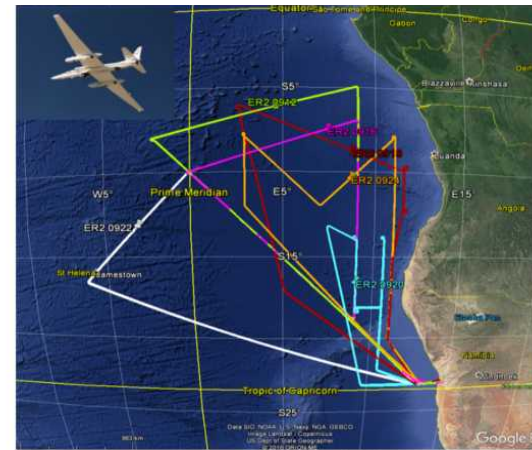


NASA Langley Research Center Airborne HSRL-2 Aerosol Measurements During Recent Field Missions

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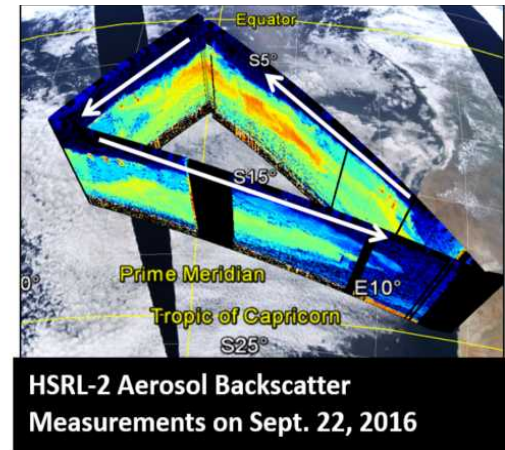
Airborne HSRL-2 Provides Valuable Aerosol Measurements during NASA ORACLES Mission



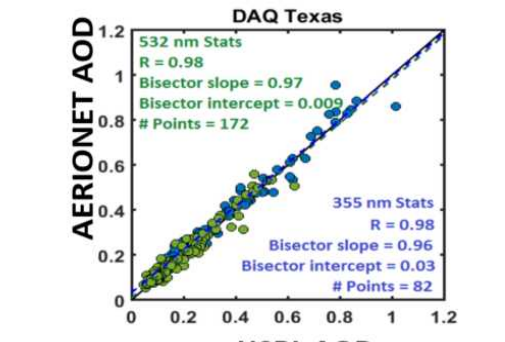
During the first ORACLES field campaign in September 2016, the ER-2 was deployed from Walvis Bay, Namibia and conducted flights over the southeastern Atlantic Ocean. This map shows the location of the HSRL-2 measurements along the ER-2 flight tracks.

HSRL-2 Data/Measurements/Retrievals:

- Aerosol backscatter, depolarization (355, 532, 1064 nm)
- Aerosol extinction and AOD profiles (355, 532 nm)
- Qualitative aerosol classification
- Mixed layer height
- Multiwavelength aerosol retrievals of particle properties (e.g. effective radius, concentration)

