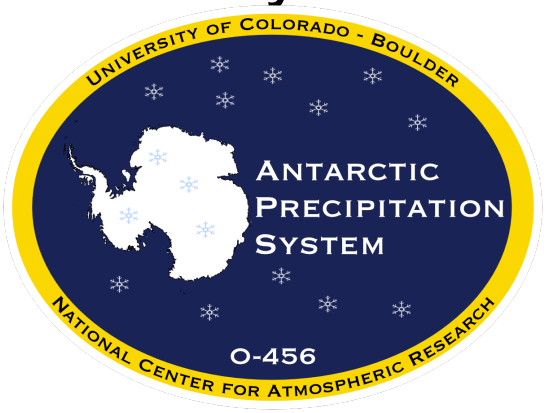
The Installation of Antarctic Precipitation Systems During the 2017-18 Field Season and the Early Results



Mark W. Seefeldt[1], Taydra Low[1],
Scott D. Landolt[2], and Andrew J. Monaghan[2]

[1]Cooperative Institute for Research in Environmental Sciences (CIRES)
University of Colorado – Boulder

[2]Research Applications Laboratory (RAL)
National Center for Atmospheric Research

Workshop on Antarctic
Meteorology and Climatology
16 July 2018

Cooperative Institute for Research in Environmental Sciences
UNIVERSITY OF COLORADO **BOULDER** and **NOAA**

Motivation

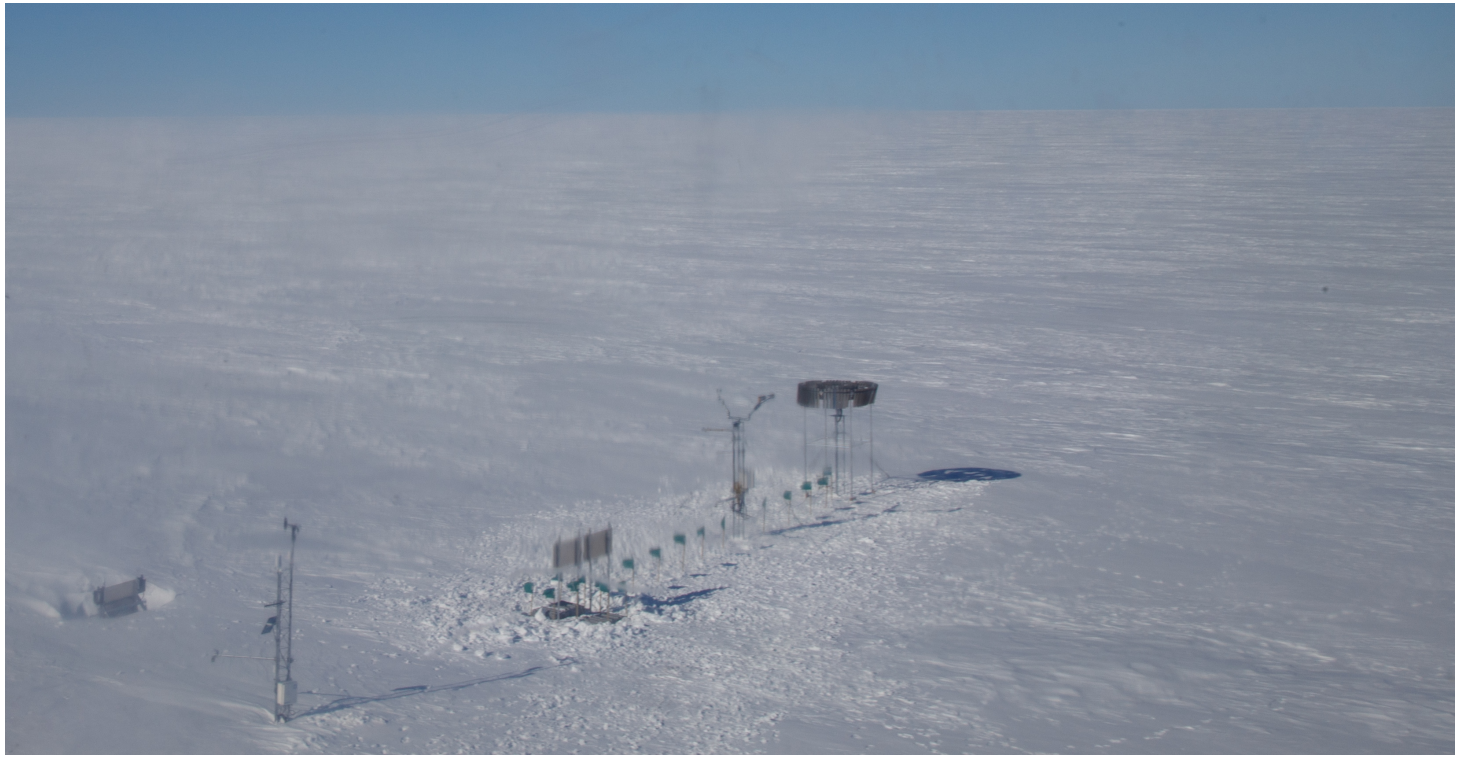
- Precipitation has proven to be exceedingly difficult to accurately measure or otherwise estimate in Antarctica due to:

  1. The relatively small amount of annual precipitation

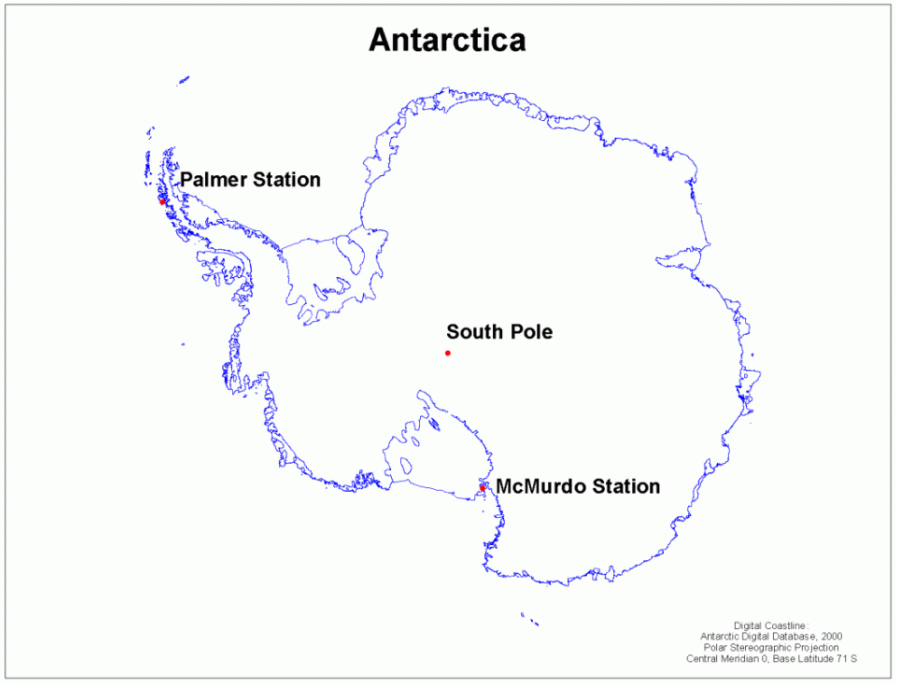
  2. Difficulty in distinguishing between falling snow (precipitation) and blowing snow

