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Isotopic composition of water vapor near the air-water interface

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Evaporation is a key process in water cycle that links liquid water to the atmosphere. In the last fifty years stable isotopes of hydrogen and oxygen have been intensively used to describe climate processes related to evaporation and precipitation, ranging in different spatial and temporal scales. Evaporation introduces large isotopic effects in the phases involved. The well known Craig-Gordon model (Craig & Gordon, 1965) describes those isotopic effects involving several steps and different processes, moving from the air-water interface to the free atmosphere. However, very few works in literature have tested the vertical behavior of the Craig-Gordon model in natural conditions on both fresh and marine waters. In this work we present the results from four field experiments aimed to describe the vertical variability of δ^{18}O and δD in the first few meters over a large water body (the coastal lagoon of Venice, northern Italy) and to test the Craig-Gordon model in such conditions. Each experiment involved cryotrapping of water vapor at different height over the water surface (0.1m, 2m and 4m) and the sampling of the liquid water at two depth (surface and 0.5m). During the experiments, water vapor was also sampled in the nearest mainland (2.5 km from gradient measurements) to determine the isotopic composition of background water vapor. Liquid samples were then analyzed with a Picarro L1102-i and Thermo-Fisher Delta Plus Advantage for water vapor and lagoon water, respectively. The last two experiments have also involved simultaneous measurements of relative humidity using commercially-available humidity probes at each height. This approach was used to determine a reference scale in order to compare observations to modeled estimates. Despite the coarse time resolution due to cryotrapping method (measurements are averaged over 1.5 hours), preliminary results show measurable differences in the isotopic composition of water vapor along the vertical gradient and good agreement between observations and predicted values from the model. Even if this work is an exploratory phase it shows an interesting potential to grow our understanding of the processes involved as well as a useful implementation for future studies focused on fractionation of water isotopes due to evaporation in natural conditions.

References

Craig, H., & Gordon, L. I. (1965). Deuterium and oxygen 18 variations in the ocean and the marine atmosphere.