NASA Applications Air Quality Program

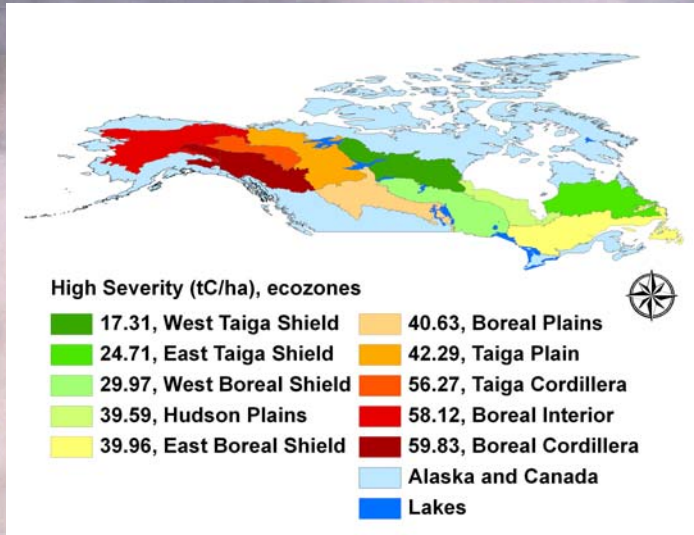
Enhancing Area Burned and Emissions for Air Quality Planning

Supporting Multi-scale Chemical Forecasting and Assimilation studies in support of AURA Validation and Science during INTEX-NA and TexAQS

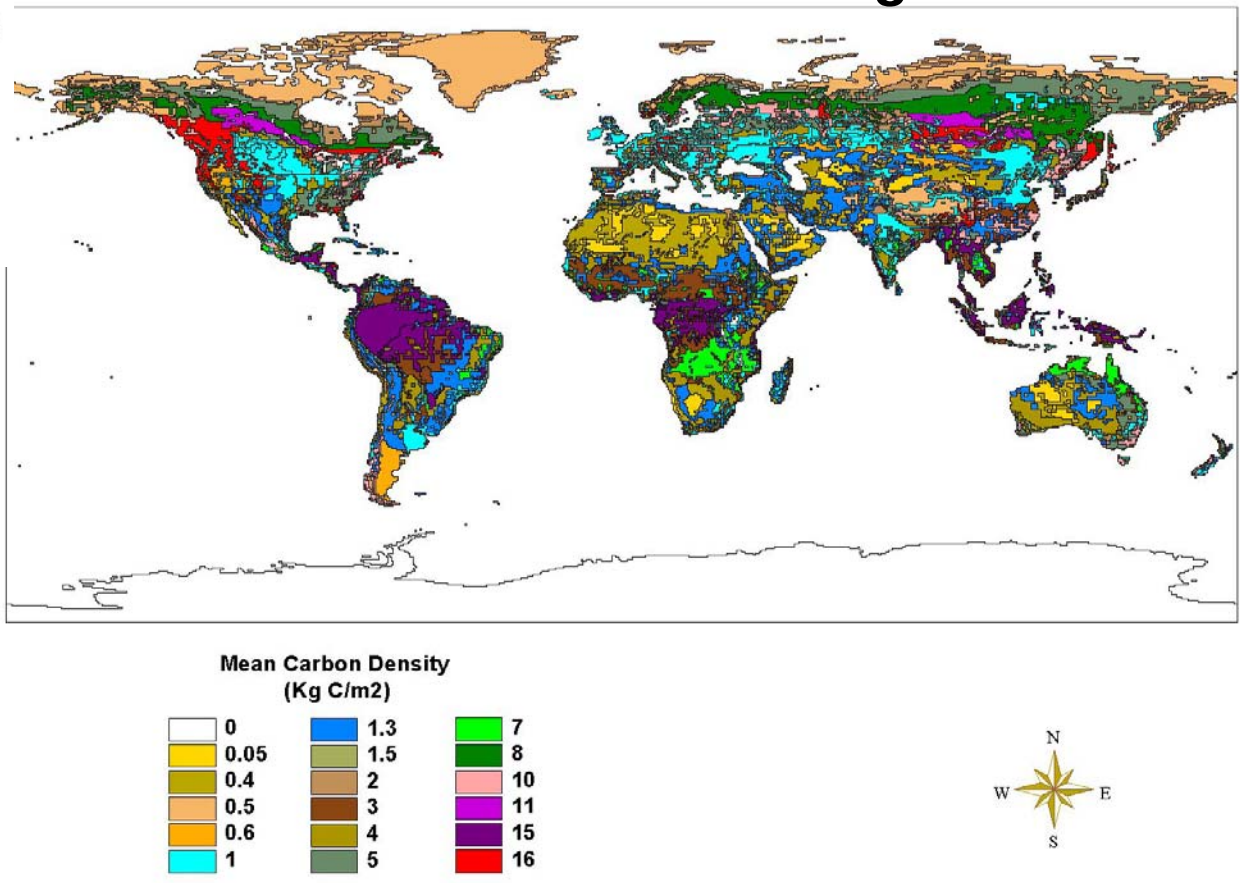
Amber Soja, Jassim Al-Saadi, Brad Pierce, Chieko Kittaka, James Szykman Louis Giglio, Dave Randall, Joe Kordzi, Sean Raffuse, Tom Moore, Biswadev A. Roy, George Pouliot, David J. Williams, Tom Pierce and Tom Pace

