An expendable polarisation backscatter sonde

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A simple LED based backscatter sonde is proposed. This will be a low-cost, lightweight add-on to a standard radio-sonde package. It will measure depolarisation of the scattered light from cloud particles and thus determine whether a cloud is composed of ice particles and liquid water, or a mix of the two.

Knowledge of the ice fraction in Antarctic clouds is important for both aircraft operations and scientific reasons. The presence of supercooled liquid is an icing hazard for aircraft and the proposed sonde will be cheap enough to assist weather forecasting. Scientifically, the ice fraction is important in determining the radiative properties of clouds. In any case, clouds in the Antarctic have had little study [1], much is unknown or not understood, and in-situ measurements of depolarisation will help to remedy this.

The instrument in its simplest form will comprise a pulsed LED emitting a peak optical power ~ 400 mW in a single colour. In using an LED it is similar to the COBALD instrument [2]. There will be two photodiode detectors, each with orthogonally oriented polarisers in front, to measure either the linear or circular depolarisation ratio [3,4]. Daytime operation will probably require bandpass optical filters as well. The electronics will incorporate a simple lock-in amplifier and an interface to the radiosonde telemetry. Extra wavelength channels could be added to gain more information about the scatterers.

Making the sonde a quantitative instrument will be challenging. Backscatter from clouds involves considerable multiple scattering, which results in depolarisation even from spherical scatterers [4]. The effect of multiple scattering in the case of clouds of ice crystals has received very little study in comparison [6]. However it seems clear that multiple scattering will have a negative impact on the ability to discriminate between ice and liquid scatterers at short ranges ~ 1 m, and to mitigate this the field of view will need to be carefully chosen.

Calibration and validation will be major issues. Laboratory measurements will be of value. These will involve making clouds of water droplets and snow. However field measurements with participation in cloud measurement campaigns with aircraft equipped with cloud particle imagers, among other instruments will be vital to test the instrument with optically thick clouds.

References

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