Academy of Finland

Evaluation and forecasting of the atmospheric concentrations of allergenic pollen in Europe

The research plan, 14 May 2004

Participants:

Finnish Meteorological Institute (FMI), Air Quality Research & Meteorological Research, Helsinki

University of Turku (UT), Aerobiological Unit, Department of Biology, Turku

University of Helsinki (UH), Department of Biological and Environmental Sciences & Department of Forest Ecology, Helsinki

Collaborators (participate using their own resources):

The Finnish Forest Research Institute (METLA), Muhos Research Station, Finland

Medical University of Vienna, HNO Clinic (co-ordinator of European Aeroallergen Network EAN) , Austria

Danish Meteorological Institute (DMI), Copenhagen, Denmark

Main Geophysical Observatory (MGO), St. Petersburg, Russia

Photographs on the cover page: a twig of birch during pollinating season, enlarged birch pollen grain s (the diameter of each grain is approximately 20 μm).

CONTENT:

1. Background and motivation

Diseases in the respiratory system due to aeroallergens, such as rhinitis and asthma, are major causes of a demand for increased healthcare, loss of productivity and an increased rate of morbidity. The overall prevalence of seasonal allergic rhinitis (allergic reactions in the upper respiratory system) in Europe is approximately 15 %; the asthma rates vary from 2.5 % - 10 %; while the prevalence of atopic dermatitis ranges from 9 % - 24 %. Pollenosis accounts for 12 - 45 % of overall allergy cases. The sensitisation to pollen allergens is increasing in most European regions.

The adverse health effects of allergens can be reduced by pre-emptive medical measures. However, their planning requires reliable forecasts of start time of high atmospheric pollen concentrations, as well their levels and durations (Rantio-Lehtimäki, 1994), (Rantio-Lehtimäki & Matikainen 2002). The World Health Organisation (WHO) and the European Phenology Network (EPN: http://www.pik-potsdam.de/~rachimow/epn/html/framepollen.html) have recently stressed the importance of the timely forecasting of the pollen seasons, and recommended new research in this area (WHO, 2003).

Many European countries have national networks of pollen monitoring stations. National networks belong to the European Aeroallergen Network (EAN: http://www.univie.ac.at/ean/), which is a non-profit initiative that maintains a European pollen database and produces the pollen forecasts for Europe. However, the currently available forecasts are based solely on local observations and do not consider the pollen transport from other regions or countries. At present, there is no modelling system in Europe that can simulate the pollen transport in the atmosphere . Further, there is no such model for evaluating the pollen emissions (including the pollinating season and the flowering characteristics of the relevant species) that would provide the input data for such atmospheric dispersion modelling.

There is convincing evidence that the long-range transport of pollen from remote regions can significantly modify pollinating seasons (i.e., the start time and duration of high atmospheric pollen concentrations) in many European regions. This is particularly important for Northern Europe - and especially for Finland, where the flowering takes place later in spring. The most important pollinating species in this respect is the birch, and Finland is neighboured by the Baltic countries, Western Russia and Byelorussia, where the proportion of birch forests regionally exceeds 40 % of forest area. This transport causes unforeseen and sudden increases of concentrations of pollen that can occur up to a month before the start of the local pollen season. The long-range transport can substantially increase the concentrations of allergenic pollen also during the local pollen seasons.

The birch pollen is the most important allergen, due to its fairly small size, and ability to be transported over large distances. There are two treelike birch species in Europe. Downy birch (*Betula pubescens*) is the most common in the northern part of Europe, while silver birch (*Betula pendula*) is dominating in more southern regions. Typical birch pollen grain has a size of 20-22 μm. It is fairly light (a full grain filled with protein material has a density of ~ 800 kg m^{-3}), and approximately spherical. The most efficient removal mechanism from the atmosphere is scavenging by precipitation.

From May 2003 to April 2004, University of Turku (UT) and Finnish Meteorological Institute (FMI) have conducted a one-year feasibility study of the modelling of long-range transport of birch pollen over Europe. The main objectives were to preliminarily evaluate the pollen emission and atmospheric transport in Europe, to review the main mechanisms behind it, and to attempt to simulate the corresponding episodes. Within that study, we showed that the pollen sources at a distance of thousands of kilometres can cause substantially high concentrations (Siljamo *et al*, 2004). The results and findings of this study have formed the scientific basis of the current proposal.

