Geophysical Research Abstracts
Vol. 21, EGU2019-18398, 2019
EGU General Assembly 2019

Relation between the water isotopic composition in the North Atlantic marine boundary layer and the boundary layer dynamic

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Water isotopes are powerful tracers of the hydrological cycle and can be used to serve many purposes in climate research. Here, we use water isotopic measurements – in the vapour and in the precipitations – from Bermuda and Iceland measurement facilities, as well as from the Infrared Remote Sensing Interferometer (IASI), to investigate the feedback between evaporation and the boundary layer development through shallow convection. The frequent intrusion of cold and dry air from the Northern American Continent (in the case of Bermuda), or from the Greenland ice sheet (in the case of Iceland), over the relatively warm Norther Atlantic ocean result in a rapid increase in the surface fluxes of heat and moisture from the sea surface and the subsequent development of boundary layer through shallow convection. Due to their sensitivity to mixing and evaporation, surface water isotopes can therefore be linked to different states of the boundary layer.

From water isotopes measurements and with the help of a simple model, we demonstrate the importance of vertical mixing in the development of the boundary layer and in controlling the humidity budget in the MBL. We also present an example where the detrainment of MBL air in the free troposphere influences the isotopic signal in the free troposphere. By using surface measurements, boundary layer depths and backward trajectory analyses arriving in the free troposphere we managed to reproduce the characteristic pattern observed in the free troposphere, highlighting the role of the MBL dynamic on the free tropospheric humidity.