„AL. I. CUZA" UNIVERSITY OF IAŞI
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„AL. I. CUZA" UNIVERSITY OF IAŞI
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WEATHER RISK ASSESSMENT IN THE AREAS OF IASI, BACAU AND SUCEAVA AIRPORTS

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INTRODUCTION

With the integration into the European Union in 2007 and the liberalization of movement of persons within the EU has been found, from one year to another, an increase in the flow of persons transiting the airports of Iasi, Bacau and Suceava.

The research is a necessity to develop solutions for the optimal use of financial resources, regional planning schemes, a comprehensive program to improve the quality services of air transport and sustainable development of human communities in the studied area, as well as the achieving of plans for prevention against meteorological phenomena of risk.

The systemic addressing of meteo-climatic issues in the areas of Iasi, Bacau and Suceava airports risk is particularly important in the structuring of their planning, for the sustainable development of aviation activity in the north-eastern Romania. Identification and detailed analysis of the implications of the climatic factors, climatic elements and weather phenomena are objectives that will lead to increased flight safety corresponding within the airspace of Iasi, Bacau and Suceava airports. On the other hand, the climatological conclusions will constitute a useful, relatively complete, which can be considered for updating the climatology of the domestic air routes that have the point of take-off or landing the Iasi, Bacau and Suceava airports.

Both in terms of geographical approach, especially by practical or operational aeronautical addressing, the content of the study can be useful to aircraft operators that operate on this three airports.

The work is based primarily on the analysis of correlated data from weather meteorological stations during 1961 to 2012 found in the archives of Database Laboratory from the National Meteorological Administration in Romania or ROMATSA. To characterize the frequency and origin of air masses that influences the weather when transiting the region of north-eastern Romania, where are located this three airports, were analyzed a series of materials (eg: synoptic maps, geopotential at 500 hPa and temperature at 850 hPa) provided by a website: www.wetterzentrale.de.

In the areas of this three airports, the meteorological situations with negative impact on aircraft flight has occurred most frequently in terms of reducing the horizontal visibility, wind gusts, in synoptic situations that have favored the deposition of ice, or when there were heavy snowfalls accompanied by strong wind. The thesis presents a series of climatological and meteorological analysis of these situations absolutely necessary in the thesis, as it allows the knowing of the synoptic context in which the weather events have a impact on aviation activity, and their understanding can improve the air traffic management on the Iasi, Bacau and Suceava airports.

I. GEOGRAPHICAL POSITION

Mathematical position of that three airports (fig. 1), crossed by following parallel: $46^0 31'$ N (Bacau airport), $47^0 10'$ N (Iasi airport) and $47^0 41'$ N (Suceava airport), show that this airports is within the area of temperate climate in continental space. Being relatively far from main sources of moisture (especially compared to the Atlantic) are common and obvious some manifestations of the climate transition in the analyzed areas.

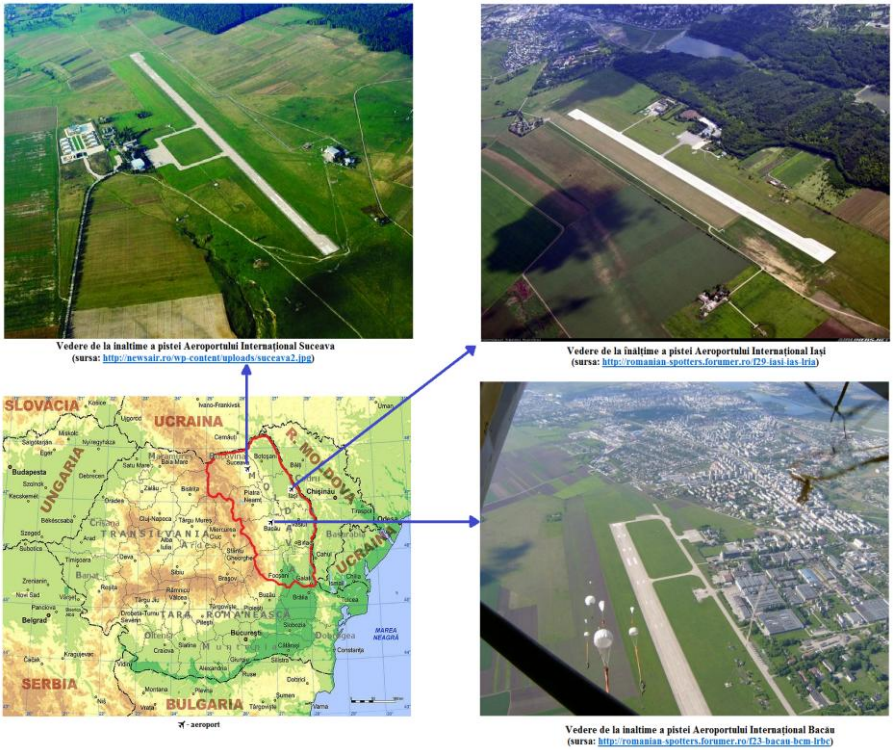


Fig. 1. Poziția geografică a aeroporturilor în regiunea Moldovei

II. SHORT HISTORY OF THE MEASUREMENTS FROM WEATHER STATIONS AND OF THE RESEARCH FROM THE AREAS OF STUDY. METHODS AND MEANS OF RESEARCH

II.1. History of the measurements from weather stations

Iasi, Bacau and Suceava weather stations switched to 1 April 1999 under Regional Meteorological Centre of Moldova, subsidiary of the National Company of which is the National Institute of Meteorology, Hydrology and Water Management SA, which became from July1, 2004, the National Meteorological Administration af Romania RA.

II.2. History of meteorological and climatological research from thea areas of study

Climate risks are currently intensively studied in view of global climate changes and climate aridity trend. Studies on the risks associated with extreme weather phenomena occur frequently in the literature: Gugiuman I., V. Chiriac, 1956 Grama (1960), Bogdan O., Dragotă C., 2000; Dragotă C., Gaceu O., A. Iordache, 2003 Dragotă C., 2006. Most of these are case studies or summaries of physical and geographical units of the country, based on long strings of data. Other contributions aimed at climate risks in their entirety (Moldovan F., 2003), their implications for agricultural production (R. Burden, 2000; R. Burden, Bojariu R., 2005) or on socio-economic system (IF Mihailescu etc. ., 2001; Bogdan O., 2004).

Currently in the international scientific literature put increasing emphasis on the study of weather-related risk in areas airports (Bech, J. et all, 2007; Dustin Fabbian et all, 2007; Stolaki, SN, 2009; Roquelaure, S ., T. Bergot, 2009, David W. Reynolds et all, 2012; Lynette van Schalkwyk, Liesl L. Dyson, 2013; Pablo Rozas-Larraondo et all, 2014; Katarina Veljović et all, 2014).

To achieve a level of safety as high flight, meteorology and climatology in Romanian specialists have examined various aspects of climatic nature that targeted different areas of the country or airport flight routes: Cristodor E. et al., 1966 D. Florea, 2004 M. Grama, 1960, Ranga C., F. Vasenciuc, 1980, etc.

For Moldavia and even throughout Romania, there is little information on the scope of visibility. Studies that have been conducted mists focuses on climatology and synoptic conditions that favor (G. Bancila, 2005; E.Bordei, G. Taulescu, 2006; The climate, 2008. Apostol, 2004; Mihailă, 2006 Tanase, 2011). Horizontal visibility is among the most important meteorological elements with negative impact on the areas of aeronautics airports Iasi, Bacau and Suceava therefore deserve special attention.

The issue of the implications of climate conditions in aviation has been approached by other thesis (eg Raicu, 2011), however, on the theme chosen, a comprehensive study of weather and climate risk assessment in areas north area airports eastern Romania not done so far, although there were a number of concerns for understanding climatic characteristics of the territory.

