Webinar EUMETCAL: warning system RMI Belgium

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21/12/2023

Contents of webinar

- 1. Forecasting at RMI Belgium
- 2. Warnings
  - Some history
  - Now
    - Some statistics & verification results
    - Synergies
    - Examples + “warning” products
- 3. Flash warnings

1. Forecasting at RMI

- Ostend : Oceanografisch Meteorologisch Station (OMS)
  - Maritime forecasts

- Uccle (Brussels) : RMI main site
  - General forecasts
  - Warnings
  - 2 shifts:
    - Day (~7 - 18h) : nowcaster, short range forecaster, medium range forecaster
    - Night (~18 - 7h) : nowcaster, short range forecaster

2. Warnings: brief history

- First project proposal 28/12/2001 (“meteo alert”)
  - 10 regions (9 provinces + coastal zone)
  - 4 parameters: wind, thunder, rain, ice/snow
  - 3 levels: green, yellow and red
  - Internal proces

- Parallel development with EMMA (meteoalarm later on)
  - 4 levels (orange added)

Faxbericht - Message de fax	
From :	KMI-IRM
	Ringlaan 3 - Avenue Circulaire 3
	B - 1180 Brussel
Subject :	Waarschuwingen - Avertissements
Date :	16/12/2005 20H
Page :	1/3

Samenvatting - Résumé

Waarschuwing - Avertissement	Hoogste Waarschuwingsniveau Niveau d'avertissement maximum
Wind - Vent	Geel - Jaune
Neerslag - Pluie	Groen - Vert
Gladheid - Verglas	Oranje - Orange
Onweer - Orage	Groen - Vert

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From :	KMI-IRM
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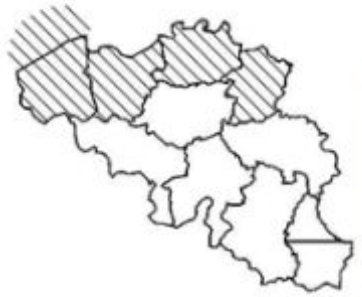
Subject :	Waarschuwingen - Avertissements
Date :	17/12/2005 07H until 18/12/2005 01H
Page :	2/3

Wind - Vent

French Text	Dutch Text
Des rafales jusqu'à 85 km/h le long du littoral. Demain, des rafales qui peuvent atteindre 90 km/h au littoral et 70 à 80 km/h dans le nord du pays.	Rukwinden tot 85 km/h aan de Kust. Morgen kunnen de windstoten aan de Kust oplopen tot 90 km/h en tot 70 à 80 km/h in het noorden van het land.



Zone	Waarschuwingsniveau Niveau - d'avertissement
Kust - Côte	Geel - Jaune
West-Vlaanderen	Geel - Jaune
Oost-Vlaanderen	Geel - Jaune
Antwerpen	Geel - Jaune
Limburg	Geel - Jaune
Brabant	Groen - Vert
Liège	Groen - Vert
Hainaut	Groen - Vert
Namur	Groen - Vert
Luxembourg	Groen - Vert
GD. Luxembourg Nord	Groen - Vert
GD. Luxembourg Sud	Groen - Vert

Faxbericht - Message de fax	
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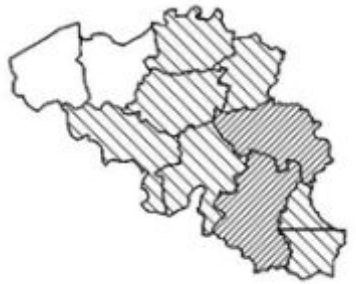
Date :	16/12/2005 21H until 18/12/2005 01H
Page :	3/3

Gladheid - Verglas

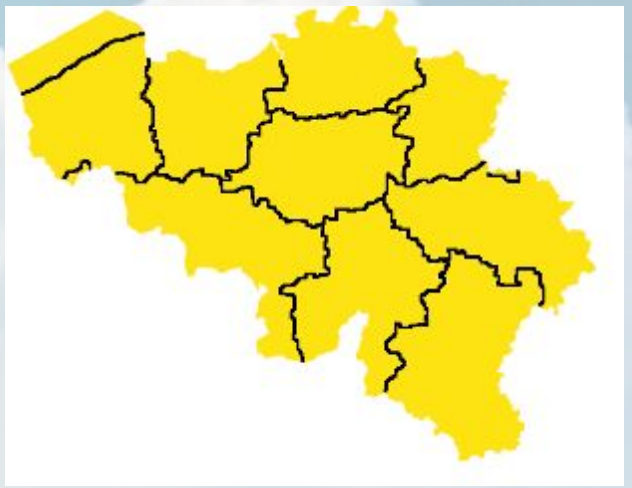
French Text	Dutch Text
A partir de ce soir, on prévoit des averses de pluie ou de neige fondante et de neige dans le sud du pays où une accumulation de plusieurs centimètres pourrait même se former. Demain, surtout à partir de l'après-midi, partout risque des averses de neige, sauf dans l'extrême ouest du pays.	Vanaf vanavond verwachten we buien van regen of smeltende sneeuw en sneeuw in het zuiden van het land. Daar kan er zich een sneeuwlaag vormen. Morgen vooral na de middag overal kans op enkele sneeuwbuien, behalve in het uiterste westen van het land.



Zone	Waarschuwingsniveau Niveau - d'avertissement
Kust - Côte	Groen - Vert
West-Vlaanderen	Groen - Vert
Oost-Vlaanderen	Groen - Vert
Antwerpen	Geel - Jaune
Limburg	Geel - Jaune
Brabant	Geel - Jaune
Liège	Oranje - Orange
Hainaut	Geel - Jaune
Namur	Geel - Jaune
Luxembourg	Oranje - Orange
GD. Luxembourg Nord	Geel - Jaune
GD. Luxembourg Sud	Geel - Jaune

2. Warnings: now

- 4 colors: green – yellow (max 48h in advance) – orange (max 24h in advance) – red (max 12h in advance)



- 10 fixed regions (coastal region + provinces (~3000 km²))
- Terminology:
  - very locally (< 25% of the area => no warning)
  - locally (25-50% of the area)
  - widespread (> 50% of the area)
- Consensus: about 65% certainty (of the available models if imminent, or aditionally with earlier runs if still far away)
  - If certainty is lower OR if phenomena are very local => lower color will be used
  - Borderline situations: sometimes time of day / day of week / other elements will determine the color

Parameters (8) :

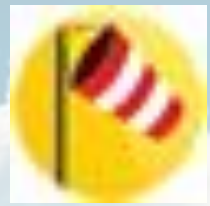
- Cold (5 days)
- Heat (5 days)
- Wind
- Rain
- Thunder
- Slippery conditions: black ice/freezing rain or wet snow; foar frost or freezing moisture; frozen surfaces (rain or other that will freeze later on)
- Fog (no red warning)
- Storm surge

2. Warnings now

- Based on thresholds (some fine-tuning along the way)

- No expertise / knowledge base on potential impacts, therefor we have:
  - Frequent contacts with regional hydrological services (rain/snow/...)
  - Frequent contacts with regional road agencies (road monitoring model) (snow/slippery conditions)
  - Regular contacts with federal health agency (heatwaves/coldwaves)
  - Offer a (paid) service to large outdoor events

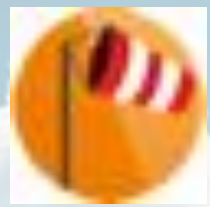
Yellow: 48h in advance



- “Be careful”
- Issued by forecaster
- Text will summarise the expected weather + mention if upscaling to orange/red is to be expected

	Thresholds
Rain	20-30 mm/h OR 20-40 mm/6h OR 25-50 mm/24h
Wind	70-90 km/h (summer) – 80-100 km/h (winter)
Thunder	Same as rain; locally heavy gusts; hail stones 1-2 cm
Ice/snow	1-5 cm fresh snow in 6h OR 5-10 cm fresh snow in 24h OR Local freezing precip/ice
Fog	Widespread vis <= 200 m OR Locally vis <= 50 m
Heat	Heat wave OR Tmax >= 32°C
Cold	Cold wave OR Tmax <= -3°C
Storm surge	5.6-6.2 m TAW (Ost) or 6.6-7.2 m TAW (Ant)

Orange: 24h in advance



- “Be ready”
- Issued by forecaster + contacts with diff. services
- Contacts with neighbouring countries (sometimes)
- Text will summarise the most likely weather + sometimes also diff. scenarios (worst case)

