# FOG RISKS IN AVIATION. CASE STUDY: PLANE CRASH AT SMOLENSK (RUSSIA) ON 10.04.2010

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**ABSTRACT. Fog - an aggravating weather phenomenon for flight safety.** Fog, irrespective of its forms, has a negative impact on all aviation activities. Fog severely diminishes visibility, sometimes to such an extent that landing may become impossible. Fog is a serious weather threat and hazard in aviation and may produce deadly events. One such unfortunate event took place at Smolensk (Russia), on 10.04.2010, when the presidential aircraft, which was transporting Poland's President, together with an official delegation, to commemorate 70 years from the Katyn massacre, simply crashed down close to the Smolensk North military aerodrome, at local hour 10:41:07.

The present study actually makes an inventory of the extremely hazardous flying conditions, by thoroughly analyzing the weather reports and data, as well as visual and synoptic messages or official elements and information from that very day. All these materials show that the airdrome of destination was under the influence of a very active anti-cyclonic ridge, which accounted for very poor meteorological conditions. On such severe weather, the flight was doomed since greatly reduced visibility due to dense fog made landmarks orientation almost impossible and, furthermore, created false perceptions which led to fatal misjudgements and errors.

***Keywords:*** fog, visibility, weather, hazard, forecast, Smolensk.

## 1. INTRODUCTION

**Description.** The fog is a mixture of small water droplets and/or fine ice crystals, which are suspended in the air, right above the surface of the ground, and reduce the visibility under 1,000m. (Ciulache S., Ionac N., 1995).

Fog may be further classified as being formed by advection processes or by radiative cooling processes. Hill fog and frontal fog are also commonly used descriptors.

Fog may cover a large, continuous area or it may form in patches, possibly covering only small parts of an airfield. If the fog layer is less than 2 meters deep overland, it is named *shallow fog*.

Fog can be considered as a low Stratus cloud in contact with the ground surface. When the fog lifts, it usually turns into true Stratus.

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## 2. CASE STUDY: PLANE CRASH AT SMOLENSK (RUSSIA) ON 10.04.2010

The president of Poland along with an official delegation traveled by the presidential aircraft to Smolensk, Russia, in order to commemorate 70 years from the massacre that took place at Katyn. The pilots attempted to land at Smolensk North Airport, a former military airbase.

Before landing, the crew was informed that fog was present in the aerodrome area. From unknown reasons, the landing procedure continued and the aircraft crashed near the Smolensk North military runway at 10:41:07, killing all the 96 people on board.

## 3. DATA AND METHODS

In this study, the following data has been used:

- official reports, information and elements from web sources;
- meteorological data acquired from observations and measurements on 10.04.2010 from Smolensk, Russia: visual and synoptic messages and airport forecasts;
- meteorological products: synoptical and aerological maps, satellite images and radiosounding.

The main methods of research that were used in the analysis, were both visual and instrumental observations, data processing (FM 12-SYNOP code), as well as the synoptic interpretation and analysis of maps.

## 4. WEATHER CONDITIONS

On 10.04.2010, the Smolensk North aerodrome was influenced by a very active anti-cyclonic ridge, which covered a large area: from the west of Siberia, over Russia, Moskow region, middle Ukraine and the Black Sea (Fig. 1).

A vast low pressure area from the North of the Caspian Sea moved to the Samara region and at the same time, it changed the longitudinal axis of the anti-cyclone, making possible an air advection from NE. This active system carried moist air from the Volga Region to the Kursk and Smolensk regions (Fig. 2). Due to the presence of the high-pressure system in the near-ground layer, a thermal inversion occured at a height of about 500 m. The melting of snow and the proximity of the Dneipr River also determined air-humidity to rise in the near-ground air.

This synoptical configuration contributed to fog occurence on the Smolensk North aerodrome. The other factor which led to fog formation in the morning hours was represented by the particles of smoke (functioning as additional nuclei of water vapour condensation) from smouldering wasteland in the vicinity of Smolensk.

