Refinement and Implementation of a Calibrated Convection Representation for Use in Global Climate Models

Department of Energy Grant DE-FG02-98ER62607
Final Technical Report
Kerry A. Emanuel, Principal Investigator

RECEIVED
JUN 15 2000
OSTI

The above-titled represents a one-year grant from the Department of Energy, in lieu of the originally requested three-year grant. Accordingly, this technical report summarizes a single year of work toward what was to have been a three year goal of testing and implementing the calibrated representation of cumulus convection developed with DOE support under previous grants.

The original work was motivated by the observation that accurate prediction of water vapor, the most important greenhouse gas in the earth's atmosphere, requires a highly accurate representation of moist convection, which is the principal means by which water substance is lofted in the atmosphere. Not only must the turbulent transport of water be handled with fidelity, but an accurate account must be made of the myriad cloud microphysical processes operating within convective clouds. A great deal of emphasis was placed on the need to calibrate and test convective representations against observations in a controlled way, in contrast to the usual method of testing schemes only in the context of global or regional models. Much of the work done in the development of the present scheme focused on such a controlled calibration and test, using data from two tropical field experiments. The results of this test are summarized in detail in Emanuel and Zivkovic-Rothman (1999) and briefly in the two figures below, which show a comparison between observed relative humidity with that predicted by a variety of schemes in two separate field experiments. When it became apparent that the new scheme was outperforming existing schemes in which there is much vested interest, funding was duly terminated.

We have no objection from a patent standpoint to the publication or dissemination of this material.
M. D. Orville
Office of Intellectual
Property Counsel
DOE Field Office, Chicago
Date 6/12/00

Figure 1: Vertical profile of relative humidity averaged over the final 100 days of operation of the Intensive Flux Array (IFA) of TOGA/COARE. Observed is shown by thin solid line; other lines show that predicted using various convective schemes, including the present one.

Figure 2: Same as Figure 1 above, but for all three weeks of operation of the rawinsonde array during Phase III of GATE.

In the brief time that has elapsed between the conclusion of calibration and single-column model testing and the time of this report, the P.I. has helped implement the new scheme in one of the global climate models developed by the NOAA Geophysical Fluid Dynamics Laboratory at Princeton. In connection with this effort, the subroutine has been partially vectorized and coded in FORTRAN 90, to supplement the existing FORTRAN 77 subroutine. Use of the scheme results in the virtual elimination of a substantial temperature error in the tropical upper troposphere which is evident when using the existing scheme based on that of Arakawa and Schubert. Extensive and meaningful evaluations have yet to be performed, however. Also, the new scheme has become the standard convective scheme used in the global modeling program at the Laboratoire Meteorologie Dynamique in France. In view of the difficulty in obtaining funds for extensive testing, it is unlikely that much further work will be done on this representation of cumulus convection.

Reference

Emanuel, K. A., and M. Zivkovic-Rothman, 1999: Development and evaluation of a convection scheme for use in climate models. *J. Atmos. Sci.*, **56**, in press.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.