One robust model response to greenhouse gas increase in the 21st century is the acceleration of the stratospheric circulation, characterized by a decrease in the mean age of air and an increase in the Brewer-Dobson circulation. Previous studies have shown that the decrease in the mean age is related to a faster Brewer-Dobson circulation, but it is not clear whether and how other transport processes such as recirculation and mixing contribute to changes in the mean age. In this study, in order to improve our understanding of stratospheric transport changes under global warming, we investigate the long-term variations in the age spectrum using simulations of the Goddard Earth Observing System Coupled Chemistry Climate Model (GEOSCCM). The age spectrum is calculated using the “pulse tracer” experiment. Pulse-tracer simulations were initiated at different times throughout a 100-year simulation (2000-2099) and a total of 50 age spectra are obtained.

Changes in the age spectra in the 21st century in the GEOSCCM are characterized by decreases in the modal age (the spectral peak time), the mean age (the first moment), and the spectral width (the second moment). Model results show that the decrease in the mean age is due to a younger modal age and a shorter tail region of the age spectrum. The younger modal age is directly caused by a stronger Brewer-Dobson circulation. And a shorter tail indicates a decrease in the long-term transport decay timescale and is closely linked with the decrease in the spectral width, suggesting a weaker recirculation.