

Mission Summary
20060918H Aircraft 42RF
SALEX Flight 2006

Scientific Crew (42RF)

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Aircraft Crew (42RF)

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Electronics Technicians	Sean McMillan Bill Olney Chuck Rasco

Mission Plan:

NOAA 42RF will participate in a two-plane (1 P-3, G-IV) Saharan Air Layer Experiment (SALEX) into Hurricane Helene as part of IFEX. The P-3 will leave Barbados at 1320 UTC and will recover back at Barbados at 2215 UTC. The flight plan will include an IP ~220 nm southwest of the storm; a southwest-northeast inbound leg to the center; an outbound leg (~130 nm) to the northeast; an east-west downwind leg (~250 nm) to a point northwest of the center; an inbound leg (~190 nm) southeast to the center; an outbound leg (~130 nm) to a point southeast of the center; a south-north leg to a point east of the center; an east-west inbound leg to the center; and an east-west outbound leg (~140 nm) to a point west of the center, completing the pattern. The P-3 will fly at 16,000-20,000 ft, dropping GPS dropwindsondes at all turnpoints, midpoints of legs, and the first and third center passes. GPS dropwindsondes may also be launched in the eyewall as well as in areas of moisture gradients associated with the Saharan Air Layer (SAL). A total of six AXBTs will also be dropped at drop points 8 (center), 10-12, 20 (center), and 22. The flight track and 25 GPS dropwindsonde points are shown in Fig. 1.

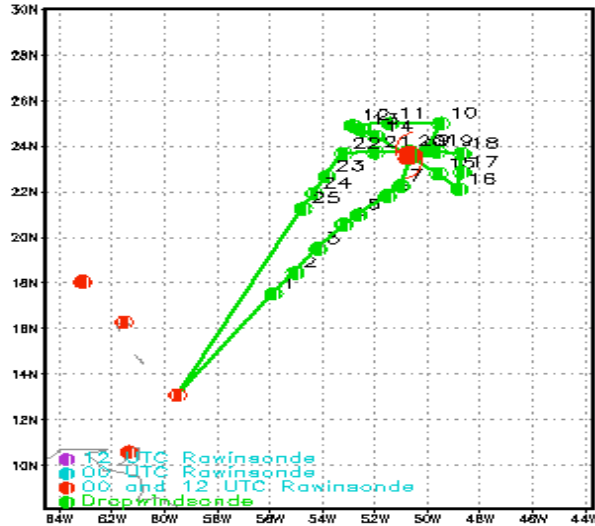


Fig. 1: Flight track (green line) for SALEX mission 060918h. The GPS dropsonde points (25 total) are indicated by green circles.

Mission Summary:

a) Synoptic Situation

Pre-Hurricane

Helene emerged from the coast of North Africa as a vigorous AEW on 12 September (Fig. 2). Figure 2 also shows that a very large Saharan Air Layer (SAL) outbreak was located to the north and west of this system at this time. The NASA

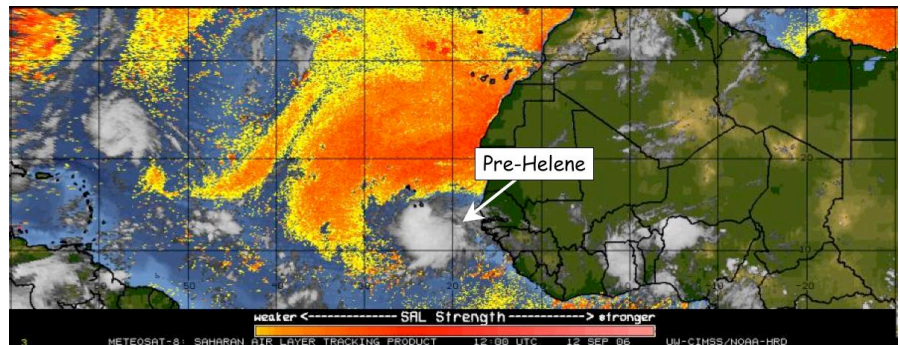


Fig. 2: SAL imagery (12 September 1200 UTC) showing a large SAL outbreak (yellow to red shading) north and west of the AEW that eventually developed into Hurricane Helene.

DC-8 flew a single mission into Tropical Depression 8 (pre-Hurricane Helene) on 12 August from Sal, Cape Verde. This mission was part of the NAMMA field program and the main objectives included cyclogenesis, Saharan Air Layer/dust, and microphysics studies. The disturbance subsequently tracked to the west-northwest around the southeast periphery of a deep layer ridge (Fig. 3, left) over the next several days, which brought it into the suppressive influence of SAL and within range of NOAA G-IV and eventually P-3 SALEX missions.

