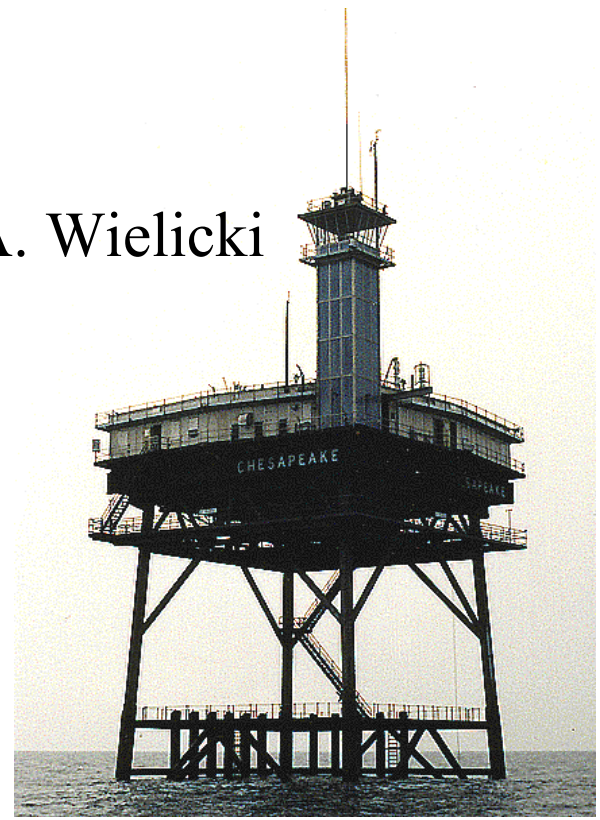
Chesapeake Lighthouse and Aircraft Measurements for Satellites "CLAMS"

