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

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Ninth Symposium on Lidar Atmospheric Applications

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University of Virginia
Department of Environmental Sciences

Office of Naval Research
ONR
Science & Technology

SWA
Simpson Weather Associates

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

University of Virginia
Department of Environmental Sciences

UWOW

Simpson Weather Associates

Stefan DeWekker (UVA)

UVA – Wind Observatory on Wheels

Dave Emmitt (SWA)

Lidar: HALO photonics StreamLine XR

Funded by Office of Naval Research (Ferek)

HALO Photonics StreamLine XR Lidar

Manufacturer	HALO Photonics Ltd. (UK)
Model	StreamLine XR Doppler lidar
Weight	85Kg/185 lbs
Wavelength	1.5 µm
Pulse Repetition Frequency (PRF)	10 kHz
Data Aquisition	Up to 10Hz
Detector type	Heterodyne (coherent)

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

Deriving wind profiles from a moving platform

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.

GPS/INS

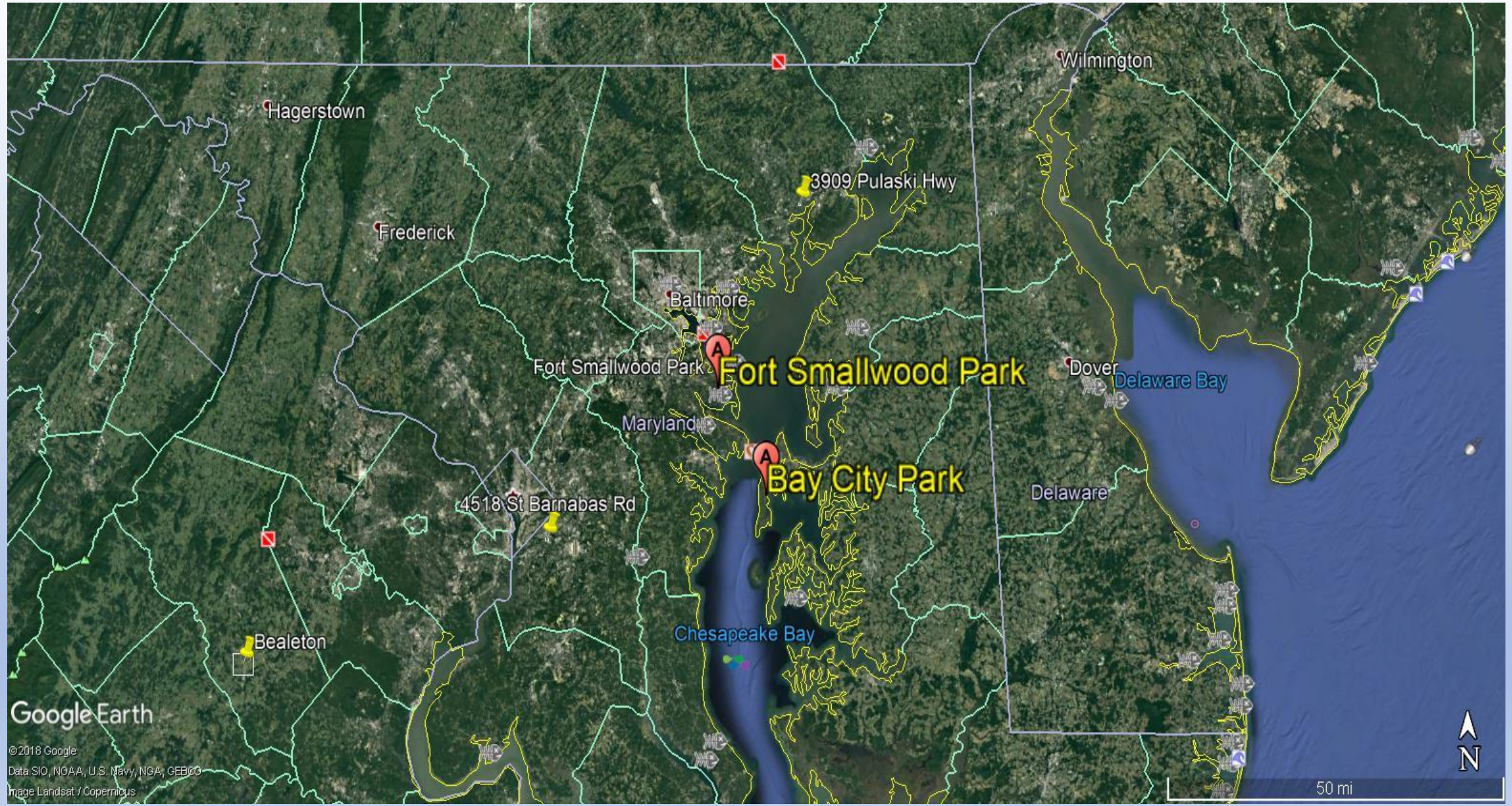
Changes to the attitude of the DWL between scans need to be taken into account when calculating the wind properties of a mobile platform. In order to account for these effects, a COTS GPS-INS was used to determine the DWL's attitude and velocity at all times.

Manufacturer	VectorNAV Technologies (USA)
Model	VN-200 GPS-Aided INS
Dynamic Accuracy &	0.3° RMS (Heading), 0.1° RMS (Pitch, Roll)
Static Accuracy	2.0° RMS (Heading), 0.5° RMS (Pitch, Roll)
Velocity Accuracy	±0.05 m/s

