Atmospheric Measurement Techniques Discussions

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Comment on amt-2022-249

Anonymous Referee #2

Referee comment on "Exploring geometrical stereoscopic aerosol top height retrieval from geostationary satellite imagery in East Asia" by Minseok Kim et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-249-RC2, 2022

Summary: This paper explores the utility of stereoscopic methods from geostationary satellites to make an aerosol plume height estimate. With the advent of next generation imagers over Asia (GK-2A; Himiwari-8, FY-4 etc.), North/South America (GOES 16, 17, and now 18), and now starting in Europe (MTG), there is great potential in combining data in overlap zones. This work is one of several in recent years trying to make use of this new capability. Here, the authors provide a relative brief paper on their experiments combining AHI with AMI and AGRI to derive aerosol heights for cases around the Korean Peninsula. The paper briefly gives a rationale for the work, a list of data sources, explication of geometry, and finally performs comparisons to CALIOP and the Korean Lidar Network. As one would expect, skill is favored by geometries with wider separation between instruments.

After reading the paper, it was not clear to me how well the products actually work. In concept (as the authors note) there are fundamental differences in what is produced between spectroscopic aerosol height methods (say OA&B based TROPOMI based) and stereographic assessment (e.g. MISR). Spectroscopic methods give a centroid height, and stereographic give a feature height. The way the paper is laid out, it is not clear what specific features are being keyed off on in the algorithm. For clouds it can be straightforward, for aerosol features uncles there is a dense plume there are multiple textures in the satellite imagery. There is no discussion on this, and other assumptions such as the presence of embedded clouds they admitted they ignored. Looking at the scatter plots, there is so much scatter I am not sure their algorithm beats a climatology. E.g., if one takes the average of the average of CALIOP heights, does the retrieval's RMSD beat that? And if so by how much? It would not surprise me that there is a bias, but what we really want to know is if the deviations as observed by the retrieval match CALIOP? Further their cases are all pretty close to the surface. Perhaps add a Siberian smoke plume case?

Anyways, while I think this is a fine effort, the paper lacks details that are required and thus I suggest major revisions. I would encourage the authors add a few more pages too zooming in further on the case studies so we can see what the retrieval is looking at. Maybe a figure that pulls the string through that includes a higher dynamic range of features? Best wishes with the endeavor.

Line 49: "Studies have shown that the use of geometrical features of elevated atmospheric structures apparent to multiple sensor imagery is effective, rather than using computationally expensive radiative transfer calculations." Well it is more than that. Spectroscopic techniques give a different product altogether-the centroid of a plume- and that is compounded when one has multiple aerosol layers. Stereography gives a plume top for those cases when one can see a feature. This is a very different thing. In practice, I would say plume height from say MISR is more tractable than the spectroscopic methods.

Line 72: "Cloud top heights have been successfully retrieved using geometrical fusion of two

geostationary satellite images (Lee at al., 2020), suggesting the applicability of such a method to any structures in the atmosphere." A quick look on web of science I found several papers on the topic of stereo heights for aerosol features worth mentioning-some of which have a lot of parallels to this paper, including Lee et al (2020)-Remote Sensing; Merucci et al., (2016)-Remote Sensing.; Prata and Lynch (2019)-Atmosphere just to name a few. And for clouds there are many more. So the field is more advanced than the paper is letting on.

Line 73: "However, aerosol layers are not as optically thick as clouds and their heights are much lower than cloud tops, so the applicability and accuracy of the geometrical method for estimating ATH remain unresolved" I am not sure what you mean by using the word "unresolved" here. You can say that about anything really. You can say it is in the early stage of development. But given the complexity of the system it may never be "resolved"

Line 117: "Their ability of lidar observations to produce aerosol profile data with high vertical resolution enables them to be a validation standard for spaceborne aerosol height retrieval algorithms." I think you mean *the*? Keep in mind, it is best not to use pronouns in the first sentence of a paragraph.   It is often unclear what “they, them, it” refers to.

Line 153-Here you reference Lee et al., 2020, but I don’t think it is in the references.

Line 225: “Although highly reflective clouds can interfere with correlation calculations, the stereoscopic ATH algorithm does not include a cloud masking procedure. By using the AHI AOD product, where retrievals are undertaken only for cloud-free pixels, we assume that selected pixels with high AOD are cloud free.” Is that a good assumption? So also what happens when you have a thick smoke or dust plume? If the retrieval fails under these circumstances some of the strongest aerosol features may be missed. In future versions, the authors may want to think hard about the aerosol-cloud discrimination.

Line 292: It is unclear to me how the CALIOP heights should be generated. The discussion of CALIOP in this and the data section is brief. To do a proper match up, CALIOP needs to observe a feature, which has high enough AOD and texture for the matching algorithm to identify it as a target. CALIOP may be able to give the AOD, but what about the texture feature? This is not really described in the paper, but is the lynchpin problem. For the discussion with Lee 2021, they had to do a extinction weighted mean to compare apples to apples. For this paper the CALIPSO baseline “We therefore define CALIOP height as the height where the cumulative EC532 represents 90 % of the total column integrated EC532, starting from the bottom of the profile.” But this has no feature identification. If you have a plume embedded in a polluted atmosphere you could be looking at completely different things.

Line 306: Why were these cases picked? Perhaps you should pick some with more dynamic range, like a Siberian smoke plume

Line 345: Looking at the scatter plots, it is not clear to me what skill this method even has for the cases they are investigating. If one assumes a simple baseline from climatology (say the mean from CALIOP or maybe 3.5 or 4 km), does this method provide any skill beyond that? Here I am more worried about the RMSD than the bias. Anything systematic you can say about what situations it works and when it doesn't overall? This really needs to be added to the paper.

Line 370: I think an error distribution like was done with CALIOP would help synthesize your findings.