



Credit: Yaowei

DCOTSS

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



**Hermit's Peak and Calf Canyon fire in Santa Fe National Forest,
New Mexico on June 16th, 2022**

AGU Fall Meeting, 13 December 2022, Chicago, IL.

Balloon-borne and Satellite Observations of the New Mexico pyroCb Plumes during the DCOTSS 2022 Field Campaign

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Wildfires and their Impact on Weather and Climate

Source: thehill.com



Poor Air quality and Visibility



Human Health



Loss of Vegetation and Wildlife

<https://www.unep.org/news-and-stories/story/ten-impacts-australian-bushfires>

Impacts of pyroCb on UTLS

- Extreme wildfires in the mid-latitudes result into **pyroCumulonimbus (pyroCbs)**.
- Sometimes pyroCbs penetrate the tropopause and inject smoke directly into the stratosphere.
- Injected mass is comparable to those of moderate volcanic eruptions.
- Impacts **thermal structure, dynamics** (*Kablick et al., 2020; Khaykin et al., 2020; Peterson et al., 2020; Allen et al., 2020; Schwartz et al., 2020*), **radiation budget** (Hirsch and Koren 2021; Liu et al., 2022) and **ozone chemistry** (*Solomon et al., 2022; Bernath et al., 2022*).
- Current measurements and parametrization are **inadequate** to describe the impacts of smoke (CCN/INP) on clouds (*Sokolik et al., JGR, 2019*).



pyroCumulonimbus (pyroCb) clouds

<https://www.unep.org/news-and-stories/story/ten-impacts-australian-bushfires>

Motivation

Science Current Issue First release papers Archive

HOME > SCIENCE > VOL. 375, NO. 6586 > WILDFIRE SMOKE DESTROYS STRATOSPHERIC OZONE

REPORT | WILDFIRES

Wildfire smoke destroys stratospheric ozone

PETER BERNATH, CHRIS BOONE, AND JEFF CROUSE

SCIENCE • 17 Mar 2022 • Vol 375, Issue 6586 • pp. 1292-

PNAS

RESEARCH ARTICLE | EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

On the stratospheric chemistry of midlatitude wildfire smoke

+13, and Doug Degenstein Authors Info & Affiliations

Science, University of Pennsylvania, Philadelphia, PA; received September

1073/pnas.2117325119

Lack of in-situ measurements of aerosols and gases in pyroCb plumes in the UTLs

Science

HOME > SCIENCE > VOL. 378, NO. 6622 > AUSTRALIAN WILDFIRES

PERSPECTIVE | ATMOSPHERIC CHEMISTRY

Australian wildfires depleted the ozone layer

Various mechanisms initiated by wildfires thinned the stratospheric ozone layer

ROSS J. SALAWITCH AND LAURA A. MCBRIDE Authors Info & Affiliations

SCIENCE • 24 Nov 2022 • Vol 378, Issue 6622 • pp. 829-830 • DOI: 10.1126/science.add2056

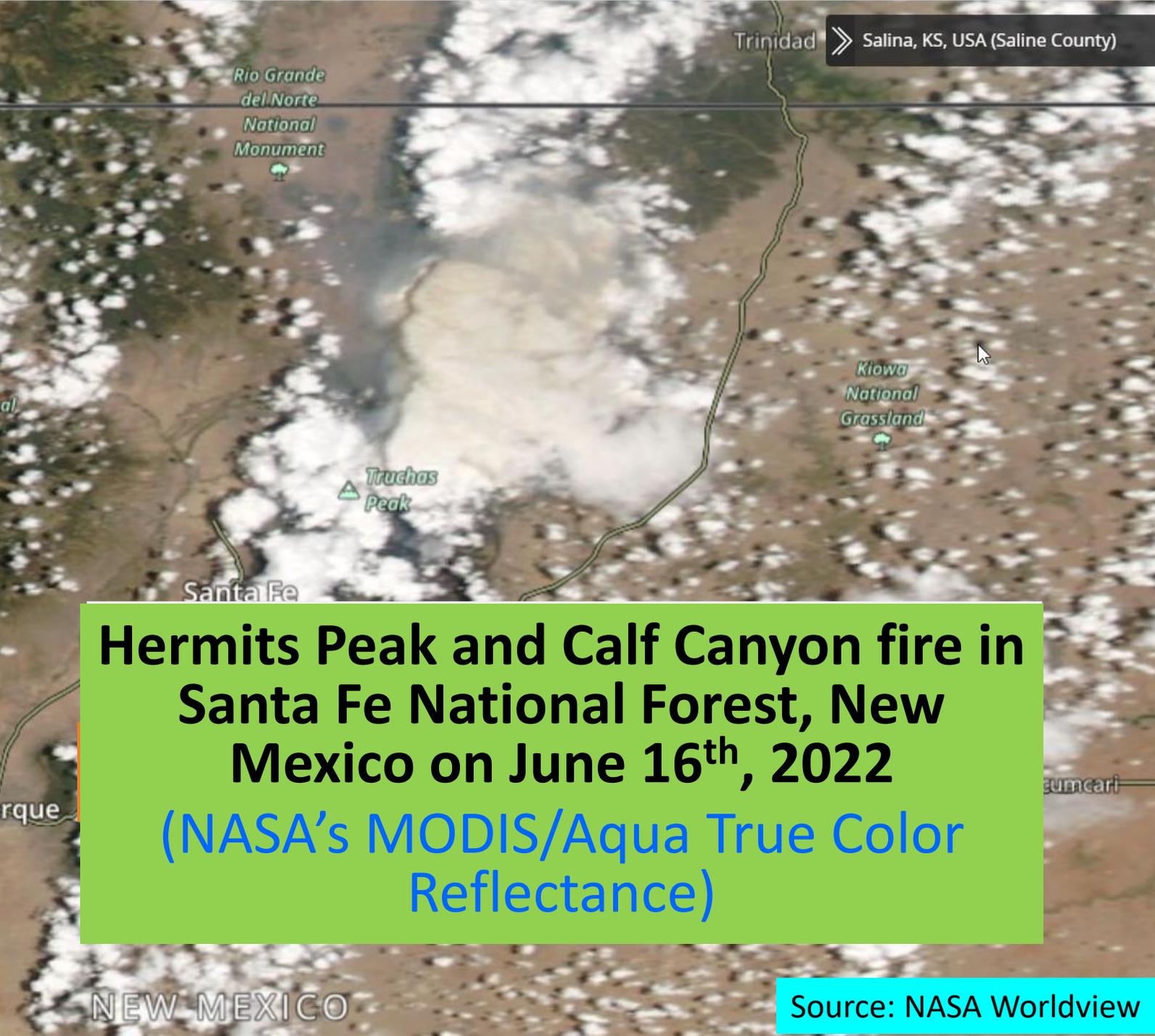
Article | Open Access | Published: 25 August 2022

Australian wildfires cause the largest stratospheric warming since Pinatubo and extends the lifetime of the Antarctic ozone hole

Lilly Damany-Pearce, Ben Johnson, Alice Wells, Martin Osborne, James Allan, Claire Belcher, Andy Jones & Jim Haywood

