

## **THUNDERSTORMS-RISK FACTORS IN AVIATION. CASE STUDY: AREA OF RESPONSABILITY OF THE BUCHAREST- OTOPENI AERODROME ON 30.06.2009**

*C. L. ȘCHIOPU<sup>1</sup>, NICOLETA IONAC<sup>2</sup>*

### **ABSTRACT - Thunderstorms-risk factors in aviation. Case study: Area of Responsibility of the Bucharest-Otopeni Aerodrome on 30.06.2009**

Thunderstorms are always dangerous weather phenomena for flight safety and, irrespective of their nature, they have a negative impact on all aviation activities. Thunderstorm clouds can generate severe and rapid changes of various meteorological elements (visibility, cloudiness and cloud lower base, wind), sometimes to such a great extent that landing may become impossible. Thunderstorms are serious weather hazards in aviation and may produce great damage and even casualties. One such unfortunate aviation event took place in the vicinity of the Bucharest-Otopeni Aerodrome, on 30.06.2009, when a military aircraft, which was operating a training flight in the responsibility area of the Bucharest - Otopeni military aerodrome, was struck by lightning at local hour 18:20. The present study actually makes an inventory of the extremely hazardous flying conditions, by thoroughly analyzing the relevant weather reports and data, as well as visual and synoptic messages from that very day. All these materials showed that the airdrome of destination was under the influence of an anti-cyclonic ridge, which accounted for the very poor meteorological conditions. On such severe weather, although the crew members tried to avoid the Cumulonimbus clouds in which a severe thunderstorm was developing, the flight was put in danger since the aircraft was struck by lightning, which simply blurred out the radar system and, therefore, landmarks orientation became almost impossible, thus creating false perceptions to the pilots trying hard to stabilize the plane.

**Key words:** weather hazard, thunderstorm, low visibility, aviation incident.

## **1. INTRODUCTION**

Thunderstorms are violent storms with thunders (hearing impact) and lightnings (visual impact) often accompanied by rain and/or hailfalls. Lightning itself is a scraping flash of light in the sky, occurring during a thunderstorm and

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<sup>1</sup> Ph.D. Student, University of Bucharest, schiopulcosmin@yahoo.com

<sup>2</sup> Ph.D., Professor, University of Bucharest, ionac.nicoleta@gmail.com

caused by a sudden discharge of electricity, either between clouds or between a cloud and the earth's surface. Electrical charges usually accumulate at the bases of the clouds until lightning discharges. The air volume along the path of the lightning suddenly expands while being heated, thus causing thunder. The resulting temperature difference favors the accumulation of negatively charged particles to the base of the cloud and positively charged particles to the top of the storm cloud. (Ciulache S., Ionac N., 1995).

Thunderstorms are weather hazards that may seriously affect aviation through lightnings, thunders, heavy rainfalls, severe turbulences, and hail.

Thunderstorms may develop in matured *Cumulonimbus* (Cb) clouds, although not all Cb's produce thunderstorms. The hazards that an aircraft may encounter while flying through such a cloud are turbulences, vigorous updrafts and downdrafts, snow, hail and rainfalls, lightning and icing. According to their causes, thunderstorms are classified into three types: the heat type (convection), the frontal type (frontal uplift) and the orographic type (orographic uplift). Thunderstorm clouds (Cb) usually develop in three stages. In the initial stage, several Cumulus clouds gather to form a bigger Cumulus cell (the so-called *Towering Cumulus*). In the second stage (*Cumulonimbus calvus*), precipitations occur (rain and hail), which create strong downward air-currents (25-30 m/s). The last stage is the most dangerous because there appear heavy precipitations (rain, snow and hail), strong winds, extreme turbulences, thunder and lightning. The cloud may extend upwards to the tropopause, where it is spread out by the upper winds to form an anvil (*Cumulonimbus capillatus incus*). At these levels, the cloud gradually gets thinner to form the Cirrus (Ci) clouds invading the sky.

## **2. THE FREQUENCY AND DISTRIBUTION OF THUNDERSTORMS IN ROMANIA**

The annual mean number of days with thunderstorms reaches the highest values in the mountain region (35-40 days, over 80 h) and the lowest values on the coast of the Black Sea and in the Danube Delta (under 20 days, less than 20 h). In the Romanian Plain, the annual mean number of thunderstorm days ranges between 25-35 days (40-50 h). All through the year, the number of thunderstorm days is maximum during the warm season (May-Aug) and minimum during the cold season (Nov-Mar). The longest periods of thunderstorms are recorded in June (18.1 h).

## **3. DATA AND METHODS**

In this study, the following data have been used: meteorological data acquired from both visual and instrumental observations and measurements on 30.06.2009 from the Bucharest Otopeni aerodrome (visual and synoptic messages:

METAR code - FM 15-XII Ext and TAF code - FM 51-XII, as well as airport forecasts) and various meteorological products: synoptical and aerological maps, satellite images and radiosounding.

