CIVIL AVIATION AUTHORITY
OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

CAA OCCURRENCE 22/4516

Cessna 182H Skylane

ZK-MGB

Collision with terrain

McCoy Glacier, Froude Range, Southern Alps

04 August 2022

ZK-MGB. Source: David Paull (nzcivair.blogspot.com)

Foreword

New Zealand's legislative mandate to investigate an accident or incident is prescribed in the Transport Accident Investigation Commission Act 1990 (the TAIC Act) and the Civil Aviation Act 1990 (the CA Act).

Following notification of an accident or incident, TAIC may open an inquiry. CAA may also investigate subject to Section 72B(2)(d) of the CA Act which prescribes the following:

> ***72B Functions of Authority***
>
> *(2) The Authority has the following functions:*
>
> *(d) To investigate and review civil aviation accidents and incidents in its capacity as the responsible safety and security authority, subject to the limitations set out in section 14(3) of the Transport Accident Investigation Commission Act 1990*

A CAA safety investigation sets out to determine the circumstances and identify contributory factors of an accident or incident. The purpose of this is to minimise or reduce the risk to an acceptable level of a similar occurrence arising in the future. The safety investigation does not seek to ascribe responsibility to any person but to establish the contributory factors of the accident or incident based on the balance of probability.

A CAA safety investigation seeks to provide the Director of Civil Aviation with the information required to assess which, if any, risk-based intervention tools may be required to attain CAA safety objectives.

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Glossary of abbreviations:

app	application
ADS-B	Automatic Dependent Surveillance–Broadcast
CAA	Civil Aviation Authority
CAR	civil aviation rule(s)
ELT	Emergency locator transmitter
ft	feet
GAP	Good Aviation Practice
GRAFOR	Graphical Aviation Forecast
km	kilometre(s)
kt	knots
NW	north-west
NZFJ	Franz Josef aerodrome
NZMC	Mount Cook aerodrome
NZRT	Rangiora aerodrome
NZST	New Zealand Standard Time
RCCNZ	Rescue Coordination Centre of New Zealand
SAR	Search and rescue
SIGWX	significant weather (chart)
TAF	Terminal Aerodrome Forecast/s

Data summary

Aircraft type, serial number, and registration:	Cessna 182H Skylane, s/n 18256545, ZK-MGB
Number and type of engines:	One, Continental O-470-R
Year of manufacture:	1965
Date and time of accident:	4 August 2022, 0858 hours[1]
Location:	McCoy Glacier, Froude Range Latitude[2]: S 43° 19.2' Longitude: E 170° 48.3'
Type of flight:	Private
Persons on board:	Crew: 1
Injuries:	Crew: 1 (fatal)
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence	Private pilot licence (Aeroplane)
Pilot-in-command's total flying experience:	288 hours (approximately) 71 hours on type (approximately)
Investigator in Charge:	L M Child

[1] All times in this report are NZST (UTC + 12 hours) unless otherwise specified.
[2] WGS-84 coordinates.

Executive summary

At 1143 on Thursday 4 August 2022 the Rescue Coordination Centre of New Zealand (RCCNZ) notified the Civil Aviation Authority (CAA) that Cessna 182H Skylane, ZK-MGB was reported missing with one person on board. At 1616 the wreckage of ZK-MGB was located below Mt Nicholson on the McCoy Glacier. Due to inclement weather and alpine hazards, search and rescue (SAR) personnel were restricted to flying over the site and could not recover the pilot. SAR personnel assessed the accident as being "unsurvivable".

The private pilot was flying his aircraft, ZK-MGB, from Franz Josef aerodrome (NZFJ) to Rangiora aerodrome (NZRT) to collect two associates and fly them back to Franz Josef.

The collision with terrain followed what appeared to be a decision by the pilot to turn back to his departure aerodrome. When flying east of Mt Nicholson, ZK-MGB likely encountered an area of very strong downdraughts resulting in a high rate of descent. These downdraughts either exceeded its climb performance and/or possibly forced it into the cloud layer. For either scenario the pilot was unable to avoid terrain.

Due to adverse weather and ongoing hazardous conditions, only a few items were recovered from the accident site. The wreckage remains on site.

Following this and previous weather-related accidents, the CAA will publish an article in the *Vector* safety magazine about pilot understanding and planning for forecast en route weather.

Pilots are recommended to complete a mountain flying training course if they frequently fly in mountainous terrain. This course provides additional knowledge and skills to help pilots operate safely in these challenging environments.

1. Factual information

1.1 History of the flight

1.1.1 On Thursday 04 August 2022, the pilot prepared his aircraft, ZK-MGB, for a flight from Franz Josef aerodrome in the West Coast Region (West Coast)[3] of the South Island to Rangiora aerodrome on the east coast.

1.1.2 The purpose of the flight was to collect two associates from Rangiora aerodrome and fly them back to Franz Josef aerodrome.

1.1.3 The pilot had pre-arranged this flight with his associates and informed them it was "weather dependent". If the weather was not suitable, the alternative plan was for the associates to drive to Franz Josef.

1.1.4 The pilot discussed the flight and likely weather conditions with a friend (a local commercial pilot) the previous day. The friend noted the Windy[4] application (app) was "all purple", indicating that strong winds of 35 to 45 knots (kt) were expected, and recommended the pilot not to go. The pilot stated, "Forecasts are not always accurate" and he would "check again in the morning".

1.1.5 The next morning the pilot advised the friend that he was going ahead with the flight. The friend had not reviewed the forecast at that point but reiterated their concern that the weather conditions were not ideal and likely to worsen. The pilot stated, "I'll go and have a look and I'll turn around if I don't like it".

1.1.6 The evening before, the pilot sent a text message to an experienced pilot based in Rangiora advising of his intentions and that "windy[5] says 40 knots at 10k". However, the text was not seen by the (Rangiora) pilot until 0550 on 04 August. They replied with a short text advising "ridge pushing in" and "talk soon".

1.1.7 The (Rangiora) pilot had appointments that morning and could not review or discuss the forecasts in detail with the (ZK-MGB) pilot. However, at 0800, they were able to text the pilot a screenshot of the latest Graphical Aviation Forecast (GRAFOR) from

[3] NZ Gazetteer identifies the South Island's West Coast Region as a defined region, whereas the east coast is not.
[4] Windy.com is a weather forecasting programme created for water and wind sports. The pilot was reported to use this app to review weather forecasts.
[5] The pilot was likely referring to the Windy app. "10k" likely referred to 10,000 ft.

MetFlight[6] and advised him to "check MetFlight". The pilot replied, "Thanks high overcast here with blue patches will leave about 8.45 will turn back if not happy". The (Rangiora) pilot had no further contact with the pilot.

1.1.8 As the Windy app does not save user login data, the investigation could not confirm what information the pilot accessed. However, the pilot's wife reported he re-checked the app on the morning of this flight and that he had contacted the Rangiora pilot. She also expressed concern about the weather and told the pilot not to feel pressured to go. He said that, "If [I'm] not happy with the weather [I] will turn around".

1.1.9 Family and pilot friends reported the pilot had discussed the issue of "Get-there-itis" and that he "was quite aware of this trap".

1.1.10 These people also reported that he was known to be very cautious about flying near cloud, even as a passenger.

1.1.11 The pilot arrived at Franz Josef aerodrome soon after 0800. Automatic Dependent Surveillance–Broadcast[7] (ADS-B) track data showed the ZK-MGB departed at 0840. Several people heard it depart and noted nothing unusual.

1.1.12 Shortly after, a local commercial pilot shared a brief radio exchange with the pilot. They noted the cloud cover and that the weather was forecast to worsen which the pilot acknowledged. The commercial pilot recalled the wind was about 40 kts at Mt Cook and forecast to increase. They also stated that, had they known ZK-MGB was headed for Rangiora, they "…would have advised him not to, knowing what the weather pattern is like and capable of".

1.1.13 Shortly after, a pilot in Whataroa, 12 nautical miles north of Franz Josef, reported hearing an aircraft (presumed to be ZK-MGB) fly overhead and noted nothing unusual.

[6] MetFlight GA is a web-based aviation weather briefing system intended primarily for general aviation pilots in New Zealand, provided by MetService.

[7] Automatic Dependent Surveillance–Broadcast (ADS-B) is an aircraft surveillance system. Aircraft receive accurate and precise location data from a satellite constellation and then broadcast this information through a transponder.

1.1.14 No further radio transmissions from the accident pilot or sightings of ZK-MGB were reported.

1.1.15 The pilot's friend followed ZK-MGB's ADS-B track on a commercial flight tracking application. The track disappeared from the application in the vicinity of Mt Nicholson which was reported as "not unusual".[8] By 0956, when the track had not reappeared, the friend texted the pilot and then rang him, with no reply.

1.1.16 Around the same time, the pilot's associates raised their concerns as the pilot had not arrived at Rangiora aerodrome as expected. Various people then tried to locate the pilot and ZK-MGB, via the flight tracking application, by contacting Airways[9] and people based at aerodromes he may have diverted to.

1.1.17 One of these people alerted the RCCNZ at 1154, who initiated a search and rescue based on the last known ADS-B point. ZK-MGB's emergency locator transmitter (ELT) had activated but was not transmitting global positioning system data, most likely due to damage to its antenna in the accident sequence.

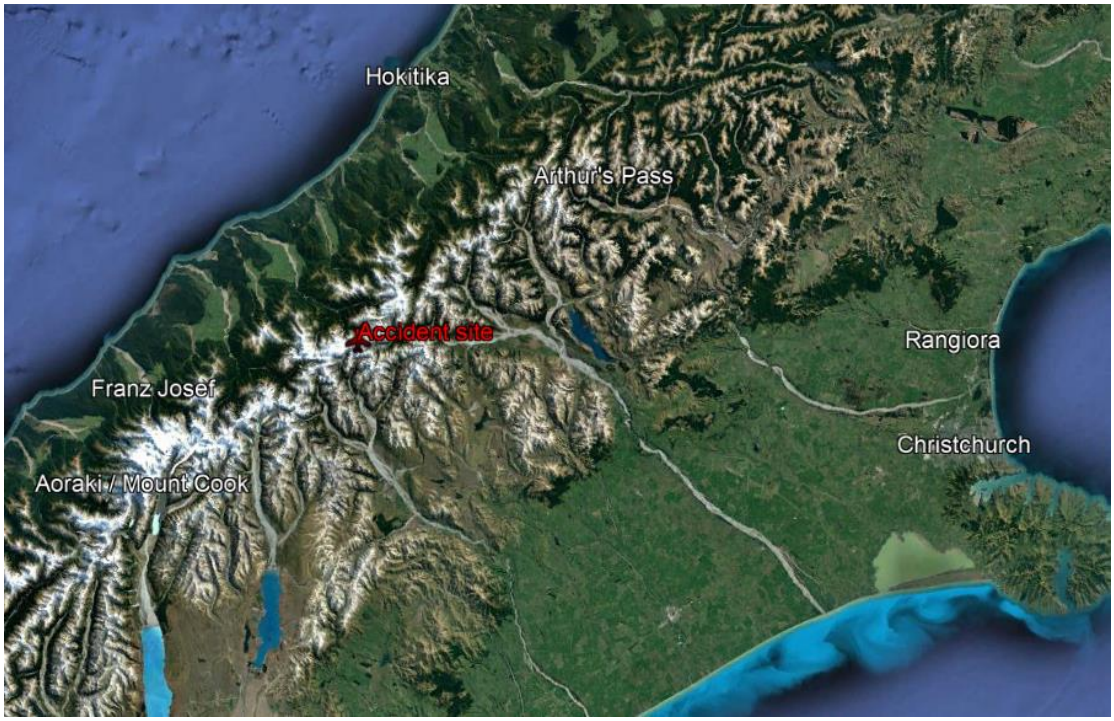

Figure 1: Map of accident area (for illustrative purposes). Source: Google Earth™.

