

# Cloud Absorption Radiometer (CAR) BRDF data collection during SnowEx 2017

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## I. SUMMARY

The Cloud Absorption Radiometer (CAR), Fig. 1, is a 14 channel airborne scanning radiometer that can perform several functions including determining the single scattering albedo of clouds, measuring angular distribution of scattered radiation, measuring bidirectional reflectance of various surface types and acquiring imagery of cloud and Earth surface features. The sensor characteristics and schematic are shown in Figure 1. During the SnowEx the CAR flew aboard the NRL P-3 Research aircraft (Fig. 3) and measured spectral and angular distribution of scattered light by clouds and aerosols, and provided bidirectional reflectance of various surfaces, and imagery of surface features.

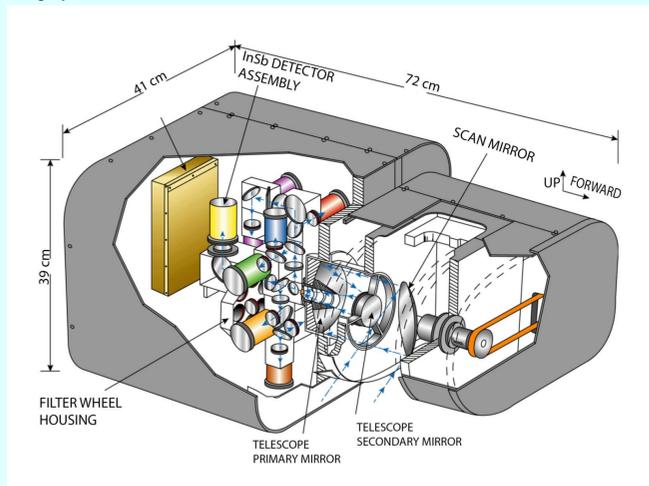


Figure 1. Cloud Absorption Radiometer (CAR) sensor characteristics and schematic of primary optics.

### CAR Sensor Characteristics

- Spectral bands = 14 • Scan rate = 1.67 Hz (0.34-2.29  $\mu\text{m}$ ) • Data channels = 9 (@ 16 bit)
  - IFOV = 1° • Pixels in scan line = 382
  - Total FOV= 190° • Weight = 50 kg
- Platform: NRL P3

<http://car.gsfc.nasa.gov>



Figure 2. NRL P3 with CAR mounted in a nose cone.

## II. BRDF Data Collection

To collect data to construct the BRDF for a particular surface, the CAR was flown in a circular flight pattern scanning from zenith to nadir (Figure 3). A complete circle is required to calculate BRDF.

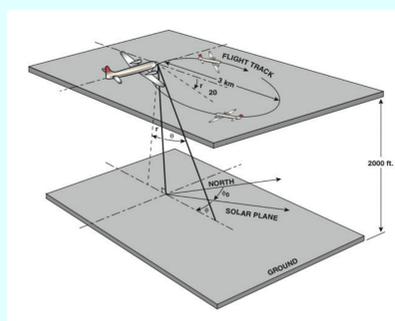


Figure 3. BRDF flight pattern.

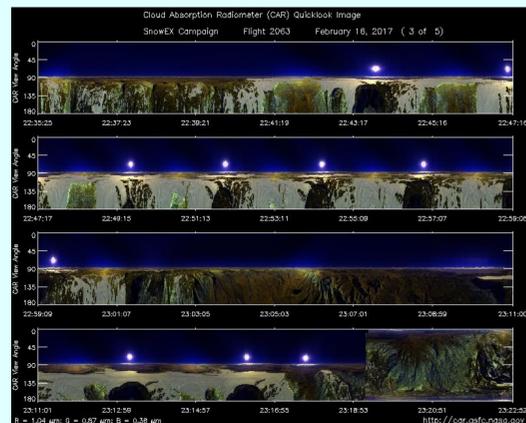


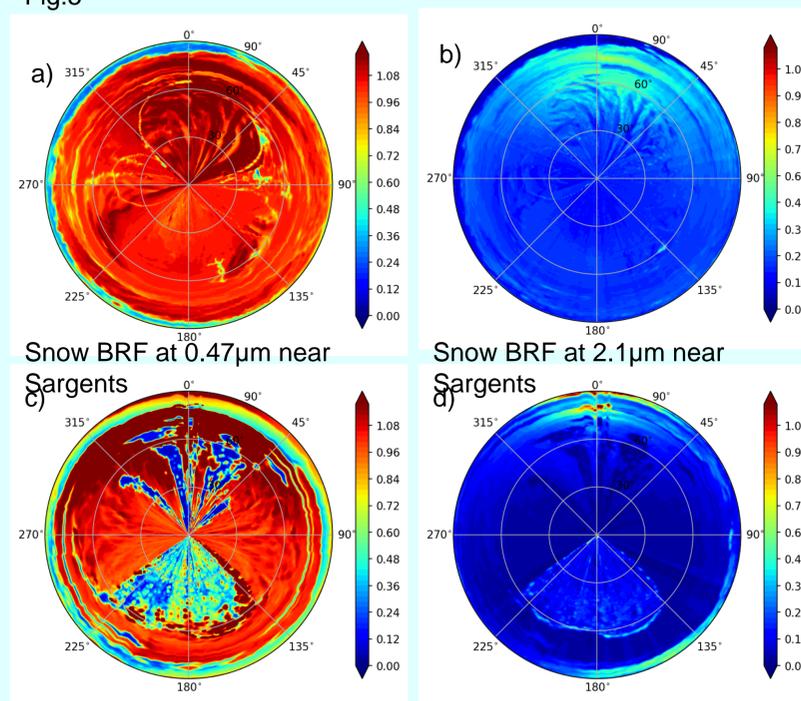
Figure 4. BRDF flight pattern. Multiple orbits acquired to smooth small inhomogeneities.

