SOUTH-EAST EUROPEAN MULTI-HAZARD EARLY WARNING ADVISORY SYSTEM (SEE-MHEWS-A)

OBSERVATIONAL REQUIREMENTS FOR SEE-MHEWS-A PROJECT

INVENTORY OF AVAILABLE DATA AND RECOMMENDATIONS FOR IMPROVEMENTS TO THE EXISTING OBSERVATIONAL NETWORKS SUPPORTING SEE-MHEWS-A

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List of abbreviations

AMDAR – Aircraft Meteorological Data Relay
ARSO – Agencija Republike Slovenije za okolje (Slovenian Environment Agency)
AWS – Automatic Weather Station
BiH – Bosnia and Herzegovina
BOBER – Better Observation for Better Environment Response
CBS – Commission for Basic Systems
DB – Database
DHMZ – Državni hidrometeorološki zavod (Croatian Meteorological and Hydrological Service)
DRM – Disaster Risk Management
EUCOS – EUMETNET Composite Observing System
EUMETNET – European Meteorological Services Network
FHMI – Federal Hydrometeorological Institute (Bosnia and Herzegovina)
GFDRR – Global Facility for Disaster Reduction and Recovery
GOS – Global Observing System
GPRS – General Packet Radio Service
GPS – Global Positioning System
IGEWE – Institute of GeoSciences Energy Water and Environment (Albania)
IHMS – Institute for Hydrometeorology and Seismology of Montenegro
IMS – Israel Meteorological Service
INCA – Integrated Nowcasting Comprehensive Analysis
IPA – Instrument for Pre-accession Assistance
ISO/IEC – International Organization for Standardization/International Electrotechnical Commission
METAR – Format for weather information predominantly from airports
NMHS – National Meteorological and Hydrorological Service
NWP – Numerical Weather Prediction
OMSZ – Országos Meteorológiai Szolgálat (Hungarian Meteorological Service)
OSCAR – Observing Systems Capability Analysis and Review Tool
PBL – Planetary Boundary Layer
QC – Quality Control
RA – Regional Association
RHMS – Republic Hydrometeorological Service
RIC – Regional Instrument Centre
RMS – Root Mean Square (standard deviation)
RNMA – Romanian National Meteorological Administration
RRR – Rolling Review of Requirements
RS – Republika Srpska (Entity in Bosnia and Herzegovina)
SEE-MHEWS-A – South-East European Multi-hazard Early Warning Advisory System
SHS – State Hydrometeorological Institute of Moldova
SOG – Statements of Guidance
SYNOP – Numerical code used for reporting weather observations made by manned and automated surface weather stations
TSMS – Turkish State Meteorological Service
UHMC – Український гідрометеорологічний центр (Ukrainian Hydrometorological Center)

UHMR – Управа за хидрометеоролошки работи (Hydrometeorological Service - Republic of North Macedonia)
USAID – United States Agency for International Development
UTC – Coordinated Universal Time
WB – World Bank
WIGOS – WMO Integrated Global Observing System
WIS – WMO Information System
WMO – World Meteorological Organization
ZAMG – Zentralanstalt für Meteorologie und Geodynamik (National Meteorological Service of Austria)

1. SUMMARY

Following the successful conclusion of the project "Building Resilience to Disasters in the Western Balkans and Turkey" in 2014, and responding to the needs identified by the beneficiaries the World Meteorological Organization (WMO) in cooperation with the U.S. Agency for International Development (USAID) initiated a project "South-East European Multi-Hazard Early Warning Advisory System (SEE-MHEWS-A)", which aims to strengthen existing early warning capacities in the South-East Europe region. During the first phase of the project, an Implementation Plan was prepared outlining the concept and guidelines for the development of the regional advisory system. The second phase of the SEE-MHEWS-A project commenced in February 2018 and is supported by the World Bank through the Global Facility for Disaster Reduction and Recovery and Instrument for Pre-accession Assistance (IPA) of the European Commission. This project phase will be the beginning of implementation of the SEE-MHEWS-A, as broadly outlined in the Implementation Plan.

As part of the activities of the 2nd phase of the SEE-MHEWS-A project, the Hungarian Meteorological Service was tasked to prepare the observational requirements for the project, based on the WMO Rolling Review of Requirements (RRR) and project objectives and recommendations for improvements to the existing observational networks supporting SEE-MHEWS-A. This document collected information on the capability of the meteorological monitoring networks of the project partners. The 17 countries have 18 National Meteorological and/or Hydrometeorological Services (NMHSs) since Bosnia and Herzegovina has two separate institutions in entity level. The countries are located in the Central and South-East Europe, as well as in the Middle East in accordance with the Regional Association VI (RA VI) of the WMO.

Automation of the surface observations is in progress in the region with the exemption of Ukraine, where the traditional manned stations produce measurements every three hours. The networks are rather dense in the EU Member States as well as in Israel and Turkey, although they cannot meet all the threshold observing requirements listed in the Table 1 of this report. Some NHMSs were forced to abandon at least partly their costly upper air and radar stations. Only a few services apply solid calibration practice; unfortunately, the others face lack of well-equipped calibration laboratory and certified personnel. Most of the NMHSs can devote only modest capacity to data quality control applying basic screening procedures. Moreover, all countries suffered from COVID-19 pandemic, which threw back thoroughly the measurements provided by the WMO Aircraft Meteorological DAta Relay (AMDAR), which are essential in data assimilation for Numerical Weather Predictions (NWPs).

The direction of further development of the observing capability in the region could be a technical improvement of the existing Automatic Weather Stations (AWSs), spatial rationalization of them, significant increase of the level of maintenance, calibration and data quality control.

Nevertheless, the existing meteorological observing networks of the project partners, supplemented with satellite products can serve as an initial base to high-resolution NWP.

2. Introduction

South-East Europe has experienced a significant number of severe meteorological and hydrological events in recent years. Heavy precipitation has caused floods and landslides. Droughts have increased the incidence of forest fires. People have also suffered under prolonged heat waves and episodes of cold spells. There have been severe thunderstorms and hailstorms. These natural hazards have had significant impacts: human lives have been lost, property and infrastructure were damaged, and the functioning of key sectors was impaired causing huge economic loss. The frequency of hydrometeorological events is expected to increase in the future. Because of this, there is greater demand for improved early warning for communities at risk as well as a need for better community-level preparedness to improve resilience.

The Project “South-East European Multi-Hazard Early Warning Advisory System” (SEE-MHEWS-A) aims at providing operational forecasters from the region with effective tools for forecasting hazardous weather and hydrological events and their possible impacts. In the demonstration phase of the project, the development of a pilot operational hydrological modelling system embedded in a high-resolution NWP models for the catchment of the Vrbas River will be implemented.

3. Rolling Review of Requirements process

WMO Members require international observations to fulfil their mandates, which include monitoring and provision of services. They endeavour to collect and share observations, which address their requirements. The requirements are documented for each of a series of Application Areas in which the observations are directly used.

It is a challenging exercise to develop a consensus view on the design and implementation of WMO integrated observing systems, in particular where the need and implementation occur on global or regional scales. The WMO Commission for Basic Systems (CBS) has encouraged the development of a process to accomplish this, as objectively as possible. The process is known as the Rolling Review of Requirements (RRR) (https://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html).

The process jointly reviews Members’ evolving requirements for observations and the capabilities of existing and planned observing systems. As a result, through so-called “Statements of Guidance” (SOG), experts in each application area address the extent to which the capabilities meet the requirements, and they produce gap analyses with recommendations on how these gaps could be addressed.

For each application area, the process consists of four stages:

i) Review of technology-free (the requirements do not consider the available technology for making the observations, whether it is surface-based or space-based) Members’ requirements for observations, within an area of application covered by WMO programmes and cosponsored programmes;
ii) Review of the observing capabilities of existing and planned observing systems, both surface- and space-based;
iii) Critical Review of the extent to which the capabilities (ii) meet the requirements (i); and
iv) Statement of Guidance based on (iii).

To facilitate the RRR process, the Infrastructure Department of the WMO Secretariat collects the requirements for observations to meet the needs of all WMO Programmes, and also catalogues the current and planned provision of observations. The resulting database is called the Database on User Requirements and Observing System Capabilities. It is accessible via the WMO website through the Observing Systems Capability Analysis and Review Tool (OSCAR).

The requirements for observations are stated quantitatively in terms of five criteria, which are the following:

- Horizontal resolution

- Vertical resolution
- Frequency (observation cycle)
- Timeliness (delay in availability)
- Uncertainty (acceptable RMS error and any limitations on bias).

For each application, there is usually no abrupt transition in the utility of an observation as its quality changes. Improved observations (in terms of resolution, frequency, accuracy, etc.) are usually more useful while degraded observations, although less useful, are usually not useless. Moreover, the range of utility varies from one application to another. Therefore, for each of these criteria, the requirement includes three values determined by experts: the "goal", the "threshold", and the "breakthrough".

- The "goal" or "maximum requirement" is the value above which further improvement of the observation would not cause any significant improvement in performance for the application in question. The cost of improving the observations beyond the goal would not be matched by a corresponding benefit.
- The "breakthrough" is an intermediate level between "threshold" and "goal". If it is achieved, it would result in a significant improvement for the targeted application.
- The "threshold" or "minimum requirement" is the value that must be met to ensure that data are useful. Below this minimum, the benefit does not compensate for the additional cost involved in using the observation. Threshold requirements for any given observing system cannot be stated in an absolute sense. Assumptions have to be made concerning which other observing systems are likely to be available.

The future Global Observing System (GOS) will play a central role in the WMO Integrated Global Observing System (WIGOS). Some general trends and issues are key in the GOS:

- The GOS will provide comprehensive observations in response to the needs of all WMO Members and Programmes for improved data products and services, for weather, water and climate;
- It will provide observations when and where they are needed in a reliable, stable, sustained and cost-effective manner;
- It will routinely respond to user requirements for observations of specified spatial and temporal resolution, accuracy and timeliness;
- It will evolve in response to a rapidly changing user and technological environment, based on improved scientific understanding and advances in observational and data-processing technologies;
- The GOS will have evolved to become part of the WIGOS, which will integrate current GOS functionalities, which are intended primarily to support operational weather forecasting, with those of other applications: climate monitoring, oceanography, atmospheric composition, hydrology, weather and climate research;
- Integration will be developed through the analysis of requirements and, where appropriate, through sharing observational infrastructure, platforms and sensors, across systems and with WMO Members and other partners;
- There will be an expansion in both the user applications served and the variables observed;
- The range and volume of observations exchanged globally (rather than locally) will be increased;

- Some level of targeted observations will be achieved, whereby additional observations are acquired, or usual observations are not acquired, in response to the local meteorological situation;
- The trend to develop fully automatic observing systems, using new observing and information technologies will continue, where it can be shown to be cost-effective;
- Access to real-time and raw data will be improved;
- Observational data will be collected and transmitted in digital forms, highly compressed where necessary. Data processing will be highly computerized;
- There will be increased standardization of instruments and observing methods;
- There will be improvements in the calibration of observations and the provision of metadata, to ensure data consistency and traceability to absolute standards;
- There will be improved methods of quality control and characterization of errors of all observations;
- There will be increased interoperability, between existing observing systems and with newly implemented systems; and
- There will be improved homogeneity of data formats and dissemination via the WIS (WMO Information System).

The list above envisions a comprehensive, developed, capable meteorological observation system. Unfortunately, the region of our project has a less-developed monitoring network. Therefore, the minimum, so-called threshold level of the high-resolution NWP SOG is examined.

High-resolution models are initialized through the assimilation of observations requiring more frequent analyses (every 6, 3 or 1 hour), and therefore more frequent observations with a shorter delivery delay. High-resolution NWP models are producing forecasts of meteorological events with a 1-5 km horizontal resolution. The key model variables for which observations are needed are the same as for global models: 3-dimensional fields of wind, temperature and humidity, and the 2-dimensional field of surface pressure.

Wind profiles are available from radiosondes, aircrafts (ascent/descent profiles), wind profilers and Doppler radars.

Recent high-resolution NWP models are generally non-hydrostatic, considering vertical velocity as a prognostic variable of the model. However, no specific assimilation on this variable is normally performed. The model derives its own vertical velocity field from the other meteorological fields in its first time-steps of integration. The reason behind is that no observing capability is able to produce some vertical velocity observations which are comparable to the model ones (at the scale of its mesh). A drastic increase on spatial resolutions of high-resolution NWP models is needed before these models can resolve the clouds and produce some vertical motion which can be compared to, for example, Doppler radar vertical velocity observations.

Temperature profiles are available from radiosondes and aircraft (ascent/descent profiles): such in-situ observations are very useful for high-resolution NWP. In populated areas, horizontal and temporal coverage may be acceptable and vertical resolution is good. In addition, a lot of information can be derived from the different sounders onboard polar-orbiting satellites.

The assimilation of humidity has big importance in modern NWP models. Tropospheric humidity profiles are available from radiosondes overpopulated land areas, and this is currently the only in-situ observing system providing humidity profiles with good accuracy to high-resolution NWP, except the very few aircraft that are currently testing humidity sensors. In these areas, horizontal and temporal resolution is usually acceptable (but sometimes marginal, due to the high horizontal variability of the humidity field), the vertical resolution is adequate, and accuracy is good or acceptable. Polar satellites provide information on tropospheric humidity with a good horizontal resolution, marginal time coverage and acceptable accuracy. Vertical resolution from passive microwave and infra-red radiometers is marginal, but advanced infra-red systems have improved (acceptable) vertical resolution.

Cloud and precipitation assimilation is more advanced in nowcasting systems than in NWP models. Observations of clouds still have many issues. Even if satellite visible/infrared measurements give marginal accuracy because of the poor relationships between cloud-top temperature and the underlying clouds and precipitation physics, cloud amount (fractional coverage) and cloud-top height can be retrieved using combinations of channels from imagers or radiometers aboard satellites. Some centres apply this information using nudging algorithms in order to make the simulated cloud cover more consistent with the observations, and thus to improve the forecast of variables such as surface air temperature. Microwave measurements are affected by sensitivity to land surface emissivity and by similar optical properties of cloud water and light rainfall. Consequently, and for high-resolution NWP models, microwave imagers and sounders offer information on clouds of marginal accuracy, horizontal and temporal resolution.

After appropriate quality control, 3D description of precipitation (liquid or solid) is given by reflectivity measurements observed by weather radar with good temporal and spatial resolutions, but with accuracy that depends on its frequency and on the rain intensity. The higher the frequency, the more the signal is affected by rain attenuation. The use of dual-polarized technology to correct such attenuation allows however to reach acceptable accuracy.

Clouds and precipitation observations are however very important data to verify model precipitation forecasts and to validate its physical processes. Over land, the conventional observations of accumulated observations have a temporal resolution and an accuracy which are highly variable from one region to another. The horizontal resolution is marginal in many areas. Instantaneous precipitation can be deduced from volume scans of reflectivity observed by ground-based radars with good horizontal and temporal resolutions and acceptable accuracy but over a few land areas only.

Table 1. Threshold observing requirements of high-resolution NWP (WMO)

Threshold observing requirements of high-resolution NWP (WMO)								
Variable	Layer(s)	Uncertainty threshold	Dimension	Hor. Res. threshold	Ver. Res. Threshold	Obs. cycle thres.	Timeliness threshold	Coverage
Accumulated precip. (over 24 h)	Near Surface	5	mm	10 km	0	6 h	24 h	Global
Air pressure (near surface)	Near Surface	1	hPa	40 km	0	3 h	2 h	Global

Air specific humidity (near surface)	Near Surface	10	%	20 km	0	6 h	2 h	Global
Air temperature (near surface)	Near Surface	2	K	20 km	0	6 h	2 h	Global
Atmospheric temperature	FT	3	K	25 km	1 km	6 h	2 h	Global
Atmospheric temperature	UTLS	3	K	100 km	3 km	6 h	2 h	Global
Atmospheric temperature	PBL	3	K	10 km	1 km	6 h	2 h	Global
Cloud base height	n/a (2D)	0,5	km	10 km	0	3 h	2 h	Global
Cloud cover	TrC	20	%	10 km	0	3 h	2 h	Global
Cloud drop effective radius	Cloud-top	5	µm	10 km	0	3 h	2 h	Global
Cloud ice	FT	20	%	10 km	0.5 km	3 h	2 h	Global
Cloud ice	PBL	20	%	10 km	0.5 km	3 h	2 h	Global
Cloud ice Total Column	TC	20	$g.m^{-2}$	10 km	0	3 h	2 h	Global
Cloud liquid water (CLW)	FT	20	%	10 km	0.5 km	3 h	2 h	Global
Cloud liquid water (CLW)	PBL	20	%	10 km	0.5 km	3 h	2 h	Global
Cloud liq. water (CLW) t. column	TC	50	$g.m^{-2}$	10 km	0	3 h	2 h	Global
Cloud top height	n/a (2D)	1	km	10 km	0	3 h	2 h	Global
Cloud type	n/a (2D)	0	$Classes^{-1}$	10 km	0	3 h	2 h	Global
Dominant wave direction	Sea surface	30	deg.	40 km	0	6 h	3 h	Global ocean
Dominant wave period	Sea surface	1	s	40 km	0	6 h	3 h	Global ocean
Earth surface albedo	Land surface	20	%	10 km	0	12 h	12 h	Global land
Fraction of Absorbed PAR (FAPAR)	Land surface	20	%	20 km	0	2 d	7 d	Global land

Integrated Water Vapour (IWV)	TC	5	$kg.m^{-2}$	20 km	0	6 h	2 h	Global
Land surface temperature	Land surface	4	K	20 km	0	6 h	2 h	Global land
Leaf Area Index (LAI)	Land surface	20	%	40 km	0	2 d	7 d	Global land
Long-wave Earth surface emissivity	Land surface	3	%	20 km	0	12 h	12 h	Global land
Normalised Diff. Veg. In. (NDVI)	Land surface	20	%	40 km	0	2 d	7 d	Global land
O3 Mole Fraction	FT	20	(mol/mol)	100 km	3 km	6 h	2 h	Global
O3 Mole Fraction	UTLS	20	(mol/mol)	100 km	3 km	6 h	2 h	Global
O3 Mole Fraction	PBL	20	(mol/mol)	100 km	3 km	6 h	2 h	Global
O3 Total Column	TC	20	%	40 km	0	6 h	2 h	Global
Precip. Int. at surface (liq. or solid)	Near Surface	1	mm/h	10 km	0 N/A	3 h	2 h	Global
Precip. intensity at surface (solid)	Near Surface	1	mm/h	10 km	0	3 h	2 h	Global
Precipitation type at the surface	Near Surface	0		5 km	0.4 km	3 h	2 h	Global
Sea surface temperature	Sea surface	1	K	20 km	0	6 h	6 h	Global ocean
Sea-ice cover	Sea surface	20	%	40 km	0	12 h	6 h	Global ocean
Sea-ice surface temperature	Sea surface	4	K	40 km	0	12 h	12 h	Global ocean
Sea-ice thickness	Sea surface	100	cm	40 km	0	2 d	3 d	Global ocean
Significant wave height	Sea surface	0.5	m	40 km	0	6 h	3 h	Global ocean
Snow cover	Land surface	20	%	20 km	0	12 h	12 h	Global land
Snow water equivalent	Land surface	20	mm	20 km	0	6 h	24 h	Global land

Soil moisture at surface	Land surface	0,08	m^3/m^3	40 km	0	6 h	6 h	Global land
Specific humidity	FT	10	%	30 km	1 km	6 h	2 h	Global
Specific humidity	PBL	10	%	20 km	1 km	6 h	2 h	Global
Upw. long-wave irradiance at TOA	TOA	20	W/m^2	50 km	0	6 h	12 h	Global
Upward short-wave irrad. at TOA	TOA	20	W/m^2	50 km	0	6 h	12 h	Global
Wind (horizontal)	FT	8	$m.s^{-1}$	20 km	1 km	12 h	2 h	Global
Wind (horizontal)	UTLS	5	$m.s^{-1}$	100 km	5 km	12 h	2 h	Global
Wind (horizontal)	PBL	5	$m.s^{-1}$	10 km	0.4 km	12 h	2 h	Global
Wind (vertical)	FT	5	$cm.s^{-1}$	20 km	1 km	12 h	2 h	Global
Wind (vertical)	UTLS	5	$cm.s^{-1}$	100 km	5 km	12 h	2 h	Global
Wind (vertical)	PBL	5	$cm.s^{-1}$	10 km	0.5 km	12 h	2 h	Global
Wind speed (near surface)	Near Surface	3	m/s	20 km	0	3 h	2 h	Global land
Wind speed (near surface)	Near Surface	3	m/s	20 km	0	12 h	2 h	Global ocean
Wind vector (near surface)	Near Surface	5	m/s	40 km	0	3 h	2 h	Global land
Wind vector (near surface)	Near Surface	5	m/s	40 km	0	12 h	2 h	Global ocean
FT = free troposphere								
PBL = planetary boundary layer								
TOA = top of the atmosphere								
UTLS = upper trop/lower strat.								
TC = total column								
TrC = troposphere column								

EUMETNET (European Meteorological Services Network) has conducted an observation gap analysis over the EUCOS (EUMETNET Composite Observing System) region lately. Key conclusions of the study are as follows:

- Major gaps remain in observing capabilities over the EUCOS region, particularly relating to the spatial resolution and the observing cycle of many variables.
- Space-based capabilities will, over the next 3 years, reduce some of the high-priority observation gaps, e.g. temperature and humidity profile in the Free Troposphere and, to a lesser extent, in the Planetary Boundary Layer (PBL).

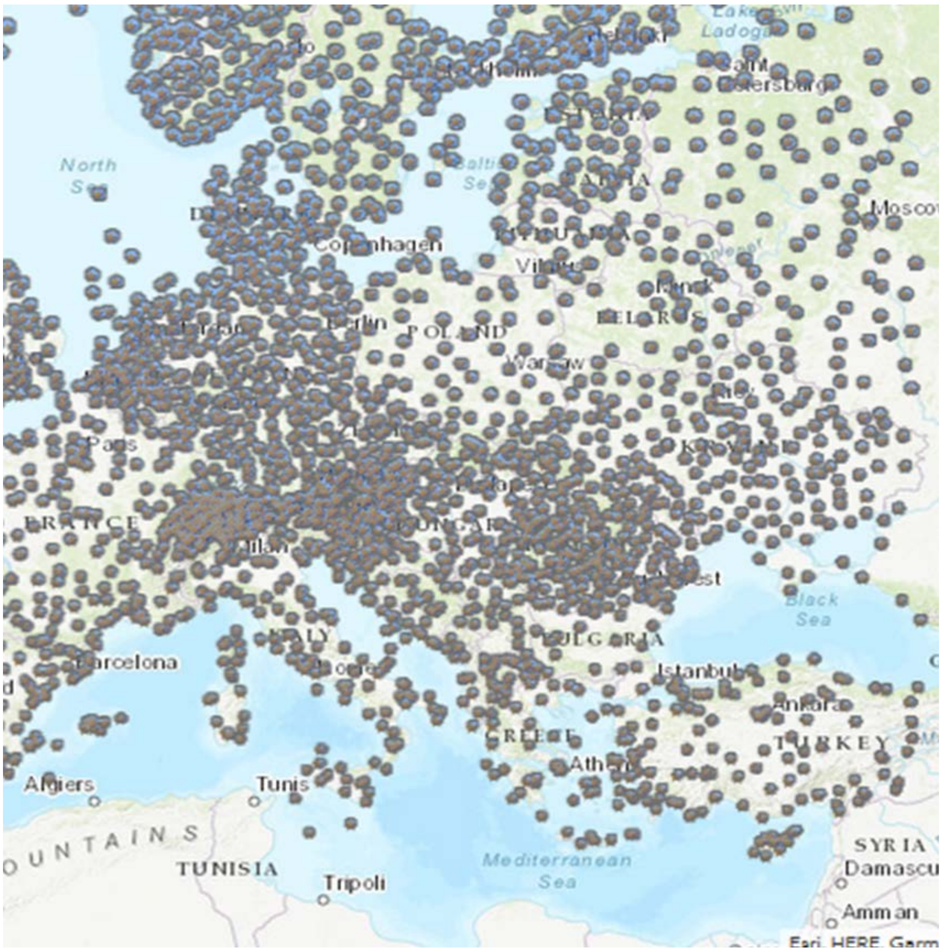

Figure 1. 20 km horizontal spacing – SR-NWP minimum requirement for temperature and humidity (EUMETNET)

The Figure 1 shows that spatial requirements for temperature and humidity are met only in Austria and Switzerland. In the project region, Slovenia and Romania operate fairly dense monitoring network, while the other partners have various gaps, especially in the mountains.

