Evaluation of AOD uncertainties in three 17-year ATSR-2/AATSR retrievals

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Introduction

In the framework of the ESA Aerosol_cci project (Popp et al., 2016), three 17 year 1995 - 2012 ATSR-2 (ERS-2) and AATSR (ENVISAT) datasets were developed at the Univ. of Swansea (SU v4.2 and v4.21), at FMI (ADV v2.3), and at the Univ. of Oxford (ORAC v3.02). Besides AOD and related products, all retrieval include pixel level uncertainties. An evaluation of uncertainty estimates over the entire 17 year data record has been performed for the three retrieval approaches. Level 2 retrievals within 50 km and 30 min of an AERONET site are considered.

Methodology

To evaluate how well the predicted standard uncertainty σ_{ATSR} represents the observed distribution of error, we consider the metric

$$\Delta = \frac{AOD_{ATSR} - AOD_{AERONET}}{\sigma_{ATSR}}.$$

If the uncertainty is a good representation of the error, Δ will be normally distributed with zero mean and unit standard deviation (68.3% of values should fall within the range [-1, +1]). A non-zero mean of Δ indicates the presence of residual systematic errors. A standard deviation of Δ greater/less than one indicates that uncertainties are under-/overestimated. Please note that the comparison will only represent the subset of environments that contain an AERONET station and that have a high probability of being cloud-free.

Evaluation of SU retrievel uncertatinties (v4.2 and v4.21)

Figure 1 shows the evaluation of the AOD retrievel uncertatinties for SU versions v4.2 and v4.21. While uncertainties were overestimated in version v4.2, the uncertainty estimate of v4.21 is quite accurate with about 60% of the AOD values falling within the [-1,1] range. Uncertainties are better estimated over continents than near coasts. The *wedge* implies an ATSR best minimum uncertainty of about 0.03 for low AOD retrievals, comparable to that of MODIS (Levy et al., 2013).

