NASA Support to EPA STAR Project:

Fires, changing climate, and consequences for U.S. air quality

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Examples of other MISR air quality applications

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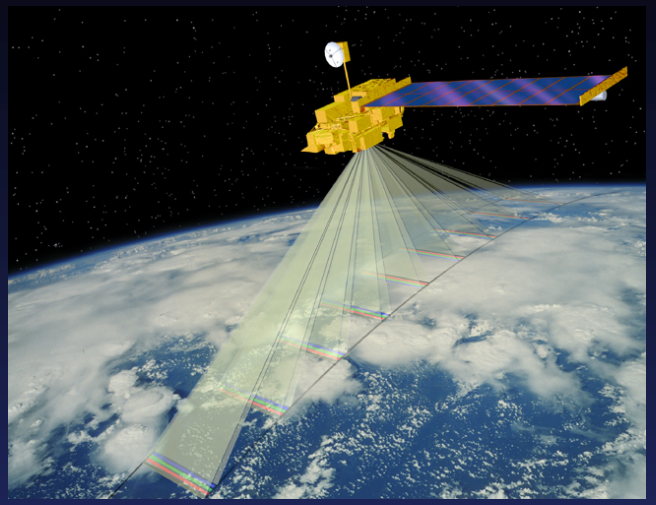
Jet Propulsion Laboratory, California Institute of Technology

with contributions from many collaborators

NASA Applied Sciences Program Air Quality Team Meeting
Potomac, MD
June 18-20, 2007

MISR on Terra: Air quality applications



Global data since March 2000

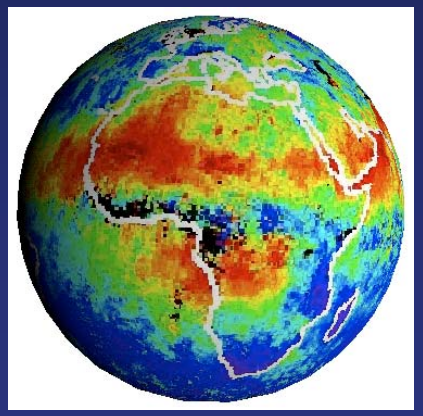
9 view angles: 70º forward to 70º aft

275 m - 1.1 km sampling

Spectral bands: 446, 558, 672, 866 nm

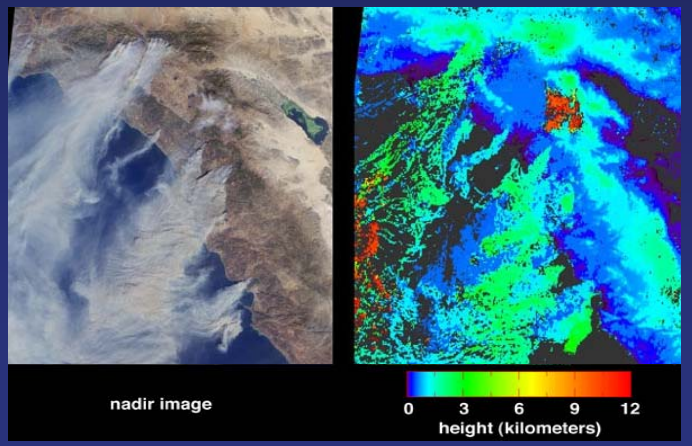
400-km swath: 9-day global coverage

Emissions inventories



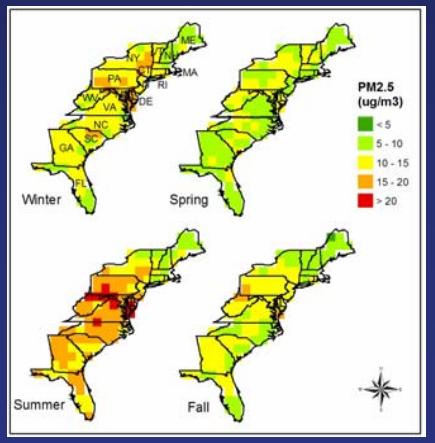
Accurate AOD retrievals over land, including bright source regions

Model validation and initialization



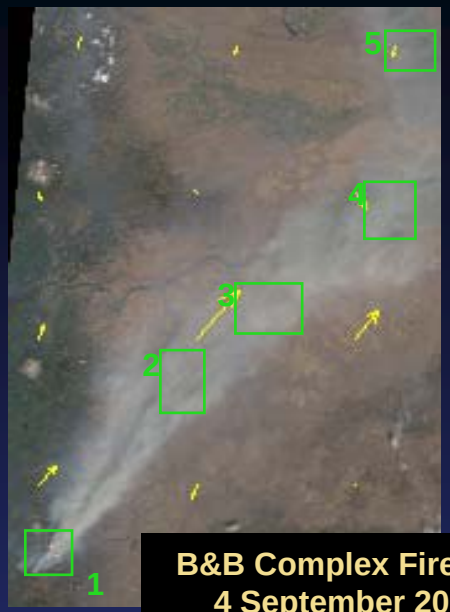
3-D perspectives and plume height mapping

