



Earth Science for Society: Applications of Environmental Remote Sensing to Air Quality and Public Health

Workshop: May 8-9, 2007

*NASA Science Mission Directorate
Applied Sciences Program*

*CDC, EPA, NOAA &
University Partners*

*Extending the societal and economic benefits of
Earth science research and technology ...*

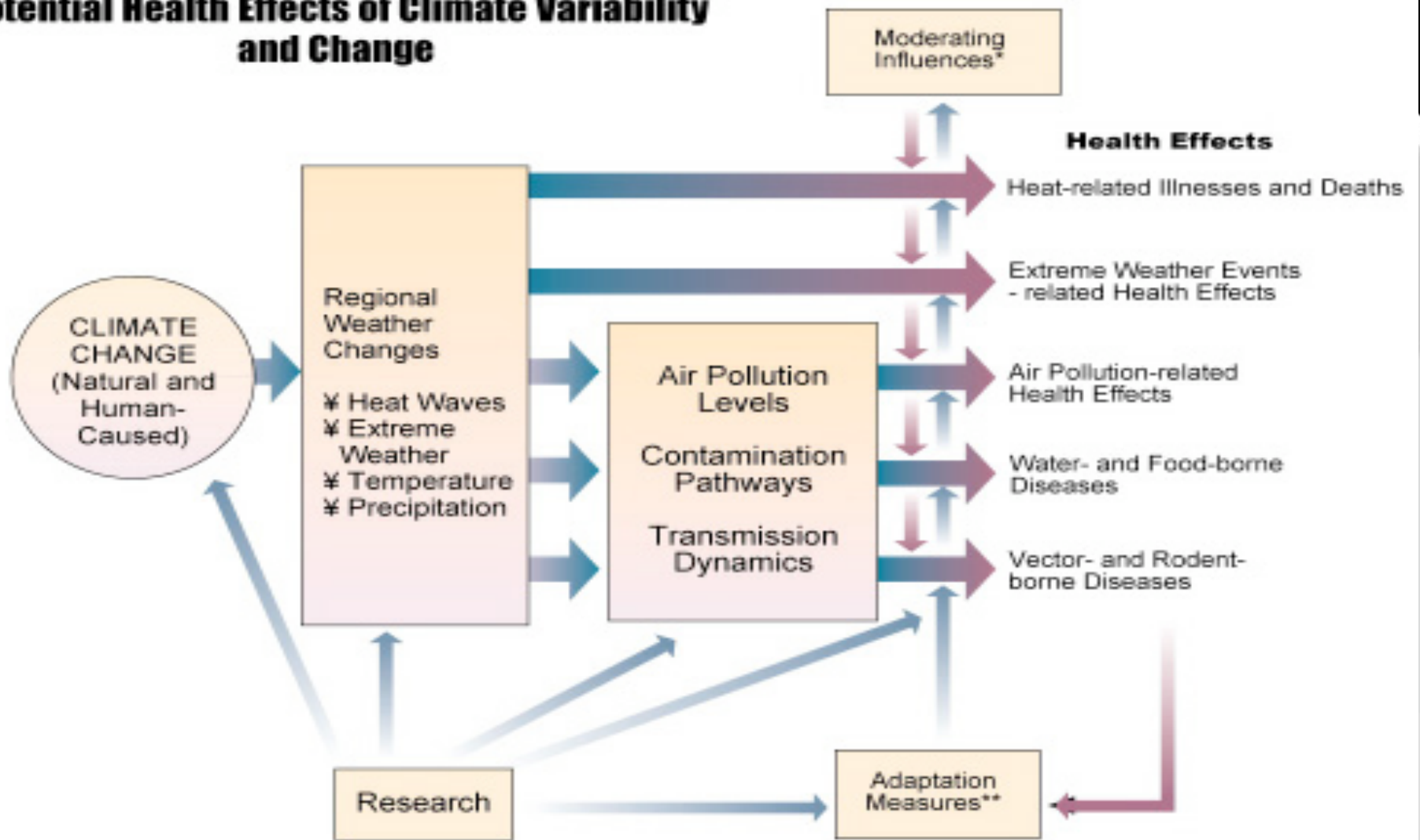
Logistics

- **All Sessions will be recorded.**
- **Speakers room is #134.**
- **Lunch will be in Osgood's Dining Room
Must have a ticket - see registration desk.**
- **Drinks and Snacks are available outside in the Break room.**
- **Any messages will be at the Registration Table.**
- **Please place cell phones on silent mode**
- **Wireless internet is available
You may have to go to the hallway, if you cannot connect inside
Also, there is a computer room is outside to right.**

