Monitoring of soil temperature and CO_2 emission from tundra soil in Ny-Ålesund, Svalbard

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Introduction

The Arctic soil will influence how northern ecosystems respond to global warming by acting as a carbon source or sink to the atmosphere, controlling energy balance at the earth's surface and serving as a source of nutrients for plant growth (Marion et al., 1997). The study of soil CO_2 emission has been widely investigated through artificial control of the environment in the laboratory and *in situ* measurements in Norway, Alaska, Canada and Greenland. Soil temperature is one of the most important environmental factors for soil CO_2 emission. The objectives are to report the monitoring of soil temperature and soil CO_2 emission.

Materials and Method

Soil temperature was measured three depth points (0.15, 0.55 and 1.08 m) in three locations near Korean Dasan station (78° 55´ N, 11° 56´E) in Ny-Ålesund in Svalbard from 2005 to 2009 (Fig. 1, 2 & 3). Soil CO_2 emission (R_s) measurement were conducted for 16 sampling points in the plot (30 m × 30 m) for July 2007, 2008 and 2009.

Measurements of soil temperature were used 9 sensors (i.e. Diver, Eijkelkamp, Netherlands) and soil CO_2 emission was conducted using a closed-dynamic chamber system (LI-6400, LI-COR, Inc., Lincoln, Nebraska, USA) with soil temperature at 0.1 m depth and soil water content (SWC) at 0-0.1 m depth (Fig. 4 & 5).

The vegetation distribution of the plot is dominated moss (e.g. *Sanionia georgico-uncinata)* by ~70% and vascular plants (e.g. *Silene acaulis* and *Salix Polaris*). Chemical and physical soil properties were analyzed in 5 locations. C was 1.6%, N was 0.2%, total P was 605 mgkg^{-1}, bulk density was 0.77 gcm^{-3} and soil water content was 13% (Fig. 6).

Figure 1. Map of the Svalvard in Norway.

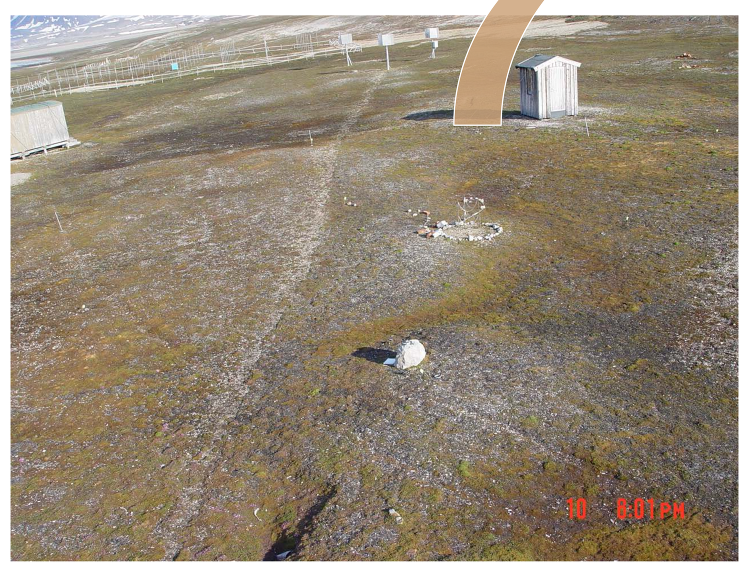

Figure 2. One of the location of soil temperature measurement near Dasan Station in Ny-Ålesund , Svalvard, Norway.

Figure 3. Location of soil temperature measurement (point #1).

Figure 4. Soil temperature sensors.

Figure 5. Chamber measurement system of soil CO_2 emission

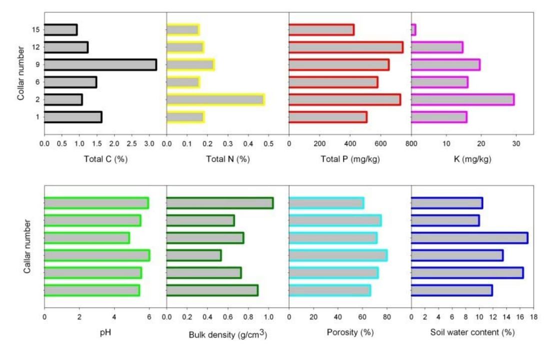

Figure 6. Soil chemical and physical properties near Dasan station.

Results and discussion

Soil temperature for three points, 0.15, 0.55 and 1.08 m ranged from -14 to 11, -15 to 6 and -10 to 3, respectively. Period of the lowest temperature was from February to early April and highest temperature was from mid July to early August. It is generally assumed that thawing is started near April. The patterns of soil temperature for study periods generally followed those of air temperature for 9 years (Fig. 7 & 8).

