# **CLAMS -** Cheasapeake **L**ighthouse & **A**ircraft **M**easurements for **S**atellites **July 10 - August 2/2001**

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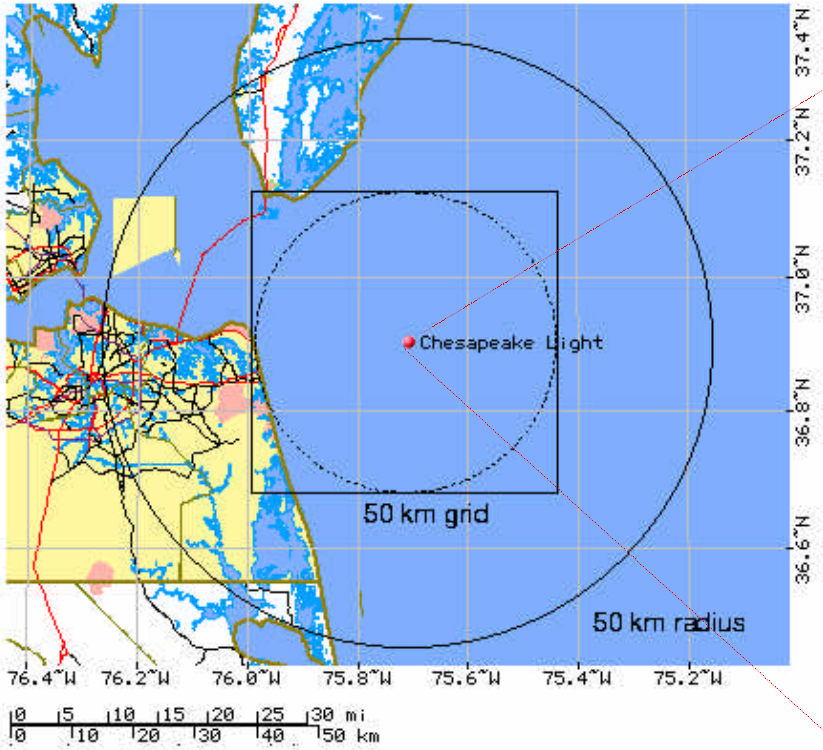



**Chesapeake Lighthouse is located at 36.9 N, 75.71 W in the Atlantic Ocean, about 25 km off of the coast of Virginia Beach, VA.**

# CLAMS Overview

Field campaign sponsored by CERES, MISR, MODIS-Atmospheres and the NASA/GEWEX Global Aerosol Climatology Project (GACP).

Chesapeake Lighthouse sea platform 20 km east of Virginia Beach, at which NASA and NOAA make continuous, long-term measurements of radiation, meteorology, and ocean waves.

Common set of objectives tied to the validation of EOS data products.

A first CLAMS campaign, currently being planned for July 2001 to validate Terra data products, is a shortwave closure experiment

A second and similar campaign is being considered for 2002 for Aqua data product validation with additional focus in the longwave and on atmospheric water vapor.

# CLAMS Project Management

The CLAMS project activities will be managed at NASA Langley Research Center (LaRC).

- William Smith - Lead Mission Scientist.
- Victor Delnore - CLAMS Program Coordinator.

CLAMS lead representatives for each teams:

- Tom Charlock for CERES and GACP
- Lorraine Remer and Jose Vanderlei Martins for MODIS-Atmospheres (GSFC)
  - -CAR instrument – Charles Gatebe and Jason Li
  - -SMART Network – Si-Chee Tsay
- Ralph Kahn for MISR.

# General Objectives

***Shortwave closure experiment over the Ocean***

- more accurate spectral and broadband radiative fluxes at the surface and within the atmosphere
- characterization of ocean optics in the vicinity of the lighthouse
- description of the atmospheric composition of aerosols

***Validating retrievals of aerosol properties from satellites***

- comparisons with in-situ measurements and sensor intercomparisons
- assessing the impact of scene variability on measurement uncertainty
- testing the impact of improved boundary specification using CLAMS measurements
- improving retrievals in sunglint regions

## *A more accurate description of the shortwave radiation budget of the cloud-free earth-atmosphere system*

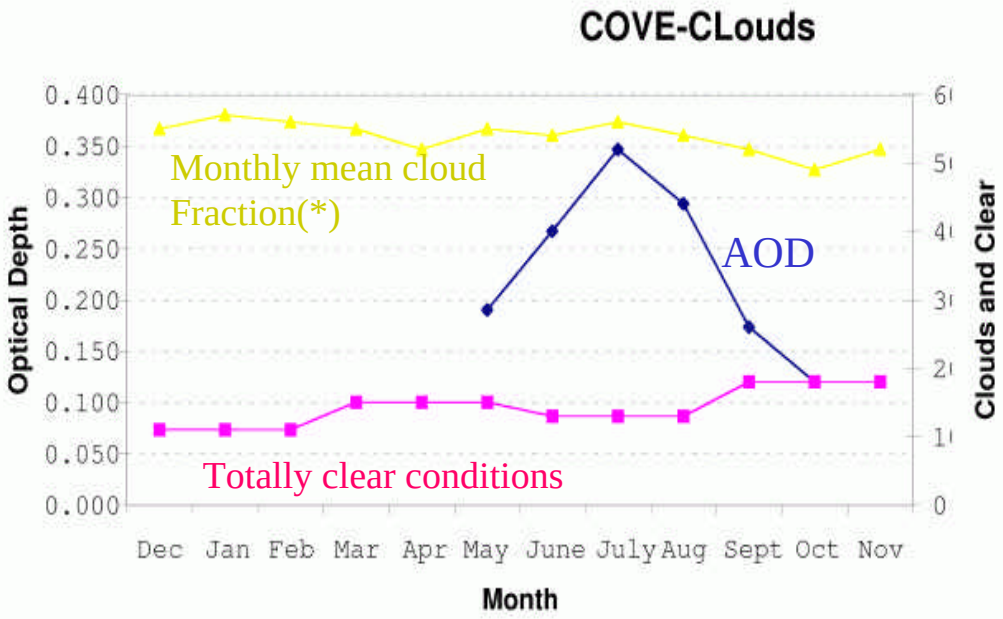
- improved characterization of ocean optics including BRDF as a function of sun angle, aerosol loading, wind and sea state
- assessing the radiative impacts of aerosols
- extending the interpretation of CLAMS data to the open ocean

