European Nowcasting Systems

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Introduction

- Cooperation of the European weather services in Nowcasting since January 2013 within the EUMETNET Nowcasting Activity
- EUMETNET Nowcasting Activity is part of the Forecasting Programme
- The Nowcasting Activity is led by ZAMG
- 23 participating members and a few additional cooperation partners

- Objective within the first project phase (lasting until 30 June 2014) is to provide an overview of:
  - nowcasting systems and techniques which are in use in the different member states
  - relevant observations and outputs of numerical weather prediction (NWP) models
  - verification standards and
  - the link to the application

• Definition of Nowcasting: Weather forecast for the next 0 to +6 hours of lead time

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Contributions

Several NWSs contributed to this presentation:

- CHMI
- DWD
- FMI
- MeteoSwiss
- OMSZ
- IMGW-NRI
- SHMU
- UK Met Office

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Nowcasting systems and their output parameters

- Nowcasting of precipitation is most common
  - CHMI (CELLTRACK, COTREC) – in operational use since 2007
  - DWD (NowCastMIX) – not in operational use
  - MeteoSwiss (Cell tracking, radar-raingauge combination, cell intensity, NORA based on air-mass stability, REAL about uncertainty in radar precipitation maps) – mostly in operational use
  - IMGW-NRI (SCENE) – in operational use since 2013
- Some of the nowcasting systems provide also information about other parameters – i.e. in 2d (cloudiness, radiation) and 3d (temperature, humidity, wind)
  - ZAMG (INCA) – in operational use since 2005
  - FMI (RAVAKE: semi-operational since 2011, LAPS: in operational use since 2009)
  - MeteoSwiss (INCA) - in operational use
  - OMSZ (INCA-HU: in operational use since 2012, MEANDER: since 2006)
  - SHMU (INCA-SK): INCA since 2006
  - UK Met Office

• INCA is quite common in Central Europe through the INCA-CE project (CE Programme; 1.4.2010-30.9.2013) and through bilateral cooperation (e.g. with Belgium, Israel, China, Turkey, Croatia)

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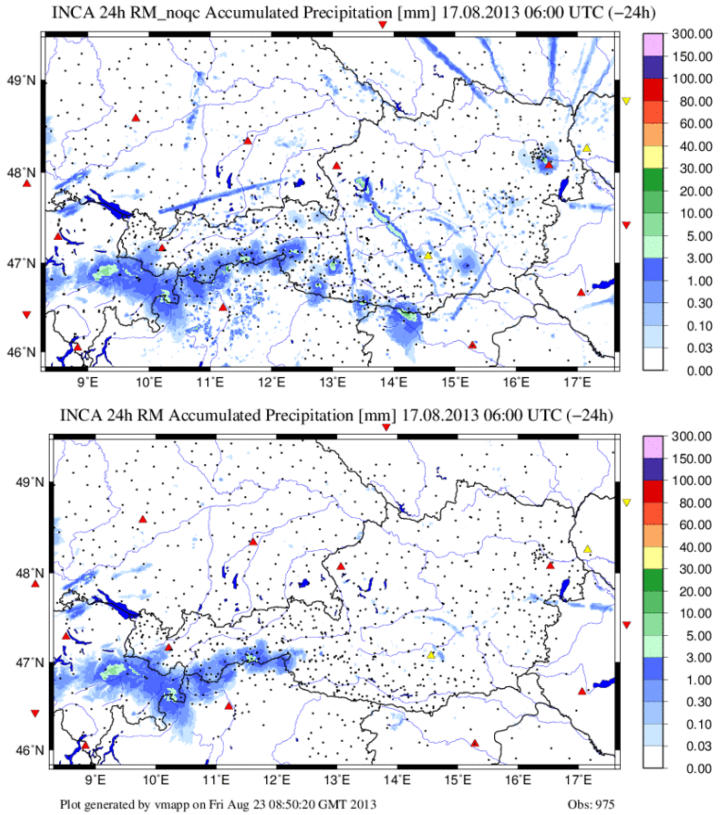
Input data and resolution of nowcasting information

- Nowcasting systems need information about
  - Topography
  - NWP data (global/LAM)
  - Surface observations
  - Radar
  - Satellites (e.g. cloud cover, cloud top height)
  - Cell vector estimates
  - Lightning detection (e.g. Saphir)
  - Sounding
  - Lidar, Amdar, Metar
  - Road weather stations
  - NWCSAF products



- Quality control: Station data consistency check, Plausibility filter, Climatological limits, Flatfilter, Singlefilter, Accumulation filter, Holefilter, SP filter, Radar filters, Blacklist

- Resolution of nowcasting information
  - Mostly 1km-3km (horizontal) and 5min-2h (time)

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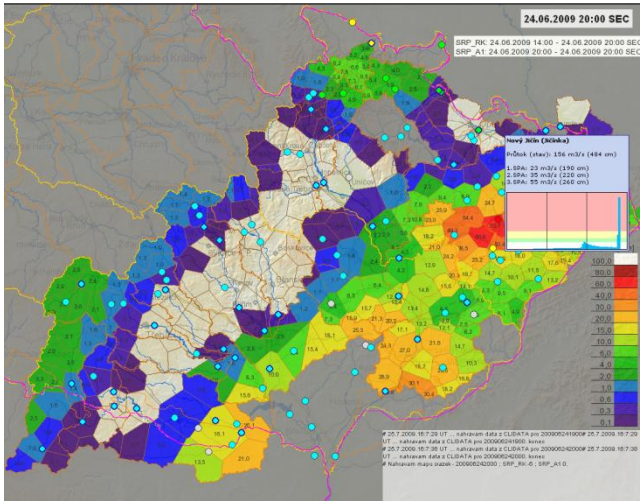
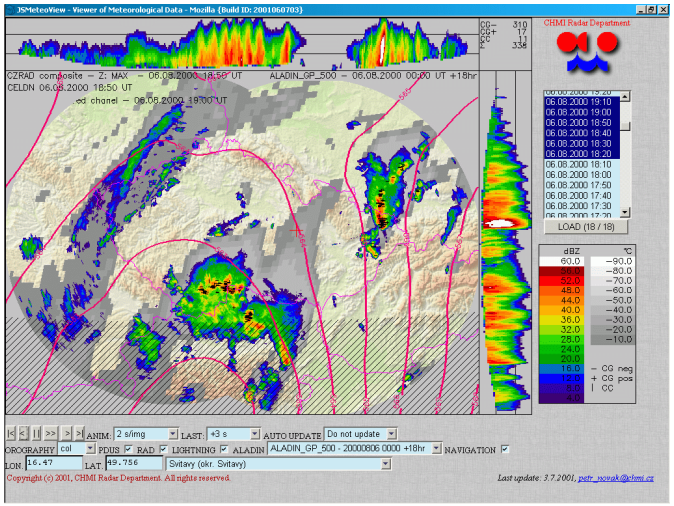
Nowcasting at CHMI

