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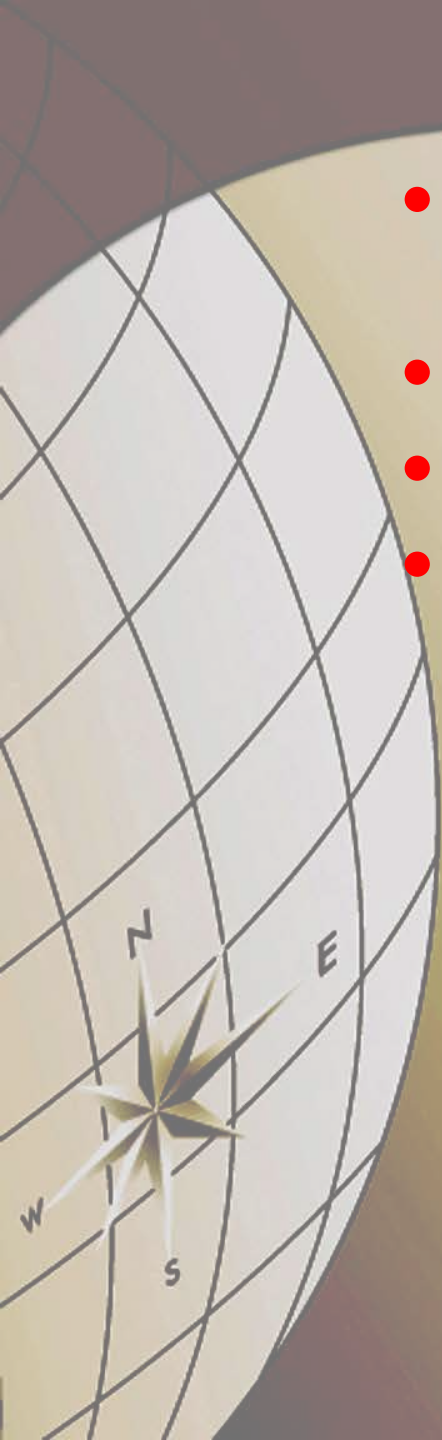


# Integrating and Analyzing Prescribed Burn Data with ArcGIS



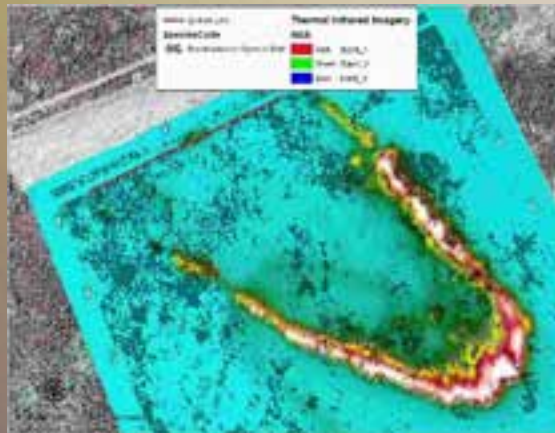
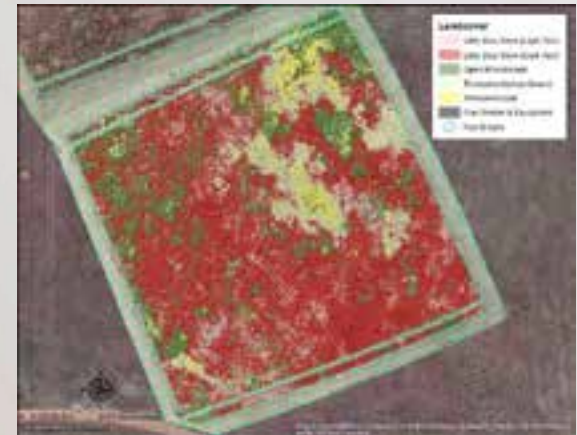
# Acknowledgements

- National Institute of Standards and Technology (NIST) Fire Research Grant
- Dr. William Mell (USFS)
- Alexander Maranghides (NIST)
- Camp Swift Data Collection Team
  - Texas Army National Guard – Camp Swift, Texas A&M Forest Service, Bastrop County Judge and Commissioners Court, Bastrop County Office of Emergency Management, US Forest Service (Missoula Fire Lab.), U.S. Forest Service (Seattle), Texas State University, Colorado State University, San Diego State University, University of Washington, University of Kentucky, University of Montana, and Joint Fire Science Program



# Presentation Outline

- Research Prescribed Burn Purpose
- Camp Swift Prescribed Burn Overview
  - Numerous Organizations Integrated
    - (NIST/USFS/JFSP) <sup>1</sup>
- Vegetation Classification & Assessment
  - Feature Analyst & ArcGIS
- Fire Behavior Assessment
  - ArcGIS Animations
- Fire Model & GIS Integration



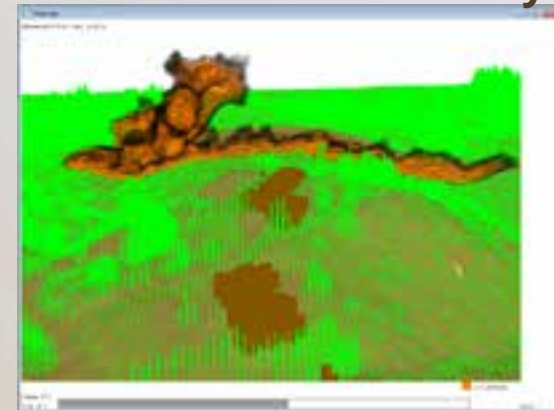
<sup>1</sup><http://www.fs.fed.us/pnw/fera/research/treatment/wui/effectiveness.shtml>



# Prescribed Burn Purpose Cont.

- **Fire Behavior Characterization**
  - **NIST/USFS Exposure Scale<sup>2</sup>**
    - **Science Based WUI Assessment**
    - **Better Understanding**
      - **Heat Fluxes/Ember Spread**
      - **Fuel Breaks, Structure Vulnerabilities**
  - **Prescribed Burns “Lower Intensity” Fires**
    - **Lower Wind Conditions**
    - **Simpler Topography**
  - **Models “Higher Intensity” Fires**
    - **Simulations Only**
    - **Empirical Model:**
      - **Limitations**

