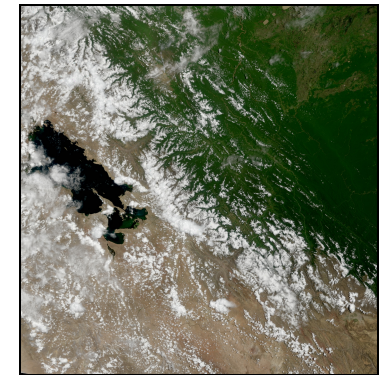
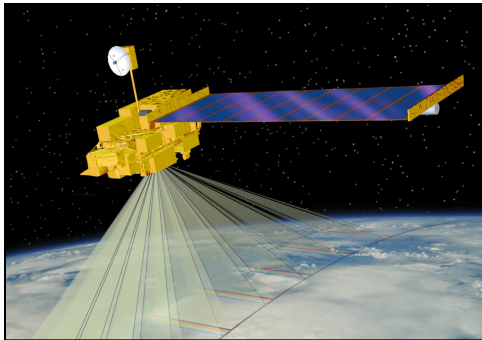




DB Product Applications

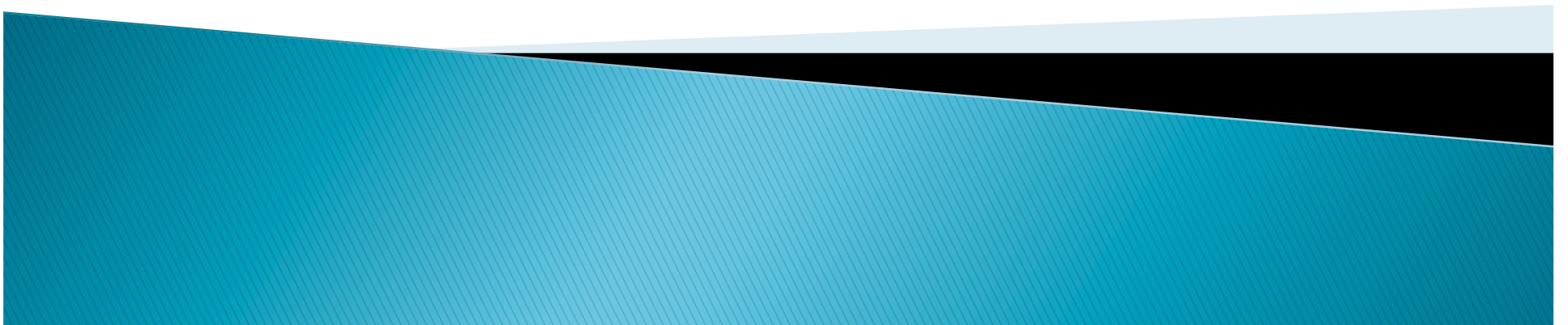
**2011 WMO RA V Workshop
Citeko, Bogor, Indonesia
22 September 2011
Part 3**



Kathleen Strabala

Cooperative Institute for Meteorological Satellite Studies
Space Science and Engineering Center
University of Wisconsin-Madison

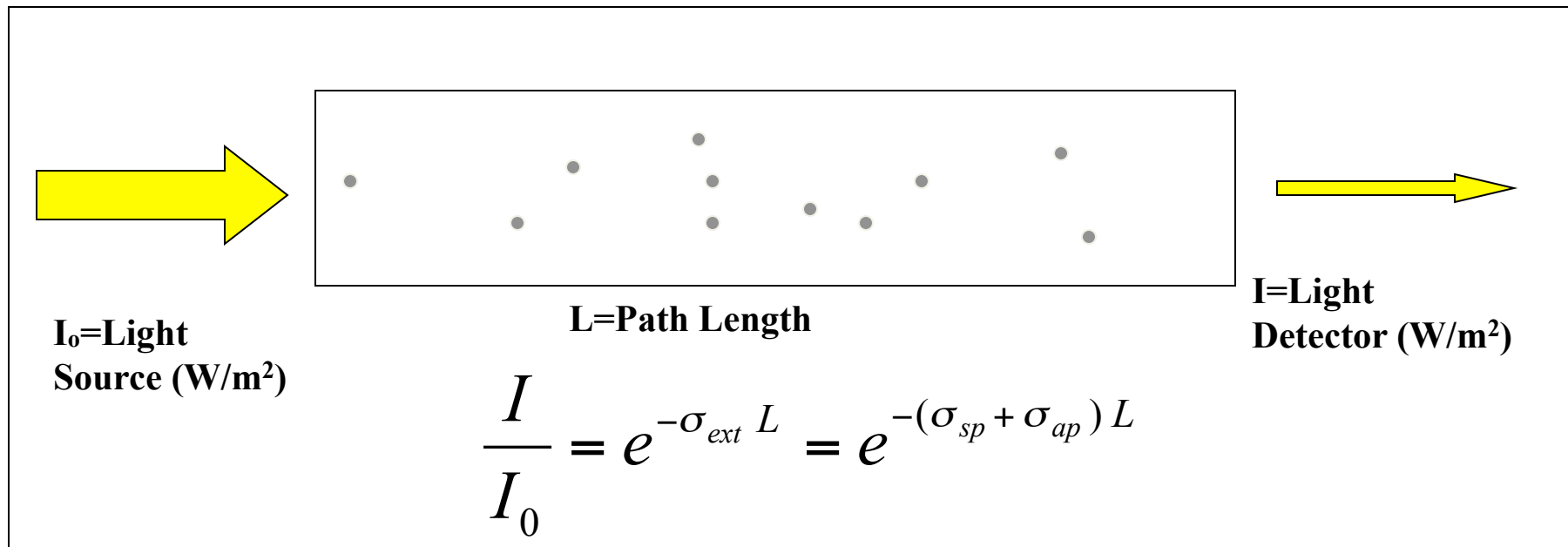
MODIS Aerosol Product (MOD04)



Air Quality Applications

Aerosol Detection

Scattering and Absorption of Light by Aerosols



$$\tau = (\sigma_{sp} + \sigma_{ap}) * L \quad \omega = \sigma_{sp} / (\sigma_{sp} + \sigma_{ap})$$

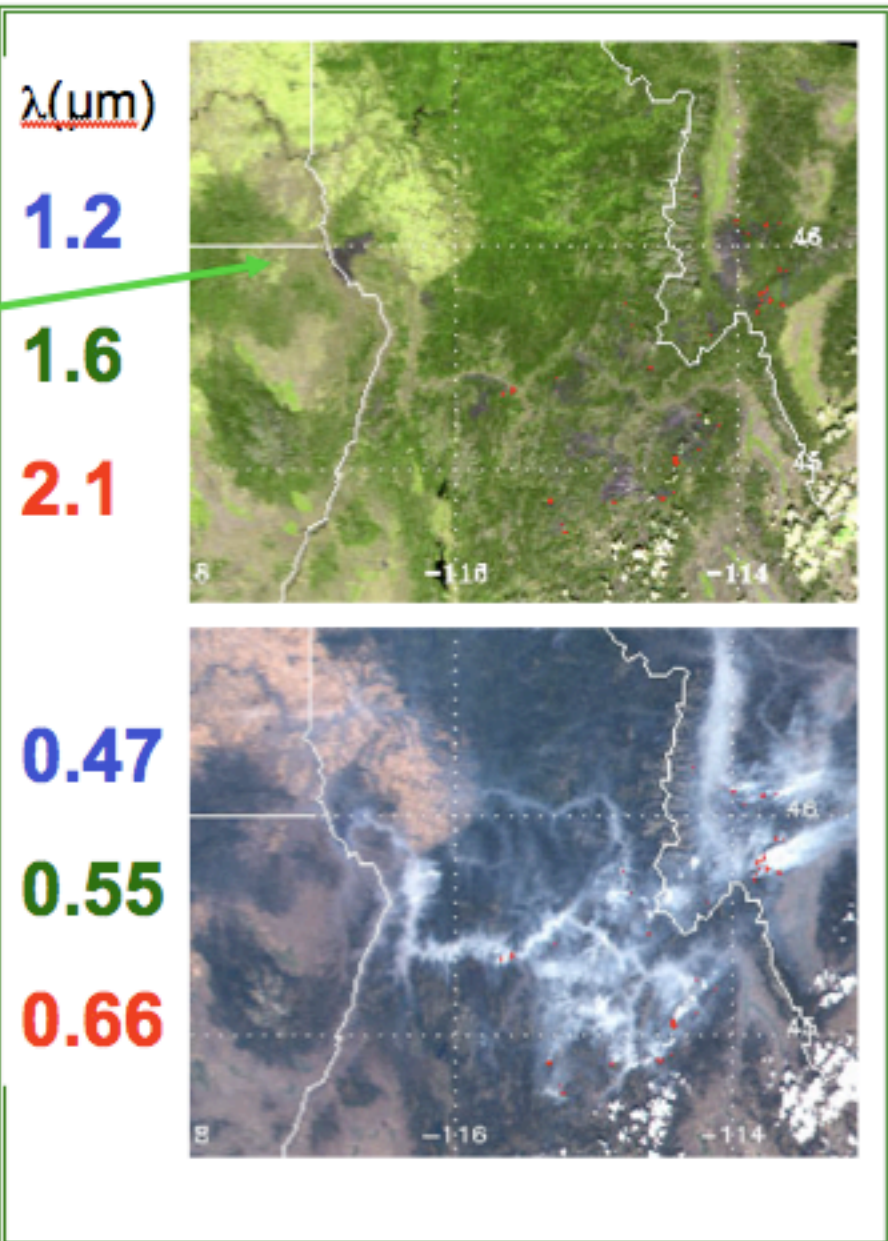
The quantity L is called the density weighted path length. $\sigma_{ext(\lambda)} L$ is a measure of the cumulative depletion that the beam of radiation has experienced as a result of its passage through the layer and is often called the optical depth τ_λ .

Wide Spectral Range makes land retrieval possible

- Mid-IR is used to observe the surface brightness
- Then aerosol is derived from estimated surface reflectance in the visible and actual reflectance

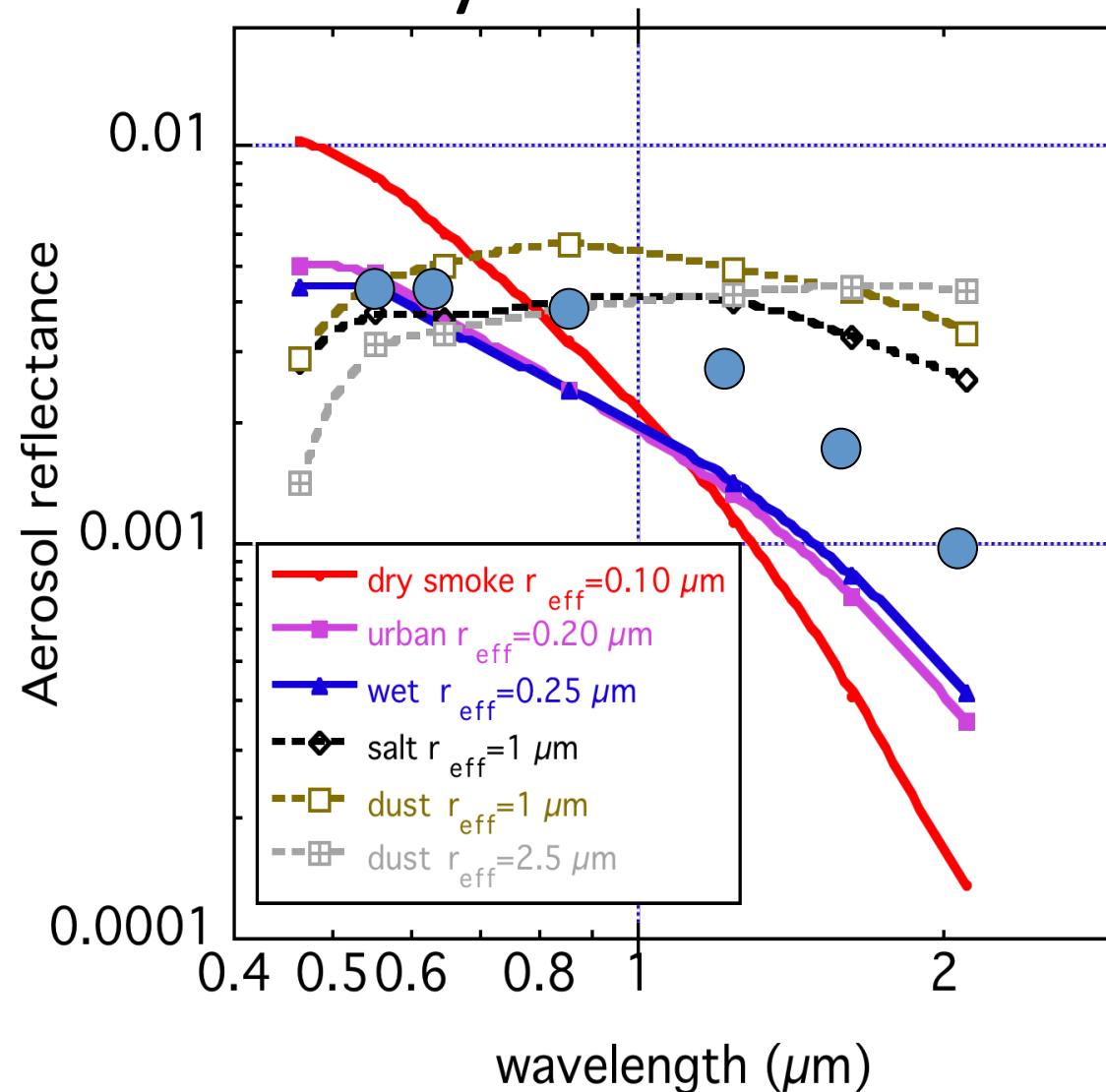
$$t_{0.66} \sim [r_{0.66}^* - 0.5r_{2.1}^*]$$

