

Jetstream 31 (J31) in INTEX-B/MILAGRO: Science Goals, Objectives, and Required Flight Patterns

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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

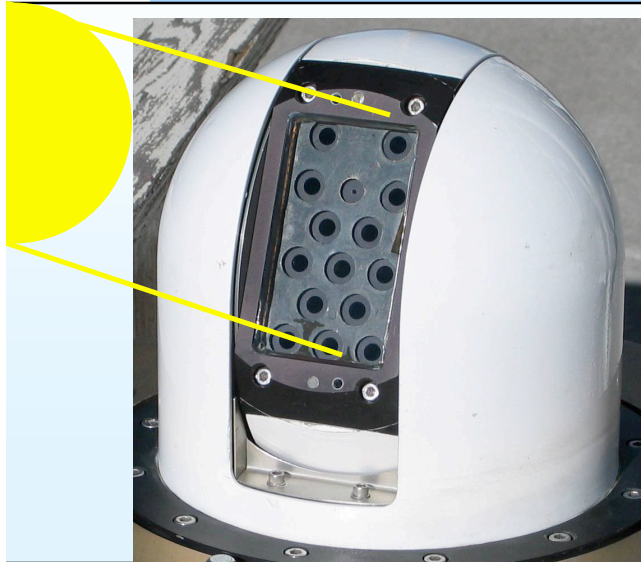
- Aerosol Optical Depth And Extinction Spectra (354-2138 nm)
- Water Vapor Columns And Profiles
- Aerosol Radiative Impacts: In Clear Sky (Direct Effect) & Via Clouds (Indirect Effect)

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

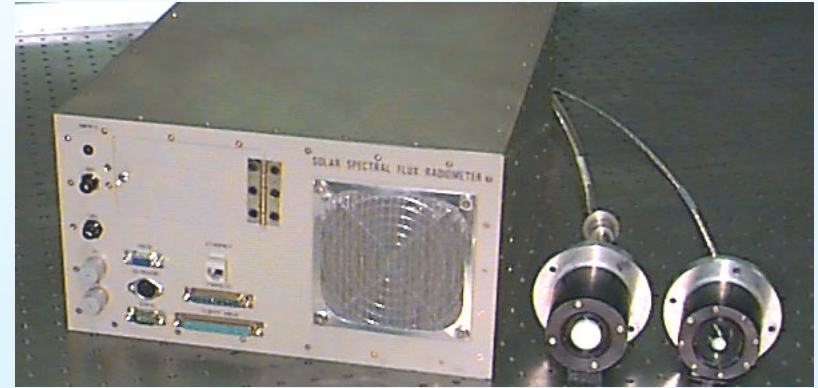
Quantify the relationships between the above and aerosol amount and type

J31 in INTEX-B/MILAGRO: Payload



**Ames
Airborne
Tracking
Sun-
photometer
(AATS)**

**Solar Spectral Flux Radiometer
(SSFR)**

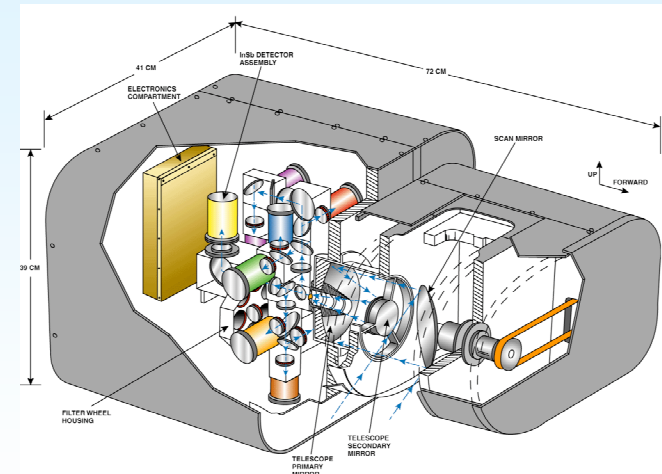


Research Scanning Polarimeter (RSP)



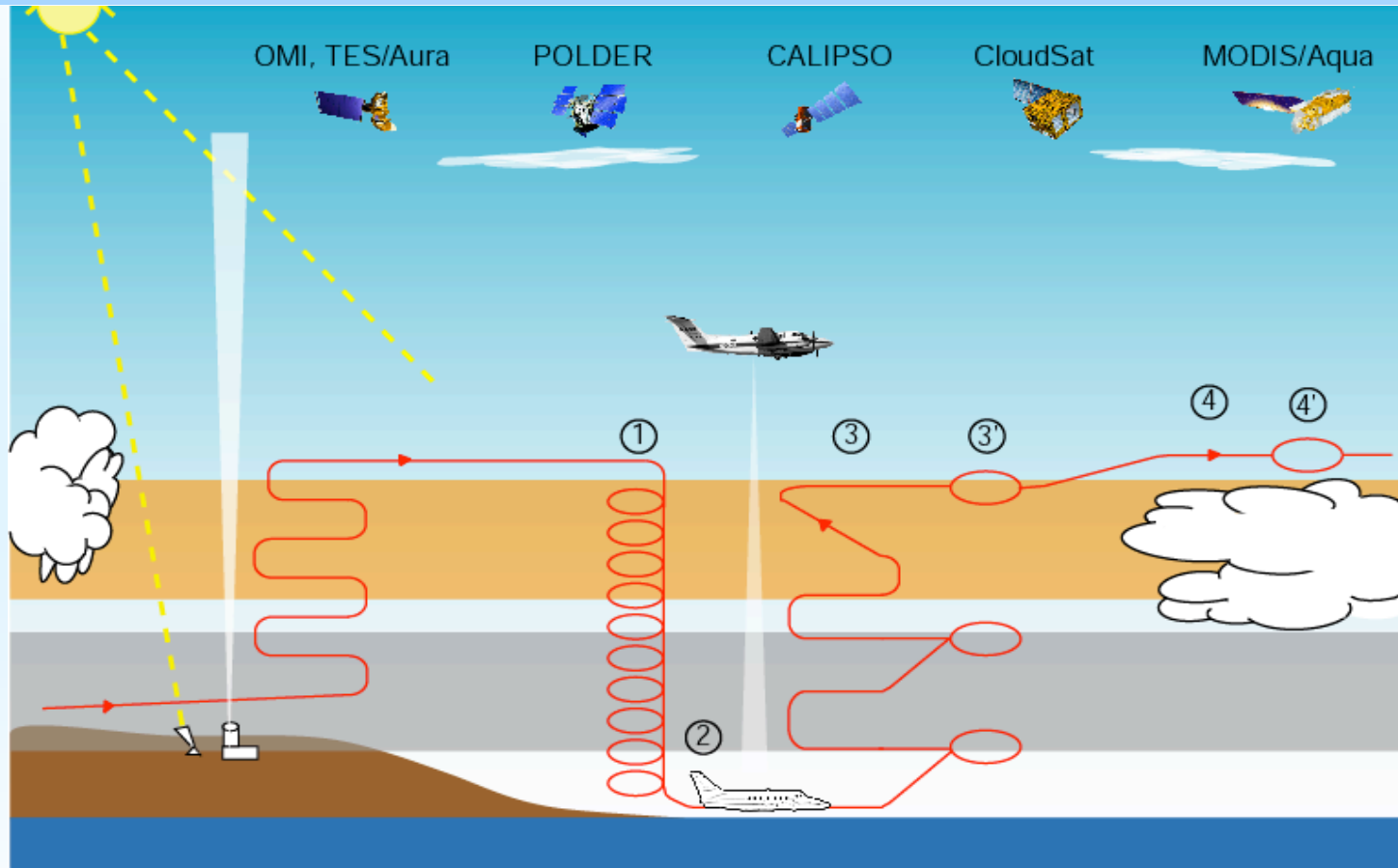
Position & Orientation System (POS)

Cloud Absorption Radiometer (CAR)



Met Sensors & Nav/Met Data System

Flight Patterns Required for J31 Scientific Objectives, INTEx-B/MILAGRO



- (1) Survey Vertical Profile. (2) Minimum-Altitude Transect.
(3) Parking Garage (Stepped Profile). (3') Parking Garage with CAR Orbits.
(4) Above-Cloud Transect. (4') Above-Cloud CAR Orbit.

