3.004 The atmospheric response to building a large-scale space-based solar power system.

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Abstract:

New rocket technology using hydrogen-burning engines may allow a vast number of relatively low cost flights to space in the near future. One such proposal for this new rocket technology is to build a space based solar power system. It is estimated that 10^5 flights per year for 10 years could build a space station capable of replacing about 10% of today's global electricity production. The emissions from these flights could pose a potential risk to the climate and stratospheric ozone. The effects of the emissions from these rocket engines are quantified for 10^4-10^6 flights per year using the CESM-WACCM climate/chemistry model and the NOCAR two-dimensional model. Water vapor from combustion is the primary emission product, however a substantial amount of NO_X is produced in the superheated engine exhaust and upon reentry. A total of 10^5 flights per year more than doubles the amount of water in the mesosphere and increases the stratospheric water vapor by roughly 10%. This added water vapor increases high altitude clouds at the poles but its effect on ozone is relatively small. The NO_X production from spacecraft re-entry is more than an order of magnitude larger than the natural production from meteors and destroys a substantial amount of ozone. At 10^5 flights per year, a reduction by about 1.5 Dobson units or roughly 0.5% occurs in the column integrated global ozone abundance. The largest losses occur in the polar regions. This is a large perturbation, but much less than at the peak of ozone loss in 1998 when global ozone was diminished by 4% due to anthropogenic emissions.