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CHIRAD-SAT: CONCORDIA HYPERSPECTRAL IMAGER AND RADIATION-TOLERANT SATELLITE

Abstract

Climate change is causing the accelerated recession of the Kaskawulsh Glaciers in Yukon, Canada. The meltwater has deviated from its standard course of direction, flowing into the Gulf of Alaska instead. A notable impact has been the drastic decline of water levels in the Slims River, the source of Yukon's Kluane Lake that is now completely dry; marking the event as a first-of-its-kind in modern history. The sediment in the region is exposed to wind erosion and dust storms. Given the high frequency of occurrence, the location serves as a natural laboratory to investigate dust emissions at northern latitudes and holds great significance to better understand past and future climates. Beyond the lower atmosphere of the Earth, the space environment is host to harsh radiation which can dismantle the electronics of satellites. Additionally, radiation-hardened electronics are costly expenditures for smallsats, which are meant to be cost-effective and provide easy access to space.

Concordia University's 3U CubeSat has been selected for CSA's *Canadian CubeSat Project* (CCP) to study these dynamic processes - improving our understanding of dust storms, while new insights to computer system reliability, health monitoring and diagnostics will help develop robust components for future small satellite missions.

The primary payload consists of a custom-designed 1U hyperspectral imager. The onboard instrument will gather spectral measurements in the visible and near infrared (VNIR) band, with the added option to include other spectral regions as well (e.g. SWIR). Imaging will identify glacier cover changes and surface properties for the parameterization of dust, all the while the scope remains accessible to broader remote sensing studies. The OBC is based on a secondary payload, Kalray's *256-Bostan* processor: a manycore high-performance chip employing the massively parallel processor array (MPPA) architecture. It integrates many time-critical applications on the same processor while still ensuring Worst Case Execution Time (WCET) for each application. Due to its intrinsic sensibility to radiation, fault-tolerant techniques will be implemented, thus leveraging the multiplicity of the cores to innovate the OBC design and improved reliability.

Both payloads are of interest to international research and technology development. *CHIRad-Sat* would provide useful data to climate scientists and the satellite industry alike, such as the retrieval of aerosol optical depth (AOD) measurements and flight heritage of a low-cost, resilient commercial off-the-shelf (COTS) onboard computer. With a tentative launch in 2021, the paper describes the preliminary mission design requirements, operations and onboard technological experiments.