Overview of WG4 activities

Anastasia Bundel

COSMO GM in Saint Petersburg, 04 September 2018

WG4

Outlook

- CORSO-A report
- WG4 users survey overview
- Activity in institutions (IMGW-PIB, MCH)
- (Preliminary) plans of new projects

CORSO-A: PT leaders: Gdaly Rivin and Inna Rozinkina

The PT is successfully finished.
The report is prepared and sent to the SMC.

CORSO-A report: Contents

1. **The guidance on the optimal domain's size selection for 1.1km resolution of nested COSMO models for the regions with complex mountain relief** *(G.Rivin, M.Shatunova, J.Helmert)*
2. **Development of algorithm of subgrid "h-correction" of T2m for mountains based on COSMO forecasts of local lapse rate (h-correction)** *(I.Rozinkina, J-M.Bettems, D.Blinov, A.Euripides)*
3. **COSMO-based ensemble forecasting for Sochi-2014 Olympics, archiving the results** *(E.Astakhova, A. Montani, D. Kiktev, D.Alferov, A.Smirnov)*
4. **Preparing recommendations for forecasters about interpretation of the results of mesoscale modeling** *(I.Rozinkina, P.Eckert, G.Rivin)*

CORSO-A results are used in planning new projects, item 4, in particular

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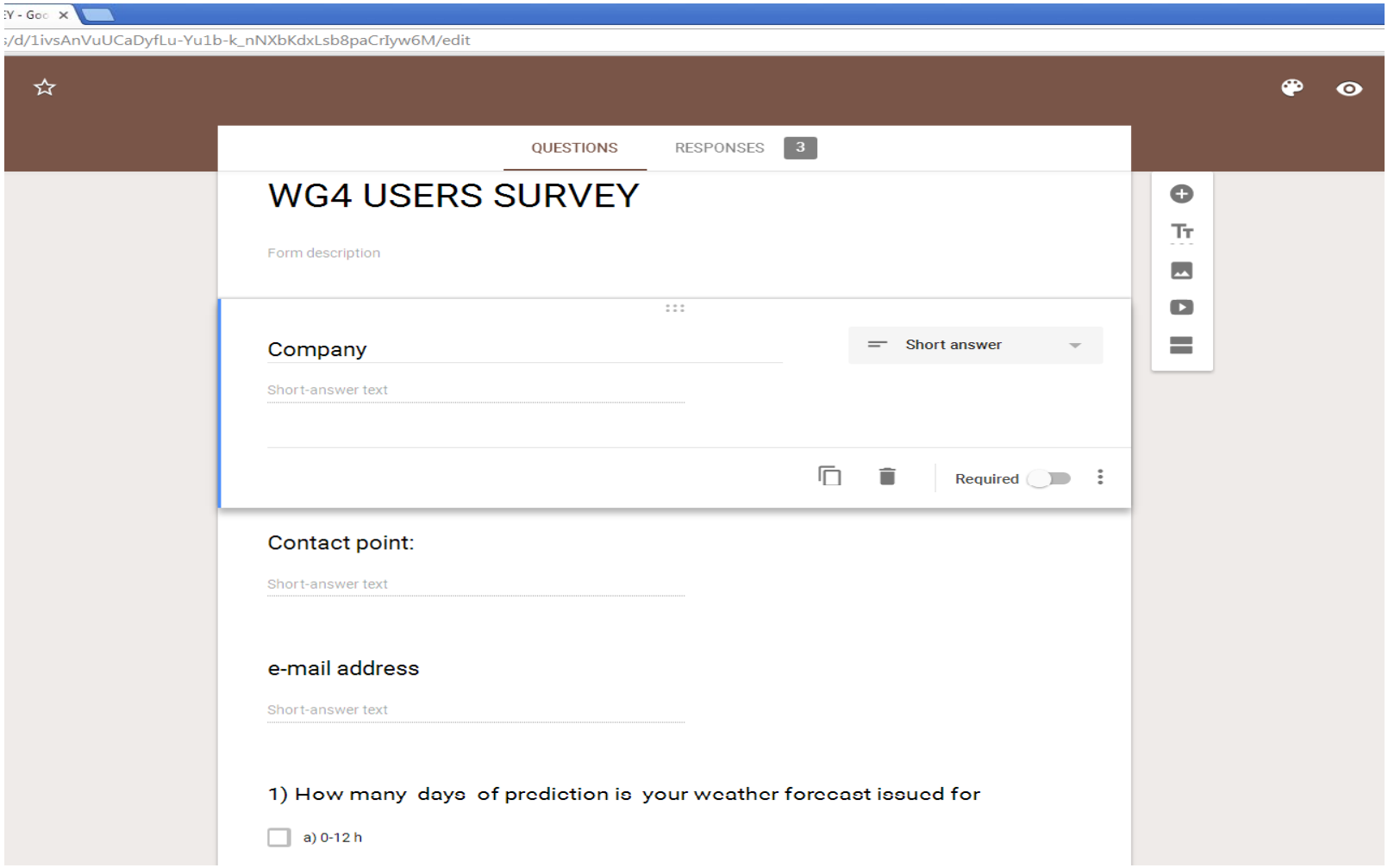
Overview of WG4 users survey responses



*It was decided at the WG4 meeting in Israel, 2017, to carry out the **WG4 users survey** to better understand perspectives as a group and the user needs*

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Contributing persons

- ***Pierre Eckert*** (MCH)
- ***Daniel Cattani*** (MCH)
- ***Andrzej Mazur*** (IMGW-PIB)
- ***Dimitra Boucouvala*** (HNMS)
- ***Anastasia Bundel*** (RHM)

  Comments to the questions from Daniel Rieger and RHM colleagues

Survey blocks

- General questions (NWP used, critical lead times, most important variables)
- Verification questions
- NWP correction
- Most important phenomena (including severe weather)
- Probabilistic forecasts, EPS
- Nowcasting questions
- COSMO/ICON ART
- Willingness to share postprocessing methods

