Geophysical Research Abstracts
Vol. 17, EGU2015-11723-1, 2015
EGU General Assembly 2015

Changes in surface solar radiation in Northeastern Spain over the past six centuries recorded by tree-ring δ^{13}C

Isabel Dorado Liñán (1), Arturo Sanchez-Lorenzo (2), Emilia Gutiérrez Merino (3), Octavi Planells (3), Ingo Heinrich (4), Gerhard Helle (4), and Eduardo Zorita (5)

(1) Technische Universität München. Chair of Ecoclimatology. München, Germany, (2) Pyrenean Institute of Ecology, Spanish National Research Council (CSIC), Zaragoza, Spain, (3) Universitat de Barcelona. Departament d'Ecologia. Barcelona,Spain., (4) Helmholtz Centre Potsdam. German Centre for Geosciences. Climate Dynamics and Landscape Evolution. Potsdam,Germany, (5) Helmholtz-Zentrum-Geesthacht. Institute for Coastal Research. Geesthacht, Germany

Stable carbon isotopes in tree rings (δ^{13}C) are assumed to be well established proxy indicators of past variations of temperature and hydroclimate variables. The discrimination of ^{13}C in the organic matter (i.e. tree rings) reflects the balance between the leaf photosynthetic rate and the stomatal conductance to CO_2 [Farquhar et al., 1982] which are strongly dependent on environmental variables such as temperature, humidity, and solar radiation. The control exerted by solar radiation on the physiological processes underlining carbon discrimination in tree rings suggests the large potential of this palaeoproxy in estimations of past changes of light availability. Based on that theory, some studies have successfully achieved the reconstructions of cloud cover and sunshine duration based on δ^{13}C variations on tree-rings [i.e. Gagen et al., 2011; Loader et al., 2013]. However, the largely inter-dependence of the climate factors governing plant physiological processes hampers the unequivocal identification of the most limiting driver of isotope discrimination in a given region (e.g., surface solar radiation signals can be easily misinterpret as temperature signals). Similarly, surface solar radiation, sunshine duration and percentage of cloud cover largely covary but the short instrumental series hinder the detection of the non-linearities and thus the identification of the main driver of plant growth. We present a detailed study in northeast Spain in which the use of several station data and the effect of the volcanic eruptions on both instrumental and tree-ring data revealed surface solar radiation as the main driver of ^{13}C discrimination in tree rings. Based on that relationship, we develop a surface solar radiation reconstruction in northeast Spain that covers the last 600 years. The relationship between past temperature and past SSR at this site is complex, with no clear linear relationship that could be used to infer the sign of a cloud cover feedback. Our results show the potential of using volcanic eruptions to discern the main driver of ^{13}C discrimination and the need to extend the geographical coverage of δ^{13}C chronologies to better understand the interaction between past temperatures and SSR on continental scales, a key parameter contributing to the overall climate sensitivity.

References

Farquhar, G. D., M. H. O'Leary, and J. A. Berry (1982), On the relationship between carbon isotope discrimination and intercellular carbon dioxide concentration in leaves, Austral. J. Plant Physiol., 9, 121–137.

Gagen, M., E. Zorita, D. McCarroll, G. H. F. Young, H. Grudd, R. Jalkanen, N. J. Loader, I. Robertson and A. J. Kirchhefer (2011), Cloud response to summer temperatures in Fennoscandia over the last thousand years, Geophys. Res. Lett., 38, L05701, doi: 10.1029/2010GL046216.

Loader, N. J., G. H. F. Young, H. Grudd, and D. McCarroll (2013), Stable carbon isotopes from Torneträsk, northern Sweden provide a millennial length reconstruction of summer sunshine and its relationship to Arctic circulation, Quaternary Sci. Rev., 62, 97–113.