The G-IV flew a set of back-to-back one-plane SALEX missions from Barbados on 15 and 16 September while Helene was still out of range of the P-3. Although Helene continued moving northwest through a weakness in the subtropical ridge to its north (Fig. 3, right), it had tracked far enough to the west to be within range of P-3 SALEX missions from Barbados. At 1800 UTC during the day of the 060918h mission, Hurricane Helene was a 110 kt Category 3 hurricane and located at ~ 23.6 N 50.7 W. Hurricane Gordon was located on the northeast edge of the bifurcated ridge that Helene was tracking through and was ~ 1600 km north-northeast of Helene (Fig. 3, right). Vertical wind shear analyses from UW-CIMSS suggested that the shear over Helene had increased slightly to ~ 10 - 15 kt (Fig. 4, left) and was likely being enhanced by the deep layer ridge to its west [Figs. 3 (right) and 4 (right)].

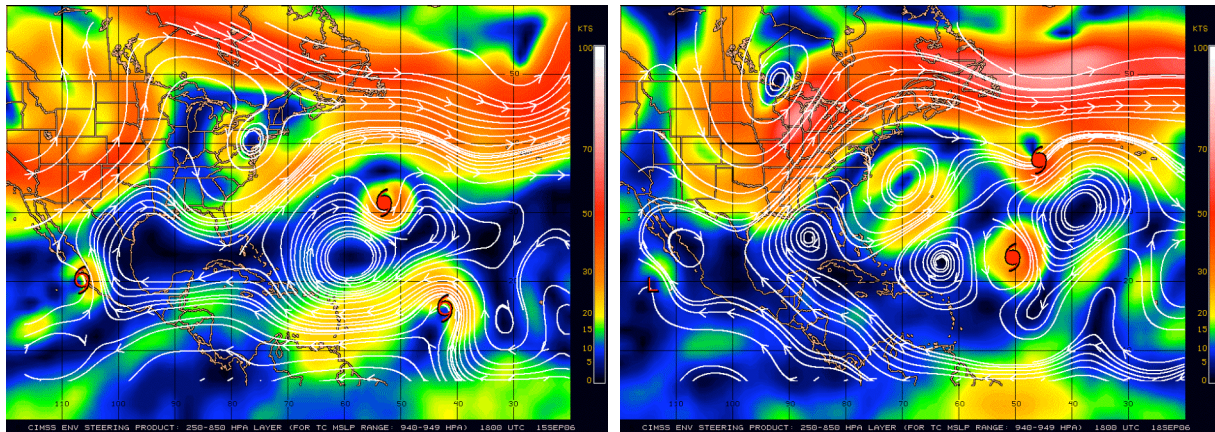


Fig. 3: Plots of 250-850 hPa deep layer mean steering [magnitude (direction) of the steering flow is indicated by colored shading (white streamlines)] for (left) 15 Sep 1800 UTC and (right) 18 Sep 1800 UTC. Helene was located at $\sim 23.6^{\circ}\text{N } 50.7^{\circ}\text{W}$ during the 060818h mission. Hurricane Gordon is also indicated on the image ~ 1600 km north-northeast of Helene. Images courtesy of UW/CIMSS.

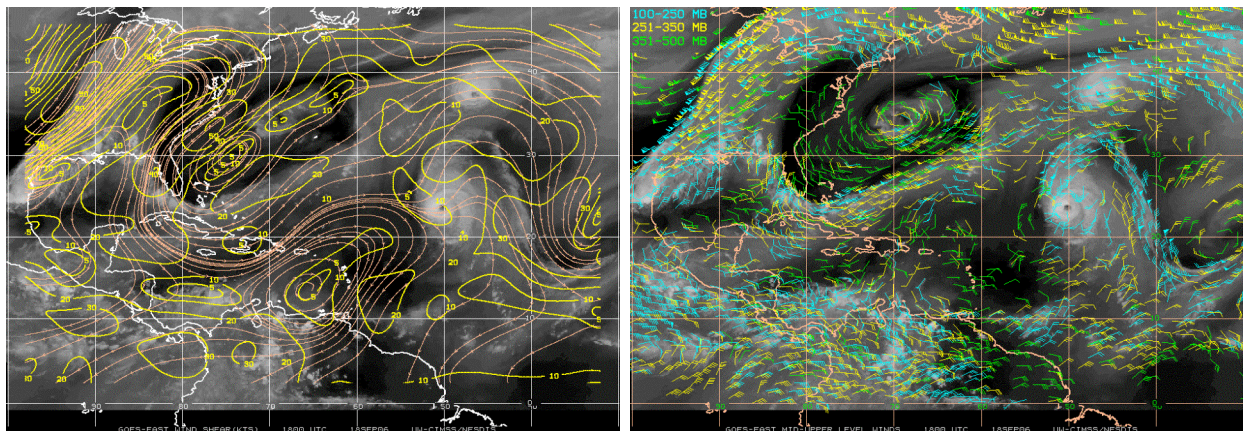


Fig. 4: Plots of (left) vertical wind shear [magnitude (direction) of the wind shear is indicated by yellow contours (orange streamlines)] and (right) mid to upper-level GOES water vapor winds for 18 August 1800 UTC. Hurricane Helene was located at $\sim 23.6^{\circ}\text{N } 50.7^{\circ}\text{W}$ at this time. Images courtesy of UW/CIMSS.

