Supporting RxCADRE Fire Measurements Unmanned Aerial Systems

4th Fire Behavior and Fuels Conference, Raleigh North Carolina

February 21, 2013

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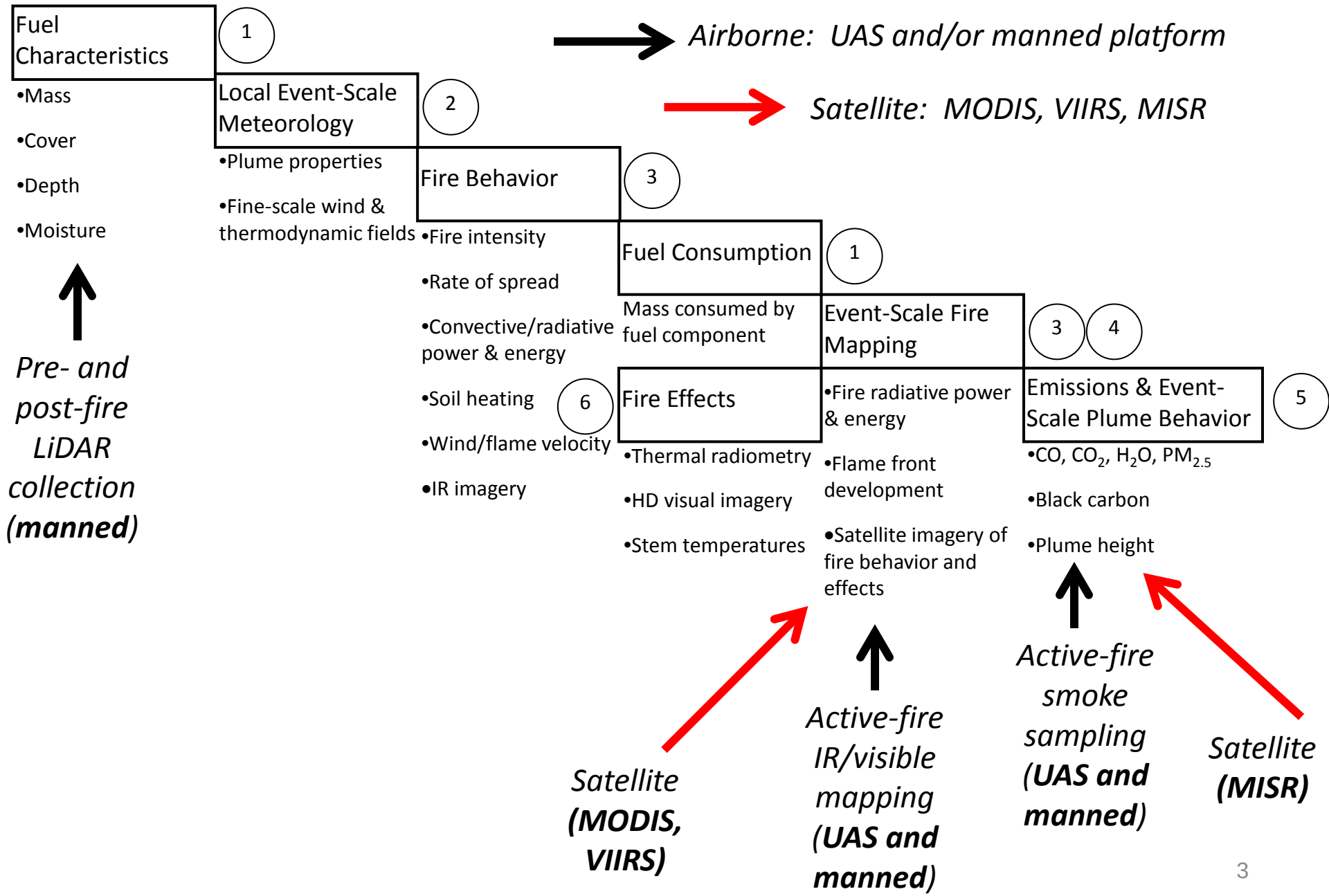
USDA Forest Service, Remote Sensing Applications Center,
FSWeb: http://fsweb.rsac.fs.fed.us
WWW: http://www.fs.fed.us/eng/rsac/

RxCadre 2011

- RxCADRE – Prescribed Fire Combustion Atmospheric Dynamics Research Experiments
- Eglin AFB February 3-6, 2011.
- 3 UAS – USGS Raven, Prioria Maveric, G2R
- Flights were successful, demonstrated that sUAS is capable of collecting scientific measurements over controlled burns

Rx-CADRE Airborne Measurements - overview



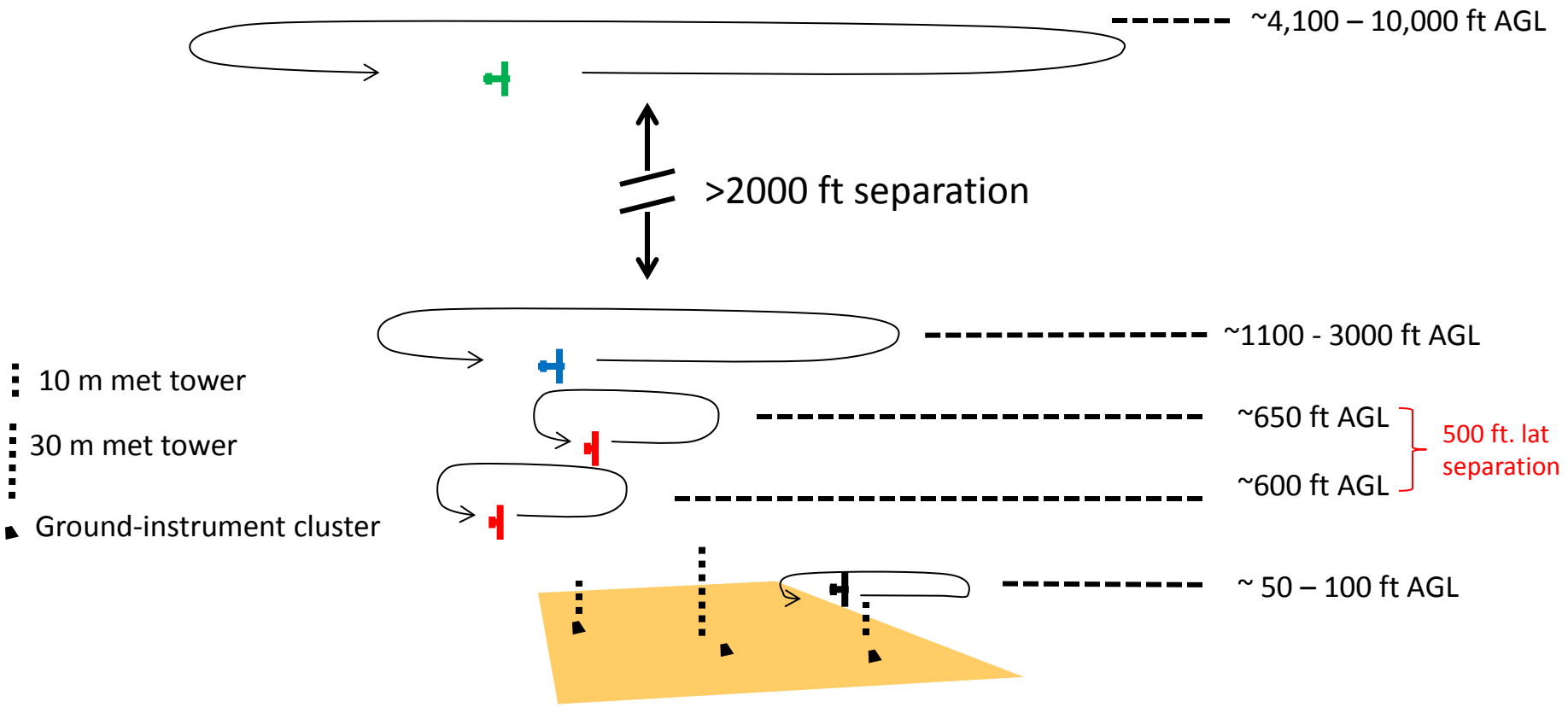
3 Types of UAS

Additional aviation assets

- Cessna 337 – Smoke Sampling
- Piper Navaho – Fire Imaging
- EPA Tethersonde – Smoke Sampling

Rx-CADRE Active Fire Measurements – Large Units (500-1000 acres)

