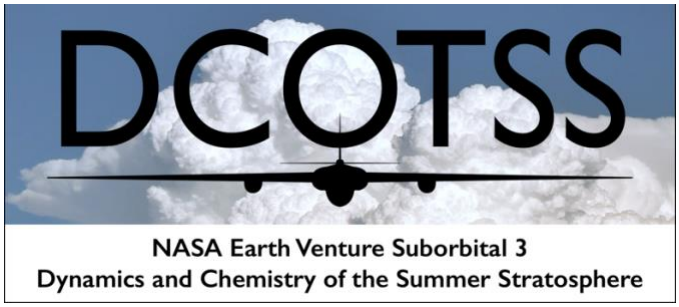
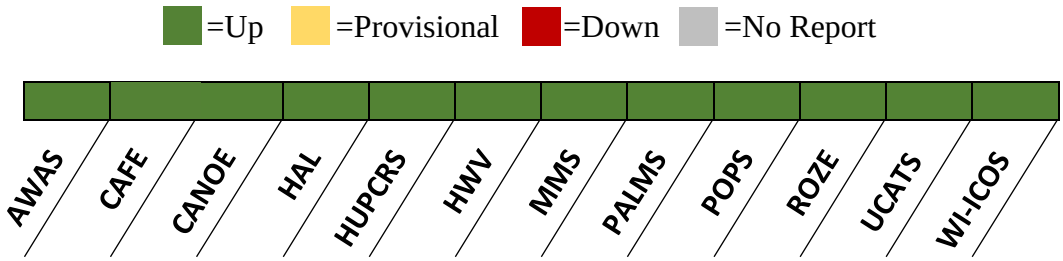
DCOTSS ER-2 Mission Scientist Flight Summary Report



Flight identifier: RF07
Science goals: Sample tracer background in the stratosphere during sunset
Start of flight (UTC): 2021-08-06 23:13Z
End of flight (UTC): 2021-08-07 04:53Z
ER-2 Pilot: Tim Williams
Mission Scientist: Chuntao Liu

Version	Report date and time (UTC)	Author
1	2021-08-07 18:00Z	Liu, Chuntao
2	2021-08-08 15:00Z	Bowman, Ken

Instrument Performance:



Aircraft Performance: Good

Science Objectives:

Based on model predictions for August 06, features of large-scale circulation include a relatively flat jet stream with short wave propagating to the east in the upper troposphere, leading to a series of convective storms in the northern US (Figure 1 left panel). The anticyclone has retreated to the south and the easterly flow dominates over the central US in the lower stratosphere (Figure 1 right panel). At 500 K potential temperature level, there is a filament of air with higher ozone mixing ratio (Figure 2).

There are three science objectives during this flight. The main objective (#1) is to sample background chemical tracers in the stratosphere during sunset. The second objective (#2) is to sample potentially 4–5 day old outflows from overshooting convection over the Sierra Madre that occurred on August 1st and 2rd. The third objective (#3) is to validate several instruments with an ozone-hygro-sonde launched from Salina.

