Glaciers of Aotearoa New Zealand

Kā Roimata o Hinehukatere/ Franz Josef Glacier in 2001, left, from Wikipedia, and 2020 by Esther Filbrun.

*Glaciers are massive ice formations that have shaped Earth's landscape and play a crucial role in our climate system. They are a component of the **cryosphere**, the snow- and ice-covered parts of the planet. By Mike Stone.*

Māori and glaciers

It is not known how far Māori ventured onto the upper reaches of glaciers, and some iwi did not climb the mountain peaks at all. They believed that this would be as if they were standing on the heads of their ancestors, and hence would be seen as an act of disrespect. However, Māori had several words for the snow and ice of high alpine areas – see Ngā Kupu below.

Ngāi Tahu tell a pūrākau of Fox and Franz Josef Glaciers. Hinehukatere, an extremely strong and fearless young woman, loved climbing in the mountains. She persuaded her lover, Wawe, to climb with her, although he had less alpine experience. An avalanche swept Wawe down the mountain to his death leaving Hinehukatere grief-stricken.

So Franz Josef glacier is known as Kā Roimata o Hinehukatere, the frozen tears of Hinehukatere. And Fox glacier is called Te Moeka o Wawe, the resting place of Wawe.

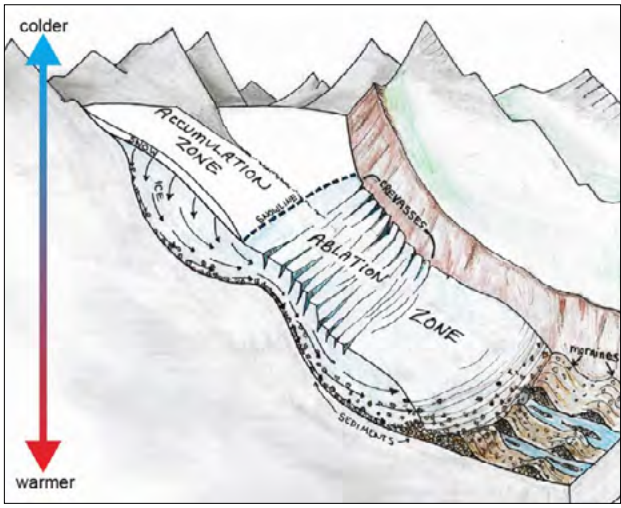
What is a glacier?

A glacier is a huge mass of ice that moves over land very slowly. Glaciers form as snow collects year after year in the same place and turns to ice. This process can take a long time, up to thousands of years.

As the snow builds up, the pressure compacts it, squeezing out most of the air bubbles and forming ice. This makes glacier ice much more dense than snow, but still less dense than water so it floats.

While snow accumulates at the top of the glacier, towards the bottom it **ablates** (loses mass) as ice melts, sublimes or breaks off. The glacier grows longer or retreats depending on the balance of accumulation and ablation.

When looking at a glacier it appears still, but over time it can be seen to move. This happens because the force of its own weight deforms the ice at the bottom, and the whole glacier gradually flows downhill, like a slow river of ice.

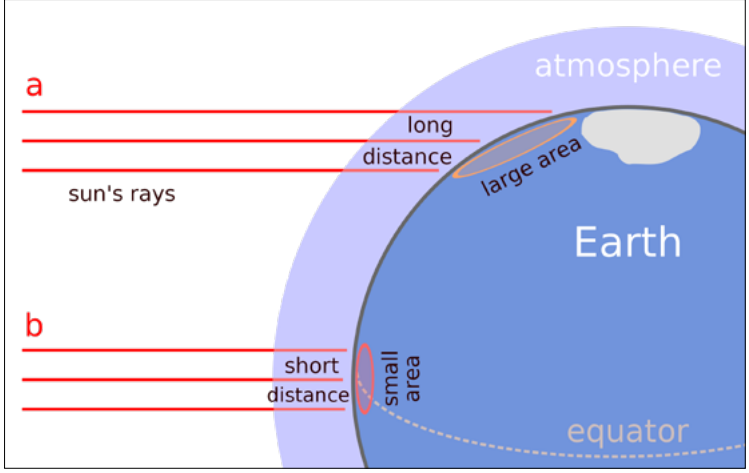


Parts of a typical alpine glacier; moraine is shown at bottom right. B. Jensen, CC BY-CC-SA.

Being in a **temperate** climate, our glaciers slide over a thin layer of water underneath. The speed of movement can vary – on the West Coast speeds of 7m/day have been recorded, but more usually those glaciers move at 0.5m/day.

There are two main types of glaciers, and they both move.

Alpine glaciers form high in the mountains on most continents and flow down through valleys. In Aotearoa we have about 3,000 alpine glaciers over 1 ha in size, most in Te Wai Pounamu/the South Island, as well as eight small ones on Ruapehu. Our biggest glaciers are Tasman (the longest), Fox, and Franz Josef (the steepest and fastest). Alpine glaciers form above the **snowline**, where the snow



Indirect sunlight at the poles spreads the sun's heat over a wider area, so the surface is cooler than at the equator, Wikipedia.

does not melt in summer – here it is cold due to its **elevation**.

