1st Asia Pacific Workshop on Flying at High Altitude under Adverse Weather Conditions

Flight at High Altitude in Adverse Conditions
Turbulence Avoidance - Weather Information To Pilot

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Organisers

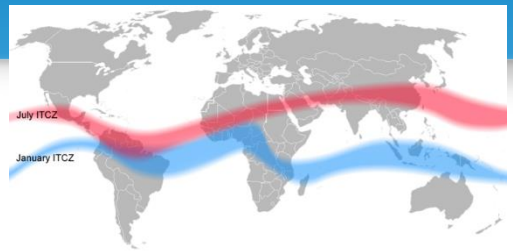
CAAS Civil Aviation Authority of Singapore

EASA European Aviation Safety Agency

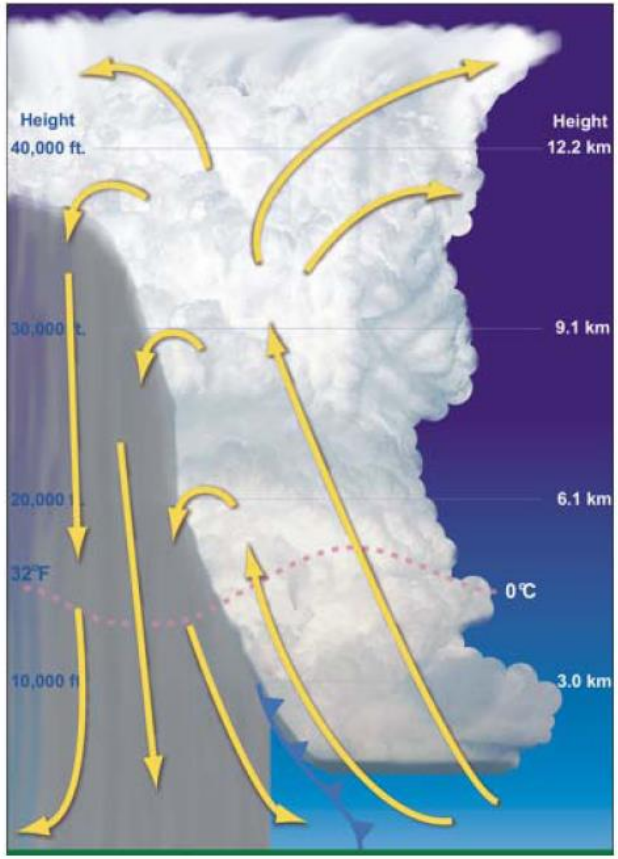
Supporting Partners

AIRBUS BOEING

ITCZ : a particular Zone of Operations



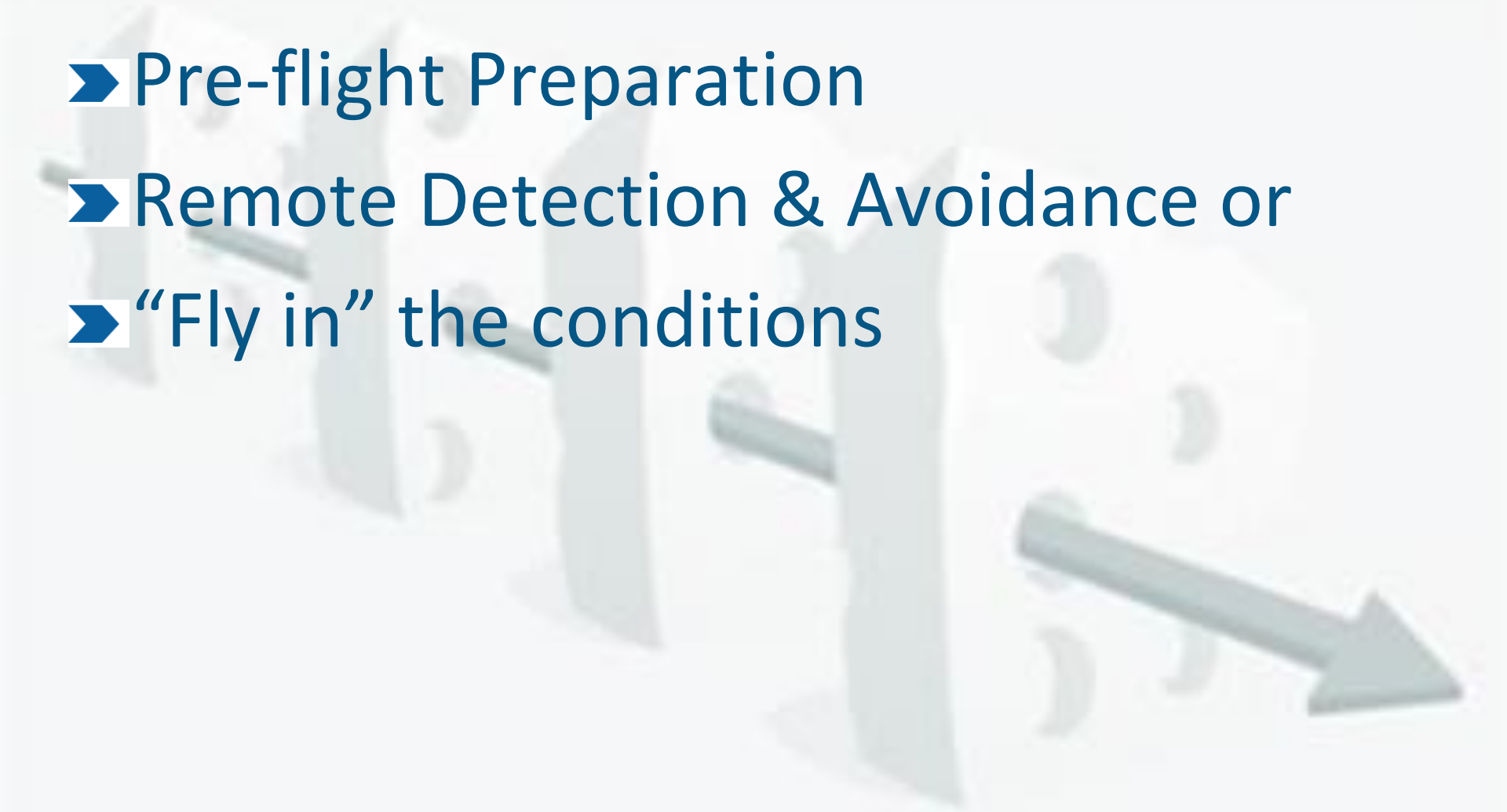
- Ref EASA SIB 2015-13
  - *Aircraft flying through an "active" ITCZ (strong trade winds) will most probably encounter the hazards associated with thunderstorms and adverse convective weather*
