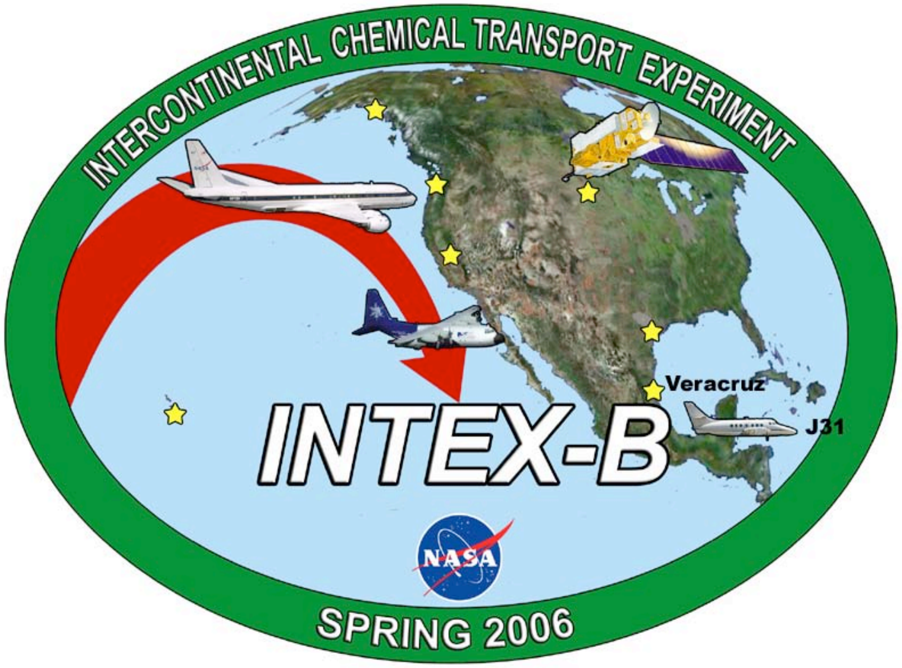
Jetstream 31 (J31) at Mid-Campaign in INTEX-B/MILAGRO:

Science Goals, Payload, Example Results, Assessment

Phil Russell, Jens Redemann, Brian Cairns, Charles Gatebe, Sebastian Schmidt, and the rest of the J31 Team

MILAGRO Mid-Campaign Science Meeting
14 March 2006, Veracruz, MEXICO


INTERCONTINENTAL CHEMICAL TRANSPORT EXPERIMENT
Veracruz
J31
INTEX-B
NASA
SPRING 2006


MILAGRO
Megacity Initiative - Local and Global Research Observations
MIRAGE-Mex
MAX-Mex
INTEX-B
MCMA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N41Z

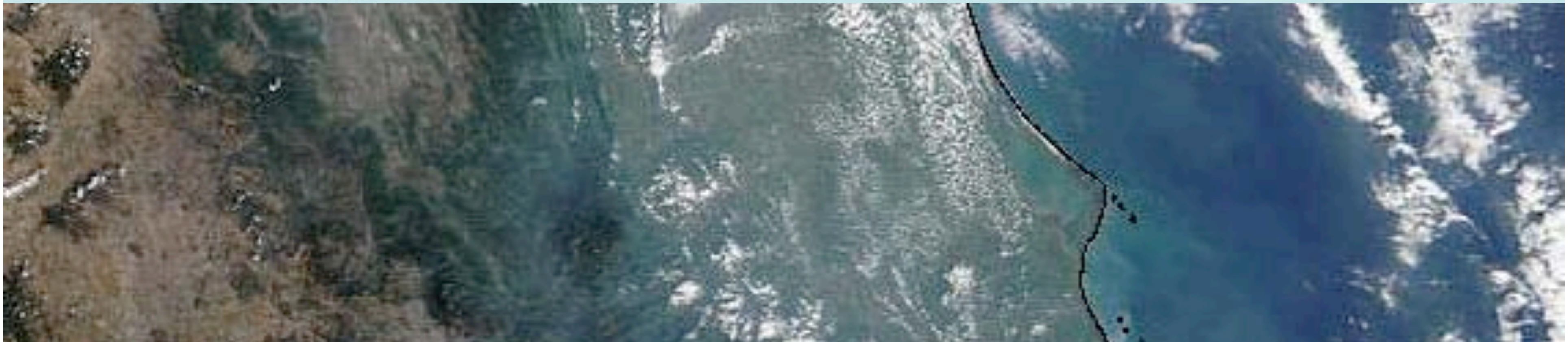
The J31 is a tool for measuring solar energy and how that energy is affected by the atmosphere and the Earth's surfaces.

The J31 is a tool for measuring solar energy and how that energy is affected by the atmosphere and the Earth's surfaces.

Since solar energy drives the Earth's climate, the J31 suite of measurements helps show how changing atmospheric and surface properties can change the climate

J31 in INTEX-B/MILAGRO:

Aerosol, Water Vapor, Cloud, & Surface Properties and Radiative Effects



GOALS

Characterize the distributions, properties, and effects of aerosols and water vapor advecting from Mexico City and biomass fires toward and over the Gulf of Mexico

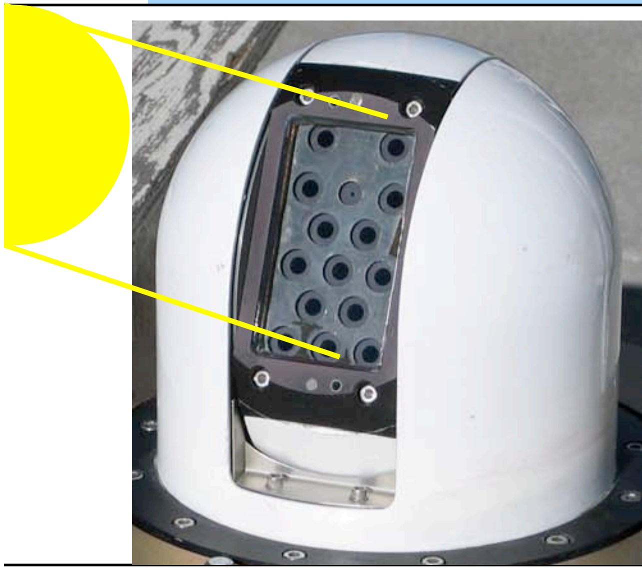
- Aerosol Optical Depth And Extinction Spectra (354-2138 nm)
- Water Vapor Columns And Profiles
- Aerosol Radiative Impacts: In Clear Sky (Direct Effect) & Via Clouds (Indirect Effect)

Test the ability of Aura, other A-Train & Terra sensors, & airborne lidar to retrieve aerosol, cloud, and water vapor properties

Characterize surface spectral albedo and bidirectional reflectance distribution function (BRDF) to help improve satellite retrievals

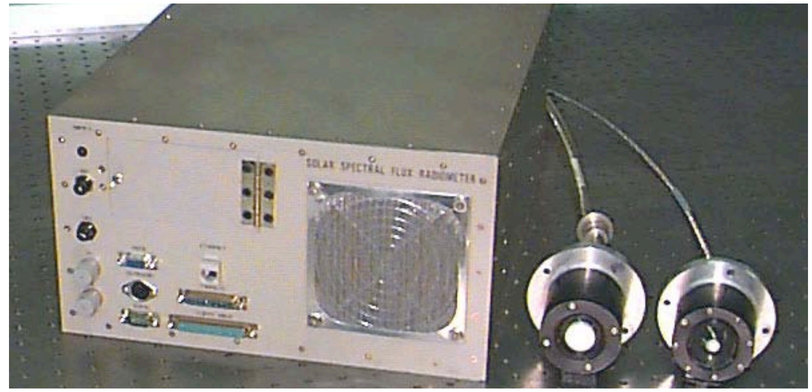
Quantify the relationships between the above and aerosol amount and type

J31 in INTEX-B/MILAGRO: Payload



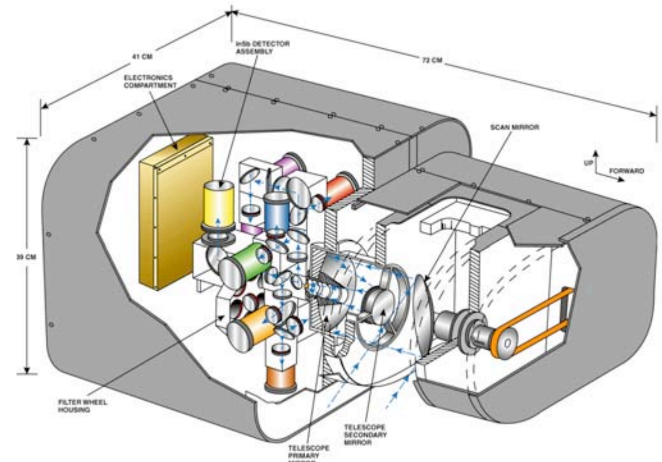
Ames Airborne Tracking Sun-photometer (AATS)

Solar Spectral Flux Radiometer (SSFR)



Research Scanning Polarimeter

Cloud Absorption Radiometer (CAR)



Position & Orientation System (POS)

Met Sensors & Nav/Met Data System

J31 Science Objectives by Sensor
1. Independent of other J31 sensors

AATS

- Characterize horizontal & vertical distributions of aerosol optical depth (AOD) and extinction spectra (354-2138 nm), water vapor columns and density
- Validate A-Train & Terra products (CALIPSO, OMI, MODIS, POLDER, TES, AIRS, MISR)
- Test closure with remote and in situ sensors on other platforms, including airborne lidar
- Test chemical transport models using AOD & extinction profiles
- Assess regional aerosol radiative effects

SSFR

- Retrieve cloud droplet radius, optical depth, and liquid water path
- Compare with satellite retrievals (MODIS) and remote & in situ sensors on the surface and other aircraft (incl. microwave, radar, optics, etc.)
- Compare spectral irradiance from SSFR to that from 3-d model using MODIS input
- Provide surface spectral albedo to help improve satellite aerosol retrievals
- Determine column solar radiative boundary conditions for modeling studies

J31 Science Objectives by Sensor

2. Objectives that combine data from 2 or more J31 sensors

RSP-AATS-SSFR

- Evaluate remote sensing methods (RSP + lidar) for determining the aerosol radiative forcing profile against the measured spectral optical depth and radiative flux profile

CAR-AATS

- Retrieve BRDF and aerosol optical properties simultaneously from combined data sets: CAR, AATS, and AERONET.

