

Regional variability of greenhouse gas emissions from grassland in The Netherlands

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Keywords

GHG balance, grassland, emission variability, management

Abstract

Grassland areas contribute significantly to the greenhouse gas (GHG) budget from terrestrial sources in the Netherlands. About half of the Dutch agricultural land is classified as grassland. Thus, realistic estimates of the greenhouse gas budgets from land sources in the Netherlands require reliable estimates of grassland emissions. Although for practical purposes grassland is considered to be a homogeneous biome, a large variability in emissions from grasslands may be expected due to differences in soil type and water- and land-management practices. We have analyzed the variability of GHG budgets between grasslands with the objective to improve regional GHG balance estimates and to enable assessment of the uncertainty in inventory reports. This analysis may help to devise high potential options for mitigation through land-management. A meta-analysis of various datasets of fluxes of CO₂, N₂O and CH₄ is presented. The datasets used are from the past decennium and represent contrasting grassland sites in the Netherlands. Comparison of the sites is based on the construction of ecosystem response characteristics, such as the photosynthesis-light response or fertilization rates and practices. Differences between the responses are then related to soil characteristics and grassland management. Significant differences between grasslands that are often treated as one and the same biome occur even on small scales. We identified regional specific and feasible management options for mitigation of GHG emissions from grasslands through water and fertilization management.

Implications of Carbon-cycle feedbacks for stabilisation and overshoot mitigation policies

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Keywords

Feedbacks, Stabilisation, Mitigation, Overshoot

Abstract

Stabilisation of atmospheric CO₂ levels, atmospheric surface temperatures and the prevention of dangerous climate change will require quantitative understanding of global carbon cycle processes, and in particular how atmospheric CO₂ concentration evolves for given anthropogenic emissions.

It is now widely accepted that climate-carbon cycle feedbacks will be instrumental in determining future CO₂ levels, changing the relationship between anthropogenic carbon emissions and atmospheric CO₂ that has persisted over recent decades. All 11 models in the C4MIP intercomparison predicted a weakening of the terrestrial carbon sink in response to climate change and an increase in the airborne fraction of anthropogenic emissions. Here we investigate implications of carbon cycle feedbacks on possible mitigation policies for stabilisation of atmospheric CO₂. Positive carbon cycle feedbacks mean greater emissions reductions will be required than previously assumed. We quantify this impact using the Hadley Centre carbon cycle GCM, HadCM3LC, for different levels of stabilisation and assess the impact of uncertainty in key terrestrial carbon cycle processes.

One important question, yet to be adequately addressed, but important to future mitigation policy is the rate at which atmospheric carbon dioxide levels may recover after emissions are reduced. We use the carbon cycle GCM to assess the rate of CO₂ decrease following hypothetical instantaneous reductions of emissions to zero at various dates. The processes determining the rate of recovery of CO₂ levels are found to vary depending on the level of climate change and the state of the terrestrial biosphere at the time of emissions cuts.

ForestGrowth, a process-based model to evaluate the effects of management practices on carbon sequestration in UK and European forests

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Keywords

Forest ecosystem dynamics, carbon cycle, pipe theory, climate change

Abstract

Forest ecosystems constitute an important component of the global carbon cycle because of their long-term potential storage ability, that can however be affected by management practices and/or climate change. A central question remains indeed on our ability to quantify and predict the current and future amount of stored carbon in those ecosystems.

We describe here ForestGrowth, a new model that simulates forest ecosystem dynamics, relying on a fully coupled, stand-scale and daily time-step soil-vegetation-atmosphere transfer mechanistic model – ForestETp – which has been evaluated against measurements from the EUROFLUX/CARBOEUROPE networks. ForestETp simulates relevant terrestrial hydrology processes (rainfall interception, vertical and lateral soil water movement, runoff, soil and canopy evaporation, and transpiration coupled with photosynthesis) for a known species growing in a locally defined soil and climate. Outputs from the ForestETp sub-model constitute the basis of ForestGrowth, which allocates carbon into the different tree compartments, based on a revised version of the pipe theory (Deckmyn et al. 2006, Tree Physiology). Coupled with a weather generator, the process-based model also allows the assessment of the influence of climate change scenarios on forest growth.

