Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-488-RC1, 2018

Atmospheric Measurement Techniques Discussions

Interactive comment on "Laser pulse bidirectional reflectance from CALIPSO mission" *by* Xiaomei Lu et al.

Anonymous Referee #1

Received and published: 21 February 2018

This is a reasonably well written paper presenting significant results employing the CALIPSO lidar response from a hard surface. While others (e.g., Josset, et al., GRL, 2008, Venkata and Reagan, Remote Sens, 2016) have reported on retrievals of aerosol optical depth (AOD) from CALIPSO lidar ocean surface returns, this paper addresses recovering the surface retro reflectance (expressed in terms of the surface bi-directional reflectance, BRDF, which can be readily compared to MODIS retrieved BRDF'S) for snow and ice surfaces which present challenges in dealing with saturated signals for such bright targets. The authors present an innovative approach for identifying and recovering the saturated signals through use of both the parallel and perpendicular (depolarized) CALIPSO 532 nm lidar channels.

As the lidar surface response is proportional to the product of round-trip transmittance

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to the surface times the surface reflectance, the reflectance can be recovered if the transmittance is known. The authors use the CALIPSO data product estimates of transmittance to recover the surface reflectance for quite clear (nearly Rayleigh) and thin cloud situations. Their retrieved reflectances (BRDF's for lidar backscatter), corrected for saturation or thin clouds, yield values in reasonable agreement with MODIS derived backscatter BRDF's, probably as good an agreement as possible given the likely uncertainty in the MODIS BRDF modeling for backscattering.

The authors define their recovered reflectance (eq. 4) in terms of the total observed surface backscattering signal which includes the long 'noise tail' observed in the lidar surface return (e.g., Hunt et al., JAOT, 2009). They could have alternately defined the reflectance in terms of the total minus tail (eq. 2 minus eq. 3) signal; i.e., main pulse signal. Which is a better/more correct is a matter of conjecture concerning whether the tail is true signal versus after-pulsing noise. The authors do note that over 90% of the surface return signal is contained in the main pulse portion, so either definition for the reflectance would yield about the same result.

In conclusion, this paper presents an innovative approach for recovering the surface BRDF (at backscatter) from CALIPSO surface return signals from snow and ice surfaces, even for saturated signal levels by using the parallel and perpendicular 532 nm lidar channels. The results are new and significant. The paper definitely merits publication.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-488, 2018.

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