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Author: Dr. Florian Renk
European Space Agency (ESA), Germany

VIGIL – TRANSFER DESIGN FOR THE EUROPEAN SPACE AGENCY'S SPACE WEATHER MISSION TO THE SUN-EARTH LIBRATION POINT 5

Abstract

The Vigil space weather observatory mission is envisioned to be placed at the triangular Sun-Earth Libration Point 5 (SEL5), located at approximately 60° from the Sun-Earth line at a distance of 1 AU. This location provides the S/C with a view of a significant part of the Sun which is not yet visible from Earth and can therefore provide earlier warning of solar activity. A spacecraft in orbit about SEL5 can also monitor the entire space between the Sun and the Earth, allowing mid-course tracking of solar wind features and predictions of arrival times at Earth.

In this paper the trajectory architecture will be presented, taking operational considerations into account. For a transfer towards the triangluar SEL5 point, the S/C must trail the Earth by 60° and thus the transfer orbit's period must be approximately 2 months + n*years. However, the simple Lambert arc solutions can only serve as a first guess for a more detailed transfer trajectory study, taking into account e.g. the launch scenario. Several options for the starting conditions were discussed for Vigil, e.g. the direct escape, launch into GTO with an additional kick-stage provided by the launcher or a launch into GTO as a co-passenger to a large primary payload.

The choice of the launch scenario makes the Vigil trajectory design particularly interesting, since the S/C is being launch into the opposite direction required for a immediate departure towards SEL5, being a secondary payload to a highly constraint GTO launch. While the other options will be briefly introduced, the paper will focus on the the shared GTO launch. It will describe how the compatibility with a daily 45 minute launch window window as well as launch on every day of the year is dealt with to e.g. avoid any problems with the moon regularly crossing the outbound trajectory. The required apogee raising sequence to reach the SEL1 region will be introduced, minimizing radiation load and at the same time achieving a minimum transfer ΔV for the following heliocentric transfer arc. This phase is followed by a heteroclinic transfer to the SEL2 region, from which the departure towards SEL5 can take place. After the heliocentric transfer arc an injection into an orbit about SEL5 will take place, where an out-of-plane component can significantly reduced the overall transfer ΔV.