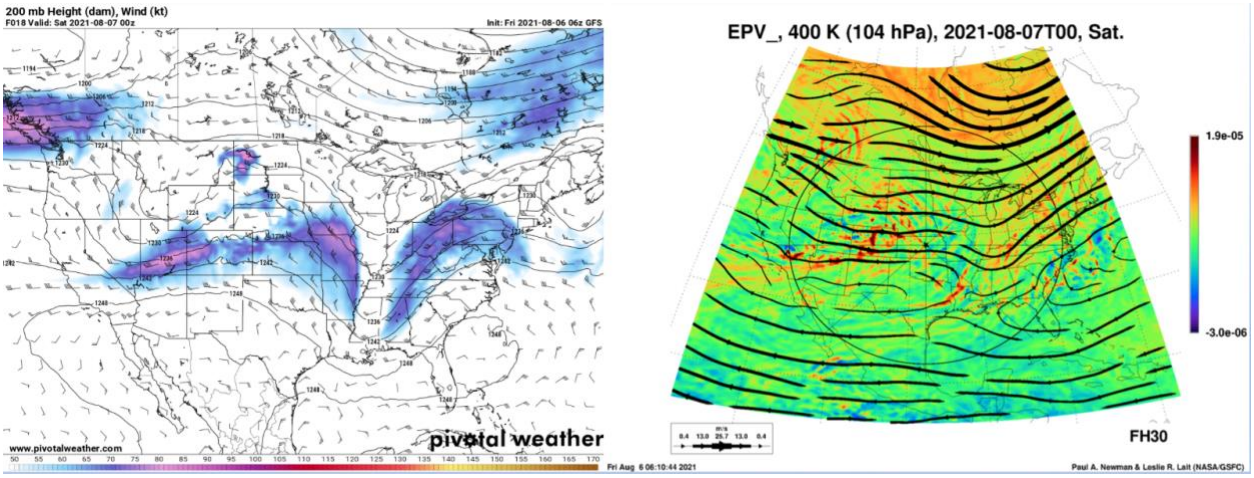


Figure 1. Left panel shows 200 hPa wind at 08/07 00Z predicted by GFS. Right panel shows equivalent potential vorticity at 400 K potential temperature level at 08/07 00Z predicted by GEOS-5.

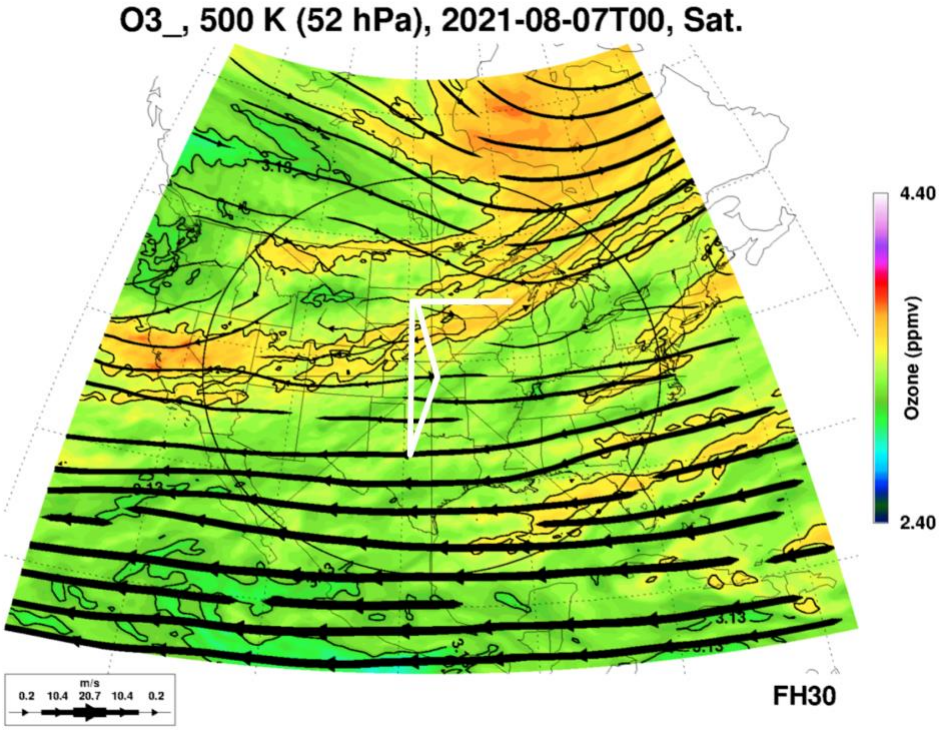


Figure 2. Ozone mixing ratio at 500 K potential temperature level at 0807 00Z predicted by GEOS-5. The planned flight track is overplotted.

Flight plan:

To achieve these three objectives, the original flight plan (Figures 3 and 4) was designed to fly south and then north to sample possible aged Sierra Madre outflow, then climb to high altitude and fly east and then west across the terminator to observe chemical changes during and after sunset.

