AERODROME METEOROLOGICAL OBSERVATION AND FORECAST STUDY GROUP (AMOFSG)

NINTH MEETING

Montréal, 26 to 30 September 2011

Agenda Item 5: Observing and forecasting at the aerodrome and in the terminal area
5.1: Observations

ON THE USE OF AN ARRAY OF CEILOMETERS IN AUTOMATED LOCAL ROUTINE AND SPECIAL REPORTS

(Presented by Jan Sondij)

SUMMARY

AMOFSG/8 discussed the issue on the location of ceilometers (one or several) installed at or around an aerodrome to provide reliable data of cloud bases and amount. The underlying assumption is that the location of a ceilometer used for automated local routine and special reports should be less restrictive than currently recommended in Annex 3. It was suggested that a position might be chosen close near the runway providing data for (AUTO) METAR reports as well, also to be representative for the vicinity of the aerodrome. To prove this statement a study is started on data from a set of 5 km spaced ceilometers located on Amsterdam International Airport Schiphol and from a set of ceilometers at a distance of about 20 km from this airport. The first results of an analysis of cloudiness data for the set on the aerodrome demonstrate significant correlation and it is concluded that only a couple of ceilometers on a large 10 x 10 km aerodrome is sufficient to supply cloudiness data accurately enough.
The study on both sets will be continued by analysing time series to demonstrate the time dependency and spatial behaviour of cloud bases.

1. BACKGROUND OF THE STUDY

1.1 The eighth meeting of the Aerodrome Meteorological Observation and Forecast Study Group (AMOFSG/8) held in Melbourne, Australia, February 2010, discussed at length the issues of how single point observations taken by automated observing systems could fulfil the ICAO requirement that “representative observations should be obtained by the use of sensors appropriately sited for local routine and special reports…..give the best practicable indications of the height of cloud base and cloud amount at the middle marker site of the instrument landing system”.

1.2 Para 4.6.5 (Annex 3, “Clouds”) clearly states that cloudiness (amount, cloud type and height of cloud base) shall be observed and reported as necessary to describe the clouds of operational significance. It is recommended that cloud observations for:

- routine and special reports should be representative of the approach area.
- METAR and SPECI should be representative of the aerodrome and its vicinity.

1.3 Appendix 3, Para 4.5.1 is more specific by *recommending* that the ceilometer should be well sited to give the best practicable indications of the height of cloud base and cloud amount at the middle marker site of the instrument landing system or, at aerodromes where a middle marker beacon is not used, at a distance of 900 to 1 200 m (3 000 to 4 000 ft) from the landing threshold at the approach end of the runway. This recommendation is explained in App. 2 of the *Manual of Aeronautical Meteorological Practice* (Doc 8896), Appendix 2, Location of Instruments at Aerodromes. In the previous edition of Doc. 8896 it was more explicitly explained with "where pilot on approach has to decide whether to continue the approach or execute a missed approach procedure (decision height)", linking the recommended location (at the (virtual) middle marker) and DH (or DA). This sentence however was deleted in the recent eighth edition (2008). So only 'approach area' is understood to be relevant. Also note that for METAR and SPECI reports a location "within the runway strip" is suggested in Doc. 8896.

1.4 Generally cloud reports are most relevant for approach and landing operations. The *Manual of All-Weather Operations* (Doc 9365) , 3rd ed., 2009 informs on precision approach minima, expressed in terms of visibility or runway visual range, decision altitude/height (DA/H) or minimum descent altitude/height (MDA/H) and cloud conditions. It states: "For the approach to landing where the aeroplane is already in flight generally a limit on the instrument approach is established, called decision altitude/height (DA/H) or minimum descent altitude/height (MDA/H) together with a horizontal visibility limitation." Relevant here is the clear reference in this document to RVR in the first place and secondly to MDA/H. The relation with DA/H ("at which a missed approach must be initiated if the required visual reference to continue the approach has not been established") is of minor interest. Moreover, the stated MDA/H values for instrument approach procedures are relatively low, typically valid for aircraft above the approach lights zone in front of TDZ. Taking these statements into account the necessity to determine cloud reports for the area above the (virtual) middle marker is not so obvious and a location of a ceilometer near the landing strip sounds more logic.

1.5 In general, approach and landings are in upwind position. This implies that clouds passing the middle marker will have passed the runway in the past. So cloud reports from ceilometers located close near the runway might have even a better nowcasting impact than those situated at about 1050 m (3 500 ft) down wind from TDZ. This assumption might also holds for VFR flights.

