Landscape Effects and Changes in Permafrost Depth in Atqasuk, Alaska

Hannah Clarida and Robert Hollister, Biology Department

Introduction

The tundra is a unique ecosystem that is highly vulnerable to the rapidly warming climate (IPCC 2013). Underneath the tundra soil is a thick layer of permafrost, and the depth from the top of the soil to the permafrost is called the thaw depth. While this thaw depth gradually deepens in the summer months as the temperature gets warmer. The International Tundra Experiment (ITEX) uses open-top chambers to simulate temperature rises, and to study the impacts of warming on arctic vegetation. Sites with open top chambers (OTC) which are used to simulate climate warming were found to have increased soil temperatures, but have little effect on thaw depth, which is interpreted to be the result of the small size of the OTC's (Hollister et al. 2006). The objective of this experiment was to interpolate the thaw depth in ArcGIS to see if any trends were visible throughout the site.

Methods

The research was established in Atqasuk, Alaska in 1996 and is located within the dry heath tundra (Fig 1A). The dry site consists of 24 control plots and 24 experimental plots which are experimentally warmed using open top chambers (OTCs) (Fig1B)(Fig 1C). Thaw depth was measured at the end of each field season at each site using a probe. The control plots were measured for thaw depths on the left and right side of the plots, and then averaged. The experimental plots were measured for thaw depth in the middle of the plot. The measurements for each plot were interpolated using the Inverse Distance Weighing (IDW) interpolation method.

Figure 1A: Location of study site in Atqasuk, Alaska. B: Putting together an OTC plot. C: Atqasuk dry site plots D: Example of attaining thaw depth measurements

Figure 2. Thaw depth of control and experimental plots over time at Atqasuk, Alaska

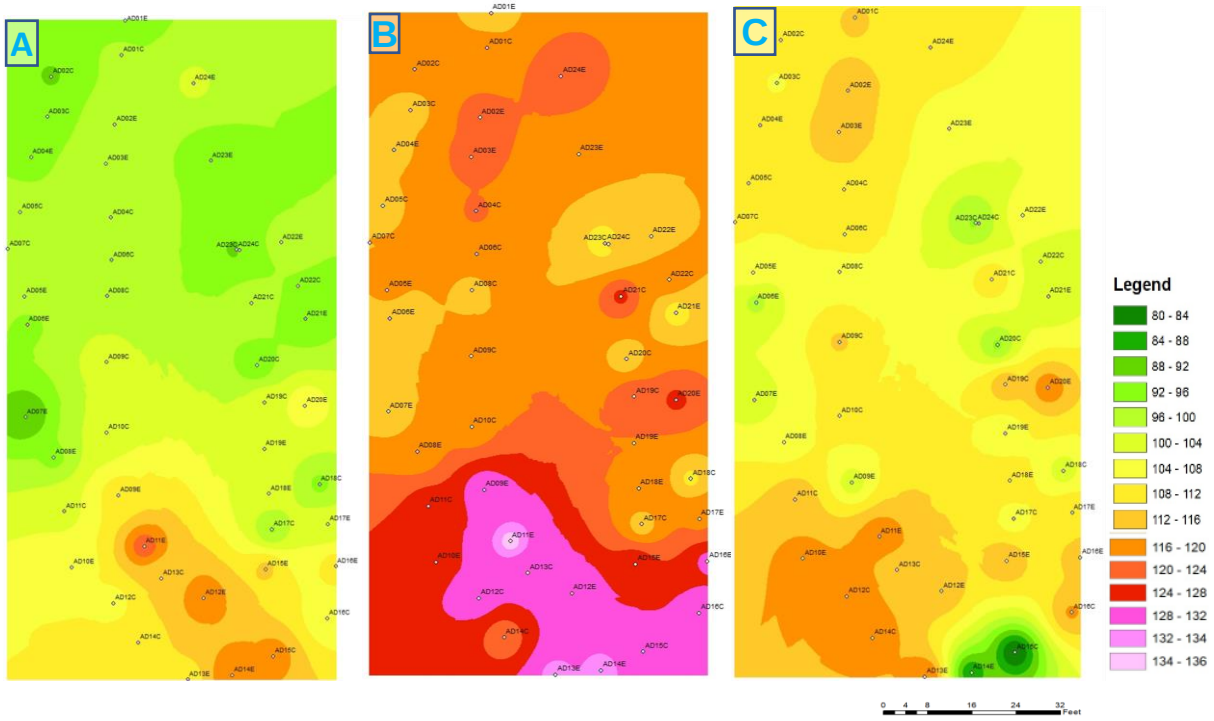

Figure 3. Spatial distribution of thaw depth in 1996 (A), 2008 (B) and 2018 (C).

Results and Discussion

The average thaw depth was 110 cm across all plots and all years. There was significant variation between years but no clear trend over time. Experimental warming had no impact on the thaw depth (Fig 2). There was significant variation between plots, but these differences were not consistent across years. These maps are able to show the variability of thaw depth over years, although we can see specifically between the 1996 (Fig 3A) and 2018 (Fig 3C) maps that while the ranges in thaw depth might be the same the site as a whole can possible be showing increase thaw depths. Across all three maps it can be seen that the southern portion of the site experiences increased thaw depth. In conclusion it is difficult to see the change in thaw depth in such a small area, but continuing to use interpolation techniques could offer helpful information to document change.

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References

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