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Comparative study of Late-Holocene glacier chronologies in the Southern Alps of New Zealand and maritime Scandinavia - potential for improvement of spatial differentiation and interpretative studies on a global scale?

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Reconstructing Holocene glacier chronologies and the related climate history helps to improve the knowledge how glaciers respond to changes of the climate. Comparative studies of Holocene glacier chronologies on a global scale offer the opportunity to assess the causes of glacier dynamics and verify the numerous hypotheses about the impact of individual climate factors. The current research project "MaMoGla" (Holocene and recent dynamics of maritime mountain glaciers) investigates the Southern Alps of New Zealand and maritime Scandinavia. It focuses on maritime mountain glaciers and their characteristics. The project should deliver a contribution towards a better spatial differentiation and decision whether there are 'global' Holocene climate modes or not?

Older Holocene glacier chronologies of the Southern Alps/New Zealand have been found as not on a comparable detailed standard as the Scandinavian counterpart. In addition, previous research has revealed the need for revision due to methodological uncertainties, e.g. the previous focus on Tasman Glacier as meanwhile disregarded key locality. A new attempt to combine the relative-age dating technique of the Schmidt-hammer with in situ (terrestrial) cosmogenic nuclide (10Be) surface exposure dating offered the opportunity to improve the New Zealand glacier chronology. Preliminary results from Strauchon Glacier, a valley glacier west of the Main Divide of the Southern Alps in Westland/Tai Poutini National Park, showed a pattern that could partially already been confirmed at neighbouring glaciers. On a large lateral moraine complex several individual moraine ridges represent three sequences, each related to one major Late-Holocene LIA ('Little Ice Age')-type event. These three Neoglacial events predate the youngest major advance ('Little Ice Age') and have been dated to 2,400/2,500 a BP, c. 1,700 a BP, and 1,000/1,100 a BP. The absence of any evidence of glacial activity during the Hypsithermal and first indications of the onset of Neoglaciation occurring around c. 5,500 a BP is in good agreement with glacier chronology in maritime Scandinavia. In addition, detailed analysis of the glacier variations during the 'Little Ice Age' and the 20th century AD shows major parallels between both study areas. However, there is little/no evidence of major Early Holocene advances in New Zealand. One hypothesis for this difference is the influence on melt-water outbursts from the disintegrating remnants of the Laurentide Ice Sheet into the North Atlantic sector representing a major but regional factor.

The importance of including analysis of recent glacier variations during the 20th and 21st centuries with the interpretation of Holocene glacier chronologies needs to be highlighted in a more pronounced way. In difference to earlier periods, there is sufficient meteorological and glaciological data (as e.g. mass-balance studies) available. Detailed investigation revealed that the most prominent periods of glacier advance and mass gain at the maritime mountain glaciers studied were unambiguously related to increased precipitation and stronger zonal patterns of atmospheric circulation. By contrast, increase summer air temperatures were found responsible for the occurrence of strong frontal retreat during recent years. Rather short periods of less than 10 years caused sufficient length variation during the past few decades, i.e. on a multi-annual to decadal scale. Furthermore, the 'glaciological regime' empirically describing the relationships between mass-balance or length variation and climate or weather conditions was demonstrated to be variable through time. As this variability is specific for maritime glaciers, one would expect temporal differentiation in addition to the widely accepted spatial differentiation in Holocene glacier

chronologies.

In contrast to more continental mountain glaciers, reconstructions of Holocene glacier variations cannot be performed entirely depending on temperature signals. Modern-day analogies point, therefore, against ‘global’ Holocene climate modes at least on a decadal scale. There is need for more research incorporating recent glaciological data necessary to judge whether this phenomenon influences glacier variation on a secular scale as well. It will be crucial to indicate possible interhemispheric teleconnections and causal links.