GH Platform Scientist Report for September 02, 2010

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September 02, 2010

Mission Objective: This would be the "maiden" voyage of the Global Hawk UAS (GH) into/above a hurricane. The primary science objectives were to collect HAMSR, LIP, and HIWRAP data while overflying a major hurricane to document intensity changes.

Operational objectives were to test the capabilities of the GH while overflying deep convection that may be electrified. A secondary objective was to fly a portion of the passes across Earl's eye in tandem with the DC8.

Pre-flight plans: The GH instruments, HAMSR, HIWRAP, and LIP were all operational but the dropsonde system was not yet certified for flight. HDVIS images from the belly camera of the GH, satellite, and lightning data viewed on the Real Time Mission Monitor (RTMM) would be the primary tools to help navigate the GH in and around weather and over the eye.

The planned flight track would include as the first module, a star pattern that would take the GH near the core but avoid the strongest convection near Earl's eyewall (Fig. 1). If the pilots felt comfortable with the turbulence measurements that were being monitored and could ascertain from the HDVIS imagery that the GH was well above the deep convection, then the plan was to switch from the star pattern to a Figure-4 pattern with crossings over the eye. If this was successful, then the second module consisted of a butterfly pattern, part of which would be flown with the DC8 below the GH.

The takeoff was scheduled for 0400 UTC followed by a 7.5 hour ferry to the storm with about 8-9 hours on station, and the same 7.5 hour ferry back to Dryden for a total flight time of about 24 hours.

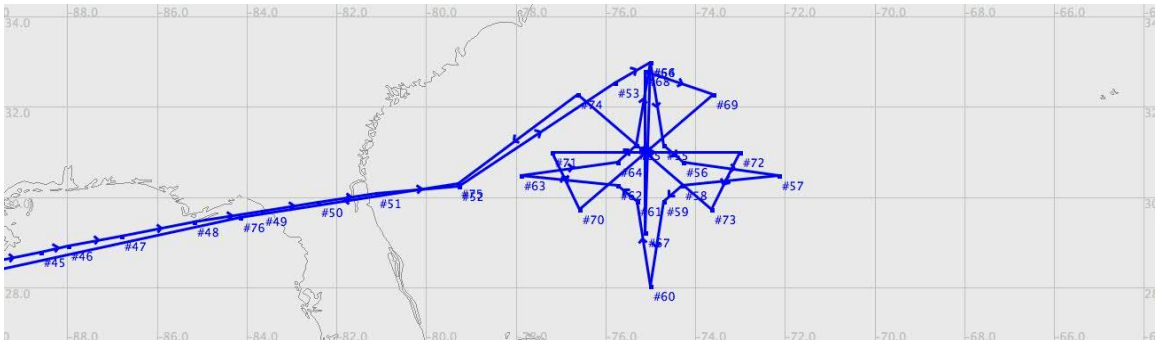


Fig. 1: Planned 100902 GH flight

The Mission: The GH took off on time near 0400 UTC and began its long ferry to Earl in the western Atlantic. AT that time, Earl was a Category 4 hurricane with maximum surface winds of 120 kt and a MSLP of 939 mb. Earl was at or just past peak intensity.

Convection within the CDO of Earl was very vigorous with cloud top temperatures of about -70°C.

The ferry out to Earl was smooth and uneventful. The GH reached the IP to the north of Earl's core about 1145 UTC and headed south to Earl's well-defined eye. (Fig. 2)

