A first estimate of the feedback between climate change and atmospheric N$_2$O concentration

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Abstract
Previous studies showed that future climate change may have a negative impact on oceanic and terrestrial carbon cycle. This has lead to the quantification of the climate-carbon positive feedback. Climate change leads to a reduction of carbon sinks, an increase in the atmospheric CO$_2$ growth rate, and hence a larger climate change.

Here we adopt a similar conceptual approach to estimate the climate N$_2$O feedback. We use the ORCHIDEE model for the land and the PISCES model for the ocean biogeochemistry. A nitrogen model based on CENTURY for organic matter and on DNDC for inorganic matter is implemented in ORCHIDEE. The model computes nitrogen fluxes as function of climate, carbon pools and nitrogen inputs. PISCES computes N$_2$O fluxes following Suntharalingam et al. approach in which N$_2$O production terms are function of oxygen concentration.

We forced the two models with climate taken from IPCC simulations of the 20$^{th}$ and 21$^{st}$ century performed by the IPSL General Circulation Model. Emissions of N$_2$O as well as atmospheric N$_2$O concentrations under changing climate are then estimated. We then estimate the radiative forcing and the warming/cooling effect due to the climate-N$_2$O feedback.

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Keywords
atmospheric CO2, Eurasian carbon exchange, source/sink signals, stable isotopes

Abstract
This paper investigates seasonally averaged atmospheric CO2 source or sink signals observed at Waliguan Baseline Observatory (WLG, 36°17’N, 100°54’E, 3816m asl) in the inland plateau of western China for the period May 1991 to December 2002. Linear regression and a test of statistical significance were performed between the detrended CO2 and stable isotope monthly data by means of the “Keeling Plot” approach and a “New Model” [Miller and Tans, 2003] which allows for variable background values of both CO2 and δ13C. The estimated seasonal ∆δ13C/∆CO2 ratio was ~ (–0.050 ± 0.001) ‰ ppm⁻¹, the isotopic composition of net seasonal CO2 exchange, δ13Cs and δ18Os, the source or sink signature, was ~ –26.159 to –25.265 ‰ and ~ –8.853 to –6.558 ‰, respectively, and the mean atmospheric δ13C discrimination (δ13Cs minus δ13Ca, where the second term is the isotopic value of the atmosphere) was (–18.174±0.035) ‰ in agreement with the results from other continental background sites in the NH. This implies that exchange with the terrestrial biosphere dominates the observed CO2, δ13C and δ18O seasonal cycles at WLG. In addition, the atmospheric CO2 and δ13C data from 11 selected Northern hemispheric (NH) sites in the NOAA CMDL air sampling network from 1998 to 2002 were analyzed and compared to the WLG data for the same period to better address common and specific features observed in this region. The annual cycle amplitude differences, secular and seasonal ∆δ13C/∆CO2 discrepancies among sites will be useful to better understand carbon uptake and release especially on the Eurasian continent. The estimated δ13Cs during certain times at each specific site could possibly provide useful information on CO2 fluxes.
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A decade of carbon exchange at Loobos in The Netherlands

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**Keywords**

forest, carbon exchange, interannual variation

**Abstract**

At the Loobos flux tower in The Netherlands, CO$_2$ flux data have been collected using the eddy covariance technique since 1995. With more than a decade of CO$_2$ flux data available, it is timely to analyze the interannual variability of the carbon exchange at the site. The flux tower is located in a forest planted on sand dunes in the year 1910. The climate at the site is classified as temperate / oceanic. The dominant tree species is *Pinus sylvestris*. The flux data analyzed here were obtained at a height of 26, about 11 m above the trees. Data have been obtained, processed and screened following the CarboEurope protocol, including supportive measurements such as soil respiration and storage fluxes. Gaps in the measurement series due to adverse conditions or instrument failure have been filled using a neural network approach. Partitioning of Net Ecosystem Exchange (NEE) into Ecosystem Respiration (RE) and Gross Primary Production (GPP) was performed using the CarboEurope methodology. Annual variations in these quantities are analysed. Results show annual differences in NEE typically amounting to about 30% of the mean. Variations in RE and GPP are correlated, but those in RE tend to be somewhat stronger than in GPP. In contrast with many other forest sites, no significant decrease in NEE is found in the extremely dry and warm year 2003. The reduction in RE largely compensates the reduction in GPP. The latter reduction is limited to only about 5% of the mean, probably due to the roots being able to extract groundwater most of the time, even during dry weather spells, in combination with reduced cloudiness.
Mediterranean forest ecosystem under changing precipitation regimes: the responses of soil CO$_2$ efflux

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Soil Respiration, through-fall manipulation

