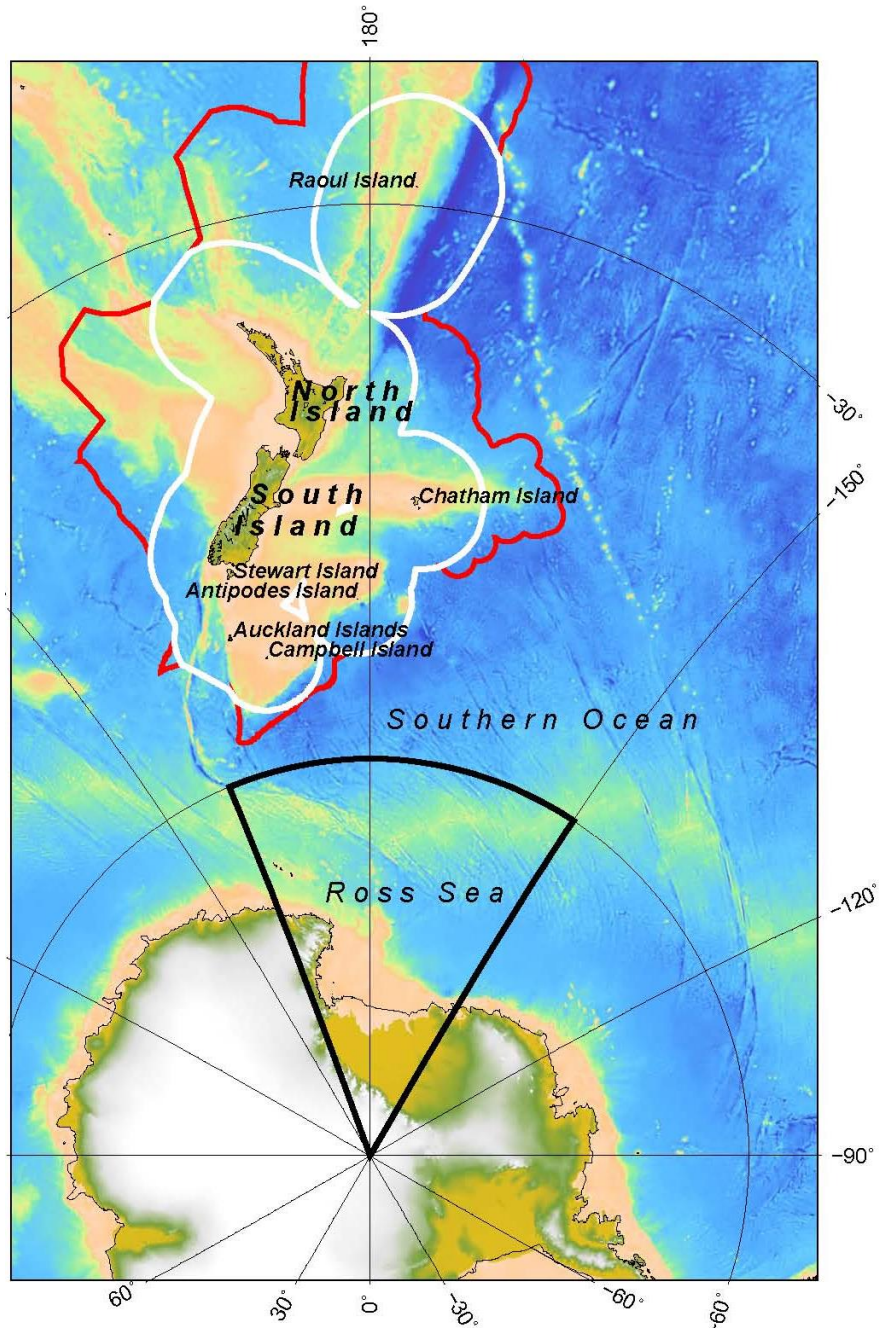
Aotearoa-New Zealand Ocean – *the meeting place of cultures, tectonic plates subtropical to polar oceans and climate systems*

