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modeliranje, meteorologija, meritve
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KOOREG PROJECT:

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Prognostic and diagnostic modelling system for controlling air pollution in the region *www.kvalitetazraka.si*

Within a nationally applied research project, MEIS d.o.o., is developing a modelling system which will display on the internet, in real time and as a 1-day forecast, the concentrations of **SO_2, NO_2 and PM10**, pollutants emitted into the atmosphere by various sources, in the region of Zasavje.

WHAT THE PORTAL DISPLAYS

We are displaying real-time concentrations of air pollutants in intervals of 30 minutes, the history for the two previous days and pollution forcast for a day. The following companies have given their explicit consent for the use of their nominal (normal highest operating) emission values for the purpose of the project: **Termoelektrarna Trbovlje, Lafarge Cement, Steklarna Hrastnik and IGM Zagorje**. For **JPK Zagorje** we got the data from public available source. For now, we are only displaying concentrations in the atmosphere as a result of the emissions from these sources. We use these values in the modelling system as if the facilities were operating continuously 24 hours every day all year round (unless they explicitly notify us about not operating), **and so we ask users of the portal to verify whether individual facilities are actually operating.** In the future, we are planning on implementing the real-time automated use of the emission values where required.

We have successfully developed meteorological forecasting for two days in advance in a detailed temporal and local resolution for Slovenia and 6 day forecasting over middle Europe.

The modelling system calculates the concentrations of air pollutants for the entire three-dimensional space above the displayed region; we are also displaying concentrations in the surface layer of the atmosphere, where regulations on ambient air quality are applicable.

We have captured an area of 20km × 20km, horizontally divided into 100 x 100 cells (each cell measures 200m x 200m). The first surface layer for which we are displaying calculated concentrations is 10m high. The concentration calculated by the modelling system is even throughout the cell, as the cell constitutes the local resolution of the system.

In collaboration with Arianet s.r.l. from Milan, we have prepared forecasts for **SO_2, NO_2, O_3, CO in PM10** over the whole Slovenia. These forecasts are used for the determination of pollutants transport from other regions.

WHY ZASAVJE?

Air pollution is a pressing issue in Zasavje. The limit values of pollutant concentrations in the ambient air are frequently exceeded.

Modelling pollutant concentrations in the ambient air provides certain answers regarding the causes and mechanisms of pollution, and, most importantly, it provides information on the spatial and temporal distribution of the pollution. Although measuring stations provide very accurate results, this information, especially in the conditions of complex terrain, only relates to a very small area in the immediate proximity of the measuring stations.

Highly complex orography and consequently very complex micrometeorological conditions over the small area of the municipalities of Zasavje pose a considerable scientific challenge for modelling both the meteorological conditions and the dispersion of pollutants in the atmosphere.

With this project, we wish to add a new dimension to the general understanding of the issue of ambient air pollution.

From a scientific point of view, one of the important objectives of this project is to demonstrate the accordance (spatial and temporal) of the modelled concentrations and the measured concentrations at the locations of the numerous automatic measuring stations in Zagorje.

For the most accurate matching of the modelled concentrations with the measured concentrations, high-quality input data are of key importance, especially the qualitative measured meteorological data in the area discussed. For now, the forecasted data on their own are not yet a sufficient basis for modelling the air pollution spreading over such a complex terrain as Zasavje. In order for the results of the models to match the actual measured concentrations, it is also necessary to include the measured local meteorological data using appropriate meteorological models.

ABOUT THE MODELS USED

The modelling system is a mathematical tool which displays the mechanisms of the dispersion of pollutants in the ambient air. The modelling system, based on the input data regarding meteorological conditions and pollutant emissions, calculates the consequences of these emissions as concentrations in the atmosphere in the vicinity of the observed emission sources. Emission sources that have not (yet) been entered into the system, are, of course, not displayed by the modelling system (emissions from other industries, outside biomass burning and burning of waste in the countryside, etc.). But we include emission from trafic and local heating.

The modelling system, which enables these calculations for the displayed area of Zasavje, consists of multiple models and uses different input data.

First, meteorological conditions are recorded for every 30 minutes in real time using the meteorological data from the automatic measuring stations in the region. As it is also essential to describe the vertical profile of the wind, temperatures and relative air humidity, the profile which is calculated using a prognostic meteorological model is used as an estimate. Measurements with the SODAR would be better, but they are, unfortunately, not available at the moment. All the data is processed by the SurfPro meteorological pre-processor and the Swift three-dimensional mass-consistent wind model.

The modelling system also processes data on terrain altitude and land use, both in the aforementioned resolution.

Data on the movement of pollutants from their sources towards the hills and valleys is then entered into this three-dimensional meteorological area, resulting in calculated pollutant concentrations, as shown in the figures. The Lagrangian numerical particle model Spray is used in this step.
The above approach, considering the current state of science in this region, provides the best results for complex terrain. This is proved by articles published in scientific magazines.

