TEO3

IMPECVOC

Impact of phenology and environmental conditions on BVOC emissions from forest ecosystems

DURATION OF THE PROJECT
Phase 1: 15/12/2006 – 31/01/2009
Phase 2: 01/02/2009 – 31/01/2011

BUDGET
1.123.952 €

KEYWORDS
Forest ecology, global climate change, meteorology, BVOC inventory, eddy covariance

CONTEXT

Natural ecosystems such as forests are important emission sources of Biogenic Volatile Organic Compounds (BVOC). On a global scale BVOC emissions (1150 Tg C per year) are estimated to be an order of magnitude larger than their anthropogenic counterparts. The main emitted BVOCs are isoprene and monoterpenes, which account for almost half of the BVOC emissions worldwide. Due to their large emissions and their high reactivity with the main oxidants in the atmosphere, BVOCs are expected to contribute significantly to atmospheric chemistry. In the presence of nitrogen oxides the atmospheric oxidation of BVOCs may result in net O3 formation and this has a significant impact on air quality. It is, therefore, important that BVOC emissions in forest ecosystems are well characterised and quantified.

PROJECT DESCRIPTION

Objectives

The overall objective of the IMPECVOC project is the detailed analysis of the emissions of BVOCs occurring from deciduous (European beech) and coniferous (Norway spruce) tree species. The driving variables behind BVOC emissions from the tree species need to be unravelled by means of well-conceived studies.

The specific objectives of this project are :

1) to characterize the ecophysiological mechanisms of BVOC emissions by means of both growth chamber and in situ measurements at different heights in the tree canopy;
2) to characterize BVOC emissions at the global stand level during different phenological periods in the growing season; and
3) to propose improved emission algorithms based on these observations and on previously reported measurements for these tree species, and to incorporate these algorithms in a BVOC emission model to provide improved BVOC emissions estimates, in particular for Belgium. These estimates will be the result of a combination of the new algorithms and detailed data for land use, species composition and biomass density.

Methodology

The overall approach of this project is a bottom-up approach, conducted at three levels, namely: (i) growth chamber level (leaf, branch and whole tree level of saplings), (ii) canopy level (leaf and branch of full grown trees) and (iii) stand level. The tree species that are selected for this project are the main species growing in Vielsalm forest, where stand level measurements will be executed. These species are beech (Fagus sylvatica L.) and Norway spruce (Picea abies). Project partners are : Laboratory of Plant Ecology (PE) and ENVOC (both Ghent University), the Belgian Institute for Space Aeronomy (BISA), and the Unit of Biosystem Physics of Gembloux Agricultural University (UBP).

Detailed measurements, in controlled conditions, will be performed on young model trees kept in growth chambers (PE, ENVOC, BISA). There, the response of the entire tree or of its leaves to changes in climatic conditions like light intensity, air temperature and air humidity can be observed. BVOC emission dynamics can also be linked to concurrent measurements of CO2 and water vapour exchange. In the growth chamber experiments, different and complementary methodologies (Proton Transfer Reaction Mass Spectrometer (PTR-MS) and gas chromatography - mass spectrometry (GC-MS)) will be applied for BVOC measurements.

In order to get more insight in BVOC emissions from older and full grown trees, emissions will also be measured in situ in the canopy of a 85 year old beech tree from the experimental forest Aelmoeseneie (Gontrode, Belgium) which is equipped with a measuring tower (PE, ENVOC, BISA). As conditions, e.g. light, air relative humidity, but also leaf anatomy and leaf nitrogen content and thus also leaf photosynthetic capacity, change throughout the canopy, leaf and branch level measurements will be conducted at various canopy heights. Measurements at this level will be organised in measurement campaigns during the different phenological phases (leaf development, fully leafed period, leaf senescence and leafless period). Again, BVOC measurements will be linked to simultaneous measurements of CO2 and water vapour exchange.

Stand level measurements link the overall behaviour of an ecosystem to its abiotic and biotic environment. They also integrate the response of the different canopy layers to vari-

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ations in environmental conditions within the canopy. In order to understand the response of BVOC emissions at varying climatic conditions, measurement campaigns (ENVOC, BISA, UBP) during the different phenological phases will be organised at the Vielsalm forest (Belgium). Measurements at global stand level require a unique experimental set-up. Eddy correlation will allow measuring simultaneously BVOC emissions, CO2 and water vapour exchange.

Finally, observations at the different scales of organisation will be integrated (BISA). This integration (scaling of BVOC emissions obtained at growth chamber and canopy level to stand level) will be done by using an existing BVOC emission model (MOHYCAN : Model for calculating the HYdrocarbon emissions by the CANopy). This scaling is important to check whether observations at growth chamber level and at branch level in the canopy are still valid at stand level. A last step in the project is the formulation of emission algorithms to obtain a reliable forest BVOC inventory for Belgium.

INTERACTION BETWEEN THE DIFFERENT PARTNERS

As indicated in the previous paragraph, collaboration between the partners will be based on the complementary knowledge and equipment of the different laboratories or institutes. Because of the high degree of specificity of this equipment, each team has an indispensable contribution to this project.

EXPECTED RESULTS AND/OR PRODUCTS

At the start of the project, a website will be constructed, and a flyer will be composed, printed and distributed. Regular meetings of the follow-up committee will also be a way for dissemination of results. These meetings will result in scientific feedback from the committee members, and will help to finally formulate relevant policy guidelines. As a continuous task, all project members will present the results of this project on international symposia and in international journals.

PARTNERS - ACTIVITIES

The laboratory of Plant Ecology (PE-UGent) focuses on the relation between vegetation, soil and atmosphere, especially plant water relations, water vapour and carbon dioxide exchange between vegetation and atmosphere. The laboratory has several growth rooms and a measuring tower (in the Aelmoeseneie forest) at its disposal.

Research activities of the Environmental Organic Chemistry and Technology research group (ENVOC-UGent) focus on environmental issues mainly related to organic micropollutants. The new project especially fits into the running activities within the discipline environmental behaviour and analysis of organic micropollutants : biogenic volatile organic compounds.

BISA has a long tradition in atmospheric research. A large part of the scientific work is devoted to the stratosphere and troposphere through laboratory, modeling and atmospheric monitoring activities. Biosphere/atmosphere interactions have been studied through development of a vegetation canopy model (MOHYCAN) and through modeling and laboratory studies of the OH-initiated oxidation of biogenic volatile organic compounds.

Since more than ten years the Unit of Biosystem Physics (UBP-FUSAGx) has centred its research activities on the study of CO2 and H2O exchanges between terrestrial ecosystems and the atmosphere. In this frame it developed two fully equipped experimental stations devoted to the measurement of these fluxes, one in a forested ecosystem (Vielsalm), and one at a crop site (Lonzée).

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Follow-up Committee
For the complete and most up-to-date composition of the Follow-up Committee, please consult our Federal Research Actions Database (FEDRA) by visiting http://www.belspo.be/fedra or http://www.belspo.be/ssd

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