NASA's Cloud Absorption Radiometer:

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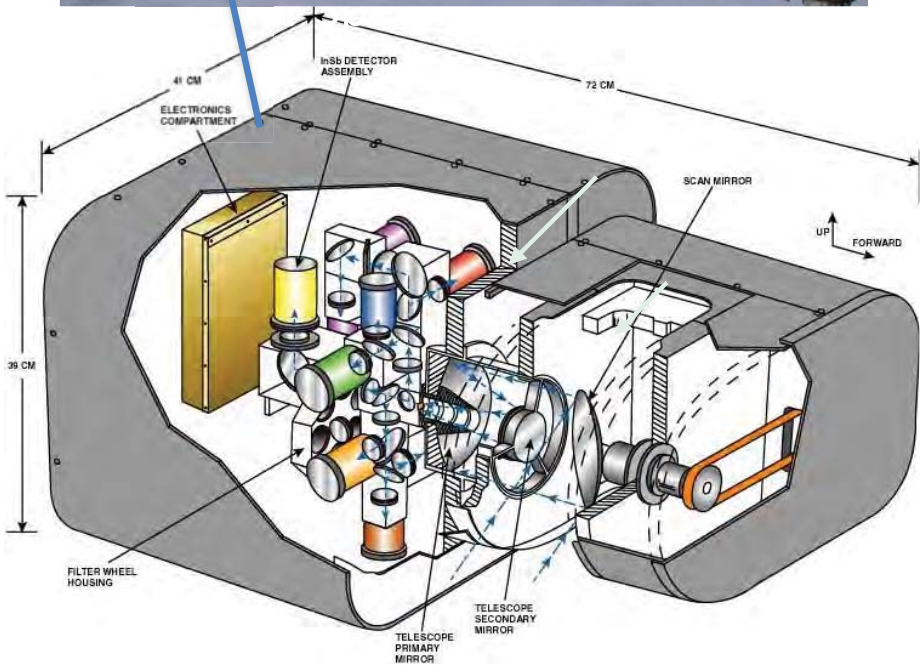
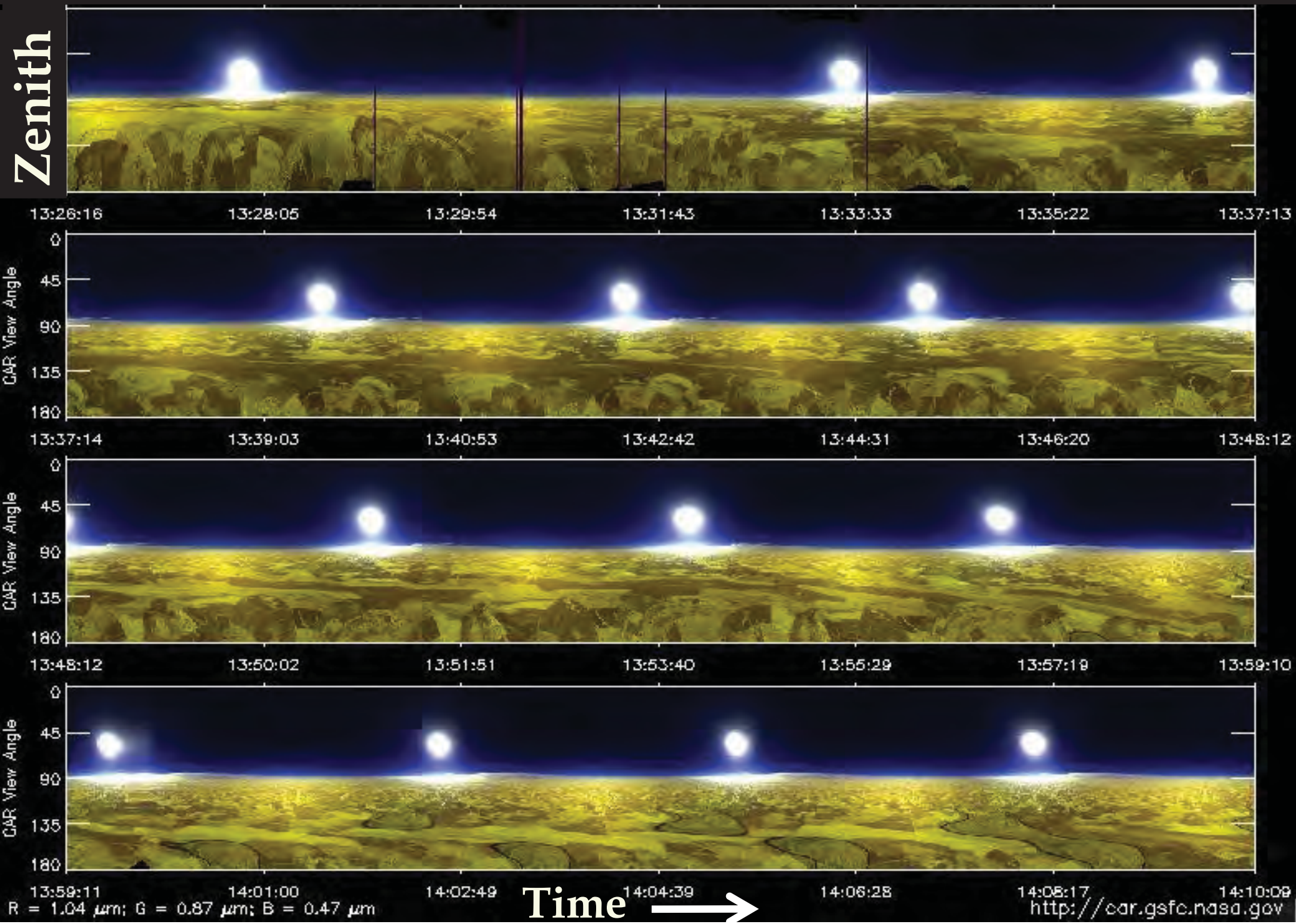
Overview of the CAR Instrument