$$t_{0.47} \sim [r_{0.47}^* - 0.25r_{2.1}^*]$$



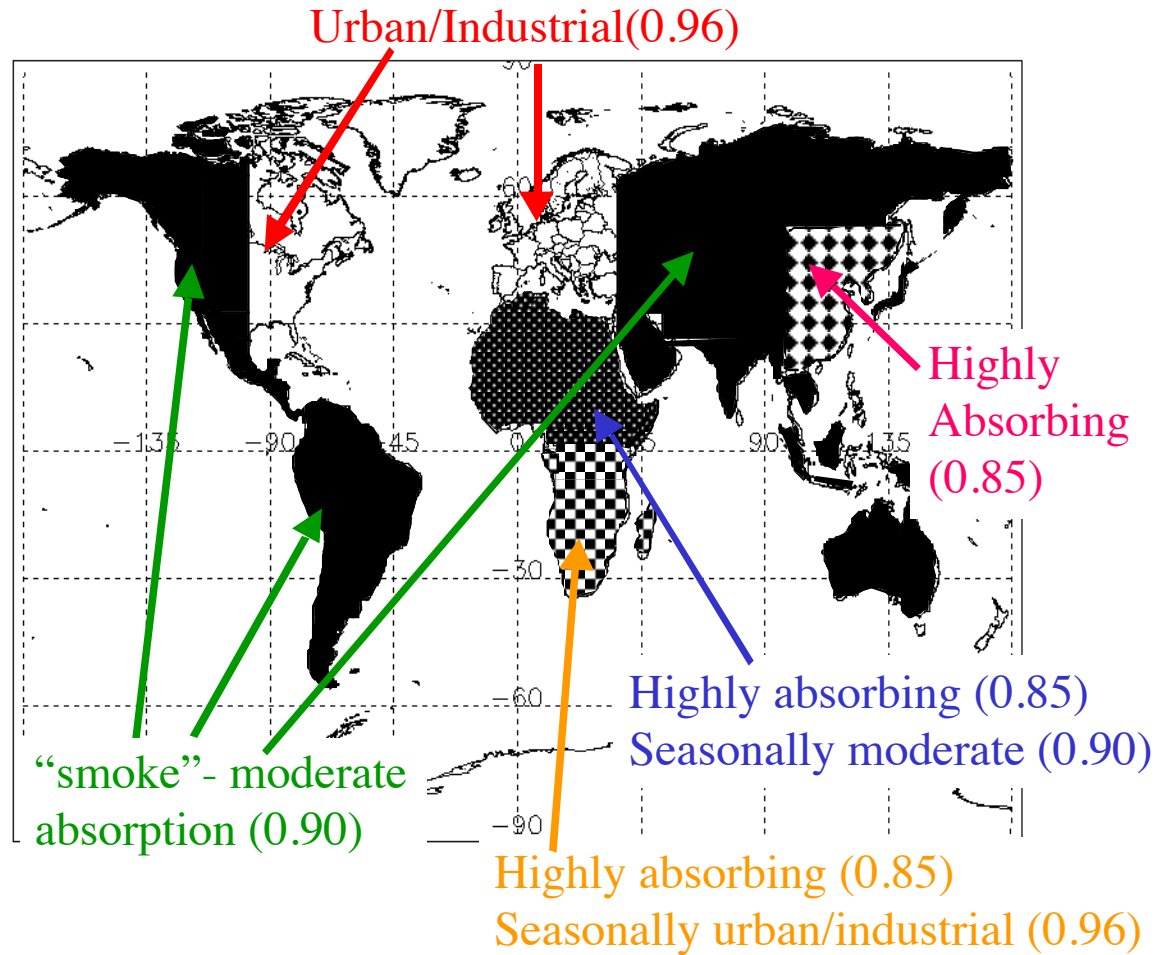
Getting A Best Fit for the Observations

Match Theory and Observations

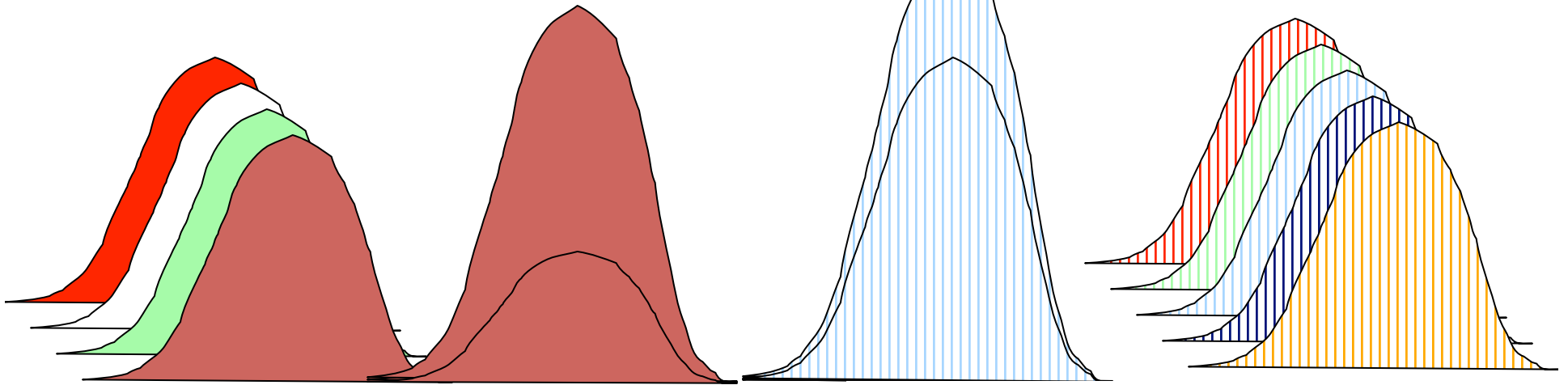


3 non-dust models
plus dust
Set by geography and
season

Models are dynamic $f(\tau)$

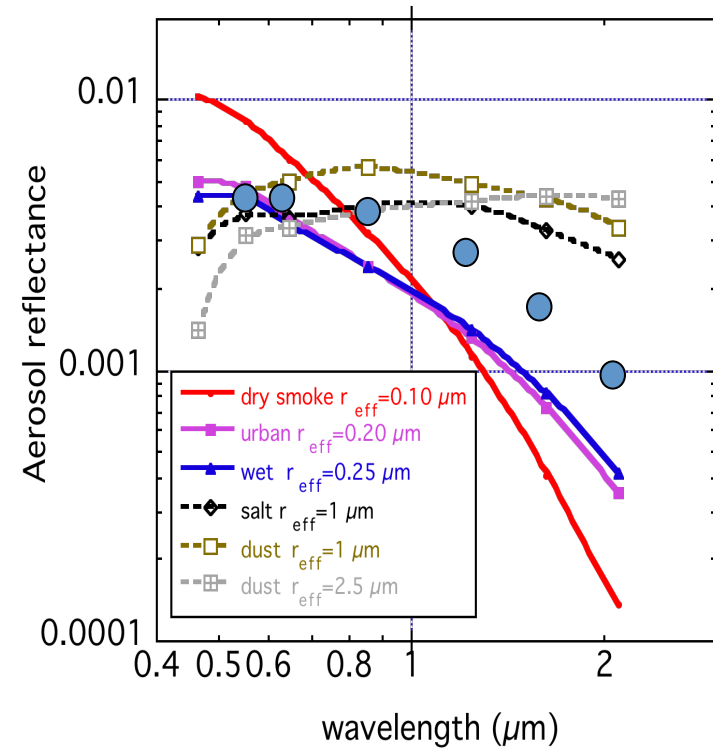


The Ocean Algorithm



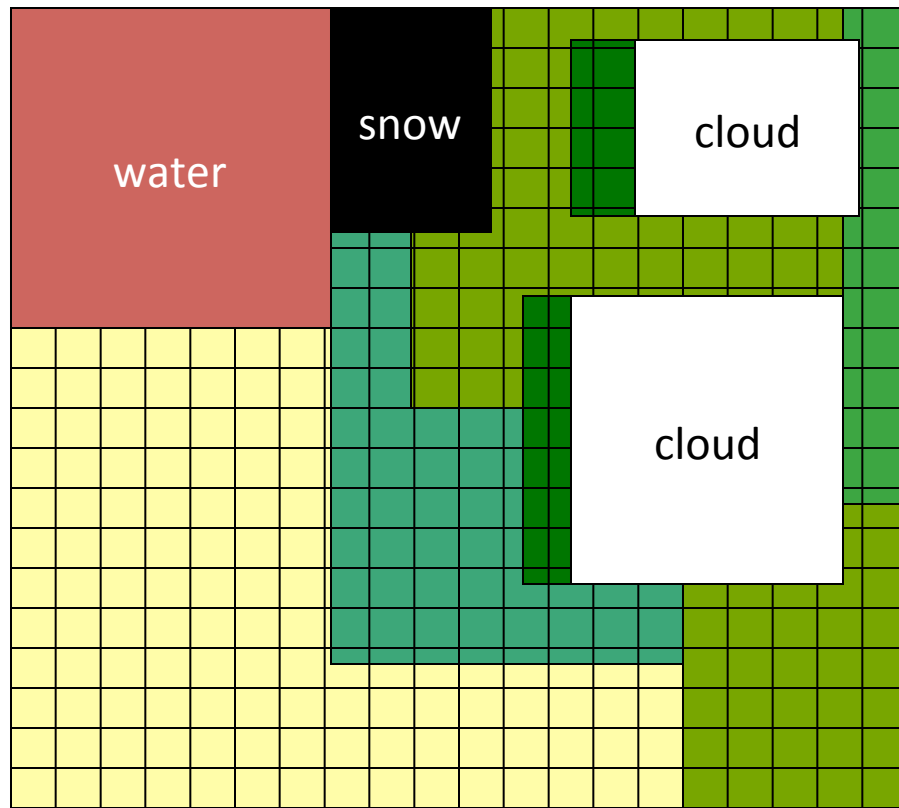
Choice of 4 fine modes
and 5 coarse modes

In order to minimize
($\rho_{\text{meas}} - \rho_{\text{LUT}}$) over 6 wavelengths



MODIS Over Land Algorithm

20 x 20 pixels at 500 m resolution
(10 km at nadir)



400 total
- 56 water

344
- 24 snow

320
- 55 cloud

265
- 116 "bright"

149 "good"

