

Acronym soup  
MPL-NET, REALM, GLAS,  
CALIPSO

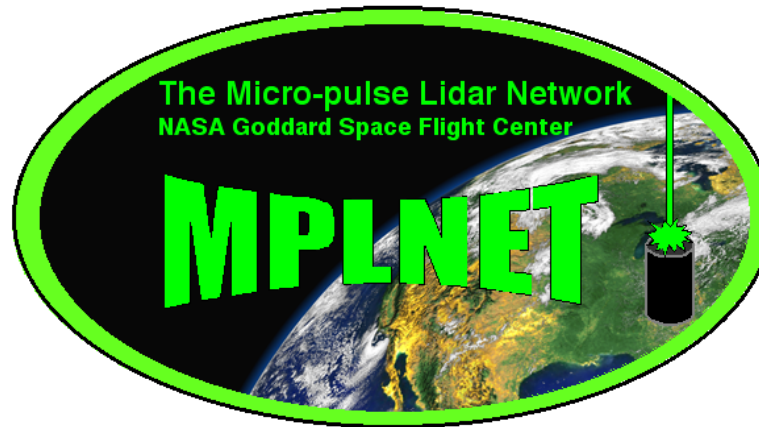
R. M. Hoff  
University of Maryland,  
Baltimore County

# The Micro-pulse Lidar Network (MPLNET)

PI: Judd Welton  
NASA Goddard Space Flight Center  
Greenbelt, MD 20771 USA

Co-I's: James Spinhirne, Si-Chee Tsay, Brent Holben

Staff: James Campbell, Timothy Berkoff



MPLNET website: <http://mplnet.gsfc.nasa.gov>



# The Micro-pulse Lidar Network : (MPLNET)

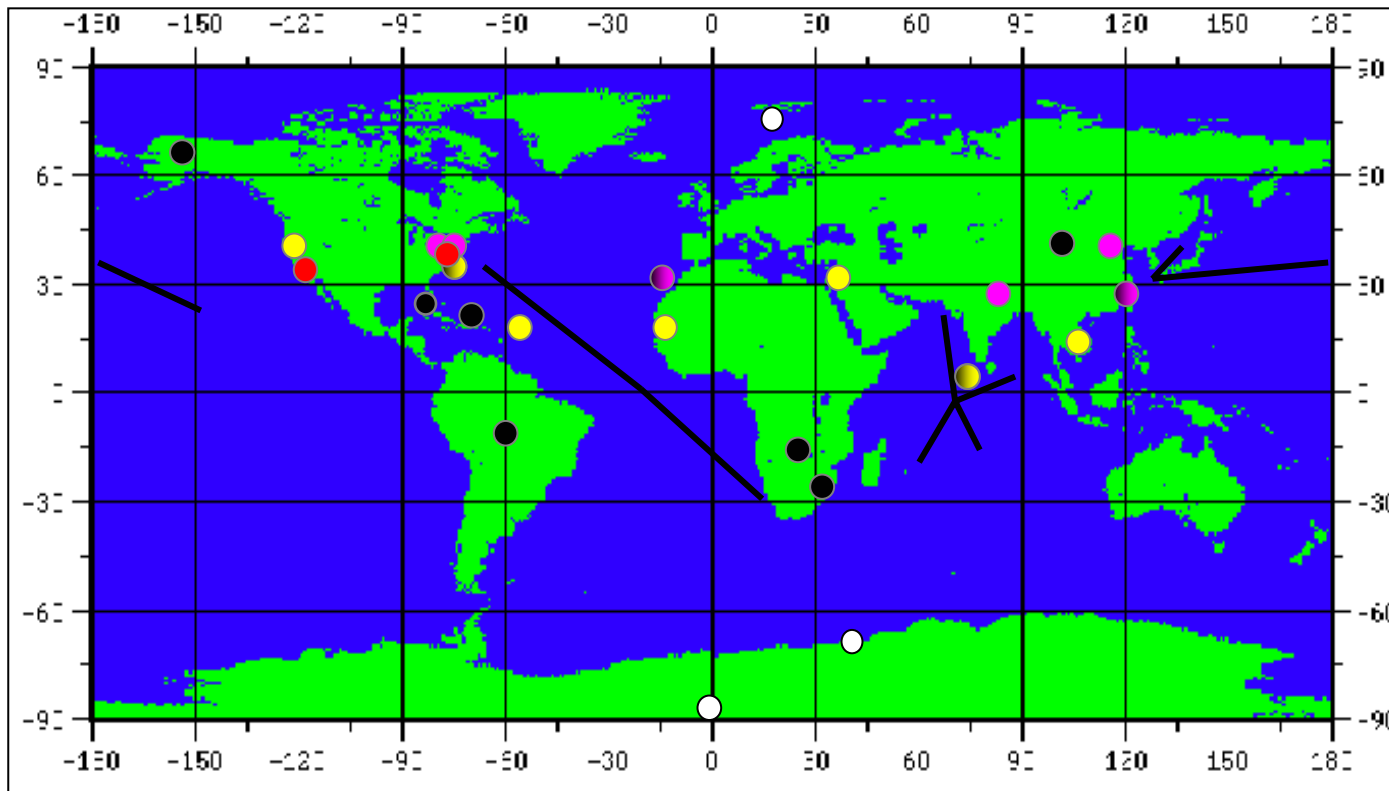
**Mission:** Long-term, world-wide observations of aerosol and cloud vertical structure using common instrument/data processing

**Funding:** NASA Earth Observing System & Radiation Sciences Program

## Activities:

- co-locate sites with AERONET sunphotometers, and if possible BSRN radiometers
- partner with other independent research groups interested in MPL measurements (federated network)
- participate in field experiments and research cruises
- work with aerosol modelers to study aerosol transport processes

**Satellite Lidar Calibration/Validation:** GLAS - ICESat (2003), CALIPSO (2005)



## Active Sites:

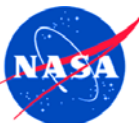
- MPLNET & AERONET
- MPLNET only
- Field Experiment
- Ship Cruise

## Proposed Sites:

- 2004
- 2005
- Transition from experiment

\* All proposed sites will be co-located with AERONET

MPLNET website: <http://mplnet.gsfc.nasa.gov>

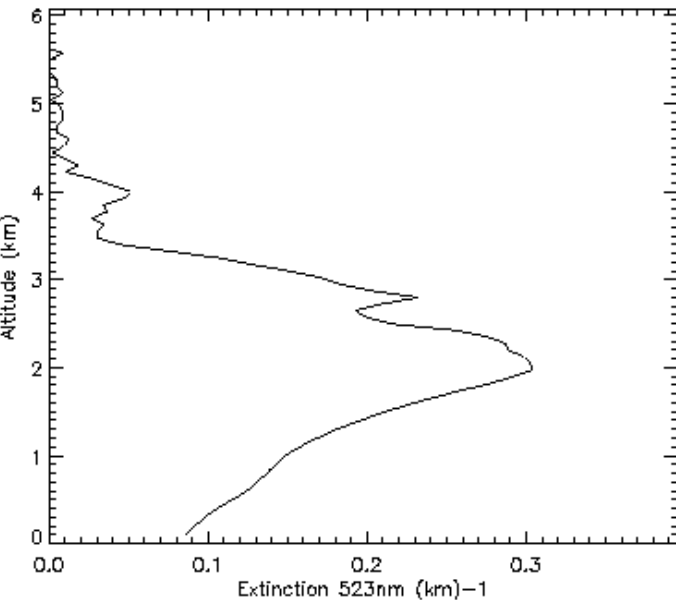
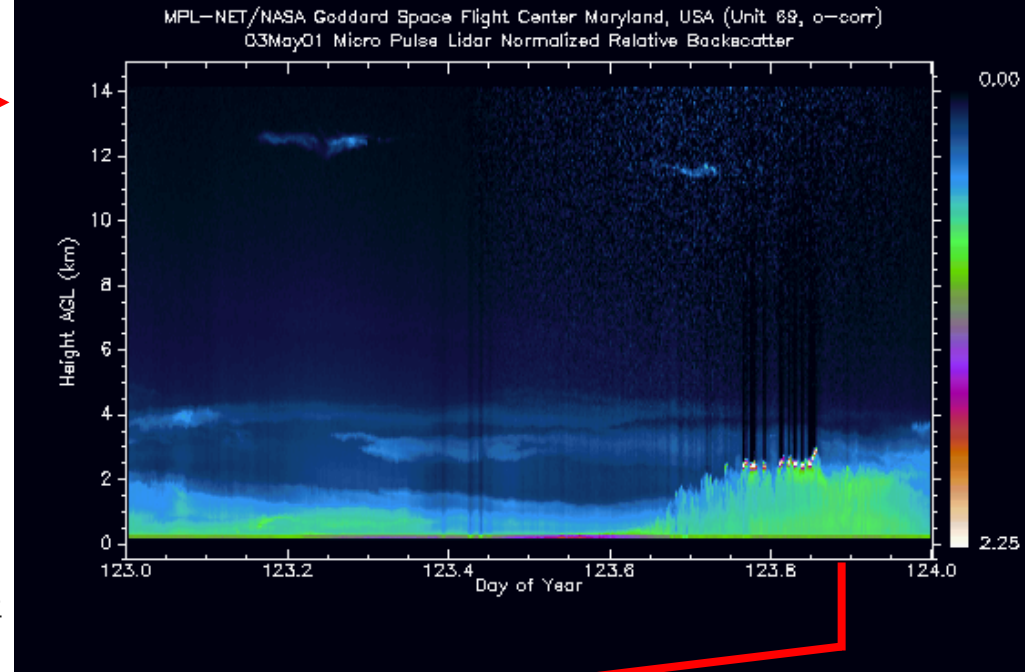


## Real-time MPLNET Data Products:

Level 1.0 - lidar signal

Level 1.5a - extinction profiles  
correlated with  
AERONET data

MPL-Net Level 1.5a Extinction Profile:  
Gsfc\_20010503\_2158UTC  
(site\_yyyyymmdd\_hhmmUTC)



C: 232.92 +- 8.17  
Sa: 69.29 +- 8.93  
AERONET AOT: 0.657 +- 0.01  
AERONET Angstrom Exp: 1.682  
 $\ln[AOT] = a_0 + a_1 \cdot \ln[\text{wave}] + a_2 \cdot \ln[\text{wave}]^2$   
a0: -2.139e+00  
a1: -1.420e+00  
a2: 1.612e-01