#### **4. CASE STUDY: AREA OF RESPONSIBILITY OF THE BUCHAREST-OTOPENI AERODROME ON 30.06.2009**

In the afternoon of 30.06.2009, during a military training flight which began at 13:00 UTC, the crew was taken by surprise by the sudden and rapid development of a *Cumulonimbus* cloud (Cb) on the flight route. They used the aircraft weather radar to detect and localize the areas with electrical discharge activity contained within the thunderstorm, trying to avoid the associated hazards.

At about 40 km north-east of the aerodrome, the aircraft was struck by lightning (15:20 UTC) during the approaching procedure. The crew heard a loud noise but didn't realize the fact that their plane was struck by the thunderbolt, instead they noticed that the radar was malfunctioning. The crew contacted and informed the Bucharest-Otopeni Tower about the emergency and requested landing priority. Their request was immediately approved and the aircraft landed safely even if the radar system was totally out of order and the weather conditions were very poor.

#### **5. WEATHER CONDITIONS**

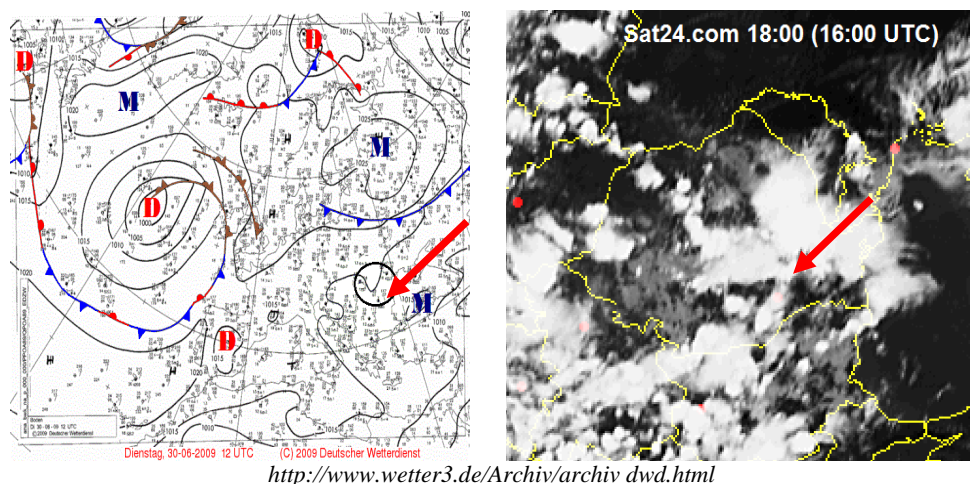
On 30.06.2009, the Bucharest Otopeni aerodrome was under the influence of an anticyclonic ridge, which was extending over a large area on Europe's central and eastern regions (Fig. 1).

A vast low-pressure area from the North of the Black Sea and its associated cold front were influencing Romania's northern and eastern regions. This synoptic context determined a strong atmospheric instability in Eastern Romania with the area of responsibility (a circular area with the radius of 50 km) around the Bucharest-Otopeni aerodrome included. Additionally, the local air convection led to the development of thunderstorm clouds (Cb) and the local heavy precipitations (shower rains), strong winds, turbulence, thunders and lightnings.

Although this synoptic configuration was not significant, the intensity of the weather phenomena was greater than it had been previously forecasted (Fig. 2).

##### **5.1. Weather forecast for Otopeni-Bucharest aerodrome**

The encoded weather forecast (*Terminal Aerodrome Forecast - TAF*) released by the meteorologist on-duty from the Otopeni Airbase:  
*TAF LROP 301100Z 3012/0112 03004KT 9999 BKN040*



**Figure. 1.** Surface map 30.06.2009, 12:00 UTC **Figure. 2.** Satellite image, 16:00 – UTC

TEMPO 3012/3022 5000 SHRA TSRA SCT015CB PROB40  
TEMPO 3015/3020 VRB20KT 3000 TSRAGR BKN040CB  
TEMPO 0102/0105 3000 BR SCT005 SCT040=  
(<http://ogimet.com/index.phtml.en>)

The weather forecast at Bucharest-Otopeni aerodrome on 30.06 was: wind direction: 030°; wind speed: 04 knots; horizontal visibility: 10 km, cloudiness: broken (5-7/8); cloud base at 1,200 m; temporarily between 12:00 and 22:00 UTC: horizontal visibility: 5,000 m, weather phenomena: shower rain, thunderstorm rain, scattered (3-4/8) *Cumulonimbus* clouds at 450 m with a probability of 40%, temporarily between 15:00 and 20:00 UTC: variable wind, wind speed 20 knots, horizontal visibility decreasing at 3,000 m, weather phenomena thunderstorm rain and hail, broken *Cumulonimbus* clouds at 1,200 m; temporarily between 02:00 and 05:00: horizontal visibility: 3,000 m stationary, weather phenomena: mist, scattered (3-4/8) at 150 m and 1,200 m.

