2016 Country Report

UNITED STATES OF AMERICA

US Permafrost Association

The annual meeting of the US Permafrost Association (USPA) Board of Directors and a general member meeting was 2016 Fall Meeting of the American Geophysical Union. Current USPA membership includes 42 student members, 52 regular members, 15 corporate/non-profits/lifetime members, for 119 members and includes several non-US members.

The U.S. Permafrost Association and the American Geosciences Institute provide access to a monthly searchable database on permafrost-related publications; the Permafrost Alerts that date back to 2011. The database is searchable at : www.coldregions.org. The individual Monthly Permafrost Alerts are found on the U.S. Permafrost Association website : http://www.uspermafrost.org/monthly-alerts.shtml. Access to past ICOP proceedings and IPA Frozen Ground is also conveniently available on the USPA web site.

Institution Member Activities:

The George Washington University

Permafrost research at GWU was focused on two thematic areas: long-term monitoring of active-layer and permafrost under changing climatic conditions and role of changing permafrost conditions on development of norther regions. The monitoring was conducted under the Circumpolar Active Layer Monitoring (CALM) project. CALM was funded by the U.S. National Science Foundation's Arctic Observing Network program for the 2014-2019 period, and provides support for field operations at permafrost observatories in northern and western Alaska, and at numerous Russian sites. The project is headquartered at GWU, with subcontracts to the University of Montana and Northern Michigan University.

Field activities for the Circumpolar Active Layer Monitoring (CALM) project were conducted in Alaska and Russia during the summer of 2016. The Alaska field team consisted of Dmitry (Dima) Streletskiy (GWU), Anna Klene (University of Montana), Fritz Nelson (Northern Michigan University and Michigan State University), and four students (K. Nyland (MSU), C. Queen (MSU), Bri Rick (University of Montana) and Forrest Melvin (GWU). Active-layer and ground-temperature observations were conducted at a series of sites representative of the diverse climatic and landscape conditions on the North Slope of Alaska and Seward Peninsula. Ground-subsidence monitoring by means of differential GPS was continued in 2016 at three locations. All data generated under CALM's programs are available through the CALM webpage at www.gwu.edu/~calm.

Numerous presentations focused on CALM data were presented during the ICOP2016 in Potsdam. The conference was followed by a one day CALM workshop. During the workshop, CALM participants from seven countries have discussed a range of issues including observational strategies, future development of CALM program, synthesis of observations with modeling and improvements to CALM data archival efforts. To better disseminate results of the CALM program, a series of papers featuring long-term active layer trends was developed focusing on several Arctic and Antarctic regions. The papers will be published in a special issue of the “Polar Geography” journal in 2017.

Figure 1 CALM Workshop participants, Potsdam Germany, June 2016.

Our research on socio-economic impacts on permafrost degradation has continued. In April of 2016 we started an international, interdisciplinary NSF-funded Partnership in International Research and Education (PIRE) project on Promoting Urban Sustainability in the Arctic. The project was developed in collaboration with the GWU Institute for European, Russian and Eurasian Studies (IERES) and has substantial permafrost-related research and educational components. It is a multi-disciplinary, international effort examining the interconnections among resource development, climate change, and evolving demographic patterns with the goal of providing advice to U.S., Russian, and other policy-makers on how to develop Arctic and related infrastructure in a way that produces minimal impact on the environment. The permafrost component of the project involves participants from the US and Russia representing geography, permafrost engineering, architecture, and climatology. In October 2016 GWU housed an Arctic PIRE meeting with 40 participants from the US, Russia, Canada, S. Korea, and Europe. The work continued on our ongoing ARCTIC-ERA (ARCTIC climate change and its impact on Environment, infrastructures and Resource Availability) Belmont project. It is a collaborative effort between Laboratoire de Glaciologie et Géophysique de l'Environnement (France), The GWU (USA), Shirshov Institute of Oceanology (Russia), the Institute of Economic Forecasting (Russia), and HS&S Corp. (USA) aimed at forecasting the magnitude of environmental changes in the Arctic and their impact on the communities' well being and infrastructure. Within the framework of the ARCTIC-ERA project the GWU team is responsible for geographic assessment of the effect of permafrost changes on human infrastructure.

Dima Streletskiy (GWU) continued serving as a Chair of the Global Terrestrial Network for Permafrost (GTN-P). The GTN-P activities, events and highlights can be found on pages 12-13 of the latest issue of Frozen Ground (http://ipa.arcticportal.org/images/fg/FrozenGround_40.pdf).

National Park Service (by Dave Swanson, NPS)

The National Park Service (NPS) is monitoring permafrost in the five NPS units in northern Alaska by ground temperature measurements at 21 climate monitoring stations, and study of landforms by remote sensing. The NPS permafrost monitoring protocol is now published in two documents

(https://irma.nps.gov/DataStore/Reference/Profile/2238783 and https://irma.nps.gov/DataStore/Reference/Profile/2238788).