  - *All thunderstorms have conditions that are a hazard to aviation*
  - *Strategic (planning) and Tactical (in-flight) weather avoidance is best practice*



Source: FAA AC 00-24C

Flying at high altitude & Adverse weather

- Pre-flight Preparation
- Remote Detection & Avoidance or
- “Fly in” the conditions



Flying at high altitude & Adverse weather

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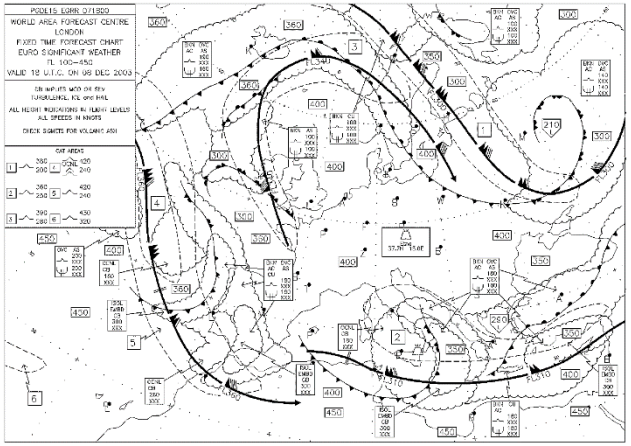
Pre-flight Preparation

- Essential preliminary to all flights
- 5 Main stages
  - Briefing
  - Meteorological Briefing
  - Route Selection
  - Chart Preparation
  - Flight Plan Preparation



