Understanding The MODIS Aerosol Products

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MODIS LEVEL II Product List

MOD04 Aerosol

MOD06 Cloud

MOD05 Water Vapor

MOD07 Atmosphere Profile

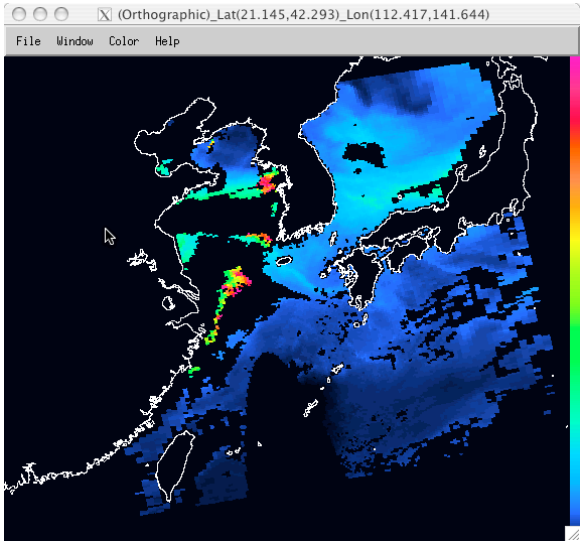
MOD35 Cloud Mask

MODIS Aerosol Products

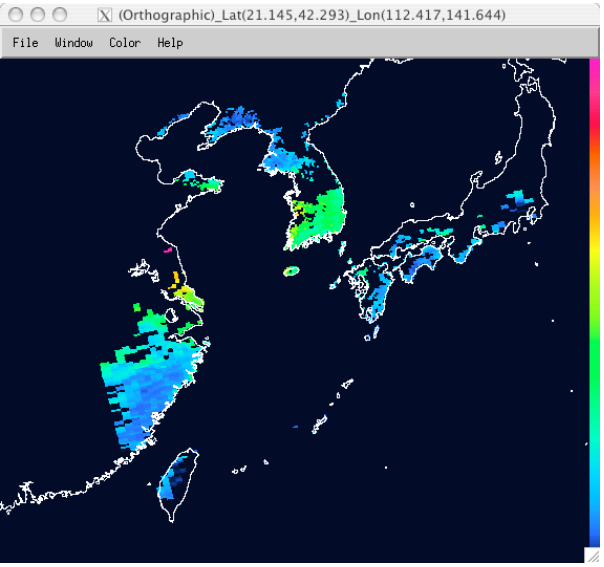
Three Separate Algorithms

Land

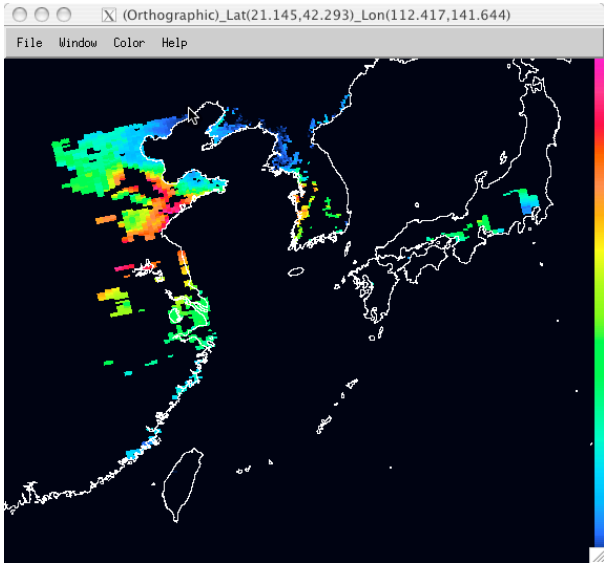
Ocean



Dark Target



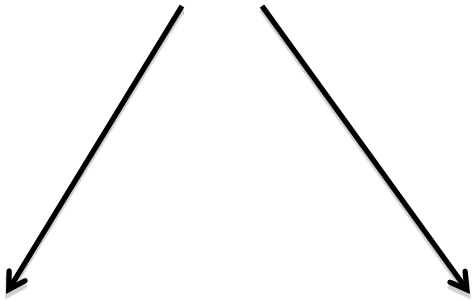
Deep Blue



MODIS Aerosol Products

Three Separate Algorithms

Land



Ocean

There is a very detailed presentation on the MODIS ocean algorithm available at http://ARSET.gsfc.nasa.gov/materials

Dark Target

Deep Blue – Used over bright land surfaces

Currently the dark target and deep blue products are separate
When both are available the user must select which one to use.