July 10 – Aug 2, 2001

W. L. Smith Jr., T. P. Charlock, B. A. Wielicki
NASA LaRC

K. Rutledge
AS&M



CERES Science Team Meeting
Newport News, VA, May. 1-3, 2001

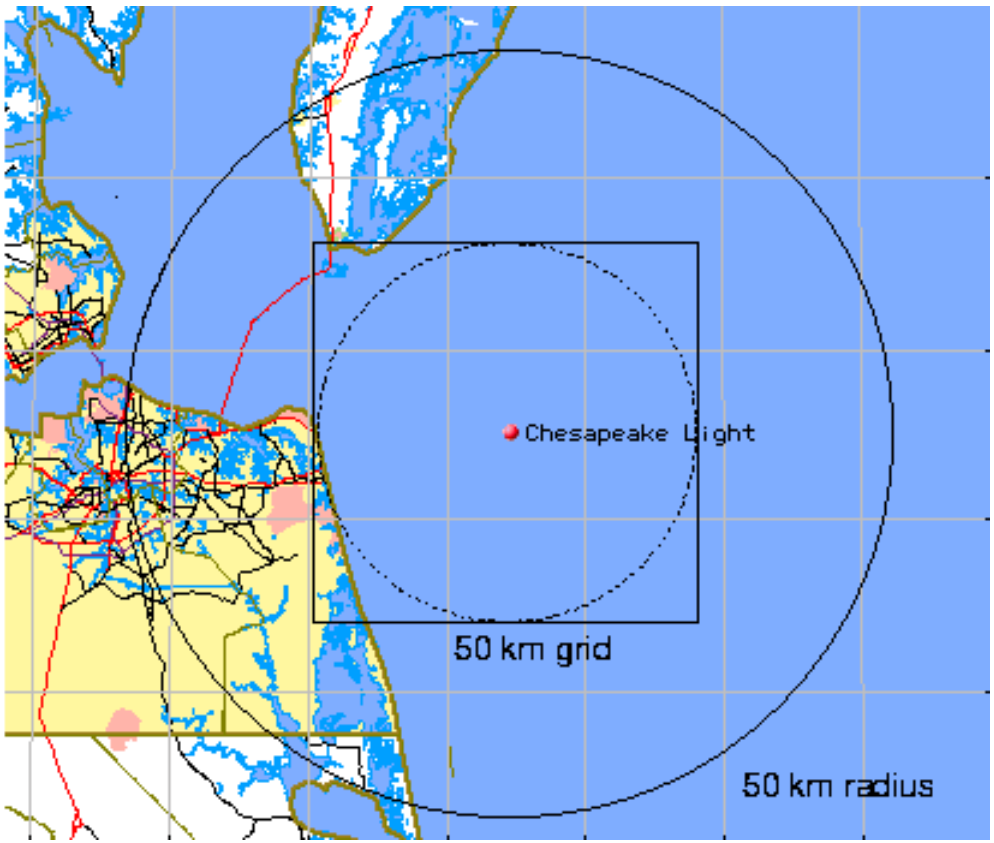
CLAMS – A Shortwave Closure Experiment

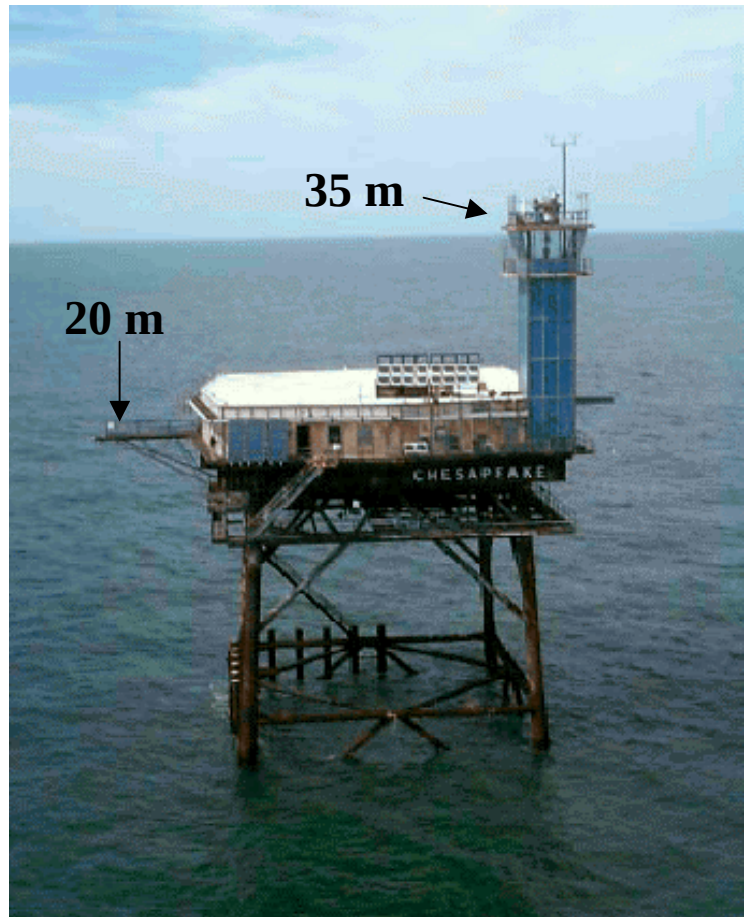
Sponsored by CERES, MISR, MODIS, GACP

PRIMARY OBJECTIVES

- Validate vertical flux profiles
- Improve a priori ocean optics
- Validate satellite retrievals of aerosols

CERES Ocean Validation Experiment (COVE)



