Pseudo METAR validation report

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1. Definition

Pseudo-METAR service have been designed specifically for the need of the SafeNcy project.

METAR are regulated observation report at airport location. They can be manual, semi-automated or fully automated. The METAR format is highly regulated by ICAO annex III. METAR typically contains temperature, dew point, wind, precipitation, cloud cover, visibility, barometric pressure.

Pseudo METAR aims at giving the same weather parameters at location that are not equipped with observation means. In the context of SafeNcy, the location is a candidate landing site. Meteorological Parameters for a given location are extracted from numerical weather models. They are not a direct live observation on location but what calculated values on this location. The idea behind is a **'better than nothing'** approach for meteorological information on a location not equipped with observation means.

The METAR format has been chosen because this is the known regulated format used by pilots for normal operation.

The pseudo-METAR service is technically a simple request-reply mechanism used by the SafeNcy platform. The service technically follows the same requirements than METAR SWIM service e.g. SWIM yellow profile.

- Request: the user specifies a location
- Reply: The MetSafe platform provides information extracted from numerical weather and present it in the format of a METAR

Numerical weather models supporting pseudo-METAR are:

- GFS 25km resolution, global coverage
- GDPS 15km resolution, global coverage
- Icon-eu 7km resolution, local coverage (Germany)
- Arome France 2.5km resolution , local coverage (France)

Here is an example of pseudo METAR generated by the MetSafe platform:
METAR LIEO 011420Z AUTO 05005KT 9999   BKN031 BKN261 18/12 Q1014

2. Objectives

The objective of the validation activities are:

- to quantify the error associated with using forecast as observation,
- to conclude on the acceptability of pseudo METAR in the frame of emergency situations
- to explore potential improvements.

A focus on the potential safety impact of pseudo METAR in the frame of the SafeNcy ConOPS has been performed with the support of a SafeNcy pilot expert.

3. Methodology

The validation is based on comparing pseudo-METAR generated by the MetSafe platform versus real METAR generated on airport location by Meteorological Service Providers in Europe.

Pseudo METAR generated by MetSafe:
METAR EBBR 240850Z AUTO 24019KT 9999 CONV BKN035 12/08 Q1006

Real METAR generated by European Meteorological service:
METAR EBBR 240850Z 24015KT 9999 VCSH FEW024TCU SCT026 13/08 Q1006
TEMPO 25015G25KT 4000 SHRA

The service has been provided to an operational pilot expert that performed some comparison based on its own tool.

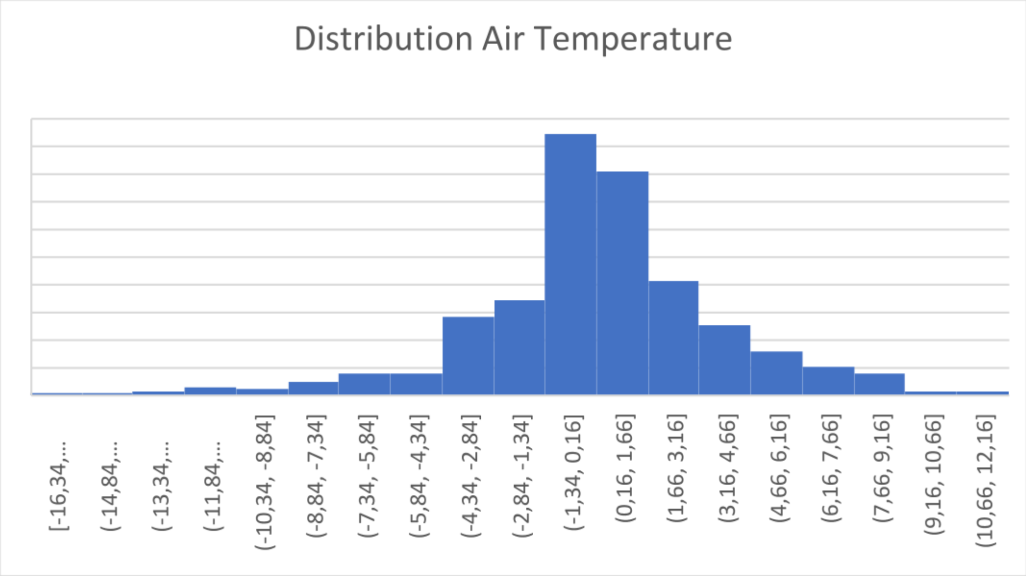
We used a sampling approach, selecting some day of interests in Europe based on meteorological situations. The validation is not exhaustive and should be performed on longer dataset. However, the sampling approach allow first order conclusions.

The result below represents 1493 samples of pseudo-METAR on the 24-05-2022 at 0900UTC.

