THE CHESAPEAKE LIGHTHOUSE AND AIRCRAFT MEASUREMENTS FOR SATELLITES (CLAMS) EXPERIMENT:
Mission Summary and Early Results

W. Smith, T. Charlock, K. Rutledge, T. Zhang and many others

A Radiative Closure Experiment for Satellite Product Validation

NASA ER-2
MAS, AirMISR, S-HIS

Cessna 210
Scanning Polarimeter

Proteus
LW, MW Spectra

NASA OV-10
SW Spectra, Broadband Radiation

University of Washington
Convair 580

In-situ Aerosols
Sun-photometry
BRDF

CERES Ocean Validation Experiment (COVE) at the Chesapeake Lighthouse

Meteorology
• RAOB
• T, Td, Wind
• GPS H2O

Radiation
• BSRN
• Spectral SW

Aerosols
• Aeronet
• MPL
• Chemistry

Oceanography
• Optical
• Biological/Chemical
• Physical
CLAMS Flight Summary

<table>
<thead>
<tr>
<th>Date (2001)</th>
<th>Aircraft</th>
<th>Location</th>
<th>AOT (500nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-Jul</td>
<td>1,2,4,5</td>
<td>COVE</td>
<td>0.23</td>
</tr>
<tr>
<td>12-Jul</td>
<td>1,2,3,4</td>
<td>COVE, E of Wallops</td>
<td>0.08</td>
</tr>
<tr>
<td>14-Jul</td>
<td>1,2,4,5</td>
<td>COVE</td>
<td>0.08</td>
</tr>
<tr>
<td>17-Jul</td>
<td>1,2,3,4,5,6</td>
<td>COVE</td>
<td>0.47</td>
</tr>
<tr>
<td>23-Jul</td>
<td>1</td>
<td>E of Wallops</td>
<td>0.06</td>
</tr>
<tr>
<td>26-Jul</td>
<td>1,2,4</td>
<td>COVE/Bouy 44014</td>
<td>0.17</td>
</tr>
<tr>
<td>30-Jul</td>
<td>1,2,3,4</td>
<td>COVE/Bouy 44014</td>
<td>0.06</td>
</tr>
<tr>
<td>31-Jul</td>
<td>1,2,3</td>
<td>Deep Ocn Bouy 44004/ D.Swamp</td>
<td>0.08</td>
</tr>
<tr>
<td>2-Aug</td>
<td>1,2,3</td>
<td>COVE</td>
<td>0.1</td>
</tr>
</tbody>
</table>

1. UW CV-580: AATS-14, CAR, BBSW, UV, in-situ Aerosols, scattering, absorption
2. LaRC OV-10: BBSW, BBLW, Spectral SW
3. NASA ER-2: AirMISR, MAS, S-HIS, AVIRIS
4. Proteus: NAST-I, NAST-M, FIRSC
5. Cessna 210: Research Scanning Polarimeter
6. Lear 25C: LAABS (LaRC A-band)

*note: the Cessna and Proteus flew missions on other days to accomplish other objectives*
CLAMS: JULY 17, 2001
Satellite

VZA = 14°
CLAMS Golden Day: July 17,
Aircraft Profiles over Chesapeake Light!
(BSRN, Aeronet, MPL, Ocean BRDF)
CLAMS Aircraft Converging on COVE during TERRA Overpass
July 17, 2001
CLAMS: July 17, 2001

COVE WINDS

The Data from JUL/17 of 2001

COVE, h 36 55', W 75 42', Alt 0 m
PI: Brent Holben, brent@aeronet.gsfc.nasa.gov
Data from JUL/17, 2001

MPL-NET/Chesapeake Lighthouse, VA -- CLAMS Experiment Observations (Unit 62, c-02-251
17Jul01 Micro Pulse Laser Normalized Relative Backscatter

138.0   138.2   138.4   138.6   138.8   140.0
0       2       4       6       8       10
Height AGL (km)

17 < Day in CMT
JUL
2001
“Window” region spectral radiance comparison between NAST-I on Proteus (~15.5 km) and SHIS on the ER-2 (~20 km) near the Chesapeake Lighthouse.