The most important publications of the project team are: Kousa et al (2002), Linkosalo (2000a), Pohjola *et al* (2003), Rantio-Lehtimaki & Matikainen (2002), Siljamo *et al* (2004), Sofiev (2000, 2002a). The experience of the group formed the basis for the invited lecture by Sofiev *et al* at coming 10^{th} Symposium on Aerobiology of Nordic Aerobiological Association (Turku, 19-20.08.2004).

Post-graduate studies in this project will be conducted by Ms. Pilvi Siljamo (FMI, doctoral degree scheduled in 2007), Ms. Minna Rantamaki (FMI, doctoral degree in 2006) and Ms. Mia Pohjola (FMI, doctoral degree in 2005) , two students at UT and one at UH (master theses in 2005 - 2006). Dr. Tapio .Linkosalo (UH) and Ms. Mia Pohjola are scheduled to conduct post-doctoral studies in this project.

2. Objectives

Overall objectives of the project are:

- to develop an integrated modelling system for simulating and forecasting in time the natural pollen emissions and transport on an European scale;
- to evaluate the spatial distributions of pollen emissions and concentrations in Europe.

We have selected birch pollen as the first example pollen species, due to substantial health effects for the population, and its ability to be transported over substantial distances. The specific objectives are:

- to develop, evaluate against experimental data and implement in numerical model a unified parameterization of the birch pollen emissions over Europe;
- to model the physical and chemical characteristics of pollen grains (as a special case of atmospheric aerosol) and implement these findings in an atmospheric dispersion model;
- to utilise in a complementary manner both the satellite and ground-based data for real-time modelling of the start of the growing and pollinating seasons in Europe;
- to simulate and forecast (for a period from one day to a week) the regional and continental scale spatial distribution of airborne birch pollen in Europe; and
- to evaluate the accuracy and reliability of the modelling system to be developed in this study by comparing model predictions with the phenological and aerobiological observations.

3. Materials and methods

3.1. Input datasets

3.1.1. Phenological observations, pollen counts and field campaigns

There are two main categories of the European-wide observations: phenological observations of the seasonal development of birch, and measurements of the atmospheric pollen concentrations.

We will utilise the phenological observations made by the European Phenological Network (EPN: http://www.pik-potsdam.de/~rachimow/epn/html/framepollen.html) and the International Phenological Garden (IPG: http://www.agrar.hu-berlin.de/pflanzenbau/agrarmet/ipg_2.html) project. The datasets contain observations of the start, intensity and duration of the growth and flowering. Atmospheric pollen concentrations are measured by the European Aeroallergen Network (EAN: http://www.univie.ac.at/ean/). These measurements comprise the sampling of airborne pollen with impaction-based devices, and the subsequent counting of the numbers of grains. This procedure yields the number concentrations of grains per m^3, which are commonly referred to as "pollen counts". Some national observations, such as those performed in Russia, are not reported to EAN and will be added to the main dataset. These networks cover most of Europe in space, several decades in time, and numerous pollinating species, including the birch species.

The information obtained during specific atmospheric field campaigns will also be utilised for evaluation of the modelling system. These campaigns include ETEX (http://rem.jrc.cec.eu.int/etex/) and large-particle alkaline dust dispersion and deposition (Kaasik et al., 2004, Sofiev et al., 2003).

3.1.2. Meteorological and forest data

The FMI modelling systems are connected to operational and historical meteorological data produced by the numerical weather prediction model HIRLAM, as well as to the databases of the European Centre of Medium-Range Weather Forecast (ECMWF). The HIRLAM model has been used operationally at the FMI since 1990 for the numerical weather predicting. Currently, the model produces 54-hour long forecasts four times a day covering Europe, Northern Atlantic and Western Russia. FMI participates also in the international HIRLAM development project.

There are several regional-scale birch forest inventories (e.g. Alexeyev& Birdsey, 1998, Köbler & Seufert, 2001), which will be used in combination with the satellite maps, in order to obtain a unified inventory of the birch forests in Europe and Western Russia. Information from satellites such as ERS and ENVISAT (MERIS) will provide the near-real-time vegetation growing index.

