

Variability of Aerosol Properties and Mixing-layer Heights from Airborne High Spectral Resolution Lidar, Ground-based Measurements, and the WRF-Chem Model During CARES



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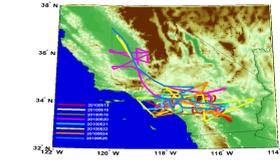


Background

The NASA airborne High Spectral Resolution Lidar (HSRL) was deployed on board the NASA Langley Research Center's B200 aircraft to California in May and June of 2010 to aid in characterizing aerosol properties during the CalNex (Research at the Nexus of Air Quality and Climate Change) and CARES (Carbonaceous Aerosols and Radiative Effects Study) field missions. Measurements of aerosol extinction (at 532 nm), backscatter (at 532 and 1064 nm), and depolarization (at 532 and 1064 nm) during over 30 flights across more than 100 hours, many in coordination with other participating research aircraft, satellites, and ground sites, constitute a diverse data set for use in characterizing the spatial and temporal distribution of aerosols, as well as properties and variability of the Mixing Layer (ML). This work examines the temporal and spatial variability of the ML and aerosol properties within and nearby the Sacramento region. ML heights derived from HSRL measurements are compared with those produced by radiosondes and the Weather Research and Forecasting (WRF) model. Backscatter and extinction comparisons are made between the WRF-Chem model and HSRL measurements. Differences between the model and measurements are explored.

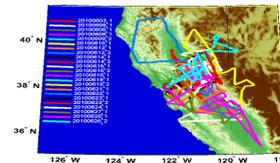
CalNex Deployment May 2010

- Ontario, California
- May 13-25
- 8 science flights (28.5 hours)
 - 6 with CIRPAS Twin Otter
 - 2 with NOAA P-3
- 6 with MODIS and/or MISR satellite overpasses



CARES Deployment June 2010

- Sacramento, California
- June 3 -28
- 23 science flights (72.3 hours)
 - 19 with DOE G1
 - 1 with NOAA R/V Atlantis
 - 2 with NOAA P3
 - 6 with NOAA Twin Otter
- 11 with MODIS and/or MISR satellite overpasses



Summary

NASA HSRL data products being used for:

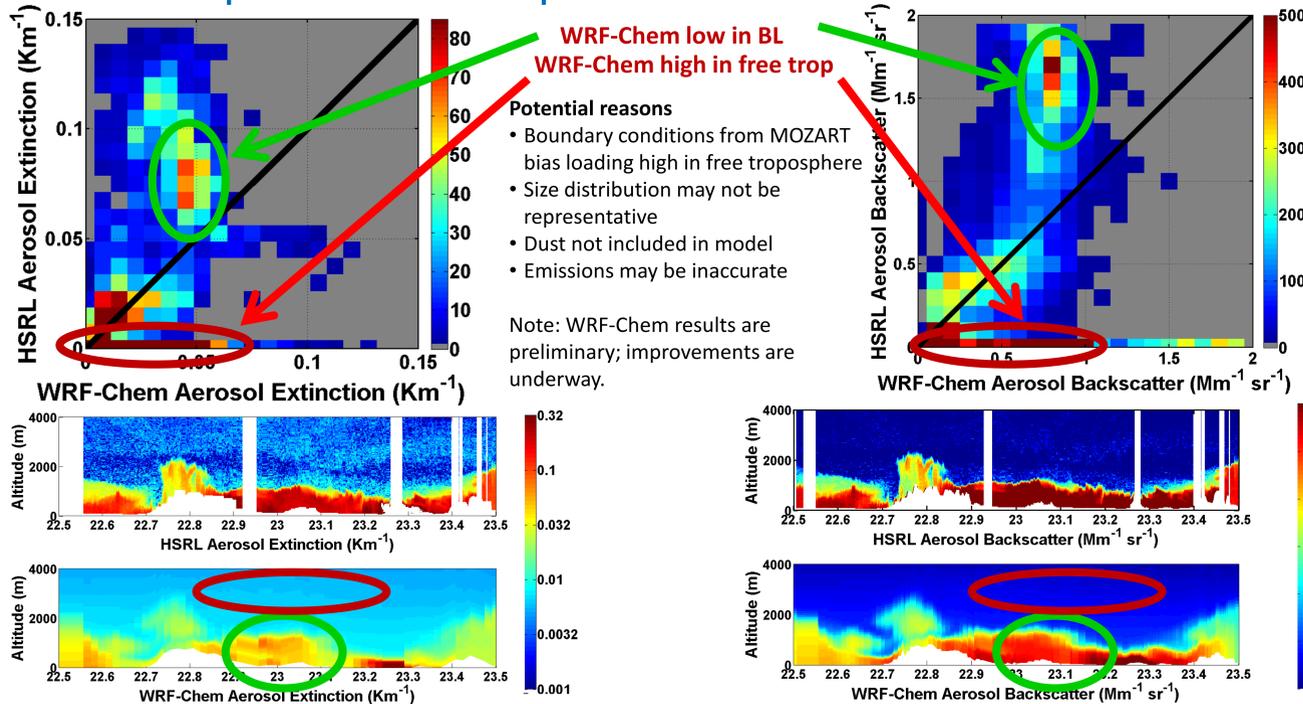
- model comparisons
- vertical context of in situ measurements
- aerosol typing
- partitioning of AOD above/below mixed layer