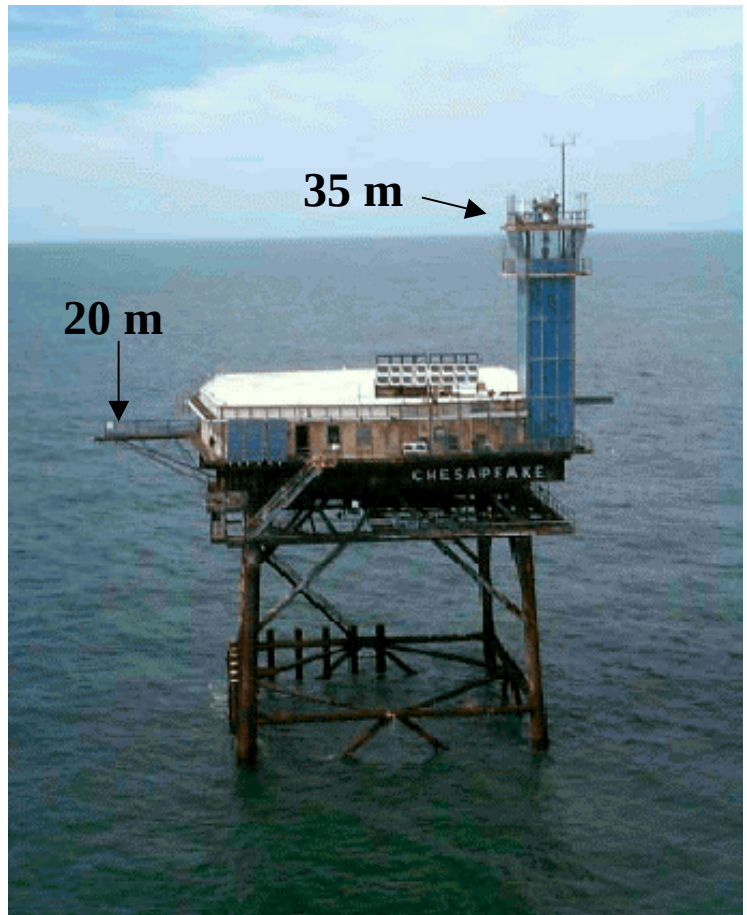


CERES Ocean Validation Experiment (COVE)

A stable sea platform providing continuous, long term measurements of

- reflected spectral radiances (SP1A)
- broadband radiation (BSRN)
- aerosol τ (AERONET)
- simultaneous wind and wave height

COVE measures the variation of ocean optics for a huge number of sun angles, aerosol and cloud conditions, wind speeds,and sea states.



CLAMS OBJECTIVES

Improve interpretation of COVE data

- determine how to account for platform obstructions and local variations in sea optics when interpreting COVE data
- determine how to scale up COVE data to satellite footprint

Validate satellite-retrieved aerosol properties

- Assess the impact of scene variability on measurement uncertainty, on 10 m to 10 km scales
- Test the impact of improved boundary conditions arrived at with CLAMS data
- Comparisons with in-situ measurements, surface-based measurements and sensor intercomparisons
- Improve retrievals in sun-glint conditions, in partly cloudy conditions and over coast

Strategy

Conduct an intense measurement campaign from Wallops Flight Facility targeting COVE and nearby deep ocean targets in primarily clear conditions over a 3 week period in July.

Deploy from Wallops

- ER-2
- UW CV-580
- Cessna 210
- Proteus

Deploy from LaRC

- OV-10

COVE Operations for CLAMS IOP

Continuously Operating

- AERONETsunphotometer
- Upwelling pyranometer*
- Upwelling pyrgeometer*
- Upwelling (ocean scanning) spectroradiometer
- Downwelling Global pyranometer*
- MFRSR / UVMFR
- pyrometer for ocean skin temperature
- NOAA - Met station
- NOAA - Wave Height Spectra
- Downwelling Diffuse pyranometer*
- Downwelling pyrgeometer*
- Pyrheliometer*
- GPS for column water vapor

Available for IOP

- Fieldspec FR spectroradiometer (ocean spectral albedo)
- Radiosonde launches
- Downwelling (skyscanning) spectroradiometer
- Micropulse Lidar (MPLNet)
- Sky and ocean surface video

Key
* BSRN archived
• to be ready by June

ER-2 Payload (32 hours)

- MAS *(MODIS Airborne Simulator)*
  50 band multispectral scanner; 50 m res
- AirMISR - *Multi-angle Imaging Spectroradiometer*
  4 color (446, 558, 672, 867 nm) pushbroom imager; 20m res
- CPL - *Cloud Physics Lidar*
- AVIRIS – *Advanced Visible and Infrared Imaging Spectrometer*
  224 band (400-2500nm) scanner; 20 m res
- S-HIS – *Scanning High Resolution Interferometer Sounder*
  3.3-18 μm (2km res)

Proteus/NAST Participation in CLAMS

Performance:

Ceiling 55-65 kft

Airspeed 300-350 ktas

Endurance 12-22 hrs

Operating Altitude:

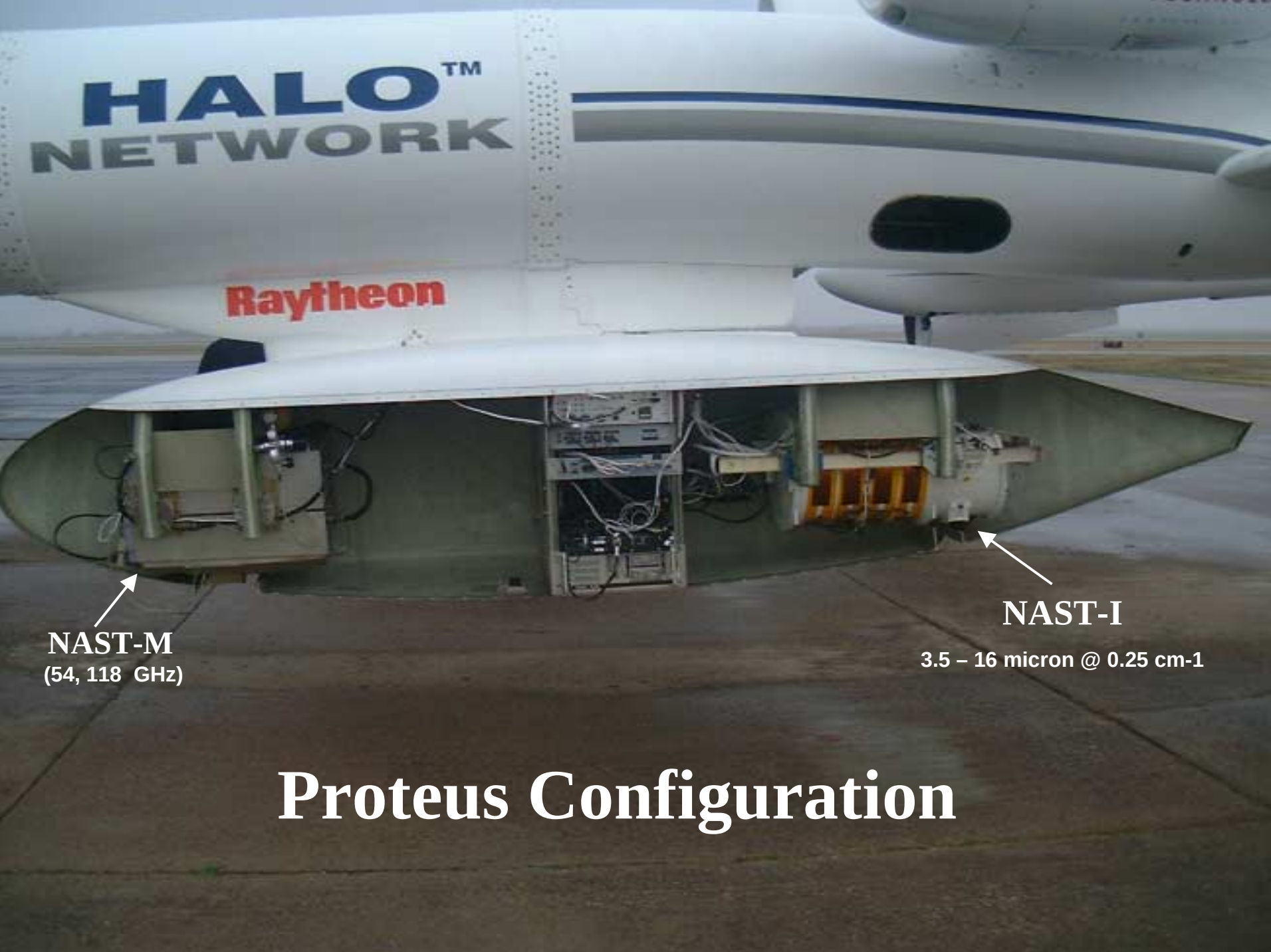
100 to 65000 ft (Can Profile)

Maximum Payload: > 4500 lbs

Runway Required: 3000 ft

Total In-field Crew:

Pilot, Co-pilot,Engineer



Proteus Configuration

CLAMS NAST Mission Objectives

- Validation of IR and MW radiation transfer algorithms under a variety of aerosol optical depth conditions
- Achievement of near "top of the atmosphere" IR and MW radiance spectra coincident with Terra, NOAA, and GOES satellite measurements (satellite measurement validation and algorithm development)
- Assessment of SST measurement accuracy
- Assessment of the dependence of geophysical product accuracy on aerosol optical depth
- Provide surface and atmospheric state data in support of CLAMS central objectives

University of Washington Convair 580

Operating Altitude
100ft – 25kft

Duration: ~7hours

In-situ aerosol profiler (AOT, g, ω_0)

- aerosol size spectrum (DMPS, PCASP-100X)
- scattering coefs (various nepholometers)
- absorption coefs (PSAP)
- humidification factor (Scanning humidograph)
- filter measurements (carbonaceous and ionic species)

