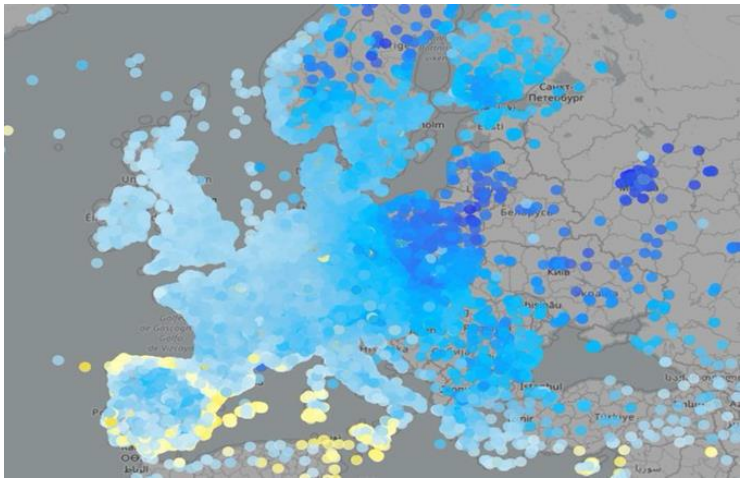
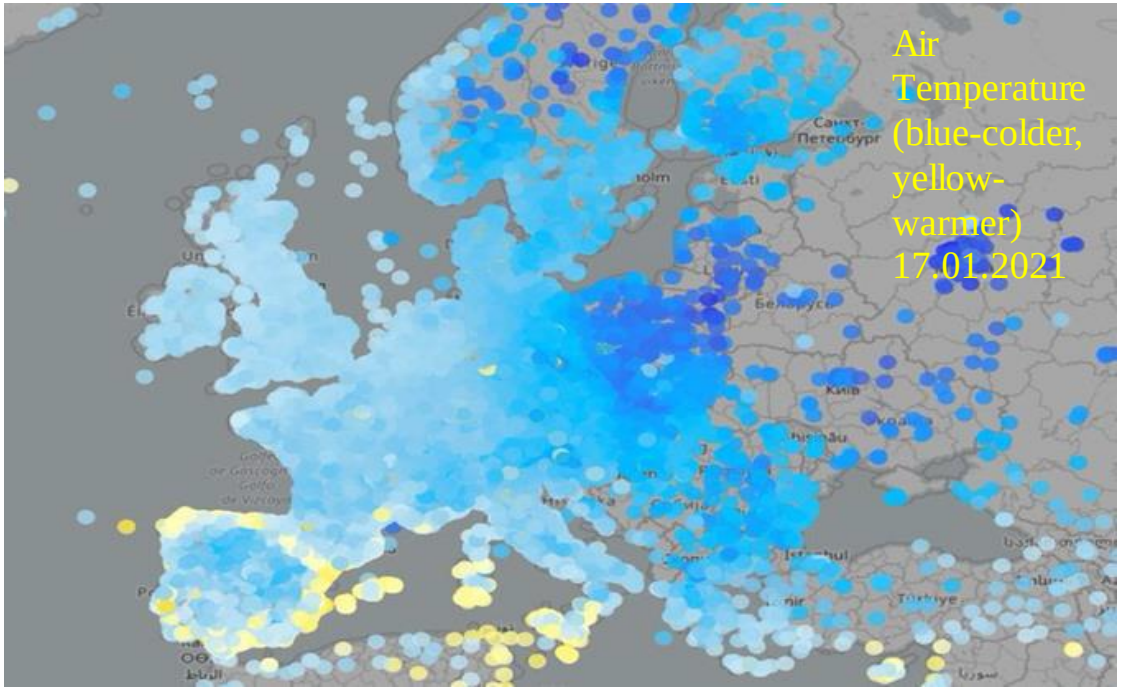
Priority Task: EPOCS (Evaluate Personal Weather Station and Opportunistic Sensor Data CrowdSourcing)



IMGW-PIB: Joanna Linkowska, Jan Szturc, Anna Jurczyk, katarzyna Ośródka, Marcin Grzelczyk, Radosław Doździoł
CIMA: Massimo Milelli, Umberto Pellegrini
CNMCA: Francesco Sudati

08/09/2022

Motivation



Networks of personal weather stations (PWS)

https://wow.metoffice.gov.uk/

- weather measuring instruments that you can install at your own home or business
- dense network of observations possess a potential to capture high-resolution meteorological information

- PWS sensors are maintained and operated by owners
- prerequisite for ensure data credibility and sustainability
- development and testing quality control (QC) methods and software
- QC assessment of a test set of data, poor quality data removal

COSMO PT EPOCS

- Initial proposition of PT EPOCS sent for a discussion at WG5/SMC
- Participants: IMGW-PIB, CIMA, CNMCA
- PT Leader: Joanna Linkowska (IMGW-PIB)
- Start: October 2022 or early spring 2023
- Duration 1 year
- Topics: PWS databases, QC analysis/tools, experimental data sets
- Further plans for a longer PP …. aplication PWS products in: verification, data assimilation, postprocessing (machine learning)

COSMO PT EPOCS Tasks

1. **Survey on PWS data availability within different networks**
   - ❑ comprehensive survey of available data platforms at the European and Global level
   - ❑ create storage for PWS opertaed by IMGW-PIB employees
   - ❑ testing integrity and correctness of stored data, external projects (CENAGIS)

2. **Data quality control (QC) of PWS**
   - ❑ survey on QC algorithms and processing software (e.g. TITAN from Norway Met Services, IMGW-PIB's software, COST-OPENSENSE developments, etc.)
   - ❑ development/tuning/testing of RainGaugeQC and TITANLIB algorithms
   - ❑ PWS QC assesment : Netatmo, Meteonetwork, Centro Meteo Lombardo, Meteotracker

3. **QC of rainfall estimates (RainGRS+)**
   - ❑ processing different rainfall data sources (private rain gauges, commercial microwave links, sewer/water service stations, etc.) combine them with other standard data (telemetry, radar, satellite) into new a enhanced rainfall estimates (RainGRS+)
   - ❑ surwey QC independent data and spatial/object based veryfiation methods

4. **Local variability of precipitation based on the testing PWS stations**
   - ❑ potential of using PWS to monitor extreme events
   - ❑ QC of PWSs precipitation depending on different meteorological conditions

COSMO PT EPOCS FTEs

Total FTEs

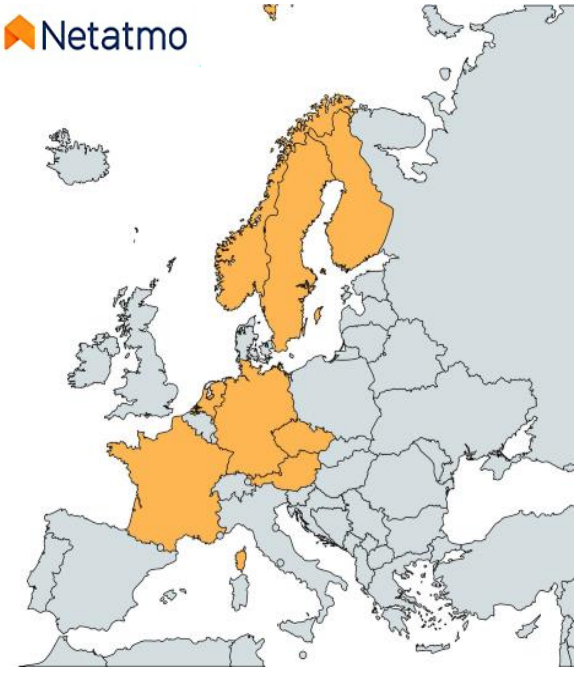
FTE-y 2022/23 (from Oct 2022 to Sep 2023): 1.00

Task	IMGW-PIB	CIRA	CNMCA
0	0.05		
1	0.2		
2	0.2	0.1	0.1
3	0.15		
4	0.2		
Total FTEs	0.8	0.1	0.1

