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HUNGARIAN NATIONAL REPORT ON IAMAS 2007–2010

ACTIVITIES AT THE HUNGARIAN METEOROLOGICAL SERVICE

L Bozó

Hungarian Meteorological Service, POB 39, H-1675 Budapest, Hungary,
e-mail: bozo.l@met.hu

One of our main tasks is the continuous, as detailed as possible measurement and observation of the state of atmosphere and its meteorological parameters. Thus, we perform surface measurements and observations, atmospheric physical measurements, upper-air (radiosonde) measurements, operate the different remote-sensing instruments such as weather radar, windprofiler, SODAR, lightning detection system and satellite receivers. We collected, processed the measured data and transmitted them to the central database. We ensured the regular control, maintenance, repair and calibration of the different measuring and automatic equipment.

We modernized the data collection system of the automated surface observation network successfully, according to the plans. From the earlier 1 and 3 hourly data collection procedure, we switched to the GPRS-based central data collection in every 10 minutes. In some minutes following the measurement, the data are available for the users, such helping and supporting climate and forecasting duties. The continuous remote connection enables the control of data collectors and sensors and the correction of most of the failures.

In the field of remote sensing, the replacement of the EDGE radar control software and hardware and the modification of measurement procedure must be pointed out. The new radar control computers were put into operation at the radar stations. The installation of the new radar control software package EDGE 5 involved the modification of the post-processing procedures as well. The preparation of 1-, 3- and 6-hourly precipitation fields has been updated and 2D wind fields derived from radar data appear in the HAWK.

The regional centers support invariably with the usual thoroughness the work of the customers in the given region. The two-year calibration cycle of the traditional measuring instruments was over, so these instruments were replaced by newly calibrated ones. Taking into consideration the new expectations, measuring instruments replacing the traditional measurements appeared also in the network of the Hungarian Meteorological Service (HMS), which brings great challenges for both the observers and the experts. As first, the Vaisala cloud base meter was installed

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at the Main Observatory. The Meteorological Main Station in Debrecen has been operating as a regional center since June 2008.

Observation network

Synoptic observations are performed at 15 stations, while the continuous regional information services are carried out at 3 centers. There are annually two planned and ad hoc (random) checks of the network at each station. 98% availability of observed data is characteristic.

At the beginning of 2008, eight stations and, on the average, 550 precipitation stations were operated in the traditional climate network. Availability of precipitation data is 99.5%.

In the raingauge network, new observers were employed at 26 stations, and 6 stations were suspended. In Kiskunhalas a new station was established, while in Érd one of our raingauge stations was closed down.

In Mosonmagyaróvár visual observation was finished on 31 July 2008, and the station in Paks was outsourced on 1 May 2008.

Upon the request of the Central Directorate of Water and Environment, HMS prepares the optimization study for the hydro-meteorological station network of the water monitoring as well as the automation plan and instrument specification of the stations.

In terms of beginning the automation of visual observations, we put into test operation 5 Vaisala VRG101 raingauges working on the principle of weight measurement and a Vaisala CL30 cloud base meter. In case of precipitation measurements, the preliminary evaluation of data series collected so far as well as the preliminary analysis of usability of measured data series deriving from the operation of the cloud base meter has been carried out.

Calibration Laboratory

The calibration of instruments connected to the scheduled maintenance of the automated meteorological surface observation network was carried out in the past two years without any special problem. In the course of this activity, we calibrated 104 thermometers, 104 humidity transmitters, 72 air pressure transmitters, 102 rain-gauges, 92 wind velocity and 86 wind direction meters in 2008 and 116 thermometers, 116 humidity transmitters, 81 air pressure transmitters, 102 rain-gauges and 113 wind velocity and wind direction meters in 2009.

Atmospheric physical measurements

At the Budapest station, the stratospheric ozone and spectral UV measurements were performed without any trouble with the help of the Brewer spectrophotometer, and the control of the measured results was also continuous.

With the aim of defining aerosol optical parameters (optical depth, wavelength exponent), spectral solar radiation measurements in the visible and in the near

infrared range were carried out with the help of the LI-1800 spectroradiometer on 30 days among the 35 days which are suitable in respect of weather.

Connected to the measurement program of the automated surface observation network, the gamma dose measurement and the control of results were carried out without trouble at the 29 stations in the last two years.

