

DIAL/HSRL Ozone and Aerosol Profiles from the DC3 Field Campaign

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<http://science.larc.nasa.gov/lidar>

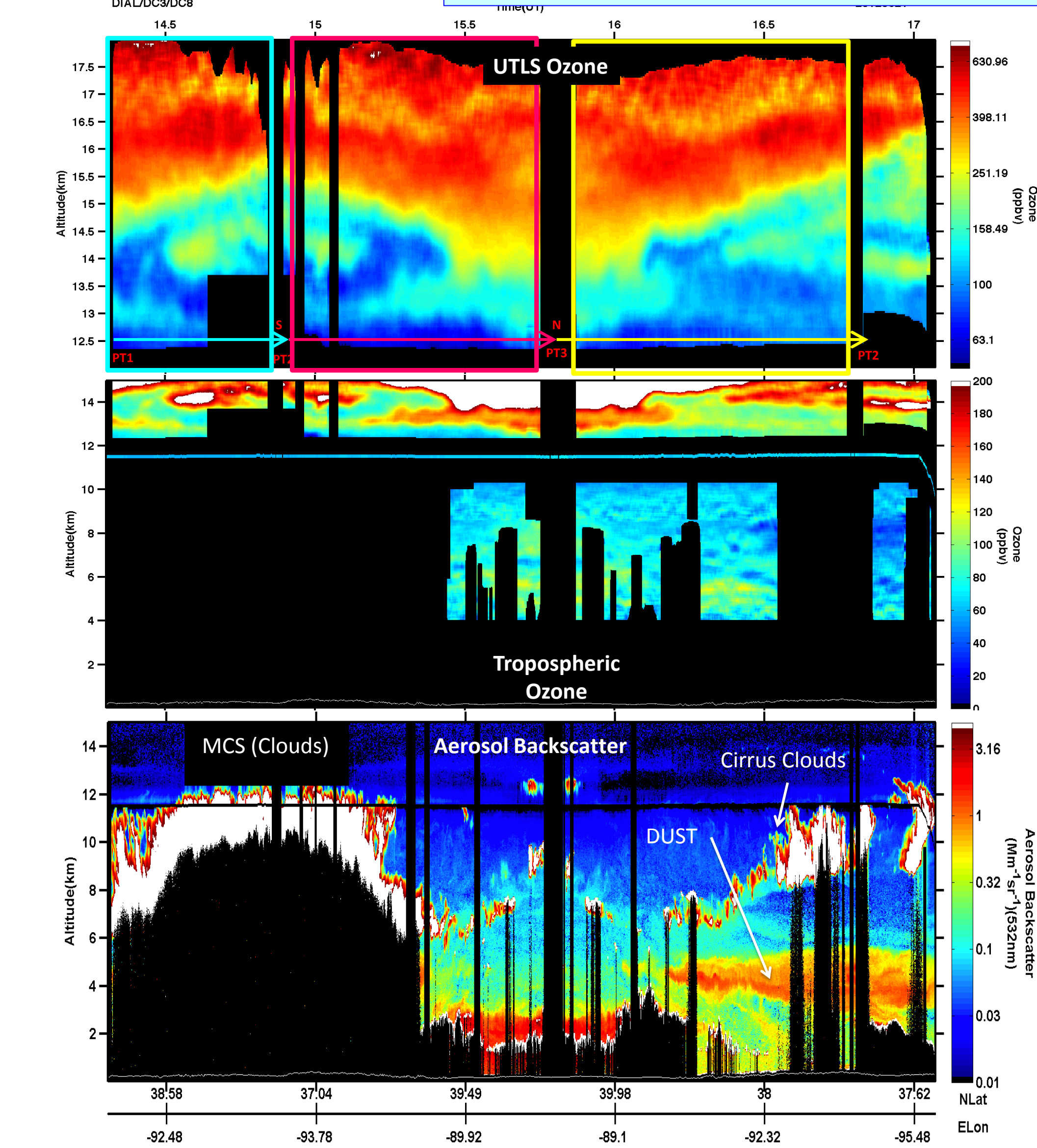
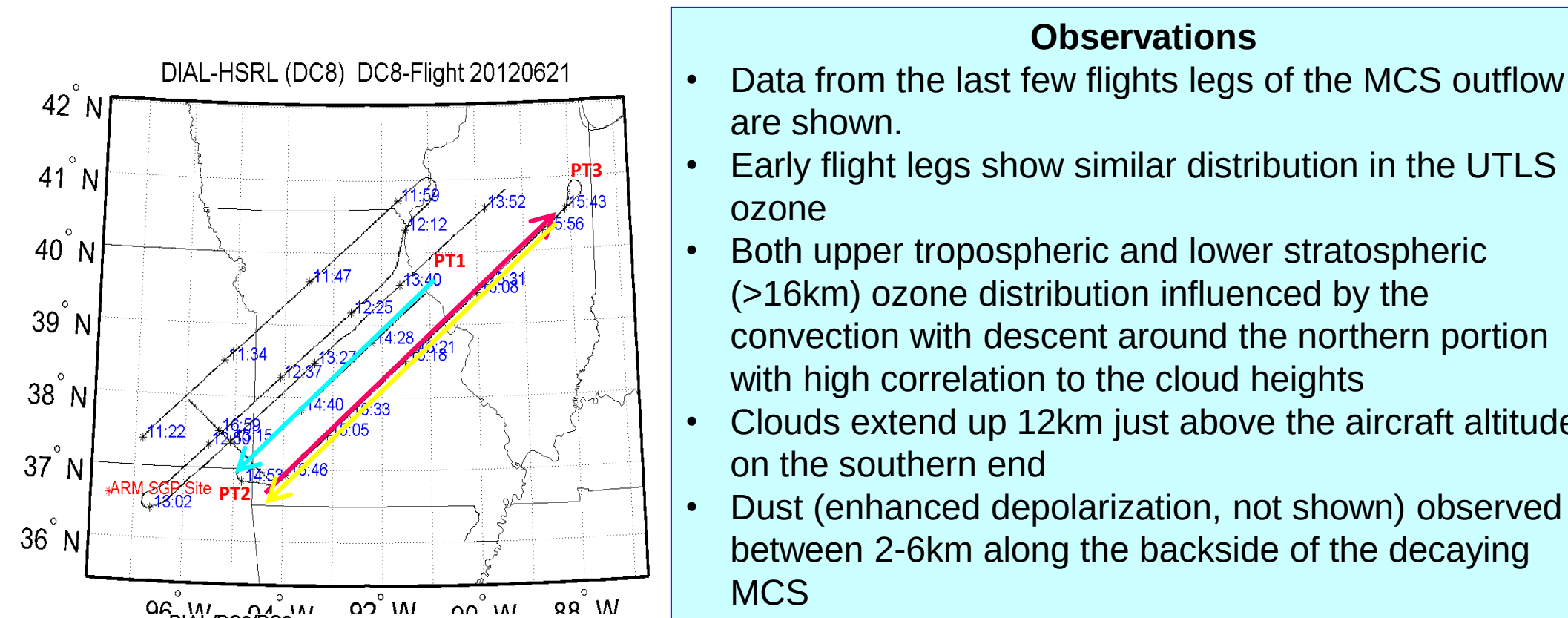
Introduction

The NASA Langley Research Center's Differential Absorption Lidar (LaRC/DIAL/HSRL) was flown aboard the NASA DC-8 and made measurements of ozone and aerosol distributions during the Deep Convective Clouds & Chemistry (DC3) field experiment. DIAL remote profile measurements of ozone were made from near the surface to above the tropopause along the flight track of the DC-8. In addition, aerosol backscatter (532,1064nm), extinction (532nm), and depolarization (355, 532,1064nm), profiles were measured to characterize the aerosol and cloud distributions.