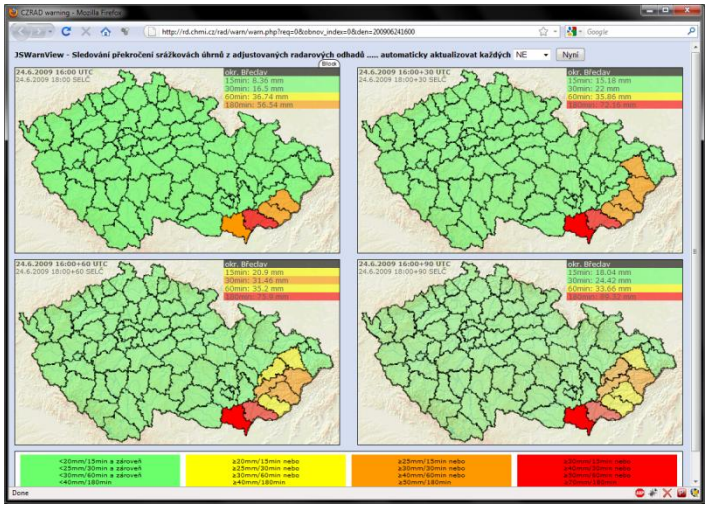
- Extrapolation of radar data; cell identification and **tracking algorithm** as well as **area based algorithm**
- Visualization:
- JSMeteoView – displays primarily radar data and other data sources, GIS features
- JSWarningView – gives warning to the observers if precipitation is higher than given thresholds – uses COTREC nowcasts
- HydroView – HYDROG hydrological model covering eastern part of the Czech Republic – operationally uses COTREC, INCA precipitation nowcasts



HydroView



JSMeteoView



JSWarnView

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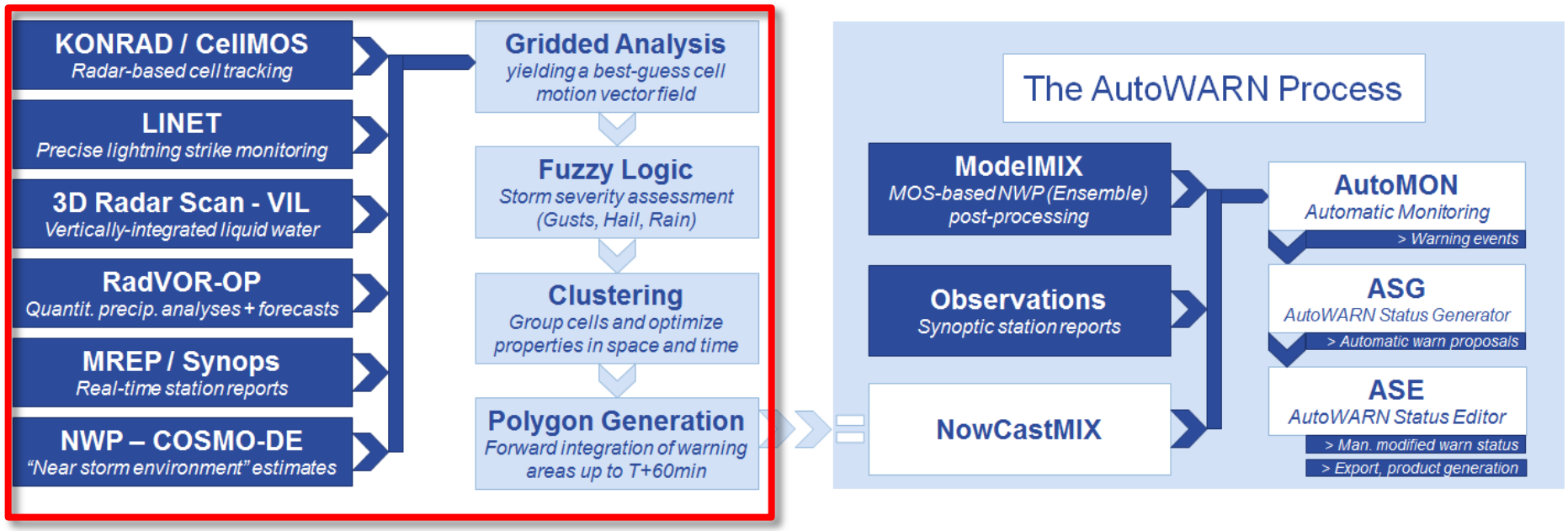
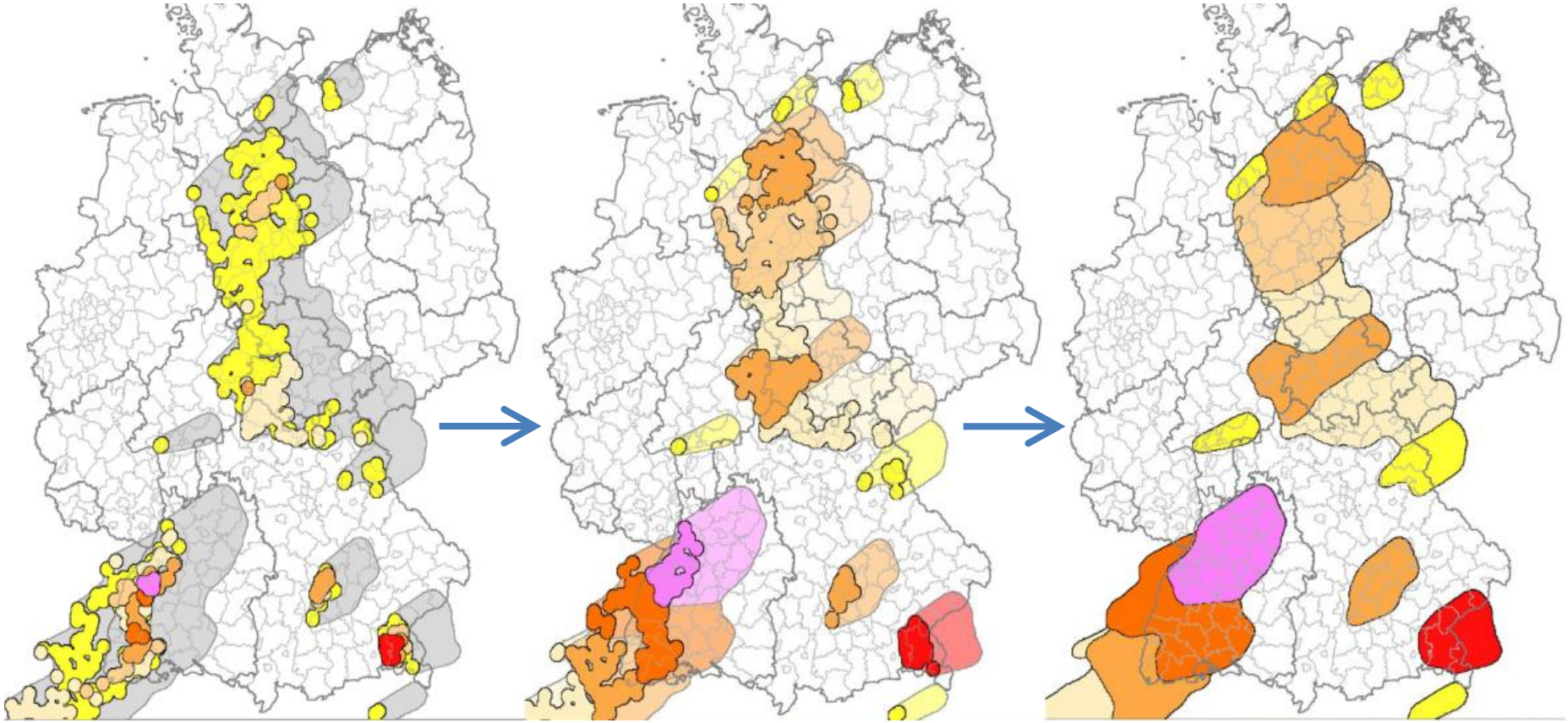
Nowcasting at DWD



- *NowCastMIX monitors several nowcasting systems on a 5 minutes update cycle*
  - *Radar products, lightning, surface obs., NWP model outputs for background*
- *Data mapped onto a 1km grid with assessment of cell motion vector field*
- *Storm severity assessments using a fuzzy-logic method*
- *Spatial and temporal optimisation using clustering techniques*
- *Warning polygons covering the next 60 minutes produced and sent on to AutoWARN*

