Upcoming Changes to the EPA Photochemical Assessment Monitoring Stations (PAMS) Network; New Meteorological Measurement Requirement for Mixing Heights and Current Activities

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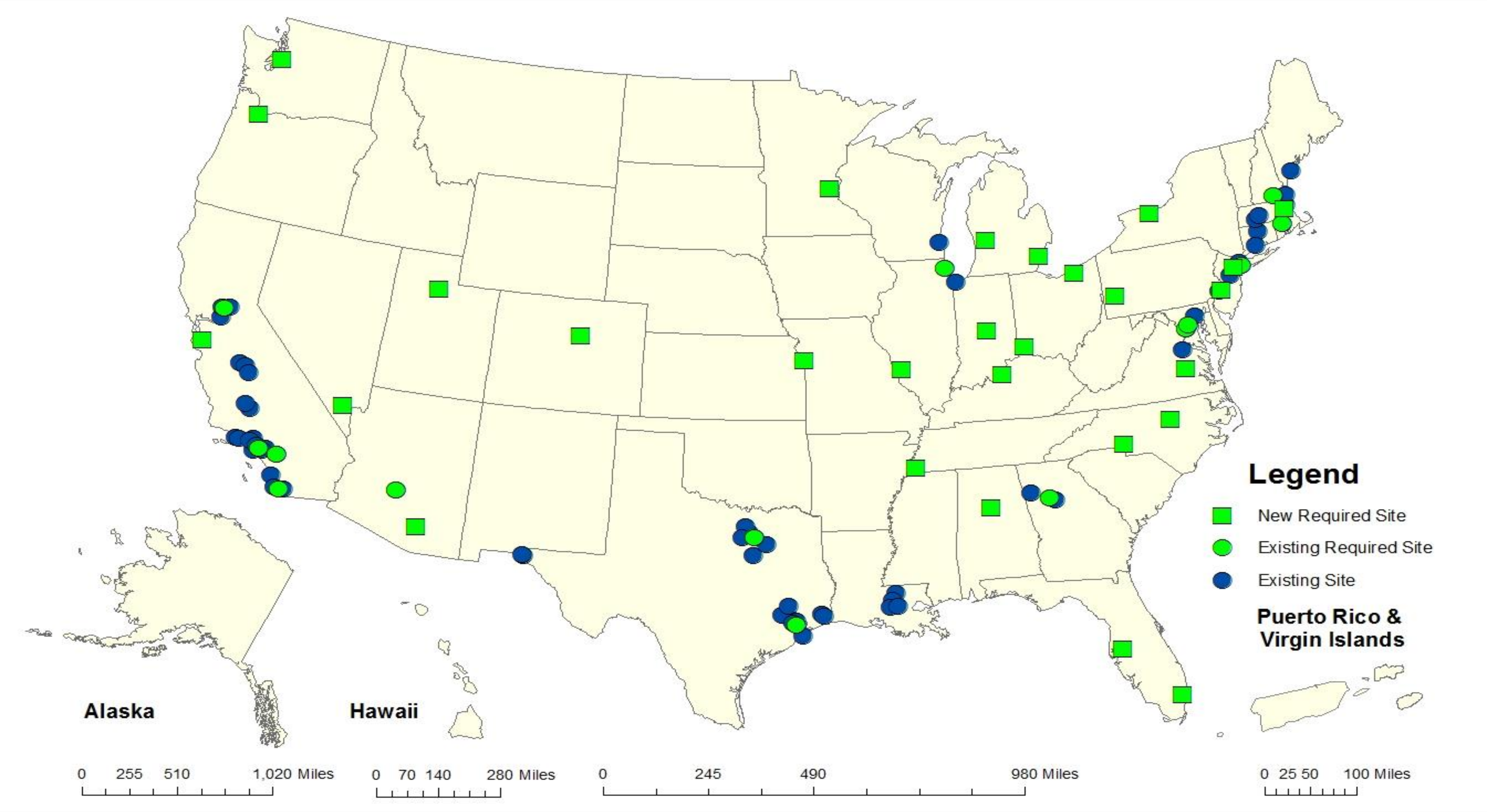
Updates to PAMS Network Design