CAR-AATS-RSP

- Extend CAR retrieval algorithm to include RSP, AATS, AERONET.

To accomplish these goals and objectives we have:

- 19 Days (3-21 Mar)
- 45 Flight Hours

J31 Science Flights out of Veracruz
in MILAGRO/INTEX-B

Flt No.	Date, 2006	Track	Comments
VER 01	3 Mar	Gulf of Mexico near VER & Tampico	Terra MODIS & A-Train near overpass times, clouds & clear. Profile, RSP legs, CAR circles.
VER 02	5 Mar	Gulf of Mexico NE of VER	Terra MODIS, clear. Profile, transects, SSFR fluxes, RSP legs, CAR circles.
VER 03	6 Mar	Mexico City	Terra (MODIS & MISR LM), clear. Racetrack stepped profile, SSFR fluxes, RSP legs, CAR racetracks near T0 & airport under King Air.
VER 04	8 Mar	Aborted on takeoff roll: bird strike	
VER 05	10 Mar	Gulf of Mexico NE of VER	Terra (MODIS & MISR LM), King Air and C-130. Clear + cirrus. 2 profiles, RSP legs.
VER 06	10 Mar	Gulf of Mexico NE of VER	A-Train in MODIS Aqua glint-free. Profiles, SSFR fluxes, CAR circles, RSP legs
VER 07	11 Mar	Mexico City	CAR circles for urban reflectivity. Profile w 18Z sonde at VER on return.

J31 Science Flights out of Veracruz
in MILAGRO/INTEX-B (cont'd)

Flt No.	Date, 2006	Track	Comments
VER 08	12 Mar	Gulf of Mexico near Tampico	Terra MODIS, King Air. Clear w clouds. 2 profiles, RSP legs. Near AERONET Tampico & Tamihua
VER 09	13 Mar	Gulf of Mexico near Tampico	Terra MODIS/Glory Glint Scenario.

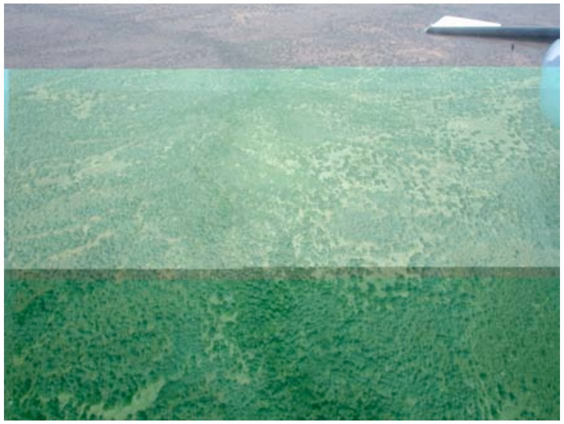
J31 Example Results

- Jens Redemann: AATS
- Tom Arnold: CAR
- Brian Cairns: RSP
- Sebastian Schmidt: SSFR

Selected Pictures for Surfaces for CAR BRDF

WATER CLOUD
(Namibian Coast, 9/13/2000)

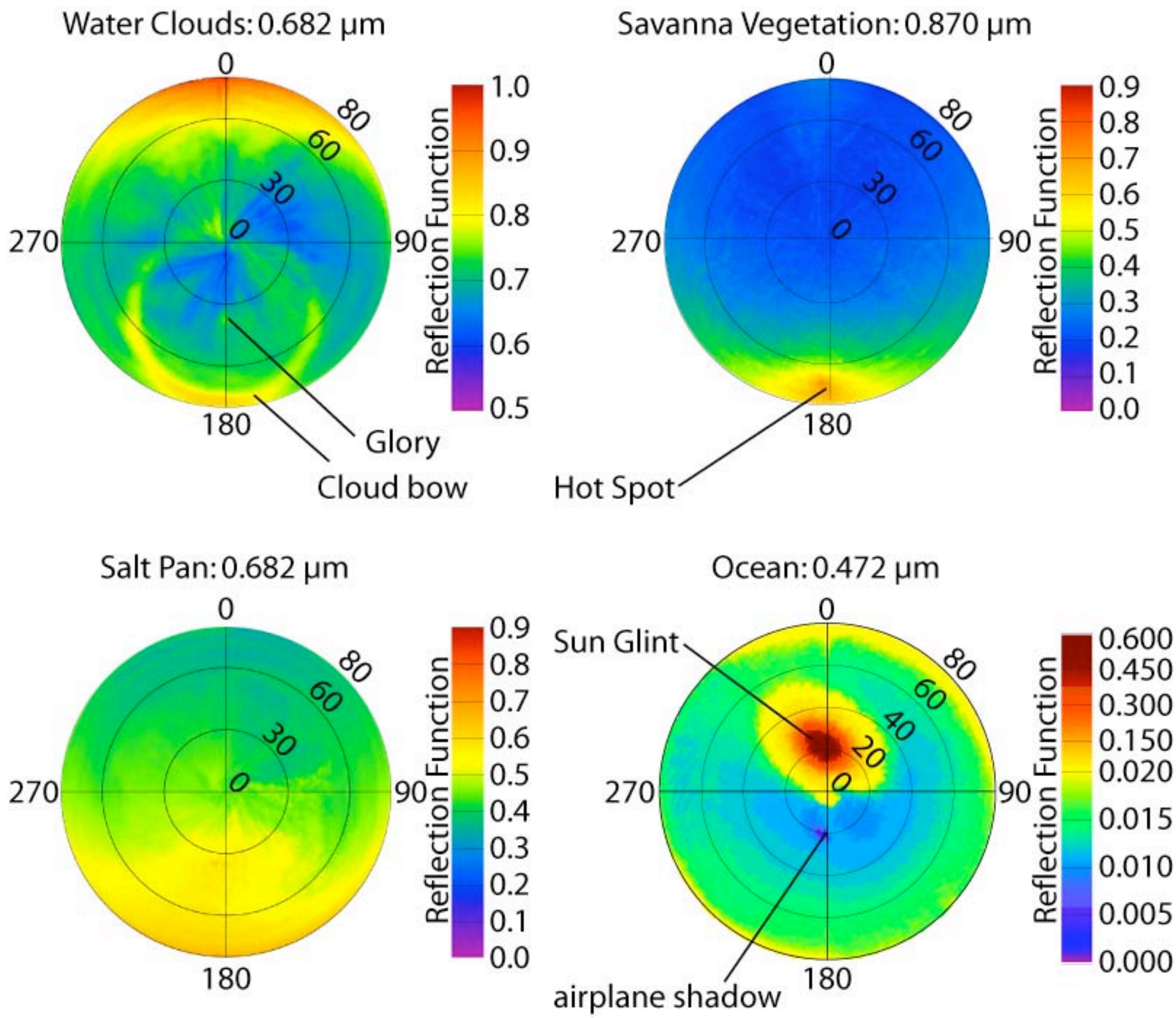
SAVANNA
(Skukuza, South Africa, 6/19/2005)



SALT PAN
(Etosha Pan, Namibia,
Landsat, 9/11/1999)

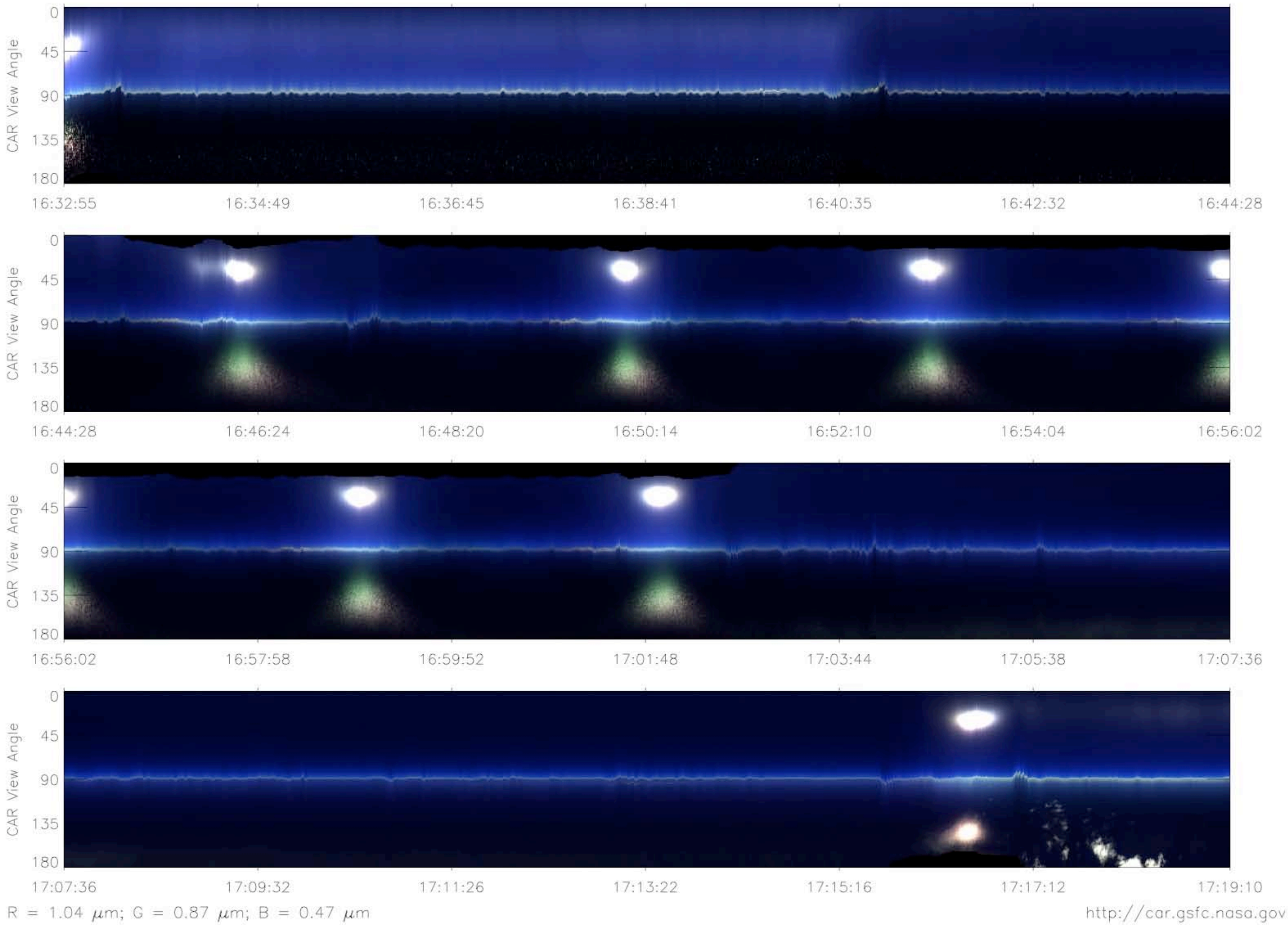
OCEAN
(Chesapeake Lighthouse, 20 km
from Virginia coast, 7/14/2001)

