ARESSA THEME III: Biodiversity: Responses to Earth System Variability

Plot- and slope-scale topographic and vegetation control on ground temperature spatial variability: synoptic-scale observations from Marion Island

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Marion Island is centrally located in the global belt of diurnal soil frost environments. It's maritime location results in a high frequency of diurnal frost cycles that cause globally- unequalled rates of sediment displacement. Landscape-scale understanding of soil frost dynamics on Marion Island and its interactions with terrestrial ecosystems, requires an understanding of spatial and temporal patterns of the environmental controls driving and constraining soil frost action. As frost cycles occur at the synoptic time-scale this is the temporal scale at which analysis should be focused. At the spatial scale, local topography and vegetation plays an important control on the radiation budget and other micro-climatic parameters. In this study, measurement results are presented of i) slope aspect control on soil temperature at the block- to slope scale, ii) diurnal spatial variability of soil surface temperature and moisture within a 18x10m plot, iii) micro-climate variations, both upwind-downwind and upslope-downslope, from *Azorella selago* cushions. Results from all three situations clearly establishes that cloud cover and air circulation type plays a dominant role in explaining ground climate spatial variability. Westerly air circulation results in mild and uniform temperatures across the landscape. In contrast, clear sky conditions associated with southerly air circulation creates a large temperature differentiation in the landscape, based primarily on topographic control of the radiation budget. Complex interactions between soil climate parameters and atmosphere are found around *Azorella selago*. A reduction in cloud cover, as suggested by Smith (2002)[1], is predicted to increase diurnal soil temperature and moisture extremes and their spatial variability across Marion Island and will increase the role of slope aspect as a control on soil frost cycle frequency and intensity. Enhanced nocturnal radiative heat loss will also (partially) offset, or even reverse, atmospheric warming effects on ground frost on cooler slopes. This can lead to a higher spatial variability in soil movement rates and indirectly, increased patchiness in vegetation patterns. Longer term ground temperature monitoring at an island scale is underway to further test this hypothesis. A synoptic climate classification is also being developed to understand decadal changes in dominant air circulation patterns at the island.

1. Smith, V. Climate change in the sub-Antarctic: An illustration from Marion Island. *Climate Change* **52**, 345-357 (2002).