Paper ID: 67495
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20th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Contribution of Moon Village to Solving Global Societal Issues (2)

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SPACE-BASED GEOENGINEERING FROM LUNAR RESOURCES

Abstract

Geoengineering or climate engineering is a controversial approach to curb the worst excesses of climate change. There are two fundamental approaches: carbon dioxide removal and radiation management. We show that direct carbon dioxide removal is not a rapid method of climate mitigation but requires sustained effort before it can achieve significant results rendering it practically ineffective. The most commonly proposed radiation management methods are terrestrial but they all have flaws. The primary flaw is that terrestrial radiation management is irreversible and cannot be recalled once deployed. We shall discuss these methods in detail. However, space-based management does not suffer these disadvantages. The space-based approach involves emplacing an array of Fresnel lenses in formation near the Sun-Earth Lagrange point with an effective radius of around 1000 km. The lenses refract sunlight away from the Earth effectively reducing Earth's solar flux by 1.7 percent sufficient to offset CO2 doubling. We discuss in detail how space-based geoengineering may be implemented at low cost by leveraging space resources, especially the Moon to which there are many proposals for returning. Robotic mining of lunar anorthite which is abundant in the highland regions alone provides the resources for the construction of Fresnel lenses of fused silica glass and aluminium structures extracted from anorthite. We have developed a lunar industrial ecology that provides the facility for extracting almost all the resources required to build space-based lenses and their supporting spacecraft bus subsystems. The implementation of additive manufacturing offers the prospect of manufacturing these lenses and supporting systems. The requirement for large numbers of these space-based lenses requires the lunar infrastructure to self-grow rapidly to achieve high productive capacity. One of the most challenging aspects will be in formation flying and station-keeping, Solar sails present the only propellantless option. We have examined some of these challenges focussing on orbital stability near L1 using solar sails. Formation flying is essential for controllability of the Fresnel lenses which in turn minimises the quantity of hardware manufactured to be emplaced near the L1 point.