Dynamic Global Vegetation Model DGVM

POEM

Vegetation Dynamics and the Earth System

The biosphere plays an active role in the Earth System with direct and indirect feedbacks on energy, momentum and water balance through albedo and trace gas exchange (the balance between production and decomposition, biomass burning, conversion fluxes associated with land cover changes). Vegetation processes affect carbon storage and physical properties of the land surface. They may both constrain and accelerate change in the overall coupled system.

Biospheric dynamics involve time-scales of variability from "fast" processes (diurnal cycle of photosynthesis and respiration) through "medium fast" processes (seasonal and life-cycle changes) to "slow" evolutionary changes modifying the genetic structure of organisms. A Dynamic Global Vegetation Model (DGVM) which describes the structure and functioning of the terrestrial biosphere is thus an important component in a comprehensive Earth-system analysis, the goal of the PIK core project POEM (**see POEM poster**).

What is a DGVM?

Most DGVMs include process-oriented formulations of biogeochemical fluxes as well as vegetation dynamics (Fig. 1), including: establishment, productivity and competition for resources, resource allocation, growth, disturbance (**see poster "Fire in a Dynamic Global Vegetation Model"**) and mortality. Basic units of the model are "Plant Functional Types" (PFTs) which are designed to capture the major types of plants in the biosphere. External forcing of the DGVM is provided by trends of (global) CO_2, climate and land use (from observations or scenarios).

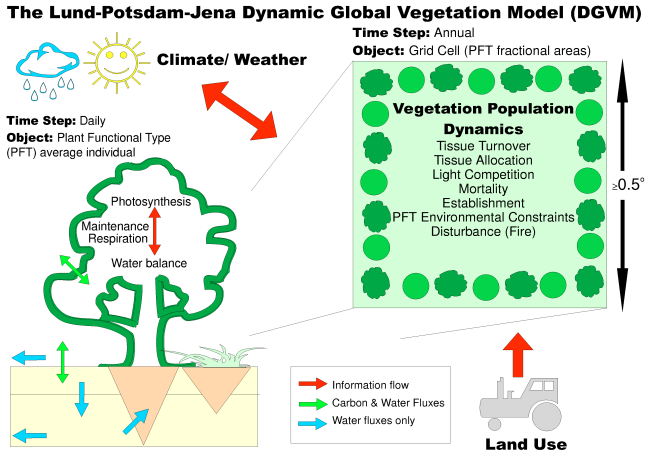

Fig. 1: Scaling from the average individual plant to a grid cell in the LPJ-DGVM

The PIK group is developing two DGVMS: the comprehensive "Lund-Potsdam-Jena - DGVM" (LPJ-DGVM) and VECODE (**see CLIMBER poster**). LPJ-DGVM is typically used at 0.5 degrees longitude/latitude, while VECODE uses the resolution of CLIMBER-2. LPJ-DGVM uses a range of time steps for different processes, while VECODE uses annual time-steps.

Direct validation of DGVMs is impossible due to the long time-scales involved. A partial validation has been provided by a separate study on the water cycle as part of the biogeochemical flux element in LPJ-DGVM, using locations in many different climate regimes. A critical model test is also provided by comparing model behaviour across the range of existing DGVMs (**see poster on the DGVM Intercomparison**).

Testing the DGVM in Different Climate Zones:

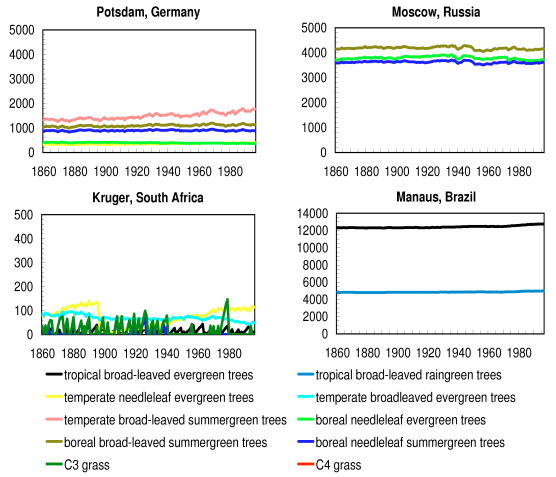

Fig. 2: DGVMs differ from earlier succession models by their capacity to simulate vegetation dynamics in all climate zones (LPJ-DGVM simulated biomass based on historical climate, in g C m^{-2})

Consequences of Changing CO_2 and Climate for Terrestrial Carbon Storage

The LPJ-DGVM, used with a scenario of climate change, driven by increasing CO_2 until 2099 and abrupt 'stabilization' until 2200, shows that CO_2 'fertilization' is a strong but temporary mechanism for additional carbon storage. Increased productivity is also counterbalanced by reduced water availability in this scenario.

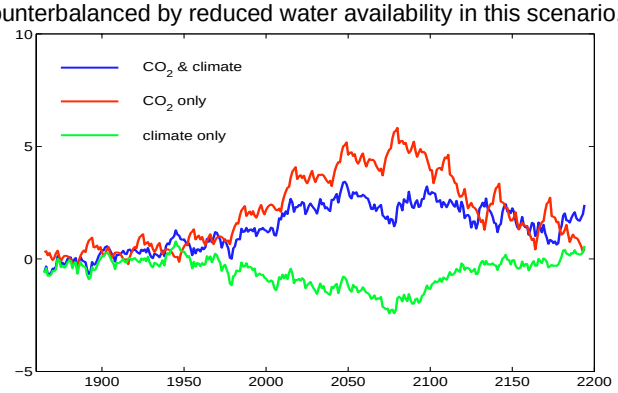

Fig. 3: Global Net Ecosystem Productivity (NEP, in Pg C) on land, simulated by the LPJ-DGVM under a business-as-usual scenario until 2100 and a stabilization scenario during 2100-2200. GCM output from HadCM2 SUL.

The spatial pattern of NEP indicates that there is strong sensitivity to the spatial pattern of the GCM-derived climate scenario:

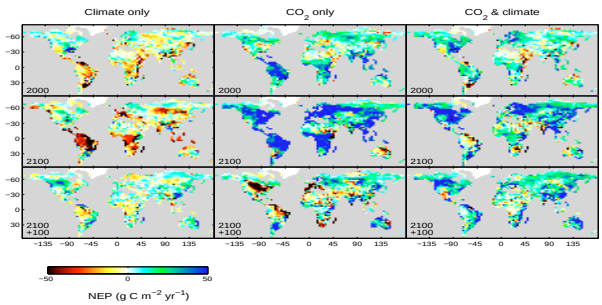

Fig. 4: Spatial pattern of NEP for the three experiments, simulated by the LPJ-DGVM, at the end of each century

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