Large amounts of rainfall in small intervals of time often causes floods, floods, excess moisture in concavities relief, accelerated erosion in sloping lands, under agricultural use, or destruction of housing and various infrastructural components, wildlife casualties, domestic and among people. Safe operation of the aircraft, in terms of rainfall, of particular importance for air carriers, aerodrome managers and providers of air traffic control. A dry

climate means less rainfall, but the results of US researchers shows that rainy events in dry climates generate a higher frequency of accidents and injuries than rainy events wetter climates (Stanley A. Changnon, 1996). Currently in the international scientific literature put increasing emphasis on the study of weather-related risk in areas airports (Bech, J. et all, 2007; Stolaki, SN, 2009).

II.3. Methods and means of research

Study of weather-related risk in areas of airports Iasi, Bacau and Suceava is designed in a new way, given the great complexity fizicogeografică northeast region of Romania. He will complete scientific information such as weather-existent, making daily meteorological data, harmonizing them into a comprehensive unified whole.

Priorities that were oriented research can be structured and synthesized in several directions:

- identify weather events with a high degree of risk to aircraft;;
- structural-functional analysis of the areas analyzed for causal explanation of phenomena relational risk by making practical models possibly be applied to other regions;
- natural and anthropogenic dynamics analysis system in order to achieve forecasts and scenarios for the evolution of the phenomenon of short-term risk, possibly even in the medium and long term;
- assessing the adverse impact of the climate weather conditions on air traffic;
- developing technical solutions judicious management, prevention, risk reduction or elimination of meteo-climatic areas of airports in Iasi, Bacau and Suceava.

The work is primarily based on the analysis of related weather data of observations made at weather stations, weather radar and in the archives of the National Administration of Meteorology and Aeronautical Meteorology Service of the Romanian Administration of Air Traffic Services. To characterize the frequency and origin of air masses in transit through the northeastern region of Moldova, the three airports are located, they were analyzed a series of materials (eg synoptic maps of soil, field of geopotential at isobaric 500 hPa and temperature at 850 hPa, aerial surveys, satellite images, etc.) provided by a number of specialized sites, such as www.wetterzentrale.de, www.estofex.org, www.satreponline. org, http://weather.uwyo.edu.

To argue the influence of climatic conditions on air navigation thesis is based on concepts and ideas taken from scientific achievements of renowned authors in the field of geography, climatology, meteorology, aeronautical meteorology and safety, both in Romania and abroad.

The final reports made after the investigations of aviation accidents and incidents existing in the archives the Center for Investigations and Analysis for Civil Aviation Security (CIAS) at the Ministry of Transport were a very useful source of information in making the thesis.

Case studies, information taken from the airlines and committees of inquiry findings have been included in the content of the paper constitutes relevant and compelling arguments, which prove concretely the influence of weather and climate on aeronautical activities, highlighting also the causal relationships of temporal and spatial variation of meteorological parameters and flight safety.

They were used geographical research methods well known in general, namely:

a. Analysis method, used as a way of knowledge and detailed study of each climatic element for understanding the role that these played in determining the main features of the climate in general and risk forecast climatic phenomena in air travel.

b. Using deductive method was needed to understand how climate regularities prove their applicability and is manifested in concrete terms that it creates physical-geographical space of the areas analyzed.

c. The comparative method was of interest in terms of detection of spatial differentiation recorded in the territorial distribution of the main climatic elements, but also in order to know the time evolution (secular, annual, seasonal, monthly, daily) of these climatic parameters.

Implementation of these main methods which showed only paths to be followed, in order to obtain the desired results, was done through the use of specific geographical procedures of research in general and climatological in particular , including the foreground stood remark (direct, instrumental and visual).

The statistical and mathematical processing of aerologic, meteorological and climatological data and graphical representation constituted the processes that has capitalized rich data fund obtained from measurements at meteorological stations and by the results were graphically transpose. Tabular presentation of data resulting from synthetic processing and preparation of graphs and maps depicting temporal or spatial variation in climatic parameters has facilitated follow written text. Throughout the paper, where applicable, give complement the methods of processing and interpretation of data fund. The tables, graphs, maps, and text that always made reference to the period used.

All climate elememtele has been analyzed both in view of their diurnal, monthly, seasonal and annual regime and in terms of their spatial distribution on the territory with quite diversified conditions of landscape.

The results were continuously reported at climatological values in reference to the whole country (RP Romîne Climate, vol. I, 1962, vol. II, 1961.1966; Climatological Atlas 1966, Atlas - RS Romania, 1972-1979; Geography of Romania, vol. 1, 1983 etc) and other works related to the whole country or whith regional character.

III. CLIMATIC FACTORS

Complex interplay of climatic factors (solar radiation, the active surface, the general circulation of the atmosphere) contribute to outline climate characteristics at the airports of Iasi, Bacau and Suceava.

III.1. Solar radiations

Radiative factors determine the major traits of climate, therefore including areas of airports Iasi, Bacau and Suceava. Solar radiation, the most important climate factor, depend directly by solar activity and indirectly by rotation of the Earth, the Earth's axis tilt from the plane of the ecliptic and the eccentricity of the orbit.

III. 1.1. Direct solar radiation

In case of the latitudes of that three airports the height of the Sun shows a upward diurnal passage until the meridian sun spot (true noon), it reaches maximum, after which it falls into the second part of the day. Since the dawn, the direct solar radiation is increasesing

in parallel with the height of the Sun above the horizon, and reach the maximum sun spot when crossing the meridian. This type of variation is maintained regardless of the month.

III.1.2. Scattered solar radiation

In the areas of Iasi, Bacau and Suceava airports the diffuse solar radiation presents early in the day a rising drive until noon, when it touches usually the maximum. In the second part of the day the diffuse radiation is descending until sunset, which is the same whatever the time of year. At noon, diffuse solar radiation is higher in the first half than in the second.

III.1.3. Global solar radiation

The annual average of global solar radiation shows a diurnal upward early on the day and downward in the afternoon. This trend follows the variation of the angle of elevation of the sun. The type of variation is maintained regardless of the time of year, what differs is the intensity of the phenomenon.

III.1.4. Reflected solar radiation

Whatever the time of year, the average values of reflected solar radiation shows an increase from sunrise until noon, when usually attained daily maximum, after which it drops in the afternoon to sunset. The reflected radiation is lower in summer and autumn and higher in winter and early spring.

III.1.5. Absorbed and effective solar radiation

By calculation, Gh. Diaconescu established at Iasi radiometric station an annual average amount of absorbed radiation in the amount of 88.0 kcal/cm^2. The highest monthly values occurs in July (14.6 kcal/cm^2), and lowest in December (0.7 kcal/cm^2).

III.1.6. Radiative balance

In the day and in the summer, when absorbed radiation is intense and the effective radiation is lower, the radiative balance is positive. Because the incident radiation is missing and partly the soil loses radiation that has accumulated during the day, at night the balance is negative. Therefore, the maximum is recorded in June, when the duration of days is higher, and the minimum occurs from December to January when the nights are longest and when active surface receives the lowest amount of radiant energy.

III. 2. The structure of the active surface

The active surface of the north-east of Romania - where Iasi, Bacau and Suceava airports are located – absorb or reflect different amount of energy emitted by the Sun and arrived at the land surface and generate throught in homogeneity the local differences of topoclimatic type, going so far as influences the thermal and humidity characteristics of air near the earth's crust.

III.2.1. Climatic role of the relief

Together, the flow of solar radiation, general atmospheric circulation and relief have complex and permanently influence on climate. The main features of the landscape with a decisive role in climate influence in the north - eastern Romania are: altitude, energy and landscape fragmentation, tilt and slope exposition.