1.1.18 Helicopters were tasked from the west and east coasts. The West Coast SAR pilots were not able to access the site due to low cloud.

[8] ADS-B track returns are often broken over mountainous terrain.

[9] Airways New Zealand is New Zealand's designated air traffic service provider.

1.1.19 At 1616, east coast SAR personnel detected a weak ELT signal and found the wreckage of ZK-MGB on a steep slope underneath an ice shelf on the McCoy Glacier. SAR personnel were unable to locate the pilot and assessed that, "It was an unsurvivable accident based on the wreckage; [and] the conditions were too dangerous to winch [a paramedic] or land."

1.1.20 Due to ongoing adverse weather conditions, it was 11 August before another SAR flight was possible. The wreckage was buried by snow with only one, small, unidentifiable piece visible.

1.1.21 Further recovery efforts were postponed until the summer thaw.

1.1.22 On 04 March 2023, the police were provided with photographs showing snow had melted and more of ZK-MGB was uncovered.

1.1.23 On 04 April 2023, the police conducted a final, partially successful recovery operation which included two small pieces of wreckage. Larger scale recovery was determined not possible due to challenges and hazards associated with the alpine environment.

1.1.24 The accident occurred at 0858, below Mt Nicholson, 27.5 nautical miles north-east of Franz Josef aerodrome at an elevation of 6107 ft. Latitude S 43° 19.2', longitude E 170 48.3'.

1.2 Injuries to persons

Injuries	*Crew*
Fatal	1

Table 1: Injuries to persons.

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Other damage

1.4.1 Nil.

1.5 Personnel information

Flying hours	All types	Relevant type
Last 24 hours	0	0
Last 7 days	0	0
Last 30 days	3.33	3.33
Last 90 days	13	13
Total hours aeroplane	215 (approximately)	74 (approximately)
Total hours helicopter	73	N/A

Table 2: Pilot flight hours.[10]

1.5.1 The pilot commenced helicopter flight training in August 1988 and gained his helicopter private pilot licence in November 1989. His last recorded helicopter flight was in May 1990, by which time he had accrued 73 hours.

1.5.2 In May 2017, the pilot commenced aeroplane flight training in his own aircraft, a PA28-200 Piper Arrow with a local B Category instructor.

1.5.3 His flight training was conducted principally on the West Coast. He completed nine hours of cross-country training and six hours of mountain flying, including flights across to the east coast above several of the alpine passes.

1.5.4 The pilot gained his PPL (Aeroplane) in September 2020.

1.5.5 A month later, the pilot purchased a Maule M5 to replace the Piper Arrow. He completed a type rating and flew 51 hours in that aircraft.

1.5.6 He replaced the Maule with ZK-MGB in July 2021.

1.5.7 His flight time in ZK-MGB was estimated to be 74 hours, which corresponded to a recent comment to a friend, "I have about 70 hours in it [ZK-MGB] now".

1.5.8 The pilot had not completed a mountain flying course and was not required to. However, his instructor stated the pilot appeared confident in the mountains and "would be more experienced in that terrain than the average PPL with similar flight hours". The instructor said he believed the pilot understood the challenges of flying in high winds in mountainous terrain.

[10] Hours estimated based on ADS-B records as the pilot's current pilot logbook was not located, presumed to be in ZK-MGB.

1.6 Aircraft information

1.6.1 ZK-MGB was a Cessna 182H Skylane, s/n 18256545 manufactured in the United States in 1965. The aeroplane was first registered in New Zealand on 29 October 2002 and issued with a non-terminating Certificate of Airworthiness.

1.6.2 The Cessna 182H Skylane is a single engine, high-wing monoplane of all metal construction and fixed tricycle undercarriage. ZK-MGB was powered by a Continental O-470-R piston engine, driving a Hartzell PHC-G3YF-IRF propeller.

1.6.3 At the time of the accident, the total time in service of the aeroplane was estimated to be 6199.92 hours[11].

1.6.4 The last maintenance activity as recorded in the aircraft logbooks was a 50-hour inspection dated 17 January 2022. A review of airworthiness was performed on 23 June 2021.

1.6.5 The next scheduled maintenance was an annual/100-hour inspection, due on 22 June 2022 or at 6,217.4 hours total time.

1.6.6 The pilot's maintenance provider is located on the east coast of the South Island. They stated the pilot contacted them about scheduling the 100-hour inspection. This would take place when suitable weather conditions existed to fly ZK-MGB across the Southern Alps to the maintenance base.

1.6.7 As the due date for this inspection had been exceeded by 43 days, ZK-MGB was operated in breach of Civil Aviation Rule 91.605 at the time of the accident. However, this was not a contributory factor in the accident.

1.6.8 Fuel remaining on board was calculated[12] to be between 40 and 60 gallons at the time of the accident. Therefore, fuel exhaustion was considered not to be a likely contributing factor.

1.6.9 The fuel supply at Franz Josef aerodrome was tested for contamination shortly after the accident, with no contamination detected.

[11] Some hours were calculated based on historic ADS-B data.

[12] Calculations were based on likely fuel remaining from ZK-MGB's previous flight, the last fuel uplift and estimated fuel burn for the 20 minute flight.

1.6.10 ZK-MGB was calculated to be within weight and balance limitations for both 'fuel remaining' scenarios.

1.6.11 Family and aviation friends stated the pilot had not expressed any concerns with ZK-MGB's reliability and he was reported to do thorough preflight inspections.

1.6.12 After take-off, ZK-MGB climbed steadily and maintained level flight. This would not be possible if there were significant engine issues. The pilot had successfully dealt with in-flight technical problems (including engine power loss) previously. If he had detected any issues with ZK-MGB it's likely he would have turned back earlier rather than flying towards an area of higher terrain.

1.6.13 Therefore, mechanical issues were considered unlikely contributory factors.

1.7 Meteorological information

1.7.1 **Analysed and forecast conditions:**

MetService New Zealand was contracted by the CAA to provide information on:

- the forecast conditions for the flight,
- the aviation forecasts available to the pilot,
- the actual conditions on the day, and
- detailed analysis of the likely conditions at the accident site.

Key information from their report is summarised in this section, with additional detail in Appendices 1 and 2 of this report.

1.7.2 A high-pressure system covered the North Island with a weak front over Fiordland. A strengthening north-westerly (NW) flow covered the central South Island, with increasing cloud about and west of the Southern Alps. There was high cloud over the Canterbury plains and east coast.

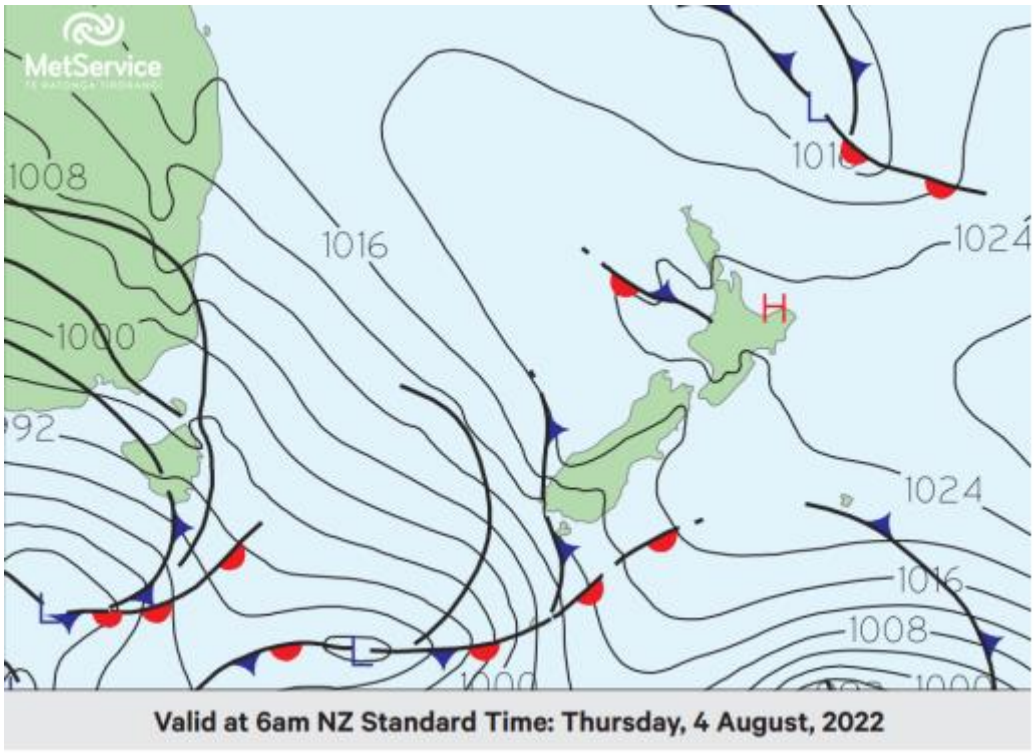

Figure 2: Mean sea level analysis chart (weather map) valid at 0600 NZST. Source: MetService.

1.7.3 Aviation forecasts[13] available for the intended route and relevant time period, predicted the following conditions:

- Moderate turbulence to above 10,000 feet (ft), as indicated on the Graphical NZ Significant Weather (SIGWX) chart. There was no SIGMET in force for severe turbulence.
- The Graphical Aviation Forecast (GRAFOR) valid for 0600 forecasted scattered cloud with bases of 2,000 ft and tops of 8,000 ft west of the Southern Alps. This cloud was expected to increase, with the GRAFOR valid for 1200, forecasting broken cloud with bases lowering to 1,500 ft at times and tops increasing to above 10,000 ft.

  No significant cloud or weather was forecast east of the Southern Alps.
- The Aviation Area Winds (AAW) forecast for the AL (alps) area forecasted a NW wind of 40 kt at 7,000 ft which is the approximate height of the main divide of the Southern Alps.

[13] Refer to Appendix 1 for more detail.

- The nearest available aerodrome forecasts (TAF) for the intended route were NZHK (Hokitika), NZMC[14] (Mt Cook) and NZCH (Christchurch). These forecasts reflected those forecasts described above. Of note, the TAF NZMC predicted the NW wind to increase to 22 kt gusting 40 kt from 0800. The associated Meteorological Aerodrome Reports (METAR) at 0800 and 0830 were consistent with the forecast conditions.

1.7.4 MetService stated that the pilot was registered for MetFlight[15] but the logs showed that no meteorological data was ever accessed through this account. It was possible for the pilot to access MetFlight using another account or via the Airways Internet Flight Information Service (IFIS).

1.7.5 Family and friends reported the pilot tended to use the Windy app to access weather forecasts. He referred to Windy in his text to the instructor the night prior.

1.7.6 **Actual conditions at the time of the flight:**

Icing

Moderate icing was forecast for the flight above 6,000 ft west of the Southern Alps and above 8,000 ft east of the Southern Alps. A local pilot reported encountering freezing rain at 1035 on the day of the accident and that his aircraft picked up ice flying below the cloud layer at 5,000 ft.

ZK-MGB had flown through a gap in the cloud layer and maintained a steady climb, so it is unlikely it had picked up airframe or icing. The environmental conditions in cruise flight were not conducive for carburettor or airframe icing.

Cloud and visibility

The main cloud layer west of the Southern Alps likely had bases of around 6,000 ft and tops of between 6,500 and 7,000 ft. There were some breaks in the cloud, and the flight path, combined with satellite imagery, suggests the pilot used one of these gaps to climb above the layer. Refer to Figures 3 and 4.

[14] NZMC is in the Southern Alps just east of the main divide and approximately 74 km south-west of the accident site.

[15] MetService provides aviation forecasts on the MetFlight website (http://metflight.metra.co.nz).

