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Geoscientific Model Development Discussions

Interactive comment on "The Sectional Stratospheric Sulfate Aerosol module S3A-v1 within the LMDZ general circulation model: Description and evaluation against stratospheric aerosol observations" *by* Christoph Kleinschmitt et al.

Anonymous Referee #2

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This manuscript describes the stratospheric aerosol model S3A and it's application in the LMDZ GCM. The model allows for interaction between aerosol radiative effects and atmospheric dynamics. Comparisons with observation for a background (unperturbed) period and for the Pinatubo period are presented. The introductory section has a thorough discussion of the evolution of global aerosol models and trade-offs related to the aerosol approach chosen. The sectional approach to aerosol is appropriate for the stratosphere. The disconnect between stratospheric and tropospheric aerosols should

be justified or it's limitations discussed and relegated to future model development. In particular, interactions between sulfate and organic aerosols in the UTLS region (see recent GRL paper by Yu et al., doi:10.1002/2016GL 070153) and affects of descending sulfate aerosol on clouds and tropospheric chemistry should be mentioned. Meteoritic particles in the middle stratosphere and polar regions could also be significant in some cases. The radiative code is appropriate to the application, with 6 shortwave and 16 longwave bands. The paper is generally well-written, though a few relevant model details and caveats have been omitted, as detailed below. The model has room to grow by adding an interactive chemical scheme and strat-trop aerosol interactions, but the version presented here is still a useful contribution to the literature and worthy of documentation in Geoscientific Model Development.

Specific Scientific Comments: Page 1, lines 16-18: "Gravitational sedimentation . . . is extremely dependent on the size of the aerosol particles and ambient air density." Air density (or pressure) explains why sedimentation is not important in the troposphere but is in the stratosphere.

Page 4, lines 6-7: It is not accurate to say that "We have included processes relevant to . . . much larger and/or longer emission rates than experienced in typical volcanic eruptions" because of the prescribed oxidants converting SO2 and OCS to sulfate. Perturbations to OH will decrease SO2 lifetime following an eruption much larger than Pinatubo. The model currently as the hooks to account for larger eruptions in the future when the REPROBUS chemical scheme is integrated into LMDZ, as explained on page 8, but currently does not have that capability.

Page 4, lines 23-25: Please include the height of the model top.

Page 7, lines 24-26: Apparently the photochemical transformation of H2SO4 gas to SO3 and SO2 above the top of the aerosol layer is neglected? This will result in errors in nucleation in the polar regions due to downwelling of SO2.

Page 8: lines 7-8: Wet and dry deposition are mentioned but not washout/cloud re-

moval processes. Are aerosols removed in clouds throughout the troposphere or at the surface only?

Page 12, lines 17-24: Can you justify using the 1981 Steele and Hamill formulation for aerosol weight percent? How does it compare to Tabazadeh et al. 1997?

Page 13, lines 24: How can you justify using a constant temperature and 75 weight percent aerosol in the optical properties calculation for all latitudes and altitudes? This weight percent will be pretty far off near the poles and near the top of the aerosol layer. How much error does this contribute to the scattering and heating rates calculations?

Page 15-16, Pinatubo Experiment: It would be nice to see a figure showing the change in temperature, particularly near the tropical tropopause, due to the volcanic aerosols, and possibly a figure showing the change in stratospheric dynamics.

Minor comments: Page 2, line 30: ". . .a dozen global three-dimensional stratospheric aerosol models". Omit "of"

Page4, line 1: "Recent reviews of scientific studies. . ." Change "on" to "of"

Page 6, line 20: "Nudging is activated in the model calculations described in Sect 3.2"

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