Subtask 1.1,Surwey on PWS data

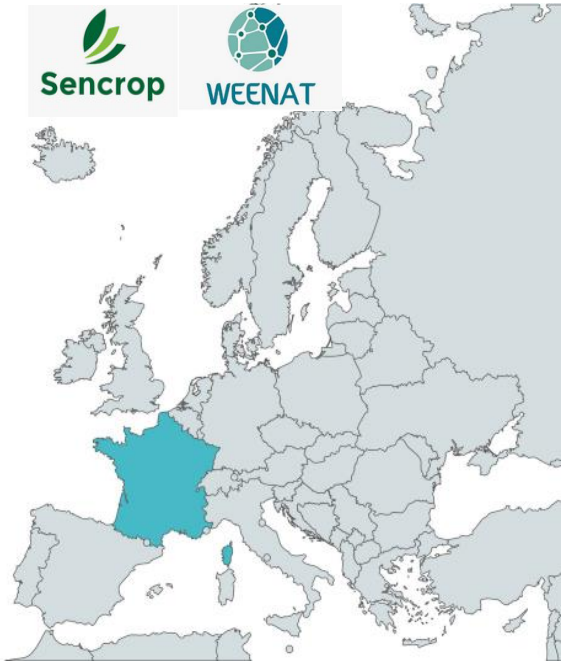
METEO IMGW-PIB
meteo.imgw.pl

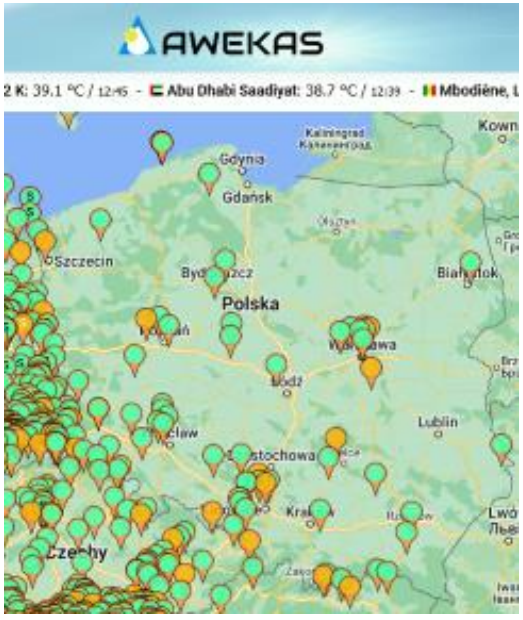
Netatmo

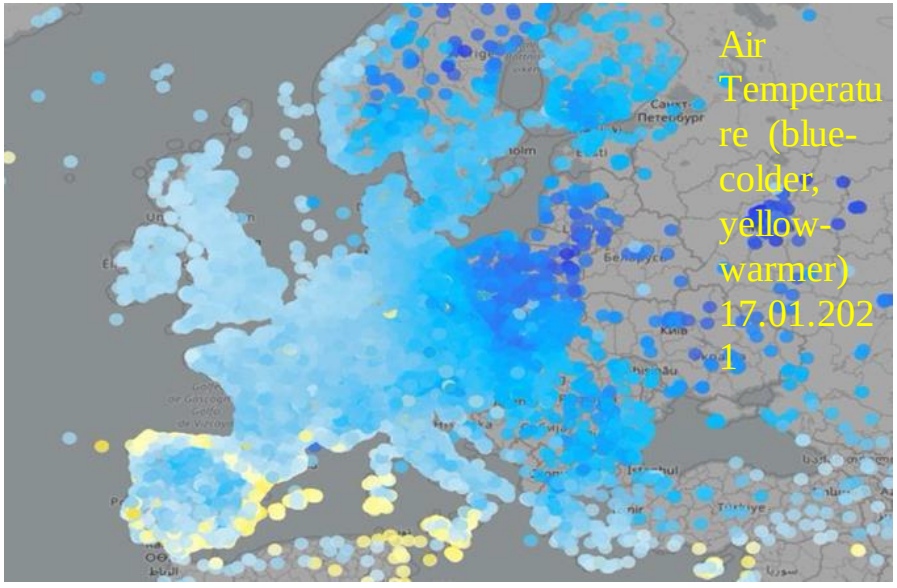


Sencrop

WEENAT

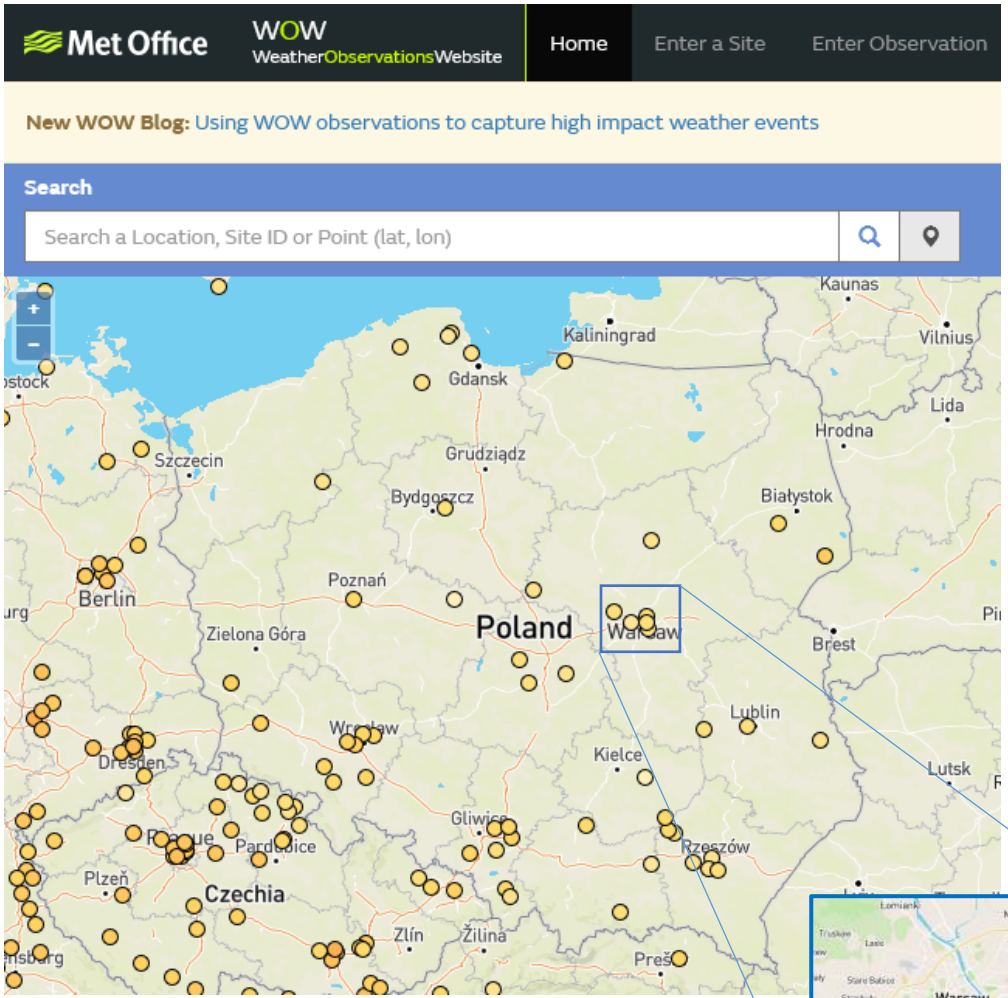


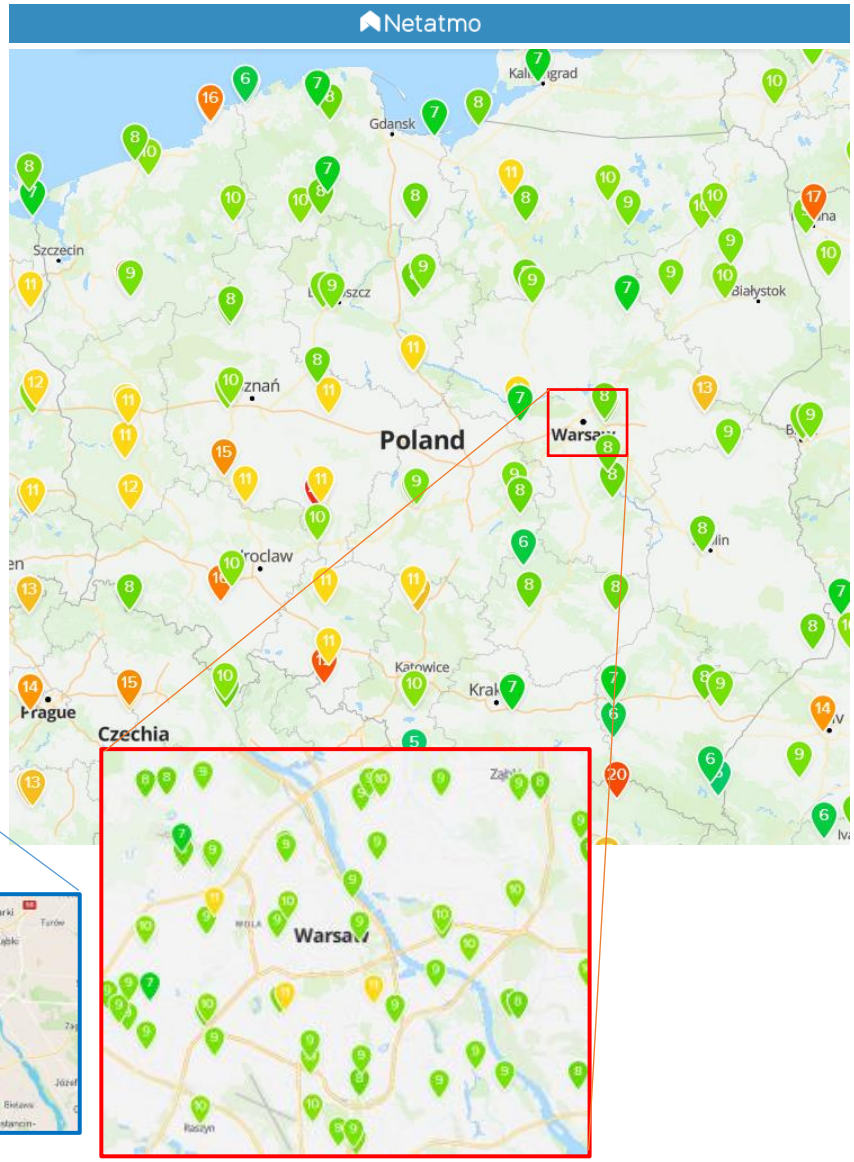




Met Office WOW (Weather Observations Website)

