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D H M Z



**Croatian Meteorological and
Hydrological Service
2017**

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Director's Preface



We support individual and collective well-being with weather, climate, water and air observation, analysis, prediction and research

Dear readers,

This report provides a glimpse into the main achievements of the DHMZ in 2017 and will become our standard reporting practice.

In the 70 years of the DHMZ's tradition, 2017 was a new beginning in many ways. In the Weather Analyses and Forecasts Sector, we completed the first phase of technological modernisation of operating procedures, increased the resolution of our numerical weather predictions, introduced numerical hydrological predictions, expanded our air quality management system, and, most importantly, we launched the strategic projects METMONIC and AIRQ, funded by the EU's structural and investment funds. The objective of these projects is to substantially modernise our operating procedures and improve the quality of our products and services at all levels by introducing new technologies and improving our organisation, the working conditions and the equipment we use. I am grateful to all dedicated employees who have made all this possible. I would also like to thank the Ministry of Environment and Energy, which has supported us on our journey, and I would like to thank our users, other ministries, numerous institutions, institutes, faculties, and state-owned and privately-owned companies whose needs continually drive the scientific and operating development of the DHMZ and help us improve the quality of our products.

The rapid development of technology, IT and communications has led to exponential development of meteorology and has made modernisation an imperative. Modern radar and satellite observation methods enabled the collection of enormous amounts of data about the characteristics of the atmosphere, the soil and the oceans. This data is processed and analysed at an increasingly fast rate, and the development of combined numerical models gives us detailed insights into the atmosphere-soil-sea system on all timescales, from short-term to long-term climate projections spanning the period until the end of the 21st century.

For all these years, the DHMZ's experts have worked hard to keep up with these accomplishments, learning new information and skills to help decision-makers in all areas of human activity, from security and civil protection, transport, food production, civil engineering, environmental protection and energy to health, tourism and sport, make decisions that will ensure the well-being and the prosperity of the citizens, and responsible and sustainable exploitation of natural resources such as water and wind and sun energy.

Branka Ivančan-Picek, Director

Croatian Meteorological and Hydrological Service – National Administrative Organisation

Structure

Mission

The DHMZ supports sustainable economic development of our country and the protection of human lives, properties and the environment by providing information on weather, climate, climate variations and change, water and air, and by issuing warnings about severe weather, water and environmental phenomena and climate extremes to help mitigate their impact in line with the recommendations of the World Meteorological Organization and the directives of the European Union.

The Service manages meteorological and hydrological infrastructure, air quality monitoring infrastructure, and the national archive of meteorological, hydrological and other related data. The DHMZ maintains solid and recognisable international partnerships, in particular in Southeast and Central Europe.

Values

Our excellence rests on our people's know-how and skills. Information is the DHMZ's main product and the greatest value it provides to its users. The DHMZ upholds open and ethical communication.

Photo by: Ante Vukušić

Director's Office

Hydrology

Surface Water and Groundwater Measurements and Observations
Hydrological Research, Analysis and Forecasts
Control, Archiving and Distribution of Hydrological Data

Weather and Climate Monitoring

Meteorological Observations
Data Processing and Control and Climate Monitoring

Weather Analyses and Forecasts

Weather Analyses and Forecasts
Marine Meteorological Centre

Meteorological Research and Development

Meteorological Research and Development of Operational Forecast Models
Climatological Research and Applied Meteorology
Agrometeorology

Air Quality

Air Quality Measurement and Research
Chemical Laboratory

Administration and Information

Information, Strategic Planning and Users
Human Resources, Legal Affairs, Workplace Health and Safety and Document Management
Finances, Accounting and Procurement
Technical Support and Communication Systems

Independent Departments:

Remote Sensing
Monitoring and Severe Weather Effects Mitigation
IT
Calibration Laboratory

Memberships in international organisations and associations

The DHMZ actively participates in the work of a number of international organisations and associations in its domain. The most important are:

- WMO** – World Meteorological Organisation,
- EUMETSAT** – European Organisation for the Exploitation of Meteorological Satellites,
- ECMWF** – European Centre for Medium-Range Weather Forecasts,
- EUMETNET** – European Meteorological Services Network,
- ECOMET** – Economic Interest Grouping of the National Meteorological Services of the European Economic Area,
- GEO** – Group on Earth Observations, which has set up the Global Earth Observing System of Systems (GEOSS),
- ALADIN** – International consortium for the implementation of project for development and exploitation of high-resolution numerical weather forecast
- RC LACE** – Regional Cooperation for Limited Area Modelling in Central Europe,
- JCOMM** – Joint Technical Commission for Oceanography and Marine Meteorology,
- EMEP** – Co-operative programme for the monitoring and evaluation of long-range transmission of air pollutants in Europe,
- EFAS** – European Flood Awareness System,
International Sava River Basin Commission.

In line with the international commitments undertaken by the Republic of Croatia, the DHMZ:

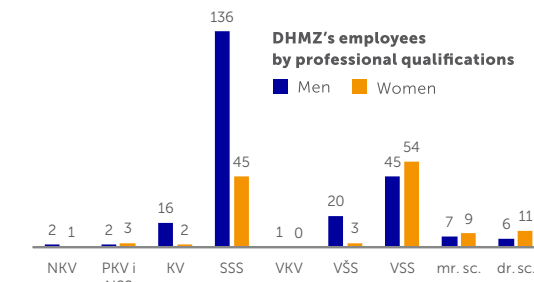
- participates in international exchange of meteorological, hydrological and air quality data through the global communication and information system maintained by the World Meteorological Organisation and other international systems,
- participates in international research and development programmes and projects,
- participates in international exchange of data and information about meteorological and hydrological disasters.



Employees

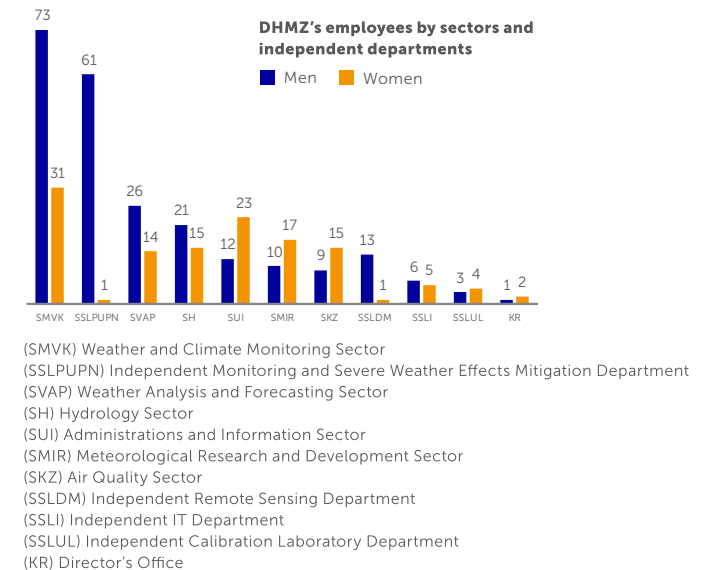
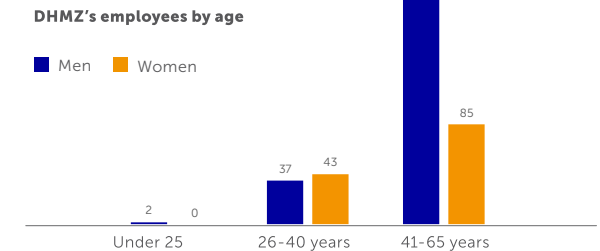
The DHMZ believes that an investment in human resources is an investment in the future. All civil servants and state employees have a duty to learn new information and skills, apply them in their respective roles, and pass them on to their colleagues. As a legal entity undertaking scientific and research activities in the field of natural sciences, the DHMZ supports scientists in post-graduate doctoral studies professionally and financially and supports the participation of its employees in Croatian and international scientific and professional conferences and workshops.

On 29 December 2017, the DHMZ employed 355 civil servants and eight staff, of which 65 % were men, and 35 % were women. As shown in the graph, the majority of DHMZ employees (181) have secondary school degrees and 132 have university degrees. 16 of those have master's degrees, and 17 have doctoral degrees. The majority of DHMZ employees (281 or 77.4 %) are over 40 years old.



NKV = unskilled, PKV I NSS = semi-skilled, basic school education, KV = skilled, SSS = secondary school education, VKV = highly skilled, VŠS = non-university college degree, VSS = university degree, mr. sc. = MSc, dr. sc. = PhD

The graph showing the distribution of employees by sectors and independent departments reveals that the highest number of employees is working in the Weather and Climate Observation Sector (104). The Independent Department Monitoring and Severe Weather Effects Mitigation (Hail Suppression) is the second largest with 62 employees. The Weather Analyses and Prognoses Sector is the next with 40 employees, followed by the Hydrology Sector with 36, and the Administration and Information Sector with 35 employees. The other sectors and independent departments have fewer than 30 employees.

