ABSTRACT
Since 2008 the POLENET-ANET project has deployed a network of autonomous, continuously-operating GPS systems that span the margin of the East Antarctic craton in the Transantarctic Mountains and across West Antarctica. The GPS time series defines the horizontal and vertical bedrock crustal motion velocity fields at mm level across the region. In 2008-2018, the POLENET-ANET project used GPS systems in the Whitmore Mountains (WHMT) with a Rigips Antenna, a large radar dome, and a Vaisala MET4 to monitor the crustal movements. In 2018-2019 austral summer season, we redesigned components of our system, including significantly lowering power requirements using a receiver integrating GNSS and Iridium communications; and developing a new antenna monument design. The new monument design presents many challenges to year-round measurement systems. Here we focus on issues arising in chocking antennas related to high winds, external rime icing, and internal ice intrusion from spin drift; as well as issues with metapack failure and snowfall. We will present technical successes, mitigation efforts, and ongoing challenges and seek new solutions from the polar technology community.

2008-2018 DESIGN: ORIGINAL
GPS Receiver and Communications:
Original POLENET-ANET station design used the Trimble NetGPS receiver paired with 2 Iridium 952/980 Dial-up modems, for a total power draw of 5 Watts. The new station design deploys the Antenna Ring GNSS receiver, which has built in RUDIS Iridium communication. RUDIS provides a more reliable form of communication with the remote stations and the overall power draw is around 1.8 Watts, or 36% of the previous station generation.

Power System:
With nearly one third of the power consumption required for GNSS data recording and communications, the battery capacity needed for year-round operation dropped from 22 100-amp hour batteries to only 10 batteries. This results in a station weight reduction of 852 lbs – fewer Power. Otter flights are required for station deployment, reducing the logistical footprint of remote site installations. Fewer batteries allowed redesign of the station enclosure, with a single enclosure to house 10 batteries and the electronics board instead of 3 Hardigg cases to house 22 batteries. The new enclosure uses a vacuum sealed panel walls for better heat retention and overall battery performance. With less boxes and less power consumption, a smaller frame, which requires only 1 solar panels as opposed to 4, can be deployed. This smaller frame has a decreased footprint, allowing for easier anchoring, and more importantly, less potential to become a wind sail. Previous stations endured severe wind damage to the solar panels and frame which we hope to mitigate with the smaller footprint design.

Monumentation and Antenna:
Several new sites had friable volcanic rock. The previous Tech2000 monument design had a small footprint with anchors at a depth of 7 inches, designed for installation in hard rocks such as granite. The new KH monument design has a much wider footprint, with anchors drilled to a depth of 36 inches. This new monument provides increased stability in friable rock while still allowing precise, millimeter scale monitoring of crustal motions. Previous ANET GPS systems used the Trimble Choke ring antenna for tracking GPS signals. However, drainage holes in the bottom of the brass antenna allowed for intrusion of fine-grained spin drift snow (discussed further to the right). To prevent this intrusion, we deployed the hermetically sealed Septentrio PolaRx-x antenna. A 12 inch stainless steel riser was also installed to help reduce rime icing on the exterior of the antenna, a problem previously observed with the wider Tech2000 monument and choke ring antenna.

Meteorological Measurements:
ANET GPS systems used Vaisala WXT520 weather transmitter to record barometric pressure, temperature, humidity, wind speed and direction. For the new generation of POLENET-ANET sites, the Paroscientific MET4 was deployed. The MET4 has increased accuracy in measuring barometric pressure, but does not record wind direction, only wind speed. Meteorological data and GPS:
Accurate measurements of barometric pressure allow calculation of precipitable water vapor in the atmosphere from the phase delay of GPS signals. Atmospheric pressure acts as a load on the Earth’s daily crust and it is a signal that can be isolated from other crustal motion components. Temperature measurements have an inverse relationship with a receiver’s signal to noise ratio (SNR). Monitoring SNR and knowing conditions that effect it, allow for better monitoring of overall station health and data quality.

2018-2020 DESIGN: NEW
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MET 4 FAILURES
16 Paroscientific MET4s were deployed in the 2018-2019 and 2019-2020 field seasons. Of those 16, 1 is currently operating, 6 were remotely disabled to protect the GNSS data acquisition, 1 was removed and replaced with a Vaisala WXT520, and 8 have failed, no longer recording any met data. Some units failed as early as 2 days after deep field deployment. Each unit was tested at the UNAVCO facility with a Resolute receiver in a cold chamber to ensure functionality. Units were tested again at the deep field base camp, making sure no damage occurred during shipping. Units that passed both sets of testing were deployed at our deep field sites. Given the rigorous prior testing, we are led to believe that environmental conditions have caused these units to fail, most likely static charges from blowing snow in the cold, dry Antarctic environment.

QUESTIONS FOR THIS COMMUNITY
In previous installations we have found evidence of static charges damaging electrical components. This led us to install a grounding plate where cables pass through the Hardigg enclosure, surge protectors for all GNSS and Iridium cables, and to place the electronics board in an anti-static bag that is connected to a negative battery terminal for discharge. These mitigation efforts have resulted in a dramatic decrease in static related failures. However, the MET4 is an exposed external component and presents its own challenges with static protection.

We look to this community for help in answering these challenging questions:
- Is it possible to static for kill the data recording and communication lines of a MET4 without disabling power to the unit?
- Is there a way to truly ground a polar GPS station installed on rock surrounded by dry blowing snow?
- What are the best grounding systems and practices for polar instrumentation?
- Any experience with a static whip, similar to those used on aircraft?