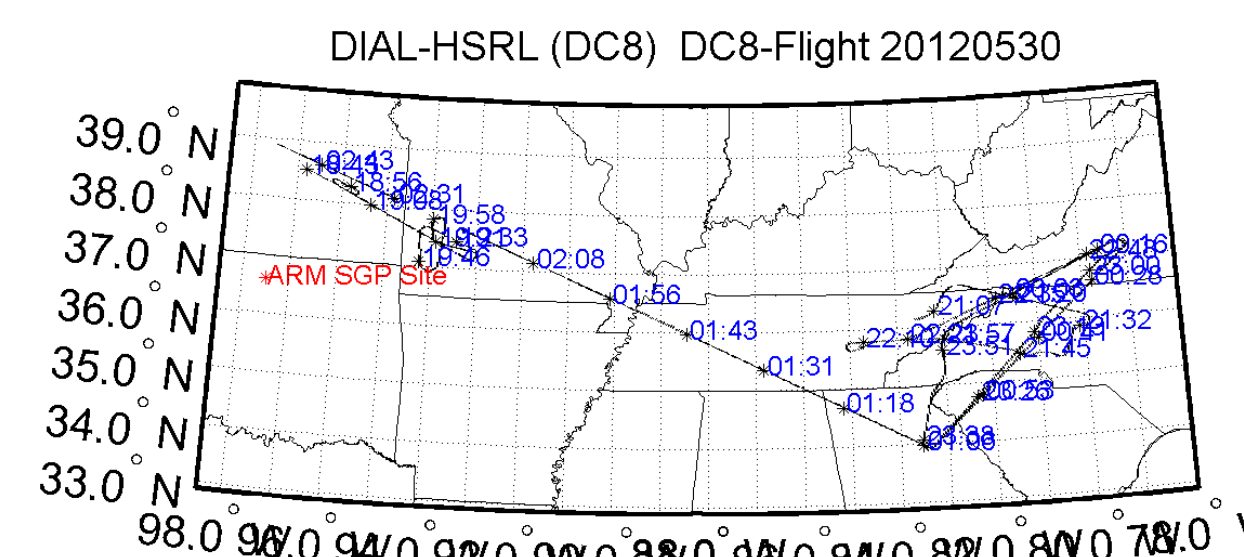
DIAL/HSRL measurements are presented for a few of the DC3 flights. These show the high variability of the ozone that was observed in the upper troposphere and lower stratosphere (UTLS) associated with the convective storms. Examples of derived aerosol products such as aerosol depolarization, spectral depolarization, lidar ratio, and aerosol backscatter wavelength dependence highlight differences in various aerosol types. An example of cloud heights (boundaries) derived from the aerosol data is provided.

UTLS Influence from Convection

21 June 2012

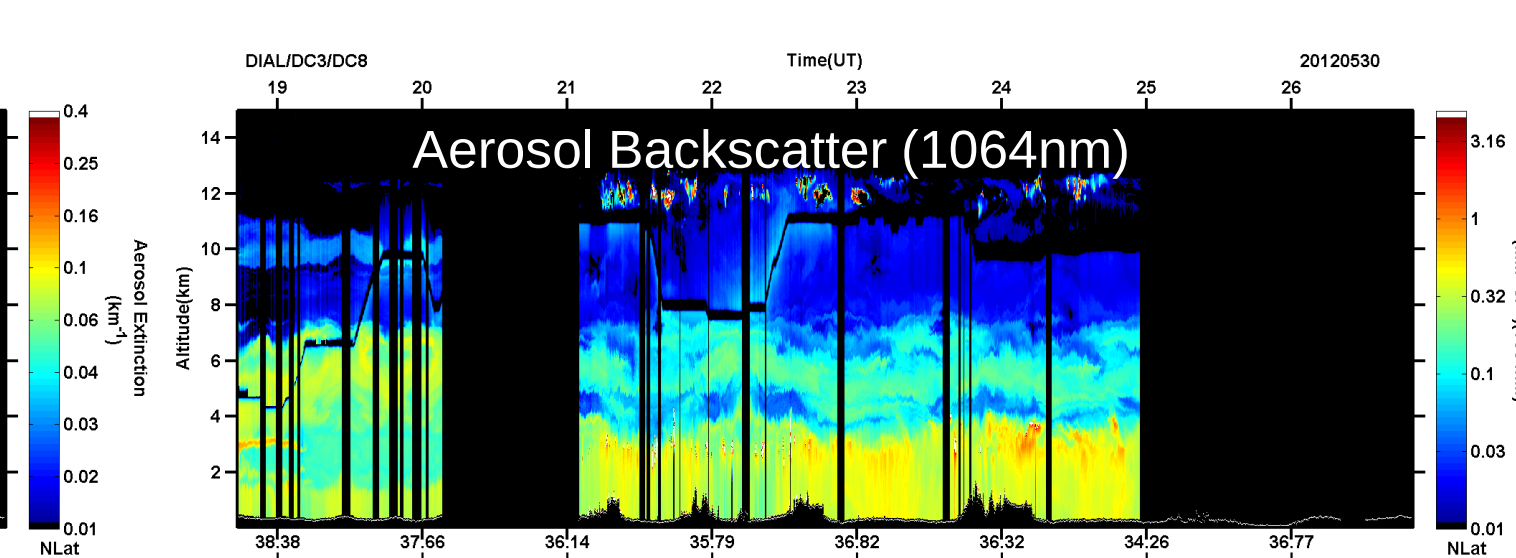
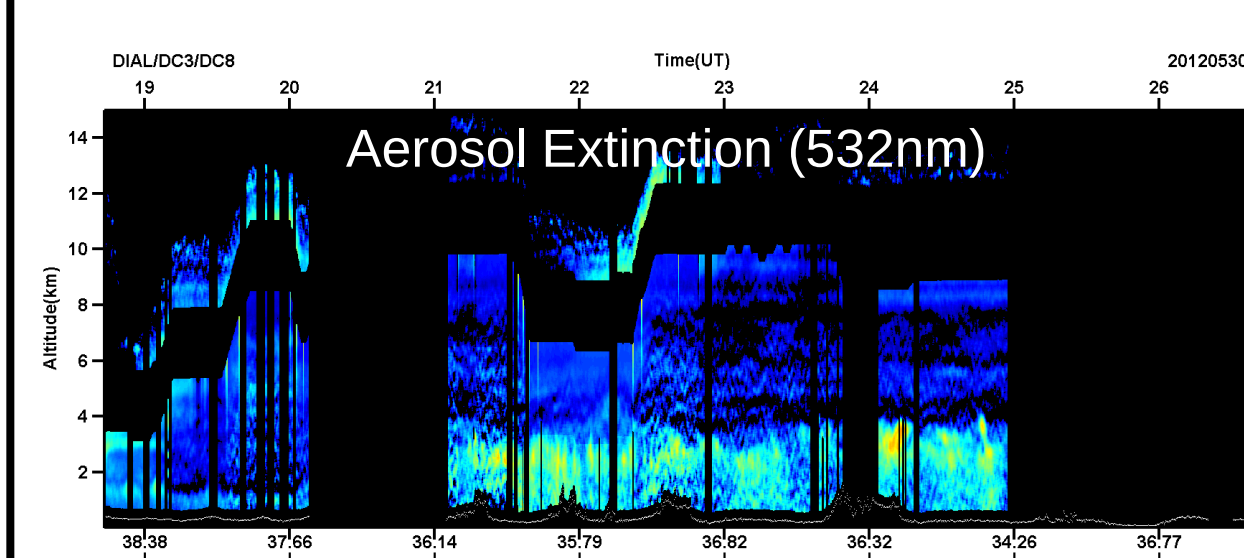