The Meeting Place

The land of Aotearoa-New Zealand covers 268,831 square kilometres. By world standards, it is a small nation. But that modest physical presence belies a much larger underwater realm. Under international law, the nation has sovereignty over the ocean and seabed within the Exclusive Economic Zone (EEZ), which extends 200 nautical miles (370 kilometres) from shore. That zone is dominated by the submarine continent of *Te Riu-a-Māui Zealandia*, formerly part of the ancient super-continent of *Gondwana.* Where Zealandia extends beyond the EEZ, in a region termed the Extended Continental Shelf (ECS), the nation has sovereignty over resources on and under the seabed. Thus Aotearoa-New Zealand has jurisdiction over 5,857,092 million square kilometres of the Southwest Pacific Ocean, which is nearly 22 times larger than the land area. We are truly a maritime nation.

What the Numbers Reveal	
Aotearoa-New Zealand (land)	268,831 km^2
Exclusive Economic Zone (includes Territorial Sea)*	4,105,393 km^2
Extended continental shelf*	1,751,699 km^2
Total area of marine jurisdiction*	5,857,092 km^2
NZ marine area is equivalent to 7th largest land nation ranking between Australia and India.	Australia (7,692,024 km^2) **§** India (3,287,263 km^2) **§**
Antarctic Treaty System (NZ Claim to Ross Dependency)	450,000 km^2
***Data from Stagpoole 2013 and GNS Science. **§** Data from United Nations Statistics Division	

However, the nation's influence does not stop in the mid latitudes and continues deep into the Southern Ocean. There it has a claim but not sovereignty over ~450,000 square kilometres of ocean, ice and land that extend to the South Pole. This is the Ross Dependency and it is regulated under the Antarctic Treaty System which focusses on international scientific research and cooperation.

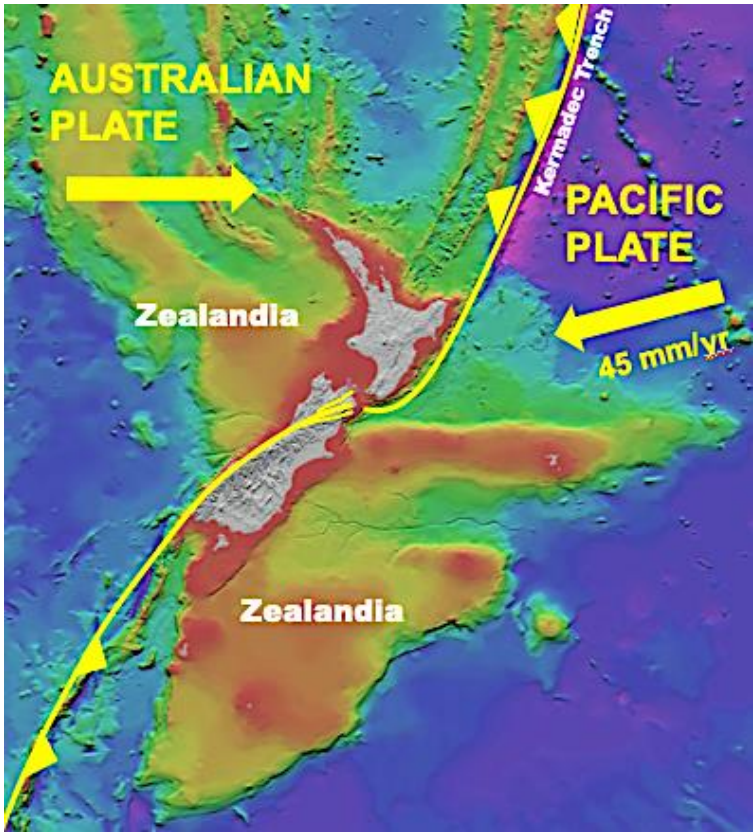


Legal boundaries for Aotearoa-New Zealand (i) White = Exclusive Economic Zone (ii) Red = Extension of the Legal Continental Shelf that extends sovereignty to cover 5.2 million square kilometres but this applies only to the seabed and (iii) Black outlines the New Zealand's claim under the Antarctic Treaty System. Image by S. Henrys GNS Science.

Because of its size and location, our ocean extends from subtropical to polar climes, intercepts ocean currents of global importance and traverses a boundary between converging tectonic plates. As such, marine New Zealand is remarkable natural laboratory. Knowledge of how ocean, climate and geology function and interact is essential to our well-being and economy.