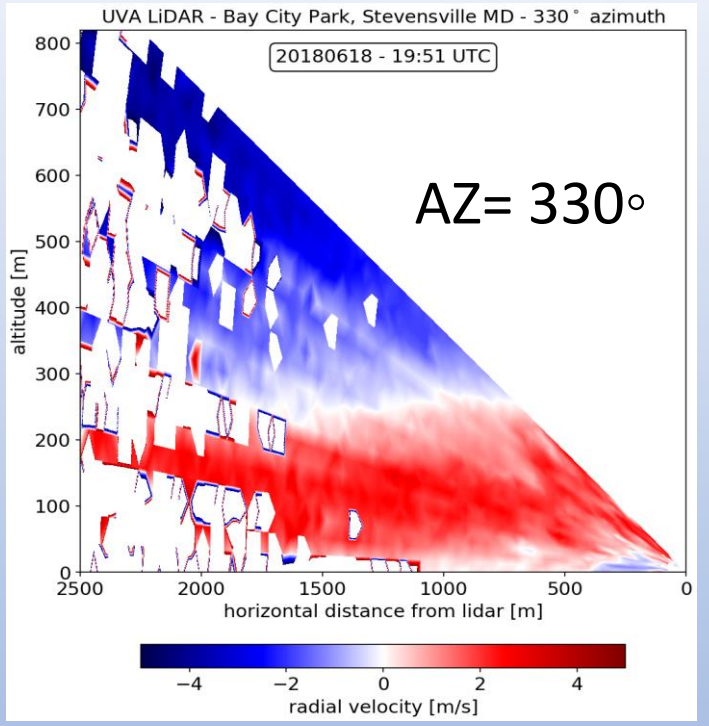
Field Deployment and Data Collection

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

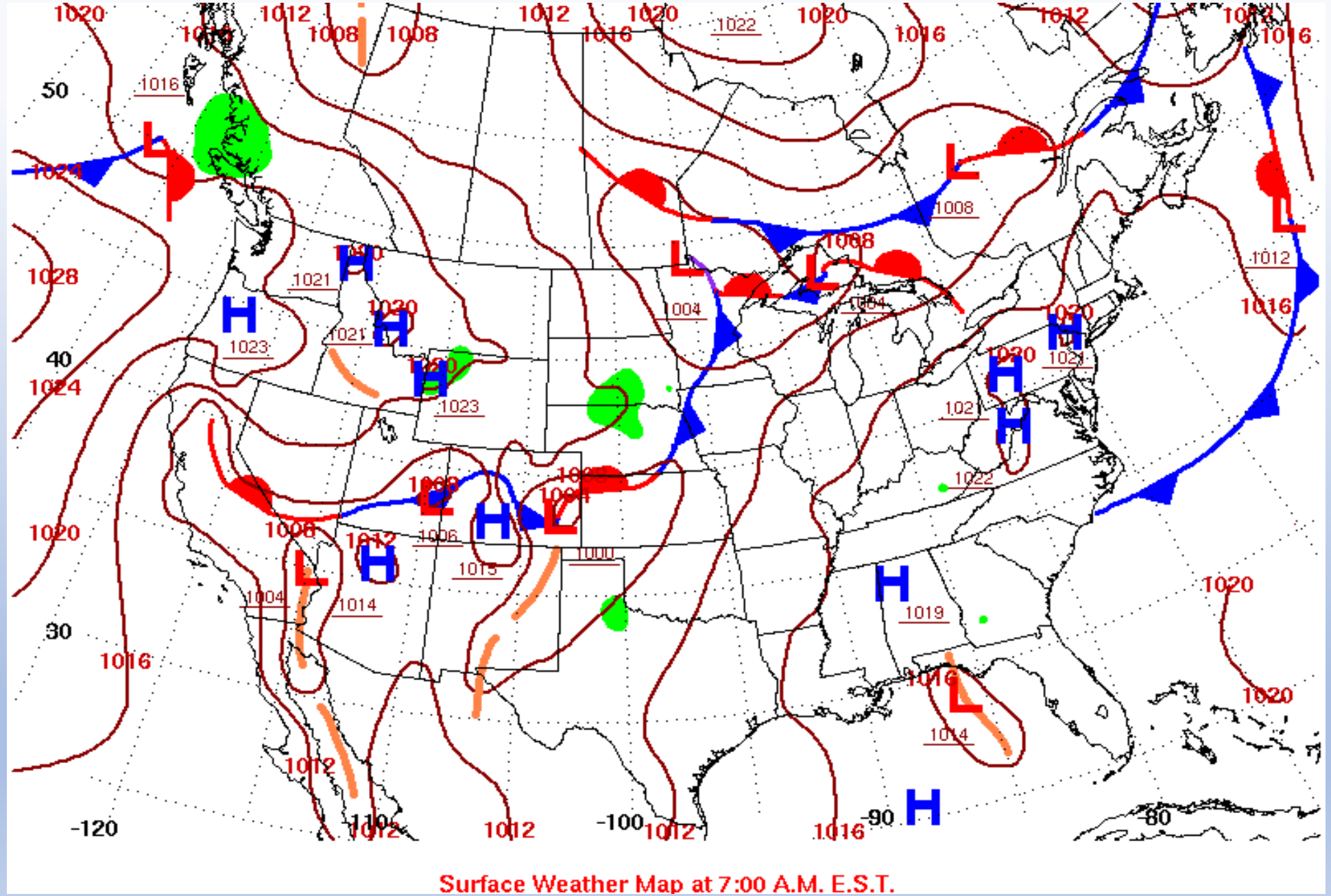

Wilmington
Hagerstown
3909 Pulaski Hwy
Frederick
Baltimore
Fort Smallwood Park
Fort Smallwood Park
Dover
Delaware Bay
Maryland
Bay City Park
Delaware
4518 St Barnabas Rd
Chesapeake Bay
Bealeton
Google Earth
©2018 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
N
50 mi

Stationary UWOW observations near the Annapolis Chesapeake Bay Bridge



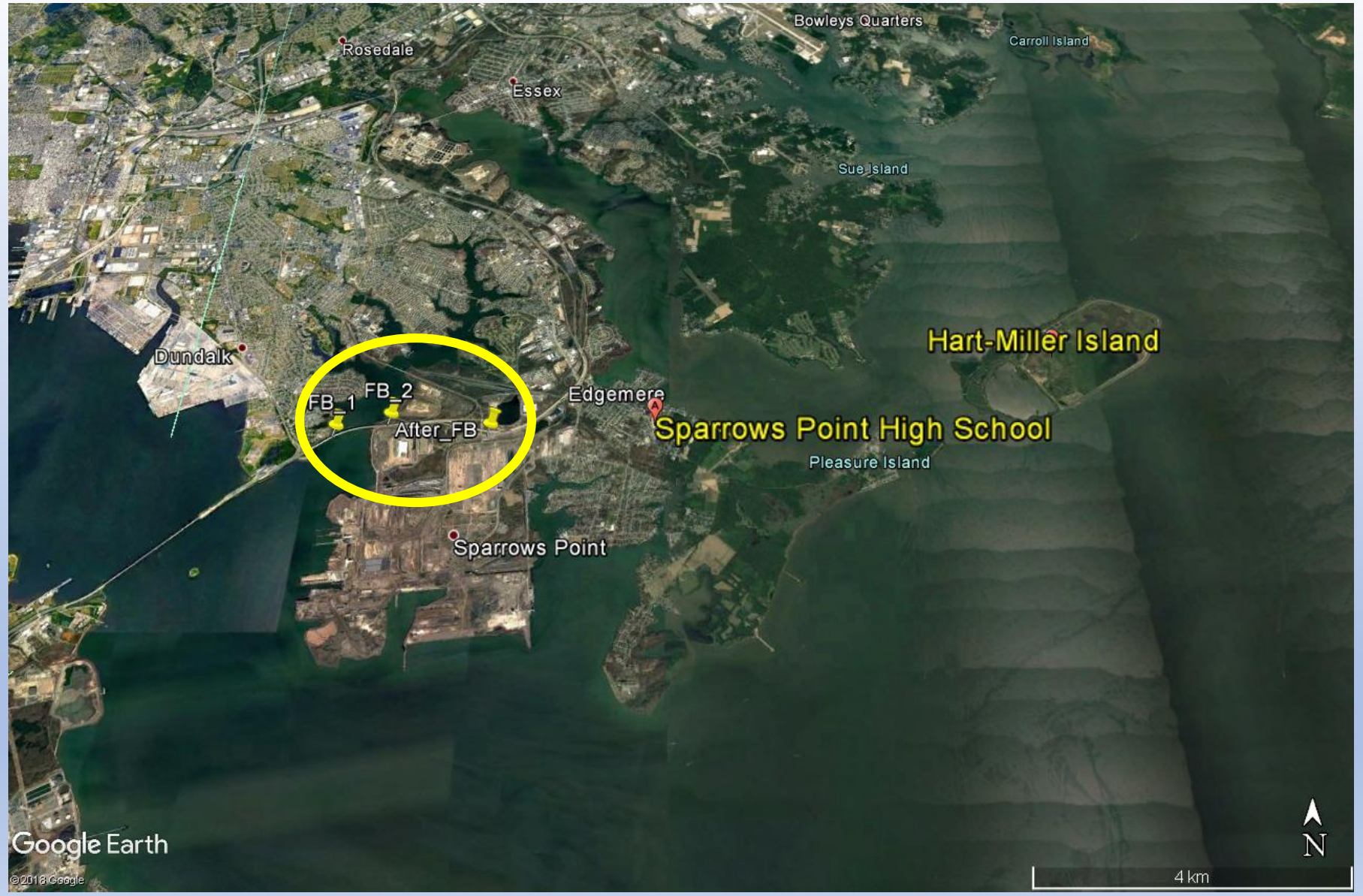
Flows in the lowest few hundred meters were typically southerly over the Bay with northwesterly synoptic flows aloft. This is a clear indication of the Bay Breeze which was observed on all three UWOW deployment days (June 18, 29 and 30).

