



## **Shrinking Glaciers- some observations from Western Canada**

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Most glaciers in western Canada reached their Holocene maximum extent in the early eighteenth or mid-nineteenth century. Reconstructing glacier extents prior to this period is difficult as the evidence is fragmentary and often transient in nature. The primary source is the recovery of non-glacial material from overridden paleosols and/or in situ buried forest layers exposed during recent glacier recession within the forefields or lateral moraines. These deposits can be dated by radiocarbon or occasionally by dendrochronology and indicate the position of the glacier at a specific time (e.g. an in situ trees killed by the ice). Detrital material lying on the surface or washed out of glaciers merely indicates that the glacier was some distance upvalley of the recovery site at the time given by the radiocarbon date. Glacier extent can also be inferred less directly through depositional records from lakes downvalley of the glacier, though reconstruction of the minimum extent is difficult by these methods. At sites where multiple buried sites have been identified the oldest sites are generally found furthest upvalley or lowest on the lateral moraines suggesting progressively more extensive glacier advances during the Holocene.

In the Rockies in-situ material has been dated to between 2800 and 3730 at several sites near present (1990s) glacier margins but the oldest site is a paleosol with in situ wood and detrital logs that were killed shortly after 4780 $\pm$ 60 yr BP. This site had been previously forested for at least 500 years. Detrital wood recovered from Athabasca and Dome Glaciers indicates that parts of the valley floor up-ice of the present margin at these glaciers had mature forest ca. 7800-8300 and 6100-6300 yr. BP. And the glaciers were obviously smaller than present Pollen and macrofossil data indicate that treeline elsewhere in the Rockies was higher at this time supporting the

inference of a lesser glacial cover. Present glacier extent can only be compared relative to former extent where such dated material is available and this varies from site to site. However, these data suggest that some of the larger 21<sup>st</sup> century glaciers are smaller than those 5-6000 years ago. Recent studies by Koch, Menounus et al. and Reyes et al. (all 2006) have described evidence for glacier advances over forest layers in the B.C. Coast Ranges ca 7700-7400, 6400-5100, 4400-3900, 3800-2000 and 2000-1100 yr BP. Perhaps the most interesting examples of change come from the Yukon where small residual ice (firn) patches have been discovered containing interbedded layers of caribou dung and archeological material dating back over 8000 years. These studies collectively suggest that the present glaciers may be as small as they have been in the last 5-8000 years. Studies of proxy mass balance and temperature data indicate that glacier extent at decade-century scales is linked to solar forcing and mass balance on decade-century scales is also influenced by PDO and el Niño. At the millennial scale the progressive increase in glacier extent over the Holocene suggests the primary forcing is orbital changes in incoming radiation.