Global outlook from the Global Terrestrial Network for Permafrost (GTN-P): Changes in thermal state of permafrost and active layer thickness over the last decade

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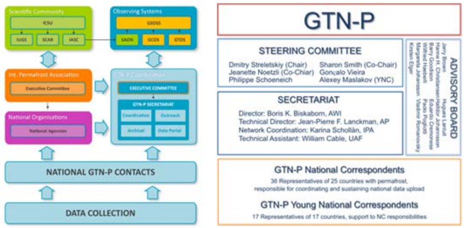
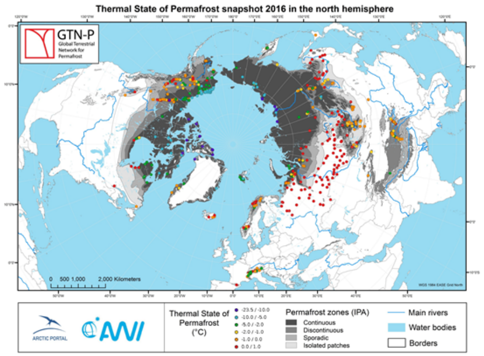
The Global Terrestrial Network for Permafrost (GTN-P) provides systematic long-term measurements of permafrost temperature and active layer thickness (ALT), and is part of the Global Terrestrial Observing System of the Global Climate Observing System. Two major components of the GTN-P are long-term monitoring of the thermal state of permafrost in an extensive borehole network, the Thermal State of Permafrost (TSP) and monitoring of the active-layer thickness, the Circumpolar Active Layer Monitoring (CALM).

Long-term monitoring of permafrost thermal state and active layer thickness generates essential baseline information for assessment of climate change impacts in polar and high mountain regions, modeling of ecosystem processes and for many engineering applications in permafrost regions.

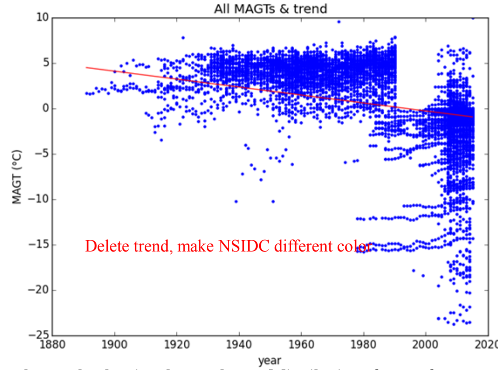


Governance structure and information flow of the GTN-P

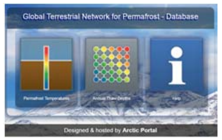
The GTN-P launched a sophisticated data management system (DMS, gtnpdatabase.org), which allows automatic data submission, standardization, quality control, processing and data access. Presently 1350 TSP boreholes and 250 active layer sites are registered within the DMS, but the geographic distribution of sites and the length, specifications and quality of observations vary within and between the regions.



The map shows permafrost temperature over the 2010-2016. Generally permafrost temperature is increasing following north – south bioclimatic gradient, but difference is site-specific conditions, such as snow depth, vegetation and soil properties complicated this general geographic trend



The graphs showing the number and distribution of permafrost monitoring sites. Majority of the sites were initiated in late 2000s. Recent integration of historic dataset allowed to extend the geography and length of observations in Russia, but differences in methodologies limit the integration of these data into GTN-P



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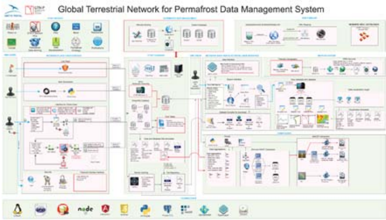
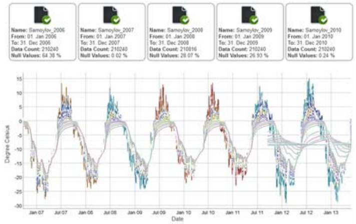
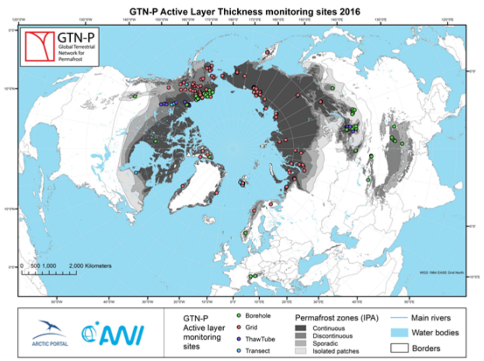