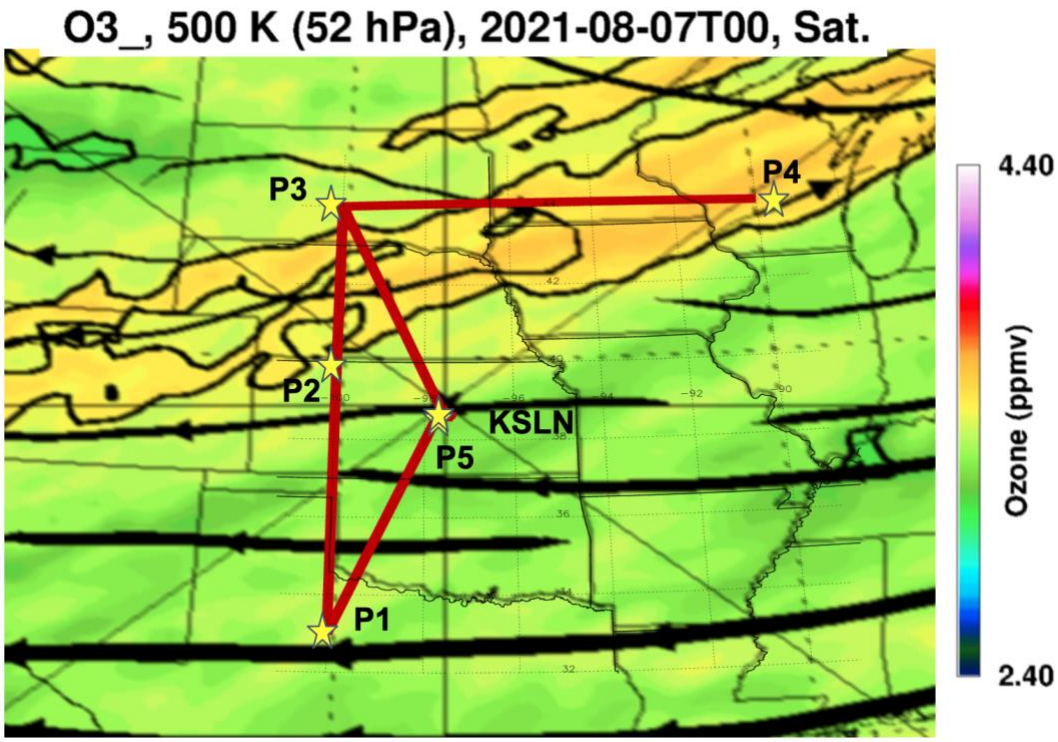


Figure 3. Zoomed in field of Figure 2 with details of flight plan and way points.