Spatially averaged soil CO_2 emission for 16 sampling locations ranged from 0.3 to 0.7 μmol m^{-2} s^{-1} and means of that were 0.56(±0.07) μmol m^{-2} s^{-1} (2007), 0.54(±0.13) μmol m^{-2} s^{-1} (2008), 0.51(±0.09) and 0.51(±0.09) μmol m^{-2} s^{-1} (2009) during July of each year (Fig. 9). Spatially averaged soil temperature ranged from 6 to 12 °C and soil water content ranged from 13 to 27% during measuring of soil CO_2 emission (Fig. 9). The patterns of soil CO_2 emission for study periods generally followed those of soil temperature. Q_{10} values in 2007, 2007 and 2009 were 1.7, 4.2 and 1.9, respectively (Fig. 10).

Monitoring of soil temperature is useful to evaluated thawing permafrost and resulting microbial decomposition previously frozen organic carbon.

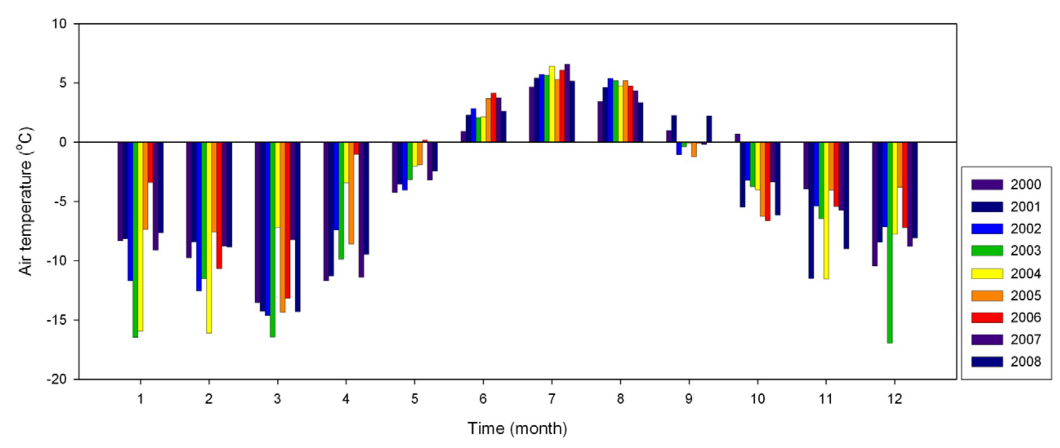

Figure 7. Monthly averaged air temperature and annual air temperature in Ny-Ålesund from 2000 to 2008 (Norwegian Meteorological Institute, http://met.no).

