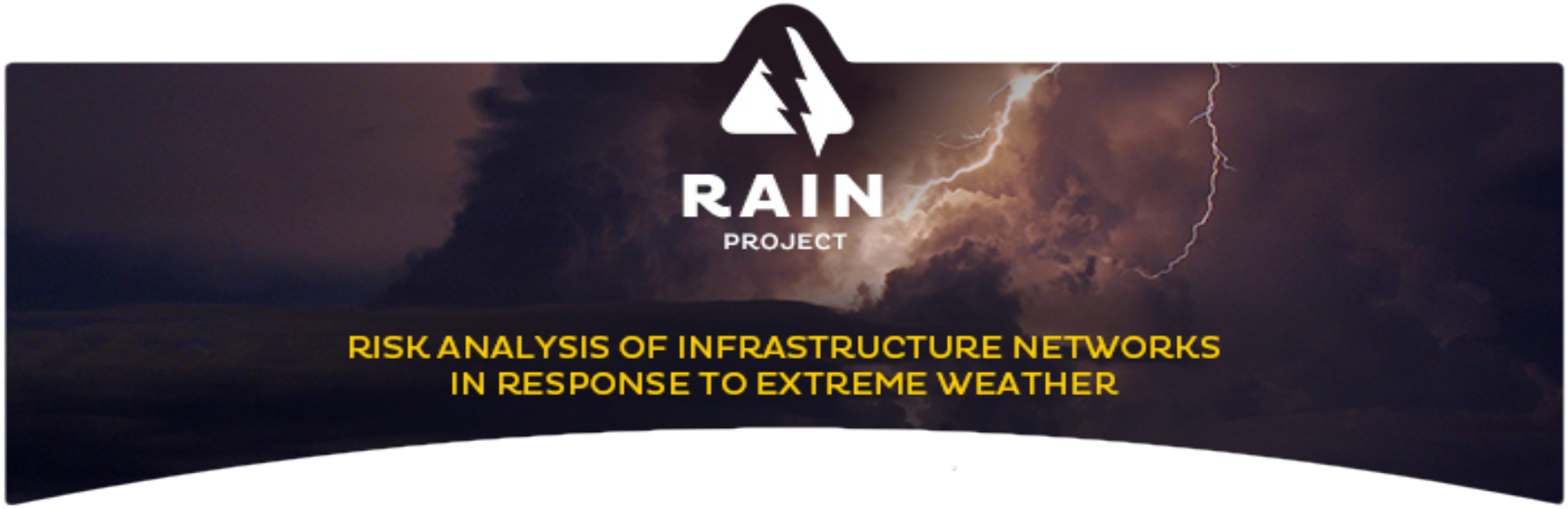

A detailed review of severe weather warning systems in Europe

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 608166. The contents of this presentation are the author's views. The European Union is not liable for any use that may be made of the information contained therein.

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A detailed review of severe weather warning systems in Europe

RAIN Workshop: Climate change and weather modelling

Trinity College Dublin, 9 Nov. 2015

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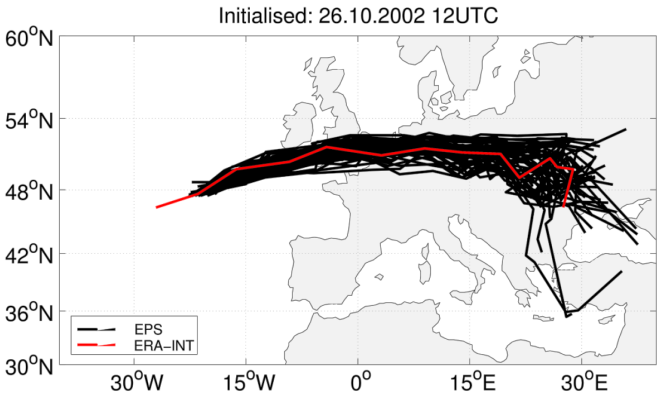
Assessment in RAIN

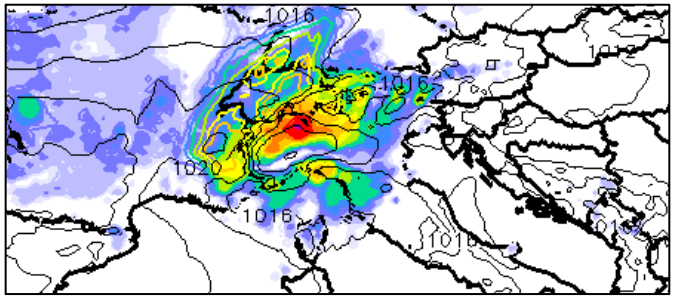
- Study the predictability of hydro-meteorological hazards in Europe
  - Nowcasting and very short-range (hours)
  - Medium-range (days)
  - Seasonal (months)



Ensemble forecasts (black) and real path of winter storm Jeannett

- Assess forecast skill of state-of the art early warning systems

- Formulate recommendations for improvements



Forecast of potential floods across the Alps

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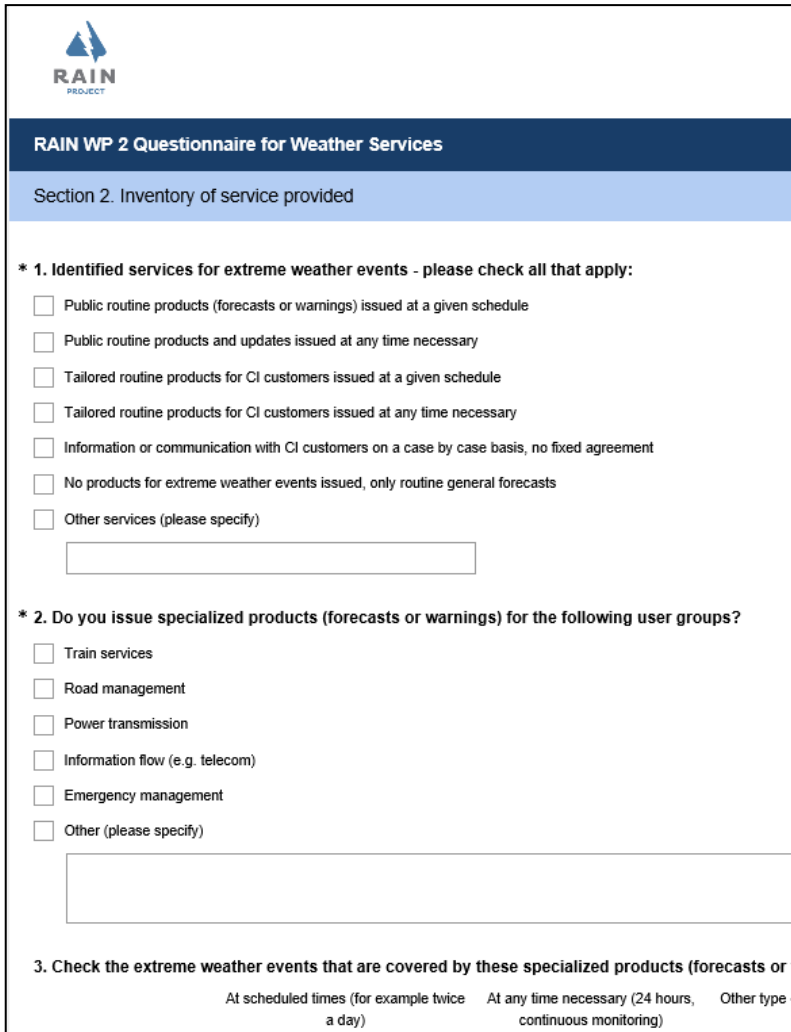
Interviews and Online Questionnaires

