Retrievals of aerosol humidification factors by lidar during CHARMS

(Combined HSRL and Raman Measurement Study)

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How can lidar \( f(\text{RH}) \) help us to better understand climate?

- Produce a data record of \( f(\text{RH}) \) at or near cloud base

- Model improved by more accurate hygroscopicity parameterizations

- Reduced uncertainty on indirect effect
Raman water vapor channel adds essential meteorological information

Mixed Layer Height

Opportunity for Raman lidar improvement! Temperature retrievals

***AERI
Time series of lidar-retrieved humidification factors could dramatically increase spatiotemporal coverage.
Combining with Raman and HSRL extinction gives desirable humidification factor retrieval.

(a. 355 nm extinction)

\[ \kappa_{\text{ext}} = 0.17 \]
\[ \gamma = 0.51 \]

(b. 532 nm extinction)

\[ \kappa_{\text{ext}} = 0.15 \]
\[ \gamma = 0.48 \]
How do lidar results compare to the ground?

![Graph showing the relationship between Humidification Factor and Relative Humidity. The graph indicates a significant increase in Humidification Factor as Relative Humidity increases, with a notable peak at around 90%.]
How do lidar results compare to the ground?
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Model Approach:
ACSM Chemistry

AERONET column PSD

Estimated $f(\text{RH})$

Nephelometer
Model
Lidar

Humidification Factor ($\theta$)

Relative Humidity (%)
Time series of fit parameters makes sense with cloud humidity halo observations (Rauber et al., 2013)
Take Home Messages

1. Lidar can retrieve aerosol humidification factors $f(RH)$

2. These $f(RH)$ are retrieved near cloud base or at the top of the mixed layer where it is important for aerosol-cloud interactions.
   *** note $3\beta + 2\alpha \rightarrow$ volume concentrations $\rightarrow$ kappa as in Petters and Kreidenweis, 2007 ***

3. Lidar $f(RH)$ aloft $\gg f(RH)$ from surface nephelometer measurements (i.e. surface PSDs and surface chemistry; reiterating take home message #1). Don’t forget about cloud proximity and ACI!

4. Surface chemical composition combined with ambient column PSD retrievals compares better to lidar retrievals (reiterating take home message #1 and #2)

5. CHARMS 2.0???
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Questions?

For more, see poster:

| Dawson | Kyle | Lidar-Retrieved Aerosol Humidification Factors at SGP Derived from CHARMS | Results from recent ARM field campaigns | B1 | Wed 3:30 - 5:00 pm |