Autonomous Modular Sensor (AMS) Update

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Tactical Fire Remote Sensing Advisory Committee (TFRSAC)
Boise, Idaho
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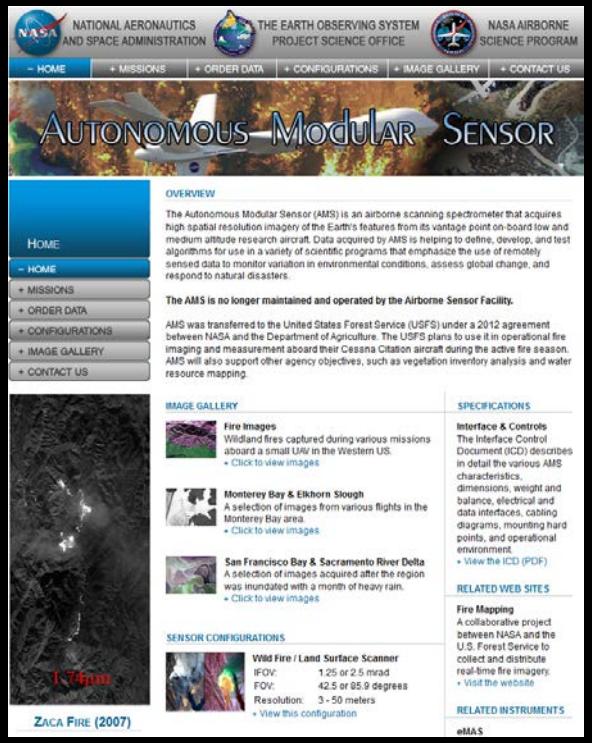
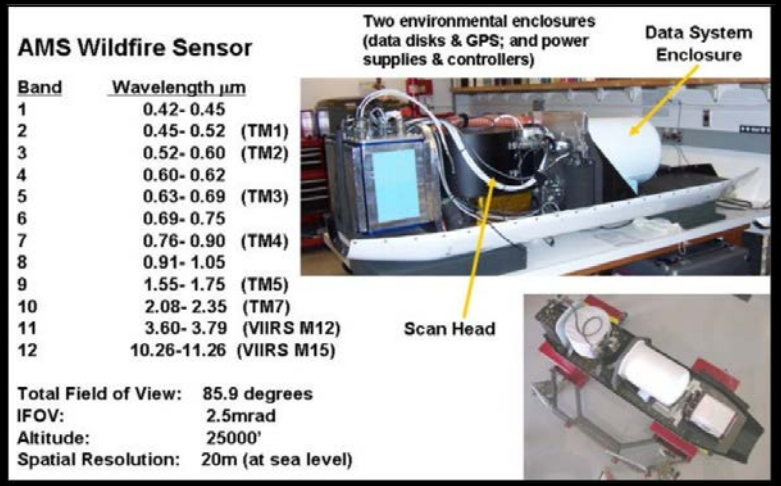
Autonomous Modular Sensor (AMS)

- 16 band multispectral scanner
- Multi-mission capability
- Developed by NASA Ames and UC Santa Cruz
- Used extensively since 2006 for wildfire mapping & Cal/Val activities
  - Western States Fire Missions
  - Targeted active fire/post-fire incident support
  - USFS tactical fire support operations





AMS Timeline

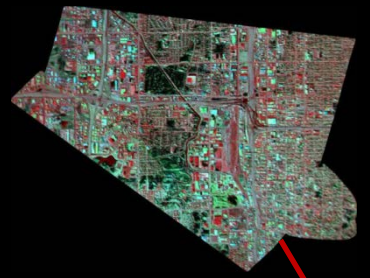
AMS integrated on Altair; flies Esperanza Fire, Oct 2006