## *Although the retrievals will be done in a cloudy environment…*

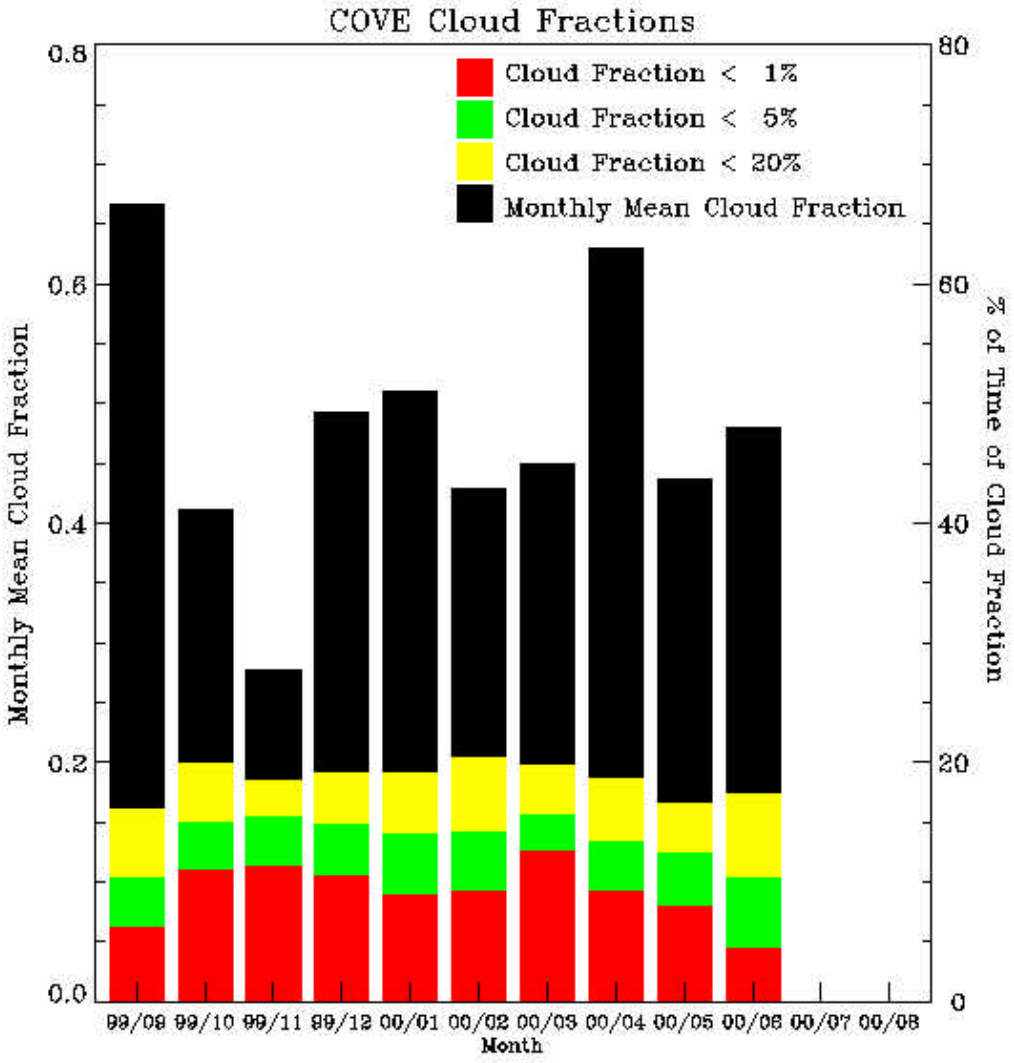
- Bettween other thinks we want to test our ability to retrieve aerosols properties in between clouds (cloud masking)

