Review

The Canadian Atmospheric Model version 5 (CanAM5.0.3). J.N.S. Cole and Co-Authors.

The paper documents the scientific structure and basic behaviors of version 5 of the Canadian Atmospheric Model. This model has and will likely continue to advance understanding climate and climate change and is a key participant in international modeling activities in support of ongoing assessment of climate change. The paper is generally clear in its explanations and presents a range of model simulations compared with observations, providing essential information for those using the model or its simulations for a range of scientific and societal impact activities.

Specific Comments and Questions

1. Regarding the cloud microphysics factors in Table 1: Are facacc, facaut, and uicefac factors that multiply nominal values for accretion rate, autoconversion efficiency, and ice fall speed? If so, what is the basis for the nominal values? The CanAM5 factors, are quite large, factors of about 10 to 6,000. Especially if these factors scale physically based parameters, is there an issue of physical plausibility? Further explanation and context would be helpful here. Related, on p. 9, l. 35, it is stated that autoconversion rates are not scaled, but the factor scaling efficiency in autoconversion (facaut) in Table 1 is listed as 0.1204. Clarification or additional information is suggested.
2. pp. 12-13, ll. 33-1, Fig. 3: The “notable increase in southern hemisphere low cloud in CanAM5” relative to CanAM4 is not evident on Fig. 3.
3. Fig. 4: What do the solid contours on the two uppermost panels on the right indicate?
4. Figs. 3, 4, 5, 8, 9, 10, and 11: Summary statistics, i.e., mean bias, rmse, correlation coefficients, for the differences between model and observations would be helpful. On Figs. 6 and 7, the bias is evident, but rmse and correlation coefficients would provide valuable additional information about the fidelity of the model patterns to the CERES observations.
5. pp. 18-19, ll. 13-1, Fig. 9: Regarding zonal-mean temperature differences, note that north of 60N in DJF and MAM a large fraction of the space has oppositely signed differences.
6. p. 21, ll. 1-2: The text states that TOA net downward flux was tuned to produce a reasonable 1850 control for CanESM5. Provide a brief characterization of this simulation, i.e., how well is the TOA radiation balanced and what, if any, drifts are occurring?
7. pp. 14-16, ll. 9-4, and p. 21, ll. 1-4: The TOA net LW+SW imbalance (Earth Energy Imbalance, EEI) in CanAM5 of 3.1 W m^{-2} is quite large relative to the CERES EBAF value of 0.9 W m^{-2} and the IPCC-estimated total anthropogenic 1750-2011 radiative forcing of 2.3 W m^{-2}. This indicates significant errors in the model’s ability to simulate the observed energy imbalance of the Earth-atmosphere system given realistic boundary conditions. Retuning to produce a stable coupled integration is effectively a flux adjustment, even if not explicitly applied as such. Alternatively, these tunings can be viewed as introducing compensating errors in the coupled model to correct whatever deficiencies lead to the drift or unrealistic simulations there. The behavior of the coupled model using tunings which produce the observed EEI in an AMIP integration of CanAM5 would provide an informative gauge of the seriousness of these model deficiencies. I would

encourage considering showing a measure of the problematic CanESM5 simulations using an uncoupled atmospheric configuration with a realistic EEI. The revised text should acknowledge the importance of these deficiencies.

Technical Corrections

p. 2, l. 17: “The the” -> “The”

p. 2, l. 18: “tropopause” -> “troposphere”

p. 4., l. 11: “CanAM5” repeated.

p. 16: l. 13: “shortwave the” -> “shortwave at the”

p. 19, l. 5: Fig. 11 shows CanAM5/4, not CanESM5/2.