AMS flies No. CA Lightning Storm Wildfires, Summer 2008

AMS flies Station Fire Post-Fire Assessment, Nov 2009

AMS Integrated on NASA B200 KA, December 2010

First Test Flight Data From AMS on Citation, March 2013

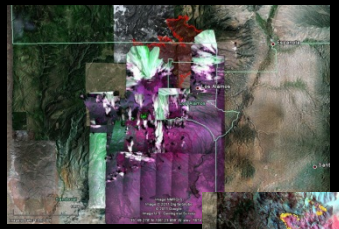


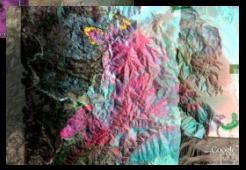
2006 2007 2008 2009 2010 2011 2012 2013

AMS integrated on Ikhana; flies four Western States Fire Missions covering eight states and +20 fires, summer 2007

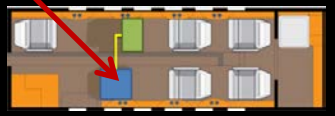
AMS flies So. CA Firestorm missions; Oct. 2007

AMS flies Los Conches NM Wildfire & 2 So. CA Wildfires





AMS Integrated on USFS Citation jet (144Z)



Courtesy of V. Ambrosia

2014-2015 AMS Testing/Integration Activities

- Collaborative effort on a limited budget!!!
  - NIFC/NIICD IR Branch, R4 F&AM, NASA Ames, RSAC
- Schedule
  - Typically conduct annual test flights from March through late May
- Missions
  - 15 target areas flown
    - Rx fires
    - Post-fire areas
    - Forest areas affected by pests/pathogens
  - Two 2014 wildfire incidents (multiple days)
- Significant test objectives/goals
  - Forest Service IR technician training
  - Refinement of onboard processing (OBP) system for NRT data production/delivery
  - Remote command and control of sensor from the ground

2016 AMS Testing/Integration Activities

- No testing/integration missions conducted
  - 144Z not available due to upgrade/maintenance schedule
  - AMS readiness after “overhaul”

AMS Integration Support Contract

- 5 year IDIQ Contract
  - One base and four option years; August 2015 - 2020
- Year 1 Tasks (primarily OBP enhancements & technical support activities)
  - Provide AMS Testing/Integration Mission Support
  - Implement AMS Algorithm Refinements/Updates
  - Implement Improved Histogram Matching/Tone Balancing for Mosaic Products
  - Enhance/Support AMS System & FS AirCell Integration
  - Implement AMS System Navigation/Flight Data Display
  - Develop and Implement AMS Boresight Process Automation
  - Develop/Maintain AMS Technical/Software Documentation
  - Provide Consultation and Technology Transfer
- Year 2 Tasks
  - Post mission processing system development

Identifying a USFS Platform for AMS

- 3rd Aircraft Proposal (N182Z)
  - Submitted to F&AM in 2015
    - Coordination with R8 and WO F&AM
  - FS Fire Imaging Technology Working Group developing requirements to ensure multi-mission capability
    - Sensor port/pod installation
    - AirCell system installation
  - Potential mission scope
    - Tactical fire support “surge” aircraft; daytime fire missions
    - Post-fire/post-storm assessment
    - Forest health monitoring
    - Cal/Val of satellite products

Multi-Mission Platform Proposal

March 2015, V4

A Proposal Submitted to US Forest Service
Fire and Aviation Management

Prepared By:

/S/_____
National Remote Sensing Program Manager
WO ENG/GMO, USDA Forest Service

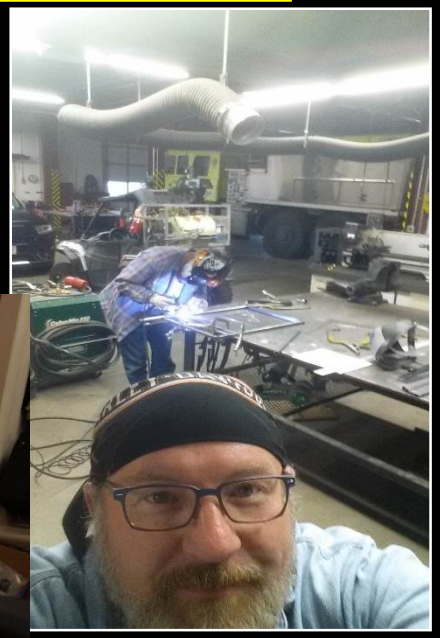
Approved By:

/S/_____
Deputy Director
WO F&AM, USDA Forest Service

AMS “Overhaul” & Current Status

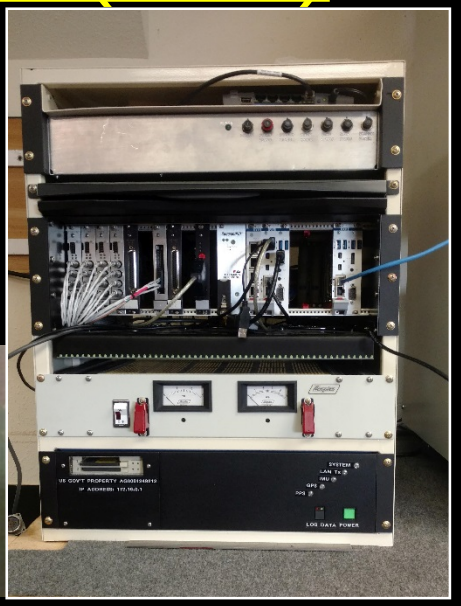
Winter 2015/2016 AMS "Overhaul"

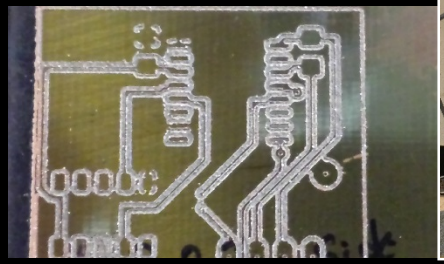
- NIFC/NIICD IR Branch Redesign
  - Designed and manufactured 19" rack/operator console
  - Built new fan cooling system

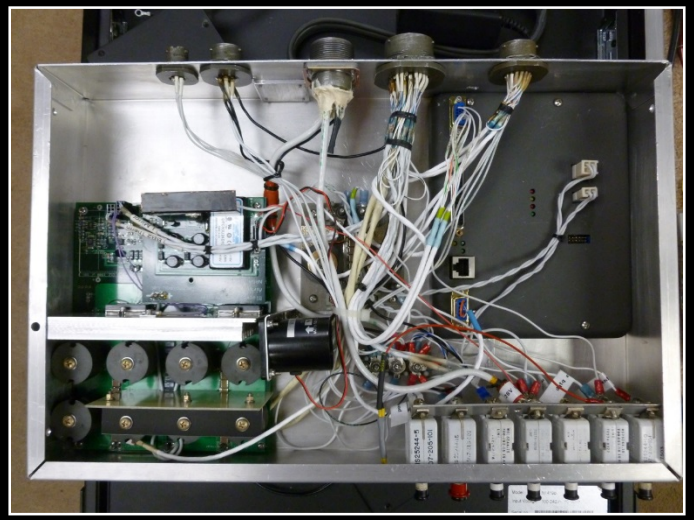


Winter 2015/2016 AMS “Overhaul” (cont.)

- Collaboration between NIFC/NIICD IR Branch and NASA Ames
  - New 19” rack/operator console
  - New UAVSys and LinkMod computers
  - New 12V rack mounted power supply
  - New WiFi router
  - New card cage for data acquisition unit, new computers, CPU power supply & related equipment
  - New cooling system for rack equipment
  - Etc., etc.