Active fire measurements



Manned — Piper Navajo – WASP sensor (LWIR/MWIR/SWIR and visible fire mapping at zenith)

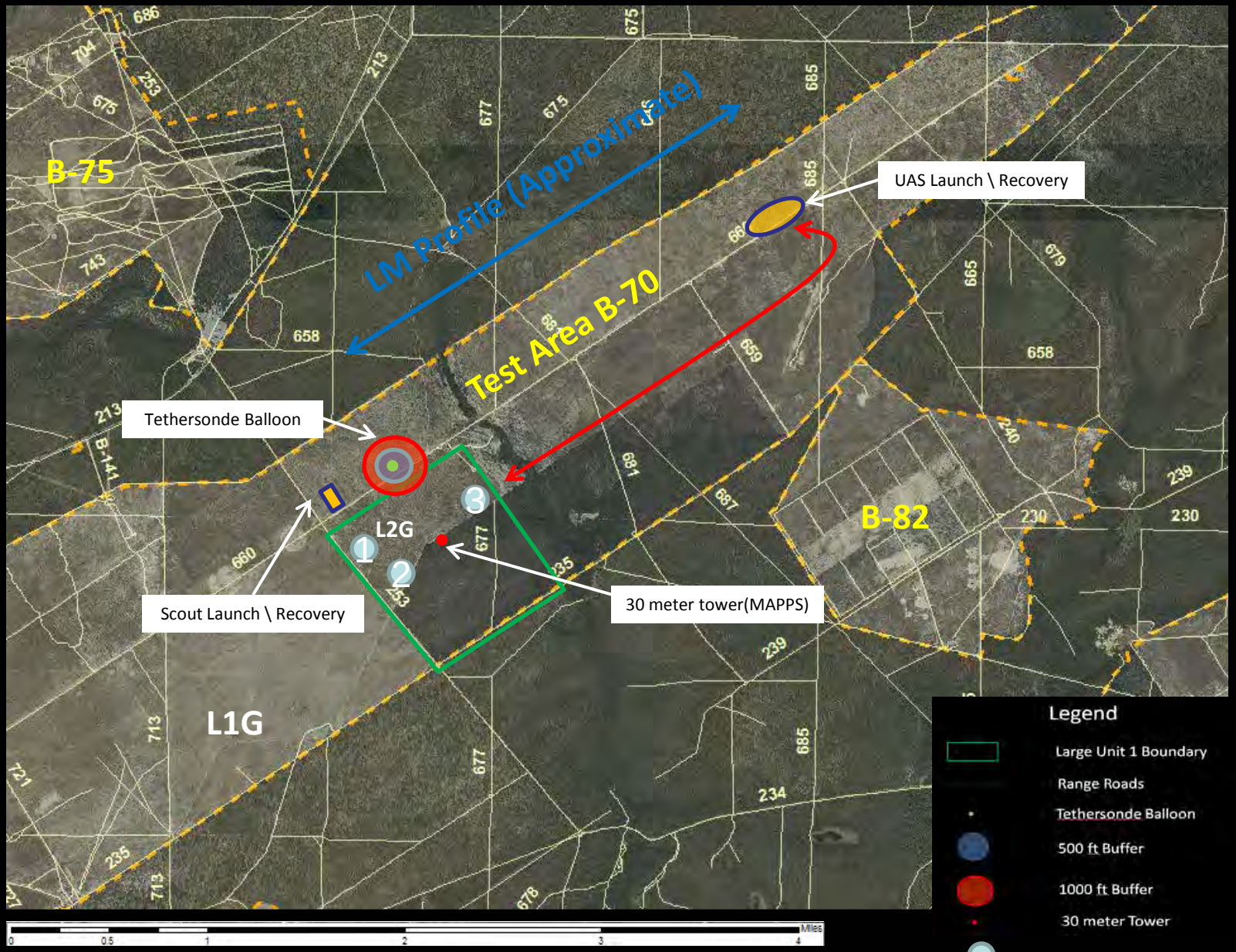
UAS
- UAF Scout – LWIR, Flight 1 HIP-3, Flight 2 as directed
- EAFB Test Wing G2R1, G2R2 – LWIR smoke sensor, wind, T, and RH sampler, F1 HIP-1, HIP-2; F2 MAPPS
- U. Alaska ScanEagle – LWIR synoptic view

NOTE: Cessna 337 smoke sampling aircraft is downwind following plume ~1000 - 8000 ft AGL

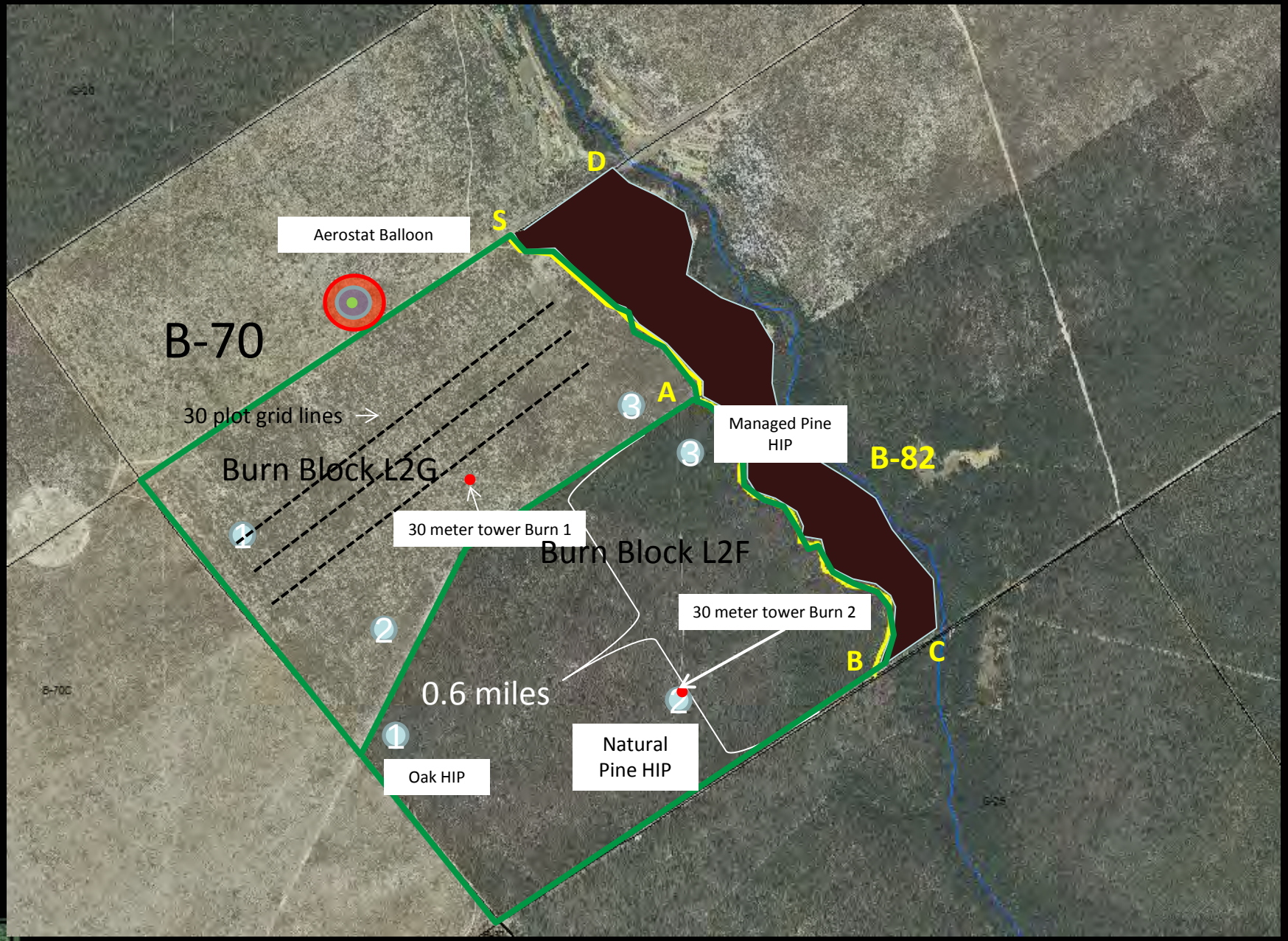
B70L2G Manned/Unmanned Schedule November 10, 2012 V2

