



SEE-MHEWS-A: Multi-Hazard Early Warning Advisory System for South-East Europe

WMO Regional Association VI (Europe)

Hydrology Forum 2019

2-4 April 2019 Bratislava, Slovakia



WMO OMM

World Meteorological Organization

Organisation météorologique mondiale

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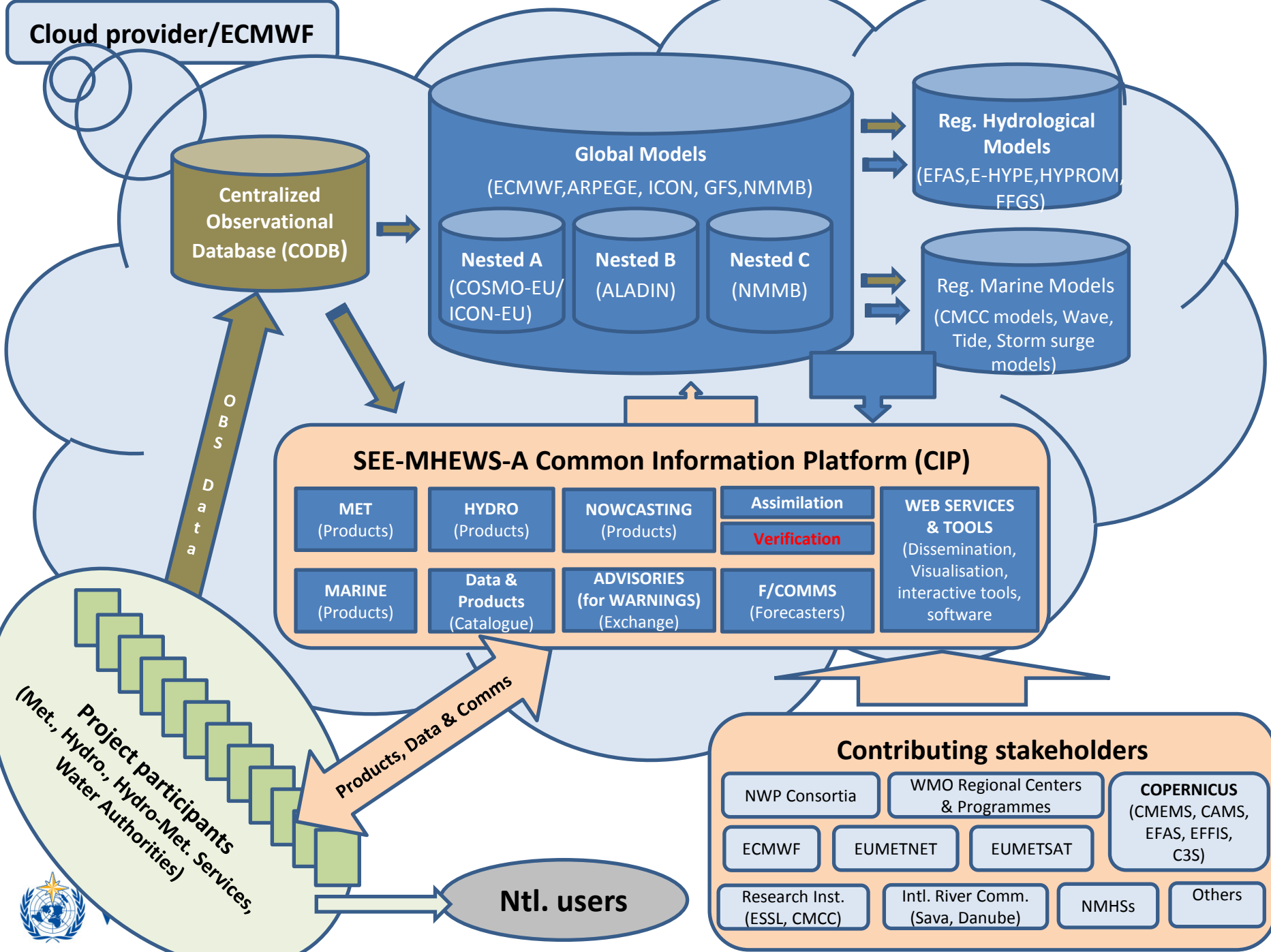
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SEE-MHEWS-A PROJECT PHASE I

Supported by USAID (580,000 USD) in 2016-2018

Major achievements:

- [Detailed Implementation Plan](#) developed providing guidelines for development of the technical part of the system and for all activities necessary to establish advisory system operations by mid-2023. Plan considers the governance structure and other management aspects of the project implementation.
- Statement of NMHSs Directors of SEE region on joint collaboration towards the implementation of activities and projects leading to full operation of SEE-MHEWS-A.
- RA VI Session [Resolution 3.1\(4\)/2 \(RA VI-17\)](#) on SEE-MHEWS-A collaboration
- Improved data exchange: Ukraine-ECMWF-WMO agreement on data exchange from more than 160 stations.



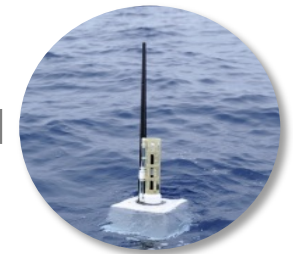
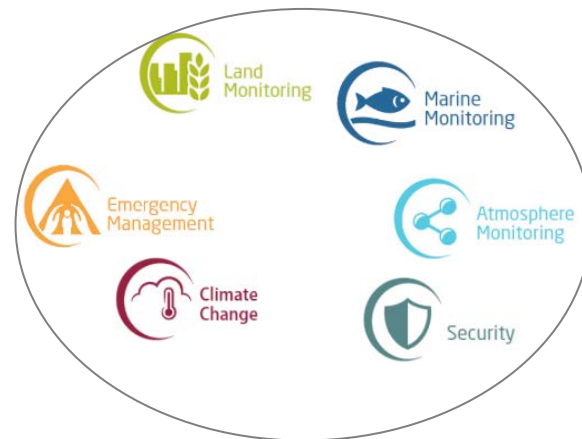
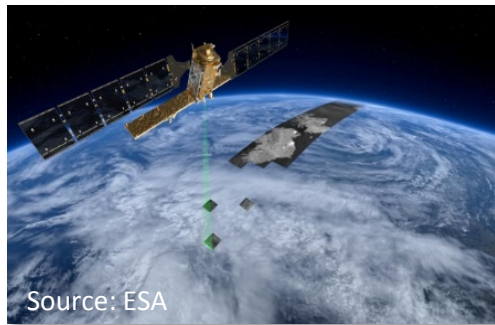
COPERNICUS SERVICES



6 services use Earth Observation data to deliver ...