**PB/GIS Integration-  
Demo WUI Community**

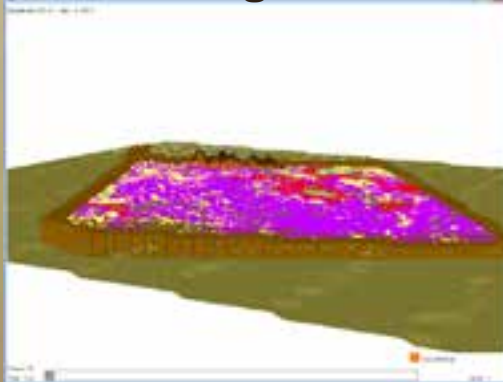


<sup>2</sup>Maranghides and Mell, 2012, National Institute of Standards and Technology, United States Forest Service (USFS)

# Prescribed Burn Purpose

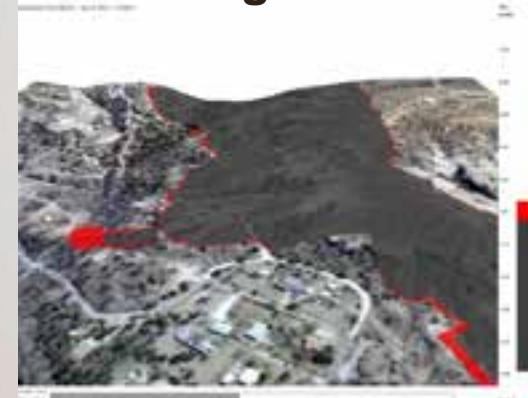
- **Fire Model Validation**
  - **Wildland/WUI Fire Dynamics Simulator<sup>3</sup>**
    - **Extension of NIST Fire Dynamics Simulator<sup>4</sup>**
    - **Smokeview Visualization Tool<sup>5</sup>**
    - **Physics Based Module (PB)**
    - **Empirical Based Module (LS)**

**PB/GIS Integration-Demo**



**Non-Physical  
Fire Behavior  
Boundary  
Conditions,  
Etc...**

**LS/GIS Integration-Demo**



<sup>3</sup>Mell, 2010, USFS, Fire and Environmental Research Applications Team

<sup>4</sup>McGrattan, 2013, National Institute of Standards and Technology

<sup>5</sup>Forney, 2013, National Institute of Standards and Technology

# Camp Swift Study Site

- Texas Army National Guard
  - Near Location of 2011 Texas Bastrop Fire
    - Worst WUI Fire
    - Texas
- Texas Forest Service<sup>6</sup>
  - Prescribed Burn Area

## ArcGIS Online Viewer<sup>7</sup>



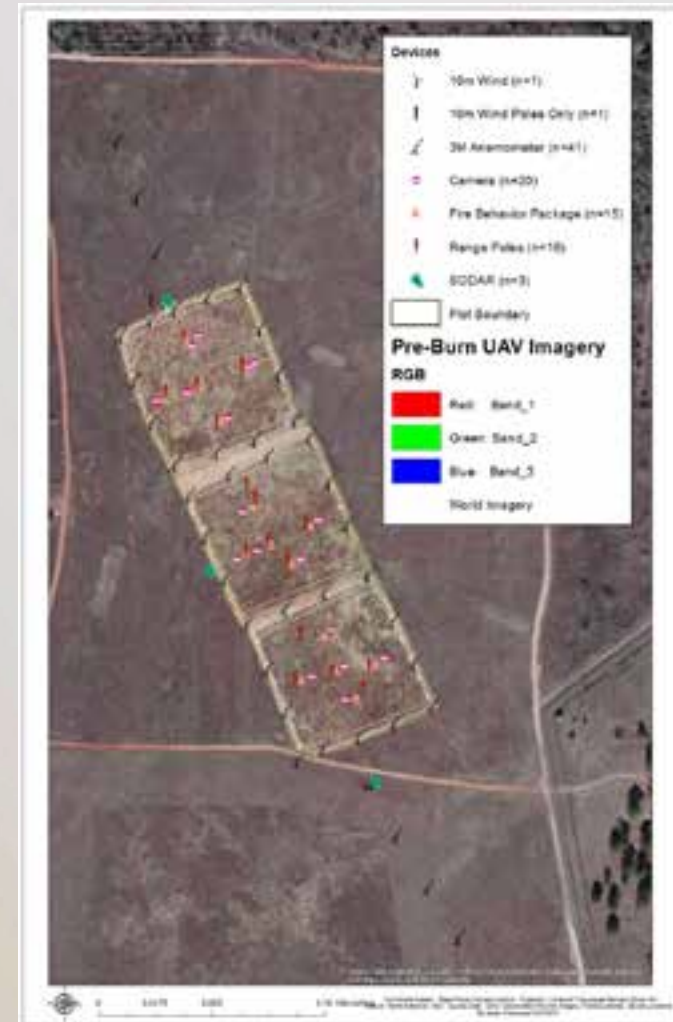
<sup>6</sup><http://texasforestservice.tamu.edu/main/popup.aspx?id=18105>

<sup>7</sup><http://gmsllc.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=e601e5246309461692bbdac48f82a0d1>



# Camp Swift Instrumentation (USFS, SDSU)

- **Anemometers**
  - 10 m<sup>8,9</sup>
  - 3m<sup>8</sup>
  - GoPro Cameras<sup>8</sup>
- **Fire Behavior Packages<sup>8</sup>**
  - Insitu Measurements
- **Thermocouple Rakes<sup>8</sup>**
  - Insitu Measurements
- **Range Height Poles<sup>8</sup>**
  - Flame Heights
- **SODAR<sup>8,9</sup>**
  - Wind Boundary Conditions



<sup>8</sup>Butler et al., (2014) United States Forest Service (USFS) Rocky Mountain Research Center

<sup>9</sup>Miller et al., (2014) San Diego State University (SDSU)

# Camp Swift Fuel Plots (USFS)


- 7 Pre-Fire Locations: 10-1m Plots
- 15-17 Samples Post-Fire
- Pre-Fire Plot Vegetation
  - Validation Difficult
  - No Pre-Fire Samples
    - Disturb Site
    - Effect Fire Behavior
    - Flanking vs Head Fire



<sup>10</sup>Vihnanek and Restaino, United States Forest Service (USFS) Fire and Environmental Research Applications (FERA), (2014)



