SPATIAL DISTRIBUTION OF ACTIVE LAYER ON A HILLSLOPE IN SIBERIAN TUNDRA

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Abstract Spatial distribution of active layer thickness (thaw depth) influences on the hydrological processes. We have observed the active layer thickness on a 100 m x 100 m hillslope grid set in tundra region related to the elevation of ground surface and the vegetation cover during the summer of 1998. From the variogram analysis, it was found that there were the anisotropy and the periodicity in the active layer thickness between horizontal and perpendicular direction to the slope. In the present paper, we will discuss that the anisotropy and the periodicity may come from tundra polygon and solifraction that are generally observed in the tundra region.

Introduction The active layer, i.e., the annually freezing and thawing upper ground in permafrost areas, is of hydrological importance as a sensor for global warming. From the observation of plain grid in Siberian tundra last year, we found that the active layer thickness (thaw depth) varied spatially mainly due to vegetation cover(1998). The observation suggests that permafrost table hard to permeable can be bumpy and give a profound affect on the circulation of soil water and total hydrological process in tundra region. Thus we observed this year the spatial distribution of active layer thickness , elevation and vegetation in a hillslope grid set as well as a plain grid set.

Field site and Methods Field observation was carried out during the summer of 1998, August 10 to 29 within the framework of a GAME (GEWEX Asia Monsoon Experiment) project in the tundra watershed. A 100 m x 100 m grid set with 10 m interval was chosen in a hillslope about 2 km north-northwest of a CALM (Circumpolar Active Layer Monitoring) grid set that was observed last year. The hillslope faces to southeast with the gradient of about 15 degree. We measured the spatial distributions of active layer thickness, elevation and vegetation at the each grid point with 10 m interval for the 100 m x 100 m grid set and also at the each point with 1 m for a 10 m x 10 m grid set which was nested within the 100 m x 100 m grid. In addition, active layer thickness and elevation were measured at the interval of 25 cm on two 50-m lines which were a steepest slope direction (y-direction) and the perpendicular direction to the y-direction (x-direction).

Elevations of ground surface and frozen table

Figure 1 shows the elevations of ground surface and frozen table in the 100 m x 100 m grid set subtracting the average gradient of the slope. The figure includes the result obtained by detail survey for two eroded gulleys in the grid set. This figure indicates that the elevation of frozen table was bumpy reflecting the ups and downs of the ground surface. Figure 2 shows contour maps of active layer thickness and vegetation in the grid set. The field site was covered mainly by sedge and mosses.

Spatial co-relation of active layer thickness

Figure 3 shows the active layer thickness and the elevations of ground surface and frozen table on a 50-m line of x-direction. Although both the ground surface and the frozen table had a slight inclination of about 1/50 to the x-direction, the active layer thickness, which is defined as the difference between the ground surface and the frozen table, fluctuated periodically. Figure 4 shows the semivariograms for the active layer thickness set on the two 50-m lines of x- and y-directions to analyze the periodicity. The semivarience of the x-direction had local minimums with the periodicity of 7 m. Although the active layer thickness are mainly dependent on the vegetation and the thermal properties of soil, the periodicity of the semivarience for the x-direction may be attributed to tundra polygons which are characteristic of geographical feature in the tundra region. On the other hand, the periodicity of the semivariences was not detected for the y-direction. The reason why the periodicity diminished in the y-direction can be explained in terms of movement of subsurface soil so-called solifraction.

Development of water tracks in hillslope

Numerous downslpoe water tracks run in the hillslope as shown in Photo. 1. The water tracks meander through the ice wedges formed with an angle around the tundra polygon and some of the water tracks develop into gulleys. This morphological characteristic of the water tracks suggests that two hydrological processes are important in the tundra hillslope hydrology: soil water movement from the active layer to the ice wedges around the tundra polygon and development of the water track from ice wedge to gulley. For understanding such processes, we need to get more information on the thawing rate, the thermal erosion and the collapse of hillslope frozen soil.

Conclusion Ground surface elevation, active layer thickness and vegetation were investigated in a 100 m x 100 m hillslope grid set in tundra during the summer of 1998. It was found from the investigation that there existed the anisotropy and the periodicity of the active layer thickness. The characteristics may come from tundra polygon and solifraction that are generally observed in tundra region.

References

1) Masaru Mizoguchi, et. al: Spatial variation of active layer thickness in Siberian tundra, Activity Report of GAME-Siberia, 1996-1997, p.54, Japan sub-Committee for GAME-Siberia. GAME Publication No. 10(1997)

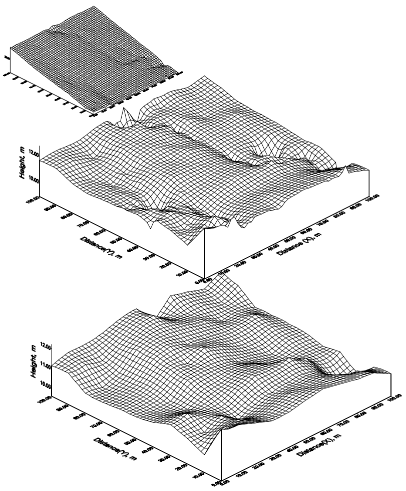
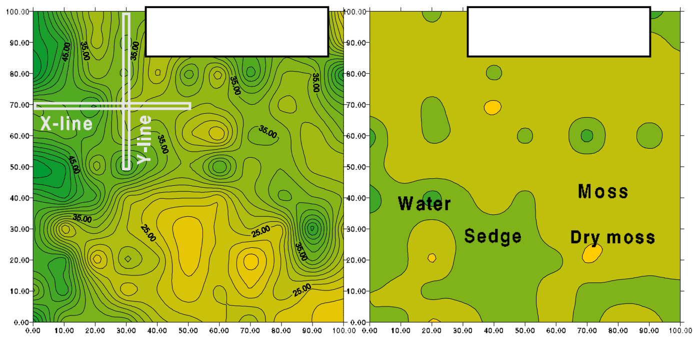


Fig.1 Elvations of ground surface and frozen table



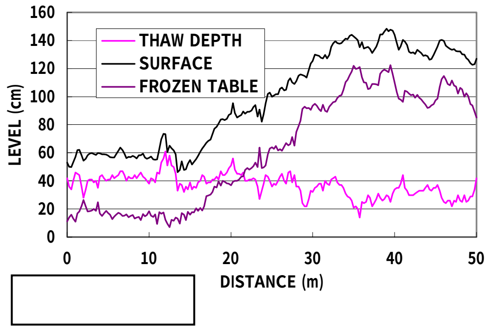


Photo.1 Numerous downslpoe water tracks in the hillslope