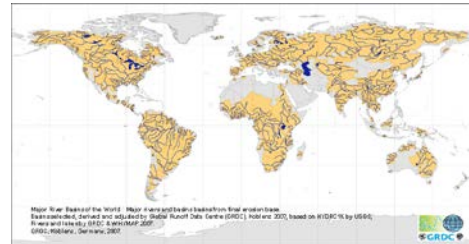
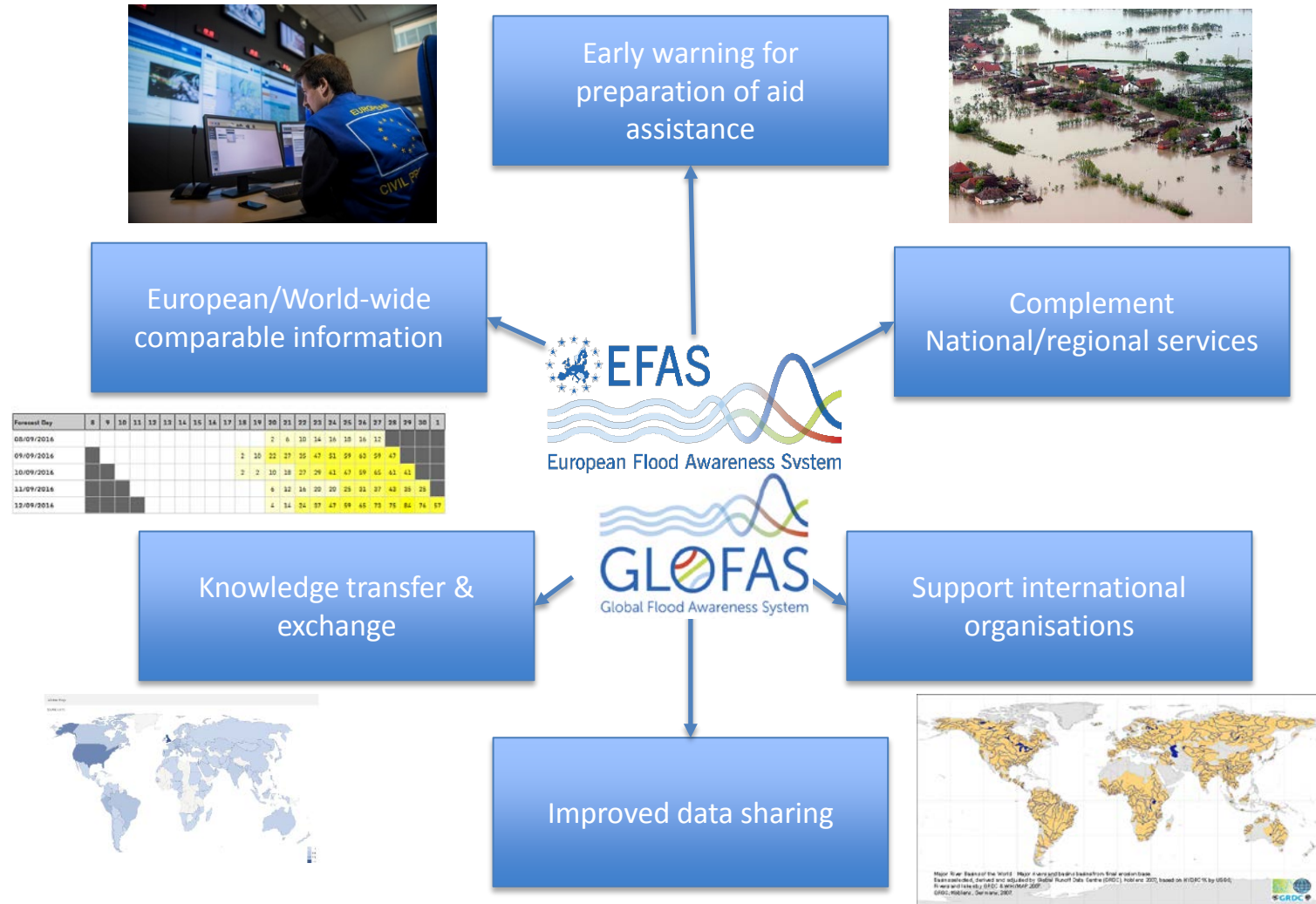
Sentinels &
Contributing Satellite Missions

In-situ measurements



... added value products

CEMS-FLOODS VISION



SEE-MHEWS-A PROJECT PHASE II

Supported by World Bank, 1 500 000 USD (GFDRR), 320 000 USD (IPA) in 2018-2020

Phase II of the SEE-MHEWS-A Project is a demonstration phase aiming to:

- Improve the availability of hydrological and meteorological data for flood forecasting and regional data sharing (cross-border river catchments).
- Consolidate and improve real-time access to regional hydrometeorological information and forecasts critical for early warning for all involved countries.
- Improve basin-level (cross-border) flood forecasting, including real-time ingestion of meteorological data and forecasts.

Activities of the phase II of the SEE-MHEWS-A Project:

- Development of the pilot operational hydrological modelling system for selected transboundary river catchment(s) in the region as the basis for development of the comprehensive regional advisory system including:
 - Setting up an operational database and archiving software on an ICT platform.
 - Existing operational limited area numerical weather prediction models that will be run in quasi-operational mode, nested in selected global weather prediction models to provide for so called poor man's ensemble forecasts.
 - Connection of high-resolution numerical model outputs to hydrological models at the basin level to provide strengthened flood forecasting capacities for the selected river catchment(s).



SEE-MHEWS-A PROJECT PHASE II

Observations and database

- Preparation of the observational requirements for the project, based on the WMO Rolling Review of Requirements (RRR).
- Inventory of available needed data for operational hydrological models including assessment of the real-time meteorological and hydrological observations, historical precipitation and temperature observations, high resolution numerical weather prediction and quantitative precipitation estimation products, satellite data including snow cover, snow water equivalent, soil moisture and soil temperature, geophysical data etc.
- Recommendations for improvements to the existing observational networks and future availability of data in SEE region.
- Development of the Centralized Observational Database (separate instance of SAPP in ECMWF) as a tool to support the meteorological, hydrological and marine/oceanographic models, their verification, calibration of hydrological models and further post-processing.
- Development of the Data Policy Agreement addressing the differences between the existing official WMO data policies (Resolution 40 (Cg-XII), Resolution 25 (Cg-XIII) and Resolution 60 (Cg-17)) and the additional data that would be required for the operation of SEE-MHEWS-A.