Health impacts and compliance

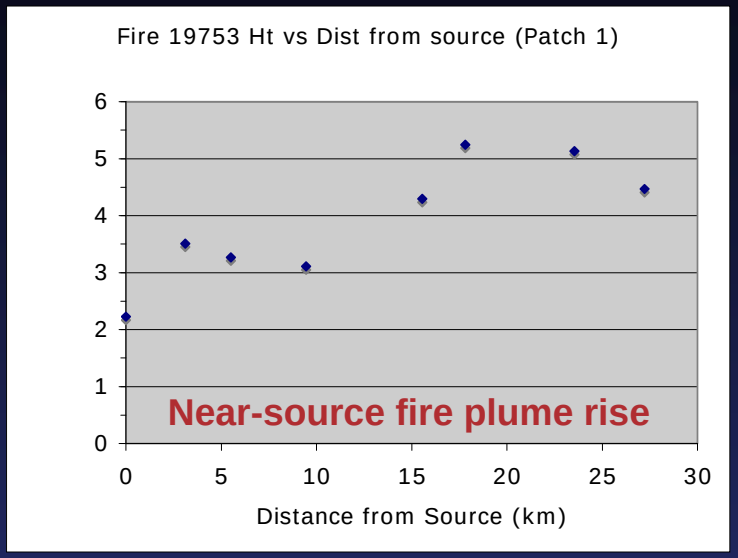


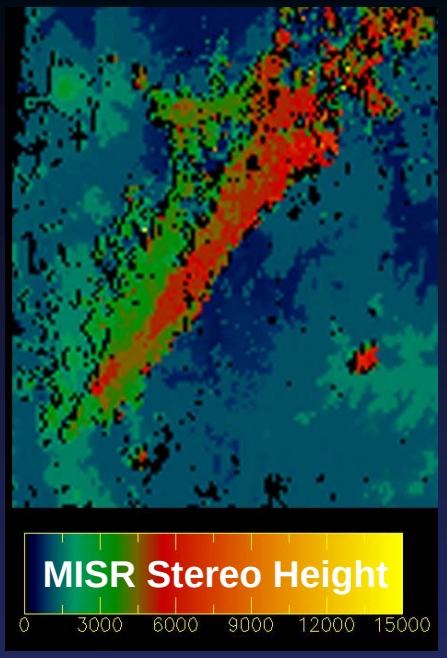
$PM_{2.5}$ component mapping

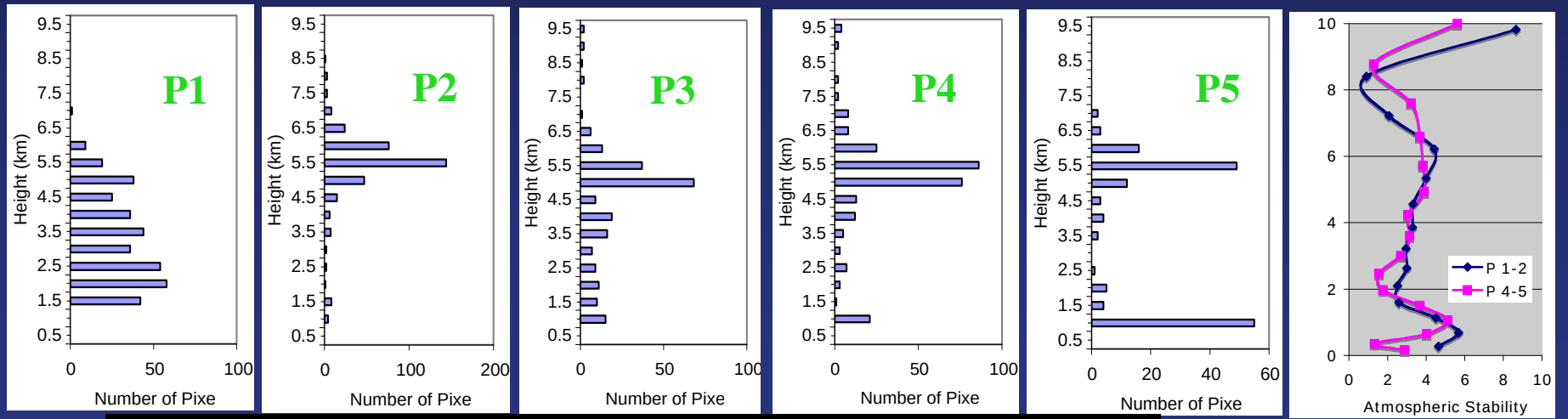
Plume rise and trapping



B&B Complex Fire, OR
4 September 2003







MISR stereo height histograms for patches progressively downwind

Stability profile

Credit: R. Kahn (JPL) et al. (2007), JGR

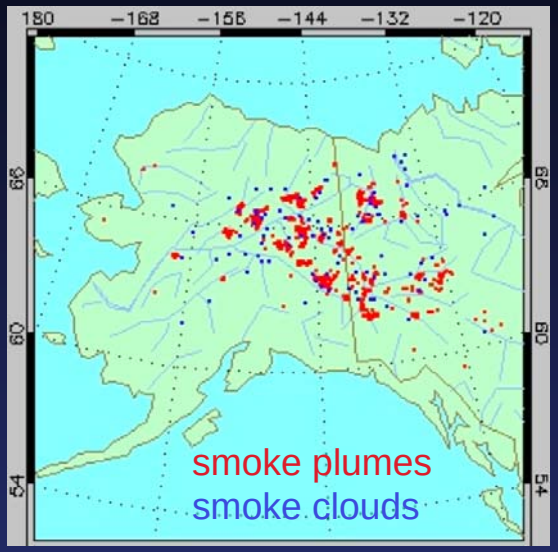
MISR-MODIS smoke plume mapping project in support of the EPA STAR program: Motivation

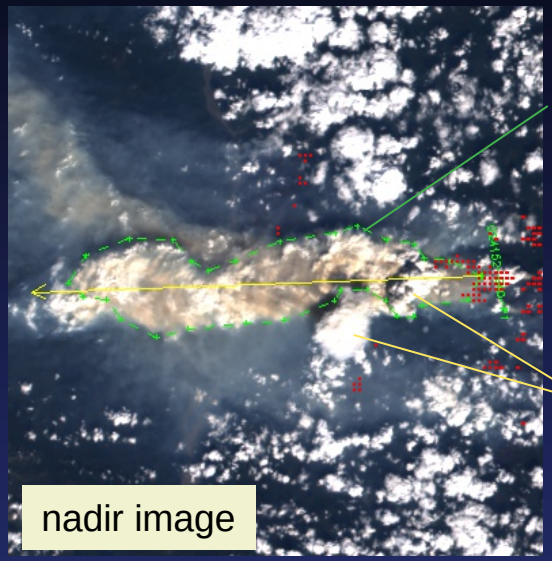
The past 2-3 decades show a trend of increasing fires, with impact on aerosol, tropospheric ozone, and CO levels.