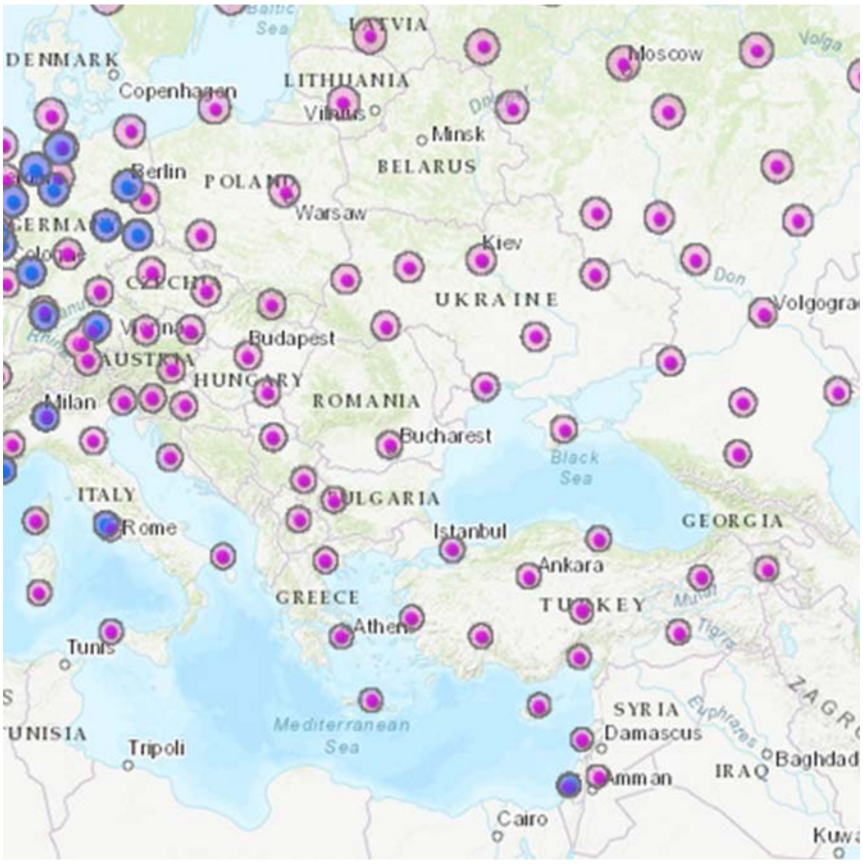

Figure 2. Temperature profile at 100 km spacing every 3-6 hours (blue – AMDAR airports) and every 12-24 hours (pink – radiosonde stations); AMDAR: Aircraft Meteorological Data Relay

The Figure 2 demonstrates the availability of temperature profile data.

Measurement of the total ozone column is carried out at four stations (Budapest, Thessaloniki, Athens and Ankara) by a Brewer spectrophotometer, while it is done via a Dobson spectrophotometer in Bucharest, and Ukraine operates likewise with a Dobson in Antarctica.

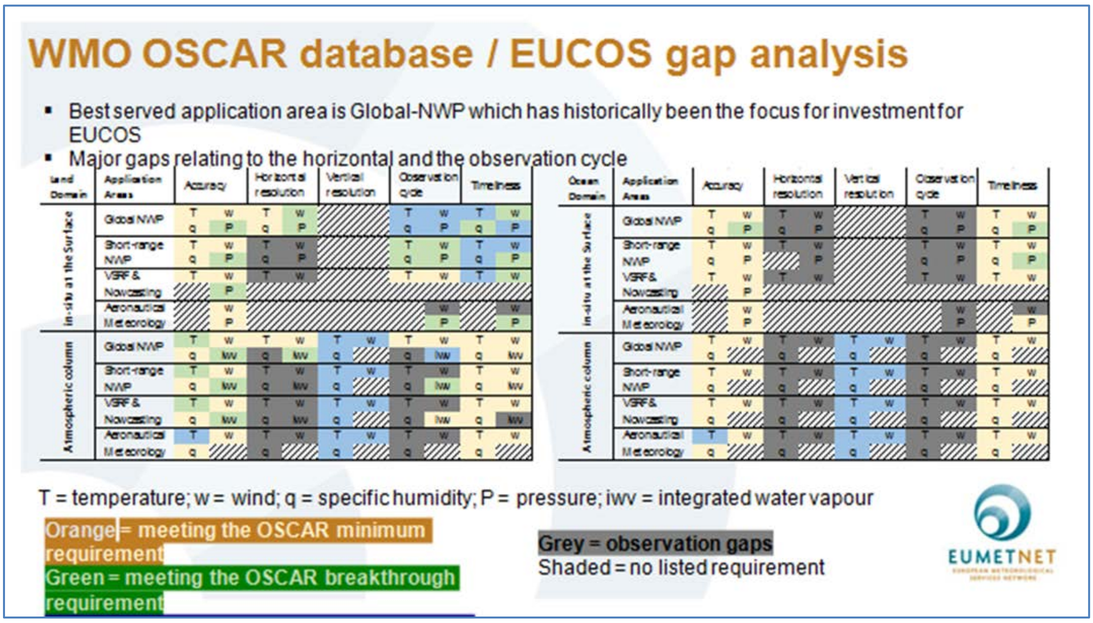

Figure 3. EUCOS Gap Analysis: Capability vs Requirements

The summary table of Figure 3 indicates that horizontal resolution over both land and ocean domains faces observational gaps in EUCOS area. Monitoring networks of NMHSs in the project region has bigger gaps. Therefore, the overall aimed goal "**generally, more surface observation everywhere!"** becomes more clearly defined as follows:

- Increase the efforts to significantly improve the provision of profile observations of humidity, wind and temperature, in terms of horizontal and temporal resolution;
- Increase the horizontal spacing and timely availability of near-surface basic atmospheric parameters (i.e. temperature, humidity and wind) as well as snow, solid moisture, wind gust, visibility, precipitation type.

4. Integrated Nowcasting Comprehensive Analysis (INCA)

In alignment with the contract concluded between Zentralanstalt für Meteorologie und Geodynamik (ZAMG) and the World Bank and within the framework of the SEE-MHEWS-A project, ZAMG is going to support participating National Meteorological and Hydrological Services (NMHSs) of the Balkans "in fulfilling their core function of providing timely and accurate warnings of hazardous weather events in order to reduce the loss of lives and other impacts on people, infrastructure and industry."

Over the past 15 years, the Austrian Met Service ZAMG has gained wide experience in the operation and application of its real-time INCA multi-parameter analysis and nowcasting system. It is making use of various input data such as ground observations, radar, satellite data and NWP background information in order to produce gridded analysis and nowcasting fields of precipitation, precipitation type, temperature, humidity, wind, cloudiness, snowfall line and many other meteorological quantities.

INCA nowcast fields are extrapolation based and may be blended into NWP forecasts, thus providing a seamless chain of forecast products from time zero up to a few days ahead. INCA output may also be used as input for applications in other fields, such as in hydrological runoff modelling or debris flow modelling.

INCA is very fast, i.e. it can produce output fields within a few minutes after the observations have been received. Therefore, INCA provides useful information at a very early stage when NWP information is not yet available. However, as INCA is an observation-based system, the quality of the resulting products is heavily depending on the timely availability and quality of the input data.

The following information is intended to give some technical specifications of the INCA system for its application in SEE-MHEWS-A.

Standard domain and spatial resolution

- The INCA domain and projection can be chosen freely according to user needs. The domain should include the selected catchment areas and their vicinity to allow monitoring of advective processes.
- A typical resolution is 1 x 1 km in the horizontal and 200 m in the vertical.

Temporal resolution and nowcast/forecast range

- A typical update frequency and forecast time step for temperature, humidity, wind, etc. is 1 hour; for precipitation, it is usually set to 5 min, 10 min or 15 min

- The nowcast range is typically set to 1-4 hours for precipitation and 6-12 hours for other parameters
- After the nowcasting range, the fields are blended into NWP forecasts with a forecast range of up to 48 hours.

Station data input

- Observations should be provided as CSV files containing the following columns: StationId (int); Longitude (decimal degrees, real); Latitude (decimal degrees, real); Station altitude (masl, real); VALUE_1 (real), VALUE_2 (real); ...; VALUE_N (real)
- Precipitation data should be provided in millimetres per time, e.g. mm/15 min or mm/5min.
- Time resolution of the data should ideally be 5 min, 10 min or 15 min, and it should be available not later than 5 min after the observations have been made. However, INCA can work with 1 hourly data, too.

Radar data

- Radar data should be available in the same temporal resolution as the rain gauge data (e.g. every 15 min, with a delay no longer than 5 min), and it should come in the same unit as the rain gauge data, e.g. mm/15 min.
- The radar data should cover the entire domain.
- Radar resolution is arbitrary, 1 km or below is advised.
- Radar format should be hdf5.

NWP data

- ZAMG has access to ECMWF data as background fields for INCA.
- Any other NWP fields need to be provided in grb2 or netcdf format.

Other input data

- Lightning information, if available, may be used for data quality control issues, but it is not required for precipitation analysis.
- The topography is provided by ZAMG; it is needed for elevation effects on various meteorological parameters.
- Sunshine duration and satellite data (HSAF cloud types) might be needed for cloudiness analysis.
- Historical observation data of all kinds might be required for testing purposes.

Output data

- INCA is producing the following output fields
  - Analysis fields in grb2 format
  - Nowcast fields in grb2 format covering the specified nowcasting range
  - Forecast fields in grb2 format covering the specified forecasting range.

5. Results

5.1. Survey of the meteorological monitoring capabilities of the region

The Hungarian Meteorological Service (OMSZ) undertook an active role in meteorological data management of the project.

As a first step, OMSZ aimed to assess the status of the existing meteorological observational networks of the participating countries. Therefore, metadata accessible in publicly available official databases, such as OSCAR/Surface, WMO radar database and European Snow Booklet were collected including mainly metadata of AWSs, weather radars, radiosonde stations and snow depth measuring sites. Metadata set referring to each country was attached to the message sent to a contact person in the participating countries with the request to check the data set, to complete that, especially because OSCAR is not fully complete yet.

Additional relevant questions were asked:

- How many online measuring points – concerning temperature, precipitation and surface wind – can you deploy in the project?
- How many of them are capable to send data at 10 minutes and 1-hour intervals?
- What calibration practice do you apply?
- What data quality management do you apply?
- Where do you think your observation network needs improvement or enlargement?

OMSZ asked for the answers and the revised metadata files by not later than 8th January 2020. By the deadline, only half of the parties had sent their contribution. Then a reminder was sent again and by February, 15 organizations had sent certain information. Jordan provided information in June. Only Bulgaria and Turkey have yet to provide an answer.

5.2. Albania

Mr Klodian Zaimi (Polytechnic University of Tirana, Institute of GeoSciences Energy Water and Environment – IGEWE, Department of Water Economy and Renewable Energy) provided information for Albania.

The Republic of Albania is a country in South-East Europe on the Adriatic and the Ionian Sea. Its total area is 28 748 km^2, 4.7% of which is water surface. The population is around 2.9 million.

There is no operational radiosonde station in Albania. An X-band mini meteorological radar (MMR-50) was installed at the coast near Durres in 2015. Currently this radar is out of order and needs maintenance. One lightning detection sensor is in operation in Tirana.

There is no information on stations delivering snow depth data manually or automatically in the country. OSCAR/Surface contained 10 meteorological stations from Albania last autumn. However, there are 24 stations operating with observers from the Military Service, from which 13 locations send data in the GTS. They measure the parameters hourly. The automatic network measures at every 10 to 15 minutes and transfers data every 2 hours but 20 stations can be reconfigurable in one hour.

The meteorological station network operated by IGEWE consists of 273 manual stations and 28 automatic stations (4 are agrometeorological stations). Observations at the manual stations are carried out by local observers, on regular time intervals depending on the station type, and sent to

IGEWE headquarters to be collected in the archive. Some of the automatic stations are located at the same site as the manual stations.

The automatic stations were procured with the support of World Bank and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Currently the instruments of the automatic weather stations are not regularly maintained and calibrated. The quality of the observations especially from the automatic stations is very low due to lack of adequate maintenance of the station network resulting from lack of qualified personnel and regular funds for network operation and maintenance budget. Majority of the automatic stations have severe problems with functioning of the instrument, and therefore not producing reliable data. Furthermore, there are issues with some station locations (not according to the relevant standards) or infrastructure (for example not adequately protected from vandalism or safe to access). Some of the manual stations also have a lack of functional equipment.

Regular calibration or maintenance of the instruments is not carried out. Field calibration kit is available, which was donated to Albania and North Macedonia by the EU. Regular data quality control is not in place, apart some automatic procedures that are being done in the data management system. These can filter some of the problems. There is no staff available for quality control. Albania faces maintenance problem with all types of equipment. Also, many areas mainly above 800 meters are not covered by in-situ measurements.

Table 2. Metadata of the 24 weather stations available in Albania

Metadata of the 24 weather stations available in Albania					
No.	Station code	Station Name	Altitude	Longitude	Latitude
1	H17AWB02	Shengjin	10	19,586865	41,807364
2	H18AWB07	Durres	10	19,452575	41,30254167
3	H19AWB11	Vlore	10	19,48103889	40,45014722
4	H20AWB13	Sarande	10	20,00348333	39,87051944
5	M01AWB01	Shupenze	480	20,424789	41,535682
6	M02AWB01	Fushe Lure	1040	20,225843	41,805934
7	M03AWB01	Kukes A	354	20,67527778	42,07444444
8	M04AWB01	Bajram Curri	360	20,102303	42,357732
9	M05AWB01	Boge	1000	19,656339	42,40186
10	M06AWB01	Rapsh	600	19,50083333	42,575
11	M07AWB01	Shkoder	30	19,488407	42,051152
12	M08AWB03	Shenkoll	6	19,647977	41,689577
13	M09AWB03	Burrel	309	20,004171	41,605854

14	M10AWB07	Tirana Airport	89	19,713774	41,420701
15	M11AWB09	Perrenjas	590	20,568277	41,071571
16	M12AWB11	Brataj	270	19,668311	40,270646
17	M13AWB10	Corovode	410	19,685559	40,954239
18	M14AWB11	Leskovik	920	20,597501	40,152059
19	M15AWB11	Gjirokaster	193	20,147351	40,087329
20	M16AWB11	Tepelene	220	20,022752	40,295255
21	M17AWB01	Puke	810	19,896398	42,050958
22	M18AWB10	Korca	899	20,766724	40,619793
23	M19AWB10	Lushnje	100	19,668311	40,270646
24	M20AWB09	Elbasan	20	20,063685	41,095962

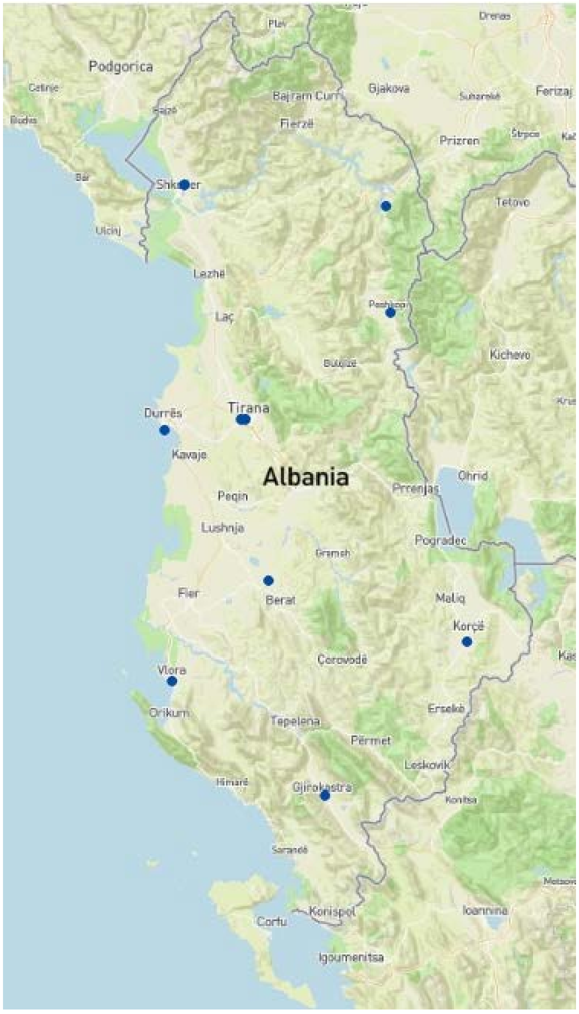

Figure 4. Land surface stations in Albania registered in OSCAR

5.3. Bosnia and Herzegovina

Bosnia and Herzegovina is located in South-East Europe, with total area is 51 129 km^2, 1.4% of which is water surface. The population is around 3.5 million.

The country is largely decentralized and comprises two autonomous entities:

- Federation of Bosnia and Herzegovina
- Republika Srpska

Both entities have their own meteorological and hydrological services. Some fields (other than meteorology) are managed on the state level (e.g. foreign affairs, military, security) but meteorology is organized at entity level. Thus, there is no meteorological or hydrological service on the state level.

5.3.1. Federation of Bosnia and Herzegovina

Mr. Kemal Sehbajraktarevic, Coordinator of Meteorological Network and Ms. Esena Kupusović, Assistant Director of Hydrology, provided information for Federation of Bosnia and Herzegovina. The Federal Hydrometeorological Institute (FHMI) is the focal point for the international exchange of data, so the data from Republika Srpska also go through FHMI into international exchange. Even if there is also internal data exchange of the stations, which do not go to the international exchange, monitoring remains on the entity level.

Banja Luka is the only station sending data to the international exchange from RS. There is neither any weather radar nor radiosonde station in the Federation of Bosnia and Herzegovina at present. There are 14 stations delivering snow depth data manually and no automatic snow measuring station in the country. FHMI has a small portable field calibration kit for on-site inspection of the three main parameters (air temperature, pressure and relative humidity). There is no real calibration process involved.

FHMI applies several level-based quality control processes, but they differ at different type of stations (e.g. SYNOP (surface synoptic observations) stations have automatic Quality Control (QC) on-site during sending the SYNOP message). Another level is human control at the end of the month, and the last one is (again) automatic QC in Database (DB) after import.

Federal Hydrometeorological Institute has only a network of synoptic and rainfall stations. All main synoptic stations already send their SYNOP reports into international exchange every hour during the working hours of each particular station.

Furthermore, FHMI has recently installed 11 Automatic Weather Stations (AWS) but only two stations send ordinary SYNOP. Others do not send SYNOP report, only measured parameters in *csv* or *xml* format (different manufacturer and each of them has its own *csv*). Some of these stations send their data hourly and others every 10 minutes. Some stations send all measured parameters in one *csv* file and other sends data from each sensor in separate file.

Table 3. Metadata of surface stations in Bosnia and Herzegovina registered in OSCAR

Metadata of surface stations in Bosnia and Herzegovina registered in OSCAR					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation
BANJA LUKA	1892-01-01	0-20000-0-14542|	44.7833333	17.2166666	153

BIHAC	1892-01-01	0-20000-0-14528|	44.807677	15.866654	244
BJELASNICA	1895-03-01	0-20000-0-14652|	43.703868	18.256973	2067
BUGOJNO	1951.01.01	0-20000-0-14544|	44.062084	17.45146	562
CEMERNO	1963.01.01	0-20000-0-14656|	43.2333333	18.6	1305
GRADACAC	1951.01.01	0-20000-0-14554|	44.85914	18.441813	225
IVAN SEDLO	1951.01.01	0-20000-0-14650|	43.751157	18.036256	970
JAJCE	1951.01.01	0-20000-0-14543|	44.343313	17.268016	421
LIVNO	1893-01-01	0-20000-0-14640|	43.822593	17.001041	722
MOSTAR	1894-01-01	0-20000-0-14648|	43.348129	17.793929	97
NEUM	2007.03.01	0-20000-0-14657|	42.927341	17.60881	10
SANSKI MOST	1951.01.01	0-20000-0-14537|	44.77095	16.676019	156
SARAJEVO-BJEL.	1895-03-01	0-20000-0-14654|	43.867791	18.42282	632
TUZLA	1910.01.01	0-20000-0-14557|	44.542016	18.68509	300
ZENICA	1951.01.01	0-20000-0-14549|	44.201983	17.900328	341

Table 4. Metadata of 11 meteorological/precipitation stations in Vrbas River basin that can send precipitation and temperature data hourly

Metadata of 11 meteorological/precipitation stations in Vrbas River basin that can send precipitation and temperature data hourly. Automatic stations are in bold.					
No.	Station	Catchment	Latitude	Longitude	Altitude
1	Gornji Vakuf	Vrbas	43. §937041		667
2	Divicani	Vrbas	44.362662	17.327946	537
3	Gracanica	Vrbas	44.002211	17.495454	600
4	Pidris	Vrbas	43.892423	17.583991	962
5	Voljice Gaj	Vrbas	43.918704	17.534243	706
6	Rovna	Vrbas	44.097676	17.490071	821
7	Kupres	Vrbas	43.990000	17.276000	0
8	Seherdzik	Vrbas	44.208407	17.418518	642
9	Borova Ravan	Vrbas	43.856088	17.68312	1020

10	Dobrosin	Vrbas	43.896907	17.635603	739
11	Rat	Vrbas	44.044085	17.687057	1053
12	Bugojno	Vrbas	44.062222	17.451389	562
13	Jajce	Vrbas	44.350000	17.266667	428

Table 5. Metadata of the 50 weather stations available the project

Metadata of the 50 weather stations available					
Name	Station Type	Schedule	Latitude	Longitude	Elevation
BANJA LUKA	SYNOP	Hourly	44.783333	17.216667	153
BIHAC	SYNOP	Hourly	44.807677	15.866654	244
BJELASNICA	SYNOP	Hourly	43.703868	18.256973	2067
BUGOJNO	SYNOP	Hourly	44.062084	17.451460	562
CEMERNO	SYNOP	Hourly	43.233333	18.600000	1305
GRADACAC	SYNOP	Hourly	44.859140	18.441813	225
IVAN SEDLO	SYNOP	Hourly	43.751157	18.036256	970
JAJCE	SYNOP	Hourly	44.343313	17.268016	421
LIVNO	SYNOP	Hourly	43.822593	17.001041	722
MOSTAR	SYNOP	Hourly	43.348129	17.793929	97
NEUM	SYNOP	Hourly	42.927341	17.608810	10
SANSKI MOST	SYNOP	Hourly	44.770950	16.676019	156
SARAJEVO-BJEL.	SYNOP	Hourly	43.867791	18.422820	632
TUZLA	SYNOP	Hourly	44.542016	18.685090	300
ZENICA	SYNOP	Hourly	44.201983	17.900328	341
MAGLAJ	AWS	10 min	44.550751	18.093814	174
GRAČANICA	AWS	10 min	44.705322	18.315676	259
ŽEPČE	AWS	10 min	44.422244°	18.014205°	232
KAKANJ	AWS	10 min	44.128958°	18.123705°	449
TRAVNIK	AWS	10 min	44.229908°	17.655091°	536
KISELJAK	AWS	10 min	43.946148	18.076195	472

BABIN DO	RS	10 min	43.715441	18.284635	1267
MOŠĆANICA	RS	10 min	43.883759	18.479908	838
SREDNJE	RS	10 min	44.005633	18.440225	698
VAREŠ	RS	10 min	44.163921	18.329670	851
VLAŠIĆ	RS	10 min	44.312117	17.572144	1259
VISOKO	RS	10 min	43.995275°	18.173318°	424
TEŠANJ	RS	10 min	44.605463°	17.989024°	280
SNIJEŽNICA	RS	10 min	44.593933°	18.955731°	298
BIJELA VODA	RS	10 min	43.727750°	18.917511°	621
USTIKOLINA	RS	10 min	43.580886°	18.799797°	392
SAPNA	RS	10 min	44.509140°	19.016484°	316
KLADANJ	AWS	10 min	44.231031°	8.699573°	555
GORAŽDE	AMS	10 min	43.661332°	18.979018°	364
GORNJI KAMEN.	RS	10 min	44.797819°	16.542219°	246
RIPAČ	RS	10 min	44.764555°	15.956822°	242
SANICA	RS	10 min	44.614903°	16.642483°	206
ŠIROKI BRIJEG	AWS	10 min	43.389298°	17.591575°	280
VOLJICE-GAJ	RS	10 min	43.918704°	17.534243°	706
GRAČANICA	RS	10 min	44.002211°	17.495454°	600
DIVIČANI	RS	10 min	44.362662°	17.327946°	537
RAT	RS	10 min	44.044085°	17.687057°	1053
PIDRIŠ	RS	10 min	43.892423°	17.583991°	962
ROVNA	RS	10 min	44.097676°	17.490071°	821
KUPRES	RS	10 min	43.989599°	17.276221°	1174
ŠEHERDŽIK	RS	10 min	44.208407°	17.418518°	642
BOROVA RAVAN	RS	10 min	43.856088°	17.683120°	571
DOBROŠIN	RS	10 min	43.896907°	17.635603°	739
GORNJI VAKUF	AWS	10 min	43.937041°	17.580115°	667

BUTMIR	AMS	10 min	43.825311°	18.316343°	502
SYNOP –fixed land station with observers					
AWS – Automatic Weather Stations					
RS – rainfall stations (automatic)					
AMS – agrometeorological stations (automatic)					

SYNOP stations measure the following variables: pressure, temperature, humidity, wind speed and direction, precipitation, sun duration, snow height, visibility, clouds (amount, type, base height). AWS stations measure pressure, temperature, humidity, wind speed and direction, precipitation, sunshine duration. AMS station measures pressure, temperature, humidity, wind speed and direction, precipitation, global solar radiation, visibility, precipitation type, snow depth, soil temperature, soil moisture. RS stations measure precipitation, temperature, humidity.

