

Approaches for making ensemble forecasting based services more suitable to end-users needs

PONZANO Matteo; JOLY Bruno; BEAU Isabelle; LEMAÎTRE Olivier; MICHEL Yann;
ROTTNER Lucie; CRISPEL Pierre

Using ECMWF's Forecasts (UEF2023)
Reading, 7 June 2023

Background and motivation

- Joint study involving the Meteorological Services and the Business Operation departments
- Identify and address **end user's needs** in ensemble forecasting products (depending on the customer profile)
- **Review** of the operational and work-in-progress products exploiting ensemble models and data
- **Enhance** the current range of products and services offered to private and institutional clients

- 1. Identify and address the end user's needs**
2. Review of the operational and work-in-progress products
3. Enhance the current range of products and services

How do end users understand probabilistic weather forecasts?

- The understanding of a probabilistic product depends on two key elements:
 - **Customer's need** (workflow planning, human resources management, preventive actions, cost/loss optimization...)
 - Aptitude of the end user to **deal with probability** and classes of events (customer profile)

Recurring management process



Able to handle cost/loss



Uncertainty and probability is
an added value

vs

Risk assessment for a rare event



Hazards = cost or loss = more charges



Uncertainty and probability are a
limitation

How do end users understand probabilistic weather forecasts?

- The understanding of a probabilistic product depends on two key elements:
 - **Customer's need** (workflow planning, human resources management, preventive actions, cost/loss optimization...)
 - Aptitude of the end user to **deal with probability** and classes of events

Experienced end user

vs

Occasional end user

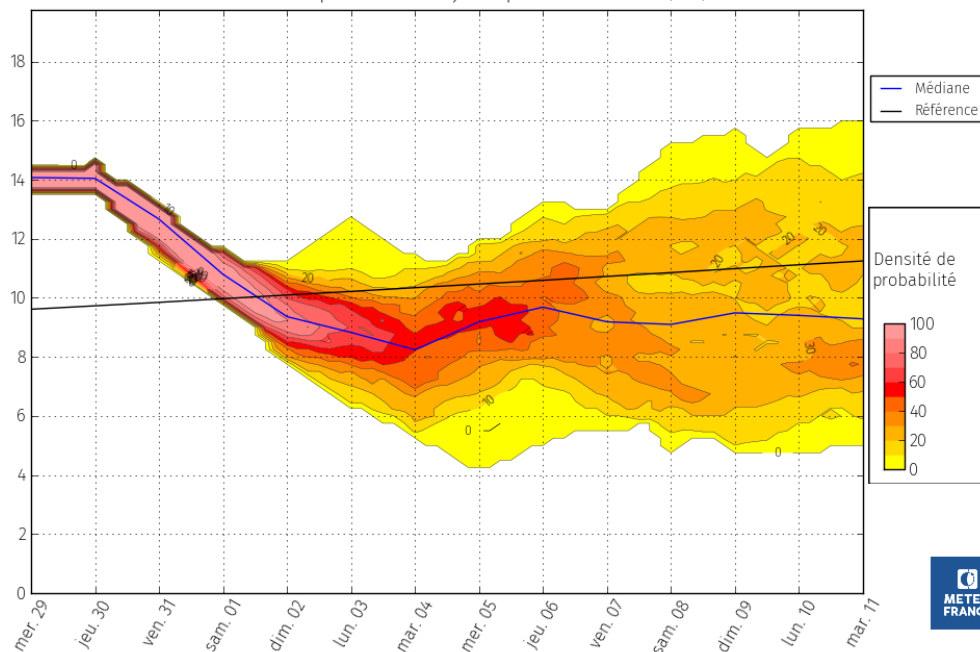
- Identify **use-cases** according to the targeted end user
- Co-developing processes are recommended to adapt uncertainty representation to decision making protocols

1. Identify and address the end user's needs
2. Review of the operational and work-in-progress products
3. Enhance the current range of products and services