4. Statistical results

4.1 Temperature

T°(pseudo-METAR)– T°(METAR)	
Means	0,139 degrees
Median	0,135 degrees
Standard deviation	2,66 degrees



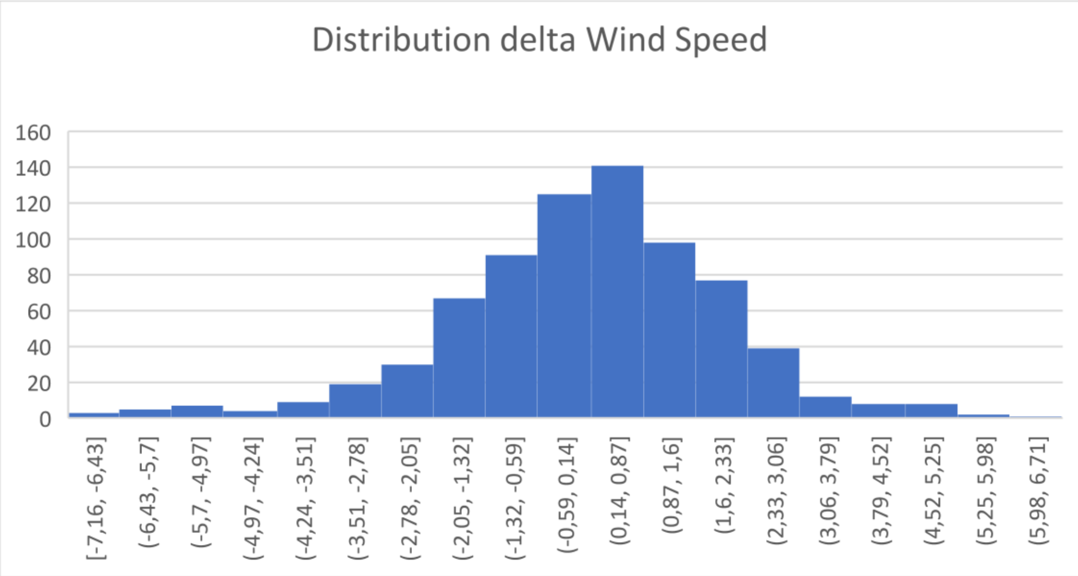
Generally speaking, temperature extracted from model are a good approximation of an observation at Airport.

The maximum temperature difference between a forecast and an observation acceptable by pilots is 2 degrees.

Potential consequence of a bad temperature in the frame of SafeNcy CONOPS has been assessed : around 0 degree Celsius it will be important to know if temperature is above zero or freezing. On a short runway and with high temperatures, a wrong temperature of more than 2 degrees start to create a serious error on landing performance.

4.2 Wind speed

Wind speed(pseudo-METAR) – Wind speed(METAR)	
Means	0,090241287 knots
Median	0,175 knots
Standard deviation	1,417948235 knots



Generally speaking, wind speed extracted from model are a good approximation of an observation at an airport.

The maximum wind speed difference between a forecast and an observation acceptable by pilot is 5kts.

Potential consequences of a bad wind speed in the frame of SafeNcy CONOPS are:
- erroneous landing performance.
- exceeding crosswind or tailwind limitations.

Wind direction

The maximum wind direction difference between a forecast and an observation acceptable by pilot is: 30 deg

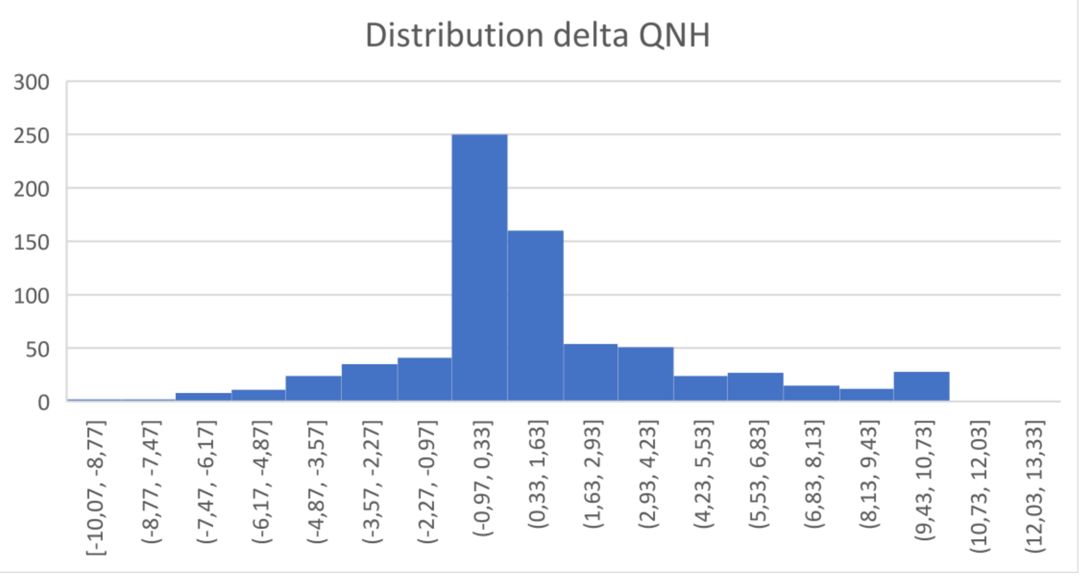
Potential consequence of a bad wind direction in the frame of SafeNcy CONOPS is a wrong landing direction with tail wind in place of head wind which could lead to a runway excursion.