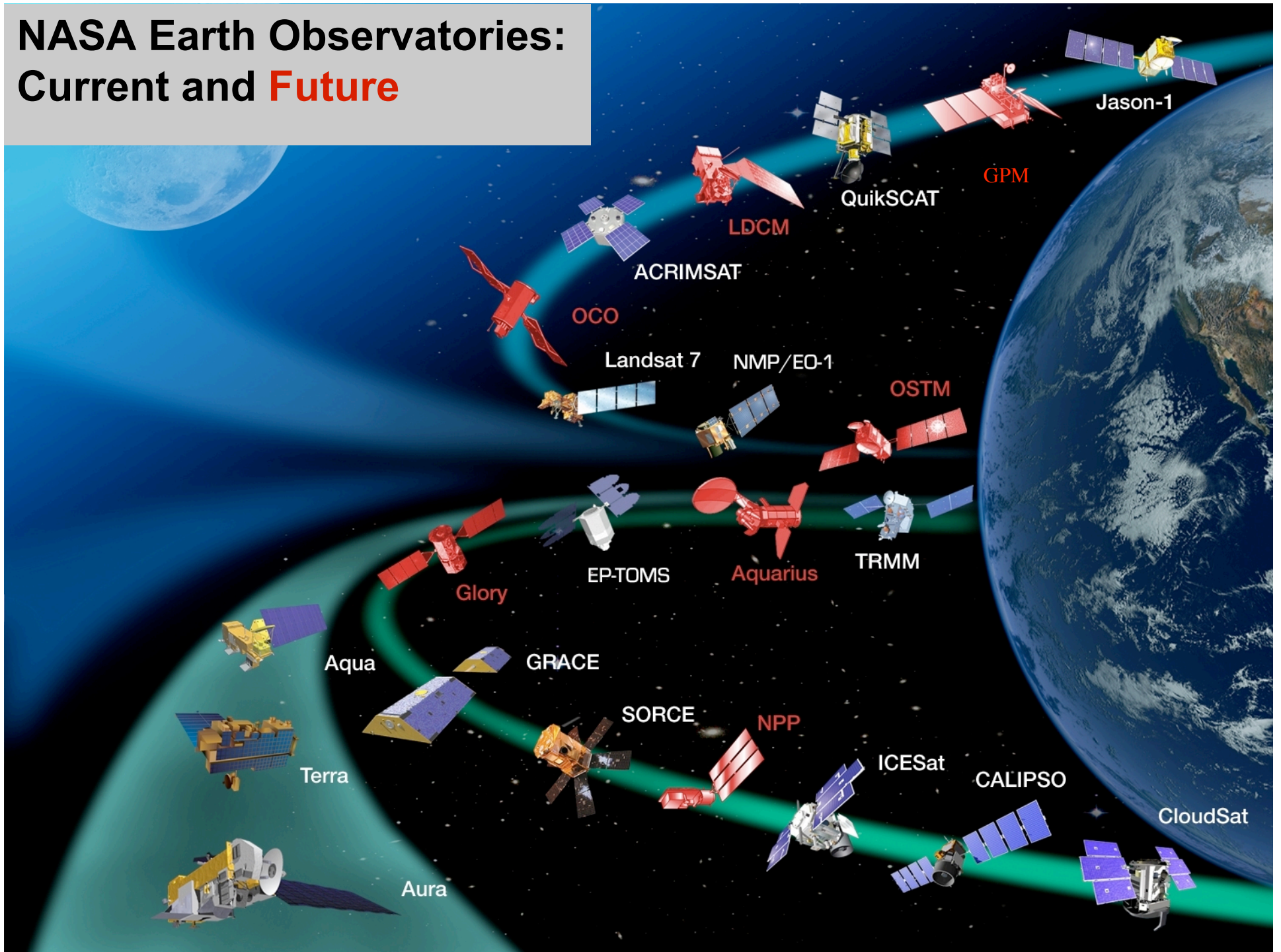


Why Public Health?

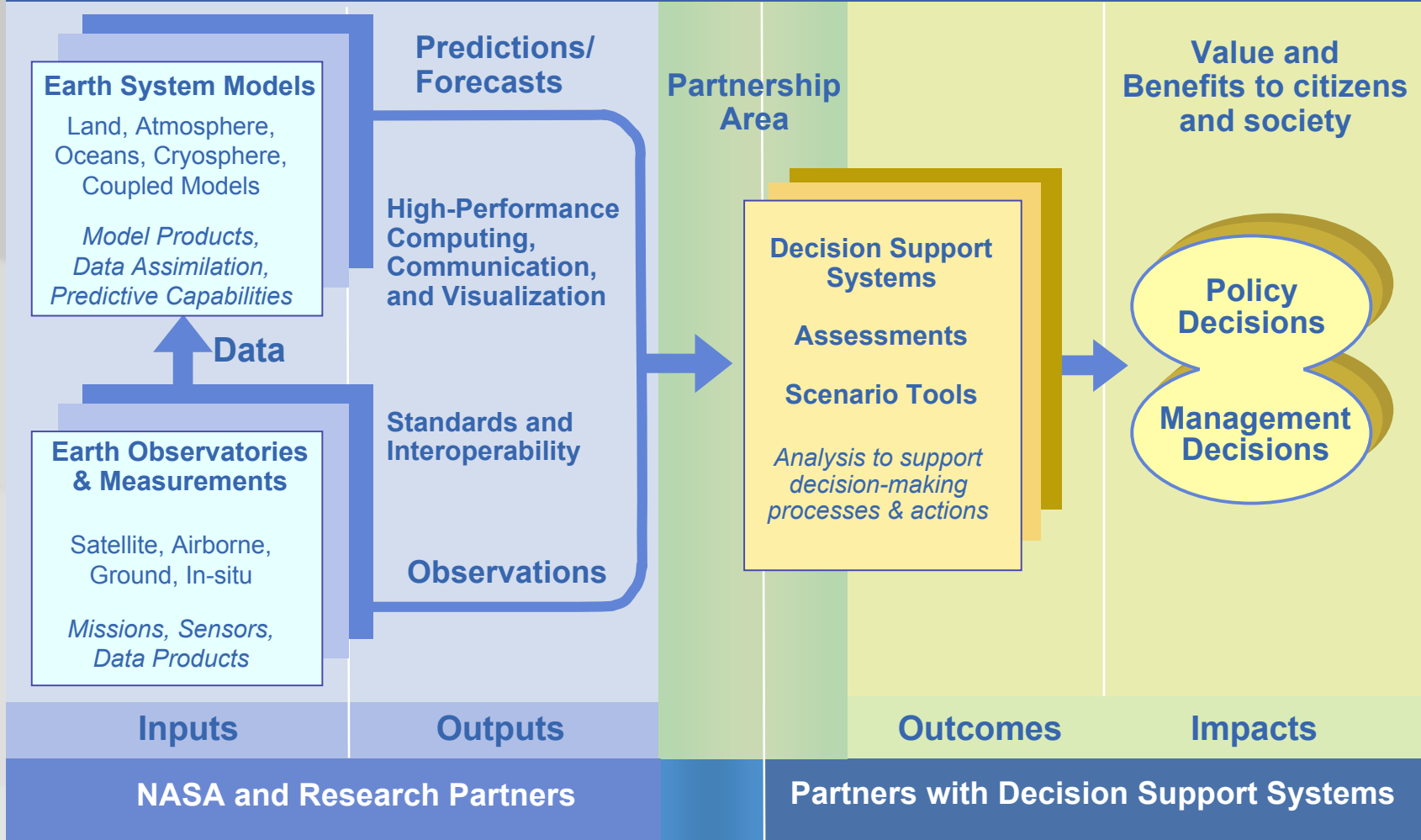
Potential Health Effects of Climate Variability and Change