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

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

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

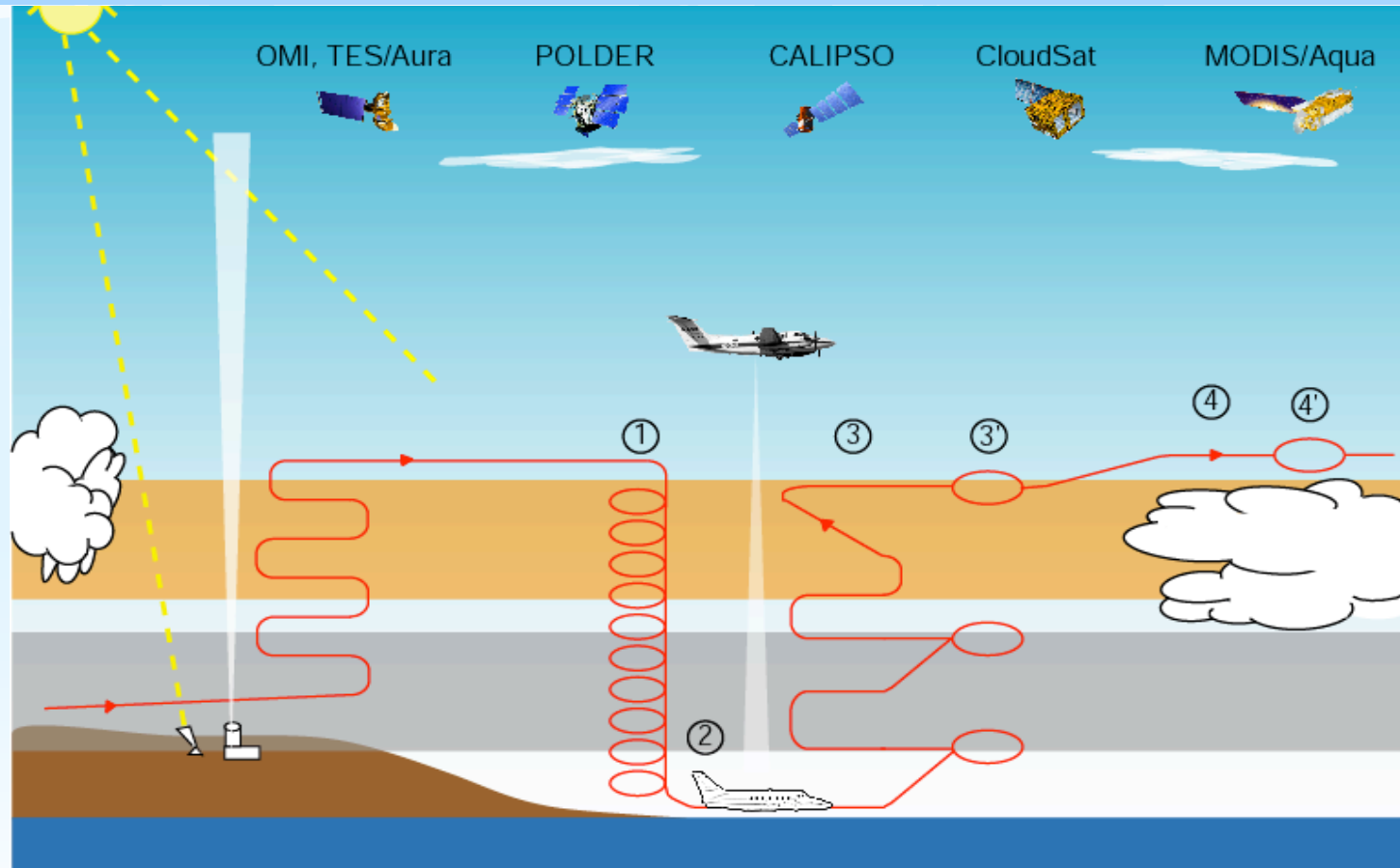
CAR-AATS

- 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.

Flight Patterns Required for J31 Scientific Objectives, INTEx-B/MILAGRO



- (1) Survey Vertical Profile. (2) Minimum-Altitude Transect.
 (3) Parking Garage (Stepped Profile). (3') Parking Garage with CAR Orbits.
 (4) Above-Cloud Transect. (4') Above-Cloud CAR Orbit.

Slide 9

Jetstream-31 in INTEX-B/MILAGRO

Specs & Performance

Parameter	Specification
Length	47' 2"
Wingspan	52'
Ceiling	25,000'
Airspeed	
Max cruise 16,000'	220 kt
Survey	150 kt
Range	850 nmi
Endurance	5 hr



J31 in INTEX-B/MILAGRO:

Preliminary Schedule

Oct-Dec 2005: Modify J31 to accommodate CAR. Integrate & test-fly CAR.

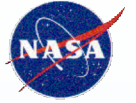
27 Feb-3 Mar 2006: Re-install & test-fly J31 payload (POS, NavMet, AATS, SSFR, RSP, CAR) at NASA Ames.

6 Mar 2006: J31 transit, NASA Ames to Veracruz.

7-27 Mar 2006: J31 science flights out of Veracruz.

28 Mar 2006: J31 transit, Veracruz to NASA Ames.

29-30 Mar 2006: Remove J31 payload instruments, NASA Ames.



End of Presentation

Remainder of Slides are Backup

Jetstream-31 in INTEX-ITCT

- 14-channel Ames Airborne Tracking Sunphotometer (AATS-14)

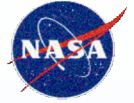


Measures: Solar direct-beam transmission, T , at 14 wavelengths, λ , 353-2139 nm

Data products

- Aerosol optical depth (AOD) at 13 λ , 353-2139 nm
 - Water vapor column content [using $T(940 \text{ nm})$]
 - Aerosol extinction, 340-2139 nm
 - Water vapor density
- } When A/C flies vertical profiles

NASA Ames Solar Spectral Flux Radiometer (SSFR)



- wavelength range:

300 nm to 1700 nm

- spectral resolution ~

8-12 nm

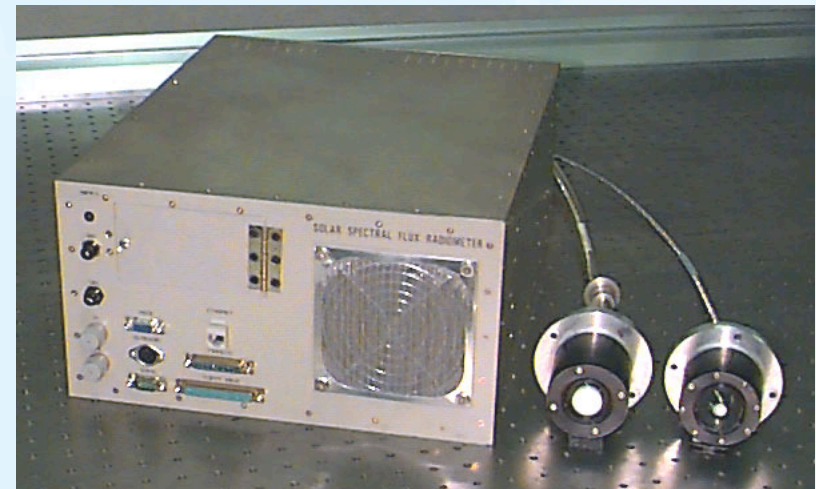
- simultaneous zenith

and nadir viewing

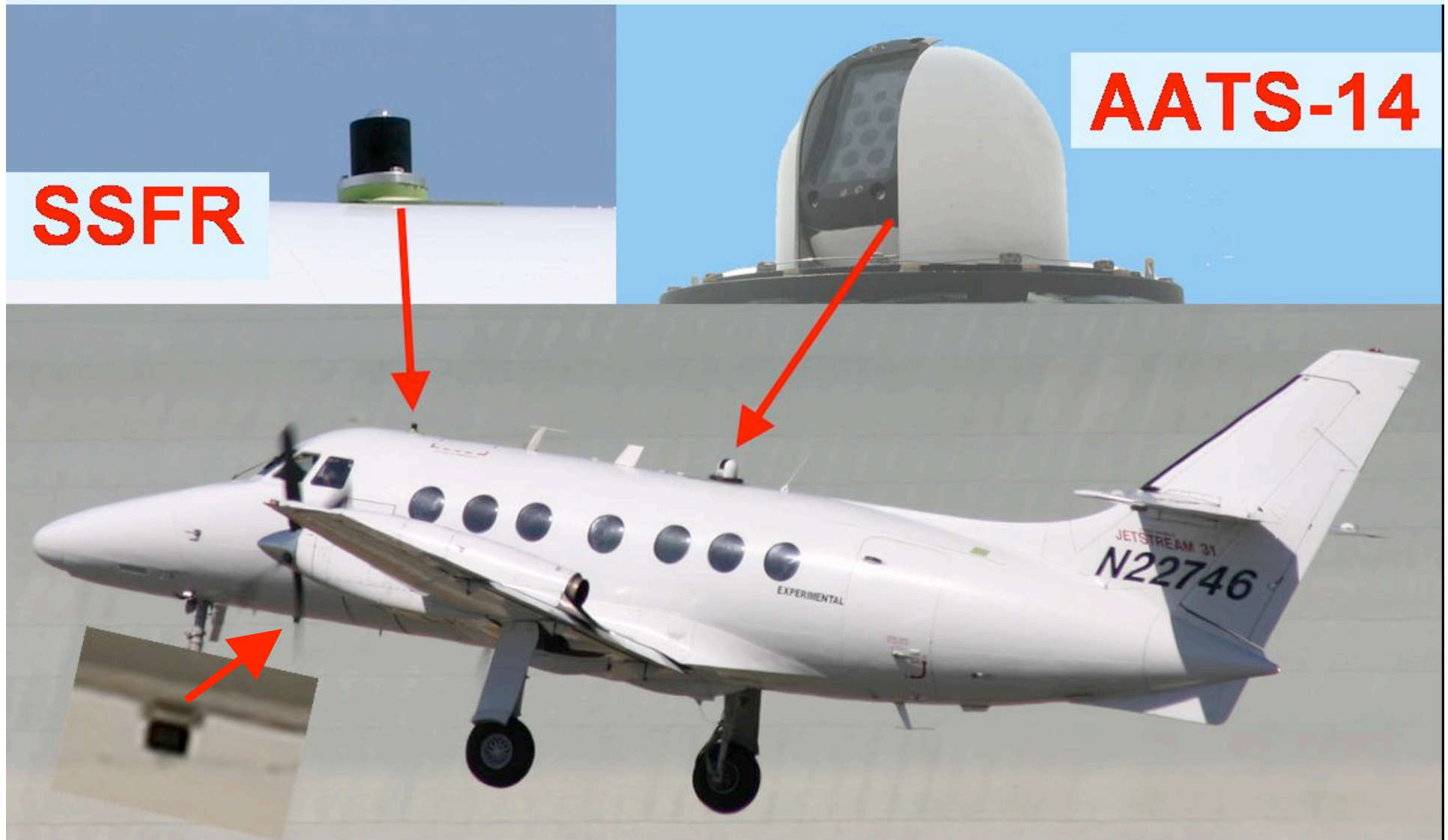
- hemispheric FOV

- Accuracy: ~ 3%; precision: 0.5%

- Missions: FIRE/SHEBA, DOE ARM UAV (1999, 2000, 2002), PRIDE, SAFARI-2000, ACE-Asia, CRYSTAL-FACE, DOE Aerosol IOP



Jetstream-31 (J31) in INTEX-ITCT



ICARTT Mid-Campaign Science Meeting
Portsmouth, NH, 19 Jul 2004

Aerosol Lidar Validation Experiment (ALIVE)

AATS-14 on Sky Research J-31



Research Scanning Polarimeter
NavMet
Aplanix POS

Cessna 206



Raman Lidar

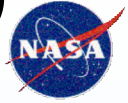
Micro Pulse Lidar



DOE
Oklahoma, Sep 11-22, 2005
Lead Scientist: B. Schmid

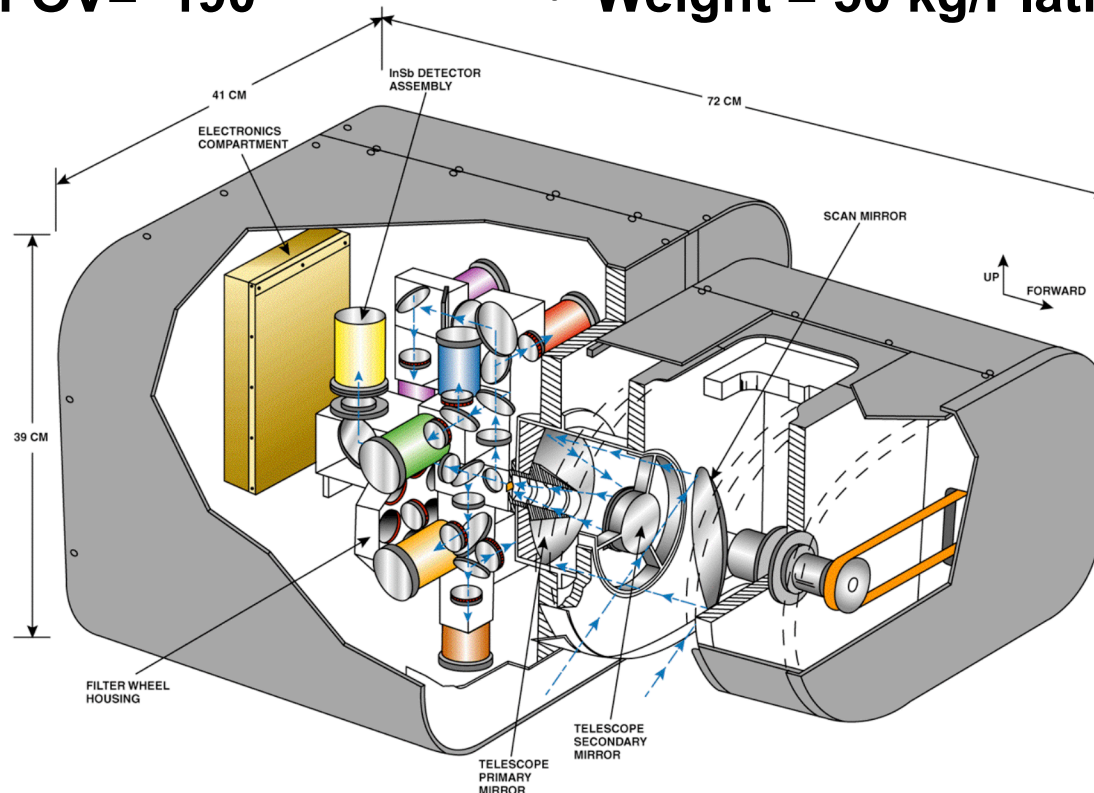
CLOUD ABSORPTION RADIOMETER (CAR)

airborne measurements of BRDF, Aerosols, etc.



Sensor Characteristics

- Spectral bands = 14
(0.34-2.29 μm)
- IFOV = 1°
- Total FOV = 190°
- Scan rate = 1.67 Hz
- Data channels = 9 (@ 16 bit)
- Pixels in scan line = 382
- Weight = 50 kg/Platform: J-31