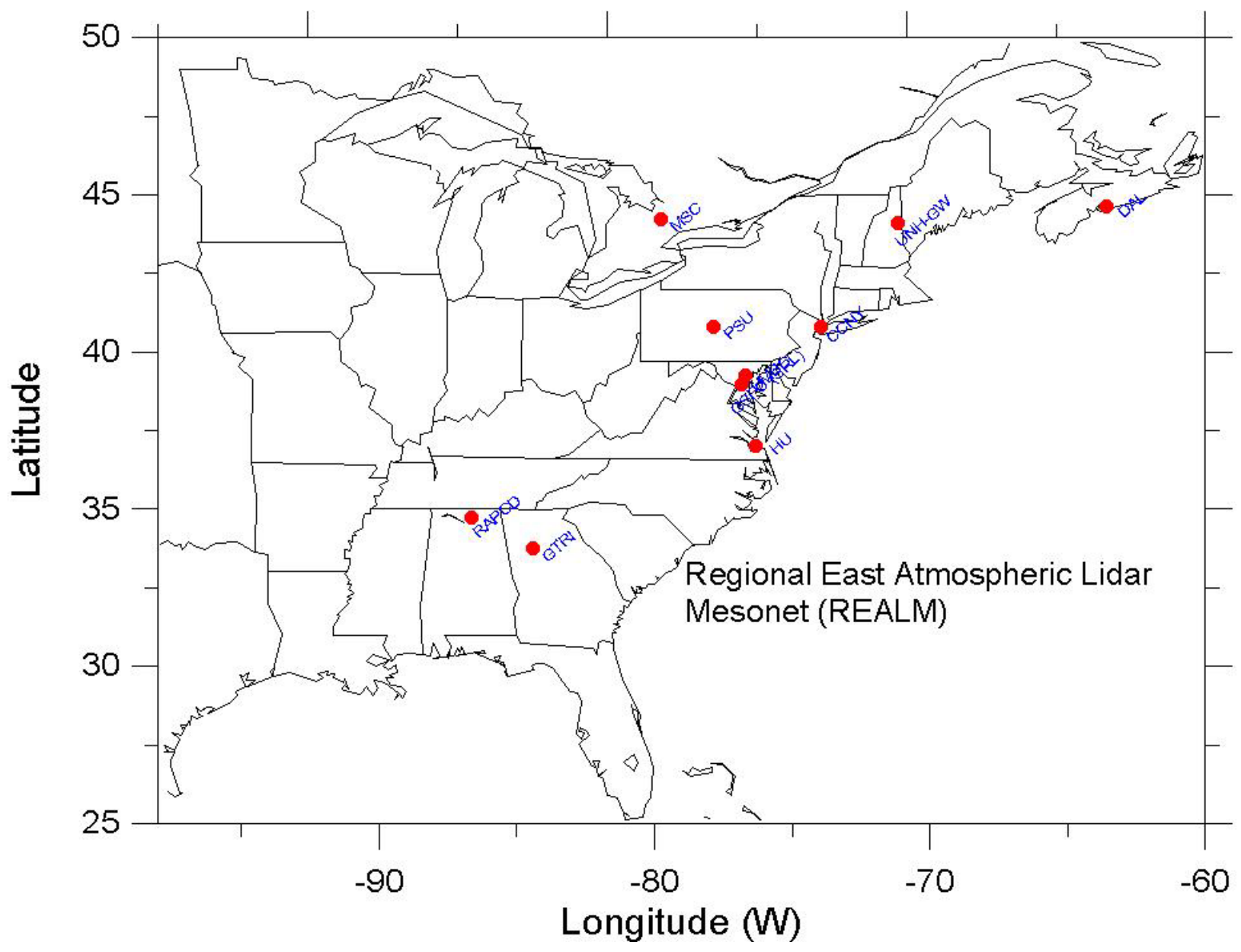
- **uncertainties are calculated for all data products**
- **MPLNET uses co-located AERONET data for processing**
- **MPLNET and AERONET results are correlated in 1 data file**

# The Regional East Atmospheric Lidar Mesonet: REALM

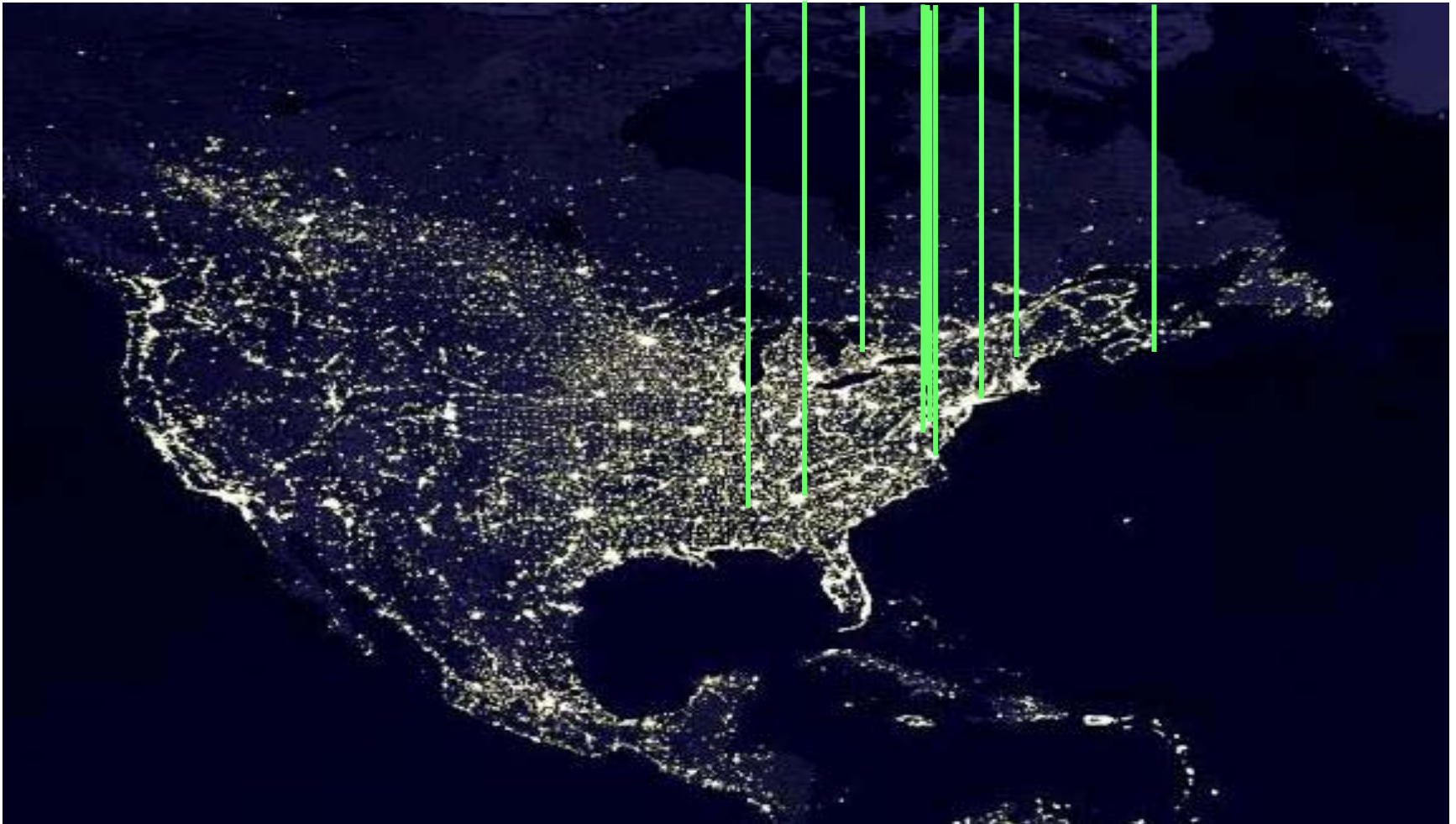
<http://alg.umbc.edu/REALM>

TABLE 1  
REALM LIDAR SYSTEMS

Location	PI	Type(s)
Egbert, ON	K.I. Strawbridge	Scanning elastic
Durham, NH	I. Dors	Winds
Halifax, NS	T. Duck	Elastic, Raman
New York, NY	S. Ahmed	Elastic, DIAL
State College, PA	C.R. Philbrick	Raman, DIAL
Baltimore, MD	R.M. Hoff	Elastic, Raman
Greenbelt, MD	D.N. Whiteman	Raman
Greenbelt, MD	D. Venables	Raman
Hampton, VA	M.P. McCormick	Elastic
Huntsville, AL	M. Newchurch	DIAL
Atlanta, GA	G. Gimmestad	DIAL