In collection 6 there will be a joint product that uses an automated procedure to select the appropriate product.

MODIS Aerosol Products

All three algorithms create a 10 Km product.
Land and Ocean 400 half kilometer pixels.
Deep Blue 100 one kilometer pixels

Ocean and Land (dark target) algorithms are based on the assumption that aerosols brighten the scene.

Retrievals can only occur where there are a sufficient number of spectrally dark pixels.

Aerosol SDS and What They Really Mean

The Ocean and Land algorithms each produce their own SDS's. When both algorithms retrieve the same parameter they may be combined into a joint Land_and_Ocean SDS.

The individual Land or Ocean SDS is generally preferred because

- it contains more wavelengths
- gives more information about quality
- at level 3 it gives a quality weighted product that screens out anomalies

Land_And_Ocean Is useful if you need both together but may not give the same results as Land or Ocean

MOD04 MODIS AEROSOL PRODUCTS MYD04

Important Points to Remember for MODIS Aerosol Products

- Ocean and Land Products are produced using totally separate and distinct algorithms. All current aerosol products are in 10 Km (10 x 10) resolution.

- The most important products are **Aerosol Optical Depth** and **Fine Fraction**. These exist for both Ocean and Land.

- **Fine Fraction** over land should be seen as a **qualitative** indicator not as a quantitative measurement.

MOD04 Aerosol Products MYD04

Main Products - Ocean

Effective_Optical_Depth_Average_Ocean
Retrieved AOD at .47, .55, .66, .86, 1.24, ***1.63***, 2.13

Optical_Depth_Ratio_Small_Ocean_0.55*
Fraction of Fine Mode AOD at 0.55

Optical_Depth_Small_Average_Ocean
AOD * Fine Mode Ratio

MOD04 Aerosol Products MYD04

Average_Ocean vs Best_Ocean

Although there is usually a unique best solution to the MODIS ocean retrieval algorithm there may be many solutions within acceptable error limits. These solutions are used to obtain the Average_Ocean SDS results.

We always recommend using:
Average_Ocean rather than Best_Ocean SDS's

Quality Assurance is Extremely Important!!

QA is our indication of how much confidence we have in quality of the retrieval.

Quality_Assurance_Ocean
Scale is 0 - 3

We use Ocean QA above 0

Factors:
Number of pixels
Error fitting
How close to glint

Quality_Assurance_Land
Scale is 0 - 3

We use Land QA of 3

Factors:
Number of pixels
Error fitting
Surface reflectance

Additional Products - Ocean

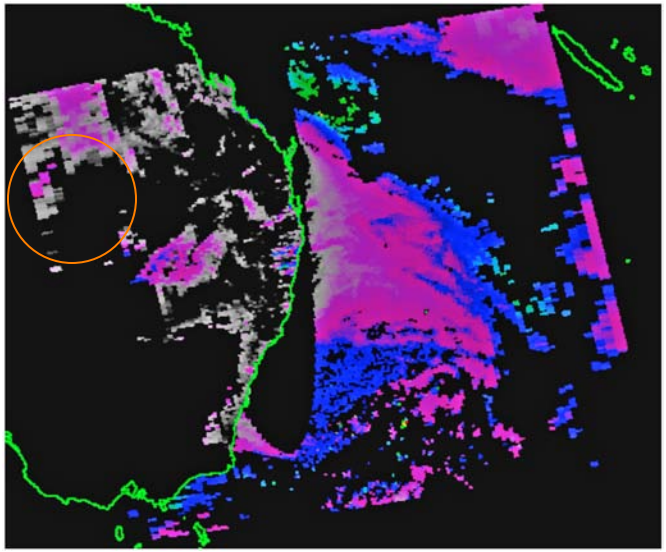
Optical_Depth_Large_Average_Ocean
(1 - Fine Fraction) * AOD for the 7 ocean wavelenghts

