

RECOVER

Rehabilitation Capability Convergence for Ecosystem Recovery
A NASA/DOI National Wildland Fires Applied Sciences Project

John Schnase

Office of Computational and Information
Sciences and Technology
NASA Goddard Space Flight Center



Wildfire Physics

Wildfire spread

- Ground - spread by subterranean roots
- Surface - spread by leaf and timber litter
- Ladder - spread by vines and shrubs
- Crown - spread by canopy vegetation

Wildfire front

- Wood is dried as water is vaporized (212 °F)
- Wood pyrolysis releases flammable gasses (450 °F)
- Wood **smolders**, burns without flame (590 °F)*
- Wood **ignites**, burns with flame (1000 °F)*
- Flame warms air on leading edge of front (>1500 °F)
- Process feeds forward ...

Wildfire forward rate of speed (FROS)

- ~6.7 mph in forests
- ~14 mph in grasslands
- with flaking, backing, jumping ...

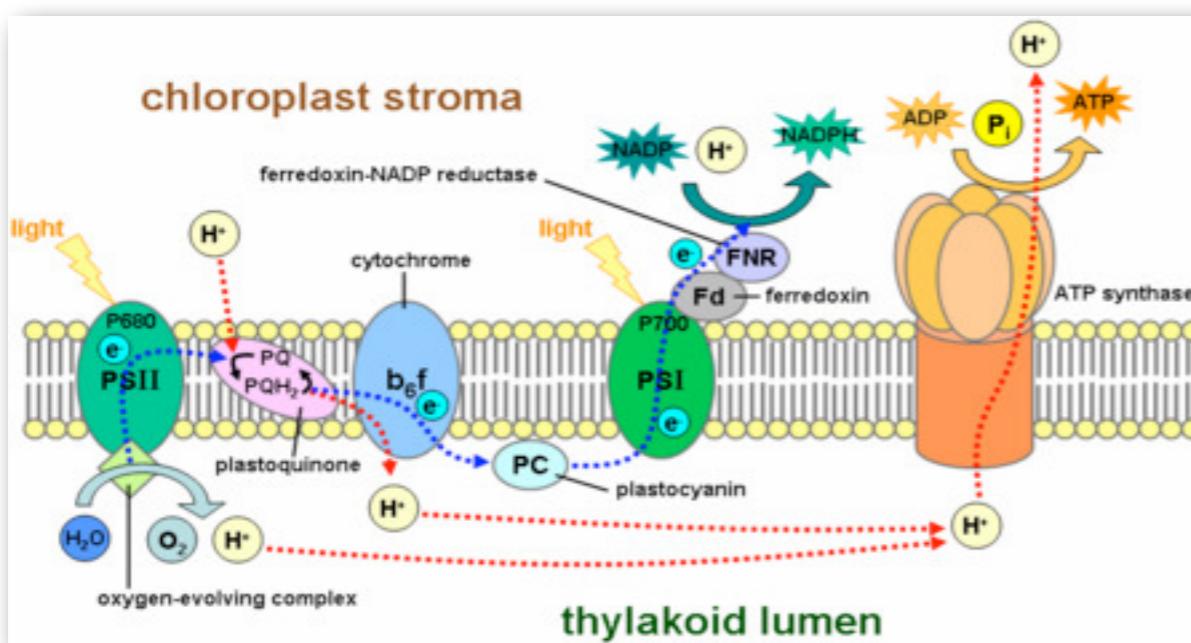
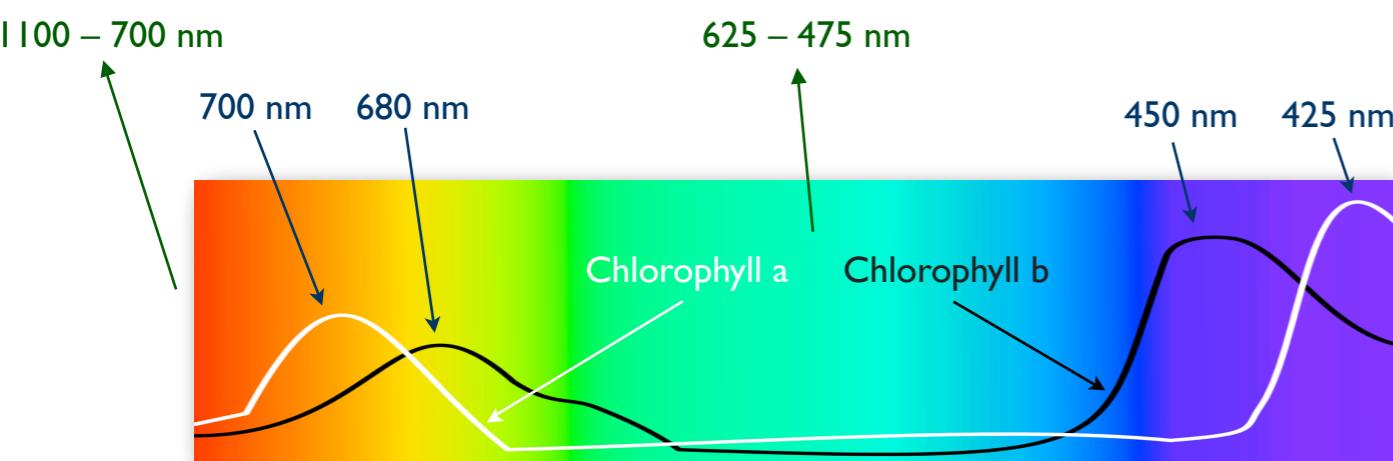




Plant Physiology

Chlorophyll ...

- Absorption** – Yellow/red and blue/violet (visible)
- Reflectance** – Green (visible) and near infrared (invisible)

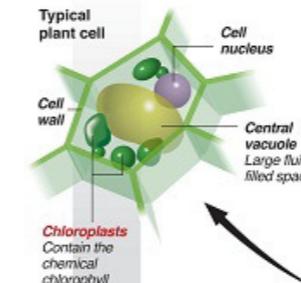


Photosynthesis

When you get hungry, you might decide to raid the cookie jar or ask your mom to make you a sandwich. You do this because humans and animals get energy from the foods they eat.

1 SUNLIGHT

Light shining down from the sun is absorbed by the plant's cells. These tiny cells are what make up the plant and its leaves.



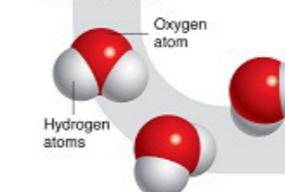
2 CHLOROPHYLL

Inside some of these cells is a special ingredient called chlorophyll. This is the compound that traps the sun's light to start the process of photosynthesis.

3 WATER

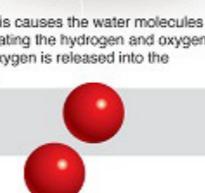
Water and carbon dioxide are two of the main ingredients for photosynthesis. These two substances are made of many smaller parts called molecules.

Water molecules



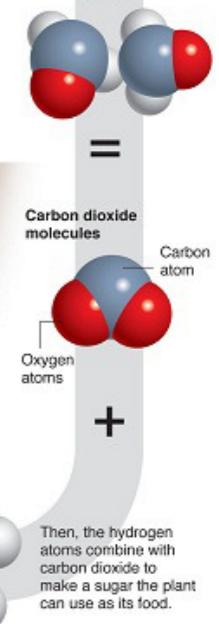
Photosynthesis causes the water molecules to split, separating the hydrogen and oxygen atoms. The oxygen is released into the atmosphere.

OXYGEN!