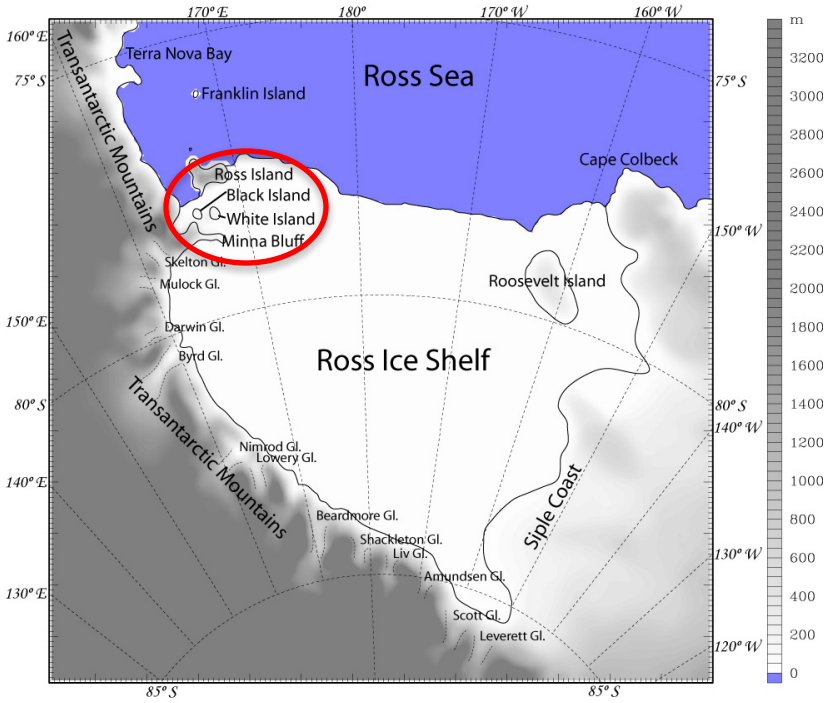
Motivation

3. The difficulties to measure precipitation are even more complex in remote locations requiring low-power and autonomous measurement systems



Geography of the Ross Ice Shelf





Significance of Precipitation Measurement

- Precipitation is currently estimated primarily by numerical models (NWP, GCMs, reanalyses)
- There is a poor understanding of cloud microphysics (e.g. how precipitation particles form) and precipitation in models in the polar regions
- Having direct measurements of precipitation will provide a means to validate and improve the computer models

Goals

- Design and install a system to accurately measure precipitation in Antarctica
- Install four Antarctic Precipitation Systems (APSs) in the Ross Island region
  - Logistical access and convenience of being adjacent to McMurdo Station
- Operate the APSs remotely in the Antarctic environment over the entire year

Science Goals

- What are the differential contributions of falling snow, ice crystals and blowing snow to overall snow accumulation in the Ross Island region?

- How does precipitation accumulation (after removing the impact of blowing snow) vary seasonally and spatially?

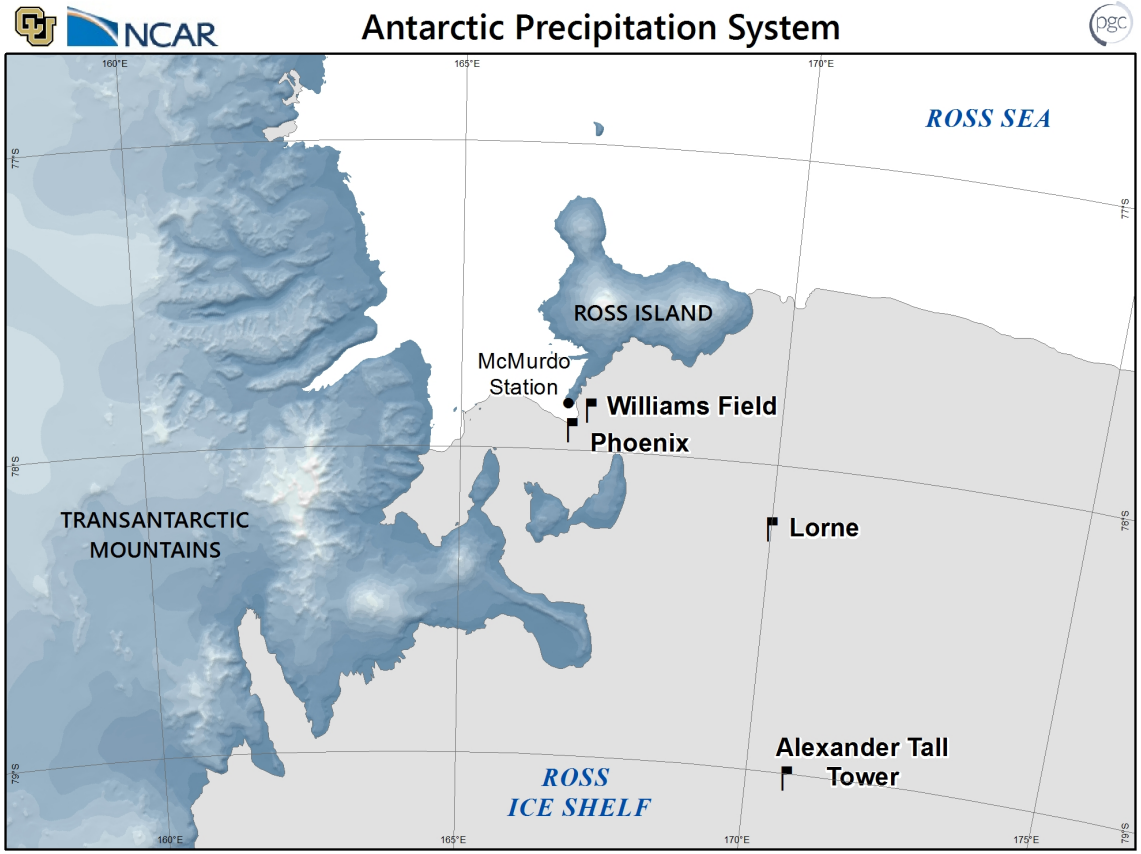
- How well do weather models simulate the spatial and seasonal aspects of precipitation accumulation and where should efforts be focused to improve the model?

Antarctic Precipitation Systems - Schedule

- Initial deployment in November 2017
- The goal is to get two years of observations
- Maintenance and adjustments will be completed in November 2018
- APS sites will be removed in November 2019
- Two-way communications allow for real-time monitoring of the observations and adjustments to the measurement algorithms

