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BELGRADE, 10-12 October 2007

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BELGRADE INITIATIVE: ENHANCING THE REGIONAL SEE COOPERATION IN THE FIELD OF CLIMATE CHANGE – CLIMATE CHANGE FRAMEWORK ACTION PLAN FOR THE SEE REGION, AND THE ESTABLISHMENT OF A SUB-REGIONAL, VIRTUAL CLIMATE CHANGE RELATED CENTRE FOR RESEARCH AND SYSTEMATIC OBSERVATION, EDUCATION, TRAINING, PUBLIC AWARENESS, AND CAPACITY BUILDING

Addendum

submitted by

Serbia and the Regional Environmental Centre for Central and Eastern Europe

through the Ad Hoc Working Group of Senior Officials

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CAPACITY-BUILDING

SOUTH-EAST EUROPEAN PERSPECTIVES

BELGRADE INITIATIVE: ENHANCING THE REGIONAL SEE COOPERATION IN THE FIELD OF CLIMATE CHANGE – CLIMATE CHANGE FRAMEWORK ACTION PLAN FOR THE SEE REGION, AND THE ESTABLISHMENT OF A SUB-REGIONAL, VIRTUAL CLIMATE CHANGE RELATED CENTRE FOR RESEARCH AND SYSTEMATIC OBSERVATION, EDUCATION, TRAINING, PUBLIC AWARENESS, AND CAPACITY BUILDING[1]

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[1] The text in this document is submitted as received from the authors.

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I. INTRODUCTION

1. During the past decades it has become all the more evident that climate changes have a great influence on the economy and population in numerous regions of the world, including the region of south-eastern Europe, to which the Republic of Serbia belongs. Preliminary results of climate research and potential climate changes on the territory of Serbia as reflections of global climate changes indicate trends of further increasing of the air temperature and a considerable precipitation decrease, especially in the warm season of the year.

2. The mentioned results clearly indicate the necessity of further systematic climate monitoring and studying on regional and local scales for the purpose of developing a reaction strategy and efficiency assessment measures. The area of Serbia, as the larger Balkan and southern Europe area, is influenced by climate conditions which enhance the occurrence of droughts, floods, heat waves and other climate extremes, which were especially pronounced during the last decades. The increasing vulnerability to climate changes and other natural disasters in the countries of our Region make necessary the need for the strengthening of international technical and scientific cooperation conducive to more successful climate monitoring and forecasting, assessments of the influence of climate changes on human health, numerous economic activities and the availability of natural resources, as well as the early identification of problems and adoption of measures and strategies for adaptation to changed climatic conditions.

3. Bearing in mind the wide experience in the field of climate monitoring and research, which in Serbia date back to the middle of the 19th century, and honouring the appeal of the World Meteorological Organisation to its Member countries to undertake, in accordance with their capabilities, measures pertinent to the strengthening of international cooperation through appropriate national, sub-regional and regional climate centres, the Republic Hydrometeorological Service initiated, at the beginning of 2006, the establishment of a sub-regional centre for climate changes for south-eastern Europe. This initiative received the full support of the Government of the Republic of Serbia, as well as of the National Hydrometeorological Services of the SEE Region countries at the meeting of the Directors held in 2006 in Dubrovnik, Croatia. This proposal is included in the priorities of sub-regional cooperation within the Sixth Ministerial Conference «Environment for Europe 2007», 10-12 October 2007, Belgrade, Serbia as one of Belgrade Initiatives (Belgrade Initiative: Enhancing Regional SEE Cooperation in the Field of Climate Change – Climate Change Framework Action Plan for the SEE Region and the Establishment of a Sub-regional Virtual Climate Change related Centre for Research and Systematic Observation, Education, Training, Public Awareness, and Capacity Building).

4. The Initiative for the establishment of a Sub-regional Virtual Climate Change related Centre in Belgrade opens up new possibilities for the strengthening of regional scientific and technical cooperation in the field of meteorology and climate changes, especially concerning the transfer of technology, know-how and experience of faster technical, technological and personnel enhancement of the National Hydrometeorological Services in the region of south-eastern Europe.