- Major changes to the PAMS requirements were finalized in October 2015 as part of the ozone NAAQS review
- We replaced the existing 20 year-old multi-site, enhanced ozone network design with an updated 2-part network design
  - Requiring PAMS measurements to be collocated with existing NCore sites in areas with population of 1 million or more irrespective of Ozone NAAQS attainment status
    - Results in a stable network of approximately 40 required sites with improved spatial distribution and reduced redundancy
    - Includes a waiver for historically low ozone areas
    - Includes an option to make PAMS measurements at an alternative location (e.g., an existing PAMS site) which may cross CBSA or even state boundaries
  - Require states with moderate or above ozone non-attainment areas and states in the Ozone Transport Region to develop and implement an Enhanced Monitoring Plan (EMP)
    - Provides support for flexible approaches for collecting data to understand ozone issues in new and existing high ozone areas

New and Existing PAMS Sites



Changes to Required PAMS Measurements

- Requires hourly VOC measurements
  - Included a waiver to allow 3 8-hr canister samples in locations with low VOC concentrations and for "logistical and programmatic constraints"
- Requires 3 8-hr carbonyls samples on a 1 in 3 day schedule
  - Included an alternative to allow for continuous formaldehyde measurements
- Requires "true NO_2" in addition to existing NO_y
- Requires hourly mixing height measurement (replaces "upper air measurements")
  - Added a waiver option to allow measurements to be made at an alternative location (e.g., NOAA ASOS sites)
- Additional required PAMS meteorology measurements that are not part of the NCore requirements include atmospheric pressure, precipitation, solar radiation, and UV radiation

Summary of Flexibility in Requirements

- A number of waiver options are available to help provide flexibility
  - Waiver for low ozone concentrations (<85% of NAAQS)
  - Waiver to move location to alternative site
  - Waiver to use longer averaged VOC sampling (i.e., canisters) instead of autoGCs in some circumstances
  - Waiver to use off-site meteorology where appropriate
- EMPs are intended to provide support for flexible approaches for collecting data to understand ozone issues in new and existing high ozone areas
  - Just because a state isn't required to have an EMP doesn't mean they can't or shouldn't!

PAMS Timeline and Milestones

- PAMS plan due July 1, 2018 as part of Annual Network Plan
  - Consider moving this up to July 1, 2017 if waivers are needed!
- PAMS monitoring at NCore sites will need to start by June 1, 2019
  - Looking for some states to be early implementors and start getting equipment installed in 2017 and 2018
- EMPs submitted within two years of designations or by October 1, 2019, whichever is later

EPA Commitments

- PAMS Funding reallocation
  - Start in 2017, and spread over multiple years
- National Procurements for autoGCs, true NO2, and ceilometers
- Guidance documents
  - Technical Assistance Document
  - Generic QAPP
  - SOPs for autoGCs, true NO2, and ceilometer
  - EMP Guidance
- National QA Program
- Training, Training, and more Training!
  - Data Validation/Reporting
  - AutoGC operation
  - Mixing height/Ceilometer

PAMS MLH requirement and Modeling Needs

- The primary purpose for the hourly mixing heights under PAMS was driven by the SIP modeling data needs.

- Within EPA the following areas have been identified as concerns wrt ability of ceilometer/lidar measurements to provide useful data:

  1)Rate of PBL rise in morning and the timing of evening transition back to nocturnal layer / residual layer along with absolute MLH values.