Figure 3: NZHK webcam image, 04 August 2022 looking north-west. Source: MetService.

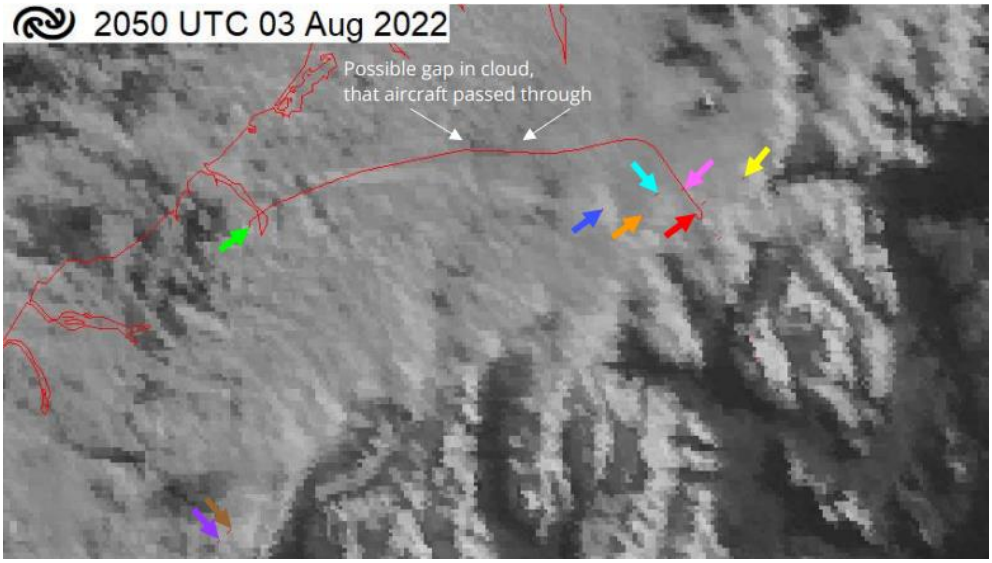

Figure 4: The visible satellite image, 0859 04 August. NZFJ is marked by the green arrow. Flight path and coastline in red. Mountain peaks identified by arrows: Mt Farrar (blue), Mt Nicholson (red), Mt Ramsay (yellow), Newton peak (orange), Mt Lambert (turquoise), Mt Stoddart (pink), The Footstool (brown) and Mt Sefton (purple). Source: MetService.

It's likely the cloud was forced up and over the main divide of the Southern Alps, in the strong NW flow. Some higher peaks may have been visible above the cloud layer or through a thin veil of cloud. The cloud tops may have been lower where the main divide is lower, including at the accident site. The cloud then evaporated as it descended into the eastern valleys. Refer to Figure 5.

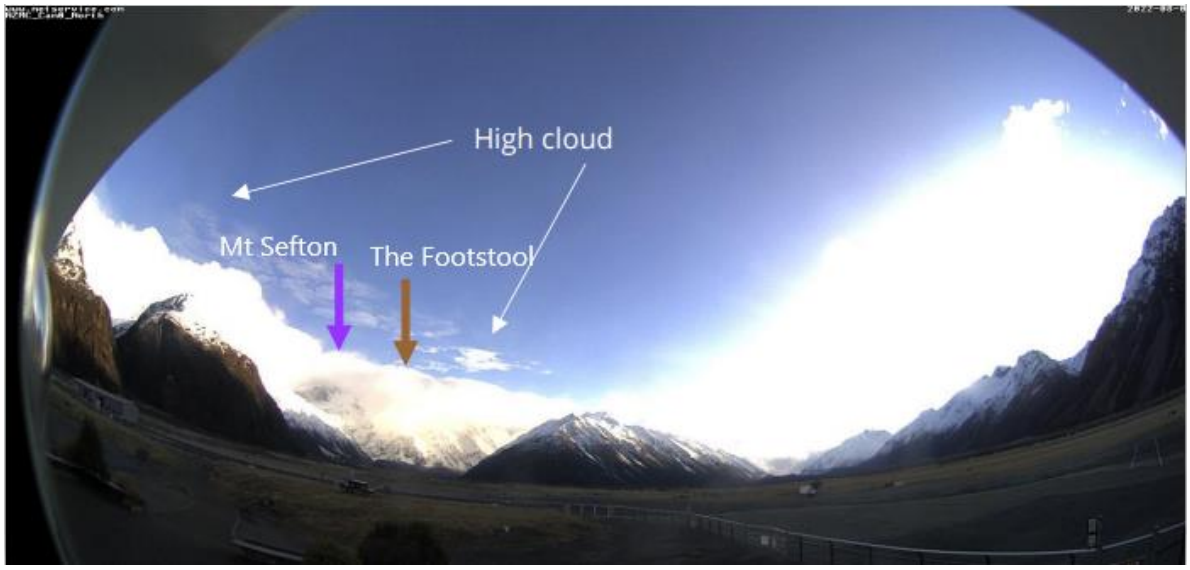

Figure 5: NZMC webcam image looking north, 0840, 04 August 2022. Source: MetService.

Wind and turbulence

The winds were light when ZK-MGB departed Franz Josef aerodrome and it was unlikely the pilot encountered any significant turbulence west of the Southern Alps. The wind speed increased significantly through the temperature inversion (5,900-7,800 ft) with a NW of around 40 kt predicted at 7,000 ft

Wind speed and direction changed, and turbulence increased crossing the main divide. In summary:

- Wind from the NW at 30 to 35 kt with significant gusts and moderate mechanical turbulence[16]
- In the upper region of the Lyell Glacier the NW flow likely descended into the valley to the east-north-east, resulting in westerly winds. In addition to moderate turbulence, there would have been some downward motion within the flow.

  ZK-MGB appears to turn back at this point.
- As ZK-MGB flew around the southern side of Mt Nicholson it would have encountered turbulent 30 to 35 kt northerly winds, flowing over the ridge and rapidly descending the McCoy Glacier and valley to the south.

[16] Mechanical turbulence is generated by the interaction of the wind flow with obstacles such as the mountains. It may appear as local eddies, in the lee of obstructions, similar to the effects of a rock in a stream, or as rapid unpredictable variations in wind speed over a wide area. MetService report "Weather Conditions Mt Nicholson, 4 August 2022", p18.

- ZK-MGB likely encountered significant downdraughts, even at altitudes higher than Mt Nicholson. These would have become stronger as ZK-MGB dropped below the ridgeline of Mt Nicholson and the Froude Range. Refer to Figure 6.

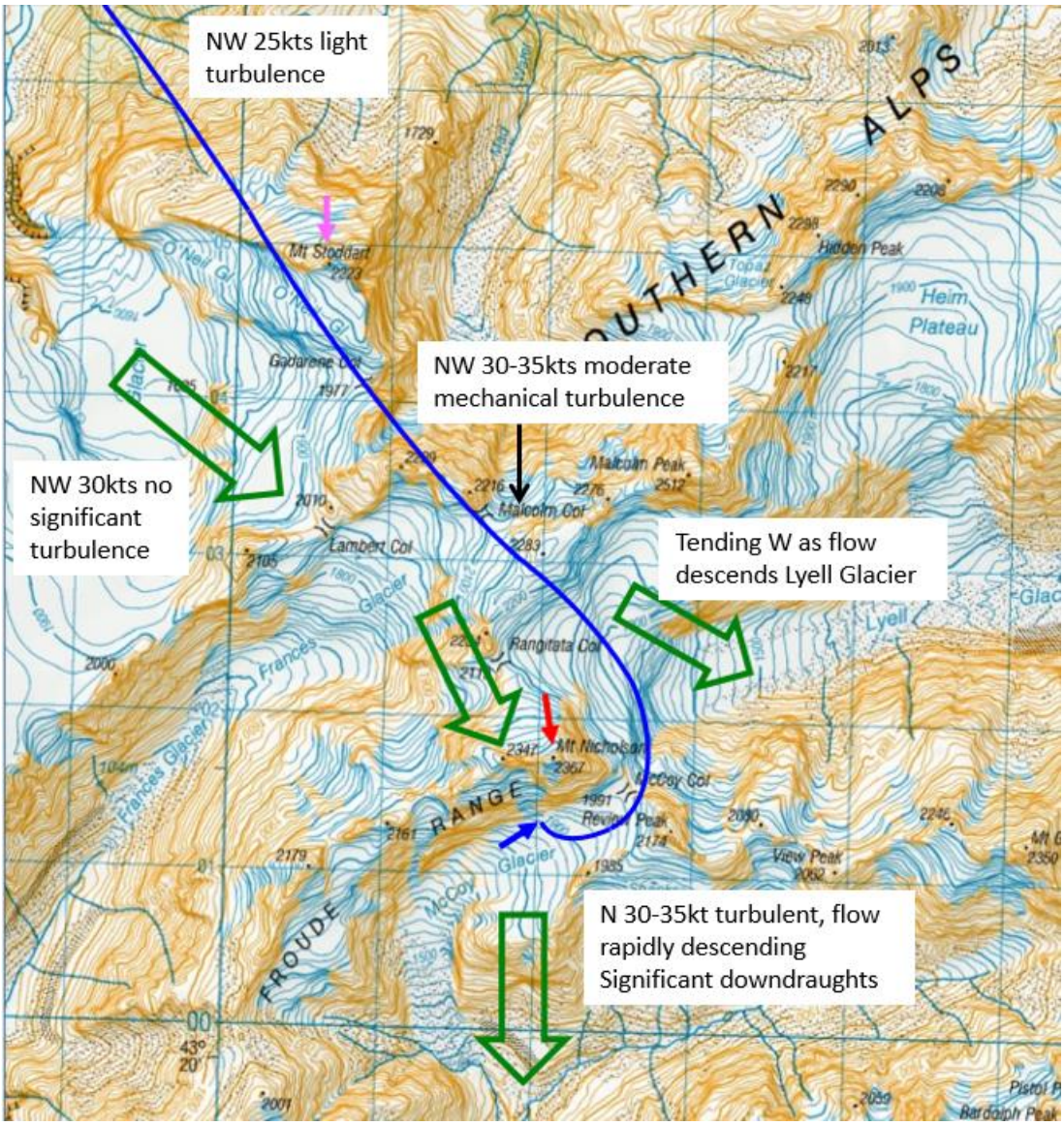

Figure 6: Possible wind flow (green arrows) around Mt Nicholson and the accident site (blue arrow). Approximate flight path (blue line); Mt Nicholson (red arrow); Mt Stoddart (pink arrow). Source: MetService report.

1.7.7 The MetService report stated that a temperature inversion existed around the tops of the main divide and it was, "…likely that mountain waves formed within this layer and propagated east of the Southern Alps".

1.7.8 The CAA Good Aviation Practice (GAP) - *Mountain flying*[17] booklet, explains how downdraughts and turbulence occurs on the lee side of mountains, and that both will increase in severity and extent with increase in wind strength.

1.7.9 Mountain waves are associated with rising, smooth air on the windward side and strong downdraughts and turbulence on the leeward side. Refer to Figure 7.

