From Permafrost Degradation Projection to Prediction

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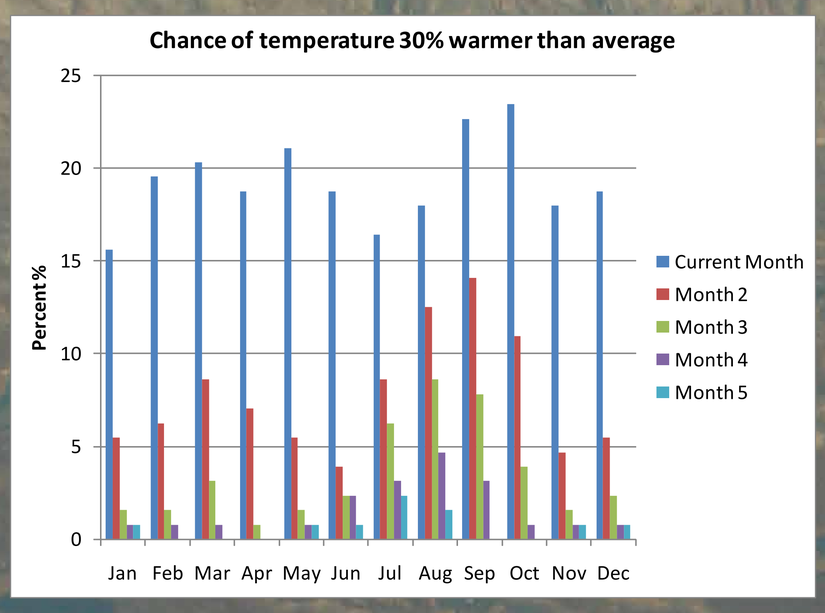
On the topic of climate warming, permafrost degradation is the main focus of attention for media, government and many researchers, from ecologists to geophysicists. The discussion is aimed at increasing ground temperatures and permafrost thaw, with the potential released of a large amount of carbon stored in permafrost. However there are great discrepancies between projected permafrost changes in the literature. Many of the differences can be attributed to a lack of physical permafrost understanding, but even among permafrost scientists there are differences of opinion on how to estimate permafrost changes as a result of a warming climate.

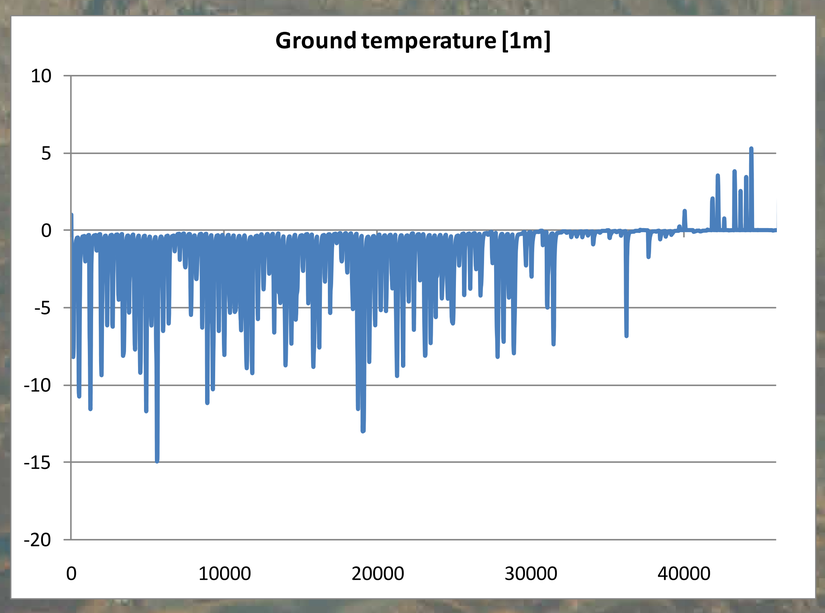
The projection of climate change into the future may be correct on average, but the problem with permafrost generation or degradation is that it depends strongly on the occurrence of a single extreme weather event, e.g. the accumulation of a large amount of snow during a particular winter may lead to permafrost degradation. To estimate the chance of these weather events occurring we analyzed climate data from a 25 km resolution climate projection over Greenland for one node point. Monthly temperatures and snow depths are analyzed statistically to understand their monthly exceedance percentages. To compare months individually we de-trend the data and calculate the distribution of temperatures for each month individually between 1950 and 2050 for the region of Ilulissat, Greenland.