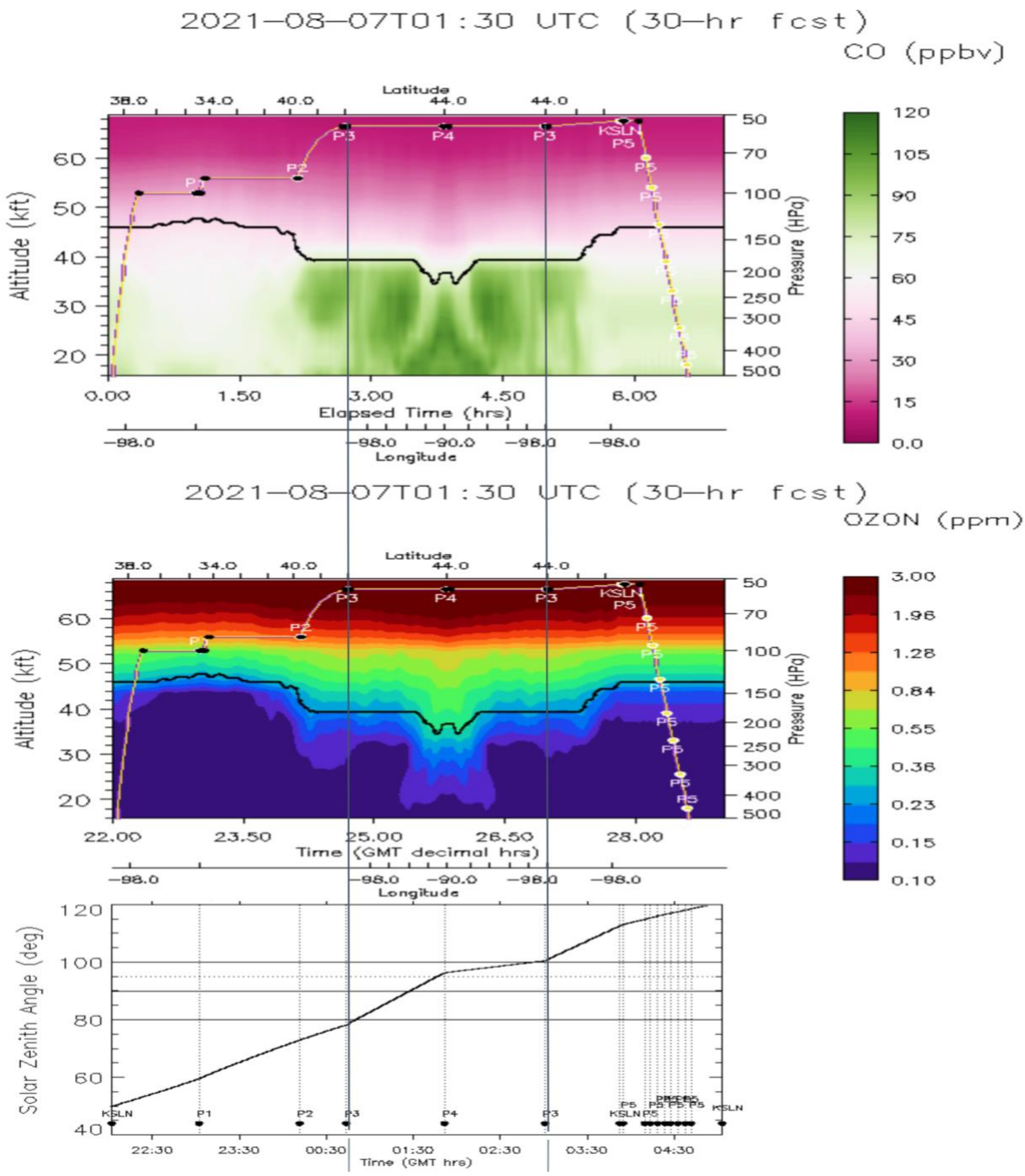


Figure 4. Top panel shows the vertical cross section of GEOS-5 predicted CO mixing ratio along the planned flight path. The flight plan altitude and the way points are overlaid with yellow curve. The tropopause height is shown in black curve. Mid panel is similar to the top panel, except for ozone mixing ratio. Bottom panel shows the predicted solar zenith angle during the flight. Note that the solar zenith angle has values within 80°-100°, implying sunset environment, during the P3-P4-P3 sector.

Flight Summary:

The original planed takeoff at 22Z (17:00 CDT) was delayed to 18:15 CDT due to an instrument issue. Due to the late takeoff, there was not enough time to complete P1-P2 sector and reach the flight way point P3 at the necessary time to carry out the sunset observations.. Therefore, the flight was shortened by removing the P1-P2 section (Figure 5 left panel). Therefore, the second science objective of sampling old outflow from overshooting convection over Sierra Madre was no longer viable.

The initial flight track was modified by ATC due to traffic (Figure 5 right panel). After reaching way point P2, aircraft climbed up and reached the way point P3 in time as planned (Figure 5). Upon return to P3 during the westward leg, a line of intense storms developed west of P3. To avoid potential aviation hazard, an early return to the way point KSLN was requested. The aircraft climbed to maximum altitude and returned to KSLN, doing the spiral maneuver requested for the balloon comparison.