II. SERBIAN PROPOSAL TO HOST A SUB-REGIONAL VIRTUAL CLIMATE CHANGE RELATEDCENTRE IN BELGRADE FOR RESEARCH AND SYSTEMATIC OBSERVATION, EDUCATION, TRAINING, PUBLIC AWARENESS, AND CAPACITY BUILDING

A. Historical background and rationale for the establishment of a sub-regional climate change related Centre

5. Belgrade has a rich historical tradition in climate science, dating back to the times of careful measurements and analyses of data as explainable on physical principles (Pavle Vujevic, cited in major mid last century reference books, such as Godske et al., Sutton); but also it is the place of work of one of the greatest climate scientists of all times, Milutin Milankovic. Milankovic's close collaboration with two other giants of climate science and of geophysics, Wladimir Köppen and Alfred Wegener, is extensively documented. In more recent times, the mid-seventies, at the dawn of the numerical modelling approach to studies of atmospheric phenomena, Belgrade was the home of the birth of a highly successful regional atmospheric model, the HIBU (Hydrometeorological Institute and Belgrade University) model, the ancestor of the today Eta and NCEP's NMM models. The development of this model was associated with the formation of what was frequently referred to as the "Belgrade modelling school". Numerous highly successful modellers were educated, today welcomed in many leading climate centres of the world, but many also resident and working in Belgrade and/or Serbia as well. Naturally, along the way, a university curriculum at the level of the best in the world was also developed, with the tradition maintained up to the present. For example, WMO's GARP Publication Series

No. 17, by Mesinger and Arakawa (1976)[2] is widely cited today beyond atmospheric sciences, hence it has become a classic, and could well be the text used more than any other in teaching numerical methods in atmospheric and oceanic sciences in various universities throughout the world.

6. The National Hydrometeorological Service of Serbia and the former Yugoslavia (Federal Republic of Yugoslavia) accomplished in the past decades significant results pertaining to the increase of bilateral and regional cooperation in the field of meteorology, especially related to the transfer of knowledge and advanced technology in the field of atmospheric modelling. In this context, the International Summer School of Meteorology in Krivaja, which was held every year in the period of 1994 to 1998 with the support of the World Meteorological Organisation, is especially noteworthy.

7. This educational manifestation was carried out in the form of two weeks of educational courses devoted to the development and operational application of numerical atmospheric models as per the requirements of weather forecasting, climate research and forecasting of trans-boundary transport of pollutants in cases of accidental nuclear and chemical atmospheric pollution.

8. Almost all the countries of south-eastern, central and Eastern Europe participated in the work of the International Summer School of Meteorology in Krivaja, Serbia, as did the representatives of some countries of America, Asia and Africa.

9. The necessity of increased international cooperation in the field of climate change is also stressed by the recommendations of the WMO bodies dealing with the implementation of the World Climate Programme, which urge Members to undertake measures, in accordance with their capabilities, pertaining to increased international cooperation through appropriate national, sub-regional and regional climate centres, the establishment of which in the Region of Europe was supported by Resolution 5.1/2 (XIV-RA VI) – Establishment of a Regional Climate Centre Network in RA VI (RCC-RA VI).

10. Based on the above experience, together with the recommendations of the WMO, the Republic of Serbia has launched an initiative for the establishment of a Sub-regional Virtual Climate Change Related Centre for Research and Systematic Observation, Education, Training, Public Awareness, and Capacity Building. This Initiative for the enhancement of sub-regional cooperation is a continuation of the previous successful regional cooperation.

[2] Mesinger, F., and A. Arakawa, 1976: Numerical Methods used in Atmospheric Models. WMO, GARP Publ. Ser. 17, Vol. I, 64 pp. [Available from the World Meteorological Organisation, Case Postale No. 5, CH-1211 Geneva 20, Switzerland.]

B. Mission, objectives and duties of the proposed Centre

Mission

11. To meet the needs of SEE countries for information on sub-regional climate change on a continuous basis;

12. Continuing support to the building capacities of the NMHSs in terms of human resources and improvements of climate change products and services in the sub-region; and

13. Serve as an exemplary partnership between the NMHSs in the region and other interested institutions dealing with climate change, as well as with relevant international organisations, regional climate centres, donor community, etc.

Objectives

14. The basic goals for the establishment of a Sub-regional Virtual Climate Change related Centre in Belgrade for Research and Systematic Observation, Education, Training, Public Awareness, and Capacity Building, within the National Hydrometeorological Service of Serbia are the following:

(a) A further strengthening of cooperation of the National Meteorological and Hydrometeorological Services of the countries in the sub-region in the field of climate change;

(b) Support a faster transfer of knowledge and technology in the field of regional climate modelling and other downscaling techniques; application of these research results in impacts and vulnerability assessment studies;

(c) The support of personnel and institutional advancement of the NMHSs for performing relevant tasks related to climate change, education and the raising of public awareness, including contributions to implementation and synergies, through cross-cutting issues, of different Conventions (UN Framework Convention on Climate Change, UN Convention on Biological Diversity and UN Convention to Combat Desertification).

