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Studying the impact of overshooting convection on the tropopause tropical layer (TTL) water vapor budget at the continental scale using a mesoscale model

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Abstract

Water vapour budget is a key component in the earth climate system. In the tropical upper troposphere, lower stratosphere (UTLS), it plays a central role both on the radiative and the chemical budget. Its abundance is mostly driven by slow ascent above the net zero radiative heating level followed by ice crystals' formation and sedimentation, so called the cold trap. In contrast to this large scale temperature driven process, overshooting convection penetrating the stratosphere could be one piece of the puzzle. It has been proven to hydrate the lower stratosphere at the local scale. Satellite-borne H_2O instruments can not measure with a fine enough resolution the water vapour enhancements caused by overshooting convection. The consequence is that it is difficult to estimate the role of overshooting deep convection at the global scale. Using a mesoscale model i.e., Brazilian Regional Atmospheric Modelling System (BRAMS), past atmospheric conditions have been simulated for the full wet season i.e., Nov 2012 to Mar 2013 having a single grid with horizontal resolution of $20km \times 20km$ over a large part of Brazil and South America. This resolution is too coarse to reproduce overshooting convection in the model, so that this simulation should be used as a reference (REF) simulation, without the impact of overshooting convection in the TTL water budget. For initialisation, as well as nudging the grid boundary in every 6 hours, European Centre for Medium-Range Weather Forecasts (ECMWF) analyses has been used. The size distribution of hydrometeors and number of cloud condensation nuclei (CCN) are fitted in order to best reproduce accumulated precipitations derived from Tropical Rainfall Measuring Mission (TRMM). Similarly, GOES and MSG IR mages have been thoroughly compared with model's outputs, using image correlation statistics for the position of the clouds. The model H_2O variability during the wet season, is compared with the in situ balloon-borne measurements during the TRO-pico campaign from Bauru, Brazil. Cloud tops of the REF simulation are evaluated from the GOES-E cloud top products. Finally, the thermal structure and evolution of the TTL in the REF simulation is evaluated from a comparison with series of radiosounding from different stations. The role of the solar activity in the variability of the thermal structure is also discussed. Globally the REF simulation is doing a rather good job in reproducing the key patterns of the TTL mentioned above, though quantitative biases are sometimes highlighted. The following step is to perform a similar simulation as REF, but injecting the hydration by overshooting convection, deduced from both the hydration rates taken from the TRO-pico balloon campaign at the local scale, and overshooting climatology taken from AMSU and comparable microwave satellite borne instruments. Preliminary results from this second simulation will be given in the presentation.

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