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Interactive Comment

Interactive comment on "The CCCma third generation AGCM and its extension into the middle atmosphere" *by* J. F. Scinocca et al.

Anonymous Referee #2

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Review of "The CCCma third generation AGCM and its extension into the middle atmosphere" by Scinocca et al.

General comments

The paper fits to the scope of ACP.

Overall I find the paper unsatisfactory, both in the documentation part and in the scientific part (GWD schemes and QBO). Both can certainly be improved, as there is generally enough material, maybe justifying a split into two separate papers. Especially the QBO section leaves the reader with many questions, hence is disappointing in its current shape.

As the purpose of the paper, especially of the first half, is to document the properties of AGCM3 and its associated physical parameterizations, and to document the formulation of AGCM3 used for middle atmosphere and chemical climate modelling studies, I wonder if the authors have also considered to publish the paper in the new Geoscientific Model Development journal of the EGU, that has the same format and review process as ACP, and specifically aims at documenting models.

Specific comments

Hybridization of moisture: Please describe the local and global sink or source magnitudes resulting from using "s" instead of "q".

How is transport of cloud water and cloud ice computed?

Is this hybridization method useful for chemical components in general? Can it be used for chemicals with very strong gradients, for example at the daylight terminator?

P.7891, L.24: Soil scheme: what is meant by "and solved by iteration"? Which method is used? Fixed number of iterations, or "error" controlled?

P.7891, L.24: "Soil albedo": Should probably be surface albedo, accounting for vegetation, snow cover etc. Please explain the spectral dependence of the albedo, if this is accounted for. Does albedo vary with zenith angle, or differ for direct or diffuse radiation?

P.7892: Ice sheets are then constant? The model does neither include melting nor accumulation, etc? But water of melting snow or rain is stored in the 3 "soil" layers and can freeze or thaw? Snow may sublimate or "soil" moisture evaporate?

How are lakes treated?

P.7892, L.17: "gleaned from the literature" please give references

P. 7895: 2.7 Moist convection Please provide a description of the cloud physics used in the convection scheme. Does the scheme differ liquid and ice phase explicitly, or diagnostically?

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P.7897, 2.8 Radiation In many AGCMs radiation transfer is not computed at every time step. How is this handled in AGCM3? Is radiation called at every dynamical time step or at larger intervals?

P.7898, L.12: "permits a more accurate treatment of cloud-radiation interactions" This argument can probably be extended to aerosol-radiation interaction.

P.7898, L.20 2.9 Clouds This section describes primarily the parameterization of cloud cover. Please explain also the (bulk) microphysics employed for the simulation of cloud water and cloud ice and precipitation/evaporation processes.

P.7900, L.9: "A zonal mean distribution of background aerosol loading is specified in AGCM3 for 10 the purpose of radiative transfer calculations. The distributions of aerosols are distinguished as continental and maritime. ..." This reads like a contradiction. Continental and maritime aerosols should have a geographical distribution, not a zonal mean distribution. A zonal mean structure would be useful for stratospheric background aerosols. Please clarify this statement on the spatial structure of the aerosols.

P.7903, L.2: or of unresolved dynamics, as for example dynamical adjustment processes. Description is in many places superficial, providing starting points for further reading, but cannot really replace a proper model documentation.

P.7905, physics filter: is this applied to all prognostic variables entering physical parameterizations? Is this technique employed for all parameterized processes or restricted to those dealing with positive definite quantities including tracers? What is the climatological effect of the physics filter if used in DYN-MAM in comparison to the standard DYN-MAM using the full fields?

P.7906, L.28: "To simplify the comparison, all non-orographic GWD has been turned off in these runs." What is the simplification achieved by this? Non-orograpic gravity wave drag forces the natural circulation, and the observed circulation (and derived climatologies) necessarily include the oro-gwd effect. The conclusions presented on

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L.7-10 ("In fact, ...") are not as convincing as they could be, had the simulations also included non-gwd effects.

It would be more interesting, and indeed better for comparing with the following Figure 3, to present here simulations including S03 as in Fig.3.

Discussion of Figure 4: - The WMO setting is such that you get a negative bias of appr. 3K at the SP in panel (d). Is this necessary or simulating a realistic ozone hole? Probably you could have tuned the parameters for a smaller temperature bias of appr. ś1K, accompanied by a smaller zonal wind bias. Would this still allow simulating the ozone hole? - The large positive bias in panel (a) at the NP should also be problematic for the simulation of polar ozone loss. Clearly this needs to be cured as well for simulations of stratospheric ozone. - All panels show local maxima of positive temperature error between 150 and 100 hPa at 60S and 40N in JJA, and less strong at 50S and 50N in DJF. Is it known what causes this error pattern?

P.7909,L.25: several weeks to more than a month –> several days to more than a month

P.7910,L.22: several weeks –> several days "several weeks" seems to be excessive, as the delay remains smaller than a month

P.7911.,L.13/14: If this is not the reason, please speculate on other possible reasons? Is the planetary wave activity weak in Antarctic spring? Is the total parameterized GWD too weak?

P.7911,L.26: "Since the background of resolved gravity waves is essentially a property of each GCM, the main quantity available to tune a spontaneous QBO is the parameterized non-orographic gravity waves in the tropics." This statement is wrong. Experience shows that resolved wave generation in GCMs is sensitive to the tuning of parameterized processes.

The QBO discussion is unfortunately superficial. The authors should at least address

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the two following questions: - Is there an observational base for 2x or 4x increased equatorial launch fluxes? - What is the relative contribution of the resolved and the parameterized wave mean-flow interaction in driving the QBO? (See for example Giorgetta et al. 2006) - What is the effect of the increased launch flux of parameterized non-orographic gravity waves on the middle atmosphere circulation in general? Altering the tropical circulation will cause changes in the extratropical circulation. What are the effects on polar cap T or 60N/S zonal wind in DJF or JJA?

P. 7912, L.2: "is often justified" Please give references.

P.7912,L.28: See also Giorgetta et al. (2006) for arguments on the sensitivity of the QBO period to changes in GWD and resolved waves.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 7883, 2008.