Small difference here (near 12 µm) consistent with the presence of small ice particles within the 15.5-20 km layer.
Vertical Profile of Scattering and Absorption Coefficients UW CV580

Flight Track

Absorption and Scattering Coefficients
Vertical aerosol structure, July 17, 2001
From the AMES Sunphotometer

[Graph showing aerosol optical depth and extinction vs. altitude]
Filter sampling in each layer

- **PM2.5 = 42 µg/m³**
  - **BC = 0.44 µg/m³**
- **PM2.5 = 30 µg/m³**
  - **BC = 0.3 µg/m³**
- **PM2.5 = 31 µg/m³**
  - **BC = N/A**
- **PM2.5 = 38 µg/m³**
  - **BC = 0.54 µg/m³**
Physical Properties in Each Layer

**Scattering Coefficient Green**

![Scattering Coefficient Green Graph]

**Single Scatterin**

![Single Scatter Graph]

*Longitude*

**Scattering Coefficient Green (10^{-5} \text{ m}^{-1})**

0.85 0.90 0.95 1.00

[Graph showing the variation of scattering coefficient green across different longitudes]
V-580/AATS-14 location, CLAMS July 17, 2001, 16:00 - 16:15 UTC
AOD variability on July 17th, 2001

AOD~25%
Downwelling Spectral Flux Profile Measured by the OV-10 near COVE (July 17, 2001)
Upwelling Spectral Flux Profile Measured by the OV-10 near COVE (July 17, 2001)
Calculated vs. Measured Downwelling Spectra at 10kft
July 17, 2001

Measured (ASD FR)
Calculated (SBDART)
BRDF from the Cloud Absorption Radiometer on the UW-CV580

CALM
CAR BRDF AT CHESAPEAKE LIGHT HOUSE: 17 JULY 2001

WINDY
CAR BRDF AT BOUY 44004: 30 J

Lat = 35.90° N
Long = 75.70 - 75.74° W
Alt = 169 m
Time = 16:46-17:03 UTC
Solar zenith angle = 21.8°

Wed, Feb 27 20:20:16 2002 CAR Team
Spectral albedo measured by the OV-10 near COVE during CLAMS
Coastal waters can be extremely dynamic and complex! (layers, runoff, mixing, etc.)

Shallow water (CLT = 11m)

Plume: FW, CDOM, & SS

Optically thick or thin

Case 1 (chl) or 2
Plant biomass (chlorophyll) vs. time at COVE

Chlorophyll time series
n = 87
Avg = 1.33
Std = 0.90
TRANSIT TO THE DARK GULF STREAM WATER ON OCT 2, 2001

OV-10 Flight Track
Oct. 2, 2001

SeaWIFS
CHLORA

Spectral Albedo Measured Near COVE (a), East of Cape Hatteras (b), and the gulf stream (c)

Albedo Time Series in Transit to Gulf Stream

BB Albedo (SZA)
0.048 (41.3°)
0.032 (40.4°)
0.033 (40.6°)
SOME TIDBITS OF RESULTS ON AEROSOLS FROM MEASUREMENTS ABOARD THE UNIVERSITY OF WASHINGTON'S CONVAIR-580 AIRCRAFT IN CLAMS

by

Peter V. Hobbs

University of Washington

and

Tom Kirchstetter and Tica Novakov

Lawrence Berkeley National Laboratory
FOR MORE INFORMATION ON THE UNIVERSITY OF WASHINGTON'S CONVAIR-580 FLIGHTS IN CLAMS SEE

Summary of Flights and Types of Data Collected Aboard University of Washington's Convair-580 Research Aircraft in the Clams Field Study on the United States East Coast From 10 July Through 2 August 2001"

by

Peter V. Hobbs

November 2001

Available at the ftp address:

//cargsun2.atmos.washington.edu/clams-report/CLAMS-MASTER
Aerosol Mass Concentration vs. Dry Scattering Coefficient From University of Washington's Airborne Measurements in CLAMS

\[ R^2 = 0.87 \]
Carbonaceous Aerosol Mass Fractions in CLAMS From University of Washington’s Airborne Measurements

