The significance of the nontraditional Coriolis terms in tropical large-scale dynamics

Hing Ong

University at Albany, State University of New York

The nontraditional Coriolis terms (NCTs) are omitted in most of the current global atmospheric models. However, NCTs are significant in tropical large-scale dynamics in the following four aspects. (1) NCTs coupled with diabatic forcing yield considerable Ertel potential vorticity (EPV) flux, using reanalysis data. At the zonal annual mean heating maximum in the tropics, NCT-diabatic and mean-advective EPV flux can yield about 2 m s^{-1} $month^{-1}$ of westward and 5 m s^{-1} $month^{-1}$ of eastward acceleration; the former is considerable using the latter as a reference. (2) Omitting NCTs causes considerable westerly bias in the response to prescribed diabatic forcing mimicking the intertropical convergence zone (ITCZ), using linearized forced-dissipative models. The westerly bias lies in the heating region. In terms of the ratio of the maximum westerly bias to the maximum westerly wind, a normalized zonal wind bias increases with a narrower ITCZ or an ITCZ closer to the equator; for example, the normal wind bias is 0.120 ± 0.007 given the width of 1000 km and the location of 600 km. (3) omitting the NCT in the hypsometric equation biases geopotential height estimation using rawinsonde data. It causes geopotential height error of ~ 1 m, which is considerable with respect to geopotential height variability of ~ 10 m associated with the Madden–Julian oscillation (MJO) or convectively coupled equatorial waves (CCEWs). (4) NCTs transmit meridional vorticity disturbances eastward given the vertically decreasing density, i.e., the compressional beta-effect, using linearized unforced models. With a statically neutral profile and initial large-scale disturbances given a half vertical wavelength spanning the troposphere on Earth, compressional Rossby waves are expected to propagate eastward at a phase speed of 0.24 m s^{-1}. Aspect (1), (2), and (3) encourage restoring NCTs into global atmospheric models for more-accurate simulations of MJO, CCEWs, and ITCZ-forced flow. Aspect (4) can serve as a benchmark for development of deep atmospheric dynamical cores for Earth system models.

Thursday, 25 July 2019, 3:30pm

Refreshments 3:15pm

NCAR-Foothills Laboratory, 3450 Mitchell Lane

FL2-1022, Large Auditorium

This seminar will be webcast live at:
http://ucarconnect.ucar.edu/live

Recorded seminar link can be viewed here:
https://www.mmm.ucar.edu/events/seminars

NCAR