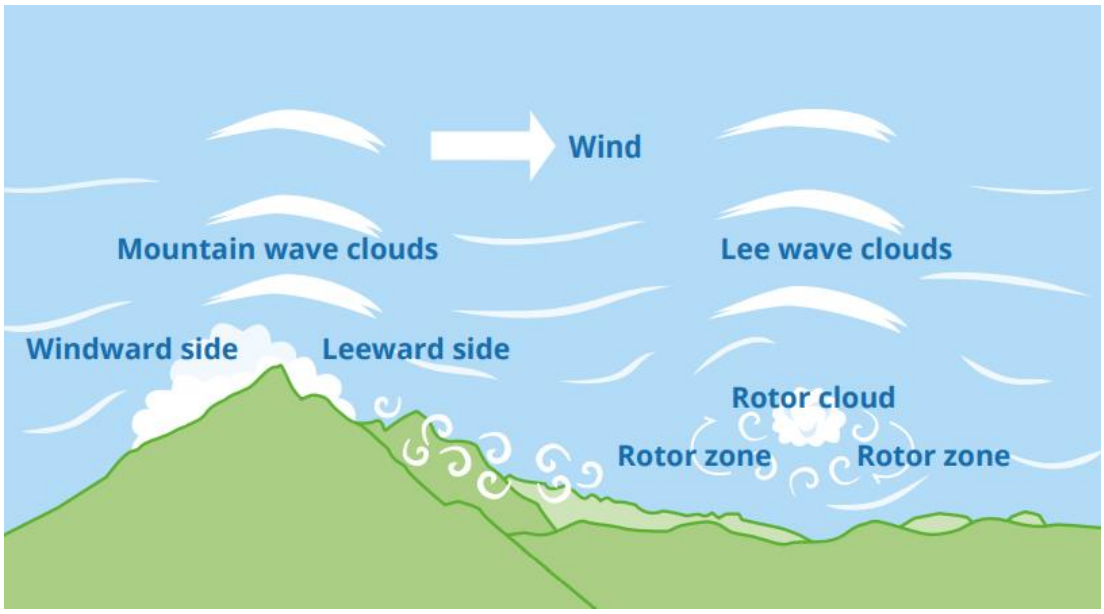

Figure 7: Mountain wave and rotor formation. Source: GAP-Mountain flying, CAA.

1.8 Aids to navigation

1.8.1 The pilot was reported to navigate via the Oz Runways™ app via a cockpit-mounted tablet. The tablet was not recovered, and the pilot had not logged into the app that day. It's not known if he used the app to assist with navigation on the flight, but it is considered likely.

1.9 Communications

1.9.1 The pilot made the required radio calls on the local area frequency. A local commercial pilot shared a brief radio exchange with the pilot. No further calls were heard after that.

1.9.2 Airways New Zealand advised there were no recorded transmissions from the pilot of ZK-MGB on any air traffic service frequency they monitor.

[17] CAA GAP –Mountain flying (aviation.govt.nz)

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 Friends used a flight tracking application to monitor ZK-MGB's ADS-B track and identified when it had stopped.

1.11.2 ADS-B data assisted RCCNZ and SAR to locate the accident site.

1.11.3 ADS-B data was used by the investigation to analyse the accident flight track and information from previous flights.

1.12 Wreckage and impact information

1.12.1 Due to the inclement weather and hazardous (unstable) nature of the site no detailed site inspection was possible.

1.12.2 SAR personnel could not locate the initial point of impact but believed ZK-MGB impacted higher up the glacier and subsequently fell over the ice shelf.

SAR imagery showed scattered debris above the ice shelf, which supports their assessment. ZK-MGB was significantly damaged by the accident sequence. Refer to Figure 8.

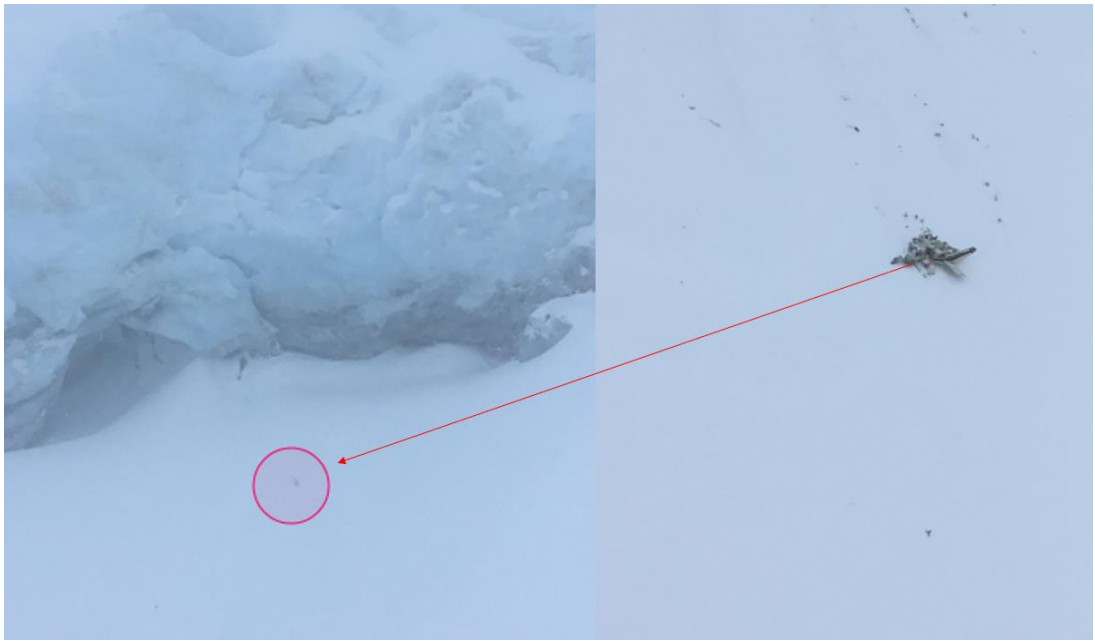

Figure 8: Proximity of final resting point of the wreckage to the ice shelf. Source: RCCNZ SAR photos.

1.12.3 It was not possible to draw conclusions about the impact sequence, but the amount of damage and pattern of debris indicates it was a high-energy impact.

1.12.4 The ELT and the Garmin GTX-335[18] transponder unit were the only aircraft parts able to be retrieved.

1.12.5 As ZK-MGB was not recovered, no detailed wreckage examination was possible.

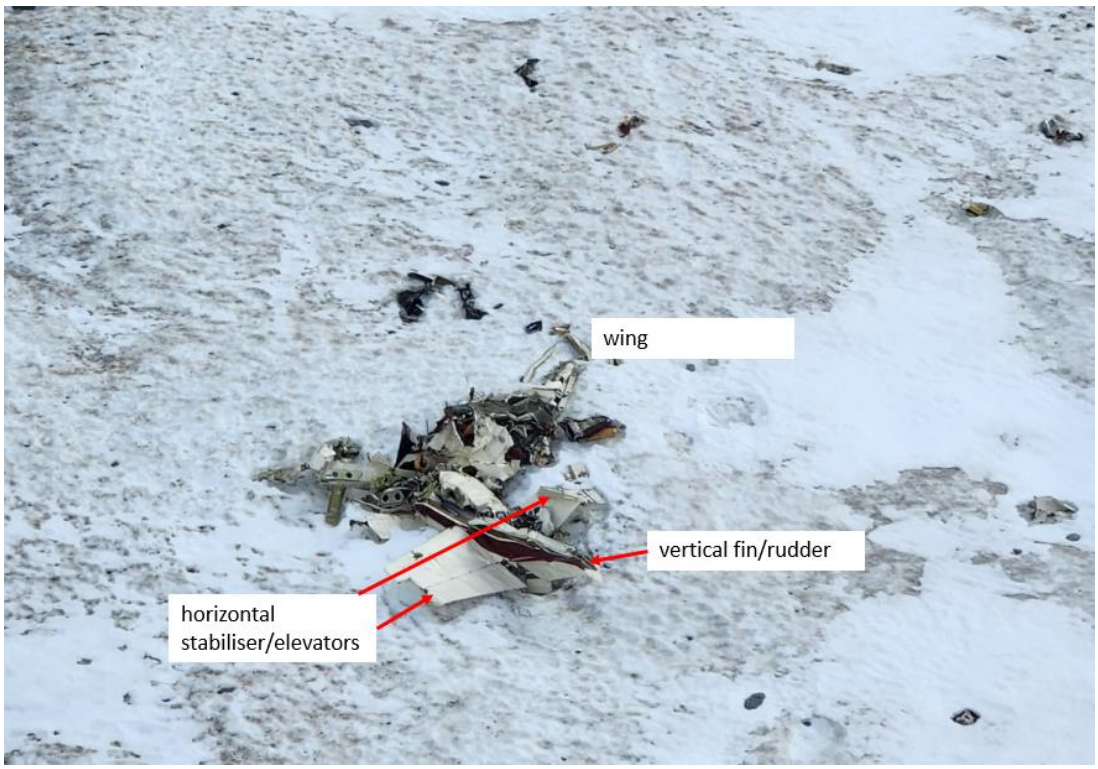

Figure 9: ZK-MGB, 04 March 2023. Source: Witness photo (edited) supplied by NZ Police.

1.13 Medical and pathological information

1.13.1 The pilot held a current Class 2 medical valid to February 2023.

1.13.2 The pilot was reported to be fit and well with no significant medical history.

1.13.3 It is most likely the pilot died from injuries suffered in the high-impact accident sequence. As the pilot's body was not able to be recovered, a post-mortem autopsy and toxicology tests could not be carried out. However, adverse effects of alcohol or drugs were considered to be unlikely given the pilot's reported lifestyle choices.

[18] This unit does not have data storage capability so provided no useful information.

1.14 Fire

1.14.1 There was no evidence in the wreckage photographs to suggest that a pre or post impact fire had occurred.

1.15 Survival aspects

1.15.1 The first responders to arrive at the accident site reported, "It was an unsurvivable accident based on the wreckage".

1.15.2 Several experienced accident investigators reviewed the accident photos and track data and concurred with the first responders' assessment.

1.15.3 ZK-MGB was fitted with an ELT which activated on impact. Location information was not sent to the RCCNZ, most likely due to separation of the externally-mounted antenna from the fuselage during the accident sequence. SAR personnel located ZK-MGB using the last recorded ADS-B track position and detected the "weak" ELT distress signal only when near the wreckage.

1.15.4 When friends and family realised ZK-MGB was overdue they alerted rescue services.

1.16 Tests and research

1.16.1 The pilot had previously flown between Franz Josef aerodrome and Rangiora aerodrome. ZK-MGB's historical ADS-B data was downloaded from a flight tracking application and compared with that of the accident flight. Refer to Figure 10.

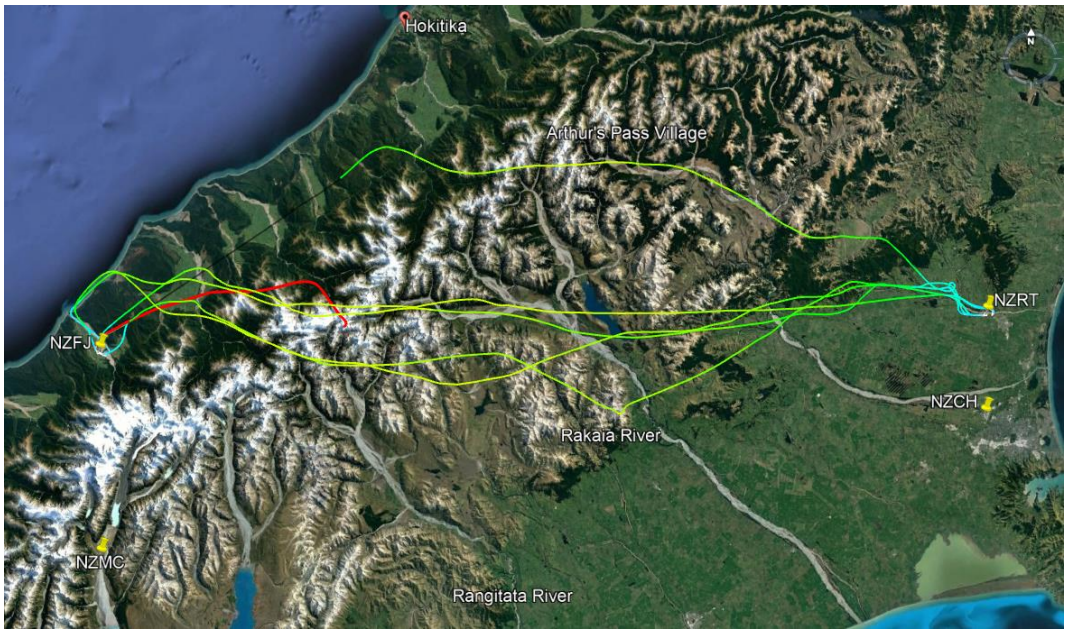

Figure 10: Previous flights between Franz Josef (NZFJ) and Rangiora (NZRT). Accident track in red. Source: ADS-B data overlaid on Google Earth™.

