Seasonal Trends in Observed Surface Ozone Conditions in the Arctic

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The Arctic is a region that is currently experiencing dramatic variations in environmental and atmospheric conditions, and is likely to continue to be influenced by a changing climate. In order to understand the implications of drastic changes to the Arctic climate system, it is imperative to understand the expected behavior and associated impacts of different atmospheric constituents. Tropospheric ozone is an important greenhouse gas that contributes to Arctic surface temperatures and is the primary component of photochemical smog. Both formed and destroyed by photochemical reactions with other compounds, ozone concentrations influence the chemical composition and photochemical oxidation properties of the atmosphere. In addition, understanding ground-level ozone is imperative as high levels of ozone can have negative impacts on ecosystem functioning and public health.

Measurements of tropospheric ozone have been made in the Arctic since 1973, which provides a unique opportunity to investigate the long-term trends and changes in observed ozone conditions. Ozonesonde profiles can provide additional information about the observed trends by providing information regarding the surface up to the tropopause from vertically distributed measurements. Currently, eight Arctic sites monitor ground-level ozone and are used for this investigation (Alert, Canada; Barrow, Alaska; Eureka, Canada; Ny-Ålesund, Svalbard; Pallas, Finland; Summit, Greenland; Tiksi, Russia; and Villum Research Station, Greenland). Ozonesondes are launched at seven sites: Churchill, Alert, Eureka, Ny-Ålesund, Sodankyla, Summit, and Scoresbysund.

Trends in ozone conditions vary between stations as well as seasons. Some measurement location records, such as Barrow, show a statistically significant increase in observed mixing ratios over the 45-year measurement period. Further evaluation of the trend reveals that the dominant increases occur during the spring months, but a slight decrease occurs during the winter months. Other Arctic measurement stations do not observe the same spring trend, but have similar trends during the winter months. Complex interactions of meteorological conditions, long-range transport patterns, sea ice conditions, pollutant sources, and photochemical processes drive spatial and temporal variations of ozone in the troposphere observed across the Arctic. Co-located measurements, climate models, back-trajectory analysis, and satellite imagery are used to interpret the trends in surface ozone conditions.

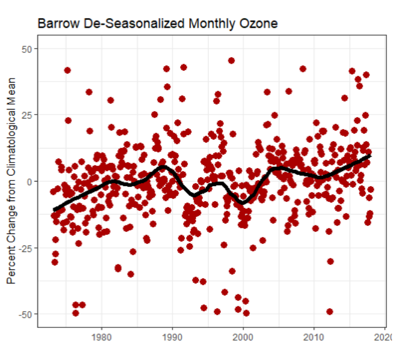

Figure 1. Percent change in monthly ozone mixing ratio across time that reveals a recent increase in observed surface ozone conditions from the Barrow Observatory.

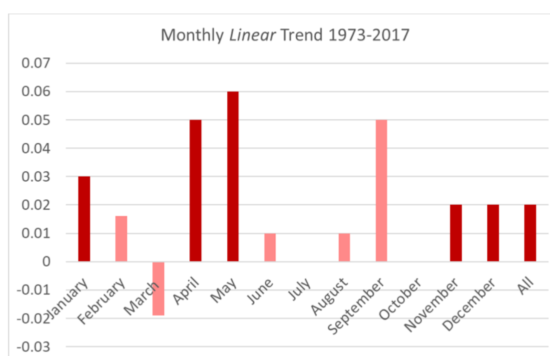

Figure 2. Trends calculated for each month of the year show the seasonality of trends which are drivng the overall patterns in observed surface ozone from Barrow, Alaska.