Carbon Mass/Total Particulate Mass (%)

Sample ID

UW Flt. #

Date (2001)

1870  1871  1872  1873  1874  1875  1878  1879  1880  1881+ 1882  1881  1881

10 July  12 July  16 July  17 July  23 July  26 July  30 July  31 July  2 Aug.  2 Aug.

1870  1871  1872  1873  1874  1875  1878  1879  1880  1881+ 1882  1881  1881

0  25  50  75  100
Total Carbon Concentration vs Dry Absorption Coefficient From University of Washington's Airborne Measurements in CLAMS

slope = 0.4 m² g⁻¹

R² = 0.72
Upcoming Milestones

- CLAMS special session (25 papers) at Spring AGU meeting (May 28-29, 2002: Wash D.C)
- Abstracts for joint publication effort due Oct 1; submissions early December
- All data in final form should be available at the Langley ASDC in early December

http://www-clams.larc.nasa.gov/clams
CLAMS SUMMARY

- Conducted nine successful coordinated aircraft experiments coincident with TERRA overpass.
- Sampled a variety of aerosol conditions ranging total 500 nm optical thickness ranging from 0.06 to 0.5 with in-situ measurements of aerosol scattering and absorption properties to validate MODIS and MISR and test CERES SARB.
- Conducted at least six good MISR and MODIS aerosol retrieval validation experiments.
- Conducted three MODIS ‘Glint’ experiments with MAS and MODIS.
- Conducted two spatial variability experiments for MISR.
- Obtained measurements of coastal, offshore and deep ocean BRDF(15 total; 8 uncontaminated by cloud) under a variety of sun angles and wind conditions for CERES, MISR and MODIS.
- Conducted twelve OV-10 flights measuring shortwave fluxes for CERES to improve ocean optics parameterizations, test the validity of COVE platform measurements and assess the spatial variability of ocean optical properties.
- July 17 was “Golden Day” with moderate aerosol and six aircraft vertically stacked over the Chesapeake Lighthouse at TERRA overpass time.
Chesapeake Lighthouse and Aircraft Measurements for S

CLAMS DO FLY!

YOU BELIEVE EVERY THING YOU HEAR

WHAT WAS THAT?

I DON'T KNOW!

CLUNK

Uh-Oh

Mayday, Mayday...

PUTTER

CLUNK RATTLE

I SEE THE LIGHT!

WHICH WAY DO WE GO?

CRUNK SPAP

WE'VE GOT "LESS" WHAT MORE DO YOU WANT?

WINGS!

ODE TO CLA

THERE IS A L

THERE WAS A F

CLAMS DO F

BY THE LIGHT OVER THE LIG.

CLAMS DO F
CLAMS: July 17, 2001

CV-580
- slow spiral over COVE (100 ft – 11kft)
- Aerosol chemistry@ 9, 6, 3 kft (L-pattern)
- 100 ft AOD run (west to east)
- BRDF near COVE

T/O = 1235 UTC
Land=1812 UTC

ER-2
- Glint pattern
- Geo-Cal
- COVE track (parallel to TERRA);
  airMISR nine angle mode
- Track to 44014

T/O = 1300 UTC
Land=1701 UTC
CLAMS: July 17, 2001

**OV-10**
- 10 kft leg mouth of bay to east of COVE
- 3 kft reverse leg
- 600 ft daisy at NE waypoint
- 600 ft crop-duster over COVE
- 600 ft tack se to nw COVE to bay bridge

T/O = 1623 UTC
Land=1812 UTC

**CESSNA**
- 12kft crop-duster (PP), tracks 90° to PP
- 200 ft rosette
- 12 kft rosette
- Dismal swamp tracks

T/O = 1330 UTC
Land=1800UTC
CLAMS: July 17, 2001

**PROTEUS**
- COVE profile (2-55 kft)
- Mapping pattern (55 kft)
- Wallops Profile (55-2 kft)

T/O = 1431 UTC  
Land=1832 UTC

**Lear Jet**
- Tracks at 40 kft parallel to TERRA overpass with LAABS (A-band)

T/O = 1500 UTC  
Land=1800 UTC