Roadmap of future applications

D4.5 - RoFA

PNOWWA

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PNOWWA

PROBABILISTIC NOWCASTING OF WINTER WEATHER FOR AIRPORTS

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Abstract

This document describes a roadmap about how the results will be developed into operational applications and which parameters has to be added in future probabilistic products. During PNOWWA, the user feedback lead to possible further developments such as the extension of lead time or the implementation of additional forecast parameters and also to extent the use of probabilistic forecasts from winter to summer weather, since probabilistic forecasts consider the intrinsic variability of weather and will help to increase the resilience of airports in future adverse weather operations.

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Abbreviations

CDM	Collaborative Decision Making
ICAO	International Civil Aviation Organization
METAR	METeorological Aerodrome Report
MG	Maturity Gate
PNOWWA	Probabilistic Nowcasting of Winter Weather for Airports
TAF	Terminal Aerodrome Forecast
TRL	Technical Readiness Level

Executive Summary

PNOWWA - Probabilistic Nowcasting of Winter Weather for Airports – is a research project developing methods to support the Air Traffic Management (ATM) challenged by winter weather. In winter 2017, PNOWWA organized a real-time demonstration campaign providing to selected end-users very short-term (0-3h) probabilistic winter weather forecasts in 15 minute time resolution. The nowcasts are based on extrapolation of the movement of weather radar echoes, and ensembles are generated by adding stochastic perturbations.

In this deliverable document an overview of the roadmap of future applications for probabilistic forecasts at airports is introduced. The roadmap spans a period from 2018 to 2029 for product development of probabilistic winter weather forecasts and further 2 years (toward 2031) are estimated to integrate all weather elements, e.g. such as thunderstorms, to create an all-weather probabilistic forecast system as if made from one piece.

1 Introduction

PNOWWA (Probabilistic nowcasting of winter weather for airports) is a SESAR H2020 fundamental exploratory research. Presented demonstrator in this project is used as proof of concept. The focus of the project is development of probabilistic forecast for short-range and collection of user feedback. To reach higher maturity levels, more work is needed.

User survey (see [1]) and the user feedback after 2 winter demonstration phases (see [2], [3]) has been collected, which results in following suggestions, listed in chapter 2 in this document.

In PNOWWA, we are using weather radar data for short-range forecasting. These data of precipitation fields are characterized by highly spatial and temporal resolution and subsequent an ideal source for the generation of extrapolated precipitation fields for using in nowcasting (sort range forecasts within 0-3 hours). Nevertheless, data fusion is needed to extend forecast lead time to integrate all relevant additional forecast parameters. Thise was requested by airport stakeholders for tactical planning.

Future application of probabilistic forecasts for airports has to consider four main tasks:

- Quality of the product with respect to automation (decision making and automated short range forecast)
- Product layout (such as adequate and interactive graphics, mobile apps and automatic update)
- Extension of lead time - seamless prediction up to at least 48 hours
- General probabilistic forecast tool for all weather events (extend winter weather toward summer deep convection and fog conditions)

2 Roadmap

An overview of the roadmap of future applications for probabilistic forecasts at airports is given in Fig. 1. The roadmap spans a period from 2018 to 2029 for product development of probabilistic winter weather forecasts and further 2 years (toward 2031) are estimated to integrate all weather elements, e.g. such as thunderstorms, to create an all-weather probabilistic forecast system as if made from one piece. Results from demonstration campaign 1 during winter 2017 [2] showed the need for a seamless (short and long range –from hours to days) forecasting system of high quality which can be used not only for adverse winter weather prediction.