BRDF Flight Pattern

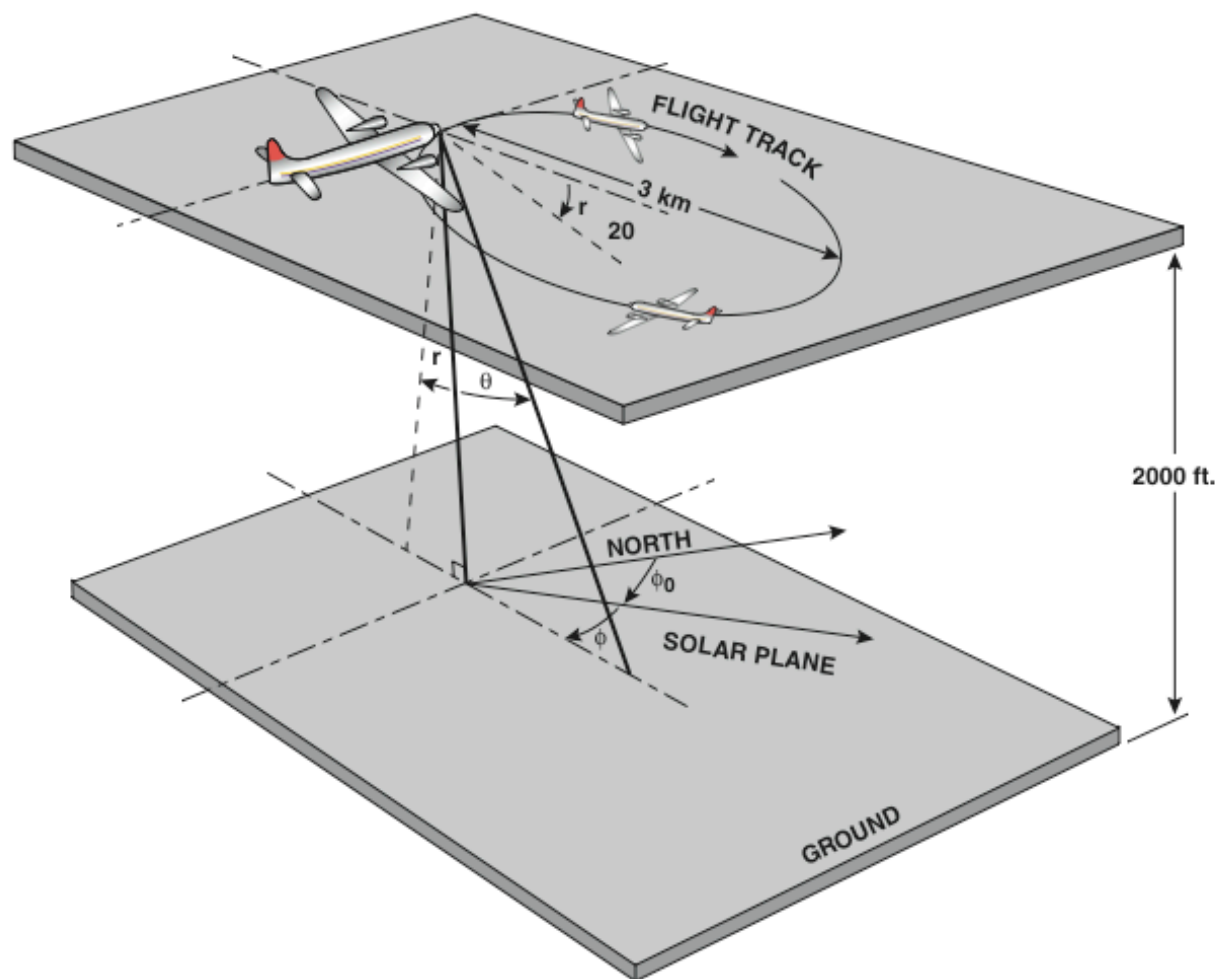
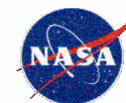
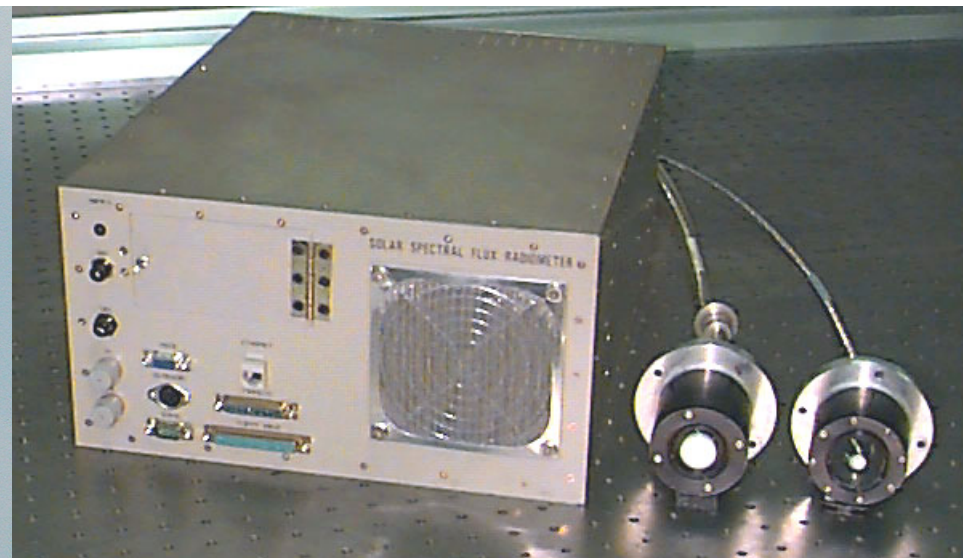


Illustration of typical flight pattern for BRDF measurements. Flight patterns at several attitudes and Sun angles will be flown during MILAGRO.

NASA Ames Spectral Solar Flux Radiometer (SSFR)

- Up und downwelling flux
- 300-1700 nm, Resolution 8-12 nm, 1Hz
- On CV-580, ER-2 and Skukuza ground-site



