

# WP-3D-1901 (19 Jan 2020)

Robert Pincus

## 1. Objective

Research flight 02. As cloud physics information was not available, the initial plan was to ferry towards the Ron Brown dropping six sondes before starting a dropsonde circle around the ship, perform slow profiling for isotope sampling *en route* to sampling an extended array encompassing the Swift buoys with AXBTs, then to return home along HALO's ferry flight track to sample clouds with the W-band radar. Given reports of few clouds under the HALO track this plan was modified during flight to ferry south from the end of the AXBT deployment to 14N, then transit almost directly west to Barbados. A second isotope sampling profile was performed beginning roughly 54.5W.

## 2. Crew

Eleven crew plus five science: R. Pincus (flight scientist), Adriana Bailey (isotope sampling), G de Boer (observer), Graham Feingold (observer, W-band operator), K. Moran (W-band).

## 3. Synoptic Situation

A mid-latitude disturbance extended into the Caribbean the day before the flight and it was anticipated that clouds might be few in the study area. On flight day, however, both the sonde circle and AXBT pattern sampled a wide range of cloudiness, including a ~100 km radius coherent cloud region within the sonde circle. The sonde circle was centered on the position of the Ron Brown and the AXBTs were deployed near the Swift buoys.

A very wide range of clouds was sampled, ranging from large almost cloud-free areas in the AXBT array to relatively thick precipitating clouds. Thin stratiform layers that appeared detached from lower cumulus clouds were observed relatively frequently. Satellite imagery and conversations with the Ron Brown suggested a cloud entity of order 100 km near the RHB with tops near 3.5 km.

## 4. Flight Elements

Element	(°N, °W)	Flight Level (FL)	Time (UTC)	Notes
Takeoff-Ferry	GAIA	Ascent to 7.6km	13:25	
Circle (RHB)	(14.5, 53)	7.6 km	14:57	
Isotope profile	(53.75)	3.3 km-150m	15:47	
AXBTs	(14.75, 52.5)	2.9 km	16:31	
Transit	(15.75, 50.75)	2.9 km	19:05	
Isotope profile	(13.25, 54.50)	2.9km-300m	20:34	

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**Circle:** Position noted is circle center at nominal position of Ron Brown; circle was 90 km in radius. Dropped twelve sondes with roughly even spacing, turning and flying straight legs between drops.

**Isotope sampling 1:** The aircraft orbited briefly while waiting for clearance to descend, then descended from roughly the SE edge of the sonde circle to the beginning of the AXBT array. Descent from 25000 feet to 13200 feet at 1500 ft/min, then slower descent (1000 ft/min) to 500 ft, a short level

leg for installing the AXBT deployment equipment, then turn to the south and ascent to 10000 ft. During this transit the aircraft traveled near the RHB.

**AXBT deployment:** AXBTs were dropped every 0.25 degrees on a regular grid starting at 14.75N,52.5W and proceeding NW to 15.75N,50..75W (5 lat lines with 8 AXBTs each). AXBT data collection was terminated after 800 m (roughly 10 min) so the receiver channel was free. Two AXBTs failed on the airplane; two more in the water. WSRA radar data show a N-S gradient in wave height.

**Isotope sampling 2:** During the return transit another isotope sampling descent and ascent were performed starting at roughly 54.5W.

**Overflights:** During the first isotope sampling profile the aircraft passed near the Ron Brown.

## 5. Instrument Status

*Radiosondes:* all provided good data. Sampling was uneven on the ferry due to a miscalculation of airspeed.

*AXBTs:* two bad on plane; two bad in the water. Sampling in the interior of the array was reduced to compensate

*Cloud physics:* probes were not operational due to a failed data acquisition computer.