Flying at high altitude & Adverse weather

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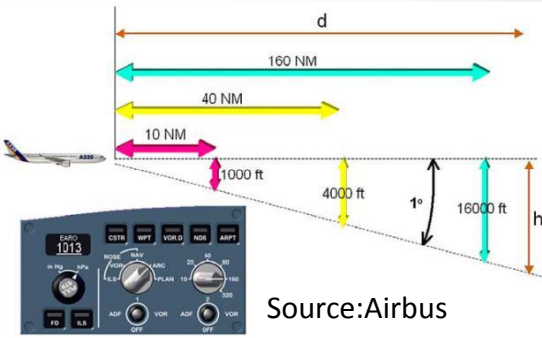
- “Fly in” the conditions

Remote Detection & Avoidance

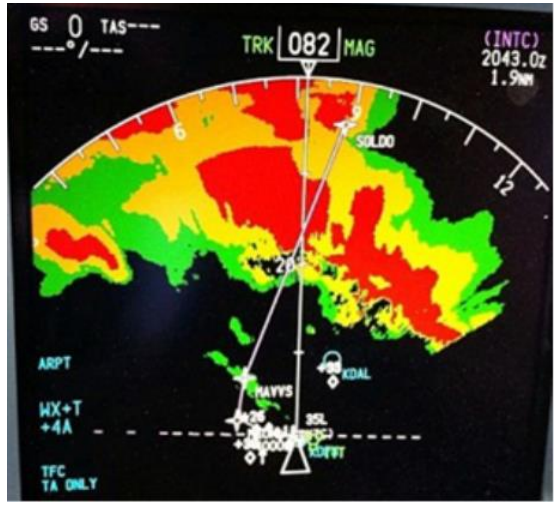
- In-flight phase: the Airborne Weather Radar is the main tool for avoiding severe weather
- Particular benefit to identify areas of deep convection

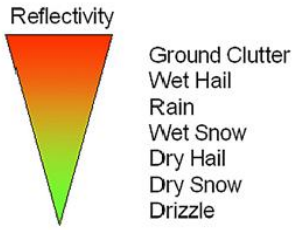


Source:Airbus

BUT

- Information nearby cells becomes partial, and possibly misleading
- Colours indicate a reflectivity level, not a hazard level!
- Direction and Range are limited
- Tilt & Gain: must be adjusted
- Reflection of the frontal part only
- Detects only precipitation drops (liquid only, not glaciated)





