Status Report of Bulgaria

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1. Introduction

The largest city of Bulgaria – the capital Sofia (1,2 million inhabitants) is located in a broad valley at 550 m a.s.l. (above sea level) and the second largest town is Plovdiv at the Maritza river. Other major towns are located at the Black-sea cost (Varna and Bourgas), and there are a number of smaller towns in mountainous regions. Local circulation systems are therefore significant for the air pollution in Bulgarian cities. Strong temperature inversions during anticyclonic weather conditions in the coldest time of the year lead to accumulation of pollutants in the surface layer and often to exceedances of air quality limits (Batchvarova et al., 1994, Batchvarova and Teneva, 1989 and Teneva et al., 1988).

By decree of the Council of Ministers form in 1994, 14 regions in Bulgaria where ambient air quality causes the most serious problems were declared as ecological "hot spots". In most cases, non-compliance of admissible air quality standards is registered in these locations (Boneva, 2001). Dust (as total suspended particulates) concentrations are traditionally high, in 1997 the average annual concentrations in some of the major towns were from 1.2 to 2 times above the maximum admissible limit-annual average of 0.15 mgm^{-3}. Household heating using brown coal and wood in a number of major towns lead to high annual (1997) SO_2 concentrations that were from 1.2 to 3.5 times the admissible limit–annual average (0.05 mgm^{-3}). The drastically increased number of second hand cars imported into the country during the last few years has contributed to significantly high concentrations of nitrogen dioxide in major Bulgarian cities.

2. Main objectives

The main objective for the Bulgarian participants will be to contribute to the improvement of urban boundary layer parameterization schemes, with regard especially to the wind speed and wind direction, and the mixing height. Part of the work will be comparison of previous and new proposed schemes, their validation against urban data sets and their possible implementation in a meteorological preprocessor. We are also interested in gaining knowledge and exchange of information in application-oriented modeling techniques for the atmospheric dynamics and the dispersion of pollutants in cities with complex terrain.

3. Available meteorological and concentration data

The National Institute of Meteorology and Hydrology (NIMH) of the Bulgarian Academy of Sciences (BAS) is responsible for the weather prediction in Bulgaria. It operates a national network of synoptic and climatological stations. At present this network consists of 36 synoptic stations. Half of those stations are situated in towns with more than 40 000 inhabitants. The remaining ones cover mountain tops (5), caps in the Black Sea (3) and small towns and villages (10). The equipment of the stations is rather old (only one of them is automatic, in Sofia). Measurements of specific quantities related to air pollution problems (e.g., surface fluxes) are missing. Radiosonde is launched only in Sofia, once daily.

The National Environmental Monitoring System (NEMS) has been in operation since 1974. The air quality stations belong to three different governmental authorities – Ministry of Environment and Water (MOEW), Ministry of Healthcare and NIMH. The Executive Environmental Agency (EEA) at the MOEW is responsible for the data management; it drafts daily, weekly and quarterly bulletins and annual reports on the air quality.

NEMS consisted in 1998 of totally 99 stations situated in and around 39 towns. Of these stations 16 are automatic and collect information per half an hour, the remaining 83 are manually operated and collect data four times per day in daytime. 42 monitoring stations have been included in the EU Environmental Monitoring and Information network since 1997. The construction of the national database designed in ORACLE was started in 2000. At the end of the same year a PHARE project was initiated for the construction of the National Real-Time Ambient Air Quality Information Network.

The majority of the stations monitor the concentrations of basic indicators – dust (as total suspended particulates), SO_2, NO_x (NO and NO_2), H_2S and Pb aerosols. Only a limited number of stations monitor O_3 and CO_2 because of the lack of automatic monitoring equipment. There are also some specific measurements of phenol, ammonia, heavy metals in particulate form, H_2SO_4 and HCl. There are no measurements of PM_{10} or $PM_{2.5}$.

4. Available models

At NIMH the following weather prediction and air pollution models are available:

- The numerical weather prediction model ALADIN (Aire Limitée Adaptation Dynamique développement InterNational, http://www.cnrm.meteo.fr/aladin/) - has been used as operational model in Bulgaria since June 1999. The weather forecast for 48 hours over the Balkan Peninsula is computed twice a day using as initial conditions the predictions for 12 and 00 UTC of the French global model ARPEGE (Action de Recherche Petite Echelle Grande Echelle). The horizontal resolution of ALADIN is approximately 12 km, with 31 levels vertically.
- GAS_R, AER_R – multisource Gaussian plume models for point and linear sources that have been developed at NIMH. Different versions of the models treat dispersion of gases and dispersion of aerosols, with meteorological input extracted either from climatic data or from time-series of meteorological data. The models are used in activities related to environmental impact assessment (Syrakov et al., 2000).
- LED (Lagrangian-Eulerian Diffusion) – a long-range puff-model with boundary layer chemistry (Djolov et al., 1987).