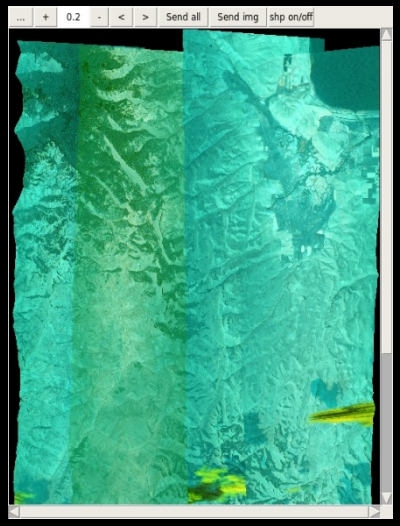
AMS Software, Algorithm & Processing Updates

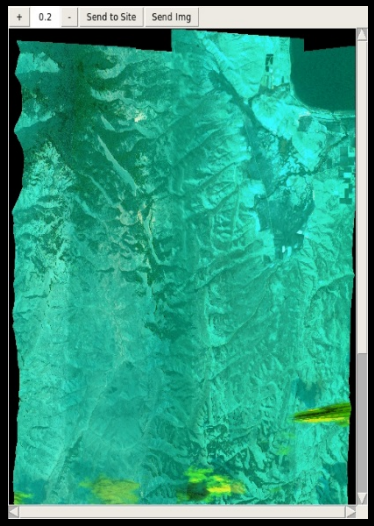
Histogram Matching

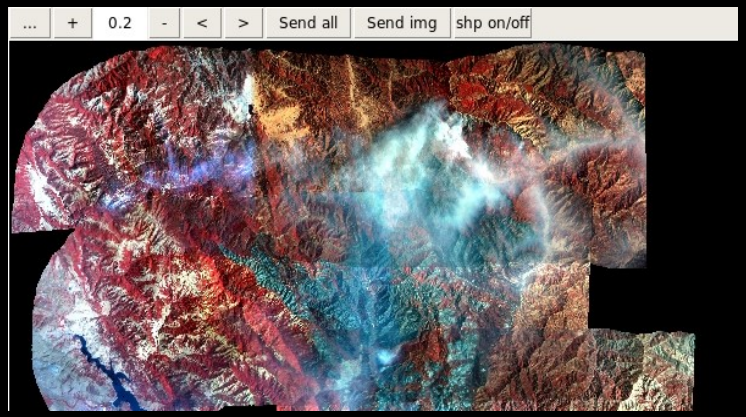
Standard Algorithm

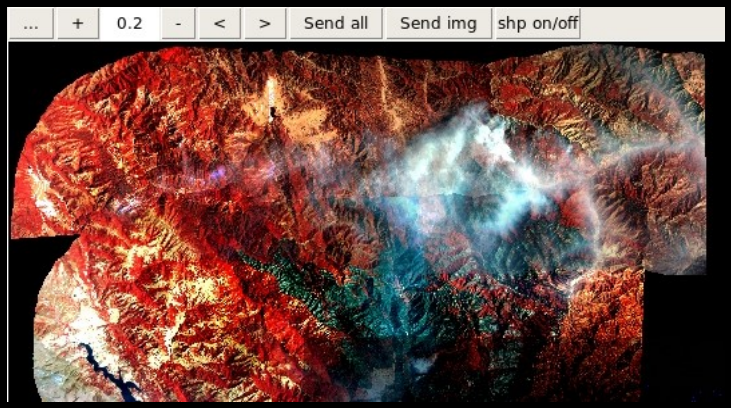
overlap or full image
no masking or edge treatment

