Reconstruction of regional drought indexes in southern Sweden since 1750 AD

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Objectives

In this study we present a dendrochronological reconstruction of drought conditions for two areas of the southern Scandinavia, centred on 57.0° N 12.7° E and 58.8° N 18.2° E, respectively. Although both areas are located in the temperate zone, there is considerable variation in the precipitation and temperature regimes between them.

North-East part of the region is characterized by predominance of high pressure systems during the growing period, which results in the high amount sunshine and low amount of precipitation during the summer months (Lundin, 2009).

The south-west part of the area experience one of the largest amounts of Atlantic-originated precipitation within Scandinavia, with lower amount of sunshine and temperature.

For each of these areas we employ bioclimatic model to calculate the drought index of growing period, which is believed to provide a realistic representation of the physiologically relevant dynamics of soil water availability. We use drought-sensitive oak (*Quercus robur* L.) chronologies to independently parameterize the relationship between tree-ring growth and the drought index for two areas and proved reconstruction of the drought index till the year 1750.

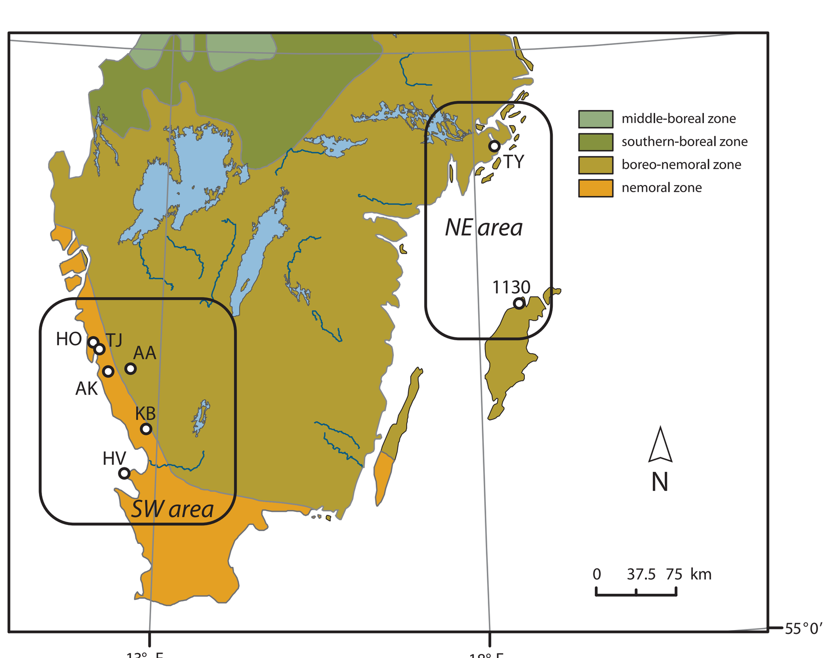

Fig. 1. Two areas and respective study sites used in the reconstruction of the growing season drought index. Boundaries of vegetation zones are according to the Swedish National Atlas (SNA, 2001).

Contexte

Reconstructing past variation in water availability can help identify dominant modes of climatic variability closely related to physiological processes of growth. Despite its rather northern location, the region of Southern Sweden is affected by summer droughts, which results in regional negative growth anomalies.

A study of recent oak growth trends revealed that such growth anomalies have an effect on the growth in the following years and can be important drivers of biomass accumulation in forest ecosystems at above-annual timescales (Drobyshev et al., 2008). Future climate projections suggest an increased frequency of drought episodes in Northern Europe (Rummukainen et al., 2001; Brabson et al., 2005), which may imply even stronger dependence of tree growth on water availability in this region. It is thus of immediate practical interest to analyse the historical dynamic of water availability and to identify its likely driving factors.

Growing season drought index

Dates of the beginning and ending of the growth season, defined as period with daily values of average temperature above 5 °C, was calculated for each year in the bioclimatic model STASH (Sykes et al., 1996). The model was used to calculate the ratio of actual to equilibrium evapotranspiration (AET/EET) as a measure of growing-season drought. The water supply is proportional to soil moisture (Federer, 1982), calculated for a one-layer bucket model (Prentice et al., 1993).

