NASA Air Quality Applications: State of the Program

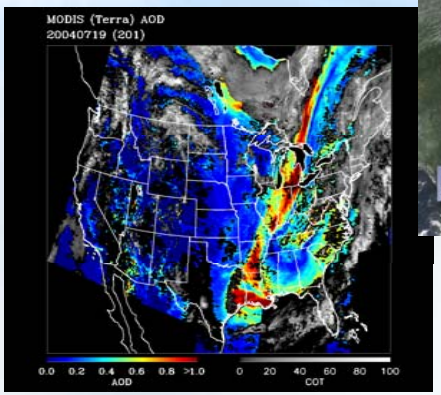
June 18, 2007

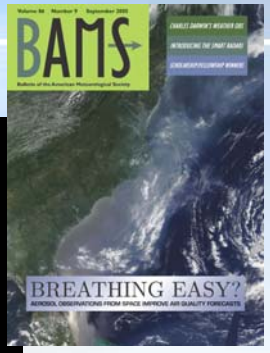
Lawrence Friedl

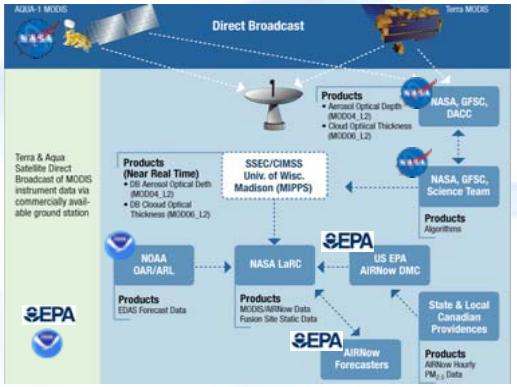
Program Manager
NASA Air Quality Applications
Earth Science Division

Earth Science Serving Society

Air Quality Applications Program

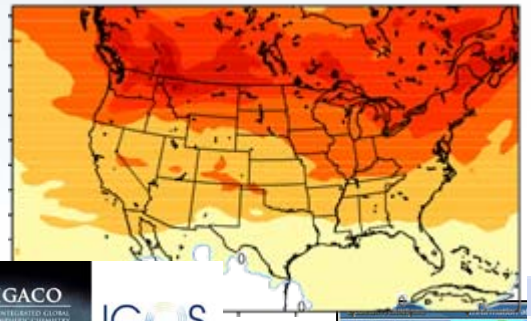






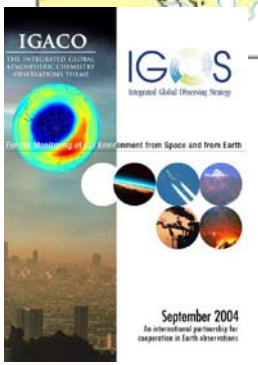
April 2002

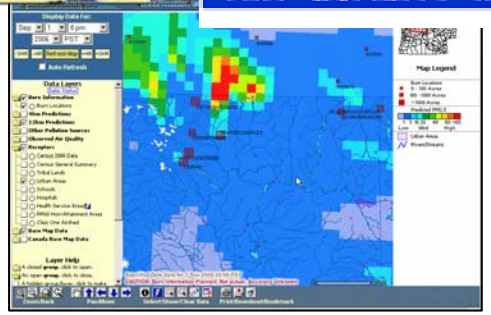
LRTAP
Long-range Transboundary Air Pollution

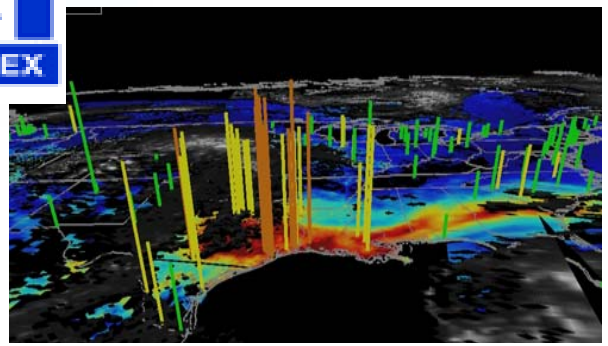


2006
The Texas Air Quality Study

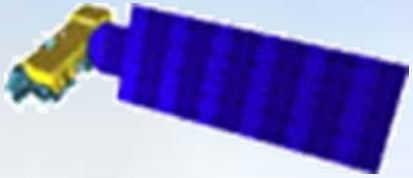
AQI
AIR QUALITY INDEX



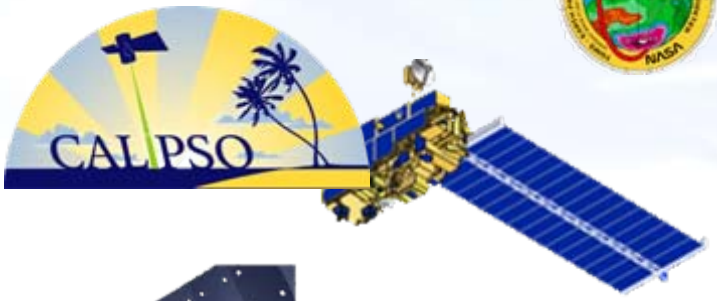


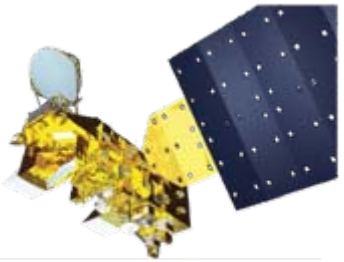


Air Quality Applications Program

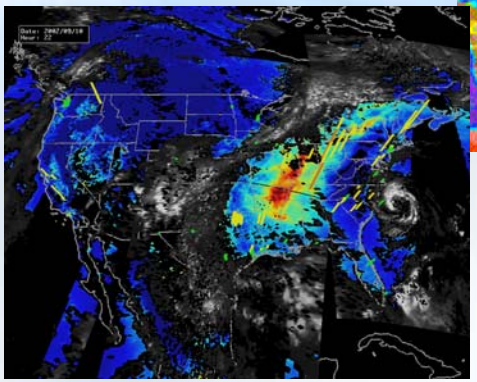


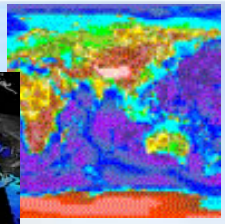
April 2002

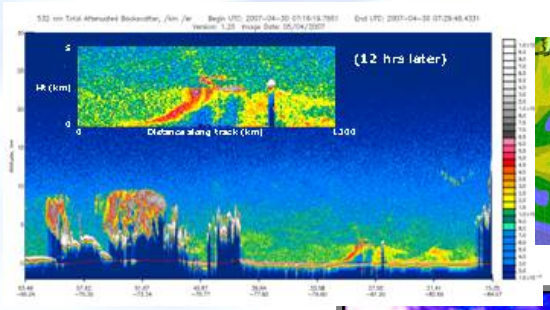


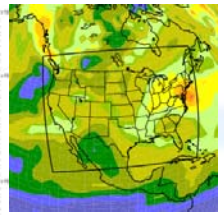


Air Quality Applications Program









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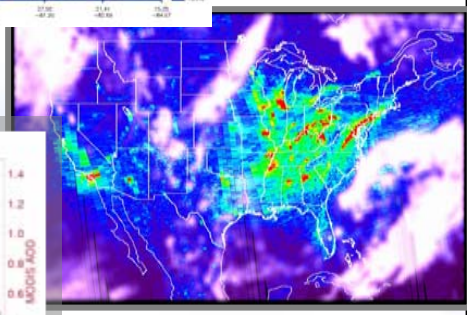
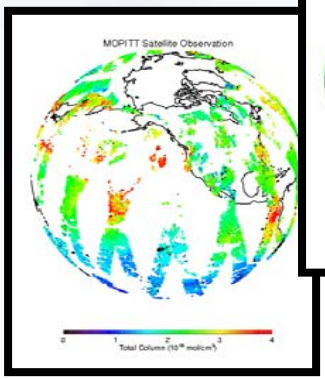
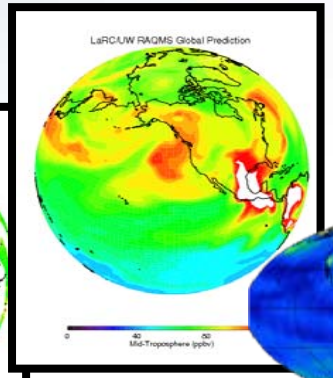
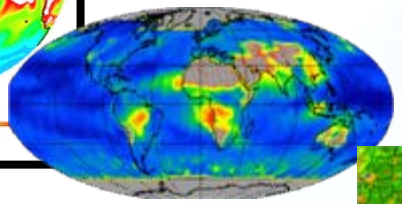
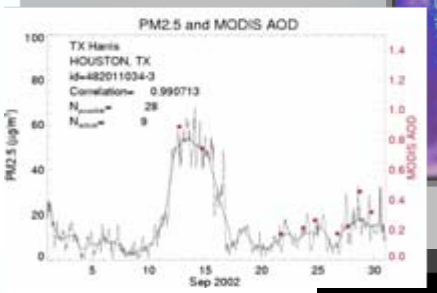
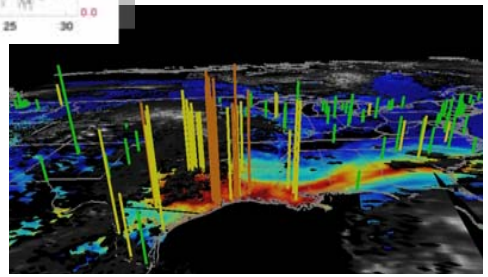


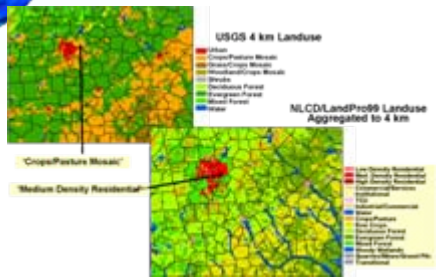


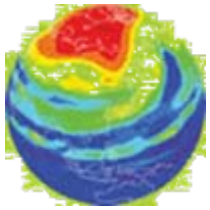


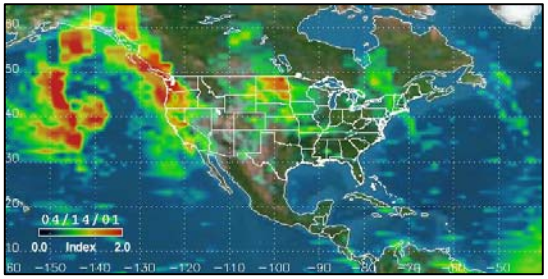












Air Quality Applications Program

April 2002

Air Quality Applications Program

State of the Program

Numerous examples and enthusiasm for Air Quality

Achieving applications of Earth Science observations

Air Quality a pathfinder for Applied Sciences Program

Organized, mature, and active community

Interagency/community partnerships continue to strengthen

Existing gaps to address

Sound basis/foundation to build from

Remarkable progress warrants enthusiasm,

yet fragile programmatic surroundings

Air Quality Applications Program

State of the Presentation

I. Where We've Come From

II. Where We Are Now
- *Air Quality Applications Program*
- *NASA Applied Sciences & Earth Science*

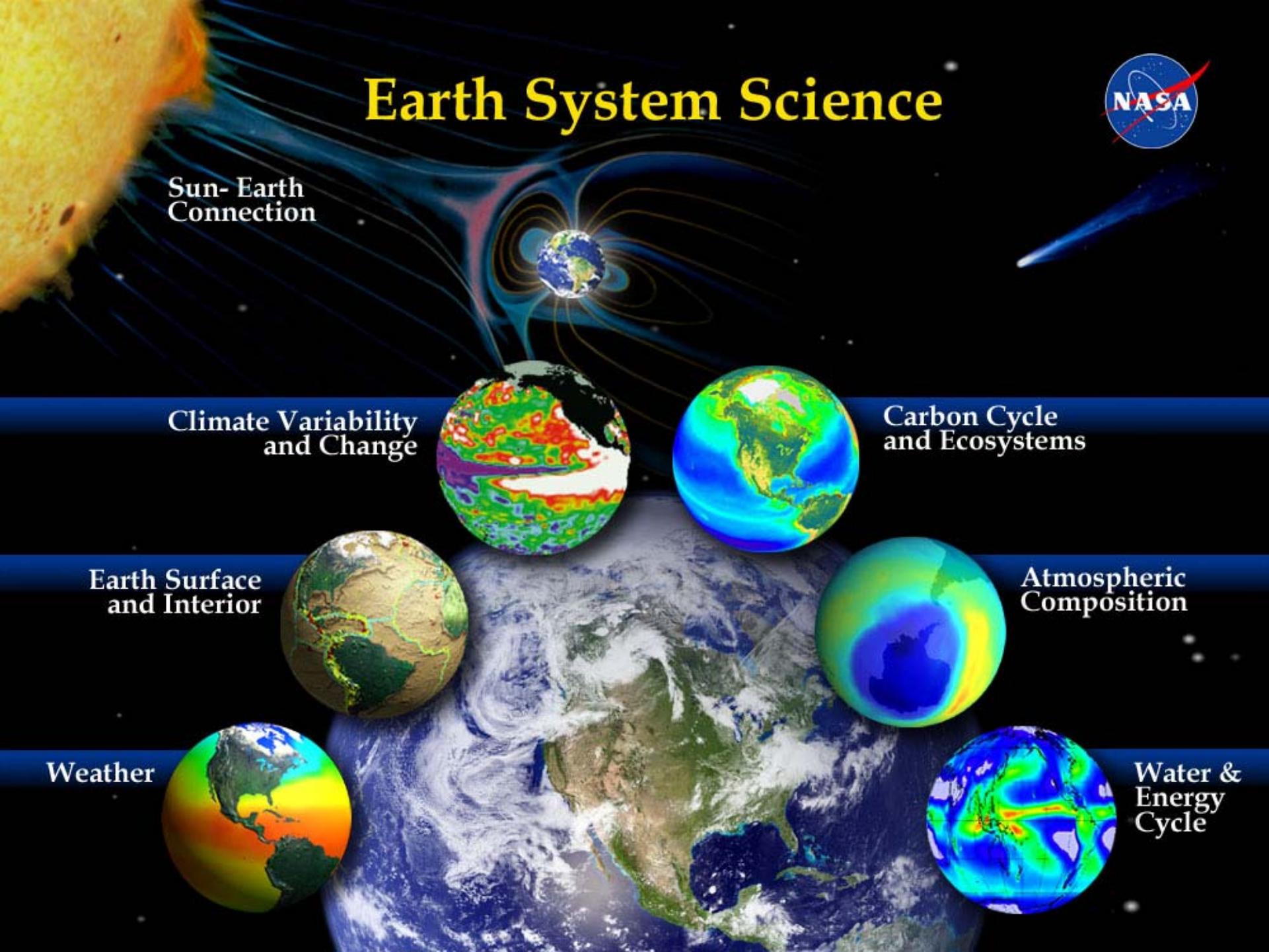
III. Forces, Drivers, and Opportunities
- *Internal*
- *External*

IV. Where We Want To Go: Future Directions

Section I.