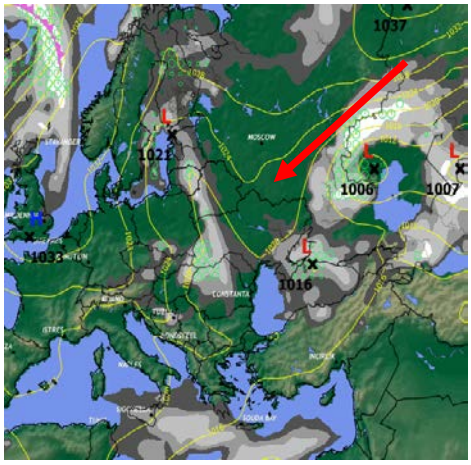


***Fig. 1. Surface map 10.04.2010, 06:45 UTC***
*http://ows.public.sembach.af.mil*

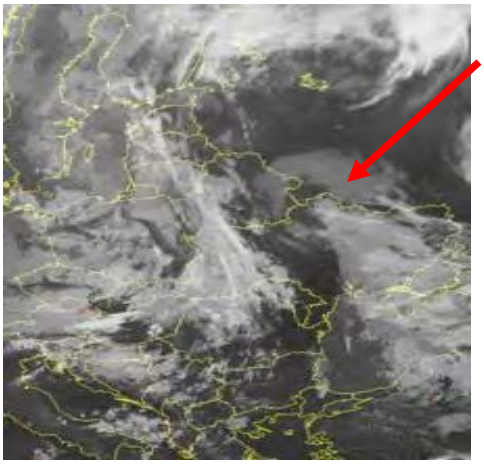

***Fig. 2. Satellite image, 06:00 – UTC***

**Weather forecast for Smolensk North aerodrome**

The weather forecast emitted by the meteorologist on-duty from the Regiment 36, for Tu-154 and Yak-40 aircrafts was: scattered, cloud base 200-300 m, overcast, cloud base over 2500 m, horizontal visibility 3-5 km.

The weather forecast emitted by the Hidrometeorological Center of Polish Army was: for Yak-40: nebulosity 5-7/8, cloud base: 90-150 m, visibility: 600-1500 m, foggy conditions and for Tu-154: nebulosity 5-7/8, cloud base 150 m, visibility 1-3 km, foggy conditions.

The weather forecast emitted by the Meteorological Bureau of TWR from the air base at 01:30 UTC was: visibility 3-4 km, cloud base 600-1000m. At 05:15, the forecast was refreshed, giving a warning against poor weather conditions: visibility 1.5-2 km, cloud base 150-200 m.

The latter two forecasts were not given to the crew before the take off and moreover, not even when the crew communicated with the ATC by radio.

**Weather information and data given to the crew**

Before the take-off, the crew recieved the following documents from the meteorologist-on-duty:

1. a satellite image in Infrared array from 04:00;
2. a colour map from the CAPPI surveillance system from 04:00;
3. a set of measurements from met stations: Legionowo, Leba, Wroclaw (Poland), Lindenberg (Germany), containing data of wind speed and wind direction at: 1,000 m, 3,000 m, 5,000 m, 7,000 m, 9,000 m and 12,000 m;
4. TAFs (Terminal Airport Forecast) and METARs (Metorological Aerodrome Report) for: Warsow, Witebsk, Minsk, Moskow – Szeremietewo, from 03:00 and 04:00;

5. TAFs (Terminal Airport Forecast) and METARs (Metorological Aerodrome Report) for: Gdansk, Wilno, Gomel, Moskow-Vnukovo, Moskow-Domodiedovo;
6. two SIGWX (Significant Weather) maps for the next 12 hours, for Europe, including a forecast for the FL300 (almost 10 km) and FL240 (almost 7.2 km)
7. two SIGWX (Significant Weather) maps for the next 6-12 hours, for Europe, including cloudiness, turbulence and icing forecasts for FL100 to FL450 (13.5 km). These maps were emitted by the WAFA-London.

