COST STSM Report

Action FP1202

Period: From 2013-07-18 to 2013-07-27

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STSM Topic: *BVOC emission from a northern population of Silver birch under climate change stressors (ozone and nitrogen)*

Host: Dr. Gina Mills, CEH Centre for Ecology and Hydrology Natural Environment Research Council, Bangor Gwynedd Wales UK

1. Background

Marginal/peripheral populations are particularly important for adapting forests to global changes. These populations are particularly threatened by climatic changes because the changes act in combination with other disturbances originating from human activities. In Europe, all major biomes contain marginal or peripheral populations. *Betula pendula* (silver birch) is a widespread European birch, an essential component of temperate and boreal forests and has positive effect on the diversity of ecosystems. Main threats to the genetic diversity of silver birch occur at the margin of its distribution range, where occurrence is discontinuous and consisting of isolated and frequently small populations. In particular, southern (Italy, Spain and France) and northern edges of the distribution area (such as Scotland) are subject to this fragmentation process. Human activities are contributing to climate change releasing pollutants into the atmosphere every year. Climate changes directly are affecting the growth, the productivity and genetic variation of forests due to changes in climate and forest ecosystems. Developing conservation and management strategies for Forest Genetic Resources of marginal populations is needed to adapt European forests to Global Change.

2. Purpose of the STSM

Silver birch is the most common of Britain's native broad-leaved trees found naturally in Northern Europe because it can grows in cold climates and further north than any other tree. It has been reported that this tree is a monoterpene (e.g. alpha-pinene, beta-pinene, sabinene, ocimenes and in early summer also 3-carene) and sesquiterpene emitter (Vuorinen et al, 2005). This emission of volatiles from plant leaves may be enhanced when the tree is under environmental stress, and these emissions are the main precursors in the formation of tropospheric ozone (Fehsenfeld et al., 1992). Indeed the capacity of BVOC emission in marginal populations of forest tree species has never been specifically investigated.

The main objective of this STSM was understand if a marginal/ peripheral population of *Betula pendula* changes the quality and quantity of volatile organic emissions under two typical climate change stressors, i.e. elevated ozone nitrogen. The experiment took place in the CEH solardomes in Bangor UK. These are seven dome-shaped greenhouses with finely-controlled ozone exposure and different nitrogen deposition regimes (Fig.1.); in these domes there are six trees of *Betula pendula,* a Northern European birch, exposed at seven different levels of ozone and four levels of nitrogen in the ground.

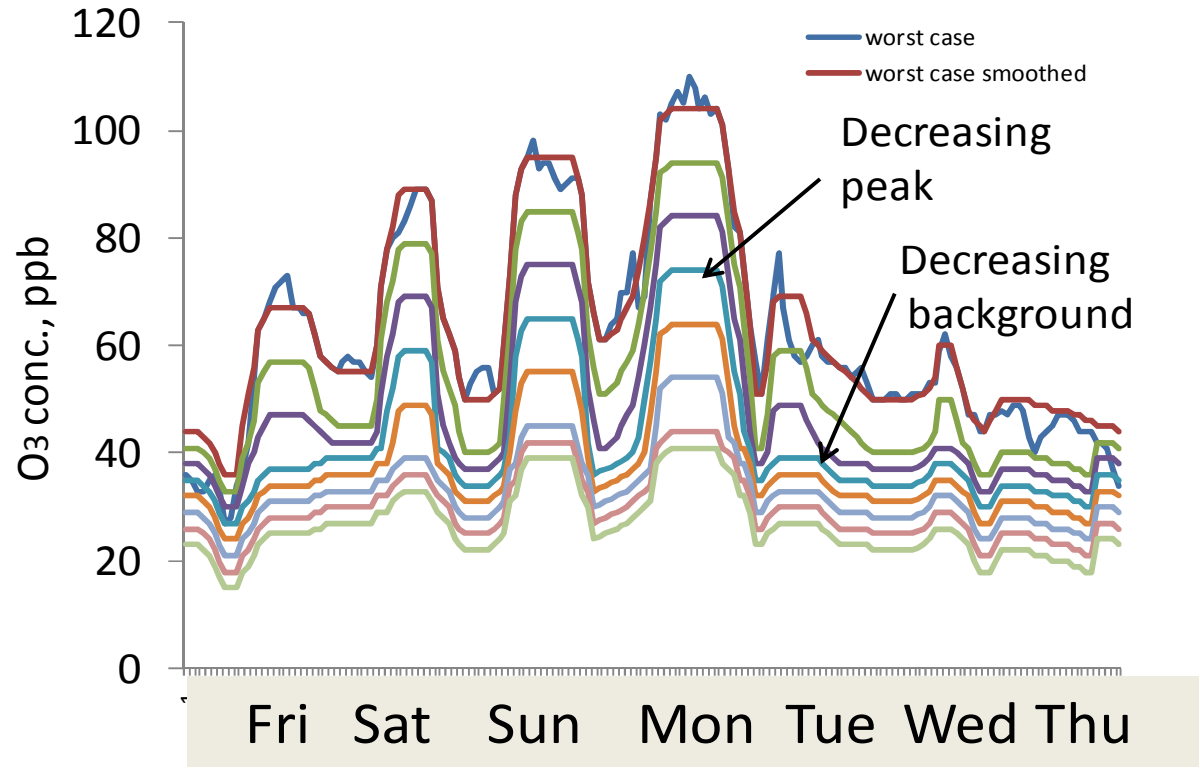
Fig.1. Solardomes of the Centre of Ecology and Hydrology (CEH) in Bangor (UK)

