Overview of activities in COSMO working group on Interpretation and Applications (WG4)

Anastasia Bundel

Hydrometcentre of Russia

41st EWGLAM and 26th SRNWP Workshop,

30 September – 3 October 2019, Sofia, Bulgaria

Outlook

- **Cases of model failures**
- **Activity in COSMO institutes**
- **WG4 for the PP C2I (COSMO to ICON): forecasters' feedback on ICON performance**

Common COSMO activity: Collecting cases of model failures

- Analysis of cases of notorious failures of the COSMO model (most notably the cases for which the model is specifically tailored)
- 2-4 cases from each COSMO member
- **To try to understand why the model fails**

Participants:

Some of WG4 people are operational forecasters or are in close contact with forecasters

- MCH (Daniel Cattani)
- HNMS (Dimitra Boucouvala)
- CNMCA (Alessio Canessa)
- IMGW-PIB (Andrzej Mazur and Joanna Linkowska)
- ARPAE-SIMC (Maria Stefania Tesini and Giacomo Pincini)
- RHM (Anastasia Bundel, Tatiana Dmitrieva, Denis Zakharchenko)
- NMS (Bogdan Maco)

Summer 2019

- **Many cases of convective HIW events in Europe (Supercells, heavy rain, hail, downbursts, a tornado in Rome!)**

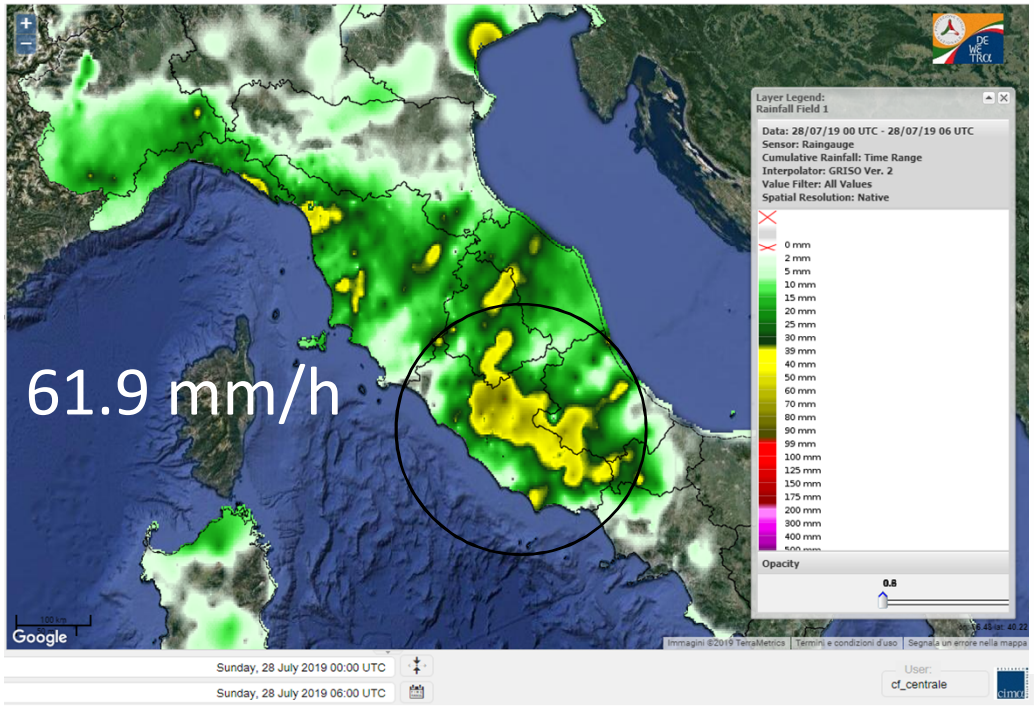
- **A challenge for forecasters**

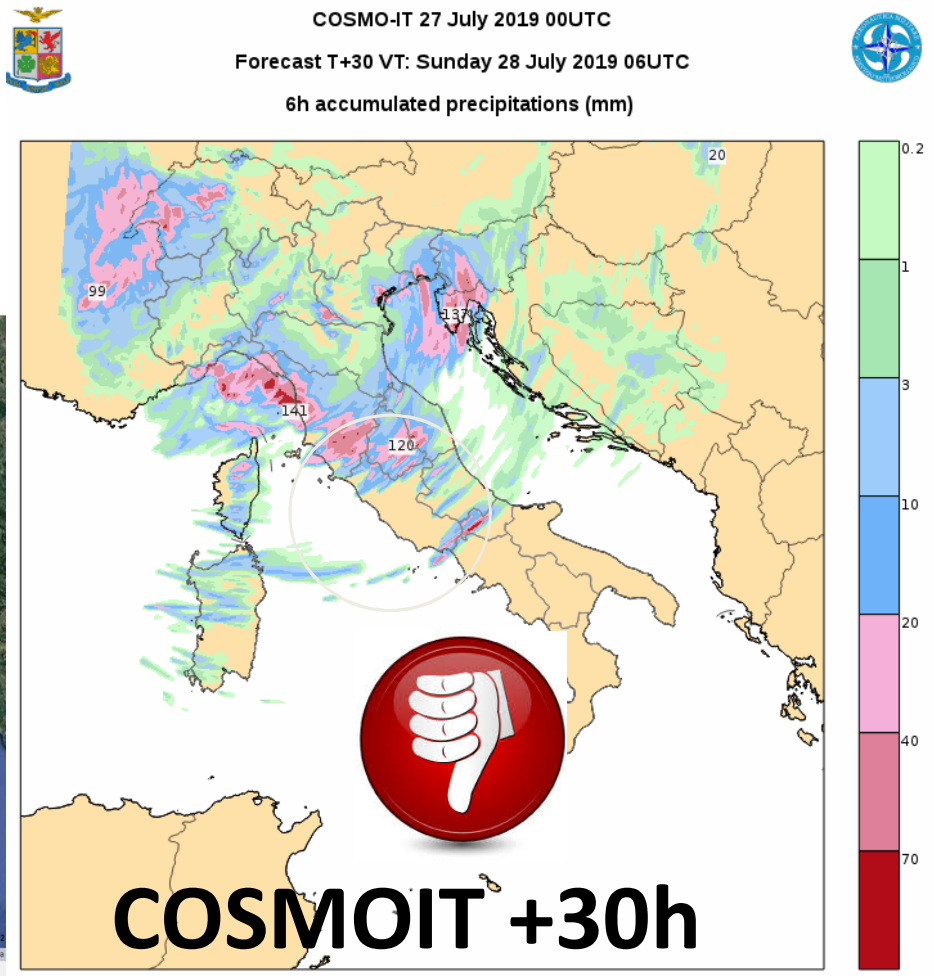
CNMCA (Meteosupport for civil activities), Italy

28 july 2019, 00-06UTC
Rome: heavy rain and a Tornado at 00.30UTC - 1 victim

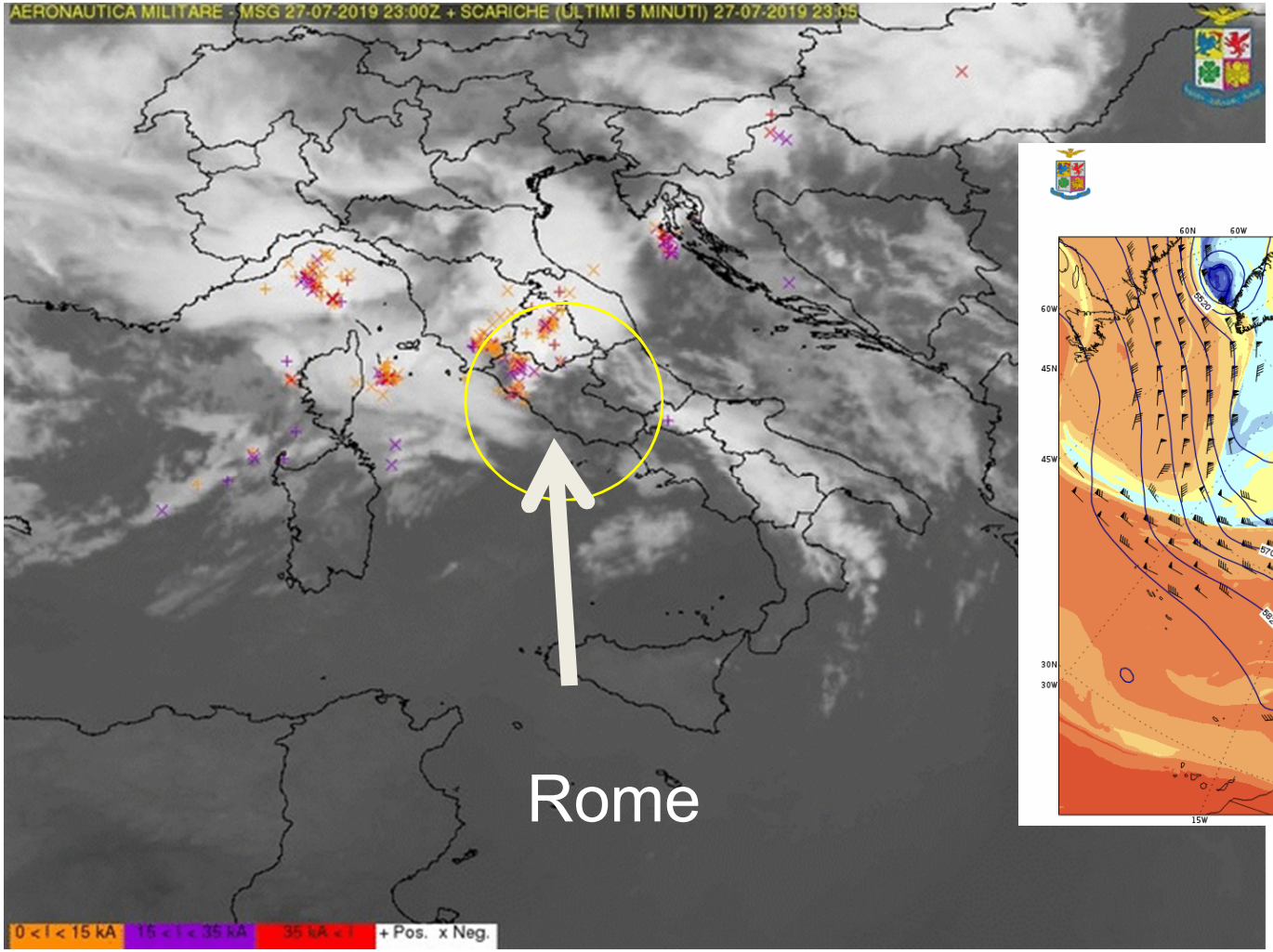
28 july 2019 Rome (heavy rain and a Tornado 00.30UTC - 1 victim)