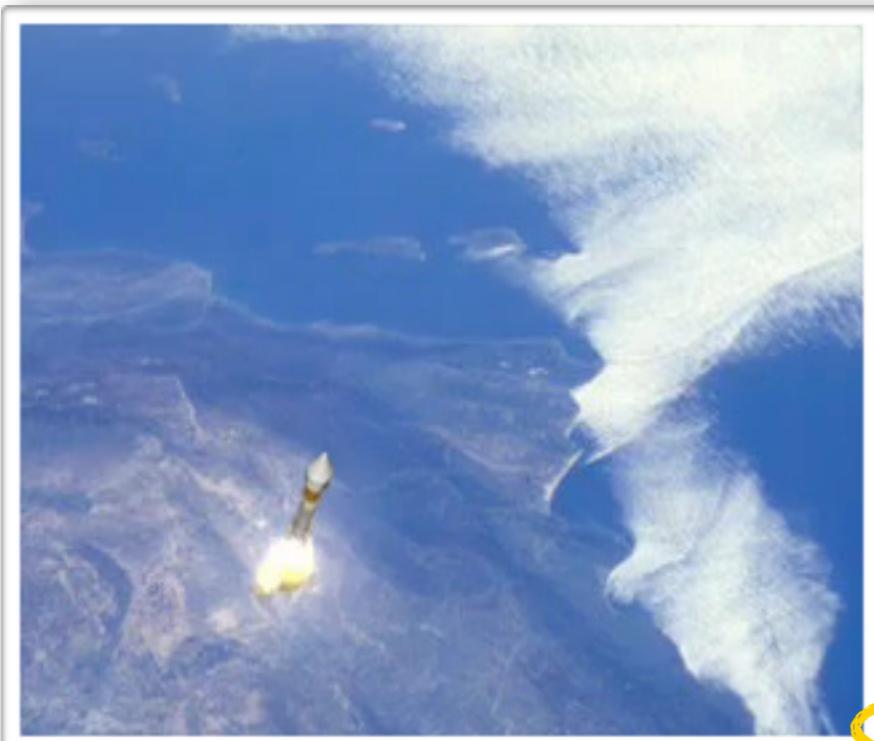
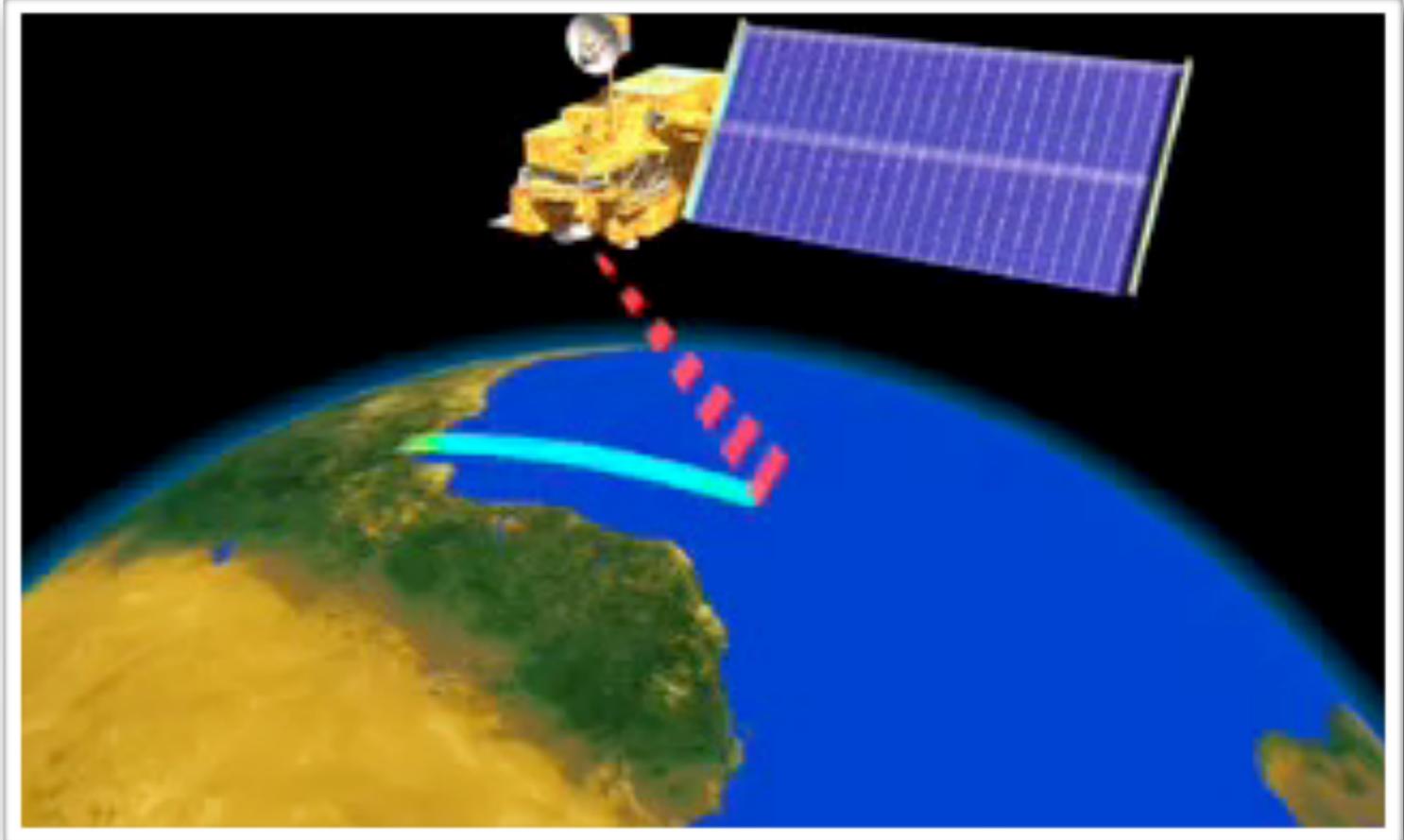
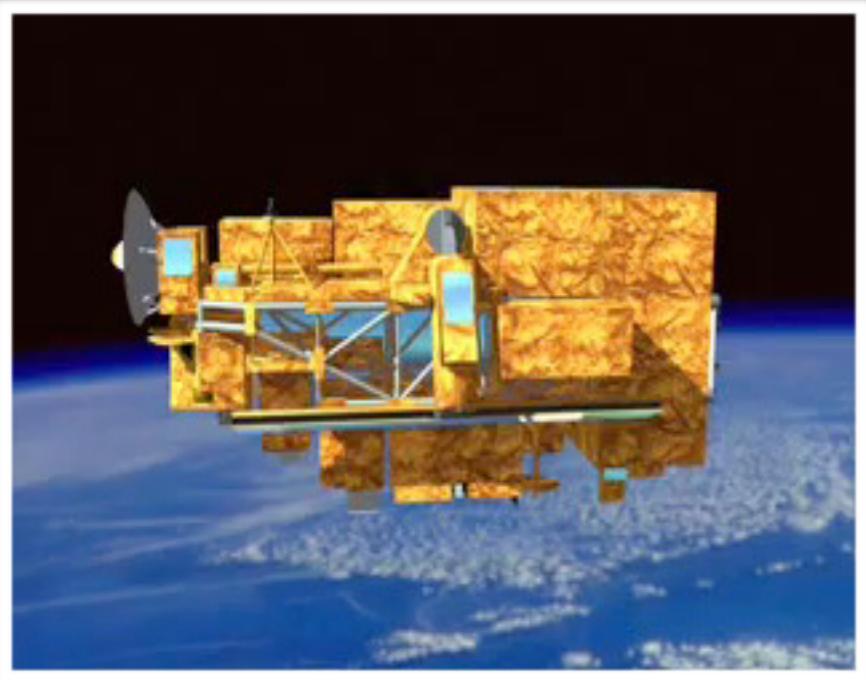
4 END RESULT

The sugar created by photosynthesis is sent to the rest of the plant for food.



Sources: BBC, Science aid, University of Arizona

MODIS – A Spatiotemporal Technology for "Geotagging" Electromagnetic Radiation at a Global Scale ...