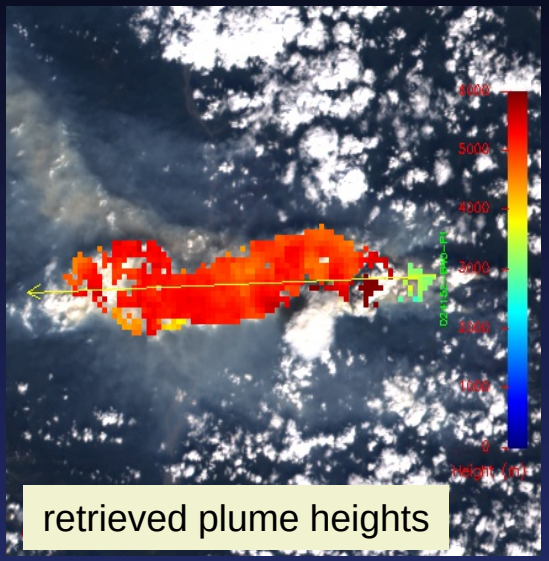
The EPA STAR project (Jennifer Logan, PI) uses MISR data to derive smoke plume injection heights and their relationships to other environmental variables. Its objective is to improve aerosol transport model predictions of fire impact on air quality.

- Plume rise is governed by fire characteristics (rate of fuel consumption, buoyant energy) and local meteorology (wind direction, convection, atmospheric stability).
- Aerosol injection height is a major factor governing atmospheric residence time and transport distance.
- Transport models require a means of parameterizing plume injection height on a coarse grid.