Target : **experienced end user**

Energy sector - temperature forecast

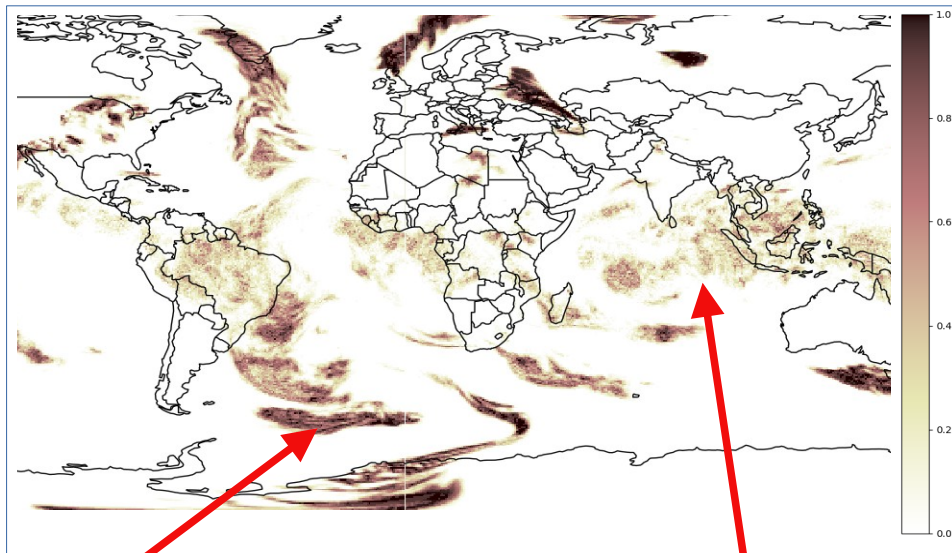
Prévision de la température moyenne France (moyenne pondérée 32 stations)
Densité des runs de la prévision à 14 jours pour le réseau 28/03/2023 12H



- Electric network management
- Pre-tactical planning
- PDF representation → easy to show divergence among ensemble forecast members

Prediction of areas in which contrails are likely to be persistent

Probability of persistent contrail occurrence – case of the 2nd December 2022 r00z H+12

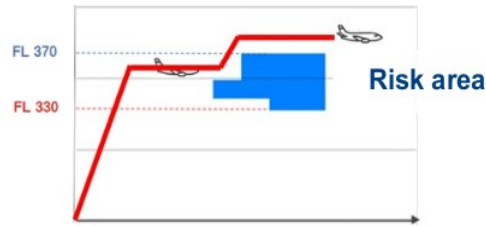


Higher probability

Lower probability

Target : **experienced end user**

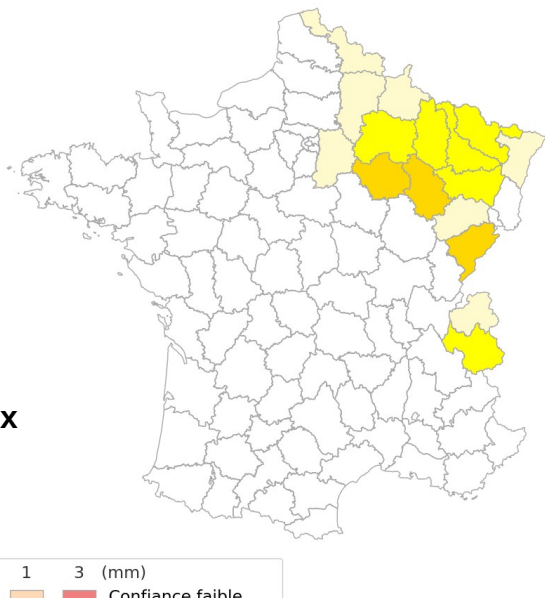
- Impact-oriented persistent contrails → global positive impact on the radiative forcing
- Optimisation problem against climate change
- Loss of spatial consistency of the targeted parameter
- SESAR3 – CICONIA project (2023-2026): quantify the radiative forcing induced by persistent contrails
- Further plans: exploit this product through optimisation algorithms for air traffic management



Target : inexperienced end user

WIRE: ice thickness on electric cables or wind turbines

WIRE: Carte de surveillance probabiliste
Risque de manchon de glace sur câble 15mm hauteur 010m
Période: du 26/04/2023 03h UTC au 27/04/2023 15h UTC



Risk matrix

Seuil 0.01 1 3 (mm)

Light yellow	Light orange	Red	Confiance faible
Yellow	Orange	Dark red	moyenne
Dark yellow	Dark orange	Dark red	élevée

Avertissement: cette production est destinée aux professionnels des secteurs de l'énergie et des transports. Elle ne se substitue pas à la vigilance météorologique institutionnelle.

