Study of Meteorological Conditions Risks for the Aviation over Sudan

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Abstract: Weather is a very important factor in aviation. Severe weather may lead to dangerous situations in air transportation. While National Transportation Safety Board (NTSB) reports most commonly find human errors to be the direct accident causes, weather is a primary contributing factor in 23 percent of all aviation accidents. This study is provided to clear up different factors contributing flight safety.
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Introduction:

Weather changes continuously, these changes may take place rapidly and sometimes they are unpredictable. Therefore, aviation is quite dependent to weather forecasts and their improvements.

Perilous weather conditions, such as poor visibility, and thunderstorms can have serious effects on efficiency, safety, and flight operations. And according to the weather conditions, the pilot can decide to commence, postpone, or cancel his flight.

The Most Dangerous Weather Conditions and Their Effects on Flight Safety can be counted as follows:

a. Thunderstorms:

Thunderstorms are the weather phenomena that the most likely to affect aircrafts in flight and airport operations on ground. They produce most of the dangerous weather elements in aviation. Thunderstorms are perilous because they Usually associated with Hazards such as; severe turbulence, lightning, heavy precipitation, icing, hail, intense updrafts and downdrafts, wind shear, microbursts, strong low-level winds, and tornadoes.

Thunderstorms can cause many dangerous situations to the flight operations, therefore, it is essential for aircrews to be familiar with thunderstorms nature and how to treat them.

b. Poor Visibility:

Visibility is an important parameter for aviation. When the visibility range is less than the approved limits (for both pilots and aircraft certifications), the aircraft may be banned from using the runway. besides, visibility associated with low clouds ceiling (The height above the ground or water of the base of the lowest layer of cloud below 6000m (20000ft) covering more than half of the sky) determine whether or not to close the airport.

Visibility for aeronautical purpose is defined as:

a. The greatest distance at which a black object of suitable dimensions situated near the ground can be seen and recognized when observed against a bright background.

b. The greatest distance at which lights in the vicinity of 1000 candles can be seen and identified against an unlit background.

There are many phenomena can reduce the visibility, one of these phenomena are the clouds. In thin clouds visibility may be about a kilometer, whereas the heavy rainy clouds may reduce visibility to a few meters.

Precipitation may reduce the visibility as well. Rain droplets don't reduce the visibility very much, but they can irritate pilots when settled on the windshield. Snow fall can reduce the visibility very much.

Blowing dust and sand storms are some phenomena that may reduce visibility as well. Severe sand storms may reduce visibility to zero.

Visibility may be reduced due to smoke and other pollutants near industrial areas and forest fires, especially in case of low level inversion.

c. Wind shear

The wind shear expresses the stability of weather and the turbulence status in the atmosphere.

Wind shear is defined as a change in wind speed or/and direction along the distance between two points. When these points are in a horizontal direction the shear is called horizontal wind shear, whereas, it is called vertical wind shear when the points are in a vertical direction.

Sever wind shear may happen if the surface wind that blow through a valley significantly differs from the free blowing wind overhead. In mountainous areas, changes in speed of 25 knots and in direction of 90° are sensibly common. Downdrafts and updrafts induce wind shears as well. Also wind shear may be

confronted across the fronts, so aircrews taking off or approaching to land through a front which is just above the ground should be careful.

Methodology and Aims:

According to the statistics of Federal Aviation Administration (FAA) in USA, weather causes approximately 70 percent of the delays in the American National Airspace System (NAS). Moreover, weather continues to play a significant role in aviation accidents and incidents numbers.

Thunderstorms and their phenomena can close airports, degrade airport capacities for acceptance and departure, also they can stop or hinder ground operations. Convective hazards during the flight may lead to diversions and rerouting which result in surplus operating costs and loss of passenger's time. Lightning and hail damage can remove aircraft from operations which result in both revenues lost and excess maintenance costs.

Poor visibility is the most meteorological element that affects flight operations, it is a safety hazard for all aviation types. Poor visibility causes accidents when pilots aren't properly trained or they are flying an aircraft which isn't equipped with the necessary instrumentation encounter such condition, causing loss of control, or controlling the flight into terrains.

The icing effects on an aircraft could be very dangerous and include:

- Icing disrupts the smooth laminar flow above the wings which decrease the lift and increase the stall speed which is very dangerous effect.
- Increase the drag and the weight, which leads to consume more fuel.
- Icing may completely or partially block the static ports and pitot heads leading to incorrect instrument readings.
- Visibility restriction due to windshield is glazed over.
- Mechanical icing in engine air intakes, carburetors, and fuel cells declines engine performance, causing power reduction.

