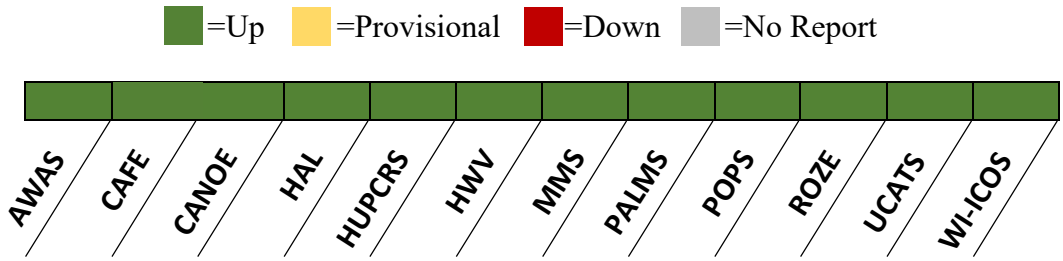
DCOTSS ER-2 Mission Scientist Flight Summary Report

NASA Earth Venture Suborbital 3
Dynamics and Chemistry of the Summer Stratosphere

Flight identifier: RF10
Science goals: Sample the vertical and horizontal gradients of tracers under the low and high tropopause environments between Salina and TS Fred and a coordinated flight with WB-57.
Start of flight (UTC): 2021-08-17 15:08Z
End of flight (UTC): 2021-08-17 21:56Z
ER-2 Pilot: Tim Williams
Mission Scientist: Chuntao Liu

Version	Report date and time (UTC)	Author
1	2021-08-18 8:40Z	Chuntao Liu
2	2021-08-20 15:01 Z	Kenneth Bowman, Frank Keutsch

Instrument Performance:



Aircraft Performance: Good

Science Objectives:

On August 17th, there was a low tropopause region over the Nebraska-Kansas region corresponding to a cut-off low at upper levels (Figure 1 left panel). To the southeast, tropical storm Fred made landfall over the Florida panhandle area and was moving northward through Georgia into eastern Tennessee. Between these two major synoptic systems, some 2 to 3 day old and freshly injected material over Kansas, Oklahoma, and northern Texas accumulated in the

lower stratosphere along a southwest-northeast belt over west Texas, Arkansas, and Tennessee (Figure 1 right panel).

There are three main objectives for science flight RF10. The first objective (#1) is to sample the vertical and horizontal gradients of chemical tracers (Figure 2, 3) under the low and high tropopause environments between Salina and the edge of tropical storm Fred (Figure 1 left panel). The second objective (#2) is to conduct a coordinated flight with WB-57 from ACCLIP mission to intercompare measurements from two aircraft. The third object (#3) is to sample fresh and some 2 to 3 day old overshoot material in the upper troposphere and the lower stratosphere (Figure 1 right panel).