Photo courtesy of Brian Stocks

Biomass burning emission estimates for use in near-real-time forecasting for field campaigns and in regional-to-global transport models.



Ground-based carbon consumption estimates were developed to estimate near-real-time biomass burning emissions.



Paired with satellite-derived estimates of area burned, these data are currently used in large-scale regional transport models.

Biomass burning … ates for use in near real-time forecasti… s ar… bal …s.

Ground-based carbon data

Carbon cycle program

Satellite-based fire data (MODIS)

…ates were de…

…ear-real-time biomass … issions.

Regional to Global Air Quality

Feedback to and from Science and Applications

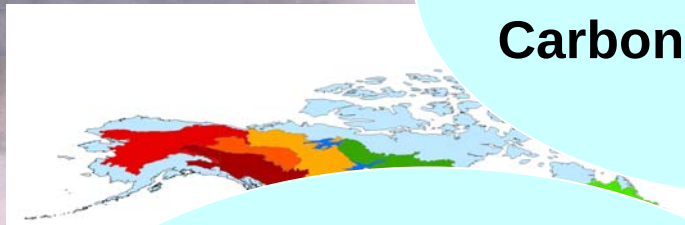
Large-scale Chemical Transport models

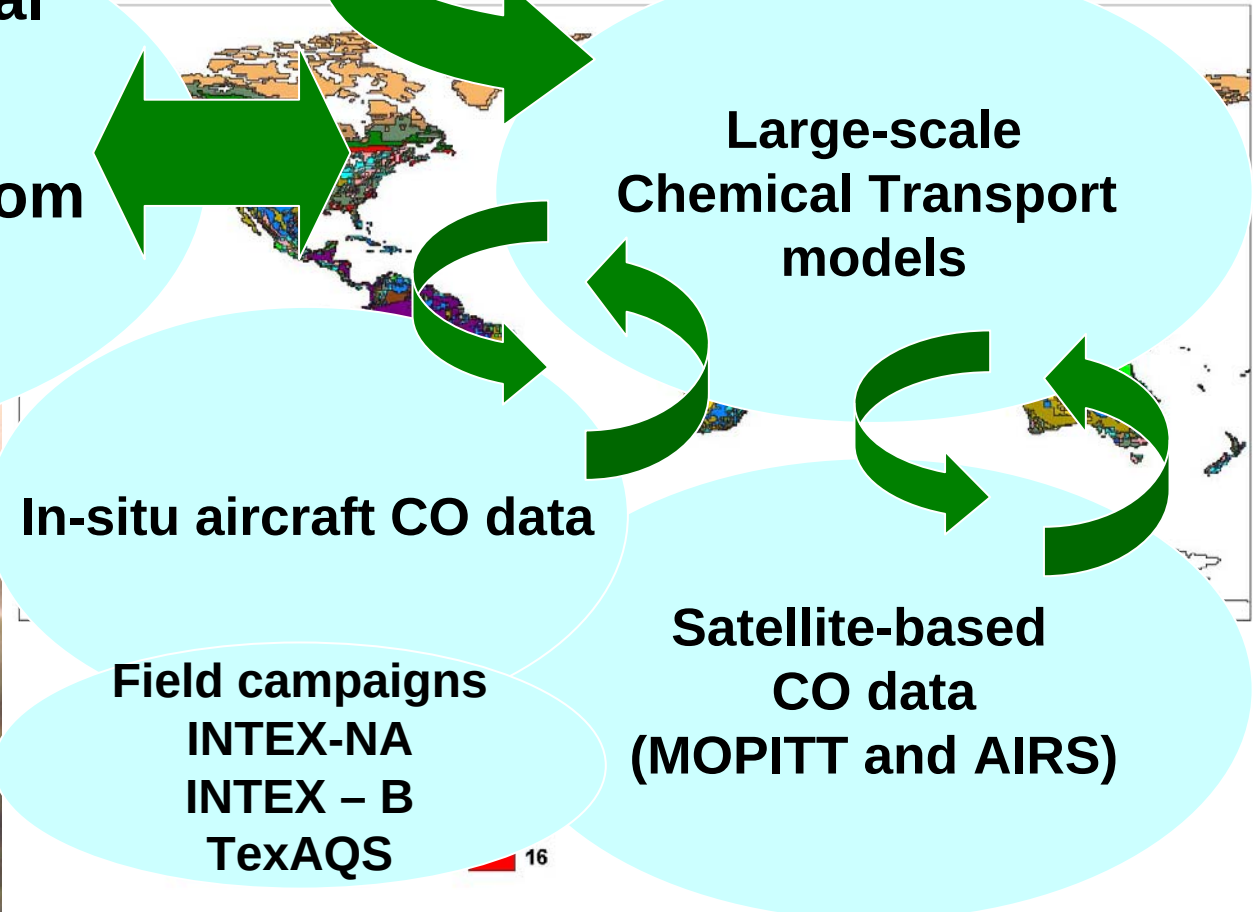
In-situ aircraft CO data

Satellite-based CO data (MOPITT and AIRS)

Field campaigns
INTEX-NA
INTEX – B
TexAQS

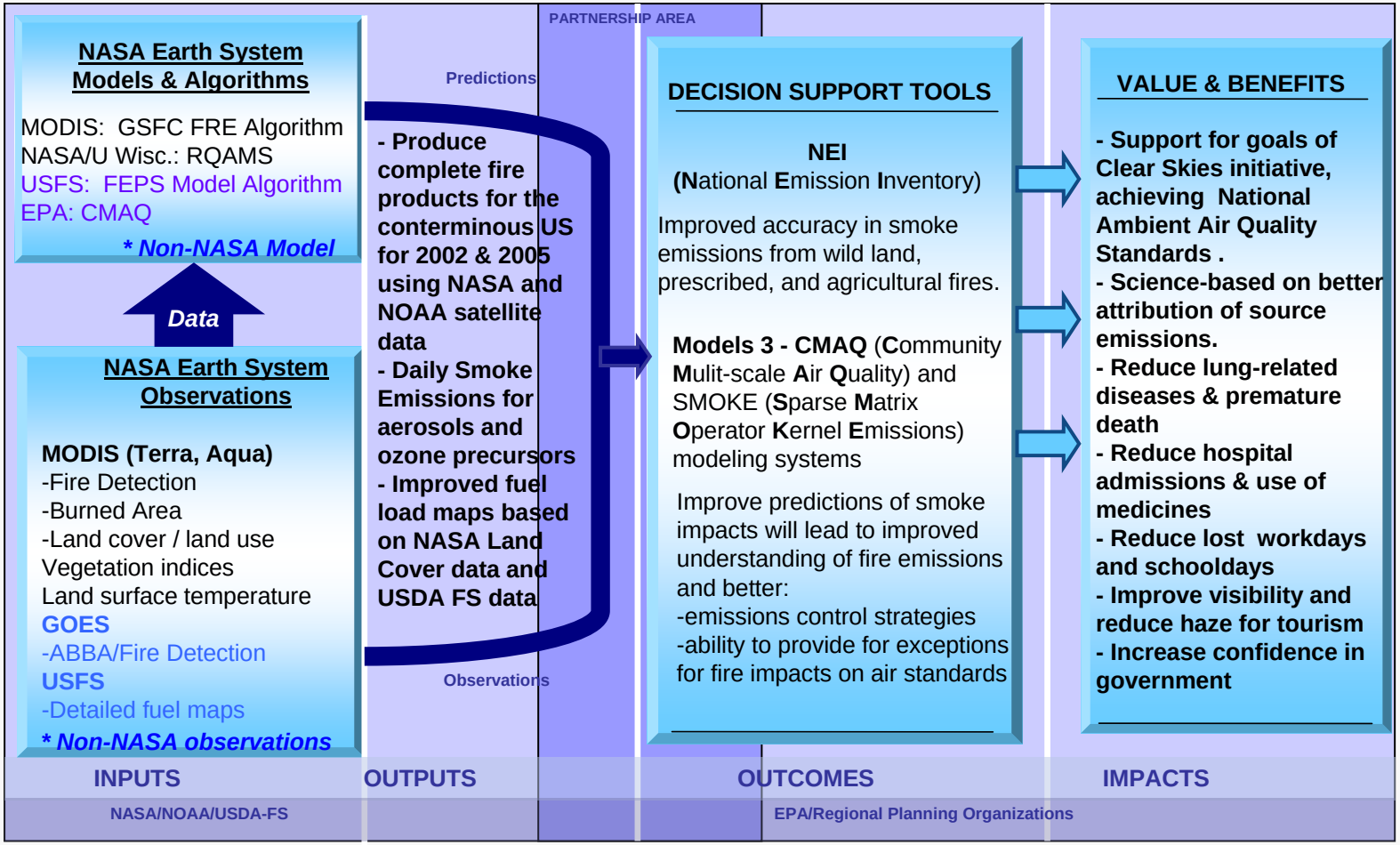
…estimates of area burned, these data are currently used in large-scale regional transport models.





