Ozone and Aerosol Profiles from a Shipborne Lidar

Janet Machol,[1,2] Brandi McCarty,[1,2] Wynn Eberhard,[2] Richard Marchbanks,[1,2] Sara Tucker,[1,2] Lisa Darby,[2] and Christoph Senff[1,2]

[1]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80303, USA
[2]National Oceanic and Atmospheric Administration, Earth System Research Laboratory, Boulder, CO 80305, USA

Lidars on the RV Ronald H. Brown

During the TexAQS 2006, two NOAA lidars aboard the RV Ronald H. Brown (RHB) provided remote sensing observations of aerosols, ozone and winds. The Ozone Profiling Atmospheric Lidar (OPAL) measured vertically resolved profiles of ozone and aerosol backscatter. The High Resolution Doppler Lidar (HRDL) measured boundary layer winds, velocity variance, and relative 2-micron aerosol backscatter. The lidar observations provide context and transport information, including boundary layer mixing, cloud and aerosol layer heights.

Summary

This poster describes the OPAL lidar as well as example OPAL measurements for two days when the sea breeze impacted the afternoon ozone and aerosol, August 15 and September 1. August 15 is notable for its nighttime vertical structure, while September 1 has the highest ozone recorded during the TexAQS experiment.

OPAL Instrument

OPAL is a DIfferential Absorption Lidar (DIAL) which emits laser pulses at four ultraviolet wavelengths [266, 289, 299 and 355 nm]. In these examples, the ozone profiles are calculated with the wavelengths 266 and 355 nm, and aerosol information is calculated with the 355-nm data.

OPAL uses a unique scanning technique whereby data from multiple angles are combined to extend the profiles very close to the surface. This method assumes horizontal homogeneity.

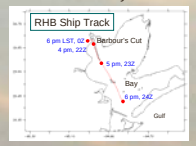
OPAL Products

- Ozone profiles
  0-1.2 km, ±10 ppB, 50-m and 20-min. resolution
- Aerosol backscatter profiles
  0-5 km, 5-m and 3-minute resolution
- Extinction profiles
- Uncalibrated total backscatter (molecular plus particulate) profiles
  0-12 km, 5-m and 90-s resolution
- Boundary layer heights
- Cloud base heights (to 12 km)

http://esrl.noaa.gov/csd/ors/data_pages/TexAQS06/opal/
aerosols: wynn.eberhard@noaa.gov
mixed layer: brandi.mccarty@noaa.gov
ozone: janet.machol@noaa.gov

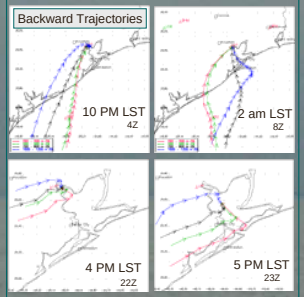
August 15 UTC

On August 15 there was significant layering of the stable atmosphere at night. Daytime brought mixing and an increase in ozone at the surface and aloft. The RHB remained near Barbour's Cut from 6 pm until 4 pm LST (22Z). The ship crossed Galveston Bay during the final two hours. In the afternoon, the sea breeze brought in cleaner air below the daytime mixed layer.