NowCastMIX – From analysis to warning polygons

14:05 to 15:05 UTC, 22.06.2011



Analysis* + Warning areas
* 20 minute time window (13:45-14:05)

Clusters + Warning polygons

Warning situation for the next hour

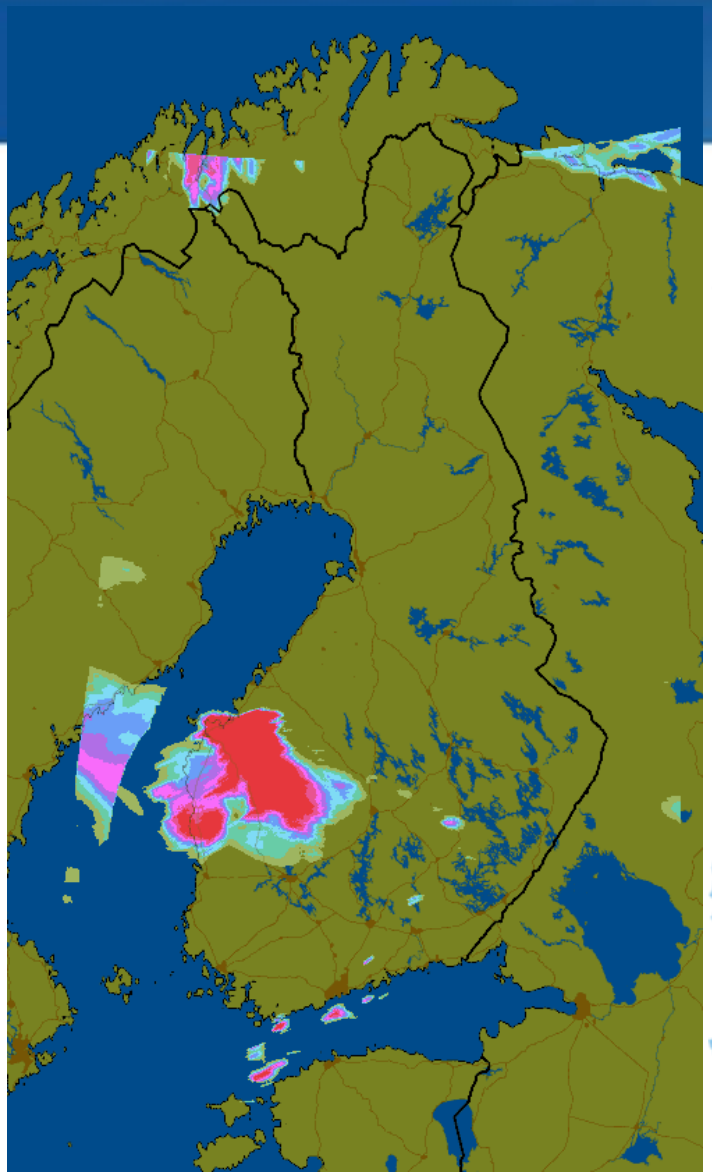
Nowcasting at FMI

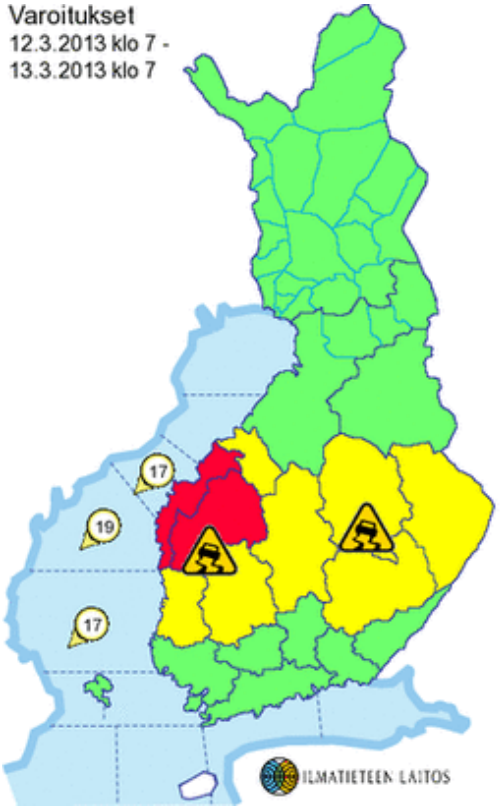
Probability of rainfall accumulation with multiple exceedance thresholds (RAVAKE) / objective analysis: multi-scale successive correction methods (LAPS - Local Analysis and Prediction System)

An example on 12 Mar 2013 at 9:00 local time

Animation of forecasted probability of precipitation

- Forecast 24h ahead, starting at 10:00 local time, 1h intervals
- In this case snowfall!





Nowcasting at MeteoSwiss

TRT (Thunderstorm Radar Tracking algorithm): **Operational** cell-tracking-based nowcasting tool. It allows cells to be detected and tracked throughout their evolution. The cell severity ranking is also computed. Detection is based on an adaptive threshold scheme while cell split and merging is taken into account.

(Hering et al., 2005, 2006, 2008)

CombiPrecip: **Operational** geostatistics-based spatiotemporal radar-raingauge combination tool, equipped with algorithms for convection control and out-of border extrapolation. Produces 5-min, 1km^2 output precipitation fields, with practically zero bias.

(Sideris et al., 2013)

MAPLE: **Under development** application for precipitation nowcasting. Based on an area-tracking algorithm originally developed by the McGill (Canada) radar group. Adjustment of the code for the complex alpine terrain of Switzerland is currently taken place.

(Germann et al., 2002. 2004, 2006)

COALITION: **Operational** tool used for prediction of the development of severe thunderstorms. Integrates information of thunderstorms and their surrounding environment in a heuristic model. Produces 5-60 minutes forecasts of cell intensity.

(Nisi et al., 2013)

INCA: **Operational** tool which produces nowcasts for precipitation, temperature, humidity, wind, cloudiness and snowfall. Advection-based forecast for the first two hours, which is then gradually converted to the NWP precipitation forecast.

(developed by ZAMG; Haiden et al., 2006)

NORA: **Prototype** tool centered in nowcasting orographic rainfall employing spatiotemporal analogues. It produces rainfall forecasts by using mesoscale winds and air-mass stability as predictors of orographic precipitation.