Where We've Come From

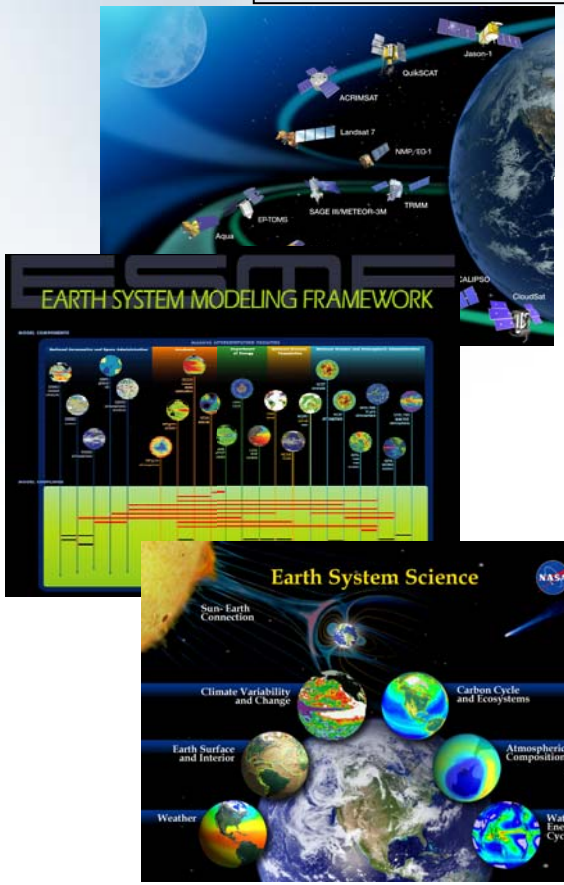
Earth System Science



NASA Applied Sciences Program

A Pathway Between Earth Science & Society

Results of NASA Earth Science Research

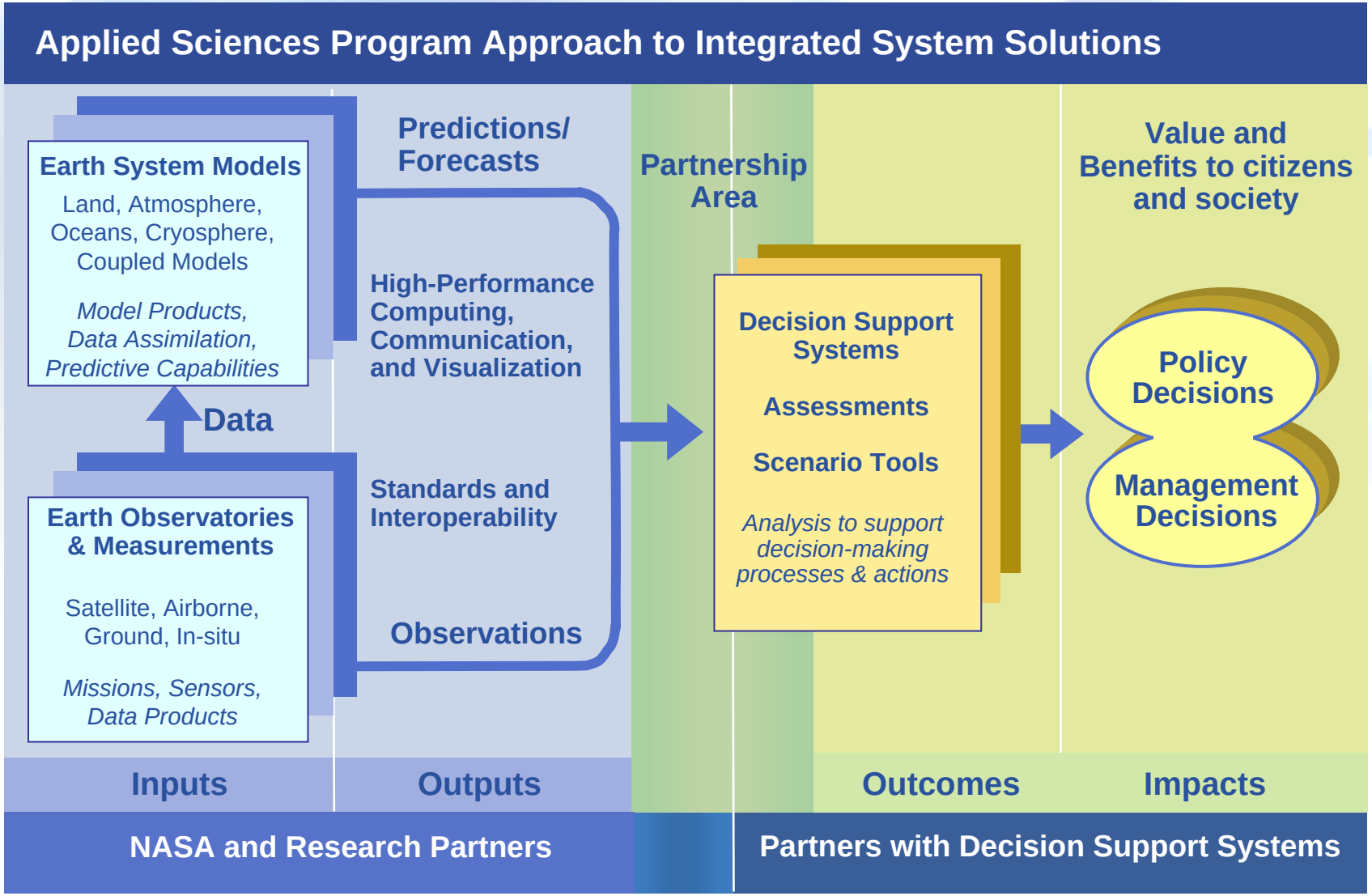


NASA Applied Sciences Program

Uses by Partners and Stakeholder Communities

NASA Applied Sciences Program

Integrated Solutions & Decision Support



Air Quality Applications Program

Goal and Programmatic Themes

Goal

Enable and expand the sustained use of NASA Earth science observations and models in the air quality community to enhance policy, business, and management for societal benefits

Programmatic Themes

- Air Quality Planning
- Air Quality Forecasting
- Air Quality Compliance
- Emissions Inventories (cross-cuts others)
- *Programmatic Activities (studies, outreach, etc.)*

Air Quality Applications Program

Budgets

FY03	1.04 M
FY04	1.72 M
FY05	1.85 M
FY06	3.11 M
FY07	3.33 M
Total	*11.05 M*

Note: NASA's switch to full-cost accounting occurred in this timeframe; earlier years may not reflect full-costs.

Air Quality Applications Program

Solicitations

NASA Applied Sciences Program - Solicitations *Total and Air Quality Proposals, by announcement*			
	REASoN	Decisions-04	ROSES-05
Total	145	172	87
Selected	12	24	20
Air Quality	9	11	13
Selected	1	2	3
Solicitation Information	*5-year awards*	*3-year awards*	*3-year awards*
	Started 2003-4	*Started 2006*	*Started 2006*

Air Quality Applications Program

Interagency Developments

- EPA-NOAA Agreement on Air Quality, May 2003
- NOAA pursuing national forecast guidance
  - Next-day Ozone by 2008, PM by 2012
  - Extend forecasts to 2^{+} days
  - Add additional pollutants
- EPA AIRNow a strong network
  - Air Quality Index widely used
- EPA-NASA Agreement (Research and Applications)
- USDA-NASA Agreement
- Clean Air Interstate Rule
- Stronger Focus on Accountability
- Long-range Transport

Air Quality Applications

Broader Developments

Group on Earth Observations

Ministerial-level leadership for coordination of Earth observing systems 10-year implementation plan

Began August 2003

Integrate scientific capacity of organizations and observing systems to support nine societal benefit areas:

- Disasters - Water
- Ecosystems - Biodiversity
- Agriculture - Energy
- Climate - Weather
- Human Health

An international *political* endeavor to recognize the importance of Earth Observations

Earth Observation Summit III
Feb. 2005

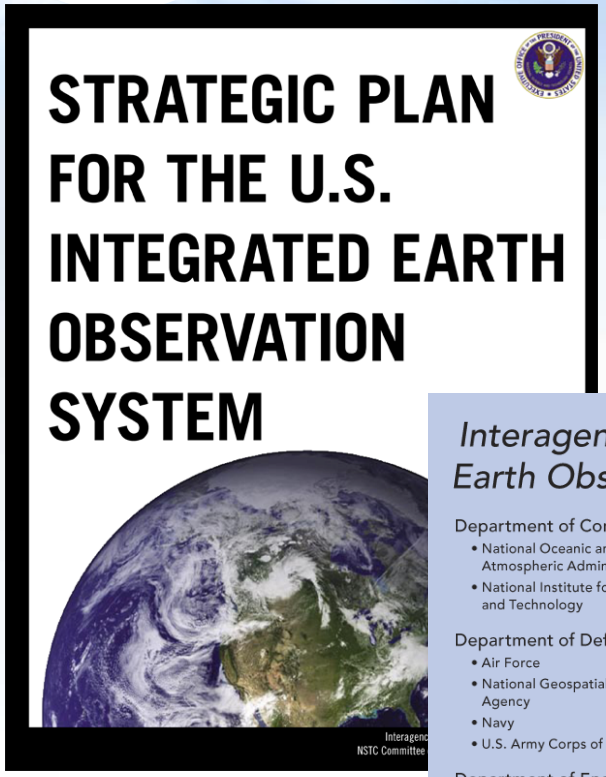
GEO involves:
70 nations (plus EU)

48+ international Organizations

GEO Secretariat at WMO in Geneva

Air Quality Applications

United States GEO



Interagency Working Group on Earth Observations Membership

Department of Commerce
- National Oceanic and Atmospheric Administration
- National Institute for Standards and Technology

Department of Defense
- Air Force
- National Geospatial-Intelligence Agency
- Navy
- U.S. Army Corps of Engineers

Department of Energy

Department of Health & Human Services
- National Institute of Environmental Health Sciences

Department of Homeland Security
- Federal Emergency Management Agency

Department of the Interior
- US Geological Survey

Department of State

Department of Transportation

Environmental Protection Agency

National Aeronautics and Space Administration

National Science Foundation

Smithsonian Institution

Tennessee Valley Authority

U.S. Agency for International Development

U.S. Department of Agriculture
- Agriculture Research Service
- U.S. Forest Service

White House Council on Environmental Quality

White House Office of Management and Budget

White House Office of Science and Technology Policy

USGEO & IEOS
<u>Near-Term Opportunities</u>

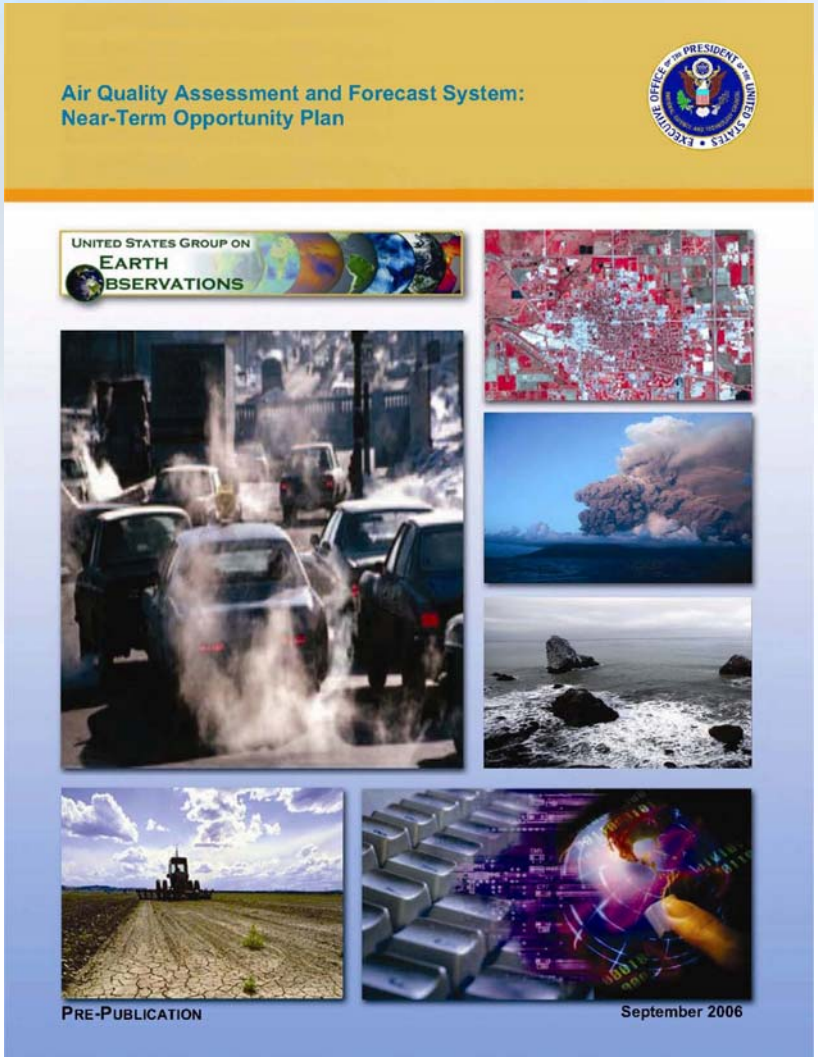
Air Quality Assessment and Forecast System

Improved Observations for Disaster Reduction

National Integrated Drought Information System

Air Quality Applications

United States GEO



USGEO & IEOS
Near-Term Opportunities

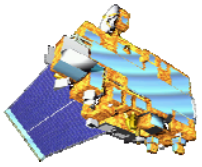
Air Quality Assessment and Forecast System

Improved Observations for Disaster Reduction

National Integrated Drought Information System

Air Quality: IDEA Project

Data fusion to support EPA AirNOW & NOAA next-day fine particle air quality forecasting.



