**Response to reviwer 1: (JCLI-D-11-00013)**

To follow your recommendation, we have asked the Editor of JCLI, Dr. Eric Maloney to forward our manuscript to MWR.

**Response to reviwer 2: (JCLI-D-11-00013)**

Thank you for your insightful and detailed comments. These are very helpful to us in improving the manuscript.

**Major Comments:**

1) To follow your suggestion, a description of the IAP AGCM4.0 dynamical core has been included in section 2a.

2) To address the impact of different resolutions with spectral and grid point models, we conducted another simulation with finer resolution of 1° x 1° using the IAP AGCM4.0 to be comparable with T85. We found that this difference in resolution cannot account for the differences of simulations between the CAM and IAP AGCM that we reported here. We have revised the paper to include a Figure 5 and discussions on page 13.

The way the physics package coupled to the dynamical core and the physics time step of the IAP AGCM4.0 have been described in the last paragraph of section 2a on page 9, and those of the CAM3.1 have been described in section 2b on page 9. The empirical physics tuning parameters were the same in the two models, which are now stated in the revised paper on page 9.

3) We are grateful that the reviewer pointed out to us the bug in the setup of the Held-Suarez experiment in the publically released CAM code, and the subroutine where this bug can be corrected. We have corrected the bugs in the Held-Suarez setup in both the IAP AGCM4.0 and the CAM3.1 have been corrected, repeated all the Held-Suarez experiments. These experiments do not change the conclusion of the paper, but all related Figures 6-9, 11a, 11b, 12a, 12b and 13a have been re-plotted.

4) We have added the comparison with the NCEP reanalysis data for the Eddy statistics on page 12 (Figure 3c and Figure 4c). The computation for the transient eddy statistics is now described along with equation 11 on page 12.

**Minor comments and corrections:**

1. The reference to describe the vertical *σ* coordinate has been added. The acronym 9L has been explained.
2. The typo in ‘summery’ has been corrected to ‘summary’. Thank you.
3. The details of IAP AGCM4.0 dynamical core have been described in section 2a.
4. Acronym AMWG has been explained. The 15-year-mean data have been specific in Figs. 1-4.
5. When the bug of the Held-Suarez setup is corrected, the asymmetry in Fig. 7a (Fig. 8a in the revised paper) vanishes. We did not do a formal statistical analysis since we found that the results from the Held-Suarez experiments became stable with very small variability after 100 model days.
6. The typo in ‘Neal’ has been corrected to ‘Neale’. The published year of Neale and Hoskins paper has been corrected to ‘2000’.
7. To apply the correct formulation of the TEM equations for the primitive equations, the term  is needed. The output variables of the 15 years climate simulations from the IAP AGCM4.0 and the CAM3.1 are monthly means, and  is not saved. The QG form is easy to carry out, and it is intended to interpret our results poleward of 10°. We use bold ‘**F**’ instead of superscript arrow to denote vectors. Other recommendations in this part have been adopted in the revision.
8. We plotted the  velocities directly, the figure was similar to the stream function, but less clear, so we keep the streamfunction. We improved and simplified the description of the associated vertical motion on page 19.
9. The total heating rate ‘TTEND’ is at the original list of the output variables. We added the diabatic heating ‘DTPHY’ form physical package as the output field, and then the adiabatic heating ‘DTDYN’ can be derived by DTDYN = TTEND – DTPHY. Therefore, the frictional heating was classified to DTDYN. Besides, heating from energy fixer ‘TFIX’ was also classified to DTDYN, but it is so small that can neglect. All of these sets are the same in the IAP AGCM4.0 and the CAM3.1. We clarified these descriptions on page 20.
10. All of the mentioned typos have been corrected. Thank you.
11. The typos have been corrected. Thank you.
12. ’15-year means’ have been added.
13. The typo has been corrected.
14. The typo has been corrected.
15. New figures and analysis have been finished.
16. The purpose of aqua-planet experiments in this paper was to investigate the impact of different treatment of topography between the two models, thus we think the difference plots were enough to answer the questions and the fields for the IAP simulation seem redundant.
17. Both directions of the EP fluxes have the same units kg s-2 from Equation 14.
18. Fig.12a (Fig. 13a in the revised paper) has been re-plotted with the new HS run, the correlation coefficients in Table 1 have also been updated. In this plot, frictional heating is contained in the dynamical core (dTdyn in Fig.13)
19. ‘qrs’ means solar heating rate while ‘qrl’ means longwave heating rate and thus ‘qrs+qrl’ the total radiative heating rate. There are now described in the text and in the figure caption of the revised paper.

**Response to reviwer 3: (JCLI-D-11-00013)**

**Thank you for your reviews. To follow your suggestion, we have asked Dr. Eric Maloney to forward our paper to MWR.**

One of the reviewers pointed out to us a bug in the public release of the CAM Held-Suarez experiment setup. We have fixed the bug and repeated all the experiments. They do not affect the results of the paper, but Figs. 6-9, 11-13 have been updated.

The main finding of the paper is that the IAP model simulated a colder troposphere relative to CAM with full physics, but a warmer troposphere in the dry model. This difference is traced to less energetic eddies in the IAP model, leading to weaker residual circulation, and warmer troposphere in the dry model, but also less high clouds and less greenhouse effect of these clouds, thus colder troposphere in the full-physics model. To our knowledge, no previous studies have reported different responses of dry and moist models to different dynamical cores. We have added analysis in Section 3e and Figures 17 and 18 to show how the dynamical core affected moisture transport, relative humidity and then high clouds. The causes of why the different numeric algorithms caused different eddies are complex, but the sensitivity of eddies to dynamical cores have been reported in the literature

For your specific comments,

1. The results from finer resolution with 1° x 1° from the IAP AGCM4.0 have been added in Figure 5 to address the difference of effective resolution of spectral and grid-point models. This issue was also raised by reviewer 2 and is now discussed on page 13.
2. Both the ‘lower’ resolution and lower order of the horizontal diffusion scheme (2th order .vs. 4th order) could cause the weaker eddies in the IAP model. This plausible explanation has been added in Page 13. As for the intensities of the eddies, we refer to the transports at 300 hPa around 30N and 30S. It is clear in the figures that the eddies are weaker in the IAP model, in both the dry version and moist version.
3. We investigated surface sensible and latent heat flux and found both fluxes are larger in the IAP than in the CAM. In fact, the surface temperature simulated by IAP is slight warmer than CAM. Therefore, the surface fluxes only affect surface temperature, but have little impact on tropospheric temperature above 850 hPa. We therefore concluded that it’s the eddy forced residual circulation and the radiative heating that caused the difference among the models.
4. In the dry models, the dominant control of temperature is the residual circulation which is overall weaker near 30N to 30S in the IAP model. In the moist models, the difference in the tropics is additionally due to diabatic heating. The exact causes of why the different numeric algorithms caused different intensities and clouds are complex and require further study, as you suggested. Our objective in this paper is to report that the IAP simulated a colder troposphere relative to CAM with full physics, but a warmer troposphere, and to provide plausible explanations While the impacts of different static stability and different damping methods at the model top are interesting to investigate, they do not appear to be important and will be studied in the future.