Aerosol feature identification and analysis using ARM HSRL measurements

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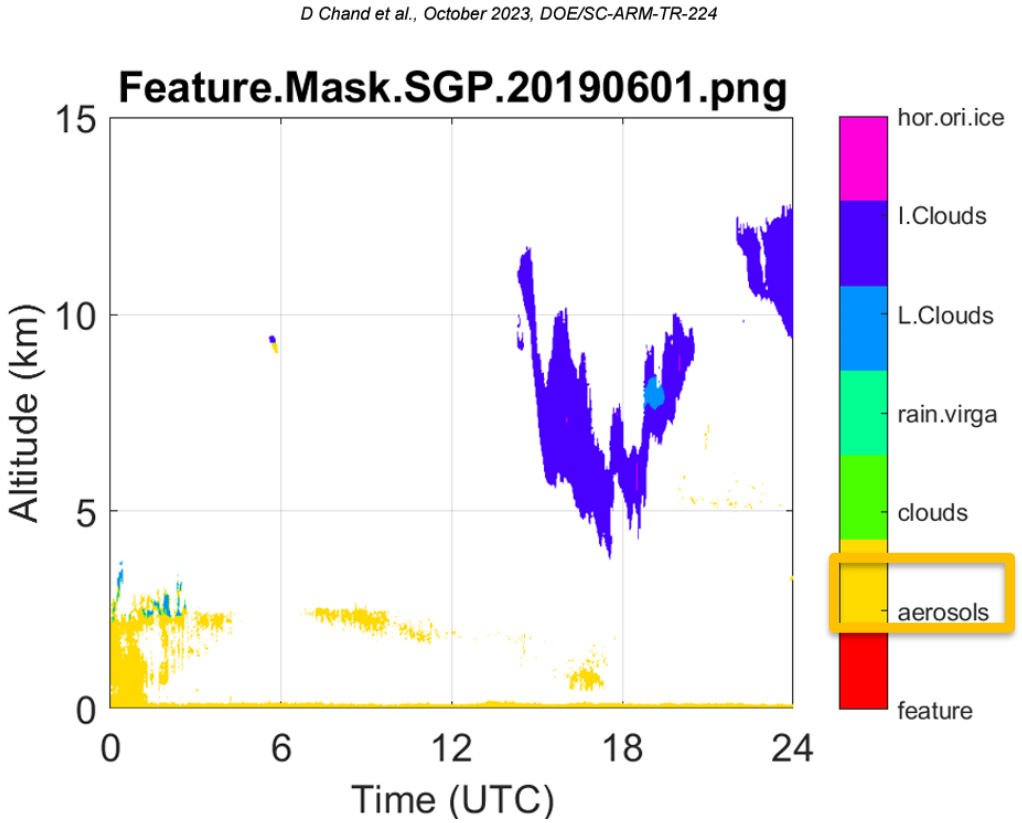
Background

- To better understand the vertical and temporal distributions of aerosols, we are developing an aerosol feature identification Value-added Product (VAP) using ARM high spectral resolution lidar (HSRL) measurements
- Raman lidar Feature Detection and Extinction (RL-FEX) VAP provides similar aerosol features, but HSRL measurements have better signal-to-noise ratio
- A planned activity is to retrieve aerosol microphysics from the combined HSRL and RL measurements



An example of the RL-FEX VAP

Aerosol feature detection method

- Follow the method of RL-FEX data product (Thorsen et al. 2015), we detect aerosol features when the calculated scattering ratio (SR) is greater than the SR threshold (τ).

- Signal-to-noise ratio (SNR) greater than 3 are treated as good data.

