

HAZARDOUS WEATHER PHENOMENA

Fog

Bureau of Meteorology › Weather Services › Aviation



Fog is a major hazard and inconvenience to aviation traffic in Australia.



Introduction

The major problem posed by fog is the closure of airports and the subsequent disruptions that occur such as diversions of aircraft already nearing their destination. Widespread fog may obscure ground features so that visual enroute navigation is impaired, but the major problem is its effect on landing and take off.

Fog is defined as a concentrated suspension of very small water droplets causing horizontal visibility to be less than 1000 metres.

Fog is actually a cloud occurring at ground level. It forms in the same basic way as cloud—either a moist air mass is cooled beyond its saturation point (dew point) and condensation occurs, or extra moisture is added to make the air saturated at that temperature. Most fogs are initiated when moist air is cooled by contact with an underlying cold surface (whereas clouds form as a result of moist air being cooled by lifting). In addition, some turbulent mixing of air must occur to transfer the cooled air to higher levels before fog will form to any depth.

Types of Fog

Radiation Fog

Radiation fog forms when moist air is cooled below its dew-point by contact with a cold land surface that is losing heat by radiation. The ideal conditions are:

- High relative humidity at low levels so that overnight cooling will be sufficient for the air temperature to fall to below its dewpoint temperature resulting in condensation occurring.
- Cloudless, or near cloudless skies, to allow a large heat loss at the ground, and subsequent cooling of the air in contact with the ground.
- Light winds to promote mixing of this cooled air through a few hundred feet of the surface (a calm wind tends to restrict the fog to low-lying pockets).



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The mix of ingredients is often critical. Small particulate matter assists the process by providing condensation nuclei, so a fog that would not form in open countryside may form under the same circumstances near a city where small pollution particles provide the necessary nuclei. If the wind is calm, the cooling may take place through a depth of just a few centimetres and heavy dew is the only result. The small amount of turbulence (and subsequent mixing of the cooled air) caused by the sun's first warming rays may tip the balance and change fine conditions into an all-enveloping shroud.

Because cold air sinks into valleys, these are preferred areas for radiation fogs, especially if a stream or river adds moisture to the air. From the air, fog can be seen like a smooth carpet snaking through the valleys while surrounding hill tops are clear.

Anticyclones (high pressure systems) provide the most favourable situations for radiation fog, particularly if the preceding situation has brought a moist air mass to the area. Moisture in the ground can also contribute, so a clear, calm night after a period of rain is a particularly favourable situation.

Radiation fog usually disperses a few hours after sunrise. An exception occurs when the fog is very thick or when middle level cloud has moved over the fog and effectively blocks the heating effect of the sun.

Advection Fog

Advection fog develops when warm moist air moves (advects) over a cooler surface resulting in the cooling of the air to below its dewpoint temperature, and subsequent saturation and condensation. Radiation processes frequently assist in the formation and maintenance of this type of fog, but it is still usually called an advection fog. A certain amount of turbulence is needed for proper development of advection fog, thus wind between 6–15 knots are commonly associated with advection fog. Not only does the turbulence facilitate cooling through a thicker layer, but it also carries the fog to greater heights. Unlike radiation fogs, advection fogs are often thick and persistent.



Sea Fog

Sea fogs are usually advection fogs. They develop when moist air that has been lying over a warm water surface moves over a colder water surface, resulting in the cooling of this air to below its dewpoint temperature. They are relatively rare in the Australian region, but when they do occur they are often widespread and persistent even in moderate strength winds. Sea fog has been known to persist for several days around the Australian coastline. They can occur at any time of the year. The main dangers to aviation presented by sea fog are when it drifts inland over coastal aerodromes during daytime, usually with a seabreeze, or obscures the sea surface for seaplane operations.

Advected Fog

Advected fog is any fog that forms remotely and is transported (advected), by light winds into an area previously clear of fog. Advected fogs are common in Australia, with Sydney, Adelaide and Hobart being particularly susceptible to this type of fog in the cooler months.

Steam Fog

Steam fog is caused by evaporation from water into overlying colder air, causing the air to become saturated and condensation to occur. The convection currents above the water give rise to the steaming appearance. The fog may remain in situ but any light wind may advect it many kilometres. This is a common occurrence in inland Australia where large, shallow and warm waterways and dams exist. In coastal areas where cool land breezes have opportunity to flow across warm seas, steam fog can be extensive and lift into low stratus.

Frontal Fog

Frontal fog occurs at the boundary of two air masses rather than within a single air mass (as is the case with the previously discussed types). It mainly develops due to

precipitation falling from relatively warm air above a frontal surface, evaporating into drier and cooler air below, causing this air to saturate and condense. Such fogs usually form rapidly and are very extensive. The danger of such fogs to aviation is that, unlike radiation fog where the visibility above the fog is good, a frontal fog will be associated with generally poor weather such as dense cloud and precipitation. Fortunately, such fogs are not common in Australia.



Upslope Fog

Upslope fog is formed when moist air is forced up a terrain slope and cools to saturation. It is important to note however that a hill or mountain is not a necessity—a gentle slope will do. For example, upslope lifting in a southerly air stream is the principle reason for the formation of low stratus at Broken Hill Airport. Upslope fogs can be long lived when the airstream is very moist.

