Tree rings : High resolution records of past environmental changes

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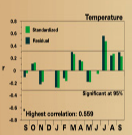
DENDRO Paleoclimatology

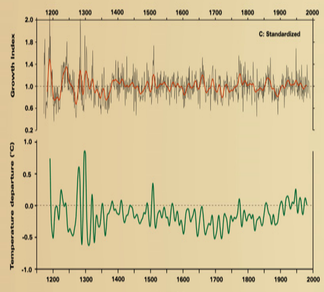
Studying the natural variability of temperature and precipitation regime

Climate changes in the Mackenzie River basin.

Eskimo Lakes



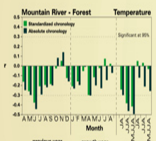
Correlation of tree growth with monthly mean temperature at Inuvik (1957-1989) for the standardized and residual Eskimo Lakes tree-line chronology.



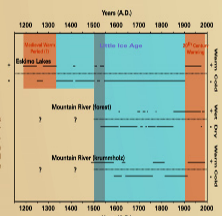
Standardized tree-ring chronology from Eskimo Lakes (tree-line) and reconstructed July temperature at Inuvik for the period 1172-1991 (departure from the 1957-1989 normal period)

Mountain River

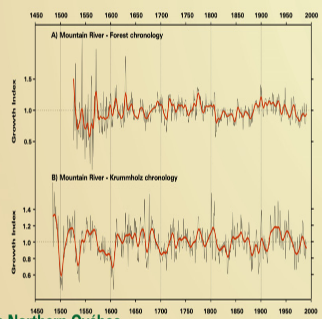
Old-growth white spruce krummholz at the Mountain River (NWT) characterized by stunted subfossil and living trees.



Climate changes inferred from tree rings

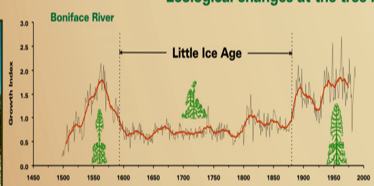


Synthesis of the reconstructed climate changes based on tree growth-climate relationship for Eskimo Lakes and Mountain River sites. Tree-growth excursions above and below the mean are indicated by straight lines while coloured sections emphasize broad scale climate changes.

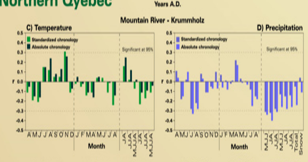


Ecological changes at the tree ligne,Northern Qyébec

Boniface River



Indexed tree-ring chronology at the tree-line in northern Québec (Boniface River) showing the same growth trends than ones observed in northwestern Canada. First order variations are related to growth form changes driven by snow level variations while high frequency fluctuations are mainly controled by mean July temperatures.



Standardized ring-width chronologies from Mountain River forest (A) and krummholz (B) sites. At forest site, tree growth is strongly influenced by the negative effect of high temperatures during the previous growing season because high temperatures impair moisture availibility in xeric sites. At krummholz site, better tree growth indicate higher temperatures (C) and lower precipitations (D) during the previous growing season.

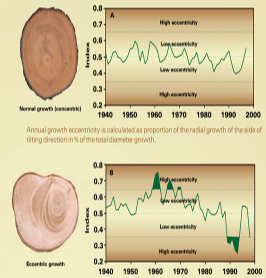
DENDRO Geomorphology

Studying the impact of climate change on earth processes

In many cases, earth processes are directly controlled by climate conditions. The historical perspective given by tree-rings allows to investigate the causual relationship between earth process dynamics and climatic conditions

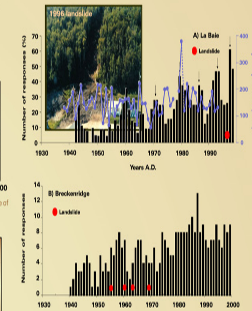
Slope dynamics in marine clay deposits

Eccentric growth, usually related to the development of reaction wood, is caused by the tilting of trees; therefore, the annual growth eccentricity can be used to monitor slope movements.



Annual growth eccentricity is calculated as proportion of the radial growth of the side of tilting direction in % of the total diameter growth.

Annual growth eccentricity for a tree growing on a stable substrate (A) compare to annual growth eccentricity for a tree growing on an unstable substrate (B).

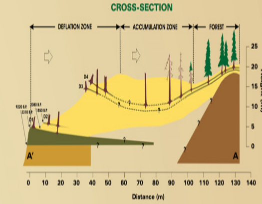


Response frequency of trees to the instability of a clay slope affected by a landslide in July 1996 in the area of La Baie (Saguenay) (A) and for a clay slope affected by failures in 1955, 1960, 1963 and 1969, in the area of the Brekenridge River (B). An annual growth eccentricity value higher than 2σ is consider as a single response. It shows that the evolution of slopes is marked by several period of degradation that lead to its failure. In the La Baie sector, higher spring precipitations seem to generate favourable conditions for slope instability.

