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Utility of Highly Elliptical Orbit for Radiation Budget and Surface Albedo Mapping Over Polar Regions

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The accurate estimates of the Top-Of-the-Atmosphere (TOA) and surface level radiation budget components and surface albedo require satellite observations acquired with high temporal refresh rate and over the wide range of geometrical conditions. The high refresh rate is needed to address temporal variability of radiative fluxes associated with continuously evolving cloudiness, atmospheric state and solar illumination conditions. The wide range of geometrical conditions is needed to adequately sample the angular anisotropy of radiation reflection, scattering and emission from the surface and the atmosphere. So far, the most suitable satellite observations for these applications are obtained from the geostationary satellites (GEO) and multi-angular sensors operated from the Low Earth polar Orbiting (LEO) platforms. The multi-angular observations at high temporal refresh rate, however, cannot be achieved from the LEO system over the Polar Regions.

In this regard, Highly Elliptical Orbit (HEO) offers very unique opportunity for enhanced angular and temporal sampling of Polar Regions. Such a new satellite observing system called the Polar Communication and Weather (PCW) mission is currently considered for development in Canada. This system is envisioned as a constellation of two satellites launched on a highly elliptical orbit that allows quasi-geostationary imaging of the entire Arctic region above 60degN. Tentatively, the PCW system is expected to start operations in 2018. It will be equipped with advanced imager making observations in solar and infrared part of spectrum with spatial resolution from 0.5km to 2km at 15 min refresh rate. Several channels are selected to be particularly useful for snow and ice property mapping. The HEO orbit offers a unique opportunity for BRDF retrievals due to rich angular sampling, high refresh rate and specifics of the HEO orbit. We will present modeling results that show advantages of HEO observing system for albedo and radiation budget mapping relative to LEO constellation. Continuous observations at very high temporal resolution provide the best opportunity to generate albedo and surface products for Arctic region, because such a system is able to capture essentially all available clear-sky observations. The PCW mission has a great potential for addressing existing gaps in services and generating high-quality essential climate variables (ECVs) related to the Arctic environment and cryosphere.

The World Meteorological Organization (WMO) identifies the HEO observing system as a component of the future space–based observing system in its vision for Global Observing System (GOS) in 2025. To ensure adequate quality of PCW data and derived products, it is envisioned that PCW data will be calibrated using comprehensive onboard calibration system and will be included as part of Global Space-Based Inter-Calibration System (GSICS) coordinated by NOAA in the framework of WMO Space Programme.