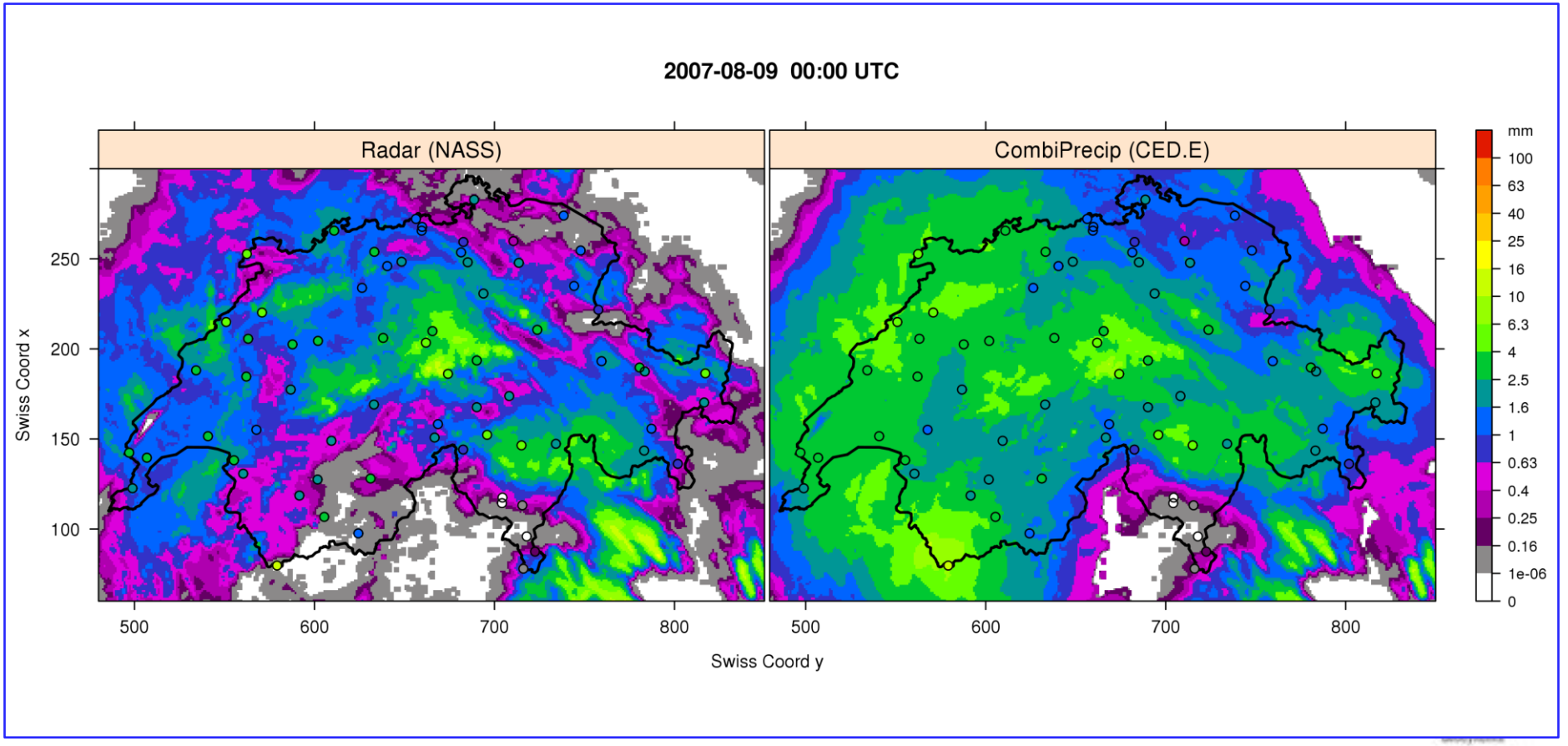
(Panziera et al., 2011)

REAL: **Prototype** tool to express uncertainty in radar precipitation maps in the form of an ensemble by combining knowledge of the radar error structure with stochastic simulation.

(Germann et al., 2009)

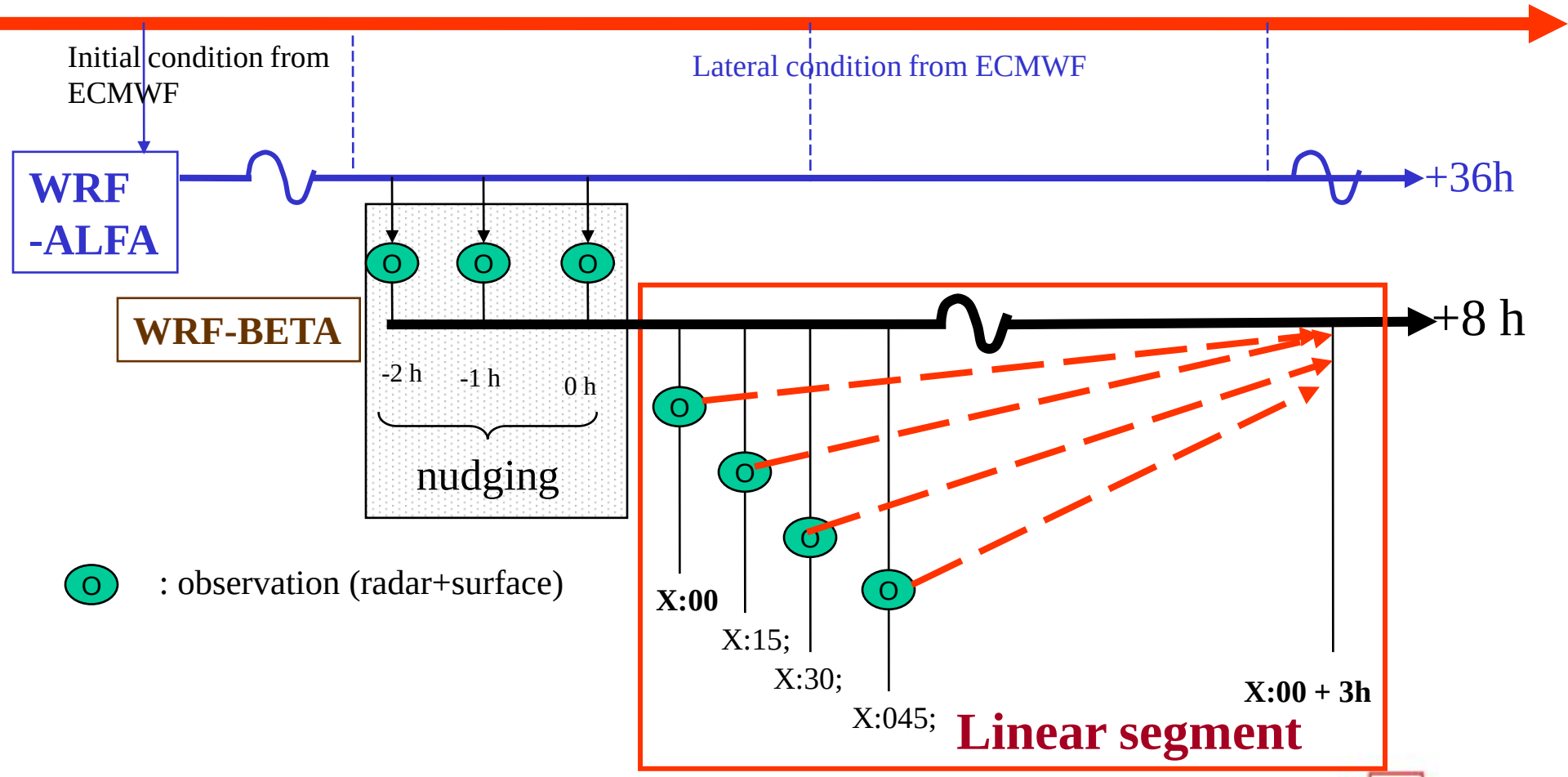
CombiPrecip

On the left the original radar precipitation field. On the right the radar-raingauge combination field. The color inside the circles indicates the rainfall amounts measured by the raingauges. Observe that the right image agrees almost perfectly with the over-imposed raingauge measurement (circles).