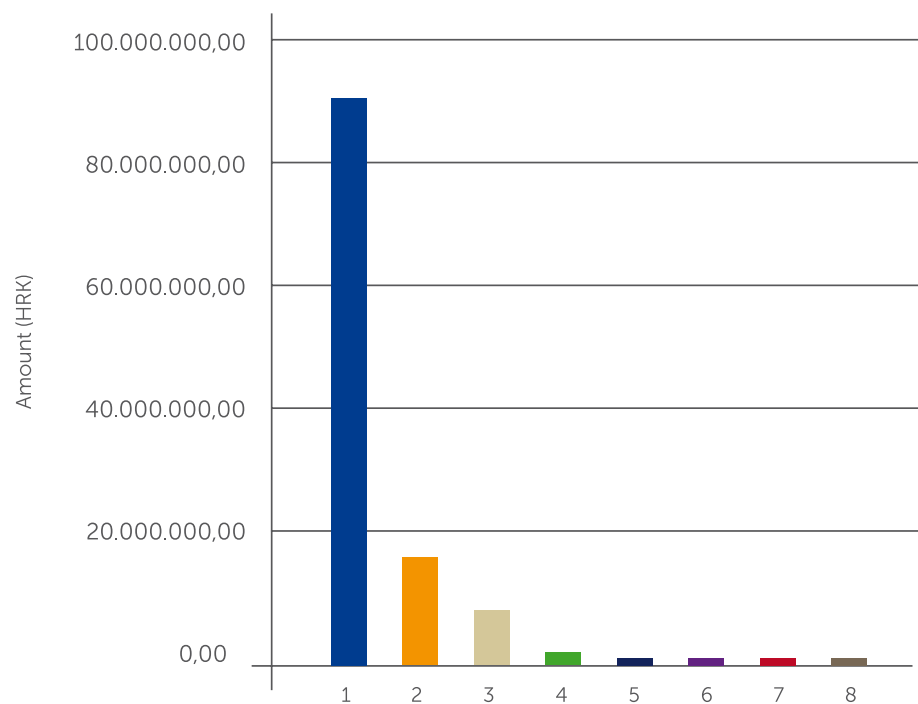


Finances

The funding for the DHMZ's work is included in the budget of the Ministry of Environment and Energy. The DHMZ executed a financial plan in the total amount of **116.6 million HRK** in 2017.

DHMZ activity and project financing

As shown in the graph, among eight different sources of funding*, the General Revenues and Receipts of the State Budget account for most of the DHMZ's financial plan or **90.2 million HRK** (1st column). Revenues that the DHMZ earns in the market account for **16.4 million HRK** (2nd column). Other Aid and Grants are the DHMZ's third largest source of funding. The DHMZ received **7.5 million HRK** from county and City of Zagreb budgets and from the Environmental Protection and Energy Efficiency Fund (3rd column). All other sources (columns 4 – 8) account for up to **2.5 million HRK** in the financial plan.



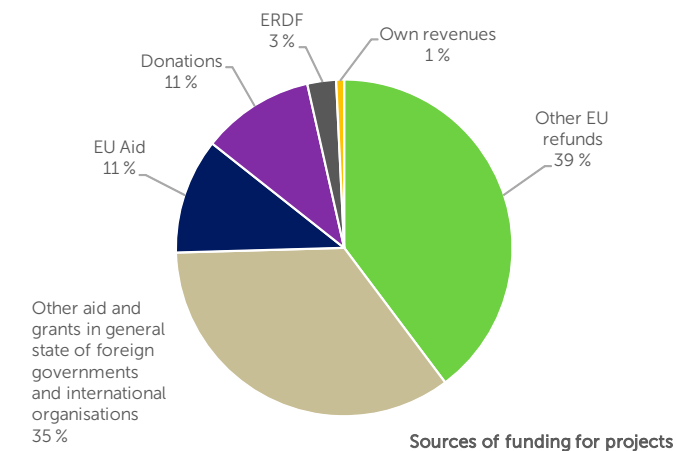
*DHMZ funding by sources

- 1. General Revenues and Receipts of the State Budget**
- 2. Own Revenues** – from selling products and services in the market
- 3. Other Aid and Grants** – from the budgets of local and regional self-government units; from other general state subjects; from foreign governments and international organisations
- 4. Other refunds from EU aid** – for EU funded projects that are financed from national funds first, and then refunded
- 5. Donations** – all donations paid to the state budget
- 6. EU aid** – aid from EU institutions and bodies
- 7. Other revenues for special purposes** – defined by special regulations
- 8. European Regional Development Fund (ERDF)**

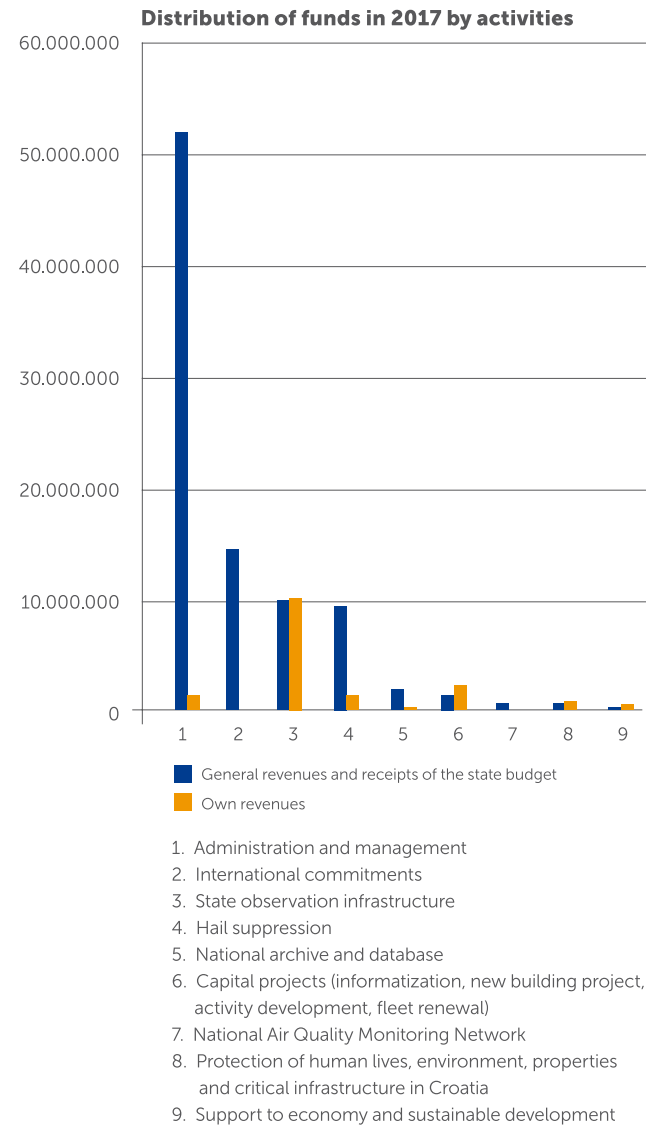
Note: For more information on sources of funding in the state budget please see:
<http://www.mfin.hr/adminmax/docs/Prilog%20.%20Izvori%20financiranja%20u%20drzavnom%20proracunu.pdf>

Distribution of project funding by sources

As the graph shows, 11 DHMZ projects were financed from different sources in the total amount of 2.3 million HRK. The project Frisco 1 received the largest amount of 925,543.75 HRK (39 % of the total amount) from Other Refunds and EU Aid. The expenditures on this project will be refunded by the EU after the authorisation of the costs paid.

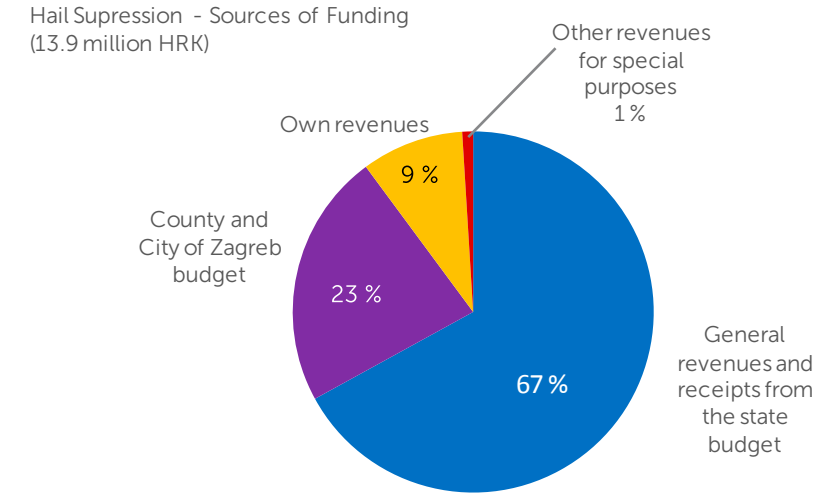


Distribution of project funding by activities

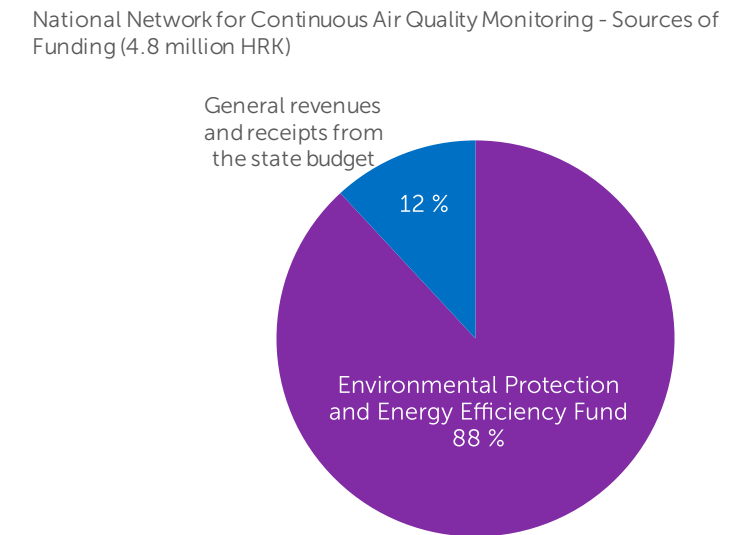


The graph shows that the majority of the funds from General Revenues and Receipts of the State Budget and Own Revenues, 53 million HRK, was allocated to the activity Administration and Management, not surprisingly, since this activity includes salaries, contributions and other employee benefits in the total amount of more than 43 million HRK.

The expenditures for International Commitments are the next (2nd column) with an amount of 14.5 million HRK. They are fully funded by the General Revenues and Receipts of the State Budget. The activity National Observation Infrastructure is shown in the third column, but the total expenditure on this activity is larger than International Commitments and amounts to 20 million HRK (10 million HRK from General Revenues and Receipts of the State Budget and 10 million HRK from Own Revenues). 10.6 million HRK from General Revenues and Receipts of the State Budget and Own Revenues was allocated to Hail Suppression, representing 76 % of the total revenues of this activity, which is funded from two other sources as well (see graph on page 13).



