

Biogenic volatile organic compound emissions in the changing biosphere-atmosphere system in Europe (*BIOBASE.NET*)

Expression of Interest for an FP6 Network of Excellence Research priority area 1.6.3 “Global change and ecosystems”

1. Aim of the *BIOBASE.NET* Network of Excellence

BIOBASE.NET will bring together scientists from a wide range of disciplines who carry out internationally recognised research into the production and emissions of volatile organic compounds (VOCs) by plants and the resultant interactions between the biosphere and the atmosphere in the context of global change and ecosystems. It will span plant processes and ecosystem functioning, environmental controls on VOC emission fluxes, flux measurements and modelling on the leaf, canopy, ecosystem and regional scales, and the emission of these compounds into the atmosphere. *BIOBASE.NET* will directly address the priority area 1.6.3 “Global change and ecosystems”. The Network will reduce the considerable fragmentation that exists at present in this multi-disciplinary field of research and will spread excellence through and beyond the Network. It will establish European research at the forefront of this area of international importance and will foster pan-European research leading to a better understanding of how biogenic VOC emissions affect the present and future relationship between the biosphere and the atmosphere.

The Network will directly address the FP6 research priority area 1.6.3 “Global change and ecosystems”. It will do this by facilitating, supporting, and co-ordinating a range of research activities by atmospheric chemists, plant biologists, pathologists, entomologists, agronomists and foresters. The Network will span plant processes and ecosystem functioning, environmental controls on emission fluxes, flux measurements and modelling on the leaf, canopy, ecosystem and regional scales, and the emission of these compounds into the atmosphere. It is anticipated that one or more other Networks of Excellence will provide expertise on the chemistry of biogenic VOCs once in the atmosphere, on their role in ozone and aerosol formation and on their effects on the radiative balance of the atmosphere. At every stage, the effects of global change on the biosphere-atmosphere system will be at the centre of the scientific activities of the Network.

1.1 Contribution of *BIOBASE.NET* to Priority Thematic Areas of FP 6

The *BIOBASE.NET* Network of Excellence will directly address priority area 1.6.3 “Global change and ecosystems” and the research priorities therein on “Impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks”.

1.2 Contribution of *BIOBASE.NET* to the European Research Area

BIOBASE.NET will contribute to the European Research Area by: reducing the fragmentation of research in the field of biosphere-atmosphere interactions and climate change across Europe; by providing training and employment opportunities to European scientists and hence improving European scientific competitiveness and reducing the loss of skilled personnel to other regions; by presenting a coherent case for research funding in this area of science; by providing an interface between scientists, SMEs and the public, so aiding economic and social development; and by providing linkages and communication between nationally funded research programmes in this area.

2. Background to the *BIOBASE.NET* Network of Excellence

Plants produce a wide range of volatile organic compounds for a variety of reasons. The release of these gaseous compounds to the atmosphere has been demonstrated to affect the chemical and physical properties of the atmosphere. In the presence of NO_x, produced by fossil fuel combustion and natural processes, these biogenic VOCs react in the atmosphere to form tropospheric ozone, an important pollutant and greenhouse gas. These reactions may also cause a decrease in the concentrations of the hydroxyl radical (OH) and so lead to the accumulation of methane and other greenhouse gases. A further consequence of these reactions is the formation of secondary organic aerosol particles, a component of PM10 in the atmosphere, which has known adverse effects on

human health. The interactions between the biosphere and the atmosphere mediated by the production and emission of reactive trace gases are a crucial and central component of the study of Earth System Science. Their importance to the functioning of the Earth's climate is only now beginning to be appreciated, and there is agreement that this warrants concerted scientific research on a large scale.

The emissions of VOC by plants accounts for a significant fraction of the carbon fixed by photosynthesis, especially under stress conditions. These emissions reduce the amount of carbon that is fixed by vegetation. They take place on the continental scale and can therefore play a role in atmospheric chemistry even in remote areas. BVOC emissions are currently modelled using empirical algorithms based on environmental factors. However, a thorough understanding of BVOC synthesis mechanisms and plant and ecosystem responses to climate change is required if future emissions are to be reliably predicted on the regional scale. At the ecosystem scale, the role of BVOC in plants and ecosystem functioning is not clearly understood. In some plants, BVOCs accumulate in specialised organs in leaves, stems or trunks, and may be released as deterrents against pathogens and herbivores, or in response to damage to aid wound sealing. In some plants, BVOCs are not stored in this way, but are rapidly emitted after production. The reasons for this are not yet clear, but they may play a part in providing thermal protection to plants, attracting pollinators and herbivore enemies, and in plant to plant communication.