Where Tectonic Plates Converge

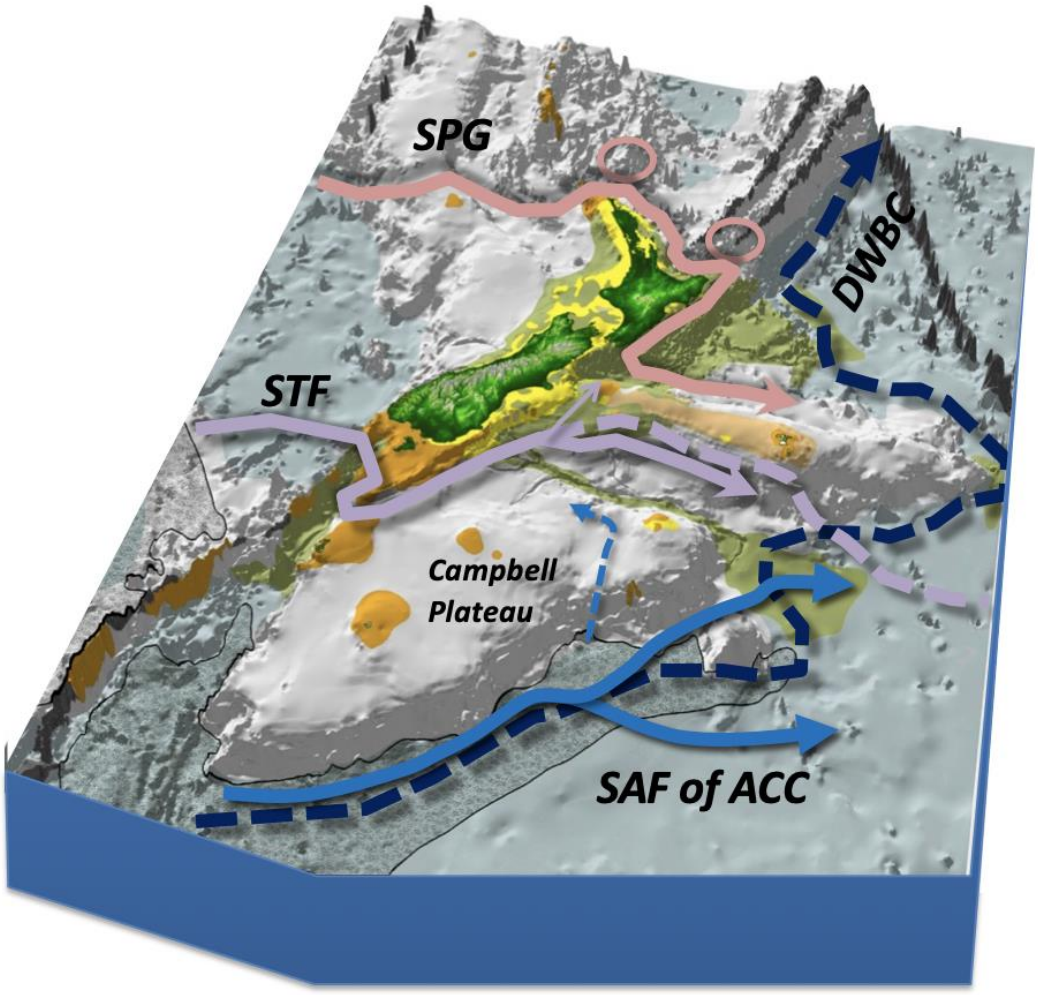
About 23 million years ago, tectonic plates in the south west Pacific Ocean, began to move. Today, the boundary between the converging Pacific and Australian plates slices through the land and the south west Pacific Ocean. Onshore that collision forms the actively rising Southern Alps whereas offshore one plate has buckled beneath the other to form ocean trenches such as the 10,000 metre deep Kermadec Trench. As the buckled plate descends deep into Earth's interior, rising temperatures melt rocks to feed terrestrial and submarine volcanoes. Plate collision creates tremendous strain in the crust that is periodically released as earthquakes. Such shocks further modify the seacape through landslides and dense mud-laden flows that scour and deposit sediment over 100's kilometres of ocean floor. This ongoing activity, supplemented by ocean currents and storms, has created a remarkable seascape that rivals or exceeds any onshore topography. For example, the Waikato River is New Zealand's longest at 425 kilometres whereas Hikurangi Channel off the eastern North Island is about 1500 kilometres long.



