



Photo courtesy of Mount Cook Ski Planes

**F**og can cause major disruptions to aviation activity. In February, fog closed Wellington airport for six days causing disruption to thousands of passengers. Forecasting fog is not easy, as each incidence can vary slightly in its formation and dispersal. It is important, therefore, when planning a flight in weather conditions where fog may be present, or is present, en route or at your destination aerodrome, to obtain regular weather updates.

This article provides an overview on the types of fog, and a general description of the weather conditions associated with fog at a number of aerodromes around New Zealand.

## What Is Fog?

Fog is simply cloud that touches the earth's surface. There are two main types of fog – radiation and advection.

### Radiation Fog

Radiation fog forms when humid air next to the ground is cooled enough to reach its saturation point, and water vapour starts to condense into liquid droplets. This generally occurs on a clear night with light winds, usually under an anticyclone, but is highly dependent on the wind speed.

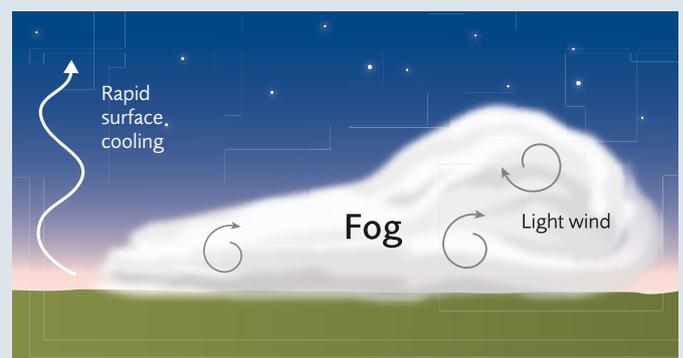
If there is no wind, then the water drops will fall from the air to sit on the surface as dew. Fog may form over grass areas, but it will only be a few metres thick.

If a light wind of four to five knots develops, then the air cooled by the ground will be mixed gently through a deeper layer of the atmosphere and the fog layer will thicken.

If the wind is too strong, the fog may be lifted above the surface and a low layer of stratus cloud will form, or the skies will remain clear.

Although radiation fog typically occurs during the night, it is not unusual for it to form after sunrise when the relative humidity has been high but when a lack of mixing during the night prevented its formation.

Radiation fog typically occurs at sheltered inland areas, and is thicker near moisture sources such as lakes and rivers. If it forms in hilly or mountainous terrain, then katabatic flow will intensify its development and will enhance the development of valley fog. This can flow down the valleys and gorges, and settle on low-lying areas.



Radiation fog can occur on a clear night with a light wind, if humid air is cooled enough to reach its saturation point.

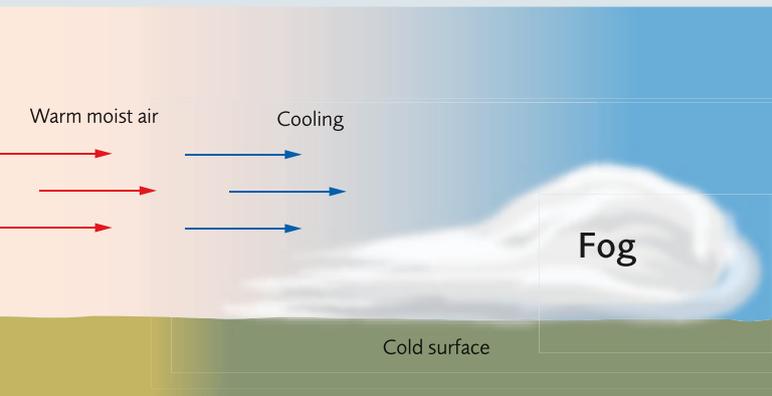
### Advection Fog

Advection fog forms when moist air is transported (advected) over a surface that is sufficiently cold to lower the air temperature to its saturation point. It can form over water as well as land and is more persistent than radiation fog. It is not uncommon for advection fog to linger for an entire day.

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Unlike radiation fog, advection fog does not necessarily require anticyclonic or cold conditions. It may form if the air is stable and moist, and is blown across a sufficiently cold surface, provided the wind is not too strong.



Advection fog can occur when warm moist air is blown across a sufficiently cold surface to lower the air temperature to its saturation point.

