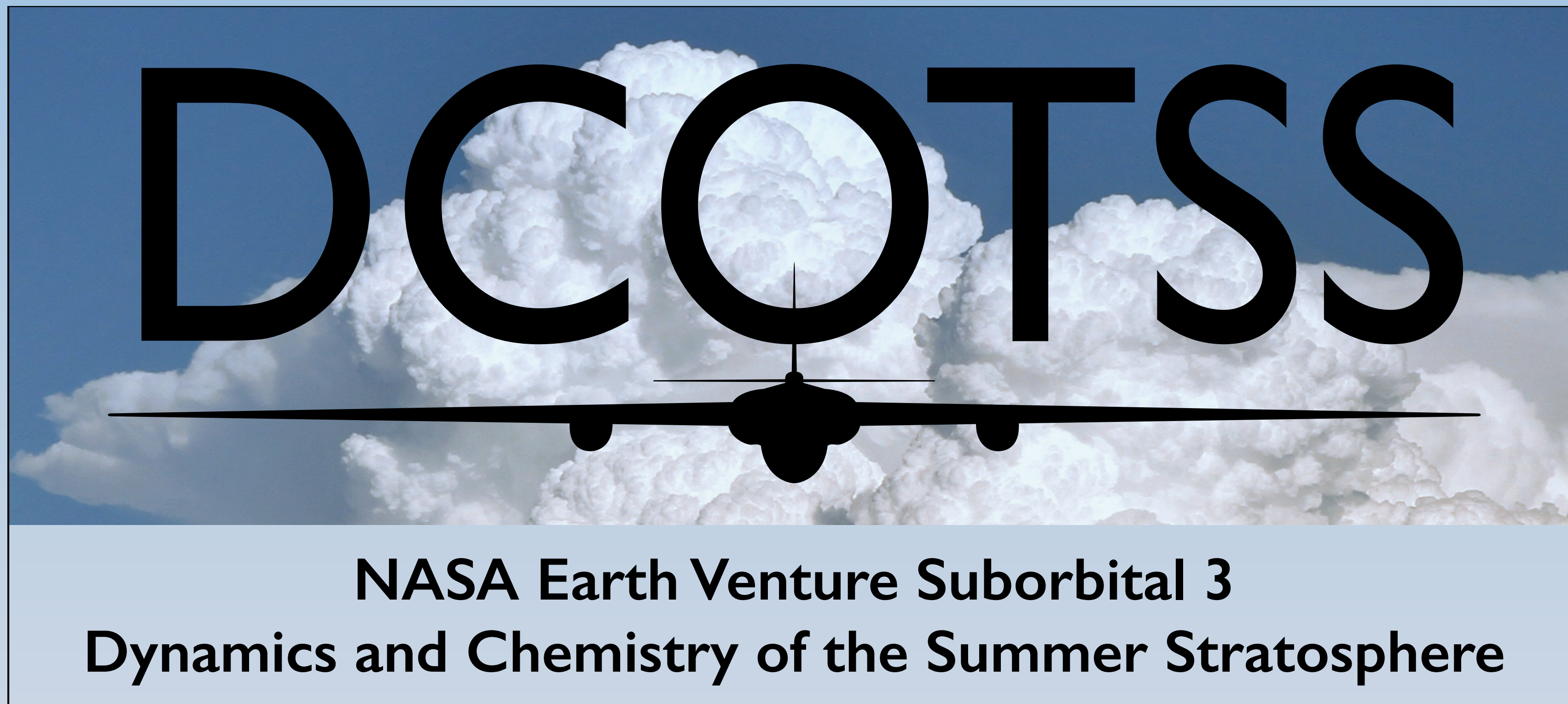


Overview of the Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) Mission

Kenneth P. Bowman and the DCOTSS Team

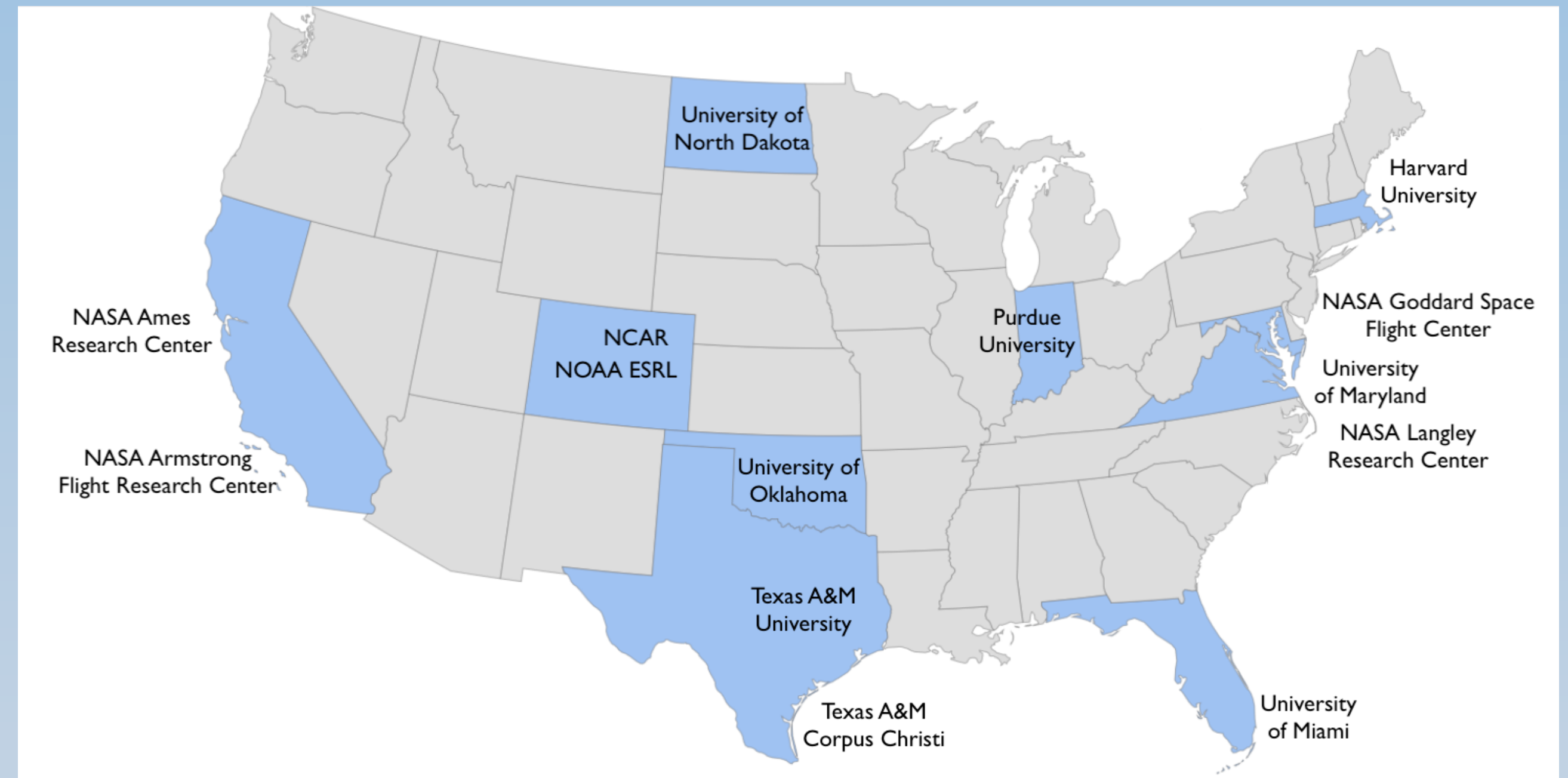


NASA ESSP Forum 2023-08-22

Acknowledgments

- DCOTSS was funded by the NASA Earth Venture Suborbital 3 Program
- Thanks to everyone who made our deployments a success
 - DCOTSS science team
