Paper ID: 83027
oral

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Sustainable Approaches and Impact of Space Transportation Solutions on Earth + Space Environment and on General Safety (9-D6.2)

Author: Mr. Jan-Steffen Fischer
Institute of Space Systems, University of Stuttgart, Germany

Prof. Stefanos Fasoulas
Institute of Space Systems, University of Stuttgart, Germany

ASSESSMENT OF LAUNCH AND RE-ENTRY EMISSIONS OF SPACE TRANSPORTATION SYSTEMS AND THEIR ENVIRONMENTAL IMPACT

Abstract

The assessment of the environmental impact of space transport systems is a major scientific challenge due to many unknowns and missing measurement data. New orbital launch rate records raise the question of the extent to which space travel contributes to climate change and ozone depletion. Studies based on atmospheric models that assume a large growth of up to thousands of launches per year show a significant impact on the climate and ozone. Thus, the efforts achieved by the Montreal Protocol could be endangered by space travel. However, these studies are based on general assumptions for emissions and their effects in the atmosphere independent of launch system and trajectory.

To close this gap, the University of Stuttgart is developing two tools, which will be presented in this paper. On the one hand, a tool was developed that calculates the emissions during launch. For this purpose, emission calculations are carried out for the combustion chamber, nozzle and afterburning, thus mapping liquid and gaseous species. This tool also makes it possible to estimate the formation of thermal NOx as well as soot and aluminium particles in dependency of height and location, based on literature values.

Furthermore, a tool was developed which estimates the destructive re-entry of upper stages, the occurring emissions depending on the structural material and re-entry conditions and the formation of thermal NOx as well as its formation during the re-entry of capsules.

Both tools are used to estimate the total emissions from space flight in 2023 and thus provide a basis for climate and ozone modelling using common data formats. Together with simplified climate and ozone assessment methods, the global impact of spaceflight is calculated. The paper discusses further the structure of the tools, the uncertainties in the modelling of the emissions as well as in the overall estimation. It is intended to help determine and mitigate the environmental impact of space travel in order to enable sustainable space transportation in the long term.