THE 2002 NEW ENGLAND AIR QUALITY STUDY: METEOROLOGICAL OBSERVATIONS CONDUCTED BY THE NOAA ENVIRONMENTAL TECHNOLOGY LABORATORY'S WEATHER AND CLIMATE APPLICATIONS DIVISION

Why ? New England can experience unhealthy levels of air pollution, especially during the summer months. For example, Figure 1 shows a color-coded map of ozone pollution recorded on August 2, 2001. Areas shaded with orange experienced ozone concentrations (measured in parts per billion or ppb) that are considered unhealthy for people with respiratory problems. Areas shaded in red had ozone levels that pose health risks to everyone. Note that on this day the worst ozone pollution occurred in the coastal regions extending from Connecticut into northeastern Maine. This distribution is believed to be caused by long-range transport of pollutants from the East Coast metroplex extending from Washington D.C. to Boston, long-range transport from the industrial Midwest, and local wind patterns associated with a meteorological phenomenon known as the land-sea breeze circulation. To help scientists to understand New England's air quality better, the U.S. Congress funded The New England Air Quality Study. This summer's activities represent a pilot study for a larger study that may occur in 2004. The overarching goal of this program is to gain a better understanding of what causes bad air quality in New England and, ultimately, to improve air quality forecasts. The goal of the NOAA Environmental Technology Laboratory's Weather and Climate Applications Division (www.etl.noaa.gov/et7) is to gain a better understanding of the meteorological processes that control air quality in the Northeast.