Air Quality Applications Enhancing Biomass Emissions

Integrated System Solution – Fire National Emission Inventory



Initiated work at the suggestion of James Szykman (EPA), while an NRC post-doc resident at NASA LaRC (funded through NRC in 2004 and 2005).

Received NASA Applications funding through unsolicited proposal in 2006 and 2007.

Expected benefits

Benefit to partner(s): Improvement in emissions inventory by enhancing ground-based area burned data using satellite imagery and decrease the cost necessary to generate accurate emissions inventories.

NASA Applied Science Program

Benefit to NASA Earth science: Utilize existing NASA imagery and by demonstrating satellite utility, create the conditions necessary for sustained use.

Benefit to NASA Applied science: Benchmarking quantification of the ability of satellite data to enhance ground-based data and to identify missed fires. A complete end-to end analysis of area burned, direct emissions, chemical transport and verification using coincident field campaigns (INTEX, TEXAS-AQ), EPA ground Stations and modeling.

Air Quality Applications Enhancing Biomass Emissions

Goal: *Improve the EPA and Regional Planning Organizations (RPOs) biomass emissions estimates within the National Emissions Inventory (NEI) by enhancing ground-based fire data using satellite-derived fire products.*

Overview: Decisions Support System, User/Partners, Earth Science Products

- **Primary Partners:** EPA ORD/NERL and OAR/OAQPS, NOAA NESDIS/ORA, 5 Regional Planning Organizations (RPOs), DEQs, and interested state and local governments.
- **DSS:** EPA, RPOs, NEI
- **Earth Science measurements:** MODIS and GOES

Approach and Major Milestones

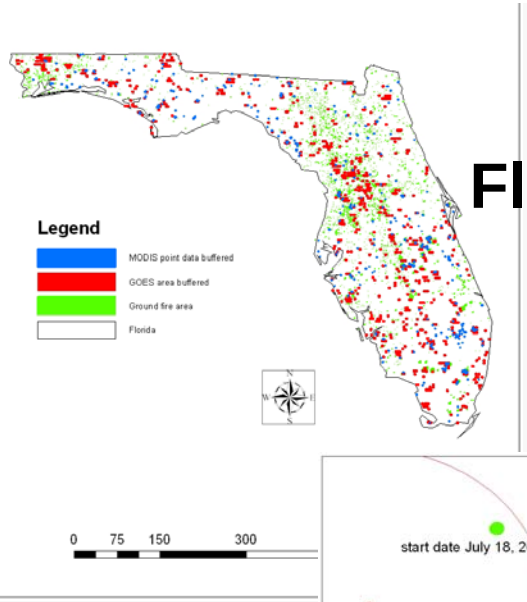
- Demonstrate the usefulness and value of incorporating satellite-based fire data in the National Emissions Inventory.
- Benchmark the improvement in area burned and the ability to accurately assess fire using satellite-based fire data.
- Aid in the implementation and validation of satellite data to the NEI and the CMAQ model.
- Benchmark the improvement in biomass emissions to the NEI and CMAQ using satellite-based data.

Justification

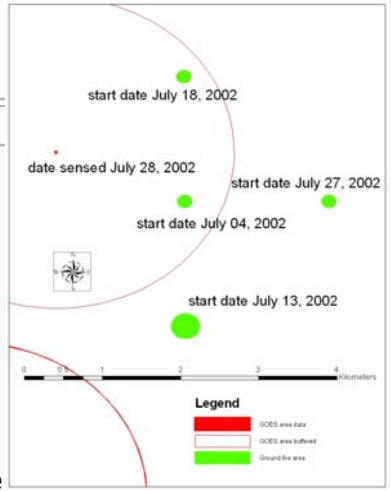
- In 1990, Congress amended the Clean Air Act (CAA) to require the United States Environmental Protection Agency (EPA) to address regional haze.
- As a result of the Regional Haze rule, 5 RPOs were formed across the U.S. in an effort to initiate and coordinate activities associated with the management of regional haze and other air quality issues. The RPOs are tasked with assisting the States in the development of regional haze State Implementation Plans (SIPs).
- Biomass burning can be a significant contributor to a regions inability to achieve the National Ambient Air Quality Standards for PM 2.5 and ozone, particularly on the top 20% worst air quality days.
- Biomass burning is a major contributor of particulate matter and other pollutants to the atmosphere and is one of the most poorly documented of all sources.