## Dispersal of Fog

There are a number of ways that fog can clear. Fog usually disperses when there is enough solar radiation to either directly evaporate the fog, or to mix the moist air within the fog bank with the drier air above. Fog can initially thicken for a short time after sunrise before dispersing. It may also clear if there is a change in wind direction and strength. This can occur with the approach of a front.

Fog also clears if there is insufficient moisture to replenish the fog as the water droplets that form it slowly fall to the ground due to gravity. Cloud moving over fog can also clear it by radiating heat downwards. For example, a layer of stratocumulus moving over Christchurch airport during a cold night can raise the temperature by more than 4 degrees Celsius.

## Occurrence of Fog at New Zealand Aerodromes

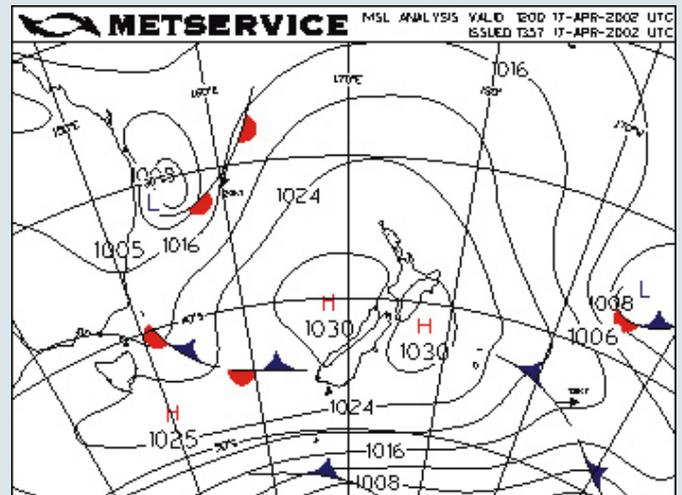
Fog can significantly affect aircraft arriving at or departing from an aerodrome. It can close an aerodrome, as we have seen recently at Wellington, resulting in significant disruption to operations. Fog can also hinder VFR cross-country flight by lingering in valley areas for the entire day(s), and closing access to inland aerodromes.

### Auckland

Radiation fog is most common between April and late August, with anticyclonic conditions and clear skies at night. It usually forms in the early morning between 0300 and 0700 hours and clears around 0900 hours (all times are local). When fog coverage is extensive and covers the Manukau Harbour, clearance may be delayed until at least midday.

The onset and persistence of fog is influenced by the prevailing wind direction. When the wind is from the northeast, fog often envelops Wiroa Island (the small island south-east of the RWY 23 threshold) while the runway itself is clear, or is subjected only to patches of fog. With light west to northwest winds, fog normally forms initially over the Ihumatao sandbank. This fog usually forms earlier (between 2200 hours and 0300 hours) and spreads rapidly over the entire airfield. Its persistence is difficult to predict.

After sunrise, a temporary clearance may take place, but a substantial fog bank remains over the Papakura Channel, to the south of the runway. When warming of the land starts, and a gentle southwesterly sea breeze begins, this brings the fog back over the airfield. Under these conditions, the fog may persist into the afternoon.



Weather chart with fog occurring at Auckland. Note the very high pressure and the light winds ideal for the development of radiation fog during the early hours of the morning.

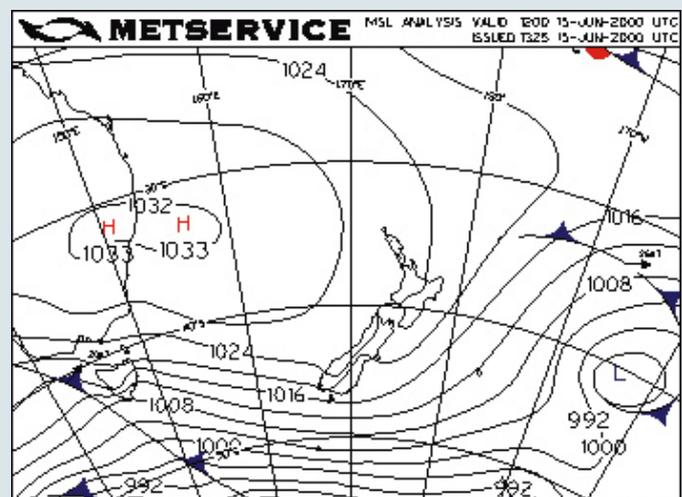
Tidal activity at Auckland can also influence fog. If there is a low tide during a clear night, then the exposed mud flats will lose heat quickly and there is a higher chance of fog forming.