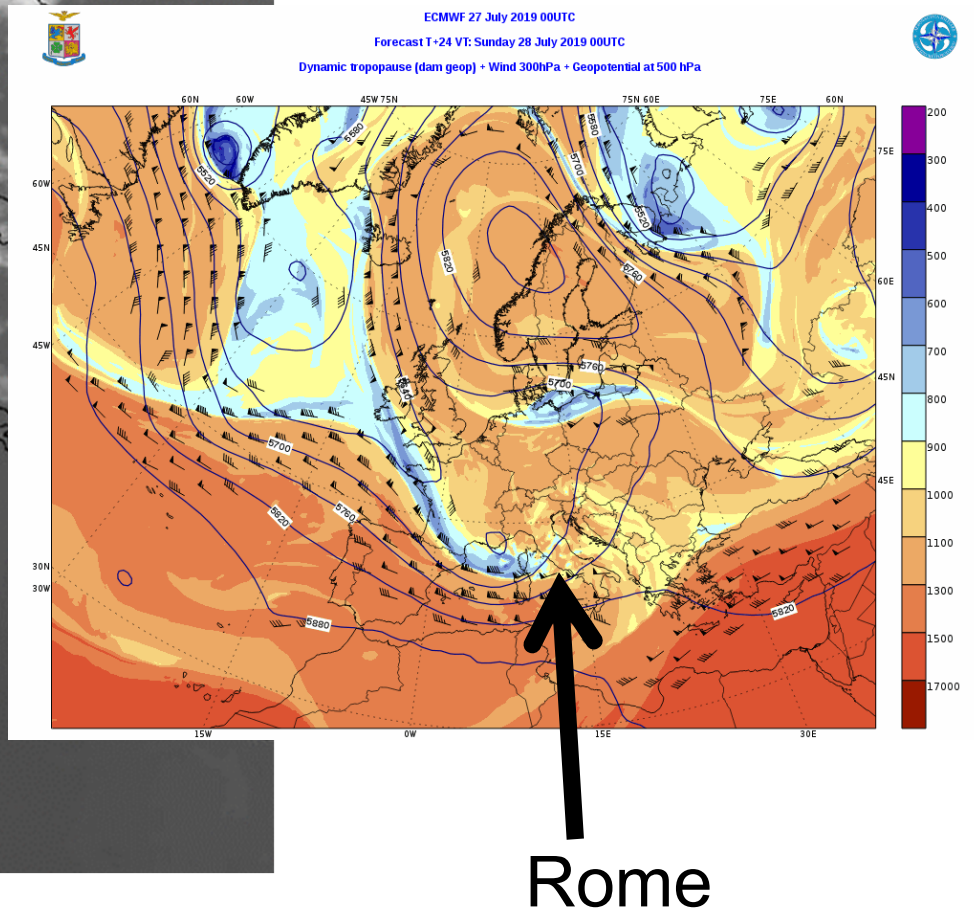
observed





28 july 2019 Rome (heavy rain and a Tornado 00.30UTC - 1 victim)





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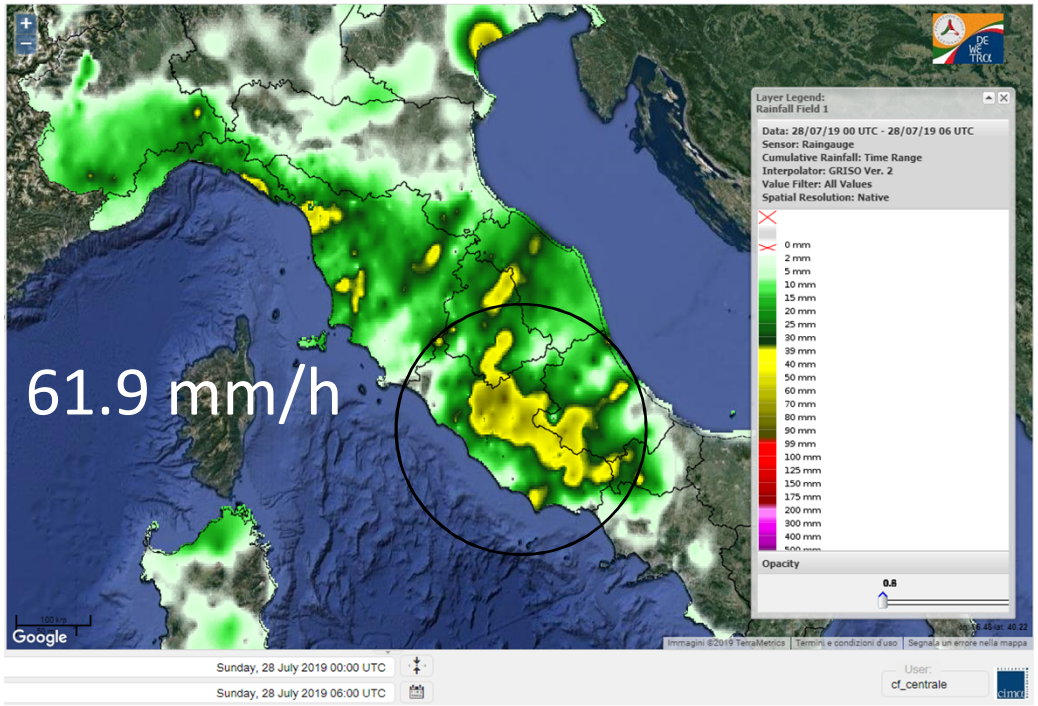
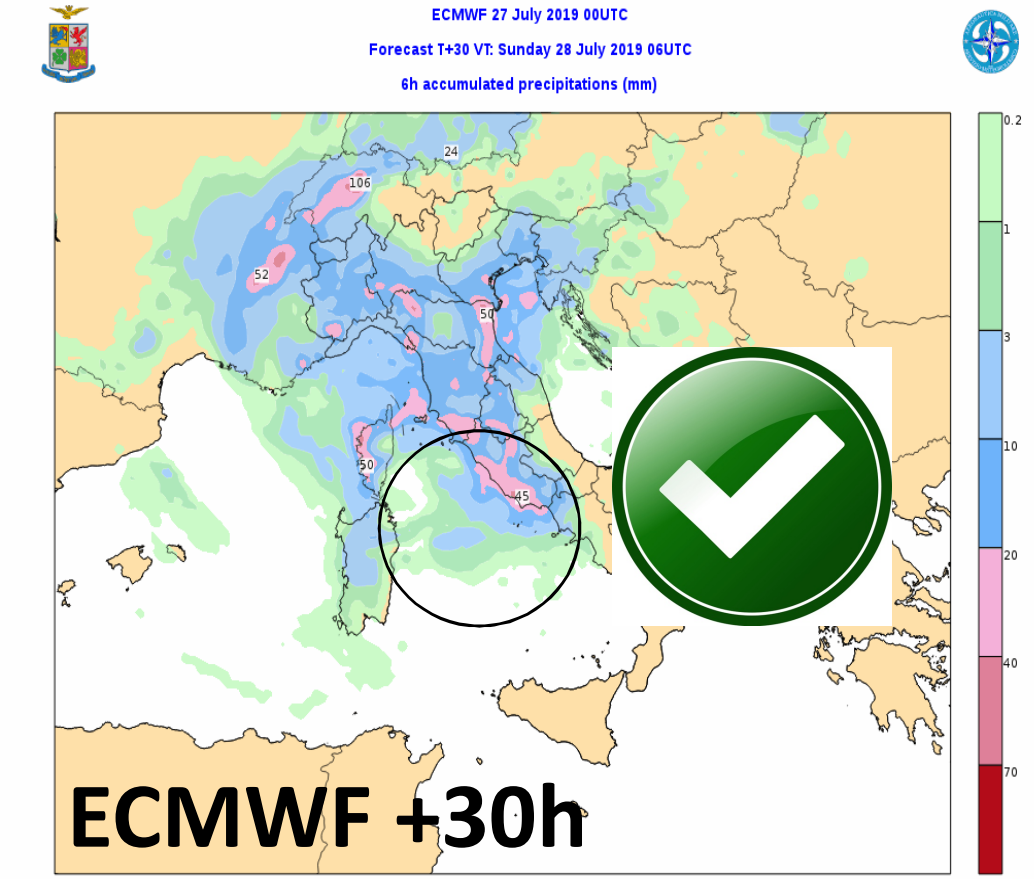




Roshydromet: 13 JULY 2016

Thunderstorm in the Moscow region

Tornado passage

(Analysis by Denis Zakharchenko,

researcher at the Hydrometcentre of Russia)

