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Continental Slovenia and Croatia as a common information area for pollen forecasting

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Pollen has been definitely proven as one of the most potent allergens. Allergenic plants are characteristic for particular areas, depending on the geographic-climatic zone and vegetation. Pollen concentrations of such plants depend on particular species phenological stage and weather conditions in the area. Providing preventive information on the occurrence of pollen allergens in the residential and industrial areas is crucial for allergic individuals to improve the quality of their lives. More over, modern human life style and population migration allows pollen allergens to aggressively spread, and this is actually a macro-regional problem.

Due to these reasons a lot of European countries conduct pollen monitoring on their and neighbouring territory. That was the reason why we started a bilateral project "Continental Slovenia and Croatia as a common information area for aeropalynological researches". The project started at the beginning of 2003 and we now have first results.

We are compiling aerobiological researches of the similar climatic-phytogeographic area of the continental parts of Slovenia and Croatia. Specific attention was devoted to the most invasive aeroallergen *Ambrosia artemisiifolia*. From the beginning of the project we collected pollen at four stations in Slovenia (Ljubljana, Hrasce, Zalec and Maribor) and four in Croatia (Samobor, Zagreb, Ivanić Grad and Osijek). Reports about pollen appearance were made monthly and after the pollen season we prepared yearly reports and diagrams for the researched area, which will be presented here. So far we can conclude that the most important allergenic plants in continental area of Slovenia and Croatia are *Betula*, *Corylus*, Urticaceae, Cupressaceae, Poaceae, *Alnus*, *Ambrosia*, *Fraxinus*, *Quercus*, *Carpinus and Castanea*.

The project is ongoing and we expect it will help in prevention of the symptoms of allergic reactions in individuals with regard to pollen hypersensitivity and in the future in forecasting the specific pollen season in this region.

From Pollen Counts to Allergy Risks or Meaningful Aerobiology

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Even if there are now standard methods and techniques to collect and measure the atmospheric pollen content, the way this content is then reported as so called "pollen counts" is at best confusing and at worst misleading. Indeed, most pollen reports will differ when they are presented by different groups, even if they are coming from the same region. Pollen counts are "transformed" into risk by rules of thumbs that have no scientific basis what so ever. Moreover, there are a lot of factors that can explain these differences different regions are considered: phytogeography, phenology, allergenicity. In this regard, we would like to propose a multi-faceted methodology that would try to make sense of all these factors. First, instead of having risk reports linked to raw counts, these should be modulated by the different species. Then, the site representativeness should be taken into account. Finally, a statistical estimate of the risk, as compared to the average expected for one region, should be taken into account. This can be based on the Main Pollen Season Average Minimum (MPSAM), Mean Pollen Season Mean (MPSM), Minimum Yearly Maximum (MYM), Maximum Yearly Average (MYA). Examples from Canadian and Swiss sites will be exposed. From these standards, it should be possible to obtain comparable risks from different settings.

Session c4

POLLEN AND FUNGAL SPORE DISPERSAL / LONG DISTANCE TRANSPORT

Long distance transport of allergenic pollen – a common phenomenon?

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Long-distance transport (LDT) of biological particles is well known everywhere; for instance, phenomena called 'yellow snow' or 'yellow rain'containing foreign pollen from distances of several thousands of kilometres have been reported repeatedly. Pollen from far origin have lost their protein content, the grains are empty and therefore not allergologically important. However, pollen from 1000 km distance has been shown to retain the potency and might thus also cause allergic symptoms. Strange results in many published papers concerning the start of pollen period could find explanations in LDT pollen. Early separate peaks in several pollen calendars certainly reason in LDT and not only in abnormal meteorological conditions as often suggested. The LDT phenomenon is not easy to study if no local phenological observations exist. Extreme geographical areas like Alaska or Lapland in the North, or respectively, Southern Spain or Italy are natural LDT study areas. When non-local pollen (i.e. marijuana pollen in Spain or pollen of southern herbs in Alaska) occur, LDT is the obvious explanation. To find out the origin of foreign pollen, trajectories of air currents backwards are necessary.