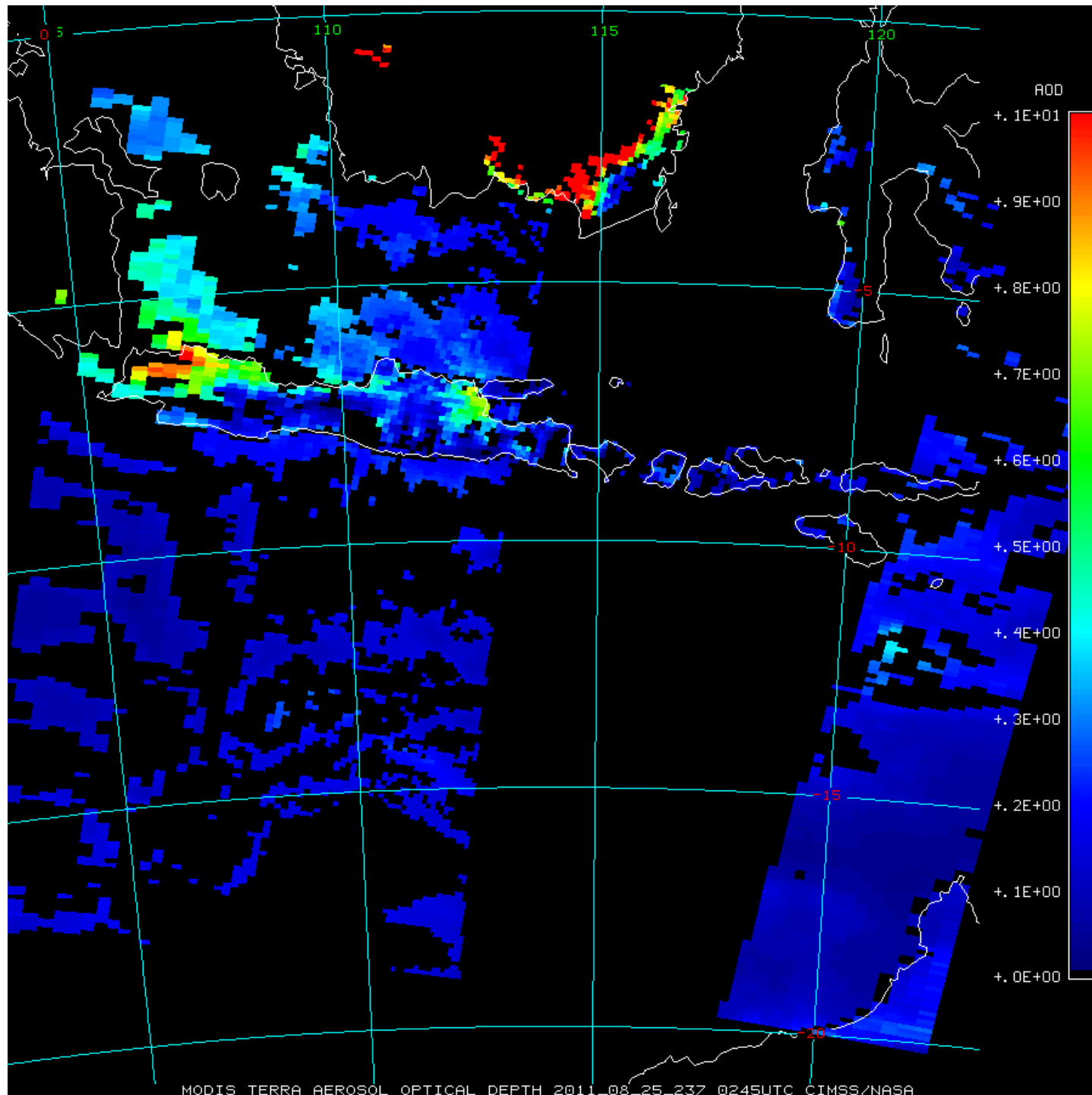
Discard brightest 50%
and darkest 20% of the
149 good pixels.

====> 44 pixels

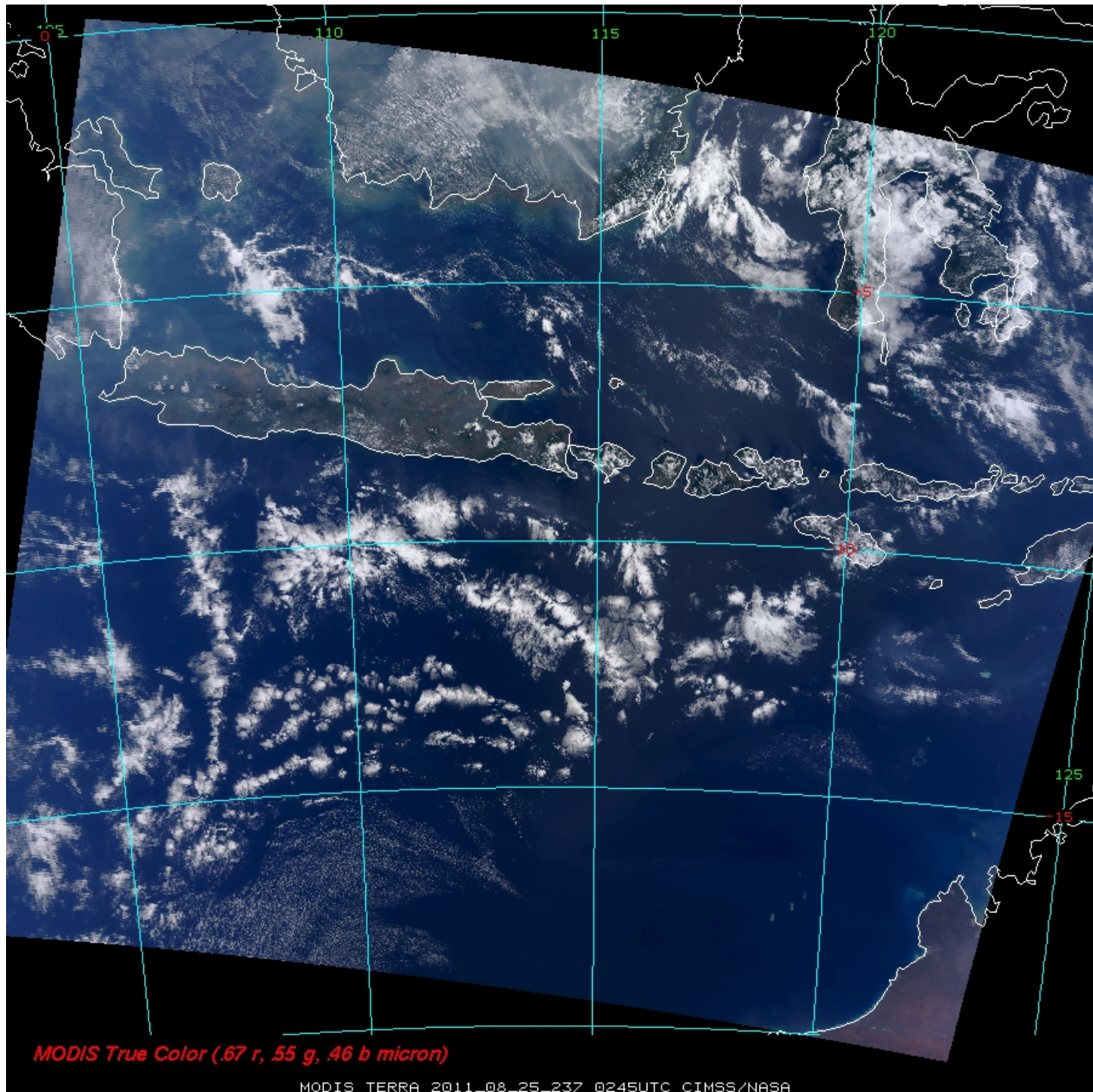
MOD04 Key Output Parameters

10x10 pixel (1km) resolution

- Optical_Depth_Land_And_Ocean – Aerosol Optical Thickness (AOT) at 0.55 microns for both ocean (best) and land (corrected)
- Optical_Depth_Ratio_Small_Land_And_Ocean - Ratio of small mode optical depth to total at 0.55 microns
- Corrected_Optical_Depth_Land (3 bands) - Corrected optical thickness at 0.47, 0.55, and 0.66 microns
- Effective_Optical_Depth_Average_Ocean (7 bands) - AOT at seven bands for average solution at .47, .55, .66, .86, 1.2, 1.6 and 2.1 microns



MODIS TERRA AEROSOL OPTICAL DEPTH 2011_08_25_237 0245UTC CIMSS/NASA



MODIS True Color (.67 r, .55 g, .46 b micron)

MODIS TERRA 2011_08_25_237 0245UTC CIMSS/NASA

How does the DB product differ from the NASA archived product?

- Not HDFEOS (Straight HDF4)
- DB version includes 4 arrays only
- No Deep Blue algorithm included

Collection 6 (before the end of the year) will include:

- One product that includes the best retrieval for the pixel
- Ocean/Land or Deep Blue
- 1 km retrieval

MODIS Aerosol Products

Three Separate Algorithms

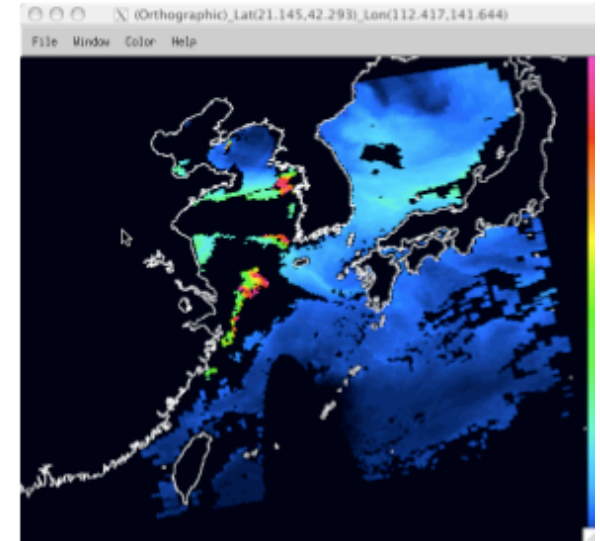
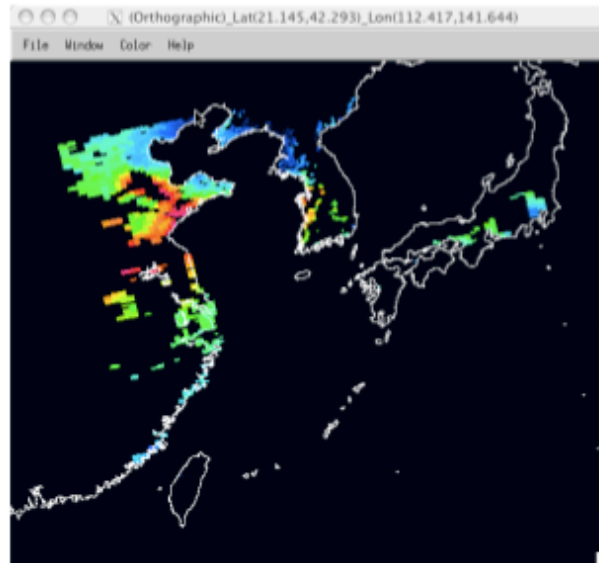
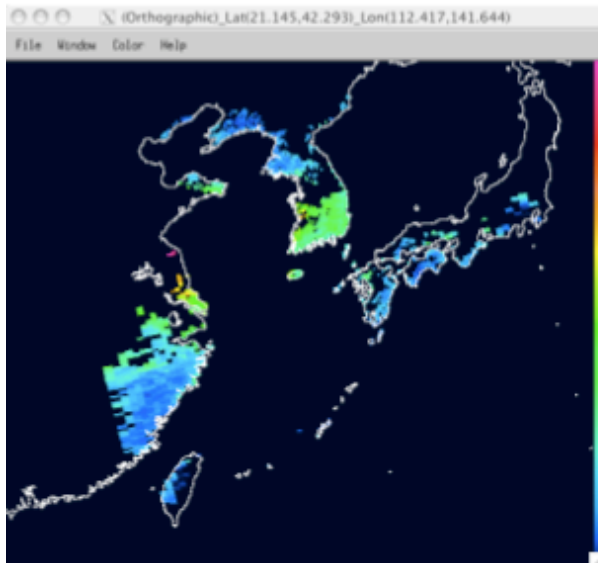
Land