Evolution of one success story…

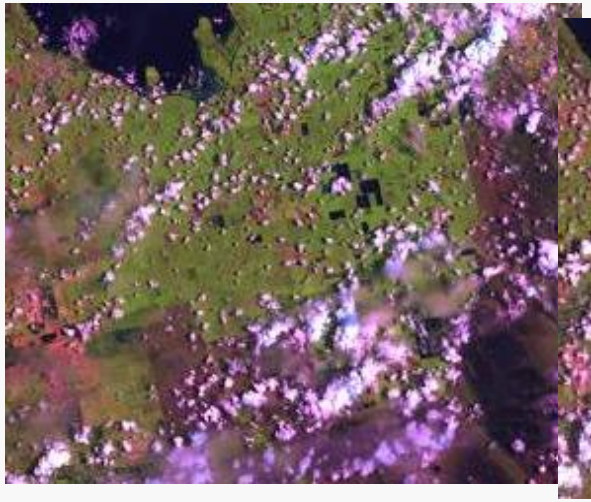
We used GIS models. MODIS, GOES ABBA and Landsat imagery to compare the National Emissions Inventory (NEI) area burned data to satellite-derived fire data. We were able to demonstrate that the satellite was able to detect unreported fires and to provide accurate geographic information. This research (conference and EPA manuscript) demonstrated the useful capability of satellite-derived fire data and helped to establish credibility of the satellite data and trust.

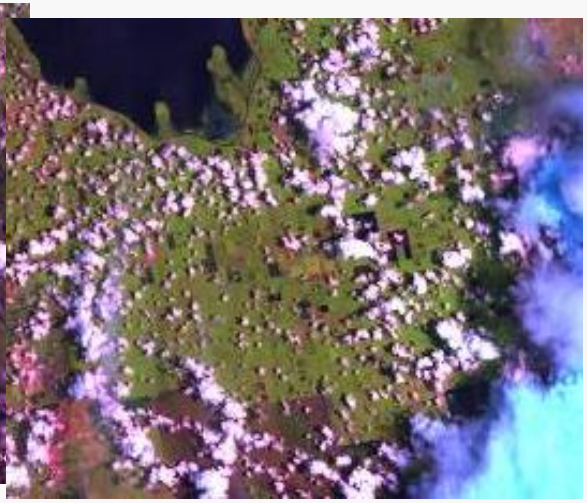


Florida



Landsat Enhanced Thematic Mapper (ETM+) 30m resolution imagery



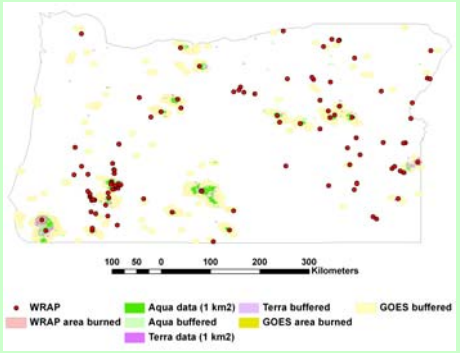


2004 – Explored the customers needs.

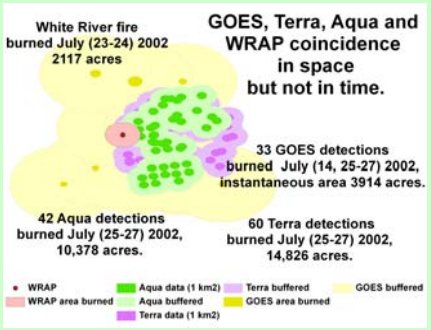
2005 – March submitted EPA Internal Manuscript

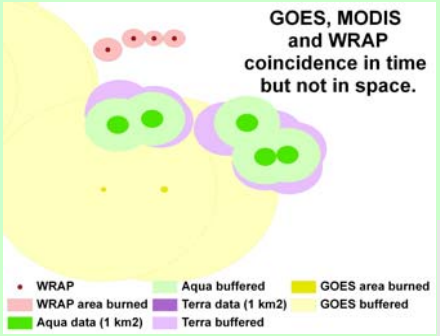
2005 – April, presented results at annual EI conference

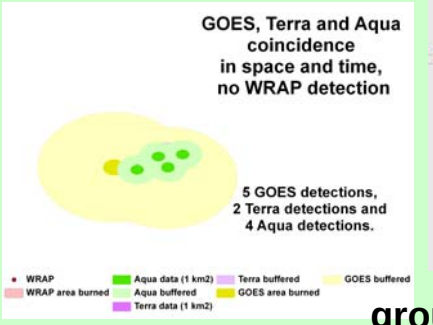
In 2005 and 2006, we presented (manuscript and EI conference) statistical analyses comparing satellite-based fire data to the currently used and trusted ground-based inventory data. We identified inconsistencies and highlighted the improved value in using satellite data in identifying the time the fires occurred, the geographic location of the fires and the spatial movement of the fires as they burned over time. This analysis defined error between the methodologies, without which the emissions estimates would not have been viewed with confidence.

