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Overview and recent developments of the nowcasting system INCA in Belgium (INCA-BE)

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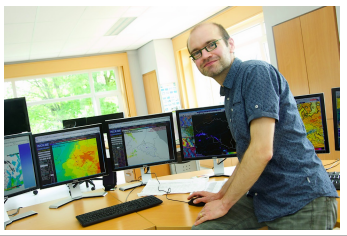

1 INCA main features

- Integrated Nowcasting through Comprehensive Analysis
- Developed by the national meteorological institute of Austria (ZAMG)
- Nowcasting system for the following meteorological fields:

1. **Basic**
   Fields: 2m temperature, 10m wind, 2m dewpoint, 2m relative humidity, snowfall level, freezing level, wind chill and ground temperature
   Forecast: up to +12h, time step of 1 hour
   Update: twice an hour
2. **Precipitation + lightning**
   Fields: precipitation intensity, precipitation type and lightning activity
   Forecast: up to +4h, time step of 10 minutes
   Update: every 10 min
3. **Convection**
   Fields: CAPE, CIN, LCL, Level of free convection, Lifted Index, Showalter Index, Deep Convection Index, Trigger temperature, Trigger temperature deficit, Equivalent Potential Temperature, Moisture convergence, Flow divergence and Precipitable water
   Forecast: no forecast, only analysis (hourly)
   Update: twice an hour
4. **Cloudiness**
   Fields: cloudiness and visibility
   Forecast: no forecast, only analysis (every 10 min)
   Update: every 10 min

- Spatial resolution: 1km
- INCA combines observations and NWP: the INCA forecast starts with an extrapolation of observations, and converges to the NWP forecast for longer lead times
- For a full description of INCA see Haiden et al., 2011, *Wea. Forecasting*, **26**, 166–183

2 INCA in Europe

- More and more European countries have implemented (or are implementing) INCA as their operational nowcasting system, including Slovakia, Slovenia, Croatia, Poland, Switzerland, Czech Republic, Italy (region Friuli-Venezia Giulia), Turkey, and Israel.
- INCA-CE: recently ended European project (from 05.2010 till 09.2013) with 16 partners to develop a transnational INCA version for Central Europe; see project website http://www.inca-ce.eu and Kann et al., 2012, *Adv. Sci. Res.*, **8**, 67–75

3 INCA in Belgium: INCA-BE

General

- Domain is 600×590 km (601×591 gridpoints) centered around Belgium (**Fig. 1**)
- Runs on an operational Linux machine (Ubuntu 12.04 LTS) in a virtual environment
- Graphical output is presented on a dedicated webportal (see **Sect. 5**). Binary output is sent to selected clients e.g. regional hydrological services and Belgocontrol

Input

- NWP: ALARO-0 4km (=ALADIN adapted for high resolution), 4 runs per day
- Surface stations: for Basic fields 30 stations inside Belgium available within 10 min and ∼120 foreign synop stations within INCA-BE domain available after ∼25 min; for Precipitation fields 89 and 39 near real-time gauges from hydrological services of Walloon and Flemish region respectively
- Radars: real-time composite of 4 C-band radars Wideumont (RMI), Jabbeke (RMI), Zaventem (Belgocontrol) and Avesnois (Météo-France) with a 5 min time sampling
- Lightning: data from the Belgian Lightning Location System (BELLS, **Fig. 1** and **2**) which is a total lightning location network with time-of-arrival technique
- Webcams: RMI network of 10 HD weather cameras and 3 snowcams

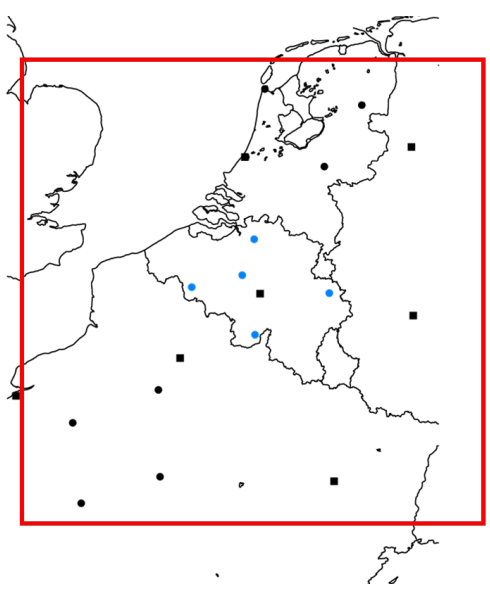

Fig. 1. Red square: INCA-BE domain; dots: lightning sensors attached to the BELLS network.

Fig. 2. Lightning sensor

4 Lightning activity forecast

- Introduction of a “Lightning Activity” (LA) field which is defined as follows: for each INCA-BE gridbox, LA is 1 if at least one lightning was observed (intracloud or cloud-to-ground) in the time interval [t-10min,t]; and 0 otherwise.
- Forecast: LA field is advected along with the precipitation. At each advection step, the field is renormalized by setting all values greater than 0.0001 to 1, and 0 elsewhere.
- Interpretation: the LA field is not intended to be a deterministic field, but has to be interpreted as a *risk zone* where lightning potentially can occur.
- Visualisation: as a transparent purple overlay on the precipitation field (**Fig. 3**).