The submarine continent of Zealandia, (yellow-orange regions) crowned by terrestrial New Zealand (grey) and sheared by the boundary between the actively mobile Pacific and Australian plates (yellow line). Image L. Carter and NIWA

The meeting of Polar and Subtropical Ocean Currents

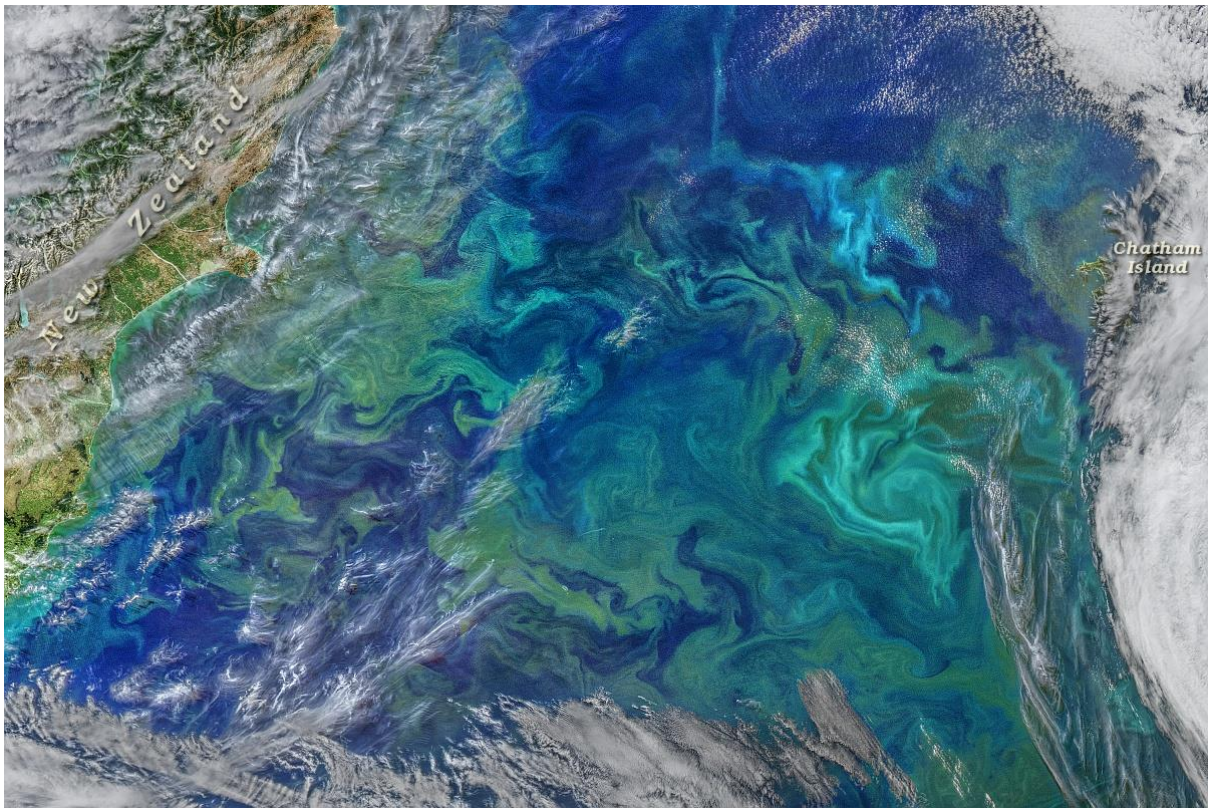
Aotearoa popularly translates as “land of the long white cloud” - an apt descriptor as the cloudiness of New Zealand is in part due to the merging of warm and cold waters. Southern Zealandia projects into the *Antarctic Circumpolar Current* (ACC) *,* bringing cold polar waters to the EEZ. Driven by powerful westerly winds, the ACC flows 24,000 kilometres, clockwise around Antarctica making it the longest, largest current and the only one to connect the major oceans. It dominates the Southern Ocean and is a major influence on the global distribution of heat, gases and nutrients. It thus plays a vital role in softening the impacts of modern climate change by taking up ~ 43% of carbon dioxide and 75% of heat generated by human activities.