Scientific Reports 12, Article number: 12665 (2022) | Cite this article

6705 Accesses | 1 Citations | 482 Altmetric | Metrics



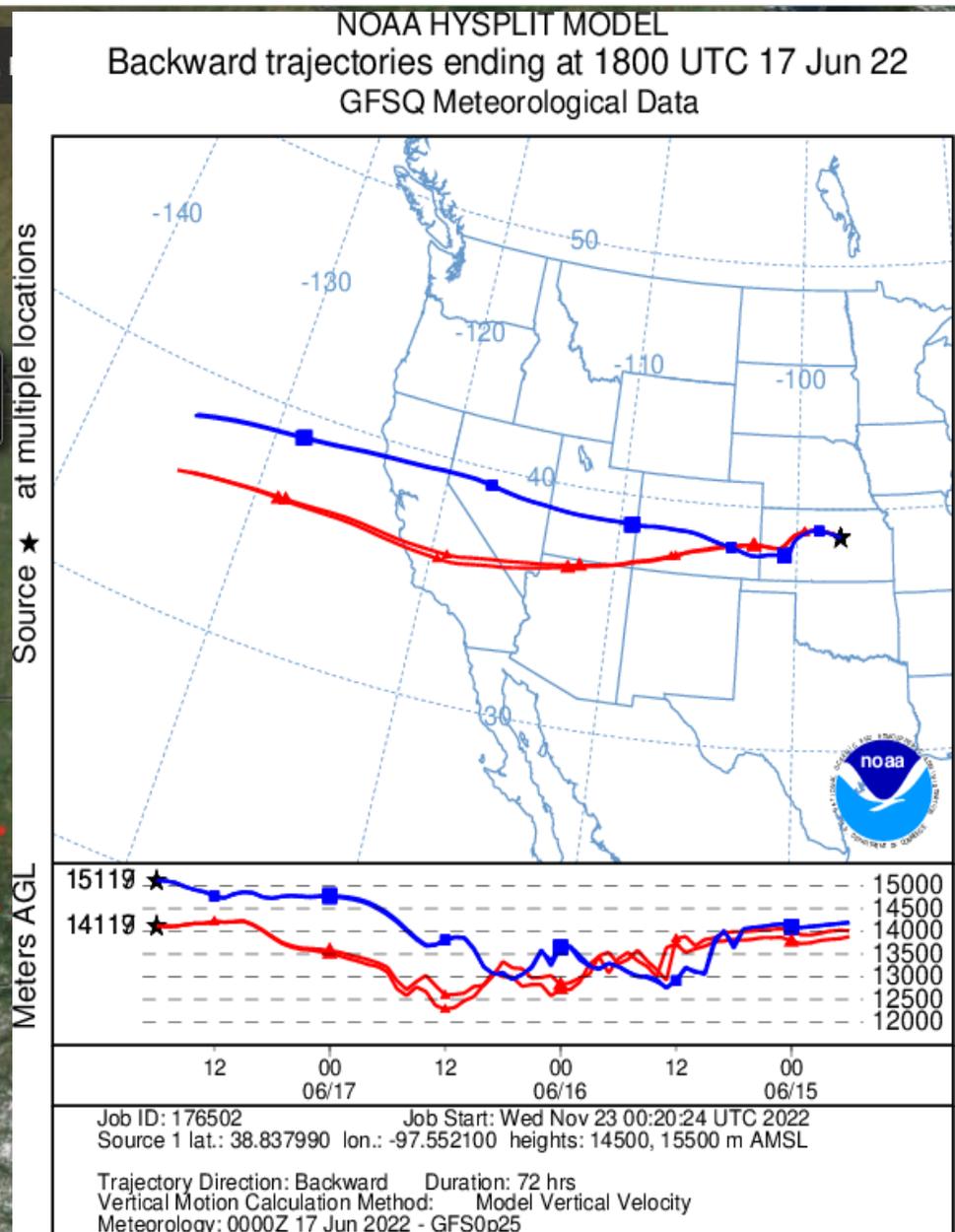
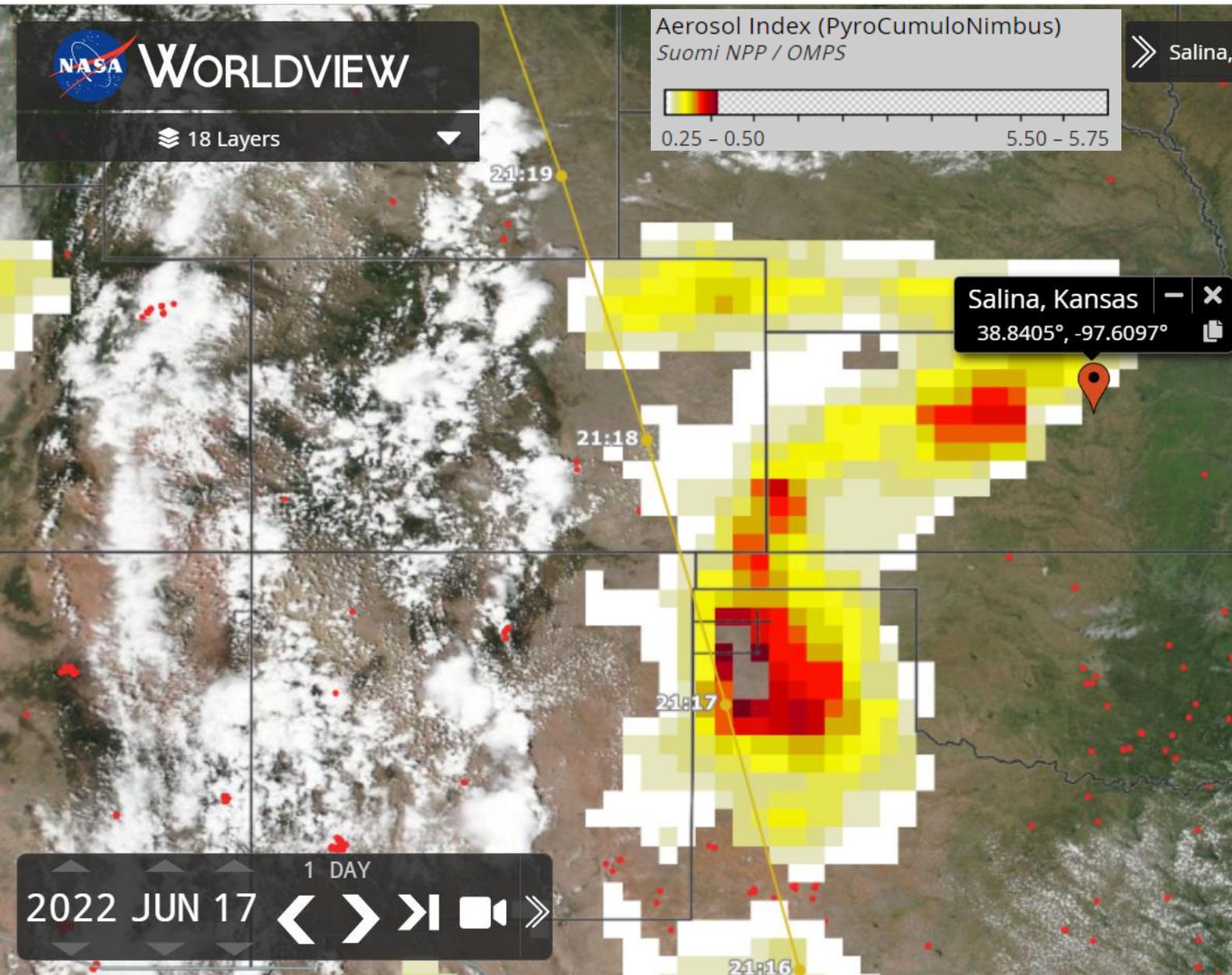
Hermits Peak and Calf Canyon fire in Santa Fe National Forest, New Mexico on June 16th, 2022
(NASA's MODIS/Aqua True Color Reflectance)

Source: NASA Worldview



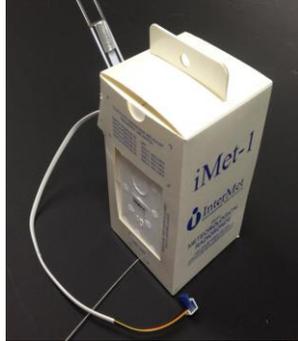
Source: <https://www.taosnews.com>

New Mexico pyroCb Plume Transport



Balloon-borne Instruments

iMet-1 Radiosonde



- T, P, RH, u, & v
- GPS location

Compact Optical Backscatter Aerosol Detector (COBALD)



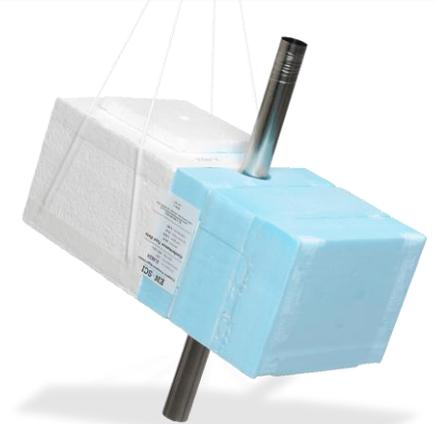
- A two-wavelength backscatter sonde
- Backscatter ratio (BSR) at 455 nm (blue) & 940 nm (IR) wavelengths.
- Color Ratio = BSR_{940}/BSR_{455}

En-Sci ECC Ozone sonde (NOAA GML)



- Potassium iodide based ECC.
- Ozone mixing ratio profile.

Cryogenic Frost-point Hygrometer



- Based on chilled mirror principle
- Frost-point temperature
- Water vapor mixing ratio & RH_{ice}

Particle Plus Optical Particle Counter (POPC) 8306



- Laser diode based optical particle counter
- Particle counts at six size channels every 2 seconds
- Size channels: 0.3, 0.5, 1, 2.5, 5, and 10 μm (diameter)
- Flow: 2.83 LPM (0.1 CFM)

Particle Plus 9301 OEM Series Particle Counter (NPOPC)

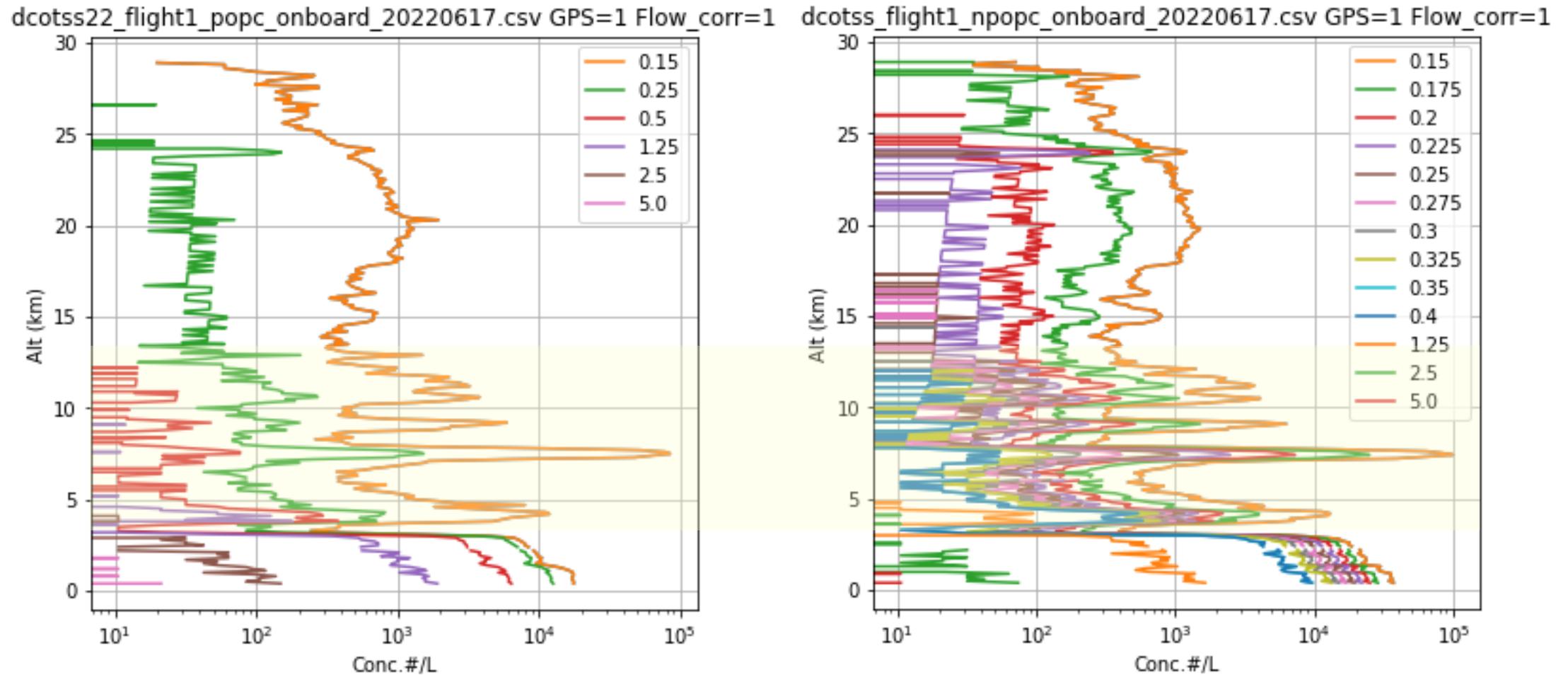


- Size channels: 0.3 -25 μm (30 channels)
- Flow: 2.83 LPM (0.1 CFM)

