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Supplement of

The Global Space-based Stratospheric Aerosol Climatology (version 2.0): 1979–2018

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In this supplementary material, we report how uncertainties are estimated in GloSSAC version 2.0 data set. The error estimations are particularly for the post-SAGEII era for which we use OSIRIS, CALIPSO, and SAGE III/ISS in GloSSAC v2.0.

S1 OSIRIS

We use OSIRIS level 2 version 7.0 aerosol product. OSIRIS aerosol extinction is reported at its native wavelength of 750 nm. For the work here, we use zonally averaged monthly data gridded to 5 degree latitude. We report the uncertainties related to OSIRIS 750 nm extinction data as a median value and zonal standard deviation for each latitude grid in the same GloSSAC netcdf file. We use monthly climatology of Angstrom exponents to convert 750 nm extinction to 525 and 1020 nm. For this conversion, we report uncertainties as relative standard deviation in percentage with respect to the converted extinction at each grid point.

OSIRIS aerosol extinction at 525 nm is computed as:

$$k_{525[t,m,i,j]} = k_{750[t,m,i,j]} \left(\frac{\lambda_{525}}{\lambda_{750}}\right)^{\eta_{[m,i,j]}} \quad \text{(S1)}$$

where, $k_{525[t,m,i,j]}$, and $k_{750[t,m,i,j]}$ are extinctions at 525 nm and 750 nm respectively, $\eta_{[m,i,j]}$ is the angstrom exponent while the indices $[t,m,i,j]$ represent year, month, latitude, and altitude respectively. We first compute standard deviation of $k_{750[t,m,i,j]}$ and $\eta_{[m,i,j]}$. Since we use these two different quantities to compute $k_{525[t,m,i,j]}$, the uncertainties in each quantity must be incorporated into the uncertainty estimation of $k_{525[t,m,i,j]}$.

The uncertainty is then estimated using the error propagation formula and is defined as:

$$\sigma_{k525[t,m,i,j]} = \sqrt{\left[\left(\left(\frac{\lambda_{525}}{\lambda_{750}}\right)^{\eta_{[m,i,j]}}\right)^2 \times (\sigma_{k750[t,m,i,j]})^2\right] + \left[\left(k_{750[t,m,i,j]} \times \left(\frac{\lambda_{525}}{\lambda_{750}}\right)^{\eta_{[m,i,j]}} \times log(\frac{\lambda_{525}}{\lambda_{750}})\right)^2 \times (\sigma_{\eta[m,i,j]})^2\right]} \quad \text{(S2)}$$

where, $\sigma_{k525[t,m,i,j]}$, $\sigma_{k750[t,m,i,j]}$, and $\sigma_{\eta[m,i,j]}$ are standard deviations of $k_{525[t,m,i,j]}$, $k_{750[t,m,i,j]}$ and $\eta_{[m,i,j]}$ respectively.

The uncertainties associated with OSIRIS aerosol extinction at 1020 nm is also computed in a similar way, except that all subscripts of 525 in equation (S2) is replaced by 1020.

S2 CALIPSO

We use the monthly values of the newly computed particulate backscatter and OSIRIS bias corrected 525 nm extinction to compute annual median of OSIRIS extinction to CALIPSO backscatter ratios (scale factor (SF)) on Altitude-Latitude basis. The corrected CALIPSO extinction is then computed as:

$$k_{525\_CALIPSO\_corrected[t,m,i,j]} = BKS_{532\_CALIPSO[t,m,i,j]} \times \alpha_{[i,j]} \quad \text{(S3)}$$

where, $k_{525\_CALIPSO\_corrected[t,m,i,j]}$ is the corrected extinction at 525 nm, $BKS_{532\_CALIPSO[t,m,i,j]}$, is CALIPSO particulate backscatter at 532 nm, and $\alpha_{[i,j]}$ is the median SF respectively. The indices $[t,m,i,j]$ represent year, month, latitude, and altitude respectively.

For the error estimation, we simply compute relative standard deviation as:

$$relative\_sd_{[i,j]} = \left(\frac{\sigma_{525[i,j]}}{\alpha_{525[i,j]}}\right) \times 100 \quad \text{(S4)}$$

where $\alpha_{525[i,j]}$, and $\sigma_{525[i,j]}$ are the median SF and its standard deviation respectively. The indices $[i,j]$ represent latitude, and altitude respectively. For 1020 nm extinction, uncertainties are estimated in a similar way but replacing 525 with 1020 nm values. Figure 7(b,d) of the main manuscript show relative standard deviation.

S3 SAGEIII-ISS

For SAGEIII-ISS, no wavelength conversion is necessary as extinction measurements are readily available at 525 and 1020 nm. We, therefore only include zonal median and standard deviation at each grid point along with the extinction values.