1.6 Aerodromes with a multi runway configuration usually will have a number of ceilometers. This number will depend on the number of TDZ and ability for precision approach landings. According to the recommendation in Annex 3 — *Meteorological Service for International Air Navigation*, the positions of these ceilometers should depend on the location of TDZ related middle markers. In reality, however, it is questionable if this recommendation is fulfilled and also if this recommendation should be fulfilled. In practice, information on clouds above the airport and its vicinity and all of the approach areas can also be generated if we know the state of the atmosphere and its clouds in a volume covering the aerodrome. In other words, if a set of ceilometers is located at the edges of the aerodrome or in an area around the aerodrome (independent of middle marker locations) we might be able to generate such information. The advantage of such a configuration might be that it may provide trends and very short term forecast as well.

1.7 A study with data analysis with observations from a set of ceilometers on the aerodrome and a set of ceilometers at a well chosen distance from the aerodrome will give the knowledge to prove the stated assumption. Typical variables to investigate will be cloud coverage and height of cloud base. Conclusions may be drawn based on procedures described in WMO/TD-No. 217 ("WMO International Ceilometer Intercomparison", Instruments and Observing Methods reports No. 32, WMO, 1988) and also by using contingency tables for binary events providing success indices, probability of detection figures and false alarm ratio.

2. DESCRIPTION OF THE STUDY

2.1 Data analyses is and will be performed on data obtained from a set of four ceilometers location on the aerodrome of Amsterdam International Airport Schiphol (EHAM) and a set of 4 or 5 ceilometers located around this aerodrome. The mutual distance of the ceilometers on the aerodrome is about 5 km. The mutual distance from the ceilometers around the aerodrome to the central observation area on the aerodrome is about 20 km (see fig. 1)