The interest in biogenic VOCs has grown rapidly over the last decade in both Europe and the USA. In Europe national funding as well as the EC Framework Programmes has allowed a considerable research capability to be built up in this field, from cellular level plant biochemistry, through the leaf, plant, canopy and ecosystem scales to the global atmospheric scale. European researchers are actively engaged in the organisation of international meetings and participate in national and international research programmes in their respective scientific disciplines.

The establishment of a European Network of Excellence in "Biogenic volatile organic compounds in the changing biosphere-atmosphere system in Europe" (*BIOBASE.NET*) will bring together scientists from across Europe and facilitate, organise, co-ordinate, and integrate research in the important multi-disciplinary area.

3. Objectives of *BIOBASE.NET*

The specific objectives of the *BIOBASE.NET* Network of Excellence will be:

- a) to co-ordinate and integrate research carried out by participating laboratories on the synthesis, accumulation and release, ecological role, environmental control on emissions of biogenic VOCs in the context of global change.
- b) to assist in the organisation of specific research activities where these are best carried out at the European scale (e.g. inter-comparison experiments and model validations, large field campaigns).
- c) to utilise conventional and emerging communications techniques to facilitate dialogue, discussion and information exchange between participants, so allowing adaptation of participants' research activities and hence strengthening complementarity, giving added value to European research.
- d) to facilitate training programmes and exchange of personnel, particularly aimed at enhancing the expertise and skills of young scientists and at bringing scientists from other disciplines (e.g. biochemistry, genetics, mathematics, statistics, geographical information science, remote sensing) into the field.
- e) to facilitate the development and use of shared and new infrastructure and facilities, including the exploitation of new analytical technologies.
- f) to create and maintain data-bases of relevant information (e.g. VOC emission rates) and to make these available to the scientific community.
- g) to promote the sharing and dissemination of information both within and outside the Network and to communicate the achievements of the Network to the widest possible audience.
- h) to carry out any other activities that will spread excellence and the dissemination of results and will strengthen European research excellence in this area.

4. Structure of *BIOBASE.NET*

BIOBASE.NET will cover five specific aspects of research into biogenic VOCs and their importance in the context of global change and ecosystems. It will therefore be organised into five themes, with one participant responsible as convenor for each theme. The five themes, convenors and other *BIOBASE.NET* participants will be:

- Theme 1: Plant processes and biosynthesis of BVOCs (convenor: Loreto; Gershenson, Boronat, Lichtenhaler, Rohmer, Schnitzler, Isidorov, Niinemets, Velikova)
- Theme 2: Ecosystem functioning and the role of BVOCs (convenor: Holopainen; Dicke, Peneulas, Rambal, Hilker)
- Theme 3: Environmental controls on BVOC formation and emission (convenor: Koppmann; Wildt, Kesselmeier, Kreuzwieser)
- Theme 4: Emission fluxes: measurements and modelling (convenor Steinbrecher; Hewitt, Pio, Hansel, Laurila, Ciccioli, Valentini, Sanz, Puxbaum)
- Theme 5: Prediction of emissions on the European regional scale (convenor: Winiwarter; Simpson, Seufert, Hayman)

5. Activities to achieve the objectives of *BIOBASE.NET*

The activities of the five themes will be integrated in a series of multidisciplinary activities which will foster jointly executed research, allow integration and spread excellence:

Activity 1: workshop and conference organisation (objectives a, b, c) (*research activity; integration and excellence spreading activity*)

Activity 2: organisation of inter-comparison modelling, laboratory and field experiments and facilitation of field and laboratory campaigns and modelling activities (b, e) (*research and integration activity*)

Activity 3: development of common frameworks for research, dissemination and communication (objectives c, e) (*integration activity*)

Activity 4: training, courses, and grants (objectives d) (*integration and excellence spreading activity*)

Activity 5: data-base preparation and management (objectives f, g) (*research, integration and excellence spreading activity*) .

Each theme will develop a common framework in which the participants will carry out their research. This framework will explore common priorities, share infrastructure and expertise on methods and techniques, and develop common funding strategies. A biannual workshop will be held in alternate years to the Gordon Research Conference on Biogenic Hydrocarbons and the Atmosphere (which is the other occasion given to the BVOC community to share research and develop new ideas) and this will be open to researchers from inside and outside the Network. The training of young scientists and of scientists from outside the Network will be enhanced by training and exchange programmes. This activity will enforce integration among the network Institutions, including the dissemination of competences toward the participating EU associated countries, and the strengthening of the leading role of EU countries in the field of BVOC studies in relation to climate change.

