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https://www.eol.ucar.edu/content/pecan-integrated-sounding-arrays-pisas

https://en.wikipedia.org/wiki/Wind_profiler

NEXRAD-Based Convective Boundary Layer (CBL) Height estimation: *Comparison to Observations by Multiple Instruments*

Tatiana Della Porta[1], Belay Demoz[1,2]

[1] University of Maryland, Baltimore County, [2] Joint Center for Earth Systems Technology

https://www.roc.noaa.gov/WSR88D/Engineering/NEXRADTechInfo.aspx

Introduction

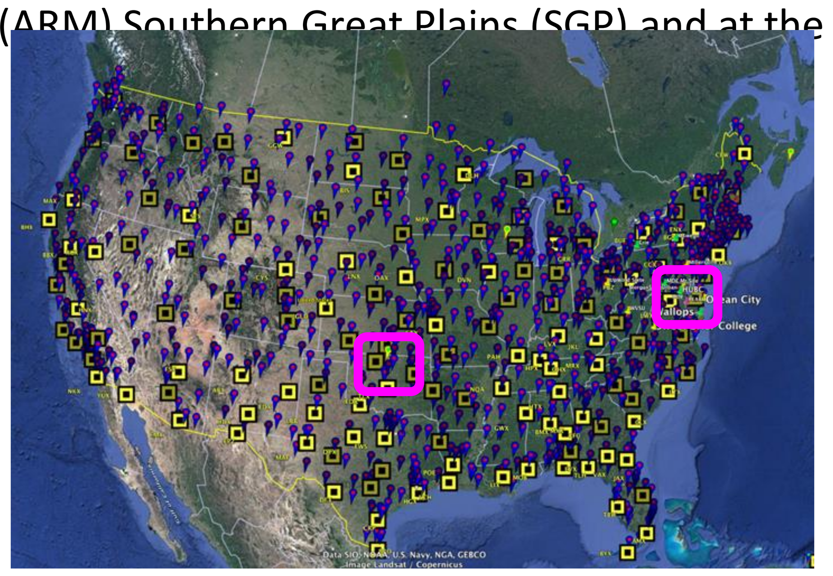
Introduction and Motivation

The Planetary Boundary Layer (PBL) is the most weather active region in lower 2-4 km above the surface of the earth. Despite its importance in the study of weather and air quality, it has been not been well observed. While there are many remote sensing, in-situ, and satellite-based instruments that are able to detect an aspect of the PBL, there has not been an organized network that provides dependable data within the PBL. A very useful PBL variable to measure is its evolution in height/depth (also known as Mixing Layer Height). There are many methods that use lidar, radio sondes, and passive sensors to measure the MLH but none have been implemented as a network within the USA.

Banghoff and Hicks methods:

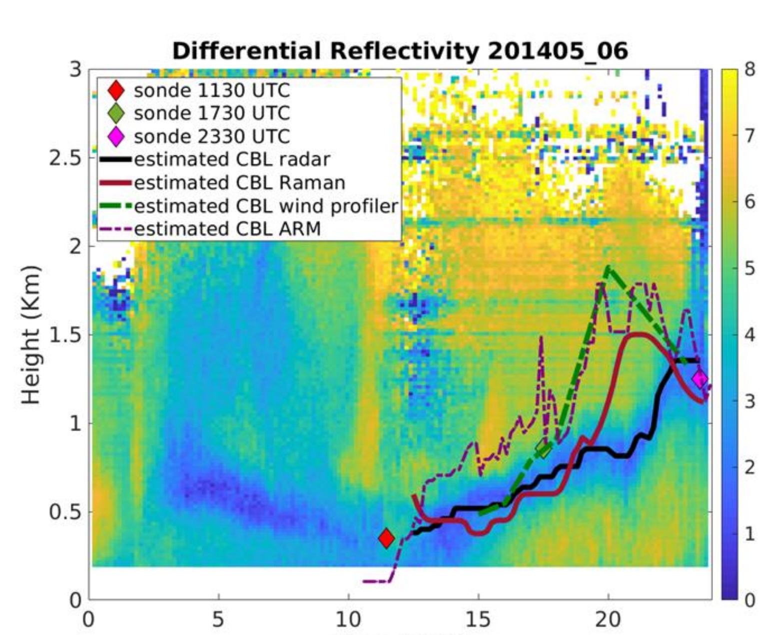
Two potential methods of already existing instrument networks are the Ceilometers which are part of the Automated Surface Observing Stations (ASOS), and the national RADAR network, both operated by the National Weather Service (NWS). Ceilometer based methods were discussed by Hicks et al 2019 and are in the process of being implemented. RADAR-based, NEXRAD (WSR-88D) Convective Boundary Layer Height (CBL), has been reported (Banghoff et al) 2018, but has not been extensively compared to other standard measurements.

