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Development and parameterisation of a simplified aggregated canopy model of gross primary productivity and evapotranspiration (ACM-GPP-ET) for global application

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Ecosystem photosynthetic (i.e. gross primary productivity) and evapotranspiration processes (i.e. transpiration and soil evaporation) are key fluxes for the regulation of climate as well as and the terrestrial carbon and water cycles. However their estimation and quantification of uncertainties remain challenging due to the computational demand (complex processes), biogeochemical and biogeophysical uncertainty. Increasing availability of global trait data bases and fine resolution remotely sensed information can provide prior information on both biogeochemical and biogeophysical status with some quantification of uncertainty with which models can be confronted via a model-data fusion framework. Thus, leaving computational requirements being a key remaining stumbling block. Here we present a simple aggregated canopy model for gross primary productivity and evapotranspiration (ACM-GPP-ET), linking directly to ecosystem traits and a process-orientated coupling between photosynthetic and transpiration via stomatal conductance. Using a model-data fusion approach we have calibrated our model using simulated output from a well validated state-of-the-art terrestrial ecosystem model. ACM-GPP-ET reproduces the training GPP (r^2 = 0.95, rmse = 0.8 gC/m^2/day, bias = -0.018 gC/m2/day) and transpiration (r^2 = 0.83, rmse = 0.35 kgH2O/m^2/day, bias = -0.024 kgH2O/m^2/day) with a good degree of skill. Moreover the retrieved parameters are consistent with those known parameters used in the training model (e.g. optimum temperature for photosynthesis training = 30^{o}C, retrieved = 30.4^{o}C). Combing ACM-GPP-ET with remotely sensed leaf area and trait databased information on foliar nitrogen and rooting depths we generate a global 1 x 1 degree analysis at a weekly time step between 2000 and 2015 for GPP (135 +/- 22 PgC/yr) including drought stress and direct propagation of process uncertainty. ACM-GPP-ET allows for explicit simulation of photosynthesis and evapotranspiration processes, quantification of ecosystem traits and uncertainties from training datasets. Moreover, give the skill in retrieving ecosystem trait information ACM-GPP-ET could be used to retrieve ecosystem trait information directly from observed GPP and evaporative fluxes such as those generated from eddy covariance analyses.