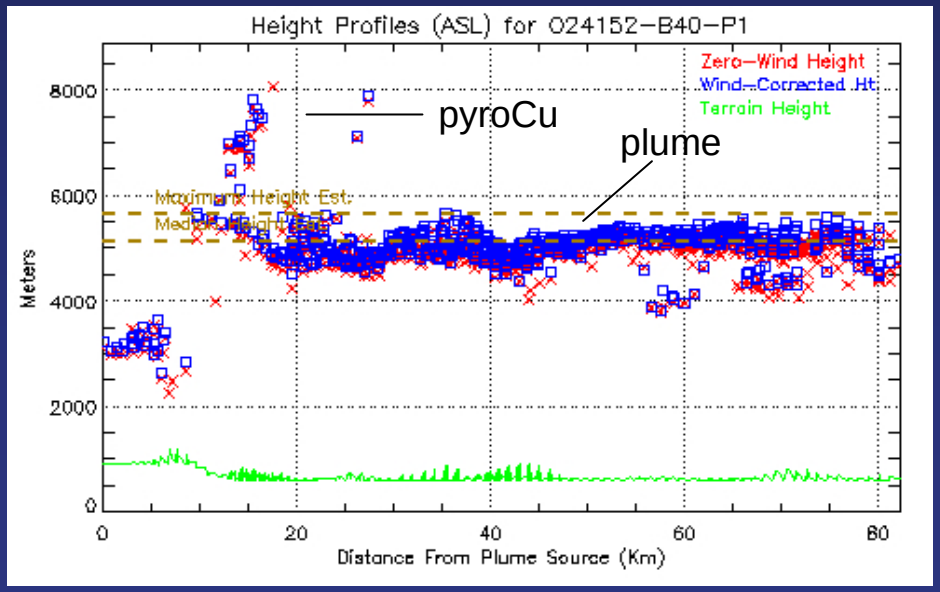
MISR-MODIS smoke plume mapping project in support of the EPA STAR program: Status





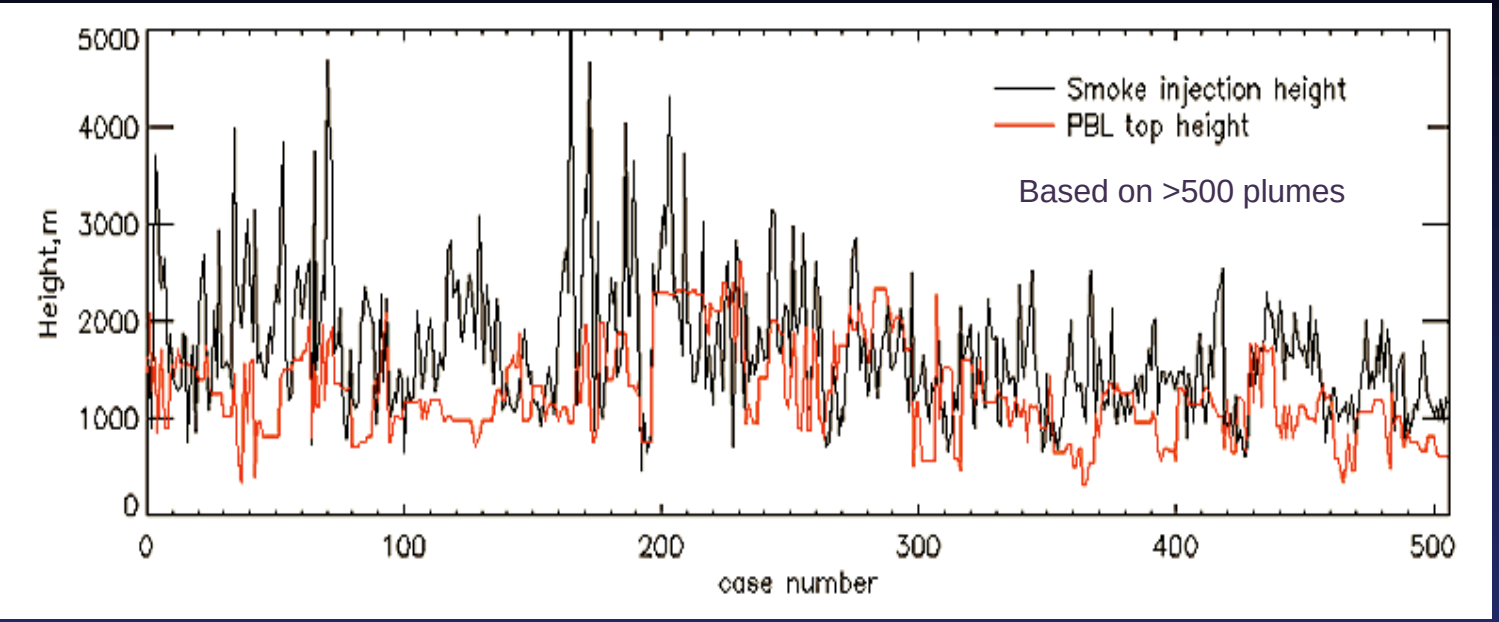


MODIS thermal anomalies identify active fires and MISR stereo retrieves smoke injection heights. So far we have mapped > 500 plumes in Alaska and Yukon, summer 2004. The database is being extended to all of N. America for 2000 - present.

