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Spatial variations of temperature on a coastal site in Sweden as a response to insolation

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Temperature and humidity are major factors controlling ecosystem development. In a context of changing climate, the spatial distribution of temperature is likely to be affected, and species distribution might be subsequently modified. In particular, topographic heterogeneity is affecting the micro-climate and thus regulates the expansion or restriction of species in a landscape. During a change of climate, certain species might become restricted to localized refugia, or on the contrary expand from old refugia when the overall landscape becomes favorable.

In this research we are using GIS based model of incoming solar radiation and subsequently derived monthly averaged temperatures to increase the understanding of changes in local climate and how it affects species repartition. The model is based on topography and observed variations in atmospheric conditions and is accounting for site latitude, elevation, surface orientation, daily and seasonal shifts in sun angle and the effect of shadows from the surrounding topography.

A 2500 km2 forested field site located on the western coast of Sweden, along the Baltic Sea, is investigated both in terms of temperature heterogeneity and plant communities. We derive 50 m resolution insolation maps and analyze the response of monthly temperature to insolation. Surface and near surface temperatures are measured by a dense network of temperature sensors during the spring and summer of 2011 and are used for comparison with the modeled temperature maps.

We investigate the potential of this modeling approach to scale climate trend analysis down to local climate change in heterogeneous landscapes. We build on the methodology used by Huang et al. (2008) in a mountain ecosystem and develop it for use on a coastal site that is largely influence by the presence of the sea. The time lag that is appropriate between insolation and subsequent temperature response appears to be influenced by the presence of a large water body and follows an exponential decay from the coastal to the inland measurement sites. We use the insolation and an appropriate time lag dependent on the distance to the sea in a linear regression model to derive estimates of spatially distributed temperature in our landscape. The dataset indicates a strong potential for monthly temperature to be predicted from solar radiation.

Huang, S., Rich, P.M., Crabtree, R.L., Potter, C.S., Fu, P., 2008. Modeling Monthly Near-Surface Air Temperature from Solar Radiation and Lapse Rate: Application over Complex Terrain in Yellowstone National Park. Physical Geography 29, 158–178.