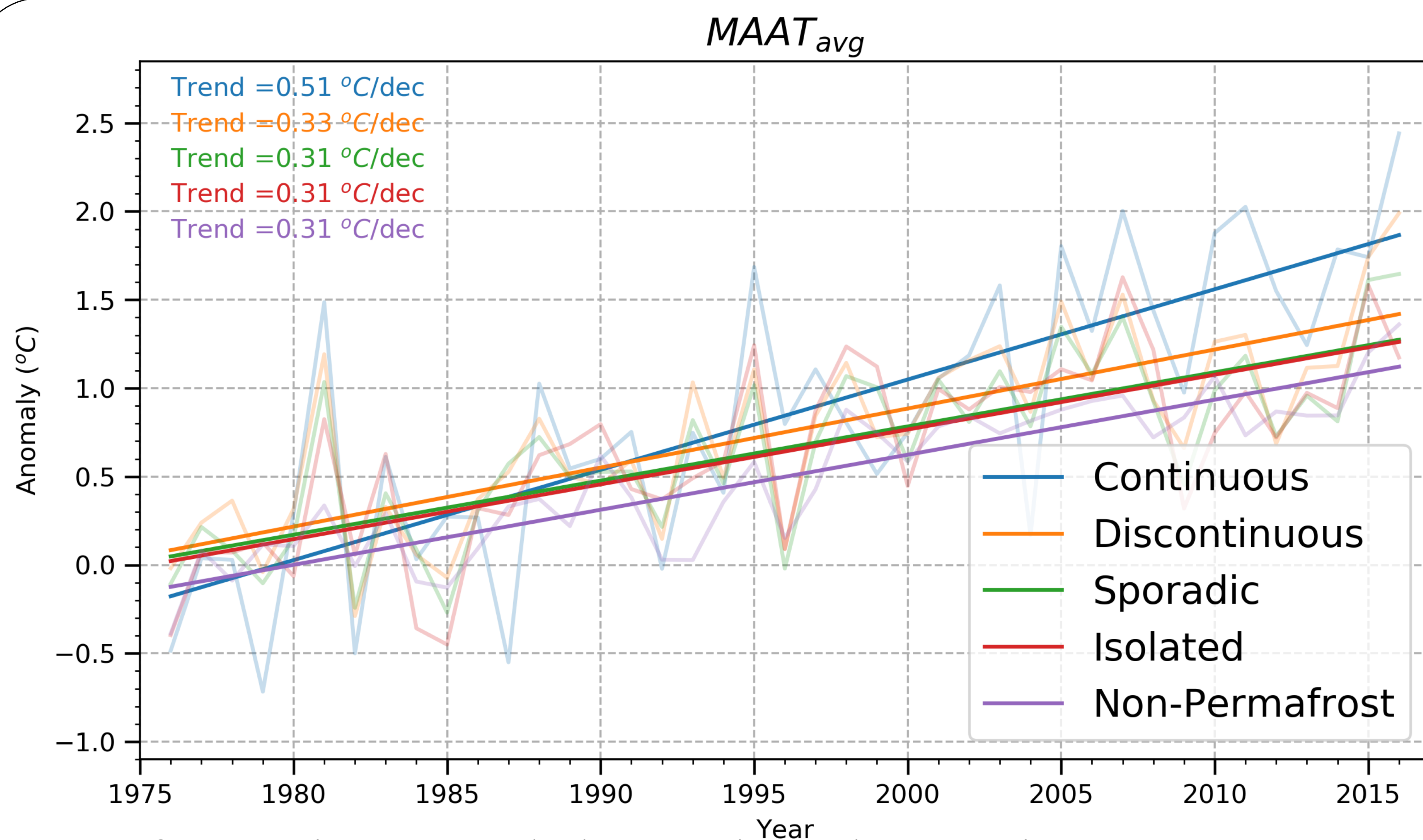


Enhanced Cold-Season Climate Warming and its Implications on Permafrost Thermal Dynamics

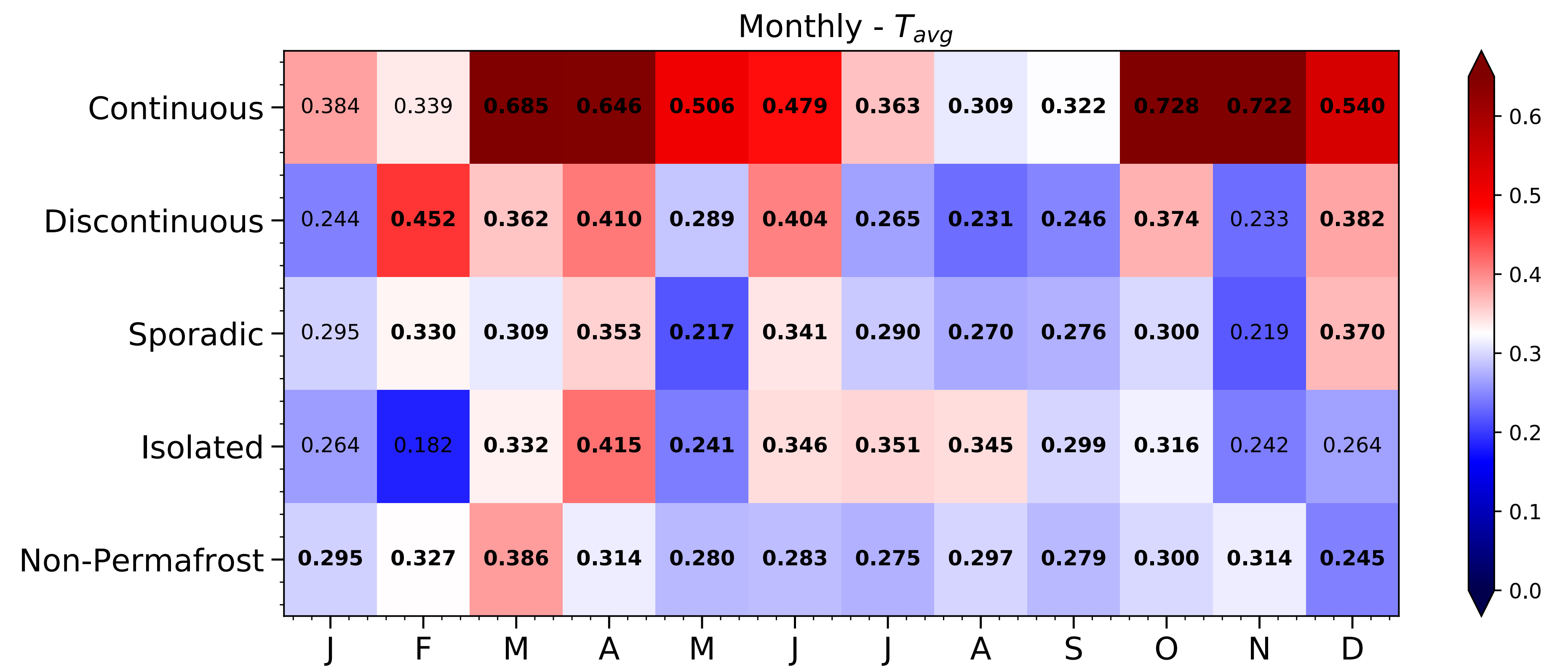
Kang Wang^{1*}, Tingjun Zhang², Irina Overeem¹