The activity National Network for Continuous Air Quality Monitoring is for the most part funded from Other Aid and Grants - Environmental Protection and Energy Efficiency Fund (88 %) while 12 % is funded from General Revenues and Receipts of the State Budget.

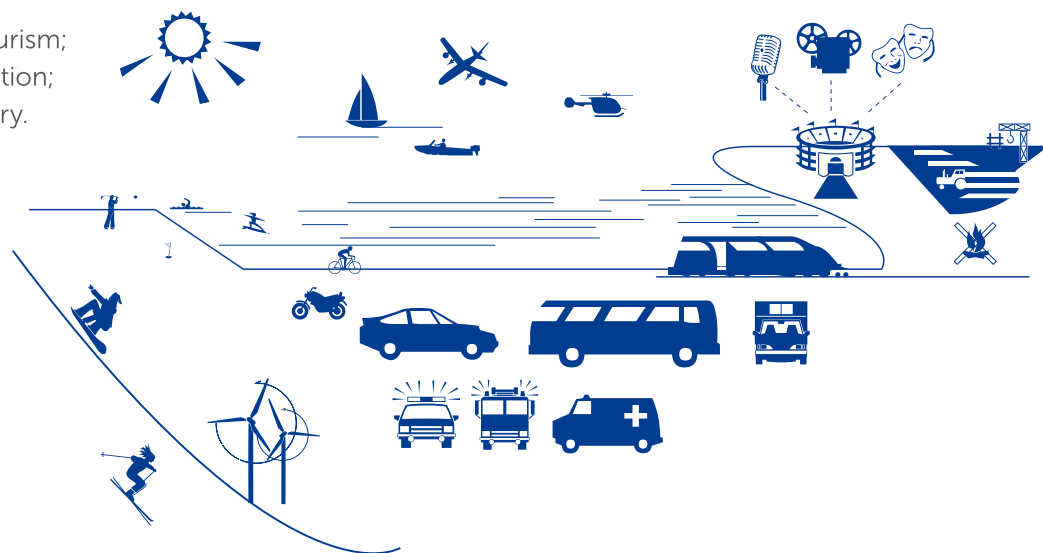


The users of the DHMZ's products and services

In addition to numerous data and information for the public about the weather, the climate, water and air quality, which the DHMZ publishes on its website www.meteo.hr, the DHMZ also prepares analyses, forecasts, studies, expert analyses, specialised web portals and more.

The DHMZ's products are used in the following sectors:

- People and property protection and safety;
- Public information;
- Physical planning, urbanism, construction, architecture;
- Water management;
- Energy;
- Transport;
- Health, recreation, tourism;
- Environmental protection;
- Agriculture and forestry.

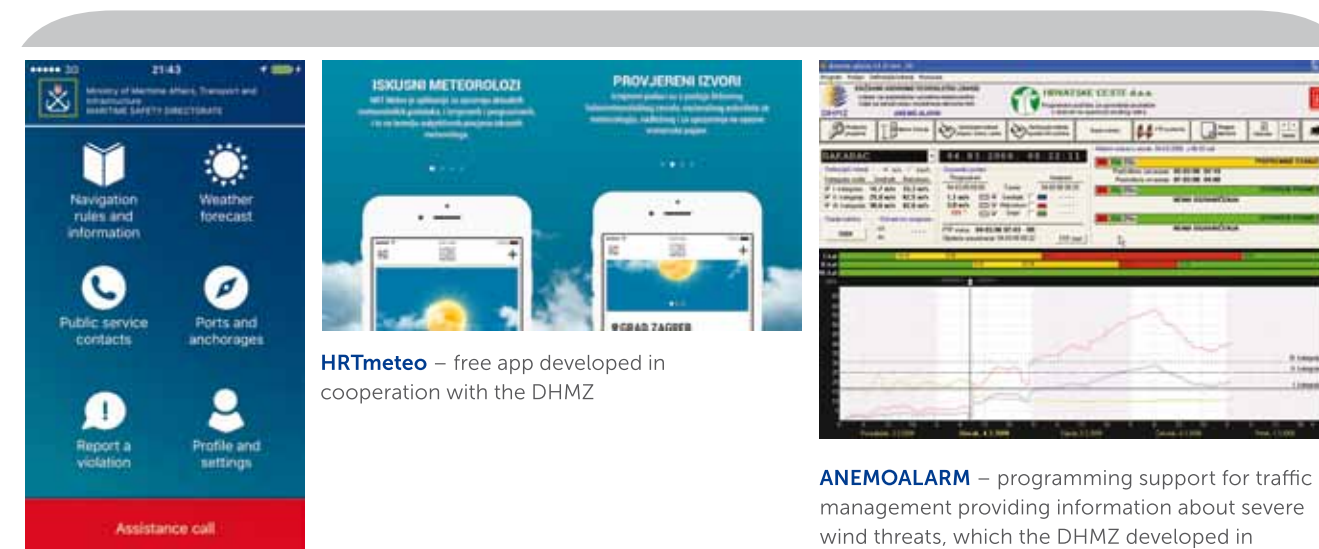


The citizens are the largest DHMZ's user category. Other large users and strategic partners include public authorities (ministries of the interior, defence, environmental protection and energy, sea, transport and infrastructure, agriculture, tourism, and science and education, National Protection and Rescue Directorate, Croatian Agency for the Environment and Nature).

State-owned and private companies are also a big user category: Hrvatska elektroprivreda (national power company), Hrvatske vode (water management), Hrvatske šume (forest management), Hrvatski autoklub (Croatian Automobile Club), Hrvatske željeznice (railways), Hrvatske ceste (roads), Hrvatske autoceste (motorways), Croatia control (air traffic control), the media (televisions HRT, Nova TV, RTL, many radio stations), news agencies (Hina, Mediaservis,), sports, cultural and public institutions, insurance companies, nautical marinas and more.



To make our products more available and better adjusted to our users' needs, the DHMZ develops specialised web portals and apps providing all required information.

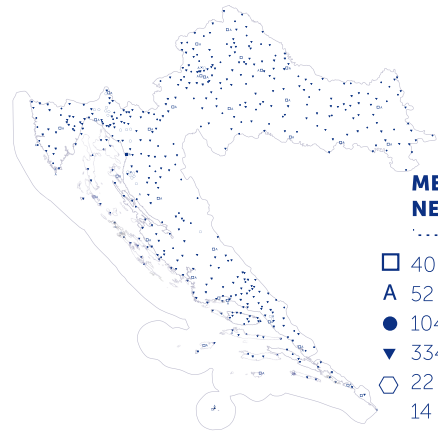


HRTmeteo – free app developed in cooperation with the DHMZ

Nautical Information Service (NIS) – free app developed by the Ministry of the Sea, Transport and Infrastructure in cooperation with the DHMZ

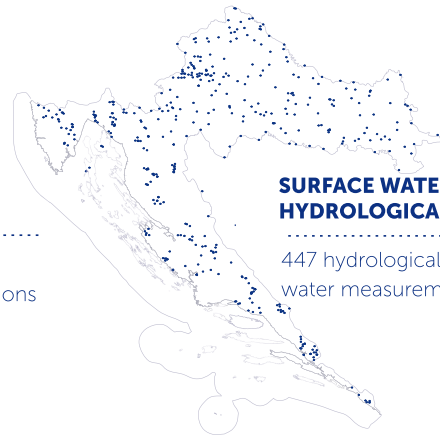
ANEMOALARM – programming support for traffic management providing information about severe wind threats, which the DHMZ developed in cooperation with and for the company Croatian Roads

**NATIONAL METEOROLOGICAL AND HYDROLOGICAL INFRASTRUCTURE
AND AIR QUALITY MONITORING INFRASTRUCTURE**



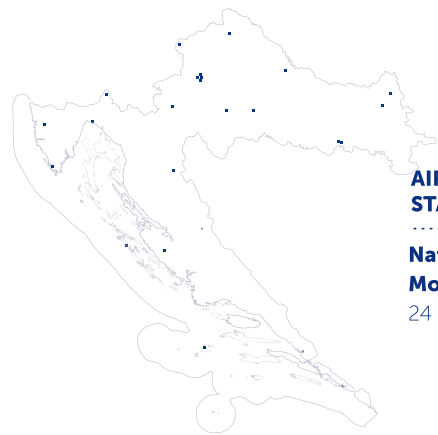
METEOROLOGICAL STATION NETWORK

- 40 main meteorological stations
- A 52 automated meteorological stations
- 104 climatological stations
- ▼ 334 precipitation stations
- 22 totalizers
- 14 automated rain gauges



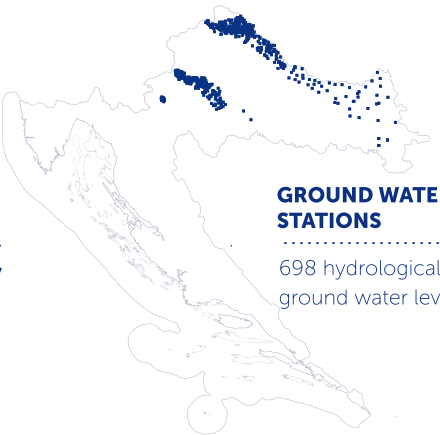
SURFACE WATER HYDROLOGICAL STATIONS

447 hydrological stations for surface water measurement



AIR QUALITY MONITORING STATIONS

National Continuous Air Quality Monitoring Network,
24 air quality monitoring stations



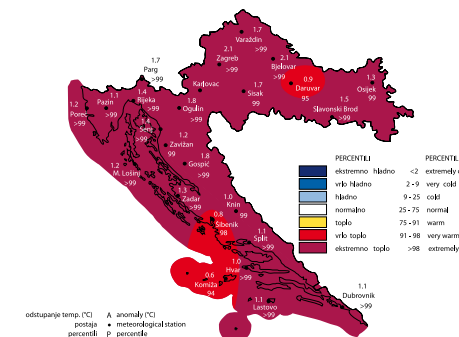
GROUND WATER HYDROLOGICAL STATIONS

698 hydrological stations for ground water level measurement



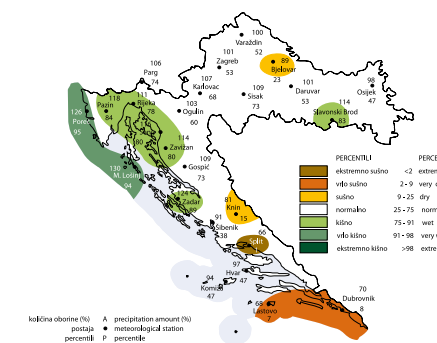
3

Weather and Climate – The Hottest Topics Climate anomalies in 2017



Mean annual temperature above the average (1961–1990)

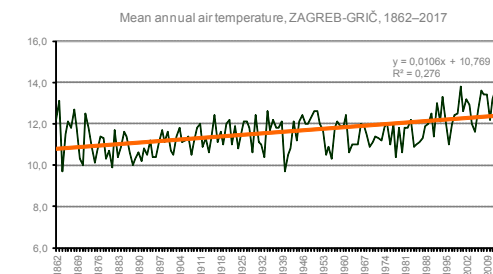
Anomalies range from 0.6 °C (Komiža) to 2.1 °C (Bjelovar and Zagreb-Grič).