Mass_Concentration_Ocean*
Total column mass per unit area in units of $1.0e^{-6}g/cm^2$

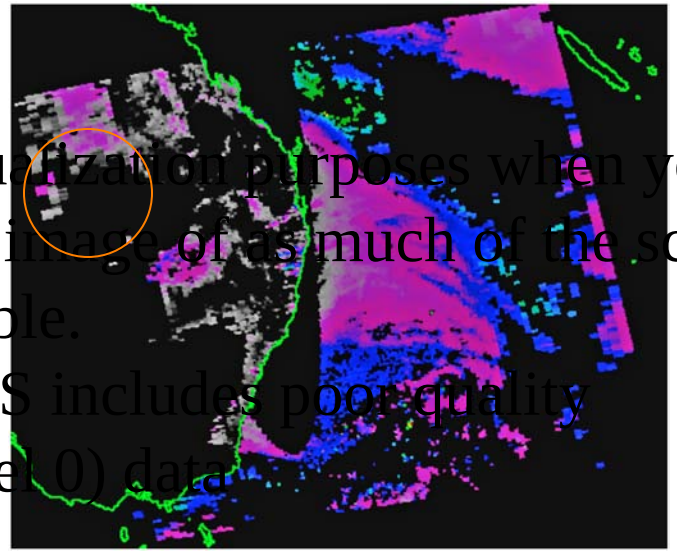
Angstrom_Exponent_1_Ocean* 0.55/0.86
Angstrom_Exponent_2_Ocean* 0.86/2.1

Optical_Depth_by_models_ocean
Retrieval AOT per model. This information is carried into the level 3 products.

Effective_Radius_Ocean
Effective Radius at 0.55 for both the fine and coarse modes.

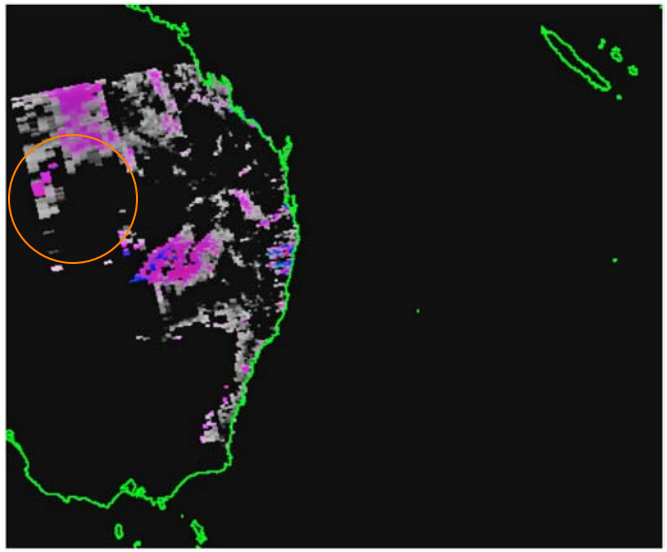


Image_Optical_Depth_Land
_and_Ocean



Optical_Depth_Land_and_Ocean

For Visualization purposes when you want an image of as much of the scene as possible.
This SDS includes poor quality (QA level 0) data.



Corrected_Optical_Depth_Land

Land_And_Ocean vs Land or Ocean

Land or Ocean separately is preferred because
- it contains more wavelengths
- gives more information about quality
- at level 3 it gives a quality weighted product that screens out anomolies

Land_And_Ocean Useful if you need both together and may not give the same results as Land or Ocean

Average_Ocean vs Best_Ocean

Average_Ocean is the average of all solutions to the AOT retrieval algorithm having results within acceptable error limits.

Best_Ocean is the single best solution to the AOT retrieval algorithm

There are several SDS results that have two dimensions one corresponding to the average solution and one correponding to the best solution.

