

Release Notes for the Whole Atmosphere Community Climate Model - eXtended, v. 2.0

8 June, 2018

New features in this release:

WACCM-X specific features:

Self-consistent electrodynamics calculated from model wind, temperature, and conductance.
Dynamical transport of O^+ in the F-region (above ~130 km).
Magnetospheric inputs parameterized using Heelis convection, based on 3-hour Kp
Time-dependent solution of electron and ion temperatures.
Metastable oxygen ion chemistry.
Cooling by atomic oxygen fine structure.
Improvements to thermospheric neutral dynamics, including:
 variable mean molecular mass and specific heat
 Exner function vertical coordinate changed to log-pressure vertical coordinate
 variability of κ taken into account when solving for potential temperature
 new divergence damping scheme for improved tidal amplitudes

General WACCM features:

Revision of parameterized nonorographic gravity wave forcing.
Introduction of surface stress due to unresolved topography to improve frequency of SSWs.
Chemical kinetic and photochemical rate constants updated to latest JPL recommendations.
New treatment of stratospheric heterogeneous ozone loss.
Chemistry Climate Model Initiative protocols used for specification of greenhouse gases.

Known Issues:

The gravity wave parameterization scheme produces excessive eddy diffusivity in the lower thermosphere, ~100~150 km altitude. This causes the atomic/molecular composition ratio to be low, which in turn causes the F-region ionosphere to be systematically lower than observations indicate, perhaps ~20~40%. In v. 2.1, K_{zz} will be ramped down with increasing altitude, as is done in the TIME-GCM, to fix this problem.

The time-dependent electron temperature solver can become unstable at very low Ne, producing spikes or “checkerboarding” in some regions where T_e sporadically goes to its maximum value of 7000 K. This has a negligible effect on energetics, however, because it only happens when Ne is very low.

Reference:

Liu, H.-L., et al (2018). Development and validation of the Whole Atmosphere Community Climate Model with thermosphere and ionosphere extension (WACCM-X 2.0). *Journal of Advances in Modeling Earth Systems*, 10, 381. <https://doi.org/10.1002/2017MS001232>.