Antarctic Precipitation Systems - Locations

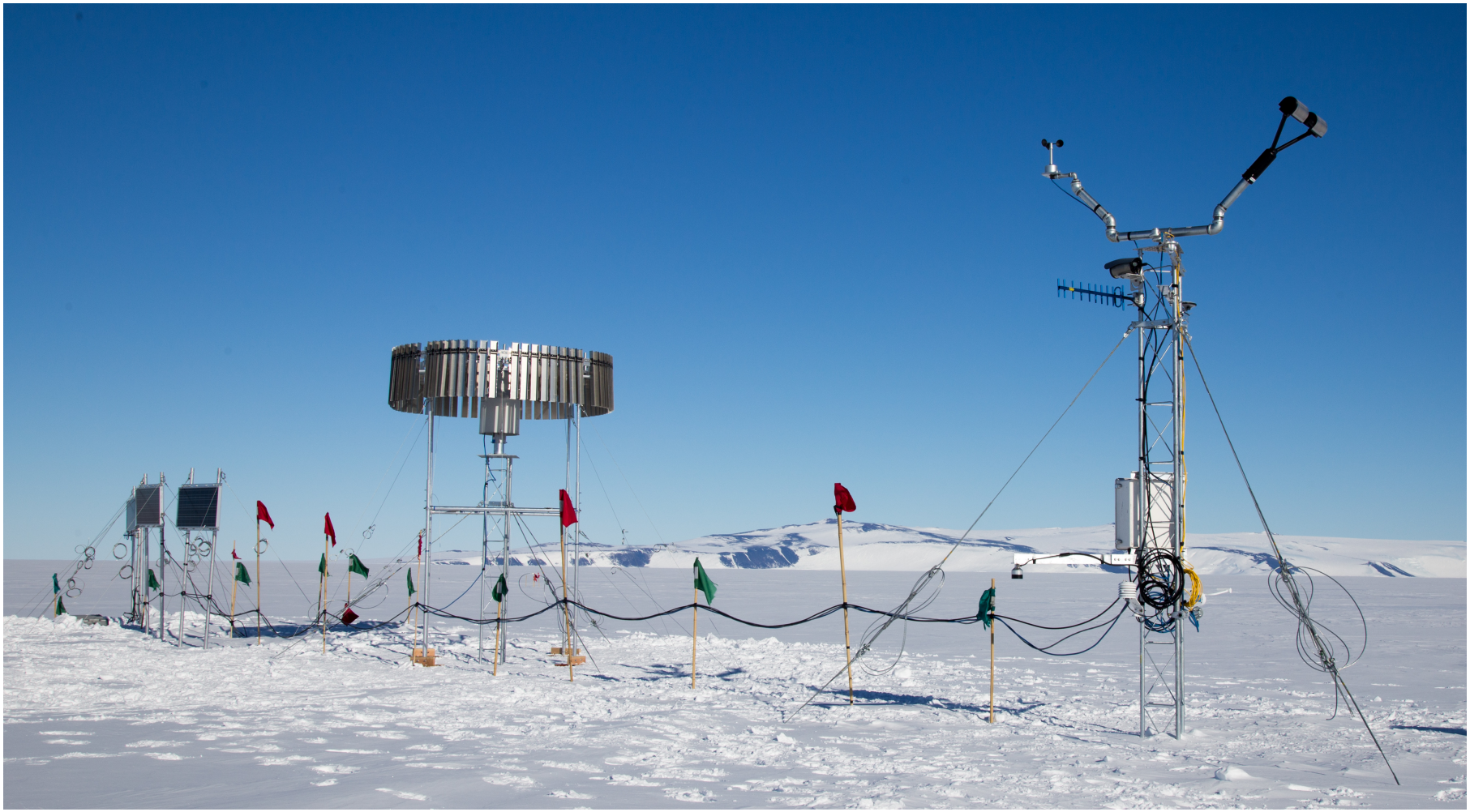
- Premier APS Site:
  - Willie Field AWS
- Standard APS Sites
  - Phoenix (AWS)
  - Alexander Tall Tower
  - Lorne AWS



Antarctic Precipitation Systems – Instruments

- Primary:
  - Weighing Precipitation Gauge: Ott Pluvio^2
    - Installed inside a double Alter wind shield
  - Snow Height: Two Methods
    - Sonic Ranging Sensor
    - GPS Interferometry Reflectivity (GPS-IR)
- Supplementary:
  - Laser Disdrometer: Ott Parsivel^2 or Thies Laser Precipitation Monitor
  - Particle Counter: ETI Optical Precipitation Detector
  - Web Cam: Campbell Scientific - CCFC Field Camera
  - Wind Speed: Vaisala WAA151 3-cup Anemometer

APS Standard Site



November 2017 APS Field Season

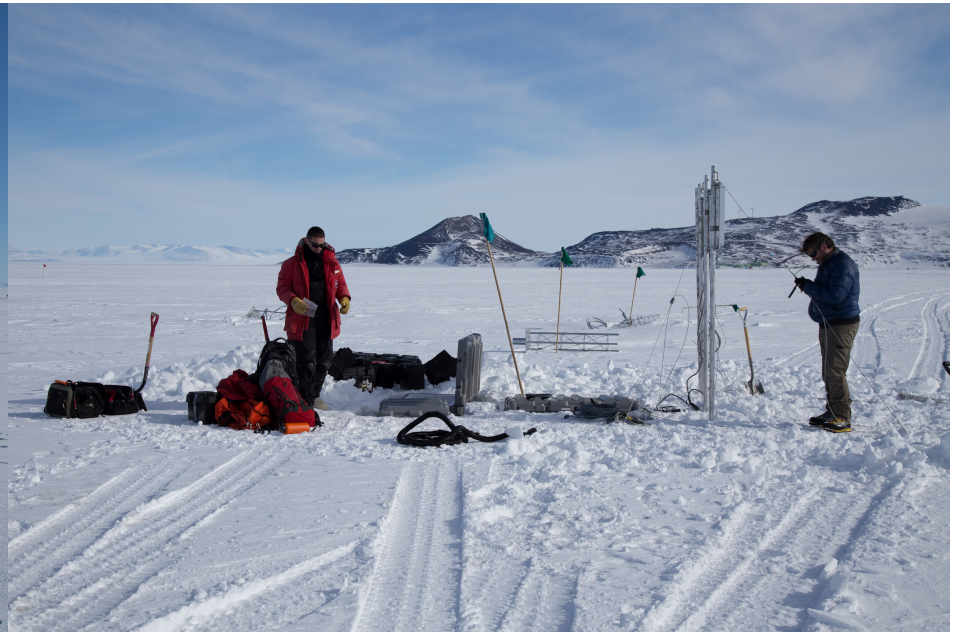
- Goal: Install three standard APS sites and the premier site
- On ice: October 31 to December 1, 2017
  - Required a four day extension, approved by ASC and NSF
  - Two of the four sites were installed in those four days
- Success of the season was a joint effort with assistance across a range of support and science groups
  - UNAVCO
  - O-283 (Carol Constanza – University of Wisconsin)
  - Crary Lab Staff, Crary IT
  - MEC, Riggers, Carp Shop, BFC, PGC
  - Fixed Wing / KBA, Helicopters / PHI

Elaine → Lorne APS Site

- The initial plan was to install the 4th APS site at Elaine AWS site on the southern end of the Ross Ice Shelf
- Difficulties were encountered in establishing two-way Iridium comms with the CR6 dataloggers
- Logistical problems due to weather and fuel problems with Fixed Wing limited access to Elaine
- UNAVCO powers systems weigh ~1600 pounds
- Midway through the field season the installation of the 4th site was moved to Lorne AWS site

Phoenix and Willie Field APS Sites

- Most of the field season was focused on the installation of the Phoenix and Willie Field APS sites
- November 4 – 27



Phoenix and Willie Field APS Sites

- Ease of access by truck allowed for progressive development and deployment of the APS sites
- Lessons were learned and methods improved