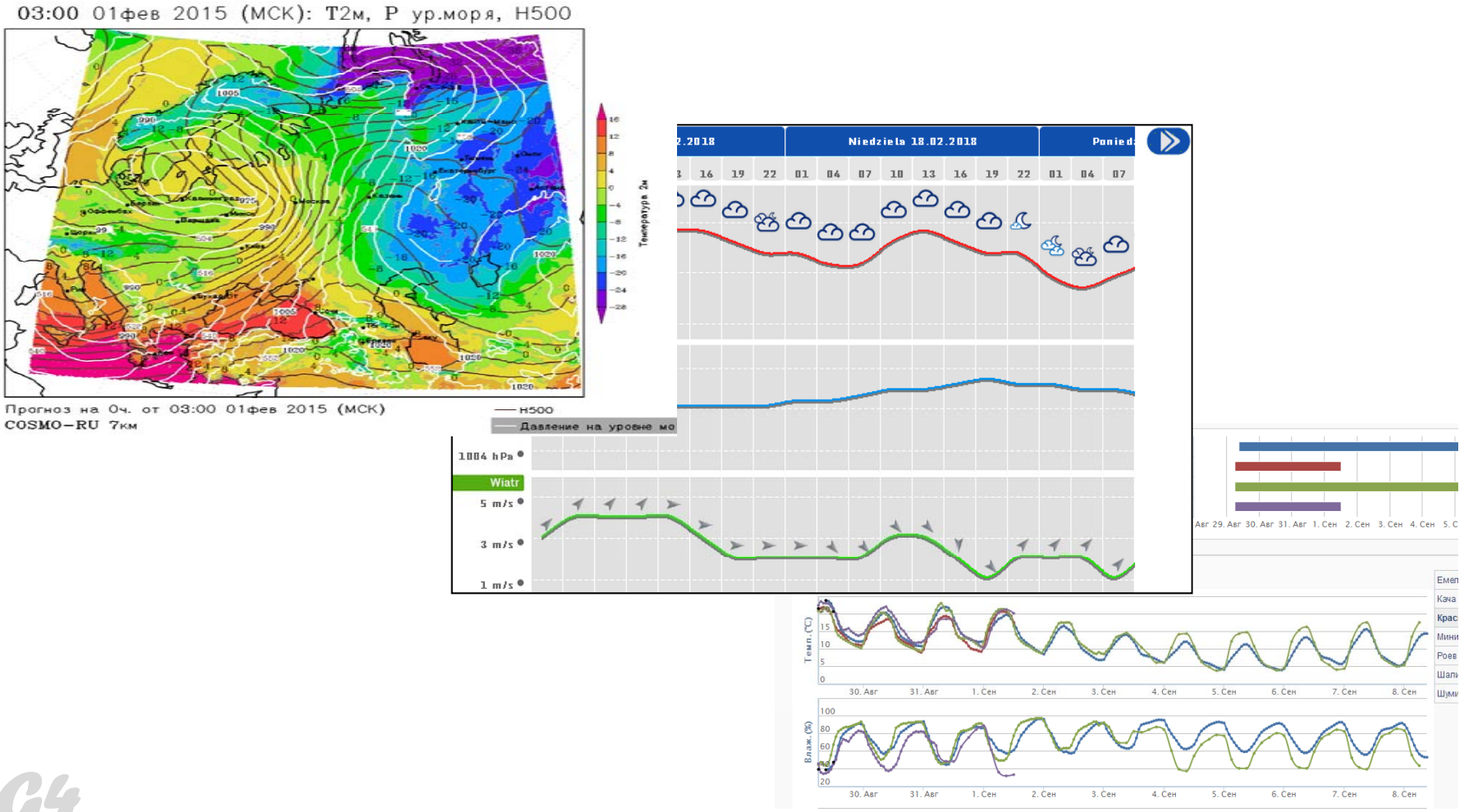
NWP used

- **COSMO (1, 2, 4, 7 km) and ECMWF-hres and ENS**.
- The **COSMO guidance** is estimated as **good** by majority of answers!
- ICON-LAM is not used operationally in any of the services as yet, but transition to ICON is taken into account.

  WG4 will participate in Task 5.6 of the C2I PP, and the survey will be updated to obtain users' feedback on ICON-LAM forecasts.

NWP representation from

- Mostly traditional forms: maps -> meteograms -> other plots



Warnings for the population are most important!

Special products (aeronautical, sea-route, other…)

- Big diversity, but the main sectors are:

➢ ***Transport (mainly aviation and road services)***

➢ ***Energy production and supply***

Examples: HNMS is responsible for sea (automatically produced) and aeronautical forecasts. In Russia, COSMO forecasts are provided to a special semi-commercial institution, which prepares aeronautical forecasts. Road forecasts (MCH, Poland).

