Nowcasting systems and user applications; experiences from INCA, PROFORCE and ASIST

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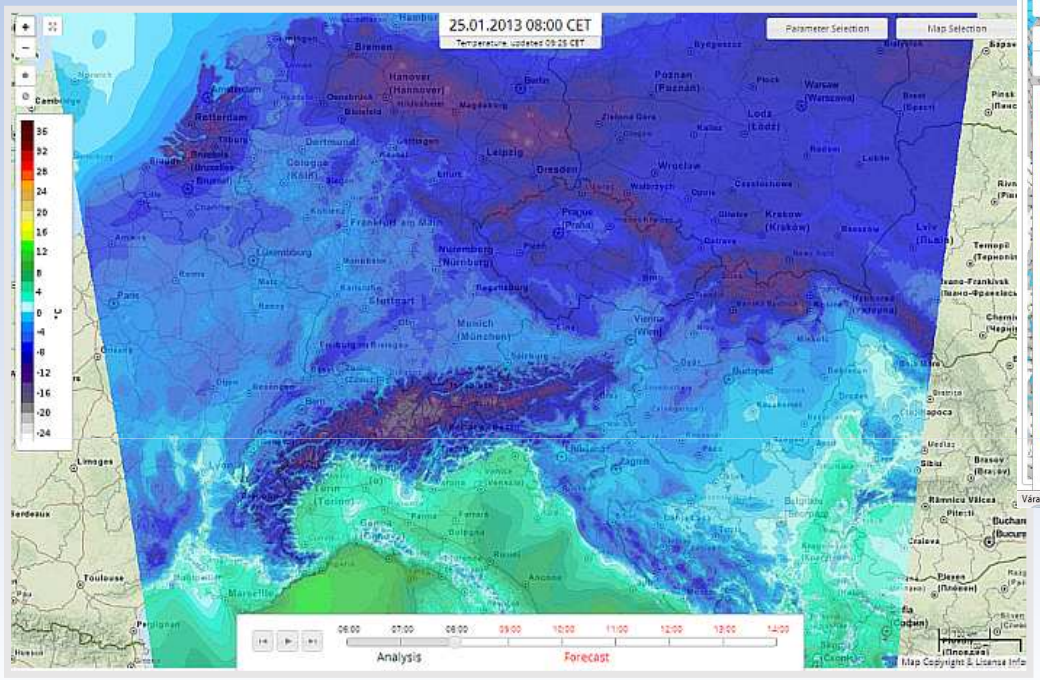
User applications

- Not standard NWP outputs, interdisciplinary use (e.g. hydrological or road forecast models, calculation of special parameters like road surface temperature, icing or wet snow loads, etc.)
- User-specific visualization, format and media (e.g. smartphone applications, webportals)
- Further improvement of analysis/forecast accuracy (blending with recent observations, treatment of local effects, correction of systematic errors, statistical postprocessing, etc.)
- Decision algorithms (e.g. for wind energy users or in hydrology)

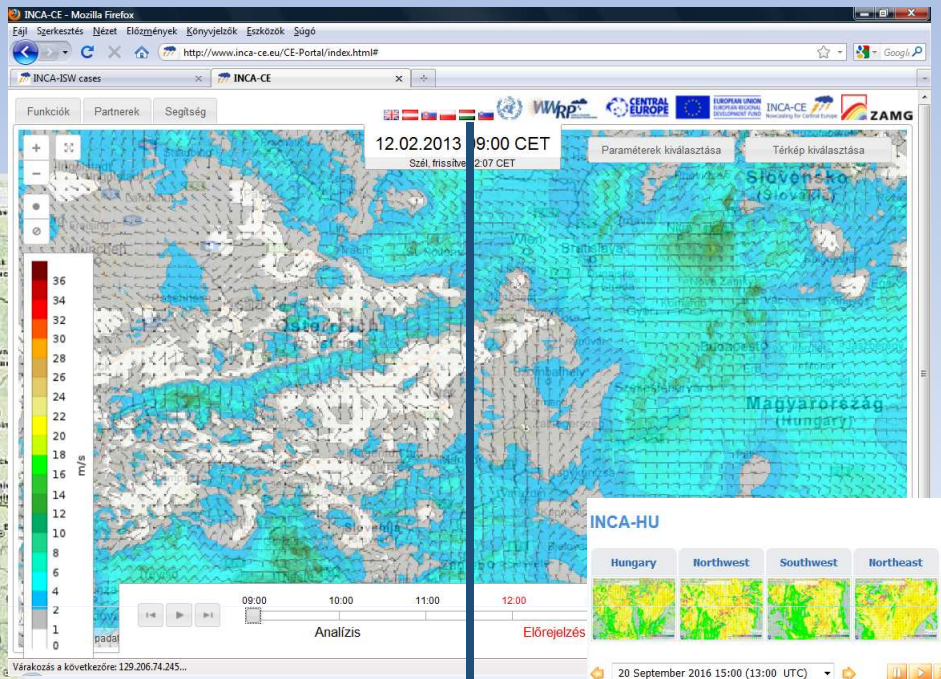
Applications for general public

- Webportals
- INCA-CE nowcasting portal for Central Europe (INCA-CE project, 2010-2013) in cooperation with several meteorological offices (ZAMG – lead partner, SHMÚ, CHMI, IMWM-NRI, OMSZ, OSMER-ARPA FVG, ARSO), partners from disaster and road managements, research institutes (IOSB, CGS+)
- INCA nowcasting system for the Central Europe domain, 1km resolution, 1h update, 2m temperature, wind, wind gust forecasts, coupled with ALADIN model (run at SHMÚ), precipitation composite from local analyses and nowcasts
- google-map background, overlays, interactivity, location determination, mobile version
- national INCA web portals (more detailed, local OBS and NWP inputs)

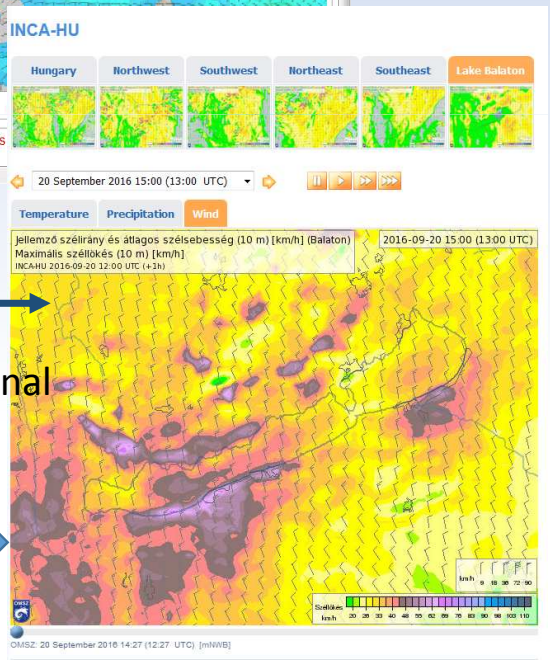
INCA-CE webportal



2m temperature analysis for the CE domain



Links to national INCA portals



10m wind/wind gust forecasts for the area of Lake Balaton (OMSZ)