*W-band radar:* operational; turned off below ~1500 m during isotope sampling

*WSRA surface wave radar:* operational

*SFMR:* operational

*Picarro isotope sampler:* operational

## 6. Figures

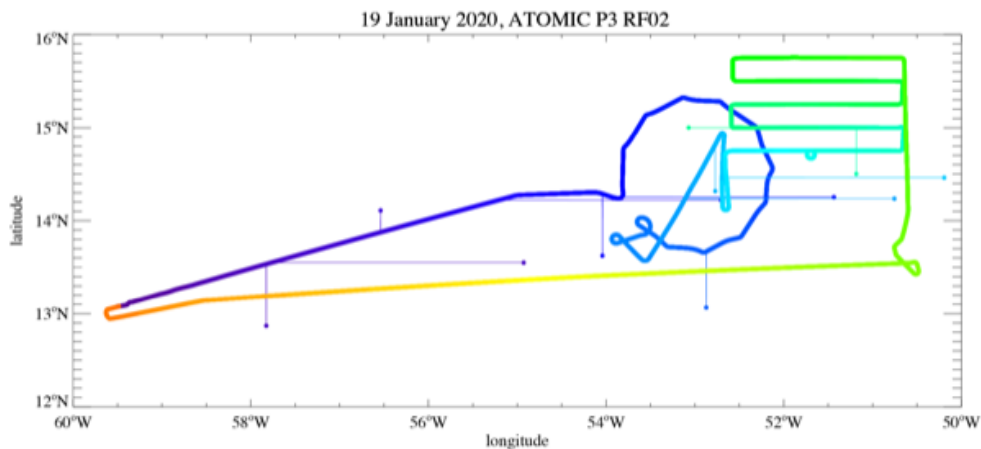


Figure 1. Plan view of flight path for WP-3D RF02.

