EGUsphere, referee comment RC2
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Comment on egusphere-2022-170

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Referee comment on "Bayesian atmospheric correction over land: Sentinel-2/MSI and Landsat 8/OLI" by Feng Yin et al., EGUsphere,
https://doi.org/10.5194/egusphere-2022-170-RC2, 2022

I reviewed the manuscript years ago submitted to another journal + I did look forwarding to the revision which I did not see. Now I saw it in a different journal with significantly improvement in the experimental design and presentation style.

I recommended for publication as the study

- presented a novel way for medium resolution (Landsat-8 and Sentinel-2) satellite data atmospheric correction
- showed the presented method significantly improves the surface reflectance and aerosol property retrieval accuracy
- systematically validated the presented method using Landsat and Sentinel-2 data over globally distributed AERONET

Impressive work and I have to say this is a hard paper to review as there are many techniques used in the study. I appreciated the authors make the codes public available. I like many ideas in the paper but in particular the spatial smoothness prior and the validation of the uncertainty (many geostationary satellite Bayesian AOD estimation

output uncertainty without validation). I really hope the authors later (not in this manuscript) can experimentally show that the proposed method is better than LaSRC and Sen2Cor – by running LaSRC and Sen2Cor software on the datasets used in this study (this maybe boring to the authors but I believe it is beneficial to the community and to the authors if the algorithm more convinced). Or simply participate ACIX and hope to see the algorithm will be an unambiguous winner in ACIX.

I have a few comments before the publication of the manuscript

Major issues

1, The readers may wonder what is the computational cost of the proposed method and the iteration nature of the gradient descent (L-BFGS-B algorithm) may boost the computation time rapidly. Add a paragraph for discussion.

2, The authors omitted the deep blue bands for both Landsat-8 and Sentinel-2 and the band is most sensitive to aerosol among all the bands, any particular reason for doing so. MODIS does not have this band? use MODIS blue to replace not work ?

3, Spatial smoothness is interesting but unclear mostly related to how D matrix is derived. Is the spatial difference applied to the intermediate AOD and WV results derived for each iteration of L-BFGS-B algorithm. If so, Cxb is changing with iterations? The spatial difference is calculated over neighbor 8 pixels or over an entire 40 km window? How the row and column direction are averaged? Simply give an example of deriving D would solve my concern. After the line of 775, "over the whole of Gc" or of sub-40 km? Looks like the sub-40 km is used as a block to solve the equation which means the solution of each

sub-40 km is independent to the neighbor sub-40 km block (but I am not sure).

The study need a consistent check of the writing style. For example, lines 102-103.

Minor issues

Discuss the possible shift from MODIS to VIIRS considering the dying of MODIS.

Line 105, how to treat b09. Is MODIS band 2 reflectance (after D2 transformation) used as a prior for b09 reflectance?

Line 675, there is another MCD43 PSF estimation paper worth citing (Che et al. 2021).

Che, X., Zhang, H. K., & Liu, J. (2021). Making Landsat 5, 7 and 8 reflectance consistent using MODIS nadir-BRDF adjusted reflectance as reference. Remote Sensing of Environment, 262, 112517.

Line 130, not quite familiar with the L-BFGS-B algorithm. But does the L-BFGS-B algorithm have its own way to calculate the gradient or the authors really used the back propagation of ANN to calculate ANN (ANN uses an automatic differentiation method) to feed into L-BFGS-B algorithm. Or back prorogation gradient is only used in B4 for RBF uncertainty but not used in L-BFGS-B?

Line 140, the LaSRC cannot be considered as DDV method anymore as each single pixel on the global have a visible/SWIR ratio (not just DDV pixels) see Vermote et al. 2016.

Line 155, the framework can tolerate incomplete coverage of Y^, how? If incomplete Y^, then the incomplete inversion of aod and wv will be spatially interpolated? Or get value using spatial smooth prior.

Line 200, "a estimates" – grammar

Line 260, how the σxaero is set

Line 310, which TOA band, the blue band should definitely greater than 10% mostly

Line 330 we are already in Section 4.3

Please label and re-arrange figures 10-12 correctly. Some are clearly surface but labelled as TOA. Check the labels of the plots. Rearrange them so that the TOA spectra and TOA plot are at the same row.

Line 470, yes, in many Landsat calibration literature, the calibration accuracy is 3%. Should this linked to appendix H?

Line 580. There is no Schaff 2021 in reference list