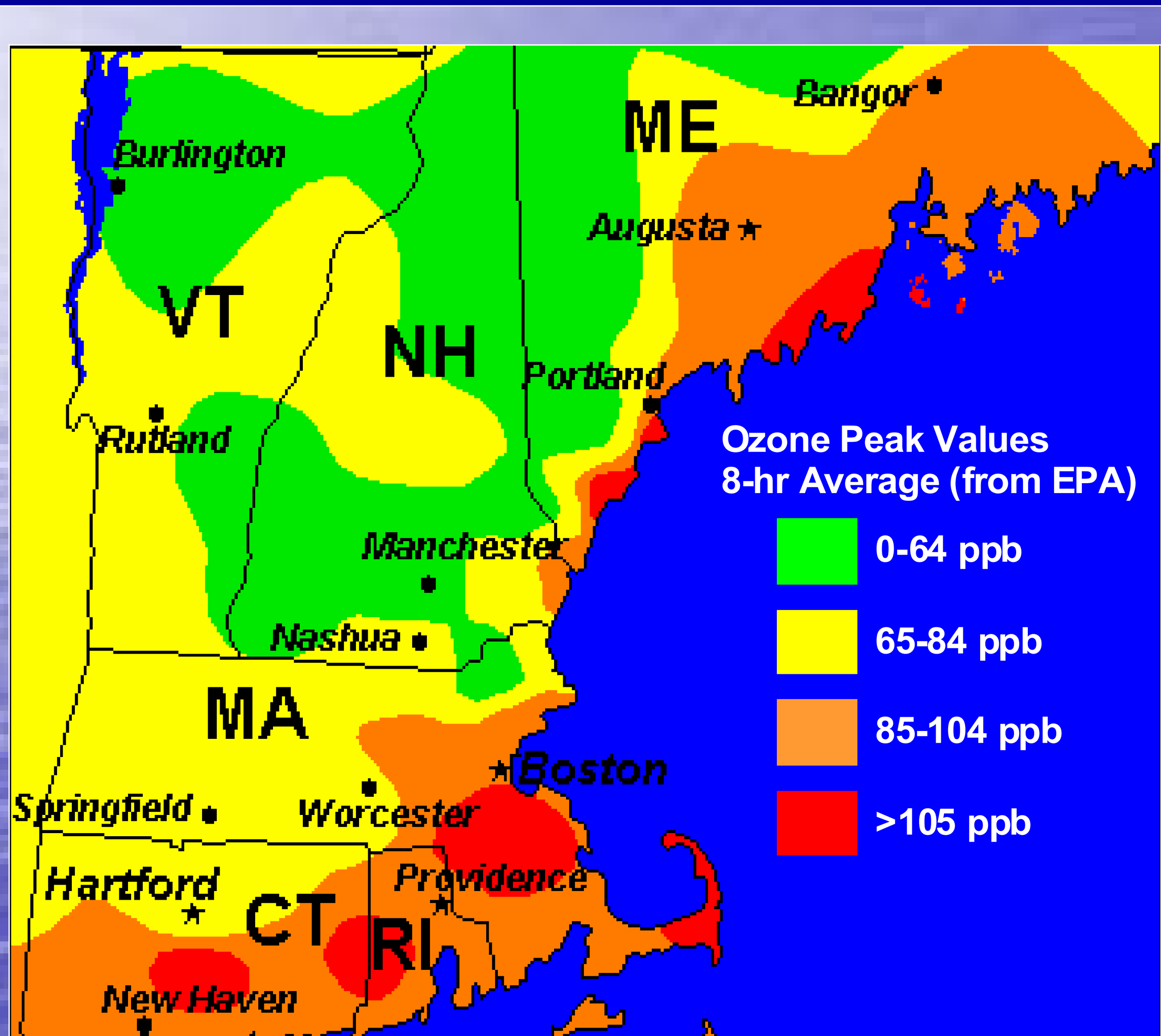


Figure 1. August 2, 2001

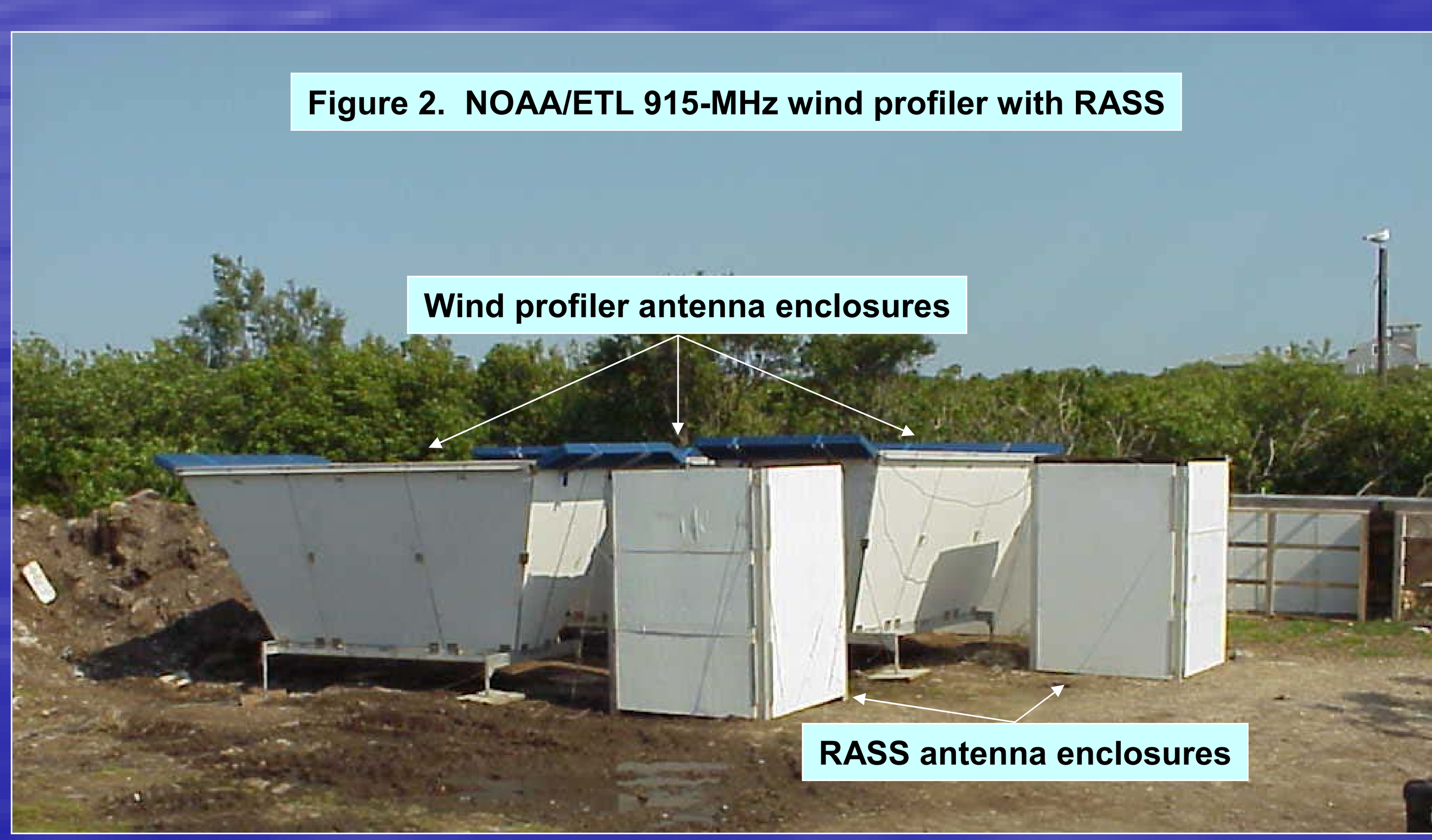


Figure 2. NOAA/ETL 915-MHz wind profiler with RASS

What ? The Weather and Climate Applications Division at NOAA/ETL operates and maintains an instrument pool of meteorological equipment for weather and air quality studies. The most commonly used combination of instruments deployed for air quality studies make up an integrated wind profiler observing system. At the heart of this system is a 915-MHz Doppler wind profiling radar (see Figure 2). The wind profiler transmits pulses of electromagnetic radiation into the atmosphere. These pulses scatter from variations in the refractive index of the atmosphere, which move with the mean background wind. The backscattered energy returned to the radar has a Doppler shifted frequency, which is analyzed through signal processing to provide an estimate of the wind speed. The wind direction is determined by measuring the radial (along beam) wind speed in multiple directions (a minimum of three is required). The wind profiler provides wind profile measurements from approximately 150 meters above ground to 2-4 kilometers above ground, depending on atmospheric conditions.

The integrated profiling system also uses a radio acoustic sounding system (RASS) to measure temperature profiles. RASS works on the principle that the speed sound travels in air is proportional to the temperature of the air. The acoustic waves transmitted by RASS serve as a target for the radar. In this case the Doppler shifted signals measured by the radar provide the speed of sound, which then is translated into temperature. The RASS and wind profiler antennas are not visible in Figure 2 because they are enclosed in shrouds to help focus vertically the transmitted signals from the wind profiler and RASS and to prevent reflections from nearby buildings and vegetation.

