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Interactive comment

Interactive comment on "Mesoscale simulations of tropical cyclone Enawo (March 2017) and its impact on TTL water vapor" *by* Damien Héron et al.

Anonymous Referee #2

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The article by Damien Héron and coauthors investigates the impact of deep convection associated with tropical cyclone Enawo in March 2017 on water vapour in the tropical tropopause layer using high-resolution cloud-resolving modeling with Meso-NH model. The effect of tropical cyclones on the gaseous composition of the tropical lower stratosphere is a topical issue given the lack of consistency across the various observational and/or modeling studies on this subject that provide highly variable estimates on the magnitude and even the sign of the effect of overshooting convection on TTL/LS water vapour.

The paper is fluently written and easy to follow. The experimental and modeling setup is comprehensively described. The results of MesoNH simulation are compared with various types of observations regarding the accumulated precipitation (GPM); water

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Discussion paper

vapour and state parameters (CFH balloon sounding from La Reunion island several hundred kilometers away from Enawo); IR brightness temperature (METEOSAT8) and ice water content derived from a CALIOP transact across the cyclone. The simulations are further reported as mass fluxes and vertical profiles of vapour and ice as well as the horizontal evolution of water vapour immediately above the tropopause relative to the TC center. The simulated cross-sections through the overshooting cloud suggest peak values of water vapour reaching 40-50 ppmv above 380 K level, whereas an average profile within 500 km radius shows an enhancement of up to 2.1 ppmv between 17 – 19 km, which is attributed to TTL hydration as a result of sublimated ice crystals detrained by overshooting updrafts of TC Enawo.

The results of simulation are upscaled to the global tropics using IBTrACS statistics on TCs and the authors conclude that the tropical cyclones are responsible for the global tropical lower stratosphere moistening of 0.3 – 0.5 ppmv. This is the central message of this study however as explained in the following, it suffers from very low credibility of Meso-NH simulations of this particular case.

The simulations are far from being realistic, they reveal important differences with observations regarding the key parameters: temperature, water vapour and ice water. In particular, the simulated temperature profile (Fig. 4a) doesn't agree with the radiosounding neither in vertical structure nor in the absolute values showing differences reaching 2 K, which translates to RHi bias of up to about 50%. The simulated water vapour shows a flat profile above CPT with a wet bias of about 1 ppmv compared to the measurements. The warm and wet bias suggests that the model does not properly account for dehydration process.

A more important issue is that the simulation overestimates the IWC by a factor of 10 and shows significant amount of condensed water well above the CPT, where CALIOP does not see any ice crystals (Fig. 6). This renders further estimates of moistening due to ice sublimation highly uncertain. While a certain effort towards evaluation of simulations against the observations is made within this study, it is far from satisfactory as far as the key parameters are concerned. In particular, the IWC validation could benefit from more than one CALIOP samplings of Enawo within the simulated domain as well as from similar measurements by CATS lidar. The water vapour could be compared to the respective MLS/SAGEIII/ACE-FTS observations, which could also serve to assess the bulk effect of Enawo TC on the TTL/LS water vapour. Finally, the simulated thermal structure, which is crucial for the moistening potential of detrained ice, could be compared with GPS-RO temperature profiling or with ERA reanalysis assimilating these measurements with high level of confidence. None of this has been done for this study.

The unrealistic nature of mesoscale simulations together with a simplified approach to their upscaling and unclear representability of TC Enawo renders the central conclusion of the manuscript misleading. Hence, I cannot recommend it for publication at ACP.

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