General comments

This paper develops a statistical model to estimate ground-level PM over Korea from AOD retrieved by the GOCI geostationary satellite instrument. It is interesting to see how well a statistical model can estimate PM from geostationary AOD. This study also presents a thorough comparison to other commonly used approaches like AOD from MODIS vs GOCI and simulations by CTMs vs statistical models. The paper is generally clear, although it can be more concise and better organized. I recommend it for publication in ACP after the following questions are well addressed.

Major comments:

1. In Fig 8, the GOCI-GEOS-Chem fused $PM_{2.5}$ seems to have considerably larger bias than even just the GEOS-Chem simulated $PM_{2.5}$, which is not what I was expecting since GOCI AOD provides an observational constraint to the simulation. Could you please explain why GOCI-GEOS-Chem fused $PM_{2.5}$ has such a large bias? Also you mentioned in text P20L10 that R^2 and slope of the GOCI-GEOS-Chem fused $PM_{2.5}$ is better than the GEOS-Chem $PM_{2.5}$. Could you please put them into numbers?

2. The description of data used in this study needs to be more detailed. For example, for observations of PM, suggest to include general description of how PM is measured, like what instrument is used. For GEOS-Chem and CMAQ simulations, you should include model version, what meteorological fields are used, what emissions are used to help readers interpret results.

3. I didn't understand why the RF PM in Fig 8 was different from that in Fig 9. Could you please explain what makes the difference?

4. I'm surprised to see that the PM estimates from MODIS are basically the same as they are from GOCI given that MODIS provides about 8 times less data than GOCI and that MODIS cannot resolve the diurnal variation of AOD yet GOCI can. I was expecting that MODIS will have at least larger variability than GOCI but it is not the case either in Fig 7. Could you please explain why GOCI is not showing a pronounced enhancement over MODIS here?

5. As you've shown in Fig 4 that meteorological parameters have playing an important role in relating AOD to PM2.5 as well. Could you please comment on the accuracy of these parameters?

6. You mentioned in the paper that RF well estimates PM high concentrations. Could you please elaborate what findings support this statement? And why RF is good in estimating high concentrations but not small? What potential bias in RF can be reflected from this finding?

7. P11L19. Could you please make clear if the remaining aerosol variables (AE, FMF, etc) come from GOCI? If so, they are given at different temporal resolutions from MODIS AOD. Could you please justify this?

Minor comments:

1. Suggest to distinguish subplots (e.g., Fig 3, 4, 5, 6, 7, 8, 9) by adding titles and remove letter like (a), (b), so readers don't need to refer to the caption to find what each subplots means. Then captions can be more concise.
2. In Fig 3, what do different colors in circles mean?
3. P2L10-17: I didn't understand how the example of Zang et al., (2017) supported the statement of the limitation of ground-based measurements.
4. P2L31: I suggest to move CTM to the next paragraph to have this paragraph focused on statistical method. Also this is a good place to introduce RF. Maybe moving the introduction of RF starting from P10L15 to this paragraph.
5. P5 section 2.2.2 and 2.2.3: suggest to describe what data a satellite or model is used to provide to this study as the very first sentence when introducing a new model. It can be very confusing given so many different models and names all introduced in this section.
6. P7L23, please put "high concentration" into numbers.
7. P11L16, "MODIS only provides AOD with 3 km resolution". Could you please verify whether MODIS AOD is 3 km? I think it should be 10 km.
8. P13L8, why summer sample size is small? If it's due to cloud contamination, then should be swap the order of cloud contamination and small sample size in the sentence.
9. P15L3-4: It seems that the example of Asia dust events at high altitudes is used to support the case of high PM and low AOD. I think it's actually conflicting to the statement. I'd expect high altitude dusts contribute to high AOD yet low surface PM. Could you please explain?
10. P15L8: "in which solar radiation increases with decreasing aerosol concentration", do you mean solar radiation reaching the surface increases with …?
11. P18L16, I got an impression that the author seemed to be overemphasizing the 500m resolution in the paper. However, all GOCI data used in this study are aggregated to 6km, so suggest to change 500 m resolution to 6 km and change high spatial resolution to moderate spatial resolution. Also please change the spatial resolution about GOCI aerosol products to 6km elsewhere too.

Technical comments:

1. P1L1: should be "ground-level"
2. P1L16: "The long exposure" should be "Long-term exposure".
3. P1L29: "the proposed RF MODELS yielded better performance" than what?
4. P2L3: "especially PM10 and PM2.5". This is where the abbreviation PM should be introduced, not at line 11.
5. P2L17: cut "on the other hand".
6. P5L7: should be "at" 400nm and 870nm.
7. P5L8: change "MODIS" to "MODIS satellite instrument".
8. P5L9: cut "to observe the Earth's environment".
9. P5L10, change "and Aerosol…" to ", Aerosol"
10. P7L4, change "which is one of the … and" to "as"
11. P16L9, cut " Thus, .. data pixels".

12. P16L13, cut "season".
13. P20L3-4, suggest to cut "Some studies investigated … Xu et al., 2015a) to avoid repetition to the introduction.