Sensor Characteristics:

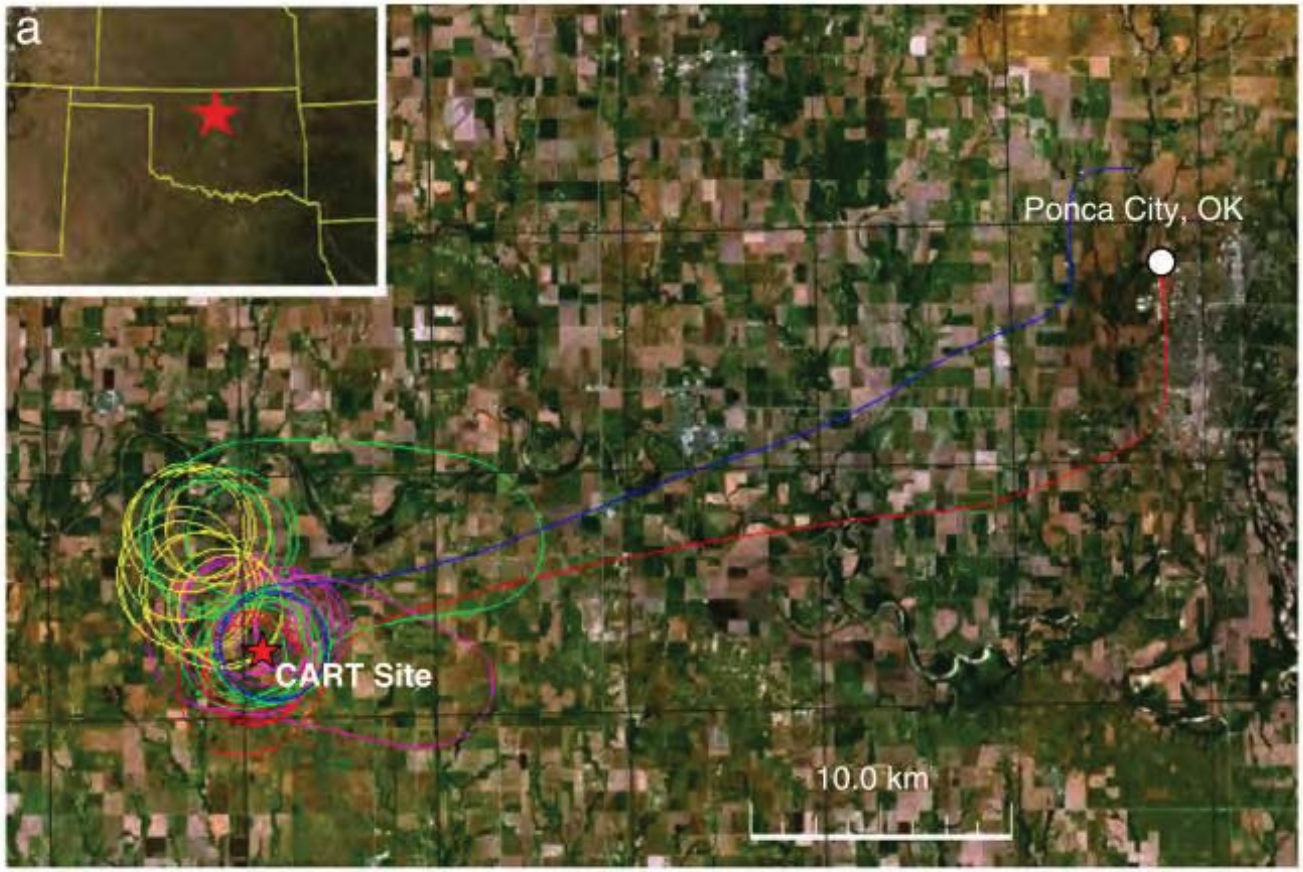
- 14 spectral bands (0.34 to 2.29 μm)
- scan ±95° from horizon on right-hand side of aircraft or image 190° horizon-to-horizon
- field of view 17.5 mrad (1°)
- scan rate 1.67 Hz (100 rpm)
- data system 9 channels @ 16 bit
- 395 pixels in scan line
- Platform: NASA P-3B



