NASA’s Earth Science Division

Research

Flight

Applied Sciences

Technology
Applications Themes & Societal Benefit Areas

Emphasis in 4 Applications Areas

- Health & Air Quality
- Water Resources
- Disasters
- Ecological Forecasting

Support opportunities in 5 additional areas

- Agriculture
- Climate
- Weather
- Energy
- Oceans

Crosscutting theme: Wildland Fires
Advancing NASA’s Wildland Fire Applications Capabilities

- **Wildland Fire application science answering questions and supporting decisions** transforming EO data and research results into environmental intelligence.

- **Coordination and collaboration** informing brokers, managers, and responders with critical products and services.

- **Creation and leverage of partnerships** strengthening and enabling effective response throughout the wildfire lifecycle.
NASA Wildland Fire Program

Zachary Holden / USDA Forest Service:
A Prototype System for Predicting Insect and Climate-Induced Impacts on Fire Hazard in Complex Terrain;

Sher Schranz / NOAA:
Wildland Fire Behavior and Risk Prediction;

James Vogelmann / USGS EROS Center
Improving National Shrub and Grass Fuel Maps Using Remotely Sensed Data and Biogeochemical Modeling to Support Fire Risk Assessments;

Birgit Peterson / USGS EROS Center:
Enhanced Wildland Fire Management Decision Support Using Lidar-Infused LANDFIRE Data;

Karyn Tabor / Conservation International Foundation
An Integrated Forest and Fire Monitoring and Forecasting System for Improved Forest Management in the Tropics;

Wilfrid Schroeder / University of Maryland
Development and Application of Spatially Refined Remote Sensing Active Fire Data Sets in Support of Fire Monitoring, Management and Planning;

Stephen Howard / USGS EROS Center:
Utilization of Multi-Sensor Active Fire Detections to Map Fires in the US;

Mary Ellen Miller / Michigan Tech Research Institute (MTRI):
Linking Remote Sensing and Process-Based Hydrological Models to Increase Understanding of Wildfire Effects on Watersheds and Improve Post-Fire Remediation Efforts;

Keith Weber / Idaho State University;
RECOVER: Rehabilitation Capability Convergence for Ecosystem Recovery;
The new VIIRS 375 m active fire detection product enables early detection of small fires and improved mapping of large wildfires.

King Fire: Comparing MODIS 1 km, VIIRS 750 m, and VIIRS 375 m products

“These refined data further improve the situational awareness of fire managers and are also ingested into operational modeling, analysis and visualization applications that support fire management decision-making at a landscape scale.” – Brad Quayle, U.S. Forest Service

The new VIIRS fire data and algorithm are currently being used operationally to complement limited aircraft and satellite data in time and space, with the ultimate purpose of protecting resources, property and lives.
NASA Support to the Massive Soda Fire, Idaho

NASA ASP-Funded Project Team – RECOVER, supporting 24/7 operations on Soda Mega-Fire in Idaho with Fire Modeling Capabilities!!!

- Fire started Aug 10
  - Grew to 78 k acres by Aug 12
  - Grew ~6X from Aug 12 to Aug 13 (to 218.000 acres)!
  - RECOVER team requested to support with modeling and mapping efforts on 8-13-15; continued thru end of fire.

- NASA RECOVER supporting Incident managers with real-time tools (NASA satellite data, cloud-enabled, geospatial modeling tools, critical data layers, etc.) to shorten burn area assessments for remediation operations (from multiple days to minutes!!)
- NASA efforts are helping to pinpoint active fire mitigation strategies and post-fire burn conditions by modeling vegetation cover, terrain, soil, etc., for rapid remediation.
- Positively impacting fire management strategy efficiencies and post-burn planning.

Image courtesy of Idahopress.com

MODIS Soda Fire Hot Detects 8-14-15

Boise
Webinars and Workshops…

Webinar: March 31 - April 28, 2015

• **Objectives:** Provide an overview of relevant NASA Earth science data products, tools, and access portals for wildfire applications for enhanced decision-making and assessment methods.