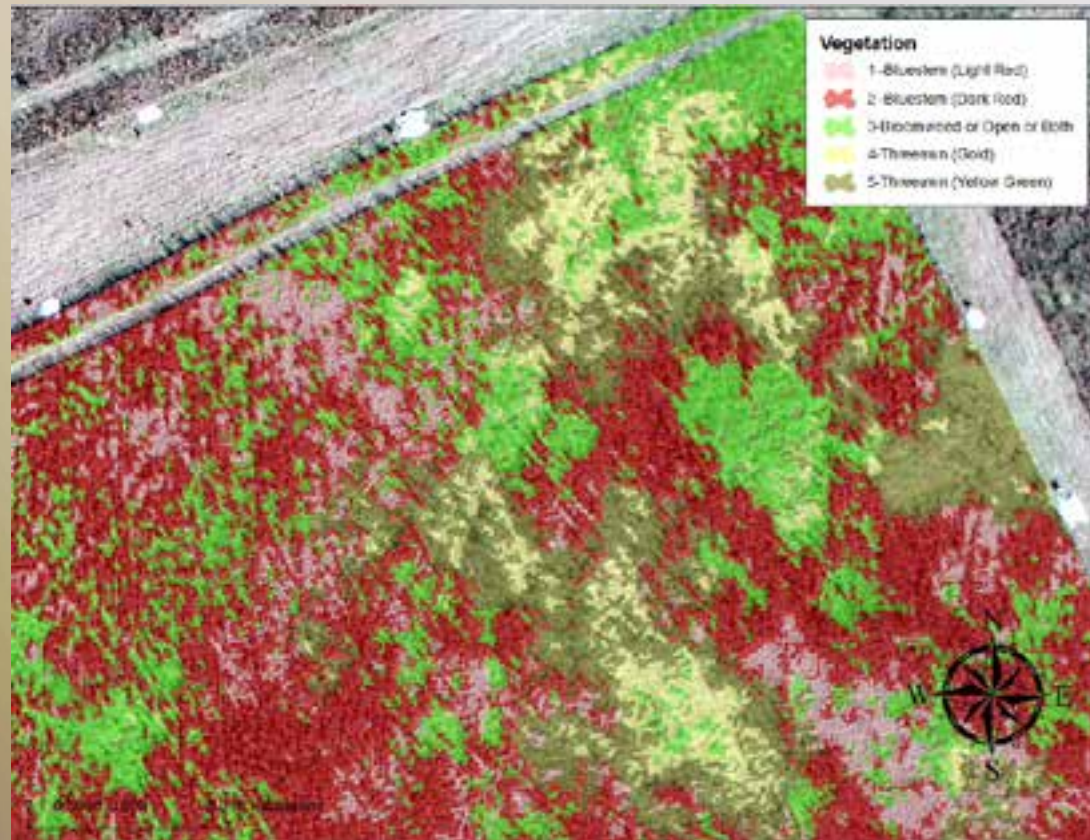
# Vegetation Classification (NIST UAV<sup>11</sup>)

- 
- **Pre- and Post-Fire UAV Acquired Imagery**
    - **Georeferenced Images**
      - **Future Efforts Collected Data:**
        - **Orthorectification**
        - **Point Cloud Creation**
  - **During-Fire Video Stills**
    - **Non-MISB Compliant**
      - **Georeferenced Select Stills**
    - **Could be Orthorectified –Little Topography**
      - **Not “True” Orthorectification**
        - **Multiple Views, Multiple Planes**
        - **Logistically Difficult**

<sup>11</sup>Maranghides, (2014) National Institute of Standards and Technology

# Vegetation Classification

- ArcGIS/Feature Analyst (FA) Work Flows<sup>12</sup>
  - Vegetation Spectrally/Texturally Distinct
    - Blue Stem Height
      - Relationship Material Properties (???)

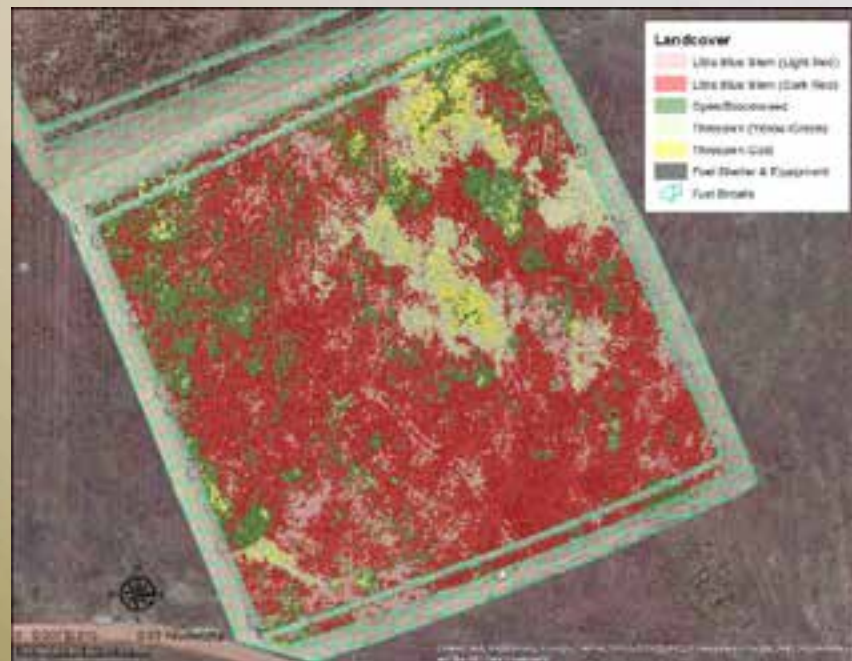


<sup>12</sup><http://www.gmsgis.com/camp-swift-burns.html>



# Plot 1 Vegetation Distribution

Fuel Type Classification	Percent Area
Bluestem (Dark Red)	54%
Bluestem (Light Red)	11%
Open/Broomweed	21.7%
Threeawn (gold)	3.7%
Threeawn (yellow/green)	9.6%





# Vegetation Classification Accuracy Assessment

Post-Fire  Field Sampled Fuel Class	UAV Imagery Derived Fuel Class						
	Little Bluestem	Threeawn	Open/ Broomwee d	Total	Omissions	Commissions	Mapping Accuracy
Little Bluestem	9	1	2	12	25%	0%	75%
Threeawn	0	0	0	0	NA	NA	NA
Open/ Broomwe ed	0	3 (Threeawn :yellow/ green)	2	5	60%	40%	29%
Total	9	4	4	17	Overall Fuel Classification = 65%		