III.2.2. Climatic role of soil and vegetation

For short periods of time (transition seasons, given the lack of vegetation and snow) the soil throught its physical properties (color, porosity, thermal conductivity, water retention capacity etc.), which differ from one soil type to another, causes important changes to local of meteorological elements in the layer of air from the ground. In the summer season, in the anticyclone regime with clear skies and weak winds, the micro-climatic differences are particularly evident from one soil type to another.

In north - eastern Romania, the vegetal cover not only suffer the influence of climatic conditions, but also help on topoclimatic creation. The development stage of annual plant density and crop rotation are additional factors of climate tint, so while of culture duration and space and vertically expanding. The surface role underlying assets is taken, in this context, by the carpet plant, whose physical features are depending on the type and the stage of vegetation; therefore, as with natural vegetation, we are dealing with an active layer underlying, extended vertically from the upper level of the vegetation to the point where sunlight can penetrate. In the active layer, solar radiation is absorbed selectively, it is transformed into heat, reflected and diffused, which is leading to thermal and pressure differences, as well as moisture to the surrounding area (Romania Climate, 2008).

III.2.3. Climatic rol of aquatic surface

The influence on climate of water accumulations from rivers in the area where Iasi, Bacau and Suceava airports are located is reduced, manifesting only locally, the climatic role of this consisting in increasing of moisture air over the lake and right their approach, mitigating thermal regime, especially in summer, more dew, fog by radiation or by evaporation, frost and late frosts. Even though their influence is small, we must take them into account. Generally, in warm season the river are small due to reduced river flow that feeds them.

In northeastern Romania, water accumulations were originally built to mitigate flood effects manifested in the warm seasons and now they have multiple functions, such as drinking and industrial water supply of towns, fishing, irrigation.

III.2.4. The influence of human society

Population growth, the development of settlements, more powerful intervention means upon the environment have produced increasingly deeper changes on its environment elements, thus on climate and urban microclimates areas where there are Iasi, Bacau and Suceava.airports.

III. 3. General circulation of the atmosphere

General circulation of the atmosphere largely determine the climatic conditions in the Iasi, Bacau and Suceava airports, as a result of the significant changes that movement of air masses requires in the evolution of atmospheric processes and phenomena from these areas.

III. 3.1. Barometric centers of action in the atmosphere

Based on average annual and monthly baric fields over Europe and adjacent areas, were able delineate of high tensile, intensity and frequency, of baric formations which have a decisive role on atmospheric circulation in our country.

III. 3.2. Types of atmospheric circulation

Across the Europe, implicitly on Romania, Dumitru Balta and Anton Geicu have identified seven types of air movement: the western, pole (direct, inverted, ultrapolar), tropical, the blockage (Romania Climate, 2008).

IV. THE ANALYSIS OF CLIMATIC ELEMENTS AND METEOROLOGICAL PHENOMENA WITH INFLUENCE ON THE FLIGHTS IN THE AREAS OF IAȘI, BACĂU AND SUCEAVA AIRPORTS

IV. 1. Atmospheric pressure

In the north-eastern Romania, where the Iasi, Bacau and Suceava airports are located, the active heating of different surface generate local maximum and minimum pressure that constitute causes of local air movements between the low and the high plains from the airports areas, between wooded and the look, between the lake basin and surrounding areas, or between urban and surrounding areas thereof (in Iasi city the urban breeze is a fact, clearly outlined in the study "The climate and microclimat in the City of Iasi" - Elena Erhan, 1979).

IV. 2. Duration of sunshine

For aircraft on race, the horizon limit being more distant as the increase of echelon of flight, the sunset and sunrise varies depending on the level of flight. Therefore, a plane at 5000 m height still shines in direct sunlight, although the sun has set several minutes at the airport.

This three meteorological stations are distinguished by a different duration of sunshine, due to their position in relation with the movement of air masses. Thus, while in Suceava, the average of annual insolation totals only 1,800 hours as a direct result of Baltic air masses, in Bacau and Iasi it varies between 1857 hours in Bacau, respectively 1942 hours Iasi, under the influence of continental air masses from Eastern Europe.

In the long term (1961-2012) evolution tendencies in the duration of sunshine, it shows an increasing trend to all three meteorological stations.

VI. 3. Nebulosity

Clouds has a great importance for aviation, for their low ceiling embarrasses or even prevents takeoff and landing of airplanes, clouds forcing to use the tools of guidance, the visual flight being impossible in these conditions. By their nature, clouds creates conditions that can be dangerous sometimes for flight because of icing, turbulence, thunderstorms, hail and even because they induce precipitation.

IV.3.1. Total nebulosity

The mean values of total cloud cover in the three airport locations in Moldavia were ranged between 6.2 and 6.5 tenths. Looking at these statistics are not very spectacular observed distribution of total cloud cover, which can be explained by the relatively small spatial extent of the area studied. Spring and autumn, cloud cover has intermediate values, higher the closer we get to winter and lower summer, spring is characterized by somewhat higher values than fall.

The total cloud regime cover during the year is characterized by maximum value in winter and minimum value in late summer, being directly influenced by the movement of air masses, but also regional and local geographical conditions. The maximum in December (from 7.2 to 7.7 tenths) is explained by the high frequency of baric depressions, into which the upward air movement results in condensation of water vapor, thereby generating systems in all three locations from moldovavian airports, but it is also due to thermal inversions leading to confinement of dense air mass causing a greater frequency of radiation mists accompanied by stratiform clouds, in the latter case it is especially Iasi and Bacau airports.

IV.3.2. Lower nebulosity

Compared with total cloud cover, lower cloud cover manifests the strongest influences to the other climate components and processes, and is one of the factors that require specific safety measures in air flights. To the Iasi, Bacau and Suceava weather stations, in terms of monthly and annual averages lower cloud cover, is a good correlation between these values and total cloud cover, lower cloud cover having generally value of 2/3 of the value of total cloud cover.

As whith the case of total cloud cover, the highest average annual values is recorded throughout the Iași (4.2 tenths), but in Bacau and Suceava the values of lower cloud cover are 3.6 tenths in the first case and 3.7 tenths in the second. It was observed an increasing trend of lower nebulosity of the highest areas (Suceava - 3.7 tenths) to the lows (Iasi - 4.2 tenths).

IV.3.3. The lower nebulosity frequency

The number of sunny days varies inversely with the ratio of days covered. In the analyzed period there were on average per year, 38-53 blue sky days and 101-122 days overcast.

IV.3.4. Clouds type frequency

For aviation activity, special importance present the clouds with lower base, because of their strong ascending / descending air currents and wind gusts that may adversely affect the normal airline flights. Clouds undertakes, when passing through them, to have recourse to instrument flight, the visual flight not allowed. Clouds, by their nature, can sometimes create hazardous conditions for flying because of associated phenomena, such as icing, turbulence, lightings, hail and even accompanying precipitation.

The following categories of clouds Nimbostratus (Ns) and Stratus (St) shows a decreasing trend in low-lying areas to higher ground (between 243-277 cases in Iasi and 199 cases in Bacau and Suceava). In terms of frequency during the year pair of clouds Nimbostratus (Ns) and Stratus (St) has the highest frequency in the cold season, from November to March, the peak being reached in December in Bacau and Suceava respectively in January in Iasi, in this time low temperatures inversions with stratifications stable air masses promoting their genesis.

The last two categories of clouds Cumulus (Cu) and cumulonimbus (Cb), presented annually lowest frequency. However, due to active thermal convection of warm and very active summer months, their frequency increases significantly. It should be noted that the highest frequency of this pair of clouds is to Bacau (325 cases).

IV.3.5. Height of the base of low clouds in fog conditions

Using hourly data horizontal visibility and cloud ceiling, recorded in the period 2000 – 2012 at weather stations from ROMATSA network and located at Iasi, Bacau and Suceava airports, was done a comparative statistical analysis of the frequency of low clouds ceiling height in the fog condition with visible sky and fog with frost deposition. This analysis supports the assessment of suitability aircraft conducting flights over the three airports of Moldova, under low clouds registration associated with reduced horizontal visibility at ground surface and the risk of ice deposits.

