Geophysical Research Abstracts
Vol. 15, EGU2013-7306, 2013
EGU General Assembly 2013

Interacting effects of elevated temperature and additional water on plant physiology and net ecosystem carbon fluxes in a high Arctic ecosystem

Kadmiel Maseyk (1), Ulrike Seibt (1,2), Céline Lett (1), Massimo Lupascu (3), Claudia Czimczik (3), Patrick Sullivan (4), and Jeff Welker (4)

(1) Bioemco, Université Pierre et Marie Curie, Paris, France (kadmiel.maseyk@gmail.com), (2) Dept. of Atmospheric and Oceanic Science, University of California, Los Angeles, CA, USA, (3) Dept. of Earth System Science, University of California, Irvine, CA, USA, (4) Dept. of Biological Sciences, University of Alaska, Anchorage, Alaska, USA.

Arctic ecosystems are experiencing temperature increases more strongly than the global average, and increases in precipitation are also expected amongst the climate impacts on this region in the future. These changes are expected to strongly influence plant physiology and soil biogeochemistry with subsequent implications for system carbon balance. We have investigated the effects of a long-term (10 years) increase in temperature, soil water and the combination of both on a tundra ecosystem at a field manipulation experiment in NW Greenland. Leaf gas exchange, chlorophyll fluorescence, carbon (C) and nitrogen (N) content and leaf isotopic composition, and leaf morphology were measured on Salix arctica plants in treatment and control plots in June-July 2011, and continuous measurements of net plant and soil fluxes of CO_2 and water were made using automatic chambers coupled to a trace gas laser analyzer.

Plants in the elevated temperature (T2) treatment had the highest photosynthetic capacity in terms of net CO_2 assimilation rates and photosystem II efficiencies, and lowest rates of non-photochemical energy dissipation during photosynthesis. T2 plants also had the highest leaf N content, specific leaf area (SLA) and saturation light level of photosynthesis. It appears that warming increases soil N availability, which the plants direct towards increasing photosynthetic capacity and producing larger thinner leaves. On the other hand, the plants in the plots with both elevated temperatures and additional water (T2W) had the lowest photosystem II efficiencies and the highest rates of non-photochemical energy dissipation, due more to higher levels of constitutive energy dissipation than regulated thermal quenching. Watering, both in combination with higher temperatures and alone (W treatment), also reduced leaf SLA and leaf N relative to control plots. However, net photosynthetic rates remained similar to control plants, due in part to higher stomatal conductance (W) and lower dark respiration rates (T2W). However, net ecosystem fluxes were highest in the T2W plots due to 35% increase in leaf area. Total growing season C accumulation was 3-5 times greater, water fluxes were 1.5-2 times higher, and water use efficiency was about 3 times higher in the combined treatment than the control. Net carbon and water fluxes in the elevated temperature plots were similar to the control plots, possibly indicating that enhanced soil respiration may balance increased photosynthetic uptake. The influence of climatic change on system C budgets and ecosystem-atmosphere fluxes in the high arctic systems clearly depends on the interaction between plant strategies, soil responses and the impact of multiple climatic drivers.