 - Airborne Science Program and the ER-2 team
 - Earth Science Project Office (ESPO) staff
 - Airborne Science Data Center (ASDC) data management group
 - Salina airport management
 - Special thanks to NASA for their support in weathering the pandemic

Participating Institutions and Centers



Overshooting Convective Storm

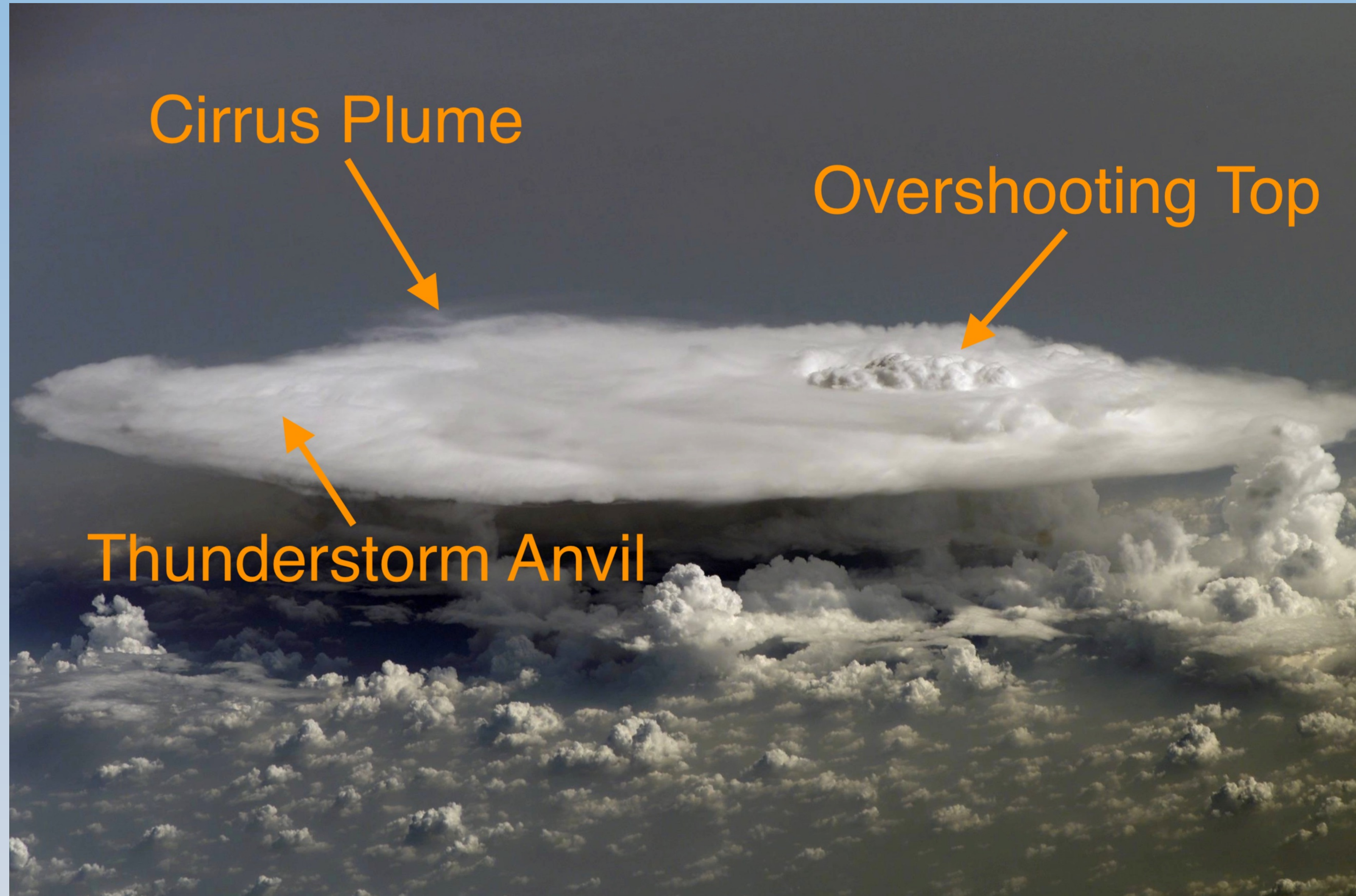
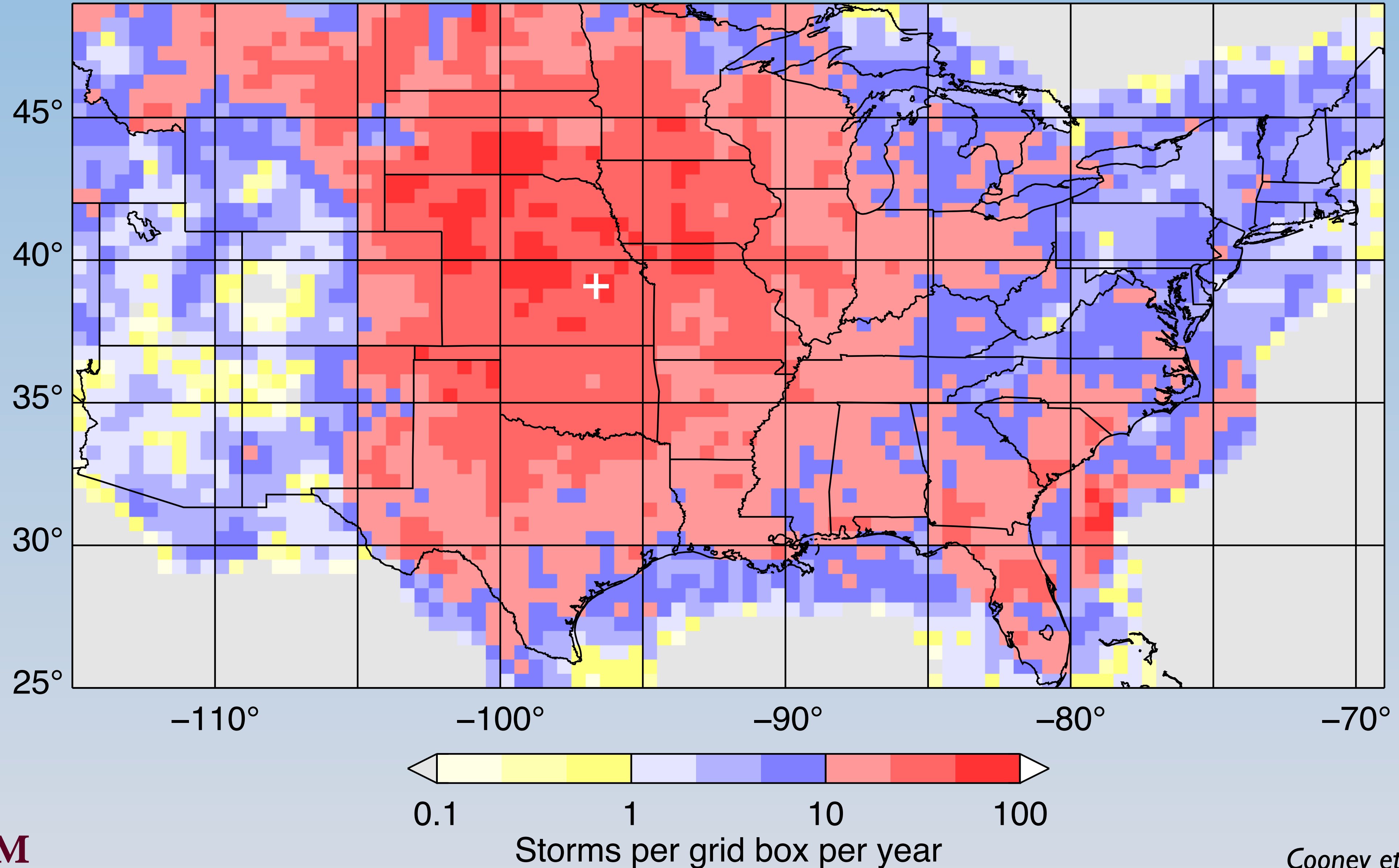