All times approximate, based upon ignition time

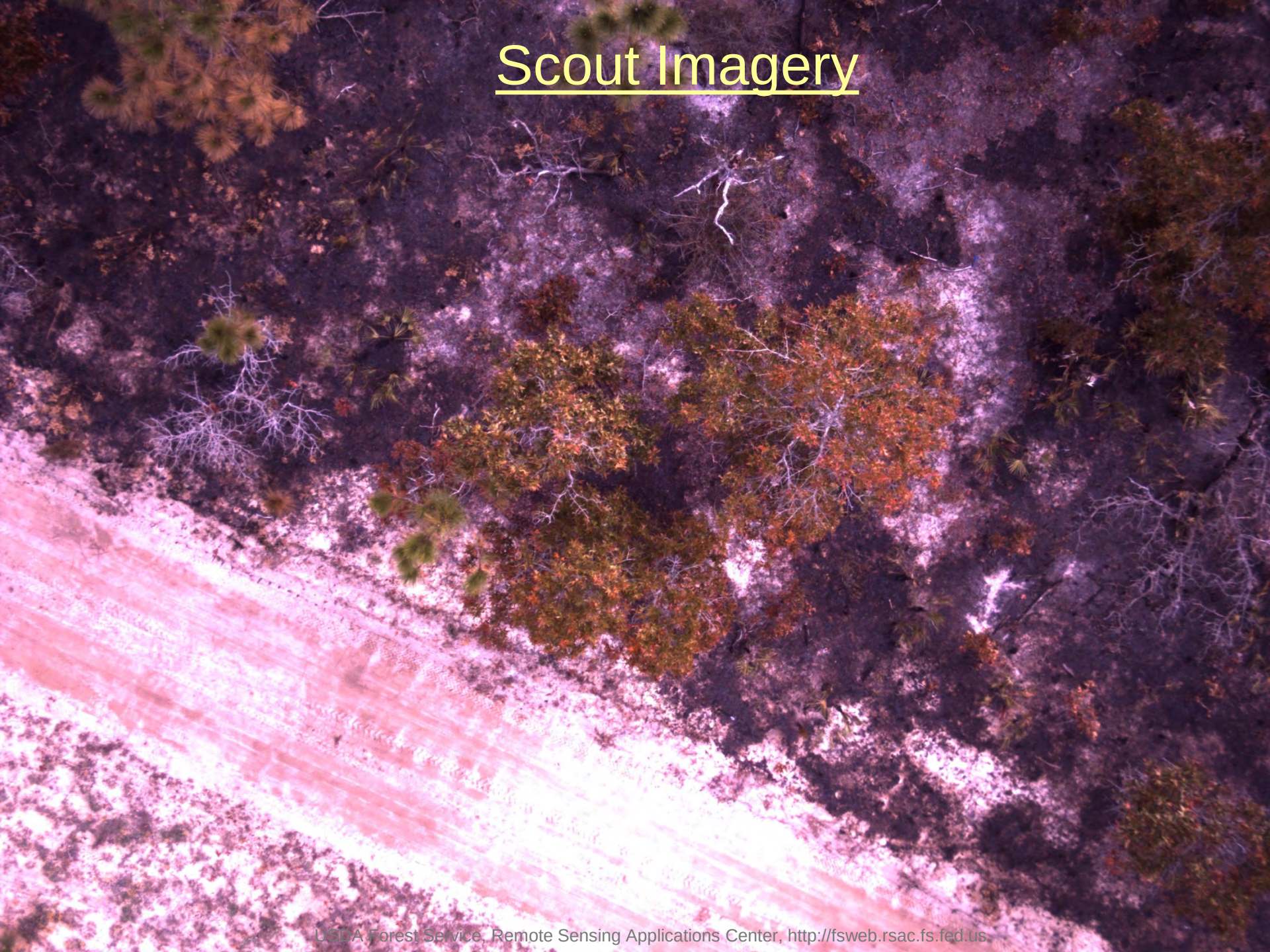
- 1000 Launch Weather Balloon 1
- 1000 Get MAPPs and Thethersonde coordinates.
- 1100 Launch Scan Eagle (SE)—1500 AGL
- 1115 Launch Low Manned (LM) (Urbanski, Smoke Sampling)
- 1130 Launch High Manned (HM) (Kremens, WASP)
- 1150 Low Manned begins sampling over B70L2G once SE Upwind LG1
- 1220 IGINITION
  - Launch Scout
  - Raise Tethersonde to 300 ft. AGL
  - Launch G2R1
  - Launch G2R2
  - LM Cleared to Orbit as desired North of Range Downwind
  - HM Orbit 6000 – 10000 ft. AGL over L2G
  - SE Orbit 1100 – 3000 ft. AGL over L2G
  - G2R1 – G2R2 Orbit 600/650 ft. AGL , 500 ft. lateral separation over HIP 2 – 3
  - Scout Orbit 50 – 100 ft. AGL HIP – 1
- 1235 Retrieve Scout once HIP – 1 is burned over
- 1235 Focus SE imagery over MAPPS
- 1240 Re-launch Scout (As needed / Directed)
- 1242 Satellite Overpass VIIRS
- 1243 Satellite Overpass MODIS
- 1245 Retrieve G2R1
- 1300 Retrieve G2R2
- 1305 Burnout Complete
  - Retrieve SE once LM confirms it is clear of B70 (Tree Line) or above 5000 ft. AGL
  - Retrieve G2R1
  - Release HM
- 1330 Lower Tethersonde
  - Confirm LM has departed
  - Confirm HM has departed B70
  - Confirm SE has landed
  - Confirm no RxCadre Aircraft Manned/Unmanned are airborne
- 1400 Launch Weather Balloon
- 1430 Release Airspace



