Climatology of low visibility for Amsterdam Airport Schiphol

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Horizontal visibility, which is primarily associated with fog, has a direct influence on the airport capacity (for instance through regulations concerning the separation time of inbound traffic). It is observed that lately low-visibility situations occur less frequently than in the past. An investigation was therefore started at the Royal Netherlands Meteorological Institute (KNMI) with the objective of investigating changes in the climatology of low-visibility at Amsterdam Airport Schiphol and work towards a climate-change scenario. The first results of this investigation are discussed here.

1. Introduction

Within the context of aviation, visibility is defined as the distance at which the runway (or its lights) can still be distinguished, called 'runway visible range' (RVR). In a meteorological sense visibility is quantified as the 'meteorological optical range' (MOR), the distance across which 95% of a light source is scattered by the air and droplets therein, which in broad daylight equals the RVR-value (though in the dark and twilight RVR is larger, depending on the configuration of the runway lights).

2. Trends in visibility

In agreement with the findings of Van Oldenborgh, *et al.*(2010) for De Bilt, the occurrence of low-visibility at Schiphol at various thresholds shows a decline. The estimated decrease over the period of measurements 1955-2009 is estimated to be approximately 2% a year.

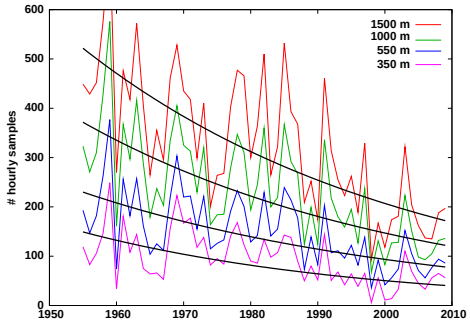

Figure A. Decline in the frequency of low-visibility. Thresholds of 1500, 550, 350 and 200 meters have been chosen because of their relevance to the airport.

3. 1990-2009 versus 1961-1980

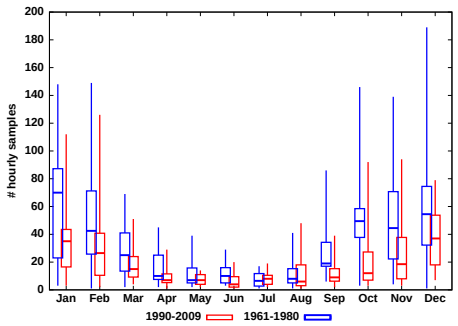

Figure B. Occurrence of low visibility (below 1500 meters) in the period 1990-2009, compared to that in the period 1961-1980 presented as box plots (min,Q25,Q50,Q75,max).

Homogeneity tests applied to the series in Figure A indicate a change point around 1987. Hence, 1990-2009 was considered suitable for establishing a climatology representative of the 'current' situation and the results where compared with those from the years 1961-1980, as shown in Figure B. The changes are largest in the winter halfyear, in particular January and October. In particular January shows a strong decrease of the variability (i.e. $Q_{75} - Q_{25}$).

4. Comparison with other stations

To see whether the probability on low visibility on a monthly basis is purely determined by local factors, comparisons have been made between the number of 'fog'-hours at Schiphol and the average over five stations across the Netherlands (De Bilt, Rotterdam, Valkenburg, Eelde, Lelystad), as shown in Figure C for a threshold of 550 meters. The agreement between the patterns suggests that (in most months) favourable conditions for fog are set on a large scale, though the events themselves might typically have a local character. Figure D illustrates that this correspondence is slightly more pronounced in winter than in summer. The correlation coefficient in the DJF-season almost reaches 0.9.

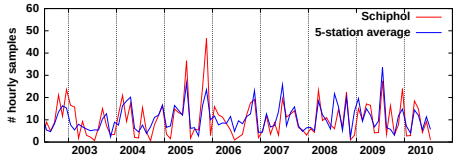

Figure C. Monthly occurrence of MOR below 550 meters at Schiphol compared to the average of five stations.