NASA Earth Observatories: Current and **Future**



Applied Sciences Program Approach to Integrated System Solutions



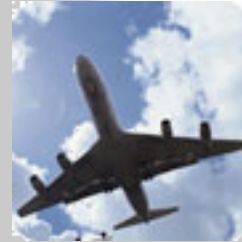
Applications of National Priority



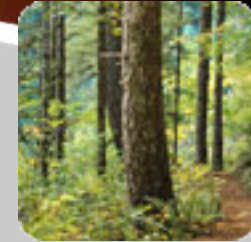
Agricultural Efficiency



Air Quality



Aviation



Carbon Management



Coastal Management



Disaster Management



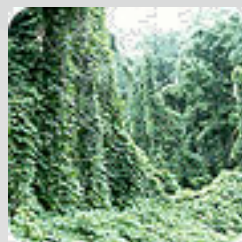
Ecological Forecasting



Energy Management



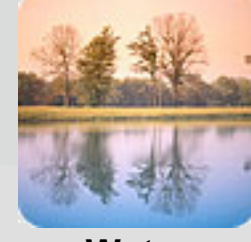
Homeland Security



Invasive Species



Public Health



Water Management



Applied Sciences Program: *Public Health & Air Quality*

Public Health

Programmatic Themes

- Environmental Health
- Infectious Disease
- Emergency Preparedness/Response
- Public Health Tracking/Information Network (crosscuts)

Primary Federal Agency Partners

- Health & Tracking: CDC, EPA, DOE
- Disease & Emer.: USAID, DOD, USGS

NASA Centers Involved in Program

- Marshall, Goddard, Ames, Langley

Air Quality

Programmatic Themes

- AQ Planning
- AQ Forecasting
- AQ Compliance
- Emissions Inventories (*crosscuts*)

Primary Federal Agency Partners

- EPA, NOAA
- Developing: NPS, USDA

NASA Centers Involved in Program

- Langley, Goddard, Marshall, JPL



Public Health

Integrated System Solution



EARTH SYSTEM MODELS

Terrestrial / Atmospheric:
*MAESTRO**

Climate Variability Models: *GHCN*

Land Surface Model: *CLSM, LSE*

Weather/ Seasonal Models: *COLA*

Science & Research: *GSFC Plague Algorithm*

Atmospheric / Ocean Models:
GMAO

Data

EARTH OBSERVATORIES

- EO-1
 - TRMM
 - Terra, Aqua
 - ASTER
 - MISR
 - MODIS
 - Landsat 4, 5, 7
 - **NPOESS***
 - SRTM
- Land cover / land use
 - Surface temperature
 - Vegetation indices
 - Aerosol properties
 - Surface topography

**Future Mission*

Predictions

- Soil Moisture
- Atmosphere Temp
- Ground Temp
- Humidity
- Precipitation
- Total Column Ozone
- Total Aerosol Amount

Observations

DECISION SUPPORT TOOLS

▪ ArboNET/Plague Surveillance System

▪ EPHTN / HELIX

▪ Malaria Surveillance/GSAT

▪ GeoMedStat

▪ ArboNET/CMVRSP

▪ FEWS NET/MEWS

▪ PHAiRS/Rapid Syndrome Validation Project

VALUE & BENEFITS

- Early Warnings for harmful exposures, conditions favorable to vector proliferation.
- Reduction of environmental-related diseases.
- Improved prevention initiative targeting.
- Improved bio-terrorism response and emergency event preparedness.