IMGW-PIB

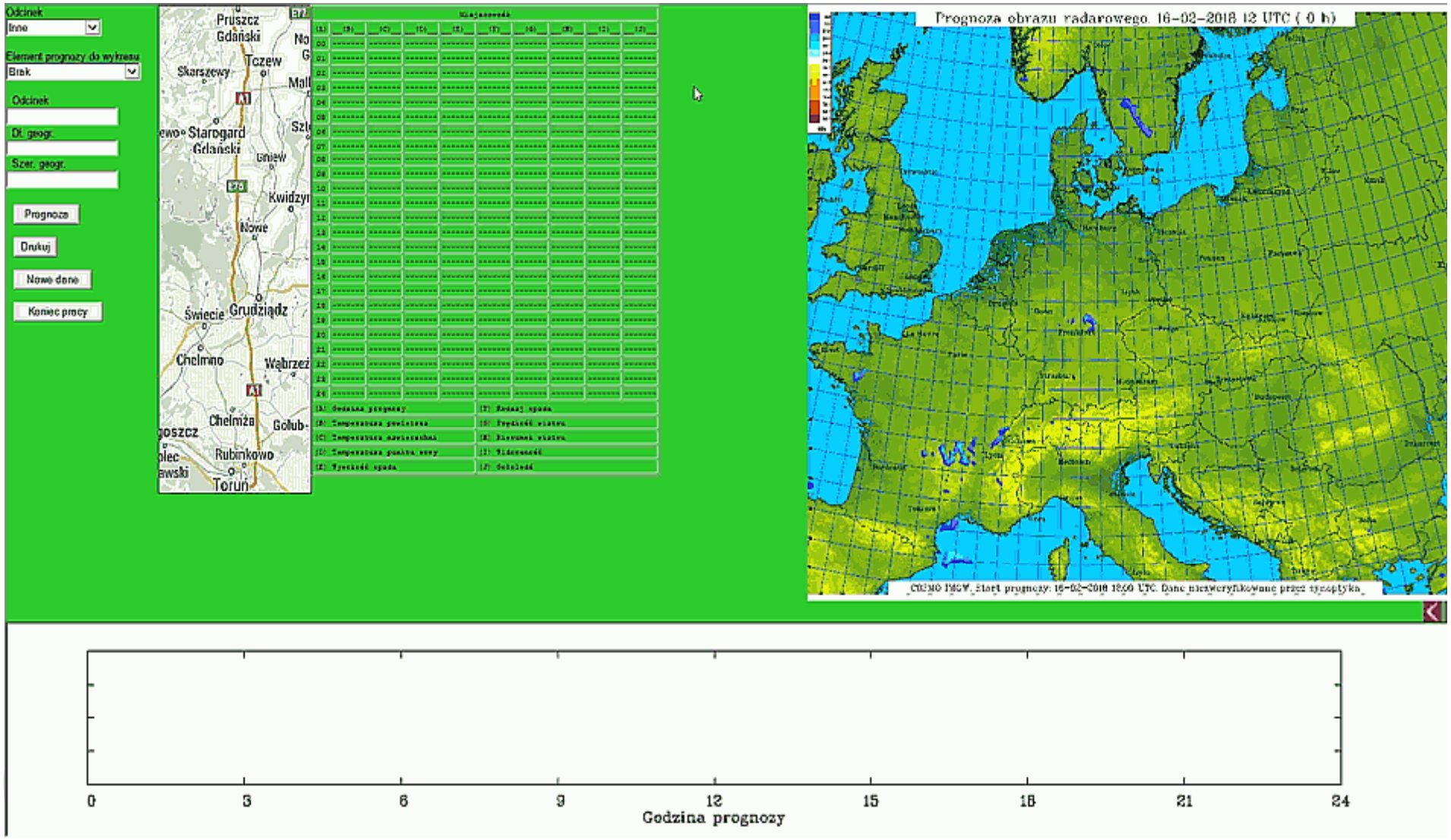
has long experience of providing the special users with meteorological data:

- *aviation, road services, and energy production and supply: thunderstorms, frost, wind gusts, strong winter storms, fog, wind shear, power lines- and road icing*
- *For renewable energy production: wind, insolation, precipitation for hydroelectric power plants*
- ***What else is needed:*** *squall lines, could ceiling, road/constructions (bridges) temperatures (for aviation and road maintenance)*

However: the number of contracts decreased with the introduction of the "open-data law"

IMGW-PIB. Special requirements

Forecasts included into prepared, dedicated environment
Example: fcst interface for road maintenance services



Verification

- Historical verification is taken into account, but could be used wider.
- Forecaster experience is essential!
- Some forecasters underlined the importance of real-time forecast quality monitoring, that is, taking into account the errors of the last forecasts.
- Mostly traditional observations are used

Could be useful

- More interactive and real-time verification products
- Stratified verification (weather types, …)
- Spatial verification using gridded data

Probabilistic forecasts, EPSs

- **EPSs are used, but moderately** (COSMO-EPS, ICON-EU, ECMWF ENS)
- **Added value** of EPSs by majority of answers. E.g., good experience combining EPS and COSMO-1 in case of convective situations (MCH), good guidance for days 2-7 (HNMS, RHM)
- Most useful EPS products: Ensemble median and spread, uncertainty, confidence index, spaghetti plots, clustering, probability maps for precipitation, extreme temperatures, precipitation, wind

Further expectations from EPSs:

- More friendly to non-experienced forecasters, easier to interpret
- Statistical adaptation of EPS output

Forecast correction

- **is necessary**. Automatic (e.g., Kalman filter) or based on forecaster experience

Nowcasting

- “Blending of obs and model should give the possibility to extend the useful range to a few hours”
- “Seamless forecast from actual measurements to model forecast”
- “A nowcasting product would be helpful for short term predictions (0-9h). This means that it should be available in almost real time to the forecaster, and provide information for decision making in the case of the evolution of a phenomenon, so mainly important in severe weather”

Common wish to have nowcasting blended with model output for extended range of 6-9 hours

COSMO/ICON-ART

At present:

- Pollen in MCH
- In RHM, concentrations of pollutants: CO, NO, NO2, O3, etc. in Moscow are sent to Mosecomonitoring (an organization controlling the air quality)

In future:

- «Processes like fog formation could benefit from a prognostic (hygroscopic) aerosol forecast. Radiation as well» (Pierre E.)
- «We are interested in COSMO/ICON-ART in the near future. The most important species are O3, SO2, NOx, aerosols" (Dimitra B.)

What type of postprocessing method are you ready to share with other COSMO members?

- **All who answered noted that they could share all available methods, possibly, after official approval of their administration**

The WG4 Users survey already helped a lot in preparing the project plans and will serve in the future. It can be modified according to the applications

Flashrate – definition

Assumption – relationship between CAPE (→ updraft velocity *W*), cloud-top/cloud-base temperatures (*CTT/CBT*, respectively) and frequency of lightnings *(FR, #/minutes)*. Additional filters can be applied.

$$W = 0.3 \cdot \sqrt{2 \cdot CAPE}$$

$$FR = \left(\frac{W}{14.66} \right)^{4.54}$$

$$if \quad CTT > -15°C \quad FR = FR \cdot \left[\max\left(\frac{-CTT}{15}, 0.01 \right) \right]$$

$$if \quad CBT < -5°C \quad FR = FR \cdot \left[\max\left(\frac{CBT + 15}{10}, 0.01 \right) \right]$$

Wong *et al.*, 2013: Evaluating a lightning parameterization based on cloud-top height for mesoscale numerical model simulations. Geosci. Model Dev., 6.
Lopez, 2016: A Lightning Parameterization for the ECMWF Integrated Forecasting System. Mon.Wea. Rev. 144
Forecasts verified against measurements at Polish lightning detection network

IMGW-PIB: Flashrate forecast users

- Three main groups of customers: aviation services, energy production sector, crisis management centers
- The most obvious impact of severe weather on electric utility operations – power outrages. Improvements in forecasts of thunderstorms – an aid for managers in resource scheduling and management.