13 July 2016 Tornado damage

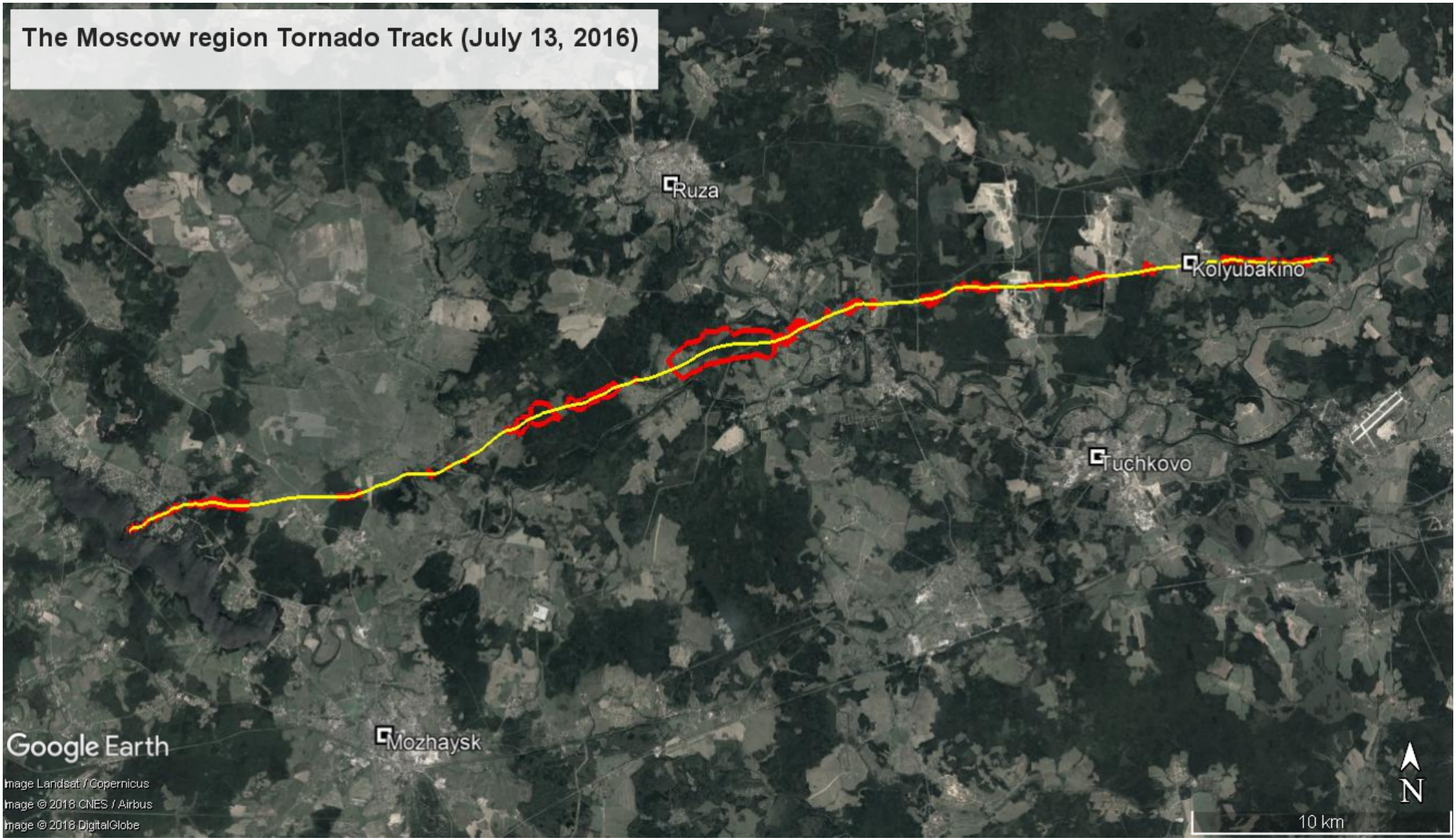
Two deaths, 17 wounded,
100 houses destroyed in the Moscow Region, Kolyubakino village suffered most

In Moscow: 9 wounded,
2 hit by lightning

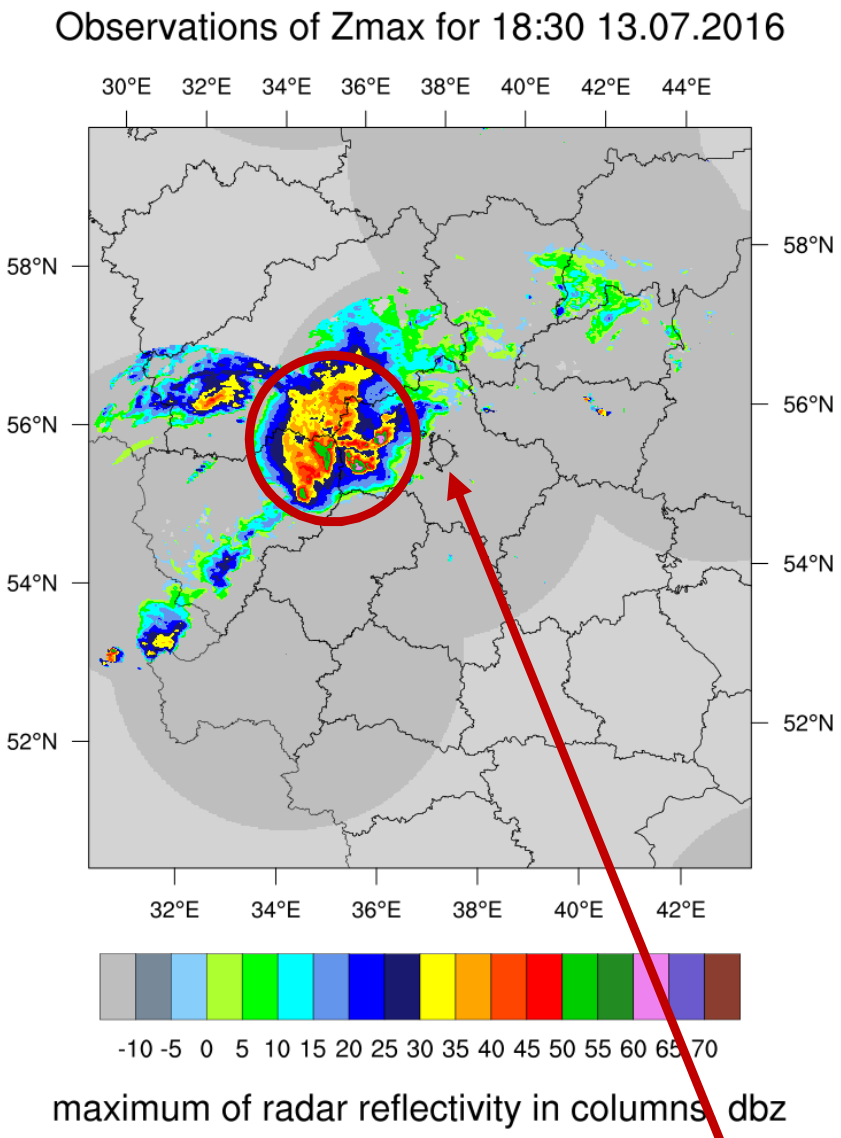
Thousands of trees broken

Tornado-Induced Tree Fall Pattern

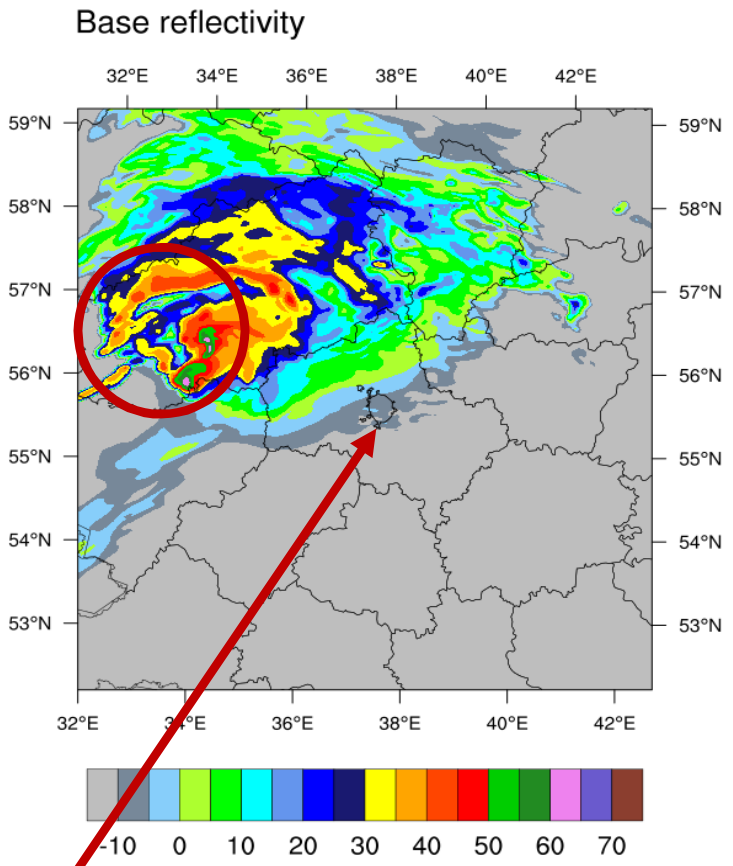
Tornado track



Maximum radar reflectivity, dBZ
18:30 UTC 13 July 2016



COSMO-Ru02 forecast for 18:30 UTC,
run from 13 Jul 2016, 12 UTC



Moscow

The high maximum reflectivity is forecasted by COSMO-Ru02 but shifted to North-west by about 200 km

RHM: Outlook

- **At present, with the models of 1-2 km grid mesh, the risk of tornado can be predicted mainly from the maximum reflectivity structure and convective instability indices (CAPE, Supercell detection index, SRH, SCP, …)**
- **To assess the feasibility of direct tornado risk forecast, we plan the experiments with the ICON-LAM with very high resolution (1000 m -> 500 m -> 200 m, up to tens of meters later on) *with two-way nesting***