Currently, ForestGrowth is used to assess the impact of forest management strategies and climate change on carbon sequestration in UK and European forests. The mechanisms and behaviour of the model are finally compared with major other existing published models.

Potential and Dynamic of Carbon Sequestration in Forests and Timber

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Keywords

Carbon Sequestration, Forestry, Wood Chain, IPCC Scenarios,

Abstract

Within the project the potential contribution of the German forestry and timber industry to the reduction and stabilisation of the carbon dioxide concentration in the atmosphere will be quantified and evaluated. The potential of forestry and timber industry will include carbon sequestration, substitution of fossil fuel as well as substitution for productive materials. Different model based scenarios according to the “B1” and “A1B” scenarios of the IPCC Special Report on Emission Scenarios (SRES) will be applied for the estimates. Virtual forest enterprises will be created to demonstrate the modelling of above and below ground carbon contents and the silvicultural scenarios, which will be evaluated according to the Pan-European Forest Process on Criteria and Indicators for Sustainable Forest Management. All scenarios will be evaluated in economical terms.

First model results and scenario definitions will be presented. The project results should support political decisions in the field of environment, forestry and timber industry. The entire project will be accompanied by a scientific committee consisting of stakeholders, NGOs and members of economy. The committee will especially advice the project members during the scenario selection and the result evaluation procedures. The scenarios of investigation will allow the evaluation of the ecological, economical and social consequences of alternative decisions in the field of silviculture, timber use and different assumptions about climate change. The scenarios will allow the realisation of the social dialog about sustainable management and the support of political decisions.

Applications of the EFIMOD-System of simulation models of carbon and nitrogen cycles in forest ecosystems at strong external impacts (climate changes, cuttings, forest fires, windfalls)

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Keywords

C and N dynamics, forest-soil system, greenhouse gases

Abstract

The system of simulation models EFIMOD was developed for the evaluation of the global climate change and decision making for sustainable forest management. It comprises the tree stand model at population level, the model of soil organic matter dynamics ROMUL, statistical soil climate generator SCLISS, the model of different types of cuttings FOREST MANAGER, and the FIRE SIMULATOR.

The individual-based tree stand model simulates the stand as a population consisting of separate trees with competition for available light and for the redistribution of available nitrogen coming from soil among the trees. ROMUL model describes the mineralization and humification of forest litter with respect to carbon and nitrogen dynamics and returns available nitrogen for forest growth.

Structure of the model system allows for use of standard forest inventory data. Output variables are the inventory stand data, pools of carbon and nitrogen in the stand and soil, the dynamics of CO₂ emission and some other characteristics.

The model was applied at different sites in European part of Russia, Scandinavia, Central Europe and Canada for analyzing of different silvicultural scenarios, forest fires and results of climate changes in forest growth and elements cycling. The advantages of selective cuttings were demonstrated, difference in carbon dioxide emission at different scenarios were evaluated at local and regional levels. Problems of initialization and evaluation of parameters are discussed.

Land surface carbon exchange under contrasting agricultural management.

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Keywords

NEE, carbon balance, grassland

Abstract

Net ecosystem exchange (NEE) of carbon was measured by eddy covariance at three sites, with contrasting soil types and land management practices. Data was collected at an extensive peat bog, and two agricultural grasslands. The grasslands differ in management practice, one being continuously extensively grazed but receiving little fertiliser, with the other receiving 150 – 300 kg N per year, and having up to two cuts per year plus sheep and cattle grazing. Between-site variation in NEE and its partitioning between photosynthesis and respiration was observed. However, the pattern of variation did not reflect the relative quantity of fertiliser applied. It is shown that the carbon balance of the site is affected by the interaction of several variables, with the nitrogen input a contributing but not dominating factor.