• **Overview Statistics:** 278 participants, 178 organizations, 42 countries, 33 states


• **End-of-Training Survey:** Majority of attendees (73%) indicated that the webinar met their expectations while 23% indicated that it exceeded expectations. 93% showed some level of improvement for understanding specific remote sensing data products appropriate for work needs.
Applications Readiness Levels (ARL)

9. Approved, Operational Deployment and Use in Decision Making
8. Application Completed and Qualified
7. Application Prototype in Partners’ Decision Making
6. Demonstrate in Relevant Environment
5. Validation in Relevant Environment
4. Initial Integration and Verification
3. Proof of Application Concept
2. Application Concept
1. Basic Research

ARL 9 – ARL 8 – ARL 7 – ARL 6 – ARL 5 – ARL 4 – ARL 3 – ARL 2 – ARL 1

Discovery and Feasibility
Development, Test, and Validation
Partner Demonstration and Transition

Measures of Project Performance
NASA collaborates with numerous U.S. land management agencies and other partners to improve wildfire characterization.
NASA Participates in National / International Fire Committees

- Group on Earth Observations (GEO), Global Wildfire Information System (GWIS);

- National Science & Technology Council (NSTC) Subcommittee on Disaster Reduction (SDR) Wildland Fire Science and Technology Task Force (WFST TF);

- Interagency Arctic Research Policy Committee (IARPC); Wildfire Implementation Team (WIT);

- NRC, Div. of Earth & Life Sciences, Wildfire Study Team;

- JFS Program, Fire and Smoke Model Evaluation Experiment (FASMEE) Team
NASA Applied Science Program website:

http://appliedsciences.nasa.gov/
WILDFIRE PROGRAM
http://appliedsciences.nasa.gov/programs/wildfire

Wildfire Management Team:
Lawrence Friedl (PM)
Vince Ambrosia (Assoc.),
Amber Soja (Assoc.)

Further Information
http://AppliedSciences.NASA.gov

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Applied Sciences Program
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The NASA RECOVER DSS

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Kindra Serr\textsuperscript{1}, Jeff May\textsuperscript{1}, John Schnase\textsuperscript{2}, Mark Carroll\textsuperscript{2}, Roger Gill\textsuperscript{2}, Maggie Wooten\textsuperscript{2}, Bryan Nicholson\textsuperscript{1}, and Cody Feldman\textsuperscript{1}

\textsuperscript{1} - Idaho State University- GIST ReC
\textsuperscript{2} - NASA Goddard Space Flight Center
What is RECOVER?

• Customer-driven, Customer-centric*
• Decision Support System (DSS)
  – Rapid assembly of site-specific data
  – Delivered in customized GIS analysis environment
  – Wildfire focus

* Our “customer” is anyone with wildfire management responsibilities (BLM, NPS, USFS, State Lands, DOT’s, NGO’s, etc.)
Data Architecture

• RECOVER covers the Western US
• Esri ArcGIS 10.3.1
  – File Geodatabase
  – Vector and raster data
  – Automated Map Services
• Transitioning to 10.4.1
How Does it Work?

1. Fire Ignition
2. Gather Fire Info
3. Web Map Generator
   - Additional Data Requests
   - Email Notifications
4. Site-Specific Web Application
   - Create Map Services
   - Process Additional Data
5. Fire specific reports
GIS Layers

- By default each RECOVER web map contains...
  - 25 base layers automatically clipped to fire extent
  - One real-time data feed (Collector)
  - Fire-specific reports
Fire-specific Reports

Soda Fire - Summary Report

Administrative Agency | Acres
--- | ---
BLM | 227,835
BOR | 196
PVT | 42,824
ST | 12,741

Total Acres: 283,396

Soda Fire - Detailed Report

Administration Agency | Area Symbol | Map Unit Symbol | Acres
--- | --- | --- | ---
BLM | | | 227,835
BOR | | | 196
PVT | | | 42,824
ST | | | 12,741

Total Acres: 283,396

Ecological Site/Plant Association and Vegetation (ID)

Owyhee County Area, Idaho

<table>
<thead>
<tr>
<th>Map symbol and soil name</th>
<th>Ecological site or plant association</th>
<th>Common trees</th>
<th>Forest understory or rangeland characteristic vegetation</th>
<th>Composition</th>
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USDA Natural Resources Conservation Service

Survey Area Version: 11
Survey Area Version Date: 06/13/2012
Page 1
Done in 5-minutes!