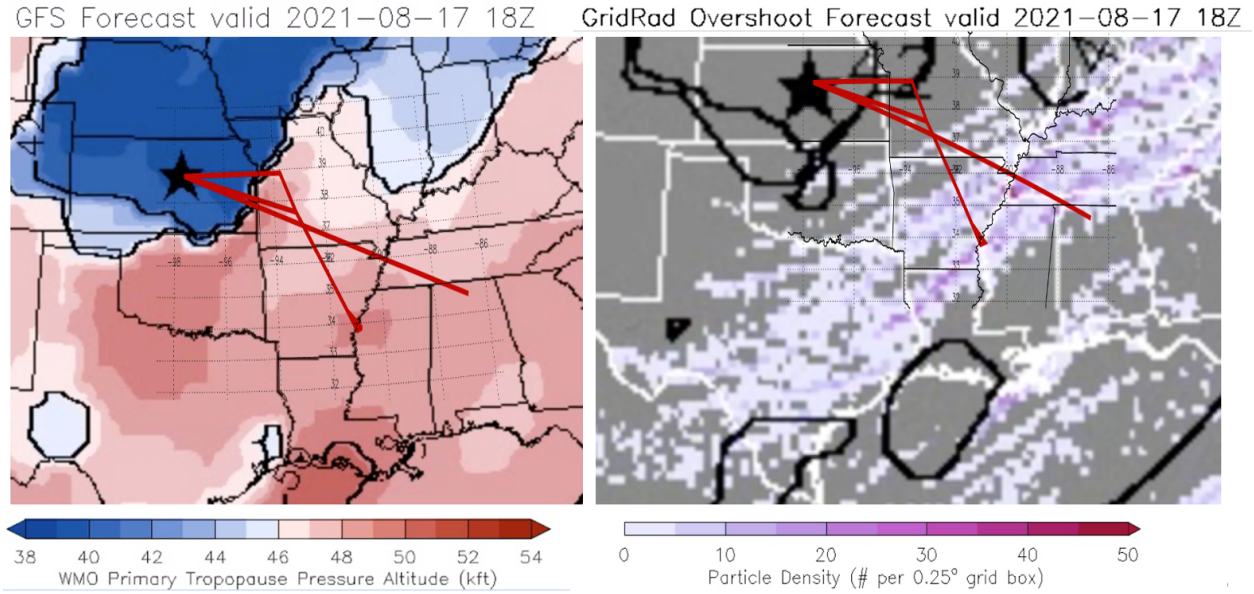


Figure 1. Left panel shows tropopause height predicted by GFS. Right panel shows particle density of overshoot material by convection in the past three days predicted by the trajectory tool using GFS predicted wind. The planned RF10 flight track is overplotted.

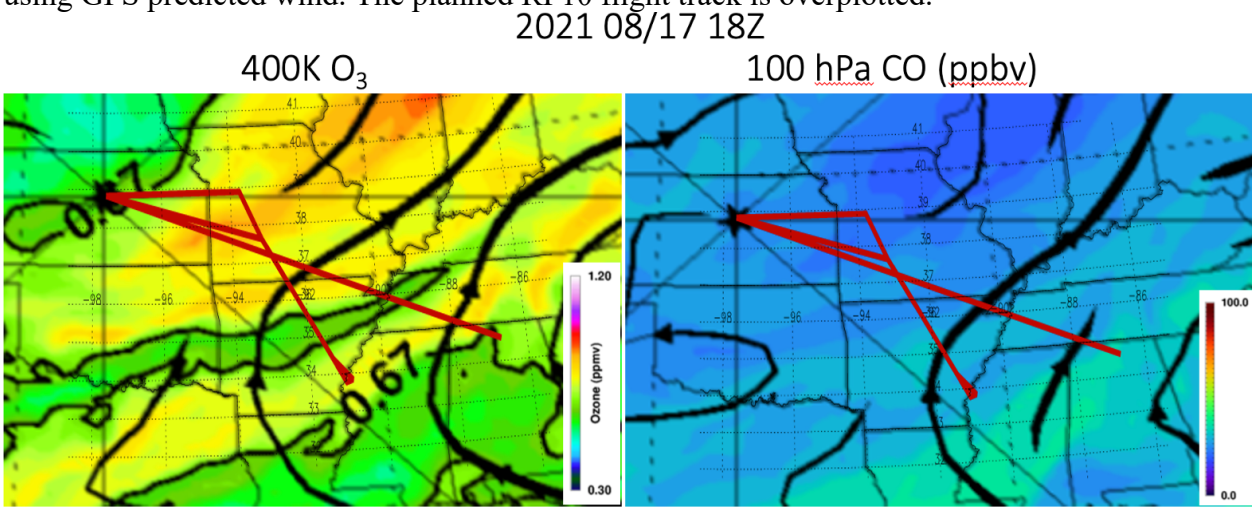


Figure 2. Ozone mixing ratio at 400 K potential temperature level (left) and 100 hPa CO mixing ratio (right) at 0817 18Z predicted by GEOS-5. The planned flight track is overplotted.