3.2. Models

3.2.1. Models of the birch growing and flowering seasons

There are several semi-empirical models for predicting the start and duration of the flowering seasons. Descriptions of the flowering start time are based on three main principles: (i) climatological averaging of long-term observations (e.g., Rötzer & Chmielewski, 2001), (ii) heat sums (such as the so-called degree-days, and period units (Hänninen, 1990, Linkosalo, 2000 a,b, Luomajoki, 1999 and Sarvas, 1972) and (iii) dynamic models (e.g., promoter-inhibitor model of Schaber & Badeck, 2003). The estimates based on climatological averages are not suitable for performing dynamical short-term simulations, in which the conditions can be substantially different from climatic averages (e.g. Emberlin *et al.*, 2002). However, the climate-based values are available over the whole of Europe, while the methods (ii) and (iii) are usually based on local or, at best, country-wide observations, and are therefore not representative on a European scale.

The description of other parameters of flowering such as its intensity and the total amount of released pollen also require the use of semi-empirical models that predict the next-year flowering features, based on the conditions of the previous growing season (Masaka & Maguchi, 2001).

3.2.2. Atmospheric dispersion model and supplementary tools

The development of the integrated model will be based on the emergency modelling system SILAM (Sofiev, 2002), (Sofiev & Siljamo, 2003), (http://www.fmi.fi/research_air/air_50.html), which is currently used for the operational forecasting of the consequences of potential emergency situations in the vicinity of Finland. The system is based on a so-called Lagrangian Monte-Carlo random walk dispersion model. The treatment of aerosol is based on a modal representation of the aerosol size spectrum and state-of-the-art parameterizations of the dry and wet deposition processes. The transport modules have been tested in the EU-funded ENSEMBLE project (http://ensemble.ei.jrc.it/), the ETEX project (http://rem.jrc.cec.eu.int/etex/) and the Nordic NKS MetNet (http://hirlam.fmi.fi/MetNet) project. The parameterization of deposition processes has been evaluated against the data of an observational campaign of alkaline dust deposition from Estonian power plants (Kaasik *et al* 2004).

The model comparison with observations will utilise the Model and Measurement Analysis Software (MMAS: http://www.fmi.fi/research_air/air_49.html) developed at FMI. This tool has recently also been tested and used for the needs of EU-funded FUMAPEX project.

3.3. Ethical questions and data protection issues

Utilisation of the above data sets and models do not cause any ethical problems since none of the datasets or tools has any official restrictions. However, a use of the information in co-operation with the data producers and owners in envisaged and partially approached via the mechanism of the project collaborators. In few cases, the extraction costs are applicable for individual datasets (mostly those produced in Russia), which is reflected in the project financial plan.

4. Work plan and expected results

The block diagram of data, models and model evaluation of this study is presented in (Figure **1**).