$$SR(z) = \frac{\beta_m(z)+\beta_p(z)}{\beta_m(z)}$$

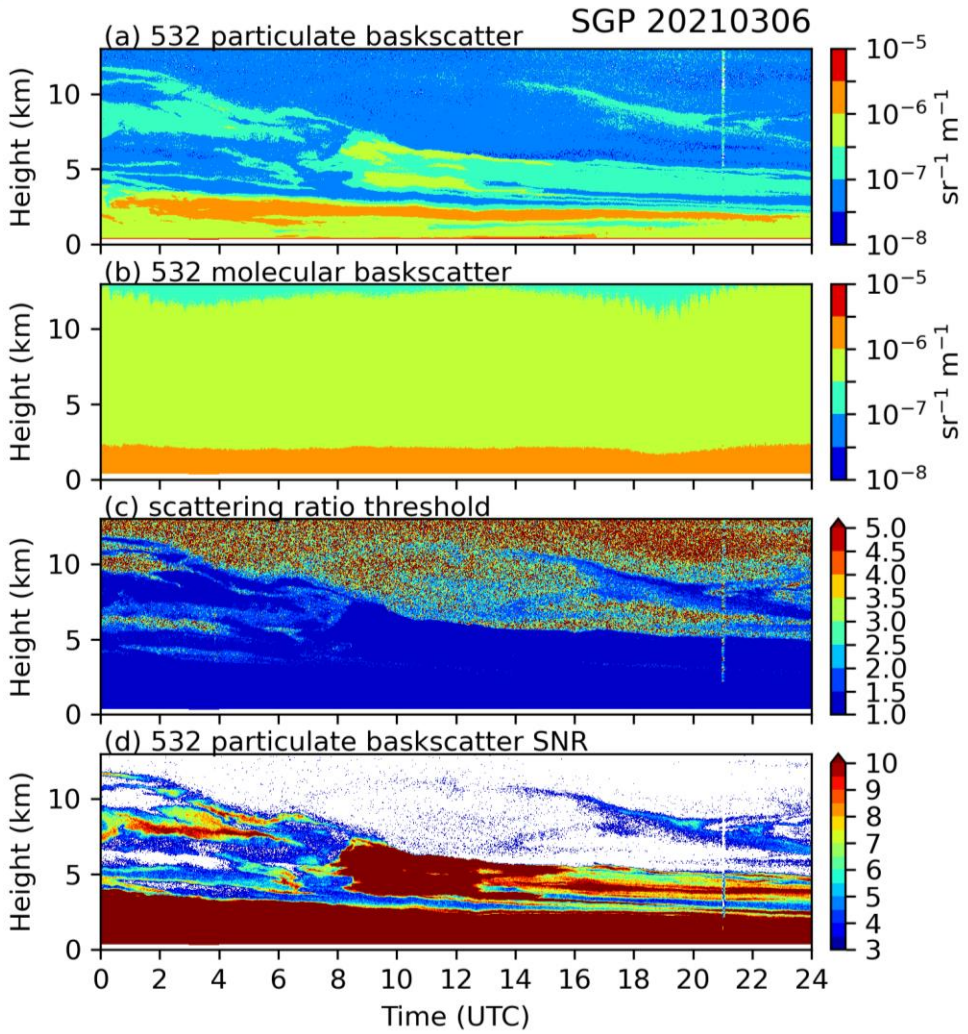
$$\tau(z) = 1 + \frac{(\beta_p(z) + \beta_m(z))/\mathrm{SNR(z)}}{\beta_m(z)}$$

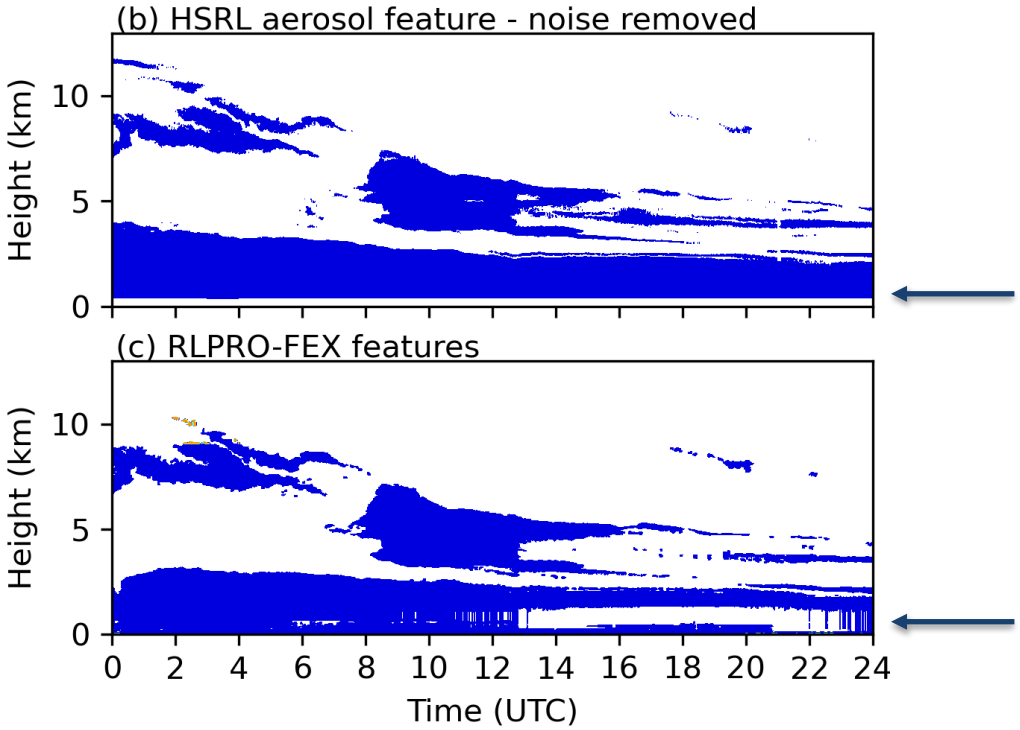
If no aerosol, SR=1 theoretically
If measurements are perfect, SR>1 means there is aerosol
In practice, measurements have noise