Impact of NO_x emission from the operation of gas pipeline “Yamal-West” on carbon cycling in Podzolic environment of European Russia

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Keywords

nitrogen deposition, carbon cycle

Abstract

Industrial NO_x emission to the atmosphere is well known to be the cause of eutrophication and (or) acidification processes in terrestrial and freshwater ecosystems because of nitrogen surplus. In boreal forests, increased nitrogen depositions have been also recognized as a factor of changing regional carbon cycle. Impacts of nitrogen oxides emitted by gas pipelines as a result of both regular work and emergency situations affect the broad lands of European Russia. This exposure will intensify in the nearest future owing to increasing gas pipeline transportation. Thus, nitrogen depositions in the area being under the effects of gas pipeline “Yamal-West” in accordance with present accounts will be augmented from 5-7 kg N/ha/yr up to 14-15 kg N/ha/yr in 2015. The purpose of our study was to estimate carbon cycle dynamics in forest ecosystems of Podzolic zone of European Russia at different levels of nitrogen deposition and to reveal the changes in carbon sink dealt with increasing NO_x impact. Dynamics of carbon mass-balance has been calculated on the example of Pine tree stands using forest model EFIMOD2. Model installation has been carried out on the base of forest inventory data from Kostroma Region. Results of NPP estimating have shown that nitrogen is mainly consumed on tree biomass supplementation in young and middle-aged forest stands. Maximum C sink was revealed in Myrtillus forest type with sandy-loam soils. In old forest stands, the pool of annual carbon sequestration in SOM is comparable with C stock in tree biomass. Maximum values of carbon accumulated in SOM were calculated for Vaccinum forest type with loam soils. Nitrogen surplus from presumptive increase of NO_x emission for carbon sequestration is accounted to be more effective in middle-aged forest stands. Financial support of this study was received from RFBR Grant N04-05-97221 and FP6 Grant n.PL013388.

Regular measurements of CO/CO₂ mixing ratios in urban atmosphere: a case study from Poland

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Keywords

carbon monoxide, carbon dioxide, urban air, gas chromatography

Abstract

Regular, parallel measurements of carbon monoxide and carbon dioxide concentrations in the atmosphere of the city of Krakow using gas chromatography techniques have been initiated in May 2005. Krakow (50°04'N, 19°55'E, 220 m a.s.l.), with about 1 million inhabitants, rapidly growing car traffic and significant industrial activities, represents a typical urban environment. Consumption of coal, gas and oil for communal and transport purposes generates major fluxes of anthropogenic carbon dioxide and carbon monoxide within the region. In addition, with the prevailing westerly air circulation, the Krakow region is under substantial influence of a large coal mining and industrial centre (Upper Silesia) located approximately 60 km west of the city. The sampling site for analyses of CO/CO₂ mixing ratios is situated at the Faculty of Physics and Applied Computer Science building on the campus of the AGH-University of Science and Technology, in the western part of the Kraków city, bordering recreation and sports grounds. The air intake is located on the roof of the building, about 20 meters above the local ground level. The measurement technique is based on chromatographic separation of the analysed gases on micropacked Shincarbon column, conversion to CH₄ on Ni catalyst and detection with FID detector. The analysis of CO mixing ratio is performed simultaneously with CO₂ and methane, every 15 minutes on the same measurement path of GC. Reproducibility of CO analysis remains under 0,5% of the measured value. However, the detection limit for CO which is at present around 10ppb, can still be improved because oxygen was not by-passed and affected the CO peak. The corresponding values for CO₂ equal 0,02% and 0,5ppm for reproducibility and detection limit, respectively. Both gases reveal well pronounced diurnal changes during winter season. The recorded average amplitudes of diurnal changes are in the order of 100 ppm and 2000 ppb, for CO₂ and CO, respectively. The patterns of CO changes respond to car traffic during a day and local emissions during night hours. During summer CO is no more correlated with CO₂ signal. However, morning and afternoon short peaks of CO are still visible. Concentration of CO remains under 1000 ppb level. Assuming reference concentration values of CO and CO₂ in regional atmospheric as measured at Kasprowy Wierch (CO from flasks collected in biweekly intervals, CO₂ from continuous measurements), the ratio of additional "urban" carbon monoxide to carbon dioxide (DCO/DCO₂) may provide first-order indication of the combustion efficiency of local CO₂ source. The average DCO/ DCO₂ ratio in Krakow observed during summer was close to 15 ppb/ppm and raised to 30ppb/ppm when house-heating low emission was active (late autumn, winter).