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Visibility Range – definition

Forecasts of visibility range – from DMO; algorithm based on forecast of extinction coefficient $ß_{ext}$ (a function of water/ice amount in the air):

$$VIS = -\frac{\ln(0.02)}{\beta_{ext}}$$

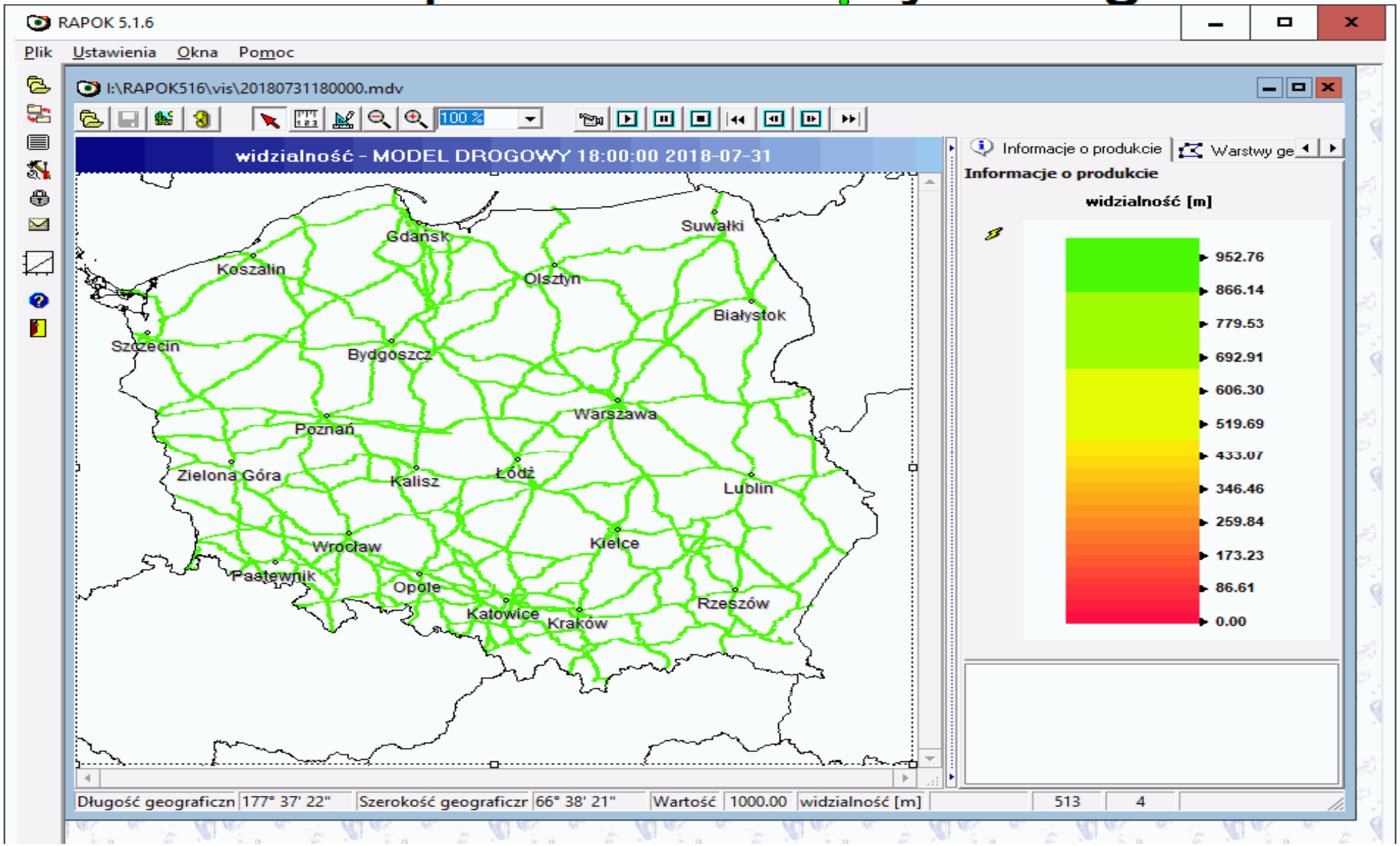
(Boudala *et al.*, 2012: Parameterization of Runway Visual Range as a Function of Visibility Implications for Numerical Weather Prediction Models. Journal of Atmospheric and Oceanic Technology, (**2**) vol. 29.
See also Kunkel, 1984: Parametrization of Droplet Terminal Velocity and Extinction Coefficient in Fog Models. Journal of Climate and Applied Meteorology, vol. 23)