Tasks

15. The Centre is envisaged to engage in:

Research and development

(a) Development of regional climate models. The employment of more than one regional climate model is foreseen. The Eta model, developed to a significant degree in Belgrade, is the primary choice, but the UK Met Office's Hadley Centre's PRECIS is foreseen to be used as well. The Eta model coupled to the GFDL's POM (Princeton Ocean Model) is also being run in Belgrade at present. Several components of the Eta and the Eta/POM model are being experimented with at this time by potential collaborators of the centre; for example, an upgrade of the Eta model to be very nearly a finite volume model, with encouraging first results, is in progress at present;

(b) Use of regional climate models for seasonal climate prediction. Relatively straightforward approaches can be put in place relatively easily to perform seasonal climate predictions, for example following the practice of the Brazilian Centre for weather prediction and studies of climate (CPTEC), which has used the Eta model for this purpose (Chou et al., 2005)[3];

(c) Use of the regional climate models for downscaling and/or regional reanalysis. One should note the very successful – and the first effort of its kind ever – use of the Eta model for NCEP's North American Regional Reanalysis (Mesinger et al. 2006)[4]. Following in the footsteps of this effort, regional downscaling for an SEE domain is planned to be performed – running a regional model at high resolution using lateral boundary data of a global reanalysis run with no data ingest – and regional reanalysis, including subsequently data ingest;

Operational functions

(a) Providing the operational functions in assessing the numerical weather prediction outputs, generating sub-regional analysis and seasonal and inter-annual prediction products;

Capacity building

(a) Education and training/capacity building in the SEE region. To provide training and make available the sharing of the best experience and practice in climate change, particularly in climate modelling and interpretation of model outputs for the capacity building of NMHSs climate centres in the sub-region.

16. In summary, the main activities of the proposed centre shall be training and capacity building and the issue of climate information relevant for the south-eastern Europe, particularly its Western Balkan sub-region.

C. Proposed organisational structure

17. The proposed sub-regional climate change related centre in Belgrade shall be of a virtual type, as defined in the WMO Technical Document WMO-TD No.1198[5] and will be inclusive, allowing the participation of all members. This type of centre requires no financial contributions of the participating countries.

18. With respect to other institutions and the National Meteorological and Hydrological Services (NMHSs) within the region, the virtual climate change centre is to be complementary (non-duplicating) and supportive of the NMHSs. The products from the center will be provided to the NMHSs for further definition and dissemination and are not to be distributed to end users

[3] Chou, S. C., J. F. Bustamante, and J. L. Gomes, 2005: Evaluation of seasonal precipitation forecasts over South America using Eta model. Nonlin. Proc. Geophys., 12, 537-555.
[4] Mesinger, F., G. DiMego, E. Kalnay, K. Mitchell, P. C. Shafran, W. Ebisuzaki, D. Jovic, J. Woollen, E. Rogers, E. H. Berbery, M. B. Ek, Y. Fan, R. Grumbine, W. Higgins, H. Li, Y. Lin, G. Manikin, D. Parrish, and W. Shi, 2006: North American Regional Reanalysis. Bull. Amer. Meteor. Soc., 87, 343-360.
[5] Proceedings of the meeting on organisation and implementation of regional climate centres, Geneva, Switzerland, 27 - 28 November 2003, WCASP - No. 62.

without the permission of the NMHSs within the region. It is expected that all participating members of the virtual centre should always adhere to the principles of the WMO concerning the exchange of data and products.

D. Available resources and facilities for running the Centre

19. **Human resources** potentially required for a successful work are more than adequate, given the world standard education at the Institute of Meteorology of the University of Belgrade, but just as well the potentials of neighbouring SEE countries.

