Geophysical Research Abstracts
Vol. 15, EGU2013-9869, 2013
EGU General Assembly 2013

Impact of extreme inter-annual climatic differences on the net ecosystem carbon dioxide exchange of a Sitka spruce forest.

Matthew Saunders (1), Brian Tobin (2), Margherita Gioria (1), Giuseppe Benanti (1), Erica Cacciotti (1), and Bruce Osborne (1)

(1) University College Dublin, School of Biology and Environmental Sciences, Belfield, D4, Dublin, Ireland (matthew.saunders147@gmail.com; margheritagioria@yahoo.com; giuseppe.benanti@ucdconnect.ie; e.cacciotti@gmail.com; bruce.osborne@ucd.ie)), (2) University College Dublin, School of Agriculture, Food Science and Veterinary Science, University College Dublin, Belfield, D4, Dublin, Ireland (brian.tobin@ucd.ie)

Sitka spruce forest plantations are well suited to growing in the temperate climate of Ireland and represent some of the most productive forest stands in Europe, assimilating between 8-10 t C ha-1 yr-1. Temperature and precipitation are key drivers of the global carbon cycle and both inter-annual climatic variability and extreme climatic events have been shown to influence rates of carbon sequestration and greenhouse gas mitigation potential within terrestrial biological ecosystems. The impacts of the timing, intensity and duration of extreme climatic events, characterised by major differences in rainfall and minimum temperatures, were assessed using long-term eddy covariance measurements of net ecosystem carbon dioxide exchange (2002-2012). Precipitation in 2009 and 2010 was 1156 mm and 741 mm, respectively and was approximately 35% higher and 16% lower than the 30 year mean precipitation for this region (1978-2007). The difference in precipitation in 2009 was not uniformly distributed throughout the year and occurred largely during the growing season (April-August). The mean annual air temperature in 2010 (8.2ºC) was also 1.7ºC lower than the 30 year mean, and was characterised by a number of extended sub-zero temperature events during the winter months. Despite these differences, annual estimates of NEE were remarkably similar between years, ranging between 8.14 $\pm$ 1.94 t C ha yr-1 and 8.18 $\pm$ 0.88 t C ha yr-1 in 2009 and 2010 respectively. However, the measured NEE in both 2009 and 2010 were approximately 6% lower than the long-term mean measured at this site (2002-2008; 8.62 $\pm$ 1.39 t C ha yr-1). The components of NEE, gross primary productivity (GPP) and ecosystem respiration (Reco) did, however, show differences between years. In 2009, GPP was $\sim$15% lower when compared to 2010, most likely due to a reduction in stand photosynthesis at higher irradiances during the growing season that was related to higher water availability in the surface layers of the soil. Also the extended sub-zero temperatures experienced during the winter of 2010 had a greater impact on GPP, relative to Reco, resulting in a net loss of carbon during these periods. Variations in GPP were, however, positively correlated with Reco in both years. NEE was closely correlated with temperature in all years, with a slope (negative) of 0.2 to 0.3 g C m-2 d-1 per degree increase in air temperature. At temperatures below $\sim$0oC the forest acted as a carbon source, whilst there was a progressive increase in sink capacity as temperatures increased up to $\sim$20oC. The observed decrease in NEE was dependent on both the duration of exposure and the extent of sub-zero temperatures. This information indicates that while temperature is the main driver of NEE in this forest ecosystem, the timing of extreme precipitation events and resultant periods of high water availability during periods of peak growth may reduce carbon assimilation (GPP) and the net carbon sink strength (NEE) of these ecosystems.