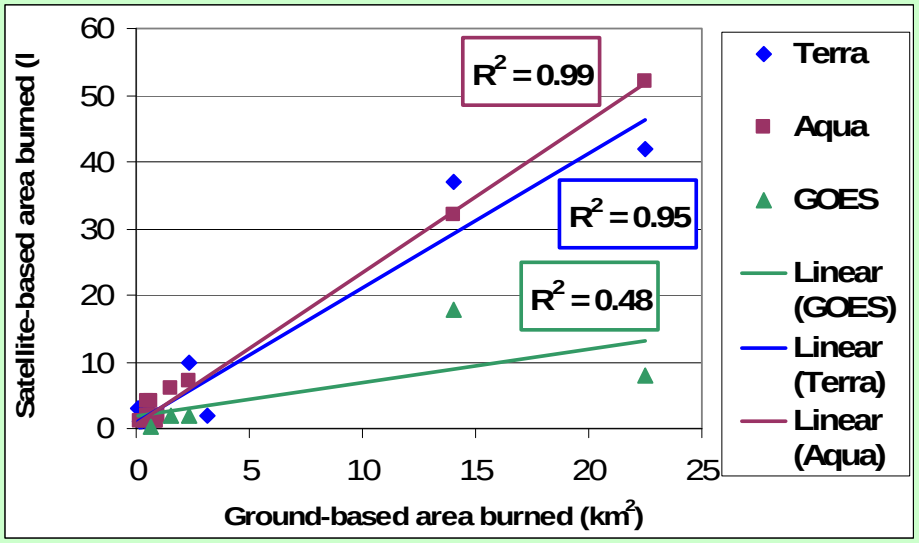


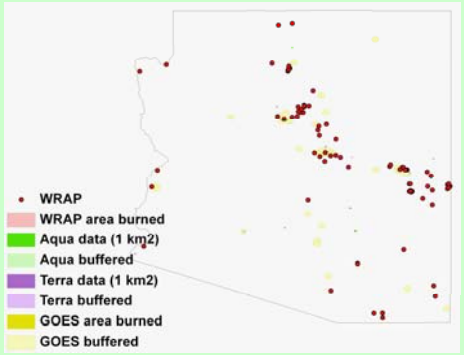
Oregon



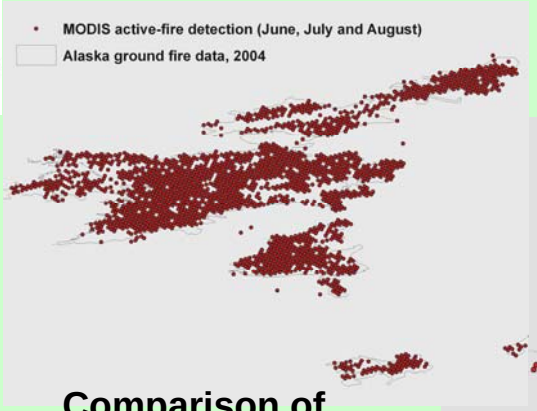




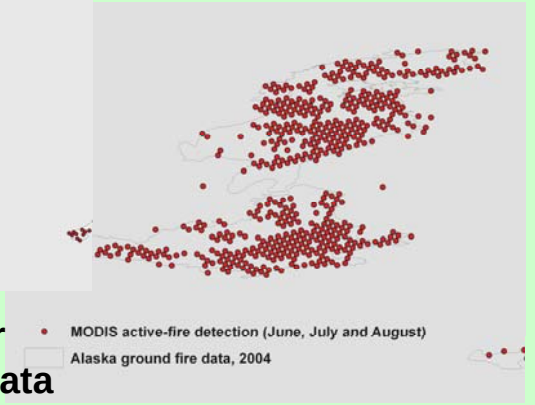




Arizona

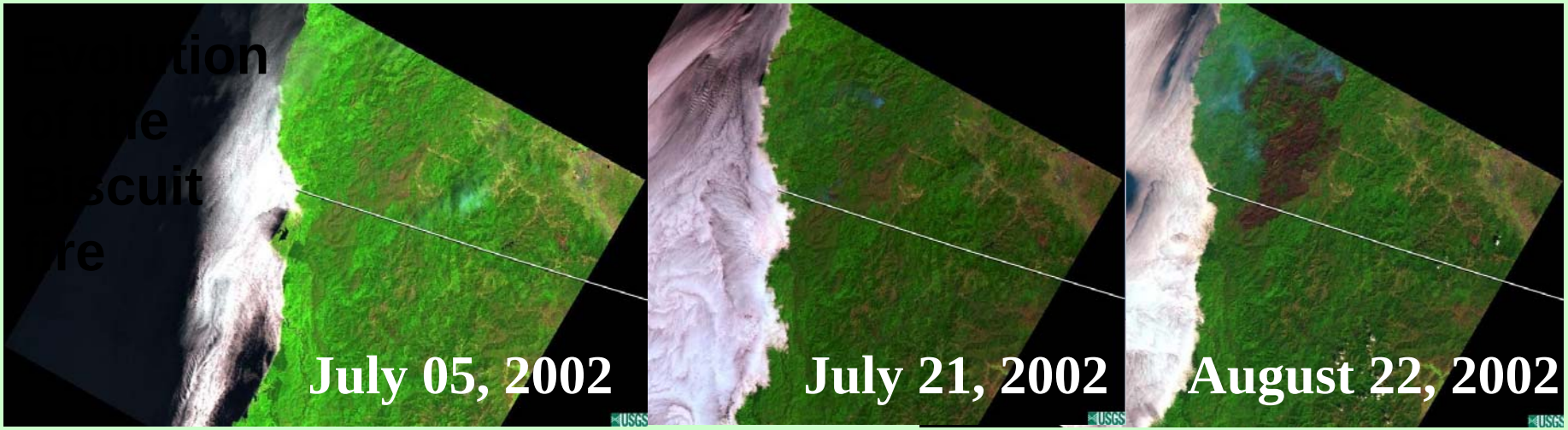


