Snapshot of permafrost - active layer observations on the North Slope of Alaska

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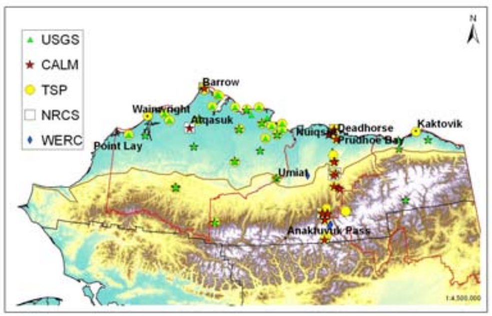
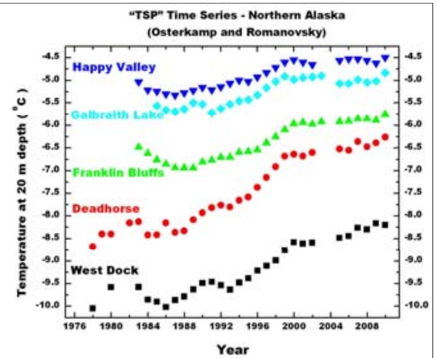
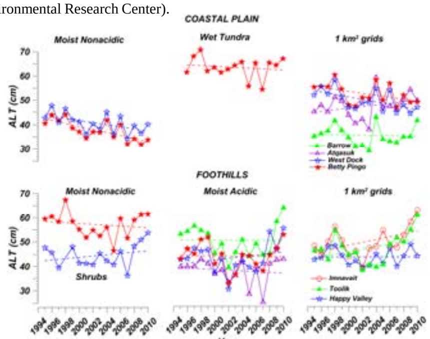
Permafrost is a central component of the cryosphere. It underlies nearly a quarter of the Earth's terrestrial surface, including essentially the entire North Slope of Alaska. Most permafrost monitoring sites on the North Slope were established in the 1980s, and many active-layer monitoring sites were established there in the early1990s. These sites contribute to the Global Terrestrial Network for Permafrost (GTN-P), which consists of two components: the Circumpolar Active Layer Monitoring (CALM) and Thermal State of Permafrost (TSP) programs. The North Slope components of these programs currently consist of 90 sites north of the Brooks Range, operated by personnel from several universities and government organizations (see affiliations). The majority of the sites are located in coastal areas and along the route of the Trans-Alaska Pipeline. Observational data show that permafrost temperature is changing along the bioclimatic gradient from –9 to -6°C at Coastal Plain sites and from -6 to -4°C at Foothills sites. Temperature is highly variable in the Brooks Range, owing to complex topographic effects. Active-layer thickness (ALT) generally increases towards the south if similar landscape units are compared. Permafrost temperature has increased since the 1980s, reflecting increases in air temperature and snow depth and, along the coast, possibly due to longer periods of ice-free conditions on the Arctic Ocean. The record of ALT measurements do not show significant trends over the last 15 years, instead reflecting interannual variations in regional summer climatic conditions. The summers with the three deepest thaws on the record correspond to the warmest summers of 1998, 2004, and 2010.



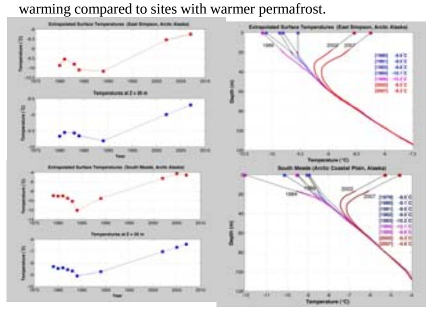
Locations of sites on the North Slope of Alaska: USGS (United States Geological Survey), CALM (Circumpolar Active Layer Monitoring), TSP (Thermal State of Permafrost), NRCS (Natural Resources Conservation Service), WERC (Water and Environmental Research Center).



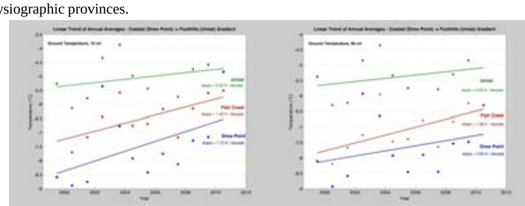
Permafrost temperatures at approximately 20 m depth at sites located along the primary (N-S) bioclimatic gradient on the North Slope of Alaska. Note that sites with cold permafrost experience higher rates of warming compared to sites with warmer permafrost.



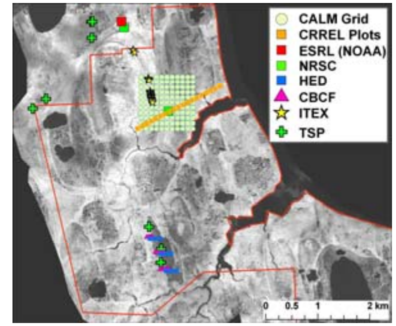
Site-specific 16-year (1995-2010) records of annual active-layer thickness. Nine 1 ha sites and six 1 km² sites are grouped by landscape category characteristic of the two physiographic provinces.