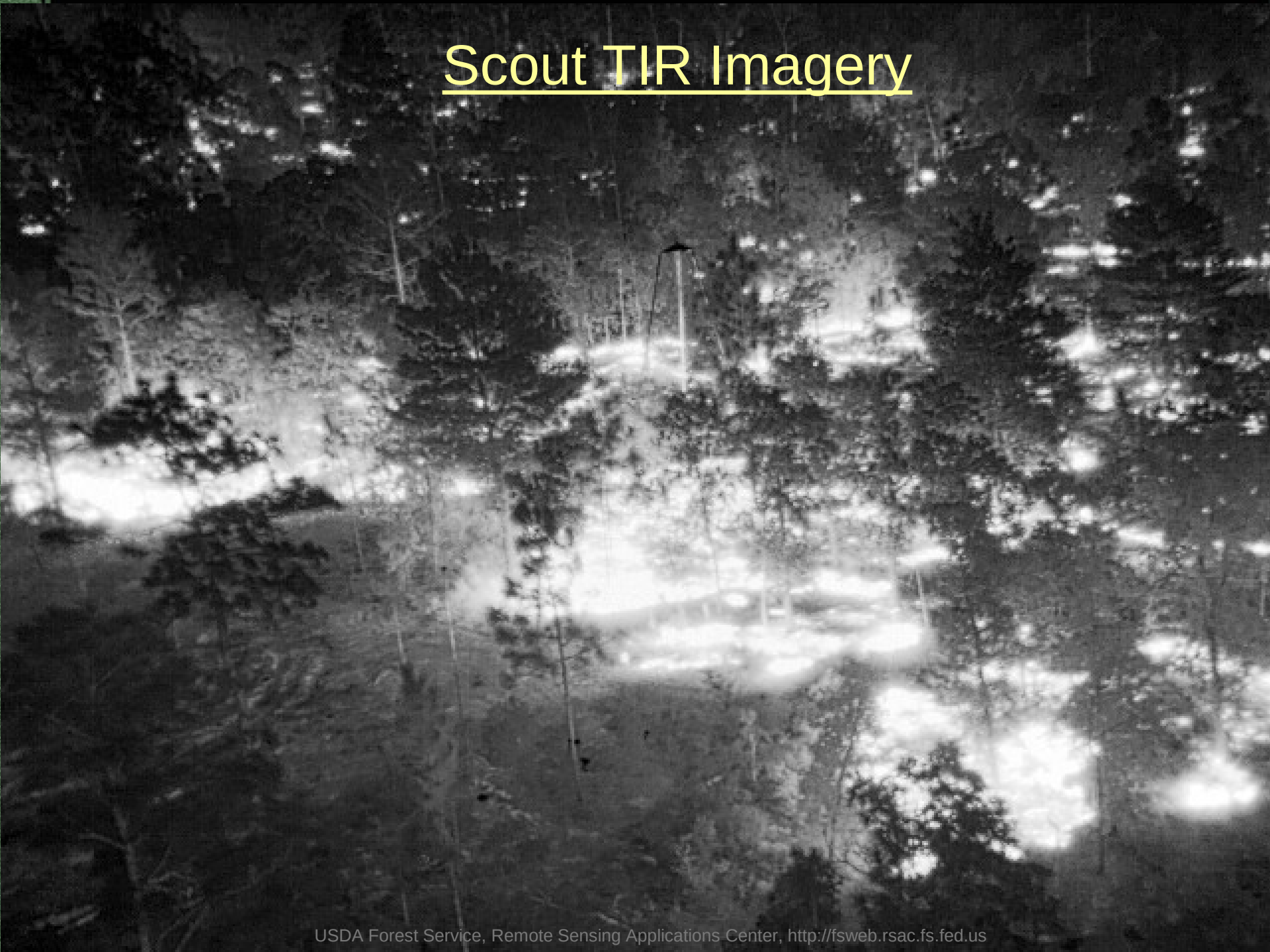
B70L2G Air Plan 10Nov12


D
S
Aerostat Balloon
B-70
30 plot grid lines
A
3
Managed Pine HIP
B-82
Burn Block L2G
30 meter tower Burn 1
Burn Block L2F
1
2
30 meter tower Burn 2
B
C
0.6 miles
2
1
Natural Pine HIP
Oak HIP
N

Scout Imagery

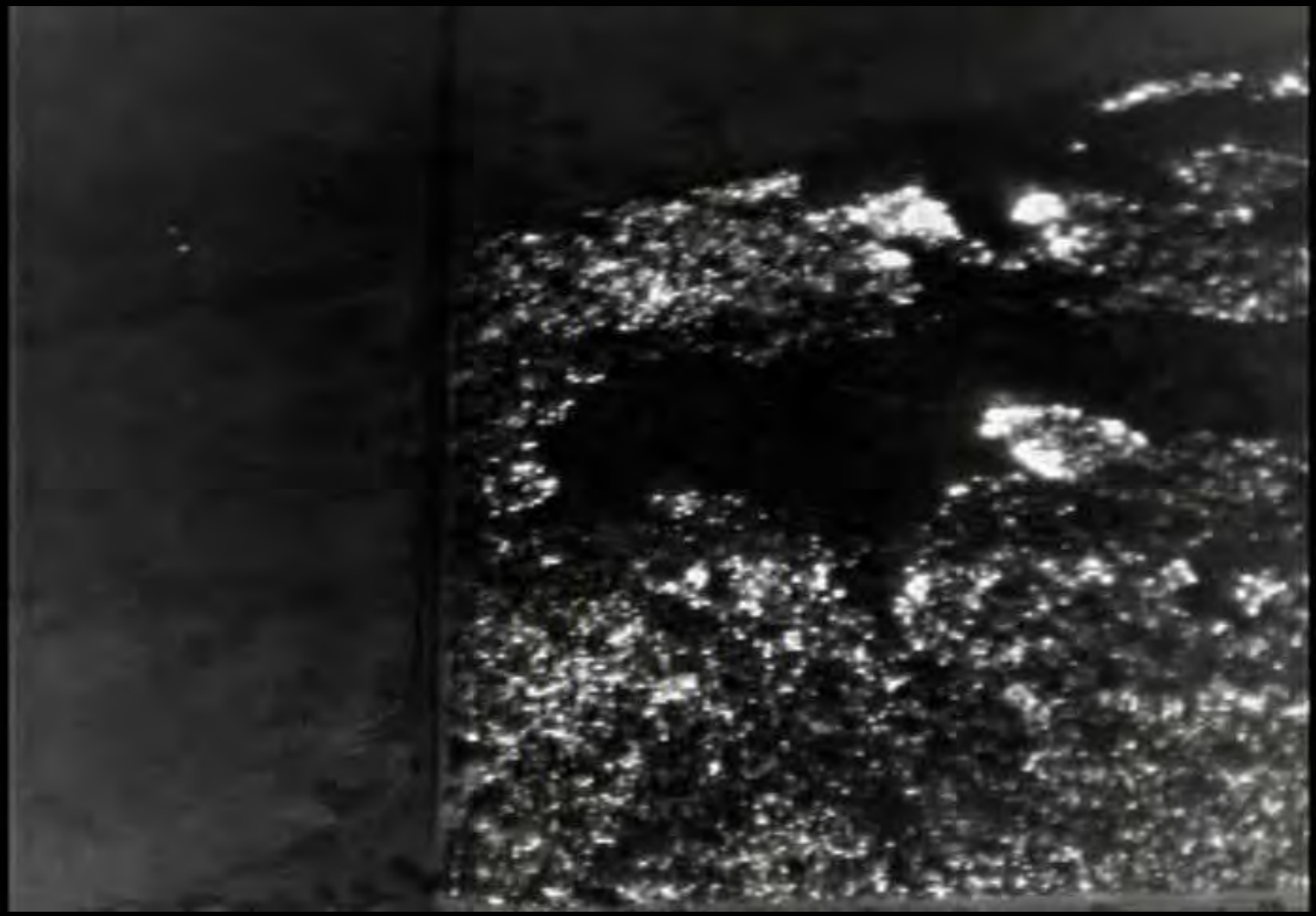


Scout TIR Imagery

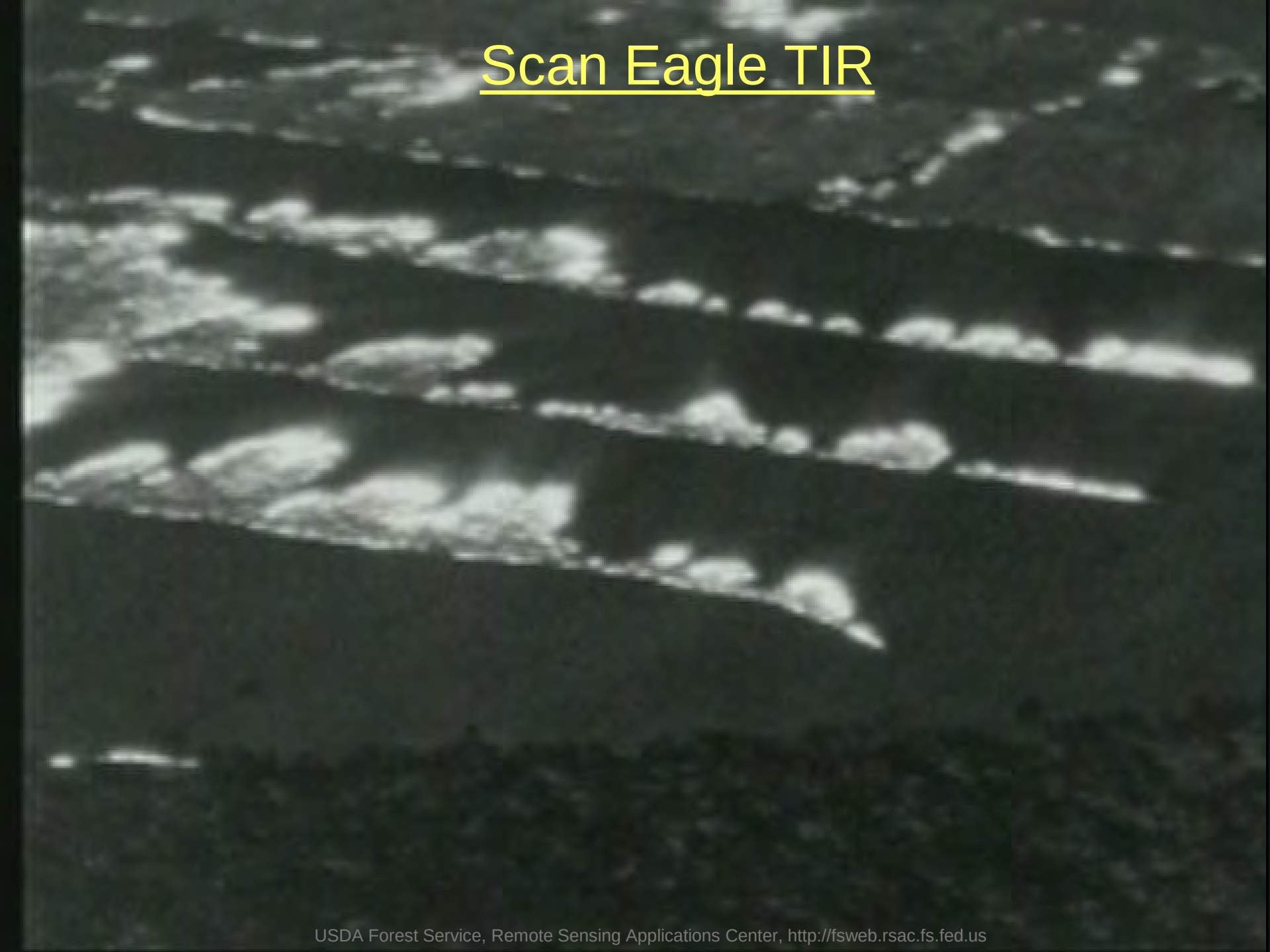


USDA Forest Service, Remote Sensing Applications Center, http://fsweb.rsac.fs.fed.us