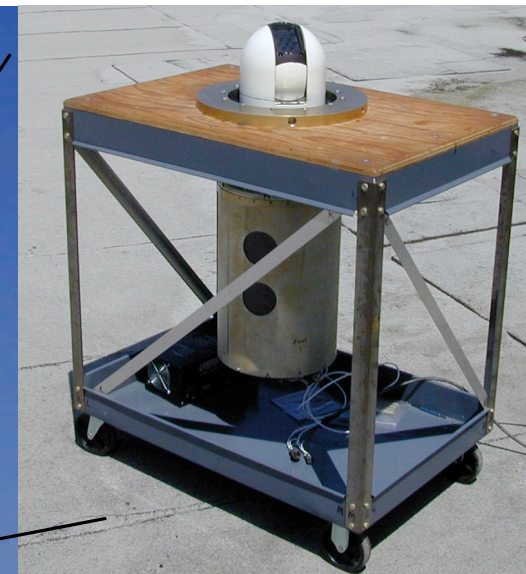
MODIS AIRBORNE SIMULATOR



- Aerosol extinction profiles
532 and 1064 nm

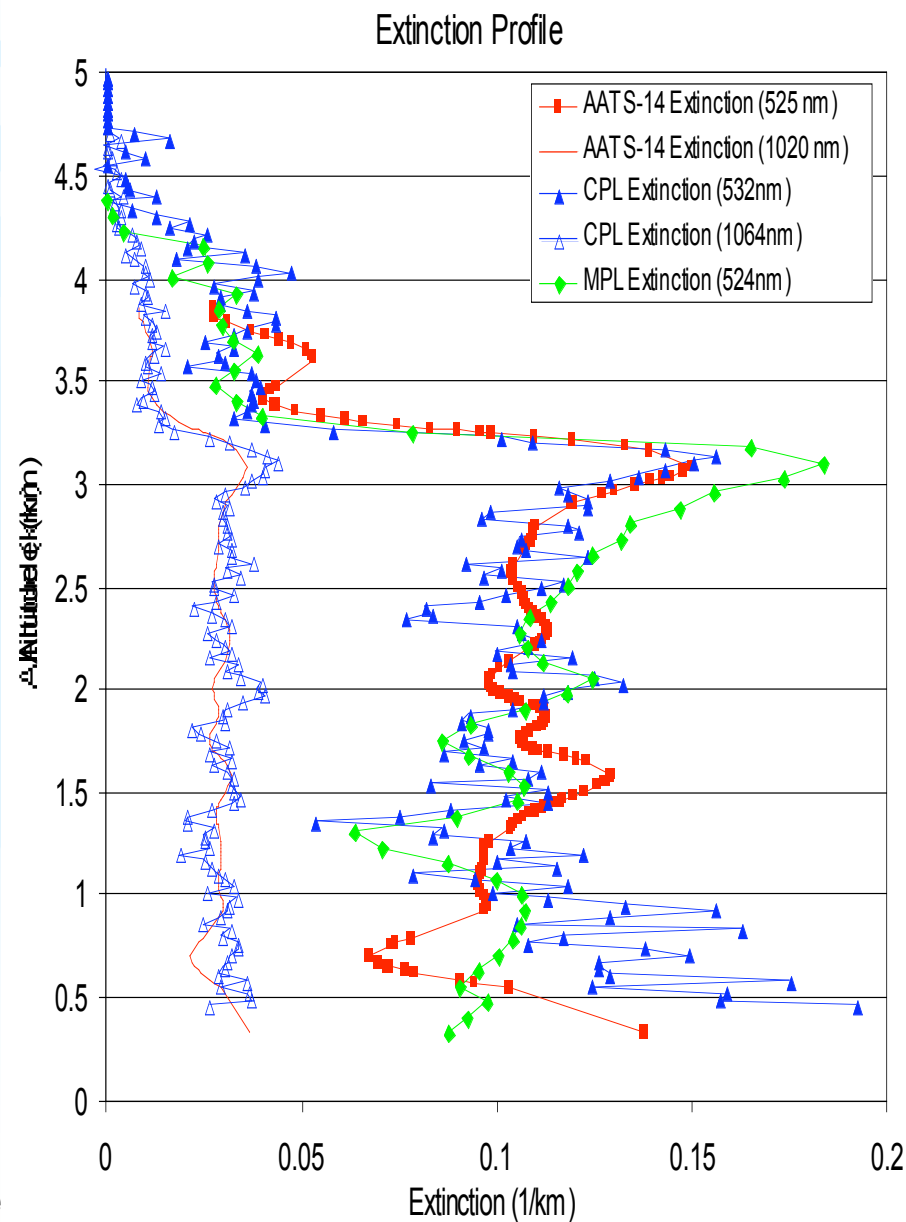
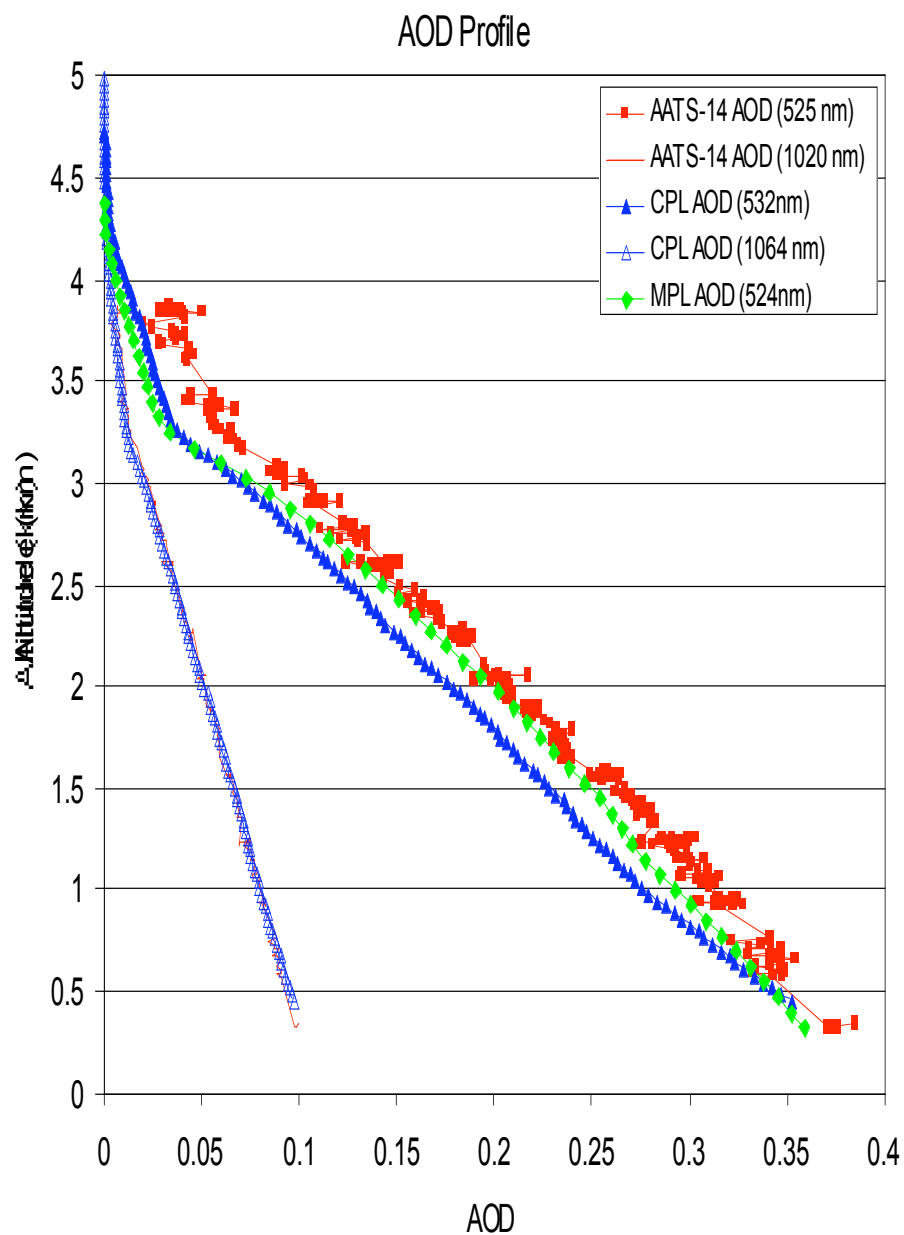
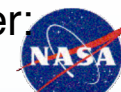
NASA Ames Airborne Tracking 14-Channel Sunphotometer (AATS-14)

- Aerosol Optical Depth/Extinction
(354-1558 nm, 12 wavelengths)
- Water Vapor Column/Density
- 24 data flights on CV-580



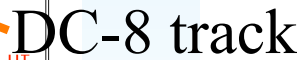
UNIVERSITY OF WASHINGTON CV-580
31 Flights (120 hours) during SAFARI-2000

Aerosol profile from ground-based and airborne lidars and airborne sun photometer: Skukuza, South Africa, 22 August 2000



10/31/05 8:19 AM

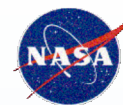
- ## J-31 track



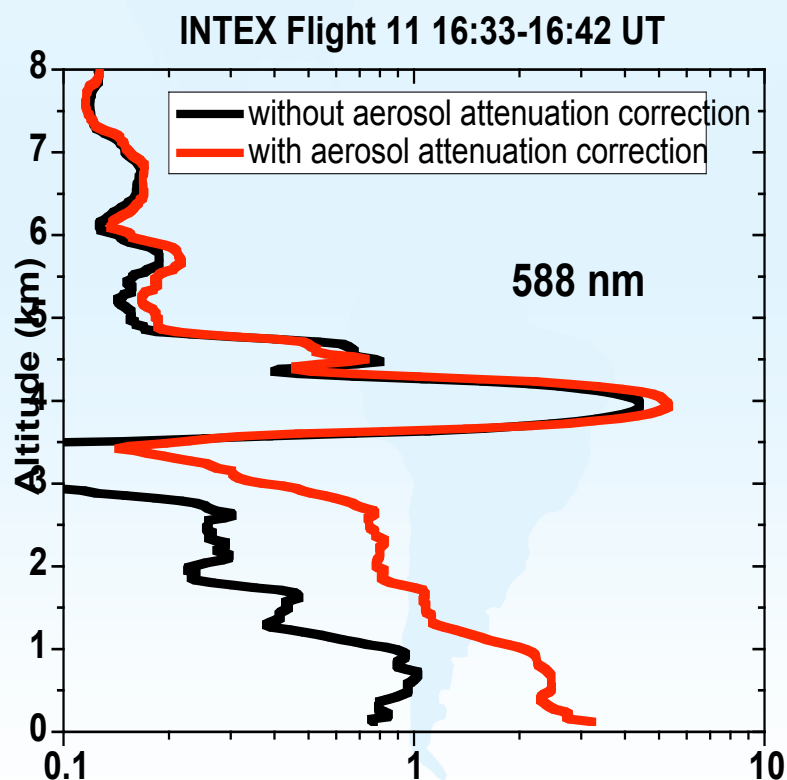
Slide 22



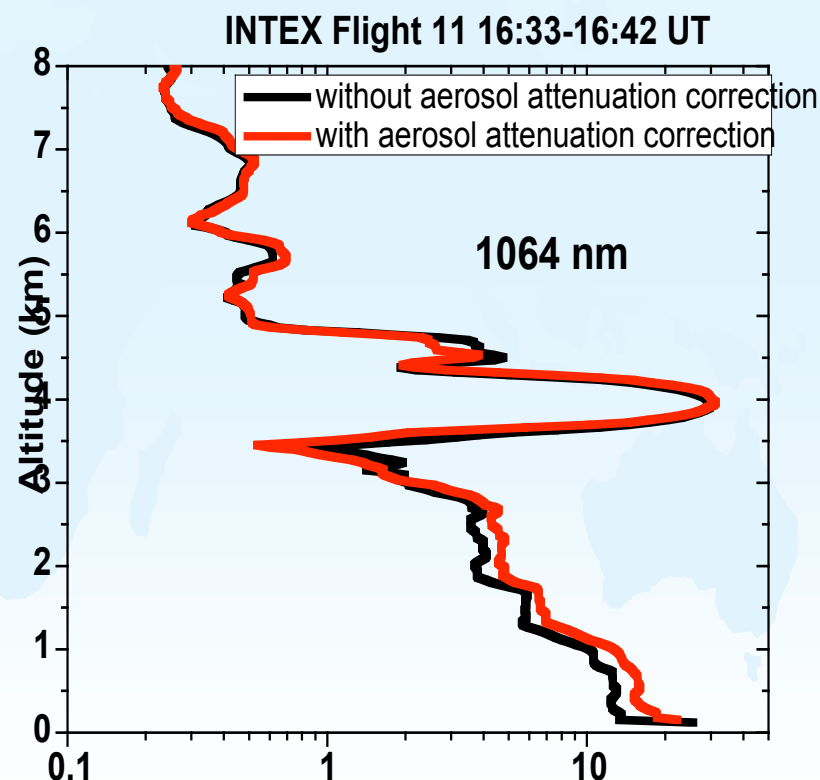
Aerosol Profile Retrieval – July 22, 2004



