CITIZEN WEATHER REPORTS AT RMIB AND THEIR USE FOR RADAR-BASED HAIL DETECTION VERIFICATION

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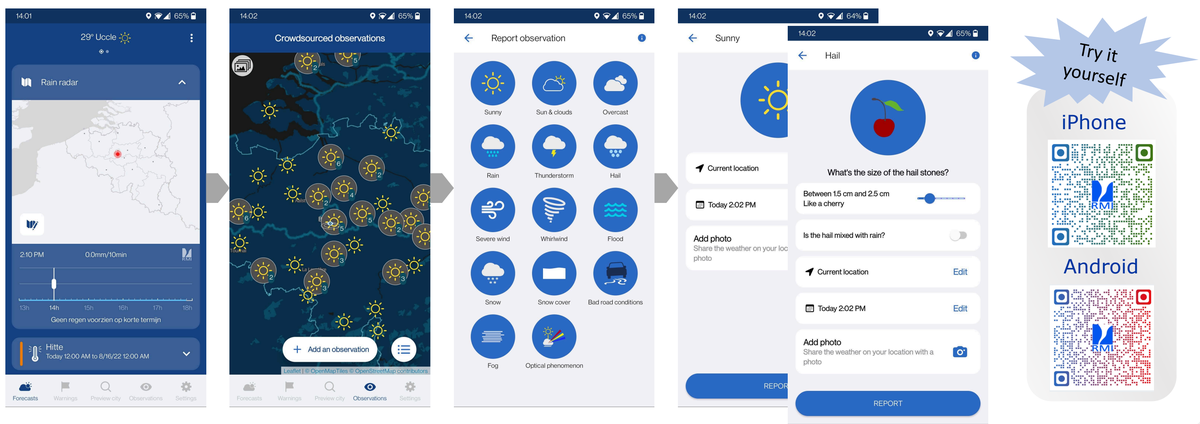
Summary

- RMIB's smartphone app is a **popular weather app** in Belgium (659k active users in July 2022)
- Since August 2019, users can send a geolocated **weather report**
- Observations **publicly available** in the app and on the WOW-platform (wow.meteo.be)
- **2,3 million observations** collected over a period of **three years**
- **Basic quality control** (plausibility check) is performed on every incoming observation
- **User reputation** mechanism while respecting GDPR regulations
- Current **use cases** of collected data at RMIB:
  - Evaluating the performance of radar-based hail detection (this poster)
  - Dual-pol based hydrometeor classification scheme (this poster + talk by S. Watelet)
  - Verification of the official weather warnings and the forecasts per commune
  - Verification of the fog and precipitation prediction of the Alaro-1.3 km NWP model
  - Experimental ML fog prediction algorithm

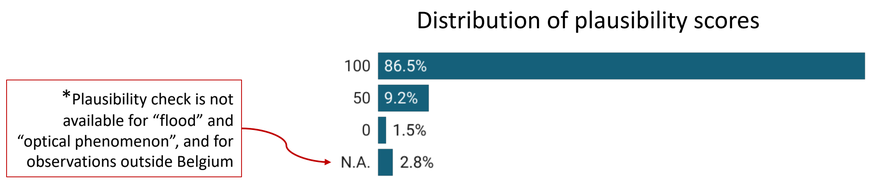
General concept

Users can send their weather observation with a few simple taps on the screen.

