A Unique Airborne Multi-angular Dataset for Calibration and Validation of Earth Satellite Products

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https://car.gsfc.nasa.gov/

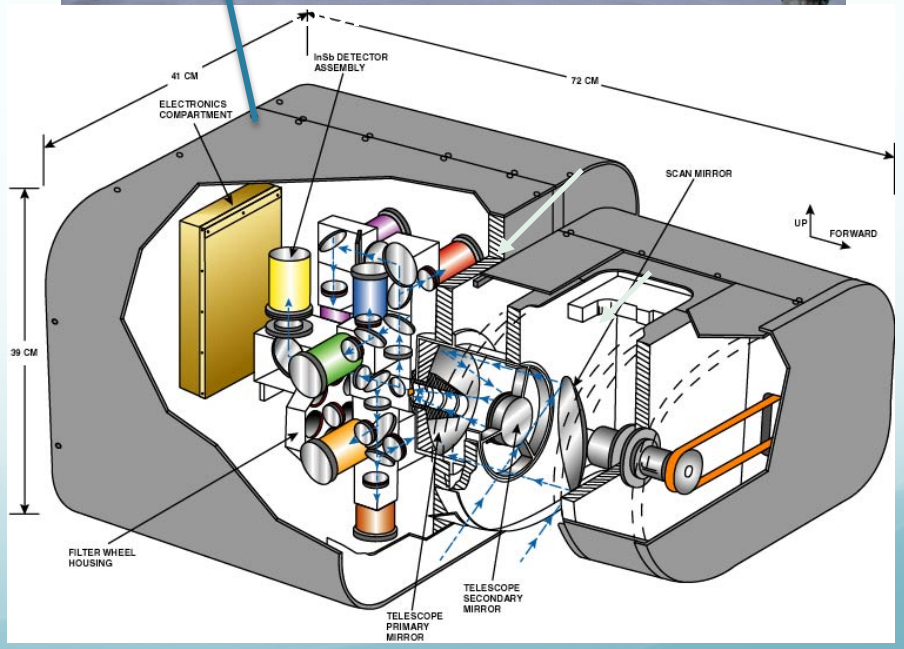
EGU General Assembly 2020

Overview of the CAR Instrument

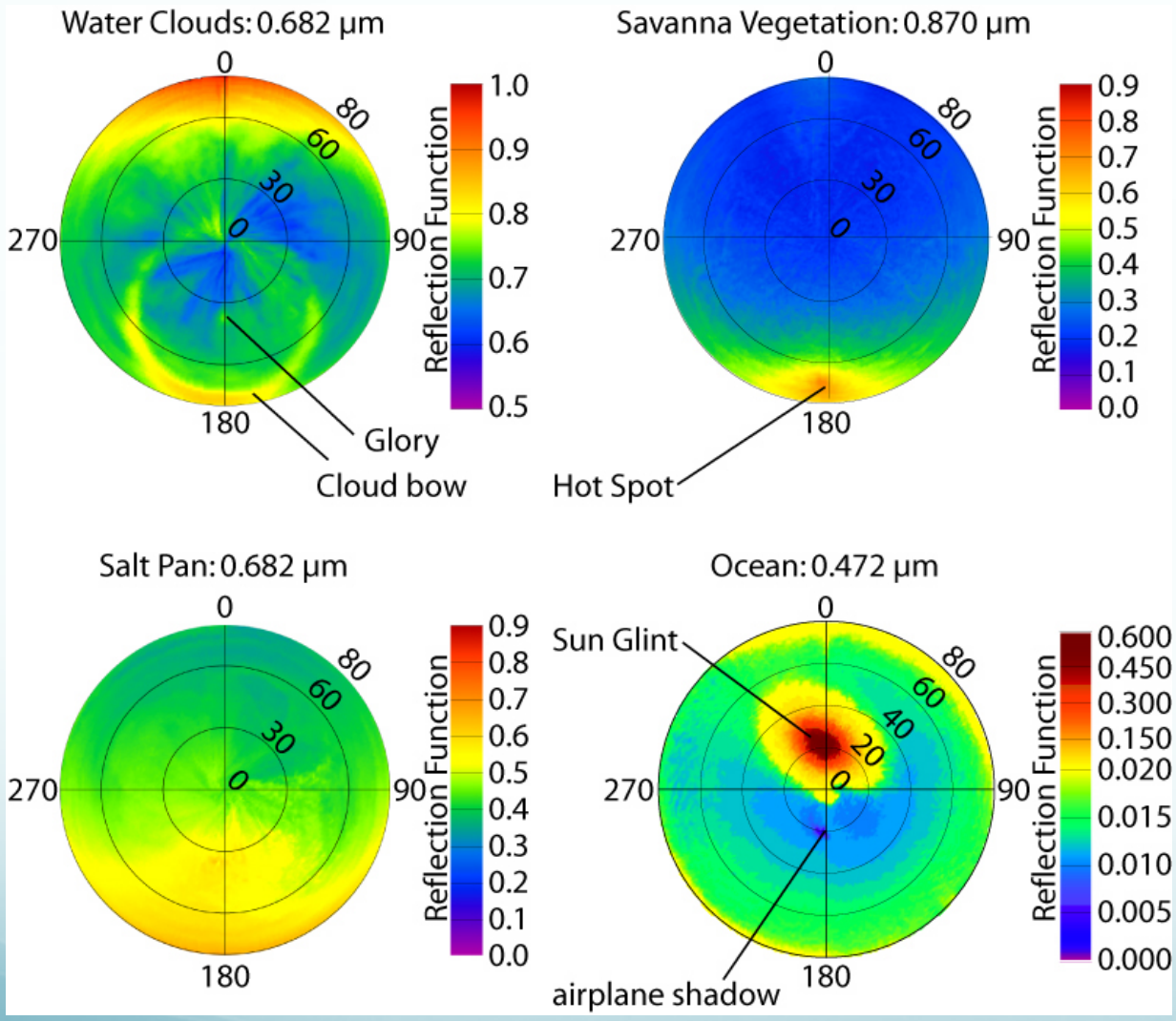
Sensor Characteristics:

- 14 spectral bands (0.34 to 2.29 μm).
- IFOV: 1° (17.5 mrad).
- scan 190° from zenith to nadir.
- scan rate: 100 scans per minute (1.67 Hz).
- Platform: NASA P-3B.

https://car.gsfc.nasa.gov/



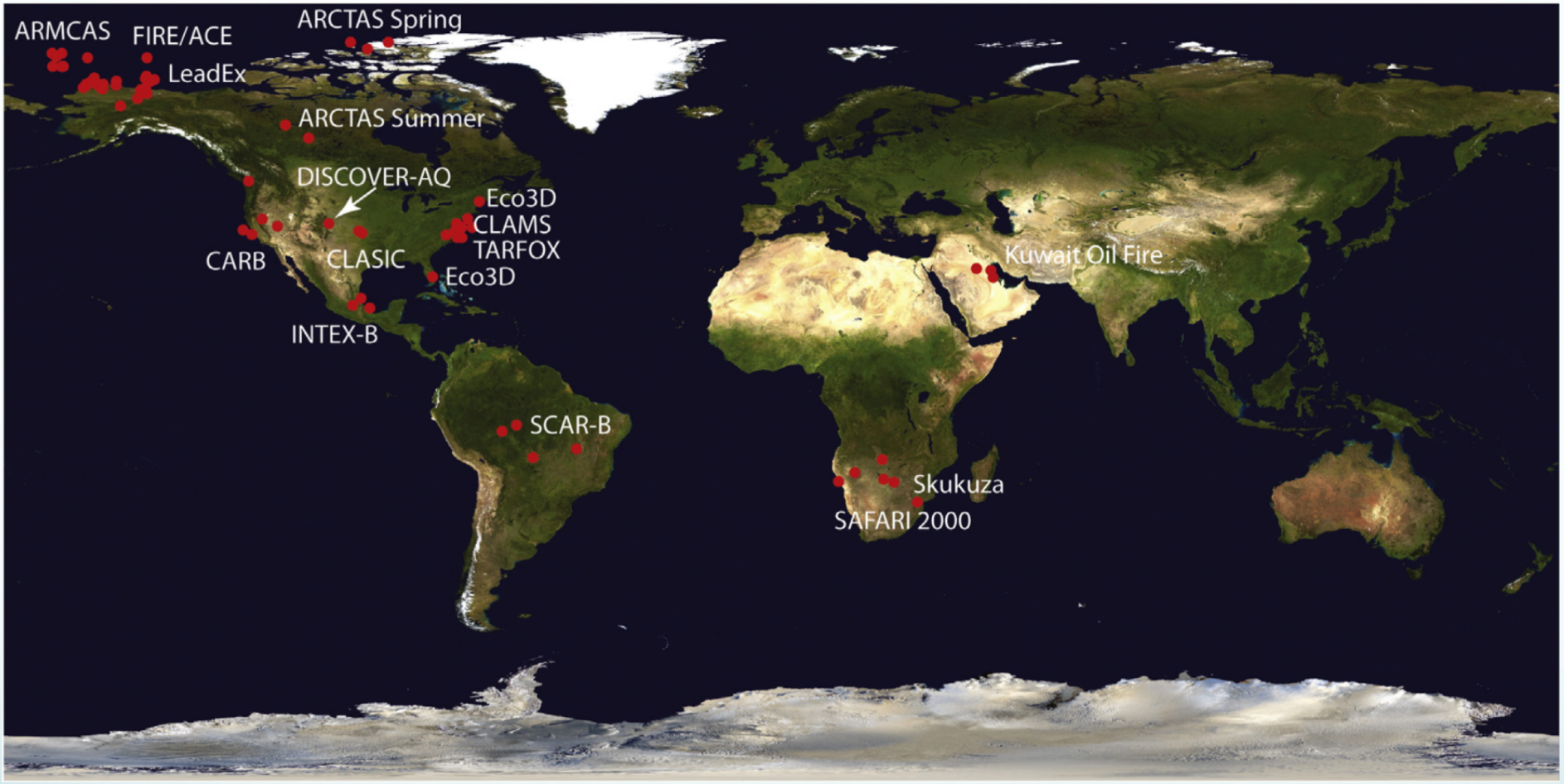
BRDF of Different Natural Surfaces



- **Seven types:**
  - **water**
  - **vegetation**
  - **clouds**
  - **snow/ sea ice,**
  - **non-vegetation**
  - **wetlands**
  - **smoke (biomass burning and fuel)**