1. Interviews with critical infrastructure (CI) operators: *What are their needs?*

2. Online questionnaire for weather services in Europe: *What do they offer?*

   55 requests to participate
   18 responses:
   13 public, 5 commercial – a slight overrepresentation of public services in the sample



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RAIN WP 2 Questionnaire for Weather Services

Section 2. Inventory of service provided

*** 1. Identified services for extreme weather events - please check all that apply:**

- ☐ Public routine products (forecasts or warnings) issued at a given schedule
- ☐ Public routine products and updates issued at any time necessary
- ☐ Tailored routine products for CI customers issued at a given schedule
- ☐ Tailored routine products for CI customers issued at any time necessary
- ☐ Information or communication with CI customers on a case by case basis, no fixed agreement
- ☐ No products for extreme weather events issued, only routine general forecasts
- ☐ Other services (please specify)

*** 2. Do you issue specialized products (forecasts or warnings) for the following user groups?**

- ☐ Train services
- ☐ Road management
- ☐ Power transmission
- ☐ Information flow (e.g. telecom)
- ☐ Emergency management
- ☐ Other (please specify)

3. Check the extreme weather events that are covered by these specialized products (forecasts or

At scheduled times (for example twice a day) | At any time necessary (24 hours, continuous monitoring) | Other type

Interviews and Online Questionnaires

Questions about:

- Services provided
- Specialized products for different user groups
- Covered types of weather events
- Types and magnitudes of thresholds
- Essential framework arrangements
- Means of information exchange
- Constraints
- Improvements in METEOALARM project

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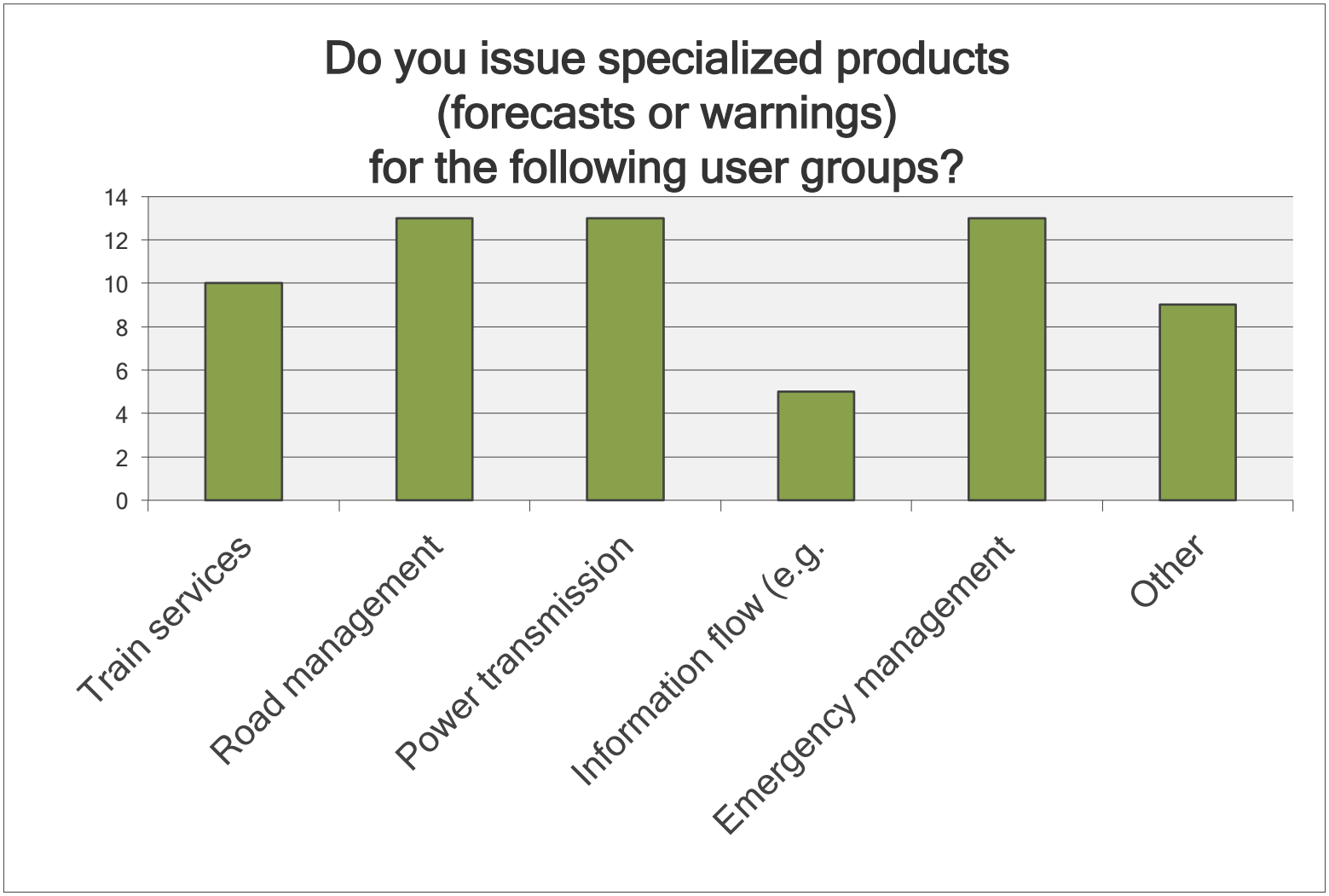
CI target groups for weather services