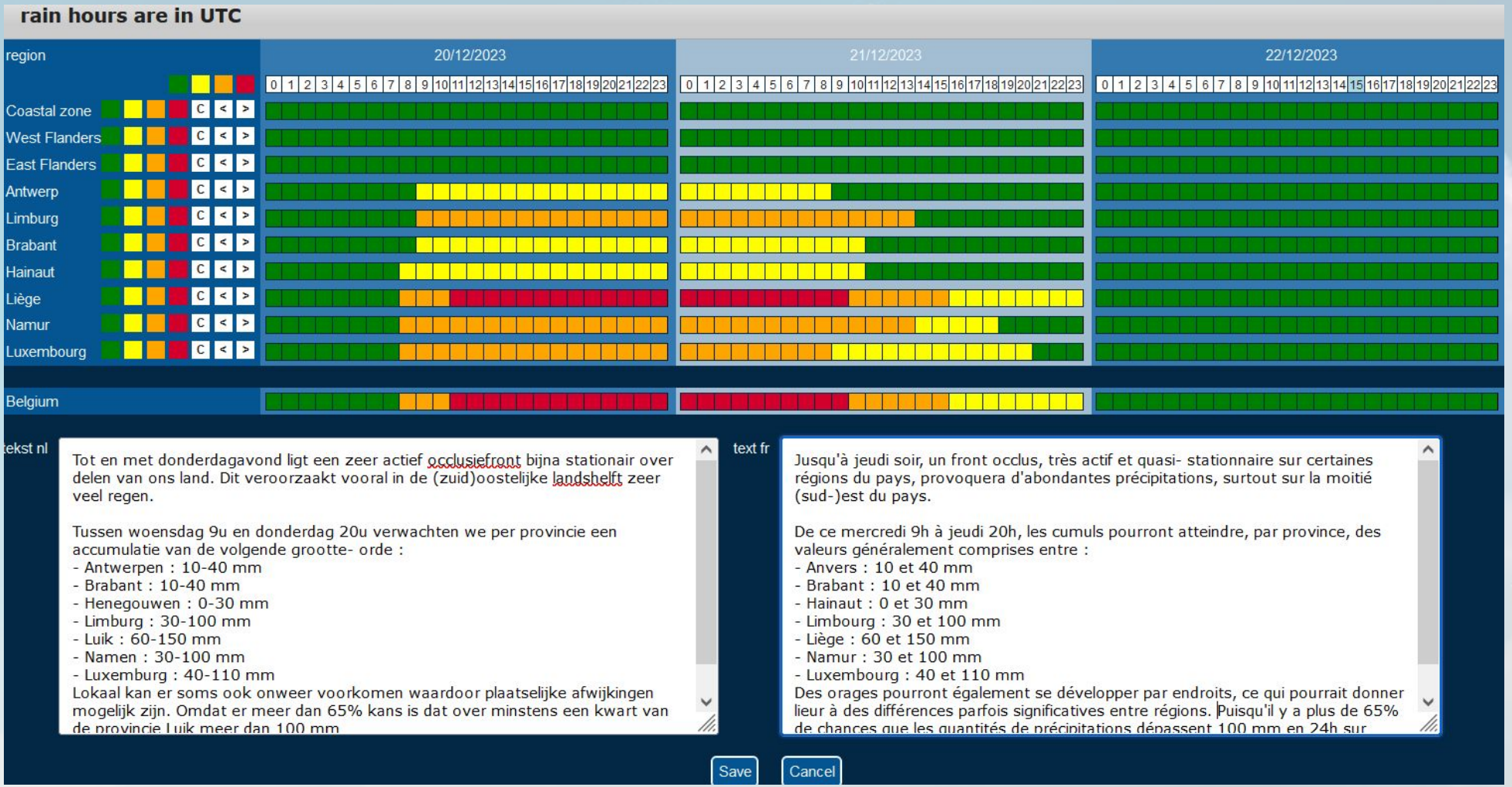
	Thresholds
Rain	31-50 mm/h OR 41-60 mm/6h OR 51-100 mm/24h
Wind	91-120 km/h (summer) – 101-130 km/h (winter)
Thunder	Same as rain; widespread heavy gusts; hail stones 3-5 cm
Ice/snow	3-5 cm fresh snow in 1h OR 6-10 cm fresh snow in 6h OR 11-25 cm fresh snow in 24h OR Widespread freezing precip/ice
Fog	Widespread vis <= 50 m
Heat	Heat wave AND Tmax(1D) >= 35°C OR Tmax(3D) >= 32°C
Cold	Cold wave AND Tmax(1D) < -5°C OR Tmax(3D) <= -3°C
Storm surge	6.21-6.5 m TAW (Ost) or 7.21-7.5 m TAW (Ant)

Red: 12h in advance

- “Take the necessary measures and strictly follow instructions”
- Issued by forecaster + chief
- Text will describe in detail the most likely weather + sometimes also diff. scenarios (worst case)

	Thresholds
Rain	>50 mm/h OR >60 mm/6h OR >100 mm/24h
Wind	>120 km/h (summer) – >130 km/h (winter)
Thunder	Same as rain; widespread severe gusts; hail stones >5 cm
Ice/snow	>5 cm fresh snow in 1h OR >10 cm fresh snow in 6h OR >25 cm fresh snow in 24h Widespread heavy freezing precip
Fog	(no code red)
Heat	Heat wave AND Tmax(1D) >= 40°C OR Tmax(3D) >= 35°C
Cold	Cold wave AND Tmax(1D) <= -10°C OR Tmax(3D) <= -5°C
Storm surge	> 6.5 m TAW (Ost) or > 7.5 m TAW (Ant)

2. Warnings: example warning interface

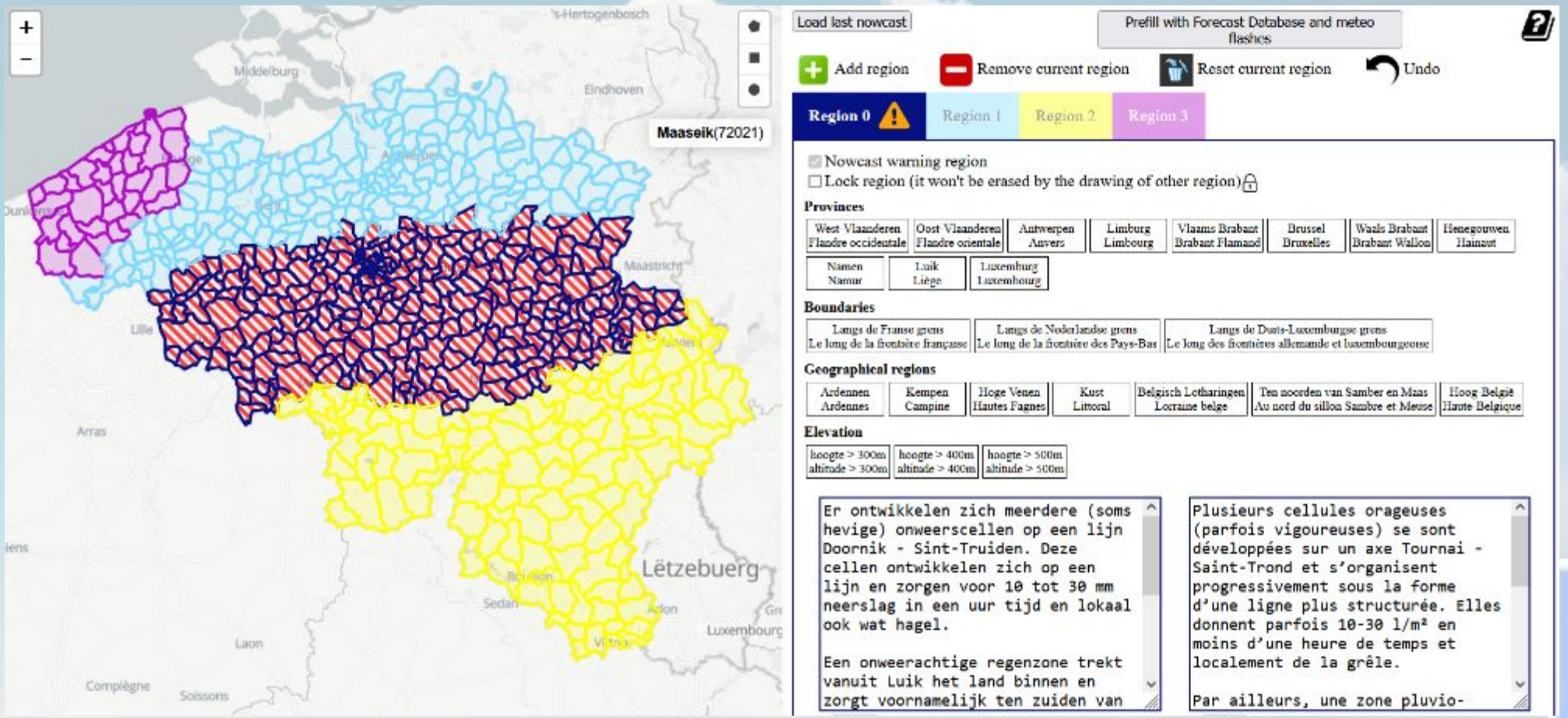


2. Nowcast warnings

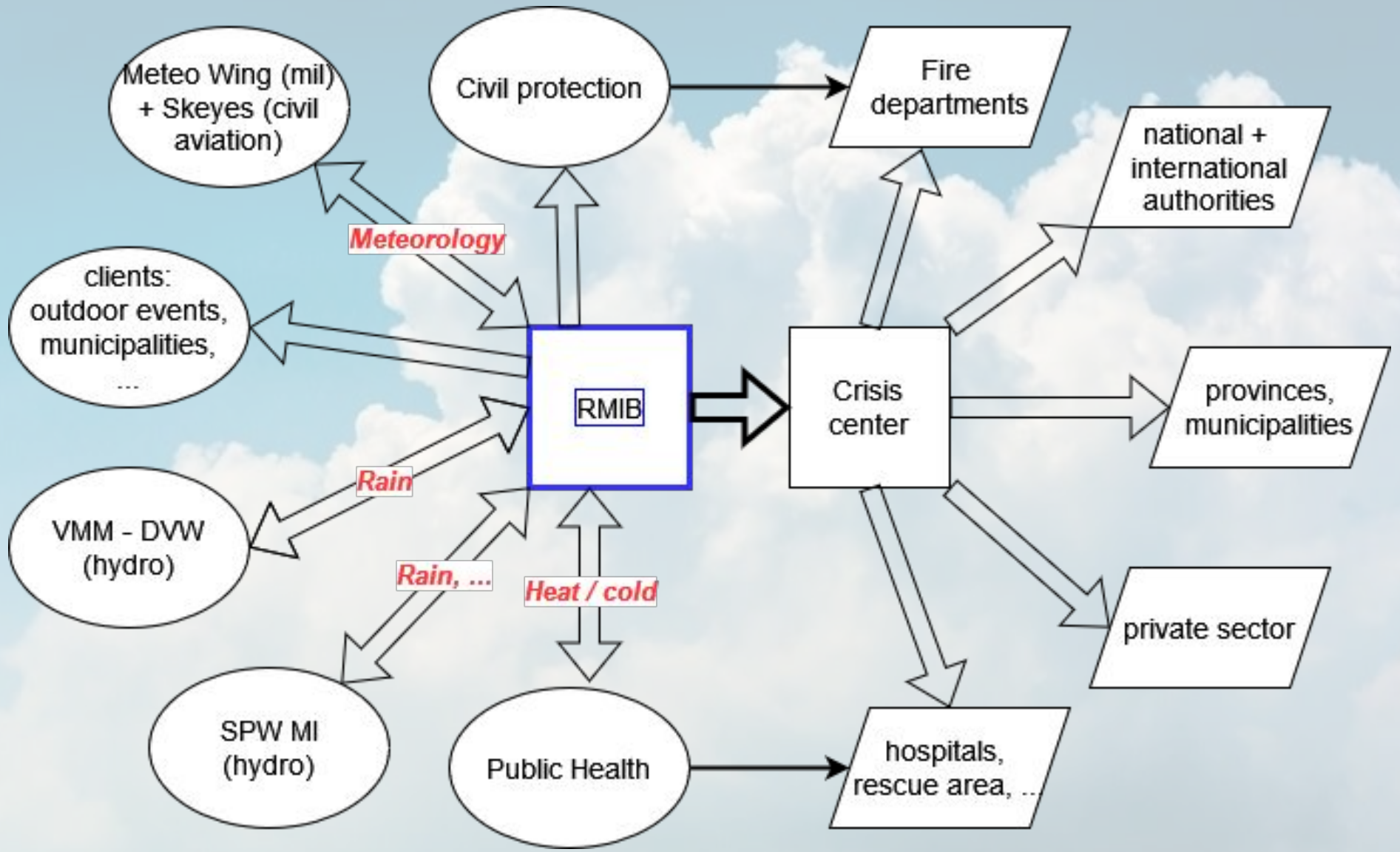
If there is an active orange or red warning for slippery conditions (only with snow or freezing rain) or thunder, nowcast warnings are produced:

Rapid updates (hourly or shorter if needed) of the situation, with enhanced spatial detail (scale of municipalities (~50 km^2) instead of provinces (~3000 km^2))

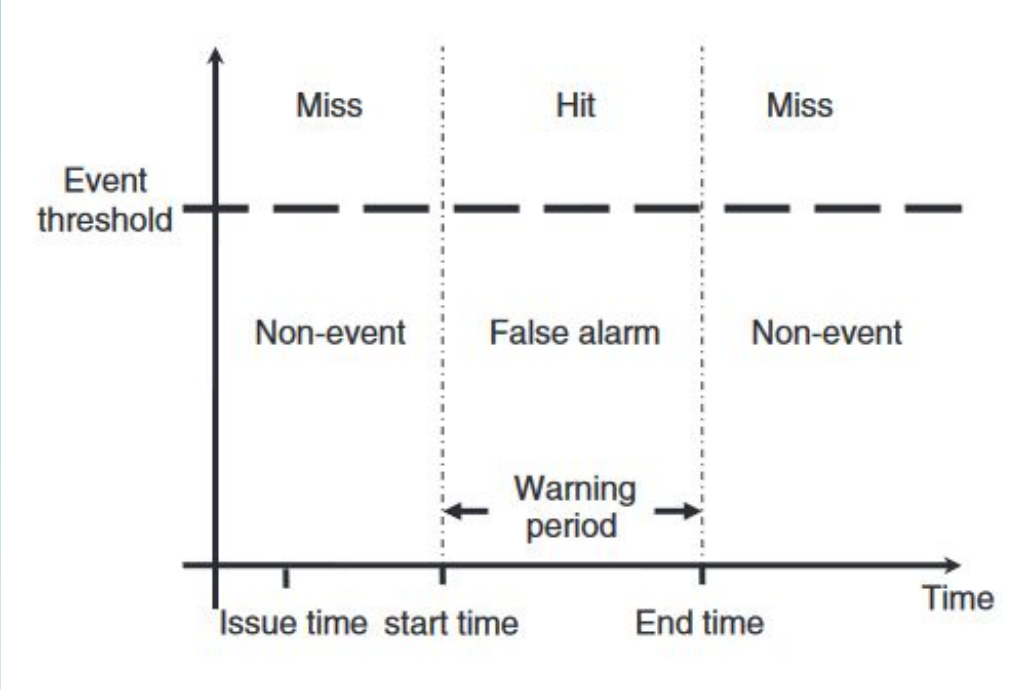
2. Warnings: example nowcast warning interface



2. Warnings: RMI and its partners

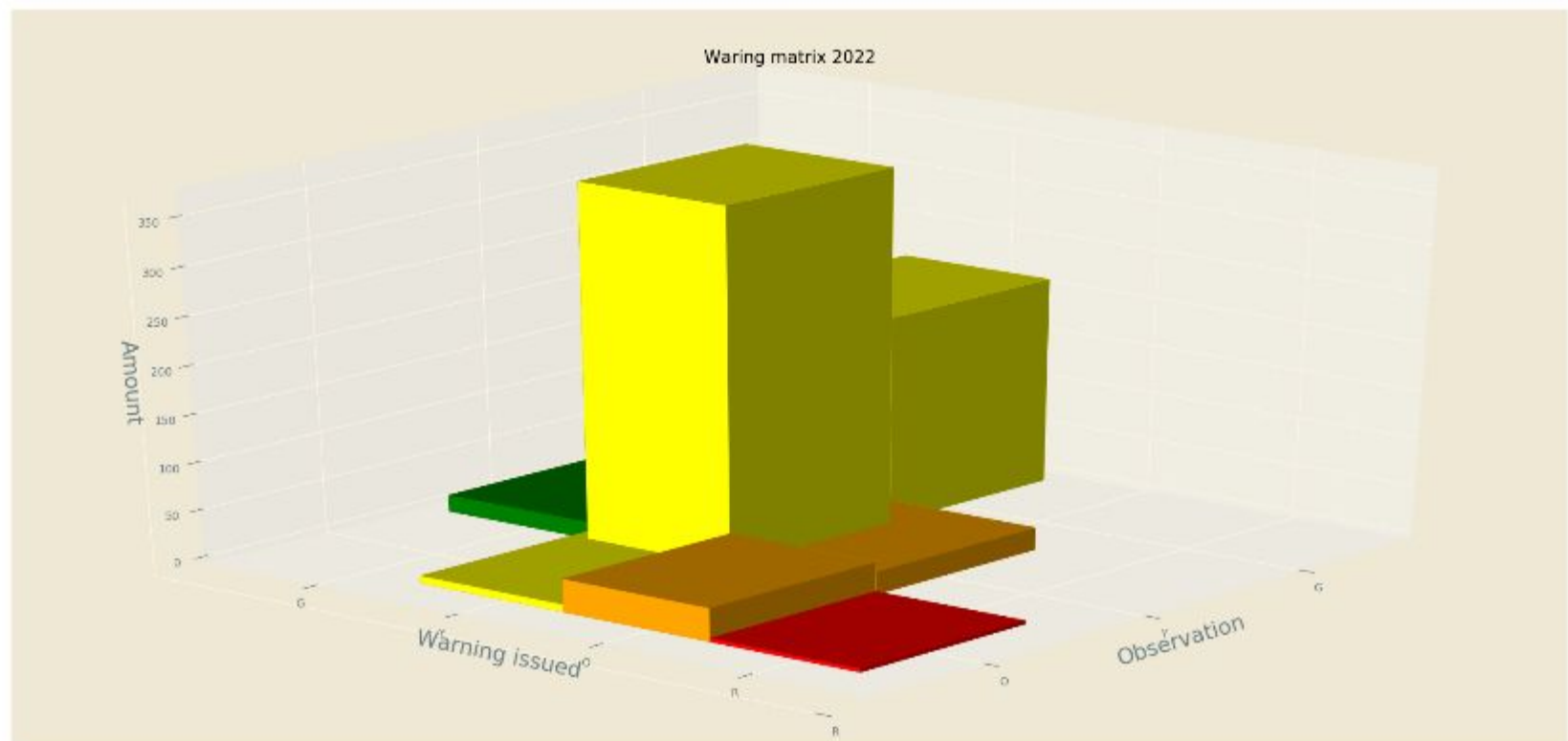


2. Warnings: some statistics



Statistics (POD, FAR, ...) depend on type of warning and geography

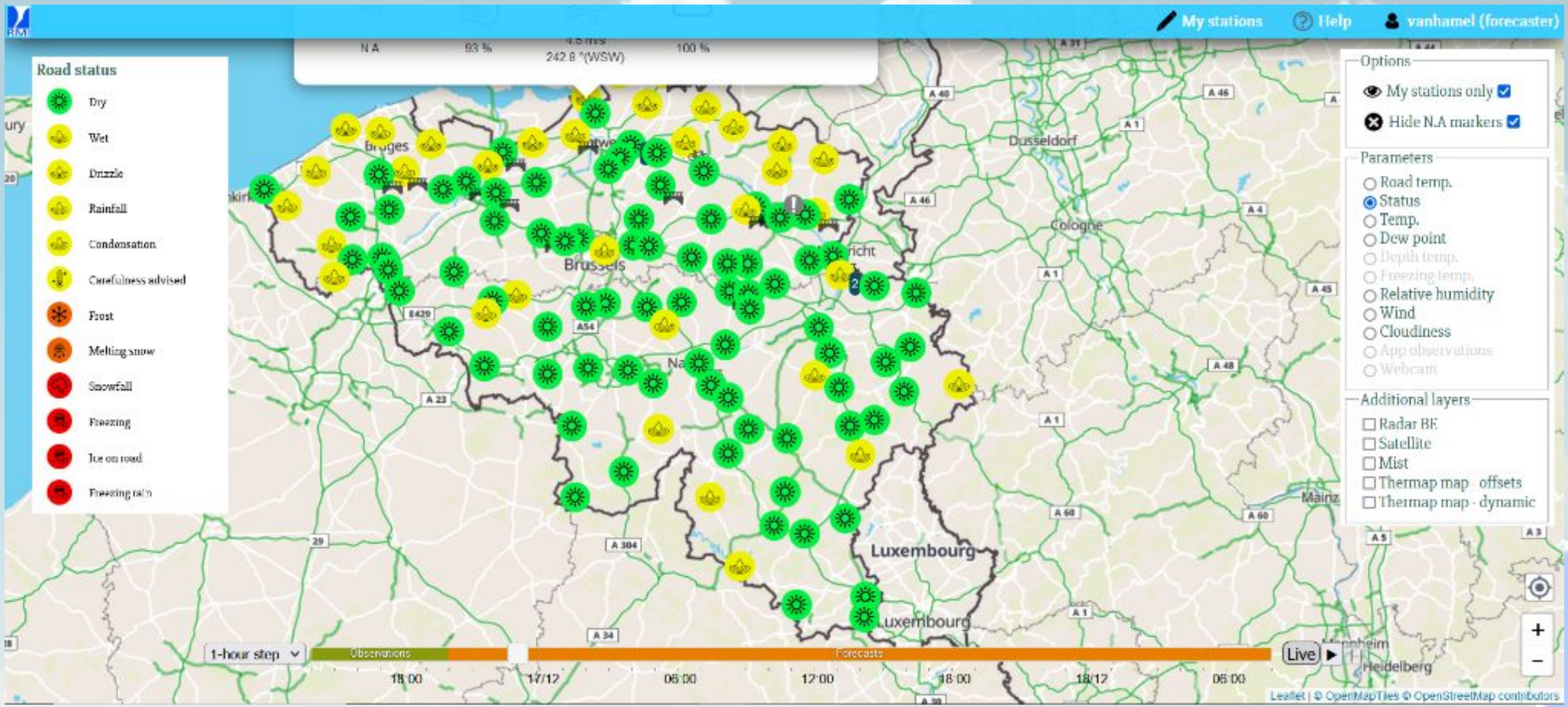
2. Warnings: some statistics (example 2022)