Because the wind profiler and RASS measurements start at a height of 150 meters above the ground, a 10-meter meteorological tower is installed to extend the wind and temperature measurements from the wind profiler and RASS down to the surface. In addition to wind and temperature, the tower has sensors to measure the air pressure, relative humidity, solar and net radiation, and rainfall accumulation. For NEAQS-2002, NOAA/ETL also installed a Doppler mini-sodar. This instrument uses pulses of sound to measure the winds in the lowest 200 meters of the atmosphere with 5-meter resolution. Because phone service is not available on Appledore Island, data from all instruments are transmitted back to NOAA/ETL via communication with one of NOAA's GOES satellites.

Examples of data from the wind profiler and RASS located on Appledore Island collected on June 18 of this year are shown, respectively, in Figures 4 and 5. Wind barbs are commonly used by meteorologists to convey wind speed and direction information. The pole of a wind barb points from the direction of the wind. For example, most of the winds shown in Figure 4 have a westerly component. The number of barbs on the pole determines the wind speed. The key for decoding the wind speed is shown at the bottom of Figure 4. The background colors in Figure 4 give the strength of the radar backscatter from the atmosphere. In Figure 5, wind barbs are displayed on background colors that represent the air temperature, as measured by RASS. The speed of sound is also affected by humidity in the atmosphere. Therefore, the temperature plotted in Figure 5 is actually the *virtual temperature* in degrees Celsius, which is the temperature that dry air would have if its pressure and density were equal to those of a given sample of moist air. The height coverage of RASS is not as good as for the wind profiler primarily because the RASS acoustic signal is blown away from the radar as it propagates upward. The time axis in both Figures 4 and 5 proceeds from right to left, which is a meteorological convention. The height axis is in meters above mean sea level (msl).