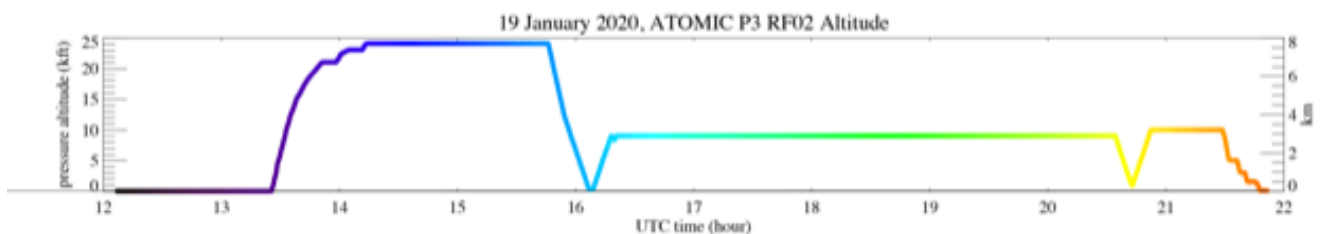
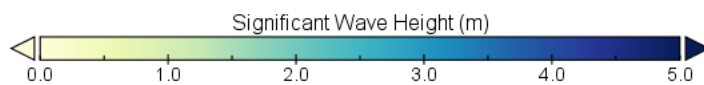
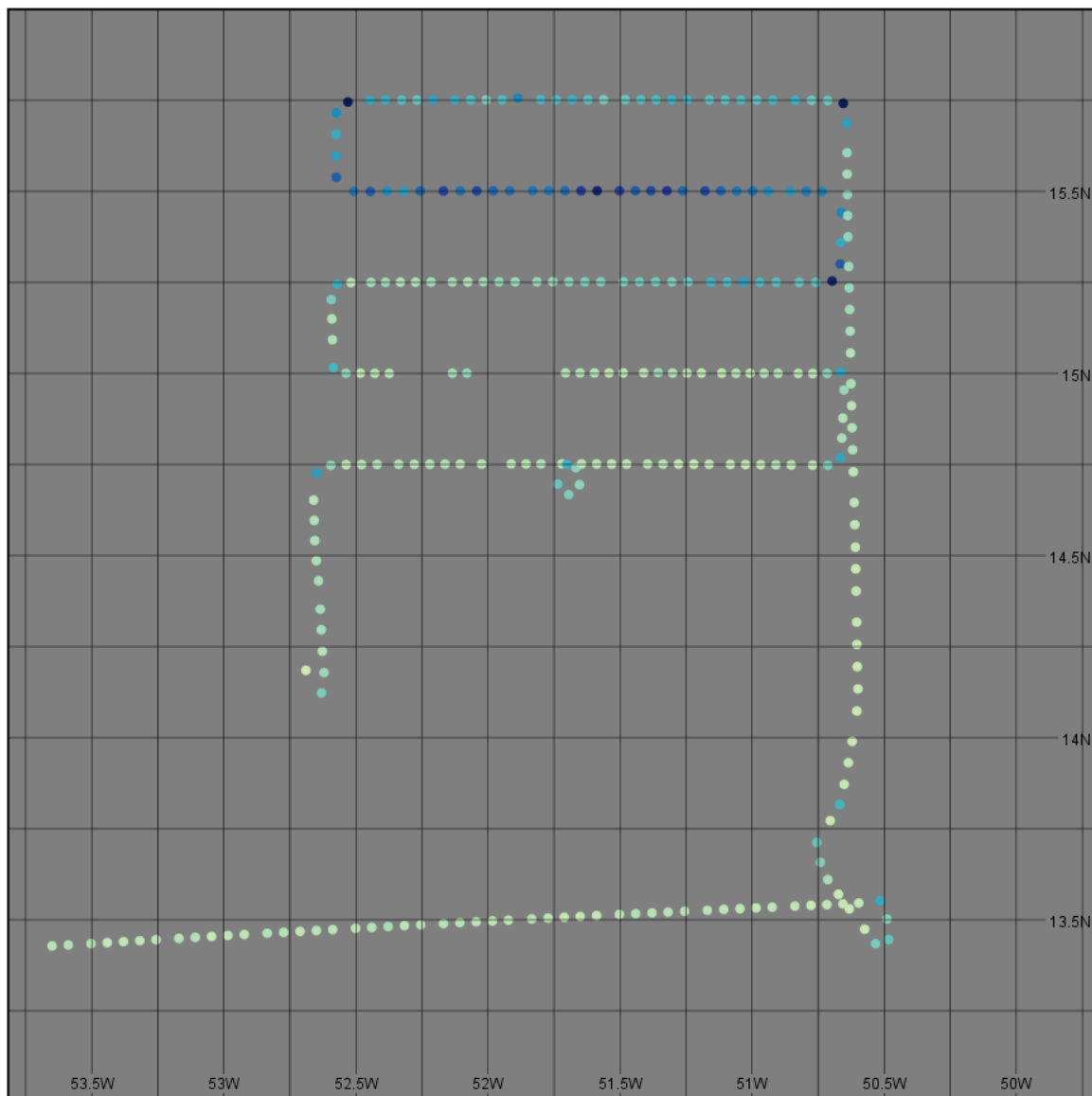


Figure 2. Profile view of flight plan.

### WSRA Significant Wave Height

ATOMIC 2020 JAN 19



FlightID 20200119I

Data Min = 1.1, Max = 6.0

START TIME 16:07 STOP TIME 20:35:00

Figure 3. Significant wave height reported by the WSRA radar during the AXBT array

