Managing the risks of sudden and heavy rain showers on short final
A cooperative approach
Safety Forum 2024 -Brussels

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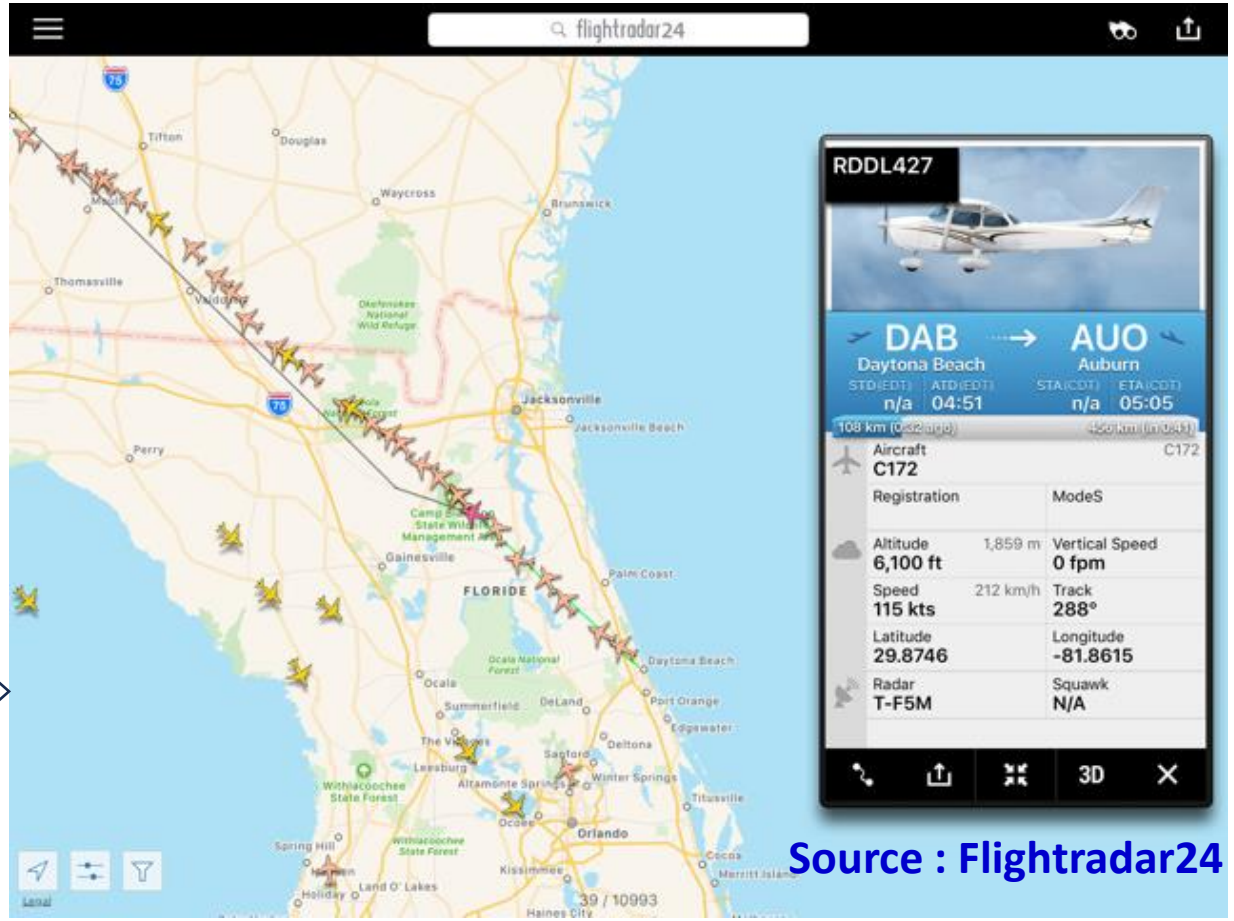
Is weather a high risk for aviation ?

