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Tropospheric moisture transport pathways and stable water isotopes over the eastern subtropical North Atlantic

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The subtropical atmospheric water cycle is a key component in the climate system. The free tropospheric humidity and the low cloud cover over the subtropical oceans strongly affect the global radiative balance via the greenhouse and the albedo effects. However, the complex interaction of atmospheric processes controlling the subtropical tropospheric moisture budget and the formation of low clouds is still not fully understood and not well represented in climate models.

Stable water isotopes have proven to be highly useful to investigate the physical mechanisms involved in the atmospheric water cycle. They are natural tracers of water phase changes and hence capture the microphysical history of air parcels. Additionally, due to the distinct fingerprints of air masses with different origin, the isotopic composition of water vapor can further provide indirect information about atmospheric processes without phase changes involved, for instance, turbulent mixing or large-scale water vapor transport.

To enhance our understanding of moisture pathways and mixing processes over the subtropical eastern North Atlantic, we combine ground-based NDACC FTIR and ISOWAT aircraft MUSICA isotope observations (http://www.imk-asf.kit.edu/english/musica.php) with dedicated high-resolution simulations of the isotope-enabled regional weather prediction and climate model COSMOiso. The isotope simulations are complemented by two diagnostic tools: (i) kinematic backward trajectory calculations based on COSMOiso output and (ii) passive tracers following water that evaporates from specific source regions throughout the simulation (the so-called tagging technique). Based on this combination, we can quantitatively investigate the physical processes driving isotopic variability on time scales of hours to days in contrasting climatic conditions over the eastern subtropical North Atlantic and the connection of this isotopic variability to moisture contributions from different sources. In particular, the importance of moisture export from the African continent to the North Atlantic within the Saharan Air Layer as well as the mixing between the marine boundary layer and the free troposphere are assessed.