Public Health

Environmental Health

Partners: CDC, EPA, Univ. of NM, Univ. of AZ, UAB, State of MS, Kaiser-Perm.

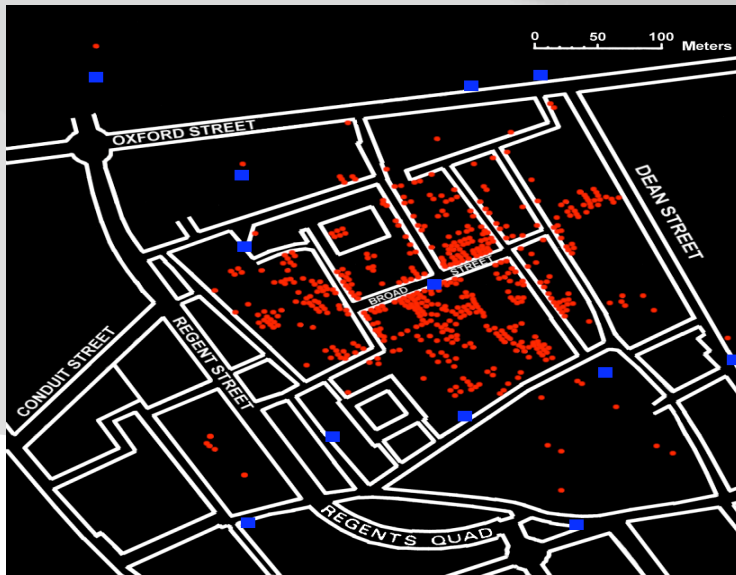
Constituencies: Federal regulators and public health managers; state and local public health officials; health care providers; general public

Needs/Issues: The community needs products which are more representative (on both spatial and temporal scales) of the true concentrations of aerosols and other atmospheric contaminants. These products need to be correlated with respiratory distress admissions at health care providers. In the future, these correlations will lead to patient admission forecasts which will benefit resource management at HMOs, hospitals, etc.

The community is also focused on the continued development of a Public Health Tracking/Information Network -- a national network of local, state, and federal public health agencies that tracks trends in priority chronic diseases with emphases on epidemiological modeling and uncertainty.

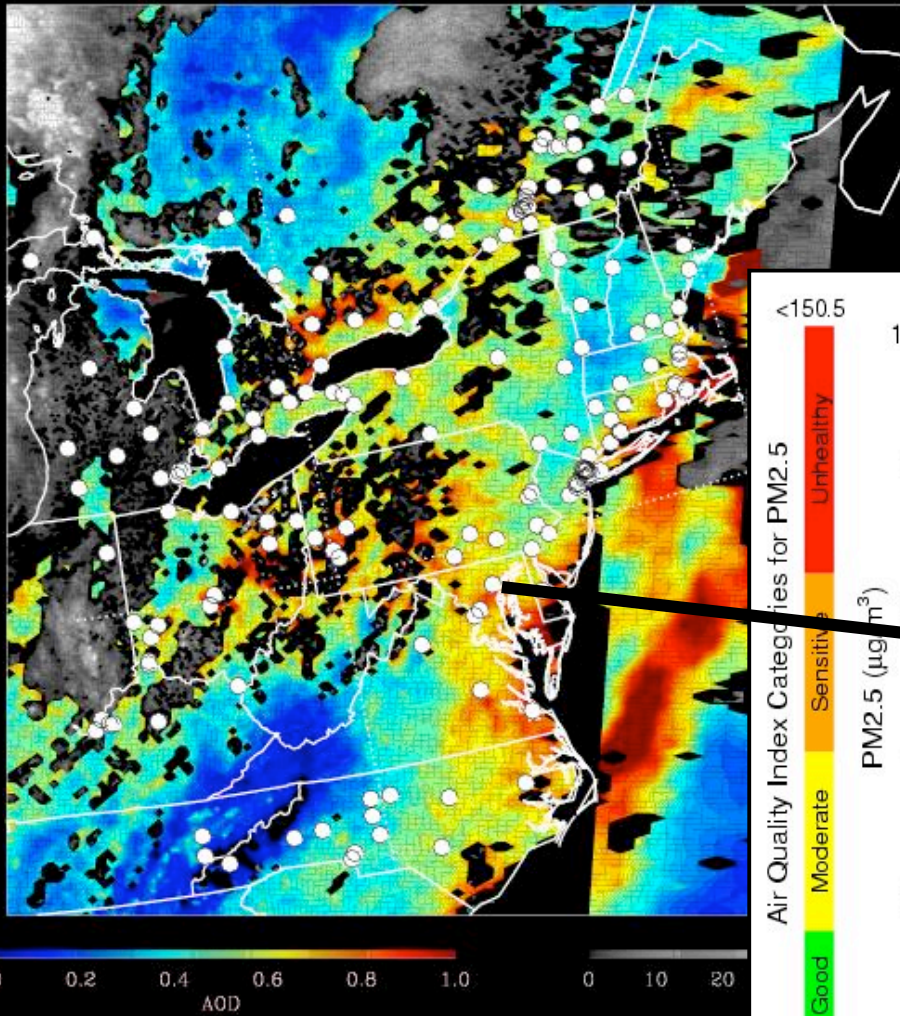
Future Directions: Asthma research (why are asthma deaths increasing in an era of improving air quality?), oceans and human health (HABs), climate change (changes to contaminant transmission dynamics and pathways)