METEO IMGW-PIB meteo.imgw.pl





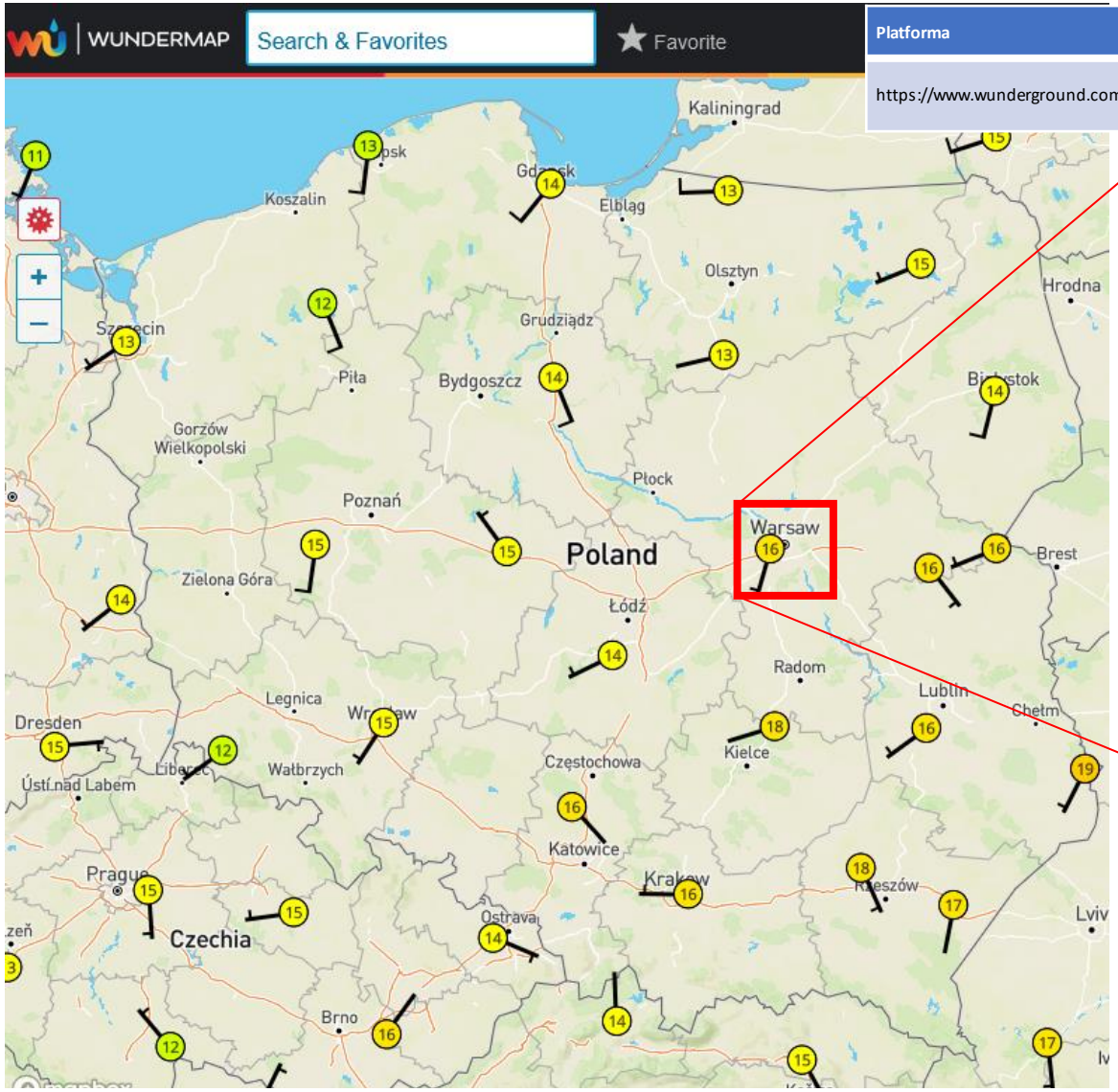
https://wow.metoffice.gov.uk/

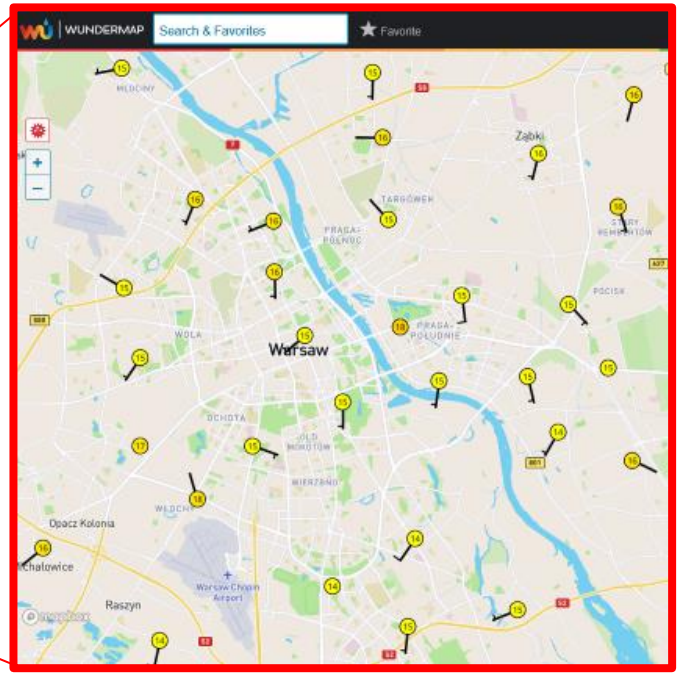
https://weathermap.netatmo.com/

WEATHER UNDERGROUND - WUNDERMAP

METEO IMGW-PIB
meteo.imgw.pl

Platforma	Sieć w Polsce	Aspekt prawny	API	Dane	Powstanie
https://www.wunderground.com	>1000	Niekomercyjnie, prywatny użytek danych po logowaniu	Tak, profesjonalne	1-60min	1995