SEE-MHEWS-A PROJECT PHASE II

Numerical Weather Prediction (NWP)

- Implementation of the state of the art, high-resolution, quasi-operational NWP system at European Centre for Medium-range Weather Forecasts (ECMWF) and provision of forecasts for the SEE-MHEWS-A project.
- Setting up of high resolution limited area NWP models (ALADIN, COSMO and NMM-B) covering the SEE region in quasi-operational mode, nested in selected global weather prediction model(s) in cooperation with the NMHSs of Slovenia, Croatia, Greece, and Israel, University of Belgrade, and ECMWF.
- Adoption of a verification methodology and its quasi-operational application for meteorological variables in broader SEE region, and in case of hydrological variables for the pilot river catchment(s).
- Visualization of the NWP models outputs and provision of access to all WMO Member states-participants in the project.
- Connection of NWP models to hydrological model(s) for the selected river catchments.
- Testing of nowcasting tool (such as INCA) for selected river catchment(s).



SEE-MHEWS-A PROJECT PHASE II

Hydrological modelling

- Development of the survey of the river basins in the SEE region, including availability of the data, current use of hydrological (and hydraulic) models for forecasting purposes and needs for improvement,
- Selection of the pilot (transboundary?) river catchment(s) to be covered by the SEE-MHEWS-A during the Phase II of the project.
- Calibration of selected hydrological model(s) for the selected pilot-river catchment(s) utilizing the processed historical meteorological and hydrological data.
- Verification of the hydrological forecasts against the near real time observations at the river catchment scale.
- Visualization of the model outputs and provision of access to all WMO Member states-participants in the project (utilization of the Copernicus-like visualization tool in use by ECMWF is considered).



Hydrological component - Approach

Selecting pilot basins from all three groups
(limited, moderate, well-developed)

Model(s) selection

- properties (physiographic, man made)
- data conditions
- end-user requirements

Calibration/validation

Updating
procedure

Validating the system with NWP inputs

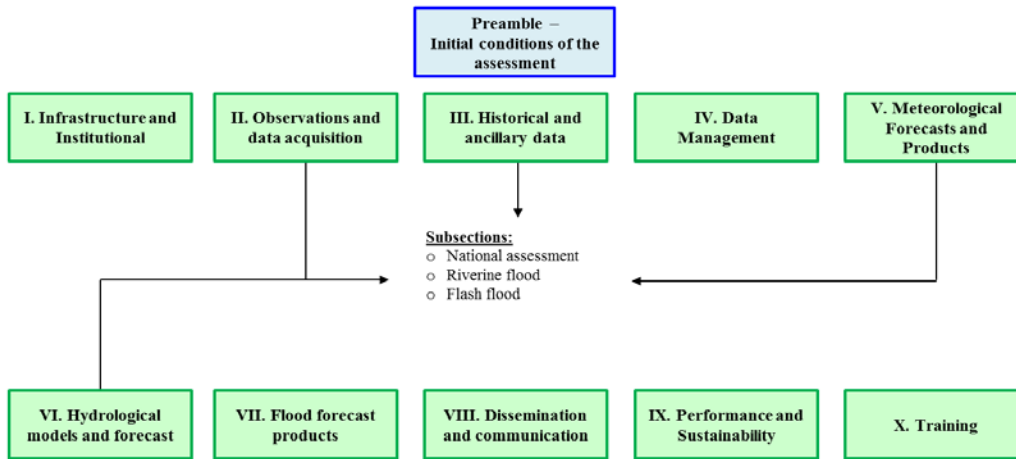
Implementing the modeling system into
operational use

- transboundary basin
- Hydrometeorological data availability
- Need in hydrologic forecast system improvement/implementation on WMO Manual on flood forecasting and warning

Guide to hydrological practices.
Volume II

Assessment - mechanism

Implementing the CHy Assessment Guidelines for the SEE-MHEWS-A countries



Selection pilot basin(s) for the hydrologic modeling/forecasting with taking into account following criteria:

- transboundary
- enough data
- need for/to increase modeling capabilities
- support from NHS(s) covering the target basins

Report on the requirements for the E2E EWS for flood forecasting within for the selected basin(s)

Model selection - mechanism

*Implementing the CHy model and platform selection criteria (developments of the CHy TT's
On interoperable models and platforms advances for flood forecasting)*

Criteria
Operationally used(must) model and platform
Freely available
Hardware requirements (low end)
Availability of training material
Institutional Support
Languages training and software
Sustainability - longevity
Peer review or Case studies (modelling only)

Must: Strongly to be required

Should: Important components

Could: Less important but good to have

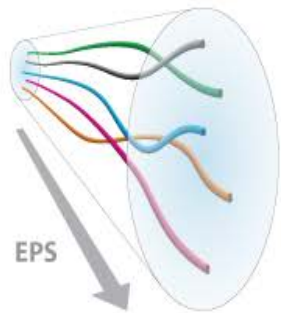
Criteria
Open source or source is available (should) model and platform
Updating (modelling only)
Simplicity – calibration, parsimony (modelling only)
Simplicity – usability(m & p)
Pre-existing CoP (m &p) could
Data Format (model) could
Data Format (platform) must/should
Visualization (platform)
Data QA/QC (platform)
Open/closed platforms
Internet-based system (platforms)
Redundancy capability (platforms)

For more information please visit: <http://www.wmo.int/pages/prog/hwrrp/chy/E2E-EarlyWarningSystems/flood-forecasting/index.php>