Examples of UWOW wind profiles while on the move - June 30, 2018

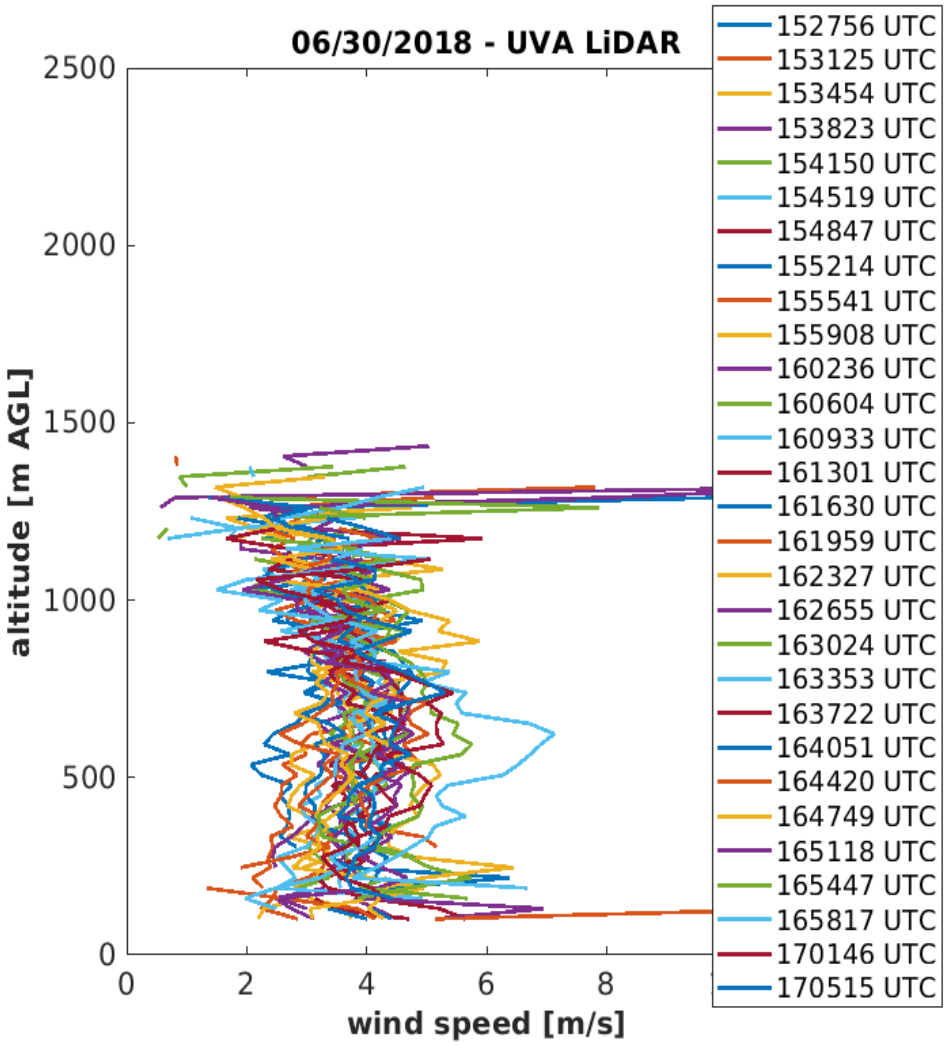

Surface Weather Map at 7:00 A.M. E.S.T.

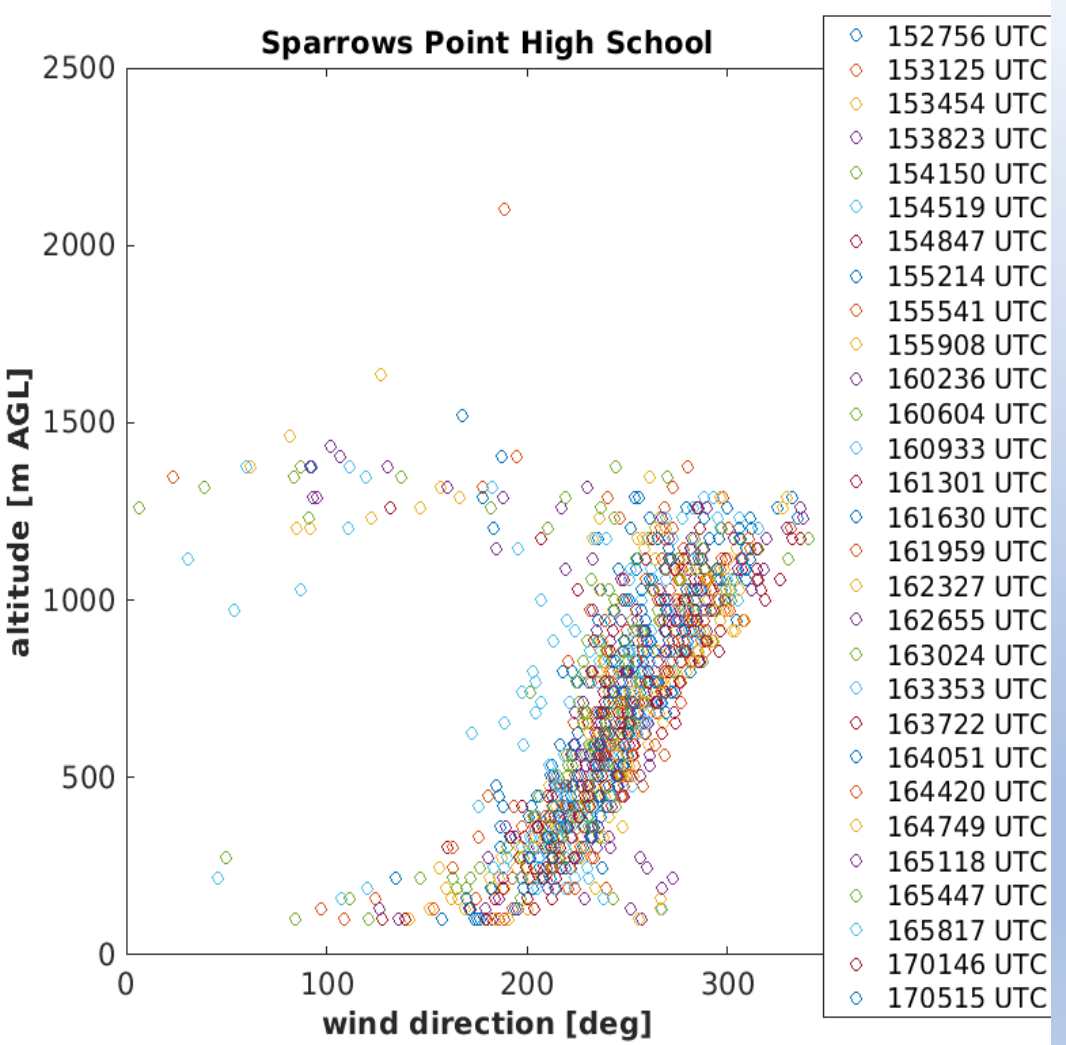
June 30th Key Bridge Crossings (2)