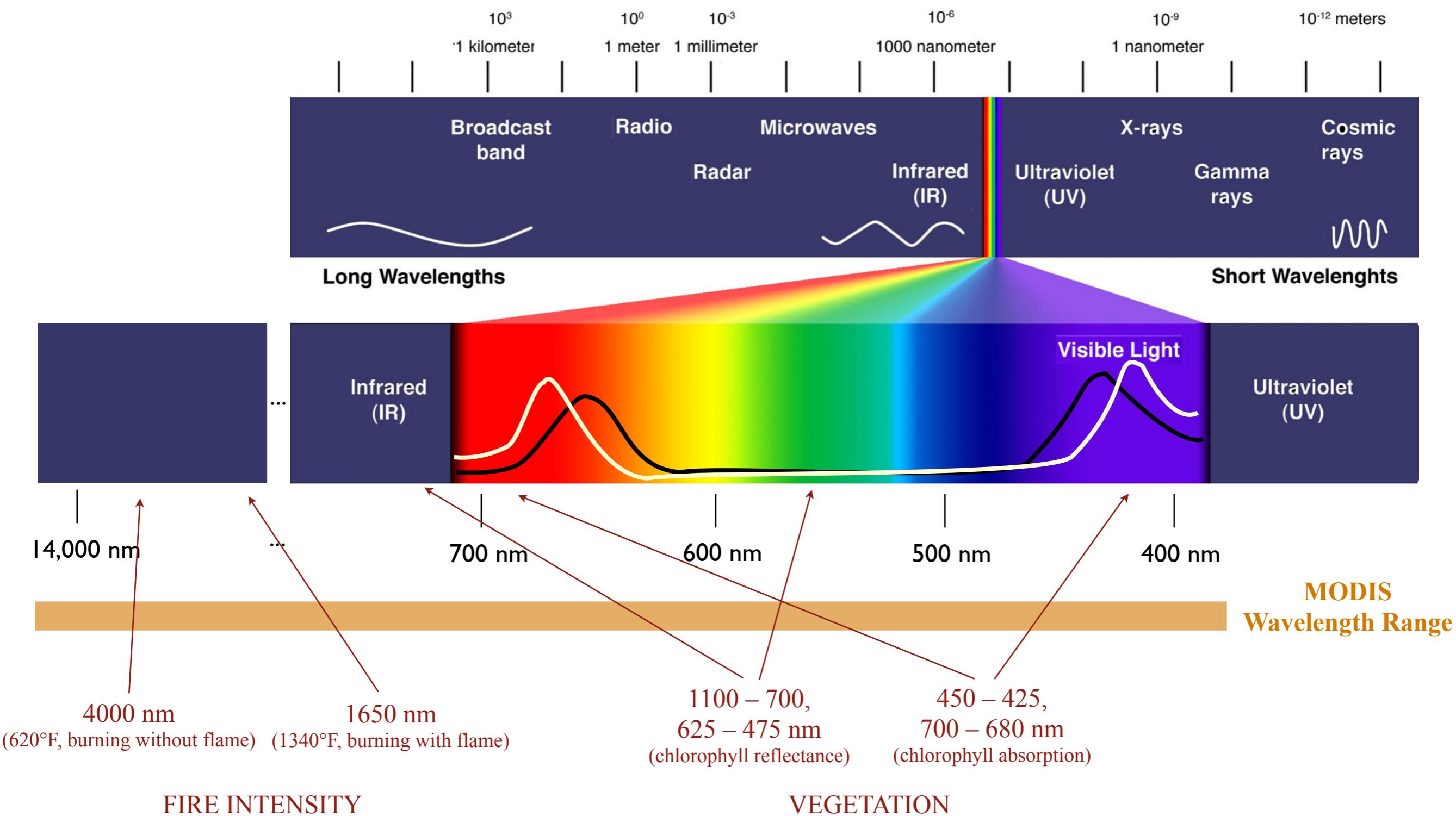


Moderate Resolution Imaging Spectroradiometer

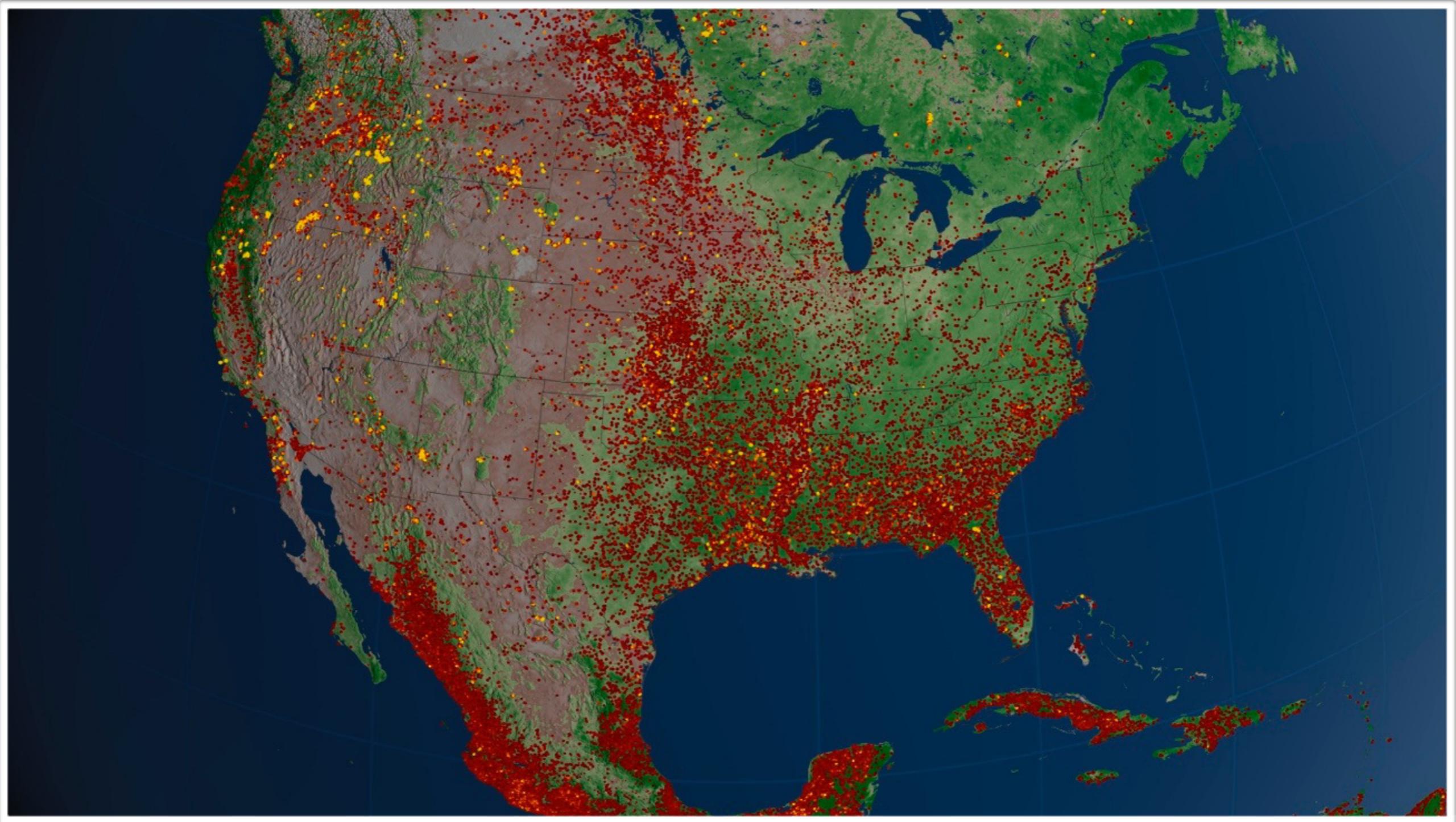
- Key instrument on Terra and Aqua satellites.
- Launched in 1999 (Terra) and 2002 (Aqua), orbit at 705 km.
- Scans the earth every 1-2 days, swath width is 2330 km.
- 36 spectral bands, range in wavelengths from 400 nm to 14,400 nm.
- Resolution 250, 500, and 1000 m².

In other words, a measurement of the electromagnetic radiation at each pixel location is geotagged at least every two days ...

MODIS – A Spatiotemporal Technology for "Geotagging" Electromagnetic Radiation at a Global Scale ...



MODIS – Fire Intensity and Vegetation – 2012



Vegetation (NDVI)