Data related to the accidents is gathered from the Sudanese air accident investigation Central Directorate's (AAICD's) accident Investigation Reports.

The study focused only on accidents where the AAICD final reports indicated that weather was a cause or a contributing factor in the accident.

The research topic includes data of weather conditions related to the accidents dates, weather data was gathered from Sudanese Meteorological Authority's Reports of Observations. These weather data were then analyzed to extract how these weather conditions led up to the accidents.

The purpose of this study is to provide warning to the aviation community on the relationship between weather and aviation accidents.

Fatal Weather-Related Accidents from 2003 To 2011:

Case 1: The Airbus A 310:

On June 10th 2008 the airbus A310, ST-ATN was in a flight back to base, it is encountered by cumulonimbus clouds and rain, so the flight was diverted to Port Sudan airport east of Sudan. After 75 minutes on ground the aircraft departed to Khartoum. On the final approach the pilots were provided by the wind information, and runway condition (wet).

At 17:26 UTC the aircraft landed at Khartoum airport on runway 36. The pilots reported that they couldn't maintain the airplane on runway center line when they operate both engine reversers. Then due to the slippery wet runway pilots failed to decelerate the aircraft nor stop it prior to the runway end. The aircraft overran the runway and stop 215 meters far from the runway end. Then the right side of the aircraft caught fire. The accident claimed the lives of 29 passengers and 1 cabin crew.

Weather reports at Khartoum airport (METAR) on 10th of June 2008:

10 1600z 360 12kt 6000m CB
10 1630z 320 07kt 6000m CB
10 1700z 270 07kt 9999 TSRA
10 1730z 180 12kt 9999 CB
10 1800z 180 17kt 9999 CB

Decode:

On June 10th at 4 pm UTC wind blow from the north with speed of 12 knots, the visibility was 6 kilometers with cumulonimbus cloud over the airport. At 4:30 pm UTC wind blow from the North West with 7 knots speed, visibility 6 kilometers, and cumulonimbus cloud still overhead. At 5 pm UTC westerly wind with speed of 7 knots blow over Khartoum airport, visibility was more than 10 kilometers, associated with thunderstorm and rain over the station caused flooded runway. At 5:30 pm UTC wind became southerly with speed 12 knots, visibility is more than 10 kilometers, and cumulonimbus cloud overhead. At 6 pm UTC wind blow from the south with speed 17 knots, the same weather phenomenon continued.

Figures (1) and (2) show that due to dominate developed through which its center over the Red sea, cumulonimbus clouds formed causing heavy continuous raining which will affect horizontal visibility.

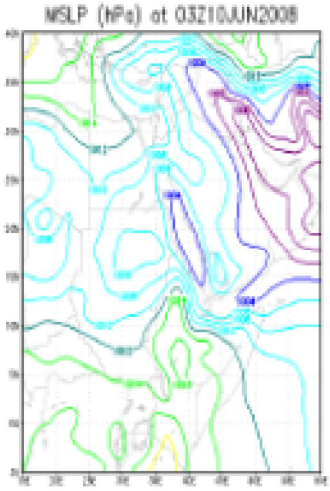

Figure 1: Low pressure center over north of Sudan at 3 am UTC.

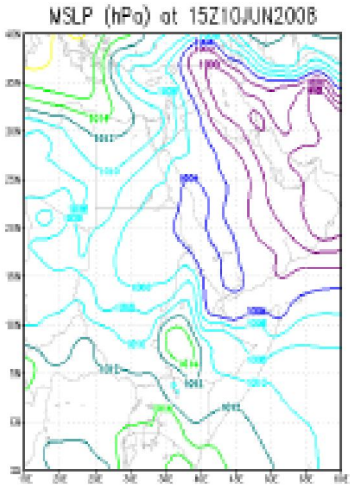

Figure 2: Trough developed to dominate over Sudan at 3 pm UTC.

Case 2: The antonov-12:

On June 27th 2008 at 0405 UTC, an accident occurred 25 nautical miles north of Malakal. The antinov-12 "ST-ARN" was a cargo flight from Khartoum to Juba. En-route the AN-12 encountered a thunderstorm affected the aircraft negatively which led the aircraft to crash, the AN-12 hit trees then the ground, it separated to parts and got fire. Seven people died and one had serious injuries.

Weather report in Malakal on 27th of June 2008:

27 0400z 230 16kt 9999 TSRA

Decode:

On the 27th of June at 04:00 am UTC, the wind over Malakal blow from the south west with speed 16 knots, the visibility was more than 10 kilometers associated with thunderstorm and rain.

