



Palaeo volcanoes, solar activity and tree-ring responses over the last millennium

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It has been analyzed the external factor (solar activity, volcanic eruptions) influence on tree growth at the Kola Peninsula, northwestern Russia. *Pinus sylvestris* L. (Scots pine) tree-ring chronologies collected nearby the northern timberline (68.63N, 33.25E) include the oldest (1445-2005 AD) living pine tree found up to date in the Kola Peninsula. A total of 18 living trees *Pinus sylvestris* were sampled taking two cores. Tree rings measured with a precision of 0.01 mm by using an image analysis system (scanner and relevant software). The samples were cross-dated using standard dendrochronological practices and the COFECHA program. A negative exponential curve was used to remove the age trend from individual annual ring series prior to construction of the chronology using the ARSTAN program. It was shown that the past climatic variations in the Kola Peninsula were fairly strongly connected to solar variability and volcanic activity. The results of both MTM and wavelet analysis permitted us to select periodicities in our tree-ring record corresponding to solar cycles: 11.7, 22, 50-66, and 80-100 years. Maunder (1645-1715 AD) and Dalton (1801-1816 AD) minima of solar activity were also reflected in our tree-ring record. A superposed epoch analysis of 18 large (Volcanic Explosivity Index, $VEI > 5$) volcanic events revealed a significant ($p < 0.05$) suppression of tree growth for up to 8 years following volcanic eruptions. As well we considered volcanic signal in the other remote regions in Russia (Taymir, Siberia), Scandinavia and Northern America (Alaska and California) for several volcanic events. The data analysis enabled us to get some conclusions on the past climate variations and to demonstrate the relation of global and regional climatic variations in the northern hemisphere.