Project IMA

Seamless predictions at the Royal Meteorological Institute of Belgium

Lesley De Cruz[1,2], Michiel Van Ginderachter[1], Maarten Reyniers[1], Alex Deckmyn[1], Simon De Kock[1,2], Idir Dehmous[1], Wout Dewettinck[3], Felix Erdmann[1], Ruben Imhoff[4], Arthur Moraux[1,2], Ricardo Reinoso-Rondinel[1,5], Mats Veldhuizen[6], Joseph James Casey[1], Loic Faleu Kemajou[1], Anshul Kumar[1], Viktor Van Nieuwenhuize[1]

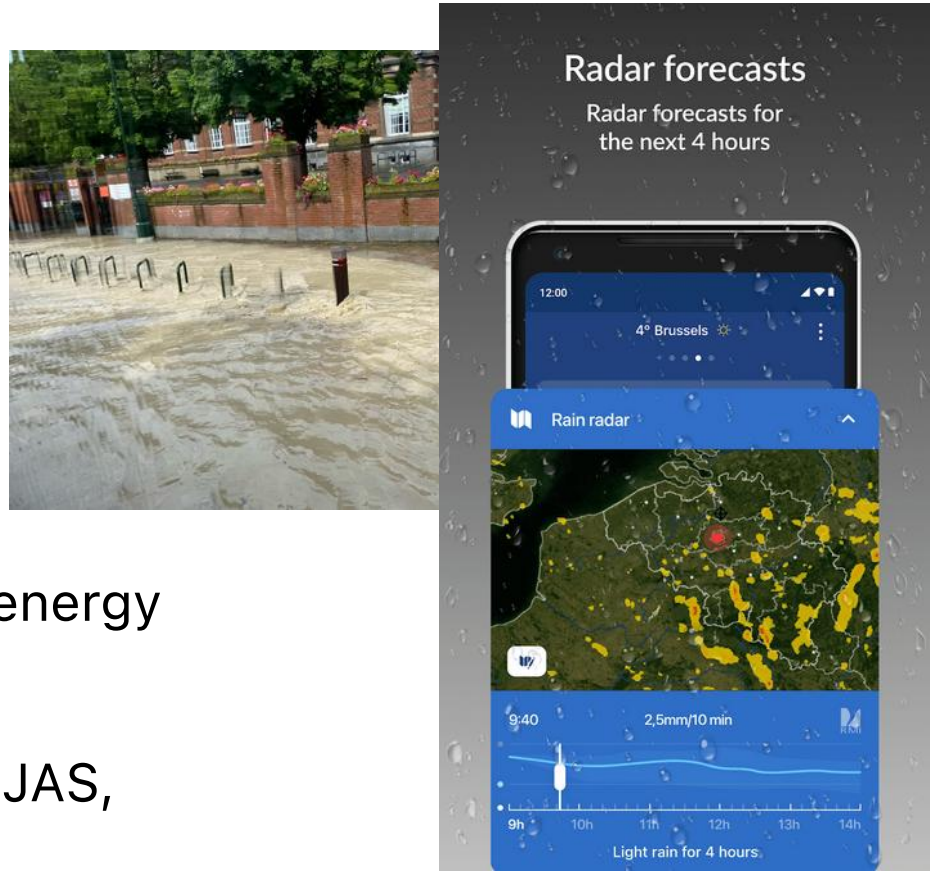
1 Royal Meteorological Institute, Brussels, Belgium
2 Electronics and Informatics (ETRO), Vrije Universiteit Brussel, Brussels, Belgium
3 Physics and Astronomy, Ghent University, Ghent, Belgium
4 Operational Water Management & Early Warning, Deltares, Delft, The Netherlands
5 Civil Engineering, Hydraulics & Geotechnics, KU Leuven, Leuven, Belgium
6 Royal Netherlands Meteorological Institute (KNMI), De Bilt, the Netherlands

Seamless Prediction Programme: Rationale

Need for rapidly updating forecasts which

- integrate the latest high-resolution **observations**
- cover timescales from **minutes** to **days** ahead
- optimize forecast **skill** over this range
- combine **nowcasting** and high-resolution **NWP**
- target users in (urban) **hydrology**, the renewable energy sector, and the general public.