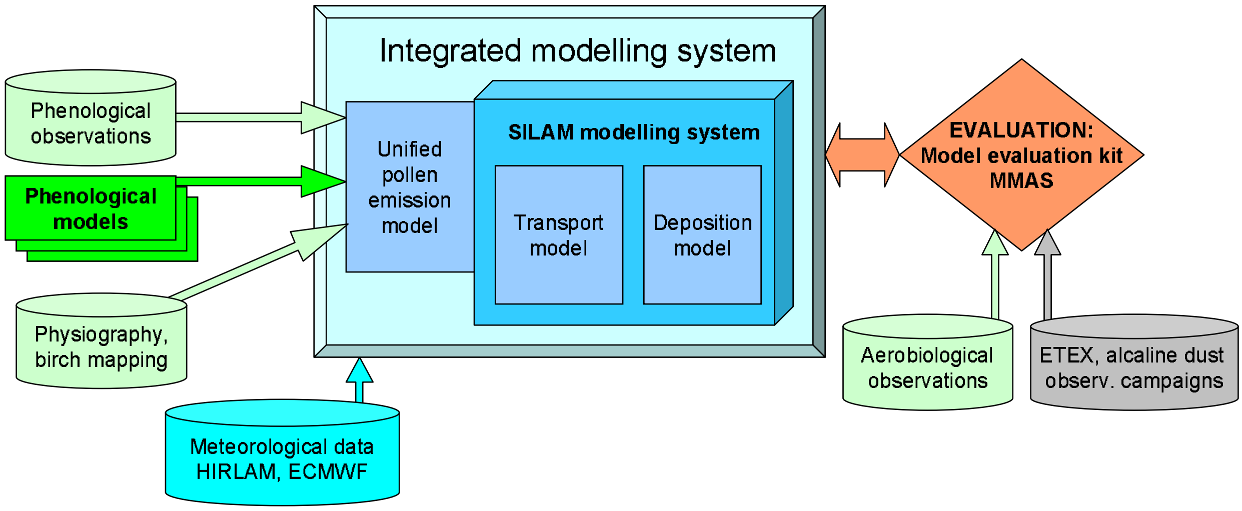

Figure 1. A schematic presentation of the utilization of the various input datasets, the integrated modelling system, and the evaluation of the system against experimental data.

4.1. The project work packages

4.1.1. Workpackage 1. Development of a birch pollen emission model (co-ordinated by Doc. Rantio-Lehtimäki, UT)

Task 1.1. Development of a unified model of birch flowering. The task will use the above three types of flowering models (p.3.2.1). It will include development of a unified parameterization for the heat sum models (having a climatological mean as a common basis), selection of the best-performing model or models and their evaluation.

Result: A unified model for the simulation of the birch flowering start time and duration in Europe.

Task 1.2. Forecasting of the birch flowering characteristics. The amount of flower production of birch may vary from year to year within more than an order of magnitude. (Herrera et al., 1998). The initiation and growth of birch catkins take place in spring and early summer nearly one year before pollination. Weather conditions and the resource allocation to reproduction can be used to predict the intensity of the pollination in the next year (Dahl & Strandhede, 1996, Masaka & Maguchi, 2001). The task includes an evaluation of long-term pollen and catkin data provided by the METLA, IPG and EPN against processed meteorological data, and the subsequent adaptation of empirical models.

Result: a model for prediction of the flowering intensity based on meteorological and phenological conditions of the preceding year.

Task 1.3. Mapping of the pollen forests. Up to date, a unified birch forest map has not existed for Europe. Digital datasets , such as (Köbler & Seufert 2001), have been compiled from national surveys or expert estimates, and contain internal discrepancies in the data and in the mapping methodology. The task therefore includes a critical evaluation of the existing data, combining them with satellite information and new inventories, and compiling a detailed map of birch forests in Europe.

Result: A unified map of the birch forest in Europe, and an evaluation of the information accuracy.

4.1.2. Workpackage 2. Development of an integrated model including emission and atmospheric dispersion (co-ordinated by Dr. Mikhail Sofiev, FMI)

Task 2.1. Parameterizing the physico-chemical characteristics of the pollen grains with regard to the atmospheric transport. The previously developed (the feasibility study) mathematical treatments for advection and dry deposition will be refined, tested and implemented. The model currently allows for the specific properties of pollen particulates, e.g., the particles with low density, fairly large size, specific morphology and a moderately hydrophobic behaviour. The main attention inside this task will be put on the scavenging process and its inter-actions with other mechanisms.

Result: Refined and tested atmospheric transport and removal modules (computer programs).

Task 2.2. Update of the SILAM modelling system. Current research version 3.5 (dated May 2004) of the SILAM model (Sofiev, 2002) will be used as the basis for model development. It already contains a prototype for pollen dispersion model (the feasibility study). The emission sub-models (developed in the WP1) and mathematical treatment for transport and removal processes (task 2.1) will be implemented to the SILAM model. The forecasts will cover a period from one day to a week.

Result: An integrated model containing the treatment for emissions, atmospheric transport and removal processes, specifically adapted for pollen grains.

Task 2.3. Model evaluation. The evaluation will be based on a few selected years and selected episodes of high pollen concentrations, for which both phenological and aerobiological data are available. This will be performed simultaneously with the implementation of task 2.2, in order to ensure the overall system consistency and to provide a preliminary quality assurance (QA) for the integrated model. The statistical tool used in model evaluation is the Model and Measurement Analysis Software (MMAS, http://www.fmi.fi/research_air/air_49.html).