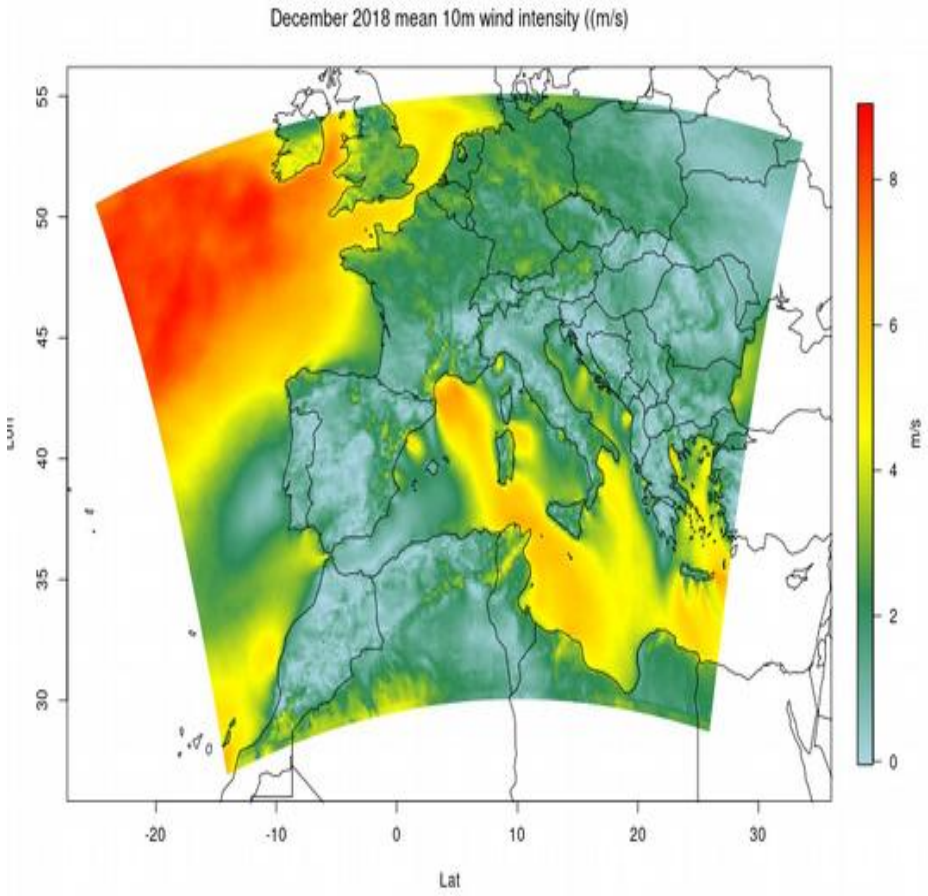
1-5 December 2018
ARPAE-SIMC

An application to air quality

The problem: December 2018 in the Po Valley

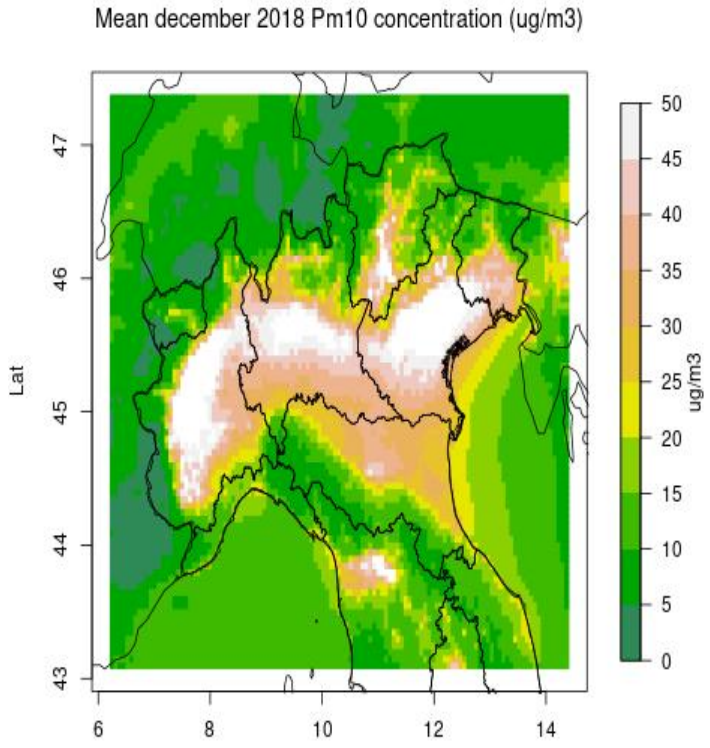
The peaks in pollutants concentrations occurring in the Po Valley are mainly due to ''unlucky'' meteorological condition associated with high static stability and unfavourable dispersion situation in the lower layers

Analysis from CHIMERE model: mean wind intensity for December 2018



Wind intensity: very weak winds in the Po Valley

Analysis from CHIMERE model: mean PM10 concentration for December 2018



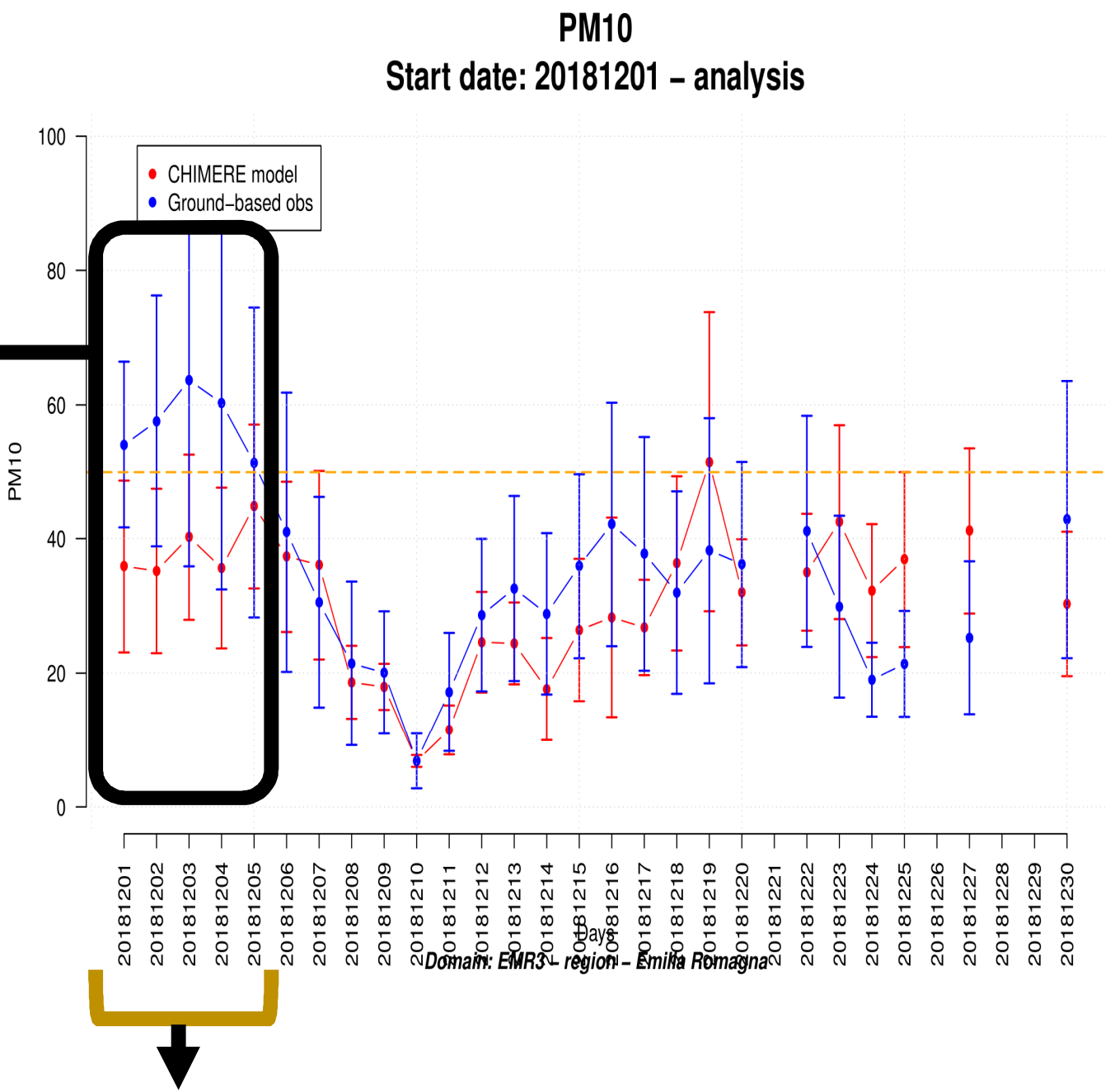
PM10 concentration: very high concentrations of atmospheric particulate over the Po Valley, especially on the northernmost part

The problem

There is a great difference between the observations and the forecasts, interalia through the legal limit of 50ug/m^3

CHIMERE uses the meteorology of COSMO 5M

Ground-based observations are obtained from regional averages with standard deviation