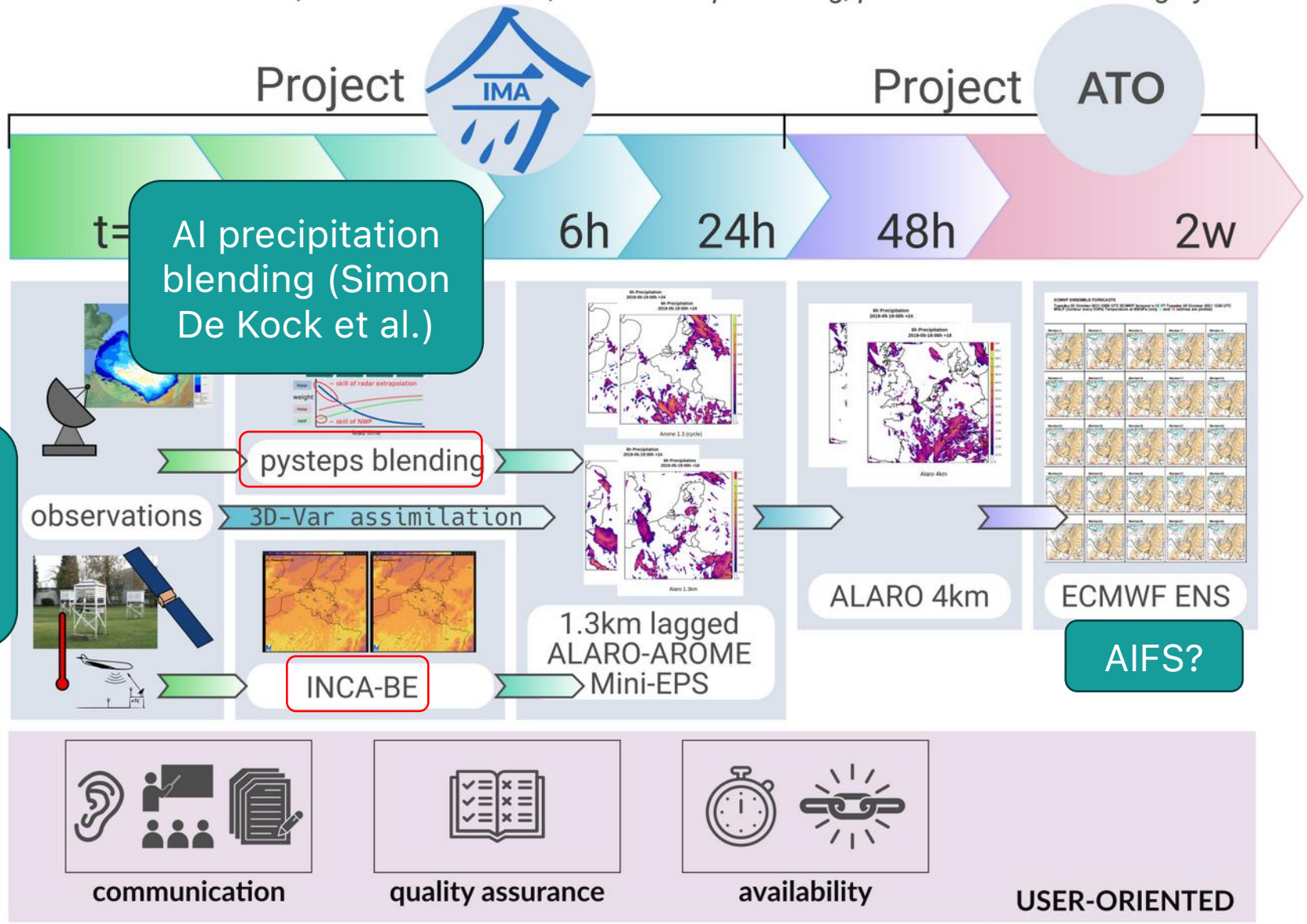
Other European systems: DWD's SINFONY; FMI's ULJAS, MetOffice's IMPROVER, ...