Weather risk is very low when it can be properly

- Anticipated (forecast)
- Detected
- Avoided

Evacuation of training aircraft in Florida at the approach of hurricane Irma (9 Sept. 2017).



Source : Flightradar24

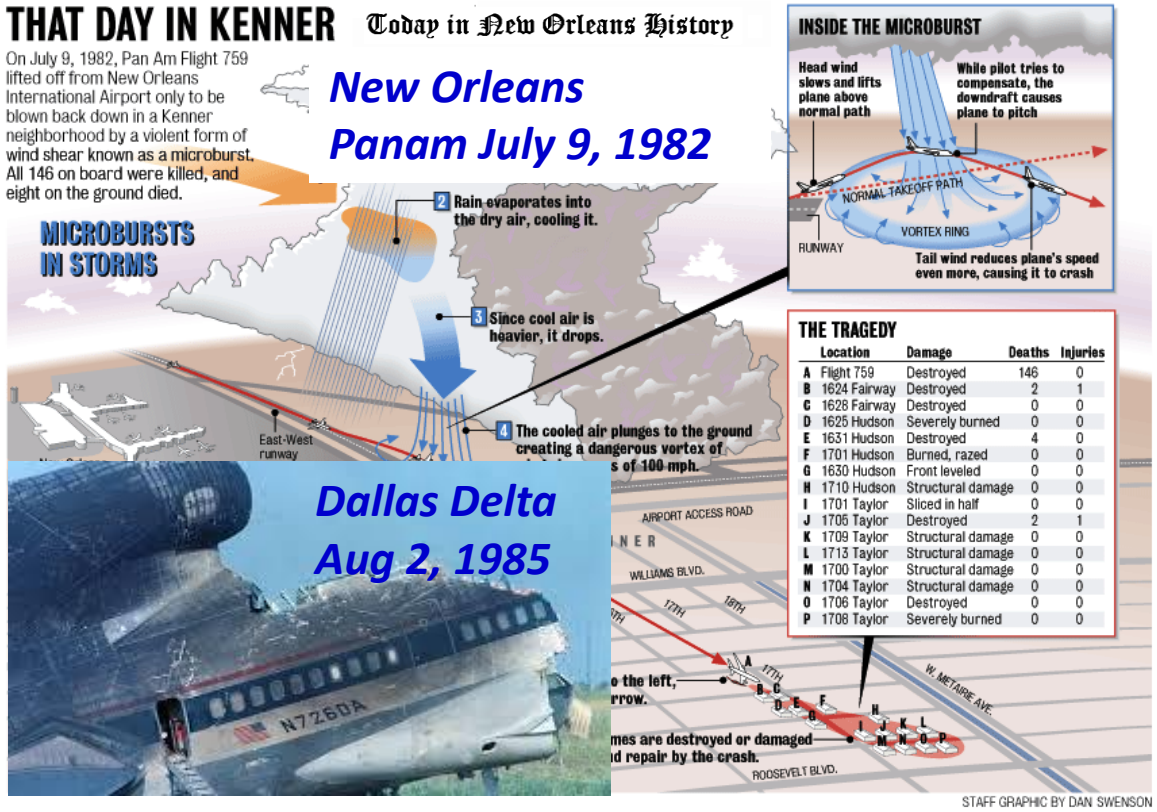
When does weather become a high risk ?

When “forecast”, “detection” and/or “avoidance” principles fail or become inefficient.