# Vegetation Classification Accuracy Assessment

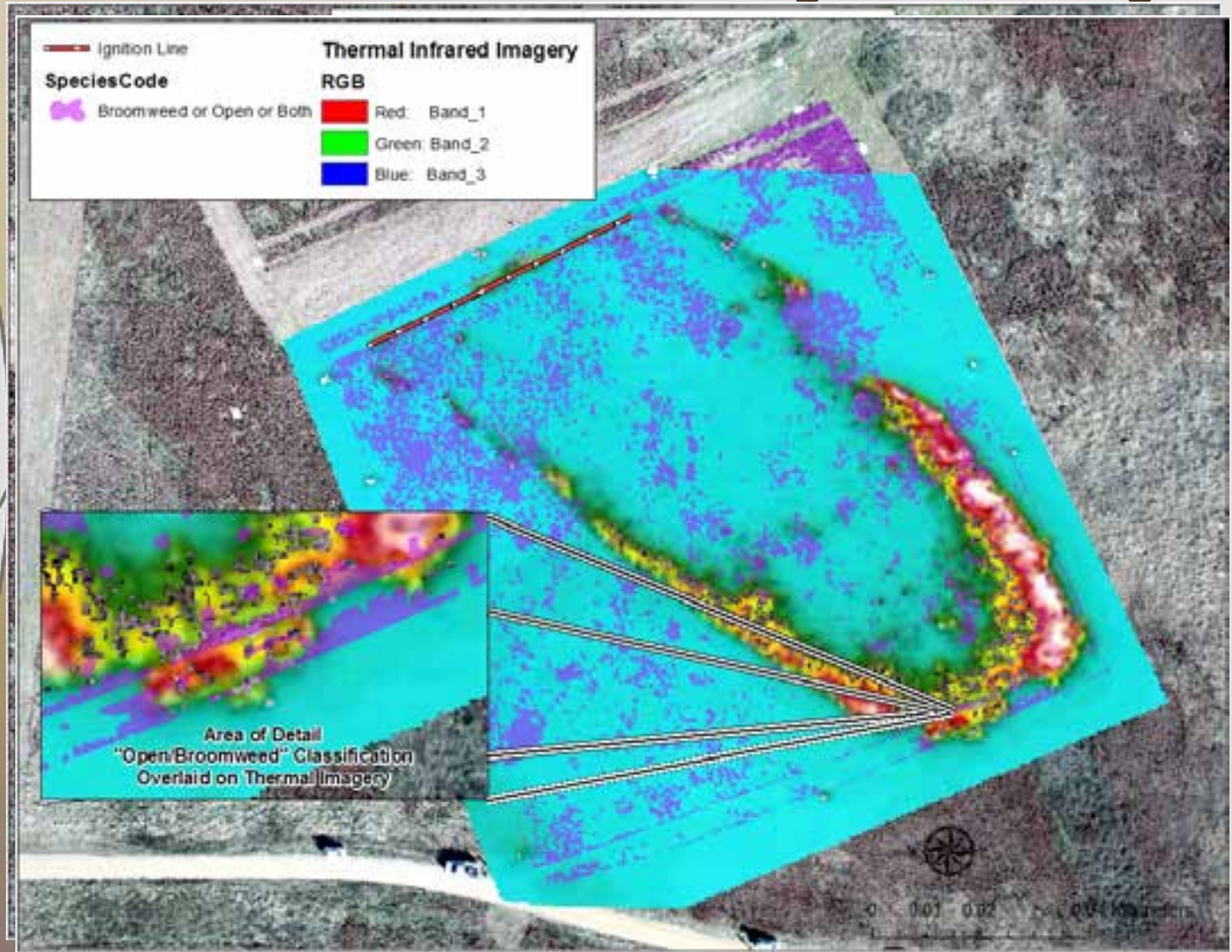
- Only Post-Fire Samples Available (Logistical)
  - Fire Consumed Species
    - Threeawn Not Identified
  - Samples Not Distributed Among Species
  - GPS Locations & Image Resolution
    - Not Precisely Aligned
      - Image Higher Resolution
  - Assessment Biased!!!
- Threeawn
  - Species Unknown
- Threeawn (yellow/green)
  - Mix of Species???
  - Species Transition Area???

Little Blue Stem  
(*Schizachyrium  
scoparium* (Michx.)  
Nash)<sup>13</sup>



# Fire Behavior and Vegetation

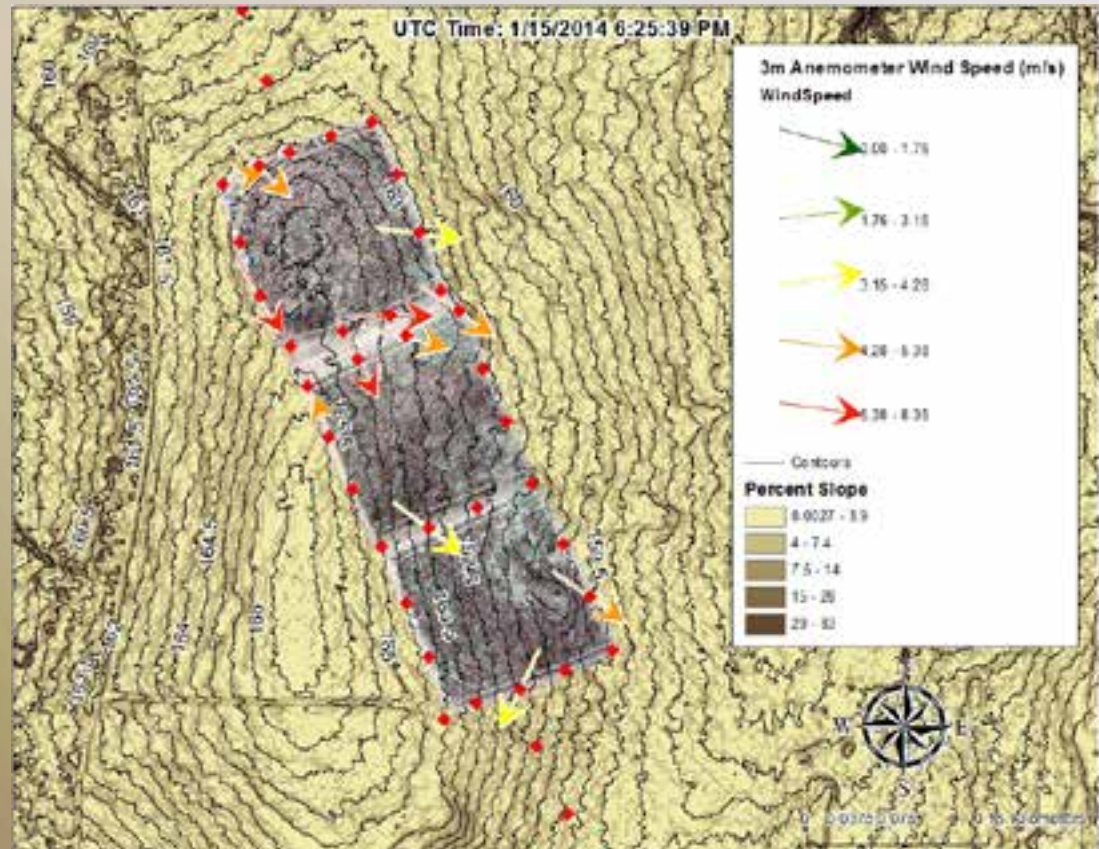
- Fire Behavior Changes
  - Visual Correlations W/ Vegetation Changes