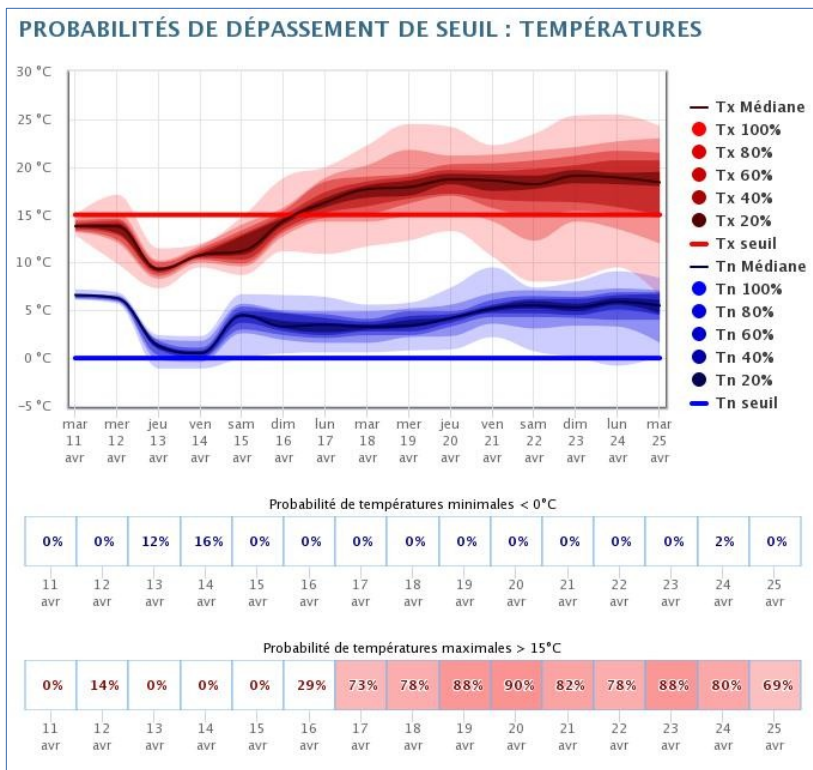
- **Benefit:** take actions to avoid power cuts
- Impact based warning for a Department-wide strategy (36-hour time window)
- Risk matrix approach
- Ensemble prediction-based information is implicitly integrated in the warning tool
- Probability and impact thresholds should be selected depending on the end user exposure





Target : occasional end user

“PréviProba” product



- Evolution of predicted daily Tmin and Tmax for a given location
- The probability that the parameter is above or below a selected threshold is provided at each lead time
- Additional variables available: *wind gust, daily total rainfall and daily total snowfall*
- Is an occasional end user able to suitably exploit this product?

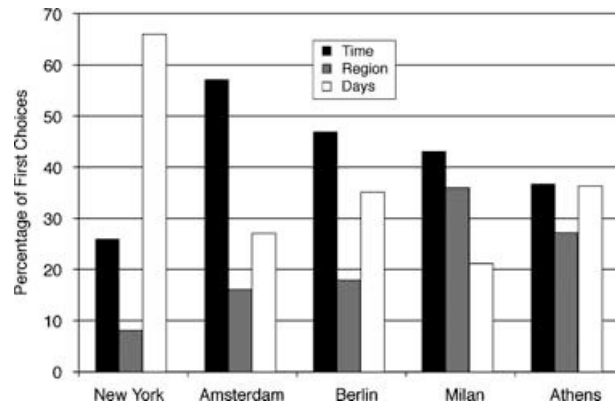
Occasional end user: dealing with probability

1. Misinterpretation of quantitative probability for a single event:

- “There is a 30% chance of rain”
 - a) It will rain tomorrow in 30% of the region
 - b) It will rain tomorrow for 30% of the time
 - c) It will rain on 30% of the days like tomorrow

2. Decision-making process:

- many occasional end users are not able to quantify a risk on the basis of a probability of occurrence of a specific event
- is probability really useful for binary decision end users?



First choice. People in New York (n = 103), Amsterdam (n = 117), Berlin (n = 219), Milan (n = 203), and Athens (n = 108).