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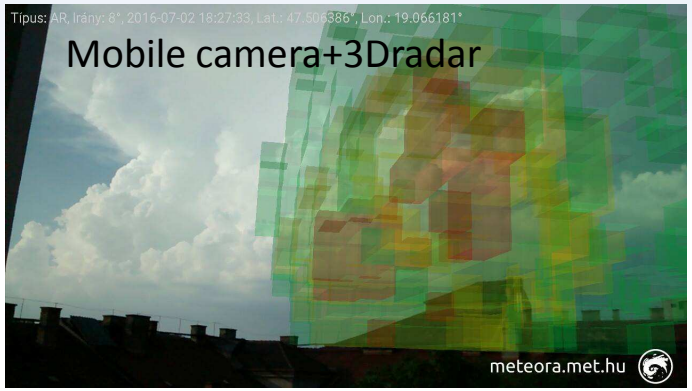
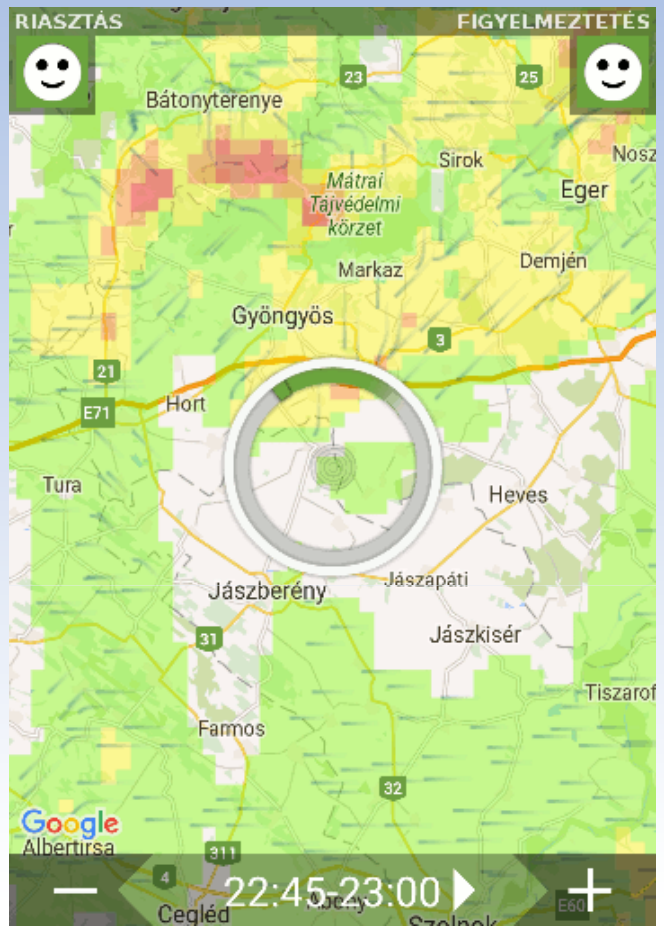
Smartphone applications

- Example: METEORA (OMSZ)
- MEANDER nowcasting system (OMSZ)
- 0-1.5h nowcasts, 15 min. updates
- Temperature, wind, precipitation intensity
- Severe weather warnings
- AR (augmented reality) 3D radar views





METEORA wind forecast and warnings

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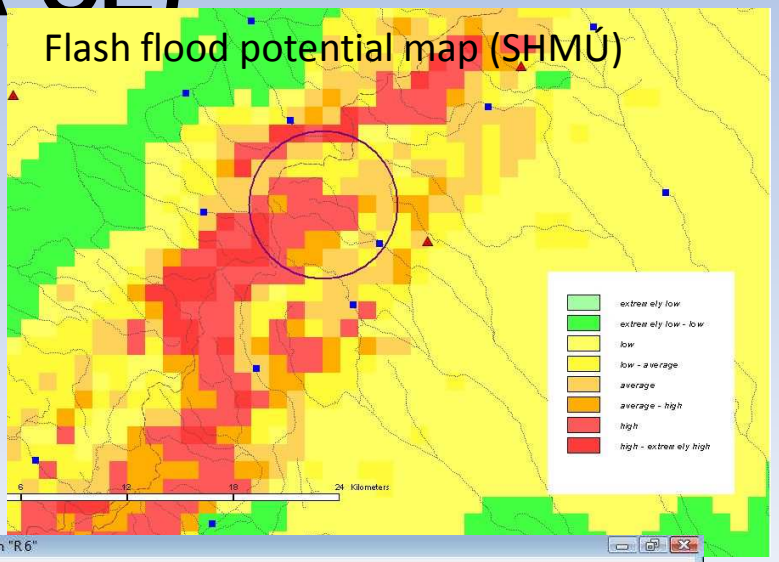
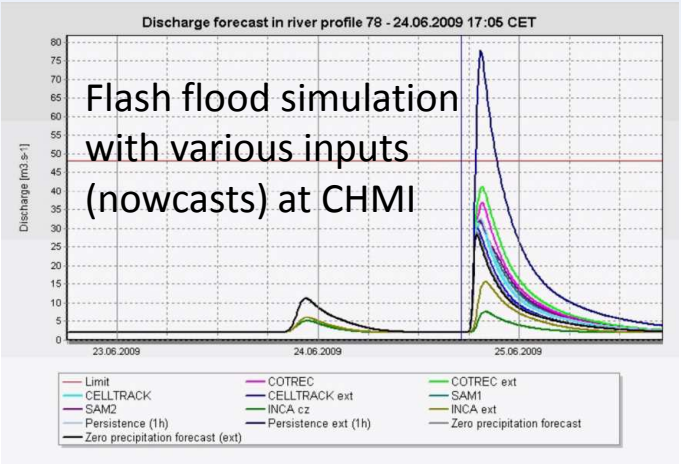
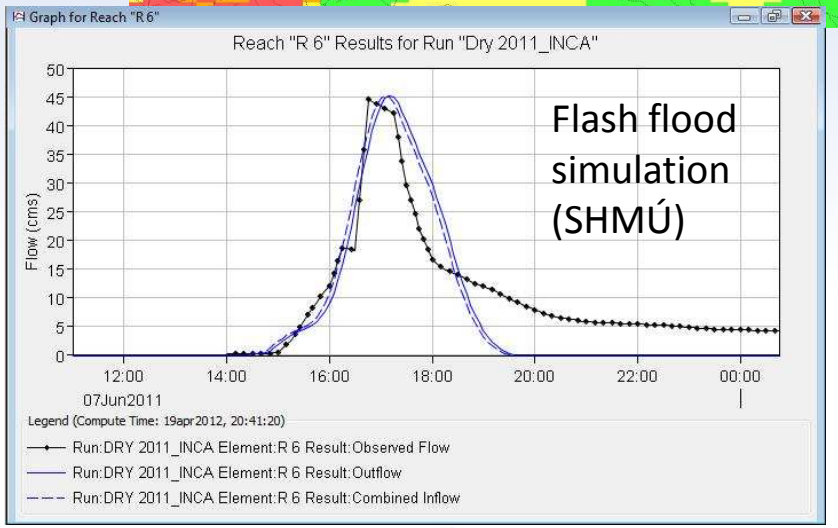
Applications for hydrology (INCA-CE)

- ZAMG, CHMI, IMWM-NRI, SHMÚ
- Rainfall-runoff models (MIKE 11, HEC-HMS, HYDROG)
- Discharge forecasts, retention and flash flood potential
- Flash floods – case studies
- Landslides (ELDEWAS, IOSB),
  landslide potential+INCA precipitation nowcast
- High uncertainty in case of convection (EPS approach)







