Remote Sensing Needs Assessment

Supporting Wildland Fire Research, Monitoring and Operations

Contributors in alphabetical order:

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Background and Objectives

Everett - untapped potential for public products derived from classified data to support needs of wildland fire operations, monitoring, and research

The remote sensing side needs to know specific **product requirements** to be developed through a collaborative needs-assessment process.

- Objective 1 (this discussion): Identify existing and prospective pre-, active-, and post-fire remote-sensing products:
  - Brainstorm (**work in progress!**)
  - Identify limitations that could be improved

- Objective 2 (collaborative across the wall): Propose, evaluate, and develop requirements

Objective 1 – Existing/prospective products and their limitations

Pre-fire phase:

- LANDFIRE fuel and vegetation maps
- Soil (SMAP) and live fuel moisture
- Tree mortality

Ignition / Active-fire phases:

- Fire detection (HAWKEYE)
- Fire Radiative Power (MODIS, VIIRS, GOES-R, others)
- Nighttime wildfire perimeters (NIROPS, FIREHAWK)
- Plume height and smoke transport monitoring

Post-fire phase:

- LANDSAT-derived soils effects (BAER), tree mortality (RAVG), and severity (MTBS)

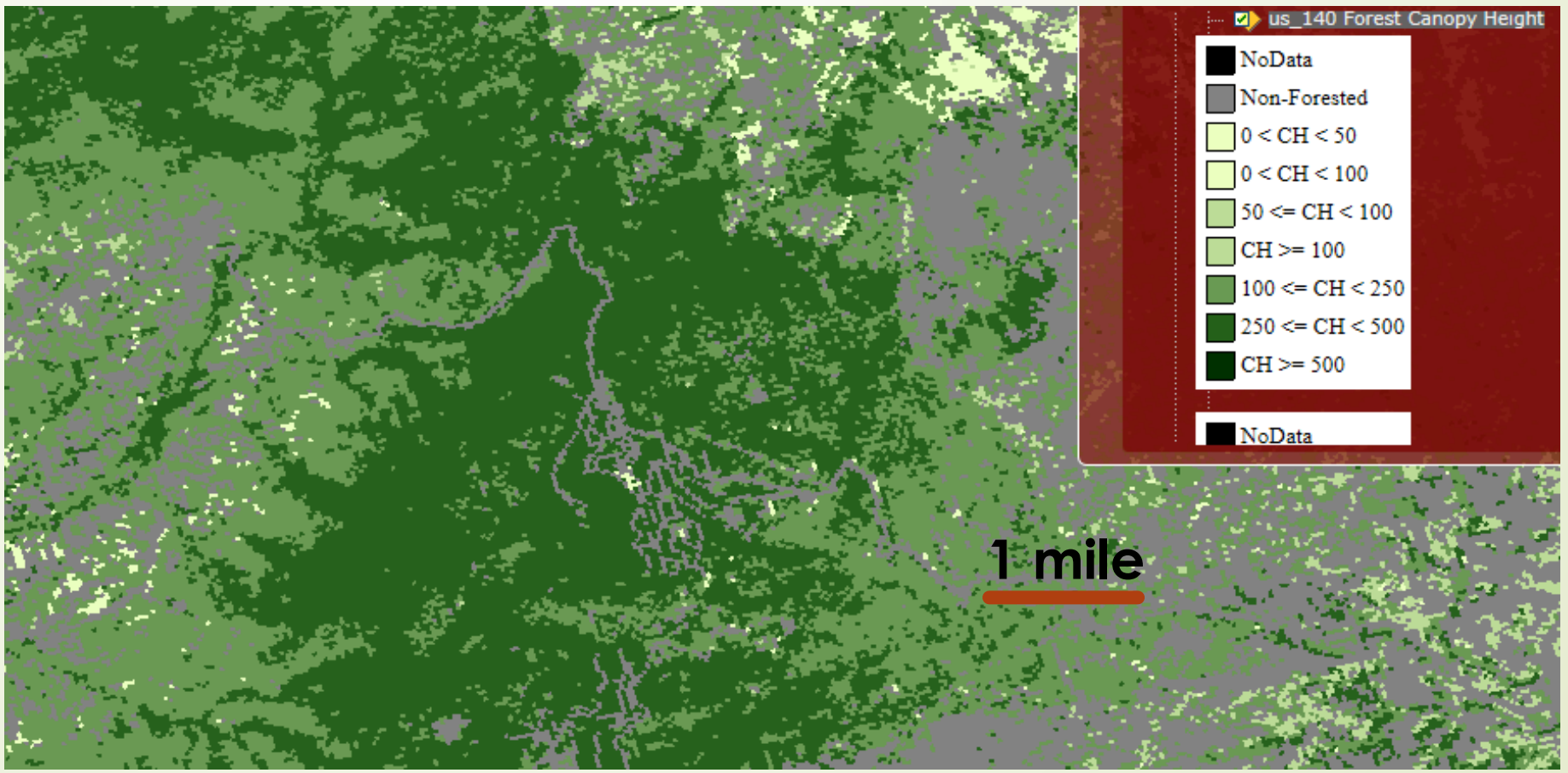
Objective 1 – Existing/prospective products and their limitations

