Response to Reviewer 1

The authors thank the reviewer for the careful review and for providing constructive comments on the paper.

General comments

1. Regarding the more clearly stated/accessible number, we now provide those numbers as recommended by the reviewer: global means of the net atmospheric heating (NAH) due to NO_2 for January and July; tropospheric and stratospheric NO_2 contributions to NAH separately; cloud impact on NAH in percent; estimates of surface albedo error; diurnal averaging error.

2. Regarding the consequences of NO_2 NAH for the atmospheric radiation budget, we added a discussion of what regional NAHs mean in terms of atmospheric temperature changes.

Specific comments

1. Yes, the dependence of NAH on surface is significant. NAH changes by approximately 2.0 W/m^2 for clear skies in the entire range of albedo changes (0.0 to 1.0). Fortunately, variations of land surface albedo in most NO_2 polluted areas are not so significant during a month (January or July). The upper limit of surface albedo can be estimated as ±0.05. Therefore, the uncertainty in NAH due to error in surface albedo has an upper limit of about ±0.1 W/m^2. In reality, the uncertainty in the monthly means may be less because of averaging of the NAH errors due to surface albedo variations. Of course, the NAH errors will be larger in case of variable snow not accounted for in the climatological surface albedo that was used in the computations. We added a discussion of this in the conclusions.

2. Solomon et al. reported estimated atmospheric heating in the wide range of 5 to 30 W/m^2. They assumed a vertically uniform cloud with different NO_2 vertical distributions: uniform NO_2 mixing ratio throughout the cloud, distributed within bottom or top 2 km, and 80% distributed throughout cloud with 20% above cloud. The broad range of atmospheric heating clearly shows the effect of the NO_2 vertical distribution on NAH. Solomon et al. assumed uniform clouds in the absence of data concerning cloud vertical distribution. Our study highlights the importance of vertical cloud structure; therefore our work can be considered as an extension of Solomon et al. work. We show that NAH depends not on NO_2 distribution solely but on vertical distribution of the cloud extinction. CloudSat data have also proven that clouds are vertically inhomogeneous for a large fraction of cases. Regarding the importance of cloud height, it should be noted that the above consideration is valid when NO_2 is placed within a cloud. When NO_2 is entirely below the cloud, which is the case for tropospheric NO_2, the cloud height and its vertical distribution is not significant. The NO_2 NAH mostly depends on cloud transmittance, i.e. on cloud optical depth. Because we lack information about the vertical profile of NO_2 within clouds, it remains an open issue.

3. The globally and daily averaged NAH values are very low. For instance, the globally-averaged NAH values are just 0.044 W/m^2 for July and 0.046 W/m^2 for January. The zonal mean is approximately twice higher for latitudes of 20^0 to 60^0 in the Northern hemisphere. The values are now provided in Section 4.3.1.

4. Because most tropospheric NO_2 in polluted areas resides in the planetary boundary layer (PBL), the NAH values can be associated with the atmosphere within the PBL height. Assuming no temperature adjustment, we can roughly calculate the atmospheric temperature change as NAH/(c_p*ρ*H), where $c_p \approx 10^3$ J/kg/K is the specific heat capacity of air, ρ=1.29 kg/m^3 is the air density, H ~10^3 m is the PBL height. Thus, NAH values of 2-4 W/m^2 correspond to 0.16-0.32 K/day. These numbers are significantly lower than the average solar heating rate at the surface (about 1K/day at the solar zenith angle of 45^0) but not negligible. It should be noted that so high values of NAH were computed for heavily polluted areas only. That is why these numbers of 0.16-0.32 K/day should be considered locally only. A discussion is now included in the revised manuscript.

5. The stratospheric NO_2 contribution to NAH is fairly low but more evenly distributed over the globe. The globally-averaged NAH values are less than 0.2 W/m^2. However, our radiative transfer computations show that the instantaneous values of NAH due to the stratospheric NO_2 can be as large as 0.5 W/m^2 for clear sky and 0.9 W/m^2 for bright clouds. We added some discussion in the conclusions.

6. We added in the abstract and conclusions more quantitative information. (1) The globally-averaged NAH values due to tropospheric NO_2 are very low: they are about 0.05 W/m^2. (2) Clouds reduce the globally-averaged NAH values by 5-6% only. However, they can significantly reduce the regional NAH values in the polluted areas by a factor of 2. (3) Diurnal variations of NO_2 not accounted in the computations can cause an error of just 11-14% in the daily-averaged NAHs.

7. We changed the color scale as suggested in Fig. 6 to a logarithmic scale to enhance contrast.