Dorsey

3. Synoptic Situation: Please HALO report on this day.

4. Flight Summary

The two flights sampled both cloud and aerosol and thermodynamic properties in the Joint Operating Area circle.

A boundary layer aerosol leg was flown below 300 m, including flybys of Ragged Point observatory at 15 m and 30 m, whilst also taking a filter sample for comparison with the Manchester University aerosol sampling site and BCO

Conditions Overview

Whilst some of the clouds produced precipitation, they were arranged in lines that followed the mean winds, to varying degrees, and with weak winds and their shallow extent it is thought that these clouds could be part of the sugar category of cumulus clouds. This sector had previously had stratiform clouds that were visible on satellite but by the time the aircraft arrived these had dissipated leaving little cloud cover in the vicinity.

Thermodynamic Structure

Winds were light, 3 m/s, and variable between 090 and 130 degrees in the boundary layer. Winds at 1500 m were 4 m/s from the south in the range 170 to 220, giving some degree of windshear with the layer below. A climb between 500m and 975m found a drop in dew point

temperature of 2 K at 800 m. Specific humidity reduced above 1950m with wind-shear above 2000 m suggesting a different airmass aloft.

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Aerosol Properties

In clear air the PCASP typically measured aerosol concentrations of ~150 cm-3, and CPC measured CN concentrations of ~300cm-3

Accumulation mode aerosol number concentrations (NA) were between 150 and 200 cm-3 in the boundary layer at 300 m. Both PCASP and SMPS saw a mode close to 200 nm with SMPS also resolving a smaller mode at 50 nm. CCN concentrations between cloud elements were lower than in the boundary layer. CN concentrations from CPC were close to 200 cm-3 with PCASP reporting accumulation mode aerosol number concentrations of between 100 and 150 cm-3.

A "clean" layer was observed at 1200 m characterised by CN concentrations of only 34 cm-3 in a shallow layer underneath a weak temperature inversion above which dew point decreased markedly. A wind speed minima of 2 m/s was observed here.

Cloud Properties
Cloud bases: About 500 m. Cloud tops: maximum of 2.1 km
Cloud drop concentrations between 100 and 200 cm-3.

Cloud bases (sugar?) were 500 m and tops of the shallow fair-weather cumulus were 700m. The aircraft sampled these clouds at 640 m along a line of clouds. Cloud droplet numbers were in the range 100 to 125 cm-3, comparing well with the CCN observations, and turbulence was weak. Precipitation sized particles were observed on the windshield with reports from microphysics probes of particles up to 90 microns in diameter. Some cloud bases were observed to be higher than 750 m.

A cloud sampling run at 975m was close to many cloud tops (~100 m), where cloud drop numbers were between 120 and 150 cm-3. Turbulence was again experienced as weak although some light updraughts were felt by the crew.

Sampling in cloud turrets took place at 1430 m, 1650 m and 1730 m (within 150 m of cloud tops). Slightly more vigour was felt to the updraughts above 1430 m, and small precipitation observed (< 0.5 mm). Patches with updraughts were noted by the crew on the flight deck. Cloud tops collapsed quickly at the 1730 m level to leave cumulus remnants at 1600 m.