Abstract
In order to predict long-term trends in C sequestration by terrestrial ecosystems in a changing environment, it is important to understand the response of soil C dynamics to environmental parameters. Soil respiration is the main process through which soil can release C to the atmosphere and it is strongly correlated to soil water and temperature. Climatic changes are likely to have a strong impact on Mediterranean ecosystems, which are expected to experience large changes in precipitation patterns leading to an intensification of drought stress. In the framework of the European project MIND, a large scale throughfall manipulation experiment has been established in an Arbutus unedo coppiced woodland, at Tolfà-Allumiere, central Italy. The manipulation consisted of two treatments: a dry, with 20% of the throughfall being removed, and a wet one, where soil moisture was kept above deficit by targeted irrigation. Soil respiration has been continuously monitored, during year 2005, as well as, they were soil moisture and temperature. Results showed a strong positive relationship between soil respiration and temperature up to 19°C, temperature above which other factors (i.e. soil moisture and available substrate) exerted a limiting effect, as confirmed by modelling of litter decomposition process using the DayCent Model. The responses of soil respiration to changing soil water regimes will be reported in terms of short-term (i.e. immediate response to the rain event) as well as long-term (i.e. annual budget of soil CO$_2$ efflux) and implications discussed.
The European terrestrial biosphere affected by the 2005 and 2003 climate anomalies: comparative analysis of processes and spatial patterns


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Keywords
Interannual variability, climate extremes, carbon and water fluxes, ecosystem modelling, remote sensing

Abstract
The 2003 and 2005 (and 2006) climate anomalies over Europe were quite different both in terms of spatial patterns and in terms of climate variables affected. These differences lead to quite contrasting responses of the terrestrial biosphere functioning with respect to both, the spatial patterns, the processes involved (e.g. respiration, photosynthesis) and the dominating climate factors (temperature, water balance). On this topic an integrated paper grant was given by the CarboEurope project SC.

We present a detailed integrated, comparative analysis of these two ‘natural experiments’ from eddy flux tower, ecosystem modelling and remote sensing perspectives. We find consistent descriptions of spatial anomaly patterns between modelling and remote sensing approaches: While in 2003 central Eastern and Western Europe were strongly affected, in 2005 strong reductions in modelled productivity and observed fPAR were found over the Iberian peninsula and around the Caspian Sea. These patterns are also reflected by the point observations via eddy flux towers (where available). According to the process modelling and the eddy data separated into gross primary productivity and terrestrial ecosystem respiration,
the anomalies in NEE were largely driven by changes in productivity rather respiration, except for the Baltic region where no models indicated strong positive respiration anomalies but no eddy flux towers exist. Modelling experiments indicate that memory effects with respect to soil water storage do exist, i.e. the productivity may depend also on the hydrological patterns during the previous year depending on whether soil water was restored or not.

Preliminary analysis of the year 2006 indicates that with similarly high temperatures and little summer rainfall, but a hydrologically different spring in 2006 forest productivity was less affected while severe reductions in shallow-rooted grass and croplands occurred. Overall, from the analysis we conclude that water-carbon interactions are very - and maybe increasingly - important for the understanding of carbon balance inter-annual variability.
Recent carbon cycle response to climate anomalies assessed from atmospheric 'top-down' information

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Keywords
atmospheric CO$_2$, carbon cycle anomalies, drought

Abstract
In recent years, the atmospheric CO$_2$ content underwent several periods of anomalously high growth, in particular in 1997/1998, 2002, 2003, and 2005. From measurements of atmospheric CO$_2$ concentrations at observing sites, the likely geographic origins of anomalous CO$_2$ sources have been estimated, using two independent atmospheric inversion systems. Based on these flux estimates in comparison with climate data and independent information, we discuss the roles of tropical El Niño responses, biomass burning intensity, rising fossil fuel emissions, or drought responses in midlatitudes, such as the European heat/drought wave in 2003. The comparison of the two independent ‘top-down’ estimates is used to discuss their uncertainties.
Extended seasonal drought and high productivity in an semi-arid Mediterranean Aleppo pine forest

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Keywords
Drought, dry land afforestation, phenology, carbon sequestration, energy fluxes

Abstract
There is a need to better understand land ecosystem response to drought. This notion is supported by model predictions of future decrease in precipitation in the entire Mediterranean Basin (IPCC), and by the expectation for recurring episodes of extreme droughts such as the 2003 drought across Europe and the 2005 drought in south Western Europe.

We present results from research at a site that is likely at the driest limit to forest growth (the Yatir afforestation, southern Israel, aridity factor of 0.18), where the forest is exposed to soil and/or atmospheric water stress over extended rather than short periods. It was found that forest growth under these conditions has shifted phenology and time of peak activity. Leaf-level and physiological adjustments were also observed (e.g. changes in leaf pigmentation, leaf energy dissipation mechanism or drastic changes in leaf conductance). As a result of these adjustments, the period of peak photosynthesis activity and respiration and the highest water use efficiency was observed when soil moisture is maximal and temperatures are mild, around March (as opposed to mid July in temperate forests). And the forest remained active, at low rates, throughout the summer drought. Annual NEE of the forest was above 2 t ha-1 on average during the 5 years study period (max 3.5 t ha-1).

As part of an afforestation effort in the region, our results show that such land use changes influence local hydrology and surface energy characteristics (e.g. elimination of runoff, decreasing albedo while increasing sensible and reducing the LWR flux). This study demonstrates the potential of forest expansion into dry areas, with the unexpectedly high productivity, and the changes in surface conditions associated with this land use change.