Lower Troposphere Remote Sensing Activities at UMBC

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Ad-Hoc Mixing Layer Height Working Group
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JCET
The Joint Center for Earth Systems Technology

Research Areas

- Inversion algorithms, optical, chemical and physical properties of atmospheric aerosols, gases, and clouds.

- Boundary Layer Dynamics (Air Quality and Wind Energy)

- Continental and intercontinental plume transport to Eastern US and Caribbean.

- AOD-$PM_{2.5}$ Estimator Development from Ground, Satellite Observations, NWF and Global Models

- New remote sensing technologies for atmospheric observations.

NOAA Office of Education
Cooperative Science Centers

- Center for Earth Systems Science and Remote Sensing Technologies (NOAA-CREST)

  - *CREST Earth System Observing Network (CESON)*

    Enhancement to the CREST Lidar Network with extensive remote and in-situ observation capabilities, and Direct Broadcast Satellite stations for satellites.

    CCNY (NYC)
    HU (Hampton, VA)
    UMBC (Baltimore, MD)
    UPRM (Mayaguez, PR)

  - Recognized by the National Science Technology Council Committee on Environment, Natural Resources, and Sustainability as one of three networks in (MPLNET/CLN/NDACC) in report titled “Air Quality Observation Systems in the United States”.

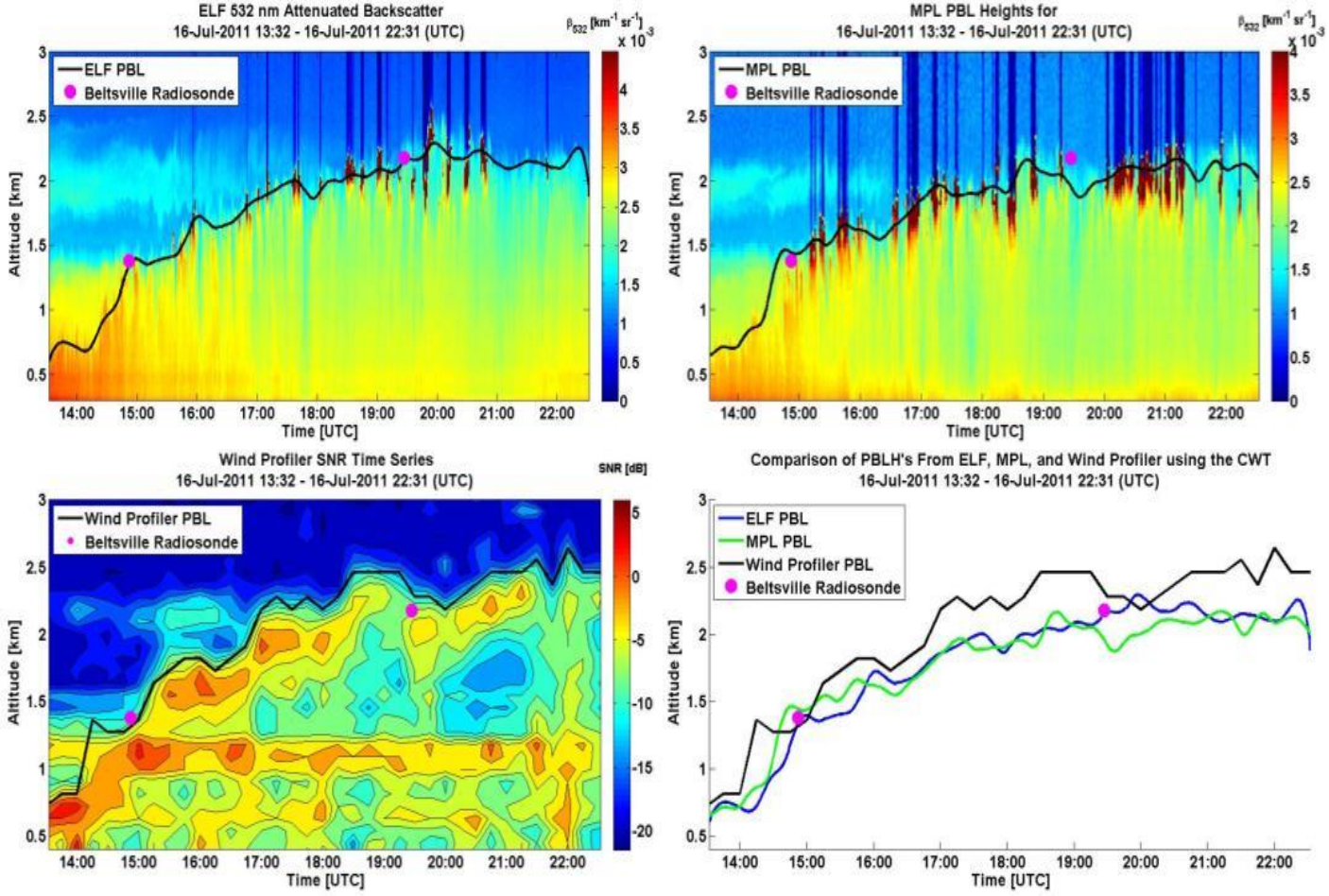
- Center for Atmospheric Sciences and Meteorology (NOAA-CASM)

