REMOTE SENSING MONITORING OF CANADIAN WILDFIRE SMOKE AND ITS IMPACT ON BALTIMORE AIR QUALITY

Shelbi Tippett[1,2], Ruben Delgado[1]

[1]Joint Center for Earth Systems Technology, UMBC, [2]Department of Mechanical Engineering, UMBC

Background

High spatial and temporal resolution Elastic light detection and ranging (lidar) measurements allows to monitor long-range transport of particulates, such as dust and smoke, that impact local and regional air quality. These lidar measurements enhance current knowledge and understanding on how vertical layering and long range transport of natural and anthropogenic particle pollution may alter the relationship between column aerosol optical depth (AOD) and surface particle pollution concentrations. The UMBC Elastic lidar system is illustrated in **Figure 1**. Integration of multiple remote sensors (**Figure 2**) allow us to provide a 3D representation of the impact particle pollution may have over an urban area in the analysis of an air quality event.

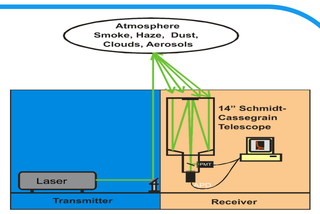

Figure 1. ELF Schematic

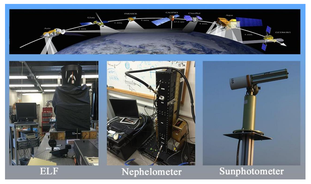

Figure 2. UMBC Monitoring of Atmospheric Pollution (UMAP)

June 2015 Smoke Event

During the week of June 7th of 2015, various wildfires in Alberta and Saskatchewan, Canada, produced smoke that was transported over the Baltimore area causing elevated AOD and particle pollution values. **Figure 3** (Alberta Wildfire Info, 2015) is an aerial view of one such contributing wildfire in the Willmore Wilderness Park. It was discovered on June 8th and by June 12th the fire had spread out of control to approximately 14,000 hectares.

Figure 3. Aerial view of Willmore Wilderness Park fire, compliments of the Alberta Wildfire Info Facebook page

In **Figure 4**, the Hazard Mapping System (HMS) smoke and fire products shown are from June 6th, 2015. Fires in Alberta and Saskatchewan Canada were producing light to heavy smoke. The overlaid Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model shows the path traveled by the light smoke into the Baltimore area between the 6th and 11th of June 2015.

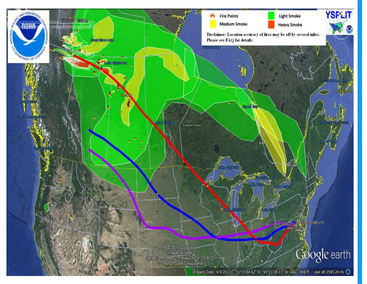

Figure 4. Google Earth overlay of HMS Fire and Smoke Product with NOAA HYSPLIT back trajectory

Satellite

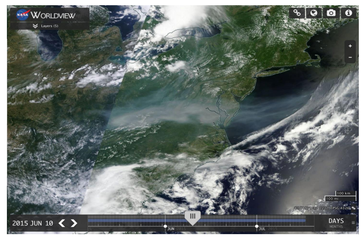

Figure 5. NASA's EOSDIS Worldview image for June 10th

NASA's Earth Observing System Data and Information System (EOSDIS) Worldview Image (**Figure 5**) from June 10th, 2015 displays a large plume of smoke extending across portions of Maryland, covering the Baltimore area.

The NOAA Geostationary Operational Environmental Satellite Aerosol Smoke Product imagery, **Figure 6**, indicates a heavily increased aerosol loading on the night of June 10th over Baltimore. The distribution of heavy AOD corresponds to the size and shape of the plume of smoke shown in **Figure 5**.

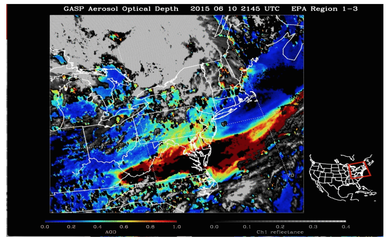

Figure 6. NOAA GASP Aerosol Optical Depth image for June 10th

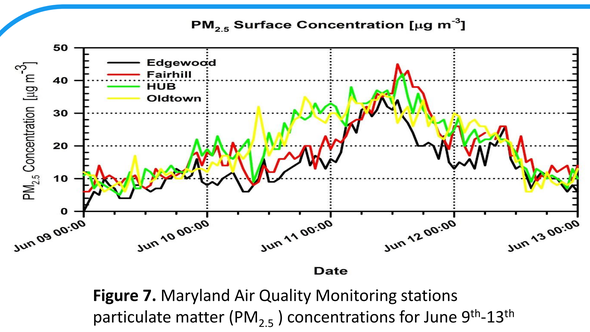

Figure 7. Maryland Air Quality Monitoring stations particulate matter ($PM_{2.5}$) concentrations for June 9th-13th

$PM_{2.5}$ concentrations were elevated throughout June 11th-12th, displayed in **Figure 7**. $PM_{2.5}$ particles are the smaller particulates typically comprised of toxic organic compounds which make them potentially more harmful. They can travel hundreds of miles and remain in the air for days at a time

Lidar

The peak on June 11th in the scattering/extinction profile (**Figure 8**) is characteristic of increased absorption therefore the presence of uncommon particles. The ELF system detected particles shown in **Figure 9**, which corresponds to the presence of smoke over Baltimore on June 11th.