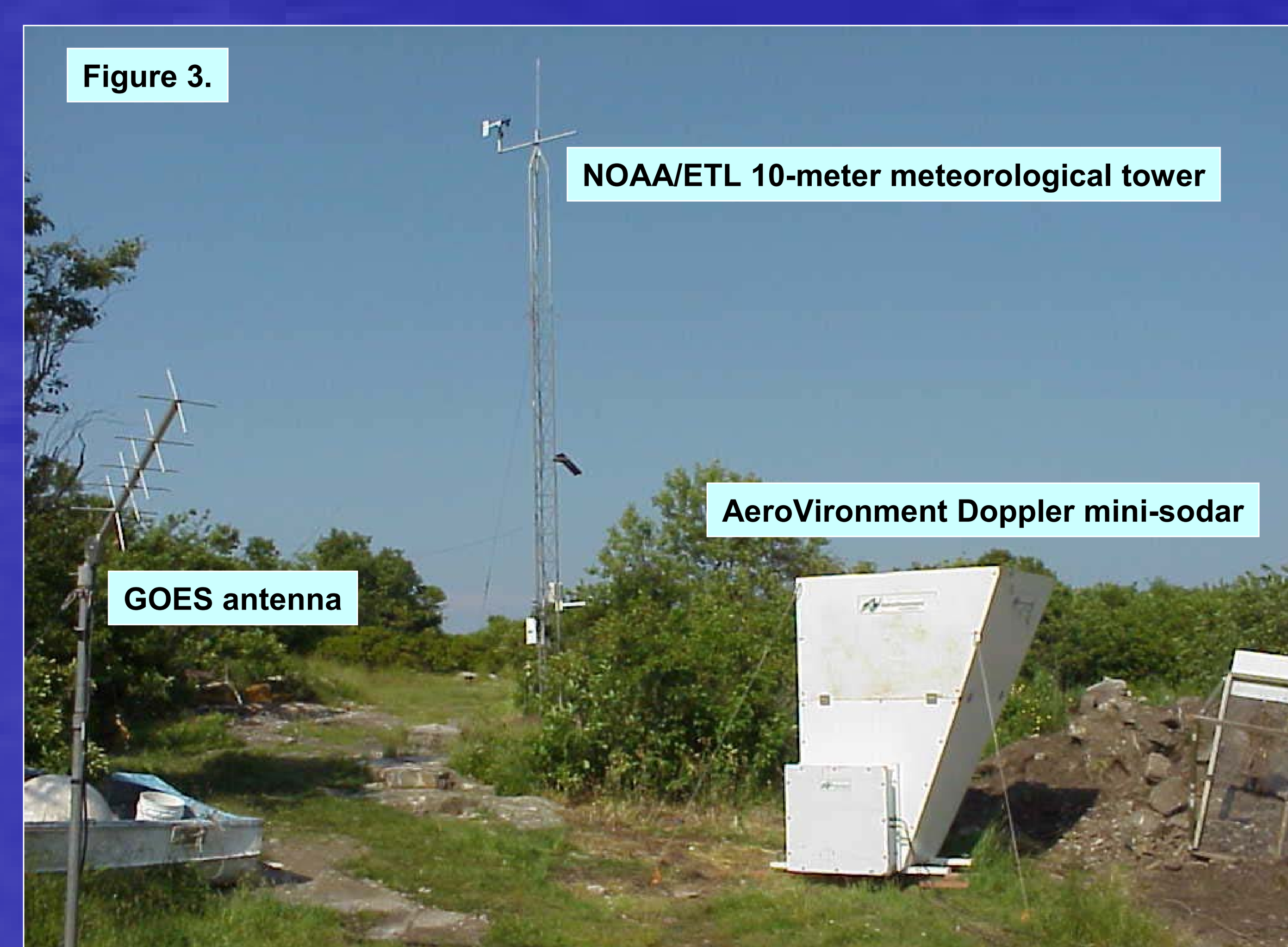
