Implementation and first evaluation of the nowcasting system INCA in Belgium (INCA-BE)

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I. INTRODUCTION

The improvement of the forecasts for short lead-times (nowcasts), including the dissemination of accurate warnings in case of severe events, is one of the key projects of the Royal Meteorological Institute of Belgium (RMI) for the coming years. More and more end-users are interested in accurate and precise (locally and timely) short-term predictions, but currently the RMI cannot fully satisfy this demand since there is no dedicated system producing these nowcasts. In the beginning of 2010, the RMI started the implementation of the INCA system in Belgium: INCA-BE. INCA (Integrated Nowcasting through Comprehensive Analysis, see Haiden et al. 2011 for a comprehensive description) is a nowcasting system that has been developed at the meteorological service of Austria (ZAMG), and it is actively maintained, updated and extended by the same institute.

More and more meteorological services in Europe have adopted INCA as their operational nowcasting system including Slovakia, Slovenia, Croatia and Poland. Recently, an ambitious European program with 16 partners has started to set up an INCA version for Central Europe: INCA-CE. INCA-CE will be a transnational weather information system using state-of-the-art nowcasting, which will allow an improved prediction of severe situations like heavy rainfall and associated flooding risks. In this contribution, we concentrate on the current status of the implementation of INCA in Belgium.

II. OVERVIEW

The INCA-BE covers a domain of 600×590 km with 1 km resolution (601×591 gridpoints), and with a “Belgian Lambert 2008” projection (EPSG 3812). The INCA-BE domain does not cover only Belgium, but also Luxembourg, the Netherlands (almost completely), the north of France, a large part of western Germany and the southeast coast of the U.K. Also note that a significant part of the domain consists of a water surface (the North Sea and the Channel). The full INCA-BE domain is shown in Fig. 1.

INCA-BE calculates analyses and nowcasts of several meteorological fields: temperature (3d), humidity (3d), wind (3d), precipitation (2d), precipitation type (2d), cloudiness (2d) and global radiation (2d). In addition, also some derived fields are computed, like snowfall line, wind chill and icing potential. There is also a module which performs a convective analysis producing 13 fields to assess the atmospheric stability. An overview of all the INCA-BE modules and their current implementation status is given in Table I.

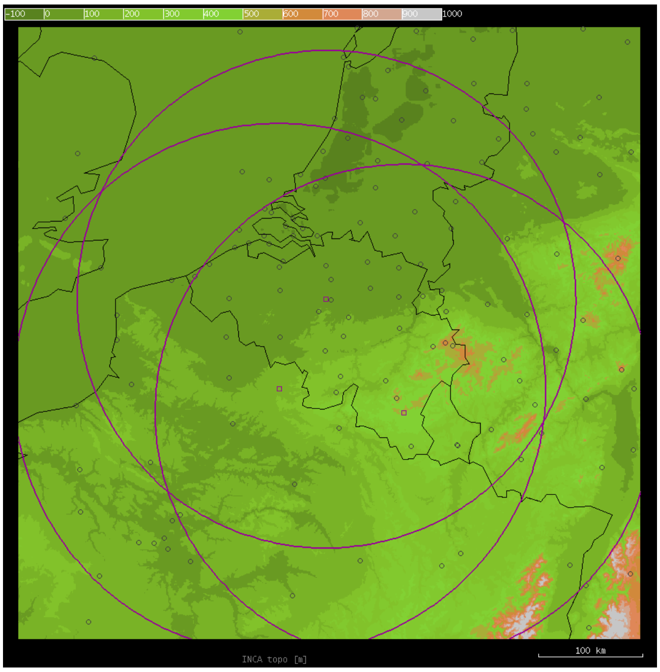

FIG. 1: The full INCA-BE domain (600×590 km). Superimposed are the positions of the radars and their ranges (purple squares and circles) of which the composite is ingested into INCA-BE, and the surface stations (small circles).

III. INPUT DATA

A. NWP output: ALARO 4km

Table I shows that NWP data are a crucial input source for all modules in INCA. For the three-dimensional INCA analyses of temperature, humidity and wind, NWP forecast fields provide the first guess on which corrections based on observations are superimposed. For the 2d precipitation forecast, NWP wind fields are indispensable in the process of producing the motion vector field. The NWP that is used in INCA-BE is the limited area model ALARO (Deckmyn et al., 2010) which runs operationally at the RMI. ALARO is a version of ALADIN with a new physics package so that it is suitable for higher resolutions. The NWP fields are 1-hourly, at a resolution of 4 km, with 46 levels in the vertical. Four ALARO forecast runs per day are performed (00Z, 06Z, 12Z, 18Z) and are integrated to +36 h. Post-processed fields are available roughly 4 hours after analysis time. The ALARO forecast fields used in INCA are geopotential, temperature, relative humidity, u-, v-, w- wind components (3-d fields), 2m temperature and relative humidity, u-, v- 10m-wind compo-