In allergological point of view LDT pollen is especially important at northern latitudes, where high frequencies of foreign pollen often occur 2-3 weeks before the beginning of local flowering. Global warming has been reported to induce generally an earlier start in flowering of allergenic plants in Europe, but results concerning the northermost areas of the continent have been contradictory. Instead, LDT pollen in general has increased and changes in air currents due to climate change is one of the suggested explanations. The separation of LDT pollen from local production was studied at Kevo, Finnish Lapland. Two approaches were used to mark the beginning of pollen season: cumulative degree days (d.d.), and the date of anthesis based on phenological observations. Using these starting dates, the 2,5% threshold widely in use was calculated. Only phenological observations gave reliable results about the start of local flowering.

To predict LDT pollen episodes, a comprehensive model of atmospheric transport is needed, and again, network of phenological observations and/or reliable phenological model would be essential to detect the possible pollen source areas. The computer model can be built on the basis of existing emergency models for radioactive nuclear emissions. Only some changes especially in source dimensions and other details are needed. Both very small allergenic particles and intact pollen grains can be modelled with the same program. In the future we hope to end up with the prototype of the atmospheric dispersion model for the LDT pollen. It would be a useful tool for every day pollen information service. A multidiscliplinary collaboration and combined networks of phenologists, meteorologists, allergologists and aerobiologists would be essential to clarify the relationships between changing climate, allergens and allergic disorders and to improve forecasting accuracy and effectiveness.

The behaviour of the atmosphere in long-range transport

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The purpose of this paper is to review the basic principles of long-range transport from the point of view of Atmospheric Physics.

The transport of all aerosols reaching the atmosphere from their place of production depends on topographical and meteorological conditions. In many cases, it is the action of the atmospheric system itself that causes particles already precipitated to re-enter it.

In the study of meteorological conditions and their influence on the transport of aerosols, we consider the atmosphere as a physical system and firstly we shall analyse the energy exchange processes taking place in it. As the energy source is solar radiation, we have to consider the amount of energy entering the atmosphere and its spatial distribution, which depends not only on latitude, but also on cloud cover.

Secondly, we shall study the conditions of air movement, which is the basic driver of transport. A review will be made of the meteorological concepts of stability, convection and thermal inversion, which are closely bound up with the vertical transport of pollutants. We shall also examine the pressure systems at the Earth's surface causing horizontal movement of air. We shall focus especially on the extent of the influence of winds due to the pressure gradient and the Coriolis effect, and analyse the equations of air movement and the most frequent approximations to transport models.

Following with pressure centres, we shall analyse the meteorological situations on a synoptic scale in order to explain the movement of air based on isobar patterns. When these patterns become in some way persistent, mention is made of kinds of weather, some of which are usually associated with high or low concentrations of aerosols.

Another meteorological phenomenon with an influence on transport is the formation and dissipation of clouds. Clouds regulate the entrance of outside energy and therefore moderate the air's capacity for movement. On the other hand, the production of rain acts as a new means of downward transport of aerosols.

We shall finish by setting out the physical principles of the equations determining some of the models more often used in long-range transport and discussing some practical applications of aerosol transport of interest in the fields of meteorology and atmospheric pollution, such as the amount of particulate matter reaching Spain. Particular attention will be given to how dust from the Sahara Desert is able to reach Europe and form nuclei of condensation and freezing to precipitate later with convective showers.

Aerobiology; ¿A tool for the evaluation of naturals impacts in PM 10 values?

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The COUNCIL DIRECTIVE 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air in its article 5.4 states that

"Where the limit values for PM10 laid down in Section I of Annex III are exceeded owing to concentrations of PM10 in ambient air due to natural events which result in concentrations significantly in excess of normal background levels from natural sources". "Natural events" are defined in article 2 as "volcanic eruptions, seismic activities, geothermal activities, wild-land fires, high-wind events or the atmospheric re-suspension or transport of natural particles from dry regions". In the occurrence of natural events Member States shall inform the Commission in accordance with Article 11(1) of Directive 96/62/EC, providing the necessary justification to demonstrate that such exceedances are due to natural events. Natural events may have a local origin (re-suspension) or an external origin (long range transport of mineral dust from dry regions, volcanic activity). The EC Working Group on Particulate Matter (2002) developed three strategies as alternative options to detect these different origins (In the working group report is stressed that Spain helped extensively in the development of strategies): Strategy 1.-Detection of natural events due to long range transport of mineral dust such as Sahara air mass intrusions. Strategy 2.-Detection of natural events due to local re-suspension. Strategy 3.-Detection of natural events due to volcanic, seismic events or wild fires.