1st Key Bridge Crossing (~1505Z)

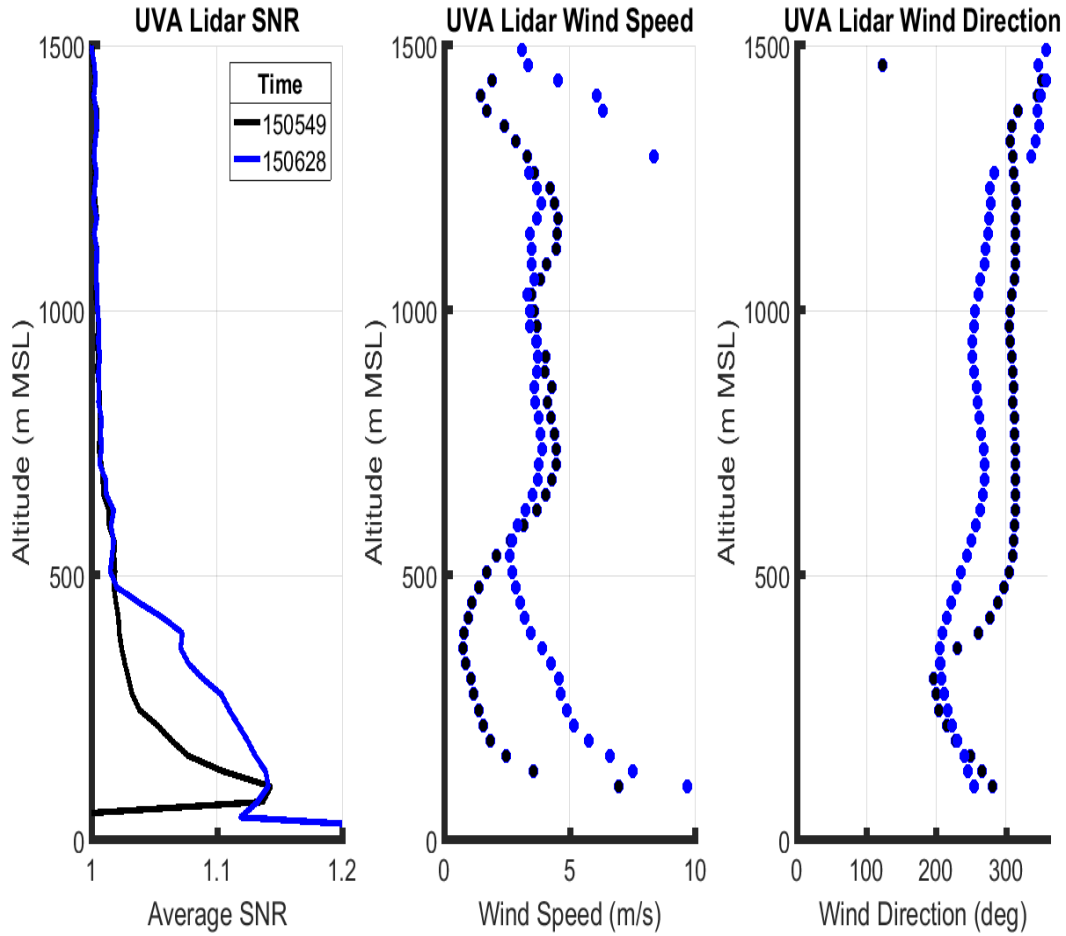


Parked at Sparrows Point Hight School

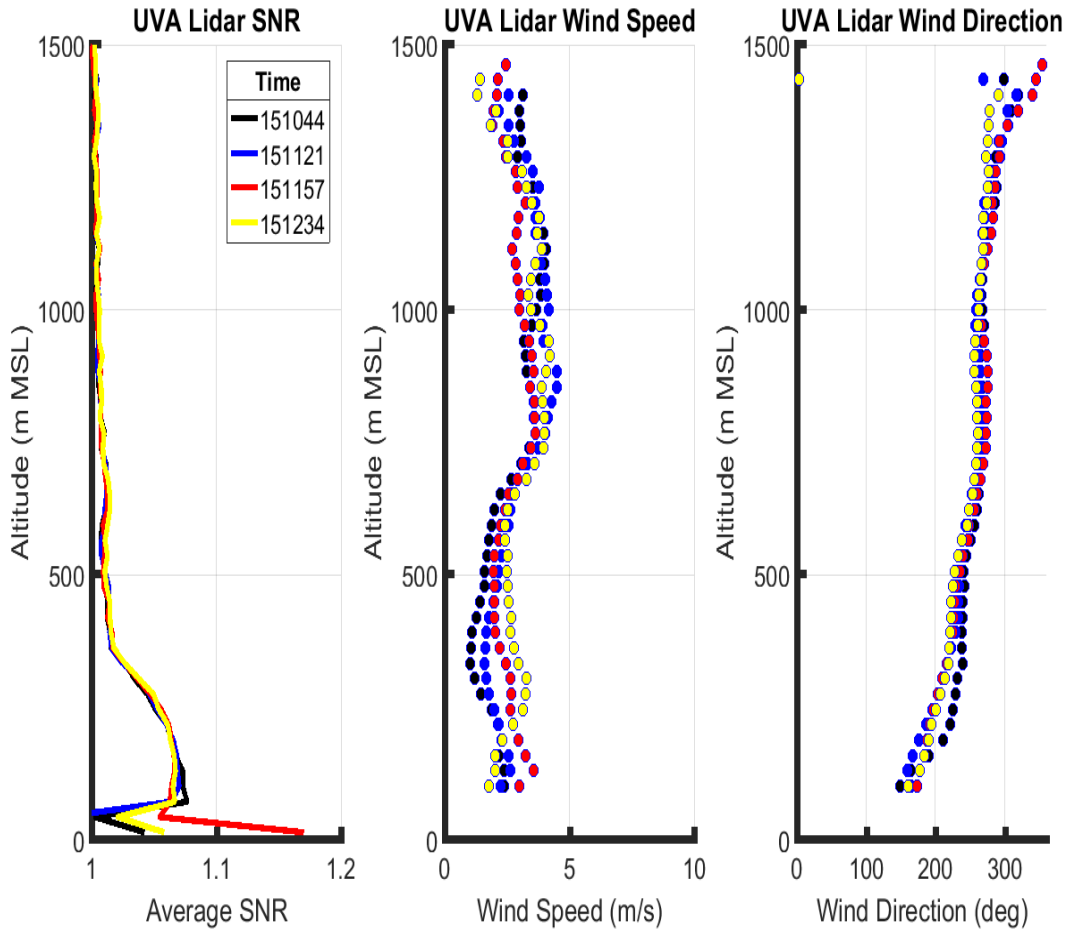