Nowcasting at OMSZ

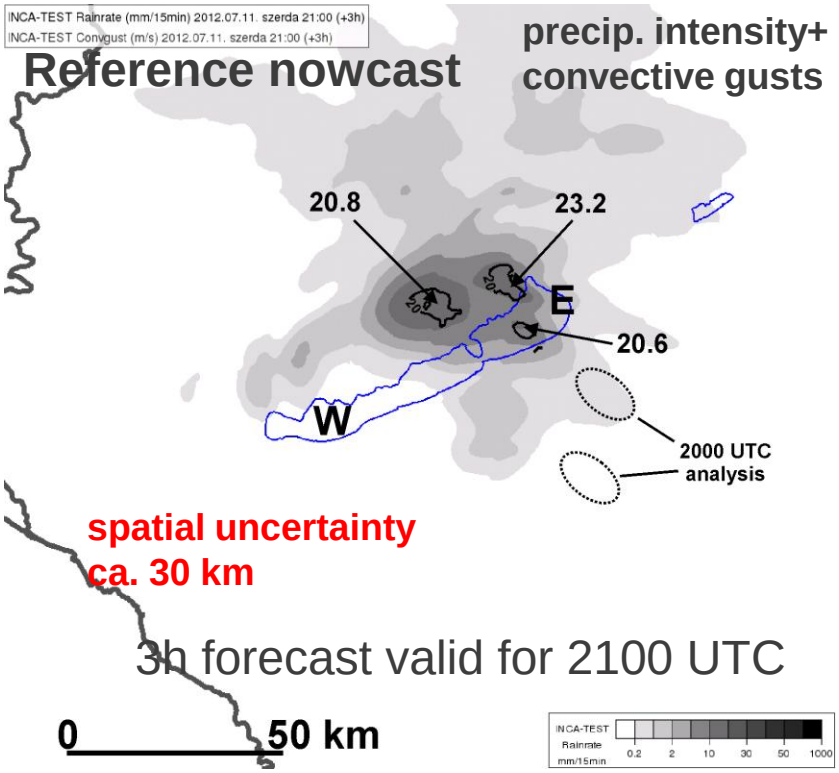
Linear extrapolation in MEANDER; blending; finally closer interaction between NWP and linear segment

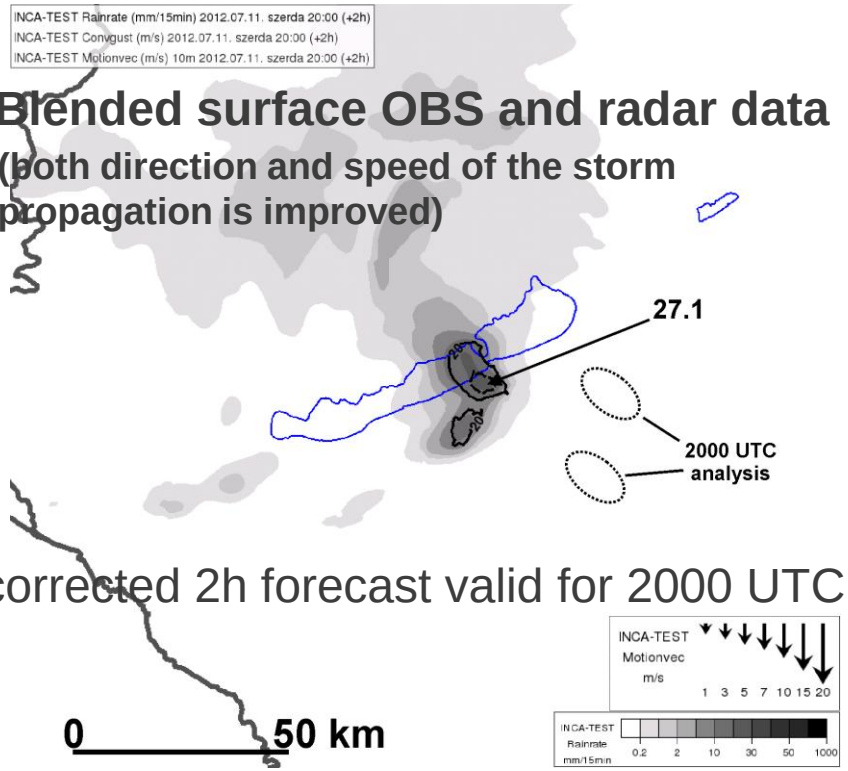


Nowcast for the next 3 hours refreshes in every 15 minutes

Nowcasting at OMSZ

INCA in use at OMSZ: The consistency of different observations is important for correct computation of the motion vectors and forecasting of the future position of the precipitation





Severe storm on 11 July 2012

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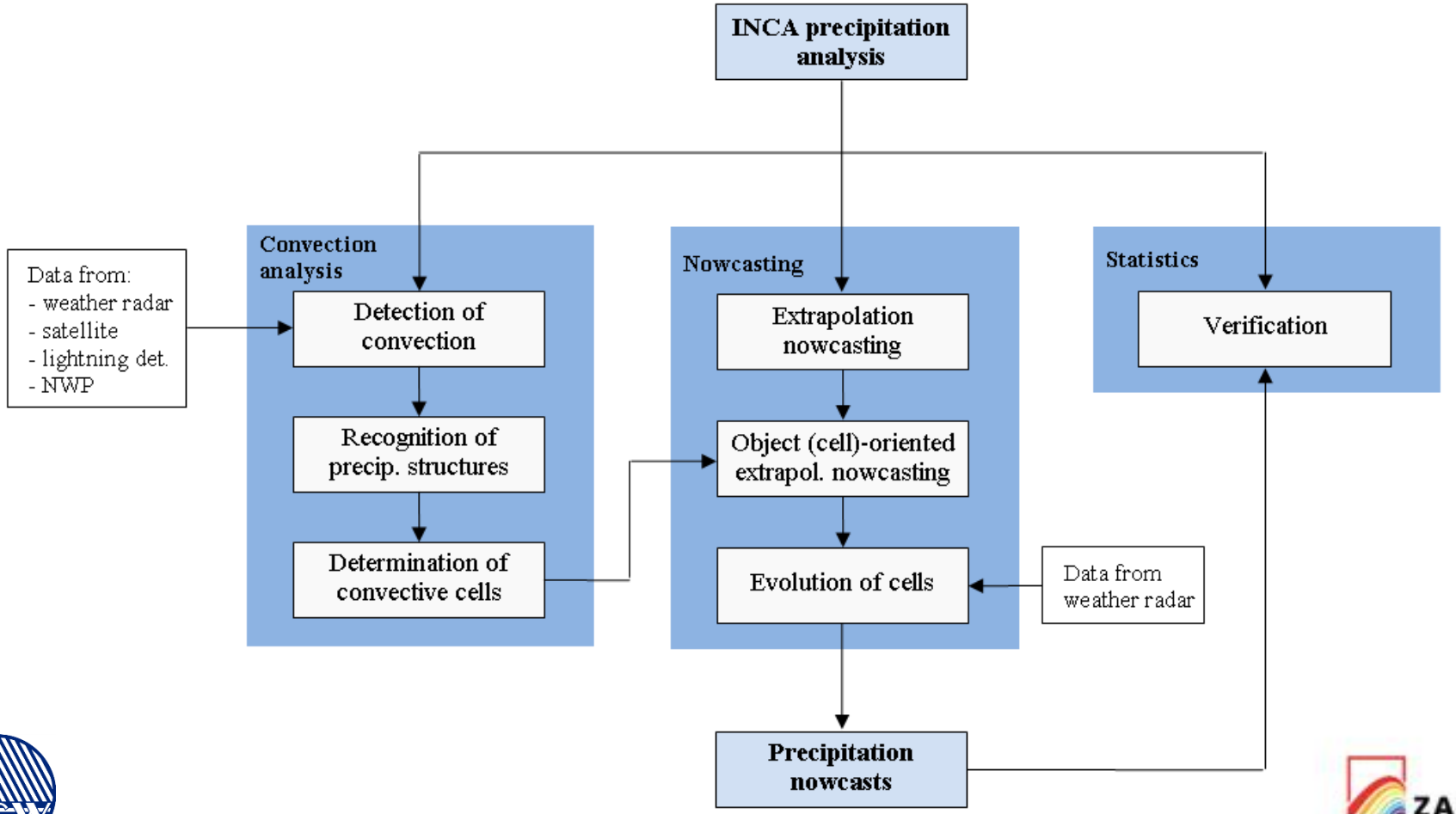
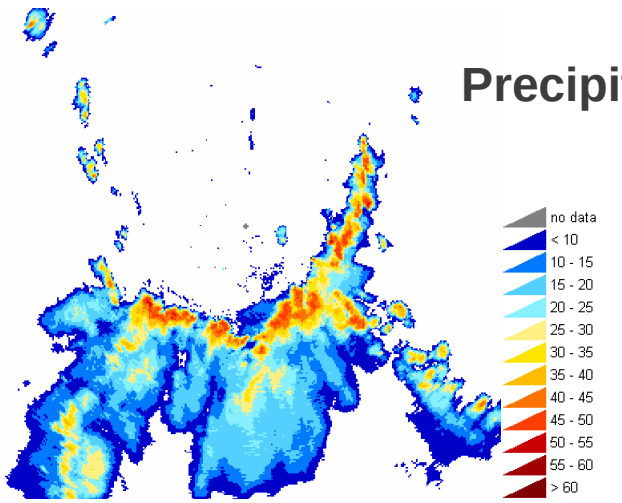
Nowcasting at IMGW-NRI