Our ground temperature monitoring showed dramatic warming from 2013 to 2016, as summarized in the reports at

https://irma.nps.gov/DataStore/Reference/Profile/2226036 and

https://irma.nps.gov/DataStore/Reference/Profile/2236995. NPS permafrost landform monitoring includes thermokarst and thermo-erosion features. Ice-wedge polygon degradation was documented in lowlands of both the Kobuk and Noatak River valleys (https://irma.nps.gov/DataStore/Reference/Profile/2230516).

In an NPS-funded study, S. K. Panda, V. E. Romanovsky, and S. S. Marchenko from University of Alaska Geophysical Institute Permafrost Laboratory have completed modeling of current and future ground temperatures and active-layer depths for most of the National Parks in Alaska. This modeling predicts dramatic loss of permafrost in the coming century. The report for the five northern parks was completed in 2016 (https://irma.nps.gov/DataStore/Reference/Profile/2237720).

In 2016 NPS acquired high-resolution digital elevations models and orthophotos of numerous retrogressive thaw slumps in the Noatak Valley, created from 35-mm photos by Matt Nolan. We now have four or more dates between 2010 and 2016 with detailed topographic data and orthophotos and are currently analyzing the growth of these slumps.

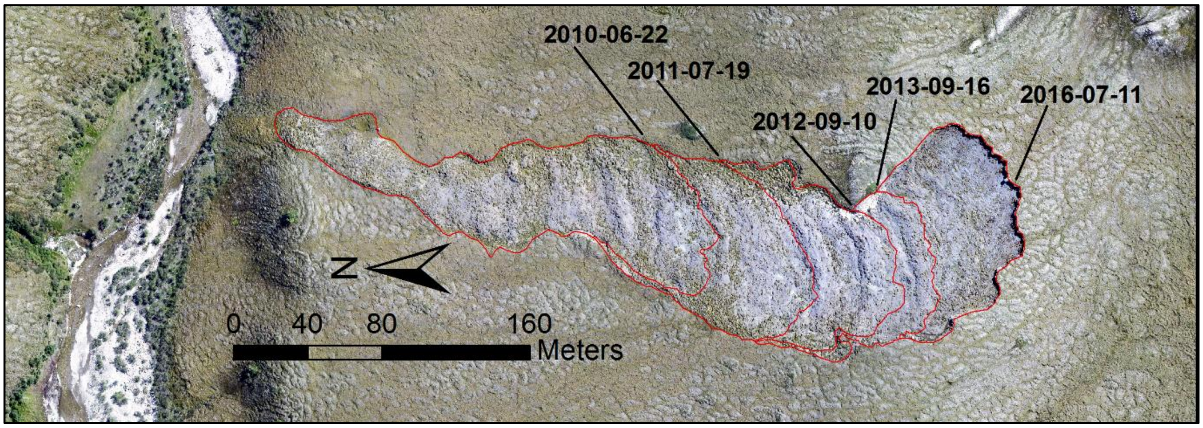

Figure 2. The escarpment of this retrogressive thaw slump in the Noatak River valley of northern Alaska advanced about 175 meters between 2010 and 2016.

The Next-Generation Ecosystem Experiment (NGEE Arctic): Using geochemistry to understand climate driven changes in permafrost hydrology (Dr. Carli Arendt, Los Alamos National Laboratory)

Placing realistic constraints on the future trajectory of surface and subsurface hydrology in ice-rich Arctic landscapes is crucial to better understand the changes in water distribution, carbon and nutrient fluxes, and geomorphology that potentially accompany permafrost degradation in a warming climate. Phase 2 of the NGEE Arctic project, a decade-long investment in high-latitude ecosystems by the Department of Energy, Biological and Environmental Research (BER) program, investigates linkages between hydrology, biogeochemistry, ecology, and geomorphology in both the surface and subsurface of discontinuous permafrost landscapes within the Seward Peninsula in western Alaska. Dynamic relationships between these processes and the local environmental conditions in which they occur provide distinct chemical signatures. NGEE Arctic researchers, including a strong team of geochemists from Los Alamos National Laboratory use these signatures to understand how the current state of permafrost, and its interactions with bedrock, controls hydrological processes and flow pathways at selected field sites outside Nome, AK. Their goal is to better describe, and model, how changes in permafrost and hydrology would impact other aspects of the Arctic terrestrial system with changing climate conditions.

