

Cloud seeding

Frequently Asked Questions

What are clouds and how are they formed?

Clouds are composed of water droplets and sometimes ice crystals. Clouds form when air that is rich in moisture near the Earth's surface rises higher into the atmosphere, either because of an encroaching air mass or the heat of the sun. As the air is lifted, the pressure drops and the moist air is cooled. The combination of the two factors causes water vapour to condense into water droplets, which are visible to the naked eye.

The main weather systems suitable for cloud seeding are associated with westerly air streams. As these systems approach mountain ranges the air mass is lifted and condenses to form clouds. Often the tiny cloud droplets remain in liquid form, even at temperatures below 0°C. This is known as super-cooled liquid water.

What is cloud seeding?

Cloud seeding is a technique for increasing precipitation (e.g. rain or snow) using naturally occurring clouds. It involves the introduction of additional particles into suitable clouds to encourage the formation and growth of ice crystals or raindrops and thus increase the amount of precipitation that will fall from the cloud.

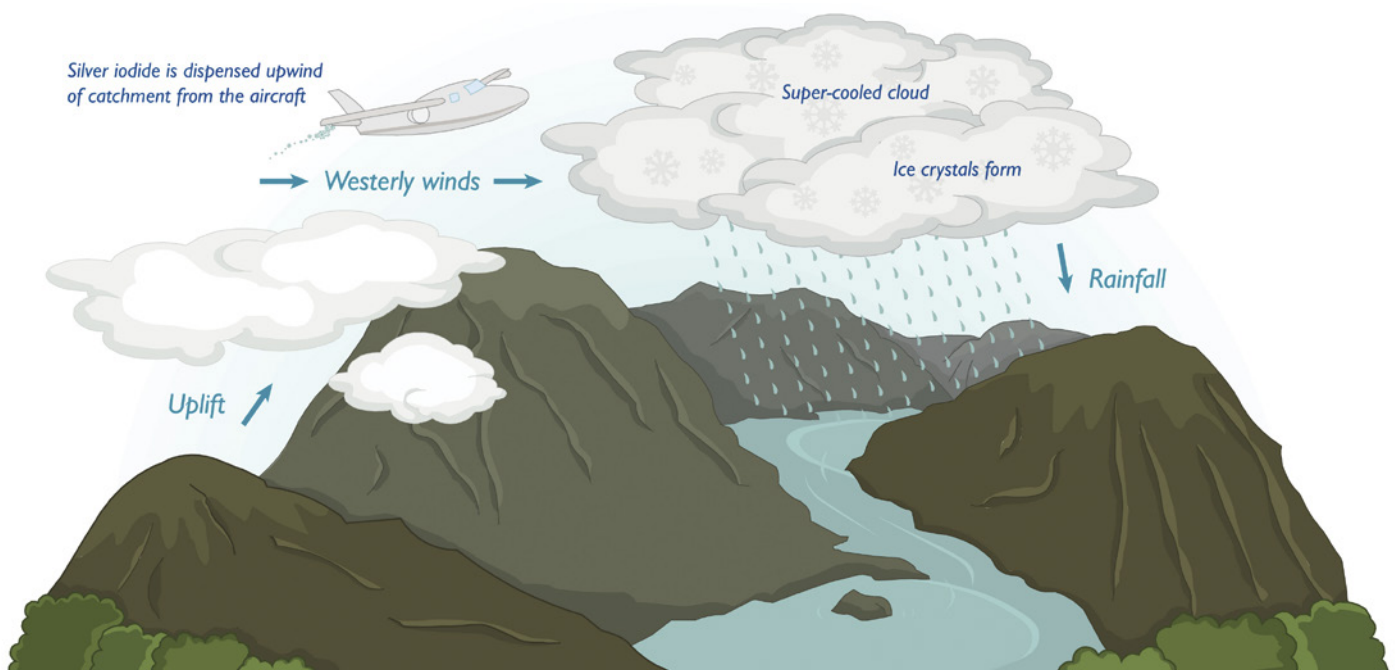
Cloud seeding only occurs when the Bureau of Meteorology forecasts rain and even then only if conditions are favourable for cloud seeding to be successful. A successful cloud seeding operation in Tasmania will make it rain a little bit harder for a bit longer than would have occurred naturally.