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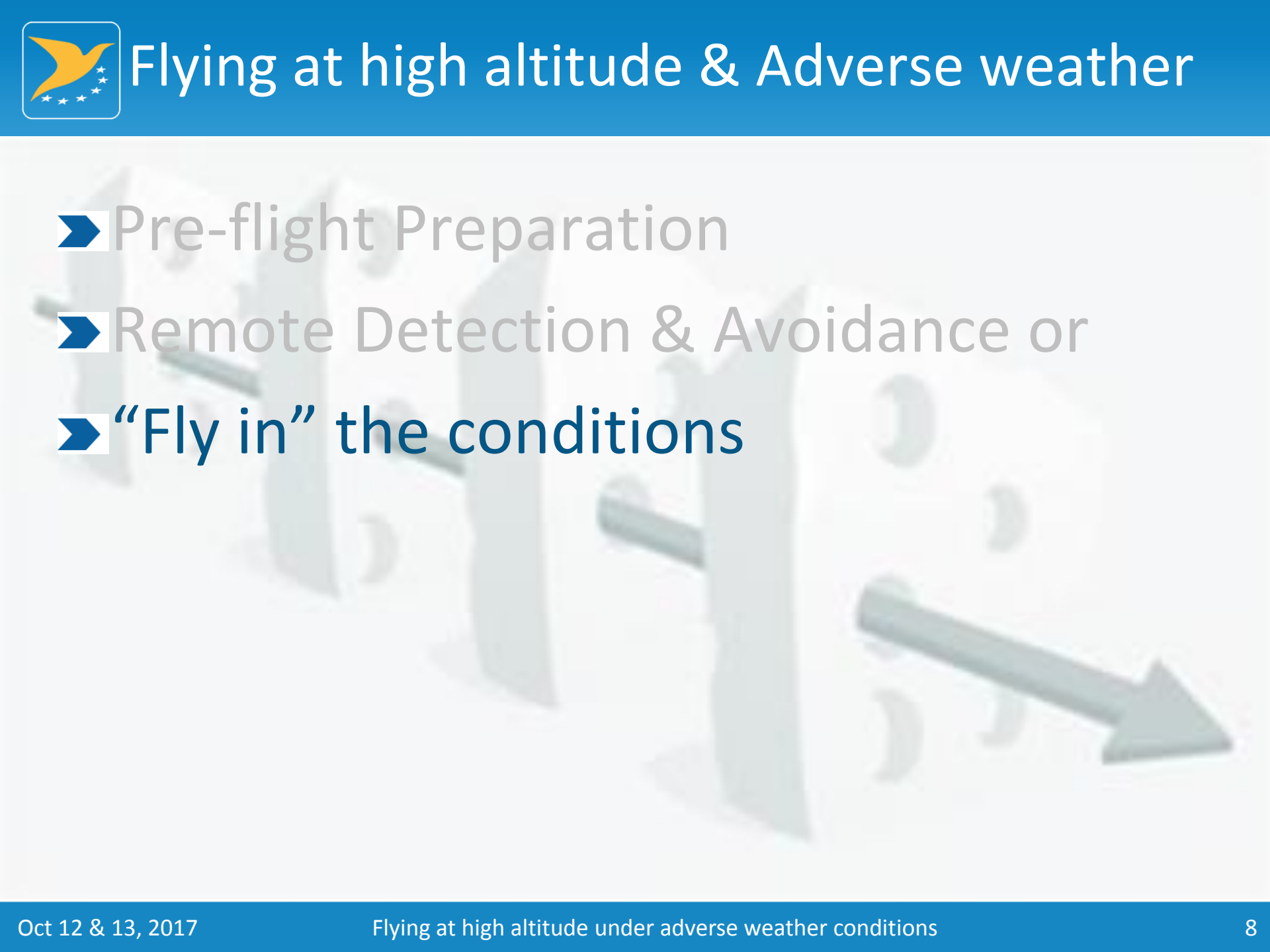
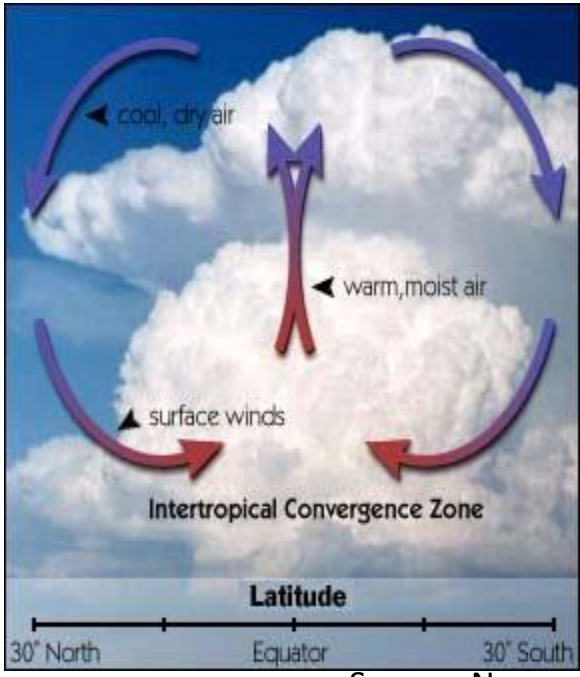


”Fly In”: Which conditions ?

