PRACE GEOGRAFICZNE, zeszyt 107
Instytut Geografii UJ
Kraków 2000

Zygmunt Wilczek

COMPARISON OF CLOUDINESS TYPES FOR NEIGHBOURING AIRPORTS

Abstract: The foundation and practical application of cloudiness types classification for aviation has been submitted in this paper. Significant differentiation of the frequency of hours with particular cloudiness types at both meteorological stations has been noticed. The most similar courses of analysed factors were found for aviation type of cloudiness connected with hard and minimum flying atmospheric conditions. The comparison of daily courses of cloudiness types for neighbouring airports has indicated significant conformity for some types (H, ML, MX, Z0) and almost complete lack of conformity for others (WT, ZL, ZH).

Key words: aviation type of cloudiness, safety flying atmospheric conditions (SFAC), hard flying atmospheric conditions (HFAC), minimum flying atmospheric conditions (MFAC).

1. Methodology and Purpose

The types of cloudiness were assigned for hourly observations at Tomaszów Mazowiecki (Tom. Maz.) and Nowe Miasto (Nowe M.) airports in 1993 on the grounds of aviation cloudiness classification. The frequencies of daily cloudiness types occurrence have been compared for both airports for every month. The differentiation of the cloudiness types' occurrence for yearly and daily courses between the two airports was investigated with the use of correlation coefficient (R) and the frequency factor. The main purpose of this paper is finding the answer to the question: what is the influence of the local factors on the differentiation of flying atmospheric conditions connected with cloudiness types?

2. Grounds and Assumptions for Aviation Cloudiness Classification

In order to meet the demands of prevention from dangers and difficulties connected with flights realised inside and in vicinity of clouds, the proposed classification concentrated mostly on five types of clouds causing a lot of aviation hazards. Their bases are within the low level (Cb, Cu med and con, Ns, Sc, St). The remained types of clouds (Ci, Cs, Cc, As, Ac) do not threaten the flights realisation as their bases are above 2000 m. The flights below the mentioned clouds are executed in safety flying conditions, without regard to degree of cloudiness, because of the light or moderate intensity of aviation hazards there. Due to little thickness of middle and high level clouds it is very easy to fly inside or through it.

The next criterion of assignation of aviation cloudiness types was connected with the share of selected types of clouds in the total cloud cover (N). According to RLLW (DWL 1986) the maximum value of N is 6/10.

The basic index for evaluating aviation cloudiness types at two sites is comparing the height of cloud base (h) designated separately for various light conditions during nights and days over aerodrome. Taking into account the limit values for MFAC (minimum flying atmospheric conditions) and HFAC (hard flying atmospheric conditions) for Tom. Maz. and Nowe M. aerodromes and TS–11 Iskra aircraft, according to suitable instructions and orders the limit values of cloud base height have been determined which is presented in Table 1.

Tab. 1. The values of limit cloudbase altitude (h) in [m] relating to particular types of cloudiness.

AVIATION TYPES OF CLOUDINESS FOR:					
MFAC		HFAC		SFAC	
night	day	night	day	night	day
h < 150	H ≤ 100	150 ≤ h ≤ 400	100 ≤ h ≤ 300	h > 400	h > 300

The described criterions have become the base of assignation of three main groups of cloudiness. The fourth „mixed" group was defined for complex atmospheric situations when HFAC and MFAC assumptions for cloud base height were appearing simultaneously with N <6/10. In this case scattered cloudiness and at the same time possibility of short-duration local atmospheric difficulties for flights (due to low h) were present in aerodrome's vicinity. The fifth special group (H) was selected for cases with severe and very severe turbulence created by convection currents like Cb and towering Cu, regardless the degree of cloud cover and the cloud base height (Wilczek 1998).

Types of cloudiness for SFAC:

Z_0 – sky clear,

Z_H – only high level clouds,

Z_M - only medium level clouds,

Z_S - high and medium level clouds together,

Z_L – low clouds with h >300 m by day and h >400 m at night; also N =6/10,

Notice: Z_H, Z_M, Z_S were marked off irrespective of cloud cover degree.

Types of cloudiness for HFAC

T_L – low clouds with h >300 m by day and h >400 m at night; also N >6/10,

T_{LH}- low cloud with 100 ≤ h ≤ 300 m by day and 150 ≤ h ≤ 400 at night; also N >6/10,

Types of cloudiness for MFAC

M_X – sky obscured,

M_L – low cloud with h <100 by day and h <150 m at night; also N >6/10,

Mixed types of cloudiness

W_T – low clouds with 100 ≤ h ≤ 300 by day and 150 ≤ h ≤ 400 m at night, also N ≤ 6/10,

W_M – low clouds with h<100 m by day and h<150 m at night; also N ≤ 6/10,

Type of cloudiness with turbulence

H – Cb, Cu con, Cu med regardless to N degree and h.

3. The Occurrence of Aviation Cloudiness Types

Comparing the number of hours with the same types of aviation cloudiness at two neighbouring airports is the simplest method of assessing the impact of the local factors on meteorological flight conditions.