iMet-4 Radiosonde

OPC Measurements of Smoke Plumes on 17th June 2022

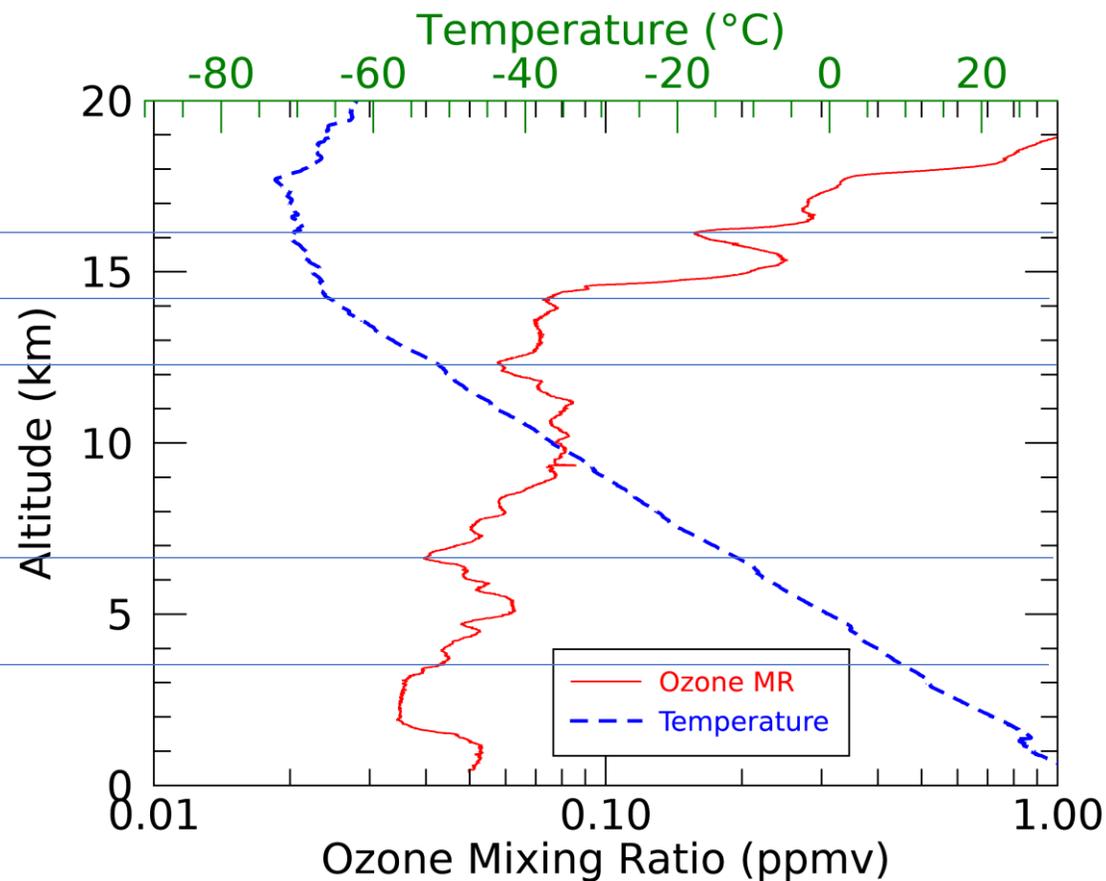
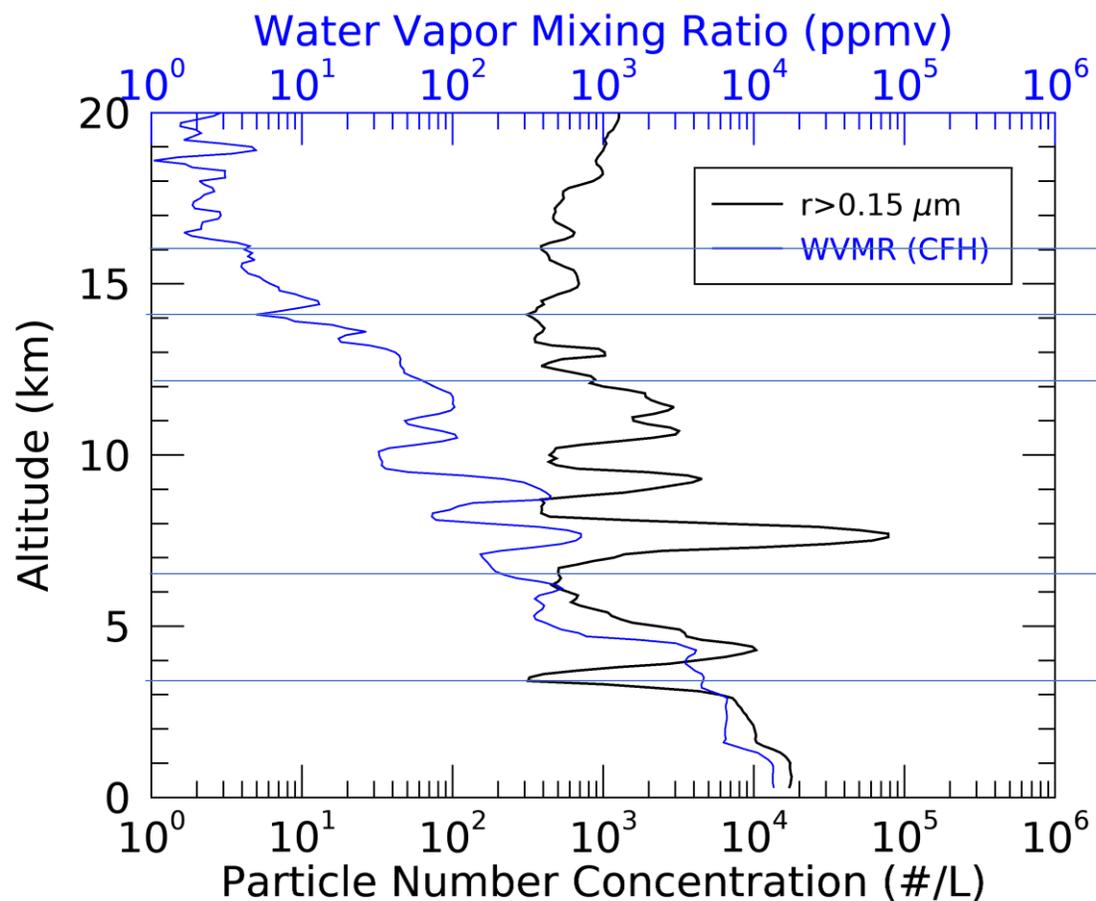
Flight #1

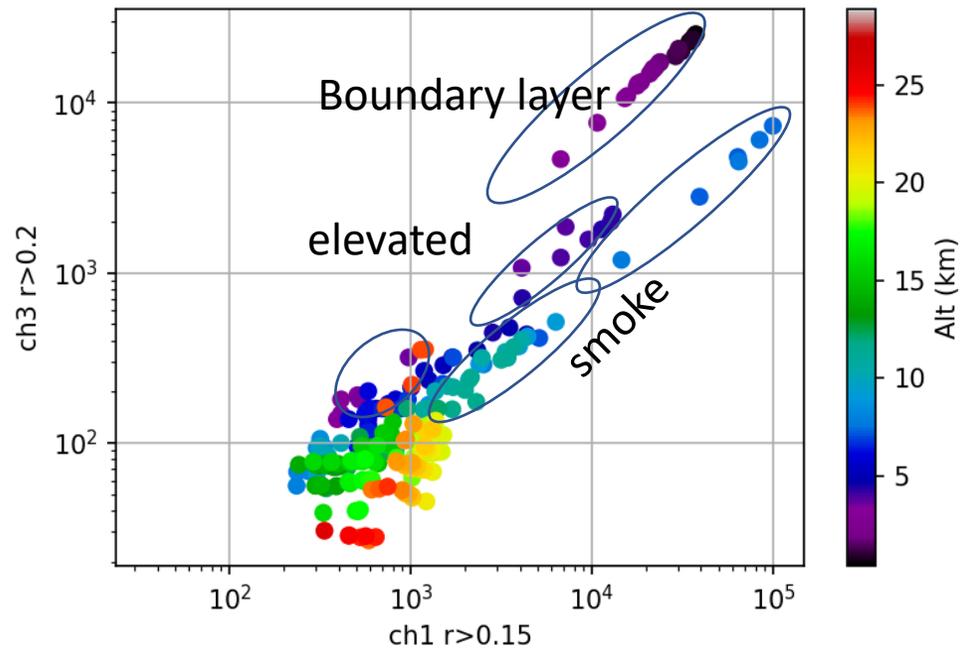


- Same structure between old and new POPC
- Additional channel gives more info about aerosol layers.