Epidemiology in the 21st Century



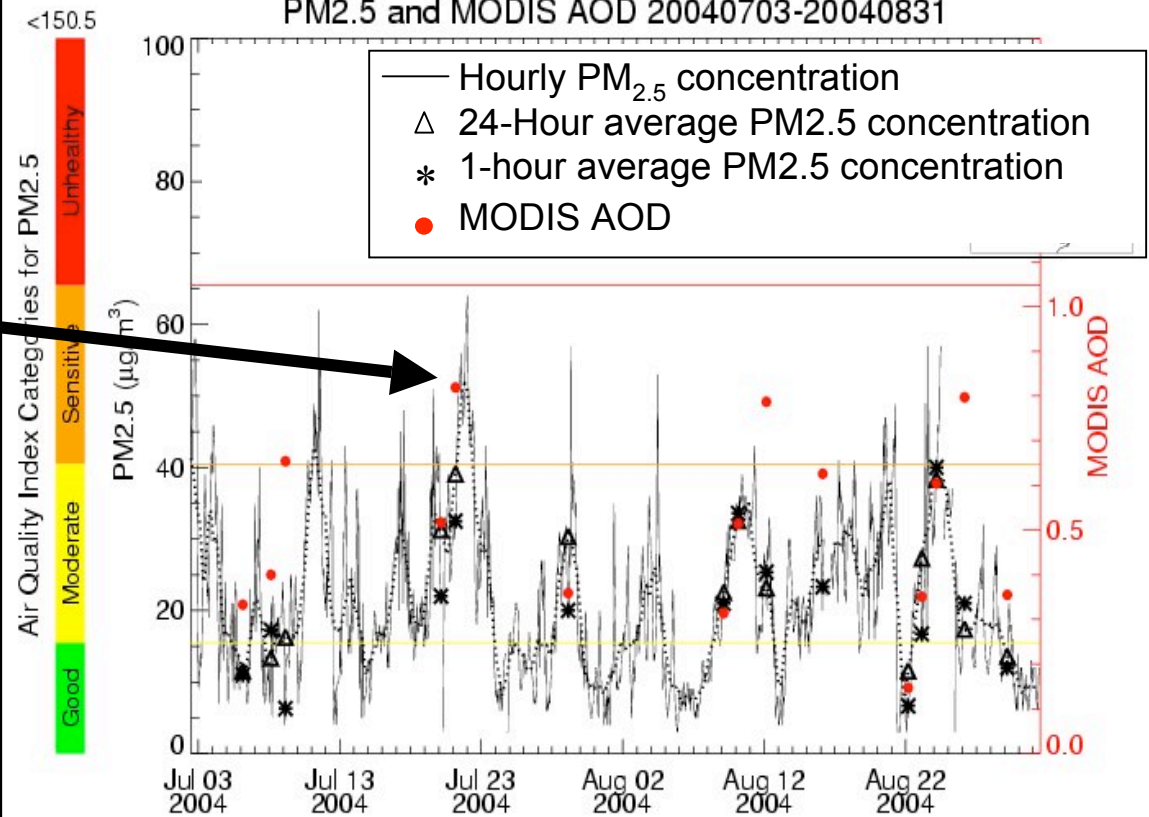
Satellite & Ground Measurements

MODIS Aerosol Optical Depth 2004 07 21 EPA Region 1-3



Baltimore, Maryland, USA

PM2.5 and MODIS AOD 20040703-20040831



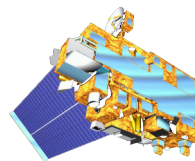


Air Quality: EPA AIRNow



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

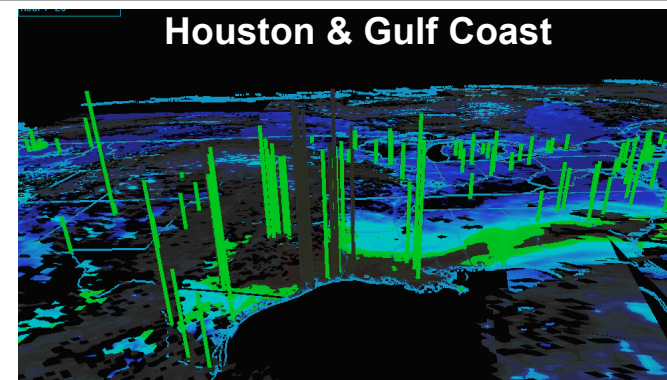
- Terra/Aqua MODIS Aerosol Optical Depth

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

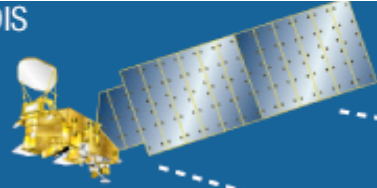
Provided “weight of evidence” supporting EPA transport rule-making.