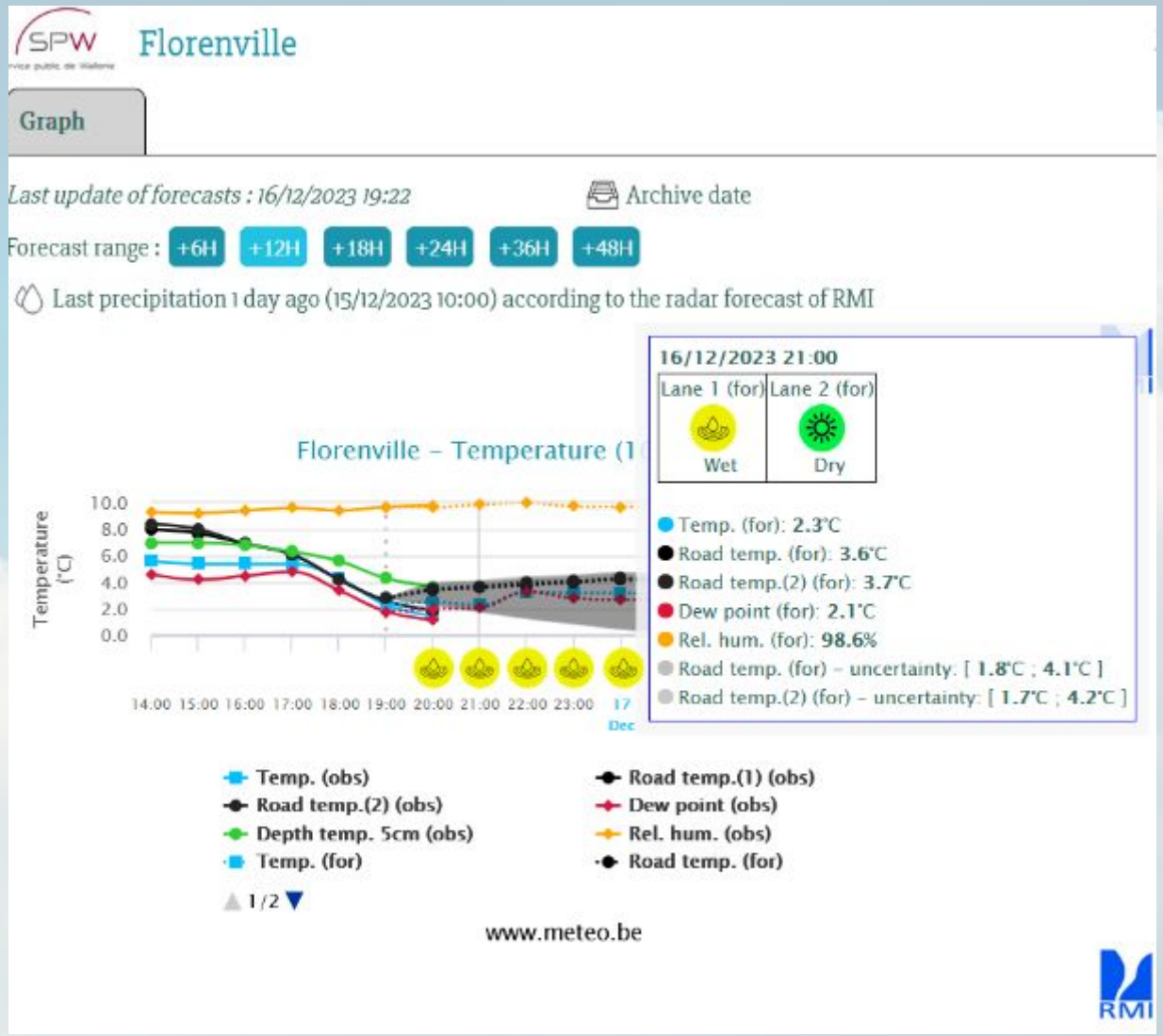
2. Warnings: OMS

- Bulletins and warnings at sea (Thames & Dover) and the Belgian coast
- Storm surge

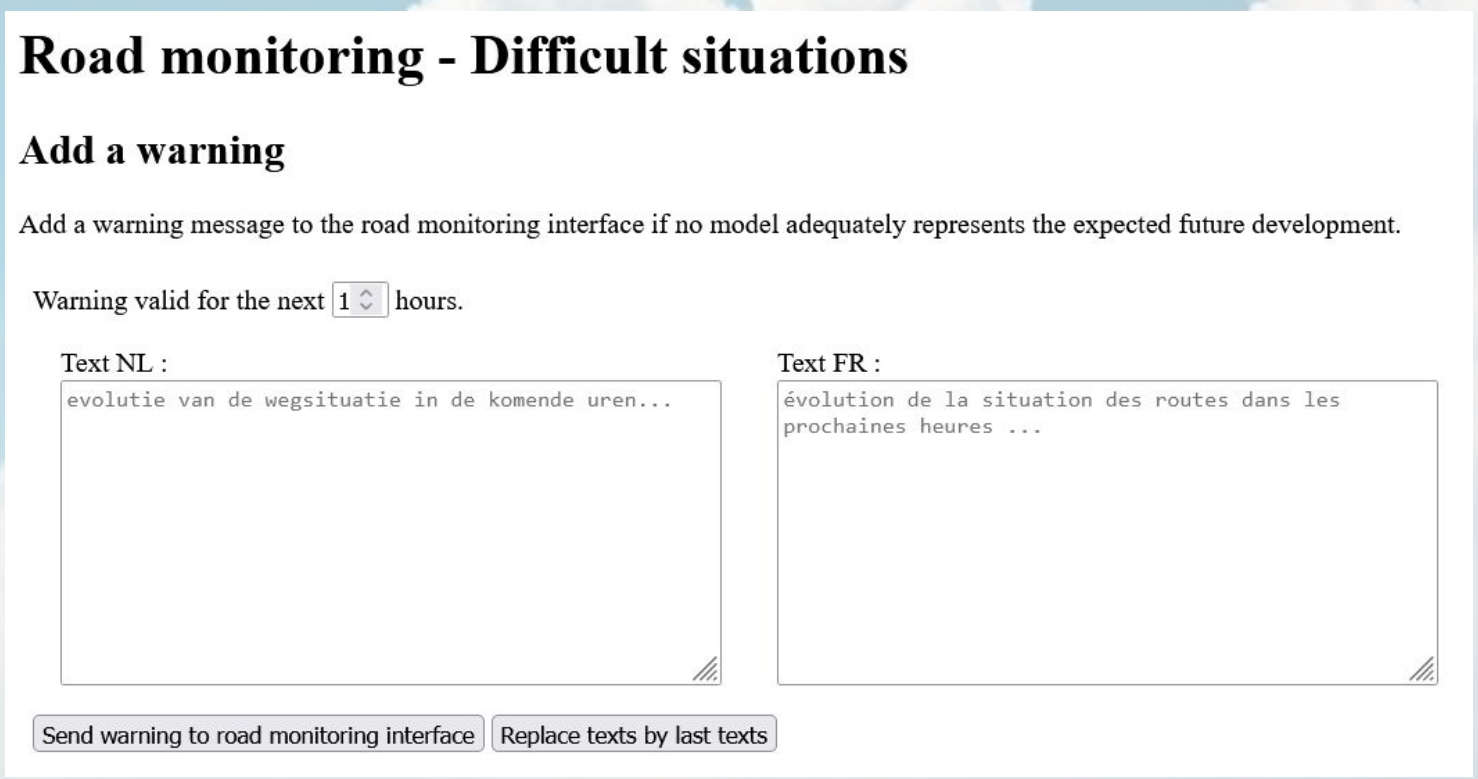
2. Road monitoring (not a warning)



2. Road monitoring



2. Road monitoring



2. Warnings: special warnings

- CO-intoxication and pollen (appear on our website – no colour scale)
- Underground parking lots in Brussels (only for client)

Last issued warning:

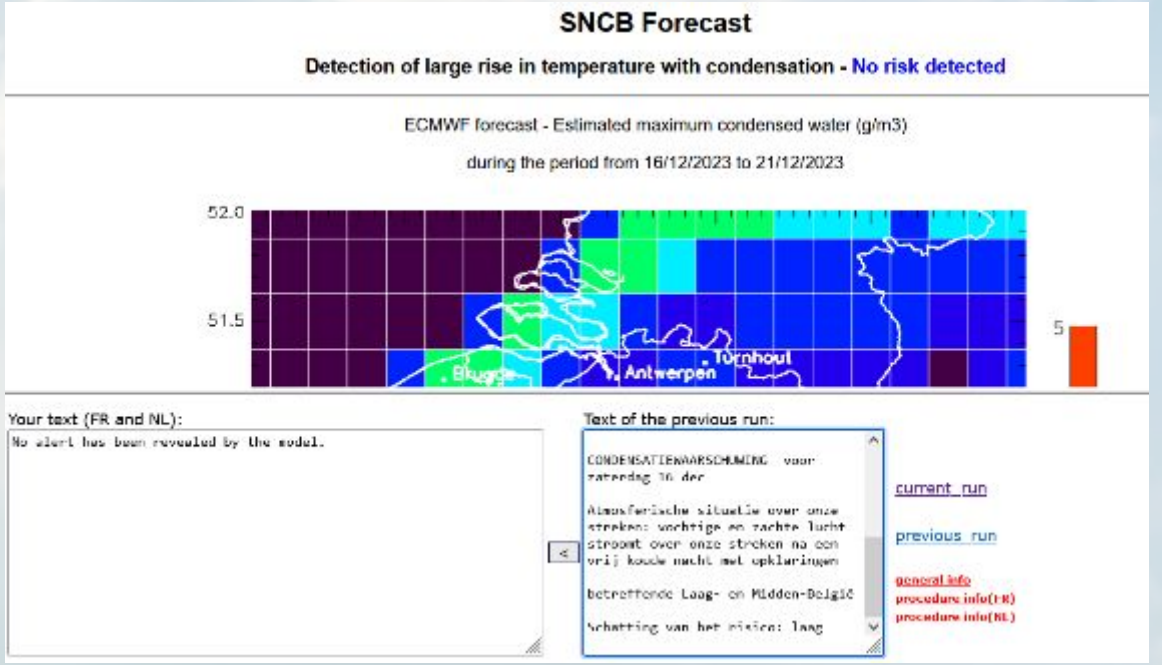
Issue date: 14/11/2023 07:44:07

Initial date: 14/11/2023 07:00:00

+0 +6 +12 +18 +24 +30 +36 +42

Commentaire (en français): Un couloir d'averses intenses et orageuses semble se former sur notre pays cet après-midi, touchant le centre du pays. Deux scénarios entrevoient + de 40 l/m² en 6 h.