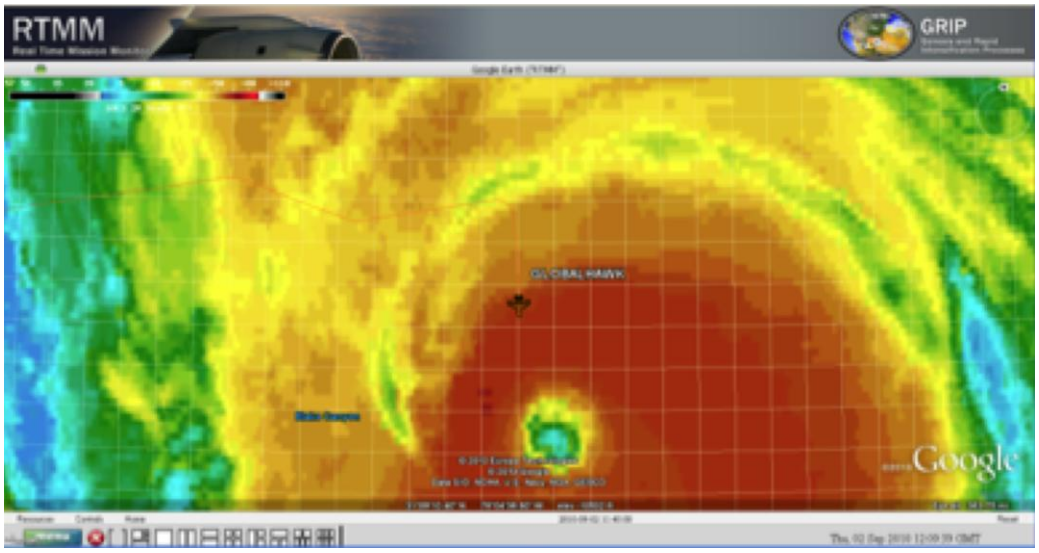


Fig. 2: RTMM screen capture showing the GH approaching Earl's eye on the first pass.

As the GH got near the eye, the pilot veered the plane to the right (East). The mission scientists asked about the deviation and it turned out that the pilot was flying the planned track around the eye but was comfortable flying right over top of the eye/eyewall. So, on this first pass, the GH just missed flying over the center of Earl but instead flew over the eastern eyewall (Fig. 3.).

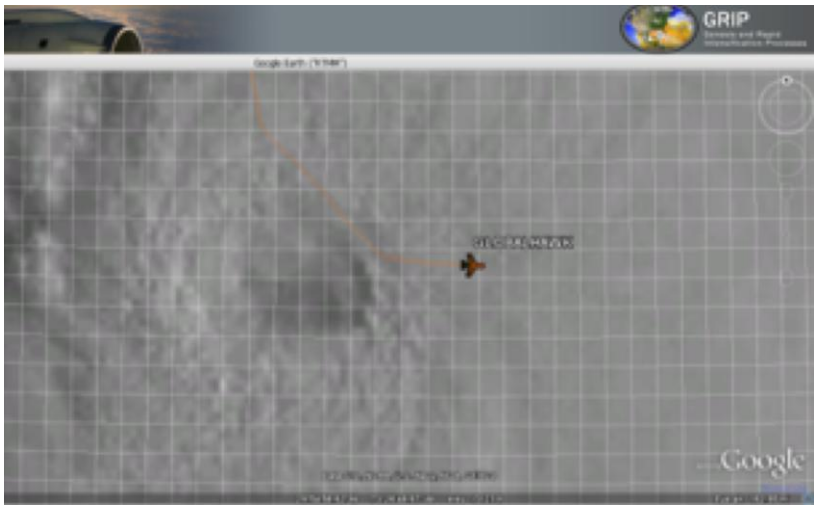


Fig. 3 RTMM screen capture of visible satellite imagery showing the GH's track over the eastern eyewall of Earl.

Having realized that the GH was well above all but the strongest of overshooting tops, the mission scientists conferred with the pilots who agreed to abandon the star pattern and instead fly the alternative plan, a figure 4 with passes directly over the eye. The GH made an additional 3 passes over Earl's eye while performing the figure-4 pattern, providing spectacular visual imagery of the eyewall and eye. The images of the eye revealed complex mesocyclone structure within the low clouds about 50,000 feet below the GH (Figs. 5 and 6).