SELECTED BRDFs OF DIFFERENT SURFACES

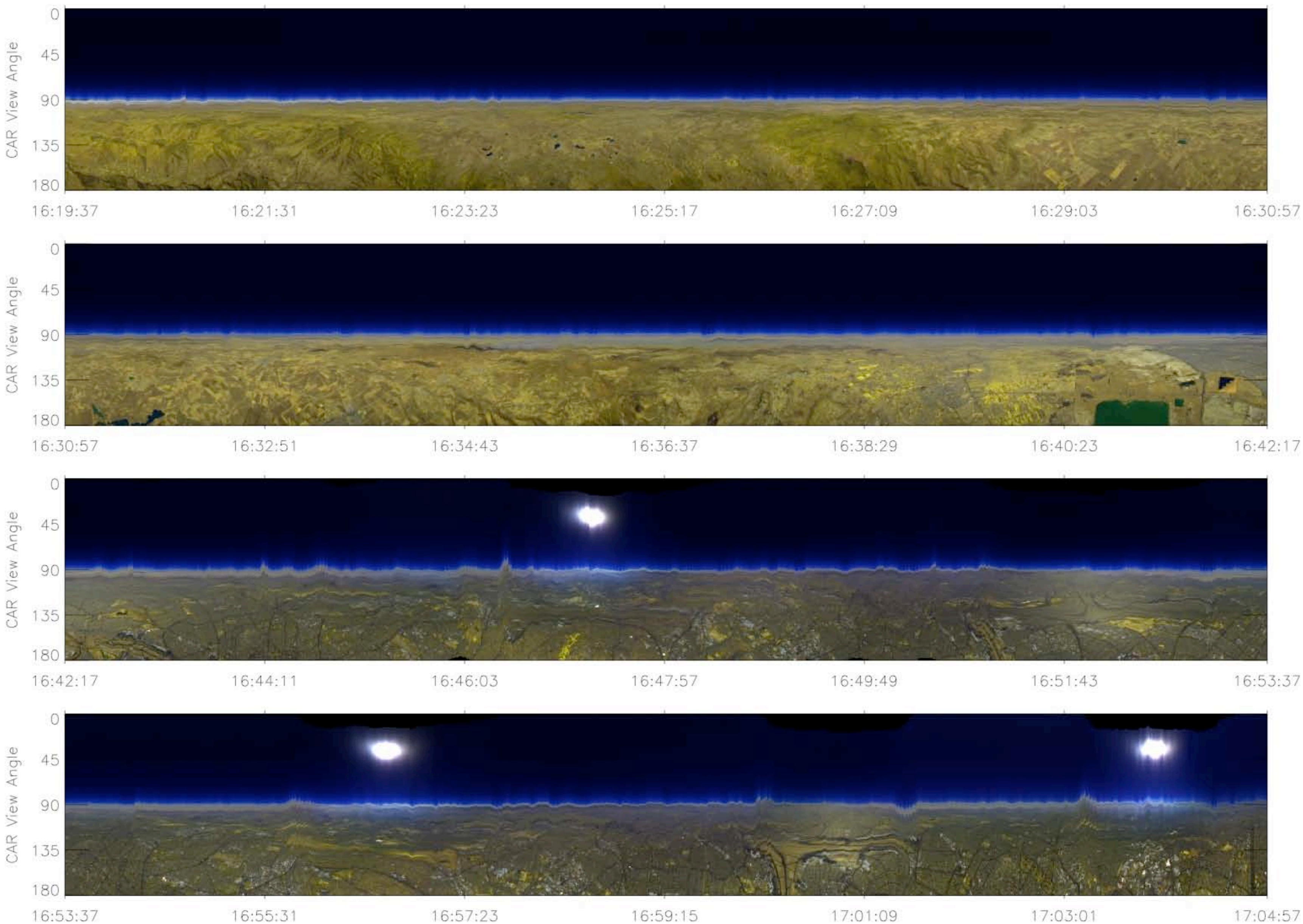


Gatebe et al 2003 & 2005: car.gsfc.nasa.gov/publications

Cloud Absorption Radiometer (CAR) Quicklook Image
INTEX-B/MILAGRO J31 Flight VER02 March 05, 2006



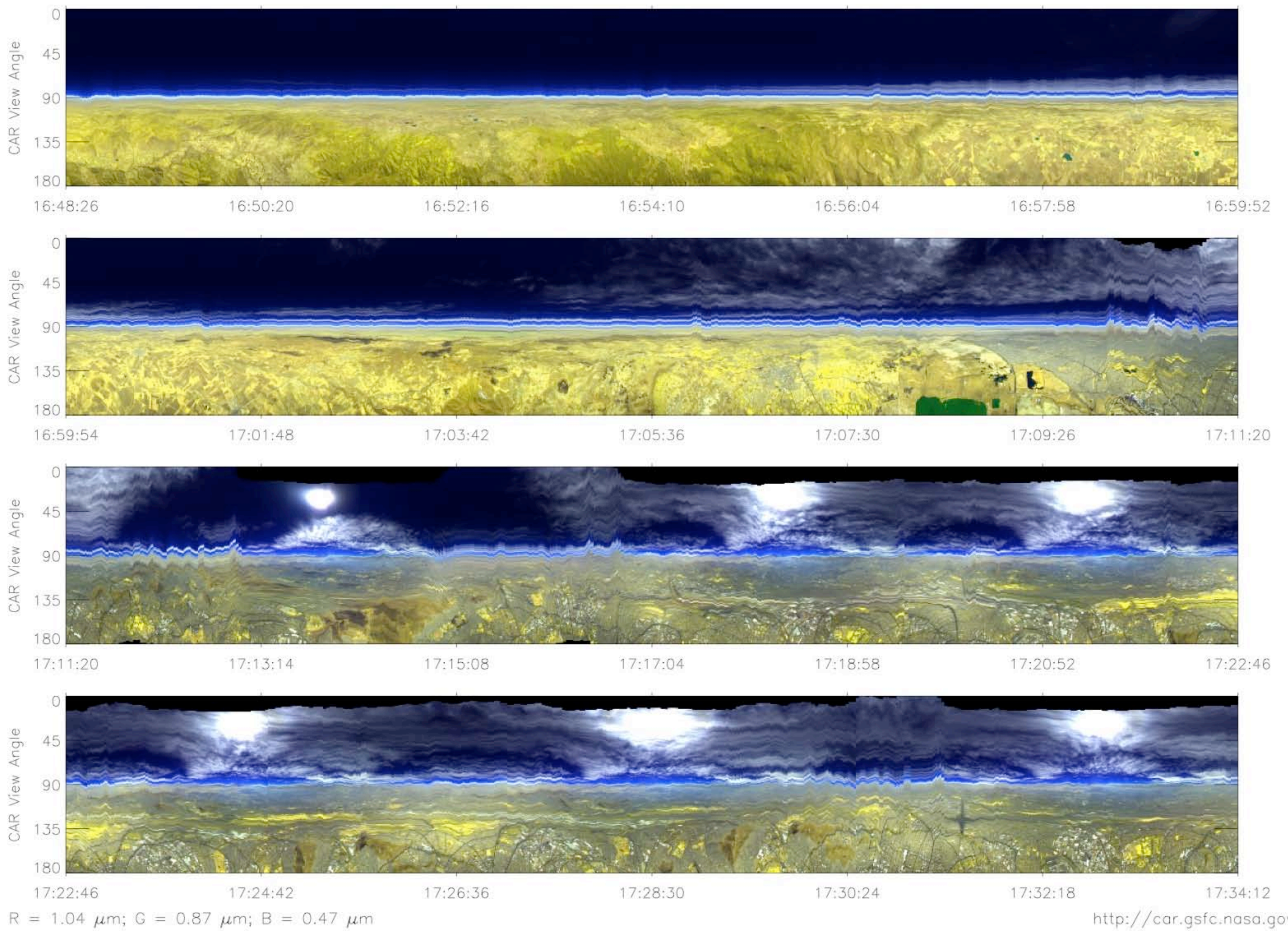
Cloud Absorption Radiometer (CAR) Quicklook Image
INTEX-B/MILAGRO J31 Flight VER03   March 06, 2006