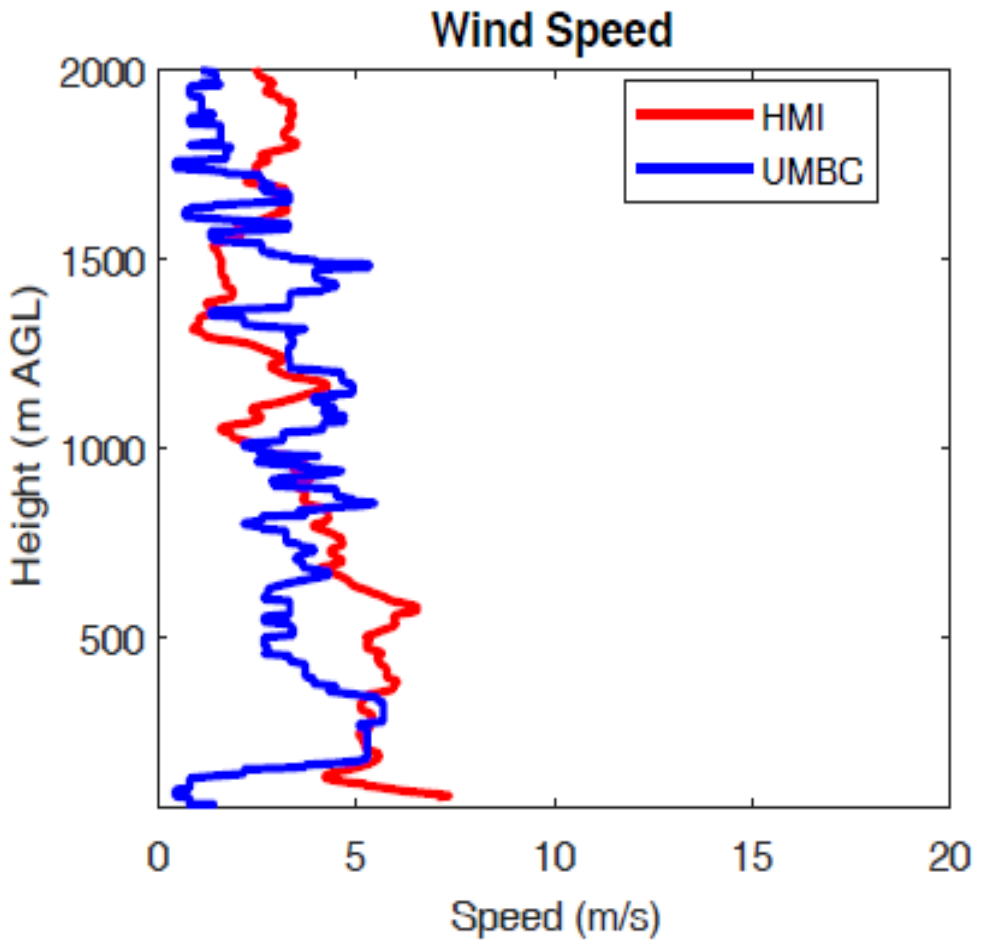
Mobile Mode 1st Bridge Crossing

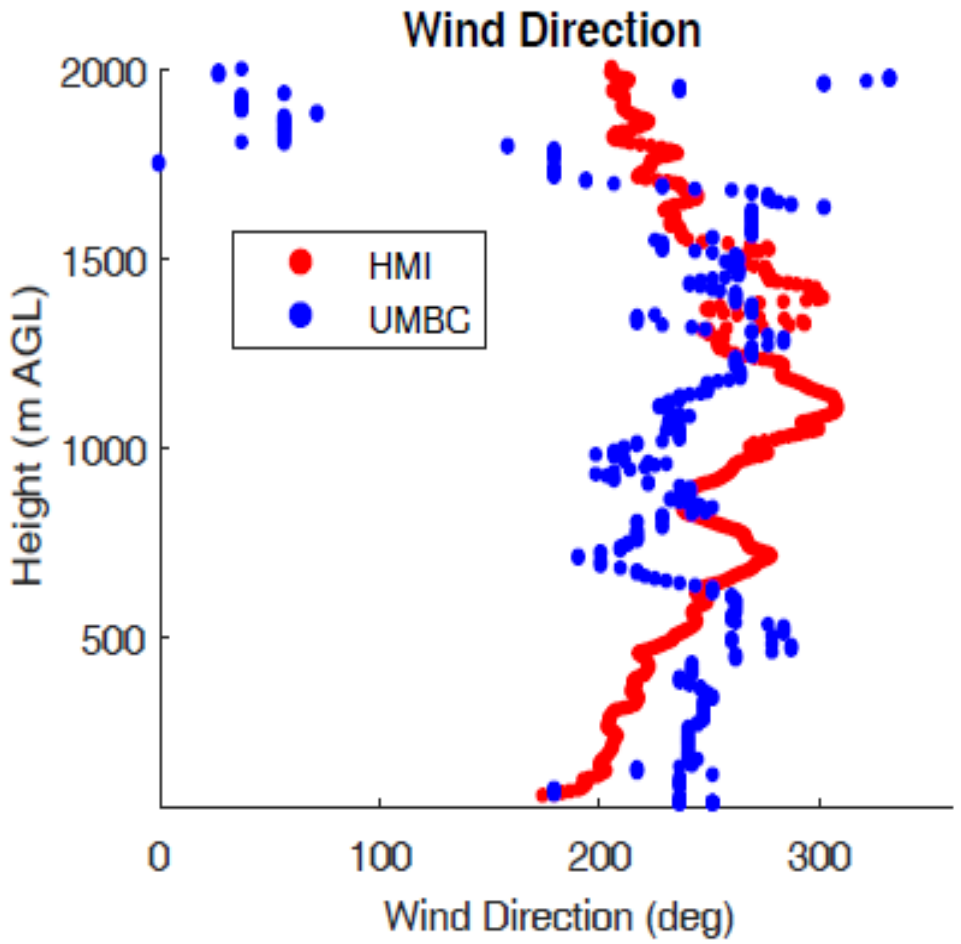


Stopped After 1st Bridge Crossing

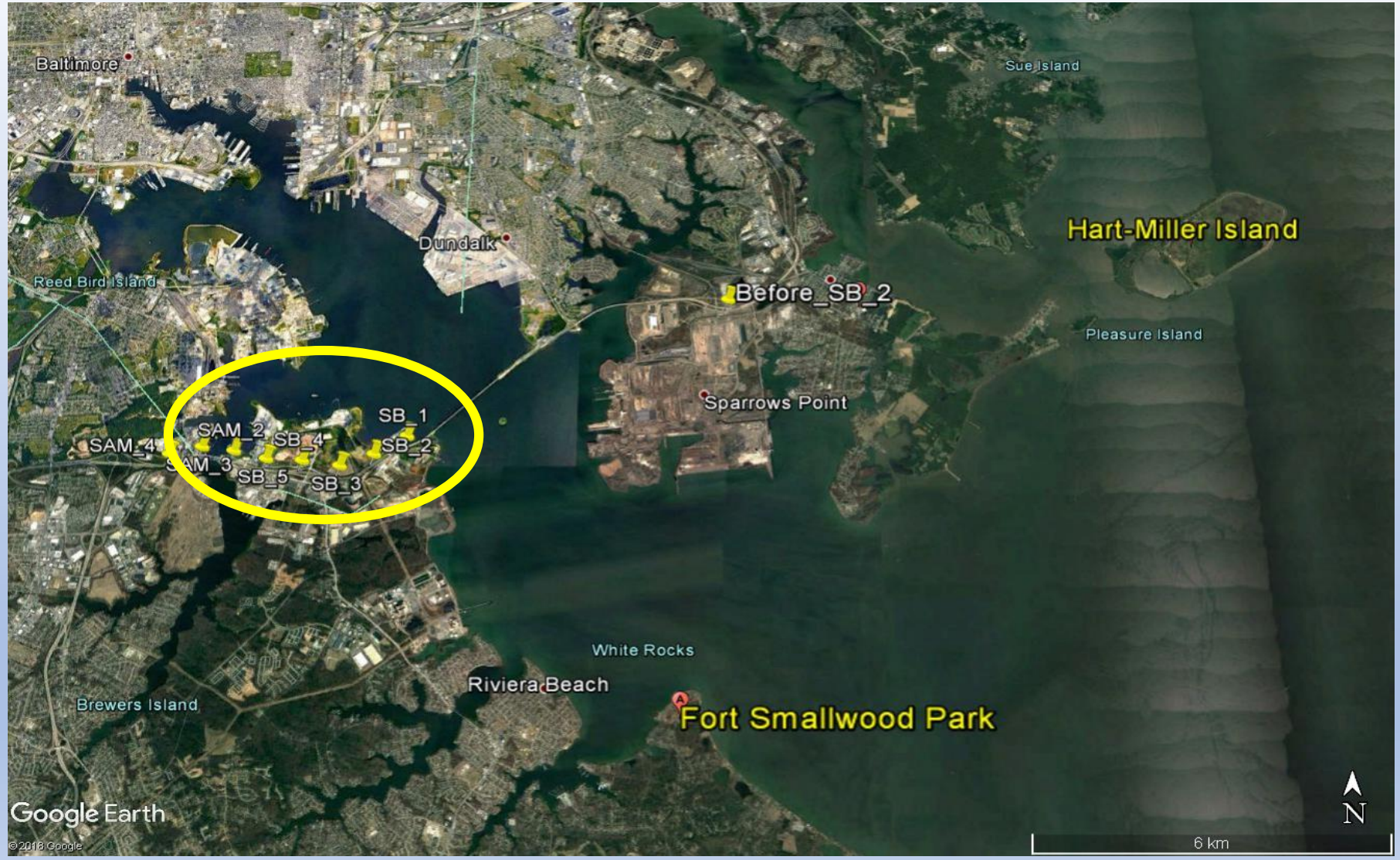