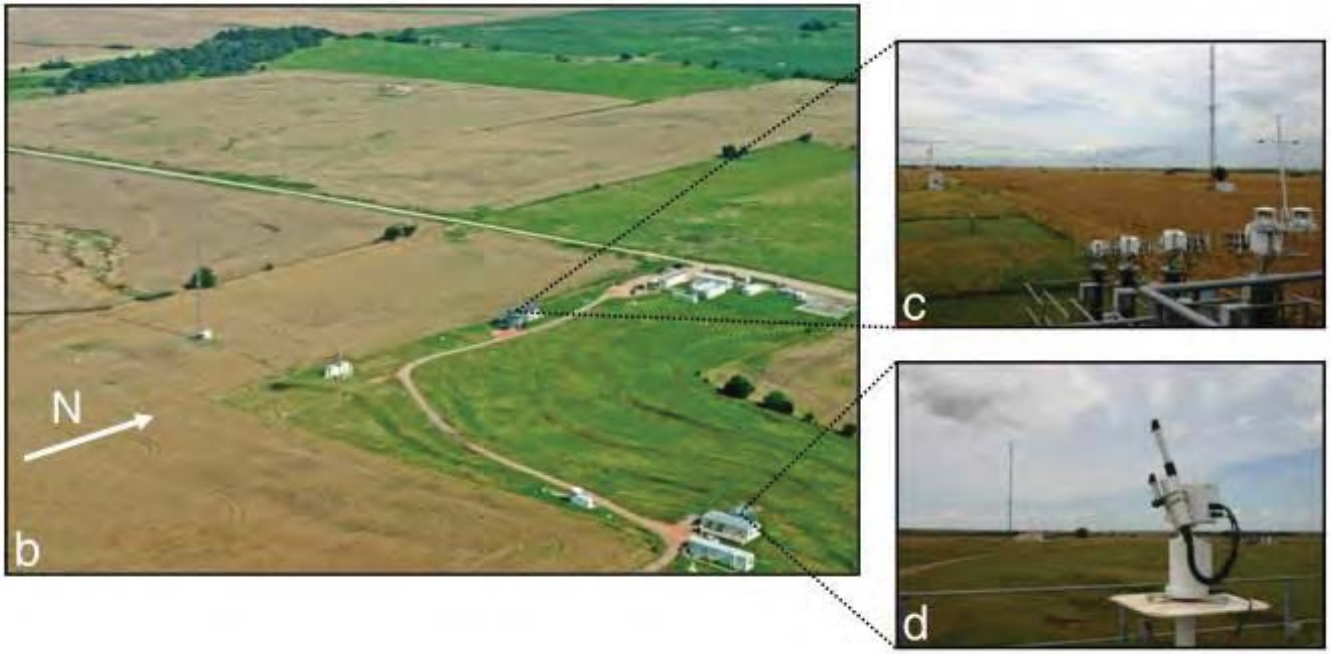
CAR Quick-Look Image: CLASIC Flight #1928



