

POLAR TECHNOLOGY CONFERENCE MEETING REPORT 2020

10 - 12 MARCH 2020
UNIVERSITY OF COLORADO BOULDER
BOULDER, COLORADO, USA



INTRODUCTION

The Polar Technology Conference (PTC) is a meeting of experts from industry, academia, government, and the military to share experiences and solve challenges related to applications of technology in the polar regions for advancing science goals. The PTC was born out of informal gatherings at Stanford University focused on small autonomous power, weather, and communications systems for the polar environment. The PTC was later hosted by SRI International in Menlo Park, California, where technicians focused on polar operations were eager to meet in person to discuss and troubleshoot the technology they brought to the field. The PTC continued for the next decade, with formal meetings held annually from 2005–2016. Meetings relied on volunteers and interested institutions willing to take on the hosting efforts. Crisscrossing the country, the PTC has been hosted at nine different locations since 2007. In 2016, the organizers noted that the PTC had grown to the point of needing significant administration and planning. Planning efforts for the 2017 PTC were delayed and the conference entered a hiatus, in need of a dedicated funding source and planning team. Detailed information on all past PTCs, including participants and presentations, can be found here: <http://www.polartechnologyconference.org/list.html>.

In 2019, the Arctic Research Consortium of the US (ARCUS) was tasked by the National Science Foundation's Office of Polar Programs to reinvigorate the conference (Award #OPP-01304316). The 2020 PTC was held 10–12 March in Boulder, Colorado, USA and was attended by 82 in-person, and approximately 130 virtual, attendees. The goal of the updated PTC for 2020 was to link experts in polar science and technology development. The 2020 meeting created an interdisciplinary space for technical and theoretical exchange on challenges impeding polar research and field operations. The sharing of ideas and experiences by the community is crucial to ensure that technological infrastructure investments are efficient, satisfy science drivers, and meet

field requirements. The conference addressed approaches to working and studying in the polar regions, including: terrestrial, marine, atmospheric, and social science disciplines; autonomous instrumentation; observation platforms; and all levels of logistical support.

The Organizing Committee outlined a discrete set of objectives to help guide the planning of the conference:

1. Identify and define priorities using bottom-up community feedback to enhance polar science through technological advances;
2. Scope out areas where research and development (R&D) projects could deliver new technology to meet scientific or logistical user needs and identify where new technology would benefit from field trial;
3. Increase awareness of current funding calls appropriate for technical or R&D projects and provide input to funding agencies on effective support of technology-related projects for polar research; and
4. Build on past PTCs to create a community of practice for future dialogue between the users, manufacturers, and developers of technology used in polar research.

The following summary provides highlights from the 2020 PTC and potential future plans for this conference and the community.

For more detailed information such as the meeting agenda, participants, speakers, presentation abstracts, slides, videos, and other products, please visit the 2020 PTC webpage at:

<https://www.arcus.org/logistics/2020-polar-technology>

CONFERENCE TOPICS & PRESENTATIONS

The conference was formatted around six themes: Science Drivers, Power Systems, Instrumentation, Communications, Data Access and Sharing, and Overarching and Integrative Technologies. The conference consisted of keynote talks followed by presentations with interspersed panel and poster sessions surrounding each theme. All plenary presentations and panels were live-streamed.

Six speakers provided keynote presentations, delving into the leading edges of problems and/or solutions for their designated topic. These speakers provided unique perspectives that set the stage for the following presenters and a deeper panel discussion involving all of the presenters for that theme. Some of the keynotes were from disciplines and industries that have not traditionally been supported by polar science research, in hopes of pushing the audience to consider new collaborations and partnerships in their work. All presentations and Q&A panel discussion recordings are available at:

<https://www.arcus.org/logistics/2020-polar-technology/agenda>



The conference also featured small breakout group discussions during day one. PTC attendees formed small groups of 8-10 participants to address polar challenges using a peer-coaching approach. All members of each group were given the opportunity to share a polar technology challenge in their own work and receive guidance and problem-solving suggestions from the collective group.

