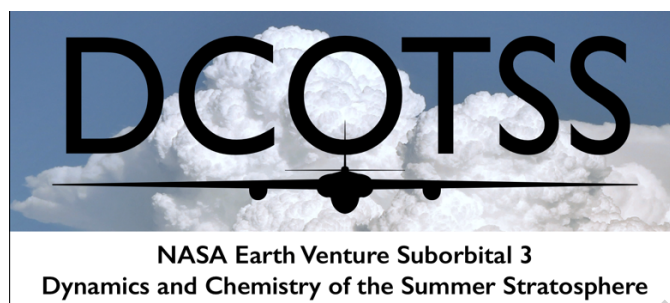


DCOTSS ER-2 Mission Scientist Flight Summary Report



Flight identifier: RF18

Science goals: survey flight for good particle sampling and deep profiles from center anticyclone across the jet and ozone gradient, with secondary goal of pyroCb smoke plume sampling

Start of flight (UTC): 2022-06-21 13:05Z

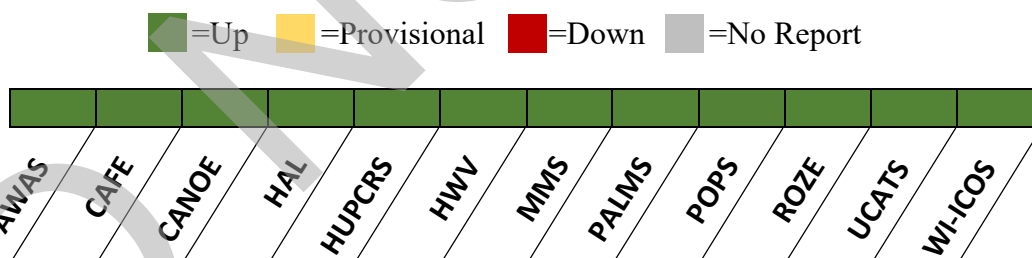
End of flight (UTC): 2022-06-21 20:06Z

ER-2 Pilot: Greg “Coach” Nelson

Mission Scientist: Anita Rapp

Version	Report date and time (UTC)	Author
1	2022-06-26 2100Z	Rapp, Anita
2	2022-07-01 15:35Z	Kenneth Bowman, Frank Keutsch
3	2022-07-06 16:00Z	Rapp, Anita

Instrument Performance:



Aircraft Performance: Good; new INS is also drifting and remains a concern

Science Objectives:

The primary objectives of RF18 were to use two sampling strategies – long level legs for good statistics and deep vertical profiles – for a survey flight from near the center of the anticyclone across the jet stream and ozone gradient. The planned flight (Figure 1) shows the series of 10-minute level legs stepping up through 45, 46, 48, 50, 53, 56, 60 kft from KSLN to P1 and a 20-minute level leg at 63 kft between P1 and P2. On the return from P2 to S3, a series of 3 deep profile maneuvers from 62-42 kft, 64-45 kft, and 65-45 kft with level legs at the top and bottom of each profile were planned.