Entering into the second full year of investigations on the Seward Peninsula, and armed with experience gained since 2012 working on the North Slope of Alaska, NGEE Arctic scientists are using a combination of field and laboratory studies to analyze relationships between soil water content, redox conditions, *in situ* chemistry, and associated nutrient production and fixation processes across diverse macro- and microtopographic environments and vegetation types. Hydrogeochemistry samples are collected using wick samplers, grab samples of surface waters, and rhizons. Knowledge gained from these investigations offer insights into how hydrogeochemistry changes with different states of water availability and with landscape characteristics. Watershed scale hydrogeochemical surveys were conducted during the summer of 2016 and an initial set of field and laboratory measurements of key parameters including alkalinity, dissolved oxygen, cations, anions, stable water isotopes, iron, nitrate and ammonia, were made. The resulting chemical compositions of the samples highlight a correlation between depth, soil water content, organic matter decay, and redox conditions. Significant hydrogeochemical variability exists across the watershed being intensively investigated, suggesting a variety of shallow and deep hydrological flow paths related to spatial patterns of active layer depth, permafrost, and bedrock that are now being characterized by geophysicists from Lawrence Berkeley National Laboratory.

Time-series water samples were also collected over the summer months in 2016 from 1) the headwaters of a primary drainage channel, 2) a tributary, and 3) from below the confluence of the tributary on the main drainage channel. Chemical analyses of this time-series record show that the upper headwaters and lower reach are influenced by different water sources. Headwater springs exhibit a stronger organic signature than the tributary and lower reach, which may result from direct interaction with degrading permafrost or a greater proportion of water derived from higher in the watershed where there is an extensive degraded peat plateau. An elemental and isotopic mixing model will be utilized after all end-member source contributors to water in the region are defined (i.e., permafrost, snowmelt, and summer precipitation chemical compositions). This model will ideally provide much-needed insight into rates at which permafrost is degrading, recharge pathways from snowmelt and precipitation, flow paths above, within and below degrading permafrost, and storage times.

These hydrogeochemical data and analyses are incorporated into both conceptual and process-resolving and spatially-explicit watershed models, in order to identify key controls on hydrologic flow paths and how flow paths will change and redistribute water, carbon and other nutrients across the landscape as permafrost degradation occurs. These datasets and models are informing better parameterization of permafrost controls on hydrology in Earth System Models, specifically the DOE-sponsored Accelerated

Climate Modeling for Energy (i.e., ACME) which will improve the prediction of biogeochemical and ecosystem responses and feedbacks in the Arctic climate system.

The NGEE Arctic project is managed by Oak Ridge National Laboratory, Oak Ridge, TN. Additional collaborators include Brookhaven National laboratory, University of Alaska Fairbanks, and Sitnasuak Native Corporation, Nome, AK.

Pictures: Photo credit, Carli Arendt, Los Alamos National Laboratory.

Figure 3: Headwater springs at main drainage of the intensively-studied watershed.

Figure 4: Springs appeared from willow-dense regions.

Figure 5: Seepages were located downgradient from solifluction lobes.

Figure 6: Rhizon samplers collecting water from discrete depths of a degraded peat plateau.

Northern Michigan University and Michigan State University

Northern Michigan University's (NMU) Department of Earth, Environmental, and Geographical Sciences continues to administer part of the CALM IV project concerned with northern and western Alaska, with NMU Research Associate Fritz Nelson serving as co-PI. Details about current activities and recent publications in this project are provided in the report from The George Washington University.

Nelson also serves in a professorial capacity in the Department of Geography, Environment, and Spatial Sciences (DGESS) at Michigan State University (MSU). Doctoral student Kelsey Nyland and masters student Clayton Queen are closely involved in the CALM IV program, and spent much of the 2016 summer in Alaska, monitoring CALM's sites near Toolik Lake, Prudhoe Bay, Barrow, and Nome.

Nyland, Queen, and Nelson are also conducting a program of geomorphological research in eastern Beringia (interior and western Alaska) concerned with the genesis, age, and rates of development of cryoplanation terraces (CTs), large step-like periglacial features that ascend ridge crests and hillsides, culminating in flattened summits. CTs are characteristic upland periglacial landforms. Although they dominate many Beringian landscapes and literature about them spans more than a century, little process-oriented research has been performed on these landforms. Our work thus far (a) confirms that the elevation trends of cryoplanation terraces and glacial cirques are nearly identical along east-west transects through central Alaska, indicating that similar climatic controls influence their development; and (b) indicates that development of CTs is cyclic, and appears to occur primarily during glacial intervals.

In 2016, the MSU group made presentations about its cryoplanation research at the ICOP meeting in Potsdam, at the Fall Meeting of the American Geophysical Union in San Francisco, and at the East/West Lakes meeting of the American Association of Geographers (AAG) held in Marquette Michigan. Queen's presentation at the AAG meeting won a best-poster award.