CLASIC'07



IKONOS 2.4 m RGB



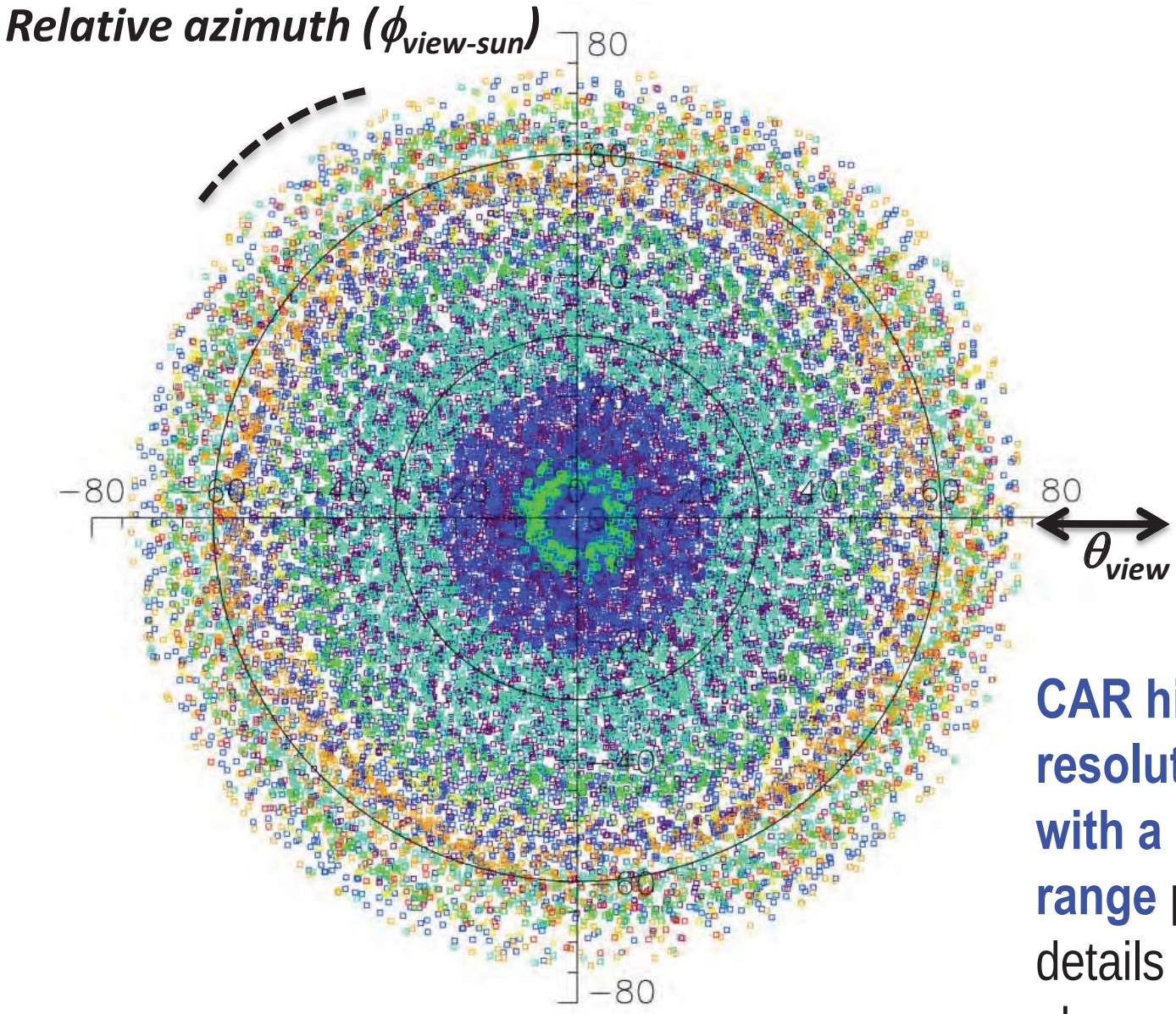
Coincident

Surface BRF and Albedo from Ground, Aircraft, and Satellite.

Best ever

Multi-scale observations of the Surface BRDF.

Cloud Absorption Radiometer: BRDF Sampling



Pixel Size (GIFOV)

- 5–20m
- 20–40m
- 40–60m
- 60–80m
- 80–100m
- 100–250m
- 250–500m

CAR high angular and spatial resolution (1° IFOV) coupled with a high SNR and dynamic range provides unmatched details of the radiance field above clouds and various surfaces.

Román et al. 2011 - RSE

CAR Science Focus Areas

Focus Area	Current and Potential Applications	Campaign/ Project	Key Players†
Cryospheric Science	• Retrieval of BRDF/albedo/snow grain size; • Satellite aerosol retrieval over snow; • Surface energy balance of seasonal snow cover for snowmelt estimation. • Characterize the effects of blowing snow & cloud forward scattering on altimetry (Lidar) measurements to evaluate the imprint of climatic changes on ice dynamics (e.g., flow of ice & mass balance).	ARCTAS, IceBridge§, ICESat	Lyapustin et al. (2010) Gatebe et al. (2010) Arnold et al. (2002) **Collaborators:** Marshak, Yang, Hall, Kahn, Schaaf
Terrestrial Ecology & Biospheric Science	• MODIS/MISR Land and Aerosol Product Cal/Val efforts; • Diurnal-to-seasonal characteristics of surface energy balance; • Retrieval of surface biophysical parameters (e.g., BRDF-Albedo, VI, and Clumping index) at multiple spatial scales and angular distributions; • Retrieval of vegetation structural parameters (e.g., leaf size, canopy height, and canopy roughness) over complex heterogeneous surfaces.	ARCTAS, CLASIC, INTEX-B, Skukuza, CLAMS, SAFARI 2000, TARFOX, SCAR-B, CLAMS	Román et al. (2011;2013) Gatebe et al. (2003; 2010) Soulen et al. (2000), Tsay et al. (1998) **Collaborators:** Schaaf, Wang, Shuai, Masek, Butler, Georgiev, Cooper, King, Ni-Meister, Varnai, Marshak
Freshwater/ Coastal & Marine Climate Science	• Retrieval of surface BRDF/albedo over aquatic biomes (e.g., coastlines, estuaries, ponds, and lakes) under clear and turbid waters. • Impact of anthropogenic forcing (e.g., ship wakes) on ocean energy balance.	ARCTAS-CARB, CLAMS, ARCTAS	Gatebe et al. (2005;2010) **Collaborators:** Lyapustin, Stamnes, Wilcox, Wang
Cloud & Smoke Radiative Properties	• Cloud/Smoke interior: Energy budget; Actinix flux; • Wildfire smoke: Effects of boreal/savanna fire regimes on atmospheric chemistry, global carbon cycling, and climate; • Precipitating cloud: Impact on land-atmosphere interactions and locally generated cumulus convection. • Retrieval of Cloud Effective Radius.	SCAR-B, SAFARI 2000, Skukuza, CLASIC, ARCTAS	Gatebe et al. (2003;2011) King (1992) **Collaborators:** Ichoku, Kahn, Melnikova, Marshak, Ewald, Zinner, Varnai, Ewald

