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The effects of ground-track only sampling of aerosol fields

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We investigate the effects of the spatial sampling of aerosol fields by the Advanced Polarimeter Sensor (APS). This research was part of the APS-2 reflight study after the original APS failed to launch in March 2011. The APS-2 sensor would provide retrievals along the satellite ground track with a horizontal sampling similar to that provided by CALIPSO.

Aerosol Optical Thickness (AOT) is the most variable aerosol field, and it is therefore important to understand what the limitations of the sample of this field obtained by an APS-2 would be. We show here that APS-2 sampling uncertainties for the geometric mean AOT at a $10^\circ \times 10^\circ$ monthly mean scale are less than the accuracy requirements for an advanced global climatology of aerosol properties (Mishchenko et al. 2004, 2007a) between 80% and 95% of the time.

The two sources of AOT fields that can be used in assessing the sampling properties of an APS-2 sensor are global imagers, such as MODIS, and GCMs. The advantage of using the daily pixel level aerosol retrievals from MODIS to assess APS-2 sampling is that limitations caused by the presence of clouds are implicit in the sample and their seasonal and regional effects are captured coherently.

The problem with using an imager to assess a ground-track only sample is possible scattering and view angle biases. These are caused by inappropriate aerosol and surface model assumptions in the retrieval algorithm and are likely to have surface type, regional, and seasonal dependencies that make their diagnosis and disentanglement from sampling effects difficult.

GCMs are available that provide AOT fields with a daily temporal sampling and a spatial sampling finer (1.125°) than the equatorial ground track spacing of the A-train (1.6°). Re-sampling the model AOT field does not have the problem of view angle dependencies but the 1.125° resolution does not permit a realistic test of the reduction in the sample caused by clouds.

MODIS and GCM AOT fields are therefore complementary in assessing the sampling provided by APS-2. Using the MODIS AOT field to get an APS-2 like sample will, with its potential view angle dependencies, tend to overestimate sampling errors while a GCM AOT will tend to underestimate sampling errors.

Based on our analysis we expect that large-scale ($10^\circ \times 10^\circ$) long-term (monthly-mean) averages provided by an APS-2 sensor will be affected by random sampling errors at a level that is substantially less than the bias errors caused by calibration errors. These bias errors are themselves substantially less than the cited uncertainties in AOT retrievals from sensors that are currently on orbit. Moreover the purpose of APS-2 is to provide measurements of aerosols that are far more informative than the AOT alone and that, through the accurate retrieval of complex refractive indices and sizes of aerosols, allow the regional radiative forcing of aerosols to be determined. This study demonstrates that the APS-2 sampling would be sufficient to perform that task.

References

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