Overview of A Study on MODIS Aerosol Retrievals Under Cloudy Sky Conditions

Nitchie Manalo-Smith
Analytical Services & Materials

Norman Loeb
Hampton Univ./NASA LaRC

Question: How consistent are the MODIS cloud mask and the CERES cloud mask?

- Does MODIS perform aerosol retrievals when CERES identifies a scene as cloudy?
- Determine frequency of occurrence of MODIS aerosol retrievals when the CERES cloud algorithm detects the presence of clouds.
- Determine regional distribution of these occurrences as well as mean aerosol properties (AOD) for these cases.

Method

- DATA: SSF/Terra/RAPS (Aug/Sep 2002)

  CERES - Cloud Cover condition in FOV (% Cloud Fraction)

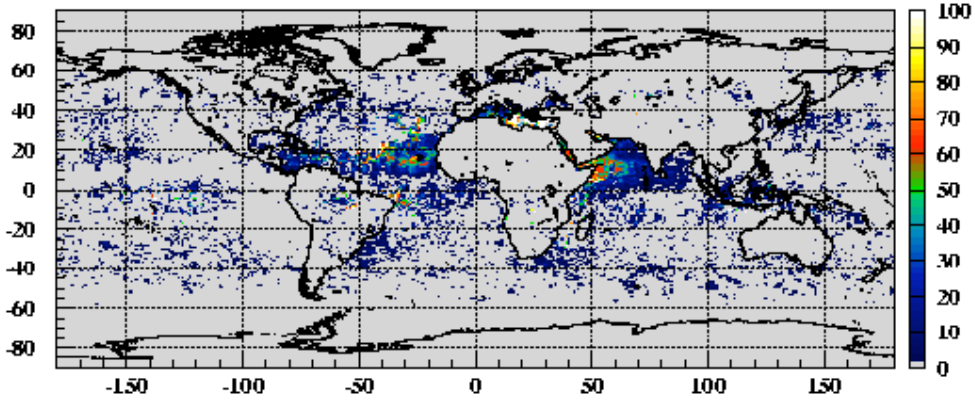
  MODIS - MOD04 Aerosol Product

  - Aerosol optical depth (AOD from 0.66 μm)
  - % aerosol coverage (estimated from flags indicating percentages of various aerosol types)

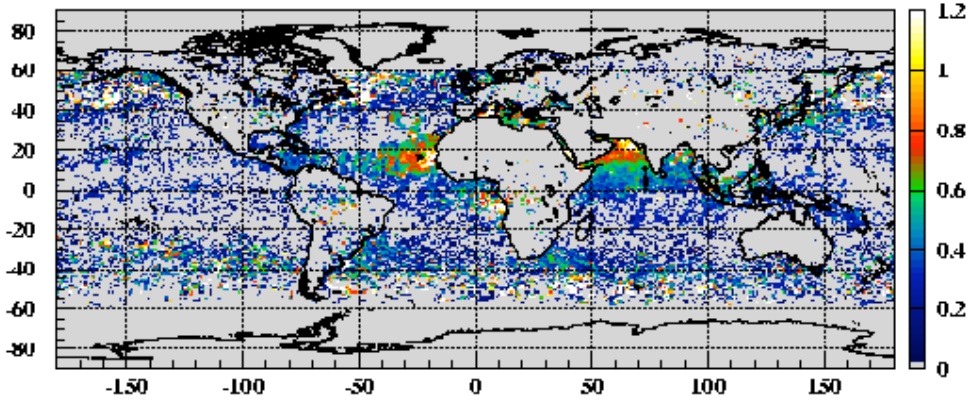
- Determine FQ of aerosol retrievals for % CF range (< 25,25-50, 50-75, >75, 100%) and mean optical depth (computed for 1°x1° latitude/longitude regions).