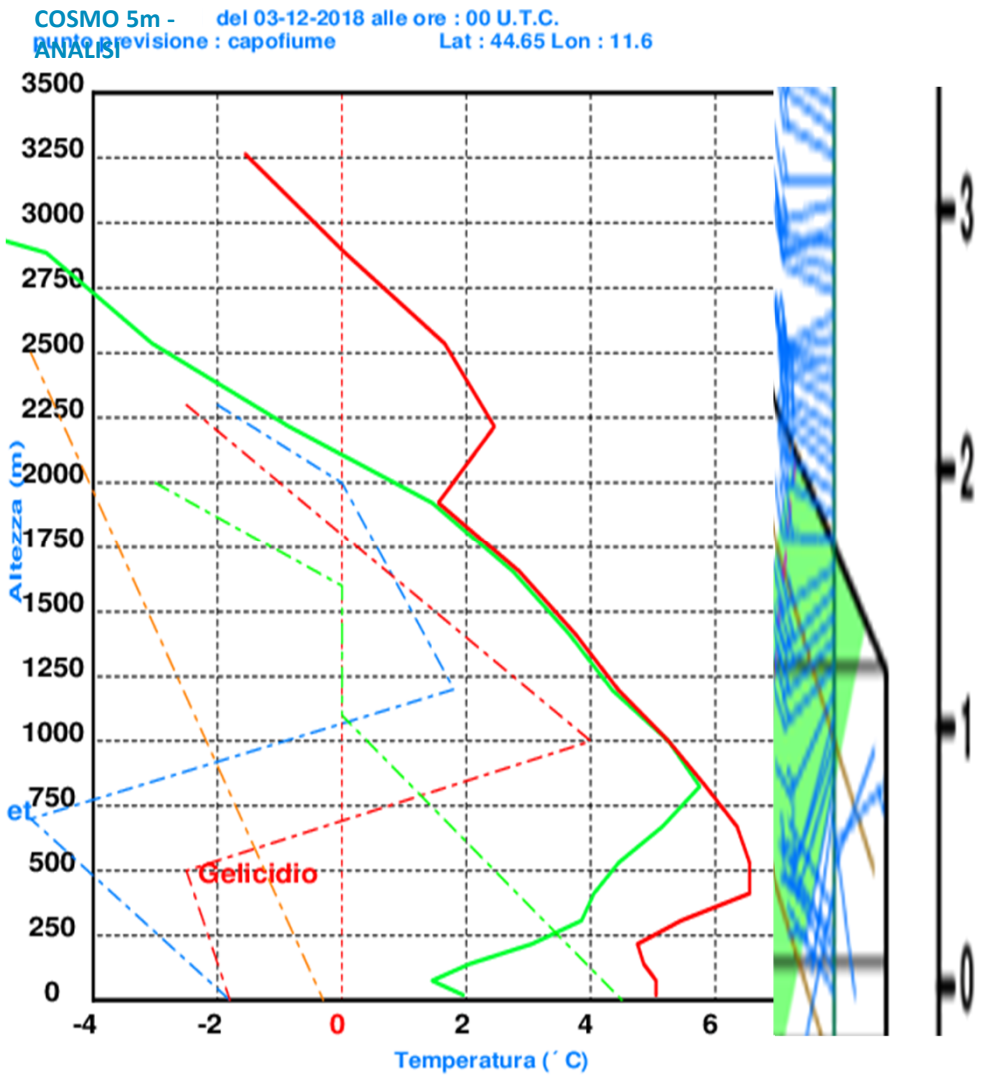


From 1/12/2018 to 5/12/2018

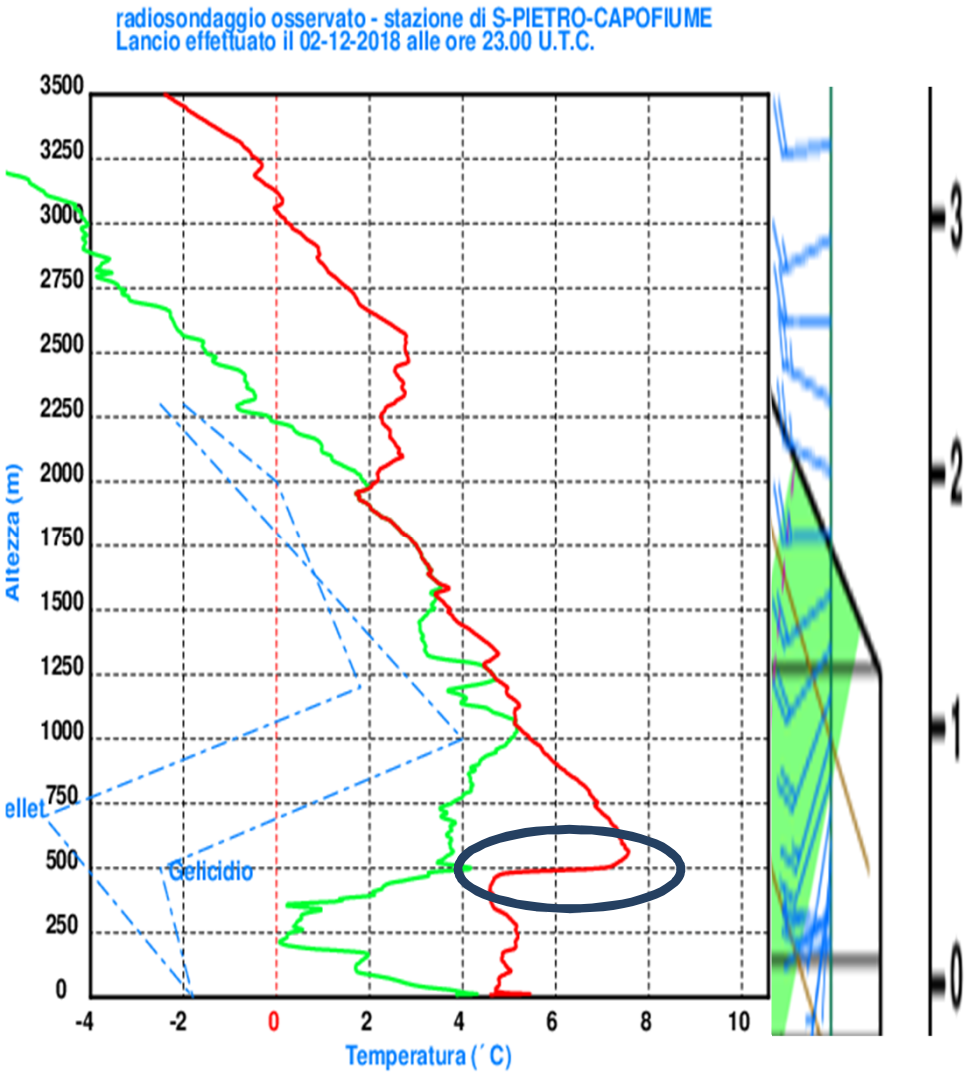
Thermodynamic profile of the atmosphere

Radio sounding San Pietro Capofiume

Analysis

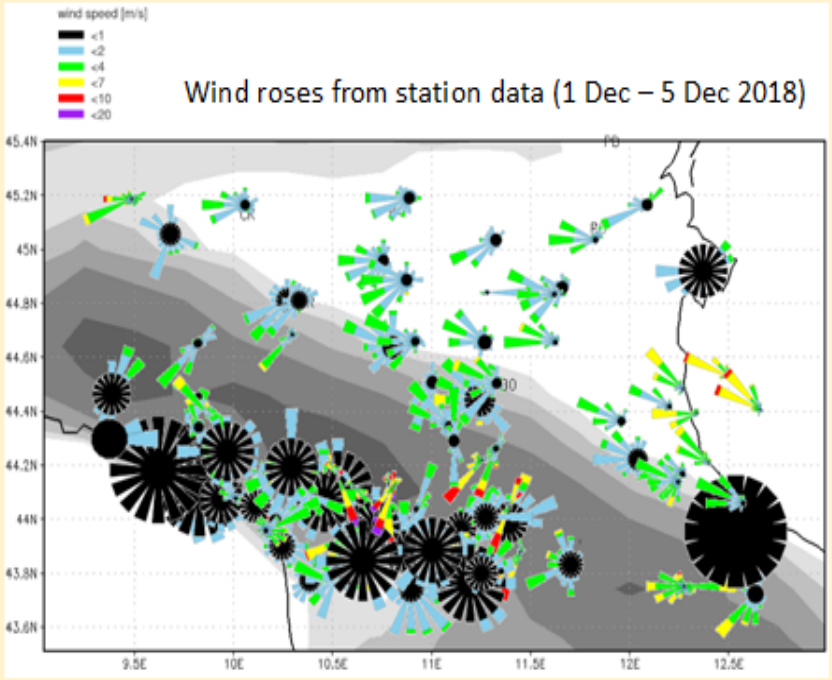


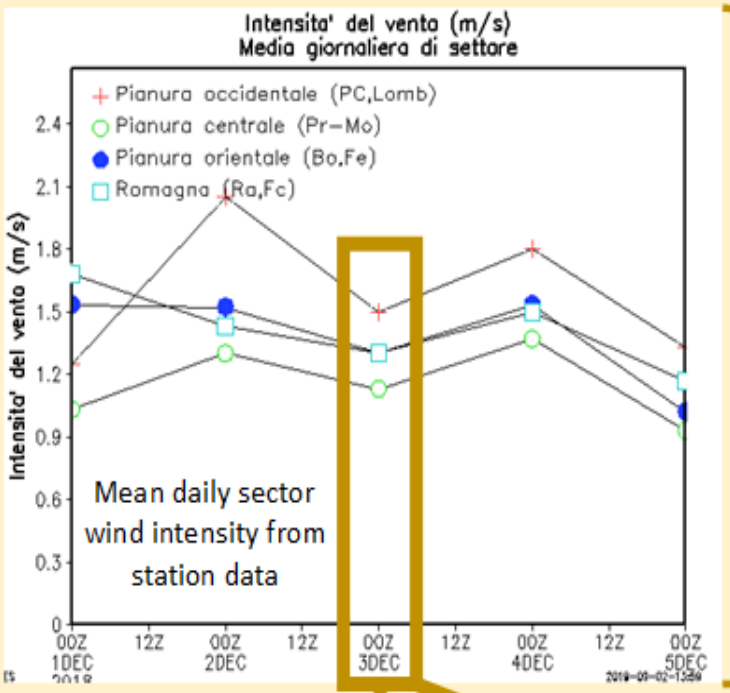
Observation



Stronger inversion at about 500m

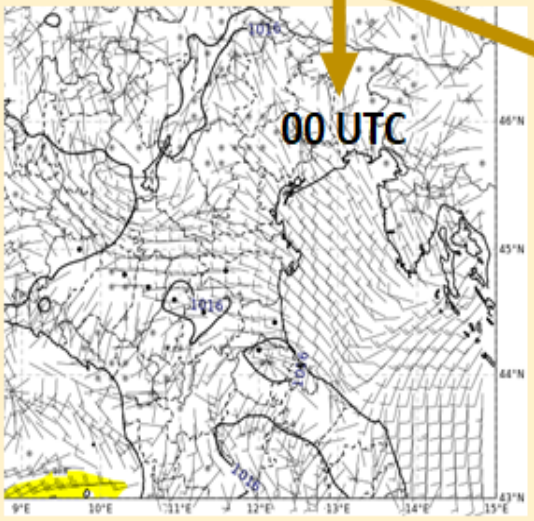
Wind

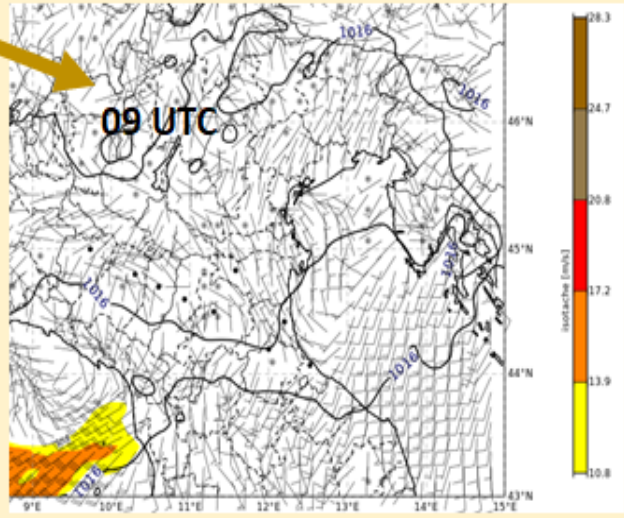




Observed weak NW winds over the plain

Example 3 Dec 2018: the the wind forecasted by COSMO 5M is too strong compared to the observations (almost > 5 kn = 3 m/s)