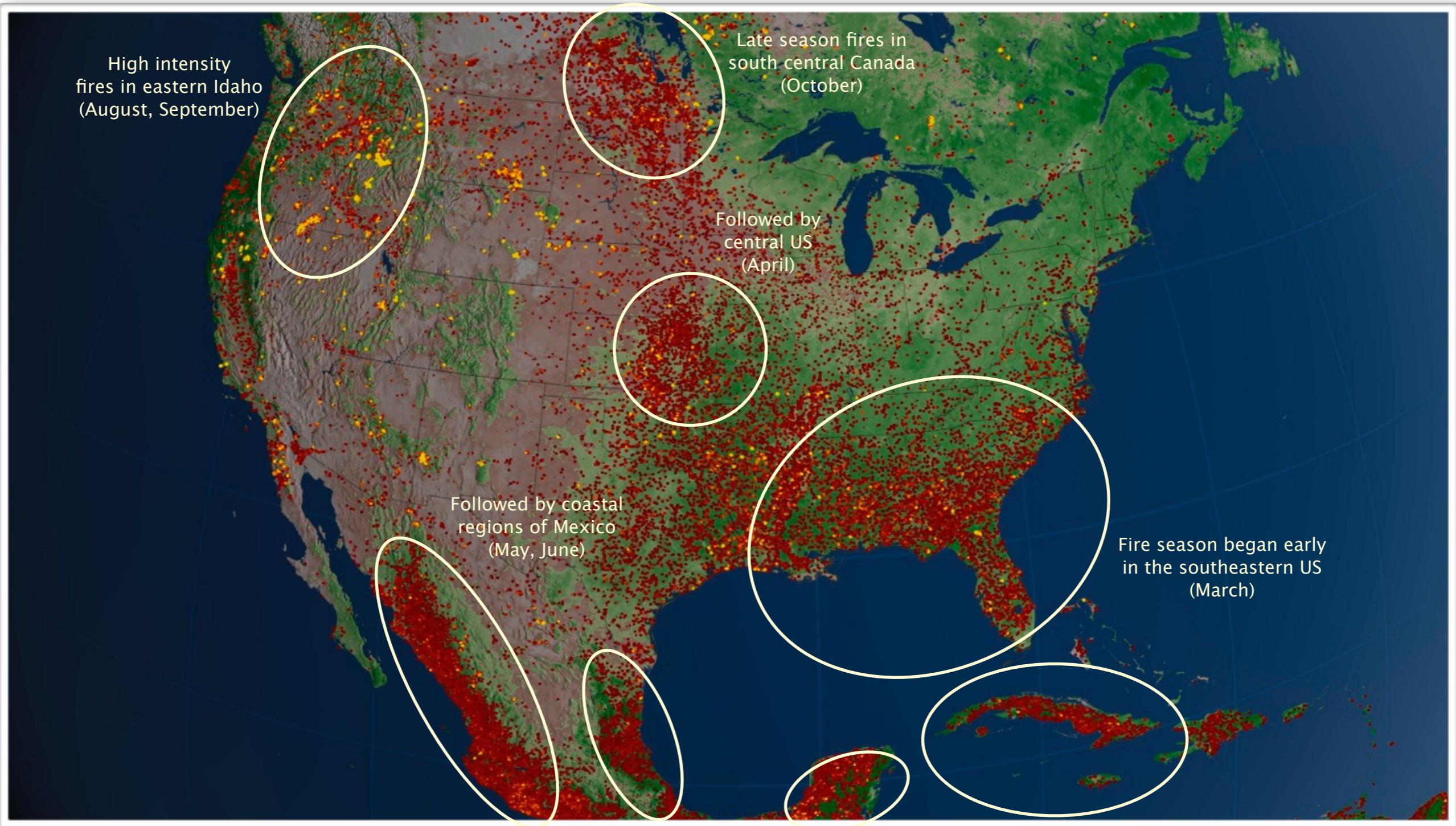
Fire Intensity



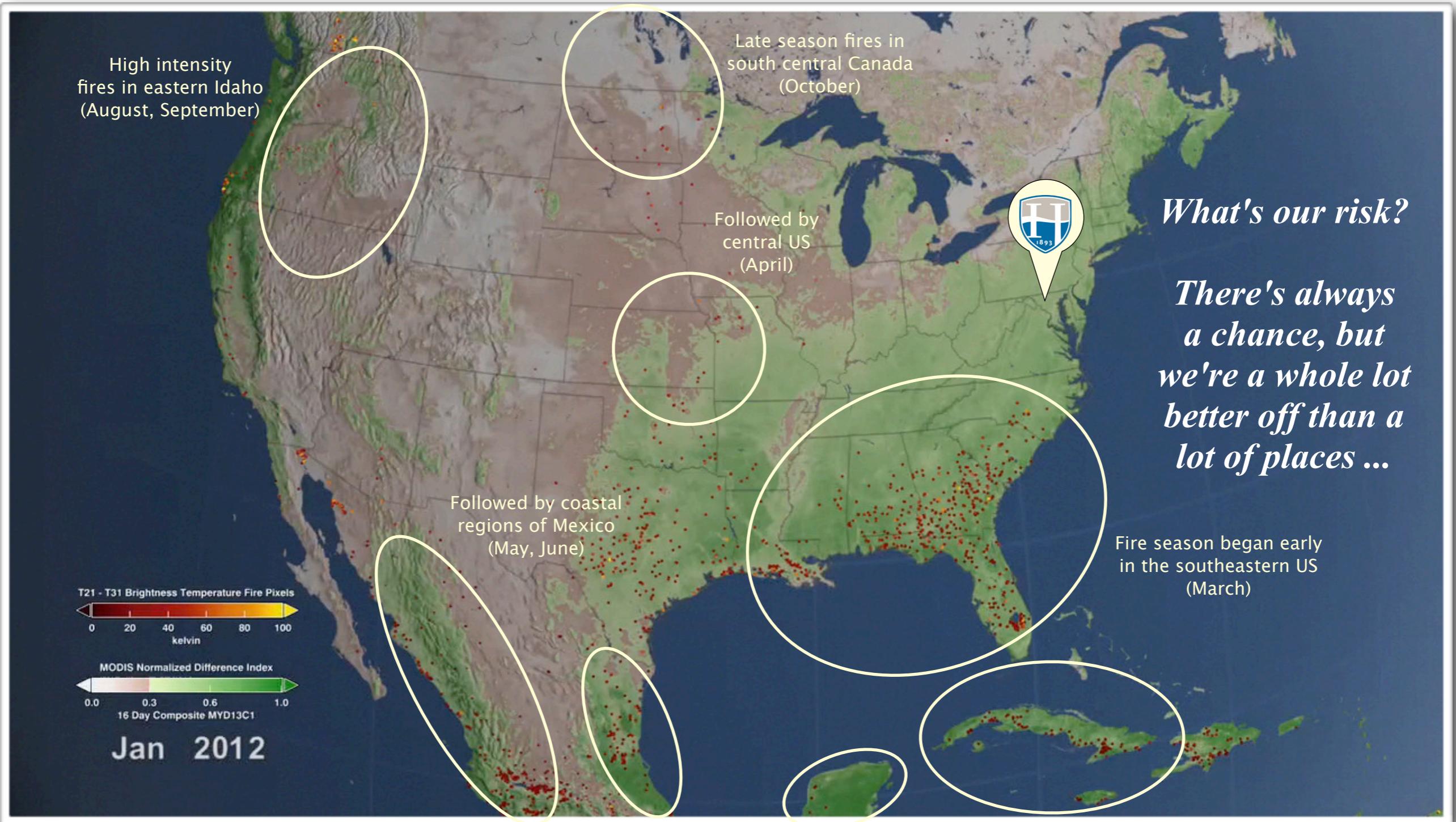
MODIS – Fire Intensity and Vegetation – 2012



MODIS – Fire Intensity and Vegetation – 2012



MODIS – Fire Intensity and Vegetation – 2012



Wildfire Response

- The National Interagency Fire Center (NIFC), located in Boise, Idaho, is the nation's support center for wildland firefighting.
- Eight different agencies and organizations are part of NIFC: USFS, BLM, NWS, NPS, BIA, USFS, US Fire Administration, & FEMA.
- Decisions are made using the interagency cooperation concept because NIFC has no single director or manager.

The screenshot shows the homepage of the National Interagency Fire Center (NIFC) website. The header features a large image of a charred tree trunk with green pine branches on the right. Below the image, the text "NATIONAL INTERAGENCY FIRE CENTER" is displayed, with "FIRE CENTER" in large, bold, yellow letters. A navigation menu bar below the header includes links for Aviation, Communications, Fire Information, Fire Shelters, NICC, Policies, Prevention/Education, Programs, Safety, and Training. The "Communications" link is highlighted in yellow. The main content area on the left contains a photograph of a red and white helicopter landing on a riverbank, with the caption "Springs Fire, Idaho" and "Credit: Boise National Forest". To the right of the image, a section titled "Welcome to the Nation's Logistical Support Center" provides information about NIFC's mission and history. Another section, "Current Fire Season Outlook", discusses fire potential for November through February. A "History" section details the center's evolution from the Boise Interagency Fire Center to its current name. On the far right, a sidebar titled "In the Spotlight" lists various resources and social media links. At the bottom of the page, there is a QR code, the website URL "www.nifc.gov", and contact information for the National Interagency Fire Center.

Wildfire Response

- After a major wildfire, law requires that the federal land management agencies certify a comprehensive plan for public safety, burned area stabilization, resource protection, and site recovery.
- These BAER plans are due within 14 days of containment of a major wildfire and become the guiding document for managing the activities and budgets for all subsequent remediation efforts.
- There are few instances in the federal government where plans of such wide-ranging scope are assembled on such short notice and translated into action more quickly.
- Post-fire rehabilitation planning is a data-intensive process and requires better access to new types of data products ...

<http://video.nationalgeographic.com/video/environment/environment-natural-disasters/landslides-and-more/wildfire-research/>

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

United States
Department of the Interior
Bureau of Land Management

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

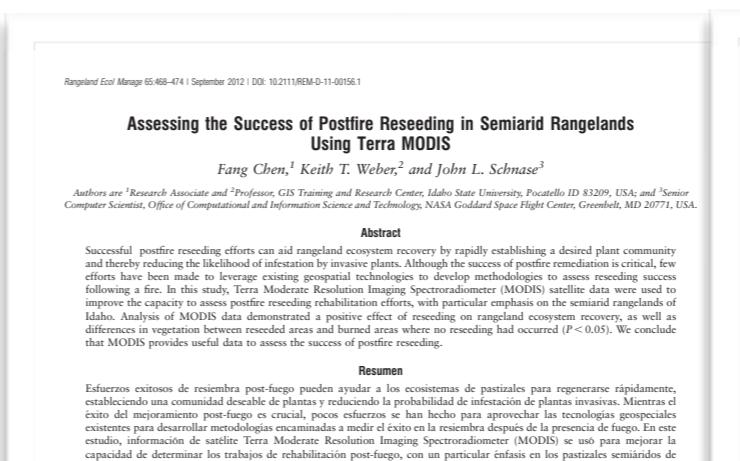
BURNED AREA EMERGENCY STABILIZATION and REHABILITATION



BLM Handbook H-1742-1

The RECOVER Project

- Goal is to build an automated decision support system for post-fire rehabilitation planning.
- Focus is on savanna ecosystems of the Western US.
- Funded by NASA's Applied Sciences Program.
- Outgrowth of NASA-sponsored research on post-fire assessment and monitoring and decision support application development.
- Interagency Collaboration:
 - Idaho State University's GIS Training and Research Center (GIS TReC)
 - NASA Goddard Space Flight Center (GSFC)
 - DOI Bureau of Land Management (BLM)
 - Idaho Department of Lands (IDL).
- Stage 1 - Feasibility Study.
- Stage 2 - Operational Deployment.

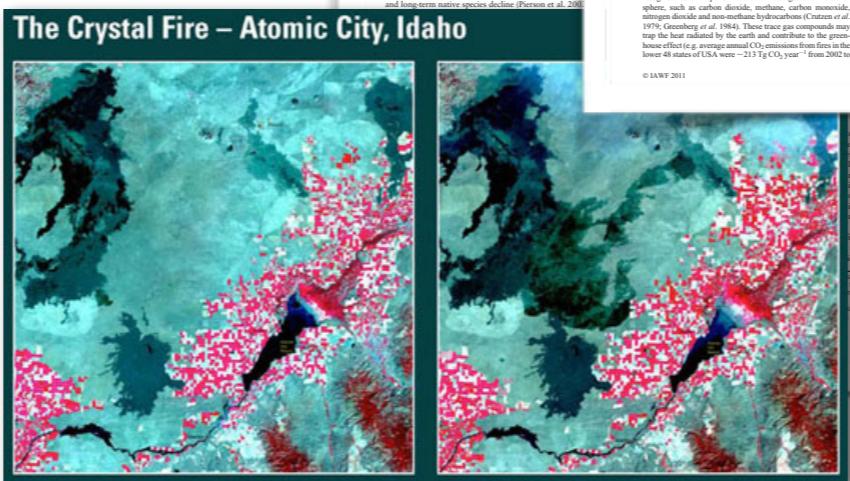


RECOVER: Rehabilitation Capability Convergence for Ecosystem Recovery

An Automated Burned Area Emergency Response Decision Support System for Post-fire Rehabilitation Management of Savanna Ecosystems in the Western US

Keith T. Weber
GIS Training and Research Center
Idaho State University

John L. Schnase^{1,2}, Molly E. Brown³, and Mark Carroll³
¹Office of Computational and Information Science and Technology,
²NASA Center for Climate Simulation, and ³Biospheric Sciences Branch
NASA Goddard Space Flight Center



In the aftermath of Interior's Bureau of Land Management (BLM), we propose to build RECOVER decision support system. RECOVER will be an automatically criteria decision aid that brings together in a single application the BAER teams to plan reseeding strategies

uses-of-the-art cloud-based data management technologies to improve site-specific flexibility for each fire. Customized RECOVER will be deployed in the Amazon EC2 Cloud when a fire is detected. RECOVER's will be assembled from the existing network of data resources. RECOVER refresh derived fire severity, fire intensity, and other products throughout contained, BAER teams will have at hand a complete and ready-to-use for the target wildfire. Since BAER remediation plans must be completed attainment, RECOVER has the potential to significantly improve the

focuses on forest wildfires. RECOVER adds an important new dimension

on ecosystem rehabilitation in semiarid savannas. A novel

involves the use of soil moisture estimates, which are an important but

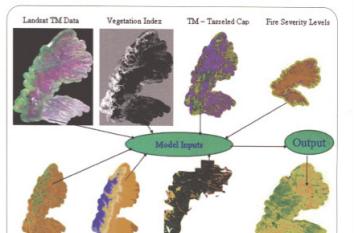
post-fire rehabilitation planning. We will use downscaled soil moisture data

sources currently available to begin evaluating the use of soil

The National Invasive Species Forecasting System:

A Strategic NASA/USGS Partnership to Manage Biological Invasions

By John L. Schnase, Thomas J. Stohlgren and James A. Smith



Non-indigenous invasive species pose a significant threat to the United States. The 21st century's single most formidable threat of non-native species is the introduction of non-native species that have been increasing into all U.S. ecosystems. A growing number of these species are becoming invasive and threatening to declines in native species and to changes in ecosystem function. The total economic cost of non-native species in the United States is estimated at \$100-200 billion per year, including all other natural disasters combined.