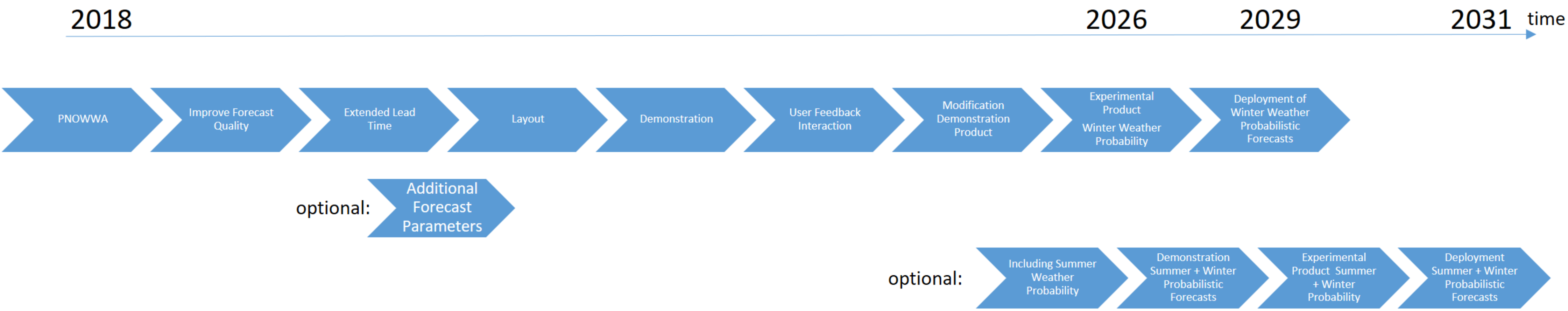

Fig. 1: Overview of the roadmap of probabilistic weather forecasts for airports

More details including additional description and maturity gates are listed in Fig. 2 next page.

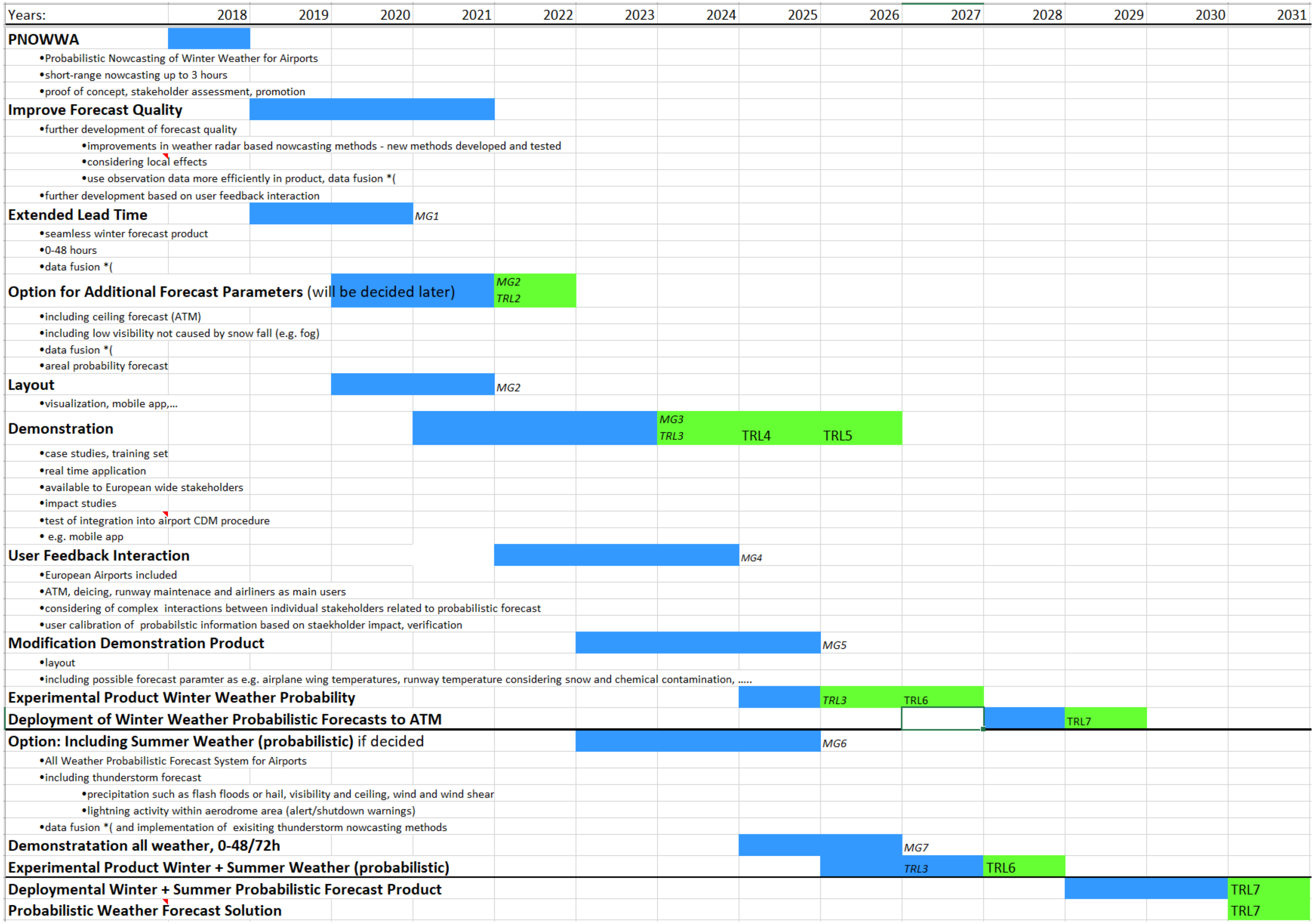

Fig. 2: Roadmap of probabilistic weather forecasts for airports.

