ESF Short Visit Grant – Scientific Report

CLIMMANI - Exchange Grant - 3075

Applicant: Wouter Dieleman, Research Group of Plant- and Vegetation Ecology, University of Antwerp, Belgium

Host: Peter van Bodegom, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

1. Purpose of the visit

Soil carbon respiration, i.e. the flux of carbon dioxide from the soil to the atmosphere, is determined by climate variables and soil organic carbon quality. The quality of soil organic matter is significantly affected by litter inputs and litter decomposition rates. Moreover, litter decomposition may contribute directly to soil carbon fluxes and is affected in turn by climate.

Although litter decomposition rates are ultimately linked to soil carbon respiration fluxes, they have hitherto not been quantitatively compared (neither stand-alone nor in interaction with climate). We will bring change into this situation by combining databases on litter decomposition with databases on soil carbon fluxes. Litter decomposition databases are available at the VU Amsterdam: one on global patterns in litter decomposition as related to litter traits (Cornwell et al. 2008) and to climate variables (van Bodegom; unpublished) and one on litter decomposition rates across (sub-)arctic environments as affected by climate change and growth forms (Cornelissen et al. 2007). At the University of Antwerp a large database on soil carbon fluxes across different climates in Europe (Luyssaert et al. 2008) is available.

During this short visit, a synthesis of these climate related databases will be made (by linking fluxes through the vegetation composition of the sites included) to i) test the correspondence of these fluxes across sites, ii) to predict how climate change may affect soil carbon fluxes through changes in litter quality.

2. Description of the work carried out

This visit took place in two parts. During the first visit by Wouter Dieleman to Amsterdam, the databases were compared and linked. Analyses were concluded at the individual places. Originally, it was aimed for that, during a second visit by Peter van Bodegom to Antwerp (CLIMMANI grant 3074), a draft of a scientific paper would be prepared. However, given the complications discussed below, this visit and grant has been cancelled.

Several databases were available that had decomposition data; the MOL database (Cornelissen et al., 2007), ART-Deco database (Cornwell et al., 2008) and the LIDET database (Harmon et al., 2000; Parton et al., 2007). Independent database combining flux and pool size data of plants and soil of global change experiments (Dieleman, unpublished) and a global fluxes database (Luyssaert et al., 2009) were also available. For all these databases, the contents was carefully evaluated and compared. To perform the proposed analyses, we needed litter decomposition rates and fluxes (soil respiration and/or microbial respiration data) for the same site, and an adequate description of the dominant species in the experiments. This condition was essential to eliminate effects of between-site variation in plant traits (like litter quality) and in fluxes that could not be controlled for. Only in this way, litter decomposition constants might be properly linked to soil C fluxes at a particular site.

Comparing and selecting data from the available datasets showed that this condition was only fulfilled when combining the MOL database with the database compiled by Dieleman. Moreover, this combination of databases allowed -thanks to using global change experiment data- the use of response ratios of both flux data and of decomposition data, further reducing the impact of unknown and uncontrolled (ambient) site conditions. Altogether, this reduced our dataset to 6 experiments, all located in the arctic/boreal region (Table 1).

Site	Manipulation treatment	Latitude		Longitude		MAP	MAT
Abisko subalpine heath (Paddustieva)	Fertilization	68.33	N	20.85	E	213	-0.3
Abisko subalpine heath (Paddustieva)	WarmingxFertilization	68.33	N	20.85	E	213	-0.3
Abisko subalpine heath (Paddustieva)	Warming	68.33	N	20.85	E	213	-0.3
Toolik Lake	Warming	68.63	N	149.72	W	180	12.03
Abisko subarctic bog	Warming	68.35	N	18.82	E		
Kilpisjärvi	Warming	69.5	N	20.83	E		-2.3

3. Description of the main results

Both litter decomposition and soil CO_2 effluxes are regulated by a number of abiotic factors, among which temperature, moisture content and litter quality. We analysed i) whether the response ratios in litter quality, as expressed by responses in %C, %C, C/N and litter phenolics contents to global change experiments, affected the response in soil respiration to the same treatments, and ii) whether the response in decomposition to global change was related to the response in soil respiration.

The preliminary analyses thus include analyzing the soil respiration responses' relationships with those for litter %N, litter %C, litter C/N and N/C-ratio, litter phenolics content and the decomposition losses of the litter at the respective sites (Fig. 1).

