Understanding the Lake Breeze Front in Eastern WI Through Remote Sensing and Aircraft Measurements

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INTRODUCTION

ABSTRACT

The lake breeze is a meteorological phenomenon which factors into the air quality near the shorelines of Lake Michigan with significant impacts in studies of meteorology, chemistry, atmospheric physics, and more. Using high resolution radar imagery of base reflectivity on days with ozone levels greater than 70ppb, we were able to categorize near-shore and inland lake breeze events from the historic ground-based monitoring data sets, to better quantify the correlation between lake breeze events with ozone episodes. During the Lake Michigan Ozone Study of 2017, an aircraft flew spirals above and within the marine inversion layer. One such day captured spirals above the lake breeze front at a shoreline site, with unique signatures of small spatial gradients in ozone and wind direction in the spiral. We intend to use the data collected from the aircraft platform to understand the low altitude meteorology and air quality relationships near this lake breeze front.

LAKE BREEZES

Lake breezes are natural phenomena that occur when the air above land becomes warmer than the air over the water—in this case, Lake Michigan. The warmer air decreases in density which decreases localized atmospheric pressure. This produces a pressure gradient between the land and water’s air, and makes a breeze moving inland. These lake breezes not only bring cooler air to the land, but can also transport substances in the air, such as ozone, from one location to another. Lake breezes are further classified as near-shore lake breezes—where the lake breeze does not permeate far onto land- and inland lake breezes—where the lake breeze can be monitored several miles away from the lake shore.

LAKE MICHIGAN OZONE STUDY 2017 (LMOS)

The Lake Michigan Ozone Study of 2017 was a collaborative, multi-agency field campaign that employed a family of various ground and automobile platforms, ships, and two aircraft measurement platforms to better understand the ozone production chemistry and precursor emissions in the region along the Wisconsin and Northern Illinois coastline of Lake Michigan. This study ran from May 22, 2017 through June 12, 2017, with this project assessing data pulled from June 12, 2017.

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REFERENCES

1. Doak JAWMA 2021 (in press)
2. Stanier BAMS (2021 submitted)

DISCUSSION

In Figure 3, there is a slight lowering of temperature at low altitudes consistent with high ozone concentrations present in Figure 4. Note in Figures 5 and 6, the data indicates a largely Western wind component. Combined, this is in indication that the flight path crossed into the Marine Layer which contains enhanced ozone levels.