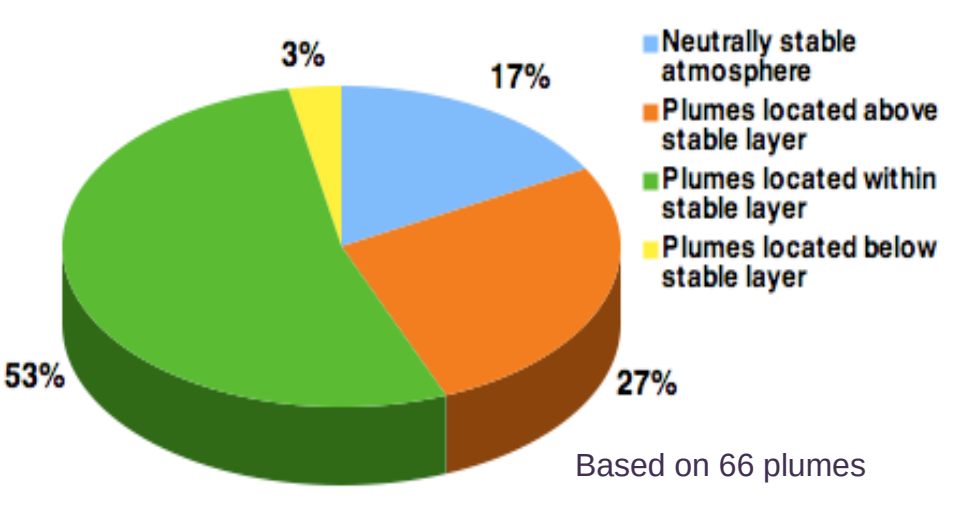


Credit: D. Mazzoni (Google) et al. (2007), RSE
J. Logan (Harvard); D. Nelson (JPL)

Relationship of plume heights to atmospheric structure



Alaska/Yukon fires, summer 2004

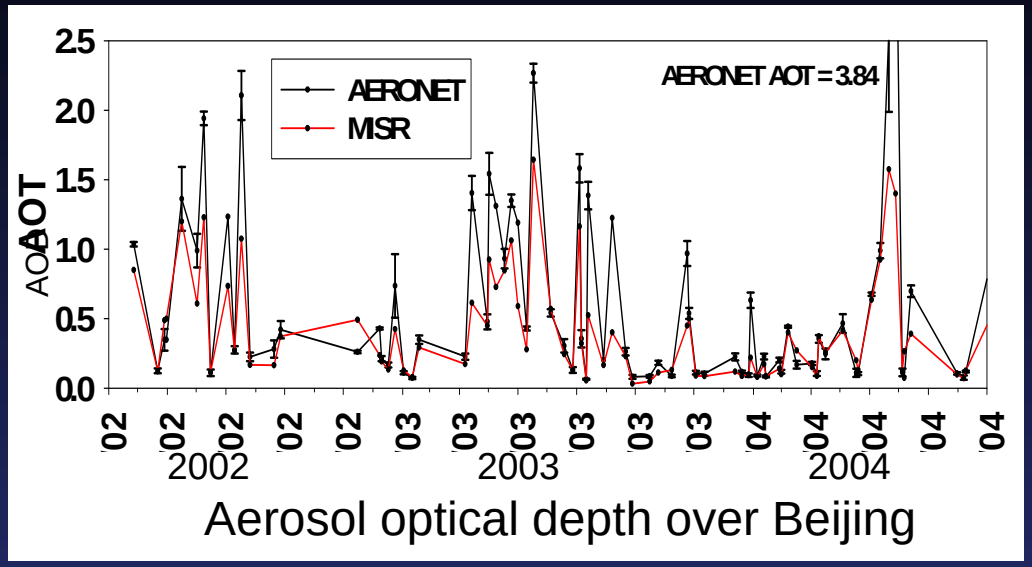


Plume injection heights tend to be at or above planetary boundary layer height.