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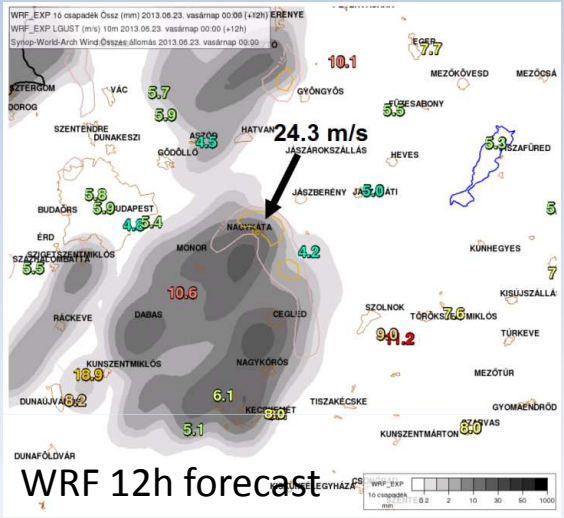
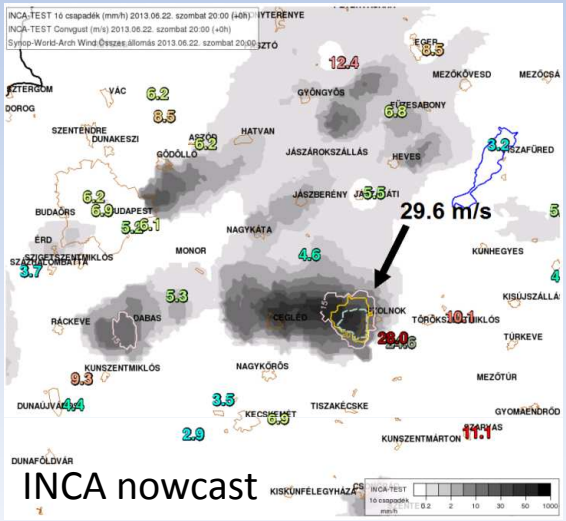
Applications in Civil Protection (INCA-CE)

- ZAMG, OMSZ
- Protection of contests, festivals, open-air concerts
- Convective gust nowcasts, upon the method of Yeung (2008)
- Special forecasts for the Lake Balaton, wave-height assessment (Shore Protection Manual, 1984)



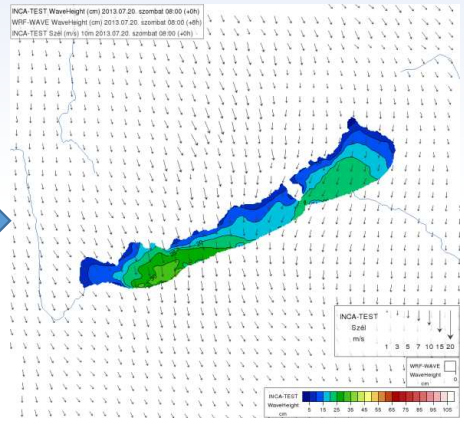
WRF 12h forecast



INCA nowcast

1h precipitation+wind gust

Wave-height nowcast for the 2013 Balaton cross-swimming contest



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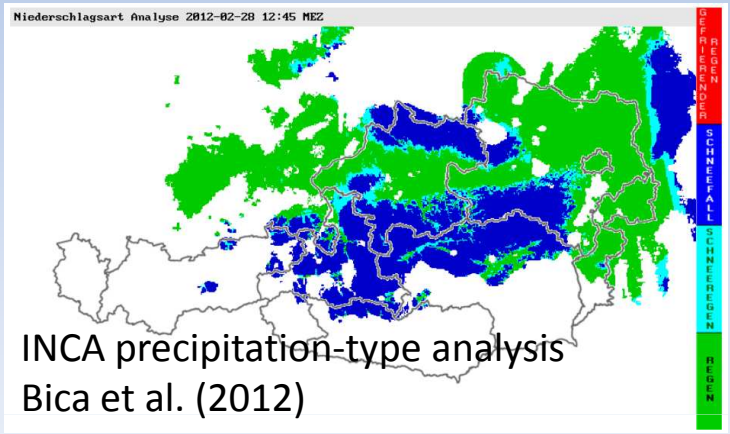
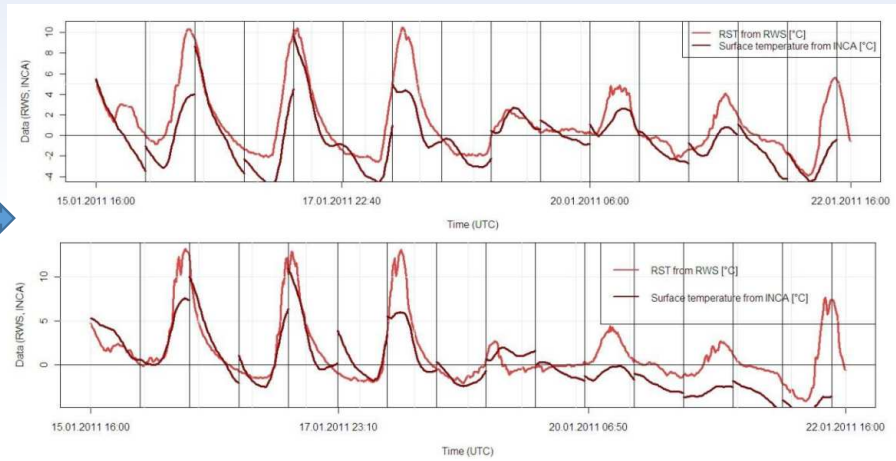
Applications in road safety (INCA-CE)

- ZAMG, CGS+, SHMÚ
- Ground temperature nowcasts
- Nowcasts of precipitation-type (freezing rain) and associated phenomena (e.g. black-ice)
- Inputs to RWIS (Road Weather Information systems)



INCA precipitation-type analysis
Bica et al. (2012)

INCA surface temperature forecasts and road weather station measurements (Šajn-Slak et al., 2012)



Electricity transmission

- Forecasts of glaze or wet-snow loads
- Accretion models (ISO12494, 2001)
- Input parameters: precipitation type, fall speed, density, sticking efficiency

Accreted mass

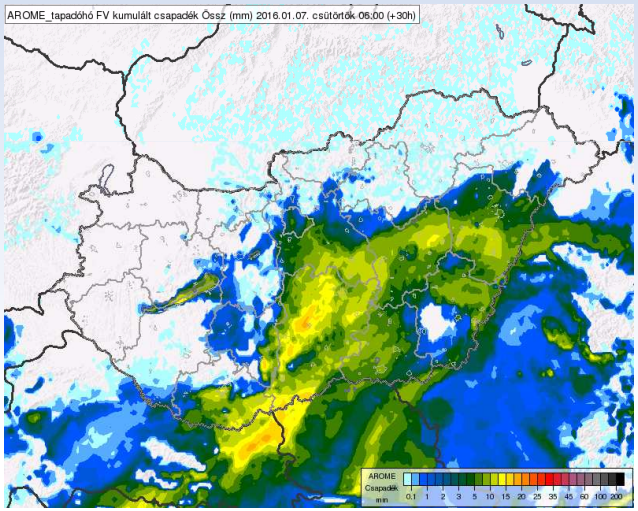
Collision, sticking efficiency, etc. coefficients

