Response to RC1

Specific Comments: In the abstract, I suggest including a sentence with the improved calibration numbers between the three methods, moving average (MA), the current operational version (OPER), and the Gaussian Process (GP) with improved dynamic input uncertainty for at least one site (HI01, IL02, or OK02).

We have revised and added the following sentences with the improved calibration numbers in the abstract (lines 23 to 29).

The validation results at the three test sites (i.e. HI02 at Mauna Loa, Hawaii, IL02 at Bondville, Illinois, and OK02 at Billings, Oklahoma) demonstrated that the agreement between aerosol optical depths (AODs) at the 368 nm channel calculated using Vo determined by the GP mean function and the equivalent AERONET AODs were consistently better than those calculated using Vo from standard techniques (e.g. moving average). For example, the average AOD biases by the GP method (0.0036 and 0.0032) are much lower than those by the moving average method (0.0119 and 0.0119) at IL02 and OK02, respectively. The GP method's absolute differences between UV-MFRSR and AERONET AOD values are approximately 4.5%, 21.6%, and 16.0% lower than those of the moving average method at HI02, IL02, and OK02, respectively.

Pg 8, line 193: Just a note to correct the wording of this sentence (though the sentence refers to irradiance at 369-nm). The Physikalish-Meteorological Observatorium Davos, World Calibration Center has a Precision Filter Radiometer (PFR) that measures AOD at 368-nm. Using this type of instrument would avoid additional uncertainties in AOD caused by the interpolation between wavelengths when comparing the MFRSR with the AERONET CIMEL. At the sites used for the comparison in this paper, the site HI02 has a PFR but I do not know about the other two sites. This isn't essential for the analysis, nor conclusions of the paper, only suggest the sentence be modified.

Thanks for pointing out the existence of the WMO reference instruments that measure at 368 nm. We have changed the beginning sentence of section 2.4 to the following (lines 199 to 205).

Ideally, to avoid additional uncertainties caused by the interpolation between wavelengths, the calibration factors should be validated via a direct comparison of direct sun signals from the to-be-calibrated UV-MFRSR and a reference instrument measuring at the 368 nm channel (e.g. the standard precision Filter radiometer (PFR) operated by the Physikalisches-Meteorologisches Observatorium Davos, World Optical Depth Research Calibration Center (WORCC)). However, such reference measurements are not available at most UVMRP stations. Therefore, the estimated mean normalized Vo (Vo_norm) values from the Gaussian Process regression and the other two comparison methods (i.e. MA and OPER) are validated indirectly in terms of aerosol optical depth (AOD) against those obtained from the collocated AERONET sites.

For validation of the technique, the authors compare AOD at 368-nm from the UVMFRSR indirectly to the AERONET CIMEL using information of AOD at two wavelengths (340 and 380 nm). Different types of measurement techniques have their own source of uncertainties as with the CIMEL and the addition of the few paragraphs on previous literature that highlights these differences is crucial to the understanding the improvements using the GP technique.

We agree that the discrepancy/uncertainties in deriving AOD values from the two instruments' measurements should be highlighted explicitly. The following sentences were added at the end of section 2.4 (lines 273 to 288).

Since AERONET and UV-MFRSR AOD values at 368 nm are derived from measurements involving different instruments and wavelengths, the uncertainties when comparing these AOD values should be noted. Some important sources of uncertainties include:

1) AERONET calibration error – At the time of calibration at MLO, AERONET reference instruments have an uncertainty of ~0.2 to 0.5%, which is equivalent to a 0.002 to 0.005 uncertainty in AERONET AOD (Holben et al. 2001). These calibration factors are likely to shift within the year following calibration, which may result in a total AOD uncertainty of ~0.01 to 0.02 (wavelength dependent, higher in the UV) (Holben et al. 2001).
2) Instrument Field of View (FOV) - AERONET CIMELs have a field-of-view (FOV) of 1.2° while the UV-MFRSR has a larger FOV (e.g. ~6.5°, reported by Kazadzis et al. 2018). AODs obtained from instruments with larger FOVs are associated with greater AOD uncertainty due to larger contributions of scattered light to the direct irradiance measurement (Kim et al. 2005).
3) Instrument maintenance – Periodic soiling and cleaning of the UV-MFRSR diffuser can result in spurious increases and decreases in AOD, respectively. The frequency of on-site maintenance (e.g. cleaning of the UV-MFRSR dome) as well as rainfall events may therefore account for some of the AOD difference (Kim et al. 2005; Kim et al. 2008).
4) Trace gases - As mentioned above, AERONET AOD accounts for NO_2 optical depth (e.g. ~0.002 at OK02) while UV-MFRSR AOD does not.

Pg. 7, section 2.2 on Moving Average. This doesn't describe the moving window size used in the analysis.

We have added the following sentence describing the moving window size in section 2.2 (lines 183 to 184).

The parameter *win_size* of MA is set at 20 for all applicable cases in this study.

Technical corrections:

Pg 18, line 395. AEROENT needs to be AERONET.

We have corrected the error accordingly (5 instances).

Pg 420, line 422-423. Incomplete sentence.

The sentence has been revised as below.

As a result, higher accuracy of Rayleigh and other optical depth components is required to discern small improvement on AOD for HI02.