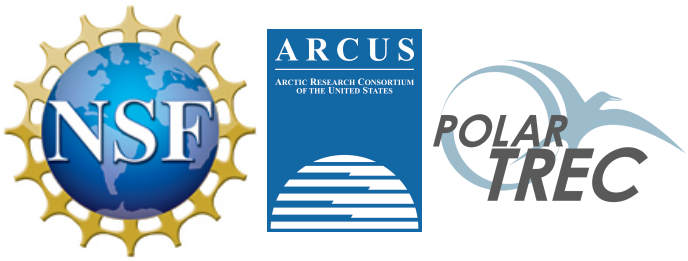
TEACHERS AND RESEARCHERS EXPLORING AND COLLABORATING

PolarTREC STEM Experience Report

Antarctic Automatic Weather Stations

PolarTREC Expedition Page
https://www.polartrec.com/expeditions/antarctic-automatic-weather-stations



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Formal Introduction

My name is George Hademenos and I am a physics teacher currently in my 17th year at Richardson High School in Richardson, TX. My primary instructional mission as an educator is to ensure that not only are my students exposed to the knowledge, content and lab experiences consistent with a science course, but that they are also afforded the opportunity and presented with the challenges to develop and sharpen their critical inquiry, thinking, and reasoning skills – skills that are directly related and exclusively linked to a 21st century of invention and innovation. I constantly strive to incorporate and integrate these strategies to: educate students about the relevance of science in the world, enlighten them to the STEM-based technological challenges that await them in the future, embolden them to accept these challenges, and empower them to apply their knowledge toward practical solutions of problems, both on a small scale and a large scale. I am always looking for unique and creative instructional opportunities to bring to my classroom as well as to share with other teachers. The PolarTREC experience provided me with opportunities that address all of these criteria.

A photo of me standing in front of a Mattracks vehicle.

PolarTREC Expedition

I was chosen to be part of the 2017 – 2018 cohort of PolarTREC teachers by Carol Costanza and Dr. Matthew Lazzara from the University of Wisconsin at Madison Space Science and Engineering Center (SSEC) to work on the Antarctic Automatic Weather Station project. Automatic Weather Stations (AWS) are free-standing structures equipped with mounted sensors that collect meteorological data on a consistent basis. The University of Wisconsin at Madison currently manages approximately 60 AWS located across Antarctica.

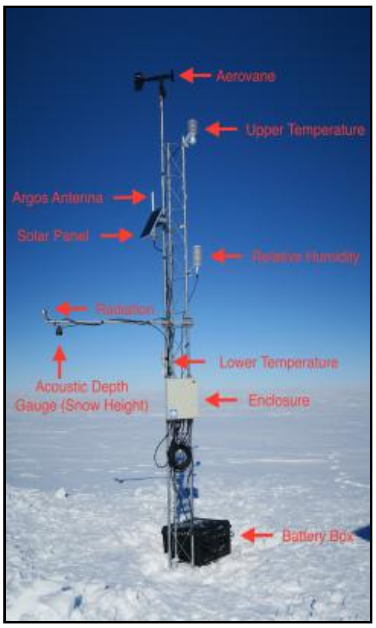
An Introduction to Automatic Weather Stations

The AWS group is responsible for the development, construction, assembly, and data analysis of approximately 60 AWS units positioned across the continent. An AWS is a free-standing structure with attached sensors designed to collect data representing the following weather variables: temperature, air pressure, relative humidity, wind speed and direction, and depth of snow accumulation. The collected sensor data from an AWS is stored and transmitted to Madison, Wisconsin for data analysis.

STEM Experience with Automatic Weather Stations

My STEM Experience was clearly described in a journal entry posted November 23 entitled, “Wishin and Hopin (and Liftin and Totin),” and a condensed summary of that posting follows. At the onset of this expedition, our planned itinerary included visits to 9 AWS with each requiring various tasks ranging from inspection to raising sensors up the tower to protect them from

snow accumulation to specific checks of sensors that have not been transmitting either any data at all or erroneous data. Five of the AWS (Lorne, Cape Bird, Minna Bluff, White Island, and Marble Point) were to be reached by helicopter flights and the remaining four AWS (Gill, Elaine, Sabrina, and Alexander Tall Tower) were to be reached by Twin Otter aircraft. Both sets of AWS visits have been hampered by unfavorable weather conditions and, for the Twin Otter flights, also by tainted fuel which had to be replaced at a local fuel cache before those flights could be rescheduled.



Labeled photo of an Automatic Weather Station.