Summarising

In the Po Valley

In very stable atmospheric conditions, when synoptic forcing is missing and thermodynamic processes are very important

	MODEL
INVERSIONS	≈
WIND INTENSITY	>
CLOUD COVER	≈
POLLUTANTS	-

Small inaccuracies in meteorological parameters are sufficient to create large differences between expected and observed pollutants concentration

Overview of IMGW-PIB tasks within PP AWARE

COSMO-PL "failures"

Setup

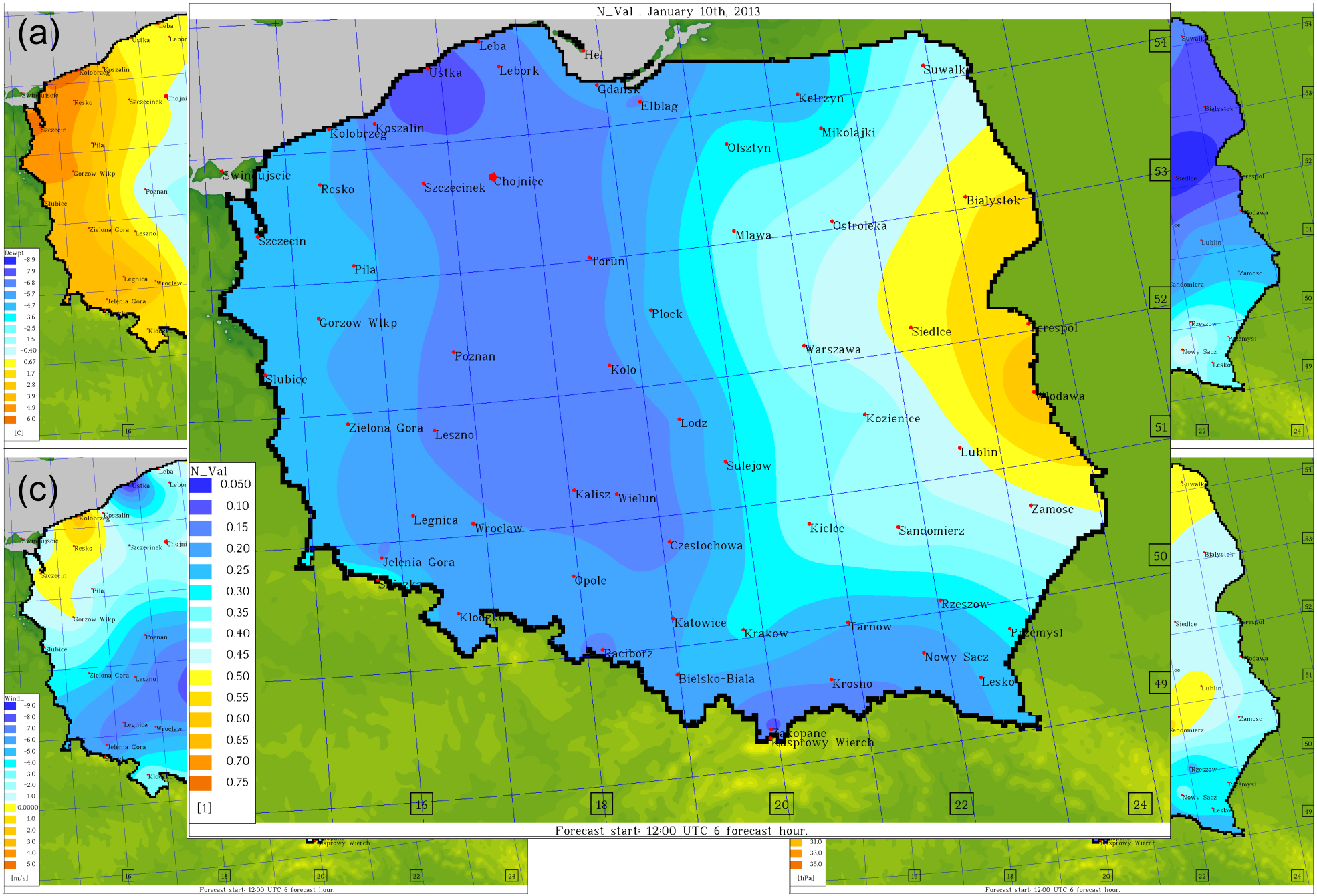
To assess (more or less automatic) poor forecasts surface parameters were used.
T2M, TD2M, RH, U10M, SFC Press. and PMSL were selected to assess the questionable forecasts and their quality.
The values of all elements have been normalized as follows:

N_Val = abs (FCST-OBS) / maxdif (OBS, FCST; *dt*)

0 <= N_Val <= 1

with *dt* being the period (climatological, 2012-2018), maxdif - maximum difference between OBServation and ForeCaST in a given period
The sum of N_Val from the above elements was determined. The worst forecasts were determined – those for which this sum was the highest.

COSMO-PL ”failures”



FORFAIT

Conclusions from the overview of cases of model failures

- **Most of the cases are related to precipitation. In case of deep lows or troughs, the global models provide good guidance, in particular, in winter, when the convection is rare**
- **For convective cases (e.g., supercells and HIW related to them: wind gusts, showers, downbursts) the high-resolution models are useful, but mostly the reflectivity fields and the convective indices (CAPE, supercell detection index, etc.)**
- **Intense precipitation objects are often over- or underestimated and shifted by the model**
- **These case studies are a good groundwork for the new COSMO priority project AWARE: Appraisal of "Challenging WeAther" FoRECasts**

Cases of model failures: future work

- In some (most) cases, it was difficult to understand the source of failure
- **Coordination with the other working groups is necessary!** (surface aspects, upper air physics, data assimilation, in particular)
- We are going to **rerun some cases** for different model versions, **make sensitivity tests and analyze the impact**
- **In future, we will take record not only of poor forecasts, but of successes too, and will prepare similar analysis for ICON-LAM**

Another plan: A COSMO project on Machine learning (ML)

- To summarize the experience of COSMO countries in applying the ML for postprocessing (MeteoSwiss, DWD, IMGW-PIB, Roshydromet)
- To improve existing postprocessing methods
- To develop adaptive ML methods

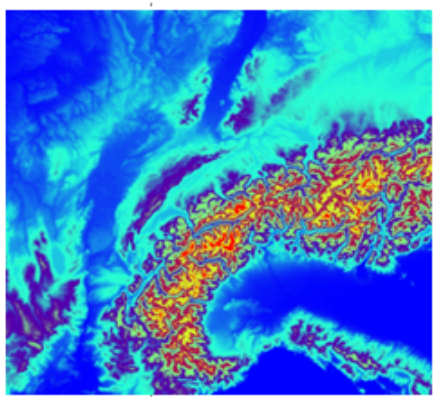
ML in MeteoSwiss (within PostprocVeri)

Compute topographical predictors and get model predictors:
Matching with closer observations

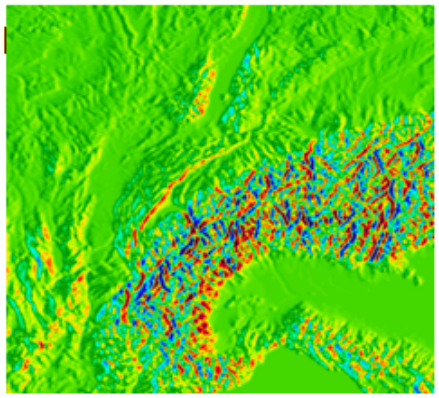
Wind forecast

ML on COSMO-1

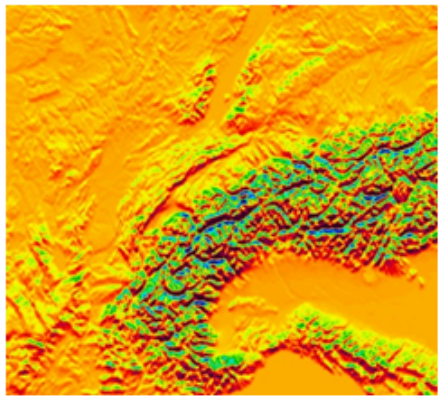
DEM



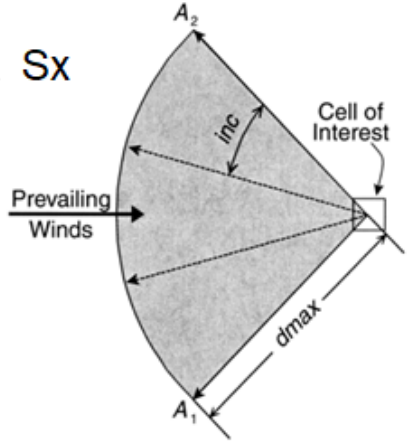
E-W derivative



N-S derivative

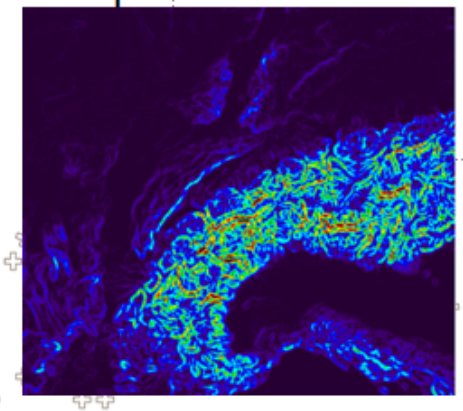


Sx

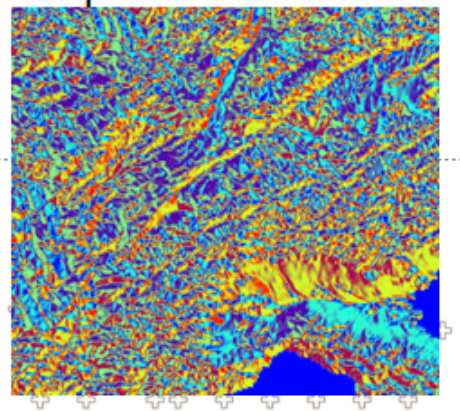


Winstral et al. (2016)