Phase: Pre-fire

LANDFIRE nationwide spatial data used as inputs to predict wildfire growth (from WFDSS – the Wildland Fire Decision Support System)

Fire effects prediction in WFDSS later

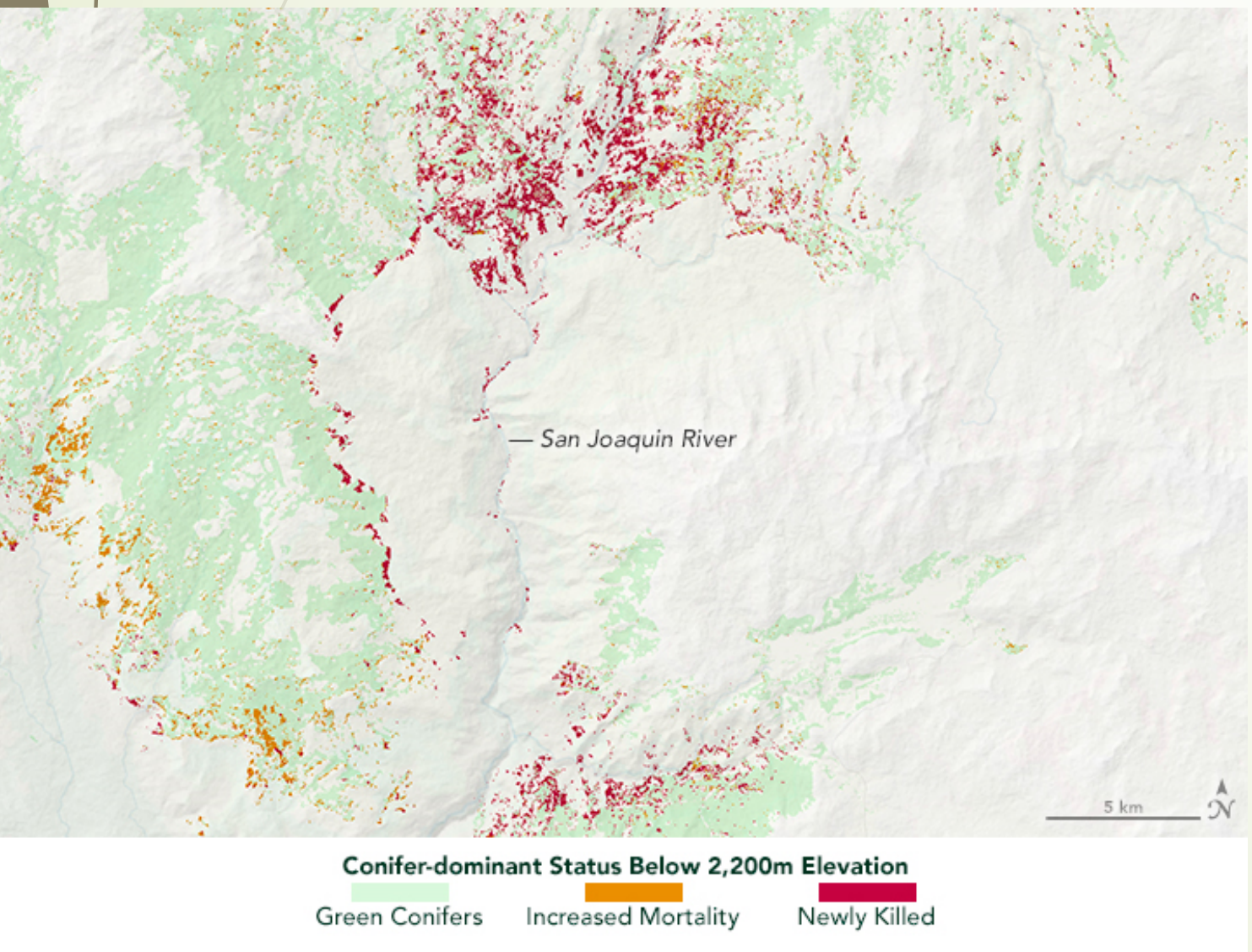
Product description	Use	Limitations	Means for improvement
Spatial layers of crown base height, tree height, canopy density	Wildfire growth projection	Poorly resolved spatially and inaccurate	Active remote sensing, stereo image analysis (Phodar), multispectral