Mixing Layer Height (MLH)

- Diagnostic variable atmospheric transport and dispersion forecasting models.
- Without realistic MLH models have large errors that result in inadequate public protection against unhealthy air quality.
- National Research Council has recommended a "network of networks"[1]
  - After 60 years of remote sensing research, it is astounding that the PBL is not measured regularly throughout its diurnal cycle

1- NRC. 2009. *Observing Weather and Climate from the Ground Up: A Nationwide Network of Networks*. Washington, DC: National Academy Press.

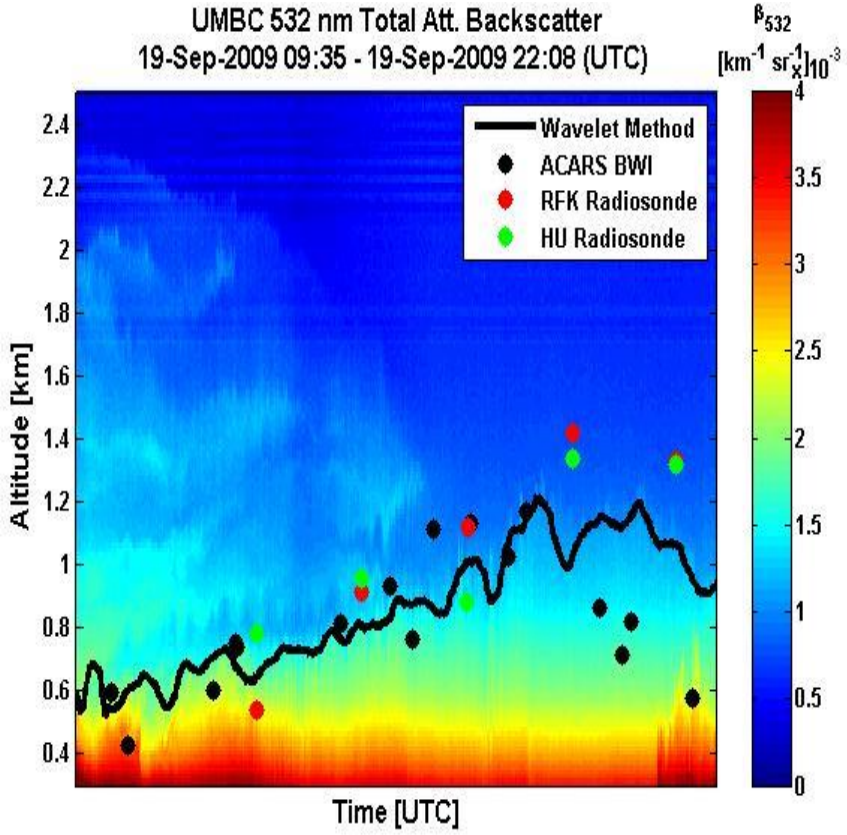
MLH Algorithms

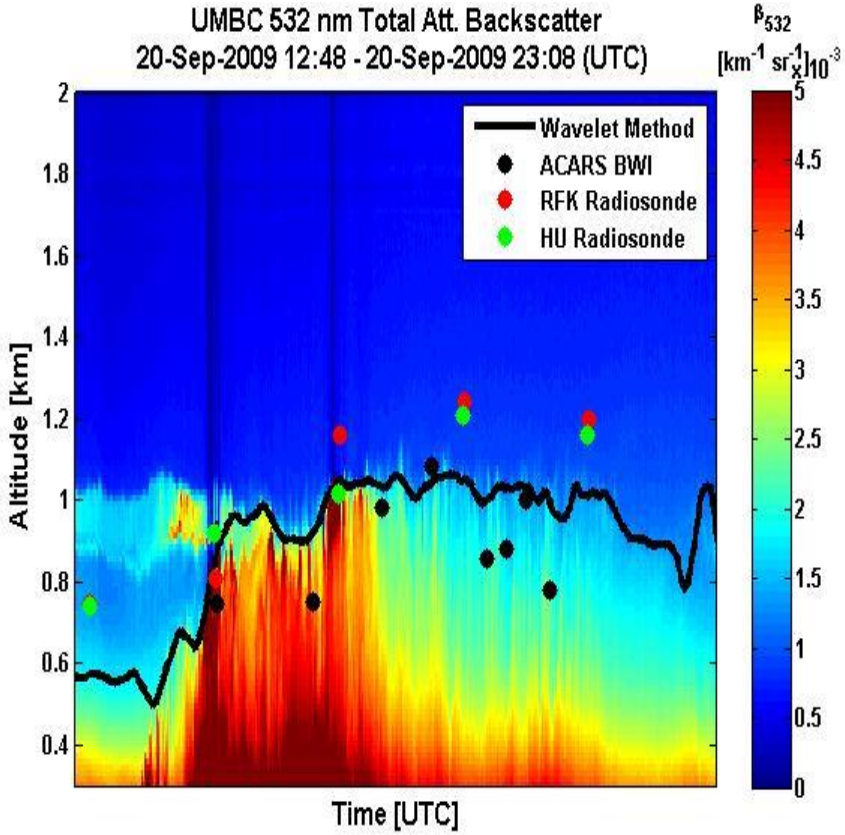


Lidar and radar wind profilers MLH from Covariance Wavelet Transform

*Compton et al. (2013), J. Atmos. Ocean. Tech., doi:10.1175/JTECHD-12-00116.1

Joint NOAA/ARL-NCEP Field Study

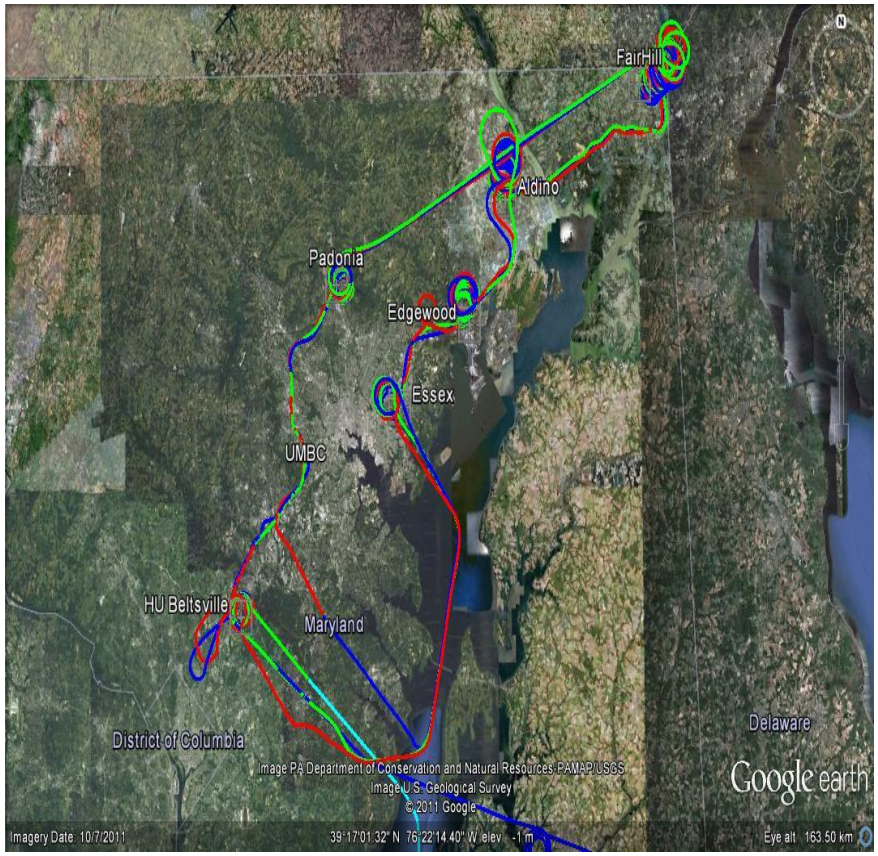




Lidar measurements helped to identify problems with automatic PBLH calculation from aircraft profiles (ACARS).

DISCOVER-AQ

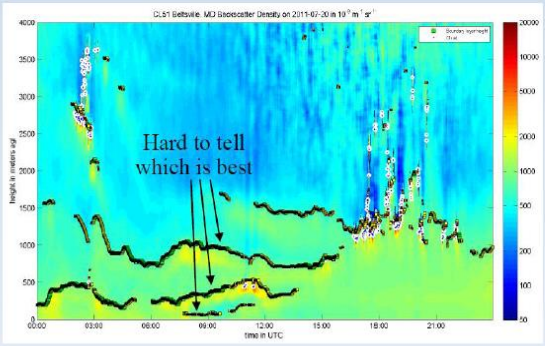
