Review
Anonymous Referee #2


The Authors discuss a method to evaluate theoretical uncertainties in retrieved aerosol and ocean surface properties from multi-angle polarimetric remote sensing measurements. Through a Monte Carlo sampling approach, they propose a method to compare theoretical uncertainties with observed observed-true parameter differences computed from validation. The method is applied to synthetic as well as to real AirHarp measurements. In addition, the Authors briefly discuss a way to speed up a posteriori uncertainty calculations by analytic differentiation of a neural network-based forward model.

The topic is very interesting and within the scope of AMT, the analyses appear sound and convincing. The only slight criticism that I have is that I found the paper rather long and not always easy to follow. A large amount of detailed analyses are presented, and the task of deciding what are the most important points of the study appears to be mostly left to the reader. I wonder if the information can be synthesized a bit to make the paper easier to read. Furthermore, it seems to me that the aspects of "performance evaluation" and "speed improvement" are a bit intermixed when it comes to the way the sections of the manuscript are organized, which does not help readability. Given that it seems to me that the "performance evaluation" aspect of the manuscript is given a much wider space than the "speed improvement", I wonder whether it would be better to move this latter to an appendix. Apart from this, I think this is an excellent paper. Below are a few other minor comments:

- L113: A more recent reference is

- L156-157. Does your forward model covers the entire HARP spectral range? If so, is it not unrealistic to assume spectrally flat refractive index? Especially dust aerosols are way more absorbing in the UV than in the VIS/NIR.

- L173-175. "The forward calculation of aerosol size etc.". I suggest rephrasing as... "The forward calculation of aerosol optical depth (AOD) and single scattering albedo (SSA) from aerosol size and refractive index"

- L192. "interior method". Do you mean "interior point method"?

- Personally I think section 3 breaks the flow of the paper a bit. While the paper is mostly about illustrating how theoretical uncertainties compare with observed errors, here you discuss a technical detail of how to speed up theoretical uncertainty calculations. Wouldn't it be better to have this as an appendix?

- L413. A ratio of 1.5 means a 50% difference. Not sure I would regard this as a "slight underestimate"