Geophysical Research Abstracts
Vol. 15, EGU2013-5194, 2013
EGU General Assembly 2013

HDO/H_2O Retrievals from Shortwave infrared soundings of GOSAT

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Water vapour is the most important greenhouse gas and an accurate representation of the water cycle and its associated feedback mechanisms are crucial for reliable climate model predictions. The water cycle is a complex system involving many different competing processes. Thus it is important that climate models do not only manage to reproduce the atmospheric water vapour concentrations but also that the individual processes are correctly represented. The isotopic composition of water vapour between $H_2^{16}O$ and the heavier HDO (or $H_2^{18}O$) changes during phase changes due to condensation and evaporation. In addition, kinetic and equilibrium fractionation yield different HDO/H_2O ratios. Thus, the history of water vapour in an air parcel is imprinted in the ratio of HDO/H_2O and measurements of the HDO/H_2O ratio can contribute to improving our understanding of the processes involved in the water cycle and allow critical testing of the water cycle representation in climate models.

We report a new shortwave infrared (SWIR) retrieval of the column-averaged HDO/H_2O ratio from the Japanese Greenhouse Gases Observing SATellite (GOSAT). From synthetic simulation studies, we have estimated that the inferred δD values will typically have random errors between 20‰ (desert surface and 30^o solar zenith angle) and 120‰ (conifer surface and 60^o solar zenith angle). We find that the retrieval will have a small, but significant sensitivity to the presence of cirrus clouds, the HDO a priori profile shape and atmospheric temperature, which has the potential of introducing some regional-scale biases in the retrieval. From comparisons to ground-based column observations from the Total Carbon Column Observing Network (TCCON) we find differences between δD from GOSAT and TCCON of around -30‰ for northern hemispheric sites which increase up to -70‰ for Australian sites. The bias for the Australian sites significantly reduces when decreasing the spatial co-location criteria, which shows that spatial averaging contributes to the observed differences over Australia. The GOSAT retrievals allow mapping the global distribution of δD and its variations with season and we find in our global GOSAT retrievals the expected strong latitudinal gradients with significant enhancements over the tropics. The comparisons to the ground-based TCCON network and the results of the global retrieval are very encouraging and they show that δD retrieved from GOSAT should be a useful product that can be used to complement datasets from thermal-infrared sounder and groundbased networks and to extend the δD dataset from SWIR retrievals established from the recently ended SCIAMACHY mission.