SOME PRINCIPLES FOR STUDYING REDUCED VISIBILITY CONDITIONS IN REGIONS AROUND AIRPORTS

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16. Abstract

The difficulty of making accurate visibility forecasts has prompted the search for a new procedure for gathering data and formulating forecasts. A set of guidelines based on the experiences of the meteorological team at Tashkent airport is presented. These guidelines pertain to all the possible immediate and specific sources of relevant information in the vicinity of a given airport and to the combination of theoretical and experimental information which should be used in evaluating the data.

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SOME PRINCIPLES FOR STUDYING REDUCED VISIBILITY CONDITIONS IN REGIONS AROUND AIRPORTS

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It is well known that the visibility on the runway is usually the determining factor for flight operations. In studying the meteorological and synoptic conditions responsible for reduced visibility at the Tashkent airport, the authors encountered a number of difficulties which could be overcome only by revising certain ndamental precepts in the methodology of such investigations. The problem lies in the fact that the factors which determine visibility conditions are numerous and often physically complex, and their interaction often leads to transient, varied forms of visibility fluctuations. One need only consider the visibility dynamics accompanying dust and snow storms and certain types of fog. /117*

Airport visibility forecasts, however, require clear, precise visibility data, especially at the boundary of flight minima. Such requirements are at odds with the very nature of time fluctuations in visibility. As a result many attempts to devise a single, universal technique for visibility forecasting (e.g. for the various kinds of fog) have met with little success. Even classifying fogs according to three basic types (radiation, advective and frontal) with the object of devising simple, fast methods of visibility forecasting does not always lead to the desired result. The problem is no less complex in the case of dust and snow storms. All these circumstances make it necessary to investigate reduced visibility conditions according to a broader program based on the principles outlined below.

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* Numbers in the margin indicate pagination in the foreign text.

1. Complete, high-quality aereometeorological observations. Series of observations over at least a 20-year period are desirable. Conventional climatological descriptions of airports based on five-year series of observations are inadequate /118 for the study of visibility (the probability being high that rare but practically-important situations and cases will be overlooked). During periods of restricted visibility, observations must be made at least four times per hour, with the site of the observation relative to the runway precisely specified. Besides statements on general standard weather conditions, supplementary notes on the phenomena which determine visibility (e.g., horizontal and vertical characteristics of haze, fog, industrial smoke and dust storms, their direction of movement, rapid fluctuations of visibility, etc.) are valuable.

2. A study of the space-time characteristics of all meteorological factors which reduce visibility at airports (within the limits of interest to air traffic). The following data are utilized for this purpose:

a) all conventional, standard means of aereosynoptic analysis;

b) all permanent meteorological observation points located within a radius of 30-40 km of the airport (not included in the regular synotpic network);

c) materials from simplified, specialized observations made within an auxiliary network of stations which surround the airport and are active only during periods of the year in which reduced visibility conditions are most common (this network should consist of 15 to 20 stations);

d) expeditionary studies of reduced visibility zones (e.g., for fogs) involving a large number of participants and rapid means of transport;

e) aereal surveys of local reduced visibility zones from small aircraft (if possible);

f) operative inquiries among airport workers (especially meteorologists) living in various parts of the city and its suburbs concerning phenomena which severely restrict visibility;

g) reports from 50 to 100 general-education schools located within a radius of 30-40 km from the airport (based on a prior agreement regarding voluntary, selective meteorological observations made by upper-class students);

h) the results of a systematic study of visibility distribution within the airport zone;

i) satellite pictures may be useful in some cases.

3. A detailed synoptic analysis of all processes which influence visibility, and particularly those which reduce it, is necessary. In many cases the characteristics generally accepted for regional types of synoptic processes will be clearly unsatisfactory for this purpose, and it will be necessary to define new, specific characteristic features. Also needed is a more comprehensive genetic classification of the actual phenomena which determine visibility to one degree or another. For example, true advective fogs are virtually nonexistant in many of the southern regions of the USSR, while fogs are quite common in southward-moving cold air masses. /119

4. A general climatological analysis of aereometeorological observations (based on a series of observations spanning at

least 20 years) will enable certain useful forecasting recommendations to be made. Such a general analysis can yield only limited information, however, and should be preliminary to a more detailed approach.