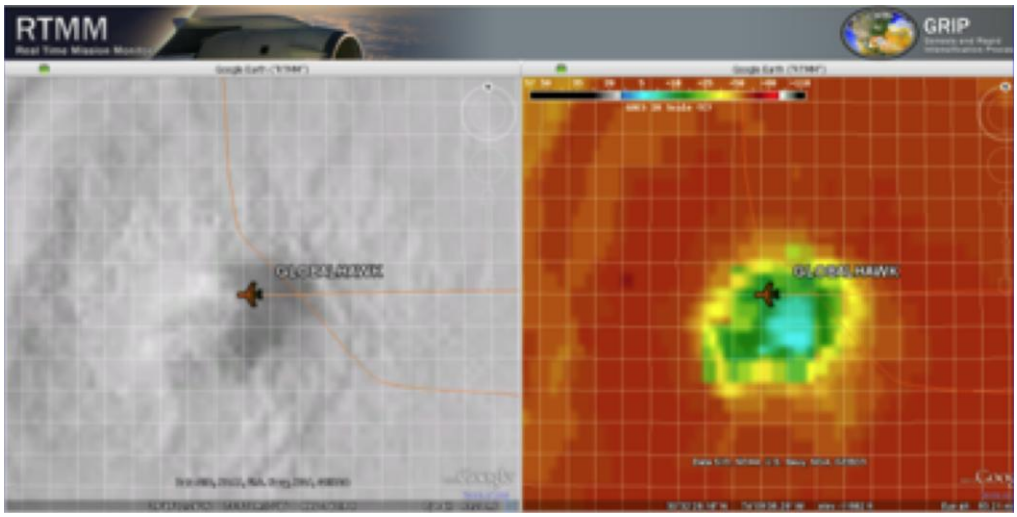
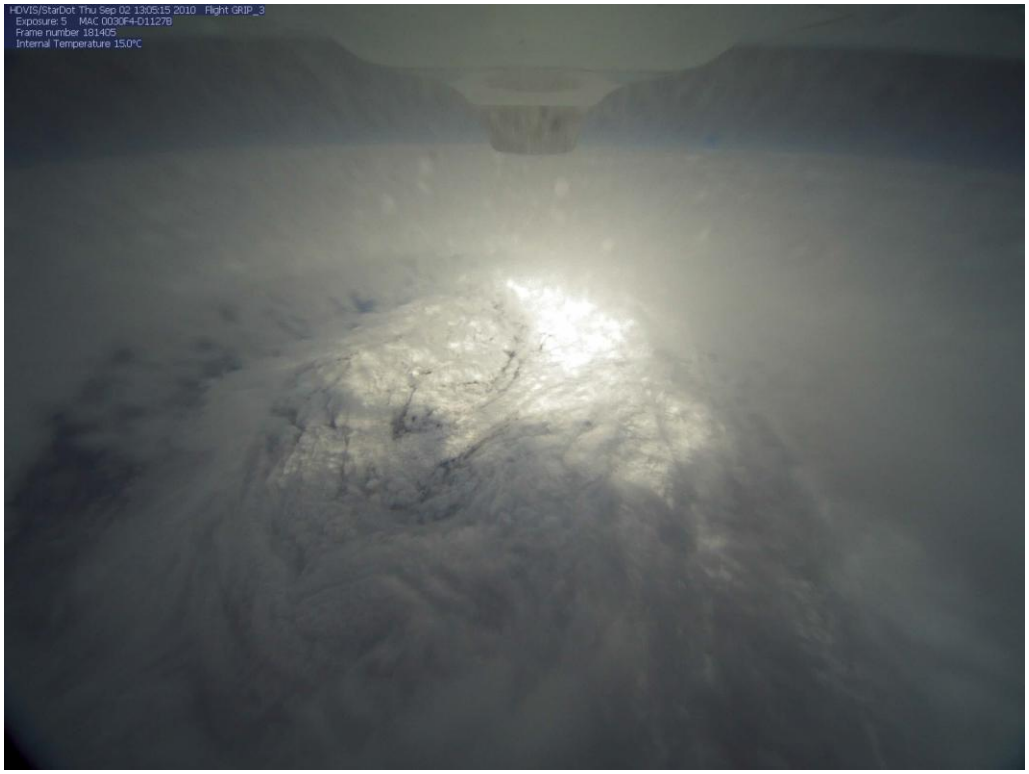


Fig. 5: (Top) Visible (left) and IR (right) images of Earls eye near 1300 UTC at nearly the same time of the HDVIS photo from the GH camera (bottom)



The last pass through the eye during the figure 4 was from N to S and the eyewall and eye had evolved considerably in 45 minutes since the last pass. Now, the eye contained two large mesocyclones, one near the northern eyewall and the other near the SW eyewall. (Figs. 6 and 8).