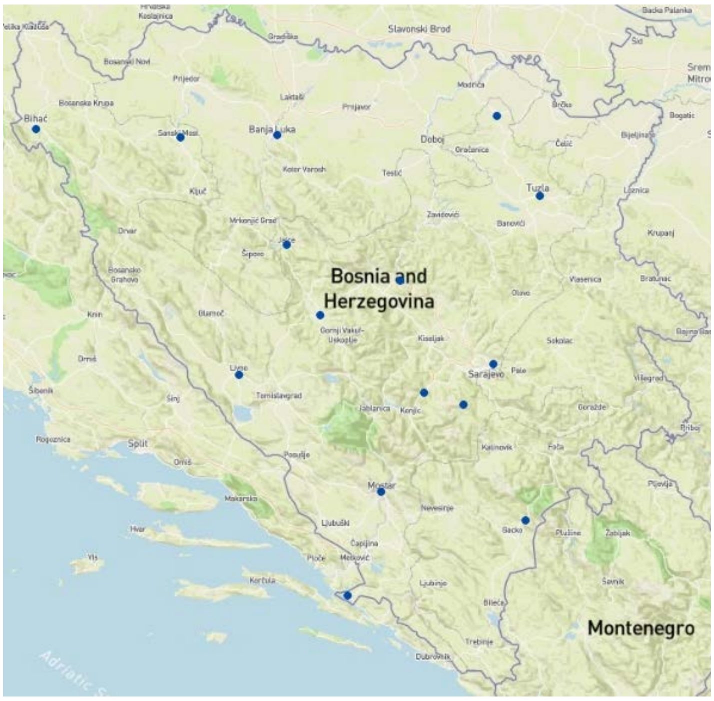

Figure 5. Land surface stations in BiH registered in OSCAR

5.3.2. Republika Srpska (RS)

Mr Igor Kovačić, Assistant Director for Meteorology (Republic Hydrometeorological Service of Republika Srpska, Banja Luka) provided information for the Republika Srpska (RS).

Banja Luka is the only station sending data to the international exchange from RS. There is a hail-suppression agency in RS, which operates radars.

Table 6. Metadata of AWSs operated by RHMS RS

Metadata of AWSs operated by RHMS RS				
Station number	Name of station	Latitude	Longitude	Elevation

31115	Sipovo	44.28419	17.08773	454 m
41115	Majevac	44.24021	17.02607	468 m
51115	Banja Luka	44.79375	17.20577	152 m
71115	Mrkonjic Grad	44.41111	17.08359	569 m
91115	Manjaca	44.66326	17.00554	543 m
101115	Krupa na Vrbasu	44.61528	17.14425	208 m
111115	Srbac	45.10268	17.51449	89 m
131115	Celinac	44.73379	17.34716	293 m
141115	Borojevici	44.52427	17.3182	737 m
151115	Kotor Varos	44.60949	17.38862	268 m
161115	PMF	44.77907	17.19902	160 m

Table 7. Metadata of SYNOP stations operated by RHMS RS

Metadata of SYNOP stations operated by RHMS RS				
Station number	Name of station	Decimal		
		latitude	longitude	elevation
14535	Novi Grad	45.05042	16.37733	122 m
14536	Prijedor	44.97193	16.71257	133 m
14545	Mrkonjic Grad	44.41113	17.08355	570 m
14551	Doboj	44.72629	18.08904	143 m
14562	Bijeljina	44.75361	19.19267	90 m
14564	Srebrenica	44.09303	19.30301	434 m
14655	Gacko	43.16459	18.50949	939 m
14658	Sokolac	43.92246	18.78007	898 m
14667	Bileca	42.86743	18.42132	438 m

5.4. Bulgaria

National Institute of Meteorology and Hydrology did not provide information for this assessment, so the monitoring network described below reflected by metadata kept in publicly available databases.

The Republic of Bulgaria is located in the South-East Europe at the Black Sea. Its total area is 110 994 km^2, 2.16% of which is water surface. The population is around 7 million.

There is one operational radiosonde station in the country in Sofia. There were three radars in Bulgaria in 2010. Today there are two operational C-band weather radars, in Sofia and Varna. There are 15 stations delivering snow depth data manually and 2 automatic snow measuring stations in the country.

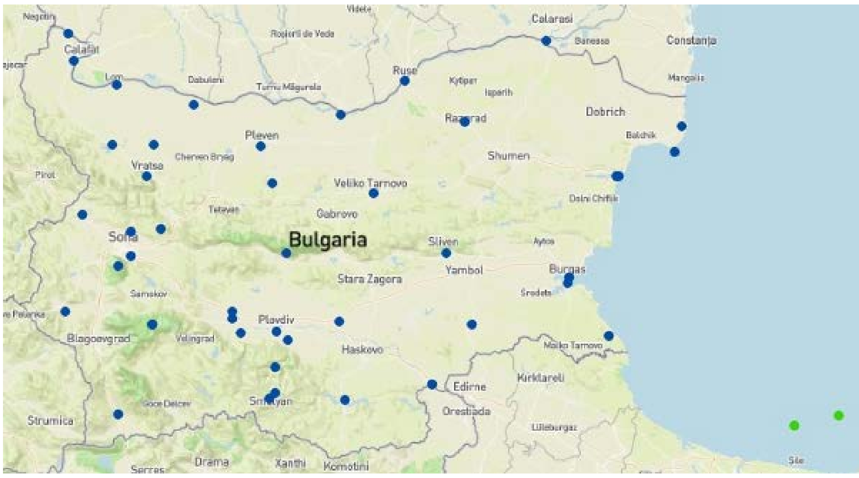

Figure 6. Land surface stations (and two underwater mobile stations – green) in Bulgaria registered in OSCAR

Table 8. Metadata of land surface stations in Bulgaria registered in OSCAR

Metadata of land surface stations in Bulgaria registered in OSCAR					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation
ACHTOPOL	1977.01.01	0-20000-0-15661|	42.1	27.85	18
BEO Moussala	1999.09.30	0-20008-0-BEO|	42.1791992188	23.5855998993	2925
BOTEV VRAH (TOP/SOM.)	1946.01.01	0-20000-0-15627|	42.6666666667	24.8333333333	2384
BURGAS	1951.01.01	0-20000-0-15655|	42.5	27.4833333333	27
CHERNI VRAH (TOP/SOMM.)	1936.01.01	0-20000-0-15613|	42.5833333333	23.2666666667	2286
CHIRPAN	1960.01.01	0-20000-0-15635|	42.2	25.3333333333	173
DRAGOMAN	1977.01.01	0-20000-0-15605|	42.9333333333	22.9333333333	714
ELHOVO	1960.01.01	0-20000-0-15642|	42.1833333333	26.5666666667	138
IVAILO	1977.01.01	0-20000-0-15628|	42.2166666667	24.3333333333	213

KALIAKPA	1977.01.01	0-20000-0-15562|	43.3666666667	28.4666666667	63
KURDJALI	1966.01.01	0-20000-0-15730|	41.65	25.3833333333	330
KUSTENDIL	1960.01.01	0-20000-0-15601|	42.2666666667	22.7666666667	522
LOM	1961.01.01	0-20000-0-15511|	43.8166666667	23.25	32
LOVETCH	1977.01.01	0-20000-0-15525|	43.15	24.7	220
MONTANA (15507-0)	MONTANA (15507-0)	0-20000-0-15507|	43.4166666667	23.2166666667	202
MOURGASH	1977.01.01	0-20000-0-15600|	42.8333333333	23.6666666667	1687
MUSSALA (TOP/SOMMET)	2016.04.28	0-20000-0-15615|	42.1833333333	23.5833333333	2925
NOVO SELO	1962.01.01	0-20000-0-15501|	44.1666666667	22.8	36
ORYAHOVO	1966.01.01	0-20000-0-15514|	43.6833333333	23.9666666667	29
PLEVEN	1951.01.01	0-20000-0-15528|	43.4	24.6	156
PLOVDIV	1951.01.01	0-20000-0-15626|	42.0666666667	24.85	154
PLOVDIV-KRUMOVO	1951.01.01	0-20000-0-15625|	42.1333333333	24.75	179
RADAR Gelemenovo, Mrl - 5			42.2711111111	24.3261111111	250
RAZGRAD	1980.01.01	0-20000-0-15549|	43.5666666667	26.05	346
ROJEN	2001.01.01	0-20000-0-15726|	41.8833333333	24.7333333333	1754
ROUSSE	1960.01.01	0-20000-0-15535|	43.85	25.95	37
Rojen Peak	2003.01.01	0-20008-0-RJP|	41.7000007629	24.7333335876	1750
SANDANSKI	1960.01.01	0-20000-0-15712|	41.55	23.2666666667	203
SHABLA	1977.01.01	0-20000-0-15561|	43.5333333	28.5333333	27

			333	333	
SILISTRA	1960.01.01	0-20000-0-15550|	44.1166666 667	27.2666666 667	16
SLIVEN *	1889-01-01	0-20000-0-15640|	42.6666666 667	26.3333333 333	257
SNEJANKA (TOP/SOMMET)	1960.01.01	0-20000-0-15725|	41.6666666 667	24.6833333 333	1923
SOFIA (OBSERV.)		0-20000-0-15614|	42.65	23.3833333 333	595
SVICHTOV	1960.01.01	0-20000-0-15533|	43.6166666 667	25.35	24
SVILENGRAD	1960.01.01	0-20000-0-15741|	41.7666666 667	26.02	54
Sofia	1981.10.01	0-20008-0-SOF|	42.8166656 494	23.3833293 915	588
VARNA	1960.01.01	0-20000-0-15552|	43.2	27.95	40
VELIKO TARNOVO	1977.01.01	0-20000-0-15530|	43.0833333 333	25.65	217
VIDIN	1991.01.01	0-20000-0-15502|	43.9833333 333	22.85	31
VRATZA	1951.01.01	0-20000-0-15505|	43.2	23.5333333 333	308
Varna	1981.10.01	0-20008-0-VRN|	43.2000007 629	27.9166660 309	41

5.5. Croatia

Ms. Ines Srzić, Head of Department (Croatian Meteorological and Hydrological Service, Weather and Climate Monitoring Sector, Meteorological Observation Department) provided information to the project on the meteorological monitoring network of Croatia.

Republic of Croatia is located in South-East Europe. Its total area is 56 594 km^2, 1.09% of which is water surface. The population is around 4 million.

There are 2 operational radiosonde stations in Croatia: one in Zagreb and another one in Zadar. There are 247 stations delivering snow depth data manually and no automatic snow measuring station in the country.

Ms Ines Srzić communicated that Croatia could send those observational data for the SEE-MHEWS-A project, which are already sent in international exchange. Those stations are reflected properly in the metadata sets listed in Table 10.

No responses were received for the questions related to calibration practice, data quality management and observation network improvement.

Figure 7. Land surface stations in Croatia registered in OSCAR

Table 9. Weather radars in Croatia according to WMO radar database

Weather radars in Croatia according to WMO radar database						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Croatia	Bilogora	Active	Magnetron	Single	S
2	Croatia	Osijek	Active	Magnetron	Single	S
3	Croatia	Puntijarka	Active	-	Single	S

Table 10. Metadata of land fixed stations operated by DHMZ in Croatia

Metadata of land fixed stations operated by DHMZ in Croatia					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation
BILOGORA	1994.01.01	0-20000-0-14256	45.883611111	17.200277777	262
BJELOVAR	1994.01.01	0-20000-0-14253|	45.909722222	16.869444444	141
Bilogora	1996.01.01	0-20008-0-BGO|	45.883335113	17.200000762	262
DARUVAR	1963.01.01	0-20000-0-14258|	45.59138888	17.21	153

			8		
DUBROVNIK/CILIPI	1963.02.01	0-20000-0-14474|	42.562777777	18.27	157
DUBROVNIK/GORICA		0-20000-0-14472	42.644722222	18.085	52
GOSPIC	1982.01.01	0-20000-0-14330|	44.550555555	15.373055555	564
GRADISTE	1994.01.01	0-20000-0-14382|	45.159166666	18.703611111	97
HVAR	1982.01.01	0-20000-0-14447|	43.171111111	16.436944444	20
KARLOVAC	1993.01.01	0-20000-0-14232|	45.493611111	15.565	110
KNIN	1983.01.01	0-20000-0-14442|	44.040833333	16.206944444	255
KOMIZA	1994.01.01	0-20000-0-14441|	43.048333333	16.085277777	20
KRAPINA	1995.01.01	0-20000-0-14234|	46.137777777	15.888333333	202
KRIZEVCI	1998.01.01	0-20000-0-14248|	46.028888888	16.553611111	157
LASTOVO	1983.01.01	0-20000-0-14452|	42.768333333	16.9	186
MAKARSKA	1994.01.01	0-20000-0-14454|	43.2875	17.019722222	49
MALI LOSINJ	1963.01.01	0-20000-0-14314|	44.5325	14.471944444	53
OGULIN	1963.01.01	0-20000-0-14328|	45.262777777	15.222222222	328
OSIJEK-CEPIN	2003.01.01	0-20000-0-14280|	45.5025	18.561388888	89
OSIJEK/KLISA	OSIJEK/KLISA	0-20000-0-14284|	45.467777777	18.806388888	89
PALAGRUZA	1993.01.01	0-20000-0-14443|	42.392222222	16.243055555	97
PARG	1994.01.01	0-20000-0-14219|	45.593611111	14.630555555	863

PAZIN	1990.01.01	0-20000-0-14308|	45.240833333	13.945277777	291
PLOCE	1994.01.01	0-20000-0-14462|	43.0475	17.442777777	2
PULA AERODROME		0-20000-0-14307|	44.896388888	13.931944444	63
PUNTIJARKA	PUNTIJARKA	0-20000-0-14235|	45.9075	15.968333333	991
Puntijarka	1978.01.01	0-20008-0-PUJ|	45.916667938	15.966666221	988
RAB	1994.01.01	0-20000-0-14321|	44.755555555	14.769444444	24
RADAR Osijek			45.502777777	18.561388888	88
RIJEKA/KOZALA		0-20000-0-14216|	45.336944444	14.442777777	120
RIJEKA/OMISALJ		0-20000-0-14317|	45.223888888	14.581944444	85
SENJ	1982.01.01	0-20000-0-14323|	44.9925	14.903333333	26
SIBENIK	1963.01.01	0-20000-0-14438|	43.728055555	15.906388888	77
SISAK	1994.01.01	0-20000-0-14244|	45.499722222	16.366666666	98
SLAVONSKI BROD	1952.01.01	0-20000-0-14370|	45.159166666	17.995277777	88
SPLIT/MARJAN		0-20000-0-14445|	43.508333333	16.426388888	122
SPLIT/RESNIK		0-20000-0-14444|	43.539444444	16.301111111	19
VARAZDIN	1963.01.01	0-20000-0-14246|	46.282777777	16.363888888	167
ZADAR RS	2003.01.01	0-20000-0-14430|	44.096944444	15.340277777	78
ZADAR/PUNTAMIKA		0-20000-0-14428|	44.13	15.205833333	5
ZADAR/ZEMUNIK		0-20000-0-14431|	44.09694444	15.3627777	82

			4	77	
ZAGREB/GRIC	1861-01-01	0-20000-0-14236|	45.81444444 4	15.9719444 44	157
ZAGREB/MAKSIMIR		0-20000-0-14240|	45.82194444 4	16.0336111 11	123
ZAGREB/PLESO		0-20000-0-14241|	45.72916666 6	16.0538888 88	107
ZAVIZAN	1974.01.01	0-20000-0-14324|	44.81472222 2	14.9752777 77	1594
Zavizan	1978.01.01	0-20008-0-ZAV|	44.81666564 9	14.9833335 876	1594

5.6. Cyprus

Dr Kleanthis Nicolaides, Director of the Department of Meteorology, provided information on monitoring network in Cyprus.

The Republic of Cyprus is an island country in the Eastern Mediterranean. Its total area is 9251 km^2, only negligible percentage of which is water surface. The population is around 1.2 million.

There is one operational radiosonde station in the country, in the centre of the island at 17607 Athalassa station. They launch a radiosonde at 06.00 and 12.00 every day. It is planned to perform ascents at 00.00 and 12.00 as well.

Since it can only snow in the Troodos Mountains in the central part of the island during winter, there is only 1 station delivering snow depth data manually and 1 automatic snow measuring station in Cyprus.

There are six fixed land stations sending data in GTS from Cyprus according to OSCAR/Surface.

Table 11. Metadata of fixed land stations in Cyprus registered in OSCAR

Metadata of fixed land stations in Cyprus registered in OSCAR					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Eleva-tion
AKROTIRI	1957.01.01	0-20000-0-17601	34.5927777 8	32.98778	23
ATHALASSA	1983.01.01	0-20000-0-17607	35.1408333 3	33.3963888 8	162
Cyprus Atmospheric Obs.	2015.01.01	0-20008-0-CYP	35.0381	33.0578	520
LARNACA AIRPORT	1984.05.01	0-20000-0-17609	34.8733333 3	33.6172222 2	1.69
PAPHOS AP	1960.01.01	0-20000-0-17600	34.7194444	32.4847222	8.38

			4	2	
RADAR Kykkos			34.98	32.73	1310

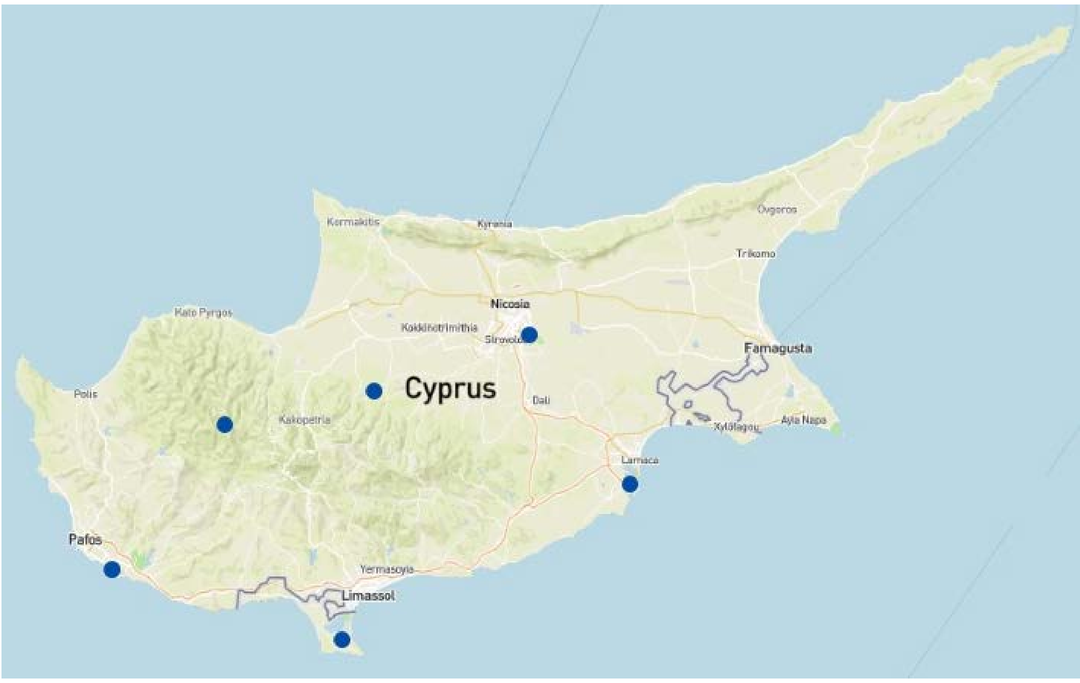

Figure 8. Land surface stations in Cyprus registered in OSCAR

The actual number of online measuring points in Cyprus is much more, than the above six stations: 33 AWSs deliver data on real-time base. In the near future, another one will be operational. A number of stations delivering data on request (download procedure) are planned to be upgraded to real-time AWS gradually 10-minute measurement data are available from these 33 AWSs.

Applying basic data quality control at data-acquisition level, whereby any measurements that happen to lie outside certain limits (these limits are usually provided by the instrument manufacturer), are automatically filtered out. Additional quality control procedures are in force on a daily basis.

As far as instrument calibration, automatic temperature-humidity sensors are checked on average every three months, with visits at the AWS locations. The check is performed using Vaisala probes which are regularly calibrated by Vaisala. Rain gauges are checked as per manufacturer instructions, using funnels with standard flow rates of 50 mm/hr., 75 mm/hr and 100 mm/hr. Department of Meteorology does not possess wind tunnel for checking wind sensors. A basic check of wind measurements is done by comparing wind measurements at 2 m and 10 m.

The radar network consists now of a radar over the western part of the Island and a radar to the south-eastern part. Kykkos Radar was decomposed in 2013.

Table 12. Weather radars in Cyprus according to WMO radar database

Weather radars in Cyprus according to WMO radar database						
No.	Country	Radar Name	Status	TX Type	Polarization	Band

1	Cyprus	Rizoelia, Aradippou	Active	Solid State D	Dual	X
2	Cyprus	Eliovounos	Active	Solid State D		X
3	Cyprus	Kykkos	Removed	Magnetron	Single	C

The observation network requires improvement, especially with respect to its spatial distribution. A maximum of 40 to 50 AWS is the desirable network to cover the local requirements. The feasibility of such enlargement is highly depending on the available resources.

5.7. Greece

Mr Nick Kalamaras (Hellenic National Meteorological Service, HNMS) provided information on the monitoring network in Greece.

The Hellenic Republic is located in South-East Europe at the crossroads of Europe, Asia and Africa, at the southern tip of the Balkan Peninsula. Greece features a vast number of islands; among them Crete is the largest. The total area of the country is 131 957 km^2, 0.87% of which is water surface. Its population is around 10.4 million.

There are three operational radiosonde stations in Greece: Thessaloniki, Athens and Herakleion. The number of stations that measure snow depth manually is 41. These stations are listed in the Table 13.

Table 13. Stations in Greece measuring snow depth manually

Stations in Greece measuring snow depth manually						
No.	Station	LOC IND	WMO CODE	Latitude	Longitude	Elevation
1	ATHENS (HELLINIKON)	LGAT	16716	37 53 23	23 44 31	43.13
2	AKTION (PREVEZA)	LGPZ	16643	38 55 19	20 46 07	1.47
3	ALEXANDROUPOLIS	LGAL	16627	40 51 26	25 56 49	3.52
4	ANDRAVIDA	LGAD	16682	37 55 22	21 17 14	10.1
5	HERAKLEION	LGIR	16754	35 20 07	25 10 55	39
6	THESSALONIKI	LGTS	16622	40 31 39	22 58 18	1.68
7	KARPATHOS	LGKP	16765	35 25 39	27 08 49	10.5
8	KASTORIA	LGKA	16614	40 26 56	21 16 25	654.64
9	KERKIRA	LGKR	16641	39 36 29	19 54 50	1.13
10	KOS	LGKO	16742	36 48 02	27 05 26	126.22
11	LIMNOS	LGLM	16650	39 55 20	25 13 58	4.81
12	MITILINI	LGMT	16667	39 03 15	26 36 14	4.22

13	RODOS	LGRP	16749	36 24 08	28 05 18	6.63
14	SKYROS	LGSY	16684	38 57 46	24 29 27	22
15	SOUDA	LGSA	16746	35 31 44	24 08 43	147.64
16	CHIOS	LGHI	16706	38 20 43	26 08 31	4.69
17	CHRISOUPOLI	LGKV	16624	40 55 13	24 37 13	4.2
18	ARAXOS	LGRX	16687	38 08 57	21 25 20	11.29
19	DEKELEIA (TATOI)	LGTT	16715	38 06 25	23 46 48	236.55
20	DOXATO		16840	41 03 59	24 15 07	86.7
21	ELEFSINA	LGEL	16718	38 04 03	23 33 08	26.54
22	ZAKYNTHOS	LGZA	16719	37 45 05	20 53 15	5.2
23	SANTORINI (THIRA)	LGSR	16744	36 24 08	25 28 25	40.29
24	IOANNINA	LGIO	16642	39 41 42	20 49 10	483.36
25	KALAMATA	LGKL	16726	37 04 09	22 01 21	6.2
26	KASTELI	LGTL	16760	35 11 20	25 19 44	337
27	KEFALLONIA	LGKF	16685	38 07 13	20 30 18	25.2
28	KOZANI	LGKZ	16632	40 17 22	21 50 29	621
29	LARISA	LGLR	16648	39 38 46	22 27 37	71.15
30	NEA ANCHIALOS	LGBL	16665	39 13 28	22 47 36	12.85
31	SAMOS	LGSM	16723	37 41 28	26 54 58	5.93
32	SITIA	LGST	16757	35 12 56	26 06 10	113.65
33	ELEFTHERIOS VENIZELOS	LGAV	16741	37 55 17	23 55 53	72.45
34	TANAGRA	LGTG	16699	38 20 07	23 33 46	138.05
35	TRIPOLI	LGTP	16710	37 31 28	22 23 50	650.57
36	MIKONOS	LGMK	16750	37 26 09	25 20 45	121.6
37	PAROS	LGPA	16766	37 01 20	25 06 54	33.3
38	SKIATHOS	LGSK	16660	39 10 31	23 30 06	2
39	SYROS	LGSO	16774	37 25 16	24 56 53	69.85
40	KONITSA	LGAT	16628	40 02 47	20 44 17	465

41	SERRES	LGPZ	16606	41 04 35	23 31 46	32.05

Figure 9. Land surface stations in Greece registered in OSCAR

The weather station network of HNMS consisted of 110 weather stations in 2017. There were 27 fully manned, 33 semi-automated and 50 automatic stations equipped with Vaisala instruments.