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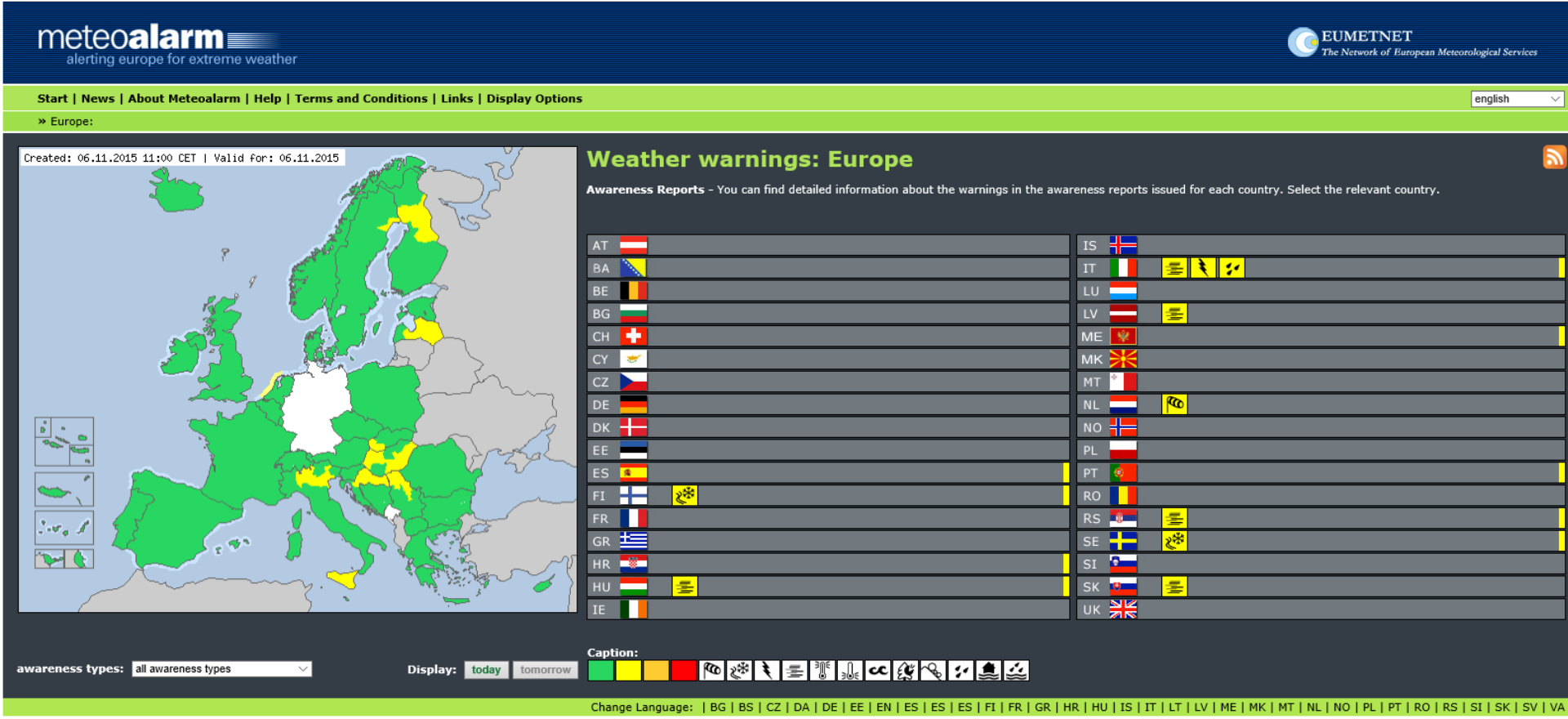

Source: www.meteoalarm.eu

Thresholds: **Fixed?**
Climatological?
Impact related?
Related to density of phenomena?

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White

Missing, insufficient, outdated or suspicious data.

Green

No particular awareness of the weather is required.

Yellow

The weather is potentially dangerous. The weather phenomena that have been forecast are not unusual, but be attentive if you intend to practice activities exposed to meteorological risks. Keep informed about the expected meteorological conditions and do not take any avoidable risk.

Orange

The weather is dangerous. Unusual meteorological phenomena have been forecast. Damage and casualties are likely to happen. Be very vigilant and keep regularly informed about the detailed expected meteorological conditions. Be aware of the risks that might be unavoidable. Follow any advice given by your authorities.

Red

The weather is very dangerous. Exceptionally intense meteorological phenomena have been forecast. Major damage and accidents are likely, in many cases with threat to life and limb, over a wide area. Keep frequently informed about detailed expected meteorological conditions and risks. Follow orders and any advice given by your authorities under all circumstances, be prepared for extraordinary measures.

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Source: www.meteoalarm.eu

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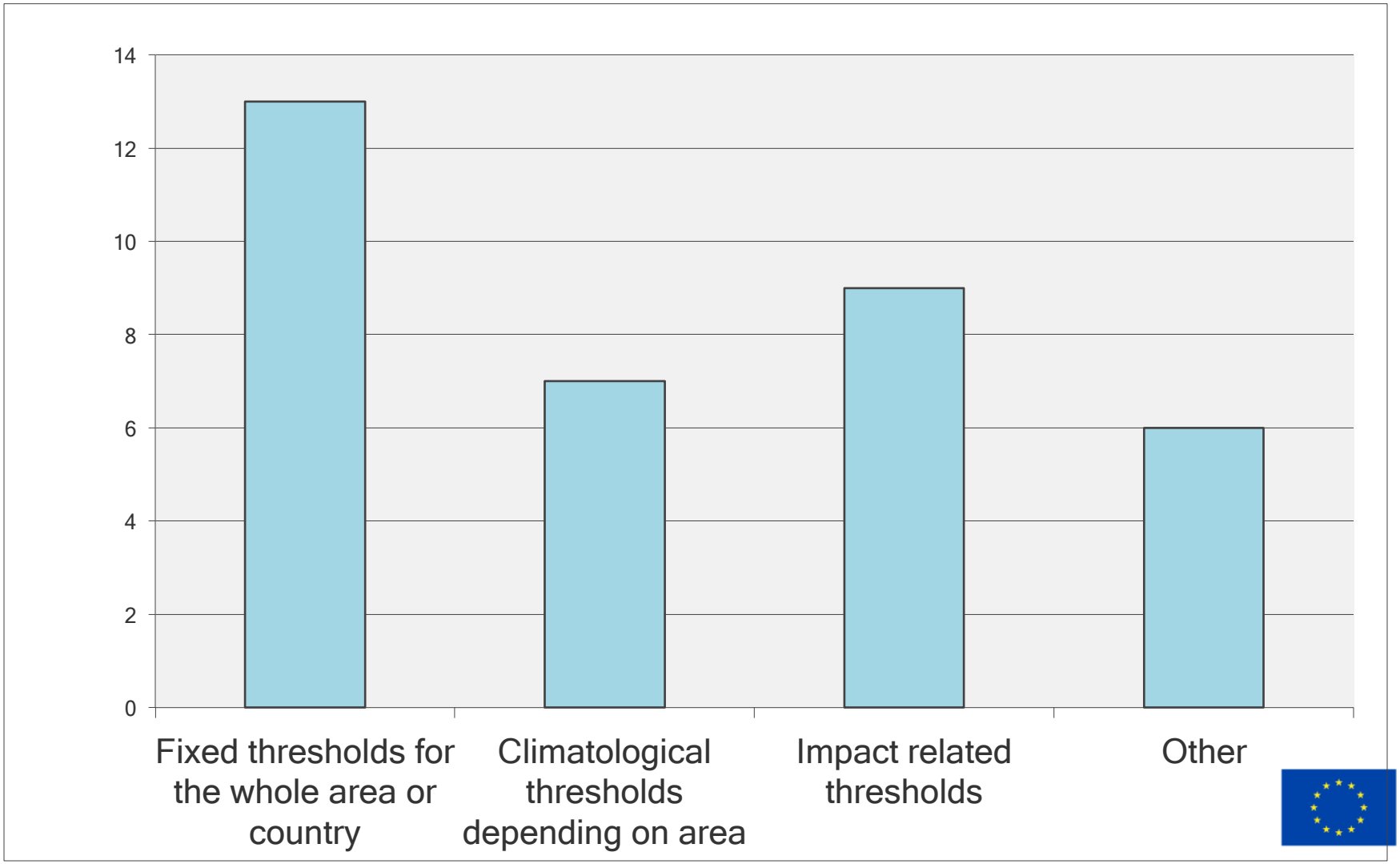
Type of warning thresholds – in reality quite diverse