• Once submitted from our Generator, the web map will be ready in about 5-minutes
How Does it Work?

1. **Fire Ignition**
2. **Gather Fire Info**
3. **Web Map Generator**
   - Additional Data Requests
   - Email Notifications
4. **Site-Specific Web Application**
   - Process Additional Data
   - Create Map Services
5. **Fire specific reports**
Additional data requests

• Fire-affected Vegetation
• Debris-flow probability (AKA mudslide or landslide)
• NDVI vegetation anomaly
  – 16-day MODIS NDVI-composite imagery
  – Long-term average NDVI (2001-present)
  – Current fire season compared against long-term trend
NDVI Anomaly Data

Map layer

Charts
Transform Data into Information

• Help your data speak to the user
  – Authoritative source data
  – Common sense Colormaps (raster)
  – Accepted symbology (Map service and Layer files)
Listen to the Customer

- “Make it mobile”
- “High-resolution is nice, but fast is critical”
  – NIFC
- “Drowning in Data, but still thirsting for Information”
  – USFS RSAC
Assemble a Great Team

- Idea
- Plan
- Infrastructure
- Data
- People
How Does it Work?

• You can learn more....
  – Visit YouTube for a full tour
Automating wildfire and disaster mapping with ArcGIS and Python

Jeff May


1- Idaho State University- GIS TReC
2- NASA Goddard Space Flight Center
Presentation Overview

1. Technology overview
2. RECOVER workflow review
3. Evolution of RECOVER automation
4. How does it work?
RECOVER Technology

Data management, service rendering, Real time GIS with Collector

Server side processing exposed as an ArcGIS geoprocessing service

Application development
The RECOVER Workflow
RECOVER Evolution

- Stand alone-python script
- Semi-automated process requiring back and forth communication with end-user
- Manual creation of site reports
- 1 hour processing time

- Python script tool
- Leverages locally stored data
- Parameters now variable and selected from toolbox UI
- Back and forth communication with end-user
- Report generation now automated
- 30 minute processing time

- Geoprocessing service, initiated through a web application
- Leverages data via a map service
- User initiated process
- Notifications sent automatically
- Additional data request still process manually
- 5 minute processing time
RECOVER Automation: How it works
Automation Space

– Data space
  • Contains:
    – Data
    – Map document templates
      » Applied symbology
      » Store relative pathnames to data sources
    – Reports
      » Report layout files (.rlf)
Automation Space

– Website space
  • Contains:
    – Configuration templates
      » Application
      » Widgets
    • “Tags”
      • Find and replace “[NAME]”
Initiate a process using the RECOVER “Web Map Generator”
Server Side Processing

The RECOVER automation process can be broken down into these 6 steps:

1. Input validation
2. File system set-up
3. Data processing
4. Service publishing
5. Notifications
6. Post-process tasks

~ 5min processing time
Server Side Processing

Input validation: Fire boundary folder

```python
if arcpy.Exists(fireBoundary):
    v = v丰富的_file_丰富Folder

    # Use search cursor to calculate the area (acres) of areaOfInterest.
    if AOI area > limit, process will fail.

limit = 3000000
AOIacres = arcpy.CalculateField_management(areaOfInterest, "ACRES", "!shape.area@acres!", "PYTHON")
SC = arcpy.SearchCursor(areaOfInterest)
AcresTot = 0
for row in SC:
    AcresTot += row.getValue("ACRES")
    arcpy.AddMessage("Extent defined is " + str(AcresTot) + " acres.")

if AcresTot > limit:
    sys.exit(0)
    arcpy.AddError("Extent defined is too large. Please try again with a smaller AOI (max area = 3 million acres")
    if setting Limit ("pr") = -1:
        arcpy.AddError("Zipfile contains files that are not allowed, please remove unacceptable files and try again")
        sys.exit(0)
    else:
        if shapefile is missing .pr
            arcpy.AddError("Shapefile being uploaded is missing projection (.prj) file, please add projection and try again")
            sys.exit(0)

arcpy.AddMessage("Zipfile ok")
# Extract fire boundary zipfile
2.extractAll(zipData)
arcpy.AddMessage("...fire boundary extracted to " + zipData)
```
Server Side Processing