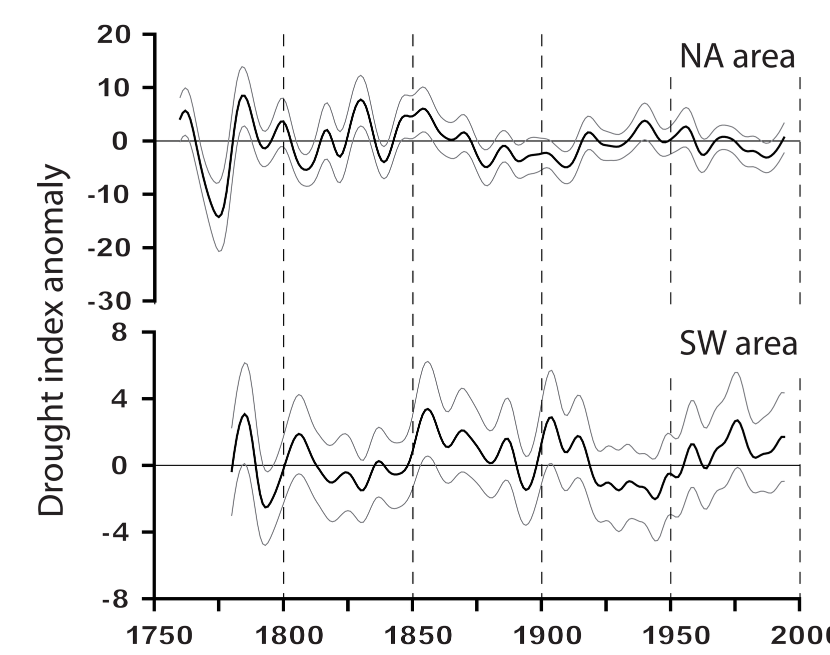

Fig. 2. Reconstructions of growing season drought index for two areas in southern Fennoscandia (SW and NE, see Fig. 1). Data is smoothed with Gaussian filter. Thin gray lines are confidence interval envelops at p = 0.9. Data ispresented as departures in drought index from the long-term mean (1922-2000) at each location.

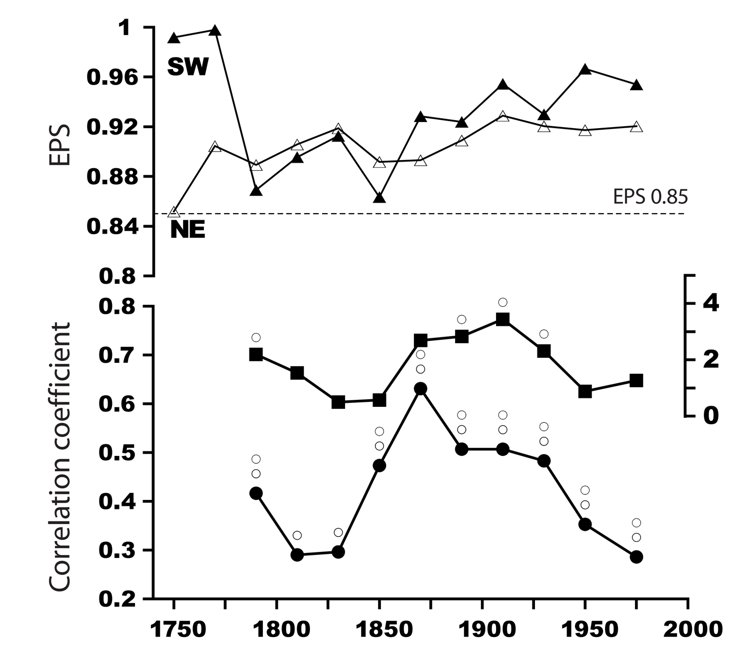

Fig. 3. Expressed population signal (EPS) of two master chronologies and association between the master chronologies, expressed as correlation and T coefficients (40 year time frame, overlapping by 20 years).