The meeting of subpolar waters introduced by the Antarctic Circumpolar Current (ACC -Blue) and subtropical waters transported by the South Pacific Gyre (SPG – pink). These complex flows are separated by the Subtropical Front (STF – purple). The pathways of these currents are controlled by winds and seabed topography. Image L. Carter and NIWA.

Where Subtropical and Subantarctic ocean waters mix

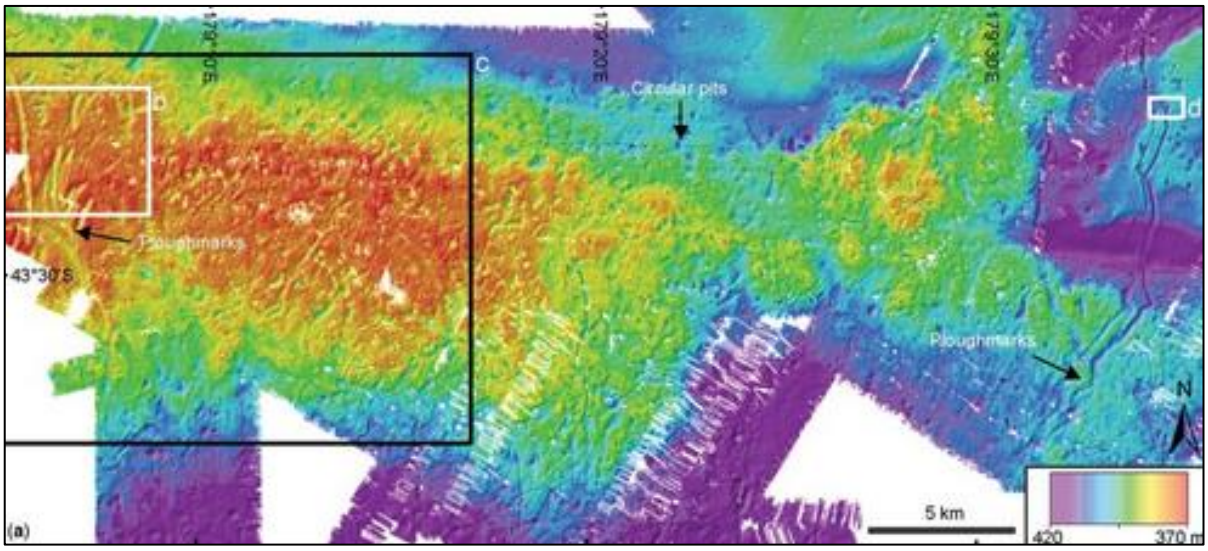
The Chatham Rise is a banquet hall for *phytoplankton* – plant plankton that underpin the marine food chain. Subantarctic waters are enriched in nutrients such as nitrate, phosphate and silicate that are essential for phytoplankton growth. However, subantarctic waters are low in the iron needed for plants to photosynthesise and grow. Fortunately, that deficiency is rectified by iron supplied by subtropical waters. During late spring and early autumn the ocean over the Chatham Rise is turned into a rich plankton soup that is clearly observed from space.



The ocean surface along the crest of Chatham Rise between the South Island (left) and Chatham Island (right) as viewed by Aqua Modis satellite imagery collected on 4 March 2020. The intricate, swirly patches of blues and greens are plankton blooms taking advantage of the mixing of subtropical and subantarctic waters.