Aerological Station (radio-sounding)

In 2008 and 2009, we launched three, mainly RS92-KL and sometimes GPS, radiosondes every day. In July 2008, the Hungarian Meteorological Service joined the Data Targeting System (DTS) observation program coordinated by PREVIEW/ EURORISK (Met. Office), in the framework of which extra (06 and 18 UTC) radiosonde launchings were carried out in the autumn. The program of DTS was finished in 19 December 2009.

Meteorological radio-locators (radar stations)

The radars in Napkor, Pogányvár and Budapest ensured essentially reliable data supply, the data were supplied for internal and external users in time.

There was a significant change in the configuration and operation of the radar network in the middle of 2008 aiming to improve availability and reliability. The control computers were installed at the stations, in the course of which the computers were replaced by Proliant ML350 server computers. A new version of EDGE 5 radar control software was installed on them, and the replacement of firmware and PROM became also necessary on the radars. According to statistics, data availability improved, and there are no data losses or compass errors due to communication disturbances. After switching over to the new configuration, the availability of data is around 99%.

Windprofiler (WP) and SODAR equipment

The operation of WP-s is continuous, there was no significant deficiency. The availability of measured data met the requirements. In case of both profilers, data availability to the height of 3000 m is 97%. In Budapest, RLAN was replaced by LAN connection.

The SODAR equipment was put into operation at the end of July 2008 in Ráckeresztúr where it is working with more than 97% data availability.

Radar and SAFIR

Instead of SAFIR programs, we concentrated on the operational availability of LINET data, and we managed to visualize them in the HAWK.

In order to improve the reliability of radar precipitation data, we made operational the so-called advection interpolation method in generating precipitation amount. As a by-product, the displacement vectors calculated in every 15 minutes

can be visualized by the forecasters on the HAWK workstations together with the radar images.

We have been fully integrated in the OPERA program of EUMETNET, our radar data are infiltrated operationally in the European radar composite with an update in every 5 minutes and they become part of the NATO NAMIS service as well. Together with the Polish Institute of Meteorology and Water Management, we work on the execution of one of the OPERA work programs marked 1.5a, in the course of which we presented the RLAN study prepared together with the National Communications Authority to the OPERA community.

Meteorological satellites

In October 2008, Hungary became a full member of EUMETSAT. Since May 2008, EUMETSAT has been transmitting, beside the METEOSAT images in every 15 minutes, so-called rapid scan images about Europe in every 5 minutes as well. The reception and processing of images of a slightly different format were solved by September, and the images have been getting into the HAWK workstation operationally since that time. Rapid scan data will help in the summer period in observing storm activity and in recognizing storms earlier, but so far they proved to be useful in tracing the dissipation of fog as well. We take part actively in the work of the Hydrological SAF (5 year-long project), we compare the precipitation products with Hungarian radar and surface measurements. We installed the satellite storm tracking product developed by the Italian Meteorological Service with the aim of visualizing it in the HAWK, comparing it with lightning and examining its accuracy. Upon the order of the Nowcasting SAF, we began the verification of the module performing parallax correction.

Weather forecasting

The role of the Weather Forecasting Division is to prepare short-, medium-, and long-range baseline forecasts, thus to fulfil a prescribed governmental task. In the course of the weather forecasting process, synoptists have been building mainly upon model predictions for years, but in case of short-range forecasts, traditional synoptical methods are still of high account. For the preparation of short- and medium-range forecasts the ECMWF and the ALADIN/HU models (the latter is run within the HMS) are applied. The German, English and other models (for example the American) has only complementary role. The HAWK visualization system (Hungarian Advanced Workstation) remained the most important tool for the operative work, since it is capable by now for the complex visualisation of the meteorological observations and forecasts.

We provided various events with meteorological information both in 2008 and 2009: For instance, detailed weather forecasts have been issued for the 15 March, 1 May, Children's Day, 20 August and 23 October ceremonies, many days prior to the events.

In addition to the detailed evaluation of the ECMWF and ALADIN models,

several years' trends are analyzed as well. According to these verifications, reliability of the forecasts prepared by our synoptists are improving, and the difference between the forecasters and the models are increasing in reference not only to the first but also to the sixth day. The medium-range verification table, that is prepared automatically each day, has been evolved in order to improve the verification techniques. The software performs an elementwise comparison between the ECMWF forecast and the prognosis prepared by the forecaster, from the second to the sixth days. Then it quantifies the reliability of the medium-range forecasts in form of a complex score.

HMS has issuing the Daily Weather Reports for already 122 years, and the renewed "10-day Forecast" brochure is updated three times a month. In accordance with our age's requirements, the renewed brochure comprises a lot more forecast information, compared to the previous version. In addition to the textual prognosis, various EPS products (ensemble plume diagram of minimum, maximum and mean temperature, as well as precipitation probability fields) are also to be found therein.