The online measuring points – concerning temperature, precipitation and surface wind – which HNMS can deploy in the project are 62 for temperature and wind and 58 for precipitation. These stations are listed in the Table 14.

Table 14. Automatic weather stations in Greece measuring temperature, wind and precipitation

Automatic weather stations in Greece measuring temperature, wind and precipitation									
No.	Station	LOC IND	WMO CODE	Latitude	Longitude	Elevation	Temperature	Wind	Prec. Amo.
1	ATHENS (HELLINIKON)	LGAT	16716	37 53 23	23 44 31	43.13	YES	YES	YES
2	AKTIO (PREVEZA)	LGPZ	16643	38 55 19	20 46 07	1.47	YES	YES	YES
3	ALEXANDROUPOLIS	LGAL	16627	40 51 26	25 56 49	3.52	YES	YES	YES
4	ANDRAVIDA	LGAD	16682	37 55 22	21 17 14	10.1	YES	YES	YES
5	HERAKLEION	LGIR	16754	35 20 07	25 10 55	39	YES	YES	YES
6	THESSALONIKI	LGTS	16622	40 31 39	22 58 18	1.68	YES	YES	YES
7	KARPATHOS	LGKP	16765	35 25 39	27 08 49	10.5	YES	YES	YES
8	KASTORIA	LGKA	16614	40 26 56	21 16 25	654.64	YES	YES	YES

9	KERKIRA	LGKR	16641	39 36 29	19 54 50	1.13	YES	YES	YES
10	KOS	LGKO	16742	36 48 02	27 05 26	126.22	YES	YES	YES
11	LIMNOS	LGLM	16650	39 55 20	25 13 58	4.81	YES	YES	YES
12	MITILINI	LGMT	16667	39 03 15	26 36 14	4.22	YES	YES	YES
13	RODOS	LGRP	16749	36 24 08	28 05 18	6.63	YES	YES	YES
14	SKYROS	LGSY	16684	38 57 46	24 29 27	22	YES	YES	YES
15	SOUDA	LGSA	16746	35 31 44	24 08 43	147.64	YES	YES	YES
16	CHIOS	LGHI	16706	38 20 43	26 08 31	4.69	YES	YES	YES
17	CHRISOUPOLI	LGKV	16624	40 55 13	24 37 13	4.2	YES	YES	YES
18	ARAXOS	LGRX	16687	38 08 57	21 25 20	11.29	YES	YES	YES
19	DEKELEIA (TATOI)	LGTT	16715	38 06 25	23 46 48	236.55	YES	YES	YES
20	DOXATO		16840	41 03 59	24 15 07	86.7	YES	YES	YES
21	ELEFSINA	LGEL	16718	38 04 03	23 33 08	26.54	YES	YES	YES
22	ZAKYNTHOS	LGZA	16719	37 45 05	20 53 15	5.2	YES	YES	YES
23	SANTORINI (THIRA)	LGSR	16744	36 24 08	25 28 25	40.29	YES	YES	YES
24	IOANNINA	LGIO	16642	39 41 42	20 49 10	483.36	YES	YES	YES
25	KALAMATA	LGKL	16726	37 04 09	22 01 21	6.2	YES	YES	YES
26	KASTELI	LGTL	16760	35 11 20	25 19 44	337	YES	YES	YES
27	KEFALLONIA	LGKF	16685	38 07 13	20 30 18	25.2	YES	YES	YES
28	KOZANI	LGKZ	16632	40 17 22	21 50 29	621	YES	YES	YES
29	LARISA	LGLR	16648	39 38 46	22 27 37	71.15	YES	YES	YES
30	NEA ANCHIALOS	LGBL	16665	39 13 28	22 47 36	12.85	YES	YES	YES
31	SAMOS	LGSM	16723	37 41 28	26 54 58	5.93	YES	YES	YES
32	SITIA	LGST	16757	35 12 56	26 06 10	113.65	YES	YES	YES
33	ELEFTHERIOS VENI.	LGAV	16741	37 55 17	23 55 53	72.45	YES	YES	YES
34	TANAGRA	LGTG	16699	38 20 07	23 33 46	138.05	YES	YES	YES
35	TRIPOLI	LGTP	16710	37 31 28	22 23 50	650.57	YES	YES	YES
36	TYMPAKI	LGTY	16759	35 03 59	24 45 44	6	YES	YES	YES

37	ASTYPALAIA	LGPL	16739	36 34 55	26 22 27	50	YES	YES	YES
38	IKARIA	LGIK	16779	37 40 58	26 20 41	18.4	YES	YES	YES
39	KALIMNOS	LGKY	16833	36 57 53	26 56 21	228.28	YES	YES	YES
40	KASOS	LGKS	16770	35 25 15	26 54 52	9.44	YES	YES	YES
41	KASTELORIZO	LGKJ	16767	36 08 36	29 34 31	151.57	YES	YES	YES
42	KITHIRA (AIRPORT)	LGKC	16843	36 16 30	23 00 53	313.92	YES	YES	
43	LEROS	LGLE	16768	37 10 57	26 48 11	9.21	YES	YES	YES
44	MILOS (AIRPORT)	LGML	16838	36 41 52	24 28 13	3.77	YES	YES	
45	MIKONOS	LGMK	16750	37 26 09	25 20 45	121.6	YES	YES	YES
46	NAXOS (AIRPORT)	LGNX	16832	37 04 50	25 22 10	3	YES	YES	
47	PAROS	LGPA	16766	37 01 20	25 06 54	33.3	YES	YES	YES
48	MEGARA	LGMG	16835	37 58 52	23 22 56	1.05	YES	YES	
49	SKIATHOS	LGSK	16660	39 10 31	23 30 06	2	YES	YES	YES
50	SYROS	LGSO	16774	37 25 16	24 56 53	69.85	YES	YES	YES
51	ASTROS		16655	37 24 24	22 43 09	25	YES	YES	YES
52	KONITSA		16628	40 02 47	20 44 17	465	YES	YES	YES
53	SERRES		16606	41 04 35	23 31 46	32.05	YES	YES	YES
54	ARGOS		16724	37 37 58	22 45 35	12	YES	YES	YES
55	EDESSA		16618	40 48 31	22 02 27	314.83	YES	YES	YES
56	KITHIRA		16743	36 08 57	22 59 19	166.1	YES	YES	YES
57	LAMIA		16675	38 52 35	22 26 10	12.46	YES	YES	YES
58	METHONI		16734	36 49 31	21 42 16	51.84	YES	YES	YES
59	MILOS		16738	36 44 19	24 25 45	166.85	YES	YES	YES
60	NAXOS		16732	37 06 05	25 22 24	10.75	YES	YES	YES
61	FLORINA		16613	40 48 17	21 25 41	619.4	YES	YES	YES
62	DESFINA		16693	38 25 15	22 31 47	585	YES	YES	YES

The stations that are capable to send data at 10 minutes and 1-hour intervals are 41 and they are listed in the Table 15. In general, these stations are equipped with an automated system.

Table 15. Automatic weather stations in Greece sending data at 10-or 60-minutes interval

Automatic weather stations in Greece sending data at 10-or 60-minutes interval						
No.	Station	LOC IND	WMO CODE	Latitude	Longitude	Elevation
1	ATHENS (HELLINIKON)	LGAT	16716	37 53 23	23 44 31	43.13
2	AKTIO (PREVEZA)	LGPZ	16643	38 55 19	20 46 07	1.47
3	ANDRAVIDA	LGAD	16682	37 55 22	21 17 14	10.1
4	THESSALONIKI	LGTS	16622	40 31 39	22 58 18	1.68
5	KARPATHOS	LGKP	16765	35 25 39	27 08 49	10.5
6	KASTORIA	LGKA	16614	40 26 56	21 16 25	654.64
7	LIMNOS	LGLM	16650	39 55 20	25 13 58	4.81
8	SKYROS	LGSY	16684	38 57 46	24 29 27	22
9	ARAXOS	LGRX	16687	38 08 57	21 25 20	11.29
10	DEKELEIA (TATOI)	LGTT	16715	38 06 25	23 46 48	236.55
11	DOXATO		16840	41 03 59	24 15 07	86.7
12	ELEFSINA	LGEL	16718	38 04 03	23 33 08	26.54
13	ZAKYNTHOS	LGZA	16719	37 45 05	20 53 15	5.2
14	SANTORINI (THIRA)	LGSR	16744	36 24 08	25 28 25	40.29
15	IOANNINA	LGIO	16642	39 41 42	20 49 10	483.36
16	KALAMATA	LGKL	16726	37 04 09	22 01 21	6.2
17	KASTELI	LGTL	16760	35 11 20	25 19 44	337
18	KEFALLONIA	LGKF	16685	38 07 13	20 30 18	25.2
19	KOZANI	LGKZ	16632	40 17 22	21 50 29	621
20	LARISA	LGLR	16648	39 38 46	22 27 37	71.15
21	NEA ANCHIALOS	LGBL	16665	39 13 28	22 47 36	12.85
22	SITIA	LGST	16757	35 12 56	26 06 10	113.65
23	TANAGRA	LGTG	16699	38 20 07	23 33 46	138.05
24	TRIPOLI	LGTP	16710	37 31 28	22 23 50	650.57
25	ASTYPALAIA	LGPL	16739	36 34 55	26 22 27	50
26	IKARIA	LGIK	16779	37 40 58	26 20 41	18.4

27	KASTELORIZO	LGKJ	16767	36 08 36	29 34 31	151.57
28	LEROS	LGLE	16768	37 10 57	26 48 11	9.21
29	PAROS	LGPA	16766	37 01 20	25 06 54	33.3
30	SYROS	LGSO	16774	37 25 16	24 56 53	69.85
31	KONITSA		16628	40 02 47	20 44 17	465
32	SERRES		16606	41 04 35	23 31 46	32.05
33	ARGOS		16724	37 37 58	22 45 35	12
34	EDESSA		16618	40 48 31	22 02 27	314.83
35	KITHIRA		16743	36 08 57	22 59 19	166.1
36	LAMIA		16675	38 52 35	22 26 10	12.46
37	METHONI		16734	36 49 31	21 42 16	51.84
38	MILOS		16738	36 44 19	24 25 45	166.85
39	NAXOS		16732	37 06 05	25 22 24	10.75
40	FLORINA		16613	40 48 17	21 25 41	619.4
41	DESFINA		16693	38 25 15	22 31 47	585

The stations are calibrated every 2 years in situ by the experienced HNMS technicians who use standard instruments, especially for temperature, humidity, wind and pressure.

Regarding data quality management, it consists of two stages:

- The first control is made at the MSS for all the received messages. For instance, messages are checked for syntax errors, abnormal values or other errors (for example, dew point value greater than air temperature value).
- The second stage of quality control is made by the Database software. At this stage, the consistency of the parameters (compared with neighbouring stations) is examined. Observational data are also checked for other errors, for example about the existence of extreme values.

There are eight operational weather radars in Greece as WMO radar database keeps records, while OSCAR/Surface contains only four of them.

Table 16. Weather radars in Greece according to WMO radar database

Weather radars in Greece according to WMO radar database						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Greece	Aigina	Active	-	Single	C

2	Greece	Andrabida	Active	-	Single	C
3	Greece	Imıttos	Active	Magnetron	Single	C
4	Greece	Larissa	Active	Magnetron	Single	S
5	Greece	Preveza	Active	Klystron	Single	C
6	Greece	Thessaloniki	Active	Magnetron	Single	S
7	Greece	Astypalaia	Active	Klystron	Single	C
8	Greece	Xrisoupoli	Active	Klystron	Dual	C

HNMS network needs improvement. Therefore, further automation and reorganization of the observation network are planned. The main problem of the existing network is that there are very few stations in mountainous areas. For example, there is almost no station in the Pindhos mountain range area in the mainland of Greece.

5.8. Hungary

Mr Róbert Tóth, meteorologist and Head of the Unit for Data Quality Control (Hungarian Meteorological Service, OMSZ), provided information on the monitoring network in Hungary.

Hungary is located in Central Europe, in the Carpathian Basin. Its total area is 93 030 km^2, 0.74% of which is water surface. Balaton is the largest lake in Central Europe with around 600 km^2. The population is approximately 9.8 million. The predecessor institute (Royal Hungarian Central Institute of Meteorology and Earth Magnetism) of the Hungarian Meteorological Service was founded in 1870 during the Austro-Hungarian Monarchy, although the regular meteorological measurements were launched in 1717.

There are two operational radiosonde stations in Hungary: Budapest and Szeged. Both stations perform two ascents per day at 12:00 and 00:00 UTC. OMSZ plans total automation of radio sounding at both stations by Vaisala equipment in 2020.

The number of stations that measure snow depth manually is 444. There is one station measuring snow depth automatically in Kékestető, the highest measuring point in the country.

Table 17. Metadata of fixed land stations in Hungary registered in OSCAR

Metadata of fixed land stations in Hungary registered in OSCAR					
Station	Date established	WIGOS Station Identifier	Latitude	Longitude	Elevation
AGÁRD	1997.01.01	0-20000-0-12846	47.183	18.616	105
BAGAMÉR	2014.06.12	0-20000-0-12894	47.433	22.00	124
BAJA CSÁVOLY	1962.01.01	0-20000-0-12960	46.183	19.016	112
BÉKÉSCSABA	1962.01.01	0-20000-0-12992	46.683	21.166	88

BOGYOSZLÓ	2014.06.03	24120	47.58	17.18	119
BUDAPEST/belterület	1962.01.01	0-20000-0-12839	47.500	19.016	152
BUDAPEST/PESTSZENTLŐRINC	1953.01.01	0-20000-0-12843	47.433	19.183	138
CSENGER	2014.06.05	0-20000-0-12898	47.833	22.65	118
DEBRECEN repülőtér	1853.01.01	0-20000-0-12882	47.483	21.600	107
EGER	1962.01.01	0-20000-0-12870	47.901	20.383	224
GYŐR Likócs	1962.01.01	0-20000-0-12822	47.7166	17.683	116
HOMOKSZENTGYÖRGY	1997.09.25	28700	46.100	17.53	159
IREGSZEMCSE	1997.09.25	36500	46.69	18.18	165
JÓSVAFŐ	1997.01.01	0-20000-0-12766	48.483	20.533	308
KECSKEMÉT repülőtér	1962.01.01	0-20000-0-12970	46.916	19.75	113
KÉKESTETŐ	1962.01.01	0-20000-0-12851	47.866	20.016	1011
KESZTHELY TANYAKERESZT	1973.01.01	0-20000-0-12920	46.733	17.233	111
LŐKÖSHÁZA	2014.06.27	0-20000-0-12993	46.416	21.233	100
MILOTA	1998.12.31	72805	48.100	22.77	116
MISKOLC Diósgyőr	1950.01.01	0-20000-0-12772	48.094	20.726	161
MOSONMAGYARÓVÁR	1951.01.01	0-20000-0-12815	47.883	17.283	120
NAGYKANIZSA	1962.01.01	0-20000-0-12925	46.45	16.966	139
NYÍREGYHÁZA/NAPKOR	1962.01.01	0-20000-0-12892	47.966	21.883	141
OROSHÁZA	2000.10.31	57311	46.54	20.69	89
PAKS	1981.01.01	0-20000-0-12950	46.583	18.85	97
PÁPA repülőtér (dél)	1962.01.01	0-20000-0-12824	47.35	17.50	144
PÉCS/POGÁNY	2004.03.31	0-20000-0-12821	45.983	18.233	199
PÉR repülőtér	2014.06.27	0-20000-0-12943	47.616	17.80	128
POROSZLÓ	1997.01.01	0-20000-0-12866	47.65	20.633	91
SÁRMELLÉK repülőtér	2001.01.01	0-20000-0-12922	46.683	17.166	122
SÁTORALJAÚJHELY	1997.11.20	61709	48.38	21.66	100
SIÓFOK	1962.01.01	0-20000-0-12935	46.916	18.053	108

SOLTVADKERT	1997.10.20	47200	46.59	19.34	109
SOPRON Fertőrákos	1962.01.01	0-20000-0-12805	47.683	16.650	117
SZÉCSÉNY	1997.01.01	0-20000-0-12756	48.116	19.516	152
SZEGED	1871.01.01	0-20000-0-12982	46.25	20.083	81
SZENTGOTTHÁRD/FARKASFA	1962.01.01	0-20000-0-12910	46.916	16.316	311
SZEREP	1998.12.07	65105	47.23	21.15	86
SZOLNOK repülőtér	1962.01.01	0-20000-0-12860	47.116	20.233	89
SZOMBATHELY	1962.01.01	0-20000-0-12782	47.266	16.633	200
TARCAL	2000.11.28	0-20000-0-12813	48.133	21.333	124
TÁT	2001.01.01	0-20000-0-12847	47.75	18.600	109
TATA	1997.01.01	0-20000-0-12836	47.65	18.316	123
TÁPIÓSZELE	2000.01.13	44811	47.36	19.89	96
TÚRKEVE	2014.05.28	0-20000-0-12878	47.833	20.75	83
VÁSÁROSNAMÉNY	1998.03.12	0-20000-0-12797	48.116	22.283	109
VÉRTESKETHELY	1997.09.25	34500	47.49	18.090	205
VESZPRÉM/SZENTKIRÁLYSZ.	2005.03.25	0-20000-0-12830	47.066	17.833	280
ZÁHONY	1997.01.01	0-20000-0-12786	48.383	22.166	103
ZALAEGERSZEG/Nagykutas	1977.01.01	0-20000-0-12915	46.866	16.800	239

Figure 10. AWSs in Hungary contributing to the project

There are 40 automatic weather stations sending data regularly in GTS, those are indicated by blue circles and their metadata are in OSCAR. For the time being – taking into account the current data policy of OMSZ – ten additional stations can contribute with 10-minute interval data to SEE-MHEWS-A project ensuring rather good spatial resolution. Those indicated by purple points.

The lightning detection system was renewed by new Linet antennas.

There are four operational weather radars in Hungary as WMO radar database keeps records, as well as OSCAR/Surface.

Table 18. Weather radars in Hungary according to WMO radar database

Weather radars in Hungary according to WMO radar database						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Hungary	Budapest	Active	Magnetron	Dual	C
2	Hungary	Napkor	Active	Magnetron	Dual	C
3	Hungary	Pogányvár	Active	Magnetron	Dual	C
4	Hungary	Szentes	Active	Magnetron	Dual	C

OMSZ plans to install one additional C-band, dual-polarization radar this year.

The Instrument Calibration Laboratory of OMSZ performs regular calibration of the sensors, in most cases annually according to the WMO protocol. The equipment of the Laboratory was considerably modernized that resulted in higher quality performance of calibration of air pressure, humidity and temperature sensors. Experts working in the Laboratory participated in training on metrology. At the sixth meeting of the WMO Regional Association VI held in October 1978, Marczell György Main Observatory was admitted to the regional radiation centres in RA VI.

Operational data quality control activity is committed to eliminating the erroneous values mainly in the real-time data flow between the monitoring network and the database. In order to improve the effectiveness of the data quality control activities integration of the different tasks – that used to run in several units – into one organizational unit took place in 2017 at OMSZ. Staff of the Unit tries to minimize the erroneous data by analysing the weather situation, the measurement program of the neighbouring stations and the given meteorological station. Continuous software development supports this activity.

The AWSs installed at the beginning of the automation period are now 20-27 years old. OMSZ tries to make them up to date via development of data loggers and change the sensors. Furthermore, additional web cameras, disdrometers and ceilometers help the observation activity. Since the vicinity of several stations has unfavourably changed, reinstallation of them became necessary. Additional AWSs and ceilometers could foster nowcasting activity.

5.9. Israel

Ms. Lilach Lev, Training and International Relations Expert (Israel Meteorological Service provided information on the monitoring network in Israel.

The State of Israel is located in Western Asia on the southeaster shore of the Mediterranean Sea and the northern shore of the Red Sea. Its territory is 22 072 km^2 including Golan Heights and East Jerusalem, 2.1% of which is water surface. The population is around 9.2 million.

There are 2 operational radiosonde stations in Israel: in Bet Dagan and Ashdod. IMS operates 73 weather stations, measuring temperature, wind and precipitation. Another 10 stations measure temperature and precipitation, but not wind. All stations are capable of sending data at 10-minute intervals. Table 18. contains metadata of more stations, many of them not supervised by the IMS.

Table 19. Metadata of fixed land stations in Israel registered in OSCAR

Metadata of fixed land stations in Israel registered in OSCAR					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation
ASHDOD NORTH		0-20000-0-40186	31.86666666	34.683333	
Afeq	1999.10.21	0-376-0-511|	32.8466	35.1123	10
Afula ENV	2000.06.01	0-376-0-302|	32.6033	35.29097	57
Afula Nir Haemeq	1994.11.01	0-376-0-526|	32.596	35.2769	60
Ahisamakh IEC	2010.06.06	0-376-1-610|	31.93503	34.90888	80
Allon Shevut ENV	2000.06.01	0-376-0-310|	31.65647	35.11681	960

Ammiad	2004.03.29	0-376-0-613|	32.915	35.5135	215
Arad	1991.01.01	0-376-0-663|	31.25	35.1855	564
Ariel	1995.01.02	0-376-0-639|	32.1056	35.2114	685
Ashalim	2016.07.20	0-376-0-459|	30.983	34.708	305
Ashdod Port	1998.07.09	0-376-0-556|	31.8342	34.6377	5
Ashdod quarter 6 IEC	2011.01.27	0-376-1-619|	31.79383	34.65491	25
Ashqelon Port	2006.01.23	0-376-0-665|	31.6394	34.5215	5
Avdat	2008.09.26	0-376-0-577|	30.7877	34.7712	555
Avne Etan	1993.07.01	0-376-0-517|	32.8174	35.7622	375
Ayyelet Hashahar	2010.10.13	0-376-0-503|	33.0244	35.5735	170
BEER SHEVA CITY	1963.01.01	0-20000-0-40190	31.25	34.08	280
BEN-GURION INT. AIRPORT	1963.01.01	0-20000-0-40180	32	34.09	40
BET DAGAN	1962.01.01	0-20000-0-40179	32	34.816666	
Beer Sheva	1991.08.31	0-376-0-669|	31.2515	34.7995	279
Beer Sheva ENV	1999.06.01	0-376-0-311|	31.25674	34.78132	270
Beit Hashmonai IEC	2017.03.29	0-376-1-613|	31.88949	34.91516	108
Beit Jimal	1998.03.23	0-376-0-557|	31.7248	34.9762	355
Besor Farm	1990.06.27	0-376-0-565|	31.2716	34.3894	110
Bet Dagan	1992.03.08	0-376-0-645|	32.0073	34.8138	31
Bet Haarava	2007.04.25	0-376-0-554|	31.8052	35.501	-330
Bet Shemesh ENV	2000.06.01	0-376-0-308|	31.75016	34.99278	350
Bet Zayda	1996.01.01	0-376-0-516|	32.88	35.6504	-200
Caesaria IEC	2009.06.01	0-376-1-605|	32.49896	34.93499	19
Central Karmel IEC	1988.06.01	0-376-1-603|	32.8012	34.99145	274
Dafna	2010.03.22	0-376-0-602|	33.2277	35.635	135
Dorot	2003.01.01	0-376-0-562|	31.5036	34.648	115
EILAT	1945.01.01	0-20000-0-40199	29.55	34.95	

Eden Farm	1993.02.18	0-376-0-532|	32.4679	35.4888	-120
Elat	1998.11.29	0-376-0-699|	29.5526	34.952	22
Elat Airport IAA	2014.02.16	0-376-0-497|	29.558333	34.958889	14
Elat mast IEC	2011.01.01	0-376-1-622|	29.56691	34.94936	68
Elon	1998.12.14	0-376-0-607|	33.0653	35.2173	300
En Gedi	2006.08.22	0-376-0-564|	31.42	35.3871	-415
En Hahoresh	2003.08.28	0-376-0-634|	32.3877	34.9376	15
En Hashofet	1997.11.18	0-376-0-523|	32.6028	35.0964	265
En Karmel	1992.03.30	0-376-0-524|	32.6808	34.9594	25
Eshhar	2005.10.10	0-376-0-614|	32.8844	35.3015	370
Ezuz	2009.03.01	0-376-0-576|	30.7911	34.4715	335
Galed	2008.03.30	0-376-0-630|	32.5564	35.0725	180
Gamla	2007.03.21	0-376-0-612|	32.9052	35.7487	405
Gat	2007.08.13	0-376-0-559|	31.6003	34.7913	140
Gilgal	1991.01.01	0-376-0-547|	31.9973	35.4509	-255
Givat Hamore IEC	2000.06.01	0-376-1-601|	32.61959	35.35491	495
HAR-KNAAN (ZEFAT)	1950.01.01	0-20000-0-40153	32.96666666	35.05	
Hadera Port	1990.01.01	0-376-0-529|	32.4732	34.8815	5
Hafez Hayyim	2004.03.15	0-376-0-655|	31.791	34.805	80
Haifa Airport IAA	2014.02.16	0-376-0-425|	32.808233	35.042778	8
Haifa Refineries	1990.03.01	0-376-0-515|	32.8034	35.0548	5
Haifa Technion	1993.01.01	0-376-0-519|	32.7736	35.0223	245
Haifa University	1994.01.01	0-376-0-518|	32.7611	35.0208	475
Hakfar Hayarok	1996.03.07	0-376-0-539|	32.13	34.8324	65
Har Harasha	2001.10.05	0-376-0-545|	31.9449	35.1499	770
Harashim	2008.09.10	0-376-0-506|	32.956	35.3287	830
Hazeva	1994.02.01	0-376-0-679|	30.7787	35.2389	-135