The results show the following aspects of frequency (%) of ceiling height of low clouds in the fog condition with visible sky:

a) *From Iași:*

- in fog with visible sky and horizontal visibility of between 500 - 1000 m, in one of two cases low clouds ceiling is between 100 and 300 m;
- in fog with visible sky and horizontal visibility below 100 m, in nine out of ten cases low clouds ceiling is between 30 and 100 m, while in other cases the sky is clear.

b) *From Bacău:*

- în condiții de ceață cu cer vizibil și indiferent de pragul vizibilității orizontale, în cel puțin unu din două cazuri plafonul norilor joși este cuprins între 30 și 100 m;
- în condiții de ceață cu cer vizibil și vizibilitate orizontală sub 100 m, în trei din zece cazuri cerul este senin, iar în restul cazurilor, în general, plafonul norilor joși este mai mic de 100 m.

c) *La Suceava:*

- in fog with visible sky and regardless of horizontal visibility threshold in at least one of two cases low clouds ceiling is between 30 and 100 m;
- in fog with visible sky and horizontal visibility below 100 m, in three out of ten cases the sky is clear, and in other cases generally low clouds ceiling is less than 100 m.

The results show the following aspects of frequency (%) of ceiling height of low clouds in the fog with frost deposition:

a) *From Iași:*

- in fog frost deposition and horizontal visibility of between 200 - 1000 m, in one of two cases low clouds ceiling is between 100 and 300 m;
- in case of fog and frost deposition horizontal visibility below 200 m, in one of two cases low clouds ceiling is between 30 and 100 m.

b) *From Bacău:*

- in fog frost deposition and horizontal visibility of between 100 - 1000 m, in at least one of two cases low clouds ceiling is between 30 and 100 m;
- In the analyzed period there was fog and frost deposition horizontal visibility below 100 m.

c) *From Suceava:*

- in case of fog and frost deposition regardless of threshold horizontal visibility, at least two of the three cases low clouds ceiling is between 30 and 100 m;
- in case of fog and frost deposition horizontal visibility below 100 m, in two out of ten low clouds ceiling is below 30 m and in one in ten cases cloudless sky.

IV.4. Air temperature

The air temperature is important in aviation, both climatological perspective, but also by the number of works necessary to prepare an aircraft for flight, imposing a greater number of works for extreme temperature scales.

IV.4.1. Monthly and annual mean temperatures

In the north-eastern Romania, where Iasi, Bacau and Suceava airports are located, the annual average air temperature decreases from south to north and generally increase from northwest to southeast (Fig. 51), with the increasing of continentalism level and decreasing of elevation.

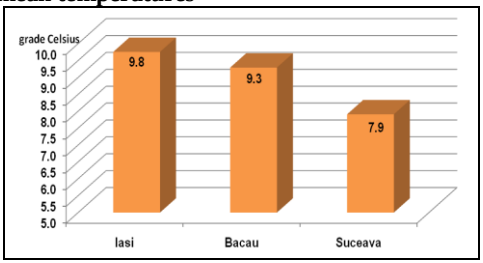


Fig. 51. The annual average air temperature at weather stations Iasi, Bacau and Suceava (1961-2012)

Long-term trends of air temperature (1961 - 2012) at the three stations indicates that this element, beyond his repeated fluctuations, is now a clear upward trend.

IV.4.2. The absolute maximum and minimum temperatures

Very high or low temperatures may have an impact on aviation safety in a variety of ways. Extreme temperatures increase the air density at high altitude and may have a negative impact on aircraft performance. High temperatures may also cause a condition known as "vapor lock" (FAA Aviation Weather-Related Accident Study 2003-2007).

Also, high temperatures can heat the running surfaces of aircraft, such as tar, making them unsuitable for landing and taxiing. If there is water in the system at extremely low temperatures, it may freeze and make the system unworkable. When an aircraft is a long period in a negative temperature environment or in flight or on the ground, the aircraft structure is substantially cooled. This phenomenon causes contraction of the structure of the fuselage and a variety of mechanical difficulties.

The absolute minimum temperature ever recorded at this three meteorological stations was -30.8 ^{0}C in Bacau, -30,6 ^{0}C in Iasi, both registered in January 1963, respectively -29.8 ^{0}C in Suceava in December 1996, and all was produced under baric anticyclones conditions, generated by the extension to the southeast of Greenland anticyclone in case of Iasi and Bacau and by the southwesterly extension of the eurosiberian anticyclone for Suceava, combined with radiative heat loss.

IV.4.3. The number of days with different air temperatures

Monthly and annual frequency of days when there were reached or exceeded down different thresholds constitutes an important feature of the thermal regime of the three airports.

Long term evolution of the number of days with minimum air temperatures of $\leq -10^0$C show a decreasing trend at all three meteorological stations. As regards the evolution of the number of days with maximum air temperature ≥ 30 ^{0}C, in the period 1961-2012, we can say that the first 20 years the trend line shows a decrease and then increase.

Given the above, it can be appreciated that for the last 52 years in the areas of airports Iasi, Bacau and Suceava, the winters weakened in intensity and are less cold and summers have become warmer.

IV.5. Air humidity

The presence of water in various states play an important role in meteorological processes in the atmosphere. The water vapor, liquid water, and ice crystals that exists in the atmosphere depend to a very large extent mist, reducing visibility, cloud formation, precipitation of various types, to thunderstorms, icing times. Weather events listed are subject and other factors which have a close interdependence.

IV.5.1. Water vapor tension

Distribution of water vapor indicates important variations between Suceava and Bacau meteorological station and Iasi weather stations that have similar values, these variations due to the differences in both temperature and altitude difference.

As shown in the monthly and yearly averages analysis show that the lowest monthly average ($\leq$ 4.5 mb) recorded in January, and the highest monthly average ($\geq$ 16.0 mb) was recorded in July.

The annual regime of water vapor tension present the same upward (January-July) and downward (July to January) including when we take as a basis for analysis of monthly multiannual size at 1^{00}, 7^{00}, 13^{00}, 19^{00} hours.

In detail, the annual minimum zone occurs at the level of January at 7 o'clock at all three meteorological stations and the maximum at the level of July at 7 o'clock in Iasi and at 19 o'clock in Bacau and Suceava.

IV.5.2. Dew point temperature

Distribution of the values of dew point temperature reveals that this oscillate between $3,9^0$C in Suceava and $5,4^0$C in Bacau.

The lowest value of monthly dew point temperature was recorded in the coldest month of the year (January), when the saturation deficit is minimal, and the largest was recorded in the hottest month of the year, this being achieved against the background of a hight waterr vapor tension, but a maximum saturation deficiency at the same time.

IV.5.3. Relative humidity

Most average annual relative humidity is between 73% and 83%. During most dry and warm, relative humidity values have fallen below the lower threshold being exceeded the upper threshold mentioned in the most rainy and wet years.

In the long term (1961 - 2012), the evolution trends of relative humidity indicate a slight decline (between 5 and 10%), showing a reverse situation prevailing trends in long-term air temperature.

During the year, relative humidity is fluctuating, the maximum was recorded in December. January have values which are very close to December, but not equals, so December, with short days, low temperatures and high cloudiness remains the maximum relative humidity.

IV.6. Atmospheric precipitations

Rainfall may affect air flight safety by reducing visibility, aircraft performance and cause conditions for the emergence of ice deposits.

