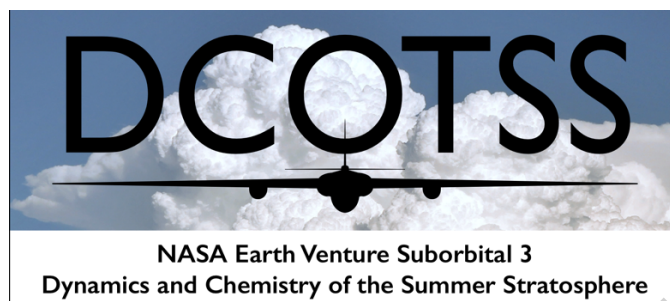


DCOTSS ER-2 Mission Scientist Flight Summary Report



Flight identifier: RF04

Science goals: Intensively sample 13-20 hour-old plume from recent overshooting convection

Start of flight (UTC): 2021-07-27 15:23Z

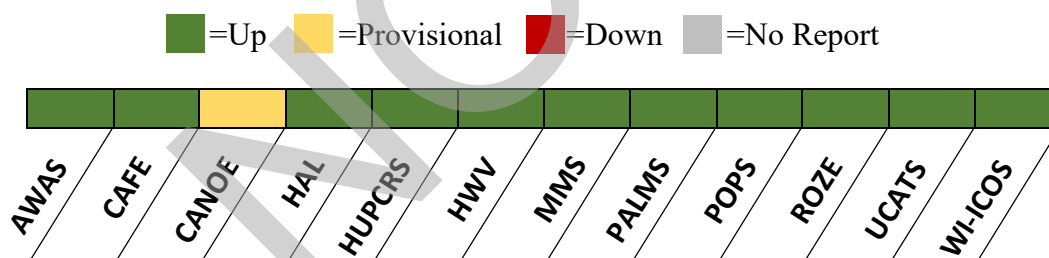
End of flight (UTC): 2021-07-27 21:41Z

ER-2 Pilot: Gary "Thor" Toroni

Mission Scientist: Anita D. Rapp

Version	Report date and time (UTC)	Author
1	2018-07-30 18:40Z	Rapp, Anita

Instrument Performance:



Aircraft Performance: Good

Science Objectives:

DCOTSS research flight #4 was designed with the objective to sample a fresh convective outflow plume (13-20 hours old) and its environment over the Texas panhandle. Multiple overshooting events occurred in the overnight hours in this region, with the target plumes resulting from cells beginning to overshoot the tropopause at approximately 0Z along the eastern Texas panhandle/OK border and propagating eastward and continuing to overshoot until about 03Z (Fig. 1a). At times echo tops extended >3km above the GFS-estimated tropopause. The location of the overshooting was near the elongated center of the upper level anticyclone, with plumes transported toward the west with the upper level flow (Fig 1b).

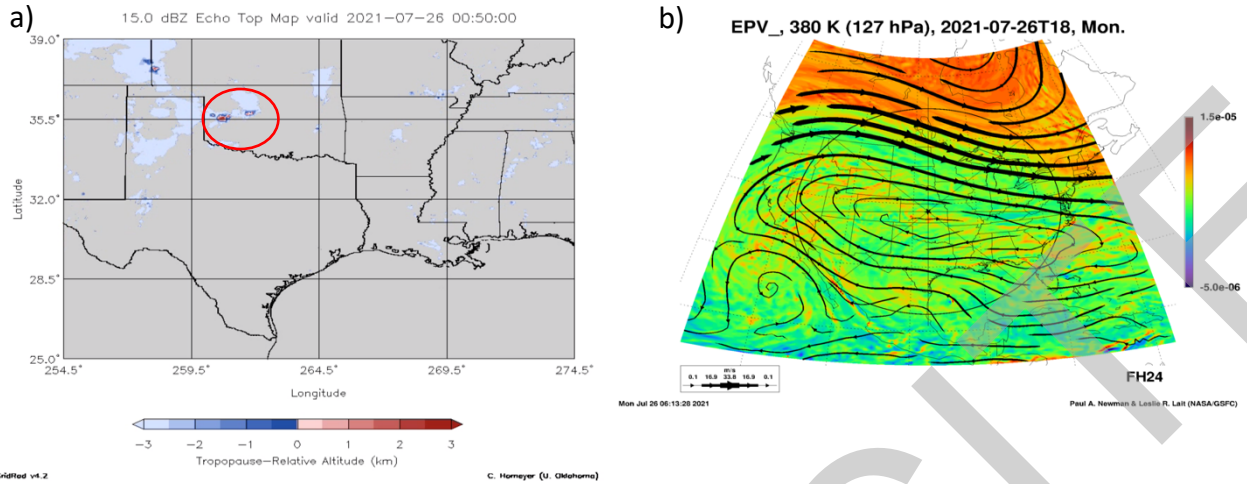


Figure 1. (a) Tropopause-relative altitude for cells responsible for generating targeted outflow plumes and (b) PV at 380K with streamlines showing location and flow of anticyclone.