The documents from points 3 and 4 were signed by the meteorologist on-duty and by a member of the crew, while the ones from points 5,6 and 7 were not signed.

**Atmospheric conditions in Smolensk North area (from 03:00 to 09:00)**

From 03:00, the cloud cover was 1-3/8 with high and medium level clouds, expanding to an overcast sky (8/8) after 05:00, through low level clouds (Stratus) with the cloud base swiftly lowering from initial 150-120 m to over 60 m (at 05:17). A Yak-40 aircraft, landing at 05:17, was noticed by the Terminal Controller near RWY THR 26 at a height of around 40 m, which means that, at that time, the cloud base (vertical visibility) was already below 60 m. Low, layer stratus clouds were blending with the approaching fog into one continual atmospheric object (stratus clouds and fog have the same character and structure, the difference is only in the height of their occurrence). The fog and clouds extended from the ground to about 500 m above.

The horizontal visibility between 03:00 and 05:00 was restricted to 6,000-4,000 m through mist and smoke. The visibility from 05:00 to 05:10 was deteriorating quickly to 1,000 m as the mist was thickening also because of the smoke from smouldering wasteland in the vicinity of Smolensk. The fog reduced visibility below 1,000m around 05:10. At Smolensk North aerodrome, the fog which obscured horizontal visibility to 500 m at ground level, came 20 min earlier, at 04:50 (the time when the warning message - STORM - was sent).

The present weather phenomena at twilight and after sunrise, until 05:10, were mist in the area of Smolensk North aerodrome and, after 05:10, fog developed on the aerodrome area. This phenomenon persisted until 08:00. Due to rising temperatures, after 08:15, the fog changed into mist. Another phenomenon has been present for a few days in the area of the aerodrome, smoke from smouldering wasteland and dry grassland, once the snow melted away.

The surface wind was from the direction 110°-160°, at 2-4 m/s , the air temperature at the ground ranged from +1.0 to +2.0°C, the relative humidity of the air at the ground was 92-100%, the height of the 0°C isotherm was 650 m, wind direction and speed at a height of 500 m – 170°/7 m/s, at 1,000 m – 140°/6 m/s, and at 2,000 m – 110°/4 m/s, the atmospheric pressure (QFE) (at aerodrome elevation) was rising very slowly from 744.5 to 744.8 mmHg (from 992.6 to 993.0 hPa), the atmospheric pressure (QNH) (reduced to mean sea level) was rising very slowly from 767.3 to 767.6 mmHg (from 1024.4 to 1024.8 hPa), the sunrise occurred at 03:02 UTC.

**The SYNOP message from Smolensk (Russia) - 26781**
**(Latitude 54°45'N, Longitude 032°04'E, Altitude 241 m)**
(http://ogimet.com/index.phtml.en)

*10/04/2010 06:00*
*AAXX 10061 26781 31/93 91403 10009 20009 39956 40255 53003 74540 333 20005=*

In the above-mentioned SYNOP message sent by the Smolensk Meterological Station (Latitude 54°45'N, Longitude 032°04'E, Altitude 241 m) at 06:00 UTC, the following atmospheric conditions have been encoded: *cloudiness* - invisible sky, *cloud base* - unknown, *present weather phenomenon* - fog or freezing fog with invisible sky, *recent weather phenomenon* - fog or freezing fog, *horizontal visibility* - 0.5 km, *surface wind* - from 140°/ speed 3m/s, *air temperature at the ground* - 0.9°C, *dew point temperature* - 0.9°C, *atmospheric pressure at station* - 995.6 hPa, *atmospheric pressure at mean sea level* - 1,025.5 hPa, *barometric trend* - stationary or decreasing by 0.3 hPa, *minimum temperature* - 0.5°C.