5. Instrument Status:
FFSSP: humidity. CCN – suffers from “fogging”
PCASP noise in lower size channels.

6. Figures

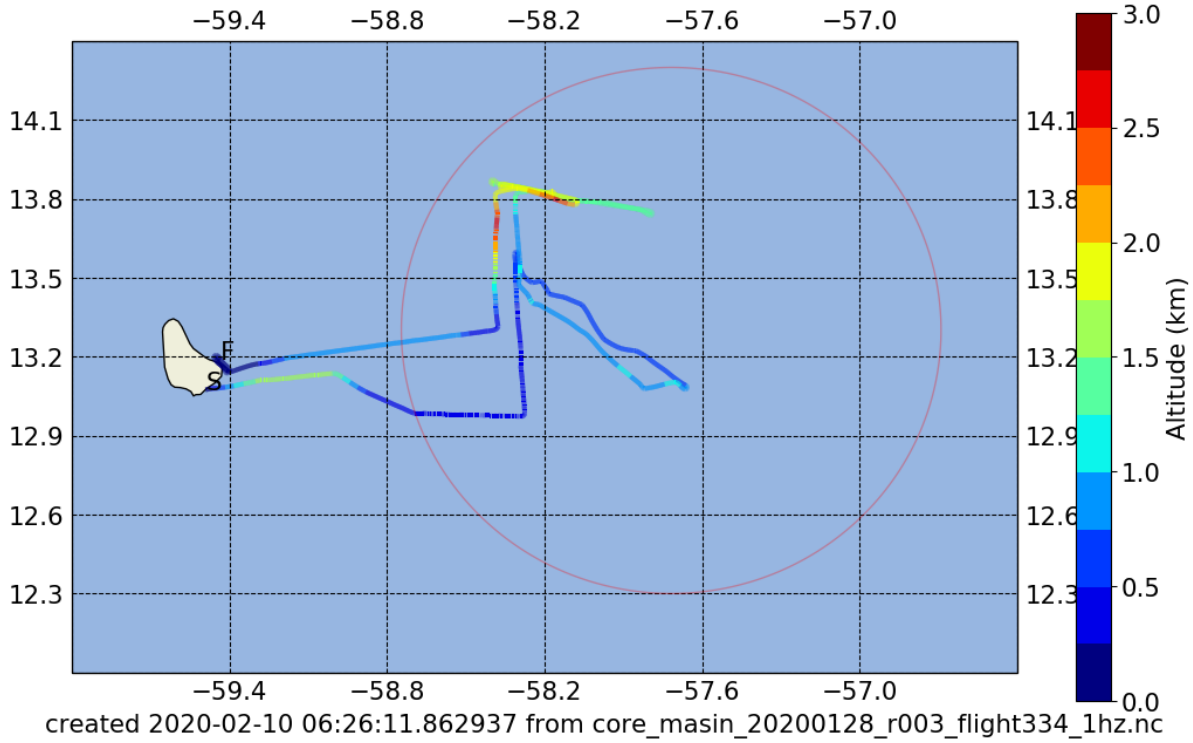

Figure 1: Flight track from flight 1, TO334

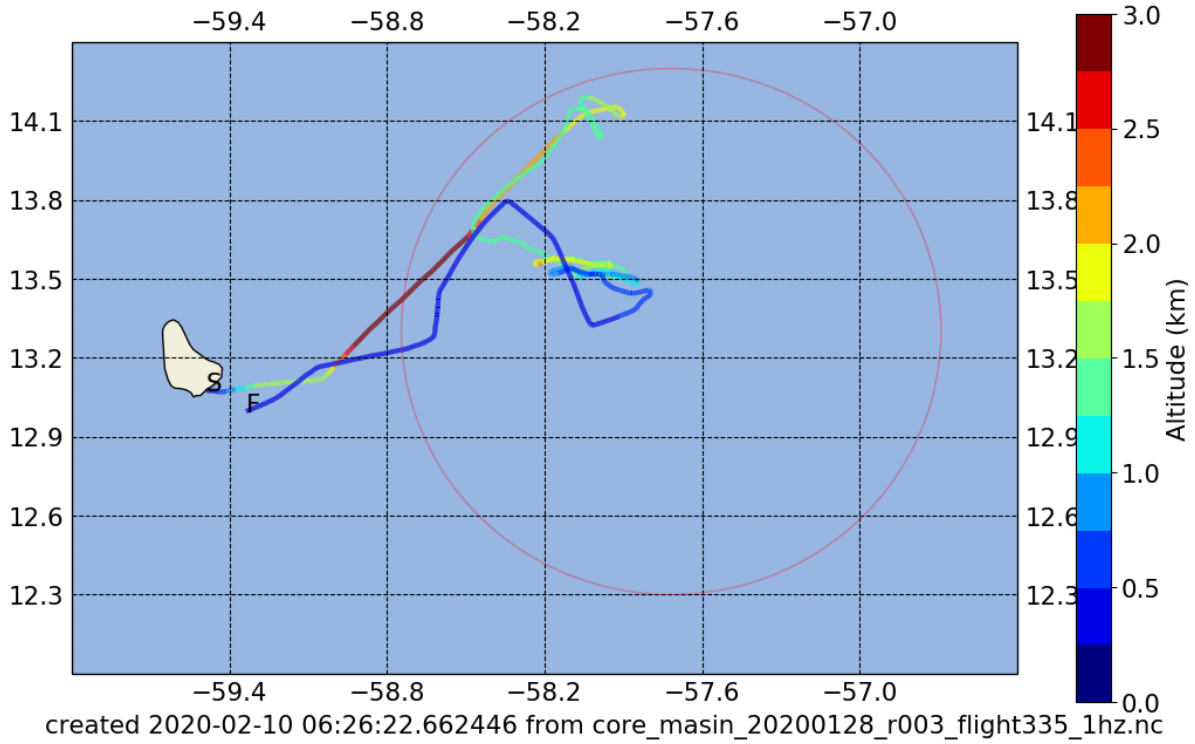

Figure 2: Flight track from flight 2, TO335