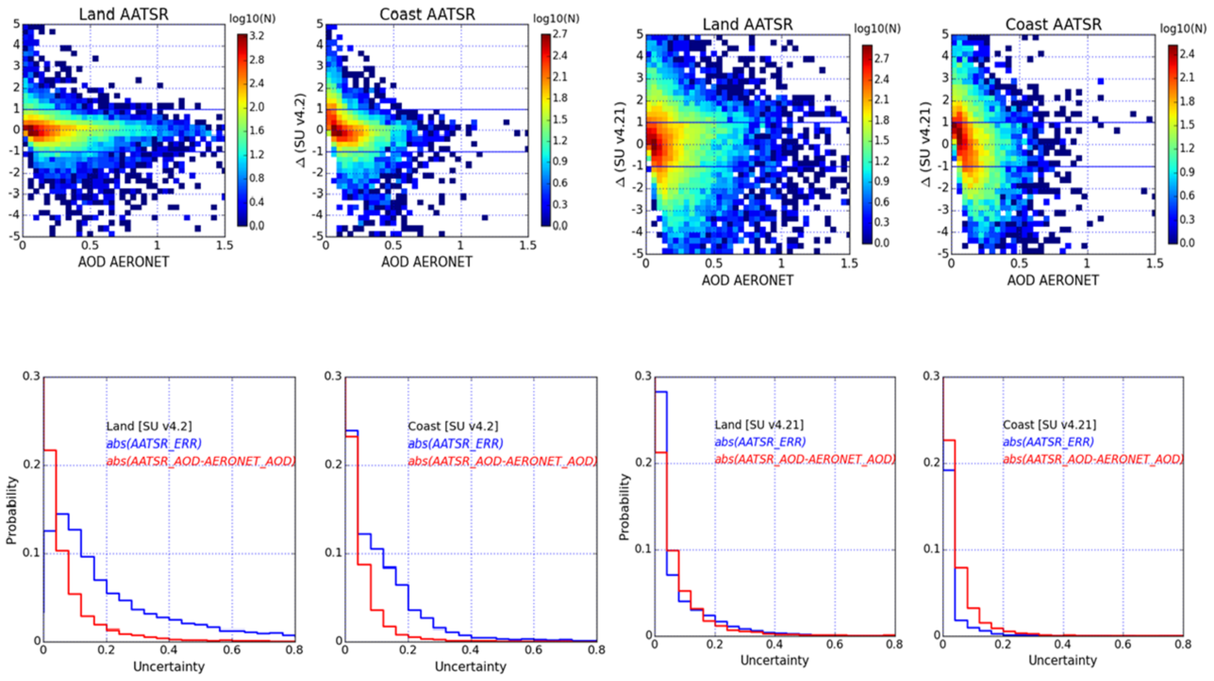

Figure 1: 2D scatter plots (upper panels) and error histograms (lower panels) for the SU approach over continental and coastal sites for SU version 4.2 (left two panels) and SU version 4.21 (right two panels) 2003-2011 AATSR data. The requirement of no negative retrievals causes the data-void wedge at the bottom left in the scatter plot.

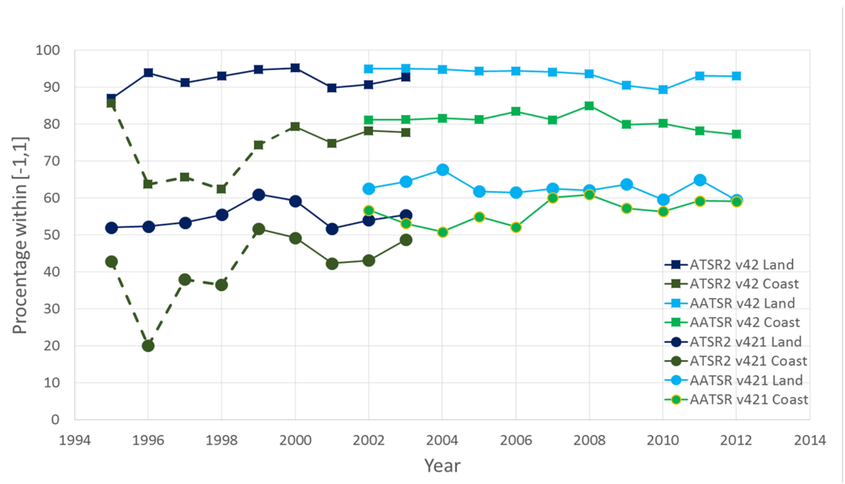

Figure 2: Percentage of ratio Δ within [-1; 1] per year for two versions of the SU algorithm for two sensors ATSR-2 and AATSR over land and coastal sites.

Stability of SU retrieval AOD uncertainties

Furthermore, the stability of the uncertainty to represent the distribution of error was evaluated (see Figure 2). The fraction of the points where the ratio Δ falls within [-1; +1] shows that version 4.21 presents a sensible representation of the error over land throughout the 17-year record., though it is less consistent between ATSR-2 and AATSR than version 4.2. The underestimation of coastal uncertainty exhibits greater variability, indicating the sources of error omitted from the current uncertainty estimate are more likely to be transient, such as data coverage, rather than a relatively consistent feature, such as the incorrect modelling of shallow waters. Note that for the early part of the ATSR-2 period there were many fewer AERONET sites.

AOD uncertatinties from ORAC (v3.02) and ADV (v2.3)

Figure 3 shows the uncertainty evaluation results for the ORAC and ADV retrieval. The uncertainty estimate of the ORAC v3.02 dataset is well represented over land with about 55% of the AOD values falling in the range [-1,1]. However over coastal regions the estimated uncertainty is underestimated, as only 23 % of the AOD values fall into the [-1,1] range. The uncertainty estimate of the ADV v2.3 data represents underestimates as only about 34 % of the AOD values over land and only about 24 % of the AOD values over coastal areas fall in the [-1,1] range. The missing *wedge* in both datasets implies a minimum uncertainty of about 0.05.

