

WP-3D-0502 (5 February 2020, RF08)

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1. Objective

With cloud probes now functional, and a relative dearth of in-cloud sampling, the primary objective was to sample in clouds as much as possible. The plan called for a dropsonde circle centered approximately at 13.5/53.1 followed by an isotope profile, 3 cloud modules in a cloud-rich region (to be determined), and a ferry back home. AXBTs were to be dropped, not on the usual lawnmower pattern, but together with dropsondes on the cloud module legs, and in transit between cloud modules. Since RHB was in port for medical emergency there was no compelling need to do a circle in their vicinity. A circle center of 13.5/53.1 was chosen, arbitrarily but changed to a more southerly point (~12.5/53.5) to encompass one of a few sparsely distributed flowers. All other EUREC4A aircraft were operating in the region at a similar time so coordination was required. To deconflict, P-3 operations were all east of 56.6, except for ferry out and back.

1. Crew

Eleven crew and five science: Graham Feingold (flight scientist), Dean Henze (isotope sampling), Jan Kazil (observer, W-band operator), Tim Cronin (guest/observer), Carolyn Peck (guest/observer).

2. Synoptic Situation

Ridging to west aiding a dry-air intrusion into our region. Sea level pressure gradient tightening slightly to our north, expected to increase surface winds. Low pressure system to the NE. Winds aloft from the NW, surface winds easterly.

Gravity wave activity in the area likely associated with a frontal region to the NE continues to influence cloud formation in the operating region. The passage of these gravity waves can be seen in GOES animations as 'shadows' of cloud free regions propagating through the system. They tend to alternatively create cloud clearings or promote cloud formation, which has proven to exacerbate prediction of cloud persistence. They should be discernible in Raman lidar water vapor time-height timeseries at BCO (likely better at night when less averaging is required).

Clouds sampled were a mix of flowers in an organized pattern (see Fig. 1), sugar, and a strong convergence line in which open divergence structures were opening up. The area north of the flowers was often characterized by a network like structure oriented approximately ENE-WSW.

Dust remains in the area but decidedly lower in concentration compared to its peak. Notable dustier than early flights.

3. Flight Elements

Element	(°N, °W)	Flight Level (FL)	Time (UTC)	Notes
Takeoff-Ferry	GAIA	Ascent to 7.6km	13:20	
Circle (RHB)	(12.2,53.2)	7.6 km	14:00	
Isotope profile	(53.75)	3.3 km-150m	15:45	

Element	(°N, °W)	Flight Level (FL)	Time (UTC)	Notes
Cloud Module1	(12.17,52.6)	5 level legs	16:05	
Cloud Module2	(11.2,54.0)	5 level legs	17:50	
Cloud Module3	(13.0, 54.5)	5 level legs	19:15	
Transit	(15.75, 50.75)	2.9 km	21:05	
Landing	GAIA	0 m	22:00	

Notes

Circle: 90 km in radius, centred on approximately 12.2/53.2. Dropped twelve sondes on a smooth circle.

Isotope sampling: Following the circle, the isotope descent was from 24000 ft down to 13,200 ft at 1500 ft/minute. At this point, the descent rate was slowed to 1000 ft/min down to 500 ft, with a heading of approximately 90 degrees for optimal positioning of the start of the cloud legs to the east of circle center.

Cloud Sampling: Three cloud modules were completed. The first targeted a dissipating flower near circle center that was one of about 5 flowers, organized in an approximate hexagon, that persisted for many hours through the morning and early afternoon while slowly breaking up. East-West legs were run from ~ 12/52.8 to 12/53.8, with adjustments as the system moved westward. The lines covered the deeper dissipating flower at the west side of the line and shallower clouds oriented approximately E-W at the east side of the line.

The second targeted a more robust circle south of the first. Shorter legs (~ 10 min)

Flight levels (for all 3 modules): 8000 ft, 4400 ft (in cloud), 2600 ft (above cloud bases), 1800 ft (below cloud bases), 500 ft.

4. Instrument Status

Radiosondes: Only three dropsondes were deployed on the ferry out because of other EUREC4A assets in the region. A total of 29 sondes dropped, all good.

AXBTs: A total of 20 were dropped, one of which was bad.

Cloud physics: appeared to be functioning well with the exception of CDP. CAS provides redundancy in that size range. Images from CIP and PIP looked reasonable.

W-band radar: operational; turned off below ~3200 ft throughout.