Precipitation above the average (1961–1990)

The precipitation amount was above the average at many analysed stations. The precipitation amount ranged from 66 % (Split-Marjan) to 130 % (Mali Lošinj) of the average for the above period.

Station Zagreb-Grič, The mean annual air temperature in 2017 was 13.6 °C (same as in 2007), which makes it the **third hottest year on record** at this station (since 1862).



The continuation of the positive mean annual air temperature trend is evident at Zagreb-Grič (1.06 °C/100 years). This shows that air temperatures in Croatia are still consistent with the **global warming trend**, with certain interannual fluctuations.

Photo by: Ante Vukušić

Extreme Weather in 2017

Winter – ice at Split coastline

We had an unusual surge of polar air in January. Many rivers and lakes froze over. The soil froze to substantial depths and the ice reached even the coastal region. Vransko and Modro jezero lakes, the mouth of the Neretva river, and even the sea at the coastline in Šibenik and Split froze over! Inland temperatures dropped to below -20 °C. Deviations from average values were much greater in the **Adriatic**, which was hit by a **cold wave**. Negative temperatures were measured even on the Dalmatian islands, which is an exceptionally rare phenomenon. Temperatures in the interior of Istria dropped to below -15 °C! Strong northern wind in the interior and **storm-force and hurricane-force bura wind** in the Adriatic, with speeds occasionally higher than 200 km/h, resulted in even greater subjective cold perception. Heavy snow was recorded around the country and there was snow episode even on the island Vis.

Spring – drought and late frost

Drought began in the spring and continued in the summer, with occasional heavy rain, in particular in Slavonia. A late frost hit the country in the second half of April. Even the vineyards in Dalmatia sustained damage. Many counties declared a **state of natural disaster**.

As temperatures rose in late spring, there were frequent storms with gale, local heavy rain and even hail. Slavonia and Northwest Croatia were affected the most, but other areas were hit too.

On average, 70 % of all damage and economic losses caused by natural disasters in the period 1980–2016 were caused by meteorological and hydrological factors. Investments in prevention have an average benefit ratio of 1:5.

Summer – extreme heat

The summer was marked by **intense and long heat waves**, the strongest of which hit the country in early August. Even though the absolute Croatian temperature record of 42.8 °C, measured in Ploče in 1981, was not beaten, new records were set at many of the stations: 42.2 °C at the Split Airport, 42 °C in Knin, and 41 °C in Imotski and Sinj. Temperatures between 38 and 40 °C were almost an everyday occurrence!

Dozens of large wildfires broke out, supported by the heat, the drought and strong winds (especially bura). Some of the wildfires came close to or even spread to human settlements, and one of them put the second largest Croatian city Split at risk. Many crops were destroyed by fire and drought. Yields were down by a minimum of 30–40 %.

Autumn – September almost like October. And vice versa!

The weather in **September** was very unstable, with heavy rain. North Adriatic, especially Istria, was hit by one violent storm after another, with heavy rain, sometimes even spouts. The worst episode happened in **Zadar**, which was hit by a storm of almost unprecedented violence on 11 September. **Around 250 litres of rain per square meter**, several times more than the September average, fell in a little over three hours, and it continued to rain the whole day. Zadar's roads literally turned into rivers, and the central city square, the Forum, was covered with half a metre of water. Water abstraction sites were contaminated, the hospital was flooded, and the schools and the nursery schools were closed. **State of natural disaster** was declared, and the damage in the whole county was estimated to about 250 million HRK.

In this past period, the DHMZ's Hydrology Sector has been actively using the SEEFFGS (South East Europe Flash Flood Guidance System), developed and deployed in cooperation with the WMO. The SEEFFGS is a tool that allows us to forecast flash floods in a specific area with a high degree of probability. The information obtained through this system in the summer of 2017 became a constituent part of the basis for all Metealarm meteorological and hydrological warnings.



Consequences of the flash floods that hit Nin on 11 September 2017



Metealarm warning for 11 September 2017

4

Substantial Investments in Upgrading Our Operations to Improve Our Products and Services

Technological breakthrough in weather analyses and forecasting

A new technological system was introduced in the first stage of technological modernisation of our operating procedures in the Weather Analyses and Forecasts Sector.

After the experimental stage, the system has been in regular application since 1 October 2017.

It is used to process, visualise and review meteorological data and products for special industry purposes, make products for our users, enter reports into the system centrally, and disseminate products and reports to our users.

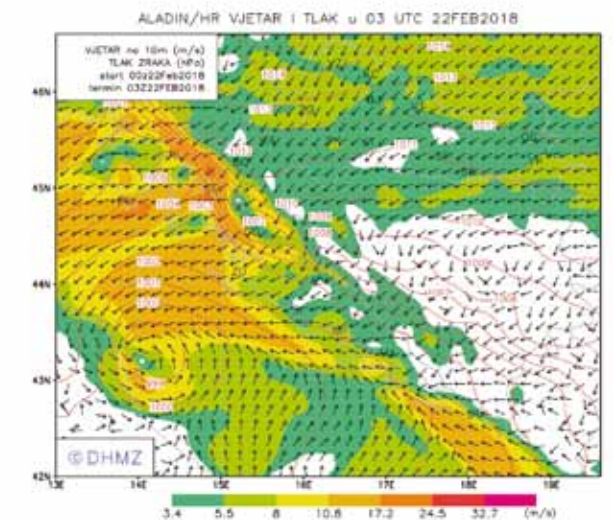


Using new technologies

ALADIN – numerical forecast – higher resolution – better forecasts

The horizontal resolution of our operational forecast model was increased from 8 km to 4 km, and the number of vertical levels was increased to 73 (ALADIN-4). As a result, we have obtained more reliable 72-hour weather forecasts, especially with regard to the amount of precipitation.

A more accurate forecast increases the efficiency of early warnings systems for severe weather and hydrological events and provides more reliable information for various industries, including the energy sector (planning energy production from renewable sources), transport (road maintenance and closing), flood control, civil engineering and many others.



Wind and surface pressure forecast using ALADIN/HR model

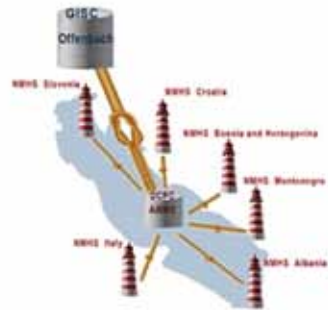
ALADIN as a part of the Nautical Information Service (NIS)

Under its safety at sea and accident prevention programme, the Ministry of the Sea, Transport and Infrastructure, in cooperation with the DHMZ, made a free smartphone app, available in several languages, which, in addition to the regular marine forecast, includes the numerical forecast made by **ALADIN model**.

Developing the organisation of the Regional Marine Meteorological Centre for the Adriatic

In 2017, we continued to develop the organisation of the Regional Marine Meteorological Centre for the Adriatic, a part of the DHMZ. The centre is a part of the new WMO Information System (WIS) and the WMO Integrated Global Observing System (WIGOS) (*Data Collection and Product Collection – Adriatic Marine Meteorological Centre, abbreviated as DCPC AMMC*).

The task of the DCPC AMMC is to integrate data and to establish communication and cooperation between the users and all authorised institutions producing marine meteorological and oceanographic information for the Adriatic Sea area on national and sub-regional level between Albania, Bosnia and Herzegovina, Montenegro, Croatia, Italy and Slovenia.



The DCPC AMMC is a network of six national hydrological and meteorological services in the Adriatic that connects the national marine meteorological activities with the WIS GISC centre in Offenbach; DHMZ functions as the national hydrological and meteorological service and as the regional DCPC centre.

Severe weather warnings are one of the most important activities of the DHMZ, considering that it is the only institution obligated by the law to perform continual measurements and provide forecasts of the atmospheric conditions and severe weather warnings for Croatia.

DHMZ sets up hydrological forecast

In cooperation with Hrvatske vode, the DHMZ set up the Sava SM hydrological forecast model for the Sava River basin in Croatia. In addition to real-time hydrological and meteorological data from Croatia, this model uses the results of numerical weather prediction models (ALADIN and ECMWF), the results of Slovenia's hydrological forecast model, and the data for the main tributaries of the Sava from Bosnia and Herzegovina, to the extent to which they are available at this moment, as its input data. Results are expected to improve as more data from Bosnia and Herzegovina becomes available. National Protection and Rescue Directorate and Hrvatske vode use the model's results for warning and flood control purposes, and the results are also available to the institutions in Bosnia and Herzegovina.