Water Vapor & Ozone Mixing Ratio Measurements

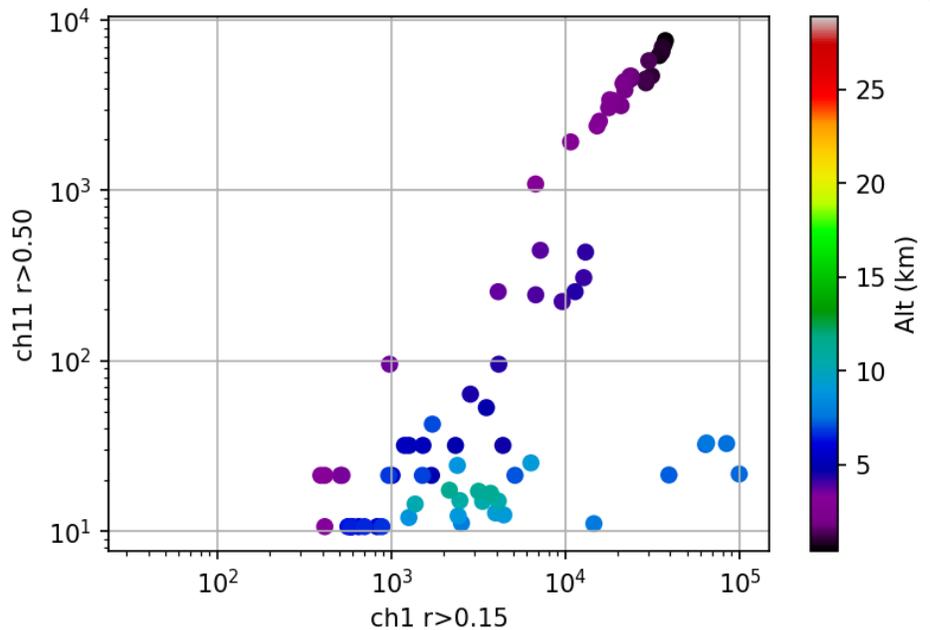
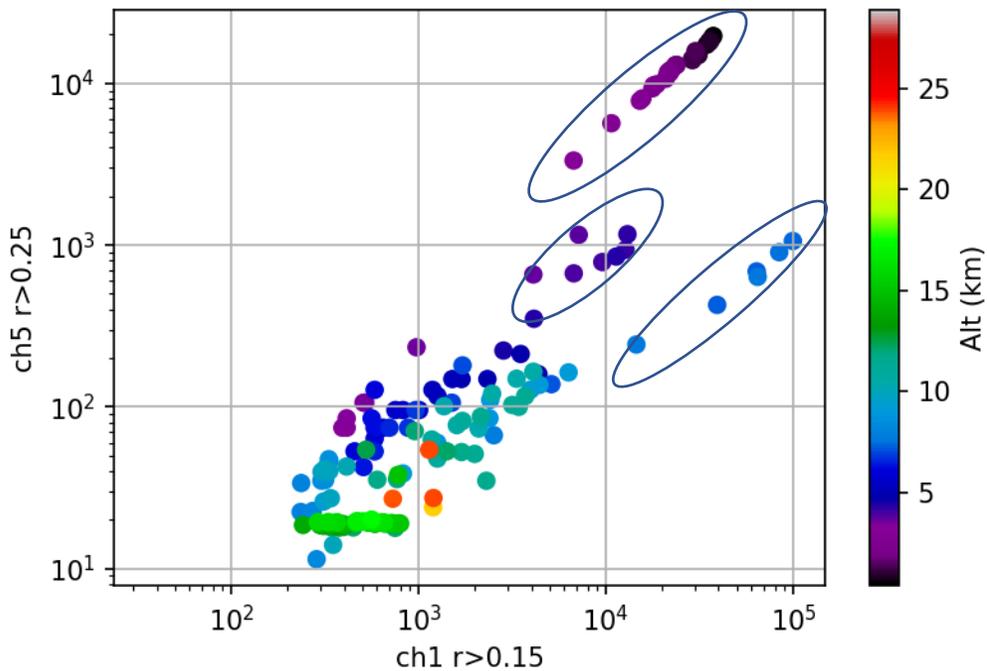
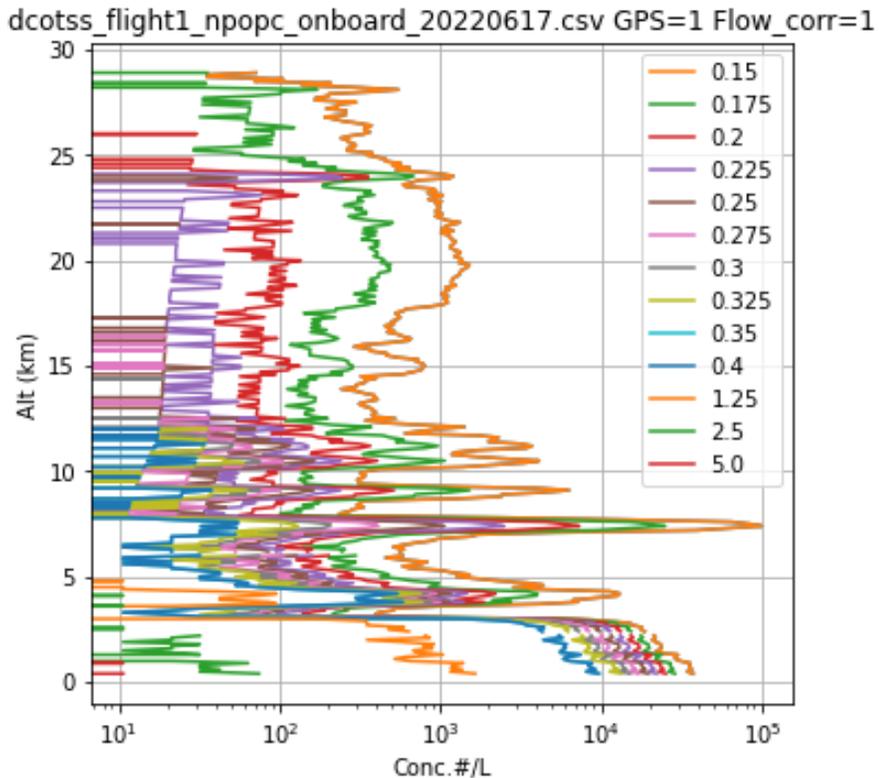
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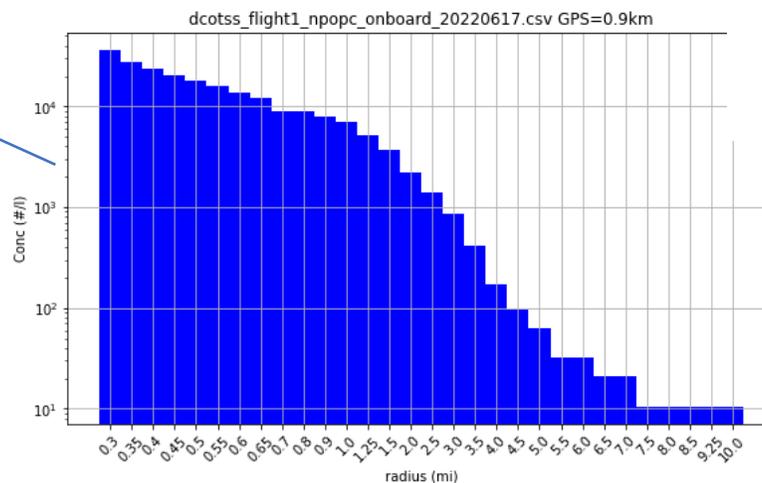
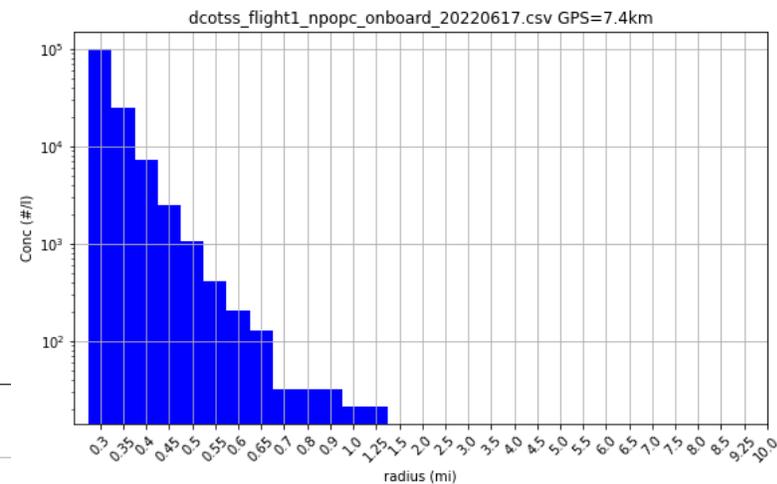
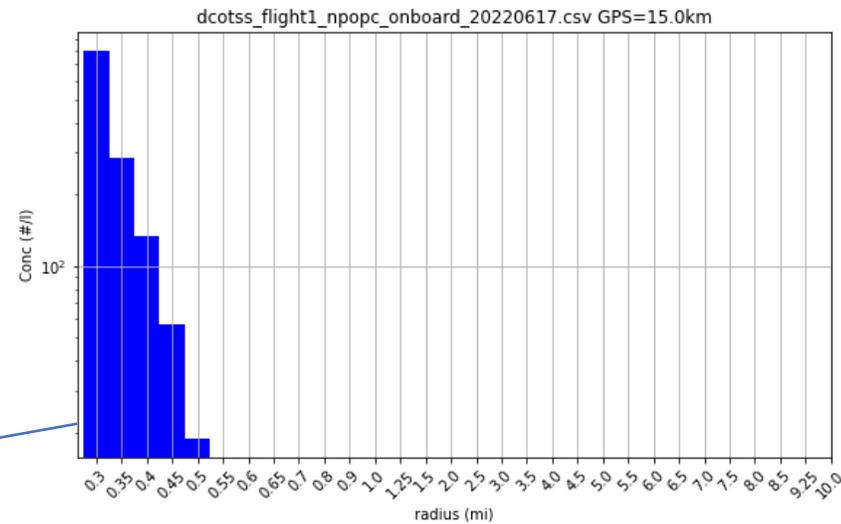
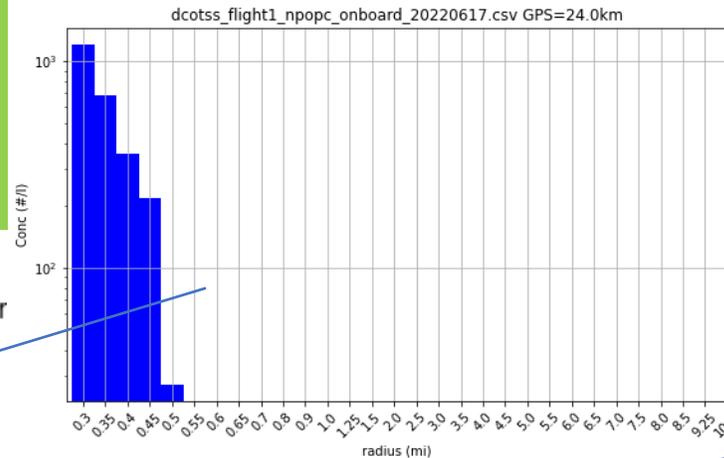
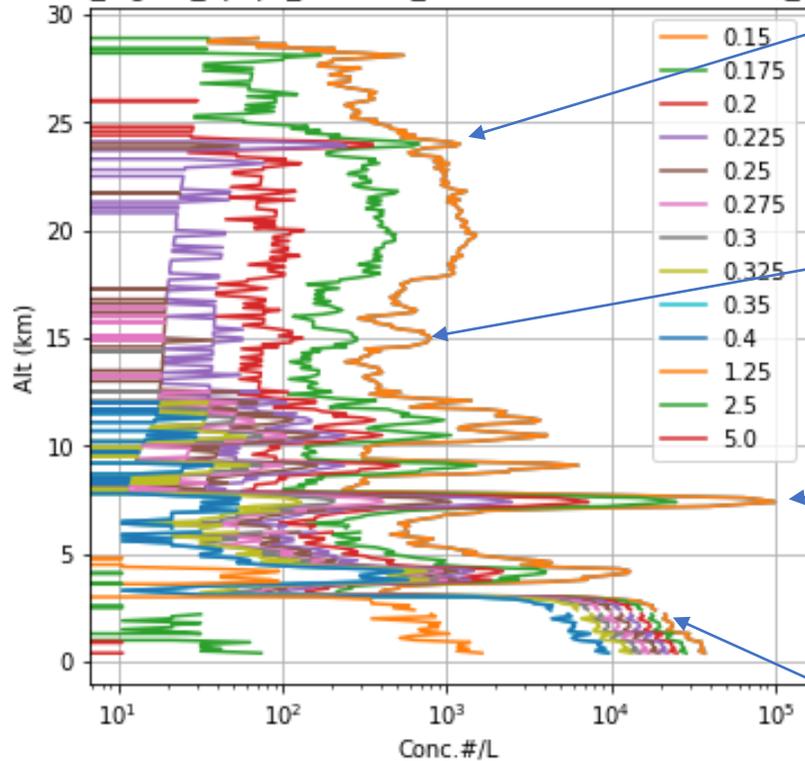
Flight #1