WSRA surface wave radar: operational

SFMR: operational

Picarro isotope sampler: operational

5. Figures

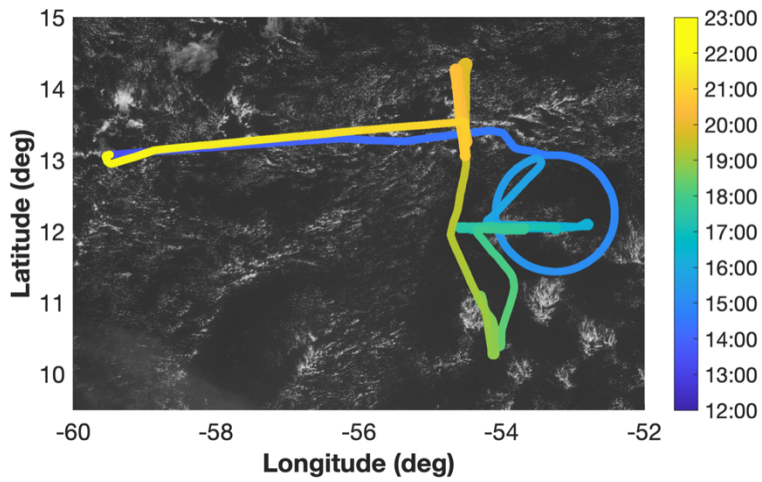


Figure 1. Plan view/timeline of flight path for WP-3D RF08 superimposed on GOES imagery. The first cloud module (CM1) targeted a dissipating flower at circle center. CM2 sampled a more robust flower further south. CM3 traversed north, passing through the center of CM1 (dropping a sonde at 11.9/54.7) and proceeded to a N-S line (13-14N/54.5W) that crossed a strong convergence line. In all cloud modules, pilots attempted to target clouds and modify lines as the cloud fields advected.

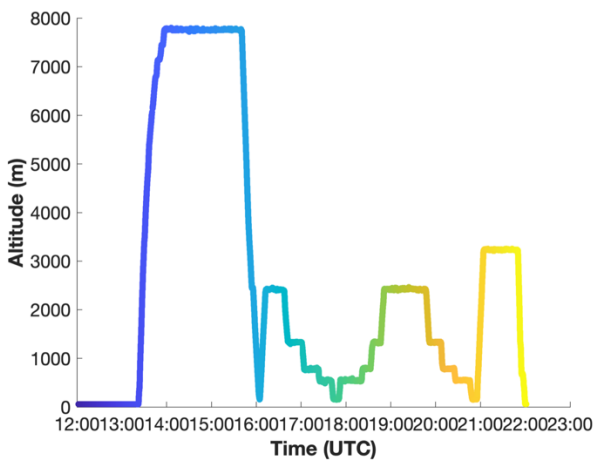


Figure 2. Altitude timeseries of flight path for WP-3D RF08. The dropsonde circle is followed by the isotope descent, three cloud modules that can be identified by the three stepwise descents/ascent, and the final ferry home at 3000 m.