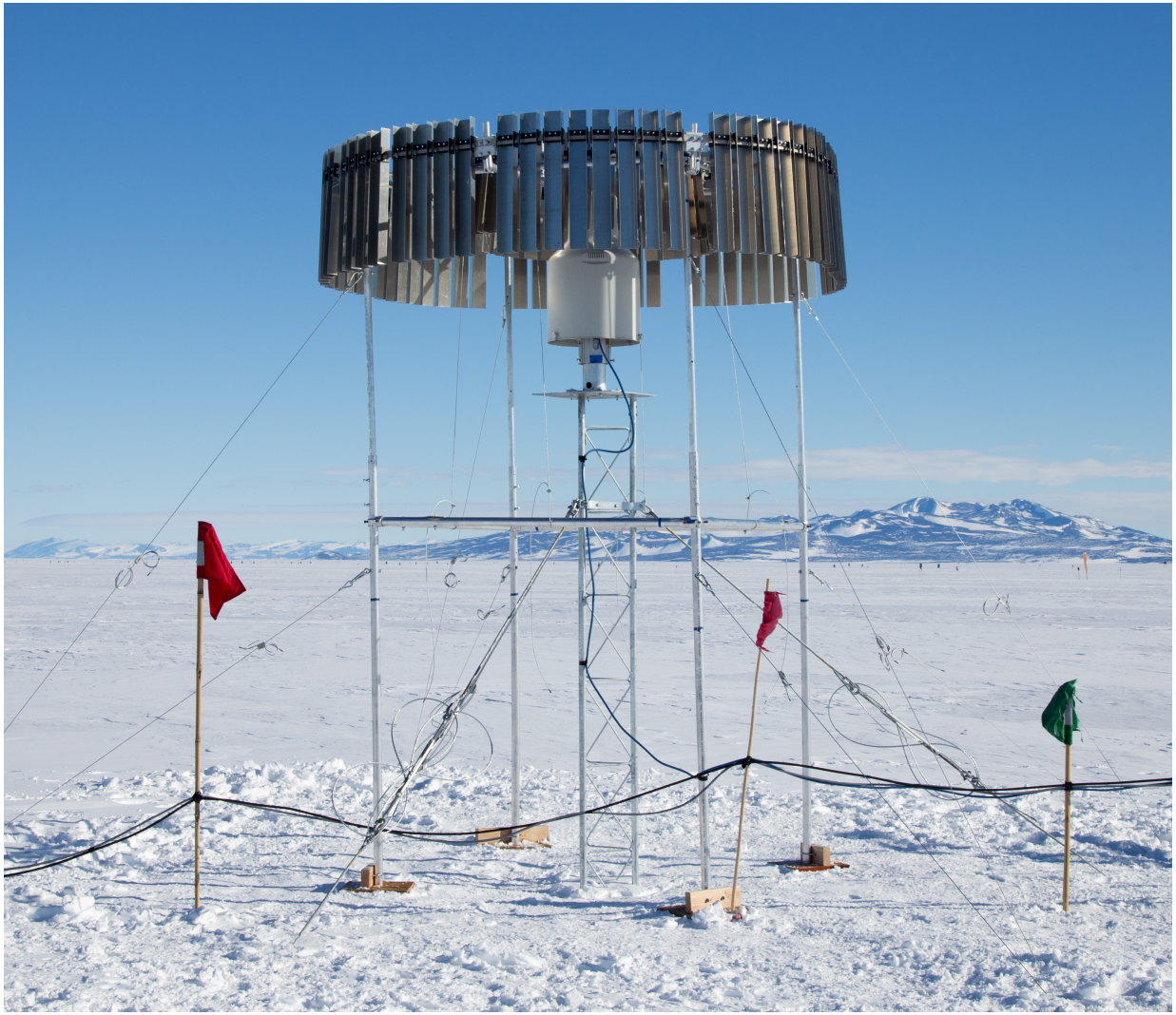
Phoenix and Willie Field APS Sites

- There were typical delays associated with field work in Antarctica

Phoenix and Willie Field APS Sites

- The Willie Field premier site required extra time and effort
- The installation of the Double Fence Intercomparison Reference (DFIR) required a full day in the field