Particle Size Distribution & Particle Types



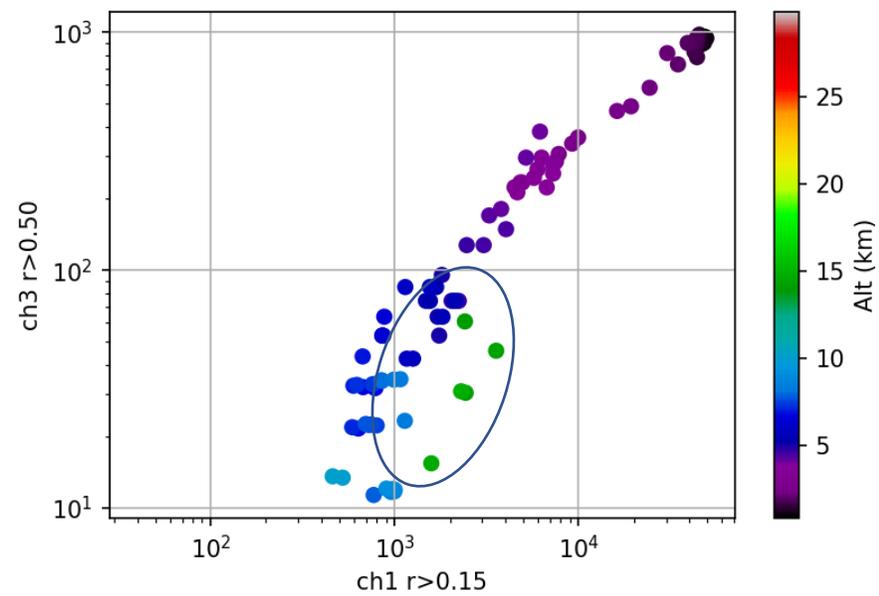
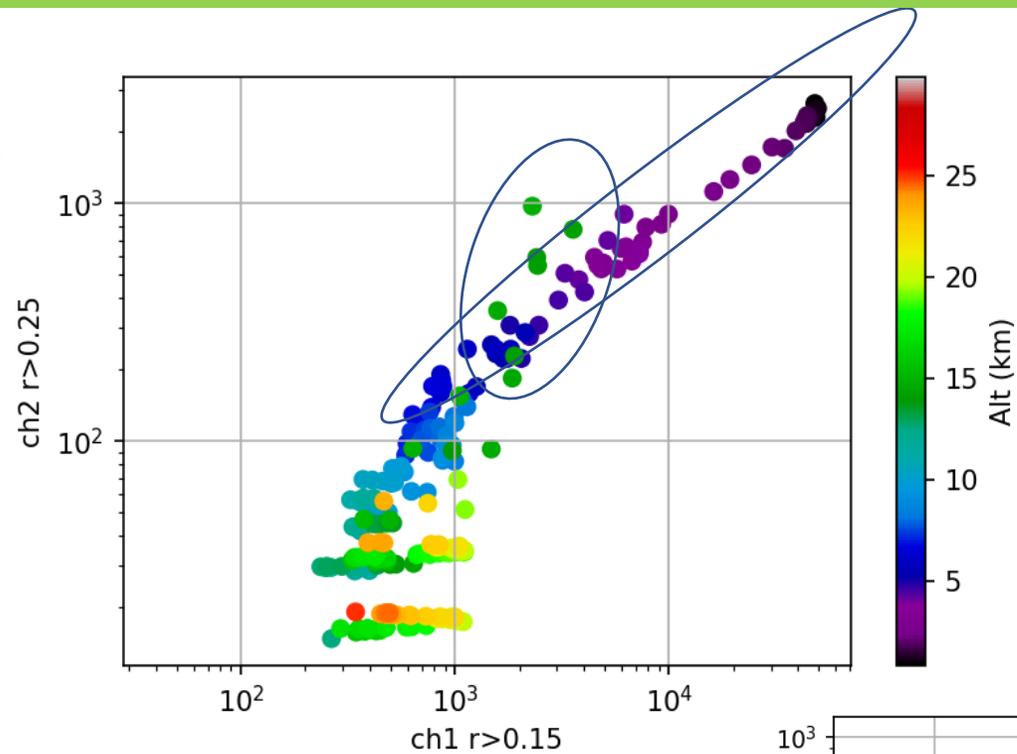
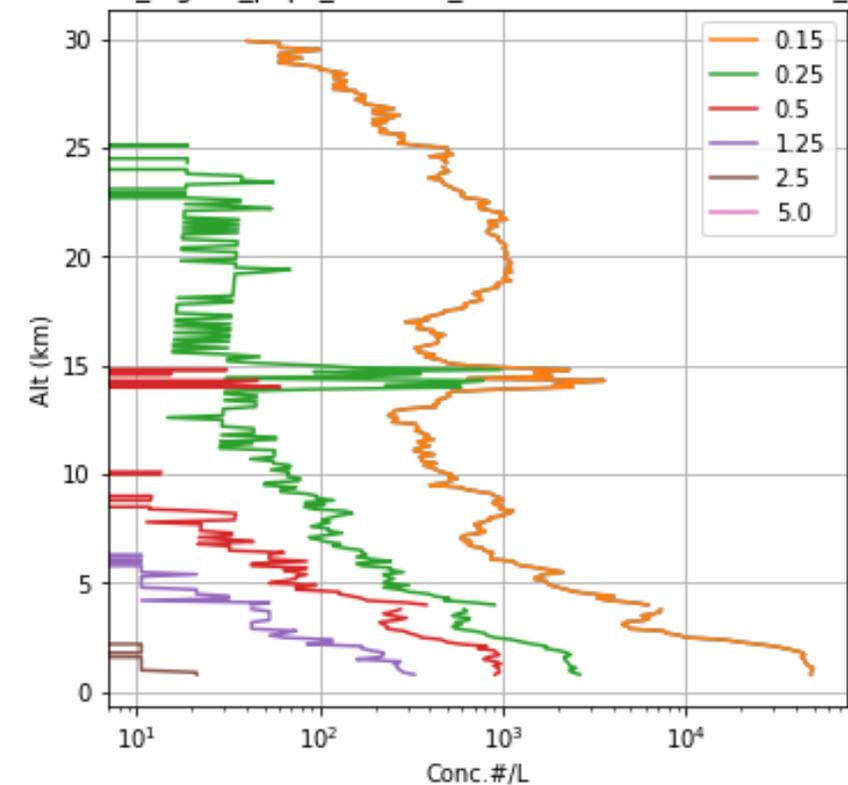
Flight#1: Particle Size Distribution

dcotss_flight1_npopc_onboard_20220617.csv GPS=1 Flow_cor

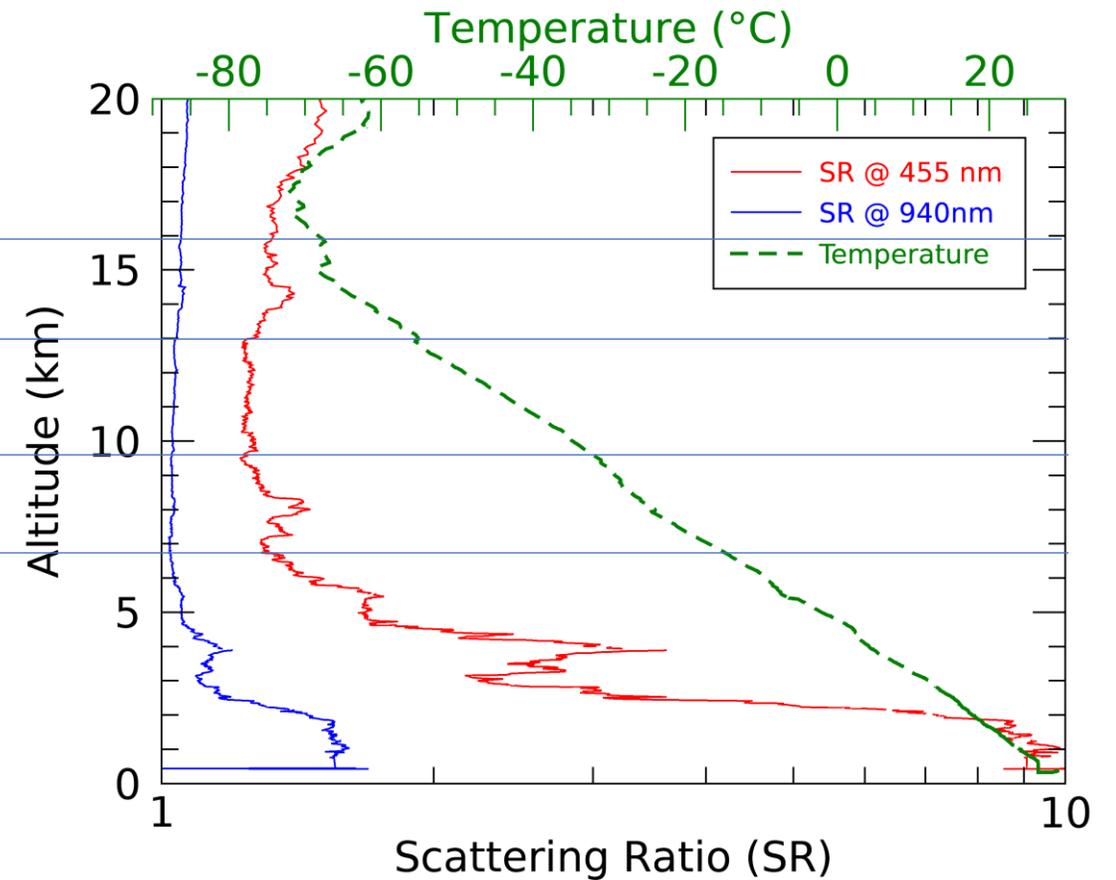
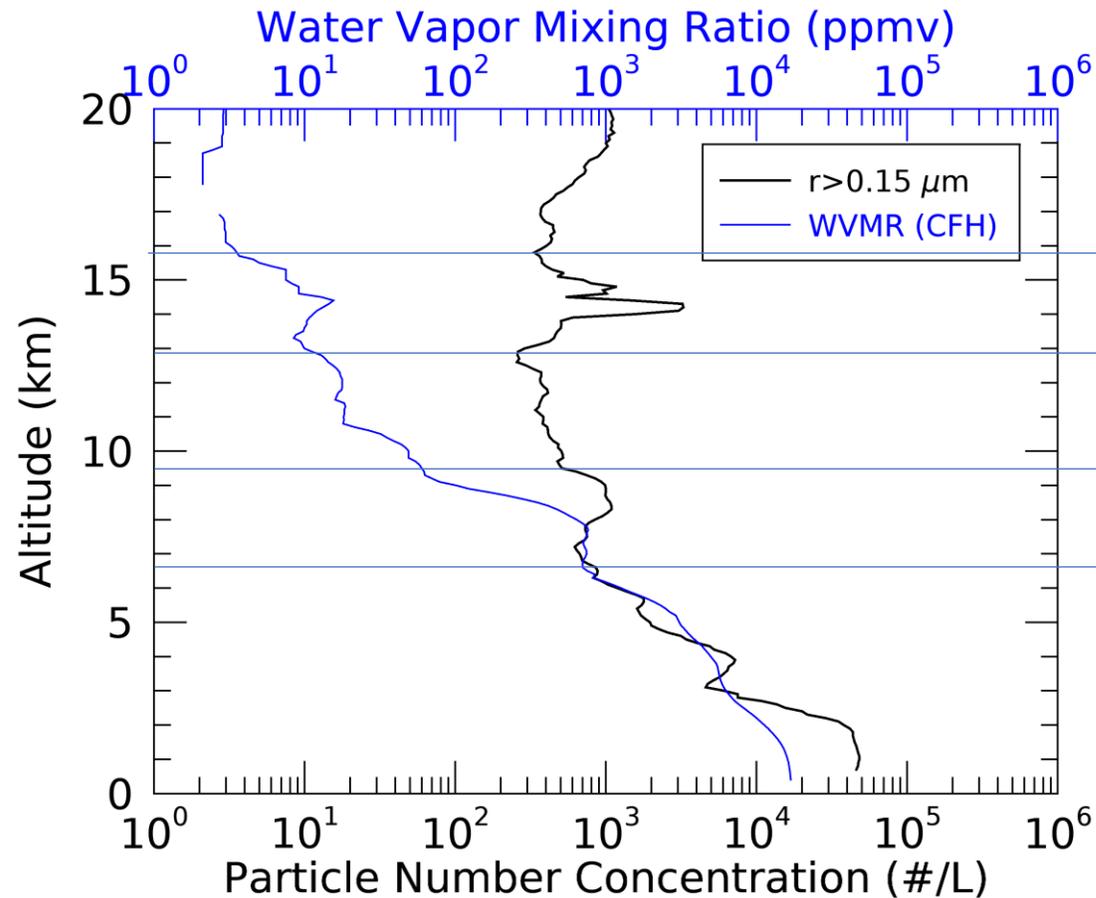