The outflow from these <1 day old storms (Fig 2a) was forecast to be above the tropopause (Fig 2d) primarily concentrated within the 50-59 kft altitudes (Fig. 2b) and centered over the Texas panhandle during the time of the planned flight. The flight plan was designed to intensively sample this plume with high vertical resolution from two different directions through the densest part of the plume (Fig. 3).

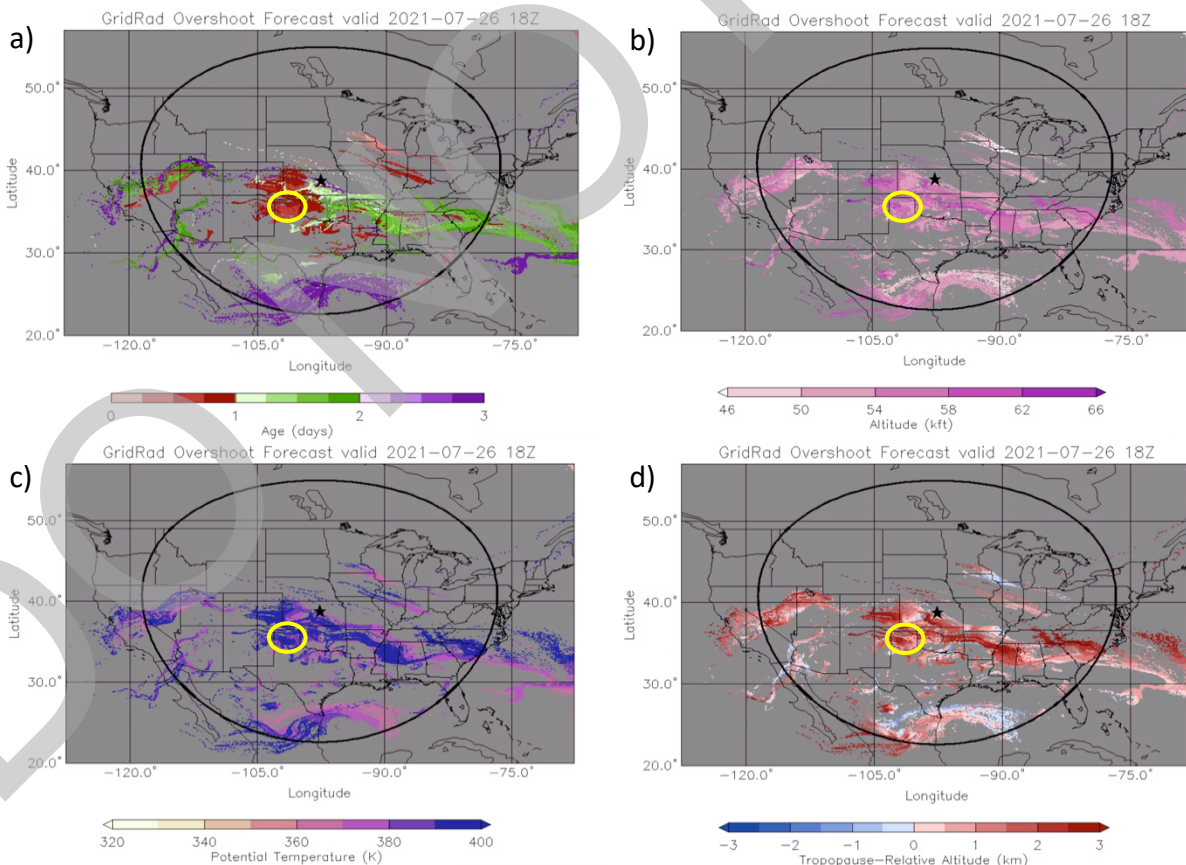


Figure 2. GridRad overshoot (a) age, (b) altitude, (c) potential temperature, and (d) tropopause relative altitude forecast for 26 July 2021 at 18Z (midflight).