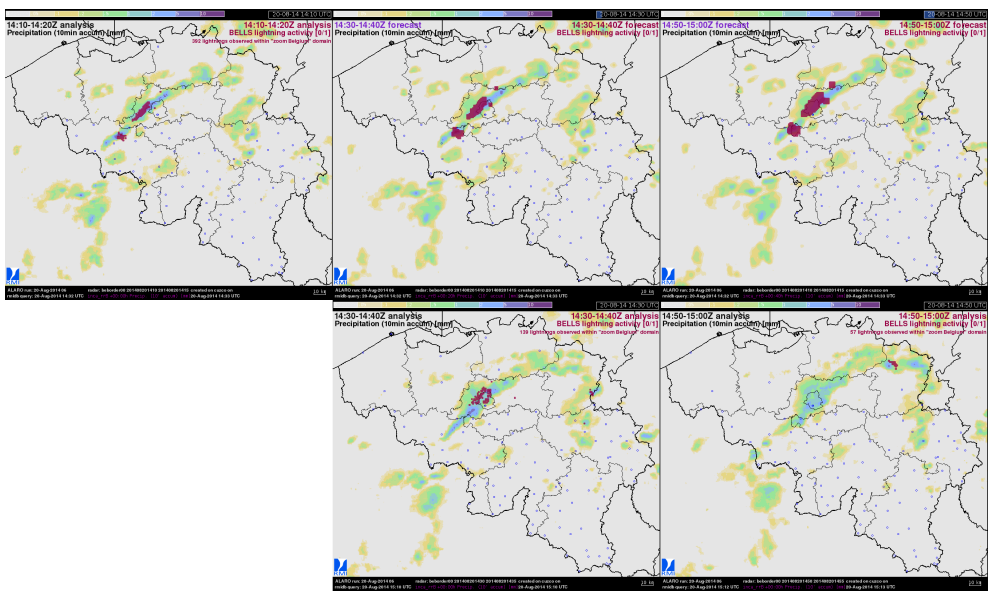

Fig. 3. INCA-BE precipitation and lightning forecast (upper row) and corresponding verification images (lower row) for T+20’ and T+40’ for a convective situation on 20.08.2014. For this particular situation, the lightning forecast has some predictive value up to T+20’, but then rapidly looses skill since the electric activity in the main cell vanishes around 14:40UT.

5 INCA-BE webportal

- Dedicated INCA-BE webportal on the intranet (**Fig. 4**), with a limited access from outside (e.g. for MeteoLux).
- Includes a field browser, time browser, contour plotting, zoom on Belgium, overlays for georeference (highways, rivers, towns), time animation control
- Possibility of generating meteograms for ∼400 predefined places (towns, synop stations, gauge stations, nuclear sites and ongoing outdoor events)
- The range of the radar composite is added as a mask to the precipitation images. The mask is advected along with the precipitation, indicating to what extent the precipitation forecast is reliable for a certain location.
- Latest novelty on the webportal is the integration of the RMI weathercam images to better assess the actual conditions at the station locations.

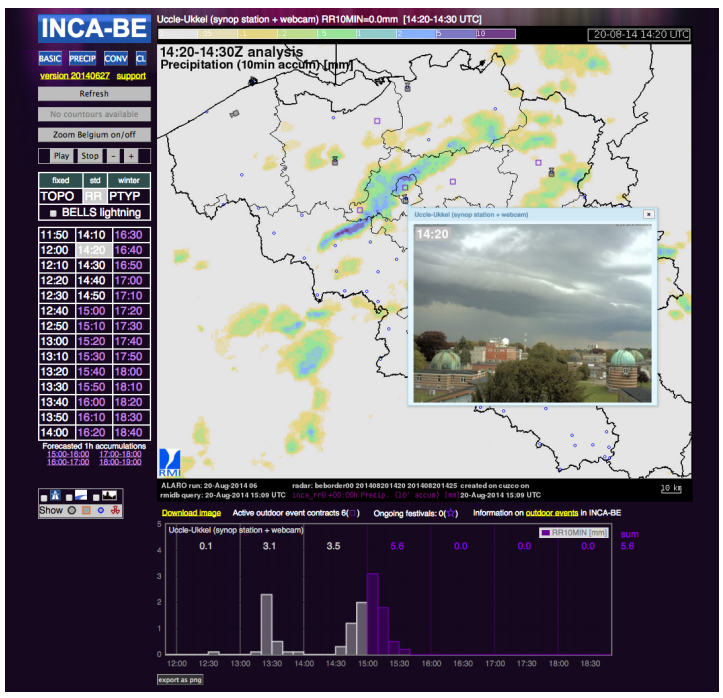

Fig. 4. The INCA-BE webportal. In the time browser on the left and in the meteograms, the analysis is shown in white, while the forecast is marked in purple. The webcam symbols are oriented corresponding to their real orientation.

6 Conclusion

INCA-BE has reached a mature level of implementation at the Royal Meteorological Institute of Belgium: the system runs on an operational machine and a dedicated webportal is developed to present its output. Several features were added compared to the original INCA version of ZAMG. A lightning forecasting module was developed and added to the operational version. Other new features include the addition of the outdoor event locations in Belgium and the images of the weather camera network. These all contribute to a better nowcasting, especially in case of severe (summer) convection.

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