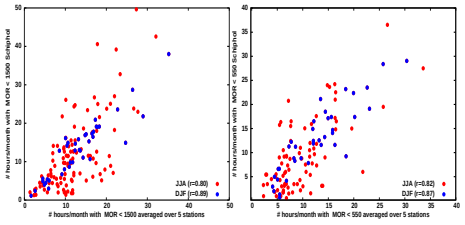

Figure D. Schiphol versus the five-station average: Low-visibility hours per month for thresholds 1500 meters (left) and 550 meters (right) in the summer months JJA (red) and winter months DJF (blue).

5. Spatial differences in low visibility

To investigate spatial differences within the airport perimeter, visibility measurements at various sites (Figure E) were compared for the years 2004-2009. Figure F illustrates the differences in the seasonal cycles for these sites. The sites 36Lt and 18Rt differ from the other sites in February and, to a lesser extent, in June through August (together with 18Ct) Figure G shows the differences among sites for a range of visibility thresholds throughout the year. Sites 18Rt and 36Lt are clearly distinguishable for thresholds between 400 and 1200 meters, though their curves are topmost for the entire range. Site 09t clearly suffers the least from low visibility, probably due to the proximity of Schiphol buildings ('urban-heat-island' effect).

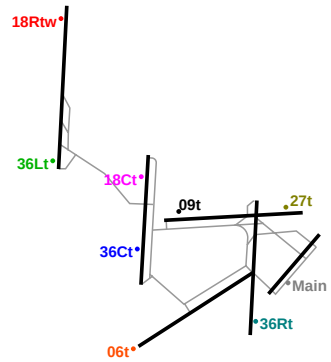

Figure E. Positions of measurement sites and runways at Schiphol Airport. 'Main' denotes the primary measurement site for visibility.

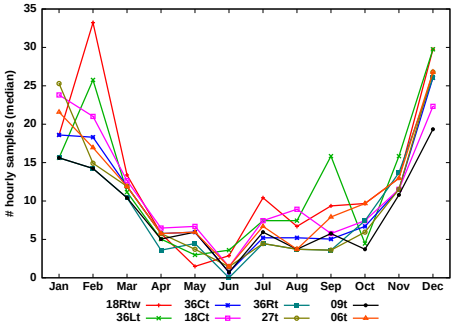

Figure F. Spatial variation in the seasonal cycle of the median number of hourly samples per month with MOR below 550 meters.

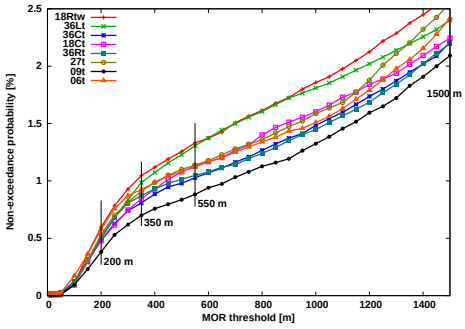

Figure G. Non-exceedance probability of various MOR thresholds at different sites at the airport.

6. Preliminary conclusions

- **The decline in the number of low-visibility hours is in agreement with that found in the rest of western Europe with a distinct change in 1987.**
- **The occurrence of low-visibility on a monthly basis is rather correlated for different locations in the Netherlands, suggesting the influence of large scales on the conditions for low visibility (on this time scale)**
- **Slight local differences are also found. The north-west region of the airport seems relatively prone to reduced visibility, but not in all months.**

Future work involves the relation of fog-climatology to large-scale meteorological variables and the development of climate-change scenarios.

References

van Oldenborgh, G., Yiou, P., and Vautard, R. (2010) On the roles of circulation and aerosols in the decline of mist and dense fog in europe over the last 30 years. Atmospheric Chemistry and Physics, 10, 4597-4609.

[1] *Royal Netherlands Meteorological Institute (KNMI)*

5th International Conference on Fog, Fog Collection and Dew, July 2010