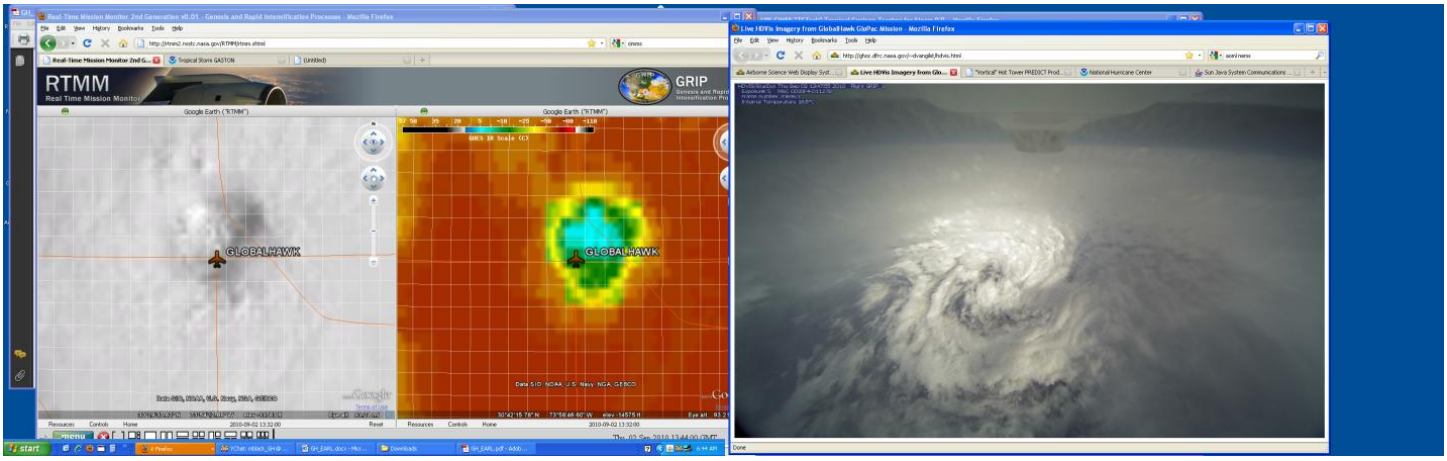


Fig. 6: Visible and IRA imagery of Earls eye at 1344 UTC (left) and an HDVIS image of Earls eye at the same time.

The HAMSR system was working well during the flight and we were able to see real-time images of the precipitation structure of Earl, including the shape and size of the eyewall (Fig. 7). Earl was undergoing an eyewall replacement cycle at the time of the GH flight and data from HAMSR and HIWRAP should be able to document much of the evolution associated with the eyewall cycle (Fig. 9).

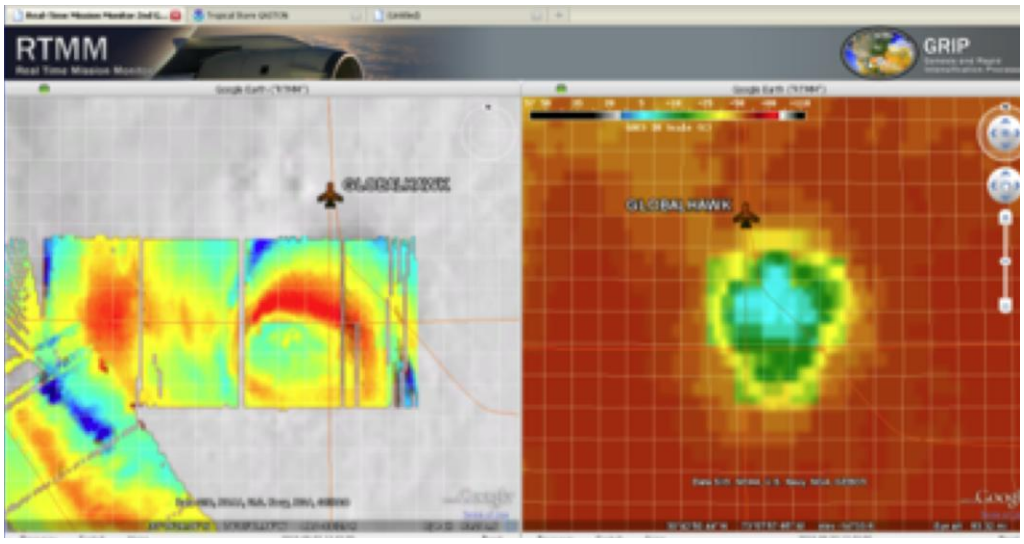


Fig. 7: Visible satellite image of Earl overlain with swaths of radar reflectivity from HAMSR (left) and IR image of Earl's eye (right).