Result: A preliminary evaluated and quality assured (QA) integrated model.

4.1.3. Workpackage 3. Utilization of the satellite and other real-time data for the evaluation of emission fluxes (co-ordinated by Prof. Heikki Hänninen, UH)

The real-time assimilation of the observed meteorological data has been the most important factor in improving of the meteorological forecasts during the last decades. A similar methodology can also be used in order to improve the pollen forecasts, especially concerning the characterization of flowering periods. However, the scarcity of the observation network of pollen concentrations remains to be a limitation for this methodology.

Task 3.1. Utilization of the satellite data regarding the vegetation growing index. The analysis will be based on the data extracted from the ENVISAT satellite dataset. The vegetation growing index for previous years will be compared with phenological observations in order to generate a model that connects the observed growing index and the pollinating seasons. The model will subsequently be applied in other years in order to evaluate its performance.

Result: Evaluation of the accuracy of the integrated model (developed in WP 2) utilising the satellite-observed growing index as input data, compared with the accuracy of the integrated model using as input the phenological approaches for the pollen emissions.

Task 3.2. Direct assimilation of the near-real-time EAN pollen counts. Test runs using the integrated model will be performed for a few latest years using the EAN pollen counts in Central Europe as the initial concentrations of the pollen grains. The results (predicted pollen concentrations over the whole of Europe) will be compared with the rest of the EAN dataset and with the corresponding model runs based on the phenological emission modelling.

Result: The relative accuracy of the model using actual EAN observations as initial data, and a comparison of this accuracy to that using the pollen emission sub-model.

4.1.4. Workpackage 4. Application of the integrated model and forecasting in time the pollen concentrations (co-ordinated by Prof. Jaakko Kukkonen, FMI)

Task 4.1. Creation and analysis of the historical long-term data sets describing the spatial distribution of the pollen concentrations in spring. The task includes a comparison of the predicted concentrations with aerobiological observations. This provides the second part of the overall evaluation of the integrated modelling system (the first one was in the Task 2.3.). The computed patterns will represent the spatial distribution of the pollen concentrations on a continental scale in Europe. These predicted results will be used to assess the main source areas, and the year-to-year variability of the resulting spatial distributions.

Results: The regional and continental scale spatial distribution of pollen concentrations in Europe for several past years; and an evaluation of accuracy and reliability of the integrated model.

Task 4.2. Inverse (adjoint) modelling studies of the main pollen sources that affect Northern Europe. The adjoint dispersion model simulations will use the measured pollen concentrations as input data, and delineate the most probable sources of the observed pollen concentrations. This is complementary to the task 4.1. The computational methods have been discussed by Sofiev & Sofieva (2000), Sofiev (2002), and Sofiev & Siljamo (2003).

Results: The source-receptor relationships for the spatial European pollen distribution.

Task 4.3. The sensitivity of the modelling system to variations of the input data and the model setup. A set of sensitivity runs with regard to emission and meteorological data, as well as with regard to the model setup will be performed. The results will be used for assessing the main potential sources of uncertainties in the model predictions. These results also lead to an improved insight in view of further model development.

Result: Assessment of the sensitivity of the modelling system to emission and meteorological data and to the model setup.

For the project duration of 2005 – 2007, the timetable planned is the following.

WP No	Short title	2005	2006	2007
WP1	Development of the pollen emission model	**********		
WP2	Development of the integrated model	*******	********	
WP3	Utilization of satellite and other real-time data		**********	**
WP4	Application of the integrated model		*****	*********

4.2. *Publication and dissemination of the research results*

The main research results will be published in international peer-reviewed papers, throughout the duration of the project. The final stage of the project (late summer and autumn of 2007) is specifically devoted to writing such papers and a final technical report. Fairly short review-type papers will be published nationally in Finnish. A www site will be created for the dissemination of information, and also to act as a working platform, within the first three months of the project

Dissemination of the results will include the following:

- The scientific results (both observational and model-based) are disseminated within EAN and EPN communities, world-wide IAA (International Association for Aerobiology), EMEP and the European atmospheric dispersion modelling community, and interested Russian organizations, mainly via presentations and publications in peer-reviewed scientific journals.
- the integrated model can later be converted into an operational system and included into the FMI operational suite of models. The pollen forecasts can then be distributed to the relevant authorities and institutes. The results will be made available to the decision-making authorities in the area of public health and the environment in Finland.
- The results will be available for the forest research and agricultural institutes regarding the migration paths of the biological genetic material due to atmospheric transport in Europe.