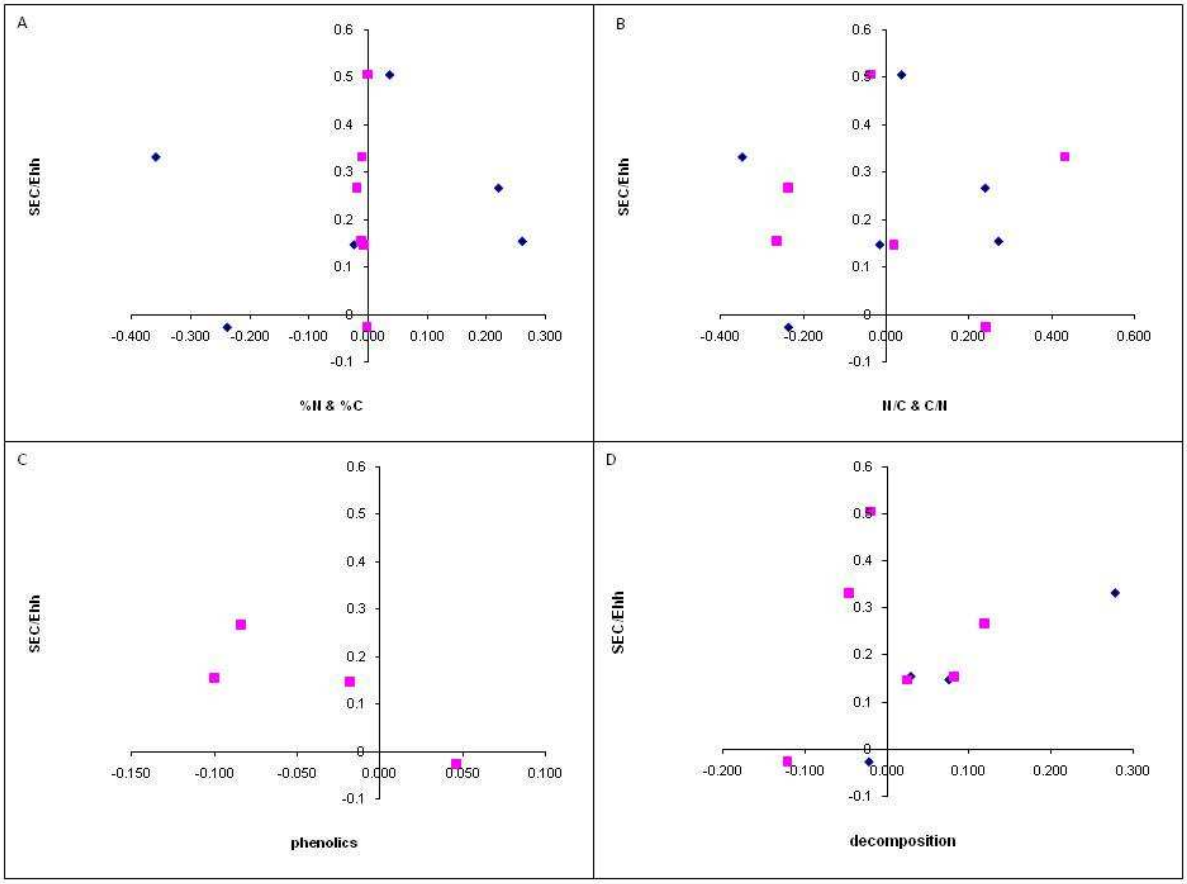

Fig. 1: Scatter plots of soil CO_2 efflux (SCE) effect sizes plotted against effect sizes in litter %N and %C (A), litter C/N and N/C ratio (B), litter phenolic scontent (C), and litter mass loss in decomposition (D). All effect sizes were calculated as the natural logarithm of response ratios.

The scatter plots showed that the responses in litter quality parameters were not related to those in soil respiration, yielding highly insignificant relationships. However, the scatter plot of SCE with litter

decomposition mass loss was significant ($P<0.05$). The data thus suggest that a large portion ($R^2= 0.81$) of the responses in soil fluxes to global change treatments could be explained by responses in litter decomposition. This would imply that soil C inputs, and therefore substrate supply to the microbial community would largely determine the amount of C respired from soil.

The lack of a relationship with litter %N and %C was unexpected, given that it is generally expected that %N and %C indicate the litter quality, which should be related to litter decomposition. However, this seems to be mainly true for between-species comparisons. Within species, e.g. in response to warming or increased N-mineralisation, %N and %C seem to be less related to litter quality changes. For instance, upon warming, it seems that N is sequestered in the more labile fractions of the plant, and therefore the change in %N is no longer linked to a change in decomposition rates when comparing litter decomposition responses between species (for species comparisons, %N is used as a measure for the amount of stable polymers).

The dataset for litter phenolics content was too small to make any suggestions: although the R2 of the relationship with the response in soil respiration equaled 0.70, the relationship remained insignificant due to a lack of data points.

Further analysis consists of enlarging the database to have a robust dataset, providing a strong argument for the relationship between litter decomposition and soil respiration. An attempt to extrapolate our results to a broader range of ecosystems is another challenge, as our current dataset mostly contains data from arctic/boreal regions.

4. Future collaboration/ projected publications/articles resulting from the grant

The short visit was successful to the extent that it was very useful to learn from each other databases and meta-analysis experiences. Also testing whether the databases could be linked was useful. Unfortunately, however, the overlap in sites and species was rather small.

Elaborating the dataset is therefore the primary goal at this point. If we succeed in collecting a dataset that is large enough to find a robust relationship of fluxes and litter decomposition, a scientific paper will be prepared.