Downwind Outflow & Salina MCS – 2012 May 30

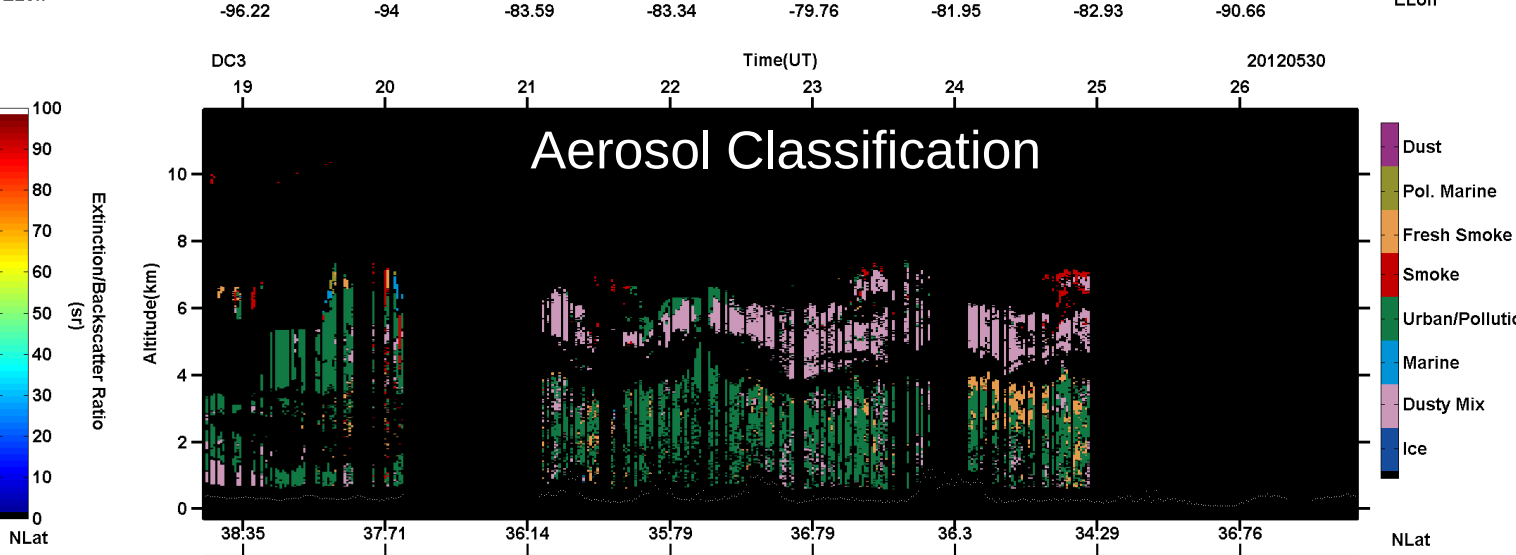
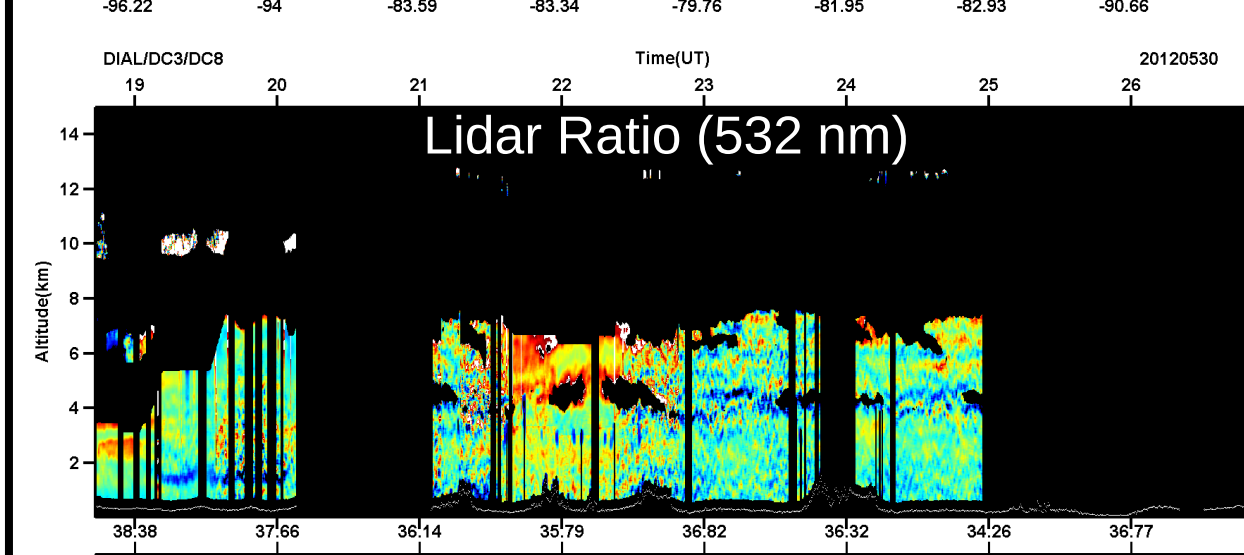