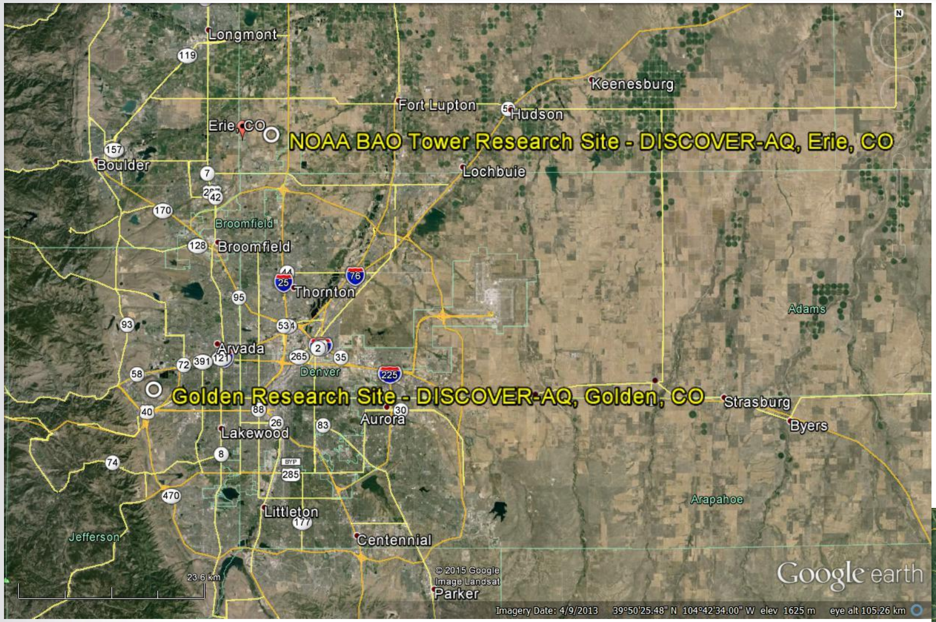
  2) Measurement-to-model comparison - which parameters should be pulled from WRF (or MCIP) that best matches what the ceilometers measure,

  3) Models have a specific vertical layer structure which may have coarser resolution than the measurements, how can this be accounted for in assessments,

  4) Spatial representativeness of MLH relative to model grid cell, and relative to adjacent/nearby grid cells,

  5)Data gaps in data (e.g., overnight w/ lidars).

