Geophysical Research Abstracts
Vol. 16, EGU2014-5293, 2014
EGU General Assembly 2014

Role of deep convection in moistening the stratosphere: LES of Hector the Convector

Thibaut Dauhut, Jean-Pierre Chaboureau, Juan Escobar, and Patrick Mascart
Laboratoire d'Aérologie, Université de Toulouse and CNRS, Toulouse, France (thibaut.dauhut@aero.obs-mip.fr)

The trend of stratospheric water vapour during the past decades is not correctly reproduced by current GCMs. This may be due to lack of representation of rapid water transfers from troposphere to stratosphere. Our modeling study focused on a particular case of tropical deep convection which takes an active part in this transport. We aimed at understanding its dynamics and the stratosphere moistening processes. We selected a Hector thunderstorm observed on 30 November 2005 over Tiwi Islands, Australia, during the SCOUT-O_3 field campaign. Plumes of ice particles reaching 19 km altitude were measured by lidar aboard the Geophysica stratospheric aircraft. We performed a Large-Eddy Simulation of Hector (100 m horizontal resolution) using cutting-edge computing resources, as well as a series of simulations with coarser and coarser horizontal resolutions, from 200 m to 1600 m. Strong morning sea breeze deviated boundary layer westerlies and led to intense convergence of humid air over Tiwi Islands. Deep convection triggered around 1 pm. The most intense upward transport started straight after and lasted around 2 hours. Updraft cores statistics showed that stronger upward winds in the boundary layer and at the cloud base lead to weaker cloud fraction aloft and higher hydrometeor content in updraft cores. Turbulence analysis also showed that the faster the updrafts are, the lower the dilution and the more efficient the vertical transfer of water. As a result, some updrafts overshooted the tropopause and carried ice crystals in the stratosphere. Overshoots in the LES compared well with the observations. Part of the ice particles precipitated then whereas the remainder sublimated in lower stratosphere. The consequent vapour pockets were transported and diluted within the stratosphere by easterlies. In total, 2776 tonnes of water were transported from troposphere to stratosphere. Associated net hydration of the lower stratosphere was found with a 16 % increase in water vapour. Upscaling this result using 5-year TRMM radar observations we found that deep convection penetrating 380 K potential temperature level could represent 18 % of troposphere-stratosphere total water flux. While moistening appeared to be robust with respect to the grid spacing used, grid spacing on the order of 100 m may be necessary for a reliable estimate of hydration. This study was supported by the StratoClim project.