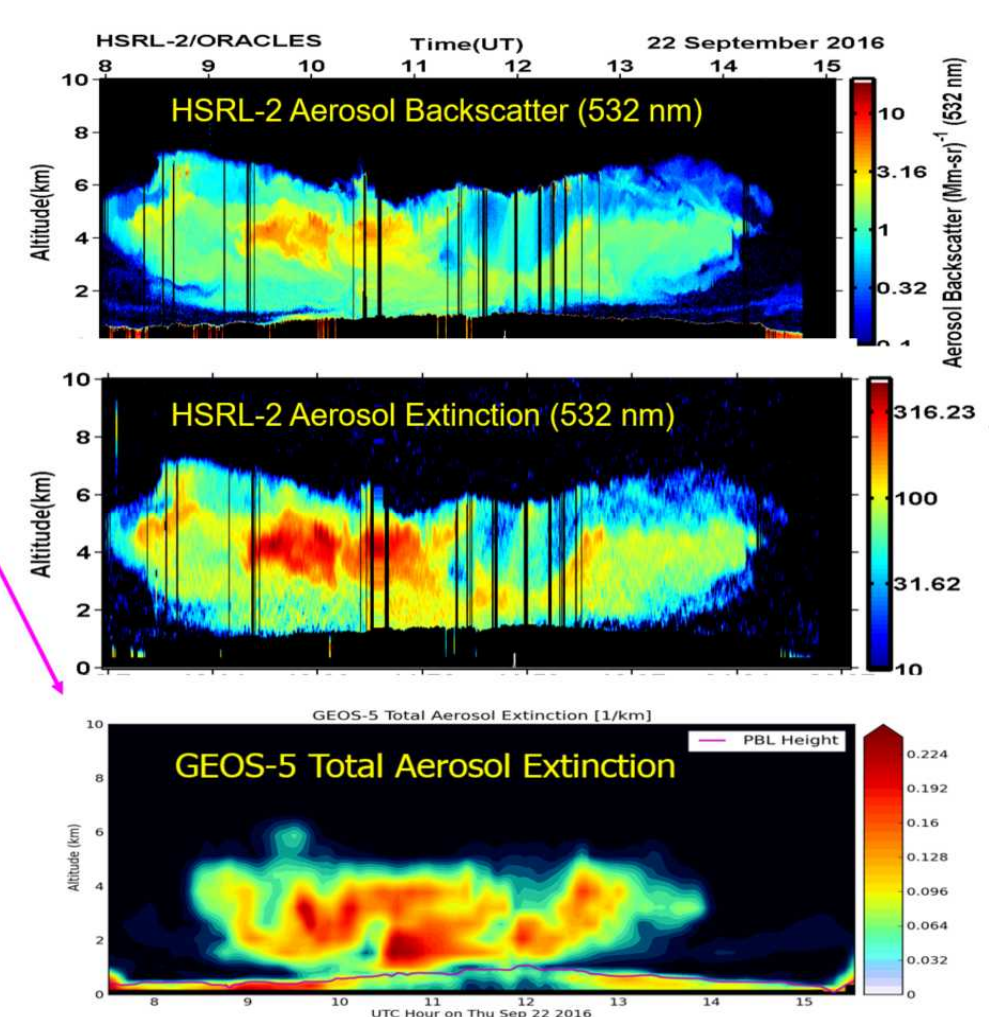
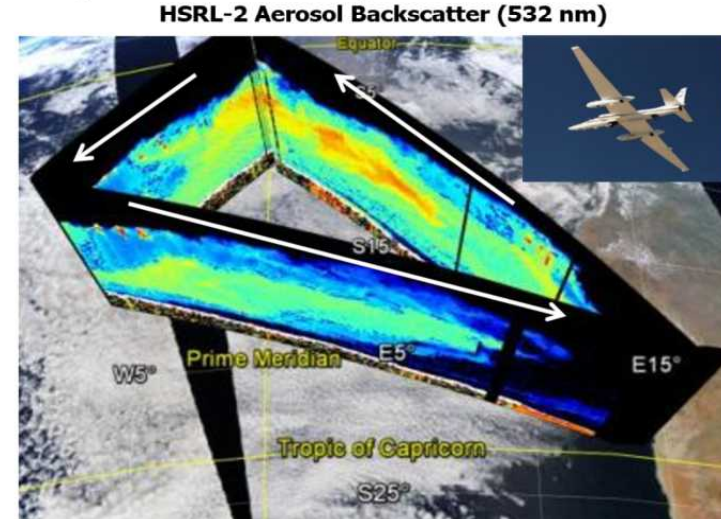


HSRL-2 aerosol backscatter profiles along the ER-2 flight track on Sept. 22, 2016.