1.16.2 The tracks from two flights flown in October 2021 closely matched the track of the accident flight. Another two tracked about 11 km to the south and another to the north via Arthur's Pass.

1.16.3 Three of the pilot's PPL cross-country training flights were conducted slightly north of the accident location. The pilot's logbook also recorded two flights in his Maule between Franz Josef aerodrome and Rangiora aerodrome via Arthur's Pass.

1.16.4 It appears from this route history, that the pilot was following a route he was familiar with.

1.16.5 Humans have limitations on their cognitive abilities and information-processing capabilities (i.e., attention and perception) and thus some factors and/or biases can distort the way we perceive situations. Confirmation bias is a common example. This occurs when a person searches for evidence, or information supporting their current view or understanding of the situation, and ignores, or minimises, information which doesn't.[19]

This can then lead to plan continuation bias; described as "the unconscious cognitive bias to continue with the original plan in spite of changing conditions"[20]. Once a plan is made, it becomes increasingly difficult to change it.

1.16.6 When continuation bias affects the pilot's ability to detect important cues, or their implications, decisions can be made which could compromise safety.

1.16.7 Therefore, it's important for pilots to:

- understand that continuation bias can occur
- carefully analyse changes in the situation
- consider the implications of those changes
- determine whether a change of plan is appropriate.

1.17 Organisational and management information

1.17.1 Nil.

[19] https://www.aviation.govt.nz/assets/safety/human-factors/situational-awareness-guidance.pdf
[20] Continuation Bias | SKYbrary Aviation Safety

1.18 Additional information

1.18.1 CAA Advisory Circular 61-3 Rev 28, *Pilot Licences and ratings-Private Pilot Licence*[21] advises that aeroplane pilots complete:

"A minimum of 5 hours dual low-flying and terrain awareness training to include at least:

- 2 hours low-flying training; and
- 2 hours terrain and weather awareness training.

It is recommended that the additional hour be terrain awareness practically applied on cross country training flights."

1.18.2 Additionally, CAR 61 requires pilots to complete 10 hours of cross-country navigation training if they wish to exercise PPL cross-country privileges.

1.18.3 The CAA 19/6687 ZK-SGO fatal accident investigation report[22] identified several previous accidents in which pilots were caught out by the weather conditions along their route. That report observed that most of these accidents could likely have been prevented by thorough flight planning, and/or by making an earlier decision to turn back or divert.

To help pilots decode, collate, and interpret general weather information the CAA has several meteorology-related products available. The CAA also publishes Good Aviation Practice (GAP) booklets regarding mountain flying in general, and operations into certain aerodromes located in mountainous areas. These are:

- GAP booklet titled *VFR Met*. This describes weather in general and VFR flight requirements.
- GAP booklets titled *Mountain flying; In, out and around Milford; In, out and around Queenstown;* and *In, out and around Mount Cook* are relevant for flight into mountainous areas.
- *Weather Card/Met Abbreviations.* These describe abbreviations, codes, products [Metar, Grafor, TAF, etc], issue times and validity periods.
- *Weather-related indicators*. These provide reminders of which weather elements to monitor for change during a flight.

[21] https://www.aviation.govt.nz/assets/rules/advisory-circulars/ac061-3.pdf
[22] https://www.aviation.govt.nz/assets/publications/fatal-accident-reports/19-6687-zk-sgo.pdf

- *VFR MET Minima*. This card pictorially shows horizontal and vertical distance requirements from cloud in various altitude blocks.

1.19 Useful or effective investigation techniques

1.19.1 Nil.

2. Analysis

2.1 The pilot had prearranged a flight to Rangiora aerodrome to collect associates, over a route he had previously flown and was likely familiar with.

2.2 The pilot appears to have had some concerns about the weather as he consulted two experienced pilots the day prior and on the morning of the flight. He was cautioned by one pilot and strongly advised not to go by the other. His wife also asked him not to go due to concerns about the weather.

The pilot appeared satisfied with his planning and decided to proceed with the flight, expressing a clear intent to turn around if he assessed the conditions as not suitable.

2.3 Shortly after take-off the pilot was cautioned again by a local commercial pilot about the forecast deteriorating weather. The pilot acknowledged this and appeared comfortable to proceed.

2.4 ZK-MGB's ADS-B track history provided key evidence for the investigation.
Note there are limitations to the accuracy of ADS-B data based on aircraft altitude, altimeter sub-scale setting, distance from the ground station site, obstructing terrain, and satellite geometry.

2.5 After departure, ZK-MGB climbed steadily to 8,200 ft. Passing 6,000 ft, a break in the cloud likely enabled the pilot to climb above the cloud layer. Once above the cloud, there would have been further gaps in the cloud and the ground was likely visible to the pilot for most of the time.

2.6 At 0857 ZK-MGB was above cloud and level at 8,200 ft on a heading of 135° with a groundspeed of 144 kt. The wind at that height was estimated at 30-35 kt from the NW.

2.7 ZK-MGB crossed the main divide near Malcolm Col. The pilot then turned back towards Mt Nicholson. At this point the ground speed progressively dropped as the wind now flowed across ZK-MGB's track. Refer to Figure 11.

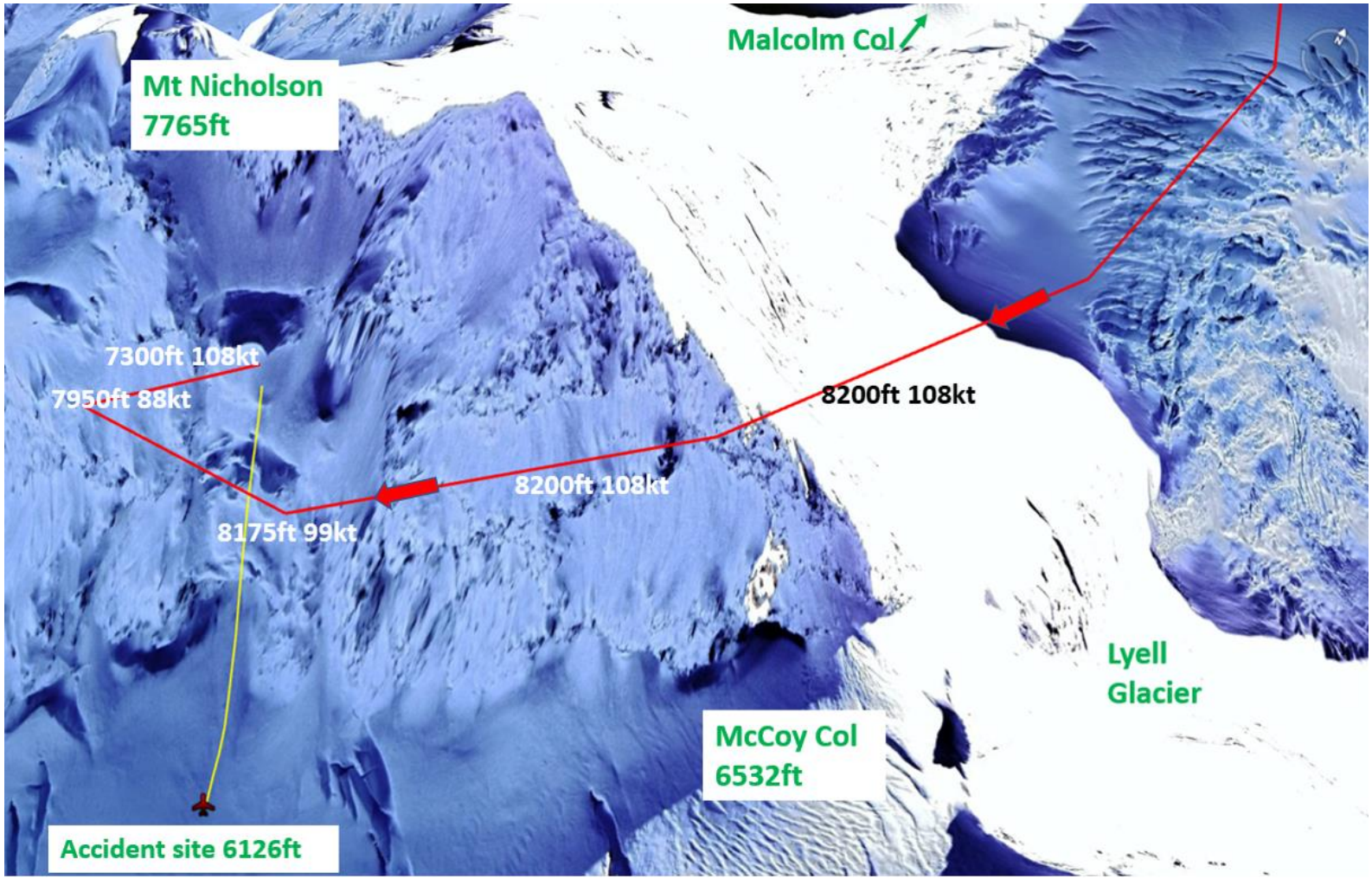

Figure 11: Approximate path (red), altitude, and speeds of ZK-MGB. Yellow line is the approximate path from last track point and accident site. Source: ADS-B Aireon data. Airways New Zealand. Overlay on Google Earth™.

2.8 At 0858 the data shows a high rate of descent developed while ZK-MGB was above the McCoy Col (6,532 ft) at 8,175 ft. Approximately 2,100 ft of altitude was lost in a period of 14 seconds, before the recorded track stops.

2.9 The high rate of descent just prior to ZK-MGB striking the terrain and the wreckage pattern indicates a high-energy accident sequence.

2.10 ZK-MGB's track shows a right turn, consistent with a conscious pilot decision to turn back. Several possible reasons for that decision are considered:

- **Turbulence**: the pilot would have encountered moderate turbulence, with some downward motion in the airflow as it descended over the Lyell Glacier. The pilot may have been concerned that the turbulence would increase or that it could be difficult to maintain altitude in the downward flow.

- **Weather deterioration:** The pilot may have realised the weather conditions were deteriorating on the West Coast, and that it was unlikely the return flight from Rangiora would be possible.

- **Cloud:** Satellite imagery suggests the flight altitude was at least 500 ft above cloud in that area, and that it was clear of cloud ahead to the east coast. However, the pilot was known to be cautious about flying near cloud, so seeing cloud spilling over the mountains could have contributed to his decision.

The turn-back was consistent with his earlier statements of "I will go and have a look and I'll turn around if I don't like it".

2.11 Consideration was given to whether the pilot was able to differentiate the snow-covered terrain from cloud. While cloud was cascading over the main divide south-west of Malcolm Peak, and down the Lyell Glacier, the higher peaks (such as Mt Stoddart) were clear above cloud, and possibly Mt Nicholson as well. The pilot conducted the right turn at approximately 450-500 ft above Mt Nicholson, which, at 7,766 ft, was the highest peak in that direction.

Given that analysis, and the pilot's reported aversion to flying in or close to cloud, it's likely the turn-back manoeuvre was conducted clear of cloud.

2.12 Approximately 23 seconds after commencing the right turn, ZK-MGB suddenly lost height and collided with terrain. The MetService report stated:

"It is likely that there were significant downdrafts around the southern side of Mt Nicholson in the vicinity of the accident site, even at altitudes higher than the peak. The downdrafts would have become strong as ZK-MGB dropped below the ridgeline of Mt Nicholson and the Froude Range."