RMI Weather app on the Google Play Store

Seamless Prediction Programme

Towards a seamless, observation-driven, convection-permitting, probabilistic forecasting system



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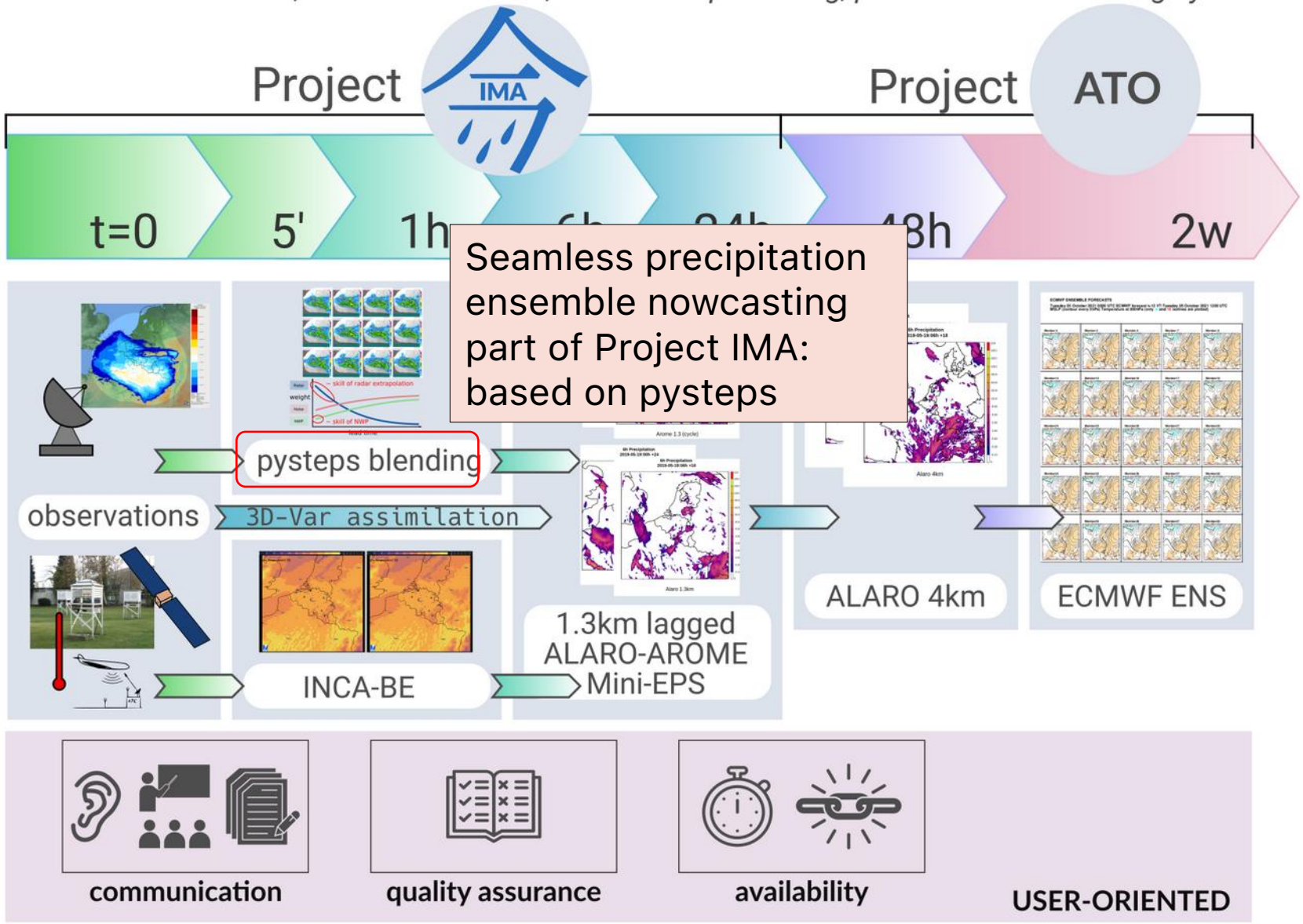