6. Expertise needed to achieve the objectives of *BIOBASE.NET*

6.1 Critical mass required

There are around 30 research groups in the European Union that are active in *BIOBASE.NET* science working at a level of excellence that is clearly recognised as being internationally competitive. In order to keep the Network at a manageable size, and to ensure a balanced distribution across Member States, it is proposed to initially establish the Network with this core group of around 30 internationally excellent participants. This will provide a sufficient critical mass and breadth of expertise in the different disciplines to allow leverage of the proposed research activities, while maintaining a focus on the specific objectives of the Network. However, the Network will be open to other participants and active steps will be taken to widen membership during the first year. The balanced distribution of initial participants across Member States will

facilitate the dissemination of information about the Network within national scientific communities and so aid in the widening of participation. It is anticipated that around 10 participants will join during the lifetime of the Network.

6.2 Complementary with other Networks of Excellence and Integrated Projects

It is anticipated that other Networks of Excellence and Integrated Projects (e.g. *EFAVOC*) will address related issue of relevance in biosphere-atmosphere interactions, particularly in ecosystem functioning and in atmospheric chemistry and modelling. Although overlap will be avoided it is envisaged that related Networks will provide complementarity to *BIOBASE.NET* and dialogue and interaction will be important. Joint meetings and other activities will be carried out. It is anticipated that *BIOBASE.NET* participants will be actively involved in one or more Integrated Projects in this field.

7. Integration and structuring effects of *BIOBASE.NET*

The study of biogenic volatile organic compound emissions in the changing biosphere-atmosphere system in Europe will require the application of many different levels of analysis, from the molecular level to the cellular to the whole plant to the ecosystem to the atmosphere, and will require a truly multi-disciplinary approach. This will provide a unique synergism of the sort possible for only a few scientific issues. Such synergism should lead to the rapid development and dissemination of new experimental approaches. For example, in the field of BVOC biosynthesis (Theme 1), new molecular methods are becoming available for manipulating the biosynthesis of BVOCs. These could be developed in such a way that they could be incorporated into experiments to study the role of BVOCs at the whole plant level for investigation of their ecological roles (Theme 2) and environmental controls on formation and emission (Theme 3). The strengthening of scientific and technological excellence within *BIOBASE.NET* by the integration of activities and expertise currently dispersed across Europe will contribute to the creation of the ERA.

8. Participants and competencies [see definitions below]

1. Lancaster University, UK, Prof Nick Hewitt (n.hewitt@lancaster.ac.uk) [4,6,7,8]
2. AEATechnology, UK, Dr Garry Hayman (garry.hayman@aeat.co.uk) (industrial partner) [5,8]
3. ARC Seibersdorf Research, AT, Dr Wilfried Winiwarter (wilfried.winiwarter@arcs.ac.at) [5,8]
4. Bialystok University, Poland, Prof V Isidorov (isidorov@uwb.edu.pl) (associated participant) [2]
5. Bulgarian Academy of Sciences, Acad. M. Popov Institute of Plant Physiology, Dr Violeta Velikova, (vili33@yahoo.com) (associated participant) [1,2]
6. CEAM, ES, Dr Maria José Sanz (mjose@ceam.es) [2,3,4,7]
7. CNR, I, Dr Paolo Ciccioli (ciccioli@ntserver.iiia.mlib.cnr.it) [4,7]
8. CNR-Institute of Environmental Biology, I, Dr Francesco Loreto (franci@mlib.cnr.it) [2,3,4,6,7]
9. CNRS-Montpellier, FR, Prof Serge Rambal (rambal@cefe.cnrs-mop.fr) [1,2,3]
10. CSIC-CREAF-Universitat Autònoma de Barcelona, ES, Prof Josep Penuelas (Josep.Penuelas@uab.es) [2,3,4,6,7]
11. Finnish Meteorological Institute, FI, Dr Toumas Laurila (tuomas.laurila@fmi.fi) [4,7]
12. Forschungszentrum Juelich, DE, Dr Juergen Wildt (j.wildt@fz-juelich.de) [2,3,4]
13. Forschungszentrum Juelich, DE, Dr Ralph Koppman (r.koppmann@fz-juelich.de) [4,6,7]
14. Freie Universität Berlin, DE, Prof Monika Hilker (hilker@zedat.fu-berlin.de) [1,2,3,6]
15. Institut fuer Meteorologie und Klimaforschung, Bereich Atmosphärische Umweltforschung, DE, Dr Joerg-Peter Schnitzler (schnitzler@ifu.fhg.de) [1,5,8]
16. Institut fuer Meteorologie und Klimaforschung, Bereich Atmosphärische Umweltforschung, DE, Dr Rainer Steinbrecher (rainer.steinbrecher@imk.fzk.de) [2,3,4,5,6,7,8]
17. Ionicon GmbH, AT, Dr Armin Hansel (armin.hansel@uibk.ac.at) (industrial partner) [4,6,7]
18. IVL, SE, Dr David Simpson (david.simpson@ivl.se) [5,8]
19. Joint Research Centre Ispra, IT, Dr Guenther Seufert (guenther.seufert@jrc.it) [4,6,7]