EPA/NOAA interest in PM 2.5:
AQ Forecasting and Transport

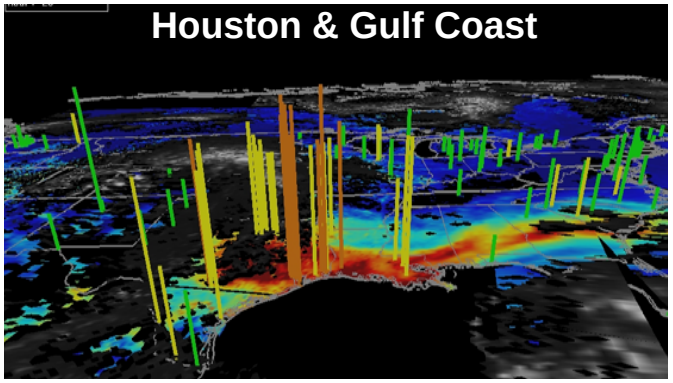
Comparisons of satellite observations data with EPA TEOM ground monitors
- Terra/Aqua MODIS Aerosol Optical Depth

Favorable comparisons, through methodology worked out by AQ team. Visual and statistical correlations.

Developed data fusion techniques to support visualizations of regional transport. Added additional data sets and modeling activities – aerosols, clouds, winds, fire locations, ground aerosols. Multiple day sequences of:

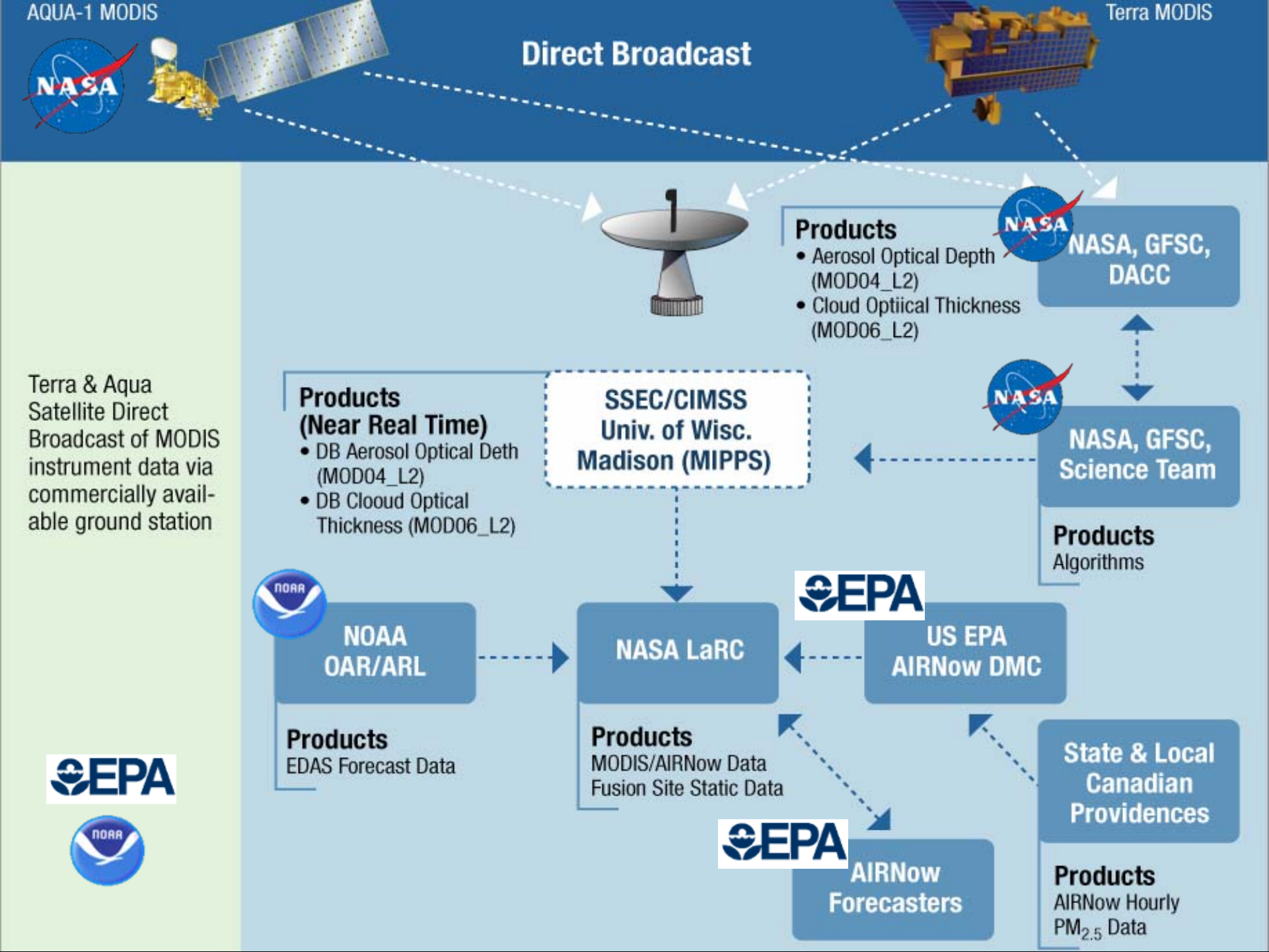
- MODIS AOD
- EPA TEOM
- NOAA EDAS winds
- MODIS COT
- NOAA WF-ABBA fire counts
- Air parcel trajectories

Provided "weight of evidence" supporting EPA transport rule-making.



Project Successes

- ***EPA conducted forecaster training on use of integrated data products***
- ***Demonstration to EPA AA for Air & Radiation***
- ***MODIS and project referenced in EPA's Clear Air Interstate Rule (Fed. Reg. Jan'05)***
- ***Cover story of BAMS (Sept. 2005)***
- ***Interagency, inter-Center project***
- ***Prompted independent follow-on projects to add CALIPSO for 3-D aspects***
- ***Benchmark report showed general support from forecasters for use of satellite products***
- ***Transition to EPA/NOAA payment of system operations at CIMSS (May 2004)***
- ***Transition to NOAA NESDIS operations***


AQUA-1 MODIS
Terra MODIS
Direct Broadcast
Products
• Aerosol Optical Depth (MOD04_L2)
• Cloud Optiical Thickness (MOD06_L2)
NASA, GFSC, DACC
Terra & Aqua Satellite Direct Broadcast of MODIS instrument data via commercially avail-able ground station
Products (Near Real Time)
• DB Aerosol Optical Deth (MOD04_L2)
• DB Clooud Optical Thickness (MOD06_L2)
SSEC/CIMSS Univ. of Wisc. Madison (MIPPS)
NASA, GFSC, Science Team
Products
Algorithms
NOAA OAR/ARL
Products
EDAS Forecast Data
NASA LaRC
Products
MODIS/AIRNow Data
Fusion Site Static Data
US EPA AIRNow DMC
State & Local Canadian Providences
Products
AIRNow Hourly $PM_{2.5}$ Data
AIRNow Forecasters

Air Quality Applications Program

IDEA Project a Great Beginning

National Aeronautics and
Space Administration

The Application of Satellite Data for Forecasting Particle Pollution

Atmospheric Science Competency, Earth and Space Science Program Office
Langley Research Center, Virginia

Earth Science Applications Directorate
John C. Stennis Space Center, Mississippi

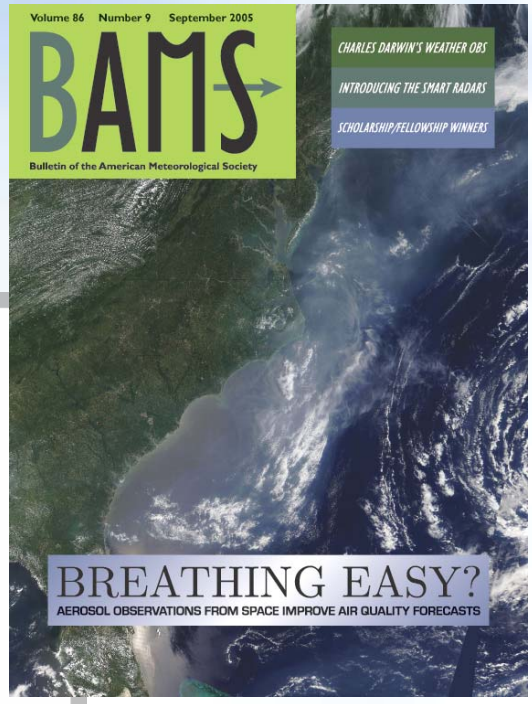
Laboratory for Atmospheres
Goddard Space Flight Center, Maryland

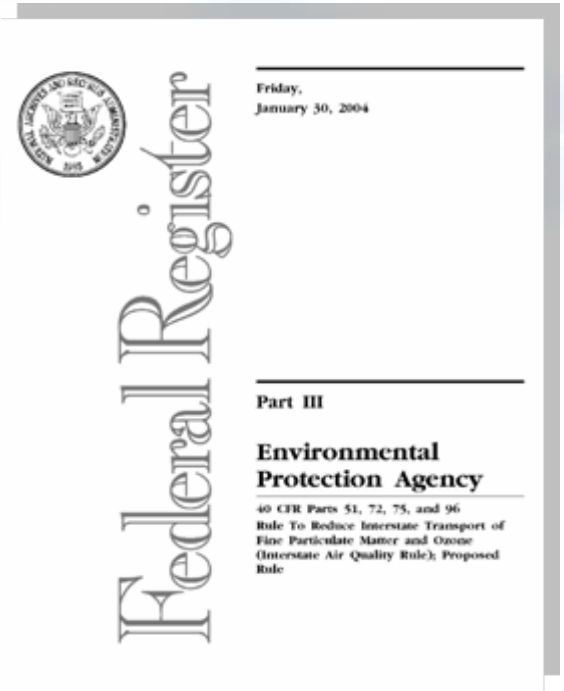
Performed in cooperation with the U.S. Environmental Protection Agency

National Aeronautics and
Space Administration
Earth Science Enterprise
Earth Science Applications Program

Langley Research Center, Hampton, Virginia 23681 | John C. Stennis Space Center, SSC, Mississippi 39529 | Goddard Space Flight Center, Greenbelt, Maryland 20771

November 28, 2003





Federal Register

Friday,
January 30, 2004

Part III

Environmental Protection Agency

40 CFR Parts 51, 72, 75, and 96
Rule To Reduce Interstate Transport of Fine Particulate Matter and Ozone (Interstate Air Quality Rule); Proposed Rule

Air Quality Applications Program

CMAQ & Boundary Conditions

Use of Globally Assimilated Lateral Boundary Conditions to Improve CMAQ Ozone Estimates

- Context: CMAQ originally developed for regional scale domains. Boundary conditions for initiating CMAQ runs were problematic and not realistic
- Purpose: Provide and assess lateral boundary conditions generated from a global model output to CMAQ.
- Activity: Use a multi-scale modeling and data assimilation framework to improve the prediction of large-scale transport and local productions of surface ozone and overall CMAQ performance.
- Primary comparison:
  CMAQ (Baseline)
  CMAQ (using RAQMS-based BCs)

Project Insights

There were no significant differences in the surface distributions of ozone during the benchmark period between CMAQ/Baseline and CMAQ/RAQMS.

Required directed project (rather than solicitation)

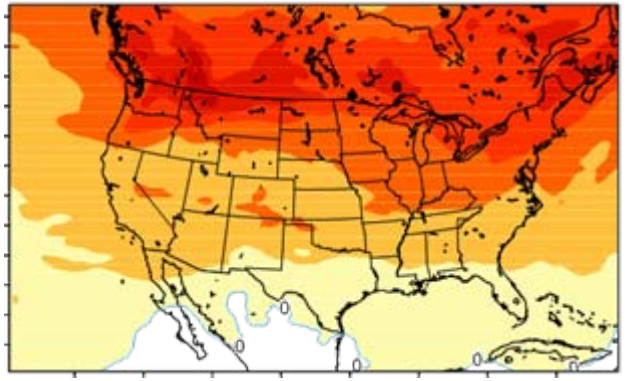
Project Results

Average upper tropospheric differences of over 60 ppbv occur in the northern part of the domain

Mean ozone differences (ppbv) between CMAQ/baseline and CMAQ/RAQMS observed in the upper trop. (sigma= 0.350).