We apply Image and Signal Processing Algorithms to averaged differential reflectivity of already archived NEXRAD datasets to compare against the observations of other instruments from the Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) and at the East Coast of Maryland/Delaware.



Location of Instruments used in the analysis

NEXRAD (Yellow squares) and ASOS (purple) location network sites over the USA. Approximate location of the study area (SGP and MD) are also indicated by Magenta squares. *See Banghoff et al (2018) for Radar technique and Hicks et al (2019) for ASOS methods and discussions.*



Edge detection and statistical analysis

Twenty clear days of observations from SGP were analyzed, and edge detection was performed on all the NEXRAD datasets.

Four instruments were utilized to compare against the NEXRAD CBL height estimates: Radiosondes, 915 MHz wind profiler, Raman Lidar, AERI-Raman based inversion CBL height estimate.

An example: A Multi-instrument CBL height comparison at SGP derived from active (lidar, RADAR, wind profiler), in-situ (sonde), and ARM Value Added Product (VAP from AERI/Raman). Edge detected NEXRAD based RADAR height estimate is shown in black.

Multiple Instruments and NEXRAD vs Radiosonde

NEXRAD vs Radiosondes

A statistical comparison of observations between both instruments shows similarity with an average error within +/- 200 m.

SGP

Total days(12 UTC) : 15

Total days(17 UTC) : 14

- 2 daily radiosondes measurements, from the Summer of 2014 at ~17 UTC and ~12 UTC were used to compare against the NEXRAD estimated CBL height.

17 UTC (SGP)

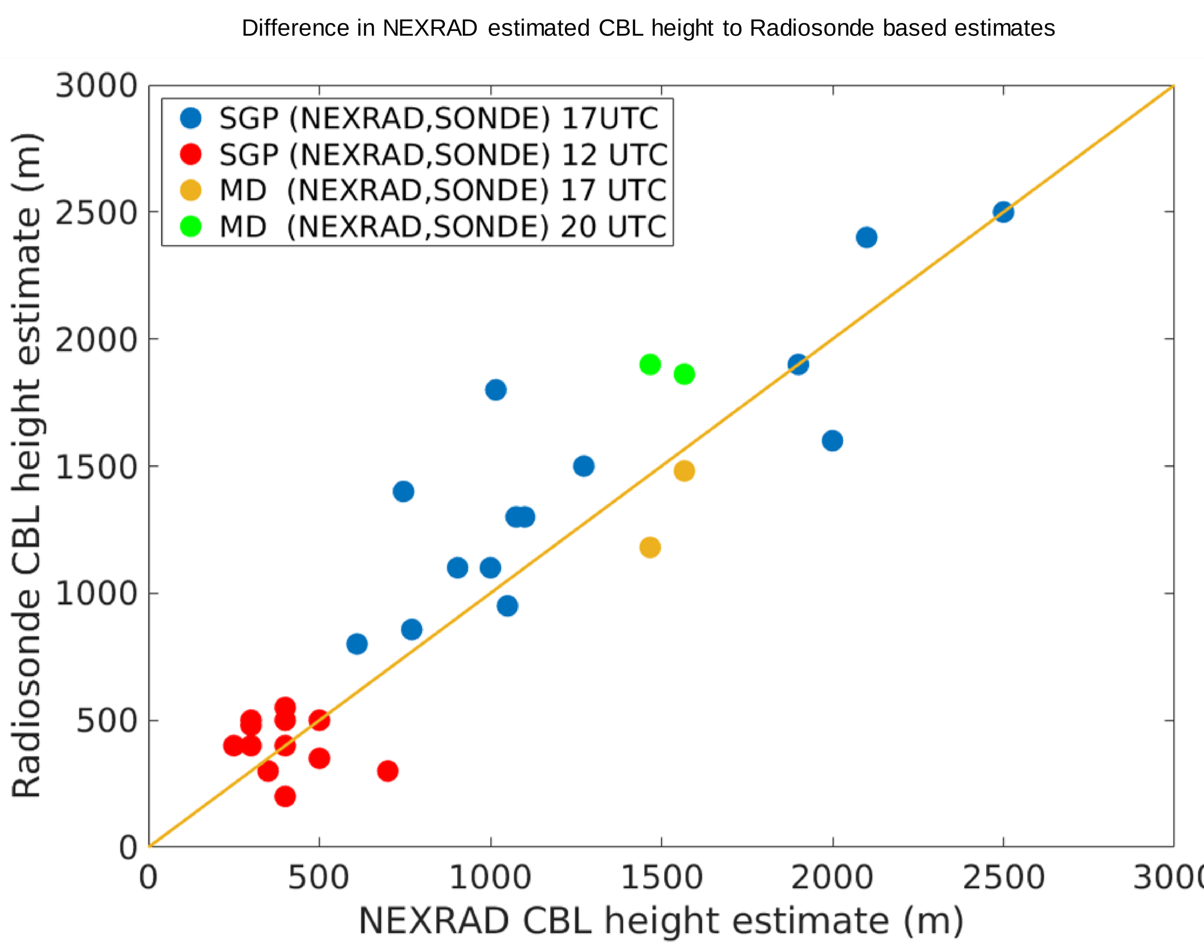
- The median error height was 198 m.
- The mean error height was 247 m.