Photo from ISS

Overshooting Events from NEXRAD

Number of Overshooting Storms per 0.5° x 0.5° Grid Box per Warm Season



DCOTSS Project Concept



1. **Identify overshooting storms** in real-time using NEXRAD and GOES.



2. **Forecast the motion of injected air** using the TRAJ3D trajectory model driven by GFS and GEOS5 weather forecasts.



3. **Design ER-2 flight plans** to safely intercept convective plumes and to survey the NAMA circulation.



4. **Make in situ measurements** of the composition of plumes and their environment using the ER-2. Adjust in real time.

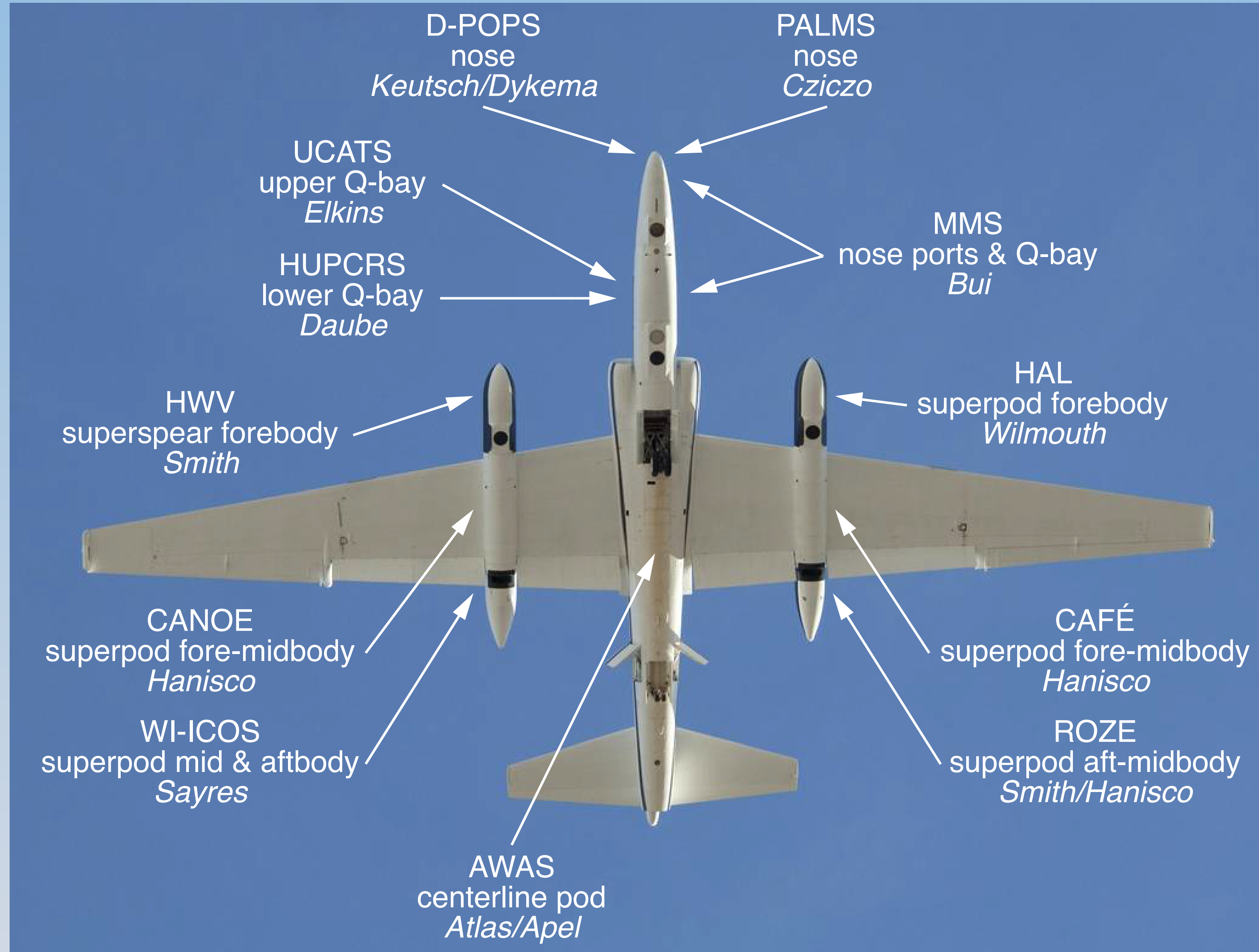
in progress

5. **Model dynamics** of injection process; **chemical evolution** of convective plume; and **export to global circulation.**

in progress

6. **Evaluate impact of convective injection** over N. America on the lower stratosphere at multiple scales.

ER-2 Payload Configuration



Project Flight Summary

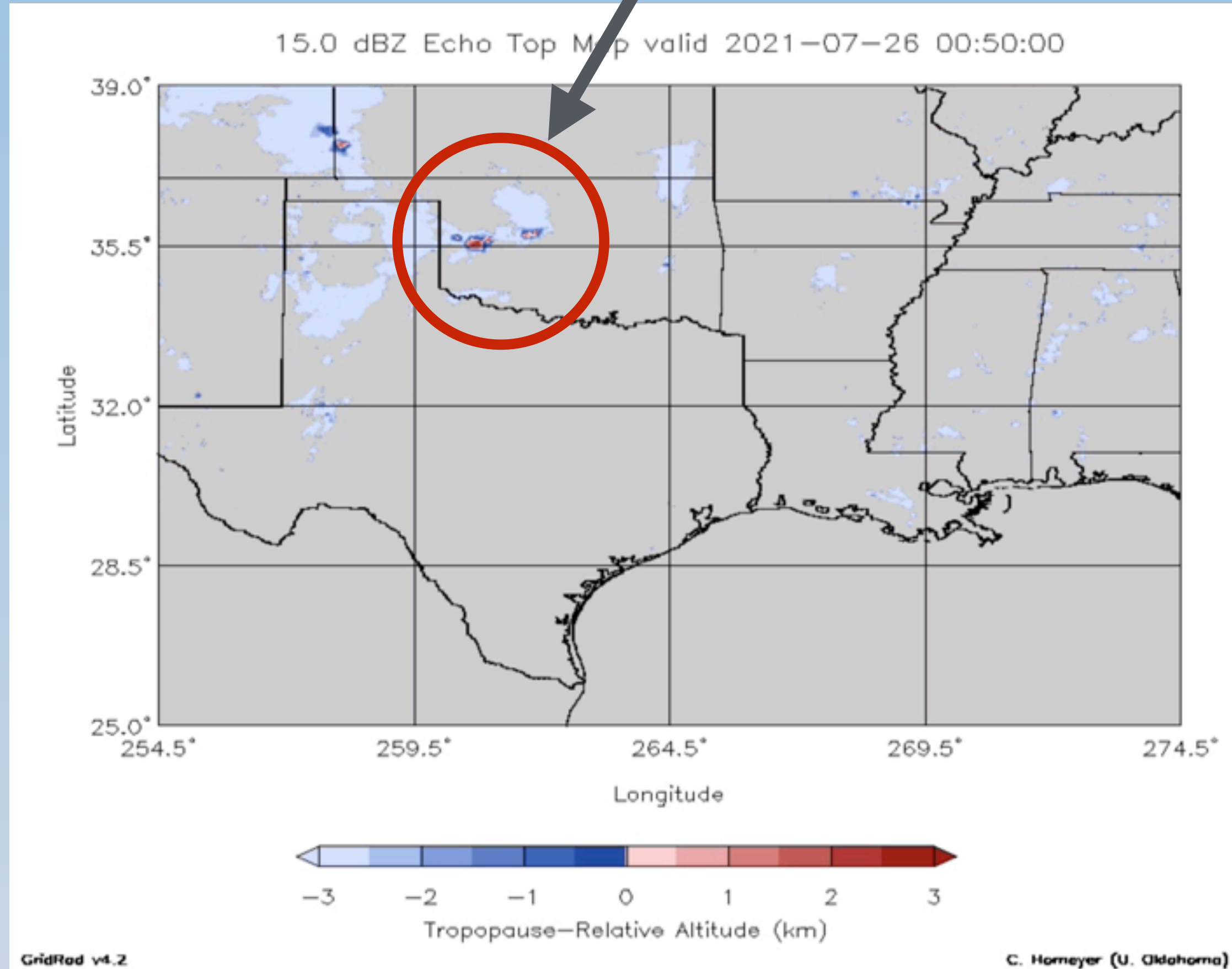
- Original plan called for 3 deployments in 2020 and 2021
- Covid and schedule conflicts forced change to 2 slightly longer deployments in 2021 and 2022
- Both deployments carried out successfully
- Most science flights took place from Salina, KS (3 flights from Palmdale)
- Payload and aircraft mostly functioned well
- Project data is in the Airborne Science Data Center (ASDC) at Langley
- All data is public
- Next data workshop at 2023 Fall AGU

