NOAA Global Monitoring Division Surface Ozone Measurements During FRAPPE/DISCOVER-AQ Campaign (July 16-August 18, 2014)

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Introduction:

NOAA Global Monitoring Division has been monitoring surface level ozone in the Colorado Front Range since 1990. The long-term record allows for essential analysis of changes in background conditions and seasonality of surface ozone. These data support understanding the dynamics of ozone production and associated air quality studies. The FRAPPE/DISCOVER-AQ campaign in July/August of 2014 provided a strong foundation for analysis of ozone accumulation by the addition of targeted measurements to understand precursor emissions (i.e. gas and oil, mobile, power plant, agricultural sources), meteorological conditions, and atmospheric composition. NOAA Global Monitoring Division is looking forward to collaborations with all participants and to provide additional information regarding the quality of data and background conditions.

Measurement Locations:

Site Location	Site Code	Instrument Type	Measurement Error	Lat	Long	Elevation (masl)	Measurement dates
Erie, Colorado 6m	BAO	Thermo-Scientific	+/- 1%	40.05	-105.00	1584	2008-Current
Erie, Colorado 300m	BAO	2b Technologies	+/- 2%	40.05	-105.00	1584	2008-Current
Niwot Ridge, Colorado C1	NWR	Thermo-Scientific	+/- 1%	40.04	-105.54	3022	1990-Current
Niwot Ridge, Colorado Tundra Lab	TUN	Thermo-Scientific	+/- 1%	40.05	-105.59	3538	2003-Current

Instrument information:

All ground based ozone data in this study was collected from the NOAA/ESRL/GMD Surface Ozone monitoring network through Thermo-Scientific model 49 ozone monitors. These instruments use the Beer-Lambert Law to calculate ozone mixing ratio; measuring the degree to which UV light is absorbed in the instrument cells. Each instrument is calibrated to the NIST Standard through the NIST Calibrated instrument maintained at NOAA/OAR/ESRL/GMD in Boulder, Colorado.

More information on the monitoring equipment can be found through Thermo-Scientific: http://www.thermoscientific.com/en/product/model-49-i-i-i-ozone-analyzer.html

All tower ozone data in this study was collected from the NOAA/ESRL/GMD Tall tower network through 2btechnologies, inc. model 205 ozone monitors. These instruments also use the Beer-Lambert law to calculate ozone mixing ratio. These dual beam ozone monitors operate on the absorption of UV light at 254 nm. The tower instrument at BAO is traceable to the NIST calibrated standard Thermo-Scientific instrument.
More information on the 2b monitoring equipment can be found through 2btechnologies:
http://www.twobtech.com/model_205.html

Data Format:
The following information describes the data file format for the surface ozone mixing ratio data available on the NOAA-GMD ftp server and to be archived to the FRAPPE/DISCOVER-AQ data system. The data have been averaged into hourly files and are recorded in UTC (GMT) times.
File Name:
Surfaceo3.STATIONNAME.YYYYmmddhhmm.Thermo_ozone.txt
STATIONNAME:
BAO_Tower (BAO300m)
BAO_Surface (BAO6m)
Niwot_Ridge (NWR)
Tundra_lab (TUN)

File format:
MM/DD/YYYY hh:mm O3 (ppb)
MM Month
DD Day
YYYY Year
hh: Hour
mm: Minute
O3 (ppb): Ozone Mixing Ratio (ppb)

Data Location:
Data from this campaign are available for use through NOAA/OAR/ESRL/GMD ftp server
ftp://aftp.cmdl.noaa.gov/data/ozwv/SurfaceOzone/FRAPPE-DISCOVERAQ/
This data will be archived through the DISCOVER-AQ Data system prior to 12/31/2014.

Data Use Statement:
These data have been made freely available for open access with the assumption that the scientific community will benefit and use these data for new scientific discoveries and further understanding of air quality. NOAA relies on the ethics and integrity of the user to give fair credit to the scientists and technicians who perform and maintain these measurements. Manuscripts using this data should be sent to NOAA/OAR/ESRL/GMD for review before they are submitted. This allows for lead scientists to ensure the quality and limitations of the data are properly represented. There exists the potential for these data to be modified at the discretion of NOAA/OAR/ESRL/GMD.