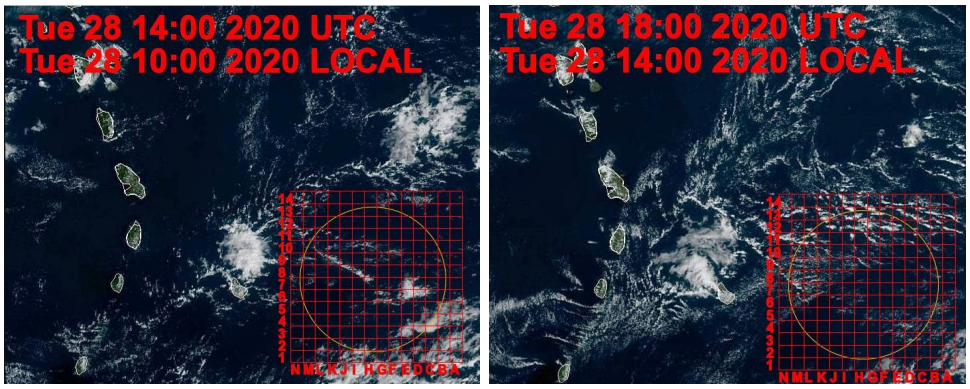

Figure 3 Visible GOES16 image for Left: 1000L (1400UTC) and Right: 1400L (1800UTC)

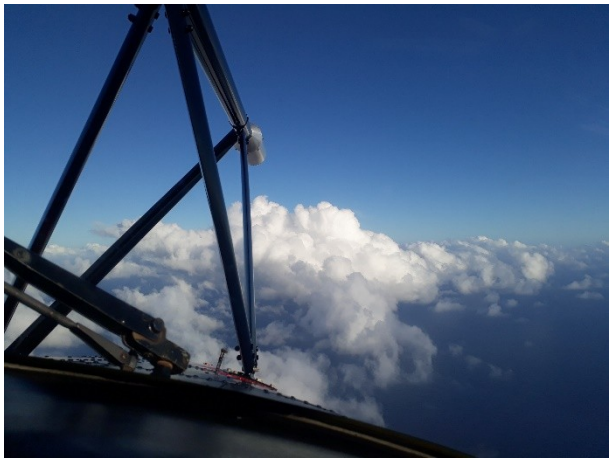

Figure 4 Cumulus cloud field with low level fair weather cumulus - sugar, and developing cloud to 2 km

