The Huntsville Ozonesonde Station:

First Year Results

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June, 2000

The Huntsville, Alabama ozonesonde station is a collaborative effort between the Earth System Science Center and the Atmospheric Science Department at the University of Alabama in Huntsville (UAH/ESSC and ATS) and the NOAA Climate Monitoring and Diagnostics Laboratory (NOAA/CMDL) in Boulder Colorado.

Because very little high-resolution tropospheric ozone data is available for the Southeastern United States and virtually none on a long-term basis, the station's scientific focus is on studying tropospheric ozone in the Southeastern United States in context of the regional meteorology, chemistry, and air quality. The station commenced operations in April 1999 and continues to launch weekly ozonesondes, with occasional high frequency launch experiments.

The Huntsville ozonesonde station participated in the Southern Oxidants Study 1999 field campaign in Nashville, TN with daily ozonesondes, and will also participate in the Texas Air Quality Study (TEXAQS 2000) in Houston, TX in the same capacity this summer. Future collaborative efforts are also under consideration.

To date, the Huntsville ozonesonde station has recorded over a year's worth of weekly ozone profiles through the troposphere and middle stratosphere (up to about 35 km or 6 mbar). The seasonal signature in ozone concentrations (ppbv mixing ratio) and integrated ozone (DU) is clearly evident in Figure 1 and is related to variations in tropospheric water content (% relative humidity) and the seasonal oscillation in tropopause height.

Strong day-to-day variations in tropospheric ozone are observed during the spring and fall months, with steadily increasing ground-level concentrations during the spring and decreasing through the fall. During the summer months, we see high free-tropospheric and boundary-layer ozone concentrations strongly contrasted with lower tropospheric-ozone levels throughout the winter. The 3-6 day signature of many of the enhanced ozone events in Figure 2, is evidence of the effect of synoptic scale phenomena on tropospheric ozone levels.

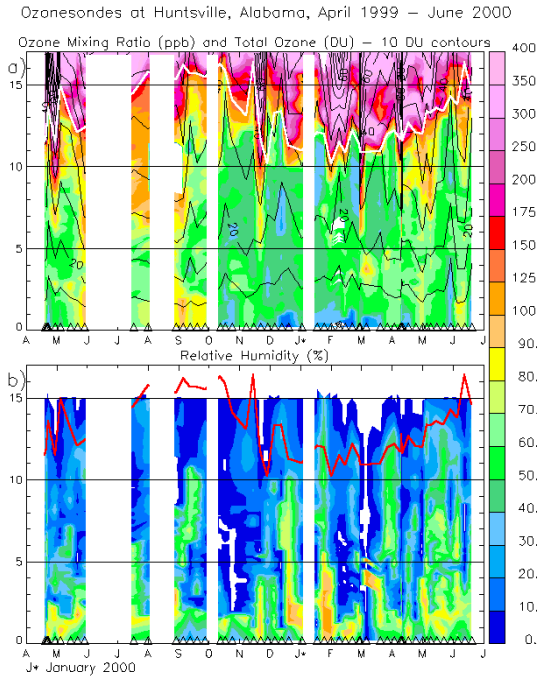

Figure 1. Time-height cross sections at Huntsville, Alabama for April 1999 through June 2000 (a) ozone mixing ratio (ppbv) and integrated ozone in Dobson Units (DU) solid black lines, and (b) relative humidity (%). The solid white line in (a) and red line in (b) marks the tropopause height. The triangles at the base of the cross-sections indicate the time of soundings.

The high vertical resolution data obtained from the balloon borne sondes are analyzed using meteorological data obtained at launch time, vertical motion modeled back-trajectories through the depth of the troposphere, comparison with ETA reanalysis data, as well as MM5, MOZART and MODELS-3 runs. This is done in an attempt to objectively determine how

tropospheric ozone concentrations are affected by meteorological and chemical conditions leading to the observed profiles.