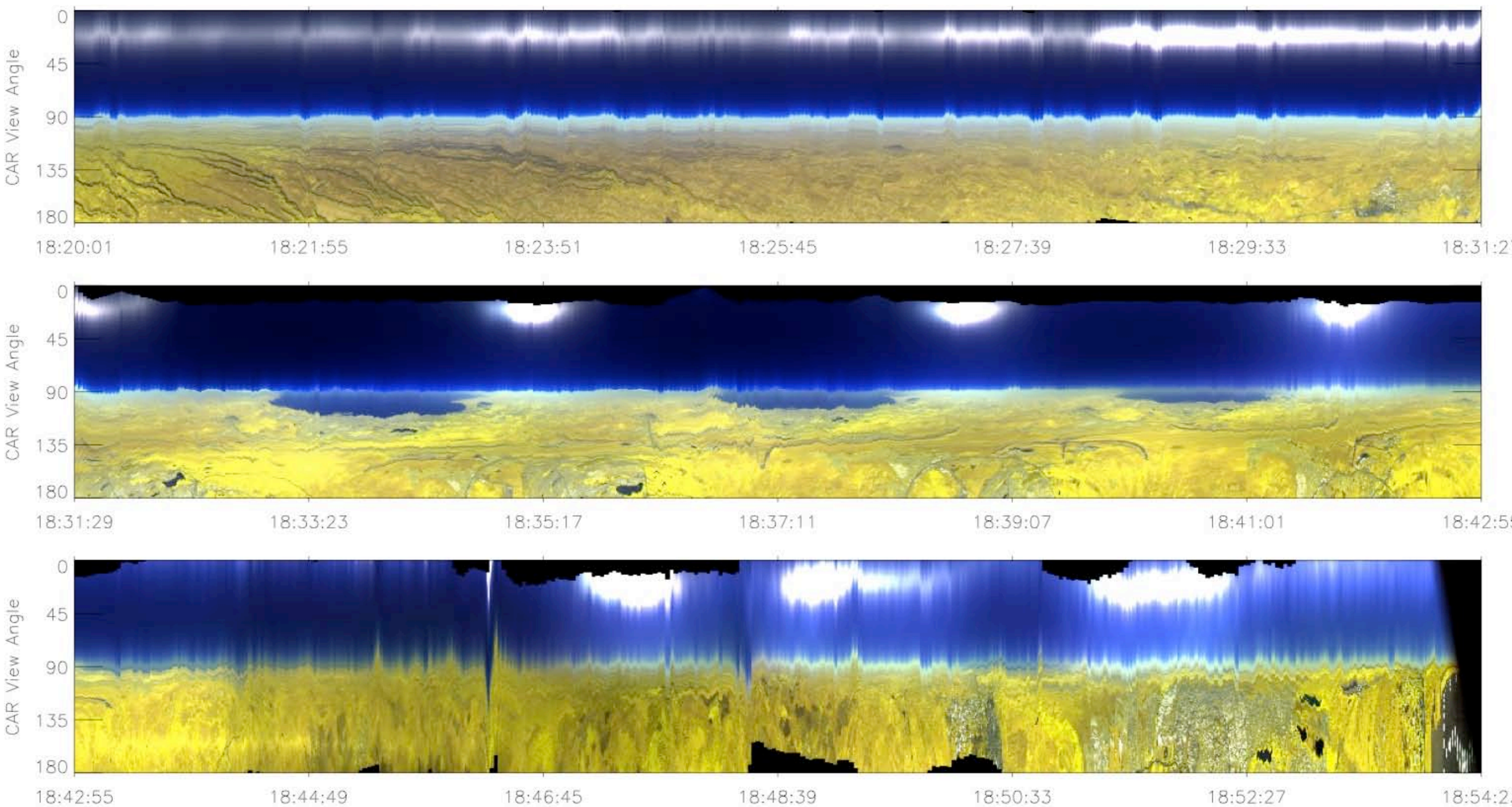
R = 1.04 μm; G = 0.87 μm; B = 0.47 μm

http://car.gsfc.nasa.gov

Cloud Absorption Radiometer (CAR) Quicklook Image
INTEX-B/MILAGRO J31 Flight VER07   March 11, 2006



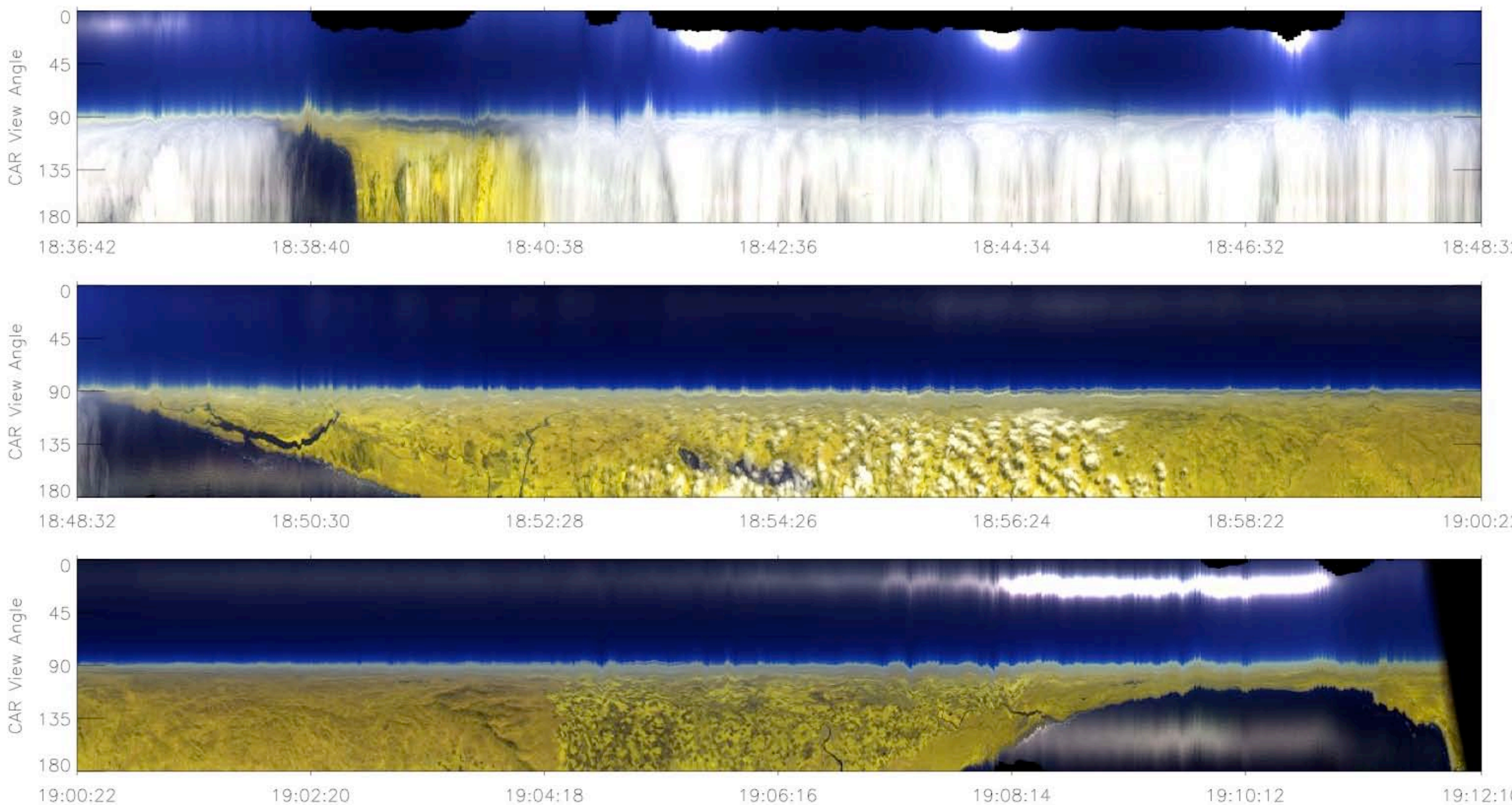
Cloud Absorption Radiometer (CAR) Quicklook Image
INTEX-B/MILAGRO J31 Flight VER07 March 11, 2006



R = 1.04 μm; G = 0.87 μm; B = 0.47 μm

http://car.gsfc.nasa.gov

Cloud Absorption Radiometer (CAR) Quicklook Image
INTEX-B/MILAGRO J31 Flight VER09 March 13, 2006



R = 1.04 μm; G = 0.87 μm; B = 0.47 μm

http://car.gsfc.nasa.gov

J31 Example Results

- **Jens Redemann: AATS**
- **Tom Arnold: CAR**
- **Brian Cairns: RSP**
- **Sebastian Schmidt: SSFR**

RSP on J31

RSP

- Evaluate aerosol and cloud retrieval algorithms for the NASA Glory mission Aerosol Polarimetry Sensor.
- Validate aerosol and cloud products from A-train & Terra (MODIS, MISR, POLDER on Parasol, OMI, CLOUDSAT)

