Geophysical Research Abstracts
Vol. 16, EGU2014-6825, 2014
EGU General Assembly 2014

Dynamically Consistent Shallow-Atmosphere Equations with a Complete Coriolis force

Marine Tort (1), Thomas Dubos (1), François Bouchut (2), Vladimir Zeitlin (1,3)

(1) Laboratoire of Dynamical Meteorology, Univ. P. and M. Curie, Ecole Normale Supérieure, and Ecole Polytechnique, FRANCE, (2) Université Paris-Est, Laboratoire d'Analyse et de Mathématiques Appliquées, FRANCE, (3) Institut Universitaire de France

Dynamically Consistent Shallow-Atmosphere Equations with a Complete Coriolis force

Marine Tort[1], Thomas Dubos[1], François Bouchut[2] & Vladimir Zeitlin[1,3]
[1] Laboratoire of Dynamical Meteorology, Univ. P. and M. Curie, Ecole Normale Supérieure, and Ecole Polytechnique, FRANCE
[2] Université Paris-Est, Laboratoire d'Analyse et de Mathématiques Appliquées, FRANCE
[3] Institut Universitaire de France

Atmospheric and oceanic motion are usually modeled within the shallow-fluid approximation, which simplifies the 3D spherical geometry. For dynamical consistency, i.e. to ensure conservation laws for potential vorticity, energy and angular momentum, the horizontal component of the Coriolis force is neglected. Here new equation sets combining consistently a simplified shallow-fluid geometry with a complete Coriolis force is presented.

The derivation invokes Hamilton's principle of least action with an approximate Lagrangian capturing the small increase with height of the solid-body entrainment velocity due to planetary rotation. A three-dimensional compressible model and a one-layer shallow-water model are obtained. The latter extends previous work done on the f-plane and β-plane. Preliminary numerical results confirm the accuracy of the 3D model within the range of parameters for which the equations are relevant.

These new models could be useful to incorporate a full Coriolis force into existing numerical models and to disentangle the effects of the shallow-atmosphere approximation from those of the traditional approximation.

Related papers:

Tort M., Dubos T., Bouchut F. and Zeitlin V. *Consistent shallow-water equations on the rotating sphere with complete Coriolis force and topography.* J. Fluid Mech. (under revisions)
Tort M. and Dubos T. *Dynamically consistent shallow-atmosphere equations with a complete Coriolis force.* Q.J.R. Meteorol. Soc. (DOI: 10.1002/qj.2274)