Single-Column Model for Atmospheric Radiation Measurement Sites: Model Development and Sensitivity Test

Q. Xu and M. Dong
Cooperative Institute of Mesoscale Meteorological Studies
University of Oklahoma
Norman, Oklahoma

A single-column model (SCM) is constructed by extracting the physical subroutines from the community climate model (CCM1) of the National Center for Atmospheric Research. Using observational data obtained from the Oklahoma Atmospheric Radiation Measurement (ARM) site and the National Weather Services, this SCM will perform diagnostic studies of radiation and cloud parameterizations.

So far, the model has been tested with simulated data generated by CCM1 global runs. The global runs provide the SCM with initial and lateral boundary conditions that represent the Oklahoma ARM site. The preliminary results can be summarized as follows:

- The SCM can produce nearly the same results as the CCM1 if the lateral boundary conditions are precisely given from the spectral forms of representation of boundary fluxes (see Figure 1).
- The SCM results are moderately sensitive to noise in the lateral boundary conditions. The SCM simulated temperature can (or cannot) closely follow the CCM1 global run if the noise in the lateral boundary fluxes is below (or above) 10% of the single level (see Figures 1 and 2).
- The representativeness of the lateral boundary conditions seems crucial for the SCM simulations. When the advection term is calculated by using the central finite difference scheme from the gridded (instead of spectral) data produced by the CCM1 run, the SCM simulated temperature can differ significantly from that of the CCM1 global run (see Figure 3).

Since the advection terms are among the leading-order terms (larger or much larger than some physical terms) in

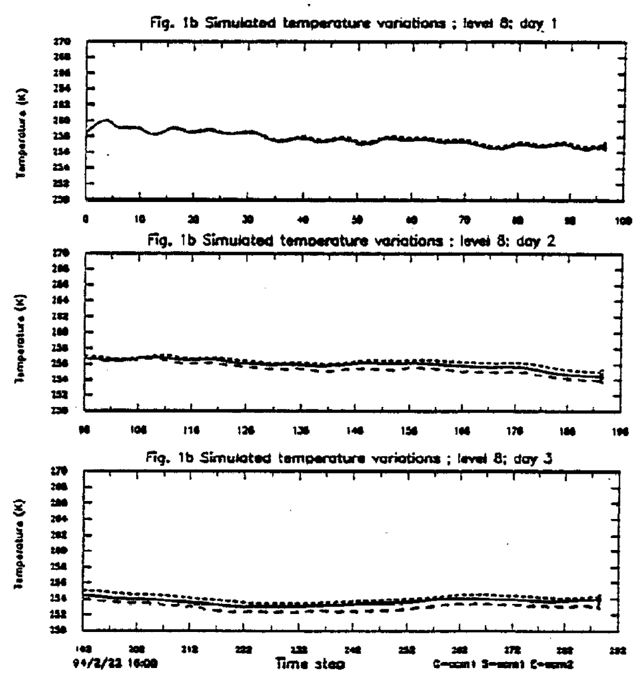

Figure 1. Simulated temperature variations over 3 days at the Oklahoma ARM site and model level 8 (σ = 0.5). Dashed line (C) is the CCM1 run. Solid line (S) is the control SCM run with the temperature advection extracted, in spectral form, from the CCM1 global run. Long dashed line (E) is the experimental SCM run with the temperature advection contaminated by 10% white noise (relative to the standard deviation of the temperature advection during the 3-day period).

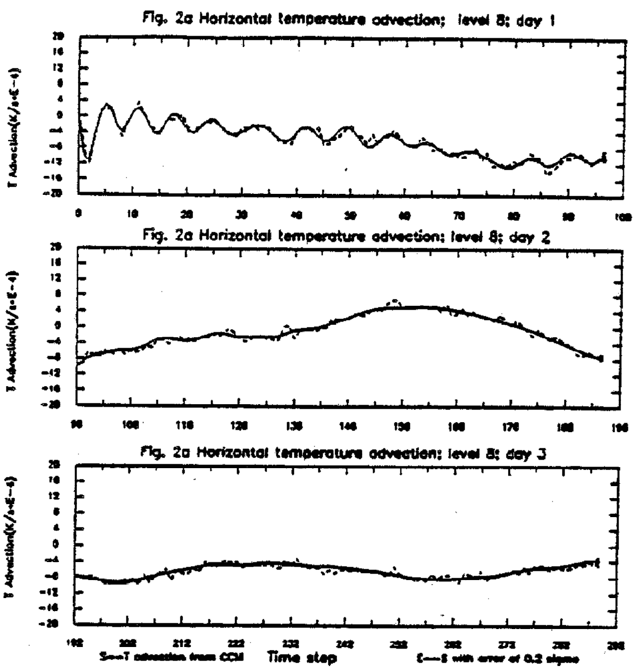

Figure 2a. Horizontal temperature advections (10^{-4} °K/s) used for two SCM runs in Figure 2b. Solid line is for the control SCM run. Dashed line is for the experimental SCM run with the temperature advection contaminated by 20% white noise.