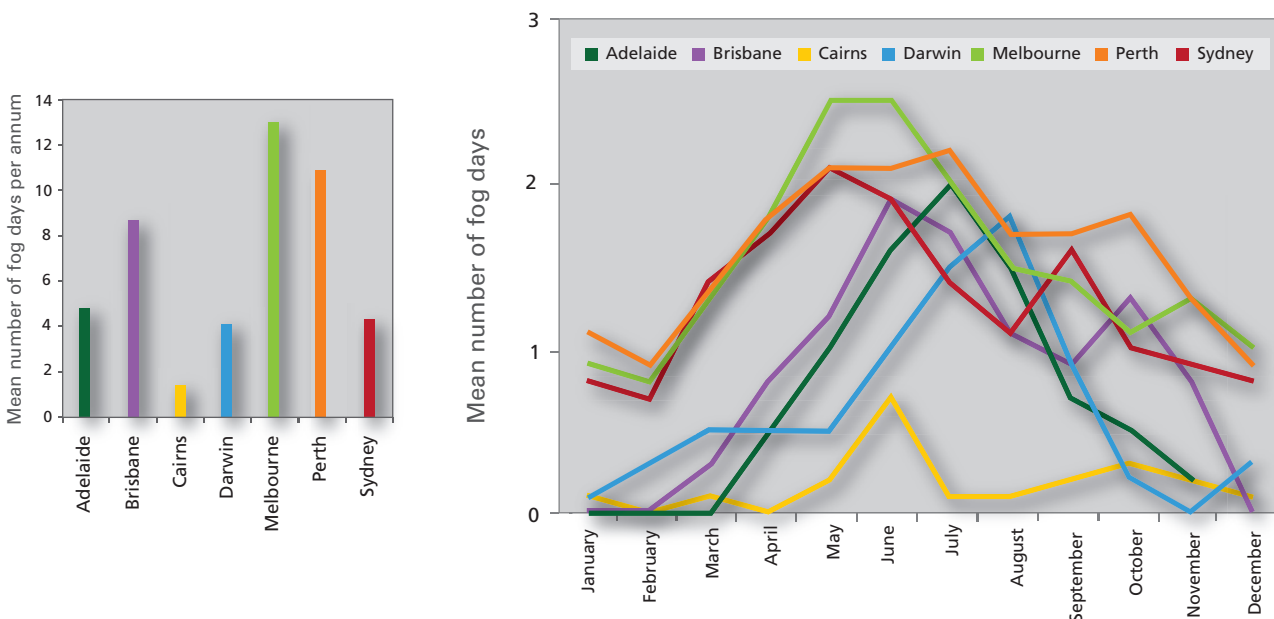
Fog Frequency

The occurrence of fog generally follows a seasonal trend, being less likely in summer than in winter and transition months.

In southwest Australia, radiation fogs are common inland in winter when the Sub-tropical Ridge lies over the southern states, resulting in clear skies and light winds. These fogs are usually isolated and dissipate by mid-morning. More widespread fogs tend to form in the wake of cold fronts when rapid ridging behind the front forms a temperature inversion which traps the moisture deposited as rainfall. The West Coast Trough can produce fog about the coastal plain when it moves inland with moist maritime air. Additionally, sea fog can form with the trough off-shore, and may be advected inland if the trough moves inland.

In southeast Australia, the incidence of fog is generally low at aerodromes close to the coast (e.g. Coffs Harbour, Hobart), but increases very rapidly only a short distance inland. Aerodromes such as Richmond (NSW), Launceston, Mt Gambier and aerodromes along the Great Dividing Range generally experience in excess of 40 fogs per annum. On the western slopes of the Great Dividing Range, particularly in southern regions, locations experience in excess of 25 fogs per annum, while the incidence tapers off further inland. In the fog-prone parts of Australia, in late autumn or winter, fog may form in early evening and persist till midday or longer; on isolated occasions fog may persist unbroken for two days at aerodromes such as Canberra and Launceston.

Monthly fog frequency for selected airports





Fogs in tropical Australia are most common near the coast in the dry season. Fogs are reported from major coastal airports in Western Australia (e.g. Broome, Port Hedland) about 15 times a year. Fogs also occur in North Queensland, more commonly about the coast and during the cooler months. The number of fogs occurring is largely dependant on the airport location. Fogs can be expected at Rockhampton more than 30 times each year while at Cairns fogs are very rare. Often radiation fogs forming in tropical areas are shallow and do not significantly affect aviation operations. A few times each year, sea fogs form along the coast and persist for much of the day. Sea fogs are a regular occurrence during the dry and transition seasons about the Gulf of Carpentaria coast and frequently affect aerodromes such as Ngukurr, Borroloola and McArthur River Mine. Fogs and low stratus also occur about coastal valleys in the Northern Territory's top end during the dry season, occasionally extending as far inland as Tindal.

Detection & Monitoring

Fog can be detected by a combination of direct surface observations, satellite observations, and inference from vertical temperature profiles. Surface trends of wind, temperature, humidity, cloud and visibility provide the basic observational support for likely fog conditions, both in the formative and dissipative stages. Satellite observations provide the best estimate of areal coverage and trends in fog cover, especially at night when direct observations are limited. However, fog cannot be differentiated from low cloud. Inference from vertical temperature profiles provides important indicators of moisture depth, wind regimes and conditions conducive to radiative cooling.

Forecasts & Warnings

Fog forecasts are included in Area Forecasts, Trend Forecasts (TTF) and Aerodrome Forecasts (TAF), with specific reference to timing and horizontal visibility at ground level. Warnings are not issued for fog.



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