Phoenix APS – Standard Site

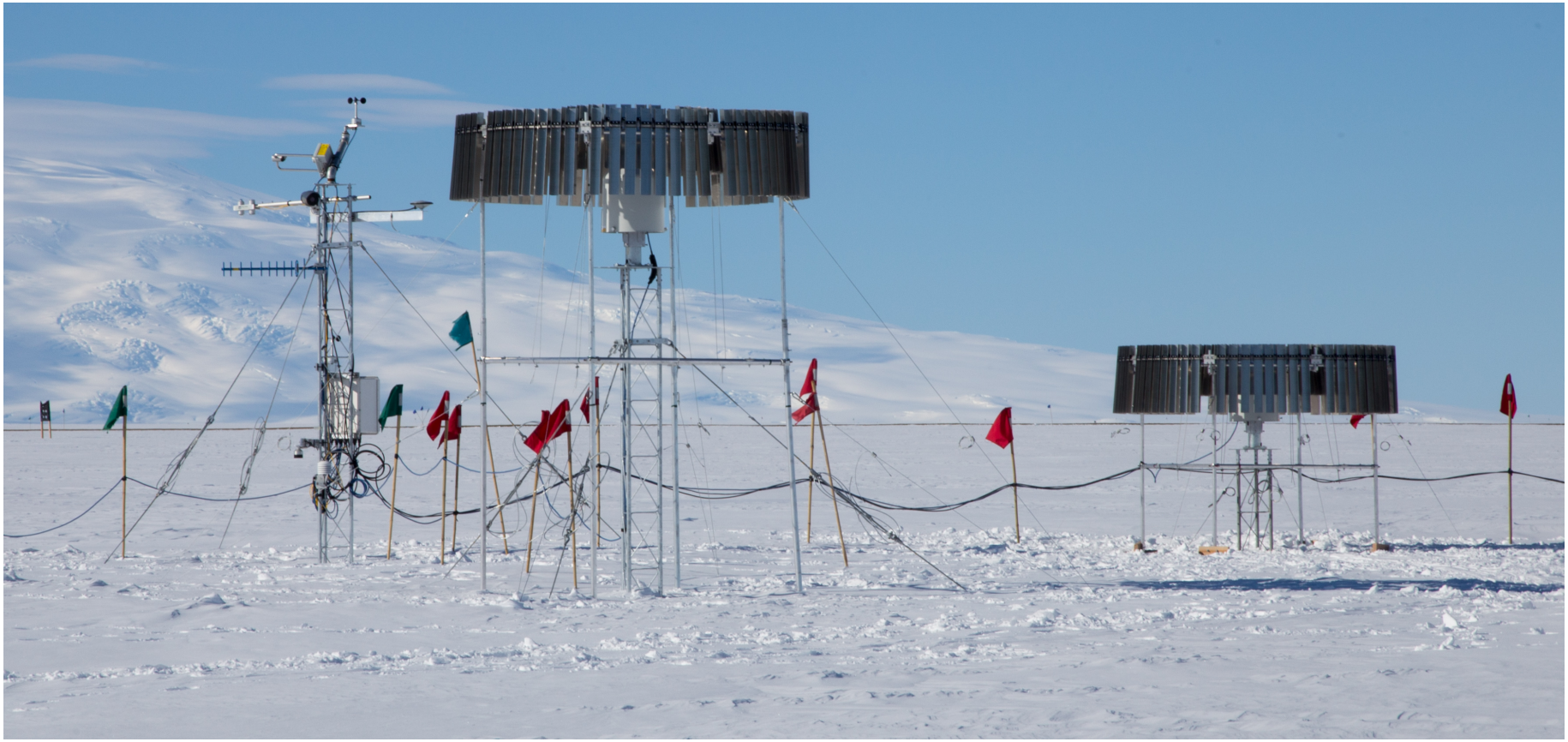


Phoenix APS – Standard Site

Phoenix APS – Standard Site

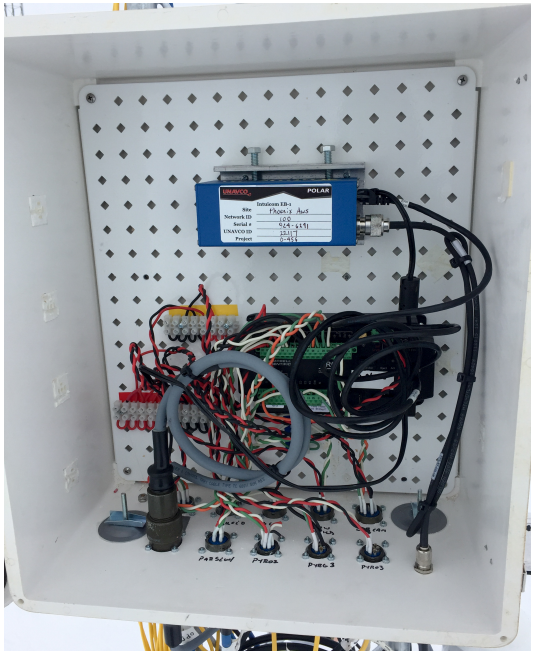
Willie Field APS – Premier Site

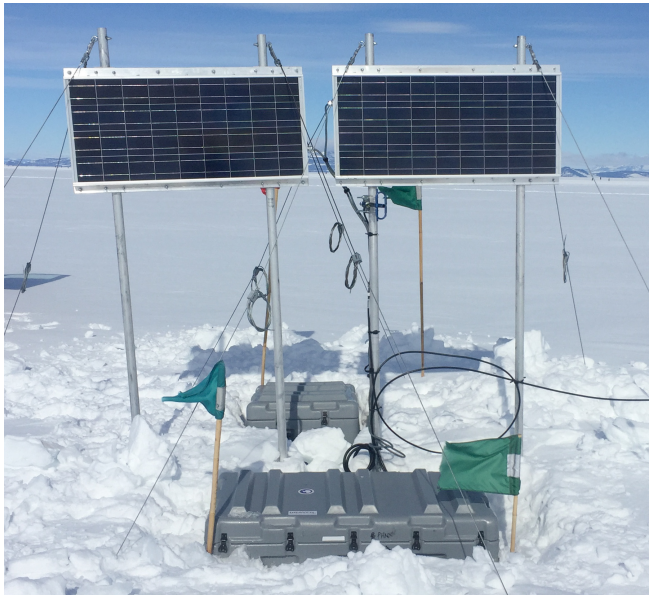
Willie Field APS – Premier Site



APS Site – Datalogger / Comms / Power

- Campbell Scientific CR6 Datalogger
- Intuicom EB-1 radio Ethernet Bridge for radio communications
- 3 or 5 W power systems provided by UNAVCO

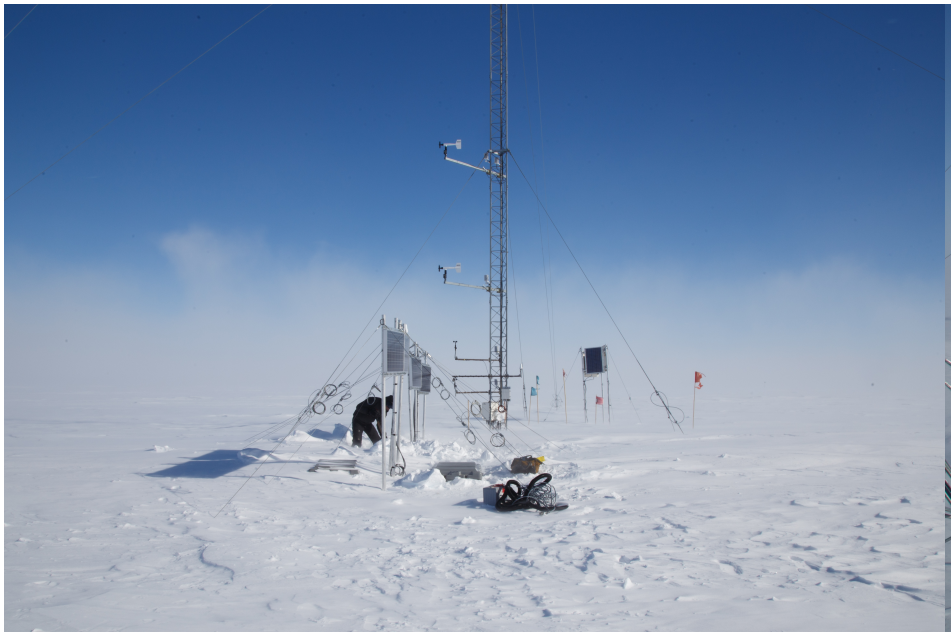


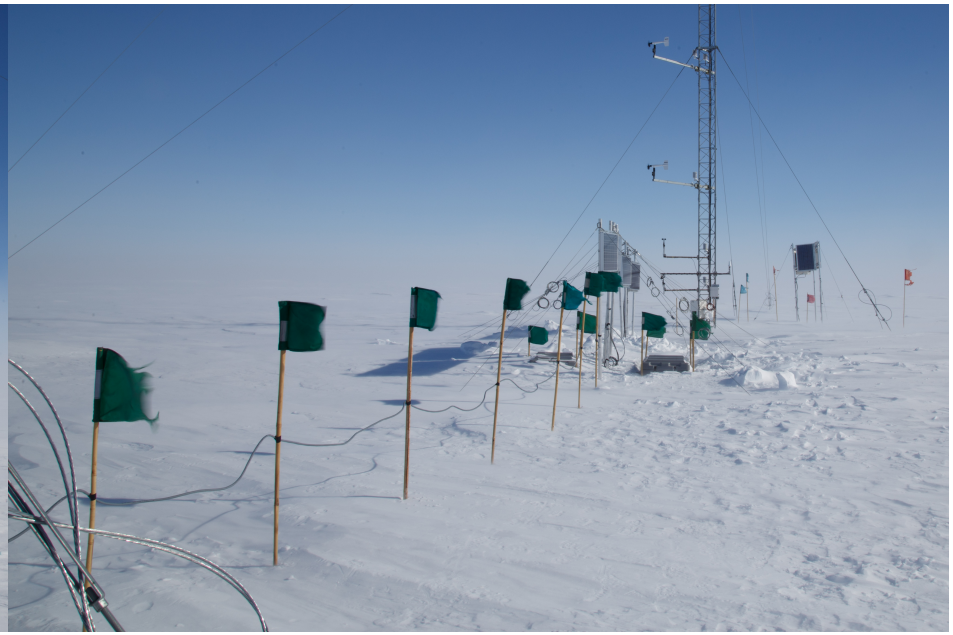


APS Premier Site – In Action

Alexander Tall Tower APS Site

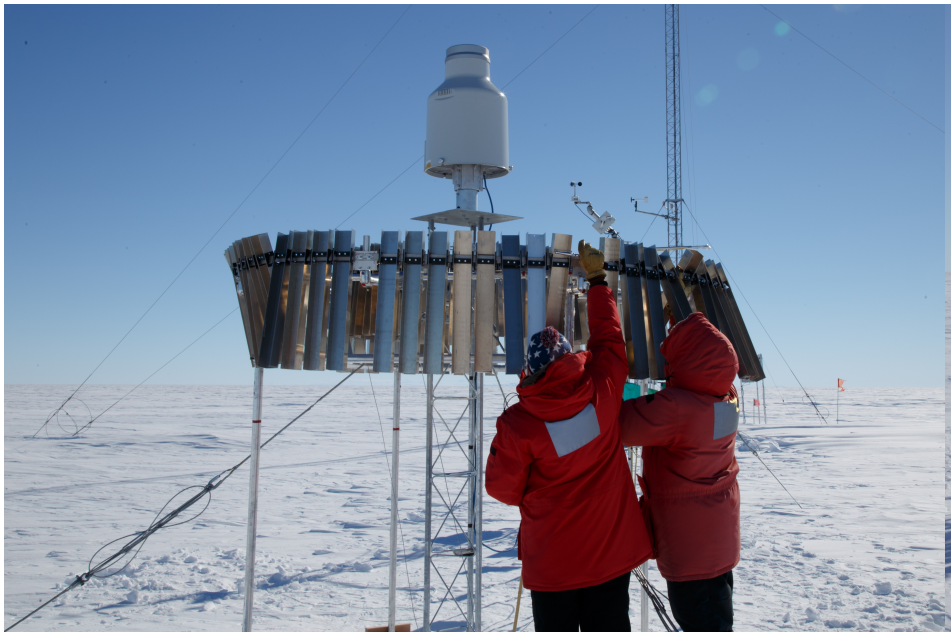
- The Tall Tower installation was intended to be done in two visits, a third was required due to limitations in weather
- November 22, 28, and 30