Liquid water mass

Area

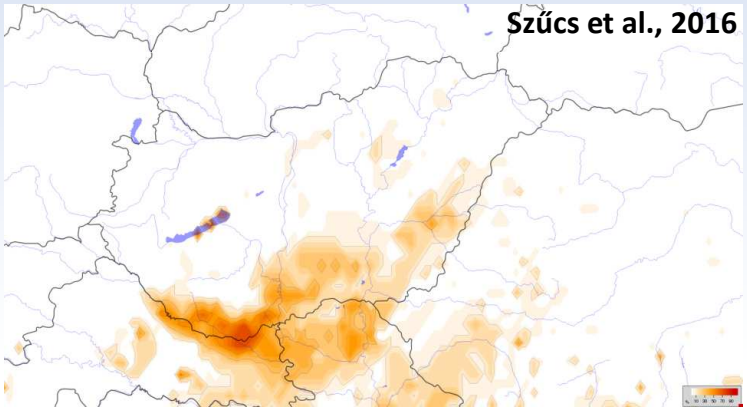
Wind speed

$$\frac{dM}{dt} = \alpha_1 \alpha_2 \alpha_3 \cdot w \cdot A \cdot V$$

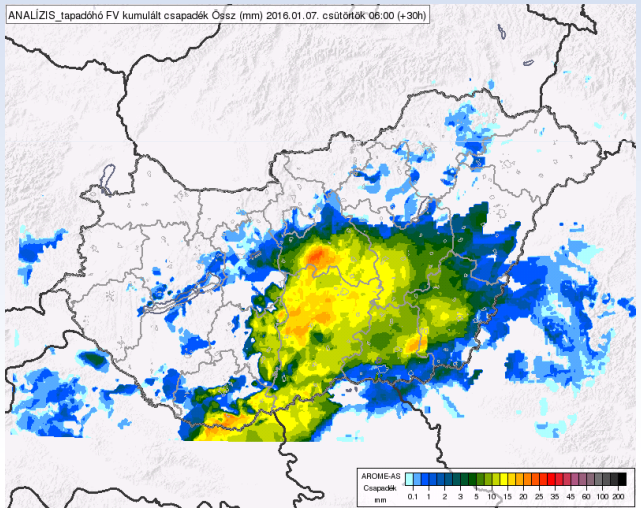


AROME 30h forecast of wet snow precipitation

Wet snow precipitation, 7 January 2016



ALADIN-EPS probability of P > 5mm



Analysis (NWP+radar combination)

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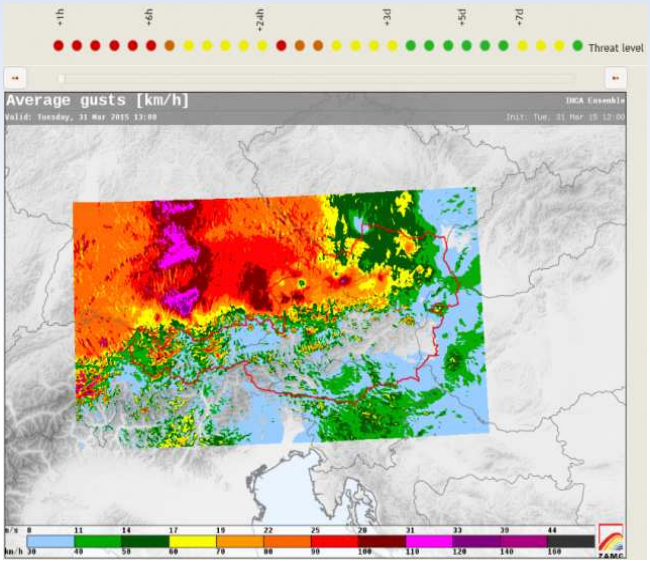
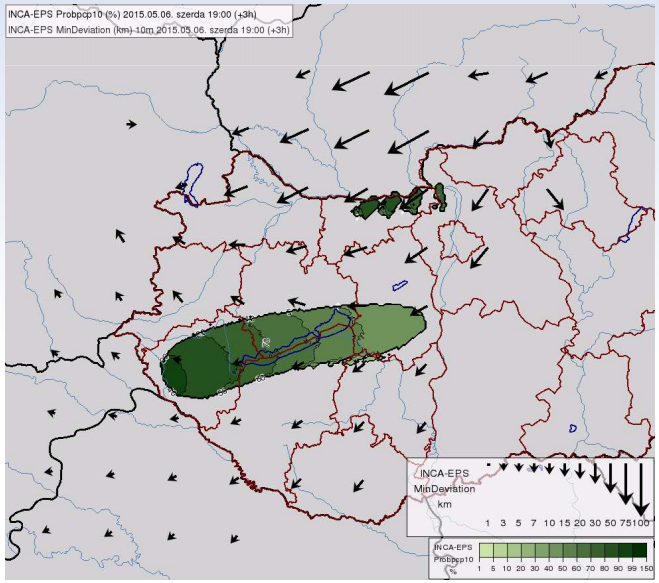
Probabilistic, seamless forecasting (PROFORCE)

- Forecasts for Lower Austria and Somogy County disaster managements (ZAMG-lead partner, OMSZ, DMDSC, NOEL-CP), civil protection portals (Austria, Hungary)
- Seamless probabilistic system (from nowcasting to medium-range)
- Nowcasting EPS: multinowcast, EPS background model (ALADIN-LAEF) for wind and temperature, uncertainty of precipitation field displacement



INCA-EPS (ZAMG)
Maximum gust forecast
Niklas storm, 31 March 2015

INCA-EPS (OMSZ)
Probability of P>10mm
6 May 2015
thunderstorms



Methods of deviation vectors:
analyses vs previous forecasts
(Simon 2013, Suklitsch 2015)

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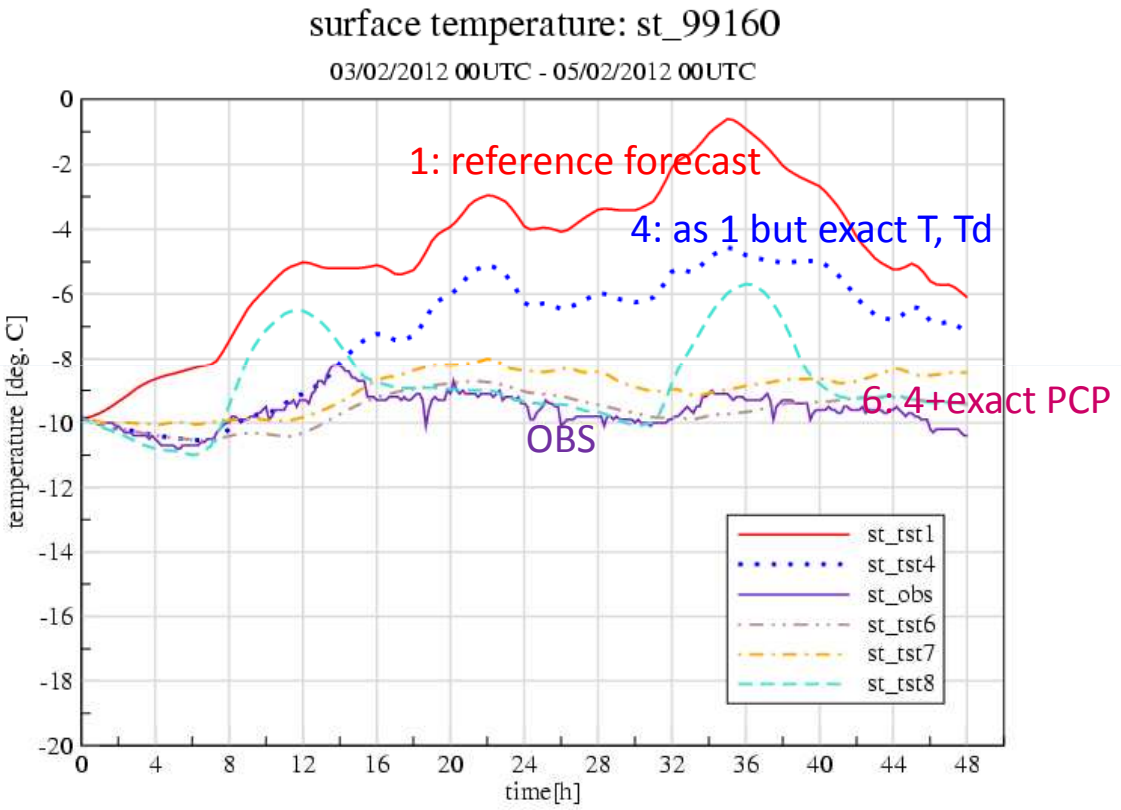
ASIST activities and experiences