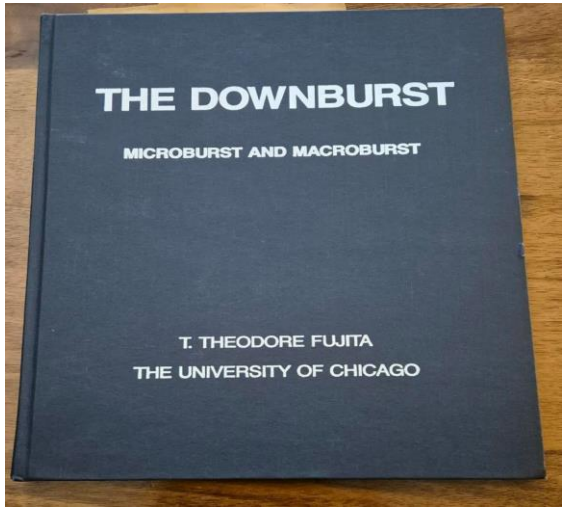
This could happen in case of …

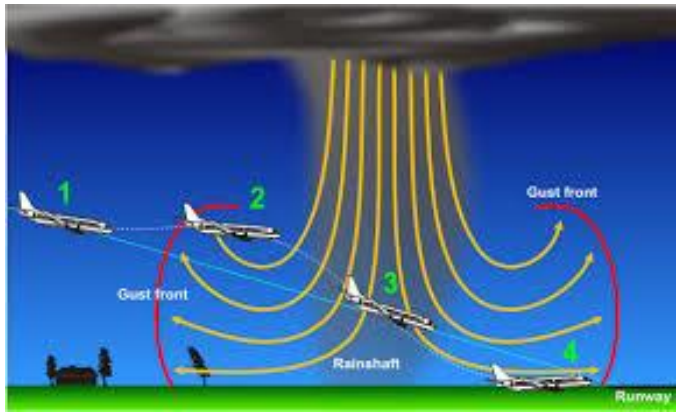
Weather phenomena not yet sufficiently understood

Microburst (in the 80s)