Short-range baseline forecasts

In order to prepare reliable short-range prognoses, forecasters should be aware of the actual weather conditions and of the few hours forecasts. Therefore synoptists utilize also observed data and information coming from various remote sensing systems (such as radar, satellite, lightning detectors), when preparing short-range forecasts. Accordingly, new services, that has been developed from MSG (Meteosat Second Generation) satellite images in the past few years, are also applied by them. Such as the different MSG-SAF nowcasting products, majority of which has already been integrated into the operative practice in 2007.

Medium- and long-range baseline forecasts

When preparing medium-range forecasts we growingly rely upon the ensemble forecasts. Spaghetti diagrams of the ground and the 500 hPa level, plume diagrams for more regions of Hungary, EPS meteograms as well as the precipitation probability fields are already the essentials of the more days forecasts. When preparing medium-range forecasts, clusters are increasingly used in the course of prognosis preparation. By the help of them various meteorological scenarios can be prognosticated in case of questionable weather conditions. All fields that has been prepared by clustering (average, representative members etc.) can be visualized operatively in the HAWK system. Under more problematic weather conditions, fields of COSMO LEPS project are applied as well. The long-range (30-day and 6-month) forecasts are prepared automatically by the ECMWF model products.

Verification

Verification results of the short- and medium-range forecasts are continuously monitored by the forecasters. According to these results, synoptists prepare more reliable forecasts (by using their knowledge and competence) than numerical models. The same holds in respect of the medium-range forecasts, where synoptists are able to improve deterministic model results, since their capability for applying ensemble products are increasing both in effectiveness and extensiveness. As recently prepared prognoses are closely related to the numerical model products, false model outputs are also revealed by the verification of weather forecasts. Case studies and long-term investigations may provide exceedingly useful information about the applied models, and may determine the main directions of their required development.

In 2008 the complex reliability index values, that have been derived from the verification of short- and medium-range forecasts, exceeded 80% for 1-day forecasts, 75% for 2-day forecasts, 60% for 3–6-day forecasts. In yearly average, reliability of the prognoses prepared by forecasters were better compared to the model results, by 3–5 percent for the first 1–2 days, and by 1–3% for the sixth day.

The reliability index of the long-range (30-day) and seasonal (6-month) forecasts' mean absolute error should be kept within the (+1, –1) interval.

Water management and disaster management

One of the basic task of the Weather Forecasting Division is to prepare meteorological forecasts for the Danube and Tisza cathcment areas, two times a day, for the purpose of flood and inland waters control. Most important element of these forecasts is the quantitative precipitation prediction, since water budget of rivers, steams, lakes is greatly affected by the magnitude of the precipitation. Besides, knowledge of precipitation conditions is essential in certain cases (e.g. flood control, water level in lakes, water storage). In addition to the services provided in case of flood, water conservancy organizations require special information as well. These information has been sent to the decision-making bodies both in 2008 and 2009.

Aviation meteorology

Our aviation meteorological forecasts are applied in both national and international air transport. One of our main tasks is to provide the civil aviation with meteorological information, and, in the frame of that to hold continuous intercourse with the HungaroControl Hungarian Air Navigation Service Ltd. Being a competent authority, we participated again in the yearly audit of the countryside airports in 2009, at the request of the Civil Aeronautics Board. In the last two years we provided many hot air balloon contests and open-air programs with meteorological information.

Severe weather warning and storm warning

In case of atmospheric conditions that expected to be dangerous to lives and goods, we issue severe weather warnings 1–2 days prior to the event, and update them three times a day. The warnings are modified according to the development of the weather conditions. We issue warnings 1–3 hours prior to the evolution of the severe weather event. It includes detailed information on the probable occurrence, on the course, on the specified location, and on the timing of the event. The warning is in force so long as a solvent or modificatory message is issued. Information on the severe events are displayed on the HMS homepage at all 24 hours of the day (updated continuously if needed) in regional resolution, both in textual and map form, indicating the degrees of danger. In 2009 preparation of severe weather warnings for micro-regions has been started in the framework of an European Union project.

In 2009 more severe thunderstorm warnings has been issued than in the similar period of 2008. In 2009 code orange warnings have been ordered on 35 days, code red warnings on 3 days. The latter was imperative due to freezing rain and thunderstorm events. In 2008 only 15 code orange and 2 code red warnings have been issued.