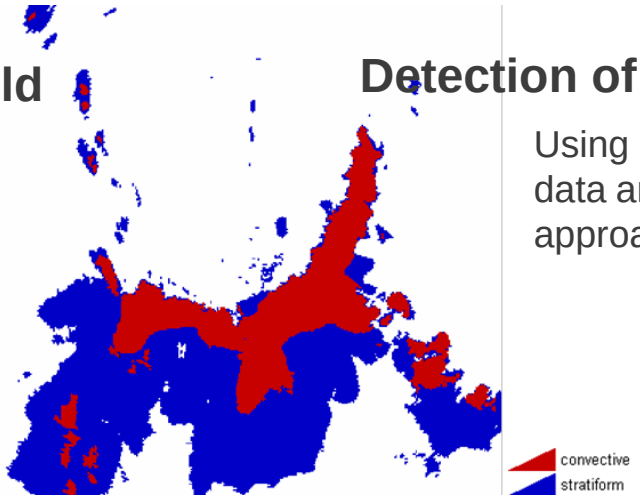
SCENE model (Storm Cell Evolution and Nowcasting) modules:



Example of convection analysis with SCENE

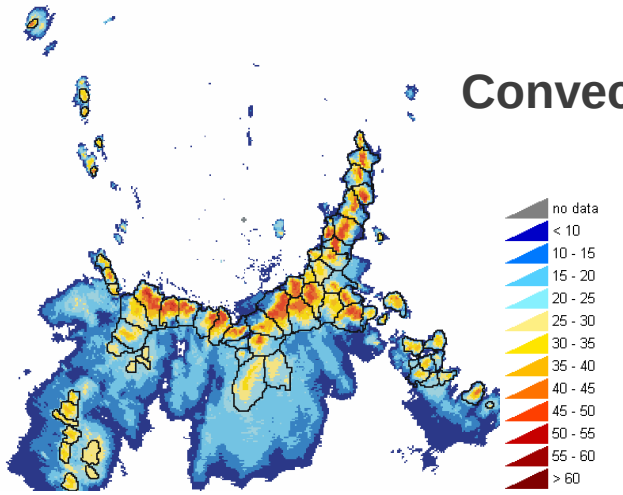


Precipitation field



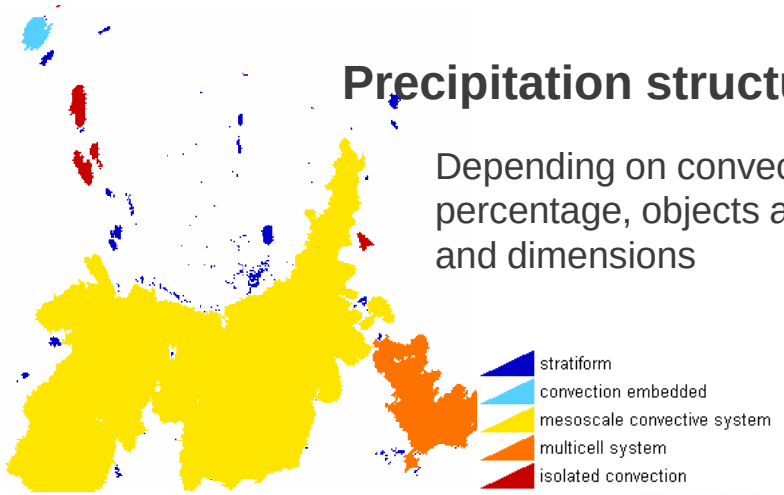
Detection of convection

Using multi-source data and fuzzy logic approach



Convective cells

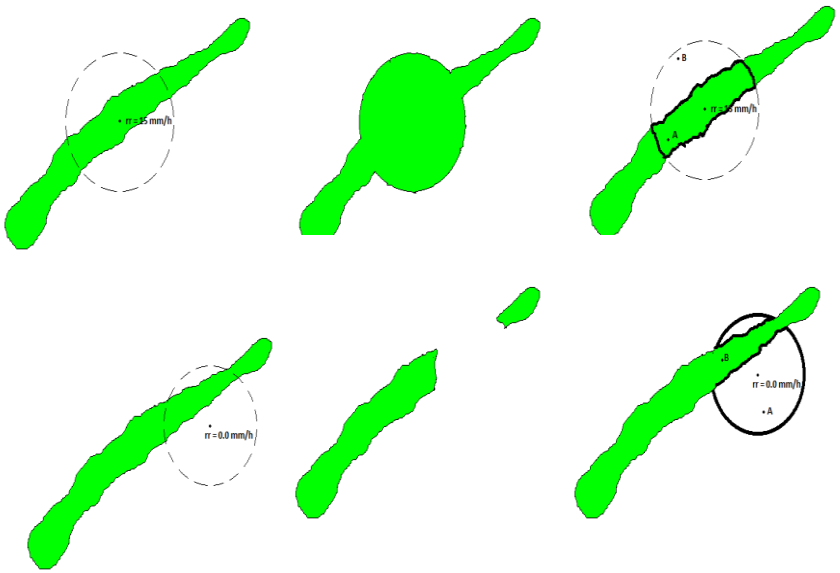
Using 2-D geometrical analysis



Precipitation structures

Depending on convection percentage, objects area, and dimensions

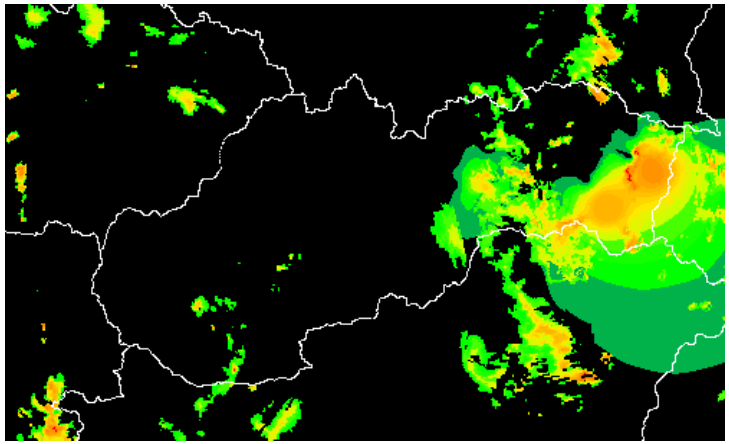
Nowcasting at SHMU



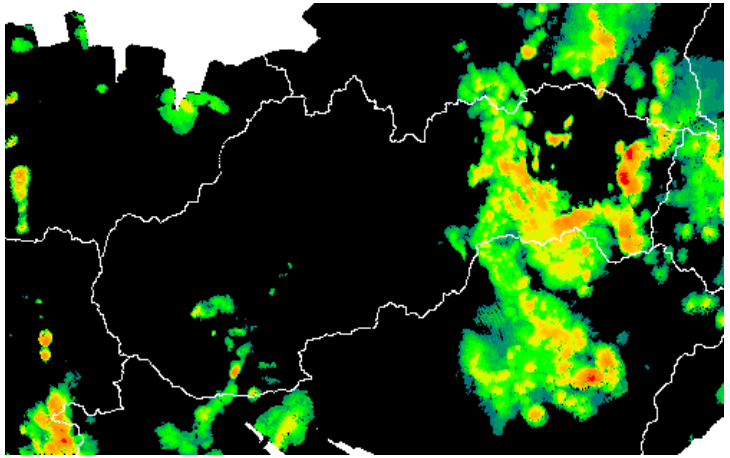
A station might be hit by a narrow squall line or a small precipitation cell.