✓ Aerosols are detected if $SR(z) > \tau(z)$

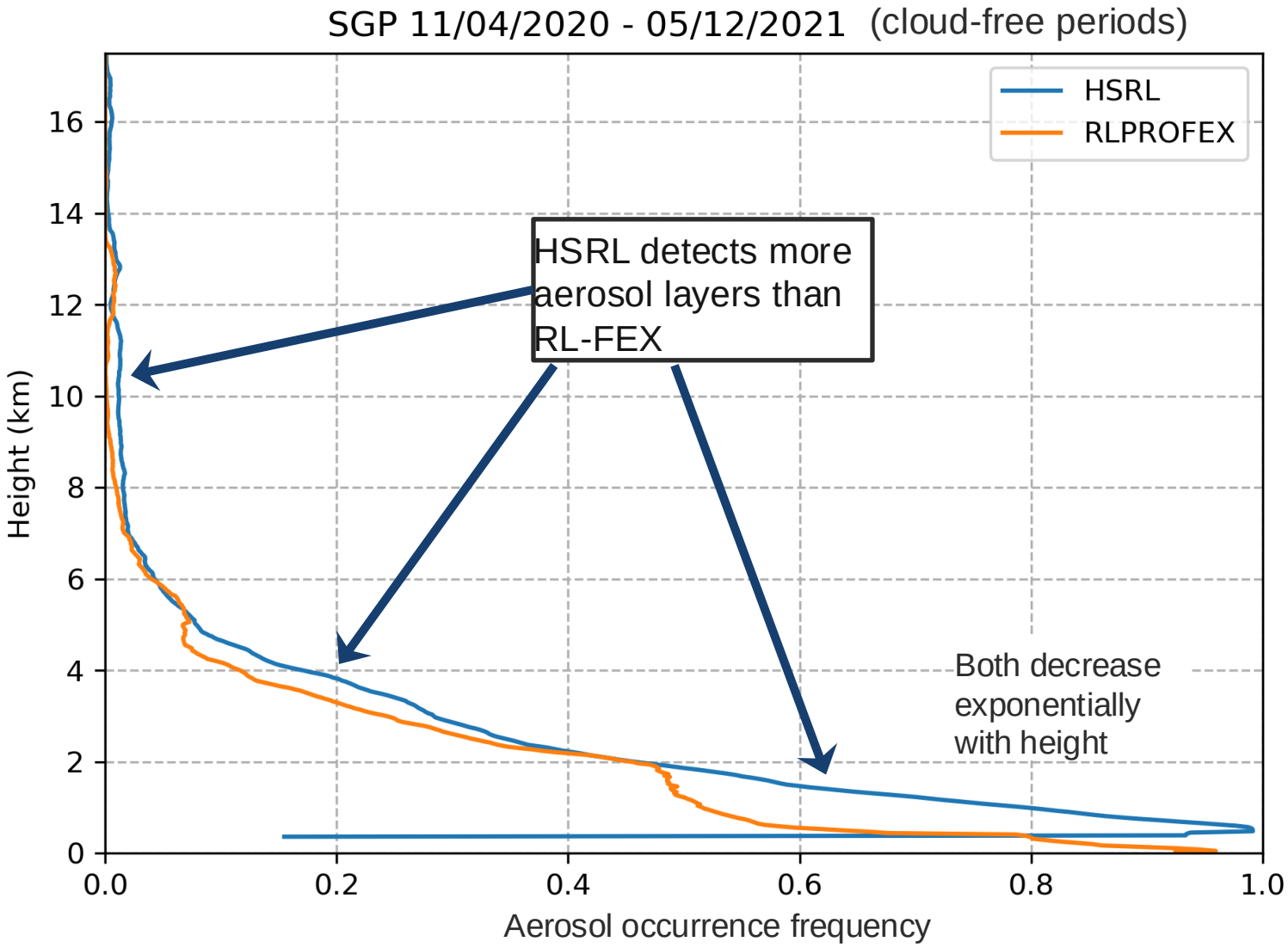
β_p: particulate backscatter
β_m: molecular backscatter