T. Fujita Research
University of Chicago
1982

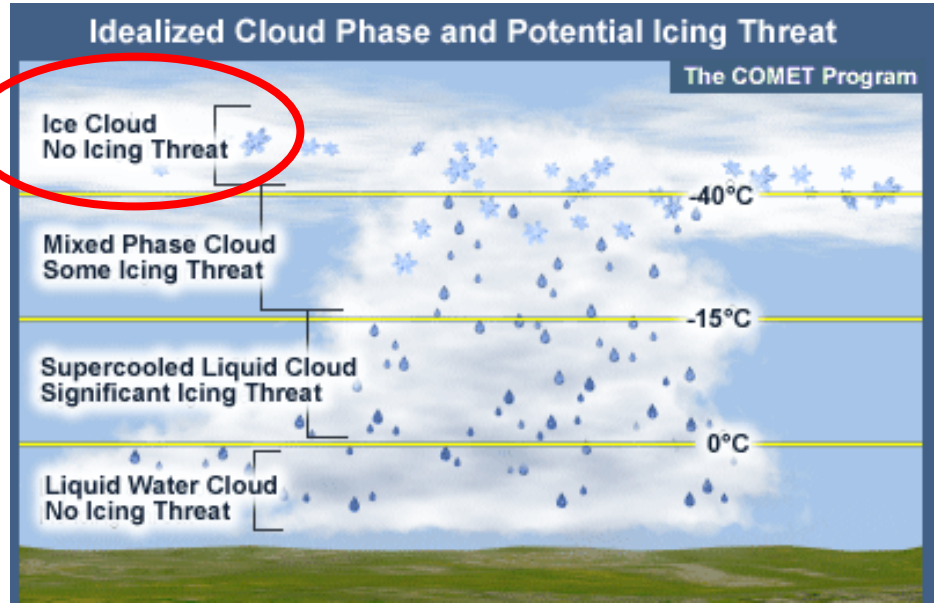




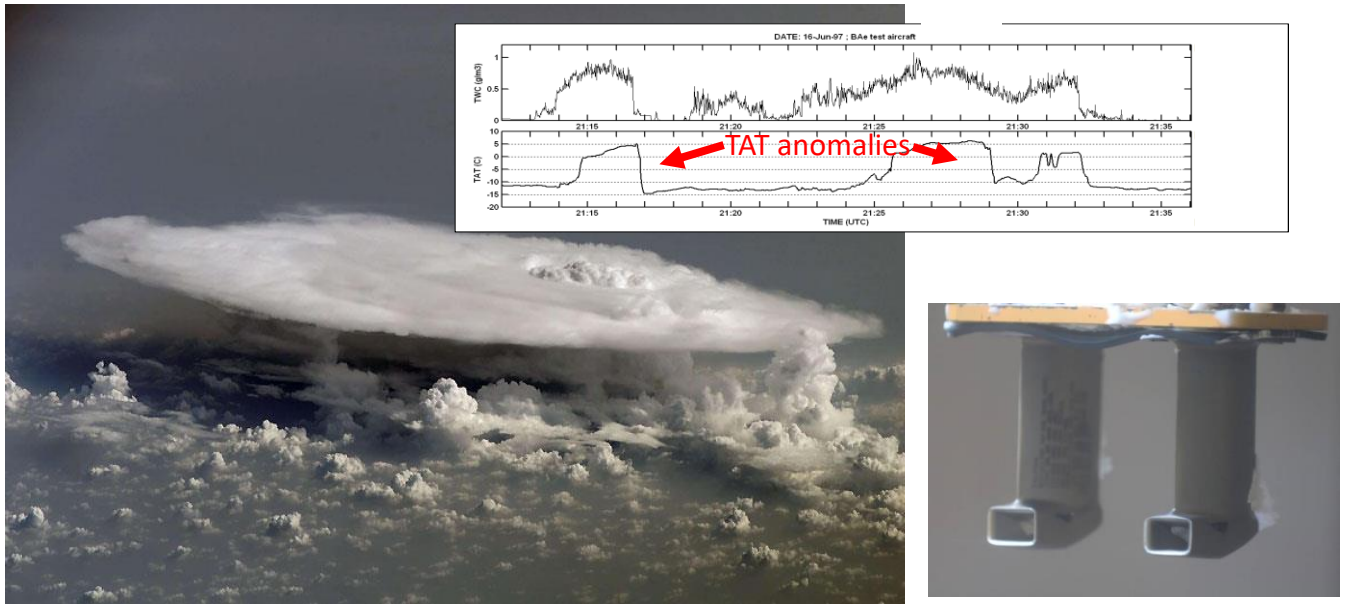
Weather phenomena not yet sufficiently understood

High Ice water Content or High altitude Ice Cristals

Past theory & Regulation



Reality Ice cristals « icing »



Weather change too rapid to be reported

When hazardous weather phenomena evolve too rapidly to be reported in due time to pilots such as **unexpected and sudden heavy rain showers (rain storm) at landing.**

Two examples

- View from a B737 BBJ cockpit on short final in the US

  https://www.youtube.com/watch?v=vtlS0sxFlHk

- View from a ground camera at Hong Kong Airport

  https://www.youtube.com/watch?v=RQS9KTR0U1A

Unexpected/sudden heavy rain showers at landing

How many pilots in this room have been trained in the simulator …

- to make a go around decision **because of fog ?**
- to make a go around decision **because of heavy rain?**


12


12

Unexpected/sudden heavy rain showers at landing

- **Partial** loss of visual reference at or below DA/MDA
- Visual contact with runway encourage to continue but…
- Pilot are unaware of actual visual segment (no ATC report)
- Undetected vertical or lateral deviation at low height
- At night, no possible anticipation
- High risk of landing short, hard landing or runway overrun (vert. dev.)
- High risk of runway lateral excursion

Weather change too rapid to be reported

View from a ground camera at Hong Kong Airport

https://www.youtube.com/watch?v=RQS9KTR0U1A

How this problem is tackled?

- ICAO, in collaboration with the World Meteorological Organization (WMO), **regulates the provision of meteorological services in support of airport operations**.

- Specifically, the Annex 3 (Chicago Convention) states that it is necessary to deliver specific weather forecasts and warnings to meet the needs of flight operations at each aerodrome.