PTC 2020 THEMES AND PRESENTATION HIGHLIGHTS

SCIENCE DRIVERS

This theme focused on key research needs and tools for improving observations and monitoring from multiple domains of polar science with an emphasis on system requirements. Research and technology development have a reciprocal relationship in polar science, where basic research fuels technological innovation, while technology allows scientists to ask novel questions in innovative ways. Merritt Turetsky, Director of the Institute of Arctic and Alpine Research at the University of Colorado Boulder, was the keynote speaker for this session. Her talk focused on the causes and consequences of change in polar regions. She had informally surveyed her peers to understand the technological requirements needed to document and understand the mechanisms for rapid change in polar regions. The common stories emerging from the survey responses included, Arctic greening/browning, tundra fires, methane hotspot emissions, and coastal erosion. Olivia Lee from the University of Alaska Fairbanks then gave a talk on using satellite remote sensing and data access to study Arctic marine mammal sea-ice habitat. This was a case study in how remote sensing and collection of community observations allowed for an estimate of sea-ice habitat at large spatial and frequent temporal scales. Qian Wu is a project scientist at the High Altitude Observatory associated with the National

Center for Atmospheric Research (NCAR). He wrapped up the session with how space weather and thermospheric winds impact the polar regions. Space weather can be disruptive to navigation and communication systems. Understanding space weather patterns and impacts is important for safe operations at both poles, especially as human activity in both regions is likely to increase in the coming decades.

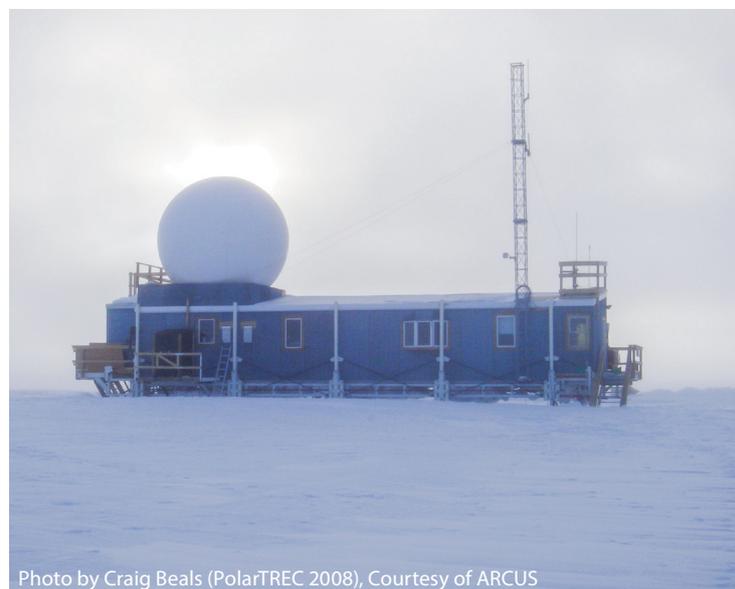


Photo by Craig Beals (PolarTREC 2008), Courtesy of ARCUS

POWER SYSTEMS

This theme focused on power system transmission, storage, and alternative energy generation. Power is crucial for all aspects of research and operations in polar areas. Power storage, harvesting, management, and monitoring has consistently been a central topic for the PTC. This year, there were several presentations and posters on many groups' efforts and advancements on this subject. Piper Foster Wilder's keynote talk introduced 60Hertz Microgrids, a company that provides microgrid monitoring technology with human-centered design. 60Hertz has found that adding this user focus to their technology has improved the interaction of local maintenance crews with the monitoring efforts, which in turn had returns in maintenance effectiveness and performance of the power stations. Thomas Nylen from UNAVCO presented an update to their Continuous GNSS (Global Navigation Satellite Systems) Station design, which has been deployed in many locations across the Arctic and Antarctica in several science networks. UNAVCO has been utilizing the Resolute Polar geodetic receiver in their stations, which has allowed for several improvements, including a significant power consumption decrease. In addition, Nylen discussed several other aspects that UNAVCO Polar group works with in these stations and in other areas, such as point-to-point radios, UAVs, state of health (SOH) data, and data analysis providing better predictive calculations for maintenance and pre-station deployments. Richard Armstrong with RSA Engineering, Inc. presented a summary of a 65kW microturbine power generator demonstration unit installed for three years at the Summit Station in Greenland. Armstrong discussed the successes and accomplishments of his project as well as the hurdles, struggles, and complications that often arise from dealing with power in polar regions.