20. **Computer resources**. Computer resources for the initial development work are available at the Republic Hydrometeorological Institute (see Section on technical information). There are plans to upgrade these resources. The centre can also expect free use of the significant computer resources of the Institute of Meteorology of the University of Belgrade. Furthermore, the centre may use the NEC supercomputers of the Joint Japan - Serbia and Montenegro Centre for Simulation Science which was opened on August 31, 2004 in the Centre for Science and Technological Development, University of Belgrade. The Centre is equipped with NEC supercomputers SX-6i, the provision of which was realised through the generous cooperation of NEC (Nippon Electric Corporation) and the support of Professor Tetsuya Sato[6], Director-General of the Earth Simulator Centre, where "Earth Simulator", at the time the world's fastest supercomputer, is situated.

21. The Republic Hydrometeorological Service of Serbia, as a government authority hosting the centre, contributes in-kind to the virtual centre with its communication, computational and technical infrastructure resources, including offices with the necessary office equipment (see Section on Technical information). At present, 15 skilled personnel out of over 600 employees of the NMHS of Serbia from three divisions are engaged to serve the missions of (1) producing climate forecasts (2) interacting with other national/regional/global Centres, including dissemination of research and climate forecasts products, and (3) training division.

III. INFORMATION ON THE INSTITUTIONAL AND TECHNICAL CAPACITY TO HOST A SUB-REGIONAL VIRTUAL CLIMATE CHANGE RELATED CENTRE IN BELGRADE FOR RESEARCH AND SYSTEMATICOBSERVATION, EDUCATION, TRAINING, PUBLIC AWARENESS, AND CAPACITY-BUILDING

A. Institutional capacity

22. The Republic Hydrometeorological Service (RHMS) as a body of the Government of the Republic of Serbia performs the tasks of monitoring the weather, climate and waters, air and water pollution, and air and precipitation radioactivity, including the monitoring of the trans-boundary air and water pollution as well as other tasks of the National Hydrometeorological Service as a public service of importance for the preventive protection and remedy of the consequences of atmospheric and hydrological disasters and the consequences in cases of accidental air and water pollution. These duties of the RHMS are set by National laws, including the laws on the ratification of relevant international conventions and bilateral agreements.

[6] <http://www.es.jamstec.go.jp/esc/eng/ESC/message.html>.

23. In accordance with the abovementioned laws, the functions of the Republic Hydrometeorological Service include international cooperation including the functions of the National Meteorological and Hydrological Centre/National Focal Point of Serbia in the following organisations/Conventions:

(a) World Meteorological Organisation (WMO),

(b) International Civil Aviation Organisation (ICAO),

(c) Intergovernmental Panel on Climate Change (IPCC),

(d) European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT),

(e) European Regional Centre for Medium-range Weather Forecasts (ECMWF),

(f) European Meteorological Data Communication Network (RMDCN),

(g) Danube Commission for safe navigation on the Danube,

(h) Protocol on long-term financing of the Cooperation programme for the assessment of trans-boundary long-range transport of pollutants in Europe (EMEP Programme).

24. Participating in the World Climate Programme, GCOS, GAW, and other WMO programmes, as well as in the work of IPCC, the Republic Hydrometeorological Service of Serbia directly participates in the implementation of the UN Framework Convention on Climate Change (UNFCCC) related to Research and Systematic observations. In addition, the RHMS is designated as a national focal point for Article 6 of the UNFCCC.

B. Existing infrastructure of the RHMS of the Republic of Serbia

25. In accordance with existing laws and international obligations undertaken through the ratification of the above stated Conventions and Protocols, the RHMS as a National meteorological and hydrological centre provides the functioning of meteorological and hydrological observing systems, a hydrometeorological telecommunication system for operative collection, exchange and dissemination of data and information, and an analytical-forecasting system for analysis and forecasting of weather, climate and water, early notification and warning against atmospheric and hydrological disasters and accidental air pollution in cases of nuclear disasters and technological catastrophes.

26. The RHMS is able to provide high quality services through its quality assurance policy and is undergoing certification by ISO 9001 and ISO 17025 standards (final stages).

Meteorological and hydrological observation network

27. The observational network of the RHMS consists of more then 600 stations of different categories and purposes, 30 of which are synoptic/principal climatological stations with programmes of hourly observations and reports for the needs of weather forecasting, monitoring and research of climate and climate change, applied meteorology, aviation meteorology and agrometeorology. The hourly SYNOP reports are operationally (in real-time) collected from these 30 stations and are included in international data exchange. These stations are an integral part of the European WMO-RA VI meteorological observation network within the Global

Observation System of the World Meteorological Organisation (WMO), one of which is included in the GAW/WMO and ECE/UN/EMEP monitoring programme of atmospheric pollution.