In the last two years, storm warning season (regarding the regions of the Lake Balaton and the Lake Velencei) started on April 1 and ended on October 31. In 2009, during the 7 months long storm warning season, 9 heavy storm events (with windspeed over 90 km/h) have been occurred, which is over the many years' average. Apart from April (which was less windy than average), wind gusts greater than 90 km/h occurred at the Lake Balaton in each month, in one or two days. Considering the average wind speeds, storm warning season was on the whole less windy than average.

The Lake Balaton region was under a level one storm warning in the 13.6% of the entire warning season, while in the Lake Velencei region this proportion was 7.4%.

During the season we provided several prominent events with meteorological data. Some of the most considerable ones were the Balaton Cross-Swimming, the Balaton Blue- Ribbon Sailing Contest and the Balaton Sound Festival.

Our duties in the field of nuclear accident prevention has been executed. We participated in the work of the Technical Scientific Board, the Governmental Coordination Committee, and the preparatory committees, and we took part in the organized trainings.

Numerical modeling

HAWK Visualization system

By the enlargement of the range of numerical weather prediction models and of the surface and remote sensing data, systematization and efficient visualization of the information, that provide a sound basis for forecasters in their daily work, became an increasing challenge. Within the Hungarian Meteorological Service mainly the HAWK (Hungarian Advanced WorKstation), its own developed visualization system is used. HAWK-3, the next generation version of the system has been re-

leased in 2008, but by 2009 it replaced HAWK-2 in many fields. Its main virtues are the less fettered panel arrangements, the advanced graphical adjustments, the more effective time management, and the possibility for preparing automatic images, image series and animations.

Data types of HAWK-3 that currently can be displayed on map:

— gridded data (deterministic and ensemble model predictions, analyses) – as isolines, by windbarbs, by areal colouring, as streamlines

— satellite and radar images – in raster form

— lightning data – by symbols

— SYNOP, radiosonde measurements – by symbols and numerals

— AMDAR data – by numerals

— webcams and other immovable image type products.

On vertical profile (Emeagram, Stuvegram, Tephigram, Skew-T):

— radiosonde, AMDAR measurements

— forecasted vertical profiles that has been produced from weather prediction models.

Similarly to HAWK-2, HAWK-3 is also meant to be used not only in the course of the operative preparation of weather forecasts, but we also intend to sell it to our interested partners.

Ultra-short range and short-range numerical predictions

The main role of the Numerical Modeling and Climate Dynamics Division is to satisfy all the modeling needs connected to weather forecasting and climate research, i.e. to carry out the operative application, maintenance and further development of the numerical models.

The leading numerical weather prediction model of HMS is the ALADIN model, which is run four times a day for 2 days ahead. The operative ALADIN model has lately been improved in many ways, mainly by developing the data assimilation scheme that is used to provide the initial conditions (inclusion of new observational types, operative installation of the surface data assimilation system, more accurate consideration of the forecast error characteristics etc.), and by applying the lateral boundary conditions of the ECMWF model. By now the deterministic ALADIN system is operatively completed with ensemble prediction information by the help of the 11-membered ALADIN ensemble forecasting system.

In 2009, after a many years' developing process, became the AROME non-hidrostatic ultra-short range NWP model (with the highest resolution within our forecast system (2.5 km for Hungary)) adaptable for every day use. By means of the AROME model our forecasts can be refined in a consistent way in the first 24–36 hours (naturally, we intend to operatively run AROME model more times a day).

Climate modeling

In climate modeling we rely on two regional climate models, the ALADIN-Climate and the REMO (both run within the HMS) when investigating the current and future climate of the Carpathian Basin. After completing the testing of the model against past climate, preparation of (both near and distant) future projections has been started as well. In consequence of that, climate simulations of ALADIN-Climate model are available for the 1961–1990, 2021–2050 and 2071–2100 periods (preparation of simulations for the intermediate periods are in progress). Climate simulations of the REMO model has been accomplished for the 1951–2100 period.

We build more and more contacts with experts investigating the effects of climate change, and we are increasingly able to meet their requirements according to the above mentioned databases. By our initiation, cooperation with the Eötvös Loránd University has been continued in order to build not only upon our two climate models, but on the all four models that are available in Hungary (ALADIN-Climate, REMO, ELTE PRECIS and RegCM) when modeling the future climate of the Carpathian Basin.