Bigger picture: the pysteps initiative

Community-driven free and open-source framework for precipitation nowcasting

Deterministic and probabilistic nowcasting, validation, visualization, …

Friendly and welcoming community at https://github.com/pysteps/pysteps

Reference publications

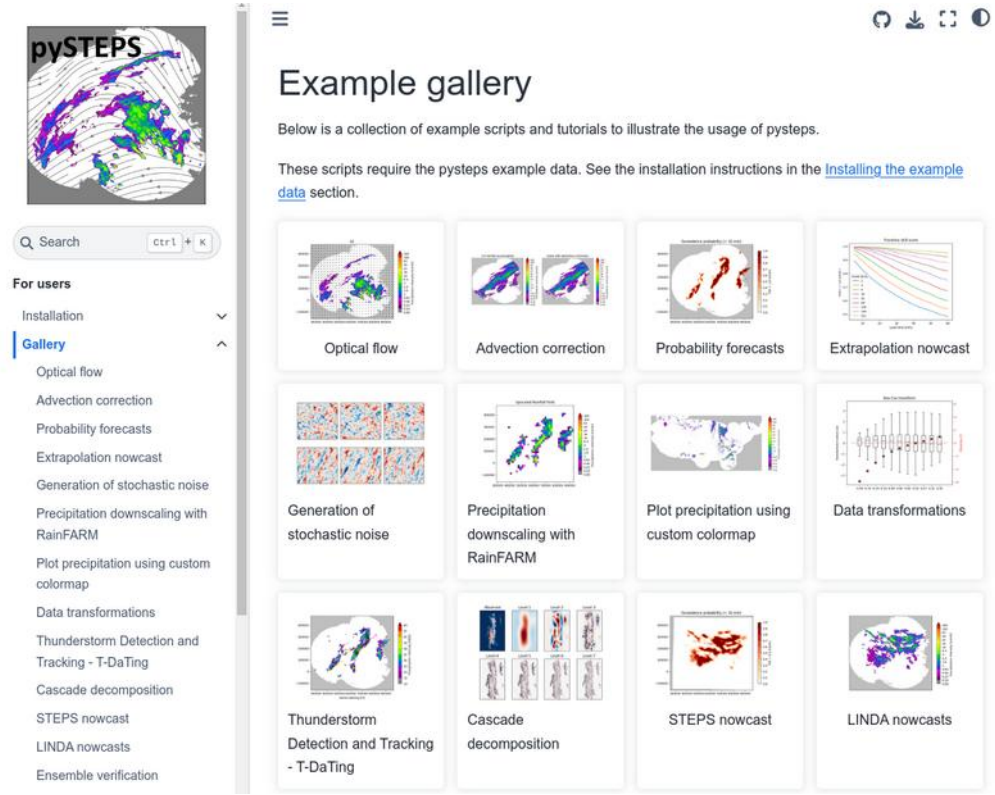
The overall library is described in

Pulkkinen, S., D. Nerini, A. Perez Hortal, C. Velasco-Forero, U. Germann, A. Seed, and L. Foresti, 2019: Pysteps: an open-source Python library for probabilistic precipitation nowcasting (v1.0). *Geosci. Model Dev.*, **12 (10)**, 4185–4219, doi:10.5194/gmd-12-4185-2019.