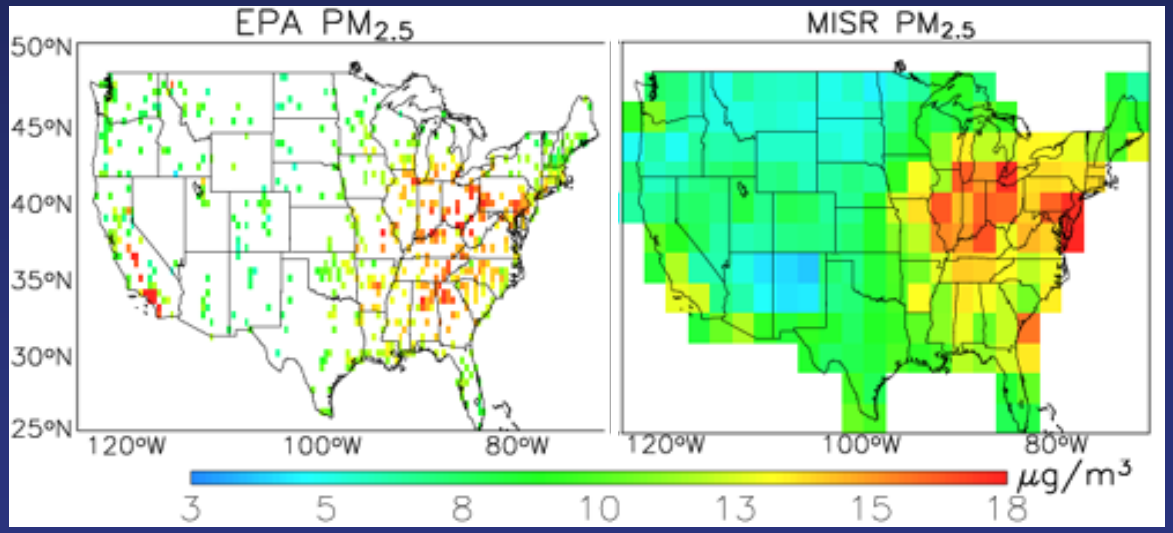
Plumes tend to be trapped within layers of atmospheric stability.

Credit: D. Nelson, Y. Chen (JPL), F. Leung (Harvard)

Transforming total column AOD to surface $PM_{2.5}$



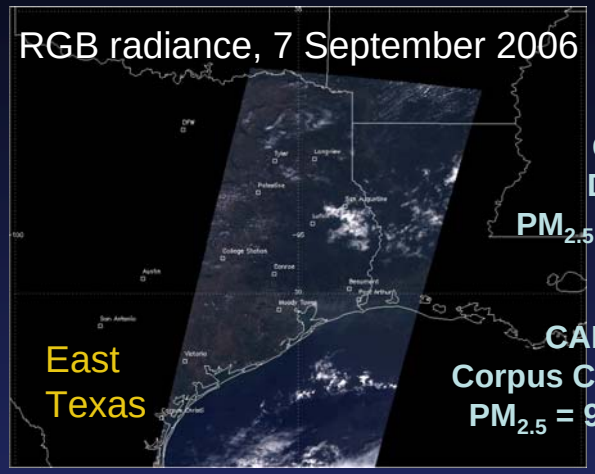
MISR and AERONET optical depths over cities with high particulate levels (e.g., Beijing) are highly correlated.

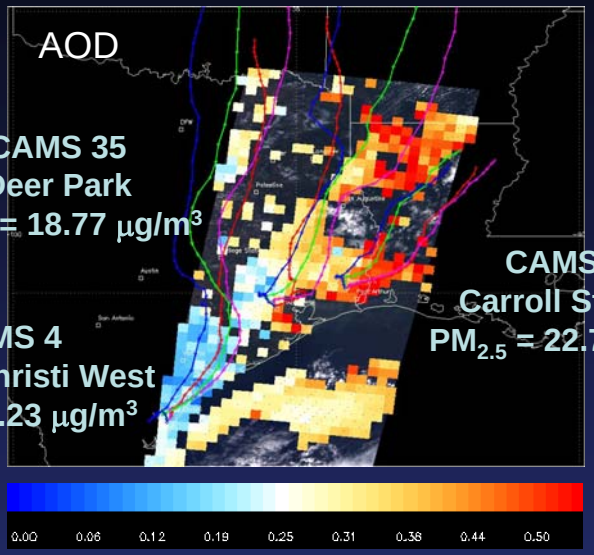


Use of a transport model (GEOS-CHEM) relates MISR column AOD to surface $PM_{2.5}$, yielding good agreement with US EPA surface data.