The DHMZ consigned the Sava SM model to the International Sava River Basin Commission, which will incorporate it into the Sava-FEWS, a model spanning the entire basin of the Sava, which is currently in the development stage. The results of the Sava-FEWS model will include numerical hydrological forecasts for the entire Sava River basin and will be made available to the DHMZ.

Air for Life on Earth

Expansion of the Air Quality Management System

In 2017, the DHMZ expanded its Air Quality Management System by including the measurement of benzene according to the method HRN EN 14662-3:2015: Measurement of benzene concentrations by automated pumped sampling with in situ gas chromatography.

Establishment of new measurement stations

Two new air quality monitoring stations were established in Karlovac and Varaždin. The stations are using accredited methods, and their construction was funded by the Environmental Protection and Energy Efficiency Fund. Measurement of the effect of atmospheric pollution on metals, glass and stone started at the Meteorological and Aerological Observatory Zagreb-Maksimir. The measurements are a part of the International Co-operative Programme on Effects on Materials including Historic and Cultural Monuments (ICP-Materials).

A testing laboratory for air quality measurement equipment, a repair and maintenance work-room, and offices were established in the new premises at Brodarski Institute.



Air Quality Monitoring Station Karlovac-1

The number of services provided by the Calibration Laboratory on the rise

The DHMZ's Calibration Laboratory (SOUL) successfully passed the re-accreditation inspection in January 2017 after having continually worked on improving its operating procedures and expanding its accreditation area for the past five years. Using newly purchased equipment, the SOUL introduced and accredited one of the most accurate calibration methods for relative air humidity measurement instruments.



The reference system for the calibration of instruments for measuring relative air humidity (on the left) and mass flow rate (on the right)

As of 2017, the SOUL calibrates instruments for mass flow rate measurements using a new calibration system that is reference system.

Having purchased a standard reference photometer, the SOUL gained the status of the national measuring standard for the concentration of ground-level ozone and gas mixture in the Croatian Metrology Institute's tender and started calibrating instruments. The SOUL is now in the process of proving its status with the International Bureau of Weights and Measures (BIPM) and the European Association of National Metrology Institutes (EURAMET).



Standard reference photometer



5

The European Union Supports the DHMZ's Development – European Structural and Investment Funds (ESI)

Projects under way



Modernisation of the National Weather Observation Network in Croatia

METMONIC project

The project Modernisation of the National Weather Observation Network in Croatia – METMONIC (KK 05.1.1.01.0001) kicked off on 1 October 2017.

The project is implemented by the DHMZ and will last for four years. Project value is 343.9 million HRK, of which the European Regional Development Fund provides 85 % through Operational Programme Competitiveness and Cohesion, and the Environmental Protection and Energy Efficiency Fund provides 15 %.

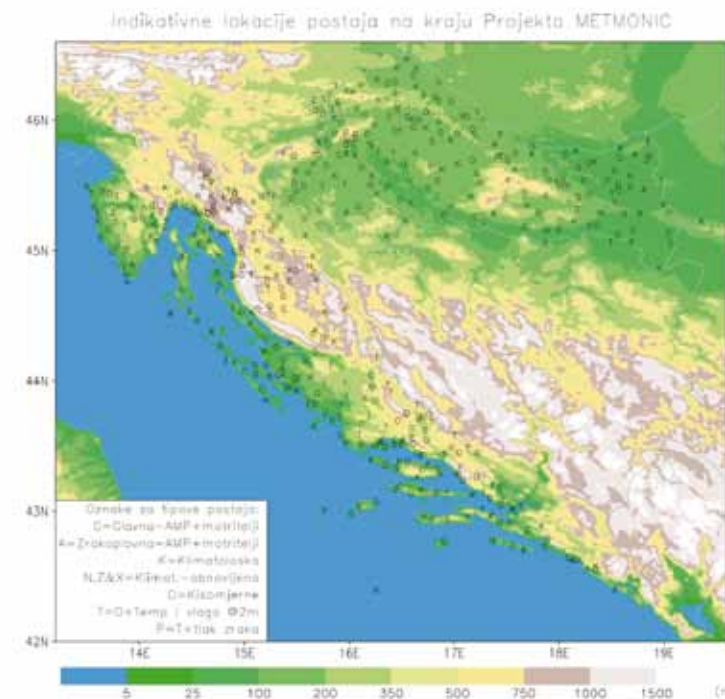
DHMZ modernisation projects were covered by several studies, the most comprehensive among which was The DMHZ Modernisation Feasibility Study, completed in June 2009 under the supervision of the Oklahoma University, which defines the DHMZ's fundamental development requirements. This study is a successful model of an in-depth sub-regional feasibility study about the modernisation of the DHMZ, based on analysis and the documents DHMZ Strategic Development Plan and Benefits of the Meteorological Service in Croatia, produced under the supervision of the VTT Technical Research Centre of Finland, and on a broader study for Southeast Europe (SEE study WB/UN-ISDR/WMO/FMI, which the DHMZ's experts also worked on).

Photo by: Ante Vukušić

The project aims to modernise the entire meteorological observing network, including the automatization and modernisation of existing stations or installation of new stations, including 34 main stations, 139 climatological stations, 264 precipitation stations, six meteorological radars, two upper-air stations (lidar and wind-profiler with microwave radiometer) and five meteorological and oceanographic buoys, totalling 450 stations. The meteorological calibration laboratory will also be modernised, and the data control system and access to meteorological data will be upgraded. Continuous measurements of meteorological variables and availability of meteorological data in near-real time will be a major breakthrough.

The project will provide traceable, representative, high-quality, reliable and timely data on the state of the atmosphere and the sea in the entire Croatian territory.

This will enable continuous monitoring of weather, climate and climate change (monitoring of relevant atmospheric, oceanographic and land climate variables in accordance with the recommendations of the World Meteorological Organization and the UN Framework Convention on Climate Change) and severe weather warnings that will support climate change adaptation systems and natural disaster relief, providing direct support to sustainable development, increasing security, and protecting human lives and properties.



Indicative meteorological station locations at the end of the METMONIC project

Station types:

- G=main – AMP + observers,
- A=aviation – AMP + observers,
- K=climatological,
- N,Z&X=climatological, renewed,
- O=precipitation,
- T=O + temperature and humidity @2m,
- P=T + air pressure



Upgrading the National Network for Continuous Air Quality Monitoring AIRQ project

The AIRQ project – Expansion and Modernisation of the National Network for Continuous Air Quality Monitoring kicked off in September 2017. The project is implemented by the DHMZ, with the Institute for Medical Research and Occupational Health (IMI) as the project partner. It will last for four years. Total project value is 125.1 million HRK, of which the European Regional Development Fund provides 85 %, and the Environmental Protection and Energy Efficiency Fund provides 15 %.

The objective of the project is to upgrade and expand the National Network for Continuous Air Quality Monitoring and to achieve efficient air quality control and management in urban areas, zones and agglomerations. The project will support the implementation of the legislative framework for air quality and environmental protection. This entails developing strategies and projects that will establish the prerequisites for the implementation of adequate measures against air pollution.

The AIRQ project will increase the percentage of population covered by air quality data in urban areas from 50 % to 100 %, build five new air quality monitoring stations and modernise 19 existing ones, develop an operational model for the evaluation of ground-level pollutant concentrations, equip the DHMZ laboratory for analysing the chemical composition of precipitation and air, equip the IMI chemical laboratory for analysing the chemical composition of particulate matter, and equip the DHMZ calibration laboratory for calibrating air quality monitoring instruments and related measures so as to ensure the traceability of the said measurements to international measuring standards.

Drought risk management

DriDanube project



The international EU project DriDanube – Drought Risks in the Danube Region, funded under the Interreg Danube – Danube Transnational Cooperation Programme, kicked off in January 2017. The DHMZ as project partner and the Directorate for Water Management of the Ministry of Environment and Energy as associated partner are representing Croatia in the project. Project value is 14.8 million HRK.

The appropriations for the DHMZ amount to 0.6 million HRK, 85 % of which will be provided by the European Regional Development Fund, and the DHMZ will cover 15 % with its own resources.

The objective of the project is to provide a timely drought response in the Danube Region and to improve drought preparedness by introducing new tools for the monitoring and evaluation of drought risks.

The project will include the establishment of operational drought monitoring (so-called Drought User Service) for the purpose of providing drought warnings, preparing a uniform transnational protocol for drought risk evaluation, and aligning drought-related decision-making processes in order to make drought risk management as efficient as possible. The emphasis of the project will be on communication activities for the development of methodology and tools from the beginning of the project, taking specific user needs into account.

Projects continued

A panEuropean Framework for strengthening Critical Infrastructure resilience to climate change



To support climate change adaptation, the project EU-CIRCLE, featuring 20 partners from Greece, Italy, United Kingdom, Cyprus, Germany, France, Croatia, Poland and Norway, has been tasked with designing a European framework to support the establishment of infrastructure that will be resilient to natural disasters (especially in energy, transport, civil engineering, navigation and water management) in accordance with national programmes and the EU strategy on adaptation to climate change.

Such a framework is necessary because natural disasters caused by climate change can impact the viability and efficiency of critical infrastructure and even destroy it, resulting in immeasurable social and economic losses. Building on existing weather and climate knowledge, the main objective of the project is to make a web platform that will be updated with different information adapted to the community's needs, supporting a timely and adequate response to weather-related disasters and extremes, and creating efficient long-term adaptation measures.

Total project value is 53.9 million HRK and the appropriations for the DHMZ amount to 1.2 million HRK. The project is fully funded by the European Regional Development Fund under the Horizon 2020 programme, and it kicked off in June 2015.