¹ Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309

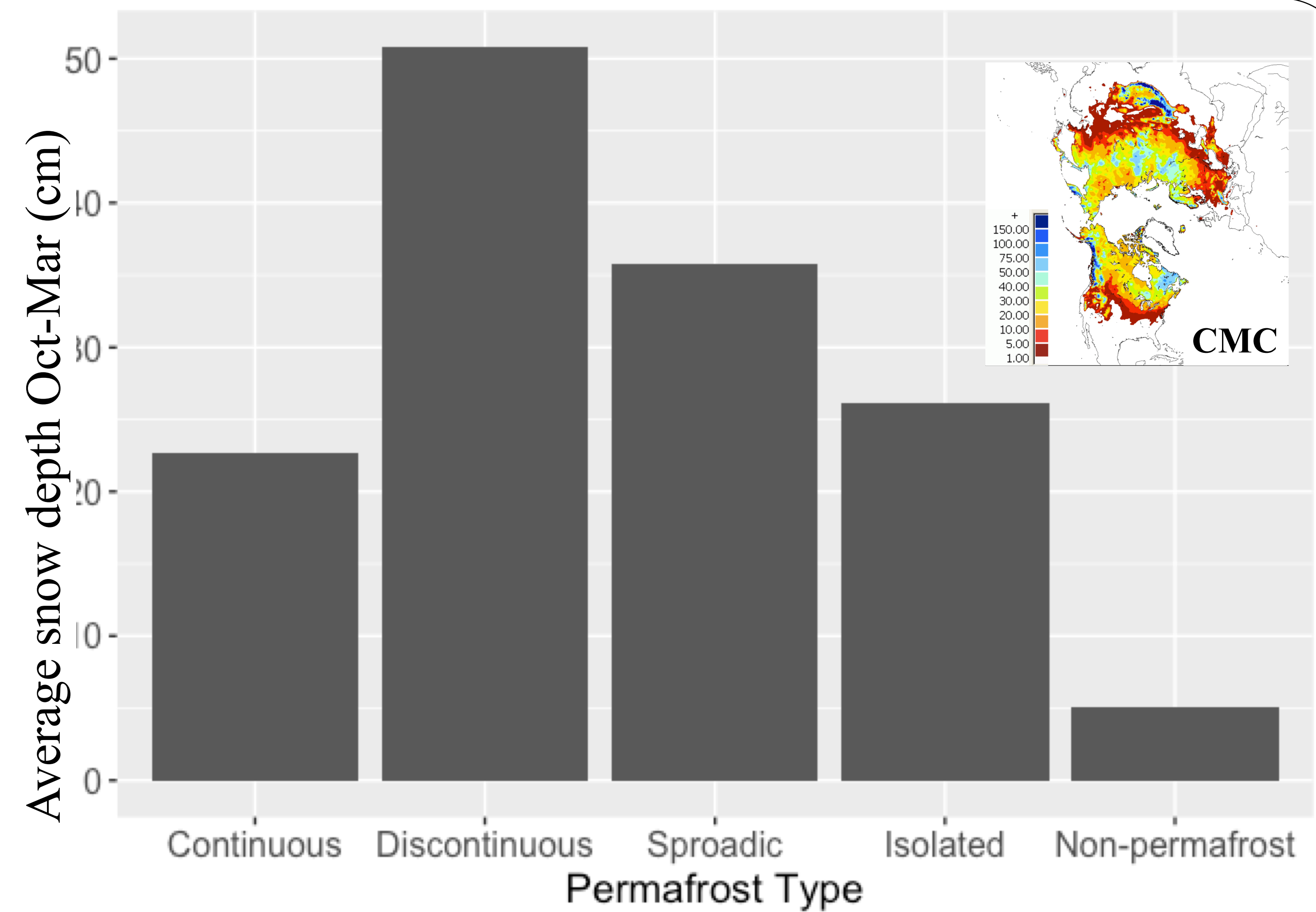
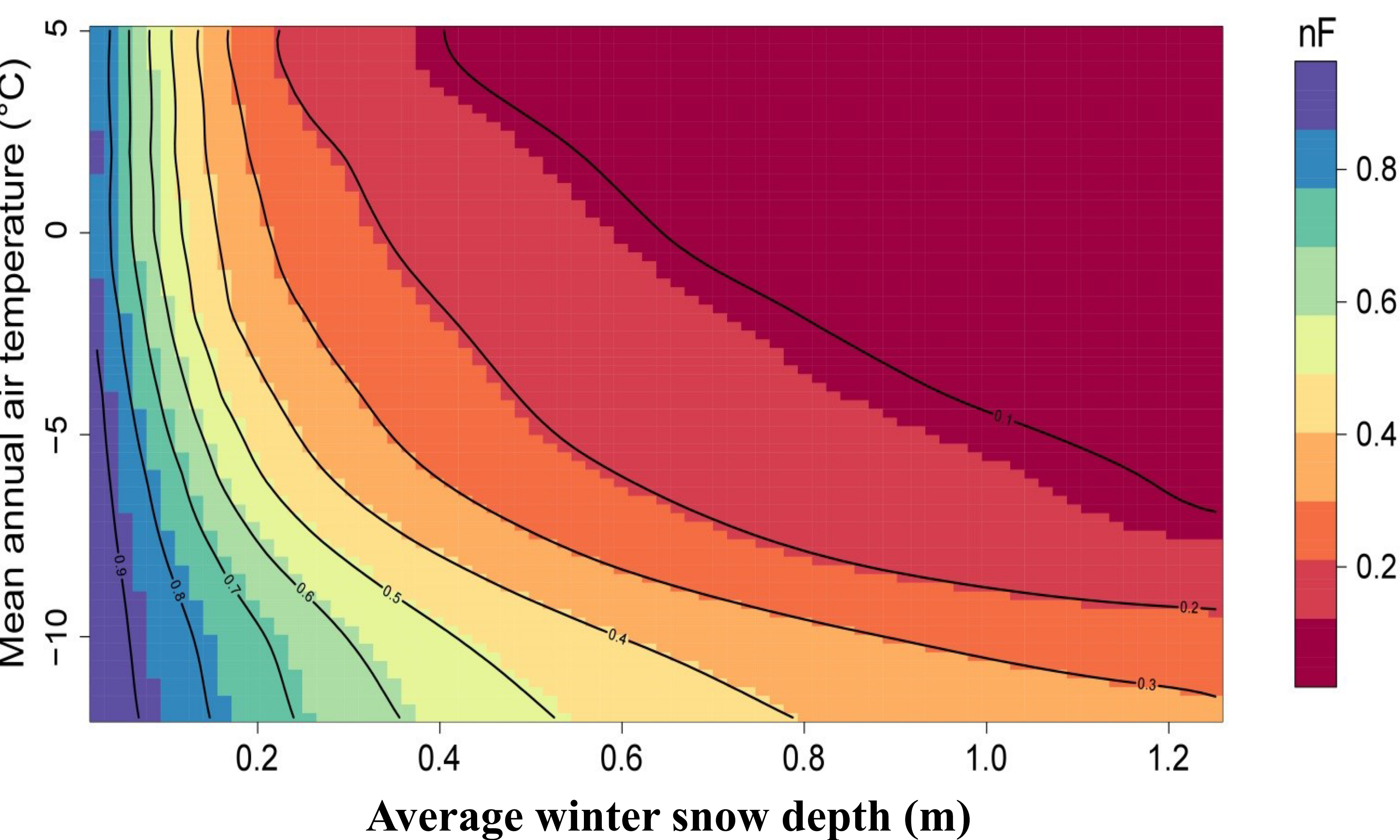
² College of Earth and Environmental Sciences, Lanzhou