During 2008 and 2009 we have organized three conferences that have been appreciated internationally. In 2008 a Mini Workshop on Regional Climate Modeling (out of the most important presentations of which a Special Issue has been compiled in the (English speaking) *Időjárás* Quarterly Journal of the HMS), while in 2009 the Final CLAVIER Meeting and CLAVIER Stakeholders Workshop, as well as a Summer School on Climate Variability and Climate Change have been organized.

Climate activities

Data recording and control

Data recording and control activities have been continued on a high standard. In reference to the database our main tasks are to continuously control and correct incoming data, to record paper based data, and to maintain climate archives. Controlling of data measured by four termini climate stations, synoptic stations with observers and precipitation measurement stations are still performed by using the classical method, but lately also radar and lightning images are applied. In 2008 a new daily data error filter program was developed for automatic weather station data, which is of huge service to the data controllers. The climate archives is increasing by the continuous incoming of datasheets, which are minded and methodized. In addition to the regular daily control, many retrospective data control has been performed as well.

In order to reduce the difference between the electronic and paper based databases a new method has been developed, that enables observers of countryside stations to record paper based precipitation data. The selection of stations whose data has to be recorded, the comparison of precipitation sheets as well as the arrangement of meta data are continuously in progress, hence precipitation sheets that must be recorded are continuously provided to the observers of countryside stations. Mean-

while controlling of meta data of standard precipitation measurement stations, that has been recorded in the last few years, are in progress as well.

Data supply

The interest towards our climate services is still considerable. We pursue data supply and data evaluation activities in an operative way, in the framework of contracts (for establishments representing different sectors of the national economy, for courts, prosecutions and constabulary organizations), or in reply to individual orders. The demand for meteorological certificates, that are pre-requisite to making an application for *vis major* subsidies, has been soaring. Our free data supply that has been elaborated for undergraduate students is continuous, the students' demands are administered by unitary aspects. Authorities continue laying claims to data supply in many instances, and, on occasion they order expertises as well.

Daily and monthly reports are prepared regularly for the Hungarian Central Statistical Office and to the WMO. As in previous years, monthly, seasonal and annual reports are published both on the HMS Homepage and in the *Légkör* journal.

Research activity

Research activities has been continued in 2008 and 2009. Among other things, mathematical investigations have been performed for the data control part of MISH-MASH software package, and program development has been accomplished for the modeling part of MISH interpolation software. Presentations and studies has been prepared, and testing has been performed for the COST Action ES0601. Additionally, a method has been developed within the MISH system for modeling standard deviation, which is required for the data control part of the software. Within the WP4 working group of the Cecilia Project we calculated extreme climate indices on homogenized, controlled, gridded data, for the 1961–1990 period, by the help of the MISH-MASH package.

In the framework of the OTKA's (Hungarian Scientific Research Fund) sunshine duration project, monthly sunshine durations have been modeled by means of the MISH system, and cloud cover (that has been used as an auxiliary variable) has been homogenized (by MASH) and modeled (by MISH). In this topic we submitted a successful OTKA tender ("Improvement of interpolation methods for sunshine duration and global radiation"), that has been supporting since 2009.

Calculation of biochemical indices, that are used for characterizing human comfort, are in progress. At present PET (Physiologically Equivalent Temperature) and PMV (Predicted Mean Vote) dataset of 8 synoptic stations are available for the 1961–2006 (2007) period. Specification of the bioclimatic features of the Lake Balaton Resort Area, as well as the analysis on the changes has been accomplished. Additionally, research on the climatological and bioclimatological terms of winter tourism has also been completed. In the second half of 2008 a research was begun on the changes in thermal bioclimate, by the application of measured data and products of various regional climate models (Aladin Climate, REMO, CLM)

therefore we cooperated with the Numerical Modeling Division of HMS and the Meteorological Institute of the Freiburg University.

Between 11–15 May we organised the "Second Conference on Spatial Interpolation in Climatology and Meteorology".

In the subject of medical meteorology, the connection has been investigated among mortality (due to circulatory system diseases, cardiovascular diseases, respiratory diseases and violence), 3 different types of weather conditions and 8 meteorological parameters.

Results of our climate researches have been published in several articles as well as in the frame of conferences and educational lectures.

We maintained bilateral cooperation with Croatia, Slovakia, Slovenia and with the Republic of South Africa. In the framework of the CDFree activity issues on the 100 years long climatic data series of Budapest, Szeged and Debrecen has been published, and are to be looked also at the HMS Homepage. As the fourth piece of the series, the 100 years climatic data series of Szombathely and the belonging analyses has been accomplished as well.

