A Lidar for Cirrus and Mixed Phase Cloud Studies

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Simon André Curtis

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List of Acronyms and Symbols

%	Percentage
°C	Degrees Celsius
CALIOP	Cloud-Aerosol Lidar with Orthogonal Polarisation
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CW	Continuous Wave
I	Stokes Parameter - Total intensity
KHz	Kilo hertz
Km	Kilo metre
LIDAR	LIght Detection And Ranging
m	Metre
mA	Milli amp
nJ	Nano joule
MHz	Mega hertz
ms	Milli seconds
ns	Nano seconds
m^{-1}	per Metre
mrad	Milli radian
Q	Stokes Parameter - Degree of horizontal/vertical polarisation
Qt	A C++ development environment
s	Second
U	Stokes Parameter - Degree of oblique polarisation
µs	Micro second
v	Volts
V	Stokes Parameter - Degree of circular polarisation
W	Watt

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Software used:

MATLAB.

Qt; in particular the QWT library.

Licel Software.

Abstract

Cirrus and mixed phase clouds represent a major uncertainty in climate and weather models. This uncertainty can be reduced with a better understanding of the lifecycle and radiative properties of cirrus and mixed phase clouds, and by inputting local measurements into models. A cloud's radiative properties are dependent on the thermodynamic phase of the cloud particles. Measurements made with a polarimetric lidar can be used to determine thermodynamic phase and improve our understanding of cirrus and mixed phase clouds. Few polarimetric lidar instruments are used in the southern hemisphere, representing a gap in understanding and measurements. An existing lidar instrument was upgraded and run for 6 months; 3 months with polarisation measurements. Important properties such as height, frequency of occurrence and thermodynamic phase have been measured up to heights of around 6 km. These measurements are consistent with ground and satellite based lidar, and with radiosonde measurements. Methods for determining additional properties of the clouds, such as the optical thickness and lidar ratio were researched. Sufficient measurements of cloud macrophysical properties allow for the determination of cloud microphysical properties, such as particle density and shape. To assist with determining these properties a polarimetric lidar simulation was written. Microphysical properties were not determined due to the lidar lacking sufficient range and resolution. Due to the low peak power of the laser used, increasing the range and resolution by increasing the peak power of the laser would be relatively easy.