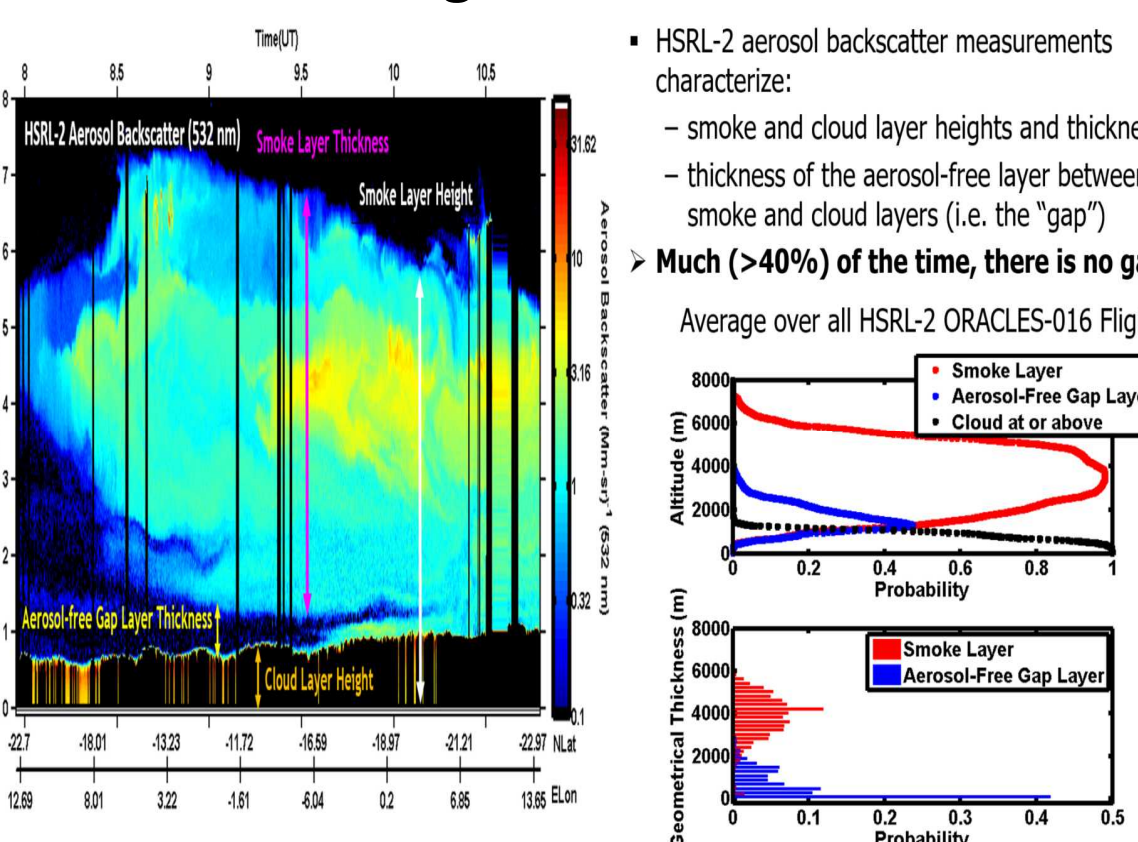


HSRL-2 measurements of aerosol optical depth (AOD) are in excellent agreement with those from AERONET (Sawamura et al., 2017)

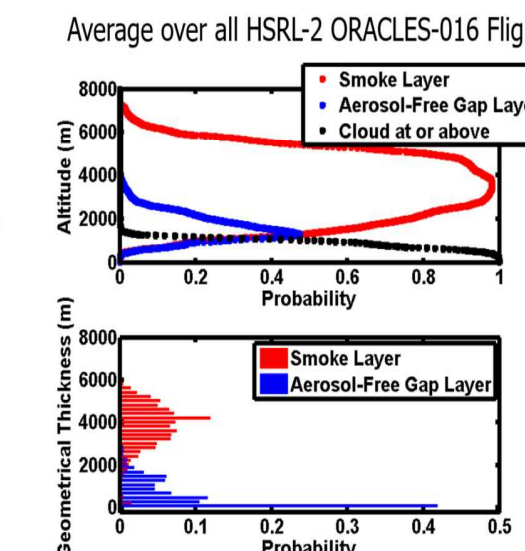
- ORACLES Earth Venture Suborbital mission
- Target: Extensive biomass smoke plume over persistent stratus cloud deck off the west coast of Africa
 - Smoke has significant radiative effect: localized absorption and impacts cloud microphysics
- During first ORACLES mission, GEOS-5 model smoke plume was systematically lower than HSRL-2 observations (da Silva - GSFC)



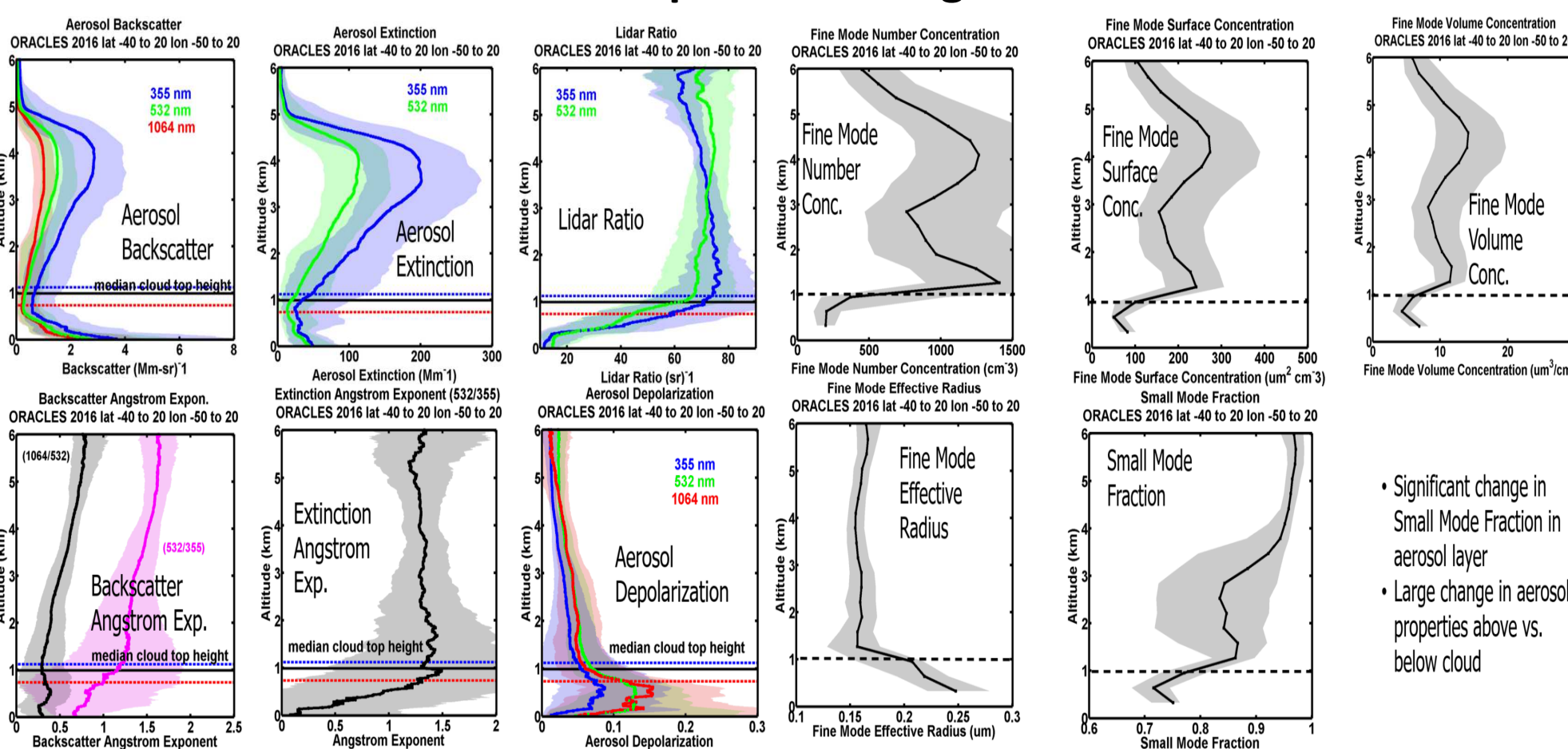
HSRL-2 characterizes smoke layer during ORACLES-2016