Air quality

Reference center for clean air protection

In this center certain quality control tasks are fulfilled relevant to different measurement methods and measurement equipments that are applied in clean air protection. Next to that, the Hungarian Air Quality Network's (HAQN) technical coordinating roles, quality management tasks and duties as national database are also performed by this body. The main activities of the division can be categorized as follows:

Calibration laboratory tasks:

— to maintain accredited laboratory

— to fulfil certain reference laboratory tasks connected to clean air protection: to maintain national reference gauge(s), to ensure traceability of measuring equipments and calibrating instruments, to establish new rating and measuring methods, to keep connection with international organizations, to participate in international comparison measurements

— to perform verifier calibration of gas analyzers (used for clean air protection purposes) in the laboratory and on site

— to organize interlaboratory comparisons of emission measurements

— to arrange interlaboratory comparisons and field comparison measurements for emission gas analyzers

— to fulfil HAQN's quality management tasks, to prepare quality assurance/quality control plans, to supervise their implementing, to coordinate developments and training courses

— to participate in national and international comparison measurements, in demonstration measurements, and in national and international projects.

Air pollution database management tasks:

— to collect data from the atmospheric monitoring network, to monitor data transfer, to oversee the applied software, to validate data, to prepare annual reports

— to accomplish international and national data supply

— to provide technical supervision over the public information system of HAQN

— to hold intercourse with EU organizations in the field

— to supervise and coordinate technically all data supply and data management tasks of HAQN, to coordinate developments and law modifications relevant to these tasks, and to hold quality management roles.

Clean air protection tasks:

— to perform type approval testing on continuously operated measurement instruments used in clean air protection

— close cooperation with the Inspectorates for Environmental Protection, Nature Conservation and Water Management that operate HAQN: to keep daily contact in the field of data collection and supply, to organize regular meetings in order to handle coordination tasks that promote HAQN's operation (actual tasks, training courses, law modifications etc.)

— to accomplish complementary tasks on emission inventory, to participate in the completion of international data supply.

Monitoring background air pollution

At the Hungarian Meteorological Service background air pollution has been measuring for decades. A background air pollution monitoring network consists of 4 stations (K-puszta, Farkasfa, Nyirjes, Hortobágy) is operated by the HMS, where daily precipitation and 24 hour air pollution samplings are performed.

Next to measuring ambient air pollution, HMS's background air pollution monitoring stations take part in two leading international program by sharing their data. K-puszta and Hegyhátsál are participating stations of the WMO GAW program (Global Atmosphere Watch), the main role of which is to study the interrelationship between the meteorological and climatological characteristics and the chemical processes. Additionally, K-puszta is part of the EMEP (European Monitoring and Evaluation Program) monitoring network, hence recommendations and quality standards of EMEP are authoritative during both samplings and analytical methods. Measured data are directed to WMO and EMEP once a year.

Our data sharing commitment ordered by national and international organizations are fulfilled on the one hand by the data that has been measured and verified by the laboratory and are directed on schedule to HMS's CLDB database, and, on the other hand by the Gudance on Atmospheric Environment that is issued once a month.

Modeling pollutant dispersion

For modeling air pollution dispersion on local scale, the AERMOD (AMS/EPA Regulatory Model) dispersion model is applied by the HMS. The AERMOD model is a so-called second-generation dispersion model, i.e. atmospheric boundary layer parameters that mainly determine pollutants dispersion are no longer estimated by empirically derived equations, but some form of the Monin-Obukhov similarity theory is used by the model. Additionally, in the course of pollutants dispersion, flow modification effect of topography is understanded by the model, which leds to more accurate modeling. The AERMOD model is mainly used for regulatory purposes of industrial sources. The model may play important role in preparing environmental impact studies. At the request of the National Inspectorates for Environmental Protection many AERMOD model runs has been performed in order to prove what kind of additional pollution will be induced by a planned industrial project in the surroundings of the source. Local-scale dispersion calculations could be done for any place of our country using the available meteorological dispersion database.

Air quality forecast

Air quality model system has been improved with the aim of predicting the expected concentration of pollutants in Budapest, for 1–2 days ahead, hence occurrent smog alert decree (ordainment or abolishment) could be calculated as well. During the improvement a chemistry transport model (CHIMERE) has been adapted. Meteorological fields, that are required as input data, are provided by the MM5 and the WRF numerical models. The traffic emission grid database, which is an essential input to the model, is based on the traffic count data collected in Budapest

Greenhouse gas inventory division

Registration of greenhouse gases has just recently started within the Hungarian Meteorological Service. Each party to the United Nations Framework Convention on Climate Change and the Kyoto Protocol (hence Hungary as well) has to monitor the national emissions (by anthropogenic sources) and removals (by sinks) of GHGs, i.e. greenhouse gas inventory has to be prepared. At the request of the Ministry of Environment and Water, technical part of the inventory preparation is being done by the HMS. The first National Inventory Report coordinated and compiled by the HMS has been submitted to the European Commission and to the United Nations at the beginning of 2008.

