A Land-Based Mobile Wind Lidar for Boundary Layer Wind Measurements: Overview and Recent Results

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UVA Wind Observatory on Wheels (UWOW)

• Dual purpose mobile Doppler Wind Lidar funded by the Office of Naval Research to provide wind measurements of the boundary layer.
  • Housed in a towable trailer (small truck/personal vehicle)
  • Provides fixed location wind measurements
  • Provides mobile measurement on the road
  • Dedicated GPS/INS provides the data that allows platform motion to be accounted for in mobile wind retrievals
  • A generator enables continuous “on the go” operations for ~ 8 hours
UWOW

UVA – Wind Observatory on Wheels

Funded by Office of Naval Research (Ferek)
# HALO Photonics StreamLine XR Lidar

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>HALO Photonics Ltd. (UK)</th>
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<tbody>
<tr>
<td>Model</td>
<td>StreamLine XR Doppler lidar</td>
</tr>
<tr>
<td>Weight</td>
<td>85Kg/185 lbs</td>
</tr>
<tr>
<td>Wavelength</td>
<td>1.5 µm</td>
</tr>
<tr>
<td>Pulse Repetition Frequency (PRF)</td>
<td>10 kHz</td>
</tr>
<tr>
<td>Data Acquisition</td>
<td>Up to 10Hz</td>
</tr>
<tr>
<td>Detector type</td>
<td>Heterodyne (coherent)</td>
</tr>
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Haulmark Covered Trailer

- Torflex suspension and tandem axles for increased stability while moving.
- Scissor jack on each corner to stabilize the trailer when stationary
- Overall dimensions: 16’00”L x 7’08”W x 7’11”H
- Weight Fully Loaded: 7000lbs
- Hole cut out in roof piece to accommodate the heat shield and scanner
Trailer attitude and navigation data from a GPS-INS are needed in addition to the lidar data to enable the removal of the platform motion from the 6 look Line of Sight lidar observations.

The UWOW’s GPS-INS data and lidar radial velocity data file are used as input to software previously developed by SWA for calculating the wind field from aircraft-mounted Doppler lidars.
Changes to the attitude of the DWL between scans need to be taken into account when calculating the wind properties of a mobile platform. In order to account for these effects, a COTS GPS-INS was used to determine the DWL’s attitude and velocity at all times.

<table>
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<tr>
<th>Manufacturer</th>
<th>VectorNAV Technologies (USA)</th>
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<tr>
<td>Model</td>
<td>VN-200 GPS-Aided INS</td>
</tr>
<tr>
<td>Dynamic Accuracy &amp;</td>
<td>0.3° RMS (Heading), 0.1° RMS (Pitch, Roll)</td>
</tr>
<tr>
<td>Static Accuracy</td>
<td>2.0° RMS (Heading), 0.5° RMS (Pitch, Roll)</td>
</tr>
<tr>
<td>Velocity Accuracy</td>
<td>±0.05 m/s</td>
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Deployed during the Ozone Water-Land Environmental Transition Study (OWLETS-2) near Baltimore, MD in June 2018 to measure the boundary layer wind field of the water-land transition zone in the upper portion of the Chesapeake Bay

- Parked overnight at UMBC collecting wind profiles every few minutes over 15 days
- Stationary measurements at Bay City Park looking out into the Chesapeake Bay
- Three mobile deployments (June 18, June 29, June 30)
- Two bridge crossing on June 30
- Stationary measurements during “missions”
  1) Fort Smallwood Park
  2) Sparrows Point High School
- Comparison with winds from Ozonesondes
Flows in the lowest few hundred meters were typically southerly over the Bay with northwesterly synoptic flows aloft. This is a clear indication of the Bay Breeze which was observed on all three UWOW deployment days (June 18, 29 and 30).
Examples of UWOW wind profiles while on the move - June 30, 2018
June 30th Key Bridge Crossings (2)
1st Key Bridge Crossing (~1505Z)
Parked at Sparrows Point High School
Mobile Mode 1st Bridge Crossing

Stopped After 1st Bridge Crossing
Ozonesondes around 1714Z at HMI and UMBC
2nd Key Bridge Crossing (~2110Z)
Parked at Sparrows Point High School
Ozonesondes around 2005Z at HMI, UMBC, and HUBV
Mobile Mode 2\textsuperscript{nd} Bridge Crossing

Stopped Before 2\textsuperscript{nd} Bridge Crossing
Conclusions

UWOW was successfully deployed during OWLETS-2 (2018):

1) Provided both stationary and mobile lidar measurements of the boundary layer wind field

2) Stationary measurements showed consistent flow patterns in the Chesapeake Bay area. The presence of afternoon southerly Bay breezes in the presence of westerly synoptic flows is present in all measurements

3) The first ever UWOW mobile wind profiles look promising and offer a new and cost-efficient way to investigate the spatial and temporal variability of local- and mesoscale flows, including over the water-land transition zone