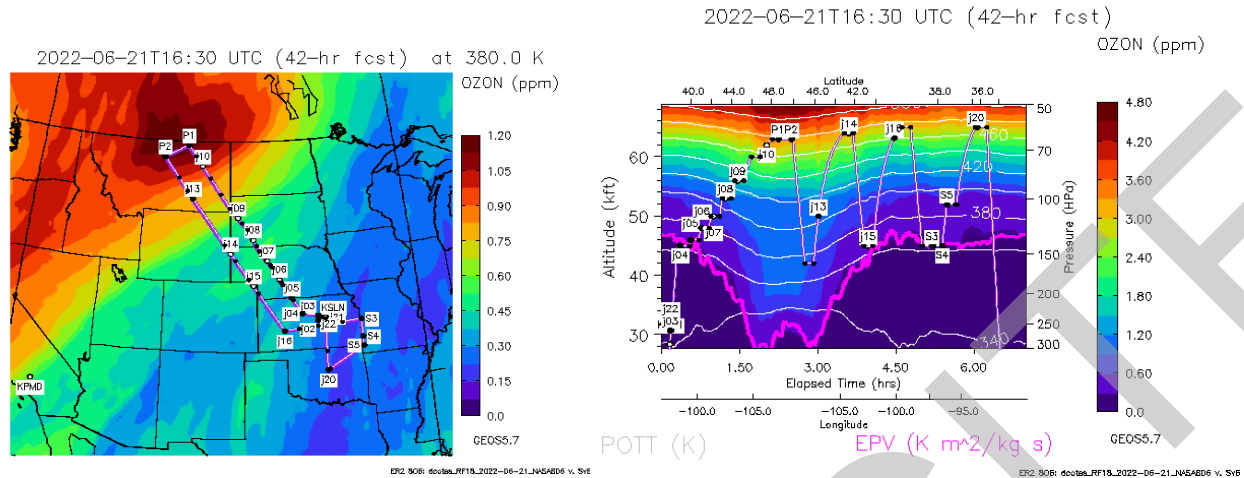


Figure 1. Left panel: flight plan overlaid on GEOS-5 O₃ forecast at 380K. Right panel: curtain of flight altitude vs time and O₃ forecast profile along the flight track.

At the bottom of the 3rd dive, the 45 kft level leg continued to S3 and turned to S4 for a total of ~40 minutes to achieve the secondary objective of sampling a ~5-day old smoke plume. This plume had been transported to the NE from a relatively large pyrocumulus that occurred in New Mexico on 16 June. Figure 2 shows a close-up of the flight track from S3 to S4 sampling the plume that was still evident (circled in green) in the GOES-16 1.37 μ m cirrus band imagery. After S4 the plan was to ascend to 52 kft at S5 for an MMS maneuver, followed by an ascent to max altitude to J20, and then turn and descend back to Salina. Takeoff was planned for 13 UTC with a 7-hour flight.

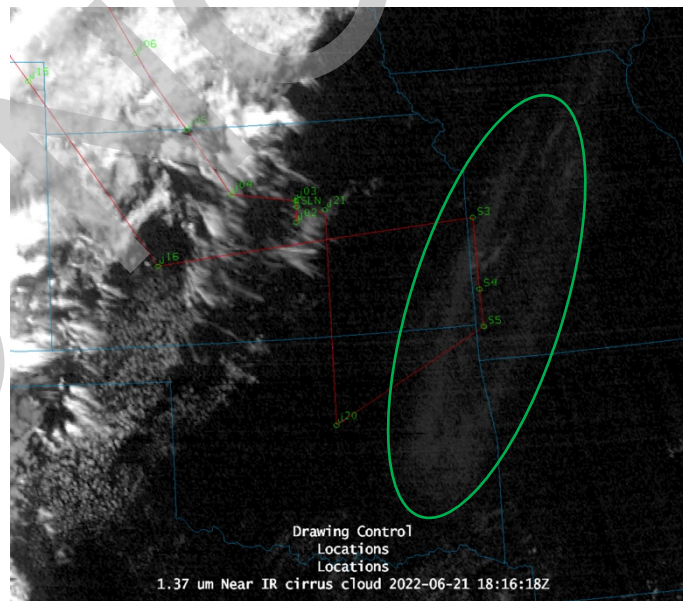


Figure 2. GOES 1.37 μ m cirrus band reflectance at 1816Z on 21 June 2022 with planned flight track overlaid in red. The green oval shows the approximate location of the smoke plume evident in the satellite image.

Flight Summary:

The ER-2 departed Salina at 1305 UTC and initially followed the flight plan stepping up through the series of 10-minute level legs. The measured altitude, temperature, and potential temperature timeseries from MMS for RF18 are shown in the left panel of Figure 3, with the water vapor mixing ratio from HHH, total water from WI-ICOS, ROZE ozone timeseries shown in the right panels of Figure 3.

