Changes in phenology and the influence on the carbon sequestration in a Danish beech forest over 20 years

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1 Introduction
Observations of carbon sequestration in a Danish beech forest over the last 20 years have shown a steady increase in NEE. Earlier studies (Pilegaard et al. 2011) have shown, that about half of the increase can be attributed to an increase in the growing season length. The growing season has been determined as the carbon uptake period (CUP); i.e. the period with net uptake, determined from flux data. Additionally, we have determined the period with leaves (LP) from the attenuation of light below the canopy. In this analysis we add information from a phenology camera with data from the last 6 years using the R package Phenopix (Filippa et al. 2016). The new data is compared with CUP and LP to give more detailed information on the phenology. The information is used to examine the evolution of net ecosystem exchange (NEE) over the 20 year period.

2 Phenology analysis
We used 3 methods to extract phenology information:
1. Determining the carbon uptake period (CUP) as the period with a net uptake of carbon by the forest using breakpoint analysis.
2. Determining the leaf period (LP) by finding abrupt changes in the ratio of PAR above and below the canopy.
3. Determining the start of season (sos) and end of season (eos) by means of image based analysis of pictures of the forest canopy taken with a PhenoCam.

3 Comparison of indices of phenology
There seems to be a good correlation between the indices identified by the different methods. However, the end of CUP, as identified from the flux data, does not have a corresponding index in the image based analysis. The start of season (sos) indicated by the image analysis occurs on average 6 days earlier than the end of LP, probably due to the complete loss of chlorofyll before the leaves are shed. The trends in both start and end of the growing season are not significant. The trend of LP is also not significant, but there is a significant increasing trend in CUP with an increase of 1 day yr⁻¹.

4 Carbon sequestration and phenology
The uptake of carbon by the forest has increased significantly over the period with an increase of 19 g C m⁻² yr⁻¹. There is a significant correlation between annual NEE and CUP, although the increase in CUP only explains about half of the increase in NEE.

5 References

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