# Clouds and Aerosol Climatology

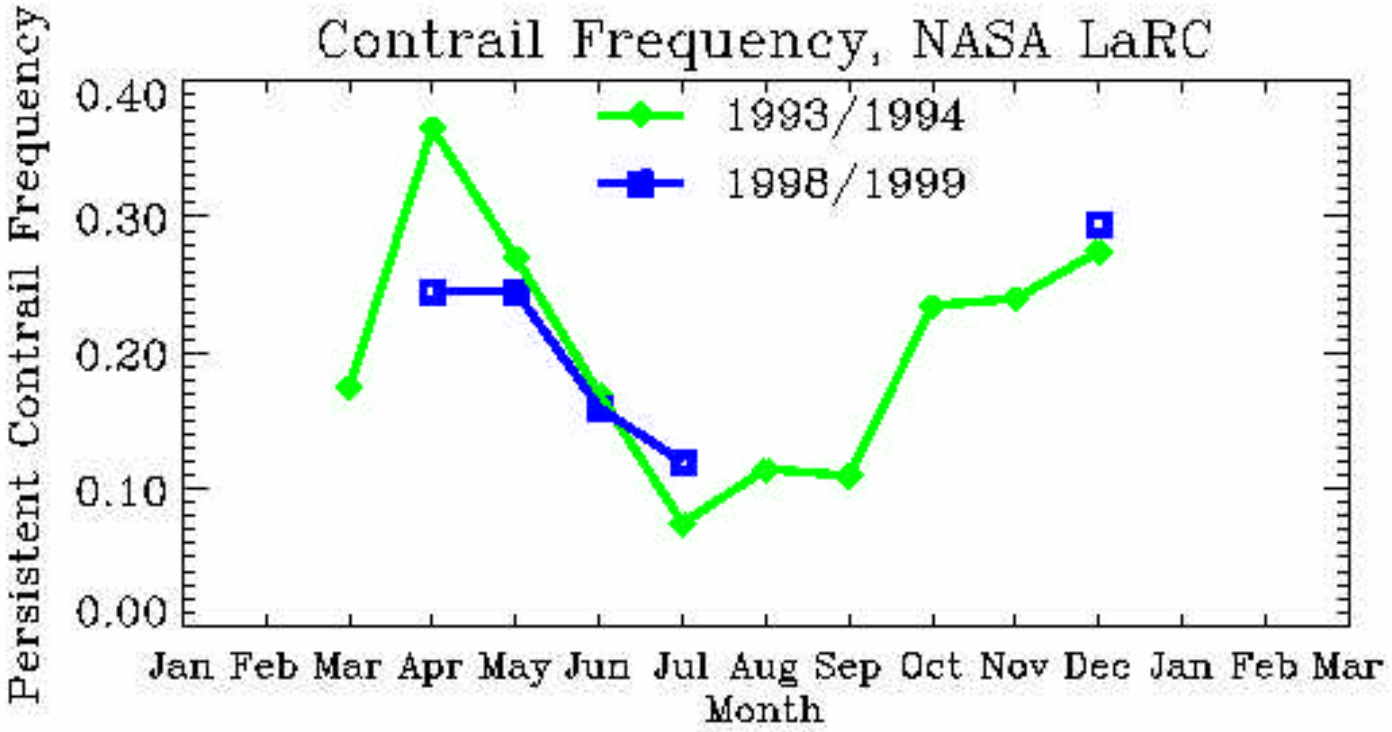
| | AOT 1997 | AOT 1998 | AOT 1999 | AOT AVG | Totally clear conditions (%) |
|---|---|---|---|---|---|
| Dec | | | | | 11 |
| Jan | | | | | 11 |
| Feb | | | | | 11 |
| Mar | | | | | 15 |
| Apr | | | | | 15 |
| May | 0.14 | 0.27 | 0.16 | 0.190 | 15 |
| June | 0.3 | 0.26 | 0.24 | 0.267 | 13 |
| July | 0.29 | 0.36 | 0.39 | 0.347 | 13 |
| Aug | 0.28 | 0.27 | 0.33 | 0.293 | 13 |
| Sept | 0.11 | 0.27 | 0.14 | 0.173 | 18 |
| Oct | 0.17 | 0.08 | 0.11 | 0.120 | 18 |
| Nov | | | | | 18 |




(*) from Hahn-Warren-London surface-based cloud climatology (1952-81).




This graph shows cloud fractions based on the Long/Ackerman clear sky detection algorithm applied to the COVE uplooking SW radiometery. The red, green, & yellow colors give temporal cloud fractions and are appropriate to the right y-axis. The Black shows the monthly mean cloud fraction appropriate to the left y-axis.




Pat Minnis supplies this picture of the frequency of contrails over the Hampton Roads area for 1993 & 1998. The data is based on observations from Langley Airforce Base, Hampton, VA.

# Instrumentation

- ***Aircraft Platforms and Sensors***
- ***"Water" based instrumentation***
- ***Ground based instrumentation***

# ER-2 Payload

- 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* (3 wavelengths)
- AVIRIS – *Advanced Visible and Infrared Imaging Spectrometer*
  224 band (400-2500nm) scanner; 20 m res
- Leonardo Airborne Simulator – Visible and IR spectrometer

# University of Washington Convair 580

## In-situ aerosol profiler

- aerosol size spectrum (DMPS, PCASP-100X)
- scattering coefs (various nepholometers)
- humidification factor (Scanning humidograph)
- Light absorption
- Chemical Composition
- LIDAR

## Radiation

- AOT, g, $\omega_0$
- BRDF (NASA GSFC Cloud Abs. Radiometer)
- Sunphotometry (NASA AMES AATS-14)
- Broadband LW & SW
- Skin Temperature
- Spectral Flux (SSFR ; 350-2500nm)  ??