4.3. Project innovation and benefits

The project is multi-disciplinary in nature, and combines in a novel way experts on atmospheric science, aerobiology and forest research. The project will develop a unique integrated modelling system for emission, transport and deposition of natural allergenic species, using the birch pollen as the most prominent example. The individual sub-models include a unified model for predicting both spatially and temporally the European birch pollen emissions, and the corresponding atmospheric dispersion model adapted to the characteristics of pollen grains. Such models and modelling systems have not previously been developed.

We have focused in particular on the critical evaluation of the accuracy and reliability of the modelling methods against available experimental data. The project does not plan specific measurement campaigns, we rather intend to fully utilise the existing extensive European datasets. However, UT is performing the atmospheric pollen observations (not charged from the project) that will be available for the study. The utilization of satellite data in combination with the ground-based observations, in the form planned in this proposal, has also not been done previously.

The application of this model will generate several new European-wide data sets. These include, e.g., a birch forest map, and the predicted multi-annual spatial distributions of the birch pollen concentrations. The utilization of these results and datasets will lead to an improved knowledge regarding the geographic regions affected by the birch pollen transport, as well as the main source areas of birch pollen in Europe.

5. Performers of the research and resources

The FMI research team is responsible for project coordination and management, and atmospheric dispersion modelling. It has extensive expertise on urban, regional and continental air pollution research. Short-range atmospheric dispersion models have been developed and applied at FMI since the early 1970's. FMI has strong positions in remote sensing, in particular, it hosts one of the European processing centres for the new ENVISAT satellite (the ever-biggest ESA environmental project). We are actively taking part in international research co-operation and extensively publishing in international refereed journals.

The UT team is responsible for the aerobiological expertise in the project, development and evaluation of the pollen emission model and forecasting the birch flowering characteristics. The team has a broad experience with aerobiological observations and, being authorized by the Ministry of social affairs and public health, is responsible for the pollen information service in Finland.

UH is responsible for the utilization of the satellite-derived and ground-based near-real-time data and other phenological expertise of the project. The team possesses the broadest expertise on plant-related processes, their monitoring and modelling, including ecophysiology, research on climate change and its influence on the plant phenology.

The main researchers participating in the study are the following:

Finnish Meteorological Institute:

Prof. Jaakko Kukkonen, Manager of Air Quality Research (AQ), project co-ordinator
Dr. Mikhail Sofiev, senior scientist in AQ, responsible for the integrated model development
Ms. Mia Pohjola, scientist in AQ, will obtain PhD in 2005, then will work as a post-doc
Ms. Pilvi Siljamo, scientist in Meteorological Research (MET), will obtain PhD in 2007
Ms. Minna Rantamäki, scientist in MET, will obtain PhD in 2006

University of Turku, Aerobiology Unit

Dr. Auli Rantio-Lehtimäki, Docent, responsible for the pollen emission module development
Dr. Hanna Ranta, University of Turku (UT), Docent, senior scientist, birch flowering characteristics

University of Helsinki

Prof. Heikki Hänninen, Dept. of Biological and Environmental Sciences, phenological models
Dr. Tapio Linkosalo, Dept. of Forest Ecology, satellite data, phenological models

Collaborators (participating with own resources), contributors to the project:

Dr. Eero Kubin, The Finnish Forest Research Institute, Muhos Research Station, Timing of phenological events in changing climate, Finnish phenological data.

Prof. Siegfried Jäger, HNO Clinic, Medical University of Vienna, Austria. Co-ordinator of EAN. Aerobiological data collection, exchange and analysis.

Dr. Aleksander Baklanov, Dr. Alix Rasmussen, Danish Meteorological Institute, Copenhagen, Denmark. Pollen observations and forecasting system (Rasmussen, 2002; Porsbjerg *et al.*, 2003).