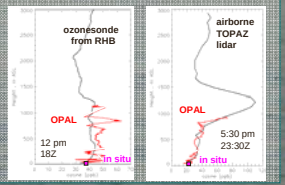


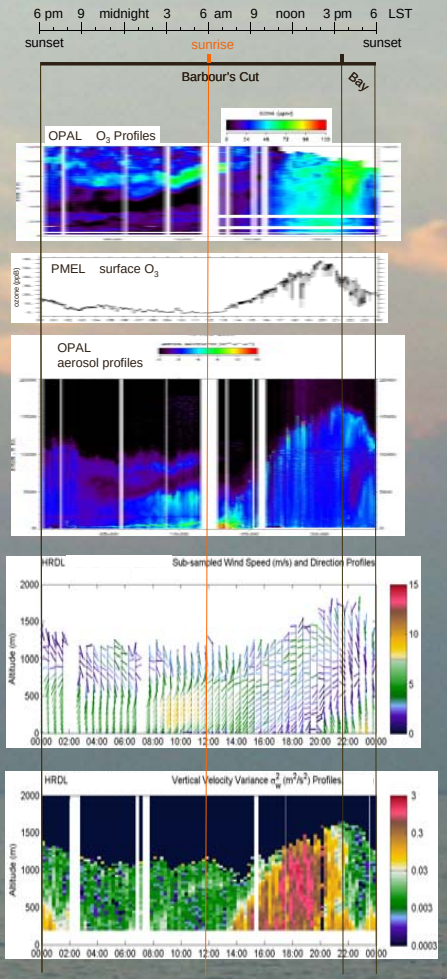
6 pm to 7 am LST (0- 13Z)
The ozone profiles show minimal ozone below 700 m and a residual layer aloft separated by shear. The backscatter profiles show corresponding aerosol layers. Throughout the night there was a low level jet which reached speeds of 8 m/s between 3 and 6 am LST. A shallow surface layer with enhanced aerosols around dawn corresponded to a layer of stagnant (low velocity) air. Embedded in this layer were aerosols in plumes from local sources.

7 am to 6 pm LST (13Z- 24Z)
After dawn and until late afternoon, both convection (as seen in the vertical velocity variance and the rise of the boundary layer) and photo-production of ozone increased. The bay breeze, first encountered at 1 pm LST (19Z), undercut the convective layer with air with less ozone.



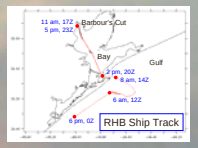
Comparisons of ozone measurements

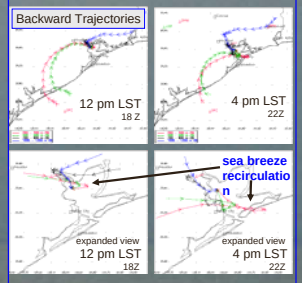
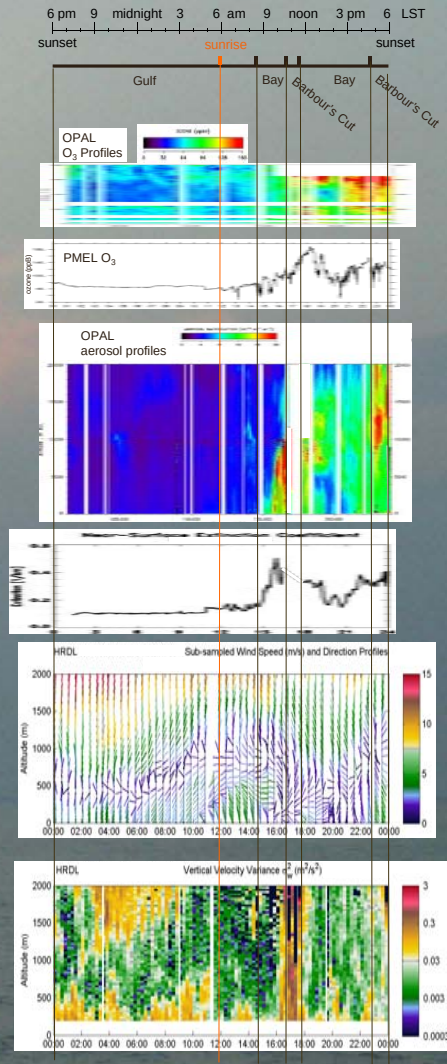




September 1 UTC

The highest ozone values in Houston for the summer of 2006 were recorded on September 1. On the RHB, OPAL and the in-situ sensors also observed the highest ozone values of the TexAQS 2006 experiment on that day. The RHB spent the night in the Gulf and then crossed Galveston Bay three times before remaining in Barbour's Cut.



6 pm to 7 am LST (0- 13Z)
During the night in the Gulf, the surface and low levels of ozone were around 70 ppB, a rather elevated nighttime value.

7 am to 6 pm LST (13Z- 24Z)
After dawn and until late afternoon, both convection and photo-production of ozone increased. The bay breeze was first encountered at 10:30 am LST (16:30Z). Considerable vertical mixing occured from 10 am to noon (16Z to 18Z). The afternoon ozone levels were enhanced by recirculation; i.e., the bay breeze air had been recently advected off of the land.