CMIP-6 Stratospheric Aerosol Data

Updates of version 3.0 (made available on 15 September 2017)

A revised version of the stratospheric aerosol SAD data and radiative forcing data is provided (including the aerosol forcing datasets for each individual model). The following changes were made with respect to the previous version v2.0:

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(1) **AOD for 1972 corrected**
A bug for AOD in 1972 has been corrected. A typo had caused a factor of 10 higher AOD for 1972.

(2) **Revised background values**
In v2.0, we had assumed that the background stratospheric aerosol loading at preindustrial times was equal to the cleanest time period of the satellite era (namely 1999-2005). Mike Mills (private communication) pointed out that this was overly simplifying, as the industrial emissions of CS_2 (converted to OCS) and SO_2 contribute significantly to the background aerosol (Montzka et al., 2004). Based on Sheng et al. (2015) we estimate a stratospheric burden of 73.6 Gg S in year 1850, while the burden in the modern times is 109 Gg S. We use these values to scale the background values.

(3) **AER simulation for Krakatau updated**
In v2.0, simulations were performed with the AER-2D aerosol model for the following eruptions: 1860-Unknown, 1883-Krakatau, 1886-Tarawera, 1902-Santa Maria, 1912-Katmai, 1963-Agung, 1976-Fuego). Data compiled by Stothers (1996) were used to constrain the AOD of AER-2D at specific latitudes. In v3.0, we modified the results for Krakatau, and left the others unchanged. For Krakatau, the measured high pyrheliometric AOD at the station Montpellier (43.5°N, 4.0°E) reported by Stothers has very large uncertainty. In v2.0 we scaled the AER-2D simulation to obtain agreement with Montpellier, but this led to very high NH aerosol burdens, which were compensated by reducing the SH values (keeping the globally averaged AOD constant). In v3.0, we use instead the AER-2D results directly, but releasing the plume only into the equatorial grid cell instead partly into the 5°-15°S cell, resulting in consistency with the Montpellier measurements.

(4) **Small adjustments for minor eruptions**
Data sources for minor eruptions used by Stothers (1852, 1873, 1880-1881, 1890-1892, 1907-1908, 1922-1923, 1928-1929, 1932-1933, 1962, 1967-1973) show events with enhanced AOD in the pyrheliometric measurements. However, in particular the earlier events (before 1900) are based only on few measurements with correspondingly large uncertainties.
(a) In v2.0 we distributed the Stothers AOD vertically proportional to the background extinction coefficients throughout the air column (troposphere to 40 km altitude). In order to better take account of lower tropospheric washout processes, in v3.0 we distributed the AOD only between 1 km below the tropopause to 40 km (and proportional to the background extinction coefficients).

(b) Stothers used a constant factor of 1.6 to convert the pyrheliometric AOD (τ_{pyr}) to AOD at 550 nm. This is a coarse approximation. As improvement in v3.0 we use a size dependent (or τ_{pyr}-dependent) conversion factor (which is typically 1.2-1.5).
(c) For the time period 1890-1933, the monthly τ_{pyr} data are used in v3.0, while in v2.0, annual means were used.
(d) For the time period 1890-1892, there were only pyrheliometric data at the station Montpellier with high uncertainty. In v3.0, we assume the volcanic aerosols to cover only 30°N-90°N instead of the whole northern hemisphere.

(5) Improvement on mean radius calculation

For the calculation of the mean radius, which is required for the heterogeneous reaction HCl + HOCl, we use the SAD-weighted value in v3.0 (equal to the effective radius), while a number density weighted mean radius was used in v2.0.

The 1850-2014 average AOD differs by ΔAOD = 3E-6 from v2.0 (i.e. about 0.03% of AOD). This corresponds a forcing of roughly 3E-4 W/m^2. The average SAD of v3.0 is lower by 1.6% compared from v2.0 (which cannot easily be further reduced because of the smaller historical aerosol background values). These remaining small differences are unlikely to play any role in piControl.

The extinction coefficients at 550 nm have been updated correspondingly and are available at ftp://iacftp.ethz.ch/pub_read/luo/CMIP6/VOLMIP550/.