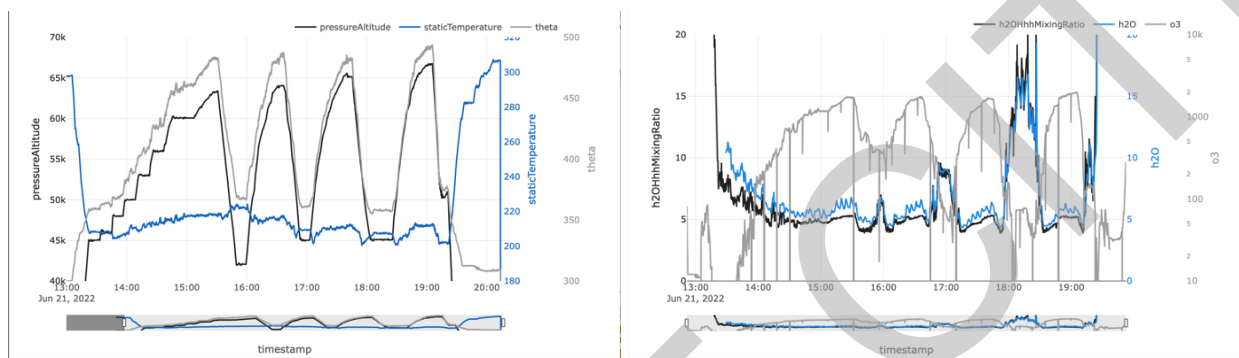


Figure 3. (Left panel) Time series of pressure altitude (black), MMS temperature (blue), and MMS theta (gray), and (Right panel) HHH water vapor mixing ratio (black), WI-ICOS total water (blue), and ROZE ozone mixing ratio (gray) during RF18.

During the level-leg sampling, several water vapor enhancements of 1-1.5 ppmv above background levels were observed over northern Nebraska and southern South Dakota at 50 and 53kft between 1355 and 1425 UTC (Figure 4). The FFP team believes this material was originally injected by storms in Missouri occurring ~4-5 days prior that had been wrapped around the anticyclone and carried north into the sampling domain.

The original flight plan had a 10-min level leg at 60 kft and a 20-min level leg at 63 kft to allow for good particle statistics. Because an extra 10 minutes was flown at 60 kft, the aircraft did not have enough time to ascend to 63 kft and complete a 20-min level leg before turning at P2. Instead, the aircraft reached 63 kft at P2 and immediately turned toward S3 and began the first deep profile maneuver from 63 to 42 kft.

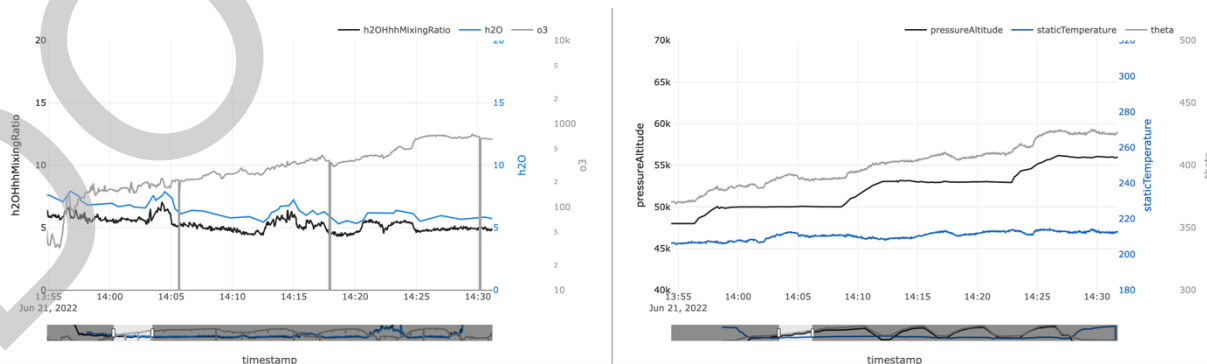


Figure 4. H_2O enhancements were apparent in HHH and WI-ICOS at 50 and 53 kft.

During the flight, monitoring of the smoke plume in satellite imagery showed the plume drifting east from S3. In addition, real-time monitoring of aircraft location indicated that the aircraft would reach 45 kft on the 3rd deep dive farther east than the original plan. Because convection was possible in the Salina area after our planned landing time, we did not want to significantly increase the flight time. However, to ensure adequate sampling at this lower altitude and account for the drift of the smoke plume, we requested that the pilot continue to the east past point S3 for an additional 5 minutes and then turn to join the original flight plan at S4 (top left panel in Figure 5). The smoke plume was clearly evident in the large increase in particle concentration and enhancement of water vapor, CO, NO₂, and O₃ shown in Figure 5. Analysis of the temperature profile from a nearby sounding (not shown) indicated that this plume sample at 45 kft was just below the tropopause.

