Studies with the Finnish 7644-yr Scots pine chronology

Introduction. The growth of Scots pine (Pinus sylvestris L.) is highly sensitive to June-July temperatures at the Finnish pine timberline. Exceptional preservation of pine wood and an accumulation in northeastern boreal regions of ice-cold lakes have made it possible to build a 7641-yr long continuous tree-ring chronology.

The characteristics of this chronology, the distribution of the samples (on both sides of the present timberline) and the strong June-July temperature connection have provided exceptional tools for dendroclimatic analysis and reconstruction.

Objectives. We discuss here three topics: 1. The “Past Timberline” model; 2. Climatic trends during the Last Millennium; and 3. Modeling future natural climate.

Data and Methods. The “Past Timberline” model was built by combining information from megafossil locations, lake sediments, GIS-based vegetation and climate data. Our models predicting future climate were established on two steps and climatic data. Spectral analysis was used for identifying the most significant cycles. FFT (Fast Fourier Transformation) smoothing techniques was applied to removing high-frequency variation from the chronology. Cycle pattern analysis and duplicating techniques were used in fitting the cycle history of the past 100 years as a part of our prediction models.

Results. 1. A MODEL FOR THE “PAST TIMBERLINE”. The model suggests that climate about 6000 years ago was 2.5 degrees warmer than today. More to read, check Fig. 1.

2. CLIMATE IN LAST MILLENNIUM. The warmest and coldest reconstructed 250-year periods occurred AD 911-1180 and AD 1633-1890 (Fig. 5). These periods overlap with the Medieval Warm Period (MWP) and the Little Ice Age (LIA). The coldest and warmest of all reconstructed 100-year periods occurred AD 1565-1660 and AD 1065-1098, respectively.

App. a 50-yr cycle is attributable to North Atlantic thermohaline circulation (THC) during the MWP but not during the LIA.

3. CLIMATE-TREERING RELATIONSHIPS. The most significant cycles in our supra-long chronology range from 30 to 95 years (30-37, 47-49, 51-53 and 90-95 years, Fig. 2). We hypothesize that climate during the last 100 years has had a varying cyclic pattern of 60-95 years. Our two models predict natural climatic variation for the rest of this century (Fig. 7) lean on this judgment.

Conclusions. Detailed picture of temperature evolution shows that MWP was a long unremarked interval with mean temperature warmer than temperatures during the following centuries but not warmer than during the 20th century. Cooling of climate since the MWP until the termination of the LIA follows the hemispheric trend supposedly by orbital forcing and changes in sea water activity, amplification of volcanic signature years and hemispheric vegetation changes with amplifying mechanism from regional Forest limit retreat. THC further appears to be an agent behind the initiation and continuation of MWP and the mid-LIA transitory warm.

We assume in our climate prediction model that the last cold maximum occurred in 1348, 1640, 1710, 1755 and 1832 and the minimum in 1610, 1710, 1793, 1895 and 1970. Applying the varying cycle of 80–95 years, the next warm cycle should peak some 2050–2060 and the next cool one 2090–2095.

One should, however, note that climate is basically a chaotic system with a number of unknowns and uncertainties. Abrupt changes in climate and switching to alternative climate modes may make it very difficult to build reliable models even in our case i.e. providing only future natural climate variation.

Fig. 3. 50-yr FFT smoothing visualises the 60–95-yr cyclicity in the tree-ring chronology.

Fig. 4. Finnish timberline region (Spits with horizontal lines) is close to Arctic and neighboring vegetation.