Contrasting Behavior of Inert and Photochemically Reactive Gases during the August 21, 2017, Solar Eclipse at the Boulder Reservoir

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(http://instaar.colorado.edu/arl/boulder_reservoir.html)

Summary

The total solar eclipse on August 21, 2017 provided a rare opportunity to observe and test our understanding of atmospheric dynamics and photochemical dependency on solar irradiance. Here, observations from a continuously operating monitoring of both inert and photoreactive trace gases at the Boulder Reservoir, Colorado, were used for contrasting the unique dynamic and photochemical forcings on the eclipse day. The monitoring station saw a ~93% solar obstruction during the peak of the eclipse. The loss of irradiance caused cooling of the surface air by ~3°C, and weakened convective and turbulent mixing. This resulted in a buildup of non-reactive gases (methane, volatile organic compounds) as well as nitrogen oxides (NO, NO_2) in the surface layer. In contrast, ozone (O_3) declined by ~15 ppb compared to median August diurnal mixing ratios during the ~2 hours of the first half of the eclipse. Similar O_3 signatures were observed at a series of network stations along the Northern Colorado Front Range. With the loss of irradiance, the initial ratio of NO/(NO+NO_2) of ~0.2 dropped steadily, bottoming out at <0.01, but rebounded to ~50% above average levels towards the end of the eclipse. Further, above average O_3 enhancements were seen in the afternoon hours following the eclipse. Similar O3 signatures were observed at a series of network stations along the Northern Colora-do Front Range. The contrasting behavior of reactive and non-reactive gases, and comparison with other published eclipse data, allow characterizing these responses at the Boulder Reservoir as urban/polluted behavior.