The front page of the database and the workflow diagram of the GTN-P Data Management System. The DMS allows data search, queries, visualization and download in common formats (including csv and netCDF among others)

Using DMS capabilities we selected sites with data available around the last International Polar Year (2005-2009), when major push was made to improve the permafrost observational network, and in the last five years (2010-2015). The selected sites were used to estimate changes in thermal state of permafrost and active layer thickness between the two reference periods. The preliminary results are outlines below.

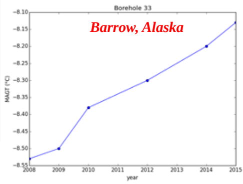


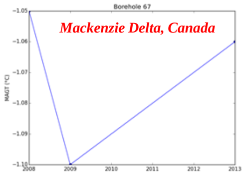
Map of active layer monitoring sites in the Norther Hemisphere. Note that majority of the sites are grids (100 x 100 m or 1 x 1 km) allowing estimations of spatial variability of ALT.

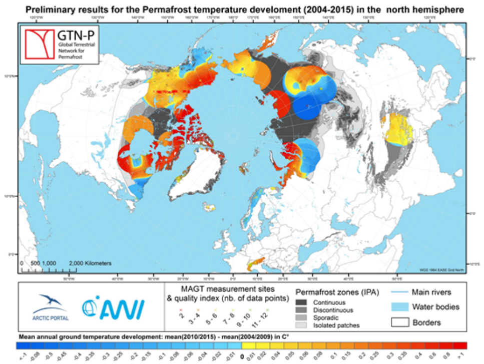
The results show that ALT exhibits large interannual variability, but has generally increased in the majority of regions, especially in European Arctic where several sites experienced permafrost degradation. At several sites of the northwest Antarctic Peninsula, ALT has been stable or even decreased. The detailed analysis of ALT spatial and temporal variability is available tomorrow in **GC31H-1200 Long-term active-layer dynamics: results of 22 years of field observations in Northern Hemisphere permafrost regions.**

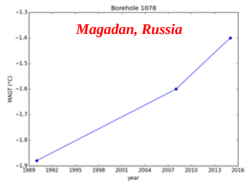
Permafrost temperature has generally increased across the entire permafrost domain which is consistent with air temperature trends, however, there is considerable spatial and temporal variability. The greatest increases in permafrost temperature are found in the High Arctic of Canada and western Siberia and are generally pronounced in regions with cold continuous permafrost such as Russia and North America. In the Subarctic, where permafrost temperatures are relatively high and within 2°C of the freezing point, there has been little change and permafrost temperature is similar to that of the IPY snapshot. In Alpine permafrost areas, however, most measurement sites also show significant warming since 2009.

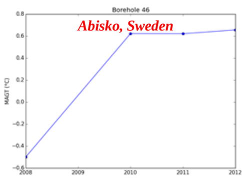
This work reveals further need for improved geographic coverage of the observational network in order to assess changes in permafrost system at global scales.

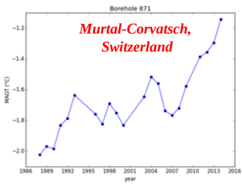


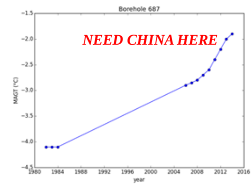












The map in the centre shows the changes in permafrost temperature from 2004-2009 to 2010-2015. The quality index shown on the pap is based on number of years with complete observations, with red markers show low confidence, yellow show medium confidence and green showing high confidence of the estimates. The time series of permafrost temperature are chosen from various regions and have variable lengths and temperature scales in order to showcase various examples of changes in permafrost temperature and also with data availability.

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