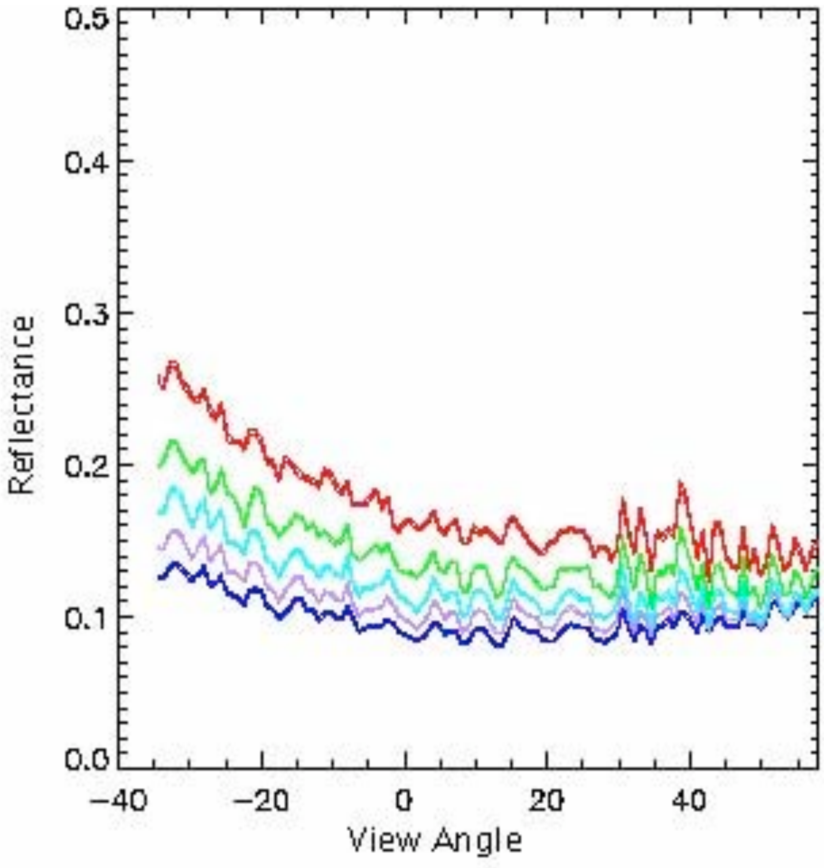
RSP-AATS

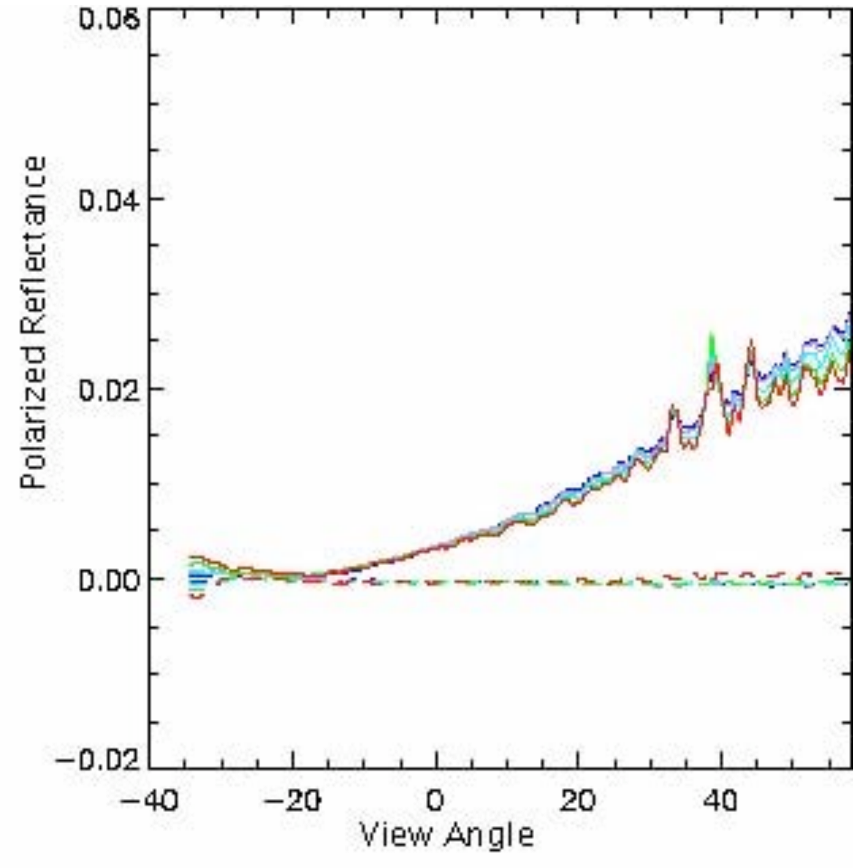
- Validate RSP retrieved spectral optical depth
- Atmospheric correction of low altitude measurements to provide accurate surface polarized BRDF

RSP on J31

RSP

- Urban surfaces are bright, heterogeneous and filled with man-made objects
- How well do simple conceptual models work?
- Surface reflectance is bright
- Polarized reflectance is not

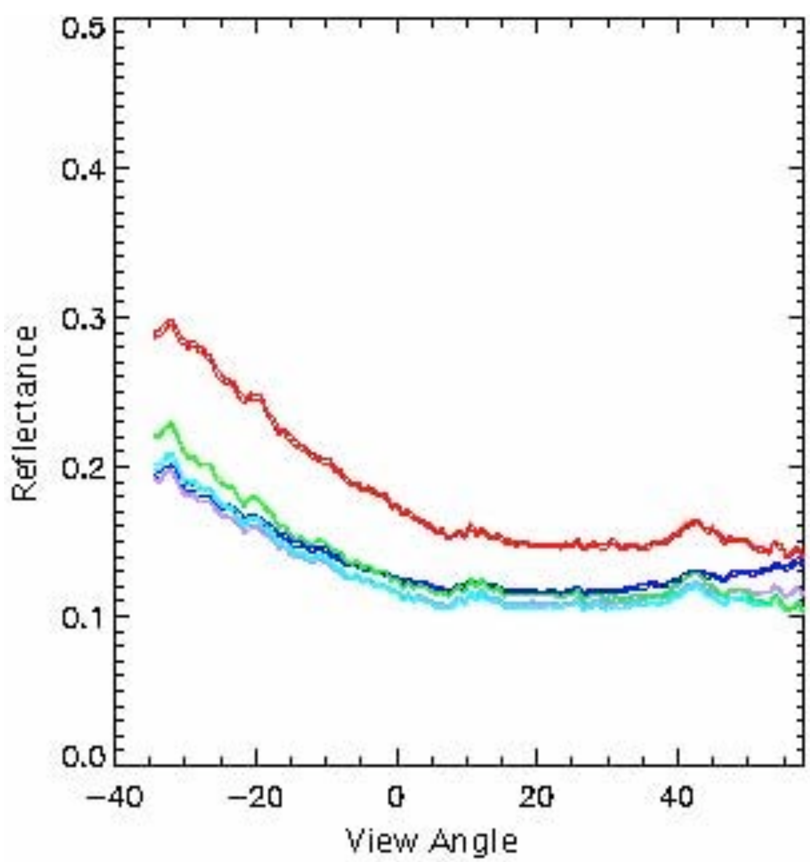


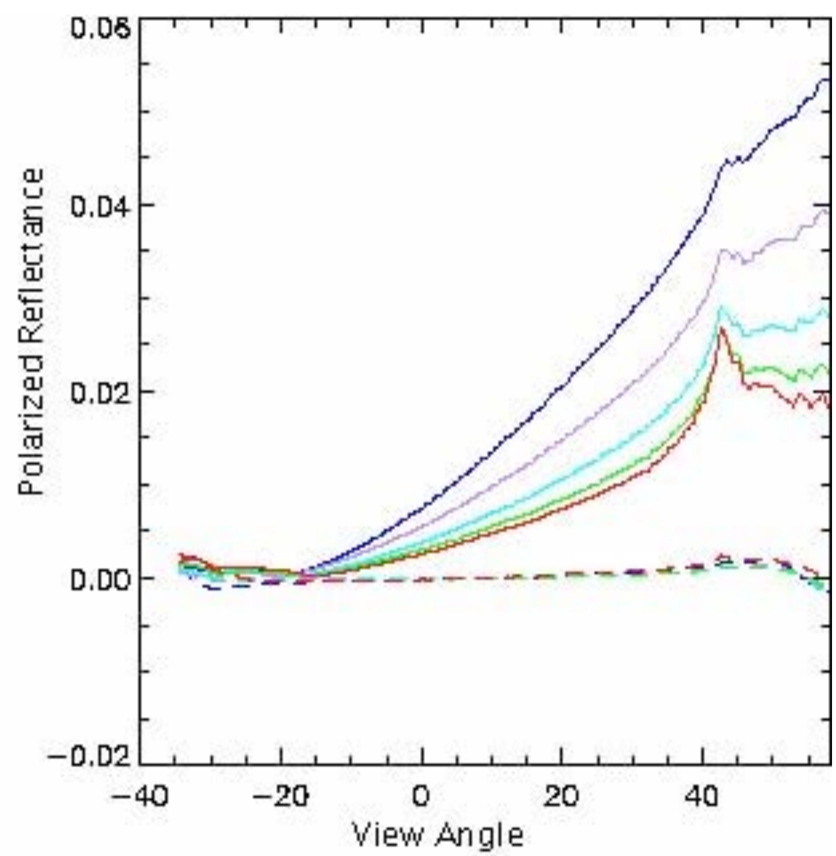


RSP on J31

RSP

- **Atmospheric signal large compared to surface**
- **Surface quite grey**
- **implies aerosol retrievals should be of comparable accuracy to other retrievals over land (i.e. optical depth within 0.03, refractive index, single scattering albedo for optical depths greater than 0.3)**