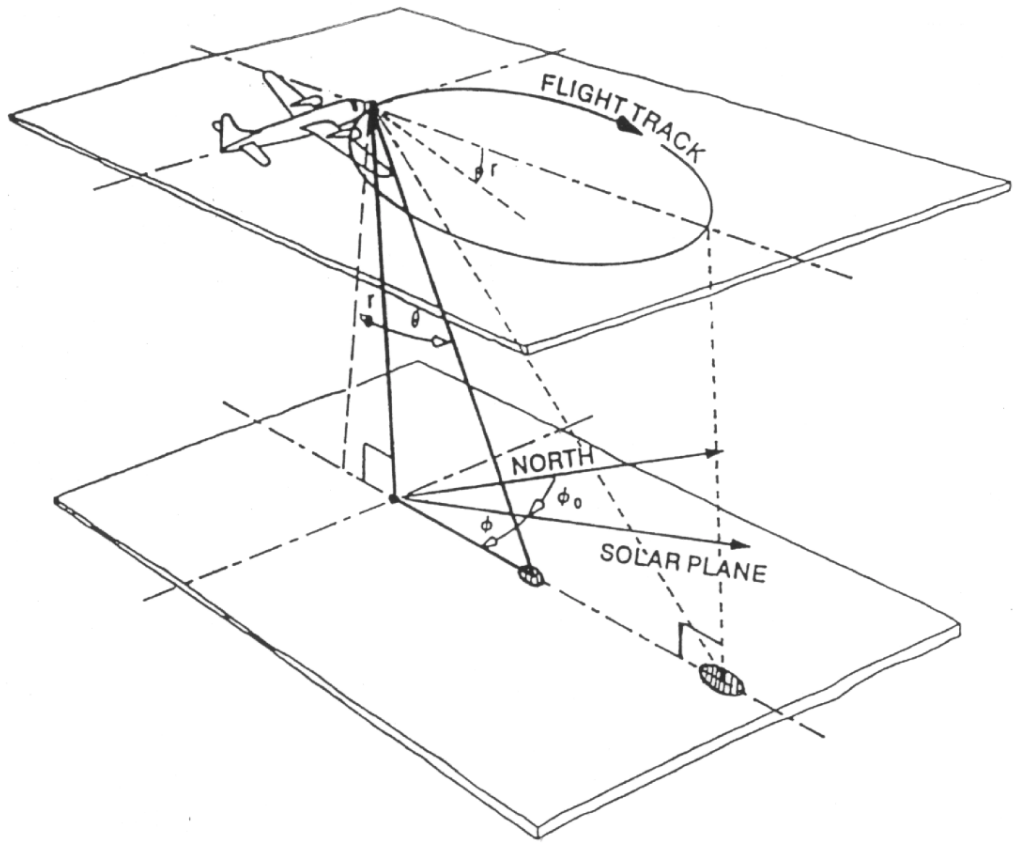
University of Washington Convair 580

Radiation

- BRDF (NASA GSFC Cloud Abs. Radiometer)
- Broadband LW & SW
- Skin Temperature
- Sunphotometry (NASA AMES AATS-14)

Illustration of Bidirectional Reflectance Measurements

- Roll: ~20°
- Time: ~3 min
- Speed: ~80 m s^{-1}
- Height: ~667 m
- Diameter: ~3 km
- Resolution
  - 10 m (nadir)
  - 270 m (θ = 80°)
- Channels
  - 8 continuously sampled (0.34-1.27 µm)
  - 2 filter wheel channels used for BRDF measurements (1.64 & 2.20 µm)



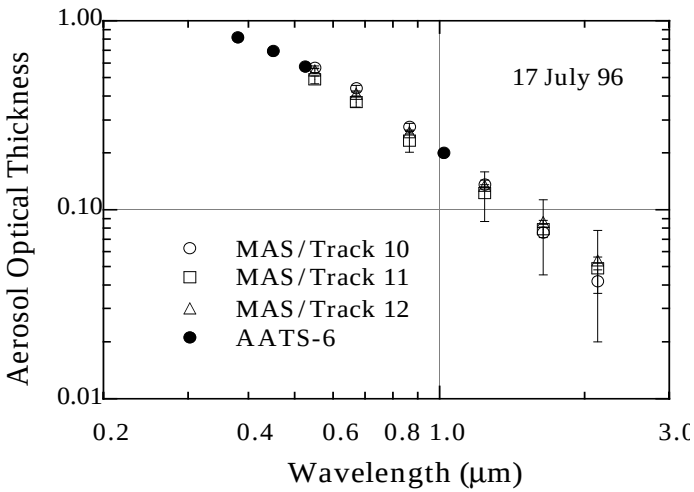
AATS-14 (14-channel Ames Airborne Tracking Sunphotometer) aboard the UW CV-580