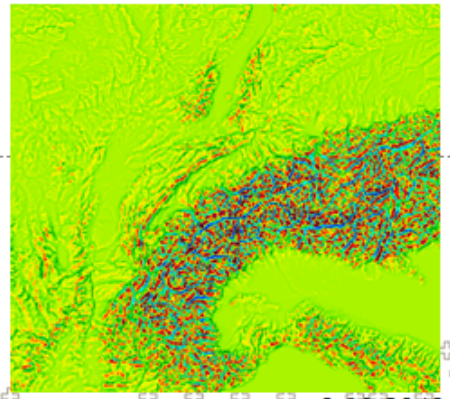
Slope

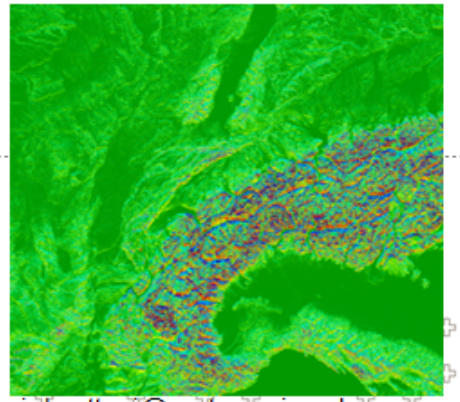


Aspect



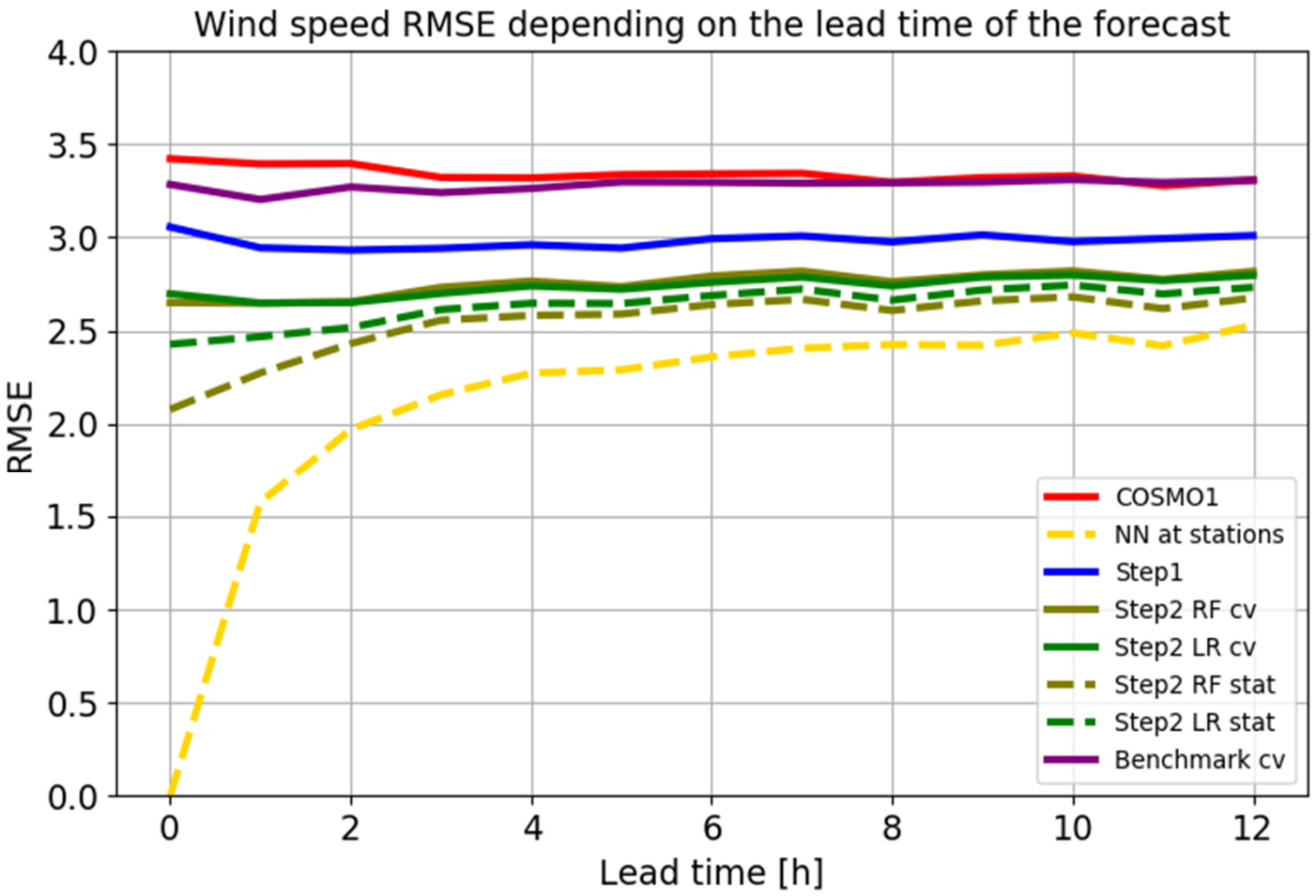
TPI





Wind forecast

ML on COSMO-1



Step 1: ML to remove
Bias on the long term period (3 years)
Step 2: Second ML (Random forecast or Linear regression) to remove short-term bias
Benchmark is close to actual INCA system with correction at stations and then applied to the grid

Machine learning for wind on locations without measurements remains a very difficult task in the Alpine region.