Heftziba neighborhood IEC	2005.06.01	0-376-1-604|	32.45986	34.89974	16
Herzliyya Airport IAA	2014.02.16	0-376-0-174|	32.179444	34.834444	4
Holon ENV	1997.06.01	0-376-0-305|	32.01779	34.76814	24
Itamar	2002.01.05	0-376-0-542|	32.1598	35.3513	820
JERUSALEM	1861.01.01	0-20000-0-40184	31.86666666	35.216666	757
JERUSALEM CENTRE	1971.01.01	0-20000-0-40183	31.76666666	35.216666	815
Jerusalem Baka ENV	1998.06.01	0-376-0-309|	31.75709	35.21741	749
Jerusalem Centre	1993.01.01	0-376-0-652|	31.7806	35.2217	810
Jerusalem Givat Ram	1990.01.02	0-376-0-551|	31.7704	35.1973	770
Karmei Yosef IEC	1999.06.01	0-376-1-614|	31.84703	34.92024	260
Katzir IEC	1988.06.01	0-376-1-606|	32.49119	35.10948	390
Kefar Blum	2005.06.27	0-376-0-604|	33.1716	35.6133	75
Kefar Giladi	2007.09.23	0-376-0-603|	33.2404	35.5696	365
Kefar Nahum	2007.07.17	0-376-0-617|	32.8835	35.5792	-200
Kfar Menahem IEC	2004.06.01	0-376-1-617|	31.72911	34.83345	119
Lahav	2010.06.16	0-376-0-567|	31.3812	34.8729	460
Lod Airport IAA	2014.02.03	0-376-0-180|	32.00735	34.876702	44
Luzit IEC	2009.06.01	0-376-1-615|	31.68509	34.88257	189
Maale Adummim	2006.12.25	0-376-0-642|	31.774	35.2961	490
Maale Gilboa	2007.02.05	0-376-0-628|	32.481	35.415	495
Mahanayim Airport IAA	2014.02.16	0-376-0-412|	32.980829	35.571968	269
Massada	2010.12.23	0-376-0-620|	32.6833	35.6008	-200
Merom Golan Picman	1997.12.21	0-376-0-502|	33.1288	35.8045	945
Metzoke Dragot	2006.06.03	0-376-0-662|	31.5881	35.3916	20
Mizpe Ramon	2014.12.03	0-376-0-582|	30.6101	34.8046	845
Modiin West IEC	2005.06.01	0-376-1-612|	31.89335	34.99615	267
Mount Karmel National	1998.06.01	0-376-1-602|	32.73869	35.03692	507

Park					
Nahshon	2007.12.13	0-376-0-550|	31.8341	34.9616	180
Nathan camp IEC	2011.06.22	0-376-1-621|	31.21979	34.80543	280
Negba	2001.05.05	0-376-0-658|	31.6585	34.6798	95
Neot Smadar	2007.06.18	0-376-0-588|	30.048	35.0233	400
Netiv Halamed He	1994.01.01	0-376-0-560|	31.6898	34.9744	275
Nevatim	2010.04.28	0-376-0-568|	31.205	34.9227	350
Newe Yaar	2005.03.27	0-376-0-619|	32.7078	35.1784	115
Nir Galim IEC	1988.06.01	0-376-1-618|	31.82695	34.68506	27
Nizzan	2008.12.17	0-376-0-653|	31.7319	34.6348	30
OVDA	1982.01.01	0-20000-0-40198	30	34.833333	
Orot Rabin Power Station IEC	2011.01.05	0-376-1-607|	32.46861	34.89749	5
Ovda Airport IAA	2014.02.10	0-376-0-490|	29.935	34.940833	452
Paran	1993.06.06	0-376-0-687|	30.3655	35.1479	100
Qarne Shomeron	1999.05.01	0-376-0-541|	32.1752	35.0959	330
Qevuzat Yavne	1998.06.19	0-376-0-654|	31.8166	34.7244	50
RADAR Dwsr-90c + sigmet			32.0180555	34.820555	52
Rehovot ENV	1997.06.01	0-376-0-306|	31.89912	34.81562	70
Rosh Haniqra	2003.08.12	0-376-0-608|	33.0806	35.1079	10
Rosh Zurim	1999.12.30	0-376-0-661|	31.6644	35.1233	950
SDE-DOV (TEL-AVIV)		0-20000-0-40176	32.01	34.783333	
Sede Boker	1995.11.27	0-20008-0-WIS	31.1299991	34.88000	400
Sede Boqer	2002.10.30	0-376-0-674|	30.8702	34.795	475
Sede Eliyyahu	2011.01.24	0-376-0-531|	32.439	35.5106	-185
Sedom	1991.01.01	0-376-0-678|	31.0306	35.3919	-388
Shani	1996.01.01	0-376-0-563|	31.3568	35.0662	700
Shave Ziyyon	2009.09.09	0-376-0-507|	32.9836	35.0923	5

Shemen site IEC	2011.06.27	0-376-1-620|	31.14545	34.82915	386
Tavor Kadoorie	1992.01.01	0-376-0-521|	32.7053	35.4069	145
Tel Aviv Bizzaron IEC	1990.06.03	0-376-1-608|	32.06688	34.79567	17
Tel Aviv Coast	2005.03.02	0-376-0-644|	32.058	34.7588	10
Tel Aviv Old Central Bus St.	1991.06.03	0-376-1-609|	32.06223	34.77735	28
Tel Aviv Ramat Aviv ENV	1999.06.01	0-376-0-303|	32.119	34.8025	39
Tel Aviv sede dov IAA	2014.02.10	0-376-0-440|	32.114167	34.781944	13
Tel Yosef	1994.04.03	0-376-0-530|	32.5462	35.3945	-65
West Galilea ENV	1998.06.01	0-376-0-301|	32.91575	35.29302	297
Yavne IEC	1994.06.01	0-376-1-616|	31.87515	34.73874	38
Yavneel	1996.07.02	0-376-0-520|	32.6978	35.5101	0
Yotvata	1990.01.01	0-376-0-594|	29.8851	35.0771	70
Zefat Har Kenaan	1999.05.19	0-376-0-606|	32.98	35.507	936
Zemah	1994.01.01	0-376-0-621|	32.7024	35.5839	-200
Zikhron Yaaqov	1989.01.01	0-376-0-528|	32.5724	34.9546	175
Zomet Hanegev	2003.11.23	0-376-0-672|	31.0708	34.8513	360
Zova	1998.09.18	0-376-0-656|	31.7878	35.1258	710

Figure 11. Map of fixed land stations in Israel registered in OSCAR

All instruments operated by IMS are being calibrated once a year at their lab, according to the WMO protocol. At the moment, IMS applies only a minor number of real-time examinations. They do not have a common protocol for data quality management, but IMS intends to introduce one.

Concerning improvement or enlargement of the observation network, there is still a lack of several stations in various areas, which leads to some difficulties to produce high quality forecasting for these places as well as best climatological evaluations. IMS knows the equipment and the surrounding of each and every station, thus their limitations can be evaluated. For example, the stations along the coast and at the mountains, rain measurements are in deficit. Also, some of the stations are in deficit in wind speed, due to the surroundings, however, this is well noted at the CIMO classification, which have been performed to all of stations operated by IMS.

Table 20. Weather radar in Israel

Weather radar in Israel						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Israel	Dwsr-90c + sigmet	Active	Magnetron	Single	C

5.10. Jordan

Dafi Elryalat provided information on the monitoring network in Jordan (Eng. Dafi Elryalat, Deputy Director-General, Jordan Meteorological Department).

The Hashemite Kingdom of Jordan is located in Western Asia, east of Israel. The country has a 26-kilometre coastline. The total area is 89 342 km^2, 0.6% of which is water surface. It is a semi-arid, almost landlocked country. The population is around 10.4 million.

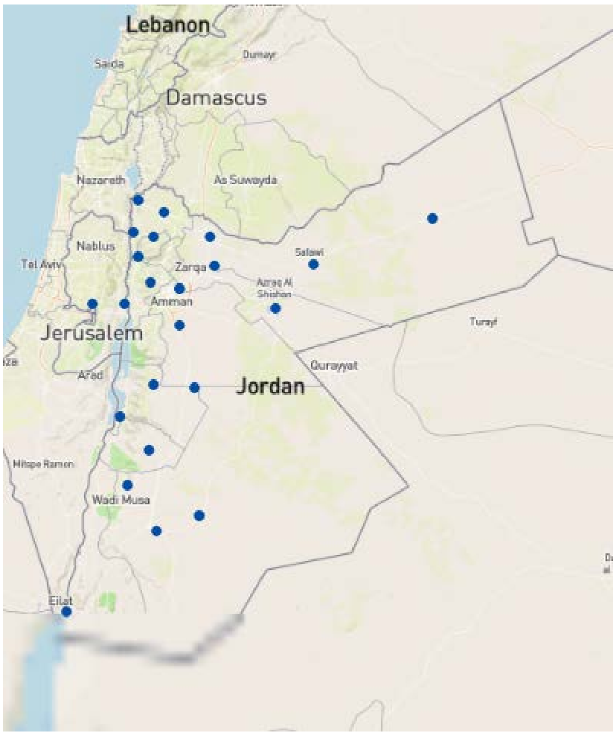

Figure 12. Map of fixed land stations in Jordan registered in OSCAR

Table 21. Metadata of fixed land stations in Jordan registered in OSCAR

Metadata of fixed land stations in Jordan registered in OSCAR					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation
AMMAN AIRPORT		0-20000-0-40270|	31.9833333333	35.9833333333	778
AQABA AIRPORT	1963.01.01	0-20000-0-40340|	29.55	35	53
AZRAQ SOUTH	2001.01.01	0-20000-0-40288|	31.8333333333	36.8166666667	527
BAQURA	2001.01.01	0-20000-0-40253|	32.6333333333	35.6166666667	
DEIR ALLA	2001.01.01	0-20000-0-40285|	32.2166666667	35.6166666667	
ER RABBAH	2001.01.01	0-20000-0-40292|	31.2666666667	35.75	
GHOR SAFI		0-20000-0-40296|	31.0333333333	35.4666666667	
H-4 RWASHED		0-20000-0-40250|	32.5	38.2	
H-5 'SAFAWI'		0-20000-0-40260|	32.1608333333	37.1538888889	674
IRBED		0-20000-0-40255|	32.55	35.85	

JAFER	2001.01.01	0-20000-0-40305|	30.2833333333	36.15	861
JERICHO	1963.01.01	0-20000-0-40280|	31.8666666667	35.5	-276
JERUSALEM AIRPORT		0-20000-0-40290|	31.8666666667	35.2166666667	749
MA'AN	1961.01.01	0-20000-0-40310|	30.1666666667	35.7833333333	
MAFRAQ	1963.01.01	0-20000-0-40265|	32.3666666667	36.25	683
QATRANEH	2001.01.01	0-20000-0-40275|	31.25	36.1166666667	
QUEEN ALIA AIRPORT	1983.01.01	0-20000-0-40272|	31.7166666667	35.9833333333	720
RADAR Kafurus Radtec			31.9833333333	35.9833333333	778
RAS MUNEEF	2001.01.01	0-20000-0-40257|	32.3666666667	35.75	
SALT	2001.01.01	0-20000-0-40268|	32.0333333333	35.7333333333	
SHOUBAK	2001.01.01	0-20000-0-40300|	30.5166666667	35.5333333333	
TAFILEH	2001.01.01	0-20000-0-40298|	30.7833333333	35.7166666667	
WADI DHULAIL	2001.01.01	0-20000-0-40267|	32.15	36.2833333333	
WADI RAYAN	2001.01.01	0-20000-0-40256|	32.4	35.5833333333	

Table 22. Classic observing stations in Jordan

Classic observing stations in Jordan							
Station Name	Station ID	Latitude	Longitude	Elevation	1h	3h	6h
Ras Muneeef	40257	32° 22’ 49”	35°48’ 42”	1150			
Shoubak	40300	30° 30’ 38”	35° 31’ 51”	1365			
Tafileh	40298	30° 50’ 51”	35° 37’ 37”	1258			
Er Rabbah	40292	31° 16’ 32”	35° 44’ 20”	942			
Salt	40268	32° 02’ 27”	35° 44’ 39”	935			
Zarqa	40273	32° 05’ 03”	36° 05’ 00”	644			
Ma'an	40310	30° 10’ 14”	35° 45’ 54”	1069		✓	
Qatraneh	40275	31° 14’ 58”	36° 02’ 48”	768			
Rewaished	40250	32° 30’ 14”	38° 11’ 41”	683			✓
Ghabawi	40244	32° 00’ 09”	36° 12’ 54”	721			

Azraq	40288	31° 50’ 15”	36° 47’ 04”	521			
Mafraq	40265	32° 21’ 07”	36° 15’ 23”	686		✓	
Safawi	40260	32° 09’ 38”	37° 09’ 17”	674		✓	
Jafer	40305	30° 20’ 32”	36° 08’ 31”	865			
Amman Civil Airport	40270	31° 58’ 05”	35° 59’ 06”	780	✓		
Queen Alia Internat. Airport	40272	31° 43’ 38”	36° 01’ 10”	722	✓		
King Hussien Airport	40340	29° 36’ 14”	35° 01’ 08”	55	✓		
Baqura	40253	32° 37’ 26”	35° 36’ 40”	-170		✓	
Dier alla	40285	32° 12’ 08”	35° 37’ 14”	-224			
Irbid	40253	32° 32’ 05”	35° 51’ 19”	616			✓
Ghour Safi	40296	31° 03’ 30”	35° 29’ 37”	-350			✓
Dhulail	40267	32° 10’ 01”	36° 17’ 45”	580			

Recently 30 AWSs have been installed, which were a grant from the government of Japan. Most of these stations are installed in the same site of the classic stations in order to replace the classic stations with AWS. Until now, AWS data have not been uploaded on GTS because of some technical problems with the software and database.

The reports received from the meteorological weather stations are audited at the beginning of each month, and these reports are brought from the meteorological stations after the meteorological station official has fully completed it. The auditing process is carried out in two stages:

1. Manual verification is done as follows:

- The auditor must have full knowledge of the weather observation process, as well as knowledge of all the meteorological elements that present in the monthly report and how to measure, record and calculate them.
- Weather elements are known to be interrelated with each other, so the auditor links the weather elements with each other and deals with the monthly report as one unit.
- The auditor should know the climate in which the meteorological station is located, the nature of the surrounding geographical area and the effect of terrain on the measurement of weather elements. The auditor must also understand the effects of weather systems on the weather elements that have been measured at the weather station for a given day.
- The maximum, minimum and grass minimum temperatures are audited with the dry temperature as a whole, for example: the minimum temperature does not exceed the dry temperature nor the maximum temperature falls below the dry temperature and so on. In case of doubt about a number, the number is checked through the attached charts or from the weather monthly notebook.

- Checking the air pressure, rain amount, wind speed and all other elements in the same way as before.

2. Electronic auditing:

After the report is manually checked and entered into the climate section database, this information is retrieved and any abnormal numbers are searched, for example: too high humidity (above 100%) or irrational temperature values, etc. may be the result of a mistake in entering information and that will be corrected in the database.

There is one operational radiosonde station in Jordan in Mafraq. There is no information about stations delivering snow depth data manually or automatically in the country. There is snow every few years around Amman.

Table 23. Weather radar in Jordan

Weather radar in Jordan						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Jordan	Kafurus Radtec	Active	Magnetron	Dual	S

5.11. Lebanon

Mr. Wiam Kordab, Acting Chief of Observation Section (Lebanese Meteorological Department, under Directorate General of Civil Aviation) provided information on the monitoring network in Lebanon.

The Lebanese Republic is located in Western Asia by the Mediterranean Sea. With its 10 452 km^2 area (1.8% of which is water surface) it is the smallest recognized sovereign state on the mainland Asian continent. The population is around 6.9 million. The government faces economic problems and a great number of refugees, mainly from the Syrian Arab Republic. In addition on 4 August 2020 two explosions occurred at the port of Beirut causing catastrophic damages.

There is one operational radiosonde station in Lebanon at the Beirut Airport. There is no information on stations delivering snow depth data manually or automatically in the country, although there is snow cover on the higher mountains during winter. There is one weather radar under installation in Lebanon.

Concerning the surface meteorological monitoring network, in general, there are 30 automatic stations working but most of the stations are not connected directly so measured data are collected by card. There is a plan for updating the monitoring network, including a tender to buy 44 new AWSs. Unfortunately, because of financial difficulties, the project has not been implemented yet. There are 9 AWSs (Vaisala) connecting the network but only three of these stations send data to the GTS: Tripoli, Zahleh (hawch-al-omara) and Beirut Airport**.**

These are the stations available in the GTS:

- The Beirut Airport sends METAR (olba) every 1 hour, and SYNOP every 3 hour (40100; wind direction and speed, pressure, temperature, humidity, precipitation). This is the only civil airport in Beirut, all the aeronautical equipment needed for observation were upgraded at the end of 2016.

- Zahleh (40101) sends SYNOP every 3 hours (wind direction and speed, pressure, temp, humidity, precipitation)
- Tripoli (40103) SYNOP every 3 hours (wind direction and speed, pressure, temp, humidity, precipitation)

10-minute data and 1-hour data are not available automatically.

The calibration of sensors is carried out by a calibration kit for temperature, humidity, wind, pressure and precipitation. Most of the sensors are from Vaisala and their calibration is performed by the special calibration equipment.

Data quality management system has not been applied. There is a certain quality control for data by a small computer program. There is intention to purchase the new stations with all the programs needed for quality control on the data.

The directions of the necessary improvement and enlargement of the Lebanese observation network are as follows:

- Modernization of the surface observations infrastructure (installation of 44 new automatic weather stations with 3 marine stations considering the existing automatic stations have become old since 1998);
- Installation of a new radar C band 360 kW from the American company EEC; and
- Modernization of the radiosonde station in case of governmental financing.

Figure 13. Map of fixed land stations in Lebanon registered in OSCAR

Table 24. Metadata of fixed land stations in Lebanon registered in OSCAR

Metadata of fixed land stations in Lebanon registered in OSCAR					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation
AL-ARZ (LES CEDRES)		0-20000-0-40105	34.25	36.05	
BEYROUTH (AEROPORT)	1843.01.01	0-20000-0-40100	33.8166666667	35.4833333333	29
DAHR BAIDAR	1966.01.01	0-20000-0-40110	33.8166666667	35.7666666667	
HOUCHE-AL-OUMARA	1994.01.01	0-20000-0-40101	33.8166666667	35.85	
MERDJAYOUN	1963.01.01	0-20000-0-40104	33.3666666667	35.5833333333	
RAYACK	1949.01.01	0-20000-0-40102	33.8666666667	36	927
TRIPOLI	1949.01.01	0-20000-0-40103	34.45	35.08	

5.12. Republic of Moldova

Ms Lidia Trescilo, Head of the Meteorology Department (State Hydrometeorological Service) provided information on the monitoring network of the Republic of Moldova.

The Republic of Moldova is a landlocked country in Eastern Europe. Its total area (including Transnistria) is 33 846 km^2, 1.4% of which is water surface. The population is around 3 million.

Upper-air radiosonde stations in Chisinau is mentioned in the OSCAR/Surface, but it is not working for several years. State Hydrometeorological Service plans to resume its work, but it is unlikely that it will be soon, as this requires additional funds.

There are 55 stations delivering snow depth data manually according to the European snow booklet. State Hydrometeorological Service does not have automatic sensors to measure snow cover characteristics.

The Republic of Moldova sends meteorological data/information from all the 18 meteorological stations every 3 hours to the Regional Centre in Moscow. At this stage, State Hydrometeorological Service is able to provide online measurement data from 14 meteorological stations: Briceni, Soroca, Balti, Faleşti, Bravicea, Cornesti, Codrii, Baltata, Chisinau, Ştefan-Voda, Leova, Comrat, Ceadir-Lunga, Cahul. From these stations, it is possible to send data on air temperature, rainfall and surface winds every 10 minutes, but this data transmission technically has not been solved yet.

As far as calibration is concerned the automatic stations are new and at this stage the calibration of the sensors has not been carried out yet. State Hydrometeorological Service has a laboratory for testing temperature and humidity sensors and atmospheric pressure. But this laboratory is currently not accredited in accordance with national law.

The quality of observations of automatic stations is checked in comparison with classical observations. State Hydrometeorological Service cannot apply data quality management at the moment and would require training in this issue.

WMO databases contain nine active MRL-5 weather radars in Moldova listed below. Only one active dual polarization weather radar is active.

Table 25. Weather radars in the Republic of Moldova according to WMO radar database

Weather radars in the Republic of Moldova according to WMO radar database						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Republic of Moldova	Chimishlia, MRL-5	Active	Magnetron	Single	S
2	Republic of Moldova	Edintci, MRL-5	Active	Magnetron	Single	SX
3	Republic of Moldova	Falesti, MRL-5	Active	Magnetron	Single	SX
4	Republic of Moldova	Kalarash, MRL-5	Active	Magnetron	Single	SX
5	Republic of Moldova	Kornesti, MRL-5	Active	Magnetron	Single	SX
6	Republic of Moldova	Shtefan-Vode, MRL-5	Active	Magnetron	Single	S
7	Republic of Moldova	Singerya, MRL-5	Active	Magnetron	Single	SX
8	Republic of Moldova	Soroki, MRL-5	Active	Magnetron	Single	SX
9	Republic of Moldova	XChadir-Lunga, MRL-5	Active	Magnetron	Single	SX

Table 26. Active weather radar in the Republic of Moldova

Active weather radar in the Republic of Moldova						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Republic of Moldova	Chisinau, DWSR-3501C	Active	Magnetron	Dual	C

Figure 14. Map of fixed land stations in the Republic of Moldova registered in OSCAR

Table 27. Metadata of land fixed in the Republic of Moldova

Metadata of land fixed in the Republic of Moldova confirmed by the Expert of SHS					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation
BALTATA	1953.12.06	0-20000-0-33824|	47.0513	29.0477	79
BALTI	1944.12.07	0-20000-0-33745|	47.7539	27.9184	156
BRAVICEA	1952.09.02	0-20000-0-33749|	47.3666	28.4333	78
BRICENI	1944.07.08	0-20000-0-33664|	48.3598	27.0812	261
CAHUL	1947.06.19	0-20000-0-33885|	45.9017	28.1979	110
CAMENCA	1950.06.01	0-20000-0-33679|	48.0333	28.7000	172
CEADIR-LUNGA	1956.11.24	0-20000-0-33886|	46.0607	28.8327	65
CHISINAU	01.11.1886	0-20000-0-33815|	46.9715	28.8484	168
CODRII	1994.04.16	0-20000-0-33810|	47.1334	28.3840	152
CORNESTI	1944.09.18	0-20000-0-33748|	47.3561	28.0083	232
DUBASARI	1956.12.31	0-20000-0-33821|	47.2833	29.1333	40
FALESTI	1957.08.12	0-20000-0-33744|	47.5801	27.7162	162
COMRAT	1944.10.06	0-20000-0-33883|	46.2973	28.6419	133
LEOVA	1948.08.24	0-20000-0-33881|	46.4751	28.2593	158
RIBNITA	1963.04.27	0-20000-0-33754|	47.7667	29.0167	119

SOROCA	1945.06.27	0-20000-0-33678|	48.1666	28.2999	172
STEFAN-VODA	1981.01.01	0-20000-0-33892|	46.5142	29.6503	173
TIRASPOL	01.03.1898	0-20000-0-33829|	46.5142	29.6503	40
RADAR Chisinau		DWSR-3501C	46.5557	28.5703	112
Chisinau	2003.09.19	0-20008-0-ARG|	47.00130	28.81559	205

5.13. Montenegro

Ms Tamara Mijanovic, Database Administrator (Institute of Hydrometeorology and Seismology of Montenegro, IHMS), provided information on the meteorological monitoring network of Montenegro.

Montenegro is located in Mediterranean Europe at the shore of the Adriatic Sea. Its territory is 13 812 km^2, 2.6% of which is water surface. The population is around 631 thousand. There is long-lasting snow cover in the higher mountains.

There is neither an operational radiosonde station nor weather radar in Montenegro. There are 36 stations delivering snow depth data manually and no automatic snow measuring station in the country.

The online measuring points Montenegro can deploy in the project are as follows:

8 main stations (not including Niksic, which is not working for some time, it is planned to be replaced), 5 climatological stations and 18 stations with measurements of temperature and precipitation but NO WIND. The 8 main stations are capable to send data at 10-15minutes and others at one-hour intervals. The stations have been listed by IHMS (see http://meteo.co.me/mreza.html).

Due to limited financial sources, the calibration of instruments is done rarely.

As far as data quality management concerns there are limit controls in the acquisition software and in the database, there are automatic control procedures done on import as limits and reference parameter value errors and warnings.

Improvement of current meteorological monitoring network is very important at this moment, especially because IHMS does not have enough resources to regularly maintain the stations to meet their requirements and do the necessary calibration.

IHMS needs more sensors; there are difficulties with spare parts; they are ordered mostly when a station/sensor is out of order and because of that there are gaps for month or two while it becomes operational again. If more stations/sensors simultaneously (in a short time) stop working, there are no funds for all. Furthermore, the 9 main stations have rather obsolete sensors up to 15 years old.