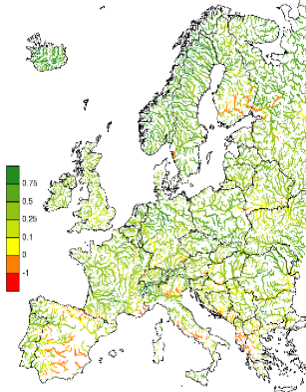
WMO OMM

MODELLING CHAIN



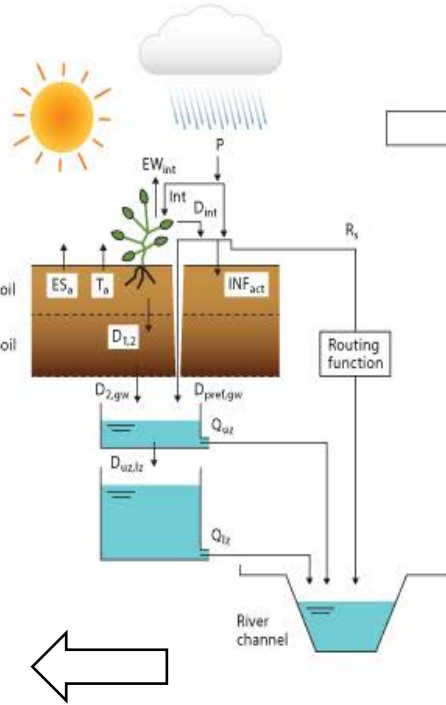
EPS

Pre-processing



Verification

Hydrological model

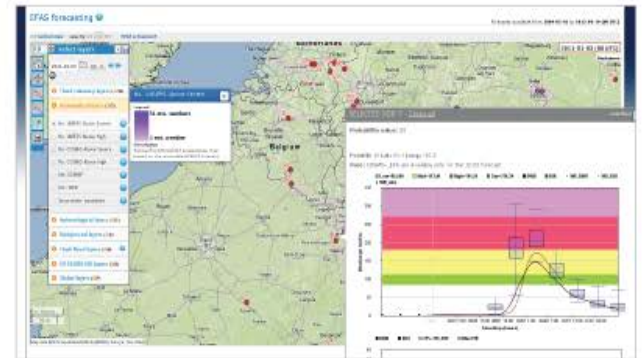


Post-processing

Forecast Day	21	2	3	4	5	6	7	8	9	10	11	12
2011-06-11 0600												
2011-06-11 1200												
2011-06-01 0600												
2011-06-01 1200												
2011-06-02 0600												
2011-06-02 1200												
2011-06-03 0600												
2011-06-03 1200												



Warning



Cloud provider

Centralized
Observational
Database (CODB)

Global Models

(ECMWF,ARPEGE, GFS,NMMB,ICON)

Nested A
(COSMO-EU/
ICON-EU)

Nested B
(ALADIN)

Nested C
(NMMB)

Reg. Hydrological
Models
(EFAS,E-HYPE,HYPROM,
FFGS)

Reg. Marine Models
(CMCC models, Wave,
Tide, Storm surge
models)

SEE-MHEWS-A HYDRO products
(as part of Common Information Platform (CIP))

Hydrologic
model

Assimilation

Verification

Ensemble
forecasting

F/COMMS
(Forecasters)

WEB SERVICES
& TOOLS
(Dissemination,
Visualisation,
interactive tools,
software)

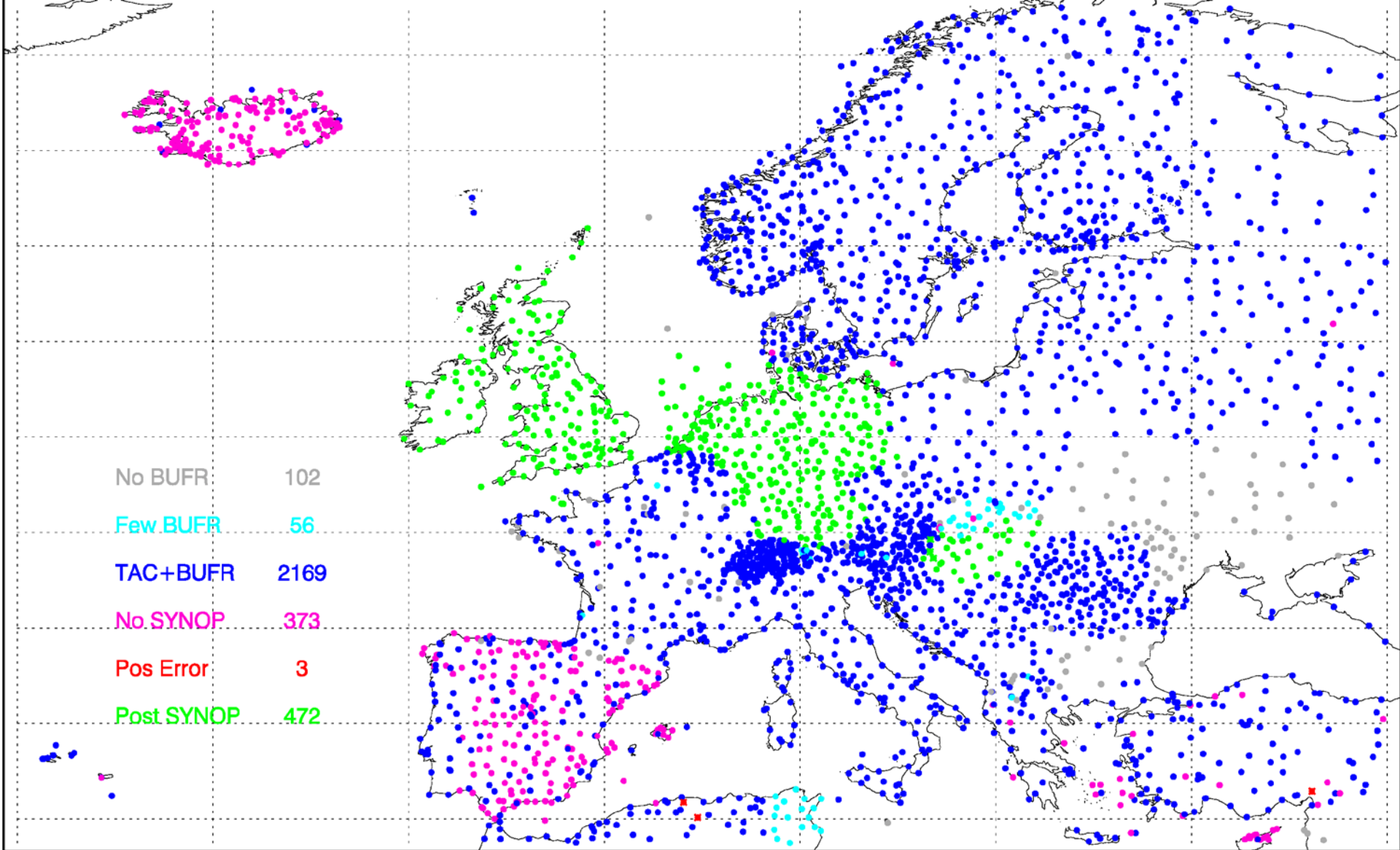
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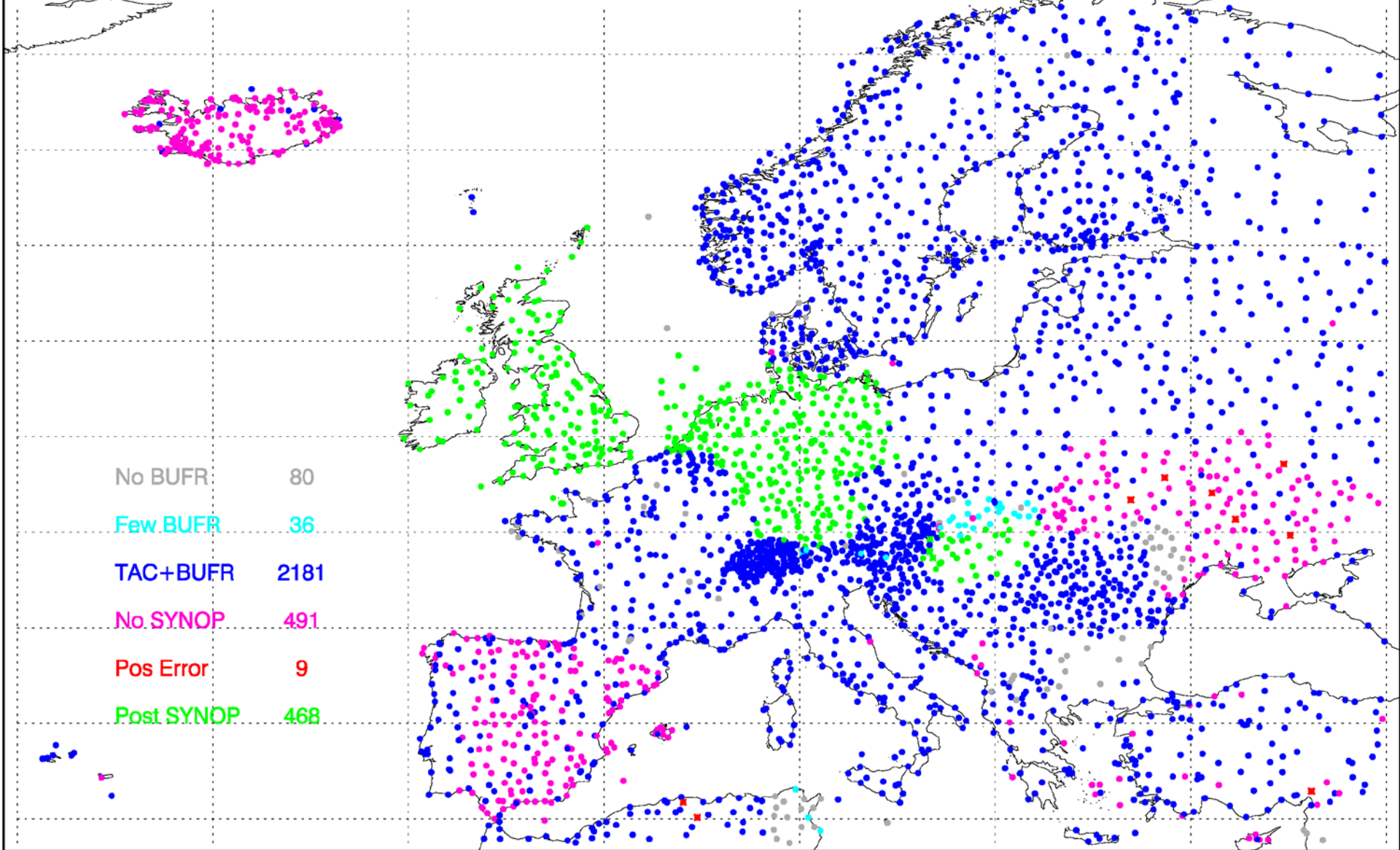
Products, Data & Comms