Cloud seeding is only effective if suitable clouds are present.

How do we know cloud seeding works in Tasmania?

There have been three successful trials to determine if and how well cloud seeding works in Tasmania. The trials were conducted between 1964 and 1994.

More recent research completed by Monash University and published in 2009 has confirmed that cloud seeding is effective and that it increases rainfall across the target areas by at least five per cent.



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What types of clouds are suitable for seeding over Tasmania?

Not all clouds are suitable. Significant levels of super-cooled liquid water have to be present in the cloud. Generally in Tasmania clouds at temperatures colder than -5°C and with a liquid water content of more than 0.1g per cubic metre are considered suitable for seeding. Once all the criteria are met, cloud seeding can be successfully utilised to produce rain or snow.

In Tasmania, there are two main types of clouds suitable for cloud seeding:

Cumuliform Cloud:



These clouds are characterised by a dense discrete appearance with sharp outlines, which develop vertically in the form of towers or domes.

The sunlit part of the cloud is often a brilliant white while the bottom is a darker grey and flat in appearance.

Stratiform Cloud:



These clouds are characterised by their layered structure.

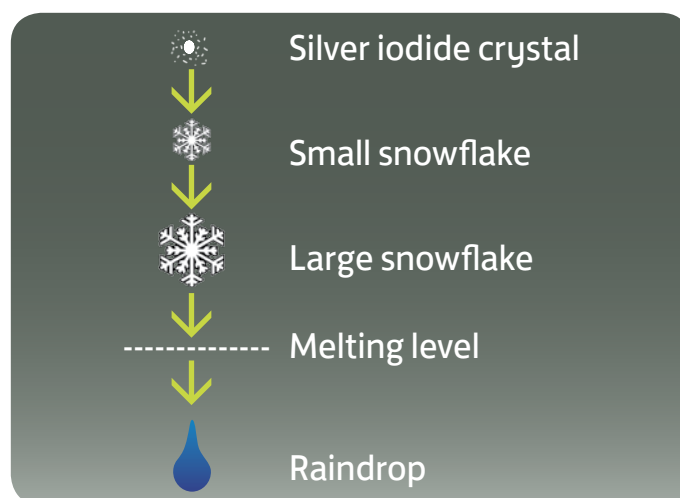
They are overall grey with a fairly flat base extending for many kilometres in all directions. Generally there is very little convective activity in the cloud.

How does cloud seeding work?

For clouds made up of super-cooled liquid water to produce precipitation, droplets within the clouds need to form ice crystals. This normally occurs through interaction with tiny airborne particles called ice nuclei (such as dust or other ice crystals), or when cloud temperatures are very cold.

The ice crystals grow when they collide with water droplets in the cloud. Eventually these ice crystals fall from the cloud and melt as they pass through the melting point (0°C) to fall as rain. This process is known as glaciogenic cloud seeding.

The amount of rain the cloud can produce is related to the number of ice nuclei within the cloud. The air in Tasmania is very clean with very few ice nuclei compared with other parts of the world. Cloud seeding increases the number of ice nuclei. Silver iodide is a form of ice nuclei which is very effective in Tasmanian conditions.



Why does Hydro Tasmania cloud seed?

Tasmania produces the majority of its electricity from renewable hydro-generation. This power is produced from the water which falls as rain in Hydro Tasmania's catchments. The water is stored in dams until the energy is required. Cloud seeding is a cost-effective means of increasing rainfall in selected catchment areas.

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What is in the cloud seeding solution used by Hydro Tasmania?

The active ingredient in the cloud seeding solution used by Hydro Tasmania is silver iodide.