Problems with public power supply infrastructure are not rare and therefore IHMS also needs protection from voltage surge, power out as well as grounding improvement.

Table 28. Metadata of fixed land stations in Montenegro

Metadata of fixed land stations in Montenegro confirmed by the Expert of IHMS					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation

BAR	2003.08.01	0-20000-0-13461|prim	42.1	19.08333333	5.7
HERCEG NOVI-IGALO	2007.01.01	0-20000-0-13455|prim	42.45	18.55	10
KOLASIN	2008.11.26	0-20000-0-13465|prim	42.83333333	19,5167	944
NIKSIC	2003.01.01	0-20000-0-13459|prim	42.76666666	18.95	647
PLJEVLJA	2006.01.01	0-20000-0-13363|prim	43.35	19.35	784
PODGORICA-GOLUB.	1951.01.01	0-20000-0-13462|airp	42.36666666	19.25	33
PODGORICA-GRAD	2004.01.01	0-20000-0-13463|prim	42.43333333	19.28333333	49
TIVAT	1963.01.01	0-20000-0-13457|airp	42.04	18.73333333	5
ULCINJ	2005.01.01	0-20000-0-13464|prim	41.91666666	19.21666666	24
ZABLJAK	2004.01.01	0-20000-0-13361|prim	43.15	19.13333333	1450
CETINJE	2011.03.16	-	42.3833	18.9167	640
BUDVA	2011.02.07	-			
BIJELO POLJE	2010.06.01	-	43.0333	19.7333	606
DANILOVGRAD	2011.09.06	-	42.55	19.1	53
BERANE	2019.06.01	-			
ROZAJE	2019.06.01	-			

Figure 15. Map of fixed land stations in Montenegro registered in OSCAR

5.14. North Macedonia

Mr Aleksandar Karanfilovski, Observation Expert (National Hydrometeorological Service, UHMR), provided information on the meteorological monitoring network of North Macedonia.

The Republic of North Macedonia is a landlocked country in the Balkan peninsula. Its territory is 25 713 km^2, 1.9% of which is water surface. The population is around 2.1 million. Four different seasons are found in the country with warm and dry summers and moderately cold and snowy winters.

There was one operational radiosonde station in the country at Skopje Petrovec, however, the radiosonde station was closed a few years ago.

There are 129 stations delivering snow depth data manually and 4 automatic snow measuring stations in the country.

Table 29. Active weather radars in North Macedonia

Active weather radars in North Macedonia						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	North Macedonia	Guriste, WSR 74 X/S	Active	Magnetron	Single	X/S
2	North Macedonia	Topolcani, MRL-5	Active	Magnetron	Single	X/S

The radar in Guriste has been operational since 1986, while the other one in Topolcani from 1992. Both radar systems were upgraded in 2005 (digitalisation and automation) by company “Antigrad-A” (Russia) with software “ASU-MRL”. Both radar systems are temporary active, especially in the warm period of the year.

UHMR operates 44 automatic weather stations. Precipitation is measured at each site, while air temperature at 42 stations and surface wind (10 m) at 37 stations. They produce data every 10 minutes and data are collected every 30 minutes with GPRS transfer. Commercial mobile operator is used and since there are no dedicated transfer channels, interruptions in the communications with AWSs happen frequently.

Data are archived in CLIDATA database where some basic QC procedures are implemented. In near-real-time data are not used directly from AWSs but after import/export in/from DB. Because of this, in this moment, UHMR is not able to send quality data every 10 minutes. Data transfer at 1-hour intervals could be possible, when due to the procedures of receiving from AWSs, importing and exporting data in DB, the data would be sent in exchange during 15–20th minutes of every whole hour.

Regarding calibration, UHMR has calibration kit for relative humidity (air temperature and relative humidity sensors are HMP 155A) with salt (NaCl and LiCl). Furthermore, there is a baro-chamber but referent barometer is not re-calibrated.

Regarding the expansion of AWS network, UHMR has a long-term plan for additional new 30-50 AWSs with standard equipment (air temperature, humidity, pressure, wind and solar radiation), but due to the limited financial and personal resources, it could not be implemented yet.

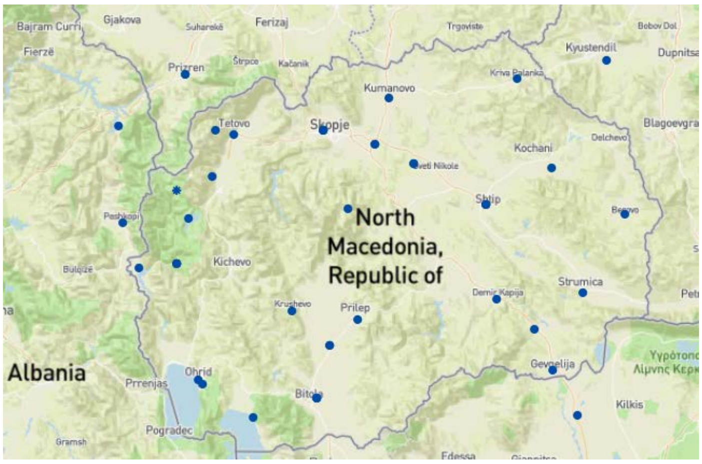

Figure 16. Map of fixed land stations in North Macedonia registered in OSCAR

Table 30. Metadata of fixed land stations in North Macedonia registered in OSCAR

Metadata of fixed land stations in North Macedonia registered in OSCAR					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Eleva-tion
BEROVO	1949.08.01	0-20000-0-13598|	41.716666666	22.85	837
BITOLA	1896.01.01	0-20000-0-13583|	41.5	21.3666666667	589
DEBAR	2003.01.01	0-20000-0-13573|	41.516666666	20.5333333333	
DEMIR KAPIJA	1932.09.01	0-20000-0-13592|	41.409335	22.237293	126
GEVGELIJA	1996.01.01	0-20000-0-13597|	41.15	22.5	60
GURISTE-PGC	1927.01.01	0-20000-0-13590|	41.9	21.85	854
KAVADARCI	2003.01.01	0-20000-0-13599|	41.433333333	22.0333333333	

KRIVA PALANKA	1947.01.01	0-20000-0-13493|	42.2	22.3333333333	691
KRUSEVO	2003.01.01	0-20000-0-13582|	41.366666666	21.25	
KUMANOVO	2003.01.01	0-20000-0-13589|	42.133333333	21.7166666667	338
LAZAROPOLE	1948.01.01	0-20000-0-13577|	41.533333333	20.07l	1332
MAVROVO	2003.01.01	0-20000-0-13576|	41.7	20.75	
OHRID	1945.01.01	0-20000-0-13578|	41.116666666	20.8	758
OHRID-AERODROME		0-20000-0-13579|	41.1	20.8166666667	705
POPOVA SAPKA	1996.01.01	0-20000-0-13492|	41.016666666	20.8830555556	
POZAR-PGC		0-20000-0-13593|	41.3	22.4166666667	1031
POZARANE-PGC		0-20000-0-13575|	41.85	20.8666666667	
PRETOR-PGC		0-20000-0-13580|	40.979722222	21.065	912
PRILEP	1974.01.01	0-20000-0-13585|	41.333333333	21.5666666667	673
RADAR Guriste	1986		41.898611111	21.8358333333	846
RADAR Topolcani	1992		41.240277777	21.4330555556	848
SKOPJE PETROVEC		0-20000-0-13586|	41.966666666	21.65	238
SKOPJE-ZAJCEV RID	1978.03.01	0-20000-0-13588|	42.016666666	21.4	302
SOLUNSKA GLAVA	1996.01.01	0-20000-0-13584|	41.733333333	21.5166666667	
STIP	1927.01.01	0-20000-0-13591|	41.75	22.1833333333	326
STRUMICA	2000.01.01	0-20000-0-13595|	41.433333333	22.65	
TETOVO	2003.01.01	0-20000-0-13571|	42	20.9666666667	
TOPOLCANI-PGC		0-20000-0-13581|	41.216666666	21.4666666667	
VINICA-PGC		0-20000-0-13594|	41.883333333	22.5	518

5.15. Romania

Ms Ancuta Manea, Scientific Researcher (Romanian National Meteorological Administration, RNMA) provided information on the meteorological monitoring network of Romania.

Romania is located in Eastern Europe by the Black Sea. Its territory is 238 397 km^2, 3% of which is water surface. The population is around 19.3 million. The country has a continental climate with four distinct seasons.

There is one operational radiosonde station in Romania at Bucharest Baneasa, although there worked another one as well in Cluj-Napoca in the past.

144 weather stations deliver snow depth data and RNMA has in operation 4 automatic ultrasonic sensors for snow depth measurements.

RNMA can deploy in the project a maximum of 160 weather stations that are declared in OSCAR/Surface. Data can be transferred with a frequency of 10 minutes for a maximum of 152 weather stations and of 1 hour for all the 160 weather stations.

The calibration practice for wind sensors is made following the manufacture's procedure; for air temperature and atmospheric pressure sensors, the calibration is made at the Romanian National Meteorological Administration by comparison using a manufacturer's standard, following an internal procedure. 76 automatic weather stations were upgraded until 2020 and RNMA plans to extend the upgrade to the rest of the automated weather stations in the near future.

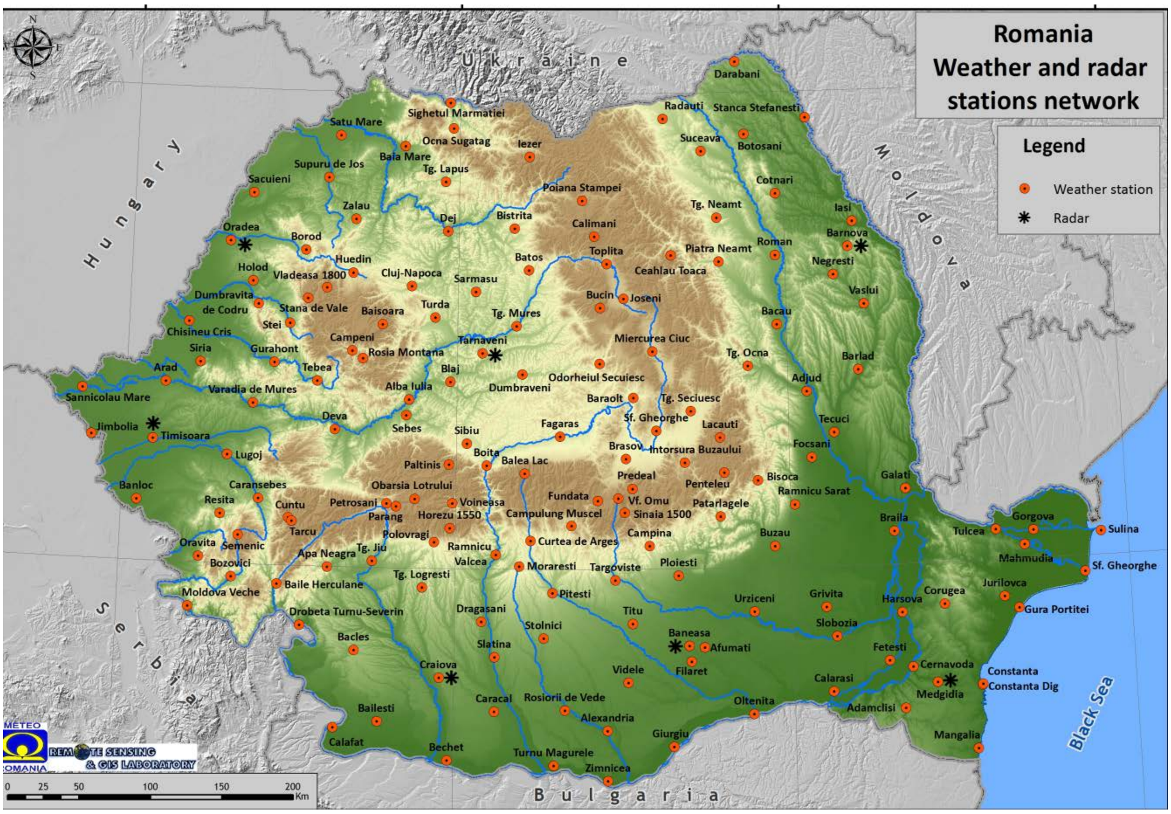

Figure 17. Map of fixed land stations in Romania registered in OSCAR

Table 31. Weather radars in Romania

Weather radars in Romania						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Romania	Barnova	Active	Klystron	Single	S
2	Romania	Bobohalma	Active	Klystron	Single	S
3	Romania	Bucharest	Active	Magnetron	Single	C
4	Romania	Craiova	Active	Magnetron	Single	C
5	Romania	Medgidia	Active	Klystron	Single	S

6	Romania	Oradea	Active	Klystron	Single	S
7	Romania	Timisoara	Active	Klystron	Single	S

The metadata of the weather stations operated by RNMA are up to date in OSCAR/Surface. Stations Bucharest, Constanta Black Sea and Magurele INOE are not administered by RNMA.

Table 32. Metadata of fixed land stations in Romania registered in OSCAR

Metadata of fixed land stations in Romania registered in OSCAR					
Station	Date established	WIGOS Station Identifier(s)	Latitude	Longitude	Elevation
ADAMCLISI	1956.08.01	0-20000-0-15479|	44.0882700719	27.965626028	158
ADJUD	1953.01.01	0-20000-0-15219|	46.1047277462	27.1704041393	101
ALBA IULIA	1881.01.01	0-20000-0-15208|	46.0639114563	23.5634021392	246
ALEXANDRIA	1899.07.01	0-20000-0-15489|	43.9779209155	25.3528455408	75.46
APA NEAGRA	1954.04.01	0-20000-0-15341|	44.9968061809	22.8595071983	250
ARAD	1923.10.01	0-20000-0-15200|	46.1335163958	21.3536215174	116.59
BACAU	1896-01-01	0-20000-0-15150|	46.5577777778	26.8966666667	174
BACLES	1961.10.01	0-20000-0-15412|	44.4761811099	23.1130718953	313
BAIA MARE	1874-12-01	0-20000-0-15014|	47.6608333	23.473333	186.11
BAILE HERCULANE	1979.01.01	0-20000-0-15366|	44.8810293002	22.416445096	190
BAILESTI	1943.04.01	0-20000-0-15465|	44.0292658083	23.3312240839	57
BAISOARA	1941.01.01	0-20000-0-15163|	46.5354712632	23.310232954	1360
BALEA LAC	1978.11.01	0-20000-0-15279|	45.6039304609	24.6147505485	2070
BANLOC	1941.08.01	0-20000-0-15289|	45.3827010758	21.1363985692	83.04

BARAOLT	1953.01.01	0-20000-0-15215|	46.0807711649	25.59584994	508
BARLAD	1900.01.01	0-20000-0-15197|	46.233050198	27.6444496932	172
BARNOVA	2003.11.01	0-20000-0-15094|	47.0123926218	27.5826095797	396
BATOS	1986.10.01	0-20000-0-15124|	46.8861693577	24.6453747609	449
BECHET	1950.10.01	0-20000-0-15494|	43.7897215766	23.9441860197	36
BISOCA	1984.01.01	0-20000-0-15285|	45.5489008949	26.710345849	850
BISTRITA	1909.01.01	0-20000-0-15085|	47.1491021687	24.5139566618	366
BLAJ	1929.10.01	0-20000-0-15209|	46.1784379811	23.9351792246	337
BOITA	1938.01.01	0-20000-0-15277|	45.6529638084	24.2715547534	518
BOROD	1961.01.01	0-20000-0-15095|	46.9936527094	22.5902241962	333
BOTOSANI	1896-01-01	0-20000-0-15020|	47.7356532437	26.6455501701	161
BOZOVICI	1950.03.01	0-20000-0-15364|	44.9183069357	22.00618488	256
BRAILA	1888-01-01	0-20000-0-15333|	45.2066017928	27.9197057994	14.52
BRASOV-GHIMBAV	1871-01-01	0-20000-0-15300|	45.6958549147	25.526183209	534
BUCIN	1977.11.01	0-20000-0-15148|	46.649005211	25.2965138284	1282
BUCURESTI AFUMATI	1949.07.01	0-20000-0-15421|	44.5000964571	26.2127967631	90
BUCURESTI BANEASA	1930.01.01	0-20000-0-15420|	44.5104330044	26.0781904077	90
BUCURESTI FILARET	1896-01-01	0-20000-0-15422|	44.4120630857	26.093829108	82
BUZAU	1896-01-01	0-20000-0-15350|	45.13266328	26.85173192	97

			57	31	
Bucharest	1857-01-01	0-20008-0-ANM|	44.511447	26.077882	91
CALAFAT	1904.03.01	0-20000-0-15482|	43.98489980 35	22.94605240 02	61
CALARASI	1898-01-01	0-20000-0-15460|	44.20573852 89	27.33830807 18	18.72
CALIMANI RETITIS	1990.01.01	0-20000-0-15088|	47.09791896 64	25.24618467	2022
CAMPENI	1938.01.01	0-20000-0-15162|	46.36380006 23	23.04036666 48	591
CAMPINA	1901.01.01	0-20000-0-15349|	45.14370436 59	25.73342579 25	461
CAMPULUNG MUSCEL	1896-01-01	0-20000-0-15324|	45.27476117 45	25.03659903 67	680.7
CARACAL	1896-01-01	0-20000-0-15469|	44.10012091 18	24.35730893 16	106
CARANSEBES	1921.07.01	0-20000-0-15292|	45.41667	22.22917	241
CEAHLAU TOACA	1964.01.01	0-20000-0-15108|	46.97750999 73	25.94993997 49	1897
CERNAVODA	1943.07.01	0-20000-0-15445|	44.34563907 42	28.04371044 17	87.17
CHISINEU-CRIS	1941.08.01	0-20000-0-15136|	46.51852302 73	21.54166030 87	96
CLUJ-NAPOCA	1880-01-01	0-20000-0-15120|	46.77777050 44	23.57130529 39	410
CONSTANTA	1896-01-01	0-20000-0-15480|	44.21381438 88	28.64556468 39	08.dec
CONSTANTA DIG	2018.06.01	0-20000-0-15483|	44.21974	28.64896	0
CORUGEA	1954.02.01	0-20000-0-15408|	44.73433502 16	28.34204745	219.2
COTNARI	1928.10.01	0-20000-0-15056|	47.35832019 48	26.92563603 57	289
CRAIOVA	1897-01-01	0-20000-0-15450|	44.31014043 13	23.86698474 41	192
CUNTU	1956.12.01	0-20000-0-15316|	45.30048006 07	22.50149032 42	1456

CURTEA DE ARGES	1933.08.01	0-20000-0-15347|	45.1787908991	24.6697421436	448
Constanta (Black Sea)	1994.10.19	0-20008-0-BSC|	44.1699981689	28.6800003052	3
DARABANI	1986.11.01	0-20000-0-15000|	48.1949023042	26.5734788625	259
DEJ	1952.07.01	0-20000-0-15083|	47.1279938132	23.8988573877	232
DEVA	1921.05.01	0-20000-0-15230|	45.8649230138	22.898806236	240
DRAGASANI	1956.01.01	0-20000-0-15395|	44.6654393541	24.2371862568	280
DROBETA-TURNU SEVERIN	1896-01-01	0-20000-0-15410|	44.6264587019	22.6260737132	77
DUMBRAVENI	1939.09.01	0-20000-0-15189|	46.2278711318	24.5916128495	318
DUMBRAVITA DE CODRU	1983.01.01	0-20000-0-15138|	46.6446237915	22.1712028507	586
FAGARAS	1923.02.01	0-20000-0-15235|	45.8362544124	24.9352552192	428
FETESTI	1949.09.01	0-20000-0-15444|	44.3915170894	27.8390070314	58.25
FOCSANI	1976.11.01	0-20000-0-15264|	45.6875233618	27.1997887135	57
FUNDATA	1949.07.01	0-20000-0-15301|	45.43147039	25.2715382709	1384
GALATI	1896-01-01	0-20000-0-15310|	45.4729181384	28.0323010582	69
GIURGIU	1896-01-01	0-20000-0-15491|	43.8751663023	25.9327409543	23.jún
GORGOVA	1954.01.01	0-20000-0-15336|	45.17612	29.15154	1
GRIVITA	1928.11.01	0-20000-0-15405|	44.740788915	27.2945982971	50
GURA PORTITEI	1985.04.09	0-20000-0-15428|	44.6898373603	28.9989878847	2
GURAHONT	1944.03.01	0-20000-0-15182|	46.2791917177	22.3333052054	177

HARSOVA	1953.04.20	0-20000-0-15406|	44.6916964069	27.9635349291	37.51
HOLOD	1967.11.01	0-20000-0-15117|	46.7885831307	22.1122616011	163
HOREZU 1550	2018.10.19	0-642-20000-15343	45.2552890527	23.9482361032	1555.47
HUEDIN	1958.01.01	0-20000-0-15099|	46.8573120648	23.0325446006	560
IASI	1886-01-01	0-20000-0-15090|	47.163333333	27.6272222222	74.29
IEZER	1958.01.01	0-20000-0-15033|	47.6025812783	24.6490206127	1785
INTORSURA BUZAULUI	1946.01.01	0-20000-0-15261|	45.6682744785	26.0567735881	707
JIMBOLIA	1985.12.01	0-20000-0-15245|	45.78085003	20.7023580223	79
JOSENI	1921.06.01	0-20000-0-15127|	46.7057389033	25.5125729394	750
JURILOVCA	1953.01.01	0-20000-0-15409|	44.7660720152	28.8764185996	37.65
LACAUTI	1956.02.01	0-20000-0-15262|	45.8239179572	26.3755541583	1776
LUGOJ	1930.07.01	0-20000-0-15270|	45.6865410804	21.933284932	123
MAHMUDIA	1992.07.01	0-20000-0-15337|	45.0871787552	29.0733967991	167.53
MANGALIA	1928.08.01	0-20000-0-15499|	43.816124375	28.5874503506	6
MEDGIDIA	1950.05.01	0-20000-0-15462|	44.243198519	28.2513983724	69.54
MIERCUREA CIUC	1948.01.01	0-20000-0-15170|	46.3713166568	25.7726166755	661
MOLDOVA VECHE	1962.01.01	0-20000-0-15388|	44.7224425719	21.6332589523	82
MORARESTI	1959.01.01	0-20000-0-15345|	45.0163091541	24.5701480532	548
Magurele_INOE	2005.12.20	0-20008-0-INO|	44.34805	26.02888	93

NEGRESTI	1949.07.01	0-20000-0-15113|	46.83809870 92	27.44214555 98	133
OBARSIA LOTRULUI	1974.05.04	0-20000-0-15297|	45.43546044 55	23.63084568 34	1348
OCNA SUGATAG	1901.01.01	0-20000-0-15015|	47.77706162 58	23.94046026 38	503
ODORHEIUL SECUIESC	1933.06.01	0-20000-0-15168|	46.29677147 72	25.29176213 58	523
OLTENITA	1983.01.01	0-20000-0-15475|	44.07469355 82	26.63713682 4	14.09
ORADEA	1871-07-01	0-20000-0-15080|	47.03570900 98	21.89592406 38	136
ORAVITA	1871-01-01	0-20000-0-15338|	45.03871153 3	21.71048270 83	309
PALTINIS SIBIU	1925.08.01	0-20000-0-15254|	45.65712277 09	23.93244362 04	1453
PARANG	1940.12.01	0-20000-0-15320|	45.38737165 24	23.46307024 11	1548
PATARLAGELE	1951.09.01	0-20000-0-15328|	45.32465241 95	26.36950780 21	289
PENTELEU	1988.01.01	0-20000-0-15284|	45.60266628 78	26.40983710 15	1632
PETROSANI	1939.12.01	0-20000-0-15296|	45.40629492 65	23.37670106 07	607
PIATRA NEAMT	1899-02-01	0-20000-0-15109|	46.93367892 61	26.38951754 57	360
PITESTI	1899-07-01	0-20000-0-15373|	44.84893196 1	24.86598913 12	316
PLOIESTI	1898-01-01	0-20000-0-15377|	44.95575309 03	25.98741925 27	177
POIANA STAMPEI	1954.01.18	0-20000-0-15069|	47.32466450 76	25.13445047 11	923
POLOVRAGI	1953.12.27	0-20000-0-15344|	45.16545041 36	23.80860656 98	531
PREDEAL	1927.09.01	0-20000-0-15302|	45.50628452 11	25.58350572 55	1090
RADAR Bobohalma			46.36	24.225	523