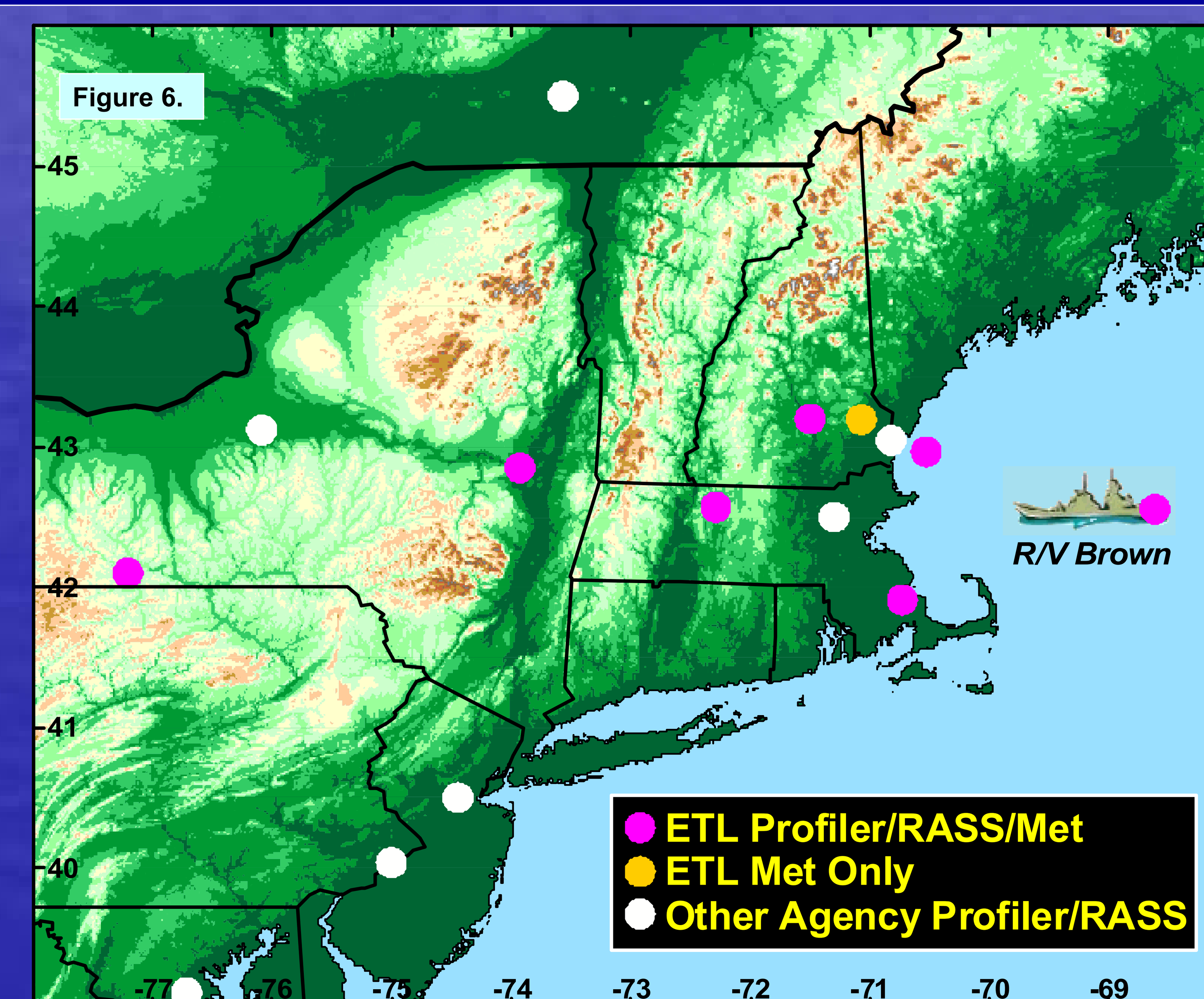