**Atmospheric conditions on the place and time of the crash**

Before landing, the crew received information about the poor weather conditions, which threatened a safe landing: *cloud cover* - overcast, through low layer stratus, blending with thick fog to the ground, up to about 500 m, *ground visibility in approach area to RWY 26THR*: 50-100 m, *ground visibility on RWY 26 THR*: 100-200 m, *vertical visibility*: below 20 m, *weather phenomena*: fog, *surface wind*: from the direction 110°-130°, speed 2-4 m/s, *atmospheric pressure (QFE)*: 744.8 mmHg (993.0 hPa), *atmospheric pressure (QNH) (at sea level)*: 767.6 mmHg (1,024.8 hPa), *air temperature on the ground*: ranging from +1.0 to +2.0°C, *relative air humidity* -100%.

**Possibilities of forecasting the Stratus clouds and the advection fog**

The accident was investigated by Poland's Committee for Investigation of National Aviation Accidents with the aim to establish the circumstances and causes of the Smolensk crash (*http://mswia.datacenter-poland.pl/FinalReportTu-154M.pdf*).

In the Committee's opinion, as far as the weather forecast preparation for Smolensk was concerned, the results of sounding the atmosphere could have helped in forecasting the advection of air from the SE, which determined the formation of stratus low-layer clouds, mist and fog.

The areas of stratus low clouds/fog were visible from the NOAA atmospheric satellites which circle the Earth on polar orbits at a height of 800 km. Moreover, most substantial information was contained in photos in the NM array (Night Microphysical RGB composite image – Fig. 3). On 10.04.2010, at 01:12, a

willow green layer of stratus clouds/fog was clearly seen against a cloudless, pink-tinted background.

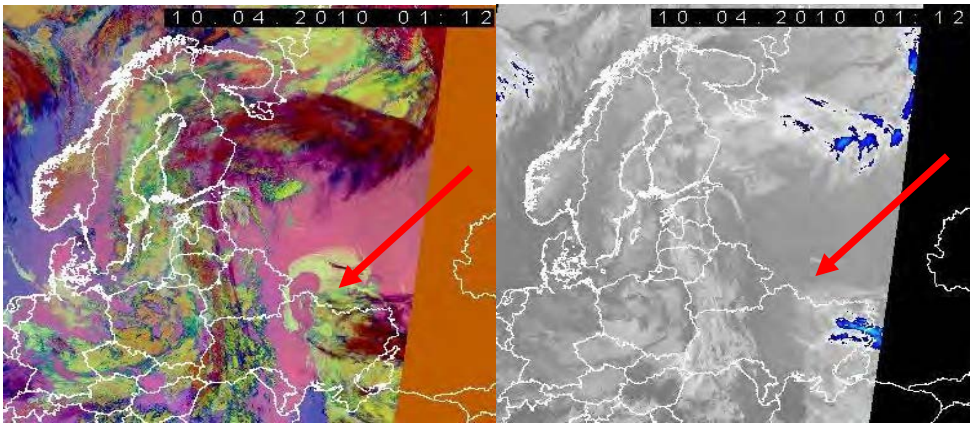


**Fig. 3. Processed NM photos by NOAA-18:01:12; 10.04.2010 Type b4BT IR photo**

In the Committee's opinion, the data from radiosondes indicated the cause of stratus clouds combined with fog, and established its movement. The satellite photos reveal its existence to the south of the Smoleńsk area even the day before, as well as its slow advection during the night, to the NW. This zone was not clearly visible on the satellite pictures in standard IR region, yet, perfectly visible and with contour in a special array of channels destined to detect low level clouds and fog.

## 5. CONCLUSIONS

Flying in foggy conditions (low visibility) is mainly difficult because of the impossibility of orientation after landmarks and pilots may be given a false sense of security. Fog is a serious threat at take-off, during the landing approach procedure, at landing, but also for the ground maneuvers (taxiways).

Freezing fog has similar visibility restrictions, but in addition to this, untreated taxiways and runways may be covered with a layer of ice, thus amplifying the risks.

## REFERENCES

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