- Rail service: snow or condensation



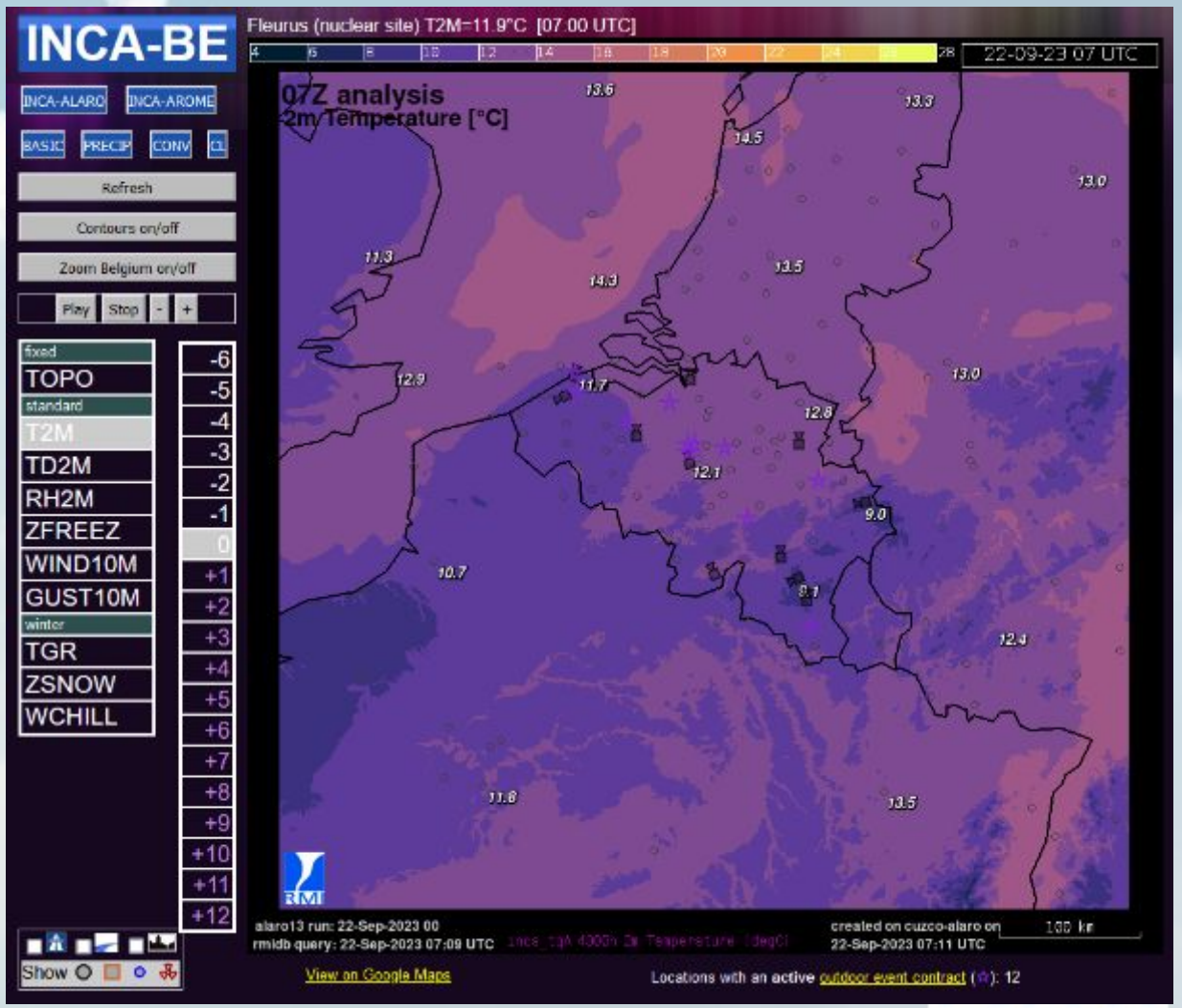
3. Flash warnings: what are they?

- Not like “normal” warnings
  - Automated, limited influence of the forecaster
  - Small spatial scale (municipality; ~50 km²)
  - Small temporal scale (nowcast range)
    - Next 10-30 minutes
    - Next 20-80 minutes
- Like traditional warnings, they come in 3 classes (assigned to a color, in increasing intensity) : yellow, orange and red
- There are, for now, 3 types in production:
  - Heavy rain (with possibility of thunder and/or hail)
  - Snowfall
  - Freezing precipitation
- Distributed via the app (users can select if they wish to receive notifications), since 14/01/2020

3. Primary data source => INCA-BE nowcast

INCA = analysis + forecast (using ALARO or AROME-BE) on 1x1 km² grid cells

- Basic field (12 h forecast – 1 h resolution)
  - T2, TD2, RH2, U10, V10, GUST10, ZFREEZ, ZSNOW
- Precipitation field (4 h forecast – 10 min resolution)
  - TP (10min accum), PTYPE, LIGHTNING, SWI
- Cloudiness field (no forecast – 10 min resolution)
  - TCC, VIS



3. Additional processing

- Average temperature for freezing precipitation must be <0°C and for snow <0.5°C
- Long term:
  - Precipitation is accumulated between +20’ and +80’
- Short term:
  - Maximum of 10’ precipitation intensity between analysis and +20’
  - Maximum value for hail and for lightning between analysis and +20’
- Post processing (influence of the forecaster) :
  - The forecaster can choose to set all precipitation to 0 for a time window (e.g. when radar shows a lot of false echoes)
  - The forecaster can choose to force a certain precipitation type for a time window (e.g. when observations and analysis/inca/model does not correspond)
- If at least 33% of INCA grid cells that fall within a municipality meets a criterion => flash is generated

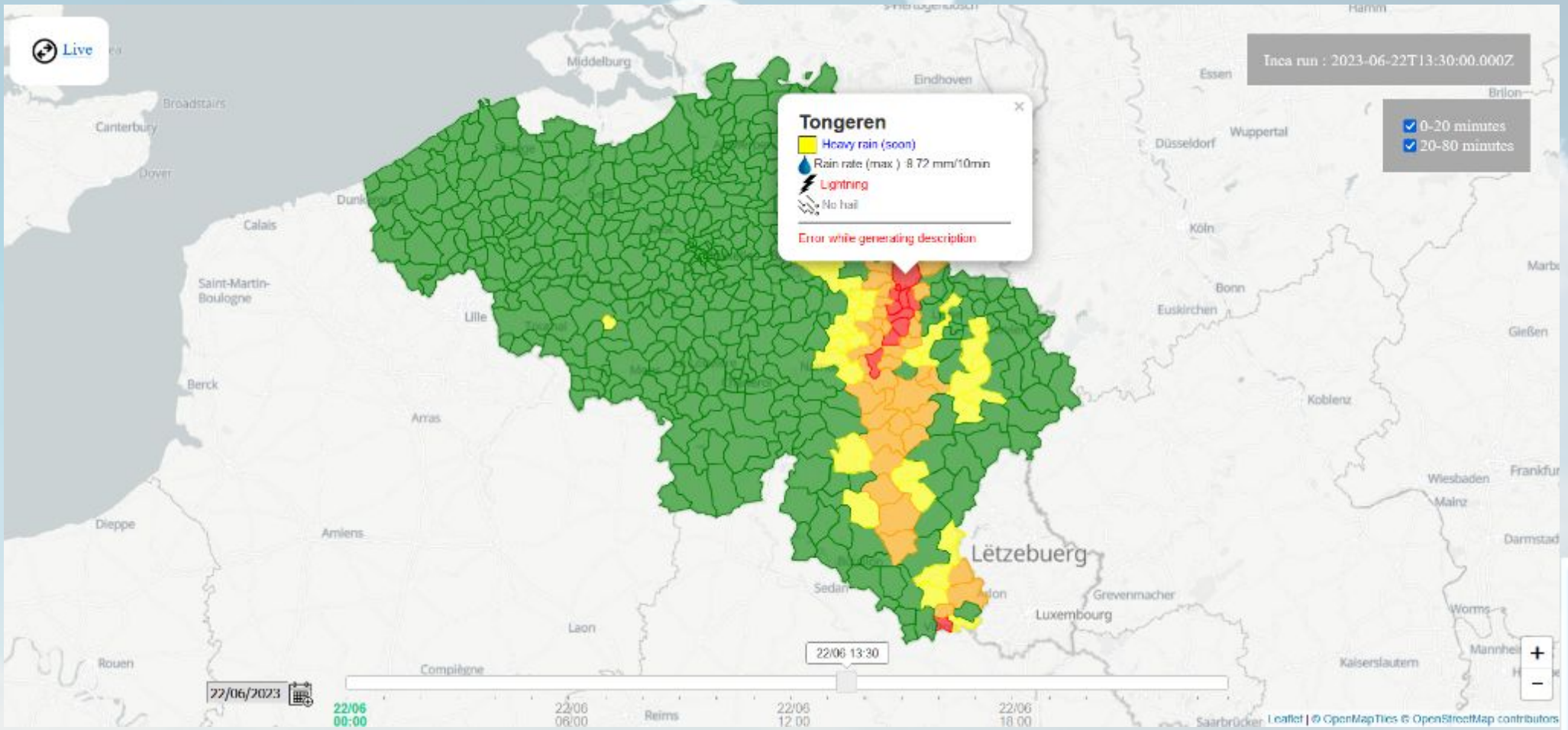
3. Criteria flash warnings: existing parameters

		Criteria Short term (10-30 minutes)	Criteria Long term (20-80 minutes)
Rain	Yellow	>= 3.3 mm/10min and < 6.7 mm/10min	>= 20 mm/h and < 30 mm/h
	Orange	>= 6.7 mm/10min and < 13.3 mm/10min	>= 30 mm/h and < 50 mm/h
	Red	>= 13.3 mm/10min	>= 50 mm/h
Snow	Yellow	>= 0.14 cm/10min and < 1 cm/10min	>= 1 cm/h and < 3 cm/h
	Orange	>= 1 cm/10min and < 2 cm/10min	>= 3 cm/h and < 6 cm/h
	Red	>= 2 cm/10min	>= 6 cm/h
Freezing precip	Yellow	>= 0.2 mm/10min and < 1 mm/10min	>= 0.5 mm/h and < 2 mm/h
	Orange	>= 1 mm/10min and < 2 mm/10min	>= 2 mm/h and < 6 mm/h
	Red	>= 2 mm/10min	>= 6 mm/h

For the short term warning flashes for rain, the flash sentence (not the color) is also determined by:

- Presence of lightning
- Presence of small / large hail

3. Example: interface for RMI forecasters

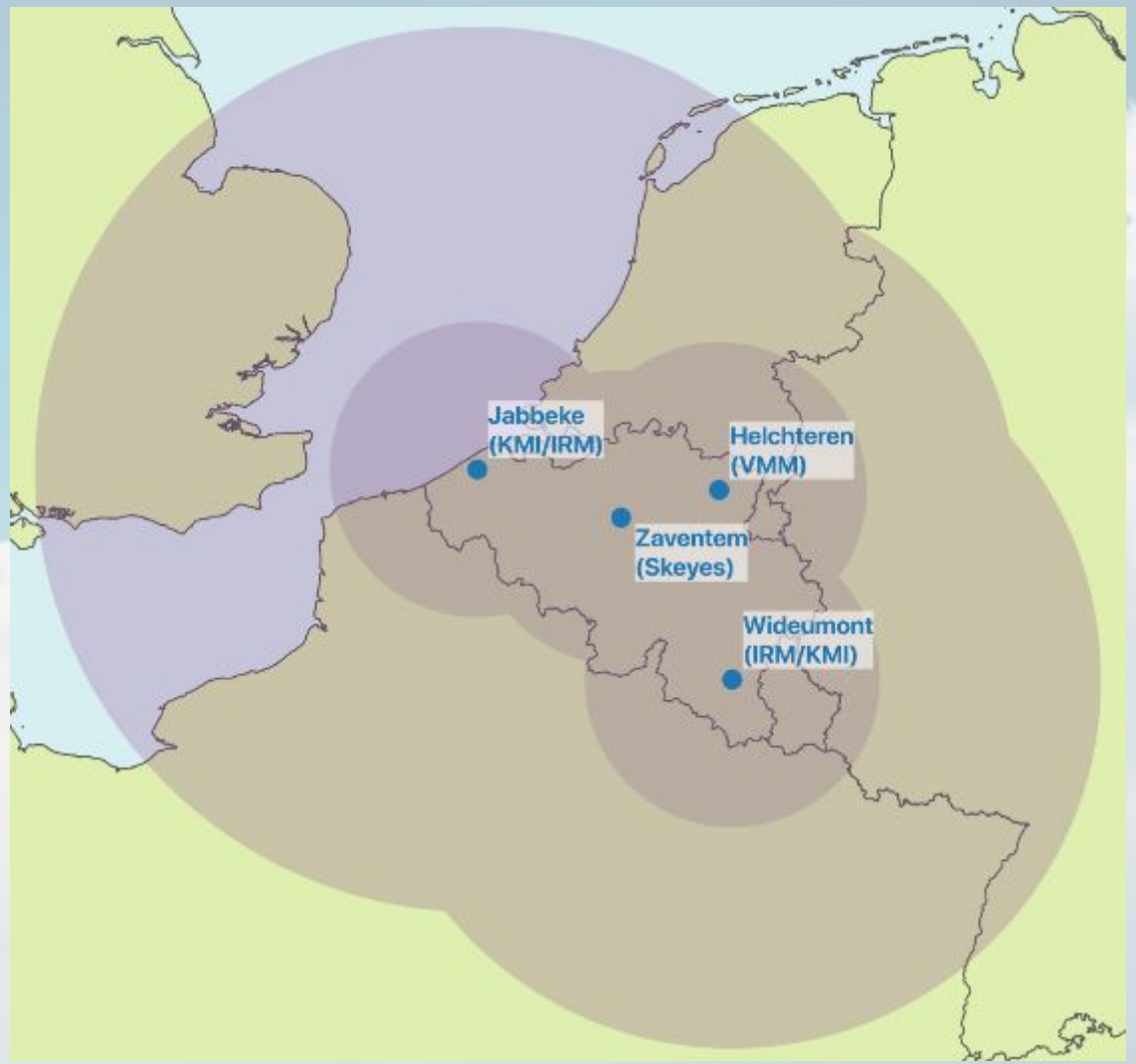


3. Example: push notification on smartphone

3. New type: gust flash warning

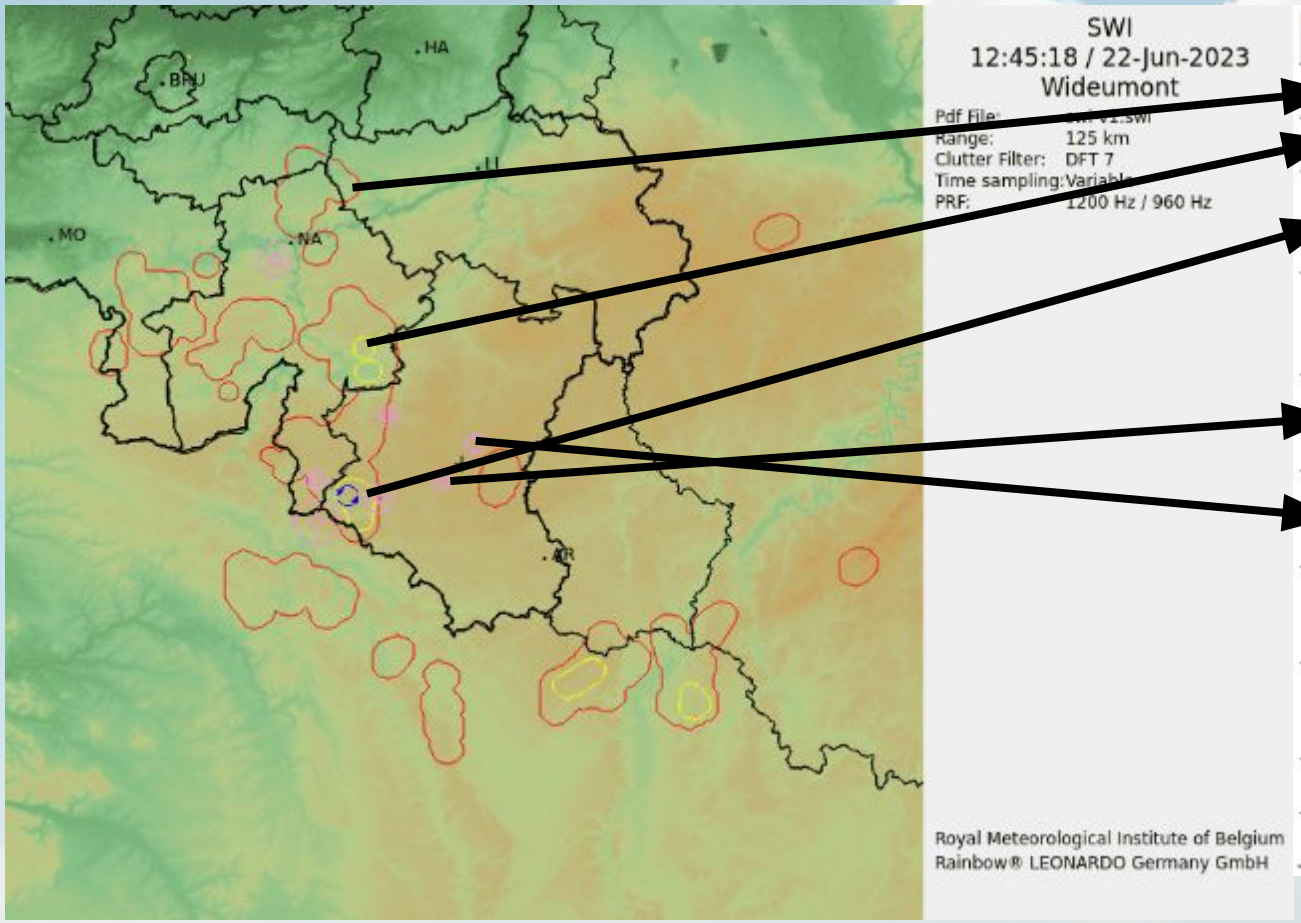
- A new type of flash warning was developed and will be added this year, to warn for severe wind gusts
- Data source:
  - INCA-BE: wind field
  - Radar: SWI (Severe Weather Indicator) = a phenomena detection product derived from radar volume data (Z, reflectivity; V, radial velocity; W, spectral width) (products as delivered by Rainbow software – Leonardo, Germany)
- Severe Weather Indicator Algorithm detects :
  - Storm cells
  - Mesocyclone
  - Con-/divergence
  - ...

3. Radar network in Belgium (RMI, Skeyes, VMM)



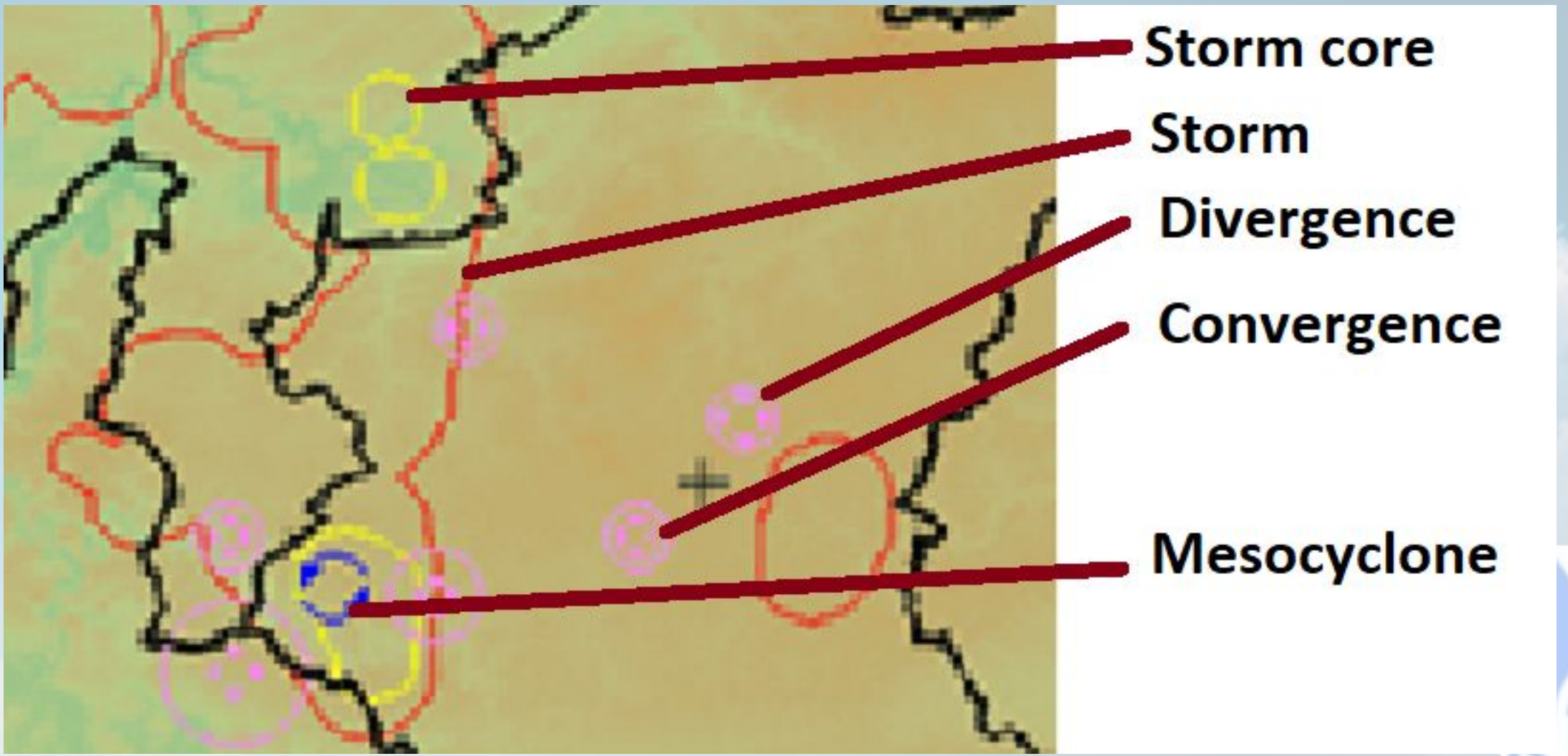
Helchteren does not have SWI data

3. SWI product from Wideumont radar



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

3. (same) SWI attributes (zoomed in)