- Cooperation in order to reveal problems in development and usage of nowcasting and very short range forecasting (VSRF) applications and possibilities of international cooperation (data exchange, etc.)
- Survey on nowcasting and VSRF applications (14 European met. services) - accuracy, technical aspects, advantages and weaknesses, use of probabilistic methods, forecasts consistency, possibility of international cooperation, etc.
- Review of methods and publications
- Case studies

Accuracy of applications - examples

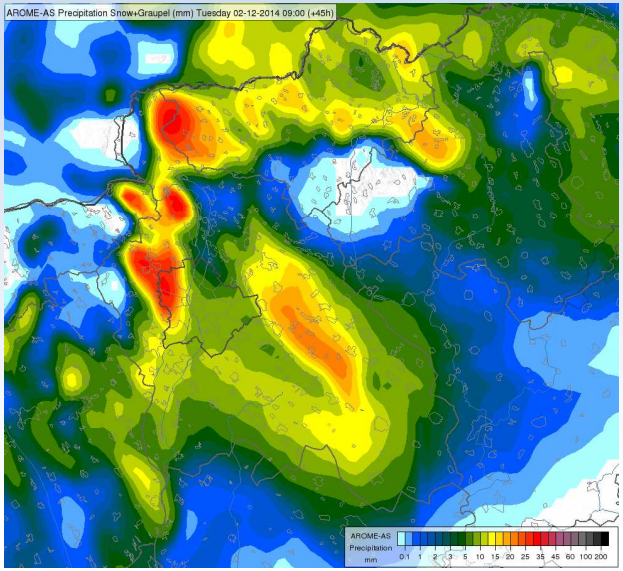
- Parameters in winter-precipitation or road-condition forecasting are very sensitive on the precision of NWP inputs
- High forecast errors can be related to delays or displacements of precipitation bands, errors in the precipitation-type determination, etc.
- EPS-approach could be helpful

Sensitivity tests on road temperature forecast
(METRO model coupled with WRF)
Forecast for Szeged (southeast Hungary)

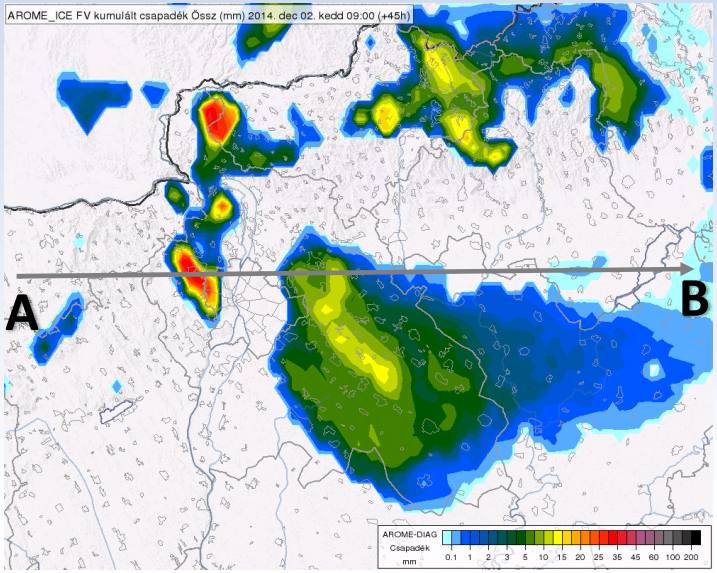


Why we still use empirical postprocessing methods?

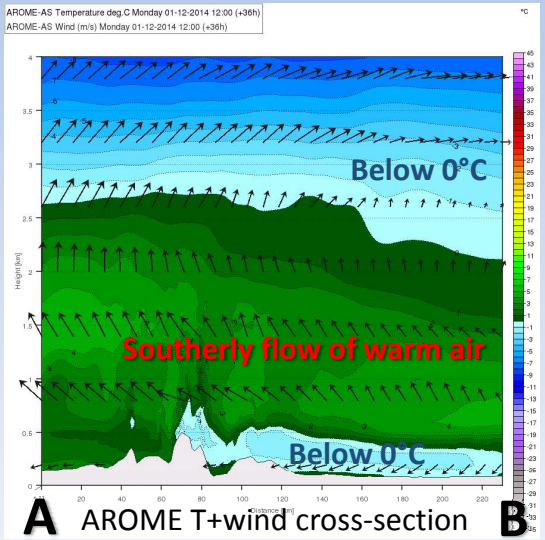
- Problems with the identification of the precipitation type even if the temperature profiles are well forecast



Snowfall forecast from the original precipitation-type parameterization



Freezing rain forecast with statistic-based postprocessing method of Fövényi, 2001 (which was correct)



AROME T+wind cross-section

Severe freezing rain event
1 December 2014, Hungary

Glaze developed in hills and mountains on cold (< 0°C) surfaces
The direct model-outputs predicted rather snow or graupel in this area