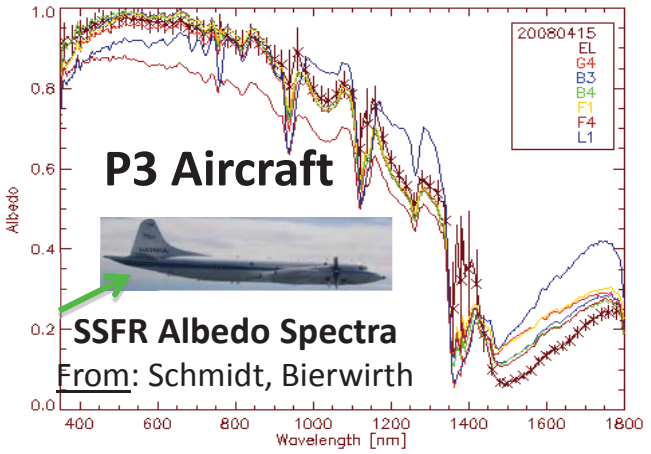
†Cited publications are available at: http://car.gsfc.nasa.gov/publications/

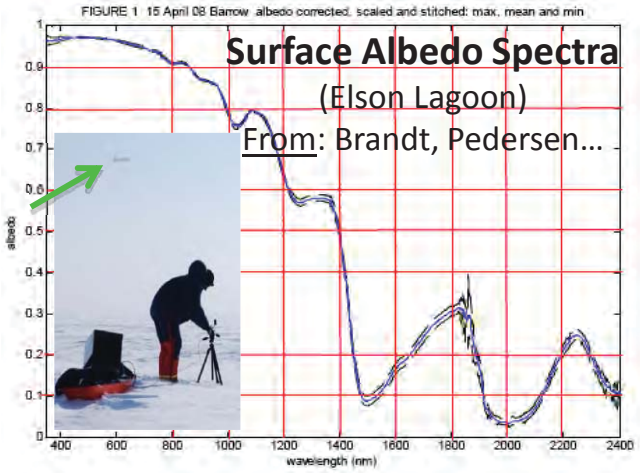
ARCTAS'08: Barrow/Elson Lagoon 15 April 2008

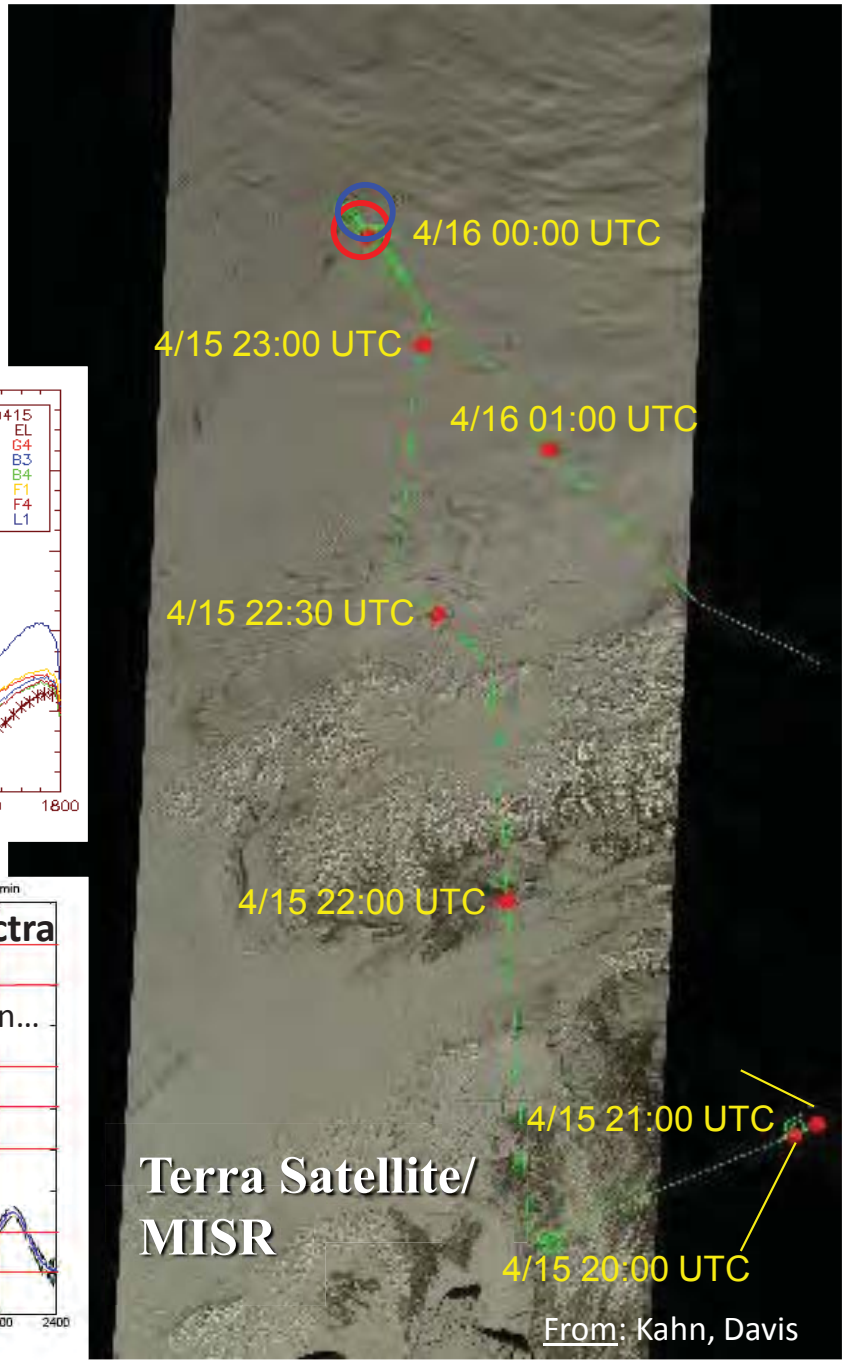
Lat 71.3° Lon -156.7; SZA 61.1° [Terra at 22:30 UTC]