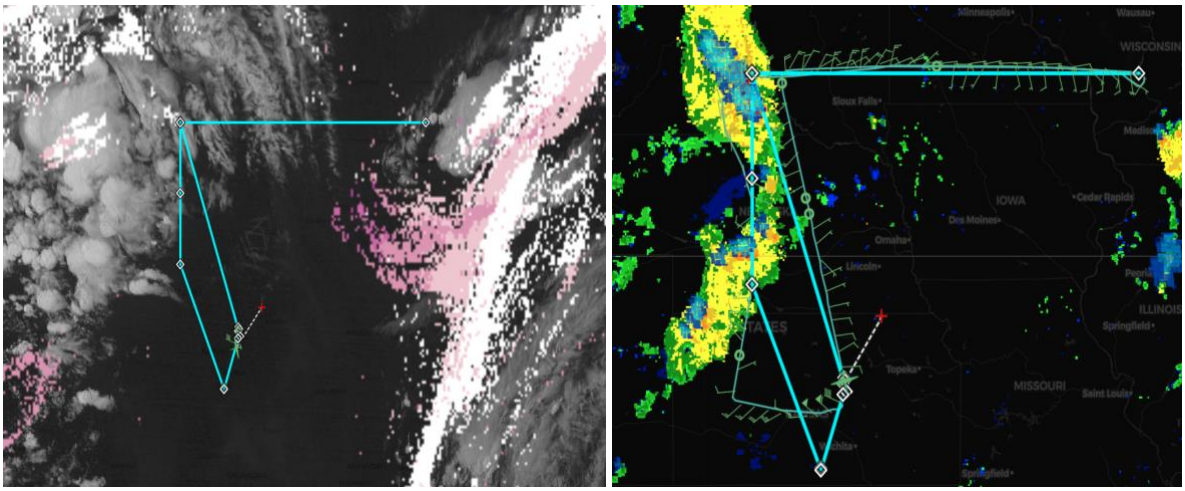


Figure 5. Left panel shows the modified flight plan at the takeoff over the GOES-16 Visible image and the predicted overshot particle density. Right panel shows the real flight path over the NEXRAD echo top height and GLM lightning density. Two real time changes were made from the modified flight plan. One was the deviation to the west as requested by air traffic control after taking off. Another was the early turning to south without reaching way point P3 to avoid developing intense convection.

Interesting pictures from the PTZ camera

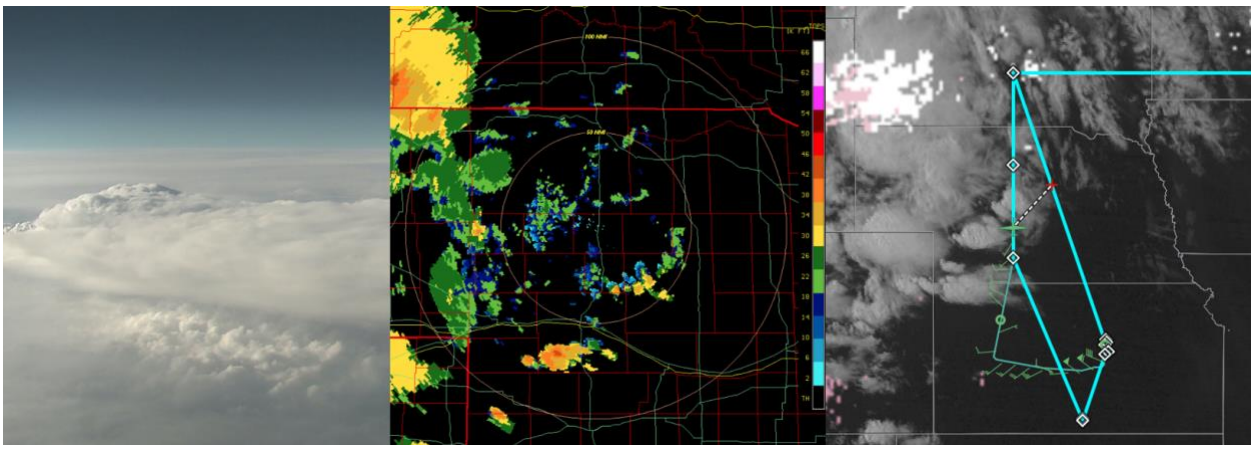


Figure 6. An overshooting storm over southeast Nebraska. The middle panel shows radar echo-top height. The right panel shows the location of the aircraft and flight path overlaid on a GOES-16 visible image.