- Attenuation correction applied using MODIS AOT constraint
- Correction at low altitudes $\sim 200\text{-}300\%$ at 588 nm, 20-40% at 1064 nm



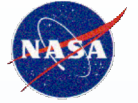
Aerosol Scattering Ratio (588



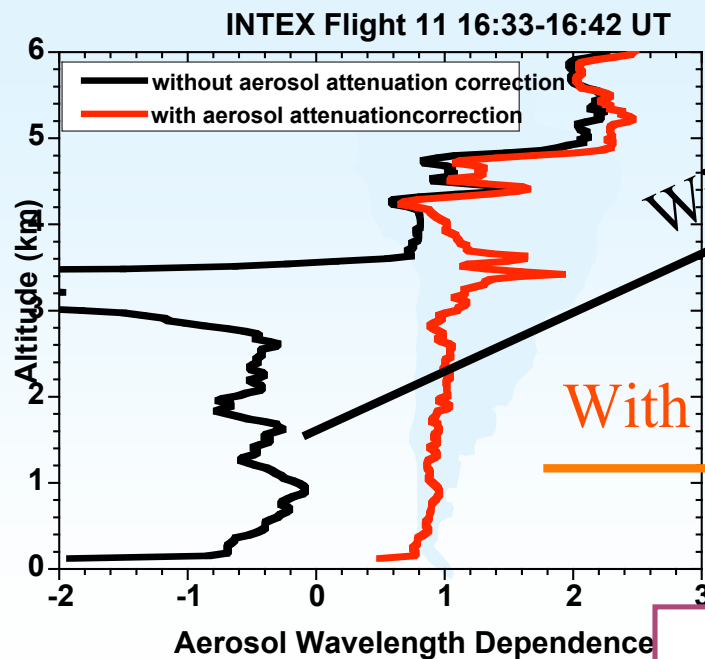
Aerosol Scattering Ratio (1064 nm)

Ferrare et al.

Aerosol Wavelength Dependence



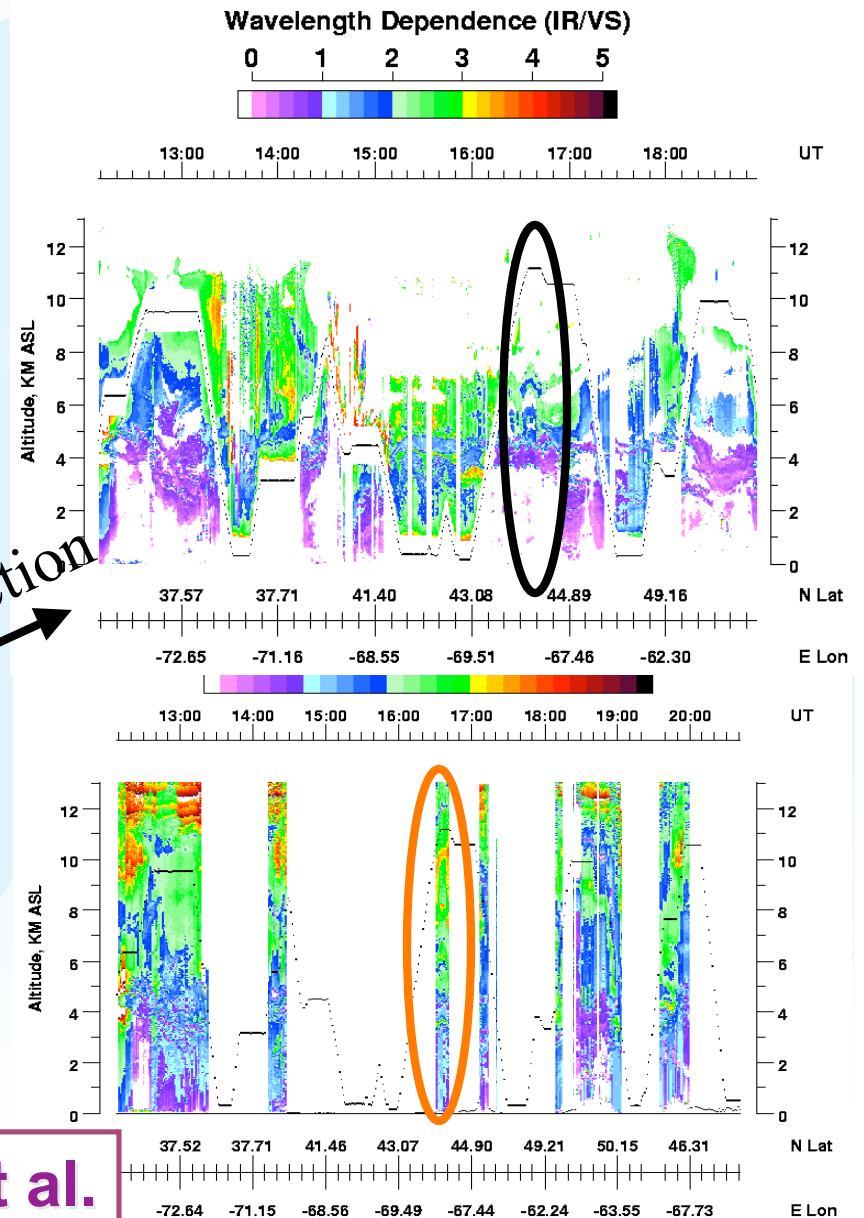
- Attenuation correction applied using MODIS AOT constraint
- Correction retrieves profiles under layers of large aerosol attenuation