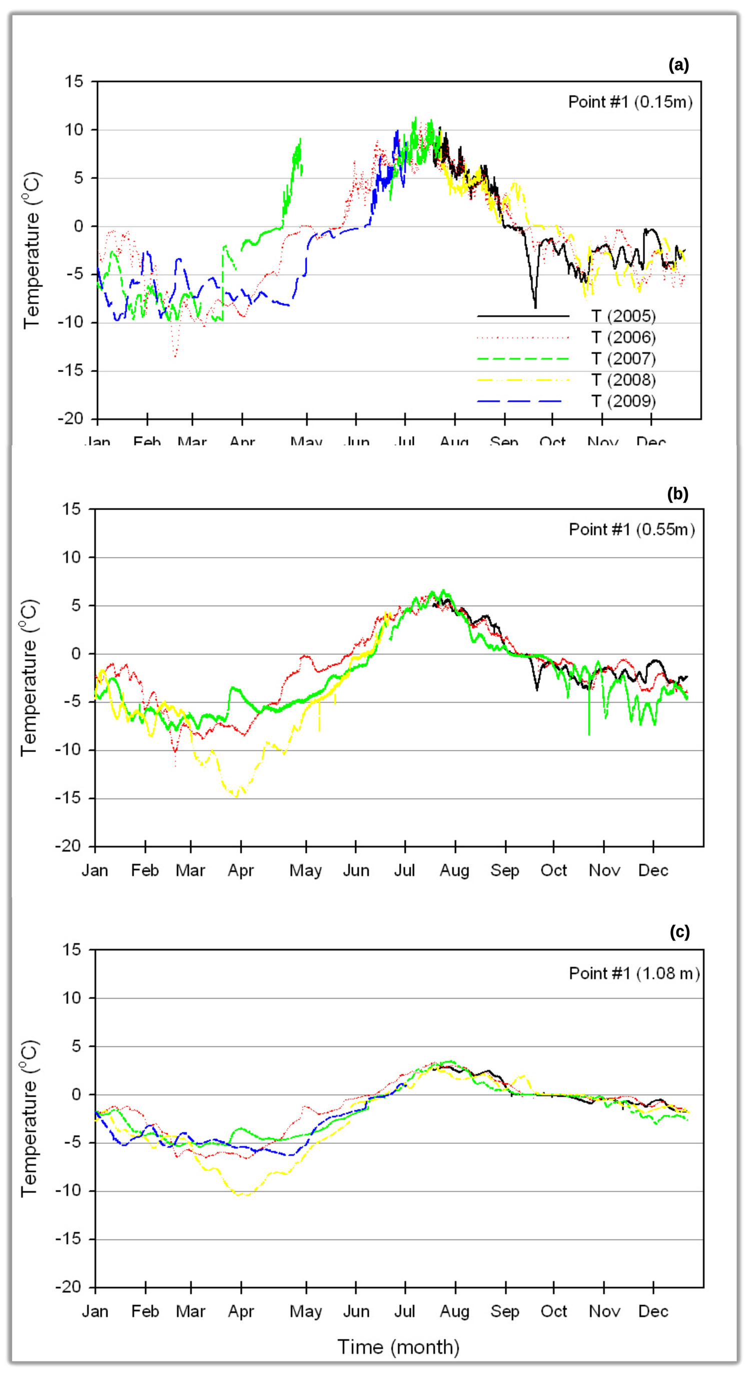

Figure 8. Soil temperature of each soil depth,(a) 0.15m, (b) 0.55m and (c) 1.08m from 2006 to 2009.

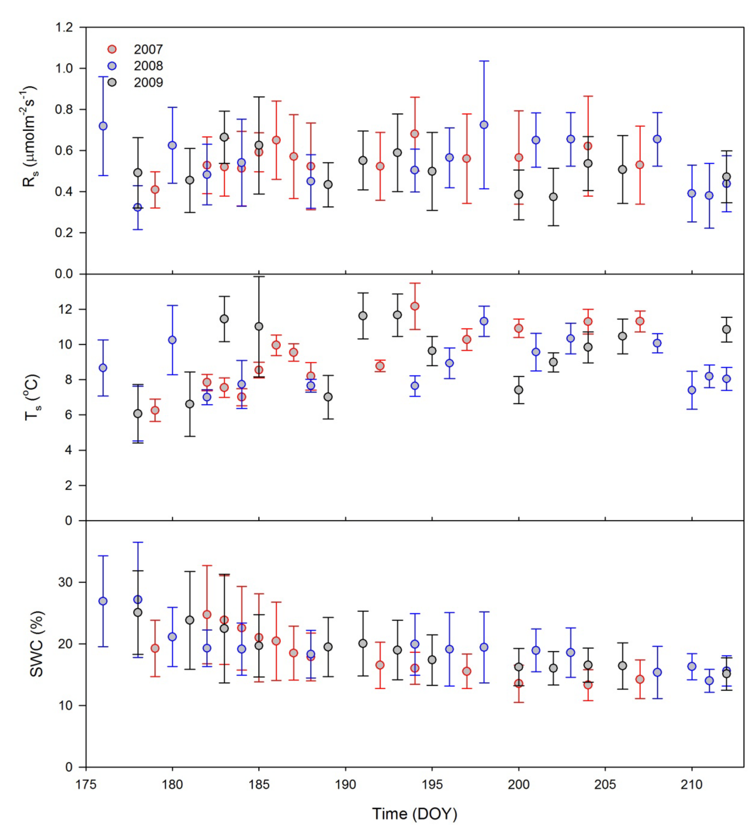

Figure 9. Temporal variation of soil CO_2 emission, soil temperature and soil water content during measurement period in 2007, 2008 and 2009.

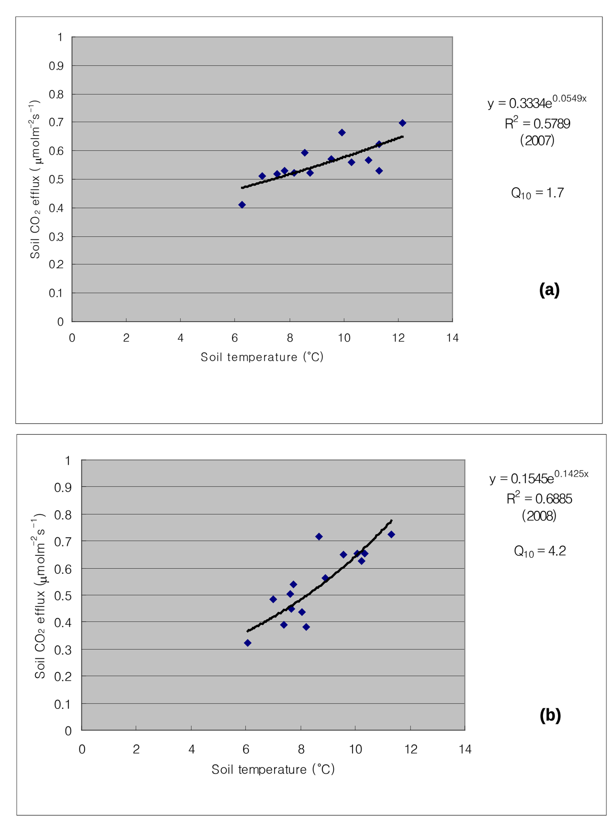

Figure 10. Q10 values during July 2007(a) and 2008(b).

Acknowledgements

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