CAN-DOO: Climate Action Network Through Direct Observations And Outreach

By: Brett Taubman

Participants: Howie Neufeld - Biology, Brett Taubman - Chemistry, Barkley Sive - Chemistry, Rahman Tashakkori - Computer Science, Baker Perry - Geography, Jim Sherman - Physics, Ryan Emanuel - NC State, Doug Miller - UNCA

Abstract

2011 Fall Southeast Regional Space Grant Meeting, September 9, 2011. The urgency of climate change demands a greater understanding of our climate system, not only by the leaders of today, but by the scientists, policy makers, and citizens of tomorrow. Unfortunately, a large segment of the population currently possesses inadequate knowledge of climate science. In direct response to a need for greater scientific literacy with respect to climate science, researchers from Appalachian State University's Appalachian Atmospheric Interdisciplinary Research (AppalAIR) group, with support from NASA, have developed CAN-DOO: the Climate Action Network through Direct Observations and Outreach. CAN-DOO addresses climate science literacy by 1) Developing the infrastructure for sustaining and expanding public outreach through long-term climate measurements capable of complementing existing NASA measurements, 2) Enhancing public awareness of climate science and NASA's role in advancing our understanding of the Earth System, and 3) Introducing Science, Technology, Engineering, and Mathematics principles to homeschooled, public school, and Appalachian State University students through applied climate science activities. Project partners include the Grandfather Mountain Stewardship Foundation, Pisgah Astronomical Research Institute, and local elementary schools. In partnership with Grandfather Mountain, climate science awareness is promoted through citizen science activities, interactive public displays, and staff training. CAN-DOO engages students by involving them in the entire scientific investigative process as applied to climate science. We introduce local elementary and middle school students, homeschooled students throughout North Carolina, and undergraduate students in a new Global Climate Change course and select other courses at Appalachian State University to instrument assembly, measurement techniques, data collection, hypothesis testing, and drawing conclusions. Results are placed in the proper context via comparisons with other student data products, local research-grade measurements, and NASA measurements. Several educational modules have been developed that address specific topics in climate science. The modules are scalable and have been successfully implemented at levels ranging from 2nd grade through first-year graduate as well as with citizen science groups. They also can be applied in user-desired segments to a variety of Earth Science units. In this paper, we will introduce the project activities and present results from the first year of observations and outreach, with a special emphasis on two of the developed modules, the surface energy balance and aerosol optical depth module.

CAN-DOO:
Climate Action Network through Direct Observations and Outreach

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Outline

I. Introduction to AppalAIR
II. Measurement Capabilities
III. NASA/NOAA Partnerships
IV. CAN-DOO outreach
V. Highlights from Year One
VI. Sample Measurements
VII. Future Directions
Appalachian Atmospheric Interdisciplinary Research
an air quality/climate research and public outreach facility for exploring air pollution formation and transport and the relationship of pollution to a changing climate and its effects on regional ecosystems

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Measurements
Aerosol light scattering – TSI 3 \( \lambda \) integrating nephelometer;
   Humidified Radiance Research integrating nephelometer
Aerosol light absorption – Radiance Research 3 \( \lambda \) PSAP; Magee
   Scientific 7 \( \lambda \) aethalometer and custom UV 6 \( \lambda \) aethalometer
Aerosol Optical Depth-CIMEL 918EBN
Aerosol vertical profiles – Micro-Pulse Lidar
Aerosol number concentration – TSI CNC 3007
Trace gases – \( \text{O}_3 \), \( \text{CO}_2 \), and \( \text{H}_2\text{O} \)
All-Sky Imager – Yankee Scientific TSI-440
Direct and Diffuse Irradiance – Kipp&Zonen CM22 Pyranometer
Present Weather Detector – Vaisala PWD12
Standard and Micrometeorology
Lots more aerosol/trace gas chemistry and microphysics coming...
NOAA GMD Aerosol Sampling Stations

Legend
- NOAA
- affiliate
- future sites
Climate Action Network through Direct Observations and Outreach

- 21st Century may become known as the Climate Century, yet majority of citizens do not have a basic understanding of atmospheric processes!

- Urgency of changing climate demands a greater understanding of our climate system, not only of the leaders of today, but by the policymakers, citizens, and scientists of tomorrow.
1. Develop the infrastructure for sustaining and expanding public outreach through long-term climate measurements capable of complementing existing NASA measurements.

