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Assessing the saturated and unsaturated air relative contributions to tropical convective momentum transport

Susana M. Mendes (1), Christopher S. Bretherton (2), and Alfredo Rocha (1)

(1) CESAM and Department of Physics, University of Aveiro, Aveiro, Portugal (smmendes@ua.pt), (2) Department of Atmospheric Sciences, University of Washington, Seattle, WA, USA (breth@washington.edu)

When tropospheric convection research is concerned, one must consider the study of contributions from saturated air (air within the clouds) and unsaturated air (air outside or between clouds, or free air) as well as their underlying mechanisms. The core assumption made in all Convective Momentum Transport (CMT) parameterizations is that CMT mainly occurs within vigorous cumulus clouds updrafts and downdrafts, i.e. CMT is dominated by large horizontal velocity anomalies in the cumuli. Unsaturated updrafts and downdrafts are not taken into account, therefore they aren't considered as subject of research. Delving further, the CMT parameterizations evolved, over time, in a particular direction where it is assumed that cloudy updrafts have the strongest signature on CMT leading to a slower investigation of saturated downdrafts. These are not fully explored, no saturated downdrafts parameterization is established so far. Consequently, understanding the roles played by the saturated and unsaturated air is of vital importance to aid the development of an appropriate parameterization of convective momentum fluxes within general circulation models.

The aim of the proposed research is the investigation of vertical transport of horizontal momentum (CMT) by tropical oceanic deep convective cloud systems, using a unique set of tridimensional cloud-resolving model (CRM) simulations of the Tropical Ocean Global Atmosphere Coupled Ocean-Atmosphere Response Experiment (TOGA COARE). Emphasis is given to the study of cumulus-scale characteristics of convective momentum transport during a specific deep convective episode: the late December westerly wind burst, 1992.

The role of saturated and unsaturated drafts on CMT is investigated in an attempt to reach a better understanding of their underlying physical mechanisms. The unsaturated air via downdrafts, and the saturated downdrafts have an important contribution to CMT, and they must be considered in future CMT and cumulus convection parameterizations. Binning methods are applied to these saturated and unsaturated contributions, through the analysis of buoyancy force and vertical velocity fields, pointing out for the presence of internal gravity waves driving the unsaturated air, for this specific deep convective event.