microscopic scattering particles of anthropogenic[17] and natural[18] origins is comparable to the half-decade residence time of its molecular components,[19] so that appropriately fine-scale particulate loadings of the middle stratosphere will persist for five-year intervals. However, the stratosphere is a chemically uncongenial location due to the high flux of ultraviolet radiation from the Sun and the presence of oxygen, particularly in the more reactive form of ozone.

Ideally, we would prefer to deploy scattering systems – or their principal components – that would remain in place and retain their performance-pertinent properties for a century, which is of the order of the interval[20] required for a CO_2 emission pulse to be effectively sunk into the deep ocean. However, we consider the half-decade mid-stratosphere residence time to be sufficiently long for practical deployments. We may re-constitute the deployment of a scattering system twice per decade (or 20% per year), and we even consider such a short duration to constitute a relatively rapid, naturally-operating means of disposing of possible unwanted side-effects of insolation modulation. Chemical stability in the stratosphere, even for material with readily available electrons on its surface, is a tractable issue for present purposes.

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contract with commercial space-launch services is ~$5,000, for 5-15 ton payloads. Indeed, some types of stratospheric deployment of oxide particulates – e.g., SO_2 or Al_2O_3 – might be accomplished simply by operating one or more well-engineered combustors – e.g., of elemental S or Al – at high-altitude, near-equatorial ground-sites, from which stratospheric injection of warm gas is intrinsically advantaged. (Combustor engineering would focus on mass-efficient, optimal-sized scatterer particle generation in the vertically-directed exhaust, which likely would have a rocket nozzle character in order to facilitate swift manipulation of the temperature and density of combustion products across usefully large ranges.)

[17]Feely HW and Spar J, Tungsten-185 From Nuclear Bomb Tests As a Tracer For Stratospheric Meteorology, *Nature* **188**,1062-4 (1960); Telegadas K and List RJ, Atmospheric Radioactivity along the HASL Ground-Level Sampling Network, 1968 to mid-70, as an Indicator of Tropospheric and Stratospheric Sources, *J. Geophys. Res.* **74**, 1339(1969); Telegadas K, Report 243 (U.S. Atomic Energy Commission, Washington, DC, 1971);

[18]Trepte CR and Hitchman MH, Tropical stratospheric circulation deduced from satellite aerosol data, *Nature* **355**, 626-8 (1992); Trepte CR, Veiga RE, and McCormick MP, The Poleward Dispersal of Mount Pinatubo Volcanic Aerosol, *J. Geophys. Res.* **98**, 18563-73 (1993); Grant WB et al, Use of volcanic aerosols to study the tropical stratospheric reservoir, *J. Geophys. Res.* **101**, 3973-88 (1996).

[19]Boering KA, Wofsy SC, Daube BC et al, Stratospheric Mean Ages and Transport Rates from Observations of Carbon Dioxide and Nitrous Oxide, *Science* **274**, 1340-3 (1996).

[20]See, e.g., Manabe S and Stouffer RJ, Century-scale effects of increased atmospheric CO_2 on the ocean-atmosphere system, Nature **364**, 215-7 (1993).