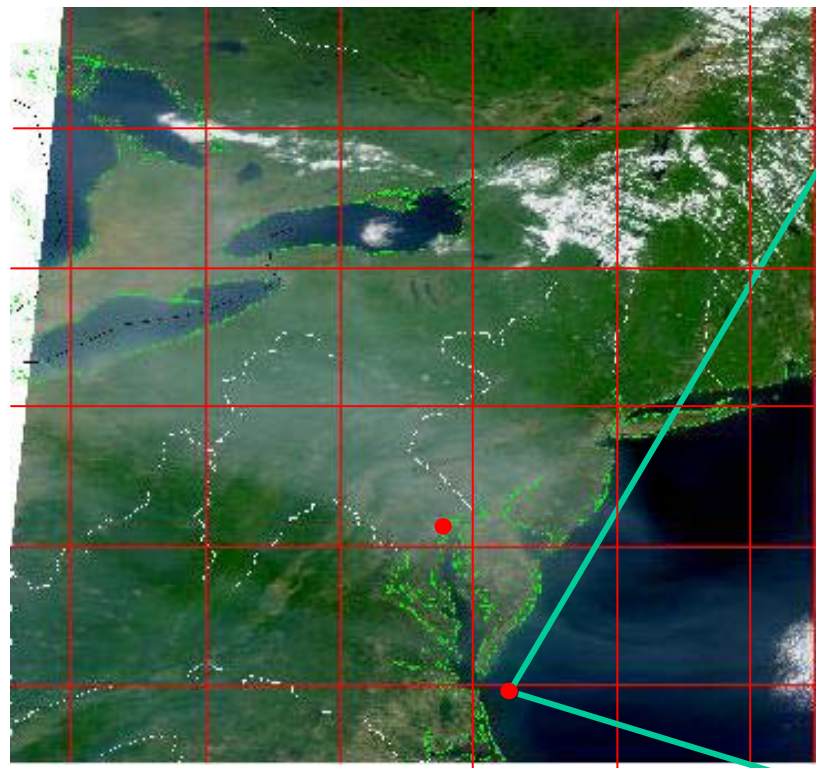
# Monitoring the Megacity





# June 2, 2003 ELF Lidar

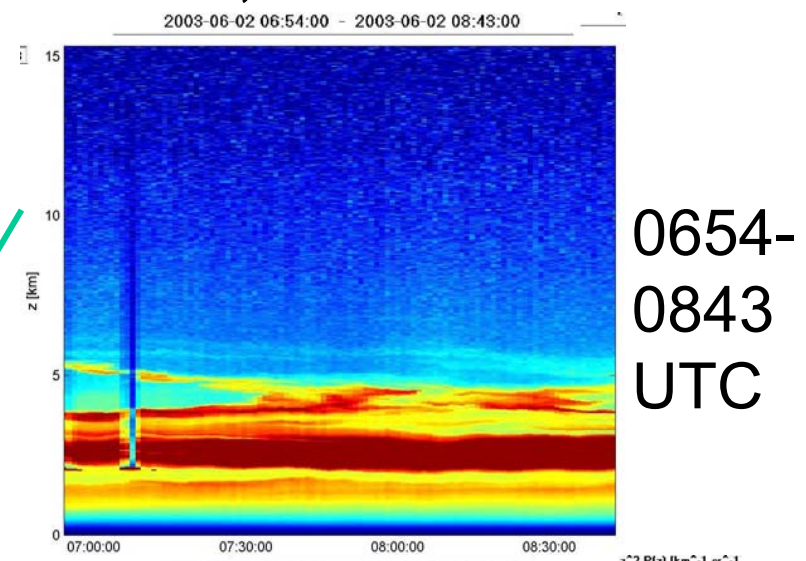
## Terra MODIS 1530 UT



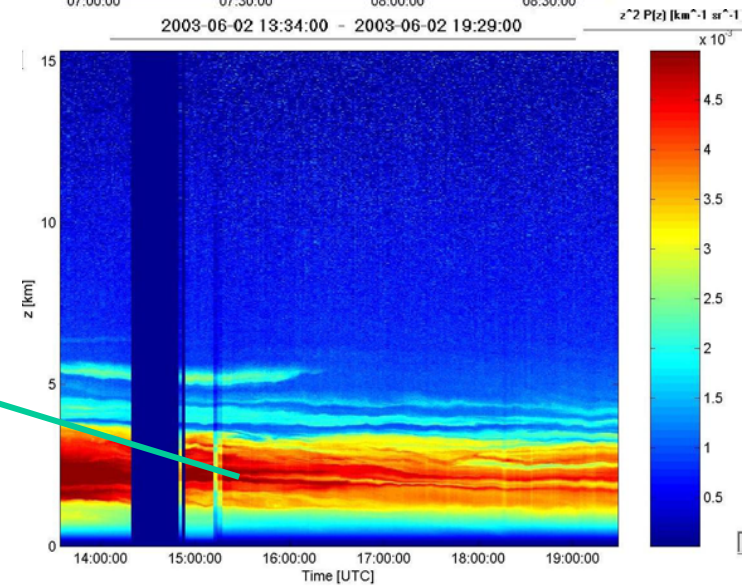
0.5° x 0.5° grid

ABOVE  
ELF, Chesapeake  
Lighthouse, VA

Hoff, UMBC



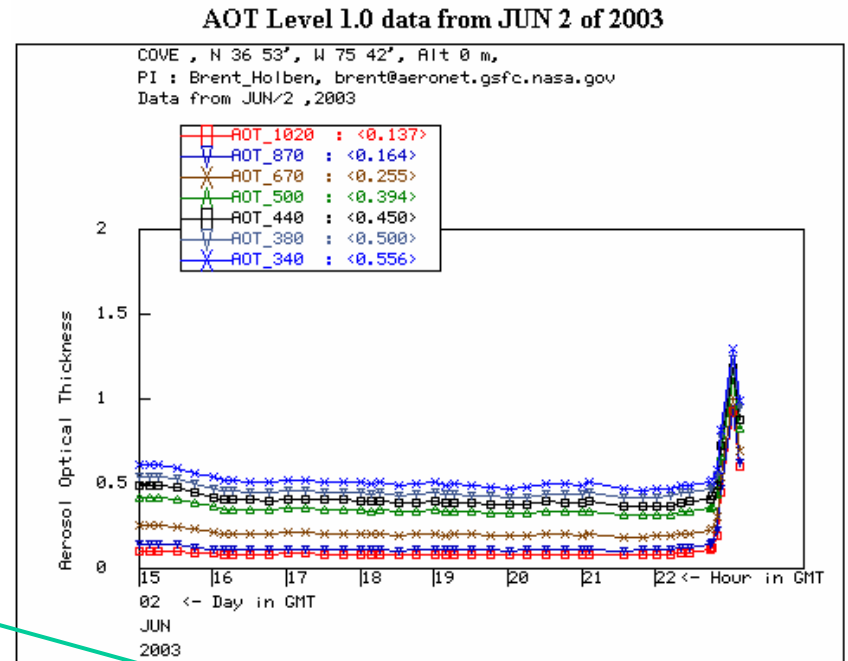
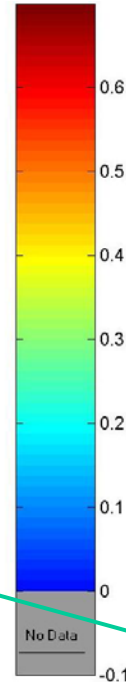
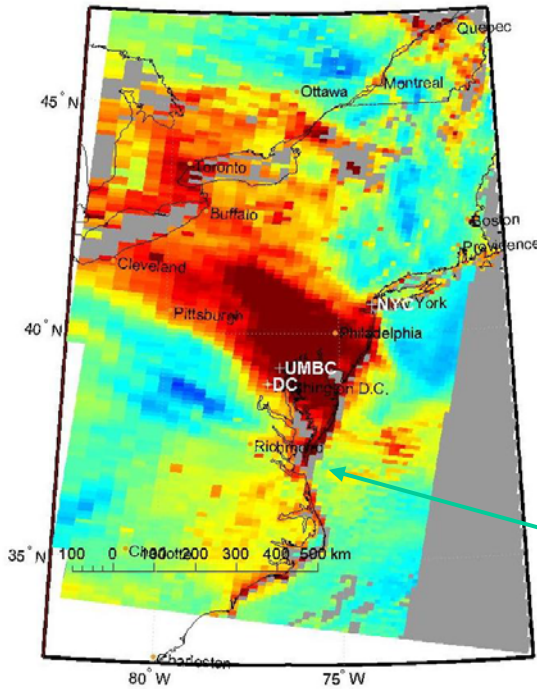
0654-  
0843  
UTC



1334-1929 UTC



# Optical Depth from MODIS/AERONET



MOD04 Aerosol OD  
 15:30 UT June 2

AOT, Cove Site = 0.394  
 @ 500 nm

# Colorco trajectories, GSFC.

Initial time: May 19, 2003 1800 UTC

Forward trajectories +/- 2° of GSFC Site between June 1 - 3, 2003  
between 700 - 400 hPa

Modis  
Firecounts

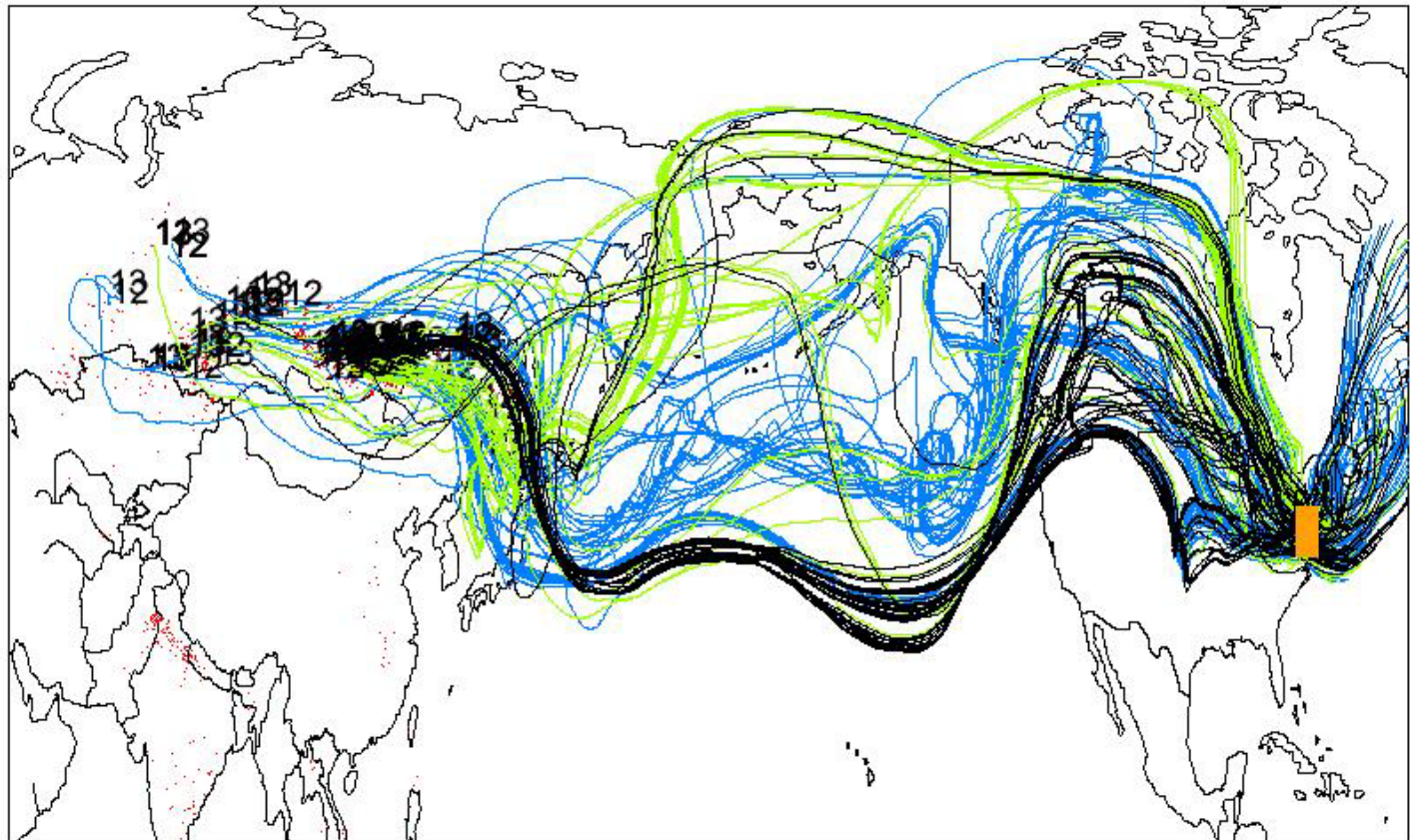
Target Site

Days (approx)  
to reach target

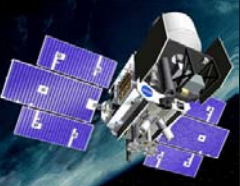
300 hPa n=(93)

500 hPa n=(52)