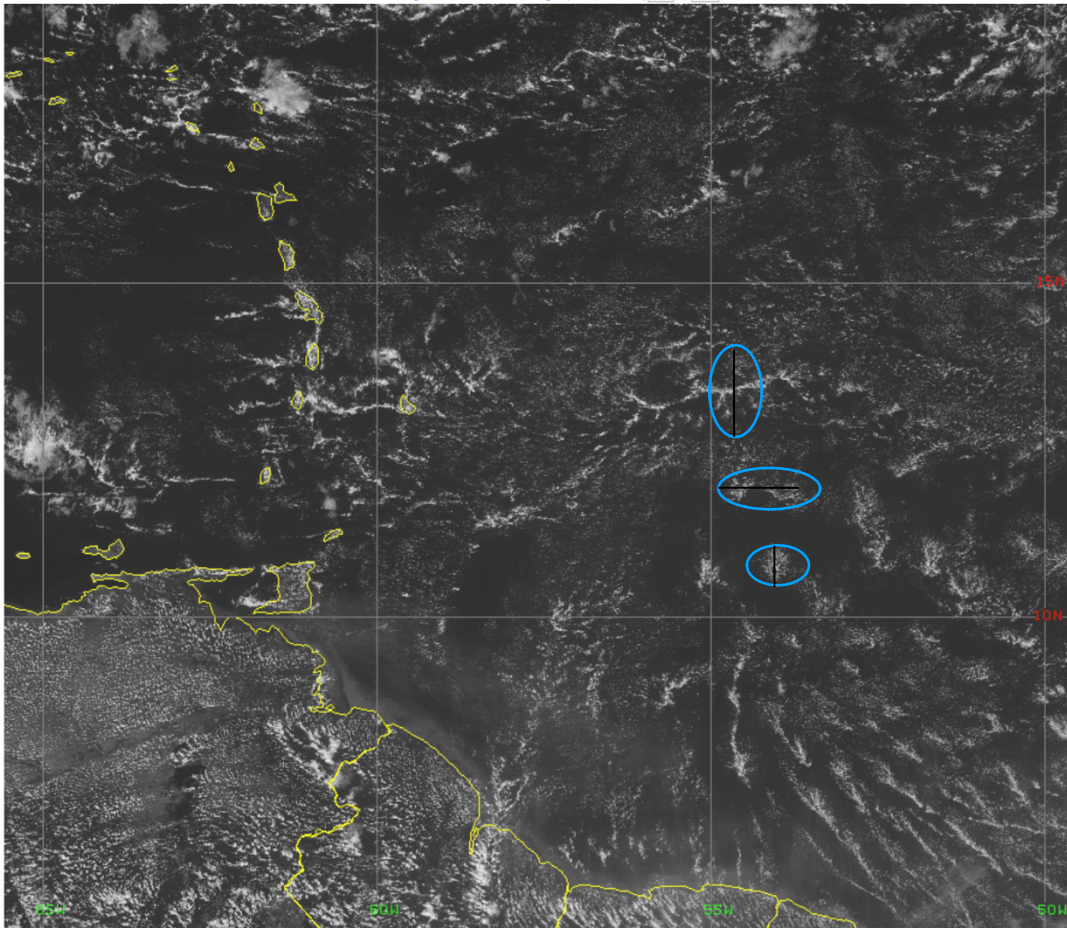


Fig. 3 GOES-16 18:00 UTC showing three cloud modules (blue circles) and approximate sampling lines (black lines).

OMIC (2020-02-05, DOY036, Hr-16). W-Band (motionread=1, Kongsberg=0)

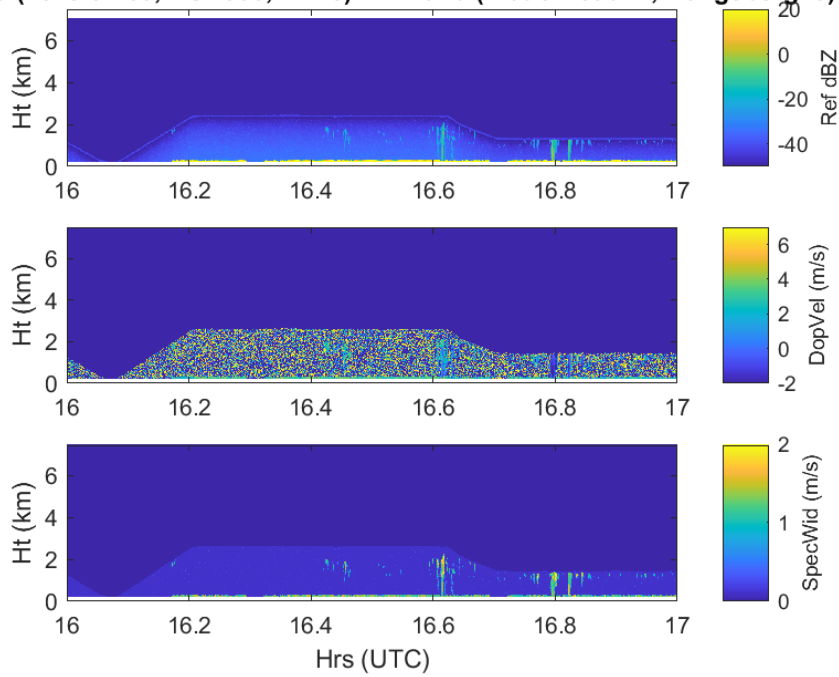


Fig. 4 Sample of W-band radar timeseries profiles during cloud module 1.