From: *Gigerenzer et al. (2005)*

1. Identify and address the end user's needs
2. Review of the operational and work-in-progress products
3. Enhance the current range of products and services

A preliminary study: Spring frost in the vineyards in Bordeaux region

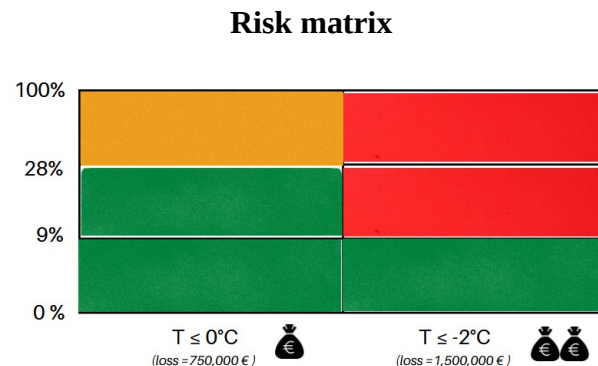
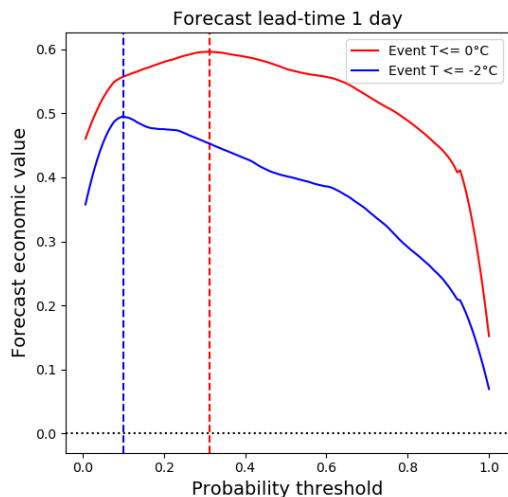
- Frost impacts the buds during April/May
- Burned buds cannot produce grapes
- Consequence: loss of productivity
- Two impact temperature thresholds: 0°C and -2°C
- Challenging issue: on the basis of a probabilistic forecast, should a **preventive action** be triggered or not?



candles

A preliminary study: Spring frost in the vineyards in Bordeaux region

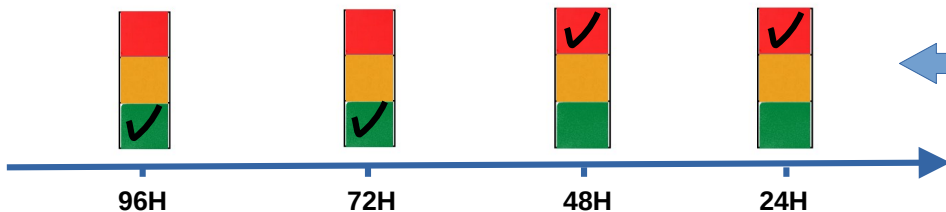
- Customisation of the probability decision threshold using the forecast economic value
- The economic value depends on the **forecast skill** (using forecast from the past) and **cost/loss** ratio
- Estimation of this value using the method described by *Myline K. (2002)*



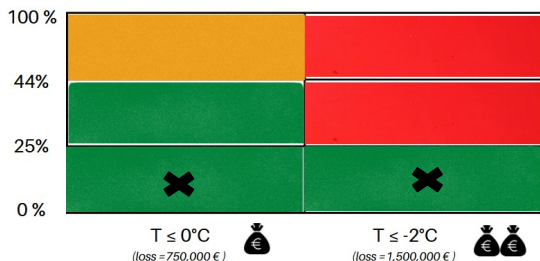
A case study: 3th April 2022

- Cost : 300 000 € for 0°C, 400 000 € for -2°C
- Loss : 750 000 € for 0°C, 1 500 000 € for -2°C