RADAUTI	1943.06.01	0-20000-0-15007|	47.83786045 86	25.89044943 53	389
RAMNICU SARAT	1898-01-01	0-20000-0-15307|	45.39064338 4	27.03853107 4	152
RAMNICU VALCEA	1904.01.01	0-20000-0-15346|	45.08882112 25	24.36281391 23	237
RESITA	1978.12.01	0-20000-0-15314|	45.31436745 71	21.88698931 14	279
ROMAN	1886-02-01	0-20000-0-15111|	46.96910270 95	26.91183400 72	216
ROSIA MONTANA	1983.01.01	0-20000-0-15184|	46.31759461 62	23.13904696 6	1196
ROSIORII DE VEDE	1899-07-01	0-20000-0-15470|	44.10721333 62	24.97874007 13	102.15
SACUIENI	1949.06.01	0-20000-0-15042|	47.34415861 53	22.09450715 73	124
SANNICOLAUL MARE	1930.02.01	0-20000-0-15199|	46.07128625 47	20.60156002 5	85
SARMASU	1966.11.01	0-20000-0-15123|	46.74755310 73	24.15980390 59	399
SATU MARE	1936.12.01	0-20000-0-15010|	47.72148469 25	22.88714902 92	123
SEBES-ALBA	1950.04.01	0-20000-0-15231|	45.96361	23.53306	271
SEMENIC	1955.12.20	0-20000-0-15315|	45.18139465 84	22.05580461 1	1432
SFANTU GHEO. COVASNA	1927.02.01	0-20000-0-15238|	45.87155902 07	25.80212023 34	523
SFANTU GHEORGHE DEL.	1942.04.01	0-20000-0-15387|	44.89764853 1	29.59910764 09	1.43
SIBIU	1920.01.01	0-20000-0-15260|	45.78930664 25	24.09141966 4	443
SIGHETUL MARMATIEI	1948.06.01	0-20000-0-15004|	47.93930334 12	23.90433593 91	275
SINAIA 1500	1886-01-01	0-20000-0-15325|	45.35497159 29	25.51418529	1510
SIRIA	1984.01.01	0-20000-0-15179|	46.26485555 73	21.66278297 48	473

SLATINA	1976.08.01	0-20000-0-15434|	44.4421752469	24.3545284292	172
SLOBOZIA	1979.06.06	0-20000-0-15425|	44.5527589143	27.3835630226	51.18
STANA DE VALE	1979.01.01	0-20000-0-15118|	46.6898199891	22.6233821978	1108
STANCA STEFANESTI	1984.09.01	0-20000-0-15025|	47.832254341	27.2197246685	110
STEI	1952.07.16	0-20000-0-15160|	46.5280068183	22.4664942118	278
STOLNICI	1958.11.18	0-20000-0-15416|	44.5627196672	24.7898097642	208.72
SUCEAVA	1940.03.01	0-20000-0-15023|	47.632900414	26.2405527914	352
SULINA	1878-01-01	0-20000-0-15360|	45.1623111	29.7268286	12.69
SUPURU DE JOS	1970.01.01	0-20000-0-15044|	47.4550888274	22.7835807335	159
TARCU	1961.01.01	0-20000-0-15317|	45.2810049052	22.5327216473	2180
TARGOVISTE	1895-08-01	0-20000-0-15375|	44.92972222	25.42777778	296.49
TARGU LAPUS	1984.01.01	0-20000-0-15047|	47.4396279324	23.8722144087	363
TARGU LOGRESTI	1953.01.01	0-20000-0-15369|	44.8780985268	23.708702262	262
TARGU NEAMT	1899-01-01	0-20000-0-15073|	47.2121375672	26.3791903054	387
TARGU OCNA	1894-02-01	0-20000-0-15194|	46.2727079276	26.6410447048	242
TARGU SECUIESC	1954.02.01	0-20000-0-15217|	45.9929011242	26.1150763345	568
TARGU-JIU	1899-01-01	0-20000-0-15340|	45.04055555	23.26027777	204.26
TARGU-MURES	1924.02.01	0-20000-0-15145|	46.52805555	24.52249999	310
TARNAVENI	1987.01.01	0-20000-0-15165|	46.360077246	24.2259752006	523
TEBEA	1963.04.15	0-20000-0-15206|	46.169477607	22.7261887503	273

TECUCI	1904.08.13	0-20000-0-15265|	45.8415702599	27.4090147093	60
TIMISOARA	1921.06.01	0-20000-0-15247|	45.77105643	21.258071077	86
TITU	1951.08.11	0-20000-0-15419|	44.652858712	25.5792011539	159.03
TOPLITA	1953.05.01	0-20000-0-15107|	46.9263921762	25.3599048511	687
TULCEA	1904.06.01	0-20000-0-15335|	45.1905064849	28.8241607619	4.36
TURDA	1941.01.01	0-20000-0-15143|	46.5830478134	23.791249006	427
TURNU-MAGURELE	1896-01-01	0-20000-0-15490|	43.7602777778	24.8783333333	30.64
URZICENI	1944.01.01	0-20000-0-15402|	44.7217357495	26.6572078568	60
VARADIA DE MURES	1954.01.01	0-20000-0-15204|	46.0192079273	22.1509534266	156
VARFU OMU	1927.01.01	0-20000-0-15280|	45.4457927989	25.456690976	2504
VASLUI	1893-12-01	0-20000-0-15154|	46.6461181829	27.7144460799	116
VIDELE	1951.01.01	0-20000-0-15455|	44.282867058	25.5370038888	106.18
VLADEASA 1800	1961.01.01	0-20000-0-15119|	46.7592547489	22.7941829277	1836
VOINEASA	1953.06.15	0-20000-0-15319|	45.4111963067	23.9670060623	573
ZALAU	1935.09.01	0-20000-0-15063|	47.1948817857	23.0467374013	295
ZIMNICEA	1979.11.01	0-20000-0-15498|	43.661515743	25.3536153412	33.63

5.16. Slovenia

Mr. Drago Groselj, Director of the Environmental Measurement Office (Slovenian Environment Agency, ARSO), provided information on the meteorological monitoring network of Slovenia.

The Republic of Slovenia is located in Central Europe by the Adriatic Sea. Its territory is 20 271 km^2, 0.7% of which is water surface. The population is around 2.1 million. Snow is quite frequent in winter.

There is one radiosonde station in Slovenia at Ljubljana/Bezigrad. There are 182 stations delivering snow depth data manually and 68 automatic snow measuring stations in the country.

ARSO operates 54 automatic meteorological stations equipped (at least) with thermometers, ombrometers and anemometers. 33 AWSs report data in 10- minute intervals and 21 AWSs have report intervals of 30 min.

The Slovenian Environment Agency has operated calibration laboratory with ISO/IEC 17025/2017 accreditation for thermometer, hygrometer, barometer and air quality parameters calibrations since 1999. Calibration laboratory also performs calibration of pyranometers, cup/vane anemometer testing and calibration of precipitation instruments. ARSO calibration laboratory is also WMO Regional Instrument Centre and supports activities related to WMO Terms of References for RIC. Slovenian Environment Agency recalibrates meteorological instruments in the calibration laboratory and do not perform field test or field calibrations.

Meteorological instruments deployed in the meteorological network are subject to periodical recalibrations in calibration laboratory. Recalibration frequency depends on type of usage and type of instruments and is defined in basic document "Quality Assurance System for Measuring Networks of the ARSO (2003)" which defines with quality assurance procedures for field instruments.

For data which are available in real time, ARSO makes some basic controls such as control of physical limits, climatological limits, temporal consistency (if there are sudden spikes). For newer stations which provide data in 10 min resolution sensors themselves send information if anything is wrong. With a certain delay spatial control, control between different parameters, control with the meteorological radar, human control is also carried out.

The Slovenian Environment Agency has successfully concluded infrastructure investment project BOBER in last cohesion perspective. The goal of the project was to renew the technical infrastructure of the Agency. The goals also included upgrades or new automatic meteorological and hydrological stations and second meteorological radar in the western part of Slovenia was installed. Some of the observation stations need future infrastructural upgrades (stations not included in above-mentioned project).

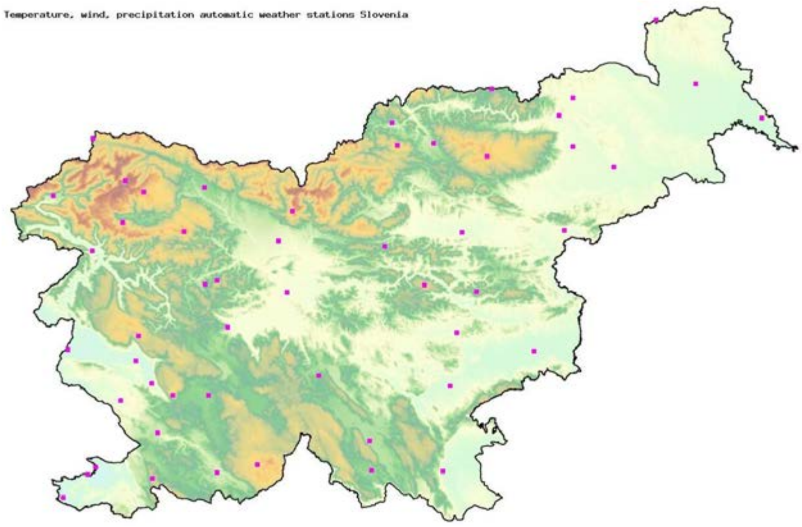

Figure 18. Automatic Weather Stations in Slovenia

Table 33. Metadata of the Slovenian AWSs – 30 min data

Metadata of the Slovenian AWSs – 30 min data				
Station Name	Date established	Latitude	Longitude	Elevation
BORŠT PRI GORENJI VASI	2004-09-25	46.0867203	14.1806215	530
BOVEC - LETALIŠČE	1998-12-18	46.3317114	13.5538317	441
CELJE - MEDLOG	2008-02-01	46.2365796	15.2258697	241.73
CERKLJE - LETALIŠČE	2004-07-11	45.8987056	15.5184432	154
ILIRSKA BISTRICA - KOSEZE	2005-01-18	45.5530831	14.2354512	415
KOPER - KAPITANIJA	2006-03-20	45.5481335	13.7245716	4
LENDAVA	2006-04-11	46.5525562	16.4579583	159
LESCE - LETALIŠČE	2004-03-17	46.3619870	14.1717817	509
LETALIŠČE EDVARDA RUSJANA MARIBOR	2000-10-17	46.4796661	15.6817898	264
LJUBLJANA - BEŽIGRAD	1993-06-17	46.0655056	14.5123590	299
MALKOVEC	2006-03-17	5.9531144	15.2048916	397
ŠKOCJAN	2004-09-01	45.6638409	13.9931187	420
PODČETRTEK – ATOMSKE TOPLICE	2000-05-19	46.1547407	15.6083464	202
PORTOROŽ - LETALIŠČE	1993-03-25	45.4753421	13.6160354	2
RATEČE	1999-12-27	46.4970892	13.7128961	864
RAVNE NA KOROŠKEM	2009-04-02	46.5477322	14.9400262	396
SOTINSKI BREG	2006-12-01	46.8359030	16.0306726	415
ČRNOMELJ - DOBLIČE	2002-04-11	45.5599784	15.1461858	157
KOPER	2005-07-05	45.5430156	13.7135205	56
AJDOVŠČINA - DOLENJE	1993-01-27	45.8661839	13.9013289	86
KOPER - LUKA	1991-08-22	45.5645364	13.7447878	2

Table 34. Metadata of the Slovenian AWSs – 10 min data

Metadata of the Slovenian AWSs – 10 min data				
Station Name	Date established	Latitude	Longitude	Elevation
BILJE	1991-11-27	45.8955597	13.6239843	55

GAČNIK	1999-03-10	46.6177836	15.6837874	292
GODNJE	2016-02-15	45.7546841	13.8433452	320
ISKRBA	2014-01-13	45.5612122	14.8580434	532
KOČEVJE	2015-09-14	45.6458223	14.8496220	468
KREDARICA	1994-09-12	46.3787038	13.8488997	2513
KRVAVEC	1999-08-06	46.2973495	14.5333144	1742
KUM	2016-06-15	46.0878555	15.0732371	1211
LETALIŠČE JOŽETA PUČNIKA LJUBLJANA	2017-08-18	46.2113776	14.4784423	362.13
LISCA	1996-11-05	46.0677706	15.2848952	947
MARIBOR - VRBANSKI PLATO	2016-12-06	46.5677779	15.6260334	279
MURSKA SOBOTA - RAKIČAN	1993-07-09	46.6520777	16.1912806	186.7
NANOS	2016-05-09	45.7713727	14.0535887	1241
NOVO MESTO	1993-01-18	45.8018158	15.1772634	220
PASJA RAVAN	2015-01-06	46.0979467	14.2281808	1019
PODNANOS	2015-07-22	45.8045461	13.9659152	153
POSTOJNA	1994-02-17	45.7722455	14.1973024	538
PTUJ	1995-11-30	46.4197380	15.8492017	222
RATITOVEC	2016-09-14	46.2361884	14.0901703	1639
ROGAŠKA SLATINA	2015-12-27	46.2409210	15.6438847	289
ROGLA	1995-04-01	46.4530451	15.3314697	1495
RUDNO POLJE	1995-10-12	46.3462562	13.9234793	1344
SLAVNIK	2016-05-09	45.5336171	13.9760050	1020
SVIŠČAKI	2016-07-05	45.575642	14.3988088	1302
TOLMIN - VOLČE	2015-09-11	46.1776973	13.7180399	188
TROJANE - LIMOVCE	2016-01-11	46.1984447	14.9113324	673
URŠLJA GORA	2016-07-07	46.4849251	14.9633558	1696
VELIKE LAŠČE	2015-11-11	45.8309980	14.6427335	528

VOGEL	2016-08-24	46.2594406	13.8396158	1515
VRHNIKA	2015-12-16	45.9660100	14.2716872	370
ZGORNJA KAPLA	2015-07-22	46.6433992	15.3501023	722
ŠMARTNO PRI SLOVENJ GRADCU	1994-05-17	46.4895619	15.1112254	444
OTLICA	2006-06-08	45.9376714	13.9115656	965

Table 35. Operational weather radars in Slovenia

Operational weather radars in Slovenia						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Slovenia	Lisca wgs84	Active	Magnetron	Single	C
2	Slovenia	Pasja Ravan	Active	Magnetron	Dual	C

5.17. Turkey

No information has been sent by Turkish State Meteorological Service, so the monitoring network described below reflected by the metadata kept in publicly available databases and other studies.

The Republic of Turkey is a transcontinental country located mainly on the Anatolian peninsula in Western Asia, with a smaller portion on the Balkan peninsula in Southeast Europe. The total area is 783 356 km^2, 1.3% of which is water surface. The population is about 83.2 million.

Turkey has the largest territory among the SEE-MHEWS partners and the Turkish State Meteorological Service (TSMS) operates the biggest monitoring network. There are 9 operational radiosonde stations in Turkey, with GPS-based system launching twice a day (00 and 12 UTC): in Izmir, Istanbul, Isparta, Ankara, Samsun, Kayseri, Adana, Diyarbakir and Erzurum. There are 131 stations delivering snow depth data manually and no automatic snow measuring station in the country.

Mr. Ercan Büyükbas, the former Head of the Observing Systems Department at TSMS, described the Turkish monitoring network in 2015 as it can be seen in Figure 19.

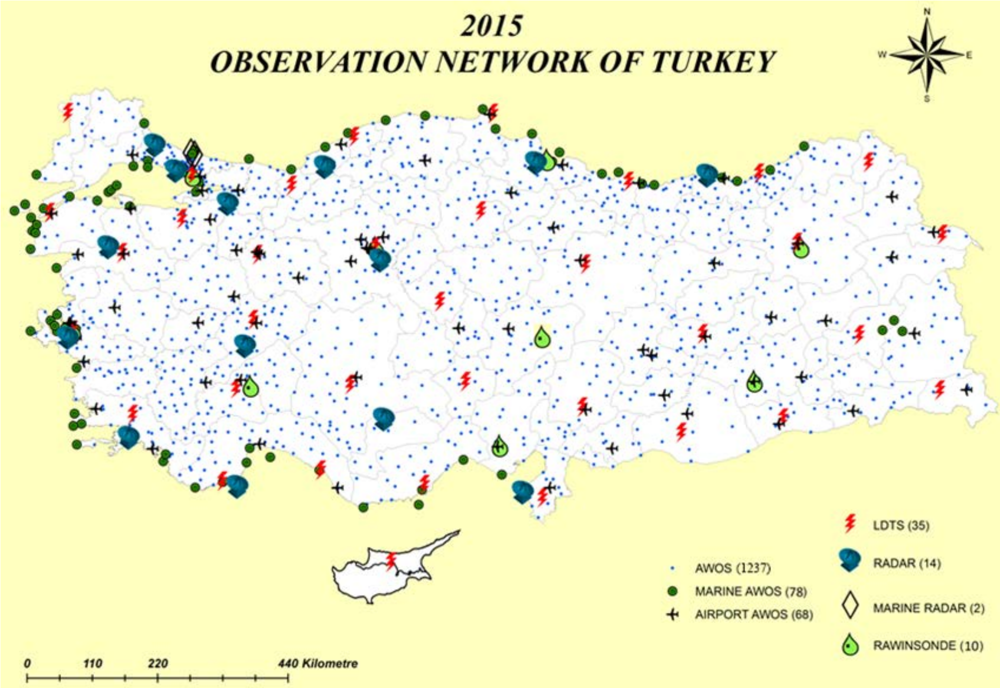

Figure 19. Meteorological observational network of Turkey in 2015

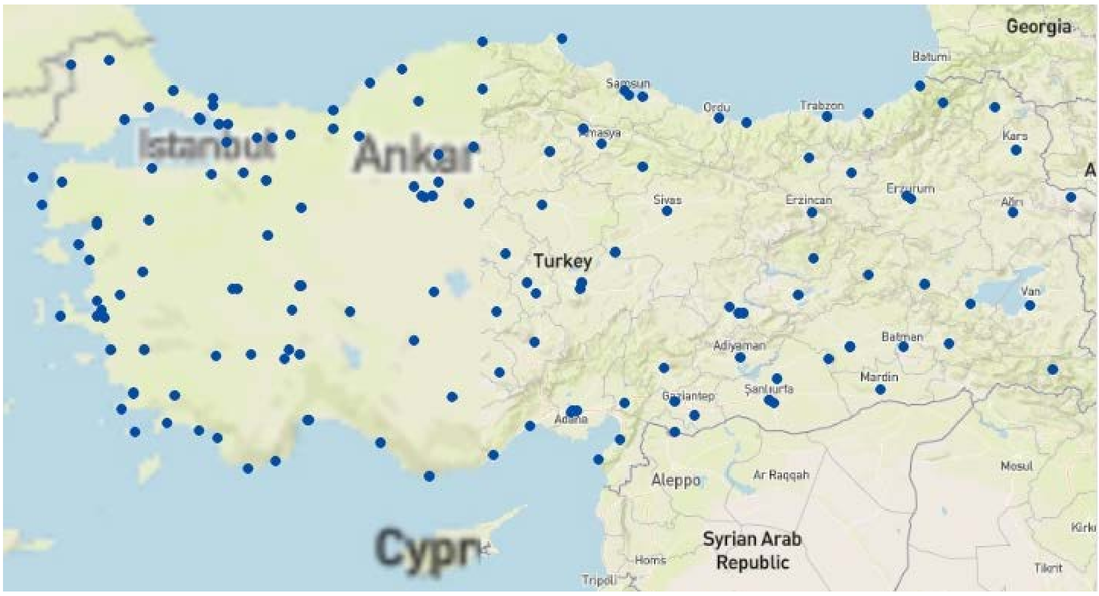

Figure 20. Map of fixed land stations in Turkey registered in OSCAR

Table 36. Metadata of fixed land stations in Turkey registered in OSCAR

Metadata of fixed land stations in Turkey registered in OSCAR					
Station	Date established	WIGOS station Identifier(s)	Latitude	Longitude	Elevation
ADANA ĺžAKÄ°RPAĺžA HAVALÄ°MANI	1972.01.01		36.9838	35.298	20
ADANA/BOLGE	1928.01.01		37.0041	35.3443	23

ADAPAZARI	1951.01.01		40.767573	30.393406	30
ADIYAMAN	1962.09.17		37.75533333	38.2775	672
AFYONKARAHISAR HAVALÄ°MANI	2005.07.16		38.7328	30.5999	1001
AFYONKARAHÄ°SAR	1929.02.01		38.738019	30.560374	1034
AGRI	1940.01.01		39.725333	43.052167	1646
AKHISAR	1937.01.01		38.911776333	27.823285667	92
AKSARAY	1929.01.01		38.3705	33.9987	970
AKSEHIR	1941.01.01		38.368833	31.429667	1002
AKÄ‡AKOCA	1959.01.01		41.0895	31.1374	10
ALANYA	1941.01.01		36.550736	31.980348	6
AMASYA	1961.01.01		40.65	35.85	412
ANAMUR	1948.01.01		36.0833333333	32.8333333333	3
ANKARA BÄ–LGE	1926.01.01		39.95	32.8833333333	891
ANKARA ESENBOGA HAVALIMANI	1956.01.01		40.124	32.9992	959
ANKARA GUVERCINLIK HAVALÄ°MANI	2001.07.06		39.9343	32.7387	820
ANKARA MÄśRTED HAVALÄ°MANI	2001.01.01		40.0788	32.5657	838
ANTALYA HAVALÄ°MANI	1930.01.01		36.8666666667	30.7333333333	51
ANTALYA-BOLGE	2001.04.03		36.8666666667	30.7	45
ARDAHAN	1958.01.01		41.1166666667	42.7166666667	1829
ARTVIN	1929.01.01		41.1833333333	41.8166666667	628
AYDIN	1940.01.04		37.85	27.85	55
AYVALIK	1958.01.01		márc.39	26.7	4
Ankara	1994.01.01		39.9500007629	32.8829994202	896

BALIKESÄ°R HAVALÄ°MANI	1998.07.01		39.61666666 67	27.9166666 667	103
BANDIRMA HAVALÄ°MANI	2001.01.01		40.31666666 67	27.9666666 667	51
BARTIN	1961.01.01		41.6248	32.3569	33
BATMAN	1952.01.01		37.88333333 33	41.1166666 667	545
BAYBURT	1959.01.01		40.25	40.2333333 333	1584
BILECIK	1939.01.01		40.15	29.9666666 667	539
BINGOL	1961.01.01		38.884667	40.500667	1139
BODRUM	1937.04.01		37.032839	27.439801	26
BODRUM/MILAS			37.23333333 33	27.6666666 667	6
BOLU	1929.01.01		40.732893	31.60218	743
BOZCAADA	1967.01.01		39.83333333 33	26.0666666 667	30
BURDUR	1931.02.13		37.721988	30.293968	957
BURSA	1926.09.01		40.230827	29.013347	100
CANAKKALE	1929.01.01		40.141	26.399284	6
CANKIRI	1929.01.01		40.608167	33.610231	755
CESME	1963.04.01		38.303649	26.372437	5
CIHANBEYLI	1929.01.01		38.650578	32.92186	973
CORLU	1961.01.01		41.13333333 33	27.9166666 667	174
CORUM	1929.01.01		40.546117	34.936221	776
Cubuk II	1993.03.01		40.5	33	1169
DALAMAN HAVALÄ°MANI	2001.01.01		36.7229	28.7896	5
DATCA	1965.01.01		36.708342	27.691873	28
DENIZLI	1957.01.01		37.762028	29.092075	425
DIKILI	1941.01.01		39.07372	26.887984	3

DIYARBAKIR HAVALÄ°MANI	1929.01.01		37.8973	40.2027	674
DIYARBAKIR-BOLGE			37.9	40.2	675
DUZCE	1959.01.01		40.843664	31.148755	146
EDIRNE	1930.01.01		41.676694	26.550838	51
EDREMIT	1959.01.01		39.58947	27.01915	21
ELAZIG	2001.01.01		38.6058	39.2973	881
EREGLI/KONYA	1964.01.01		37.5255	34.0485	1046
ERZINCAN HAVALÄ°MANI	2001.01.01		39.716	39.525	1154
ERZURUM BOLGE	2002.11.01		39.905833	41.254444	1860
ERZURUM HAVALÄ°MANI	1929.01.01		39.9529	41.1897	1758
ESKISEHIR HAVALIMANI	1978.06.01		39.781	30.5797	786
ETIMESGUT HAVALÄ°MANI	1994.06.01		39.9558	32.6854	806
FETHIYE	1941.01.01		36.626611	29.123804	3
FINIKE	1960.01.01		36.3024	30.1458	2
GAZIANTEP HAVALÄ°MANI	2001.01.01		36.9468	37.4617	700
GEMEREK	1963.06.15		39.185	36.0805	1182
GIRESUN	1929.01.01		40.922667	38.387833	38
GOLCUK/DUMLUPINAR	1954.01.01		40.72677883	29.8065693	18
GUMUSHANE	1929.01.01		40.459833	39.465333	1216
HAKKARI	1961.01.01		37.5745	43.738833	1727
HOPA	1962.01.01		41.4065	41.433	33
IGDIR	1940.11.03		39.922666	44.052333	856
INEBOLU	1951.01.01		41.9789	33.7636	64
ISKENDERUN	1939.01.01		36.592358	36.158158	4
ISPARTA	1929.01.01		37.784833	30.567912	997
ISPARTA/SULEYMAN DEMIREL HAVALÄ°MANI	2006.03.01		37.8554	30.3683	869
ISTANBUL BOLGE (KARTAL)	2007.11.24		40.911345	29.155803	18

