Review of "Contrails and their impact on shortwave radiation and photovoltaic power production – A regional model study" by Gruber et al.

The authors use a regional scale model and contrail parameterization to simulate contrails and cirrus clouds occurring over central Europe during a single day – December 3rd, 2013. The simulated cloud cover and ice crystal mass mixing ratios are used in an online radiation scheme to understand the impact of aviation on direct and diffuse shortwave radiation reaching the surface, which in turn, affect the production of photovoltaic power. Overall, it is reported that aviation-induced cloudiness reduces PV power production by up to 10%. Assumptions related to the emissions index of ice crystals and crystal loss during the contrail vortex phase significantly alter this estimate. This is an interesting case study, which should be worth publishing in ACP; however, the limited time and spatial coverage of the reported model simulations limit the usefulness of authors' conclusions for broader understanding the relevance of aviation contrail cirrus to solar energy production. It certainly would be nice to see more data points for other spatial locations or time periods (e.g., summer). The following comments must be adequately addressed before I can recommend that this paper be acceptable for publication.

1) Pg. 2, Line 16-17: This sentence is confusing. What is being claimed here – that this is the first time a regional scale model has been applied to study contrails and contrail cirrus? I don't think a statement like this is really necessary, but in any case, please be specific with what is being claimed as novel.

2) Pg. 3, Line 12: What is the state of the art with respect to PV forecasts? There does appear to be some literature on this topic using both NWP and statistical models (e.g., Wan et al., 2015). Please expand this section to discuss current methods and considerations.

3) Pg. 3, Line 14-15 and Pg. 9, Lines 2-5: How are the flight radar data obtained and input into the model? How do these flight tracks compare/interface with the ADS-B data presented in Figure 2? Are these data publicly available, and if so, how can the reader obtain the data?

4) Pg. 3, Line 20: In the following what? This sentence is confusing.

5) Pg. 4, Line 21: How often and under what conditions are these limits actually reached in the simulations?

6) Pg. 5, Line 26-28: How are contrail and contrail cirrus ice distinguished from cirrus ice given the statement on Pg. 5, Line 5 that the cirrus and contrail cirrus ice classes are lumped together?

7) Pg. 7, Line 26: Is there a citation for the assumed EI_iceno?

8) Pg. 8, Line 18: What is the vertical resolution of the model?

9) Pg. 10, Line 30: Is this sentence referring to Figure 3 instead of Figure 4?

10) Pg. 12, Line 3-4: What properties are being referred to here? I certainly wouldn't say that the number concentration in 4e and 4f are similar, and there are also large differences in IWC in 4b and 4c.

11) Pg. 14, Lines 11-12: Why do contrails only form at altitudes between 11 km and 13 km? Is this because air traffic is restricted to these altitudes on this line or are there lower altitude flights but the Schmidt-Appleman criterion is only satisfied at these altitudes?

12) Pg. 15, Line 6: Should the first word be "below"?

13) Pg. 15, Line 10: Does the model account for downward subsidence of the aircraft vortices and plumes or is the vertical structure in the modeled contrails only due to gravitational settling of the larger ice crystals? The enhancements in ice number shown in Figure 6 appear to occur at flight level, but the enhancement in IWC is below flight level.