IV.6.1. Monthly and annualy precipitation amounts

The relatively small space area where Iasi, Bacau and Suceava airports are located, there is still significant regional variations in annual quantities of rainfall. Rainfall decreases slightly from northwest to southeast, an explanation for this in decreasing of altitude of relief in this direction, another explanation could be that a higher frequency of humid air masses to the north and north west, which is Atlantic air masses who became low in moisture with south and southeast movement, plus and continental air masses coming from the northeast, east and southeast often dried or loaded with small amounts of water, also contributing to poor quantities in the south-east and south.

The frequency and intensity of wet or dry air advection in northeastern Romania, where the Iasi, Bacau and Suceava airports are located, undergoes changes from month to month, and dynamic thermal convection takes place in different parameters so months their sequence year presents different values of rainfall, like the season or fall season (table 36).

Table 36. Monthly and annual precipitation quantities (l/m^2) of rainfall recorded at weather stations Iasi, Bacau and Suceava (1961-2012)

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Iași	30,1	29,0	31,7	49,4	59,4	88,2	79,6	55,8	51,3	33.1	34,3	32,3	**574,3**
Bacău	23,0	24,4	28,4	51,6	70,4	84,1	90,2	56,6	50,4	35,7	30,4	28,2	**573,6**
Suceava	22,3	22,5	28,0	51,9	76,2	98,8	107,3	70,0	47,7	33,8	29,6	25,2	**613,3**

The graphics analysis on observations made during the 52 years, at Bacau and Suceava stations, is observed a synonym of the evolution of annual amounts of precipitation. Long-term trends - 1961-2012 (fig. 69) of precipitation, shows that precipitations are in obvious decline in Iasi and Suceava and show an upward trend at Bacau. In absolute value, both decrease and increase in precipitation did not exceed 50 mm.

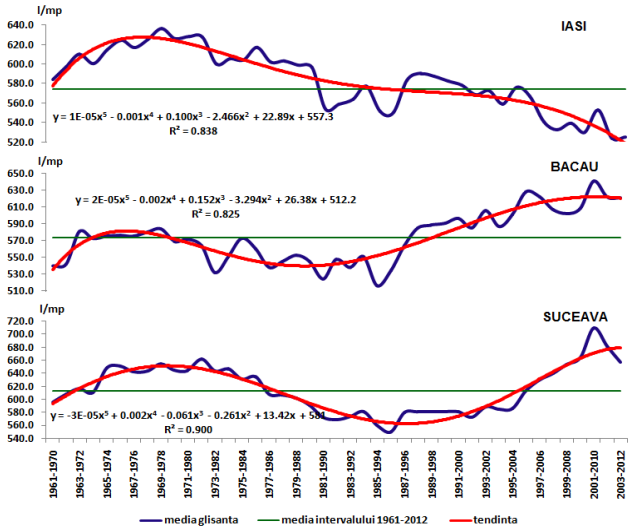


Fig. 69. 10-year sliding averages successively delayed by one year of the annual quantities of precipitation (l/m^2) calculated by averaging the values obtained from weather stations Iasi, Bacau and Suceava (1961-2012)

IV.6.2. The number of days with different amounts of rainfall

Within a year, the number of days with rainfall amounts exceeding certain thresholds decreases progressively as the daily amounts of precipitation are consistent.

IV.7. Wind

The annual frequency of wind weather at Iasi, Bacau and Suceava stations highlights the correlation between the main action directions of the wind and interfluves orientation and valleys. Air masses coming to a component spreads north to south in a direction parallel to that of the Carpathians. The data recorded during the period 1961-2012 shows that dominant winds blow predominantly from the northwest at Suceava and Iasi and north at Bacau.

During the year, monthly average speeds occur in late winter and early spring, and the lowest in late summer. Cyclonic activity is intensifies in spring and horizontal gradients barometric becomes elevated, same situation presenting it in the cold season of the year. In August the thermal contrasts between different geographical areas are small, horizontal gradients barometric have low values, so the movements of air masses from side to side do not have a special force or violence, and in July and September monthly average speeds wind is generally low (fig. 75).

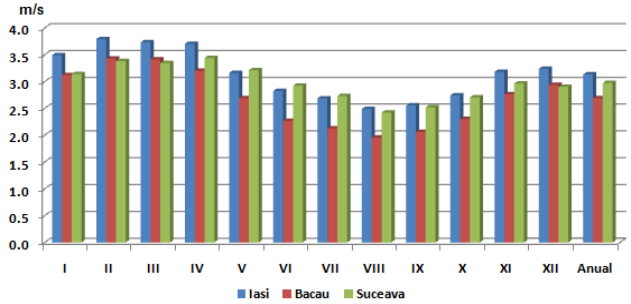


Fig. 75. The annual regime of average speeds (m / s) of wind weather at Iasi, Bacau and Suceava stations (1961-2012)

IV.8. Horizontal visibility

Looking at annual frequency of horizontal visibility at the weather stations from that three airports was found that it was less than 1 km in only 2.8% of cases in Iasi, 3.7% of cases in Suceava and 5.7% of cases in Bacau.

Between seasons, the summer recorded the lowest frequencies) with horizontal visibility ≤ 1 km (0.1% in Iasi, 0.2% in Suceava and 0.5% in Bacau), which is the period when the fog generally radiative have an ephemeral presence. In the winter season, horizontal visibility ≤ 1 km are highest frequency (6.8% in Iasi, 8.1% inSuceava and 14.2% in Bacau).

In the long term (1961-2012), trend lines of horizontal visibility ≤ 1 km evolution clearly show a downward trend.

Using hourly data recorded in the period 2000 – 2012, at ROMATSA network weather stations located on Iasi, Bacau and Suceava airports, was done a comparative statistical analysis of weather events that caused reduced horizontal visibility below 1000 m. As shown in fig. 85 at all three meteorological stations the fog phenomenon is the main factor which reducing the horizontal visibility less than 1.000 m in more than 90% of the

cases. In Iasi, in about 10% of the cases horizontal visibility drops below 1000 m in terms of snow, sleet and blizzards, while at other weather stations percentage is much lower.

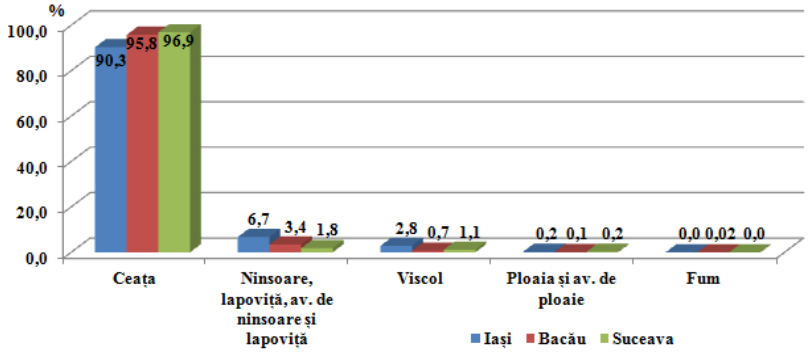


Fig. 85. Frequency (%) of weather phenomena which cause horizontal visibility reduction below 1000 m at ROMATSA network weather stations located on Iasi, Bacau and Suceava airports (2000 -2012)

In the period of 2000 to 2012, in fog conditions with visible sky, because of the transparency, existing clouds in the sky, blue sky or luminaries in more than half of the total cases, horizontal visibility it was greater than 400 m at all three meteorological stations and fell below 100 m in 4.1% of cases in Suceava, 1.8% of cases in Bacau and 1.3% of cases in Iasi.

Often in winter, fog phenomenon is accompanied by the deposition of frost. Near the soil surface frost occurrence is an indicator of the risk of icing fog. Accordingly, in over half the cases, the horizontal visibility is less than 400 m from Bacau and Iasi, while Suceava the visibility falls below 200 m.

