Laser pulse bidirectional reflectance from CALIPSO mission

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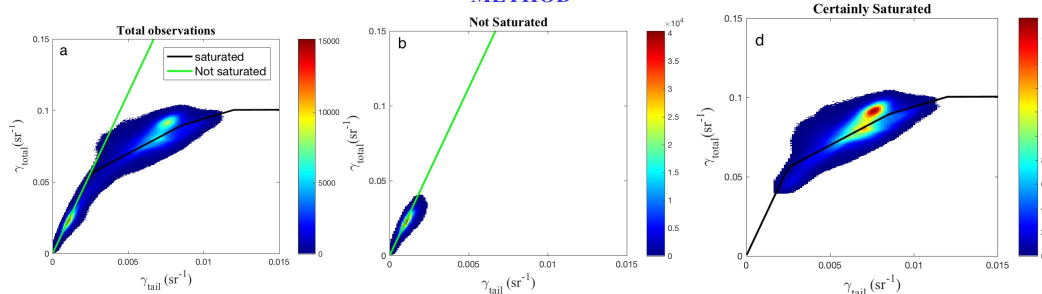
SUMMARY

In this study, we present a simple way of determining laser pulse bidirectional reflectance over snow/ice surface using the CALIOP 532 nm polarization channels' measurements. The saturated laser pulse returns from snow and ice surfaces are recovered based on surface tail information. The method overview and initial assessment of the method performance will be presented.

The retrieved snow surface bidirectional reflectance is compared with reflectance from both CALIOP cloud cover regions and MODIS BRDF/Albedo model parameters. The comparisons show that the snow surface bidirectional reflectance over Antarctica for saturation region are generally reliable with a mean value of about 0.90±0.10, while the mean surface reflectance from cloud cover region is about 0.84±0.13 and the calculated MODIS reflectance at 555 nm from BRDF/Albedo model with near nadir illumination and viewing angles is about 0.96±0.04. The comparisons here demonstrate that the snow surface reflectance underneath the cloud with cloud optical depth of about 1 is significant lower than that for clear sky condition.

METHOD



For the saturated signals, the total integrated attenuated backscatter (γ_{total}) can be estimated from the surface tail as $\gamma'_{total} = c\gamma'_{tail}$. The land surface bi-directional reflectance (ρ) can be obtained directly from the surface total integrated attenuated backscatter as, $\rho = \gamma'_{total}\pi/T^2$, where T^2 is the two-way atmospheric transmittance that can be estimated from CALIOP data.

INITIAL RESULTS

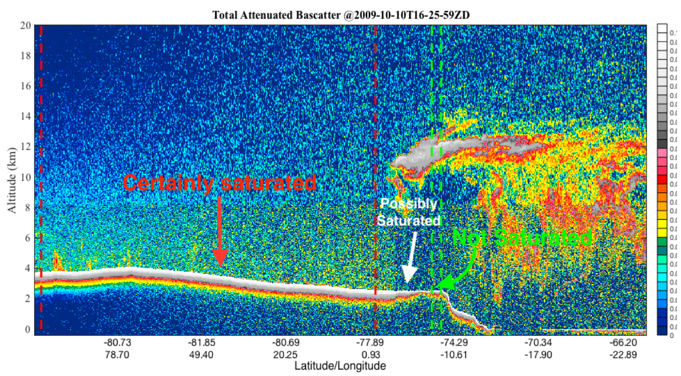


Fig. 1 Total Attenuated backscatter at 532 nm (km^{-1} sr^{-1}) on October 10th 2009

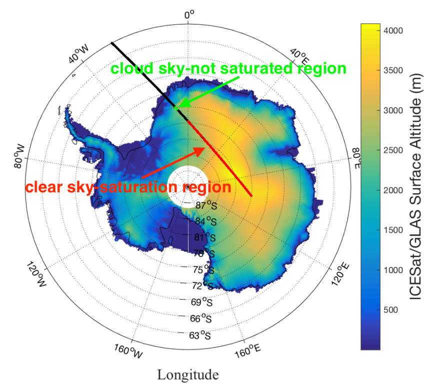


Fig. 2 CALIOP ground-track over Antarctic (black line). The background color is the snow surface elevation (unit meter) from GLAS/ICESat Antarctic 500 m DEM product.