# NASA Langley OV-10 Aircraft


**Up and Downlooking Radiometers**

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

**In-situ temperature, humidity, pressure**

# Aircraft platforms and key instruments for CLAMS. (*) indicates platform or instrument not yet committed.

| Platform/Instruments | Investigator/Institution |
|---|---|
| **OV-10**<br>Eppley Broadband LW and SW upwelling and downwelling fluxes, ASD Fieldspec upwelling and downwelling SW spectral irradiance/radiance from 300-2500 nm at 3-10 nm resolution, IR Radiometer for skin temperature, Meteorology (T, P, Td) | Smith, Larman/LaRC |
| **NASA ER-2**<br>MAS<br>AirMISR<br>Cloud Physics Lidar (CPL)<br>(*) AVIRIS | <br>Martins, Remer/GSFC<br>Kahn/JPL<br>Spinhirne, McGill/GSFC<br>TBD |
| **(*) Univ. of Wash. Convair-580**<br><br>Eppley Broadband LW and SW upwelling and downwelling fluxes<br>Omega IR Radiometer for skin temperature<br>TSI APS, PMS FSSP's , PMS PCASP, PSAP, nepholometer(s) for aerosol measurements<br>Meteorology (T, P, Td, U, V)<br>(*) NASA AMES SSFR upwelling and downwelling SW spectral irradiance/radiance from 300-2500 nm at 5-10 nm resolution<br>(*) NASA AMES AATS suntracking photometer | Hobbs/U. of Washington<br><br><br><br><br><br>Pilewskie/NASA AMES<br><br>Russell/NASA AMES |

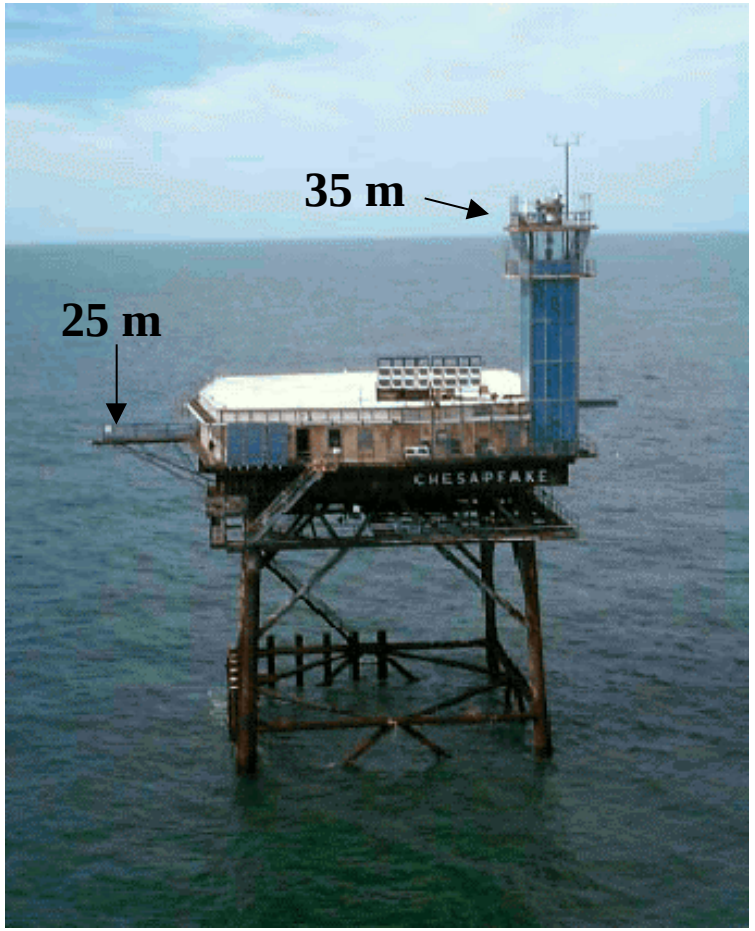
# Preliminary breakdown of science objectives and flight hours for CLAMS.

| Sponsor | Objective | Hours | Location | Platforms | Key Instruments |
|---|---|---|---|---|---|
| MODIS | Validation of aerosol retrievals in cloud-free and mainly partly cloudy conditions | 10 | 50% around COVE site and open ocean 50% over coastal regions | ER-2, OV-10 | MAS, CPL, AirMISR, AVIRIS, COVE aerosol retrievals, Fieldspec FR |
| MODIS/ CERES | Validation of retrievals over glint areas | 6 | COVE site and open ocean | ER-2, CV-580, OV10 | MAS, AirMISR |
| MODIS/ CERES | Complex aerosol vertical structures | 4 | COVE site and open ocean | ER-2, CV-580, OV-10 | MAS, CPL, AirMISR, AVIRIS, COVE aerosol retrievals, cameras. |
| MISR/ CERES | Cloud-free SW closure experiment | 6 | COVE site | ER-2, CV-580, OV-10 | ALL |
| MISR | Cloud-free spatial variability test | 6 | COVE site | ER-2, CV-580, OV-10 | ALL |
| CERES | Ocean BRDF | 8 | COVE site and open ocean | CV-580 | CAR |

# CERES Ocean Validation Experiment "COVE"

Provides continuous long term radiation measurements at a stable sea platform

- Up, down broadband fluxes, spectral, directional radiances
- Broadband (BSRN), MFRSR, Cimel (AERONET), SP1A (GACP), Waves and Meteorology (NOAA)