Ntl. users

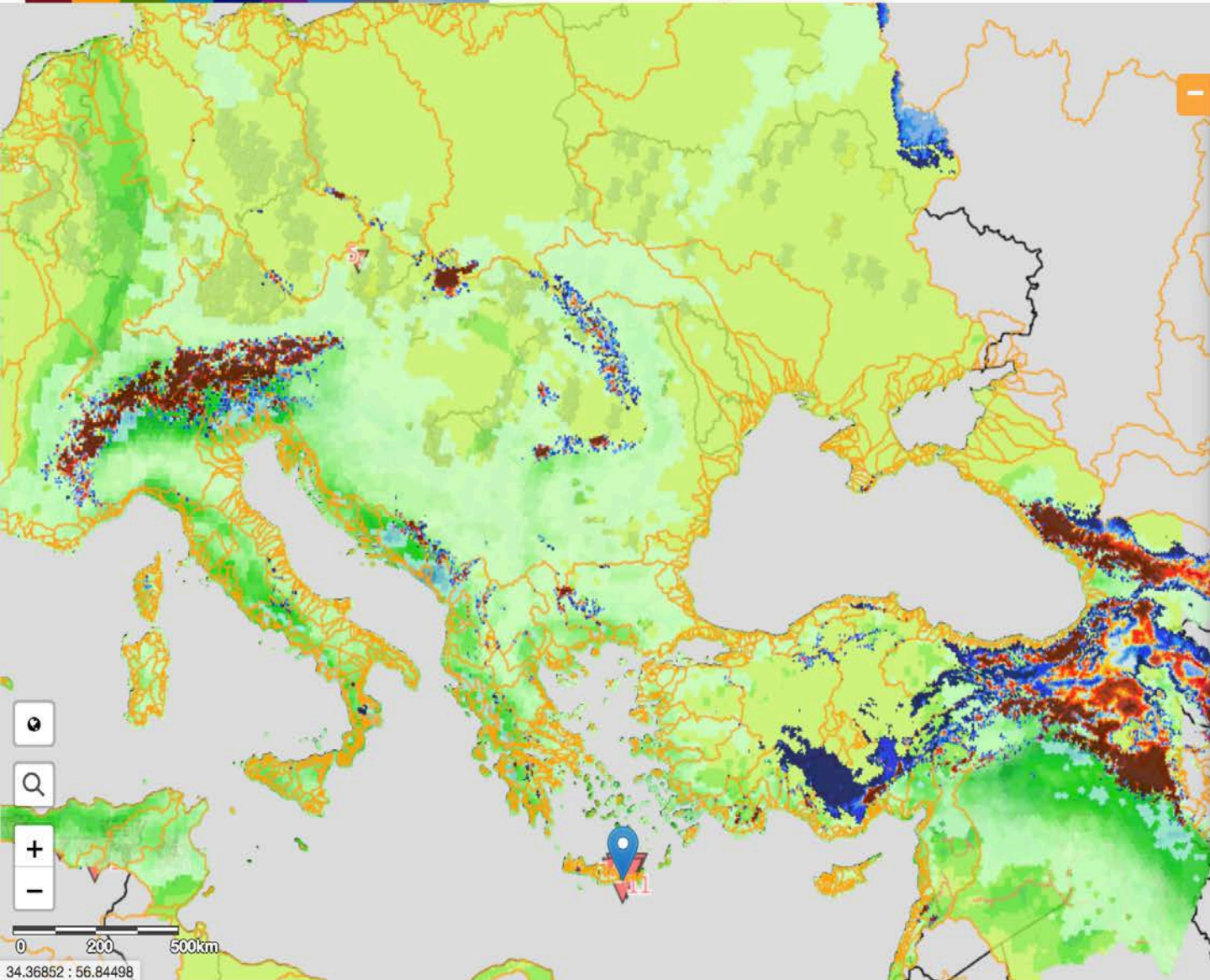
Project participants
(Met., Hydro., Hydro-Met. Services,
Water Authorities)