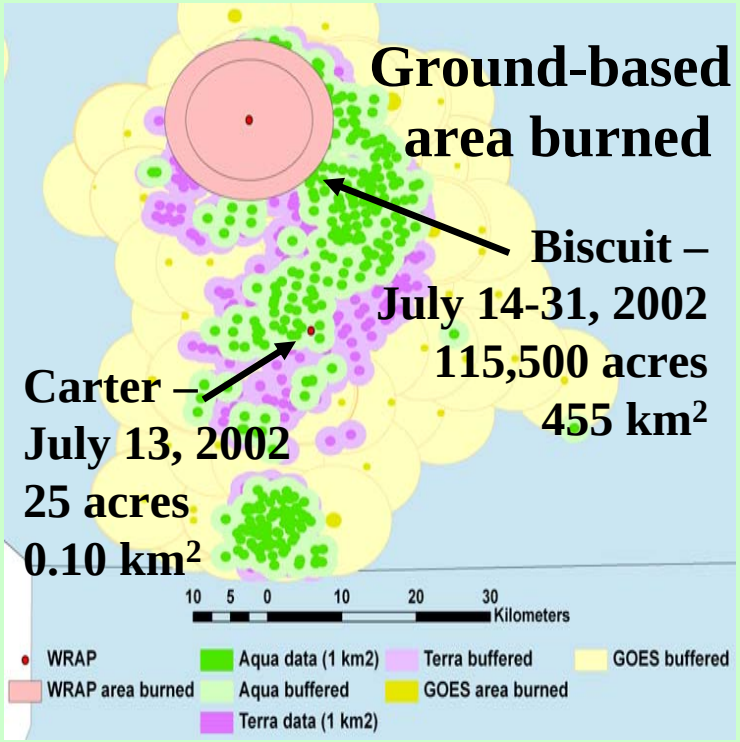
Alaska



Comparison of ground-based fire perimeter and MODIS thermal anomaly data

NASA Applied Science Program



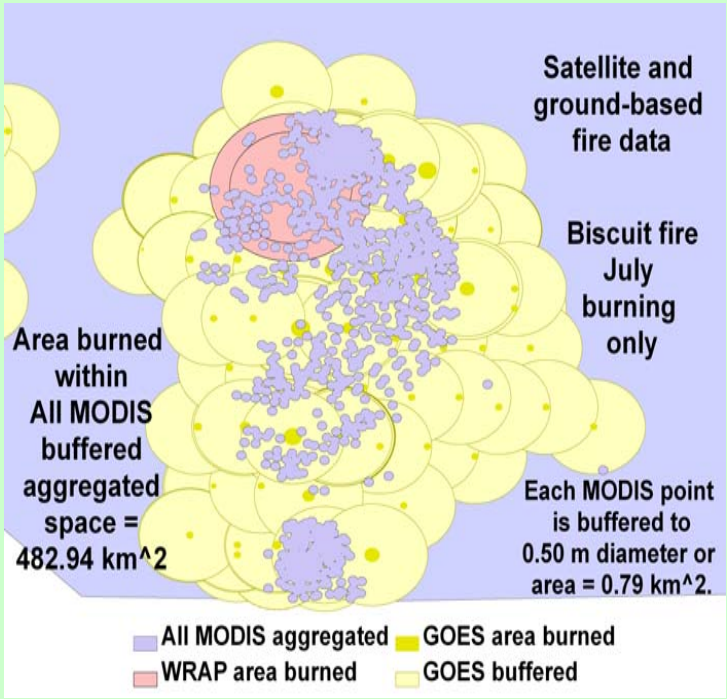


Fire detections
(1 detect = 1 km²)