Figure 3.

Who, where, and when ? The primary participants in NEAQS-2002 field study are the NOAA Aeronomy Laboratory (NOAA/AL), NOAA/ETL, the NOAA Pacific Marine Environment Laboratory (NOAA/PMEL), the University of New Hampshire, and Plymouth State College, but many other institutions are contributing. Figure 6 is a map of the Northeast indicating the locations of the wind profiling stations. Real-time data can be viewed at www.etl.noaa.gov/et7/data/sitemap/Northeast. In addition to land-based networks of meteorological and air quality measurement stations, NOAA/AL, NOAA/ETL, and NOAA/PMEL have instrumented the NOAA research vessel (R/V) Ron Brown for detailed chemistry and meteorological observations over the Atlantic. Forecasters will use data from the land-based networks to guide the ship to a particular location on a given day based on the specific scientific objectives of that day. The official period of the NEAQS-2002 field study is from mid July to mid August. Further details are available at www.al.noaa.gov/neaqs.

For more information, contact Dr. Allen B. White, allen.b.white@noaa.gov

Figure 6.



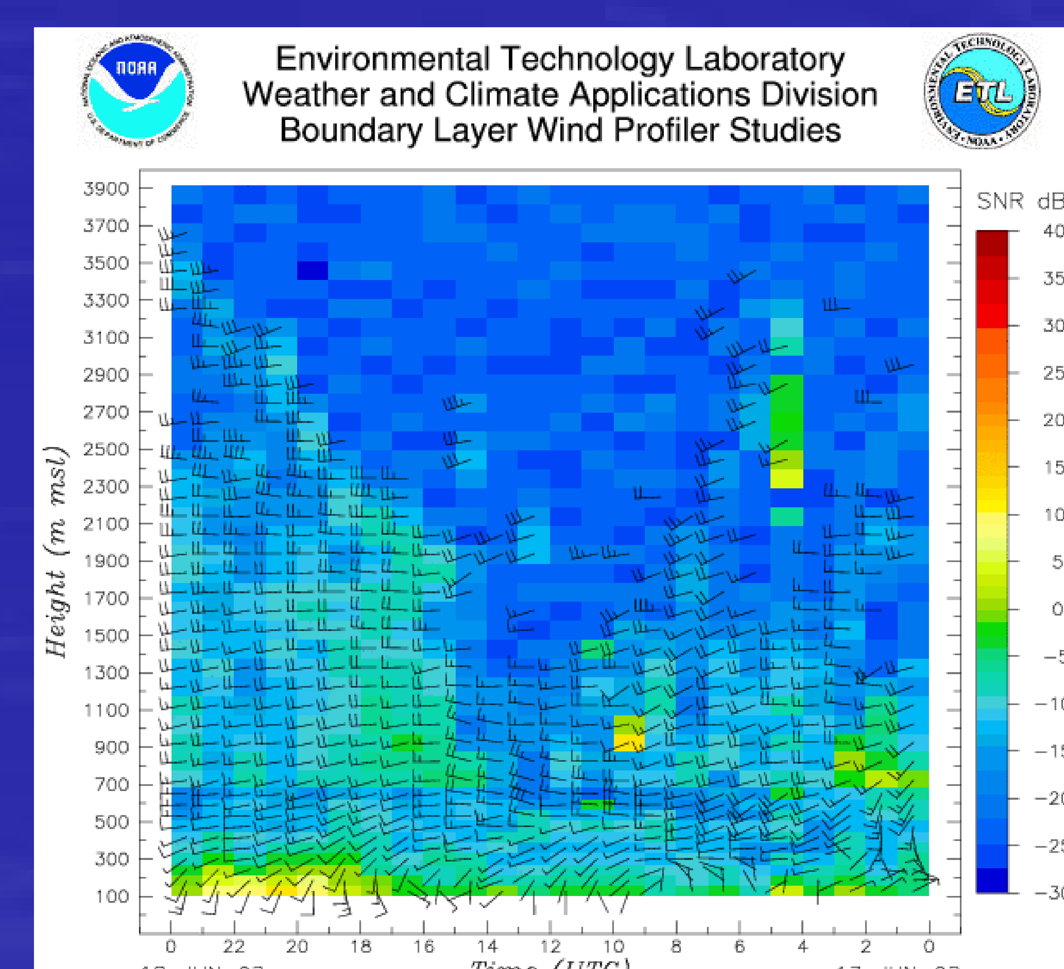


Figure 4.