MOD04 Aerosol Products

Main Products - Land

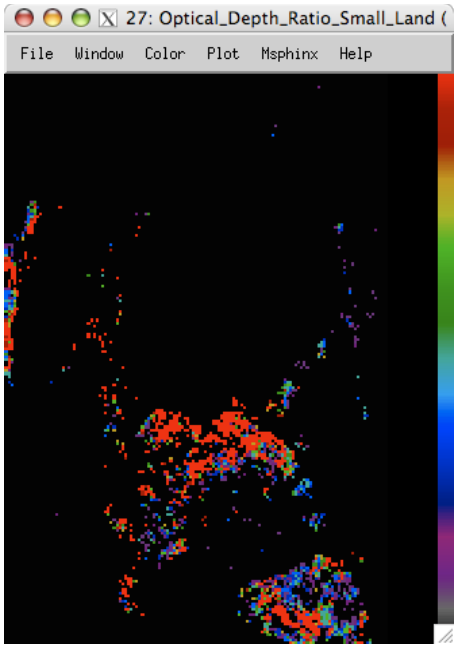
Corrected_Optical_Depth_Land
Retrieved AOD at .47, .55, and .66

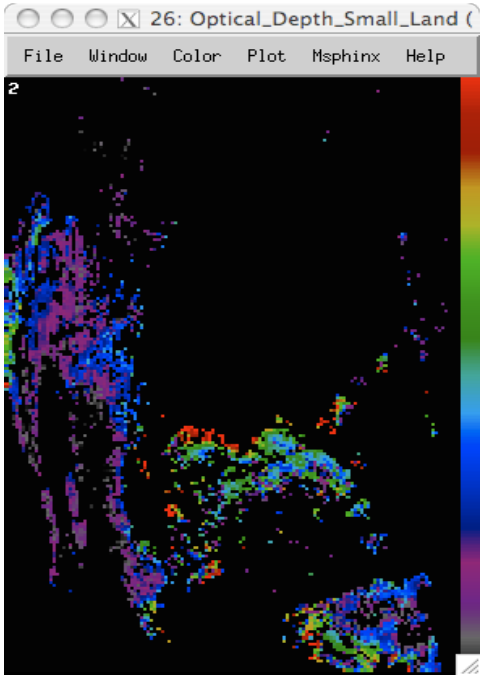
Optical_Depth_Ratio_Small_Land
Frac

A Qualitative Product Only!

Not reported for AOD < 0.2

Optical_Depth_Small_Land
AOD * Fine Mode Ratio
(may be a threshold)





The standard MODIS aerosol LAND algorithm
relies on finding dark targets.
For this reason it is unable to make retrievals over bright surfaces such as deserts.

To correct this problem a new algorithm called "Deep Blue" was developed.

Deep Blue relies on the blue wavelengths and libraries of surface reflectance to make retrievals in these areas.

Deep Blue SDS Names:
Deep_Blue_Aerosol_Optical_Depth_550_Land
Deep_Blue_Aerosol_Optical_Depth_Land
Deep_Blue_Angstrom_Exponent_Land
Deep_Blue_Single_Scattering_Albedo_Land
Deep_Blue_Surface_Reflectance_Land

Dark Target Algorithm Summary (Land)

1) Screen out unwanted features
   - clouds
   - water
   - snow/ice pixels

2) Discard brightest 50% and darkest 20% of pixels

3) Apply retrieval algorithm if sufficient pixels remain

Dark Target Land Algorithm

1) Use spectral relationships to remove residual surface effects

2) Based on location and season select the correct model of fine mode aerosol. There are three possible models.

3) There is one coarse mode model representing dust aerosol.

4) Use inversion procedure to mix the amount of fine and coarse aerosol to obtain the best match to the measured spectral reflectances within the error limits.

Deep Blue Aerosol Retrieval Algorithm

(1) Screen-out unwanted features (e.g., clouds, water, snow/ice, and vegetated pixels).

(2) Estimate surface reflectance from seasonally-varying global data base.