University, Lanzhou, China * E-mail: Kang.Wang@colorado.edu



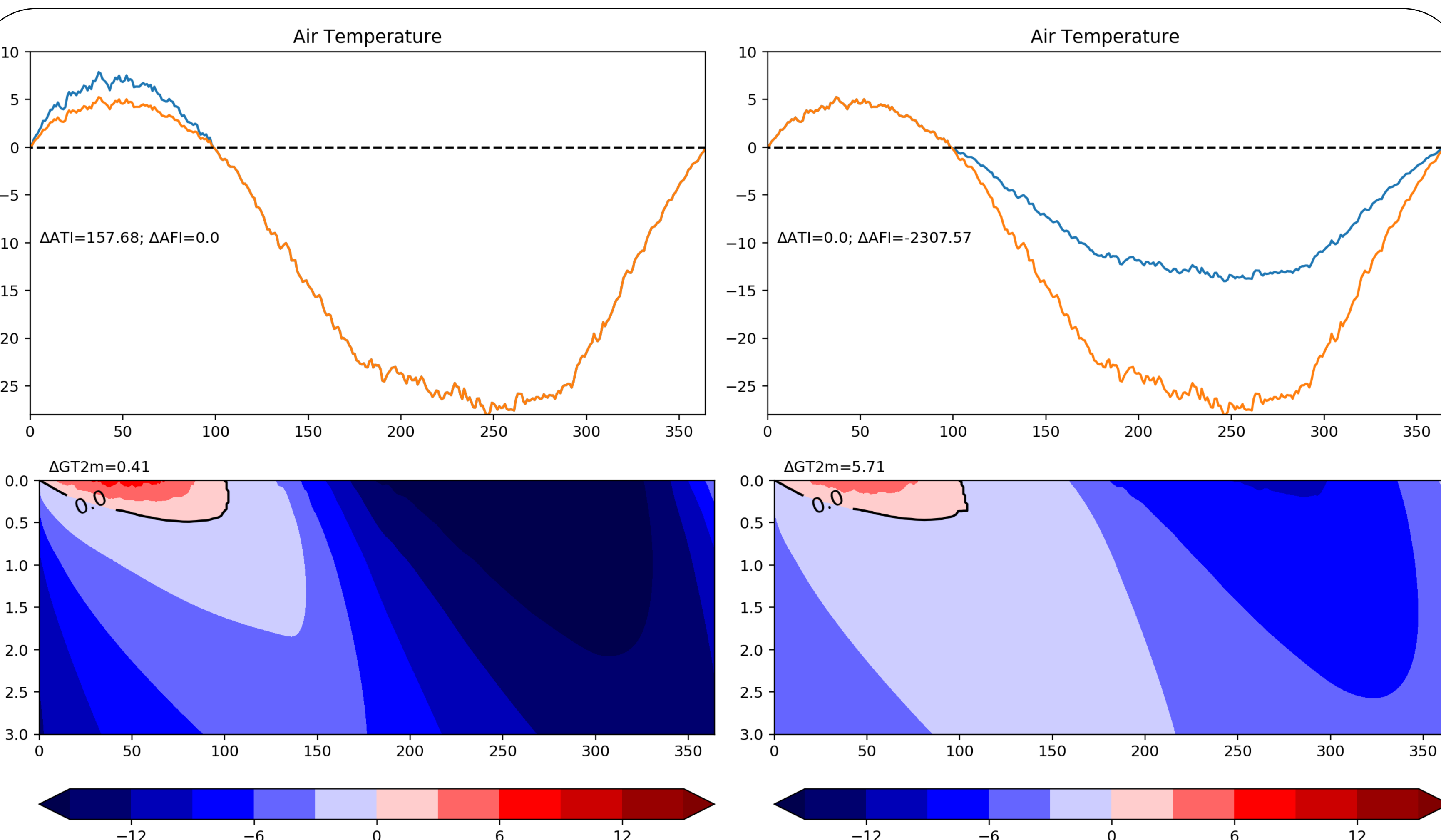
Permafrost regions as a whole experienced a warming at 0.36, 0.41, and 0.46 C/decade in mean annual maximum, mean, and minimum air temperatures, respectively, which were 16%, 32%, and 44% higher than the corresponding trend in non-permafrost regions. More importantly, strong increases occurred in cold months and nighttime over continuous permafrost zone, exceeding 0.72 C/decade in spring and autumn, while summer air temperature had a relatively small increase or no statistically significant trends.