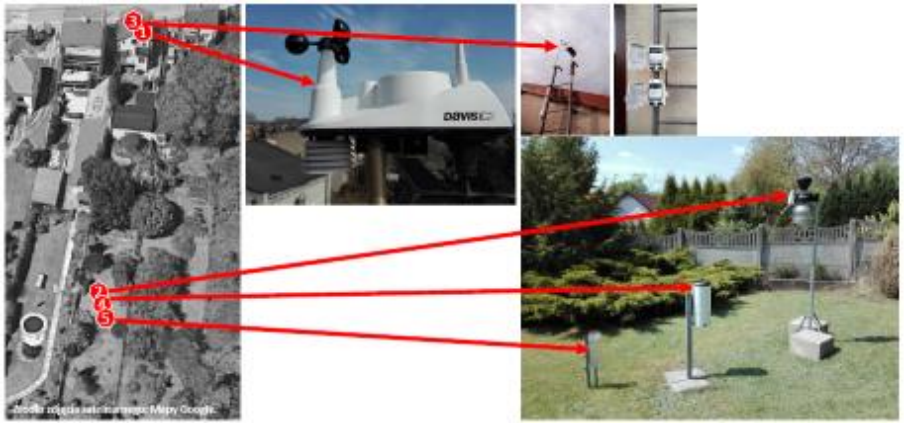


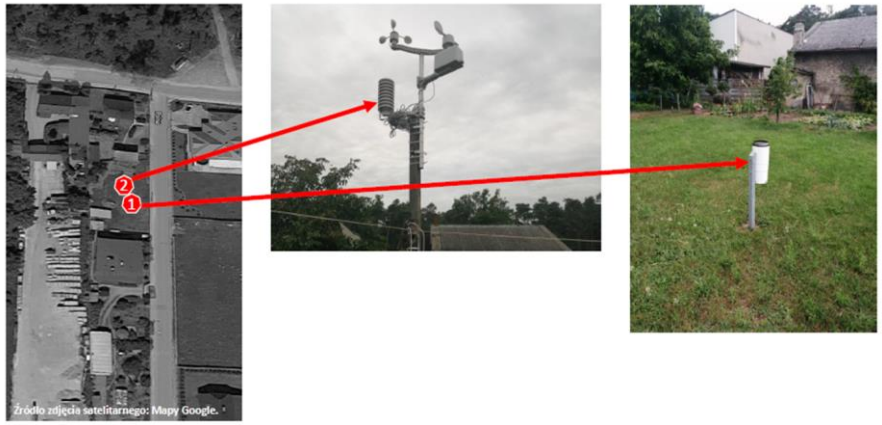
https://www.wunderground.com/wundermap

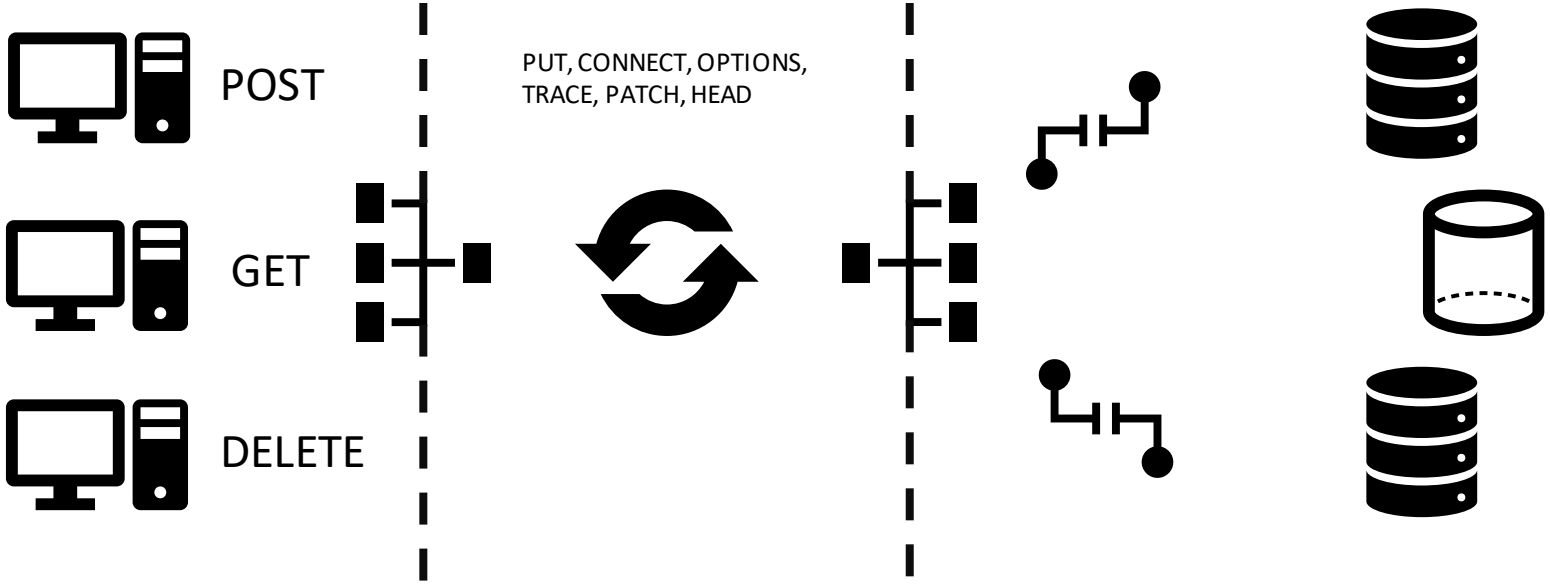
https://weathermap.netatmo.com/

Subtask 1.2, 1.3 collection of real-time operational PWS data from IMGW-PIB employees

METEO
IMGW-PIB
meteo.imgw.pl







subtask 2.1 Quality control of PWS with RainGaugeQC

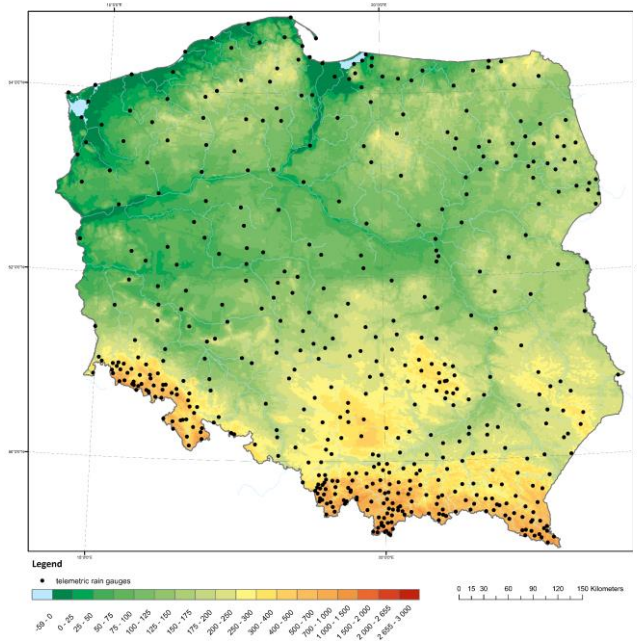
Design and implementation of adaptation of the RainGaugeQC software for QC of unprofessional gauges (standard RainGaugeQC: Ośródka et al., AMT 2022, submitted)

Abbr.	Algorithm	Sub-algorithms	Standard RainGaugeQC	…version for unprofess. gauges
GEC	Gross Error Check		x	x
RC	Range Check		x	x
RCC	Radar Conformity Check	1) Detection of incorrect „no precipitation” data	x	x
		2) Detection of false precipitation reports	x	x
TCC	Temporal Consistency Check	1) Detection of blocked sensors	x	x
		2) Comparison of two sensors	x	
		3) Time series comparison with weather radar		x
		4) Bias correction with adjusted radar data		x
SCC	Spatial Consistency Check	1) Detection of outliers from the local vicinity	x	x
		2) Advanced detection of outliers taking into account additional percentiles	x	x

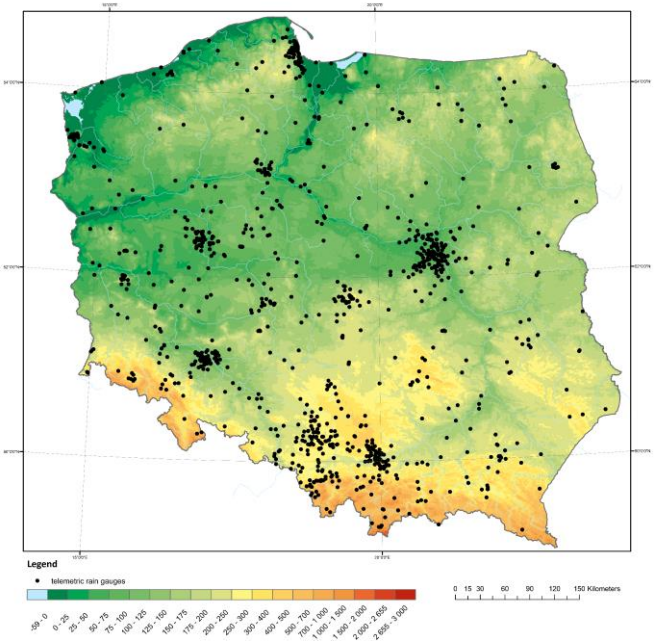
subtask 2.1 Quality control of PWS with RainGaugeQC