CMAQ/RAQMS was in better agreement with ozonesonde observations (100 – 400 ppbv).

Mean O3 differences (ppbv) in CMAQ with & without time-varying globally assimilated B.C.s



Upper Trop. ozone difference

Significant over most of US

Air Quality Applications Program

CMAQ & Boundary Conditions

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- Act
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- Primary comparison:
  CMAQ (Baseline)
  CMAQ (using RAQMS-based BCs)

Note: As part of the project, U.S. EPA graciously agreed to modify Models-3/CMAQ to accept time- and spatially-varying lateral boundary conditions from NASA models and to conduct evaluations of CMAQ performance. Our thanks to EPA for its commitment to the project.

Project Insights

There were no significant differences in the surface distributions of ozone during the benchmark period between CMAQ/Baseline and CMAQ/RAQMS.

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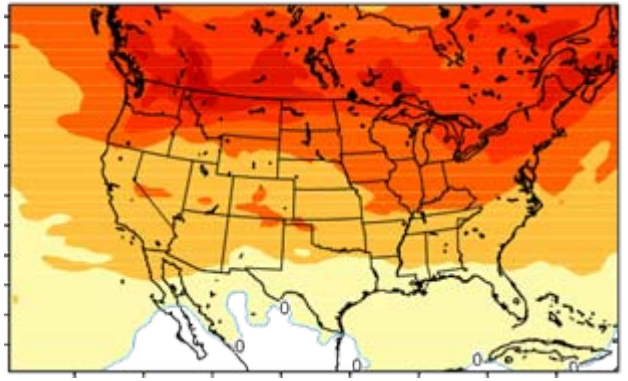


Upper Trop. ozone difference

Significant over most of US

Air Quality Applications Program

Benchmark Reports & Studies

NASA SCIENCE MISSION DIRECTORATE

Earth-Sun System Applied Sciences Program
Air Quality Program Element

Benchmark Report:

Globally Assimilated Lateral Boundary Conditions Improve CMAQ Ozone Estimates

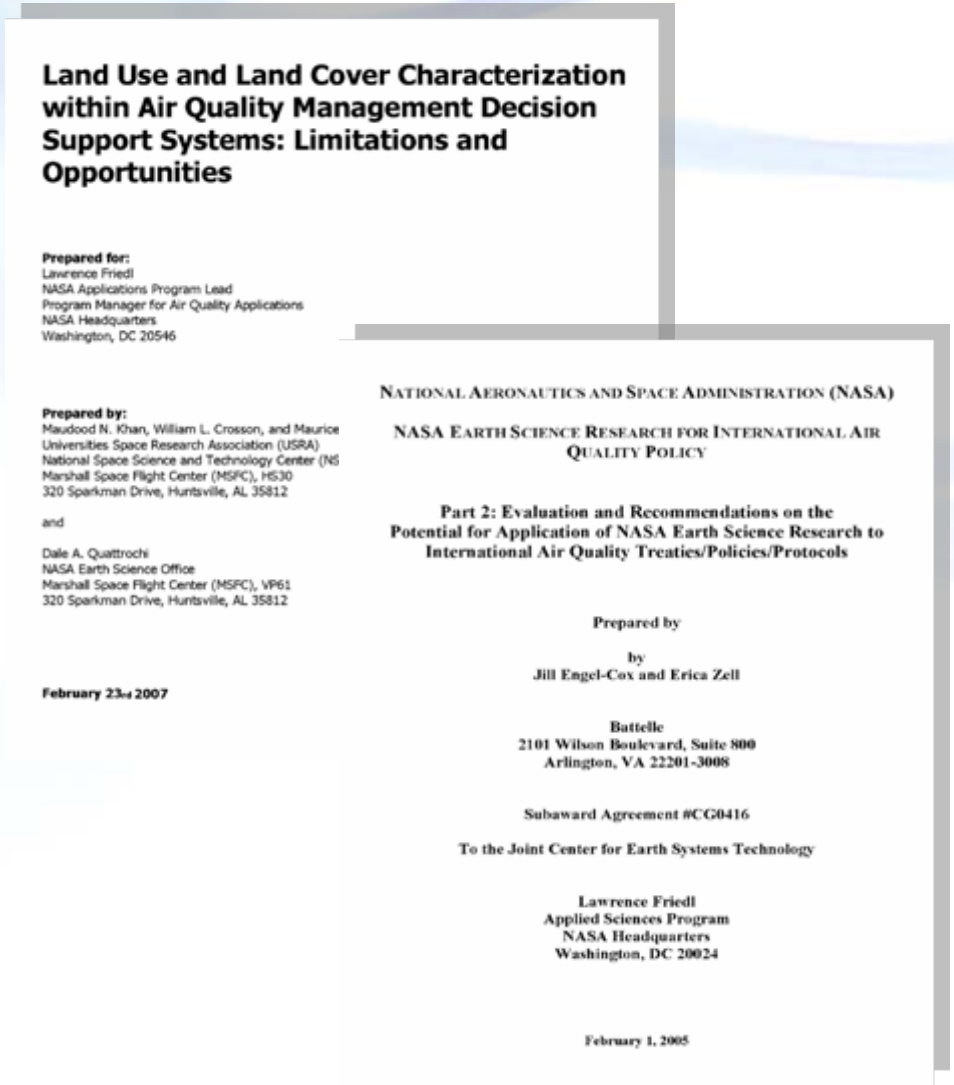
NASA Air Quality Applications Benchmark Report:
The Application of Satellite-Derived High Resolution Land Use/Land Cover Data to Improve Urban Air Quality Model Forecasts

Authors: NASA: Dale Quattrochi, William LaPenta; USRA: William Crosson, Maurice Estes, Jr., Ashutosh Limaye; Georgia Environmental Protection Division: Maudood Khan

Expanding an benefits from

Partners:
NASA/Marshall Space Flight Center
U.S. Environmental Protection Agency
Georgia Environmental Protection Division
Georgia Cool Communities
Georgia Institute of Technology
Prescott College
Atlanta Regional Commission
Georgia Regional Transportation Authority

April 2006



Land Use and Land Cover Characterization within Air Quality Management Decision Support Systems: Limitations and Opportunities

Prepared for:
Lawrence Friedl
NASA Applications Program Lead
Program Manager for Air Quality Applications
NASA Headquarters
Washington, DC 20546

Prepared by:
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and

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February 23rd 2007

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA EARTH SCIENCE RESEARCH FOR INTERNATIONAL AIR QUALITY POLICY

Part 2: Evaluation and Recommendations on the Potential for Application of NASA Earth Science Research to International Air Quality Treaties/Policies/Protocols

Prepared by

by
Jill Engel-Cox and Erica Zell

Battelle
2101 Wilson Boulevard, Suite 800
Arlington, VA 22201-3008

Subaward Agreement #CG0416

To the Joint Center for Earth Systems Technology

Lawrence Friedl
Applied Sciences Program
NASA Headquarters
Washington, DC 20024

February 1, 2005

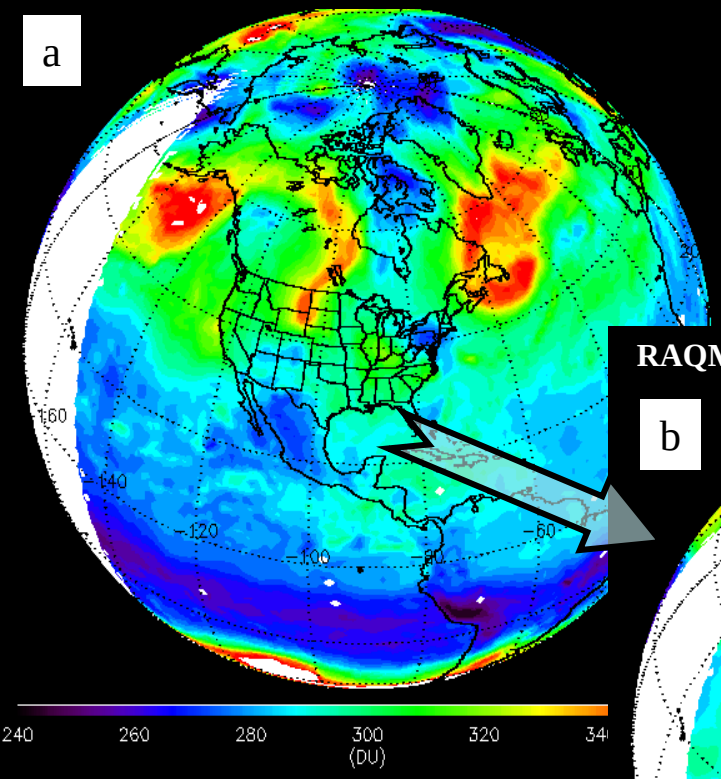
Satellite Retrievals → Global Assimilation → Regional Prediction → Validation

RAQMS Realtime Air Quality Modeling System

NASA | NOAA | U.S. Environmental Protection Agency | 2006 The Texas Air Quality Study

OMI Total Column Ozone 09/01/2006

a

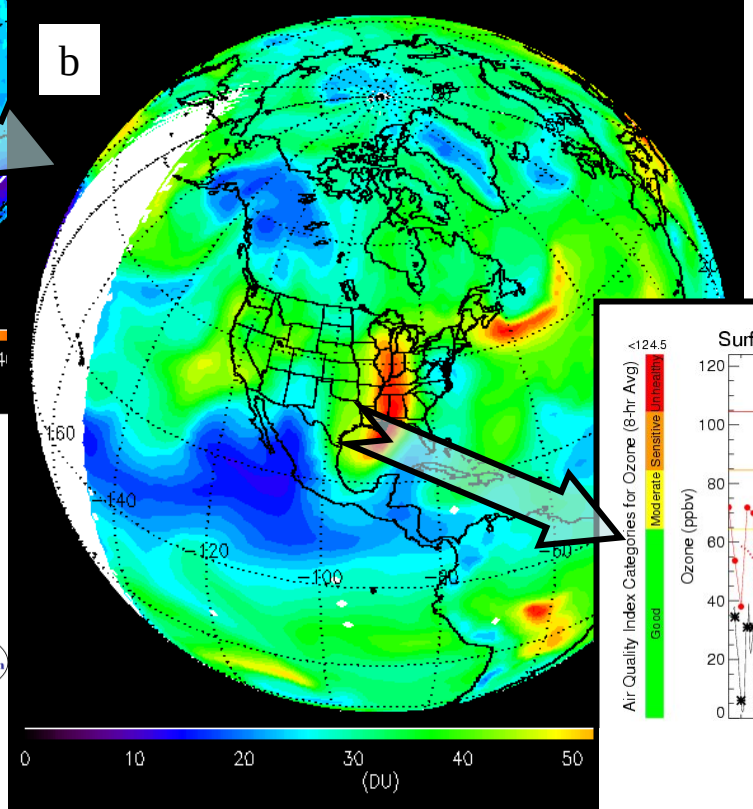


In summer 2006, RAQMS chemical assimilation/forecasts were used during the NOAA Texas Air Quality Study (TEXAQS II) to provide estimates of background composition Houston and Dallas metropolitan areas.

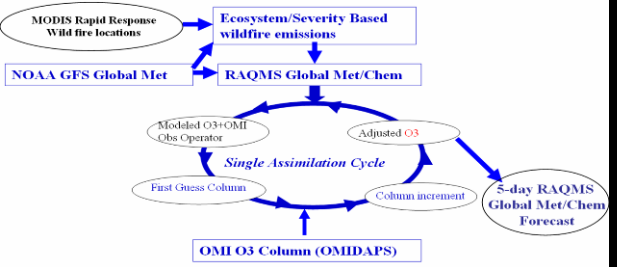
The RAQMS ozone assimilation utilizes near-real-time total column ozone measurements from the Ozone Monitoring Instrument (OMI) on the NASA Aura satellite (a). RAQMS tropospheric ozone analysis (b) provides information on the regional distribution of ozone that is useful for predicting surface ozone concentrations (c), a key component of photochemical smog. Comparisons between analyzed and observed surface ozone shows that the RAQMS surface ozone analysis (red) compares well with observations from the EPA AIRNow network (black).