Practically, GHG inventories are databases that provide detailed information on each of the main source and sink categories. Among others, the following questions

are answered by a national GHG inventory: what is the total emission amount of greenhouse gases in Hungary (78.6 million tones carbon dioxide equivalents), how much of that is absorbed by forests (4–5 million tones CO_2), what is the main source of CO_2 emissions in Hungary (25% of total emissions are derived from electricity and heat generation), how much have the road traffic CO_2 emissions increased (by more than 80%, between 1996–2007). The National Inventory Report, that is attached to the national GHG inventories, comprises the applied calculation methodologies, the trend interpretations, the institutional and legal backgrounds of the inventory preparation, the quality control policies, the explanation and justification for recalculations, and the development projects.

The national inventory is regularly audited by both the United Nations and the European Union. Additionally, deficiencies might be revealed during our own quality control procedures as well, hence GHG inventory preparation is a continuous improvement process. The main improvements in 2008 include:

— the estimation of emission from the digestive process of cattle by a higher-level methodology

— the recalculation of emissions and removals from woody biomass (vineyards and orchards)

— the segregation of oil refining and coke production in accordance with the regulations

— the uniform consideration of land use categories, the recalculation of soil subcategory by external experts.

The inventory submitted in 2009 was exceptional, since for 2007 the lowest ever emission has been detected ("lowest" compared to the emission rates recorded between 1985–2007). It might be well known that as a consequence of the regime change in Hungary (1989–1990) emissions decreased by 30%. However, the total GHG emissions in 2007 in Hungary (75.9 million tones carbon dioxide equivalents) were lower by 5 percent even compared to the average of the relatively stable 1996–2005 period (that is characteristic to the period after the regime change). Total GHG emissions have decreased by 4% between 2006–2007, and by 6% between 2005–2007, consequently they have reached the lowest ever level. (Even in 2000, when the second lowest emission rate was recorded, were emission values higher by 2.1 million tones (by almost 3%).) The emission reduction in 2007 occurred mainly due to the extreme mild winter, whereupon energy demand of heating has decreased. This sudden reduction could not be compensated by the steady growth in GHG emissions from electricity generation and transport, that has been observed for years.

Improvement of the informatics and telecommunication systems

Informatics investments and modernizations

In 2008 both the hardware and software (Zorp) firewall systems (that has been used for more than 4 years) was replaced. The memory capacity of the cluster server was increased to 8 GB. The more than 5 years old FC4700 backup disk module was replaced, and a new disk storage system (with adequate capacity) was purchased. In the new central storage (CX4-480C) the required capacity (∼25 TB) is ensured by 15 pieces of 1000 GB SATA and 40 pieces of 300 GB FC disks. The CX700 system (15 TB) will operate as a disaster recovery disk copy, while the FC4700 old backup disk module (8 TB) will be developed to store special science materials.

The storage and maintenance of the continuously increasing archive database is promoted also by the tape storage system. 8 drives facilitate the more effective movability of the capacity that has been increased to 190 tapes (∼53 TB).

Since sometimes the HMS homepage is visited by more than 200,000 people a day, the web server has been enlarged by 4 processors and 8 GB memory.

The tower of the Storm Warning Observatory in Siófok has been entirely renovated in 2008. In the frame of the months long work, the computer and telephone network has been renewed as well.

The rebuilding of the HMS Headquarters' 3rd floor (renewal of the engine room, building-up of the outside elevator and the working rooms) was finished in September 2008. The engine-room, where servers and active networking devices (switch, router) are stored, is now equipped with automatic fire protection system, with new air-conditioners, with low and high voltage distribution network and with Uninterrupted Power Supply in order to ensure the correct and smooth operation of the IT system.

So as to properly manage the large quantity of model data, in 2009 the storage area network has been accelerated (4 Gbps FC switch), and the central storage (CX4-480C) has been enlarged by 15 pieces of 1000 GB SATA discs.

The enlargement (by 28 m^2) of the underground engine-room of the HMS Headquarters was finished in March. First the enlargement (by 80 KVA) of the Uninterrupted Power Supply has been finished, then the air conditioning system has been altered (i.e. enlarged by 28 KW), and the fire protection system has been extended.