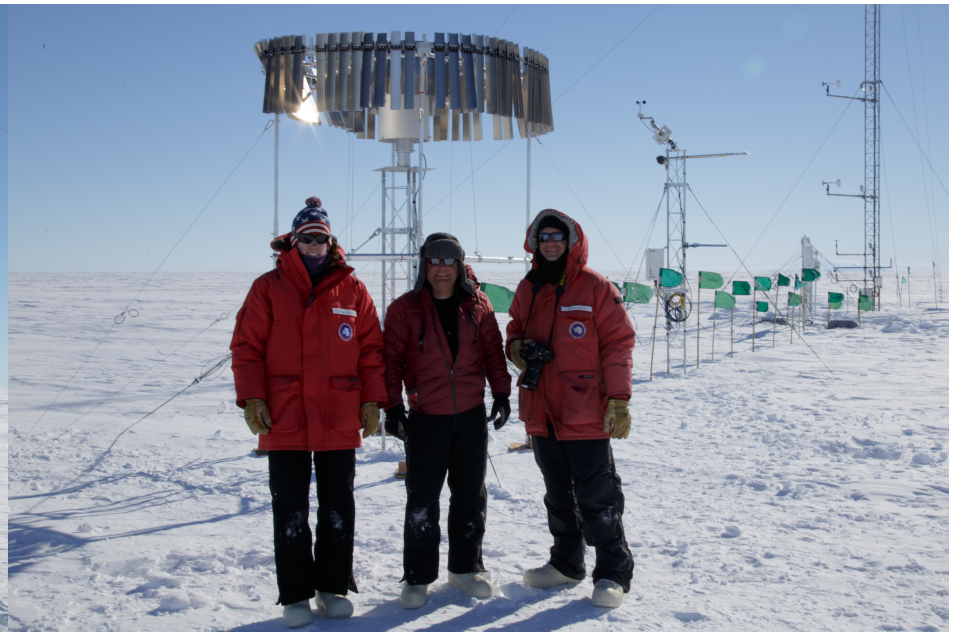




Alexander Tall Tower APS Site

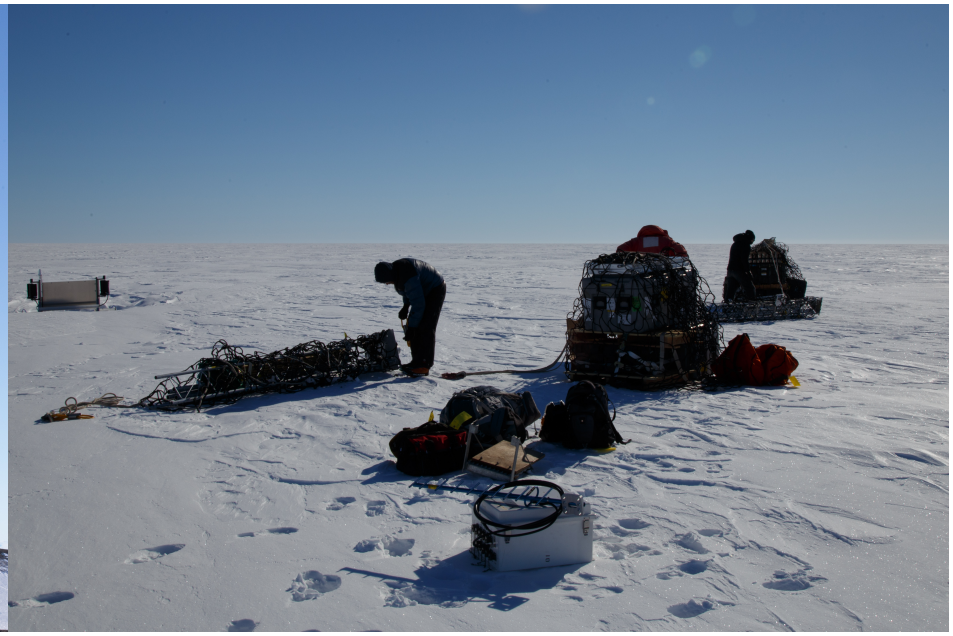
- On the last day of the field season the Tall Tower installation was completed
- UHF radio comms is working over a distance of 200 km



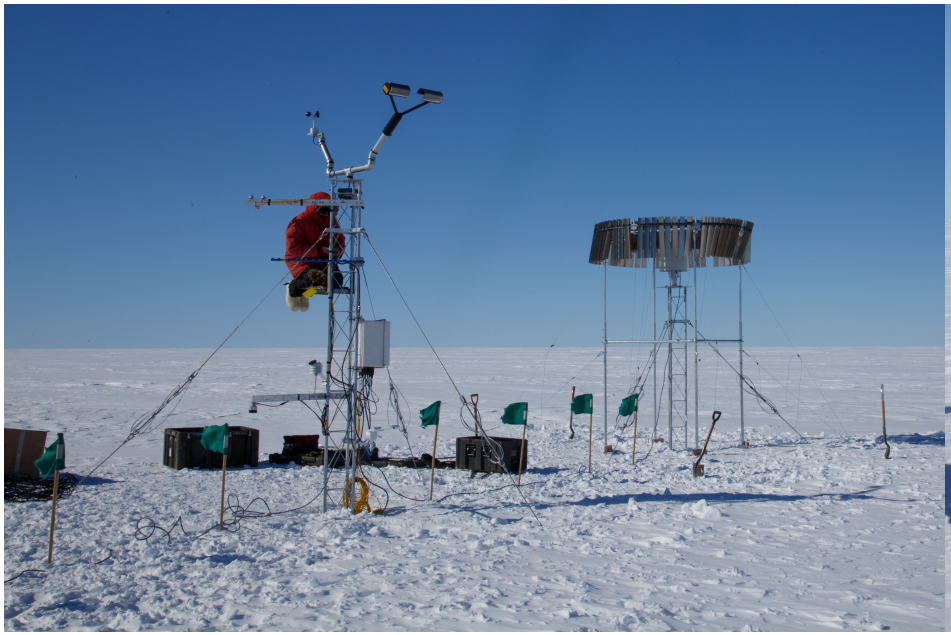


Lorne APS Site

- The lessons and practice from the initial three sites resulted in Lorne site being installed in 6 ½ hours
- November 29



Lorne APS Site



Cooperative Institute for Research in Environmental Sciences
UNIVERSITY OF COLORADO **BOULDER** and **NOAA**