Some types of cloudiness have almost the same frequency for both sites (H, ZH); for others types it is less similar (Z0, TLH, TL) or very different (MX, ML, ZL, WT). In case of the type WM the frequency was so little that it has not been included in further studies (Fig. 1).

Fig. 1. The comparison of the occurrence of yearly sums of hours with particular aviation cloudiness types at Tomaszów Mazowiecki and Nowe Miasto airports.

At the Tom. Maz. airport an increase of duration for type ML (530 hours) in comparison with Nowe M. airport (378 hours) was noticed, but the frequency for the types of cloudiness corresponding with minimum atmospheric flying conditions (ML and MX together) was almost the same (Tom. Maz. 8.0%; Nowe M. 7.7% - Tab. 2).

Tab. 2. The comparison of aviation cloudiness types frequency [%] for neighboring airports.

Airports	Aviation cloudiness types												Total
	H	ML	MX	TL	TLH	WM	WT	Z0	ZH	ZL	ZM	ZS	
Tom. Maz.	14.5	6.1	1.9	9.9	17.0	0.0	0.9	18.9	7.3	7.5	13.0	2.9	100.0
Nowe Miasto	14.5	4.3	3.4	12.0	15.0	0.1	1.5	15.2	7.0	12.0	10.0	4.6	100.0

Similar relationship has been observed for types of cloudiness connected with hard atmospheric flying conditions (TL, TLH), which composed almost 27% frequency of the year for both regions. The cloud base height is the factor which influenced hard atmospheric flying conditions at the Tom. Maz. airport more than at Nowe M. (TLH: Tom. Maz. = 17%, Nowe M. = 15%). Inversely, the degree of cloudiness is the factor which influenced the hard atmospheric flying conditions more at the Nowe M. airport (TL = 12%), than at Tom. Maz. (9.9%). Not too numerous type WT is more frequent at the Nowe M. airport (1.5%), than at Tom. Maz. (0.9%).

Safety atmospheric flying conditions occurring at cloudless sky (Z0) and medium clouds (ZM) are more often observed at Tom. Maz., and at Nowe M. such flying conditions are more frequently connected with types ZL and ZS.

4. The Comparison of Aviation Cloudiness Types Yearly Occurrence for Neighbouring Airports

The attempt of comparing the aviation cloudiness types' occurrence during the year was realised with the use of correlation coefficients (R) between the number of hours of particular aviation cloudiness types at both airports. In case the monthly number of hours of particular types for both airports was the same, then R = 1 and there was no difference between the conditions at both stations. Taking the results in Table 3 into consideration it might be stated that in spring (March, April) and in autumn (September, October) the analysed resemblance is considerably minor than in summer or winter.

Tab. 3. The annual pattern of correlation coefficients (R) between number of hours of particular aviation cloudiness types near Tom. Maz. and Nowe M. airports.

R	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
	0.79	0.89	0.53	0.62	0.67	0.78	0.78	0.77	0.56	0.58	0.61	0.67	0.97

5. The Daily Courses of Occurrence Frequency for Particular Aviation Cloudiness Types

The correlation coefficients (R) between yearly sums of hours with particular aviation cloudiness types' occurrence for two airports have been taken as the conformity indicator (Tab. 4). Afterwards, the daily courses of occurrence's frequency for the cloudiness types have been compared for the two airports.

Tab. 4. The correlation coefficients (R) between daily courses of cloudiness type occurence at Tom. Maz. and Nowe M. airports.

	Aviation cloudiness types										
	H	ML	MX	TL	TLH	WT	Z0	ZH	ZL	ZM	ZS
R	0.83	0.89	0.95	0.32	0.76	-0.58	0.77	0.24	0.36	0.79	0.42

The comparison of daily courses of occurrence's frequency for particular aviation cloudiness types for two airport regions near Tomaszów Mazowiecki and Nowe Miasto has indicated significant conformity for some types (H, ML, MX, Z0) and almost complete lack of conformity for others (WT, ZL, ZH).

The most symmetry and conformity of daily courses has been noticed at Figure 2 for type H (R = 0.83). The process of formation and decay of Cb and Cu con clouds was slowed down at Nowe Miasto airport in comparison with Tomaszów Mazowiecki. The author thinks that this may be connected with the necessity of delivering much more quantity of heat to be used for warming up more wet soils and for evaporation at Nowe Miasto region than in Tomaszów Mazowiecki region (Wilczek, Ziarko 1997).

The types of cloudiness corresponding with minimum atmospheric flying conditions (ML and MX) have got much the same daily courses for both airports. The largest value of R (0.95) for MX type has found its expression in high resemblance of daily courses of occurrence's frequency of analysed type at both regions. At both airports for ML type (R = 0.89) the increase of the lowest clouds frequency has observed at night and morning hours, while the decrease of frequency was observed from 8 a.m. to 3 p.m. The described daily course has been more distinctly shown at Nowe Miasto region because of greater daily amplitude than at Tomaszów Mazowiecki region.