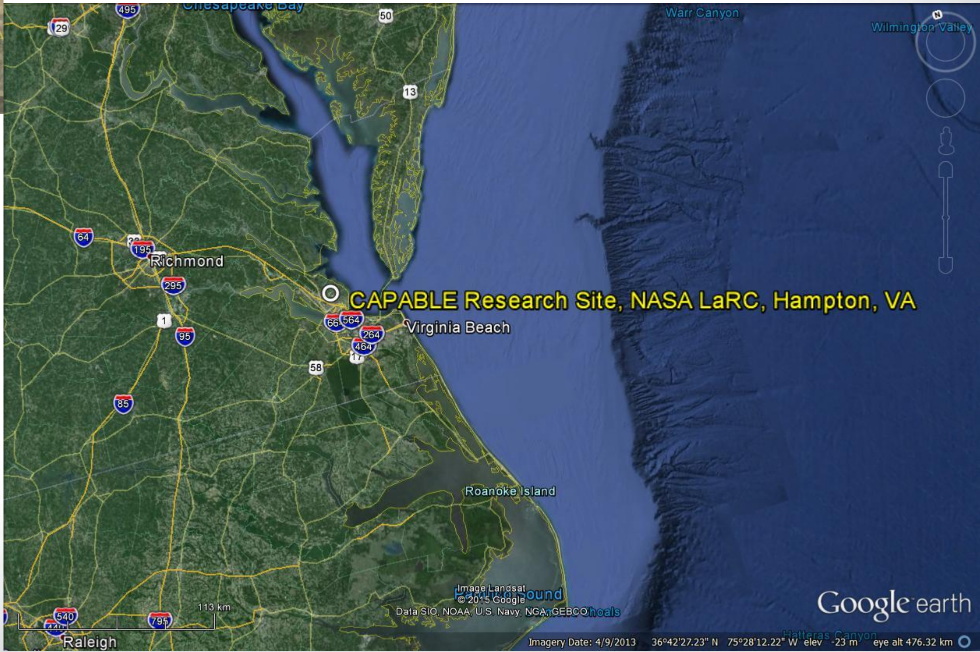
Field Evaluation locations for CL-51



NOAA BOA Tower Site (Erie, CO) – start of High Plains

Golden NREL Site
-On a mesa -intermountain site

Both sites low aerosol loading



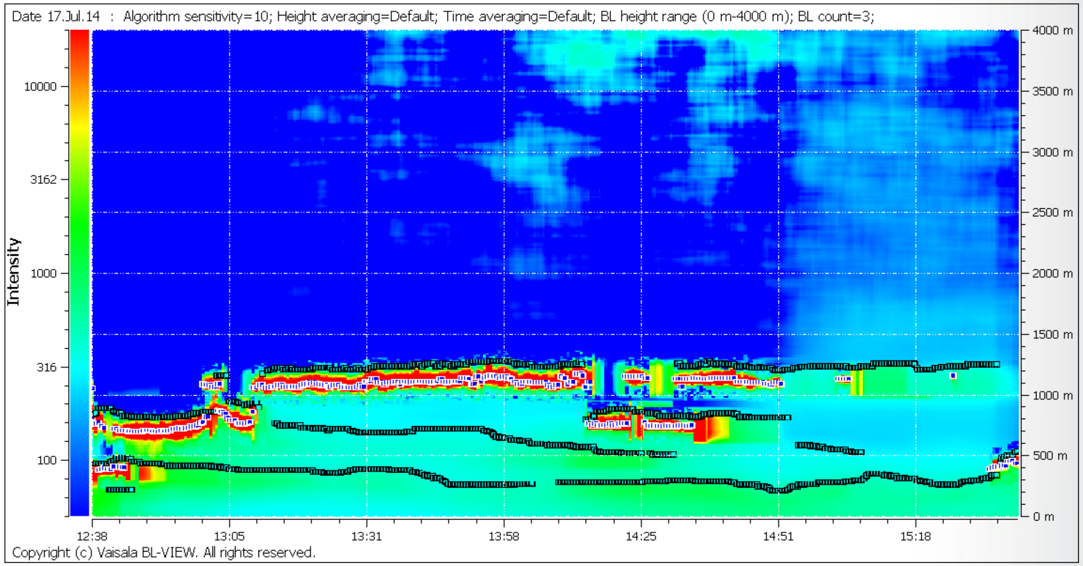
NASA Langley (Hampton, VA)
- Near sea level – coastal site

Low-moderate aerosol loading – with marine influence

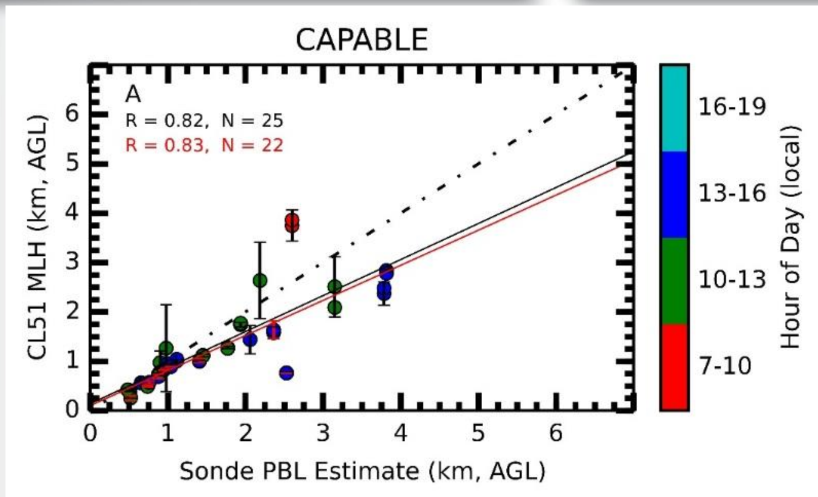
CL-51 Comparison was conducted using the Vaisala BL-View Software for the CL-51 MLHs