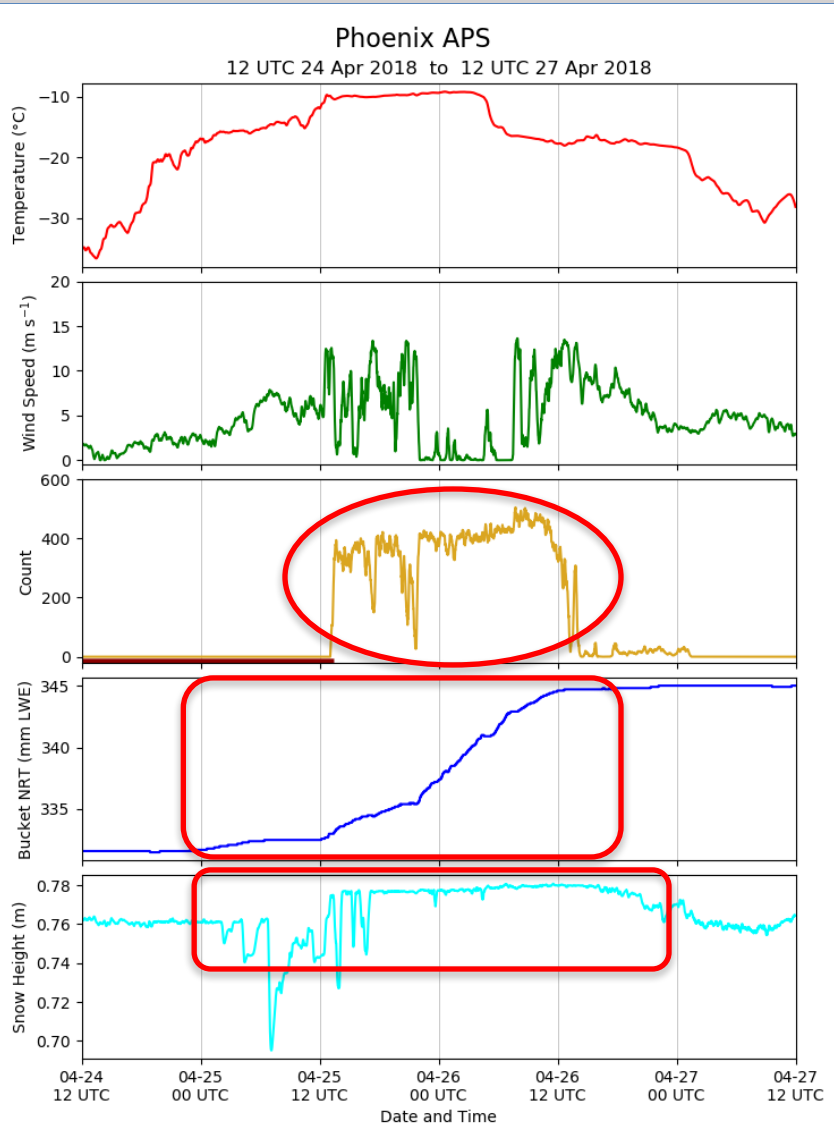
APS Current Status

- All four APS sites remain in radio comms with data retrieval and ability to alter and upload new algorithms
- All data from the instruments are being downloaded to Boulder, Colorado daily
  - The webcam video files are not being actively retrieved due to bandwidth / battery limitations
- There might be problems with the disdrometers – not sure if it is software or hardware
- The UNAVCO power systems are in good condition and the batteries are likely going to be sufficient

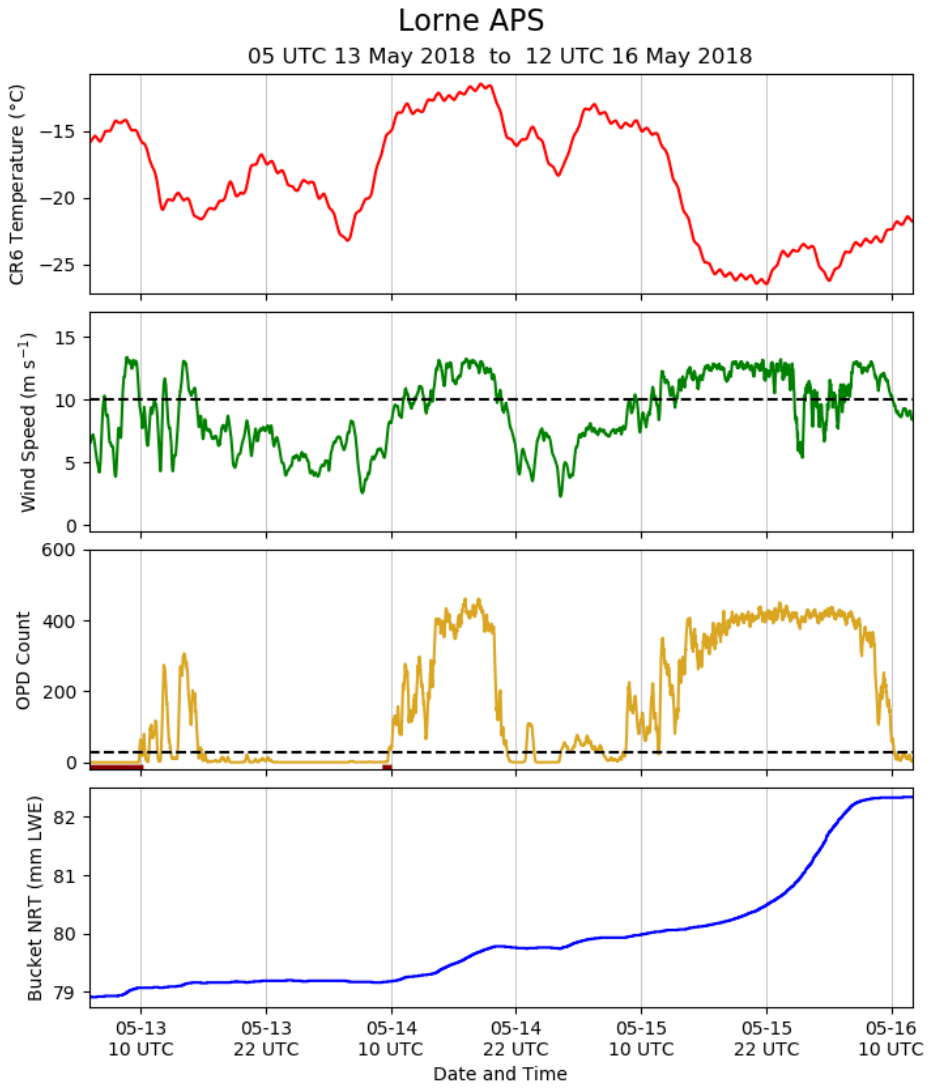
Precipitation Event – Phoenix – January 2018