Credit: X. Jiang (Peking Univ.) et al. (2007), RSE; Y. Liu (Harvard) et al. (2004), JGR

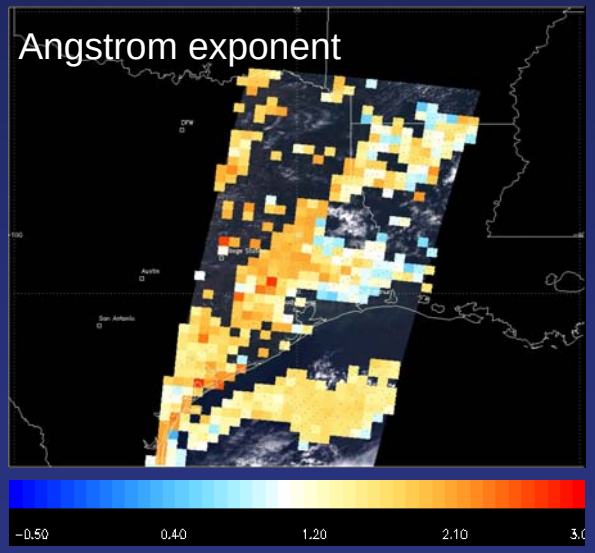
Airmass discrimination using MISR

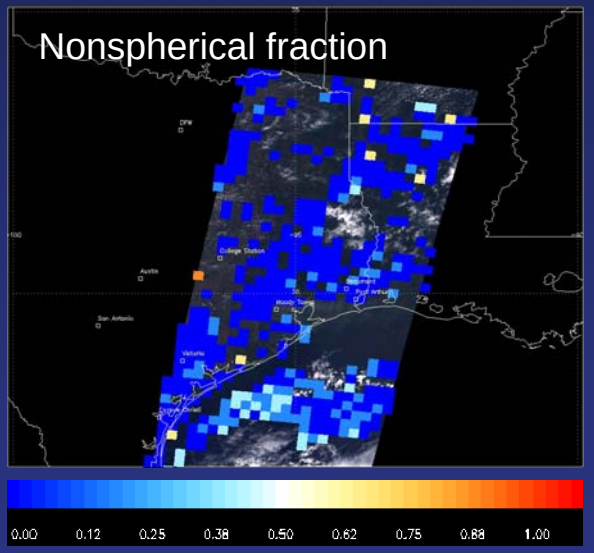




Trajectory heights
- 200-600 m ASL
- 600-1000 m ASL
- 1000-1400 m ASL
- 1400-1800 m ASL

24 and 48 hour back trajectories
http://www.etl.noaa.gov/programs/2006/texaqs/traj/





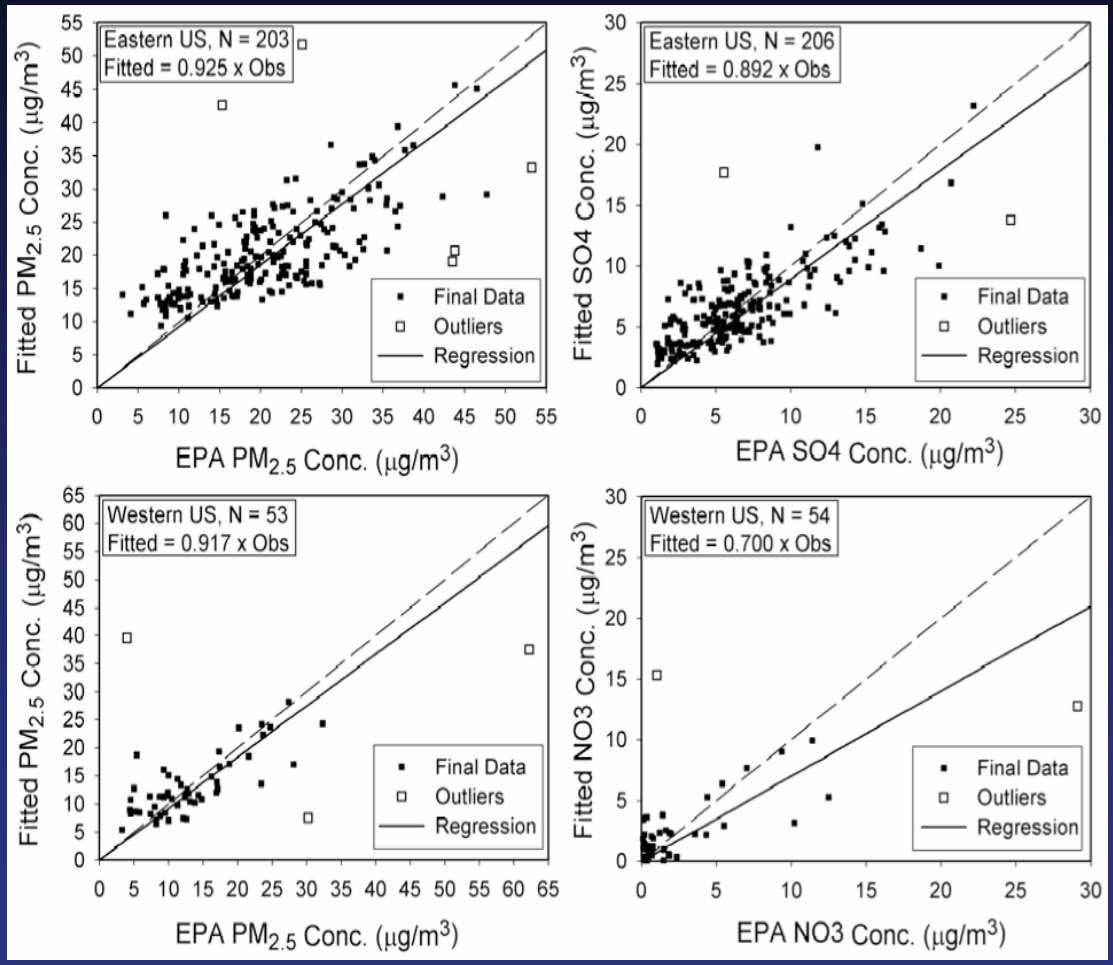
Credit: M.Garay (JPL) et al. (2007), TexAQS II/GoMACCS Data Analysis Workshop