2.13 The conditions described above are common to the Southern Alps in high winds. Even pilots of larger aircraft have reported experiencing insufficient aircraft performance to maintain altitude in similar conditions. The downdraughts experienced by the pilot in ZK-MGB likely exceeded the climb performance of the light aircraft.

2.14 If a downdraught is encountered, pilots are advised not to try to outclimb it but to turn out of the down-flowing air as soon as possible[23]. With only approximately 14 seconds from the initial loss of altitude to collision with terrain it's possible the pilot did not have sufficient time to identify the downdraught conditions and manoeuvre to avoid the terrain.

2.15 The downdraughts may also have forced ZK-MGB into the cloud flowing over the ranges. If this had occurred, the pilot would have rapidly lost visual reference with the snow-covered terrain.

For either scenario the pilot was unable to clear the terrain.

2.16 The pilot had completed the required theoretical and practical training for the issue of his PPL. This included a refresher on meteorology[24] theory and aspects were reviewed with his instructor prior to each flight. During his cross-country flight training, preflight review of forecasts and discussion on weather en route was taught in more detail. The pilot's cross-country flights were conducted in winds of 15 kt or less. However, his instructor said he considered the pilot "…understood the challenges of flying in high winds in mountainous terrain…" and "…had more experience than most PPL pilots with similar flight time".

[23] CAA GAP – Mountain flying (aviation.govt.nz) page 9.

[24] The instructor felt this necessary as it had been 32 years since the pilot gained the PPL meteorology exam credit.

2.17 It is not known how much experience the pilot had flying in strong winds since gaining his PPL. He confided to a friend about encountering turbulence and low cloud conditions on one flight and appeared to have been shaken by that experience.

2.18 The pilot had not completed a mountain flying course and was not required to. The GAP *Mountain flying* booklet provides guidance to pilots, and page 35 specifically recommends:

- *Get and use as much weather information as you can. Check winds, especially at altitude.*
- *Don't go when upper winds are forecast over 25 knots. Winds will be much stronger over mountain passes.*
- *Constantly assess the wind direction and speed, and logically apply this to your flight path. There can often be abrupt changes to wind direction and speed.*

It also recommends: *Always anticipate. If you find yourself reacting to cues, rather than anticipating them, then you are strongly advised to seek some specialist mountain flying training.*

It is not known how familiar the pilot was with the GAP *Mountain flying* booklet.

2.19 Though the pilot had a MetFlight login, this had never been used. If the pilot used another account to login to MetFlight he hadn't mentioned this to witnesses. He had been taught to use the MetFlight forecasting products during his flight training. It's not known whether he used this after gaining his PPL.

It cannot be determined if the pilot's decisions that day would have been different had he obtained the en route forecasts such as the GRAFOR and AAW.

2.20 The CAA Chief Meteorologist advises there are limitations to using the Windy app as the sole source of weather information. The app does not provide aerodrome or route-specific forecasts with sufficient detail such as visibility or ceiling information for pilots to plan their flight. Further, Windy does not provide information on significant weather such as turbulence, airframe icing or mountain waves, among other aviation weather hazards. While Windy makes available four different weather models, they are not always of sufficient resolution to adequately identify the terrain-induced effects on wind and weather that pilots may experience in mountainous

regions. Therefore, it's recommended that pilots review aviation weather forecasts provided by a suitably qualified meteorologist, who can identify such phenomena.

MetService is the only certificated Part 174 aviation meteorological service organisation in NZ. It provides detailed general aviation forecasts and products (through MetFlight, IFIS and now PreFlight) to help pilots understand the wider meteorological situation. It's important pilots understand the limitations of other forecasting websites/apps.

2.21 The winds were light when the pilot departed Franz Josef and as he climbed north underneath the inversion layer. He had information that the weather was good at Rangiora and on the east coast. However, it appears he did not fully appreciate the likely en route weather conditions.

It was only when he approached Mt Stoddart, just prior to crossing The Divide that he would have experienced stronger wind and associated turbulence. It's not known if he didn't pick up the cues of the high wind conditions[25] approaching the ranges, or if he considered it was still suitable to continue.

2.22 The pilot had briefed his associates that weather may prevent the flight from going ahead and had an alternative plan for them to drive to Franz Josef. Several people knew of the plan and, in their opinion, considered the pilot was not under pressure to do the flight.

2.23 However, it's possible the pilot was subject to plan continuation bias in that he proceeded with the flight, despite being cautioned against it. The knowledge that the weather was fine at Rangiora and that he could likely see the east coast was clear, may have influenced his decision to continue. When he did decide to turn back, it was too late to do so safely.

[25] Such as high ground speed from the tailwind, cloud rising and spilling over the ranges.

3. Conclusions

3.1 The accident occurred as a result of a high-energy collision with terrain.

3.2 It's likely ZK-MGB encountered an area of severe downdraughts that exceeded its climb performance and/or forced it down into the cloud layer. For either scenario, the pilot was unable to clear the terrain.

3.3 The collision with terrain occurred following what appeared to be a decision by the pilot to turn back to his departure aerodrome.

3.4 It cannot be conclusively determined why the pilot decided to turn back; however, it was likely weather-related. When he did, it was too late to do so safely.

3.5 The pilot referred to the Windy app and experienced pilots to plan his flight.

3.6 It is possible the pilot was subject to plan continuation bias in that he proceeded with the flight, despite being cautioned against it.

3.7 It appears the pilot did not fully appreciate the weather conditions to the east of The Divide. MetFlight products would have provided better information regarding the likely en route weather conditions.

3.8 On approaching the ranges, the pilot either did not pick up the cues of the high wind conditions or he considered it was still suitable to continue.

3.9 The pilot was appropriately licensed and fit to carry out the flight.

3.10 The high energy of the impact forces meant the accident was probably not survivable.

3.11 ZK-MGB and pilot were not recovered due to the hazardous nature of the site.

4. Safety messages/actions

4.1 Pilots are strongly recommended to become familiar with the CAA GAP *Mountain flying* booklet before flying into mountainous terrain.

4.2 Pilots who frequently fly in mountainous terrain are recommended to complete a mountain flying training course. This course provides further knowledge and skills when flying in this challenging environment.

4.3 The CAA will publish an article entitled *High Safety* in the Spring 2023 *Vector* safety magazine. This article discusses the risks that mountain flying presents and provides advice to pilots.

4.4 Pilots are cautioned about relying solely on uncertificated meteorological forecasting providers such as Windy when conducting extended cross-country flights. Pilots are recommended to obtain detailed aviation-specific forecasts including GRAFOR and AAW, Graphical NZ SIGWX and SIGMET.

4.5 Following this and previous weather-related accidents, the CAA will publish an article in the *Vector* safety magazine about understanding and planning for forecast en route weather.

Report written by:

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Date: 17 August 2023

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Appendix One: Meteorological forecasts

Additional meteorological forecast information further to Section 1.7 Meteorological information is described below.

Significant weather Graphical NZ SIGWX[26] (forecasts turbulence, icing, mountain wave)

NZ SIGWX issued at 0511 04 August[27] (refer to Figure 12) included the following phenomena:

- Moderate turbulence below flight level 140[28] southwest of Oamaru aerodrome (NZOU) at 0300, spreading north, reaching Mt Cook aerodrome (NZMC) by 0900 and elsewhere by 1200 and becoming severe from the south from 0600.
- Moderate mountain waves east of the Southern Alps between flight levels 160 and 380 (16,000 and 38,000 ft). This wouldn't have appeared on the GA version.

An updated NZ SIGWX was issued at 0720. Of relevance, the base of the mountain waves east of the Southern Alps were forecast to lower to flight level 130 (refer to Figure 13).

Another updated NZ SIGWX was issued at 0811, valid from 0900 (refer to Figure 14). Changes included:

- Moderate icing between 6,000 ft and flight level 140 (14,000 ft; indicated as "XXX" on the GA version) west of the Southern Alps and south of Harihari (just north of Franz Josef).
- Moderate icing between 8,000 ft and flight level 200 (20,000 ft; indicated as "XXX" on the GA version) east of the Southern Alps and mainly south of Christchurch aerodrome.
- The area of moderate turbulence was simplified: it was expected below (14,000 ft; indicated as "XXX" on the GA version) with no other details.
- Mountain waves were still expected east of the Southern Alps above flight level 140 (14,000 ft).

[26] The general aviation (GA) versions of the SIGWX charts stop at 10,000 ft (the upper limit of the chart). For phenomena that cross this boundary, the upper boundary is replaced with "xxx". Phenomena forecast entirely above 10,000 ft, are removed. MetService archives only the full version of the Graphical NZ SIGWX charts, thus the GA version was not available.

[27] Forecasts are reported in UTC. For ease of readability all times have been converted to NZST.

[28] FL 140 equates to 14,000 ft; indicated as "XXX" on the GA version.

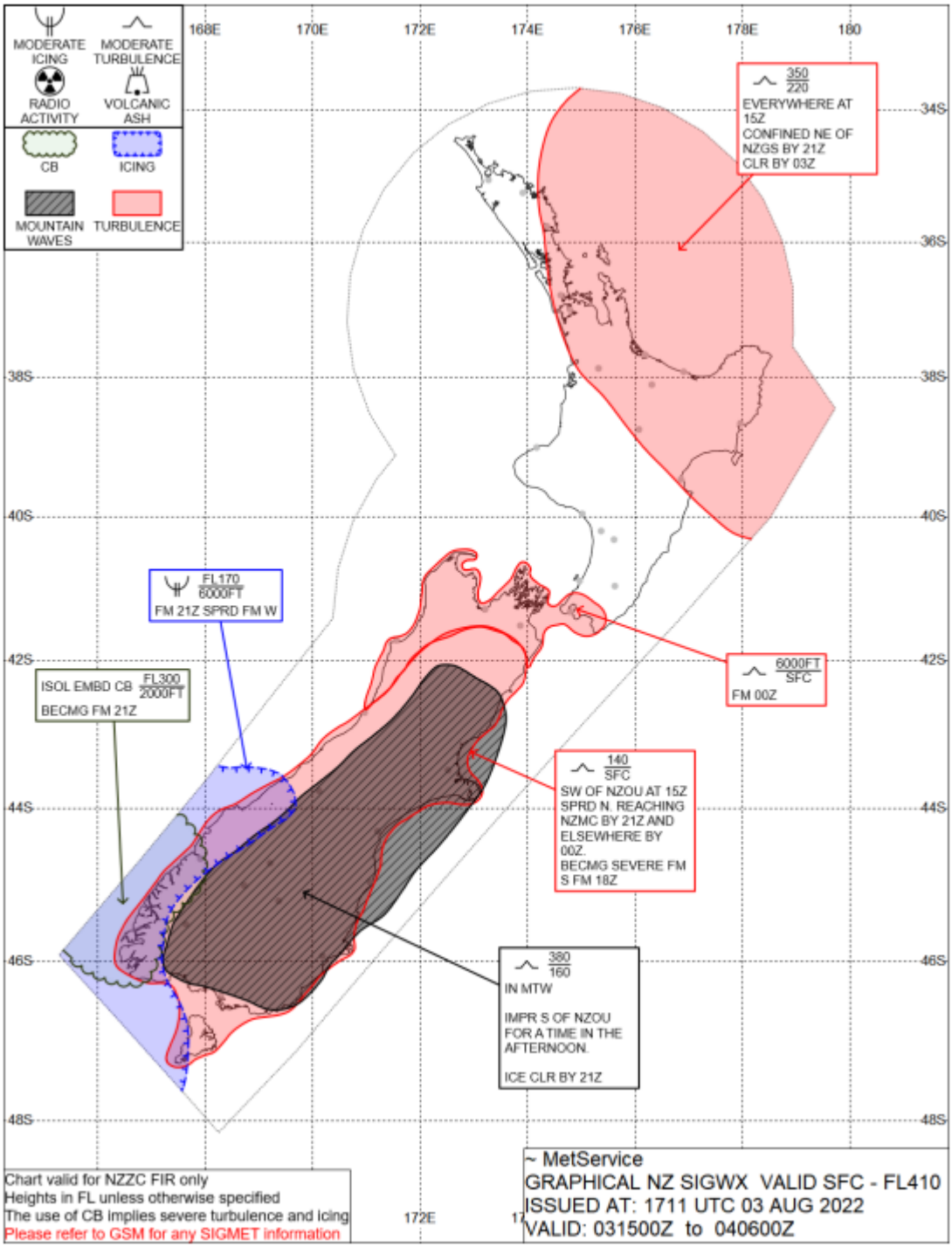

Figure 12: NZSIGWX issued 0511 04 August 2023 NZST. Source: MetService.