MODIS Aerosol Retrievals Under Overcast Conditions

Terra / August 2002



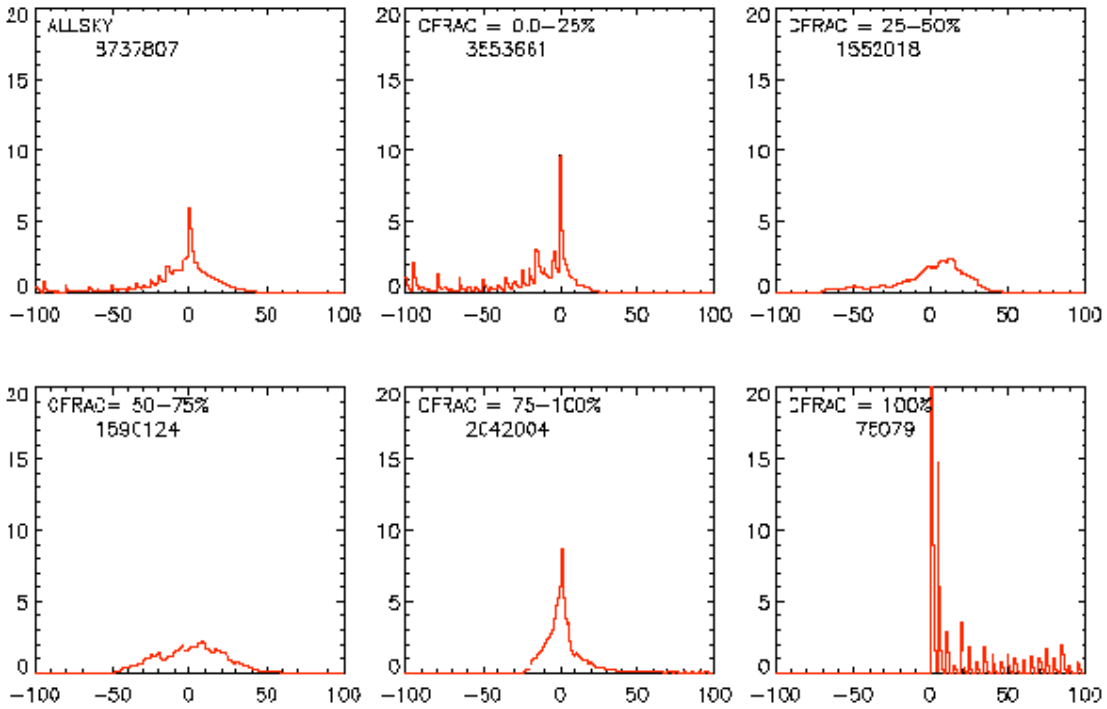
% of Overcast FOVs with MODIS Aerosol Retrievals



Mean Aerosol Optical Depth (0.66 μm)

Relative FQ of [MODIS %Aerosol Coverage - CERES Clear Area % Coverage)

FQ



% Aerosol Coverage - [100-Cloud Fraction (%)]

Aerosol Direct Radiative Impact Experiment
ADRIEX
August/September 2004

- Objectives: (http://metresearch.net/adriex)

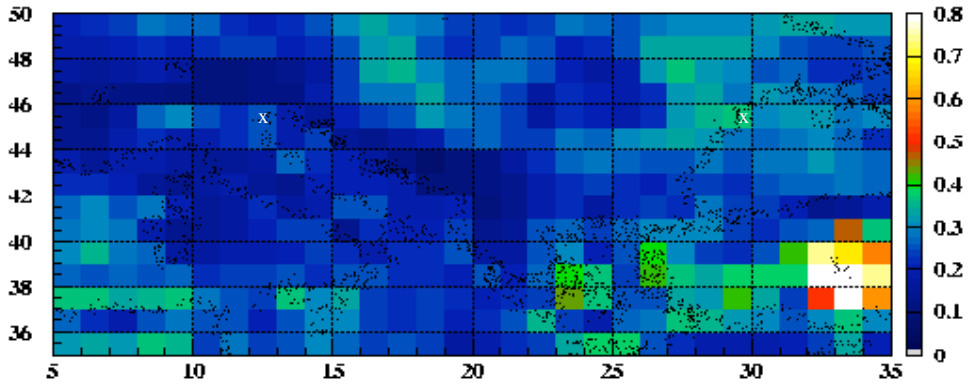
  - To obtain high quality in-situ and remotely-sensed measurements of physical and optical properties of anthropogenic aerosols that will be used to quantify and understand direct aerosol effects over the Eastern/Western European ocean regions.

- Time/Location: Aug. 21-27 / 45N, 13E (Treviso, Italy)
  Aug. 27 - Sept. 6 / 45N, 30 E (Kishinev,Moldova)

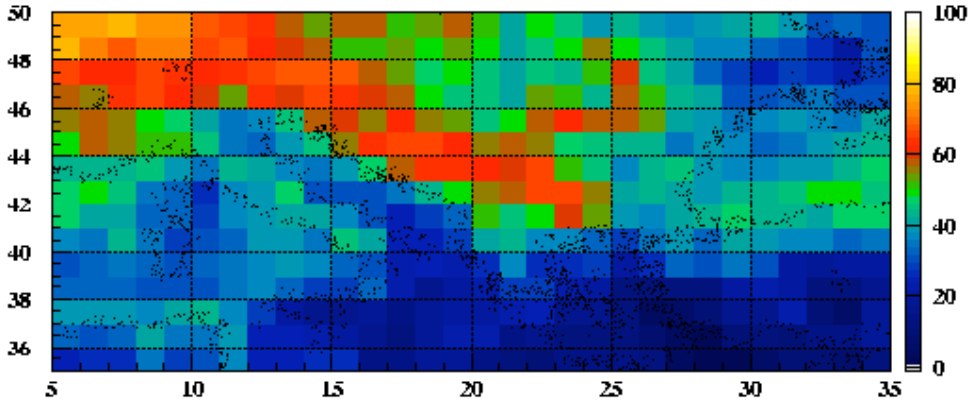
- CERES Support: Terra/Aqua to provide PAPS (Programmable Azimuth Plane Scanning) measurements over the ADRIEX region.

