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# Satellite-based remote sensing of carbon dioxide over snow-covered surfaces

**Antti Mikkonen**[1], Hannakaisa Lindqvist[1], Jouni Peltoniemi[2], and Johanna Tamminen[1]
[1]Finnish Meteorological Institute, Helsinki, Finland
[2]Finnish Geospatial Research Institute, Helsinki, Finland

Global coverage of carbon dioxide ($CO_2$) satellite observations is necessary for accurate seasonal carbon flux estimates. Sufficient seasonal coverage is particularly important for quantifying the carbon cycle at high Northern latitudes which are sensitive to the rapidly changing climate. However, high latitudes pose significant challenges to reliable space-based observations of greenhouse gases. One reason for the shortage of good quality $CO_2$ observations in the high latitudes is the low reflectivity of snow-covered surfaces in the $CO_2$ absorption bands, in addition to large solar zenith angles and frequent cloud coverage over the Arctic and boreal regions. Snow surfaces are highly forward-scattering and therefore the traditional nadir-viewing geometries over land might not be optimal. In addition, the contributions from the 1.6 um and 2.0 um $CO_2$ absorption bands need to be evaluated over snow. In this work, we present a realistic, non-Lambertian surface reflection model of snow based on snow reflectance measurements and examine results of atmospheric radiative transfer simulations in various satellite observation geometries and the contributions from different absorption bands. This research lays important ground work for a dedicated feasibility study of $CO_2$ retrievals over snow, which would ultimately help increase the quantity and reliability of satellite observations at high latitudes from late winter to spring – an important period for the carbon cycle in the rapidly changing Arctic climate.