One such example is the four-day, high ozone event observed over Old Hickory, TN (days 185-188) during SOS99, Figure 2. Back trajectories for day 187 (07/06) indicate strong convection which lifted air from around eastern Kansas between 3-5 km three days earlier to an altitude between 10-14 km. We hypothesize that the air, containing ozone precursors lifted during convection, along with lightning NOx associated with higher clouds, was put into circulation in a strong upper-level high and used to make the observed ozone concentrations en route. Photochemical 3-D modeling of the observed meteorology and chemistry is necessary to prove or disprove this hypothesis and attempts to do so with MODELS-3 are underway here at ESSC and in future collaborative efforts with the NOAA/Aeronomy Laboratory.

Another example of high ozone conditions studied at the Huntsville ozonesonde station is stratosphere troposphere exchange (STE) associated with strong tropopause folding events. A high-frequency launch experiment during a strong STE event was performed in April 2000. A total of five ozonesondes were launched within a 38 hr period to quantify and study the change in tropospheric and lower stratospheric ozone concentrations as the tropopause fold passed over Huntsville, AL. The launches were timed to coincide with measurements before, during, and after the frontal system and associated fold.

Results from the STE experiment have been corroborated with back-trajectory data and meteorological conditions observed at the time of each sounding. Comparisons with model runs from ETA reanalysis, MM5 and MOZART all show remarkable agreement between prediction and measurement. Further efforts to quantify the total volume amount of ozone exchanged during this event and identify its ultimate fate are under way. An important question to answer is whether the STE associated with this event is irreversibly injected ozone into the troposphere, or whether the fold pushed back up into the stratosphere without cross-isentropic exchange of stratospheric air. From the preliminary data, it appears that the STE was reversible and that most of the ozone was returned to the stratosphere, however, it must be noted that mixing ratios in excess of 450 ppb below 10 km were observed over Huntsville with the passage of this system.

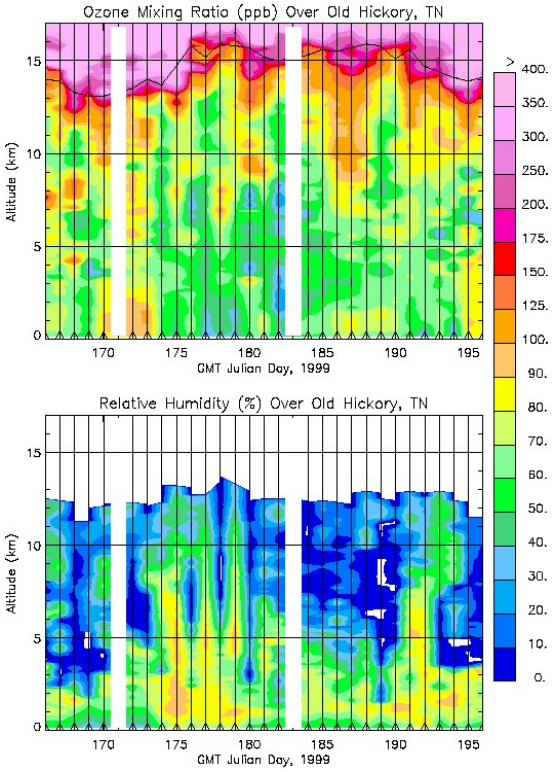

Figure 2. Tropospheric ozone mixing ratios in ppbv (a) and relative humidity in % (b) cross sections over Old Hickory, TN, (990615-990715) during the Nashville 1999 Southern Oxidants Study field intensive. Note the strong day-to-day variability in ozone mixing ratios and relative humidity at all levels of the troposphere.

The Huntsville soundings have produced a wealth of information that is currently being analyzed and compared to long-term ozonesonde data available for Boulder, CO and Wallops Island, VA. The average tropospheric profiles for Huntsville and Boulder appear to exhibit similar characteristics but higher low-stratospheric ozone concentrations are observed over Boulder with a reversal in the mid-stratosphere. The Wallops Island average profile however, exhibits substantially higher ozone concentrations than both Boulder and Huntsville, at all levels.

The Huntsville ozonesonde station, both with its location and cooperative efforts promises to yield a valuable tropospheric ozone data set for the Atmospheric Science Department and the scientific community as a whole.