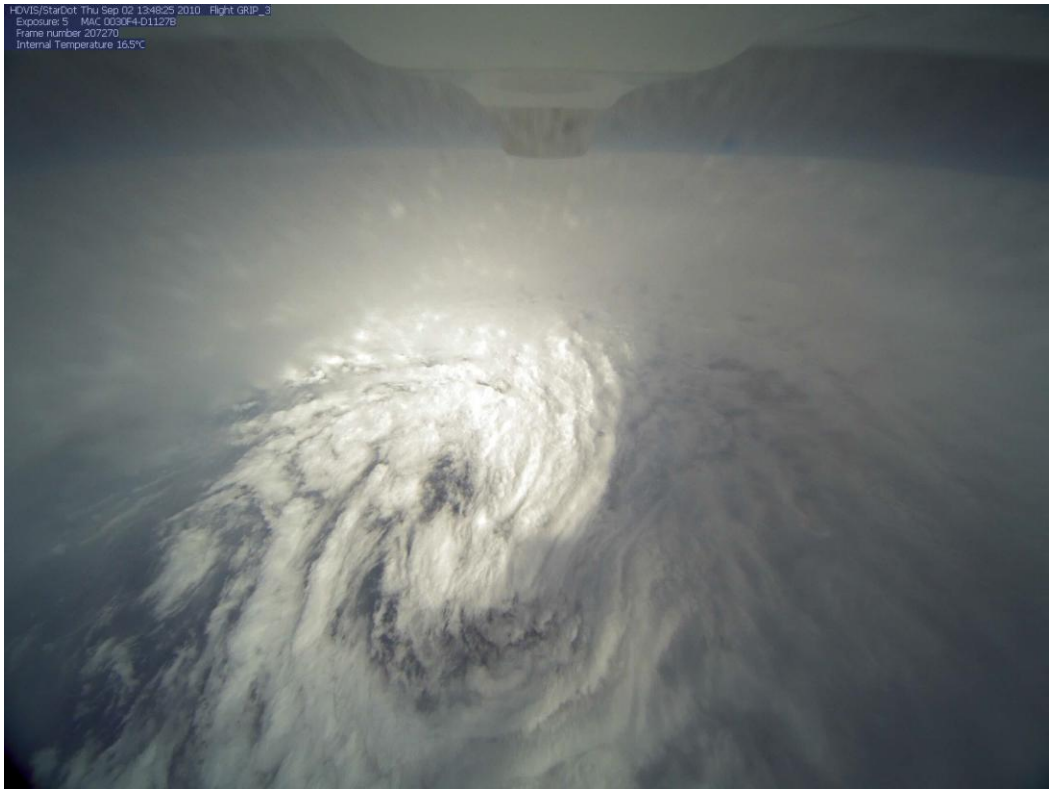


Fig. 8: Close-up of the eye mesocyclones and northern eyewall of Earl.