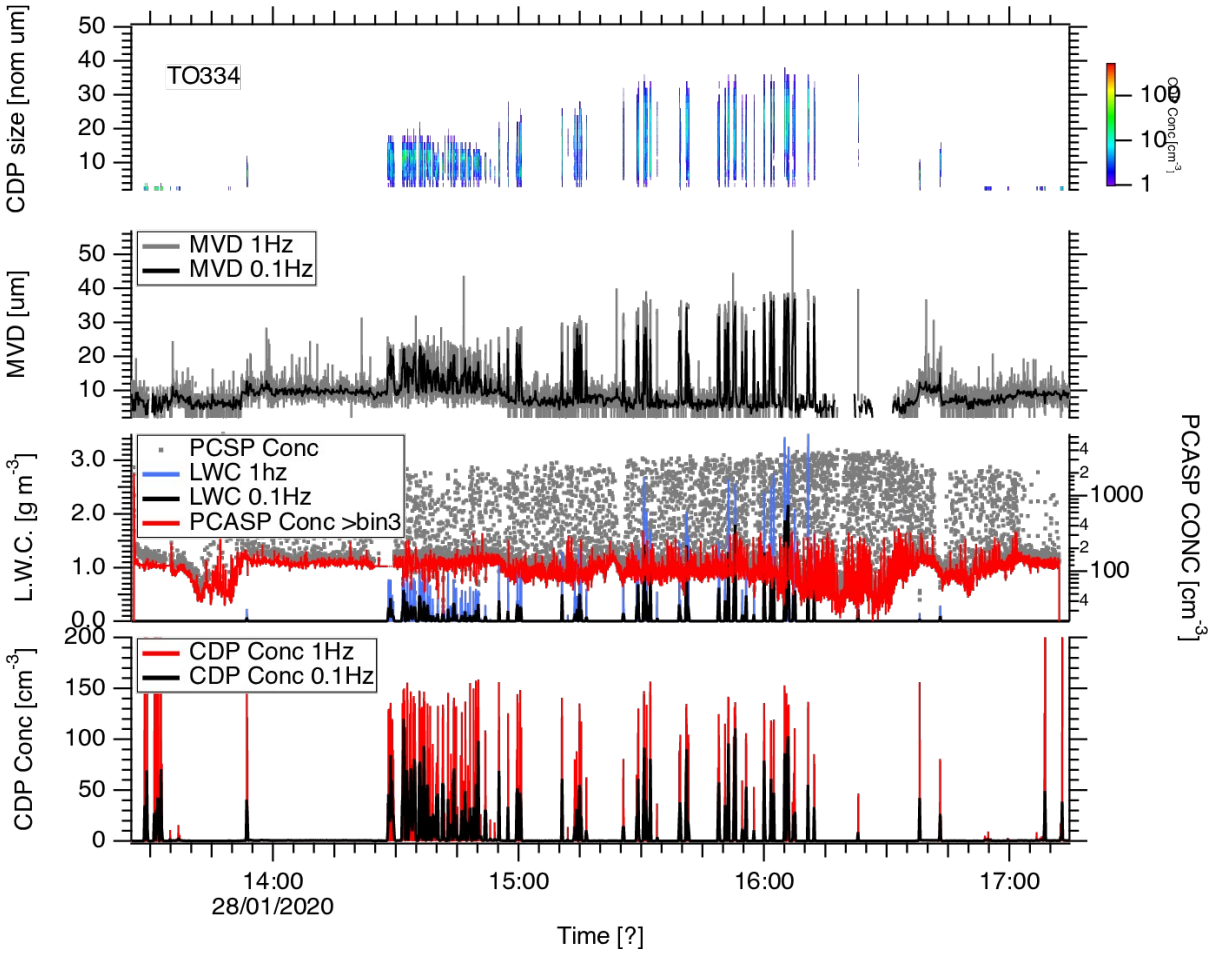

Figure 5 Cloud and aerosol observations from Flight 1, TO334