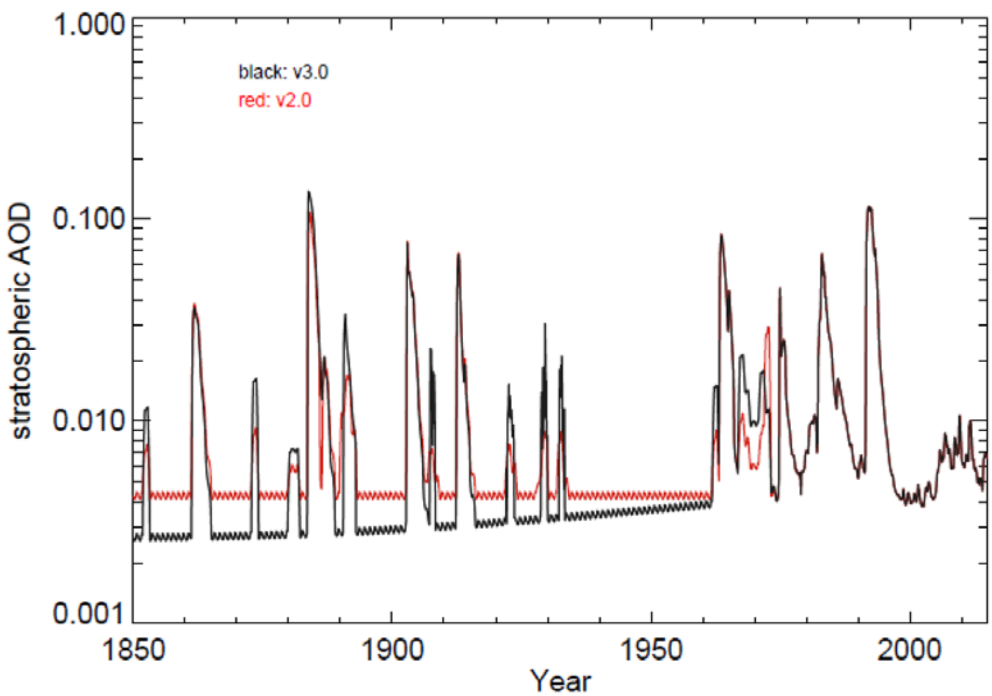

Figure 1: The global mean stratospheric AOD of v3.0 and v2.0

The original PDF is available at ftp://iacftp.ethz.ch/pub_read/luo/CMIP6/

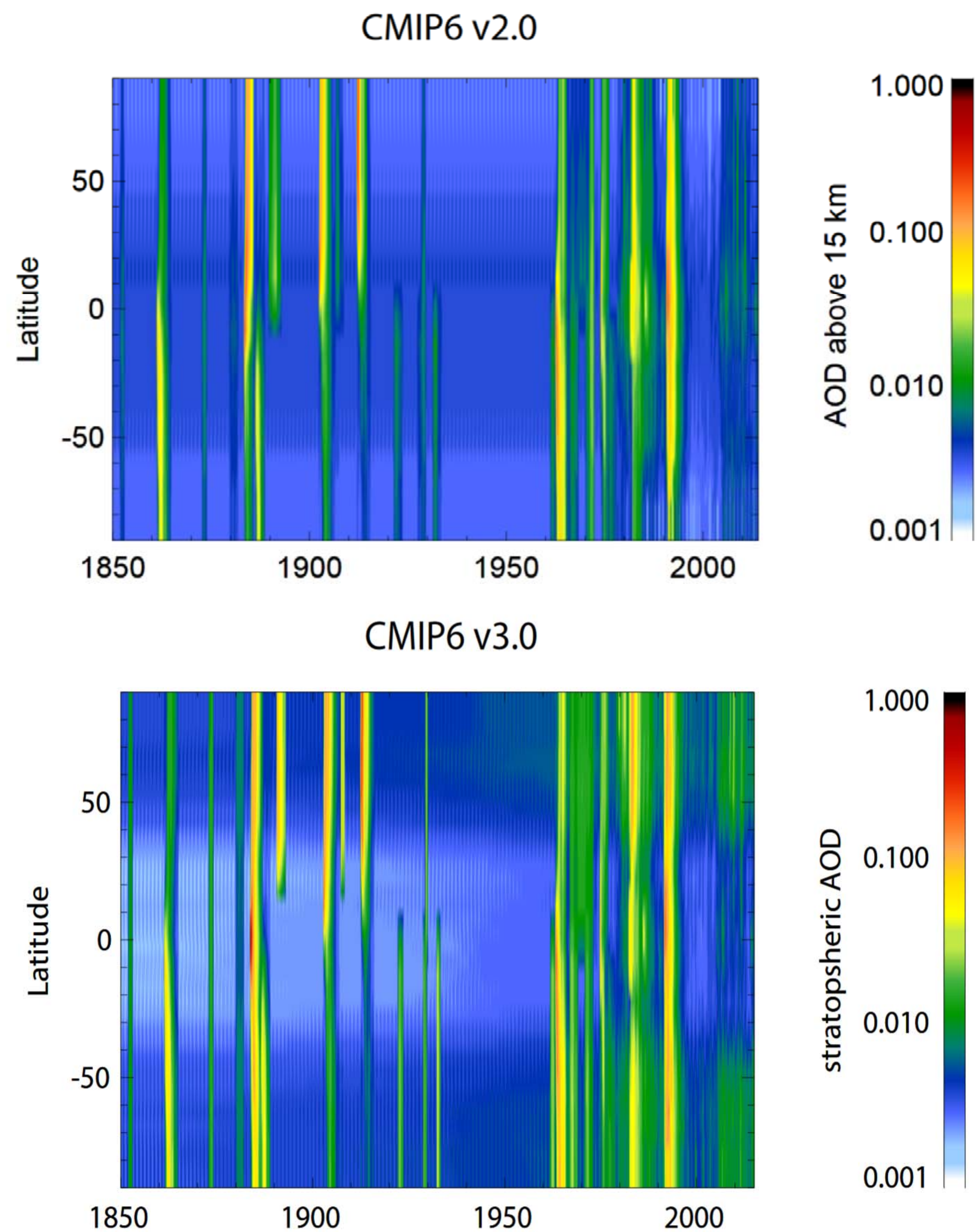

Figure 2: Latitude distribution of stratospheric AOD of v3.0 and v2.0.

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