Flight#2: Particle Measurements on 20th June 2022

dcotss22_flight2_popc_onboard_20220619.csv GPS=1 Flow_corr=

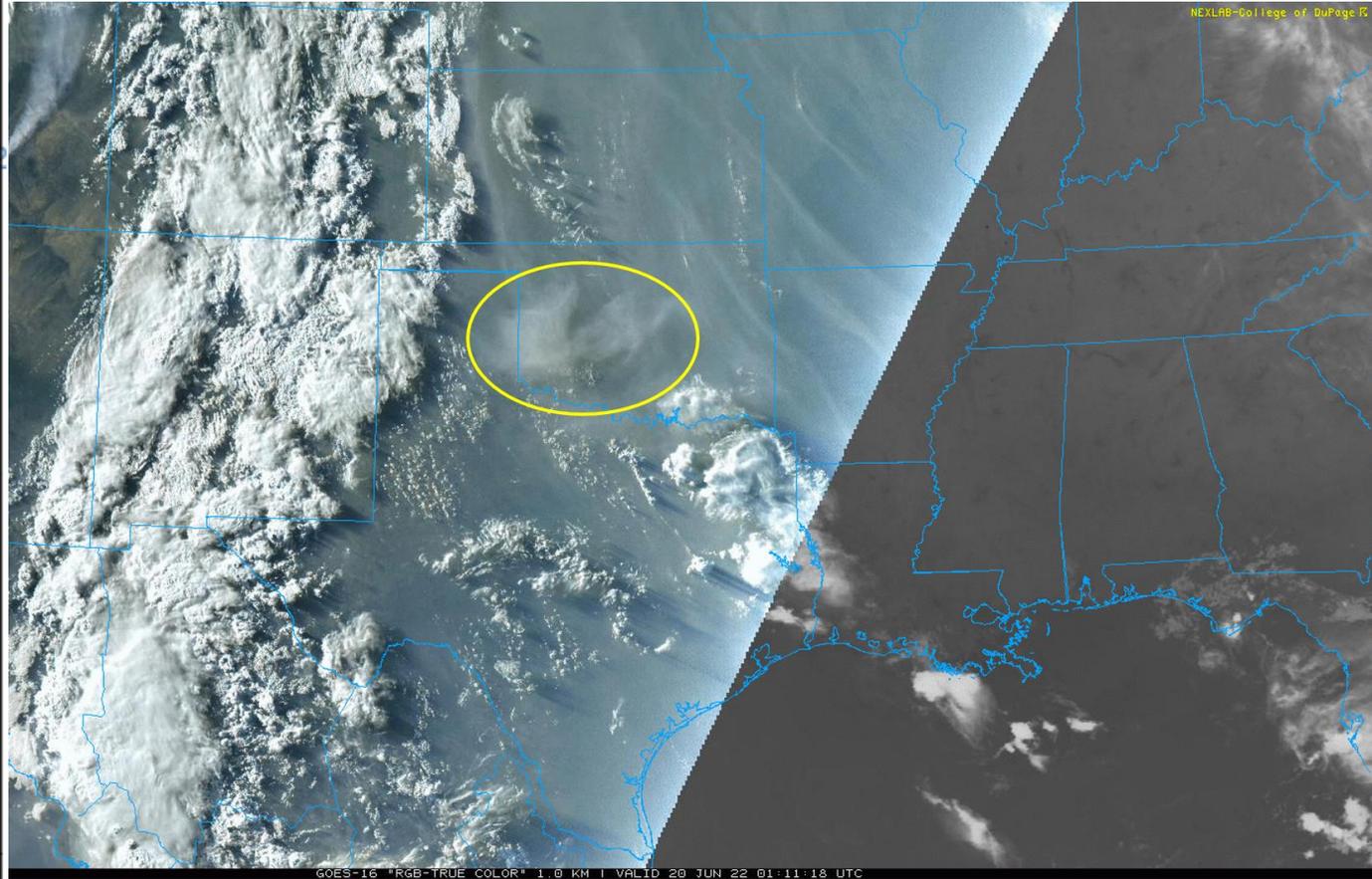
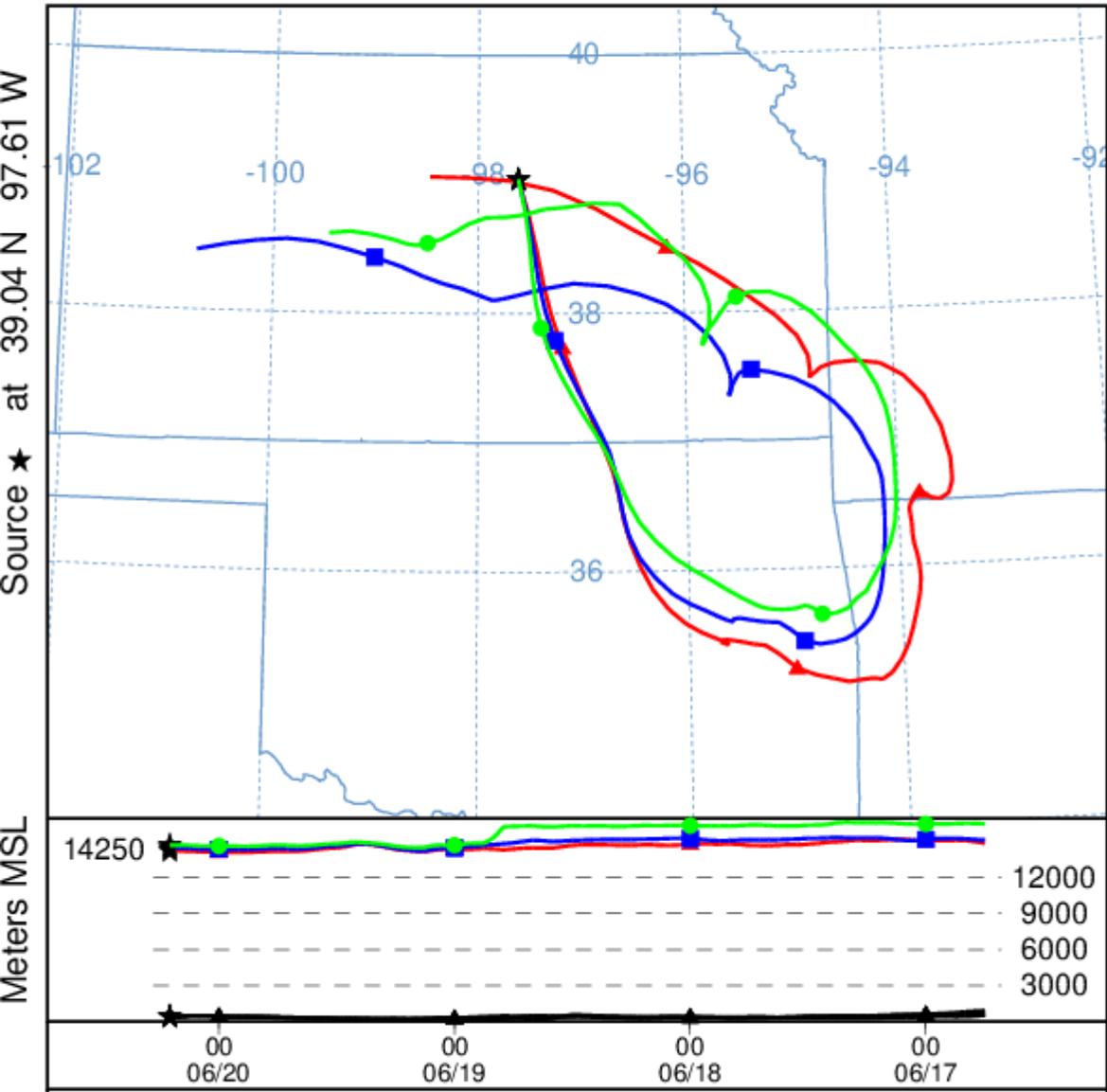


Flight#2: Particle Concentration, Water Vapor & Backscatter Measurements on 20th June 2022



HYSPLIT Back-trajectories for 20th June 2022 measurements

NOAA HYSPLIT MODEL
Backward trajectories ending at 0500 UTC 20 Jun 22
NAMS Meteorological Data



Summary

18 Jun 2022
00:36 UTC

- During the DCOTSS 2022 campaign, plumes from the New Mexico pyroCb event were sampled by balloon-borne sensors launched on 17th and 20th June 2022 .
- Multiple elevated layers of smokes were noticed in the OPC measurements between 10-13 km.
- Enhanced water vapor (~100 ppmv) and ozone concentrations (~70 ppbv) were measured in these layers.
- POPC and COBALD observed a layer between 13 and 15 km with peak water vapor concentrations of ~ 10-20 ppmv on 19th/20th June 2022 nighttime balloon flight.
- Back-trajectories suggest that these two balloon measurements are connected.