MSU has a long and distinguished history of faculty and graduate student research in the polar regions, and is in the process of formalizing that emphasis though a university-wide organization of Arctic researchers. DGESS is developing a strong cryospheric research emphasis through the addition of Nelson, Dorothy Hall (formerly of NASA-Goddard), and Grant Gunn (formerly of the University of Waterloo) to existing DGESS faculty strengths in geomorphology, Quaternary research, climatology, and glacial chronology. DGESS and MSU offer a wide range of financial support to graduate students, and invite inquiries and applications from prospective students interested in permafrost, periglacial geomorphology, glacial and soils geomorphology, snow science, glaciology, and cold-regions remote sensing. Information about DGESS and its research programs can be found at <http://geo.msu.edu/>.

Recent peer-reviewed publications

Brown, J., Nelson, F.E., Romanovsky, V.E., Seybold, C., Hollister, R.D., and Tweedie, C.E. (2015). Long term observations of active layer thawing and freezing, Barrow, Alaska. *Proceedings of the Seventh Canadian Permafrost Conference*. Quebec: Canadian Geotechnical Society.

Nelson, F.E., and Schimek, M.A. (2015). Topoclimatic controls over active-layer thickness, Alaskan Arctic Coastal Plain. In Burn, C.R. (ed.) *Proceedings of a Symposium to Commemorate the Contributions of Professor J. Ross Mackay (1915-2014) to Permafrost Science in Canada, Seventh Canadian Permafrost Conference, Quebec City, QC, 20-23 September 2016*, 119-126. http://carleton.ca/permafrost/symposium-honour-professor-j-r-mackay-1915-2014/

Streletskiy, D.A., Sherstiukov, A., Frauenfeld, O. and Nelson, F.E. (2015). Changes in the 1963-2013 shallow ground thermal regime in Russian permafrost regions. *Environmental Research Letters* 10: doi.10.1088/1748-9326/10/12/125005.

Touyz, J., Streletskiy, D.A., Nelson, F.E. and Apanasovich, T. (2015). A spatio-temporal framework for modeling active layer thickness. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Vol. II-4/W2, 199-206.

Brigham, L.W. and Nelson, F.E. (eds., 2017). Special Issue: Geographical Perspectives on the Arctic. *Geographical Review* 107(1): 1-257.

Fagan, J.E. and Nelson, F.E. (2017). Sampling designs in the Circumpolar Active Layer Monitoring (CALM) program. *Permafrost and Periglacial Processes* 28(1): 42-51.

Nyland, K.E., Klene, A.E., Brown, J., Shiklomanov, N.I., Nelson,F.E., Streletskiy, D.E., and Yoshikawa, K. (2017). Traditional Iñupiat ice cellars (Siġḷuaq) in Barrow, Alaska: characteristics, temperature monitoring, and distribution. Geographical Review 107: 143-158. doi: 10.1111/j.1931-0846.2016.12204.

Streletsky, D.A., Shiklomanov, N.I., Little, J.D., Nelson, F.E., Brown, J., Nyland, K.E., and Klene, A.E. (2017). Thaw subsidence in undisturbed tundra landscapes, Barrow, Alaska, 1962-2015. Permafrost and Periglacial Processes. (in press). doi: 10.1002/ppp.1918

Nelson, F.E. and Nyland, K.E. (submitted). Periglacial cirque analogs: regional trends of cryoplanation terrace elevation in eastern Beringia. *Geomorphology*.

2016 presentations

Nelson, F.E. Geocryological investigations in Louise Arner Boyd’s 1933 and 1937 American Geographical Society expeditions to East Greenland. Oral presentation, International Conference on Permafrost, Potsdam, Germany, June 2016.

Nyland, K.E. and Nelson, F.E., and Queen C.W. Cryoplanation terraces: A characteristic upland periglacial landscape. Poster presentation, 2016 Fall Meeting of the American Geophysical Union, San Francisco.

Nyland, K.E. and Nelson, F.E. Periglacial cirque analogs: regional trends of cryoplanation terrace elevation in eastern Beringia. Poster presentation, International Conference on Permafrost, Potsdam, Germany, June 2016.

Queen, C.W., Nyland, K.E., and Nelson, F.E. Cryoplanation terraces: climatically controlled periglacial landforms. Poster presentation, joint meeting of the East Lakes and West Lakes divisions of the American Association of Geographers, Marquette, Michigan, September 2016.