Comparisons with WRF-Chem ML heights, backscatter, and extinction currently underway

HSRL mixed layer heights are also available for CHAPS, RACORO, CalNex, and CARES

HSRL will deploy on summer portion of TCAP campaign

Comparison of Aerosol Properties from the WRF-Chem model and HSRL



Mixing Layer Height Methodology

HSRL Backscatter

- ML heights derived from cloud-screened HSRL aerosol backscatter profile and automated technique using Haar wavelet covariance transform with multiple wavelet dilations to identify sharp gradients in aerosol backscatter at top of the ML (Brooks, JAOT, 2003), modified to handle complex situations with elevated aerosol layers

Radiosonde Potential Temperature

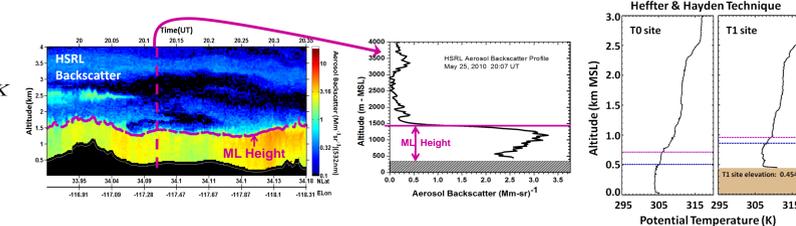
- ML heights derived from radiosondes launched at the T0 and T1 sites during CARES
- Automated technique uses a modified Heffter method to determine the inversion in the potential temperature profile (Heffter, 1980; Hayden, 1997)

Lapse Rate: $\frac{\Delta\theta}{\Delta z} \geq 0.002 \text{ } ^\circ\text{K/m}$

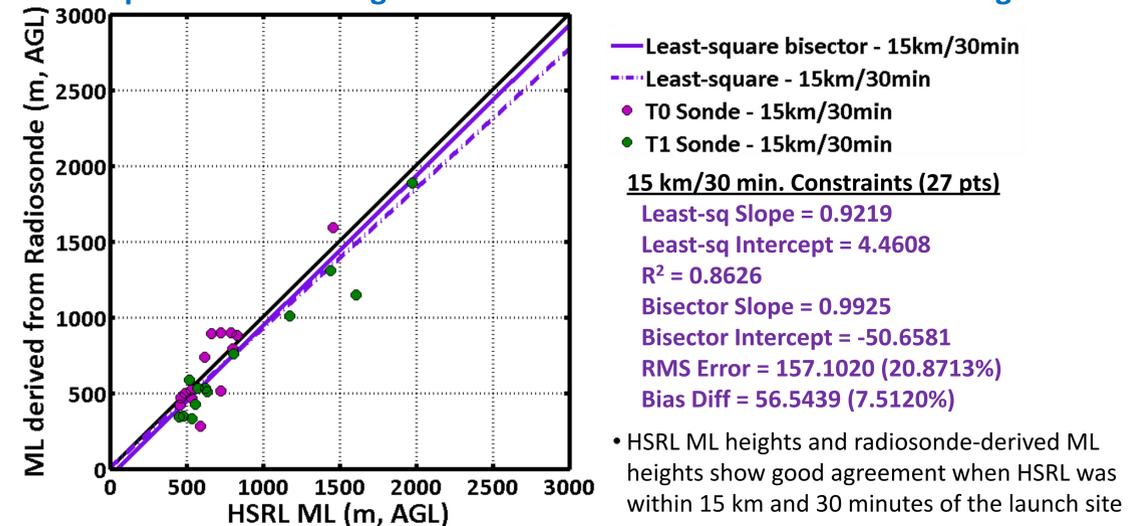
Inversion Strength: $\theta_{top} - \theta_{base} \geq 1^\circ\text{K}$

