Effect of snow change on the C balance in various northern ecosystems: a synthesis based on Fluxnet data

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Snow is an important regulator of soil processes. Continuous snow cover can effectively insulate soil from the atmosphere, prevent soil freezing, and provide abundant moisture to soil biotic processes. Normally, snow cover more than 30-cm depth can successfully preserve soil heat, while shallow and temporary snow cover cannot preserve heat effectively. A decrease in snow cover depth could lead to larger daily fluctuations in soil temperature, more frequent freeze-thaw cycles, and higher root death (Decker et al., 2003). Recent research has highlighted the importance of understanding the linkage between snow cover change and winter terrestrial carbon exchange in the Northern Hemisphere. Monson et al. (2006) found that variations in winter soil respiration were very sensitive to variations in snow cover depth – a reduction in snow cover depth led to a decrease in winter soil respiration rate. In addition, the length of snow cover was also found to affect the soil respiration rate in winter. Fahnestock et al. (1998) measured soil respiration rate in winter and early spring in tundra of northern Alaska. They found that earlier and deeper snow cover helped the soil microbes free of impact by winter low temperature, which resulted in higher soil respiration rate than later and shallower snow cover.

In the past century, the snow cover in the Northern Hemisphere has decreased significantly by 10%, and the timing of snow falling and melting (snow phenology) both have changed dramatically (IPCC, 2007). However, the impacts of those changes in snow cover (depth and area), and snow phenology on winter soil CO_2 emission and carbon sink/source function of the Northern Hemisphere remain uncertain.

In this project， we intend to address the impact of changes in the amount of snow falling, snow depth and snow phenology on the winter and growing season terrestrial ecosystem respiration (TER) for different ecosystems, based on Fluxnet datasets across the Northern Hemisphere. In addition, we will also compare the sensitivity of TER (Q_{10}) to temperature under snow cover with that without snow. Based on the knowledge developed above, we could modify current ORCHIDEE model, to take into account the effect of snow change correctly across ecosystems. Due to the lack of snow information from the Fluxnet data, we will try to use satellite data and albedo change information to define the period of snow coverage and to estimate snow depth. Ideally it would be great to get direct observational data from each Fluxnet site. This study will improve our understanding of the role of snow change in the carbon sink/source function of the Northern Hemisphere.