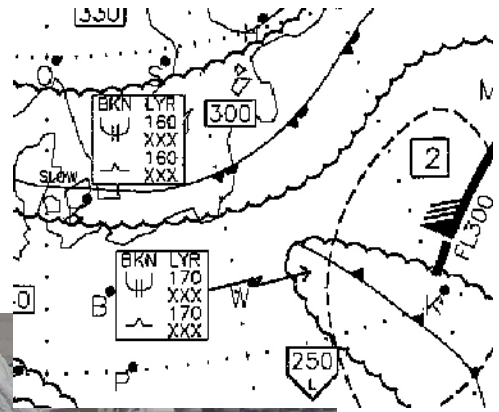
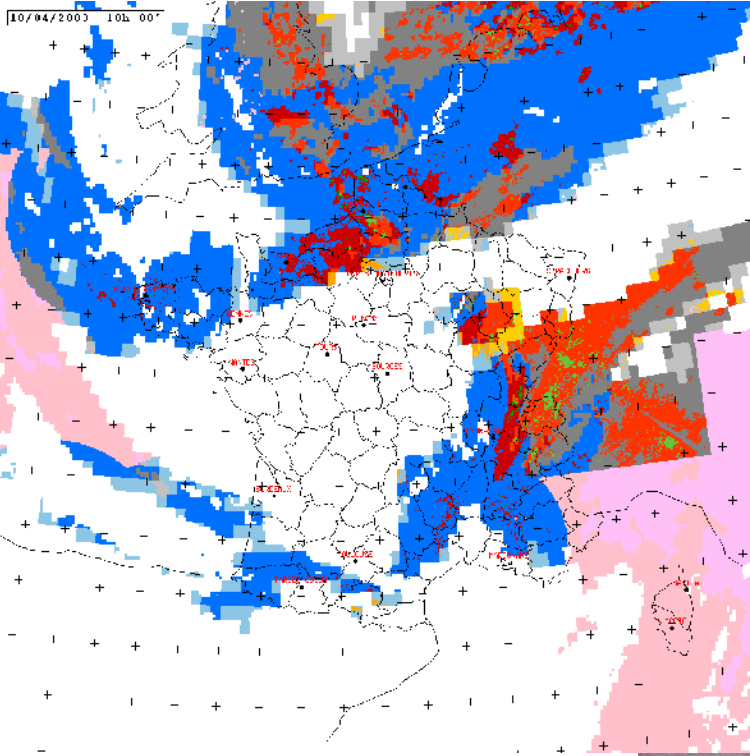


Title: Freezing contamination : aircraft icing



FREEZING CONTAMINATION : AIRCRAFT ICING

INTRODUCTION

Description of the hazard

- A few definitions

- Process of ice formation

- An historic accident

- Statistics on aircraft accidents related to icing

- Costs induced by icing

General framework for this presentation

Items marked (*) or (**) are discussed further in the “Notes for Teachers” available from the last slide in each section.

Contamination, contaminant : general term used in aeronautics to identify the deposit of a “foreign” body onto a surface. For instance, water on a runway is a contaminant.

Icing : contamination of an aircraft by ice. This contamination can happen both on surface and in the air.

Accretion (of ice) : accumulation (of ice) on a certain part of the aircraft.

Icing Conditions : state of the atmosphere favourable for ice accretion on an aircraft.

Icing Potential : information about the state of the atmosphere giving (and graduating) the risk for icing.

Ice can form on objects in the atmosphere :

- Through freezing of liquid water drops that were deposited in the form of droplets, drops, film or puddles on an object. The temperature of the object determines the solidification.

In an atmosphere with a sub-zero temperature :

- Through sublimation, water vapour transforms directly into ice. The amount of water is relatively small.
- Through ending the state of supercooling of drops and droplets present in the atmosphere. Supercooling is frequently present in clouds with negative temperature until -20°C .

On 31 October 1994, a commuter aircraft departs from Indianapolis going to Chicago-O'Hare (USA) for a regular flight taking about 1 hour 5 minutes. At 50 nm from Chicago, the aircraft is put in a holding pattern at 10 000ft because of the heavy traffic. 30 minutes later the plane crashes in a field close to Roselawn, Indiana. The 68 passengers and crew die.

Conclusions of the investigations :

- Holding pattern with liquid precipitation during 24 minutes.
- Air temperature varying between -2°C and -4°C .
- Total estimated ice accretion between 35 and 65 millimetres.
- Flight above certification limits.
- No action was taken by the crew in order to “de-ice” the aircraft.
- Icing conditions were communicated in the Met Flight Folder handed to the crew, through the transmission of an AIRMET signalling precipitation with temperatures below freezing at the chosen flight level of the aircraft.

- The Investment Analysis and Operations Research department of the FAA (Federal Aviation Administration) researched a little over 10 000 accidents between 1982 and 2001.
- In 20% of the cases, meteorological factors were the main cause and within this about 25% of the accidents resulted in loss of human life.
- Icing including flight in icing conditions, freezing fog and carburettor icing for light aviation represented about 10% of the meteorological factors causing these accidents.
- 13% of the accidents due to icing resulted in loss of life, about 30 cases in 20 years.

- On the aircraft: when designing aircraft with possibility to fly in icing conditions, it is necessary to include equipment preventing icing or de-icing equipment.
- At the airports: specific means to de-ice surfaces have to be deployed.

The methods have a high “operational” cost.

- In flight the possible pay-load and autonomy are reduced. (*).
- On the ground, the operational procedures are often time consuming and induce frequent delays on the bigger airports. (**).

Atmospheric Icing Potential

The meteorologist puts forward a diagnostic on the icing potential of the atmosphere. He qualifies, localises and quantifies the phenomena using different parameters (temperature, LWC...).

The feedback of the aviators is necessary to improve the forecasts.

The information has to be adapted for use by the aviation community

The user filters the information and the operator evaluates the risk. The “filter” consists of aircraft, pilot, ATC, airport officials or more in general terms “the aeronautical system”.

The **induced effects** precipitate into operational decisions, otherwise the safety is compromised.

Forward to: effects of icing on aircraft

Notes for teachers