The authors would like to thank the Reviewer for evaluation the manuscript and the helpful comments that improve the manuscript. We have taken the comments into account in the revised manuscript.
The detailed replies (black font) to all the reviewer comments (blue font) are given below.
The pages, line numbers and equation numbers refer to the manuscript under discussion.

Referee #2

General comments
The manuscript is devoted to a very important problem: correct model selection taken into accounting the uncertainties due to forward model approximations. The results are demonstrated and analyzed on several cases. The application of the developed method to different satellite remote sensing applications is described in the manuscript.

Overall, the manuscript is well written. Presented method and results can be interesting for broad remote sensing scientific community.

Reply: We like to thank the reviewer for the positive and encouraging comment.

Specific comments
The manuscript presents the method accounting for uncertainties due to forward model approximations. To model top of atmosphere measurements the approximation of RT based on assumption of Lambertian surface reflectance is used. This RT-approximation may introduce additional uncertainties in comparison to the case when full surface BRDF is taken into account together with correct accounting for surface and atmosphere coupling. These uncertainties depend on the observation geometry, in particularly, on the solar and observation zenith angles. What is important for these studies, they also depend on different combination of surface and aerosol properties as well as on aerosol optical depth and may affect the selection of best model. Some discussion of this problem would be interesting to see in this manuscript.

Reply: We thank the reviewer for bringing up this important issue related to the uncertainty due to incorrect surface reflectance assumption and not correctly accounting for radiative coupling between the atmosphere and surface.

The effect of surface reflectance assumptions to the forward model error has not been studied in more detail in this work, but the intention is to use as correct surface reflectance data as possible, e.g. full surface BRDF, in the further studies.
Since we have empirically estimated the forward model error using the residuals of model fits, i.e. observedR-modelledR, it could be possible to analyse the different combined effect of surface reflectance and aerosol properties to the forward model error, and its influence to the best model selection.

We will remove a following sentence in p7 line 212: “We assumed the Lambertian surface when simulating the LUT’s reflectances with RT model.”. It is misleading and unrelevant here since the Eq. (2) reveals that the surface reflectance is not accounted for until when computing modelled TOA reflectance.

Changes to manuscript:
We have removed the sentences in p7 lines 212-213 as misleading information.
As suggested by the reviewer we have added the following paragraph to the Section Discussion and Conclusion:
“The difficulty in the satellite aerosol retrieval is how to take into account the surface reflectance as well as surface and atmosphere coupling correctly. These sources of uncertainties in the aerosol retrieval are dependent on the observation geometry, i.e. the solar and observation zenith angles. The effect of improper surface reflectance assumption on the forward model uncertainty has not been considered separately in this paper. However, the surface reflectance is implicitly included in the forward model error as it is empirically estimated based on the residuals of model fits. If using the direction dependent surface reflectance assumptions, i.e. full surface bidirectional reflectance distribution function (BRDF), together with the correct coupling of surface and atmosphere it may affect the forward model uncertainty. The proposed methodology enables to

analyse the different combined effect of surface reflectance and aerosol properties to the forward model error, and its influence to the best model selection.”