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Atmospheric Measurement Techniques
Discussions

Interactive comment on "A physics-based approach to oversample multi-satellite, multi-species observations to a common grid" *by* K. Sun et al.

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This paper develops a new oversampling approach which use spatial sensitivity rather than overlapping area (tessellation approach) between target grid cell and sensor footprint as weight. The spatial sensitivity weight is calculated from sensor spatial response function which is represented by 2-D super Gaussian function. Errors from tessellation and discretization of spatial response function are well compared. Additionally, it uses several cases to show application. The paper is well written and has significant impact. I recommend its publication after addressing the following comments.

Specific comments:

1. The definition of total number of overlapping pixel polygons used in averaging for grid cell j (formula (4)) is somewhat confusing. To my understanding, $S(i,j)$ is the overlapping area, thus $D(j) = \sum_i S(i,j)$ is just sum of overlapping area and the unit of $D(j) = \sum_i S(i,j)$ is km^2. If so, is the unit of $D(j)$ for tessellation in figure 8 and 9 also km^2? Is $D(j)$ actually defined as $\sum_i \frac{S(i,j)}{\sum_j S(i,j)}$ or $\sum_i \frac{S(i,j)}{grid\ cell\ area}$ in figure 8 and 9?

2. In formula (10), why $\int\int_{grid\ j} S(x,y|i)dxdy$ is normalized by grid cell area? If $S(i,j)$ is just defined as $\int\int_{grid\ j} S(x,y|i)dxdy$, $W(i,j) = \frac{S(i,j)}{\sum_j S(i,j)}$ is the normalized spatial response function for observation i and its spatial integration $\sum_j W(i,j)$ is unity. Considering discretization of spatial response function in computation, both definitions of $S(i,j)$ are fine. Physically, should $\int\int_{grid\ j} S(x,y|i)dxdy$ be normalized by grid cell area or not?

3. Levi Golston has a good point of what is the extent of the enhanced resolution result physical real (Short comment 1 for this discussion paper, https://www.atmos-meas-tech-discuss.net/amt-2018-253/amt-2018-253-SC1-supplement.pdf). Levi Golston shows an example that "true" value is unity while oversampling result is 1/63. The result is, however, based on using 2-D boxcar spatial response function on observation generation and oversampling. If 2-D super Gaussian function is used, will it show better oversampling result? For 2-D super Gaussian function, will small k_1 and k_2 give better result than larger ones for Levi Golston's example? I suggest adding discussion of it.

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