3. Flash warning algorithm

- For each different SWI class (storm, mesocyclone, div/conv ...) from the composite radar image, the “raw” SWI product data (latitude, longitude, polygon data) are extracted and interpolated to the INCA-BE grid

- 4 classes are determined (green = no warning), with:

YELLOW

- The intersection of the storm polygon with the INCA-BE wind field where the wind speed >= 7 m/s is considered (to decrease the false alarms)
- There need to be at least one mesocyclone or div/conv class in this intersection

3. Flash warning algorithm

ORANGE

- A storm polygon that has as least one storm core polygon within
- There need to be at least one mesocyclone or div/conv class in this polygon
- No restrictions from INCA-BE wind field

RED

- The intersection of a storm core polygon with a storm polygon
- There need to be at least 2 mesocyclone or 2 div/conv classes in this polygon
- No restrictions from INCA-BE wind field

- Only the short flash warning is considered

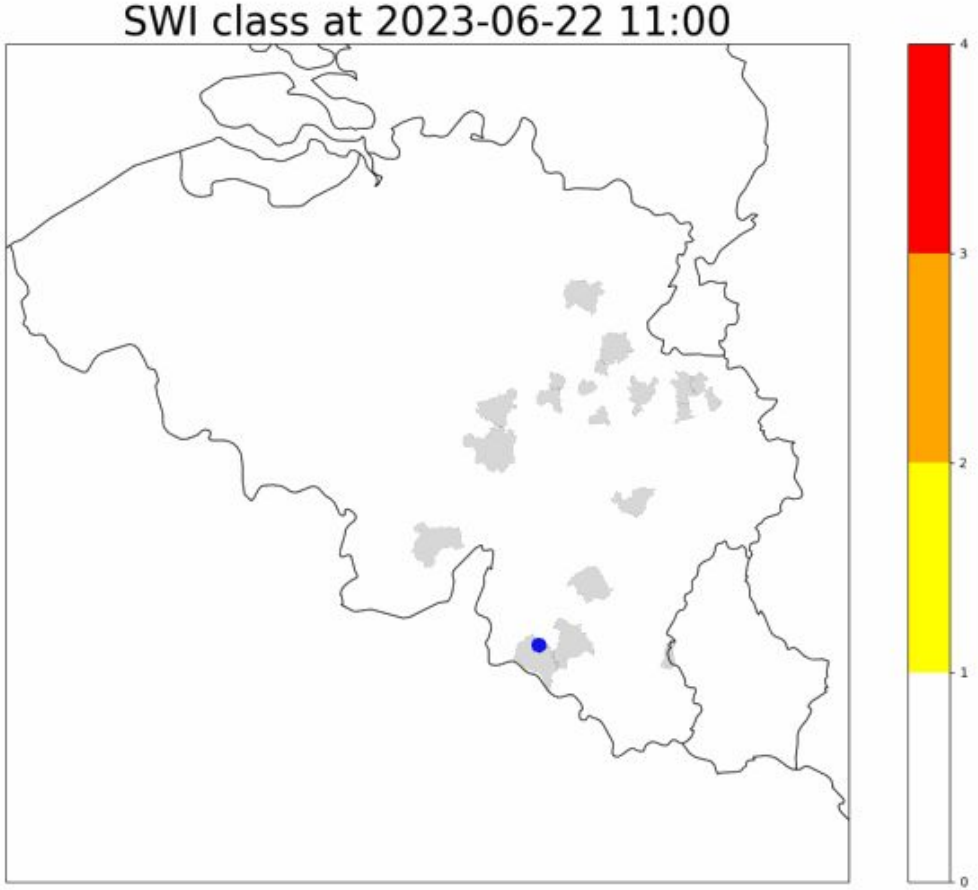
- These set of rules are based on the product experience, but can be adjusted in the course of time

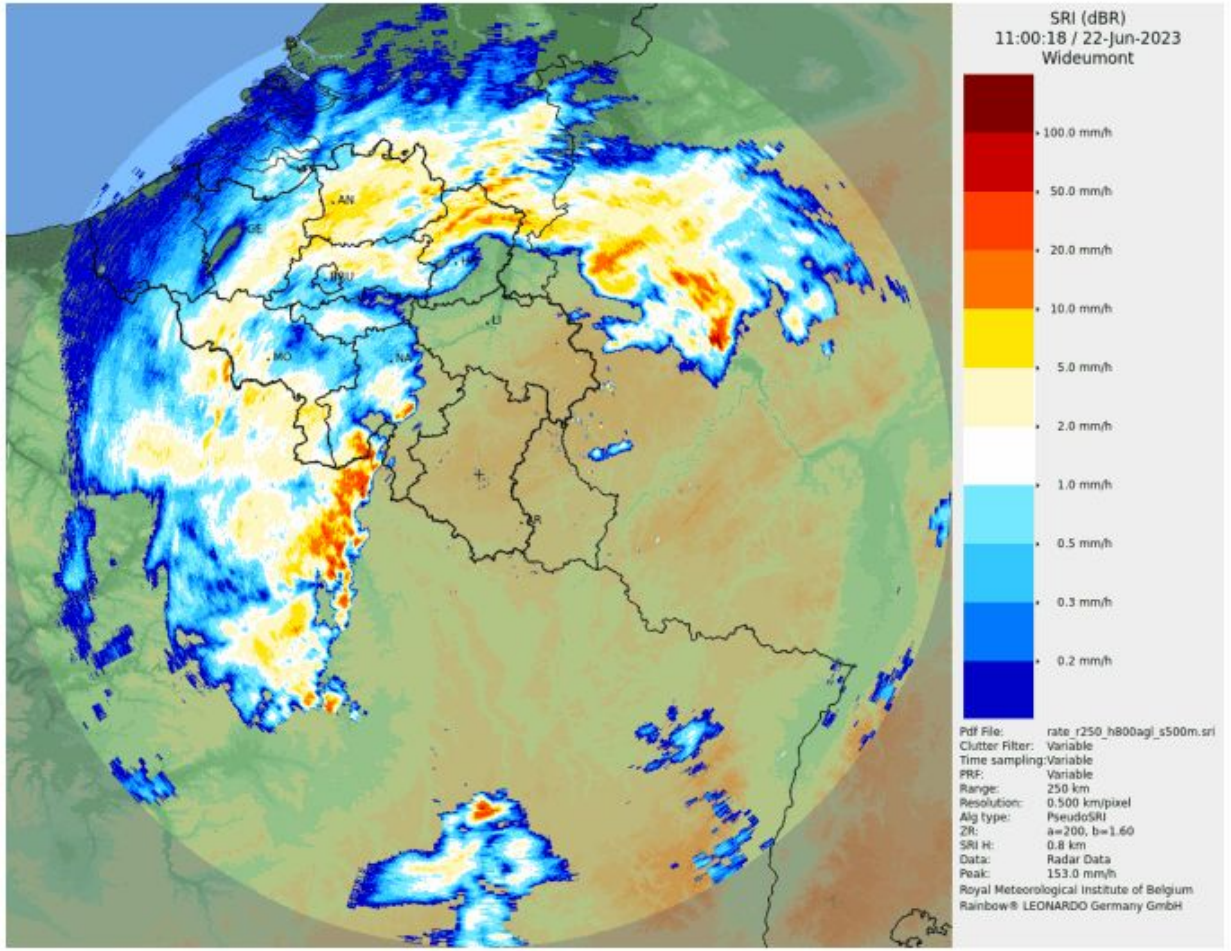
3. Some examples...

- Relatively few (convective) wind cases are available of this spring & summer 2023

- Severe wind cases from ESWD:
  - 1 tornado on 22/06/2023 in Bouillon (near France)
  - Frontal system on 04/07/2023 in western part of Belgium
  - Storm (Poly) on 05/07/2023 mainly in northern Belgium