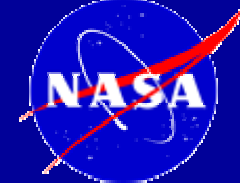
700 hPa n=(61)



Initial time: May 19, 2003 1800 UTC



# GLAS



Judd Welton

NASA Goddard Space Flight Center  
Laboratory for Atmospheres

GLAS Atmospheric Science Team:

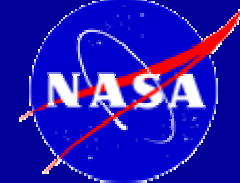
James D. Spinhirne, Stephen P. Palm,  
Dennis Hlavka, William Hart, Matthew McGill





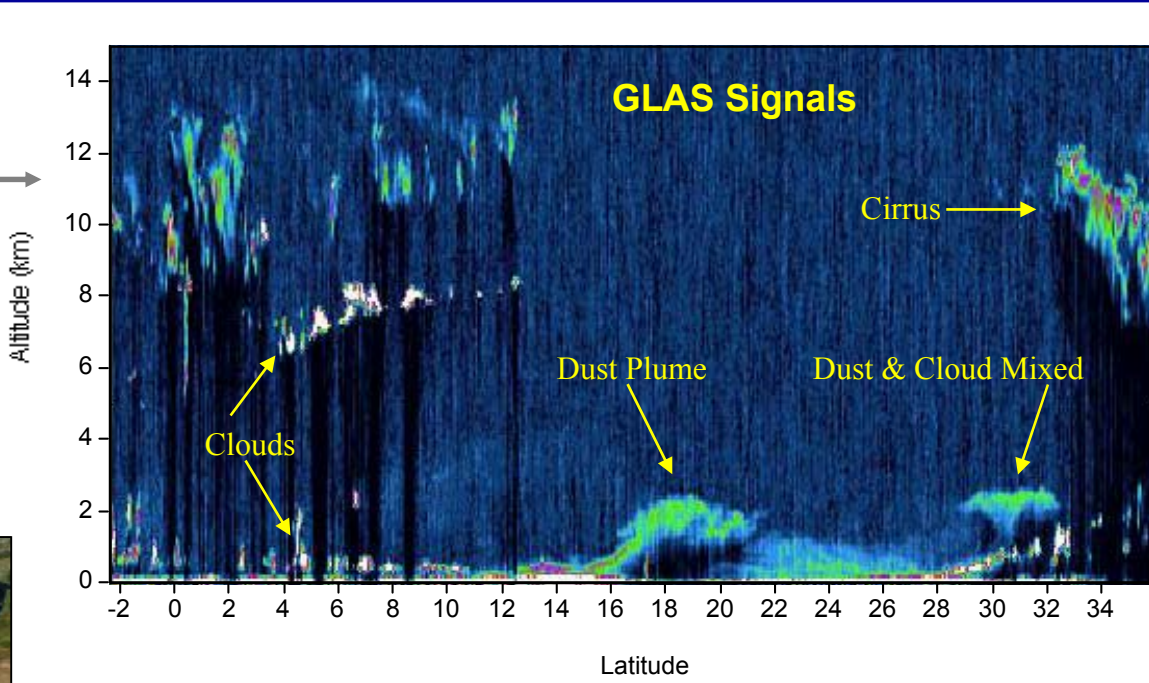


# Results at 532 nm

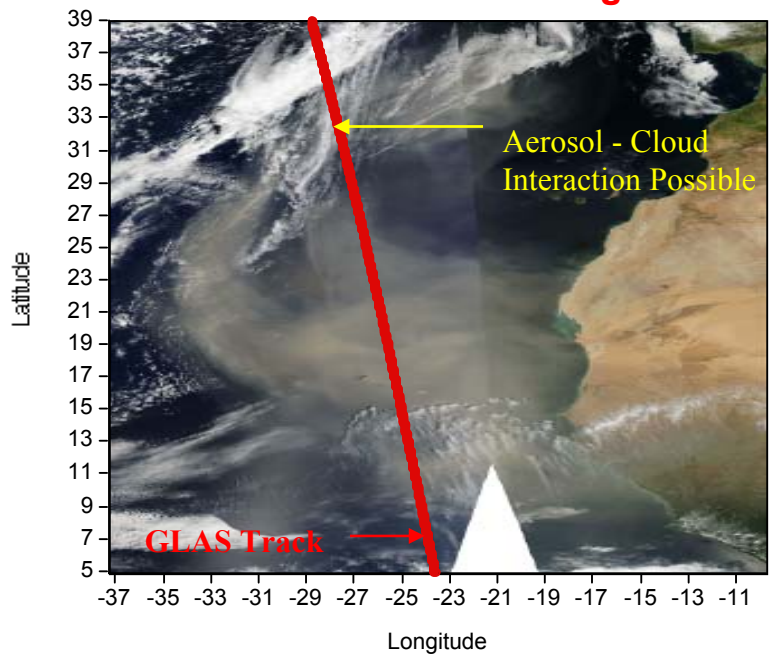


E.J. Welton, NASA Goddard Space Flight Center, Judd.Welton@nasa.gov, 11/18/03

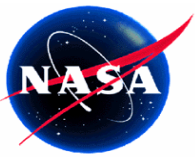
**Example of Initial GLAS Data (1064 nm)**  
**March 3, 2003 Dust from West Africa**  
 GLAS signals from ICESat:  
 04:40 UTC  
 MODIS images from Terra and Aqua:  
 12:40 and 14:00 UTC  
 (MODIS rapid response website -  
[rapidfire.sci.gsfc.nasa.gov](http://rapidfire.sci.gsfc.nasa.gov))



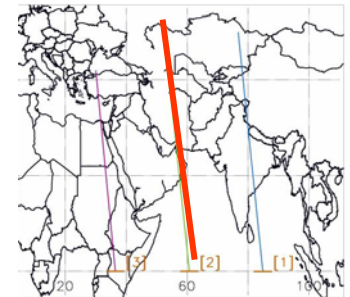
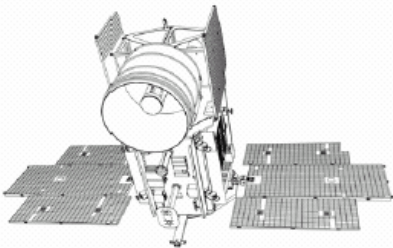
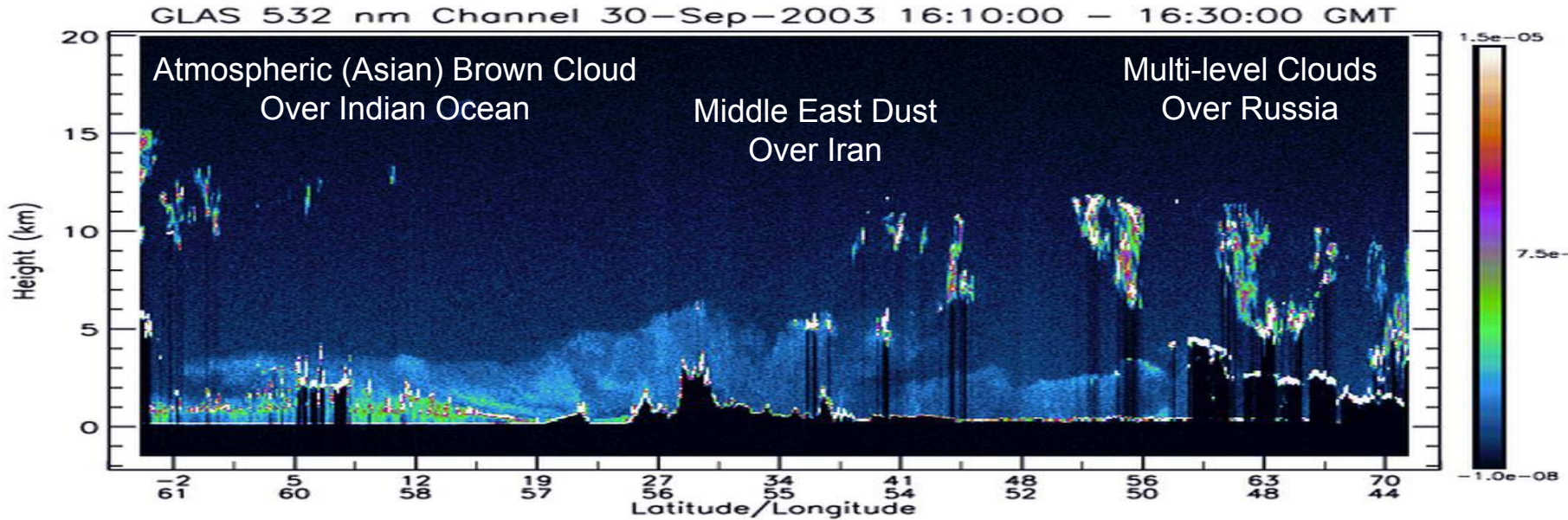
## NASA MODIS Images



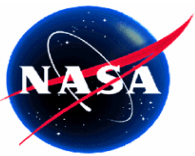
Preliminary outcome from initial dataset:  
 GLAS 1064 nm channel is detecting water & ice clouds,  
 and moderate to high concentration aerosol plumes  
 GLAS was not within MODIS swath during Feb/Mar  
 03, but despite time difference of several hours,  
 comparisons with dust plume images are not bad