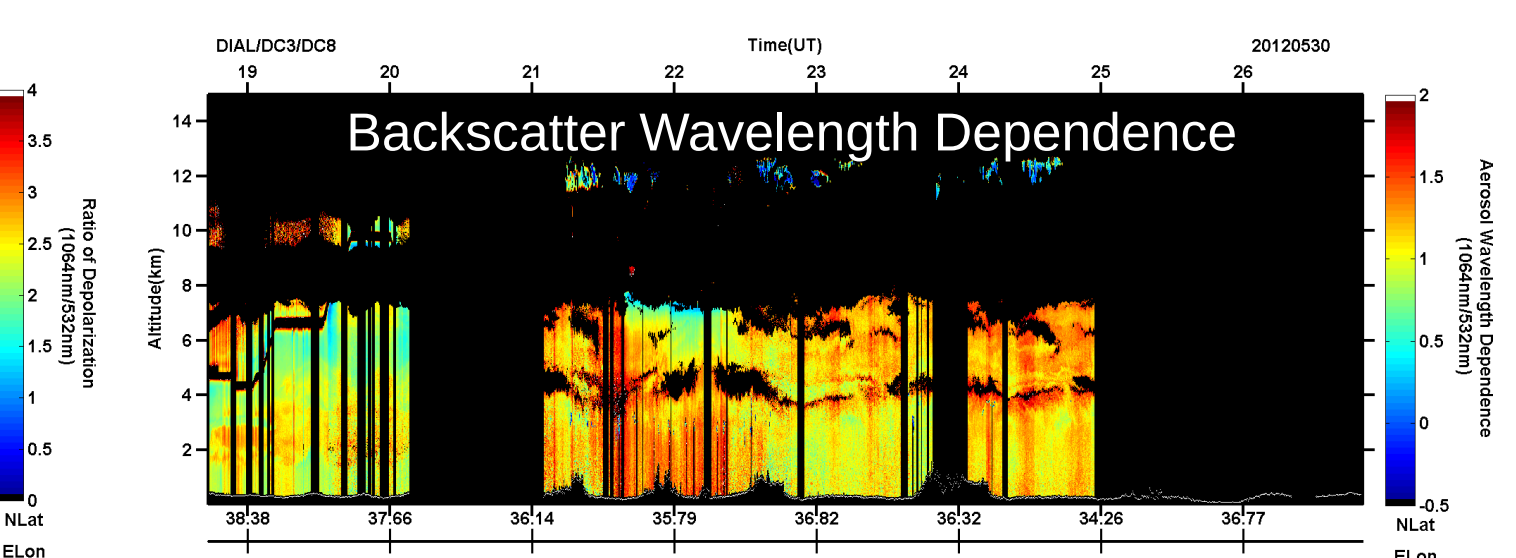
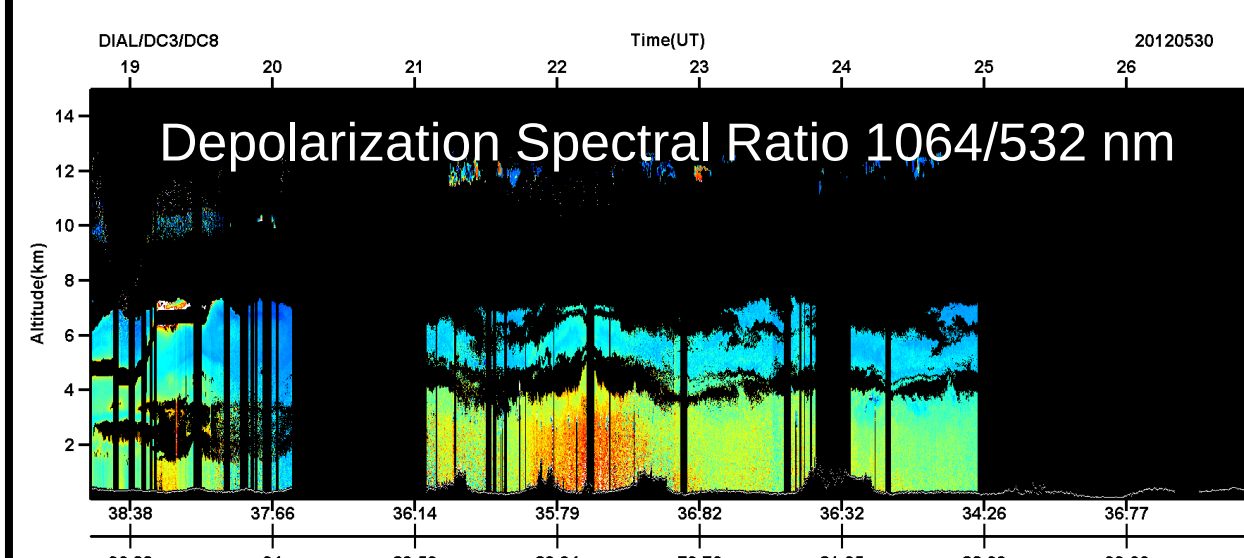
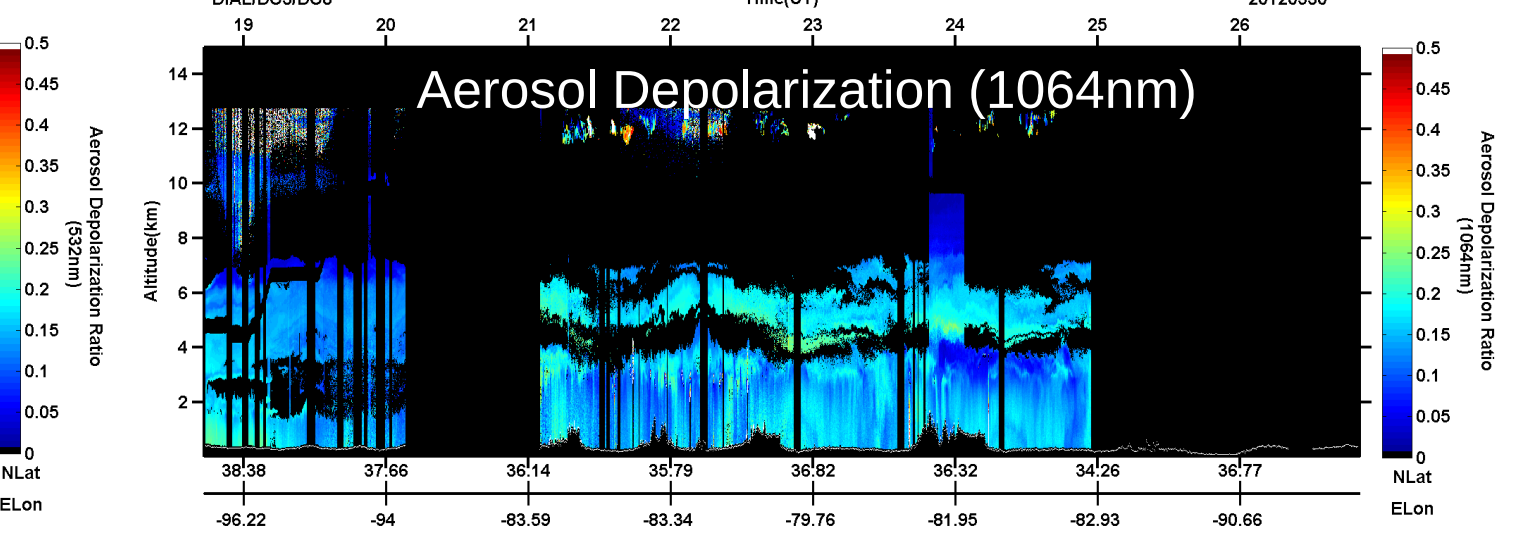
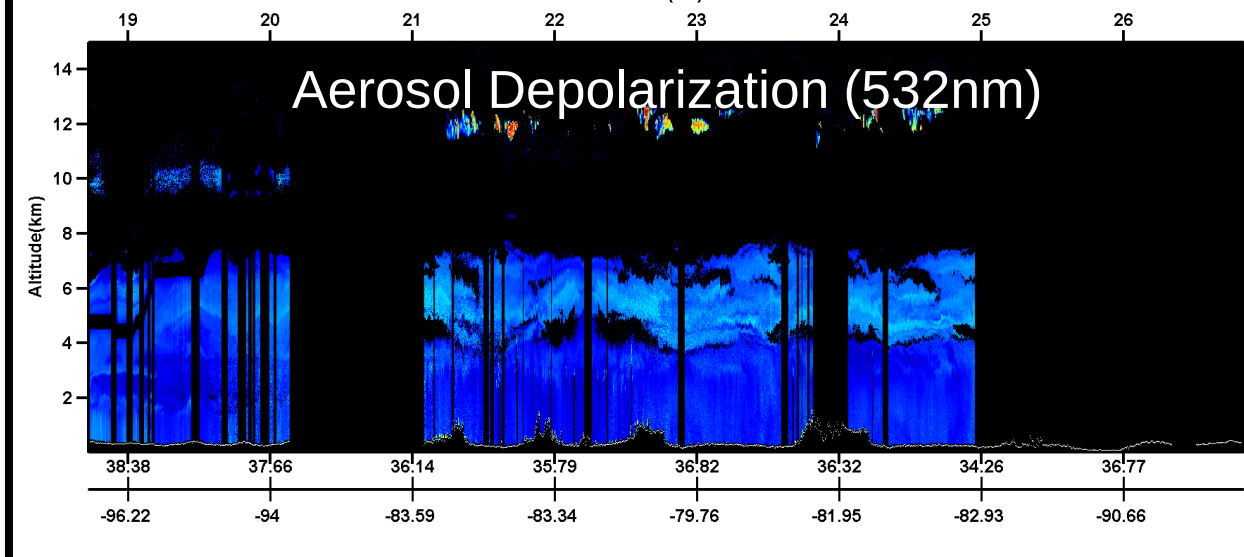