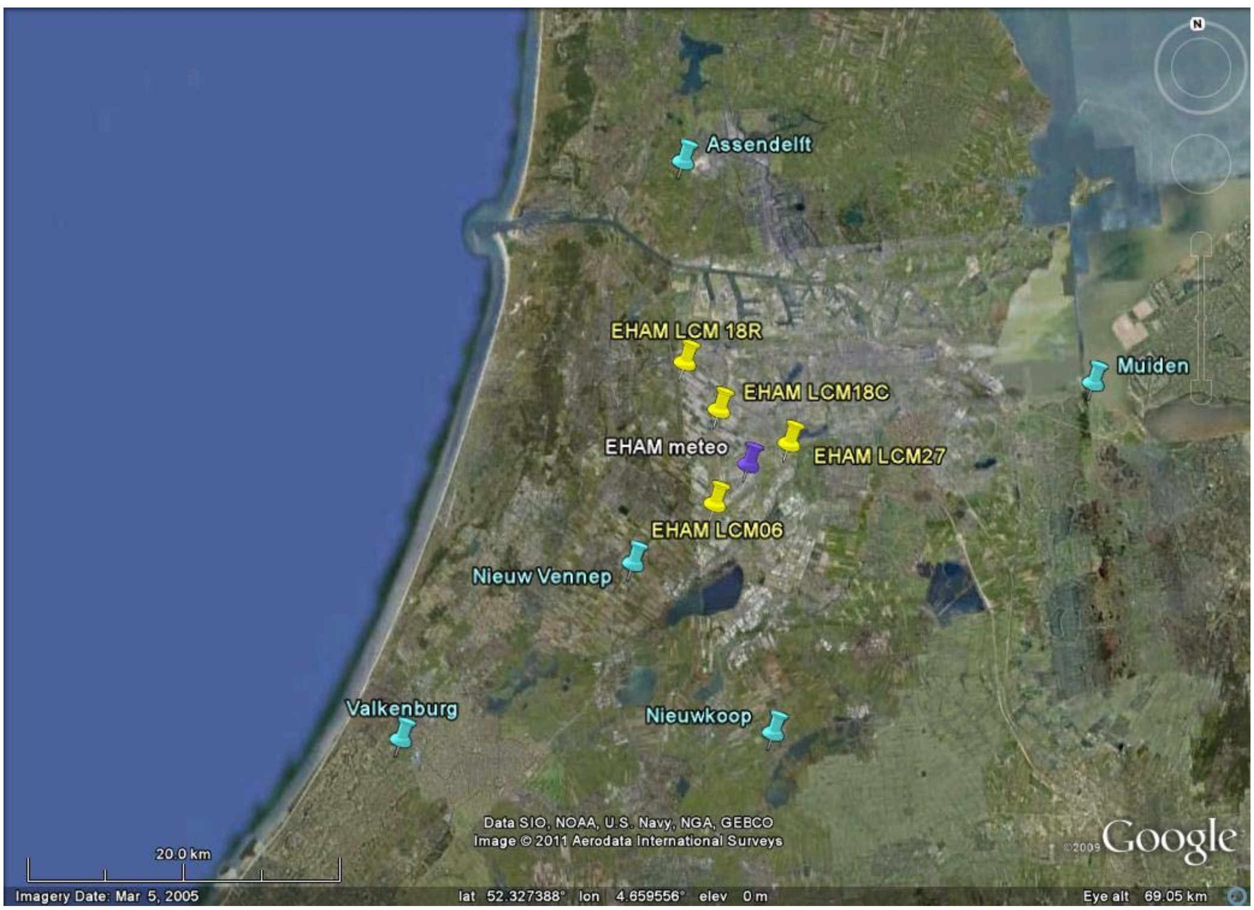

fig. 1 - overview of the locations of the four ceilometers at the aerodrome (EHAM LCMnn) and the others at a distance of about 20 km from the meteo observations site.

2.2 Two variables are and will be investigated: [1] Cloud Amount and [2] Height of Cloud Base. As constraint to determine quality figures reference will be made to the "Operationally Desirable Accuracy of Measurement or Observation" as stated in Attachment A to Annex 3. Techniques to analyse ceilometer data are already well described in WMO/TD-No. 217 and a number of papers published at the WMO/CIMO Technical Conferences (TECO).

2.3 Availability of data: Source data (time series with 1 min update frequency) from the ceilometers at the aerodrome are stored and archived already for many years. Data form the 4 -5 ceilometers located outside the aerodrome is stored and archived only recently (starting 2010) when the ceilometers were installed. Note that this late instalment in 2010 has caused a serious delay in the further analyses of this study and report.

3. FIRST RESULTS

3.1 Investigations on the ability to automatically generate cloud amount (i.e. without the help of an observer) were started already some 12 years ago. Wauben published the first results in 2002 (Wauben, W.M.F., "Automation of Visual Observations at KNMI; (II) Comparison of Automated Cloud Reports with Routine Visual Observations", Proceedings of the Annual Meeting of the American Meteorological Society, 13-17 January 2002, Orlando, Florida,). This study was based on data processing using the well-known Larsson algorithm, developed by SMHI. It was concluded that using 2 or 3 instead of 1 sensor at a location improves the overall results only slightly. To improve spatial representativeness and the detection of high clouds of data from geostationary satellites (like Meteosat) was recommended. Moreover good agreement was found with visual observations.

3.2 More recently results of a study on cloudiness using a multi-sensor approach were presented (Wauben, W.M.F., et al., "On The Generation of an Optimized Fractional Cloudiness Time Series Using a Multi-Sensor Approach" presented at TECO-2010 - WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation, Helsinki, Finland, 30 August - 1 September 2010, WMO/TD-No. 1546). It is found that combinations of different observation technologies will improve cloud amount determinations. Of interest here is a study based on a test with a scanning infrared radiometer (a 'Nubiscope') to find solutions to reduce the lack of spatial representativeness of automatic cloud amount reports which shows promising results (see Wauben, W.M.F. et al., "Laboratory and Field Evaluation of the Nubiscope", presented at TECO-2010 - WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation, Helsinki, Finland, 30 August - 1 September 2010, WMO/TD-No. 1546).

3.3 The study will be continued and in particular with a focus on cloud base performances.

4. CONCLUSIONS

4.1 Based on preliminary studies carried out at Amsterdam International Airport Schiphol (EHAM) around 2000 it was concluded that the automatic determination of cloud cover from ceilometers will not improve by extending the number of ceilometers at the aerodrome. In practice the performance based on one single instrument is comparable to results based on 2 - 3.

4.2 The study will be continued by investigating the impact of increasing/decreasing spatial distances in the distribution of two sets of four ceilometers. Variables to be considered are cloud amount and cloud base. Of interest will be tendency behaviour and spatial distributions to describe the state of cloudiness a volume of the atmosphere above and around the aerodrome.

5. ACTION BY THE AMOFSG

5.1 The AMOFSG is invited to:

a) note the contents of this paper; and

b) consider appropriate follow-up actions.

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