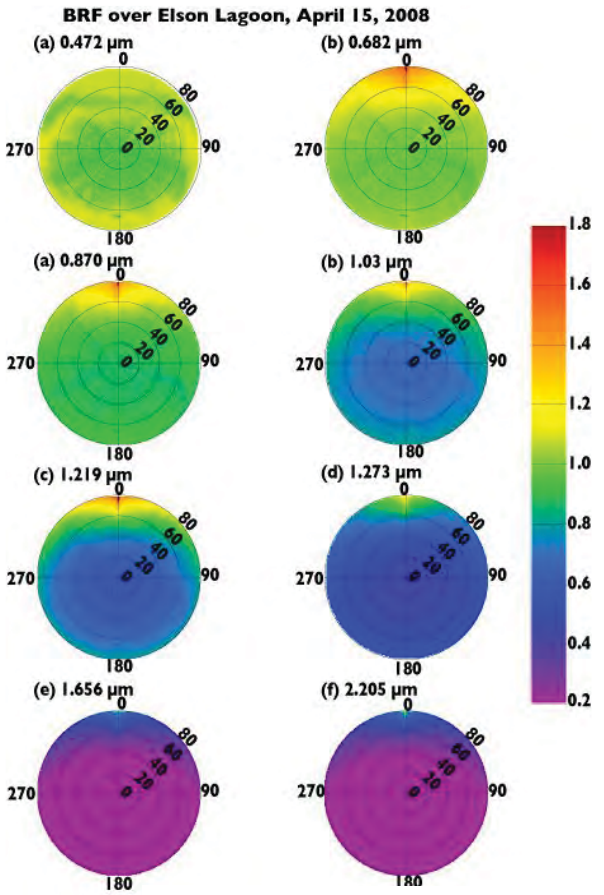
Coincident
Snow Albedo & BRF from Surface, Aircraft, and Satellite.

Best ever multi-scale observations over snow-covered areas.