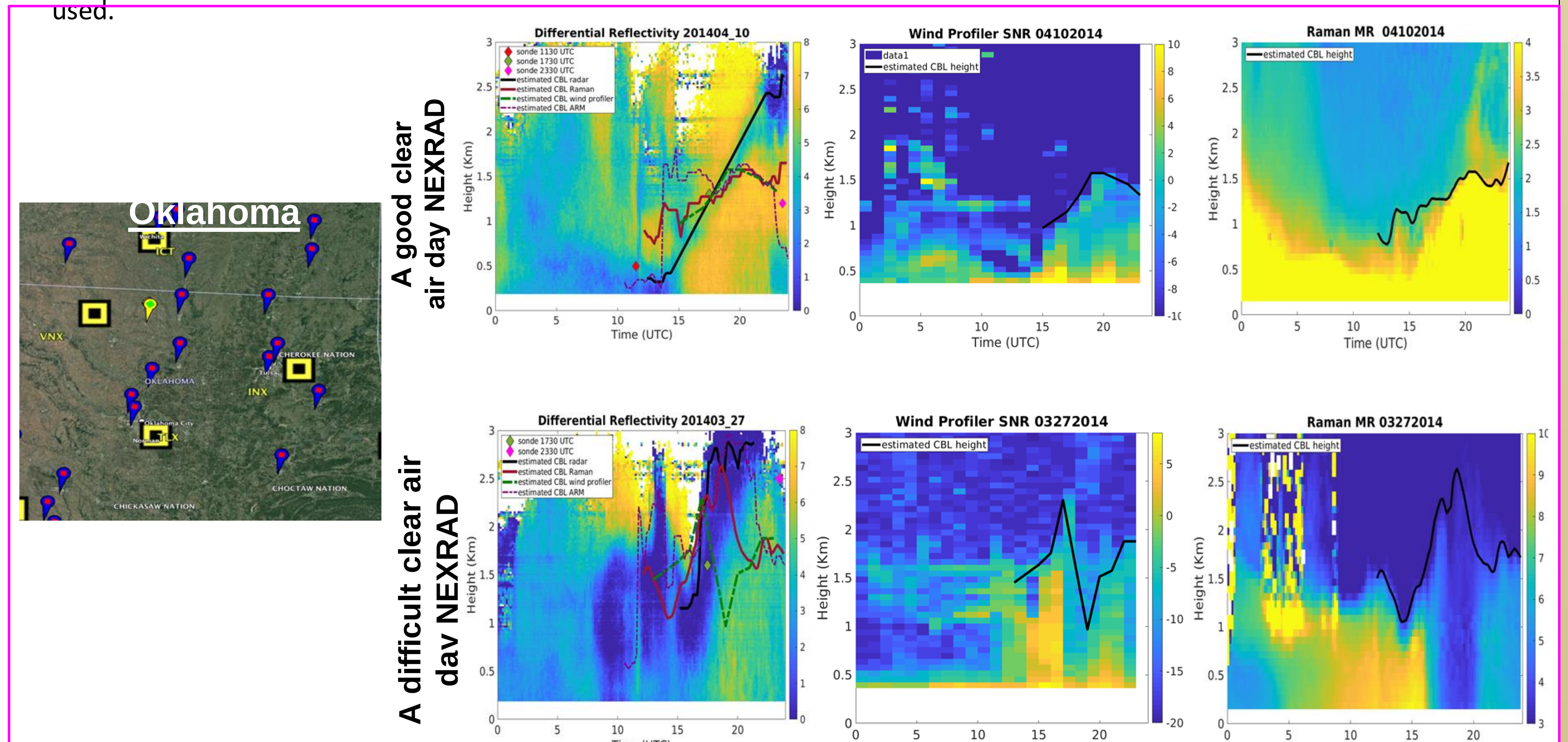
12 UTC (SGP)

