Carbon Flux and Climate Change

Collaborative project with Qiaolin Gu, SoLS, TUM
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Global climate and land use change and its effects on our habitat are one of the major social challenges of the 21st century. Terrestrial ecosystems play an important role in this by storing large amounts of carbon and thus counteracting climate change. The present project is part of a large scale scientific approach to understand the interplay between different carbon sources and sinks, which in turn is a central ingredient to be able to predict and to influence the climate change.

In a 3-year experiment (C-Turn), plants have been grown in climate chambers, mimicking three possible scenario(?) of the climate. One aspect in the project was that - after these three years - the plants were exposed for three days to CO_2 labeled with the stable isotope ^{13}C. The concentration of labeled CO_2 they exhale was measured over time by a high throughput device.
The aim of this part of the experiment is to develop a compartmental model for CO_2 uptake, storage, and release, and to identify the parameters based on the measured data. Particularly, it is interesting to investigate the influence of climate (different environments) on the carbon flux within the plants. In particular, a profound knowledge of the shift in carbon fluxes as a result of climate change is of importance for an appropriate understanding of the interdependence between climate and ecosystems.

The student's project consists of two parts: First, a compartmental model will be developed, which should be as simple as possible but as complex as necessary. In here, a close collaboration with Qiaolin Gu and her expert knowledge will be desirable. The team will also provide a theoretical analysis of the model (long term behavior, two-time methods to tell apart long term trend and daily pattern, structure of transient solutions etc.).
In the second part, the parameters will be estimated. The experience shows that the parameter estimation in this situation often is ill posed. Therefore, methods from Bayes statistics will be utilized. The plan is to implement the model in a simulation/statistics package called "Winbugs". An adapted formulation/implementation of the model allows to handle all three experiments in one run, and to reveal the differences in the parameters, which are caused by the different environmental conditions.

Lit.:

Mirindi Eric Dusenge, Andre Galvao Duarteand Danielle A. Way.
Plant carbon metabolism and climate change: elevated CO_2 and temperature impacts on photosynthesis, photorespiration and respiration. *The New Phytologist*, Vol. 221, (2019), 32-49.