The Central Database of CarboEurope-IP

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Keywords

Database, Dataset, Metadata, Documentation, Access

Abstract

The CarboEurope-IP (CE-IP) central database interlinks distributed data collections of the CE-IP components. The database offers dataset descriptions that are publicly available from the beginning in most cases. Documented datasets include measured data as well as modelling forcing and results. Actual datasets are stored in the component databases and will be made public only later. In some cases also datasets or data files are stored in the database besides their descriptions. This is the case for the intercomparison activity of the Bottom-up modelling work package of the Integration component of CE-IP.

Data descriptions concerning the Atmosphere, Ecosystem and Regional component are delivered by data providers to the database managers of the component databases who in turn check and upload them to the central database. A standard for data descriptions ensures completeness of data documentation, clearness of the data catalogue and well-defined retrieval results.

A user of the central database can retrieve datasets using different search criteria like time range, site, contributor and dataset topic through a web interface. The user is guided to the component databases or to data within the central database through links on the web pages. In case remote data are not online information is provided where data can be accessed.

**AFOLU DATA: a web-based information system on greenhouse gases in
Agriculture, Forestry, and Other Land Uses in Europe**

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Keywords

Kyoto Protocol, EC Monitoring Mechanism, GHG inventory, Agriculture, Forestry

Abstract

The UNFCCC and its Kyoto Protocol requires the Parties to report regularly inventories of greenhouse gas (GHG) anthropogenic emissions and removals. In this context, the AFOLU sector (Agriculture, Forestry and Other Land Uses; following the 2006 IPCC Guidelines, this sector will consolidate the previous LULUCF and AGRICULTURE sectors) is considered important to achieve the reduction targets. However, due to the high complexity and uncertainty of this sector, quantifying and reporting its GHG balance represents an extraordinary technical and scientific challenge.

This is especially valid for a Party like the European Union who needs to have in place a National system for GHG reporting and to deliver the annual GHG Inventory like any other Party to the Convention. European Council and Parliament established the Monitoring Mechanism and Implementing Provisions in order to guarantee the quality of the inventory that is required to implement additional agreements like the ones on burden sharing and emission trading. The Commission within its DG Joint Research Centre created a dedicated project (GHG Data in FP6 and GHG AFOLU in FP7) in order to work in this direction for the sectors Agriculture and LULUCF

In the frame of this project (see http://ies.jrc.ec.eu.int/Action_2211-GHG-Data.86.0.html) we developed the web-based information system "AFOLU-DATA" (<http://afoludata.jrc.it/>) to offer data, models and other tools to promote transparent, complete, consistent and comparable greenhouse gas estimates for the AFOLU sector in Europe. Target users are both greenhouse gas inventory practitioners and scientists. The core part is a collection of databases (e.g., allometric biomass compartment, forest inventories, yield tables,...) and tools for the assessment of GHG fluxes in the AFOLU sector in Europe, using different methods and at different scales.

The presentation will focus on the aim and structure of AFOLU DATA, and practical examples on the use of the various databases will be given.

