Review of Tang et al. -- Assessing sub-grid variability within satellite pixels using airborne mapping spectrometer measurements

The authors investigate the variability of NO2 within hypothetical satellite footprint sizes based on high spatial resolution airborne imaging datasets. For this purpose, two different methods (random pixel sampling and spatial structure functions) are applied that provide consistent results. In addition, the authors also address temporal variability. The topic is of importance for the scientific community and fits well into the scope of AMT. However, I miss some information on the airborne dataset that should be included before publication.

General comments

- There is no explanation on the L2 retrieval of the NO2 tropospheric VCD.. I think that you need to briefly describe, or at least reference to the retrieval settings. The auxiliary data used in the L2 retrieval also impacts on the observed variability (e.g. NO2 vertical profile shape, surface reflectance)
    - What input data was used for the airborne measurements?
    - Did you use a consistent retrieval for all regions (SMA, Busan, LA)
- I think that the study on temporal variability would benefit from consideration of the wind conditions (speed, direction, variability)

Detailed comments & technical corrections:

Page	Line	Comment
0	0	What is the meaning of the bold polygon in Fig 1, Fig 2, Fig S1?
2	65	also mention that comparison to in-situ observations is also difficult due to imperfect knowledge of the vertical profile
2	75	there are several more airborne instruments, which provide similar datasets. So these measurements are not really unique, see also P4.L126
4	130	Remove square brackets from citation
5	165	You state that you sample 10k hypothetical pixels. However, considering the area covered by the flights and pixel sizes of up to 25km^2 it is not clear to me how many distinct samples are actually evaluated
5	167	Does -> do
5	169	How do you treat overlappings swaths from adjacent flight tracks? Do you also account for temporal differences between these overpasses?
6	222	The SSF a~~i~~s defined here follows Follette-Cook et al. (2015)
6	234	“SMA in the Discussion section”… Please include a proper cross-reference
S	Fig S3	The labels are way too small. Please increase the font size or reduce white space between subplots
7 / S	250/Fig S3	The differences between median and mean values seem to be much larger for the SMA region that for Busan and LA. Please discuss possible reasons and the impact on the normalized SGV

7	257	“discussed below”. Please include a proper cross-reference.
S6	Fig S6	Add a legend to the figure. Mention in the caption that "red" corresponds to low values, and "blue" to high values. Consider using different colors, because “red” is also the color for the median
7	265	What is “this relationship”
S	S7	Add a legend to the figure
8	290ff	I am not sure if the threshold of ~10km spatial resolution can be generalized. It may be true for the regions investigated here. However, the spatial distribution of the NO2 field is also stongly affected by the meteorological conditions (strong winds lead to confined plumes, calm winds to high pollution levels above the sources) as well as the spatial distribution of the sources.
9	341	Why does a thicker PBL lead to stronger horizontal dispersion?
9	348	What about changing wind directions? A change in wind direction would also lead to a shifted spatial pollution pattern, which consequently leads to a change in pollution levels over time above a certain location.
10	373	In Fig 6 you describe the increase of the mean differences of NO2 VCD with increasing time for the SMA region. The data over LA (Fig S11) does not show a similar behavior. Instead there is almost no change between Dt=4h and Dt=8h. Please provide possible explanations.
10	349	SSP? Do you mean SSF?
10	406	Are wind speeds of ~5m/s also representative for the measurement conditions of this study?
11	425ff	What would be the dimensions of such a lookup table? Would you also consider the size of the city, the distribution of sources….?
14	546ff	The reference styles are inconsistent. * Some refereces have a DOI, others do not * Some references have DOI as as clickable (blue) link, others do not * Some refernces use doi:xxxxx, most others use https://doi.org/xxxx