Review of article : « Parafog v2.0 : a near real-time decision tool to support nowcasting fog formation events at local scales » by Ribaud *et al.*

General comments:

The article presents an evolution of a near real-time forecast system of fogs based solely on local observations made by sensors that are commonly available on airports (ceilometers, visibilimeters, surface weather stations). The original forecast system was published in 2016. The evolution proposed in the present article improves its performance by 1./ discriminating radiation and stratus-lowering fogs (using ceilometer data), and 2./ using a fuzzy-logic approaches for issuing alerts (low, medium or high probability of fog) in both cases.

The prediction of fogs on airports is a real issue. Fogs impair airport operations, reduce the capacity (number of flights allowed to land or take-off per unit time period), and generate costly delays and missed connections. Airport authorities would like to have reliable fog forecasts at ranges going from a few tens of minutes to about 12 to 24 hours in order to adapt the operations and mitigate the impact. Such forecasts are not yet available. The phenomenon is particularly difficult to predict by numerical weather prediction systems as the involve highly non-linear processes. Studies are on-going in order to test the impact of improved model parametrisations (microphysics, turbulence, surface exchanges) and refined vertical/horizontal model resolutions (see for instance Philip et al., 2016). Ensemble-predictions with these improved models could in principle provide useful probability forecasts, but they will not become operational before years. Approaches based solely on local observations as in the present article are relevant for short term (minutes to a few hours) predictions. Signatures of the processes involved in fog formation under favorable fog conditions can indeed be detected. A main limitation for this kind of approach is that it does not give a precise time for the formation (a formation in an hour rather than in 15 minutes has a different impact on airport operations), but it nevertheless gives a highly valuable information.

The short-term alert system of fog formation proposed in the present article is thus of great interest as it could be easily implemented on current airports since it uses standard observation equipments already available. The performances reported in the article are very good. However, the performance scores (hit-rate and false-alarm ratio) used in the article confirm the warning system has been able to detect early for formation processes, but they do not measure the practical usefulness of the system in an operational context. As mentioned in the article, 10-minute alerts can vary quite a lot from one 10-minute time slot to the next. This variability is smoothed out by considering the prevalent alert in the last 45 minutes, which then becomes an alarm. The scores show the alarm achieves very good performances, but with a lead-time substantially reduced (up to 45 minutes between the first high probability alert and the issued high probability alarm). Scores measuring the relevance of the alerts or alarms for the prediction of fogs in 30 minutes, 1 hr, 1.5 hr, 2hrs… would be more relevant.

The article is rather well written, but its clarity could be greatly improved by giving or reminding definitions of variables before they are used (the definition of skill scores is given on page 15 but they are substantially mentioned before; the attenuated backscatter ratio gradient).

Overall, considering the importance of fog forecasts on airports, the inability of present systems to meet airport operators needs and the good scores of the PFG2, I consider the article deserves to be published. Small modifications would improve its clarity, and the addition, if possible, of skill-scores for 30-minute fog prediction ranges, would allow to better assess the particle usefulness of the system.

Minor comments

- Page 3, line 50: an international definition of fog by WMO exists (see https://cloudatlas.wmo.int/en/fog-compared-with-mist.html) and should be cited here rather than AMS.
- Page 3, 1st paragraph: military operations could be added among fog impacts.
- Page 3, 2nd paragraph: the studies on improved version of operational NWP systems such as those reported by Philip at al., 2016, should be added at the end of the paragraph.
- Page 7, line 172: the article addresses RAD and STL fogs only. The authors claim they represent more than 90% of fogs on the study sites considered in the article. But they may represent much less on other sites (coastal sites for instance where advection fogs prevail). This should be stated here as it is a probable limit to the application of PFG2.
- Page 8, line 211: the definition or the meaning of hit-rate and false alarm should be given here as both notions are used in the following paragraph.
- Page 9, line 250: the RG is not defined. A reference is given, but a short summary of what is is would improve the readability of the article.
- Page 18: low-level wind speed could be added here as a relevant parameter that is measured at ground by weather stations or could be measured at low altitudes by small Doppler lidars.
- Page 27, Table 2. CBH parameters appear in RAD and Ratio Gradient in STL. There seams to be here a swap between lines. To be checked and corrected if swap confirmed.
- Page 35, Figure 8: the word FOG is unreadable in velvet cells.

References

Philip, A., Bergot, T., Bouteloup, Y., & Bouyssel, F. (2016). The Impact of Vertical Resolution on Fog Forecasting in the Kilometric-Scale Model AROME: A Case Study and Statistics, Weather and Forecasting, 31(5), 1655-1671. https://doi.org/10.1175/WAF-D-16-0074.1