WRF-Chem

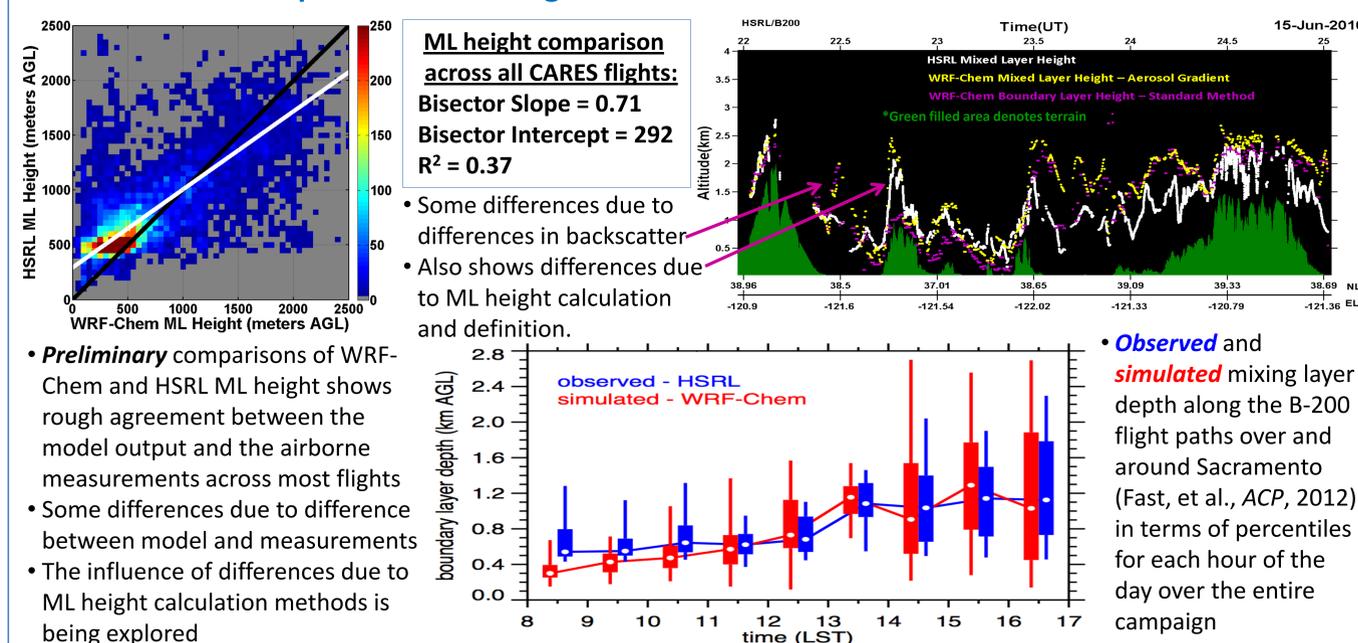
- ML heights estimated by potential temperature and relative humidity gradients



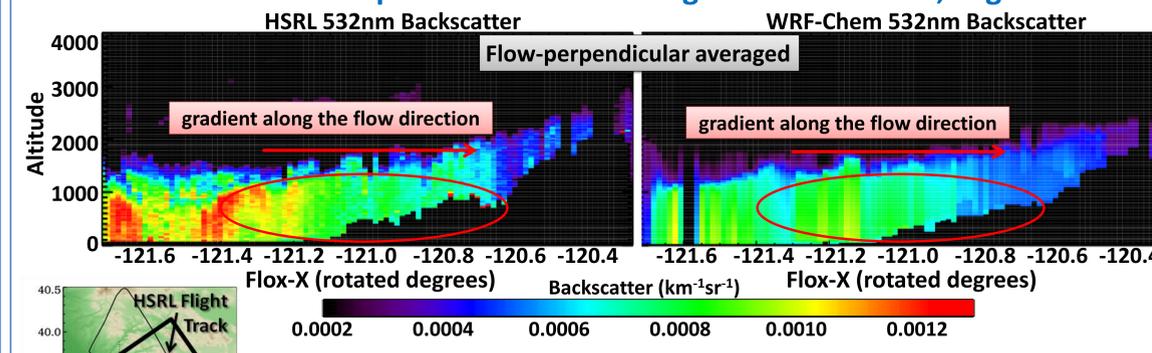
Comparison of ML heights from PNNL radiosondes and HSRL during CARES



Comparison of ML heights from the WRF-Chem model and HSRL



Distribution and Transport of aerosols during CARES – June 19, Flight 2 Case



Acknowledgements

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