Up until Tuesday, November 21, one visit was made via helicopter to Lorne AWS where several items were on the itinerary upon reaching Lorne, but we had run into issues with the first task of extracting the battery box which had been sealed within its ice trench by a layer of ice on the bottom surface of the box. We had neither the tools nor the manpower to separate the battery box from the layer of ice and extract the battery box. Interestingly enough, on Saturday, November 18, we were placed on the helicopter schedule for a return flight to Lorne AWS, this time securing the necessary tools to handle the ice and recruiting two boondogglers (members from the community who volunteer their time and effort to help the scientists on their various expeditions). At our arranged time, we transported all of the required equipment to the helipad and entered the main office to meet our boondogglers and await the necessary training prior to boarding a helicopter when we got the word that has become all too common. The flight was scrapped – not because of the weather at the helipad but this time because of the weather at Lorne AWS which showed sustained wind gusts of 20 – 25 knots, making accessibility of the helicopter to the landing site at Lorne a risky mission.


A photo of a deadman that will act to stabilize the AWS tower.

Yes, everything looked grim and glum…until yesterday! We finally got our opportunity to make great strides in our to-do list in the field. So, what I would like to do is take time in this journal post to talk about AWS units – one that we are erecting at Phoenix Field and four others (outside of Lorne AWS) that are established and have been transmitting correct data on a continual basis. Although each of these four AWS sites were on the plan for inspection, one AWS (Minna Bluff) was transmitting incorrect temperature and wind speed data, and we wanted to see what the problem was. I will be showing photos of each of the AWS units, including Minna Bluff, so you can see exactly why we were having problems with the data. At this point, I have had the opportunity to observe and become involved in various aspects of the AWS on various dates. In this journal, I would like to compile and discuss my observations with the AWS – starting from the beginning.

The Structural Framework of an AWS

The first stage in constructing an AWS in the structural framework consisting of a triangular tower that typically extends 10 – 20 feet from the ground. The tower comes in sections which can be attached, allowing the scientists to vary the height of the AWS according to the parameters presented by the local topography. In addition, a major challenge of the AWS framework is that the AWS tower must be stable enough to withstand the rather strong wind gusts that can occur for extended periods of time. To construct an AWS out in the field, a lengthy list of tools, equipment, hardware, segments of tower and all of the sensors and components related to the measurement of the scientific data to be acquired by the AWS. The planning process is rather involved to insure that not only the required hardware is identified and placed on the list for transport out to the field site but also to include hardware and tools that might be needed for unexpected or unforeseen mishaps in the field such as dropping small washers or bolts or needing a different-sized wrench. The field site for the new AWS is Phoenix Field. Phoenix Field is the current airfield/runway for flights originating in/out of McMurdo Station to/from Christchurch, New Zealand. It is approximately 11 miles from McMurdo Station.

A photo of the infrastructure of an AWS.

On the date of the planned installation, all of the cargo required to construct an AWS is transported to the loading dock and then placed into the cargo bed of a truck – but not just any truck. We used a Mattracks vehicle. The wheels of the truck are replaced with treads similar to those found on tanks, allowing the vehicle to navigate the snow-covered and ice-topped terrains commonly experienced on the roads leading up the field sites where AWS units are installed.

Cargo for the AWS loaded onto a banana sled.

Once the tower is constructed according to the planned height, the tower must be anchored in order to keep stabilized and upright for two reasons: (1) the tower with all of the sensors and attachments to the power supply must remain freestanding in order to continue collecting weather data under extreme weather conditions and, (2) the tower must be upright and aligned perpendicular as best as possible (using a level and line of sight) to ensure that any data dependent on orientation such as wind speed/direction be scientifically accurate. To accomplish this, the tower is stabilized by 3 guy wires (yes, it is spelled correctly), which are each anchored into an angled L-shaped bar called a deadman (again, it is spelled correctly), buried in a 2-foot trench, buried and packed with snow, as shown in the figure below.

Three deadmen (I believe that is the correct plural presentation of a deadman and not deadmans) are required to secure the three guy wires to support the AWS tower. Below is the final product of the AWS tower infrastructure.

Installation of the AWS Power Supply, Solar Panels and Sensors

Once the tower is erected, the next steps that follow are: mount the sensors at appropriate positions along the tower supporting rods; connect the sensors to a data logger that will collect and transmit the weather data obtained by the sensors; mount a solar panel along the tower supporting rods that will transfer solar energy collected by the sun (remember, during the summer months, Antarctica sees virtually 24 hours of continuous sunlight) to a power supply; and finally connect the data logger control box and the solar panel to a battery box. The batteries within the battery box are solar powered which means they take the solar energy from the panel and then in turn convert it into electrical energy which powers the data logger and the connected sensors.