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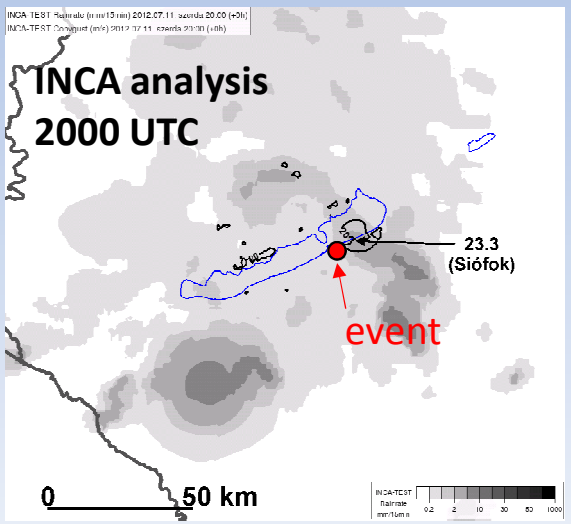
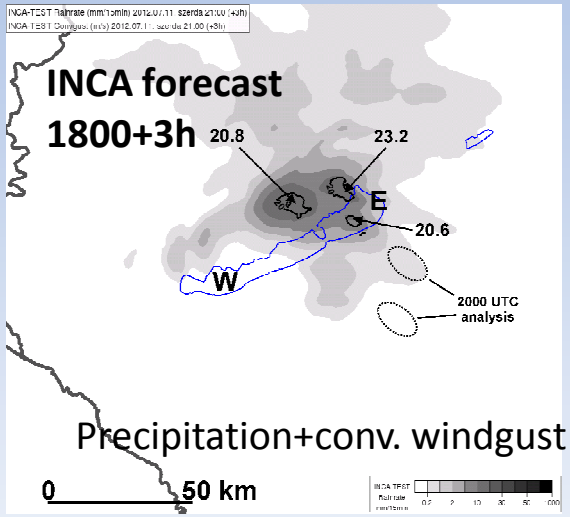
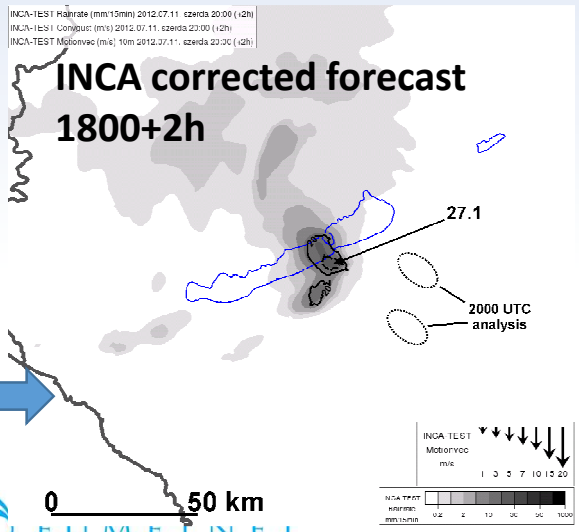
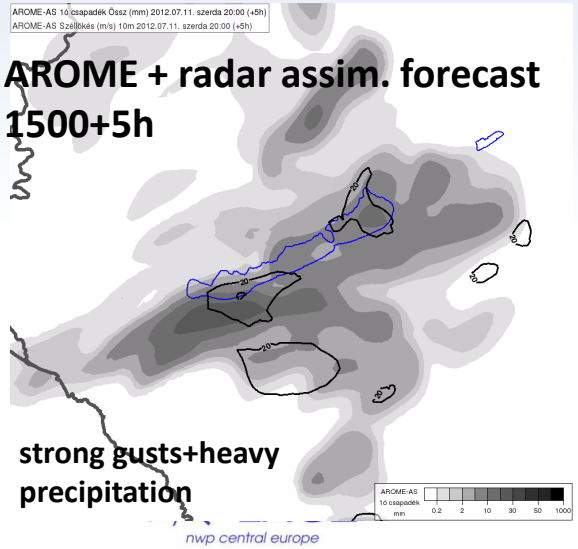
Convection: NWP or extrapolation?

- Early forecast of convection is one of the biggest challenges
- NWP with local data assimilation provides acceptable results in case of strong synoptic forcing
- Many nowcasting applications use only extrapolation (no development, life-cycle, etc.)









Forecasts of thunderstorms, 11 July 2012
(protection of large concert at the Lake Balaton)

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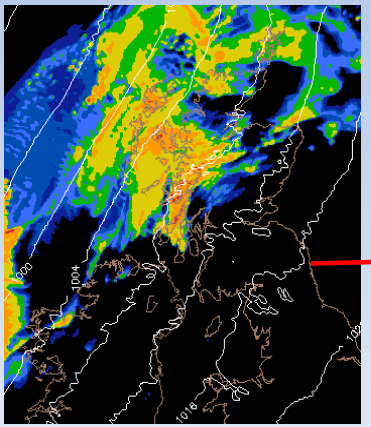
Limits of NWP nowcasting use

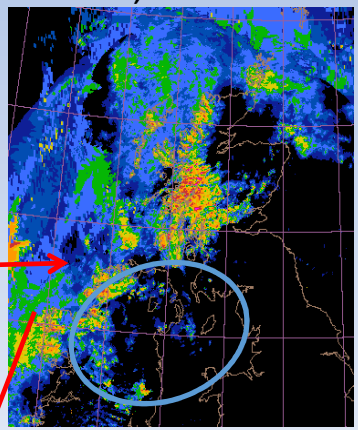
- Frequent cycle of data assimilation and NWP integration is seen as the way forward for objective nowcasting

- Still significant problems to overcome with this, e.g. if a large convective cluster is non-existent or misplaced in a high resolution model, getting the model to correctly take it on board whilst maintaining dynamical balance necessary for starting conditions is a big challenge

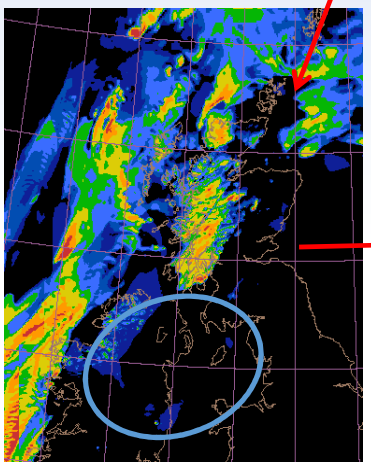
UKPP T+3 VT 21Z



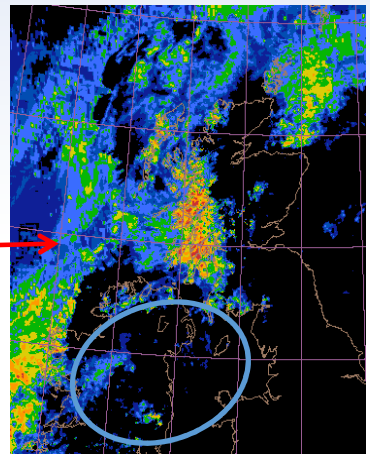
UKPP Nowcast analysis VT 21Z, forced towards radar



UKPP Nowcast T+3 VT 24Z



Radar 24Z



Nowcasts tend to drift quickly back towards model's preferred state since environmental dynamics not supportive

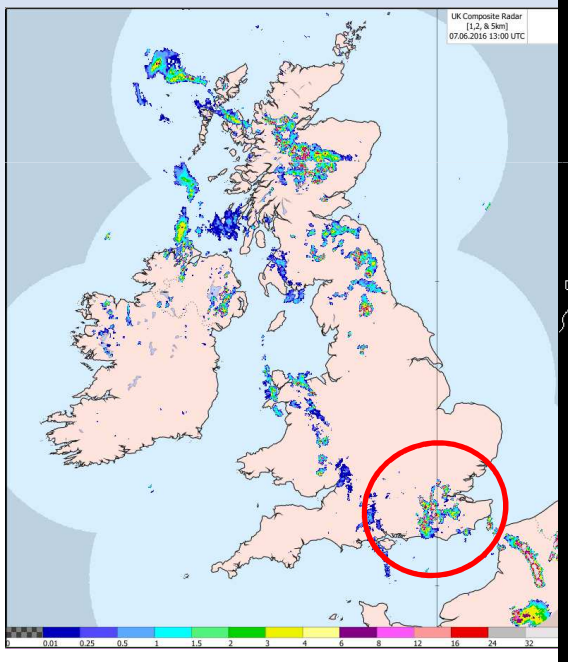
Consistency problems

- Automatic outputs in the applications can be inconsistent with official forecasts (reasons: systematic errors, disagreement with observations and conceptual models, etc.)
- Tools to „correct" explicit NWP forecasts, NWP proposals used for severe weather warning from nowcasting systems
- There are few (if any) user applications, where the final product would be automatically corrected with respect to current, valid warnings and forecasts
- Contradictory forecasts can be confusing for users and cause serious misunderstandings (e.g. in the Civil Protection)