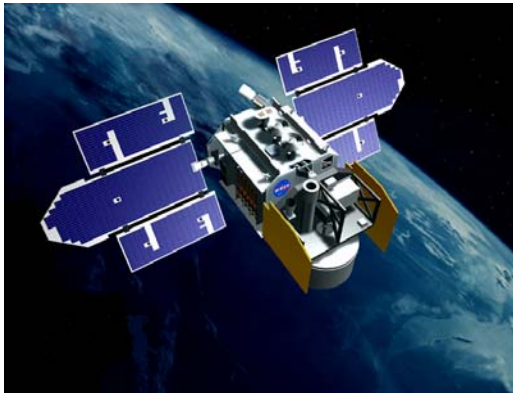
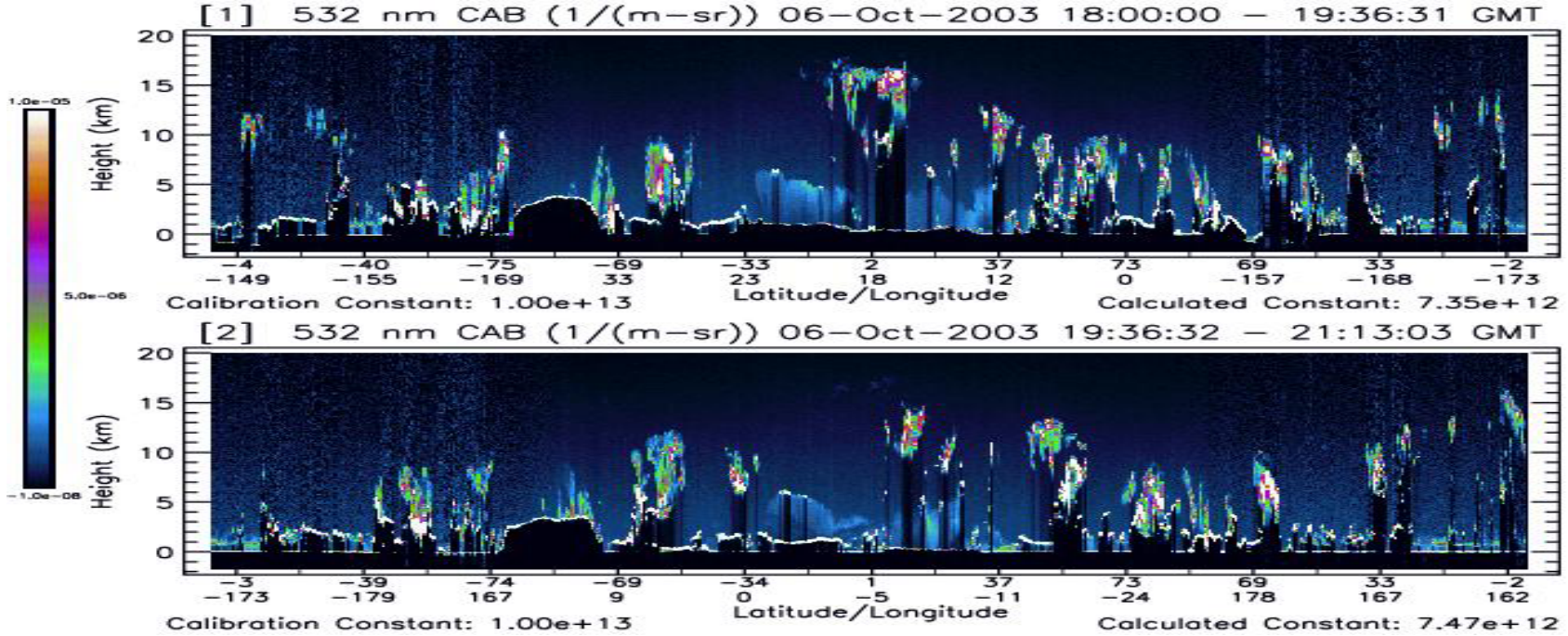
# Geoscience Laser Altimeter System Global Lidar Measurements of Clouds and Aerosol in the Atmosphere



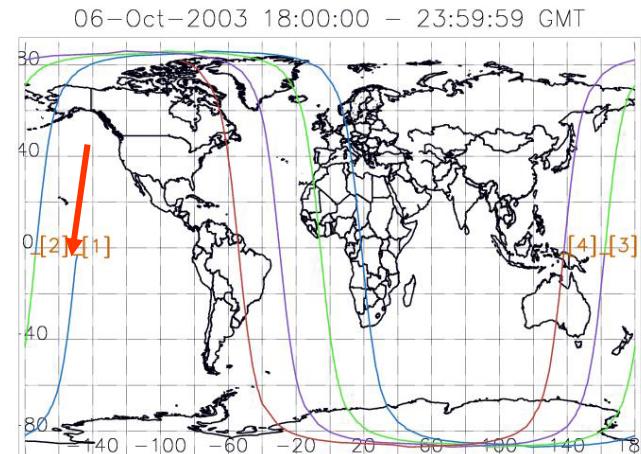




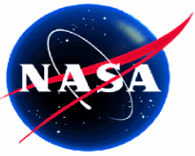
# GLOBAL ORBITAL LIDAR OBSERVATIONS OF CLOUD AND AEROSOL VERTICAL DISTRIBUTION



## Geoscience Laser Altimeter System

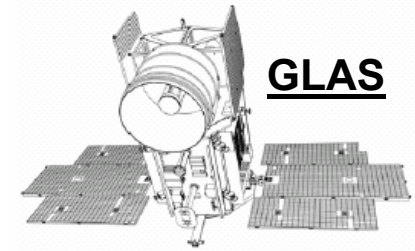






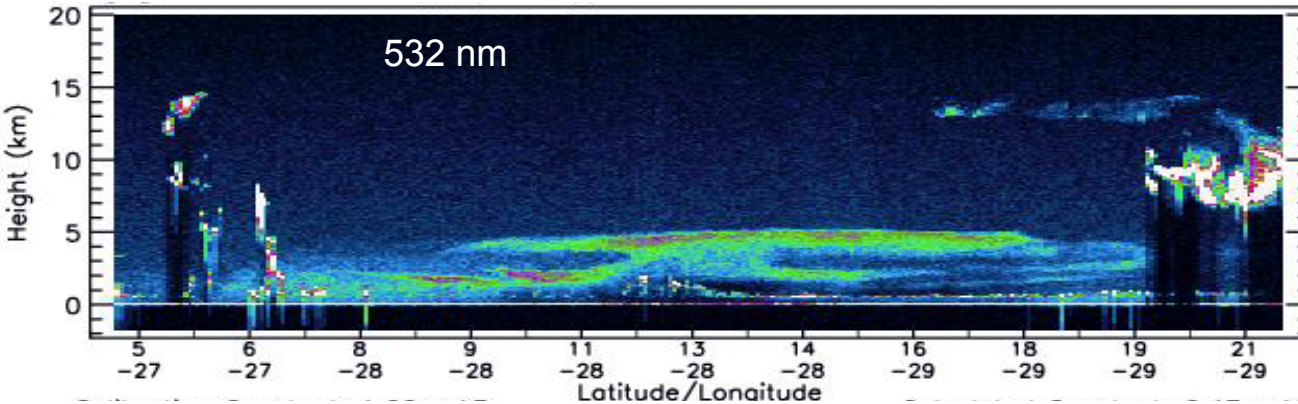
# SPACE LIDAR OBSERVATION OF THE DISTRIBUTION OF AEROSOL

## New Input for Models

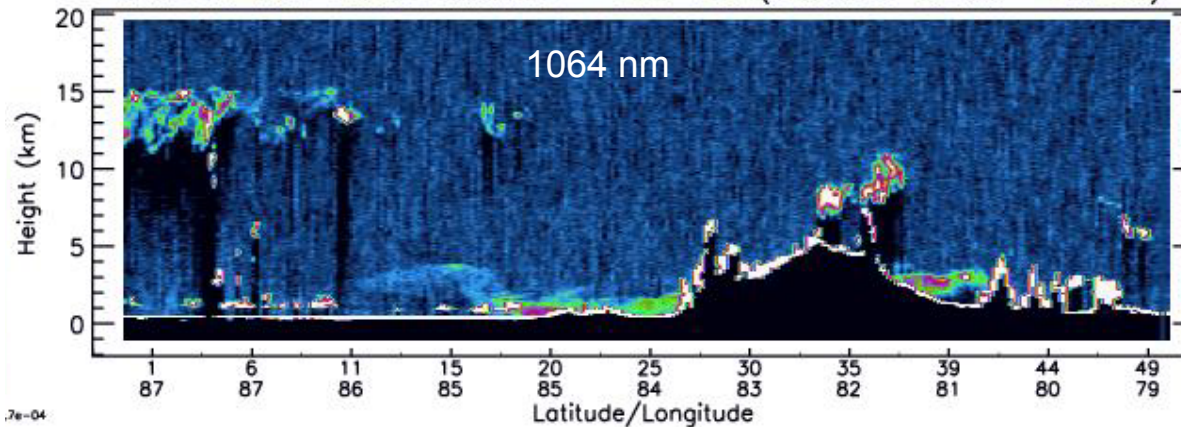


**GLAS**

### GLAS View of Saharan Dust Layer



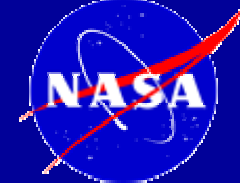
NRB 05-Mar-2003 21:01:05 - 21:14:25 (Seconds 10865 - 11665)



### Asian Dust and Pollution




# Data Access



E.J. Welton, NASA Goddard Space Flight Center, Judd.Welton@nasa.gov, 11/18/03

## GLAS Atmospheric Science Team Website: [glo.gsfc.nasa.gov](http://glo.gsfc.nasa.gov)

GLAS Atmospheric Science Team



### The Geoscience Laser Altimeter System (GLAS)


Atmospheric Sciences Team

- Home
- Science
- Navigation
- Links
- Contacts

GLAS has Launched! On January 12th from Vandenberg Airforce Base

GLAS (the Geoscience Laser Altimeter System) was successfully launched aboard the Ice, Cloud and Land Elevation Satellite (ICESat) into a near-polar orbit (inclination 94 degrees) on January 12th 2003. GLAS is part of NASA's Earth Science Enterprise (ESE) which includes a series of satellites beginning in 1999 to measure Earth's atmosphere, oceans, land, ice, and biosphere for a period of 10 to 15 years. The main goal of ESE is to measure changes in the earth-atmosphere system which are indicative of climate and environmental change.

GLAS will be the first atmospheric backscatter lidar to make continuous measurements of the Earth's atmosphere from space. The lidar will provide unprecedented views of atmospheric cloud and aerosol structure and give us information on the height and thickness of radiatively important cloud layers which is needed for accurate short term climate and weather prediction.



*Geoscience Laser Altimeter System*

<http://glo.gsfc.nasa.gov/> (1 of 2) [11/18/2003 12:59:24 PM]

GLAS Quick Look Map!

### GLAS Science: GLAS Quick Look Images

#### Realtime Images from GLAS

Realtime images from GLAS are available for 6 hour orbit segments each day:

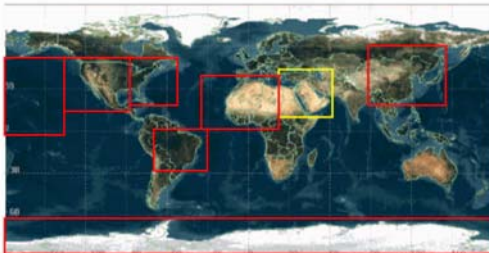
- 00:00 - 05:59 UTC
- 06:00 - 11:59 UTC
- 12:00 - 17:59 UTC
- 18:00 - 23:59 UTC

Our archive is updated automatically, and images are typically available about an hour after each segment. Each orbit segment is broken into 4 signal images with separate map images to show location.