Please cite data as the following:
McClure-Begley, A., Petropavlovskikh, I., Oltmans, S., (2014) NOAA Global Monitoring Surface Ozone Network. 1973-2014. National Oceanic and Atmospheric Administration, Earth Systems Research Laboratory Global Monitoring Division. Boulder, CO. doi: 10.7289/V5P8WBF

Data Examples:

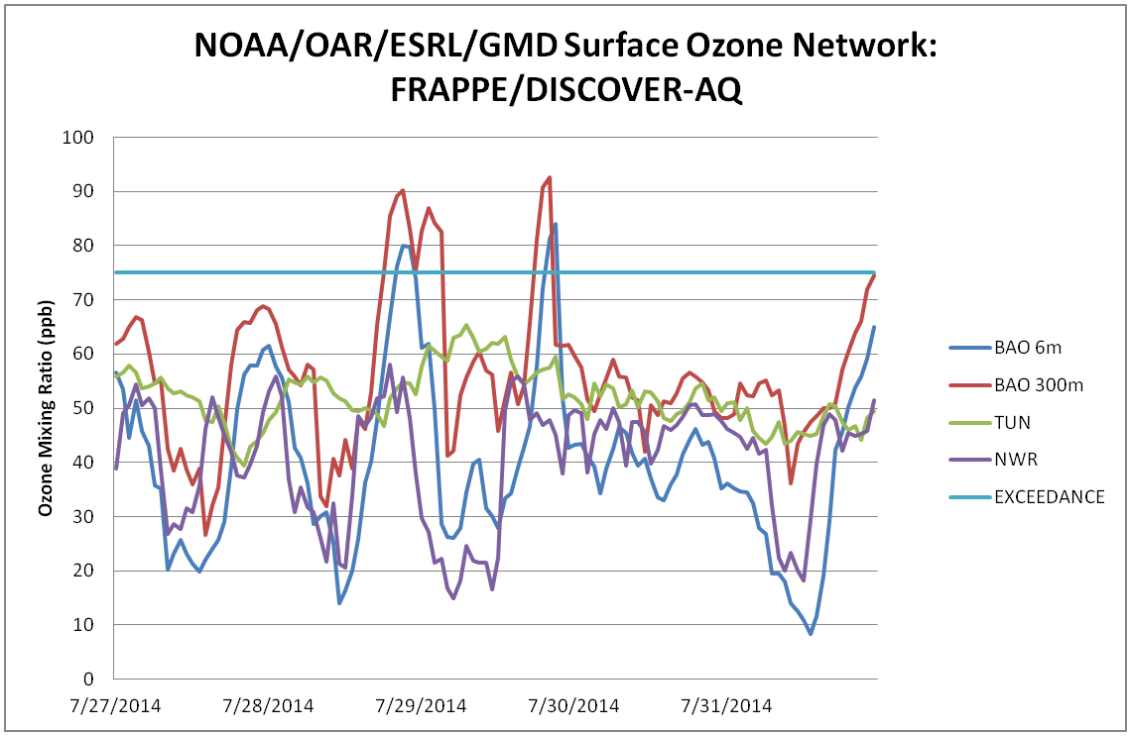


Figure 1) Hourly ozone data from the four Colorado NOAA-GMD monitoring locations shows the daily variability with-in the measurement network.

Erie, Colorado:

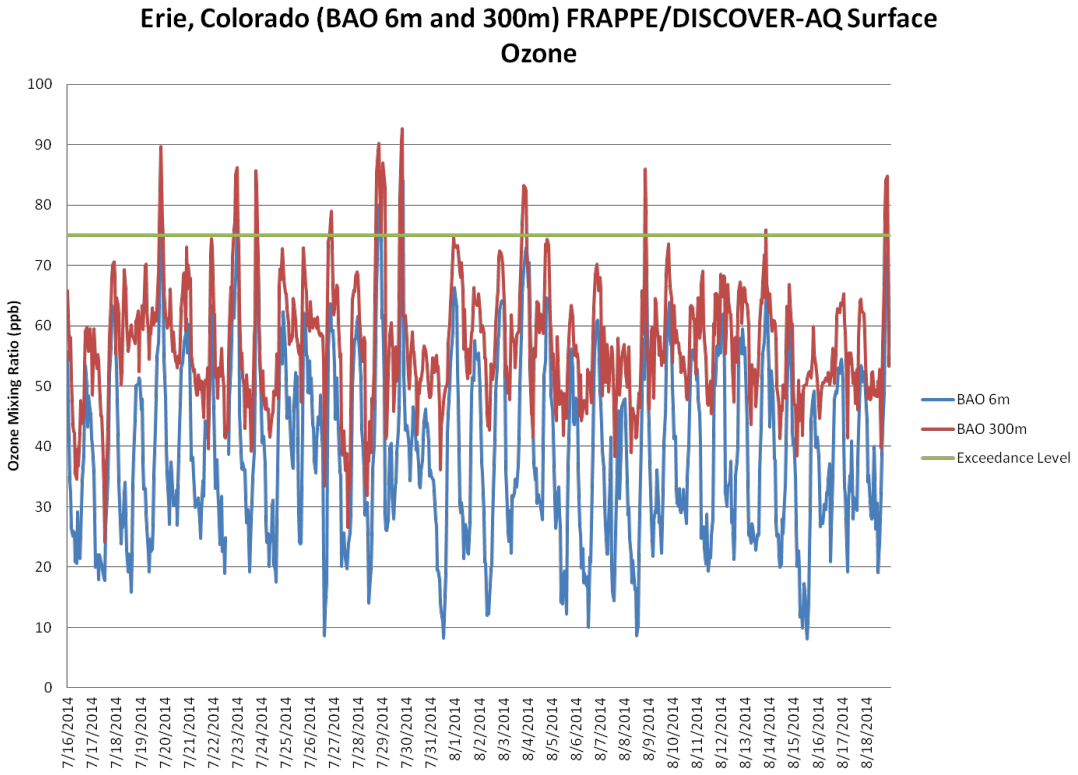


Figure 2) Hourly ozone data from both measurement heights (6m inlet-Surface, 300m inlet-Tower) taken from the Erie, Colorado Boulder Atmospheric Observatory during the campaign period.

Niwot Ridge:

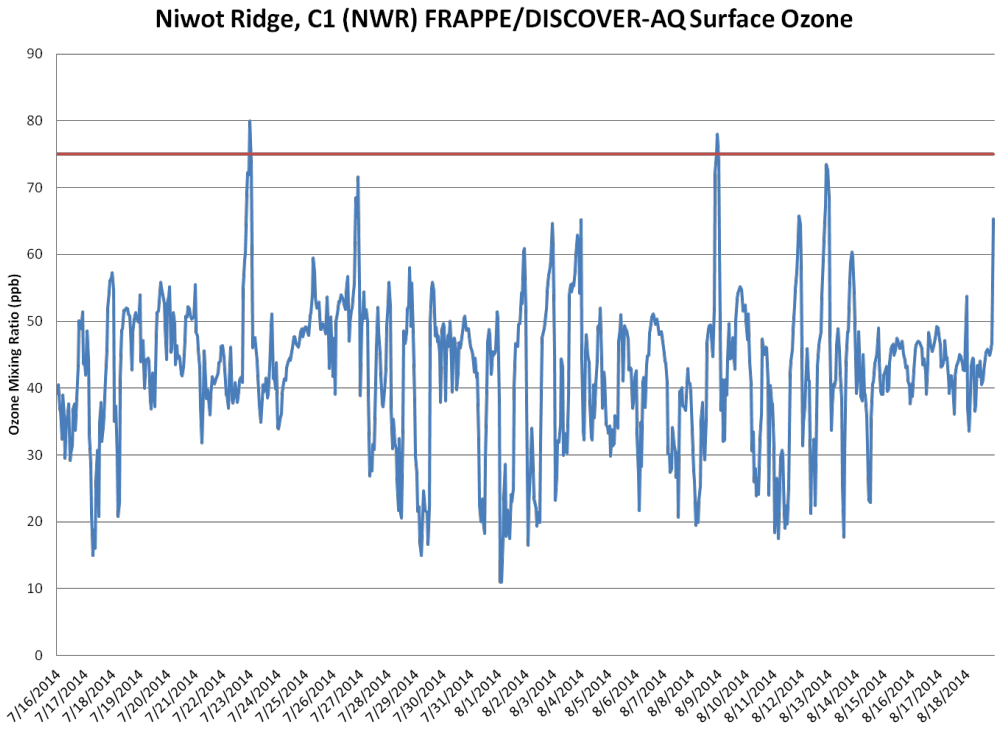


Figure 3) Hourly ozone averages measured from the C1 location of the University of Colorado-Mountain Research station during the campaign period