Right: bands 10,11,12 rgb
Below: Lick Fire bands 7,5,3 rgb



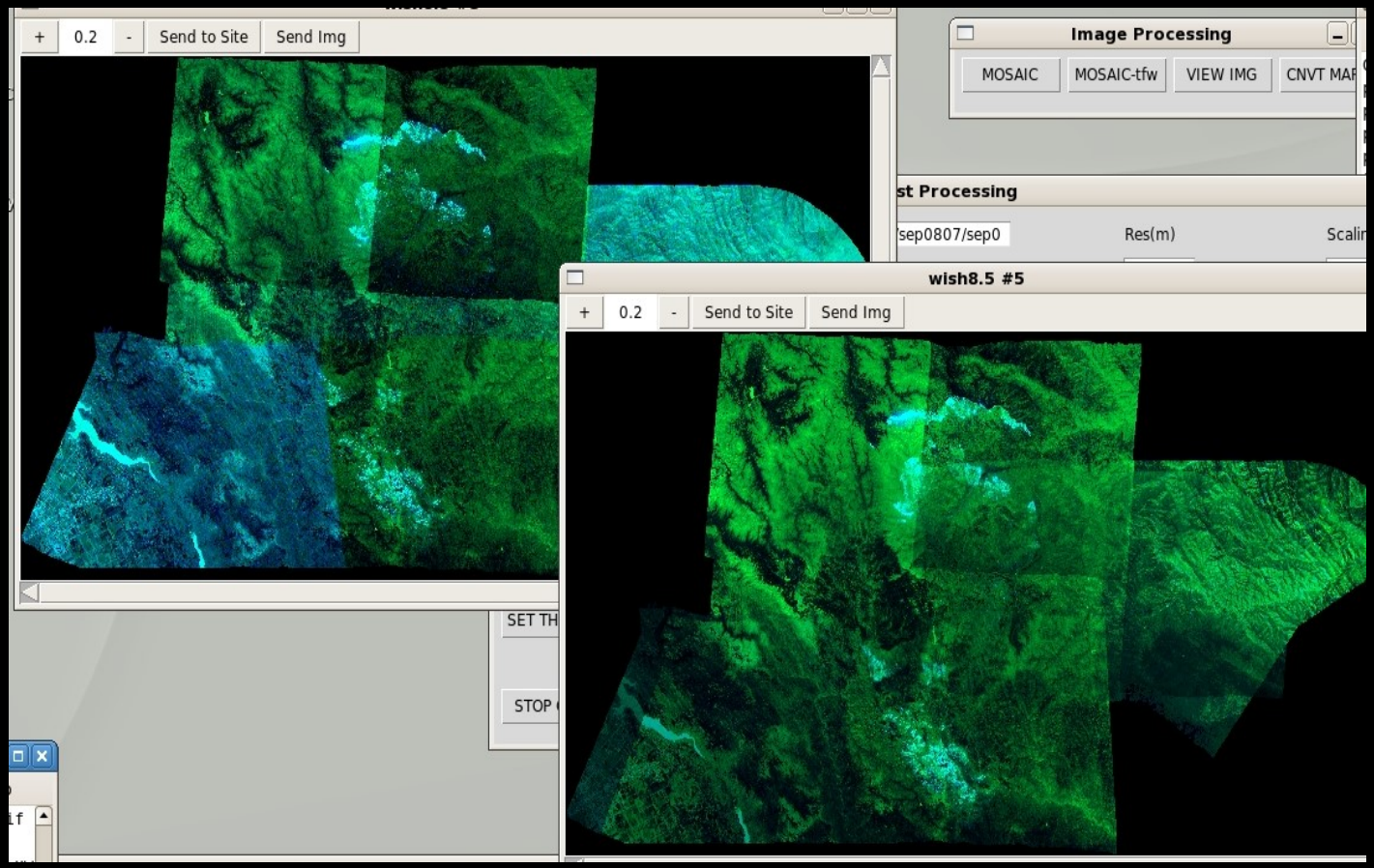






Histogram Matching

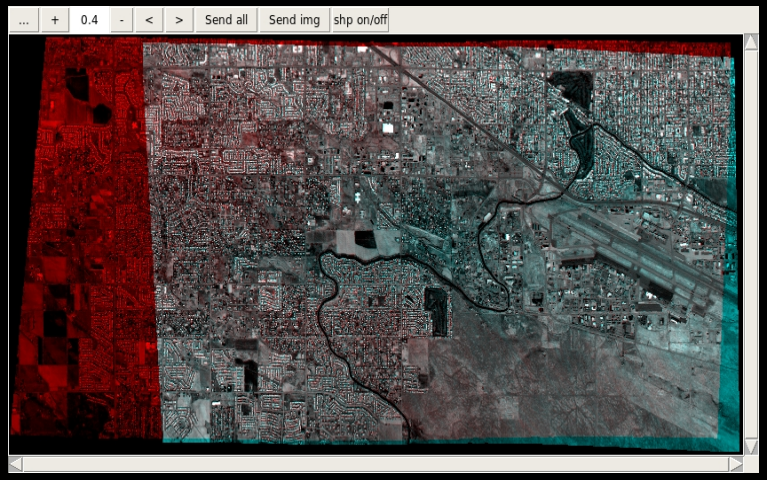
Example of real-time segment