Case demonstration



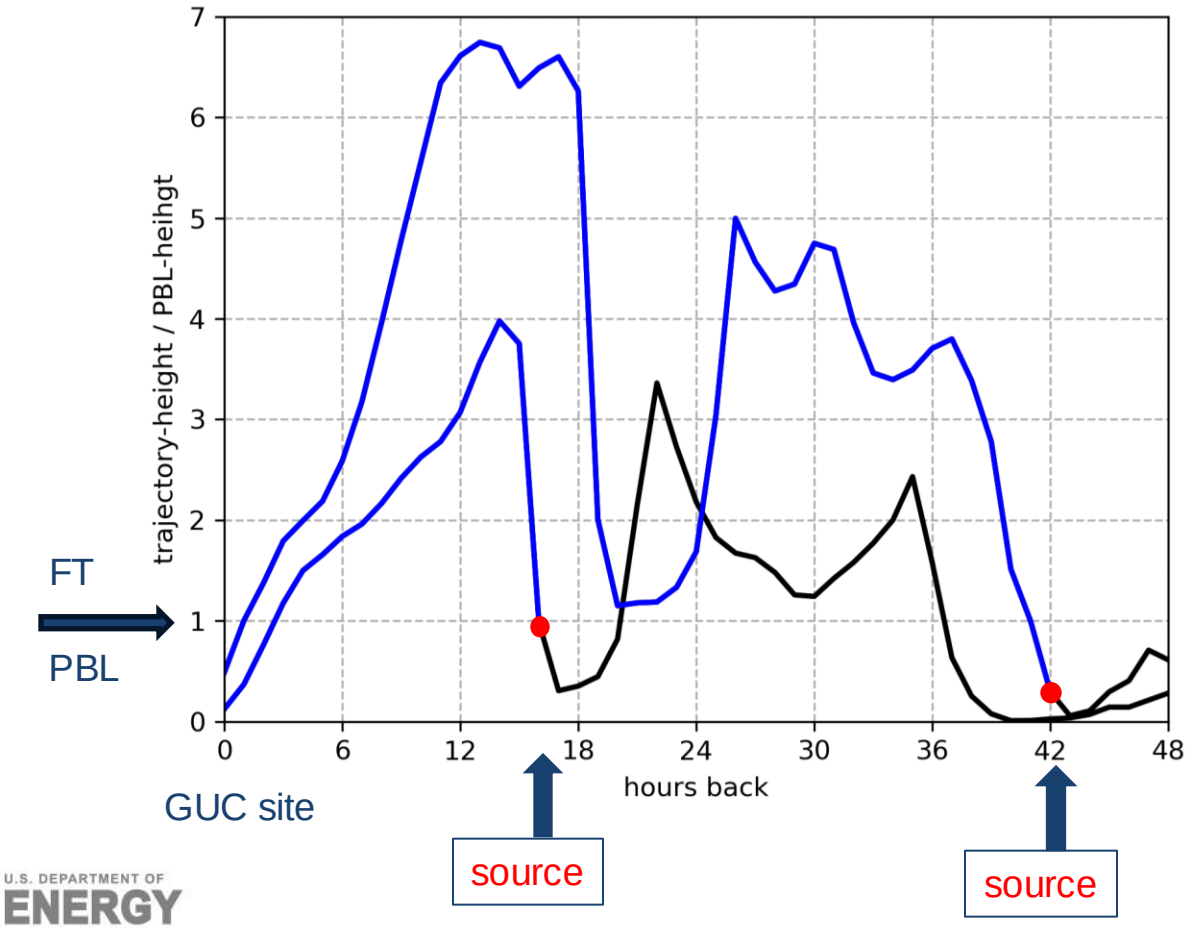