These strategies share the initial procedures: 1.- Identify particulate peak in the PM10 time series. 2.- Compile information from simultaneous time series of different monitoring stations of the network and form a rural/remote/EMEP area (reference series) close to de monitoring station. 3.-Compare the PM10 reference series from those events with high PM10 levels and identify a list of high PM10 peaks.

The strategy 1 changes procedure 3 including a daily collection of the results of the TOMS measurements of aerosol index and of the SKIRON model has to be performed to evaluate the possible Sahara/Sahel influence on the PM10 levels.

Procedures 4 and 5 for strategy 1 are: 4.-Backwards trajectory analysis. 5.-A simple check of the TOMS and SKIRON mapping of the plume of Sahara/Sahel dust for the selected days, or the backwards trajectory analysis, will confirm the Sahara/Sahel influence.

The strategy 2 is seasonally influenced, for that reason lower concentrations of particulate pollutants are expected in spring and summer, than in autumn and winter, as a consequence of the higher atmospheric dispersion conditions and the lower emission rates. Therefore, any high PM10 events occurring in spring and summer may have a higher natural input than those occurring in winter.

Procedure 4 for strategy 2 is obtain simultaneous measurements of TSP and/or PM10 and PM2,5 levels in the reference and the monitoring sites. Mineral fractions of re-suspended soil particles are mainly in the coarse range (larger than 2,5 µm). It is important to note the absence of anthropogenic primary PM10 sources.

The strategy 3 includes procedures 4, 5 and 6: 4.-Compile a list of volcanic, seismic events or wild fires occurring during the time series. 5.-Compare the time distribution of these events with that of the coincident high PM10 peaks and review information on gaseous tracers for volcanic (SO_2) or wild fires (NO_x and CO) to confirm the relation between these events and the PM10 peaks in the reference station. 6.-Modelling the dispersion plumes from volcanic events and wild fires.

Pollen counts carried with Hirst Methodology allow the recognition of particles over 2 µm, referred as coarse particles. A proper training on particle recognition associated to natural events would permit the identification of episodes of this origin during the microscopy pollen count. The targeted particles could be certain bio-markers, soil particles, ashes from fires or volcanic eruptions.

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High-resolution simulation of a ragweed pollen cloud

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A novel downscaling approach for aerobiology is proposed involving numerical Regional Climate Model (RCM-NARCM) simulations to study ragweed pollen dispersal processes and how they are influenced by multi-scale flows. Allergic rhinitis to ragweed affects close to 20% of the local population of Montreal, Canada. The pollen of this prevalent weed is produced in such large quantities in the region that it is a key contributor to Montreal's hay-fever problems (Comtois *et al.*, 1996) near the end of summer and one of the principal causes of hay fever in northeastern North America (Basset *et al.*, 1975) In principle, the only available information for the public are the pollen counts issued from the previous 24 hours and most of the time from a single sampling site in the city. In order to allow people to avoid times and places when allergens are present, it is of prime importance to improve knowledge of the spatial and temporal distribution of the pollen during the season.

Because anemophilous pollen grains are airborne, meteorological factors have a large impact on their dispersal. Different statistically based types of models tend to predict pollen concentrations from meteorological conditions as reported by Laaidi *et al.* (2003). Overall correlations can be established between concentrations and meteorological factors but this type of empirical approach does not provide any causal explanation for the day-to-day pollen variation. Current scientific efforts aim to develop source-oriented models using high-resolution meso-scale atmospheric models (*e.g.* Pasken *et al.*, 2002). In the present context, the research requires efficient physically-based approaches more complex than empirical-statistical techniques, in order to deal with the explicit simulation of atmospheric circulations, taking into account the modelling of aerosols that are transported in the flow, dispersed according to the source abundance and sedimented according to deposition processes. To account for pollen in regional climate models, several strategies can be selected depending on the objectives of the experiment, primarily dependent on the desired time space scales. The model used needs to reproduce current 3-D transport and patterns of concentration, including scavenging by precipitation and diurnal influences related to PBL characteristics.