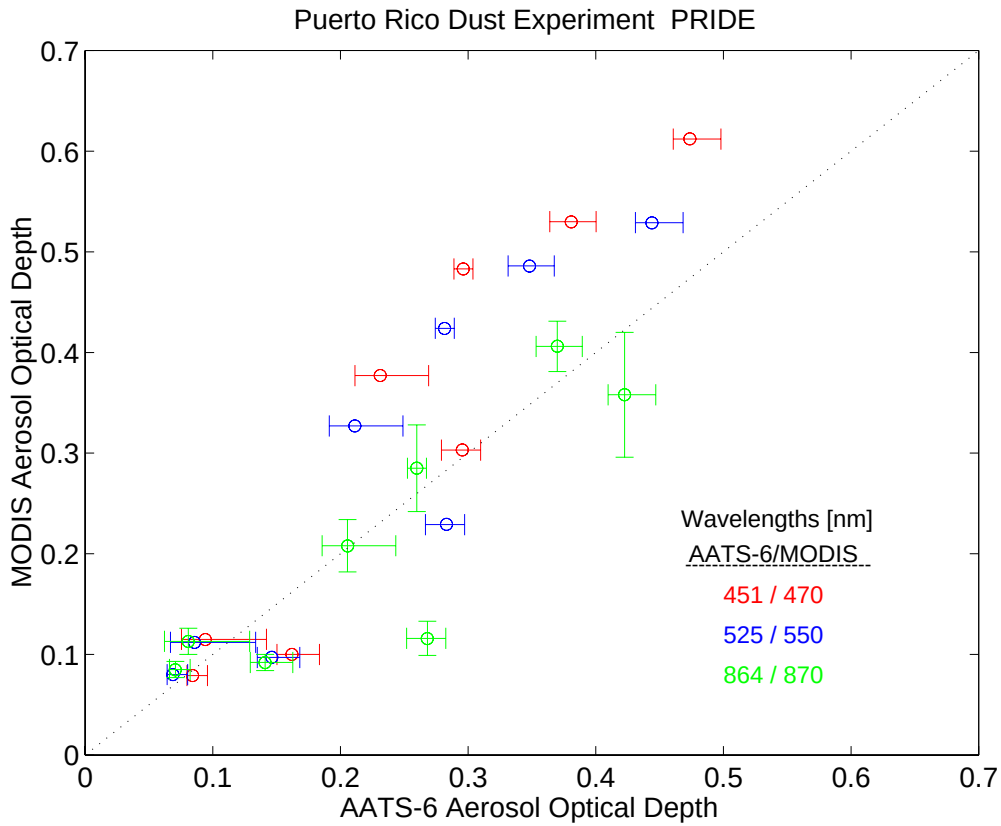
Research Areas:

1. Airborne Measurements of
   - aerosol optical depth
   - water vapor column content
   - ozone column content
2. Satellite Validation
3. Observationally-based estimates of aerosol radiative forcing of climate