- Thus, aeronautical meteorological service providers prepare and disseminate specific aeronautical weather forecasts for airports.

How is this problem tackled?

- Currently we have the following “official” products:
  - **TAF**: describes weather conditions that are expected to occur over a specific period of time, that can range from 6 up to 30h. Among others, TAF specifies the occurrence of precipitation.
  - **Aerodrome Warnings**: concise information of meteorological conditions which could adversely affect aircraft on the ground, including parked aircraft, and the aerodrome facilities and services. They are issed when a specific weather phenomenon is observed or forecasted. Among others, accumulated precipitation is one of them.
- In addition, we have **TREND forecast** a statement of the expected significant changes in the meteorological conditions at an aerodrome (among others, heavy precipitation is one of them). But this product is only issue when determined by the specific Regional Air Navigation Agreement…

How is this problem tackled?

- The previous products are well known by everyone, since they are "veterans" of the aviation community.
- They are still the only official ones. Indeed, in some countries is **mandatory to only include this meteorological information in the flight bag documentation** (e.g. Single European Sky countries). And these are the only ones that can be received via ACARS o voice communication.
- Nevertheless, it is well known that a vast majority of the aviation community checks other sources of weather information, for example during the flight preparation phase (e.g. Windy, SkyVector…).

How is this problem tackled?

- As mentioned, TREND forecast are only issued when determined by the specific regional air navigation agreement. So, not all the pilots can benefit from this short-range forecast (up to 2 hours).
- Therefore, TAF is the most used source to know the predicted weather at a specific airport.
- TAF main added value is that is a handmade product. TAF is:
  - Issued (updated) every 3 or 6 hours depending on their period of validity.
  - Amended when significant changes in the prevailing meteorological conditions are considered significant.
- This is the standard procedure stablished several decades ago…

Is there any alternative option? Forecasts

- Rapid development weather events, like heavy rain showers, can create unsafe conditions.
- This phenomenon can **occur so rapidly**…
- Until recently, and even nowadays, the diagnosis of expected weather conditions are mainly based on the outputs of the so called Numerical Weather Prediction models (NWP). Normally, this advanced systems **needs to be analysed by experienced weather forecast before being integrated in a meteorological product for the aviation community**.
- What if a similar or even more accurate and rapid-update MET product were available?

Is there any alternative option? Forecasts

- For example, several recent scientific works reveals the potential of the Artificial Intelligence (AI) to forecast weather conditions.
- Some of these works shows that AI-based models have the equivalent skill of NWP models. An in some cases, NWP models post-processed with IA improves significantly.
- Thanks to its capacity to process big data sets (including NWP models) AI-models can **fully automatically** deliver specific products for specific areas. And can be **updated more rapidly** than NWP models.
- Can standard MET products cover all the (extreme) weather events?
- Could AI-models complement standard MET products to fill specific gaps?

Is there any alternative option? Observation

- Airports are equipped with standard weather observing systems (RVR, wind, etc.). Their main task is to provide data to prepare METAR, SPECI or Aerodrome Warnings. In addition, ATC service can receive real-time weather data.
- In addition, some countries are equipped with weather radar, lidar, wind-shear alert system, etc.
- On the other hand, given existing technological capabilities, the current trend is to **fully automatize aerodrome weather observation**; i.e. remove on site weather staff.
- This is because it is possible to comply with the international standard regulations.

Is there any alternative option? Observation

- Result: weather surveillance duty is carried out far from each specific airport (complying with international standards).
- If no standard procedure is activated (e.g. LVP), ATC service can be in a **weather information overload situation**… this could lead to a poor decision-making due to a lack of time to manage weather information (e.g. RVR values).
- Could we improve the balance between international standards compliance and user's needs?
- **Could we take advantage of emerging technologies (e.g. AI) to evolve operational weather information standards (e.g. Situational Awareness tools**)?

THANK YOU !