Empirically, temperature at the top of permafrost (T_{TOP}) will be approximately : $T_{TOP} = \frac{Kt}{Kf} n_t DDT - n_f DDF$ 365



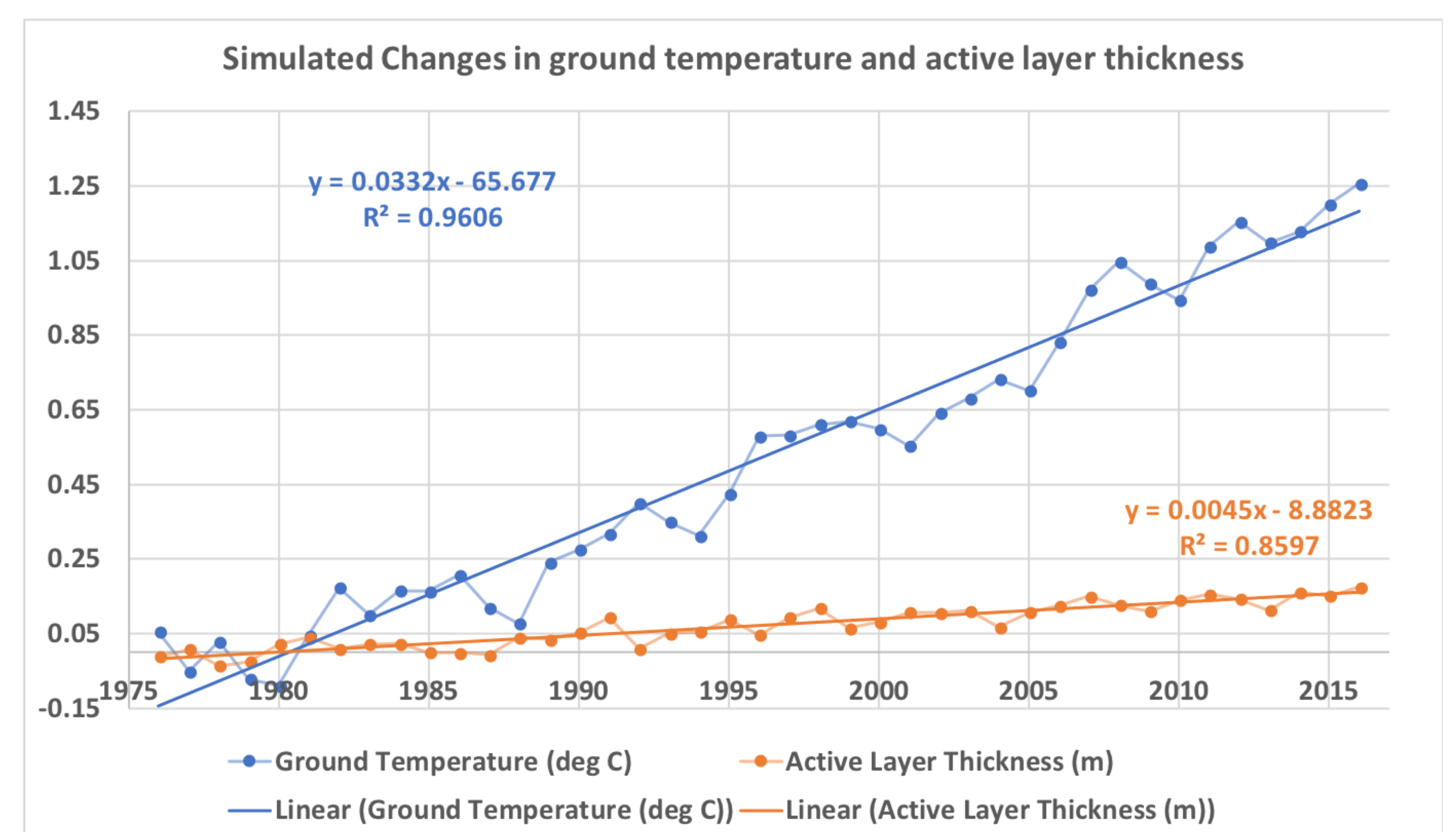
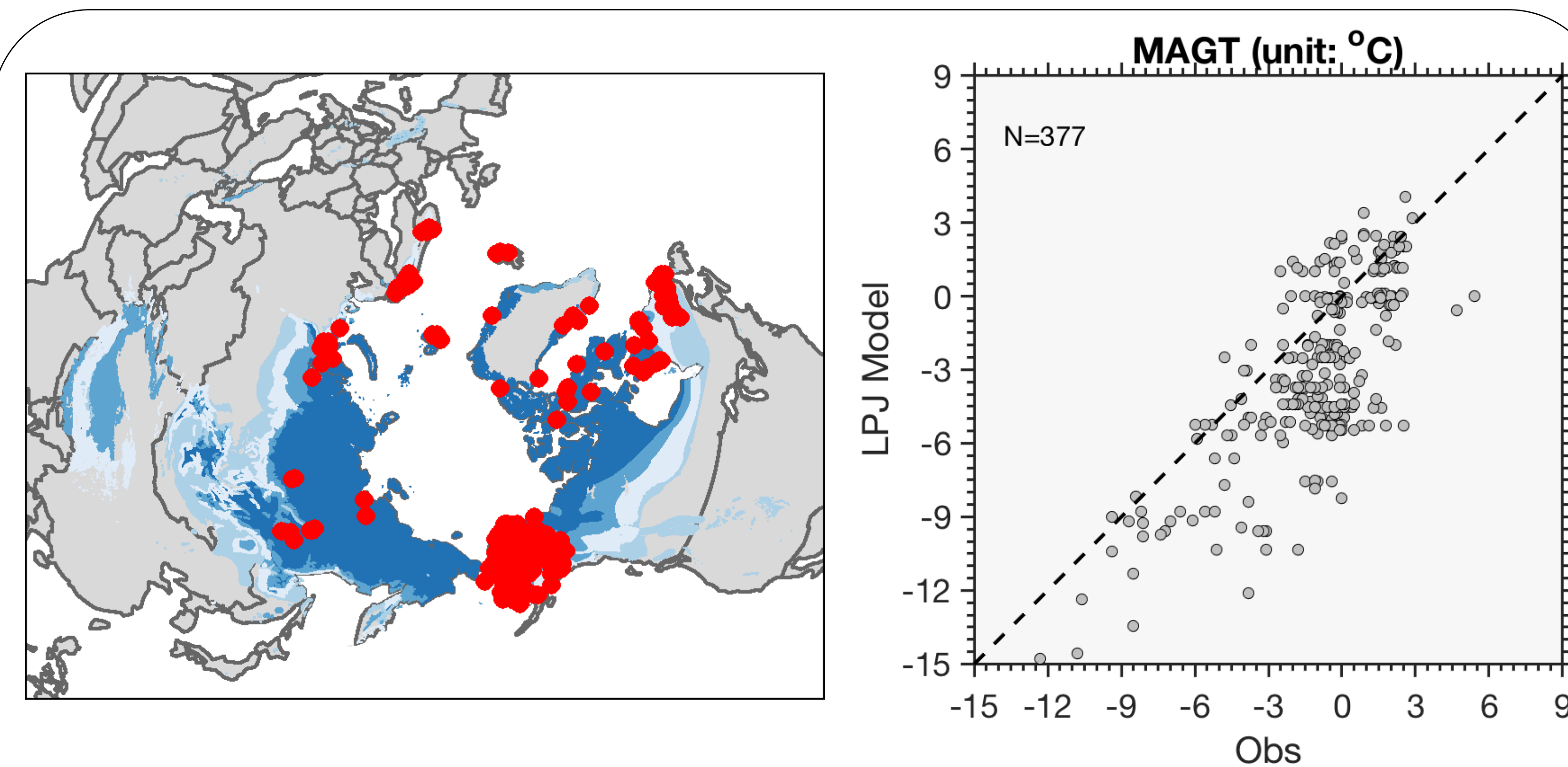
The snow effect is relatively small in colder regions with less snow (like continuous permafrost regions). CMC snow depth product shows that continuous permafrost regions have relatively thin snow cover.



GIPL 1D results at Barrow, AK showed that: (i) contribution of winter warming is significantly larger than that of summer warming, although it considers snow effects; (ii) response to summer warming is slight mainly because of the decoupling effect of active layer.

Summary

- Cold regions and permafrost regions experienced enhanced warming during the past decades, particularly in cold season over continuous permafrost zones.
- Enhanced cold season warming might be the most contribution to the rapid warming in permafrost temperature over relatively cold permafrost. Slight warming in the warm season might be one of the important reasons to explain the small changes in active layer thickness.
- Permafrost area seems not to quick decline in this century. Permafrost degradation might be not depending on deepening active layer while potential frost ability.



LPJ model results also showed a rapid changes in permafrost temperature while relatively small changes in active layer thickness over the continuous permafrost regions as a whole.