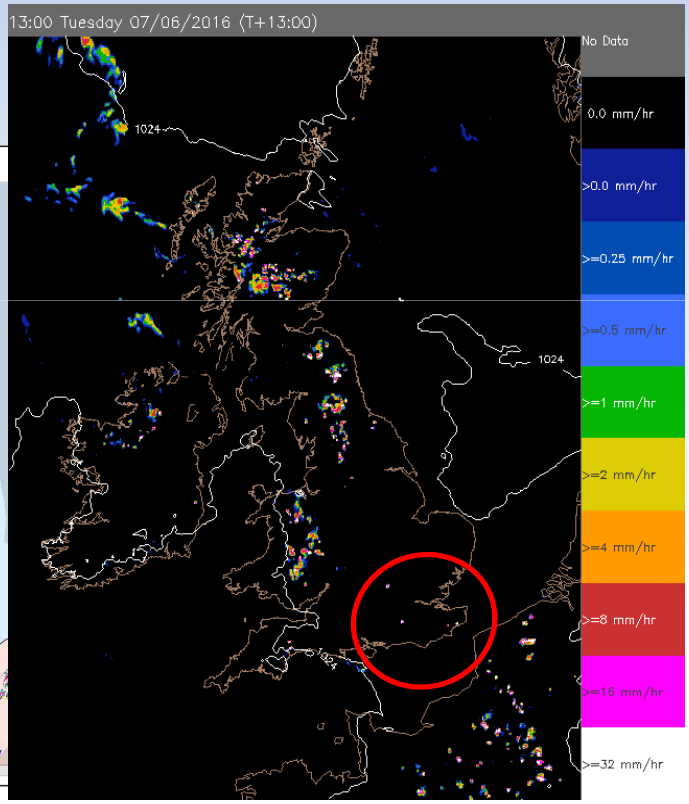
Consistency problems

- Warnings issued for thunderstorms - these caused flooding in London
- Missing from NWP => from automated feeds to mobile apps, websites, products

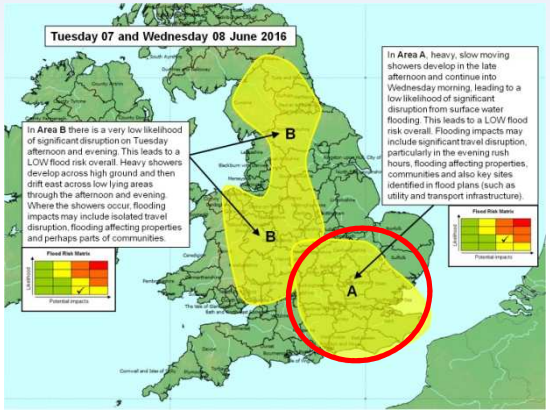
RADAR



NWP

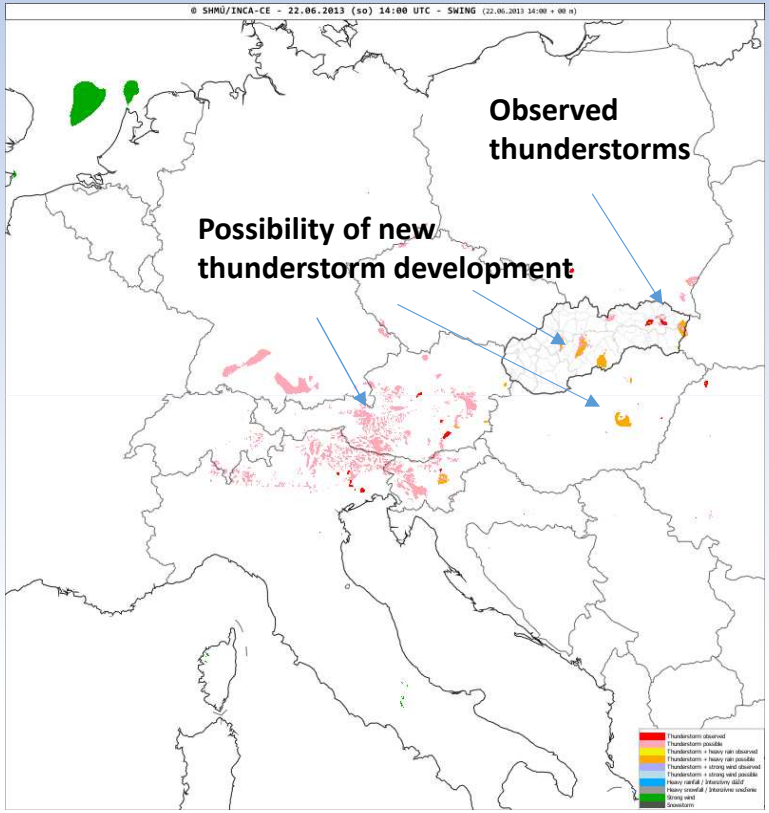


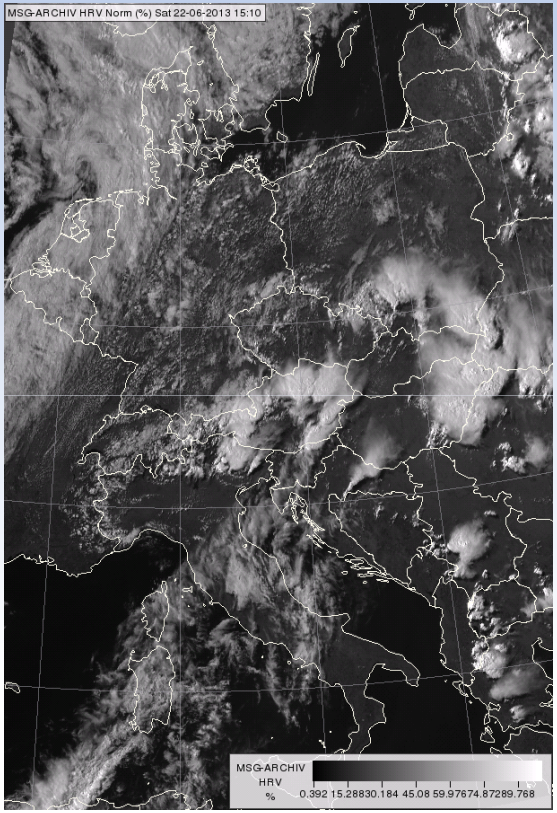
UK Flood Guidance Statement



Communication with the user (Civil Protection)

