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Variability of the aerosol content in the tropical lower stratosphere from 2013 to 2019 as influenced by moderate volcanic eruptions

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The cumulative impacts of frequent moderate-magnitude eruptions on stratospheric aerosols were identified among the factors in recent decadal climate trends. Moderate volcanic eruptions are a recurrent source of sulfur dioxide (SO₂) in the Upper Troposphere and Lower Stratosphere (UTLS) region and the resulting formation of sulfuric acid aerosol particles from the SO₂ emitted provides sites for chemical reactions leading to enhancement of stratospheric optical depth (SAOD) and ozone depletion. Modelling properly the volcanic aerosol content and its evolution in this region is important for radiative impact issues. In this work, we explore the variability of the tropical UTLS aerosol content between 2013 and 2019, a period which was particularly impacted by moderate tropical and mid-latitude volcanic eruptions. For that purpose, space-borne observations from OMPS (version 2, datasets from GES DISC), and IASI, together with simulations by the Whole Atmosphere Community Climate Model (WACCM) coupled with the Community Aerosol and Radiation Model for Atmospheres (CARMA), are used. Different model sensitive experiments, particularly for the injection altitude and timing, have been conducted to evaluate how the model captures the aerosol plume in terms of content, optical and microphysical properties, transport and residence time. We find that the decay of the Calbuco and Kelud plumes observed by OMPS version 2 is well reproduced by the model. Comparisons with unique datasets in the tropical southern hemisphere from the NDACC Maïdo observatory (Reunion Island, France, 20.5°S, 55.5°E) show good agreement between the lidar SAOD observations and WACCM-CARMA SAOD simulations although we observe a difference in the altitude of the maximum aerosol concentration between the model and the in situ profile after Calbuco eruption in April 2015. A particular focus is also made on recent eruptions like Raikoke, Ambae and Ulawun. The plume of the Ambae volcano (15°S, 167°E) which erupted in July 2018 is shown to propagate to the northern hemisphere with some influence until summer 2019 in the Asian monsoon region. For the year 2019, we investigate how the Ulawun (5°S, 151°E; ~0.14 Tg of SO₂) tropical eruption and the Raikoke mid-latitude eruption (48°N, 153°E; ~1.5Tg of SO₂), have influenced the aerosol burden in

the tropics.