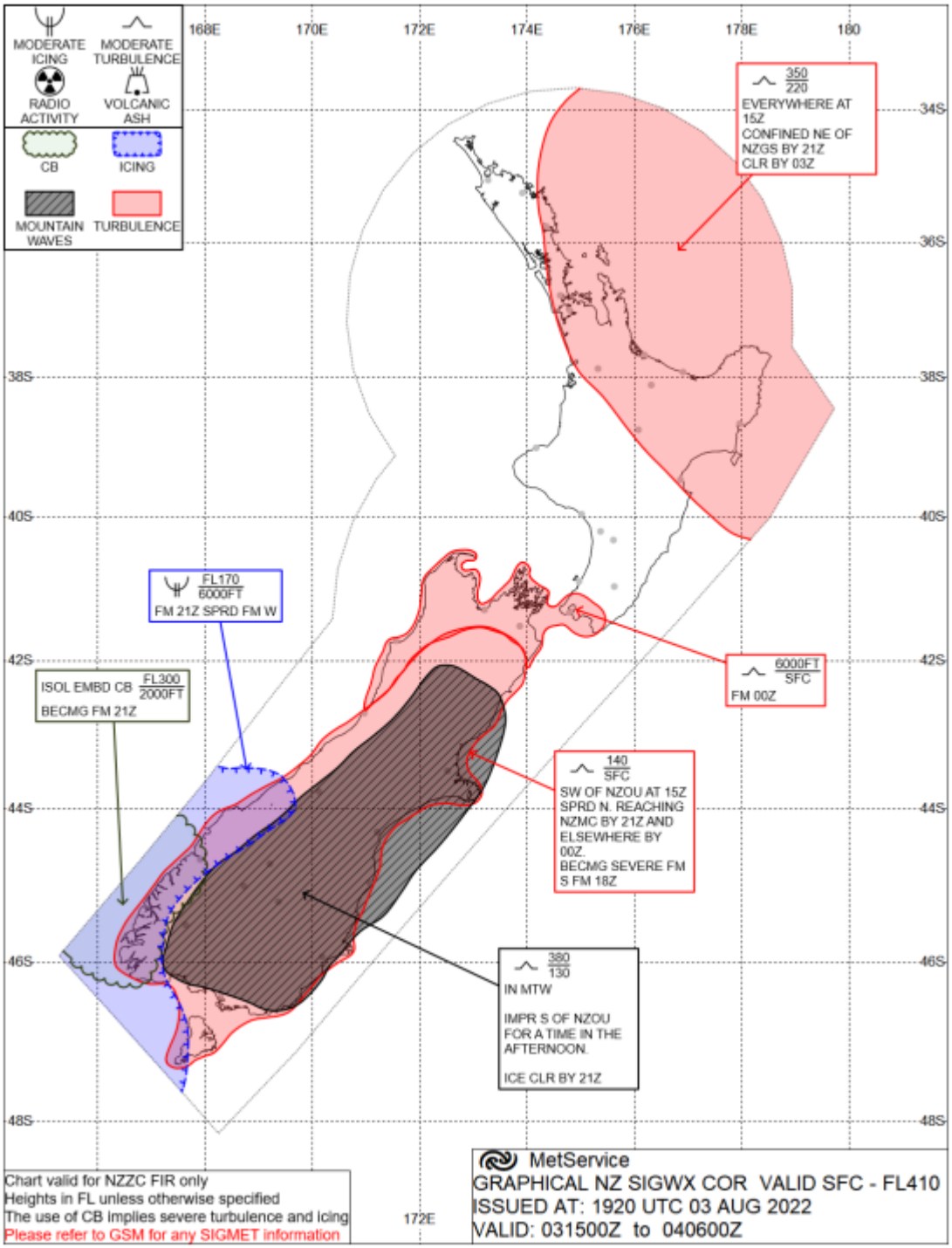

Figure 13: NZ SIGWX issued 0720 04 August 2022 NZST. Source: MetService.

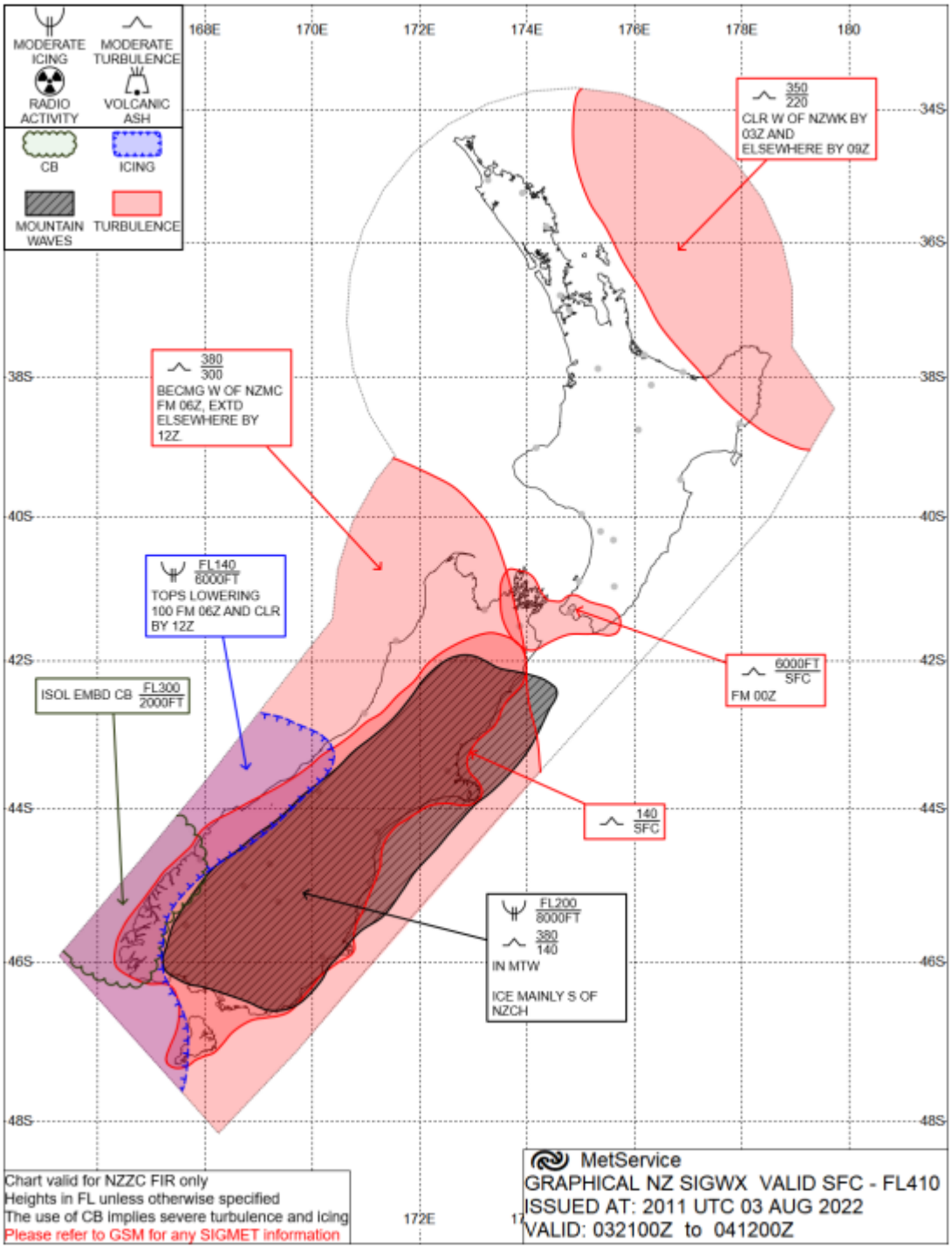

Figure 14: NZ SIGWX issued 0811 04 August 2022 NZST. Source: MetService.

Graphical Aviation Forecast (GRAFOR)[29] (forecasts freezing levels, fronts, visibility, cloud below 10,000 ft and significant weather)

The GRAFOR issued at 2247, 03 August 2022 for the West Coast, forecasted scattered cloud 2000 - 8000 ft, 20 km visibility and nil significant weather. Weather associated with the approaching front was forecast for the Fiordland area. Refer to Figure 15. This was updated 3 minutes later with slightly more cloud and showers forecast from 1200. Refer to Figure 16.

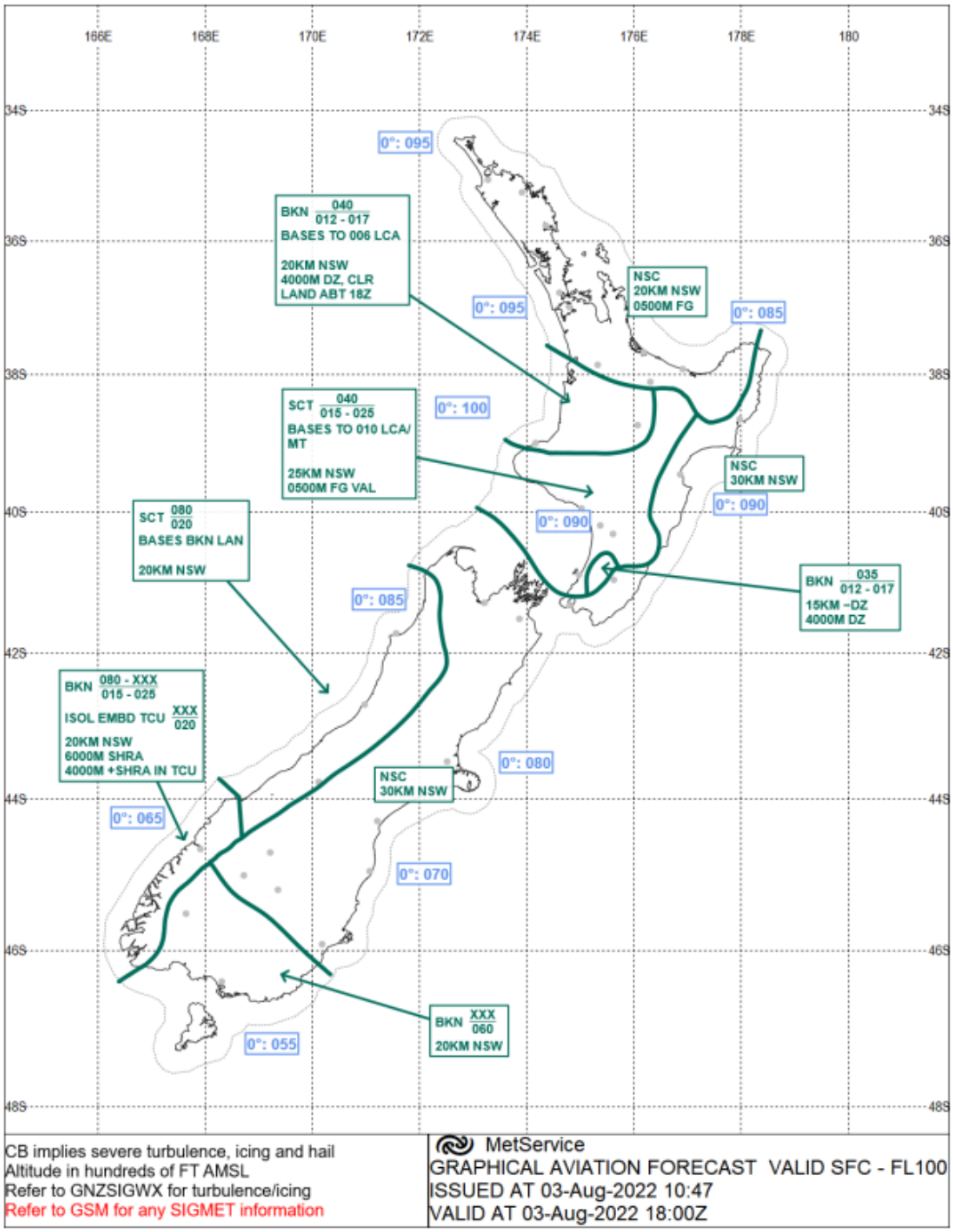

Figure 15: NZ SIGWX issued 2247 03 August 2022 NZST, valid 0600 04 August 2022. Source: MetService.