RAQMS Tropospheric Ozone Column 09/01/2006

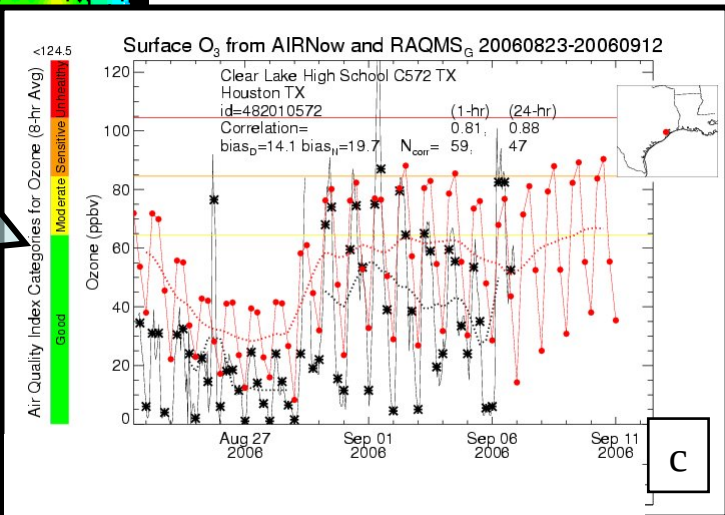
b



$RAQMS_{global}$ (2x2) Ozone Assimilation/Forecast Procedure

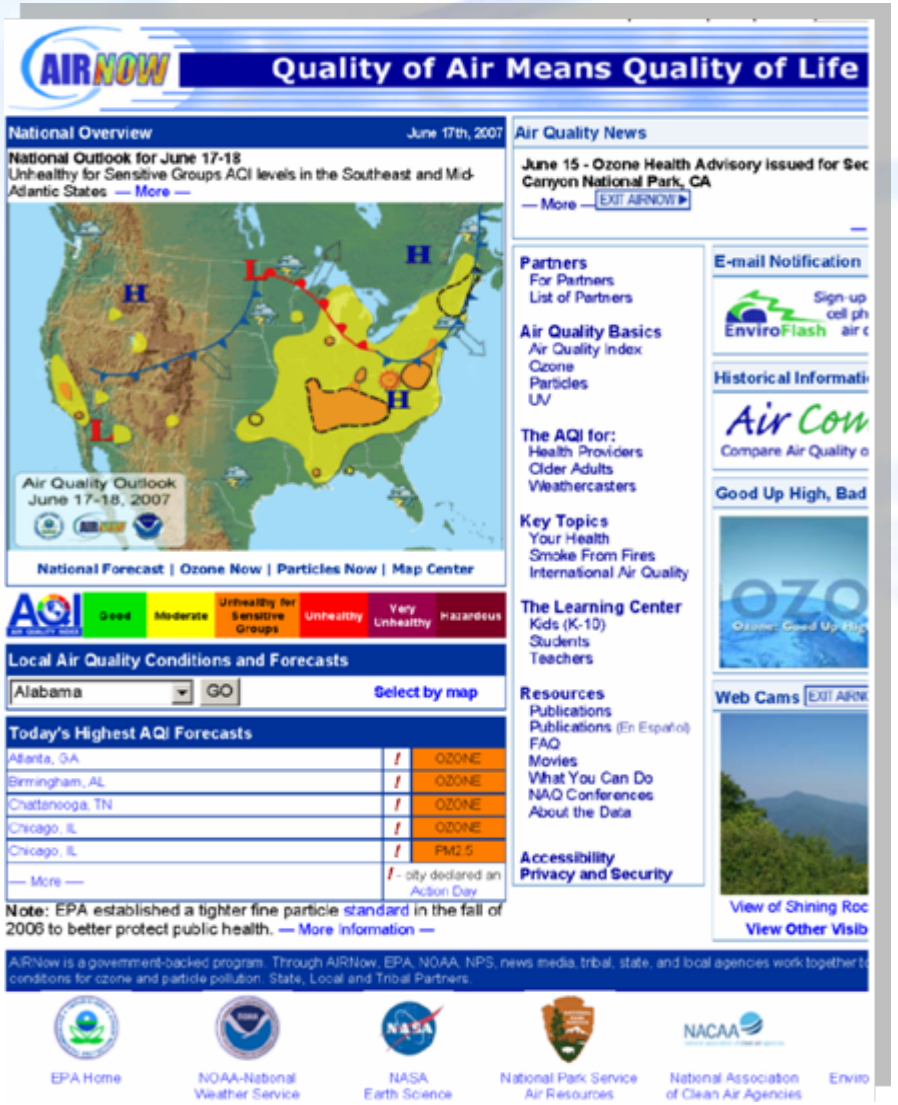


24hr real-time NASA Aura Ozone Monitoring Instrument (OMI) column ozone assimilation conducted at 2x2 degrees using Optimal Interpolation (OI) approach. 5-day RAQMS global Meteorological and Chemical Forecast used for flight planning during 2006 NSF Milagro, NASA INTEX-B, and NOAA TEXAQSII field missions



Air Quality Applications

EPA AIRNow



Air Quality Applications

Overall Assessment

Positive Indications

Initiative & Innovation

Strong Proposals

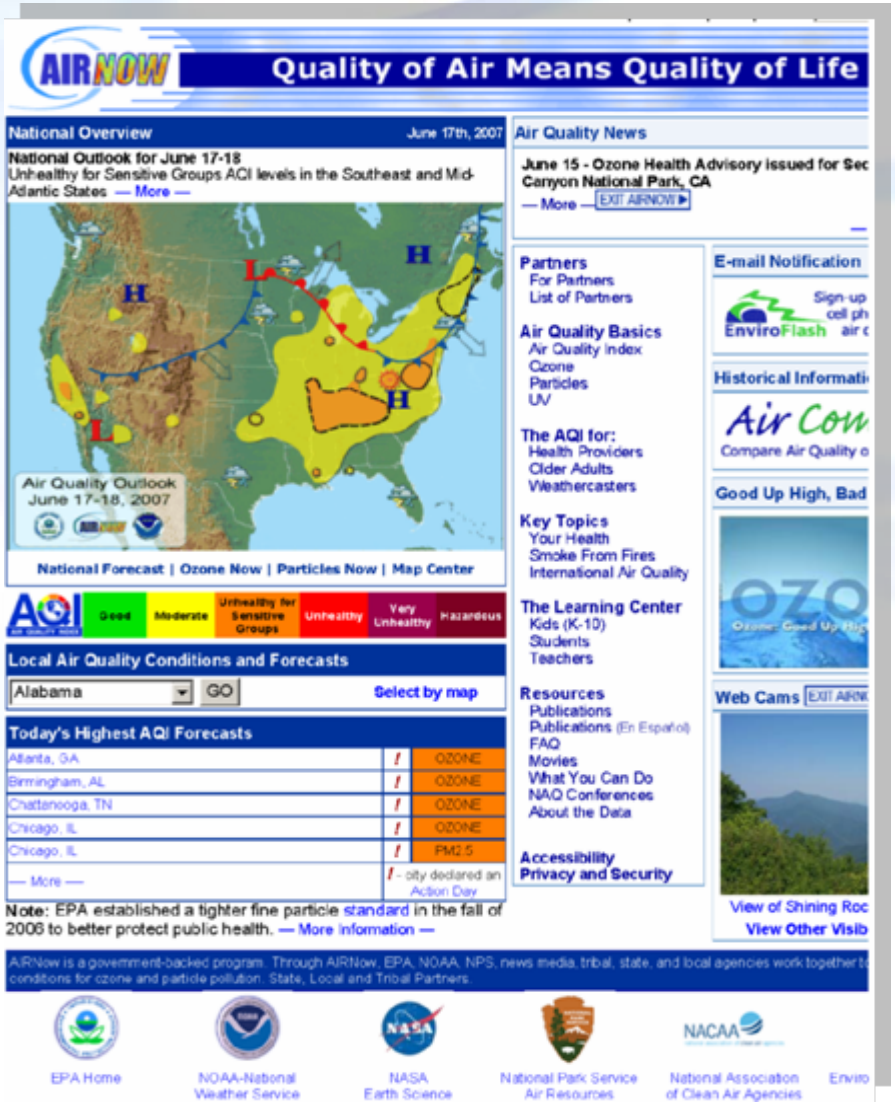
Interagency Collaboration

- *IDEA Collaboration*
- *AIRNow*
- *USGEO AQ NTO*
- *Additional Examples*

Project networking

AQ a Pathfinder

Enthusiastic Community



Air Quality Applications

Overall Assessment

Positive Indications

Initiative & Innovation

Strong Proposals

Interagency Collaboration

- *IDEA Collaboration*
- *AIRNow*
- *USGEO AQ NTO*
- *Additional Examples*

Project networking

AQ a Pathfinder

Enthusiastic Community

and Reality

Issues of Sustainability

Satellite Missions

Budget Environment

Remarkable progress warrants enthusiasm, yet fragile programmatic surroundings

Section II.

Where We Are Now

Applied Sciences Program

Strategic Functions

The Program seems to serve **three** primary, strategic functions for ESD & NASA:

Science advances and Technology transfer

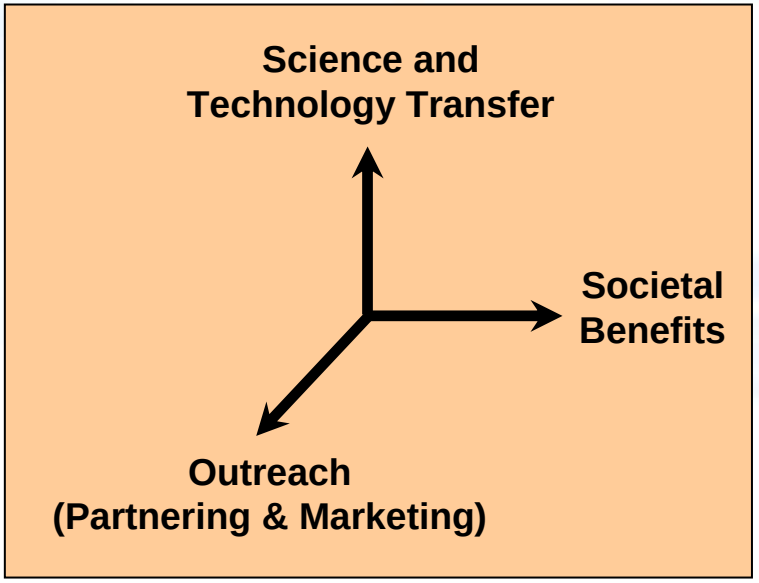
Applications projects can further scientific techniques (e.g., data assimilation, data fusion); interoperability standards drive technology; projects reduce perceived risk of its use and support transfer to private sector

Societal Benefits

The Program serves the nation and society by helping partners improve their decision making – natural resource management, public safety and health, disaster warnings, etc.

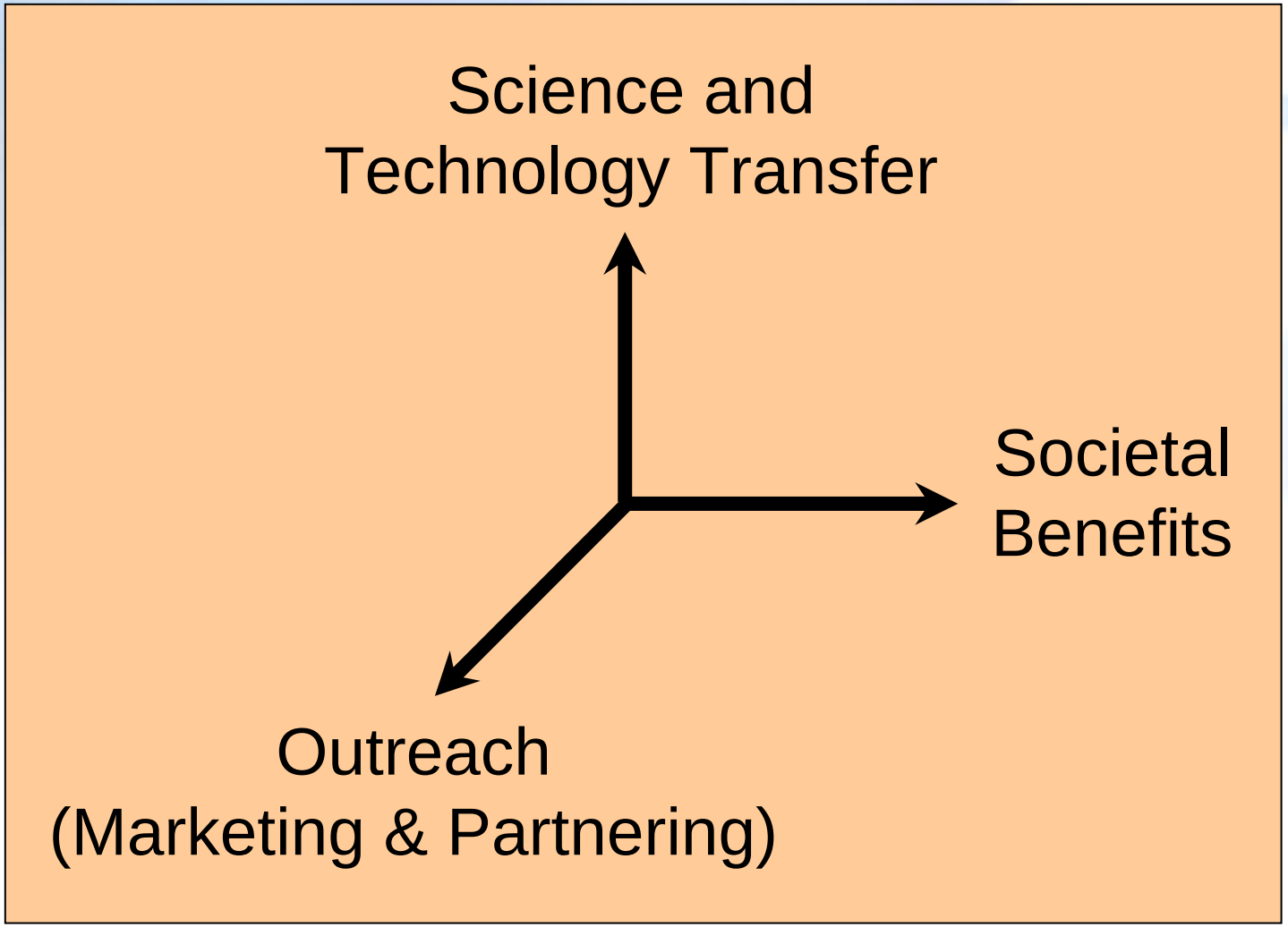
Outreach, Partnerships, and Marketing

Projects facilitating partners' sustained use of Earth science products helps induce demand for Earth science data and research. Applications of the products to policy and management issues shows the relevance of Earth science to key stakeholders.