Scan Eagle Video



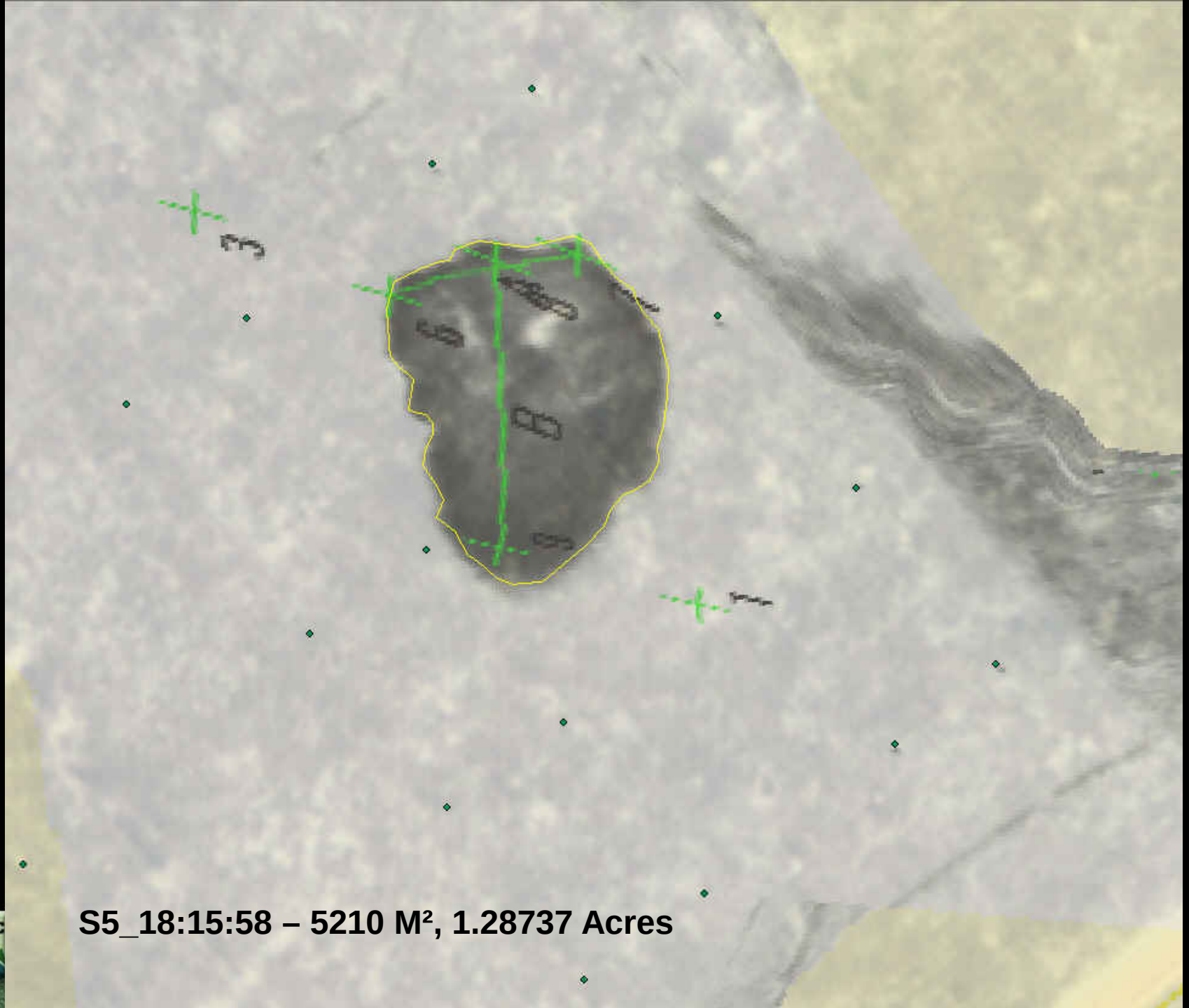
Scan Eagle TIR



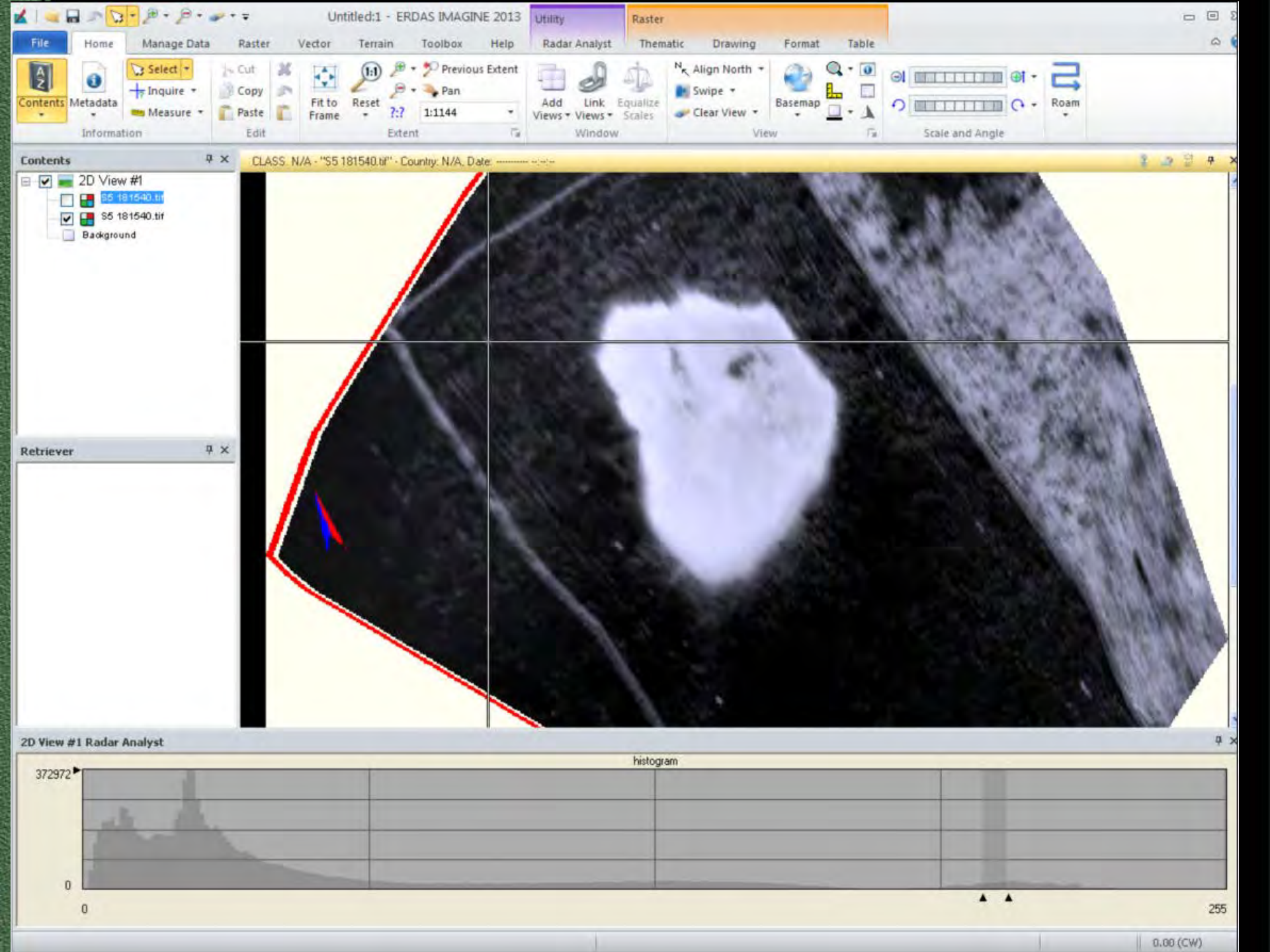
G2R Video

Sarnoff TerraSite

S5_18:15:58 – 5210 M², 1.28737 Acres



S5_18:15:58 – 5210 M², 1.28737 Acres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Utility
Raster
File
Home
Manage Data
Raster
Vector
Terrain
Toolbox
Help
Radar Analyst
Thematic
Drawing
Format
Table
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Fit to Frame
Reset
Previous Extent
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Extent
Add Views
Link Views
Equalize Scales
Window
Align North
Swipe
