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Analysis of the influence of climatic and physiological parameters on the net ecosystem carbon exchange of an apple orchard

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Net ecosystem carbon exchange (NEE) of an apple orchard located in South Tyrol (Caldaro, Bolzano, Italy) was monitored continuously since March 2009 via eddy covariance technique. Contemporary measurements of the main environmental parameters (temperature, photosynthetic active photon flux density, soil water content, vapor pressure deficit) were taken at the same field site. Leaf Area Index was also determined biometrically starting from spring 2010. Objectives of this work were (i) to assess the influence of these environmental and physiological parameters on NEE, *(ii)* to set up a model capable to fill large gap occurring in the dataset and *(iii)* predict inter-annual variability of fluxes based on the measurements of the selected explanatory variables. Daily cumulated values of the response variable (NEE, g C d^{-1}) and mean daily value of the five explanatory variables considered (air T, °C; SWC, m^3m^{-3}; PPFD, μmol $m^{-2}s^{-1}$; VPD, hPa, LAI m^2m^{-2}) were used in this analysis.

The complex interactions between the explanatory variables and NEE were analyzed with the tree model approach which draws a picture of the complexity of data structure and highlights the explanatory variable that explain the greater amount of deviance of the response variable. NEE variability was mostly explained by LAI and PPFD. The most positive values of NEE occurred below the LAI threshold of 1.16 m^2m^{-2} while above that LAI threshold and with an average daily PPFD above 13.2 μmol $m^{-2}s^{-1}$, the orchard resulted always a sink of carbon (negative daily NEE).

On half of the available data (only alternate months of the considered period were considered), a stepwise multiple regression approach was used to model NEE using the variables indicated above. Simplification by deletion of the non-significant terms was carried out until all parameters where highly significant ($p < 0.05$) and a significant increase in deviance was observed when deleting further variables. Since heteroscedasticity and non-normality of the residual were observed in the analysis, the model was further improved by transforming the linear predictor. Akaike´s Information Criterion (AIC) was used to select the model with the best fit. Besides LAI and PPFD, also soil water content and VPD were included by the model. The model explained almost 80% (adj r^2 = 0.797) of the variance observed in NEE. The modeling efficiency (MEF = 0.788), calculated on the complementary dataset, indicates a good predictive power of the model. Despite the good correlation between observed and predicted values, their correlation indicates a conservative prediction of the model with an underestimation of both highly negative and highly positive values.