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Interactive comment on "Verifications of the nonlinear numerical model and polarization relations of atmospheric acoustic-gravity waves" *by* N. M. Gavrilov and S. P. Kshevetskii

Anonymous Referee #1

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The main motivation of the discussion paper "Verifications of the nonlinear numerical model and polarization relations of atmospheric acoustic-gravity waves" by N. M. Gavrilov and S. P. Kshevetskii is to perform comparisons of amplitudes of atmospheric gravity waves (AGWs) and related characteristics of direct numerical simulations (DNS) with linear polarization relationships (LPR) given by the steady-state theory of non-rotational non-dissipative AGWs. Authors considered to use their DNS results for monochromatic sources of AGWs as a potential tool for testing and verifications of LPR used in the simplified parameterizations of AGWs. The abstract provides a concise and complete summary of the paper. As suggested, DNS of AGWs may be useful tools for testing of simplified GW parameterizations employed in the climate and weather mod-

els. The nonlinear breaking of AGWs by DNS and limitations for applications of LPR during wave breaking, however, are not examined in the article.

As discussed in the paper, comparisons between numerical simulations and analytical expressions for AGW parameters, "reveal atmospheric regions, where analytical theories give substantial errors". Modeling protocol of results is summarized in two tables for two selected AGW modes. It is suitable approach for addressing difference between the DNS and analytical solutions of the linear theory of AGWs. Authors emphasized that the DNS are required to accurately represent the transient wave fields after "switching on" the monochromatic wave source at the surface. However, for the steady state wave regimes, the representation of the DNS and analytical solutions by illustrations for vertical profiles of the energy, heat and momentum fluxes can enhance the presentation of results and conclusions, when and where LPRs are not valid for variable intensity of the AGW amplitude at the source level.

Authors provided proper credit to related work and reference on their previous modeling studies. The title of the technical report reflects content of the paper. However, stress on the nonlinear aspects of numerical model results (that present in the title) is not fully discussed in the paper. The text and tables are more solicited on the initial transience of the quasi-linear wave packets. There are no discussions on the impact of strength of wave sources on the development of the nonlinearity and transience of simulated AGWs. Perhaps authors can make explicit statements that they considered (a) the quasi-linear DNS of monochromatic dissipative waves to verify their model by the LPR valid for non-dissipative AGWs, and (b) explain their motivation to evaluate the spin-up of transient (for t < te) model results by the steady-state LPR that can be applied for t > te. It appears, the analytical transient linear wave solutions in the windless isothermal non-dissipative background atmosphere can be more appropriate analytical approach to verify transient propagation of the broad spectra of linear AGW forced in the DNS by localized sources. The upper part of tables that summarizes comparisons between DNS and the analytical steady-state (t > te) LPRs is the most appropriate for verification of DNS results for the quasi-linear monochromatic waves, while for DNS verifications at t < te (second part of tables) it would be difficult to rely on the validity of LPR for single steady-state wave without considerations of the analytical solutions for transient waves. The discussions paper of N. M. Gavrilov and S. P. Kshevetskii represents a substantial contribution to modeling science of AGWs, and it is definitely within the scope of Geoscientific Model Development Journal.

Specific comments.

(a) Abstract. “Reasonable agreements between simulated and analytical wave parameters satisfying the scope the limitations of the AGW theory proof adequacy of the used nonlinear numerical model”. Sentence needs additional clarification.

(b) 7812-20 “The modeling was performed beginning from the MSIS initial state (zero wave fields)..." It is worthy to mention the windless background flow.

(c) 7816-15 “Therefore, waves with longer vertical wavelengths can better penetrate to the upper atmosphere, where they can produce larger dynamical and thermal effects than those with shorter vertical wavelengths (see Gavrilov and Kshevetskii, 2014b)”. This sentence requires more clarification, because indeed AGWs with larger vertical wavelength can faster propagate from the surface to the upper layers but they also subject less effective dissipation and nonlinear breaking in the thermosphere. DNS results can also depend on the non-zero background flow.

Interactive comment on Geosci. Model Dev. Discuss., 7, 7805, 2014.