Clear View
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Basemap
Roam
Scale and Angle
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Retriever
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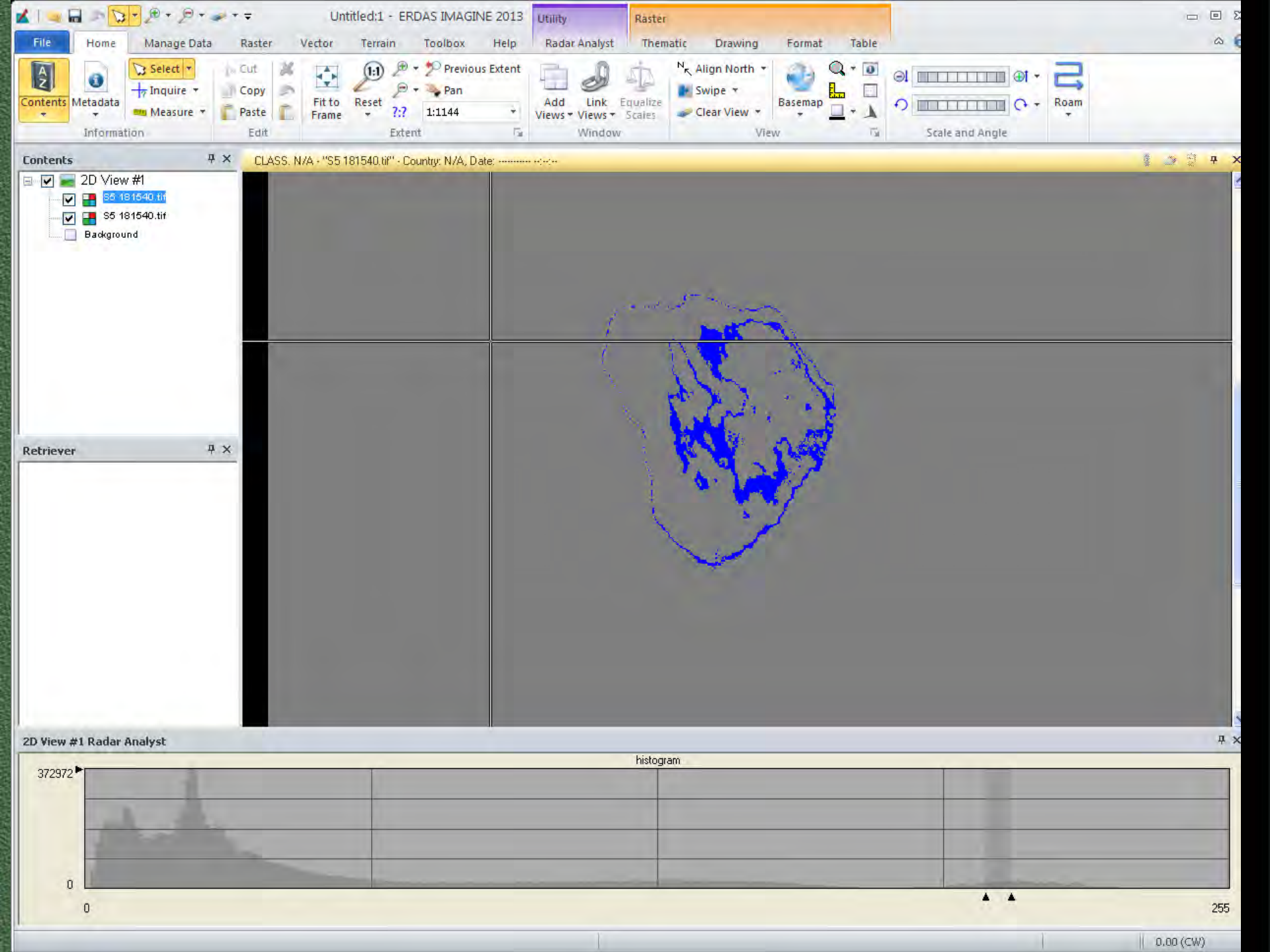
Untitled:1 - ERDAS IMAGINE 2013
Utility
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Retriever
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2D View #1 Radar Analyst
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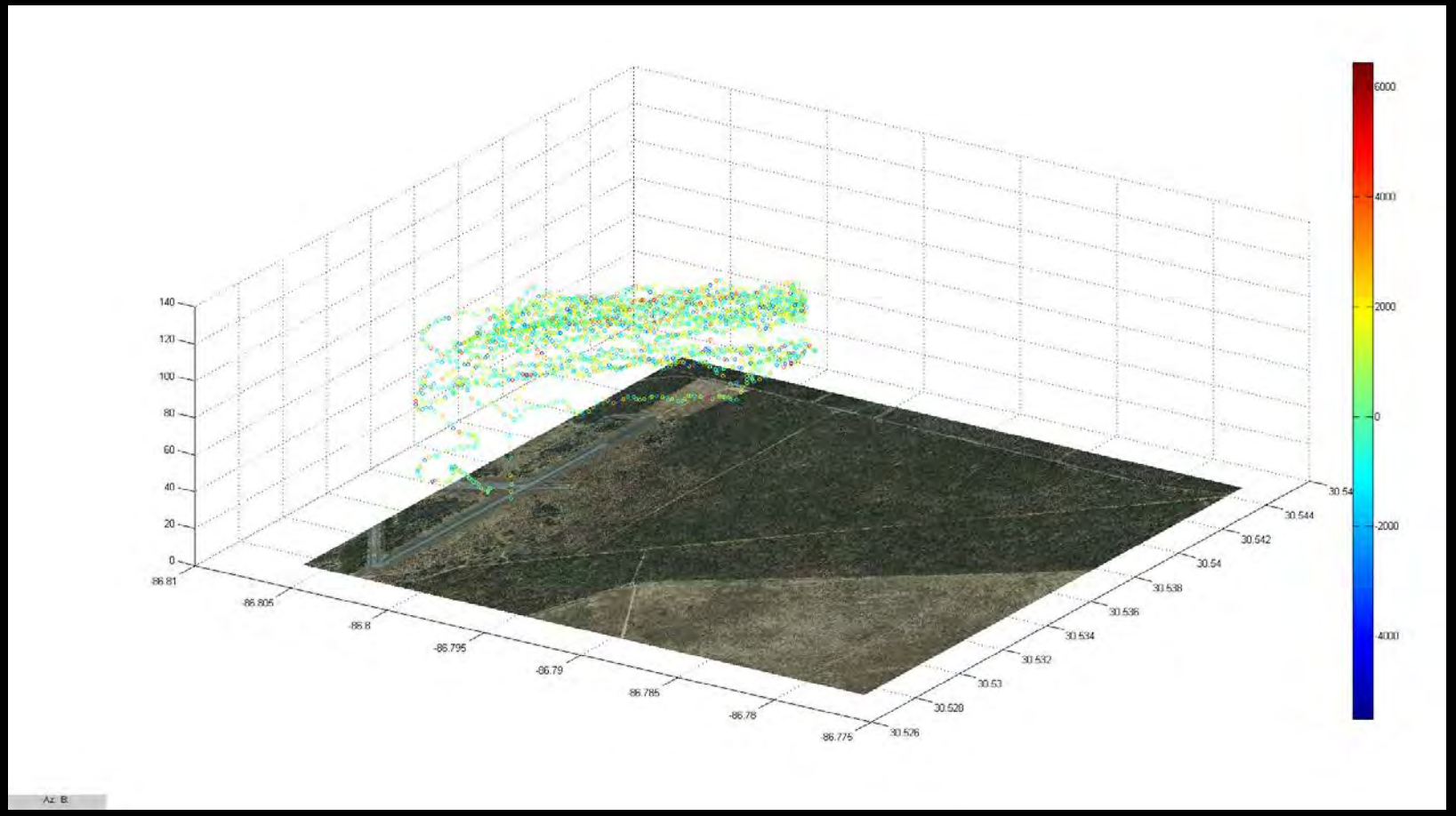
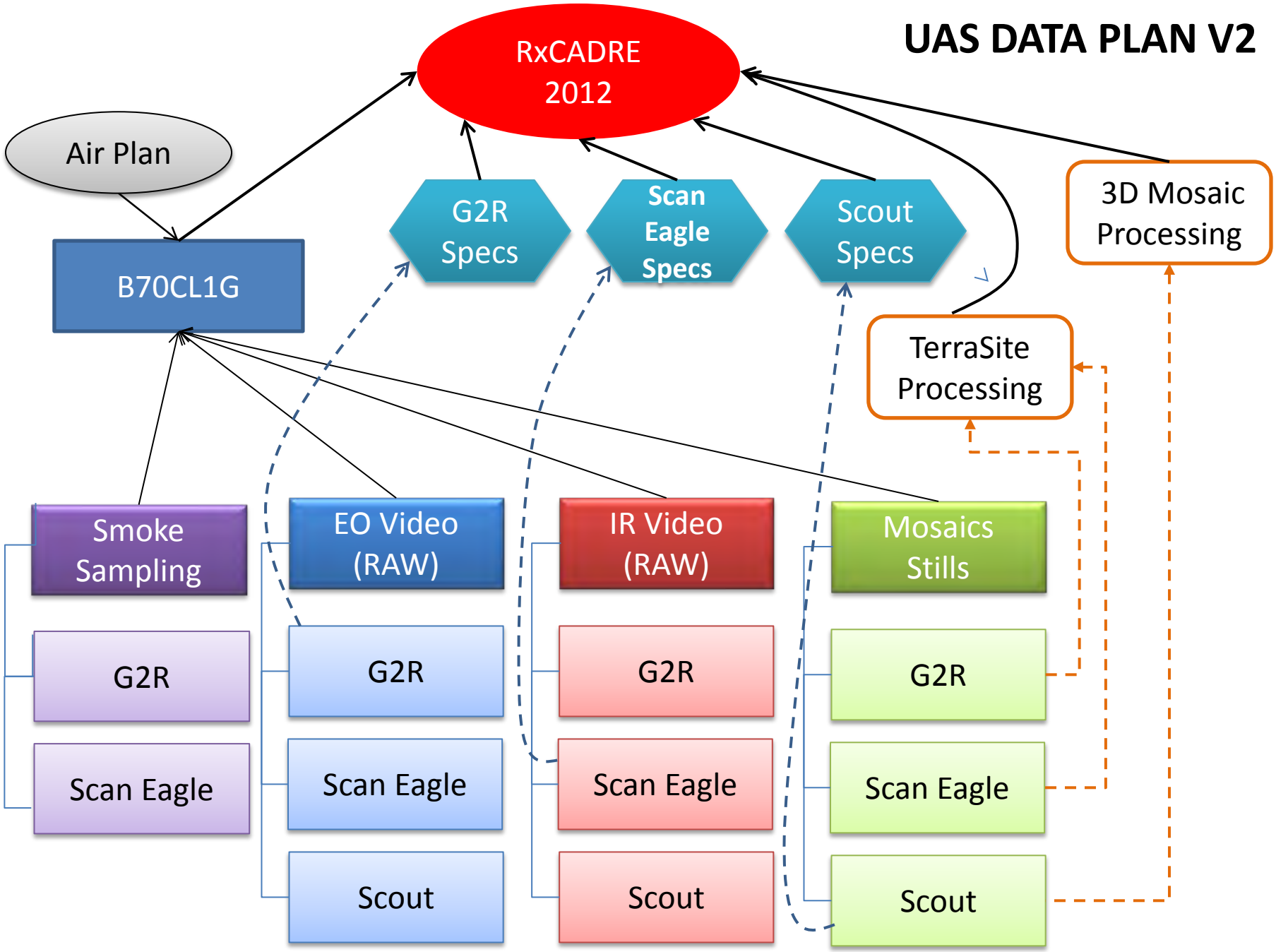
G2R Meteorological /Black Carbon