To increase the forecast quality, further analyses of weather radar data and the integration of new methods are needed. For increasing the lead time up to 24 hours and to integrate additional requested meteorological parameter such as ceiling or low visibility fog, data fusion is needed. Weather radar data alone are not able to capture all aspects as mentioned before.

Data fusion (see remark "*(" in Fig 2) means the integration of data from:

- Numerical weather prediction models: ensemble prediction systems are suitable for probability forecasting [4]
- Special models:
  - cloud physics model
  - road weather model to be used for runway conditions [5]
  - model for fog (e.g. [6]) or drifting snow [7]
- ICAO annex III products (e.g. TAF, METAR)
- Additional observations (e.g. runway or airplane wing temperature, amount of used chemicals, ..)
- Dual polarized weather radar

Future probabilistic weather forecasting experimental product should be available for all European airports which are affected by adverse winter weather. Integration in airport collaborative decision making (CDM) and state of the art layout and mobile application (e.g. mobile app for smart phones) should be tested.

Even when severe winter weather at airports are rare events with strong impact on safety and economic aspects, user have to find and derive adequate thresholds for the likelihood values of different weather parameters (e.g. freezing rain or different snow height). These thresholds give them the correct balance of the alert and false alarms for specific applications.

Future application such as forecasts for airplane wing temperatures (de-icing handling) or runway temperature considering contamination of snow of chemicals (runway maintenance) might be added when requested.

Last-mentioned, future probabilistic weather forecast system for airports should capture all weather events for all seasons, namely snow fall, fog and thunderstorms.

The maturity gates are listed in

Fig. 2 to divide into distinct stages. There are slightly overlaps, but at this point continuation of the program is decided.

MG1: The extend of forecast lead time has to be demonstrated by generating a demonstration product up to at least 24 hours and showing the performance for case studies and collecting stakeholder feedback for the use in tactical planning.

MG2: After PNOWWA the probability product has to be enriched by optional additional forecast parameters and more advanced visualization of the products. At the end of this phase, additional areal probabilistic distribution of winter precipitation and low visibility procedures has to be captured. Case studies demonstrate the forecast performance of the new parameters and user feedback has to be collected.

MG3: After passing successfully MG1 and MG2, the demonstration in close cooperation with stakeholders has to be applied and positive user feedback has to be collected. Positive effects during adverse winter weather operation in using probability winter weather forecasts has to be demonstrated.

MG4: Demonstrator will be provided European wide and a survey will collect useful hot spots in Europe, affected by adverse winter weather with high potential for using probabilistic winter weather forecasts. In cooperation with stakeholders at individual airports, probability thresholds for certain weather elements have to be defined and adjusted.

MG5: Modification of the probabilistic winter weather product will be implemented to reach higher technical readiness level of the experimental product. Experts from aviation and meteorology will decide about further implementation in operational procedures.

MG6: Case studies demonstrate the usability of probabilistic summer weather forecasts for stakeholders, such as possible application and solutions for flight planning or ATM approach procedures using areal maps of thunderstorms. Positive user feedback from online demonstration campaign has to be collected.

MG7: The use of probabilistic weather forecasts during winter and summer has to be demonstrated and validated. Positive user feedback is mandatory. To reach higher technical readiness levels the product will be modified in regard to user feedback.

3 Conclusions

The PNOWWA demonstrator was developed within SESAR H2020 fundamental exploratory research program. Further work is needed to reach higher maturity levels and to generate an experimental product for future operational application used by airport stakeholders. The roadmap for future operational application suggest the integration of additional forecast parameter (ceiling, reduced visibility due to fog, …) and the extension of lead time up to 2 days. In close cooperation with air traffic management, de-icing and runway maintenance the impact on airport operation has to be defined with respect to probability classes. From user perspective, in the future also summer weather has to be included, which results in one probabilistic forecast system to predict all weather elements relevant for airport handling.

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