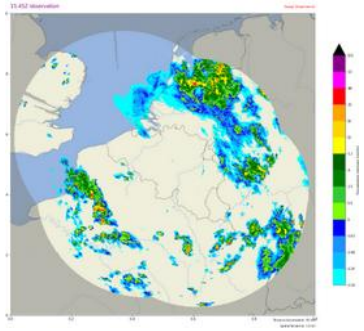
While the more recent blending module is described in

Imhoff, R.O., L. De Cruz, W. Dewettinck, C.C. Brauer, R. Uijlenhoet, K-J. van Heeringen, C. Velasco-Forero, D. Nerini, M. Van Ginderachter, and A.H. Weerts, 2023: Scale-dependent blending of ensemble rainfall nowcasts and NWP in the open-source pysteps library. *Q J R Meteorol Soc.*, 1-30, doi: 10.1002/qj.4461.

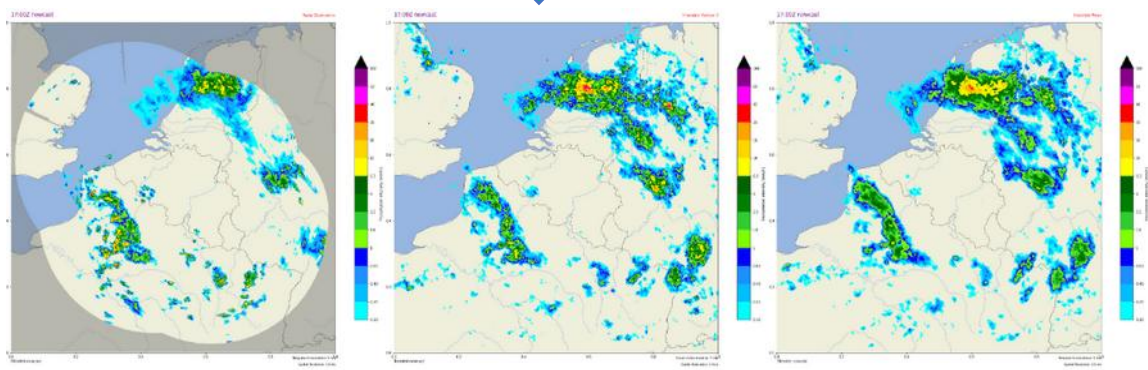
Contributors



Seamless ensemble precipitation nowcasts: "pysteps-be"



+ NWP



observation, random member, mean

Input:

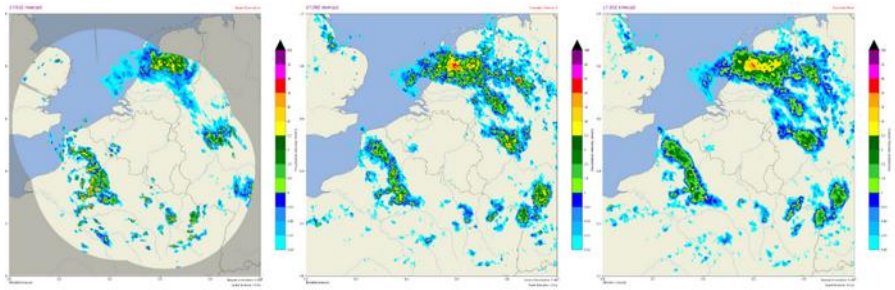
- **Observations**: RADQPE Belgian radar rainfall composite, 1km resolution, 5′ frequency. Rain gauge correction through mean field bias and external drift kriging. (Goudenhoofdt & Delobbe 2016; Journée et al. 2023)
- **NWP**: ALARO/AROME (lagged) mini-EPS at 1.3km, 45" aggregated to 5′ (Termonia et al., 2018)

Output:

- ~~48~~ 24-member ensemble
- goal: run every 5'
- timestep of 5′
- up to +6 hours lead time
- using scale-dependent stochastic perturbations (STEPS)
- with a **skill- and scale-dependent blending** (Imhoff et al. 2023)

Running in a docker container

Evolving open-source nowcasting for the future



pysteps keep improving, e.g. in the blending:

- Performance and maintainability improvements
- Better representation of extremes (probability matching)
- Spatial blending at the edge of the radar domain