- This example shows the full suite of DIAL/HSRL measurements.
- The full suite of products can be provided for specific flights or flight segments.
- Aerosol classification is based on the intensive parameters.
- The lidar data show elevated aerosol loading up to 8km. These are classified as aerosols containing dust in the 4-6km region and pollution aerosols in the boundary layer.
- Other flights will be investigated to look at the aerosol classifications between pollution, dust, and smoke.

Extensive Parameters
(Depends on particle type and concentration)
Aerosol Backscatter
Aerosol Extinction
Measured independently from HSRL technique

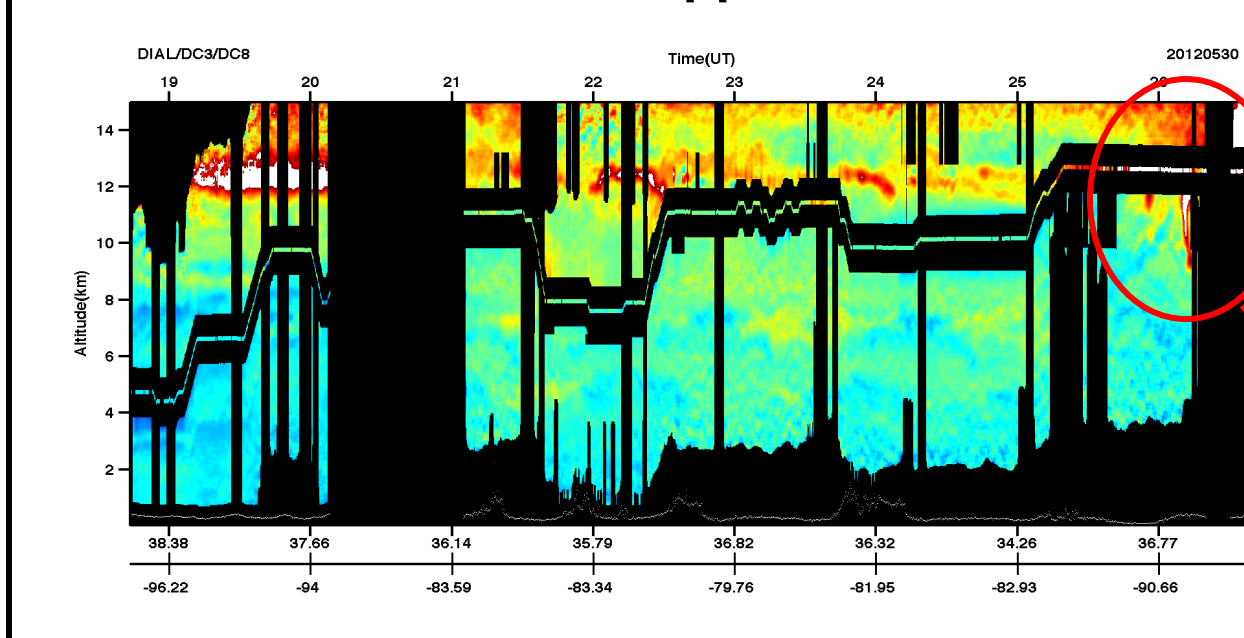


Intensive Parameters
(Depends only on particle composition, size, shape)
Aerosol Depolarization
Depolarization Spectral Ratio
Aerosol Backscatter Wavelength Dependence
Lidar Ratio (Extinction-to-Backscatter Ratio)

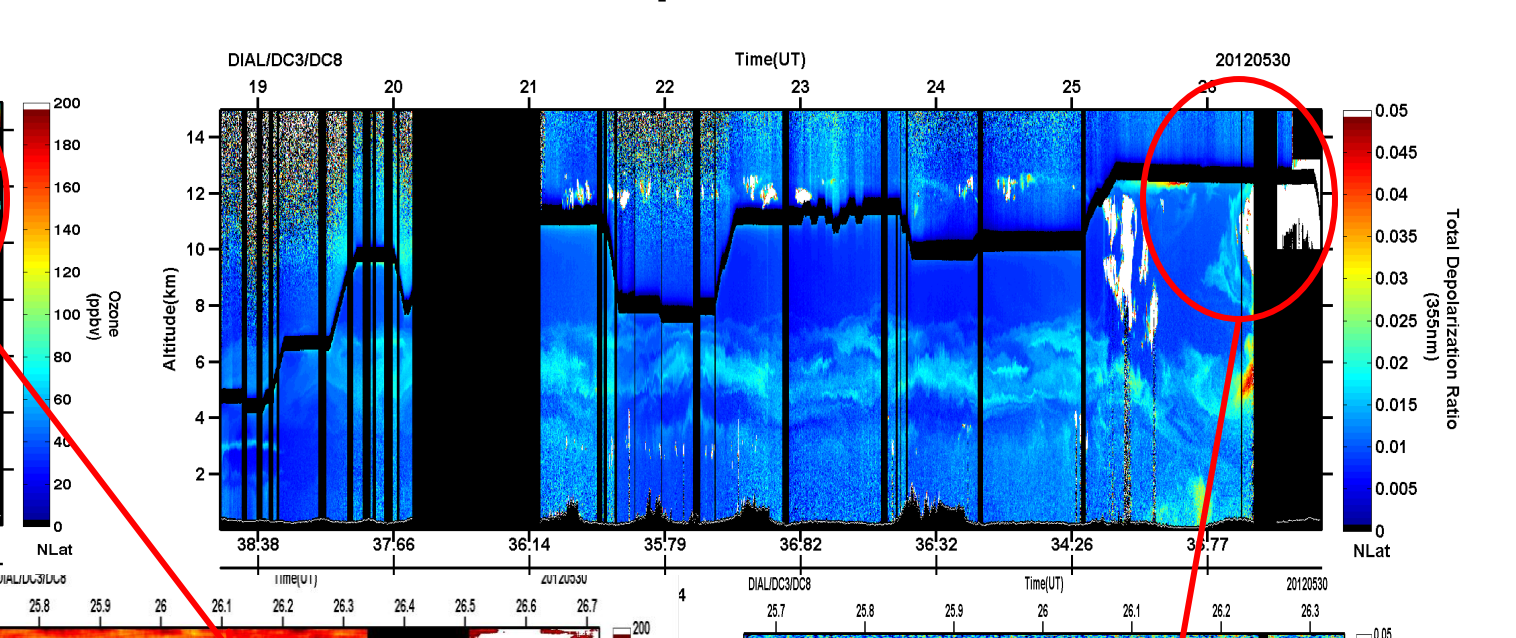


Burton et al. (2011) (AMTD)