Applied Sciences Program

Strategic Functions



Air Quality Applications Program

Where we are now

Goal

Enable and expand the sustained use of NASA Earth science observations and models in the air quality community to enhance policy, business, and management for societal benefits

Objective

Demonstrate value of at least 7 NASA sensors and models in at least 4 different Air Quality decision support systems by 2011.

Currently

At least 7 sensors/models in at least 6 different AQ DSSs

Air Quality Applications Program

Where we are now

Goal

Enable and expand the sustained use of NASA Earth science observations and models in the air quality community to enhance policy, business, and management for societal benefits

Programmatic Themes

- Air Quality Planning
  - 5 projects
- Air Quality Forecasting
  - 6 projects
- Air Quality Compliance
  - 1 project
- Emissions Inventories
  - 3 projects
- Program Management

Air Quality Applications Program

AQ Projects

NASA Applied Sciences Program *Air Quality Projects, by PI Institution Type*				
AQ Theme	NASA	Other Federal	University	Private Sector
Forecasting	2	0	2	2
Planning	3	0	2	0
Compliance	1	0	0	0
Emissions Inventories	3	0	0	0
Total	*9*	*0*	*4*	*2*

Air Quality Applications Program

AQ Projects

NASA Applied Sciences Program *Air Quality Projects, by PI Institution Type*				
AQ Theme	NASA	Other Federal	University	Private Sector
Forecasting	1	1 *EPA - AMI*	2	2
Planning	2	1 *EPA - AMI*	2	0
Compliance	0	1 *EPA - AMI*	0	0
Emissions Inventories	1	2 *EPA-AMI, STAR*	0	0
Total	*4*	*5*	*4*	2

***** Adjusting for EPA-led Project PIs *****

Air Quality Applications Program

AQ Projects

NASA Applied Sciences Program *Air Quality Projects, by PI Institution Type*				
AQ Theme	NASA	Other Federal	University	Private Sector
Forecasting	1	1 *EPA - AMI*	2	2
Planning	2	1 *EPA - AMI*	2	0
Compliance	0	1 *EPA - AMI*	0	0
Emissions Inventories	1	2 *EPA-AMI, STAR*	0	0
Total	*4*	*5*	*4*	*2*

***** Projects Competitively-selected in Red *****

Air Quality Applications Program

AQ Projects

NASA Applied Sciences Program *Air Quality Projects, by PI Institution Type*				
AQ Theme	NASA	Other Federal	University	Private Sector
Forecasting	1	0	2	2
Planning	0	0	2	0
Compliance	0	0	0	0
Emissions Inventories	1	0	0	0
Total	*2*	*0*	*4*	*2*

***** Projects over $65K in FY07 *****

Air Quality Applications Program

Program Management Activities

Studies for Evaluating Opportunities:

- FY07: Glory, Emissions Inventories
- FY08: OCO

Communications & Outreach:

- Air & Waste Management Association (5th year)
- Considering other venues also (AMS Forecasters?)
- Project Fact Sheets and Smog Stories Prototype

Training:

- Curriculum for Applied Sciences
- Module for Air Quality
- Conduct at A&WMA and 2 other locations in 2007

Air Quality Applications Program

Recent Developments & Opportunities

Partnership Opportunities

- USDA
- Environment Canada
- NPS
- Department of Defense

Recent Developments

- AQ & SERVIR
- Capacity Building
- Data Sharing Networks
- Project/PI Networking
- IDEA into Operations

Research to Operations Transition

IDEA Project

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE
Silver Spring, Maryland 20910

June 8, 2007

Dr. Teresa Fryberger
Associate Director for Applied Sciences
Earth Science Division
Science Mission Directorate
NASA Headquarters
Mail Suite: 3B74
Washington, DC 20546

Dear Dr. Fryberger:

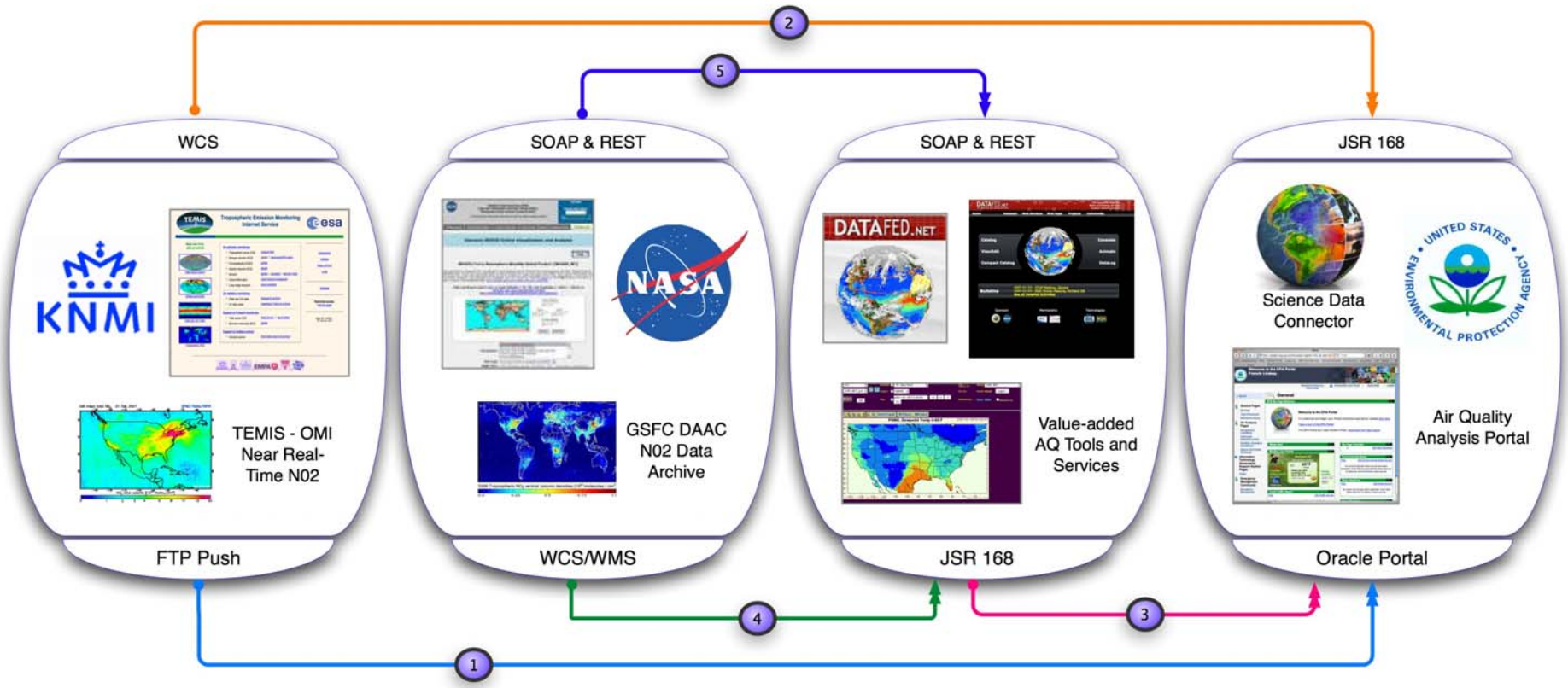
I am pleased to send this letter to confirm the commitment of the NOAA, National Environmental Satellite Data and Information Service (NESDIS), Center for Satellite Applications and Research (STAR) to transition the Infusing Satellite Data into Environmental Applications (IDEA) software to NOAA for operational implementation. The IDEA system was jointly developed by NASA, NOAA, and the EPA to assist with the forecast of long-range transport of aerosol plumes that can impact local air quality. It currently uses NASA Terra MODIS Aerosol Optical Depth (AOD), NASA/NOAA observations of fire locations, EPA surface observations of PM2.5, and a NASA trajectory model to provide forecast guidance for fine particulate matter. The EPA has requested NOAA/NESDIS to transition this product or something similar into an operational setting at NESDIS. Operational implementation will ensure the availability of product without interruptions associated with technical failures.

Sincerely,

Alfred M. Powell, Jr.
Director, Center for Satellite Applications and Research

Air Quality Web Services Data Pathfinder

ESA (KNMI) – EPA – NASA – Wash. Univ.



1. Establish a routine push of TEMIS-OMI N02 near real-time product for EPA's AQ Portal(s).
2. Develop a WCS-based feed of TEMIS-OMI N02 near real-time product.
3. DATA-FED portlet-based services for additional AQ capabilities including visualization and analysis (TBD).
4. GSFC DAAC and DATA FED provide full access to N02 science data archive @ GSFC.
5. GSFC DAAC and DATA FED collaborate on additional AQ services via SOAP or REST WS.

ACCESS

Lindsay-v.1o

Air Quality Applications Program

International Developments

Smog Blog -- http://alg.umbc.edu/usaq/archives/002228.html

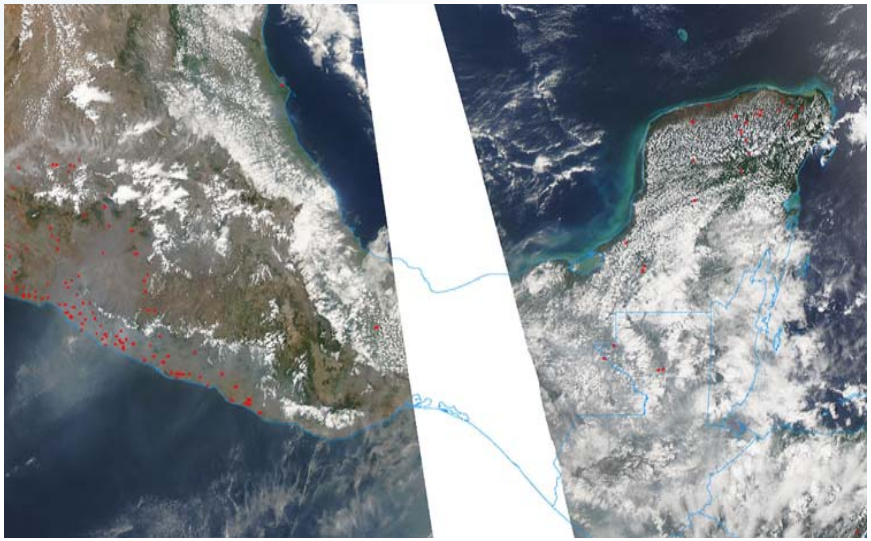
Special Feature: Fires and Smoke in MesoAmerica

On May 21, we received an email from colleagues with questions about air pollution that parts of MesoAmerica (specifically, Honduras, Costa Rica and Nicaragua) were experiencing, starting May 18. There was concern about toxics and about the possibility of Saharan dust crossing the Atlantic.

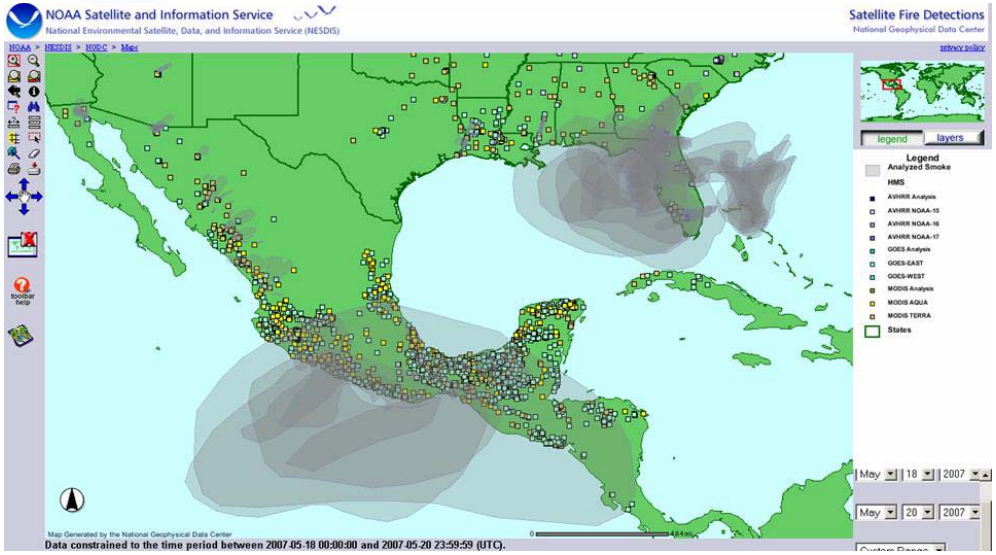
MODIS true color images told us there were many fires in Central America that entire week. The MODIS image from May 19 showed significant smoke and clouds in the entire northern part of the region (left image below). This is confirmed by the NOAA NESDIS smoke and fire detection Hazard Mapping System (right).

Additional story and materials on NASA Earth Observatory - *http://earthobservatory.nasa.gov/*

MODIS – May 19



NOAA HMS -- AVHRR, GOES, MODIS



Earth Science Applications

International Developments

GEO Plenary and Ministerial Earth Observation Summit:

- Nov. 28-30, 2007 in Cape Town, South Africa
- Report on progress since previous summit
- 3-5 major themes for discussion
- Examples and achievements of GEO & GEOSS

USGEO Preparation for Summit – Examples of Possible US Efforts

- Global Air Quality Assessment and Forecasting
- Global Drought Early Warning System
- Global Land Characterization
- Global Environmental Information Delivery Systems

Air Quality Applications Program

Programmatic Gaps

Programmatic Themes

- Air Quality Planning
  - 5 projects

- Air Quality Forecasting
  - 6 projects

- Air Quality Compliance
  - 1 project

- Emissions Inventories
  - 2 projects

Mixed needs for projects

Focused needs for projects

Broad needs for projects

Air Quality Applications Program

Solicitations – ROSES-2007 "Decisions"

ROSES-2007 Element A.20 – Air Quality Section

[The] program requests proposals focused on Air Quality Compliance, Planning, Emissions Inventories, and particular aspects of Forecasting.