Non-native species are often introduced into the environment via无意的引入 (e.g., through trade or commerce) or有意的引入 (e.g., through agriculture or horticulture). The introduction of these species can have a variety of ecological effects on rangeland ecosystem balance, with the most obvious effect being direct impact on vegetation communities (Brennan and de Wit 1983; Huntingford and Hopkins 1993). In a wildland fire, fuel is composed nearly entirely of vegetation and severe fires can leave entire landscapes devoid of vegetation. These fires can have both immediate ecological and hydrologic hazards (Peterson et al. 2002; Hiltz et al. 2004; Collman et al. 2006). In addition, biomass burning is a major source of greenhouse gases into the atmosphere, such as carbon dioxide, methane, carbon monoxide, nitrogen dioxide and non-methane hydrocarbons (Crutzen et al. 1979; Gerstel et al. 2004). The amount of CO₂ emitted by a single fire event (e.g. average annual CO₂ emissions from fires in the lower 48 states of USA were ~21.1 g CO₂ year⁻¹ from 2002 to 2009. Furthermore, following a fire, vegetation communities may transition to a different community type due to invasions by non-native species, resulting in a variety of propagated ecological changes. For example, the introduction of cheatgrass (Bromus tectorum) and Medusahead (Taeniatherum caput-medusae) and long-term native species decline (Peterson et al. 2002; Hiltz et al. 2004; Collman et al. 2006; Weber et al. 2008). These studies include both observational and modeled data and demonstrate that non-native species are becoming increasingly dominant in many areas of the western United States.

Landat TM Data, Vegetation Index, TM - Tasseled Cap, Fire Severity Levels, Model Inputs, Model, Output, Derived Slope, Elevation, Vegetation Cover Type, Spatial Statistical Map.

Recently, federal data plays a critical role in dealing with the problem of invasive species.

NASA currently provides measurements from Terra, Landat 7, Quickbird, Ikonos, and other sensors that map key ecosystem attributes required to prevent species introductions. Future missions will expand these measurements to include critical three-dimensional structure.

These measurements will support the National Research Council's Committee on Grand Challenges in Environmental Sciences identified increased understanding of biodiversity and ecosystem functioning as one of eight "Grand Challenges in Environmental Science" that face our nation and the world today. The committee also emphasized the need for improved environmental monitoring and ecological forecasting capability for non-native invasive species.

NASA and the U.S. Geological Survey (USGS) are joining forces to develop a national invasive species forecast system. This system will provide timely information and shared expertise will result in a National Invasive Species Forecasting System for the management and control of invasive species.

© John L. Schnase, Thomas J. Stohlgren and James A. Smith

DOI 10.1071/WF10001 1049-8901/11/050690

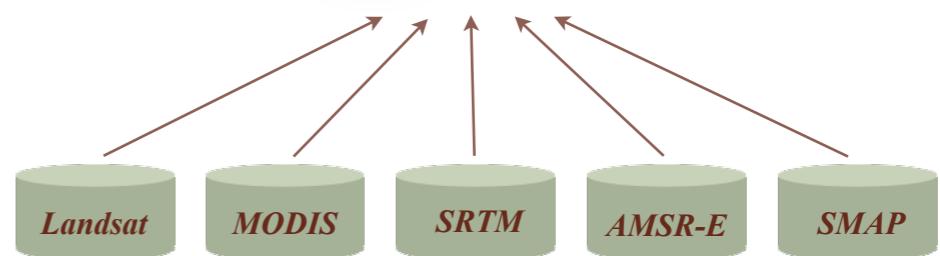
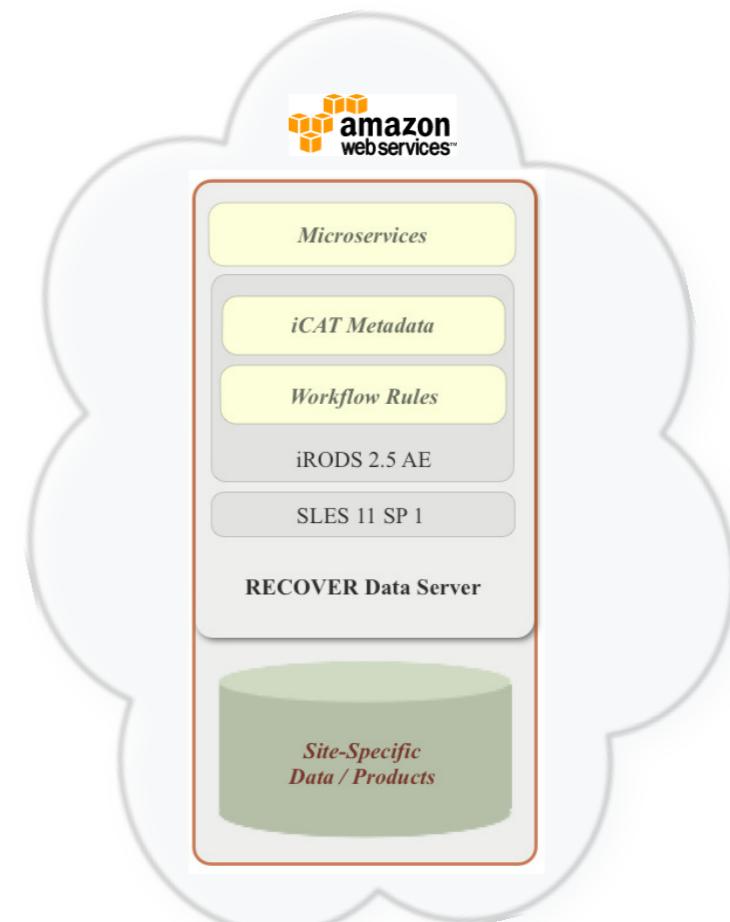
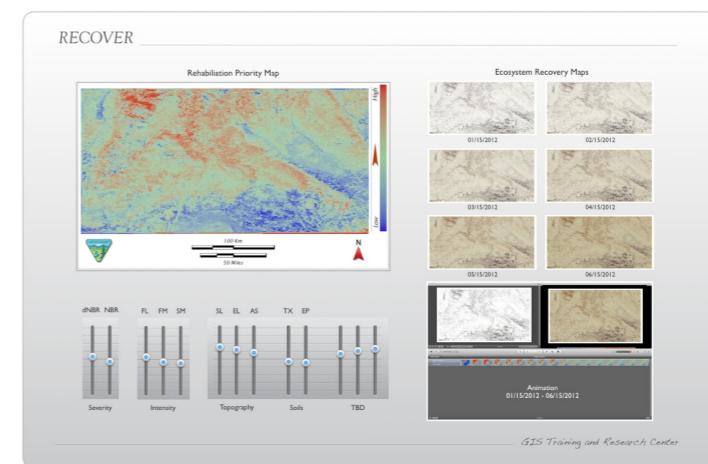
The RECOVER System

- RECOVER brings together in a single application the information necessary for BAER team post-fire rehabilitation decision-making and long-term ecosystem recovery monitoring.
- RECOVER is a web mapping application and multi-criteria decision aid that integrates information about fire severity and intensity with other types of data to help BAER teams plan reseeding strategies in the aftermath of savanna wildfires.
- Major system components:
 1. RECOVER Clients - Desktop and mobile interfaces that are able to connect to the RECOVER Server.
 2. RECOVER Server - A cloud-based data management system that automatically aggregates site-specific data from a distributed collection of relevant web-accessible resources.

GIS TReC leading client-side development

GIS TReC, BLM, IDL, and NASA together are identifying important data sets, workflows, and decision products ...