28. In the frame of the ongoing technical modernisation of the RHMS, automatic weather stations are being introduced.

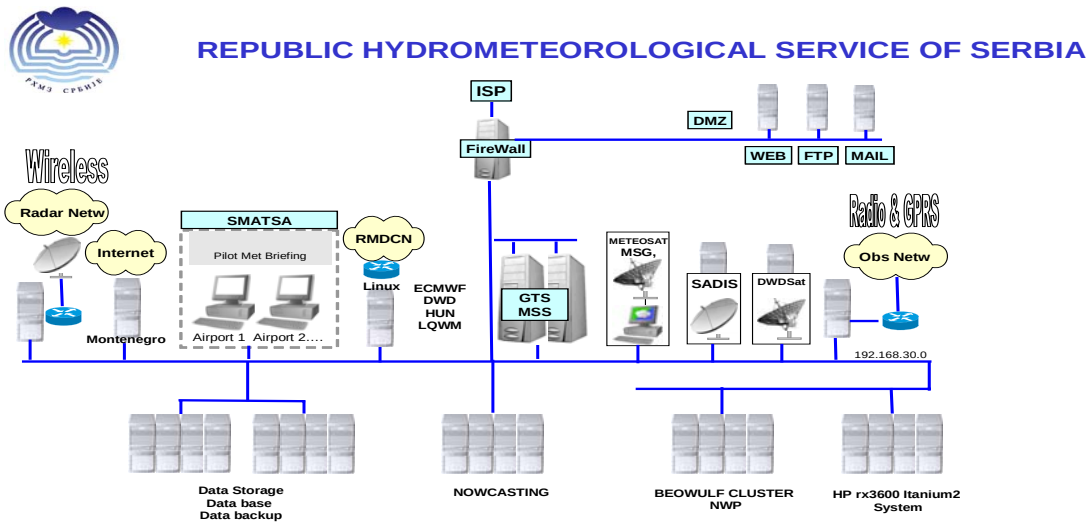
Hydrological observation system of the RHMS

29. The hydrological observation system of the RHMS consists of around 700 stations of different kinds with data operationally (in real-time) collected from 63 hydrological stations, 20 of which are included in international data exchange.

Telecommunication network

30. For the purpose of the collection, dissemination and international exchange of meteorological, hydrological and air/water quality data, in accordance with the undertaken international obligations, the hydrometeorological telecommunication system of the RHMS, which operates in line with international technical regulations and standards, was established. An upgrade of the telecommunication system is in progress. The telecommunication System (TS) is based on an integration of computer networks in the RHMS, AMCs and other local centres/services, i.e. it is based on a modern Data Communication Network – Intranet. The TS includes RMDCN (128 kbps connection with: RTH Offenbach, RTH Vienna, NMC Budapest and ECMWF) instead of existing GTS/MOTNE point to point medium range speed channels. Additional sources of data, products and satellite pictures are managed through the EUMETCast/DWDSAT, EUMETSAT and SADIS system. The System is open for integration of all the potential future requirements. The Internet is a regular facility for data/products exchange/access.

Figure 1: *Meteorological telecommunication infrastructure of the Republic Hydrometeorological Service of Serbia (www.hidmet.sr.gov.yu)*



31. In the frame of the collaboration with EUMETSAT, the Republic Hydrometeorological Service of Serbia installed a MEOS MSG HRIT/LRIT receiving station and is using the Meteosat Second Generation as of November 2005. The Meteosat Second generation (MSG) generates multi-spectral imagery of the Earth's surface and cloud systems every 15 minutes from twelve spectral channels. The resolution is 1 km for the high-resolution visible channel and 3 km for the others. Eight of the channels are in the thermal infrared, providing among other information, permanent data about the temperatures of clouds, land and sea surfaces. Using channels that absorb ozone, water vapour and carbon dioxide, MSG also allows meteorologists to analyse the characteristics of atmospheric air masses, enabling a three-dimensional view of the atmosphere to be reconstructed.

Unified Data Collection System (UDCS) and Climatological Database System (CLDB)

UDCS

32. A Data Collection System and Climatological Database System, as integral parts of the Integrated Meteorological System of the RHMS of Serbia are being established.

33. The UDCS provides all functionality necessary to operate and maintain large meteorological networks of automatic as well as of manned stations. The number of stations which can be interfaced by a single UDCS is limited only by the employed communication infrastructure.