2. Enhance public awareness of climate science and NASA’s role in advancing our understanding of the Earth System.

3. Introduce STEM principles to homeschooled, public school, and Appalachian State University students through applied climate science activities.
CAN-DOO Partners

- AppalAIR
- Grandfather Mountain Stewardship Foundation
  - Public education and outreach, citizen science, research-quality meteorological observations
- Pisgah Astronomical Research Institute (PARI)
  - Summer camp for homeschooled high school students
- Science Clubs at Watauga County Elementary Schools
  - Hardin Park Elementary School
  - Bethel Elementary School
Grandfather Mountain, NC

Calloway Peak: 1,818 m asl

Top Shop and Mile High Swinging Bridge: 1,609 m asl
Pisgah Astronomical Research
Sample STEM Activities

- Inquiry-based data collection and hypothesis testing
- Meteorological station siting at local elementary schools
- Surface energy balance measurement and calculation
- Clouds and humidity
- Precipitation patterns and processes
- Weather balloon releases
- Snow depth and snow water equivalent (SWE)
- Aerosol Optical Depth (AOD) measurement and comparison to satellite retrievals
- Climatological data analysis
- Stewardship!
Hand-held Instrumentation

- **Kestrel weather meters**
  - Temperature, relative humidity, pressure, wind speed

- **Apogee pyranometers**
  - Incoming and reflected solar radiation; calculation of surface albedo

- **Infrared thermometers**
  - Radiant temperatures of different surfaces (asphalt, grass, soil, etc.)

- **Snowmetrics snow sampling tubes and dial-stem thermometers**
  - Snow depth, snow water equivalent (SWE), snow density, and snowpack temperature

- **Sun photometers**
  - Aerosol Optical Depth (AOD)
Meteorological Stations

- **Bethel Elementary School** (823 m asl)
  - Automated temperature, relative humidity, pressure, solar radiation, and manual precipitation gauge

- **Hardin Park Elementary School** (975 m asl)
  - Automated temperature, relative humidity, pressure, solar radiation, and manual precipitation gauge

- **AppalAIR Broyhill** (1,067 m asl)
  - Automated temperature, relative humidity, pressure, solar radiation, wind speed and direction, and aerosol optical depth

- **Grandfather Mountain Nature Museum** (1,372 m asl)
  - Daily measurements of maximum and minimum temperature, precipitation, snow depth and SWE, visibility, aerosol optical depth

- **Grandfather Mountain Swinging Bridge** (1,609 m asl)
  - Automated temperature, relative humidity, pressure, wind speed, wind direction (precipitation and precipitation type coming soon!)
Bethel Meteorological Station
Weather Balloon Launches!
Sun Photometer Training at Grandfather Mountain
Year One Highlights

- **Elementary School Science Clubs**
  - Hardin Park Elementary School – 100 students grades 3-8
  - Bethel Elementary School – 20+ students grades 2-5
  - Kids are having fun!

- **New Global Climate Change Course**
  - Fully enrolled both semesters offered thus far (1 lecture & 3 labs)
  - Approved as part of the Science Inquiry Perspective in the new General Education Program

- **Meteorological Station Installations and Data Collection**
  - -22 °C at Bethel Elementary School is the lowest temperature recorded in North Carolina during winter of 2010-2011
  - 48 ms⁻¹ wind gust on Grandfather Mountain in February 2011 is one of the highest wind speeds ever recorded in North Carolina
“Parker talked nonstop all afternoon about Science Club yesterday. He had a great time with the experiments. Thanks for all that you do for the kids.”

“Thanks for exposing our kids to such a great program and weekly activity. I want you to know how thankful I am to have something for Ryan to do after school that engages his attention and that he enjoys.”

“I can't sing praises enough for the science club at Bethel. Isaac is always so excited when Tuesday comes around. When I pick him up, all he talks about is what he did, what you all talked about, who was there, etc. Thanks again for all the hard work from you and the other helpers.”
• Measurements taken at 500 nm
• Student measurements taken within 30 min of CIMEL measurements

Markham et al., J. Geosci. Ed., under review, 2011
AOD Measurements

Student measured AOD values

Markham et al., J. Geosci. Ed., under review, 2011
Surface Energy Balance

Short Wave Flux vs Temperature

Data taken during 2.5 day SEB exercise at PARI climate camp

Markham et al., J. Geosci. Ed., under review, 2011
Future Directions

- Partnerships with the Discovery Place in Charlotte, NC, and the North Carolina Science Museum in Raleigh, NC
  - Train the trainer model
  - High visibility public displays
  - Short documentary film
  - NASA satellite products

- International expansion to schools and field sites in Ethiopia, South Africa, India, and Peru
  - Global perspective is critical in understanding climate change
  - Continuing to take Appalachian undergraduate and graduate students to the Andes
  - Taking public school teachers to the field
Citizen Scientist Don Pedro Godfredo at his Observing Site (~5100 m asl) in Cordillera Vilcanota, Peru
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