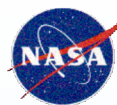
Without correction

With correction

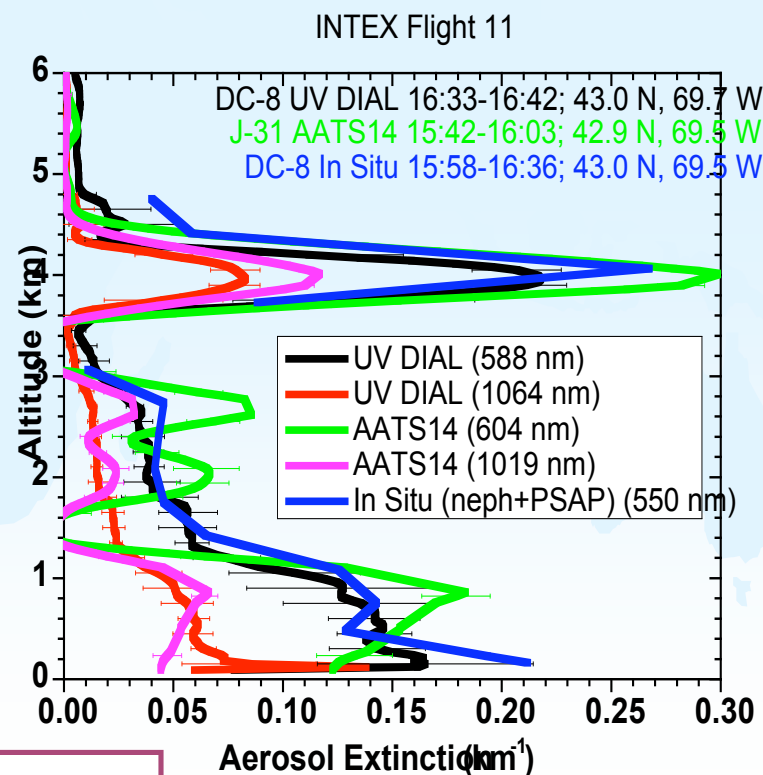
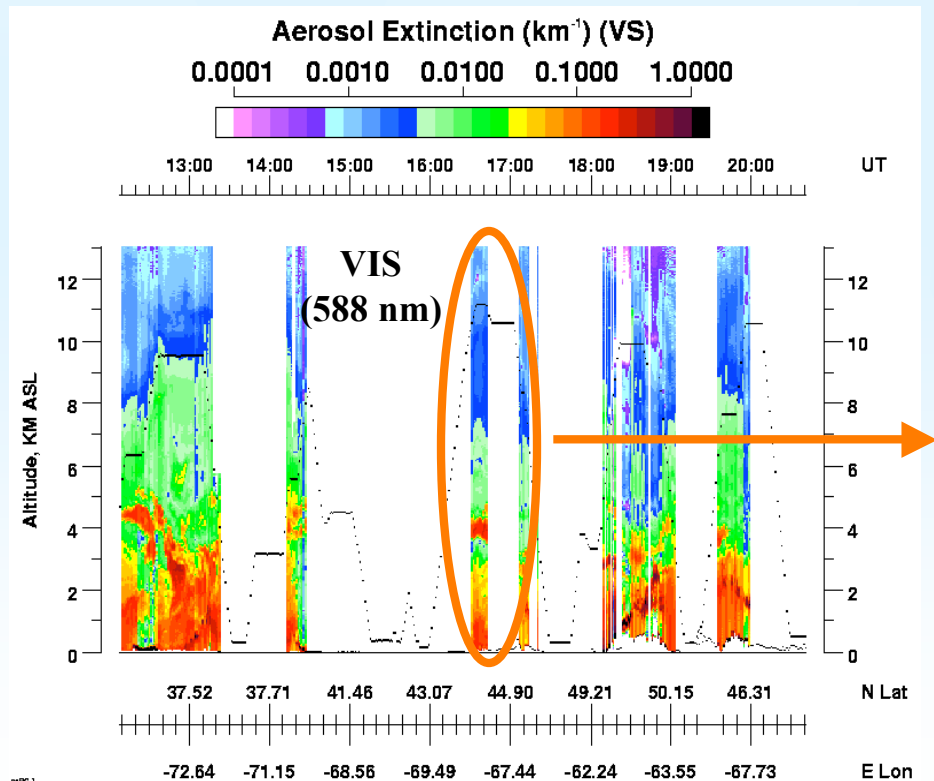
Ferrare et al.



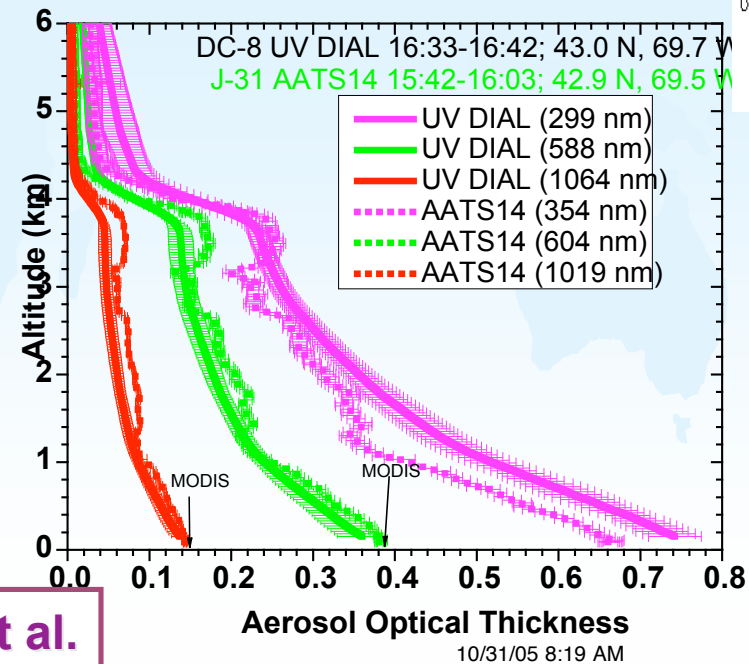
Preliminary Aerosol Extinction Comparison – July 22



- Comparisons use Preliminary Data from
 - UV DIAL
 - NASA Ames Airborne Sun Photometer (AATS14) on J-31 aircraft
 - Scattering (nephelometer) + Absorption (PSAP) in situ on DC-8

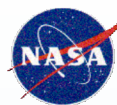


Ferrare et al.

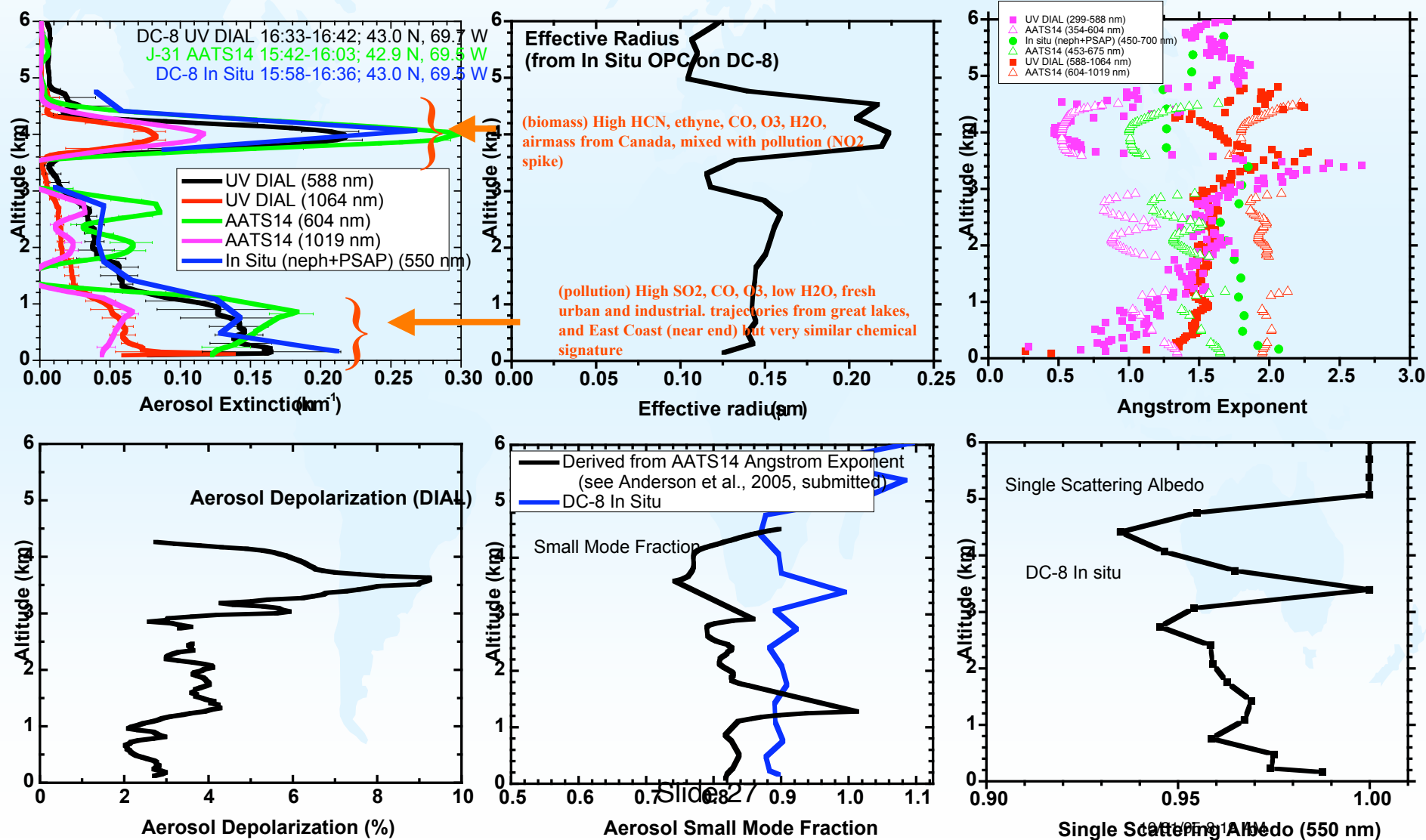


Ferrare et al.