3. Description of the work carried out and main results obtained during STSM

In this experiment, because of constraints in time, the number of ozone and nitrogen levels was reduced and three of the seven solardomes, with three different levels of ozone and three different levels of nitrogen, were chosen for each solardome. A summary of the experimental weekly design and ozone levels is available in table 1 and figure 2. The treatment of nitrogen levels is the same for each dome.

Day	Solardome	O_3 ppb	N level	N Kg Ha^{-1} yr^{-1}
Fri 19	D4 AHE-6	33	N1	10
	D4 AHE-6	33	N2	30
	D4 AHE-6	33	N4	70
Mon 22	D3 AHE	100	N4	70
	D3 AHE	100	N1	10
	D3 AHE	100	N2	30
Tue 23	D2 AHE-3	44	N2	30
	D2 AHE-3	44	N4	70
	D2 AHE-3	44	N1	10
Wed 24	D4 AHE-6	28.3	N1	10
	D4 AHE-6	28.3	N2	30
	D4 AHE-6	28.3	N4	70
	D3 AHE	54.7	N4	70
	D3 AHE	54.7	N1	10
	D3 AHE	54.7	N2	30
Thu 25	D2 AHE-3	36.5	N2	30
	D2 AHE-3	36.5	N4	70
	D2 AHE-3	36.5	N1	10
Fri 26	D4 AHE-6	26	N4	70
	D3 AHE	56	N4	70
	D2 AHE-3	40	N4	70

