Geophysical Research Abstracts
Vol. 20, EGU2018-16185-1, 2018
EGU General Assembly 2018

Oxygen isotopes in tree rings from Canary Pine as recorders of fog interception on La Palma

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Climatic variations in transitional areas from temperate to tropical regions determine the fate of local ecosystems. In some of this regions, the lack of climate records limits predictions of future climate conditions. The Canary Archipelago is such a transition zone, where atmospheric stratification caused by the Azores High and humid trade wind influence, causes distinct altitudinal gradients in vegetation. A stratocumulus cloud layer ("sea of clouds" as locally named) is formed under atmospheric stability conditions, leading to increased and isotopically heavier water supply for vegetation due to fog water droplets interception, compared to precipitation occurring under atmospheric instability conditions (isotopically lighter water). Thus, the altitude, thickness and annual frequency of the sea of clouds determines the amount of local water input on the islands. These specific climatic conditions are, however, only scarcely recorded due to the lack of climatic stations in general and the absence of instruments for quantification of water interception in particular.
In order to obtain a long-term register of the influence of the sea of clouds on vegetation, we combine dendrochronology and stable oxygen isotope analysis in plant tissues of Pinus canariensis. This species is endemic on the Canary islands and dominates vegetation between 200 and 2000 m.a.s.l., particularly on the island of La Palma. Trees damaged during volcanic eruption allowed us to obtain past oxygen isotope signatures on different recovery stages from crownless to fully crown recovered trees and to compare them to pre-eruptive tree-ring values. Four pine trees from 1780 to 1915 m.a.s.l. damaged by an eruption in 1949 were felled and 5 slices were taken from each tree. Dendrochronological measurements were performed following standard procedures. Oxygen isotope ratios were analyzed in tree-ring cellulose extracted from pools of 5 tree rings.
Trees damaged by volcanic eruption showed high δ18O values, ranging from 36.29 to 40.27‰The first tree rings formed after the volcanic damages showed, however, significantly lower isotope values compared to pre-eruptive rings and the following post eruptive rings. High δ18O values may be related to the uptake of isotopically enriched water from fog interception. Fog interception by vegetation is dependent on leave surface, thus interception in our studied trees was minimum after volcanic damages, and increased with recovery of the foliar surface. Therefore, lower oxygen values of the first post-eruptive formed rings corresponded with a lower fog intercepted water input. Besides tree-ring width indices were positively correlated with δ18O values, i.e. heavier isotope values were related to wider rings, as higher quantities of fog water may have been intercepted, increasing the water availability for pine that is its limiting resource at this altitude.