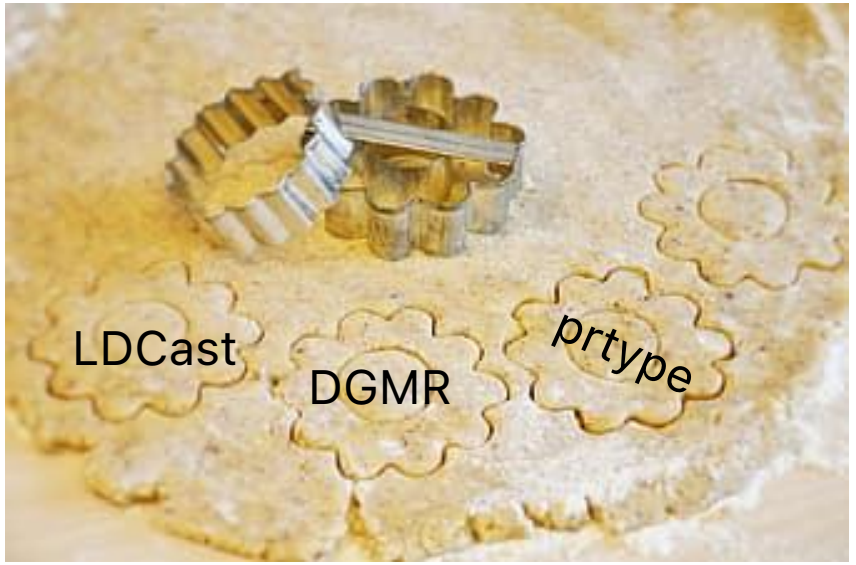
Interoperability between AI-based and "classical" nowcasting

- How to avoid reinventing the wheel?
- Conversation started in EUMETNET's E-AI WG6: nowcasting
- Integration of new AI methods in pysteps, through plugins

Welcome to integrate/interface your methods as plugins, check out:

- https://github.com/pySTEPS/cookiecutter-pysteps-plugin

(initiated by Andres Perez Hortal and extended by our colleagues)

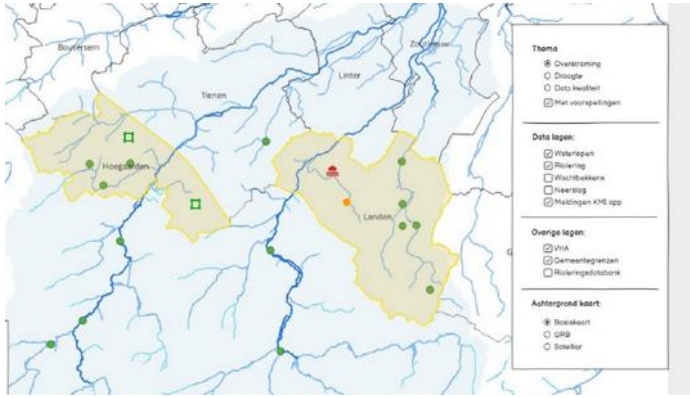


Applications (I): Waiter

Waiter

De digitale assistent voor slim waterbeheer

Tim Franken & colleagues, Sumaqua



Eigen sensoren

Overstroming Waak

Waterinfo

Meldingen burgers

Grondwater

KMI

Neerslag voorspellingen

Waiter

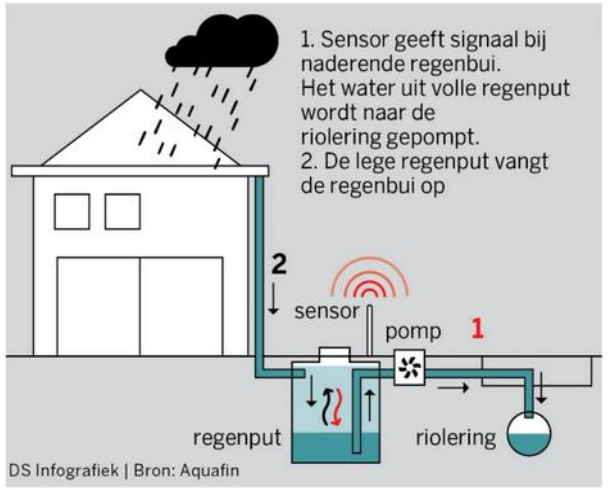
De digitale assistent die IoT-sensoren, AI, geavanceerde data-analyse en voorspellingsmodellen combineert om de stroom aan real time data om te vormen tot bruikbare inzichten.