After rejoining the original flight plan at S4, the pilot then ascended to maximum altitude (over 67 kft) toward J20. After turning toward Salina at J20, the pilot descended to 54 kft to perform the MMS maneuver and then into Salina arriving at 2006 UTC.

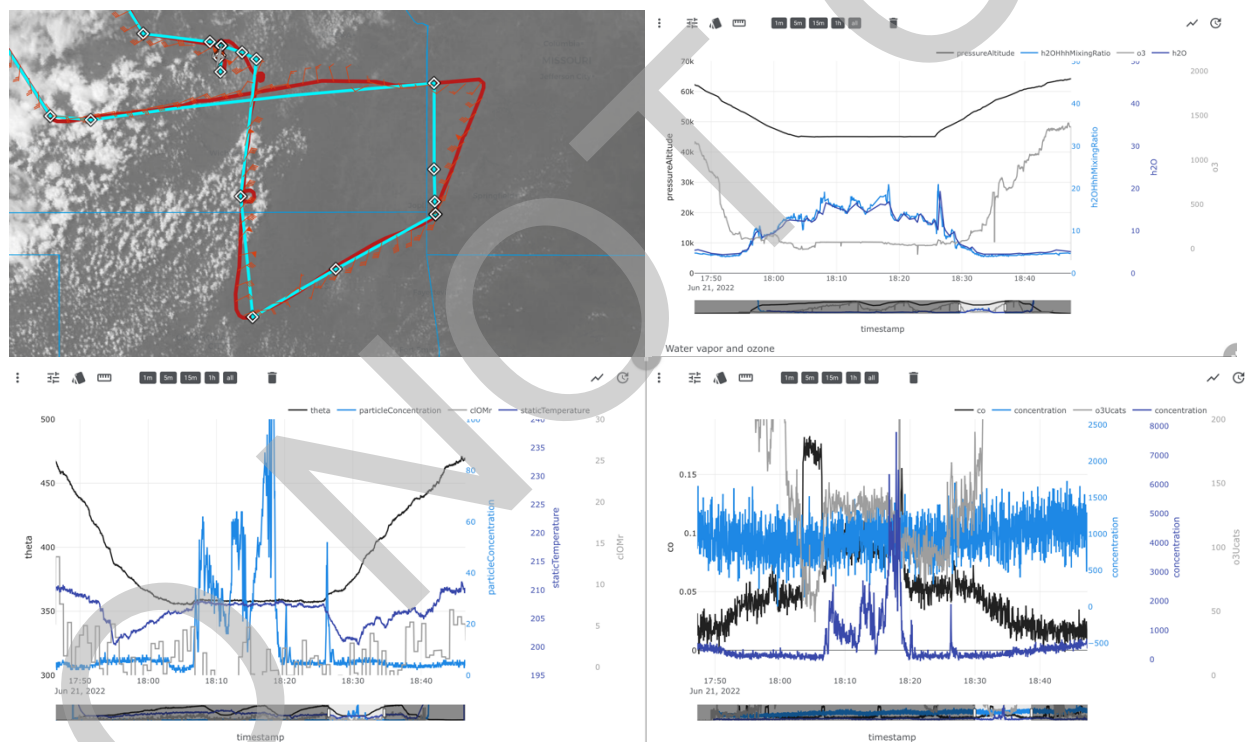


Figure 5. (Top left) Planned (cyan) vs. actual (red) flight path, (Top right) MMS pressure altitude (black), HHH water vapor mixing ratio (light blue), WI-ICOS total water (dark blue), ROZE ozone (gray), (Bottom Left) MMS potential temperature (black), DPOPS particle concentration (light blue), MMS temperature (dark blue), and ClO mixing ratio (gray), and (Bottom right) CO (black), NO₂ before particle scattering correction (dark blue), CH₂O (light blue), and UCATS O₃ (gray).