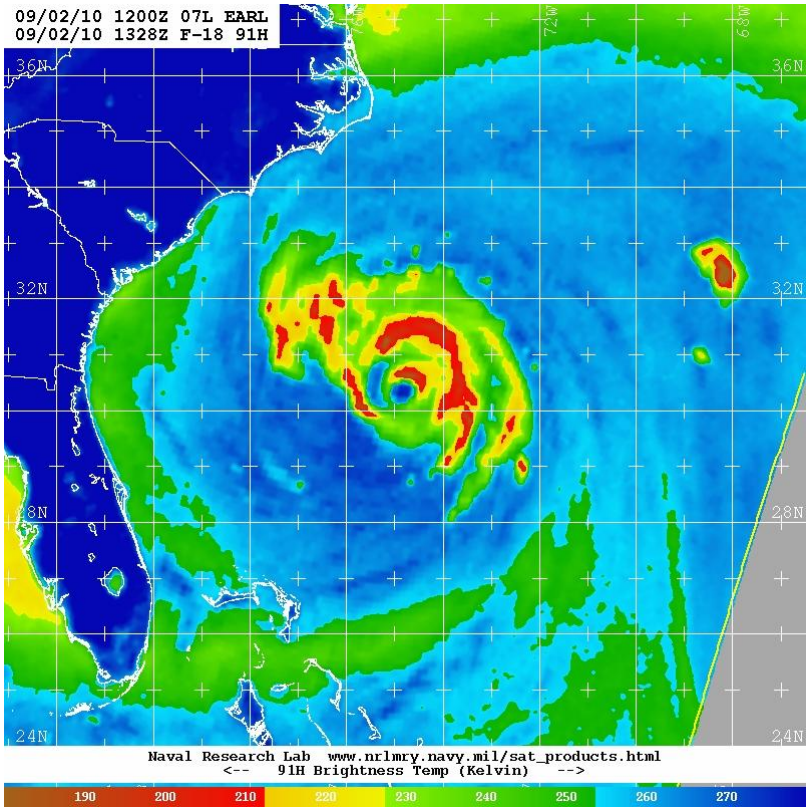


Fig. 9: 85 GHz microwave image of Hurricane Earl showing the concentric eyewall structure

After completing the Fig. 4, it was time to fly a coordinated butterfly pattern with the DC8, that was en route to Earl. Using xchat, the mission scientists for each aircraft decided to hook up on the west side of Early and track to the eye together with the GH ahead at the beginning of the leg to account for the slower (than the DC8) ground speed. The coordination worked well overall, although some maneuvering by both aircraft was needed to be in tandem near the eye.

We attempted 3 coordinated passed with the DC, two were successful, and the third was offset slightly because the GH needed to circumvent frequent lightning located in the NW eyewall. RTMM was used to display the lightning from both ground-based lightning detection networks and the LIP system onboard the GH. The LIP instrument frequently detected lightning before the ground-based networks.

An example of the RTMM display, showing the coordination between the GH and DC8 is in Fig. 10. We would have liked to complete a 4th coordinated pass but fuel was a consideration so the GH departed Earl and headed west back to Dryden.

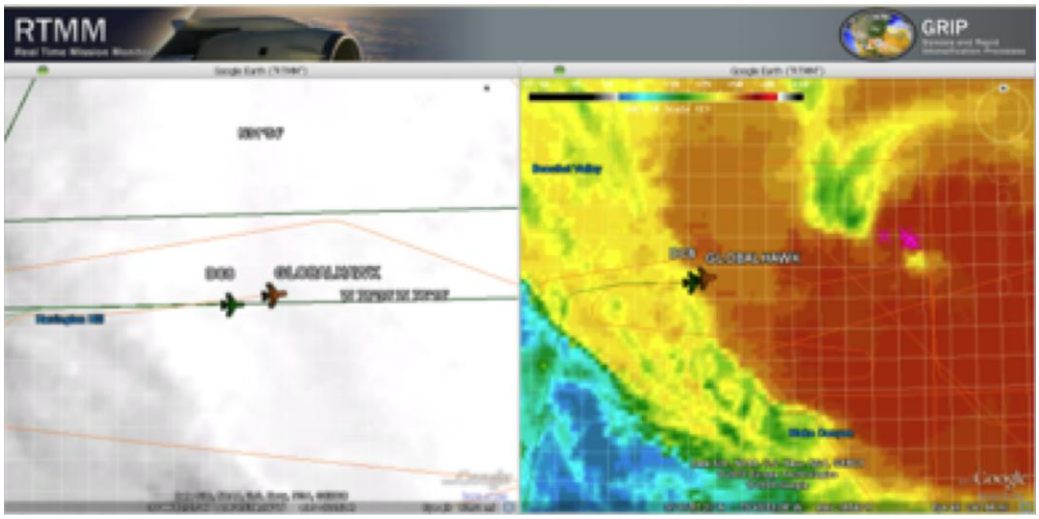


Fig. 10: RTMM screen capture showing the coordination between the GH and DC8 on an inbound leg into Earl. Also shown are lightning strokes (pink Xs) in the NW eyewall.

The ferry back to Dryden was mainly uneventful except for diverting around electrically active thunderstorms near the Texas-Mexico border. The GH landed safely almost a full 24 hours after it took off.

Overall, the mission was a tremendous success, both from a scientific viewpoint and from a capability test for the GH. The pilots allowed for many real-time track changes that made the eye passes possible and for the coordination with the DC8. The GH showed that it could fly safely and effectively over very cold cloud tops associated with deep convection in a major hurricane.

Mike Black/Gerry Heymsfield