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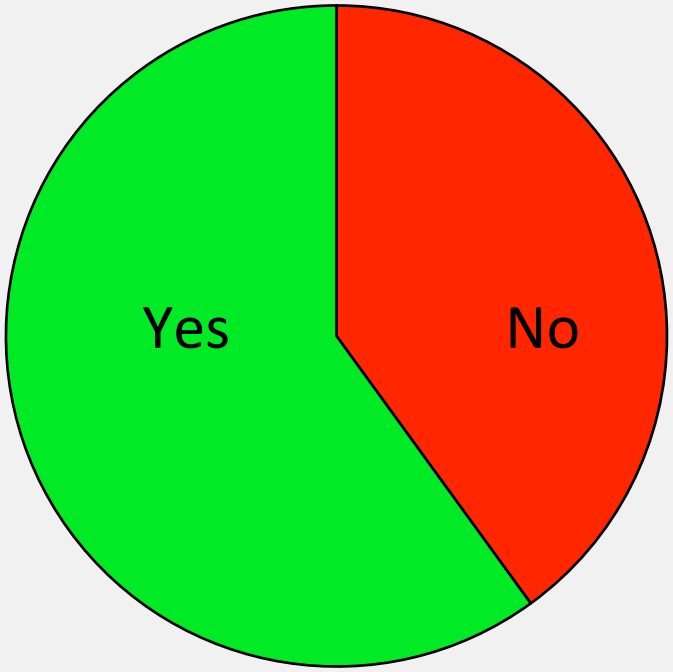
Deterministic versus probabilistic forecasts

Do you issue probabilistic forecasts?



For certain parameters like wind gusts, hail,...
Mainly for long-term forecasts.
Only for customers who want forecasts for specified locations ("points"), usually for exact time period.
Not directly to customers, but we have two levels of warnings and internally we have an ensemble system to see what kind of level we shall send to the customers.
Depending on partner organization.

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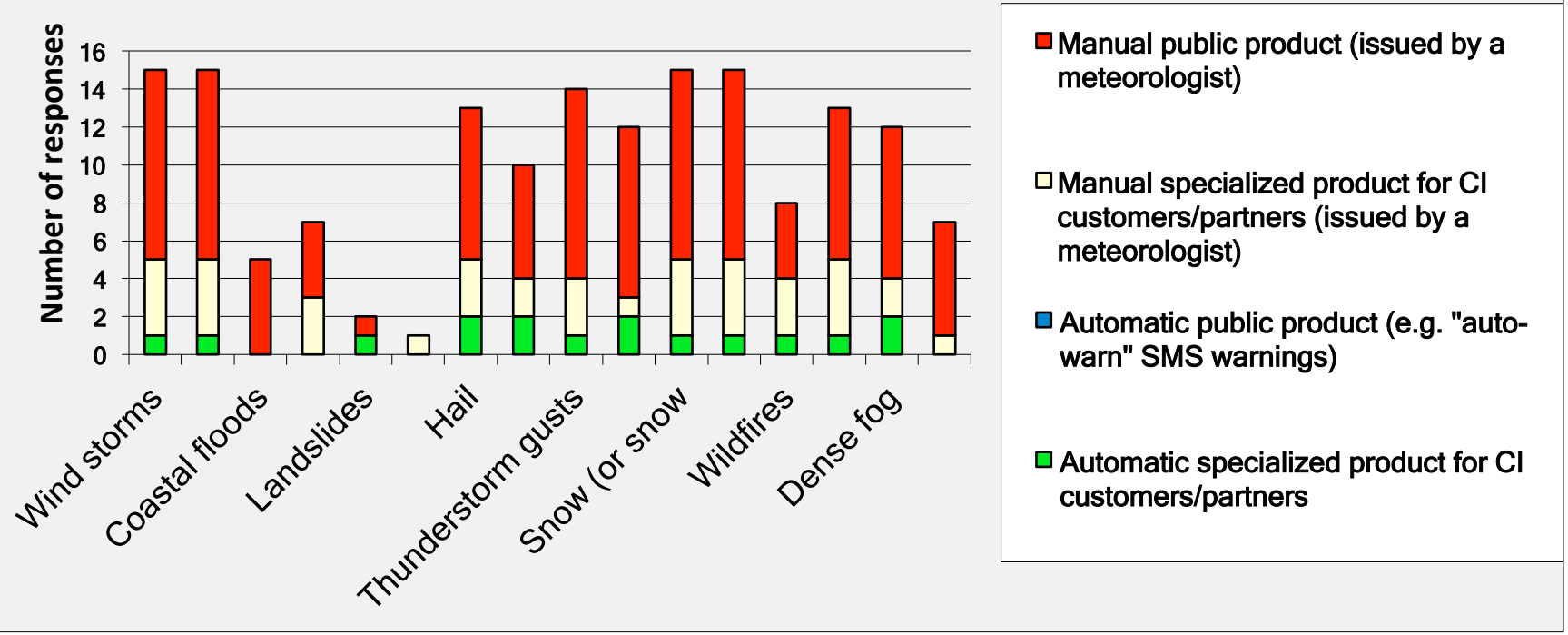

Warning products of the respondents are *mainly issued manually* for the public.

For Critical Infrastructure (CI) customers products are also issued automatically.

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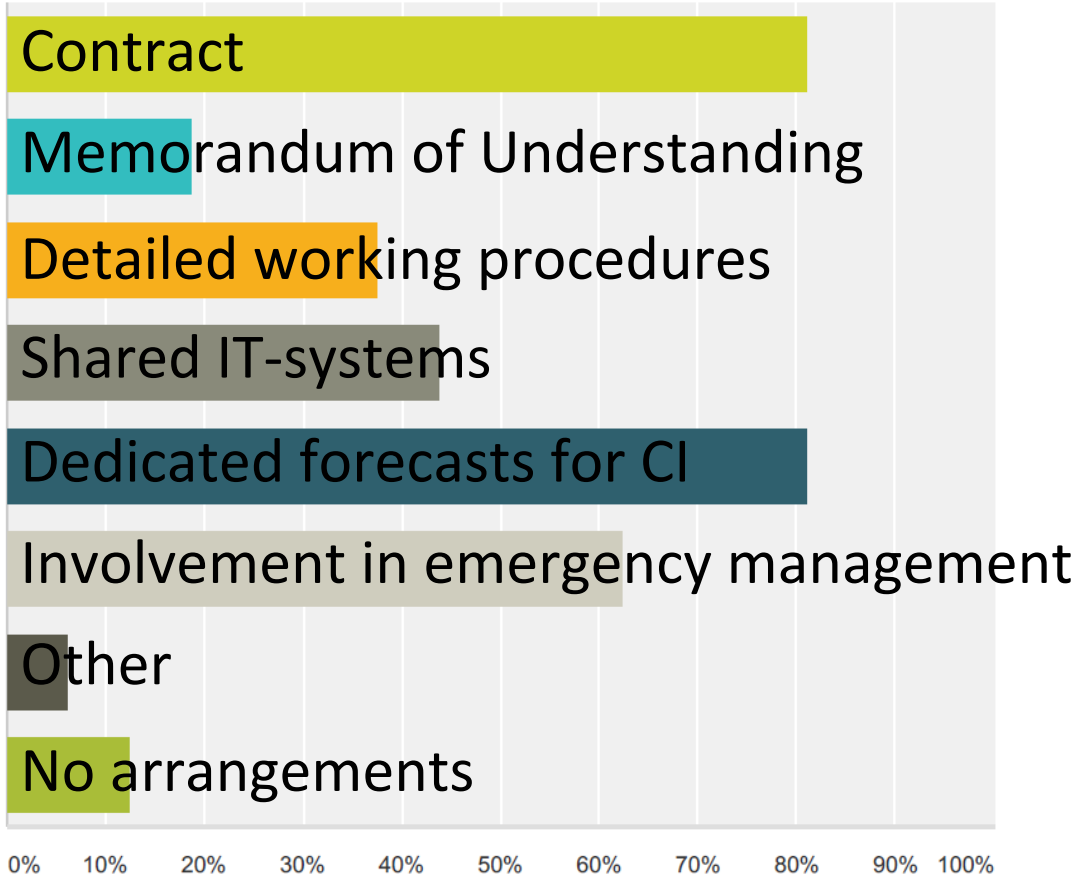
There‘s not only the meteorological component in the warning system

What kind of essential framework arrangements are made between critical infrastructure (CI) customers and your weather service?