DATA ACCESS AND SHARING

This theme focused on access to technology resources, such as networking and information technologies, data in the cloud, distributed data resources, and data processing technologies that are typical in more connected areas but often difficult to access in polar regions. The session included three talks, beginning with a keynote presentation by Martin Swany of Indiana University on advanced concepts for communication and computing in challenged environments. He included a review of hardware-software solutions for moving data into and out of areas with minimal connectivity using data ferries (data transfer links to send files without internet). He continued his presentation discussing technologies for high-efficiency data computation at the site of measurement (edge computing) and the problems and solutions available with advanced networking tools. He finished up reviewing technologies to make more efficient network connections, which can be expensive in polar settings. This was followed by Erin Trochim, from the University of Alaska Fairbanks, who presented on using big data for Arctic surface water mapping and change. Her work highlighted the use of Google Earth Engine (GEE), the challenges of using large datasets, and how GEE-like tools can assist with common processing tasks. The final talk was by Cole Kelleher of the Polar Geospatial Center (PGC). His presentation reviewed data and resources made available through the PGC. This NSF-funded Center supports Arctic and on-site Antarctic geospatial data access

and analysis services. PGC hosts over four petabytes of polar data, including an archive of commercial high-resolution satellite data from DigitalGlobe and the National Geospatial-Intelligence Agency (NGA). PGC is available to all NSF-funded polar investigators. In addition to serving out data, they produce value-added products and provide expertise and advice on how to process and use geospatial data to enable scientific objectives.



Photo by Jim Pottinger (PolarTREC 2011), Courtesy of ARCUS

COMMUNICATIONS

This theme focused on satellites, data transmission-limited environments, and telemetry. Communications continues to be an important topic for polar research—both for science and for logistics. New satellite services, both from established firms and new players, offer a much wider range of services and price points than in the past. Mike Prior-Jones of Cardiff University gave a keynote overview of all the relevant service offerings with polar coverage, and pointed out that while a very large number of new companies have declared their intention to enter the market, only one (Kepler Communications) is in commercial service. The conference heard from Charlie Lever with Iridium about their new Certus service, offering higher data transfer speeds. He also explained the new seven-year US Space Force contract offering unlimited access to many Iridium services (but not Certus) for US agencies. Jonathon Cheah and Shelley Johnson from MITRE Corporation showed how a customized antenna design could enhance access to geostationary military satellites (on ultra-high frequency, UHF) at high latitudes, and presented the results of field tests on the USCG Healy in the Arctic. Poster presentation topics included the use of the Wize standard for long range, low power VHF communications; a high-frequency radio network planning tool from MITRE; and information from both Leidos and Xeos on the practicalities of using Iridium modems in the polar regions.

INSTRUMENTATION

The instrumentation session focused on the current state of instrumentation platforms across a range of sciences and locations in the polar regions. The keynote presentation was given by Phil McGillivray of the US Coast Guard. The keynote provided a review of a range of instrument platforms used for the collection of scientific data in the Arctic, with a focus on data collection associated with the USCG Healy icebreaker. The summary of platform technology included a review of autonomous underwater vessels (AUVs), autonomous surface vessels (ASVs), and unmanned aircraft systems (UASs). Information was provided on communications, data access, and selection of materials for improved performance in the design and construction of the instrument platforms. Jeremy Miner of IRIS provided a presentation focusing on the installation, operation, and maintenance of the Transportable Array for measuring seismic data across North America, with a focus on the installations in Alaska. The Transportable Array includes a range of instruments that also provide benefits to the weather and climate community and studies on sea-ice dynamics. Lastly, Bruce Vaughn of the University of Colorado Boulder provided an in-depth review of the application of unmanned aerial vehicles for studying water vapor exchange above the Greenland Ice Sheet.