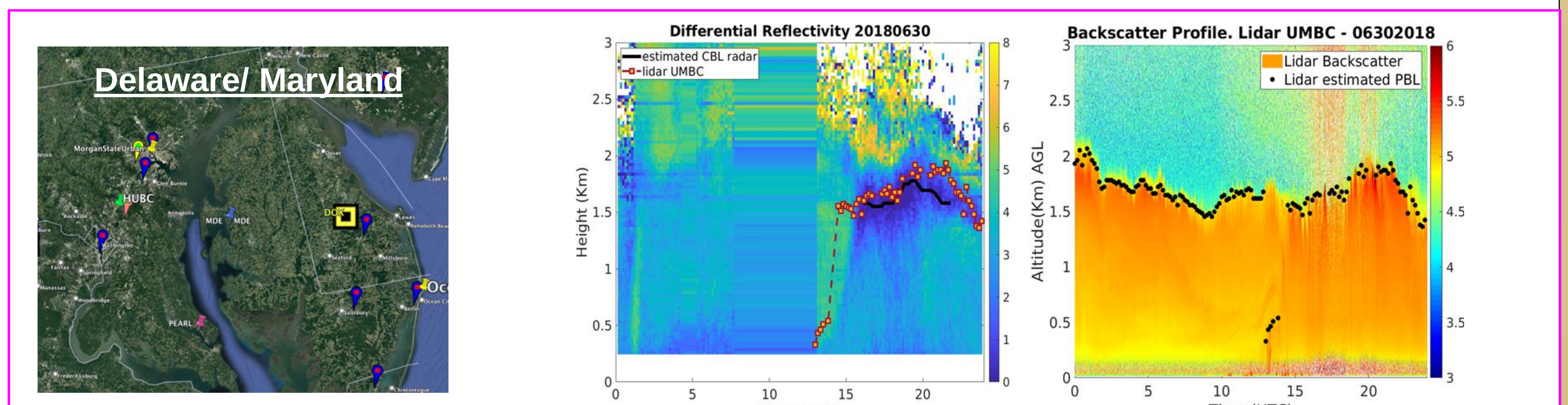
- The median error height was 128 m.
- The mean error height was 150 m.

MD

- Total days : (17 and 20 UTC): 2
- 2 daily radiosondes measurements from the Summer of 2018 at 17 UTC and 20 UTC were used.







Evaluation of the CBL/MLH estimation at two different locations: Oklahoma (above and Chesapeake (VA/MD). Shown are time-height plots of RADAR differential reflectivity, wind profiler, ceilometer (Lufft), and Raman lidar.

Preliminary Comments

- Multiple instruments at SGP corroborated the estimated CBL height produced by NEXRAD.
- Estimates at two locations in the USA were used for a preliminary study and the RADAR CBL estimates show excellent promise for systematic expansion of the technique to other sites and season.
- A preliminary statistics of limited data shows a very good agreement with other methods and instruments. We are in preliminary steps to extend the analysis and comparison to more sites using the available archive (~ 6 years of NEXRAD data) .

Future Research

Combining the forthcoming ASOS ceilometer profile data with existing RADAR-based estimates (anchored by other sensors - sonde, profiler networks, etc) will provide an excellent nationwide base for future CBLH/MLH estimates from space-based sensors and a validation database for existing model-physics.

Acknowledgements

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References

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