## II. BRDF data

The color of the polar diagram shows the magnitude of the measured BRDF from nadir to the horizon and for the full range of azimuth angles. Figure 6(a) and 6(b) show comparisons of corresponding principal plane (plane containing the incident beam defined by the plane 0° - 180°).

Images of the BRF at selected wavelengths of the CAR obtained over the western edge of Grand Mesa, Colorado with variable snow-covered vegetation and topography (5c. & 5d.) and a snow-covered open area, about 150 km southeast of Grand Mesa between Parlin and Sargents (5a. and 5b.). BRF (principal plane) comparisons for both areas (fig 6a and 6b).

Fig:5

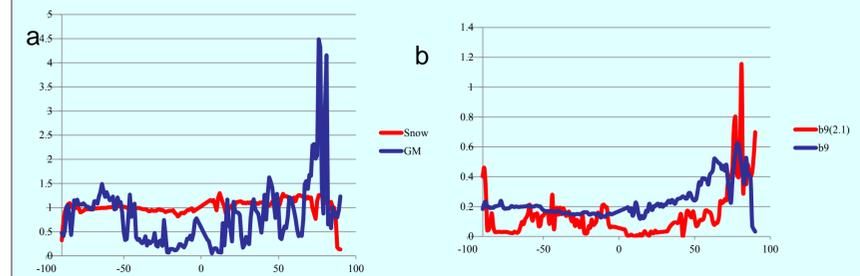


Snow BRF at 0.47 $\mu\text{m}$  at Grand Mesa

Snow BRF at 2.1 $\mu\text{m}$  at Grand Mesa

CAR quicklook image during flight 2063 over Grand Mesa. Multiple BRDF circles can be seen on the image

Fig:6



Snow BRF Principal Plane red line from fig 5a and blue from fig 5c

Snow BRF Principal Plane, red line from fig 5b, and blue from 5d

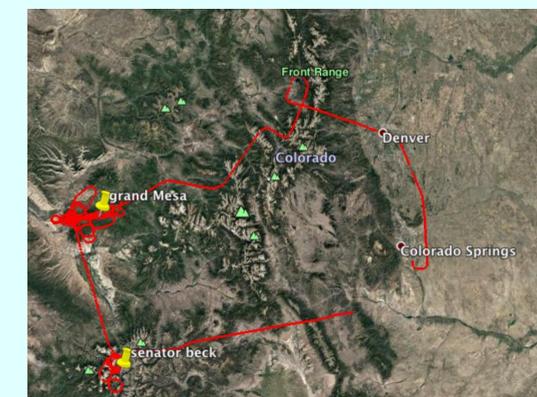


Fig 7. SnowEx flight path from feb 16, 2017

## CAR SnowEx BRDF sites

BRDF data from variety of snow surface were collected during SnowEx field campaign. This included primary site of Grand Mesa where CAR collected BRDF data of Mixed forest and snow. Over Senator Beck site BRDF data of mountain terrain with high sun angle were collected. Snow BRDF and Mixed snow and bare surface BRDF were collected near Salida, CO and Sargents, CO.

Fig 8

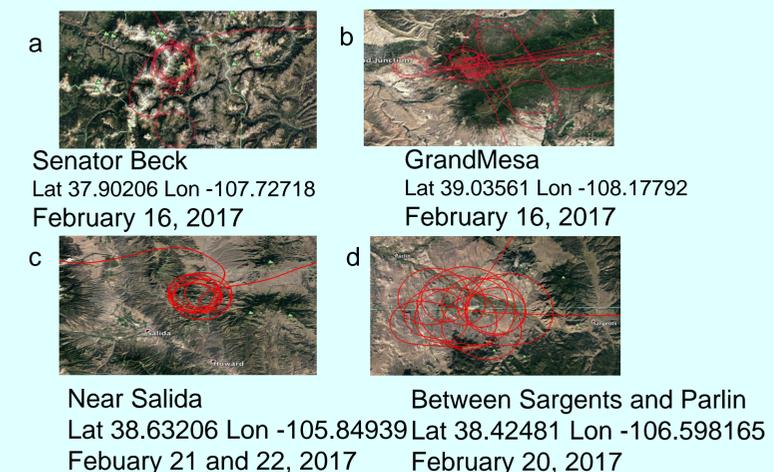


Figure 8 a-d shows the locations of BRDF data collected during SnowEx Colorado

## VI. References

1. <http://car.gsfc.nasa.gov/publications>.
2. Contact: charles.k.gatebe@nasa.gov