Do biogenic volatile organic compound (bVOC) emissions vary from different tree species in short-rotation forest (SRF) ecosystems?

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Project background

The EU has a mandatory target for 20% of all energy to be generated from renewable sources by 2020. Biomass is seen as a key contributor to meeting this aim, and the planting of short-rotation forestry (SRF) has the potential to provide some of that biomass requirement. Many broadleaf species such as alder, ash, birch and poplar, and conifers such as Scots pine and Sitka spruce, as well as exotic species such as eucalyptus are currently being grown in SRF trials. It is important that we understand all aspects of how such plantations may impact on the environment. One aspect is the emission from the vegetation and ground litter of reactive biogenic volatile organic compounds (bVOC), particularly isoprene and monoterpenes, which contribute to the formation of ozone and particles in the atmosphere, with implications for air quality and climate change. Despite considerable research on isoprene emissions from many ecosystems, the magnitude and controls of bVOC emissions from biofuel mono-cultures still need to be investigated. Eucalyptus and conifers, in particular, are likely to be strong emitters of bVOCs to the atmosphere. This project builds upon previous CEH & UoE studies investigating trace gas emissions from short-rotation coppice willow and *Miscanthus* bioenergy crops in the UK (Copeland et al. 2012; Drewer et al. 2012; Morrison et al. 2014), and work on the environmental impacts and benefits of SRF by Forest Research (McKay et al. 2011). The project will provide important evidence that will contribute to the forestry sector discussion on SRF, and will inform wider UK policy and practice for land-use transitions to woody bioenergy crops.

Example of short-rotation biofuel plantations: eucalyptus

Key research questions

(1) Are there significant differences in the magnitudes of bVOC emissions from different SRF tree species (broadleaf, conifer, exotic) under British conditions?
(2) How much do bVOC emissions from SRF species vary according to climate?
(3) How much could bVOC emissions from SRF contribute to the total UK budget?

Methodology

bVOC emissions will be measured from different tree species being trialled for use in SRF, in different climates and stand ages within the UK. Existing replicated trials managed by Forest Research for Forestry Commission Scotland and for Defra across the UK will be used. These sites cover a range of species including: ash, alder, birch, hybrid aspen, sycamore, sweet chestnut, and eucalyptus and *Nothofagus* spp. Trace gas samples will be collected from vegetation enclosures onto adsorbent tubes (Tenax and Carbotrap) and analysed using GC-MS with thermal desorption at CEH Edinburgh. Approximately bi-monthly measurements will be carried out at selected field sites to capture seasonal variation; concentrating on June-Oct

periods for deciduous species. This will provide seasonal data of bVOC fluxes from different tree species giving an indication of the variability and potential contribution to the total UK budget. In addition measurements will be taken at leaf scale in the field and laboratory using controlled environment leaf cuvettes and branch enclosures. The branch, leaf and litter data will be used to identify source strength and possible controlling factors for the plantation species, and laboratory studies will explore abiotic and biotic controls in more detail at leaf and branch scale for selected species. Results will be scaled up to potential national emissions using projections of SRF expansion and tree species suitability and productivity.

Training

A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. The latter includes a programme focused on personal effectiveness, communication, team building and career management, as well as courses on safety assessment, project management, literature searching, oral presentations, poster preparation, and thesis writing. The student will also receive training in undergraduate laboratory demonstrating and, if they wish, in areas such as schools or public outreach activities and business skills.

The student will attend relevant atmospheric and ecological courses available in the UoE Schools of GeoSciences & Chemistry. Specific skills training will include training in analytical techniques, particularly in gas chromatography and mass spectrometry. The student will make use of excellent computing facilities within both CEH and UoE, and will gain expertise in statistical packages (Genstat, Minitab, SigmaPlot, R), and use of spreadsheets (Excel) for storing and manipulating data. CEH provides underpinning research on a wide range of environmental sampling programmes and the student will receive professional training in health and safety during fieldwork, and in obtaining reliable field-based data, permitting them to design and execute an appropriate sampling regime. The student will also be encouraged to attend relevant NERC summer schools and to present results at national and international scientific meetings. The student will also benefit from training at Forest Research Northern Research Station to access information on SRF practices, trials and long-term experiment information, and gaining practical experience from researchers in forest science.

Requirements

Candidates should have a good undergraduate or Masters degree in environmental, chemical or physical sciences, with a strong focus on analytical skills. Willingness to undertake regular (UK) fieldwork and a driving licence are essential.

References

Copeland, N., Cape, J. N., Heal, M. R. (2012) Volatile organic compound emissions from *Miscanthus* and short rotation coppice willow bioenergy crops, Atmospheric Environment 60, 327-335.

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McKay, H. (ed.) (2011) Short Rotation Forestry: review of growth and environmental impacts. Forest Research Monograph, 2, Forest Research, Surrey, 212pp
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Project summary

This project will investigate the magnitude and determinants of variations in biogenic VOC emissions from different species of short-rotation forest that are being proposed in the UK to provide biomass to fulfil renewable energy requirements.