20. Max Planck Institute for Chemical Ecology, DE, Prof Jonathan Gershenzon (Gershenzon@ice.mpg.de) [1,2,3]
 21. Max-Planck Institute, Mainz, DE, Prof J. Kesselmeier (jks@mpch-mainz.mpg.de) [2,3,4,6,7]
 22. Université Louis Pasteur Strasbourg, FR, Prof Michel Rohmer (mirohmer@chimie.u-strasbg.fr) [1,2,6]
 23. University of Aveiro, PT, Prof Casimiro Pio (casimiro@ua.pt) [4,6,7]
 24. University of Barcelona, ES, Prof Albert Boronat (aborobat@bq.ub.es) [1,2,6]
 25. University of Freiburg, DE, Dr Juergen Kreuzwieser (kreuzwie@uni-freiburg.de) [1,2,3]
 26. University of Karlsruhe, DE, Prof Hartmut Lichtenthaler (hartmut.lichtenthaler@bio-geo.uni-karlsruhe.de) [1,2,6]
 27. University of Kuopio, FI, Dr Jarmo Holopainen (Jarmo.Holopainen@uku.fi) [1,2,3]
 28. University of Tartu, Estonia, Dr Ulo Niinemets (ylo@zbi.ee) (associated participant) [1,2,4]
 29. University of Tuscia, I, Prof Riccardo Valentini (rik@unitus.it) [4,7]
 30. Vienna University of Technology, AT, Prof Hans Puxbaum (hpuxbaum@mail.zserv.tuwien.ac.at) [4,7]
 31. Wageningen University, NL, Prof M. Dicke (Marcel.Dicke@Users.ENTO.WAU.NL) [1,2,3]
- Competencies: 1 Biochemistry; 2 Plant physiology; 3 Ecosystems; 4 Emissions measurements; 5 Emissions modelling; 6 Lab studies; 7 Field studies; 8 Modelling

9. Promotion of results outside of the *BIOBASE.NET* Network of Excellence

The results of the Network will be promoted by formal and informal meetings, scientific publications, popular publications, web sites and new and emerging electronic media.

10. The role of SMEs in the *BIOBASE.NET* Network of Excellence

SMEs have an important role to play in the development and exploitation of new technologies. Of relevance to *BIOBASE.NET* will be the development of new and improved chemical and biochemical analytical techniques, and the application of remote sensing and data analysis methods. The involvement of SMEs in the Network will be actively encouraged.

11. Management of the *BIOBASE.NET* Network of Excellence

The five *BIOBASE.NET* theme convenors, five members elected by the participants, and the scientific co-ordinator and assistant co-ordinator will comprise the network's Governing Body or Management Committee. The Management Committee will meet twice annually (three times in the first year) to discuss Network priorities and activities. It will co-opt other participants (and outside scientists) as necessary to aid in these discussions. In particular, it will invite membership from scientists from the International Global Atmospheric Chemistry programme (IGAC) community to ensure complementarity with research conducted outside Europe in this field. Representatives of other Networks of Excellence and related integrated Projects will be co-opted as necessary. Scientific and administrative co-ordination of *BIOBASE.NET* will be located at Lancaster University, UK.

It is anticipated that the Network will have a lifetime of 5 years. In the first phase of the Network, the Network office will be established, and the themes will be developed. A work programme for each theme will be developed and agreed, in line with the scientific activities of the respective theme members. These work programmes will be presented to a kick-off meeting of the entire Network, and each work programme will be discussed and modified. All members of the Network will be invited to participate in this. A revised version of the work programmes will be reviewed by the Management Committee. The progress made in attaining the stated objectives of the Network within each theme will be reviewed each year by the Management Committee and the work programmes for the coming year developed in the light of annual progress.

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