Ozonesondes around 1714Z at HMI and UMBC

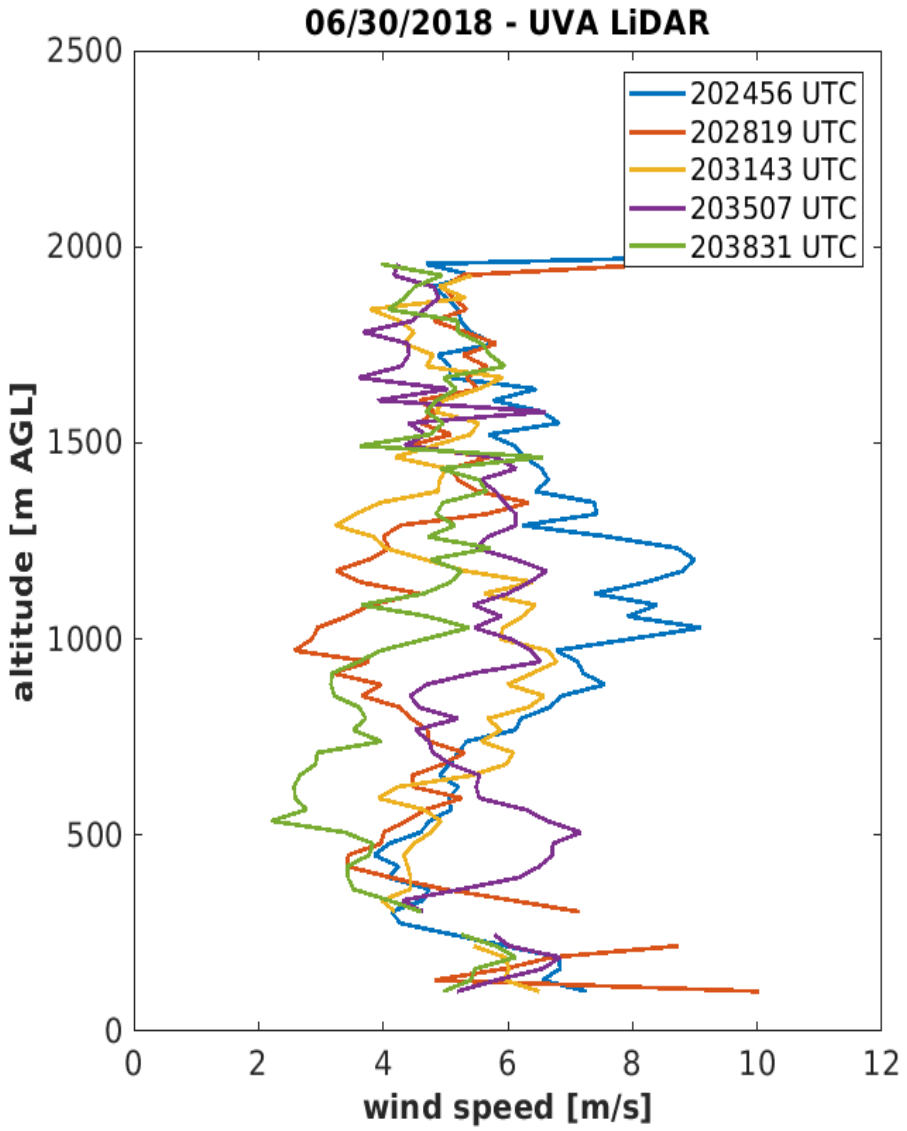


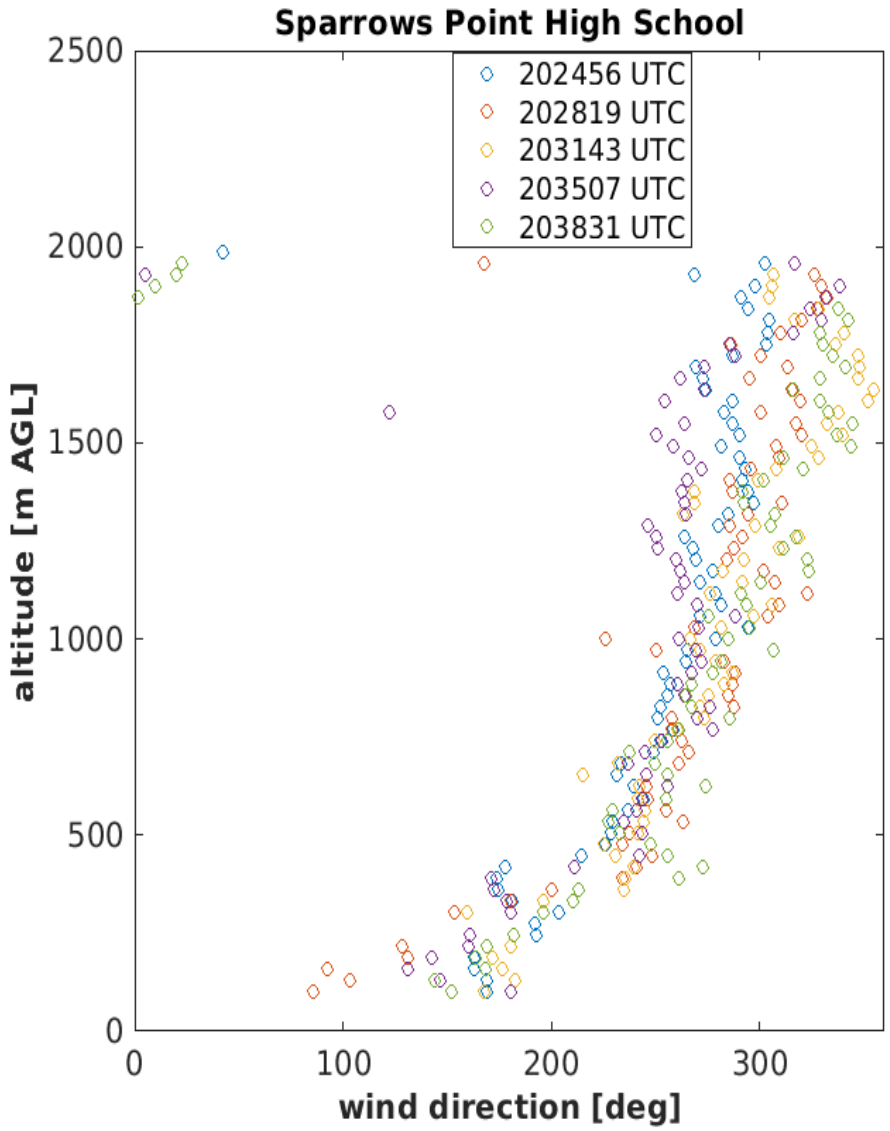


2nd Key Bridge Crossing (~2110Z)