The other components in the cloud seeding solution are:

- acetone;
- paradichlorobenzene – makes the resulting silver iodide crystal slightly hygroscopic (i.e. attractive to water); and
- sodium iodide.

How much silver iodide is dispersed during an operational cloud seeding flight?

During a one-hour period when cloud seeding is occurring, approximately 15 litres of cloud seeding solution is dispersed. This would include approximately 250 grams of silver iodide.

How much silver iodide does Hydro Tasmania use each year?

The amount of silver iodide used during cloud seeding in recent years was:

Year	Seeding flights (number)	Silver iodide (kg)
2010	26	8.1
2011	17	4.1
2012	16	5.1
2013	12	1.9

In a typical year the amount of silver iodide released is less than half of one teaspoon per square kilometre.

Are the cloud seeding chemicals hazardous to human health?

The Material Safety Data Sheet (MSDS) for silver iodide does not identify any significant adverse health effects from exposure to silver iodide. You can read more about silver iodide at:

www.sciencelab.com/msds.php?msdsId=9927257

The amount of silver iodide that may reach the ground as a result of Hydro Tasmania's cloud seeding operations is so small it is not hazardous to human health.

The main ingredient in the cloud seeding solution is acetone and this is ignited and burnt in the cloud seeding burner (shown in the photo below) so none reaches the ground.



Are the cloud seeding chemicals harmful to the environment?

Hydro Tasmania has completed an Environmental Impact Assessment of its cloud seeding work. The results indicate that there are no adverse impacts on the environment from the amounts of silver iodide released in cloud seeding activities.

How and when does Hydro Tasmania decide to go on a cloud seeding flight?

A range of information sources are used to decide if suitable clouds may be present. These include:

- weather forecasts from the Bureau of Meteorology;
- satellite pictures; and
- weather radar.

The Cloud Seeding Officer uses the available information to determine if conditions are likely to be suitable for cloud seeding. The decision to go on a cloud seeding flight is made two to three hours before a potentially suitable cloud front is expected to be over Tasmania. Weather and atmospheric conditions in a cloud may change very rapidly as a cloud front passes across Tasmania and this means the suitability of a cloud for seeding operations can only be confirmed by flying through the cloud.

Often it is found that the cloud is not suitable for seeding so there are many occasions where there is a flight, but no cloud seeding takes place. For this reason it is not possible to provide a forward program of when cloud seeding may occur.

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What equipment does Hydro Tasmania use for cloud seeding?

Hydro Tasmania uses a twin engine aircraft, a Cessna Conquest, for cloud seeding operations. This plane has silver iodide burners under each wing.

The aircraft is fitted with a number of scientific instruments to measure the atmospheric conditions encountered and to determine the suitability of clouds for seeding.



How long does it take for cloud seeding to work?

Once a cloud is seeded it takes about 30 minutes for the ice crystals formed to grow to sufficient size and fall out of the cloud as raindrops.

Is there any evidence that Hydro Tasmania's cloud seeding affects rainfall outside the target seeding areas?