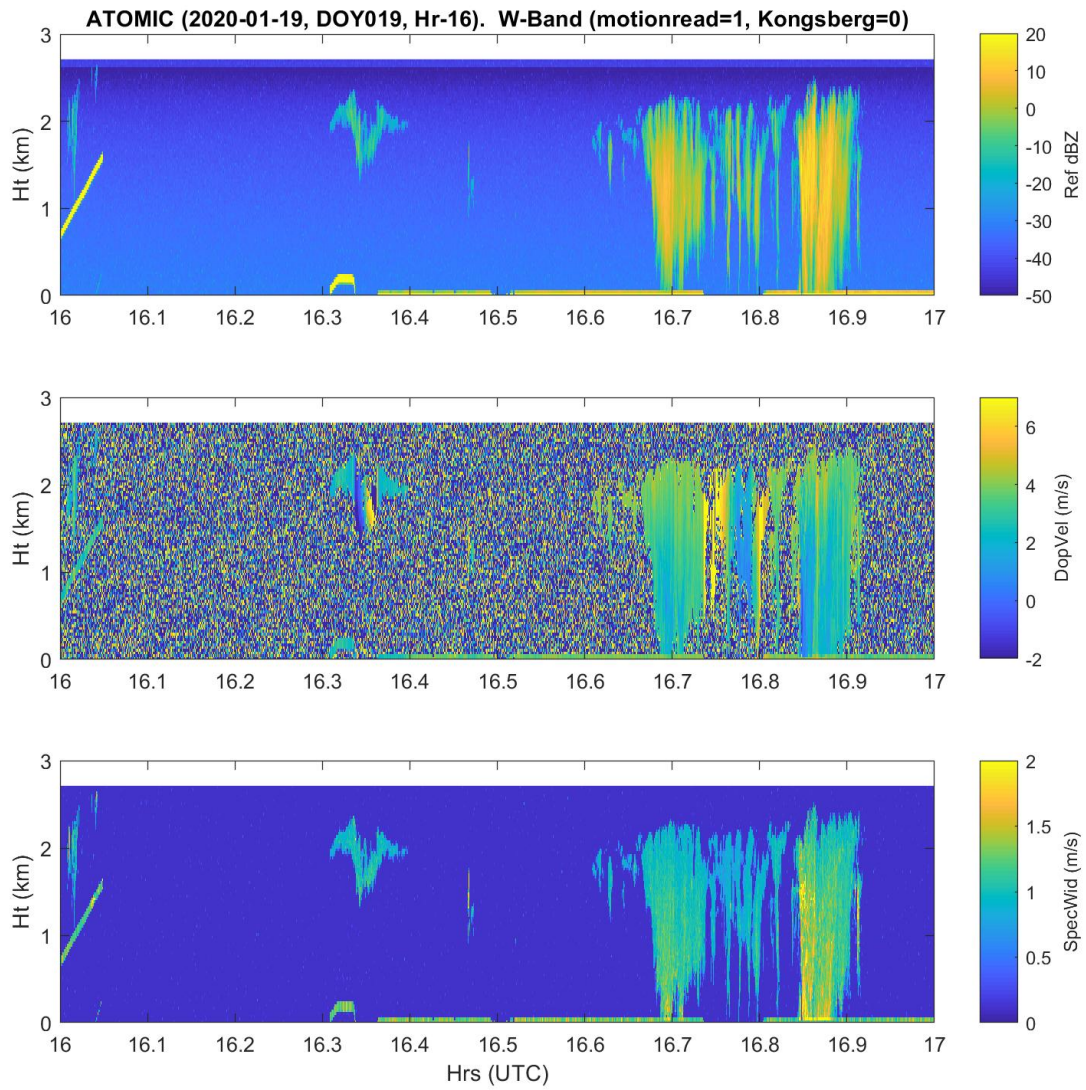
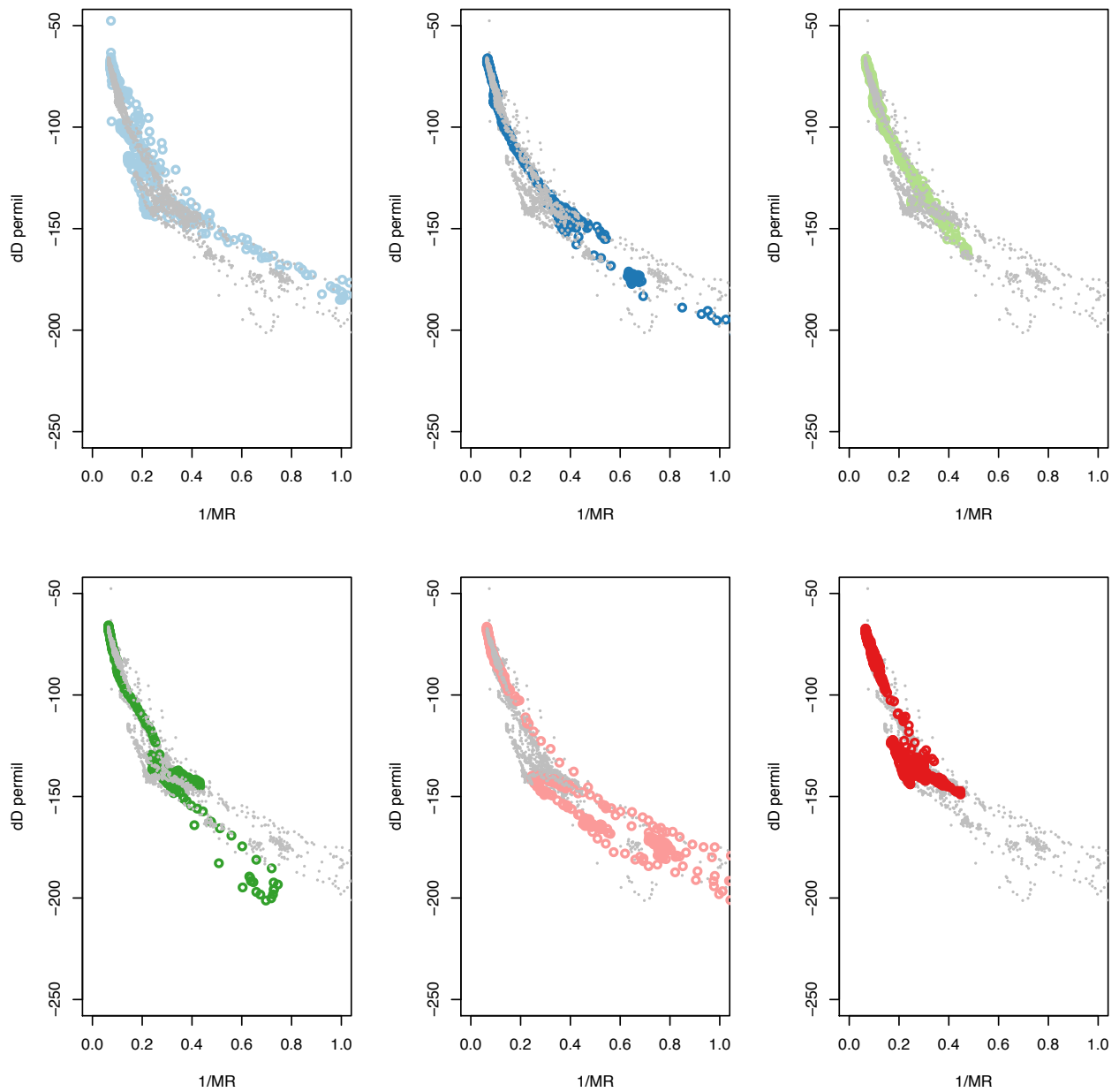


Figure 4. W-band radar cross sections for 16-17Z. Radar reflectivity (top), doppler velocity (middle), doppler width (bottom)



*Figure 5. Mixing diagrams show the water vapor isotope ratio ( $dD$ ) as a function of the inverse of the water vapor mixing ratio ( $\text{g/kg}$ )-1 during six distinct vertical profiles. Sharp changes in the isotopic slope indicate a transition from well-mixed and residual layers to free tropospheric layers moistened by cloud detrainment.*



*Figure 6. Clouds at 1854*



*Figure 7. Clouds and clear air at 1900*



*Figure 8. Clouds at 1904Z*



*Figure 9. Clear air at 1939Z*



*Figure 10. Clouds at 2036Z*