Flight Type	# of Flights
Test flights	4
Transit flights	4
Science flights	23

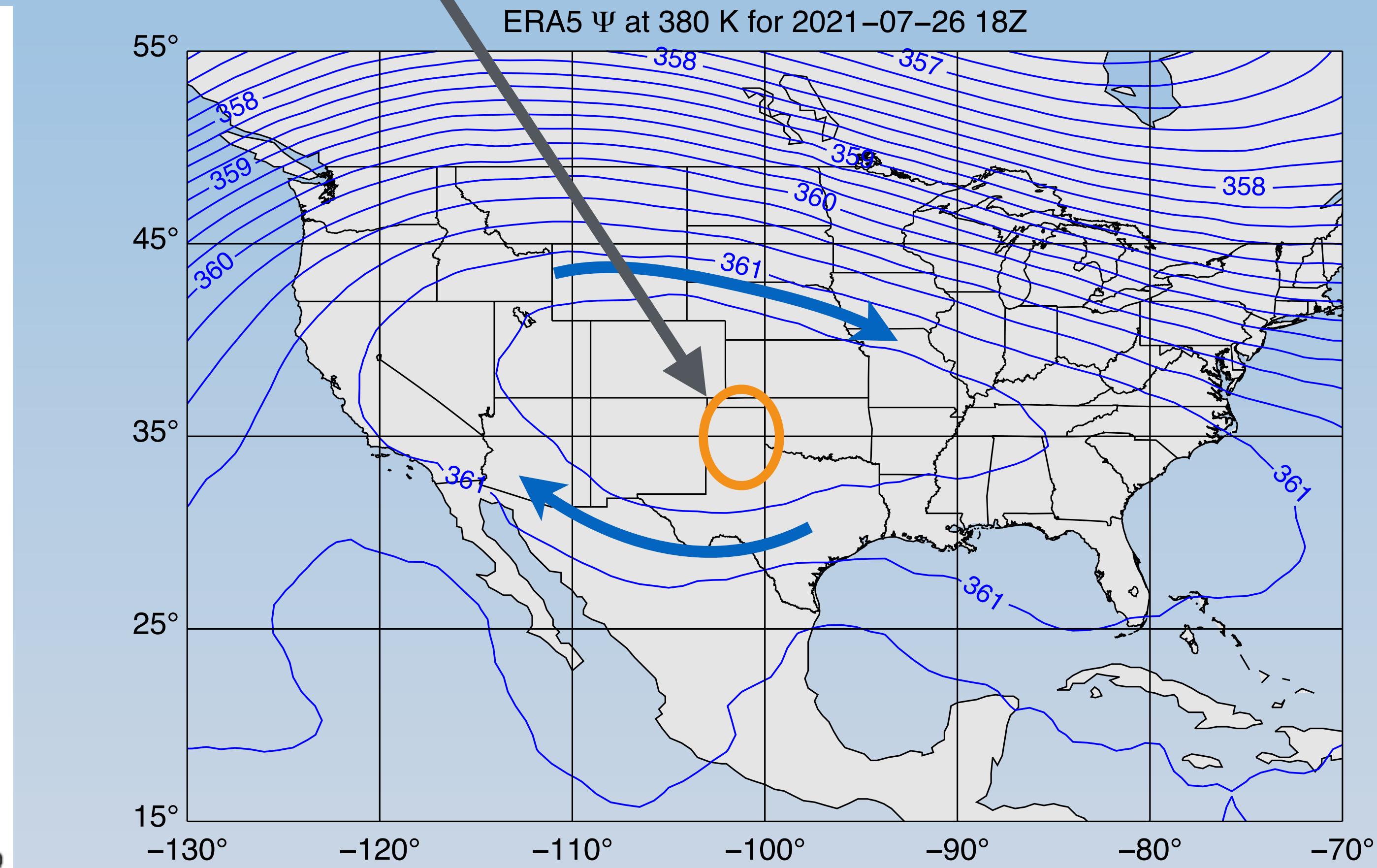
Science Targets	# of Flights
Active convection	3
Recent convection	12
Aged convection	11
Stratospheric background	25
Volcano/pyroCb	2
U.S. sources	16
Mexican sources	2
Sunrise/sunset	1 each
WB-57 comparison	1
Hunga-Tonga	1