Mean Aerosol Optical Depth and Cloud Fraction over CERES FOV

August 2002 (Proposed ADRIEX Campaign Region)



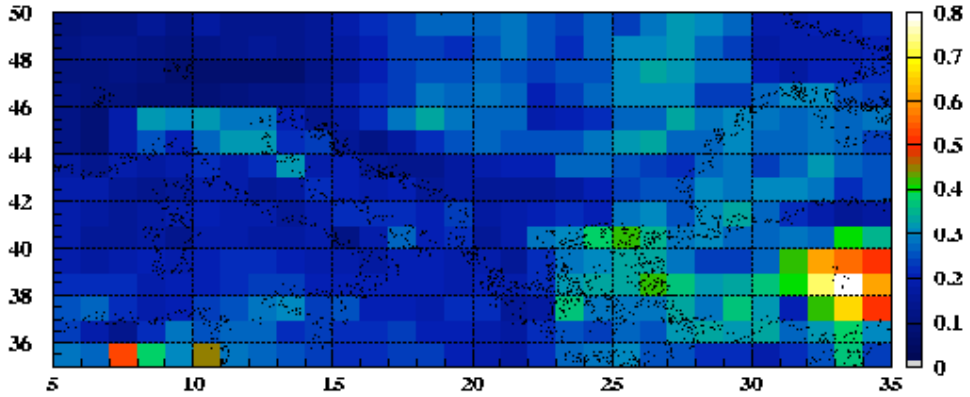
Mean Optical Depth (0.66 μm)



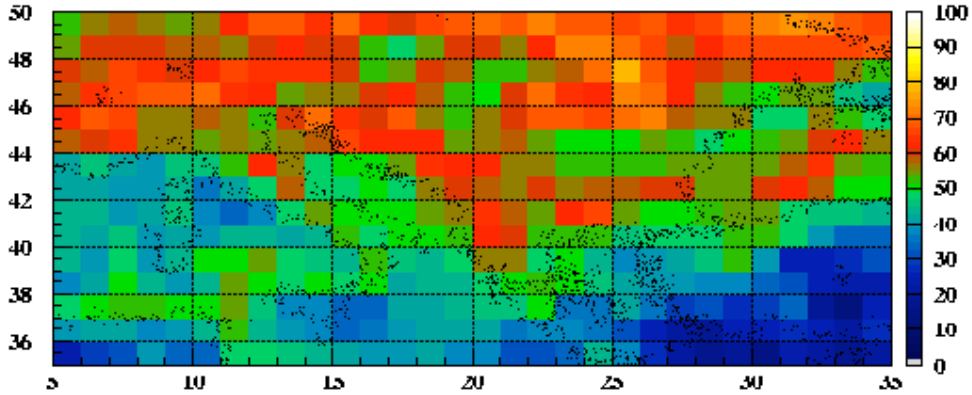
Mean Cloud Fraction (%)

Mean Aerosol Optical Depth and Cloud Fraction over CERES FOV

September 2002 (Proposed ADRIEX Campaign Region)



Mean Optical Depth (0.66 μm)



Mean Cloud Fraction (%)

Summary

- Some MODIS aerosol retrievals have been observed under cloudy sky conditions. An overcast case shows the strong presence of aerosol over the eastern equatorial Atlantic and the Arabian Sea. This may/may not be due to dust outbreaks in the region (need to define source).

- We need to further investigate the sources of these discrepancies between the MODIS and CERES cloud masks.

- For ADRIEX, CERES will provide PAPS measurements. FQ distributions of aerosol optical depths and cloud cover over the region are determined for future reference when field data becomes available.

Preliminary Results from Validation of LW Clear Sky ADMs Using Theory

Nitchie Manalo-Smith
Analytical Services & Materials

Norman Loeb
Hampton University/NASA LaRC

Overview

- Objective:

  Validate methodology of CERES LW clear sky ADM development.

- Method:

  Simulate CERES ADM development using theoretical radiances. Check consistency between ADM-derived fluxes and theoretical fluxes.

