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Can phenological data from digital images help the interpretation of carbon flux measurements?

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Vegetation phenology, photosynthesis, and thus carbon and water fluxes between ecosystem and the atmosphere are strongly connected. Consequently, the knowledge and understanding of phenological phases such as green-up, maturity, senescence and dormancy, is of further importance to climate research.

Phenological ground observations are often observer-biased and, due to missing volunteers, there is a constant decline in the number of long-term observations. For more than two decades satellite remote sensing has been providing a global integrated view of vegetation phenological states. However, satellite images often have limited spatial and temporal resolution and the application of this method still heavily depends on ground-based measurements for calibration and validation. In our project phenological phases of single tree-species are observed by use of images from a standard digital camera. The camera-based observed phenological data is jointly analyzed with CO_2-fluxes measured by eddy covariance. In our study, we analyze, if objective camera-based phenological observations help the interpretation of carbon flux measurements.

A standard digital camera was mounted on a flux tower at the Lägeren FLUXNET site (Switzerland), providing hourly digital images of a mixed forest. Parameter estimation of phenological phases is based on image statistics and red, green and blue channel colour brightness and a computed vegetation index. Net ecosystem exchange is measured by eddy covariance and separated into ecosystem respiration and gross

primary production. The joint analysis of both datasets shows that CO_2-fluxes are strongly related to phenological phases like tree canopy development and senescence. Camera-based derivation of phenological data allows species-dependant interpretation of carbon-fluxes. We anticipate that a network of digital cameras at FLUXNET research sites could provide inexpensive, spatially accurate and objective information with the required temporal resolution for phenological monitoring applications and ecosystem research.