Geophysical Research Abstracts, Vol. 8, 05847, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05847

Tree growth anomalies in supraglacial trees as a tool to date and locate surface movements on a debris covered glacier

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Dendroglaciological analysis is a highly interesting research topic for reconstructing recent glacial history and the climatic signal responsible for changes in the front and mass balance of a glacier. Damages inflicted on trees by glacier movements and growth anomalies have often proved to be suitable for recognising early phases of the Little Ice Age, whose morphological evidence were destroyed by following advances, and identifying periods of climate cooling associated with glacial advance phases. Nevertheless, other interesting applications are possible. Recent research conducted on the most representative Italian debris covered glacier, the Miage Glacier (Valle d'Aosta, Western Alps), has demonstrated, for the first time in the Italian Alps, how the ages distribution, growth anomalies and compression wood occurrence of supraglacial trees permit extremely precise substrate movement dating and localisation, interpreted as upheaval, melting lowering, push phenomena, with consequent movement of the debris cover. The Miage front, in fact, has two lateral lobes and a smaller central one, and the first are colonised by herbaceous, shrub and tree vegetation, the latter mainly represented by Larix decidua Mill. and Picea abies Karst., some of which reaching 3-4 m in height. Overall, 52 supraglacial larches were sampled (11 on the northern lobe and 41 on the southern one), 9 at the margin of the glacier and more than 50 along the valley slopes and in the proglacial area at similar heights, but in practically undisturbed conditions, for reference purposes. A skeleton plot and a growth curve were constructed for each sampled tree for comparison with the reference chronology to demonstrate their anomalies. The trees reach an altitude of 1940 m, with some already 5-6 years old in 2005. The oldest trees are 40 years old, while most are aged between 20 and 30 years. Stems have often contorted forms.

They underline continuous substrate movements tending to deviate the trees from the vertical, inducing the development of compression wood and growth anomalies. Compared to trees growing outside the glacier, the height and diameter of the supraglacial trees of the same age is lower. Concerning compression wood, two very precise periods are present on the northern lobe during which the sampled trees produced this tissue: 1990-1992 and 2001-2002. On the southern lobe we observe that from 1960 to 1983 the signal is almost absent, excepting that of single trees in 1971 and 1974, while in the following period, from 1984 to 2002, some trees produced compression wood every year, especially in: 1984, 1988, 1992, 1993 and from 1995 to 2002. On the other hand, 2003 appears to be particular since no trees show signals. The spatial distribution of the compression wood demonstrates particular situations occurring. For example, in 1995 movements and/or deformations can be identified at the extremity of the southern lobe, evidenced by a concentration of compression wood; in 1997, the lateral movement of the glacier has inclined, damaged and covered with debris some trees at the internal margin of the southern lobe. This movement is also recorded by growth anomalies in the supraglacial trees.