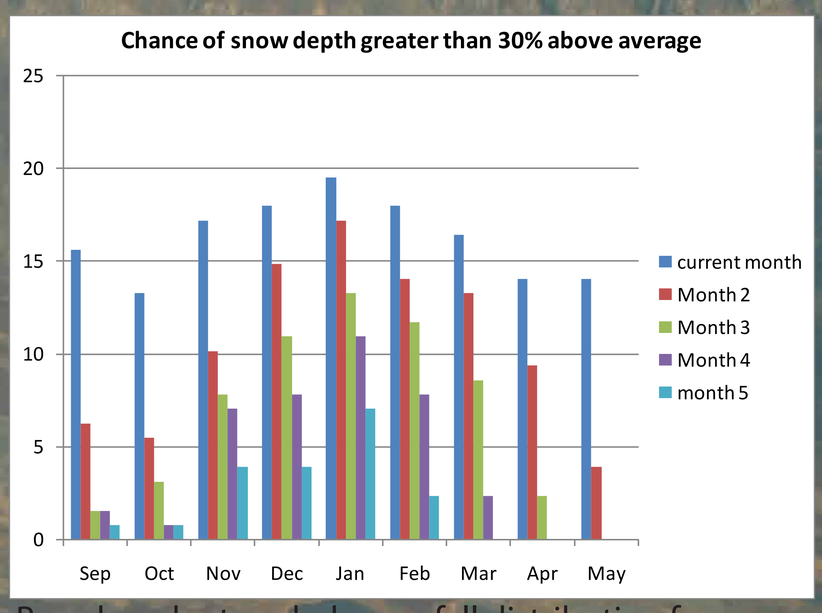
These weather patterns are input for a permafrost model that describes the physical processes of heat flux, freezing and thawing as non-linear heat conduction. We define permafrost degradation as a mean annual temperature greater than 0 degrees Celsius at 1 meter depth. Based on this analysis we can say that permafrost in a natural setting near Ilulissat is not likely degrading within the next 40 years.

Combined 30% warmer air temperature and 30% increased snow fall resulting in permafrost degradation in approximately 50 years from today.