In such a case, the original INCA method tends to create some unrealistic features in the precipitation field.

This unrealistic field of precipitation can be overcome with the new precipitation module in INCA.



INCA



Improved precipitation module in INCA

Nowcasting at UK Met Office

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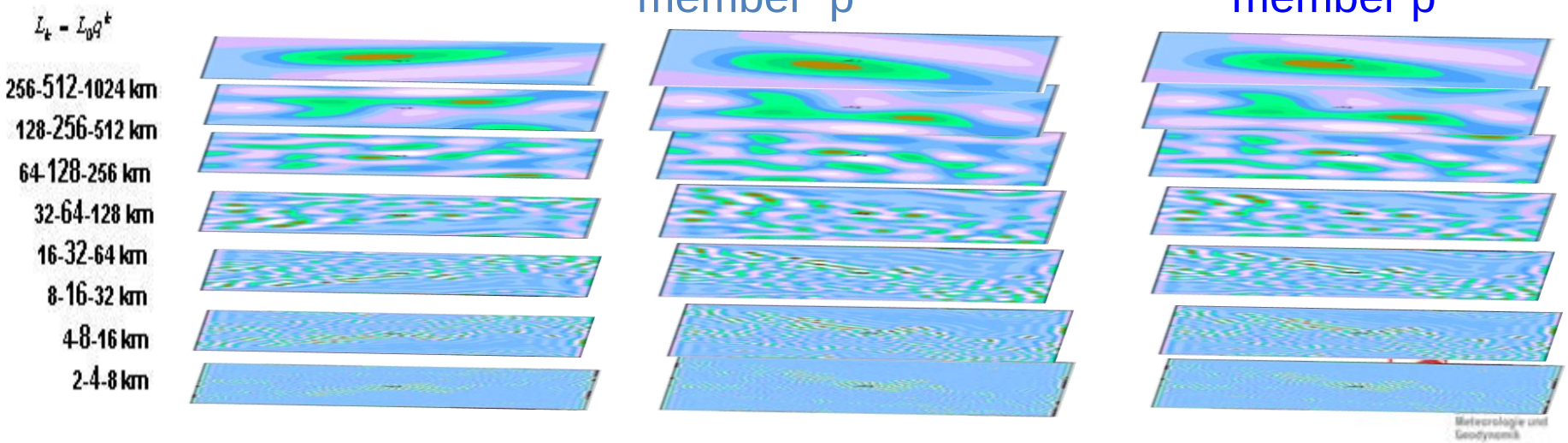
Met Office

- Short Term Ensemble Prediction System
- Scale decomposition framework
- Seamless combination of nowcast and NWP forecast(s)
- Noise used to generate ensembles and downscale NWP
- Self calibrating

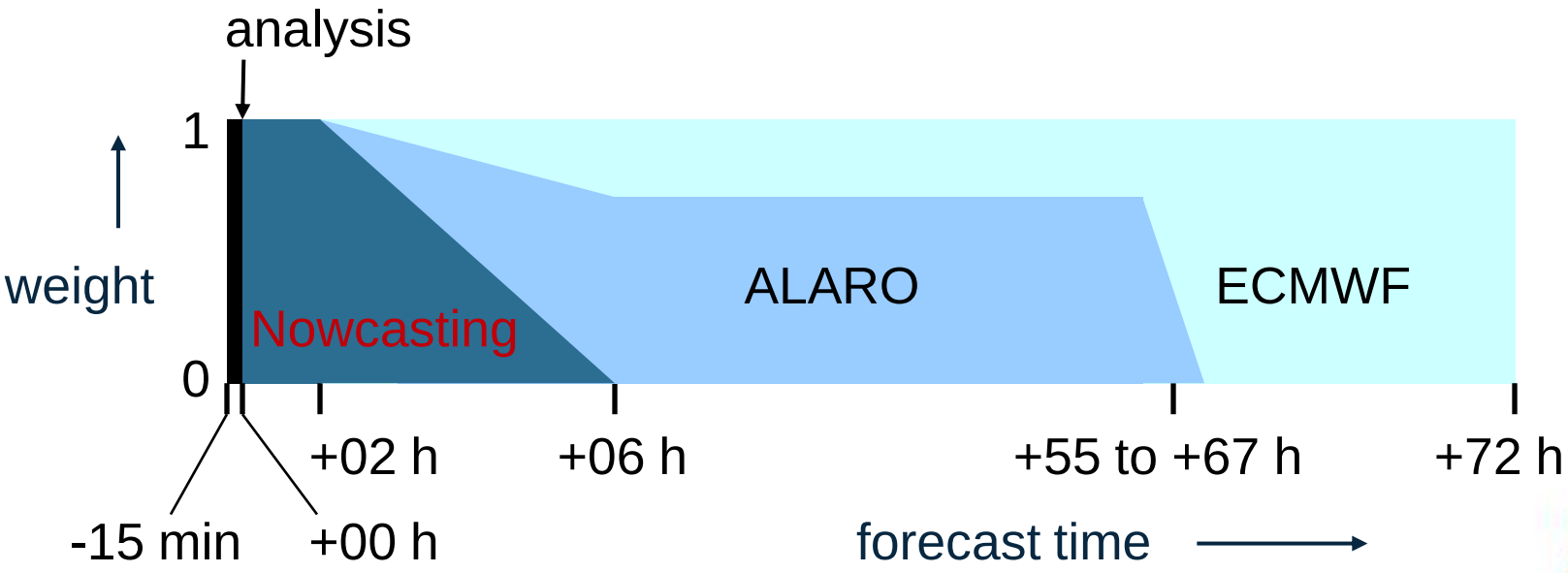
- Errors modelled
  - Radar errors
  - Extrapolation velocities
  - Evolution of extrapolated radar
  - NWP forecasts