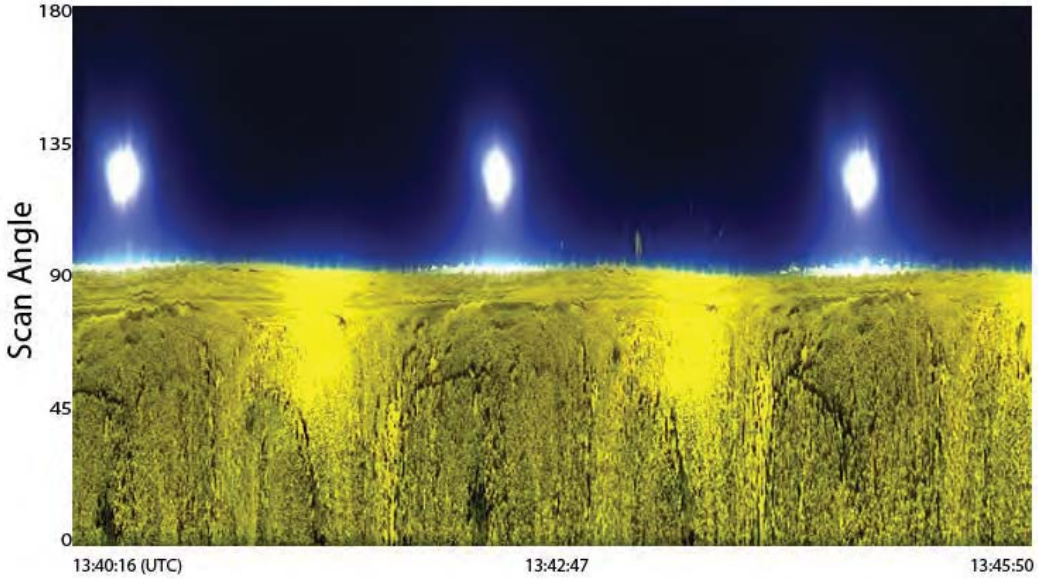
CAR Spectral BRF
From: Gatebe

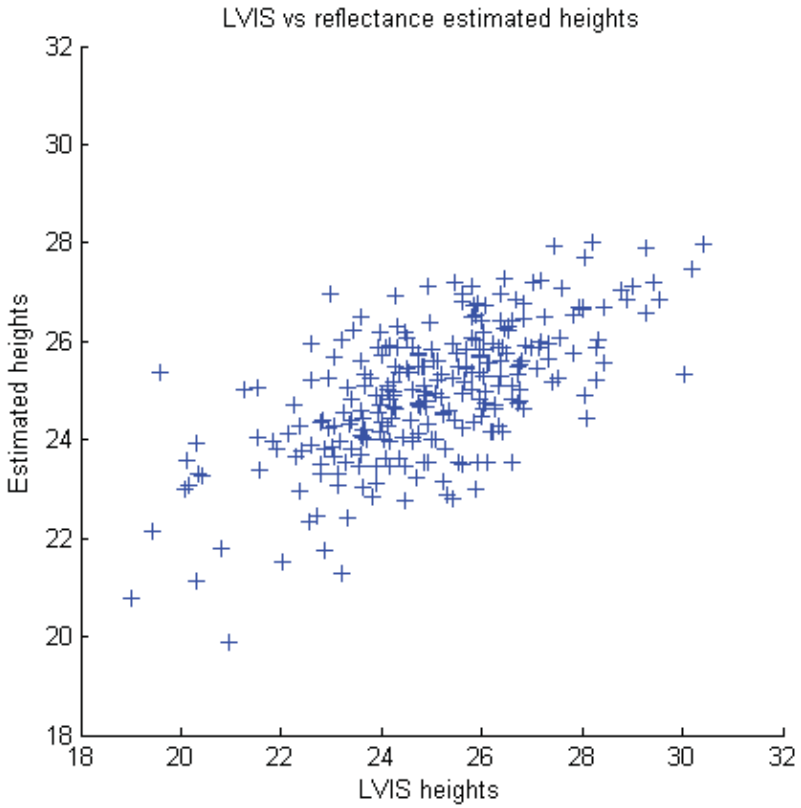
P-3 Flight Path

Barrow AERONET Site

Ground Measurements

ECO/3D: Canopy height estimation (Harvard Forest LTER)