ISTANBUL/ATATURK			40.9666666667	28.8166666667	48
ISTANBUL/GOZTEPE	1929.01.01		40.9	29.15	
IZMIR/A. MENDERES	1987.01.01		38.295	27.1481	120
IZMIR/CIGLI	1937.01.01		38.5127	27.0144	5
IZMIR/GUZELYALI	1926.01.01		38.394873	27.081855	29
KAHRAMANMARAS	1961.01.01		37.6	36.9333333333	572
KAPODOKYA			38.7666666667	34.5333333333	947
KARABUK			41.2	32.6333333333	259
KARAMAN	1929.01.01		37.193167	33.220167	1018
KARS	1994.01.01		40.564	43.1116	1795
KAS	1953.01.01		36.200166	29.650162	153
KASTAMONU	1930.01.01		41.370966	33.775609	800
KAYSERI BOLGE	1951.01.01		38.6833333333	35.4833333333	1096
KAYSERI/ERKILET	1964.01.01		38.773	35.4908	1053
KILIS	1932.01.01		36.708436	37.112022	640
KIRIKKALE	1950.01.01		39.843304	33.51807	748
KIRKLARELI	1929.01.01		41.738155	27.217845	232
KIRSEHIR	1929.01.01		39.163934	34.156098	1007
KOCAELÄ° CENGIZTOPEL HAVALÄ°M.	2001.02.13		40.73	30.8	70
KONYA	1949.01.01		37.9837	32.574	1031
KUMKOY	1951.01.01		41.25047	29.038367	38
KUSADASI	1927.01.01		37.859742	27.265216	25
KUTAHYA	1929.01.01		39.417144	29.989066	969
Koca Seyit HavalimanÄ±	1997.01.01		39.5592	27.0253	19
MALATYA/BOLGE			38.35	38.3166666	948

				667	
MALATYA/ERHAC	1937.01.01		38.4343	38.0934	849
MANISA	1929.01.01		38.615329	27.4049407	71
MARDIN	1938.01.01		37.310325	40.728361	1040
MARMARIS	1950.01.01		36.839542	28.245166	16
MERSIN	1929.01.01		36.780826	34.603055	7
MERZIFON	1949.01.01		40.8357	35.5258	535
MUGLA	1926.01.01		37.209486	28.366834	646
MUS	1933.01.01		38.750906	41.502251	1322
MUÄžLA BODRUM-MILAS HAVALÄ°M.	2003.10.25		37.251	27.6573	11
NEVSEHIR	1955.01.01		38.616324	34.702483	1260
NIGDE	1935.01.01		37.958667	34.6795	1211
ORDU	1929.01.01		40.983833	37.885833	5
OSMANIYE	1930.01.01		37.102111	36.253939	94
RADAR Afyonkarahisar			38.4016666667	30.4191666667	2247
RADAR Ataturk AirportMobile			40.9788888889	28.8038888889	41
RADAR Gaziantep			37.1372222222	37.1372222222	1456
RADAR Hatay			36.3177777778	35.7880555556	312
RADAR Ä°stanbul			41.345	28.355	378
RADAR Ä°zmir			38.3113888889	27.0011111111	973
RADAR ĹžanlÄ±urfa			37.7166666667	39.8288888889	1922
RIZE	1929.01.01		41.4	40.501333	3
SABIHA GOKCEN	2001.01.01		40.8977	29.3033	99
SAMSUN	1929.01.01		41.344167	36.256389	4
SAMSUN Ă‡ARĹžAMBA	2001.01.01		41.2583	36.5562	7

HAVALÄ°M.					
SAMSUN/MEYDAN	1819-01-01		41.2833333333	36.3333333333	165
SANLIURFA	1929.01.01		37.1608	38.7863	550
SANLIURFA/MEYDAN			37.1	38.85	452
SARIYER	1930.01.01		41.146382	29.050195	59
SIIRT	1929.01.01		37.931903	41.935389	895
SILIFKE	1929.01.01		36.382366	33.937284	10
SINOP (17026-0)	1929.01.01		42.029916	35.15447	32
SIVAS	1929.01.01		39.743667	37.002	1294
TATVAN	1963.01.01		38.4833333333	42.3	1665
TEKIRDAG	1929.01.01		40.958534	27.496509	4
TOKAT	1929.01.01		40.331167	36.557667	611
TRABZON	1949.01.01		40.995	39.783	39
TULGA MEYDAN	1998.01.01		38.35	38.25	921
TUNCELI	1950.01.01		39.105833	39.540833	981
USAK	1961.01.01		38.6833333333	29.4	919
USAK MEYDAN	2010.01.01		38.68	29.4713	874
VAN/FERITMELEN	1964.01.01		38.469	43.337	1665
YALOVA	1930.01.01		40.660344	29.28663	4
YENISEHIR	1983.01.01		40.2552	29.5624	238
YOZGAT	1929.01.01		39.824342	34.815914	1301
ZONGULDAK	1931.01.01		41.449243	31.777917	135
Ã‡ANAKKALE GOKCEADA HAVALÄ°M.	2016.11.01		40.202935	25.884023	19
Ã‡ardak	1961.01.01		37.785	29.7011	848
Ä°NCÄ°RLÄ°K HAVALÄ°MANI	2001.01.01		37.0005	35.4183	65
ÅžANLIURFA GAPHAVALÄ°MANI	2007.08.03		37.4454	38.9035	825

ADANA ĺžAKÄ°RPAĺžA HAVALÄ°MANI	1972.01.01		36.9838	35.298	20
ADANA/BOLGE	1928.01.01		37.0041	35.3443	23
ADAPAZARI	1951.01.01		40.767573	30.393406	30
ADIYAMAN	1962.09.17		37.75533333	38.2775	672
AFYONKARAHISAR HAVALÄ°MANI	2005.07.16		38.7328	30.5999	1001

Monitoring network of TSMS has dynamically developed lately. The total number of AWS is around 1700, while the number of weather radars increased to 19. The orifice of the collectors of precipitation gauges in Turkey is 400 cm^2.

Table 37. Operational weather radars in Turkey

Operational weather radars in Turkey						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Turkey	Afyonkarahisar	Active	Magnetron	Dual	C
2	Turkey	Ankara	Active	Klystron	Dual	C
3	Turkey	Antalya	Active	Klystron	Dual	C
4	Turkey	ANTALYA_X BAND	Active	Magnetron	Dual	X
5	Turkey	Balıkesir	Active	Magnetron	Single	C
6	Turkey	Bursa	Active	Magnetron	Dual	C
7	Turkey	Erzurum	Active	Magnetron	Dual	C
8	Turkey	Gaziantep	Active	Magnetron	Dual	C
9	Turkey	Hatay	Active	Klystron	Dual	C
10	Turkey	İstanbul	Active	Magnetron	Single	C
11	Turkey	İzmir	Active	Klystron	Dual	C
12	Turkey	Karaman	Active	Magnetron	Dual	C
13	Turkey	Mobile-X	Active	Magnetron	Dual	X
14	Turkey	Mugla	Active	Klystron	Dual	C
15	Turkey	Samsun	Active	Klystron	Single	C
16	Turkey	Sivas	Active	Magnetron	Dual	C
17	Turkey	Şanlıurfa	Active	Magnetron	Dual	C

18	Turkey	Trabzon	Active	Klystron	Single	C
19	Turkey	Zonguldak	Active	Magnetron	Single	C

There is a regional-based organizational structure supported from the Centre for preventive and corrective maintenance in Turkey. Turkey is divided into 15 regions. The automatic rain gauges undergo in-situ calibration twice a year. TSMS applies a Quality Management System ISO 9001:2008. Basic quality control algorithms are applied. TSMS runs a calibration centre according to ISO 17025 in Ankara with accreditation to air temperature, humidity, pressure and wind speed. Wind direction sensors and data collectors are also calibrated. All activities are inserted in a web-based monitoring programme.

5.18. Ukraine

Ms Olha Dubrovina, Focal point on OSCAR and Observations issues (Ukrainian Hydrometeorological Center, UHMC), provided information on the meteorological monitoring network of Ukraine.

Ukraine is located in Eastern Europe by the Black Sea. The total area (including Crimean Peninsula) is 603 628 km^2, 7% of which is water surface, that is the highest value among the project partners. The population is about 42.3 million (including Crimea and Sevastopol). Meteorological measurements in the territory of Crimea (27 000 km^2 with 2.3 million inhabitants) controlled by Roshydromet, Federal Service for Hydrometeorology and Environmental Monitoring. UHMC does not have access to the database of Crimea stations.

There are 6 operational radiosonde stations in the country: Lviv, Shepetivka, Kyiv, Odessa, Kryvyi Rih, Kharkiv. With the additional three stations (Uzhhorod, Chernivtsi and Bilohirsk), radio sounding was carried out at 9 stations in Ukraine over the last decades, the frequency of ascents can be seen in the figure below.

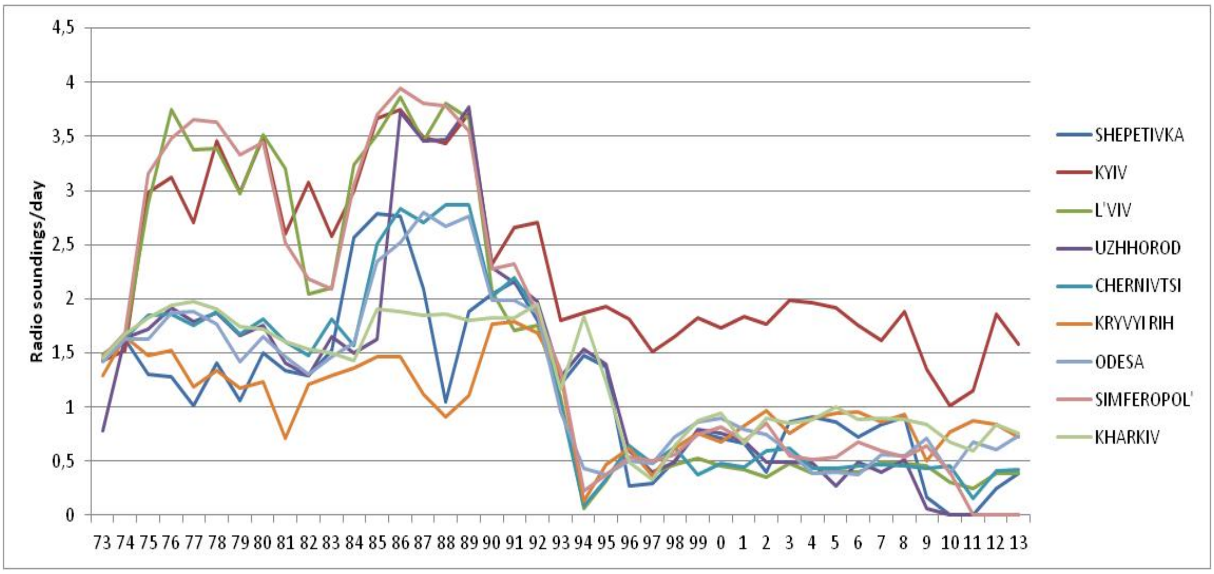

Figure 21. Frequency of upper-air measurements in Ukraine since 1973 to 2013

There are 442 stations delivering snow depth data manually and no automatic snow measuring station in the country. Some years ago, 534 snow measuring stations operated.

Meteorological data/information measured at all the 61 manned meteorological stations are transferred every 3 hours to the Ukrainian Hydrometeorological Center in Kyiv then into the Global Telecommunications System. Since UHMC does not operate automatic weather stations, Ukraine cannot provide data with periods of 10 minutes and 1 hour.

Table 38. Metadata of the fixed land stations in Ukraine

Metadata of the fixed land stations in Ukraine				
Station	Date established	Latitude	Longitude	Elevation
Askania-Nova	1925.01.01	46.451011	33.879906	30
Bakhmut	1962.01.01	48.557192	38.014736	124
Behtery	1962.01.01	46.243019	32.283111	7
Berezhany	1962.01.01	49.438633	24.936356	304
Bila Tserkva	2000.01.01	49.827833	30.106328	180
Bilopillia	1962.01.01	49.838033	28.884619	257
Bilovodsk	1962.01.01	48.565508	39.233797	75
Bobrynets	1995.01.01	48.069114	32.167547	143
Bohodukniv	2000.01.01	50.164719	35.498047	198
Boryspil	1976.01.01	50.333933	30.949289	122
Botieve	1962.01.01	46.6836778	35.8429028	19
Brody	1962.01.01	50.083586	25.158275	228
Chaplyne	1962.01.01	48.126031	36.237814	174
Cherkasy	1995.01.01	49.409169	32.002997	107
Chernihiv	1990.01.01	51.443883	31.200172	145
Chernivtsi		48.266458	25.972375	246
Chornobyl	1962.01.01	51.266194	30.225719	127
Chortkiv	1962.01.01	49.014917	25.769839	318
Chyhyryn	1995.01.01	49.058961	32.681731	124
Dnipro	1962.01.01	48.360031	35.085072	145
Drohobych	1962.01.01	49.362269	23.5667	277
Druzhba	1962.01.01	52.052814	33.953497	190

Hadiach	1962.01.01	50.368792	33.980172	154
Haisyn	1962.01.01	48.800303	29.395583	211
Henichesk	1939.01.01	46.164164	34.807253	15
Hubynykha	2000.01.01	48.792394	35.248164	127
Ivano-Frankivsk	1941.01.01	48.889197	24.689028	280
Izium	1962.01.01	49.187203	37.289517	78
Izmail	1886-01-01	45.370192	28.850822	30
Kamianets-Podils.	2000.01.01	48.692953	26.608136	222
Kharkiv	2018.09.07	49.927978	36.282428	156
Kherson	1962.01.01	46.738128	32.708783	54
Khmelnytskyi	1990.01.01	49.353658	26.937525	350
Kiev	1909.01.01	50.2400016785	30.5799999237	121
Kobeliaky	1995.01.01	49.153925	34.207656	118
Kolomyia	1962.01.01	48.548781	25.055417	298
Komisarivka	1923.01.01	48.440094	33.900536	119
Konotop	1962.01.01	51.240856	33.18705	149
Kovel	1934.01.01	51.198025	24.706633	174
Krasnohrad	1962.01.01	49.360625	35.415489	161
Kropyvnytskyi	1990.01.01	48.543528	32.283403	171
Kryvyi Rih		48.0537139	33.211139	124
Kupiansk	1962.01.01	49.649878	37.648814	83
Kyiv		50.391792	30.535631	167
Kyiv-Goloseyev	5/13/2010	50.3639984131	30.4969997406	206
Kyrylivka	1961.01.01	47.329794	36.334997	221
Liubashivka	1937.01.01	47.850825	30.268342	183
Lozova	1923.01.01	48.887133	36.344275	177
Lubny	1892-01-01	50.015789	32.986531	158
Luhansk	1837-01-01	48.565508	39.233797	62

Lutsk	1990.01.01	50.720822	25.395669	197
Lviv	1945.01.01	49.807489	23.965106	323
Lvov	1963.01.01	49.5099983215	24.0300006866	329
Mariupol	1966.01.01	47.042475	37.48433056	70
Melitopol	1962.01.01	46.830206	35.356664	34
Mohyliv-Podilskyi	1962.01.01	48.452447	27.779711	78
Mykolaiv	1831-01-01	47.05445	31.909444	50
Myronivka	1962.01.01	49.646042	31.082881	153
Nikopol	1925.01.01	47.592278	34.401883	53
Nizhyn	1962.01.01	51.037978	31.900281	126
Nova Kakhovka	2000.01.01	46.789144	33.358567	25
Nova Ushytsia	1962.01.01	48.843122	27.260781	290
Novohrad-Volynsk.	1962.01.01	50.592742	27.609611	218
Nyschni Sirohosy	1962.01.01	46.855142	34.397072	53
Odesa	1866-01-01	46.440753	30.770336	42
Odessa	1894-01-01	46.440753	30.770336	42
Ovruch	1927.01.01	51.329031	28.783292	170
Pervomaisk	1941.01.01	48.052431	30.858089	103
Poltava	1824-01-01	49.609442	34.544597	160
Pomichna	1995.01.01	48.232464	31.395919	211
Pryluky	1962.01.01	50.579069	32.363561	133
Pryshyb	1962.01.01	47.260522	35.332864	88
RADAR Meteor-500		48.95	30.75	125
Rava-Ruska	1962.01.01	50.242283	23.627156	251
Rivne	1941.01.01	50.602375	26.152683	231
Romny	1961.01.01	50.768381	33.442667	169
Rozdilna	1961.01.01	46.850264	30.07085	148
Sarata	1961.01.01	46.024247	29.670119	14

Sarny	1941.01.01	51.312717	26.614006	156
Seliatyn	1962.01.01	47.876486	25.216436	763
Semenivka	1962.01.01	52.190856	32.573994	162
Serbka	1962.01.01	47.012989	30.752036	73
Shepetivka	1899-01-01	50.161414	27.037047	278
Sumy	1946.01.01	50.858789	34.749264	181
Svatove	1962.01.01	49.4117	38.163428	89
Svitlovodsk	1995.01.01	49.071233	33.249506	84
Ternopil	2000.01.01	49.527778	25.691183	329
Teteriv	1962.01.01	50.692453	29.583478	133
Uman	1886-01-01	48.767028	30.232828	216
Uzhhorod	1946.01.01	48.633275	22.261228	118
Velyka Oleksandrivka		47.317217	33.287617	56
Velykyi Burluk	2000.01.01	50.078267	37.38465	175
Veselyi Podil	1962.01.01	49.614794	33.251925	96
Vinnytsia	1990.01.01	49.247694	28.604028	298
Volnovakha	1962.01.01	47.614828	37.489497	267
Volodymyr-Volyns.	1962.01.01	50.832917	24.343556	194
Voznesensk	1962.01.01	47.582481	31.319892	34
Yahotyn	1962.01.01	50.231542	31.793492	128
Zaporizhzhia	2000.01.01	47.87865	35.082561	61
Zhytomyr	1990.01.01	50.280617	28.659142	219
Znamianka	1961.01.01	48.73935	32.690681	181
Zolotonosha	1901.01.01	49.667169	32.017333	96
Zvenyhorodka	2000.01.01	49.082181	30.892875	215

Ukraine operates two meteorological stations in Antarctica as well.

As far as the calibration is concerned, the instruments are compared to working standards, which are calibrated in their own or authorized calibration laboratories that equal to the national standards.

Concerning the data checking, it is carried out automatically and manually (with the help of experts).

Some radar databases recently have contained 9 weather radars in Ukraine. However, according to the fresh local information UHMC operates 4 radars. The others are either on the occupied territory or in Crimea, or inactive.

Table 39. Operational weather radars in Ukraine

Operational weather radars in Ukraine						
No.	Country	Radar Name	Status	TX Type	Polarization	Band
1	Ukraine	Zaporizhzhia, MRL-5	Active	Magnetron	Single	X
2	Ukraine	Khmelnytskyi, MRL-2	Active	Magnetron	Single	X
3	Ukraine	Chernivtsi, MRL-2	Active	Magnetron	Single	X
4	Ukraine	Boryspil, Meteor-500	Active	Magnetron	Single	C

Although the horizontal density of the meteorological stations in Ukraine is far from the requirements of high-resolution NWP, UHMC considers the improvement of the technical level of their monitoring network as the highest priority, while increasing the number of stations can follow after that.

6. Recommendations for improvements to the existing observational networks supporting SEE-MHEWS-A

Automation of the surface observations is in progress in the region with the exemption of Ukraine. The surface monitoring networks are rather dense in the EU Member States as well as in Israel and Turkey, although they cannot meet all the threshold observing requirements. Some NHMSs were forced to abandon at least partly their costly upper air and radar stations. Only a few services apply solid calibration practice; unfortunately, the others face lack of well-equipped calibration laboratory and certified personnel. Most of the NHMSs can devote only modest capacity to data quality control applying basic screening procedures.

The direction of further development of the observing capability in the region could be a technical improvement of the existing Automatic Weather Stations (AWSs), spatial rationalization of them, significant increase of the level of maintenance, calibration and data quality control.

Recommendations are listed by countries.

Albania

The currently working 28 AWSs and 273 manual stations run by IGEWE should be supplemented by 3-4 AWSs in the mountains over 800 m elevation. Reliable automatic data transmission must be developed to ensure hourly online data first, then to make efforts to achieve 10 minutes data. All these activities must be supported qualified staff carrying out the maintenance, the regular calibration and data quality control. Proper budget is necessary for the running of the system. Reparation of the mini radar and installation of a new radiosonde station in the southern region of the country could give useful additional meteorological information to the forecasting models.

Bosnia and Herzegovina

Concerning the recommendations, the two entities in Bosnia and Herzegovina (Federation of Bosnia and Republika Srpska) considered together. The density of surface weather stations is fairly good. Improvement of their technical level including reliable data transmission at 10 minutes interval should be implemented. The regular calibration of the sensors and data loggers must be achieved. There is no information if the radar serving the hail suppression system in RS can be applied for general meteorological observation. If it is the case it should be maintained, if not it should be introduced. A radiosonde station in the vicinity of Mostar would be very useful. Closer cooperation between the entities could result better meteorological monitoring.

Bulgaria

Bulgaria has not given any information on the monitoring network so no confirmed metadata are available on the current situation. It can be stated that 10 additional well-equipped AWSs combined with regular calibration and maintenance as well as data quality control could considerably improve the data availability. A new radiosonde station at the seaside could contribute to the NWPs.

Croatia

The density of surface monitoring stations is rather good, 4-5 additional AWSs in the mountainous region would be proper completion. The main task is to keep the network in good condition, to carry out the regular calibrations and data quality control.

Cyprus

The country has a developed meteorological monitoring network, including among others one radiosonde station, two weather radars and 33 AWSs producing data at 10 minutes interval. Additional 8-10 AWSs could cover all domestic requirements. A wind tunnel would be a great help for calibration the wind sensors.

Greece

Greece also has a developed meteorological monitoring network both in the mainland and in the islands. However, additional 10-15 AWSs in the mountainous regions (e.g. Pindhos) could provide better basis for the data assimilation of NWPs.

Hungary

Since the automation of the surface monitoring network began in the 90'-s, great number of AWSs are now moving to their end of life. OMSZ tries to upgrade these old AWSs according to the financial possibilities. Since the vicinity of several stations has unfavourably changed, reinstallation of them became necessary. Additional AWSs and ceilometers could foster the nowcasting activity. Furthermore, shifting to autosounding is well in progress like installation of the 5th dual-polarization weather radar as well. Accreditation of the calibration laboratory is a great challenge, where further technical and financial support is necessary.

Israel

The meteorological monitoring system in Israel is well-developed having rather dense station network. The density is not evenly balanced in some areas, especially in Negev. Introduction of a data quality management system is necessary to ensure the reliable online data.

Jordan

Jordan operates 30 AWSs. Considering the territory of the country additional 20 AWSs could produce better performance, if the online data transmission, the regular calibration and maintenance can be ensured. Another radiosonde station in the eastern part of the country would also be justifiable.

Lebanon

The country faces enormous economic problems, which culminated by the explosions in Beirut harbour in August 2020. The government is not able to ensure the running cost to the 30 AWSs installed. Online data transmission has not been solved. These stations are rather old therefore installation of 44 new AWSs and one new radar is planned together with upgrading of the radiosonde station. There are no local resources for these developments. Introduction of a data quality management system is well advised.

Moldova

Since there are only 14 measuring stations producing 10 minutes data, additional 10-12 AWSs should be installed and the online data transmission should be solved for the better performance. Technical and financial support is needed in the field of calibration and data quality management. Installation of a new radiosonde station in the country would be advisable. All these developments are doubtful without external financial help.

Montenegro

IHMS faces several challenges. The public power supply infrastructure is not reliable so AWSs are needed extra protection. Application of solar cells can be a solution. Around 20 well equipped AWSs could cover the local requirements, if the online data transmission, the regular calibration and maintenance as well as thorough data quality management work well. All these developments are doubtful without external financial help.

North Macedonia

UHMR operates currently 44 AWSs. Around ten new stations could achieve better geographical coverage. Ensuring the reliable data transfer is essential. Restart of the radiosounding would be reasonable. UHMS suffers from limited financial and human resources.

Romania

RNMA operates 160 AWSs. Additional 10 stations could achieve evenly balanced coverage. RNMA works on upgrading the AWSs. It would be justifiable if all stations could produce 10 minutes data. Restart of radiosounding in Cluj-Napoca would also be useful for the NWPs.

Slovenia

ARSO operates a well-developed monitoring network. Ljubljana is one the three RICs in RA VI. Direction of the further development can be upgrading of the stations for the 10 minutes data transmission.

Turkey

TSMS operates the biggest meteorological observation network – that has dynamically developed lately – in the project region. Maintenance and calibration activity is well organized. TSMS as a

Regional Training Centre of WMO regularly organises trainings for other WMO members on radar meteorology and calibration of instruments.

Ukraine

Ukraine has the second largest area in the project region. UHMC does not operate automatic weather station in the country, although according to the WMO requirements there should be more than thousand measuring sites producing 10 minutes data. The number of operational radars and radiosonde stations decreased, similarly the daily number of ascents as well. Restart of the closed stations would be useful. UHMC considers improvement of technical level of their monitoring network as highest priority, while increasing the number of stations can follow after that. Peaceful cooperation with Russian Federation on meteorological monitoring in Crimea and East Ukraine would be advisable.

7. Conclusions

The NMHSs operate meteorological monitoring networks of very diverse level in the project region. The networks are rather dense in the EU Member States as well as in Israel and Turkey. The direction of further development of the observing capability in the region could be a technical improvement of the existing AWSs, spatial rationalization of them, significantly increase of the technical level of data transmission, maintenance and calibration of the instruments and data quality control.

Nevertheless, the existing meteorological observing networks of the project partners, supplemented with satellite products can serve as an initial base to high-resolution NWP.

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