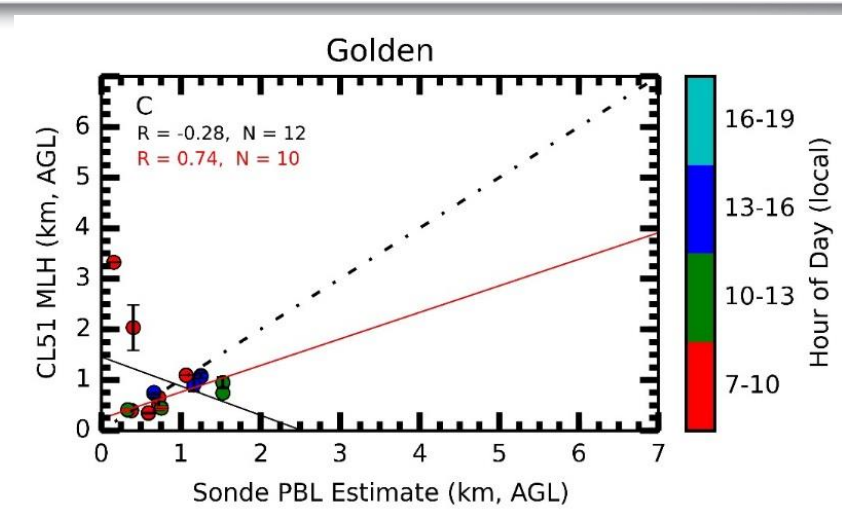
- BL-View Software:
  - Uses a proprietary gradient method algorithm
  - Identifies up to 3 aerosol layers for consideration of MLH
  - Layers assigned quality index (QI) 1 to 3; 3 highest confidence
  - Use of variable time and altitude averaging

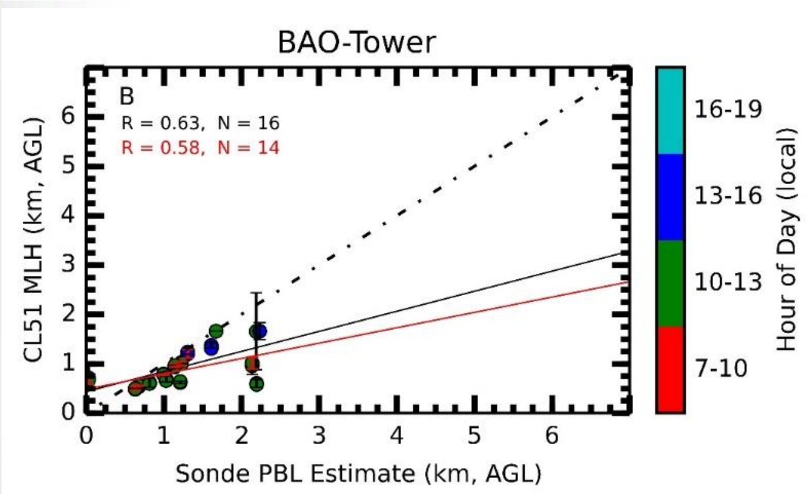
Characteristic backscatter curtain plot generated in BL-View for 17-July 2014 Golden, CO



CL-51Mixing Layer Height (aerosol gradient) vs. Planetary Boundary Layer Height (thermal gradient)