***"Water based Measurements"***

# *Ground Based Measurements*

**MODIS aerosol group:**

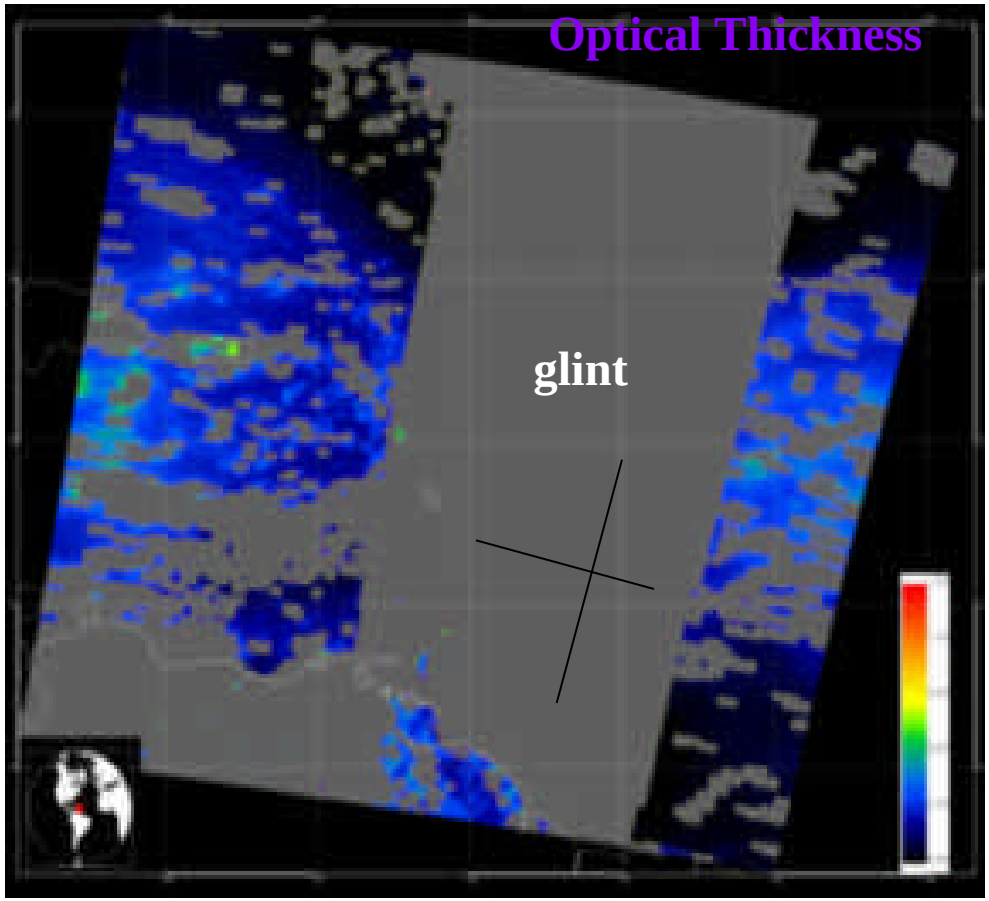
- Full Sky cameras for clouds observations
- Hand held sunphotometers (0.4 to 2.1 um)
- ASD spectral sky and ocean surface radiance measurements
- Spectral Light Absorption measurements
- Aerosol chemical composition and mass concentration

# SMART: Surface Measurements for Atmospheric Radiative Transfer

# Specific Objectives from the (GSFC) MODIS Atmosphere Team:

1. Validation of aerosol retrievals over the ocean
2. Validation of the aerosol cloud mask over the ocean
3. **Development of aerosol optical thickness and absorption retrievals over glint**
4. Validation of water vapor retrievals over glint (COVE site??)
5. **Combination between LIDAR and MODIS retrievals for separation of size distribution modes/layers**
6. Combination between in situ ground based and remote sensing measurements separating the contribution of each aerosol type for the optical depth.
7. Intercompare spectral fluxes retrieved from MODIS with ground based and possibly OV-10 measurements
8. Intercompare MODIS retrievals with MISR retrievals
9. CAR BRDF over the ocean and other scenes of interests - (as a function of sun angle, aerosol loading, wind and sea state, particularly in the UV and SWIR)
10. CAR sky radiance and surface reflectance in a vertical profile interspersed with short horizontal legs over brdf site(s).
11. Characterization of urban aerosols properties and radiative spectral fluxes with the SMART network