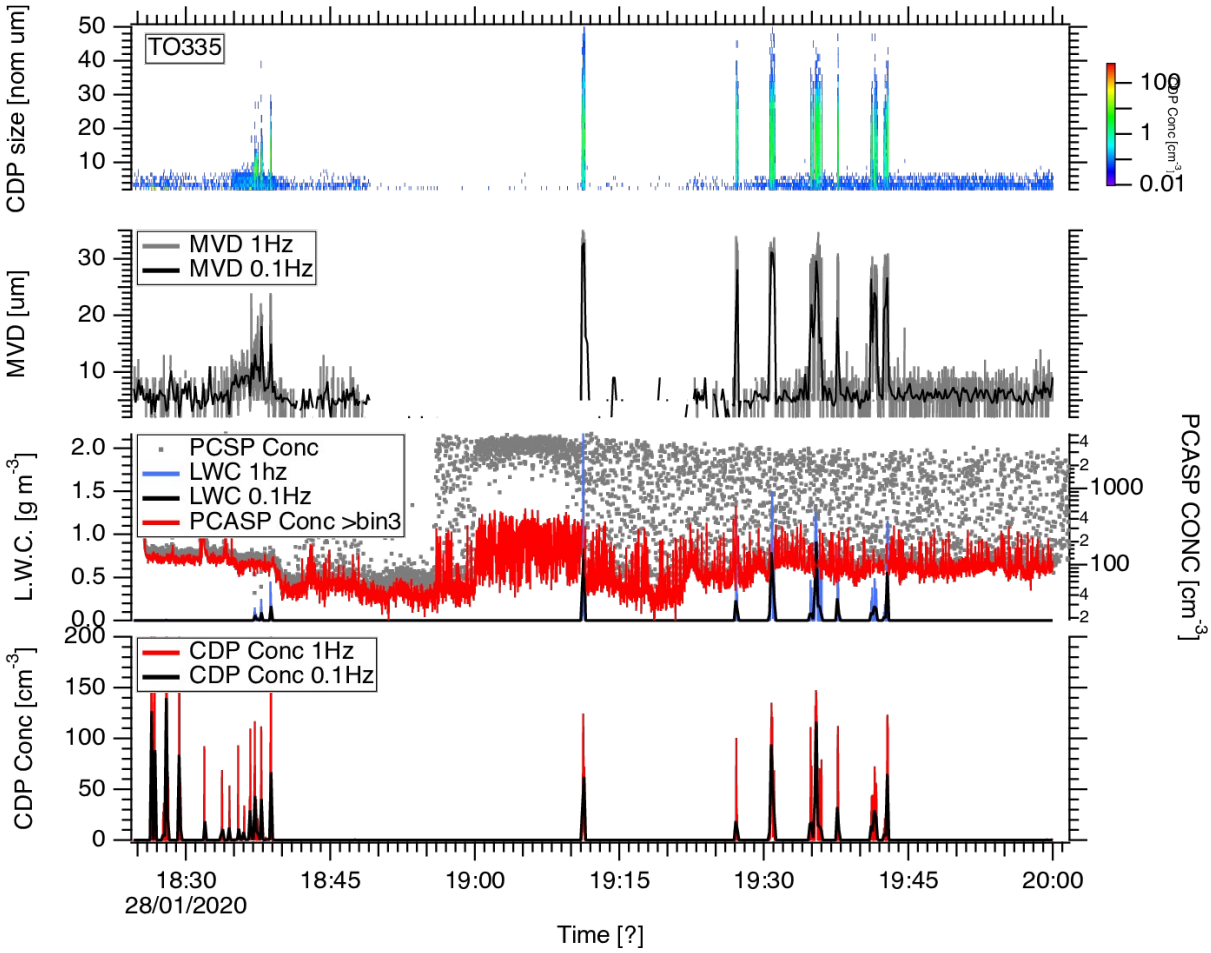

Figure 6 Cloud and aerosol observations from Flight 2, TO335