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Evaluation of the representation of the hydrological cycle in Western Siberia in the LMDZ general circulation model using ground-based and satellite measurements of water vapor and precipitation isotopic composition

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The hydrological and biochemical cycles in regions of peatlands and permafrost are particularly sensitive to climate perturbations. Credible climate change projections in these regions require a realistic representation by climate models of atmospheric and hydrological processes specific to those regions. In this context, observations of the water vapor and precipitation composition are emerging as an additional constrain to better evaluate the realism of the representation of the hydrological cycle by models. In high latitude regions, the water isotopic composition keeps an imprint of various processes such as distillation of air masses, evaporation and transpiration recycling air masses along trajectories, cloud processes and vertical mixing.

In this study we evaluate the isotopic composition simulated by LMDZ general circulation model in Western Siberia against a combination of isotopic measurements in precipitation and in water vapor. First, the GNIP and SNIP networks provide information on the geographical and seasonal variations of $H_2^{18}O$ and HDO composition (yielding δD and d-excess) in precipitation. Second, in-situ measurements by a Picarro analyzer and ground-based FTIR retrievals document hourly to seasonal variability in δD and d-excess in low-level water vapor at the site of Ekaterinburg in Western Siberia. Third, satellite measurements using the GOSAT and TES satellite instruments document the geographical and temporal (intra-seasonal to seasonal) variations of water vapor δD in the total column and at different levels of the troposphere respectively.

To first order, observed geographical and temporal variations at different time scales are well captured by LMDZ, though the latitudinal gradient and the daily variability in water vapor δD are underestimated. Simulations are investigated to interpret these model-data differences in terms of physical processes. In particular, sensitivity tests to the representation of transport, cloud processes and continental recycling are analyzed. Precipitation and water vapor δD and d-excess data are combined in an attempt to better evaluate continental recycling and its pathways (evaporation vs transpiration).

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