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Effects of climate change on carbon sequestration in a Danish beech forest during 12 years

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The CO_2 exchange over a beech forest near Sorø, Denmark, was measured continuously during 12 years (1996-2008). Simultaneously a large number of parameters influencing CO_2 uptake were measured which makes it possible to relate the CO_2 exchange to recent changes in e.g. temperature, CO_2 concentration, and nitrogen load.

The CO_2 exchange was measured by the eddy covariance method which gives a direct measure of the net ecosystem exchange (NEE) at a half hourly basis. Ecosystem respiration (RE) was estimated from nighttime values and gross ecosystem exchange (GEE) was calculated as the sum of RE and NEE.

Over the 12 years the beech forest acted as a sink of an average of 115 g C m^{-2} y^{-1}. Only during one of the years the forest acted as a small source. During the 12 years there was a general increase in annual NEE. RE increased during the time span, but GEE increased even more resulting in the forest acting as an increasing sink.

We observed significant linear trends of GEE (2.3 % per year), RE and NEE. The Carbon Uptake Period (*i.e.* the period with daily net CO_2 gain) increased with 2.5 days per year, which was 5 times more than the increase in the leafed period. This means that the leaves stayed active longer.

The uptake capacity of the forest was studied by means of light response curves. It was found that the capacity increased during the 12-year period. The N content of the leaves also increased during the period. The effects of increases in N and CO_2 were simulated by a model (MAESTRA).

We conclude that the increase in the overall uptake capacity of the forest could be due to a combination of increases in growing season, CO_2 and N. Long-term N budgets might be more important to explain the increase of fertility in an ecosystem than current deposition and that a delay in response to decreasing atmospheric deposition can well be expected.