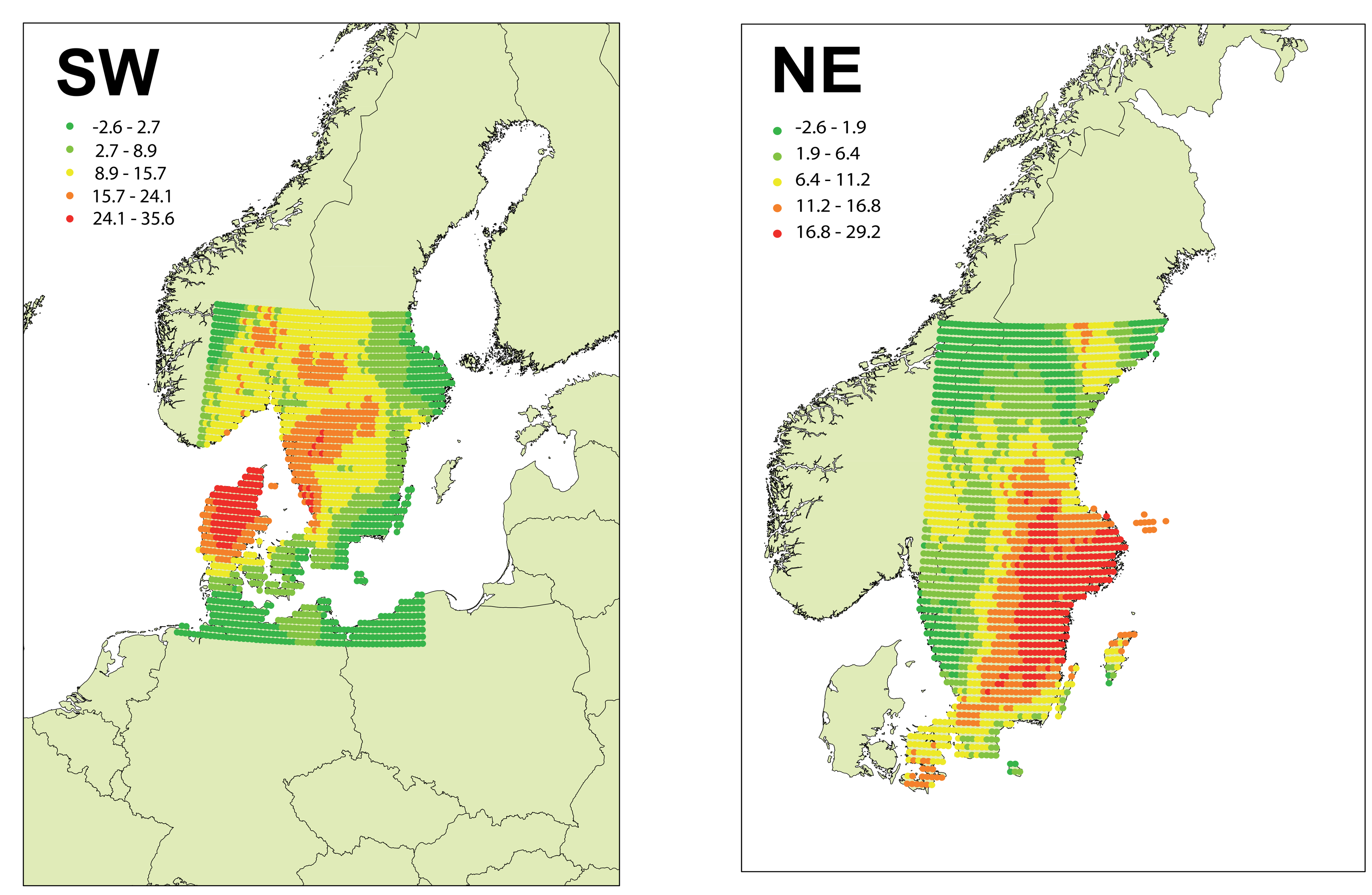

Fig. 4. Point correlations between drought index, reconstructed from a sub-regional regional oak chronology and the grid of drought indexes calculated from instrumental dataset (ALARM dataset, 1922-2000). Color represents amount of explained variation in linear regression between reconstructed index and the empirical data.

Results

(1) Regional reconstruction for SW area suggests 1790s, and generally first half of the 1900es, and possibly first hafl of 1800 as wet periods; a trend towards higher drought during vegetation period is observed during the second half of the 20th century.

(2) Regional reconstruction for NE area suggests wet periods around 1775, early 1800es, 1840es, as well as during 1875-1920. No clear trend is visible during the second half of 20th century.

(3) Comparison of regional master chronologies and the analysis of point correlation patterns indicate regional differences in the dynamics of drought index. SW and NE reconstructions reflect two different weather patterns, associated with the south-eastern Swedish coast of the Baltic sea (NE reconstruction) and the Kattegat area (SW reconstruction).