When fog occurs in conditions with invisible sky, horizontal visibility is greatly reduced and it is not possible to see the clouds, the stars or the blue sky, ground fog being unclear. Accordingly, in Iasi and Suceava is prevailing situations when the horizontal visibility falls below the 200 m and 300 m in Bacau. In conditions with invisible sky, horizontal visibility fell under 100 m in 5.0% of cases in Bacau, 6.2% of cases in Iasi and 17.8% of cases in Suceava.

At Iasi station, in conditions with invisible sky, the fog thickness ranges generally between 30 and 60 m when horizontal visibility is more than 100 m. In Iasi, when visibility drops below 100 m, thick fog prevails between 60 and 95 m. The the other two airports, Bacau and Suceava, regardless of horizontal visibility, thick fog varies usually between 30 and 60 m. However, there are situations when Bacau and Suceava airports, especially in the horizontal visibility conditions greater than 400 m, mists thickness is between 60 and 95 m and, rarely, over 95 m (Suceava).

IV.9. Meteorological phenomena with influence over the aircraft flights

It is known that some weather events affect air navigation and threaten the safety of aircraft and persons therein. The outbreak of some of these phenomena is very fast and therefore knowledge of their characteristics, providing them, the information on their existence on time to allow for action to avoid possible accidents.

IV.9.1. The rain and the showers

Annual average number of rain days is the lowest in Bacau station area, and the highest in the Iasi station. During the year, at this three weather stations, rain has the highest frequency in April and May. In the winter months, when supercooled rain probability is highest monthly number of days with rain is over 2 days (8%) in Suceava, 3 days (9%) to Bacau and 5 days (6%) to Iași.

The average annual number of days with showers of rain is higher in Bacau and Suceava, where the intersection of air circulations and high moisture creates more favorable conditions for producing this phenomenon compared to Iasi. In the first half cold season, the showers are rare, they are occurring, on average, in a number of 11 to 16 times, less than the number of days recorded for warm semester.

IV.9.2. Lighting

Average annual number of days with lighting vary between 32.9 days at Suceava to 37.2 days at Iasi, the difference being given by dynamics of air masses, their sharp warming, morphology, altimetry and other features of the landscape, but also of surface active, under the impuls and through of heat exchange of soil-atmosphere.

IV.9.3. Storm

From year to year the number of days with storm fluctuates greatly. The data recorded during 1961 to 2012 at this three meteorological stations shows that this phenomenon occurs in Iasi, on average, once a year, in Bacau approximately every two years and every three years in Suceava.

IV.9.4. Strong wind

Annually, most days with strong wind whose speed is over 16 m/s were recorded in Iasi (9.3 days) and the fewest in Bacau (5.0 days). During such days a year are recorded most frequently in winter and early spring, and the rarest in the late summer and early autumn, when the barometric horizontal gradients have low values.

IV.9.5. Hail

From the analyzed material showed that, during 1961 to 2012, there were an average of 0.9 days with hail/year at Bacau and Iasi and 1.3 days/year at Suceava. Compared to areas where other airports in Romania are located, Moldova airports are located in areas where the incidence of hail phenomenon is reduced.

IV.9.6. Drizzle

This meteorological phenomenon occurs throughout the year, but in cold semester is the best conditions of production. Of the stations analyzed stands Iași station where precipitation in the form of drizzle has the highest frequency, which give low precipitation, but maintain high humidity and very low visibility. In Iasi, the drizzle frequency is twice higher than in Suceava, and 19% higher than in Bacau.

IV.9.7. Sleet and sleet showers

Average annual number of days with sleet in the period 1961-2012, ranges between 7.9 days (2.2%) in Suceava, 8.4 days (2.3%) in Bacau and 10.1 days (2.8 %) in Iasi. The sleet showers occur more rarely, in March and April having the highest frequency.

IV.9.8. Snow and snow showers

Annually, on this three airports the average number of snow days exceeds 40 days (40.1 days in Bacau,.8 days in Iasi 43, 47.7 days in Suceava) and the average number of days with snow showers vary between 3.7 days at Bacau and Suceava to 5.9 days at Iasi.

Monthly and annual average number of days with snow cover is larger than the snow days because of maintaining of negative temperatures of air and soil, or a snow recorded in a particular day by accumulating snow flakes on the ground which can generate a continuous or discontinuous layer thicker or thinner snow, that can last until the temperature becomes positive and the process of melting begin and the layer disappears. After snow falling on that three airports situated in northeastern Romania, snow made it a presence almost mainstay in the winter months, but its presence can be early in fall or late in mid spring. Snow, generally increase in thickness from November to February, after which the thickness decreases gradually snow disappearance recorded at the latest in April.

IV.9.9. Snow transport on the ground and blizzard

The annual number of days with snow transport on the ground is between 6.5 days at Bacau and 10.8 days at Suceava. During the year, the blizzard reach a maximum manifestation in January, when recording the highest average monthly number of days with blizzard for all sites of observations.

IV.9.10. Deposition of ice

The presence of ice and frost phenomena at weather stations is the best indicator of the risk of icing formation near the soil surface. Between 2003 to 2012 there have been 34 cases of glazed frost and 87 cases of frost at Iasi, 15 cases of glazed frost and 92 cases of frost in Bacau and 23 cases of glazed frost and 101 cases of frost in Suceava

Using daily data and the hourly intervals of deposition of ice in the period 2003 - 2012 was done a comparative statistical analysis of the frequency of these phenomena at that three meteorological stations (tab. 60). This analysis supports the assessment of suitability aircraft conducting flights over the three airports of Moldova in conditions with ice deposits.

Tab. 60. The frequency (%) of deposits of ice at Iasi, Bacau and Suceava weather stations in the period 2003-2012

	Frequency (%) of glazed frost at weather station			***Frequency (%) of frost at weather station***		
	Iaşi	***Bacău***	***Suceava***	***Iaşi***	***Bacău***	***Suceava***
Only at weather station	64.8	40.0	56.6	40.3	31.5	58.4
Simultaneously all 3 stations	2.9	6.7	4.3	17.2	16.3	14.9
Simultaneously at Bacau and Suceava		20.0	13.0		20.7	18.8
Simultaneously at Suceava and Iaşi	17.6		26.1	9.2		7.9
Simultaneously at Bacău and Iaşi	14.7	33.3		33.3	31.5	

IV.9.10.1. Glazed frost

Average annual number of days with glazed frost is the largest in Iasi (5.0 days/year) and about equal to the other two weather stations (3.4 days/year in Bacau, respectively 3.5 days/year in Suceava). Following observations from the period 1961-2012, I have seen that in many years glazed frost may be missing, and in other years there have been a number of days with ice over the annual average for the station, for example: in 2002 in Suceava (18 icy days), 12-day ice in 1986 and 1996 at Iasi and 1988 at Bacau.

In the course of a year, during the period studied, ice and made sporadic presence in October to all three weather stations, monthly maximum frequency of days with ice was reached in January in Iasi and Bacau and Suceava in December.

Regarding this phenomenon during growth, from measurements made during 2003 to 2012, it was between 1.9 hours at Suceava to 4.4 hours from Iaşi. The month with the highest average duration of growth is November at Iaşi (7.7 hours), March at Bacau (5.5 hours) and February at Suceava (3.0 hours).

IV.9.10.2. Frost

Average annual number of days with frost is highest in Suceava (11.0 days / year) and lowest in Iasi (8.5 days / year). In Bacau, the average annual recorded 10.9 days / year. Winter is the season when the frequency of frost is maximum at Bacau (9.7 days). From recordings made during 1961 to -2012, it was found that in one year only missed frost in Iasi (1989), the other two stations phenomenon is present every year. In the period 1961 – 2012, the years with records of a big number of days with frost were: 1985 and 2002 to Suceava (27 days), 1962 to Bacau (25 days) and 2003 to Iasi (22 days).

