Geophysical Research Abstracts
Vol. 17, EGU2015-7851, 2015
EGU General Assembly 2015

Reconstructions of Late Holocene Climate Using Ice-entombed Mosses and Sub-fossil Peat on the Western Antarctic Peninsula

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The western Antarctic Peninsula (WAP) is one of three regions on Earth that have experienced the greatest warming over recent decades. Here we used paleo records from fossil mosses and peats on the WAP to explore a new paleoclimate archive that links climate, cryosphere and ecosystem dynamics for reconstructing climate change in recent millennia. Continuing retreat of ice and permanent snow has recently exposed numerous entombed mosses and intact peatbank ecosystems along the WAP around 65°S latitude that have been buried under ice and snow during the cold "Little Ice Age" (LIA). Radiocarbon dating indicates ages of 850-600 cal yr BP from re-exposed moss samples from retreating ice and of 100 cal yr BP from near shrinking snow. This age difference suggests that initial climate cooling and subsequent ice advance overran peatbanks immediately below the ice margin at the onset of the LIA, followed by permanent snow expansion often from low elevation upslope at the end of the LIA. Furthermore, detailed macrofossil and pollen analysis of a peat core from a moss peatbank on nearby mainland Antarctic Peninsula show dramatic shifts from a waterlogged peatland dominated by pure stands of Antarctic hairgrass (Deschampsia antarctica) before the LIA at 2400-600 cal yr BP to an aerobic peatbank dominated by erect mosses Polytrichum strictum and Chorisodontium aciphyllum in the last 50 years. At present the nearest known occurrence of Deschampsia "bog peats" is in South Georgia, about 1900 km north at 54°S, a location having a mean annual temperature 6°C higher than the study region on the WAP. If we use this modern spatial relationship as an analogue, then this suggests that the climate a few centuries ago was much warmer (up to 6°C) than today and supported very different ecosystems on the WAP. Our results show that these re-exposed sub-fossil mosses and peats are potentially very useful for the reconstructions of coastal low-elevation terrestrial climates. These records will not only complement climate histories as we know mostly from marine and ice core records but also provide more relevant environmental settings for understanding animal and ecosystem dynamics on the WAP.