- Glaciated conditions
- Mixed Phase Icing
- Supercooled Icing

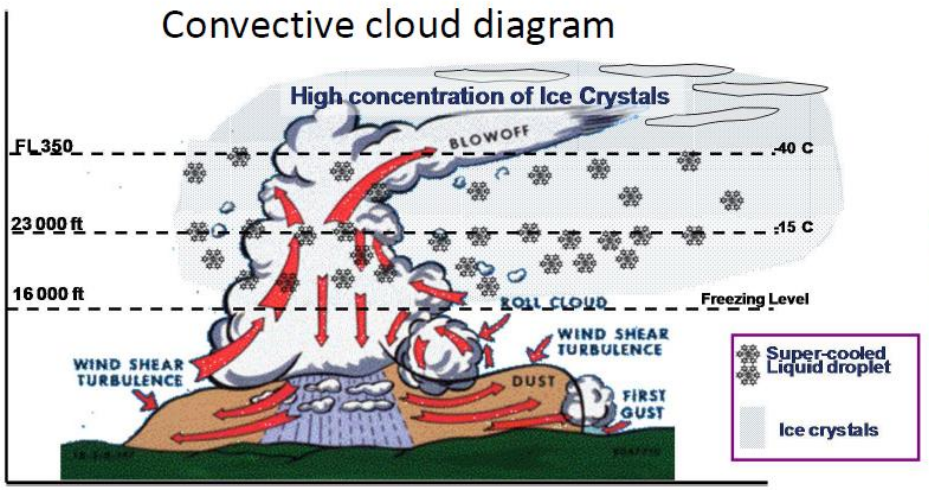
+

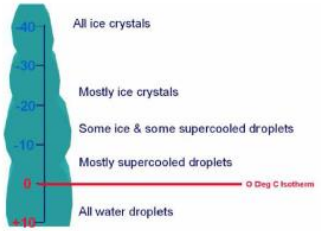
- Hail & Turbulences

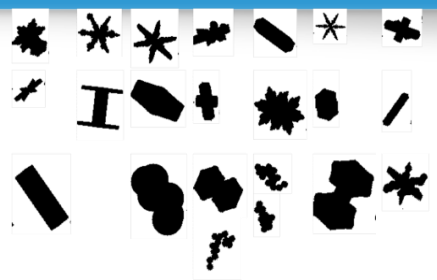


Source: Nasa

Glaciated & Mixed Phase Conditions



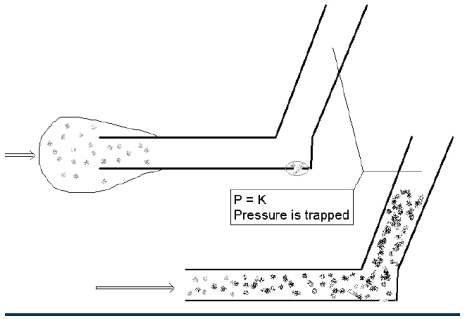




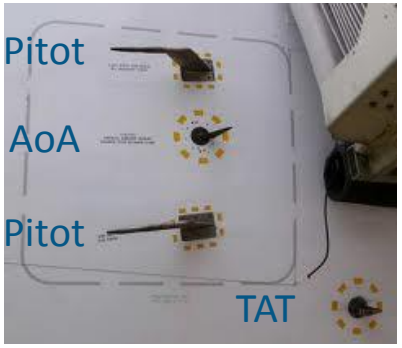
- Can develop above the max A/C altitude: **difficult to escape by climbing**
- Not visible (or very difficult) with airborne weather radars
- **Threat** for A/C items with high collection efficiency and internal warm parts: Air Data PROBES, ENGINES and APUs
- **NOT** a Threat for cold areas (crystals bouncing off), or heated lifting surfaces (no accretion or erosion)

Ice Crystals & Mixed Phase / Main Threat

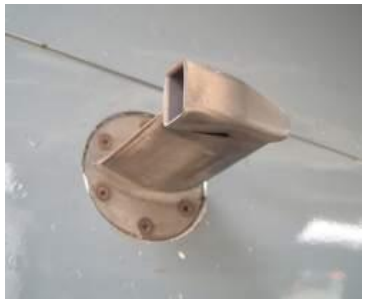
- Air Data Probes (e.g. Pitots, AoA, TAT) may provide erroneous indication in presence of high concentration of ice crystals