- HSRL-2 aerosol backscatter measurements characterize:
 - smoke and cloud layer heights and thicknesses
 - thickness of the aerosol-free layer between the smoke and cloud layers (i.e. the "gap")
- Much (>40%) of the time, there is no gap



Median Profiles of Aerosol Properties during ORACLES-2016 from HSRL-2



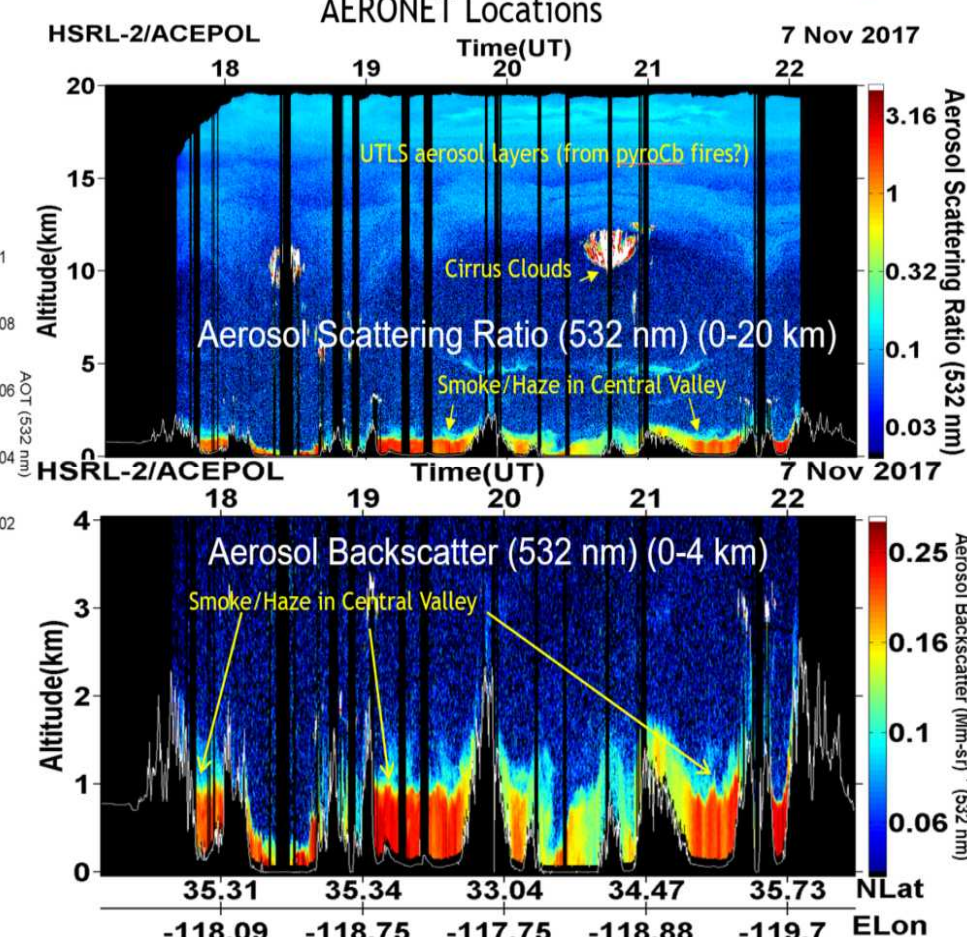
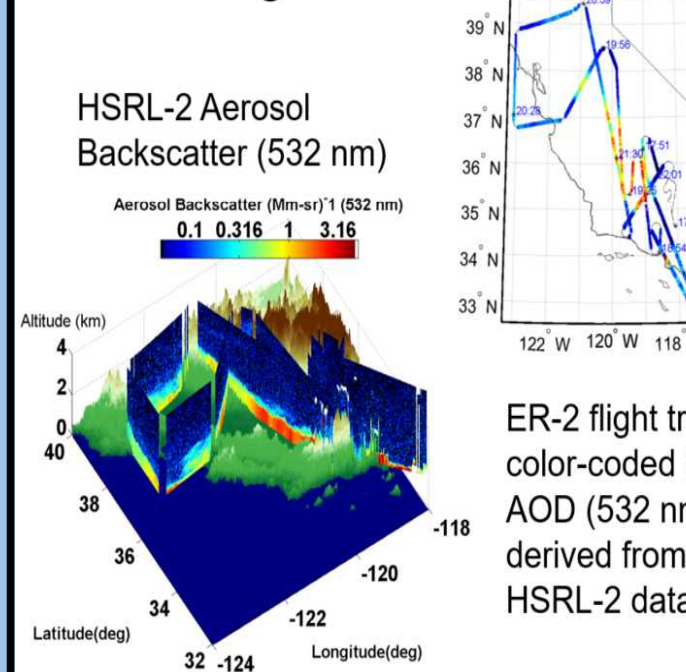
- Significant change in Small Mode Fraction in aerosol layer
- Large change in aerosol properties above vs. below cloud