Module	Time res.	F. range	Input data	Output fields	Status
NWP2INCA	1 h	36 h	ALARO gribs	NWP on INCA-BE grid	F
INCA_TQ	1 h	12 h	stations, NWP	2m Temperature, 2m Dewpoint, 2m Relative Humidity, Snowfall level, Freezing level	F
INCA_UV	1 h	12 h	stations, NWP	10m Wind	F
INCA_TG	1 h	12 h	stations, NWP	Ground temperature	F
INCA_CH	1 h	12 h	stations, NWP	Wind chill	F
INCA_IC	1 h	12 h	stations, NWP	Icing potential	F
INCA_RR	10 min	4 h	stations, NWP, radar	Precipitation, Precipitation type	R
INCA_CO	1 h	0 h	stations, NWP	CAPE, CIN, LCL, Level of free convection, Lifted Index, Showalter Index, Deep Convection Index, Trigger temperature, Trigger temperature deficit, Equivalent Pot. temperature, Moisture convergence, Flow divergence, Precipitable water	F
INCA_SP	15 min	6 h	stations, NWP, SAF	Cloudiness	N

TABLE I: Overview of the INCA-BE implementation. The rightmost column indicates the current status (Aug. 2011) of the module: F(inished and running), R(unning but incomplete), N(ot yet running).

nents, precipitation, total cloudiness, low cloudiness, and surface temperature (2-d fields). The three-dimensional fields are provided on 15 pressure surfaces with a vertical resolution of 25 hPa up to 900 hPa, 50 hPa up to 700 hPa, and a resolution of 100 hPa above.

B. Surface station observations

Temperature, dewpoint, humidity and wind data are extracted from our surface station observations database every hour. This database contains data from several station networks. For the Belgian territory, these include not only our own AWS network consisting of 17 stations, but also the stations operated by Belgocontrol (the Belgian air safety authority) and the stations operated by the military. The total number of stations for which we have data available in near-real time is 30. For the neighbouring countries, the SYNOP stations are used. The delay of the latter data is somewhat larger, but generally we find that roughly 110 foreign stations inside the INCA domain are available within 25 min. Due to the time delay between the domestic and the foreign (synop) station, we decided to perform two independent INCA-BE runs of the hourly fields each hour. The first run is scheduled at T+16min, the second at T+42min. The first run provides a quick view on the passed hour mainly intended for nowcasting purposes, while the second run is based on a larger number of stations and hence provides more accurate analyses. Ground temperature data are available for 10 stations from our AWS network.

For the precipitation module, the ingestion of station data is far from complete (this explains the status ‘R’ for the INCA_RR module in Table I). The situation is different for this module since 10 minute data is required and standard synop stations do not provide such data. Our own AWS network does record 10 min data, but transfers them to our institute only once an hour. In the near future, the situation will improve by ingestion of the precipitation data from the gauge networks operated by the regional hydrological services.

C. Radar composite

At the RMI, we generate a near-real time composite of three C-band Doppler radars: our own radar in Wideumont (south of Belgium), the Belgocontrol radar at Brussels Airport (center of Belgium), and the Avesnois radar of Météo-France (north of France). The composite is available every five minutes, and the delay is roughly five to ten minutes. The coverage of the radars compared to the INCA-BE domain is shown in Fig. 1. Unfortunately, the composite radar domain does not fully cover the INCA-BE domain. This would be solved by adding the precipitation data of surface stations outside the radar domain or the ingestion of data from other radars inside the INCA-BE domain. This could be done by ingesting into INCA-BE (a part of) the European radar composite which is generated by Odyssey, the Eumetnet/OPERA Data Centre, see `www.knmi.nl/opera`.

D. Satellite products

The INCA Cloudiness analysis (INCA_SP, see Table I) is based on a combination of sunshine duration data from our AWS network and Cloud Types, a SAF product derived from MSG. The cloudiness module (so far the only INCA module using satellite data) is, however, not yet implemented for INCA-BE.

IV. OUTPUT EXAMPLE: PRECIPITATION

While still in the implementation phase, INCA-BE is not yet systematically verified, and hence at this point we cannot assess its performance in an objective way. Nevertheless, INCA-BE is already intensively tested by some internal users like our forecasters and climatologists. So far their evaluation is positive, but still a lot of work has to be done.