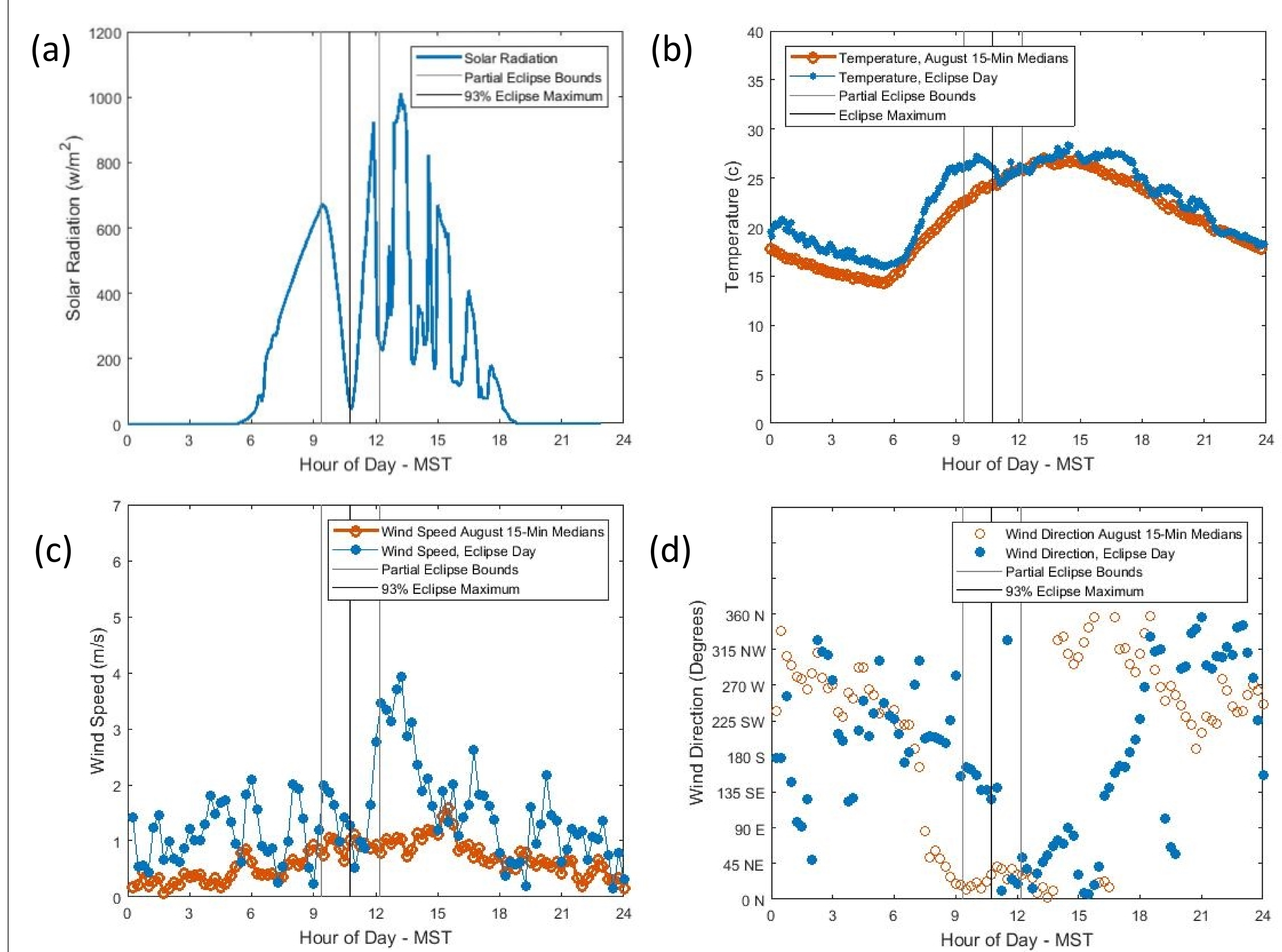


Figure 2: Meteorological conditions on eclipse day with (a) solar radiation, (b) temperature, (c) wind speed and (d) wind direction contrasted by August 2017 monthly median diurnal cycles.