# Wind and Topography

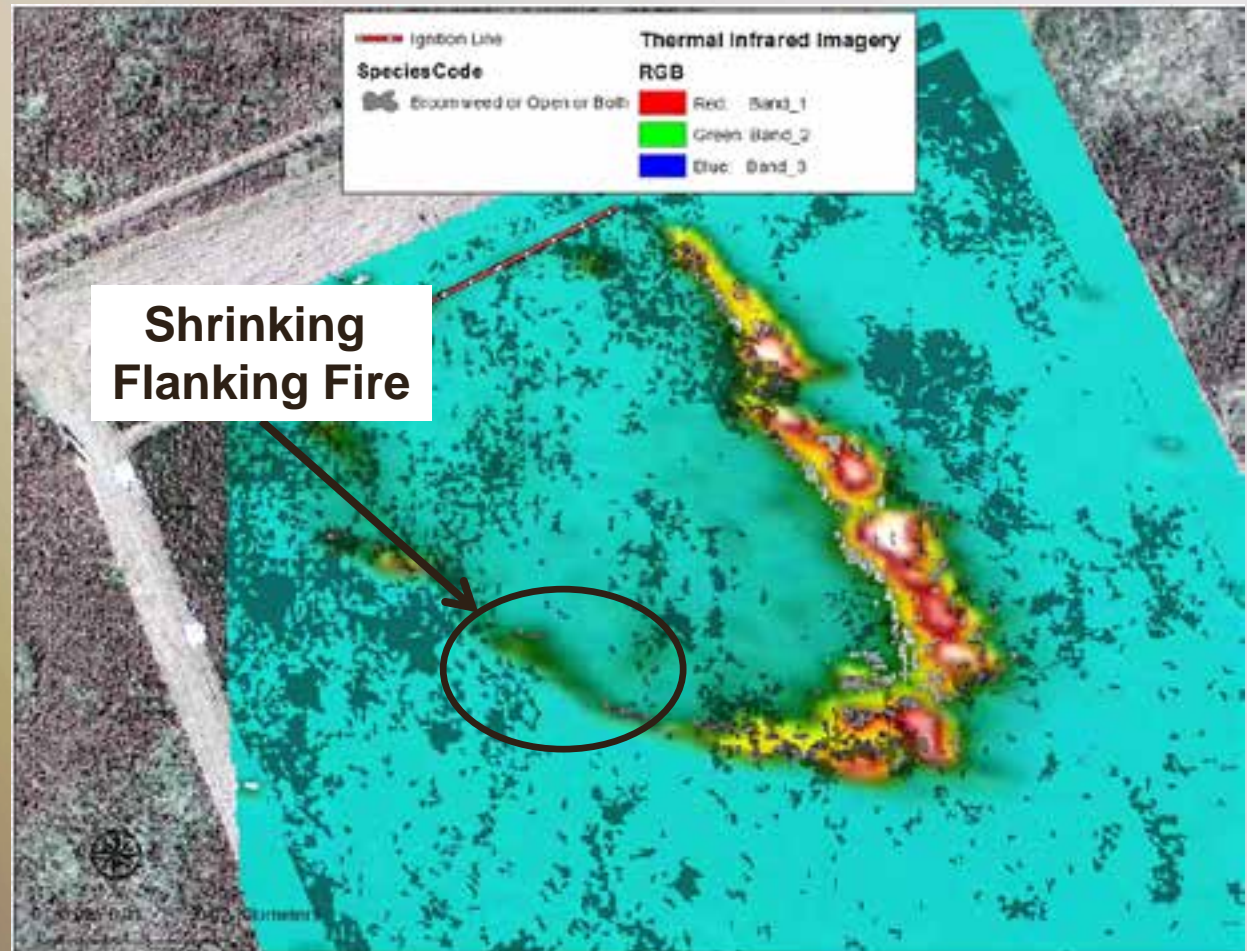
- Less Obvious Compared to Vegetation
  - Some Visual Evidence of Terrain Induced Wind
  - Further Analysis Required



<sup>8</sup>Butler et al., (2014) United States Forest Service (USFS) Rocky Mountain Research Center. 3m Anemometers.

# Fire Behavior and Wind

- Fire Behavior Changes with Wind
  - Changes in Flanking Fire
    - Coincides with Oblique Angle Distortion
    - Further Analysis Required