Dark Target

Deep Blue

Ocean

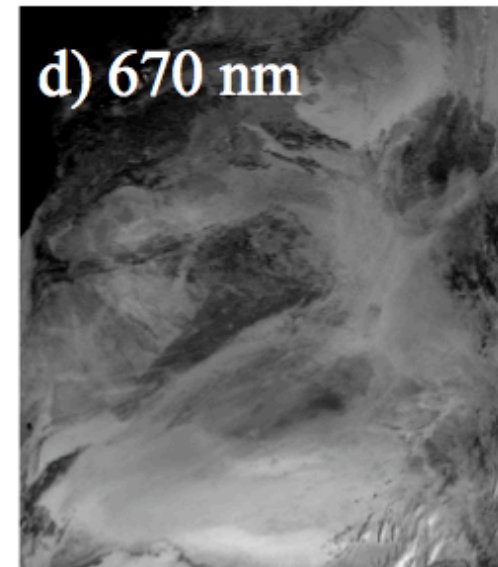
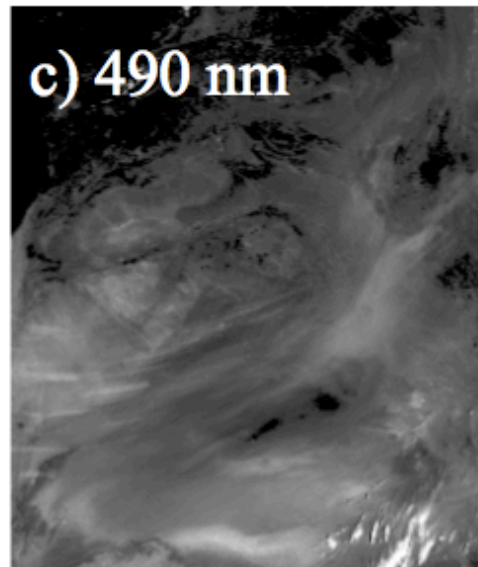
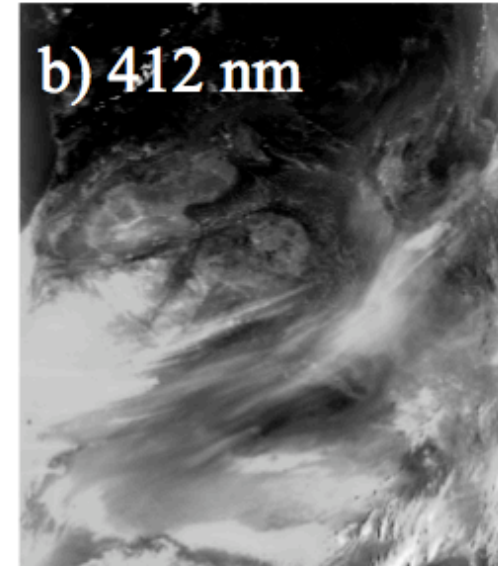
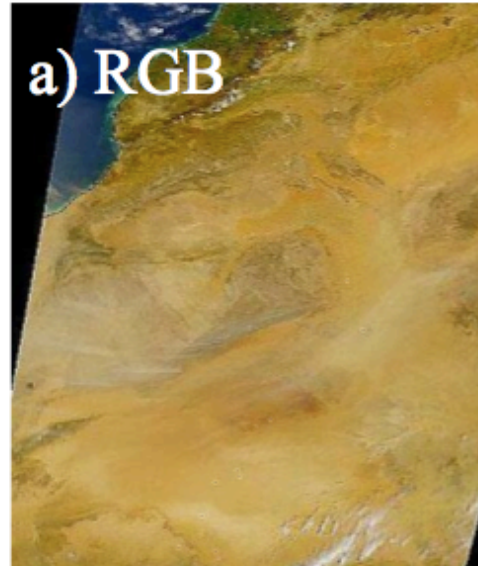


Richard Kleidman

The Deep Blue Advantage

Saharan Desert - Feb. 10, 2001

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



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

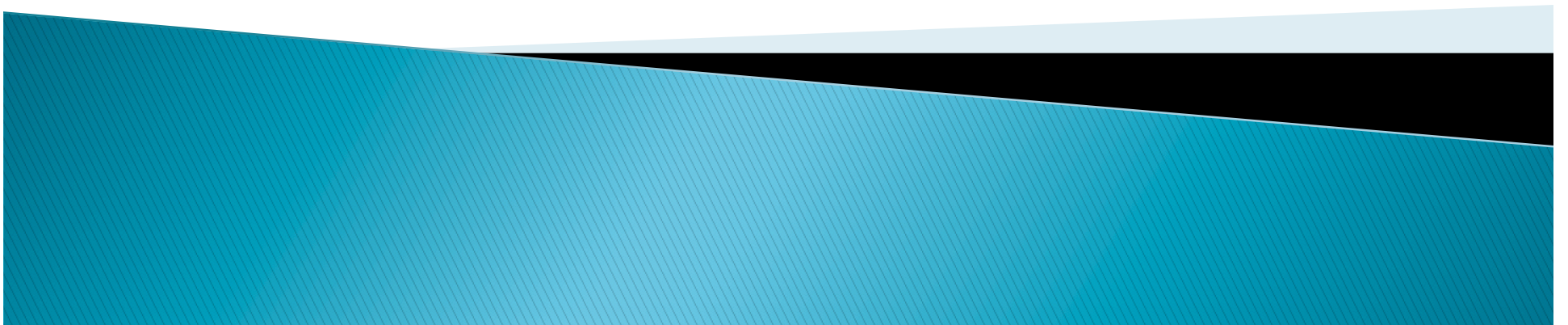
References

Levy, R. C., L. A. Remer, and O. Dubovik, 2007: Global aerosol optical properties and application to Moderate Resolution Imaging Spectroradiometer aerosol retrieval over land. *J. Geophys. Res.*, 112, D13210

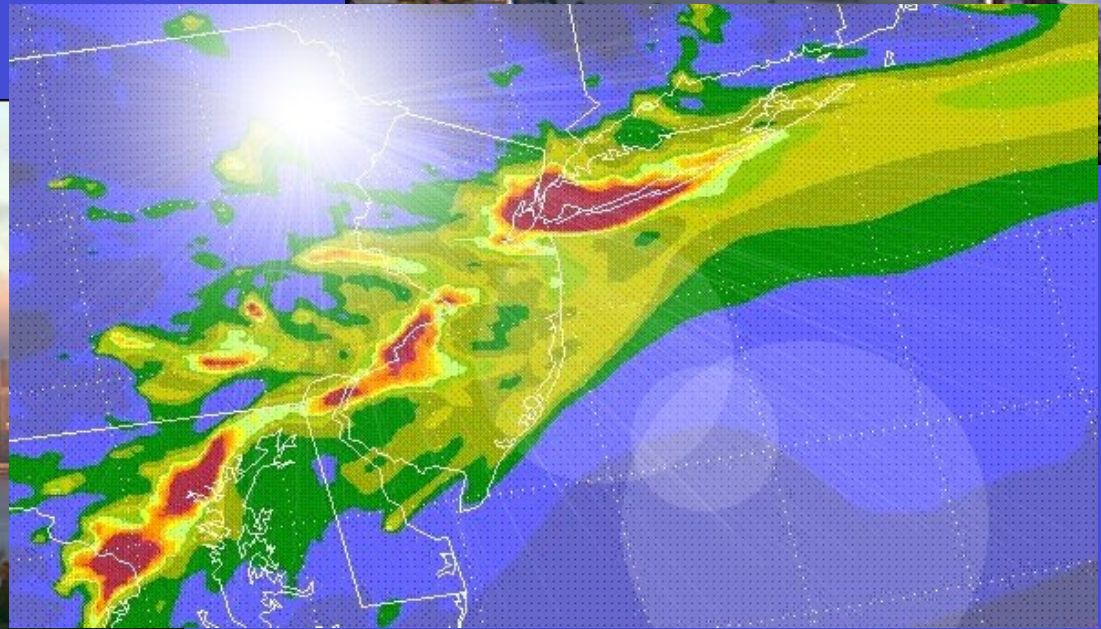
Levy, R. C., L. Remer, S. Mattoo, E. Vermote, and Y. J. Kaufman, 2007: Second-generation algorithm for retrieving aerosol properties over land from MODIS spectral reflectance. *J. Geophys. Res.*, 112, D13211, 22 pages.

Remer, L. A., Y. J. Kaufman, D. Tanre, S. Mattoo, D. A. Chu, J. V. Martins, R-R. Li, C. Ichoku, R. C. Levy, R. G. Kleidman, T. F. Eck, E. Vermote, & B. N. Holben, 2004: The MODIS Aerosol Algorithm, Products and Validation. *Journal of Atmospheric Sciences*, 64, 4, 947-973.

What is IDEA?



IDEA: NASA-EPA-NOAA partnership to improve air quality assessment, management, and prediction by infusing (NASA) satellite measurements into (EPA, NOAA) analyses for public benefit.

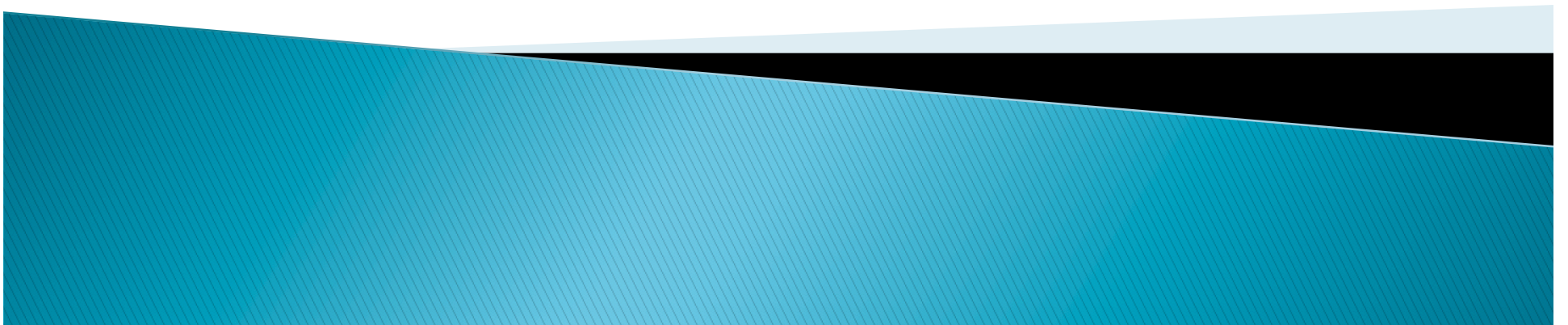


IDEA (Infusing satellite data into environmental air quality applications)

Part of NASA Earth Science Enterprise (ESE) Applications Program strategy to demonstrate practical uses of NASA sponsored observations from remote sensing systems and predictions from scientific research.