Flight plan:

To achieve these three objectives, the flight plan (Figures 3 and 4) is designed to sample between KSLN and P3 at the edge of tropical storm Fred over northern of Alabama, as predicted by the NAM and HRRR models. During the KSLN-P3 leg, four vertical profiles between 46 and 56 kft, as well as a short horizontal leg at 49 kft to sample 2-3-day old overshoot material, are included. Then a long horizontal leg at 46 kft level from P3 to KSLN is targeted on measuring horizontal gradient of tracers. The coordinated flight with the WB-57 starts at P1 at 2:00PM CDT. Between P1 and P2, two legs for the ER-2 and WB-57 are designed to sample side-by-side at 55 kft and 45 kft levels. The flight ends with an MMS maneuver and a slow descent to obtain the final profile over KSLN. During the flight, there are multiple opportunities to sample fresh and 2-3 day old overshoot materials as shown in Figure 1 and 4 to achieve the objective #3.

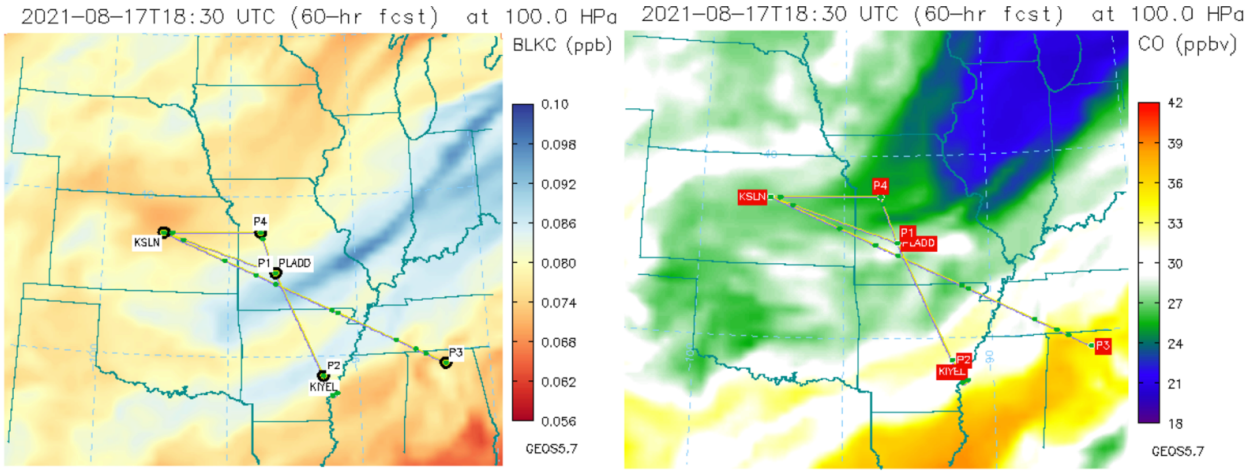


Figure 3. The flight plan over the 100 hPa black carbon (left) and CO (right) mixing ratio predicted by GEOS-5.