Example of Successful Convection Sampling

Real-time
overshoot analysis

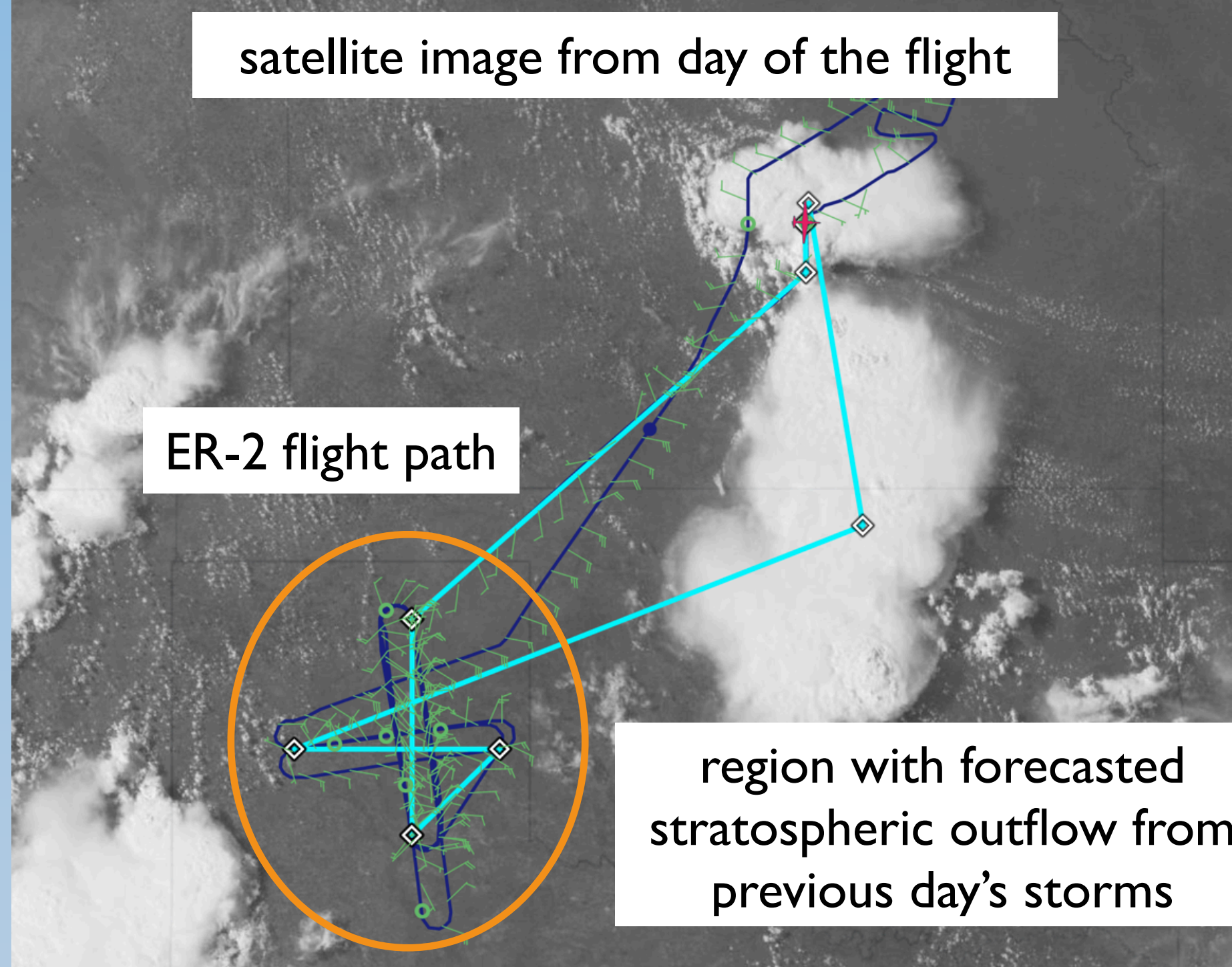