In terms of annual duration of frost growth, from measurements made during 2003 - 2012, it was between 8.7 hours at Iasi and 11.8 hours at Bacau. The month largest average of duration of growth is December at all three meteorological stations (Bacau - 14.2 hours; Iasi - 11.6 hours; Suceava - 10.8 hours).

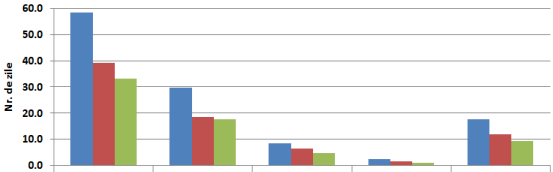
IV.9.11. Misty air

Within a year, misty air travel peaked in the winter season, when the frequency of days with visibility of between 1 and 10 km beyond 75-80% of total winter days in Bacau and Iasi and 60% of that number Suceava.

IV.9.12. Fog

In the period of 1961 to 2012, in areas of Moldavia airports, there were an average of 33.3 days with fog in Iasi and 58.6 days with fog in Bacau (Fig. 109).

From measurements made during 2003 - 2012, the average fog cases ranged from 5.4 hours at Iasi to 8.3 hours at Bacau.



	An	Iarna	Primavara	Vara	Toamna
Bacau	58.6	29.7	8.5	2.6	17.8
Suceava	39.3	18.7	6.7	1.8	12.1
Iasi	33.3	17.9	4.9	1.1	9.4

Fig. 109. Seasonal and average annual number of days with fog at Iasi, Bacau and Suceava weather stations (1961-2012)

Diurnal evolution of fog indicates most of their frequency late that afternoon and early evening when performing assets maximum surface heating and air relative humidity decreases greatly. In the second part of the night and in the morning fog have maximum frequency due to favorable thermal and moisture conditions.

Using daily data and the hourly intervals of deposition of ice in the period 2003 - 2012 was done a comparative statistical analysis of the frequency of these phenomena at that three meteorological stations (tab. 65). This analysis supports the assessment of suitability aircraft conducting flights over the three airports of Moldova in conditions with fog.

Tab. 65. The frequency (%) occurrence of fogs at Iasi, Bacau and Suceava weather stations in the period 2002 – 2012

	Frequency (%) production of fogs at weather station		
	Iaşi	***Bacău***	***Suceava***
Only at weather station	30.8	31.2	34.6
Simultaneously all 3 stations	33.2	25.4	28.6
Simultaneously at Bacau and Suceava		24.3	27.4
Simultaneously at Suceava and Iaşi	11.0		9.4
Simultaneously at Bacău and Iaşi	25.0	19.1	

V. THE ANALYSIS OF WEATHER STATEMENTS WITH IMPACT OF AIRCRAFT FLIGHTS

V.1. Impact assessment of weather conditions over aircraft flights abroad and in Romania

In the period 2002 - 2012, worldwide it found that the annual number of aviation accidents planes destroyed ranged between 23 in 2012 and 37 in 2002. In terms of the annual number of aviation fatalities it found that globally, in the same period, there were 431 deaths between 2004 and 1101 in 2002.

In Europe, the number of accidents is declining, from 39 accidents in 2011, 30 accidents in 2012 and the rate of accidents per million takeoffs, 2012, was 4.2, above the global accident rate (source : safety report 2012, CIAS).

In 2010, the Federal Aviation Administration of the United States of America (FAA) conducted a study which covered analysis of weather conditions that favored aviation accidents in that country in 2003-2007. According to him, out of the 8657 registered in the US aviation accidents in 8754 involving planes, favoring weather conditions were not the cause of accidents in 1740 (20.1%) in 1741 involving airplanes. Among the meteorological factors that contributed to weather-related accidents were mentioned: wind, visibility and cloud ceiling, air turbulence, rainfall, wind shear, the storm, icing, extreme temperatures and lightning etc.

In the last 4 years (2010-2013), the data in annual rapoarele Centre of Investigations and Analysis for Civil Aviation Safety found that the share of the total annual number of events in civil aviation in the number of events where weather conditions were their relative factors of production shows an upward trend.

In 2012, the year with the highest number of events reported in 2009-2013 by the Centre of Investigations and Analysis for Civil Aviation Safety, weather conditions were a factor of production relative to 372 events including 17 events were classified incidents and 2 events were classified, one accident and one serious incident. In 94% of these were produced on a commercial airline aviation.

The wind was the main factor in producing meteorological events civil aviation, followed by atmospheric visibility and visibility measurement. According to investigation reports of the CISA, a smaller share in the production of these accidents were recorded a general weather conditions, precipitation, cloud formations and conditions of day / night.

As regards the consequences of weather conditions on the flights they had found that in 2012, in Romania, the weather factor caused mainly aircraft missed approach airports (106 events), and diversion of aircraft to other airports (28 events). To a lesser extent, but

not insignificant, including consequences also include: return on departure (5 events), missing the landing (3 events) and Flight delay (3 events).

V.2. Weather situations with negative impact on aerial flights in the areas of Iasi, Bacau and Suceava airports in the period 2010 - 2013 - Case studies

In the areas of this three airports in the period 2010 - 2013, weather situations with negative impact on aircraft flight occurred most frequently in terms of reducing the horizontal visibility when wind intensification presented in synoptic situations that have favored the deposition of ice or when there is a heavy snow accompanied by strong wind.

V.2.1. Weather situations with negative impact on aircraft flights due to climatic phenomena of risk in the cold season

Considered adverse climatic risk for many human activities, deposits of ice, heavy snowfalls, snow and wind intensification still deeply affecting aviation activity even in the most modern airports.

V.2.1.1. Weather situations with negative impact on aircraft flights due to deposition of ice

At takeoff, causing icing off the flow of air over the surface of the aircraft, disturbing rise, forcing the aircraft to stall at a small angle of attack and increased the speed more than normal. Ice blocking affect engine intake air flow, which can lead to malfunction.

V.2.1.1.1. Case study - 31 January 2013

Conduct aircraft flights at airports Iasi, Bacau and Suceava was particularly affected by ice buildup on the morning of 31.01.2013 manifested so many airports Bacau and Iasi flights have been delayed or have been canceled.

V.2.1.2. Weather situations with negative impact on aircraft flights due to heavy snowfall, snow and wind intensification

Usually in winter, when wind, snow, or snow soil consists appears transportation of snow on the ground or in strong winds and turbulent enough, snow transport height (assimilated blizzards). By drifting snow and submission forms drifts in sheltered places, difficult or interrupt traffic on roads, railways, airports etc.

V.2.1.2.1. Case study – 25 January 2013

Due to weather conditions dated 01.25.2013 aircraft flights at airports Iasi, Bacau and Suceava was heavily affected by adverse climatic snow, snow on ground transport and in height and thick layer of snow drifts gathered so that all three airports many flights have been delayed or have been canceled.

V.2.2. Weather situations with negative impact on aircraft flights due to climatic phenomena of risk in the warm season

Flight aircraft in areas of thunderstorm phenomena significant difficulties and sometimes danger, especially in the clouds of thunderstorms and in their vicinity, where turbulence is strong. Hail, icing, precipitation associated with these cumulonimbus clouds type can hold off. On the ground because of strong winds, the storms, the lightning or hail, or anchored parked planes may be affected and torrential rainfall with inpracticabil can

airfield. That is why, in general, due to atmospheric instability, these phenomena weather during the flight should be avoided of Cumulonimbus clouds type.

V.2.2.1. Weather situations with negative impact on aircraft flights due to atmospheric instability

Instability air mass is one of the key factors influencing the intensity and type of storm, because it is proportional to the energy available to air ascension.

V.2.2.1.2. Case study - 28 May 2010

It presents the analysis of a case of severe symptoms such as convective weather that took place on 28.05.2010, when the territory of Moldova was crossed multicellular convective systems.