Examine the representativeness of column optical properties from satellites to ground-based air quality. This campaign was carried out in the Baltimore-Washington metro area during July 2011.



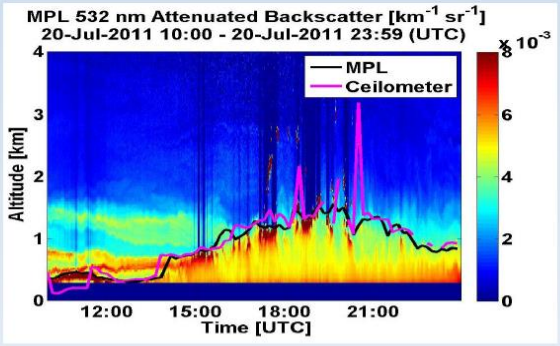
GroundSite	Lat(°)	Lon(°)
Aldino	39.5633	-76.2039
Edgewood	**39.4100**	**-76.2969**
Essex	39.3107	-76.4744
FairHill	**39.7013**	**-75.8599**
HU-Beltsville	**39.0561**	**-76.8783**
Padonia	39.4620	-76.6315
UMBC	**39.2546**	**-76.7093**

Algorithm Comparison

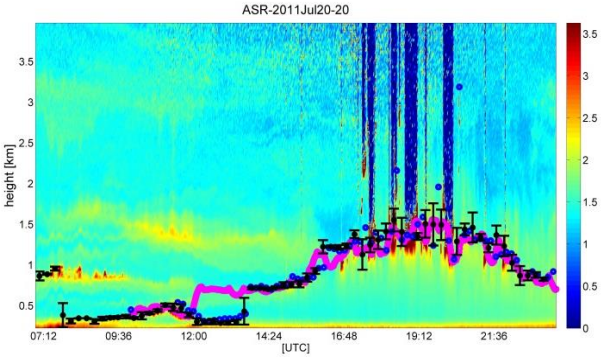
DISCOVER AQ Summer 2011 @ Beltsville, MD