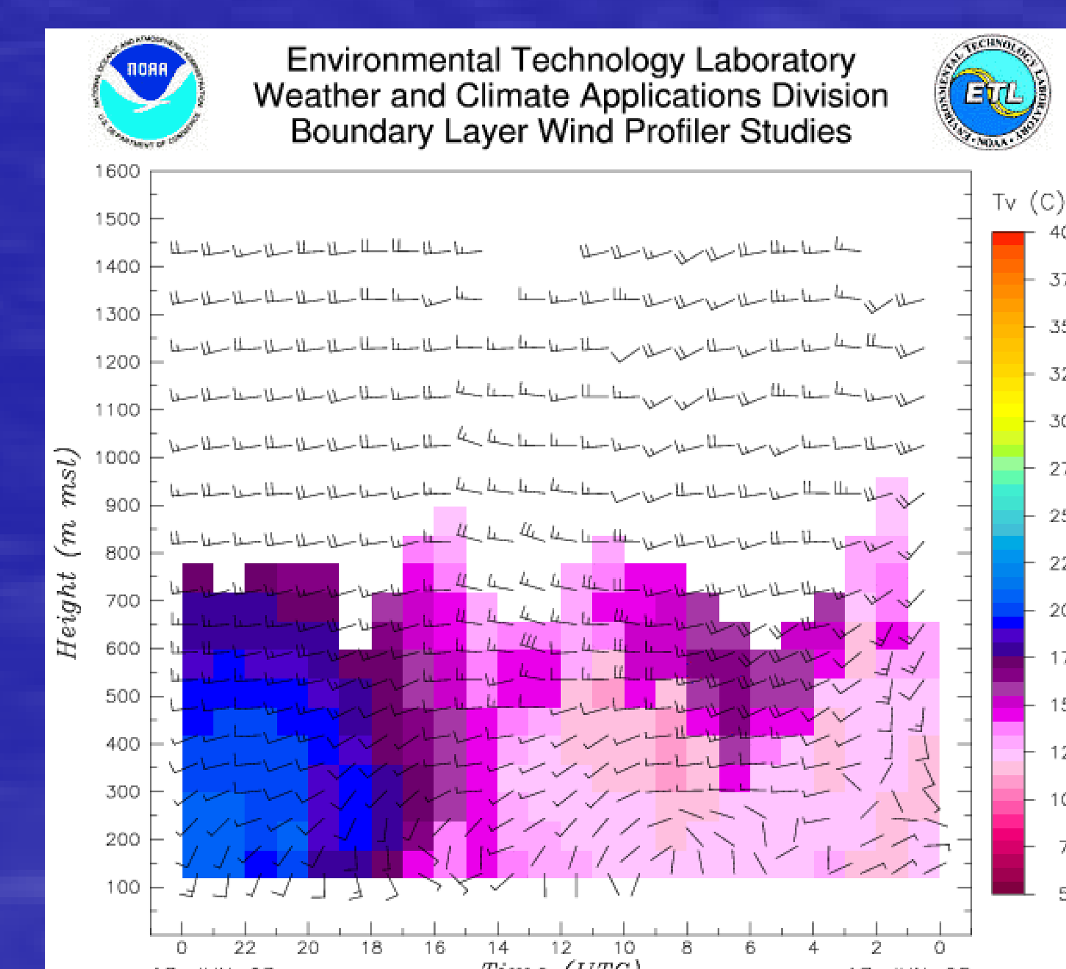


Figure 5.