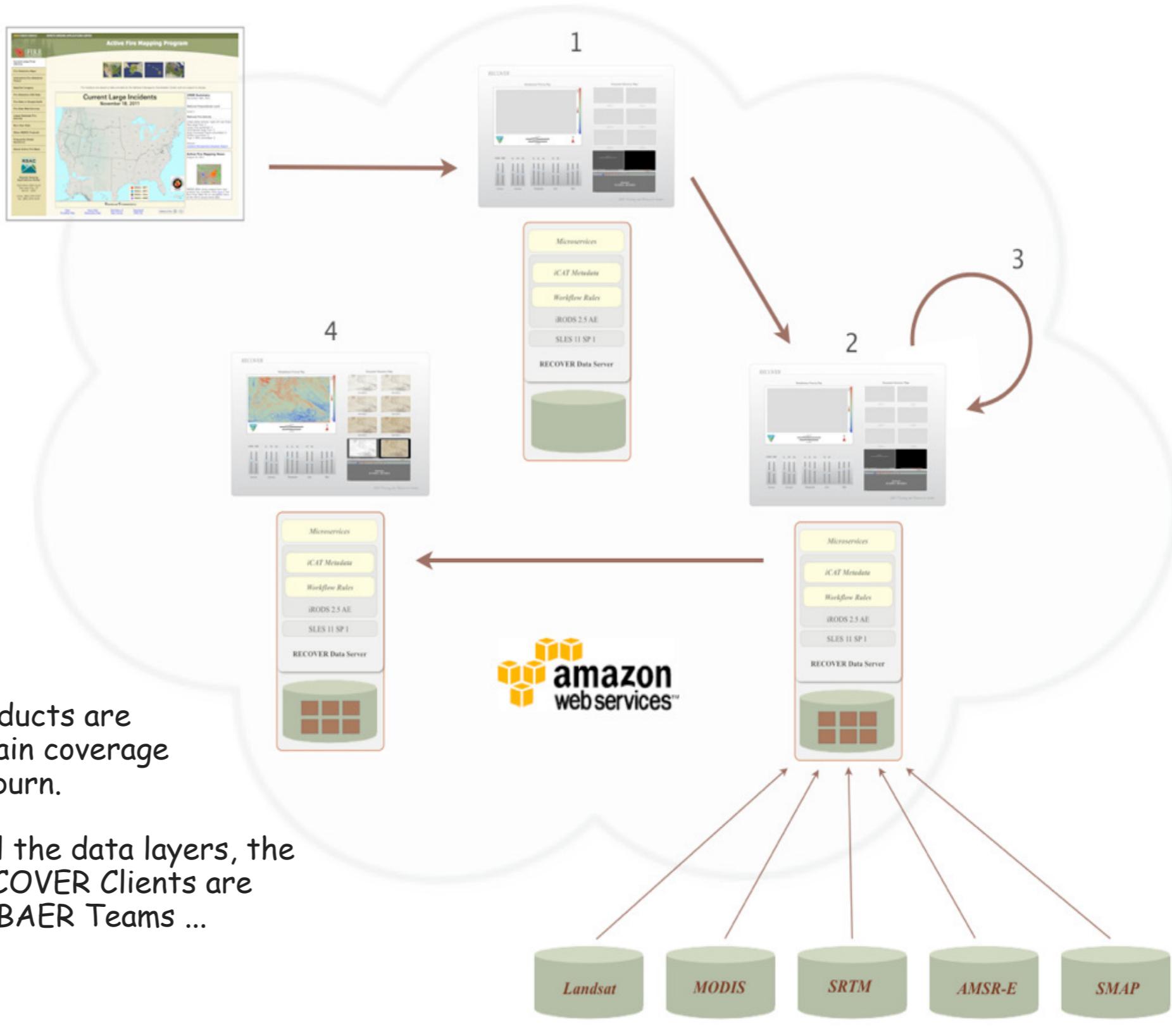
NASA leading server-side development



The RECOVER System

The typical RECOVER use scenario goes as follows:

1. A request containing the wildfire name and spatial extent is sent to the RECOVER Server.
2. The RECOVER server connects through web services to various data resources and automatically collects tailored, site-specific data and derived products.
3. These staged, aggregated products are refreshed as needed to maintain coverage and currency throughout the burn.
4. When the fire is contained, all the data layers, the RECOVER Server, and the RECOVER Clients are immediately ready for use by BAER Teams ...



The RECOVER Server

- Uses iRODS data grid software to manage site-specific data and metadata.

iRODS = Integrated Rule-Oriented Data System

Background

- Open source data grid software system.
- Developed by the Data Intensive Cyber Environments (DICE) group, University of North Carolina.
- Historic roots in data grids, digital libraries, persistent archives, and real-time data systems R&D, and SRB.

Features

- Targets large repositories, large data objects, digital preservation, and integrated complex processing.
- Supports server-side workflows implemented by chaining execution rules together based on data policies.
- Enables scalability and extensibility.

Major Concepts

- Policies => iRODS rules.
- Mechanisms => iRODS microservices.

With iRODS metadata providing the information necessary to perform these mappings

Sign on to the RECOVER Server

Account Information

Host/IP : Port :

Username:

Password:

Zone:

RECOVER V0.1 Beta Test / Experimental Prototype

www.irods.org

www.irods.org

iRODS

project page **discussion** **view source** **history** **Log in | Create account**

iRODS Independent Evaluations

INDEPENDENT EVALUATIONS OF iRODS:

- NASA's JPL Jet Propulsion Laboratory (JPL) Evaluation posted online for iRODS versions 1.1 and 2.0 for use in their large-scale NASA Planetary Data System. [Read more](#) - [Full Online Report](#)
- NASA Goddard

Evaluation of iRODS Dan Duffy, NASA Center for Computational Sciences, March 2009.

iRODS WORKSHOP: A February, 2009 workshop at CCIN2P3 in Lyon, France brought together researchers new to iRODS with others already using iRODS in a range different applications. The Workshop Agenda is online along with presentations that provide a wide range of use cases and other information about iRODS.

iRODS™, the Integrated Rule-Oriented Data System, is a data grid software system developed by the Data Intensive Cyber Environments (DICE) group (developers of the SRB, the Storage Resource Broker), and others. The iRODS system provides a framework for the development and use of advanced research in advanced technologies for managing, sharing, publishing, and preserving digital data, the group is based at the School of Information and Library Science and the Renaissance Computing Institute (RENCI) at the University of North Carolina at Chapel Hill, and the Institute for Neural Computation at the University of California, San Diego. Development of the core iRODS data grid system is funded by the National Science Foundation and the National Archives and Records Administration, with a growing open source iRODS community participating in development worldwide. For more information see the DICE website.

What is iRODS?

A Quick Overview of iRODS | Micro-Services | Attributes | Actions | Rules | Rule Engine | Execution Modes | Rule Classes | Semantics

DICE Website with Overviews of iRODS & Nonprofit Foundation | DICE Center People

iRODS 2.0.1 Released January 26, 2009

Documentation

FAQ | Installation | Release Notes | Publications | News Articles | iRODS Glossary

iRODS Development Information

Release Notes | Extensions | Contributed Software | Wish List | iRODS Roadmap

Performance and Testing

TinderBox at DICE | Performance | Testing | Independent Evaluations

Contact us

iROD-Chat discussion list | Subscribe to iROD-Chat list | Email: irods@irods.org | Bug Tracking: [Bugzilla](#)

Collaborators

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL  This page was last modified 23:52, 15 April 2009.
This page has been accessed 59,869 times.



The RECOVER Server

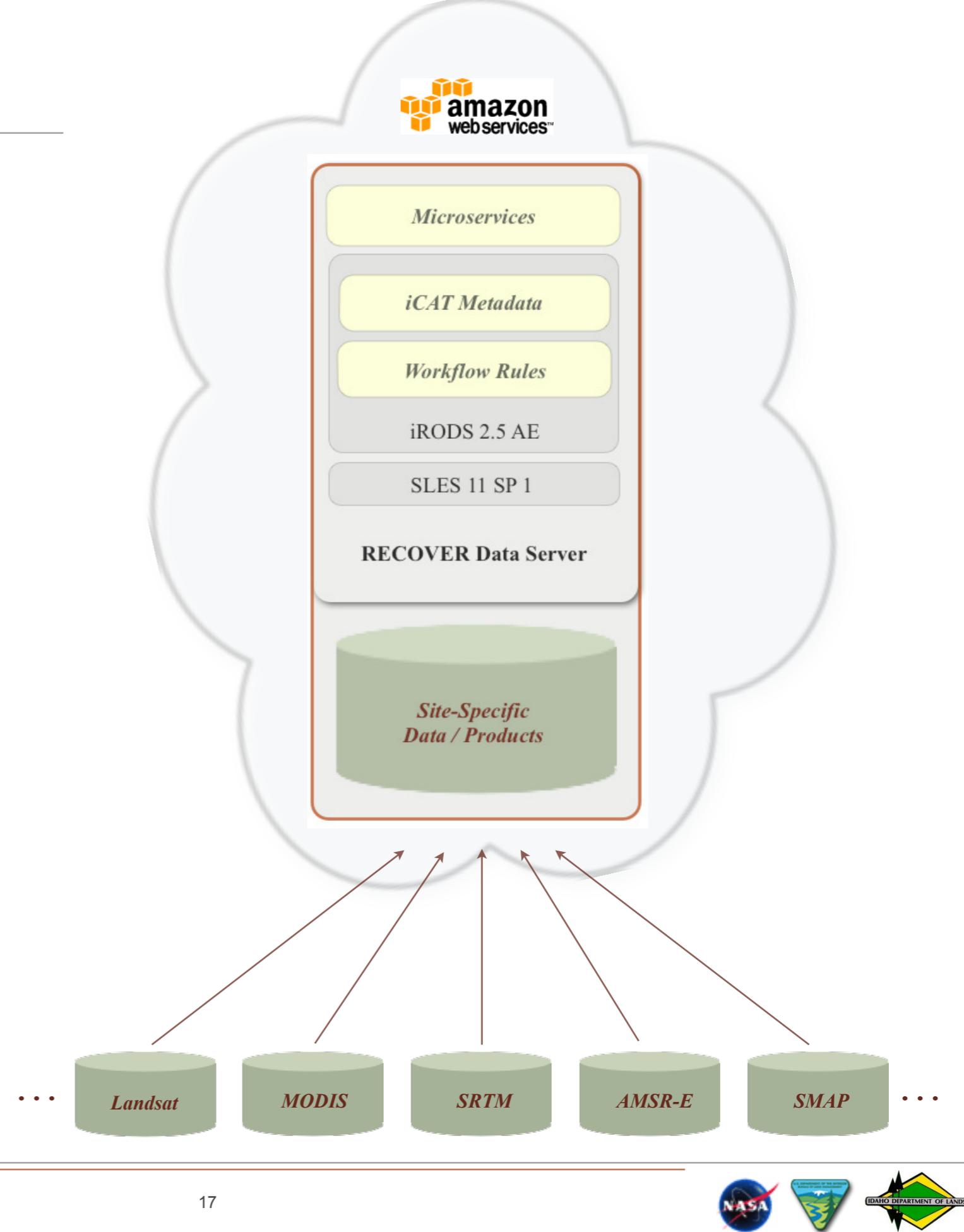
- Is deployed in the Amazon Elastic Compute Cloud (EC2).
- Assembles and manages a variety of data:

Step 1: Core Data Sets (Automatically Assembled)

Normalized Burn Ratio (NBR)
Normalized Difference Vegetation Index (NDVI)
Fraction of Photosynthetically Active Radiation (fPAR)
Net Primary Production (NPP)
Topography Aspect (TA)
Topography Elevation (TE)
Topography Slope (TS)
Soil Texture (ST)
Soil K Factor (SKF)
Biophysical Setting (BPS)
Geology (GEO)
Existing Vegetation Cover (EVC)
Existing Vegetation Type (EVT)
Environmental Type Potential (ETP)

Step 2: Derived / Ancillary (Collected and Added Manually)

Difference in Normalized Burn Ratio (dNBR)
Fire Severity (FS)
Fire Intensity (FI)
Fire Regime Condition Class (FRCC)
FRCC Percent Departure (dFRCC)
Historic Fires 1936-2012 (H0)
Historic Fires 2002-2012 (H1)



The RECOVER Server

- Is deployed in the Amazon Elastic Compute Cloud (EC2).
- Assembles and manages a variety of data:

Step 3 Data - Short-Term DSS Products

Rehabilitation Priority Maps (RPMs)

[Derived product composed of Step 1 and Step 2 inputs.]