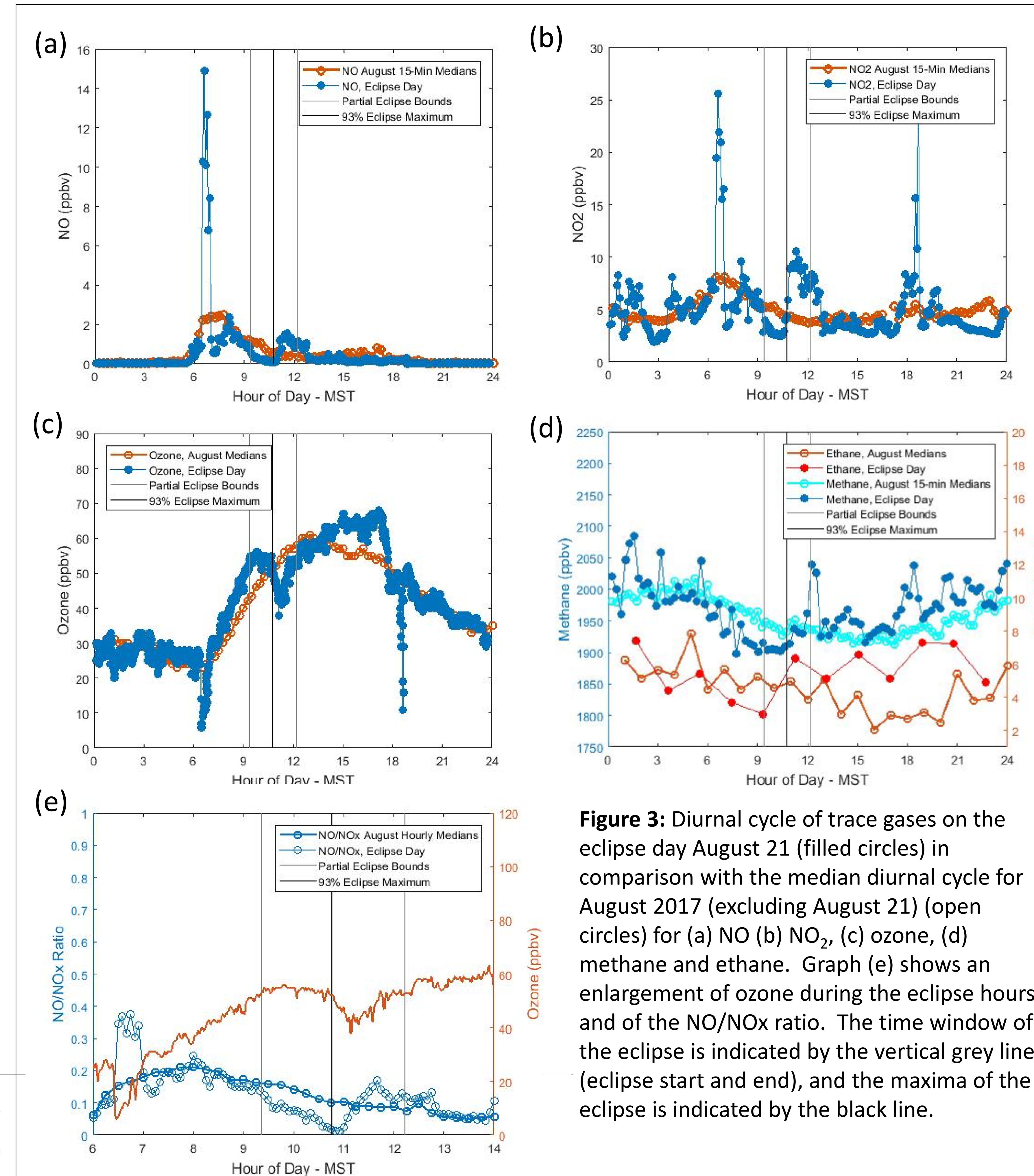
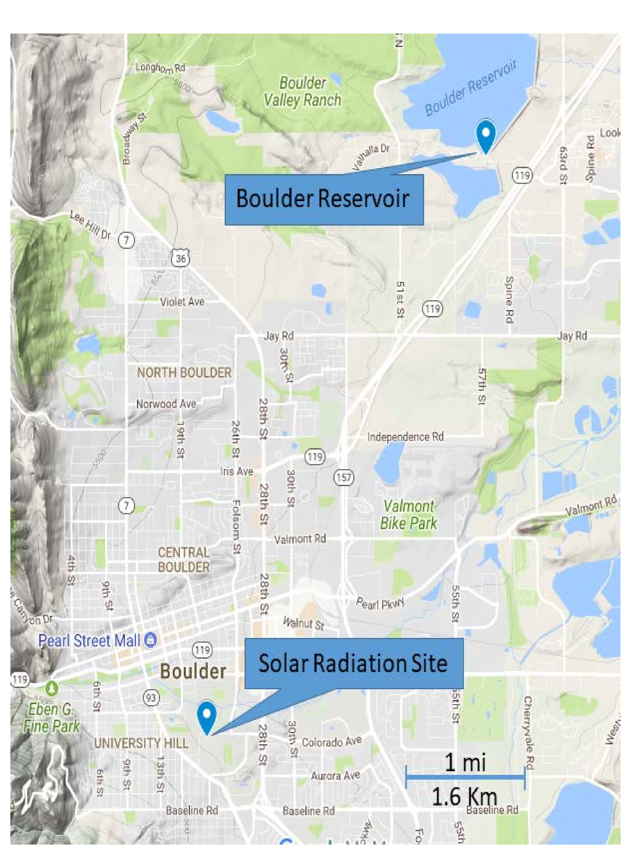


Figure 3: Diurnal cycle of trace gases on the eclipse day August 21 (filled circles) in comparison with the median diurnal cycle for August 2017 (excluding August 21) (open circles) for (a) NO (b) NO_2, (c) ozone, (d) methane and ethane. Graph (e) shows an enlargement of ozone during the eclipse hours and of the NO/NOx ratio. The time window of the eclipse is indicated by the vertical grey lines (eclipse start and end), and the maxima of the eclipse is indicated by the black line.