Project Successes

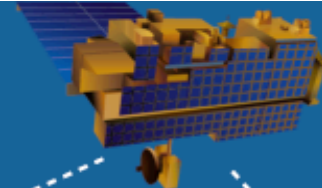
- EPA conducted forecaster training on use of integrated data products
- Demonstration to EPA AA for Air & Radiation
- MODIS and project referenced in EPA’s Clear Air Interstate Rule (Fed. Reg. Jan’05)
- Cover story of BAMS (Sept. 2005)
- Interagency, inter-Center project
- Prompted independent follow-on 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



Direct Broadcast

Terra MODIS

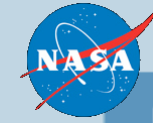


Products

- Aerosol Optical Depth (MOD04_L2)
- Cloud Optical Thickness (MOD06_L2)



NASA, GFSC, DACC



NASA, GFSC, Science Team

Products Algorithms

Products (Near Real Time)

- DB Aerosol Optical Deth (MOD04_L2)
- DB Cloud Optical Thickness (MOD06_L2)

SSEC/CIMSS
Univ. of Wisc.
Madison (MIPPS)



NOAA
OAR/ARL

Products
EDAS Forecast Data



NASA LaRC

Products
MODIS/AIRNow Data
Fusion Site Static Data

US EPA
AIRNow DMC



AIRNow
Forecasters

State & Local
Canadian
Providences

Products
AIRNow Hourly
PM_{2.5} Data

Terra & Aqua
Satellite Direct
Broadcast of MODIS
instrument data via
commercially avail-
able ground station



3-D Air Quality System for Air Quality & Public Health

Policy Environment & Project Drivers

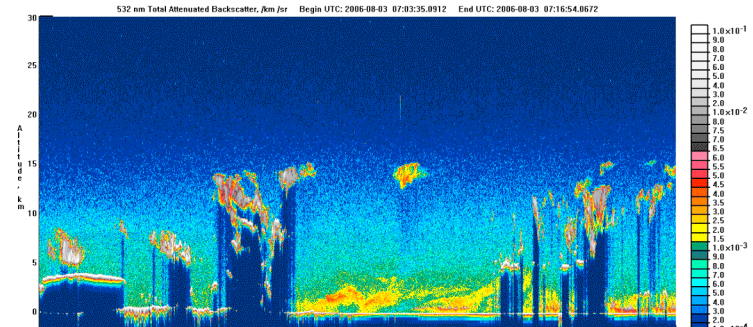
- Regulations on transport of pollutants has increased importance of monitoring in three dimensions & time.
- States using transport to address their non-compliant days and prepare their SIPs
- Academy assessment of EPA PM program stressed need for integrated 3-D characterization of AQ.
- Techniques needed to document accountability and evaluate success of PM_{2.5} reduction initiatives

Project Purpose & Activities

- Integrate NASA sensor and LIDAR data into EPA's operational AQ data systems: AQS/AirQuest, AirNow
- Provide greater accessibility and usability of satellite and LIDAR data to users
- Develop visualization tools in horizontal and vertical dimensions for forecasting and retrospective analysis

Potential Benefits

- AIRNow: Increase synoptic data for forecasters
- AIRQuest: Air Quality trends; progress of SIPs and compliance; waivers to air standards; AQ rules
- CDC: Better AQ maps through statistical models



Models: NOAA Hysplit, LaRC-mod. IMPACT traj.
Observations: Terra/Aqua (MODIS, AIRS), LIDAR (REALM, MPLNet), GOES (GASP), Aura (OMI), CALIPSO, AERONET

Progress

- Formation of end user committee & initial survey
- Determined priority datasets
- Histor. MODIS AOD-PM_{2.5} matched to AirQuest
- Started development of finer resolution AOD data
- Started development of 3D visualization methods

Timeline

2007-08: Evaluation of other sensors (OMI, AIRS) for integration into AirQuest. Implementation of 3D visualization and data output.

2008-09: Complete data integration and transition to operations



Workshop Objectives

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Identify data needs of Air Quality and Public Health research and management communities

Develop partnerships and identify collaborative research and applications opportunities



Group on Earth Observations

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

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



Earth Observation Summit III
Feb. 2005

GEO involves:
67 nations (plus EU)

**48+ international
Organizations**

**GEO Secretariat at WMO
in Geneva**

USGEO: United States Group on Earth Observations

STRATEGIC PLAN FOR THE U.S. INTEGRATED EARTH OBSERVATION SYSTEM



Interagency Working Group on Earth Observations Membership

- | | |
|---|---|
| Department of Commerce <ul style="list-style-type: none">National Oceanic and Atmospheric AdministrationNational Institute for Standards and Technology | Environmental Protection Agency |
| Department of Defense <ul style="list-style-type: none">Air ForceNational Geospatial-Intelligence AgencyNavyU.S. Army Corps of Engineers | National Aeronautics and Space Administration |
| Department of Energy | National Science Foundation |
| Department of Health & Human Services <ul style="list-style-type: none">National Institute of Environmental Health Sciences | Smithsonian Institution |
| Department of Homeland Security <ul style="list-style-type: none">Federal Emergency Management Agency | Tennessee Valley Authority |
| Department of the Interior <ul style="list-style-type: none">US Geological Survey | U.S. Agency for International Development |
| Department of State | U.S. Department of Agriculture <ul style="list-style-type: none">Agriculture Research ServiceU.S. Forest Service |
| Department of Transportation | White House Council on Environmental Quality |
| | White House Office of Management and Budget |
| | White House Office of Science and Technology Policy |