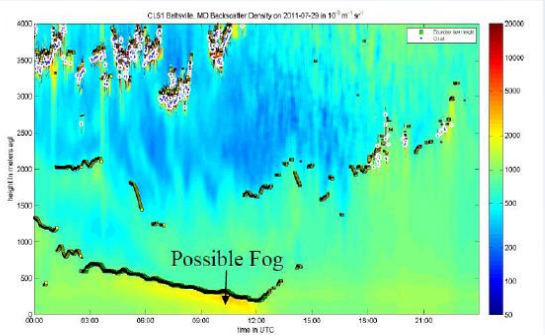
CL51 Ceilometer



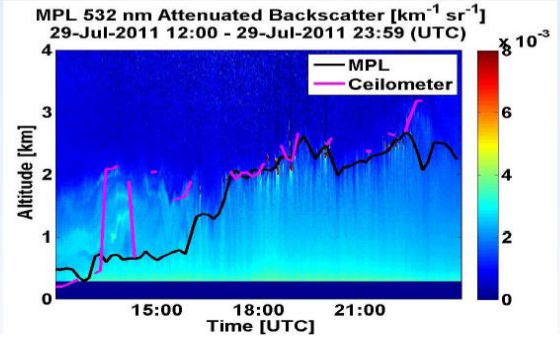
MicroPulse Lidar (MPL)



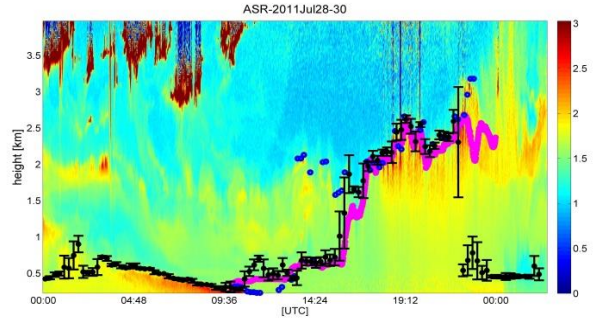
Howard Raman Lidar



Laser: InGaAs
Power: 8.9 mW
Wavelength: 910 nm
Algorithm: BL-View

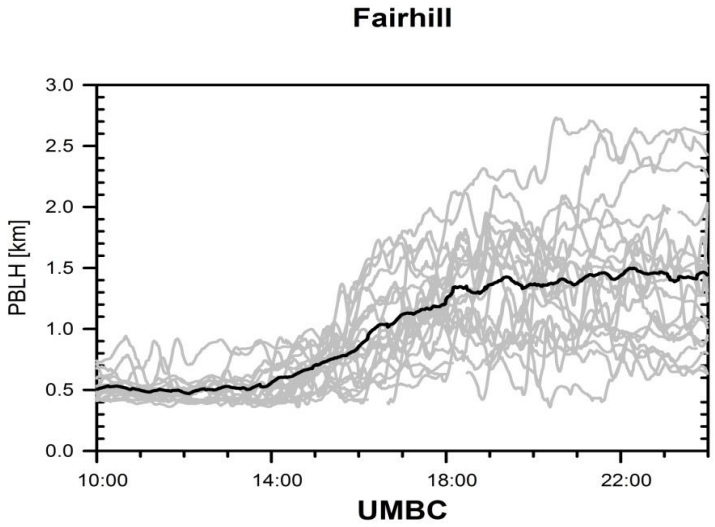


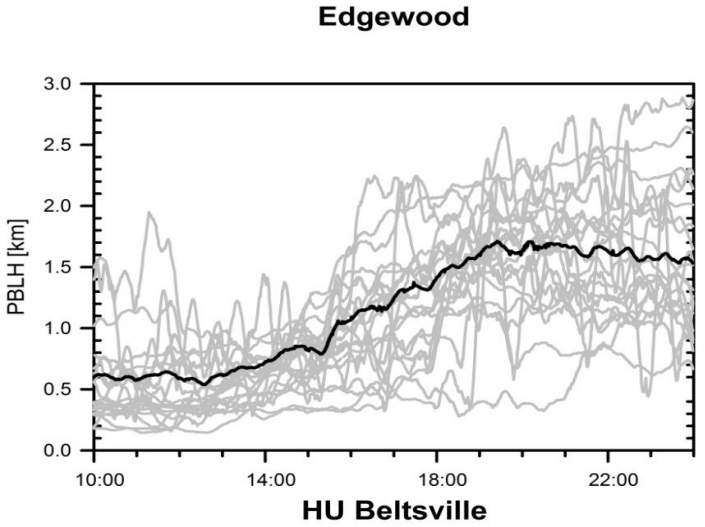
Laser: Nd-YLF
Power: 25 mW
Wavelength: 532 nm
Algorithm: Wavelet

