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Mountain Meteorology

Project EDUCT Begins in the Shenandoah

Project EDUCT is a joint meteorological experiment run by Stephan De Wekker from the University of Virginia in Charlottesville, Virginia and a team from the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. De Wekker has been maintaining a weather station called Pinnacles in the northern part of the Shenandoah National Park for roughly one year now measuring different parameters using primarily a weather tower and small HOBO weather stations mounted along a mountain slope from valley floor to ridge top near the Pinnacles weather tower. With the help of a research grant, the NCAR team comprised of Bill Brown and Lou Verstraete brought their trailer-towed Mobile Integrated Sounding System (MISS) to aid professor De Wekker in his data gathering of the thermodynamic background from a valley location next to the National Park Service headquarters from April 5 to 11, 2009. There are obvious benefits from hosting the group from NCAR. Their instruments, generally, are more sophisticated and are able to make different kinds and more efficient remote measurements. Their participation is a big help in this project where data gathering is particularly difficult due to the nature of the terrain.

Throughout the course of the experiment, De Wekker and team hope to learn more about synoptic weather patterns that are associated with the Blue Ridge mountains including both small and large scale patterns. Temperature and wind profiles will play a large part in their data gathering and analysis processes. Possible research topics could include detecting thermal belts and their frequency in the area, analyzing different wind patterns from down within the valley to high above the mountains, looking at the development of the boundary layer, and possibly

diurnal trends for aerosol layers and if they have an effect on other meteorological in the area. The hypotheses that can be made are endless. However, the results of the experiment could largely depend on the kind of weather experienced throughout the week (clearer skies are more favorable than cloudy, precipitous weather). During the first half of the week, Virginia experienced unusually cold weather. It will be interesting to see the results EDUCT and how that aspect plays a role in the analysis.

The specific devices used by De Wekker and NCAR throughout the week are sonic and cup anenometers to detect horizontal wind speeds and directions at the height of the instruments, temperature and humidity sensors (HOBOs), pressure sensors, ceilometers to detect cloud height, LIDARS to detect aerosols in the atmosphere, as well as a few more devices. MISS, brought by NCAR, brings to EDUCT a wind profiler to measure horizontal wind speeds and directions at all layers of the atmosphere up to roughly 2 kilometers depending on air quality and conditions, a distrometer to measure rain accumulation and droplet size, a ceilometer, radiosonde balloon launching capabilities as well as sensors for humidity, pressure and solar radiation. Another useful tool of MISS is the on board data processing and dissemination. Contained on the trailer are computers that can interpret the data gathered by the instruments on the trailer in near real time. Included are displays of the data often represented in graphical form which allows the analysis processes to begin almost immediately after measurements are taken. I was present for a radiosonde balloon launch in which we could track the temperature, relative humidity, and wind speed profiles as the sonde rose.

Radiosondes are helpful in that they take direct measurements of many layers in the atmosphere as they rise relatively quickly (over a matter of 30 minutes the balloon can reach heights of around 15,000 meters depending on the amount of helium in the balloon and weight of

the radio device). On that particular sonde, there was a sensor from NCAR and one of De Wekker's sensors attached to the same balloon with the purpose of hopefully obtaining two sets of data that could later be compared. Unfortunately, only the NCAR radiosonde was successful, but where the De Wekker sonde failed, there is always something to be learned (in this case it probably is that insuring the GPS tracker is completely functional and the radio is transmitting data before the sonde is launched). At the same time there will always be the possibility of technical difficulties and it is important to account for that possibility in planning the experiment. Luckily for De Wekker, there will be more opportunities to send a double radiosonde later in the week.

A more reliable method of detecting temperatures along the mountain slope are to attach a HOBO unit to the back of a car and drive from one side of the ridge, over the top, and back down the other side while taking measurements. De Wekker hopes to get some of these transect readings in before the week closes. Although reliable methods of gathering data, there are also obvious downsides to this method. Interference from the ground heat flux can influence the temperature readings. More specifically, the readings from the HOBO attached to the car are not in a completely open atmosphere environment. Still, they aid in analyzing temperature profiles where the radiosonde might fail.

Among all the instruments brought to the Shenendoah by NCAR, the wind profiler is by far one of the most unique, and most expensive. At around US $200,000, it is not an instrument that every weather station can afford (the entire trailer including instrumentation and processing equipment costs roughly US $400,000). Due to its size, it covers roughly half the trailer and contains radar sensors that point vertically, and at oblique angles in any user-specified, programmable direction. Using the oblique measurements in comparison to the vertical

measurement, the wind profiler is able to detect in which direction small particles (particularly water and ice particles) in the atmosphere are moving as well as how fast. One must also be careful that the wind profiler is positioned in a very open area. During my visit, it was detecting solid particles with zero doppler shift which probably was due to the surrounding trees. Although, through analysis these detections can be subtracted out the data, their absence altogether makes analysis easier (and more accurate). The radar operates at a wavelength of 30 centimeters which is relatively large for a wind profiler. The advantages of this wavelength is that precipitation typically does not affect/block readings. However, this size wavelength also creates problems when trying to detect small ice crystal movements high in the atmosphere. There is always a tradeoff when choosing the "optimal" wavelength.

Although not an instrument that necessarily is of direct benefit for EDUCT, the most interesting instrument I encountered at the study was the small distrometer also mounted on the NCAR trailer. It is a small metallic plate with a face pointed upward towards the sky. As rain droplets hit the plate, there are small microphones that can determine the size of the drop based on the frequency at which the plate resonates. Then by detecting the size and how often the droplets hits it can estimate a measurement for total rainfall over a period of time.

Although you probably have a good idea at this point about the technical aspects of project EDUCT, its name sill might not be so clear. Another key aspect of the project involves education component (hence the name EDUCT). Throughout the week long experiment when NCAR and De Wekker were taking measurements, groups of high school and college students visited the experiment site to learn about mountain meteorology, how an experiment is run, and get a chance to see the high-tech equipment NCAR had brought all the way from Boulder. Getting the academic community involved is an interesting aspect that De Wekker has

incorporated. Not only will this project gather data that will help scientists learn about the weather associated with the Blue Ridge, but it also promotes future potential scientists to explore similar topics. I think it is a great idea in which the meteorological community definitely benefits in the long run as more experiments include young people.

Data is still being gathered on project EDUCT and rainy weather leading into the weekend is a discouraging sign. Nevertheless, the team perseveres and has high hopes. Data has already been gathered and no doubt will be useful in analysis. The help of NCAR is a special opportunity to take measurements that De Wekker would not normally be able to do. As MISS moves to the midwest United States to chase tornadoes next week, the data gathered in EDUCT will begin to be organized to prepare for analysis. Just because the data gathering process has finished and the NCAR group has moved on, the project is far from over. It will take many months, maybe years, to analyze this data. One thing is for certain though, EDUCT has gotten at least one student interested in meteorological experimentation.