mismatch corrected Lick Fire Night Product

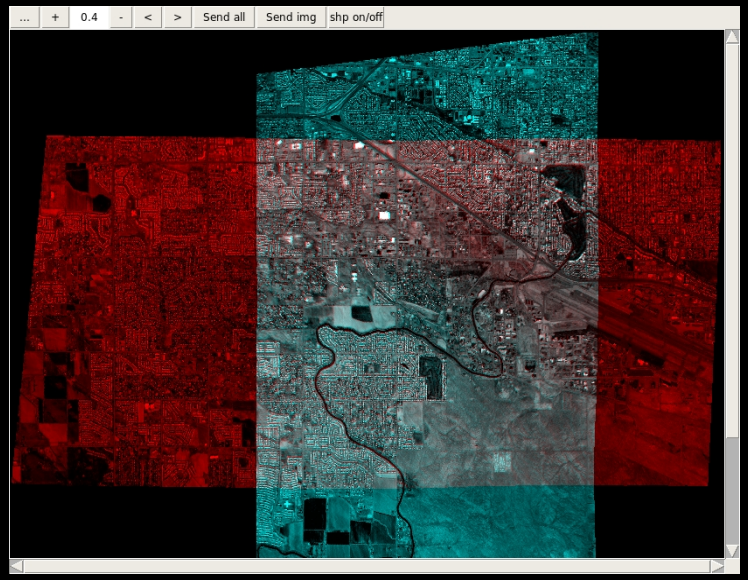


Automated Boresighting

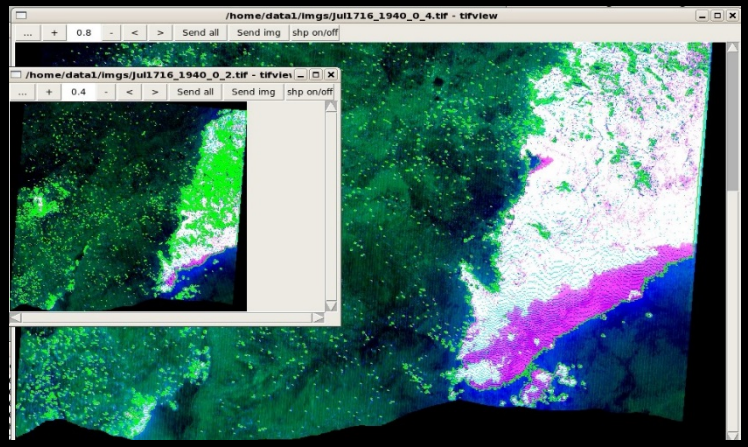
Relative point selection between E/W and E/N lines:

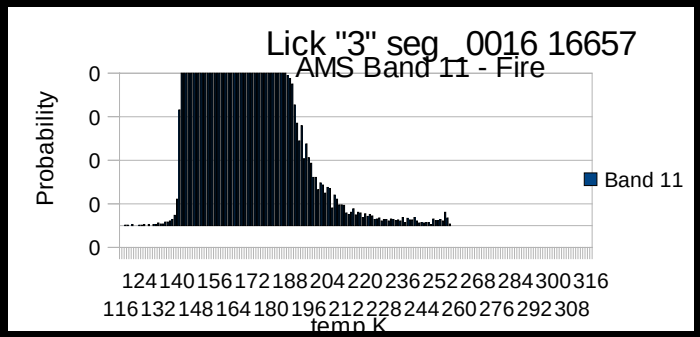
$$\text{cross correlation}(u,v) = \frac{\sum x \sum y \{ [B(x,y) - \mu_{base}] [S(x-u,y-v) - \mu_{shift}] \}}{\sqrt{\sum x \sum y [B(x,y) - \mu_{base}]^2} \sqrt{\sum x \sum y [S((x-u,y-v) - \mu_{shift}]^2}}$$

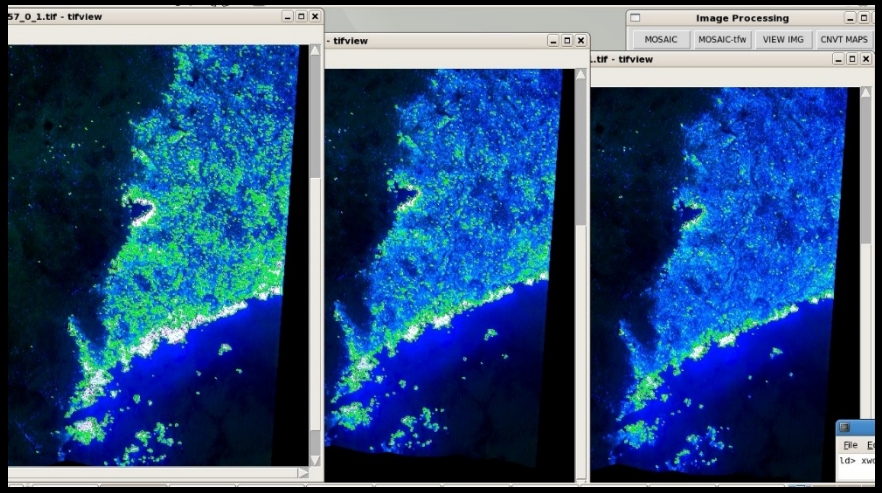


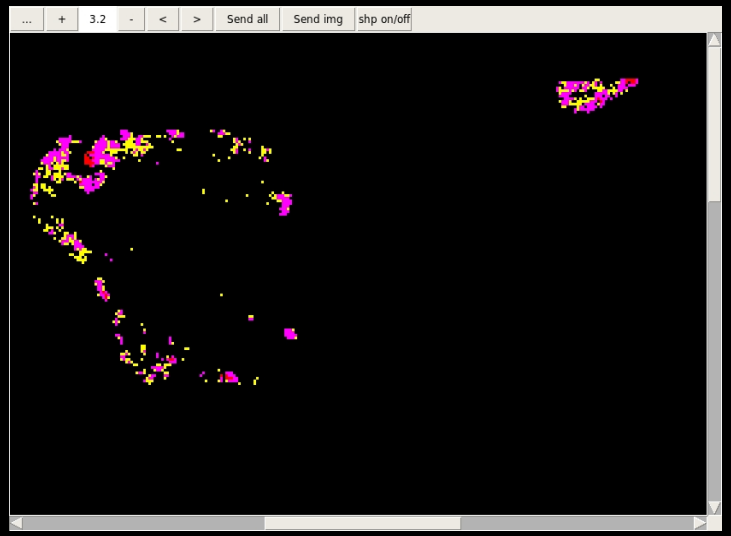


Threshold Selection for Active Fire









Threshold Selection for Active Fire

Moonlight Fire