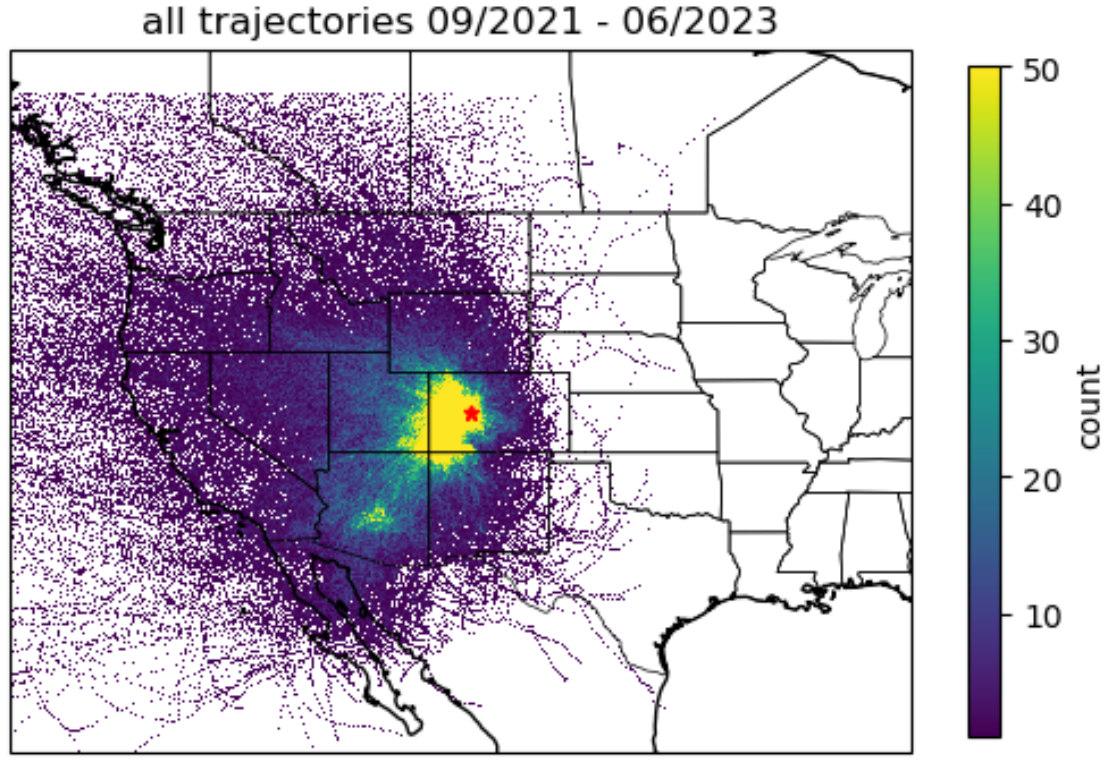
Comparison with RL-FEX



Identify air mass sources (GUC)