METEO IMGW-PIB meteo.imgw.pl

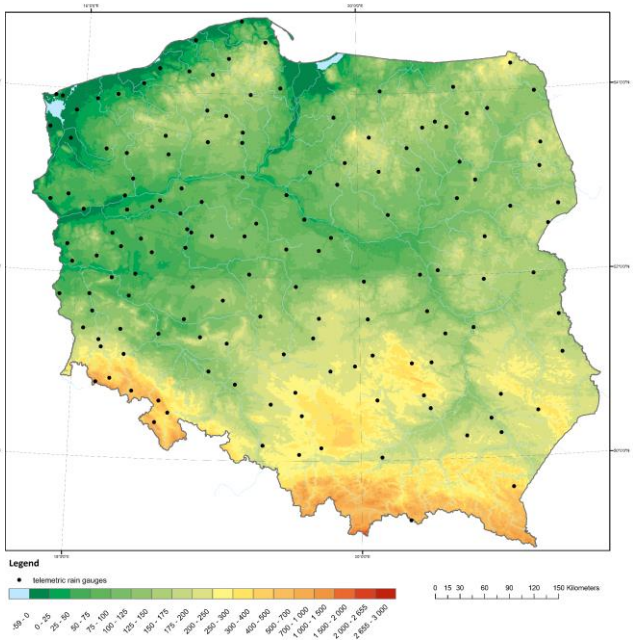
Available data from rain gauge networks



IMGW-PB
– state network, professional



Netatmo
– private, amateur gauges

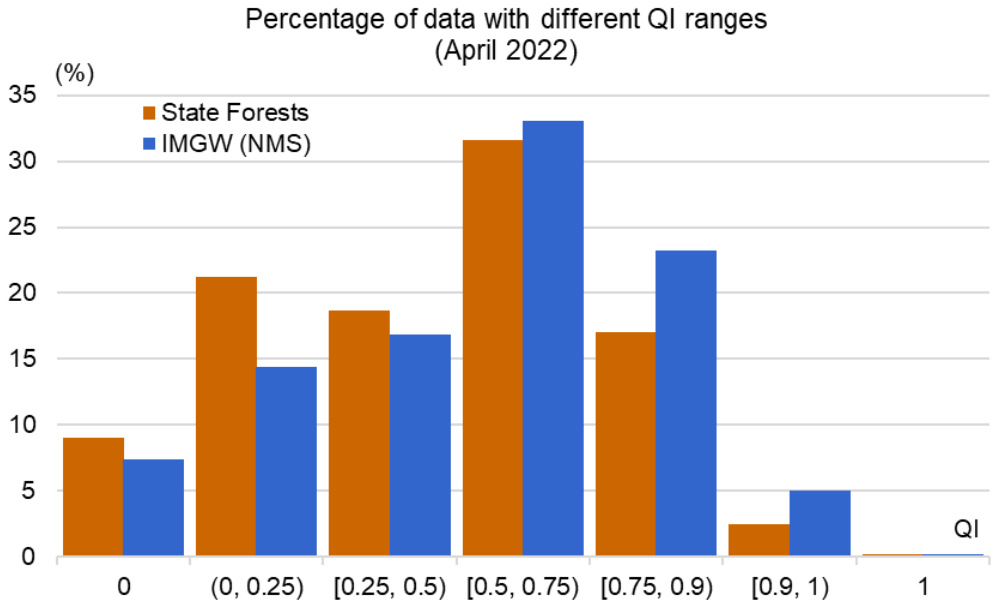


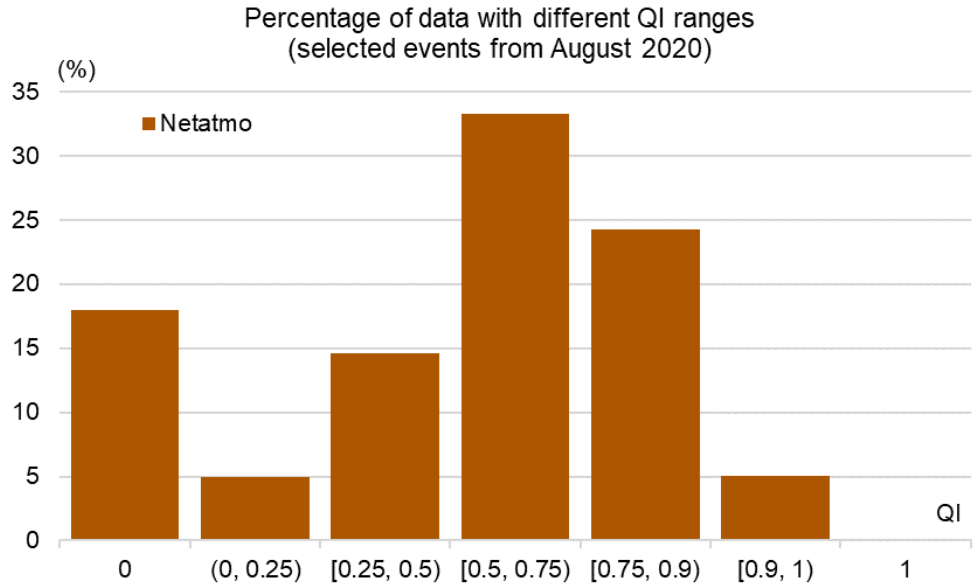
Board of the State Forests
– state network, unprofessional

subtask 2.1 Quality control of PWS with RainGaugeQC

METEO IMGW-PIB meteo.imgw.pl

Analysis of quality controlled data



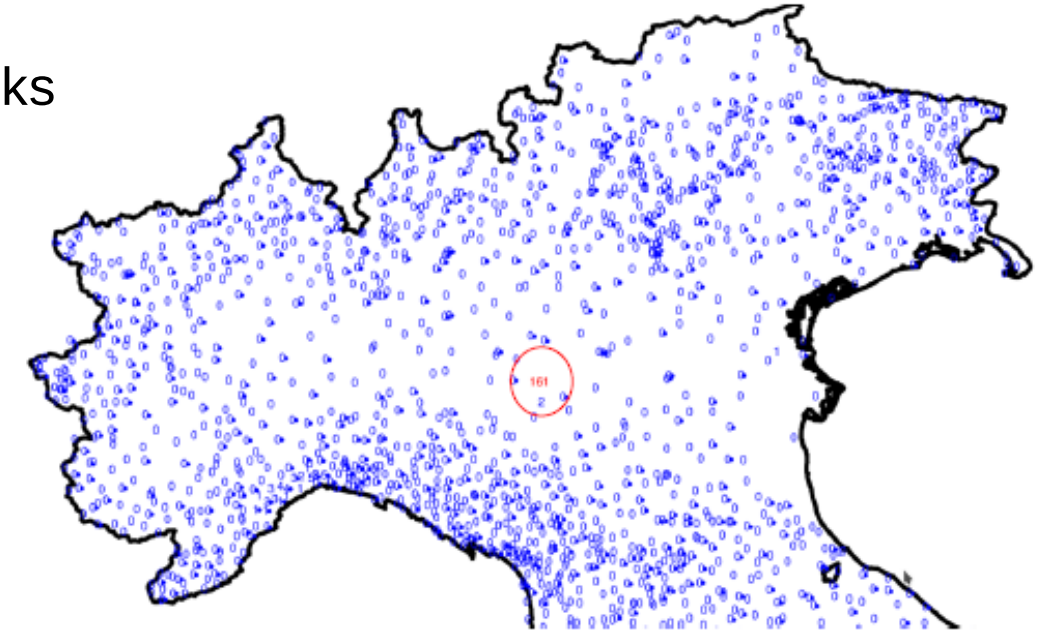


(as it is now CIMA thanks to Umberto Pellegrini)

Check precipitation of the official Italian ground network over 24h and over season. Different checks

Over 24h the controls are:

1. Isolation check
2. Buddy check
3. Buddy event check



Over season:

1. Isolation check
2. Buddy event check

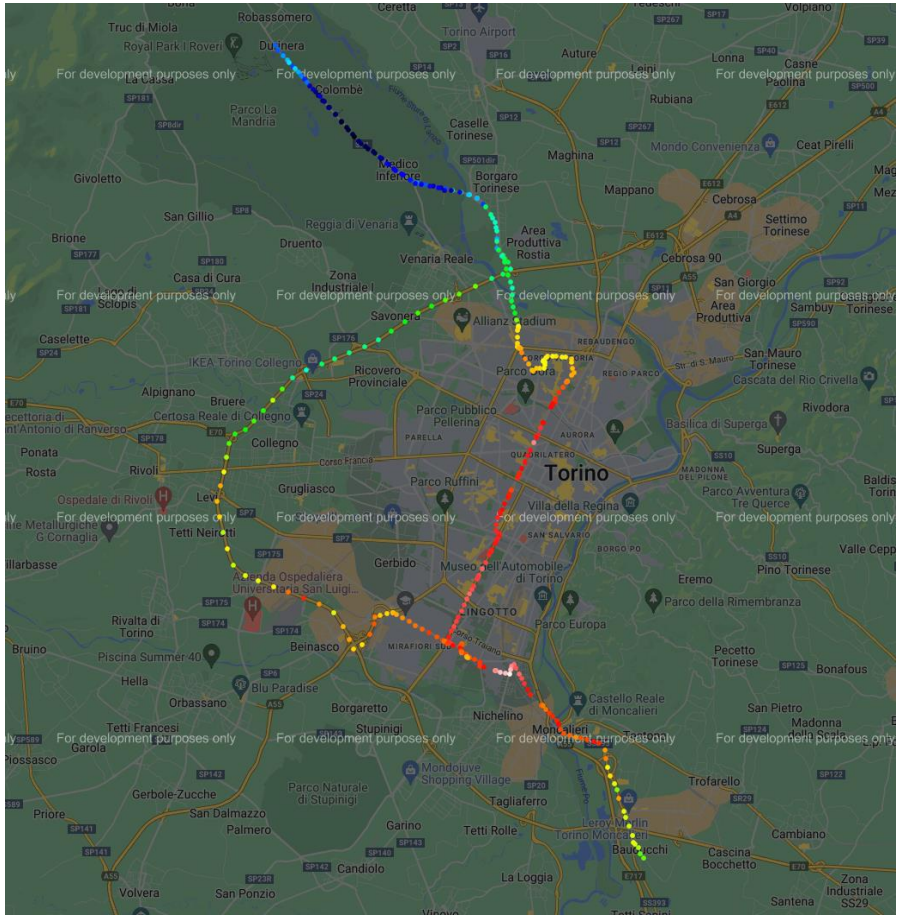
subtask 2.2 Data Quality Control using TITANLIB