Prof. Eugene Genikhovich, Main Geophysical Observatory, Air pollution modelling and forecasting laboratory, St.Petersburg, Russia. Model development and evaluation, risk assessment (after e.g. Genikhovich *et al*, 1999).

The research team consists of senior scientists (Prof. J.Kukkonen, Prof. H.Hänninen, Dr. M.Sofiev, Dr. A.Rantio-Lehtimäki, Dr. H.Ranta), post-doctoral scientists (Dr. T.Linkosalo, Ms. M.Pohjola after obtaining the PhD), PhD students (Ms. P.Siljamo, Ms. M. Rantamäki, Ms. M.Pohjola at the start of the project) and M.Sc. students involved by UT (2 students) and UH (1 student).

6. National and international co-operation, connections to other projects

The project proposal is based on the results and findings of a collaborative feasibility study 'Long-range transport of natural allergic pollutants', financed jointly by UT and FMI, and a research grant of 6000 Euro (to be used in 2004) that has been granted to P.Siljamo by Emil Aaltonen Foundation for the research in this area.

The main data providers on airborne pollen concentrations in Europe for the model evaluation will be EAN, EPN and IGP. These programmes will be also the key international users of the results.

There is an established co-operation between the FMI and UN-ECE Convention on Long-Range Transboundary Air Pollution and the European Monitoring and Evaluation Programme EMEP, regarding the modelling of atmospheric dispersion of aerosols.

Regarding the model development, its evaluation and application, the proposed project is also related to the "Cluster of European Air Quality Research", CLEAR (http://dev.allez.no/clear/aim.htm), and especially the EU-funded project "Forecasting Urban Meteorology, Air Pollution and Population

Exposure – FUMAPEX". FMI is a participant in FUMAPEX, and two other projects (OSCAR and SAPPHIRE) within CLEAR.

The mechanism of the project collaborators (see above) additionally ensures intensive contacts and harmonization of the efforts with the main European scientific groups working in the area.

7. Research training provided in connection with the project

The project has been designed to contribute to the studies of six students: PhD students Ms. Pilvi Siljamo, Ms. Minna Rantamäki and Ms. Mia Pohjola (FMI), two MSc. students from UT, and one MSc. student from UH. Additionally, Dr. Tapio Linkosalo (UH) and Ms. Mia Pohjola (UH) will conduct post-doctoral studies within the project. The managers of the participating research teams at FMI, UT and UH have leading roles in the guidance and supervision of these students. The project leader is also working part-time at UH as a docent.

The project results will be used by participating universities for their study and research courses. In particular, the proposal is related to the research and teaching of plant ecology that is part of the major Plant Biology set of courses. Phenoly is an essential part of the work related to the effects of projected climate change.

8. Project financial plan

The requested funding from Academy of Finland is 285800 Euro for a period of three years 2005-2007. Most of this funding will be spent to salaries of young and promising pre-doctoral scientists: M.Sc. P. Siljamo (FMI, 30 person-month), M.Sc. M. Rantamaki (FMI, 9 person-month), two M.Sc. students (12 person-month, UT), and a post-doctoral scientist Dr. T. Linkosalo (24 person-month, UH). Although the collaborators are not scheduled to receive direct funding from the Academy of Finland, they are nevertheless active participants in the project.

The most of the overhead costs, computing etc. will be covered from the budgets of the participating institutes. In particular, FMI will support all the runs of the integrated model at own facilities and at the supercomputer system at Centre of Scientific Computing of Finland (CSC). FMI will also provide a funding contribution mainly spent to salary of J.Kukkonen, M.Sofiev and M.Pohjola – totally 125000 Euro. UT will provide a funding contribution mainly spent to salaries of H. Ranta, A. Rantio-Lehtimäki, totally 50 000 Euros. UH will provide the contribution, mainly devoted to the salary of H. Hänninen and M.Sc. students, totally 50 000 Euros.

The travel costs (25000 Euro) are scheduled to trips mainly to the project workshops and meetings of the above pre- and post-doctoral researchers. The workshop meetings and seminars will be organised in Finland (Helsinki, Turku) or related to international conferences in this area. The item "other costs" (20000) covers publications and extraction costs for the information obtained from the databases handled by organizations outside the project.

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