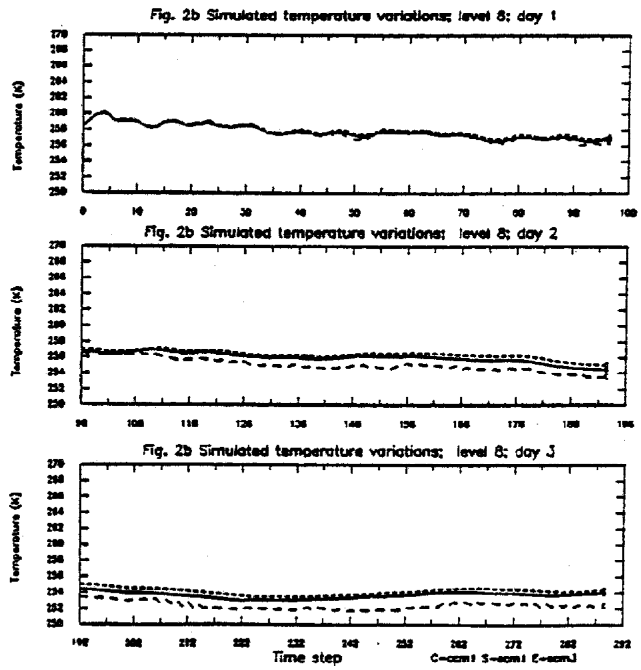

Figure 2b. As in Figure 1, except that the long dashed line for the experimental SCM run is computed by using the temperature advection contaminated by 20% white noise (shown by the dashed line in Figure 2a).

the tendency equations, the representativeness and accuracy of the lateral boundary flux measurements and calculations are crucial for the SCM and for future budget studies of climatic variables over the ARM sites. The related scientific and technical issues are

- how to estimate the large-scale advection at the lateral boundaries of the ARM site column
- how to extract the large-scale horizontal divergence from the data for the SCM.

These problems are under our investigation.

Acknowledgment

This work is supported by National Oceanic and Atmospheric Administration contract NA90-RAH00078 and U.S. Department of Energy/Pacific Northwest Laboratory contract 144880-A-Q1 at the Cooperative Institute of Mesoscale Meteorological Studies, University of Oklahoma.

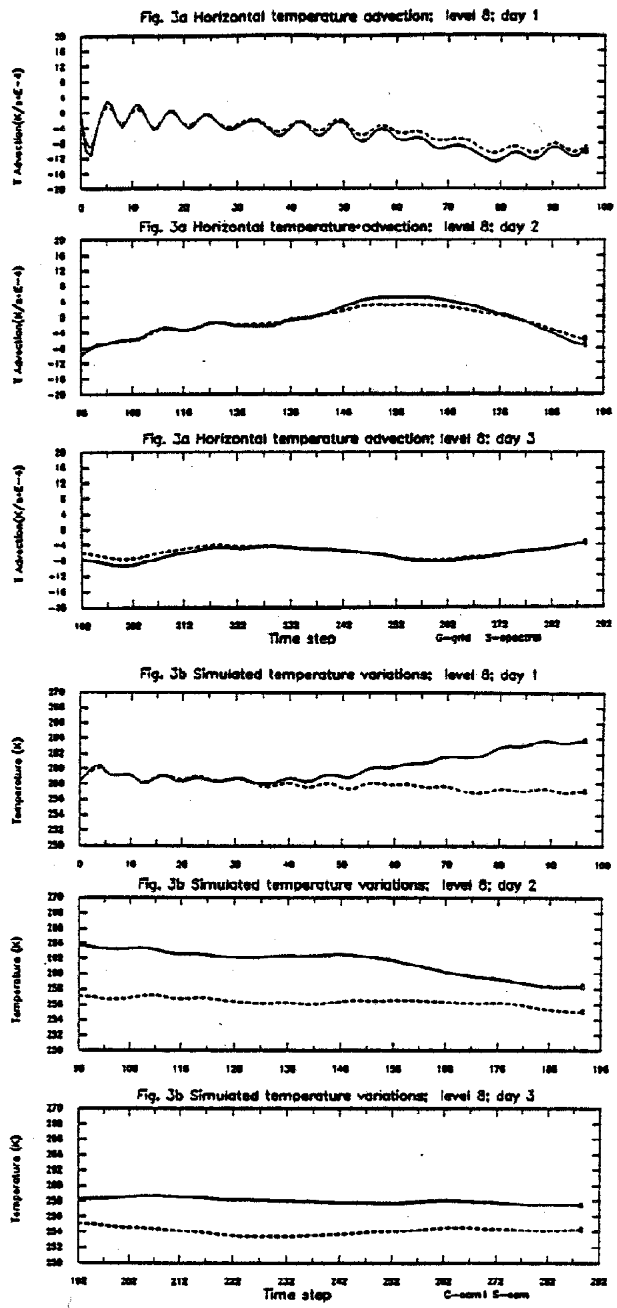

Figure 3. As in Figure 2, but the temperature advection for the experimental SCM run is calculated using the central finite difference scheme from the gridded (instead of spectral) data produced by the CCM1 run.