Langley Aerosol Research Group (LARGE)
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In-situ Aerosol Measurements for ACTIVATE
Data Workshop / STM-2022
<table>
<thead>
<tr>
<th>Observable</th>
<th>Technique</th>
<th>Wavelength</th>
<th>Instrument-Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Scattering Coefficient</td>
<td>Nephelometry</td>
<td>450, 550, 700nm</td>
<td>Nephelometer – TSI 3563</td>
</tr>
<tr>
<td>( f_{(RH)}^{80-20} ) hygroscopicity</td>
<td>Nephelometry (with custom Naﬁon Humidiﬁer at 85% RH)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Absorption Coefficient</td>
<td>Filter Transmission</td>
<td>467, 532, 660nm</td>
<td>PSAP – Radiance Research</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>Total Number</td>
<td>Condensation Particle Counters</td>
<td>( D_p &gt; 3 \text{ nm} )</td>
<td>CPC - TSI 3776</td>
</tr>
<tr>
<td>Ultraﬁne Number (by difference)</td>
<td>CPC - TSI 3772</td>
<td>( D_p &gt; 10 \text{ nm} )</td>
<td></td>
</tr>
<tr>
<td>Non-volatile Number</td>
<td>CPC - TSI 3772 (with 350°C thermodenuder)</td>
<td>( D_p &gt; 10 \text{ nm} )</td>
<td></td>
</tr>
<tr>
<td>Cloud Condensation Nuclei</td>
<td>CCN (and spectra)</td>
<td>( D_p &lt; 1000 \text{ nm} )</td>
<td>CCN Spectrometer – DMT (w/ scanning ﬂow)</td>
</tr>
<tr>
<td>Dry Size Distribution</td>
<td>Optical</td>
<td>( D_p : 100-5000 \text{ nm} )</td>
<td>LAS – TSI 3340</td>
</tr>
<tr>
<td></td>
<td>Mobility</td>
<td>( D_p : 3-100 \text{ nm} )</td>
<td>nano-SMPS – TSI/Custom (LARGE)</td>
</tr>
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<tr>
<td>Non-refractory Mass (SO\text{4}, NO\text{3}, NH\text{4}, Chl, Org, m/z)</td>
<td>Mass Spectrometer</td>
<td>( D_p : 60 - 600 \text{ nm} )</td>
<td>HR-ToF-AMS - Aerodyne</td>
</tr>
<tr>
<td>Common Ions WSO\text{C} mass</td>
<td>PILS w/IC and TOC</td>
<td>( D_p &lt; 5000 \text{ nm} )</td>
<td>PILS – BMI</td>
</tr>
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2022 LARGE-classic data are FINAL (R0) except:
- Ambient data using DLH RH will be submitted before Jan-6
- All data will get a very minor (~4 seconds) time shift synch to DLH before Jan-6
- stdTP factor will be updated with final THORNHILL data before Jan-6

2022 LARGE-AMS (and CVI) is processed, final QA will be final (R0) before Jan-6
2022 LARGE-PILS data is final (R0) for WINTER, final for SUMMER before Jan-6
2022 LARGE-CloudWater will be final (R0) before Jan-6

2021 LARGE-classic data are FINAL, although:
- AMBIENT optical and DLH time-synch will be applied before Jan-6
- LAS and SMPS data will be updated to be consistent with 2022 corrections before Jan-6
- stdTP factor will be updated with final THORNHILL data before Jan-6

2020 LARGE-classic data are FINAL, although:
- LAS and SMPS data will be updated to be consistent with 2022 corrections before Jan-6
LARGE Data Products: Number Concentration

- ACTIVATE number concentration data is critical to assess cloud interactions
- Bermuda flights capture basin-wide gradients
LARGE Data Products: Size Distributions

- Size is a fundamental aerosol property
- ACTIVATE data to be used to evaluate cloud interactions, airmass evolution, and source contributions
Data Processing Updates: Number Closure

- **Independent Laboratory** calibrations applied to final data for both SMPS and LAS
- Provides accurate closure with total number from CPC

