I know some of the authors very well, although such acquaintance does not preclude me being objective as a referee; in addition, I have asked the authors to consider if some of my papers should be cited. Therefore, I chose to disclose my name as a referee to make the review process more transparent.

In this work, Li et al. proposed "equivalent uptake coefficient", used this term to compare the relative importance of gas uptake onto aerosol surface versus group surface, and concluded that some uptake processes onto aerosol particles can be very important. The methodology is novel, and the results can be interesting for the atmospheric chemistry community. The manuscript can be accepted after the following comments are addressed.

P41, Table 1: There are some experimental studies (by Joel A Thornton, Jon Abbatt, Tim Bertram, and likely other) which explored the effect of organics on N2O5 uptake. In addition, there may be more studies on H2O2 uptake. Please check the IUPAC evaluation online as well as relevant literature.

P42, Table 2: I am not sure why the work by Wang et al. (2012) is used a representative example here. In fact the uptake coefficients used by Wang et al. are far from being updated, and they mainly used uptake coefficients adopted by two modeling studies almost 20 years ago (Dentener et al., 1996; Zhang and Carmichael, 1999). For mineral dust in specific, the uptake coefficients used by Zhu et al. (2010) were updated values recommended by IUPAC. In addition, some of the studies which are cited as the sources of uptake coefficients measured by laboratory work are in fact pure modeling work, such as Bauer et al. (2004), Dentener et al. (1996), and so on. The author may consider updating this table.

P3, L23-25: HO2 uptake can be very important for tropospheric chemistry (George et al., 2013; Mao et al., 2013; Taketani et al., 2008; Thornton et al., 2008). Is there a reason why HO2 has not been discussed in this paper?

P2, L29-30: Very recently I reviewed heterogeneous reactions of mineral dust (Tang et al., 2017). Should this paper be cited here?

P3, L12-15: Another convenient way to assess the relative importance of aerosol uptake and dry deposition is to calculate their lifetimes with respect to individual processes, as discussed by Tang et al. (2017)

P4, L24-26: This sentence is not easy to follow. I assume that the authors wanted to state

that for smaller particles, gas phase diffusion would not be a limiting step and thus can be neglected. Please consider rephrasing it, and refer to Tang et al. (2014) for a comprehensive discussion on the role of gas phase diffusion.

P12-13: In a paper published in 2017 (Tang et al., 2017), I provided a comprehensive and in-depth discussion on the two factors the authors mentioned in Section 4.2, and would like to refer the authors to take a look at that paper.

P14, L19-21 (as well as related content in the abstract): It is proposed that the following four groups of gas uptake onto aerosols can be important: (1) N2O5 on all types of aerosols, (2) HNO3 and H2O2 on mineral dust, (3) O3 on liquid organic aerosols; and (4) NO2, SO2, HNO3 on sea salt aerosols. The four groups have some overlaps and not easy to follow. I would suggest re-organizing them according to either types of gases or types of aerosols.

References:

George et al.: Measurements of uptake coefficients for heterogeneous loss of HO2 onto submicron inorganic salt aerosols, Phys. Chem. Chem. Phys., 15, 12829-12845, 2013.

Mao et al.: Radical loss in the atmosphere from Cu-Fe redox coupling in aerosols, Atmos. Chem. Phys., 12, 509-519, 2013.

Tang et al.: Compilation and evaluation of gas phase diffusion coefficients of reactive trace gases in the atmosphere: volume 1. Inorganic compounds, Atmos. Chem. Phys., 14, 9233-9247, 2014.

Tang et al.: Heterogeneous reactions of mineral dust aerosol: implications for tropospheric oxidation capacity, Atmos. Chem. Phys., 17, 11727-11777, 2017.

Taketani et al.: Kinetics of heterogeneous reactions of HO2 radical at ambient concentration levels with (NH4)2SO4 and NaCl aerosol particles, J. Phys. Chem. A, 112, 2370-2377, 2008.

Thornton et al.: Assessing known pathways for HO2 loss in aqueous atmospheric aerosols: Regional and global impacts on tropospheric oxidants, J. Geophys. Res.-Atmos, 113, D05303, doi: 05310.01029/02007JD009236, 2008.

Zhu, S., Butler, T., Sander, R., Ma, J., and Lawrence, M. G.: Impact of Dust on Tropospheric Chemistry over Polluted Regions: a Case Study of the Beijing Megacity, Atmos. Chem. Phys., 10, 3855-3873, 2010.