Delivered as kmz, shapefiles, txt???


UAS DATA PLAN V2
RxCADRE 2012
Air Plan
B70CL1G
G2R Specs
Scan Eagle Specs
Scout Specs
3D Mosaic Processing
TerraSite Processing
Smoke Sampling
G2R
Scan Eagle
EO Video (RAW)
G2R
Scan Eagle
Scout
IR Video (RAW)
G2R
Scan Eagle
Scout
Mosaics Stills
G2R
Scan Eagle
Scout

NASA SBIR/STTR Technologies

Airborne Wide Area Imager for Wildfire Mapping and Detection

Contract No. NNX09CA09C

PI: John M Green
Xiomas Technologies

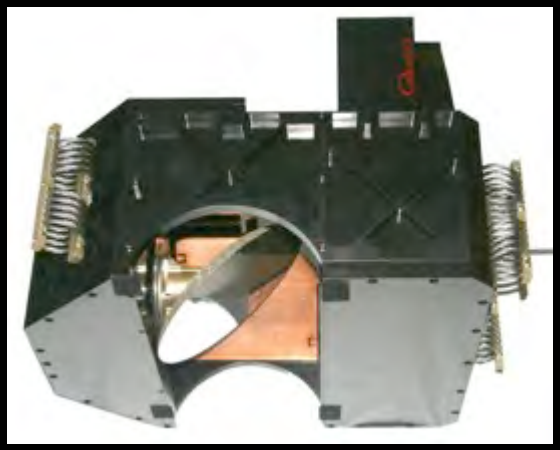
Identification and Significance of Innovation

An autonomous airborne imaging system for earth science research, disaster response, and fire detection is proposed.

The primary goal is to improve information to researchers and operations personnel at reduced cost. By operating autonomously and with higher spatial resolution, the system will deliver a 3X to 4X reduction in operating costs compared to current systems.

The system uses a two color Quantum Well Infrared Photo detector (QWIP) to improve the accuracy of energy release from wildfires, thereby improving our understanding of the carbon cycle.

Expected TRL Range at the end of Contract (1-9): 7



Xiomas Wide Area Imager Sensor Head

Technical Objectives and Work Plan

1) Detect 8-inch diameter, 600°C hot spots, while imaging the day and night ground terrain through smoke from an altitude of 30,000 to 40,000 feet.
2) Generate fuel loading and burn area classification maps.
3) Locate the image pixels to a map accuracy of 10 meters.
4) Image terrestrial features with dimensions of around 2 meters in order to observe natural and man-made fire barriers.
5) Transmit geometrically corrected and classified imagery in near real time to a centralized spatial data base.
6) The airborne system must be capable of autonomous or remote operation.
7) The airborne instrument must small enough for light aircraft or UAV installations

NASA and Non-NASA Applications

NASA:
- Unmanned Airborne System and Sensor Development
- Fire Detection and Mapping Research
- Research into the Development of Automated Sensors
- Carbon Cycle Research

US Forest Service:
- Reduced cost of National Infrared Operations
- Real Time Fire Detection and Mapping

DHS:
- Disaster Response
- Border Patrol

Firm Contacts

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1317 Skyway Drive
Ypsilanti, MI 48197
734-646-6535