In Forecasting, the program principally requests proposals focused on enhancing GFS.

In Planning, the program encourages a broad range of project concepts, including activities related to regional haze as well as use of land characteristics in air quality DSSs.

In Compliance, the program encourages a broad range of project concepts, including activities to use Earth science results to support accountability efforts and assess policy effectiveness in addition to compliance assistance.

Since the program's portfolio already includes significant MODIS-based aerosol activities, the program discourages proposals focused narrowly on MODIS-based aerosol/PM forecasting.

Air Quality Applications Program

Solicitations – ROSES-2007 "Decisions"

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…

Air Quality Applications Program

Solicitations

NASA Applied Sciences Program - Solicitations *Total and Air Quality Proposals, by announcement*				
	REASoN	Decisions-04	ROSES-05	ROSES-07
Total	145	172	87	120
Selected	12	24	20	---
Air Quality	9	11	13	20
Selected	1	2	3	---
Solicitation Information	*5-year awards*	*3-year awards*	*3-year awards*	*3-year awards*
	Started 2003-4	*Started 2006*	*Started 2006*	*Start 2008*

Air Quality Applications Program

Solicitations

Applied Sciences - Program Budget (FY07-11)

FY07-11: Based on FY07 President Request

		2006	2007	2008	2009	2010	2011
Solicitations	REASoN	5,933,000	4,757,000	1,300,000			
	Decisions04	6,800,000	6,800,000				
	ROSES2005	6,800,000	6,800,000	6,800,000			
	MRC	5,000,000					
	ROSES2007			6,000,000	6,000,000	6,000,000	
	ROSES2008				5,000,000	5,000,000	5,000,000
	ROSES2009					4,000,000	4,000,000
	ROSES2010						6,000,000
	Subtotal	24,533,000	18,357,000	14,100,000	11,000,000	15,000,000	15,000,000

Note: The years of funding often pre-date the years of project activities.

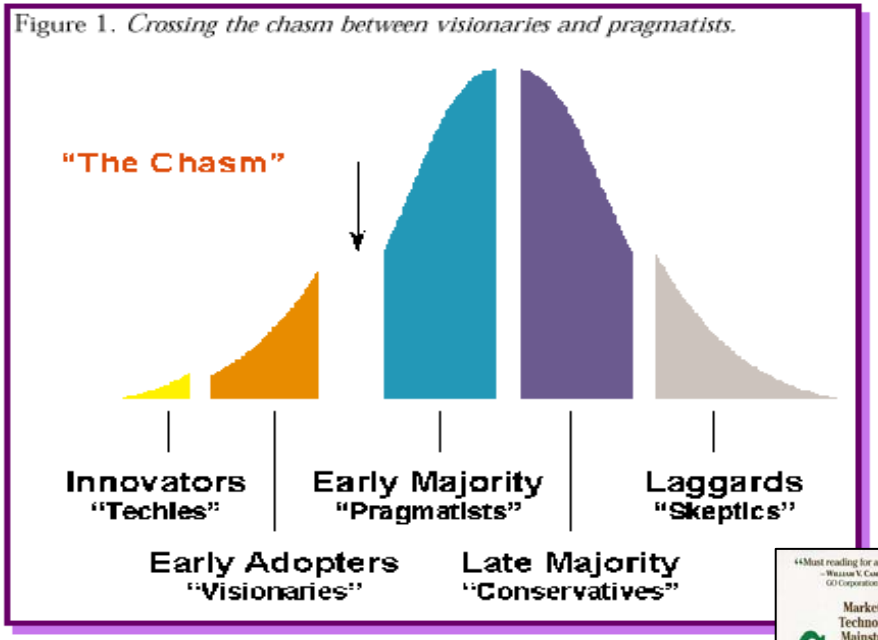
Air Quality Applications Program

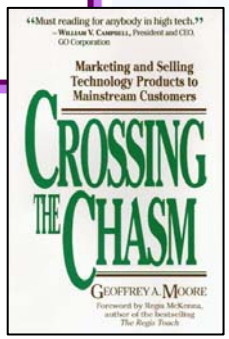
Needs & Direction

2002 – 2005: The Program worked with many federal agencies. In most cases, the Program worked with people that were either:

a) early adopters of technology; or

b) already familiar with Earth science data and remote sensing.



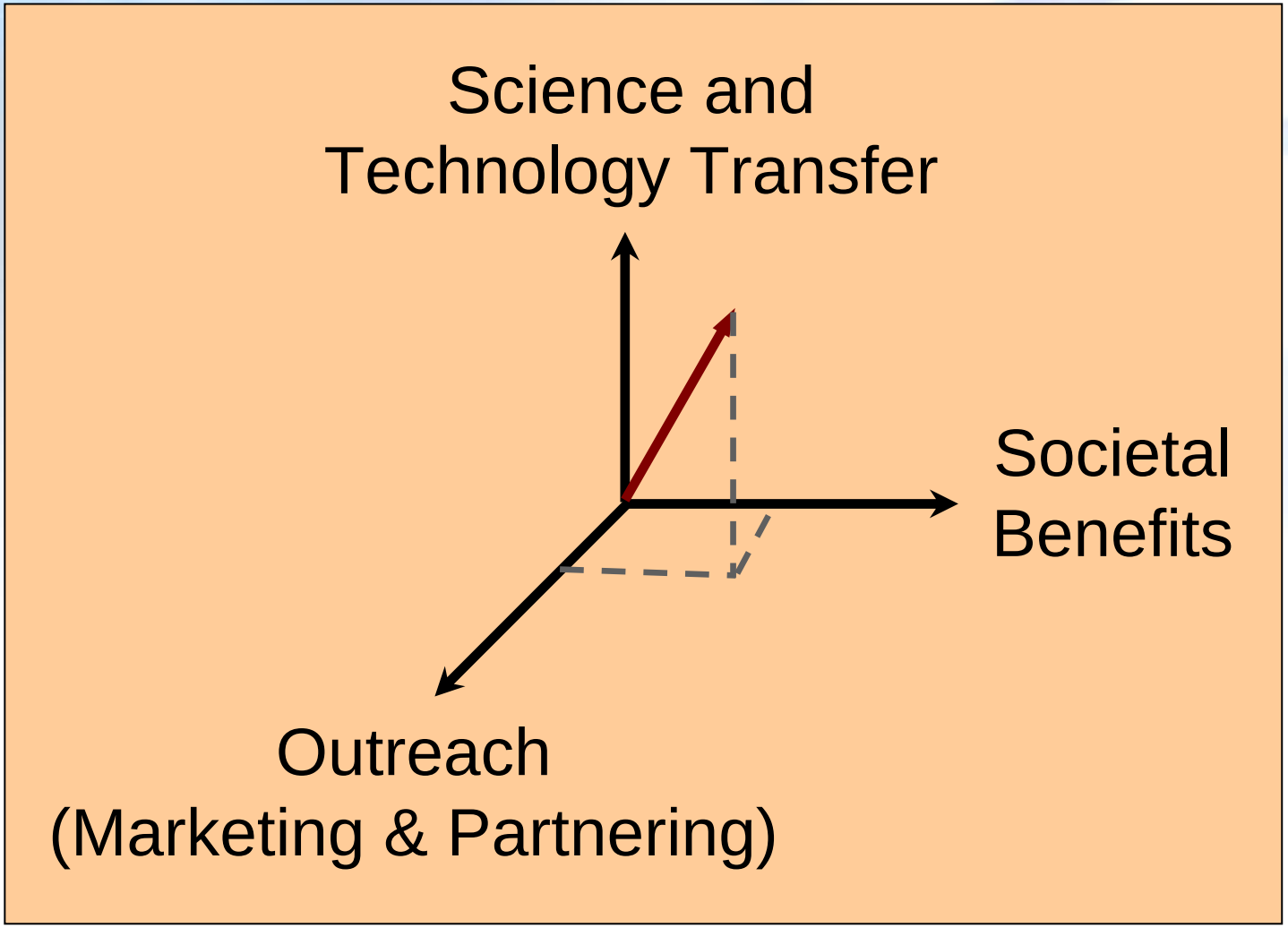


2006: The Program identified a need to build on these initial users and cultivate use by their peers within their respective agencies.

2007+: The Program may need to access the "next level" of users – people that may have heard about and seen their peers use the Earth science products but don't necessarily know how to use the products themselves.

Air Quality Applications Program

Strategic Functions & Balance



Section III.

Drivers, Factors, and Opportunities

NASA Earth Science Applications

Program Changes

Agricultural Efficiency

Air Quality

Aviation

Carbon Management

Coastal Management

Disaster Management

Ecological Forecasting

Energy Management

Homeland Security

Invasive Species

Public Health

Water Management

NASA Earth Science Applications

Program Changes

Program Director's Thoughts

Reviewing the crosscutting aspects of the program

- Supports activities for idea generation
- Formality of Rapid Prototyping and Solutions Networks

Communications

- Internal & external

Review Number and Topics of Application Themes

National Academy Review of the Program

Report due imminently

May address NASA connections to State, Local, Tribal governments

May address NASA's role in the development of decision support systems/tools

NASA Earth Science Division

Division Emphasis

Missions is primary focus for the Division Leadership

Decadal Survey

- Mission schedule rather than science priorities
- Adjust to funding, schedules, partners' plans

NASA-NOAA-OSTP NPOESS Remanifestation Studies

- Realistic, affordable solutions (involving OMB)
- Desire for science-based solutions (rather than $-based)
- Bryant Cramer leading

NASA Earth Science Applications

Congressional Attention

The 2005 NASA Authorization Act (Conference Report 109-354) includes sections relevant to the Earth Science Division and Applied Sciences Program

Under TITLE III—SCIENCE

Subtitle B—Remote Sensing

- Sec. 311. Definitions.
- Sec. 312. General responsibilities.
- Sec. 313. Pilot projects to encourage public sector applications.
- Sec. 314. Program evaluation.
- Sec. 315. Data availability.
- Sec. 316. Education.

June 15th: Meeting with House Science Committee Staffers (Hartman, Freilich, Fryberger)

June 28th: Freilich to testify to House Science Committee

Subtitle B calls for NASA Administrator to "… in conjunction with United States industry and universities, research, develop, and demonstrate prototype earth science applications to enhance Federal, State, local, and tribal governments' use of government and commercial remote sensing data, technologies, and other sources of geospatial information for improved decision support to address their needs.."

NASA Earth Science Division

Budget

House Appropriations Committee

Commerce, Justice, Science Subcommittee - June 11th Markup

NASA: +286M over request (SMD: +180M)

Climate Change/Global Warming: +171M

Significant portion for NASA ESD

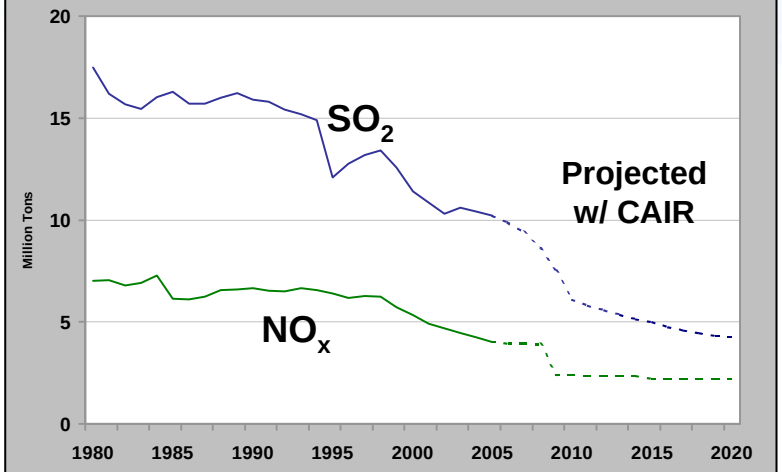
Chair noted resources included for non-specific restoration of NPOESS climate sensors and moving Decadal Survey forward

Air Quality Applications Program

Interagency Activities

- NOAA national forecast guidance
  - Next-day Ozone by 2008, PM by 2012
  - Extend forecasts to 2^{+} days
  - Add additional pollutants
- Clean Air Interstate Rule
- Long-range Transport
  - HTAP Study
  - LRTAP Convention
- Activities under USGEO & AQ NTO
- SIP Calls

National NOx and SO2 Power Plant Emissions:
Clean Air Interstate Rule (CAIR)



Federal Policy Guidance

Interagency Activities

Executive Office of the President
Office of Management and Budget

Executive Office of the President
Office of Science and Technology Policy

M-05-18

July 8, 2005

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: JOHN H. MARBURGER, III
DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

JOSHUA B. BOLTEN
DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

SUBJECT: FY 2007 Administration Research and Development Budget Priorities

This memo highlights the Administration's research and development (R&D) priorities and emphasizes improving management and performance to maintain excellence and leadership in science and technology. The memo provides general guidance for setting priorities among R&D programs, interagency R&D efforts that should receive special focus in agency budget requests, and reiteration of the R&D Investment Criteria that agencies should use to improve investment decisions for and management of their R&D programs. These updated R&D budget priorities reflect an extensive, continuous process of consultation with the President's Council of Advisors on Science and Technology (PCAST) and collaboration within the interagency National Science and Technology Council (NSTC).