Slovenia-Croatia
European Union and the European Regional
Development Fund



Flood risk reduction

Frisco 1 project

Project FRISCO 1 – Cross-Border Harmonized Slovenian-Croatian Flood Risk Reduction 1 – Non Structural Measures is a strategic project aimed at improving cross-border coordination of flood risk management in the basins of the rivers Dragonja, Kupa, Sutla, Bregana, Drava and Mura, and preparing the documentation for the implementation of strategic construction projects. FRISCO 1 has been implemented under the programme INTERREG V-A Slovenia – Croatia since April 2016. The European Regional Development Fund is financing 85 % of projects costs. Total project value is 30.3 million HRK and the appropriations for the DHMZ amount to 2.9 million HRK. The DHMZ will cover 15 % of project value with its own resources. Eight partners (national, governmental and public institutions) from Slovenia and Croatia are participating in the project.

The DHMZ and the Slovenian Environment Agency developed the database as project partners, including all required historical and spatial data related to flood risks, conducted geodetic surveying of lateral profiles on the Kupa and the Bregana rivers, purchased the required software tools, and produced hydrological atlases for some of the border watercourses. In the next phases, the DHMZ will upgrade the existing hydrological forecast model on the border watercourses Kupa, Bregana and Sutla using this information and upgrade data visualisation via the Web GIS portal.

Future projects

The DMHZ's new building

The conceptual design competition for the DMHZ's new building, a part of the documentation required to apply to the Ministry of Science and Education with the new building construction project, was completed in 2017.

The project includes the construction and equipping of a new headquarter of DMHZ, where all its sectors and activities would be housed in one place. At the moment, they are dispersed in four different locations in the City of Zagreb in inadequate security and technological conditions that are limiting the DMHZ's development in line with its strategic plan. The objective is to create the prerequisites for modern and efficient operation of the DMHZ.



The winner of the first prize in the competition for the new DMHZ's building

Author: Radionica arhitekture

Project team: Fani Frković, Tena Knežević, Klara Nikšić, Jelena Prokop,

Ana Ranogajec, Goran Rako, Josip Sabolić

Consultants: Atelier Ten, London

Information of other projects implemented by the DMHZ is available in the table on page 46 of this report.

Photo by: Ante Vukušić



6

Conferences and Workshops in Croatia – Exchanging Opinions with Croatian and International Experts**6th MetMed and MI 5**

Joint Congress of the 6th International Conference on Meteorology and Climatology of the Mediterranean (MetMed 6) & Challenges in Meteorology 5 (MI 5) were organised in Zagreb 20–22 February 2017 by the Croatian and Catalan meteorological societies and the DHMZ as the co-organiser. The conference was attended by 120 meteorologists, hydrologists and oceanographers from 14 countries of the Mediterranean and from Canada, the United Kingdom, Switzerland, Finland, Germany and Austria.

Social Responsibility of Meteorological, Oceanographic and Hydrological Research was the topic of the conference. Special emphasis was laid on joint research of the atmosphere, the sea and the waters and their mutual interactions. It was underlined that such research contributes to better understanding of climate and climate change and to the development of combined forecasting systems for extreme weather early warnings not only for the atmosphere, but also for the waters and the sea.



Participants of the joint conference 6th MetMed and MI 5 in Zagreb

How to manage drought in the countries of the Danube Region?

As the lead project partner from Croatia, the DHMZ organised the first national presentation of the international EU project DriDanube – Drought Risks in the Danube Region and a workshop for the users in Zagreb on 2 June 2017.

In addition to the project, current drought management status was presented at the workshop. Special emphasis was laid on the impact of drought as one of the consequences of climate change on agriculture and the drought adaptation tools that have so far been used in Croatia.



Participants of the first national workshop on the project DriDanube – Drought Risks in the Danube Region

Photo by: Ivan Vukušić

9th European Conference on Severe Storms (ECSS 2017)



The participants of the 9th European Conference on Severe Storms

European Severe Storms Laboratory (ESSL) and the DHMZ organised the 9th international scientific conference on severe storms (European Conference on Severe Storms – ECSS2017) 18–22 September 2017 in Pula. Approximately 200 experts from 15 European and other countries participated.

The main topics included: severe convective storms aspects, their dynamic, microphysics, electrification, prediction and detection, radar and satellite storm tracking, severe weather climatology, their socio-economic impacts and risk adaptation.

11th EUMETNET Data Management Workshop



Participants of the 11th EUMETNET Data Management Workshop

The 11th EUMETNET international scientific conference on meteorological data was held in Zagreb 18–20 October 2017.

The conference was organised by the DHMZ in cooperation with the Croatian State Archives.

57 experts from European meteorological services discussed topics including meteorological data quality control, data time-series homogenisation, databases, data analyses and archive meteorological data mining, recovery and digitalisation.

The results of homogenisation of long time-series of meteorological data using different methods were presented, and the importance of well-organised meteorological databases for easier creation of products and services and international data sharing was underlined.

Activities related to meteorological data mining and recovery (participants of the DARE programme) and international exchange of data found in other countries were discussed in separate sessions. This is especially important in Southeast Europe, where we have had as many as six different consecutive states in some regions in the past century.

International conference on seasonal forecasting

International conference on seasonal forecasting (SEECOF-18/ MedCOF-9/PRESANORD-11 Climate Outlook Forum) was organised by the DHMZ in Zagreb 20–23 November 2017 and financed by the World Meteorological Organisation. Some 40 scientists and seasonal forecasting experts from the Mediterranean countries in Europe, Asia and Africa participated. Production and application of seasonal forecasts was the main topic. A workshop was held for the users of seasonal forecasts in Croatia (DHMZ hydrologists and agrometeorologists, Ministry of Defence, HEP, Hrvatske vode (legal entity for water management), Croatian Public Health Institute, Advisory Service, Croatian roads Ltd. and others) as an interactive forum encouraging discussions between users and experts to maximally adapt the future seasonal forecasts to the users' needs.



Participants of the International conference on seasonal forecasting

Science Popularisation

World Meteorological Day, 23 March 2017



World Meteorological Day, 23 March 2017
Understanding Clouds

World Water Day, 22 March 2017



Understanding Clouds was the topic of the World Meteorological Day 2017, which included lectures by experts on cloud observation and data analysis, application of atmospheric modelling results for the well-being of the society and the economy, and remote measurement of cloud characteristics using satellites and radars.

The vital importance of meteorological and hydrological services for the safety and the well-being of the society was underlined. The topics of applied science in the service of development, the DHMZ's role in the life of Zagreb, and the DHMZ's cooperation with the Ministry of Science and Education, the Faculty of Science, Department of Geophysics, and the Croatian Meteorological Society were also discussed. Since wastewater was in the focus of this year's World Water Day, lectures focused on wastewater as a precious resource and underlined the importance of its recycling as well as the role of the hydrological service and the measurement of hydrological characteristics of watercourses in wastewater system management. At the formal celebration of World Meteorological Day, the DHMZ presented a Certificate of Appreciation to Mr. Ante Vukušić for his long-standing hard work, dedication, and contribution to the popularisation of the DHMZ, the observer profession, and the natural treasures of Mount Velebit. Croatian Meteorological Society presented the Lifetime Achievement Award to Ms. Branka Penzar, PhD, and the Best Young Meteorologist Award to Ms. Jadranka Šepić, PhD."

Participants of World Meteorological Day and
World Water Day celebration



Book Night

On 21 April 2017, World Book and Copyright Day and Croatian Book Day, the library of the Croatian Meteorological and Hydrological Service welcomed book and meteorology enthusiasts for the fifth consecutive year. The publications from the DHMZ's first 70 years and different authors' books on topics related to meteorology, climate characteristics of individual Croatian regions and the connections between speleology and flood prediction were presented to the visitors.



Meteorological instruments presented to students at the Science Festival

Science Festival

The Science Festival took place 25–29 April 2017 on 23 locations across Croatia, with time and weather as the main topics. The programme included the celebration of the 160th anniversary of the birth of the great Croatian scientist Andrija Mohorovičić, one of the founders of the seismology service in Croatia and the Geophysics Institute as the modern institute that the DHMZ was born from 70 years ago. The DHMZ's meteorologists actively participated in the programme by delivering a number of lectures and facilitating a number of workshops. A special exhibition featuring photographs, books, posters and measuring instruments, with a section on Andrija Mohorovičić, was dedicated to the 70th anniversary of the DHMZ's work. Lecturers talked about meteorological observations, the weather forecasting process, the connection between the weather and the citizens' everyday activities and moods, and about the processes occurring in the first 20 kilometres of the atmosphere.

8th Zagreb Energy Week

Zagreb Energy Week was organised by the City Office of Energy, Environmental Protection and Sustainable Development 8–13 May 2017 under the motto "Development we don't want to stop, but pollution we can!" The DHMZ's meteorologists delivered lectures for primary and secondary school students about different sources and forms of energy and their applications, and about climate change in Croatia. The METMONIC meteorological network modernisation project was presented at the event.

20th Annual GLOBE Conference and Competition

DHMZ experts participated in the 20th Annual GLOBE Conference and Competition for Croatian primary and secondary school students in Zadar 15–17 May 2017 as members of the State Commission for the evaluation of the students' meteorology projects in the Student Research Project Competition. Hellman's rain gauges (compact version) and meteorological publications were donated to the schools and the students who had the best projects in different categories to help them with their future studies and work.

Velebit House in Krasno – Visitors' Centre

The DHMZ's meteorologists contributed to the exhibition at the Velebit House, the new Visitors' Centre in the North Velebit National Park, working on the topics of Velebit's meteorological and climatological features. The interactive exhibition at the Krasno Centre was opened on 2 August 2017. Since the visiting season at the National Park is from spring to autumn, the Velebit House allows visitors to experience its treasures and moods year-round. The construction of the visitors' centre was financed by EU funds, the Environmental Protection and Energy Efficiency Fund and the Ministry of Environment and Energy.

European Mobility Week

Clean, Shared and Intelligent Mobility was the motto of this year's European Mobility Week celebrated in Zagreb 16–22 September 2017. An appeal was issued to the citizens to use public transport and to carpool more often when travelling to work and back in order to protect air quality. DHMZ experts demonstrated meteorological observations to children at two meteorological stations in Zagreb and presented the meteorology, air quality, and hydrology system upgrade projects that will be funded by European investment funds at separate lectures held within the event. Since Mobility Week started on International Day for the Preservation of the Ozone Layer, a lecture was held on the role of good (stratospheric) ozone.