34. The data from the stations can be collected in several modes using different communication protocols, and the UDCS fully supports standard WMO codes SYNOP, METAR/SPECI, CLIMAT, GRIB, BUFR, and is open for the support of proprietary/national codes.

35. The time intervals of data collection are user-configurable for each station from minutes (or even seconds) to days. In case of failure of a communication line, the robust data collection mechanism allows automatic retrieval of missing data as soon as the connection to particular station is re-established.

36. The UDCS provides data validation and export, monitoring of the status of the observing network or communication channels and data flow and provides fully remote maintenance functionality.

37. In addition to WMO standards, the UDCS supports numerous protocols and formats for communication with automatic weather and environmental stations, as well as for data distribution and exchange (text files, National and/or international formats, NWP model output, dispersion model output, radar, satellite images, JPEG images, MPEG videos, etc).

CLDB

38. A climatological database is a very important means in various climate studies for the validation of the products of climate models. The main reason of its utilization is the storage of all collected meteorological/climatological data in one unified structure to avoid data inconsistencies and discrepancies and to enable standard comfortable data access for all users and other software systems.

39. The CLDB is based on the WMO recommended practices for climatological data processing[7]. It follows the WMO suggestion of the application of a RDBMS (Relation Database Management System) with wide use in climatology (World Climate Program efforts concerning new Climate Data Management Systems - CDMSs).

40. The CLDB can hold textual and numerical data, graphical information and animations. The database is capable of receiving, decoding and storing the following types of data from different data sources (data electronically imported from a third party database system; data manually entered; data from coded meteorological messages received via GTS: SYNOP, METAR, TEMP, PILOT, Marine data (BUOY), binary messages (BUFR, GRIB); data collected from automated weather stations; other numerical, textual, binary or graphical data according to the user's requirements).

41. Climatological data in the CLDB system are processed through different modules before storing in a database.

42. Data that have passed quality control are stored in an archive. During data processing, CLDB calculates user specified climatological statistics.

43. The CLDB Reports application has a user-friendly interface for generating standard tabular and graphical daily, monthly and annual reports. The reports are generated directly in printable form or as Excel worksheets.

44. Detailed descriptions of observing stations and history metadata are inevitable parts of the climate data itself.

Information on computer resources

45. Computer resources are dedicated to the fulfilment and coverage of a variety of functions and tasks of the Integrated Meteorological System of the RHMS of Serbia. Functions such as Acquisition and Data Collection System, Message Switching System, Central Processing, National and International Exchange of Data, Presentation as well as user oriented applications (Web, Mail, FTP, ..) are all supported by the IBM and HP family of a multi-processor servers, with sufficient CPU, storage and archiving capacities.

46. To ensure the CPU capacity takes into account demands of Numerical Weather and Climate Predictions, HP rx3600 Itanium2 and Beowulf Linux Clusters are available. The Data Collection System and Message Switching System are based on HP Smart Arrays for data storage.

Global and regional forecast models in use:

47. Weather forecasting and climate prediction are based on the WMO/GOS data, numerical weather prediction and climate model products. The RHMS issue a range of weather forecasts: very short time period of two to twelve hours ahead, short-range forecasts up to five days ahead, mid-range forecasts for the next ten days, long-range forecasts for the period of thirty days and a seasonal forecast.

[7] WMO Guide No.100.

48. The non-hydrostatic numerical weather model “WRF NMM” is used to cover a very short time period for the Balkan Peninsula and the Serbian region.

49. The Eta numerical weather prediction model (regional model-Europe) is used for short-range forecast, five days ahead.

50. For medium-range weather forecasting for up to ten days ahead, the RHMS of Serbia employs numerical weather prediction products of the European Centre for Medium-Range Weather Forecasts (ECMWF) and of the DWD-Offenbach global models.

51. For long-range forecast for a period of thirty days and seasonal forecast, the RHMS of Serbia employs forecast products from the European Centre for Medium-Range Weather Forecasts.

52. For research studies, the RHMS of Serbia also employs the non-hydrostatic numerical meso model-MM5 and the “WRF NMM” model.

53. In 2006, the RHMS received a license for the use of the Regional Climate Model developed by the Climate Centre of Hadley, UK Meteorological Service. It is used for climate simulation research together with the regional climate model based on the Eta model (the so-called climEta model).

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