INFORMATION GATHERING



← 01/04/2019 12:00 → ↻

LAYERS 📍
[Efas forecasts from 2009-12-01 (00 UTC) to 2019-04-01 (12 UTC)]

Snow water equivalent
⚠️ [2019-03-30]
 ⓘ ✕

Obs. Precipitation
⚠️ [2019-03-30]
 ⓘ ✕

Catchments
 ⓘ ✕

ECMWF-ENS Prob. Pr > 150mm
 ⓘ ✕

SEE-MHEWS-A PROJECT

Governance

- **Project Steering Committee (PSC)** composed of the WMO Member states Directors of NMHSs of SEE region and chaired by the President of RA VI oversees the project implementation and makes decisions necessitated by the project implementation.
- **Project Policy Advisory Group (PPAG)** advises PSC in overseeing and monitoring the project implementation and addresses coordination and cooperation issues at national and regional levels.
- **Technical teams** including TT on observations (TT-Obs), TT on numerical weather prediction (TT-NWP), TT on hydrology (TT-HYDRO), TT on post-processing and nowcasting (TT-PP), TT on information communication technology (TT-ICT), TT on scientific issues (TT-Sci) and TT on capacity development and training (TT-CD) address issues related to the project implementation.
- **WMO Regional Office for Europe (ROE)** including the **WMO Project Office established in Croatia** supports all project implementation activities, including coordination with PSC, PPAG, TTs, project participants and contributing stakeholders.
- **Project stakeholders** such as ECMWF, EUMETNET, EUMETSAT, COPERNICUS, Joint Research Centre, European Severe Storm Laboratory, International Sava River Basin Commission (ISRBC) and NMHSs from outside the SEE region contribute to the design and/or implementation of the system.



Sustainability of operation of MHEWS system?

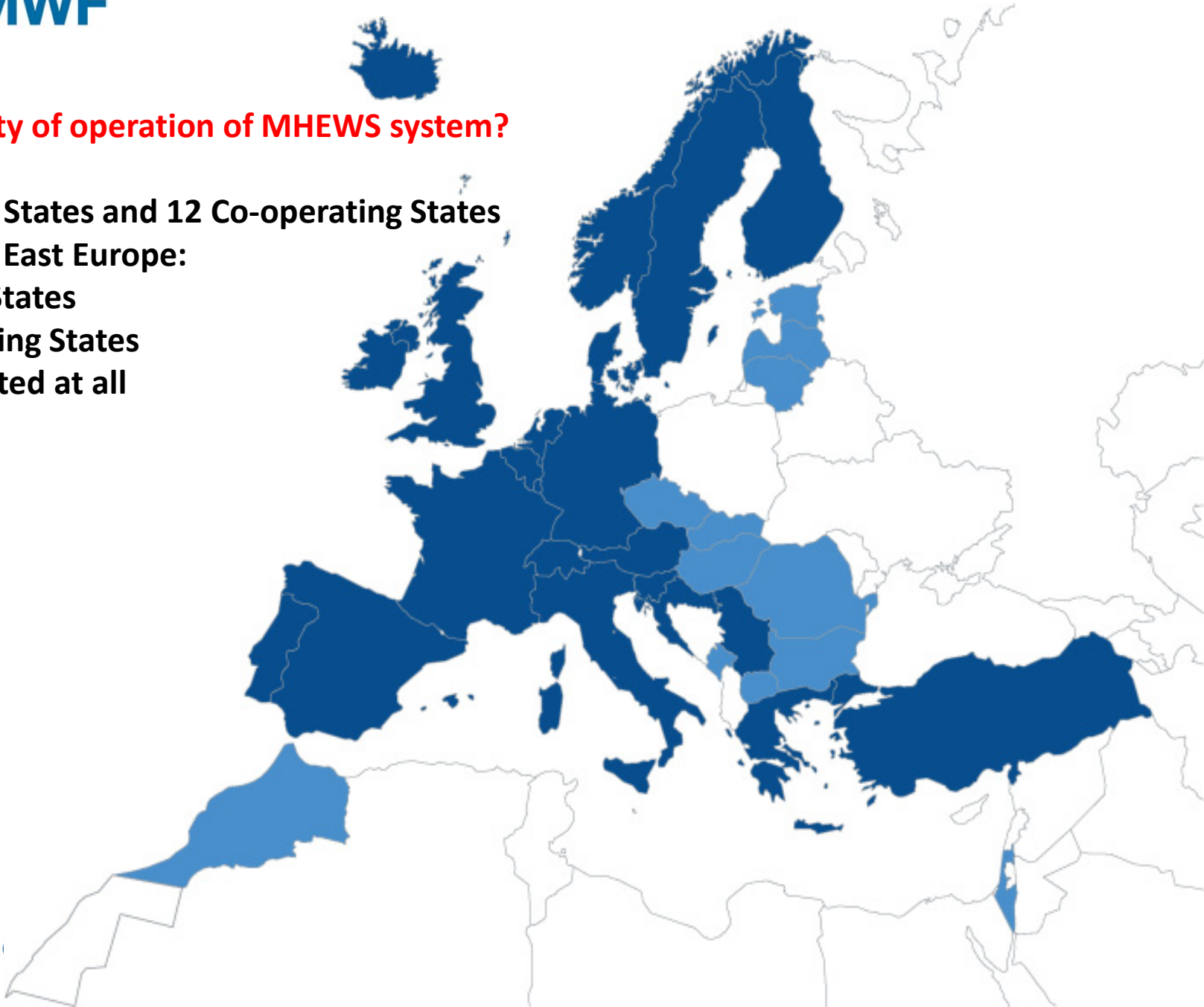
22 Member States and 12 Co-operating States