Pitot tube: partially or totally clogged for **short time duration;**



AOA: ice crystals build-up below rotating plate

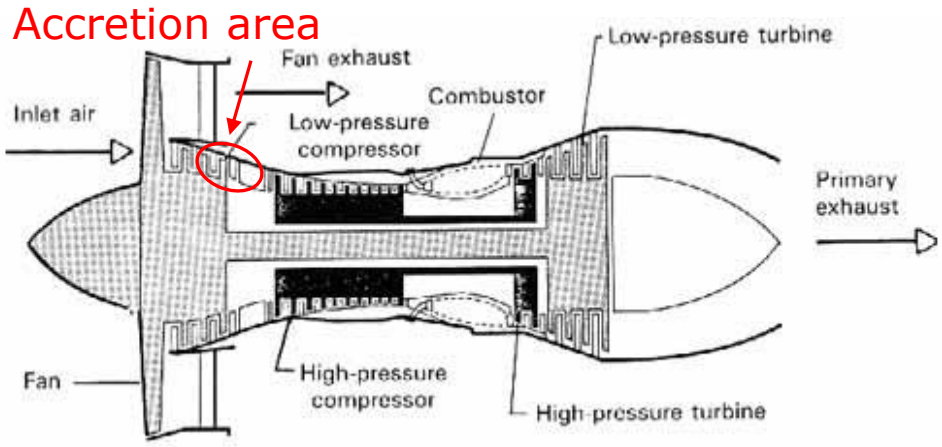


TAT probe: ice crystals build-up in thermocouple area

AoA: Angle of Attack
TAT: Total Air Temperature

Ice Crystals & Mixed Phase / Main Threat

- Ice crystal icing inside turbine engines
  - Hundreds of engine power loss events due to engine core icing since the early 1980s
  - Complex mechanism: crystals impinge on compressor (warm) vane surfaces, melt and cool the surface; when vane surfaces are cold and wet enough, ice accretion begins



- Thrust or power anomalies: loss or unstable
- vibrations,
- flameout, or
- damages from ice release

Supercooled vs Glaciated: VISUAL CUES

Supercooled

(SAT > -40°C)

- Visible moisture
- Ice accretion
  - wipers
  - specific rods

Glaciated

- May exits in clear sky
- Rain & unique sound on the windshield
  - But OAT too low for rain to exist
- Small deposits of ice particles on wipers
- Smell of ozone
- St Elmo's fire
- Possible A/C TAT anomalies
  - remain at 0 °C

Indications not so obvious for pilot awareness

Supercooled vs Glaciated: AFM Indications

Supercooled

(SAT > -40°C)

- **Conditions defined**
  - *IC exist when TAT 10°C or below and visible moisture is present*
- **Procedures defined**
  - *EAI ON: visible moisture + TAT<10°C or ice detection by detectors*
  - *WAI ON when first signs of accretion or ice detection by detectors*

Glaciated

- Some AFM's recommends to NOT activate IPS when SAT is below -40 deg C

Limited Information

Supercooled vs Glaciated: DETECTION System

Supercooled

(SAT > -40°C)

- Ice Detection Systems (IDS) installed on most of Transport A/C
- Certified as Advisory or Primary

UTC Aerospace Systems

Glaciated

- Not detected by traditional IDS
- TAT anomalies may provide indications
- New IDS in development and test

No IDS on the current fleet

Safety Promotion & Training

Safety Promotion & Training needed to improve crew awareness on:

- The importance of Strategic (planning) and Tactical (in-flight) weather avoidance best practices
- The understanding of high altitude icing conditions
- Different failure modes and A/C effects
  - Air Data probes & Engines behaviour @ high altitude

Conclusions & Recommendations

- Flights at high altitude in the ITCZ are conducted safely every day
- Strategic (planning) and Tactical (in-flight) weather avoidance is best practice,
- “Fly in” is expected to happen more often
  - Increasing traffic / operational constraints
- Global warming may render the conditions even more intense

Conclusions & Recommendations

- Crew Awareness is needed on High Altitude flight specificities
  - Safety Promotion & Training
- Technology Development & Deployment needed and on-going
  - Detection & Communication (Airborne Weather Radar & Data Link & Network)
  - Development of Simulation Capability
    - Engine operation Ice Crystals, conditions

EASA
European Aviation Safety Agency

Thank You

Your safety is our mission.

An agency of the European Union