31st IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Earth Observation Missions (4)

Author: Mr. Andrew Karim
Space Generation Advisory Council (SGAC), Canada

Mr. Soglo Raphael Eyiram
Kwame Nkrumah University of Science and Technology, Ghana
Mr. Daniel Wischert
European Space Agency (ESA), The Netherlands

ANALYSIS OF VIEWING GEOMETRY FOR HIGH AGILITY SMALL SATELLITE PLATFORM FOR GHG EMISSIONS OBSERVATIONS IN SUN GLINT MODE

Abstract

Greenhouse gas monitoring is central to solving today's climate crisis. It sheds light on various emission sources, enabling successful mitigation efforts to take place. Satellites play a key role within these monitoring networks. Complimentary to ground networks, they provide sparse coverage and allow to cover remote areas. They can notably be used to monitor offshore regions, which contain some of the world's largest producers of oil and gas. Traditional satellite measurement techniques using infrared absorption spectroscopy, as used on ESA's Sentinel-2 and NASA's Landsat-8, have difficulty measuring offshore emissions due to the ocean water's low reflectivity of infrared radiation. Recently, offshore observations of greenhouse gas concentrations have been demonstrated through a sun glint satellite configuration, which consists of orienting the satellite such that it aligns with the specular reflection of the sun off the ocean's surface. As opposed to land measurements, the satellite's viewing geometry plays a critical role during sun glint observations and must be carefully optimised such that the amount of sunlight reaching the detector is maximised. Small satellite platforms show promise for such applications, as they enable agile spacecraft pointing.

In this paper, we present an in-depth analysis of the satellite's viewing geometry for sun glint observations over a wide range of offshore oil and gas facilities. By propagating a series of sun-synchronous satellite orbits at 500 km altitude during different seasons and by pointing at specified targets, we analyse the solar scattering angle, solar zenith angle and target distance as a function of the facility's latitude. From these results, we simulate the instrument's response and present an operational framework to automate spacecraft pointing, target selection and observation time such that the viewing conditions are optimised.

The conducted analysis informs small satellite operators on the optimal spacecraft viewing geometry to monitor given offshore targets, allowing to maximise their mission's value. It offers a step forward towards global real-time monitoring of greenhouse gases, as it focuses on the world's biggest offshore oil and gas producing regions, such as the North Sea, the Gulf of Mexico and the Permian Basin. Such an initiative will help with rapid identification of offshore methane leaks, common with ageing infrastructures, ultimately mitigating greenhouse gas emissions and limiting the global temperature increase.