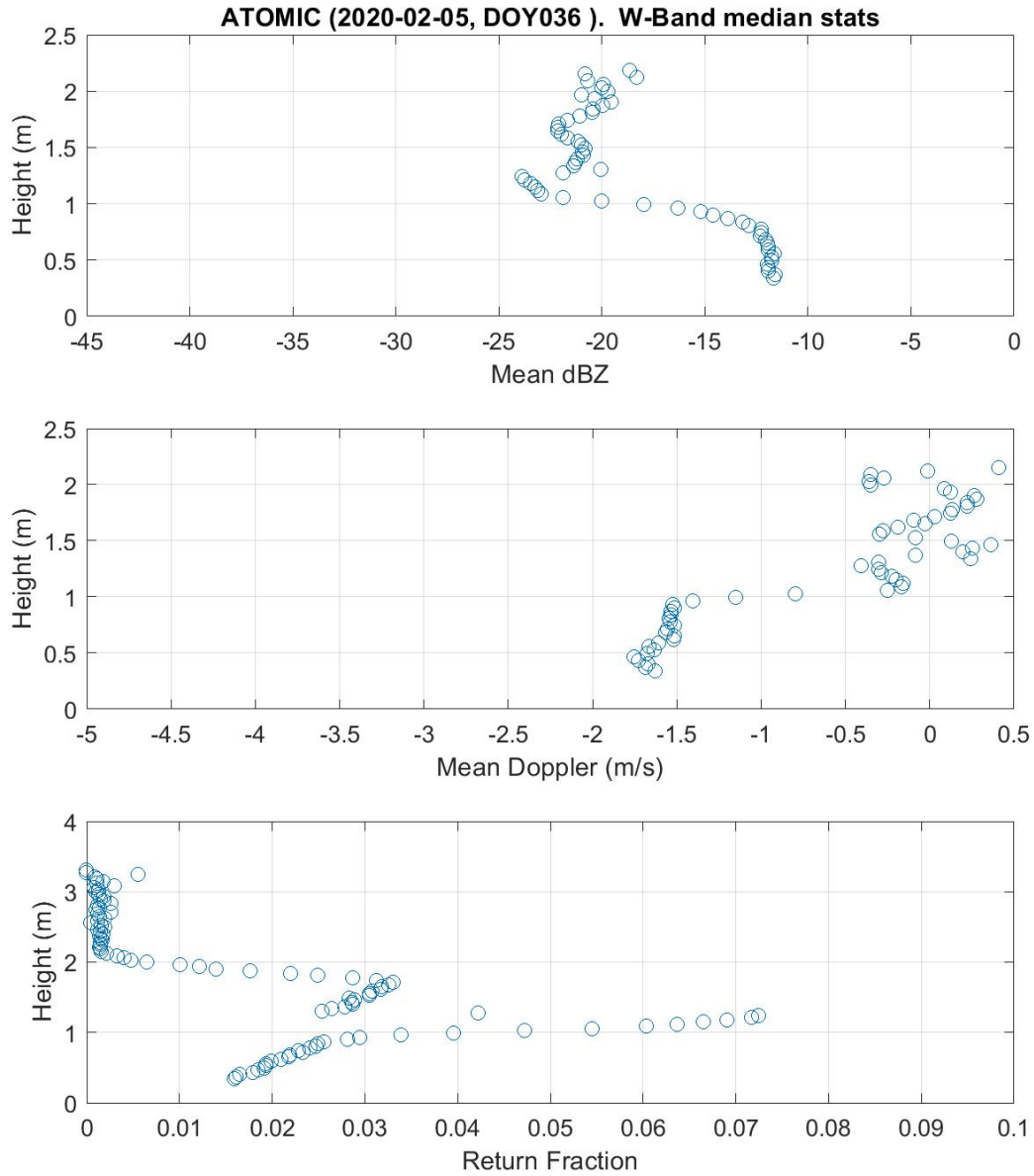


Fig. 5: W-band profiles of mean radar statistics. Top: mean reflectivity, Middle: mean Doppler velocity; Bottom: return fraction, which gives a very tough estimate of a radar-based cloud fraction profile.