b) Mission Specifics

The flight plan was designed to investigate a large SAL outbreak that was positioned west and north of Hurricane Helene (Fig. 5, *SAL 1*) and the moist tropical environment immediately surrounding Helene [Figs. 5 & 6 (TPW >45 mm; yellow to red shading)]. The flight plan called for sampling of the inner core region of the storm, as well as an inner band of dry SAL air located ~ 350 km west of the storm center (Fig. 6). The mission was conducted at an optimal flight level of 17,000-20,000 ft, so that GPS dropwindsonde vertical profiles through the SAL could be maximized. All GPS dropwindsondes were transmitted in real-time, so that data from the sondes could be assimilated into the NOAA GFS model.

Takeoff was at 1320 UTC from Barbados. During the mission, zoomed AMSR-E TPW imagery from NASA's Aqua satellite from 1641 UTC was downloaded from NRL's tropical cyclones web site and suggested that dry SAL air (Fig. 6, <45 mm TPW; green to blue shading) was surrounding Helene in what appeared to be band-like patterns around the storm (Fig. 6). The P-3 sampled one of the inner dry SAL bands, while the G-IV concurrently sampled the outer bands of dry air.

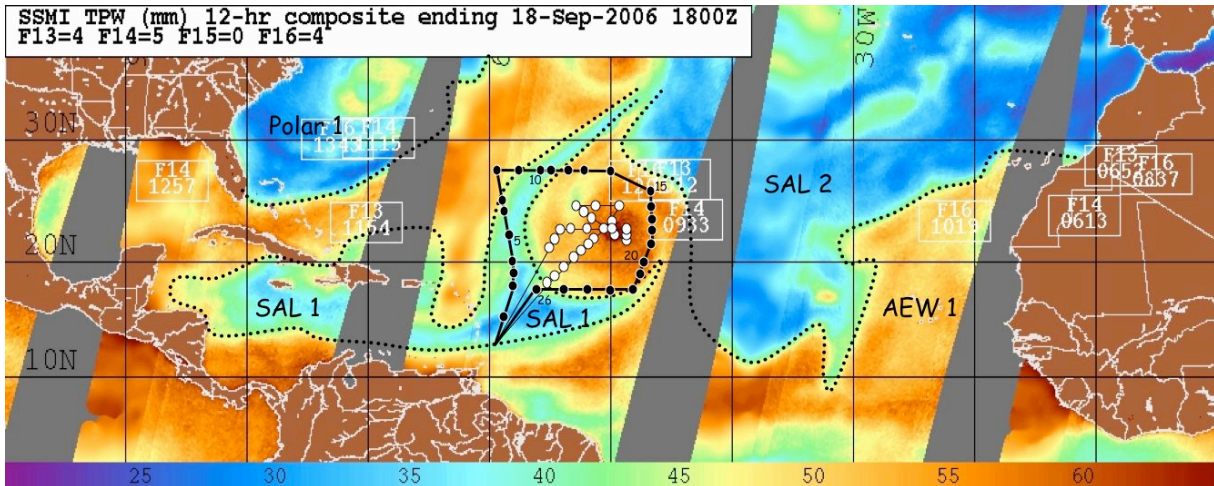


Fig. 5: Mosaic of total precipitable water (TPW) from the constellation of SSM/I satellites (1800 UTC 18 September 2006). Regions where TPW values of <45 mm (dotted lines) indicate dry air in the low to mid-levels of the atmosphere (~600-925 hPa). Two distinct areas of dry SAL air (SAL 1, & 2), one area of dry polar air (Polar 1), an African easterly wave (AEW 1), and Hurricane Helene are indicated in the imagery. The P-3 (G-IV) flight tracks [thin (thick) black curves] and dropsonde points [white (black) circles] are overlaid on the imagery. Imagery courtesy of NRL-Monterey.