Summary

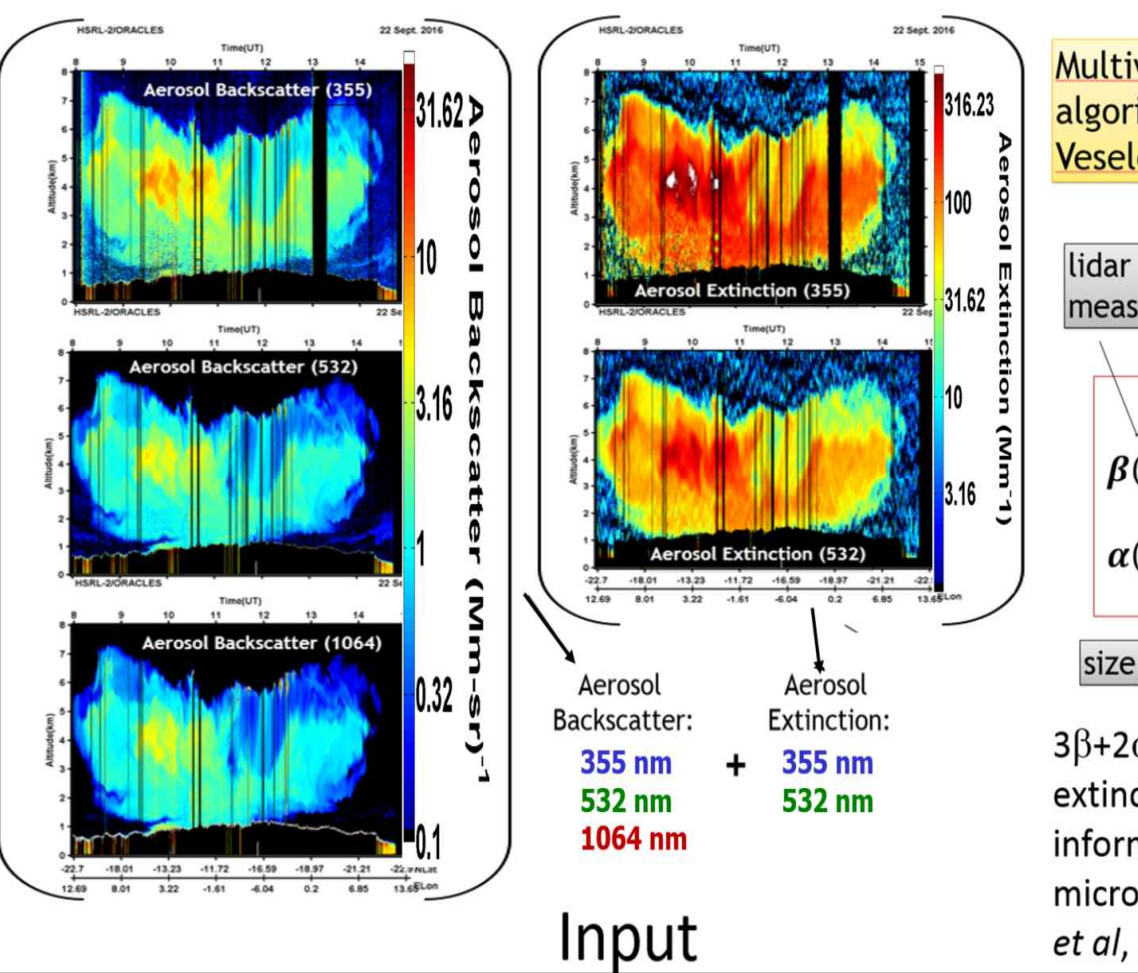
Aerosol measurements and retrievals derived from data acquired by the NASA Langley Research Center (LaRC) multiwavelength High Spectral Resolution Lidar-2 (HSRL-2) during recent field missions are discussed here. HSRL-2, which was developed as an airborne prototype of the multiwavelength HSRL planned for the NASA ACE mission, measures profiles of aerosol and thin cloud extinction and optical thickness via the HSRL technique at 355 and 532 nm, and backscatter and depolarization at 355, 532, and 1064 nm. Additional products include profiles of extinction and backscatter Ångström exponent, extinction-to-backscatter ("lidar") ratio, mixing ratio of spherical-to-nonspherical backscatter, aerosol type, and AOD partitioned by type, and aerosol mixed-layer height. Advanced, automated algorithms have been developed that use the HSRL-2 aerosol backscatter and extinction profiles to derive "curtains" of aerosol effective radius, number, surface, and volume concentrations, and fine mode fraction. Retrieved profiles of aerosol concentration and effective radius compare well with coincident airborne in situ measurements. HSRL-2 was first deployed in 2012 for the DOE TCAP mission and has subsequently been deployed on the: 1) NASA LaRC King Air for three NASA DISCOVER-AQ EV-S missions, 2) NASA ER-2 for the first ORACLES EV-S mission and the NASA ACEPOL mission, 3) NASA P-3 for the second ORACLES EV-S mission. Some of the applications of the HSRL-2 measurements and retrievals are discussed here.