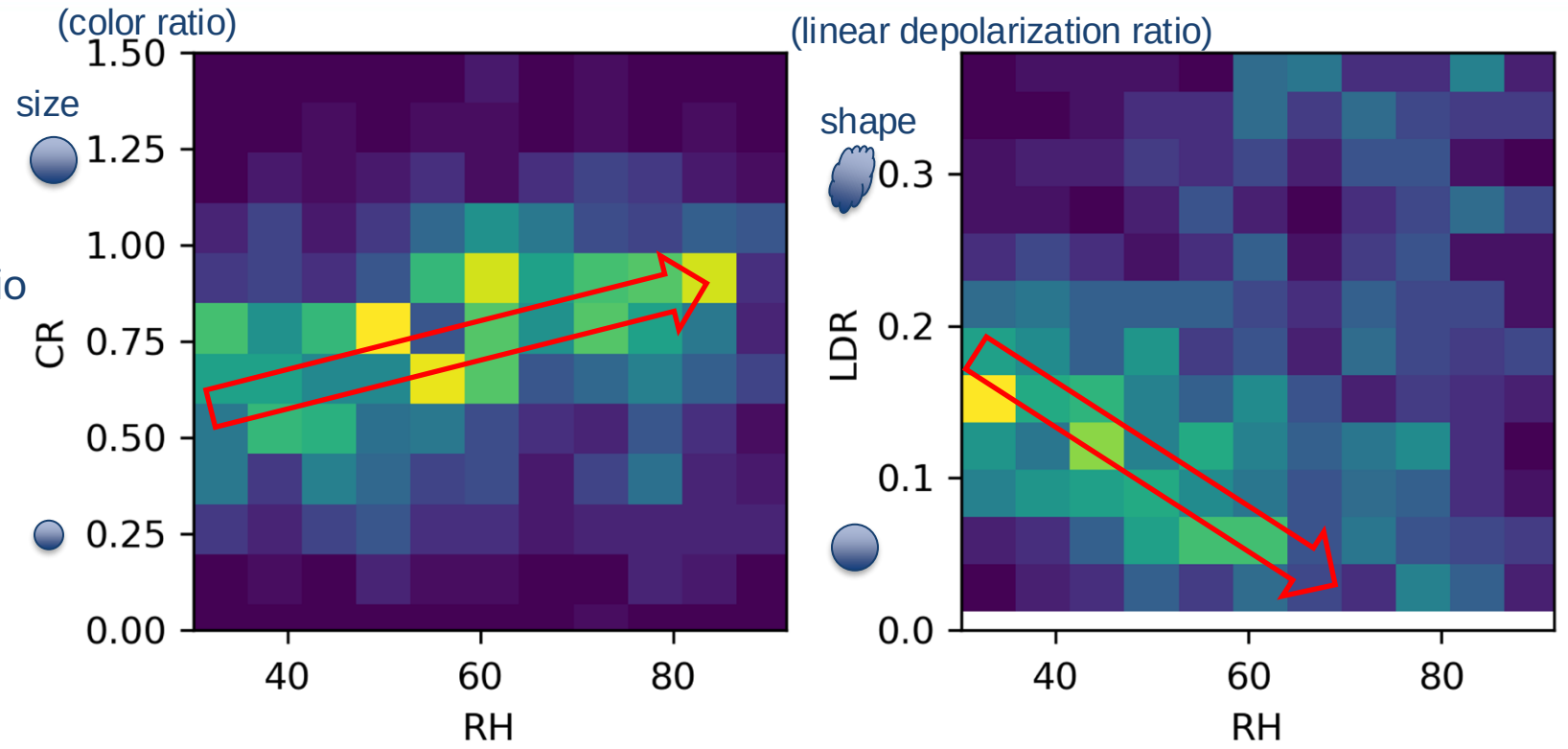
- ARMTRAJ (from Israel Silber): a multi-purpose trajectory dataset augmenting ARM observations





For each aerosol layer, a 48-hour back trajectory is calculated

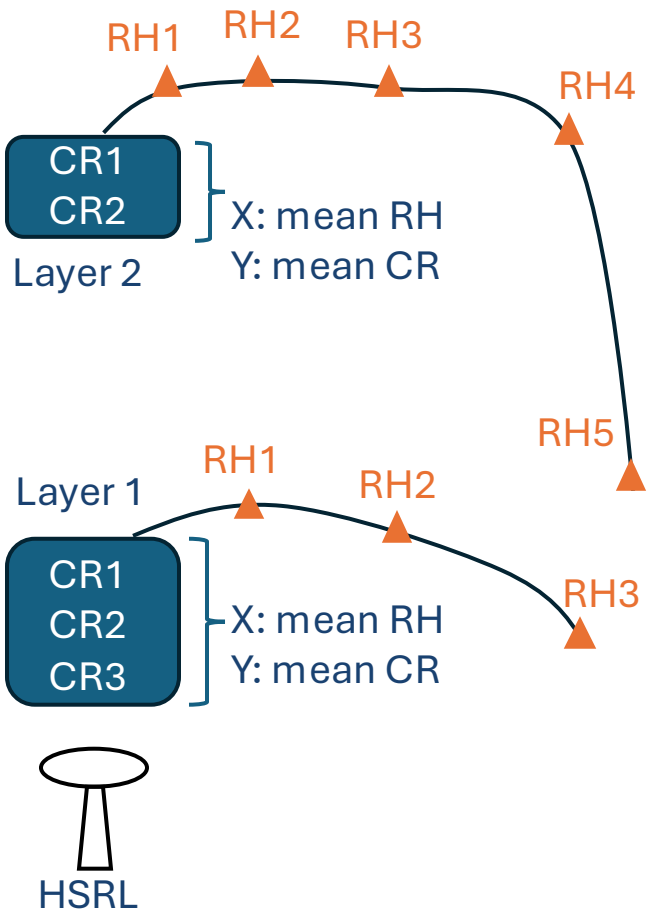
Air mass history vs HSRL measurements (GUC)