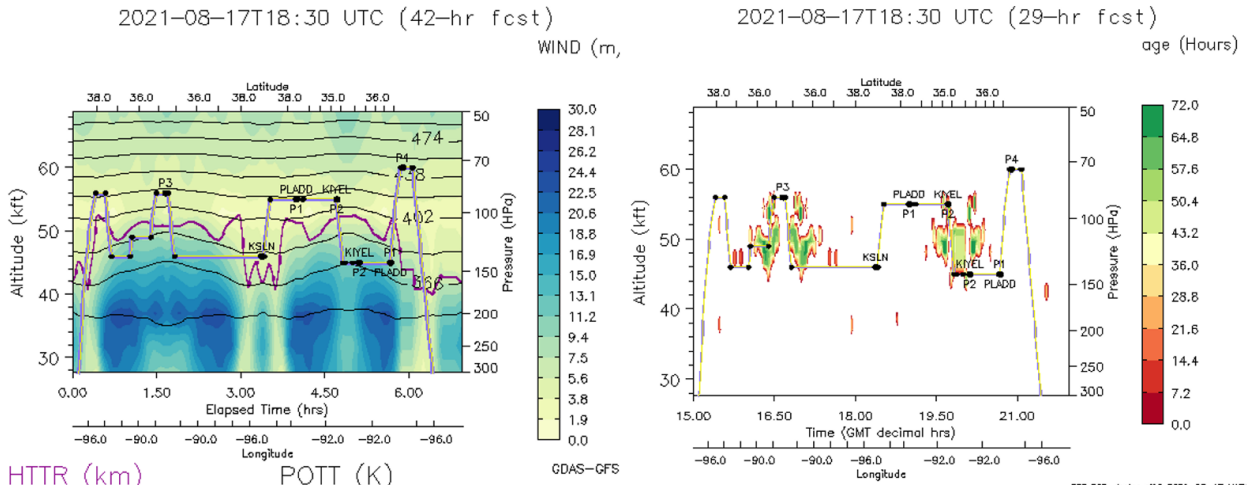


Figure 4. Vertical cross section of GFS predicted wind field and tropopause height (color fill and black curve in left panel) and trajectory of aged overshoot material (right panel). The flight plan altitude and the way points are overlaid with yellow/grey curve.

Flight Summary:

Due to airport traffic, the airplane took off at 15:08Z (10:08 CDT), slight later than planned. The flight was executed as planned from that point (Figure 5). Along the KSLN-P3-KSLN legs, tracers were sampled with multiple vertical profiles between 46-56 kft and a long horizontal transit at 46 kft (Figure 6) after turning back from the edge of TS Fred (Figure 7). The aircraft continued to P1 to coordinate with the WB-57. The two aircraft started the side-by-side leg around 19:00Z. The first camera image of the WB-57 on MTS was at 19:06Z (Figure 8). The aircraft completed the side-by-side legs around 20:24Z. The ER-2 then climbed to 60 kft, completed the MMS maneuver, and returned to KSLN. The aircraft landed at 21:56Z after a short airport traffic delay. Total flight time was 6 hours 48 minutes.

