Issues in Data Fusion for Satellite Aerosol Measurements with applications for GIVONI System at NASA GES DISC

Abstract

1. Motivation for Data Fusion

- Complementary Aerosol Measurements from a variety of space-based sensors are archived and readily available for the user.
- Community through GC DISC and other Data Centers. Each sensor's unique strengths and weaknesses contribute to the overall aerosol measurements under a variety of conditions.

2. Simple approaches to Data Fusion

2.1. We use the standard validated MODIS Terra (MOD08_D3.D05) and Aqua (MYD08_D3.D05) Terra-MISR (ML039.e004) Level-3 Global 1°x1° product. These products consist of Level-2 Swath data aggregated and binned into 1°x1° bins to form 1°x1° Area Lat-Lon grid. The Daily ACT maps will always contain gaps.

2.2. Averaging with Weighting by Pixel Counts (WPAC)

3. Experiments with Data Fusion

3.1. Plates (a) and (b) represent maps of the original MODIS Terra and Aqua Level-3 AOTs for areas with mostly irregular grids (Area IG). These data cubes in the maps are due to bright areas and gaps between orbit swaths. Plate (g) contains the map of the merged product created using the SIM method to combine the AOT values in Plates (a & b). (See figure 2)

3.2. Plates (a) and (b) also represent maps of the original MODIS Terra and Aqua Level-3 AOTs for areas with mostly irregular grids (Area IG). These gaps are due to clouds and bright land surfaces over which AOT is not retrieved. Plate (h) contains the map of the merged product created using MODIS AOT in Plates (a & b). Note the reduction but not elimination in gaps for the merged product for the case of areas IG (Plate h). Only 16% of all merged AOT map in Plate (g) contains gaps compared to 41% for Plate (h).

4. Using Measures to Understand the Merged AOT

We introduce the notion of Merging Confidence Function (MCF) to understand the maps resulting from (a) merging of Terra and Aqua AOT (e.g. Plate g) and from (b) to above and (c) merging of Terra and Aqua AOT followed by the gaps region. Broadly speaking MCF is a measure of the percentage of data values in the merged product whose deviation from the original Terra and Aqua AOT data exceed 3-Sigma.

5. Issues and Challenges in Data Fusion as applied to Satellite Aerosol Measurements

- Merging Aerosol Data Fusion at any of the above levels has to consider:
  - Measurement Uncertainties for the individual Sensors
  - Differences in Spatial and Temporal Sampling between Sensors
  - Bias between Sensors
  - Error Analysis to evaluate the quality of the fused products
  - Validation of the fused product

6. Conclusions

1. The data fusion experiments ranging from pure merging only to combinations of merging and optimal interpolation are able to take advantage of the complementary nature of Terra-MODIS, Terra-MISR, Aqua-MODIS, and Aqua-MD Insat's data. As seen from Section 5, multi-sensor composite images are able to provide more insight into the spatial distribution patterns of the aerosol field.

7. References