Tmin : -2.2°C



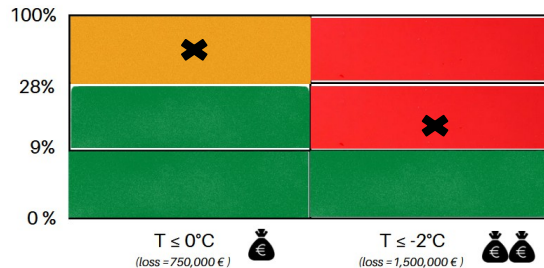
96H



$$P(T < 0^{\circ}\text{C}) = 4\%$$

$$P(T < -2^{\circ}\text{C}) = 0\%$$

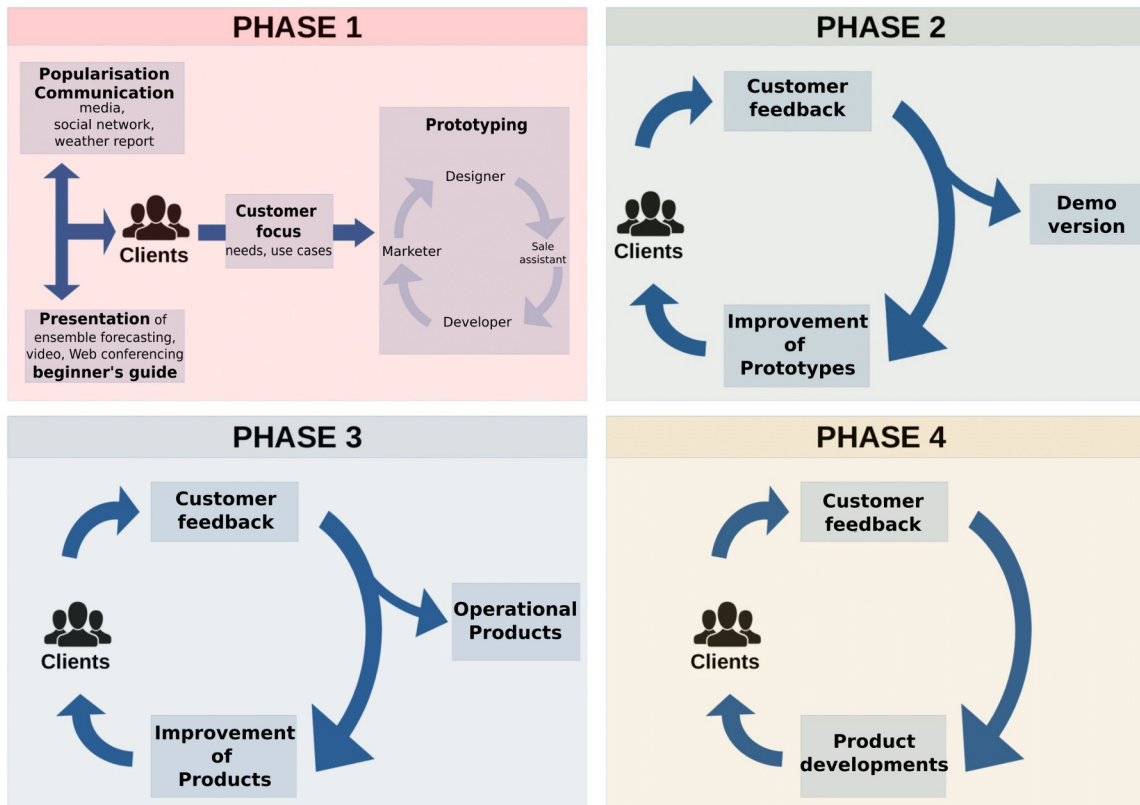
24H



$$P(T < 0^{\circ}\text{C}) = 80\%$$

$$P(T < -2^{\circ}\text{C}) = 11\%$$

A tool to design a valuable ensemble forecast product



Conclusions

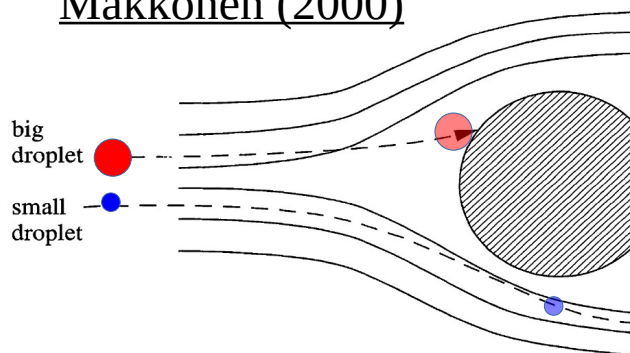
- The correct interpretation and the usage of ensemble forecast products is closely linked to the end user profile
- More specifically, for occasional end users in a decision-making situation, the correct estimation of a risk using probability forecasting is challenging
- One of the current objectives of Météo-France is to enhance the current range of products and services in order to provide suitable information for impact forecasting
- A preliminary study to design a customised ensemble based decision making product showed promising results
- Future plans include extending the employment of this approach to other commercial and institutional sectors at all lead-times and spatial resolution

Thank you for your attention!

Contact: matteo.ponzano@meteo.fr

WIRE: ice thickness on electric cables

Makkonen (2000)



$$\frac{dM}{dt} = \alpha_1 \alpha_2 \alpha_3 w v A$$

- α_1 : Collision efficiency
- α_2 : Sticking efficiency
- α_3 : Accretion efficiency



External parameters: thickness and height of the cable

Prediction of areas in which contrails are likely to be persistent