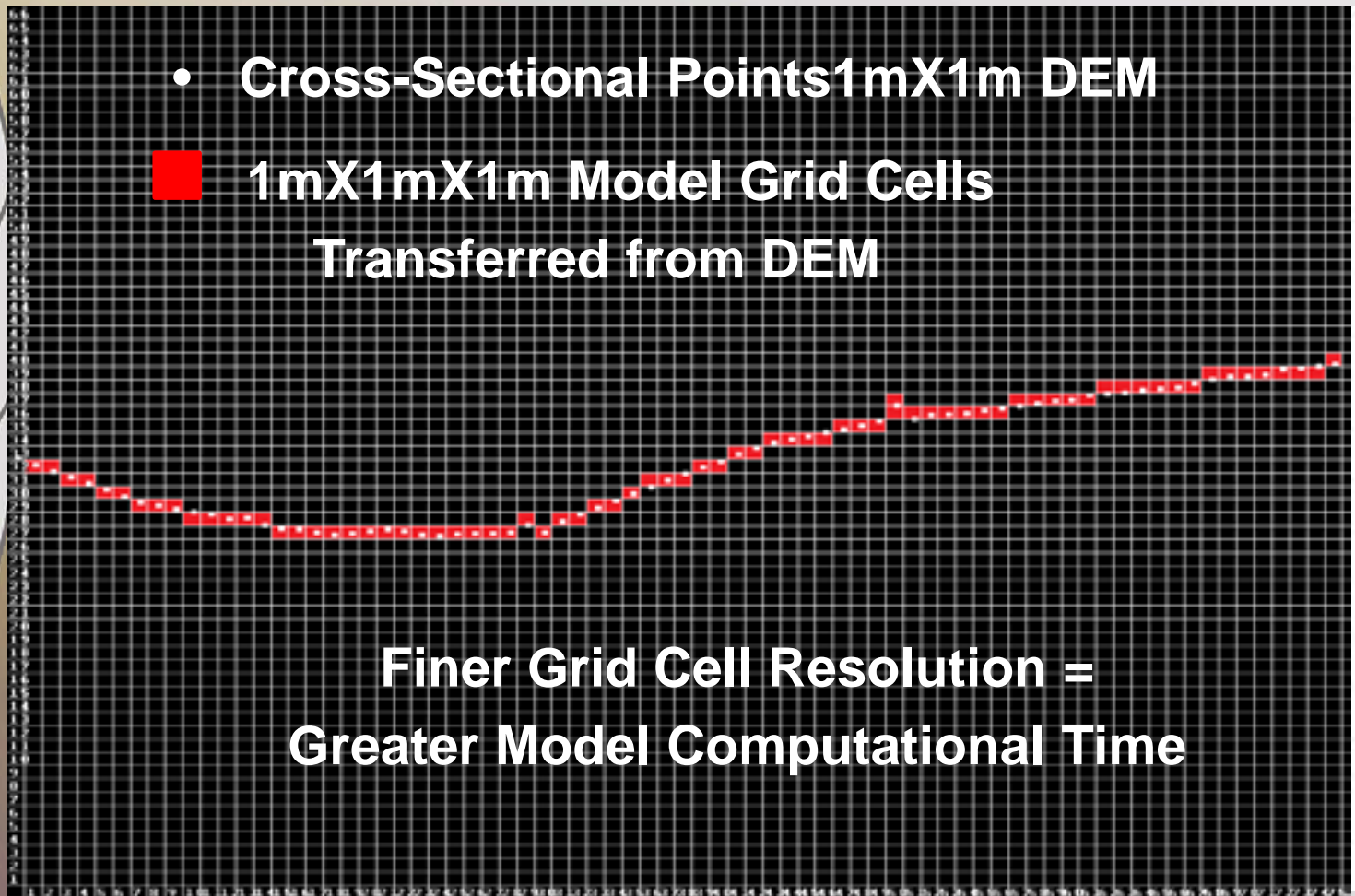
# Fire Model and GIS Integration

- **Terrain**
  - **Transfer 2.5D to 3D Data Structures**
    - **Data Degradation = Stair Stepping**

- **Cross-Sectional Points 1mX1m DEM**

■ **1mX1mX1m Model Grid Cells**  
**Transferred from DEM**

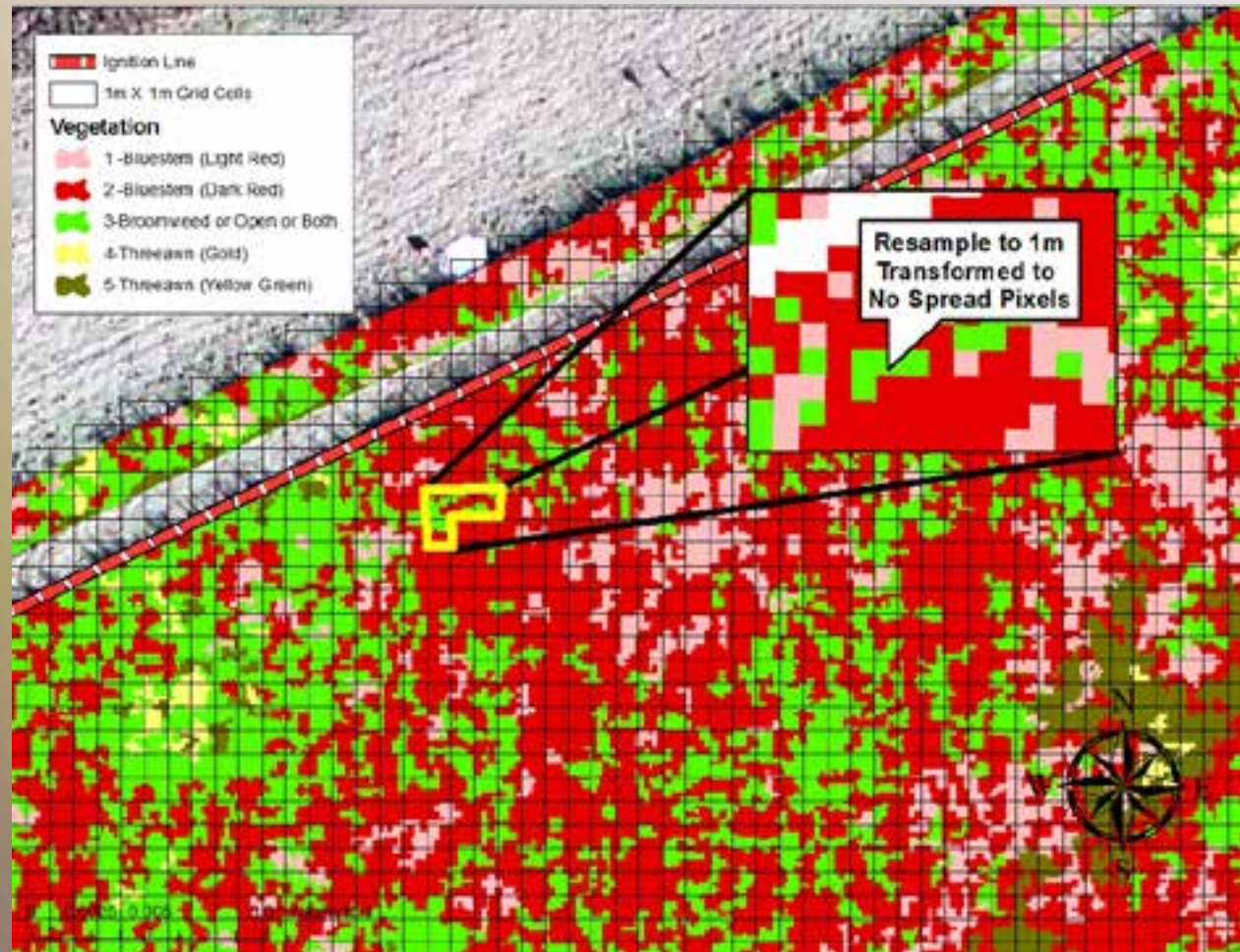
**Finer Grid Cell Resolution =  
Greater Model Computational Time**