4.2 QNH

QNH is defined as barometric pressure adjusted to sea level.

QNH(pseudo-METAR) – QNH(METAR)	
Means	1,01541555mb
Median	0,335mb

Standard deviation	2,42172667 mb



Generally speaking, QNH extracted from model are a good approximation of an observation at Airport.

The maximum QNH difference between a forecast and an observation acceptable by pilot is: 2 mb

Potential consequences of a bad QNH in the frame of SafeNcy CONOPS are:

- Bad altimeter setting, introducing height error of 28 ft per mb error.
- CFIT Controlled Flight Into Terrain

4.3 Visibility

Visibility is defined in meters. In good visibility conditions, visibility value is 10km.
The model value delivers 10km so statistically in good conditions, the model is very good but it has no meaning statically.
We had to look specifically for bad visibility conditions at specific location on certain days.

Here is an example of such conditions:

REAL METAR: METAR LFLX 240900Z AUTO 22011KT **7000** // FEW021 SCT034 BKN046 13/10Q1012
PSEUDO-METAR: METAR LFLX 240900Z AUTO 24010KT **9999** CONV FEW015 BKN199 SCT234 Q1011

In the example above, the pseudo-METAR delivers 9999meters as visibility whereas real life observation is 7000meters.

We identify several situations where the visibility delivered in the pseudo-METAR was very different form the real-life observation.

The maximum visibility difference between a forecast and an observation acceptable by pilot is variable:

- Above 5000m, 3000m acceptable

- Between 1000m and 5000m , 1000m error acceptable
- Below 1000m, 500m is a maximum

Potential operational consequences of a bad visibility in the frame of SafeNcy CONOPS are:

- A wrong situation awareness, the pilot expecting good conditions when the reality requires a precision approach (which may not be available).
- a change in type of approach (e.g. real VIS may need to change from visual to IFR (if available!), or RNAV to CAT 1 ILS (if available!).

The conclusion is that the value extracted from model is not a good enough approximation to be used operationally. This conclusion was also shared by the operational pilot expert. Pseudo Metar VIS is not "better than nothing" as it can be really misleading.

5. Operational acceptability

Operational acceptability has been assessed following two questions:

Is pseudo-METAR better than nothing?

When the only option left to the flight crew is an off-airport landing or ditching, we see that the Pseudo-METAR Temp, QNH and wind direction and speed give acceptable operational indications. They would permit to avoid landing with tail wind or (thanks to QNH) have a better estimation of height above ground. Therefore, the above listed parameters (excluding Vis and cloud base) remain a better than nothing information for the pilots

Can it be used for emergency operations ?

If there is no real METAR available for the SafeNcy emergency landing site, as said above, the pseudo METAR is better than nothing. But one must know its limitation: visibility and cloud base can be completely false. But if we compare with the present situation with no SafeNcy and no pseudo-METAR, the pseudo-METAR is a valuable additional information for the flight crew decisional process.

The analysis shows that visibility and cloud base can lead to safety issues. This excludes for today an operational use of a complete pseudo-METAR without further R&D.
But a pseudo-METAR presented without visibility and ceiling indication could already be a "better than nothing" information when diverting in emergency towards an off-airport landing site.

6. Improvement

Pseudo-METAR can be improved following several axis:

- Introduction of confidence index

Several numerical weather models are covering the same geographical area. By consulting several numerical weather models, a confidence index that would reflect the consensus of weather model on the value could be built.
It is to be assessed however if the pilot in emergency conditions is capable of dealing with this confidence index for emergency landing decision-making.

- Use of better numerical weather models

For SafeNcy, we use global model with a resolution of 25km.
Use of local numerical weather models (Typically 2km) would dramatically improve the accuracy of certain parameters.

Numerical weather models are constantly improving due to better computing capacities and increased satellite-based observations. This improvement has also to be followed to assess if they bring the accuracy need for pseudo-METAR.

- Mix approach forecast+ observation
    - Use of existing adjacent weather observation

In certain situation where the emergency landing site is close to an airport with METAR observation, it may be pertinent to use the nearby METAR that would be a better approximation that the forecast.

- Use of space-based observation

Space based observation are currently developing:

- Copernicus AEOLUS: wind and cloud profile from space.
- Observation derived from GPS radio occultation (example: https://planetiq.com)

Space based observation have a latency that need to be studied but they could give the much-needed global observation source that would feed pseudo-METAR.

7. Conclusion

Pseudo-METAR webservice has the technical potential to support emergency operation such as SafeNcy. It cannot be used today without further R&D, especially regarding safety-critical parameters such as visibility.

The pseudo-METAR concept could be reused for pseudo TAF with limited risks in a different concept of operations: supporting operations in area with limited meteorological support),