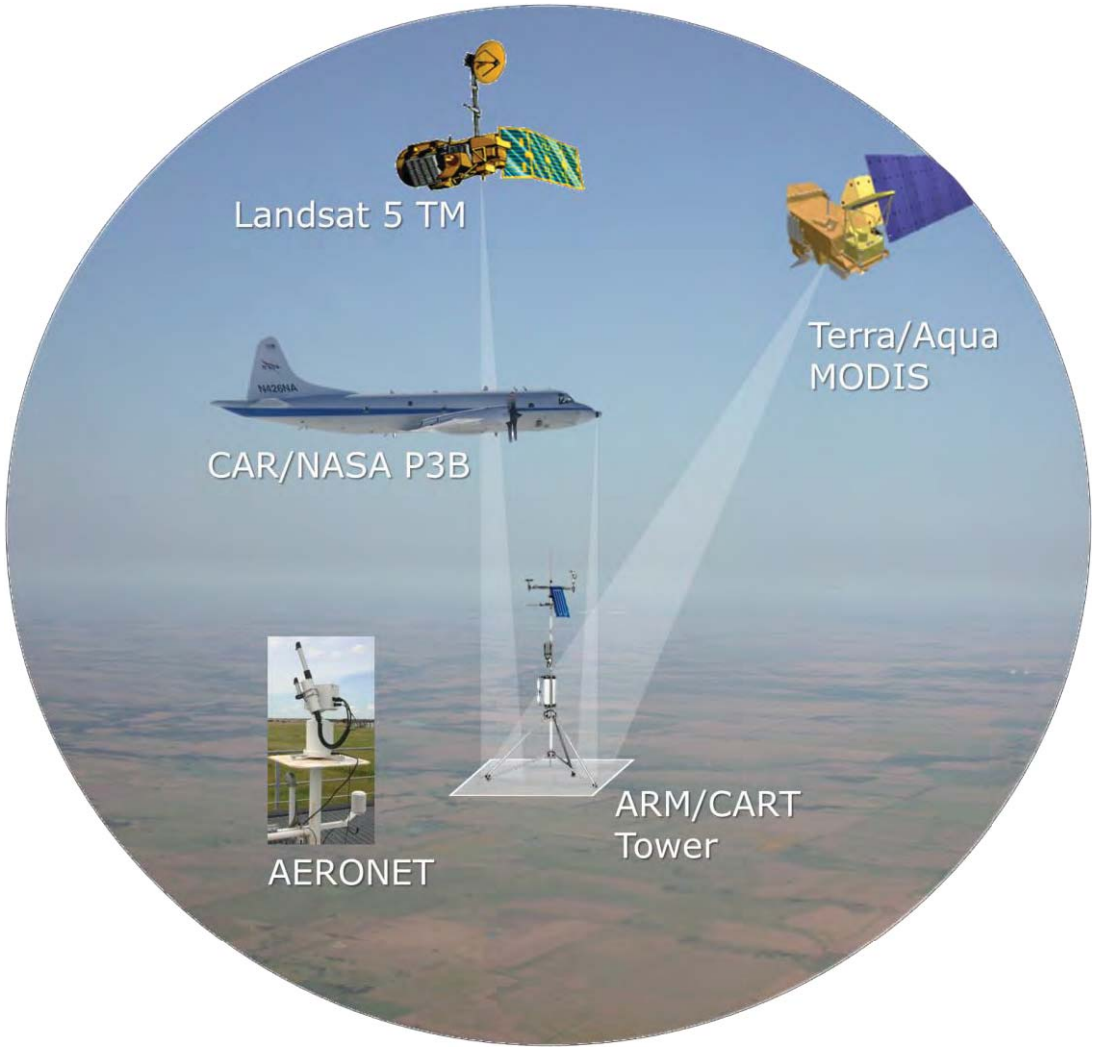




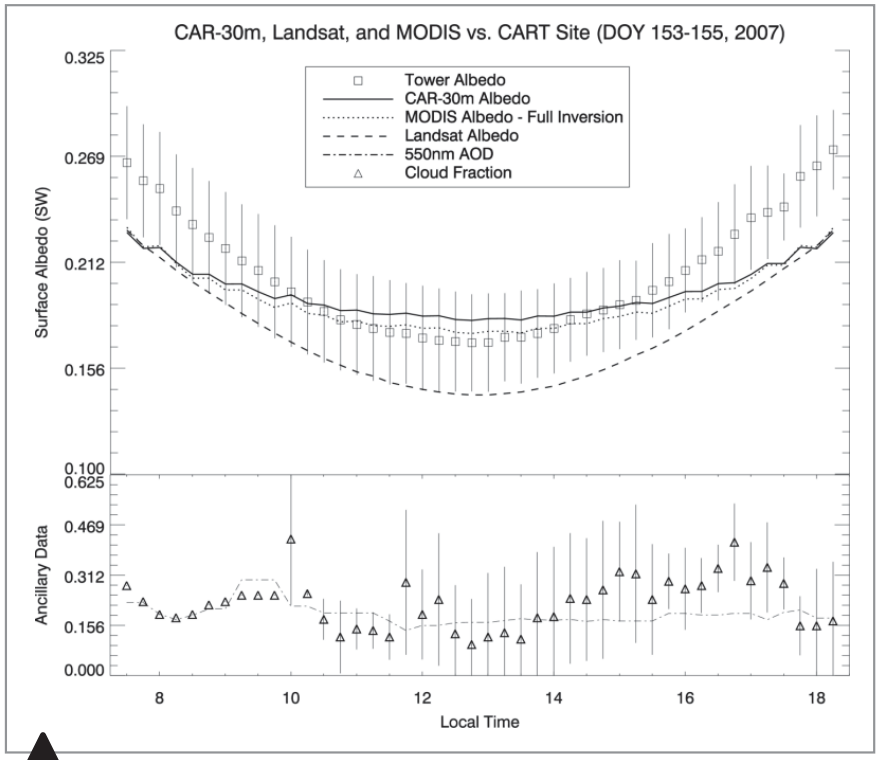
Correlation coefficient:
Multi angles surface reflectance 0.65
Escape probability 0.76
Maple leaf reflectance and broadleaf pixels

Credit: Zhuosen Wang (UMB)

Use of in situ and airborne multiangle data to assess MODIS- and Landsat-based estimates of directional reflectance and albedo (Román et a., 2013 – TGRS)

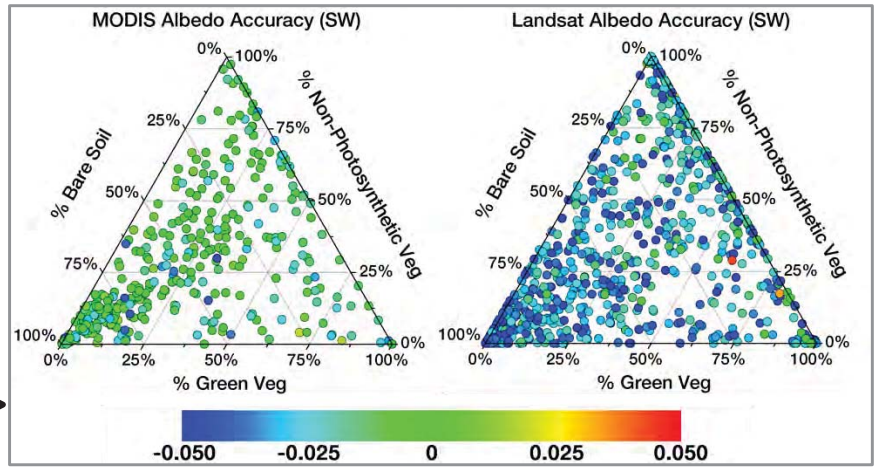


Measurement configuration for multiscale assessment of MODIS- and Landsat-albedos.



Tower albedos vs. CAR, MODIS, and Landsat.

Pixel-specific accuracy of MODIS- and Landsat-derived albedos.



Summary + Final Thoughts…

- Previous and ongoing efforts offer a unique set of tools and capabilities for ensuring mission readiness.
  - **CLASIC'07:** First comprehensive assessment BRDF/albedo at different spatial scales (30 – 500m).
  - **ARCTAS'08:** Best ever multi-scale observations over snow-covered areas.
  - **ECO/3D'11:** Capability for mapping canopy physiognomy/structure (e.g., BRDF shape & tree height) from multiangle BRF data.
- From a scientific perspective, ***SnowMASS is the next logical milestone for the CAR***.