The humid environment of southern Sudan was affected by a trough its center over the Red sea this led to form cumulonimbus clouds which developed to produce thunderstorm and rain associated with heavy horizontal and vertical wind shear, this case is clarified in figures (3) and (4).

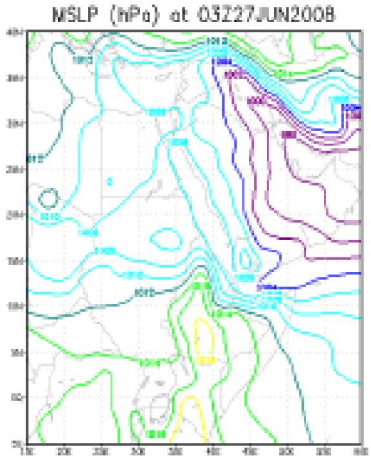

Figure 3: Pressure system over Sudan at 3 am UTC.

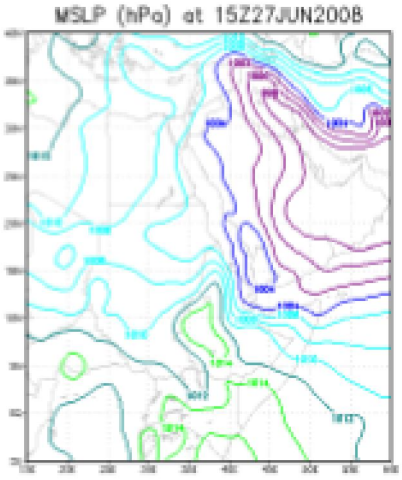

Figure 4: Low pressure center over the Red sea its trough affect Sudan.

Case 3: The antonov-2:

On 28th of July 2011 at 2:08 am UTC, while the antinov 2 "ST-ARM" was being parked at Asalaya air strip, heavy wind blow and lifted the aircraft, the aircraft hit the ground upside down. One person died, and one sustained serious injuries.

Weather reports at kosti station (the nearest meteorological station to Asalaya air strip) on 28th of July 2011:

28 1330z 090 10kt 9999 CB

28 1400z 090 10kt 9999 CB TS

Decode:

At 1:30pm UTC on the 28th of July, easterly wind blow with speed of 10 knots, visibility more than 10 kilometers and cumulonimbus clouds 500 meters above the station. At 2:00 pm UTC wind and visibility stoll the same, thunderstorm developed above the station. The thunderstorm caused the strong wind over Asalaya air strip which led to the accident.

Figures (5) and (6) show that there is trough caused strong wind with gust which may cause severe case of instability in the lower layers associated with remarkable wind shear.

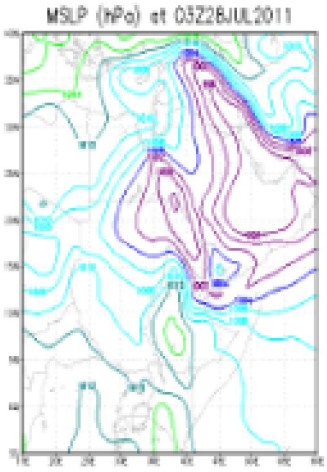

Figure 5: Deep low pressure center its trough affect Sudan.

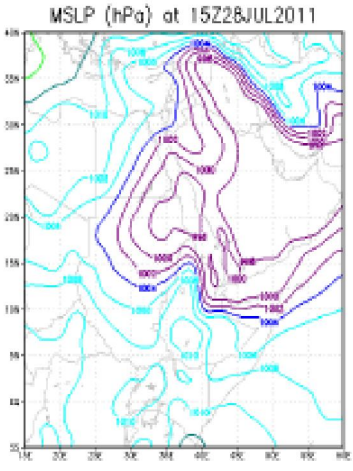

Figure 6: Deep low pressure center over the Red sea and east of Sudan dominates at 3 pm UTC.

Conclusion:

- Severe weather conditions may significantly affect the safety and efficiency of flight operations, it may have an economic effect as well. So well early warning system are recommended as operational tools.
- Weather involved accidents averaged 34%, most of them are due to low ceiling, fog, and trying to according to visual flight rules in instrument meteorological conditions.
- Most of weather-related aircrafts accidents over Sudan happen because of strong wind, wind shear, or thunderstorm and rain.
- Accurate weather forecast will help to reduce number of weather involved accidents, which may be very dangerous and deadly.
- Meteorologists and weather forecasters must take into account air pressure values over the red sea and the west coasts of Arabian Peninsula, which may have impacts on the weather over Sudan.
- Windbreaks should be put up around airports and airstrips, especially in open areas, to protect them from high wind speed.

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