The NARCM model developed at UQAM and previously applied to a number of climate-related studies (Laprise *et al.*, 1998), has been adapted specifically to pollen studies (Muñoz-Alpizar *et al.*, 2002). Its self-nesting option has also been used to downscale atmospheric flow to 1 km-scale (Goyette *et al.*, 2002). By adequately adjusting the scale of the region, it has been possible to obtain the necessary spatial coverage to address the issues related to pollen transport and dispersion. The RCM is now designed to simulate the aerobiological pathway at a 1-km resolution over the Greater Montreal area. The multiple nested grid starting from the largest scale, with a horizontal mesh of 49 km, covering several thousand km^2 is used in this study. Then, using roughly the same number of grid points (60 X 60) but with a much finer resolution, a zooming strategy is applied from grid 1 to grid 3 in order to target an area of the order of 100 x 100 km^2 with a grid resolution as high as 1 km. Recent experiments show that the patterns of ragweed concentrations simulated by the Canadian RCM are in good agreement with observations.

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Study of pollen production in six species of *Quercus (Quercus robur, Quercus pyrenaica, Quercus rubra, Quercus suber, Quercus ilex y Quercus faginea)*

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Oak is the dominant tree in many of Europe's deciduous forests. In the regions of Northwest Spain *Quercus robur* L. is the representative of this genus that occupies the greatest geographical area. In Galicia, in addition to this species, there are also *Q. pyrenaica* Willd. and, to a much more limited extent, *Q. ilex* ssp. *ballota* (Desf.) Samp. In Bol., *Q. suber* L and *Q. faginea* L.. There also exists the ornamental cultivation of American oak species: *Q. rubra* L. and *Q. palustris* Muenchn.

In addition to *Quercus* pollen's importance as a pollinosis agent, its study is also essential for evaluating the ecological conservation of Spain's woodland. Possible changes in the distribution or production of oak due to hotter spring temperatures or frost damages in recent years (JATO et al. 2002) are of great economic importance to the timber and livestock industries. Furthermore, in some areas its fruitage is used for breeding certain native species of animals (GARCÍA-MOZO et al. 2002).

Nowadays is of a great importance in phenological studies to know pollen production of trees. It gives us an idea of the quantity of pollen that the tree is able to produce in order to correlate this parameter with airborne pollen concentrations registered. There are few studies focused about *Quercus* genus' pollen production, and some of them agree that production varies according to the species, oscillating between 1.9×10^4 and 1.3×10^6 pollen grains per flower (MOORE & WEBB 1978, TORMO et al. 1996).

The objectives of this study are to know the pollen production of the six main *Quercus* species presents in the Northwest of Spain. The studied species were *Quercus robur, Quercus pyrenaica, Quercus rubra, Quercus suber, Quercus ilex* and *Quercus faginea*. As production protocol the HIDALGO et al. (1999) method was taking into account. Ten trees have been selected in each specie. In each one of them has been carried out a production study of pollen grains by anther, flower, catkin, tree and area. In the case of *Quercus ilex* and *Quercus faginea* due to the specimens are too young, it has not been carried out production/m^2, appearing the results as pollen grains/tree and pollen grains/catkin respectively.

Quercus rubra, with 697305 pollen grains, has been the specie with the highest value of pollen production by catkin followed by *Quercus pyrenaica, Quercus robur, Quercus faginea, Quercus ilex* and finally *Quercus suber* with 355236. In relation to pollen by tree production and pollen by square meter, the specie that has reached the highest records has been *Quercus robur* with $43{,}2 \times 10^{10}$ and $2{,}2 \times 10^{10}$ respectively.

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Session c5

APPLIED AEROBIOLOGY: AGRICULTURE

Forecasting olive (*Olea europaea* L.) crop yield based on pollen emission and floral phenology in Andalusia Region, Spain

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