

Recent Fennoscandian Pine Records of Temperature, Precipitation and the North Atlantic Oscillation

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Various climatic phenomena have recently been extracted from ring widths of Scots pine (*Pinus sylvestris* L.) in Fennoscandia. Individual chronologies have provided millennial temperature proxies in the northern forest-limit region and records of relative drought in the south. Furthermore, networks of pine chronologies have provided reconstructions of the North Atlantic Oscillation.

Reconstruction of Summer Temperature

Mid-summer (July) temperatures since 50 years AD have been reconstructed in Lapland, (68–70° N, 20–30° E) (Fig. 1) (Lindholm and Eronen 2000). Seasonal anomalies indicate that the warmest summer was experienced in 535 AD (2°C above the mean), although warm summers of similar amplitude occurred at least once every 200 years between 1,000 and 1,800 AD. The coldest summer (2°C below the mean) was recorded in 1601. The most dramatic interannual shift (greatest difference between any consecutive pair of years) took place between the summers of 535 and 536 AD.

The non-overlapping 100-year means of summer temperatures show little evidence of a Medieval Warm Epoch or the Little Ice Age in Fennoscandia. This only applies to

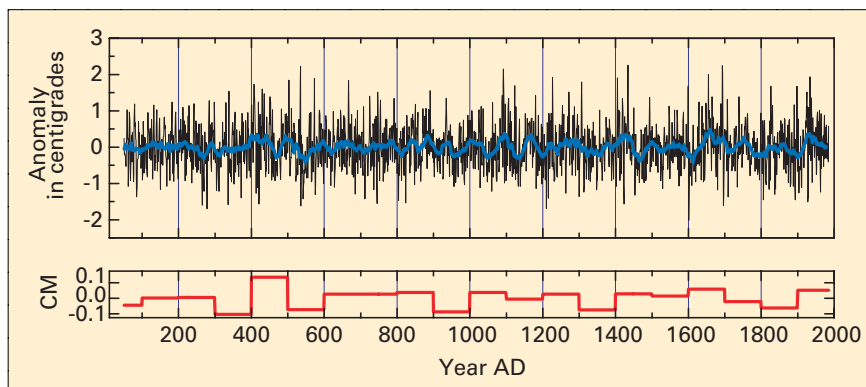


Fig. 1: Reconstructed northern Fennoscandian summer temperature anomalies (July mean). 20-year centred moving averages superimposed on interannual variability (upper plot). Non-overlapping 100-year means (CM) showing centennial variability (lower plot).

summer climate and not to other seasons.

During the whole reconstruction period, the 4th century was the coolest with anomalies 0.104 below the mean. The warmest century was the 5th with anomalies 0.136 above the mean. Somewhat unexpectedly, the 20th century is only the third warmest (0.0514 above the mean) for the last two thousand years. This reconstruction work is presently being extended using a 7500-year chronology (Eronen et al. 1999).

Seasonal North Atlantic Oscillation

A network of 30 pine chronologies from various parts of the boreal forest belt in Fennoscandia were cali-

brated against seasonal indices of the North Atlantic Oscillation (NAO) by Lindholm et al. (2001). The northernmost pines, from the forest-limit region, proved to be sensitive to summertime variations of the NAO, while most southern pines respond to winter variations in the NAO index. Our north to south transect of growth response data shows a drastic shift directly south of the northern boreal belt. The southern part of the pine network was used for building a transfer model of winter-time NAO between 1893–1981 (Fig. 2). This network is being actively expanded spatially and temporally to complement the increasing experimental activities in reconstructions of various aspects of the NAO.

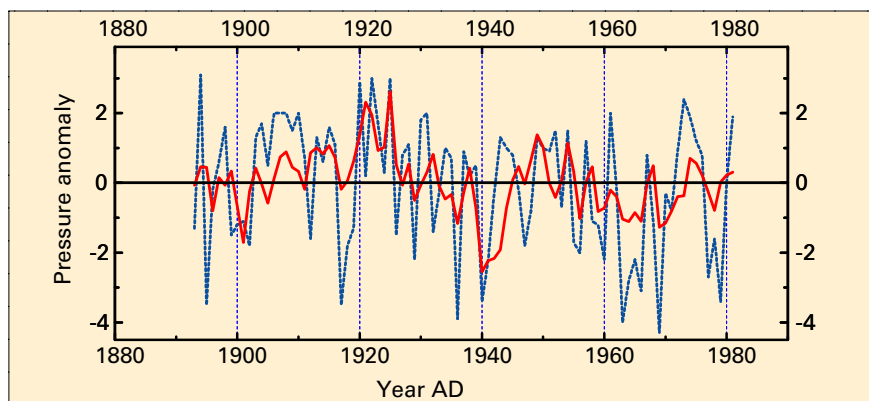


Fig. 2: The actual winter NAO index (blue, dash) plotted together with the modelled values (red, solid). The experimental model was built using 17 Fennoscandian pine chronologies south from the northern forest-limit region. Although the model explains only one quarter of the dependent winter NAO variance, the verification statistics show reasonable skill in reconstruction.

REFERENCES

- Eronen, M., Lindholm, M., Saastamoinen, S. and Zetterberg, P., 1999, Variable Holocene climate, treeline dynamics and changes in natural environments in northern Finnish Lapland. *Chemosphere: Global Change Science*, **1**, 377–387.
- Helama, S. and Lindholm, M., submitted, to *Boreal Environment Research*.
- Lindholm, M., Eggertsson, Ö., Lovelius, N., Raspopov, O., Shumilov, O. and Läänelaid, A. 2001. Growth indices of North European Scots pine record the seasonal North Atlantic Oscillation. *Boreal Environment Research*, **6**, 1–10.
- Lindholm, M. and Eronen, M., 2000, A reconstruction of mid-summer temperatures from ring-widths of Scots pine since AD 50 in northern Fennoscandia. *Geografiska Annaler*, **82A**, 527–535.