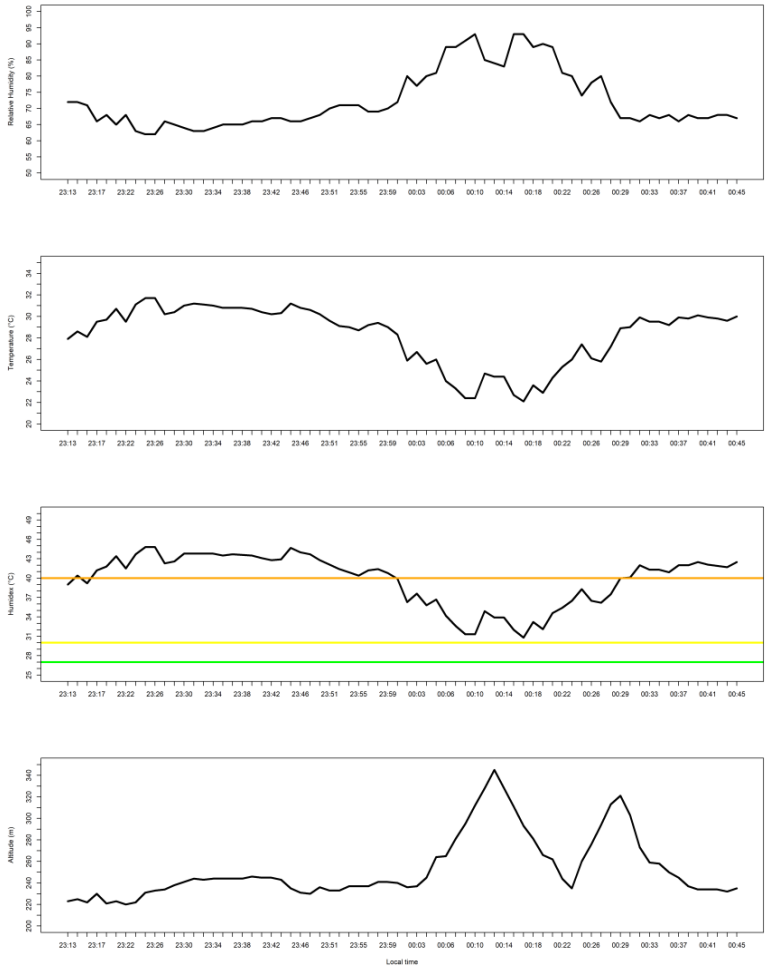
Example of MeteoTracker usage :

- measurement of Torino Urban Heat Island (UHI) and
- Urban Dry Island (UDI)

Example of MeteoTracker usage :

- measurement of Torino Urban Heat Island (UHI) and
- Urban Dry Island (UDI)

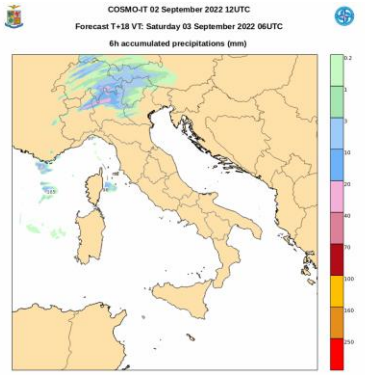


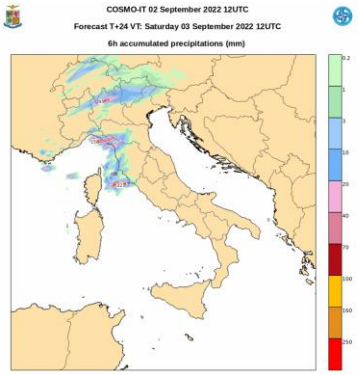


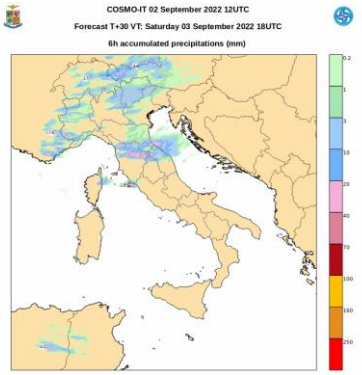
subtask 2.3 Quality control of PWS data

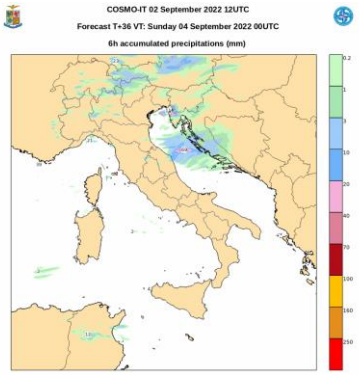
Aerospace Meteorology & Climatology National Center - ITALY

COSMO-IT

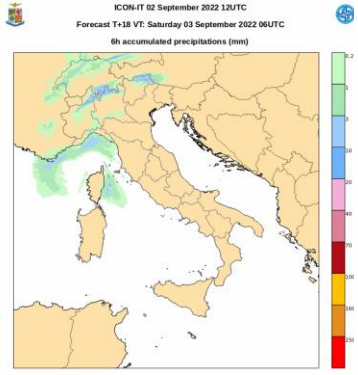


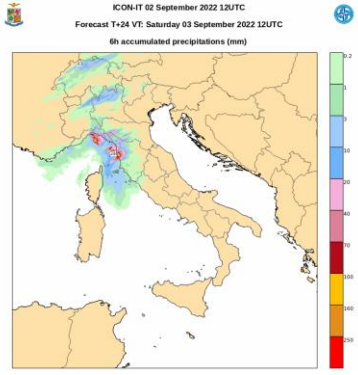


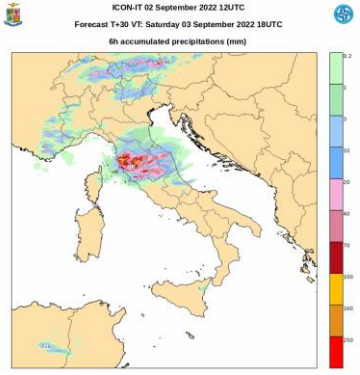


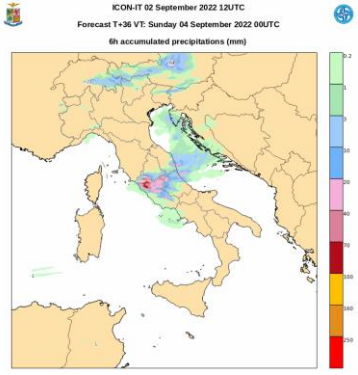


ICON-IT





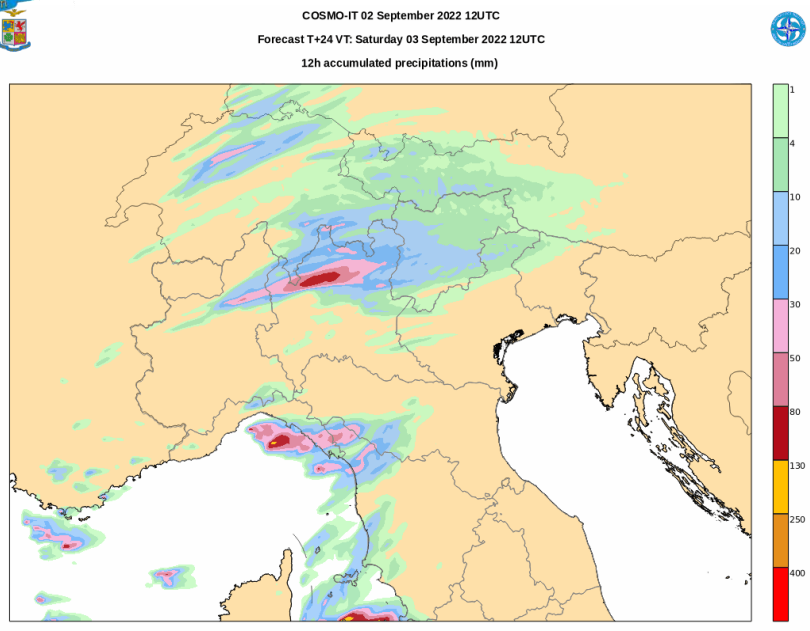




Meteonetwork and Centro Meteo Lombardo associations
PWS - quality control, data assimilation and verification