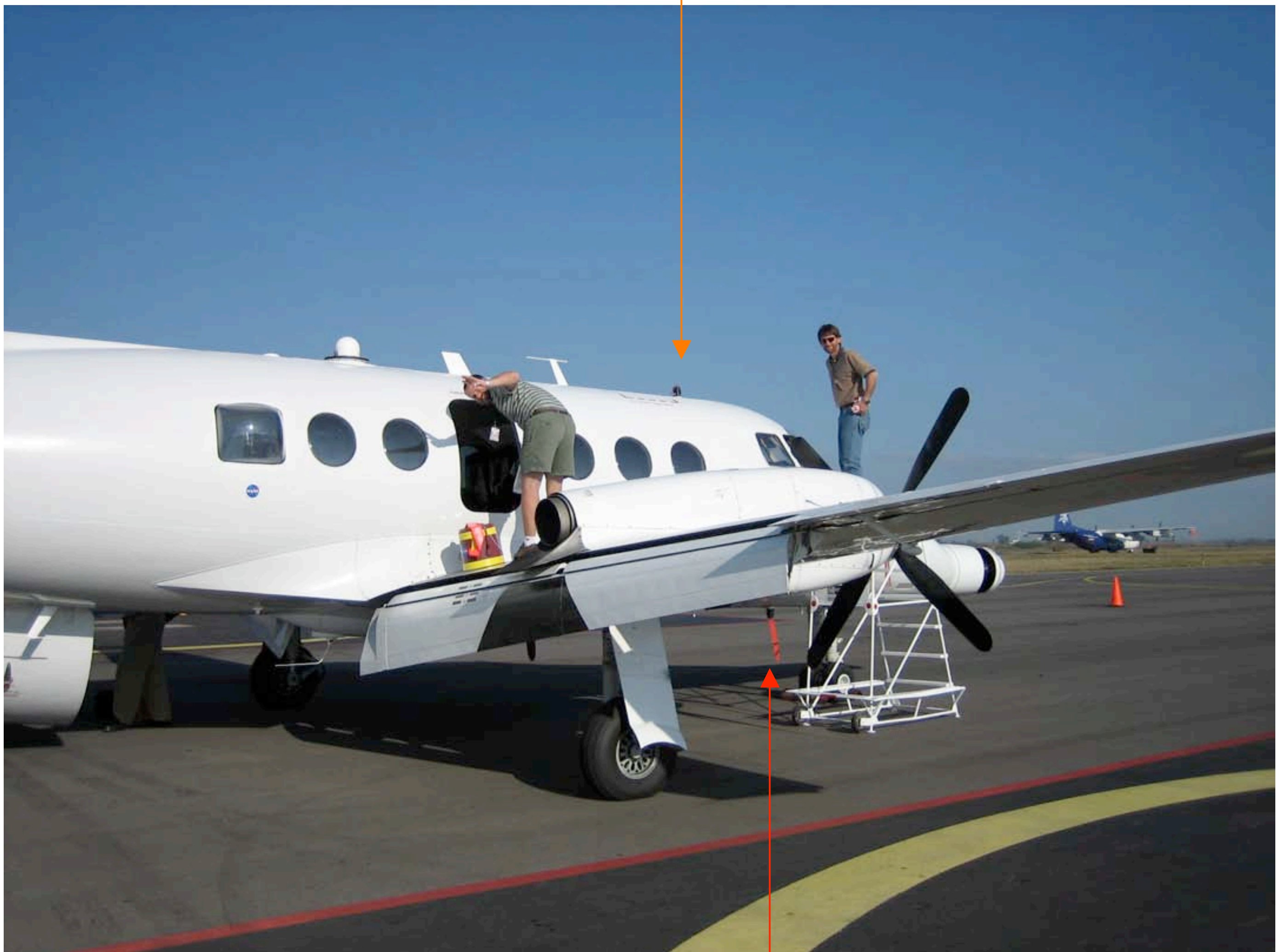


J31 Example Results

- **Jens Redemann: AATS**
- **Tom Arnold: CAR**
- **Brian Cairns: RSP**
- **Sebastian Schmidt: SSFR**

SSFR Solar Spectral Flux Radiometer on J31

F↓

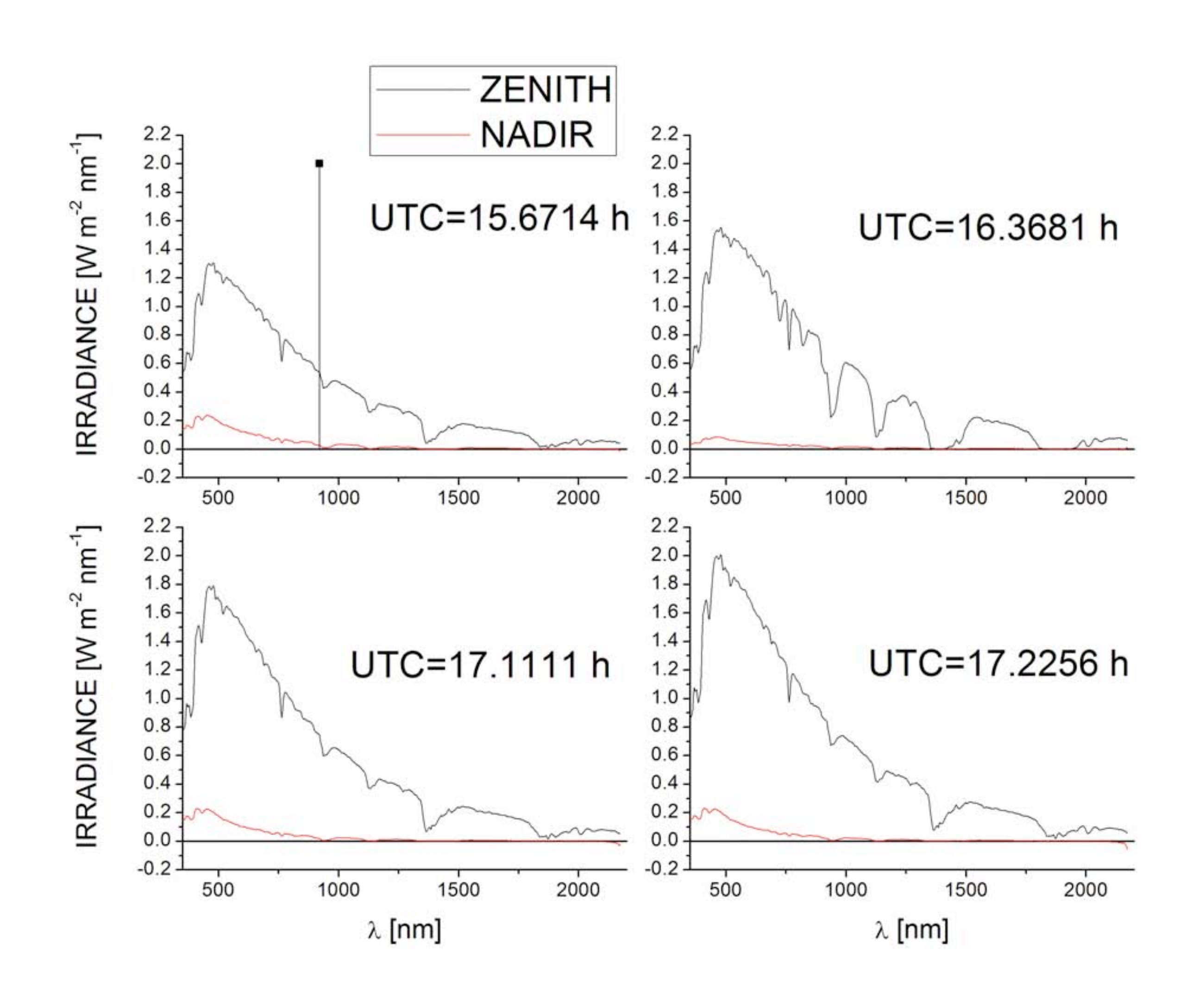


F↑

sebastian.schmidt@lasp.colorado.edu jpommier@mail.arc.nasa.gov peter.pilewskie@lasp.colorado.edu

SSFR Solar Spectral Flux Radiometer on J31

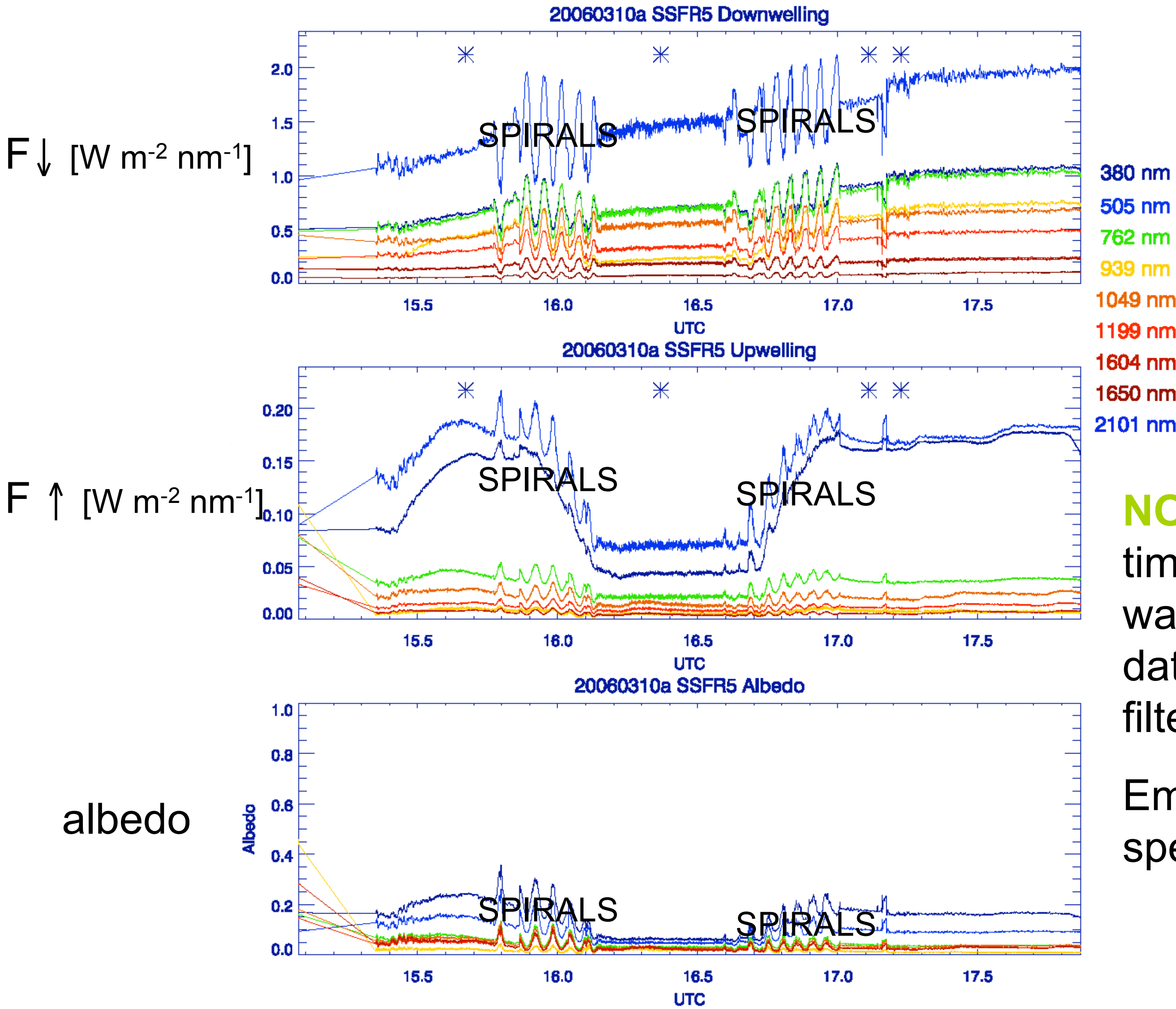
Example: MARCH-10 (A.M. flight) – Irradiance Spectra (not archived)



