Observed Evidence of Permafrost Degradation and its Impact on Hydrological Cycle in Siberia

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Permafrost study has received great attention worldwide in recent decades because changes in permafrost conditions have profound influence on hydrological cycle, plant growth and ecosystem productivity, carbon exchange between the atmosphere and the land surface, and engineering implications in cold regions. Soil temperatures have been measured up to 3.20 m from more than 41 hydro-meteorological stations in area underlain by permafrost across the Russian Arctic and Subarctic for the period from the mid-1950s through 2008. We found that the composite of mean annual temperature at the top of permafrost has increased by greater than 3.0°C. The thickness of the active layer has increased by about 25 cm. For the first time, we found that talik, a thawed layer between the maximum depth of seasonal freeze and the top of permafrost, might have formed at various sites over Siberia in the past few decades. Increase in permafrost temperature and active layer thickness and talik formation are clearly indicators of permafrost degradation in Siberia. Over the same period, increase in air temperature is about 1.0°C over the study area. Thus, changes in air temperature alone cannot account for the increase in permafrost temperatures in Siberia, which is consistent with results obtained from North American Arctic. Increase in winter air temperature and changes in snow cover conditions may be responsible for permafrost temperature increase, while increase in active layer thickness may be mainly controlled by increase in summer air temperature. Talik formation is a complicated process, changes in air temperature and precipitation, especially snowfall, may account for a deeper thaw in summer and a shallow freeze in winter, resulting in taliks over the study area. Changes in permafrost conditions will have dramatic impacts on hydrologic and carbon cycles in the Arctic and Subarctic. We will further discuss the hydrological impacts due to changes in permafrost conditions across the Russian Arctic and Subarctic.