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Semi-empirical modelling of ecosystem respiration at European scale: model optimization and quantification of the associated uncertainties.

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In this study we analyse the ecosystem respiration (R_{ECO}) data from 83 eddy covariance sites belonging to the FLUXNET network. The aim is to develop a semi-empirical model able to explain the temporal variability of R_{ECO}, the site-to-site variability within each plant-functional-type (PFT) and the variability between different PFT (e.g evergreen needleleaf, grasslands, croplands..).

At site level daily R_{ECO} data, derived from eddy covariance measurements, were described with a semi- empirical model that has been developed for soil respiration (Reichstein et al. 2003), which uses air temperature and precipitation as predictors of respiration. While the model generally gave a good description of the data, a residual analysis showed that productivity had an additional effect on R_{ECO} since model residuals were correlated with gross primary production (GPP). We analysed different functional responses of the $R_{ECO}$to the GPP and the best results, in terms of variance explained by the model, modelling efficiency and standard error of parameters estimates, were obtained with a simple linear model. Even though the model was able to explain the temporal variability of R_{ECO} for all sites, the high level of variability of model parameters estimates within each PFT was not easily generalizable into a single model parameterization. For all PFTs we found a linear relationship between

the reference respiration (R_0), and maximum leaf area index (LAI_{MAX}). Considering the LAI_{MAX} as possible factor explaining the site-to-site variability within each PFT, we included it into the model (TPGPP&LAI Model) as an additional predictor possibly accounting for spatial variability of R_{ECO}. Model parameters for each PFT were then estimated and their associated uncertainty was estimated by means of a bootstrap algorithm. The new extended model showed higher modelling efficiencies ranging from 0.51 to 0.86, indicating that both abiotic factors, recent GPP and the general site productivity (indicated by LAI_{MAX}) influence R_{ECO}. Additional variance might be explained by site history such as disturbance.

The TPGPP&LAI Model was then applied for up-scaling the R_{ECO} from flux sites to European scale using as driver different meteorological surfaces (e.g. REMO, ECMWF), different land cover datasets (e.g. GLC2000, MODIS Land Cover Product) and different daily GPP estimates (e.g. MOD17, ANN, Biome-BGC). A Montecarlo sampling for the model parameters permitted to estimate the propagation of the model parameters uncertainty to the R_{ECO} estimates. Finally, we analysed the effect of the different drivers on magnitude, spatial pattern and the interannual variability of R_{ECO}.

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