Forecasts verified against observations at Polish SYNOP stations

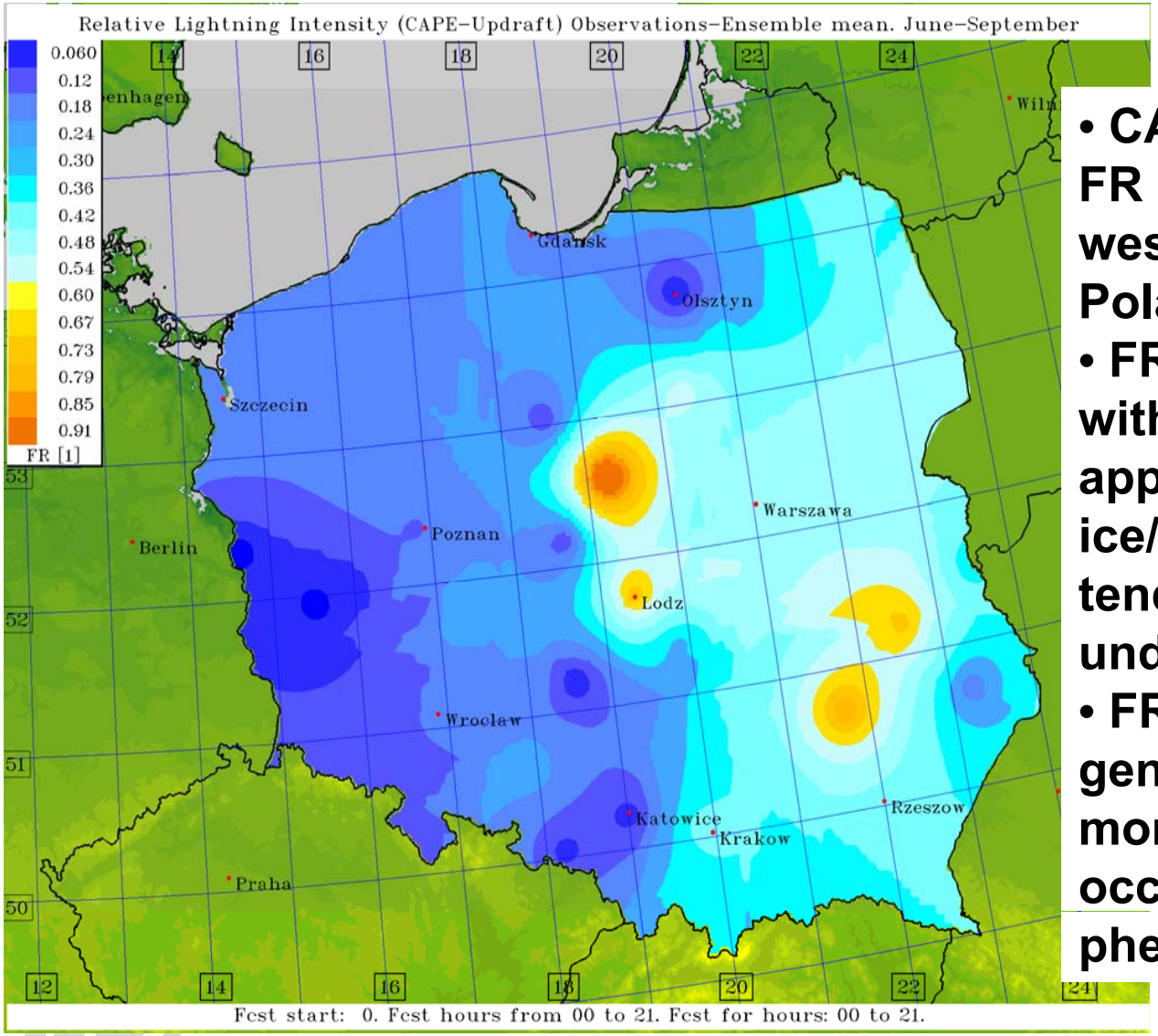
VR – usages, applications, customers

Institute of Meteorology and Water Management
National Research Institute

Examples – Visibility Range

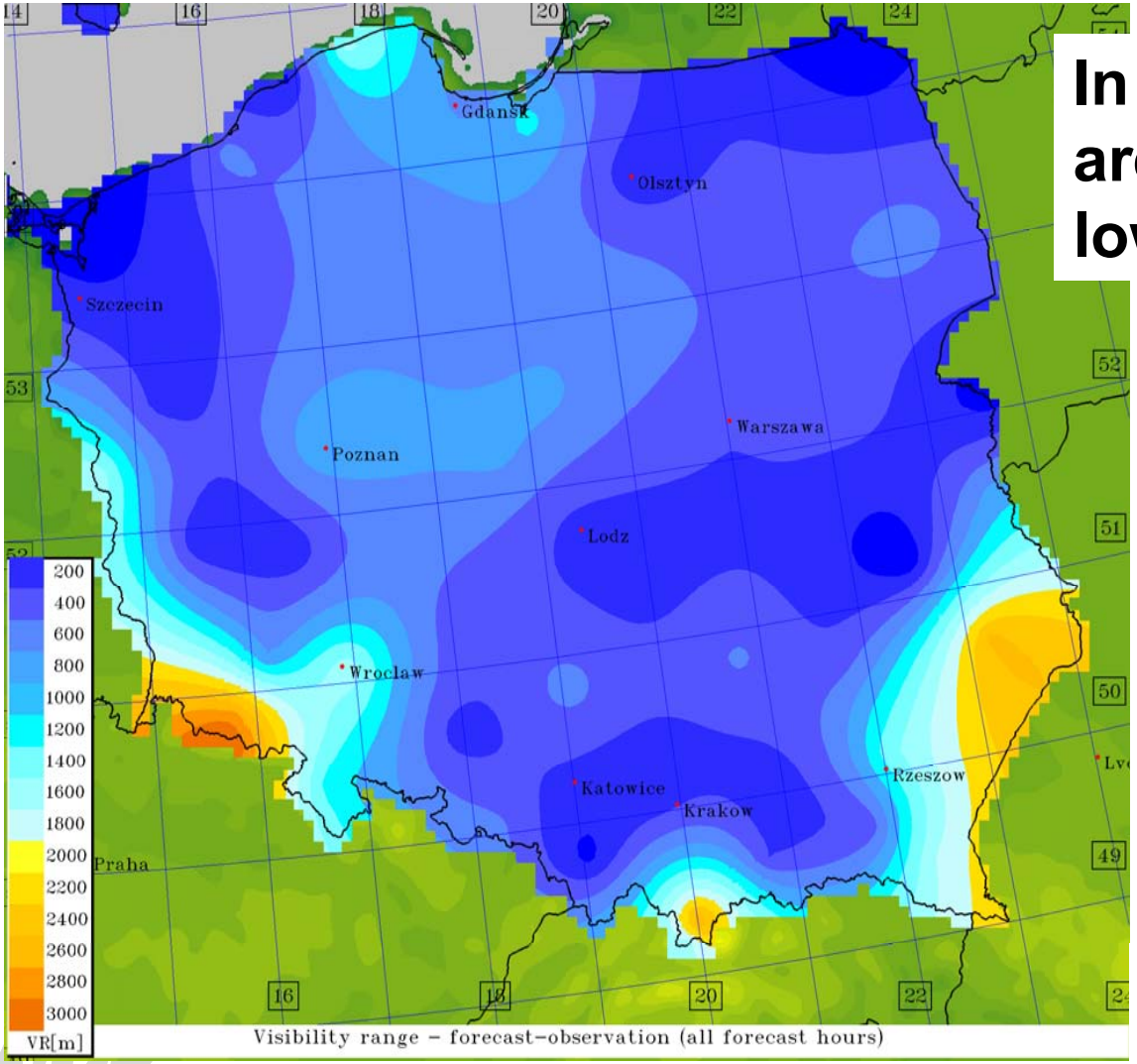


IMGW-PIB: Flashrate verification against Polish lightning network measurements, MAE, June-Sept 2013



- CAPE-based forecasts of FR produce nice skill in western and north-western Poland.
- FR is overestimated, even with some precipitation filter applied. Another filter (cloud ice/snow/water contents) tends to (slightly) underestimate FR, however.
- FR forecasts were generally better in dry months with high occurrence of convective phenomena.