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Consequences

Do you feel well informed about possible effects of extreme weather conditions on processes or assets of critical infrastructure customers?

9 Yes (for example: „*we have a lot of contact with the emergency agencies*”)

3 Partly

3 No

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Examples for hazard-specific results for 9 categories

- Windstorms
- Heavy precipitation
- Coastal floods
- River floods
- Heavy snowfall, snowload and blizzard
- Wildfires, forest fires
- Hail
- Thunderstorm gusts
- Tornadoes

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Windstorms

- Increased use of Ensemble Prediction System (EPS) output helps to forecast cones of uncertainty

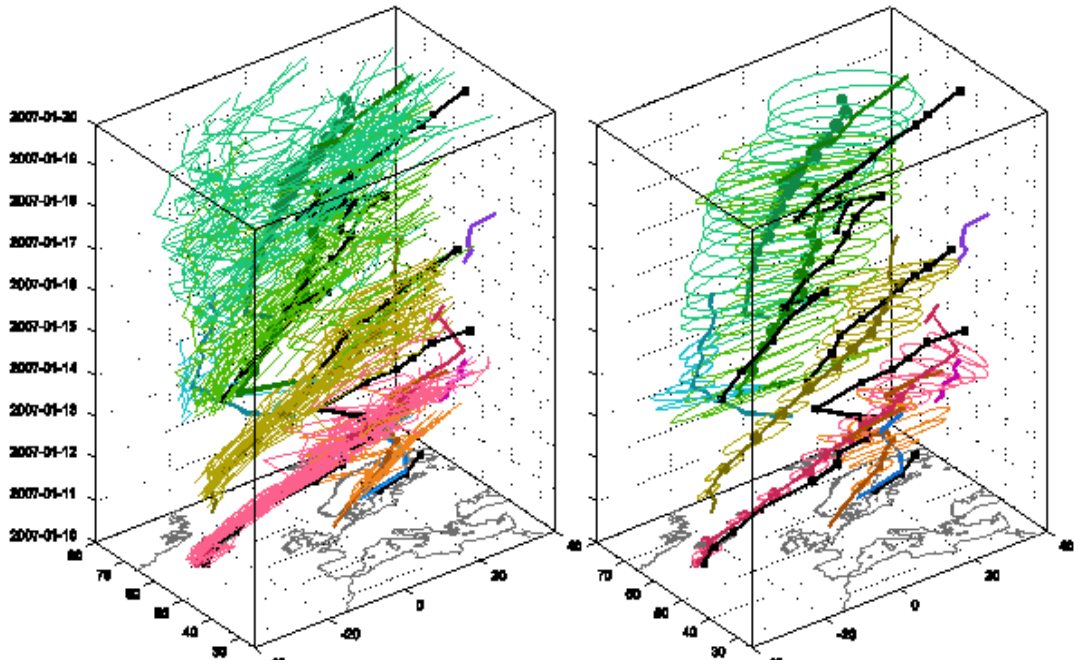

Figure: Windstorm EPS tracks in space and time (FU Berlin)

- Predictability declines after 3 days. No usable forecast skill after 10 days.

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Heavy precipitation

- Good short-term predictability from numerical models
- No skill after 10 days
  (see figure: „dangerous“ means negative correlation)

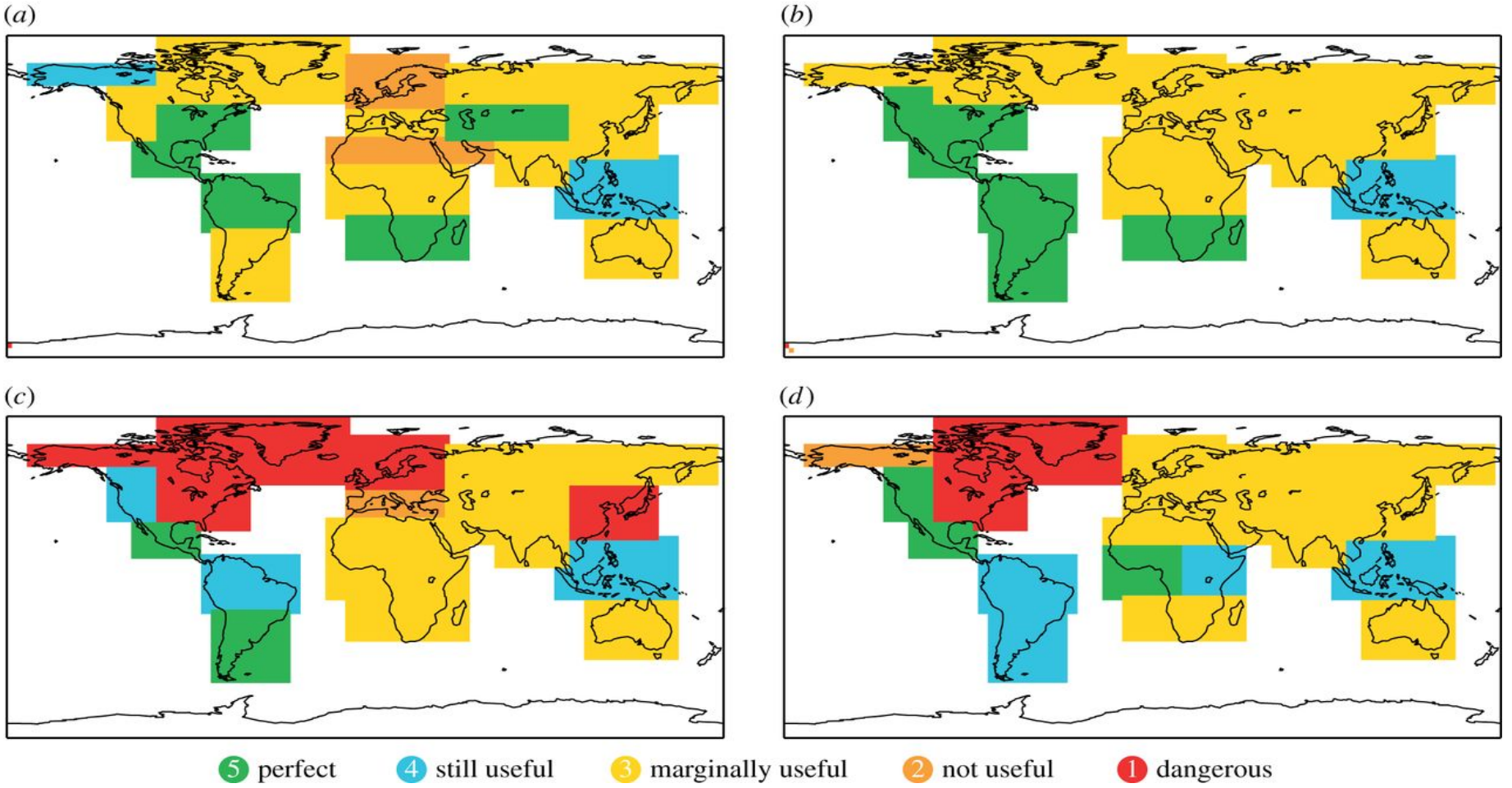

Figure: Reliability of seasonal forecasts for 4 different seasons, from Weisheimer and Palmer (2014).