Tundra Lab:

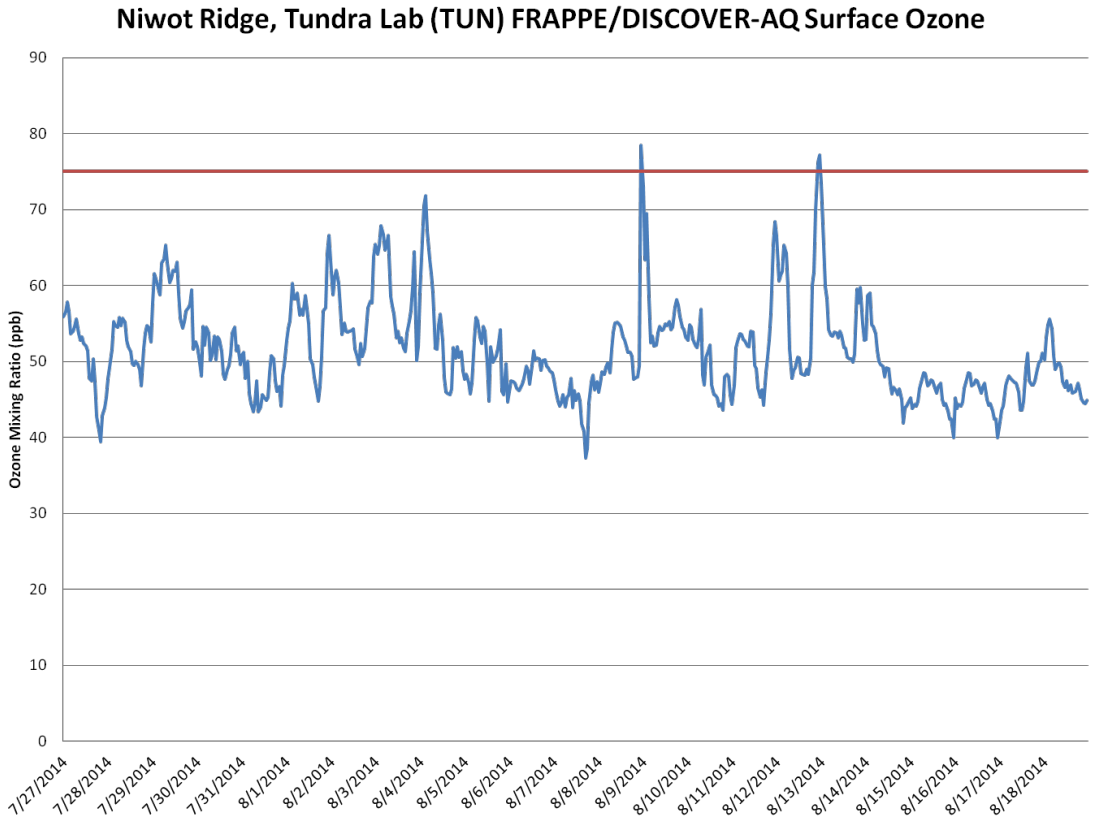


Figure 4) Hourly ozone averages measured from the Tundra Lab location of the University of Colorado-Mountain Research station during the campaign period. Note: Due to instrument pump failure, data for the campaign period begins July 27, 2014.

Current Research:

1.) Analysis of high ozone episodes, as they relate to dominant wind direction and meteorological conditions.

Pollution plots for the FRAPPE/DISCOVER-AQ campaign period use ozone and wind data from the BAO tower to create a visual representation of ozone production through the day and directional sources of ozone production. Pollution plot diagrams have been produced through R-project Open Air software (Credit: David Carslaw, Karl Ropkins)