Other CALM-related publications and presentations are listed in the report from The George Washington University

---

Matthew A. Whitley, M. Torre Jorgenson, Gerald V. Frost, Matt J. Macander, Chris. V. Maio

Matthew Whitley, Torre Jorgenson, and JJ Frost conducted fieldwork on the Yukon-Kuskokwim Delta (YKD) in July 2016 to continue long-term monitoring plots set up by Torre in the mid-1990s (Jorgenson and Ely 2001). Vegetation surveys and thaw depth probing help to track landscape changes on the delta associated with thermokarst of the permafrost there. The ecosystem-protected permafrost in the region is vulnerable to the press and pulse mechanisms of rising air temperatures and large inland storm surges, which have been known to flood 37 km inland (Terenzi et al. 2014). Ice accretion in the permafrost is strongly correlated with topography on the otherwise flat delta creating permafrost plateaus, so much of the fieldwork conducted was to collect field validation points for a mapping effort using Light Detection And Ranging (LiDAR) data acquired in 2009. A probability based approach was taken to mapping permafrost with the LiDAR (Figure 6) to identify permafrost plateaus at a high resolution.

The warm climate of the YKD makes permafrost in the region transient, so baseline permafrost maps are important to monitoring thermokarst and landscape change. Matthew's Master's thesis seeks to map permafrost presence in a variety of manners for this very reason (Whitley et al. 2017). Coastal permafrost is expected to disappear from the YKD in 30-50 years, which will have lasting effects on the local Yup'ik and Cup'ik communities. Berry crops from the permafrost plateaus is an important staple in the Alaska Native communities, which will likely diminish with the permafrost. A rich cultural heritage is also associated with archaeological sites located on the permafrost plateaus, which are threatened by the rapidly changing landscape.

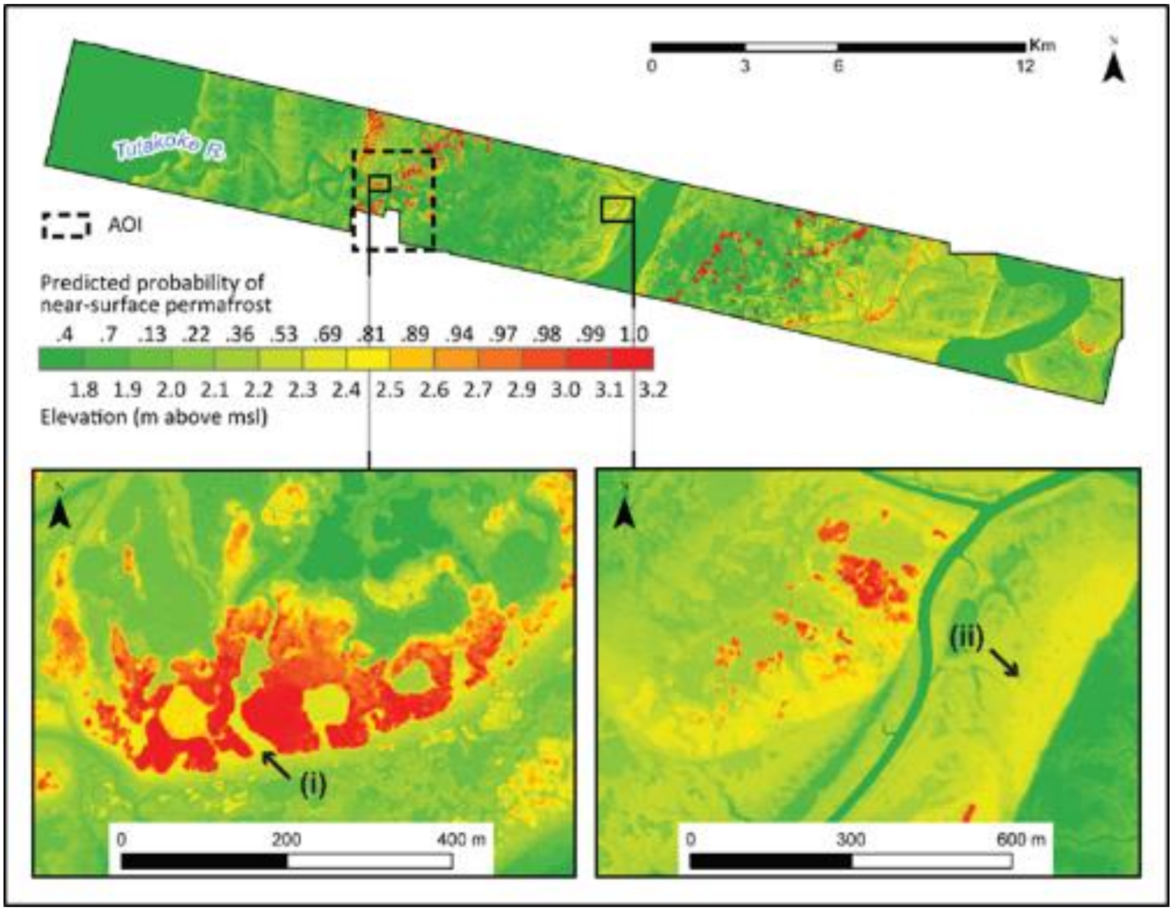

Figure 6: Predicted probability of near-surface permafrost shows elevation is a strong indicator of permafrost presence on the delta.

