Geophysical Research Abstracts
Vol. 17, EGU2015-7740-1, 2015
EGU General Assembly 2015

Active layer thermal monitoring of a Dry Valley of the Ellsworth Mountains, Continental Antarctica

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The Ellsworth Mountains occur along the southern edge of the Ronne-Filchner Ice Shelf and are subdivided by the Minnesota Glacier into the Heritage Range to the east and the Sentinel Range to the West. The climate of the Ellsworth Mountains is strongly controlled by proximity to the Ronne-Filchner Ice Shelf and elevation. The mean annual air temperature at the 1,000 m level is estimated to be -25ºC, and the average annual accumulation of water-equivalent precipitation likely ranges from 150 to 175 mm yr-1 (Weyant, 1966). The entire area is underlain by continuous permafrost of unknown thickness. Based on data collected from 22 pits, 41% of the sites contained dry permafrost below 70 cm, 27% had ice-cemented permafrost within 70 cm of the surface, 27% had bedrock within 70 cm, and 5% contained an ice-core (Bockheim, unpublished; Schaefer et al., 2015). Dry-frozen permafrost, which may be unique to Antarctica, appears to form from sublimation of moisture in ice-cemented permafrost over time. Active-layer depths in drift sheets of the Ellsworth Mountains range from 15 to 50 cm (Bockheim, unpublished); our understanding of Antarctic permafrost is poor, especially at the continent. The active layer monitoring sites were installed at Edson Hills, Ellsworth_Mountains, in the summer of 2012, and consist of thermistors (accuracy ± 0.2 ºC) installed at 1 m above ground for air temperature measurements at two soil profiles on quartzite drift deposits, arranged in a vertical array (Lithic Haplorthel 886 m asl, 5 cm, 10 cm, 30 cm and Lithic Anyorthel 850 m asl, 5 cm, 10 cm, 30 cm). All probes were connected to a Campbell Scientific CR 1000 data logger recording data at hourly intervals from January 2nd 2012 until December 29th 2013. We calculated the thawing days (TD), freezing days (FD); isothermal days (ID), freeze thaw days (FTD), thawing degree days (TDD) and freezing degree days (FDD); all according to Guglielmin et al. (2008). Temperature at 5 cm reaches a maximum daily average in late December 2012, reaching a minimum in mid July 2013 on P1 (10.9 ºC, -37.9 ºC, ± 11.1) and P2 (6.9 ºC, -37.1 ºC, ± 10.2). The active layer thickness reaches a maximum of 48.4 cm at P1 on January 17th 2013 and 47.8 cm at P2 on January 7th 2012. No ID were recorded for the studied period, one TD was recorded at 5 cm on P2, 143 FTD were recorded at 5 cm, 81 at 10 cm and 46 days at 30 cm on P1, on P2 118 FTD were recorded at 5 cm, 80 at 10 cm and 42 days at 30 cm. The majority of the days were classified as FD for both sites; 585 at 5 cm, 647 at 10 cm and 684 days at 30 cm on P1, on P2 611 FD were recorded at 5 cm, 650 at 10 cm and 688 days at 30 cm. Only 17 FTD were recorded for the air temperature and 713 FD. Over the 728 days of the studied period the sum of all positive daily average temperatures was 166.3 TDD at 5 cm and 23.8 TDD at 10 cm on P1, 45.0 TDD at 5 cm and 5.2 TDD at 10 cm on P2. No positive daily average was recorded at 30 cm for both sites. The sum of all negative daily average temperatures was -13504.5 FDD at 5 cm, -13389.9 FDD at 10 cm and -13381.0 FDD at 30 cm on P1, -13508.0 FDD at 5 cm, -13486.6 FDD at 10 cm and -13398.9 FDD at 30 cm on P2. Only 0.28 TDD were summed for the air temperature and -14430.7 FDD. The soil thermal regime at the dry valley of Edson Hill, Ellsworth Mountains is characteristic of polar desert affected by Dry-frozen permafrost. Although air temperature does not reach high positive values, variations in soil temperature are more intense during the year, showing the soil's response to solar radiation.