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SENTINEL-3 COVERAGE-DRIVEN MISSION DESIGN: COUPLING OF ORBIT SELECTION AND INSTRUMENT DESIGN

Abstract

As the crowning achievement of ten years of system design and development, the first satellite of the Sentinel-3 series was launched in February 2016. Sentinel-3 payload suite encompasses the Ocean and Land Colour Instrument (OLCI) with a swath of 1270 km, the Sea and Land Surface Temperature Radiometer (SLSTR) yielding a dual-view scan with swaths of 1420 km (nadir) and 750 km (oblique view), the Synthetic Aperture Radar Altimeter (SRAL) working in Ku-band and C-band, and the dual-frequency Microwave Radiometer (MWR).

In the early stages of mission and system design, the main driver for the Sentinel-3 reference orbit selection was the requirement to achieve a revisit time of two days or less globally over ocean areas with two satellites (i.e. 4-day global coverage with one satellite). The orbit selection was seamlessly coupled with the OLCI instrument design in terms of field of view (FoV) definition driven by the observation zenith angle (OZA) and sun-glint constraints applied to ocean observations.

The criticality of the global coverage requirement for ocean monitoring derives from the sun-glint phenomenon, i.e. the impact on visible channels of the solar ray reflection on the water surface. This constraint was finally overcome thanks to the concurrent optimisation of the orbit parameters, notably the Local Time at Descending Node (LTDN), and the OLCI instrument FoV definition.

The orbit selection process was divided into these main phases:

- Identification of orbits with short repeat cycle (2-4 days), firstly to minimise the time required to achieve global coverage with existing constraints, and then to minimise the swath required to obtain global coverage and the maximum required OZA. This step yielded the selection of a 4-day repeat cycle orbit, thus allowing 2-day coverage with two adequately spaced satellites. The selected sun-synchronous orbit (SSO) was: 14+1/4, reference altitude = 803km, LTDN=10h00.

- Identification of suitable candidate orbits with higher repeat cycles in the proximity of the selected altitudes and selection of the reference orbit. Rationale was to keep the swath for global coverage as close as possible to the previous optimum case, but to tailor the repeat cycle length (i.e. the ground track grid) to optimise the topography mission performances. The final choice converged on the SSO 14+7/27, reference altitude = 800km, LTDN=10h00.

Extensive coverage analyses were carried out to characterise the mission performance and the fulfilment of the requirements, encompassing revisit time, number of acquisitions, observation viewing geometry and swath properties.