Objective 1 – Existing/prospective products and their limitations

Phase: Pre-fire - Tree mortality for fire risk assessment

eDaRT (Ecosystem Disturbance and Recovery Tracking) – USFS Region 5, LANDSAT-based, time progression (Koltunov and others)



Other research products derived from LANDSAT and high-resolution multispectral imagery (e.g., from NASA's AVIRIS to the left)

Are improvements possible in future using other data sources?

Objective 1 – Existing/prospective products and their limitations

Phase: Pre-fire

NASA SMAP (Soil Moisture Active Passive)

Product description	Use	Limitation	Means for improvement
Soil moisture mapping from satellite-borne radar	Drought monitoring, live and dead fuel moisture prediction	Low resolution, instrument issues	Higher resolution data, redundancy

Ongoing research mapping **foliar moisture** using multispectral data (including thermal)

Objective 1 – Existing/prospective products and their limitations

Phase: ignition

Hawkeye – wildland fire detection

The **Hawkeye Fire Detection and Reporting System** is a program which uses airborne and space borne remote sensing assets to rapidly detect and report new fire starts within the continental United States. Detected fire starts are relayed to the **Ignition Point Database** (IgPoint) operated and managed by the Forest Service.

Product description	Use	Limitations	Means for improvement
Wildland fire detection	Rapidly detect and report new fire starts	Commission errors?	?

Objective 1 – Existing/prospective products and their limitations

Phase: Active fire

Orbital and geosynchronous satellite fire monitoring of **Fire Radiative Power** (FRP)

Product description	Use	Limitations	Objective for improvement	Means for improvement
FRP from orbital satellites (e.g., MODIS, VIIRS)	Fire detection, US and global fire monitoring, large wildfire operations	MWIR signal saturation, sub-pixel flame fronts/fires, off-nadir degradation (e.g., high latitudes, edges of scan)	Better define sub-pixel fire characteristics and measurement error	Provide coincident FRP, flame-front perimeters, and flame-front spread rates
FRP from geosynchronous satellites (e.g., GOES-R)	US and global fire monitoring	Sub-pixel flame fronts/fires (improved!), off-nadir degradation	Better define sub-pixel fire characteristics and measurement error	Provide coincident FRP, flame-front perimeters, and flame-front spread rates

Objective 1 – Existing/prospective products and their limitations

Phase: Active fire

Firehawk and NIROPS (USFS National Infrared Operations) nightly **wildfire perimeters** to support wildfire incidents

Firehawk = Aircraft 3

Improvement: new automated daytime progression product based on data underlying Hawkeye?