### Hamilton

Hamilton airport and surrounding areas are subject to fog all year round. Fog is more frequent from March to August.

Radiation fog forming in situ over the airfield is the most common. It is more persistent during the early stages of anticyclonic conditions when light westerly winds during the day have brought moist air from the sea to the Waikato area. In winter, fog can form as early as 2000 hours. During the night, the fog may be quite thin if there is little wind. In the morning, fog tends to thin temporarily shortly before sunrise but thickens again at sunrise, before clearing between 0900 and 1200 hours. This will vary depending on the time of year, and wind strength. This type of fog can cause frequent disruption to morning flying.

Early-evening fog will sometimes form if a front from the north or northwest crosses Hamilton in the late afternoon and is then



Radiation fog at Hamilton is more persistent during the early stages of anticyclone development over New Zealand.

followed by clear skies with light winds. The high surface humidity following the front, combined with rapid cooling after sunset, can result in sudden and widespread fog formation.

Although fog can frequently occur at the field, it is even more likely to occur near moisture sources, such as the Waikato River. In light easterly conditions, for example, fog will exist over the river to the east but not at the airfield. If the easterly becomes established during the morning after a calm night, fog can be advected onto the airfield. This is usually patchy, and clears during the morning.

Frontal fog forms occasionally in association with warm fronts moving in from the north. It is usually of short duration and clears rapidly when the front moves away.

Most fog situations (except thin radiation fog events) normally lift to a low stratus before clearing. Clearance is usually complete by 1200 hours but the development of stratocumulus above the existing layer of fog, or stratus, may delay the final clearance for some hours.

## Tauranga

Radiation fog can occur all year around but is more common in the months of March to July.

It normally forms in the early morning and clears a few hours after sunrise. On occasions, advection fog can occur from the Bay of Plenty. This is associated with weather patterns which result in a moist, humid northerly airflow. Fog will also be extensive throughout the Bay of Plenty region in these conditions.

## Gisborne

Radiation fog may occur during any month, provided there is a weak pressure gradient, clear skies, the dew point is high, and the katabatic wind fails to reach its normal strength. It is most likely to form if these conditions occur immediately after rain. This fog is usually rather shallow and patchy. Clearance is normally rapid after sunrise.

## Taupo

Radiation fog can occur between April and August. Occasionally, humid northerly flows may bring stratus cloud to the airfield level as fog. Radiation fog normally forms in the early morning. At times, it will develop in the early evening, following the rapid clearance after a cold front. Fog normally clears within a couple hours of sunrise.

Although fog does form over the lake, as well as on land, it will tend to clear from the land first. The persistence of fog over the lake can cause operating problems at the airfield if an onshore drift occurs before the lake fog has dissipated.

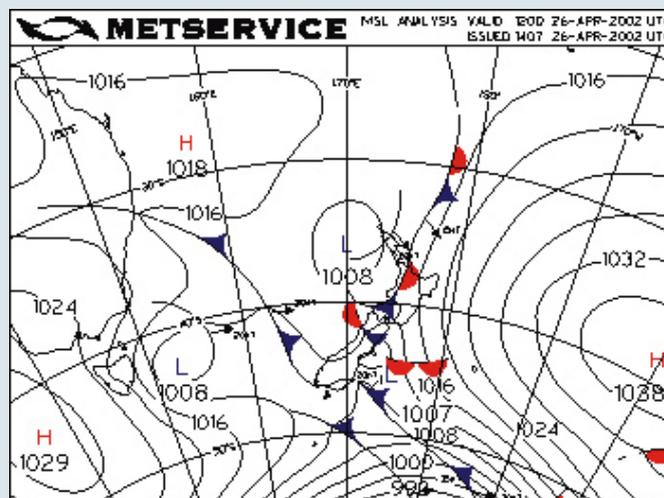
## New Plymouth

Radiation and advection fog can occur at any time throughout the year.