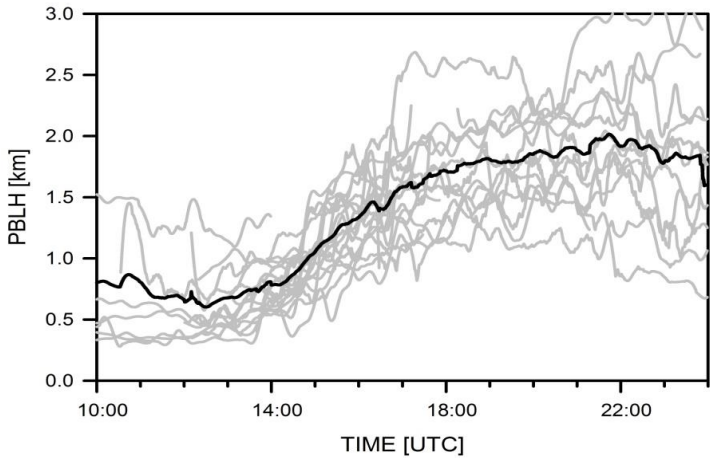


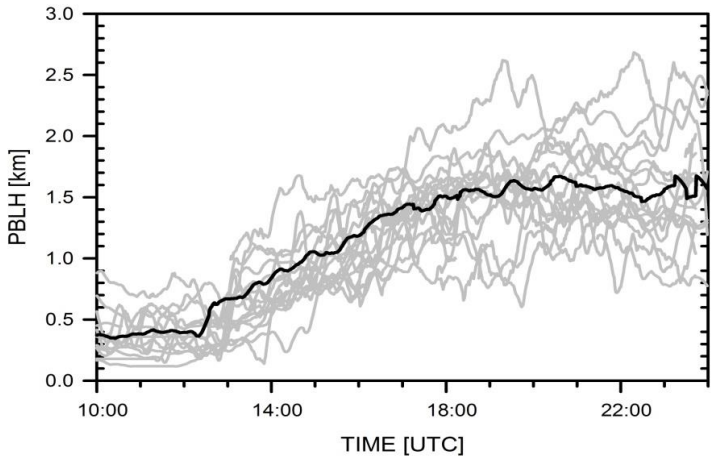
Laser: Nd-YAG
Power: 8 W
Wavelength: 355 nm
Algorithm: Wavelet

