GloSSAC Product Quality Summary

This statement applies GloSSAC v2.22 data products.

General Comments:

Despite some limitations, we believe that this is by far the best data set in this series of data sets (ASAP, CCMI). Compared to previous releases of the data set such as ASAP or the set for CCMI in 2014, we have implement a number of major improvements. These include the handling of the Pinatubo SAGE II saturation period in 1991 to 1993, the way in which missing values at high latitudes are filled during the entire SAGE II period, and how the post SAGE II period is constructed using OSIRIS and CALIPSO. The data set is focused on the providing as close to measured aerosol optical properties as possible. While continuity problems between instruments, temporal/spatial gaps, and the desire to produce as seamless, gap-free data set prohibits reporting just measurements and empirically-derived corrections are employed, all data from their original sources are preserved (at GloSSAC resolution) within the data set.

The change to version 1.1 is solely to correct an error in the way the CLAES data is incorporated into the long-term data record that caused some large errors in the lower stratosphere between July 1991 and April 1993. We recommend that all GloSSAC users update to version 1.1.

The version 2.0 is focused on improving the post-SAGE II era (after 2005) with the goal to mitigate elevated aerosol extinction in the lower stratosphere at mid and high latitudes noted in v1.0 as noted in Thomason et al. (2018). Changes include the use of version 7.0 OSIRIS and the recently released CALIPSO Lidar Level 3 Stratospheric Aerosol profile monthly product. Major changes that occurred to version 2.0 is for the post-SAGEII era data set where we implement a conformance process to OSIRIS and CALIPSO data that is based on SAGEII/SAGEIII-ISS overlap measurements. We recommend that all GloSSAC users update to version 2.0.

Important changes to version 2.1 includes version changes to individual data sets used in the post-SAGE II era (2005-2017) and SAGE III/ISS era (June 2017-present) and a revised cloud-free method used for SAGE III/ISS data. All individual data sets used from 2005 have undergone version changes and we use OSIRIS version 7.1, CALIPSO Level 3 stratospheric aerosol profile monthly product that now includes a minor version change from version 1.0 to 1.01 from July 2020. Additionally, a revised cloud-screen method is implemented for SAGE III/ISS, which improves the representation of aerosols in the lower stratosphere in particular, following volcanic/PyroCb events. The revised cloud-free data for SAGE III/ISS now shows enhancement of extinction coefficient in the lower stratosphere following these events.

For version 2.2, we have extended the dataset through December 2021. A minor version change occurred for OSIRIS data as we now use the latest version (version 7.2). Additionally, we implemented a filtering algorithm for SAGE III/ISS aerosol extinction coefficients to filter out negative extinction values that occur in the vicinity of large positive extinction, particularly below 25 km.

For version 2.21, the dataset is extended through December 2022. The only change in version 2.21 is the unavailability of CALIOP data for the year 2022. For the previous versions, CALIOP data is used mostly to fill in data the higher latitude, whereas in version 2.21 we interpolated the data along time axis to fill in the data at higher latitudes for the year 2022.

For version 2.22, the dataset is extended through December 2023. There are a couple of minor changes to version 2.22. SAGEIII/ISS version 5.3 and OSIRIS version 7.3 is used in GloSSAC version 2.22. As noted above, there is no CALIOP data available since January 2022. In this version, we interpolate SAGE III/ISS data along time axis and then used time interpolated OSIRIS to fill in any missing data poleward of 60 S/N.

For users, we recommend the following practices for this data set:

- For validation of aerosol properties derived within a chemistry-climate model, we suggest that the most robust comparisons are with the measurements directly. As a result, we suggest that they use the data flags to identify which values in the data set and compare model-derived parameters with those identified as measured and not indirectly inferred values.
- We have not focused on the derivation of bulk aerosol properties within this data set though it is suitable for that process. Even though values are reported at 525 and 1020 nm for every grid box, it is critical to recognize when data are based on a single measurement wavelength. This includes everything outside the SAGE II/SAGEIII-ISS period and some data gap periods within the SAGE II period primarily associated with Pinatubo. Users who wish to use this data set for developing climatologies of aerosol properties are welcomed to do so as well as distribute any products derived from your effort. We would appreciate attribution of the source material.

The summary of key issues associated with the data set:

- The Summer of 1991 in the tropics is poorly resolved due to the loss of SAGE II in the lower stratosphere and CLAES data do not become available until October of that year. In any case, the highly inhomogeneous state of the stratosphere in the several months following the SAGE II eruption makes a monthly depiction of questionable validity.
- While version 2.0 is improved particularly in the post-SAGEII era (2005) with a new conformance process that we implemented to OSIRIS and CALIPSO dataset based on overlap measurements with SAGEII/SAGEIII-ISS data, the OSIRIS/CALIPSO period presents some limitations. While new conformance method considerably improves extinction at 1020 nm for the post-SAGEII era (one-wavelength period where only 525 nm values are available), the size information that can be inferred is limited particularly during and following any volcanic events. However, from June 2017, SAGEIII/ISS multiwavelength measurements have been used whenever they are available which improves the quality of 1020 nm data . For version 1.0 and 1.1. , high levels of aerosol extinction has been noted in the lower stratosphere throughout the post-SAGEII era segment of the dataset. For version 2.0, the high levels of extinction are somewhat diminished but we still see some cases of higher extinction in the lower stratosphere. While we cannot exclude that it is correct, users should exercise caution with these data.
- For version 2.1, the important change is for SAGE III/ISS data with a revised cloud screen algorithm that now improves the representation of lower stratospheric data in GloSSAC data base. We have also implemented a linear interpolation along time axis for SAGE III/ISS to fill in data at the higher latitudes. The current version of OSIRIS data (version 7.1) also underwent

minor changes which now provides data for 2018 through 2020 with increased number of profiles in the polar latitudes.

- For version 2.2, the dataset is now extended through December 2021. For this version, we use version 7.1 of OSIRIS data. We also implemented a filtering algorithm for SAGE III/ISS to filter out negative extinction values that occur in the vicinity of large positive extinction values below 25 km.
- For version 2.21, data is extended through December 2022. The only difference in this version is that CALIPSO data were not available for the year 2022. Therefore, an interpolation along time is used to fill in the data for the polar latitudes.
- For version 2.22, the dataset has been extended through December 2023. SAGE III/ISS data is interpolated along the time axis, and OSIRIS data is utilized for regions poleward of 60S/N in cases where other data were not available. Users should exercise caution when utilizing data poleward of 60S/N following the Tonga eruption, as most of this data is filled using OSIRIS and may potentially be underestimated following the Tonga eruption.
- Data in the troposphere is only reported during the SAGE II period and only away from the Pinatubo eruption. Is likely that there is considerable aerosol in the upper troposphere during this period but we have little ability to produce values based on measurements in this period. While tropospheric aerosol is not the general area of concern for GloSSAC, it is likely that volcanic aerosol in the upper tropical troposphere plays a role in changing climate during the aftermath of the Pinatubo eruption.

In the future, we will look at some limitations in the data set particularly in inferring size information for the post-SAGEII period where only single wavelength measurement is available. We will also try to address the poorly resolved tropical data during Pinatubo period which occurred due to the loss of SAGE II data. We may look into deriving data at a higher temporal resolution to more fully utilize the data afforded by OSIRIS and CALIPSO.