Radiation fog is more common in the surrounding districts and valleys, although at the airfield it occurs on a few occasions during autumn and spring. In winter, the katabatic wind can be too strong for its formation. The fog normally forms in situ in the early morning, but on occasion it may drift from the area southeast of the airfield in light flows, and disperse over the sea. Fog normally clears by 0900 hours. At times, a ground fog may form in the late evening.

Advection fog is more common than radiation fog, especially during spring. This fog is advected from the North Taranaki Bight and occasionally is advected over the airfield. When it does so, this type of fog can persist for a few days.

Frontal fog sometimes forms when a warm front moves in from the North Taranaki Bight. It is normally of short duration, forming as the front reaches the airport and clearing rapidly as the front moves south.



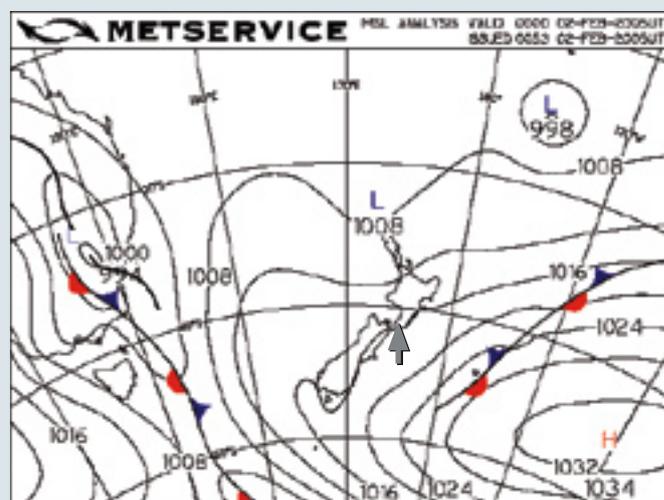
An occluded or warm front from the Tasman Sea can bring advection fog to New Plymouth. Note that anticyclonic conditions are not required for this fog to form.

## Wellington

Advection fog occurs at Wellington when an intense and slow moving anticyclone is situated over, or to the east of, the Chatham Islands.

This advects warm air away from the tropics, which then crosses over a relatively cool ocean, and is cooled from below. As the moist air cools, its relative humidity increases to the point where low cloud, or possibly fog, is formed in the moist northeasterly flow to the east of Cape Palliser. This wind is an easterly across Palliser Bay, and if it turns to a southerly at the harbour heads fog and low stratus is advected over Wellington.

In this situation, as long as the wind stays from the east or southeast (indicated by the wind on Mount Kaukau) fog will not form at



Advection fog forms at Wellington when an intense and slow-moving anticyclone is situated over, or to the east of, the Chatham Islands. If the easterly wind turns to a southerly both at Mount Kaukau and Wellington airport, fog and low stratus is advected over Wellington.

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Wellington airport. The air will be crossing the Aorangi Range and the fog will remain on the upwind side. Wellington will remain clear. If the wind on Mount Kaukau backs to the south, then the protection from the hills is lost and the fog will roll in. This change, from southeast to the south, is associated with a very subtle change in the alignment of the isobars, and is therefore difficult to forecast.

Generally, if the wind on Mount Kaukau and at the airport changes from the southeast to the south the fog bank, which typically sits in Cook Strait during easterly conditions, will be advected over the airport. This fog can be very persistent, and may remain over Wellington airport for several days.

Occasionally, fog that forms in the Hutt Valley may be advected over the airfield under northeast conditions. This type of fog does not normally persist.

### Hokitika

At Hokitika, very low stratus and fog over the sea to the west or northwest can advect over the aerodrome.

It is most persistent when it is associated with slow-moving fronts advancing from the west or southwest. These fronts are often preceded by a broad band of very humid north or northwest air, and followed by a rather stagnant onshore airstream. Such situations can give periods of fog lasting from 6 to 12 hours. Faster-moving systems will usually give only a few hours of fog.



Radiation fog clearing on the Canterbury Plains.