## 5.2. Weather information and data given to the crew

Before taking-off, the crew received the following documents from the meteorologist-on-duty:

1. a meteorological bulletin for the flight route;
2. a satellite image in Visual array from 12:00 UTC;
3. a ground map with weather measurements from the national meteorological stations at 12:00 UTC;
4. TAFs (*Terminal Airport Forecast*) and METARs (*Meteorological Aerodrome Report*) messages for: Otopeni (LROP), Baneasa (LRBS),

Fetesti (LRFT), Mihail Kogălniceanu-Constanța (LRCK) and Boboc-Buzău (LRBO) at 12:00 UTC;

5. one SIGWX (*Significant Weather*) map for the next 6-12 hours, for Romania, including cloudiness, turbulence and icing forecasts for FL100 (Fly Level-3 km) to FL450 (Fly Level 13.5 km). These maps were emitted by the WFA-London;
6. one SIGWX (*Significant Weather*) map for the next 12 hours, for South-Eastern Europe, including a forecast for the FL300 (almost 10 km) and FL240 (almost 7.2 km high);

The document mentioned at point 1 was signed by the meteorologist on-duty and by a member of the crew.

### **5.3. Weather data given to the crew during the flight (ATIS)**

The *Automatic Terminal Information Service - ATIS*, is a continuous broadcast of recorded non-control aeronautical information in terminal (airport) areas. ATIS messages contain essential information, such as weather information, which runways are active, available approaches, and any other information required by the pilots.

On 30.06.2009, 15:00 UTC, the military aircraft crew received the following weather data from ATIS: wind direction: 110°, wind speed: 3 knots, horizontal visibility: 4,000 m, weather phenomena: thunderstorm rain, low cloudiness, few *Cumulonimbus* clouds and broken, cloud base at 500 ft and the second one at 4000 ft, atmospheric pressure (mean sea level-QNH): 1014 hPa, active runway: 08°.

### **5.4. Atmospheric conditions on Bucharest-Otopeni aerodrome and in its neighbouring area (approach)**

*METAR LROP 301500Z 10004KT 070V130 4000 TSRA FEW005 SCT040CB 20/19 Q1014 8829//95 BECMG 9999 NSW=* (<http://ogimet.com/index.phtml.en>)

The weather report from Otopeni, at 15:00 UTC contained the following data: wind direction 100°, varying between 070° and 130°, wind speed 04 knots, horizontal visibility: 4,000 m, weather phenomena: thunderstorm rain, few (1-2/8) and scattered (3-4/8) *Cumulonimbus* clouds, cloud base at 150 m and 1,200 m, air temperature: 20°C; dew point: 19°C, atmospheric pressure (mean sea level-QNH): 1,014 hPa, runway condition: wet runway, affected surface between 51-100%, good grip. Trend forecast: becoming horizontal visibility: 10 km and no significant weather (NSW).

**ALTERNATIVE CHOICE:** Băneasa-Bucharest Airport.

*METAR LRBS 301500Z 36007KT 310V040 8000 TSRA SCT005  
BKN030CB 22/18 Q1014 0729//95 TEMPO VRB28KT 3000 TSRA  
(<http://ogimet.com/index.phtml.en>)*

The weather report from the alternative choice – Bucharest Băneasa aerodrome, at 15:00 UTC contained the following data: wind direction 360°, varying between 310° and 040°, wind speed 07 knots, horizontal visibility: 8,000 m, weather phenomena: thunderstorm rain, scattered (3-4/8) and broken (5-7/8) *Cumulonimbus* clouds, cloud base at 150 m and 900 m, air temperature: 22°C, dew point: 18°C, atmospheric pressure (mean sea level-QNH): 1,014 hPa, runway condition: wet runway, affected surface between 51-100%, good grip. Trend forecast: temporarily wind varying from 28 knots, horizontal visibility: 3,000 m, weather phenomena: thunderstorm rain.

Under the circumstances, when the weather conditions on the Otopeni aerodrome seemed better for a safe landing, the crew asked permission to land, even if, in the absence of a functional radar system, they had to visually orientate solely by land markings, despite poor horizontal visibility.

After landing, when the aircraft was parked, the flight crew and the maintenance crew have noticed that the aircraft was struck by lightning in its forefront area, namely in the radom box accommodating the radar system, where the lightning encountered the lowest resistance. (Photo 1).



Photo 1. Damages caused by lightning on a military aircraft

## CONCLUSIONS

Thunderstorms are one of aviation's most hazardous phenomena. Their impact on aviation is largely varying from windshears, lightning, heavy rainfalls, to severe turbulences and hail.

The airborne weather radar is one of the best instrument aids that a pilot can use in locating and avoiding thunderstorms. By knowing how to recognize and avoid thunderstorms and their hazards is one of the most important lessons in aviation weather training.

## REFERENCES

1. Ciulache S., Ionac Nicoleta (1995), *Fenomene atmosferice de risc*, Editura Științifică, București, 220 p.
2. \* \* \* (2008) *Clima României*, Administrația Națională de Meteorologie, București: Editura Academiei Române, 365 p.
3. <http://ogimet.com/index.phtml.en>.
4. <http://www.wetterzentrale.de>.
5. [http://www.wetter.3.de/Archiv/archiv\\_dwd.html](http://www.wetter.3.de/Archiv/archiv_dwd.html).