Geophysical Research Abstracts
Vol. 17, EGU2015-9968, 2015
EGU General Assembly 2015

Automated modeling of ecosystem CO_2 fluxes based on closed chamber measurements: A standardized conceptual and practical approach

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Closed chamber measurements are widely used for determining the CO_2 exchange of small-scale or heterogeneous ecosystems. Among the chamber design and operational handling, the data processing procedure is a considerable source of uncertainty of obtained results.
We developed a standardized automatic data processing algorithm, based on the language and statistical computing environment R© to (i) calculate measured CO_2 flux rates, (ii) parameterize ecosystem respiration (Reco) and gross primary production (GPP) models, (iii) optionally compute an adaptive temperature model, (iv) model Reco, GPP and net ecosystem exchange (NEE), and (v) evaluate model uncertainty (calibration, validation and uncertainty prediction). The algorithm was tested for different manual and automatic chamber measurement systems (such as e.g. automated NEE-chambers and the LI-8100A soil CO_2 Flux system) and ecosystems.
Our study shows that even minor changes within the modelling approach may result in considerable differences of calculated flux rates, derived photosynthetic active radiation and temperature dependencies and subsequently modeled Reco, GPP and NEE balance of up to 25%. Thus, certain modeling implications will be given, since automated and standardized data processing procedures, based on clearly defined criteria, such as statistical parameters and thresholds are a prerequisite and highly desirable to guarantee the reproducibility, traceability of modelling results and encourage a better comparability between closed chamber based CO_2 measurements.