Session 3: Spatial Aerobiology

Utilisation of modelling in atmospheric air quality evaluation

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Mathematical modelling has been widely used for more than 30 years for calculations of transport, deposition and concentrations of "classic" air pollution like e.g. acid gases, particulate matters or aromatic compounds. There are two main groups of models used for assessment of air quality – empirical and deterministic models. One of the main differences between them is that empirical models require air quality observations as an input, whereas deterministic models require information on meteorological parameters and emissions. Therefore, observations are used only for verification of results simulated with deterministic models. The first part of the presentation focuses on showing: (1) differences between different types of models, (2) input data to models (emissions and meteorological parameters), (3) examples of the application of the models in Europe and Poland.

Recently, atmospheric transport models (ATM) are more and more often used for simulation of transport and concentrations of bioaerosols. Bioaerosol dispersion is usually modelled by Lagrangian trajectory models such as e.g. CALPUFF or HYSPLIT, or by Gaussian advection-diffusion models such as ADMS. Recently, there has been a growing effort to simulate regional pollen dispersal with more complex regional air-quality models, like e.g. SILAM or COSMO-ART. The second part of the presentation shows: (1) capabilities of ATM for bioaerosol simulations; (2) examples of the application of ATM to bioaerosols modelling in Europe and Poland, (3) possibilities of development of bioaerosol modelling in Poland.

Pollen in a "cloud"

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Pollen allergy is considered to be one of the most common allergic diseases of the respiratory tract, manifesting as allergic rhinitis, sometimes conjunctivitis and atopic asthma. Geographically the severity of pollen allergens occurrence is presented usually as maps of pollen forecasts related to the pollen calendars. Even though there are maps with the spatial distribution of pollen allergens across the pollen season, there are knowledge gaps to present the pollen allergy symptoms (PAS) in the same way. Therefore, we introduce a preliminary study on the technical abilities and aspects of the PAS mapping with the use of WebGIS technology. We discuss the usefulness of the geoinformation for pollen allergy sufferers life comfort.

The aim of this project is to design a WebGIS platform, that collects, geoprocesses and serves data

recorded by the users as a web map of the PAS. We base our concept on Esri Inc. SaaS technology – ArcGIS Online. Unique for this platform is that no programming skills from the WebGIS designer are required.

In our project we could choose between 3 configurable templates or mobile applications, which are useful for collecting the crowdsourcing data: Collector for ArcGIS, Survey123 and GeoForm. In this work we used a GeoForm template, which is the base for the dedicated questionnaire for the allergy sufferers as well as not diagnosed people, who fill it in according to the set of questions about their symptoms. As a result the sufferers receive the map of the PAS severity against the background of pollen occurrence and local vegetation, which is implemented in the operations dashboard, serving the dynamic statistics of the PAS in the location of interest and providing the functionality of configurable filters, changeable basemaps, dynamic pop-up windows with features attributes. The result map presents, how the PAS change over time, but also in which way people suffering from pollen allergy move and change their location and what can be the advantages of that.

Moreover, the presented web map application brings together not only geolocation information on PAS, but also basic education in this area.

The usage of GIS in modelling of airpollutants

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The initial part of the presentation will be focused on the brief introduction of air pollutants modelling. All stages necessary for modelling air pollutants will be presented in the Pomeranian Region. The first part will concern the preparation of input data such as: point, line or surafce emission with the usage of GIS tools. The second part will be devoted to the usage of the CALPUFF model to determine air pollution concentration and to present the results of modelling. The summary will be focused on the boarder usage of GIS in air quality analysis.

Synoptic conditions associated with post-seasonal transport of birch pollen to Poland

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Birch (*Betula* sp.) trees are an important component of forests in Central and Northern Europe. Their inflorescences produce an enormous amount of pollen grains, that, during the phenomenon of long distance transport (LDT), might be moved to areas located thousands of kilometers from their source. As a result, elevated concentrations of birch pollen are observed even outside the main birch pollen season. The present study focuses on the post-seasonal episodes of birch pollen in Poland, with special emphasis on: (1) detecting the potential source of areas of LDT birch pollen, and (2) determining the surface and synoptic conditions during the selected LDT episodes.