(3) Apply retrieval algorithm

- **Maximum likelihood method to determine optimal aerosol model**
- **2-channel algorithm for low-to-moderate aerosols**
- **3-channel algorithm for heavy dust aerosols**

(4) Deep Blue aerosol products

- **AOT, Angstrom exponent, and SSA for dust**
- **AOT and Angstrom exponent for fine mode and mixed aerosols**

How Surface Reflectance Data Base Was Derived

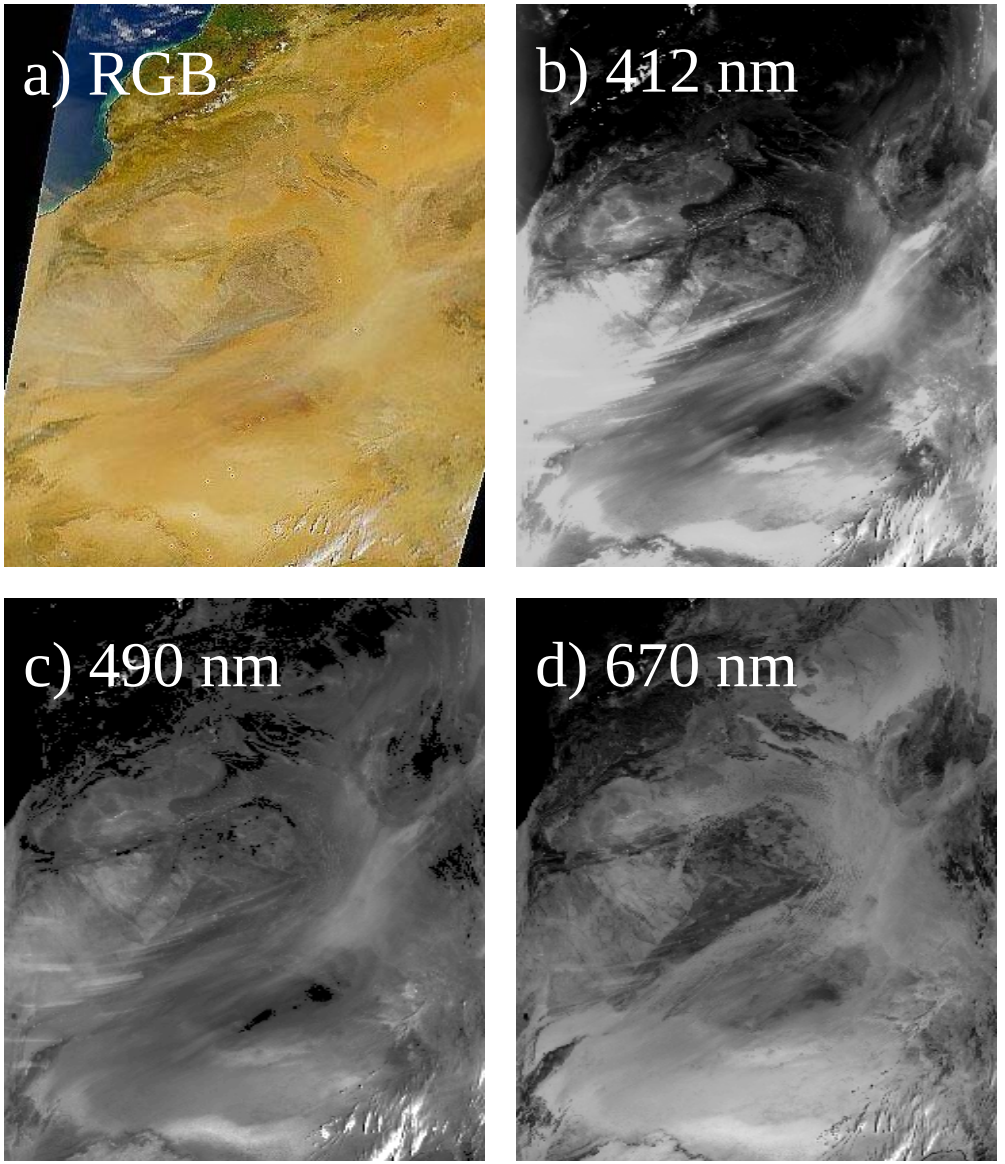
(1) We calculate the daily reflectances for each pixel and bin them into different viewing angles to account for surface BRDF effects

(2) We compile three months of data to look for the minimum reflectance for each 0.1 x 0.1 degree latitude-longitude box and for each viewing angle

The Deep Blue Advantage

- *Deep Blue uses information from blue channels, where the surface is darker*
  - *412nm, 470nm, 650nm (MODIS bands 8, 3, 1)*

Saharan Desert - Feb. 10, 2001



Thin narrow dust plumes were seen clearly at 412 nm reflectance image, but not discernible at 670 nm image.