Ozone, ppbv



Total Depolarization at 355 nm



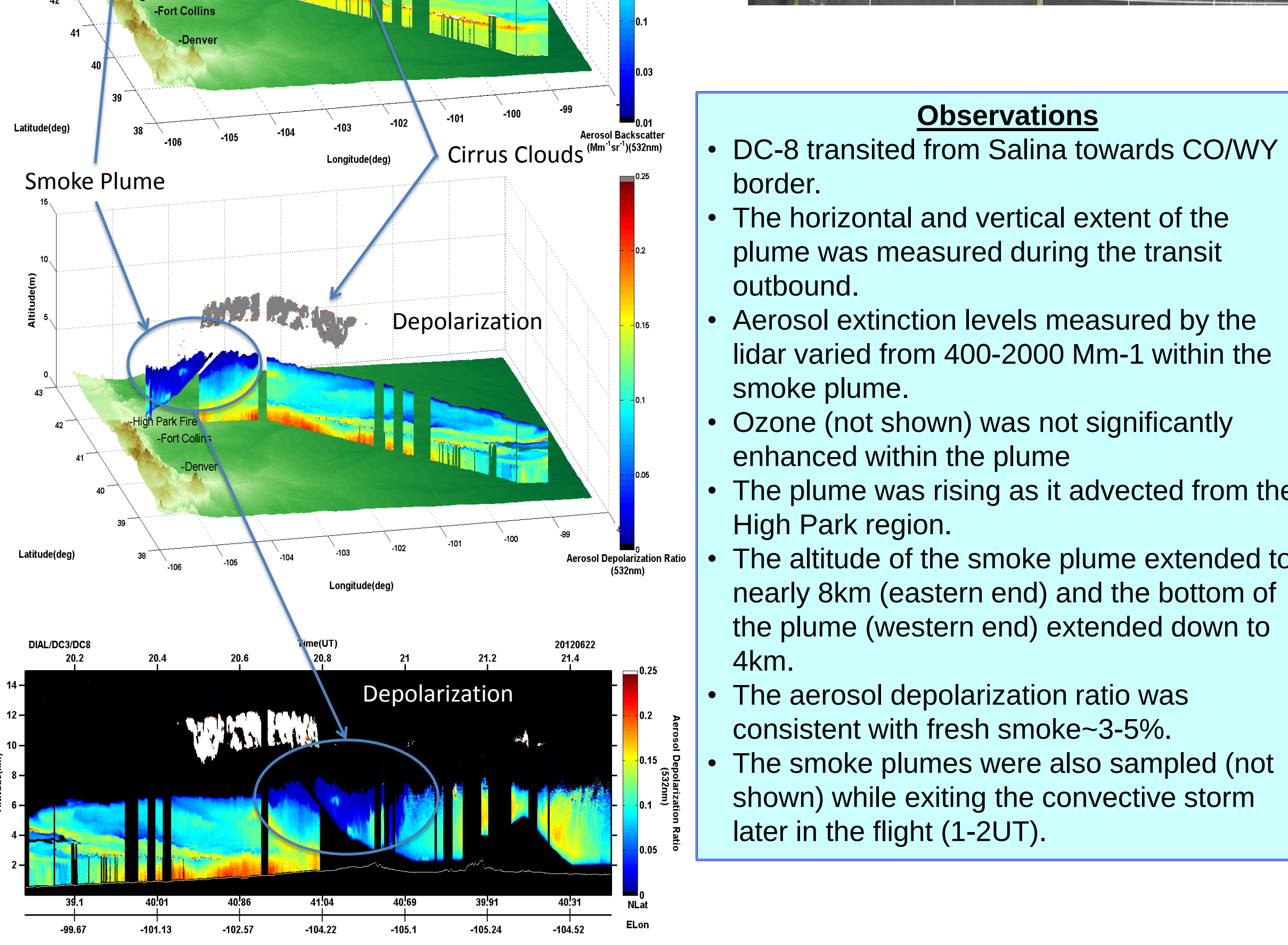
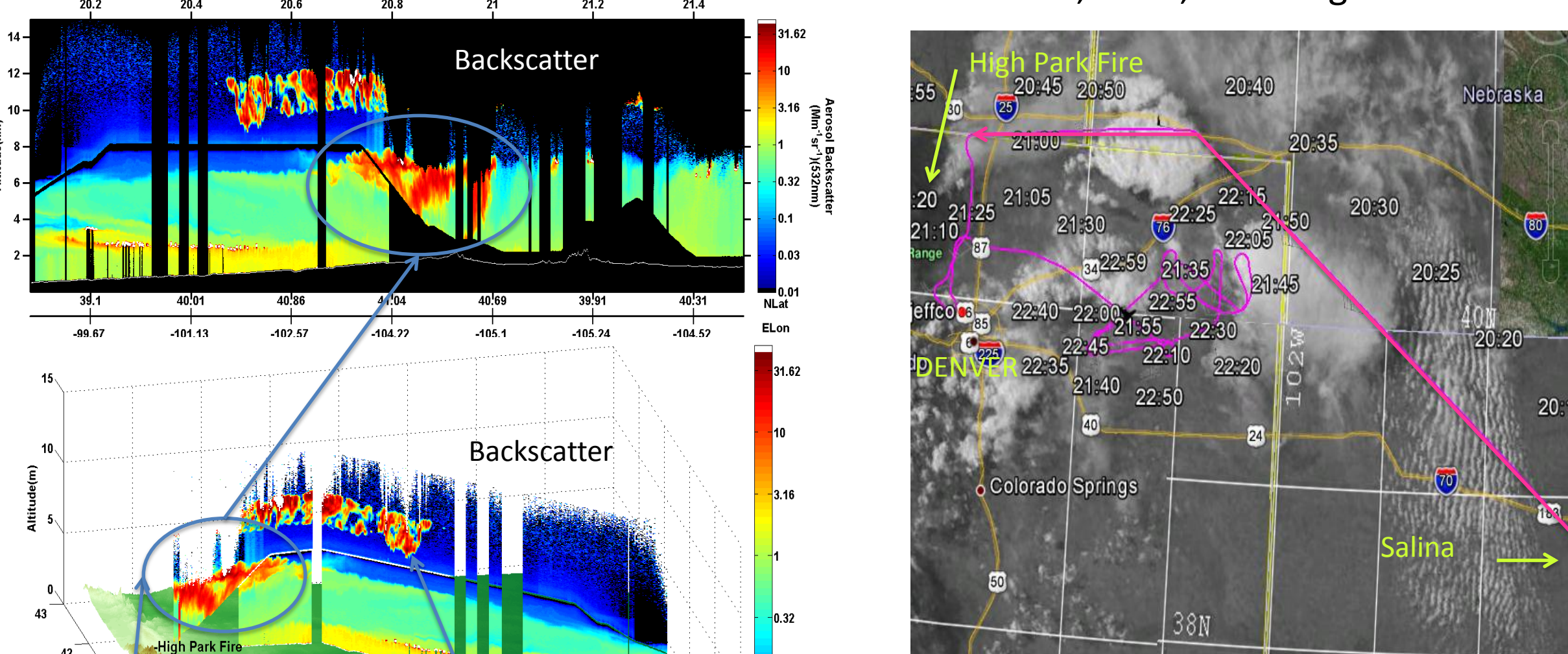
Ozone Dynamics

- Ozone profiles were measured from near the surface to the UT/LS.
- Full flight image and expanded section shown near MCS over Salina KS.
- Stratospheric ozone observed on several flights (see June 21 case) to wrap (descending) around the anvil clouds.
- High ozone measured on outbound leg (19-20UT) at ~12km similar to in situ (~2UT) ozone on inbound leg.