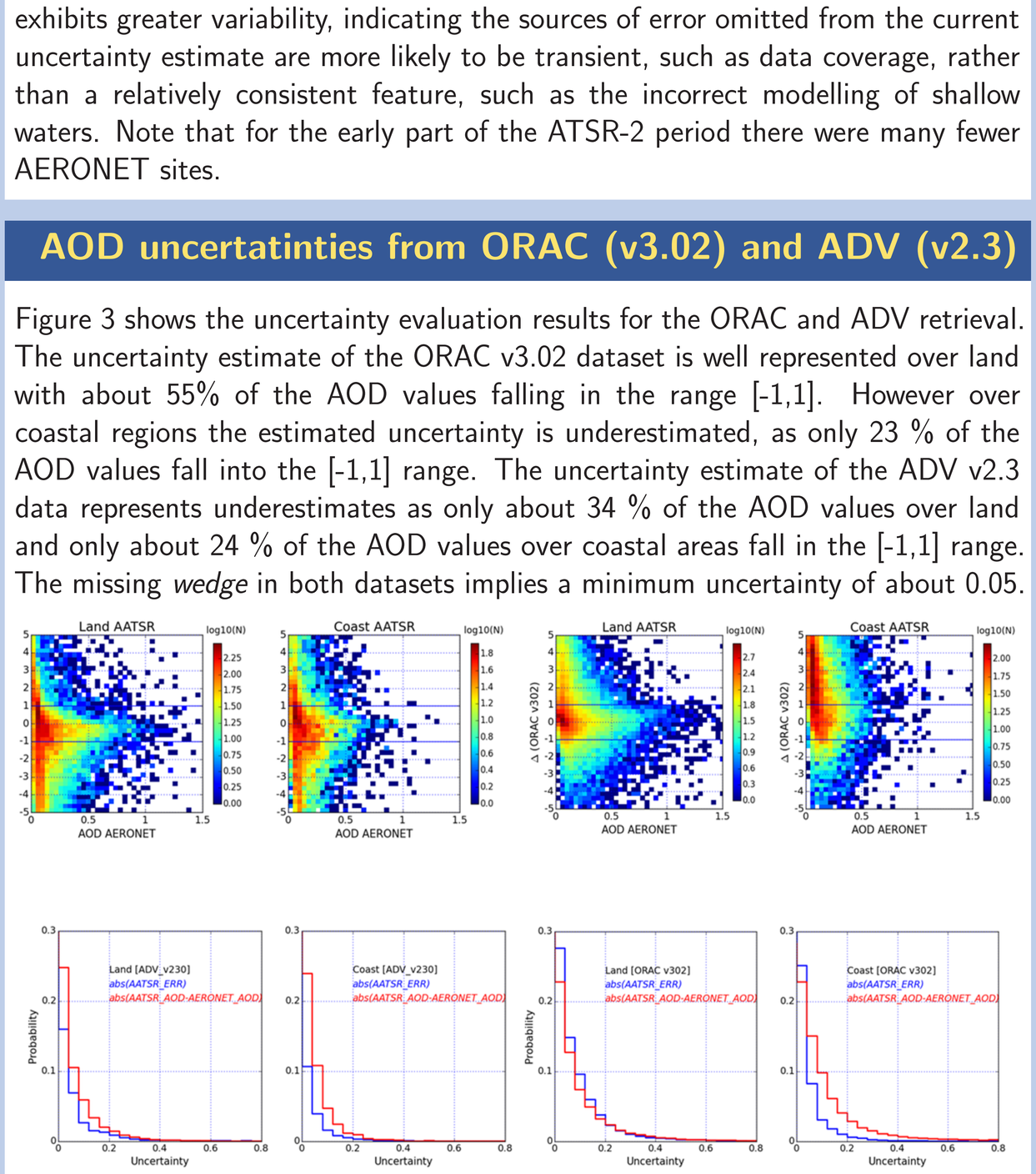

Figure 3: 2D scatter plots (upper panels) and error histograms (lower panels) for the ADV v2.3 and ORAC v3.02 over continental (left) and coastal sites (right) for 2003-2011 AATSR data.

Summary

In Table 1 the AOD uncertainty evaluation for the three retrieval approaches from Univ. of Swansea (SU), from Univ. of Oxford (ORAC), and from FMI (ADV) and are given for both ATSR sensors individually for continental and coastal matches.

Table 1: Percentage of ratio Δ within the [-1; 1] range per year for the three ATSR approaches for both ATSR sensors individually for continental and coastal matches.

Approach	ATSR-2 land	ATSR-2 coast	AATSR land	AATSR coast
SU v4.21	56 ± 3 %	45 ± 9 %	63 ± 2 %	57 ± 3 %
ORAC v3.02	54 ± 6 %	21 ± 3 %	55 ± 6 %	23 ± 3 %
ADV v2.3	8 ± 6 %	20 ± 11 %	34 ± 3 %	24 ± 3 %

Acknowledgments

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References

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