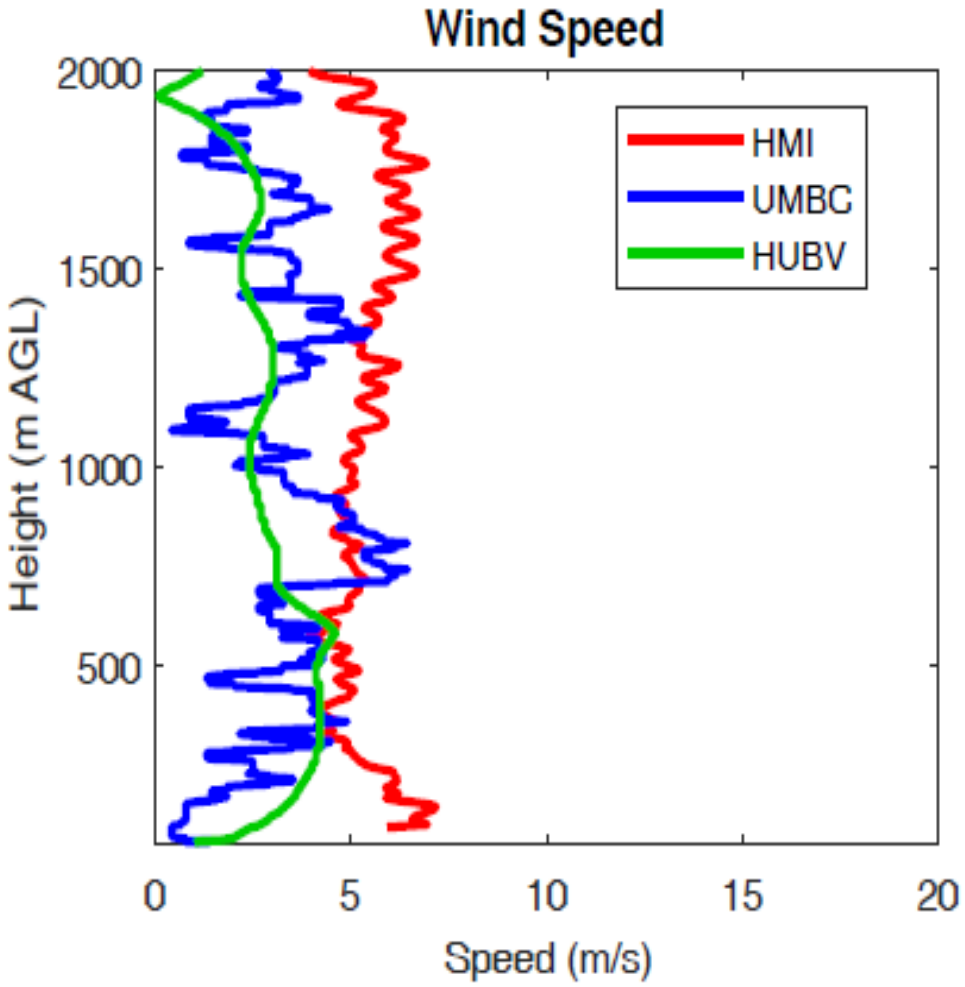


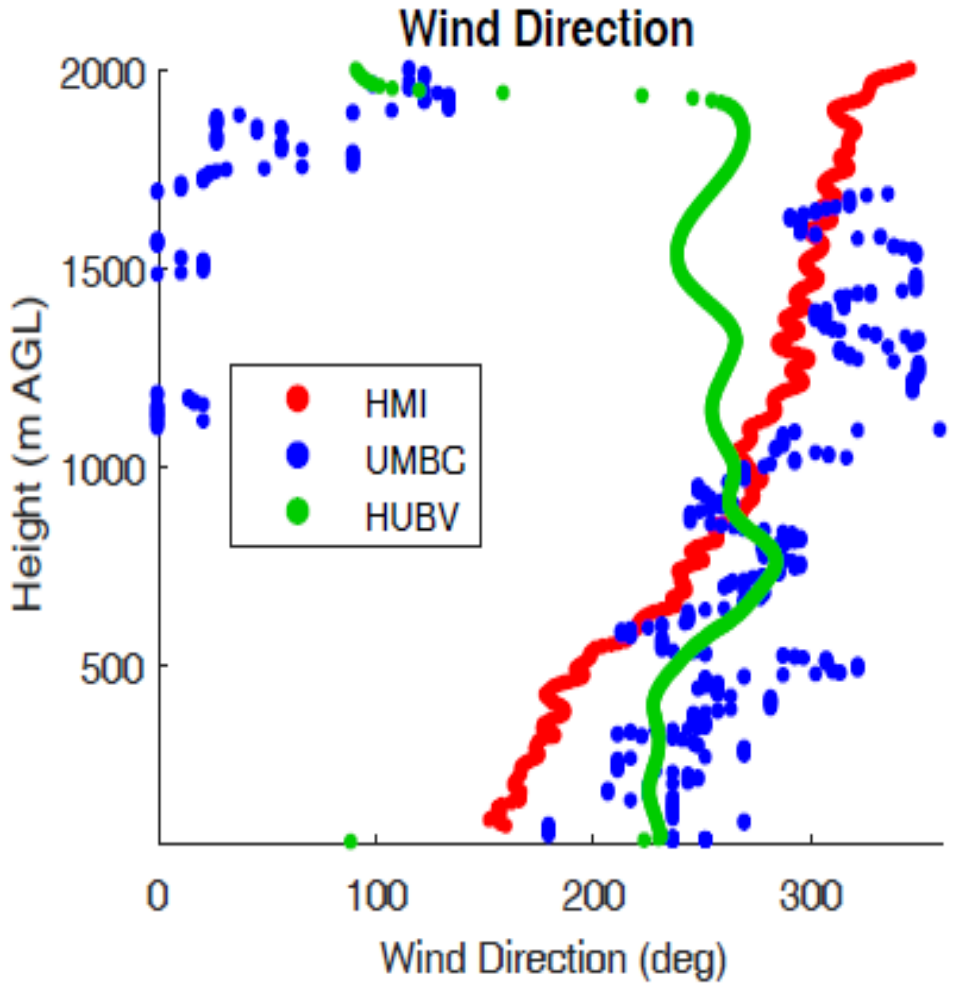
Parked at Sparrows Point Hight School





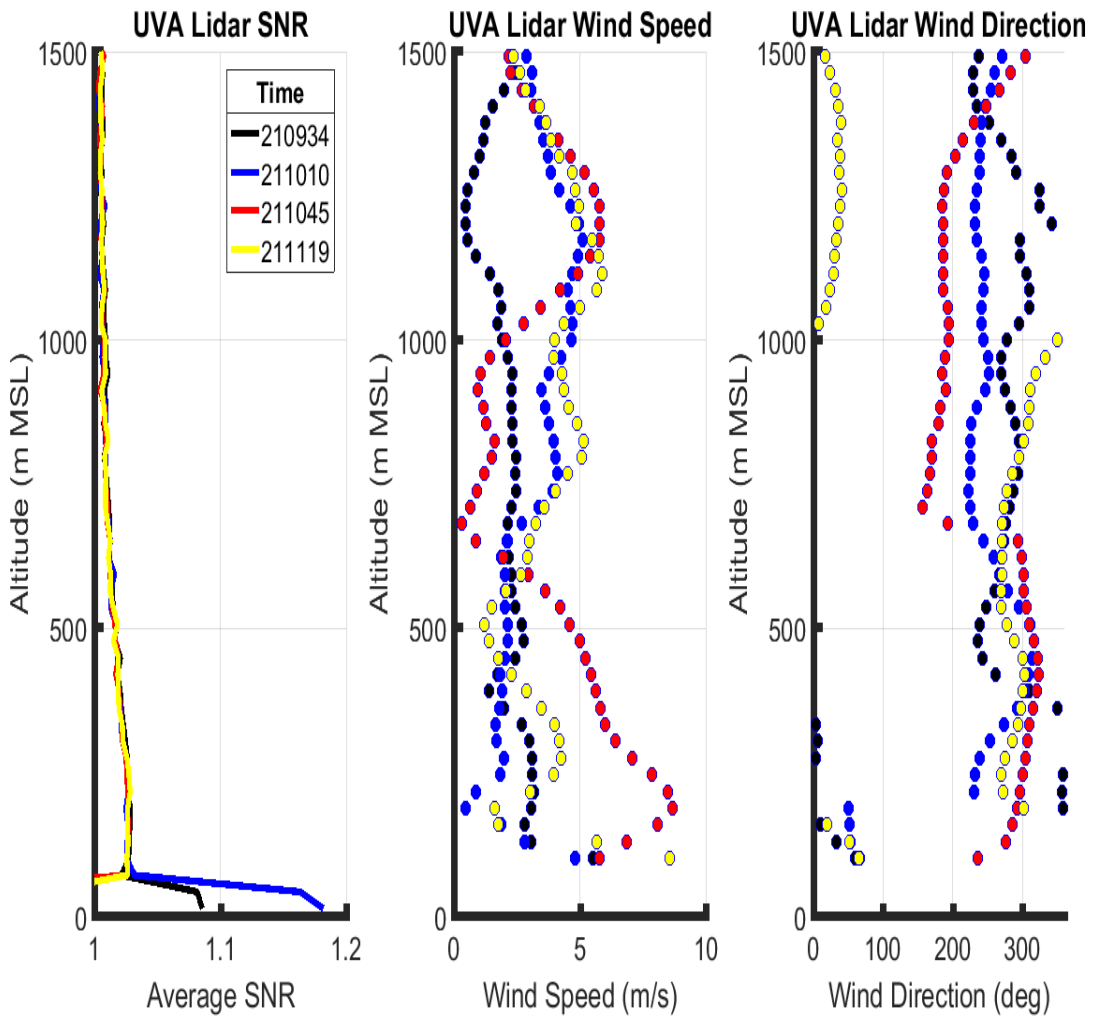