Tab.1. Scheme of the weekly sampling with levels of ozone and nitrogen chosen



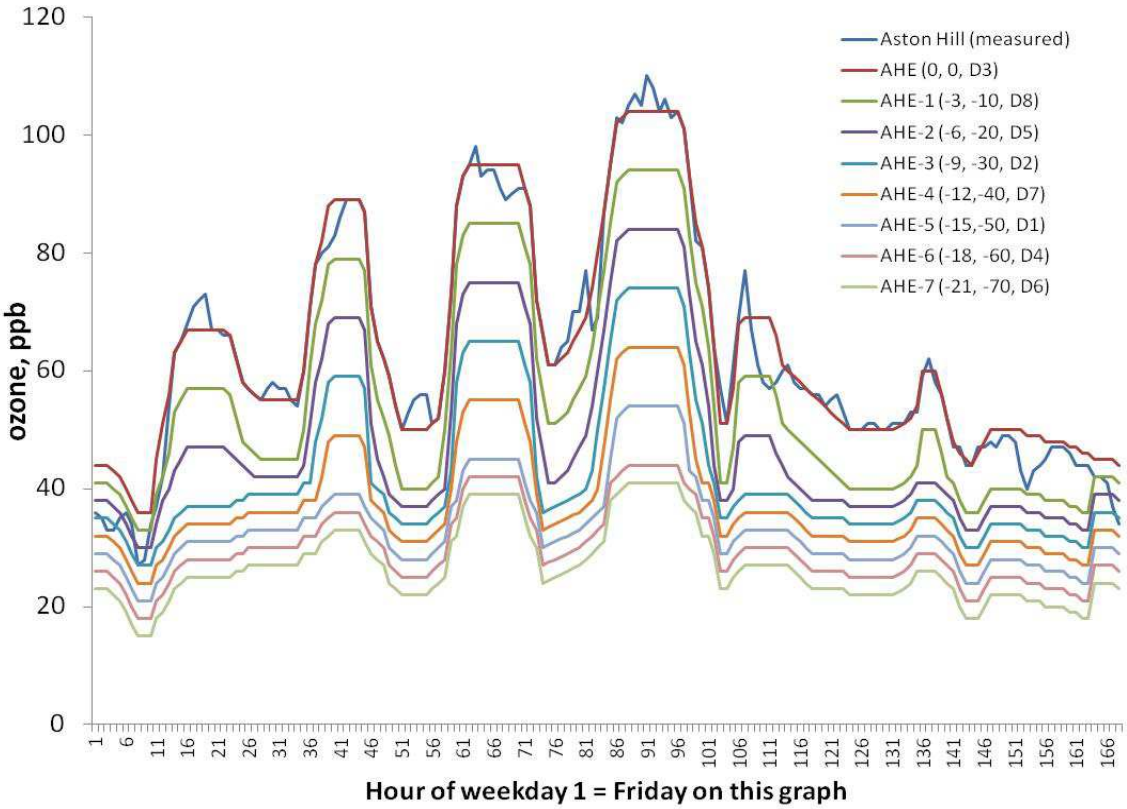


Fig.2. The target O_3 regime used in the solardomes: in the 1st graph the weekly O_3 pattern is presented. In the 2nd graph the "D" in the brackets is the solardome number and the different levels of ozone are pointed out with letters and numbers.

In each dome, three birches per each N treatment were selected and BVOC emission from birches was sampled through a LI-COR 6400. LI-COR, portable gas-exchange system, was used for sampling volatiles emission collecting them in tenax traps (TENAX TA adsorbent 200 mg Supelco) and also for setting all the parameters of the experimental tree: photosynthesis rate, stomatal conductance, temperature of leaf, relative humidity, PAR (Photosynthetically Active Radiation) etc. At the end of each day, one empty trap was used as a control of BVOC levels in ambient air (blank). Four replications for level N1, N2 and five replications for level N4 were taken in solardome D4, D3 and D2. 39 traps for collecting BVOC + 9 traps for blank were used.

The results will be obtained later when all the traps will be analyzed trough GC-MS Gas Chromatography-Mass Spectrometry with analytical thermal desorption (TD). This was a first important step of the experiment obtained thanks to the collaboration of CEH Institute of Bangor that gave me the possibility to take measurement inside solardomes not available in my country.

Fig.3. Sampling BVOC through LI-COR 6400 in the solardome

Furthermore the results of this STSM may have implications for the adaptation of European tree to global change, control of air quality and compiling information on climate change impacts on European forests and developing criteria for monitoring and conserving forest genetic resources. This may contribute to understand the role of environmental conditions and assists in forecasting plant regeneration responses to global climate change.

4. Future collaboration with the host institution

This short term scientific mission represented for me a great opportunity for working with the Environment Institute of Wales in Bangor (CEH-Centre for Ecology and Hydrology) and studying if a marginal/peripheral population of *Betula pendula* changes the quality and the quantity of volatile organic emissions (VOCs, Volatile Organic Compounds) under typical climate change stressors. This is a part of my PhD programme and actually I am working at two European projects: LIFE project **FO3REST** –Ozone and climate change impacts on French and Italian forests: refinement of criteria and thresholds for forest protections to better link ozone concentrations with ozone absorption and damages to vegetation; and **ECLAIRE** project FP7 Effect of climate change on air pollution impacts and response strategies for European ecosystems. This project quantifies how global warming and altered precipitation will affect emissions of key European primary pollutants (NOx, NH_3, VOCs), including interactions with increasing aerosol and hemispheric O_3 background concentrations, modifying atmospheric transport and deposition. Thanks to this STSM I linked the two European projects, working on both ozone and VOCs emission and the response of vegetation. In the future I will take other measurements in these solardomes because this collaboration with CEH Institute of Bangor was very helpful for improving the main objectives of my work within the two European projects.

Also this STSM was part of a collaboration between Action FP1202 and Action FP0903 “Climate Change and Forest Mitigation and Adaptation in a Polluted Environment” as it fits with the aims of both Actions.

Fig.3. Experimental field of CEH Institute of Bangor

5. Confirmation by the host institution of the successful execution of the STSM

A pdf with a certification from Dr. Gina Mills is attached to this report

Florence, 2013-07-28

Giulia Carriero