Comments by Referees are in blue. Our replies are in black. Changes to the manuscript are highlighted in red both in here and in the revised manuscript.

Reply to Ref #1

I have a few comments at this stage:

1. The authors need to have some introduction on dust and its composition. So the reader can understand why those laboratory work are discussed on different types of aerosol surfaces and how they are relevant to dust.

Reply: As suggested, in the revised manuscript (line 75-77) we have provided additional information on mineralogy of tropospheric mineral dust aerosols: "According to a recent global modeling study (Scanza et al., 2015), major minerals contained by tropospheric mineral dust particles include quartz, illite, montmorillonite, feldspar, kaolinite, calcite, hematite, and gypsum."

2. One major issue not discussed here, is the coating of mineral dust. It is well known that mineral dust may be coated by inorganic and organic acids during its lifetime in atmosphere. Consequently, this will involve aqueous chemistry in that liquid layer, particularly with dissolved substance from mineral dust. I don't think this can be reproduced from laboratory measurements, but it is something happening in the atmosphere and may cause a huge difference on gamma from those laboratory measurements. This should be discussed in the text.

Reply: We agree with ref #1 that mineral dust particles in the troposphere can be much more complex than those used in laboratory studies. In the revised manuscript (line 461-469) we have discuss this aspect: "In addition to these two important issues, it should also be mentioned that single minerals (e.g., illite, calcite, and quartz) and authentic dust samples (e.g., Saharan dust and Arizona test dust) may not necessarily reflect mineral dust particles found in the troposphere. After emitted into the troposphere, mineral dust particle will undergo heterogeneous reactions and cloud processing (Usher et al., 2003a; Tang et al., 2016a), forming soluble inorganic and organic materials coated on dust particles (Sullivan et al., 2007; Sullivan and Prather, 2007; Formenti et al., 2011; Fitzgerald et al., 2015). Therefore, heterogeneous reactivity of ambient mineral dust particles can be largely different from those used in laboratory studies."

3. Line 277-281, it should be pointed out that OH-regeneration could be also partly due to instrumental interference, see this paper for example (http://www.atmos-chem-phys.net/12/8009/2012/acp-12-8009-2012.html).

Reply: We agree. In the revised manuscript (line 294-300) we have added one sentence to mention the OH measurement interference and its implication: "Nevertheless, in a recent study (Mao et al., 2012), the proposed new OH regeneration mechanism is thought to be at least partly caused by unrecognized instrumental interference in OH measurements (Mao et al., 2012). A community effort is now started to assure the data quality of the OH measurement under different conditions especially for the chemical complex areas (http://www.fz-juelich.de/iek/iek8/EN/AboutUs/Projects/HOxROxWorkingGroup/HOxWorkshop2015_node.html)."

4. Figure 3 is a bit confusing. What is shown is actually not decay but rather increase. This can be better presented.

Reply: This figure shows the measured concentration of X. Therefore, surface deactivation would result in reduced loss of X due to heterogeneous uptake and thus increase in measured [X]. In the revised manuscript (line 578-585), we have revised and expanded the figure caption to better explain this figure, and we have also slightly modified this figure accordingly.

5. Line 722, the work from de Reus et al. 2005 suggests that the product of HO2 uptake on dust aerosols are likely H2O instead of H2O2. This should be added to the text.

Reply: The referee is right. In the revised manuscript (line 843-848) we have added a few sentences to discuss the work by de Reus et al. (2005): "In the modeling work carried out by de Reus et al. (2005), $\gamma(HO_2)$ was assumed to be 0.2 for heterogeneous uptake onto Saharan dust particles. If no H_2O_2 is formed in heterogeneous reaction of HO_2 with Saharan dust, modeled H_2O_2 concentrations would agree well with measurements; in contrast, if heterogeneous uptake of HO_2 radicals were assumed to produce H_2O_2, modeled H_2O_2 concentrations would be much larger than measured values."