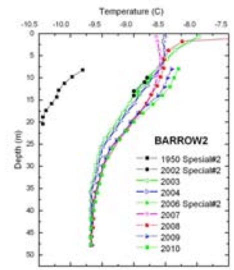
Permafrost temperature at two selected sites operated by USGS shows permafrost warming of up to 2°C over the last three decades.



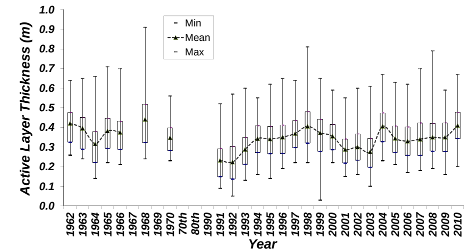
Ground temperature in the active layer and upper permafrost from three stations operated by the USGS. Near surface ground temperatures respond to a variety of site specific factors, primarily the insulating properties of snow depths, snowpack duration and air temperature. These decade long records show a distinct coastal to inland gradient, significant inter-annual variability and clear increasing trends.



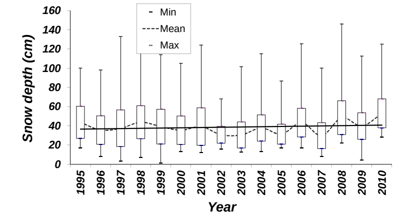
Location of active layer and permafrost temperature observations in the Barrow Environmental Observatory (BEO).



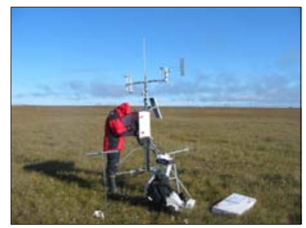
New borehole in BEO shows the warming of permafrost as compared to temperatures in the nearby1950 borehole.



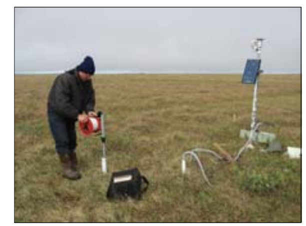
Active Layer Thickness (ALT) from the CRREL Plots (1960s) and the CALM Grid (1991-2010). Years with warm summers show thicker ALT, while cold summers show thinner values.



Late spring snow depth surveyed at the Barrow CALM Grid (121 points) shows high interannual variability of snow accumulation. Measurements of snow depth are important for evaluating permafrost temperature. Thicker snow provides more insulation to the ground, leading to increased warming of permafrost.

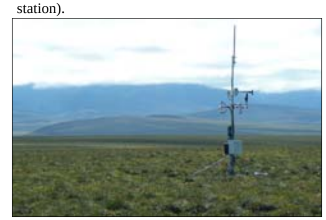


Several NRCS soil climate research stations on the North Slope provide data on near-surface ground temperature and climate conditions to help us understand short-term changes in active-layer-permafrost system (photo: NRCS West Dock1 station).



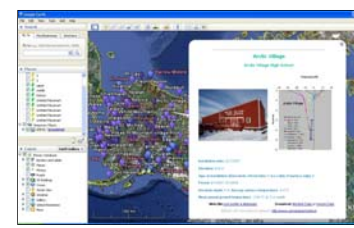
Measurements of ground temperature boreholes help us to understand long-term reaction of permafrost to climate change (Photo: UAF TSP borehole at Deadhorse).

Collaboration of scientists with local communities and educational outreach are essential components of permafrost research in Alaska. Kenji Yoshikawa shows Golovin students a "frost tube" he installed behind their school. [Photo by Ned Rozell].



USGS stations collect data on climate conditions, radiation balance, active layer and permafrost temperature. Collected data are transmitted in real time. (photo: Station U31: Marsh Creek)

USGS temperature logging set up at Atigaru deep drill site.



Network of permafrost and active-layer observations developed by UAF-Outreach project and schools and communities in Alaska.

Web sites indicating sponsors and access to data:

NSF AON CALM: The Circumpolar Active Layer Monitoring Network--CALM III (2009-2014): Long-term Observations on the Climate-Active Layer-Permafrost System [http://www.udel.edu/Geography/calm/]
NSF AON TSP: AON: Thermal State of Permafrost (TSP) in North America and Northern Eurasia: The US Contribution to the International network of Permafrost Observatories (INPO) **[**http://www.permafrostwatch.org]
USGS: [http://data.usgs.gov/climateMonitoring/alaska/]
NSF AON ITEX: Sustaining and amplifying the ITEX AON through automation and increased interdisciplinary of observations [http://www.geog.ubc.ca/itex/]
NRCS: Soil climate research stations [http://www.soils.usda.gov/survey/scan/alaska/]
Additional sites are installed in communities as outreach with schools: **UAF-Permafrost Outreach** [http://ine.uaf.edu/werc/projects/permafrost/]