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

Lightning Potential Index (LPI) and Hailcast in COSMO-1

Xavier Lapillonne

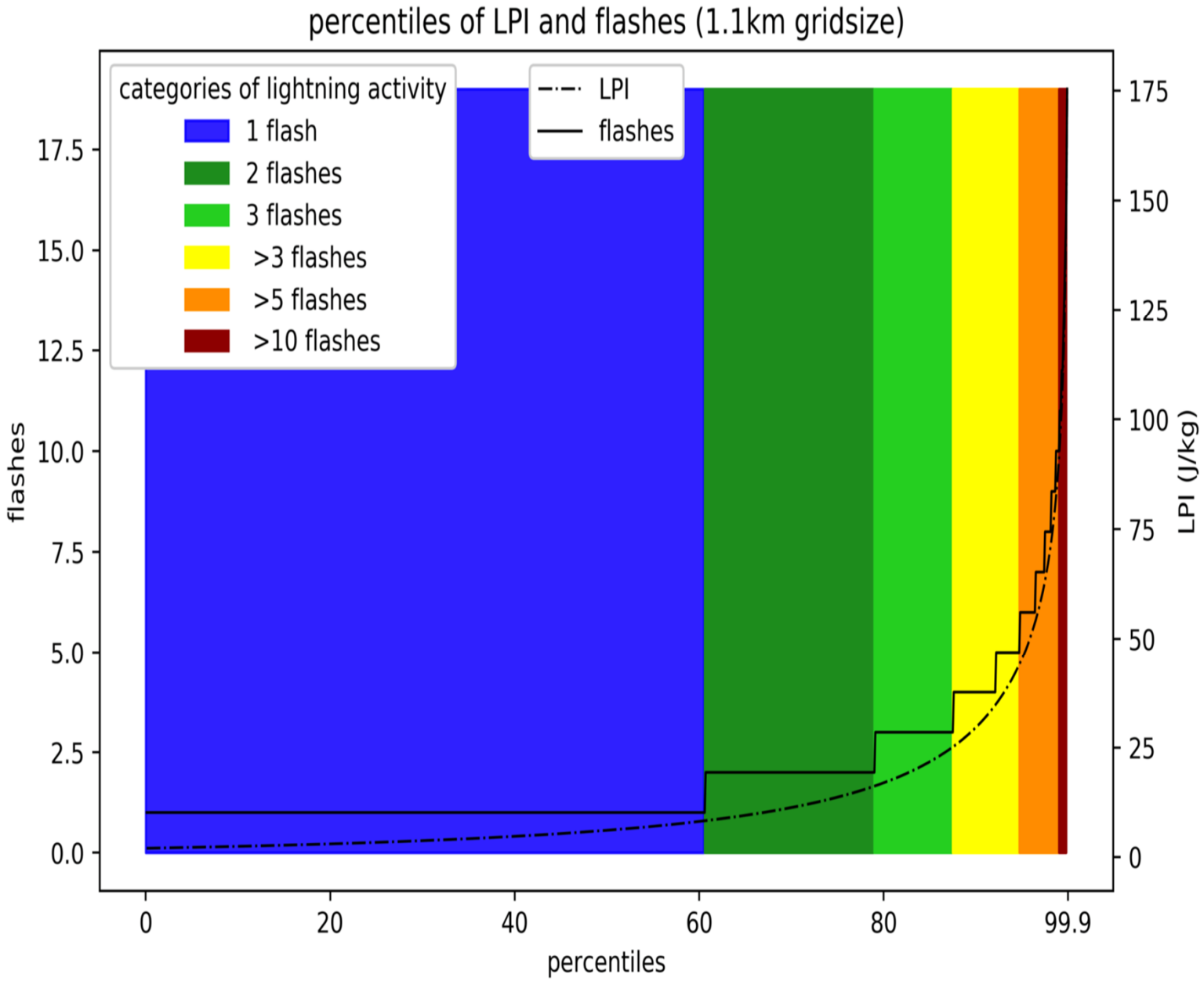
COSMO General Meeting 2019, Rome, Italy

Sources : Master Thesis Jonas Jucker, LPI

Master Thesis Raffael Aellig, Hailcast

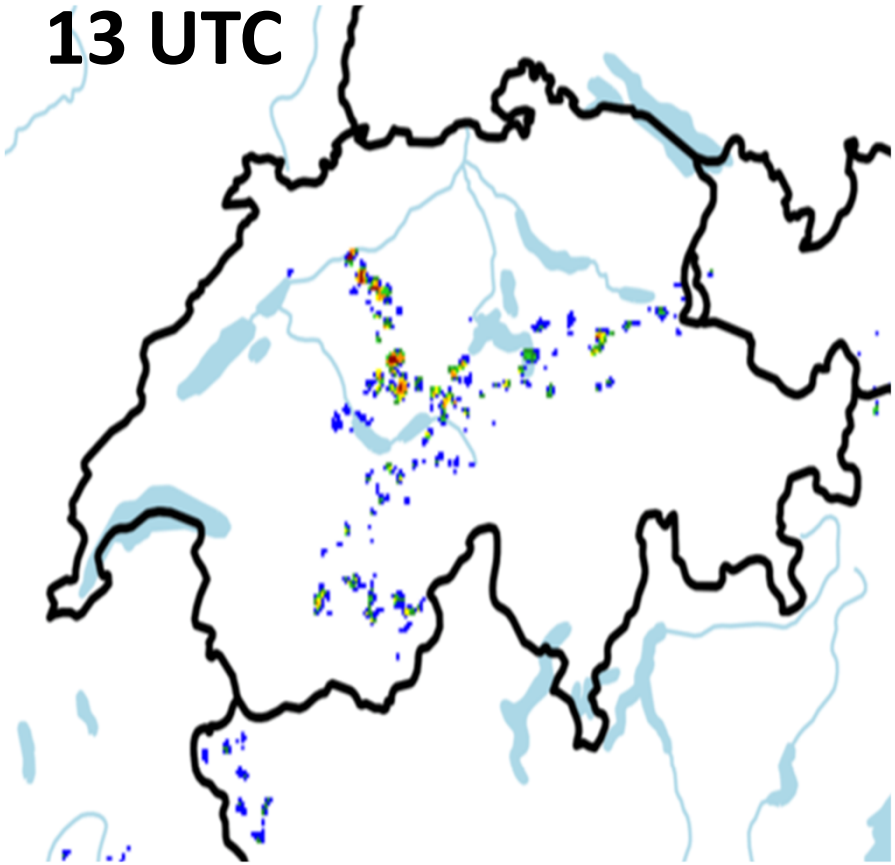
xavier.lapillonne@meteoswiss.ch

From LPI to flashrate: Empirical relationship

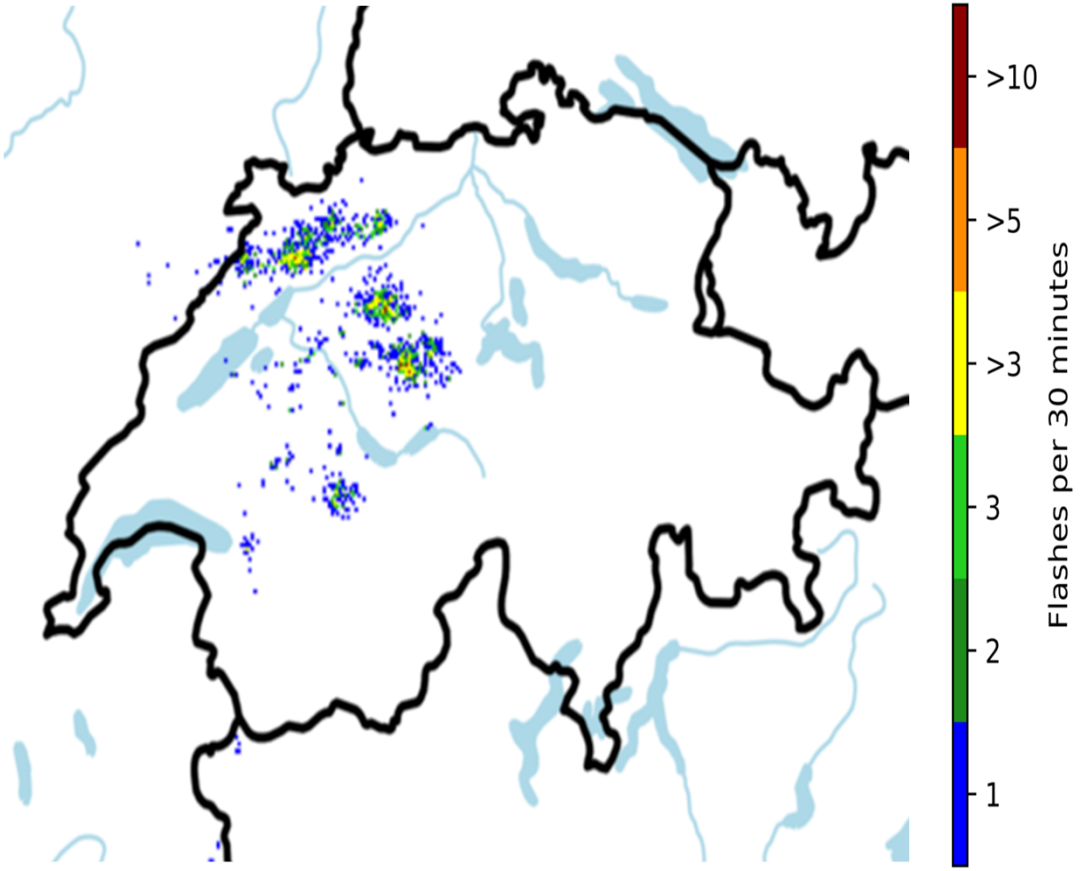


Case study 24th of August

Flashrate from LPI
13 UTC



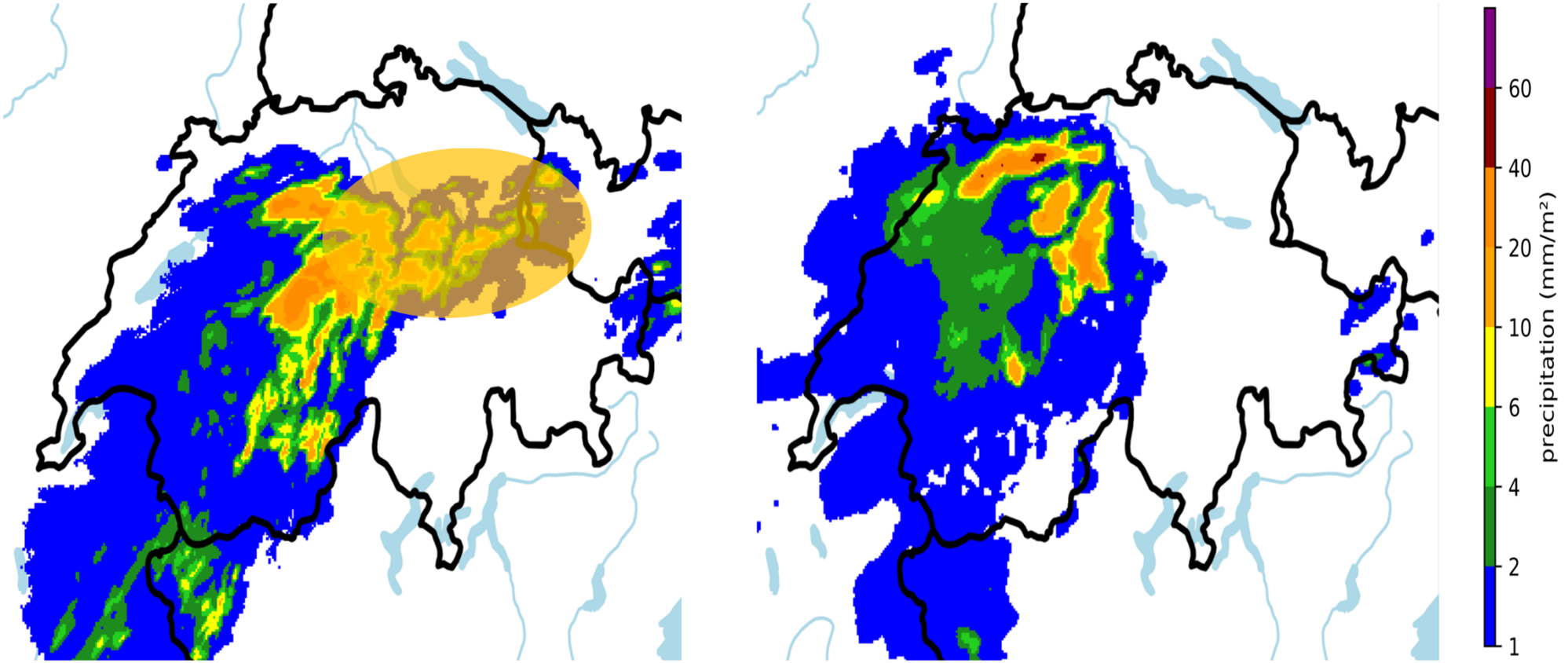
observations +/- 15 min



Case study 24th of August

TOT_PREC 13-14 UTC

CombiPrecip 13-14 UTC



Forecasters' survey within the PP C2I, transition from COSMO to ICON

- It aims at subjective evaluation of ICON-LAM added value compared to COSMO by forecasters

- Overall performance of ICON-LAM compared to COSMO
  - for particular variables
  - seasons
  - runs
  - in severe weather situations

- It will also assess:
  - Need for additional output variables
  - Timeliness and convenience of visualization

- **In the final phase of PP C2I (2022), the results will be summarized and compared to objective verification results**

Thank you! Благодаря!

ML in PostprocVeri

Project flowchart