y: mean color ratio for each aerosol layer

x: mean RH along the trajectory since the source

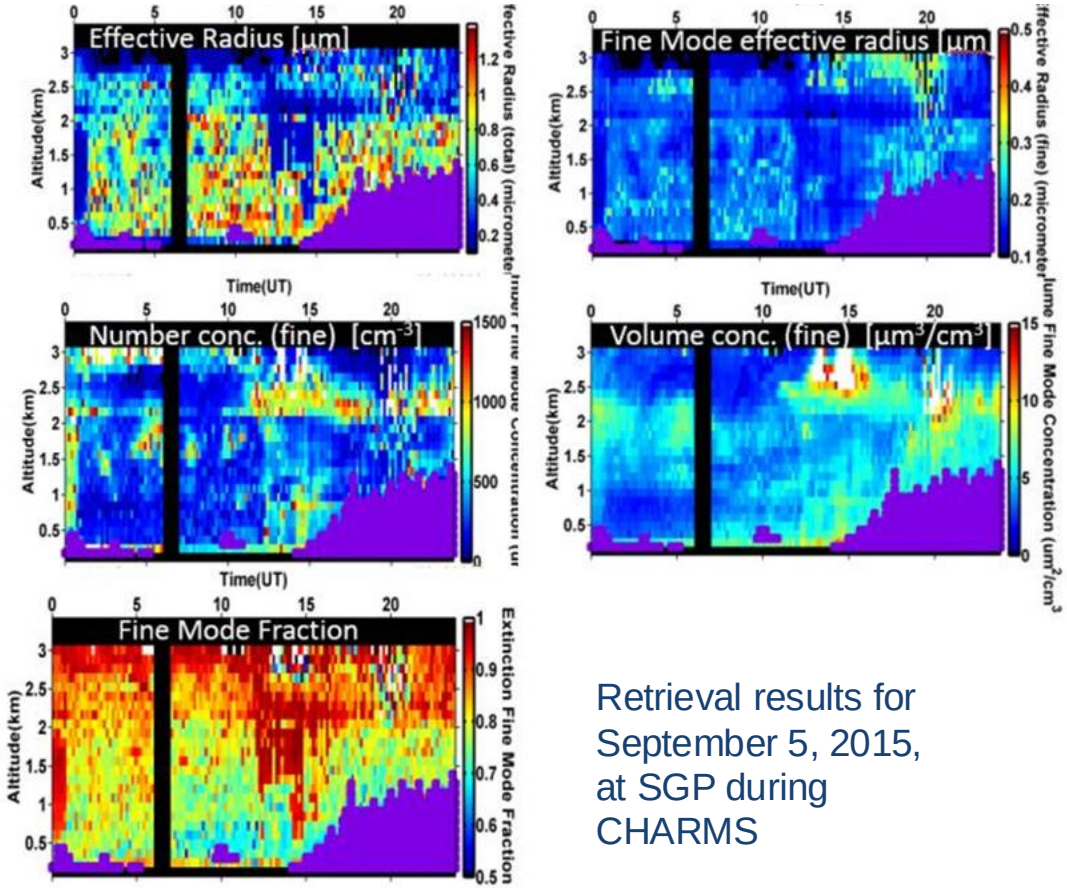
Two samples in the figure:



✓ **As the air mass becomes moister, the GUC site is more likely to observe larger, more spherical aerosol particles**

Planned work – aerosol microphysics profiles

- Aerosol properties near the surface, such as aerosol number concentration and size can be significantly different from those aloft. This is especially true when there are new particle formation events
- We are working with Rich Ferrare and team at NASA LaRC on the retrieval algorithm
- Required inputs are in β_{355}, β_{532}, β_{1064}, α_{355}, and α_{532} profiles from RL and HSRL ("$3\beta + 2\alpha$" method)
- Test the code at the SGP site and plan to apply to BNF



Retrieval results for September 5, 2015, at SGP during CHARMS

Ferrare et al. (2017)

Thank you!

Questions and comments are welcome:

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