[View Realtime GLAS Images](#)

#### GLAS Data Products

Quick look images of GLAS data products are available for the regions indicated on the map below. Click on a region to browse through our data product images:



[http://glo.gsfc.nasa.gov/Science/Quick\\_look\\_Map/](http://glo.gsfc.nasa.gov/Science/Quick_look_Map/) [11/18/2003 12:59:44 PM]

Realtime Window

#### Realtime Image Menu:

Region:

Year:

Month:

---

#### Graph GLAS Parameters:

Graph Parameter:

Version:

Start Date:  /  /

End Date:  /  /

[Return to Quick Looks Page](#)

[http://glo.gsfc.nasa.gov/cgi-bin/Realtime\\_Images/prog1.cgi](http://glo.gsfc.nasa.gov/cgi-bin/Realtime_Images/prog1.cgi) [11/18/2003 12:59:48 PM]

\* Realtime images available within ~8 hours of observation



# Update on Names



As of 11/01, PICASSO-CENA , ESSP3, ESSP3-CENA, P-C, ... is:

## The **CALIPSO** Mission

(**C**loud-**A**erosol **L**idar and **I**nfrared **P**athfinder **S**atellite **O**bservations)

D. M. Winker, LaRC/NASA, PI

And,

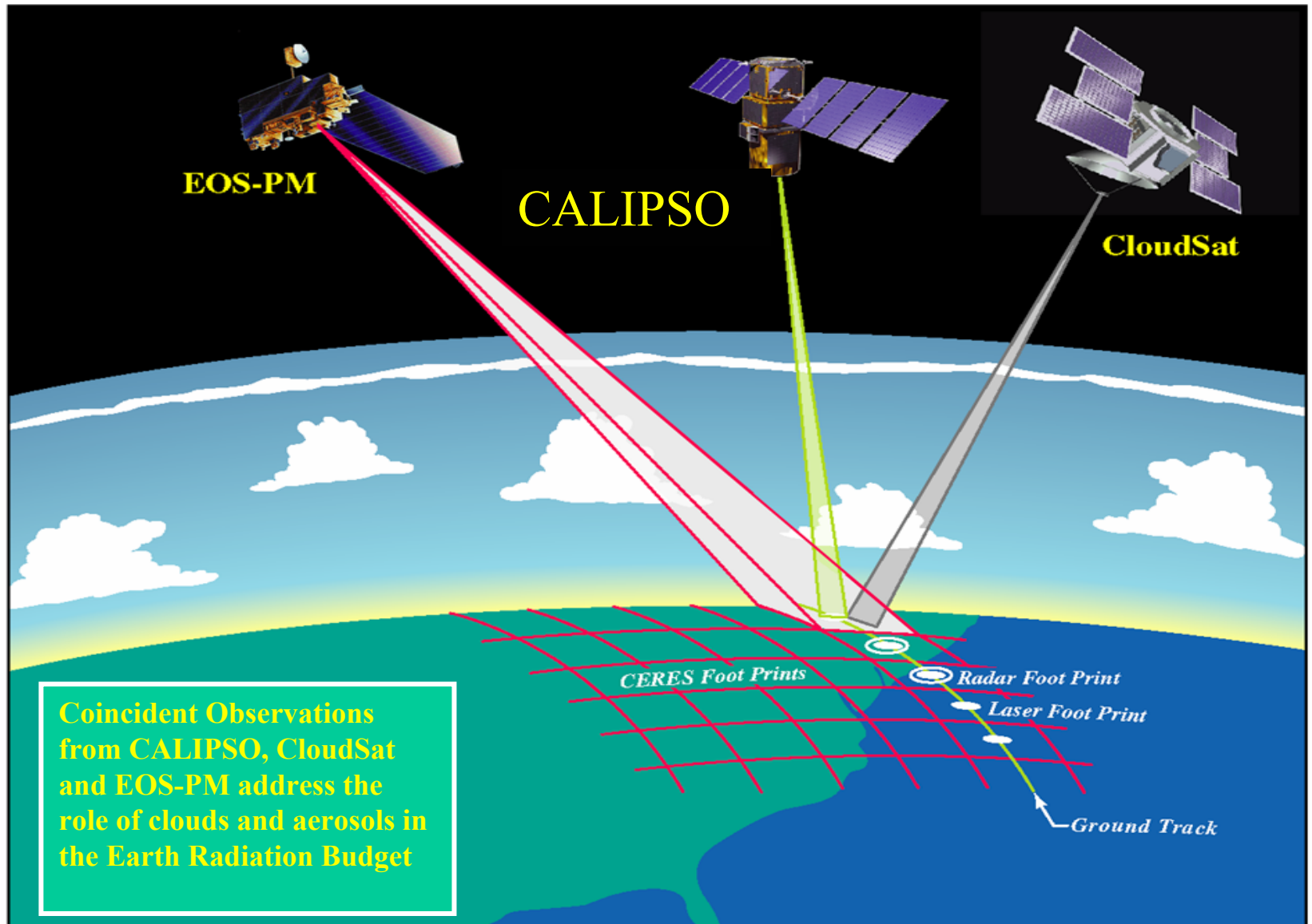
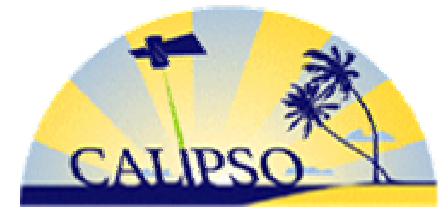
the CALIPSO lidar now has a name:

## **CALIOP**

(**C**loud-**A**erosol **L**idar with **O**rthogonal **P**olarization)

(rhymes with “I - O - P”)

# Mission Concept



Coincident Observations from CALIPSO, CloudSat and EOS-PM address the role of clouds and aerosols in the Earth Radiation Budget



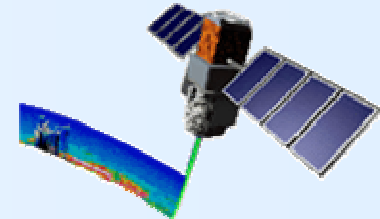
# Implementation



- **One spacecraft with 3 science instruments:**
  - 3 channel lidar
  - IR imager
  - wide-field camera
- **Launch in March 29, 2005**
- **3-year mission**
- **Fly in formation with EOS-PM in polar orbit**



# Measurement Capabilities



Data Product	Measurement Capabilities and Uncertainties	Representative Spatial Resolution	
		Night Horizontal x Vertical	Day Horizontal x Vertical
Aerosol layer top and base height	$\beta_{\min} = 2.5 \times 10^{-4} \text{ km}^{-1} \text{ sr}^{-1}$ ( $\tau = 0.005$ for a 500 m thick layer)	20 km x 120 m	50 km x 120 m
Thin cloud top and base height	$\beta_{\min} = 1 \times 10^{-3} \text{ km}^{-1} \text{ sr}^{-1}$ ( $\tau = 0.005$ for a 250 m thick layer)	1 km x 60 m	4 km x 60 m
Thick cloud base height	Layer $\tau < 5$	4 km x 60 m	50 km x 60 m
PBL cloud structure	$\beta_{\min} = 1.6 \times 10^{-2} \text{ km}^{-1} \text{ sr}^{-1}$	333 m x 30 m	333 m x 30 m
Aerosol $\tau$ (Resolutions for case of $\tau = 0.1$ )	$\frac{\partial \tau}{\tau} \leq 40\%$ (total error) $\tau$ (includes 30% error in S)	8 km horizontal	20 km horizontal
Aerosol $\sigma(z)$	$\frac{\partial \sigma}{\sigma} \leq 30\%$ (random error only)	3.5 km x 120 m	6 km x 120 m
Cirrus $\tau, \sigma(z)$	Within a factor of 2 for $\tau < 5$	15 km horizontal	NA
Ice/water phase	Layer by layer	16 km x 60 m or 4 km x 240 m	16 km x 60 m or 4 km x 240 m



# Backups

# MPLNET: Instruments



## • Micro-pulse Lidar Systems (MPL)

- compact & semi-autonomous
- 523 nm wavelength
- PRF 2500 Hz
- eye-safe, output energy in  $\mu\text{J}$
- small FOV, no multiple scattering

## • Sunphotometer

- Sites & Experiments: NASA Aerosol Robotic Network (AERONET) sunphotometers by Cimel
- Handheld Microtops sunphotometer used on ocean cruises



## • Original MPL Design (Type 1-3)

### Transceiver:

20cm Cassegrain Telescope on top  
Laser Head, Detector, Optics below

### Scalar Unit:

Data at 30, 75, 150, 300 m vert. res.

### Laser Power Supply:

1 W Nd:YLF Laser Diode  
(Doubled to 523nm on Head)

### Laptop Computer:

Data Acquisition, Storage (1 min res)



## • New MPL Design (Type4)

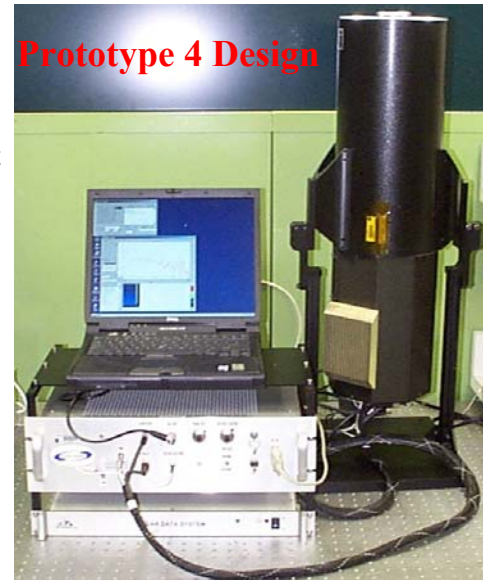
### Basic System Specifications:

Same optical design, and wavelength with similar output energy. Temporal/Spatial resolutions the same. Still eye-safe & autonomous

### Improvements:

- More rugged design
- Improved laser supply creates longer lifetime and control of laser via computer
- Multi-channel data system
- Fiber coupled detectors

### Prototype 4 Design

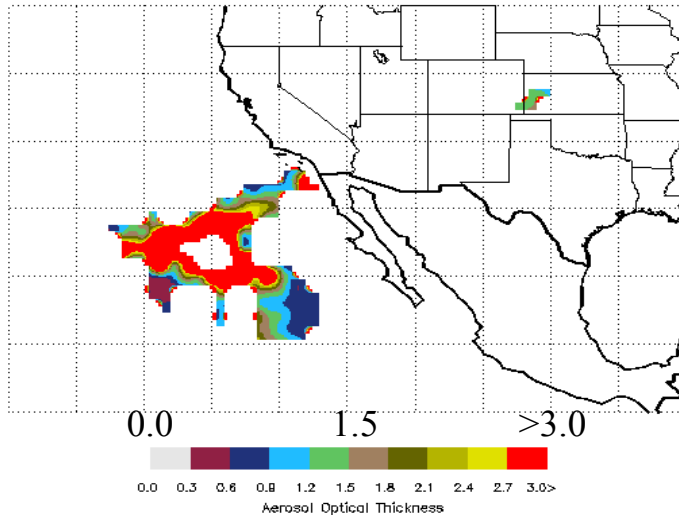


\* First three commercially produced Type 4 MPL systems are now under contract with Sigma Space Corporation.