IMGW-PIB: Visibility range verification against observations at Polish SYNOP stations, MAE, June-Sept 2013



In general, forecasts are better for lowlands.

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PostprocVeri: New postprocessing project in MeteoSwiss

Christoph Spirig, D. Cattani, J. Bhend, M. Liniger

© S Petersburg – GM COSMO, sept 2018

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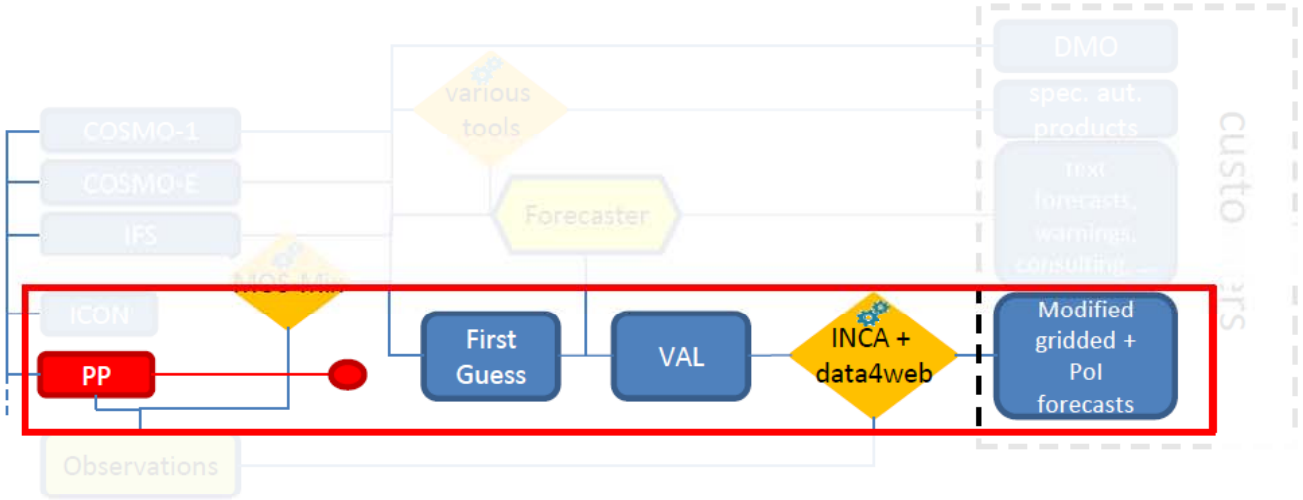
Project PostprocVeri

- Postprocessing methods yielding spatial, probabilistic, multivariate, and seamless forecasts and also to refine the verification analysis at the forecast service of MeteoSwiss.



MeteoSwiss

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Main elements

- **Probabilistic postprocessing** - well in line with NWP developments @ MeteoSwiss and international developments in the field of postprocessing → Ensemble postprocessing routines, aiming at delivering calibrated ensemble predictions
- **Spatial output** given the increasing importance of local forecast information, the postprocessing approaches aim at delivering output for any surface location of interest in Switzerland.
- **Start with basic meteorological variables** introduce postprocessing for four basic meteorological variables (temperature, precipitation, wind, and cloud cover), build up knowhow to apply to derived variables later on
- **COSMO and IFS ensembles** limit NWP data sources to COSMO and IFS ensembles (models operationally used in today's forecast production), but ensure applicability to other NWP models

Collaborations

The Project team of MeteoSwiss do not wish not develop new methods from scratch, but aims to collaborate, use know-how and experiences in PP domain.

- EUMETNET program
- University ETHZ
- COSMO WG4

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ETHZ collaborations

- Sebastian Schemm : analysis of error stratified by weather type
- ETHZ master thesis
  - Nino Weingart : deep learning based error correction of Numerical Weather Prediction for Switzerland,
    - **Automatic post-processing** of COSMO-1 output to predict temperature
      - At arbitrary point in Switzerland
      - Considering spatial-temporal dependencies
      - Including uncertainty estimation of model
    - Using **neural network architecture**

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CONSORTIUM FOR SMALL SCALE MODELING
COSMO

Recent analysis on the 10-wind forecast in Switzerland, comparing direct model output, forecasters and MOS

J. Bhend, D. Cattani, Ch. Spirig, M. Liniger

Analysis of Burglind/Eleanor storm on Zugersee, 3rd January 2018

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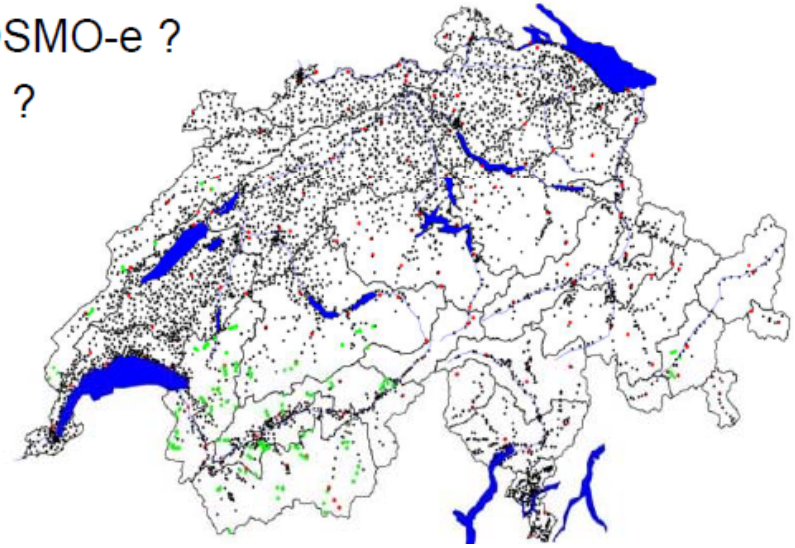
Questions

MeteoSwiss goal is to provide high quality hourly winds and gusts at ~5000 sites

- Is there a potential to postprocessing ?
- Is there an added-value form the forecasters ? How can we benefit of it ?
- Which model is better ? COSMO-1, COSMO-e ?
- How can we improve warning forecasts ?