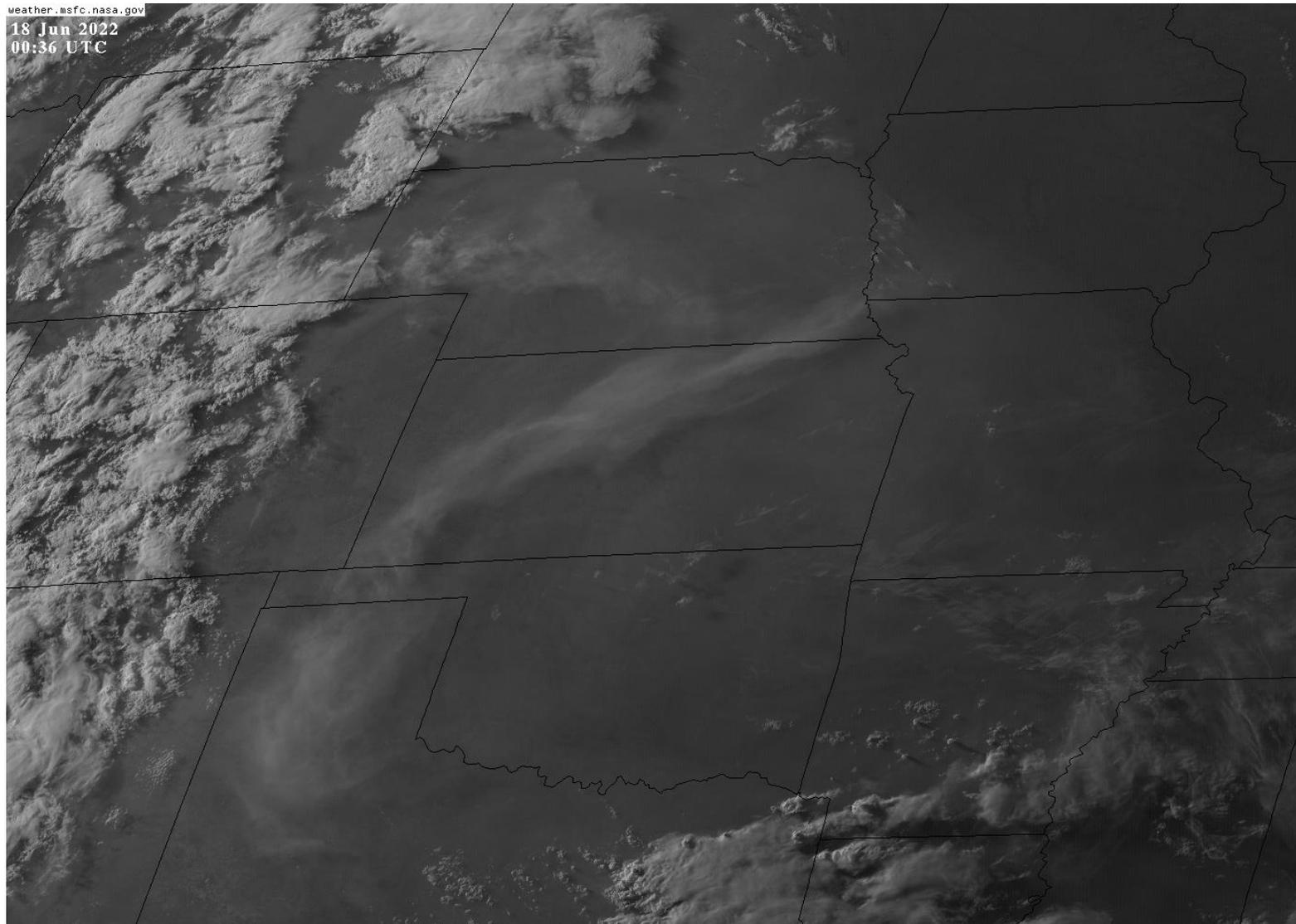
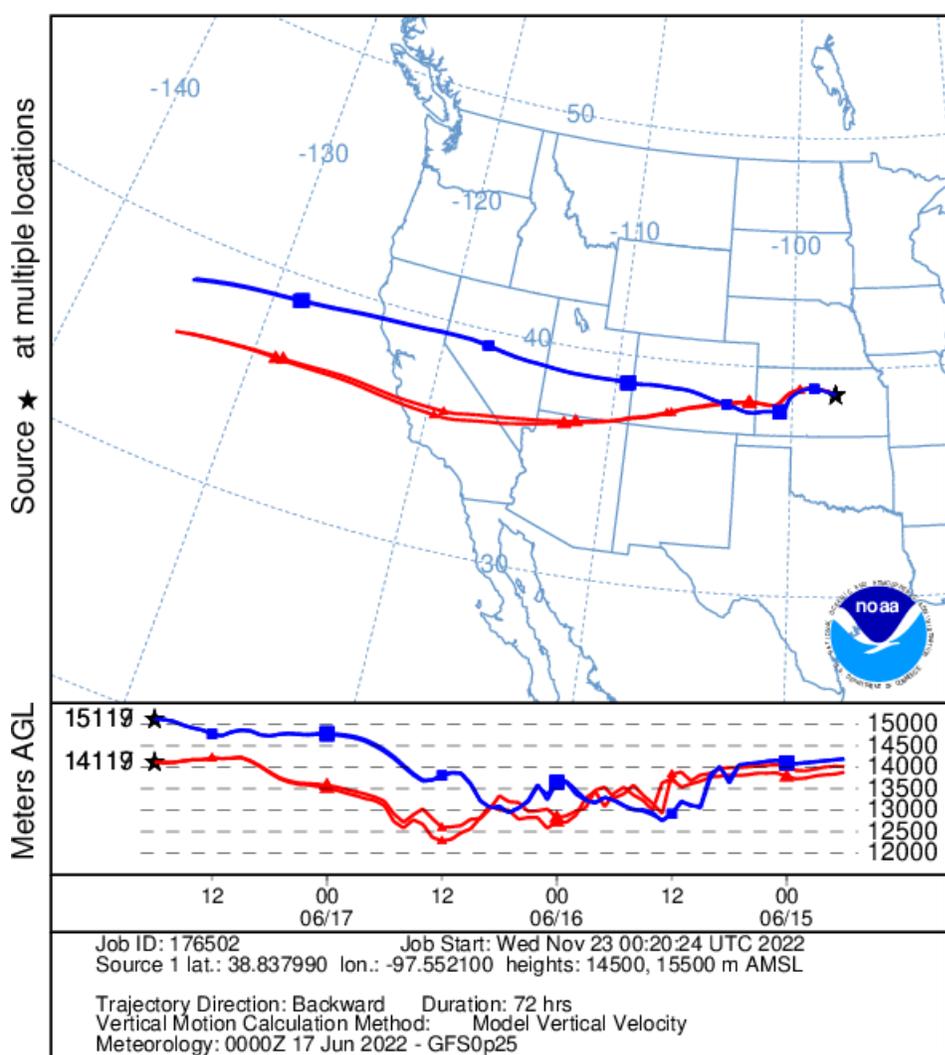
Acknowledgements

- Mr. Johnny C. Mau (NASA LaRC) for supporting the campaign.
- NASA UACO grant.
- NIA Staffs for timely approval of equipment purchase, travel and logistics.
- Entire DCOTSS team for their support and for providing logistics.
- The farmers in Kansas who helped us in recovering our payloads back.

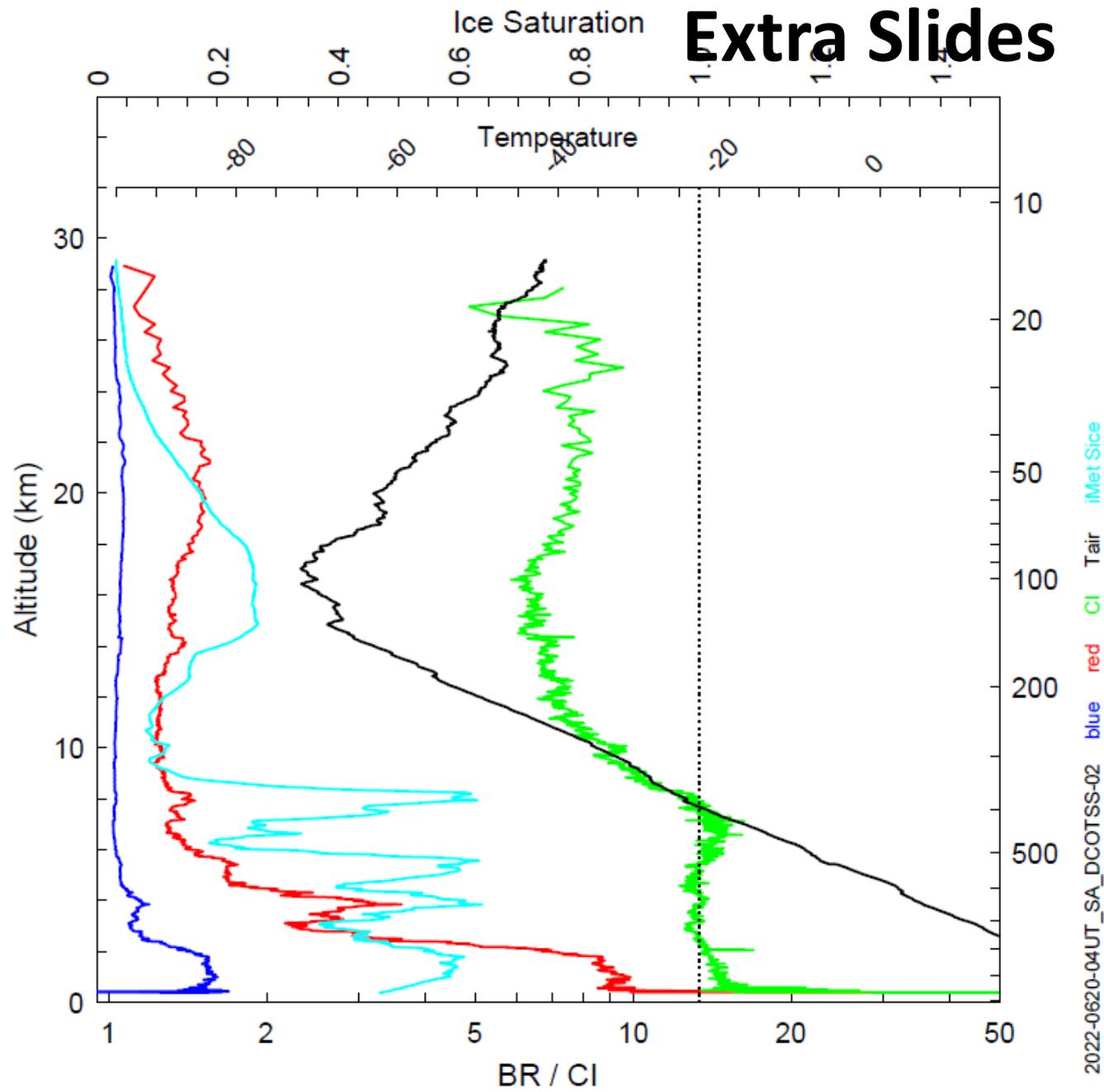
Thank you for your attention!
Questions?