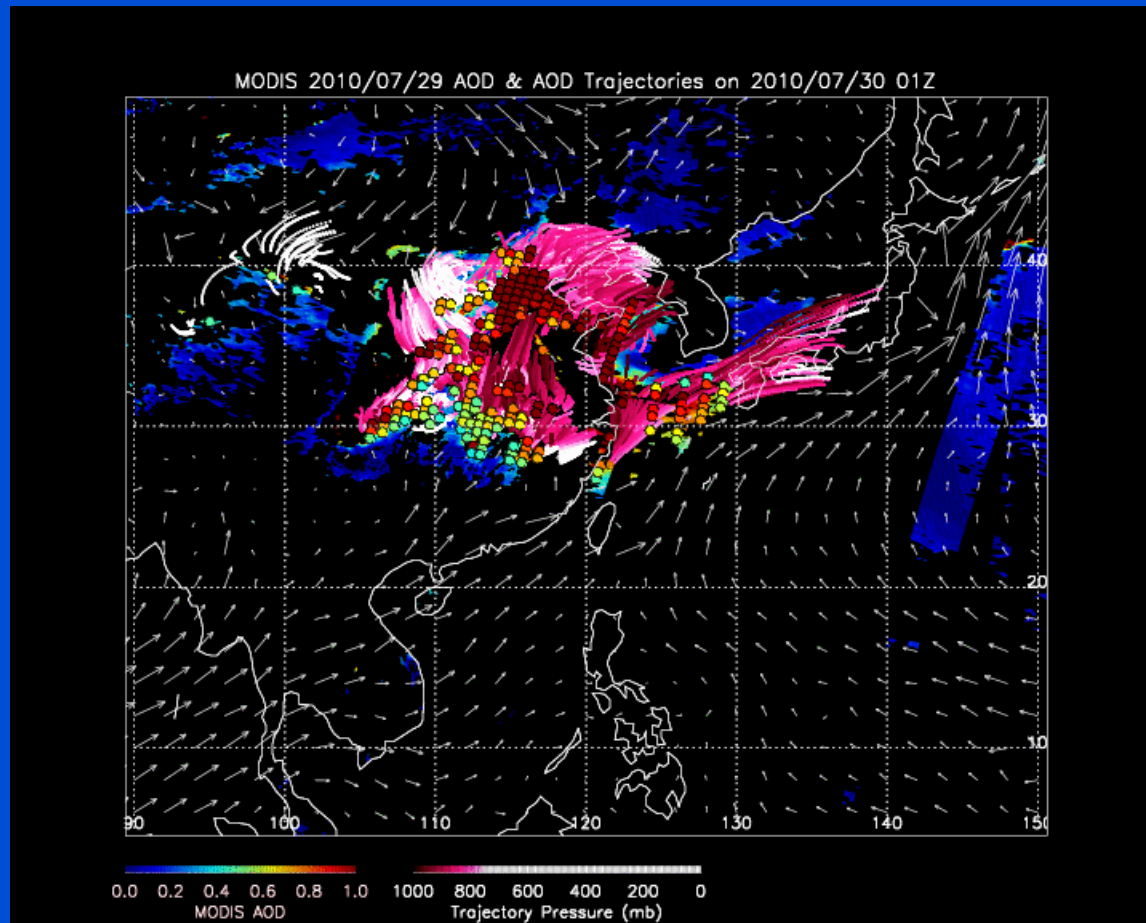
Simple IDEA-I Tutorial

Brad Pierce



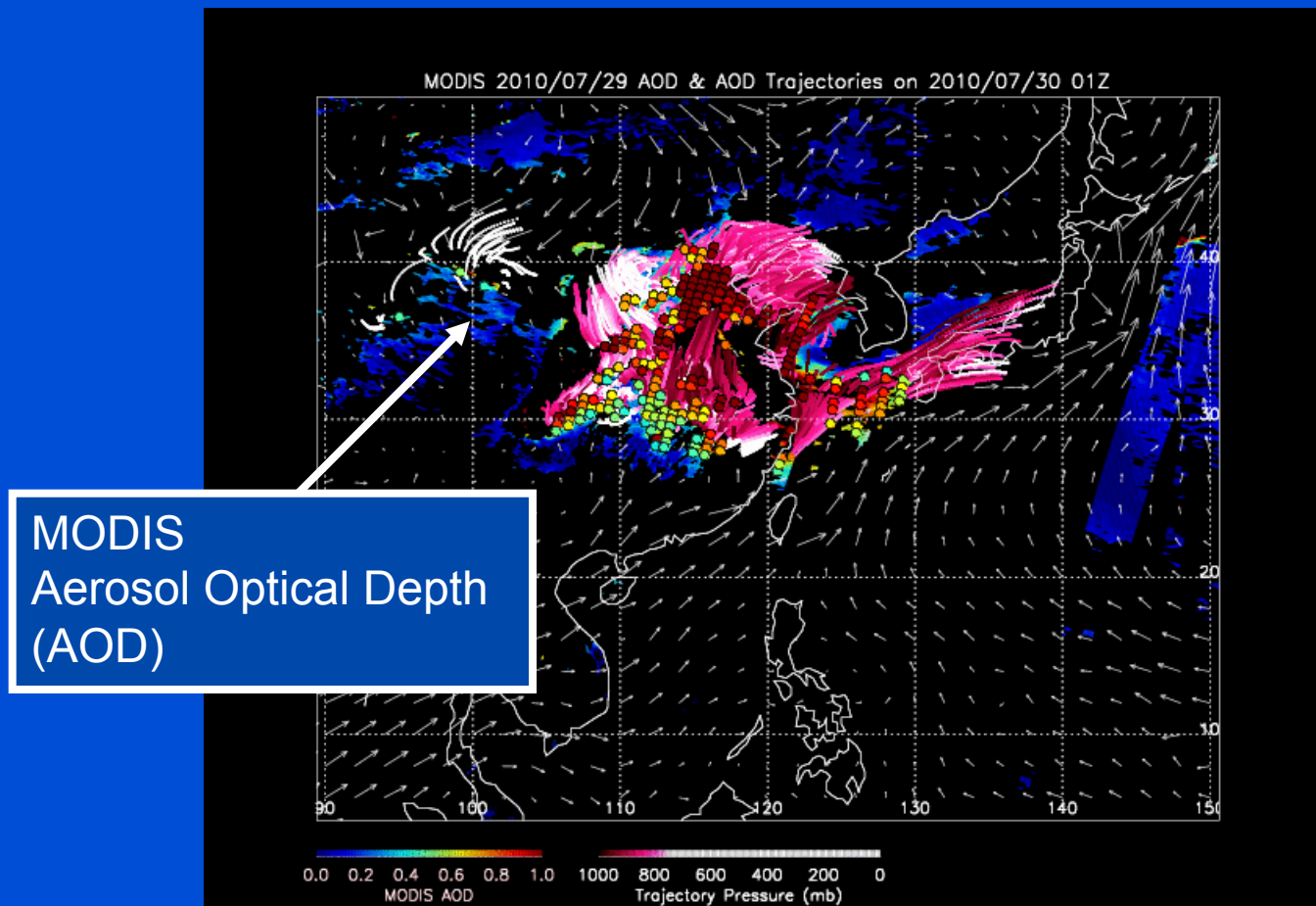
Trajectory Forecast

- The trajectory forecast animation displays the most important components of an aerosol forecasts



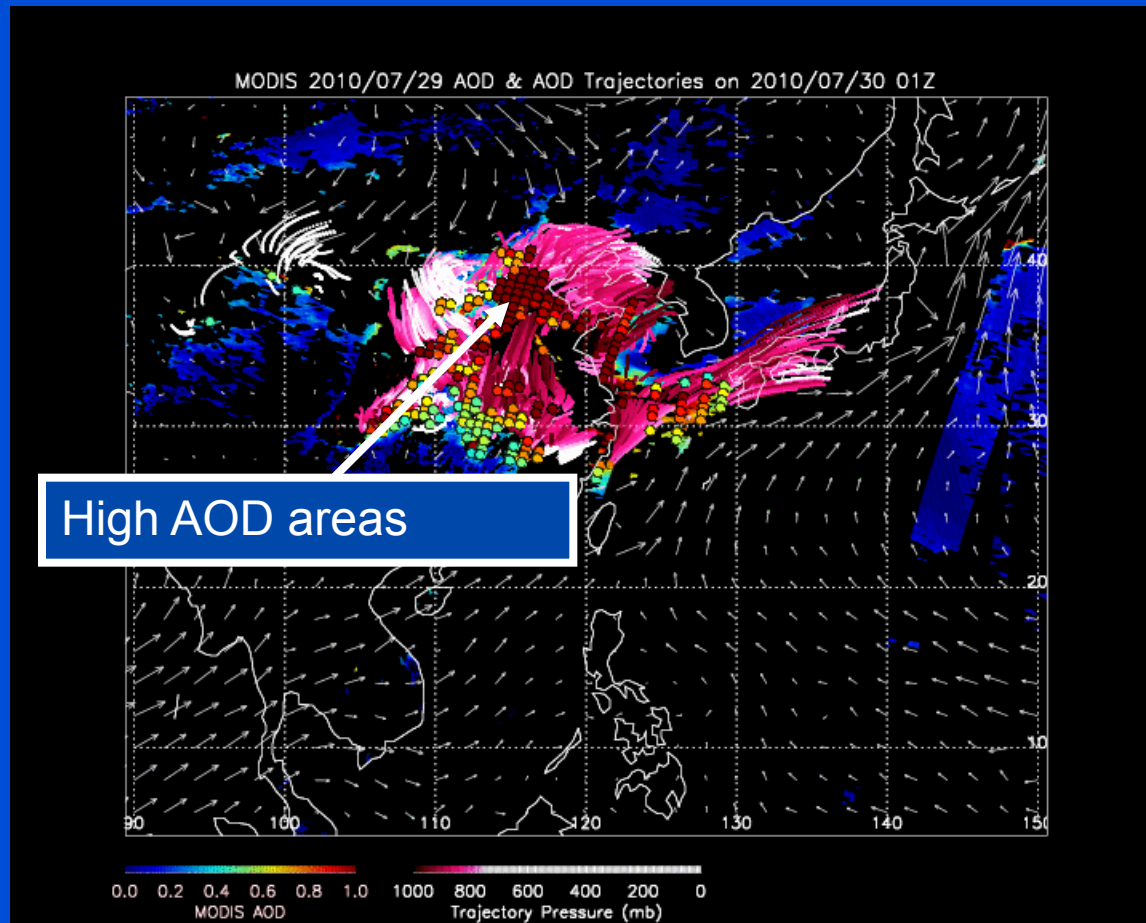
Trajectory Forecast

- The trajectory forecast animation displays the most important components of an aerosol forecasts