File System Set up

Python libs:
1. OS
2. Shutil
3. Zipfile
4. distutils

```python
def findAndReplace(file):
    arcpy.AddMessage("Updating " + file)
    input_file = open(file)
    contents = input_file.read()
    input_file.close()
    contents = contents.replace("[NAME]", fireId)
    output_file = open(file,"w")
    output_file.write(contents)
    output_file.close()
    del input_file, contents, output_file
    print("..." + file + " updated.")

for inFile in inFiles:
    findAndReplace(inFile)
```
Server Side Processing

Data processing

Select AOI

Extracted Data

*ArcMap Data Extract Tool

AOI clips against the RECOVER base layers map service

*Store relative pathnames to data sources

Replace data at source

- SodsFire_ID
  - fireIndry
  - Geology
  - Habitat
  - HistoricFires
  - LandslidePotential
  - NHD
  - PLSS
  - Roads
  - SMA
  - SMA_SodasFire_ID_summary
  - soils_SSURGO
  - soils_STATSGO
  - WatershedsWBD
  - Wetlands
- Aspect.tif
- BPS_BioPhysicalSetting.tif
- Elev.tif
- ESP_EnvironmentalSitePotential.tif
- EVC_ExistingVegetationCover.tif
- EVT_ExistingVegetationType.tif
- FRG_FireRegimeGroup.tif
- Hillshade.tif
- HistorFires_PastDecade.tif
- Slope_degree.tif
- Slope_percent.tif
- SlopeGTE30.tif
- Soils_STATSGO_KFactor.tif
Server Side Processing

Service publishing: Create a map service

```python
# Create Map Service
arcpy.AddMessage("......Creating Basemap Service")
xmd = arcpy.mapping.MapDocument("N:\arcpy\workspace\basemapServices.mxd")
arcpy.mapping.CreateMapSSDraft(xmd, ssdraft, service, "ARCGIS_SERVER", con, False, fireFolder)
analysis = arcpy.mapping.AnalyzeFor3D(ssdraft)

@stopStartServices(server, port, adminUser, adminPass, stopStart, serviceName, token=None)
# Get and set the token
if token is None:
    token = GetToken(server, port, adminUser, adminPass)

# modify the services
op_service_url = "http://{}:{}/arcgis/admin/services/{}?token={}if=json".format(server, port, serviceName, stopStart, token)
status = urllib2.urlopen(op_service_url, '').read()
if 'success' in status:
    print (serviceName + " --- " + str(stopStart))
else:
    print status
return

# Stage and upload the service if the ssdraft analysis did not contain errors
if analysis['errors'] == {}:
    # Execute StageService

arcpy.AddMessage("......Map Service Created")
else:
    # If the ssdraft analysis contained errors, display them
    arcpy.AddMessage(analysis['errors'])
arcpy.AddMessage("Service could not be published because errors were found during analysis.")
```
Server Side Processing

Notifications

```python
import smtplib

# Define function |use this function in other script that call this script.
# user_email and URL are required inputs for this function
# user_email = recipient
# URL = http address for RECOVER web map
def SendMail(userEmail, URL):

    # Define username and password for email account that will send the msg
    gmail_user = 'xxxxx
    gmail_pwd = xxxxx

    # Initialize the smtp server
    smtpserver = smtplib.SMTP("smtp.gmail.com", 587)
    smtpserver.ehlo()
    smtpserver.starttls()
    smtpserver.ehlo()
    smtpserver.login(gmail_user, gmail_pwd)

    # Header content of email
    header = 'To:' + userEmail + '\n' + 'From:' + gmail_user + '\n' + 'Subject:Your RECOVER web map \n'

    # Structure message here
    msg = header + ()

    # Send mail via smtp
    smtpserver.sendmail(gmail_user, userEmail, msg)
    smtpserver.close()
```
RESULT: A RECOVER Web Client
Post-processing tasks

• Some ArcMap tools are not supported in geoprocessing services.
  – In RECOVER’s case:
    • arcpy.mapping.ExportReport()
      – Separate python script tool
      – Task scheduler for automation

• Additional data requests
RECOVER is a NASA Applied Sciences sponsored project. K. T. Weber (PI), J. Schnase (Co-PI) and M. Carroll (Co-PI), Goddard Space Flight Center.