Jorgenson, T., & Ely, C. 2001. Topography and flooding of coastal ecosystems on the Yukon-Kuskokwim Delta, Alaska: implications for sea-level rise. Journal of Coastal Research, 124-136.

Whitley, Matthew A., G. V. F., Matt J. Macander, M. Torre Jorgenson, Chris V. Maio. In Prep. Assessment of LiDAR and spectral techniques for high-resolution mapping of permafrost on the yukon-kuskokwim delta, alaska. (M.S.), University of Alaska Fairbanks, Fairbanks.

Terenzi, J., Jorgenson, M. T., Ely, C. R., & Giguère, N. 2014. Storm-surge flooding on the Yukon-Kuskokwim Delta, Alaska. Arctic, 360-374

Permafrost Carbon Network and Permafrost Action Team

Updates for 2016

The Permafrost Carbon Network is an international scientific effort linking biological carbon cycle research with networks in the physical sciences focused on the thermal state of permafrost. The network has been successfully running since 2011 and is now part of the Permafrost Action Team under the umbrella of the Study of Environmental Arctic Change (SEARCH). The network is open to new participants by contacting network leads (contact information below).

In June of 2016, the Permafrost Carbon Network held its 6^{th} network lead meeting in Potsdam, Germany and in December, the network held its 6^{th} all scientist meeting the day before the Fall Meeting of the American Geophysical Union in San Francisco, California. At both meetings, synthesis leads gave short presentations on synthesis progress and received input from other synthesis leads and the broader science community.

Our science highlights for 2016 are multiple publications in high profile journals. A meta-analysis by Schädel *et al.* (2016) published in Nature Climate Change showed that drier, aerobic soil conditions release three times more carbon than wetter, anaerobic soil conditions. The implications of this study are that the permafrost carbon feedback will be stronger when a larger percentage of the permafrost zone undergoes thaw in a dry and oxygen-rich environment.

McGuire *et al.* (2016) presents a retrospective analysis of 15 land surface model simulations including carbon cycle processes and permafrost for 1960-2009. Published in Nature Communications, Olefeldt *et al.* (2016) combines maps and thermokarst landscapes with projections of future climates, which allows scientists to predict future greenhouse gas emissions following permafrost thaw. Wik *et al.* (2016) describes improved estimates and future predictions of CH_4 emissions from northern lakes and ponds.

2016 Synthesis Publication Highlights:

McGuire et al. (2016) Variability in the sensitivity among model simulations of permafrost and carbon dynamics in the permafrost region between 1960 and 2009. *Global Biogeochemical Cycles*. doi:10.1002/2016GB005405

Olefeldt et al. (2016) Circumpolar distribution and carbon storage of thermokarst landscapes. *Nature Communications,* 7, 13043. doi:10.1038/ncomms13043

Schädel et al. (2016) Potential carbon emissions dominated by carbon dioxide from thawed permafrost soils. *Nature Clim. Change,* 6, 950-953. doi:10.1038/nclimate3054

Wik et al. (2016) Climate-sensitive northern lakes and ponds are critical components of methane release. *Nature Geosci,* doi:10.1038/ngeo2578

Contact:

Ted Schuur - Principal Investigator, Northern Arizona University, USA. ted.schuur@nau.edu

Christina Schädel - Network Coordinator and Research Scientist, Northern Arizona University, USA. christina.schaedel@nau.edu

Website: www.permafrostcarbon.org

Figure 7: Lead Meeting of the Permafrost Carbon Network, June 18-19, 2016, Potsdam, Germany

The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) (by Tom Douglas)

The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) continued their applied studies and investigations to support infrastructure development on permafrost, to identify permafrost-hydrology and ecology relationships, and to apply geophysical and remote sensing measurements across permafrost terrains. Multiple projects were conducted in Alaska, Greenland, and Canada for a variety of Federal and State agencies such as the U.S. Dept. of Defense, Air Force, Navy, Dept. of Interior, State of Alaska Dept. of Transportation, Transport Canada, and Northwest Territories Dept. of Transportation.

Ongoing expansion of CRREL Permafrost Research Station facilities around Fairbanks continues. An experimental heating study was conducted at the Farmer's Loop site with Lawrence Berkeley National Laboratory. A major expansion of the Permafrost Tunnel is planned for the winter of 2017-2018 with the excavation of new tunnel and facility improvements to save energy and improve safety and access.