5. A specialized climatological analysis should be performed for each decade individually with allowance for a detailed synoptic typification of each visibility-restricting phenomenon. The processing of all information should be subordinated to a specific goal: finding the characteristics and criteria which afford a base for making operative forecasts. Of course not even such an exhaustive approach can yield an effective forecasting technique for all situations. But it is capable of providing a certain amount of objective and reliable forecasting information.

6. The same goals (i.e., increasing the confidence level of aviation synoptics) are also served by the principle of objective synoptic criteria. Finding such criteria is an extremely tedious and difficult task, and they still do not entirely solve the problem at hand (if only because the theory of the aviation forecasting of synoptic processes is still far from complete); but such an approach has proved to be quite useful.

7. During periods of possible visibility restrictions (especially when fog threatens), mesosynoptic analysis should be intensified. This includes the frequent compilation of regional, microregional and other auxiliary maps with a highly detailed analysis of the principal weather fields on them. The isobars and isotherms on such maps should not be plotted in five-unit intervals, as this often makes it impossible to distinguish those details of synoptic conditions which will later prove critical.

8. For the same purpose of mesosynoptic analysis, the local circulation patterns encountered in airport zones at various times of year under certain selected synoptic conditions should be studied.

9. Valuable aids in investigating reduced visibility due to haze, fog and industrial pollutants are vertical meteorological soundings, if only to an altitude of 20-50 m, as well as wind soundings to an altitude of at least 500 m.

10. The condition of the subsurface at the airport and within a radius of 100-150 km (dry, moist, wet or soggy; with dry or melting snow; freshly-fallen, polluted or melted and re-frozen snow, etc.) must be taken into account.

11. At airports located near large cities and industrial /120 centers, it is advisable to conduct specialized physicochemical experiments designed to study the components which pollute the air to the point of marked visibility deterioration and to investigate water-vapor condensation processes, the water content of hazes and fogs, the migration of agglomerated aerosol particles, etc. All these studies should be done from a concrete aereometeorological point of view.

12. When visibility is restricted to 4000 m or less, the visibility in various zones of the runway and on all approaches to it should ideally be continuously and automatically recorded using the same, reliable instruments for all recordings. Although it may be some time before such a monitoring system is a reality, its utility is beyond question.

13. The first steps have already been taken toward the numerical modeling of visibility dynamics on a thermohydrodynamic basis for the purpose of creating an automatic machine-forecasting system. However, significant progress can be made

in this area only after a fundamental study of the physical nature of all causes of visibility fluctuations.

14. The visibility of high-intensity lights merits particular study.

15. Since in the final analysis the most critical of all visibility parameters is the approach visibility, i.e. the visibility on the glide path from the cockpit of the aircraft (rather than the slant visibility in general), the correlation between general meteorological visibility and the approach visibility must be investigated for various synoptic conditions.

16. It is useful in visibility studies, incidentally, to proceed from the assumption that the principal weather elements have been correctly forecast (temperature, wind, cloudiness, precipitation, etc.). In this way the degree of their importance for visibility forecasting during various seasons can be established.

17. The development of a negative forecasting technique (i.e., forecasting the absence of reduced visibility, particularly under "obvious" conditions) should not be neglected. This will help rid synoptics of "surprise" situations and help the novice forecaster to gain the appropriate skills and experience.

18. Visibility studies should begin from simple situations and proceed to more complex ones. For this purpose all initial data can be first divided into three groups: visibility good and stable (group 1), visibility poor and stable (group 2), and all other situations (group 3). The volume of group 3 is then steadily reduced by a multiple "screening" method. The object here is to find absolute objective synoptic and meteorological criteria for forecasting various visibility ranges, each with a different term (from 15 minutes to 6-12 hours).

The recommendations outlined above in no way represent a complete methodology for visibility investigations, but they do, we believe, reflect the main aspects of this question. In any event, it should be stressed that attempts to create completely reliable approaches to visibility forecasting based solely on isolated initial meteorological observations (as is still done in some places) are unsatisfactory. /121

Some of the recommendations presented here require special efforts and facilities for their implementation. Some simply cannot be implemented at certain airports, But if we are to seriously approach the problem of airport visibility forecasting, we must recognize the necessity of many of these measures. It should be noted in closing that partial, but significant, progress can be achieved on the basis of only the first seven principles, which we consider the most important.