Prognosing terrestrial carbon cycling with uncertainties: results from a Carbon Cycle Data Assimilation System (CCDAS)

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Keywords

data assimilation, uncertainties, prognostic carbon fluxes, CCDAS

Abstract

The Carbon Cycle Data Assimilation System (CCDAS) infers values of the parameters controlling the function of a process model of the terrestrial biosphere using various observations. From this optimized parameter set and the model one can then calculate quantities of interest such as the net carbon flux. This can be done in a diagnostic mode, calculating fluxes for the same period as the assimilation. In this case the assimilation is a particular kind of inversion scheme which calculates fluxes consistent both with observations and model dynamics. If, however, the model is prognostic one can run it for other periods, either the future or the past. Here, we use an optimized parameter set within the CCDAS framework to infer prognostic carbon fluxes that are consistent with observations for the assimilation period (we fit atmospheric CO₂ data from 1979 to 1999) and model dynamics. The assimilation procedure also allows to calculate uncertainties on the parameters. These uncertainties are then propagated onto prognostic quantities. We present results from a hindcasting experiment for prognostically calculated net CO₂ fluxes plus uncertainties as well as atmospheric CO₂ concentrations plus uncertainties and compare them with recent atmospheric measurements for the years 2000 to 2003.

Model – data comparison of fossil fuel CO₂ in Europe: Uncertainties due to model transport and emissions inventories

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Keywords

fossil fuel CO₂, transport model, emissions inventory

Abstract

Estimates of continental carbon fluxes from inversions of atmospheric CO₂ measurements typically require a separation of the contribution from fossil fuel emissions in the atmospheric CO₂ signal. In order to assess the uncertainties related to the use of different transport models and different emissions inventories to estimate this fossil fuel CO₂ component, respective model simulations are compared to measurements of radiocarbon-based fossil fuel CO₂ at several stations in Europe. ¹⁴CO₂ observations allow quantitative estimation of the fossil fuel component in atmospheric CO₂ because fossil fuels are free of ¹⁴C. Fossil fuel CO₂ concentrations were simulated by three global atmospheric transport models, which are all currently used in inversion studies, and, additionally, by two regional models in order to cover a wider range of horizontal and vertical resolutions. In all model simulations we used the same set of different emissions inventories, including commonly used annual maps as well as newly available hourly estimates of CO₂ emissions from fossil fuel combustion. The comparison of these model simulations with ¹⁴CO₂-based fossil fuel CO₂ observations allows us to assess uncertainties caused by the representation of transport in the different models but it also gives some indication of the potential improvements due to the new emissions estimates with high temporal resolution. For most stations the spread between models using the same emissions inventory is still much larger than the differences caused by the use of different inventories within the same model. This calls for further evaluation and improvement of the transport models before an independent verification of emissions inventories through this kind of comparison will be reliable.

Varying seasonal constraints on regional carbon fluxes from atmospheric CO₂/CO correlations

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Keywords

regional carbon fluxes, CO₂/CO correlations, top-down constraints

Abstract

Observed atmospheric CO₂/CO correlations can provide top-down constraints on regional carbon fluxes beyond those from concentration measurements alone. The CO₂/CO emission ratio from combustion sources varies with efficiency of burning, thus providing a characteristic signature of source region and source type, and in particular, of combustion versus biospheric influence. Our analysis of CO₂/CO correlations in Asian outflow demonstrated the utility of these measurements in constraining the regional biospheric flux of CO₂ [Suntharalingam et al. 2004].

Temporal variations in CO and CO₂ sources and sinks yield associated variations in observed atmospheric CO₂/CO correlations, with implications for the utility of these constraints towards estimating carbon fluxes in different seasons. Here we contrast CO₂/CO correlations from aircraft campaigns flown in two different seasons, namely, COBRA-2000 in the summer (July-August, 2000) over North America, and TRACE-P in early springtime (March-April, 2001) off the coast of Asia. CO₂/CO correlations observed on the springtime TRACE-P mission are uniformly positive, display distinct regional signatures and a small overall range (10 to 80 mol/mol). The summertime correlations measured on COBRA-2000, while predominantly negative, are characterized by less distinct signatures and display a wider overall range (-330 to 400 mol/mol). We analyze the correlation measurements from the two campaigns in conjunction with simulations from a chemical tracer model (the GEOS-Chem CTM), and evaluate their differing constraints on regional carbon fluxes.