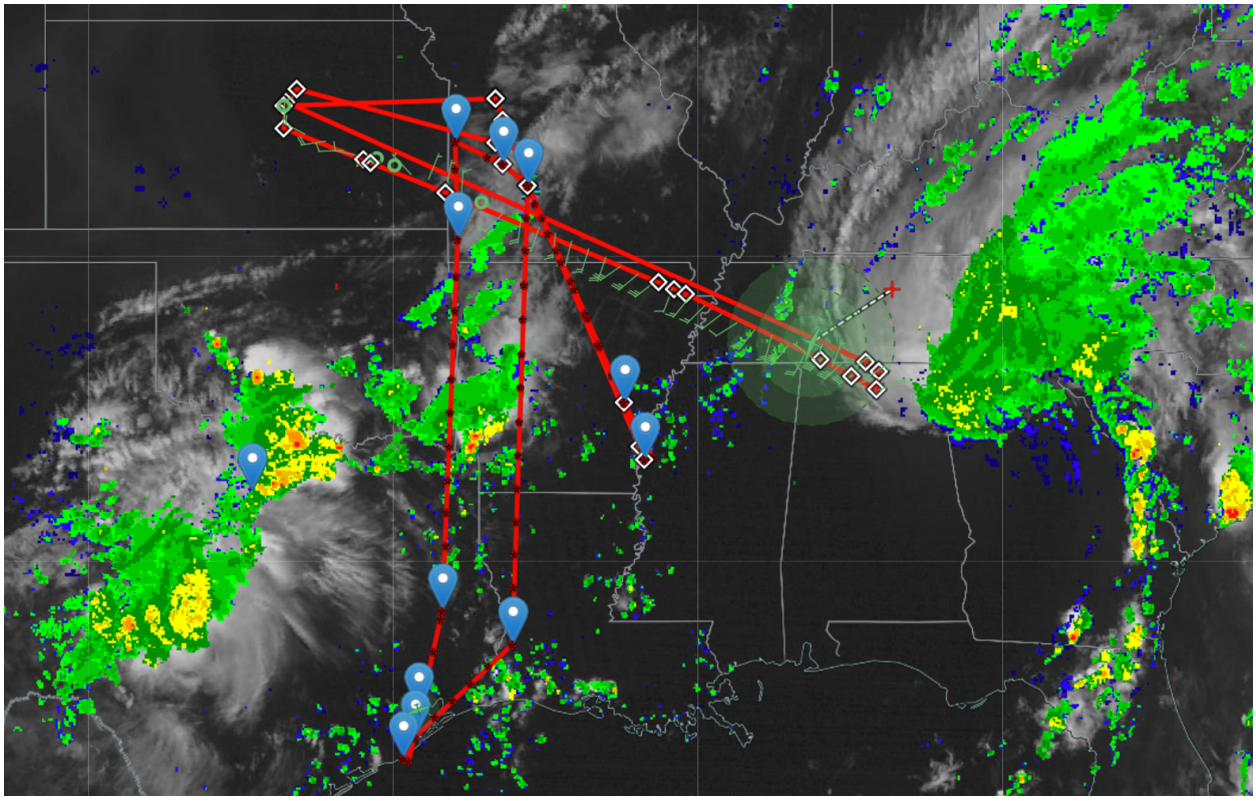


Figure 5. The flight plans of ER-2 (solid red line) and WB-57 (dotted red line) overlayed on the GOES-16 Visible image and the NEXRAD echo top height in the middle of RF10. The tropical storm Fred weakened into a tropical depression and moved up to west Tennessee. Multiple convective systems developed over central Texas and south Oklahoma.

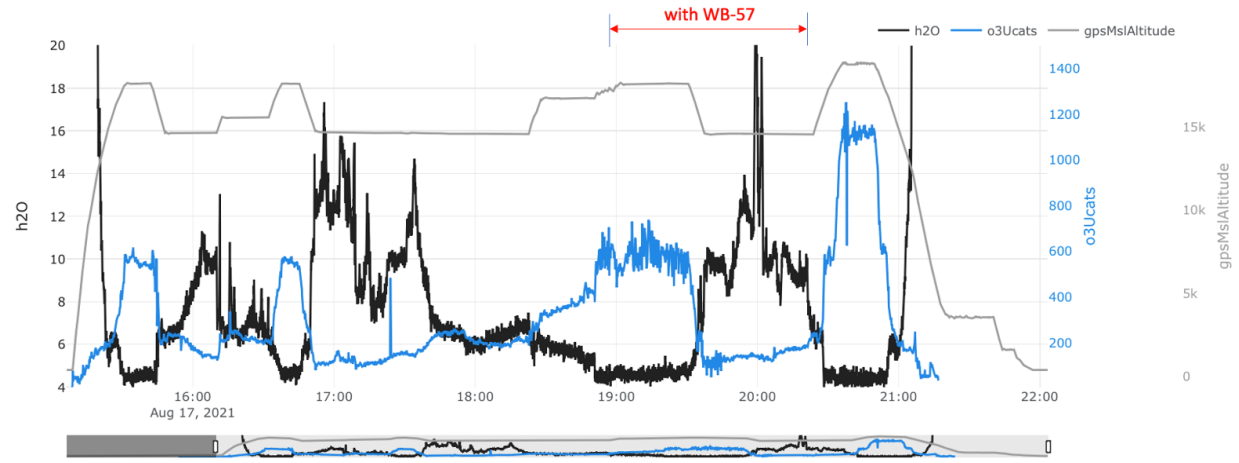


Figure 6. Timeseries of MMS aircraft GPS altitude, UCATS ozone, and HWV water vapor from MTS. Time period during the coordinated flight with WB-57 is marked with a red line.

