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CHAPTER 14 – HARZADOUS METEOROLOGY

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HAZARDOUS METEOROLOGY

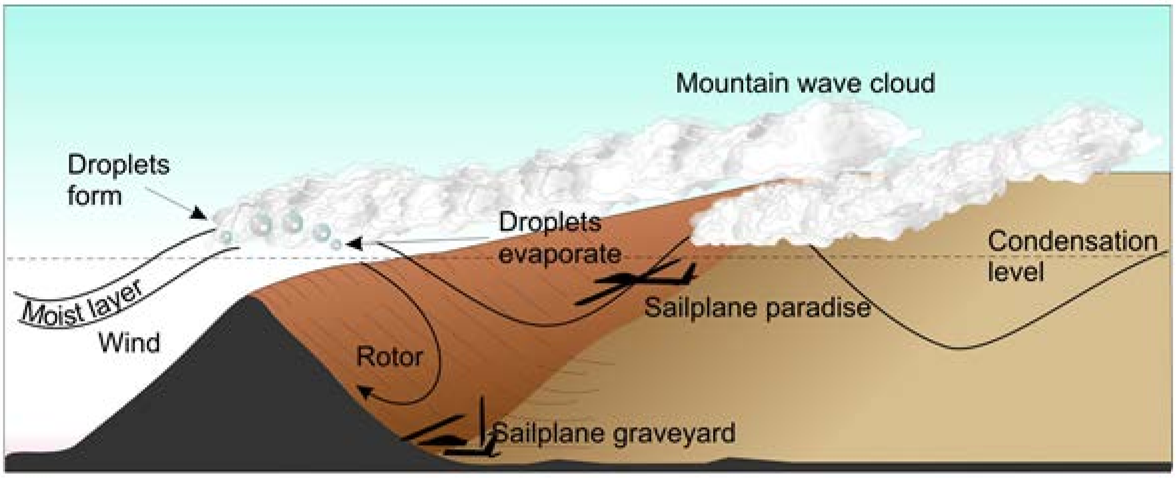
14.1 Overview

This section is a brief summary of hazardous weather that may be encountered while flying in Instrument Met Conditions (IMC). Students should revise all weather phenomena and criteria detailed in the Meteorology textbook prior to attempting the CASA IREX exam.

14.2 Mountain Waves

Under certain meteorological circumstances mountain waves may be set up. Necessary conditions:

- A wind speed of at least 25 KT blowing at about 90° to the mountain range.
- The wind speed remaining at 25 KT or increasing with height.
- An upper air inversion (stable layer) at the height of the mountain top, with unstable air below.
- The air rises over the mountain but the stable layer pushes this air down, the result is a standing wave.



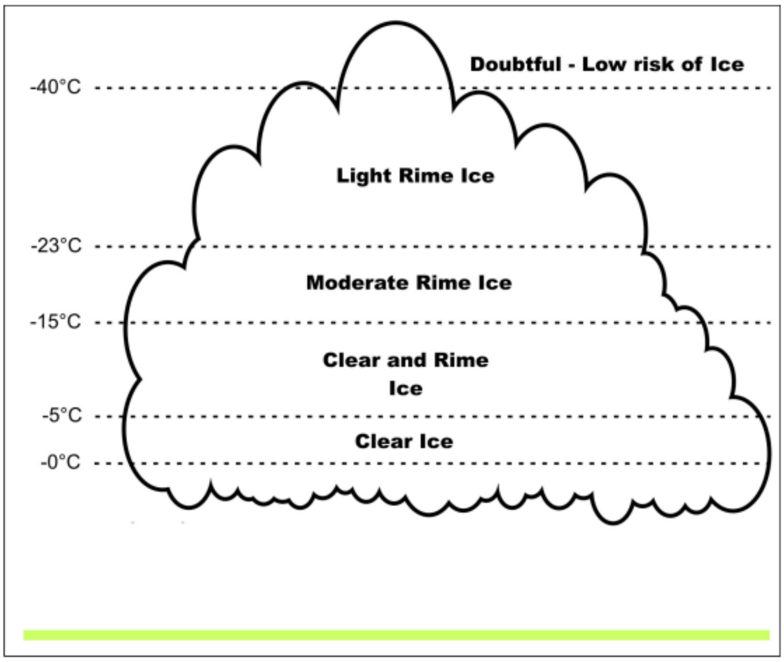
Characteristics of the mountain wave:

- A standing wave with a wavelength of between 3 to 16 NM, depending on wind speed and stability. The average is approximately 6 NM.
- Vertical speeds can be 5,000'/min. Speeds of up to 14,000'/min have been recorded.
- Lenticular (lens) clouds may form if enough moisture is present. However, a mountain wave may exist without any visual indication. (AC Lent.)