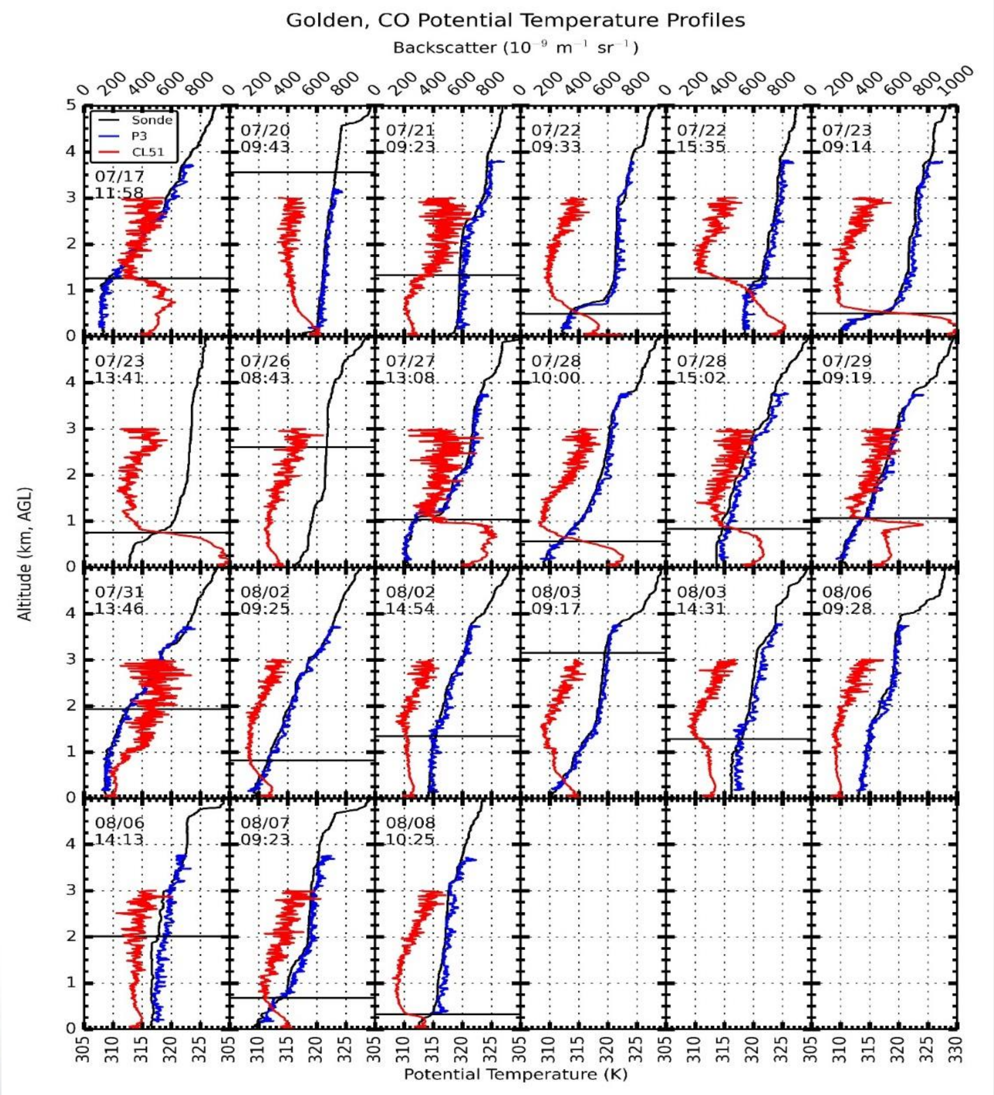
- **Total of <u>53 radio sondes</u> used for evaluation**
- **CL-51 data averaged over 5-minutes to account for spatial differences with sondes**
- **R = unfiltered**
- **R = filtered; 5-minute σ > 0.20 km or RSD > 20%**

Knepp, T.N., J. S. Szykman, R. Long, R. Duvall, J. Krug, M. Beaver, K. Cavender, K. Kronmiller, M. Wheeler, R. Delgado, R. Hoff, E. J. Welton, E. Olson, R. Clark, D. Wolfe, D. Van Gilst, and D. Neil, *Assessment of Mixed-Layer Height Estimation from Single-wavelength Ceilometer Profiles,* submitted Atmos. Chem. Phys

NASA P-3B Spirals used to Evaluate Spatial Representation of Sonde PBLH

- Potential temperature (**NASA P-3B** and **Millersville University radiosondes**) and **CL-51 backscatter** profiles collected at the Golden NREL site. Horizontal lines indicate MLH as determined via BLView.

- PBL Height from NASA P-3B spiral (~5 km) shows good agreement with sondes.



Ad-hoc Ceilometer Evaluation Study (ACES)

Location: University Baltimore Maryland County -combines EPA PAMS evaluation effort with on-going ceilometer test-bed effort.

Main instruments - Vendor/Model: Campbell Scientific –CS135, Viasala – CL-31 and CL-51, and Lufft CHM15K.
Other relevant measurement: Sigma space Micro-pulse lidar, Leosphere ALS-450, and Radiometrics MWR, Leosphere windcube 200s