A photo of me totin a battery to the AWS.

Of course, taking into account the sensors, the solar panel, the data logger control box, the antenna used to transmit the data from the data logger, the battery box and the batteries themselves, you would think that there is a lot of equipment and related hardware and tools to haul to the AWS tower. You would be right – not only is there a lot of equipment but combined, it is heavy. To facilitate the transport of all of this equipment, we checked out a pair of banana sleds – sleds which make the transport of heavy equipment across the snow surface easier. Well, easier is a relative term considering that each battery is akin to a car battery and weigh 70 pounds per battery. The two batteries in the battery box are each 13 volts and are connected in parallel, similar to how houses are wired. The battery box that would be providing power to the AWS at Phoenix Airfield would require two batteries. We loaded up the two banana sleds with the equipment and began hauling through the snow.

Carol installing sensors on the AWS tower.

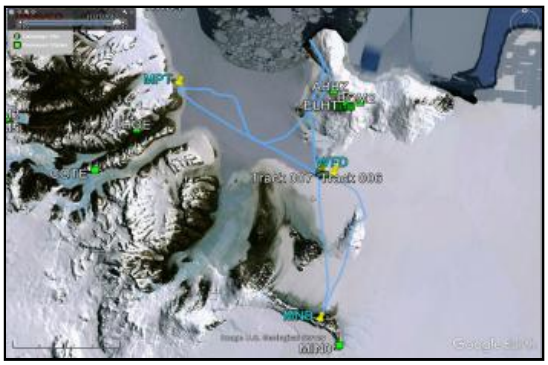
Once the banana sleds have been pulled to the location of the AWS tower, everything must be unloaded, including the batteries. I then begin the process by liftin and then totin the battery (excuse the spelling – I am working within the theme of the journal post).

Carol donned her harness and began installing the sensors one by one, making sure that they were securely fastened to the tower supporting rods and that they were all level or perpendicular to the tower.

Maintenance and Repair of Functional/Operational AWS Units

As I mentioned in the introductory paragraph of this journal, the primary objective of my time in Antarctica was the opportunity to travel to functional/operational AWS units and conduct routine maintenance evaluations. On Tuesday, we were booked on back to back helicopter flights which would eventually take is to five AWS sites. On our first leg of the trip, the helicopter pilot took us

to Marble Point and Marble Point II (both within 5 minutes of walking distance between them) and Cape Bird, before flying back to McMurdo Station to refuel. Once refueled, we flew to Minna Bluff and then on to the AWS on White Island before we returned back to base, this time for good.



A GPS track of our visit to five AWS.

Future Plans Post Expedition

Upon completion of my expedition, I have already begun to map out a list of instructional activities to implement in the classroom and vehicles/platforms upon which to share my experiences with my teaching colleagues.

Instructional Activities for the Classroom

1. An activity that I have already implemented in class which is entitled “Polar-ympics.” A description of this activity was detailed in a journal entry of October 30, Games People Play (https://www.polartrec.com/expeditions/antarctic-automatic-weather-statio...)
2. An activity that I have already implemented in class which is entitled, “Dressing the Part.” A description of this activity was detailed in a journal entry of October 30, You’ve Got a Friend (https://www.polartrec.com/expeditions/antarctic-automatic-weather-statio...)
3. I have an art student working on painting a ceiling tile to commemorate the Antarctica expedition.
4. I am working to develop a children’s book illustrated by art students to convey the science experienced during the expedition.
5. I am actively seeking grant opportunities to purchase an automatic weather station for my school to allow my students and environmental science students to explore and analyze weather data and compare them with data from Antarctica.

Vehicles/Platforms to Share with Teachers

1. I have written an article on my experience for publication in the newsletter of the Science Teachers Association of Texas, *STATellite*.
2. I have submitted an abstract to present observations of my PolarTREC experience at MiniCAST, a conference for science teachers who teach in the Dallas-Fort Worth Metroplex and surrounding school districts.
3. I am currently drafting an article with three other PolarTREC teachers which will be submitted to a special issue of The Polar Record journal.
4. I am working on a book that details my Antarctica expedition which I plan to share with my teacher colleagues.

A photo of Minna Bluff AWS.

Now do you see what the problem might have been with Minna Bluff? It looks like Minna Bluff will be on the schedule for a return visit!