

A WEB BASED MAPPING TOOL FOR THE HARMONISED INTERCOMPARISON OF AIR QUALITY MAPS

Agnes Dudek, Robert Logna and Bruce Denby
Norwegian Institute for Air Research (NILU), Kjeller, Norway

INTRODUCTION

The Air4EU project has produced valuable results and useful recommendations for improving air quality assessment in Europe (www.air4eu.nl). In order to facilitate the widespread access of these results a web based GIS tool was developed by the Norwegian Institute for Air Research (NILU). This system allows maps of air quality to be shown, in a friendly and coordinated manner, for a wide variety of pollutants and all spatial scales using an interactive GIS system. The maps available include case studies carried out within Air4EU as well as other contributed assessment maps. Figure 1 shows the home page layout. The GIS based mapping tool web page can be visited at: www.air4eumaps.info.

This paper provides a brief technical and functional description of the mapping tool and its intended use in harmonizing the presentation of air quality assessment maps. It also provides some examples of the use of uncertainty maps within the mapping tool.



Figure 1: Home page of the mapping tool www.air4eumaps.info (left). And the 'mapping room' selection tool where multiple maps can be selected based on criteria defined by the user (right).

OVERVIEW OF THE AIR4EU MAPPING TOOL

Web page set up and technical platform

The tool's technical platform is based on a web map server (WMS) and the associated GIS software MAPPER both developed by Demis (www.demis.nl). The interactive GIS window within the web browser is based on a flash application. In order to update a map, the flash application sends a request to the WMS using the OpenGIS WMS protocol developed by the OpenGIS consortium (www.opengeospatial.org). The WMS is a server where all GIS maps are registered. In order to display the appropriate map, the request to the WMS is filtered using the application server. The application server contains an application written in ColdFusion that defines the layer and information to be shown. The application server is connected to a SQL Oracle database where information describing each map is stored. Once the request is filtered the map server sends a map image as a response to the flash application request.

The GIS data displayed are of 2 types. The first is the air quality data itself, which are stored as either ASCII grid or BIL file formats, and the second is the layer information pertaining to geo-referenced data such as roads, water, parks etc., in the form of standard ESRI shape files.

Map properties and selection

Figure 1 (right) shows the map selection tool layout. The selection tool allows the database to be searched for all available maps using six map properties. These are region, pollutant name, indicator, period, mapping method and map type. Selection of any property will automatically update the list of available maps as well as repopulating the available property selection. The map properties are defined as follows:

Region: The name of the geographical area covered by the map. It can be a city, a country or a specific region such as Oslo, England, Europe, etc. The tool is flexible and new regions can be added.

Pollutant name: The name of the chemical pollutant addressed. Currently available pollutants are Benzene, CO, NO₂, O₃, PM₁₀, PM_{2.5} and SO₂ but this is dependent on the actual maps available. The tool is flexible and additional pollutants can be added.

Indicator: The statistical parameter, related to the pollutant, shown in the map. This can be any indicator, such as annual mean, number of exceedances, percentiles, AOT, etc. The indicator is usually related to limit values for particular pollutants.

Period: This simply indicates the time period for which the map is valid, usually a year for assessment purposes.

Mapping method: This indicates the methodology used for creating the maps. Currently available are: monitoring, modelling and assimilation as named methods. New methods can be added.

Map type: There are currently three map types available, assessment, uncertainty and probability. However, the mapping tool is flexible and there is no limitation to the number of map types.

In addition to the maps, information for each map is available as a pop-up window. The information displayed includes text describing the map properties and any other relevant information concerning the model, the monitoring data, and the methods used to construct the map or URL references to relevant links.

After filtering of the maps using the map properties the user can select any number of maps to be displayed. These will then be shown in a number of interactive GIS windows.