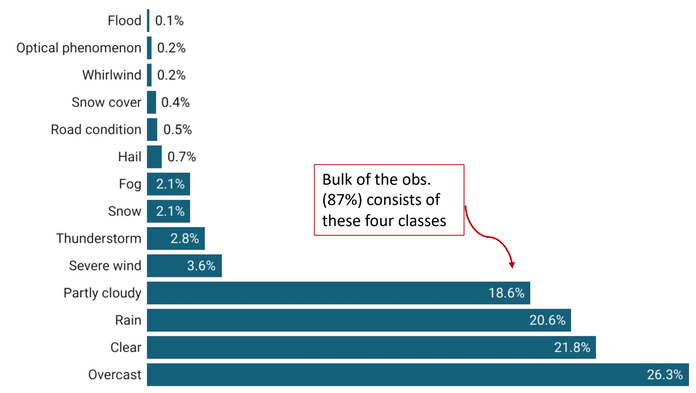


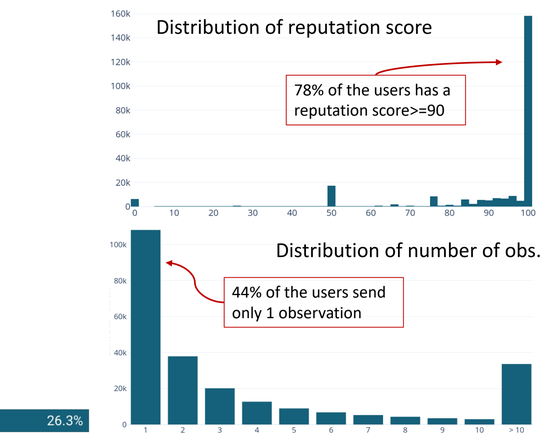
Plausibility check and user reputation

- A **plausibility score** is assigned to almost* every observation
- Scoring based on comparison with INCA-BE nowcasting system (Reyniers, 2021)
- Currently three possibilities:
  - *false* (score=0%),
  - *doubtful* (score=50%),
  - *plausible* (score=100%)
- **User reputation**: mean of plausibility scores of that particular user (more exactly: device-id)



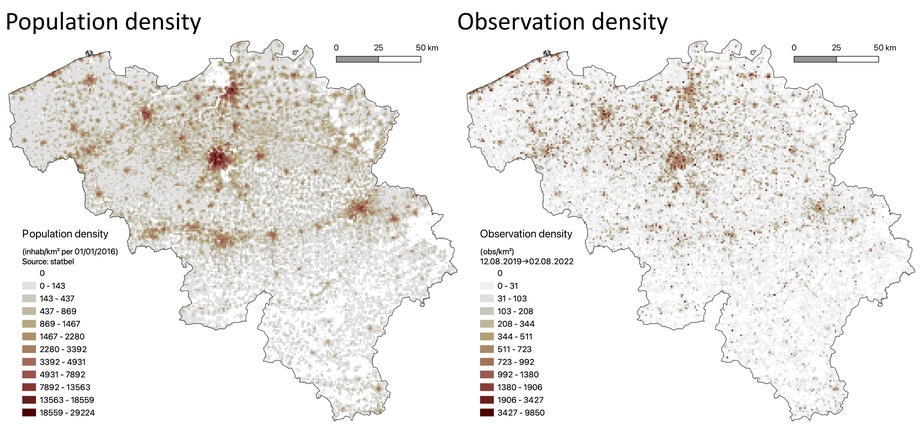
Some statistics

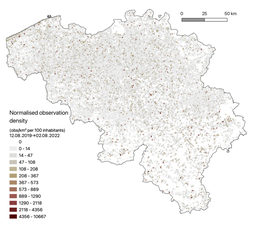




Human biases and possible corrections

[1] Strong population density bias: strong correlation between population density and spatial distribution of observations

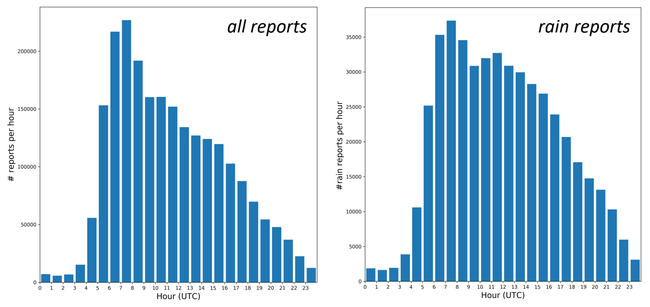




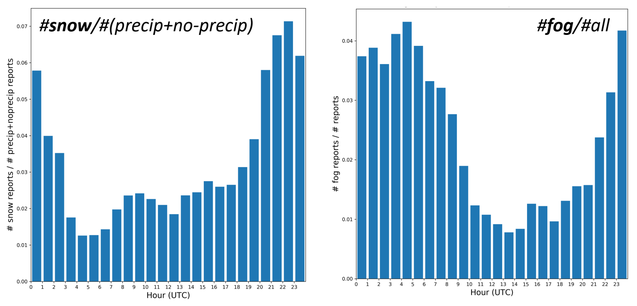
Elimination by dividing observation density by population density → no particular structure

Some hint for increased observation density along the coast though, which can have two reasons:
- temporal residents elsewhere domiciled and/or
- people at coast tend to send more observations.