See Gatebe et al., 2016: Remote Sens. Env., 179, 131–148

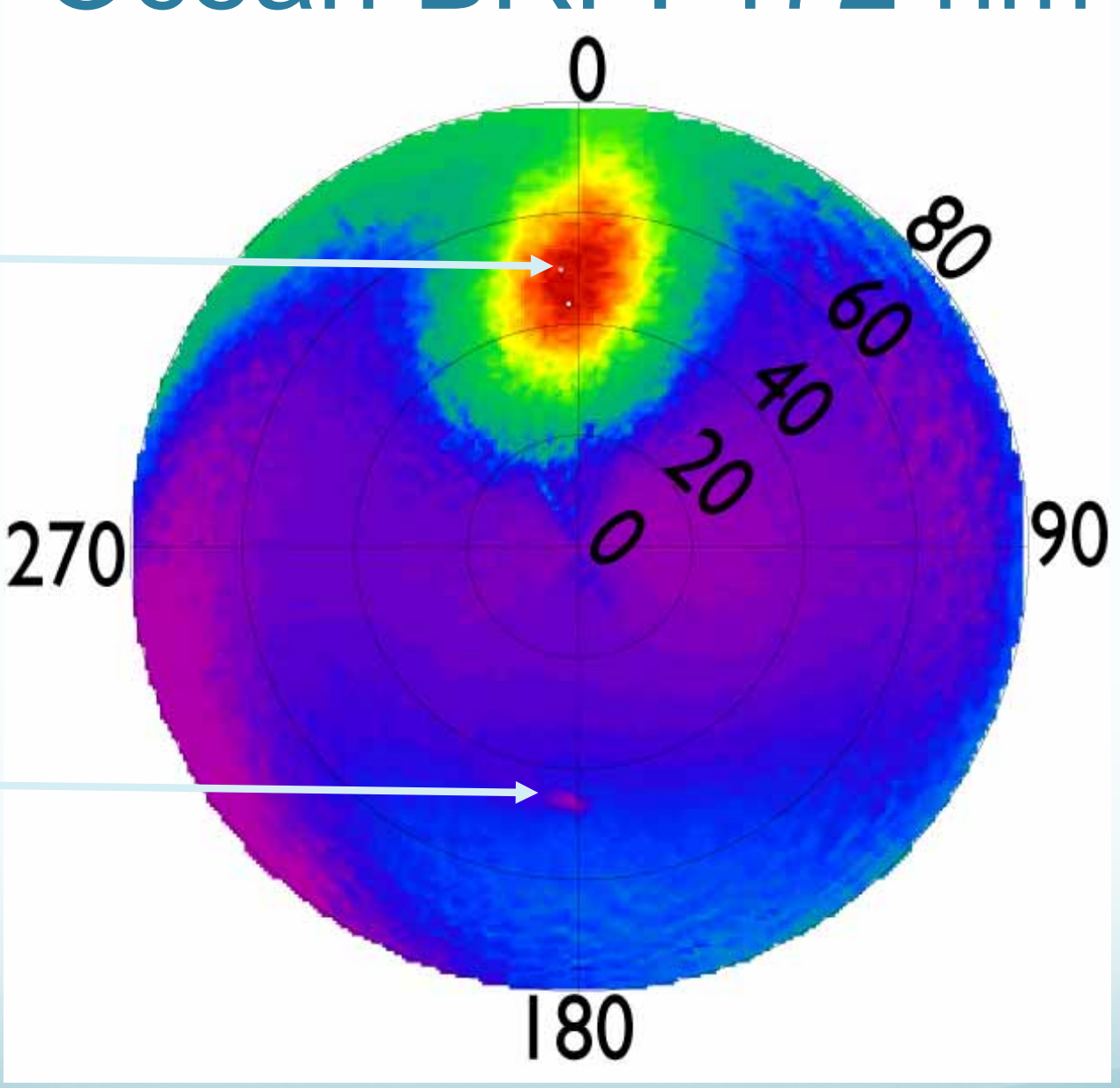
CAR BRDF Data Sets 1991-2017



Multi-spectral Surface Bidirectional Reflectance Factor (BRF) for: snow & sea ice, ocean, clouds, smoke plumes, salt pan (i.e., calibration sites), vegetation (grass, savanna, forests, etc), urban.