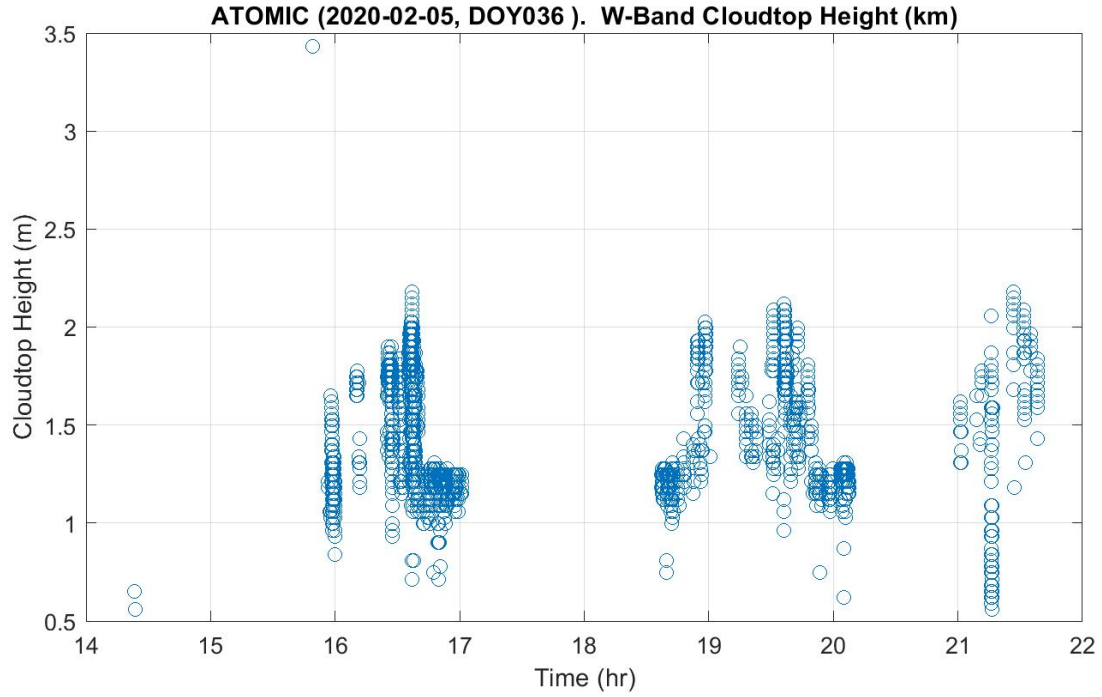


Fig. 6: W-band profiles showing cloud top heights during the 3 cloud modules.

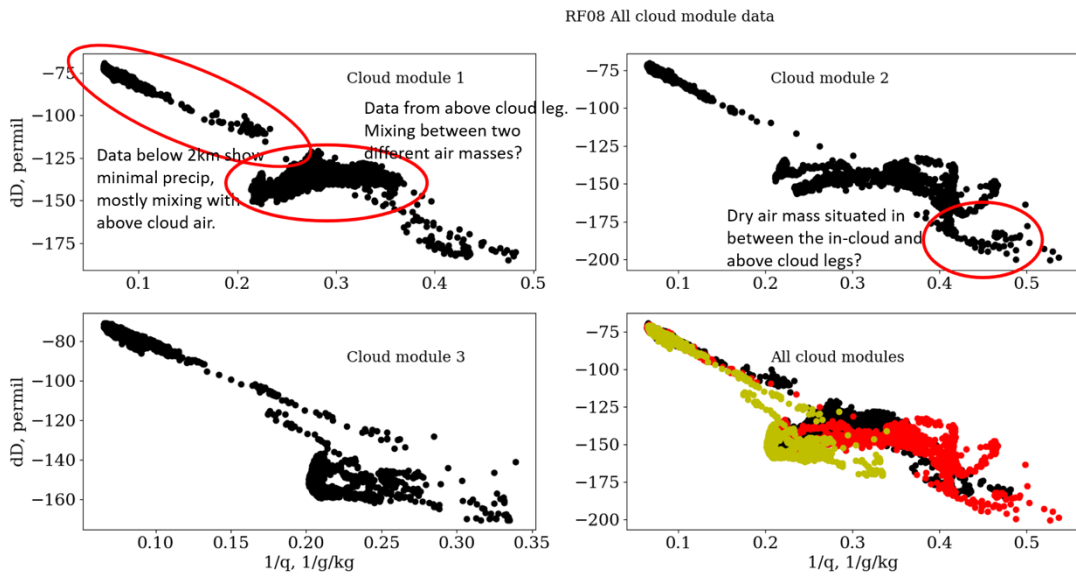


Fig. 7: Summary of isotope mixing diagrams for the 3 cloud modules.