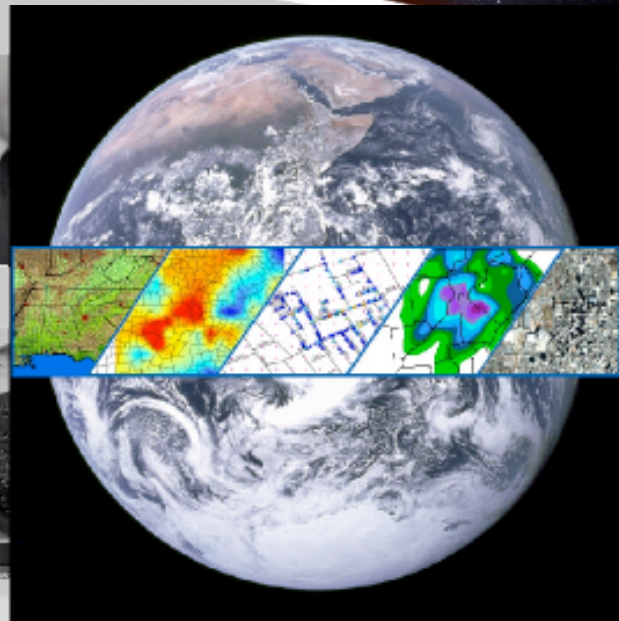
USGEO & IEOS Near-Term Opportunities

***Air Quality Assessment and
Forecast System***

***Improved Observations for
Disaster Reduction***

***National Integrated Drought
Information System***

Data Access & Interoperability



Supply

Broker
Collaboration
& Technology

Demand

Technology use supports the broker position



Data Access & Interoperability


NASA and interagency partners support significant activities to encourage interoperability:

Enabling greater access, fusion, and integration of Earth science data, products, models, etc.

- Interoperability concepts, architectures, and standards
- Designing and demonstrating prototypes, pilots and testbeds
- Publicly accessible standards through consensus bodies (ISO, FGDC, OGC)

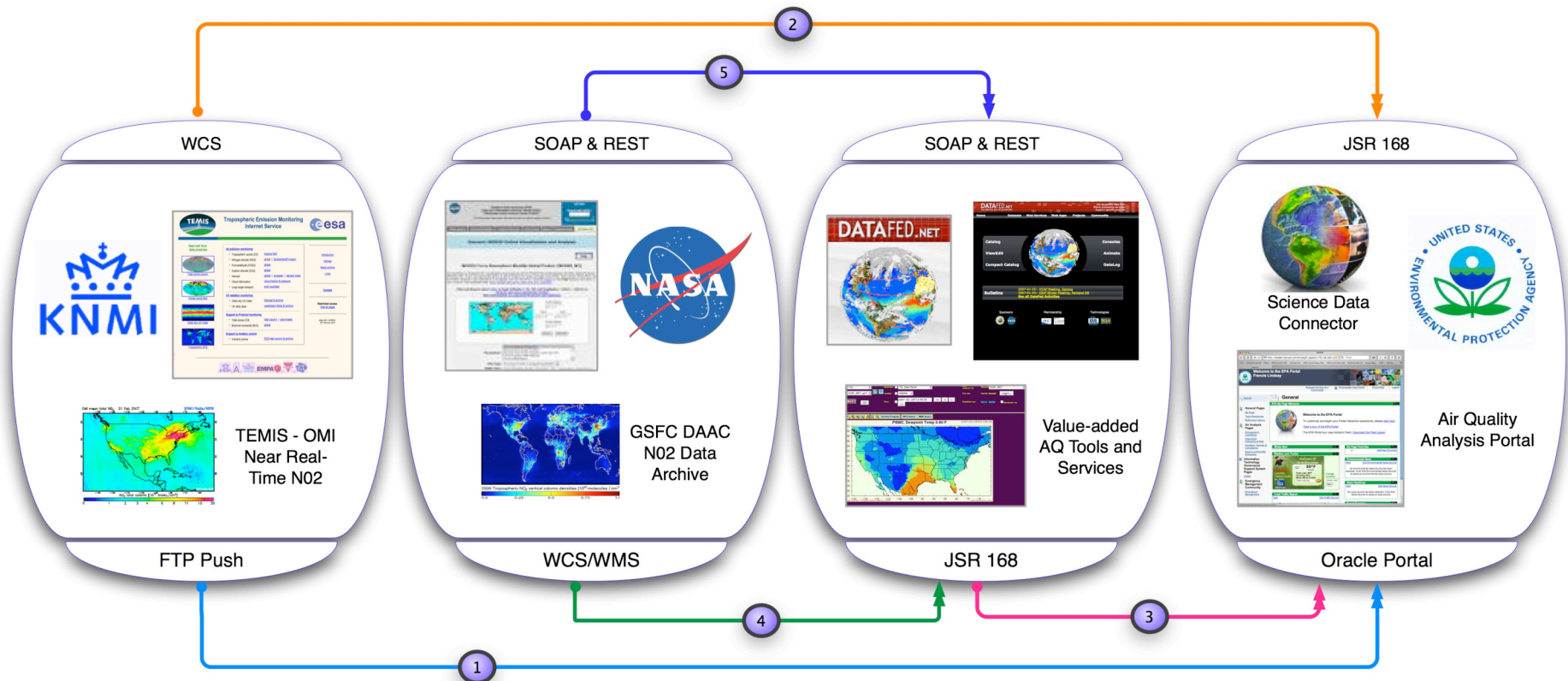
Ensure and improve abilities to access multiple, heterogeneous geoprocessing environments, either local or remote by means of open and standard software interfaces

Interoperable interfaces on sources, data sources, in-situ sensors, models, registries, catalogs, etc.