NASA/LaRC HSRL-2 Observes Smoke/Haze in California Central Valley – Nov. 7, 2017 - ACEPOL

HSRL-2 deployed from ER-2 to develop & test combined lidar+polarimeter aerosol retrieval algorithms



Multiwavelength HSRL-2 retrievals characterize aerosol concentration and size during ORACLES

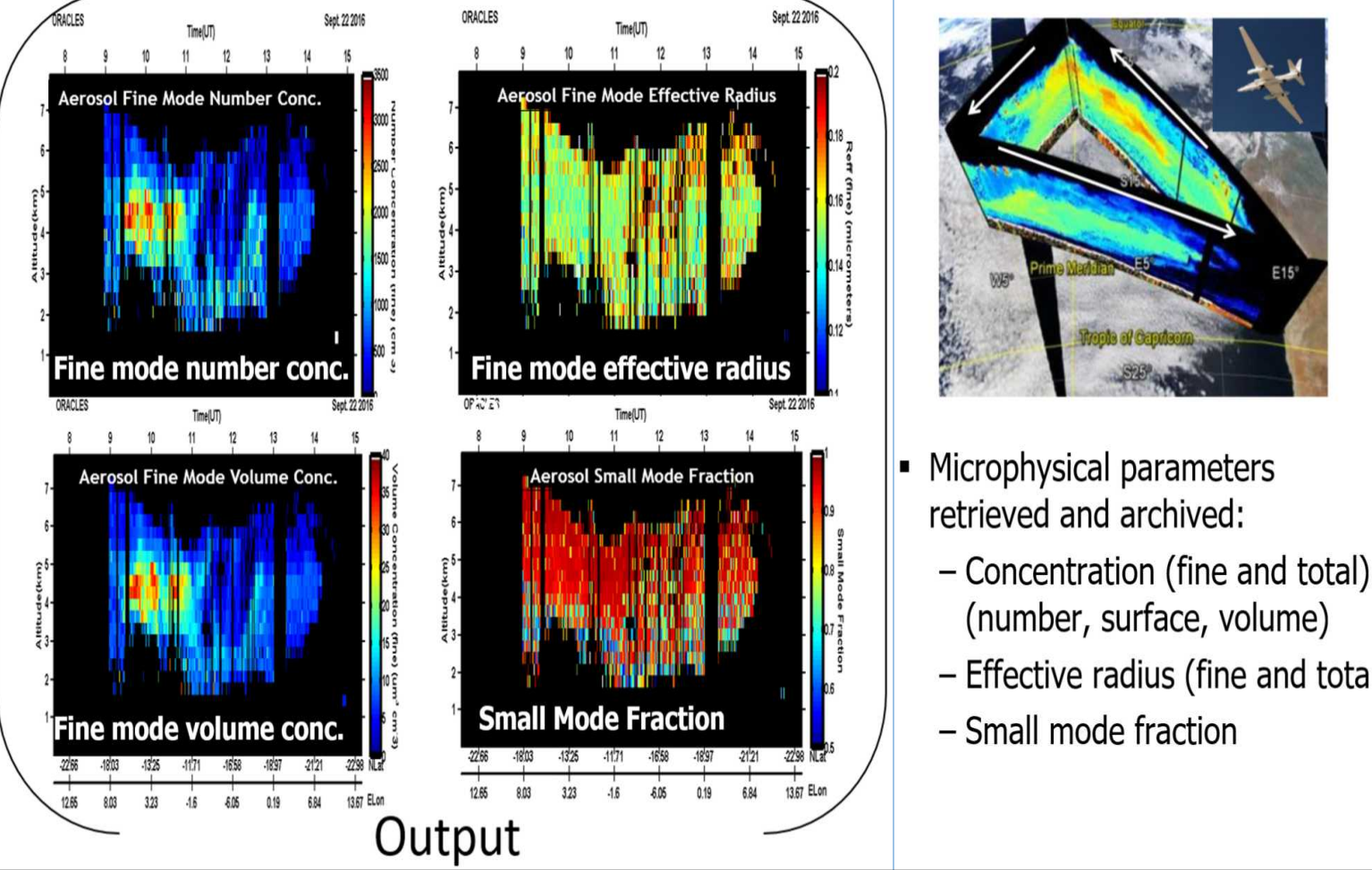


Multiwavelength lidar retrieval algorithms (Müller et al. 1999; Veselovskii et al. 2002; etc)