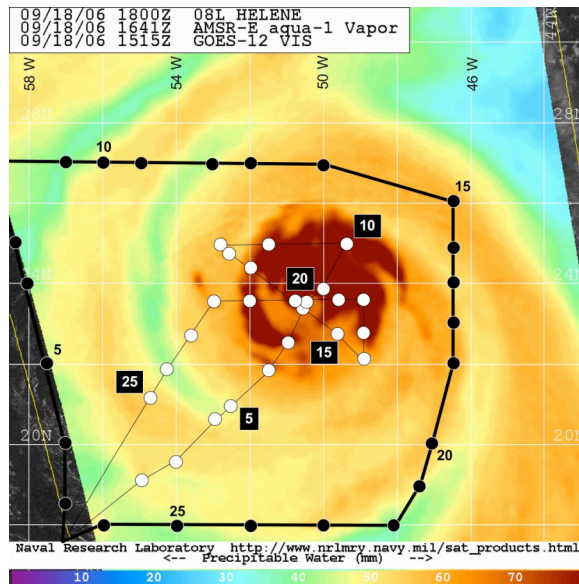


Fig. 6: (Left) AMSR-E Aqua TPW imagery showing Hurricane Helene on 18 September 1641 UTC. The SAL's dry air is indicated by values of <45 mm (green to blue shading) in the TPW image. The P-3 (G-IV) flight tracks [thin (thick) black curves] and dropsonde points [white (black) circles] are overlaid for reference. Imagery courtesy of NRL-Monterey.

Figure 7 shows the 060918h flight track overlaid on the 18 September 1800 UTC GFS model analysis of 700 hPa RH. The GFS model analysis appeared to accurately depict the spatial extent of the SAL that was surrounding Helene (Fig. 5, SAL 1 & 2; Fig. 7, 700 hPa RH of <50%), although a more in depth study using the P-3 and G-IV GPS dropsondes is needed to assess the accuracy of the magnitude of the GFS-analyzed mid-level moisture. Figure 8 shows a photo of the SAL's suspended dust taken during the end of the mission. The 060918h and 060918n SALEX missions represented the first-ever coordinated hurricane research missions between a P-3 and the G-IV aircraft.

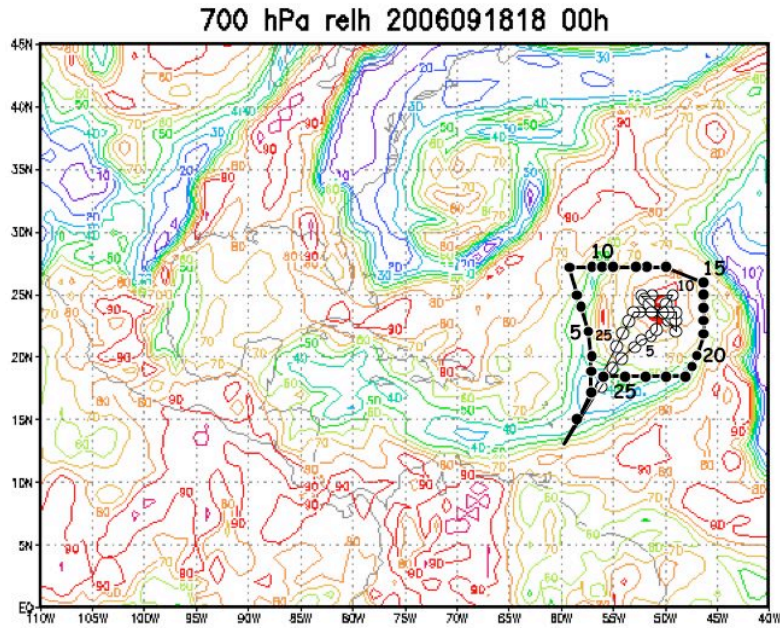


Fig. 7: Analysis of GFS 700 hPa relative humidity (%) for 18 September 1800 UTC. The P-3 (G-IV) flight tracks [thin (thick) black curves], GPS dropsonde points [white (black) circles], and location of Hurricane Helene are overlaid on the analysis.



Fig. 8: Photo of the SAL taken ~200 km northeast of Barbados from the NOAA P-3 Orion at the end of SALEX mission on 060918h. Saharan dust gave the sky an orange glow during this late afternoon sunset. Small cumulus clouds can be seen poking through the tops of the dust layer.

Problems:

There were no major problems related to this flight. Minor problems included: 5 of the 30 “Codeless” GPS dropwindsondes (mainly from 2000-2004) failed during the mission; the P-3’s ASDL system had to be shut down during the mission at ~1850 UTC, so drops 19-25 could not be transmitted to NCEP/NHC; the tail Doppler radar was inadvertently set in sector scan mode during the mission, so there was no Doppler data below flight level from 1604-1740 UTC; the lower fuselage radar was not functional during the flight.