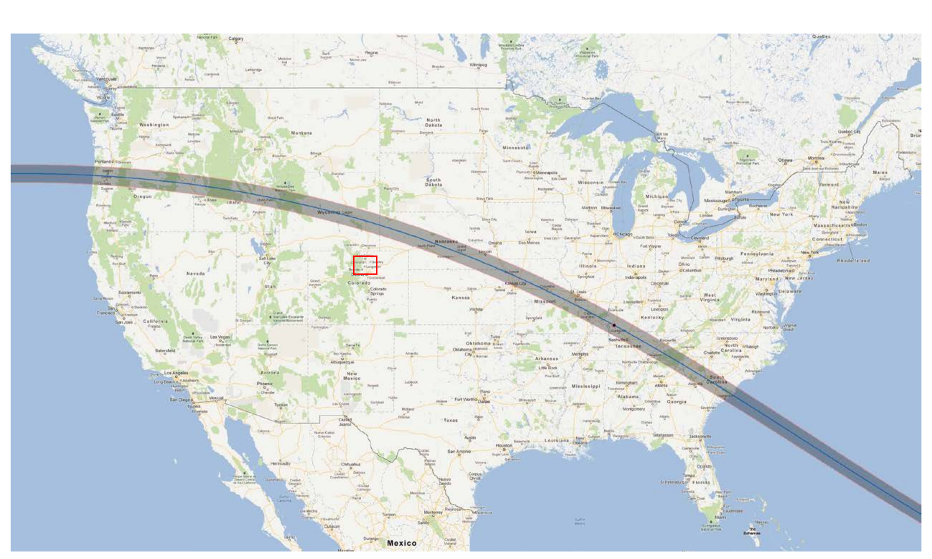


Figure 1: Top: Path of August 21, 2017, total solar eclipse, with the observation area indicated by the red square. Left: Study area, with the monitoring site at the Boulder Reservoir and the location of the solar radiation measurements on the University of Colorado, Boulder campus.

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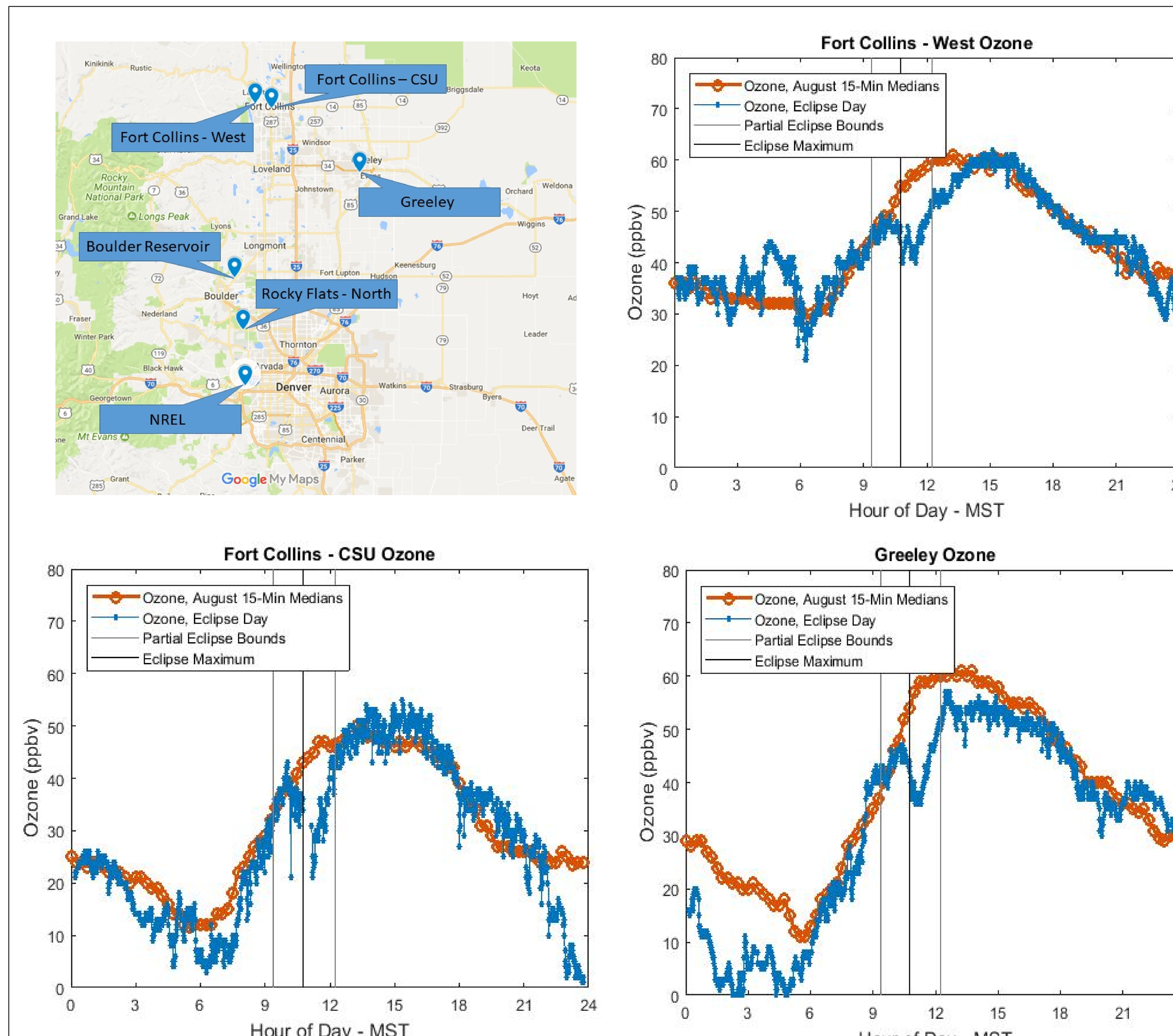