See Gatebe and King (2016). Remote Sens. Env., 179, 131–148

Ocean BRF: 472 nm



Sunglint

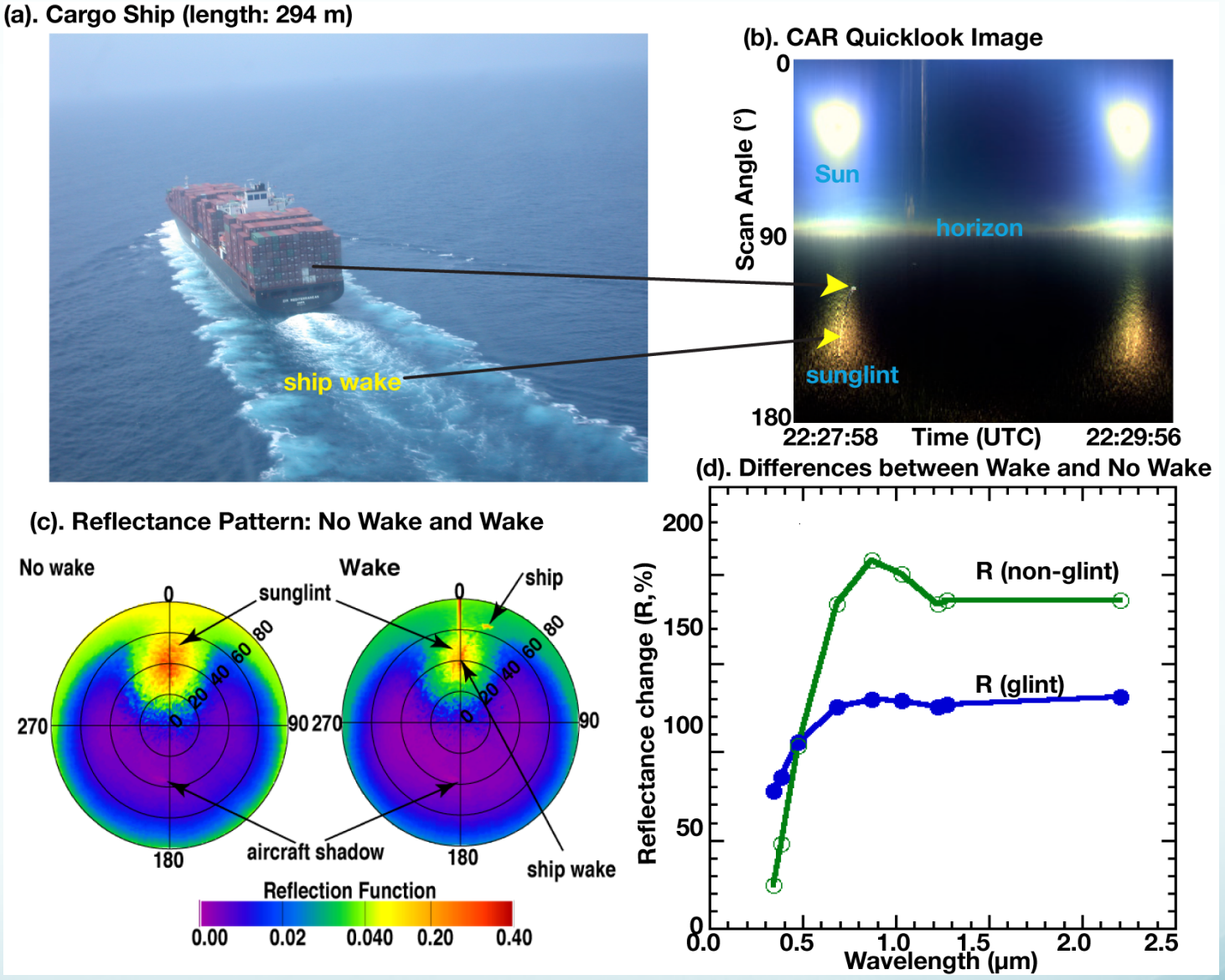
Aircraft Shadow

Chesapeake LH; August 02, 2001

See Gatebe et al., 2005: JAS, 62, 1072–1092

Highlight: Ship Wake Impact on Ocean Brightness & Climate

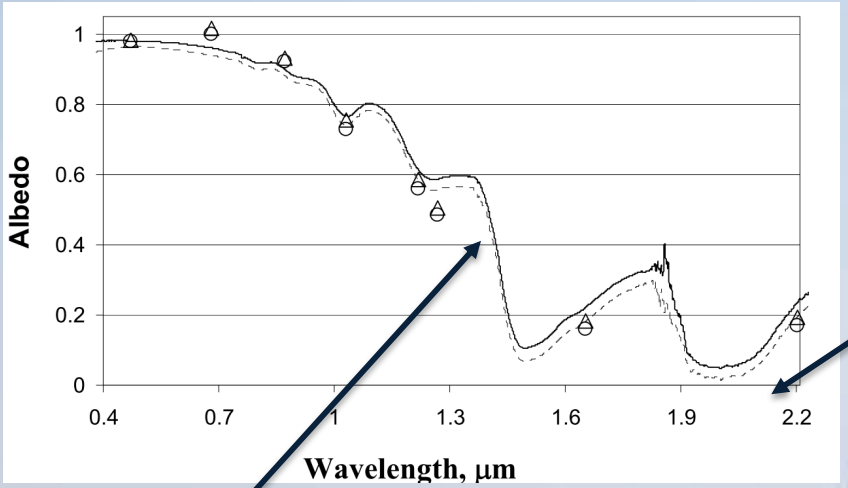
- Ship wakes produce ocean bubbles; enhance ocean reflectance >100%.
- global radiative forcing of ship wakes -(0.14 ± 50%) mWm^-2
- **Results are published in Gatebe et al., GRL 2011: doi:10.1029/2011GL048819**



(a). Cargo ship moving through the scene during airborne measurements. (b). The cargo ship can be seen in a quick-look image from NASA's Cloud Absorption Radiometer. (c). Ocean bidirectional reflectance distribution function at 0.870 μm without and with ship wake. (d). Relative change in reflectance in the solar principal plane (Rglint) and off-principal plane (Rnon-glint) due to the presence of ship wake.

ARCTAS 2008

CAR-measured Albedo



Surface-Measured Albedo

Mission Highlights:

- ***Best ever*** in-situ measurements for accuracy analysis of analytical snow BRDF models.

- ***Developed, tested, and evaluated*** new models of macroscopic surface roughness that adjust the plane-parallel radiative transfer solution to experimental snow BRF.

Lyapustin et al.: Atmos. Chem. Phys., 10, 4359–4375, 2010

Summary

- Unique airborne measurements:
  - Full Angular coverage.
  - Different scales and scene types.
  - High SNR even over dark scenes.

- Where is the data?
  - CAR data is widely distributed through NASA Goddard Earth Science Data Information and Services Center.
  - https://disc.gsfc.nasa.gov/datasets?keywords=CAR
  - The end product -- calibrated radiances in NetCDF (network Common Data Format) -- is a self-contained, self-describing, and information-rich data set.
  - Home website: https://car.gsfc.nasa.gov.

- Applications: atmosphere, land, ocean, cryosphere, etc.
  - See publications: https://car.gsfc.nasa.gov/view/biblio/year