



## **4300-year old ‘glacier forests’, southern Coast Mountains, British Columbia and their global context**

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Dendrochronologic and radiocarbon dating of in situ and detrital wood have been utilized to date Holocene glacier fluctuations in Garibaldi Provincial Park and at Pemberton Icefield in the southern Coast Mountains of British Columbia. Fieldwork at over 35 glaciers has been carried out since 2002. The focus of this paper is on wood that has been radiocarbon dated between 4500 and 4000 years ago, which has been found at six glaciers. At four glaciers the wood was washing out from beneath present-day glacier snouts. At Helm Glacier in Garibaldi Park thirteen detrital branches and stumps were recovered, and at West Squamish Glacier at Pemberton Icefield seven detrital branches, stems, and stumps were sampled. Some of these samples had diameters of up to 40 cm and were up to 250 cm long, and thus are much larger than any living trees near the present treeline. Tree-ring analysis shows that these glaciers advanced into and over mature forests that had grown near present-day glacier margins for at least 135 years (Helm) and 357 years (W Squamish). Evidence for permanent snow and ice patches forming, as well as glaciers advancing beyond present-day extents at this time is found in the central Coast Mountains, Yukon Territory, Arctic Canada, Norway, and the Swiss Alps. Glacier advances of similar age have been reconstructed not only in western Canada, but also in Europe, Asia, South America, New Zealand, and Antarctica indicating the global nature of this event. A peak in ice-rafted debris in the North Atlantic about 4200 years ago may have been the result of reduced solar output, and based on Earth’s position in the obliquity cycle glaciers should have started to expand about 4000 years ago. Furthermore, the collapses of the Mesopotamian Empire, the Egyptian ‘Old Kingdom, and the Harrappan civilization were all partly caused by regional droughts, some of which likely linked to changes to the monsoonal system due to changes in insolation. These ‘glacier forests’ thus could provide a probable start date for Neoglaciation, which coincides with major changes in ancient civilizations.