OVERARCHING AND INTEGRATIVE TECHNOLOGY

This theme focused on large-scale projects that span multiple technologies, including logistics and infrastructure projects. Robert Briggs from C-Core gave the keynote talk, highlighting integrated technologies for iceberg surveying and monitoring. This project uses a combination of UAVs, ice-penetrating radar, multibeam lidar, GPS tracking, 3-D modeling, and drift predictions to better survey and monitor icebergs to improve maritime safety and operations. Sally Shoop, representing the Cold Regions Research and Engineering Laboratory (CRREL), wrapped up the session by giving an overview of how they use science to improve winter logistics. The Research and Engineering Division of CRREL responds to a wide range of challenges in Arctic operations, but Shoop highlighted a case of using remote assessment of snow to determine its physical properties and effects on vehicle mobility. This session was impacted by COVID-19 travel restrictions because two speakers were overseas travelers that could not attend. Mike Rose of the British Antarctic Survey had intended to talk about the process of automating Halley Research Station, while Rusheng Wang of Jilin University was to present an overview of opportunities and challenges in China's polar drilling program.

SATELLITE COMMUNICATIONS SPECIAL SESSION

The discussion of satellite communications generated a large amount of interest during planning of the conference, so a special session was dedicated to a deeper dive on the topic. Patrick Smith with the National Science Foundation started the session by giving an in-depth overview of satellite communication options and coverage in both the Arctic and the Antarctic. He also highlighted upcoming communication projects and options on the US and global markets and how