Based on deptrended air temperature

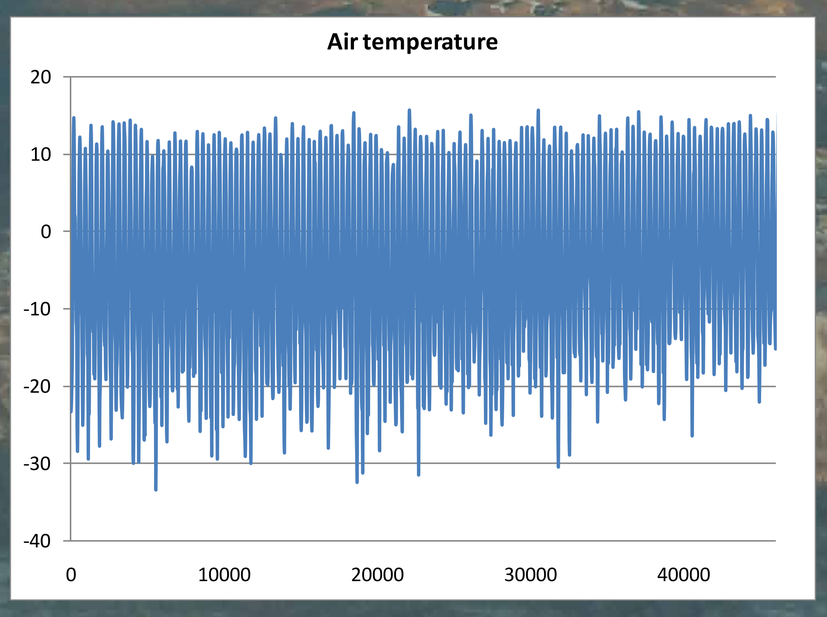


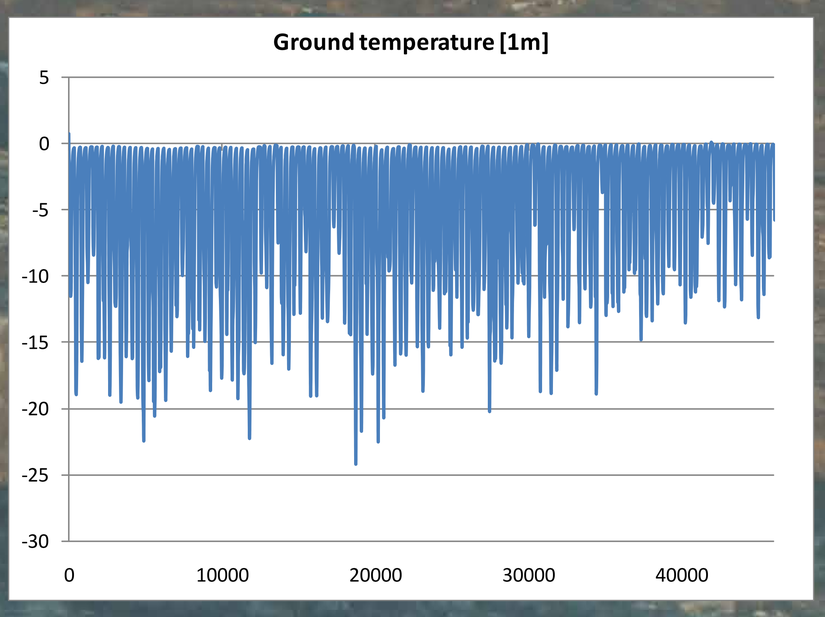


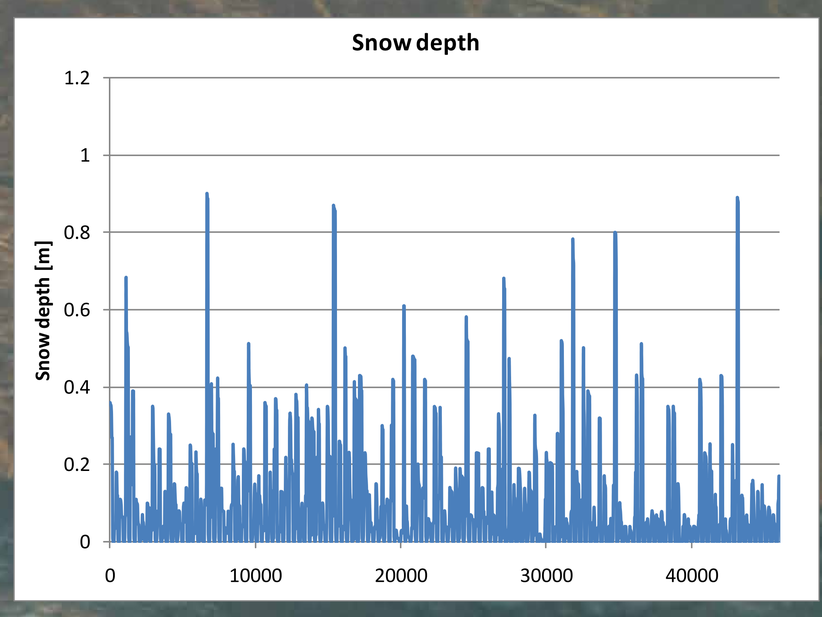
Based on deptrended snow fall distribution for each month

The horizontal axis shows the number of days into the simulation with GIPL starting with 1950 ending in 2080.

