EARL Newsletter No. 1
9 March 2004

Summary of the First Extended Measurement Session with the Agnes Scott College Eyesafe Atmospheric Research Lidar (EARL)

A four-hour measurement session with EARL was conducted on March 8, 2004. The weather was clear with highs in the low 60s and strong winds (gusts to 30 mph). The objective of this session was to conduct a thorough shakedown run of the lidar and to evaluate its performance. This paper provides a brief summary of the session and presents preliminary results.

After approximately two hours of checkout, we began collecting data at noon. The data acquisition was continuous, with the transmitter operating at 2.5 kHz, and 2000 samples were averaged together to produce each altitude profile. Forty such profiles were then averaged together and stored on the PC hard disk. The time required for this process was about one minute. The result was profiles like those shown in the Figure 1 below.

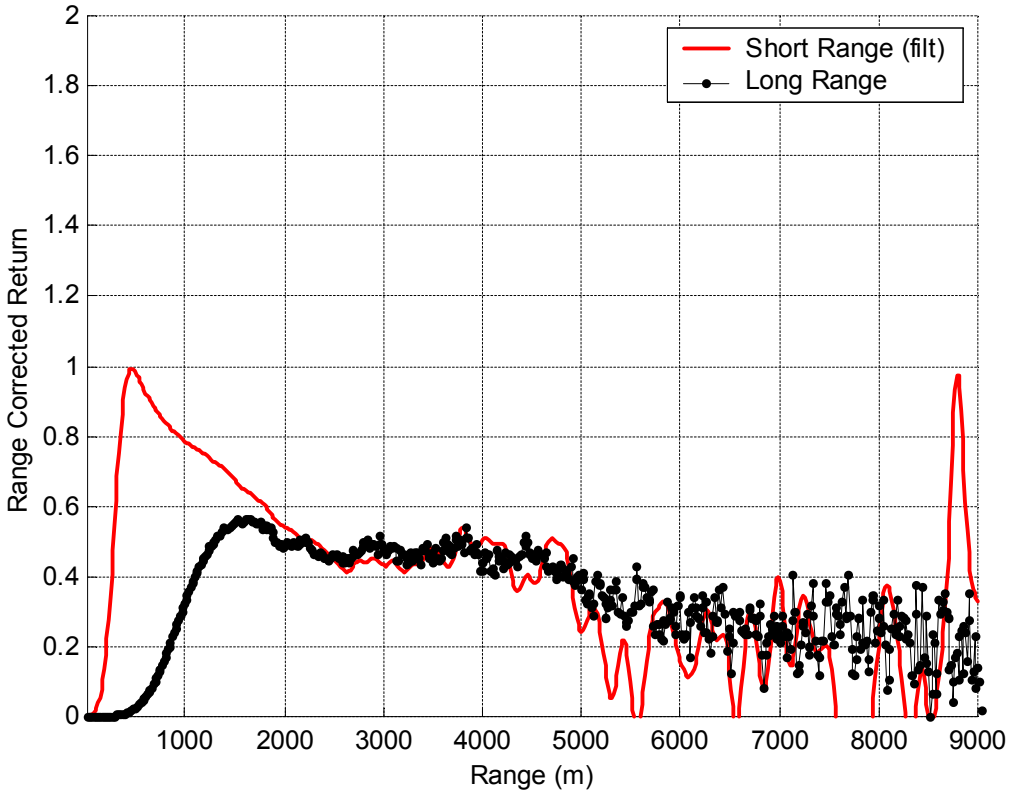

Figure 1. Range-corrected one-minute average profiles.

Figure 1 shows the range-corrected signal level as a function of altitude. The $1/r^2$ geometrical decrease in signal level has been removed by multiplying the data by r^2. The red line shows the short-range receiver channel's signal, and the black line shows the long-range channel's signal. The short-range data have been heavily filtered to reduce noise. An extensive aerosol layer is visible between 2.3 and 5.5 kilometers. The large spike near 9 km is not due to a cloud, but is a noise spike amplified by the range correction process.

Next, we investigated what the system can do at higher altitudes by averaging all of the data collected between 1200 and 1300 hrs. The results are shown in Figure 2.