![Graph showing data from Langley and Bermuda](image)

- **Langley**
- **Bermuda**

![Scatter plot showing number concentration](image)
LARGE Data Use: Size Distribution Examples

NPF near Coast during CAO
CN_{3nm} \approx 13,000 \text{cm}^{-3}
1/11/22 (RF101)

Clean FT air during NE Refuel
CN_{3nm} \approx 550 \text{cm}^{-3}
5/5/22 (RF150)

Data Use Tips
- Units = dN/d\log_{10}D (\text{cm}^{-3})
- Bins and d\log D are in header
- SMPS and LAS can be “stitched” without overlap or gap
  - Last bin of SMPS is often low, can be interpolated across
  - Discontinuities between SMPS/LAS can be from refractive index assumption (1.52)
- High concentrations sometimes result in a lack of closure
LARGE Data Use: Size Distribution Examples

Elevated Dust near Bermuda
550nm Scattering \( \sim 75 \text{Mm}^{-1} \)
6/13/22 (RF175)

Biomass Burning in MBL
550nm Scattering \( \sim 38 \text{Mm}^{-1} \)
3/3/22 (RF132)

Data Use Tips

- Be cautious interpreting coarse-mode measurements
- Volume distributions blow up at large size, can be compared relatively.
- Transport losses are not explicitly corrected.

\[
d_{\log_{10}}D = \begin{align*}
0.05 & \quad \text{SMPS} \\
0.05 & \quad \text{LAS}
\end{align*}
\]

75.1nm 84.3nm 94.0nm 106.1nm 119.0nm
LARGE Data Use: AMS Composition

- Submicron composition is typically dominated by organic (and nitrate) material near the coast, sulfate over the clean ocean
- Composition also varies with altitude

Data Use Tips

- Negative values for AMS-mass are “real”
- AMS data are reported using a collection efficiency = 1 based on comparison with PILS-sulfate
LARGE Data Use: Scattering Hygroscopicity $f(RH)$

- Variability in hygroscopicity, $f(RH)_{20-80\%}$, is related to changes in submicron composition

Data Use Tips

- Hygroscopicity data precision depends on magnitude of scattering
- Smoothing reduces noise
- Relevant for submicron aerosol only
- Dust (or a lack of accumulation-mode) seems to result in low-bias
Data Use: Best Practices for ACTIVATE Aerosol Data

*** Please read the ICARTT file headers ***

- Loadings are reported at standard T/P → use stdTP factor

- Cloud droplets produce artifacts for most measurements. Screen with LWC.
  - Precipitation can still affect BCB and MinAlt legs, especially CAO flights.

- Note that additional processing filters are applied for many 1Hz calculated products (e.g., single scattering albedo, ambient extinction coefficient). Care should be taken when averaging ratios.

- Only the AMS and LAS instruments operated on the CVI inlet:
  - AMS-CVI data are reported in separate files as relative mass fractions
  - LAS-CVI data require use of the InletFlag (0 = isokinetic; 1 = CVI)

Questions/comments/concerns/complaints? Contact us (michael.shook@nasa.gov)
Data Analysis: Aerosol Nuggets

1. Mystery absorbing layer over Bermuda
   - Is this supported by Mie Theory?
   - What is spatial extent, source?
   - What are the effects on thermodynamic structure?
2. What factors influence the Hoppel Minimum in the Particle Size Distribution?
   - Can the Hoppel diameter be quantitatively used to assess cloud super-saturation?
   - Is particle number and volume conserved during airmass evolution?
3. Why is f(RH) lower than expected in marine atmospheres?
   - Values do not seem to reflect combinations of pure sea salt and AMS composition
   - Are organics significantly lowering sea-spray hygroscopicity?
   - Corroboration from HSRL and RSP (?)
4. Nitrate aerosol is only observed at the coast, why?
   - What processes generally control changes in composition during evolution?
5. Bermuda dust
   - How efficiently do we sample it in-situ? Closure with wing probes?
   - Effects on f(RH) measurement?