Sampling
area

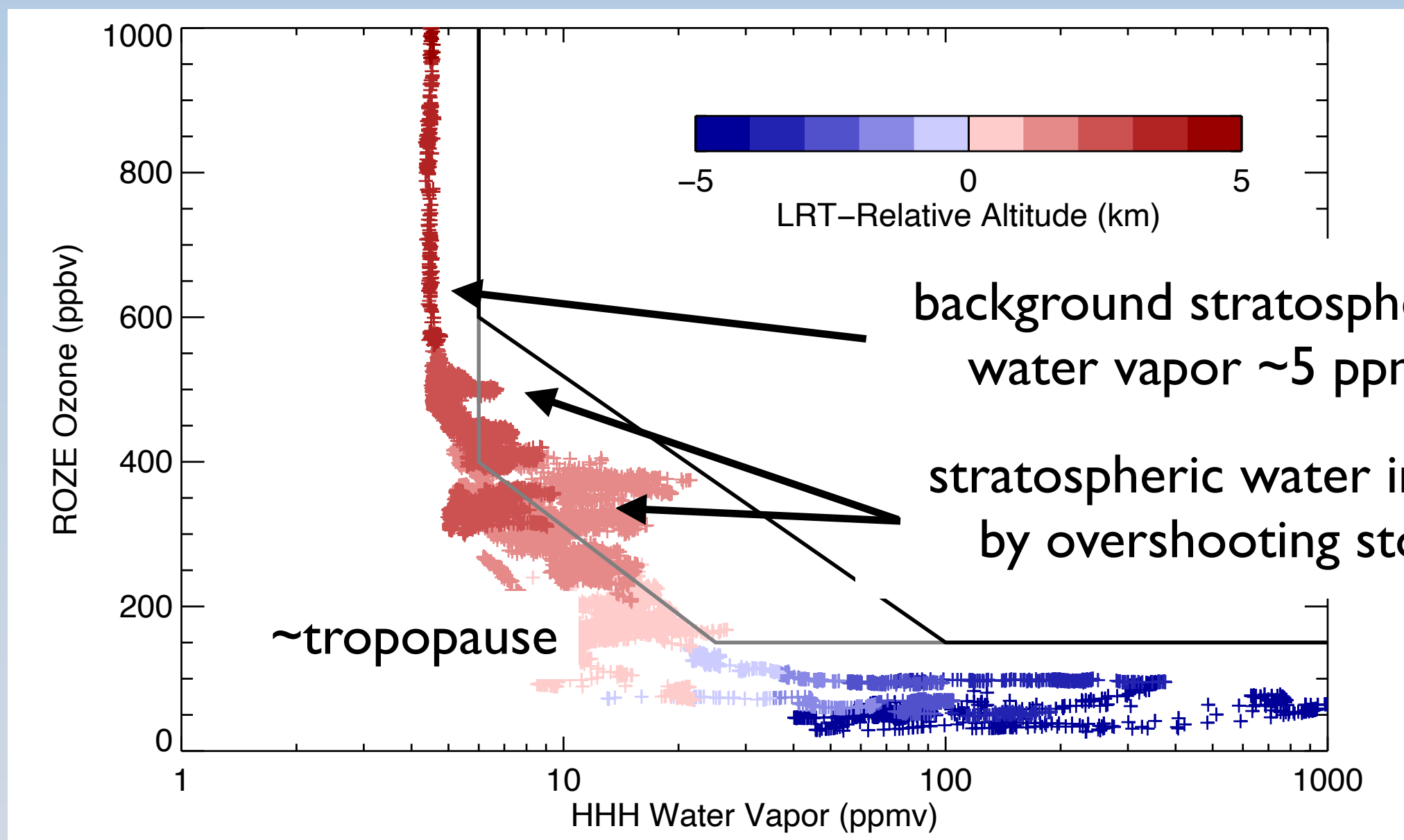
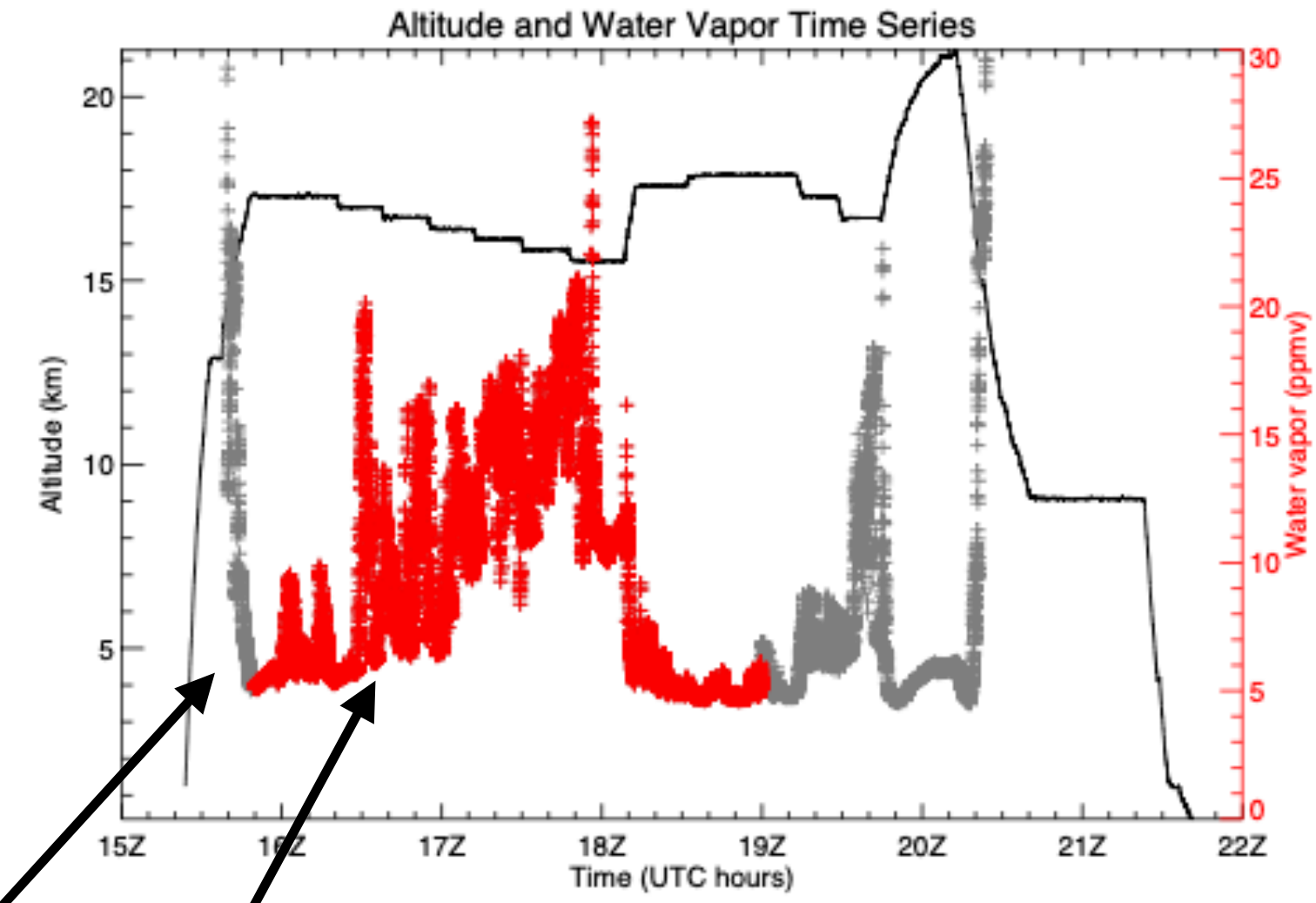


