The purpose of this study is to evaluate the planetary boundary layer height retrievals from Doppler wind lidars. Analysis was applied to data collected from the two lidar systems during the July-August 2014 Discover AQ and LUMEX campaigns. This comparison aids applications in air quality and wind energy forecasting.

The planetary boundary layer (PBL) of the atmosphere is directly influenced by the presence of the earth’s surface, making the height of the PBL change over time due to factors such as temperature, humidity, and aerosol concentration. Doppler Lidar data provide information such as wind speed, and direction, and back-scattered intensity in space and time. The Lidar scans include VAD (velocity azimuth display) scans with wind speed and direction, bowtie scans and vertical staring with velocity variance and range-corrected intensity. Three numerical analysis methods will be tested on the collected Lidar data.

### RESULTS

#### A “Typical Day”

- Divide the results for each day into six chunks.
- Visually examine each result takes up how many chunks in the BLH estimate graph.
- Successful data is defined when the result exist in the BLH Estimate graph and it fits the background data graph.
- Missing data is defined as the result doesn’t exist in the BLH Estimate graph.
- Unsuccessful data is defined when the result exist in the BLH Estimate graph, but doesn’t fit the background data graph.

#### A Bad Day

- The results of the Visual Examination Table, S/(S+U) is successful rate, (S+U)/(S+D+U) is the availability rate
- Cluster Analysis K-means result has the highest successful percentage and very high successful rate and availability rate.
- Peak threshold methods has highest successful rate but low availability rate.
- Haar Wavelet Transform method has highest availability rate but low successful rate.

#### Peak Detection Method

Using Haar Wavelet Transform

\[
\psi_a(z) = \begin{cases} 
-1, & \text{if } 4^{k+1} \leq 2^k z < 4^k \\
0, & \text{otherwise}
\end{cases}
\]

\[
W_a(x) = \int \psi_a(z) \psi_a(x-z) dz
\]

Mainly used for bt and vs range-corrected intensity profiles (Rci) and horizontal wind speed and direction

#### Cluster Analysis

Profiles chosen to apply Cluster Analysis are based on the time range of morning, day, and night.

**Morning (bt Rci and var), day (vs Rci and var), and night (bt Rci and var)**

Classic K-means \( v_k(P) = \begin{cases} 
1, & \text{if } \delta(P, C_k) = \min_{k=1...K} \delta(P, C_k) \\
0, & \text{else}
\end{cases} \)

**K-means Algorithm**

Initialize the seeds (clusters) Calculate the distance from each point to each cluster Assign each point to the closest cluster Redefine the clusters as the centroid of points assigned Repeat the process until the intra-cluster variance no longer decreases

**Convergent Test**

Calculate Euclidean distance between each point to the cluster and intra-cluster variance

The algorithm stops when the intra-cluster variance are no longer decreasing

K-means algorithm is an iterative algorithm to create clusters

The BLH is defined as the height where the cluster transitions

### FUTURE WORK

After analyzing the data collected by the High Resolution Doppler Lidar (HRDL) during the Discover AQ campaign, the results show that the Cluster Analysis is an effective method for determining the planetary boundary layer height compared to the Peak Detection method and Peak-based Thresholding. These methods will also be applied to a case study on a “typical day” and statistical analysis of all available days for Leosphere data during the LUMEX campaign. A visual examination will again be used to assess and compare the successful rate and availability rate.

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