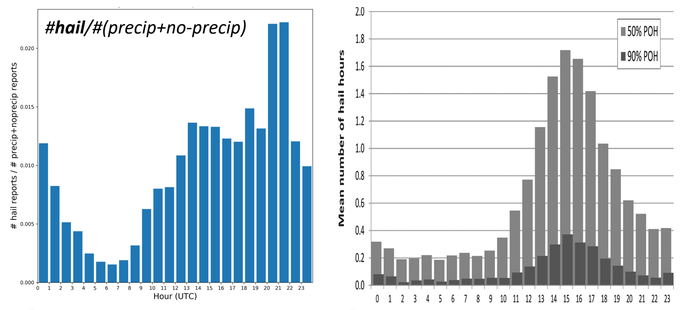
[2] Strong human-induced diurnal cycle



To obtain **intrinsic diurnal cycle** of specific meteorological phenomenon (and eliminate human one), one could:
- divide by all observations *(#all)*
- divide by *#(precip+no-precip)* observations



[2] diurnal cycle (cont'd)



Diurnal cycle of hail estimated from smartphone reports

Diurnal cycle of hail derived from radar by Lukach et al. (2017), for comparison

[3] Overrepresentation of events with more impact

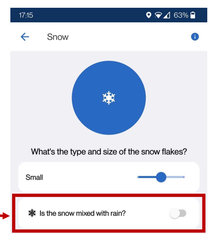
Some types will be **proportionally more reported than others**, for example hail more than rain.

E.g., #precip/#(precip+no-precip) = 0.26 = more than climatology (which is between 0.05 and 0.1)

[4] App design and default values influence reporting behaviour

No information on how users use the app.

E.g., do users take the effort to manipulate toggle for some observation types?



Use case 1: user observations as long-term dataset for evaluating the performance of an operational radar-based hail detection scheme

What?

- Waldvogel's hail detection algorithm using **single-pol data** (Echotop-45 dBZ) and **freezing level**
- Output = **probability of hail** (POH); see Lukach et al. (2017) for a detailed description

How?

- Choose **POH threshold** to convert probabilistic information **into YES/NO information** (here: 0% and 50%)
- Compare instantaneous radar-maps with observations: introduce **tolerance on time and location**
  - Max distance between radar obs. and report : 2.5 km
  - Max delay between radar obs. and report : 10 min

Results

Radar Jabbeke

Study period: May-Sept. 2020+2021

991 → 662

hail reports with plausibility > 90 % and size > 0.5 cm

at less than 150 km from radar

	Probability of detection (POD)		Probability of false detection (POFD)	
	Detection if probability > 0 %	Detection if probability > 50 %	Detection if probability > 0 %	Detection if probability > 50 %
	503 detected	390 detected	18536 hail detected (false positives)	6217 hail detected (false positives)
	159 missed	272 missed	105047 no hail (correct negatives)	117366 no hail (correct negatives)
	POD = 0.76	POD = 0.59	POFD = 0.15	POFD = 0.05

Radar Wideumont

Very similar results

POD = 0.74 (>0%)

POD = 0.65 (>50%)

PODF = 0.14 (>0%)

PODF = 0.06 (>50%)

123583 ← 158122

valid rain reports at less than 150 km

rain reports (no hail, no snow)

Use case 2: user observations as auxiliary data for the development and validation of a new dual-pol based hydrometeor classification scheme

What?

- New precipitation type product for RMIB in development

Input

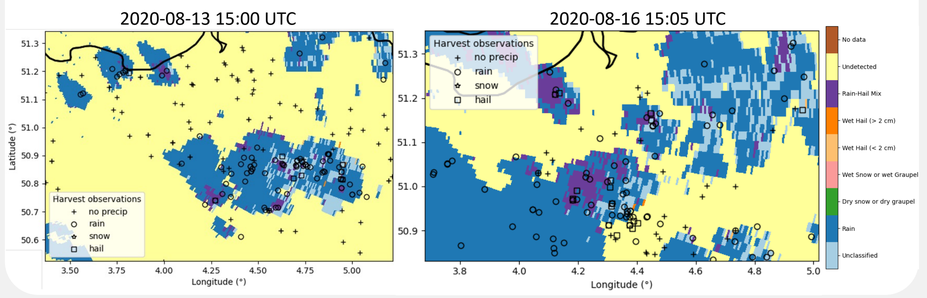
- Belgian dual-pol weather radars + NWP model Alaro

Algorithm

Combination of
- dual-pol scheme by Keenan (2003) developed at BOM
- melting scheme along the vertical from Steinert et al. (2021) at DWD

Examples

Instantaneous precipitation type product compared with observations received between 5 min before and 10 min after the product timestamp



Acknowledgements Joffrey Schmitz, Stéphane Dekeyzer, Emilie Delhaye

References Keenan (2003): Aust. Met. Mag. 52(1), 23-31 Lukach (2017): doi:10.1002/met.1623 Reyniers (2021): doi:10.5281/zenodo.5798952 Steinert (2021): doi:10.1175/WAF-D-20-0232.1