Mapping $PM_{2.5}$ components using GEOS-CHEM and MISR fractional aerosol optical depths

GEOS-CHEM scales MISR fractional AODs for different aerosol components to the boundary layer. Results estimate concentrations of $PM_{2.5}$ and component species.

Fractional AODs appear to have have significantly higher predicting power than total AOD.

This approach can be used as an extension of EPA's STN network to map $PM_{2.5}$ species, and to help validate air quality models such as CMAQ.

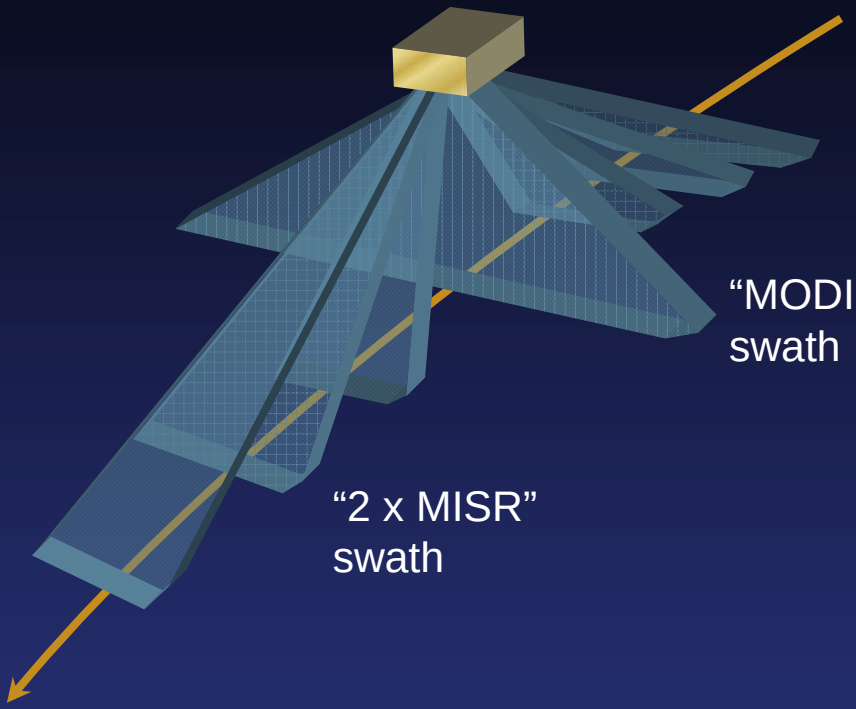


Credit: Y. Liu (Harvard) et al. (2007a,b), J. Air and Waste Mgt.

Future evolution of MISR aerosol remote sensing approach

Multiangle SpectroPolarimetric Imager (MSPI)

- Integrates multiple passive technologies for aerosol climate and air quality measurements
- Candidate instrument for Aerosol-Cloud-Ecosystem mission (NAS Decadal Survey)



	Spatial resolution	Along-track angle range	Spectral range	Polarization accuracy	Global coverage
MISR	275 m - 1.1 km	70° fore - 70° aft	446 - 866 nm	NA	9 days
MSPI	same	same	380 - 1610 nm	0.5%	1 - 4 days

Increases sensitivity to aerosol size, absorption, height

Provides sensitivity to size-resolved refractive index

Summary

MISR standard products are publicly available through the NASA Langley Atmospheric Sciences Data Center

- http://eosweb.larc.nasa.gov
- typically available within 48 hrs of acquisition

The special MISR-MODIS plume database is being made publicly available. Associated software tools will be released through the Open Channel Foundation.

MISR fractional AODs for different particle types can be used to map surface $PM_{2.5}$ and some component species for health impact assessments.

MSPI, an advanced successor to MISR, is under development as a candidate for a future aerosol mission.