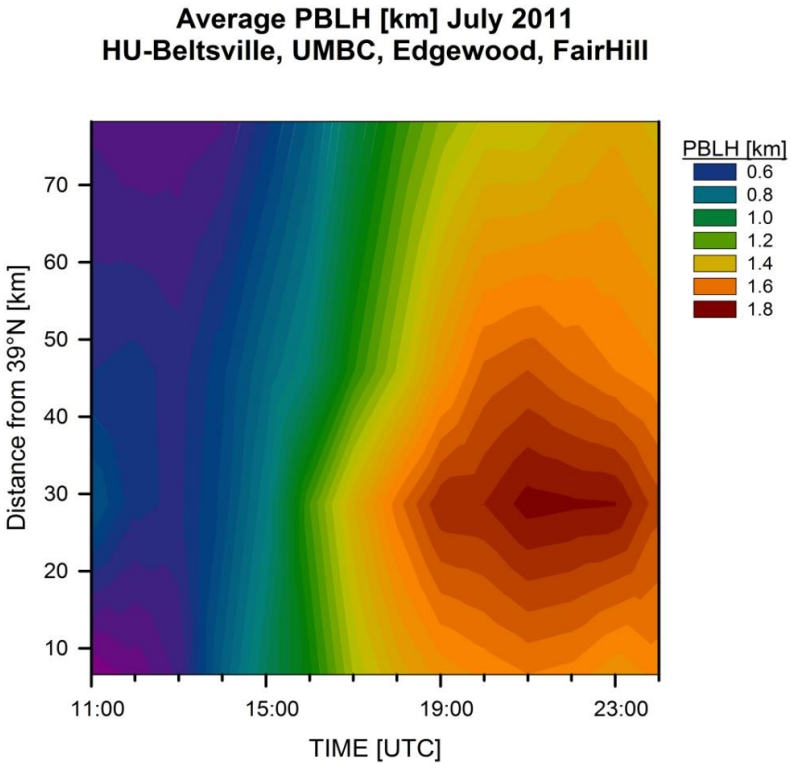
Spatial Variability

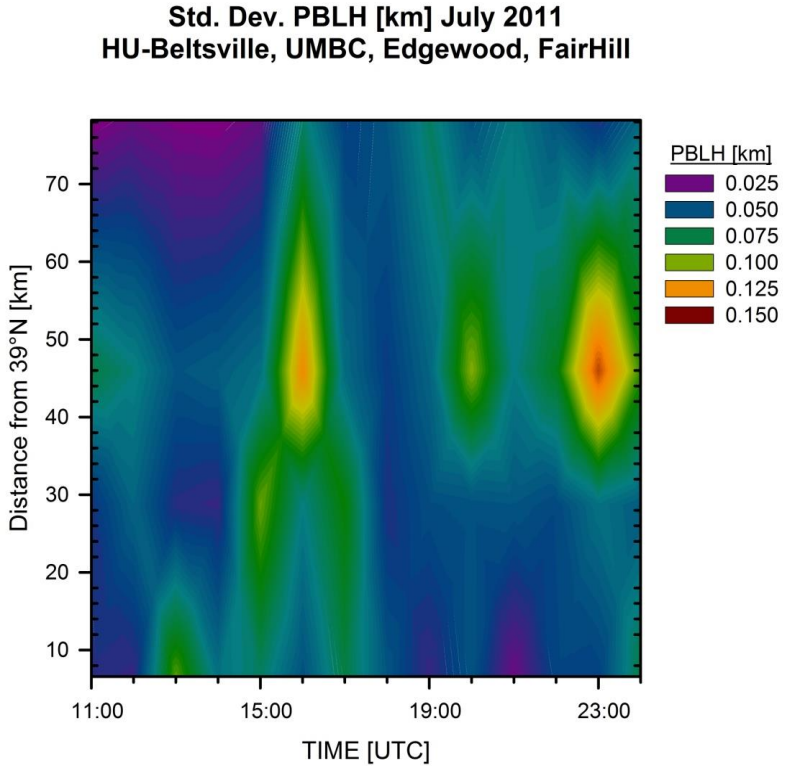












HU-Beltsville and UMBC (Urban sites):

Higher surface temperatures and increased convection result in higher afternoon mixing depths and larger diurnal ranges.

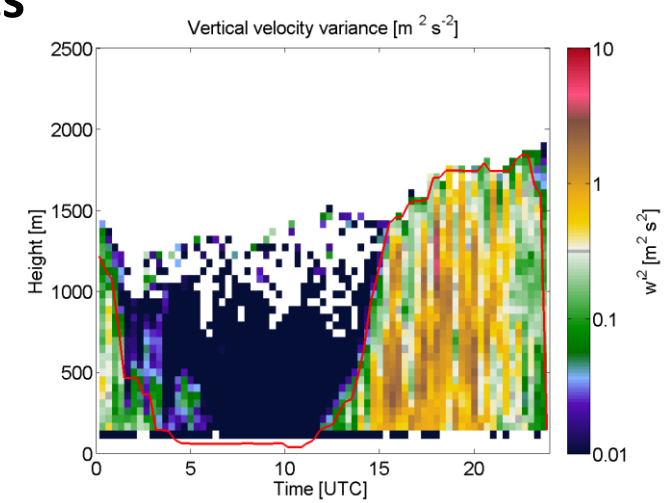
Edgewood:

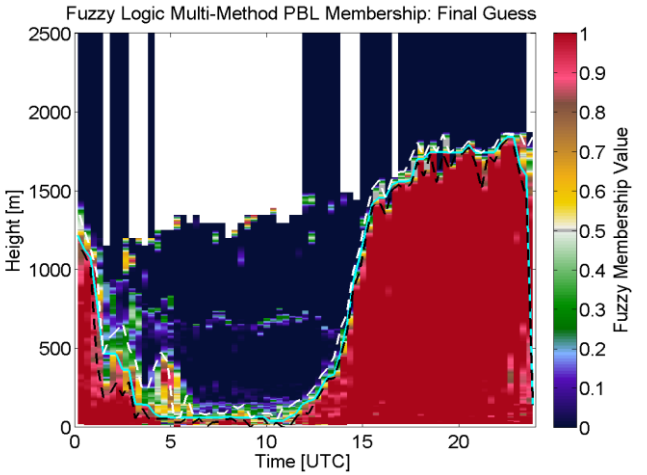
Greatest variability in the evolution of PBL. Forcing mechanisms (heat and moisture surface fluxes) dependent of mesoscale processes (i.e, bay breeze).

Determination of Planetary Boundary Layer Heights From Doppler Wind Lidar Measurements

Brian Carroll[1] , W. Alan Brewer[2] , Timothy Bonin[3], Mike Hardesty[3], Aditya Choukulkar[3]

UMBC[1], NOAA ESRL[2], CIRES[3]





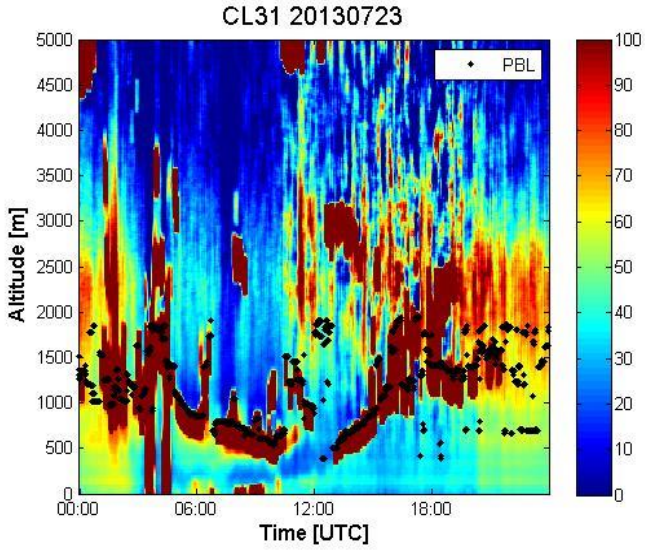
- Developed an intensive fuzzy logic algorithm to estimate boundary layer height
  - Utilizes all Doppler lidar scan types
  - Combines all independent methods of boundary layer height estimation to produce one robust value
- Algorithm also reports cloud base height and rain events
- Currently implemented in real-time for multi-year Indianapolis Flux study
- Products at http://www.esrl.noaa.gov/csd/groups/csd3/measurements/influx16/

Recommendation of ASOS Ceilometer PBL Heights for Assimilation/Verification of Forecast Products

Belay Demoz[1], Ruben Delgado[1], Kevin Veermesch[1], Keiku Mills-Robertson[1]
Ricardo Sakai[2], Dennis Atkinson[3], Michael Hicks[3], Jason Chasse[3]

UMBC[1], Howard University[2], NWS[3]

- UMBC algorithm being used to retrieve MLH from the NWS Vaisala's CL31 ceilometers, as part of a Proof of Concept CL31 Test bed.
- MLH heights from CL31 ceilometers to be implemented at nationwide ASOS sites, as support of scientific efforts of the NWS Sterling Field Support Center



Ad-hoc **C**eilometer **E**valuation **S**tudy (ACES)

- EPA/PAMS evaluation effort with on-going NWS ceilometer test-bed effort.
  - Intercomparison of Lidar/Ceilometers
  - Soundings (i-Met, Vaisala)
  - Microwave Radiometer Profiler (Radiometrics).
  - Comparison with Howard University Beltsville Research Campus

Summary

- Lidar reliable tool for monitoring of the development of the MLH.
- MLH temporal (hourly/daily) variability within all locations due to synoptic and mesoscale processes.
- Verification and validation of forecasts and models.
  - Allow proper evaluation of model MLH schemes (assimilation).
  - Assessment of long range transport of natural and anthropogenic aerosols vs. local sources to local air quality.
  - Aid source allocation of particle pollution for during Air Quality Action Days. Evidence for Exclusion of Air Quality Exceedance due to Exceptional Events

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