Map display

One of the main added values of this system is that it can display multiple interactive GIS windows at the same time, as shown in figure 2. This allows the user to view and directly compare assessment maps from different regions or cities, assessment maps of different compounds, assessment maps on different scales, assessment maps for different periods, assessment maps produced using different methods, and uncertainty maps for different mapping methods and regions. Each GIS window is interactive because it allows the user to edit the maps by zooming, selecting and viewing layers, viewing the legend, and printing and saving the edited maps.

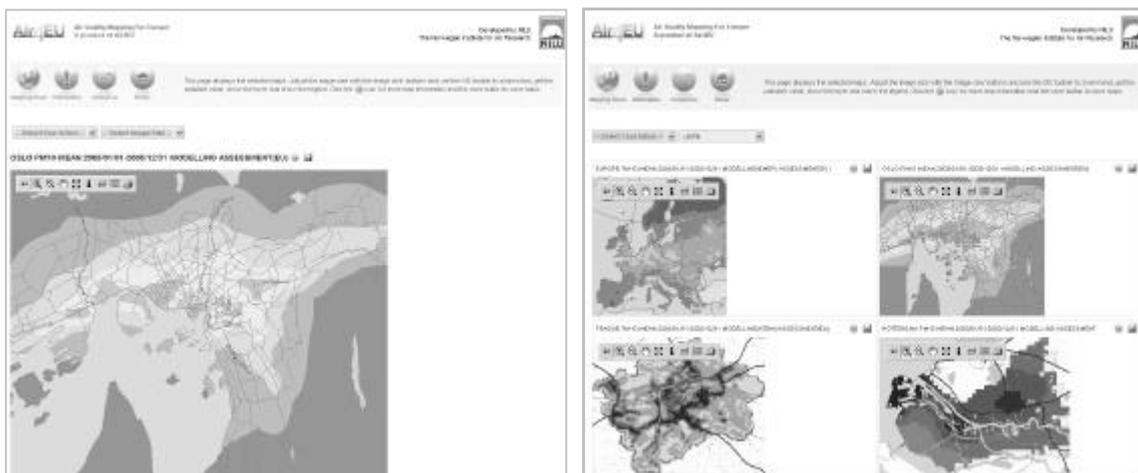


Figure 2: Screen shots showing examples of single (left) and multiple (right) interactive GIS windows. In this screen shot PM_{10} concentrations for Europe, Oslo, Prague and Rotterdam are shown.

Harmonisation of maps

There are three types of legends (contour colour scaling), currently in use in the mapping tool. For the three different mapping methods. These legends is harmonised so that maps are directly comparable. Each map may have a different contour interval, dependent on the range of concentrations, but the colour scaling has uniquely associated values so that any particular colour indicates the same value in all maps. Within the legend the pollutant level given by the European directives is indicated in red.

Within the system the monitoring stations are classified according to the DG Environment guidance on exchange of information:

<http://ec.europa.eu/environment/air/pdf/guidancetoannexes97101ec.pdf>

During the mapping tool development EU guidelines for dissemination of maps in Europe were taken into account. These concern in particular the choice of the spatial reference. According to the guideline all maps (for Europe) are projected using the European spatial reference grid ETRS 1989 LAEA. EU guideline documents are available at the following websites: <http://eionet.eu.int/gis> and http://eionet.eu.int/gis/docs/EEA_GISguide_v2.doc.

EXAMPLE ASSESSMENT AND UNCERTAINTY MAPS

As previously mentioned, a range of maps are available on the mapping tool, mostly presenting results from Air4EU case studies (Air4EU, 2007; D7.1.1-14). Two examples are selected here to demonstrate the use of the mapping tool in presenting and comparing assessment and uncertainty maps.

