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To cite this version:

HAL Id: meteo-01379589
https://hal-meteofrance.archives-ouvertes.fr/meteo-01379589
Submitted on 11 Oct 2016

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Automatic detection of boundary layer height using Doppler lidar measurements

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6. Results

Automatic detection of boundary layer height using Doppler lidar measurements

3. Peak detection method

Idea: BL top is a transition between BL and free atmosphere (FA). We identify peaks in both the turbulence and the gradient of the aerosol backscatter profiles.

Two types of profiles:
- Peaks connected to the ground
- Peaks that track a transition

Turbulence must maintain high values all the way to the ground.
1) Define a peak-based threshold
2) Look for the highest point above the threshold

BLH = highest point connected to the ground

4. Continuity test

For each peak, we look for neighbors in a window of height and time. All the peaks in the same window are linked together by a thread.

5. Cluster analysis

Idea: BL air is characterized by:
- High turbulence
- High aerosol content

We track the BL air by gathering these high values in clusters.

Algorithm: "K means" (non-hierarchical clustering). Used mainly in data-mining.
From: Toledo et al. (2013)*
Description: Iterative algorithm with three steps in the main loop:
1) Calculate point-to-seed distances.
2) Link each point with its closest seed.
3) Redefine the seed.

6.1 A good day

Transition that human eye identifies as BLH in the data is selected by both methods

6.2 A bad day

The chosen peak is not the good one, and the cluster analysis doesn’t identify the BL air

6. Conclusion and next steps

At this point, we have an estimation of BLH from each of the data (velocity variance, aerosol backscatter, wind), independently. But each one have its drawbacks (range, availability, accuracy). Mixing them intelligently could be a way to build a full time available and accurate estimator. The clustering analysis method misses the data from the beginning, but not yet the wind info. The main drawback is representativeness of the cluster.

- Add wind information (wind speed and wind direction) in clustering
- Investigate the convergence of the seeds (are the final clusters representative?)
- Improve the mechanism to choose the peaks
- Mix the 6 peak estimators into a single one
- Evaluate the algorithms on a extended dataset

Successful days

<table>
<thead>
<tr>
<th>Estimator</th>
<th>Kmeans</th>
<th>VS var</th>
<th>VS RCI</th>
<th>BT var</th>
<th>BT RCI</th>
<th>WP spd</th>
<th>WP grad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful days</td>
<td>13 (62%)</td>
<td>17 (81%)</td>
<td>9 (43%)</td>
<td>11 (53%)</td>
<td>10 (48%)</td>
<td>13 (62%)</td>
<td>7 (33%)</td>
</tr>
</tbody>
</table>