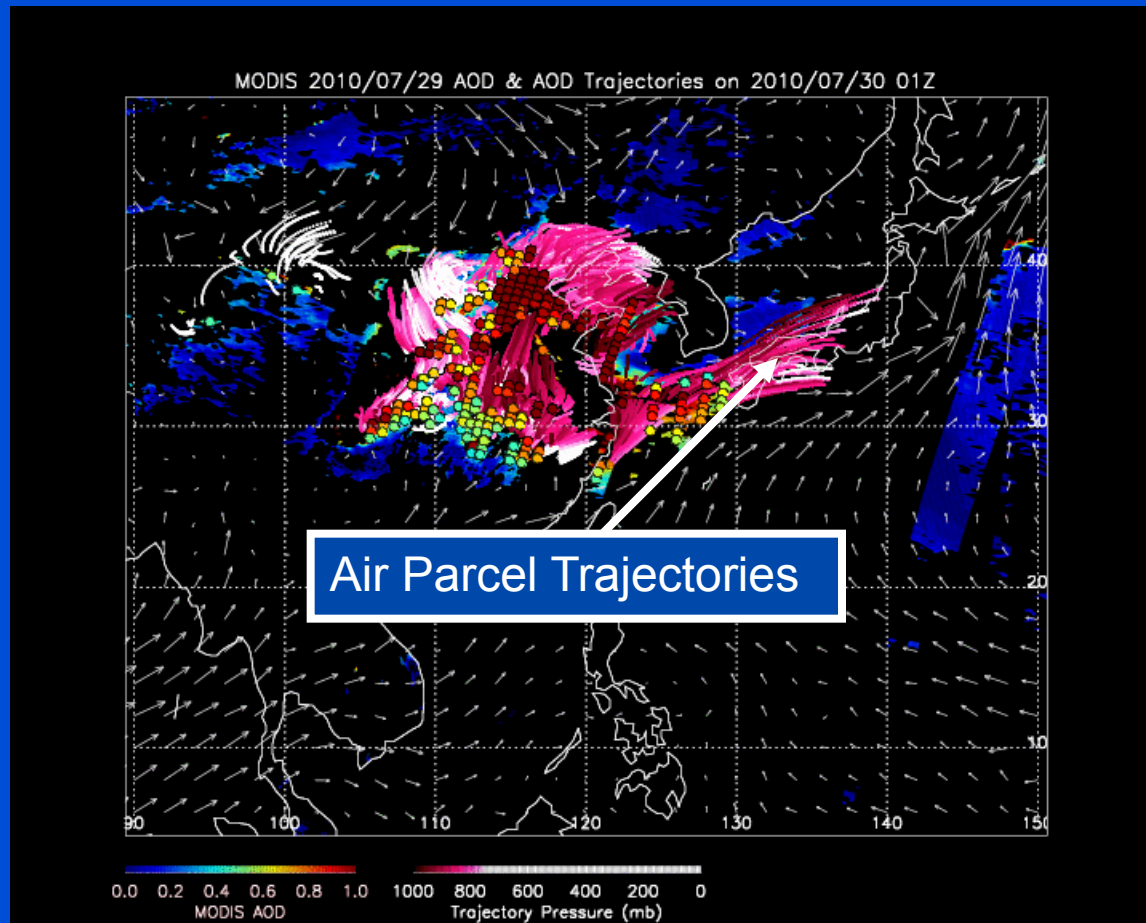
Trajectory Forecast

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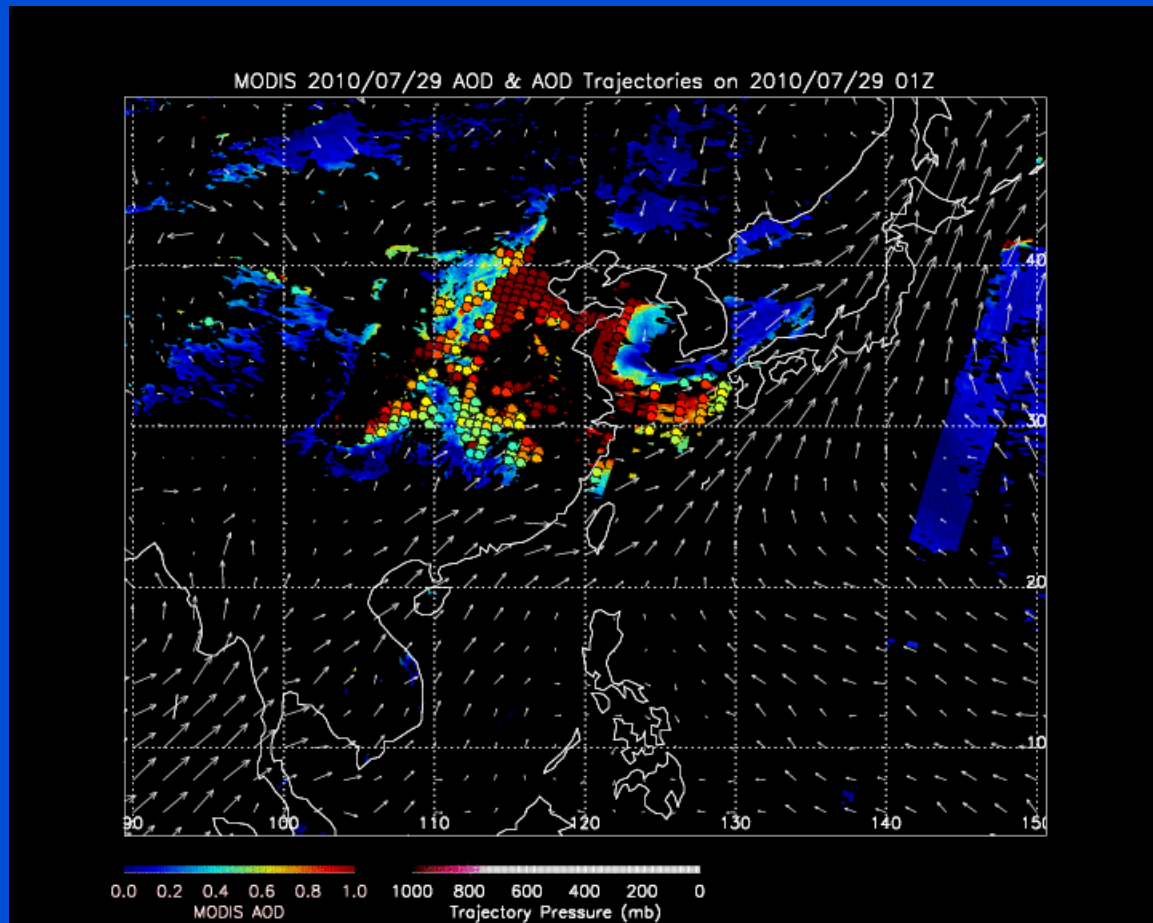
Trajectory Forecast

- The trajectory forecast animation displays the most important components of an aerosol forecasts



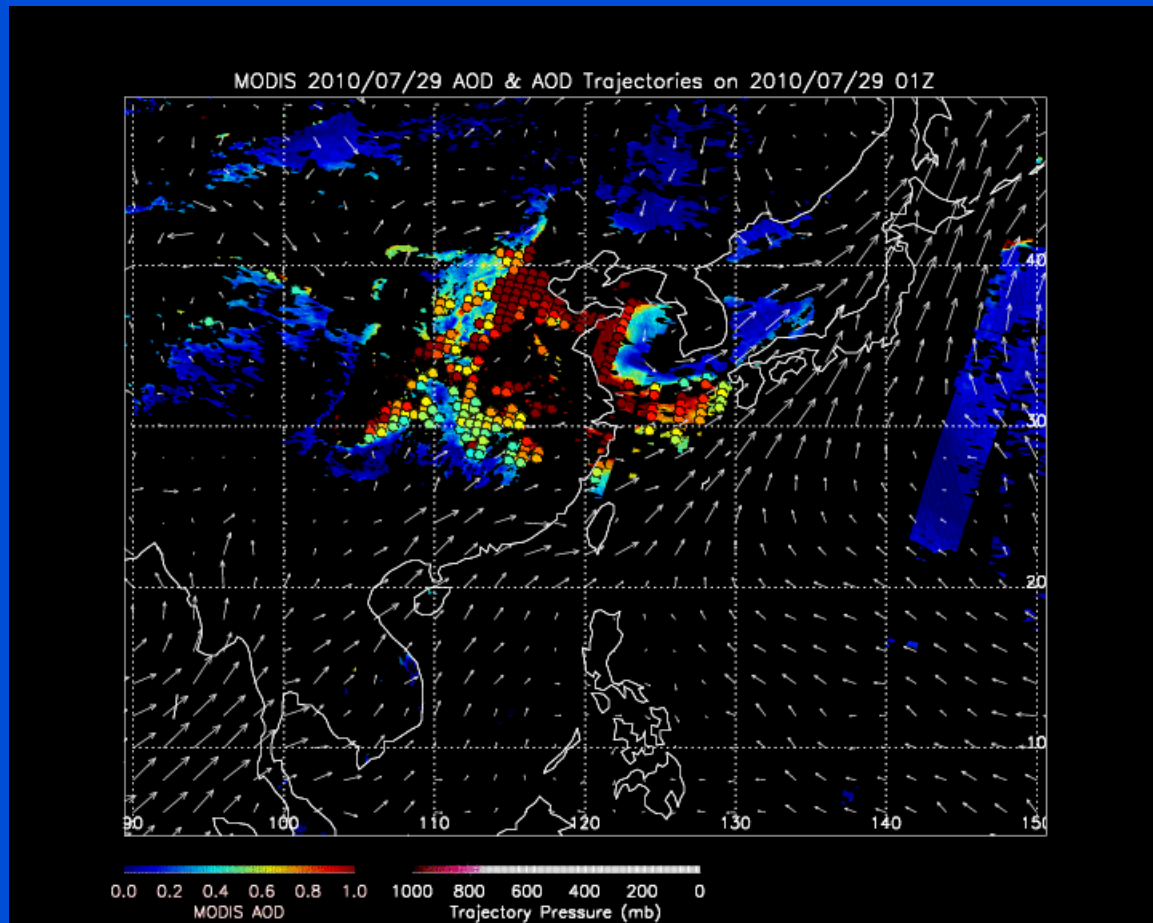
Trajectory Forecast - Initialization

- The trajectory forecast begins when the MODIS overpass occurs
- High values of AOD (>0.4) are located and used to initialize the trajectories



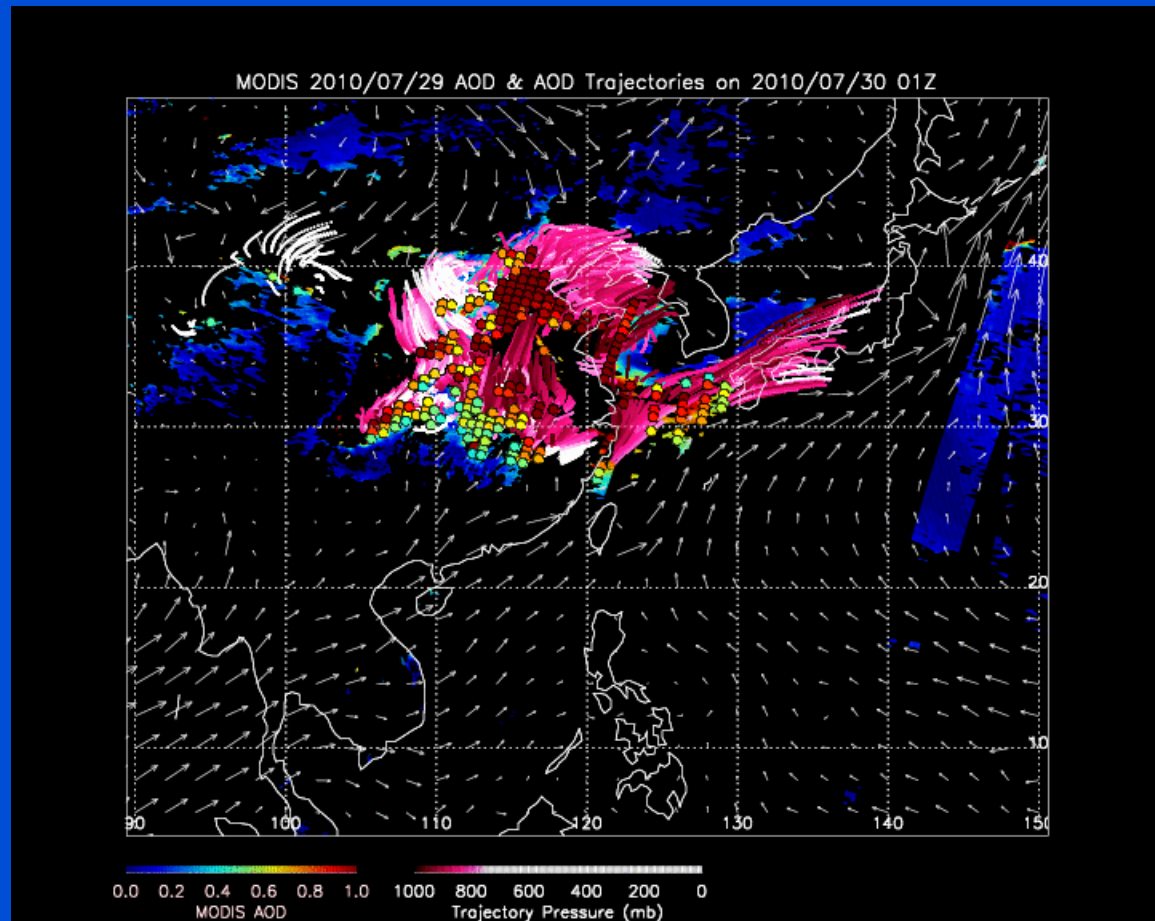
Trajectory Forecast - Initialization

- The high MODIS AOD values are determined by calculating mean AOD values on a 50kmx50km grid, or 5 pixels square



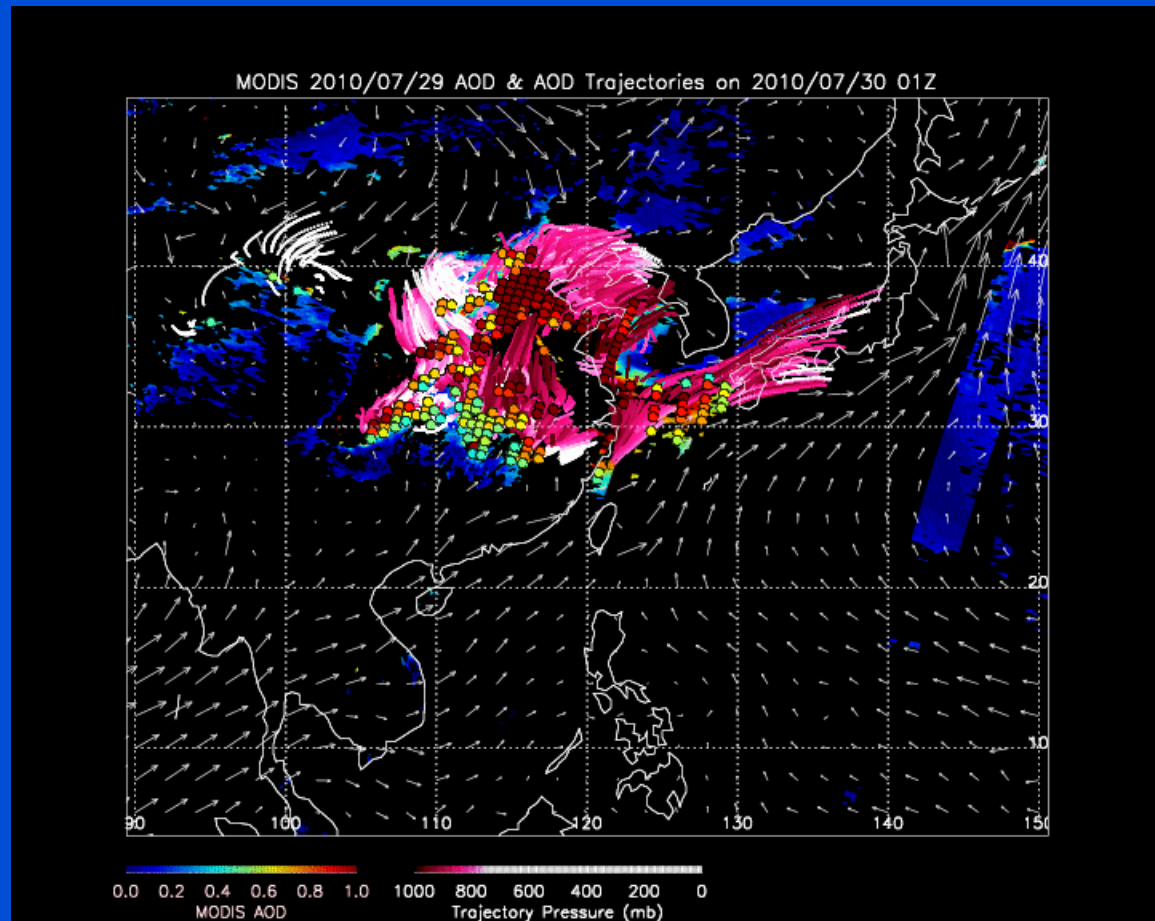
Trajectory Forecast

- The trajectories are initialized at the high AOD values at 50mb, 100mb, 150mb, and 200mb above the surface
- The air parcel trajectories are run using the 12Z NOAA/NCEP GFS forecast data providing a 48hr forecast via trajectories
- The pressure levels of the trajectories are plotted in mb and colored to a magenta-white scale. White indicates that the air parcel no longer affects the surface