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Coastal floods

- Availability modest compared to river floods
- Coastal floods are relatively rare and do not concern all countries.
- Need for a pan-European system.

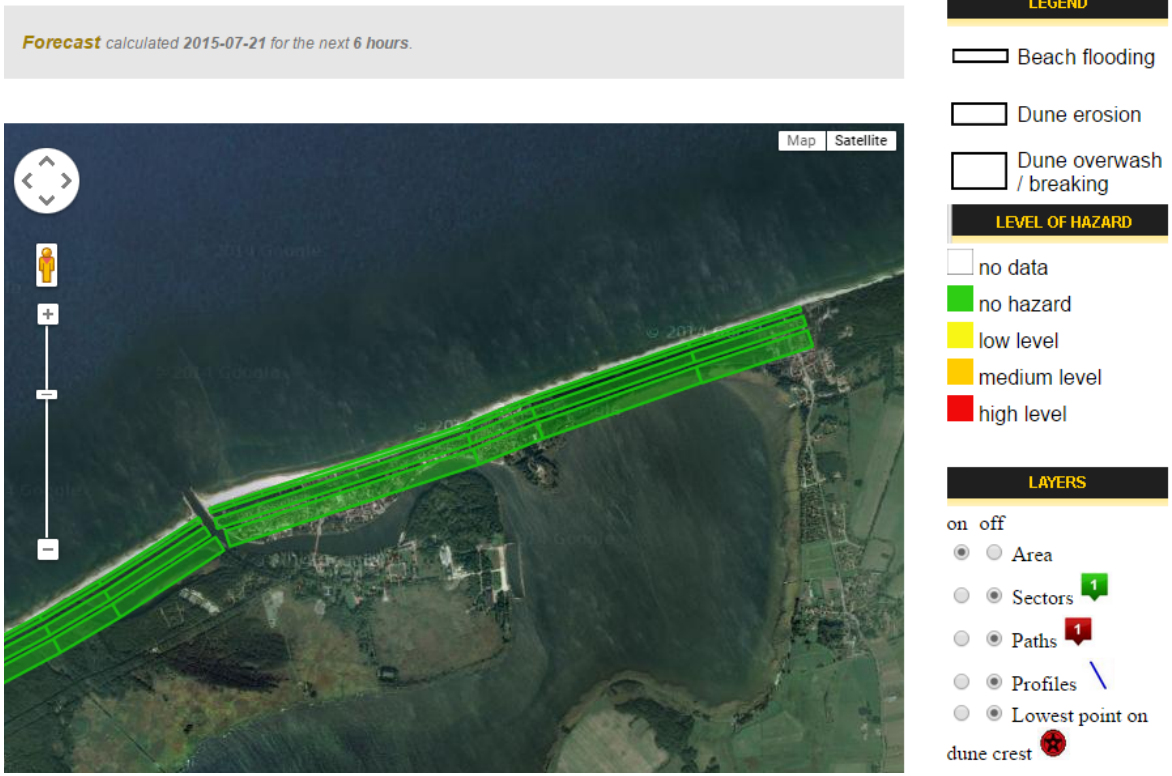

Figure: Pilot early warning system for Dziwnów, Poland, which integrates sea level and wave parameters with morphodynamics of the coast (from INoM US 2015).

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River floods

- River flood warnings now common in Europe.
- Performance good in short and medium range, depending on catchment area.
- Increased use of probabilistic products (see figure).
- Dissemination of Europe wide warnings and forecasts by EFAS/GloFAS currently restricted.

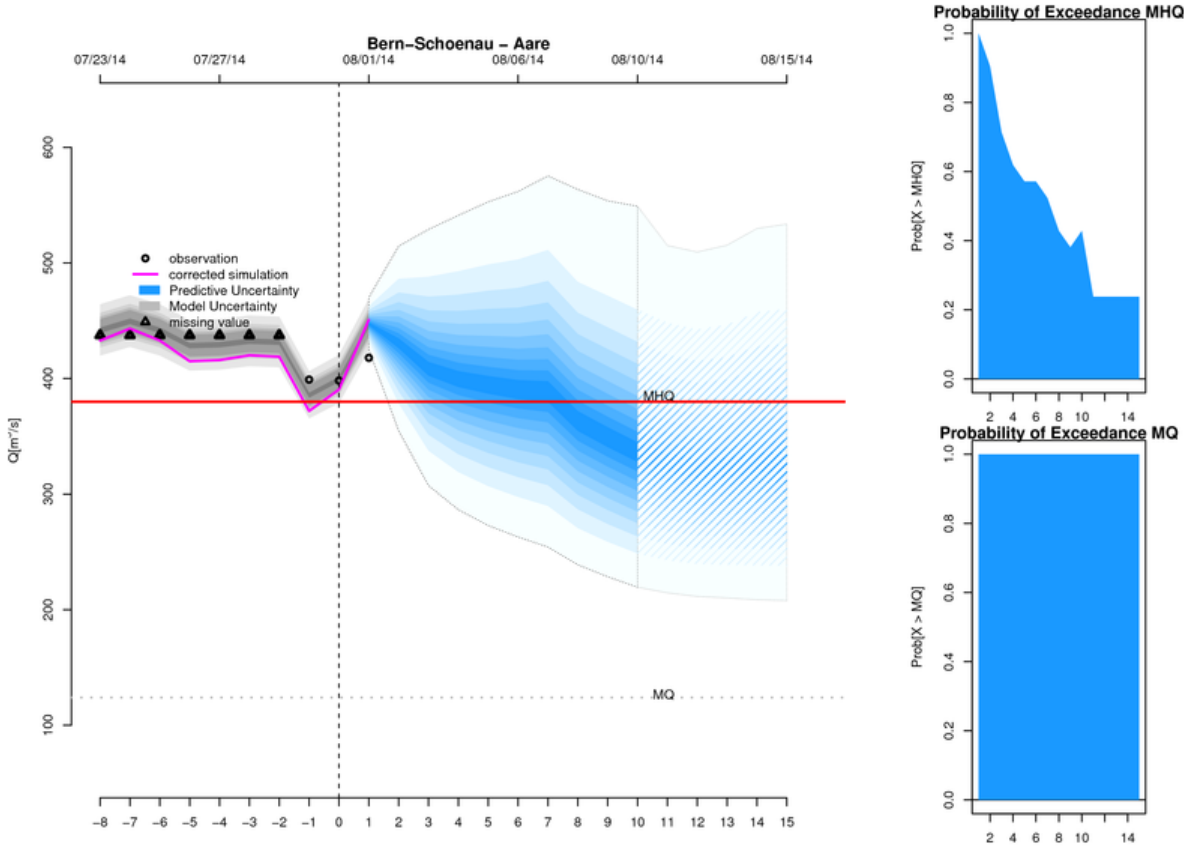

Figure: Probabilistic forecast of river discharges in Bern-Schoenau (Switzerland) and thresholds in EFAS (from EFAS 2015)