General R&D Program Guidance

Office of Science & Technology Policy
and
Office of Management & Budget

Annual Budget Priorities Memo

Federal Policy Guidance

Interagency Activities

From the OSTP/OMB Guidance Memo for 2008 (July 2006):

Global earth observations support research in a wide range of sciences important for society. The *U.S. Strategic Plan for an Integrated Earth Observations System* provides guidance for agencies contributing to these efforts and establishes six Near Term Opportunities that serve as the focal point of U.S. R&D activities. Agencies are encouraged to align their R&D programs in this area with the recommendations in the U.S Group on Earth Observations' annual report, *Development of the U.S. Integrated Earth Observations System: Progress and Recommendations for the Way Forward*.

2007 G-8 Science Advisors Meeting:

Marburger brought Earth observations as US paper

Federal Policy Guidance

National Space Policy (2006)

Fundamental goals include:

- Increase the benefits of civil exploration, scientific discovery, and environmental activities;
- Enable a robust science and technology base supporting national security, homeland security, and civil space activities;

Guidelines to meet the goals include:

Departments and agencies shall conduct the basic and applied research that increases capability and decreases cost; encourage an innovative commercial space sector, including the use of prize competitions; and ensure the availability of space related industrial capabilities in support of critical government functions.

The United States will study the Earth system from space and develop new space-based and related capabilities to advance scientific understanding and enhance civil space-based Earth observation. In particular:

- NASA shall conduct a program of research to advance scientific knowledge of the Earth through space-based observation and development and deployment of enabling technologies; and
- Commerce, NASA, and other departments/agencies as appropriate, in support of long-term operational requirements, shall transition mature research and development capabilities to long-term operations, as appropriate.

Air Quality Applications Program

USGEO Developments

USGEO Re-organizing - Evaluating roles and responsibilities for four primary committees (names are tentative)

- Policy and Planning
- Architecture and Data
- IEOS Coordination
- Outreach & Partners

Decadal Survey Recommendation:

The Office of Science and Technology Policy, in collaboration with the relevant agencies, and with consultation with the scientific community, should develop and implement a plan for achieving and sustaining global Earth observations. This plan should recognize the complexity of differing agency roles, responsibilities, and capabilities as well as the lessons learned from the implementation of the Landsat, EOS, and NPOESS programs.

Air Quality Applications Program

International Activities

Committee on Earth Observing Satellites (CEOS)

- To Coordinate the Space Component of GEO
- Developing “Virtual Constellations”

  Land Surface Imaging (Lead - USGS)
  Ocean Surface Topography (NOAA, EUMETSAT)
  Precipitation (JAXA, NASA)
  Atmospheric Composition (NASA) – the “pathfinder”

GEO Air Quality Community of Practice

GEO Ministerial Summit

Climate Change

- Acceptance of a problem may lead to demands for options

Section IV.

Program Directions

Air Quality Applications Program

Vision & Aspirations

AQ Community Using All Appropriate Observations

- Smooth transition between MODIS & VIIRS
- Private Sector forecasters to gain confidence & build demand for obs/models

Strong Public Familiarity, Demand, Expectations for AQ Forecasts

- Earth Science supports stakeholder/media outreach to public

AQ Decision Tools Using Best Land Surface Characteristics

Air Quality a successful example Nationally and Internationally

- Successful example for US GEO, CEOS, International GEO
- AQ Forecasters & EPA AIRNow receive Excellence in Government Award
- Cooperation with GMES on AQ approaches; more international data sharing
- Use in Central America (SERVIR) and other regions

Routine Short Courses on Sat.Obs/Models for AQ Management

Routine, Two-Way Personnel Exchange (NASA Centers & Partners)

Air Quality Applications Program

Vision & Aspirations

Ideal Annual Budget

Solicitations: (10 on-going projects/year)	**$4.0 M**
Joint Solicitation:	**$1.0 M**
Strategic/Directed Projects: (5 projects/year)	**$2.0 M**
Proof of Concept Projects: (4 per year)	**$0.85 M**
Early Stage/Seeding Ideas: (6 per year)	**$0.75 M**
Strategic Studies:	**$0.3 M**
HQ Support/Communications	**$0.3 M**
Program Management:	**$0.35 M**
Total	***$9.55 M***

Air Quality Applications Program

Considerations

Solicitations

Project Focus

Communications

New Initiatives

Missions, Models, Technology

Applied Sciences Program

Solicitation Schedule

REASoN CAN	**(Announced 2003)**	**Runs FY04 – FY09**
Decisions CAN	**(Announced 6/05)**	**Runs FY05+ – FY08+**
ROSES 2005	**(Announced 3/06)**	**Runs FY06 – FY09**
ROSES 2006	**No solicitation was planned**	
ROSES 2007	**(Awards 10/07)**	**Runs FY08 – FY10**
ROSES 2008	**(Awards 10/08)**	**Runs FY09 – FY11**
ROSES 2009	**(Awards 10/09)**	**Runs FY10 – FY12**
ROSES 2010	**(Awards 10/10)**	**Runs FY11 – FY13**

. . .

Applied Sciences Program

Solicitation Approach

Review the Applied Sciences Approach

Currently: Project funding at ~$300K/year for 3 years

Considerations:

- More, smaller projects? Fewer, larger projects?
- Include mechanisms for testing prototype ideas
- Other factors

Air Quality Applications Program

Project Focus

To date, projects have focused strongly on decision support

As the program matures and partners utilize the Earth science products more routinely, what roles or changes does the AQ Applications Program need to make:

- Address risk reduction more in satellite transitions?
- Invest in strengthening algorithms?
- Expanding user community?
- Strengthening activities with existing partners?
- Increase use of small-scale prototypes?

Air Quality Applications Program

Communications

What methods and venues to communicate opportunities for use of Earth science research?

- Project Descriptions for meetings, conferences, etc.
- Visualizations
- *Earth & Sky* radio spots
- Analyses of socio-economic benefits from projects

- Review articles
- Special issues of journals

DRAFT for comment only - Not for Distribution

Science Mission Directorate
Earth Science Division

Applied Sciences Program
Air Quality Applications

Three-Dimensional Air Quality System

Applying NASA Satellites and Ground LIDAR to Improve Air Quality & Public Health

2007 Satellite Image of Fires over U.S.

Assessing air quality above the ground

CALIPSO

Summary

U.S municipalities and states use information from the U.S. Environmental Protection Agency's (EPA) Air Quality System (AQS) and AIRNow monitoring system to assess airborne particulate levels, make air quality forecasts, and implement measures to meet the ambient air quality standards.

This project incorporates a range of remote sensing data (AIRS, MODIS, OMI, GOES, CALIPSO, and others) to expand AQS into a three-dimensional system, providing better assessment of pollutants that are at the surface and those which are aloft.

The project also supports the Centers for Disease Control and Prevention's (CDC) environmental public health tracking network and NOAA's air quality mapping system. The University of Maryland, Baltimore County (UMBC) leads the project with co-investigators at Battelle Memorial Institute, University of Wisconsin-Madison, CDC, EPA, and NOAA.

U.S. Air Quality & Public Health

It has become increasingly apparent that air quality is affected by long-range transport (LRT) of pollutants from other regions, traveling aloft. EPA promulgated the Clean Air Interstate Rule to address transport of pollutants across state borders in the eastern half of the U.S. States must assess the amount of LRT vs. local pollution to address their compliance with EPA regulations and prepare air quality State Implementation Plans. A National Academy assessment of the EPA fine particulate matter (PM) program stressed need for integrated 3D characterization of air quality.

These measurements, coupled with sophisticated PM air quality models, will be used by state and local agencies to determine compliance with regulations. NASA data and original project data is being incorporated into the USEPA AIRQuest decision support tool for use by federal and state officials.

UMBC Battelle CDC

Air Quality Applications Program

Ideas for Possible Initiatives

Earth System Science Fellowships (ESSF)

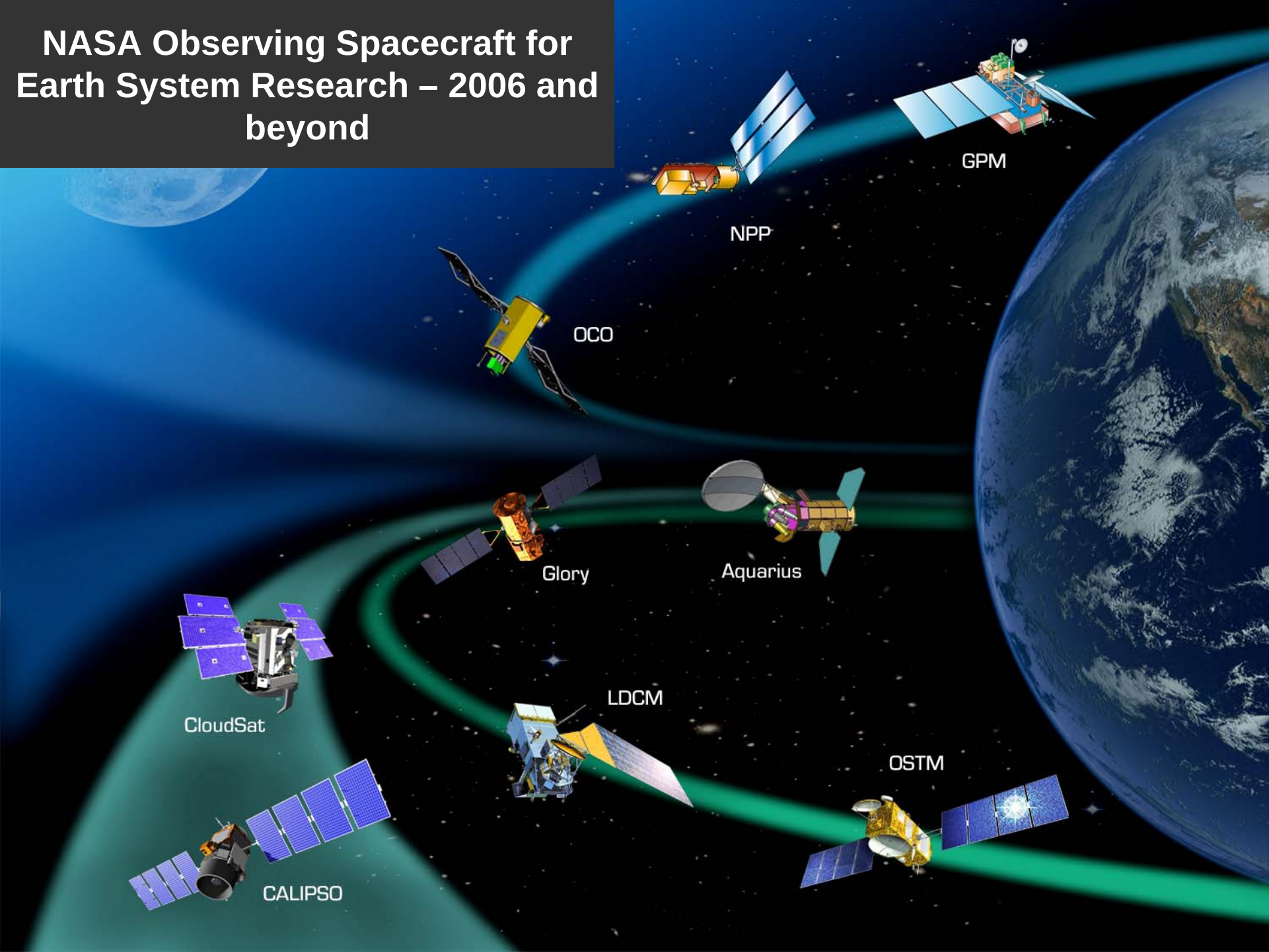
- Funds for graduate students to pursue Earth science research.
- Approximately $36K per student per year for 3 years

Idea: Create an Air Quality Applications Portion to ESSF

- Support graduate students pursuing PhDs and Masters related to use of Earth science observations for appropriate air quality management/policy issues
- Facilitate the familiarity and use of Earth science data in studies, work, research

Mission/Science Teams

NASA Observing Spacecraft for Earth System Research – 2006 and beyond



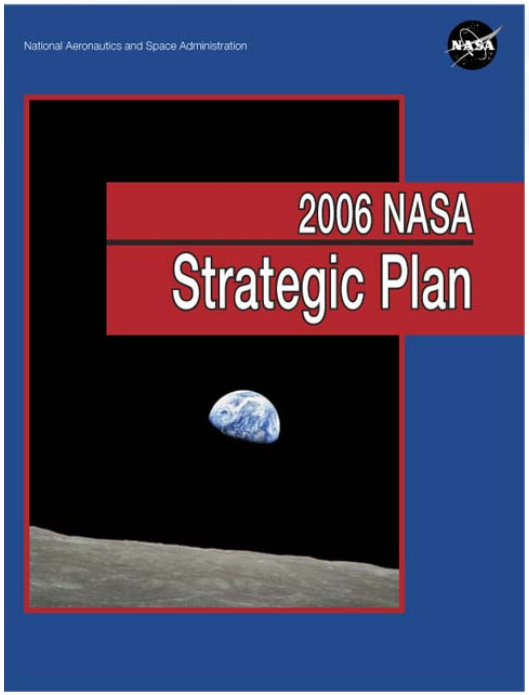
Air Quality Applications Program

2006 NASA Strategic Plan

2006 NASA Strategic Plan (Sub-goal 3A)

NASA's Applied Sciences Program will continue the Agency's efforts in benchmarking the assimilation of NASA research results into policy and management decision support tools that are vital for he Nation's environment, economy, safety, and security.

NASA also is working with NOAA and interagency forums to transition mature research capabilities to operational systems … and to utilize fully those assets for research purposes.



Air Quality Applications Program

Penultimate Slide

State of the Program

Sound, collaborative foundation

Remarkable progress, challenges, and opportunities

State of the Program Manager

Humbled and appreciative

Air Quality Applications Program

Five Years and Counting