Exceedance of PM_{10} daily mean for Europe

In one of the case studies carried out in Air4EU (Air4EU, 2007; D7.1.13) a number of basic data assimilation methods were tested for combining the Unified EMEP model with Airbase monitoring data for PM_{10} . The results shown in figure 3, and available through the mapping tool in colour, show the assessment and uncertainty maps for the number of exceedances of the daily mean limit value of $50 \mu\text{g}/\text{m}^3$ for the year 2003. The legislative limit value is 36 exceedance days. The EMEP model is known to significantly underestimate the PM_{10} concentrations and this can be seen in the assessment map as a very low number of exceedances. The assimilation map, constructed by residual kriging after linear regression of

the model on a daily basis, shows much higher exceedance numbers, close to the observed values.

The associated uncertainty maps for the model and assimilation assessments both indicate areas of quite high uncertainty, with some areas showing uncertainties greater than 40 days. The major difference between the two assessments is that the uncertainty is significantly reduced in areas where measurements are available, e.g. in The Netherlands and Western Europe in general. The high uncertainty present in the assimilation map in the Balkans is due to the lack of monitoring stations in this region reporting to Airbase. The method used to create the uncertainty maps is described in detail the Air4EU Europe II case study (*Air4EU*, 2007; D7.1.13).

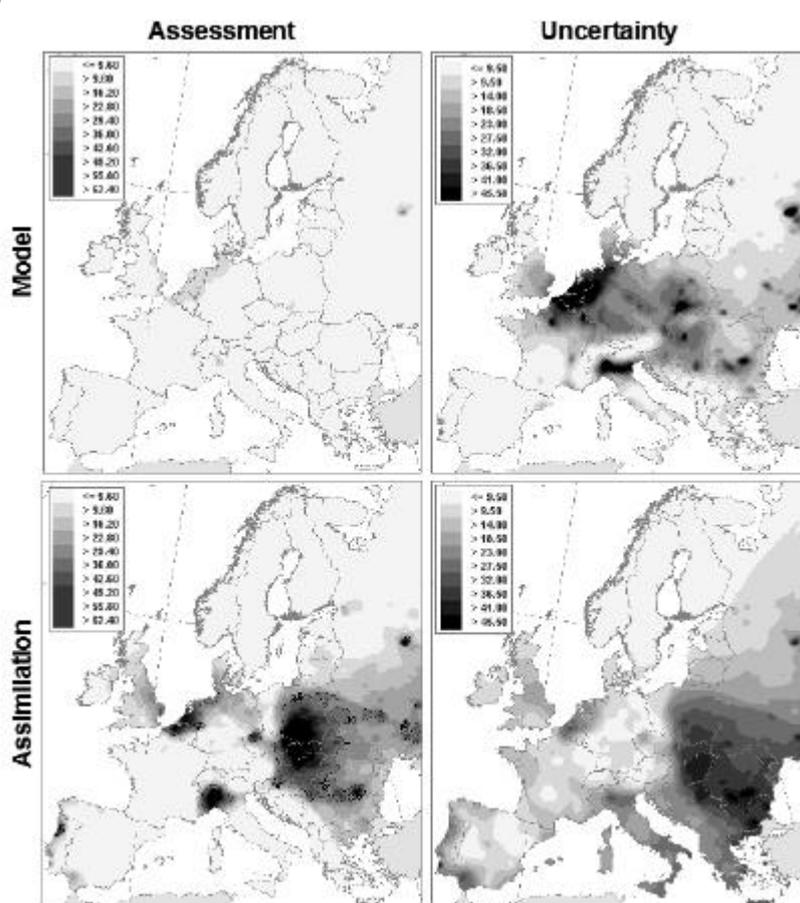


Figure 3: Four European maps taken from the Air4EU mapping tool showing an assessment of the number of exceedance days (left) and its uncertainty (right) for daily mean PM_{10} in Europe for 2003. Shown are assessments from the EMEP model and from an assimilation technique using residual kriging after linear regression (*Air4EU*, 2007; D7.1.13).

