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Carbon assimilation, translocation and respiration in Fagus sylvatica and Abies alba stands measured by gas exchange and isotopic techniques during two contrasting climatic years

Olga Gavrichkova (1,4), Andrea Scartazza (1), Roberto Zampedri (2), Mauro Cavagna (2), Matteo Sottocornola (2,5), Giorgio Matteucci (1,3), and Enrico Brugnoli (1)

(1) Consiglio Nazionale delle Ricerche, Istituto di Biologia Agroambientale e Forestale, Cinte Tesino, Porano, Montelibretti, Italy, (2) Fondazione Edmund Mach, San Michele all'Adige, Italy, (3) Consiglio Nazionale delle Ricerche, Istituto per i Sistemi Agricoli e Forestali del Mediterraneo, Rende, Italy, (4) «TORINS» Ltd, Krasnoyarsk, Russia, (5) Department of Chemical and Life Sciences, Waterford Institute of Technology, Waterford, Ireland

Global warming is tremendously influencing the climate of mountain areas through constantly rising temperatures and changes in local hydrological cycle. Increase of precipitation extremes, seasonal shifts of rainfall regime, heat waves are becoming more and more frequent events here. Vulnerability and plasticity of the local individual tree species under changing climate has still to be evaluated under field conditions.
Two consecutive years, 2012 and 2013 were quite distinct in the climatic conditions during the plant growing season. Summer 2012 was characterized by a prolonged summer drought with almost no precipitation in central Italy from the end of May up to the end of August. The situation was aggravated by a very dry winter during this year. Mean annual temperatures in 2012 were 2oC higher in respect to the temperatures measured in the last 10 years. Conversely, year 2013 was milder with occasional rain events also during the summer months and temperatures close to the average values. In the Alpine zone the difference between two years were less pronounced with 2012 being slightly warmer than average and 2013 was characterized by unusually abundant spring precipitations.
Taking advantage of these two contrasting years, we have monitored a functional response of one deciduous and one coniferous mountain forest stands growing in different mountain climate zones to variations in the local climate. The first, a deciduous European beech (Fagus sylvatica) forest, is located in the Appennine region of Italy at 1700 m height (Collelongo site, AQ) and characterized by a Mountain-Mediterranean climate. The second is a mixed forest dominated by Silver fir (Abies alba) which was chosen as a target species for our study. The site is located at 1350m height in the south-eastern Alps (Lavarone, TN) and is characterized by a mountain temperate climate. Sampling of plant material and point flux measurements were performed in the beginning, middle and the end of the growing season each year. At the beech site the middle samplings corresponded to the peak of the drought season whereas the last samplings of each year - to recovery phase.
Leaves were sampled with three replicates at three heights. Assimilation activity was monitored on the leaf level with a portable LiCor 6400 system. Leaf respiration was measured with the same instrument after keeping the leaves for 30 min in darkness. Recently assimilated soluble sugars as well as bulk leaf organic matter were analysed in the laboratory for their δ13C signature and for sugars quantity and composition. Trunk, root and soil respirations together with their δ13C signatures were measured with closed static chambers by the Keeling plot approach. Phloem was sampled with a bark core aiming to analyse the C isotopic signature and composition of assimilates translocate downward with the phloem flow.
A sequence of climatically different growing seasons and detailed analyses of plant material allowed us to evaluate climatically-induced variations in different steps of the C cycle at a plant level and to derive some conclusions on the plasticity of European beech and Silver fir in response to changing climate.