[29] GRAFOR are valid for the period three hours before and after the stated validity time.

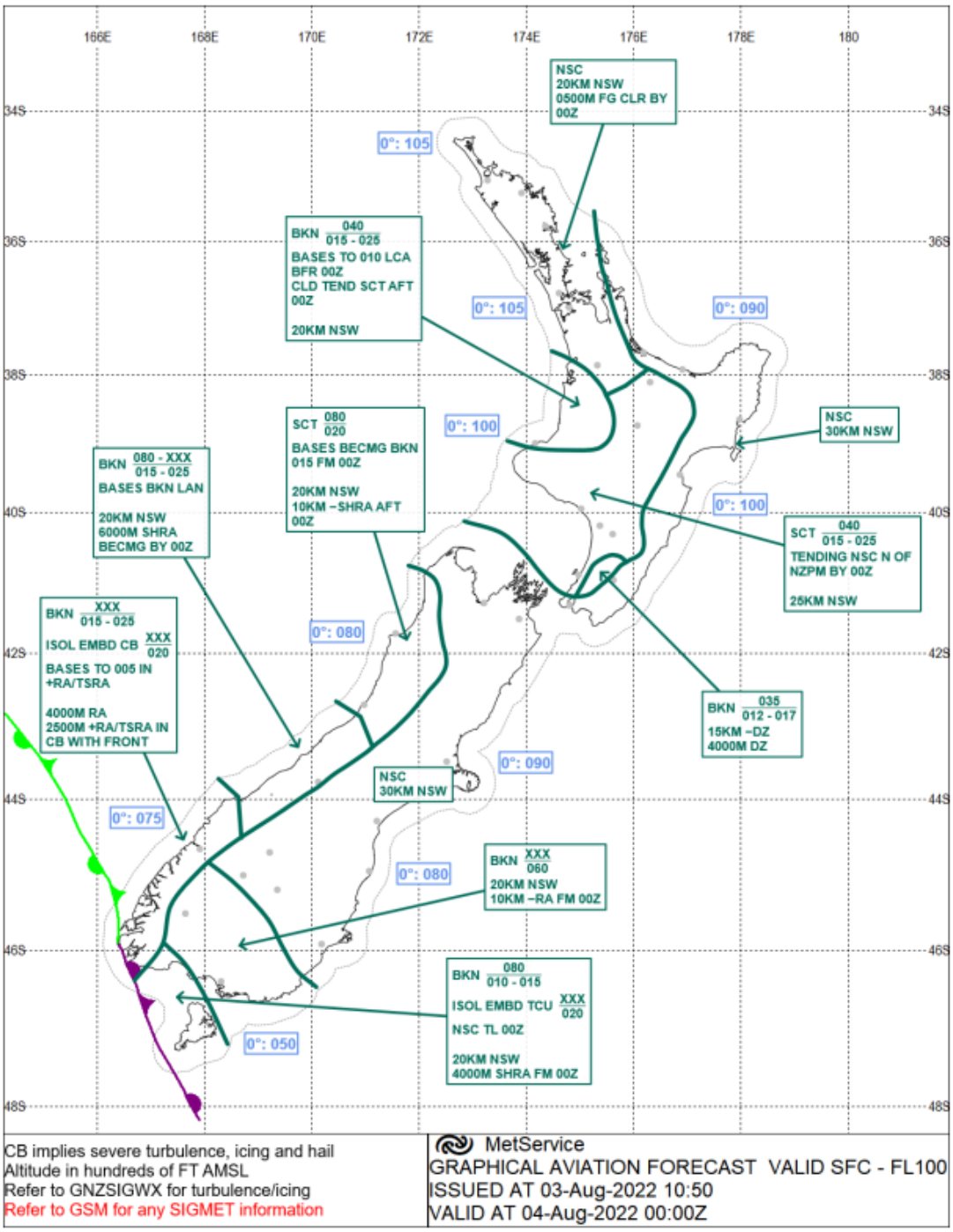

Figure 16: GRAFOR issued 2250 03 August 2022 NZST, valid 1200 04 August 2022. Source: MetService.

Aviation Area Winds (AAW) (forecasts winds between 1,000 to 10,000 ft and temperatures at three altitudes from 5,000 to 10,000 ft.)

AAW relevant to the intended flight path were:

- Windward (WW) – west of the Southern Alps;
- Alps (AL)[30] – about the Southern Alps and foothills; and
- Plains (PL) – Canterbury Plains.

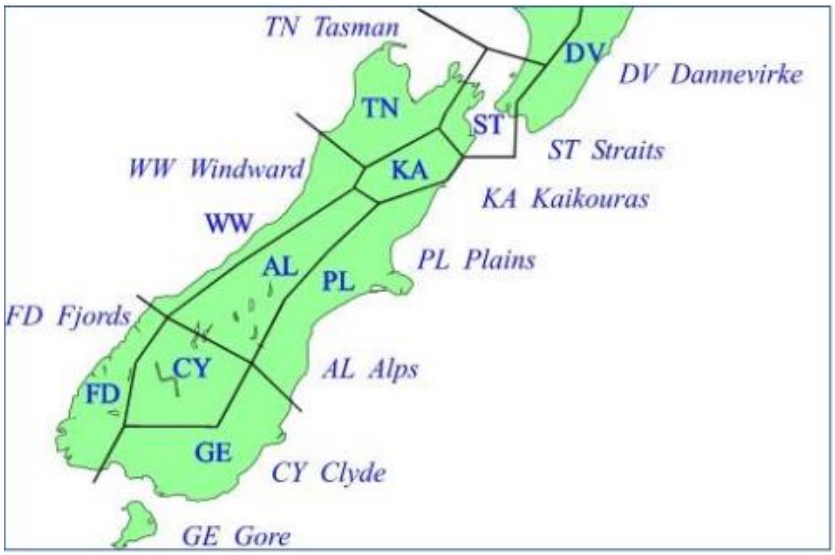

Figure 17: Map depicting the AAW areas over the South Island. Source: MetService.

The AAW forecast issued at 2254 03 August for AL predicted NW of 40 kt at the height of the main divide (7,000 ft), at the time of the accident. Refer to Table 3.

For WW and PL, westerlies of 15 to 20 kt were forecast at 7000 ft.

```
AAW: AL - Issued: 03 Aug 2022 10:54 UTC
Valid: 03 Aug 2022 12:00 to 04 Aug 2022 06:00 UTC

AVIATION AREA AL VALID 1200 TO 0600 UTC
 BECOMING                  2000-2100       2200-0000
 3000      34015                           35025
 5000      32020 ZERO      33035 PS01
 7000      29025 ZERO      31040 MS01
10000      27025 MS04      30040 MS04      30050 MS05
```

Aviation Area Winds forecast for Alps, issued at 1054 UTC 3 August 2022
Valid from 1200 UTC 3 August 2022 to 0600 UTC 4 August 2022

3,000ft: Northerly 15 knots becoming between 2200 and 0000 UTC northerly 25 knots
5,000 ft: Northwest 20 knots; 0°C becoming between 2000 and 2100 UTC northwest 35 knots; 1°C
7,000 ft: Westerly 25 knots; 0°C becoming between 2000 and 2100 UTC northwest 40 knots; -1°C
10,000 ft: Westerly 25 knots; -4°C becoming between 2000 and 2100 UTC northwest 40 knots; -4°C, and becoming between 2200 and 0000 UTC northwest 50 knots; -5°C.

Table 3: The AAW forecast for AL issued at 2254 03 August (1054 UTC) (top) and decoded in plain English (bottom). Source: MetService.

[30] The AL only provides winds at four levels; the 1,000 ft level is excluded since the ground level is almost entirely above this altitude.

Aerodrome Forecasts (TAF) for the intended flight route.

NZHK (Hokitika) issued at 2317 03 August valid 0000 to 1800 04 August.
TAF NZHK 031117Z 0312/0406 10005KT 20KM SCT020 BKN035
FM032200 04010KT 15KM -SHRA SCT020 BKN030
TEMPO 0322/0403 6000 SHRA tempo
BECMG 0401/0403 32012KT
2000FT WIND VRB05KT
BECMG 0320/0322 36010KT
BECMG 0323/0401 30015KT
QNH MNM 1018 MAX 1027

NZMC (Mt Cook) issued at 2317 03 August valid 0000 to 1800 04 August.
TAF NZMC 031117Z 0312/0406 32015KT 20KM SKC
FM032000 35022G40KT 15KM -RA SCT060
2000FT WIND 31030KT
BECMG 0319/0321 33045KT
QNH MNM 1015 MAX 1024

NZCH (Christchurch) issued at 2317 03 August valid 0000 to 2400 04 August.
TAF NZCH 031117Z 0312/0412 VRB02KT CAVOK
BECMG 0322/0400 05010KT
BECMG 0405/0407 VRB02KT
2000FT WIND 28015KT
BECMG 0401/0403 31030KT
BECMG 0407/0409 31015KT
QNH MNM 1014 MAX 1023

NZCH (Christchurch) issued at 0504 04 August valid 0600 to 0600 05 August.
TAF NZCH 031704Z 0318/0418 06010KT CAVOK
BECMG 0405/0407 VRB02KT
2000FT WIND 33015KT
BECMG 0401/0403 31030KT
BECMG 0407/0409 31015KT
QNH MNM 1012 MAX 1021

Meteorological Aerodrome Reports (METAR)

Aerodrome	UTC	Wind	Visibility	Cloud	Temp/ dewpoint	QNH	Remarks
NZHK	032000Z	13005KT	20KM	BKN033 BKN220	07/05	Q1024	
NZHK	032030Z	13004KT	20KM	FEW080 BKN210	08/06	Q1024	
NZHK	032100Z	13003KT	20KM	SCT070 BKN200	08/07	Q1024	
NZMC	032000Z	35019G29KT 310V010			10/M04	Q1018	
NZMC	032030Z	34022G35KT			09/M04	Q1018	
NZMC	032100Z	34021G37KT 310V020			10/M03	Q1018	
NZCH	032000Z	35003KT	9999	NCD	07/05	Q1018	RMK SUGARLOAF 02017KT
NZCH	032030Z	04003KT	9999	NCD	05/05	Q1018	RMK SUGARLOAF 02019KT
NZCH	032100Z	06004KT	9999	NCD	06/05	Q1018	RMK SUGARLOAF 02019KT