Exceedance of NO_2 annual mean in Prague

In another of the case studies carried out in Air4EU (*Air4EU*, 2007; D7.1.6) basic data assimilation methods were tested for the urban region of Prague using local monitoring data, 12 sites, and annual mean concentrations calculated by the ATEM model. In figure 4 the annual mean concentrations of NO_2 using the ATEM model and a Bayesian assimilation technique are shown, along with their uncertainty assessments. The use of assimilation increases the region exceeding the $40 \mu g/m^3$ limit value but clearly reduces the uncertainty, as seen in the maps taken from the mapping tool. The use of such maps, when properly constructed, allow the reader to directly assess the quality of the assessment map itself.

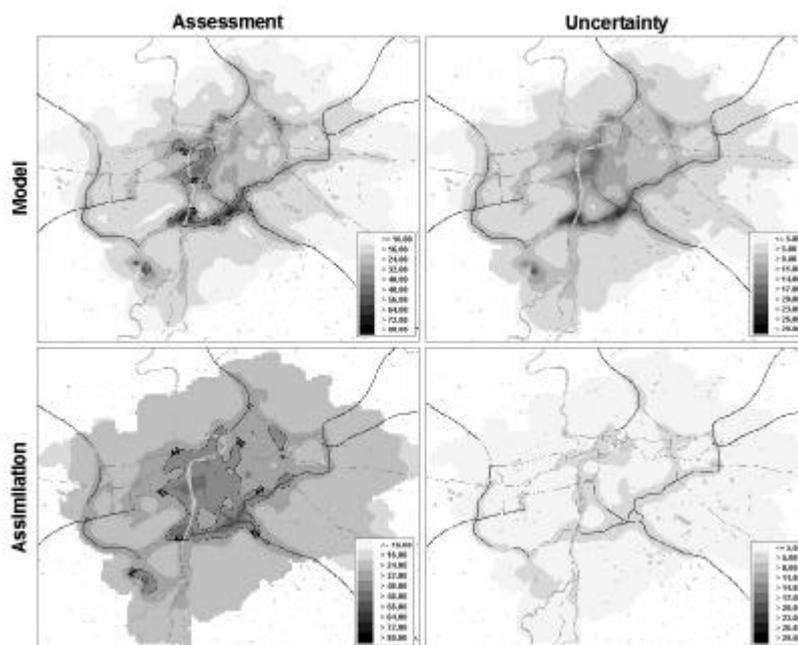


Figure 4: Four maps taken from the Air4EU mapping tool showing an assessment of the annual mean NO₂ concentrations in Prague (left) and its uncertainty (right) 2003. Shown are assessments from the ATEM model and from an assimilation technique using the Bayesian combination of kriging and model fields (Air4EU, 2007; D7.1.6).

CONCLUSIONS

The mapping tool improves and harmonises the dissemination of mapping information for both authorities and institutions involved in air quality assessment. It allows the simultaneous presentation, and comparison, of air quality assessment maps on all scales and for any number of compounds and indicators. The features which make the mapping tool unique are as follow:

- The database of maps can be viewed and selected in a simple and interactive manner.
- Selection criteria for the maps include region, pollutant, assessment period and mapping method.
- Any number of maps can be simultaneously presented.
- Contour colour scaling (legend) is homogenised for direct intercomparison, with clearly defined limit values based on EU directives.
- Information and links for each map is provided.
- Maps and information can be saved or printed directly.
- Maps of uncertainty can also be viewed concurrently with the assessment maps.
- GIS integration allows for a more comprehensive and visual assessment.

The mapping tool is presented here to encourage the harmonised presentation of maps and encourage the production of uncertainty maps associated with them. The tool provides centralised and ordered access to a mapping database and can be used to aid dissemination of mapping information for both city users and institutes involved in air quality assessment.

ACKNOWLEDGMENTS

This research was funded by the EU FP6 project Air4EU. Contract no. (503596)

REFERENCES

Air4EU (2007): Air4EU deliverable reports: http://www.air4eu.nl/reports_products.html