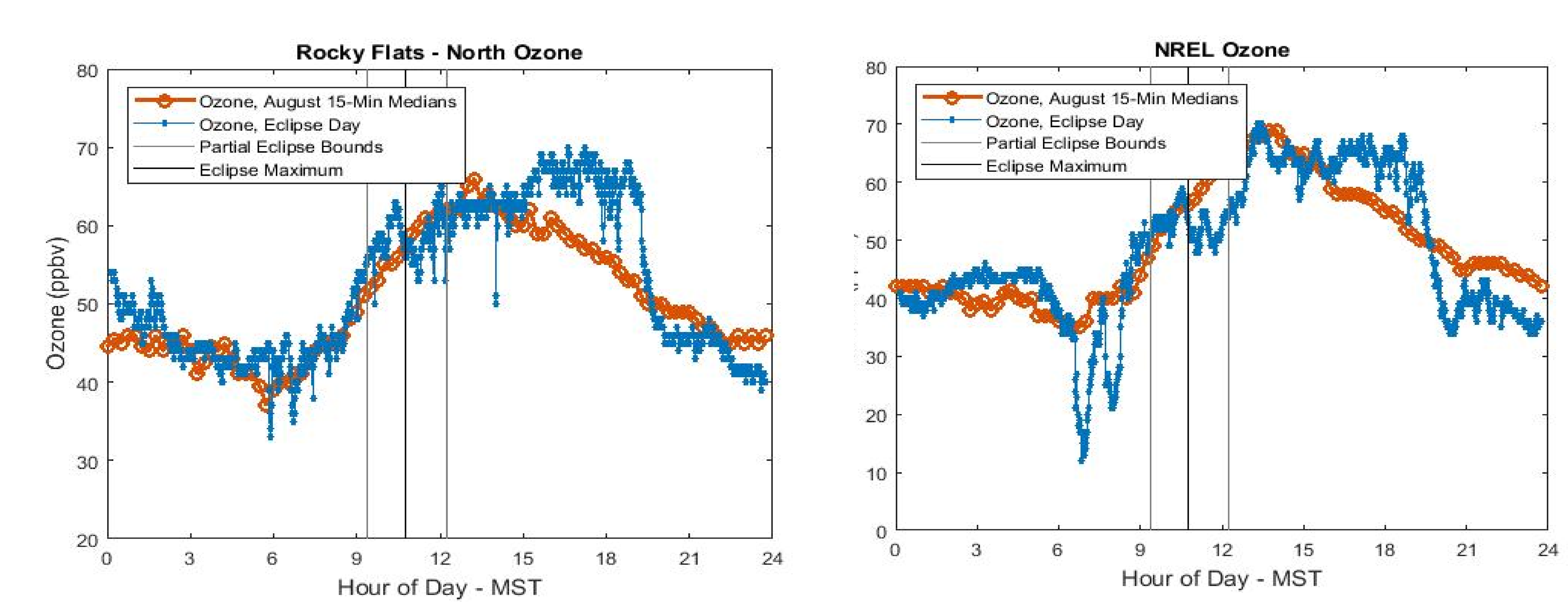

Figure 4: Ozone on the eclipse day in comparison to the median diurnal ozone cycle during all other August 2017 days at the five other Northern Colorado Front Range O_3 monitoring stations that are shown in the map.