$$\beta(\lambda) = \int K_{\beta}(r, m, \lambda) v(r) dr$$
$$\alpha(\lambda) = \int K_{\alpha}(r, m, \lambda) v(r) dr$$

size, refractive index, wavelength

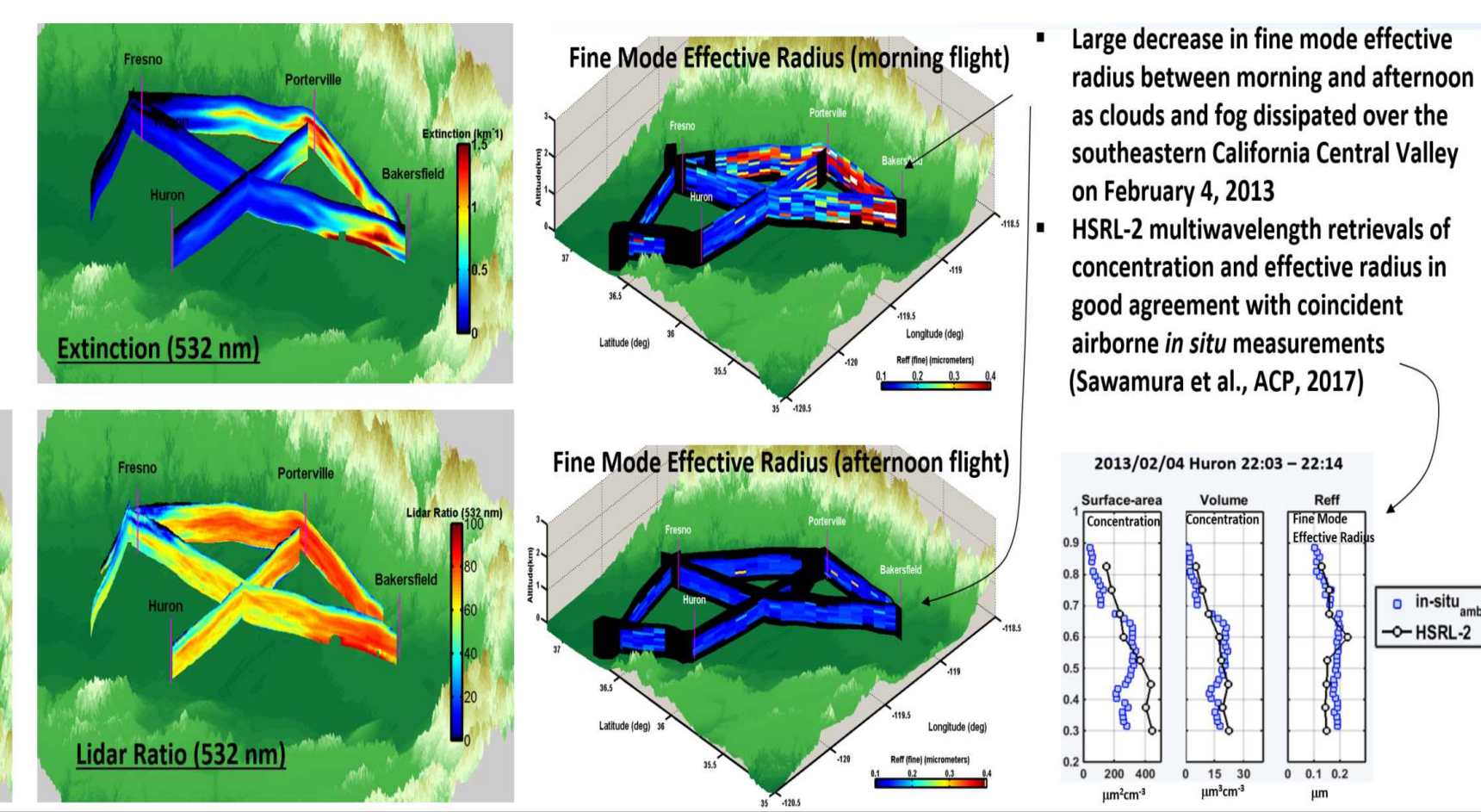
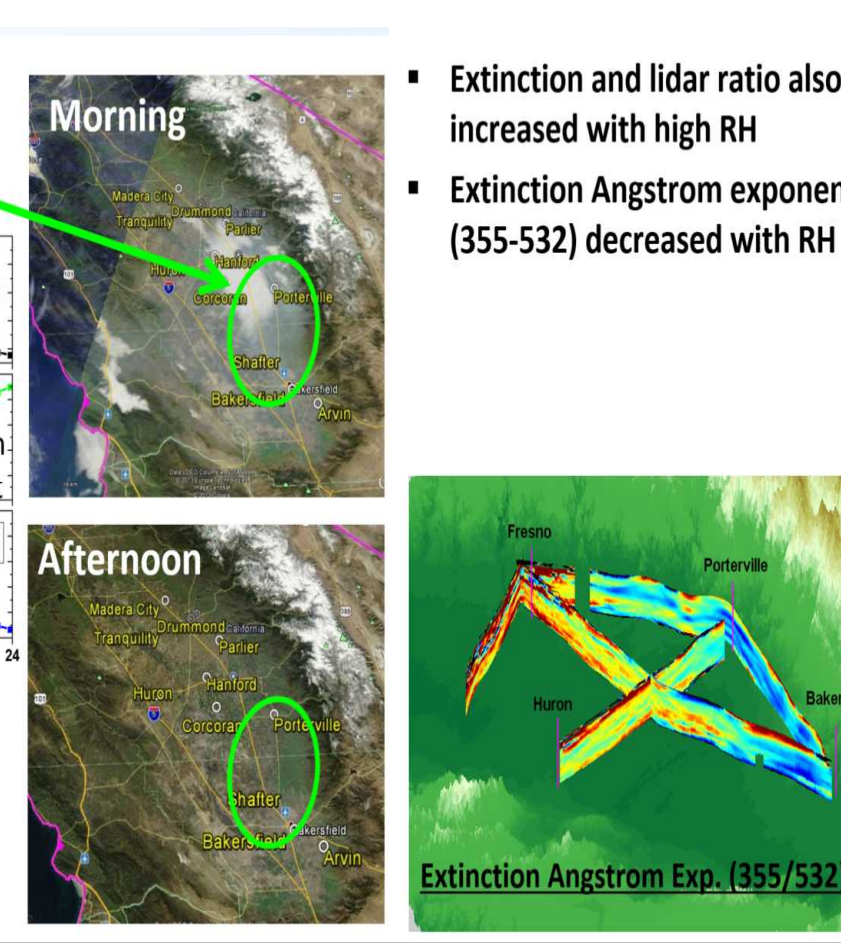
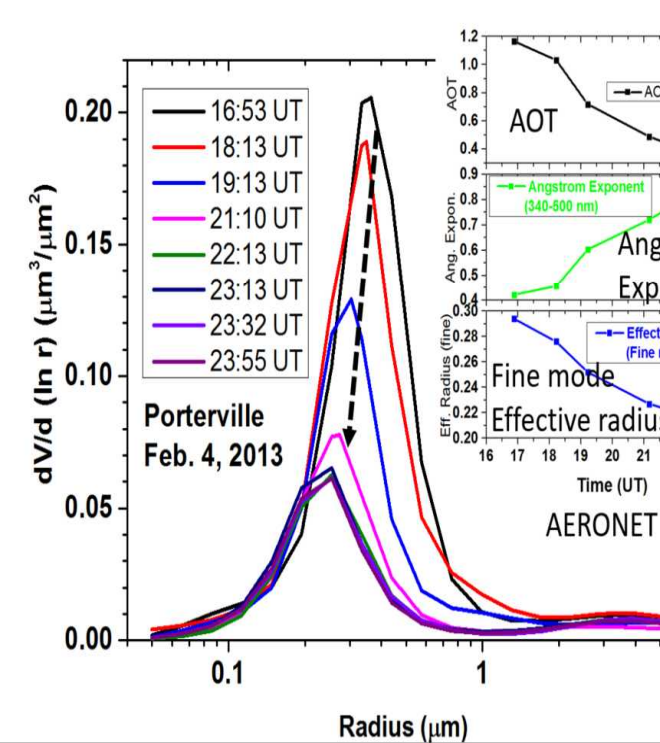
3β+2α (i.e. 3 backscatter + 2 extinction) considered the minimum information content necessary for microphysical retrievals (Bockmann et al., 2005)



- Microphysical parameters retrieved and archived:
 - Concentration (fine and total) (number, surface, volume)
 - Effective radius (fine and total)
 - Small mode fraction

HSRL-2 Measurements show changes in particle size and optical properties due to variability in RH (DISCOVER-AQ – California)

- Large decrease in AOT and fine mode size over the southern portion of DRAGON AERONET on Feb. 4
- This decrease occurred as fog processed and/or humidified aerosols transitioned to dried aerosol



- Large decrease in fine mode effective radius between morning and afternoon as clouds and fog dissipated over the southeastern California Central Valley on February 4, 2013
- HSRL-2 multiwavelength retrievals of concentration and effective radius in good agreement with coincident airborne in situ measurements (Sawamura et al., ACP, 2017)