Simulations of improved glint observations over snow for CO2M

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Space-based observations of greenhouse gases (GHG) are currently revolutionizing carbon cycle science and our ability to monitor anthropogenic GHG emissions. However, as retrievals are made using scattered and reflected solar light, snow-covered surfaces pose a challenge for retrievals in the near-infrared wavelengths due to the high absorption by the surface. Because of the resulting low radiances of the reflection measured by the satellite in nadir geometry, the retrievals over snow may be less reliable and are typically filtered or flagged for potentially poor quality.

Snow surface bidirectional reflectance factor (BRF) is angularly and spectrally relatively smooth and in general they exhibit large forward-scattering peak. The wavelength bands examined in this work are the 1.6 um and 2.0 um CO2 absorption bands and the 765 nm O2 A-band. In this work, we examine the effects of a realistic, non-Lambertian surface BRF model of snow based on snow reflectance measurements on simulated top-of-atmosphere radiances in the wavelength bands of interest. The radiance simulations were carried out with various different viewing geometries, solar angles and snow surfaces.

There are three main findings of the simulation study. Firstly, snow reflectivity varies greatly by snow type, but the forward reflection peak is present in all examined types. Secondly, glint observation mode was found to be more reflective than nadir observation mode over snow surfaces across all the examined wavelengths bands and geometries. Thirdly, the weak CO2 band had systematically greater radiances than the strong CO2 band which could indicate a greater significance in retrievals over snow.

ESA SNOWITE is a feasibility study funded by European Space Agency for examining how to improve satellite-based remote sensing of CO2 over snow-covered surfaces. It is a cooperative project between Finnish Meteorological Institute, Finnish Geospatial Research Institute and University of Leicester. The primary aim of the project is to support the development of the upcoming Copernicus CO2 Monitoring Mission (CO2M).