Following the events of convective after - 28.05.2010 afternoon of Moldavia, aircraft flights in the area only three airports have suffered delays in landing or takeoff.

V.2.3. Weather situations with negative impact on aircraft flights due to climatic phenomena of risk throughout the year

Decreasing horizontal visibility, most often associated with the occurrence of fog phenomenon is responsible for the waste of time, money and even lives in all transport activities. Regarding aviation, reducing visibility involves the emergence of issues related to flight safety, air traffic interruption, delay flights or significant financial losses for airlines (Stolaki et al, 2009).

By enhancing its extreme, and the direction opposite to the runway-landing at an airport, wind is responsible for a significant number of aviation incidents harder because control of the aircraft, especially landing. Strong winds, wind shear back or crosswinds represents on average 33% of the causes of aviation accidents produced at takeoff and landing. In connection with the condition of the runway, crosswinds is responsible for about 70% of aviation accidents or incidents recorded, 85% of them occurring landing (http://flightsafety.org/fsd/fsd_nov-feb99.pdf).

V.2.3.1. Weather situations with negative impact on aircraft flights due to fogs

The European aviation, visual flights are not commenced when the visibility is less than 3 km and not otherwise conducted when the visibility is less than 1.5 km. Below these thresholds visibility operation is permitted takeoff or landing, but with respect to specific operating procedures and guidelines established by each operator for each aerodrome planned to be used.

V.2.3.1.1. Case study – 13 February 2014

Following events fog phenomenon dated February 13, 2014 flights were affected aircraft at airports Bacau and Iasi. On Suceava airport there were no delays or cancellations of flights because within the cloud were not scheduled landings or takeoffs of aircraft, airport movement area being closed since 12 January 2014 for modernization works .

Due to fog, two aircraft company Blueair, which perform international air racing towards London Luton (England) - Bacau and Bologna (Italy) - Bacau, Iasi was redirected to, and passengers were transported by buses to Bacau.

V.2.3.2. Weather situations with negative impact on aircraft flights due to wind intensification

The earth's atmosphere, complete immobility states are virtually nonexistent, the atmosphere is constantly moving. Air movements occur in all directions, the most important being the vertical and horizontal movements.

V.2.3.2.1. Case study – 2 Decembre 2013

Because of wind intensification of 2 December 2013 on airports Iasi, Bacau and Suceava flights carrying aircraft was severely hampered in the afternoon and evening, foreign race Tarom RO408 Rome - Iaşi could not land at Iaşi International Airport at set time (21.10), the aircraft being redirected to the Henri Coanda Airport in Bucharest and passengers transported by bus to Iasi.

GENERAL CONCLUSIONS

The study has proposed a systemic approach of risk issues in meteo-climatic areas of Iasi, Bacau and Suceava airports, for the sustainable development of aviation activity in the north-eastern Romania. Thus, identification and detailed analysis of the implications of climatic factors and elements and weather phenomena on airspace of Iasi, Bacau and Suceava airports are objectives that will lead to increased flight safety.

In the areas of this three airports, meteorological situations with significant negative impact on aircraft flight occurred during 2010 - 2013 in terms of reducing the horizontal visibility, when wind presented intensification, in synoptic situations that have favored the deposition of ice, or when produce heavy snow accompanied by strong wind. Of these, the fog was the biggest climatic negative impact on the aeronautics areas for Moldavia airports, this explained by the higher frequency of fog occurrence in the areas of this three airports, compared to other phenomena.

Periods of fog frequency increase since September. The maximum frequency is recorded in November and December in Suceava, the difference between the two months being only 0.1 days with fog. The other two airports (Iasi and Bacau) trend remains upward until January. In part two of the nights and in the mornings fog have maximum frequency due to thermal and moisture conditions favorable.

On all three airports, fog phenomenon is the main factor reducing the horizontal visibility below 1000 m (over 90% of cases). In Iasi, in 9.7% of cases, the horizontal visibility drops below 1000 m in snowfall, sleet and blizzards, while at other weather stations percentage is much lower.

The fog with visible sky in over 50% of all cases the horizontal visibility is less than 400 m on all three airports and drops below 100 m in cases in Suceava (4.1%), 1.8% cases at Bacau and 1.3% cases at Iasi. The fog with visible sky and horizontal visibility below 100 m, the sky is clear in one in ten cases at Iasi, three in ten cases at Bacau and four out of ten cases at Suceava. In other cases, the fog with visible sky and horizontal visibility below 100 m, all three airports, low clouds ceiling is generally below 100 m.

In the fog with frost deposition in 50% of cases, the horizontal visibility is less than 400 m from Bacau and Iasi, while the visibility falls below 200 m at Suceava. In these conditions, low clouds ceiling is between 30 and 100 m in five of the ten cases in Iasi, when the horizontal visibility is below 200 m, at least five of the ten cases in Bacau, when the horizontal visibility is between 100 and 1000 m and in at least seven out of ten cases in

Suceava, regardless of horizontal visibility threshold of fog frost deposition. It should be noted that in the period under review (2000 - 2012), at Bacau Airport there was not fog frost deposition horizontal visibility below 100 m.

In condition of fog with invisible sky, at Iasi thickness of fog ranges generally between 30 and 60 m in conditions with horizontal visibility greater than 100 m. When visibility drops below 100 m, in Iasi, thick fog prevails between 60 and 95 m. The other two airports, Bacau and Suceava, horizontal visibility threshold matter, in condition of fog with invisible sky, the thick fog usually varies between 30 and 60 m. However, there are situations when airports Bacau and Suceava, especially in the horizontal visibility conditions greater than 400 m, the fog thickness is between 60 and 95 m and rarely over 95 m (Suceava).

By enhancing its extreme, and the direction opposite to the runway-landing at an airport, wind is responsible for a significant number of aviation incidents harder because control of the aircraft, especially at landing on all three airports in Moldova .

The meteorological phenomenon of ice is a good indicator of the risk of icing on surface. The annual number of days with ice is the largest in Iasi and about equal to the other two weather stations (3.4 days / year in Bacau, respectively 3.5 days / year in Suceava). Glazed frost may lack in many years, and in other years there have been a number of days with glazed fros over the annual average for the station, for example: in 2002 in Suceava (18 days), 12 days in 1986 and 1996 at Iasi and Bacau (1988). The average duration of such an occurrence is between 1.9 hours at Suceava to 4.4 hours at Iasi.

Flight aircraft in the areas of thunderstorm phenomena has significant difficulties and sometimes danger, especially in the clouds of thunderstorms and in their vicinity, where turbulence is strong. Average annual number of days with rain showers in Bacau and Suceava is high, where conditions of production for this are more favorable than in Iasi. Average annual number of days with thunderstorms vary between 32.9 days at Suceava and 37.2 days at Iasi. From year to year the number of days with storm fluctuates greatly. The data recorded during 1961-2012 of three weather stations show that this phenomenon occurs on average in once a year at Iasi, once at ≈ 2 years at Bacau and once at every three years at Suceava. In the period 1961 - 2012, there were an average of 0.9 days/year with hail at Bacau and Iasi and 1.3 days with hail / year at Suceava.

Heavy snow and wind intensification favoring the transport of snow on the ground or height leading to heavy snow and reduced visibility for aircraft, aircraft hindering or interrupting the flights. On this three airports, annually, the average number of days with snow exceeds 40 (40.1 days at Bacau, 43.8 days at Iasi, 47.7 days at Suceava). Snow, generally increase in thickness from November to February, after which the thickness decreases gradually by melt, the snow disappearance recorded at the latest in April. The annual number of days with the ground transport of snow is between 6.5 days at Bacau and 10.8 days at Suceava. During the year, maximum manifestation of blizzard is in January, when recording the highest average monthly number of days with blizzard for all three stations.

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