sebastian.schmidt@lasp.colorado.edu jpommier@mail.arc.nasa.gov peter.pilewskie@lasp.colorado.edu

SSFR Solar Spectral Flux Radiometer on J31

Example: MARCH-10 (A.M. flight) – Time Series



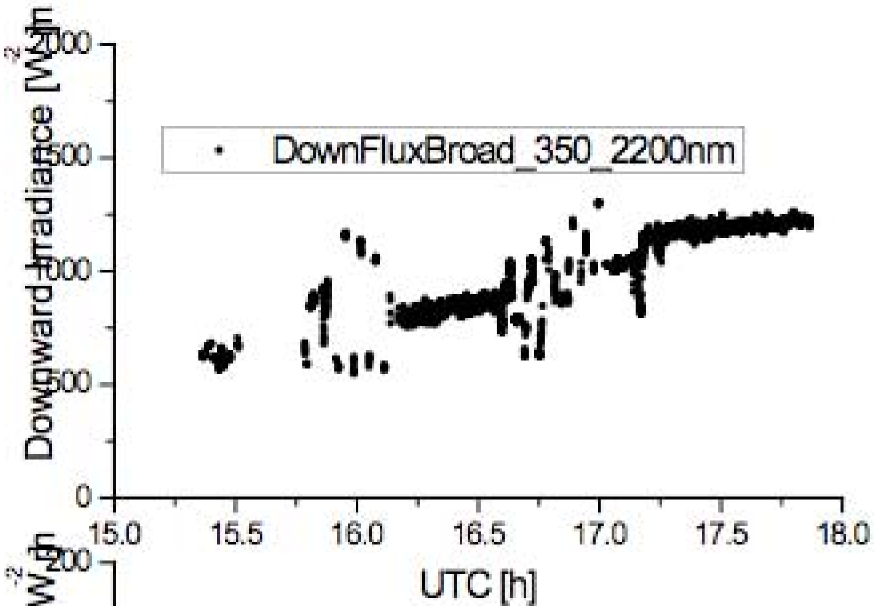
NOTE: Archive contains only time series of selected wavelengths with LEVELED data. ➔ Spirals turns etc are filtered out.

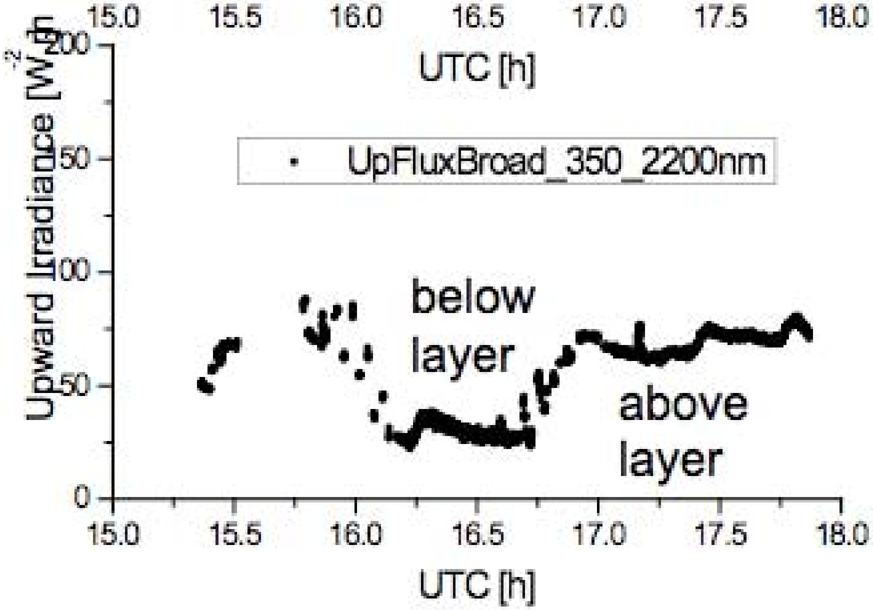
Email us for getting full spectra.

sebastian.schmidt@lasp.colorado.edu jpommier@mail.arc.nasa.gov peter.pilewskie@lasp.colorado.edu

SSFR Solar Spectral Flux Radiometer on J31

Example: MARCH-10 (A.M. flight) – Time Series – leveled data as archived





NOTE:

Archive includes time series of 9 wavelengths in VIS and NIR, and two broadband (350-700 nm and 350-2200 nm) for the upward and the downward sensor.

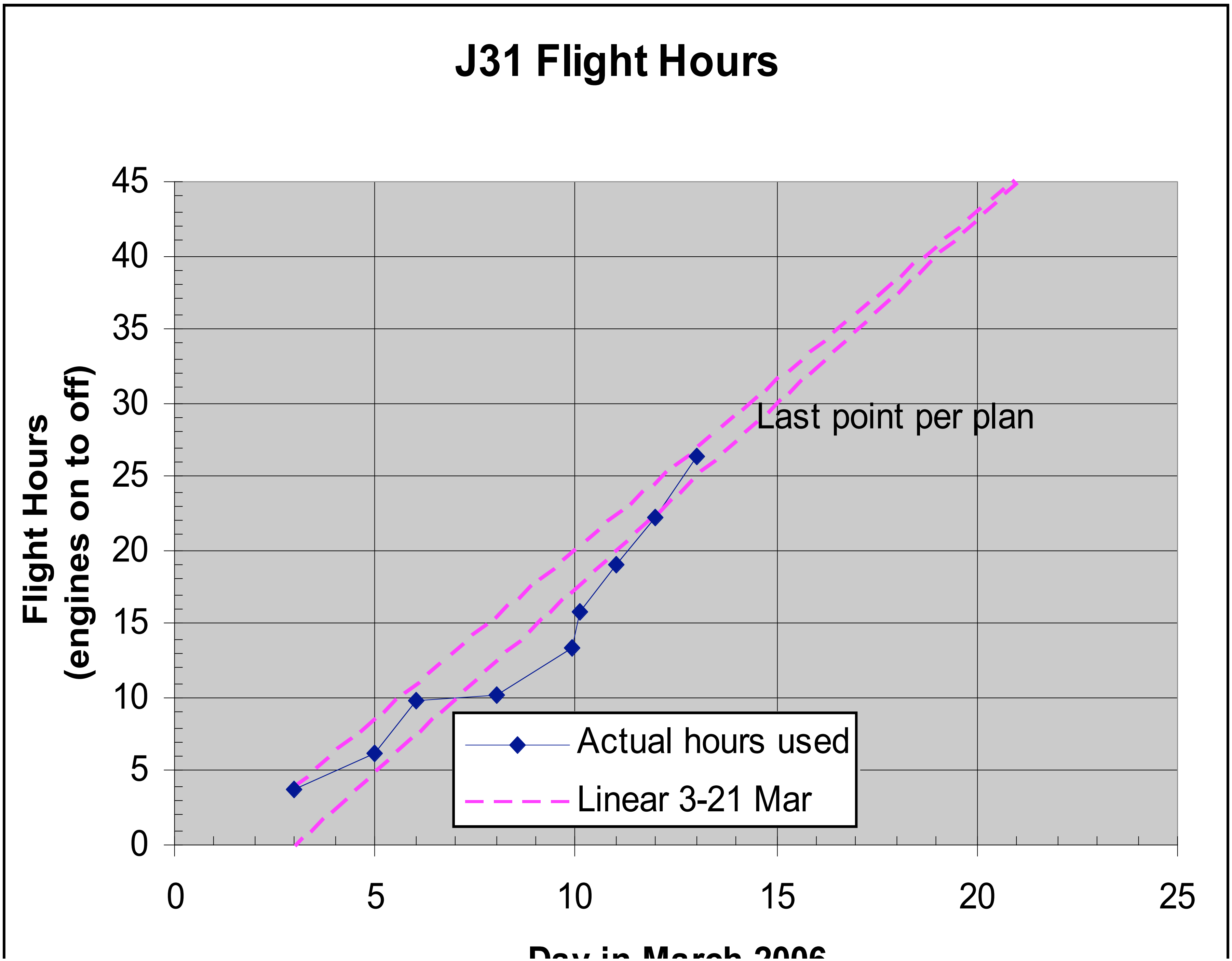
SURFACE ALBEDO FOR T0, T1, T2:

We hope to get a Ci free day to provide this product ☺

META DATA:

We have photos monitoring the general situation. Where could we post that kind of information?

sebastian.schmidt@lasp.colorado.edu jpommier@mail.arc.nasa.gov peter.pilewskie@lasp.colorado.edu