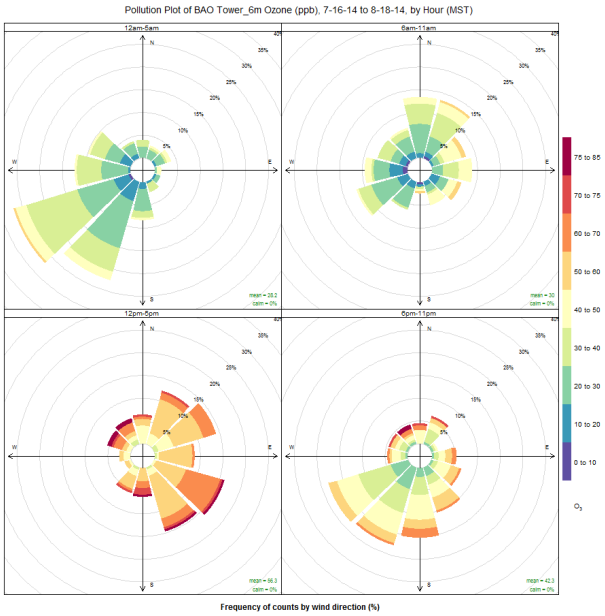
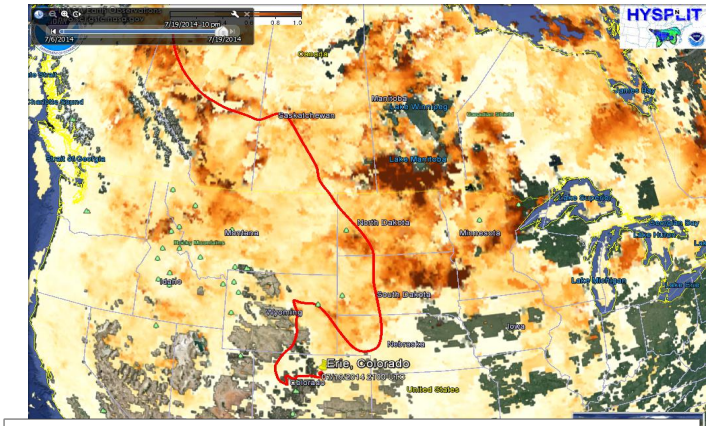


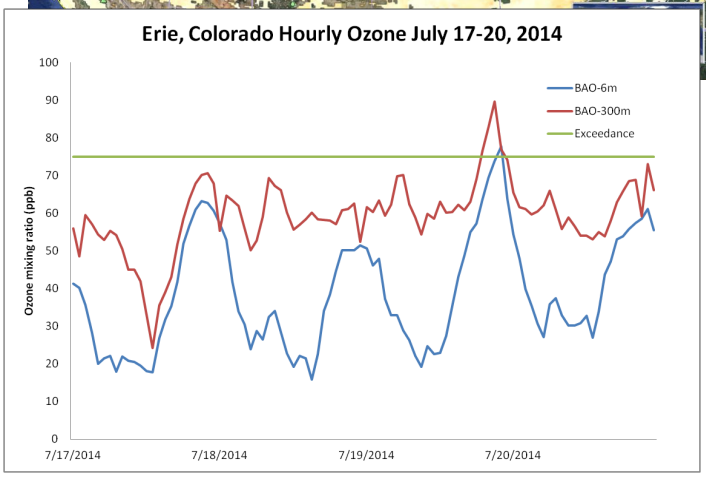
Figure 5.) Hourly ozone data categorized and visualized by dominant wind direction. Note: The data used and represented in this figure are measurements in Local Standard Time. R-OpenAir information and software can be found here: http://www.openair-project.org

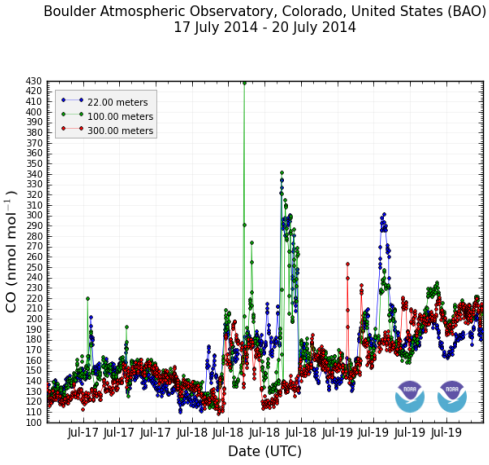
2.) High ozone episodes are analyzed with relation to precursor pollutants and pollutant sources.

July 19, 2014 high ozone values are likely a result of fire/smoke build up transported from Canada and the Northern United States. Google earth overlay of carbon monoxide in North America, NASA GEOS5 Chemical forecast model, NOAA HYSPLIT Back-trajectory, and co-located carbon monoxide measurements suggest that fire had an important role in the production of ozone transported to Colorado and observed during the July 19, 2014 high ozone episode.