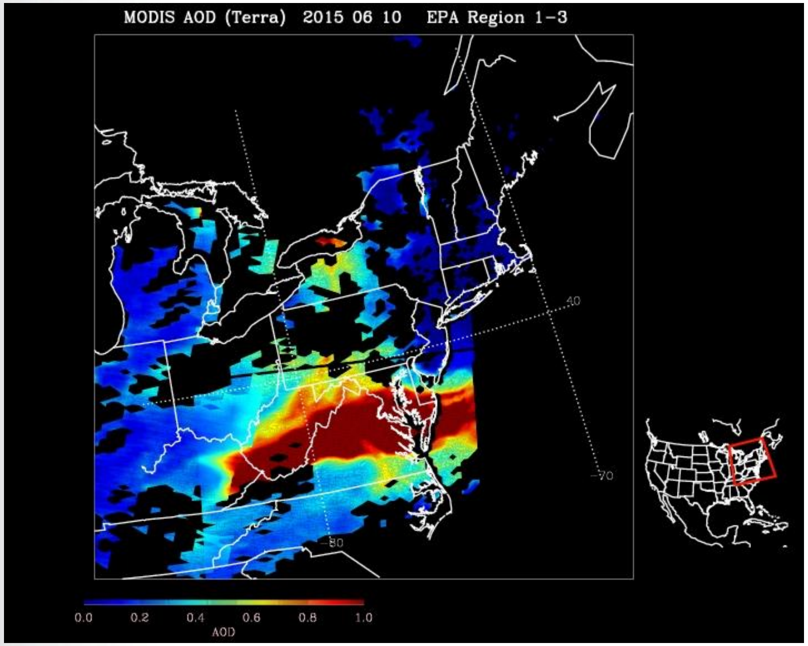
Study period: ~ November 15 through December 16, 2016+

- CL-51, CS135, and CHM15K running since November 8
- Test ceilometer performance in low aerosol loading environment
- Assess the range corrected attenuated backscatter to identify aerosol layer heights for mixing layer height determination during morning and evening transition periods:
  - MLH using available vendor software
  - MLH using a common algorithm

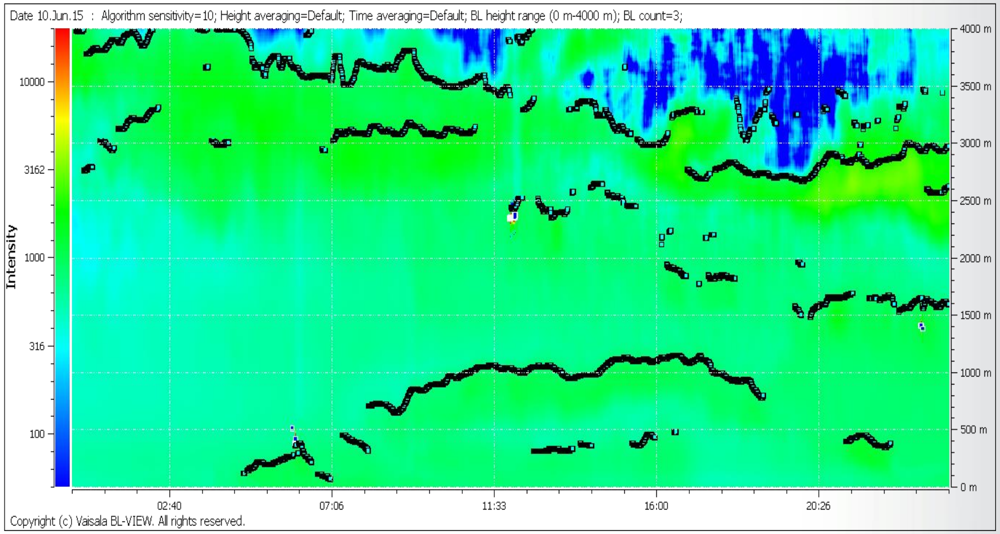
Data Considerations/Thoughts

- Hourly Mixing Height is the required variable under PAMS
- Ceilometers capable of providing attenuated backscatter profiles up to 15km+
- Data logging the entire backscatter profile allows for:
  - Alterative algorithms to derive MLH, especially if other lidars (MPL, HSRL, CL-31s) are part of any larger network
  - Visual check on the derived MLH
  - Additional uses of data:
    - EPA exceptional events analysis
- Spatial variability of MLH around PAMS sites
- How to ensure a high quality MLH at PAMS sites operated by different state and local air quality agencies.
- Synergies with other networks

June 10, 2015 – Canadian Forest Fires Smoke Plume



Characteristic backscatter curtain plot generated in BL-View for 10-June, 2015 at CAPABLE Research Site - Hampton, VA



Smoke from the Canadian forest fire was observed by increased backscatter in the 2500 – 4000 m range.