SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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ASSESSMENT OF VISIONARY GEOENGINEERING OPTIONS AND THE IMPACTS OF FREQUENT LAUNCHES WITH A GLOBAL ATMOSPHERIC MODEL

Abstract

This paper reports on the results of the application of global atmospheric models in one and two dimensions in evaluating potential effects of visionary space-and atmospheric-based geoengineering concepts and in assessing the impact of launcher emissions on the atmosphere.

The study is based on two different radiative-convective models of the Earth's atmosphere and include atmospheric chemistry of environmentally important species. The two-dimensional model, developed at NCAR, permits modeling high altitudes reaching up to the thermosphere. It allows the analysis of effects both on a very short-term time scale of hours as well as on the longer term, e.g. decades. This model was chosen following an initial tradeoff including several available atmospheric models, based on these key characteristics alongside with the accessible computational requirements. The one dimensional model, developed at the Virtual Planet Laboratory, simulates the atmosphere up to the lower mesosphere. Other than the two-dimensional model, it does not allow a resolution in time which prevents a detailed assessment of the atmospheric evolution. However, with the derived "snap-shots" of atmospheric properties it has been possible to cross-check the results yielded by the NCAR model. This combination of the two models allows a more thorough analysis of the results of the two applications within the present research work and more generally a comparison of one- and two-dimensional atmospheric models.

The first part of the research paper reports on the results obtained by applying the models to the analysis of geoengineering proposals to reduce solar radiation in the lower layers of the atmosphere, as proposed for counteracting global warming. The analysis concentrates on the alterations observed in chemistry and temperature at high altitudes, i.e. the stratosphere and above. These depict atmospheric layers for which model studies regarding geoengineering do not exist yet. Two geoengineering implementations have been evaluated and compared: 1. A scenario of shielding a small portion of the sunlight with space-based sunshields and 2. A scenario of augmenting stratospheric aerosol levels to increase the atmospheric albedo.

The second part deals with the investigation and assessment of the impact of the exhaust emissions of launchers on the atmosphere. It was performed for present day conditions in regards to short-and long-term impacts as well as for long-term impacts in regards to a possible future scenario involving very frequent and regular space launches (e.g. space tourism). For both purposes the focus was set towards changes in ozone chemistry and greenhouse gas abundances.