Advances in Project IMA, the Seamless Prediction Programme of the Royal Meteorological Institute of Belgium

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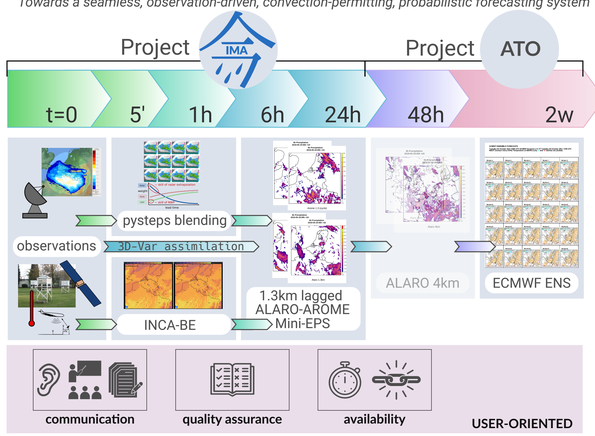
The seamless system at the Royal Meteorological Institute of Belgium



Seamless prediction

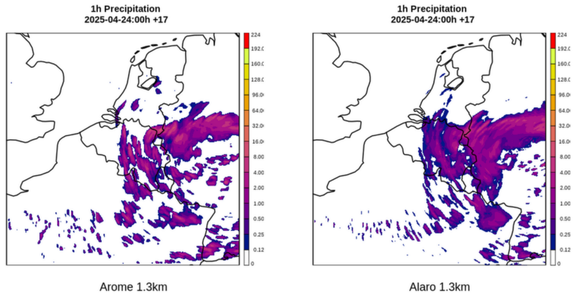
A seamless prediction system

- provides rapidly updating forecasts
- integrates the latest high-resolution observations
- covers timescales from minutes to days ahead
- optimizes forecast skill over this range
- combines nowcasting and high-resolution NWP.
- targets users such as the hydrological, renewable energy sector and the general public.

Other European systems: DWD's SINFONY; FMI's ULJAS, MetOffice's IMPROVER and Geosphere's SAPHIR [1].

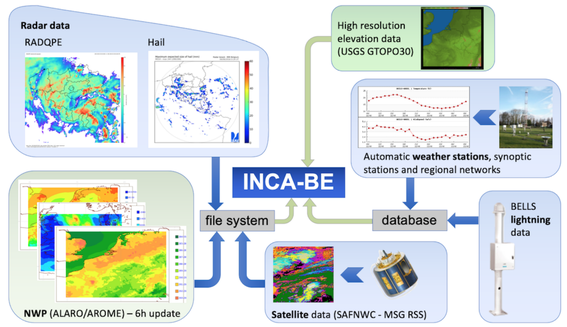
Mini-EPS of ALARO and AROME

- canonical configurations of the ACCORD Numerical Weather Prediction system
- different physics parametrization (scale-aware vs resolved convection)
- coupled to IFS (ECMWF)
- 4 runs/day (0, 6 , 12, 18 UTC)
- 3h data assimilation cycle (surface)
- +48h forecast range
- 45s timestep, 1.3 km horizontal resolution



Deterministic nowcasts: INCA-BE

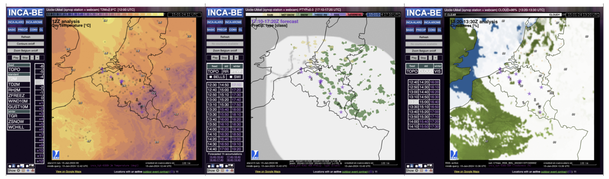
INCA = Integrated Nowcasting through Comprehensive Analysis



- Deterministic nowcasting system of several meteorological fields at 1km resolution: temperature, humidity, wind, cloudiness, but also precipitation, precipitation type
- Base code from GeoSphere, Austria
- Implemented at RMI since 2012 and heavily adapted/improved since then [5].

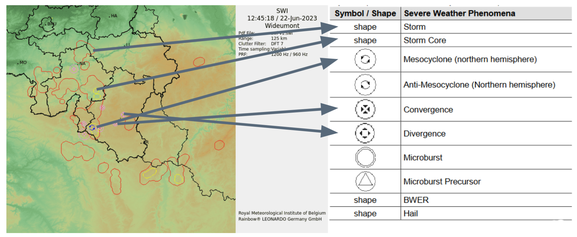
Two parallel versions, coupled to the Mini-EPS:

- INCA-ALARO and INCA-AROME



Severe weather index (M. Reyniers)

Starting point: radar-based severe weather contours and rotation detection.