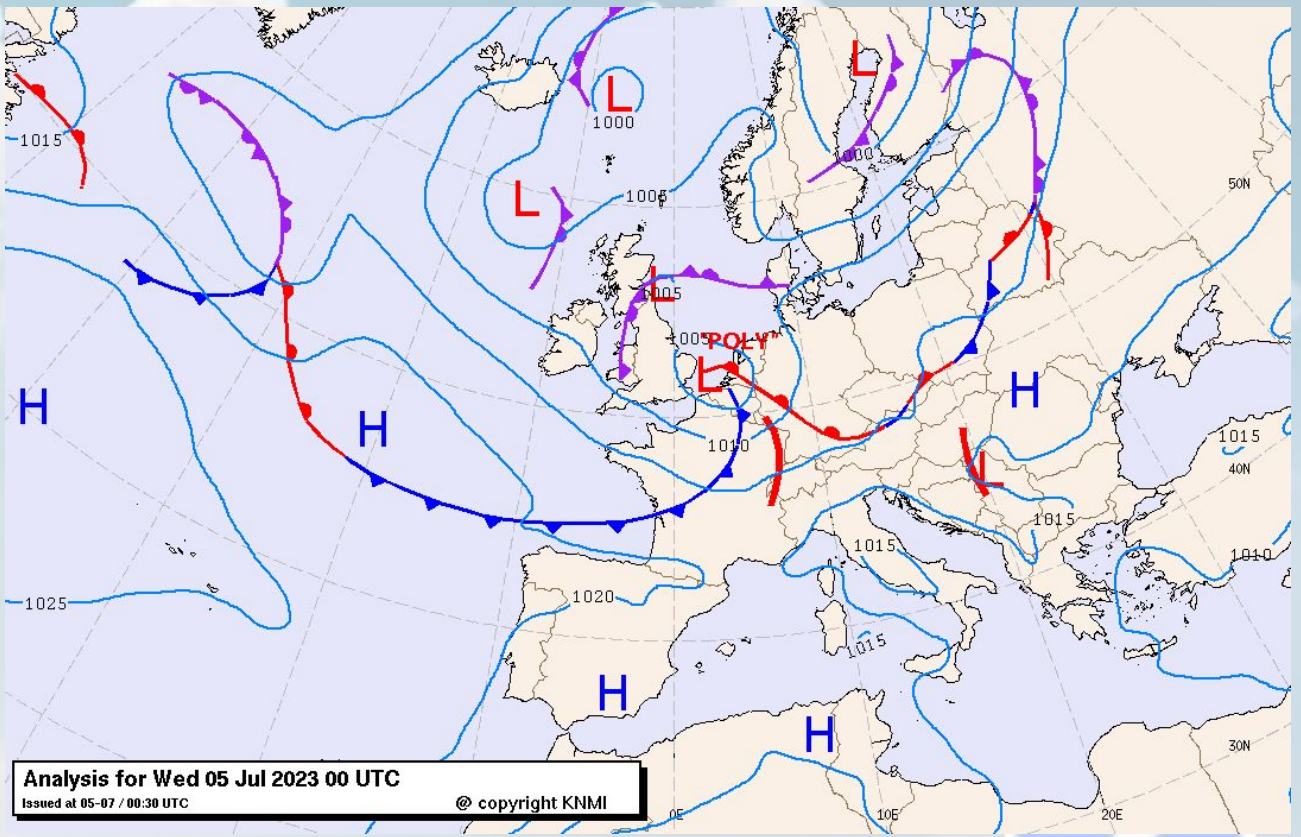
3. ESWD reports map

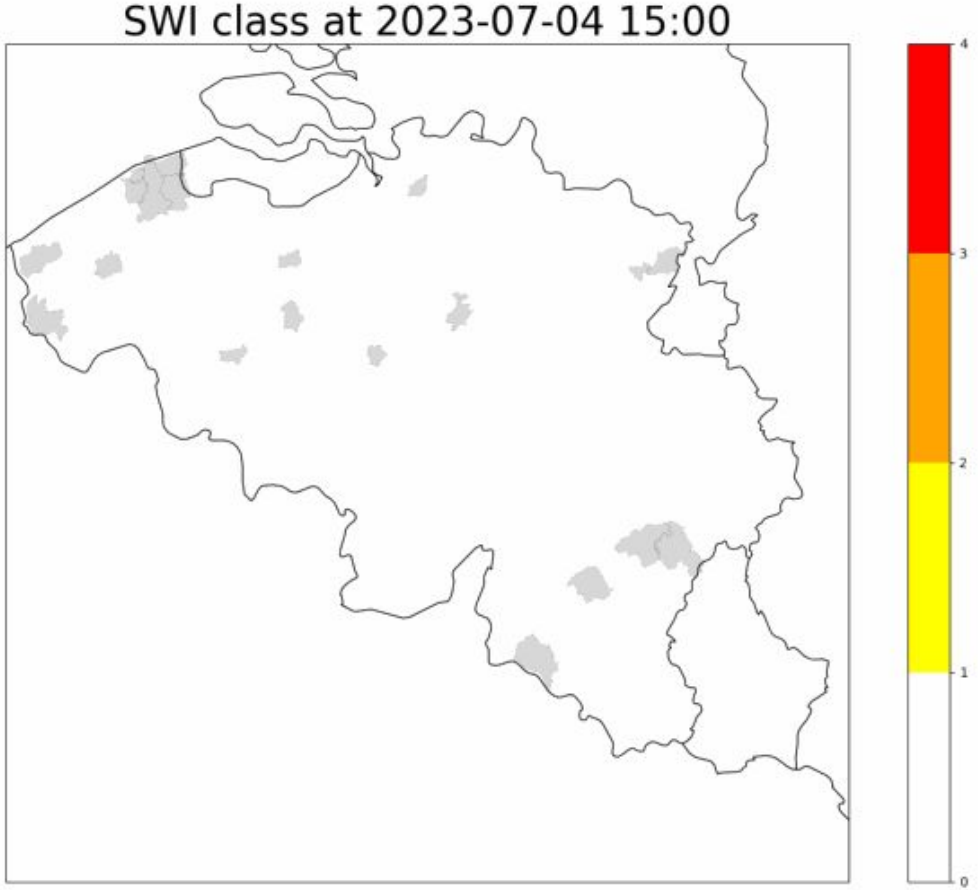

SWI class at 2023-06-22 11:00
4
3
2
1
0

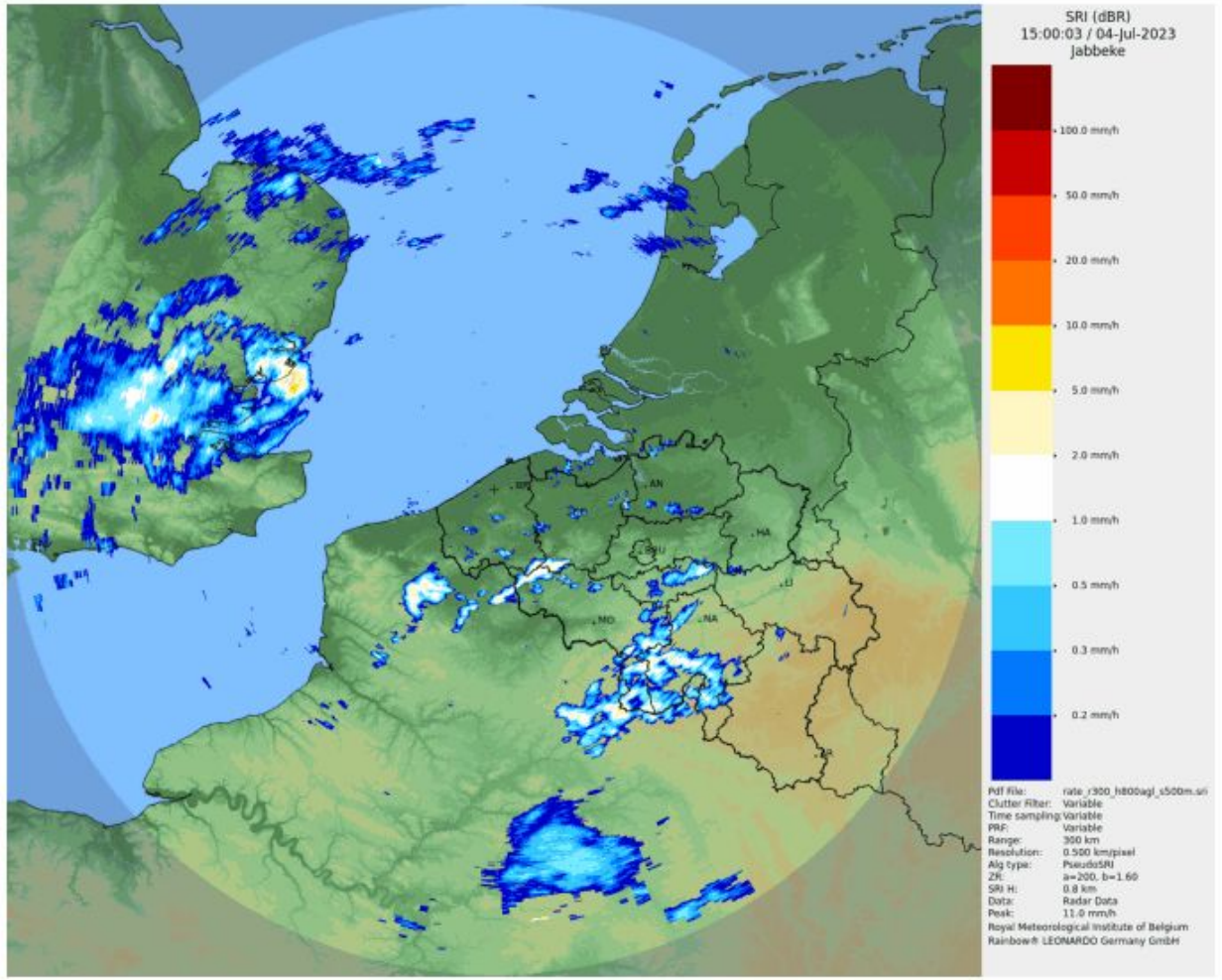

SRI (dBR)
11:00:18 / 22-Jun-2023
Wideumont
100.0 mm/h
50.0 mm/h
20.0 mm/h
10.0 mm/h
5.0 mm/h
2.0 mm/h
1.0 mm/h
0.5 mm/h
0.3 mm/h
0.2 mm/h
Pdf File: rate_r250_h800agl_s500m.sri
Clutter Filter: Variable
Time sampling: Variable
PRF: Variable
Range: 250 km
Resolution: 0.500 km/pixel
Alg type: PseudoSRI
ZR: a=200, b=1.60
SRI H: 0.8 km
Data: Radar Data
Peak: 153.0 mm/h
Royal Meteorological Institute of Belgium
Rainbow® LEONARDO Germany GmbH

3. Frontal system 04/07/2023 (evening) (storm Poly)

- Maximum wind gust of 73 km/h in Zeebrugge (coast)
- Some (limited) damage reported
- Not a typical convective situation; no SWI signal




SWI class at 2023-07-04 15:00
4
3
2
1
0


SRI (dBR)
15:00:03 / 04-Jul-2023
Jabbeke
100.0 mm/h
50.0 mm/h
20.0 mm/h
10.0 mm/h
5.0 mm/h
2.0 mm/h
1.0 mm/h
0.5 mm/h
0.3 mm/h
0.2 mm/h
Royal Meteorological Institute of Belgium
Rainbow® LEONARDO Germany GmbH

Conclusions...

- Warning system: threshold-based
  - But: good contacts with other fields of expertise that are responsible for taking correct measures to limit impact
  - Communication in our warnings are important

- Fixed spatial and temporal scale
  - Administrative reasons (civil protections/gouvernors/...)
  - But: flash-warning system gives higher detail

Thank you for your interest!