- Note the ozone profiles are averaged 2min and 330m vertically. The aerosol depolarization is a 10 sec, 30 m average.
- The 355 nm backscatter and total depolarization measurements are used to locate the cirrus cloud boundary due to night-time operations only allowing the ultraviolet wavelengths. Cirrus clouds show depolarization >25%.

High Park Fire & Colorado Convective Storm

June 22, 2012, DC-8 Flight Track

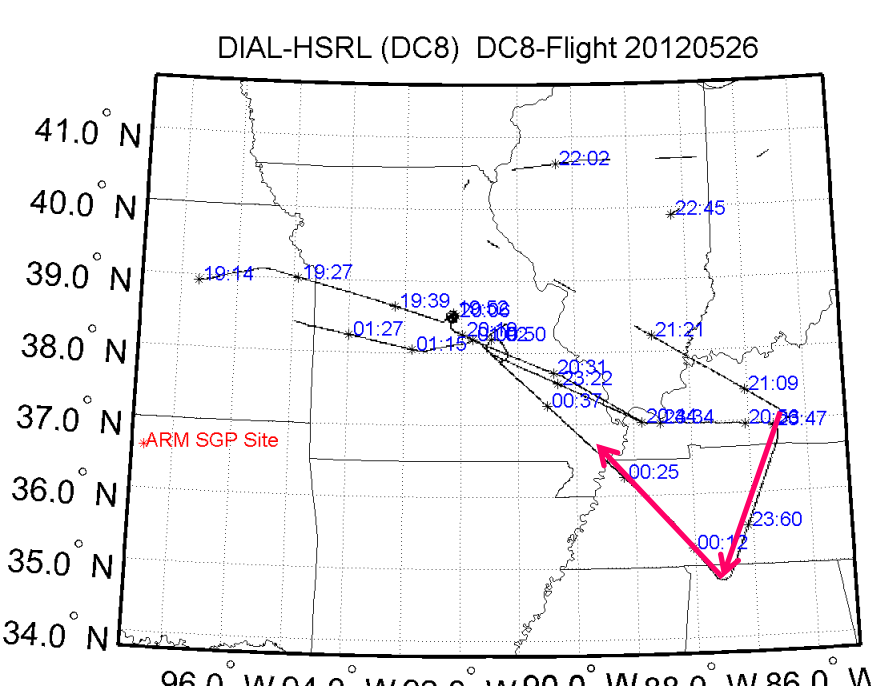


Observations

- DC-8 transited from Salina towards CO/WY border.
- The horizontal and vertical extent of the plume was measured during the transit outbound.
- Aerosol extinction levels measured by the lidar varied from 400-2000 Mm⁻¹ within the smoke plume.
- Ozone (not shown) was not significantly enhanced within the plume
- The plume was rising as it advected from the High Park region.
- The altitude of the smoke plume extended to nearly 8km (eastern end) and the bottom of the plume (western end) extended down to 4km.
- The aerosol depolarization ratio was consistent with fresh smoke~3-5%.
- The smoke plumes were also sampled (not shown) while exiting the convective storm later in the flight (1-2UT).