Ice sheets cover more than 50,000 km^2 of land in a broad dome, and flow outwards. Earth's two ice sheets cover Greenland and Antarctica, and together they hold 68% of the earth's fresh water. The Antarctic ice sheet is much bigger, covering eight times the area of the Arctic sheet, carrying 10 times the volume and having a much greater impact on sea level rise if it were to melt completely (58 m compared to 7 m).

At places the ice sheet extends into **ice shelves** over sea, which slow the flow of ice into the ocean. Ice sheets form at the poles where it is cold, due to the very low angle of sunlight.

Erosion and Deposition

As a glacier moves, it picks up and carries rocks (some very large), eroding the surface below and leaving very distinctive landforms; eg, U-shaped glacial valleys, cirques, horns and kettles. The eroded material is deposited as **moraine** (piles of debris) mostly along the glacier's sides and at the end, and as outwash plains (deposits of silt, sand and gravel carried overland by meltwater streams).

In Aotearoa, glaciers also carried taonga from the Southern Alps into the gravel beds of rivers and streams – gold and pounamu.

Importance

Glaciers are a significant store of fresh water, their seasonal melt into rivers supporting irrigation of farmland and hydropower schemes, and acting as a buffer against drought. The Waitaki River supports eight hydroelectric power stations with water fed by several glaciers, including the Tasman as well as water from Tekapo, Pūkaki, and Ohau glacial lakes. Glacial meltwater cools stream water to temperatures needed by our trout and salmon populations.

The amount of fresh water frozen in glaciers has an impact on sea level. When more of earth's water was held as ice during the last ice age, the sea level dropped hundreds of meters.

Climate impact

Glaciers influence climate and are also affected by climate.

Ice has a high **albedo** (0.7), which means it reflects most of the incoming sunlight back to space, whereas water has a low albedo (0.06). This reflection can help reduce the global temperature. If the earth was covered in ice, it is estimated this would drop the average global temperature by 15°C to -40°C, whereas if the earth were covered by water the average temperature would increase to 27°C.

However, all over the world snowlines are rising and glaciers are retreating,

NZ 18,000 years ago, with extensive glaciation (dark blue). A lower sea level exposed the shallows of the continental shelf (green). Te Ara.

reducing their cooling effect on the climate. In Aotearoa, some small glaciers have vanished, while some large glaciers such as the Tasman have become shallower and others are in retreat.

It is estimated glaciers in the Southern Alps have lost almost 30% of their ice volume over the last 40 years. A recent study showed that 264 of our glaciers have melted away – and once glaciers disappear, they won't reform unless the climate gets much colder.

These changes in glaciers are seen as the 'canary in the mine'; ie, an early danger warning. Glaciers are ablating faster than they accumulate snow, because the air temperature is rising. The break-up of ice shelves and subsequent loss of ice sheet mass is due to a rise in sea temperature.

The earth is warming due to increasing levels of CO_2 and CH_4 greenhouse gases. The resultant loss of glaciers worldwide could have a major effect on sea levels – a serious risk to low-lying settlements such as many Pacific Islands, the city of Christchurch and even Franz Josef town.

With major impacts looming, it is important the alpine glaciers and ice sheets are monitored. Each year, New Zealand scientists survey the end-of-summer snowline from the air to determine how much of the previous winter snowpack has survived the summer melt.

Alpine glaciers are photographed from a plane to measure their perimeter, thickness and thermal properties; snow markers placed to show movement; and weather stations record precipitation. At the poles, scientists use satellite imagery to map the extent of the ice sheets and radar to measure their height.

2025 is the year of glacier preservation. We take steps to preserve glaciers when we take action to stop global warming – encouraging politicians to make the right decisions and doing our own bit to support less use of fossil fuels.

Ngāi Tahu, as kaitiaki to Kā Roimata o Hinehukatere/Franz Joseph, sees climate change as diminishing the mana of such a taonga; the tears of Hine Hukatere are now melting into the rivers. To stop contributing to these melting tears, the Ngāi Tahu Group has developed an 88-point Climate Plan aimed at protecting the environment and cutting its greenhouse gas emissions. The tribal vision is "mō tātou, ā, mō kā uri ā muri ake nei – for us and our children after us".

Ngā kupu

Huka	Frost, snow, cold
Hukapapa	The great snowfields
Hukapo	Glaciers
Moeka	Final resting place
Roimata	Tears
Taonga	Treasure, something precious
Waihuka	Snow water rushing from glacial sediment
Waiparahoaka	Glacial sediment
Whenuahuka	Permanent snows of the peaks.

Activities

1. Give a clear meaning for the 10 terms in bold – cryosphere, ablate, temperate, snowline, elevation, ice shelf, erosion, deposition, moraine, albedo

2. Explain the statement "The glacier grows or retreats depending on the balance of accumulation and ablation."

3. How are glaciers related to climate change?

4. What three things does the map tell you?

5. What three actions could you take to support reduction in fossil fuel use?

6. Find out more about glaciated landforms – features that tell us glaciers once covered the landscape.

7. Select one New Zealand glacier from the list here and find out more about it.

8. Try NIWA's pressure melting activity.

This article benefitted by critique from Ross Stephen (ESS teacher) and Mere Manning (Kahungunu ki te Wairoa). My thanks to you both.