### Christchurch

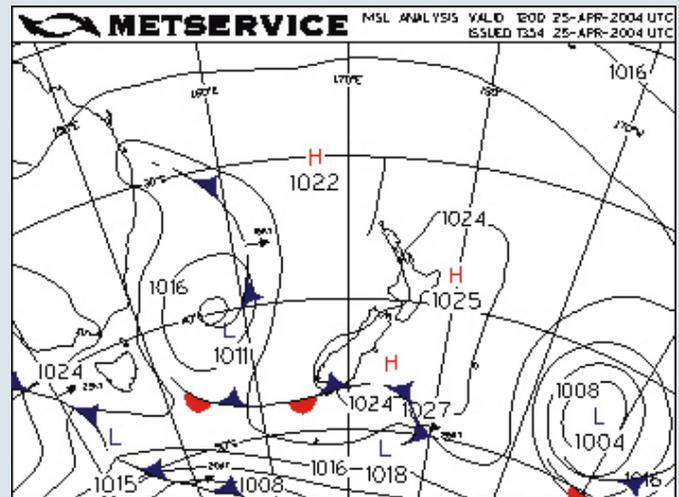
Fog is relatively common at Christchurch. It occurs most often during autumn to early spring. Fog which occurs during winter tends to persist longer than at other times of the year.

Most common is radiation fog that forms on clear nights when the pressure gradient is weak. Normally, this is associated with a northeast wind that has reduced to less than five knots, and has changed to a light northwest drift just prior to the development of fog. If the wind speed is below four knots, fog will form on the runways, but fog patches may occur over neighbouring grassed areas with wind speeds as high as eight knots. Interestingly, around half of the radiation fog events that form during the night clear before dawn.

During winter, if frost forms first, the onset of fog will be delayed by several hours, or it may not form at all. This occurs because the water vapour deposits onto the ice particles (frost). This maintains the vapour pressure below the level necessary for fog to form.

Christchurch also experiences advection fog. For example, when sea fog has formed over Pegasus Bay to the northeast of the airport, or over the Waimakariri River, it may be advected over the field. This fog usually lifts clear of the ground as it does so.

Fog advected from the Lake Ellesmere area to the south of the airport is less common but, when it occurs, is less likely to lift off the ground, and is more persistent.

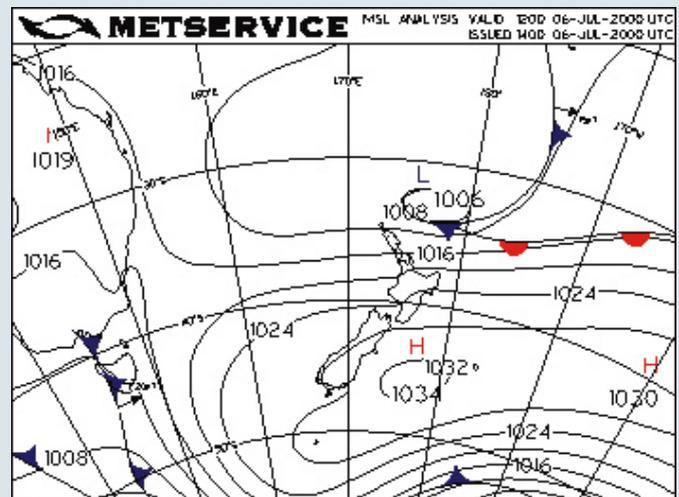


If an anticyclone is positioned to allow a light northeast flow over Christchurch, advection fog that has formed over Pegasus Bay may be advected over the airport.

### Queenstown

Fog is not common over Queenstown aerodrome itself, but during anticyclonic conditions in winter valley fog will form in the surrounding basins. This can cut off VFR access routes to Queenstown and may not be apparent on weather reports, as the Queenstown METAR may indicate clear and fine conditions.

If fog does occur at Queenstown, it is typically around the aerodrome, and along the Kawarau and Shotover Rivers.



