**Response to reviewer 1: (MWR-D-11-00132)**

We have revised the manuscript based on your comments and those from the other reviewers. We believe the revision has helped to improve the paper greatly. Thank you for your suggestions.

**Major Comments:**

1. The introduction has been completely re-written. It now emphasizes the background and objectives that are directly relevant to the paper.

The revised introduction described what is new in this paper. In the text, we also described the differences of the dynamical cores (Section 2a). We also explicitly stated that that we used the NCAR-AMWG diagnostic package developed at NCAR (page 11 line 13-15).

1. We have added a detailed description of the IAP AGCM4.0 dynamical core in section 2a.
2. The IAP model uses the standard terrain-following *σ* coordinate described by equation (3) on page 6, while the CAM model uses a hybrid *σ-p* coordinate. The positions of vertical levels in the two models are exactly the same if the surface pressure is identical to 1000 hPa. But because the surface pressure varies with locations, the positions of the vertical levels are approximately the same (line 4-5, page 10).
3. As pointed by Held and Suarez (1994) and others, attributing model simulations to the specific numerical scheme of a climate model is a challenging task. In this paper, we focused on explaining the different sensitivities between two dry models and two moist models that are due to the numerical schemes. We also discussed the possible causes of the simulated differences in the dry model (last paragraph on Page 16).
4. We have included additional analysis and diagnostics to sharpen our conclusion.
5. We have examined the diagnostic outputs from using the AMWG diagnostic packages to inspect the model results. The basic climate from using the IAP dynamical core is similar to those from the CAM3.1. The top of the model residual energy using the IAP-Dycore is -0.8 W/m2; it is about 0.2 W/m2 in the CAM3.1 simulations. Because the objective of the paper is to demonstrate and explain the different impact of dynamical core on dry and moist simulations, we do not think it necessary to show the kinetic energy spectra in the paper since the weaker eddy momentum transport terms are consistent in the dry and moist models.
6. The main differences of the two models are now described in line 16-20 on page 10. The models used the same time step 600s.
7. The time steps of the two models are the same, and we noted that the different horizontal diffusion schemes may be a significant contribution to the less energetic eddies in the IAP model (page 16, line 19-20). Also see response 2.b.
8. We explicitly stated that the NCAR-AMWG diagnostic package is from NCAR (page 11 line 13-15). The Zhang (2009) reference, which was originally referred to show the diagnostics (rather than the diagnostic package), has been removed in this paragraph.
9. The statistical significance of the differences has been added in Fig. 1, as well as in other figures.
10. The second-order horizontal diffusion scheme in the IAP core versus fourth-order in the CAM core is likely an important factor that caused the IAP core is more diffusive. This is discussed in the last paragraph of Page 16.
11. The section on the residual circulation has been removed in the new manuscript.

**Response to reviewer 2: (MWR-D-11-00132)**

Thank you for your helpful comments.

**Broad Comments:**

1. A detailed description of the IAP AGCM dynamical core has been included in section 2a.
2. We removed the term “grossly similar” to make the manuscript more clear. The statistical significance of the differences between the two models is shown in Fig. 1 and other relative figures.

**Specific Comments:**

1. The constants within the two models are identical (page 10, line 1).
2. We added the explanation of conservative finite-difference formulation on page 8 line 6-11.
3. Thank you for letting us know. These references related to the subtraction of a hydrostatic background state have been added.
4. The “nonlinear iterative time integration method” is described in page 9 line 9-14. The “flexible leaping-point scheme” is described on page 9, line 9-14.
5. For the dry simulations, the initializations of the two models are now described in line 11-18, page 14. For the moist simulations, they are now described in line 1-3 on page 6.
6. Both the H-S tests and the aqua-planet tests do not have topography, but the climate simulations have topography. If the results from the aqua-planet tests are similar to that from the H-S tests, but different from the climate simulations, we can conclude that the treatment of topography may impact the results. Otherwise, the impact of topography may be neglected. We have revised the word “examine” to “exclude” in line 15, page 20 to make this more clear.
7. The energy conservation of the IAP model is achieved under the standard stratification approximation and without any diabatic heating. With diffusion, which is in both models, energy is maintained by production due to diabatic heating and consumption by diffusion.

**Technical Comments:**

1. We added “the” in line 2 page 2.
2. This sentence has been removed.
3. This sentence has been removed.
4. This sentence has been removed.
5. The reference has been provided in page 5 line 16.
6. This sentence has been removed.
7. We changed “grids” to “grid points” in page 10 line 6.
8. We changed “of simulations in” to “of the simulations over” in page 11 line 4.
9. The acronym “AMWG” has been explained in page 11 line 15.
10. This sentence has been removed.
11. We changed “feature” to “features” and “atmosphere is” to “atmosphere are” in page 14 line 22.
12. This sentence has been removed.
13. This sentence has been removed.
14. The “counter intervals” has been corrected to “contour intervals”. Thank you.

**Response to reviewer 3: (MWR-D-11-00132)**

Thank you for your insightful and detailed comments. These are very helpful to us in improving the manuscript. For some reason, our revised paper was not transferred to the Monthly Weather Review at AMS and therefore it did not get back to you in the initial round. We value your comments greatly.

**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 in the last paragraph 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 page 10 line 1-3, and those of the CAM3.1 have been described in section 2b on page 10. The empirical physics tuning parameters were the same in the two models, which are now stated in the revised paper on page 10, line 1-2.

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, and have repeated all the Held-Suarez experiments. These experiments do not change the conclusion of the paper, but all related Figures 6-9, and 16a have been re-plotted.

4) We have added the comparison with the NCEP reanalysis data for the Eddy statistics on page 13 (Figure 3c and Figure 4c). The computation for the transient eddy statistics is now described along with equation 11 on page 13.

**Minor comments and corrections:**

1. The reference to describe the vertical *σ* coordinate has been added. The sentence with acronym 9L has been removed.
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. The statistical significance of the differences is shown in Fig. 1, as well as other relative figures. When the bug of the Held-Suarez setup is corrected, the asymmetry in Fig. 7a (Fig. 8a in the revised paper) vanishes.
6. The typo in ‘Neal’ has been corrected to ‘Neale’. The published year of Neale and Hoskins paper has been corrected to ‘2000’.
7. The section on residual circulation is removed in the revised paper.
8. The section on residual circulation is removed in the revised paper.
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 in page 19 line 19-22.
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 exclude the impact of different treatment of topography between the two models, thus we think the difference plots were enough to answer the questions.
17. Both directions of the EP fluxes have the same units kg s-2 from Equation 14, and this figure has been removed in the revised paper.
18. Fig.12a (Fig. 16a 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.16)
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.