Information and details on the NOAA Hysplit Trajectory model can be found through NOAA-Air Resourced Laboratory:
http://www.arl.noaa.gov/HYSPLIT_info.php







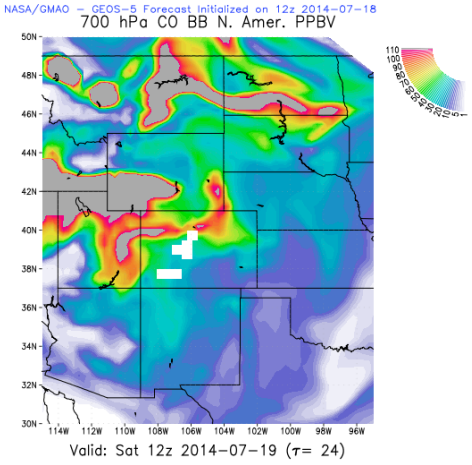


Figure 6) NOAA Hysplit back-trajectory analysis was run for one week prior to arrival at the station with a final altitude of 6 meters above ground level. This shows the path of air transported to the Erie, Colorado (BAO) measurement location. Measurements from the tall-tower network of Carbon Monoxide are provided by NOAA-GMD data visualization software and demonstrate the enhanced carbon monoxide levels on July 18-19, 2014. Ozone data from 6m and 300m inlets shows enhanced ozone levels at both sampling heights. GEOS5 Chemical Forecast was documented in the FRAPPE field catalog and is processed for Carbon Monoxide attributed to biomass burning in North America at 700 hPa pressure.

3.) Investigation of seasonality of surface ozone with emphasis on understanding the causes of variation in high ozone episodes during the summer months.