MODTRAN Calculations

- Broadband radiances from MODTRAN4
- 45 viewing zenith angles (2-deg resolution) w/ angles defined at surface reference level
- CO_2 concentration = 360 ppmv for all cases

I. Clr.outbb

Atm Models

1. Tropical (15 Annual Average)
2. Midlat Summer (45N July)
3. Midlat Winter (45N January)
4. Subarctic Summer (60N July)
5. Subarctic Winter (60N January)
6. U.S. Standard Atmosphere (1976)

PW (cm)

4.12 (Tropical)
2.89 (Midlat Summer)
0.796 (Midlat Winter)
2.03 (Subarctic Summer)
0.382 (Subarctic Winter)
2.47 (U.Standard Atmosphere)

Surface Temps (K)

250, 255, 260, 265, 270, 275, 280, 285, 290, 295, 300, 305, 310, 320,330,340,350

II. Clr2.outbb

Atm Model

Subarctic Winter (60N January)

PW (cm)

2.03 (Subarctic Summer)
0.382 (Subarctic Winter)

Surface Temps (K)

200, 205, 210, 215, 220, 225, 230, 235, 240, 245

Validating LW ADM Development Method

Read in FOV meteorological, surface and viewing angle information
Map MODTRAN radiance to appropriate profile.

Composite radiance L_{MOD} into surface type and discrete intervals of scene type parameters (VZA, PW, Vertical Temperature Change, Skin Temperature)

Generate ADMs

$$R = \pi \overline{L_{MOD}} / M$$

where $M = 2\pi \int_0^{\pi/2} \overline{L_{MOD}} \cos\theta \sin\theta \, d\theta$

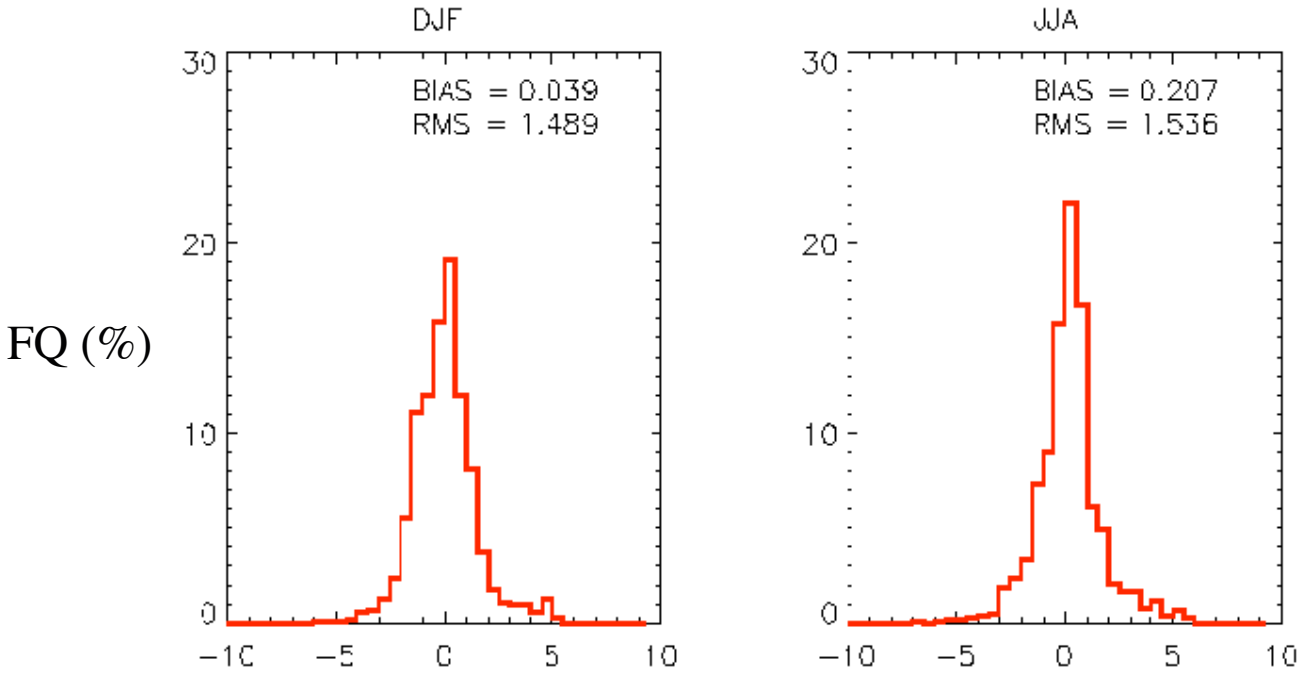
Compute Instantaneous Fluxes

MODTRAN Radiances are matched to FOV conditions

$$\hat{F} = \pi L_{MOD} / R$$

$$\Delta F = \hat{F} - F(\text{Theoretical})$$

FQ of Clear Sky LW Flux Difference (Instantaneous - Theoretical)



Summary

- Simulating the ADM development using theoretical radiances is a tool for checking for any discretization or coding errors in the methodology.
- Validation results did not show any problems with the methodology of clear sky ADM development.