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Assessing the Carbon Flux Dynamics within Virgin Forests: The Case Study 'Babia hora' in Slovakia

Die Kohlenstoffkreislaufdynamik des Urwaldes 'Babia Hora' in der Slowakei

Katarína Merganicová^{1,2}, Jan Merganic^{1,2}, Hubert Hasenauer³

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Schlagworte: Urwald, Interpolation, Mortalität, Kohlenstoffkreislauf

Abstract

Virgin forests provide unique information about natural conditions and forest ecosystem succession dynamics. Such information is needed to assess the carbon sink and source potential of our forests and to evaluate the 'self initialization procedures' within large scale ecosystem models. In this paper we use inventory data from the Babia hora virgin forest in Slovakia to assess the carbon flux dynamics of virgin or old growth Norway spruce (*Picea abies* L Karst) ecosystems. The species-specific version of the biogeochemical-mechanistic ecosystem model BIOME-BGC is applied to assess the flux dynamics of this ecosystem. The comparison of simulated versus observed data is based on the error analysis of the carbon pools. The results confirm previous findings within old growth forest ecosystems suggesting that for modeling purposes a "dynamic mortality" model is required to mimic the carbon flux dynamics of such forests correctly.

1 Forest research, inventory and monitoring (FORIM), Huta 14, 962 34 Železná Breznica, Slovakia

2 Czech University of Life Sciences in Prague, Faculty of Forestry, Wildlife and Wood Sciences, Department of Forest Management, Kamýčká 129, 165 21 Praha 6 – Suchbát, Czech Republic

3 Institute of Silviculture, University of Natural Resources and Life Sciences Vienna, Peter Jordan Straße 82, A-1190 Wien, Austria

Kurzfassung

Die wenigen in Europa verbliebenen Urwälder zeigen die Waldentwicklung ohne menschlichen Einfluss. Damit sind Urwälder wichtige Referenzflächen für die Abschätzung der Kohlenstoffkreislaufes (Senken und Quellenpotentiale) von unbewirtschafteten Waldökosystemen. Weiters sind Urwälder eine wichtige Referenzfläche für die Evaluierung von sogenannter 'Selbinstialisierungen' von Ökosystemmodellen, wie dies für die Generierung von Startwerten für die Modellierung üblich ist. In dieser Arbeit werden mit Hilfe von Daten aus dem Urwald Babiha Hora in der Slowakei die im Ökosystem Model BIOME-BGC implementierte dynamische Mortalitätsmodell evaluiert. Abschließend werden die Kohlenstoffsenken und Kohlenstoffquellen für einen Sukzessionszyklus im Urwald Babiha Hora mit Hilfe des Modells dargestellt. Ergebnis der Studie ist, dass für die richtige Abschätzung der Stoffflüsse im Urwald Babiha Hora ein dynamisches Mortalitätsmodell verwendet werden muss. Diese bestätigt frühere Untersuchung im Urwald Rothwald in Österreich, wo man zu ähnlichen Ergebnissen kam.

1. Introduction

Greenhouse gas emissions including atmospheric carbon dioxide (CO₂) have steadily increased since pre-industrial times, contributing to temperature increases in many parts of the world (IPCC 1996). A continuation of this trend is expected to cause significant changes to global ecosystems. Forests are an important part of the global carbon cycle and forest management for sequestering carbon is of increasing interest (Percy et al. 2003). European forest ecosystems have experienced a long management history resulting in substantial changes to species distributions and severe soil degradation effects affecting the nitrogen and carbon pools (Pietsch and Hasenauer 2002). Among real world ecosystems, virgin forests provide the best representation of natural conditions and give insights into the conceptual long-term potential dynamics of the carbon cycle (carbon sinks versus carbon sources in forests) without any management-related impacts (Pietsch and Hasenauer 2006, Field and Kaduk 2004).

Carbon exchange dynamics within larger virgin forest areas are poorly understood (Suchanek et al. 2004). Traditionally, old-growth forests have been assumed to be in equilibrium (Odum 1953), where the carbon uptake equals the amount of carbon released by respiration and decomposition (Križová et al. 1992), i.e. their long-term net ecosystem production is zero (Odum 1969). Hence, such forests are characterized by a long-term average volume of growing stock (Vacek 2003). However, on a smaller scale given