Example of results on the web:
http://geo.arc.nasa.gov/sgg/PRIDE

AATS Validation of Satellite AOT





NASA Langley OV-10

Operating Altitude
100ft – 10kft

Duration: ~2hours

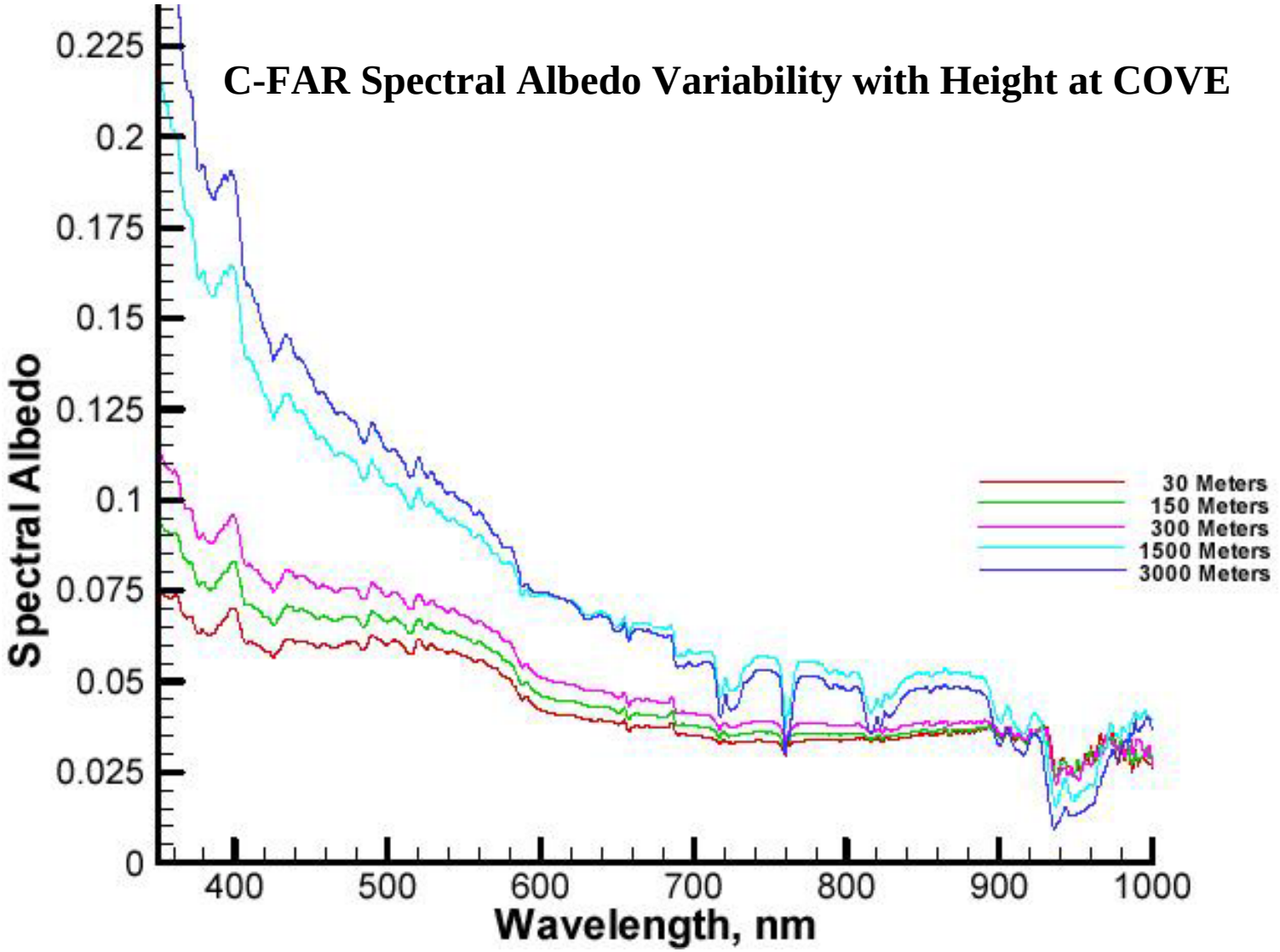
2-3 flights/day

C-FAR : CERES Fixed wing Airborne Radiometer

Up and Downlooking Radiometers

- ASD Fieldspec (350-2200 nm; 10nm res) spectral flux
- Eppley broadband LW & SW fluxes

In-situ temperature, humidity, pressure


C-FAR Spectral Albedo Variability with Height at COVE
Spectral Albedo
0.225
0.2
0.175
0.15
0.125
0.1
0.075
0.05
0.025
0
400
500
600
700
800
900
1000
Wavelength, nm
30 Meters
150 Meters
300 Meters
1500 Meters
3000 Meters

