Ice core research in the New Zealand Southern Alps

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The past holds the key for prediction of future climate changes. Only when the causes of past climate fluctuations are understood will it be possible to predict and plan for future changes. Instrumental climate records are, however, too short for precise identification of decadal and longer climate behaviour. Glaciers, with climate proxies to near instrumental precision, play an important role as archives of global climate history. Ice cores can help to understand natural variations and human influences on climate. With New Zealand's isolated position in the South Pacific Ocean, and its location with respect to the jet stream, Southern Alps glacier records are potentially very valuable for the study of timing and extent of changes in the jet stream and consequent impacts on New Zealand and global climate.

Research on New Zealand’s temperate glacier ice faces the challenge of meltwater percolation, which tends to obscure glaciochemical variations in the firn and snow. Another challenge is high snow accumulation rates, which limit the length of the preserved ice records.

Using tritium and ^{210}Pb, we have dated the older ice in the lower part of three glaciers in Mount Cook National Park to reveal the approximate length of ice records that can be expected. The oldest ice at the terminus indicates the time span that can be expected in deep ice cores from the neve. The ice at the terminus of Franz Josef and Fox Glaciers on the West Coast is 40 and 50 years, respectively. However, the Tasman Glacier on the east side of the Southern Alps, contains older ice. At the end of the white ice, we measured an age of 90 years. However, the oldest ice at the terminus is not accessible on the surface as it is covered by rock debris. The ice thickness at the end of the white ice is still several hundred meters, suggesting a total ice record of several hundred years.

Our initial studies showed that the bomb tritium from the nuclear weapons testing period in the 1960s is well preserved in the Tasman Glacier ice, suggesting little or no inter-annual exchange processes during ice formation. The seasonal bomb tritium peaks allow for accurate ice dating back to 50 years, and the natural pre-bomb tritium allows for approximate dating of ice back to 100 years. No old ice is yet available, but we plan to use ^{32}Si (half-life 140 years) to calibrate annual layer dating farther back in time to 1000 years.

We are currently also testing how well these climate signals are retained in the ice. Initial tests reveal that this ice retains its chemical and isotope composition although chemical species are washed out at lower elevations in the heavily-meltwater percolated ablation zone.