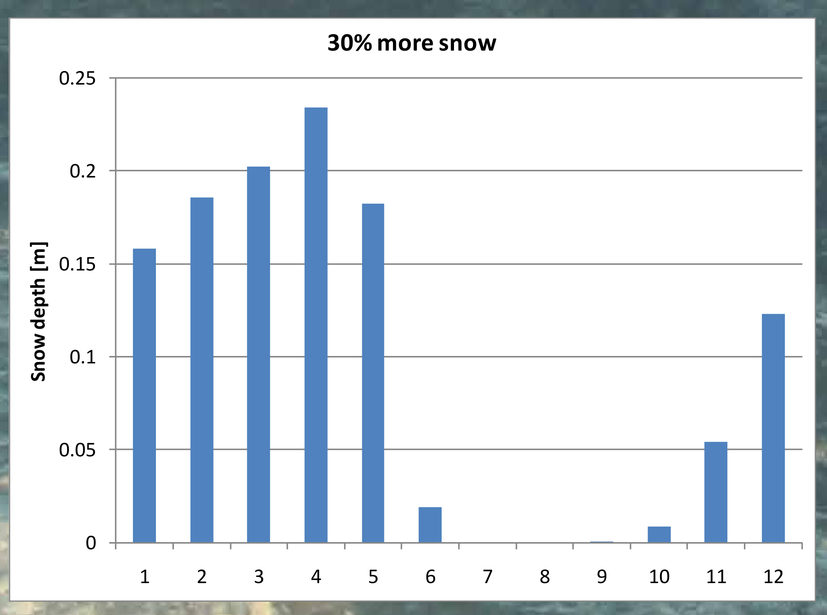
Normal condition

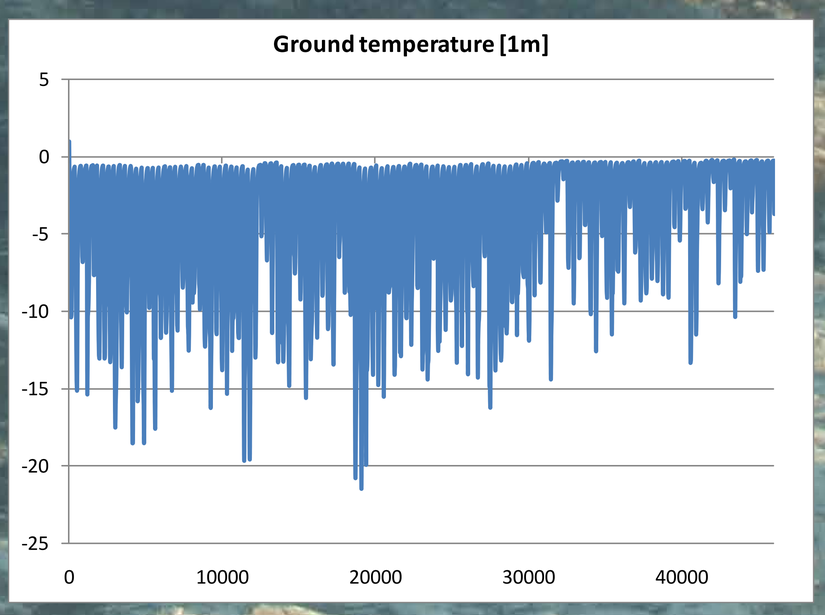


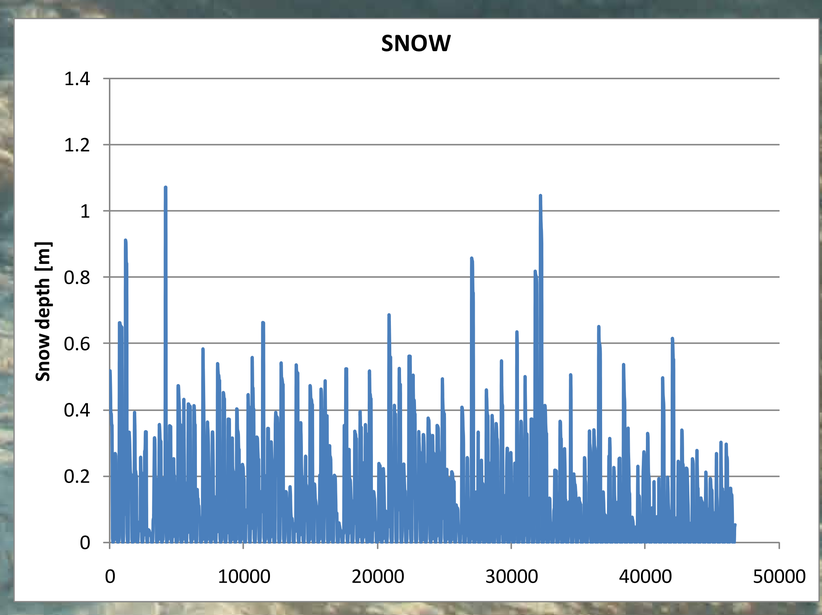