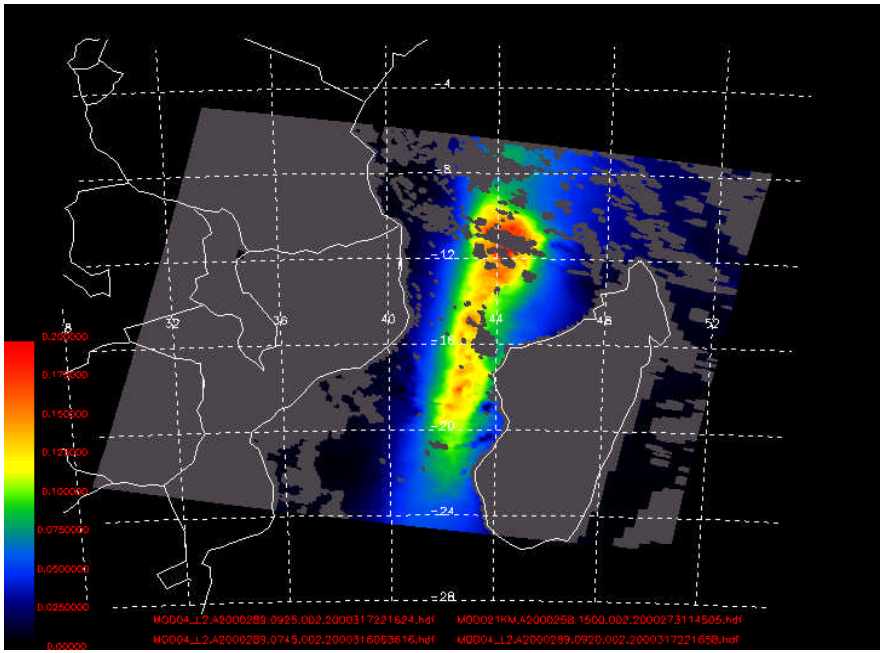
# Measurements over Glint

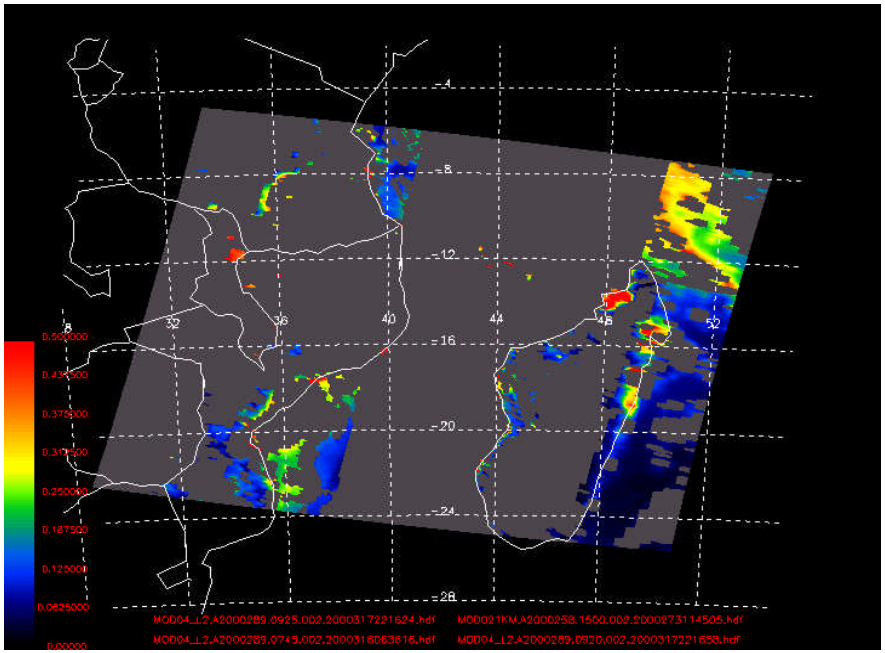


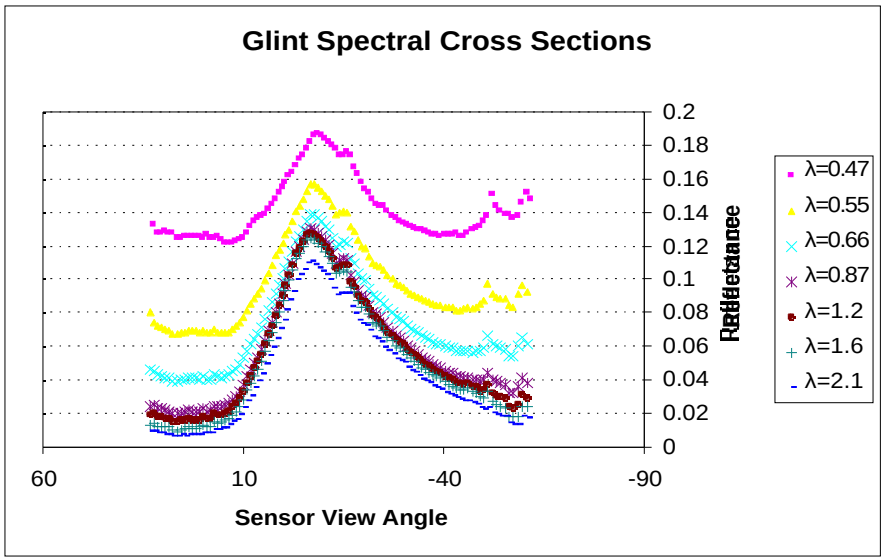

CLAMS is a good opportunity to extend and validate MODIS measurements over the glint and use strong cooperative work between: MODIS, MISR, CAR, and in situ aircraft measurements