RF04 - 26 July 2021

RF04 - 26 July 2021

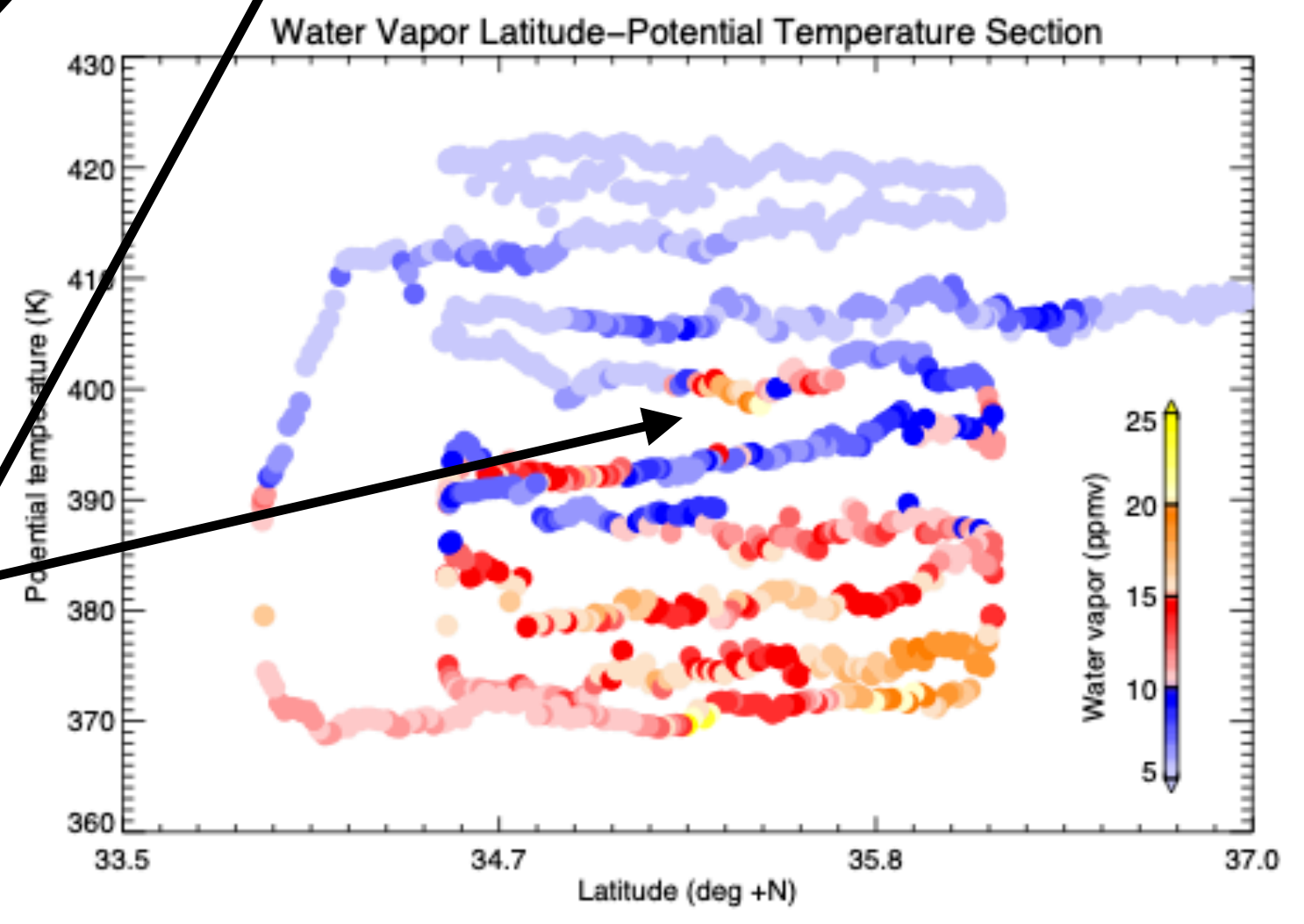


DCOTSS Merged Data, Flight RF04
Start time: 2021-07-26 15:23:53Z End time: 2021-07-26 21:41:09Z
Data file: /traid0/DCOTSS/MERGE/DCOTSS-MERGE-1S_MERGE_20210726_RA.nc



