We thank the reviewer for the time she/he took and for the comments provided, which will help us to improve the manuscript. A pointwise reply to the reviewer's comment is given below.

General Comments:

1.) *In the present paper the authors use a statistical-dynamical model (Aeolus) to analyse the sensitivity of different components of the large scale atmospheric circulation (Hadley cell, jet stream, storm tracks, and planetary waves) to changes in surface temperature. They separate changes in the forcing temperature into global mean, meridional gradient, and zonal gradient. The results indicate a linear dependence of the strength of the Hadley cell, storm track activity and jets on global mean temperature and meridional gradient, with little sensitivity to zonal temperature asymmetries. Planetary waves appear to be sensitive to all three temperature components. The Hadley cell width shows a nonlinear dependence. The authors compare their findings with other studies. In general, (i) intermediate complexity models, like the statistical-dynamical model used here, can be of great help investigating particular aspects of the climate system, (ii) a systematic analyses of the sensitivity of the global atmospheric circulation to changes in surface temperature can be an valuable contribution, and (iii) the components chosen by the authors are central to characterize the large scale circulation. Thus, in principle, overall concept and methodology of the study are sound. The paper is relatively well written and structured. However, unfortunately I do not feel that the work provides enough new and valuable information to warrant publication in the present form. So far, it is mostly an evaluation/validation of the Aeolus model illustrating that it shows similar sensitivities as more complex models (and observations). Thus, the study gives confidence to the model, but does not contribute much to the understanding of the climate system. The authors need to point out much clearer what is the particular aim (process, mechanism, etc.) they are focusing on (it seems like it is 'linearity' of response and/or sensitivity to individual forcing components), and, more important, what are new and significant findings which contribute to our understanding of the atmospheric circulation.*

Thank you very much for this comment. We are happy that the reviewer agrees that this analysis is a sound approach. As written in response to referee 1, the main goal of the paper is to investigate the effect of changes in the meridional temperature gradient versus azonal temperature changes versus mean temperature changes on the boreal winter atmospheric circulation.
The novelty is the systematic approach. With this approach it is possible to scan the full temperature phase space. This way we can scan for 'non-linearities' in the system (i.e. the HCE might be very sensitive to dTdy only for a narrow range of dTdx values, and

outside of that range it is not sensitive). It is important to know such non-linearities as it could imply more abrupt changes under global warming.
In addition, we found:

- We find little of such non-linearities (most of the atmospheric circulation behaves in a linear fashion to thermal changes.
    - **Exception 1**: Planetary waves, which is well explained by theoretic dynamical consideration
    - **Exception 2**: Hadley cell edge, which could be a model artefact or a real feature – that should be tested with GCMs (as also written in the answer letter for referee 1)

Specific Comments:

1.) *Conclusions: So far, the central/only conclusion appears to be that the results serve as a validation of the model. This, as noted in General Comments, is insufficient to justify publication in my view. Instead, novel findings of the study need to be summarized, and their (potential) implications need to be discussed.*

We agree with the reviewer and will rewrite the conclusion to:
In this paper, we present a study on multiple fundamental components of the large-scale atmosphere dynamics to different surface temperature forcing with the statistical-dynamical Atmosphere model Aeolus 1.0. Due to the statistical-dynamical approach, Aeolus 1.0 is much faster than GCMs, which allows us to do 1000s of individual simulations and thus test the sensitivity of the dynamical fields to different surface temperature changes. This way one can disentangle and separately analyse the effect of global mean temperature, equator-to-pole temperature gradient and east-west temperature differences. Therefore, we are one of the first, who scan the full temperature phase space. This way we can scan for 'non-linearities' in the system (i.e. the Hadley cell edge might be very sensitive to meridional temperature gradients only for a narrow range of temperature gradient values, and outside of that range it is not sensitive). It is important to know such non-linearities as it could imply more abrupt changes under global warming. Exceptions are the planetary waves, which is well explained by theoretic dynamical consideration and the width of the Hadley, which could be a model artefact or a real feature. Latter should be tested with GCMs.
The model's climatology generally reproduces the dynamical fields of ERA-Interim, especially in the Northern Hemisphere, which is the focus of our analysis. If possible, we

compare our findings with results of the literature and conclude that most modelled changes are in line with theory and simulations.

These results also serve as an important validation of the dynamical core of the Aeolus. We could show that Aeolus is to our knowledge the first model that captures the dynamical interactions expected from dynamical principles between the large-scale circulation components of tropical circulation, jets, storm tracks and planetary waves. In future work we would like to use the gained knowledge to simulate only specific temperature component configurations to further explore the dependence of the different atmospheric large-scale circulations on near-surface temperature profiles.

2.) *Eq.1: At P5L24/25 the authors state that using Eq.1 only the meridional temperature gradient is altered/updated in T1. Perhaps I got something wrong but as far as I understand Eq. 1 the non-zonal component is modified too. For example: for w_T_phi=0 all paper temperatures (including, in particular, the zonal asymmetries) are the same as at the equator (=T_EQ(lambda)), and thus, in general, different from T_DJF(lambda). Please clarify.*

The parameter w_T_phi is for present day climatology values w_T_phi =1 and therefore T_DJF would be only occur for w_T_phi =1 (=100% present day climatology). Changing the parameter to w_T_phi=0 would mean that the gradient is 0 between equator and T_DJF and therefore T_DJF has to be T_EQ.

3.) *Forcing: As far as I understand, and as it is stated in Sec. 3.2 and 7, the forcing of the simulations are surface temperatures for both land and ocean, but I'm still not sure: According to P4L23 the forcing appears to be sea level temperature (atmospheric temperatures extrapolated to sea level?), while in Sec. 3.1. L5/6 it is stated that the forcing is sea surface temperature only (and specific humidity at the surface). Finally, from the abstract one may infer that the forcing is the whole (3d) temperature field (P1L15-16). This may be homogenized/clarified to avoid confusions.*

Thanks, it is atmospheric temperatures extrapolated to sea level. We will homogenize the other parts.

4.) *Stationary waves & topography: Since the authors exclude topographic influences (P4L20), I'm wondering if some modification of temperature is involved in regions with high topography (see also 3). In other words: would the model have stationary waves in a w_azonal=0 experiment?*

As written in comment 2, w_azonal=1 (=100% of present day climatology) is the present-day-climatology and therefore, for w_azonal=0 there would be no stationary waves.

5.) *Sensitivities: At various places the authors state that sensitivity to meridional gradient is larger than sensitivity to zonal asymmetries (e.g. P8L8/9). However, the authors apply relative change with respect to reference values (by changing the w's). I guess (though I'm not sure) the absolute values of the meridional gradient and of the zonal asymmetries differ, and I'm wondering whether this statement still holds if absolute changes are considered. In Sec. 4.2.3 (planetary waves) L11-15 it is not clear to me at all if relative of absolute changes are meant (i.e. w or the absolute values). Please clarify.*

We mean relative changes and therefore you can be right. We will add that in the manuscript.