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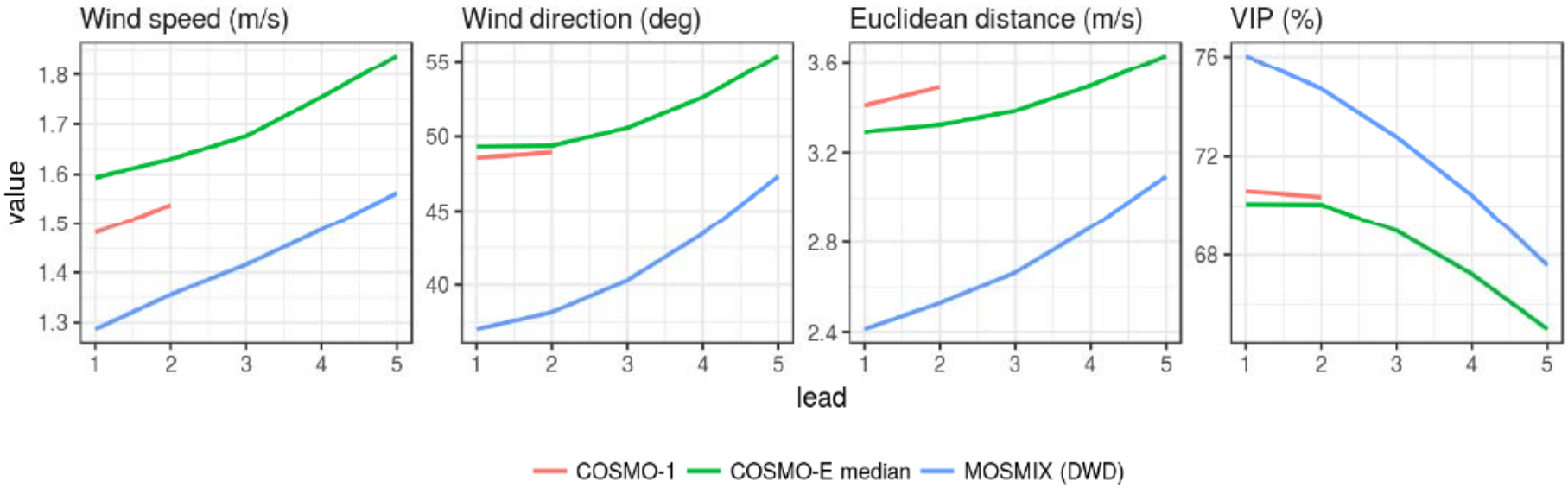
COSMO-1/E and MOSMIX



COSMO-1: 03:00 UTC
COSMO-E: 00:00 UTC
MOSMIX: 04:00 UTC (based on information available at 03:00 UTC)
The evaluation covers the period from 2016/01/01 to 2017/06/31
101 SMN stations are used

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Burglind / Eleanor storm

Verification by J. Bhend
internal report 2018

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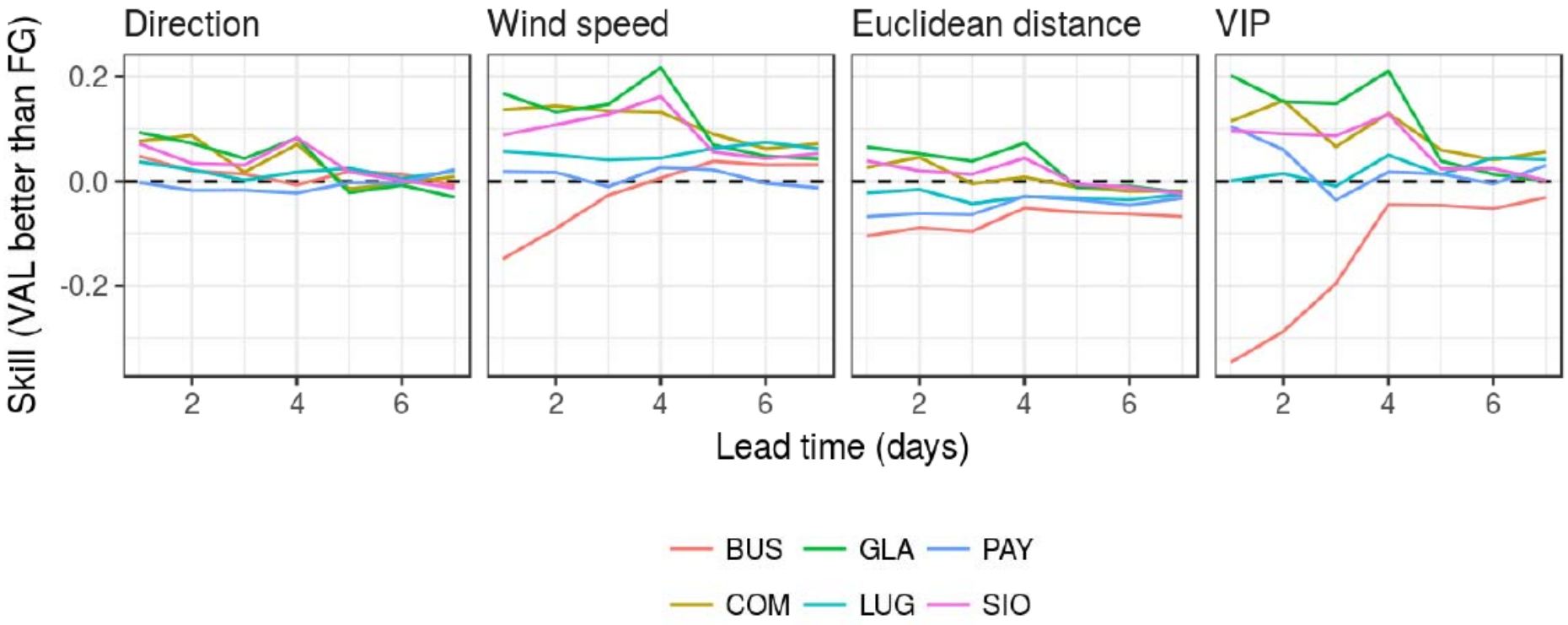
Understanding forecaster's modification



Conclusions

- Forecaster's modification is positive, but difficult to to specify

- COSMO-1,COSMO-e better than MOSMIX ?
  - In strong events, potential of COSMO-1, and –e is real
  - On large period, more stations, MOSMIX shows better scores
  - → Potential for postprocessing on winds is important