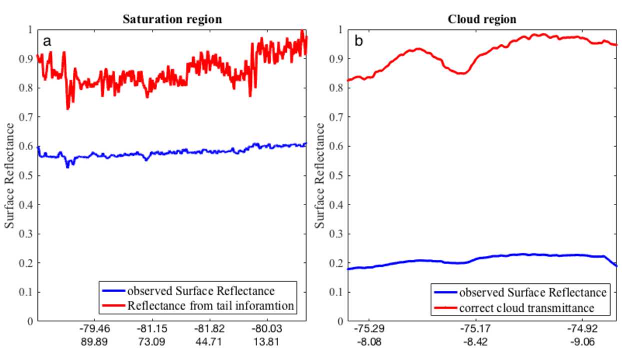


Fig. 3 Left panel (a): CALIOP observed surface bidirectional reflectance (blue) and corrected surface bidirectional reflectance (red) corresponding to the saturated region; Right panel (b): CALIOP observed surface bidirectional reflectance under transparent cloud before (blue) and after (red) correcting the cloud transmittance. It is corresponding to the not-saturated region

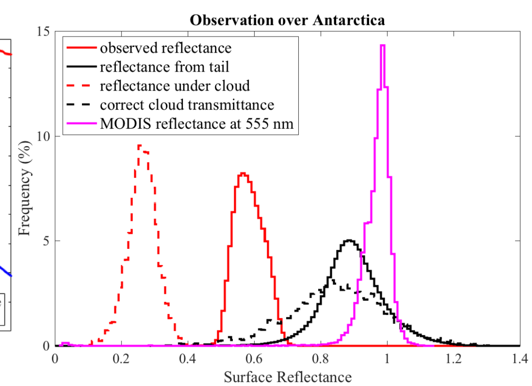


Fig. 4 The CALIOP surface bidirectional reflectance distribution over Antarctica for clear sky (solid curves) and cloud sky conditions (dash curves). The solid red is reflectance directly from the saturated signals. The solid black is reflectance estimated from surface tail with the constant total-to-tail signal ratio of 19.6. The dash red and black are surface reflectance before and after correcting the cloud transmittance. The pink is reflectance distribution at 555 nm from MODIS BRDF/Albedo model parameters.

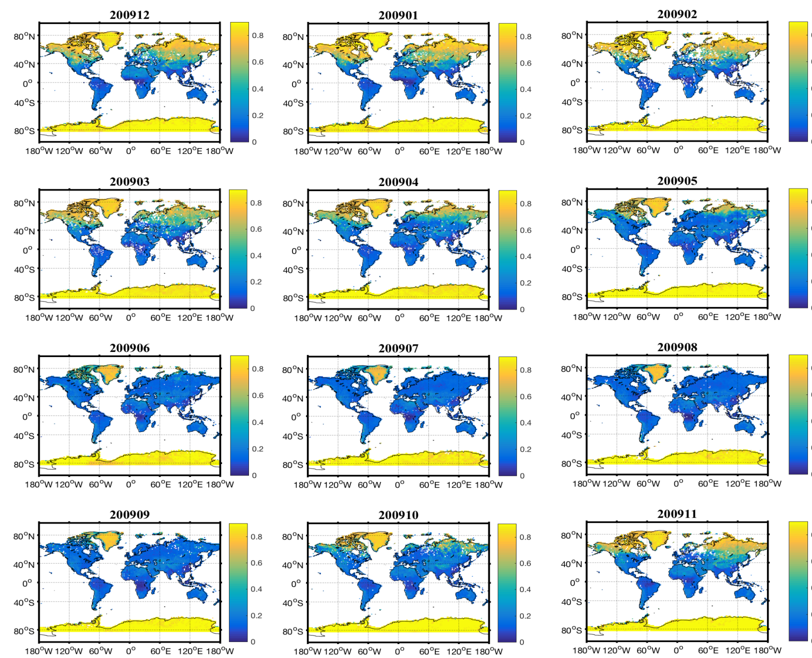


Fig. 5 The monthly CALIOP surface reflectance at 532 nm for clear sky condition in 2009. The color bar stands for the value of surface reflectance

Reference

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