

RESPONSE OF THE SPACE DEBRIS ENVIRONMENT TO GREENHOUSE COOLING

H.G. Lewis (1), G.G. Swinerd (1), C.S. Ellis (1) and C.E. Martin (2)

(1) University of Southampton, UK (2) The Space Centre, QinetiQ Ltd., UK
(hglewis@soton.ac.uk/Fax: +44-23-8059-3058)

Whilst it is well known that an increase in the density of the greenhouse gases CO₂, CH₄ and others results in warming of the troposphere, a much larger cooling of the thermosphere is also observed. Modelling studies performed in the 1990s concluded that with a doubling of CO₂ the average cooling in the thermosphere is 40 - 50 K resulting in a reduction of atmospheric density by more than 40% at a given height and significant changes in chemical composition (Akmaev and Fomichev, 1998). Observational studies of the long-term orbital decay of Earth satellites have now provided considerable evidence for a decline in thermospheric density, indicating a decrease in density in this region of approximately 10% during the past 35 years (e.g., Emmert et al, 2004). The conclusion of these studies is that within a century the average thermospheric density at a given height may be reduced to half of the present density, based on current projections of CO₂ mixing ratios. The consequences of this negative density trend are longer orbital lifetimes for both satellites and space debris.

In this paper, the results of a set of DELTA and DAMAGE studies are presented. The studies employ the IADC Baseline 2002 and include simulations of post-mission disposal scenarios for low Earth orbit over a 100 year period with thermospheric density decreasing at rates between 1% and 6% per decade.

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Emmert, J.T., Picone, J., Lean, J.L., and Knowles, S.H., *J. Geophys. Res.*, 2004, 109, A02301.