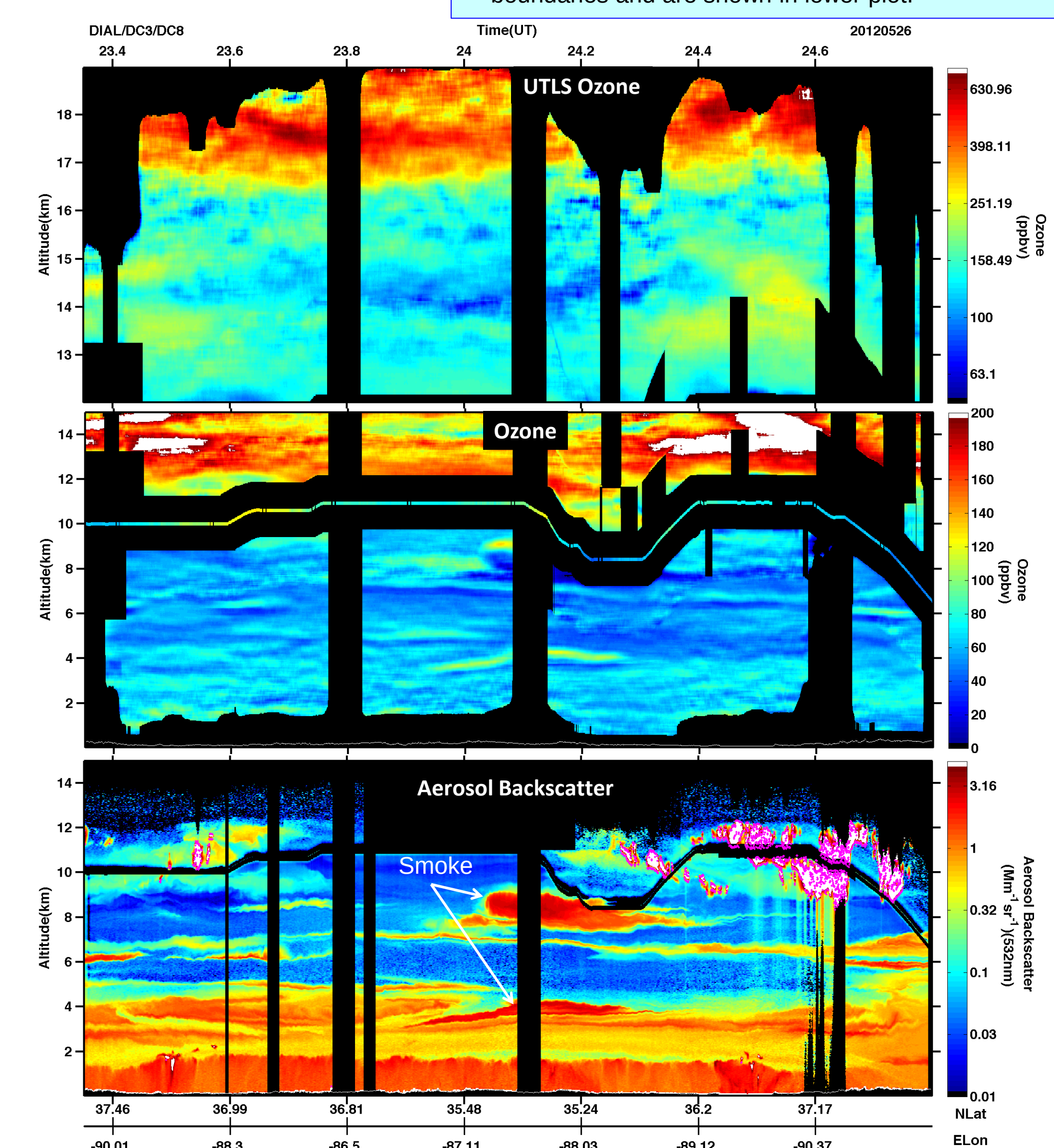
Ozone Variability of UT

26 May 2012



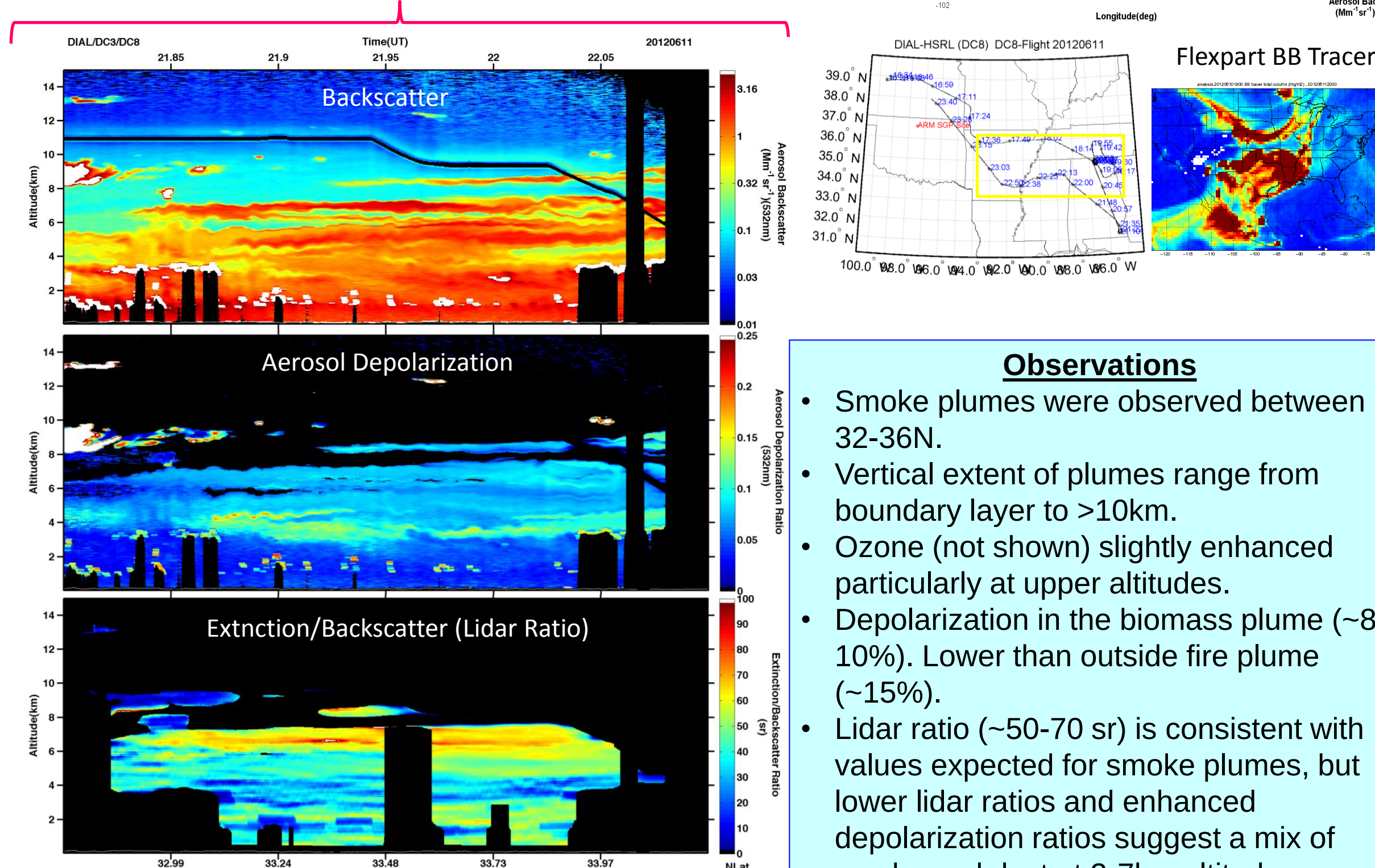
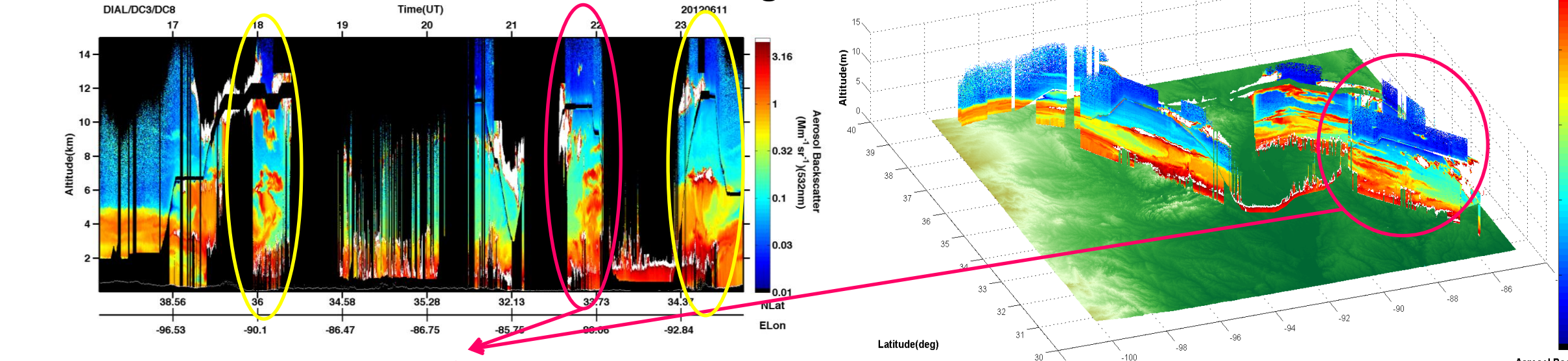
Observations

- Focus of flight to sample outflow (1-day) from OK convection.
- UTLS ozone shows large variability (~100-250 ppbv) up to ~17km.
- Enhanced ozone layers at 12 km. DC-8 did not sample at this altitude.
- Significant scattering > 0.2Mm⁻¹sr⁻¹ outside of clouds at 9-12km.
- Dust (enhanced depolarization, not shown) observed between 2-4km in mid-level mixed layers.
- High scattering plumes in free troposphere are likely smoke. Note in situ sampling of one of the plumes occurred at ~24.2UT.
- A table of cloud top and bottom altitudes are determined from the gradients in the aerosol backscatter, and this product can be made available to science team. Magenta circles identify cloud boundaries and are shown in lower plot.



New Mexico Fires – 11 June 2012

Full Flight - Backscatter



Observations

- Smoke plumes were observed between 32-36N.
- Vertical extent of plumes range from boundary layer to >10km.
- Ozone (not shown) slightly enhanced particularly at upper altitudes.
- Depolarization in the biomass plume (~8-10%). Lower than outside fire plume (~15%).
- Lidar ratio (~50-70 sr) is consistent with values expected for smoke plumes, but lower lidar ratios and enhanced depolarization ratios suggest a mix of smoke and dust at 2-7km altitude.