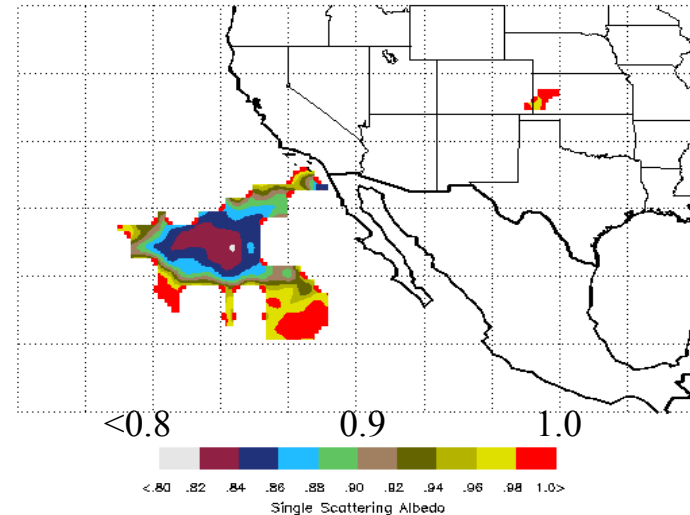
# Aerosol Properties from TOMS observations

Earth Probe Aerosol Optical Thickness at 3 km.  
on 10/27/03



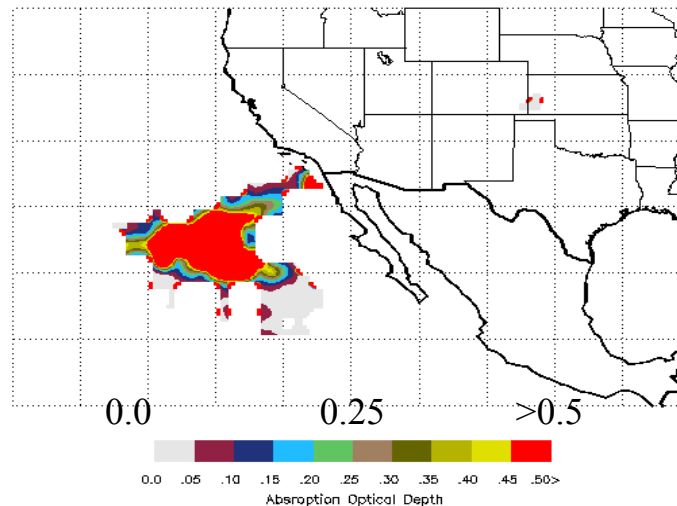
Extinction optical depth

Earth Probe Single Scattering Albedo at 3 km.  
on 10/27/03



Single scattering albedo

Earth Probe Absorption Optical Depth  
on 10/27/03



Absorption optical depth

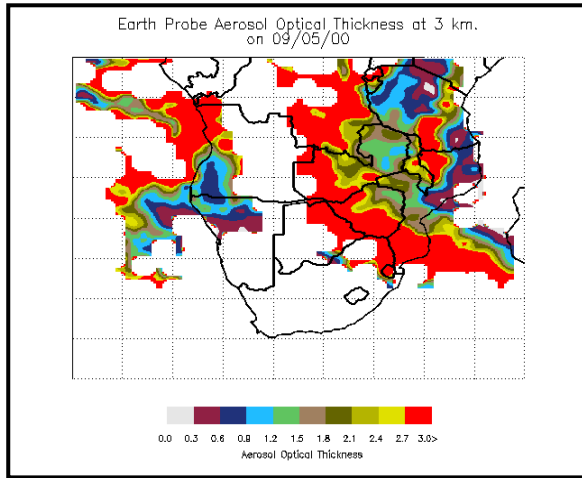
California Fires

October 27-2003

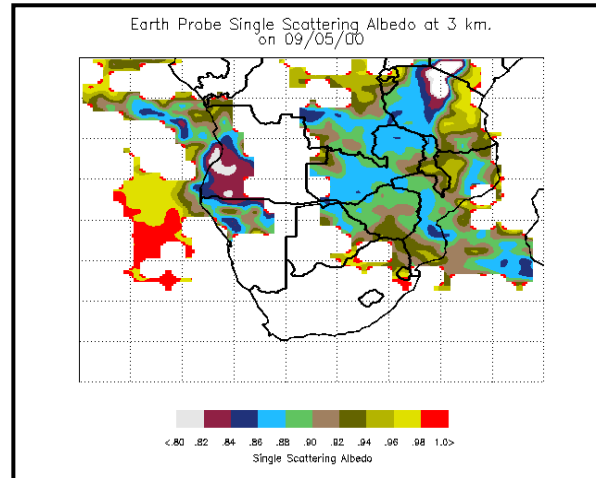
# TOMS – Aeronet comparison during SAFARI2000

Sept.5 2000

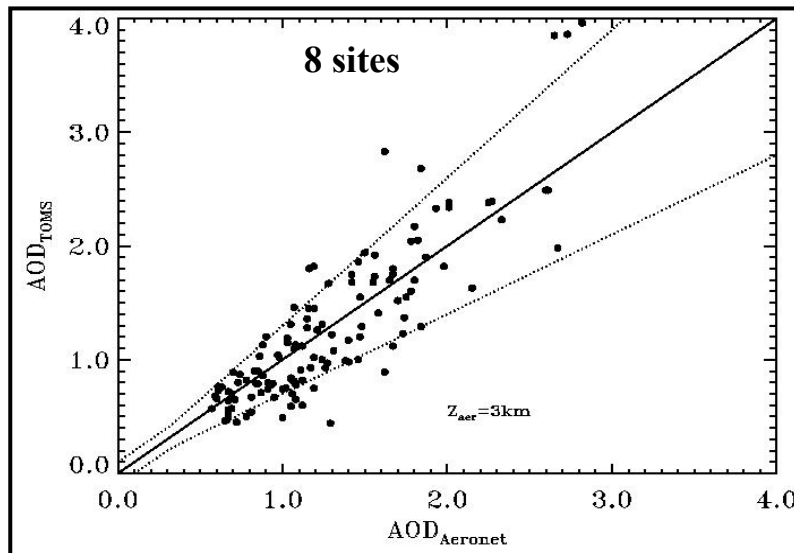
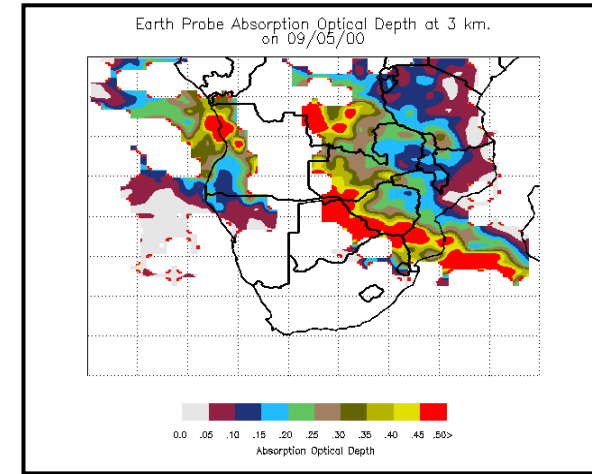
## Optical depth (380 nm)



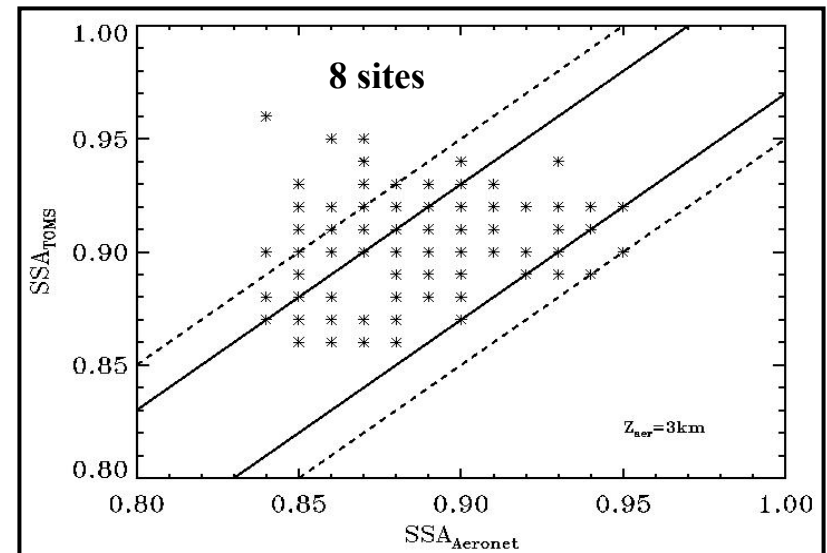
## Single scattering albedo



## Absorption optical depth

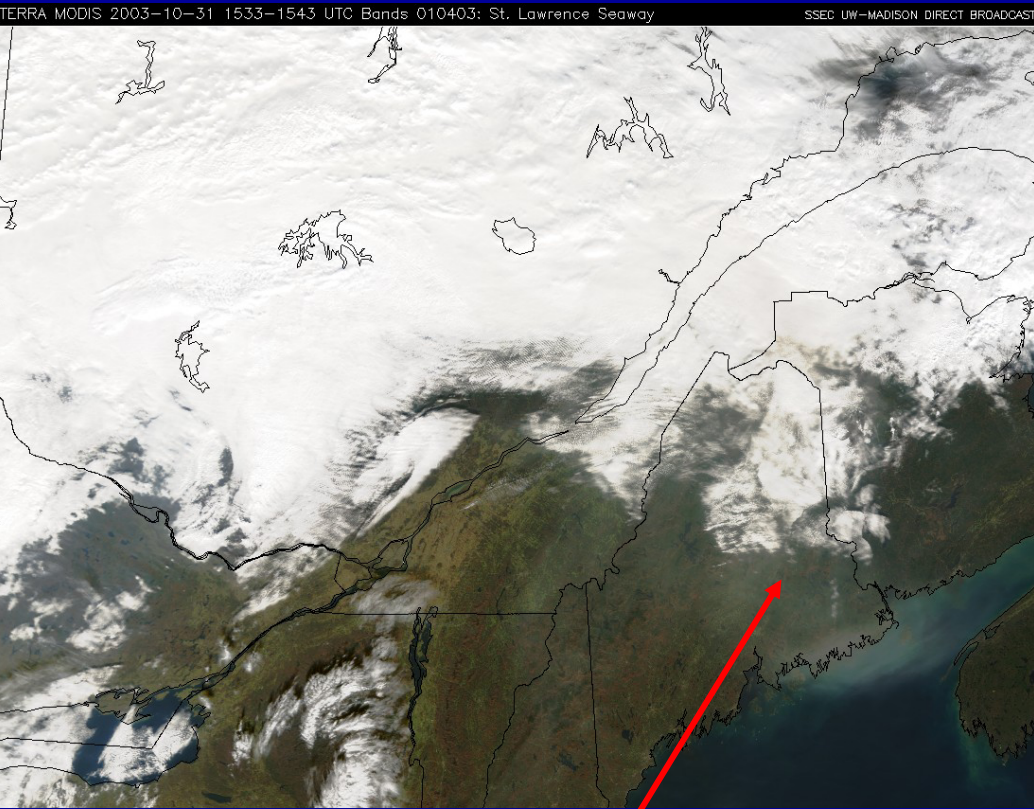


82% of points are within expected accuracy limits (0.1 or 30%)