Symbol / Shape	Severe Weather Phenomena
shape	Storm
shape	Storm Core
	Mesocyclone (northern hemisphere)
	Anti-Mesocyclone (Northern hemisphere)
	Convergence
	Divergence
	Microburst
	Microburst Precursor
shape	BWER
shape	Hail

Ensemble precipitation nowcasts: pySTEPS-BE

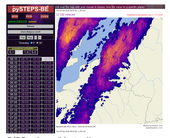
Built in the open-source nowcasting framework pysteps [3].

Input:

- Observations: RADQPE Belgian radar rainfall composite, 1km resolution, 5' frequency
- NWP: ALARO/AROME Mini-EPS at 1.3km, 5' accumulations

Output:

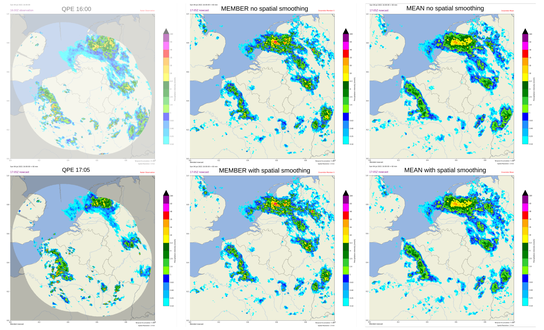
- 24-member ensemble every 10' (aim: 5')
- timestep of 5', +6 hours lead time
- using scale-dependent stochastic perturbations (STEPS [6])
- skill- and scale-dependent blending with NWP [2]



P(RR > 1mm/h) at +4h

New release: pysteps v1.17

- Performance enhancements in IO and ensemble statistics
- Improved default parameters such as the number of cascade levels
- Improved seamlessness: Enhanced spatial transitions between radar nowcasts and NWP fields.
- Advanced postprocessing: New procedure to blend extrapolation and NWP to better preserve high intensities.
- Improved plugin architecture for postprocessing plugins

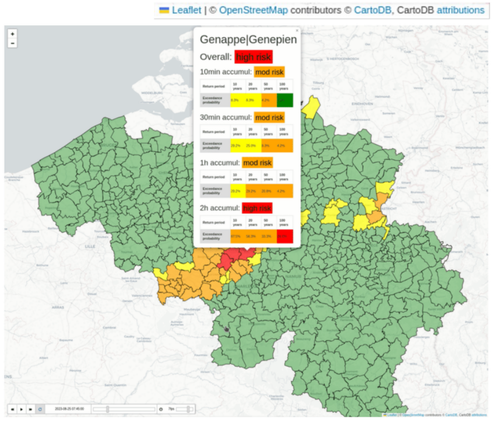


New plugins for pysteps

- Precipitation type based on INCA-BE temperature fields
- Deep learning-based nowcasting with DGMR (Deep Generative Model of Radar) [4]

PyRainWarn: Probabilistic microwarnings (F. Erdmann et al.)

- Commune-level return level exceedance probabilities based on pySTEPS-BE ensemble (warning from $n = 3$ pixels/commune)
- Return level method of Van de Vyver et al. (2012) with spatial covariate: mean annual rainfall



Research to Operations

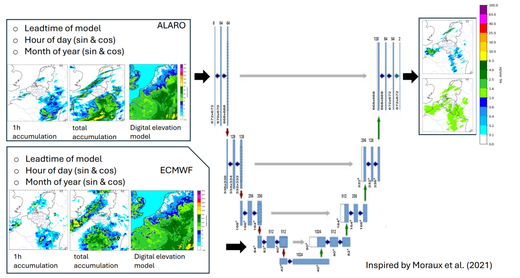
Deployed on operational infrastructure **docker containers**: isolated light-weight environments which encapsulate dependencies and configuration files.

Lessons learned:

- The devil is in the details: what seems to be 20% of the product takes 80% of the time
- The proof of the pudding is in the eating: moving to operations makes for better science.

Deep-learning based NWP-blending (De Kock et al.)

- Extension of the lead time from 6h to days/weeks ahead
- UNet architecture can ingest products of different resolutions



What's next

- Operational 3D-Var data assimilation of MODE-S, AMDAR, GNSS, radar observations
- 1-hourly cycling + Incremental Analysis Updates 3D-Var
- Advances in DL-based blending methods

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