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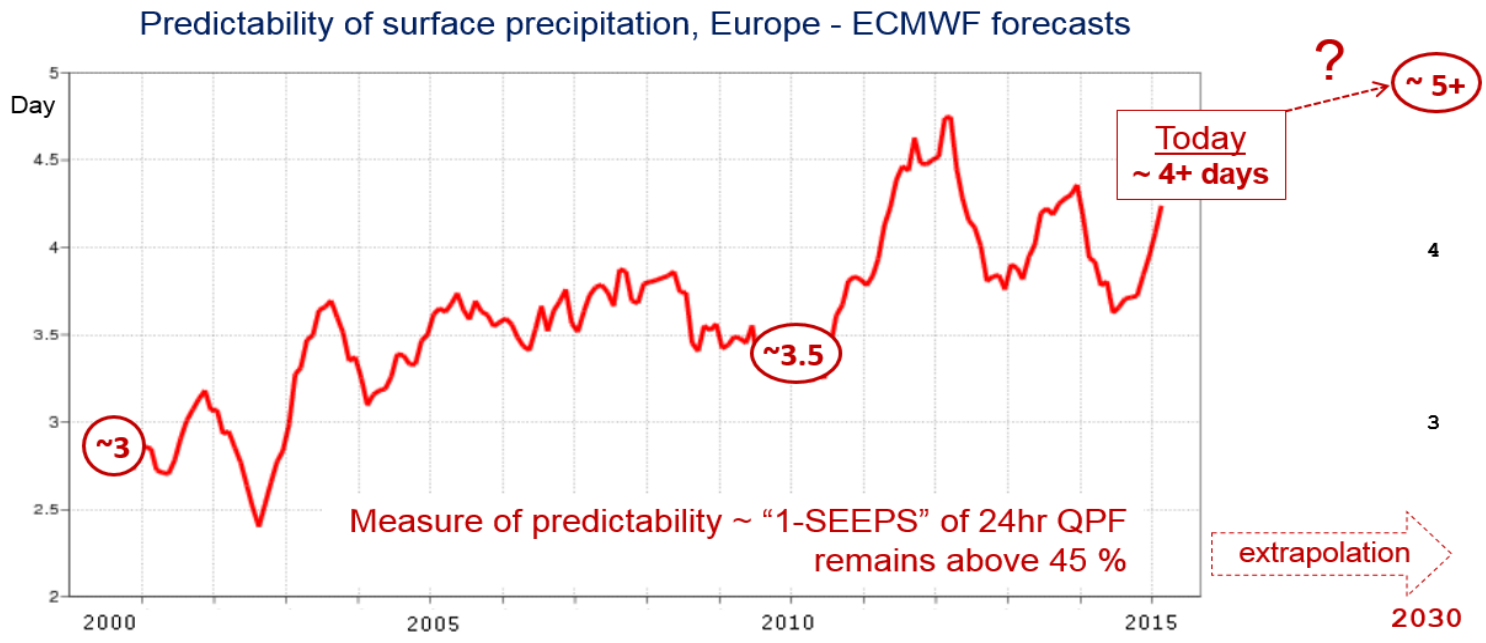
Heavy snowfall, snowload, blizzards

- Predictability depends on precipitation and temperature, for blizzards also on skill of wind forecasts.
- Precipitation forecast: least skillful.



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Wildfires, forest fires

- Warnings not available from all weather services
- Mainly forest fire indices (FFI) are used

FFI	Volumetric moisture	Moisture status
6.0	0.10	Very dry
5.9-5.0	0.11-0.14	Dry
4.9-4.0	0.15-0.19	Moderately dry
3.9-3.0	0.20-0.25	Moderately wet
2.9-2.0	0.26-0.32	Wet
1.9-1.0	0.33-0.50	Very wet

Table: Scaling of the volumetric moisture fraction (volume of water content/volume of soil) into surface wetness class and Forest Fire Index (FFI), from Vajda et al., 2013.

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Hail

- Warnings for large hail not available in many weather services.
- Nowcasting using volumetric and polarimetric radar data
- Short term forecasting using „ingredients“ for hail

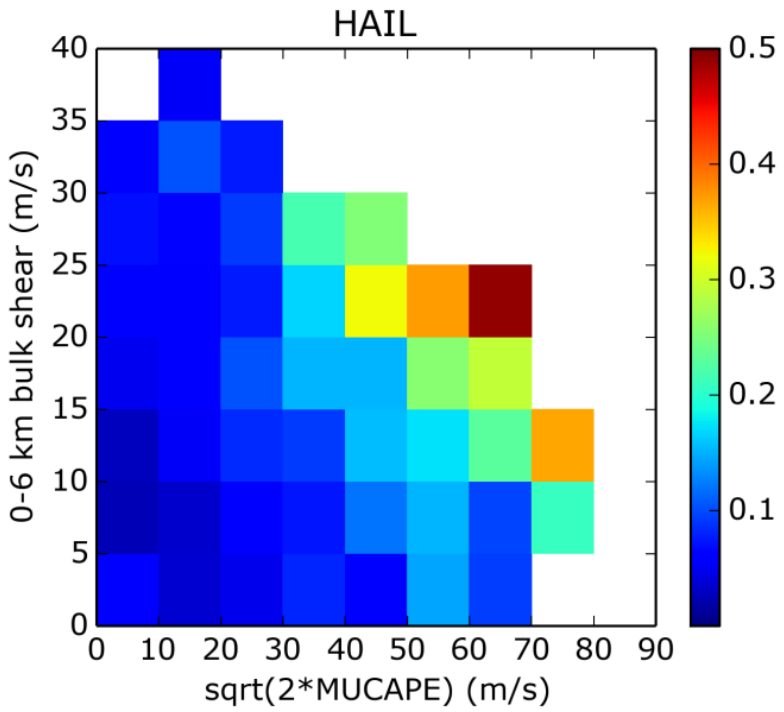

Figure: Probability of large hail in the MUCAPE/shear parameter space (from Púčik et al., 2015)

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Thunderstorm gusts

- Explicit warnings for extreme thunderstorm gusts not common.
- For CI customers only 4 out of 18 weather services offer specialized products
- Probabilistic products needed to provide seamless warning information starting from Nowcasting out to long range.