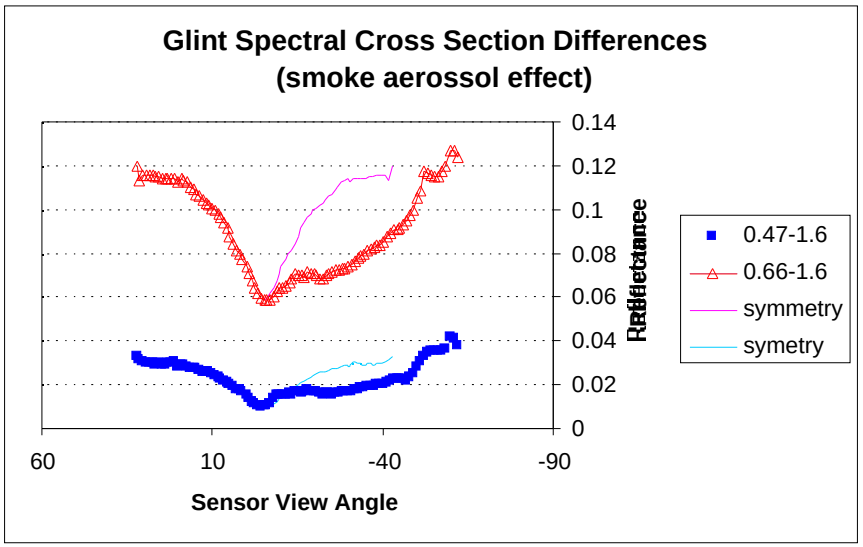
# Example from MODIS:

## Glint over Smoke from Biomass Burning  Optical Thickness Land/Ocean (misses Glint)







# Latest CLAMS updates

•ER-2 at Wallops Jul10-Aug 2. CLAMS could follow the ER-2 schedule to maximize our clear sky opportunities and also a shot at a good MISR overpass Jul 26 (science flight opportunites Jul12-Aug 1)

•We are very close to securing the CV-580. CERES is able to cover most of the CV-580 budget. There's still about a $40-80K shortfall which needs to be covered.

•An "MPLnet" MPL will be operating at ches light during CLAMS

•We've obtained a Support Manager from Wallops Flight Facility (Theodore Bugtong). He is our Wallops Liason and will be responsible for CLAMS airfield support (runways, office space, hangar space, supplies, etc). He's also reserved Wallops lodging space (barracks or dorms) as CLAMS will occur during the annual pony roundup and lodging in Chincoteague could be problematic.

# Latest CLAMS updates

•NAST wants to participate in CLAMS. There doesn't appear to be room on the ER-2. If it doesn't there's a possibility of adding another aircraft (Proteus). NAST would be self-supporting.

•Phil Russel has an airborne sunphotometer available for CLAMS but he depends on funding and personnel to support CLAMS. MODIS aerosol group is planning to help with personnel.

•We still lack an aerosol transport modelling/forecast component.

•We're still hopeful of having an AERI at ches light during CLAMS.

# CLAMS Planning Workshop
# Feb. 21-22, 2001

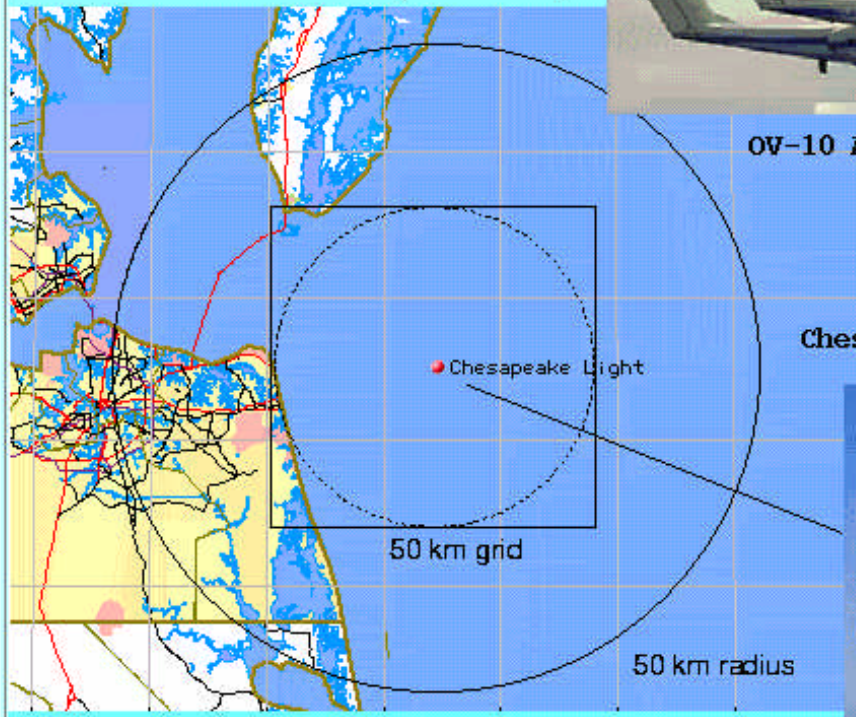
The CLAMS planning workshop will be held at the NASA Langley Research Center in Hampton, VA. starting at 8:00 AM Feb. 21-22, 2001 (all day wednesday, half-day thursday).