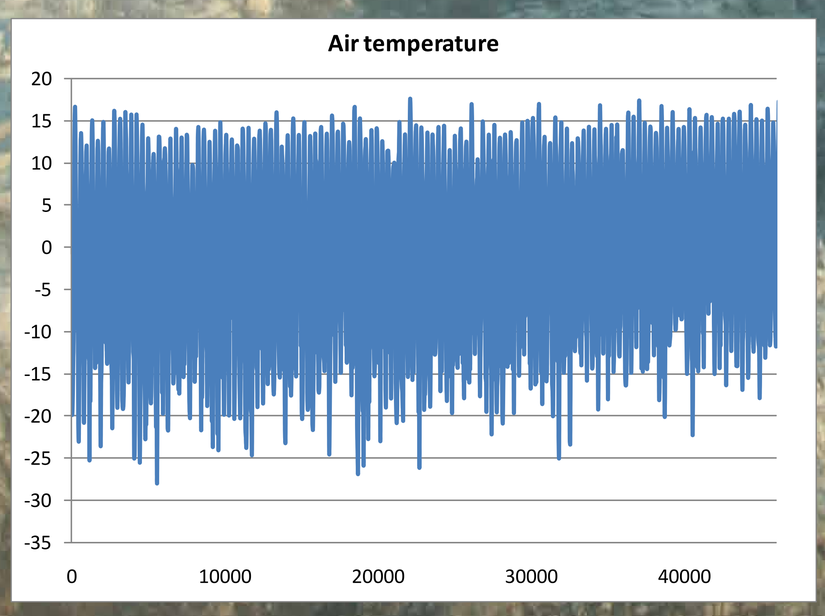
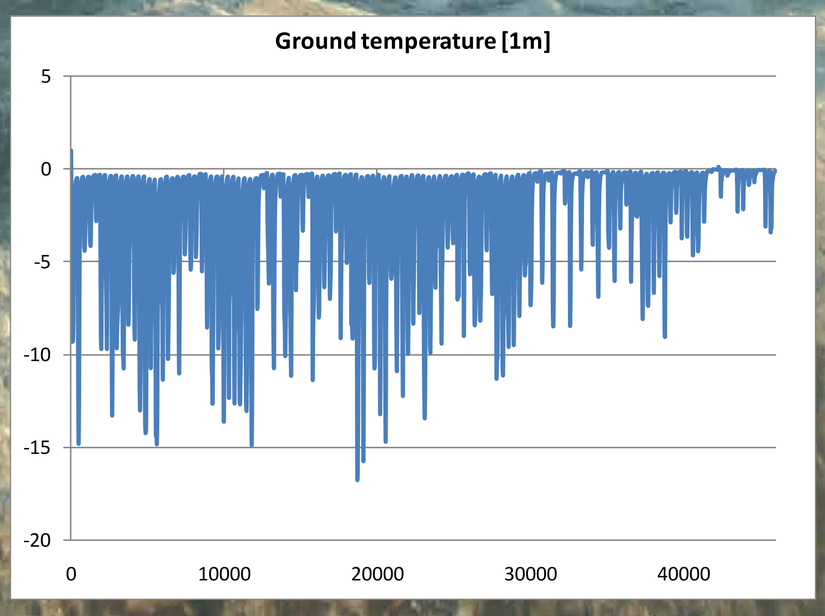
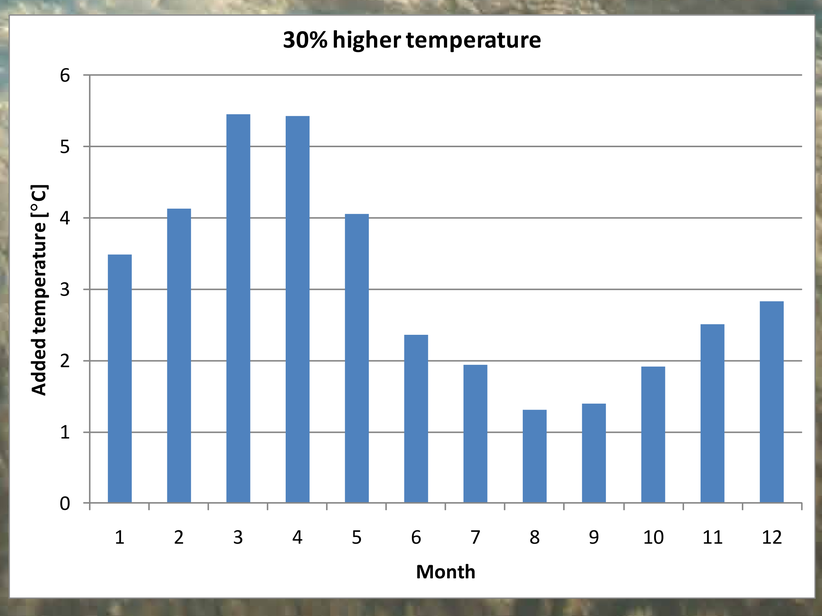




30% more snow







30% warmer