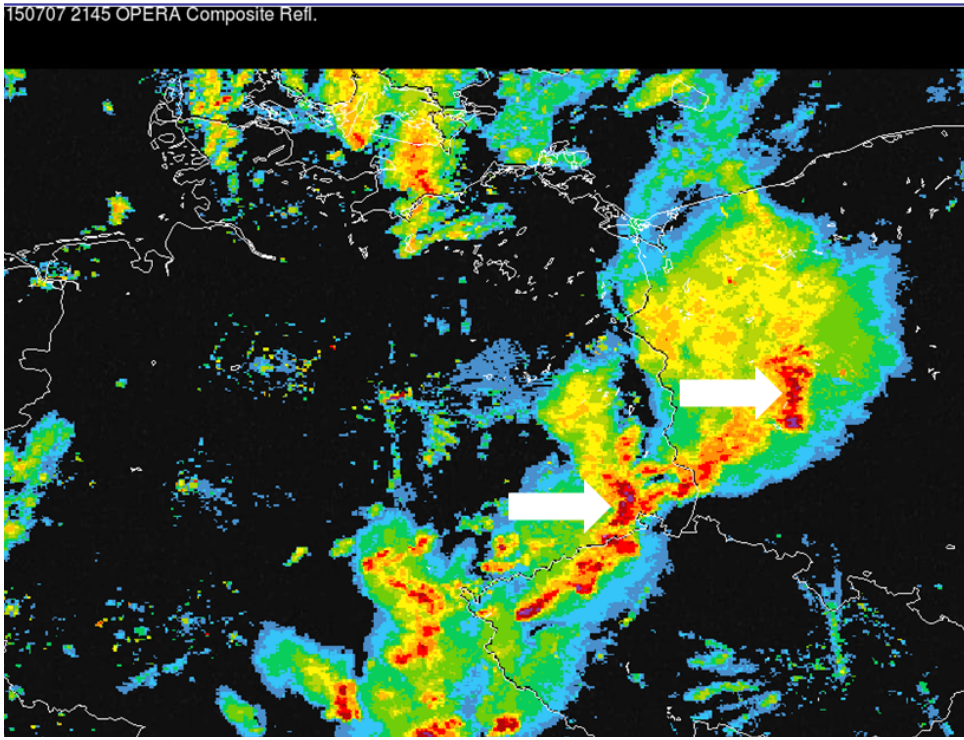

Figure: Bow echoes (marked by white arrows) associated with severe thunderstorm gusts, as seen on OPERA radar composite on late 7th July 2015 (source: OPERA via ZAMG, ESSL Testbed 2015).

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Tornadoes

- Least available warnings in Europe.
- Very short warning lead times (minutes).
- Need for a comprehensive warning system including fast communication means, fast response, and public awareness programmes - especially in tornado prone areas of Europe.

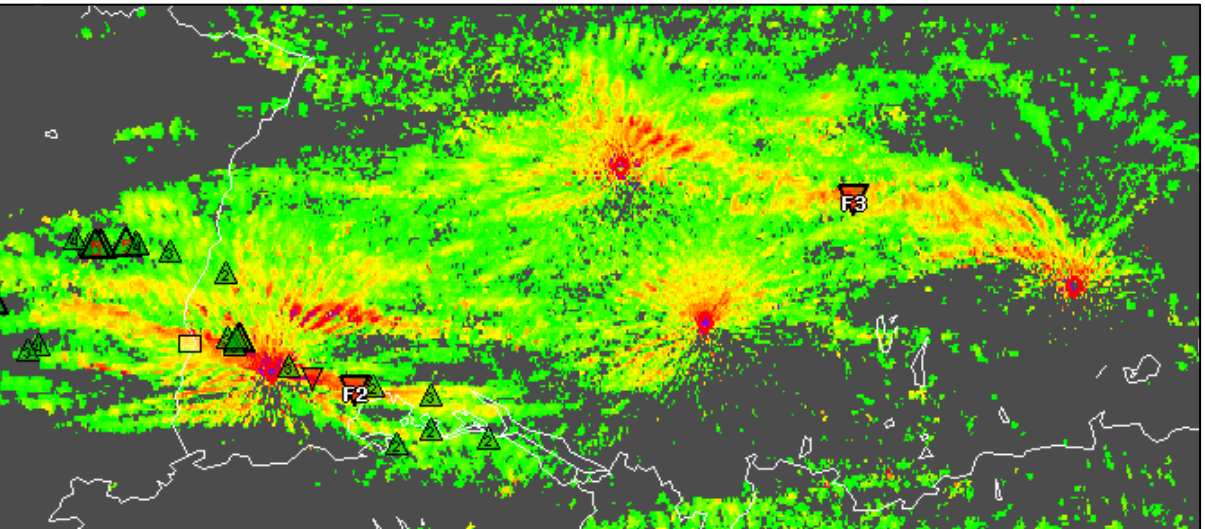

Figure:
DWD experimental low-level rotation track product and ESWD severe weather reports (DWD, ESSL Testbed 2015).

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Skill of issued warning products in Europe

Forecasting ranges according to WMO: / Hazard type:	0–2 h, Now-casting	2 – 12 h, Very Short Range Fore-casting	12 – 72 h, Short Range Fore-casting	72 – 240 h, Medium-Range Forecasting	10 – 30 d, Extended Range Fore-casting	1 – 3 m, 3 Month Outlook, Long Range Forecasting	3 m – 2 y, Seasonal Outlook (departure from climate values)
Windstorms	+	+	+	o	-	-	-
Heavy precipitation	+	+	+	o	-	-	-
Coastal floods	-	-	+	+	-	-	-
River floods	-	+	+	+	-	-	-
Heavy snowfall and blizzard	+	+	+	o	-	-	-
Wildfires/ forest fires	?	?	+	?	-	-	-
Hail	o	o	o	-	-	-	-
Thunderstorm gusts	+	+	o	?	-	-	-
Tornadoes	o	-	-	-	-	-	-

Legend	
-	Products not available or useless.
o	Little use for some applications.
+	Useful, strong additional value compared to mean climate information.
?	Unknown.

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Availability of warning products **for CI**

Forecasting ranges according to WMO: Hazard type:	0 – 2 h, Now-casting	2 – 12 h, Very Short Range Fore-casting	12 – 72 h, Short Range Fore-casting	72 – 240 h, Medium Range Forecasting	10 – 30 d, Extended Range Fore-casting	1 – 3 m, 3 Month Outlook, Long Range Forecasting	3 m – 2 y, Seasonal Outlook (departure from climate values)
Windstorms	+	+	+	?	-	-	-
Heavy precipitation	+	+	+	o	-	-	-
Coastal floods	-	-	o	o	-	-	-
River floods	-	o	+	+	-	-	-
Heavy snowfall and blizzard	+	+	+	o	?	?	?
Wildfires/ forest fires	?	?	+	o	?	-	-
Hail	o	o	o	-	-	-	-
Thunderstorm gusts	o	o	o	-	-	-	-
Tornadoes	?	?	-	-	-	-	-

Legend	
-	Not available.
o	Available from some weather services in Europe.
+	Available from many weather services in Europe (standard product).
?	Unknown.

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General recommendations to the EU

- Develop European-wide efforts to operationally monitor and study hazards that are best addressed at this scale – thunderstorms, fires, coastal floods.

- Foster international research, collaboration and coordination involving weather services around Europe on these issues:
  - weather warnings vs impacts
  - warning thresholds
  - the exchange of knowledge on best practices and innovations
  - probabilistic warnings
  - improving nowcasting and short-range forecasting
  - improving forecast skill beyond 10 days

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Recommendations - continued

- Meteorological data, warning data and warning verification data should be publicly available (for the sake of inovation)

Hazard-specific recommendations available in RAIN report D2.3:
„Present state of risk monitoring and warning systems in Europe"
… soon ready for download on the RAIN webpage
www.rain-project.eu

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Any questions?

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Conclusions

- Each of the different hazard types requires a very specific warning treatment.
- Not only are the modelling approaches very diverse, but also the availability and skill of different forecast and warning ranges.
- Some products with no forecast skill are being made available (especially long range and seasonal products).
- Forecast skill would be present for some hazards and warning ranges, which are not covered by warning products (especially Nowcasting).
- The amount and type of effort that was put into developing modern warning systems differ substantially between hazards … and also from one country to another.
- Some hazards require a European rather than a national approach, at least in the form of warning concepts, warning guidance and forecaster training.
- Specialized CI warning products are less available for CI operators than public products.

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