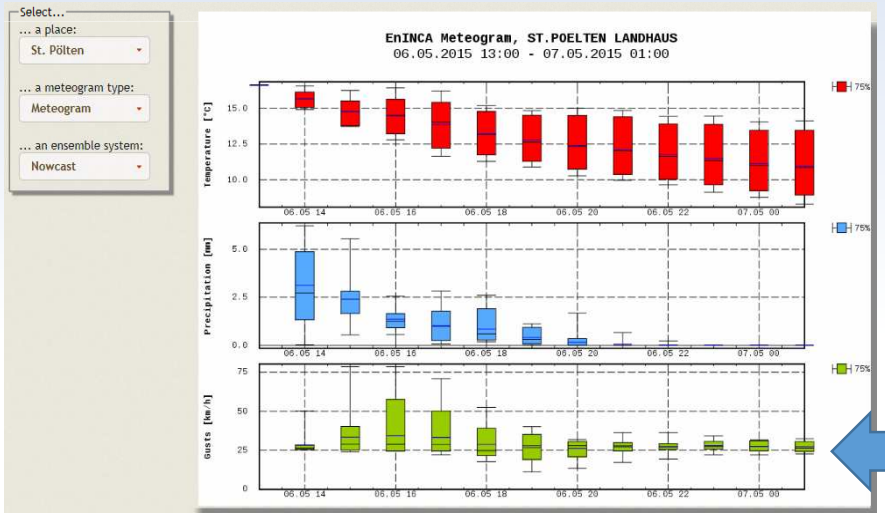
- The user should see nearly the same picture as the forecaster and should understand it
- Automatic or semi-automatic explanatory tools to emphasize the most important features, analogical to SatRep charts
- Severe Weather Interpretation Guide (INCA-SWING)



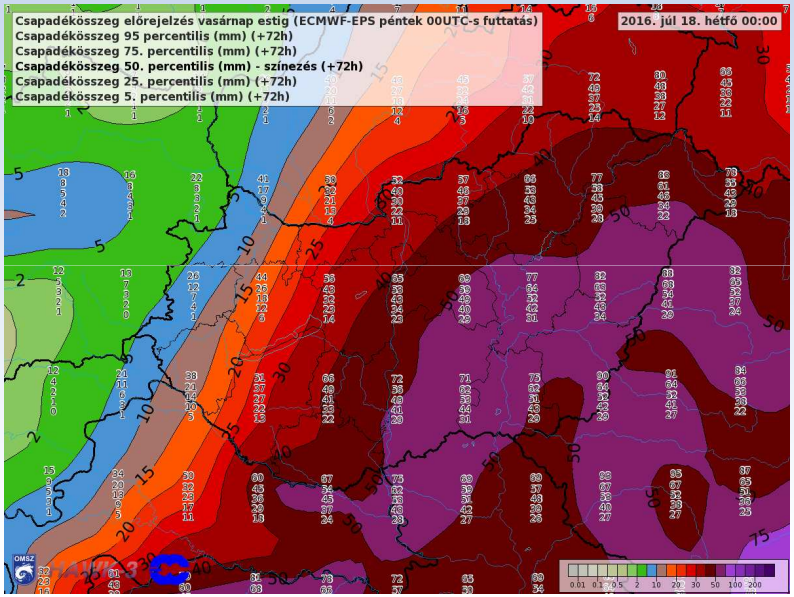


How to interpret EPS forecasts?

- Relatively easy for local forecasts (plumes, meteograms)
- Probability maps are difficult to interpret for some users
- „Quasi-deterministic” views (medians, means, etc.)
- Scale dependency (local extremes vs. large-scale EPS)
- Thresholds?



PROFORCE meteogram for the Civil Protection Nowcasting range (ZAMG)



ECMWF-EPS forecast of heavy rainfall
Color shades: EPS-median (50 percentil) of precipitation (OMSZ)

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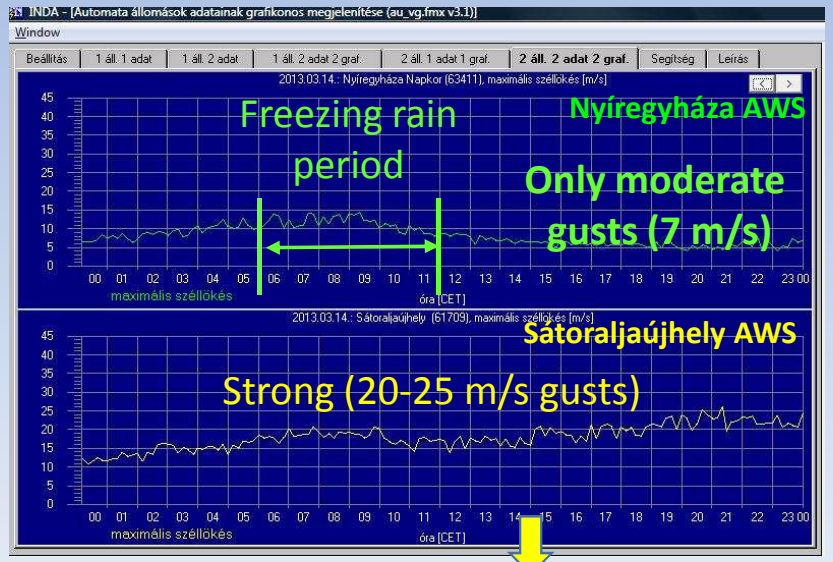
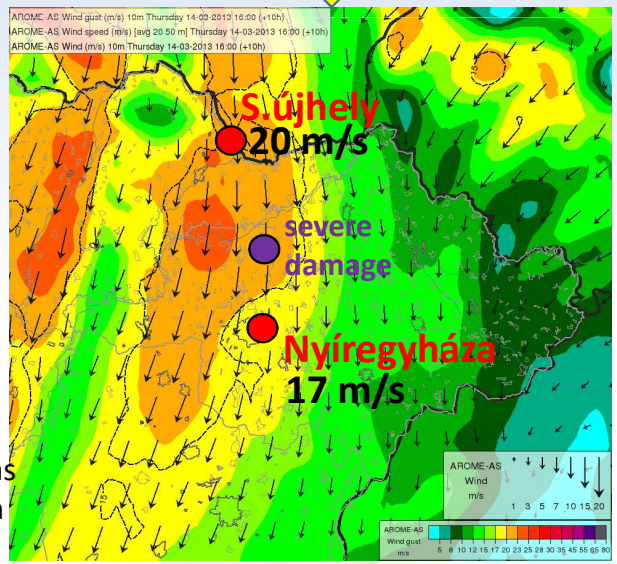
Verification

- Missing for many applications
- The focus should be on severe events, which are relatively rare
- Very difficult in case of certain „special” parameters (icing, wet-snow, hail)
- Measurement difficulties in case of severe weather (precipitation or wind OBS are not always reliable in extreme conditions, even if the devices are of high quality)

Severe freezing rain and glaze, 14 March 2013



AROME wind and gust forecast



AROME predicted increasingly strong wind and gusts in the area, confirmed also by radial Doppler velocity OBS.

The low wind velocity from AWS was probably caused by ice accretion on the measuring device

Possibility of cooperation, further development

- Not only technical issues but also exchange of experiences with end-users, methods of communication, etc.
- Enhance research in certain areas (e.g. winter precipitation, EPS, verification methods)
- Providing high-resolution nowcasting applications for large areas is still difficult (cross-border exchange of OBS in short time, etc.)
- The goal is to provide reliable information, tailored for the user's need, with sufficient lead-time

Thank you for your attention!