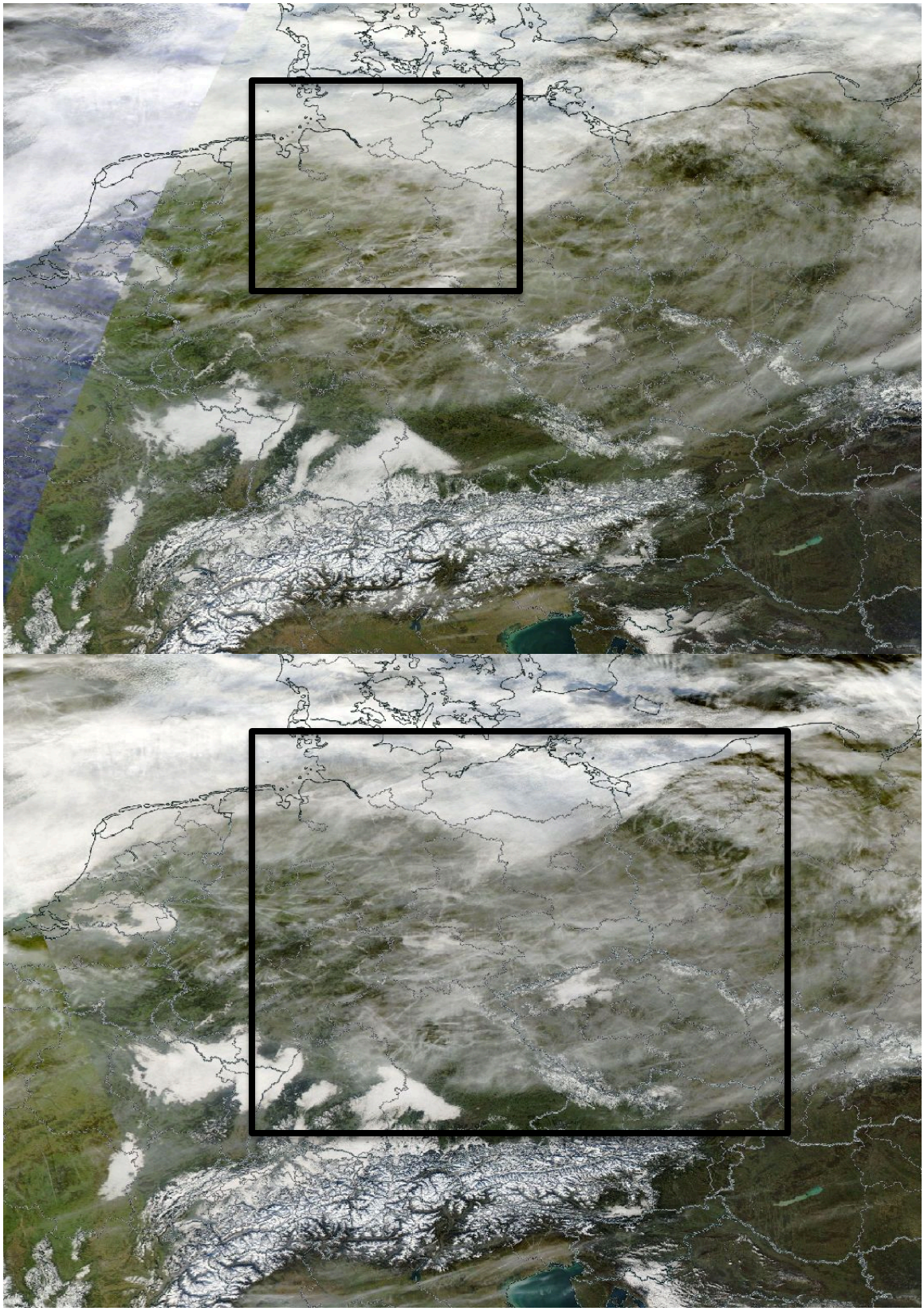
14) I would like to see the satellite observations more directly integrated into the discussion surrounding Figures 3-4 rather than in its own section since I think that it can provide a lot of context and validation for the model results. Figures 8 and 9 as they stand now are kind of on their own and not particularly informative other than to denote that there are thin, high-level cirrus and no low clouds. The cirrus clouds shown in Figure 8a appear to be much more diffuse than the MODIS imagery for this time period, with the MODIS images showing a lot of contrail structure and providing a good snapshot of the time evolution of the scene during the two simulations. I suggest the authors strike Figures 8 and 9, and add MODIS satellite images at 1000Z and 1150Z either as part of Figures 3 and 4 or as a separate figure before them. Such an example figure created from worldview.earthdata.nasa.gov images is on the next page with detailed web references at the end of this review.

15) What is the coordinate chosen for the red circle in Figure 11 and related timeseries analysis in Figure 12? Why was this coordinate chosen? Do the results change if a set of coordinates in the $\Delta SW < -5\%$ band is chosen?

16) Pg. 22, Line 20-21: Suggest rewording, "In reality…" to "This scenario explores lower engine soot emissions caused by either improved engine combustor technologies or fuel composition changes from, e.g., biofuel adoption (Moore et al., 2017).

17) Figure 2: Should this be COSMO-ART to be consistent with the text?

18) Figure 12: Please use a more descriptive legend and spell out abbreviations.



True Color Corrected Reflectance Imagery on 3 December 2013 at 10:00 UTC from MODIS Terra (top) and at 11:50 UTC from MODIS Aqua (bottom). Black boxes are eyeballed (poorly) from Figures 3 and 4.

References Cited:

Wan et al. (2015) “Photovoltaic and Solar Power Forecasting for
Smart Grid Energy Management”, CSEE Journal of Power and Energy Systems, 1(4).
Doi:10.17775/CSEEJPES.2015.00046,
http://ieeexplore.ieee.org/document/7377167/.

NASA Worldview Viewer with imagery and orbit tracks:
https://worldview.earthdata.nasa.gov/?p=geographic&l=VIIRS_SNPP_CorrectedReflectance_TrueColor(hidden),MODIS_Aqua_CorrectedReflectance_TrueColor,MODIS_Terra_CorrectedReflectance_TrueColor,Aqua_Orbit_Asc,Terra_Orbit_Dsc,Reference_Labels(hidden),Reference_Features(hidden),Coastlines&t=2013-12-03&z=3&v=-17.06324930328618,31.036661088764802,35.3750429177626,68.87135186462584

Time stamp information for the Terra and Aqua images is shown on the orbit tracks.

Editable Link to 1000Z Terra Image JPEG:
https://gibs.earthdata.nasa.gov/image-download?TIME=**2013337**&extent=**3,45,20,56**&epsg=4326&layers=**MODIS_Terra_CorrectedReflectance_TrueColor**,Coastlines,Reference_Features&opacities=1,1,1&worldfile=false&format=image/jpeg&width=**1080**&height=**768**

Similarly, for the 1150Z Aqua image JPEG:
https://gibs.earthdata.nasa.gov/image-download?TIME=**2013337**&extent=**3,45,20,56**&epsg=4326&layers=**MODIS_Aqua_CorrectedReflectance_TrueColor**,Coastlines,Reference_Features&opacities=1,1,1&worldfile=false&format=image/jpeg&width=**1080**&height=**768**

where coloring denotes: **Year and Julian Day**, **Bounding Coordinates**, **Layer**, **Image Dimensions in Pixels (controls resolution, aspect ratio)**