63% within +/- 0.03  
87% within +/- 0.05

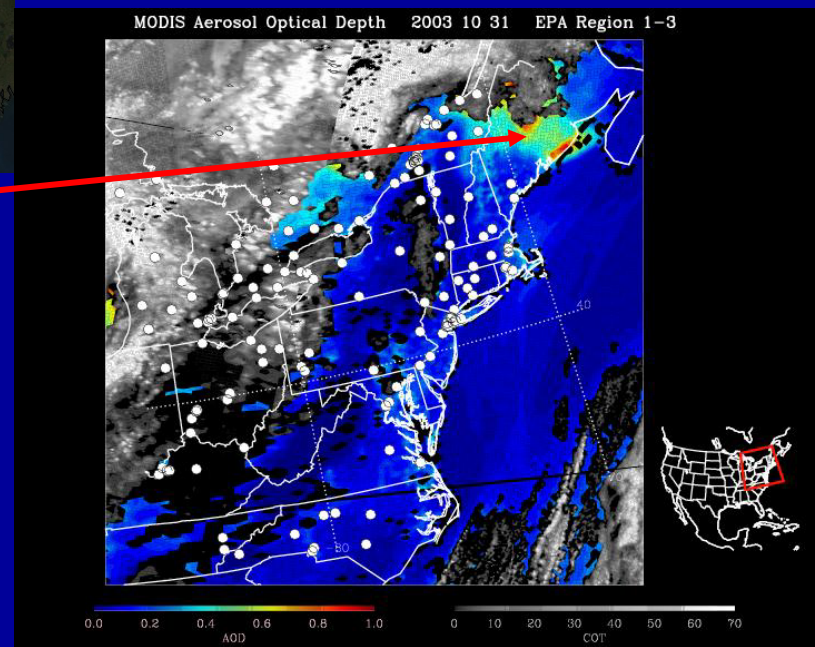




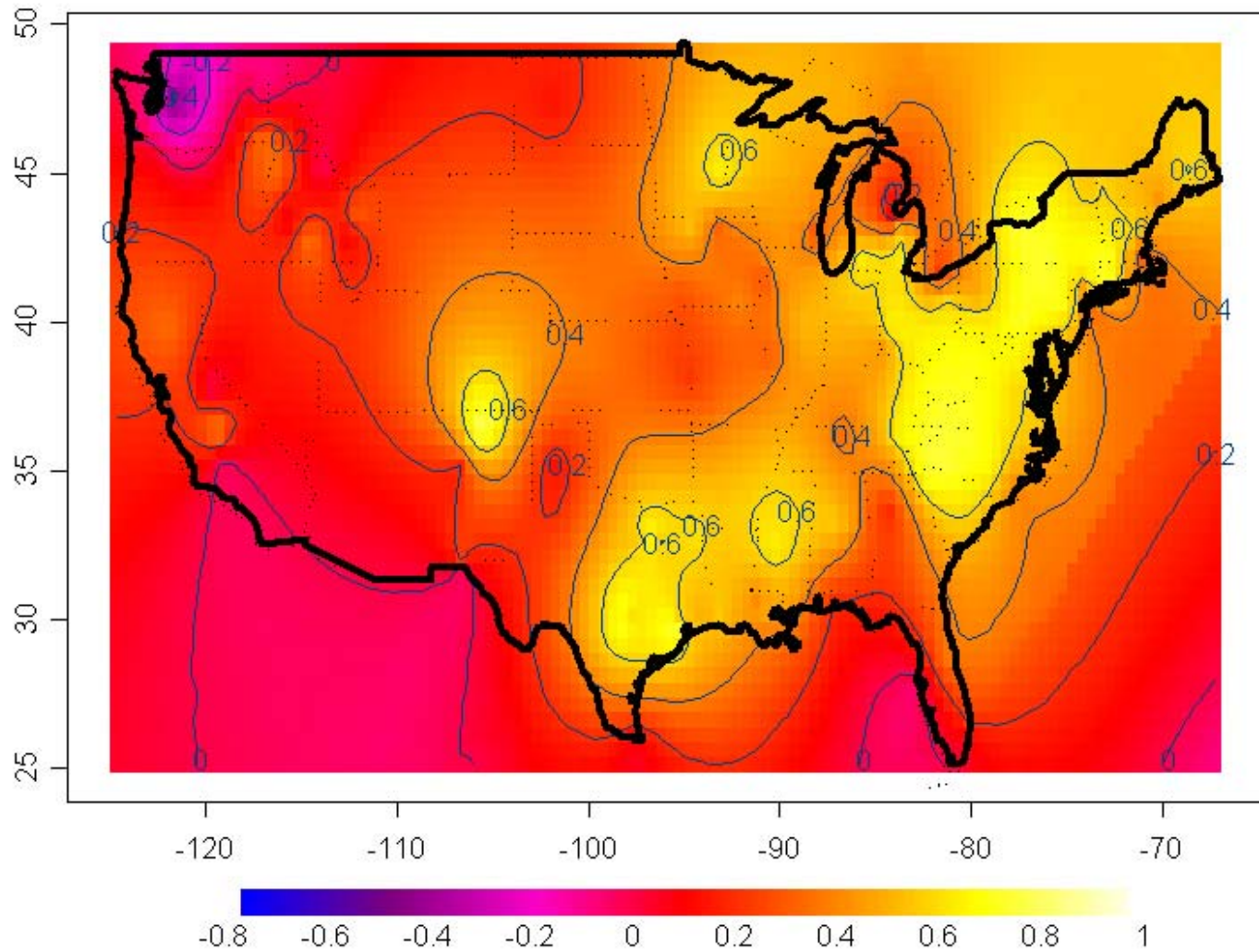
October 31, 2003  
Bay of Fundy region  
TERRA MODIS RGB

TERRA MODIS Optical Depth

Aerosol over clouds  
OD 0.6-0.8



## Correlations between AOD and PM2.5(hourly)

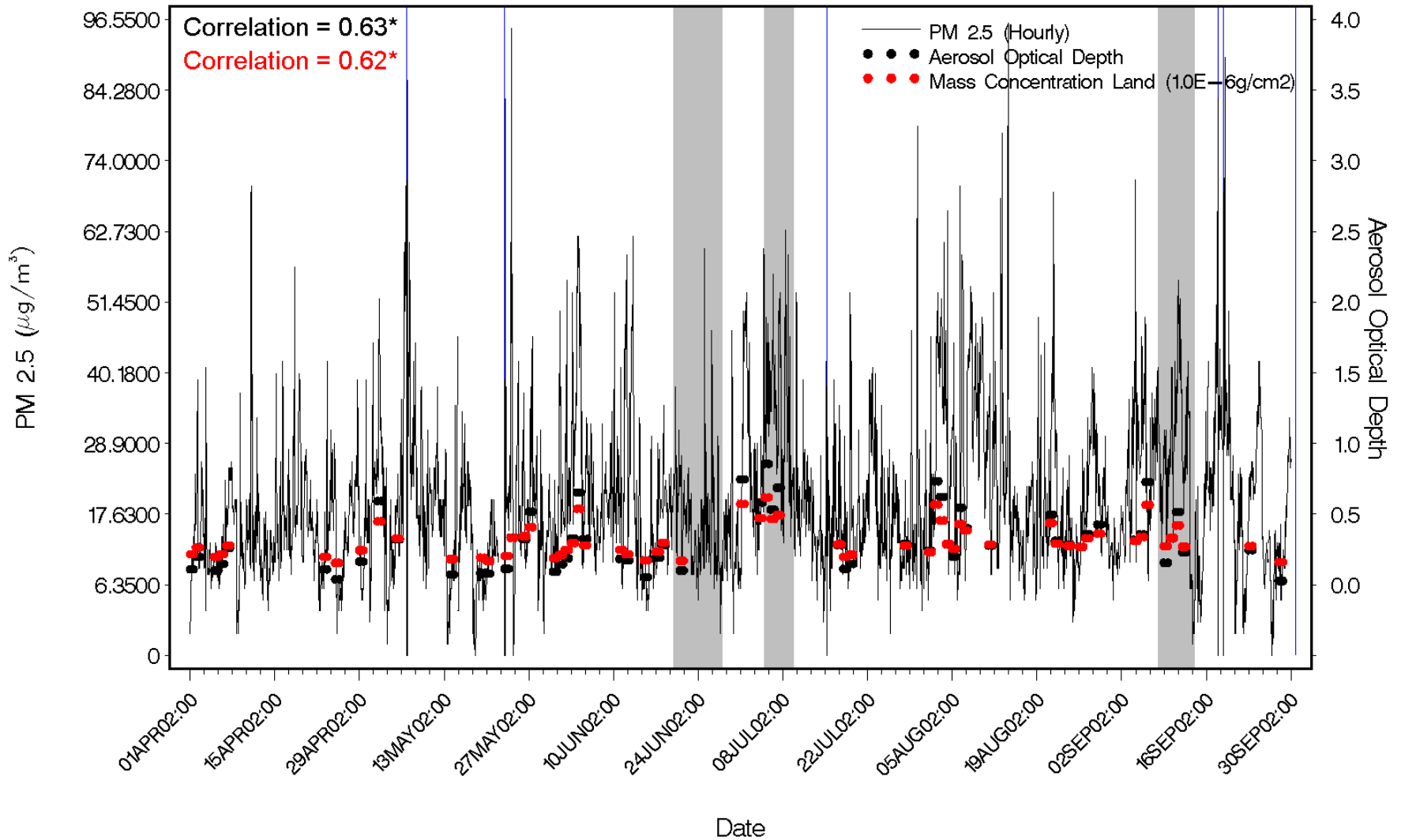


Engel-Cox et al., 2004



# BIRMINGHAM

## Site 010732003



\*Correlation estimates based on data for this site only.