Project IMA: Lessons Learned from Building the Belgian Operational Seamless Ensemble Prediction System

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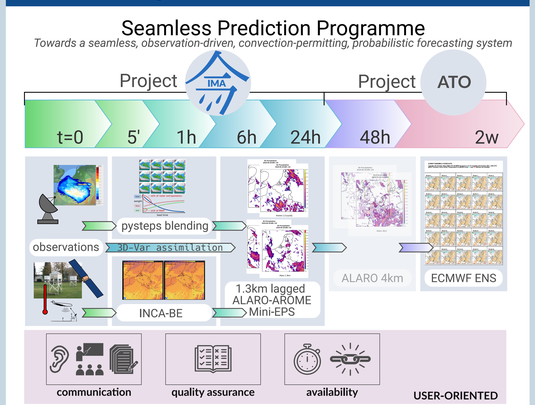
The seamless system at the Royal Meteorological Institute of Belgium



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].

Numerical weather prediction (NWP): ACCORD

Mini-EPS of ALARO and AROME

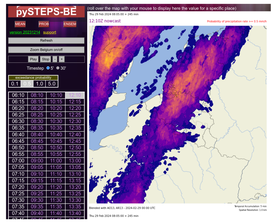
- different physics parametrization (scale-aware vs resolved convection)
- coupled to ARPEGE (MF) | IFS (ECMWF)
- 4 runs/day (0, 6 , 12, 18 UTC)
- 3h data assimilation cycle (AROME)
- +48h forecast range
- 45s timestep
- 1.3 km horizontal resolution

Ensemble Precipitation nowcasts: pySTEPS-BE

pySTEPS-BE set-up

Built in the open-source nowcasting framework pysteps.
Input:
- Observations: RADQPE Belgian radar rainfall composite, 1km resolution, 5' frequency
- NWP: ALARO/AROME Mini-EPS at 1.3km, 5' accumulations

Output:
- 48-member ensemble
- run every 10' (aim: 5')
- timestep of 5'
- up to +6 hours lead time
- using scale-dependent stochastic perturbations (STEPS [4])
- with a skill- and scale-dependent blending between with NWP [2]



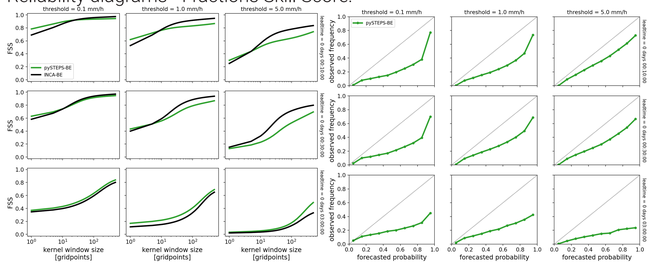
P(RR > 1mm/h) at +4h

Local adaptations

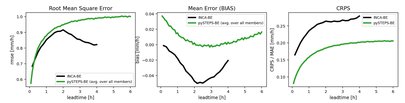
- Performance enhancements with MPI
- Optimizing number of cascade levels
- Scientific improvements to the blending procedure:
  - Better handling of no-rain cases
  - Solve loss in sharpness AND improve performance by advecting recomposed cascades

Probabilistic verification

Scores over 7 different multi-day rainy episodes 2021 - 2023.
Reliability diagrams - Fractions Skill Score:



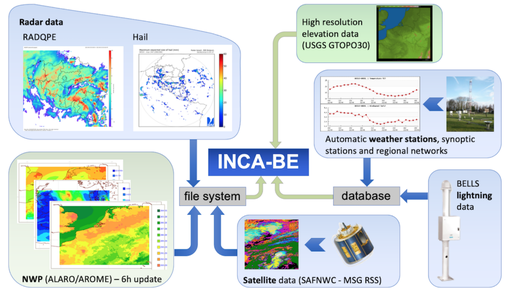
RMSE - Bias - CRPS:



Deterministic nowcasts: INCA-BE

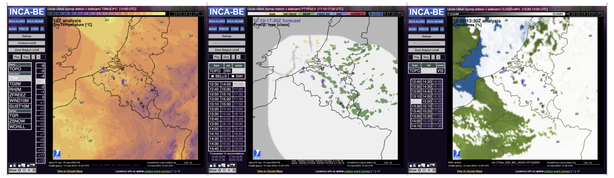
INCA-BE set-up

INCA = Integrated Nowcasting through Comprehensive Analysis



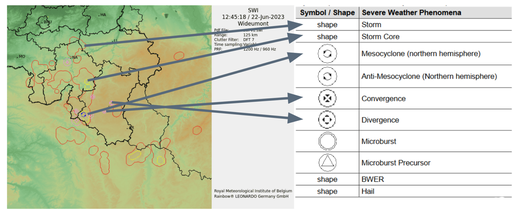
- Deterministic nowcasting system of several meteorological fields at 1km resolution:
  temperature, humidity, wind, cloudiness, but also precipitation, precipitation type
- Base code from GeoSphere, Austria
- Implemented at RMI since 2012 and heavily adapted/improved since then [3].

Two parallel versions, coupled to the Mini-EPS:
- INCA-ALARO and INCA-AROME



New developments: severe weather index

Starting point: radar-based severe weather contours and rotation detection (MC)



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.

What's next

- Testing DL-based QPE and blending methods (DERISC)
- Extension from 6h to 24h (and later to 2 weeks)
- Operational 3D-Var data assimilation of MODE-S, GNSS, radar observations
- 1-hourly cycling + Incremental Analysis Updates 3D-Var

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References

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