This will be the first formal gathering of CLAMS participants. The main focus of the workshop will be to review and modify a strawman operations plan.

oficiall CLAMS website: www.cave.larc.nasa.gov/cave/ by clicking on **CLAMS**

# Chesapeake Lighthouse & Aircraft Measurements for Satellites (CLAMS)

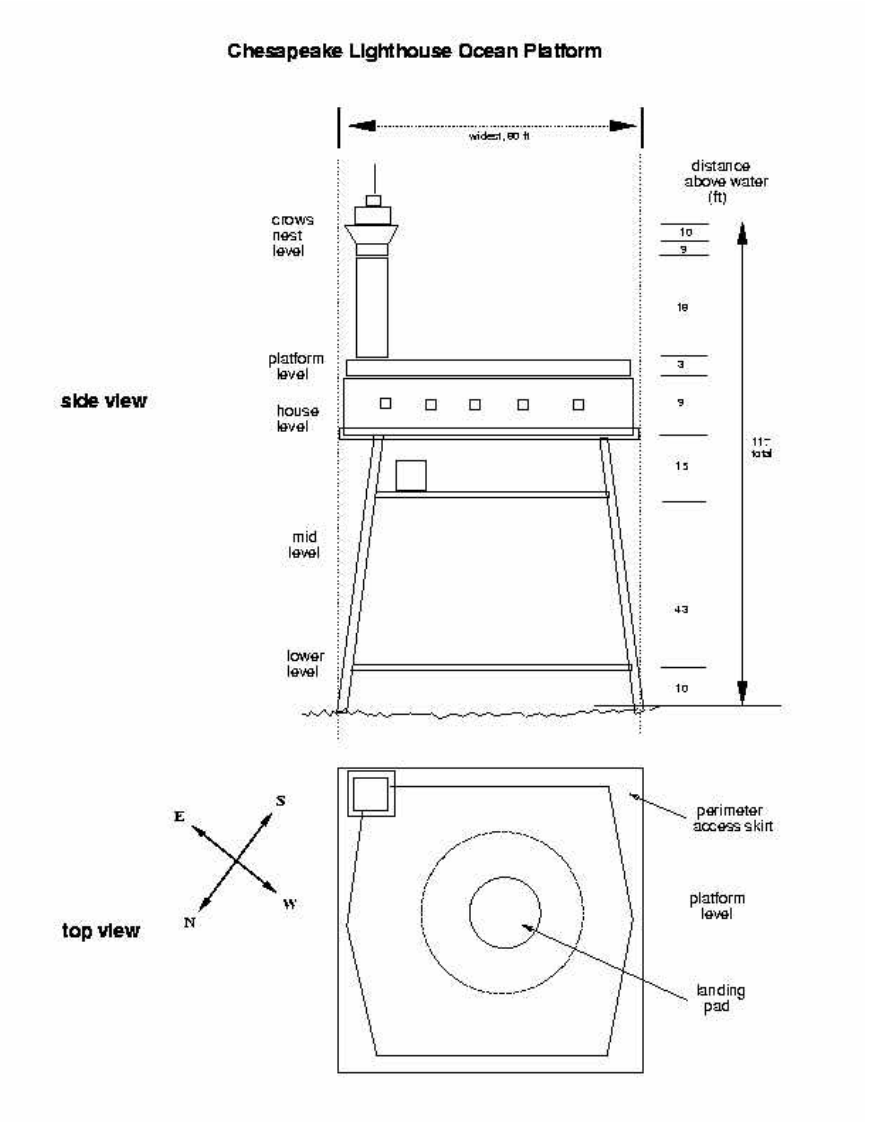
OV-10 Aircraft




Chesepeake Bay Lighthouse

Combining Long Term Ocean Spectral Surface Observations With Satellite & Aircraft Measurements To Enhance Our Knowledge of Oceans Surface Reflectences & Aerosols

# Lighthouse Schematics



| Observations | Instruments | Investigator/Institution |
|---|---|---|
| **Radiation and Aerosols** | | |
| Broadband fluxes, albedo | Solar and IR radiometers | |
| | - Eppley (BSRN), | Rutledge/LaRC |
| | - Modified Epply's | Haefflin/LaRC |
| | - Kipp & Zonen | Rutledge/LaRC |
| Spectral solar, direct, diffuse, and aerosol optical thickness | ASD FieldSpec | Rutledge/LaRC |
| | Sun Photometers | |
| | -Schultz | Su, Charlock/LaRC |
| | -Cimel | AERONET/GSFC |
| | Shadowbands | Denn/LaRC |
| | -MFRSR, TDDR | |
| Aerosols (vertical profile) | SMART network (location TBD) | Tsay/GSFC |
| | CPL | McGill, Spinhirne/GSFC |
| **Ocean Parameters** | Satlantic SMSR, SPMR | Cota/ODU |
| Incident up, down, subsurface spectral radiance, irradiance | WET Labs AC-9 (2x) | |
| Spectral absorption, attenuation | HOBI Labs HS-6 | |
| Spectral backscatter | Turner Design flourometer | |
| Chlorophyll a & phaeophytin | Shimadzu 2401 | |
| CDOM, particulate and phytoplankton abs. spectra | Elzone | |
| Particle size spectra | Schultz sunphotometer | Su, Charlock/LaRC |
| Water leaving radiance | Laser optical detector | Shaw/NOAA |
| Sea surface slope | IR wave sensor (standard) | NOAA |
| Wave activity | | |
| **Meteorology** | | |
| Surface (T, P, RH, U, V) | NOAA standard met. | NOAA |
| Profiles (T, P, RH) | Rawinsondes (Vaisala) | Maddigan/LaRC |
| Integrated water vapor | GPS | Maddigan.LaRC |