Raising flood awareness – workshops for children and adults

Ten workshops about floods were held in November 2017 in six Croatian towns in the border basins of the rivers Bregana, Sutla, Drava, Mura, Dragonja and Kupa under the project FRISCO 1 – Cross-Border Harmonized Slovenian-Croatian Flood Risk Reduction 1 – Non Structural Measures, in which the DHMZ is participating. Flood protection, flood risk reduction and risk reduction measures, and self-protection measures in a flood event were discussed at the workshops from the aspects of different professions and relevant institutions.

Children and youth visits to the DHMZ

Some 1,000 students from 30 primary and secondary schools, some 100 pre-schoolers and a number of university students visited the DHMZ in 2017. The meteorologists showed them the meteorological station and the meteorological observation and instrument measurement processes. The visit to the forecasting room and discussions with the forecaster on call about the making of weather forecasts is always an especially interesting part of their visits. Since the students and their teachers are often interested in the DHMZ's other activities (research in different meteorology sectors, calibration and instrument maintenance, and so on), we organise separate lectures to cover these topics.

Primary school students visiting the DHMZ



Scientific Papers by DHMZ Employees Published in 2017

Dissertations

1. Mikuš Jurković, Petra, 2017: **Satelitske karakteristike i grmljavinska aktivnost intenzivnih konvektivnih oluja** [Satellite signatures and lightning characteristics of severe convective storms]. Doctoral dissertation, Zagreb, Faculty of Science, Department of Geophysics, 112 p.
2. Berbić, Jadran, 2017: **Model upravljanja hidrotehničkim sustavima pomoću predviđanja nadziranim učenjem** [Hydrotechnical systems management model using supervised learning]. Doctoral dissertation, Zagreb, Faculty of Civil Engineering, 226 p.

Original scientific papers and reviews published in scientific journals with international peer review

1. Gobin, A., V. Vučetić et al, 2017: Variability in the water footprint of arable crop production across European regions. *Water*, **9**, 93.
2. Berbić, J. et al, 2017: Application of neural networks and support vector machine for significant wave height prediction. *Oceanologia*, **59**, 3, 331–349.
3. Lepri, P. et al, 2017: Bora wind characteristics for engineering applications. *Wind and structures*, **24**, 6, 579–611.
4. Stiperski, I., K. Horvath et al, 2017: Water Tank Experiments on Stratified Flow over Double Mountain-Shaped Obstacles at High-Reynolds Number. *Atmosphere*, **8**, 13.
5. Templ, B., V. Vučetić et al, 2017: Phenological patterns of flowering across biogeographical regions of Europe. *International Journal of Biometeorology*, **61**, 7, 1347–1358.
6. Kosanović, C. et al, 2017: Crystallization of Calcium Carbonate in Alginate and Xanthan Hydrogels. *Crystals*, **7**, 335–369.

Scientific papers in other journals

1. Berbić, J., E. Ocvirk, 2017: Long term prediction of inflow using the supervised learning. *Acta Hydrologica Slovaca*, **18**, 2, 282–289.
2. Güttler, I. et al, 2017: Corrigendum: Energetics of Slope Flows: Linear and Weakly Nonlinear Solutions of the Extended Prandtl Model. *Frontiers in Earth Science*, **5**:76, 1–3.
3. Nimac, I., I. Herceg Bulić, 2017: An inter-mediate complexity AGCM simulations of climate response to a doubling of atmospheric carbon dioxide. *Geofizika*, **34**, 1, 175–197.
4. Nimac, I., M. Perčec Tadić, 2017: Complete and homogeneous monthly temperature series for construction of the new 1981–2010 climatological normals for Croatia. *Geofizika*, **34**, 2, 175–197.
5. Trošić Lesar, T., A. Filipčić, 2017: Multiple Linear Regression (MLR) model simulation of hourly PM₁₀ concentrations during sea breeze events in the Split area. *Naše more*, **64**, 3, 77–85.
6. Cvitan, L., 2017: Impact of climate change on heating and cooling needs in Crikvenica as a health tourism destination. *Croatian Meteorological Journal*, **52**, 27–50.

Photo by: Ivan Vukušić

Participation in Scientific and Research Projects and International Programmes and Initiatives

Project name and objective	Project participants	Project partners	Project funding and duration	Significance
Scientific and research projects funded by the European Regional Development Fund (ERDF)				
<p>PRO NEWS Programme for improving National Early Warning System and flood prevention in Albania</p> <p>Objective: Increase the flood resilience of Albania by improving the national early warning system and disaster prevention in accordance with the good practices of the EU.</p>	<p>Project Manager: Marco Massabo, CIMA, Italy</p> <p>DHMZ participants: Krešo Pandžić, PhD Vlasta Tutiš, PhD Borivoj Terek Mario Krešić, MSc</p>	<p>International Centre on Environmental Monitoring (CIMA), Italy, Civil Protection Department, Italy, European Centre for Medium-Range Weather Forecasting (ECMWF), UK, World Meteorological Organisation, Regional Environmental Centre, Albania</p>	<p>Project value: 2,281,404 EUR, for the DHMZ: 55,000 EUR ERDF: 85 % National: 15 %</p> <p>Duration: 1 Jan 2017–9 Oct 2018</p>	<p>Knowledge transfer by Croatian experts providing assistance to Albania.</p>
Science and research projects financed by the Croatian Science Foundation				
<p>CARE Climate of the Adriatic Region in its global context</p> <p>Objective: Detect, model and interpret meteorological and oceanographic processes active on a climate timescale in the broader Adriatic area. Develop methods and evaluate impact on human activities and the environment.</p>	<p>Project Manager: Professor Mirko Orlić, PhD, Faculty of Science, Department of Geophysics</p> <p>DHMZ participants: Renata Sokol Jurković Melita Perčec Tadić, MSc Lidija Srnec, MSc Ksenija Cindrić Kalin, MSc Ksenija Zaninović, PhD Ivan Güttler, PhD</p>	<p>Faculty of Science, Department of Geophysics (leading partner)</p>	<p>Project value: 876,200 HRK</p> <p>Duration: 1 Jul 2014–31 Jun 2018</p>	<p>Detailed time and space statistical analysis of climate variables, with emphasis on multidecade changes in temperature and precipitation extremes in the Adriatic; drought, flood and heatwave analysis; research of the possible effects of climate change on tourism. Spatially interpolated fields obtained in this way will become reference data for climate model evaluation and input data for the flood warning system.</p>
<p>AGRO-DROUGHT-ADAPT Adaptability assessment of maize and soybean cultivars of Croatia in the function of breeding for drought tolerance</p> <p>Objective: Identify maize and soybean genotypes with the best drought tolerance and produce a testing method to facilitate the selection of such genotypes.</p>	<p>Project Manager: Professor Ivan Pejić, PhD, Faculty of Agriculture, Zagreb</p> <p>DHMZ participants: Krešo Pandžić, PhD Davor Tomšić Nataša Strelec Mahović, PhD Tanja Likso, PhD</p>	<p>Agricultural Institute Osijek, Faculty of Agriculture, University of J. J. Strossmayer, Osijek, Croatian Centre for Agriculture, Food and Rural Affairs, Institute for Seed and Seedlings, BC Institut, Zagreb, Križevci College of Agriculture, Institute of Agriculture and Tourism, Poreč, Institute for Adriatic Crops and Karst Melioration, Split</p>	<p>Project value: 2,000,000 HRK</p> <p>Duration: 1 Apr 2017–31 Mar 2019</p>	<p>Drought damage mitigation. Improvement of the production and selection processes for the most important maize and soybean cultivars with the best drought tolerance. Taking climate data into consideration, the project will enable precise evaluation of actual economic damage in Croatian agriculture as the basis for future development policies.</p>

Project name and objective	Project participants	Project partners	Project funding and duration	Significance
<p>ADAM-ADRIA Exploring the Adriatic Sea Dynamics using Advanced Data Assimilation Methods and Measurements</p> <p>Objective: Expand knowledge of Adriatic Sea dynamics, especially currents on the eastern coast of the Adriatic Sea; the dynamic of the Po river outflow during stratified and vertically homogeneous conditions, generation and dynamics of the sharp temperature and salinity front along the coast of Istria.</p>	<p>Project Manager: Ivica Janeković, PhD (Ruđer Bošković Institute)</p> <p>DHMZ participant: Stjepan Ivatek-Šahdan, MSc</p>	<p>Ruđer Bošković Institute (leading partner), Faculty of Science, Department of Geophysics, Institute of Oceanography and Fisheries, Split</p>	<p>Project value: 926,000 HRK</p> <p>Duration: 1 Aug 2014–31 Jul 2018</p>	<p>Establishing the bases for future research of sea biology, chemistry and geology and procedures in the event of oil discharge into the sea or integrated planning respecting the rules of environmental protection. All project data and results are available for scientific and other uses.</p>
International scientific and research projects				
<p>SEE – FFGS Development and Implementation of a Regional Flash Flood Guidance System under the South Eastern Europe Region Flash Flood Guidance project</p> <p>Objective: Reduce the region's sensitivity to hydrological disasters, in particular flash floods, in order to strengthen the regional and national capacities for the preparation of timely and reliable flash flood warnings.</p>	<p>DHMZ Project Coordinator: Borivoj Terek</p> <p>DHMZ participants: Jadran Berbić, PhD Kornelija Macek Dijana Oskoruš, PhD Tatjana Vujnović, PhD</p>	<p>World Meteorological Organisation, US Hydrologic Research Center (HRC), US National Oceanic and Atmospheric Administration (NOAA), national hydrological and meteorological services of Turkey, Slovenia, Bosnia and Herzegovina, Romania, Moldova, Montenegro, Macedonia, Albania</p>	<p>United States Agency for International Development's Office of Foreign Disaster Assistance (USAID/OFDA)</p> <p>Duration: 2013–2017</p>	<p>Development and implementation of a flash flood guidance system and timely early warning system.</p>
<p>MESSI Meteotsunamis, destructive long ocean waves in the tsunami frequency band: from observations and simulations towards a warning system</p> <p>Objective: Develop a prototype early warning forecasting system for meteotsunamis.</p>	<p>Project Manager: Jadranka Šepić, PhD, Institute of Oceanography and Fisheries, Split</p> <p>DHMZ participants: Martina Tudor, MSc (DHMZ Project Coordinator) Kristian Horvath, PhD</p>	<p>Institute of Oceanography and Fisheries, Split Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy, Universitat de les Illes Balears, Palma, Balears, International Tsunami Research, Inc., Pasadena, California</p>	<p>Unity Through Knowledge Fund (UKF)</p> <p>Duration: 2015–2017</p>	<p>Coastal communities at risk will benefit from project results in many areas: timely warnings, coastal construction work planning (roads, marinas, docks and so on), navigational safety, tsunami education and awareness raising in areas at risk. Hazard maps for the Adriatic Sea will be developed based on the output oceanographic numerical models. The warning system can be an incentive for the development of operational oceanographic forecast in the Adriatic.</p>