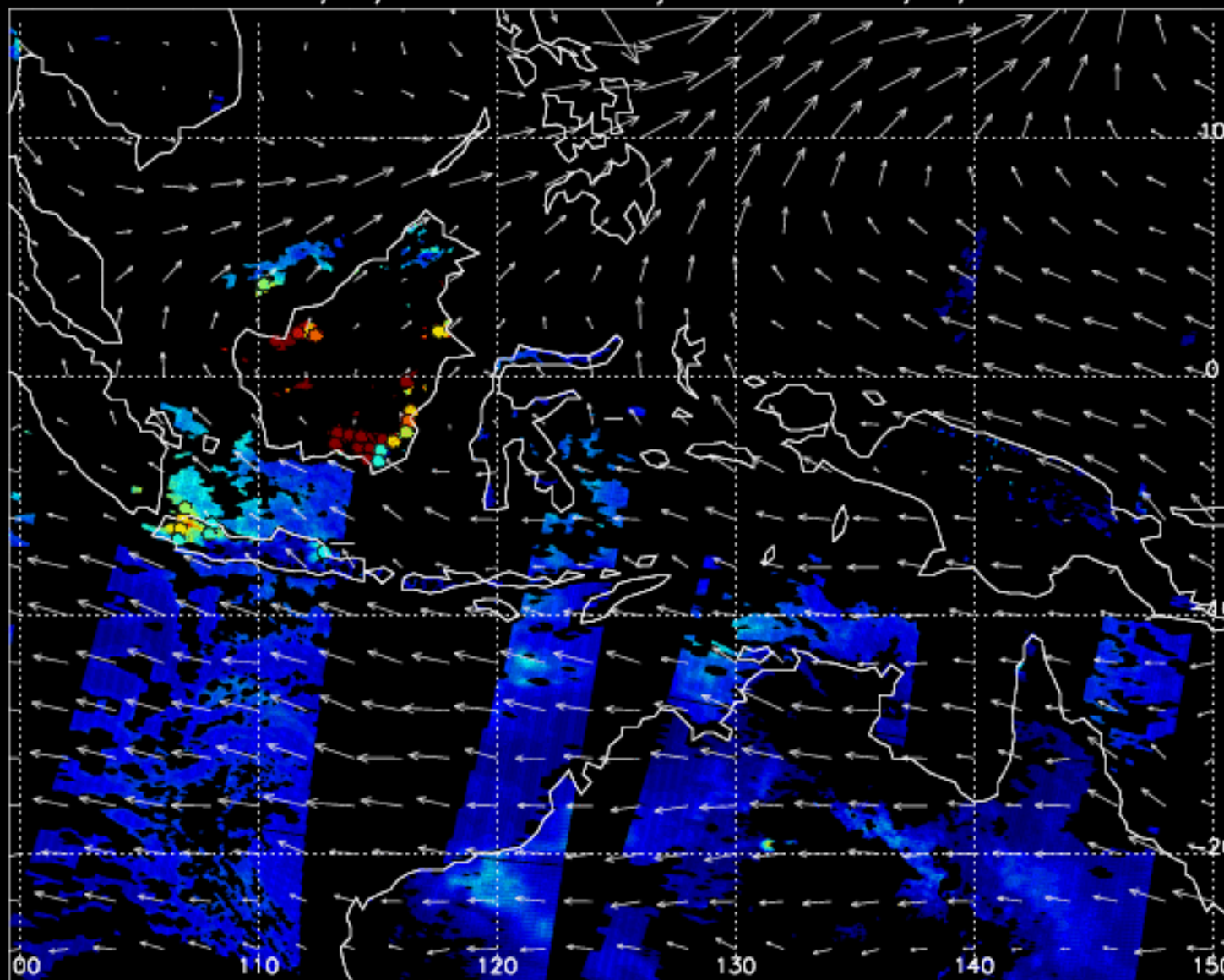


Trajectory Forecast

- The most recent 12 hours of the 48 hour forward trajectories are plotted at each frame of the animation.
- The most recent day of MODIS data remains on the plot.
- The 850mb wind field vectors are plotted to show wind direction and speed.



MODIS 2011/08/25 AOD & AOD Trajectories on 2011/08/25 03Z



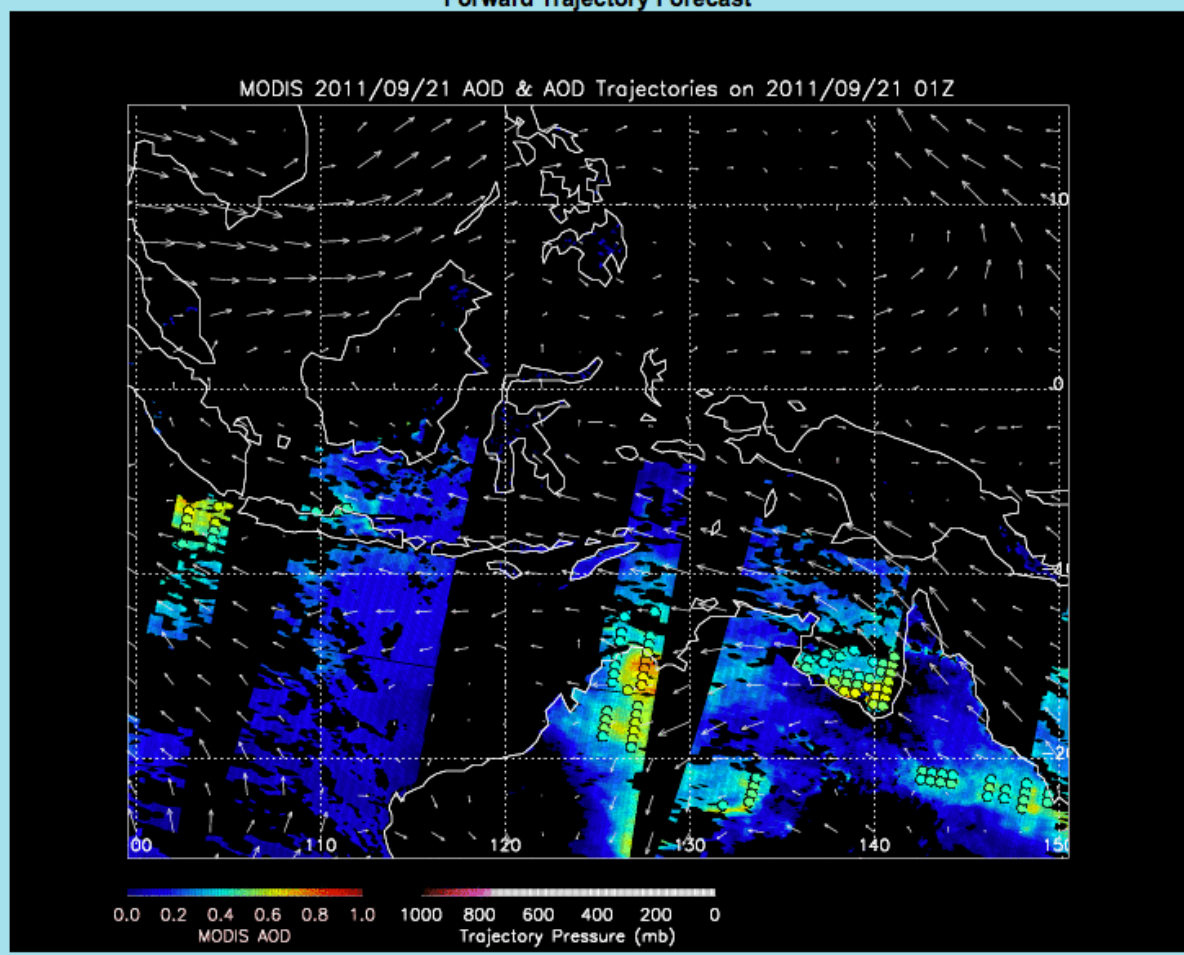
IDEA-I Infusing satellite Data into Environmental Applications - International



http://sunset.ssec.wisc.edu/idea-i/

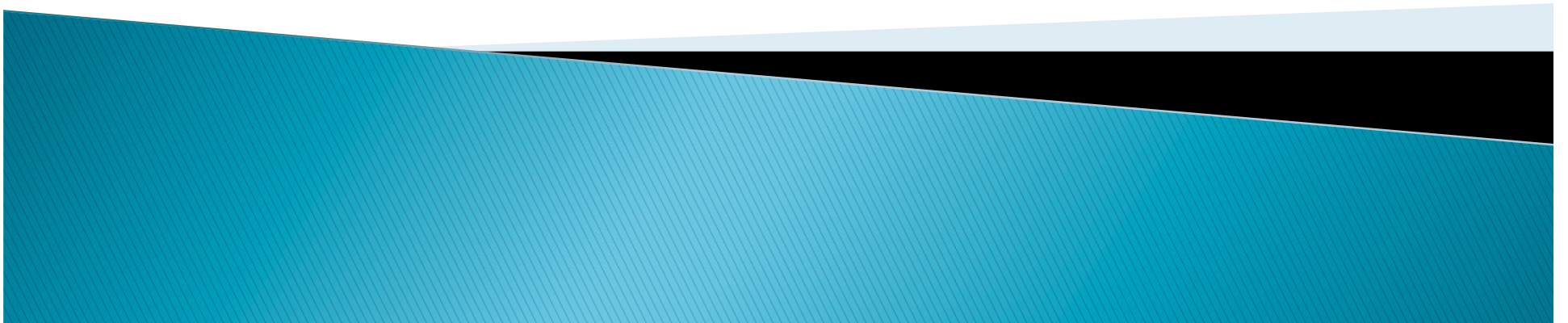


Forward Trajectory Forecast



View Latest

IDEA-I Notes



References

- Al-Saadi, J. A. et al., 2005: Improving National Air Quality Forecasts with Satellite Aerosol Observations, BAMS, DOI:10.1175/BAMS-86-9-1249.

References continued

- R. Bradley Pierce, et. al, “Impacts of background ozone production on Houston and Dallas, Texas, air quality during the Second Texas Air Quality Study field mission”, JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 114, D00F09, doi: 10.1029/2008JD011337, 2009
- R. Bradley Pierce and T. Duncan A. Fairlie, 1993 “Chaotic Advection in the Stratosphere- Implications for the Dispersal of Chemically Perturbed Air From the Polar Vortex”, JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 98, NO. D10, PAGES 18,589-18,595.

Trajectory Model and .dat files

- Trajectory Model is included in the IDEA-I
 - GFS_traject_3d_v01.fLocated in the /ideai/IMAPP_IDEA/Traject
- Trajectory forecast images are created from the daily trajectory forecast .dat files
 - Ex: traj_48hr_20110531.dat
- Dr. Bradley Pierce gave me information about how to read the .dat files using an IDL program. Ask, and I will give it to you.

