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Interannual changes in snow cover and its impact on ground surface temperatures in Livingston Island (Antarctica)

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In permafrost areas the seasonal snow cover is an important factor on the ground thermal regime. Snow depth and timing are important in ground insulation from the atmosphere, creating different snow patterns and resulting in spatially variable ground temperatures. The aim of this work is to characterize the interactions between ground thermal regimes and snow cover and the influence on permafrost spatial distribution.
The study area is the ice-free terrains of northwestern Hurd Peninsula in the vicinity of the Spanish Antarctic Station "Juan Carlos I" and Bulgarian Antarctic Station "St. Kliment Ohridski". Air and ground temperatures and snow thickness data where analysed from 4 sites along an altitudinal transect in Hurd Peninsula from 2007 to 2012: Nuevo Incinerador (25 m asl), Collado Ramos (110 m), Ohridski (140 m) and Reina Sofia Peak (275 m).
The data covers 6 cold seasons showing different conditions: i) very cold with thin snow cover; ii) cold with a gradual increase of snow cover; iii) warm with thick snow cover. The data shows three types of periods regarding the ground surface thermal regime and the thickness of snow cover: a) thin snow cover and short-term fluctuation of ground temperatures; b) thick snow cover and stable ground temperatures; c) very thick snow cover and ground temperatures nearly constant at 0°C.
a) Thin snow cover periods: Collado Ramos and Ohridski sites show frequent temperature variations, alternating between short-term fluctuations and stable ground temperatures. Nuevo Incinerador displays during most of the winter stable ground temperatures;
b) Cold winters with a gradual increase of the snow cover: Nuevo Incinerador, Collado Ramos and Ohridski sites show similar behavior, with a long period of stable ground temperatures;
c) Thick snow cover periods: Collado Ramos and Ohridski show long periods of stable ground, while Nuevo Incinerador shows temperatures close to 0°C since the beginning of the winter, due to early snow cover, which prevents cooling.
Reina Sofia shows a very different behavior from the other sites, with a frequent stabilization of ground temperatures during all the winters, and last until late-fall. This situation could be related to the structure, and physical and thermal properties of snow cover.
The analysis of the Freezing Degree Days (FDDs) and freezing n-factor reveals significant interannual variations. Ohridski shows the highest FDDs values followed by Reina Sofia. Nuevo Incinerador showed the lowest FDDs values. The freezing n-factor shows highest values at Ohridski, followed by Collado Ramos and Reina Sofia with very similar values. Nuevo Incinerador shows the lowest n-factor values.
Snow cover doesn't insulate the ground from freezing, but depending on its thickness, density and the amount of heat in the ground, it decreases ground temperatures amplitudes and increases delays relative to air temperature changes. Even where snow cover remains several centimeters thick for several months, slow decrease of bottom temperature is possible, reaching a minimum value at the end of the winter. The results demonstrate that Reina Sofia and Ohridski sites, because of the seasonal behavior, FDDs and freezing n-factor, demonstrate higher winter ground cooling.

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