background stratospheric water vapor ~5 ppm

stratospheric water injected by overshooting storms



K. Bowman - TAMU

Science Highlights

- Vastly expanded our in situ observations of convective injection into the stratosphere
- Convective injection observed 4 - 5 km above the tropopause
- Large water vapor injection, surprisingly little tropospheric *air* injection (implications for cloud microphysics and cloud chemistry)
- No evidence of chlorine activation and ozone depletion chemistry (requires high water vapor, low temperature, and high chlorine)
- Very short-lived chlorine species are transported into the stratosphere
- The anticyclone over North America confines injected air
- 40% of aerosol particles in the lower stratosphere are from biomass burning
- Operational weather forecast models under-predict overshooting (implications for severe storms forecasting)
- **For more on science results, see my poster**

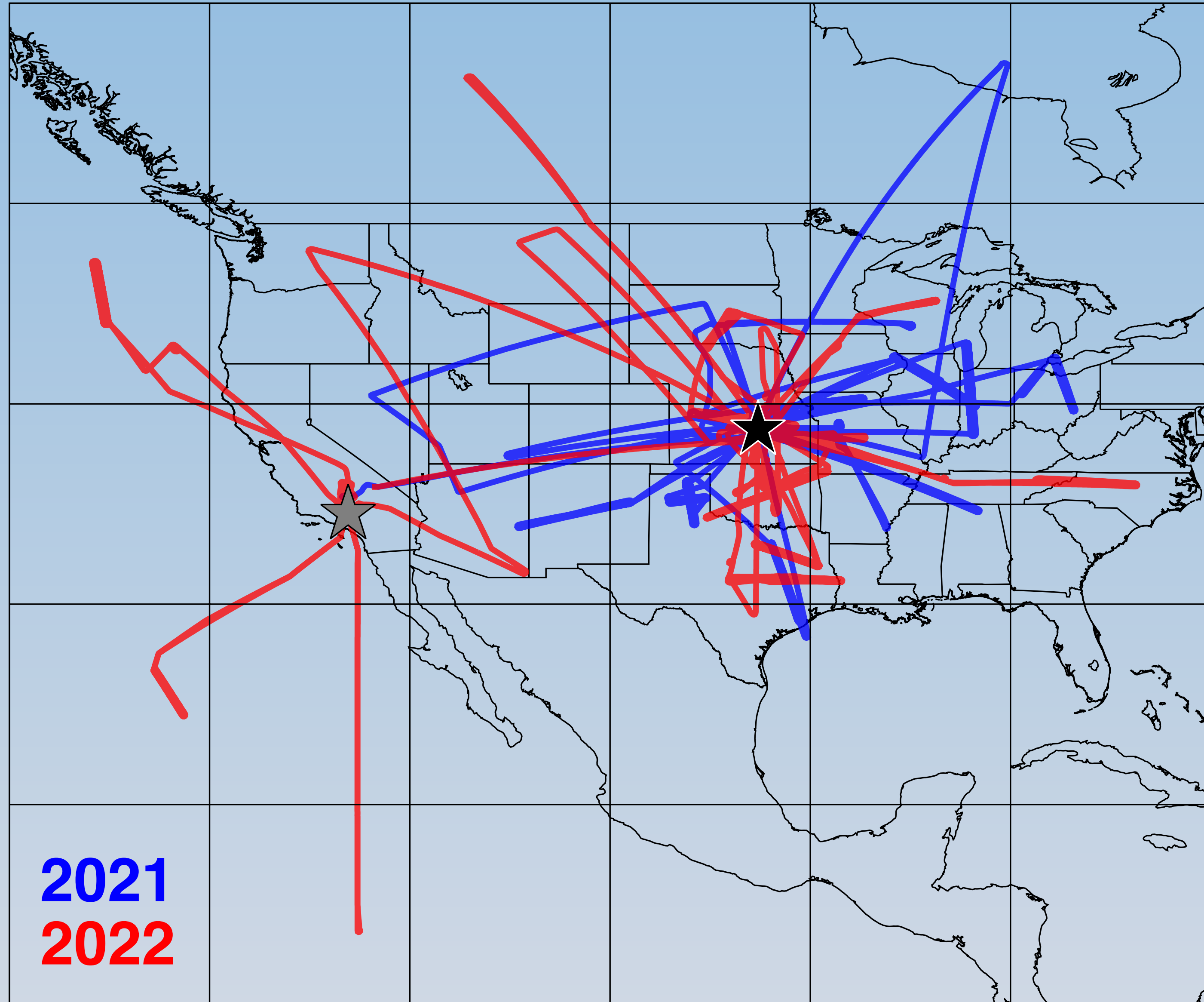
DCOTSS Data Archive

- **To access data, go to <https://search.earthdata.nasa.gov> and search for *DCOTSS***
- Data products
 - Airborne data collected by the ER-2
 - Radar and satellite derived products
 - Balloonsonde data (ozone, water, and aerosols)
 - Trajectory calculations, convection-permitting model simulations, and chemistry model output



ER-2 landing in Salina

DCOTSS ER-2 Flight Tracks



Science Questions

- **Dynamics**

- How much tropospheric air and water is irreversibly injected into the stratosphere by convection?
- Which convective source regions impact the North American Monsoon Anticyclone (NAMA)?
- What is the residence time for convectively injected air in the NAMA, and how is air from the NAMA exported to the global stratosphere?
- What dynamical mechanisms lead to the irreversible injection of material into the stratosphere by convective storms?

- **Chemistry**

- How much VSLs chlorine is present in the lower stratosphere over North America in summer?
- What chemical changes take place in the stratosphere due to convection in the NAMA?
- What are the composition and potential sources of aerosol in the lower stratosphere over North America?
- What will be the stratospheric chemical response to volcanic eruption?