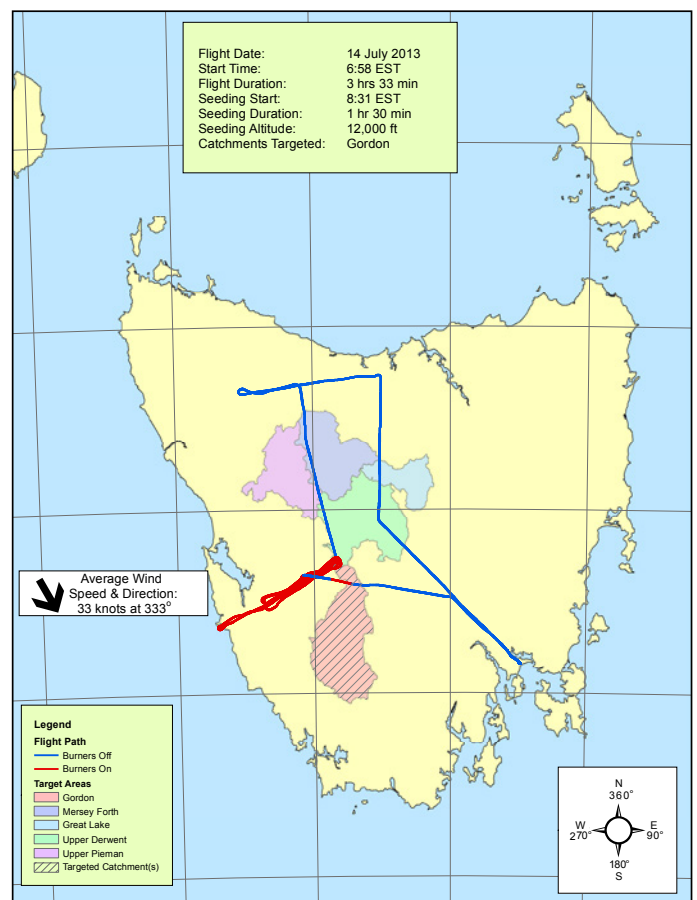
An independent review undertaken by CSIRO and by the Antarctic Cooperative Research Centre in 2002 showed cloud seeding does not cause any detectable increase in rainfall outside the identified target area, nor does it cause any measurable decrease in rainfall downwind of the target areas. The report can be found at:
www.hydro.com.au/water/cloud-seeding

Where does Hydro Tasmania fly during a cloud seeding flight?

Cloud seeding flights are conducted upwind of the target catchment. The wind carries the rain into the target catchment.

The map below shows the flight path for a cloud seeding flight targeting the Gordon catchment that took place in July 2013. The average wind direction was north westerly with a speed of 33 knots. The seeding track (shown in red) was approximately 17 nautical miles (or 32 km) upwind from the Gordon catchment target area. During the seeding there was a build-up of ice on the aircraft wings – the aircraft flew to the coast and descended to sea level so it could de-ice.

Conditions were also checked in the Mersey-Forth catchment but were not suitable for seeding (even though it was already raining).



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Where does Hydro Tasmania cloud seed?

Hydro Tasmania seeds over five target catchment areas:

- Upper Pieman (Lake Mackintosh)
- Mersey-Forth (Lakes Rowallan and Mackenzie)
- Great Lake
- Upper Derwent (Lakes St Clair, King William and Echo)
- Gordon (Lakes Gordon and Pedder).

The total area of the target catchments is more than 7500 km².



How often does Hydro Tasmania cloud seed?

The cloud seeding season runs from 1 May to 31 October each year – a period of 183 days. The number of days that cloud seeding occurs depends on how often favourable conditions are found.

The following table shows how often Hydro Tasmania has undertaken cloud seeding over each of the target catchments since 2010.

Catchments targeted	2010	2011	2012	2013
Great Lake	7	1	1	2
Upper Pieman	2	1	1	0
Mersey Forth	4	2	0	0
Gordon	17	12	14	9
Upper Derwent	7	6	3	3

On some flights two or more catchments may be targeted.

The following table provides information on the total number of days that Hydro Tasmania undertook cloud seeding in the years 2010 to 2012.

It also includes data from the Bureau of Meteorology website about the number of days that it rained at Mount Read (Upper Pieman target area), Strathgordon (Gordon target area) and Lake St Clair (Upper Derwent target area).

Year	Days cloud seeded	Number of days that it rained		
		Mount Read	Strathgordon	Lake St Clair
2010	26	158	169	145
2011	17	138	141	137
2012	16	137	163	149
2013	12	133	111	151

As the table shows, cloud seeding only occurs on a very small proportion of the total number of days each year when it rains during the cloud seeding season. On all of these occasions the Bureau of Meteorology had already forecast that it would rain.

Would you like to know more?

If you would like to know anything else about Hydro Tasmania's cloud seeding program or any other aspect of our business please visit our website (www.hydro.com.au) or email us at contactus@hydro.com.au