Interesting pictures from the PTZ camera

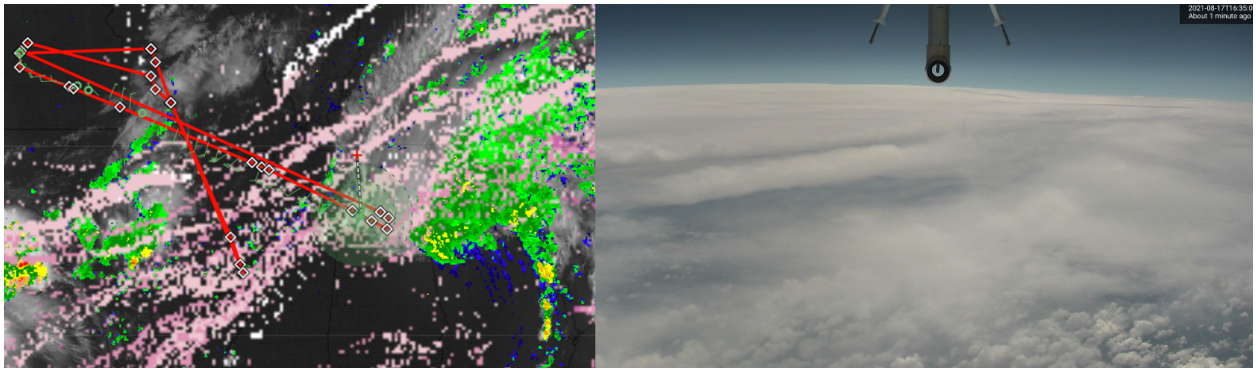


Figure 7. Left panel shows the RF10 flight plan overlayed on the GOES-16 visible image, NEXRAD echo top heights, and predicted overshoot material in the 46-52 kft layer. Right panel shows the picture of the edge of tropical depression Fred slightly before the aircraft turned back to KSLN.

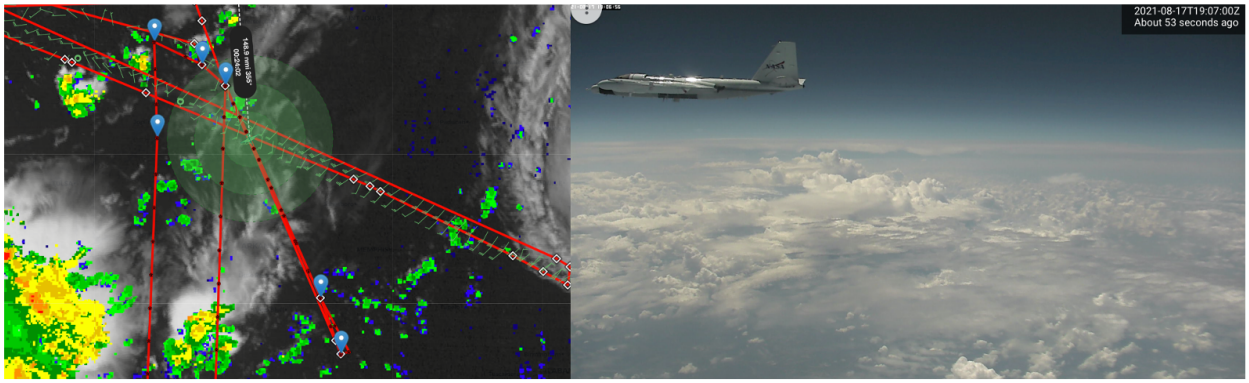


Figure 8. Left panel shows the flight plans of both the ER-2 and WB-57 overlayed on the GOES-16 visible image and NEXRAD echo top heights. Right panel shows the first camera image of the WB-57 on MTS during the coordinated flight.