Network management

In November 2007 HMS joined in the Electronic Governmental Network (EKG) with 35 Mbps total bandwidth and within that with 18 Mbps Internet bandwidth. The servers of both the Geoinformation Service of the Hungarian Army and the Hungarian Disaster Management are reached via EKG Internet VLAN. Due to the huge number of visitors to the public website of HMS, we initiated the bandwidth enhancement of our Internet backbone, thus 80 Mbps bandwidth is available for the internet users and for the EKG governmental partners.

Preparation of baseline forecasts and meteorological products, and associative developments

Thanks to RMDCN's (Regional Meteorological Data Communication Network) bandwidth enlargement (1024 kbps) and to the new process control computer, high resolution (0.25×0.25) data calculated by the ECMWF deterministic forecast model have become available.

In the frame of the improvement of the full-sky monitoring system, new cameras have been installed at the tower of the Kékestető Meteorological Station, at the Observatory of the University of Szeged, and at the top of the Panorama Hotel in Balatongyörök. The novelty of the system in Balatongyörök is that the camera is controlled by a small network router (instead of a PC), and this router transmits the images to the center.

The data management process of the wind data at the Lake Balaton has been reformed as well. Minutely wind data, that are transmitted within the Hungarian Disaster Management's system, are get directly into the central database (CLDB) from the collector computer of the Storm Warning Observatory in Siófok, at intervals of 5 minutes. Wind data measured at the Lake Balaton Region are to be found at the HMS homepage

In the framework of the EUMETNET OPERA project, HMS is able to obtain international radar information, but their utilization is limited to internal use. Operative download of radar data in BUFR format, their decoding and their transformation info JPG format images has been accomplished as well.

From July 2009 the dissemination system of ECMWF, that is accessible via the Internet, has been using operatively. The ECMWF operational products are still downloaded through the RMDCN connection (1014 kbps), but by this improvement the backup has been enlarged and new pilot products can be imported as well.

Development of the meteorological database and the archives

Due to the former, so-called EKG project (that concerned the main meteorological stations and regional centers) and because of the switch to the GPRS automatic data collection, meteorological data from more than 90 meteorological stations are received in every 10 minutes by the Meteorological Database (CLDB). NetCDF storage of ten-minute data has been completed as well, thus the application and visualization (HAWK) of new data types are well ensured.

Synchronization of minutely data (measured at the 14 meteorological stations, where also observers are at work) to the central database has also been accomplished. By means of the data visualization application, meteorological information are to be looked at in tabular form or as diagrams.

Development of the HMS homepage

The public homepage of HMS (www.met.hu) has been improved by several important information in 2008 and in 2009.

Since 2008 all sorts of meteorological records are to be found at the HMS homepage: meteorological records for Hungary, for Europe, world meteorological records as well as a collection of homepages with any types of interesting weather records.

The system that is processing and visualizing nitrogen dioxide, sulphur dioxide, ozone and particulate matter data measured by 11 stations in Budapest (operated by the Hungarian Air Quality Network) and by the meteorological station in K-Puszta (which is part of the HMS's own network), has been completed as well. Air quality data of the capital are to be found at the HMS homepage both in the form of maps and tables.

In 2008 a new page has been built about the meteorological characteristics of the Lake Balaton region. In addition to the relevant storm warning phase it includes wind data (updated in every 5 minutes), textual weather forecast, as well as wind and precipitation forecast maps.

In order to fill a need, the Aviation Meteorology portal has been accomplished as well, that provides useful information mainly for general aviation. Next to the manifold visualization of the encoded forecasts, latest data measured by the automatic meteorological stations are to be looked at on the page as well, in the form of maps and tables. Additionally, several observed (radar, lightning) and forecasted (wind, precipitation) maps help the orientation and the preparation of those who love aviation.

The observations and measurements page of the HMS homepage has been renewed. Next to the hourly data of 11 national weather stations (in form of maps and tables), remote sensing information (radar, lightning, satellite, full-sky images) are also to be found at this portal.

Weather forecasts page of the HMS homepage has been enlarged as well. In addition to the 7 day automatic forecasts (prepared for 60 Hungarian towns, based on the ECMWF model), the official synoptic and warning forecasts of HMS, as well as the hour-scale (updated 4 times a day) forecast maps (temperature, precipitation, wind, visibility) are published here as well. Weather data calculated for the larger cities of the continent are to be looked at under the entry word of international forecasts.

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