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Modeling ozone and atmospheric profiles above a shoreline Lake Michigan site

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PRESENTED AT

ACS Spring 2022

Mar 20-24, 2022

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Abstract

The lake breeze effect along the shoreline of lake Michigan has been attributed to causing high tropospheric ozone concentrations at shoreline locations. The 2021 Wisconsin's Dynamic Influence of Shoreline Circulation on Ozone (WiscoDISCO-21) campaign involved atmospheric measurements over Chiwaukee Prairie State Natural Area in Southeastern Wisconsin from May 21-26, 2021. Three different platforms were used to collect data on this campaign in addition to the regulatory monitor at this site. Two uncrewed aerial systems (UAS), an M210 multirotor copter and the University of Colorado RAAVEN fixed-wing were flown. The RAAVEN flew between 0 and 500 meters above ground level (m AGL) and measured many atmospheric conditions, the most pertinent being temperature, humidity, and winds. The M210 flew between 0 and 120 m AGL and was equipped with a 2B Technologies Personalized Ozone Monitor (POM) which captured ozone concentrations and an Interment Systems iMET-XQ2 meteorology sensor which captured relative humidity, temperature, and pressure. A Lidar Wind Profiler measured backscatter intensities, wind speeds and direction up to 2000 m AGL. Using data from the RAAVEN, the Wisconsin DNR, and the iMET-XQ2, at least one lake breeze was detected every day of the campaign. The largest lake breezes were detected on May 22, 2021, from 17:00-21:38 UTC and on May 24, 2021, from 14:24-22:51 UTC. The presence of the lake breezes correlated with detected temperature inversions measured from the RAAVEN and high ozone events measured from the M210. Lake breezes were investigated with their relationship to vertical profiles measured on the UAS, ozone concentrations, and marine boundary layer height observed with Doppler Lidar and modeled by the High-Resolution Rapid Refresh (HRRR) meteorological model.

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