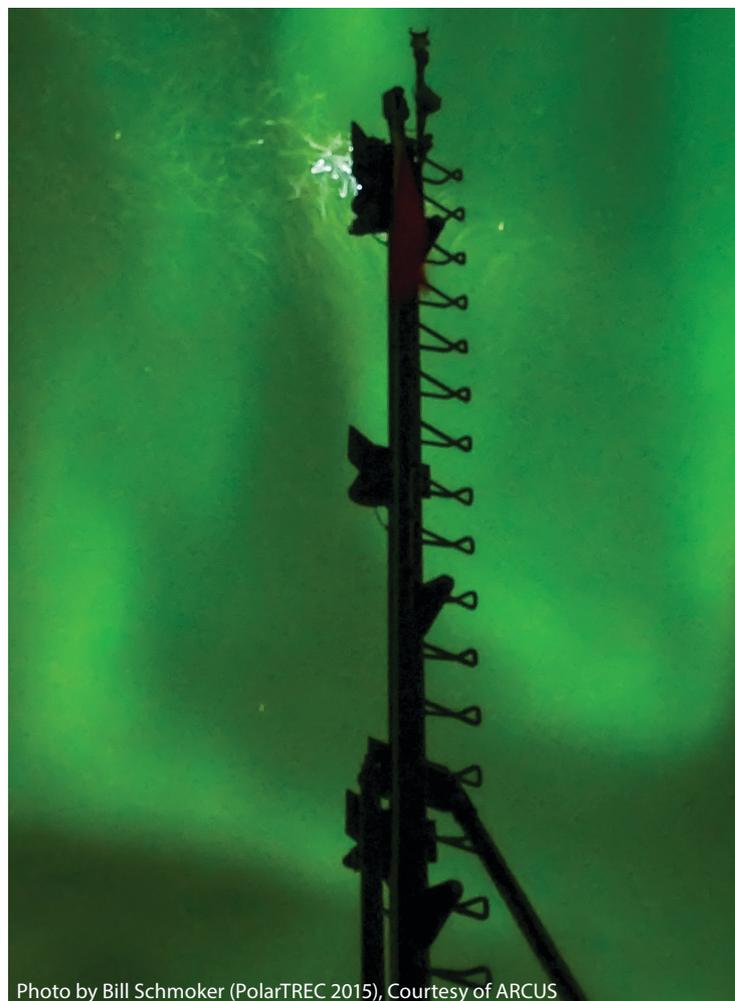


Photo by Bill Schmoker (PolarTREC 2015), Courtesy of ARCUS

that might impact operations at both poles. The session then provided an opportunity to hear directly from the vendors. Charlie Lever with Iridium's government arm was welcomed back to the stage and he presented details about some Iridium transceivers currently in production, giving the audience a better sense of their size and capabilities. He highlighted Iridium's Satellite, Time, and Location (STL) service, which provides signal positioning, navigation, and timing (PNT) capabilities with advanced security features. Jeffrey Osbourne with Kepler Communications gave an overview of his company, which focuses on low-Earth-orbit solutions. Kepler builds small telecommunication satellites for connectivity and data transfer. They have three demonstration satellites in orbit with the eventual goal of a service constellation. Robert Lorenzana, with Applied Satellite Technology (AST) Americas, explained their role as a service provider, a global distribution partner, and their focus on value-added services. He also highlighted the MY AST Portal feature, which provides instant management, control, and provisioning of AST services and SIM cards. He then focused on some AST products that would support work at the poles. Daniel Wagster from Leidos wrapped up the session. Wagster works on the Antarctic Support Contract (ASC) and gave an overview of communications support for those deploying to Antarctica under the United States Antarctic Program (USAP). He highlighted the different levels of support, frequently used equipment, and common challenges for USAP operations. Kenneth Boda with the US Northern Command was scheduled to present, but was unable to attend due to COVID-19 travel restrictions.

PLANS FOR THE FUTURE

Feedback from the 2020 PTC participant survey was overwhelmingly positive (*Table 1*). The return of the PTC was welcomed by the broader community. Elements of the conference that received good feedback were: retaining the small conference size and central location; focus on inclusion of diverse participants and early career researchers; and options to attend virtually. Suggested changes for future conferences include: exciting new topics, such as a way to incubate “half-baked ideas”; focused training sessions on common topics of interest; better integration of technology vendors and tech start-up companies; and presence of international participants that were not able to join us in-person due to COVID-19 travel restrictions. To encourage community building and exchange of ideas between conferences, which are expected to be held every two years, a self-forming team on the IARPC Collaborations site has been created.

Please join the team at:

<https://www.iarpcollaborations.org/members/people/teams/profile/Polar-Technology-Community-Forum>

Based on participant feedback, the PTC Organizing Committee also suggests a PTC name change to the Polar Technology Community Workshop, to more accurately reflect the intent and collaborative atmosphere of future meetings.

Table 1 : Results of the PTC Participant Survey completed by 21 participants. Percent positive indicates all survey responses marked agree or strongly agree, percent negative indicates all survey responses marked disagree or strongly disagree.

Success Measure	% Positive	% Neutral or n/a	% Negative
Meeting goals achieved	95%	5%	0%
Plenary talks and panel discussions informative and useful	95%	5%	0%
Poster session useful for info exchange and networking	85%	10%	5%
Venue and location	95%	5%	0%
Exhibitors helpful in connecting w/ industry and new technology	76%	24%	0%



PTC Organizing Committee :

Satish Chetty - *Beyond 66 Solutions (Co-Chair)*

Karen Frey - *Clark University*

Mark Seefeldt - *University of Colorado Boulder (Co-Chair)*

Michael Prior-Jones - *Cardiff University*

Paul Carpenter - *IRIS PASSCAL Instrument Center*

Kate Ruck - *QED Enterprises, Inc.*

Lisa Sheffield Guy - *Arctic Research Consortium of the US*

Nancy French - *Michigan Technological University (Co-Chair)*

Peter Griffith - *NASA Goddard Space Flight Center (not pictured)*

Wilson Sauthoff - *National Science Foundation (not pictured)*

PTC Funders & Partners :



To view a list of all PTC 2020 participants, please visit: <https://www.arcus.org/logistics/2020-polar-technology/attendees>

Citation: Ruck, K., L. Sheffield Guy, S. Chetty, N. French, M. Seefeldt, P. Carpenter, K. Frey, P. Griffith, M. Prior-Jones, W. Sauthoff (eds.). Polar Technology Conference 2020 Report. Arctic Research Consortium of the US (ARCUS), Fairbanks, Alaska. 2020. 5pp.

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