The slightest breakdown in smooth flow near the surface will result in rotors. Forming near the surface below the mountain wave crests, the rotors may be indicated by rotor cloud. These long clouds may have a rounded top but a ragged base. Rotors may also form above wave troughs (SC Rotor). The most severe turbulence is found in the first wave downwind from the mountain.

14.3 Cloud Types and Icing

- Stratiform Clouds: The types and severity of icing associated with stratiform clouds at various temperatures are:
  - **40°C–07°C:** No severe clear ice. Moderate rime at warmer temperatures.
  - **07°–0°C:** Increasing threat of clear ice, severe in very thick cloud, e.g. Ns, and with orographic uplift.
- Cumuliform Cloud. The types and severity of icing associated with cumuliform cloud at various temperatures are:
  - **40°C–23°C:** No severe clear ice. Moderate rime ice at warmer temperatures.
  - **23°C–0°C:** Increasing threat of clear ice, as temperature approaches 0°C. Severe in Cb clouds.



Icing in Cumulus cloud

- Lenticular Cloud: Due to the strong updraughts and the short life span of any SCWD as it passes through the lenticular cloud, there are more SCWD at lower temperatures. Severe clear ice can occur at temperatures as low as -27°C.

- Orographic Cloud: The extra uplift due to mountains enables the cloud to support more moisture. The risk of icing is increased; the potential for more severe clear ice is greater and the freezing level will be lower.

14.4 Effect of Cloud Base Temperature

Warm air can hold more moisture than cold air therefore icing of a given level in a convective cloud is likely to be greater in tropical than in temperate latitudes and greater in summer than in winter.

14.5 Classification of Icing

- Light: No change of course or altitude is necessary and no loss of speed caused
- Moderate: Change of heading and/or altitude is considered desirable. Ice accretion continues to increase but not at a rate sufficiently serious to affect the safety of the flight, unless it continues for an extended period of time; air speed may be lost.
- Severe: Change of heading and/or altitude is considered essential. Ice accretion continues to build up and begins to affect seriously the performance and manoeuvrability of the aircraft.

14.6 Thunderstorm Development

Before a thunderstorm will occur, there are three basic requirements:

- A vast amount of water vapour, especially in the lower atmosphere
- Instability or conditional instability
- A trigger mechanism to make the air rise. Given these conditions a thunderstorm can now take place. It does so in 3 phases, the cumulus (growing) stage, the mature stage and the dissipating stage.
- Cumulus (growing) stage (10–15 minutes). Cumuliform cloud will appear, becoming visibly taller. The cloud consists mainly of water droplets with some ice crystals. There will be strong up currents, of the order 15 to 20 MPS. There will be no precipitation.
- Mature stage (15–30 minutes). The onset of precipitation indicates the start of the mature stage. It is during this stage that low-level windshear, turbulence and microburst risk are the greatest.

14.7 Thunderstorm Classification

Thunderstorms need a “trigger” action to provide the initial vertical motion. This trigger is used to describe the type of thunderstorm.

- Heat thunderstorms: Convective thunderstorms are common in tropical areas on most afternoons as strong surface heating creates an unstable atmosphere.
- Cold stream thunderstorms: (Latitudinal heating). In southern Australia, as a cold Pm southerly stream moves northwards over a warmer surface, the ELR near the surface increases and becomes unstable.
- Convergence thunderstorm: These are caused by surface convergence. Air above 2,000 ft. flows parallel to the isobars but the air below 2,000 ft. veers (Southern Hemisphere) or backs (Northern Hemisphere) by about 30°. Air in a low or a trough converges and is therefore forced to rise.
- Orographic thunderstorms: Air is forced to rise on the windward side of a mountain or high ground. If the air is unstable, Cbs may form. These storms may remain stationary on the windward side.
- Frontal thunderstorms: Are most common with fast moving cold fronts. They form as a result of the warm air being pushed upwards by the incoming cold air. Frontal thunderstorms are more hazardous than air mass thunderstorms because:
  - The cells are more numerous
  - Cloud base are lower
  - They move more rapidly
  - A “wall” or a “line” of thunderstorms may form
  - They produce or contain greater turbulence.
- Nocturnal equatorial thunderstorms (upper cold pool). These occur at night over tropical oceans. A thick cover of cloud over the sea keeps the surface warm but radiation cooling of the cloud tops creates an upper air cold pool. The ELR increases and the air become unstable. They usually occur near dawn when the cooling of cloud tops is the greatest.