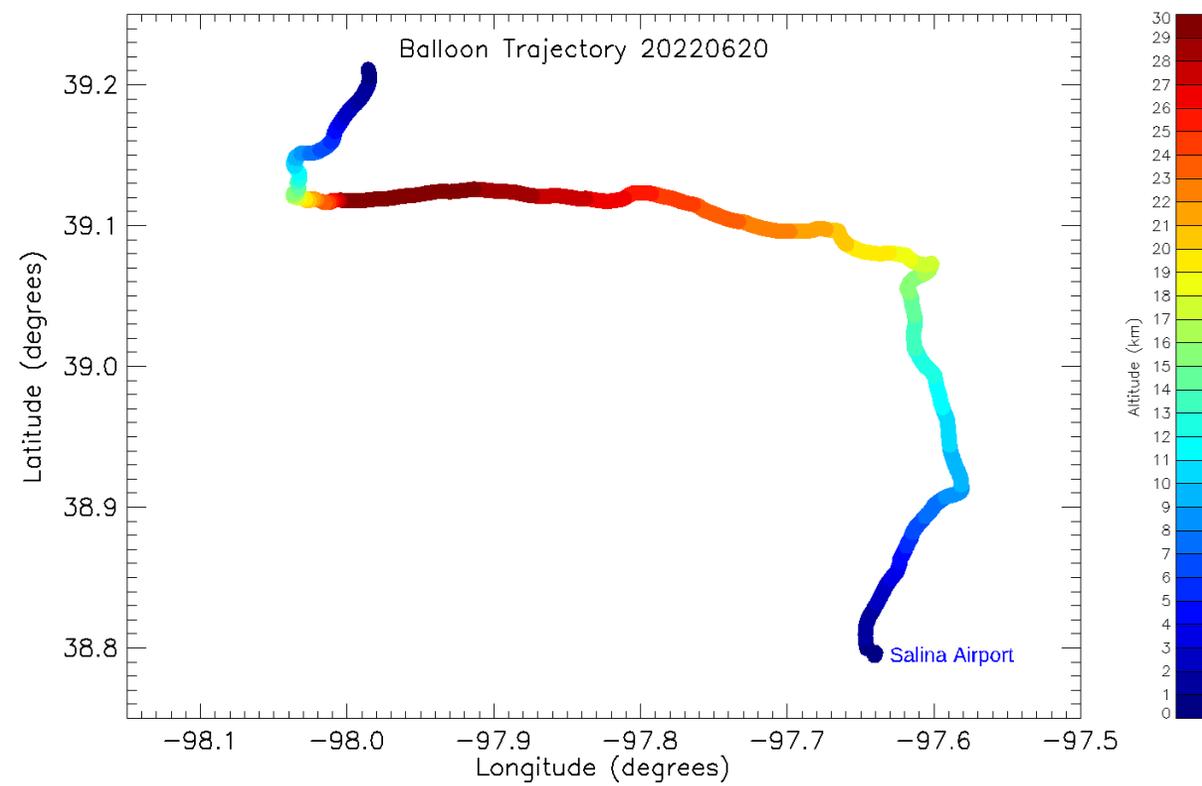
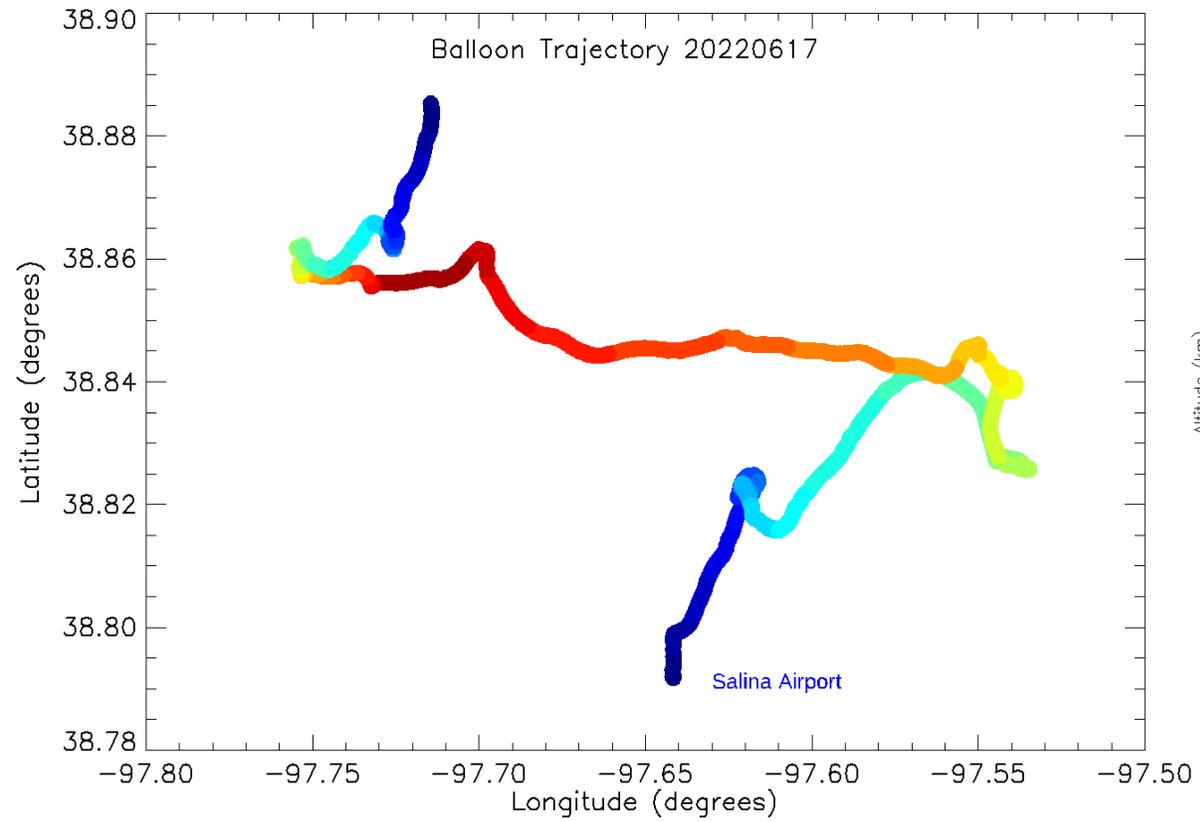
Extra Slides

NOAA HYSPLIT MODEL
 Backward trajectories ending at 1800 UTC 17 Jun 22
 GFSQ Meteorological Data

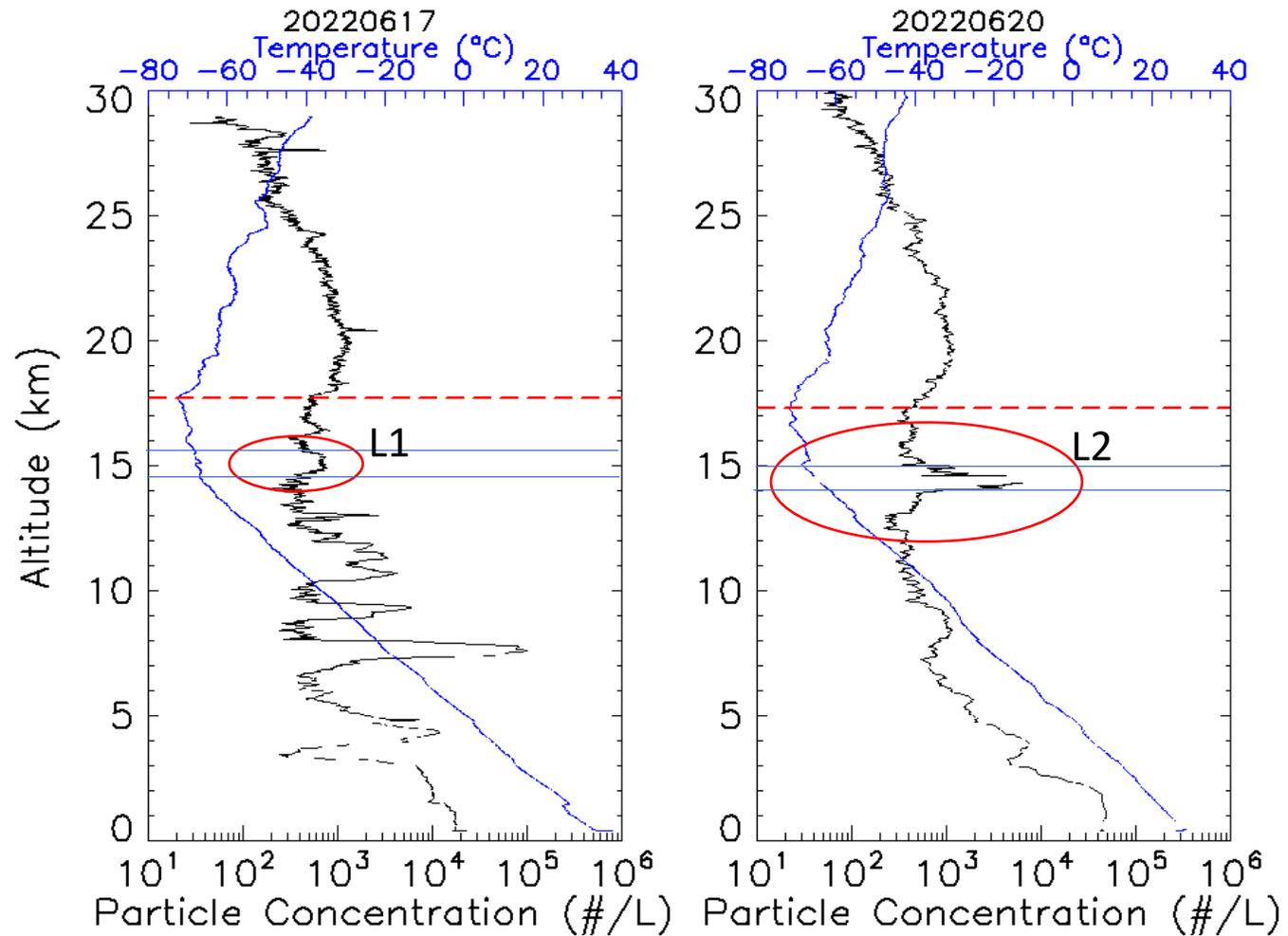


Extra Slides





Layer	Date (UTC)	Time (UTC)	Latitude	Longitude	Altitude (km)
L1 (base)	20220617	18:15:56	38.83799	-97.5521	14.5
L1 (top)	20220617	18:19:29	38.82724	-97.5434	15.5
L2 (base)	20220620	04:52:14	39.03597	-97.6131	14.0
L2 (top)	20220620	04:55:55	39.0524	-97.6165	15.0



MLS Vs CFH 20220621