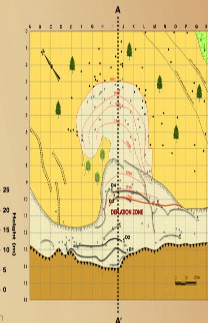
Cliff-top dune dynamics in Mountain River area NWT

Deflation zone with abundance of snags standing or lying at the sand surface.

CROSS-SECTION



Schematic longitudinal section of the cliff-top dune showing stratigraphic units and location of forest paleosols (D1 to D4).



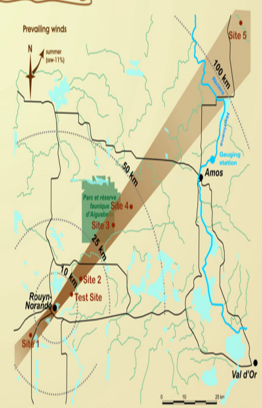
Isochronic map (10-year intervals) based on tree mortality and showing the progression of the dune front over the last century. Filled circles correspond to living tree locations while open circles indicate location of dead trees.

DENDRO Geochemistry

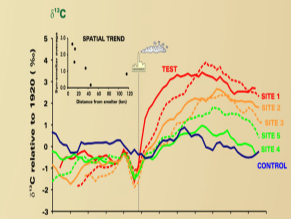
Studying the impact of anthropogenic contamination on forest ecosystem.

Objectives of DINAMITE project:

- Provide a historical perspective on environmental changes near the Horne smelter
- Distinguish natural and anthropogenic accumulations of metals in the environment
- Evaluate the impacts of smelter emissions on boreal forest

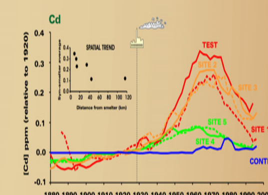


Natural tracers



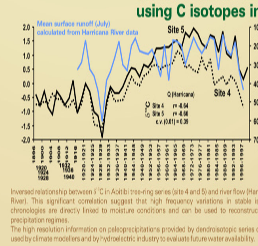
At test site, $\delta^{13}C$ values abruptly increase to +4 ‰ right after 1928 when the smelter began operations. This first order shift of 4.0 ‰ in test trees is explained by changes in their photosynthetic functions (likely stomatal closure) due to stress caused by large amounts of smelter-emitted SO_2 (and perhaps particulates). Lower CO_2 uptake caused by stomatal closure implies a reduction in photosynthetic activity. The inverse relation between the amplitude of $\delta^{13}C$ shits after 1928 and distance of sites from the smelter suggest that the impact of pollutant on photosynthesis decrease with distance.

Anthropogenic tracers



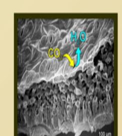
Heavy metal profiles show a significant increasing in rate of assimilation ca 12-14 years after the onset of smelter activities. This delay relatively to the smelter onset reflect the time lag for changes in soil geochemistry (pH changes, bioavailability). Metal concentrations reached maximum values at proximal sites and decreased gradually with distance from the smelter indicating a decreasing effect of emissions.

Reconstructing past water regime using C isotopes in tree rings

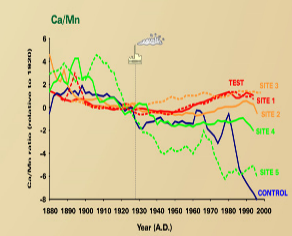


Inversed relationship between $\delta^{13}C$ in Abitibi tree-ring series (site 4 and 5) and river flow (Harricana River). This significant correlation suggest that high frequency variations in stable isotope chronologies are directly linked to moisture conditions and can be used to reconstruct past precipitation regimes.

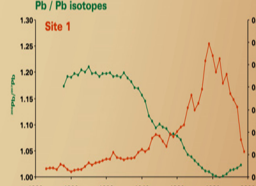
The high resolution information on paleoprecipitations provided by dendroisotopic series can be used by climate modellers and by hydroelectric industry to evaluate future water availability.



Stomata structures controlling gases exchanges at leaf surfaces are very sensitive to variations in air humidity.



The constant Ca/Mn ratio in tree-ring series at proximal sites indicate that element caracterized by a very low mobilization factor (eg. Mn) can be leached under increasing soil acidity caused by high levels of SO_2.



Changes in metal concentrations [Pb] correspond to a change in metal sources.

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