14.8 Hazards of Flying through a Thunderstorm

The following hazards exist when flying in the vicinity of thunderstorms:

- Down draughts near ground level
- Hail
- Severe turbulence
- Severe icing
- Poor visibility and a low cloud base
- Lightning

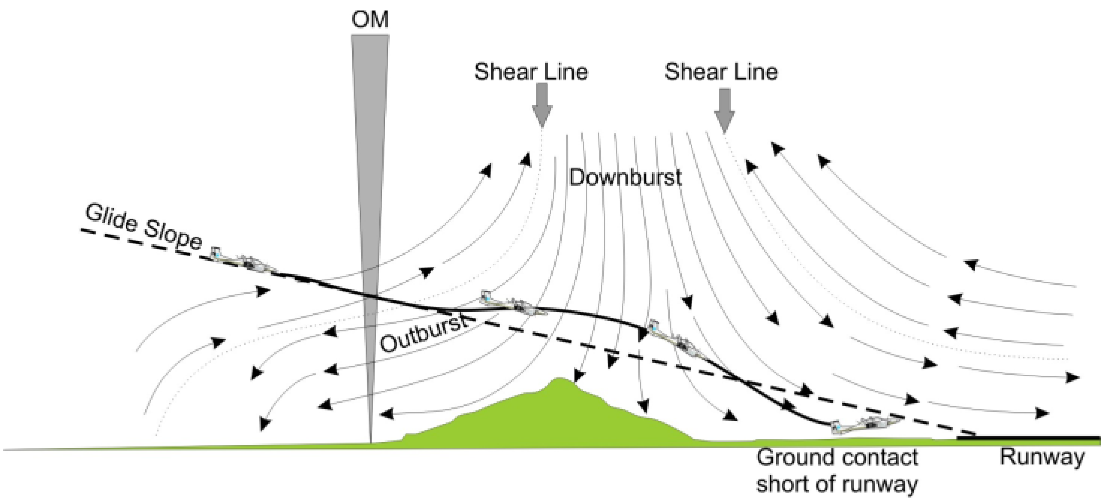
- Water Ingestion (turbine engines).

14.9 Overview of Microbursts

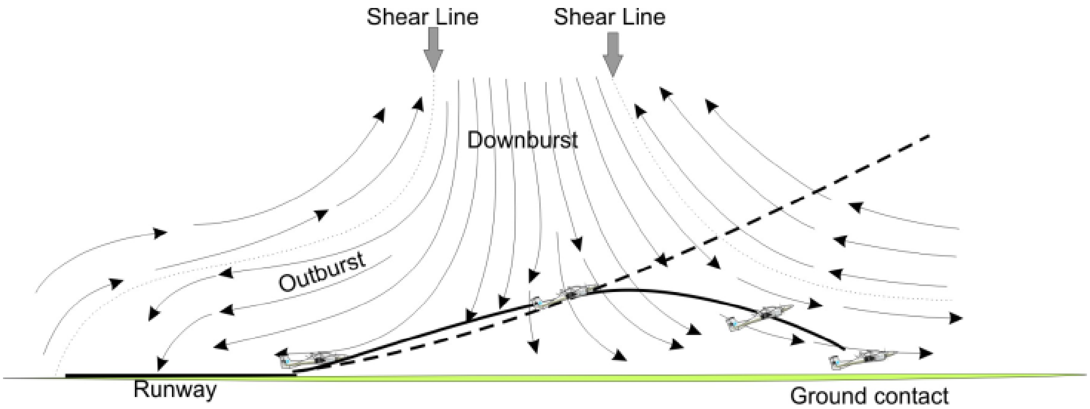
A microburst is the downburst of cold dense air (dry or wet) from the base of a convective cloud (Cb, TCu, Cu, Ac).

14.10 A typical Microburst has the following Dimensions

- Horizontal distance up to 4 KM
- Life time of about 10 minutes
- Horizontal windshear of about 50 KT
- Vertical depth of outflow of 1,000 to 4,000 FT
- The following two diagrams show the effect on an aircraft flying through a microburst on an approach and on departure
- Initial improved performance
- Decreasing headwind
- Strong down-draught
- A strong tailwind and much reduced performance.



Effect of a microburst on an approach



Effect of a microburst on take-off