Product description	Use	Limitations	Objective for improvement	Means for improvement
Wildland fire perimeters at nighttime	Wildfire operations support	Nighttime only at ~24 hour interval	Daytime perimeters, 1-hour repeat during active periods	Use Hawkeye data in new ways?

Objective 1 – Existing/prospective products and their limitations

Phase: Active fire

What about **plume height** and **smoke transport** monitoring?

Objective 1 – Existing/prospective products and their limitations

Phase: Post fire

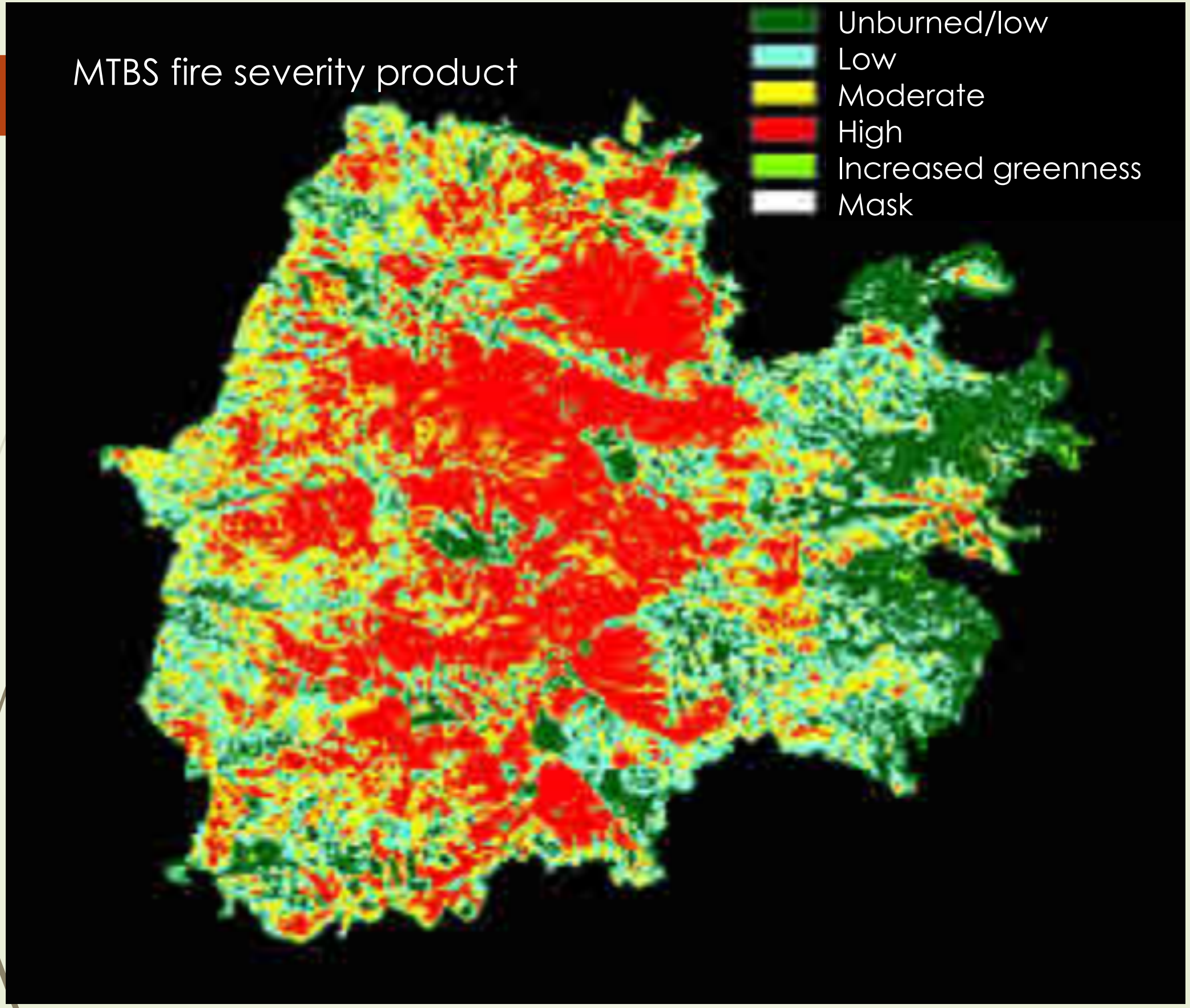
Fire effects (soils, trees, severity) monitoring for US:

- Burned Area Emergency Response (BAER)
- Rapid Assessment of Vegetation Condition after Wildfire (RAVG)
- Monitoring Trends in Burn Severity (MTBS)

LANDSAT 30m data – esp. contrast between NIR and MWIR highlights greenness change

Delivery schedule:

- BAER – days after incident
- RAVG – weeks to months after incident
- MTBS – following year


MTBS fire severity product
Unburned/low
Low
Moderate
High
Increased greenness
Mask

Objective 1 – Existing/prospective products and their limitations

Phase: Post fire

Fire effects (soils, trees, severity) monitoring for US:

- Burned Area Emergency Response (BAER)
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Product	Use	downsides	Objective for improvement	Means for improvement
BAER, RAVG, MTBS	US wildfire effects monitoring to guide response and monitor	LANDSAT re-imaging frequency is long (~18 days), cloud free problematic, no associated fire behavior information at similar resolution	Fill in gaps caused by low reimage frequency/ cloud issues, associate severity with fire behavior at similar scale	Coincident FRP, flame-front perimeters, flame-front spread rates, more cloud-free imaging

Objective 2 – Propose, evaluate, and develop requirements

Avenues for improving existing products and developing new products:

1. New uses of existing public data
2. New uses of existing non-public data
3. Development of future platforms and sensors

Requirements guided by needs assessment

My view: #2 can't advance much except collaboratively and iteratively between the public and non-public sides (with knowledgeable users being able to join in non-public discussion)

Upcoming Research Projects As Testbeds for Solutions

Team/Project	Description	Timing	Information needs	Means for improvement
Fire Behavior Assessment Team (FBAT)	Evaluating effects of heavy tree mortality on western (esp. Sierra Nevada/USFS Region 5) wildfire behavior	Fire season 2017 and beyond	Peak burning period crown fire spread rates & spotting behavior	Use Hawkeye data in a new way?
FIREChem/FIREX	Smoke transport and chemistry measurements on wildfires and prescribed fires in forest, rangeland, grassland, & cropland	Fire season 2019	Peak burning period flame front spread rates and FRP	Use Hawkeye data in a new way?
Fire and Smoke Model Evaluation Experiment (FASMEE)	Prescribed fire coordinated measurements project	2019 – 2021	Flame front spread rates and FRP	Use Hawkeye data in a new way?

Opportunistic Research Projects As Testbeds for Solutions

Generally: data for fire model evaluation

Data-driven fire modeling (data assimilation)

Team/Project	Description	Timing	Information needs	Means for improvement
Coupled Atmosphere-Wildland Fire Environment Model (CAWFE), other WRF-based activities	Data-driven fire modeling that combines model-based forecasting with periodic evaluation/ correction against data	Fire season 2017 and beyond (in coordination with research group)	Fire perimeters & peak burning period crown fire spread rates	Use Hawkeye data in a new way?

Summary/Discussion

Phase	Product (existing or potential)	Need
Pre-fire	Upgrading LANDFIRE fuel structure layers	Higher resolution passive and active
Pre-fire	Soil moisture	Higher resolution active
Pre-fire	Live fuel moisture and tree mortality	High resolution multispectral
Ignition	Fire detection	TBD
Active-fire	FRP mapping	Higher time and spatial resolution
Active-fire	Fire perimeters	Daytime perimeters and fire spread
Active-fire	Plume and smoke	TBD
Post-fire	LANDSAT-derived soil, tree, and severity maps	Associated fire behavior information, more options for cloud-free imagery