Sources:

Models used:
http://www.wrf-model.org/index.php http://www.aria-net.it/index_eng.php

General information on models:
http://www.harmo.org/Harmoni/LinksTo.asp

ABOUT MODELS AND THE ACCURACY OF MODEL CALCULATIONS

Concentrations derived from model calculations have, of course, a larger margin of error than measurements, but it is largely dependent on the modelling techniques used in the process. For the purpose of understanding the adequacy of a model, the error is not given only as a percentage, as with measurements, but an estimate of locational adequacy (or error) and temporal adequacy (error) is also given. Such validation is a complex scientific process.

The modelling system we use has been successfully tested (validated) in the past years on measurements in the vicinity of the Šoštanj Thermal Power Plant and partially in Zasavje, and numerous articles on this subject have been published. In brief — in the region of Šoštanj, the modelling system achieves a good matching of the concentrations calculated using the model with the pollutant concentrations measured at the measuring stations, if we allow a local locational error of ± 1 cell (approx. 150m) and a temporal error of ± 30 minutes. And if we allow a larger locational error of ± 2 cells and a temporal error of ± 2 half-hour intervals, the matching of measurements and calculations is excellent. Interested readers can find the articles we have published on this subject through the COBISS or the SICRIS (also accessible through this portal and through www.meis.si).

To achieve such excellent matching, it is most important to use as much measured data on meteorological conditions as possible, and suitable highly powerful models appropriate for complex terrain.

If only prognosticated meteorological data is used, the margin of error for regions such as Zasavje, considering the current state of science, would be significantly larger than if using locally measured data.

The one day pollution forecasts are thus significantly less accurate than the results from real-time modelling.

FORECASTING POLLUTANT CONCENTRATIONS

Prognosis of meteorological conditions are used for a one-day pollution prognosis, which is the goal of this project also.

To achieve both objectives (pollution prognosis and diagnosis), we have developed our own weather prognosis system for Slovenia in the best possible local and temporal resolutions. We used the WRF model, which was developed in the USA, whose creators guarantee that it can be used (proven through validation) up to a resolution (cell size) of approximately 5km x 5km over complex terrain, and a temporal resolution of 30 minutes. MEIS uses this tool to calculate, for the purpose of this project, prognoses of the weather over Slovenia in a surface resolution of 4km and a temporal resolution of 30 minutes.

MODELLING RECOMMENDATIONS

At the European level, the European Commission, in cooperation with the European Environment Agency, has set up the FAIRMODE, which provides guidance on good practice and the correct use of modelling tools for any purpose relating to regulatory use — use with the aim of calculating the concentration of pollutants in the atmosphere for pollution control purposes.

Our modelling system is compliant with all the requirements set by the FAIRMODE.

Among the most important requirements are the requirements for prior successful testing (validation) of the modelling system in a similarly

complex area (size of domain, terrain complexity and most of all a similar complexity of meteorological conditions). Furthermore, it stipulates that when using modelling systems in order to assess the consequences of emissions from industrial sources, the maximum allowed size of cells is 250m in a horizontal direction.

In brief, the FAIRMODE stipulates that the modelling system must be "adapted to the problem and the purpose".

PROJECT FINANCING

The project is financed by the Slovenian Research Agency (SRA) under number L1-2082 (A), and MEIS d.o.o. (1 May 2009 to 30 April 2012)

http://www.arrs.gov.si/sl/

http://sicris.izum.si/search/prj.aspx?lang=slv&id=6497

COMMENTS

You can leave your impressions, compliments and comments on the Facebook page: MODELLING THE POLLUTION OF ZASAVJE — THE "KOOREG" PROJECT

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STATEMENT

The results, as displayed on the portal, are purely of a research nature, they are in the testing stage and must be considered with regard to the given restrictions (most importantly the fact that a constant nominal load is used, which is different from the actual state, especially when the sources are not operating).

MEIS d.o.o., hereby explicitly states that it shall take no responsibility for any consequences arising from the use of these research results for any purpose.

OTHER INFORMATION ON THE MEIS d.o.o., RESEARCH GROUP

MEIS has a research group registered with the SRA.

The information is accessible through the SICRIS national portal:
http://sicris.izum.si/search/org.aspx?opt=3&lang=slv&id=3356

The bibliographies of our researchers are accessible through the COBISS national portal, where you can find our numerous publications from this research area and from the other areas we research:
Bibliography1 Bibliography2 Bibliography3 (available at www.meis.si)

Other information on our activities is available on the portal at www.meis.si

Project manager:

Dr. Primož Mlakar

Mali Vrh pri Šmarju, November, 30th 2011