Automatisatie
kwaliteitscontrole, data-analyse, alarmering, ...

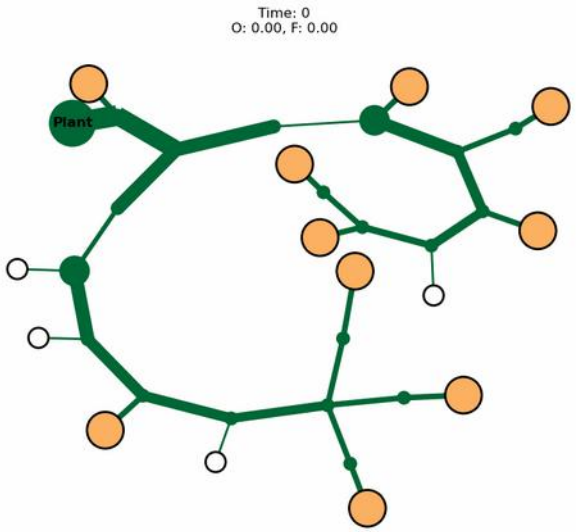
Opschaalbaar
sensoren toevoegen, deel data, eenvoud in gebruik

Nauwkeurig
Voorspellings-modellen voor droogte én wateroverlast

Applications (II): Aqtiput



ENTIRE STREET (CONTROLLED)



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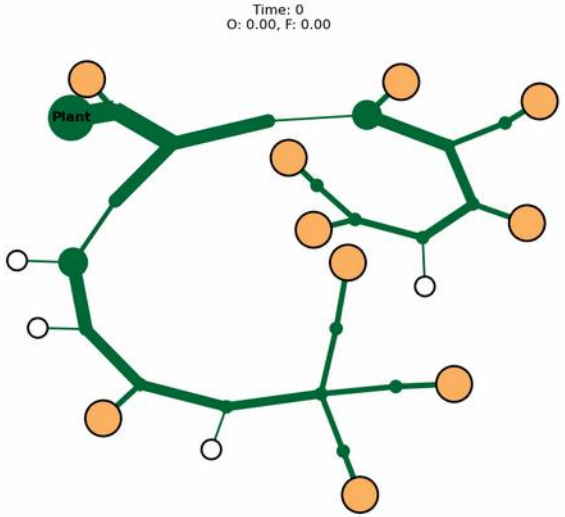


"Optimal coordinated control of private rainwater wells using ensemble rainfall forecast data" – final presentation
Mathematics for Industry study week challenge by Aquafin and RMI, 19-23 September 2023
https://be-maths-in.be/mfi23/wp-content/uploads/sites/27/2024/01/team_Aquafin_RMI-v2.pdf

Credits: Arne Bouillon, Guillaume Derval, Sheetal Jain, Thomas Lessinnes, Christian Mugisho Zagabe and Pieter Vanmechelen - supervisors: Geert Dirckx, Stefan Kroll & Lesley De Cruz