Precipitation Event – Tall Tower – April 2018

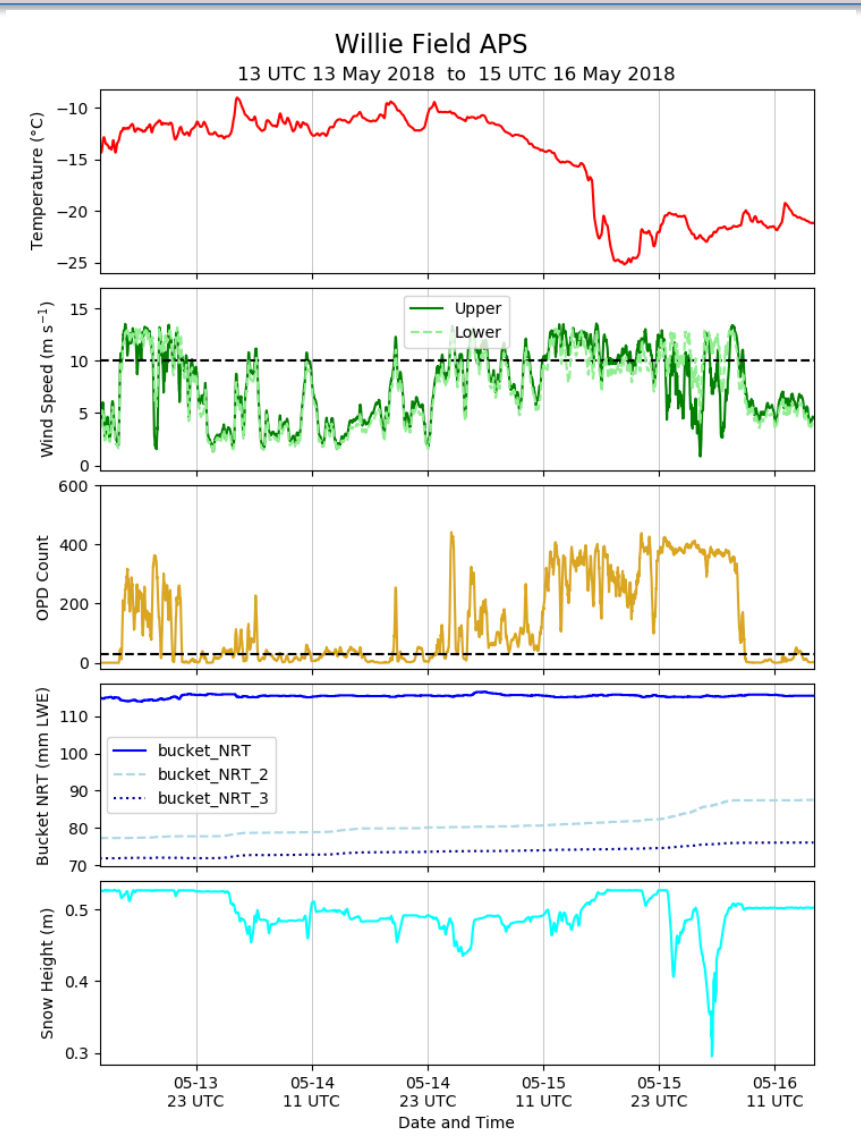
Early Results – Phoenix – April 2018



Early Results – Phoenix – April 2018

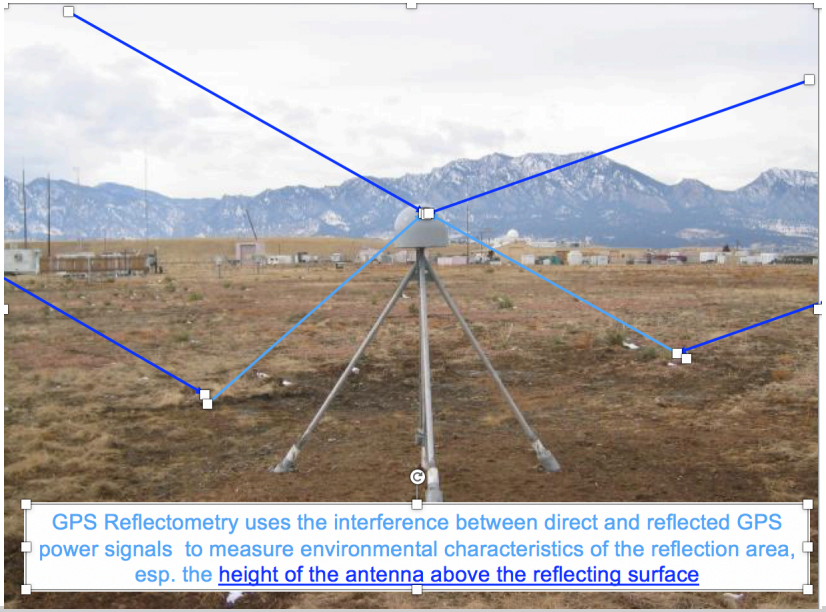


Early Results – Willie Field – April 2018

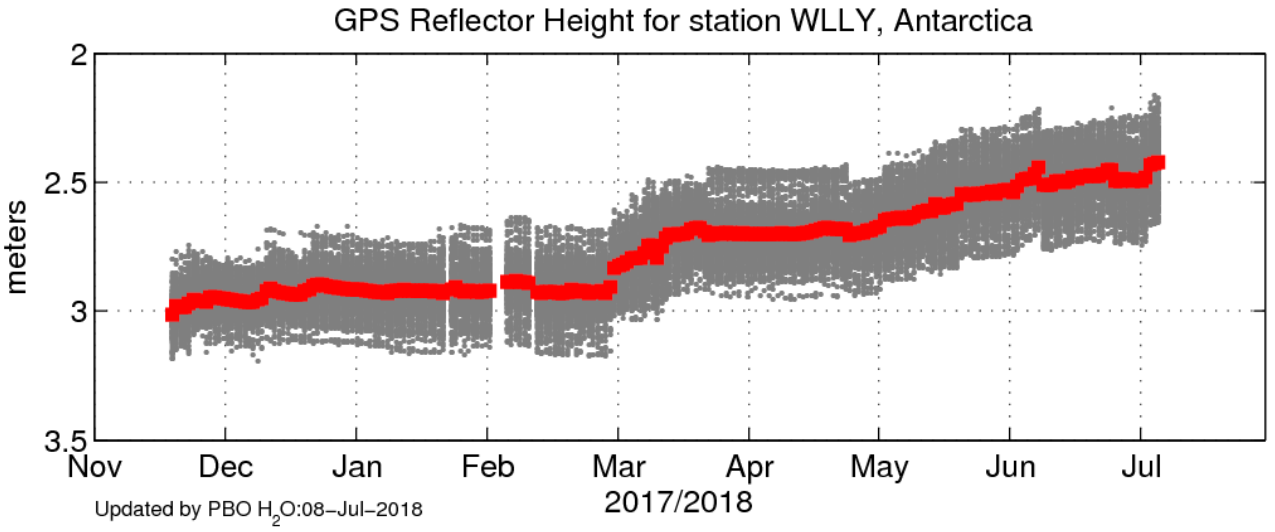


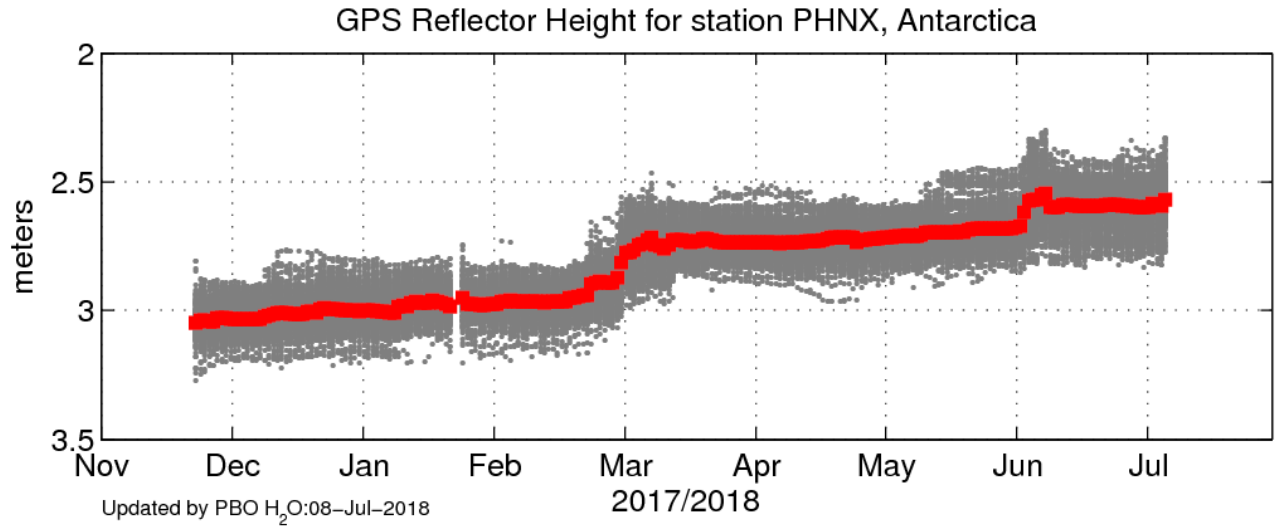
APS – Snow Height by GPS

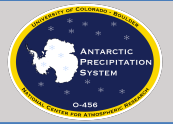
- Kristine Larson (CU-Boulder) has developed a methodology that measures snow height over an area using a GPS receiver
- Measures snow height through multipath observations using interferometry of the dual frequency GPS signals to examine the dominant height that occurs within 5 degree azimuthal bins
- GPS receivers have been installed by UNAVCO at three APS sites and a fourth will be installed during the upcoming field season



APS – Snow Height by GPS

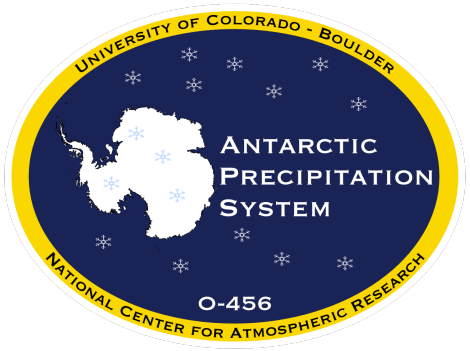






CIRES
Cooperative Institute for Research in Environmental Sciences

NCAR
National Center for Atmospheric Research



Stickers available by the registration:

Email:

Mark Seefeldt mark.seefeldt@colorado.edu

Scott Landolt landolt@ucar.edu

Acknowledgments:

- Project supported by the:

  National Science Foundation PLR 1543377