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Atmospheric Measurement Techniques Discussions
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Interactive comment on "A study of polarimetric noise induced by satellite motion: Application to the 3MI and similar sensors" *by* Souichiro Hioki et al.

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The authors present a simulation of future 3MI polarimetric data based on existing and modeled data, and assess the impact of sequential polarization-filtered intensity measurements along the ground track. This is indeed a major limiting factor to the polarimetric uncertainty of this and similar instruments, and therefore deserves an in-depth analysis and publication in AMT.

However, this reviewer wants to raise a number of fundamental and more minor aspects that should first be addressed in more detail:

1) The uncertainties discussed in the manuscript are purely systematic and not at all random, and should therefore not be labeled as “noise”. Moreover, it is debatable to what extent a statistical framework can accurately describe the uncertainties due to these systematics, as there are no random processes involved in the measurement itself. In addition, as DoLP is necessary larger than (or equal to) zero, any distributions for low DoLP will be skewed. It is only mentioned in passing, but to a large extent these systematic effects can be predicted and therefore partially mitigated, as the spatial structure that induces them is always measured. This should be discussed further.

2) It remains unclear why the Laplacian is used as a proxy for the systematics instead of a regular gradient. Indeed, the gradient literally constitutes the first-order approximation. But, as Stokes parameters are obtained through intensity differences, spurious polarization effects are readily described as the amount of uncorrected shift times the gradient in the flight direction + higher-order terms. Or do you assume that the shifts are fully corrected, and that the first non-linear term is the leading one? Can you demonstrate this by propagating a simple model through the polarimetric demodulation?

3) The other fundamental limitation of this polarimetric method is not discussed at all: Remaining pixel-to-pixel gain variations can also lead to spurious polarization signals, which are indeed more noise-like. What do you assume for the flat-fielding calibration accuracy? And why not take this into account in the simulation as well? Indeed, sub-pixel effects are mentioned, and may need to be quantified with a back-of-the-envelope propagation as well.

Detailed comments:

-It would be highly useful to list the polarimetric requirements for 3MI to put these results into context.

-Same for the atmospheric parameters that are derived from these measurements.

-l37: It would be good to discuss the basics of these vicarious calibration methods. Can they be applied to mitigate for the effects discussed in this paper?

-There is a mistake in Eq. 5: The last factor should be X_m60.

-Why not consider the Angle of Linear Polarization?

-And why not stick to the Stokes parameters [Q,U] or [Q/I, U/I] to keep things mathematically well-behaved?

-I don't understand the sentence on lines 69-70. . . Maybe you should distinguish additive and multiplicative spurious polarization effects?

-Please discuss in detail the commonalities and differences hinted at in Sect. 2.1 between the polarimetric implementations of SGLI and 3MI. A cartoon figure may come in handy.

-Please explain the particular values in Tables 1 and 2.

-l100: Please provide some more details on what you interpolate, and how.

-Why is there a difference in "center of mass" between the shifted grids in Tab. 2? Does this have an impact on the spurious polarization signals?

-Sect. 2.2.2 and further: I don't understand the meaning of "stratification" in this context. . .

-As the cloud detection algorithm is new, it would be good to provide some numbers on false positives/negatives.

-l113: Introduce all the acronyms.

-What are the confidence levels for cloud (non-)detections?

-I suppose there is a valid reason why you select a power law of -5/3 (Kolmogorov)?

-l145: Please provide a reference for the "observed empirical distribution function".

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Discussion paper

-l150-158. Why not compute this in [Q,U] over which you can actually average? If the AoLP is not constant, this math breaks down. . .

-l202: I don't understand "0.0010 (i.e. 2.2%)".

-It would be insightful to also present intensity and polarimetric images for typical simulated cloud scenes for particular power law distributions.

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