# Fire Model and GIS Integration Cont.

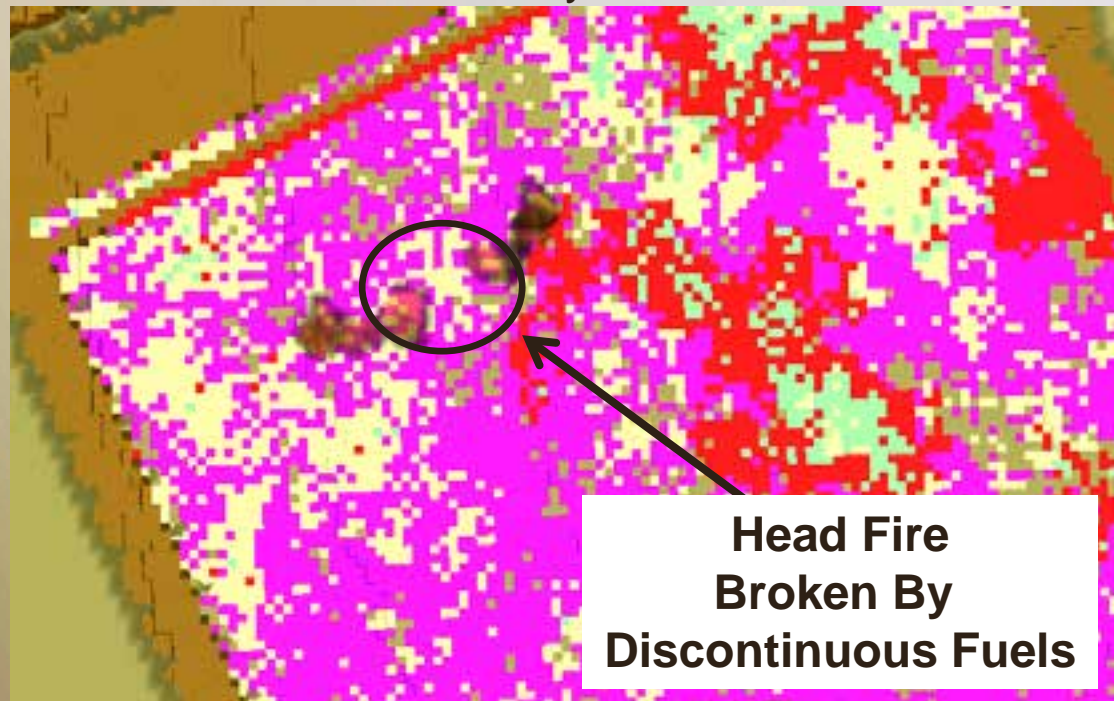
- **Grass (Boundary Fuels-Physics Based or Empirical)**
  - **Transfer Fine Resolution to Coarse Resolution**
    - **Mixed Pixels Might Transfer No Fuels**



# Fire Model and GIS Integration Cont.

- **Mixed Pixels  $\sim$  No Fuels**
  - **Might Artificially Stop Model Fire Spread (???)**
    - **Allocate By Biomass (???)**
      - **Depends on Fire Energy/Resolution**

Demonstration Only: Non-Physical Fire Behavior  
Incorrect Boundary/Initial Conditions





# Fire Model and GIS Integration Cont.

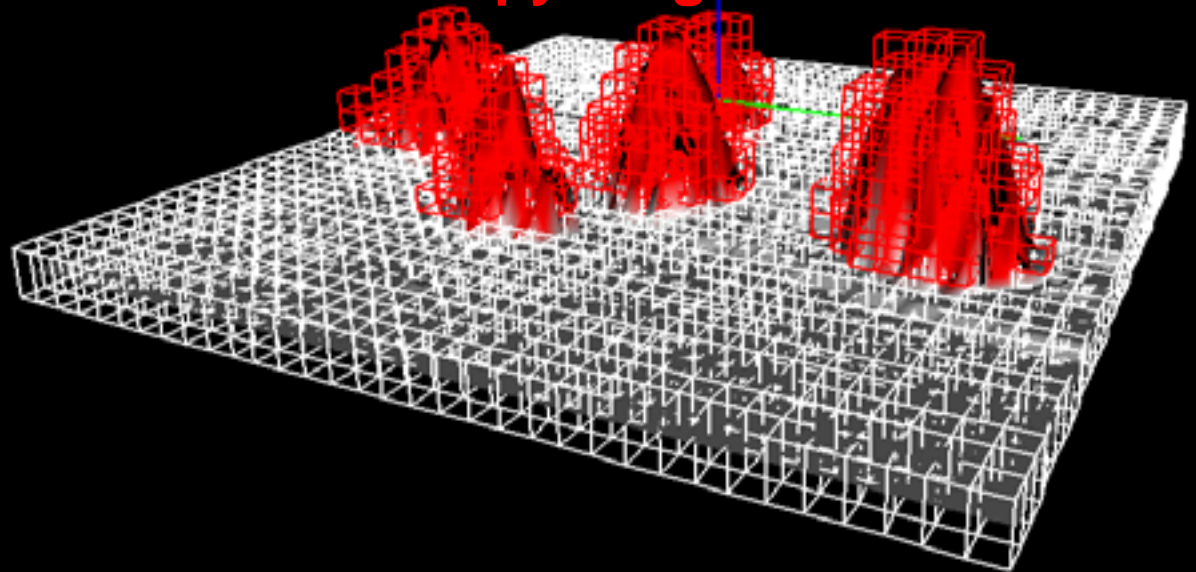
- **Raised Fuels (Thermal Elements-Physics Based)**
  - **Transfer Fine Resolution to Coarse Resolution**