From South East Europe:

5 Member States

6 Co-operating States

6 Not affiliated at all



SEE-MHEWS-A PROJECT PHASE I

Partners: NMHSs

- **ALBANIA, IGEWE (Fatos HOXHAIJ)**
- **BOSNIA AND HERZEGOVINA, Federal Hydrometeorological Institute (Almir BIJEDIC)**
- **BOSNIA AND HERZEGOVINA, Hydrometeorological Service of Republic of Srpska (Tomislav ŠAJIC)**
- **BULGARIA, National Institute of Meteorology and Hydrology(Hristomir BRANZOV)**
- **CROATIA, Meteorological and Hydrological Service (Branka IVANCAN-PICEK)**
- **CYPRUS, Department of Meteorology (Kleanthis NICOLAIDES)**
- **GREECE, Hellenic National Meteorological Service (Nikolaos VOGIATZIS)**
- **HUNGARY, Meteorological Service (Kornéla RADICS)**
- **ISRAEL, Meteorological Service (Nir STAV)**
- **JORDAN, Meteorological Department (Haitham AL-SHA'ER)**
- **LEBANON, Lebanese Meteorological Department (Marc WEHAÏBÉ)**
- **MONTENEGRO, Institute of Hydrometeorology and Seismology (Luka MITROVIC)**
- **NORTH MACEDONIA, Hydrometeorological Service (Ivica TODOROVSKI)**
- **REPUBLIC OF MOLDOVA? State Hydrometeorological Service(Violeta BALAN)**
- **ROMANIA, National Meteorological Administration(Elena MATEESCU)**
- **SERBIA, Republic Hydrometeorological Service(Jugoslav NIKOLIC)**
- **SLOVENIA, National Meteorological Service (Klemen BERGANT)**
- **TURKEY, State Meteorological Service (İsmail GÜNEŞ)**
- **UKRAINE, Hydrometeorological Center(Mykola KULBIDA)**



SEE-MHEWS-A PROJECT PHASE I

Partners: other Stakeholders (1/2)

- **ECMWF** (Florence RABIER, Florian PAPPENBERGER, Umberto MODIGLIANI, Anna GHELLI)
- **AEMET** (Migel Angel Lopez)
- **Central Institute for Meteorology and Geodynamics (ZAMG), Austria** (Michael STAUDINGER, Andreas SCHAFFHAUSER, Yong WANG)
- **China Meteorological Administration – CMA** (LIU Yaming, ZHAO Dajun, JIAO Meiyang)
- **CIMA Research Foundation** (Marco MASSABO)
- **Czech Hydrometeorological Institute** (Jan DANHELKA)
- **Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH** (Gerrit BODENBENDER)
- **Deutscher Wetterdienst (DWD), Germany** (Gerhard ADRIAN, Tijana JANJIĆ PFANDER)
- **European Severe Storms Laboratory** (Pieter GROENEMEIJER, Tomas PUCIK)
- **EUMETNET** (Eric Petermann)
- **EUMETNET/C-SRNWP** (Balazs SZINTAI)
- **EUMETSAT** (Alain RATIER)
- **Euro-Mediterranean Center on Climate Change** (Ivan FEDERICO)
- **European Severe Storms Laboratory** (Pieter GROENEMEIJER, Tomas PUCIK)
- **Finnish Meteorological Institute (FMI)** (Juhani DAMSKI, Harri PIETARILA)
- **International Sava River Basin Commission** (Mirza SARAČ)
- **Japan Meteorological Agency** (Toshihiko HASHIDA, Jitsuko HASEGAWA)
- **JRC** (Jon SKOJEN)



SEE-MHEWS-A PROJECT PHASE I

Partners: other Stakeholders (2/2)

- **KNMI, HIRLAM, the Netherlands** (Jeanette ONVLEE-HOOIMEIJER)
- **KNMI, the Netherlands** (Gerard VAN DER STEENHOVEN, Frank KROONENBERG)
- **Meteo-France** (Jean-Marc LACAVE)
- **Meteorological Services Department of Zimbabwe** (Amos MAKARAU)
- **NOAA, USA** (Louis UCCELLINI, Zaviša)
- **Republic Hydrometeorological Service of Serbia** (Slobodan NICKOVIC)
- **ROSHYDROMET, Russian Federation** (Maxim YAKOVENKO, Yuri SIMONOV, Alex GUSEV, Dmitry KIKTEV, Roman VILFAND, Alexander NURULLAEV)
- **Royal Meteorological Institute of Belgium** (Piet TERMONIA)
- **Servizio Meteorologico** (Angela CORINA)
- **Slovak Hydrometeorological Institute** (Martin BENKO)
- **Swedish Meteorological and Hydrological Institute** (Richard WYLDE, Rene CAPELL, Rolf BRENNERFELT)
- **UK Met Office** (Robert VARLEY, Paul DAVIES, Bob TURNER, Nick ASHTON)
- **UN Office for Disaster Risk Reduction** (Paola ALBRITO)
- **UNESCO Regional Bureau for Science and Culture in Europe** (Davide POLETTTO)
- **University of Belgrade/SEEVCCC** (Vladimir DJURDJEVIC)
- **University of Rijeka** (Zlatan CAR)
- **USAID Office of U.S. Foreign Disaster Assistance** (Sezin TOKAR)
- **World Bank** (Daniel KULL)



SEE-MHEWS-A PROJECT PHASE I

Partners: NMHSs Experts (1/6)

- **Petrit ZORBA** (Institute of Geosciences, Energy, Water and Environment, Albania)
- **Metodi MARKU** (Institute of Geosciences, Energy, Water and Environment, Albania)
- **Nasilda SHYTI** (Institute of Geosciences, Energy, Water and Environment, Albania)
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- **Nino RIMAC** (Federal Hydrometeorological Institute, Bosnia and Herzegovina)
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- **Ilian GOSPODINOV** (National Institute of Meteorology and Hydrology, Bulgaria)
- **Hristo HRISTOV** (National Institute of Meteorology and Hydrology, Bulgaria)
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- **Viara RAFAILOVA** (National Institute of Meteorology and Hydrology, Bulgaria)
- **Milena MILENKOVA** (National Institute of Meteorology and Hydrology, Bulgaria)
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SEE-MHEWS-A PROJECT PHASE I

Partners: NMHSs Experts (2/6)