The research was carried out in two cities in Poland: Poznań (Western Poland) and Rzeszów (South East Poland) about 500 km apart. The aerobiological monitoring was conducted between 1997-2016 using volumetric pollen traps of a Hirst design situated at 30 (Poznań) and 12 m agl (Rzeszów). Five episodes with elevated birch pollen concentrations (9-60% of the seasonal pollen peak) that occurred one to four weeks after the main pollen season were selected. The episodes were associated with weather parameters obtained from local meteorological stations and sea level pressure (SLP) over Europe with SLP anomalies acquired from NCEP/NCAR reanalysis. To detect the source areas of the air masses coming into Poland, HYSPLIT model (back trajectory analysis) was used.

The post-seasonal episodes of LDT birch pollen observed in Poznań and Rzeszów lasted from just a few hours to over several days. During these episodes, daily mean pollen concentrations varied from 53 (in 1997) to over 2056 pollen/m^3 (2016). The most severe LDT episode was recorded between the 4th and 7th of May 2016. In general, back trajectory analysis revealed that air masses arrived from N and NE directions, particularly from Scandinavia, Eastern Baltic States and, additionally in 2016, from Northern Russia. High gradient of SLP over Poland during episodes confirm the possibility of long distance movement of air masses. SLP system indicates N and NE air masses flow into Poland, which is in accordance with HYSPLIT analysis.

Conclusions: The post-seasonal elevated episodes of LDT of *Betula* pollen in Poland were recorded every few years with different intensity and were associated with high SLP gradient over Poland.

Atmospheric circulation conditioning of *Betula*, *Alnus* and *Ambrosia* pollen concentration in Wrocław, Poland

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A simple method for assessing birch pollen inventory in urban area

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Birch pollen is one of the main triggers of allergy symptoms in Poland. Information about its concentration is usually provided to the public using data from one or two pollen stations per city. These stations are mostly located in urban areas and measuring devices are placed at the roof level to ensure regional representativeness of the data. However, there is evidence that pollen concentration at the roof level is different from that recorded at the street level, where people live. Moreover, the urban areas are heterogeneous because of the presence of different obstacles disturbing air flow as buildings of different sizes, bridges, towers or trees. Among urban trees, birch trees are commonly planted due to their pollutant-resistance and ornamental function. Unfortunately, in the vast majority of cities there is no accurate information about the number and location of birch trees. Considering that the closer the birch tree, the higher pollen concentration, it is an important task to identify zones where birch pollen is commonly released. Consequently, our main objective was to estimate the spatial distribution of the population density and timing of the silver birch (*Betula pendula* Roth.) flowering in Poznań.

Betula pendula was the most frequent birch species in the study area accounting for about 95% of all birch trees in Poznań. The timing of flowering (flowering start, maximum and end) was determined on the basis of international BBCH (Biologische Bundesanstalt Bundesordenamt and Chemical Industry) phenological scale. Phenological observations were performed at 16 (year 2012), 24 (2013) and 34 (2014) sites, 10-20 birch trees each. According to the location of the phenological sites, we created Voronoi diagrams. Each cell of this diagram contained the nearest area attributed to a particular phenological site. Then, the proportion of main land-use types was calculated for each Voronoi cell. Simultaneously, the number and density of birch trees were estimated at 254 randomly selected research plots of a size 50 x 1000 m dispersed over a city. The mean number of birch trees for different land-use types was calculated.

As a result, we combined phenological and birch tree density data providing maps showing the spatial distribution of birch populations in Poznań. Moreover, we identified birch populations responsible for releasing birch pollen in different parts of the birch pollen season.

Conclusions: A method for estimating birch population density over the urban area was proposed. This low-cost method can be applied in cities where databases containing species names and location of urban trees are not available. The method obtained for Poznań could be extrapolated also for other Polish cities, but with caution. It may require estimating the density of birch trees in different land-use types. The developed maps, that were produced as a result, can be a helpful tool for allergy sufferers allowing better avoidance of high levels of birch pollen exposure – they could better avoid the exposure on high birch pollen concentrations.