- EMAP (Eulerian Model for Air Pollution) – 3D model for local to regional and regional to continental scale. This model has been developed at NIMH for EMEP (European Monitoring and Evaluation Programme; Syrakov and Galperin, 1995, Syrakov and Prodanova, 2001) activities. 1D planetary boundary layer (PBL) models are used as meteorological preprocessors (e.g., Yordanov et al., 1983).
- PolTran-1-2 – local scale PC-oriented Eulerian pollutant transport model applied for the cities of Sofia and Plovdiv (Atanassov, 1998).
- 2D street canyon flow model based on numerical solution of appropriate Navier –Stokes equations.

Moreover, a synoptic-statistical approach for describing the air pollution in Sofia qualitatively (low, medium, and high concentrations) has been elaborated and applied for three years (Vassilev et al., 1989).

At the Geophysical Institute (GFI) of BAS the following models are available:

- IMSM (Integrated Multi-Scale Model) – 3D Eulerian model for simulation of pollutant dispersion and functions of influence (the Eulerian analog of the back-wind trajectories) at different horizontal scales (Ganev et al., 1998, Zerefos et al., 2000).
- 3LTP (3-Layer Transport Model) - for evaluating local pollution (Dimitrova, 1997).

As meteorological preprocessors, various models are using – 1D PBL model, mass-consistent wind model (Georgieva, 1998), quasihydrostatic mesoscale model (Ganev, 1993) or three-layer mesoscale model (Ganev, 1996). Recently, a meteorological preprocessor has been developed and linked to a mass-consistent model for complex terrain (Georgieva and Canepa, 2000).

- PLUME – a Gaussian type model for simulation of ground level concentrations from industrial point sources. Developed at GFI for regulatory applications in the framework of a project funded by the Ministry of Environment and Water (MOEW).
- ABC – a diagnostic microscale flow model, developed in Germany with introduced parameterizations for street canyon (Georgieva, 1998).

5. Related national and international projects

- "Influence of the urban area on the air pollution" (1995-1999). Project manager: NIMH (E. Batchvarova), funded by the National Science Fund.
- "Methodology for calculation of traffic-induced air pollutionin the surface layer of the atmosphere" (2001 – 2003). Project manager: GFI (D. Yordanov), funded by the Ministry of Environment and Water.
- "CESAR (Central European Study on Air Pollution and Respiratory Health" (1995 – 1999). Project participant: NIMH, funded by the EU PHARE Program.

In the framework of projects with local authorities, NIMH has also organized and conducted measurement campaigns for estimation the air pollution situation in towns located in the "hot spots".

6. Funding situation

No external funding.

7. Expected benefits and policy relevance

The Bulgarian participants expect research collaboration with experienced participants, and the exchange of information, methods and models. The action is expected to lead to an improvement of meteorological preprocessors for dispersion models and to adequate urban data processing.

8. Conclusions

In most Bulgarian major towns, critically high concentration levels of NO_X, SO_2 and particulate matter are observed. However, the presently existing monitoring network (both meteorological and air quality) is not able to provide the basis for a comprehensive study to study peak pollution episodes and smog situations.

The modelling experience has previously been primarily related to long-range and meso-scale phenomena. Recently, increased effort has been devoted towards developing urban air quality models. Traditionally, a substantial amount of work has been performed, and such work is also in progress, regarding PBL parameterization. The improved parameterization of the urban PBL will contribute to the development of advanced meteorological preprocessors, and to an improved treatment of urban meteorological and concentration data for air pollution studies.

9. References

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10.Relevant www home pages of the participant

NIMH, weather prediction and air pollution modelling
http://www.meteo.bas.bg

GFI, air pollution modelling
http://www.geophys.bas.bg

Ministry of Environment and Water; clean ambient air policy, regulations and decree:
http://www.moew.govern.bg

Executive Environmental Agency at MOEW; daily data on air quality and annual reports
http://nfp-bg.eionet.eu.int/