CRREL staff are working to advance permafrost research across the US Federal government as a co-lead within the Interagency Arctic Research Policy Committee (IARPC) Permafrost Collaboration Team. The goal is to coordinate implementation of the Permafrost Research Goal chapter created by the team for US Federal agencies defined in the 'US Arctic Research Plan 2017-2021'. The Plan seeks to advance US Arctic science by leveraging combined expertise across federal agencies, and with non-Federal partners, to enable multidisciplinary research and synthesis.

U.S. Geological Survey (USGS):

Permafrost related research at the USGS spans multiple disciplines, mission areas, and science centers. Research themes include permafrost thermal regime, hydrology, terrestrial and aquatic carbon fluxes, mercury cycling, geophysics, remote sensing, wildlife, and ecosystem ecology. A selection of USGS research and personnel involved during 2016 are given below.

<u>USGS Alaska Science Center</u>

Benjamin Jones, Carson Baughman, and Eva Stephani with the USGS Alaska Science Center (ASC) focus on the use of remote sensing, GIS, field surveys, laboratory analyses, and model development in Arctic and Boreal regions to better understand short-term and long-term changes occurring in permafrost-influenced landscapes. During 2016, the team published research findings in The Cryosphere, Geophysical Research Letters, Environmental Research Letters, Arktos, Geomorphology, Boreas, The

Holocene, Sedimentary Geology, and Permafrost and Periglacial Processes. Ongoing field studies include investigations of isolated permafrost deposits in southcentral Alaska, sub-arctic dunes in interior Alaska, thermokarst lake dynamics in western and northern Alaska, and coastal change studies along the Beaufort Sea. In April 2017, Jones will participate in the final field season associated with the NSF-funded Arctic Lake Ice Systems Science project during a snowmachine traverse from Barrow to Toolik Field Station. Proposed future projects include the catastrophic and progressive hydrologic impacts of drained thermokarst lake basins in arctic lowland regions and development of climate resilience toolkits for remote arctic coastal communities.

Josh Koch and other members of this team based at the USGS Alaska Science Center have been active in projects focused on the implications of permafrost on hydrology and biogeochemistry. These include a NASA – ABoVE project (Project Leads: Rob Striegl and Michelle Walvoord; discussed elsewhere), and a project in the Noatak Preserve entitled "Hydro-ecology of Arctic Thaw" (HEAT). HEAT aims to identify the signatures of warming and thaw in the hydrology and chemistry of streams at the artic-boreal transition zone, and to link these changes to fish habitat, growth, and productivity. Project personnel include Josh Koch, Mike Carey, Jon O'Donnell, Ylva Sjöberg, and Chris Zimmerman, and collaborator Marty Briggs. Other projects include continued data collection and subsurface tracer experiments at the Nome Creek Experimental Watershed in the White Mountains, Alaska. Completed (2015) and planned (2017) subsurface tracer tests aim to quantify flow and storage mechanisms and rates at the decameter scale on burned and unburned boreal hillslopes. Finally, work continues on the Arctic Coastal Plain of Alaska, with a focus on thermokarst pond and lake water budgets and biogeochemistry.

USGS Mercury Research

USGS scientists Kim Wickland (National Research Program), and Dave Krabbenhoft and Mike Tate (Wisconsin Water Science Center) completed their second year of field work at Denali National Park for their project "Permafrost thaw and mercury dynamics: impacts on atmospheric emissions and water quality, and links to carbon cycling", which is funded jointly by USGS and National Park Service. The overall goal of the project is to determine whether thermokarst formation exacerbates gaseous mercury emissions to the atmosphere and/or dissolved mercury concentrations in soil pore waters and nearby surface waters. Field and experimental laboratory investigations will continue in 2017.

Permafrost Thermal Regime Measurements

Gary Clow and Frank Urban with the USGS Geosciences and Environmental Change Science Center (GECSC) oversee the DOI/GTN-P USGS Permafrost and Climate Monitoring Network located on federal lands in northern Alaska. In 2016, the annual data series update from the team was released and a subsequent release with data through July 2016 will be published before the end of the calendar year. In addition, network station maintenance, snow surveys and instrument retrievals/deployments were conducted during the spring and summer of 2016. Gary Clow is finalizing a multiscale, multidimensional permafrost model to better estimate the climate signal present in the deep borehole record.