Nowcast + UKV or MOGREPS-UK member p + Noise member p



Nowcasting at ZAMG

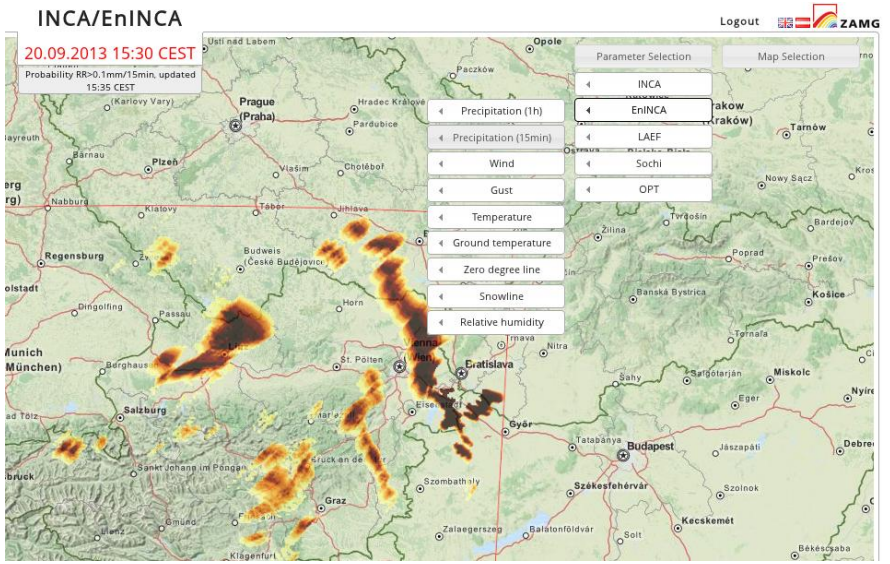
- INCA
- Extrapolation with motion vectors (computed from two consecutive analyses) for precipitation and cloudiness
- For temperature, humidity and wind: Persistence with modelled trend with a nowcasting limit of 6h (except temperature and humidity, where the limit is between 3h and 12h depending on stability)



Nowcasting developments at ZAMG

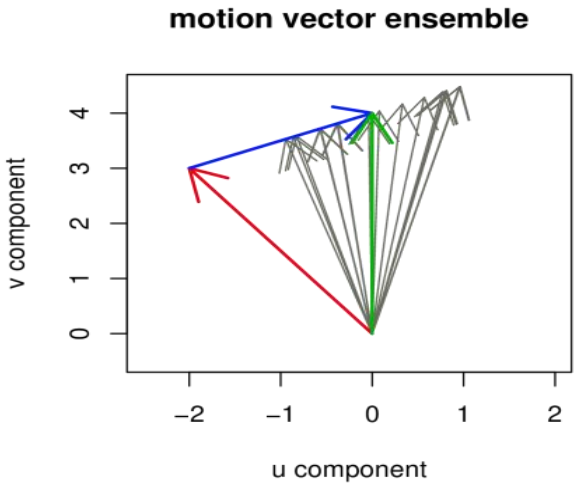
Ensemble forecasting method:

- to derive probabilistic nowcasts
- Precipitation, wind, gust, temperature, ground temperature, …



Error motion vectors (precipitation):

- Ensemble based on error motion vectors (blue)
- Error in motion vectors estimated from past analyses
- Motion vector (red) corrected by error yields the corrected motion vector (green).
- A sample of motion vectors is drawn



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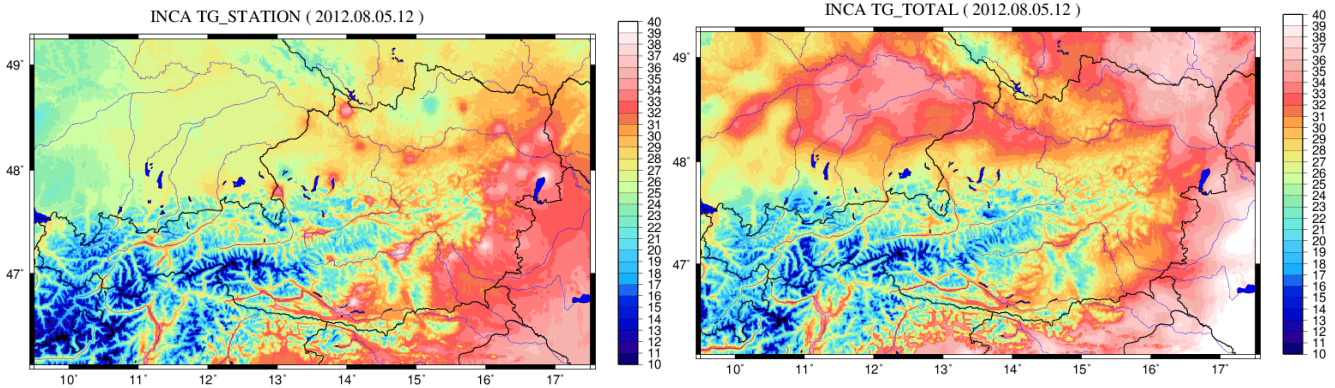
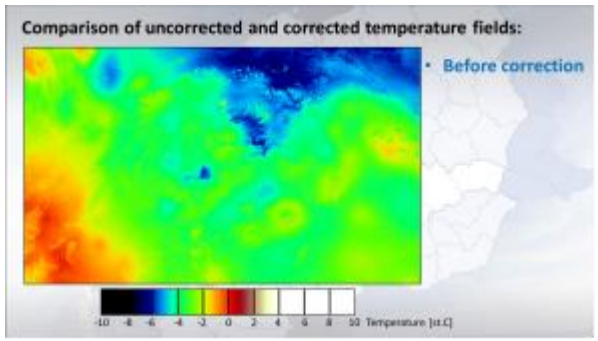
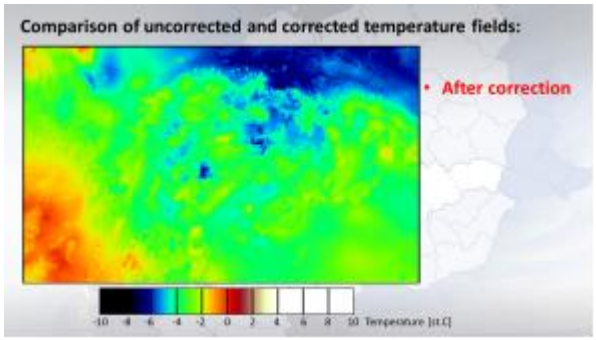
Nowcasting developments at ZAMG

Ground temperature: Use of MSG surface temperature product (LST)



Temperature (2m): Use of EUMETSAT nowcasting SAF cloud products to correct temperature of nowcasting system





Further developments/projects starting soon:
e.g. Satellite-INCA at ZAMG: Including and testing many different remote sensing products to improve INCA in data sparse regions.

Nowcasting developments at various NWSs

- Estimation of storm cell vectors by combining radar image matching techniques with cell tracking algorithms
- Fuzzy logic hierarchy to assess storm attributes
- Adaptive spatial clustering ensemble to optimize the usability of warnings
- Include verification feedback into developments
- Development of blending algorithms for the ensemble forecasts
- Wind gusts specified upon near-surface drag parameterization and Richardson number as stability parameter
- Correction of wind field in the proximity of extrapolated convective cells
- Conceptual convective cell lifecycle
- Improved quality control (e.g. filter techniques)

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Advantages of Nowcasting

- Very high spatial and temporal resolution
- High update frequency
- Optimal assessments of any combination of available input parameters
- Low computational costs
- Many parameters: RR, T2M, TG, TD, ff, gusts, GLOB, …
- Nowcasting products in standard output format (e.g. Grib) for further processing
- Large community of users

- Potential for further adaptation / development and generation of advanced products
- Active development
- Wide range of applications: e.g. energy providers, civil protection, hydrology

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Final remarks

Many of the nowcasting systems use NWP information indirectly:

- Observation of analysis and nowcast products
- Blending
- Nowcast including advection, initiation, growth and decay of convection
- Ensemble Nowcasting

However, through the progress in NWP in the last years (e.g. advanced data assimilation techniques, comprehensive model physics and cloud resolving model, assimilation of very dense observations in time and space like radar, GPS etc.) there might also be an intensified direct use of NWP in Nowcasting in the future (e.g. like in UK, Denmark).