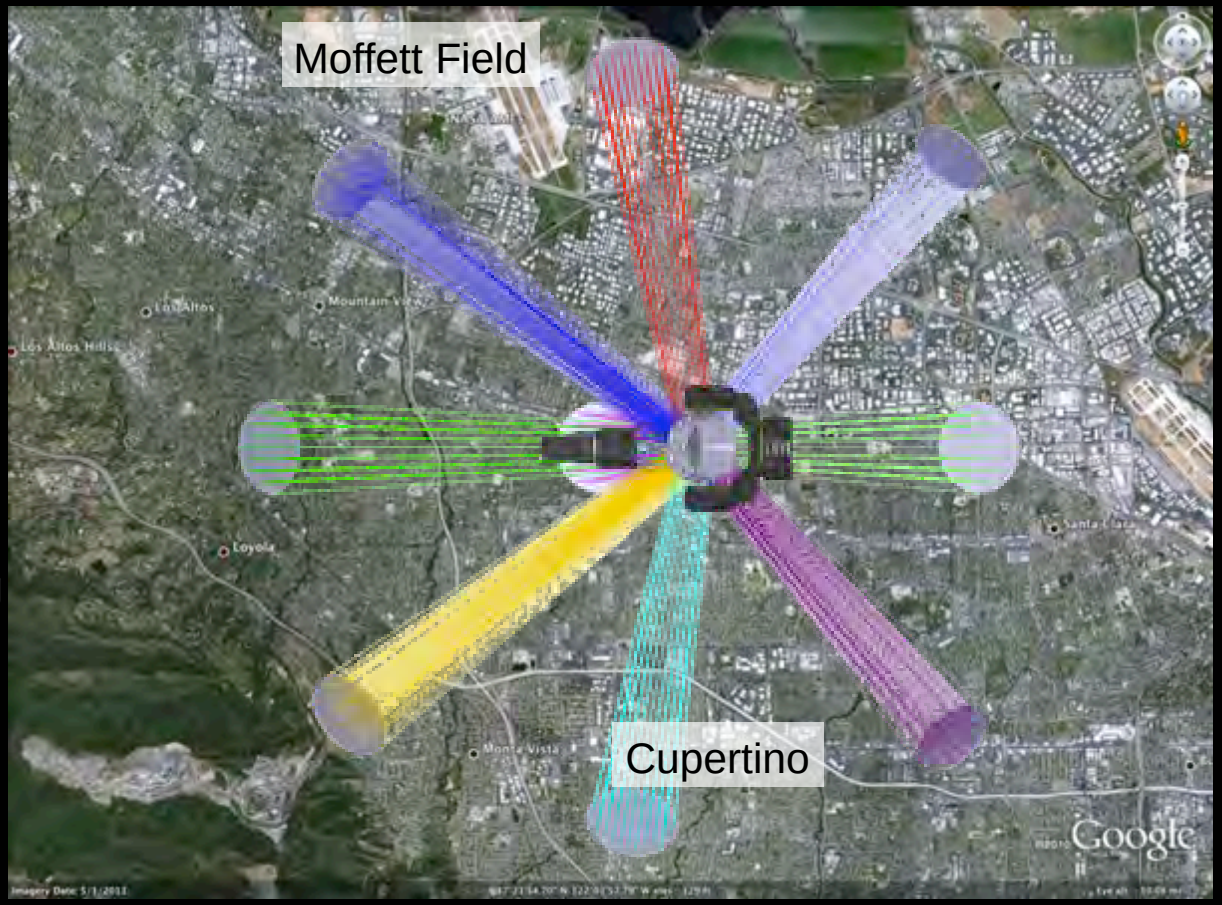
NON-PROPRIETARY DATA

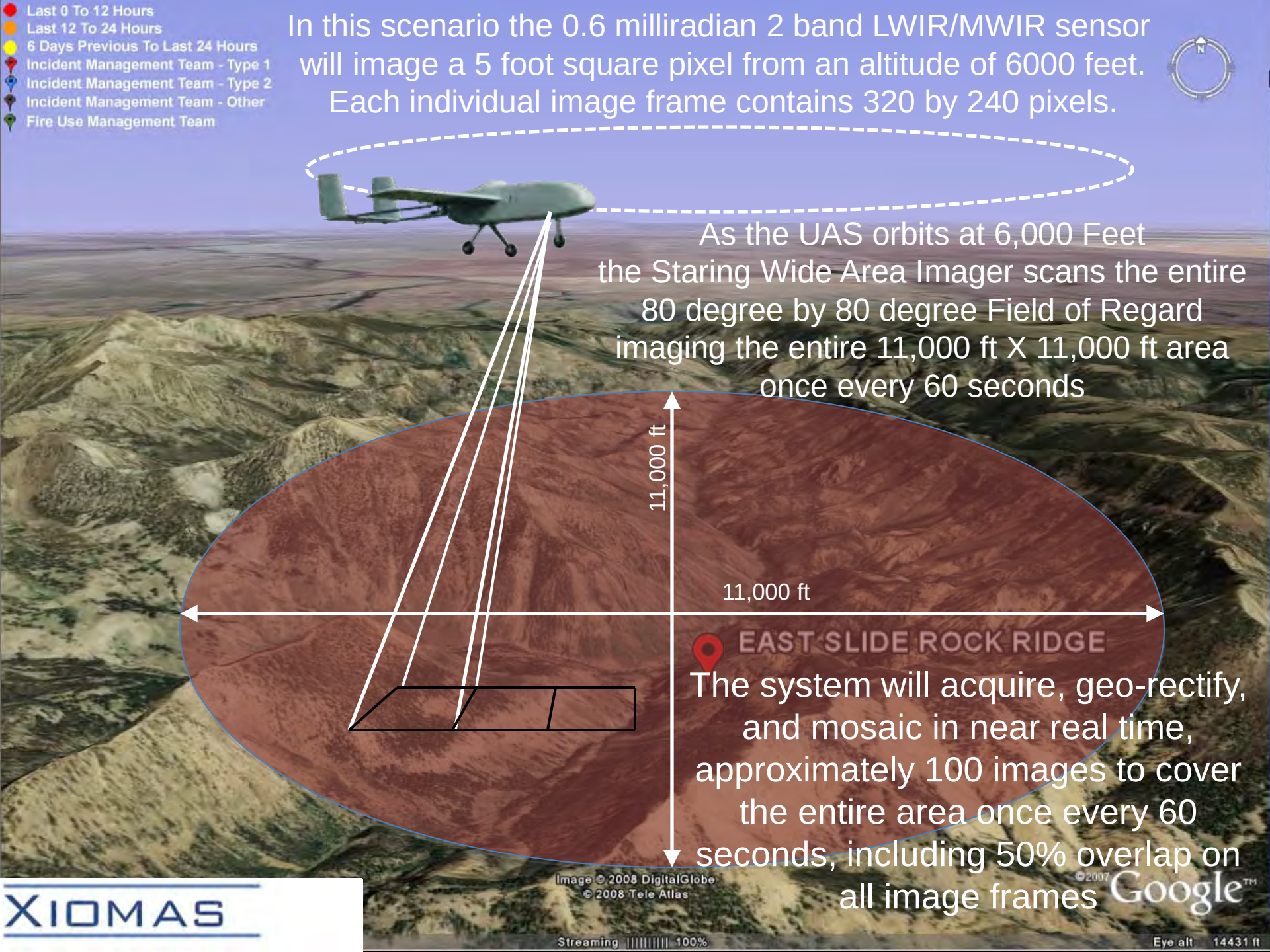
#1 Scroll (0.07979)
#1 Band 1:Line4Mosaic16bitLW.tif
File
Overlay
Enhance
Tools
Window

StareWAI

In this scenario the 0.6 milliradian 2 band LWIR/MWIR sensor will image a 14 foot square pixel from an altitude of 23,000 feet. As the aircraft orbits at 23,000 Feet the Staring Wide Area Imager scans the entire 80 degree by 80 degree Field of Regard, imaging the entire 8 mile diameter area once every 60 seconds -- acquiring, geo-rectifying, and mosaicing in near real time, approximately 100 images to cover the entire area once every 60 seconds. This calculation includes 50% overlap on all image frames

- LWIR (8 to 9 um)
- MWIR (4 – 5 um)
- SWIR 1.6 um
- 600 urad instantaneous field of view
- ground sample distance of approximately 14 feet from our notional operating altitude of 23,000 feet.
- At this altitude the system will be capable of detecting a 6 inch by 6 inch 600 degree C fire.
- 8 Mile Diameter Field of Regard




Last 0 To 12 Hours
Last 12 To 24 Hours
6 Days Previous To Last 24 Hours
Incident Management Team - Type 1
Incident Management Team - Type 2
Incident Management Team - Other
Fire Use Management Team
In this scenario the 0.6 milliradian 2 band LWIR/MWIR sensor will image a 5 foot square pixel from an altitude of 6000 feet. Each individual image frame contains 320 by 240 pixels.
As the UAS orbits at 6,000 Feet the Staring Wide Area Imager scans the entire 80 degree by 80 degree Field of Regard imaging the entire 11,000 ft X 11,000 ft area once every 60 seconds
11,000 ft
11,000 ft
EAST SLIDE ROCK RIDGE
The system will acquire, geo-rectify, and mosaic in near real time, approximately 100 images to cover the entire area once every 60 seconds, including 50% overlap on all image frames
Image © 2008 DigitalGlobe
© 2008 Tele Atlas
©2007 Google™
Streaming 100%
Eye alt 14431 ft
XIOMAS

Comments/Questions

Thank you to JFSP for funding this endeavor.

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