Air and Soil Temperature Variability in Northern Alaska

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INTRODUCTION

The Circumpolar Active Layer Monitoring (CALM) Project has been monitoring permafrost (perennially frozen ground) and its overlaying active layer (which freezes and thaws annually) throughout northern Alaska's Kuparuk River watershed and various polar regions since the mid-1990's to detect long-term responses to our changing climate. The soil-surface temperature data is collected by thermists that were positioned immediately below the surface of the ground at nine locations within a transect of 1-ha plots arranged from north to south across the region. Locations within each plot were individually selected to represent a full range of microsite conditions, with distinctions in vegetation, moisture, and microtopography. Three different datalogger models from Onset Computer Corporation® were deployed in pairs over 1-year durations from 2005-2006 and 2011-2012. Analyzing the systematic variations due to vegetation, air temperature, and moisture is necessary to quantify the reliability and consistency of the Flux Study Site database.

STUDY AREA

Alaska’s Kuparuk River flows northward from the Brooks Range. The Kuparuk River watershed spans several distinct bioclimatic zones with soil/vegetation associations ranging from moist acidic to non-acidic tundra. The Flux Study sites were chosen to represent a range of soil-surface conditions from many micro-topographic sites.

METHODOLOGY

At each 1-ha plot, a series of dataloggers manufactured by Onset Computer Corporation® were installed which measure and record 9 soil-surface and one air temperature. The thermists were installed immediately below the surface of the ground at each site, which were each selected to represent the full range of microsite conditions within each plot. Data are recorded at 2-hour intervals and stored for download each August. In 2005 and 2011 the team replaced older instrumentation with newer models which ran side-by-side for 1 year. Comparing the temperatures records from these different instrumentation models (Stowaway, Hobo Pro, and V2, from oldest to newest) allows us to quantify the variability within the dataset.

RESULTS

Statistical comparisons between the 2005-2006 Stowaway/Hobo Pro and the 2011-2012 Hobo Pro/V2 bi-hourly temperature differences yielded several results:

- Mean differences over the period of record were low (+/−0.5°C).
- Temporal variability in the differences are systematically related to seasonal cycles, with the largest differences in summer when the active layer thaws and is the most dynamic.
- Spatial variability within and between the plots is revealed by systematic differences in micro-site locations with larger differences at warmer, drier sites (e.g. Figure 8 showing Flux site 3 datalogger unit 3).

CONCLUSIONS

This analysis helped quantify the reliability of a 18-year air and soil-surface temperature dataset in northern Alaska. These plots were established to monitor the active layer of permafrost, as the thickening of this layer may lead to a positive feedback of greenhouse gases into the atmosphere. These data have been used to study climatic change within the region (Streeten et al., 2008), ecosystem-level responses (Nyland et al., 2012), improve modeling efforts (Klene et al., 2001a, 2001b, 2008), and predict soil subsidence (a hazard for human infrastructure such as roads, pipelines, and nuclear power plants (USARC)).

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