Multi-Lidar Observation of Fresh Wildfire Smoke over Hampton in Winter

Jia Su[1,2], Ruben Delgado[1,2,3], Timothy A. Berkoff[4], John T. Sullivan[5], Guillaume P. Gronoff[4,6]

[1]*Center for Atmospheric Sciences, Hampton University, Hampton, Virginia 23669, USA*
[2]*Dept. of Atmospheric and Planetary Sciences, Hampton University, Hampton, Virginia 23669, USA*
[3]*NOAA CESSRST, City College of New York, New York, 1003, USA*
[4]*NASA Langley Research Center, Hampton, VA, 23681, USA*
[5]*NASA Goddard Space Flight Center, Chemistry and Dynamics Laboratory, Greenbelt, MD 20771, USA*
[6]*Science Systems and Applications, Inc, VA, 23681, USA*

Abstract

Wildfire smoke transport during the winter can significantly affect local ozone (O_3), water vapor and particulate matter (PM) concentrations. Here, we used observations from the Multi-wavelength Raman-Mie Lidar, the small Scanning Lidar, two Doppler Lidars (Army Research Lab), the NASA Langley Mobile Ozone Lidar (LMOL), the Micro-Pulse Lidar (MPL), the local weather station, the Sun-photometer and radiosondes to study and assess fresh wildfire smoke (<3 hours old) transport, vertical distribution, optical properties, and potential impact on air quality and weather of coastal areas in Hampton, VA during the winter 2019. We investigated an episode of fresh smoke transported and mixed into the planetary boundary layer (PBL) in HU from November 20 to 21, 2019. The horizontal advection of the smoke is shown to be characterized with the prevailing northwest winds from the PBL to the top of troposphere (velocity>10 m/s) based on measurements from radiosondes and Doppler wind lidars. The wildfire smoke transport paths are identified from NOAA-Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) backward trajectory analysis. Results of remote measurements and characterization of fresh wildfire smoke observed in the troposphere over Hampton, Virginia, are presented and discussed. Quadrative analyses of optical and microphysical properties of the smoke aerosols include aerosol backscatterings, aerosol optical depth (AOD), aerosol Angstrom exponents, lidar ratios, depolarization, temperature, wind information, water vapor and ozone. The relationships of AOD of smoke aerosol and ozone or water vapor were obtained to understand the impact of wildfire smoke on local environment. Much smoke aerosol was transported to local and affected local weather in winter. We found wildfire smoke transport can change land breeze to sea breeze to affect winter marine weather. Wildfire smoke caused boundary wind shear and increased convection and turbulence to delay smoke sinking which produced and stored much cloud condensation nuclei (CCNs) above boundary layer. In following days, these CCNs can help to form clouds and precipitation in Hampton area.