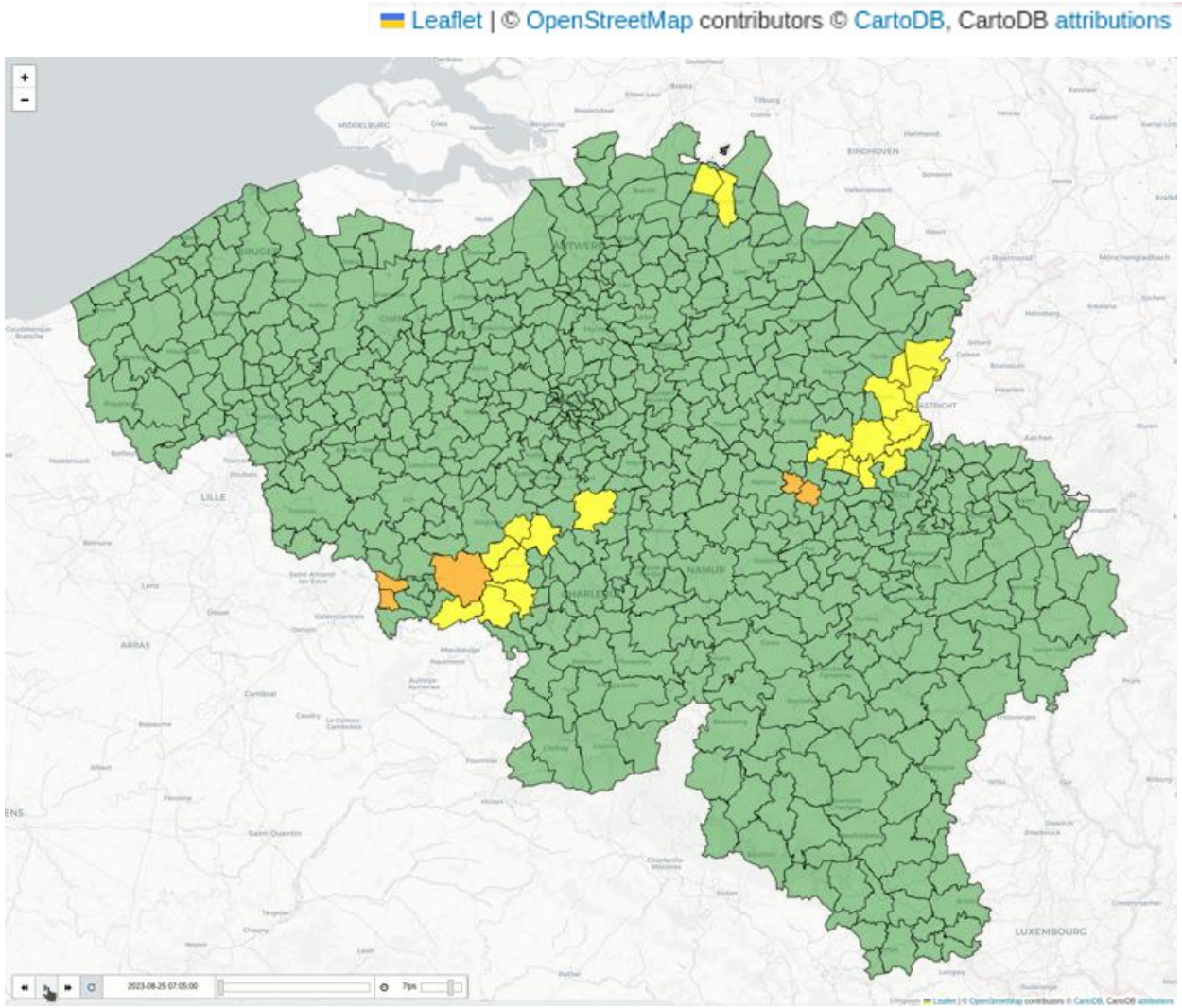
Applications (III): Rainfall warnings based on return level exceedance probabilities (*PyRainWarn*)

Credits: Felix Erdmann

Probability	10 years	20 years	50 years	100 years
100%	Medium	Medium	High	High
75%	Medium	Medium	High	High
50%	Low	Medium	Medium	High
25%	Low	Low	Medium	Medium

No risk

Return period



Pysteps hackathon 2025

- **Are you interested in joining the next pysteps hackathon in the Belgian Ardennes region?**
- **Mon 8 - Fri 12 September 2025**

Pysteps hackathon at RMI, 2024