Cessna 210 with Research Scanning Polarimeter

P.I.'s B. Cairns, M. Mishchenko, NASA GISS

http://www.giss.nasa.gov./data/rsp_air/

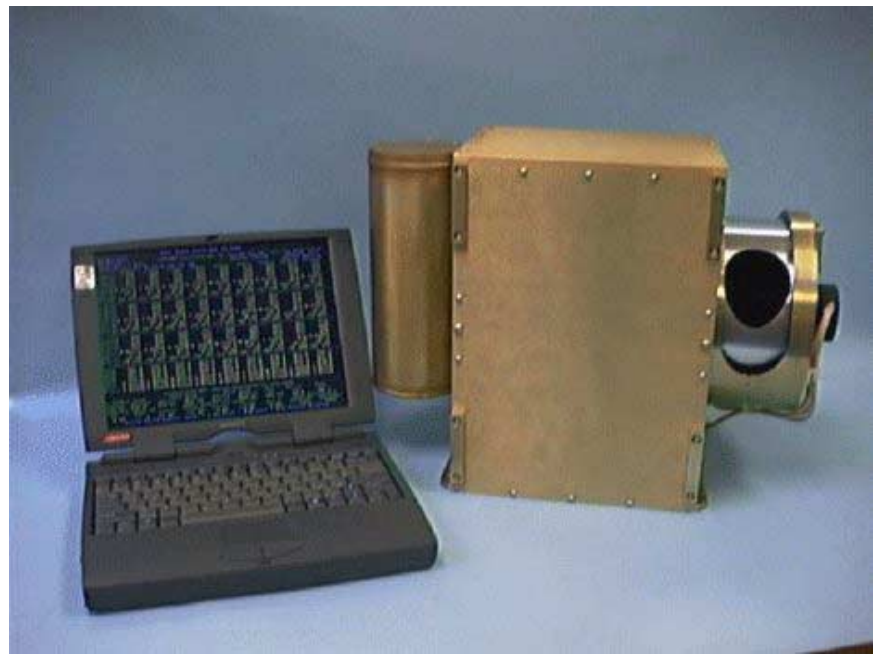
9 bands : 410 (30), 470 (20), 550 (20), 670 (20), 865 (20) and 960 (20), 1590 (60), 1880 (90), and 2250 (120) nm.

- Wide angular coverage (+/-60° from nadir) allows the identification of an aerosol model
- Polarization features in scattered radiation are less affected by multiple scattering than intensity features
- Polarization is a relative measurement which allows for simple and extremely accurate calibration (~0.2%)

Flight altitudes for CLAMS

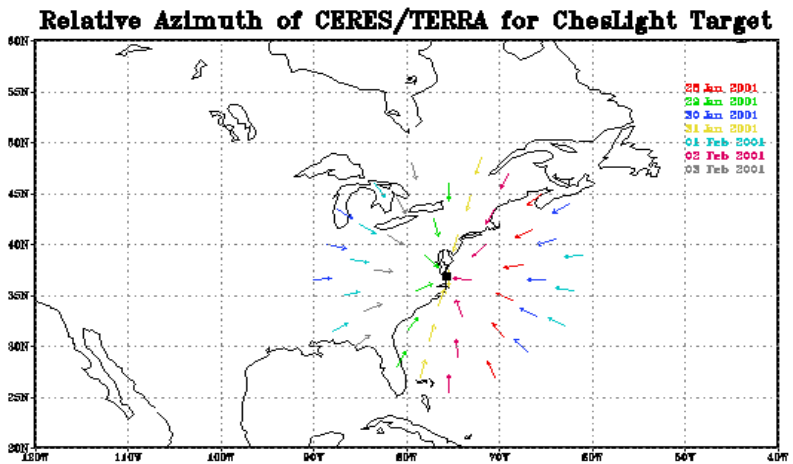
- 12kft for aerosols
- 200-500ft to characterize surface reflectances

MODIS team will also fly an ASD Fieldspec (350-2500 μm; 10nm res)



CERES Operations During CLAMS

- Operate CERES 1 in cross-track mode
- Operate CERES 2 at predicted azimuth angles:
  - Predict scan pattern every day (07/10-08/02)
  - 500 footprints in 100-km area per overpass
  - Sample 10-15 azimuth angles per overpass
  - Sample all viewing zenith angles (1 week)



Regional Land-Atmosphere-Cloud Analysis and Prediction System (ReLAPS): Application to CLAMS *(Realtime ReLAPS for CLAMS)*

Donghai Wang, NASA/LaRC

Based on : Advanced Regional Prediction System (ARPS)
University of Oklahoma

- Will provide realtime numerical weather forecasts for CLAMS at high temporal and spatial resolution

- Will be used as a forecast tool and to aid in post experiment analyses of CLAMS data.

- Will also be validated with CLAMS data.

CLAMS Information

Web site: http://www-clams/larc.nasa.gov/clams

e-mailing list: contact w.l.smith@larc.nasa.gov