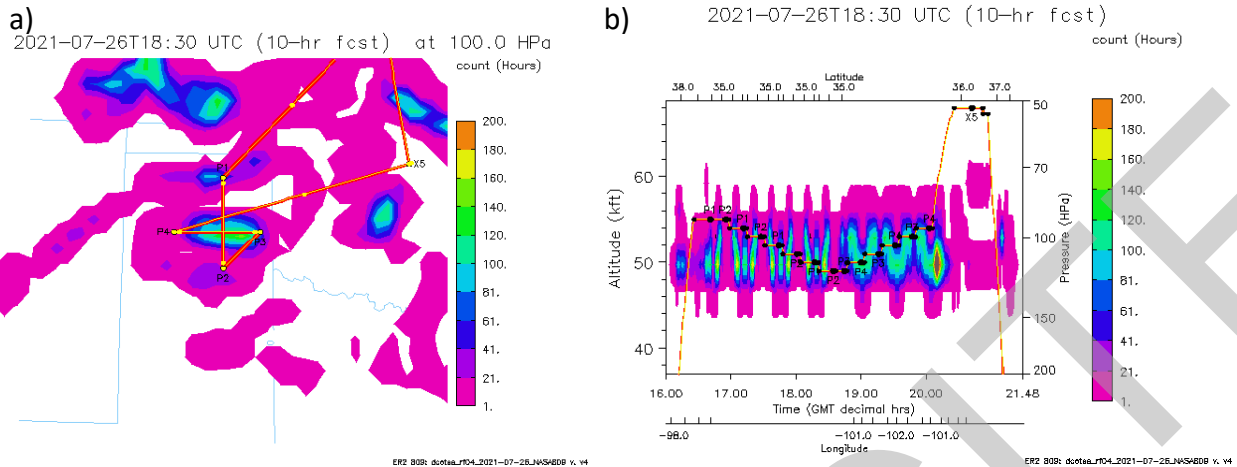


Figure 3. RF04 (a) flight plan and (b) flight profile overlaid on forecast plume particle density.

Flight Summary:

The ER-2 ground track (planned-cyan, actual-dark blue) and vertical profiles are shown in Figs. 4 and 5, respectively. The ER-2 took off at 1523 UTC (1023 CDT) toward waypoint P1 and ascended to 55kft to begin the stacked legs from 55 – 49kft at 1000ft intervals between waypoint P1 and P2. In situ water vapor measurements (Fig. 6) showed significant water vapor increases at multiple points between P1 and P2 coincident with expected locations of the targeted plumes. Depending on the altitude, water vapor values 2-3 times greater than background measurements were sampled (Fig. 6).

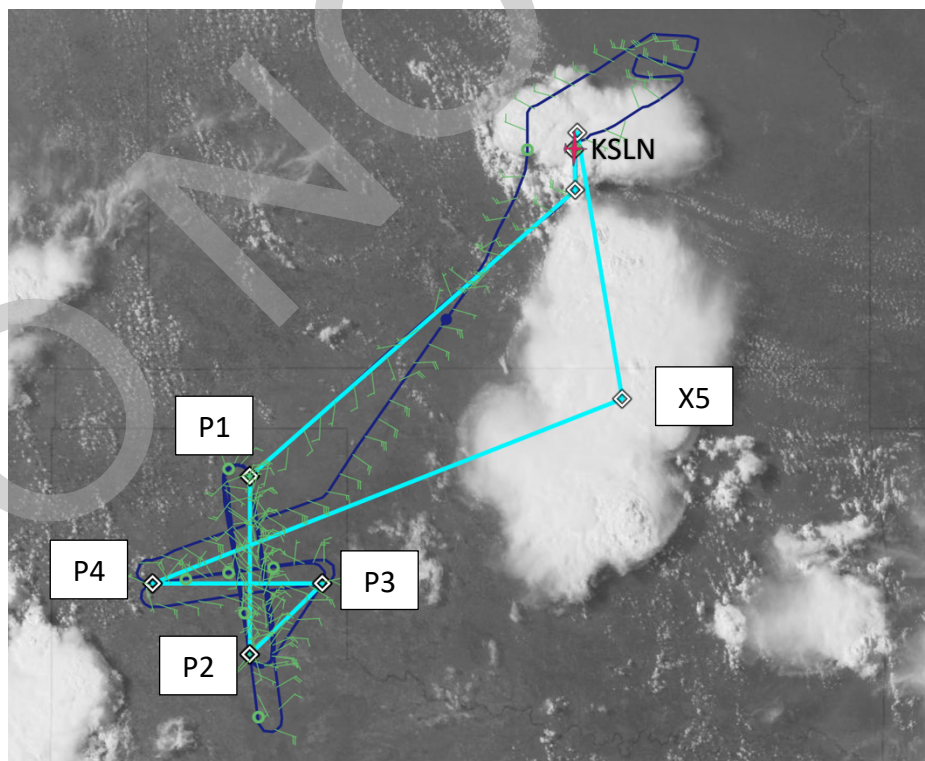


Figure 4. Planned (cyan) vs. actual (dark blue) ER-2 flight track overlaid on GOES-16 visible satellite imagery at 1641 UTC (landing) on 26 July 2021.

