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Comment on amt-2022-170

Adam Ahern (Referee)

Referee comment on "Information content and aerosol property retrieval potential for different types of in situ polar nephelometer data" by Alireza Moallemi et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-170-RC2, 2022

The manuscript "Information content and aerosol property retrieval potential for different types of in situ polar nephelometer data" by A. Moallemi et al. presents an evaluation of the information content of data from different polar nephelometer configurations for a variety of simple and complex aerosol models. They present a Bayesian sensitivity analysis with an appropriate discussion of the impact of prior assumptions and are deliberate in communicating the limitations of the analysis.

They use the Degree of Freedom for Signal (DOFS) to quantitatively compare polar nephelometer designs while varying amounts of signal truncation, number and position of detectors, and number of investigated wavelengths. This work represents a valuable contribution to the field because, similar to the work of Knobelspiesse et al. for remote sensing instruments, Moallemi et al. quantitatively explore the connection between in situ instrument design and the retrieved parameters. This was well-illustrated by the use of DOFS and the reductive greedy algorithm to optimize detector placement.

This manuscript is excellent and I could recommend it for publication in its current state, although I will use this opportunity to make a few small comments.

General comment:

Although the manuscript is impressive in the scope of the design permutations explored, I think that the fundamental choice of which wavelength(s), as opposed to how many wavelengths, to investigate is taken for granted. This might make an interesting addition to the supplemental material.

Minor comments:

3.1.3 Angular characteristics: number of proved angles assuming evenly distributed measurements

P10.148 Is it true that each data point represents a theoretical "sensor" that is infinitely narrow? As opposed to a sensor that has a non-zero solid angle?

3.5 Forward Model

P17.443 Besides Espinosa et al., consider including Schuster et al. (2019)

4.1 Dependence of information content on the angular configurations of previous polar nephelometer designs

P18.483 The way this is discussed is a little confusing because nDOFS is an analytical result. I wonder if another way to discuss this is that the nDOFS presented is specific to your test aerosol parameters. To extrapolate more broadly, i.e. if you want to compare which instrument provides more information about fine aerosol parameters (of which your test aerosol is a subset), then you must consider the sensitivity of nDOFS to the aerosol model parameters in the range of interest.

Fig. 5. Consistency of labels with Fig. 4 would be nice (e.g. VMR vs Median Radius)

4.4 Information content for the imaginary part of the refractive index

P26.674 where **the** latter is equivalent

P27.684 **atmospheric**-based a prior

4.8 Proof of concept for using DOFS as metric for optimizing angular sensor placement

Fig. 11 Consider using different marker shapes. The blue and black are hard to differentiate.

P33.843 Labels for Fig. 11 state PF and PPF, whereas this line states only PF.

5 Conclusion

P35.900 To assess **the** benefit

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