The focussing of natural phenomena is dramatically shown by the passage of icebergs that periodically reach Aotearoa-New Zealand waters via the Antarctic Circumpolar Current. Icebergs may arrive any time – the last significant arrival occurring off Dunedin in 2006. Once in our waters, currents guide icebergs to Chatham Rise. If large enough, they can ground on the 300-500m deep Rise crest. There, polar icebergs meet subtropical water

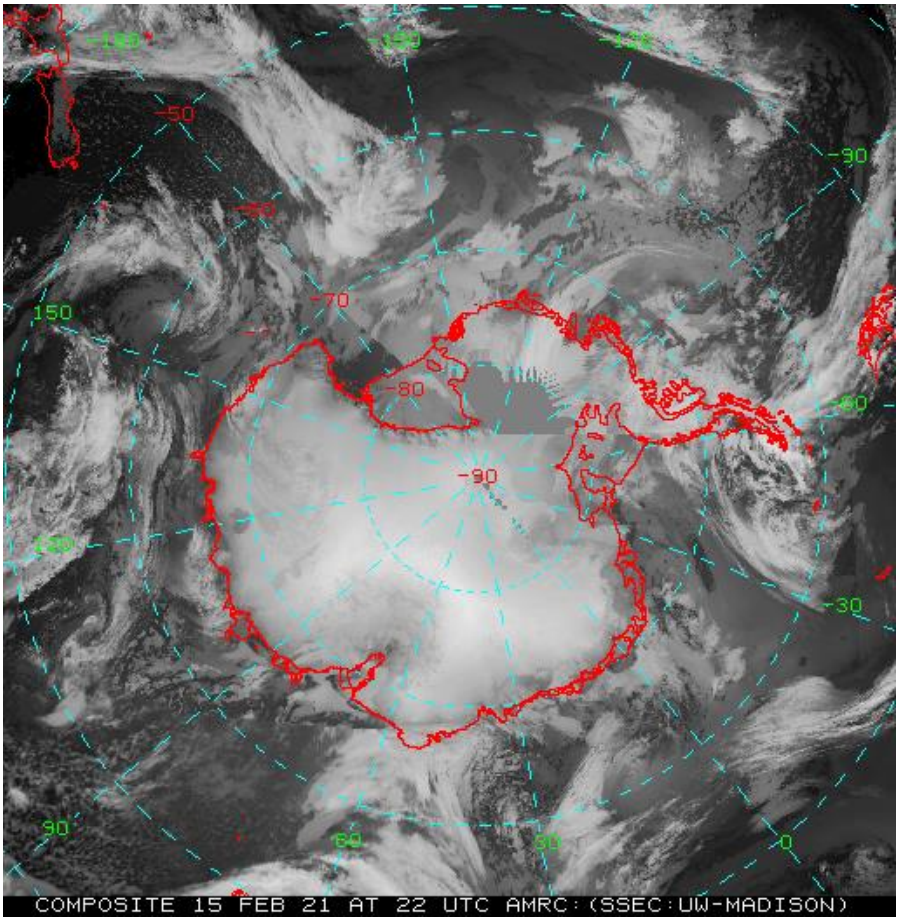
causing them to melt and deposit any debris entrapped in the ice. Unsurprisingly, Chatham Rise is littered with rocks of Antarctic origin.



A sonar image of the seabed revealing the scoured channels and pits formed by Antarctic icebergs grounding on the crest of Chatham Rise in water depths of 370 to 420 metres water depth.

Tropical to Polar Weather and Climate.

Weather affecting offshore Aotearoa New Zealand is dominated by the passage of anticyclones driven by the powerful westerly winds of the *Roaring Forties* and *Furious Fifties.* Separating the anticyclones are low pressure troughs that commonly herald strong winds and rain. The location and intensity of these weather systems vary with the seasons and longer term climatic influences. Of particular note are the 3-7 year El Niño – La Niña cycles that arise for the tropical Pacific Ocean and the circum-polar Southern Annular Mode. The interaction between these and other climatic factors including human-influenced climate change have produced a complex and highly variable response in the atmosphere and ocean. Even so, significant trends are evident. The westerly wind belt has contracted south in the face of expanding subtropical winds. This has allowed wind-driven warm ocean currents to also extend further south to affect environmental change. Off Tasmania, for example, warm currents of the South Pacific Gyre, have extended 350km south since the 1940s to replace subantarctic ecosystems with subtropical counterparts.



Weather in the Southern Ocean with a clockwise procession of cloud covered low pressure troughs punctuated by relatively clearer weather of anticyclones.