EGU22-8080
https://doi.org/10.5194/egusphere-egu22-8080
EGU General Assembly 2022

The frictional layer in the observed momentum budget of the trades

Louise Nuijens[1], Alessandro Savazzi[1], Gijs de Boer[2,3,4], Pierre-Etienne Brilouet[5], Marie Lothon[5], Geet George[6], and Dongxiao Zhang[7,8]

[1]Delft University of Technology, Department of Geoscience and Remote Sensing, Delft, Netherlands
[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, Colorado, USA
[3]Physical Sciences Laboratory, NOAA, Boulder, Colorado, USA
[4]Integrated Remote and In Situ Sensing, University of Colorado Boulder, Boulder, Colorado, USA
[5]Laboratoire d'Aérologie, University of Toulouse, CNRS, UPS, Toulouse, France
[6]Max-Planck Institute for Meteorology, Hamburg, Germany
[7]CICOES, University of Washington, USA
[8]NOAA, Pacific Environmental Laboratory, Seattle, USA

Profiles of eddy momentum flux divergence are calculated as the residual in the momentum budget constructed from from airborne circular dropsonde arrays (~ 220 km) for thirteen days during the EUREC4A/ATOMIC field study east of Barbados. The observed dynamical forcing averaged over all flight days agrees broadly with ECMWF IFS forecasts. They suggest a flux divergence, or friction on the mean flow, over a 1.5 km deep layer in the prevailing wind direction. Assuming only vertical flux divergence that is zero near a local wind maximum, the observed friction corresponds to a 10 m momentum flux of ~ 0.1 Nm^{-2}, comparable to in-situ turbulence measurements by a Saildrone. Between 1 - 1.5 km the momentum flux divergence is counter-gradient and vertical wind shear exceeds the observed thermal wind. An averaged momentum flux divergence in the cross-wind direction is also observed and corresponds to a veering of the wind that promotes flow parallel to the isobars.

The along- and cross-wind flux divergence differ substantially between days, whereby a number of flights capture ascending branches of shallow circulations where only weak flux divergence near the surface is found and flux convergence (an acceleration of the mean flow) in the cloud and inversion layer. Budget-derived and in-situ measured momentum fluxes disagree on individual days. Turbulence measurements on board the SAFIRE ATR-42 (ATR) aircraft and the UAV CU RAAVEN reveal pronounced spatial variability (5 - 60 km) of momentum flux, which suggests that convectively-driven (mesoscale) flows can compensate turbulence-induced friction within the dropsonde array.