J31 Flight Hours
Flight Hours
(engines on to off)
45
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
Last point per plan
Actual hours used
Linear 3-21 Mar

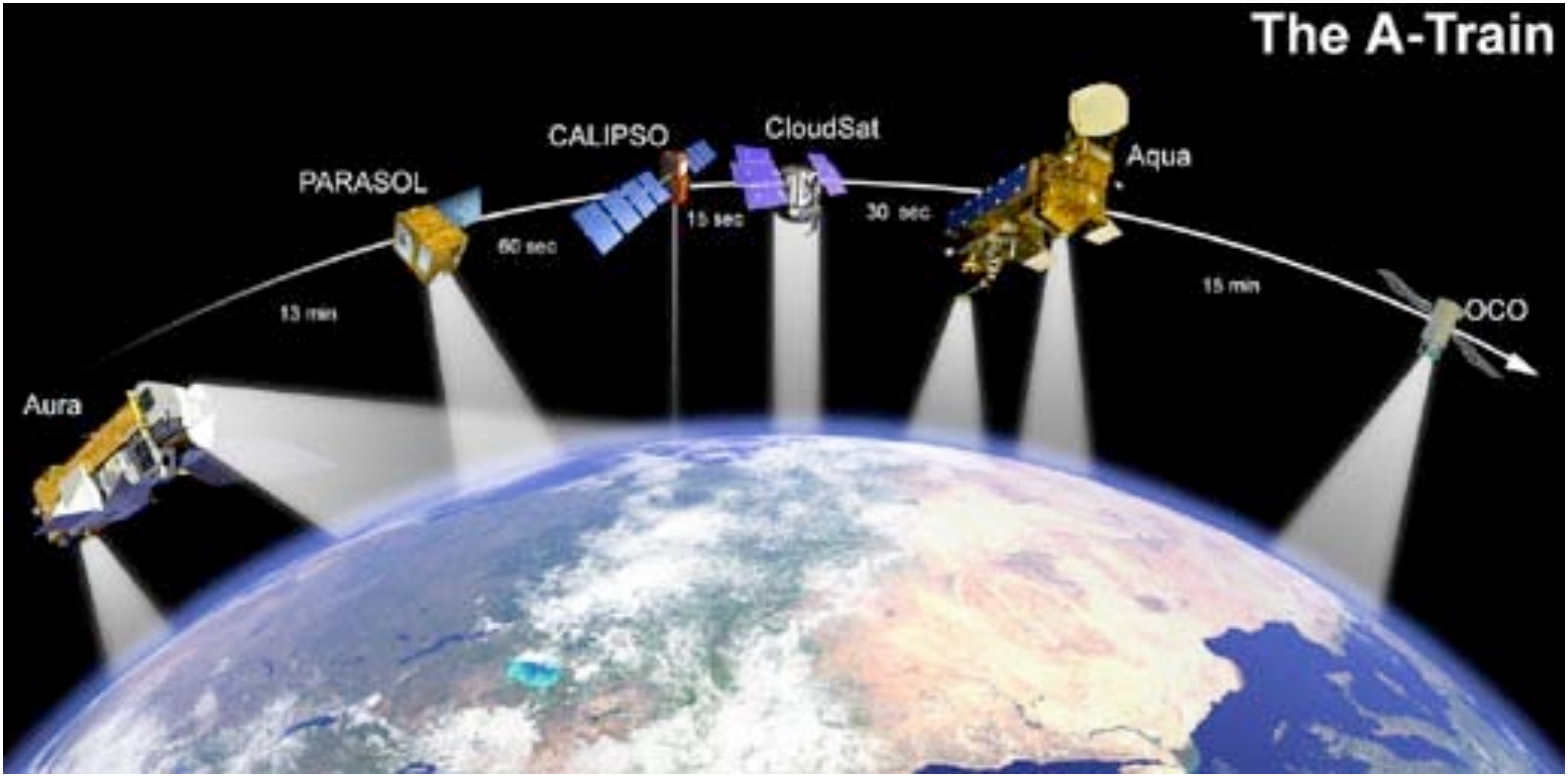
J31 Mid-Campaign Assessment

- Only 1 week of flights left (~18 flight hours).
- The 8 flights made so far have produced a very nice data set.
- J31 and its instruments have performed very well.

In our remaining week:

- We could use more pollution and less clouds!
- We need to focus more on A-Train overpasses (Aura [OMI, TES], Aqua, POLDER)—afternoon flights
- We still need to capture 1 or more coordinated spirals with the DC-8, preferably in an A-Train footprint
- We want to get SURFACE ALBEDO FOR T0, T1, T2 on a Ci free day

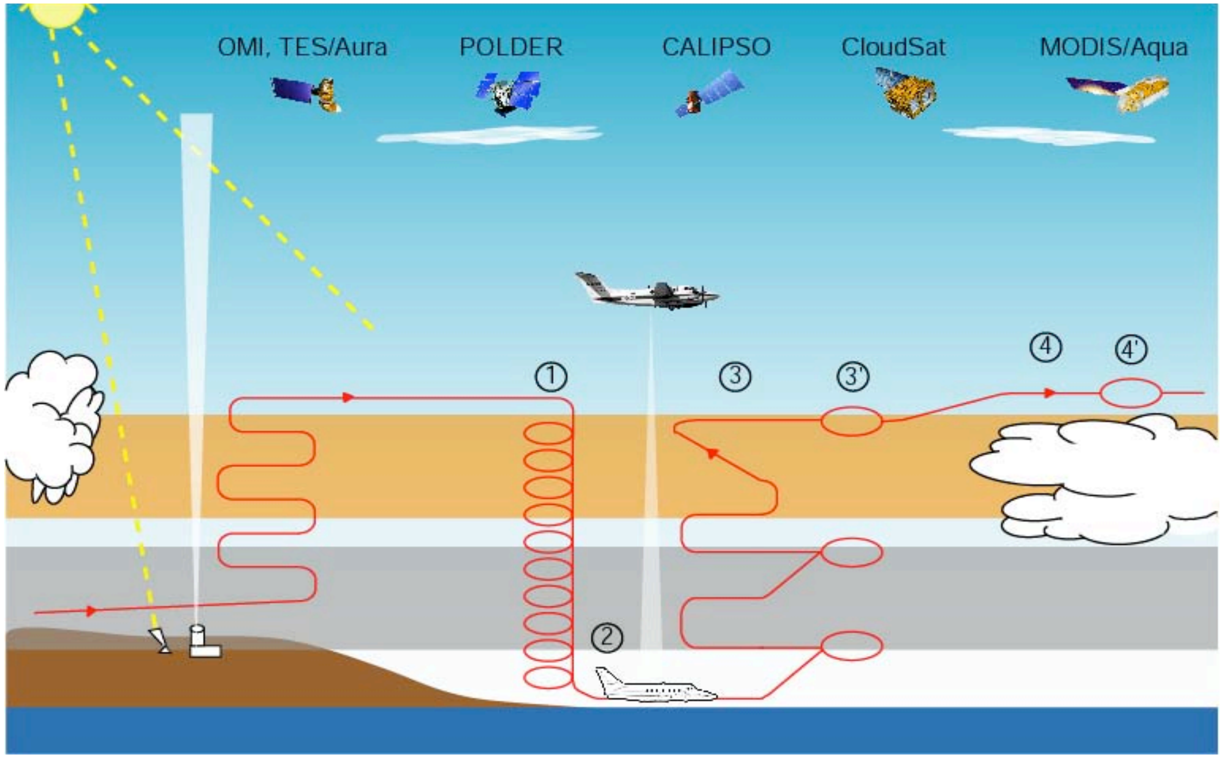
The A-Train is a set of satellites that fly in sequence over a common ground track



Many J31 flights will include legs or profiles under the A-Train or other satellites

J31 Layout, INTEX-B/MILAGRO

The scientific goals of the J31 require flights containing the basic elements or patterns shown below.



(1) Survey Vertical Profile.
(2) Minimum-Altitude Transect.
(3) Parking Garage (Stepped Profile with legs of 3-10 minutes).
(3') Parking Garage with CAR Maneuvers.
(4) Above-Cloud Transect.
(4') Above-Cloud CAR Maneuver.

- All J31 scientific instruments measure sunlight, which is strongly influenced by clouds.
- Hence, J31 flight patterns are cloud-sensitive: many seek to avoid clouds, while others seek to fly above certain types of clouds.
- Because clouds can change quickly and are difficult to predict, J31 flight plans usually require flexibility to change in response to clouds.

J31 Science Objectives by Sensor
1. Independent of other J31 sensors

RSP

- Estimate direct and indirect effects of aerosols on radiative forcing of climate
- Evaluate aerosol and cloud retrieval algorithms for the NASA Glory mission Aerosol Polarimetry Sensor.
- Validate aerosol and cloud products from A-train & Terra (MODIS, MISR, POLDER on Parasol, OMI, CLOUDSAT)

CAR

- Measure bidirectional reflectance distribution function (BRDF) for variety of surfaces (e.g., urban center, ocean, cloud, uniformly vegetated soil) at different sun angles & altitudes
- Retrieve BRDF and aerosol properties by combining CAR with AERONET
- Validate satellites and inter-compare with in-situ measurements (size distribution, SSA, albedo, etc.)

J31 Science Objectives by Sensor

2. Objectives that combine data from 2 or more J31 sensors

AATS-SSFR

- Derive aerosol radiative forcing from simultaneously measured radiative flux and AOD gradients
- Study effect of over-cloud AOD on cloud property retrievals by SSFR and satellites
- Study Influence of aerosols on cloud radiative forcing: AATS-14 extinction above cloud
- Derive spectra of aerosol absorbing fraction (1-SSA) from spectra of radiative flux and AOD in thick polluted layers

RSP-AATS

- Validate RSP retrieved spectral optical depth
- Atmospheric correction of low altitude measurements to provide accurate surface polarized BRDF