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SCIENCE GOALS AND SPACECRAFT PAYLOAD FOR LOW-ORBIT CONSTELLATIONS FOR REMOTE SENSING

Abstract

Remote sensing is one of the most demanded implications of the present and future multi-satellite constellations. Using satellite networks for Earth observations provides numerous advantages, among which are capabilities of zero latency multispectral imaging, payload reservation, onboard data processing and optimization of information flow. A challenge for designing such network is concerned with the requirement of serial production of a large number of spacecraft and science payload, in turn implying lightweight and low-cost solutions for both spacecraft platform and sensors. In addition to traditional spaceborne imaging, multispectral and hyperspectral observations in the visible and infrared spectral ranges are highly demanded in numerous applications from forest protection to national security. Not only new instruments are required but also data processing techniques based on machine learning, zero-latency data access and decision-making support based on limited datasets. Quick development of radar technology opens an opportunity to employ spaceborne synthetic aperture radars for monitoring sea ice in the Arctic Ocean, which is highly demanded for navigation on the North Polar Route. Increasing concentration of greenhouse gases in the atmosphere, including carbon dioxide, methane, and other species are commonly considered as a primary trigger of the observed climate change, particularly prominent in the Arctic region. Only a few satellites provide global monitoring of greenhouse gases today, including NASA's OCO-2 and JAXA's GOSAT. These missions, however, do not provide enough information on the polar regions. We propose a new technique based on laser spectroscopy, which provides vertical profiling of minor atmospheric species with unprecedented accuracy with simultaneous global coverage. Optical communication line between satellites included in a constellation may be used for sounding the atmosphere in the near infrared range with spectral resolution as high as 108. Such a resolution also allows Doppler sounding of the airmass flow velocity field, unavailable for sensing from satellites. Slant observation geometry provides high sensitivity in gas concentration detection, while simultaneous measurements by multiple beams results in a 3D tomographic picture revealing the dynamic structure of the Earth climate system. Such measurements may be combined with satellite-to satellite data transfer and implemented on a small-class satellites with the total mass not exceeding 200 kg. A simpler configuration of spaceborne greenhouse gas meter based on the principle of passive heterodyne detection may be implemented based on a 6U CubeSat-class probe.