Air Quality Web Services Data Pathfinder

NASA - EPA - ESA (KNMI) – 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.



Decadal Survey

GEO Plenary and Ministerial Earth Observation Summit:

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

USGEO Preparation for GEO Summit – Examples of US Efforts

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



Decadal Survey

Earth Science Decadal Survey:

Recommended Observation Types, by Panel

Modification of Table 2.4

<i>Panel</i>	<i># of Recom. Observation Types</i>
Climate	9
Ecosystem	6
Water	12
Health	29
Solid Earth	3
Weather	10
<hr/>	
<i>Total</i>	69



National Earth Observation Policy

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.




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Workshop – Day 1

Day 1: Current States and Future Directions

Review existing projects & information networks,
Examine research in air quality-health connections, and
Understand directions and priorities of key partners' programs

Session 2:

Review existing applications projects in Air Quality and Public Health

Session 3:

Review existing networks that gather, integrate, track, and provide health and air quality data, information, and products

Session 4:

Review air-health research findings, directions of key programs, and perspectives on near-term activities for integrating networks



Workshop – Day 2

Day 2: Common Needs & Synergistic Opportunities

Discuss common needs to advance the state of practice in use of Earth science tools in assessing exposure, impacts, and health outcomes. Identify specific activities to pursue.

Break-outs:

State of knowledge/practice and future needs & directions in use of Earth observations, models, error estimates, etc. relating to:

- Air quality exposure and chronic/acute health conditions
- Health-related air quality hazards and impacts
- Linkages of exposure to health outcomes

Sessions 5 & 6: Discuss findings

Needs for research, products, techniques, interoperability approaches, etc.

Opportunities for specific short-term collaborations and achievements, activities to contribute to USGEO/GEO, opportunities for public awareness, etc.

Longer-term directions, needs, and priorities.



Workshop Deliverables

Products & Deliverables:

- Workshop Report: Findings & summary of immediate, short-term opportunities & longer-term needs and directions
- Article in AGU's *Eos Transactions* (or other publication)
- Workshop Letter/Summary to USGEO Ministerial Summit Teams
- Workshop Letter/Summary to GEO Health-Air Quality Community of Practice

Workshop successful if:

- Project teams identify and pursue new partnerships & linkages
- Participants identify future research and application project ideas
- Program managers determine areas and directions to focus on
- Participants identify opportunities for & pursue/achieve short-term results
- Participants contribute to and benefit from USGEO AQ Near-term opportunity



Research Opportunities in Space and Earth Sciences 2007 (ROSES)

Amendment A.20: “Decision Support Through Earth Science Research Results”

Closing Date: May 25, 2007

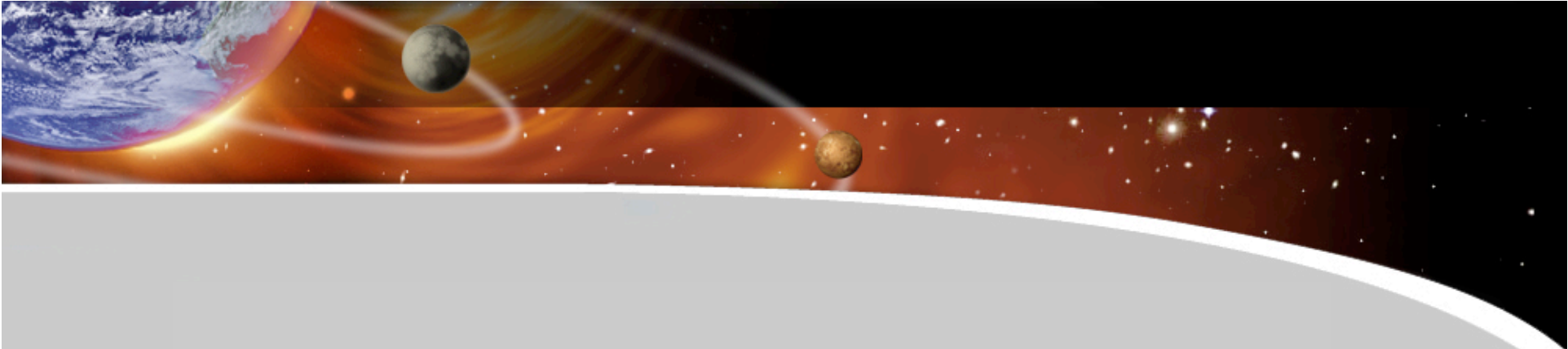
Website: <http://nspires.nasaprs.com/>

Public Health Program

Requests proposals in the areas of asthma/respiratory health, avian influenza, oceans and human health, and emergency response/preparedness (including bioterrorism).

Air Quality Program

Requests proposals focused on Air Quality Compliance, Planning, Emissions Inventories, and particular aspects of Forecasting (e.g. GFS).



*Innovation is always in conflict with
business as usual.*

*Chris Trimble,
Tuck School of Business
Dartmouth University*