**Coarser Grid Cell Resolution =  
Over Estimation Biomass  
(Empty Grid Cells Compared to CHM)**

**3mX3mX3m Grid Cells**

**Lidar DEM &**

**Canopy Height Model**



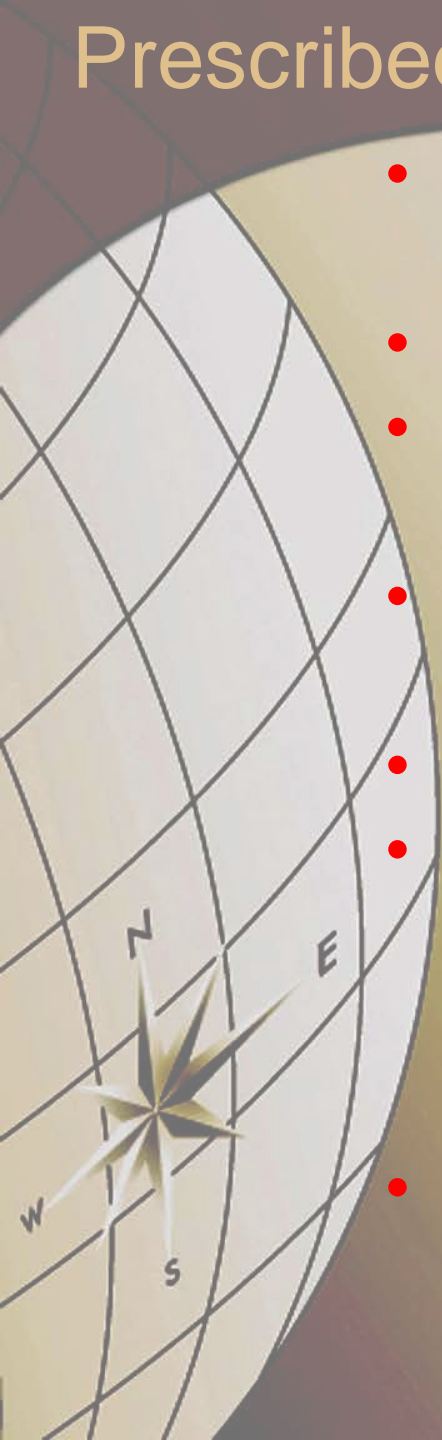


# Websites for Delivery and Dissemination



**The Job Is Not Over Until the Paperwork Is Complete (Metadata, Metadata, Metadata)**

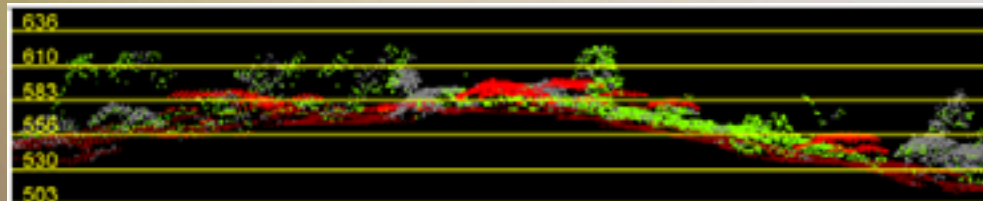
# Prescribed Burn Geospatial Recommendations

- 
- **Pre-Fire Within Plot Ground Samples**
    - **Required for Heterogeneous Vegetation**
  - **Extend Ground Control**
  - **Collect Data for Orthorectification**
    - **True Orthorectification of Fire (???)**
  - **Ground Imagery**
    - **Plot & Instrument Locations, Photosynth**
  - **Record Spatiotemporal Aspects of Everything**
  - **Data Management**
    - **Electronic Data Collection**
    - **Consistent Directory Structure/Nomenclature**
    - **Metadata, Metadata, Metadata**
  - **GIS Data Integration**
    - **ArcGIS Animations = Initial Exploratory Analysis**
    - **Exposure = Spatiotemporal**

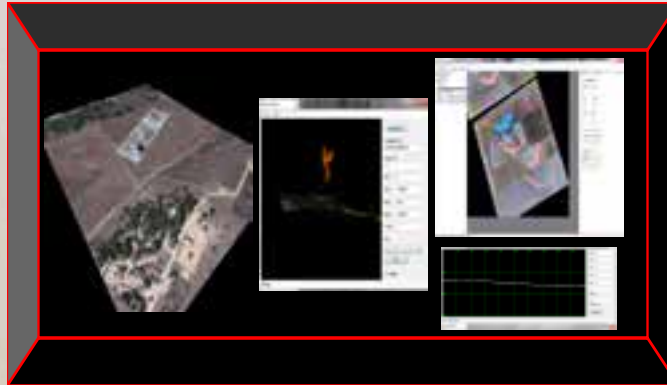


# Camp Swift & Project Remaining Work

- **Metadata, Metadata, Metadata**
- **GIS/WFDS Integration Tools**
  - **Loose Coupling: Mission Accomplished**
  - **Significant Effort Required:**
    - **Testing**
    - **Physics/Empirical Model Development**
    - **Not Part of This Grant**
- **Model Simulations Viewed in GIS**
  - **ArcGIS GDAL Driver (???)**
- **Tutorials for Tools/GIS Platforms**
  - **GIS/WFDS Integration**
  - **Future Fire Scientists**
    - **Perform GIS Integration!!!**



# QUESTIONS



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Project Websites:


<https://www.gmsgis.com/gis-model-integration.html>

<https://www.gmsgis.com/camp-swift-burns.html>

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**208-818-2152**



# REFERENCES

- 
- <sup>1</sup>Maranghides, FERA (2015) Evaluating the Effectiveness of Mitigation Advice in the Wildland Urban Interface (WUI). Joint Fire Science Project Grant.  
<http://www.fs.fed.us/pnw/fera/research/treatment/wui/effectiveness.shtml>
- <sup>2</sup>Maranghides and Mell, 2012, Framework for Addressing the National Wildland Urban Interface Fire Problem – Determining Fire and Ember Exposure Azones using a WUI Hazard Scale. NIST Technical Note 1748.
- <sup>3</sup>Mell, FERA 2010, Wildland-Urban Fire Models. <http://www.fs.fed.us/pnw/fera/wfds/index.shtml>
- <sup>4</sup>McGrattan, 2013, FDS and Smokeview. [http://www.nist.gov/el/fire\\_research/fds\\_smokeview.cfm](http://www.nist.gov/el/fire_research/fds_smokeview.cfm)
- <sup>5</sup>Forney, 2013, FDS and Smokeview. [http://www.nist.gov/el/fire\\_research/fds\\_smokeview.cfm](http://www.nist.gov/el/fire_research/fds_smokeview.cfm)
- <sup>6</sup>Texas Forest Service (2014) Texas A&M Forest Service participates in Multi-Agency Research Prescribed Burn at Camp Swift.  
<http://texasforestservice.tamu.edu/main/popup.aspx?id=18105>
- <sup>7</sup>Geospatial Measurement Solutions 2014 ArcGIS Online Camp Swift Overview.  
<http://gmsllc.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=e601e5246309461692bbdac48f82a0d1>
- <sup>8</sup>Butler, 2014 United States Forest Service (USFS) Rocky Mountain Research Center.  
<http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCEQFjAA&url=http%3A%2F%2Fwww.nrs.fs.fed.us%2Fpeople%2Fbbutler01&ei=WuVVbOYNMeGsAWJhaF4&usg=AFQjCNGYLgCbOqURPadnxMMcAjn4RS3Dyw&sig2=nEUP8fj89AgvP2h06VZELQ>
- <sup>9</sup>Miller et al., 2014 San Diego State University (SDSU)
- <sup>10</sup>Vihnanek and Restaino, United States Forest Service (USFS) Fire and Environmental Research Applications (FERA), 2014
- <sup>11</sup>Maranghides, 2014 National Institute of Standards and Technology.  
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- <sup>12</sup>Geospatial Measurement Solutions 2014 Camp Swift Data Integration  
<http://www.gmsgis.com/camp-swift-burns.html>
- <sup>13</sup>Lady Bird Johnson Wildflower Center, 2015.  
[http://www.wildflower.org/plants/result.php?id\\_plant=SCSC](http://www.wildflower.org/plants/result.php?id_plant=SCSC)