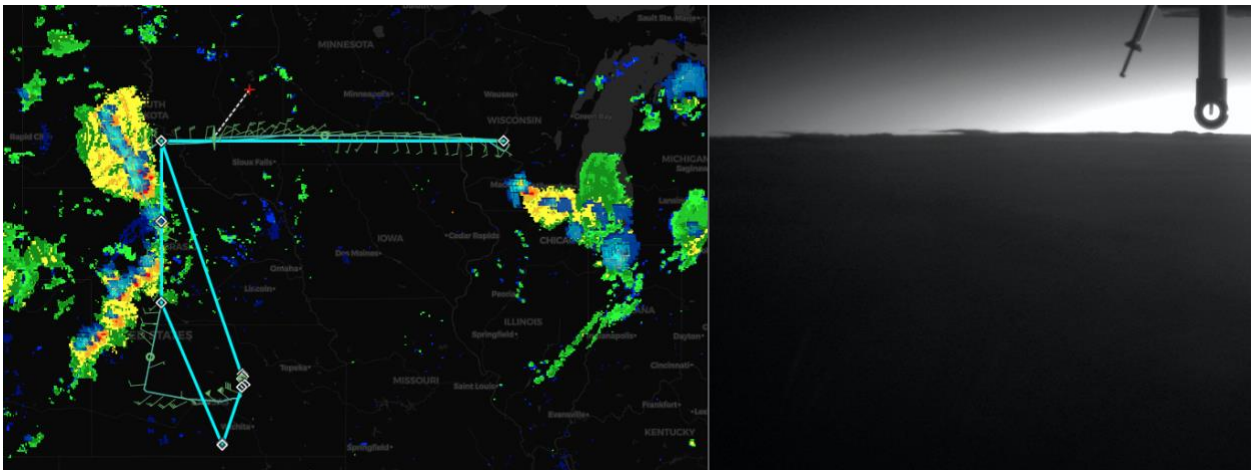


Figure 7. Outflow cirrus clouds from overshooting convection at the horizon during the sunset captured by the camera while approaching the storm from the east. The left panel shows the flight track, NEXRAD echo top height, and GLM lightning density.

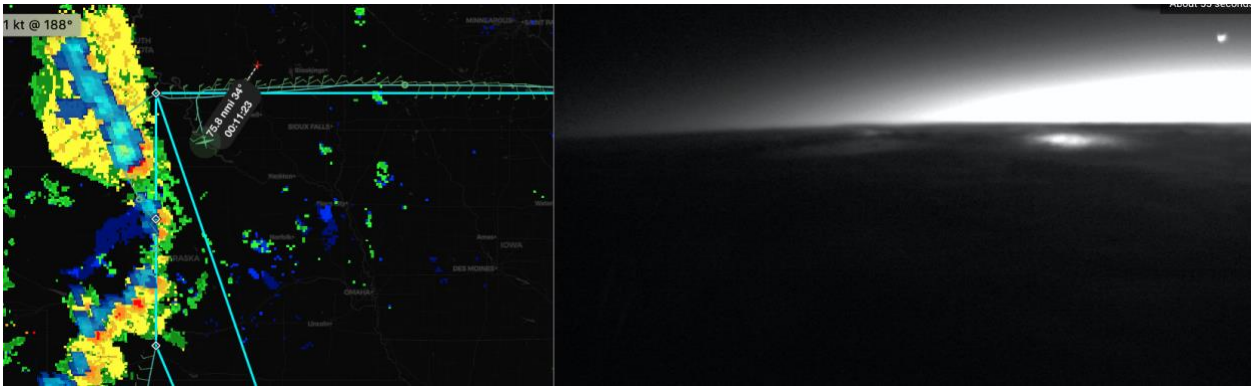


Figure 8. Lightning captured by camera after aircraft turned to south. Venus is visible in the upper-right corner of the image.