Step 4 Data - Long-Term DSS Products

Ecosystem Recovery Maps (ERMs)

[Derived product composed of periodic fPAR measurements.]

Experimental Data Sets

Evapotranspiration (modisET) <= Placeholder for SMAP Data

Soil Moisture (amsreSM)

Soil Moisture (smapSM)

Historic Temperature (merraHT)

<= Placeholder for MERRA Reanalysis Data

Historic Precipitation (merraHP)

Historic Temperature (ecmwfHT)

Historic Precipitation (ecmwfHP)

Historic Temperature (ncepHT)

Historic Precipitation (ncepHP)

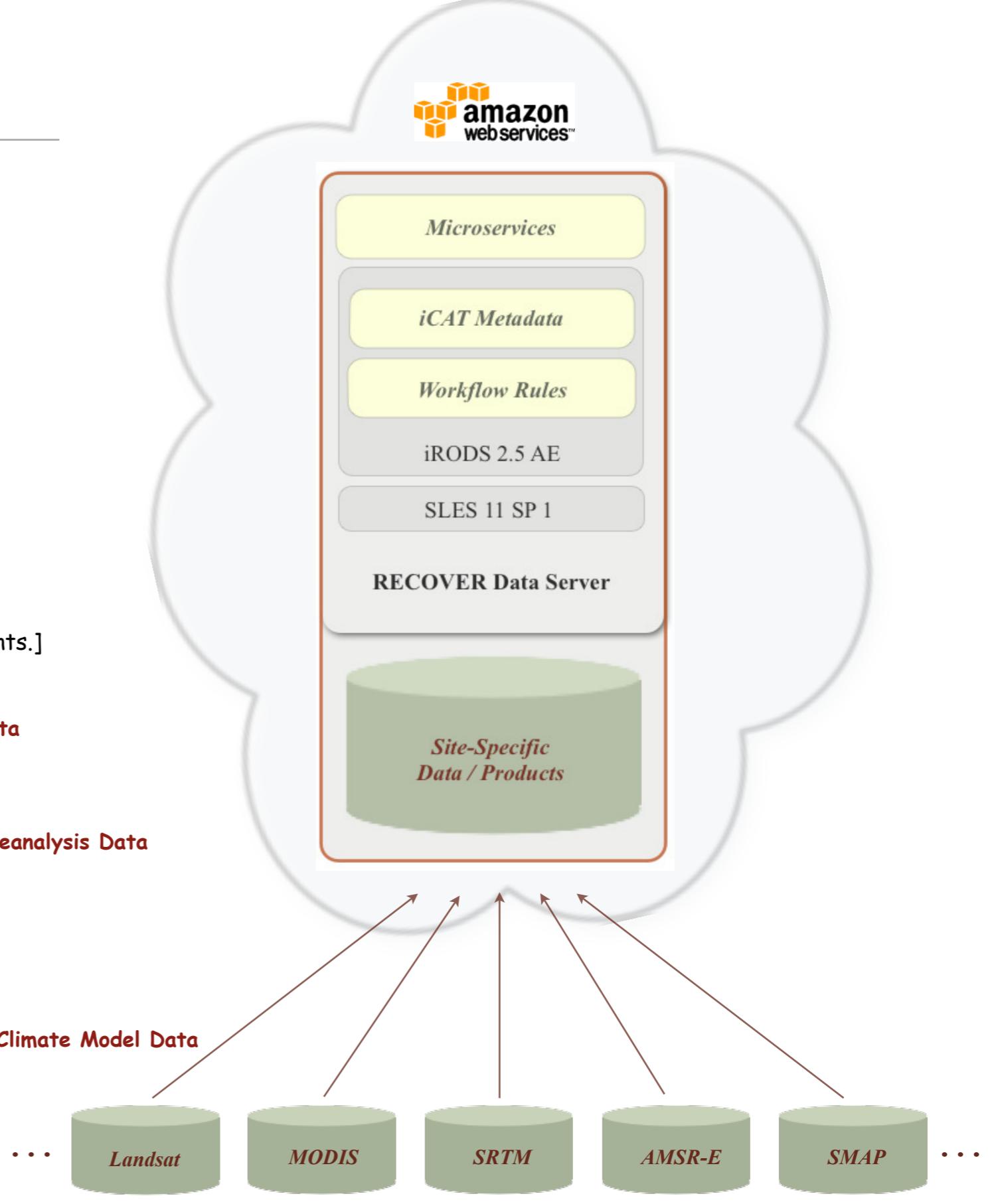
Future Temperature (goes5FT)

<= Placeholder for GEOS-5 Climate Model Data

Future Precipitation (goes5FP)

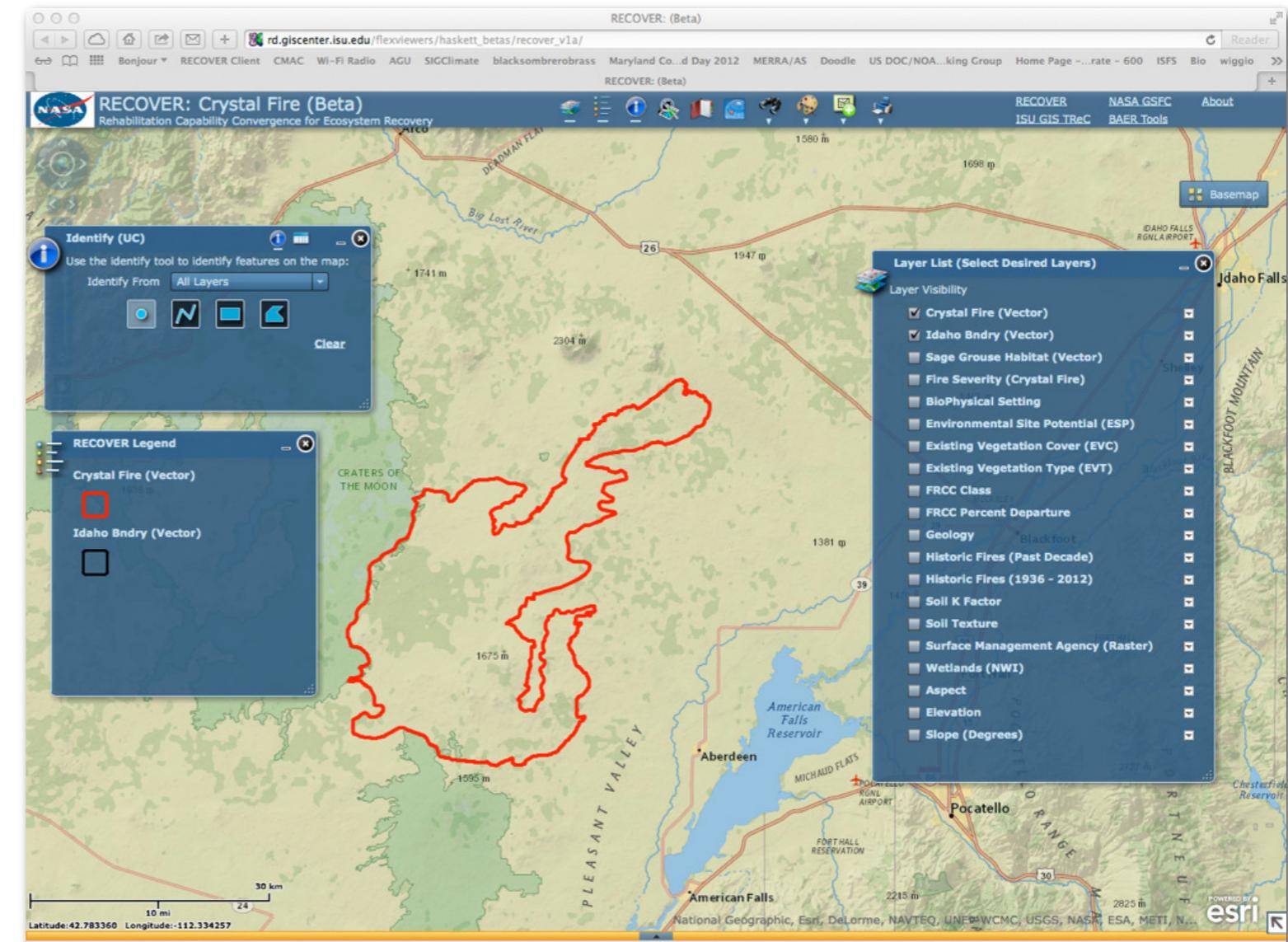
Future Temperature (modeleFT)

Future Precipitation (modeleFP)