Ozonesondes around 2005Z at HMI, UMBC, and HUBV



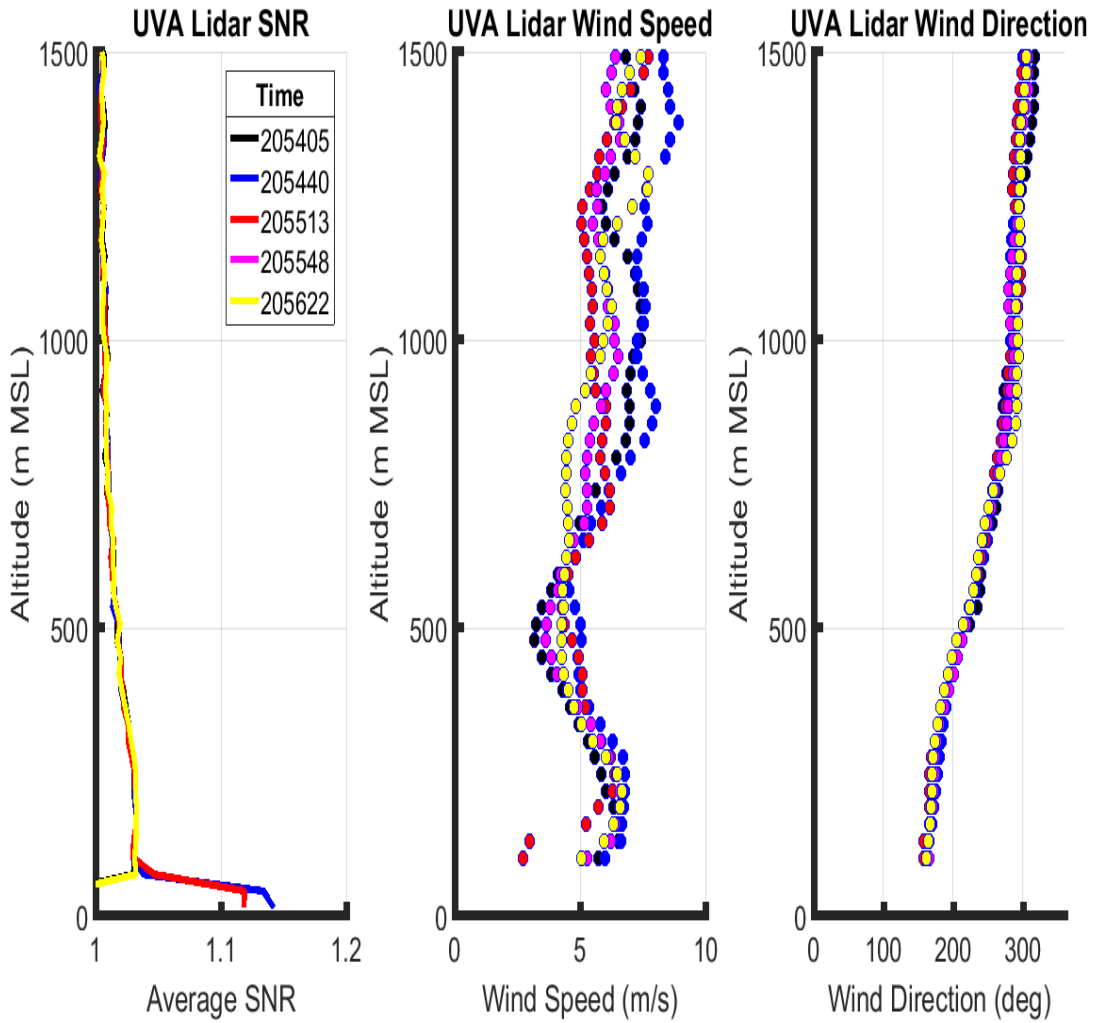


2005Z HMI

Mobile Mode 2nd Bridge Crossing



Stopped Before 2nd 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**