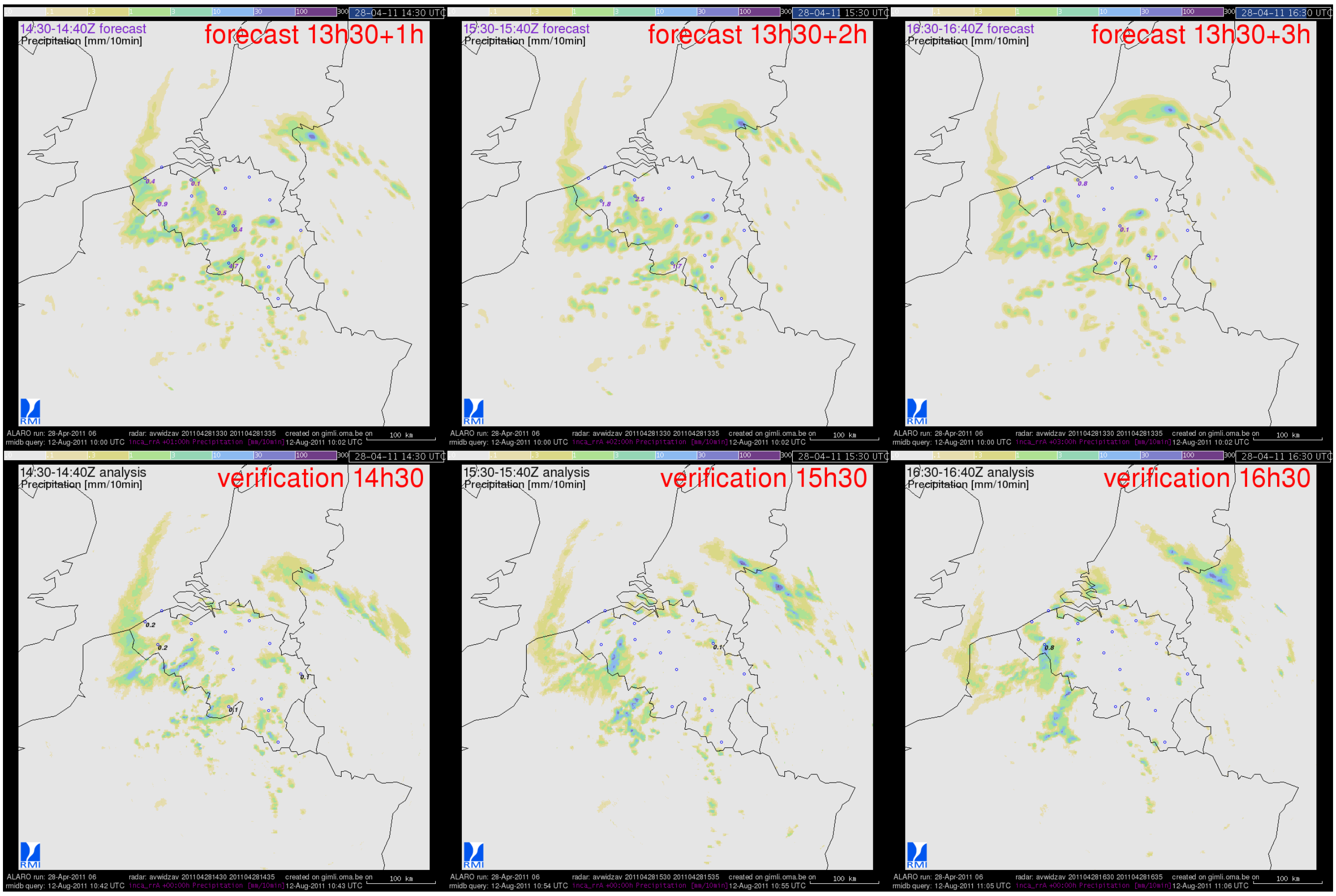

FIG. 2: INCA-BE precipitation forecasts generated at 13h30 UT on 28-Apr-2011 for +1h, +2h and +3h (top row) compared to the corresponding verification images (bottom row).

In a previous proceedings paper (Figs. 4 and 5 of Reyniers et al. 2010), we showed examples of the 2m temperature and the 10m wind forecasts of INCA-BE. Here we show some sample output of the precipitation routine. The case shown in Fig. 2 is a case with a clearly non-uniform velocity field. In the top row, images of the INCA-BE precipitation forecast are shown (for +1h, +2h and +3h) that were made at analysis time 13:30UT, while in the bottom row, the corresponding verification images are shown. For this particular case, a qualitative comparison between the images reveals that the INCA-BE precipitation forecast performs quite well up to +2h, and also the +3h has still some skill. Obviously, these statements have to be confirmed by appropriate verification techniques.

V. CONCLUSION

This contribution is intended as a progress report on the implementation of the nowcasting system INCA for Belgium, INCA-BE. The implementation is almost complete, except for the cloudiness module. INCA-BE is running in test phase for some months now and, although a thorough verification is not yet carried out, a qualitative evaluation of the available INCA-BE products by some internal users is very positive.

VI. ACKNOWLEDGMENTS

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VII. REFERENCES

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