- Postprocessing should focus on the type of errors

..... postprocessing wind forecast in complex terrain is a challenge

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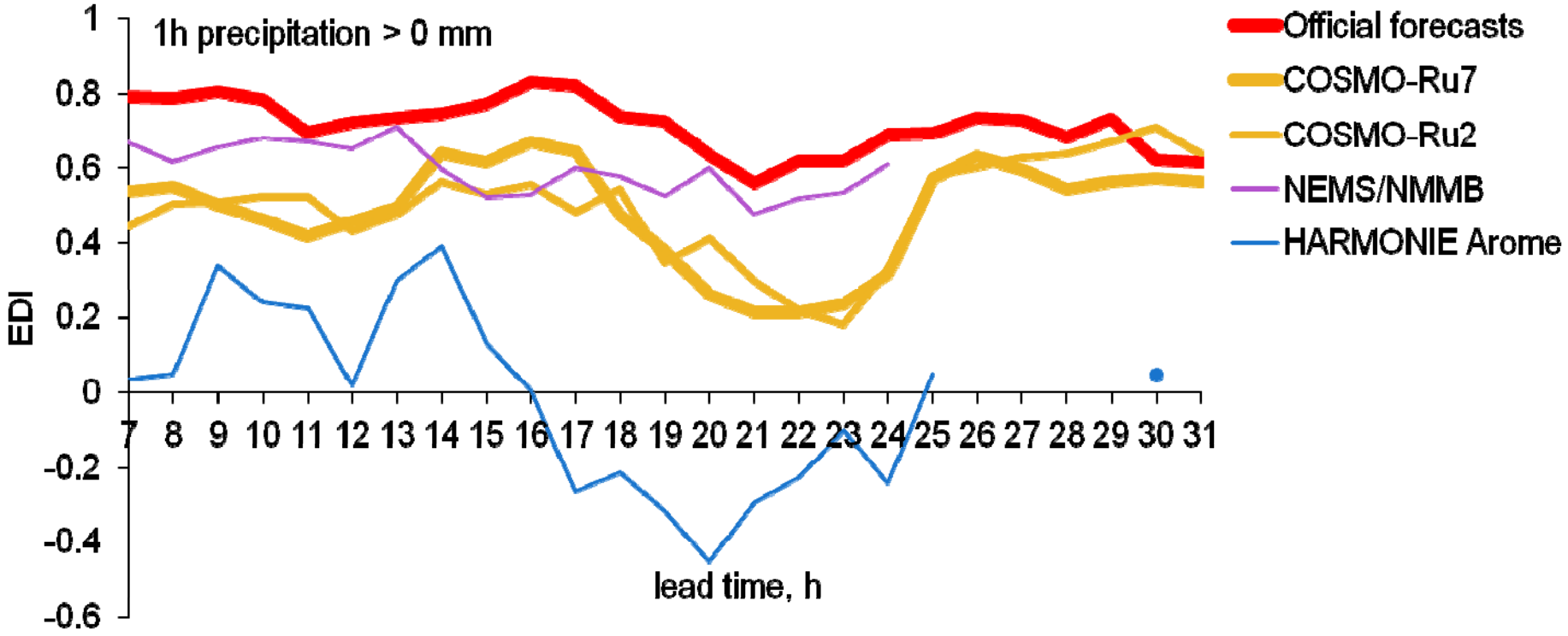
DMO vs. Official human forecasts (Sochi-2014 experience)



EDI of precipitation occurence aggregated over the Sochi mountain cluster,
1 November 2013 - 23 February 2014

From Kiktev, D., P. Joe, G. Isaac, A. Montani, I. Frogner, P. Nurmi, B. Bica, J. Milbrandt, M. Tsyrulnikov, E. Astakhova, A. Bundel, S. Belair, M. Pyle, A. Muravyev, G. Rivin, I. Rozinkina, T. Paccagnella, Y. Wang, J. Reid, T. Nipen, and K. Ahn, 2017: AMERICAN METEOROLOGICAL SOCIETY FROST-2014: The Sochi Winter Olympics International Project. Bull. Amer. Meteor. Soc. doi:10.1175/BAMS-D-15-00307.1

DMO vs. Official human forecasts (Sochi-2014 experience), conclusions

- Automated temperature forecasts, especially blended multi-model forecasts, were competitive to manual forecasts;
- for wind speed and visibility, the human forecasts demonstrated the psychological biases towards higher speed and lower visibility (the phenomenon of overforecasting hazardous events by human forecasters discussed, e.g., by Doswell (2004);
- for precipitation, the manual forecasts did add value to model forecasts.

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From Kiktev, D., P. Joe, G. Isaac, A. Montani, I. Frogner, P. Nurmi, B. Bica, J. Milbrandt, M. Tsyrulnikov, E. Astakhova, A. Bundel, S. Belair, M. Pyle, A. Muravyev, G. Rivin, I. Rozinkina, T. Paccagnella, Y. Wang, J. Reid, T. Nipen, and K. Ahn, 2017: AMERICAN METEOROLOGICAL SOCIETY FROST-2014: The Sochi Winter Olympics International Project. Bull. Amer. Meteor. Soc. doi:10.1175/BAMS-D-15-00307.1

Possible new PT:
Guidelines for users of LAM forecasts.

- **Forecast production chain: Sequences of maps, meteograms, …**
- **Improving the link between verificators and forecast users, explaining state-of-the-art verification techniques, how to read spatial verification results**
- **EPS applications. How to use EPS products.**
- **Using nowcasting products.**

Possible new joint project on HIW (High Impact Weather). WG4 participation

Most important are severe, and more generally, high impact weather forecasts, which are often a result of postprocessing

The WMO JWGFVR HIW project led by Beth Ebert

There could be a close interaction between a COSMO project and WMO project on HIW

A WG4 task about postprocessing techniques for HIW forecasts could include:

- Overview of forecast methods for HIW events: postprocessing techniques vs. direct model output, DMO (including results of parameterizations)
- Verification of postprocessing results and comparison with DMO quality, where possible
- Improving existing methods
- Exploring new approaches. Machine learning? Neural networks?
- Link to COSMO/ICON-ART for fog forecasts

Thank you! Спасибо!

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