The RECOVER Client

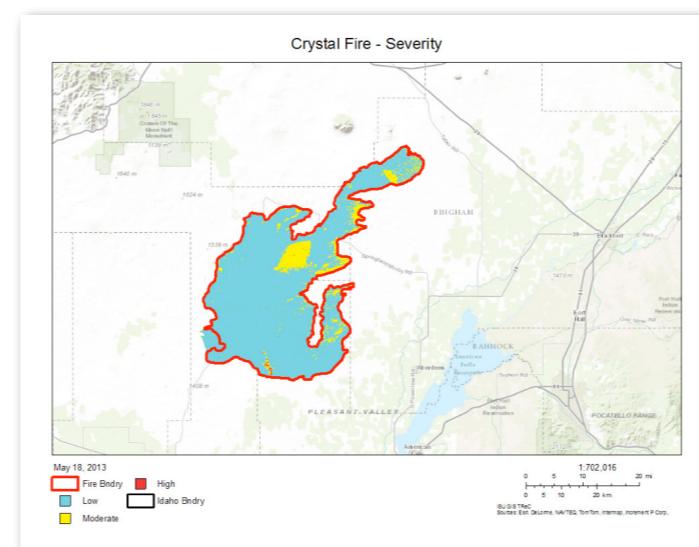
- Adobe Flex Web Mapping Application
 - Connects to the RECOVER Server through a web services interface. (Eventually - right now we just use iDrop.)
 - Allows site-specific data layers to be viewed and interrogated in a variety of ways.
 - Accommodates a wide range of base layers.
 - Additional information to aid in analysis can be uploaded through the RECOVER Client.
 - Professional, high-quality, high-resolution maps can be easily generated.



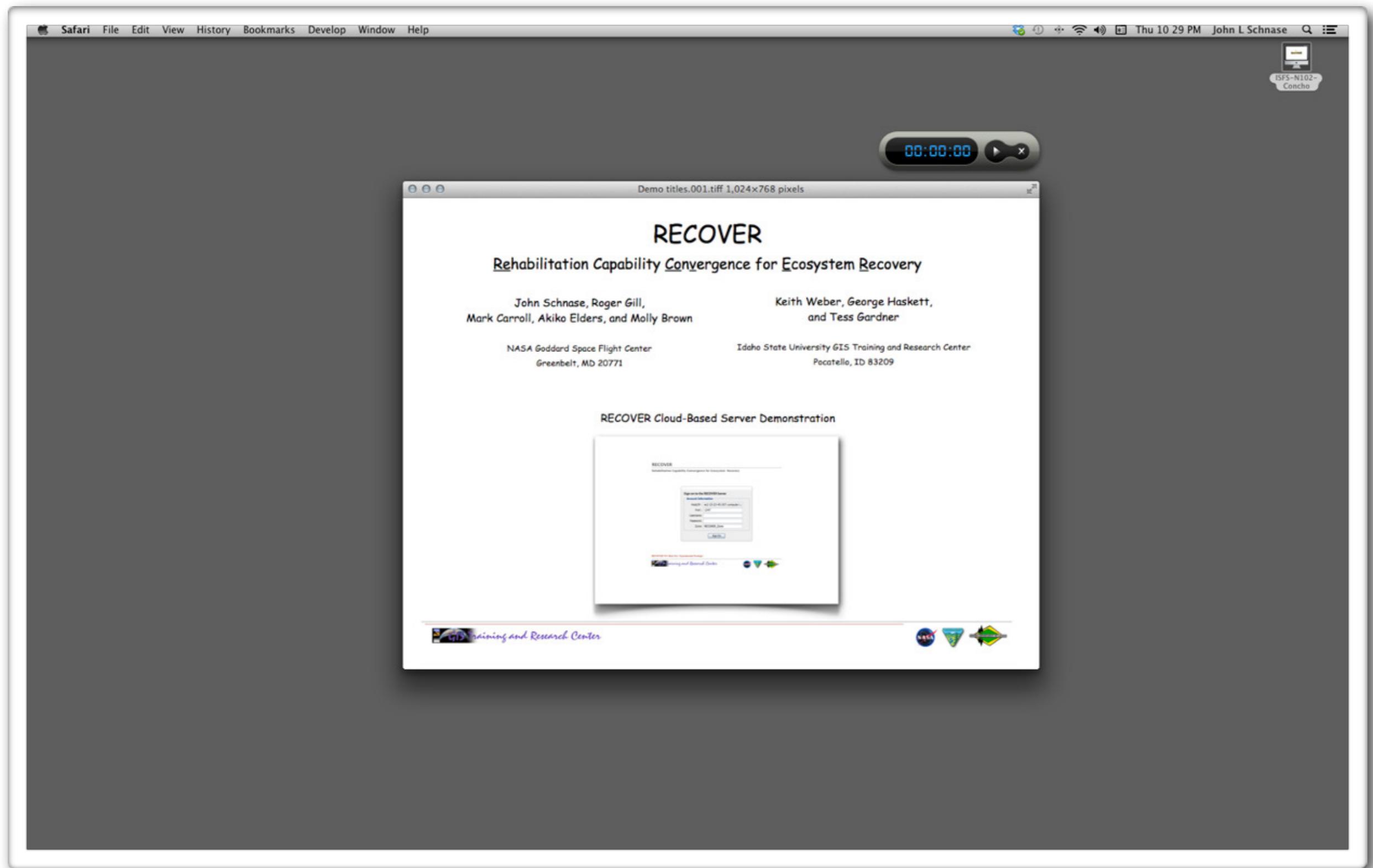
• Mobile Clients

- Prototype RECOVER Client designed for desktop and laptop use ...

... but we are beginning to work on mobile clients.



RECOVER Server Demo



00:00:00



Demo titles.001.tiff 1,024x768 pixels

RECOVER

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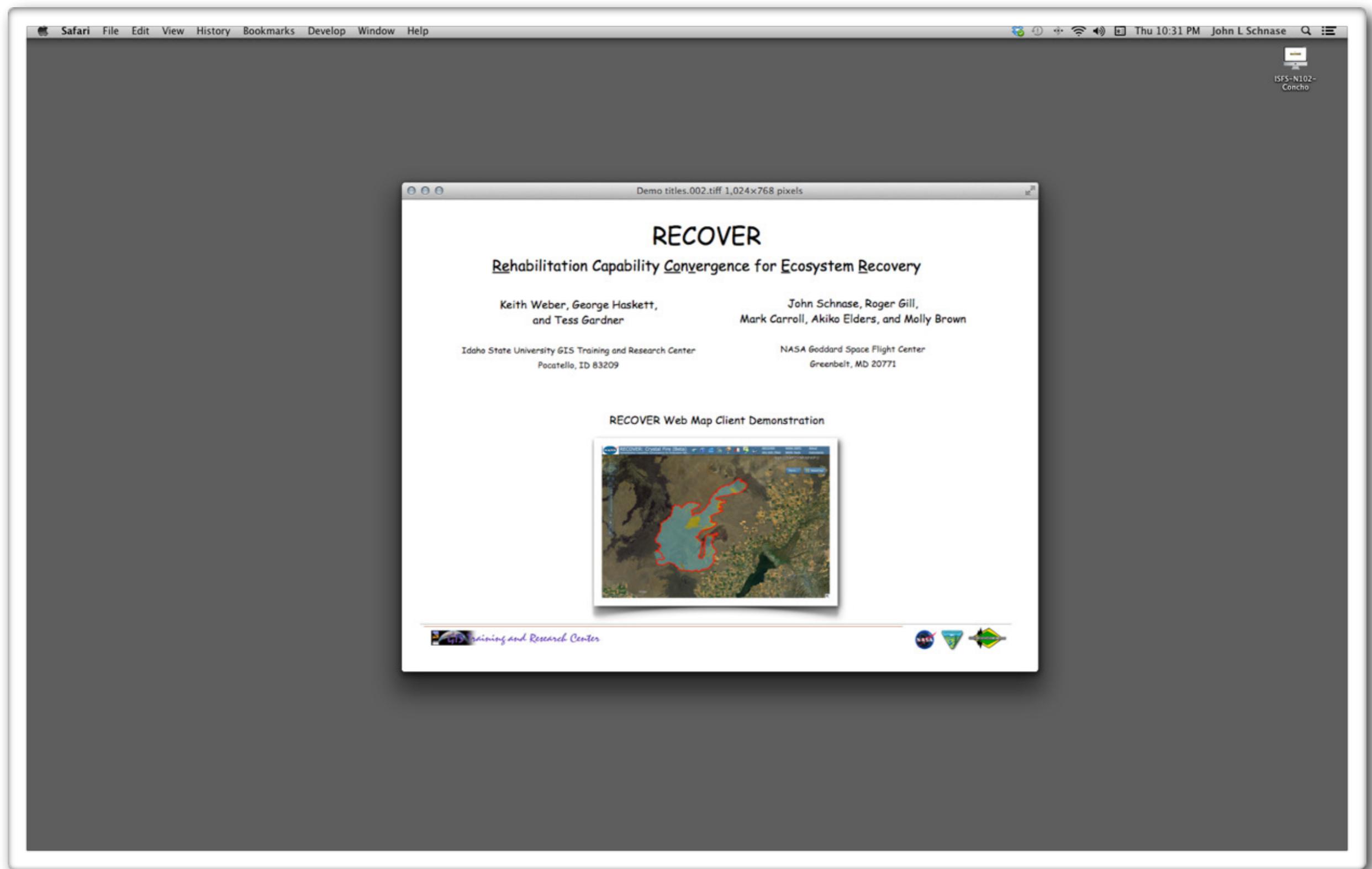
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Greenbelt, MD 20771

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Pocatello, ID 83209

RECOVER Cloud-Based Server Demonstration



RECOVER Client Demo



RECOVER

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RECOVER Web Map Client Demonstration



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