Only type TLH (R = 0.76) has got clearly marked daily course in comparison with the other types of cloudiness connected with hard atmospheric flying conditions (TL, WT) but both daily courses for TLH are not strictly the same. For instance, the maximum of frequency has been marked at Tom. Maz. at 7 a.m. while at Nowe M. at 9 a.m.

It has been noticed that the larger the value of R, the more distinct and similar the analysed courses have been for selected airports.

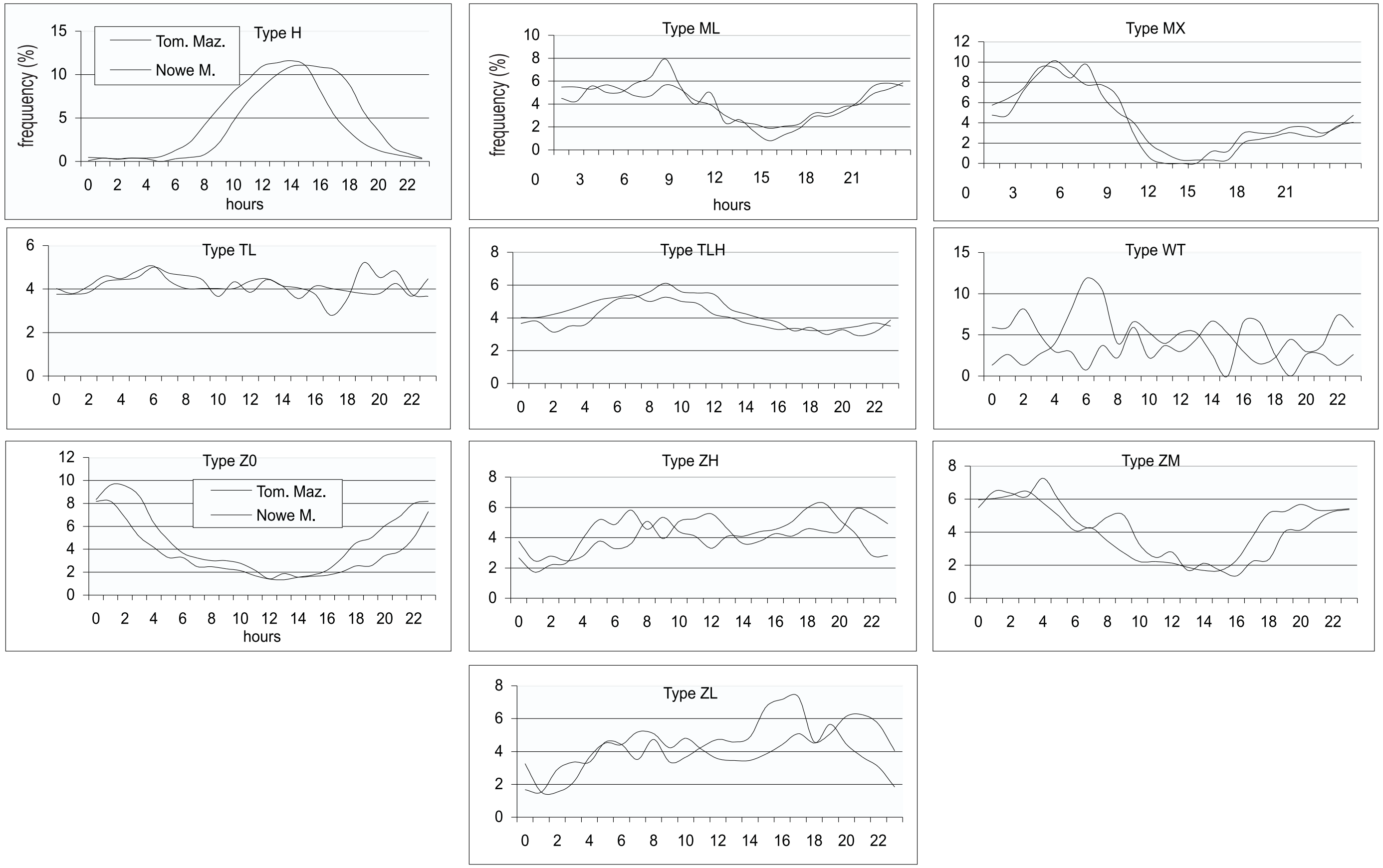

Fig. 2. The daily courses of frequency occurrence for particular aviation cloudiness types near Tomaszów Mazowiecki and Nowe Miasto airports (100% - total number of hours in the year).

References

DWL, 1986, *Regulamin lotów lotnictwa wojskowego (RL – 86)*, DWL, Poznań.

Wilczek Z., 1998, *The Methods of Qualification the Flight Atmospheric Conditions*, III Symposium on Military Meteorology, Warsaw.

Wilczek Z., Ziarko J., 1997, *Analiza występowania mgieł i niskich chmur warstwowych w rejonie Polski Środkowo-Wschodniej*. Sympozjum jubileuszowe PTG – Materiały, Warszawa.

Zygmunt Wilczek
Air Forces Academy
Dęblin
Poland