Aqua
423 records
July 11-29, 2002

Terra
746 records
July 14-31, 2002
(MODIS 257% >)

GOES
231.79 km²
July 4-31, 2002 (51%)



Area burned product
482.94 km² (6% >)

July Analysis

Satellite and ground comparison
All data including non-coincident

	MODIS Terra	MODIS Aqua	GOES instantaneous area	WRAP
Oregon	2761	1984	800	2113
Arizona	168	162	38	167

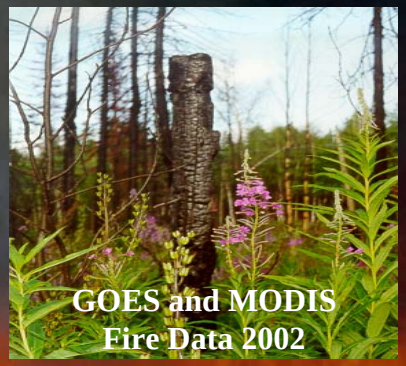
Data reported in km^2

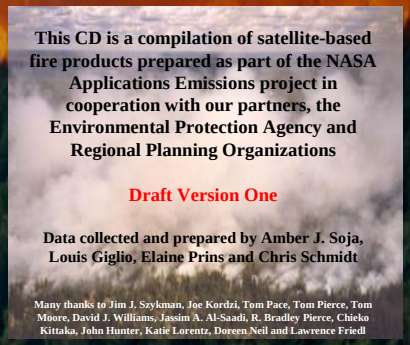
Total percent difference		
Oregon	all MODIS 225% > WRAP	38% of WRAP
Arizona	all MODIS 197% > WRAP	23% of WRAP

Total area captured by satellite-based area burned product:

Arizona - 81% of all fires (wildfire, prescribed and rangeland)
Oregon - 92% of all fires (wildfire, prescribed and agricultural)

Photo courtesy of Brian Stocks





Collaborations

NASA Langley and Goddard
NOAA
EPA
USDA Forest Service
NCAR

Departments of Environmental Quality
State and local agencies

Canadian Forest Service
Siberian Branch of the Russian Academy of Sciences, Sukachev

Air Sciences
SSAI
SAIC
MACTEC Engineering and Consulting, Inc.
Sonoma Technologies

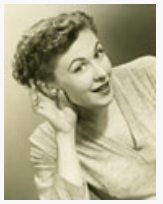
Regional Planning Organizations (RPO)
Central Regional Air Planning Association (CENRAP)
Midwest Regional Planning Organization (Midwest RPO)
Mid-Atlantic and Northeast Visibility Union (MANE-VU)
Visibility Improvement State and Tribal Association of the Southeast (VISTAS)
Western Regional Air Partnership (WRAP)

Field campaigns

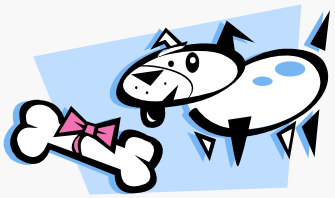
INTEX-NA A, INTEX-NA B, and TexAQS

Lesson learned from NASA Air Quality Applications project "Enhancing Biomass Emissions"

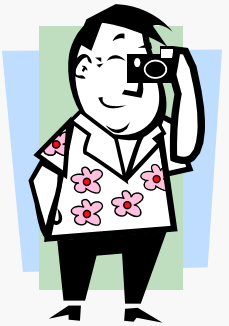
Listen to and understand the customer's needs.



Understand that it takes time to build trust with the customer and to demonstrate competency in the data, which is essential.

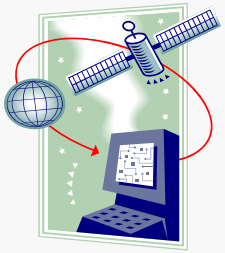


Focus on a tractable problem.



Expect and be prepared to explain data to people that have a wide range of skill, from the novice to the expert. The improved satellite product may need to be sold at many levels.

Learn the customer data and describe the benefits of the new satellite data in terms of the time-honored and trusted data source (i.e. improvements in space, time and monetary benefits)



Don't try to feed the customer with a fire hose.

Follow-up with the customers and follow through with the implementation of the data.