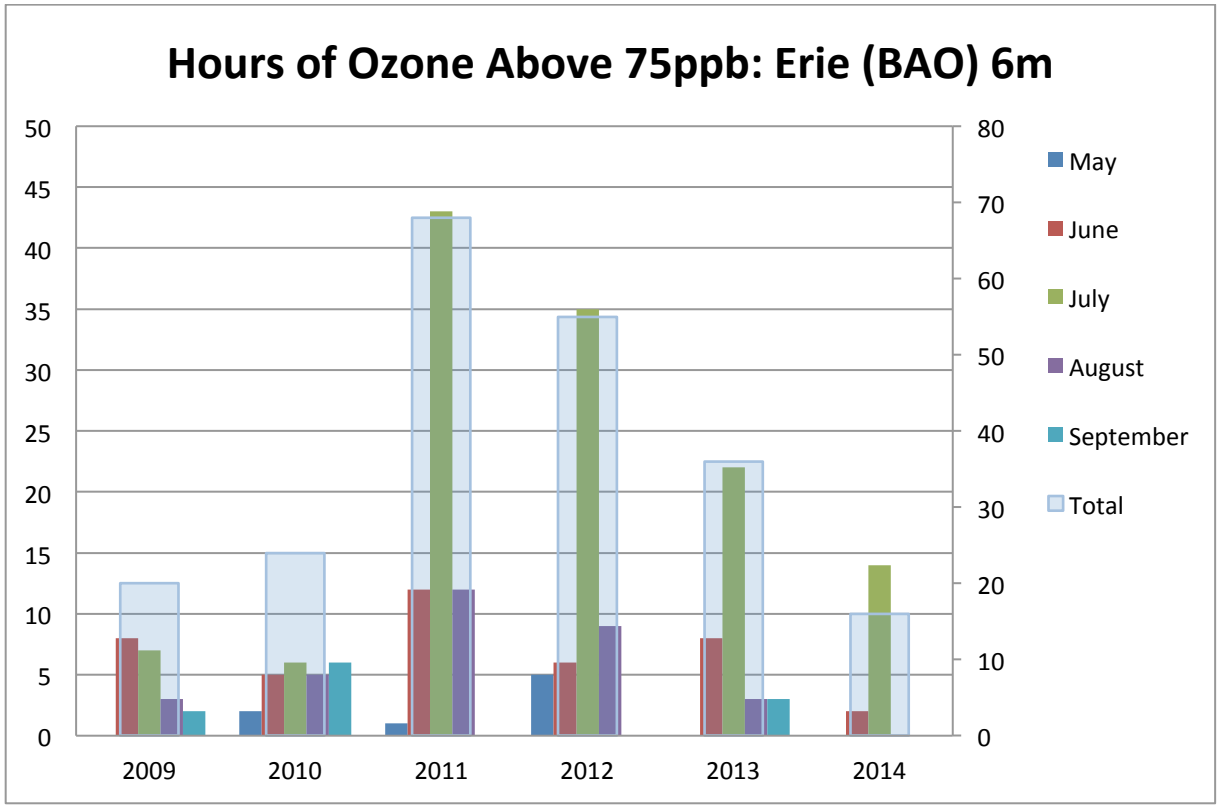


Figure 7) Estimates of the number of hours ozone exceeded 75 ppb at the Erie, Colorado location. This data is from the NOAA/OAR/ESRL/GMD continuous ozone measurements taken from the 6 meter inlet height. Data have been separated into total and monthly summaries for the summer months.

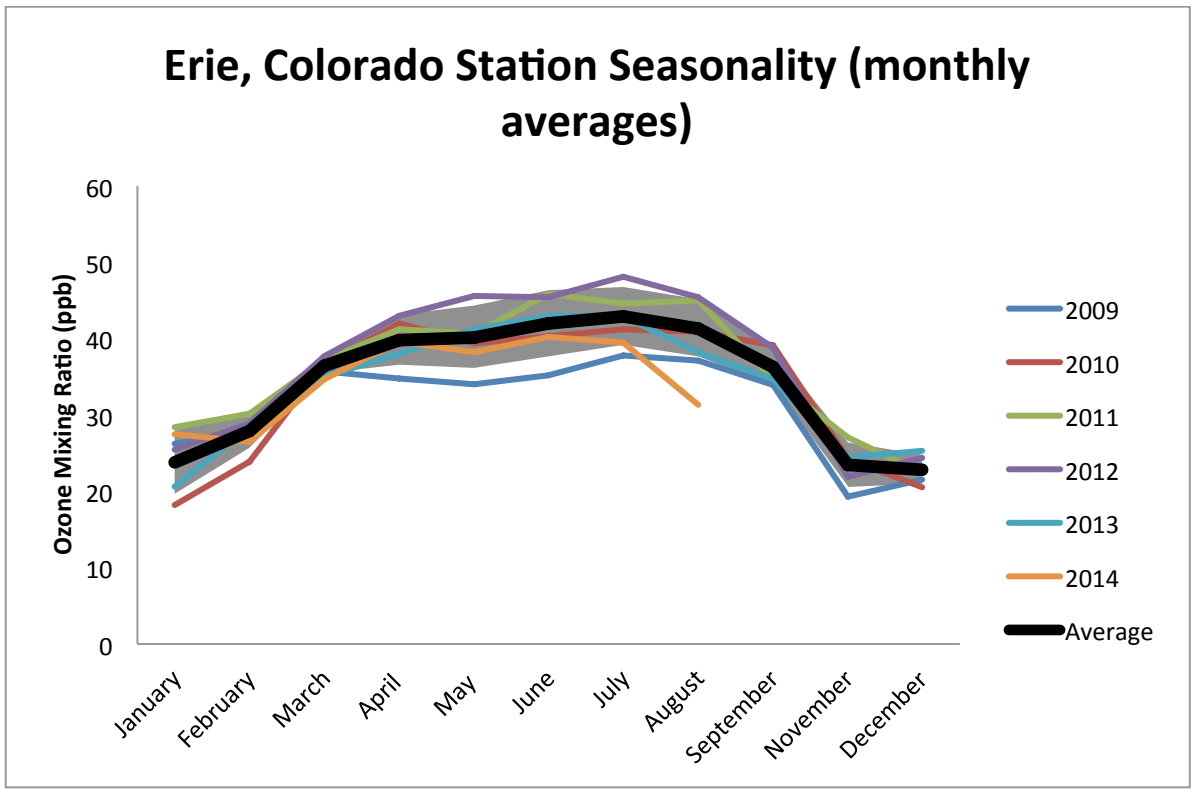


Figure 8) The seasonal cycle of surface ozone levels at Erie, Colorado (6m inlet) is shown as a function of monthly ozone values. The average seasonal ozone values are represented with the thick black line, with a standard deviation envelope (dark grey) to visualize typical seasonal behavior for this station. Yearly data is displayed for comparisons of year-to-year variability.

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Acknowledgements:
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University of Colorado-Mountain Research Station

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