Geophysical Research Abstracts,
Vol. 11, EGU2009-6594-1, 2009
EGU General Assembly 2009

Daily atmospheric circulation patterns from the North Atlantic region as recorded in high-resolution stable isotope records from Greenland ice cores

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We investigate the relationship between decadal variability of several stable isotope (deuterium and oxygen 18) high-resolution records from Greenland ice cores and the frequency of daily circulation patterns from the North Atlantic realm. Daily circulation patterns as well as their seasonal frequencies for the period 1850-2003 used in this study were published by Philipp et al. (2007). The main source of stable isotopes is the world ocean. During their path from the oceans to the Greenland ice sheet the concentration of heavy relative to light stable isotopes is modified by different fractionation processes. The fractionation depends on the moisture source locations and conditions, temperature of condensation, rain-out effect, amount effect, altitude effect, re-evaporation and kinetic processes. A correlation analysis reveals that a large part of stable isotopes decadal variability from Greenland ice cores is controlled by a summer atmospheric circulation pattern (pattern 2 according to Philipp's et al. classification). Analysis of the moisture transport using NCEP/NCAR reanalysis fields suggests a strong rain-out effect associated with this circulation pattern. This may explain the strong correlation between the frequency of this pattern and stable isotope variability from Greenland ice cores. We argue that high-resolution stable isotope records from Greenland can be used to reconstruct the frequency of certain daily circulation patterns during past periods. This helps to put the decadal variations of the daily circulation patterns as identified from analysis of observed data into a long-term context.

Reference

Philipp A, Della-Marta PM, Jacobeit J, Fereday DR, Jones PD, Moberg A, Wanner H. 2007: Long-term variability of daily North Atlantic-European pressure patterns since 1850 classified by simulated annealing clustering. J. Climate 20: 4065-4095, doi: 10.1175/JCLI4175.1