Preliminary Aerosol Profile Properties – July 22

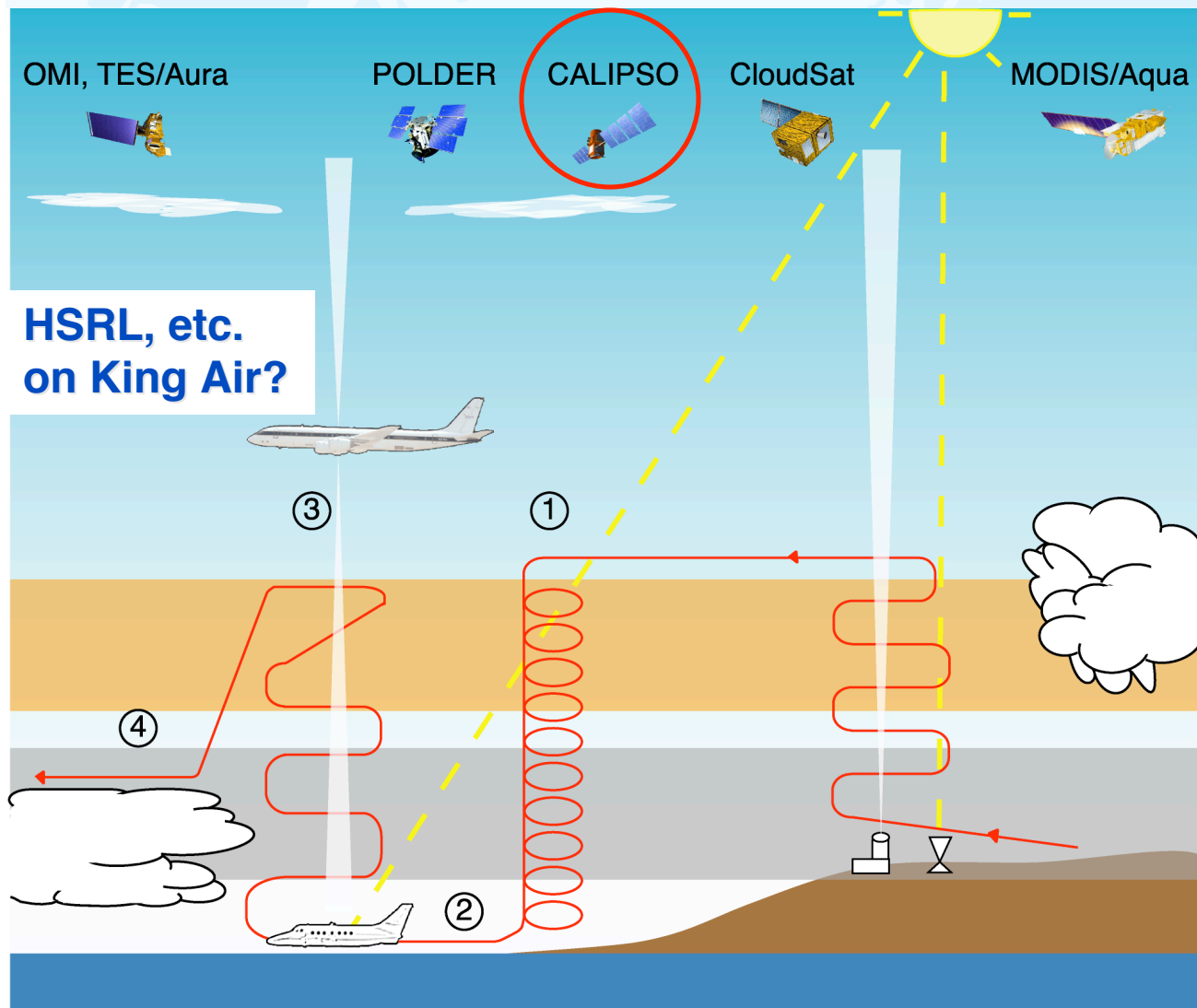


Contrasting aerosol types – elevated biomass aerosol above pollution



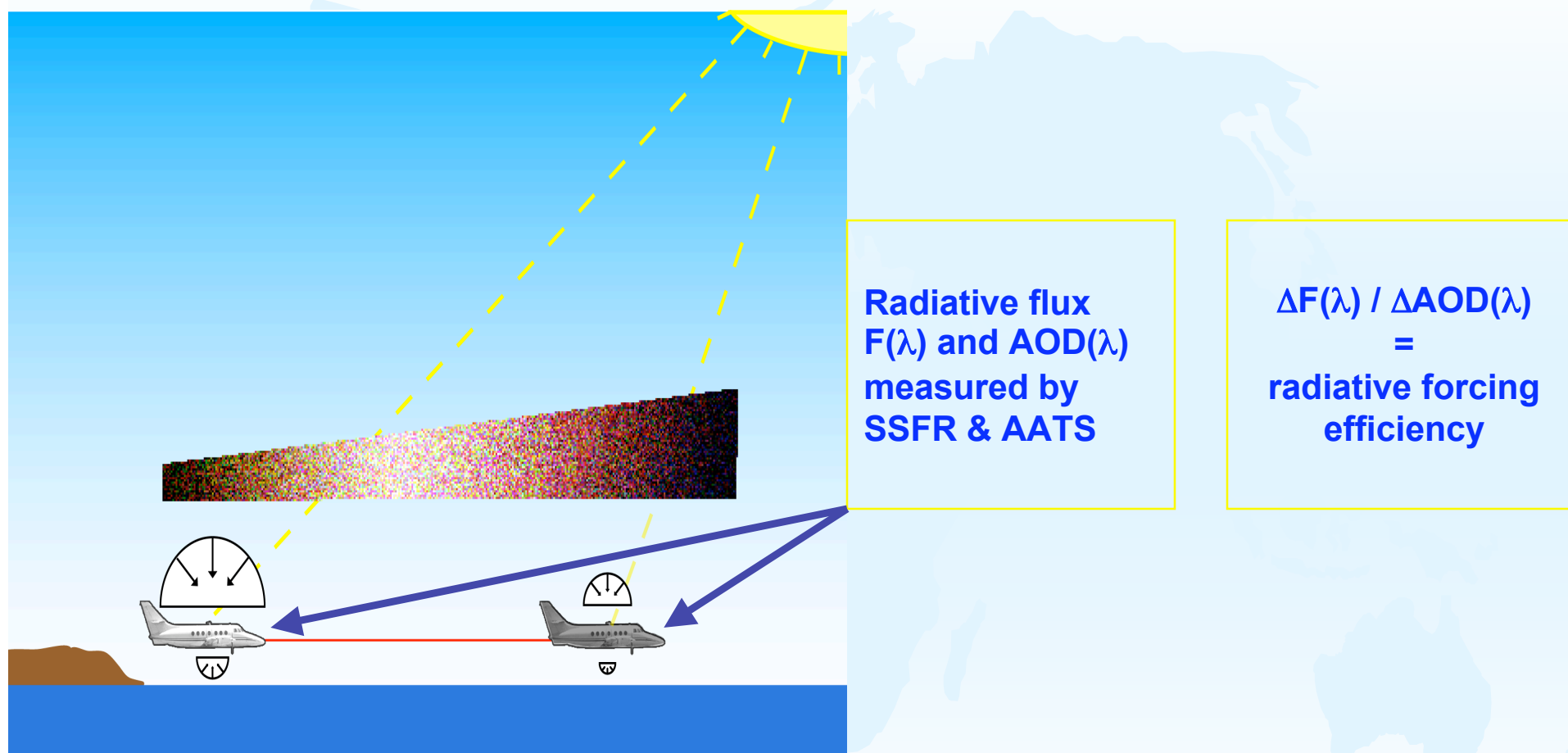
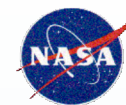
Low-altitude aircraft flight patterns

proposed for INTEX-B (MILAGRO?) studies of aerosol radiative effects and satellite validation



- (1) Survey Vertical Profile.**
- (2) Minimum-Altitude Transect.**
- (3) Stepped Profile (“Parking Garage”)**
- (4) Above-Cloud Transect.**

Measuring aerosol radiative forcing efficiency by underflying AOD gradients



Radiative flux $F(\lambda)$ and AOD(λ) measured by SSFR & AATS

$\Delta F(\lambda) / \Delta AOD(\lambda)$
=
radiative forcing efficiency

Example INTEX-A/ITCT/ICARTT 2004 result from 10 cases

Instantaneous $\Delta F_{\text{net}}(350-700 \text{ nm}) / \Delta AOD(499 \text{ nm})$ averaged -80 W m^{-2}
with large case-to-case variability (St. Dev. 27%)