

24 May 2020

Responses to the comments from referees and open discussion comments

Dear editors, referees and commentator,

Thank you very much for useful comments. We have made a large effort to improve our manuscript following your comments as specified each by each as follows. We believe the manuscript has significantly improved and is informative to the science community.

Teruyuki Nakajima on behalf of the co-authors

### **3. Open discussion comments by Dr. A. Smirnov**

C3-1. The statement in the Introduction “Combined analyses of sun and sky radiation data were not attained until the 1980s . . .” is not exact. Aureole measurements combined with the direct sun measurements to study atmospheric optical properties and stability were made by Abbot (I do not have a reference though), Kalitin (1930), Fesenkov (1933), Pyaskovskaya-Fesenkova (1957), Bullrich (1964), Lifshits (1965), and Murai (1967). B.N.Holben et al. (2001, Table 1) provided an exhausted history of the long- term optical depth measurements by various researchers over different parts of the world. A nice chronological essay regarding history of the direct sun measurements was presented by G.E.Shaw (2006).

A3-1. Thank you for an important comment regarding the early-day activities of sun and sky observation. We revised the texts for dating and added description of milestones by Abbot (1911), Abbot and Aldrich (1916), de Bary (1964), Bullrich (1964), Bullrich et al. (1967, 1968), Fesenkov (1933), Gorodetskiy et al. (1976), Holben et al. (2001), Kalitin (1930), Murai (1967), Phillips (1962), Pyaskovskaya-Fesenkova (1957), Roosen et al. (1973), Shaw (2006), Shifrin et al. (1972, 1974), Terez and Terez (2003), Turchin and Nozik (1969), Twitty et al. (1976), Yamamoto and Tanaka (1969).

We also added the name of Dr. Smirnov to the acknowledgments section.

### **4. Other revisions/corrections**

The following revisions/corrections were applied other than comments by reviewers.

- 4-1. We added two authors, Akihiro Yamazaki and Sujung Go, because we needed their data and discussion for producing answers to some of reviewers' comments.
- 4-2. We added Ministry of Ocean and Fisheries, Korea in Acknowledgments.
- 4-3. Accuracy of precipitable water vapor was 0.2 cm instead of typo 2 cm in the original manuscript.

- 4-4. Table numbering changed because of insertion of new Table 3; accordingly Table 3 became Table 4. We also added new Tables 5 and 6. Equation numbering also changed due to insertion of new Eq. (21)-(24).
- 4-5. We replaced Fig.8(b) from Roman result to Davos result, because, in the new corona virus lock-down in Rome, we had a difficulty to retrieve detailed data from the Italian university where the data are stored.

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