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- **Dijana OSKORUS** (Meteorological and Hydrological Service, Croatia)
- **Tanja RENKO** (Meteorological and Hydrological Service, Croatia)
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- **Borivoj TEREK** (Meteorological and Hydrological Service, Croatia)
- **Vlasta TUTIŠ** (Meteorological and Hydrological Service, Croatia)
- **Dario KOMPAR** (Meteorological and Hydrological Service, Croatia)
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- **Kiriaki METHENITI** (Hellenic National Meteorological Service, Greece)
- **Garyfalia PAPPA** (Hellenic National Meteorological Service, Greece)
- **Georgia RAPTI** (Hellenic National Meteorological Service, Greece)
- **Nikolaos ANDRITSOS** (Hellenic National Meteorological Service, Greece)
- **Theocharis KAMPOURIDIS** (Hellenic National Meteorological Service, Greece)
- **Anastasia LINARDI** (Hellenic National Meteorological Service, Greece)
- **Nikolaos KAMPERAKIS** (Hellenic National Meteorological Service, Greece)



SEE-MHEWS-A PROJECT PHASE I

Partners: NMHSs Experts (3/6)

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- **Nikolaos KARATARAKIS** (Hellenic National Meteorological Service, Greece)
- **Antigoni VOUDOURI** (Hellenic National Meteorological Service, Greece)
- **Angeliki MARINAKI** (Hellenic National Meteorological Service, Greece)
- **Petrou CHRYSOULA** (Hellenic National Meteorological Service; Greece)
- **Alexandros NIKOLOPOULOS** (Hellenic National Meteorological Service, Greece)
- **Gyula HORVÁTH** (Meteorological Service, Hungary)
- **Mark RAJNAJ** (Meteorological Service, Hungary)
- **Robert TOTH** (Meteorological Service, Hungary)
- **Andras CSIK** (Hungarian Hydrological Forecasting Service)
- **Mariann DARANYI** (Meteorological Service, Hungary)
- **Onn MINTZ** (Meteorological Service, Israel)
- **Elyakom VADISLAVSKY** (Meteorological Service, Israel)
- **Amit SAVIR** (Meteorological Service, Israel)
- **Nurit MEIR** (Meteorological Service, Israel)
- **Muhsen TAWFIQ ELEMAT** (Meteorological Department, Jordan)
- **AMER MAHMOUD AMER Khalil** (Meteorological Department, Jordan)
- **RAED Rafed** (Meteorological Department, Jordan)
- **DAFI Elryalat** (Meteorological Department, Jordan)



SEE-MHEWS-A PROJECT PHASE I

Partners: NMHSs Experts (4/6)

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- **AL-GRALIH ABDEL-MENEM Mousa Asmail** (Meteorological Department, Jordan)
- **Abed AL RAHMAN ZAWAWY** (Lebanese Meteorological Department)
- **Faysal AL BANNA** (Lebanese Meteorological Department)
- **Mahmoud DHAYNI** (Lebanese Meteorological Department)
- **Mohammad FARES** (Lebanese Meteorological Department)
- **Mirjana SPALEVIC** (Institute of Hydrometeorology and Seismology, Montenegro)
- **Ervin KALAC** (Institute of Hydrometeorology and Seismology, Montenegro)
- **Danijela BUBANJA** (Institute of Hydrometeorology and Seismology, Montenegro)
- **Dan TITOV** (State Hydrometeorological Service, Republic of Moldova)
- **Ecaterina TITOVA** (State Hydrometeorological Service, Republic of Moldova)
- **Ghennadii ROȘCA** (State Hydrometeorological Service, Republic of Moldova)
- **Valentina CERES** (State Hydrometeorological Service, Republic of Moldova)
- **Florea RADU** (National Meteorological Administration, Romania)
- **Ionut-Sorin BURCEA** (National Meteorological Administration, Romania)
- **Rodica DUMITRACHE** (National Meteorological Administration, Romania)
- **Florinela GEORGESCU** (National Meteorological Administration, Romania)



SEE-MHEWS-A PROJECT PHASE I

Partners: NMHSs Experts (5/6)

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- **Predrag PETKOVIC** (Republic Hydrometeorological Service of Serbia)
- **Ljiljana DEKIĆ** (Republic Hydrometeorological Service of Serbia)
- **Slobodan NICKOVIC** (Republic Hydrometeorological Service of Serbia)
- **Goran MIHAJLOVIC** (Republic Hydrometeorological Service of Serbia)
- **Dejan VLADIKOVIC** (Republic Hydrometeorological Service of Serbia)
- **Goran MIHAJLOVC** (Republic Hydrometeorological Service of Serbia)
- **Gregor GREGORIČ** (DMCSEE, Slovenia)
- **Janez POLAJNAR** (National Meteorological Service, Slovenia)
- **Bojan CERNAC** (National Meteorological Service, Slovenia)
- **Sašo PETAN** (National Meteorological Service, Slovenia)
- **Anja FETTICH** (National Meteorological Service, Slovenia)
- **Jasna VEHOVAR** (National Meteorological Service, Slovenia)
- **Joško KNEZ** (Slovenian Environment Agency)
- **Tanja CEGNAR** (National Meteorological Service, Slovenia)
- **Domen TORKAR** (Administration for Civil Protection and Disaster Relief, Slovenia)
- **Aleksandar KARANFILOVSKI** (Hydrometeorological Service, North Macedonia)



SEE-MHEWS-A PROJECT PHASE I

Partners: NMHSs Experts (6/6)

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Thank you



WMO OMM

World Meteorological Organization

Organisation météorologique mondiale

<https://public.wmo.int/en/projects/see-mhews-a>

IMO Prize

International Meteorological Organization – Predecessor to UN-World Meteorological Organization



Zaviša Janjić at ECMWF very early days



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ON THE OCCASION OF THE FIFTY-SEVENTH AWARD OF THE

INTERNATIONAL METEOROLOGICAL ORGANIZATION PRIZE MMXII

IN RECOGNITION OF

HIS OUTSTANDING LIFE-LONG CONTRIBUTIONS TO THE ADVANCEMENT OF THEORY AND PRACTICE OF ATMOSPHERIC MODELLING AND NUMERICAL WEATHER PREDICTION AND IN PARTICULAR FOR THE DEVELOPMENT OF GENERATIONS OF HIS INNOVATIVE NUMERICAL AND PHYSICAL SCHEMES THAT HAVE BEEN USED FOR RESEARCH AND WEATHER FORECASTING ALL OVER THE WORLD, INSPIRING THE WORK OF MANY SCIENTISTS AND PRODUCING FORECASTS REACHING MILLIONS OF USERS

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