Project name and objective	Project participants	Project partners	Project funding and duration	Significance
Croatian scientific and research projects				
<p>Adaptation capacity of the Mediterranean forests to environmental stress</p> <p>Objective: Determining the state of forest ecosystems and ecosystem changes using different indicators. Researching the connections between the indicators of the state of forest systems and determining the capacity of the forest ecosystems to adapt to environmental stress.</p>	<p>Project Manager: Nenad Potočić, PhD, Croatian Forest Research Institute, Jastrebarsko</p> <p>DHMZ participant: Melita Perčec Tadić, MSc</p>	<p>Croatian Forest Research Institute, Jastrebarsko Institute for Adriatic Crops and Karst Melioration, Split</p>	<p>Ministry of Agriculture</p> <p>Duration: 1 May 2016–31 Dec 2018</p>	<p>Getting to know the reactions of forest ecosystems to different climate change variables and the capacity of planning measures for the adaptation of Croatian forests to climate change.</p>

The DHMZ's representatives are participating in the following international collaborations on World Meteorological Organization (WMO) and European Meteorological Network (EUMETNET) projects:

- **EMEP** – Co-operative programme for the monitoring and evaluation of long-range transmission of air pollutants in Europe aimed at providing information to support decision making in environmental protection
- **ALADIN-HIRLAM** – Numerical weather forecasting project aimed at developing and implementing this model
- **RC LACE** – Regional Cooperation for Limited Area Atmospheric Process Modelling in Central Europe aimed at developing and implementing a numerical weather forecasting model for Central Europe
- **EUMETNET SRNWP** – Short range numerical weather prediction programme aimed at aligning and advancing the short range numerical weather prediction research and implementation efforts in EUMETNET member states
- **EUMETNET OPERA4** – Weather radars in Europe, aimed at harmonization and establishment of a European operational weather radar platform, radar data exchange, and development of national meteorological services' radar database
- **EUMeTrain** – International meteorological satellite data training project sponsored by EUMETSAT aimed at supporting and increasing the use and the understanding of meteorological satellite data
- **PEP725** – European Phenology Database, aimed at providing an integral European phenology database, updated continually, that will offer an open and unlimited access to information for science, research and education.

DHMZ scientists' collaborations on Croatian and international programmes, projects and initiatives

- **WorldDailyMeteo** – Space-time interpolation of daily meteorological variables at a horizontal resolution of 1 km, aimed at developing climatological data analysis, developing and implementing space-time data interpolation methods, interpreting the results, and detecting climate variabilities in Croatia
- **EURO-CORDEX** – Dynamic downscaling of regional climate models in Europe to make climate projections for use in environmental impact studies and climate change adaptation during and after the making of the 5th Assessment Report of the Intergovernmental Panel on Climate Change
- **PannEx** – Pannonian Basin experiment studying hydrological and energy cycles to connect research in meteorology and climatology with impact areas in agronomy, forestry and hydrology in the Pannonian Basin

- **HyMeX** – Mediterranean experiment studying the hydrological cycle to develop combined atmosphere-sea models that will increase the accuracy of the prediction models and the estimates of social and economic impact and the Mediterranean's sensitivity to disasters caused by severe weather, as well as support political decisions regarding water availability problems and adaptation to the frequency of severe weather episodes
- **RegCM** – Development of a regional climate model
- **EuroMed-CORDEX FPS Convection** – Dynamic adaptation to regional climate models in Europe and the Mediterranean; high spatial resolution simulations aimed at developing regional climate models
- **ViLab** – Virtual Laboratory – a system for the investigation of the variability of physical parameters in the atmosphere, atmosphere-ocean boundary layer and the ocean to improve climate change adaptation
- **Danube Sediment** – Danube Sediment Management – Restoration of sediment balance in the Danube to improve water, sediment and Danube morphology management
- **FairWay Danube** – Coordinated development of the fairway rehabilitation and maintenance master plan for the Danube and its navigable tributaries to modernise the hydrological station network, develop a hydrological prediction system for the Danube, and improve navigational safety, as well as maintain an international Danube fairway in Croatia
- **FAIRMODE Pilot projekt** – Air quality management – elaboration and implementation of the FAIRMODE methods to improve air quality management in the cities by applying atmospheric numerical models
- **AQMSD** – Development of an air quality modelling system and air quality modelling.

In the past 15 years, the DHMZ has become a recognisable and active partner in dynamic adaptation research in the European research community through its work on the development and application of the Regional Climate Model (RegCM). Throughout 2016–2017, the DHMZ's experts made a crucial contribution to the project Strengthening Climate Change Adaptation Capacities of the Ministry of Environment and Energy and the preparation of the Draft Climate Change Adaptation Strategy, funded by the EU technical assistance transition facility, by performing and analysing RegCM simulations.

10

70th Anniversary of the DHMZ – Historical Highlights

- 1817** — The first hydrological station on the Sava at Stara Gradiška
- 1851** — Observations started at the first official meteorological station in Dubrovnik, unfortunately, with some interruptions
- 1861** — Zagreb-Grič Observatory, Croatia's oldest station with uninterrupted meteorological observations, put in operation
- 1866** — Flow measurement office established with the civil department of the Croatian-Slavonian-Dalmatian provincial government in Zagreb
- 1901** — All stations in the territory governed by the viceroy placed under the control of the Meteorological Observatory Zagreb-Grič, with Andrija Mohorovičić at the helm. Mohorovičić started controlling the data immediately and preparing it for publication, and gave precise instructions to observers on how to conduct observations and record data
- 1947** — Directorate of the Hydrological and Meteorological Service of People's Republic of Croatia established by merging the Institute of Hydrology and the Institute of Geophysics
- 1948** — Directorate of the Croatian Hydrological and Meteorological Service established a library to collect scientific publications
- 1949** — Monitoring of ground water levels started
- 1951** — Organised agrometeorological observation started: phenology and soil temperature

Andrija Mohorovičić



Photo by: Helena Lebo

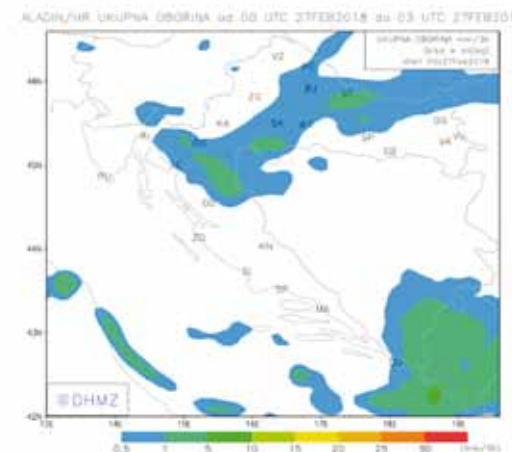


Photo by: Ante Vukušić



Long-range meteorological Doppler radar on Mount Bilogora, Photo by: Marin Mustapić

- 1955** — Radiosonde measurements established
- 1956** — - Beginning of human biometeorology;
- Name changed to Republic Hydrological and Meteorological Service (RHMZ);
- Beginning of weather forecast announcements on radio and TV (TV ZG)
- 1971** — Systematic air quality monitoring started
- 1976** — RHMZ acquired the status of legal entity for scientific and research work
- 1983** — The first long-range weather radar in Croatia established at Puntijarka
- 1985** — The second long-range weather radar in Croatia established in Osijek
- 1986** — The use of satellite images in weather forecasting started
- 1991** — RHMZ became Croatian Meteorological and Hydrological Service (DHMZ)
- 1992** — Croatia joined the World Meteorological Organization (WMO)
- 1994** — The first modern long-range meteorological Doppler radar set up on Mount Bilogora



Aladin/HR total precipitation from 00 UTC 27 FEB 2018 to 03 UTC 27 FEB 2018; Total precipitation mm/3h (rain+snow)

- 1996** — Croatia became associate ECMWF member
- Agreement signed on collaboration on developing the ALADIN project
- 2002** — ALADIN model for Croatia put in operation;
- Modernisation of operational technology and user services in the forecasting sector
- 2004** — Croatia became a full member of the GEO
- 2006** — Croatia became a full member of the EUMETSAT
- 2007** — DHMZ became a full member of the EUMETNET and ECOMET
- 2009** — The DHMZ started issuing regular warnings for the public through the international Meteoalarm system
- 2016** — - Croatia became a full ECMWF member
- The DHMZ started issuing regular marine meteorological warnings for the coastal area in the Meteoalarm system
- 2017** — beginning of METMONIC (Modernisation of the National Weather Observation Network) and AIRQ (Expansion and Modernisation of the National Network for Continuous Air Quality Monitoring) projects