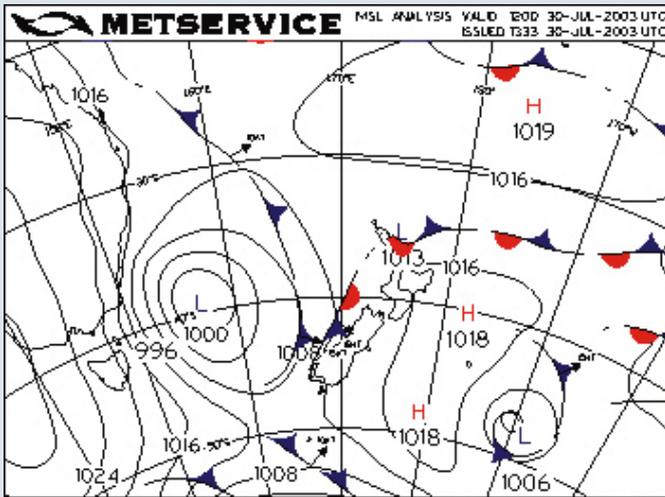
Valley fog in the inland areas of Central Otago can be very persistent, especially if there is a light easterly or southeasterly wind. In extreme instances, if the temperature of the fog is below zero the tiny water droplets remain liquid but will freeze if they come into contact with any object, such as a tree. This is known as freezing fog.

This may cover the thresholds of runways 23 and 32, thereby affecting the approach and overshoot on the reciprocal runways. This fog typically clears by late morning.

## Dunedin

Radiation fog is common during autumn and winter. It is less likely during the windier months of spring and early summer.

Fog forms mainly between 0300 and 0600 hours, but on occasions as early as 2000 hours in the evening during autumn and winter. Fog usually persists until at least 0900 hours, and occasionally until late morning. When radiation fog affects the airfield, it is normally widespread over the Taieri Plain. The swampy areas and the lake areas to the south tend to have more persistent and thicker fog than elsewhere. On some occasions, if there has been no wind during the night, fog may form after sunrise when mixing occurs after the development of a light wind.



Radiation fog at Dunedin is most likely to form during autumn and winter.

Sea fog can reach the airfield, especially during winter in moist south to southeast flows. This occurs when the fog is widespread off the Otago and Southland coasts, and also covering the Southland plains.

## Summary

In general, be on the alert for the occurrence of fog under the following situations:

- winter/autumn anticyclonic conditions with clear skies, weak pressure gradients and light winds
- in the early hours of the morning (fog may form or thicken after sunrise)
- at aerodromes near moisture sources, eg, rivers and swamps
- in conditions of high relative humidity, indicated on METARs and SPECIs by the ambient air temperature and dew point temperature being very close together.

Remember that timing of fog dispersal is very difficult to forecast. Radiation fog will usually clear by late morning, but advection fog is more persistent, and may last for the entire day, or even longer.

If you are flying to an aerodrome where fog is present, be prepared to divert to an alternative aerodrome, or to return to your departure point, in case the fog does not clear by the time you arrive. ■

# GPS Database Omission!

Brian Souter, who contributed the articles on GPS use (see January/February 2005 issue of *Vector*), has subsequently found a potentially lethal omission on the electronic database of Garmin G1000 GPS units.

Single-engine Cessna and Diamond aircraft, equipped with the Garmin G1000 glass cockpit displays, do not show Kapiti Island when being used in the “topographical mode” on the navigation page. This could be bad news for a VFR pilot, unfamiliar with the area and proceeding off the coast near Paraparaumu in reduced visibility using their Garmin G1000 for situational awareness. The G1000 topographical display doesn’t acknowledge Kapiti Island’s existence! Kapiti Island is, however, included in the “terrain mode” database.

Garmin have acknowledged the omission, but have yet to advise the CAA of the revision date when Kapiti Island will be incorporated into the G1000 “topographical mode” database.

Be wary of electronic databases! Up-to-date hard copy charts are still vital for VFR navigation. Remember, having a GPS receiver on board is **not** an excuse to push your luck operating in marginal VMC conditions.

# “Ag Work and the R22” Correction

On page eight of the March/April 2005 issue of *Vector*, we said that “The regular Beta for instance has a maximum manifold pressure of 23.7 in Hg and the Beta II only 23.5 in Hg at sea level on a 20 degree C day.”

Thank you to an eagle-eyed reader (Neil Scott) who noted that the manifold pressure figure of 23.7 in Hg for the Beta model was incorrect. It should have read 24.7 in Hg. This can be found in the Flight Manual under Power Plant Limitations Charts 2.10 and 2.11.

The figure that *Vector* gave, was in fact the calculation for the R22 Alpha model.

