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MISSION ARCHITECTURE FOR A SPACE WEATHER MONITORING MISSION FROM THE SUN-EARTH LAGRANGE POINT L5

Abstract

As part of the Space Situational Awareness (SSA) Programme, ESA has initiated a study to define a system to monitor, predict and disseminate Space Weather (SWE) information. The system will generate alerts to a wide community in sectors like space-based communications, broadcasting, weather services, navigation and terrestrial communications and infrastructure. The effects of space weather are observed in the degradation of spacecraft performance and risks to human health in manned space missions. Space weather also affects terrestrial systems by damaging aircraft electronics, disrupting power grids and degrading radio communications.

The Sun-Earth Lagrangian points L1 and L5 provide an unobstructed view of the Sun with constant geometry and hence are optimal observation positions. Necessary SWE observations like the in-situ measurement of the upstream solar wind plasma and the interplanetary magnetic field (IMF) are only possible with a spacecraft outside the Earth's magnetosphere. Spacecraft that currently enable monitoring of solar events and/or the IMF and solar wind are ACE, Wind, DSCOVR and SOHO, all observing the Sun from the L1 point. These missions (with the exception of DSCOVR) are well beyond their original design life time and need replacement to ensure continuity of the measurements. Continuous observations from L5 have not been implemented thus far and would significantly enhance SWE forecasting capabilities by observing the state of that region of the solar surface yet to rotate in the L1 field of view, and (through additional side-on viewing) by the very much improved coronal mass ejection tracking and propagation prediction capabilities. For this reason, ESA has initiated a Phase A/B1 study to define a SWE mission to L5 in scope of its SSA programme. The spacecraft will carry two suites of instruments, one composed of remote sensing instruments, while the other will be a set of instruments for in-situ measurements, together allowing the observation and measurement of the interplanetary medium and solar conditions.

This paper will present a trade-off for the mission architecture that is best suited to meeting these objectives. The L5 mission will either make use of a spacecraft to be injected directly to the final trajectory using the future ESA Ariane 6.2 launcher, or a larger spacecraft carrying the necessary amount of propellant for a departure from GTO after a shared launch using Ariane 6.4. Moreover, aspects such as the transfer strategy, ground segment architecture, and the operational orbit at L5 need to be traded.