subtask 2.3 Quality control of PWS data

FORECAST BY COSMO-IT 00-12

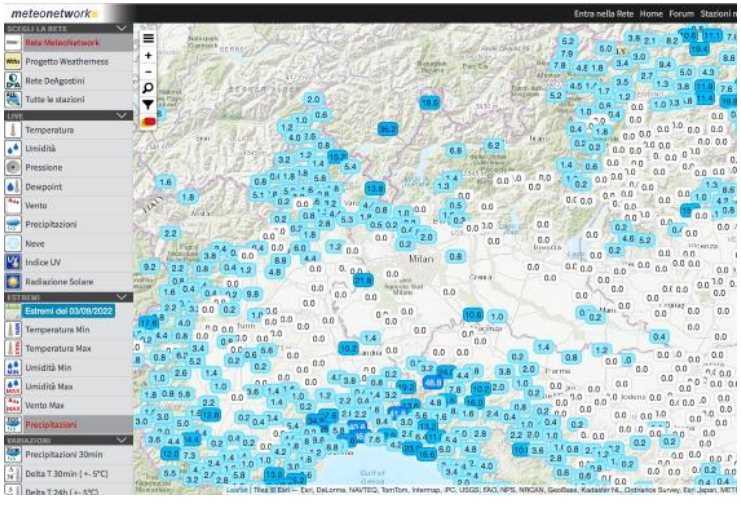


"NATIONAL" *RAIN GAUGE 00-12*

https://www.mydewetra.org

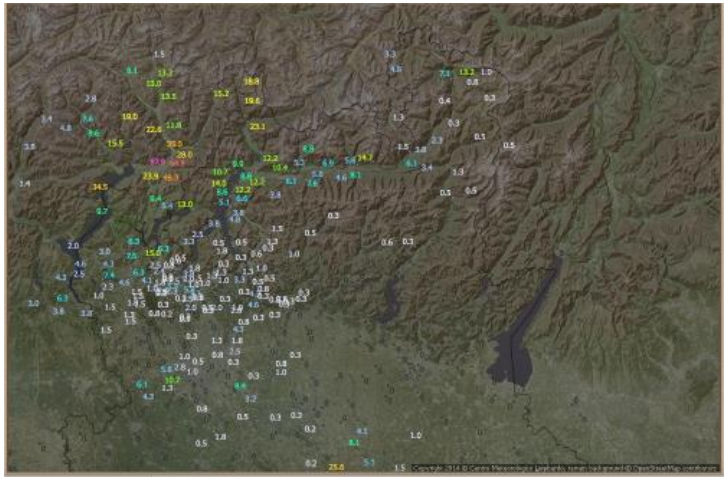
METEONETWORK *RAIN GAUGE 00-12*

https://www.meteonetwork.it



CENTRO METEO LOMBARDO *RAIN GAUGE 00-12*

http://www.centrometeolombardo.com

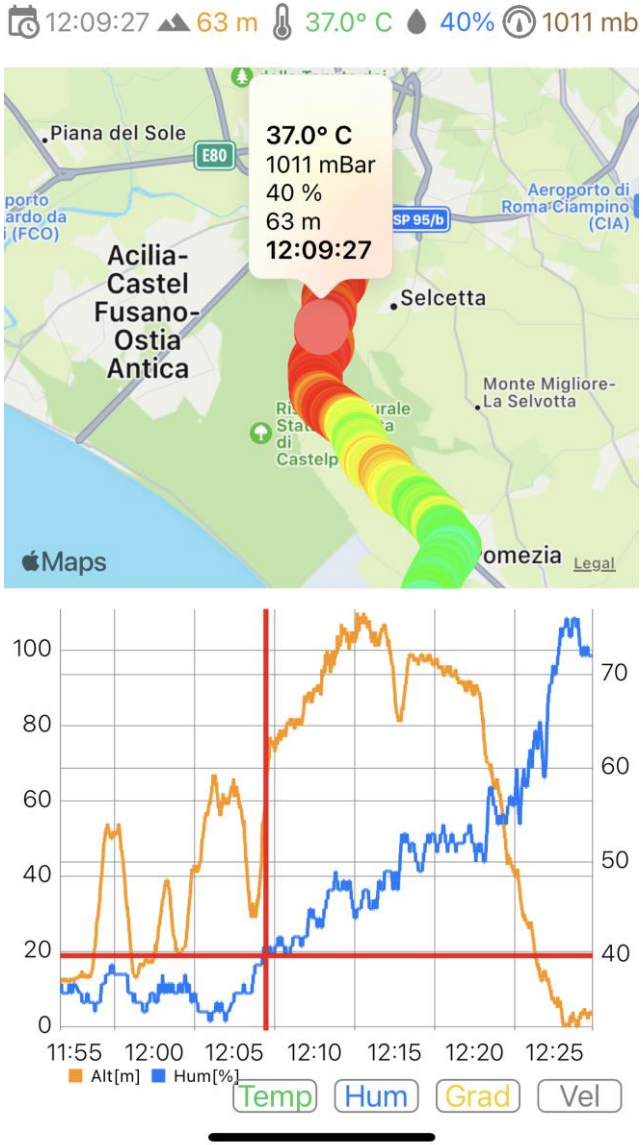


subtask 2.3 Quality control of PWS data

MeteoTracker
MOBILE WEATHER NETWORK
https://meteotracker.com

METEOTRACKER SENSOR

mobile weather sensor, to be mounted on the car roof or a bike



RainGRS model:

Quality-based combination of rain gauge, radar and satellite data (QPE):

Input data:

- IMGW rain gauge network,
- IMGW POLRAD radar network,
- EUMETNET OPERA radar precipitation,
- Meteosat (NWC-SAF) based precipitation estimation (algorithm: Jurczyk et al., 2020, Remote Sensing)
- PWS data sets

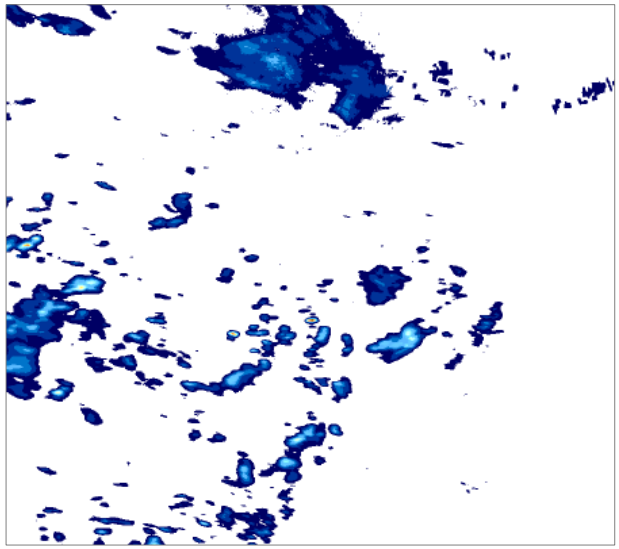
Standard combination of estimates.

1. **RainGRS** (rain gauges, radars PL, and satellite estimates) + **satellite** precipitation (using RainGRS algorithm).
2. **RainGRS** (rain gauges and radars PL) + **OPERA** radar precipitation (note: there will be gaps beyond radar data coverage).
3. **RainGRS** (rain gauges, radars PL + **OPERA**, and **satellite** precipitation (using RainGRS algorithm))

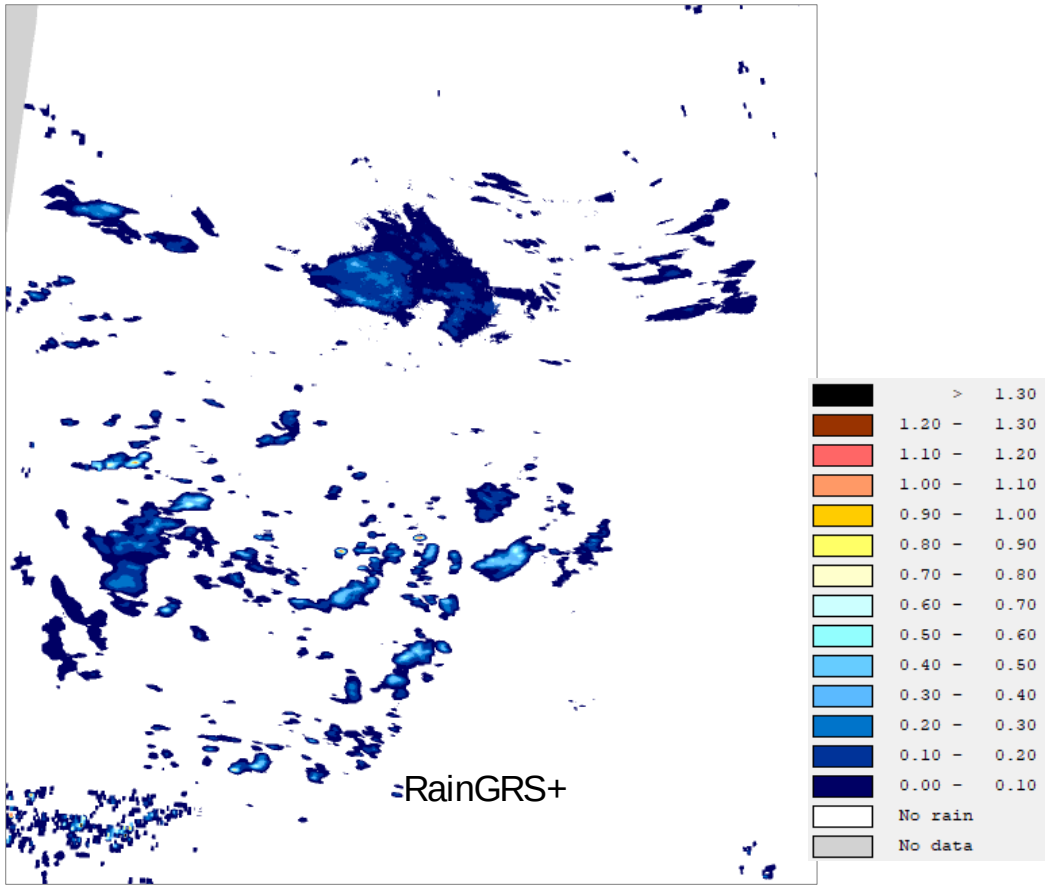
Based on our experience with processing, the last solution will give the best estimates