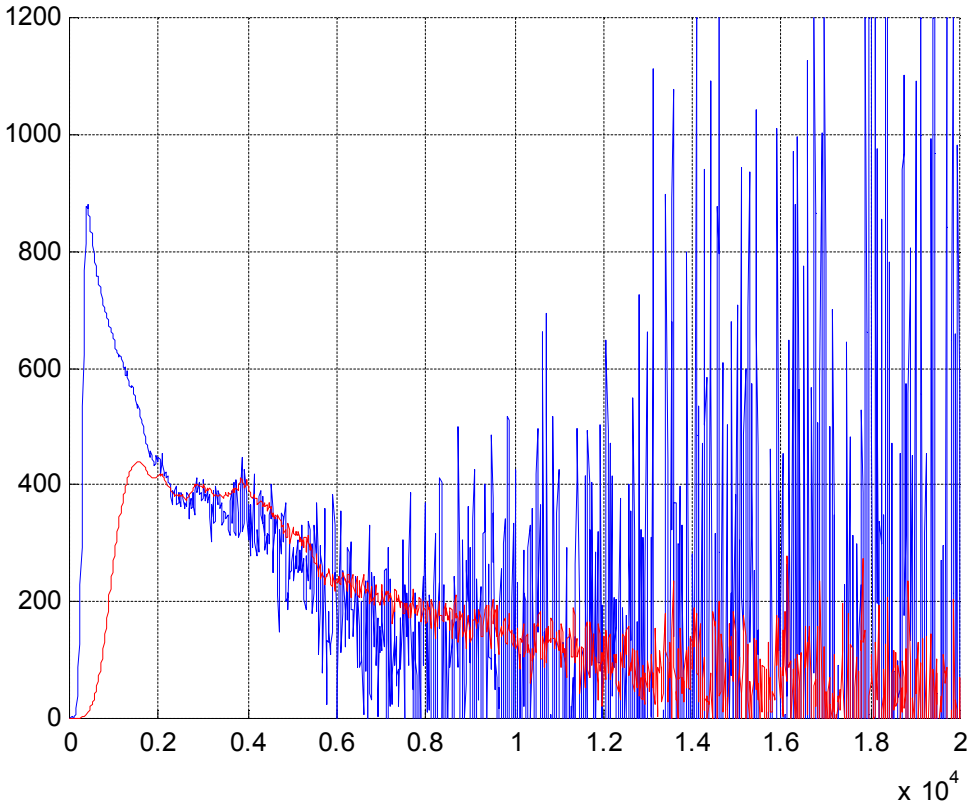

Figure 2. Range-corrected one-hour average profiles.

The blue line is the short-range channel and the red line is the long-range channel. Once again, this figure shows range-corrected signal level versus altitude in meters. The aerosol layer is clearly visible, but what is really exciting is the exponential tail shown in the long-range plot. The tail is due to light backscattered by air molecules and aerosols and shows that even at altitudes of 15 kilometers the lidar is still detecting backscattered laser photons during daytime. At night, with longer averaging times, EARL should be able to reach even higher and make measurements of stratospheric aerosols. We are currently at a 30-year low in the stratospheric aerosol, so these measurements will help

establish a background aerosol level. It will be very interesting when the next volcano erupts!

Finally, lets see if we can see any 2D trends and plot the entire data collection from 1200-1500 hrs. on a 2D time-height plot. The plot is produced by combining profiles like those in the first figure and encoding signal intensity as color. Aerosol layers become quite apparent when this is done. Only data from the long-range channel is shown.

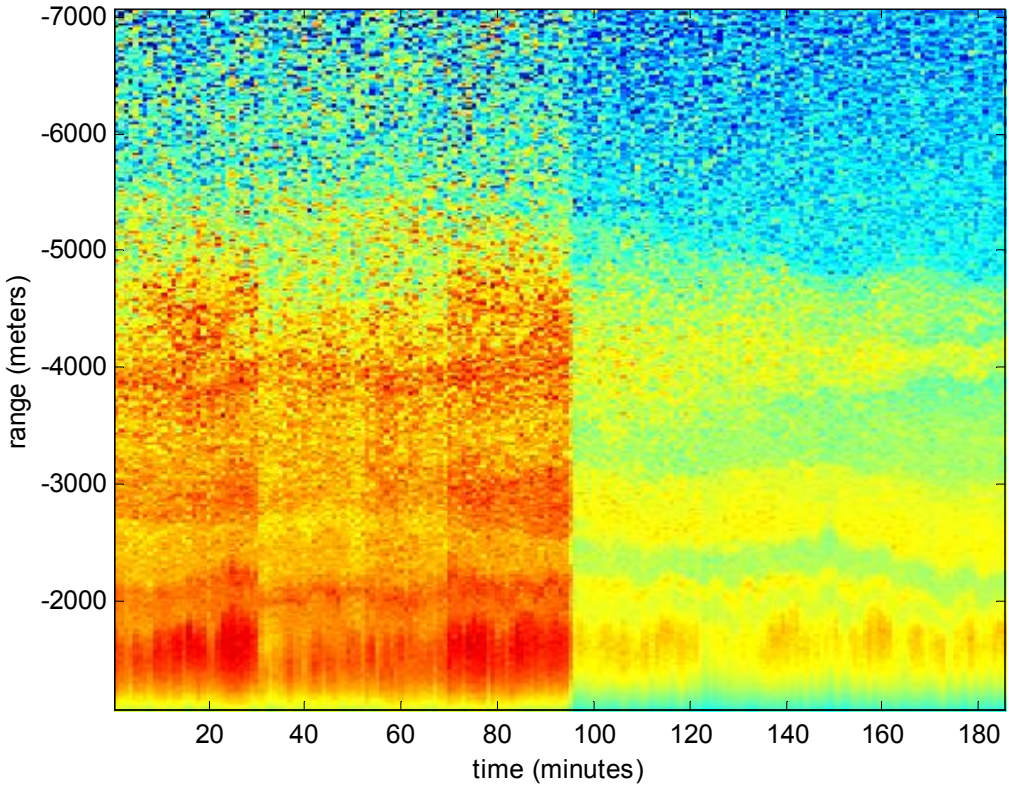

Figure 3. Time-height diagram, data from 1200 – 1500 on 8 March 2004.

The change from red to yellow at 95 minutes is due to the photomultiplier tube bias voltage being reduced in order to keep the long-range channel from being saturated by intense near-field signals (we are still learning how to use EARL). Other vertical bands are due to a problem in the temperature controller on the ultra-narrow long-range channel filter. The filter pass band was not stabilized adequately, alternately reducing and increasing the number of photons that could reach the photomultiplier. The controller will be replaced soon. Note the aerosol layers, especially the one just above 2000 meters. This layer may be due to aircraft on approach to Hartsfield International Airport. The wiggles in the layer may be due to the action of convective cells as they drift over the lidar. The layer is alternately boosted in height or pulled down by the vertical winds in the convective cells.

A number of other measurement sessions are planned for March as we continue to put EARL through his paces. We encourage you to come to the Bradley Observatory Open House on March 19th when EARL will be operating all day and into the night (weather permitting).