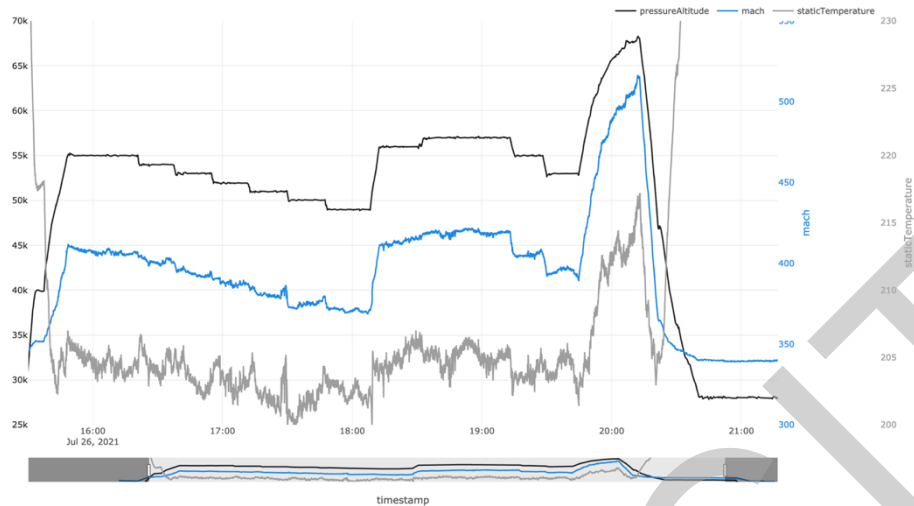


Figure 5. Vertical profile of ER-2 IWG pressure altitude (kft, black), MMS potential temperature (K, blue; incorrectly labeled as mach in the MTS), and MMS static temperature (K, gray) for RF04.

While the original flight plan was to begin profiles between waypoints P3 and P4 after the lowest leg at 49kft, the plan was modified in flight to add additional legs between waypoints P1 and P2 at 56kft and 57kft to find the top of the plume. To keep the plan within the same total flight time, the altitudes sampled between points P3 and P4 were adjusted to 57, 55, and 53kft.

During the P3 to P4 legs, development of thunderstorms near point X5 was noted and relayed to ground pilot with continued monitoring by the FFP team. After the final stacked leg ending at P4, the aircraft began climbing to max altitude en route toward point X5 to return toward KSLN; however, radar indicated cells with echo tops up to 54kft in the vicinity of X5. Unexpected convection near KSLN was also developing along a boundary that extended from X5 to KSLN so we requested the pilot immediately return to KSLN. On return, ongoing storms at KSLN and outflow from nearby convection impacted landing conditions at the field so the ER-2 circled nearby until conditions at the field cleared for landing at 2141 UTC (1641 CDT).

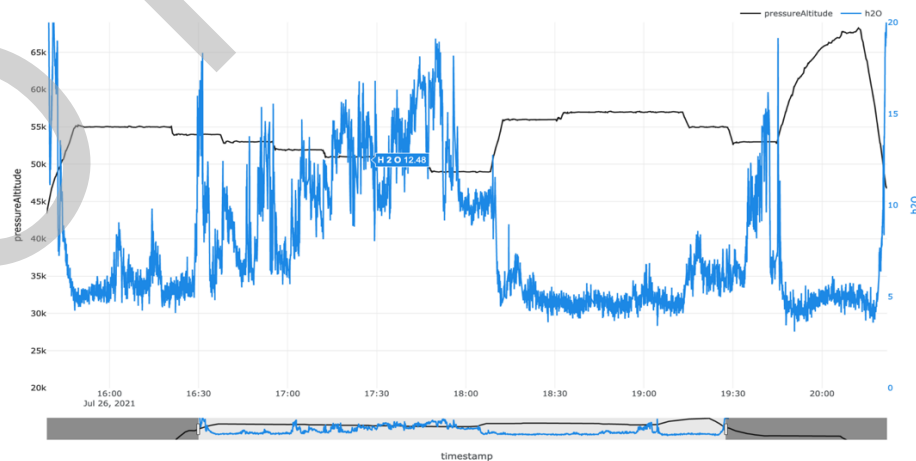


Figure 6. Measurements of H₂O (ppmv, blue) from the Harvard Water Vapor instrument collected during RF04 plotted with IWG1 pressure altitude (kft, black). Large enhancements in H₂O from overshoots were observed, e.g., at 16:30 even at high altitudes.