Determination of QPE (quantitative precipitation estimation) for COSMO 2.8 km domain (1200 km x 1300 km) with extended RainGRS+ system

Example of QPE fields: RainGRS and RainGRS+ (mm / 10 min), 2019-03-05, 12:00 UTC. Version #1.



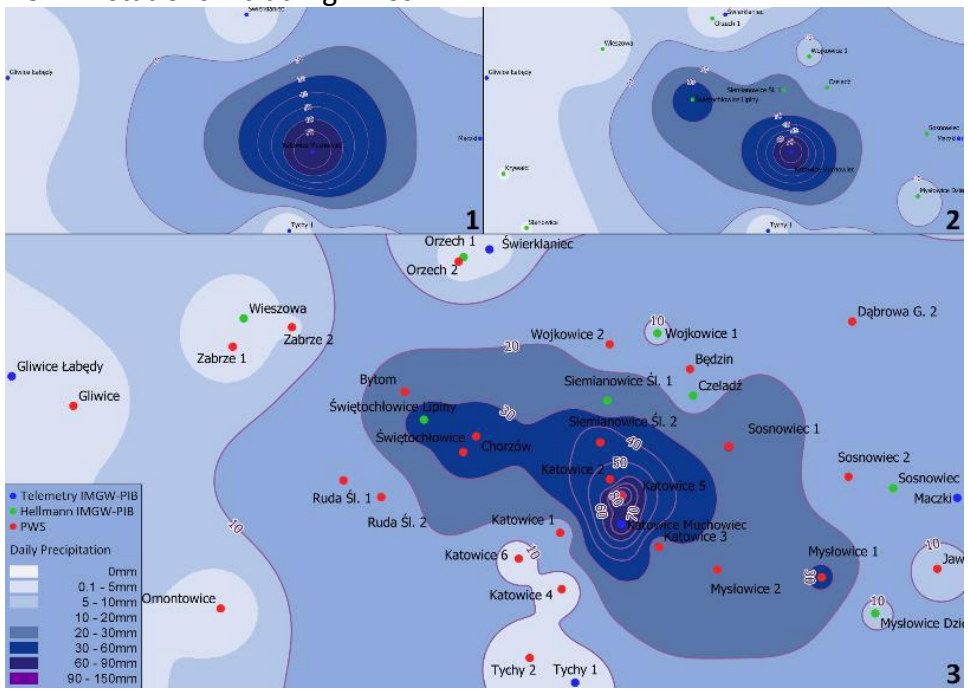
RainGRS domain
(COSMO 2.8) domain



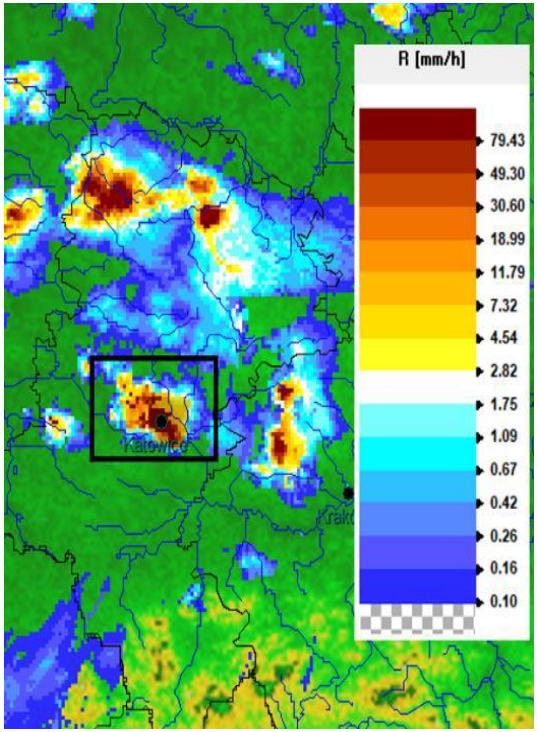
Problem: Some data not be available or of poorer quality outside the PL domain

gridded RainGRS require its QC verification by comparing two dimensional rainfall field with an independent data

1 –IMGW-PIB synoptic stations,
2 –IMGW-PIB telemetric stations (Hellmann),
3 –All stations including PWSs



Rainfall intensity SRI

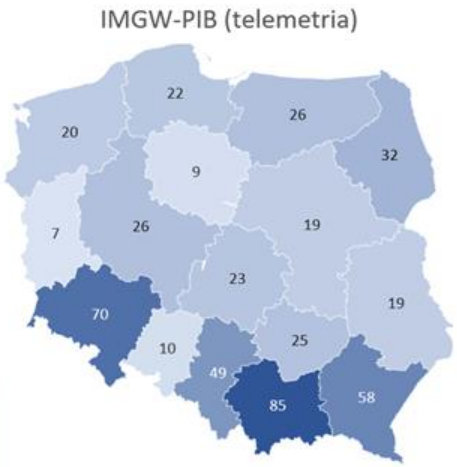


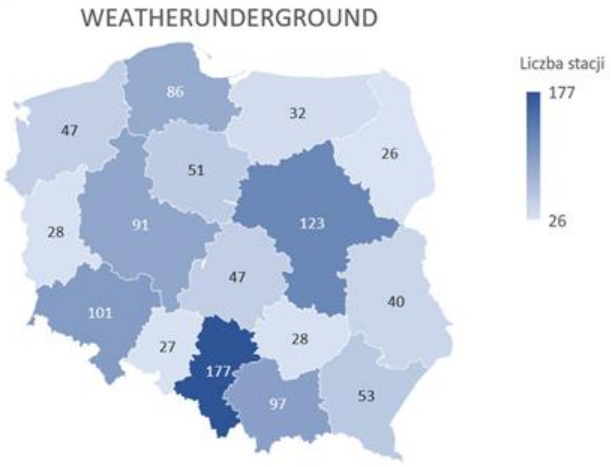
- analyse availability of **reference data sources** (e.g. radar or satellite composites, model reanalysis or RUC type radar data assimilation).
- survey on methods for **estimate properties of two dimensional precipitation fields** in terms of its spatial morphological composition (e.g. SAL or other object based methods)

METEO IMGW-PIB meteo.imgw.pl

Number of automatic weather stations in the IMGW-PIB network and in the Weather Underground (PWS) network.

Weather Underground is a commercial weather service providing real-time weather information over the Internet. Weather Underground provides weather reports for most major cities around the world on its Web site, as well as local weather reports for newspapers and third-party sites. Its information comes from the National Weather Service (NWS), and over 250,000 personal weather stations (PWS).





Private Weather Stations (PWS)

1. Davis Vantage Vue
2. Davis Vantage Pro2A
3. Netatmo Weather Station
4. WH1080 Weather Station

- ❑ potential of using PWS to monitor extreme events
- ❑ QC of PWSs precipitation depending on different meteorological conditions

CONSORTIUM FOR SMALL SCALE MODELING

COSMO

Thank you

CIMA (Centro Internazionale in Monitoraggio Ambientale) Research Foundation

CNMCA (Centro Nazionale di Meteorologia e Climatologia Aeronautica) - Italian Air Force Weather Service

IMGW-PIB (Instytut Meteorologii i Gospodarki Wodnej – Państwowy Instytut Badawczy) – Polish Weather Services

CNMCA

cima RESEARCH FOUNDATION

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

IMGW

METEO
IMGW-PIB
meteo.imgw.pl