Aquatic Carbon Cycle

The US Geological Survey and collaborators from academia and private industry completed their first year of field investigations for their project "Vulnerability of inland waters and the aquatic carbon cycle to changing permafrost and climate across boreal northwestern North America" (Project Lead: Rob Striegl). This interdisciplinary project is part of the NASA Arctic-Boreal Vulnerability Experiment (ABoVE), and includes more than 20 scientists whose expertise includes hydrology, geophysics, remote sensing, and carbon biogeochemistry. The overall goal of the project is to evaluate the vulnerability of boreal landscapes to changes in water movement and distribution as a result of permafrost thaw, the potential effects on carbon delivery to inland waters, and changes in carbon processing rates by inland waters and greenhouse gas emissions to the atmosphere. Field campaigns focus on data collection from headwater streams and surrounding watersheds, and lakes across diverse landscapes that will inform modelling and remote-sensing components of the project. Associated permafrost mapping at the Landsat 30 m scale and at the local field scale (stream, erosional nich point, or across bogs) improves subsurface understanding of permafrost and subsurface water flow. Local detailed permafrost field permafrost mapping uses Electrical Resistivity Tomography at strategically placed locations to augment hydrologic and carbon studies of the ABoVE project. Further mapping efforts include a Landsat-based mapping of the probability of land cover change and high resolution land cover change through a long time series of image interpretations at sample blocks scattered across Alaska.

Terrestrial Carbon Cycling and Permafrost Microbiology

USGS soil microbiology lab, consisting of Mark Waldrop, Kristen Manies, Jack McFarland, Mary-Catherine Leewis, in collaboration with other USGS investigators (Miriam Jones, Dave McGuire) and University academics (Rebecca Neumman, Rachel Mackelprang, Merritt Turetsky, Rob Spencer) have continue to collaborate on research focused on the causes and consequences of permafrost thaw on greenhouse gas release in interior Alaska, and secondly on microbial communities active in permafrost ice. The microbial ecology of intact permafrost is funded by a NASA exobiology grant and uses genomic techniques to investigate strategies for survival by microbial communities in frozen environments so as to understand how life may have survived on other planets. Terrestrial carbon cycling work is funded by the USGS Climate and Land Use Program and recently has focused on the use of soil and aquatic isotopes to infer rates carbon cycling processes within thermokarst. In 2016 articles were published in Global Change Biology, Biogeosciences, Biogeochemistry, and Journal of Environmental and Engineering Geophysics.

University of Montana

The University of Montana continued to be active in permafrost research in several departments. Anna Klene continued as a co-PI of the CALM IV project concerned with northern and western Alaska, and led part of the August field season in the Kuparuk river region. She accepted an invitation to become co-Chair of the Education & Outreach Committee of the IPA just before ICOP2016. New student, Brianna Rick, joined the Geography Department to begin her thesis research in northern Alaska with CALM.

John Kimble and the Numerical Terradynamic Simulation Group in the newly named W.A. Franke College of Forestry and Conservation continued their work on carbon cycle dynamics, surface hydrology, and changes in permafrost landscapes across Arctic-Boreal regions among other projects. Notably, Jennifer Watts presented and chaired a session at ICOP2016, attended several education-related workshops, completed her NASA Earth and Space Science Fellowship, co-authored five articles during 2016, and successfully defended her dissertation in January 2017. Her post-doc with John Kimble will continue their research with NASA's Arctic-Boreal Vulnerability Experiment (ABOVE).

Please see Research Gate for copies of recent publications.

Individual Member Activities:

USPA Board Member Mark Demitroff of Stockton University, New Jersey, continues work on mid-Atlantic Quaternary environments, including: intense Pleistocene wind-action, dunes, and etch-forms in ice-marginal New Jersey; the characterization of thermal-contraction wedges in Pennsylvania with Dorothy Merritts, Robert Walters, and Evan Gross from Franklin & Marshall College; and recording abrupt Younger Dryas climate change at a mastodon kill site in New York in association with deep seasonal frost phenomenon and platinum abundance analysis.

Demitroff M. 2016. Pleistocene ventifacts and ice-marginal conditions, New Jersey, USA. Permafrost and Periglacial Processes. Paleoenvironment Special Issue. 27: 123–137. DOI: 10.1002/ppp.1860

Merritts D, Walter R, Blair A, Demitroff M, Potter N, Alter S, Markey E, Guillorn S, Gigliotti S, Studnisky C, 2015. LiDAR, orthoimagery, and field analysis of periglacial landforms and their cold climate signature, unglaciated Pennsylvania and Maryland. Geological Society of America Abstracts with Programs 47, 7, p.831.

LeCompte M, West A, Demitroff M, Adeji AV, Witwer T. 2016. The Bowser Road Mastodon and the Younger Dryas Hypothesis. Eastern States Archeological Federation 83rd Annual Meeting, Book & Exhibit Room, Sheraton Bucks County, Langhorn, PA, November 04–05 (poster, book chapter in press).

Figure 8: Yardang or "rofbard" (wind-erosion remnant) within a circular New Jersey Pine Barrens blowout or "spung."

Complied by: Molly McGraw, Secretary, US Permafrost Association