Limitations

- Terra only retrievals
- Limitations of MOD04
 - Clouds
 - Bright surfaces
 - 10 km resolution
 - Aerosols too thick
- The time it takes to run the trajectory forecast is proportional to how much aerosols are found (~3 hours)

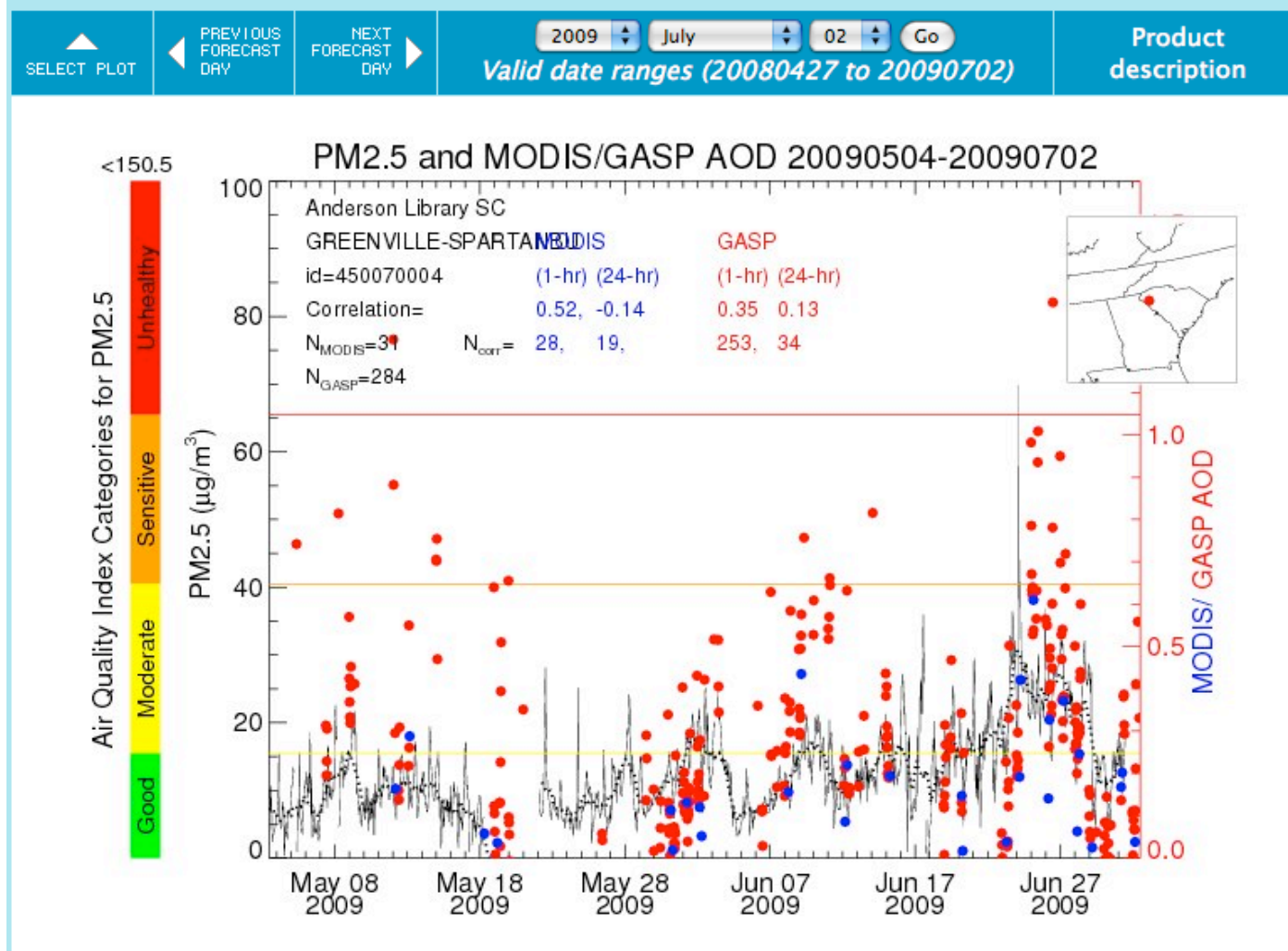
Infusing Satellite Data into Environmental Applications

Used by the US Environmental Protection Agency to Monitor and Forecast Air Quality in the United States

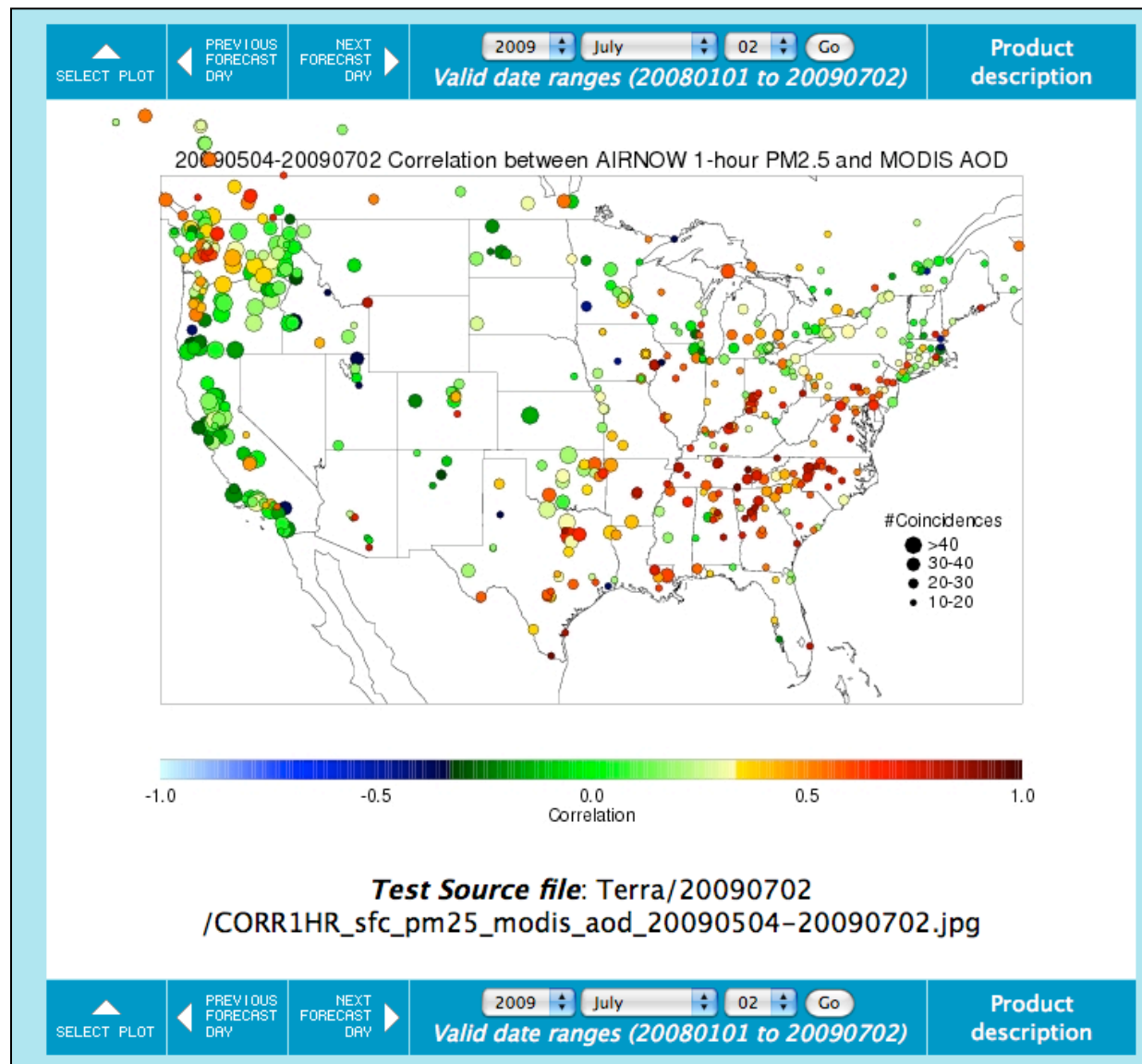
The screenshot displays the IDEA web application interface. At the top, the title is "IDEA - Infusing satellite Data into Environmental Applications" and the URL is "http://www.star.nesdis.noaa.gov/smcd/spb/daq/". The interface features a navigation bar with tabs for "MODIS (Terra)", "MODIS (Aqua)", "GASP", and "GASP WEST". Below this, there are four main sections: "Regional plots of MODIS Terra aerosol optical depth (AOD)", "48-hour aerosol trajectory forecast, with model winds and precipitation", "3-day composite history*", and "Tutorials for interpreting the IDEA products". Each section includes a map visualization and a "View latest" button. The "Regional plots" section shows a map of the United States with AOD data. The "48-hour aerosol trajectory forecast" section shows a map with wind vectors and precipitation. The "3-day composite history" section shows a 3D plot of AOD and COT. The "Tutorials" section includes an example of forecasting fine particulate matter in the eastern U.S. and a "Trajectory Forecast" animation. At the bottom, there is a footnote: "*includes aerosol optical depth (AOD), ground station PM 2.5, NAM 850mb wind vectors, and WF-ABBA fire locations".

<http://www.star.nesdis.noaa.gov/smcd/spb/daq/>

PM Observations, MODIS AOD and GOES AOD retrieval Time Series



Correlation Between MODIS AOD and PM Observations



Smog Blog



http://alg.umbc.edu/usaq/archives/003875.html

Most Visited WI_500M_RGB.JPG (U... http://clmss.ssec.wi... Getting Started Apple Personal MODIS DB Wx

U.S. Air Quality: Smoke blankets m...

U.S. Air Quality

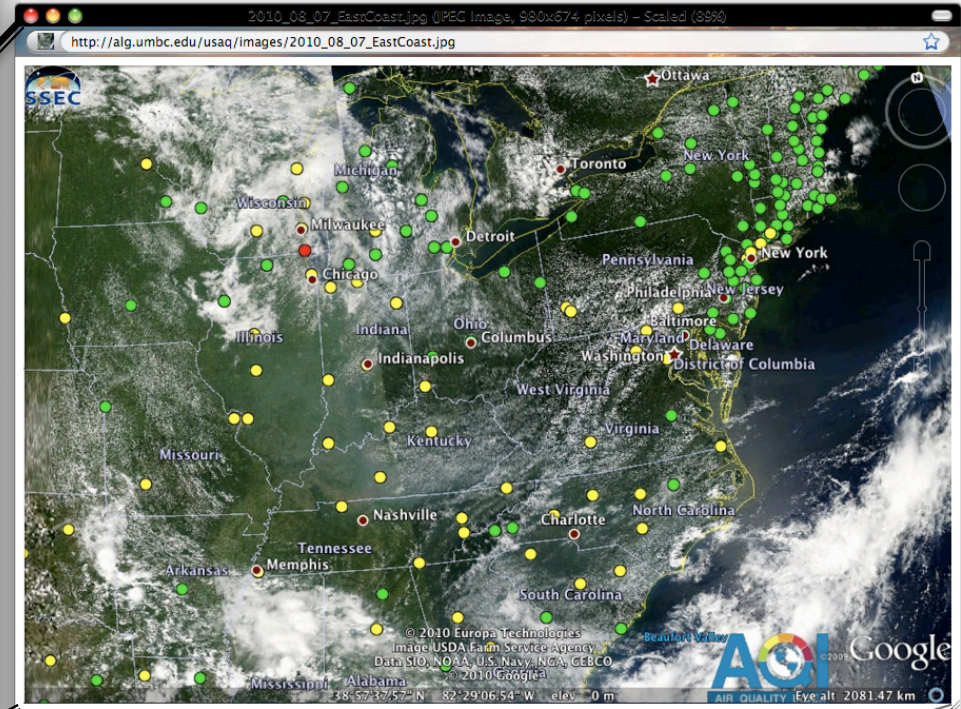
The Smog Blog

« Code Orange PM2.5 and High AOD from Smoke in Northwest; | Main | Smoke reaches the East Coast of the US »

August 7, 2010

SMOKE BLANKETS MUCH OF NORTH AMERICA

A broad band of smoke continues to pour down from Canadian wildfires and from fires in Oregon and Washington. The path of the smoke through the western Great Lakes region reaches down to Kentucky and then turns eastward pouring out into the Atlantic over the mid-Atlantic states. The smoke is largely aloft although moderate PM air quality readings are seen over the same region. The first panel (upper left) shows the Hazard Mapping System's identification of the boundaries of the smoke. The second panel (upper right) shows the GASP AOD loop for this morning and afternoon. The third panel shows the composite of the afternoon AQUA MODIS overpass and the AIRNOW AQI readings which are mostly in the yellow (hazardous for sensitive groups) levels. The bright red reading at Kenosha WI was a PM AQI of 154 which was not seen in the AIRNOW Tech plots, so some care needs to be taken on this isolated reading. On the lower right the optical depth continues to rise over the day at UMBC.



MODIS Today images are regularly used to support US Air Quality forecasters as part of the UMBC/NASA Smog Blog: <http://alg.umbc.edu/usaq/>