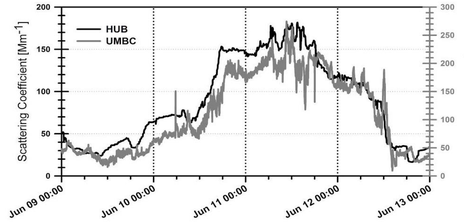

Figure 8. UMBC and HUB Scattering/Extinction Profile for June 9th-13th

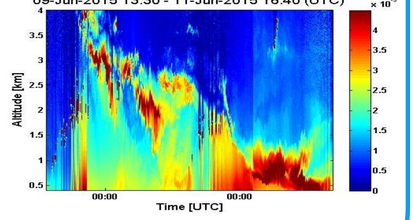

Figure 9. UMBC ELF atmospheric profile for June 9-11th

Sunphotometer

- **Figure 10** is a cluster analysis of the Absorption Ångström Exponent (AAE) versus the Extinction Ångström Exponent (EAE). This AERONET data determines aerosol type and size.
- Higher albedo values (**Figure 11**) are known to be correlated with smaller complex refractive index values [**Figure 12**] (Dubovik et al. 2002).
- An increase in size distribution for Maryland is shown in **Figure 13**.

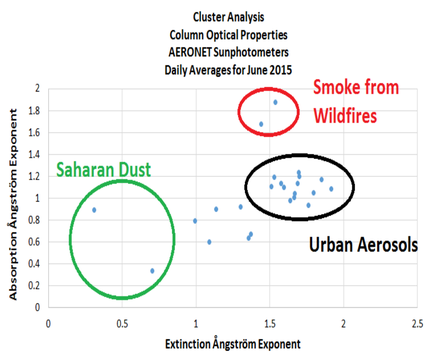

Figure 10. Cluster Analysis of Angstrom exponents from UMBC and MD Science Center stations for June 2015

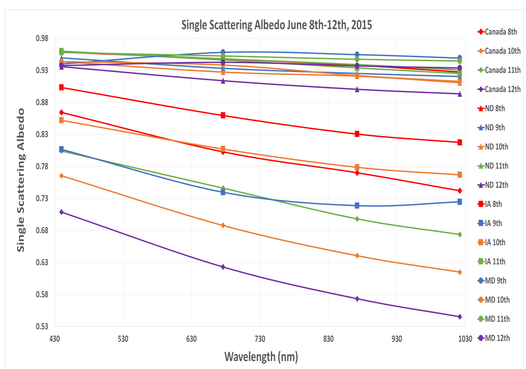

Figure 11. AERONET SSA vs. wavelength, June 8th-12th

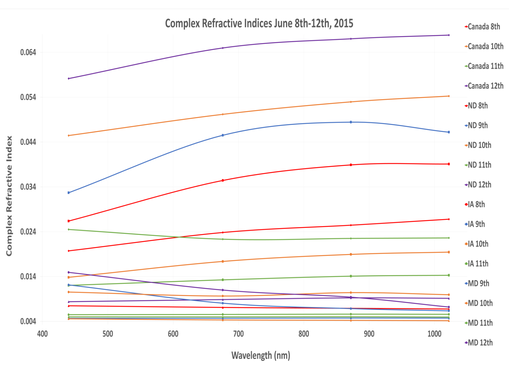

Figure 12. AERONET Complex Refractive Indices, June 8th-12th

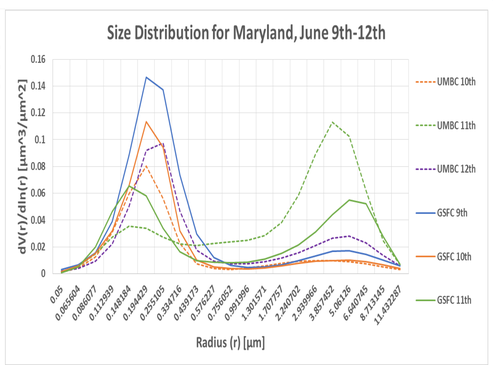

Figure 13. Size Distribution for MD, June 9th-12th

References

Alberta Wildfire Info. Facebook page June 11th [Online Image] . (2015). Retrieved July 26th, 2015 from https://www.facebook.com/AlbertaWildfireInfo

Oleg Dubovik, Brent Holben, Thomas F. Eck, Alexander Smirnov, Yoram J. Kaufman, Michael D. King, Didier Tanré, and Ilya Slutsker, 2002: Variability of absorption and optical properties of key aerosol types observed in worldwide locations, *J. Atmos. Sci.,* **59**, 3, 590-608.

P.B. Russell, R. W. Bergstrom, Y. Shinozuka, A. D. Clarke, P. F. DeCarlo, J. L. Jimenez, J. M. Livingston, J. Redemann, O. Dubovik, and A. Strawa, 2010: Absorption Angstrom Exponent in AERONET and related data as an indicator of aerosol composition. *Atmospheric Chemistry and Physics,* **10**: 1155-1164.

Acknowledgements

This research is supported by NOAA-CREST/CCNY Foundation CREST Grant-NA11SEC481004.3 and the Joint Center for Earth Systems Technology.