MODIS Global Burned Area Validation and Product Status

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http://modis-fire.umd.edu
Global 500m MODIS Burned Area Product (MCD45)

- Status

- Validation
  - Accuracy of areal extent
  - Accuracy of time of detection

- Algorithm refinement
• Algorithm run **globally** for first time in MODIS C5 - purposefully running to map burned areas conservatively

• **Validation** currently Stage 2

• **QA and Testing underway** to incrementally improve product and reduce the impact of known issues through C5
Validation Protocol

- **Landsat-based validation protocol**
  - Developed in SAFARI2000 with SAFNet
  - Expanded to other GOFC-GOLD regional networks
  - Protocol advocated & now adopted by the CEOS Cal/Val program

- **Multi-temporal Landsat data**
  - interpreted by regional experts
  - map the area burned between acquisitions
  - generate independent reference data set

- **All independent reference data to be made available to the community via the MODIS fire web site**
Time 1:
Landsat ETM+
Sept. 4th
Time 2:
Landsat ETM+
Oct 6th

Yellow vectors = ETM+ interpreted burned areas occurring between the two ETM+ acquisitions
MODIS
500m
Burned Areas

Time 1 Sept. 4
to
Time 2 Oct. 6

White vectors = ETM+ interpreted burned areas occurring between the two ETM+ acquisitions
Validation Metrics

• Regression – regional spatial accuracy assessment

• Confusion matrix statistics (overall, user’s & producer’s accuracy) – pixel level accuracy assessment
Validation Sites

• Stage 2 independent reference dataset processed; with extensive network of GOFC-GOLD partners

• Completed
  – Africa
  – Europe
  – Siberia
  – Central and South America
  – Australia

• In progress
  – India
  – China
  – South East Asia
  – US
Validation of Burned Area Product Temporal Reporting Accuracy

- To date we have concentrated on product spatial reporting accuracy
- The product also reports the ~day of detection
- The nominal uncertainty due to the daily rolling BRDF inversion window is 8 days
- Temporal product accuracy increasingly relevant to user community
  - near real time air quality
  - atm. transport models (weather on day of burn, plume injection height)
  - some regional assessment applications (nat. resource, disaster management)
• MODIS active fire product
  – validated to stage 3
  – very low commission error
  – date & time of active fire detection defined by orbit overpass
MODIS Burned Area Temporal Reporting Validation Approach

Comparison at all global locations where there is a burned area detection and an active fire detection
MODIS Burned Area Temporal Reporting
Validation Approach

Comparison at all global locations where there is a burned area detection and an active fire detection

- **Active Fire (Terra or Aqua)**
- **Burned area**
MODIS Burned Area Temporal Reporting Validation Approach

Comparison at all global locations where there is a burned area detection and an active fire detection

90 days

(time)

Active Fire (Terra or Aqua)

Burned area
Time difference analysis
global, 6 years

Median: -1 day

50%: 1 day
75%: 4 days
Consistent annual results
Median difference

50% of deviation from the median

% of pixels within the nominal 8 day uncertainty
• Algorithm run **globally** for first time in MODIS C5 - purposefully running to map burned areas conservatively

• **Validation** currently Stage 2

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Burned Area Algorithm Refinement

Example – Stupid Coding Error

Burned area emission errors occur where the 3.66-3.84 μm brightness temperature > 327.67 K

This bug took ~3 years to be discovered.

CAUSE: the pixel values brightness temperature*100 are stored as Unsigned Integers (a number 0-65535) but were *incorrectly* read into the MODIS burned area algorithm as Signed Integers (number 0 to +/- 32767). Thus, values >32767 were converted by this inconsistency in the burned area code to negative values and so were considered very cold and could not possibly be burns.
Burned Area Algorithm Refinement
Example – Fixed Stupid Coding Error

CAUSE: the pixel values brightness temperature*100 are stored as Unsigned Integers (a number 0-65535) but were *incorrectly* read into the MODIS burned area algorithm as Signed Integers (number 0 to +/- 32767). Thus, values >32767 were converted by this inconsistency in the burned area code to negative values and so were considered very cold and could not possibly be burns.

Map many more burns
Australia (C5)

Great Sandy Desert, But Plain (28338 km²)
R² = 0.608  n = 1129  y = 0.002 + 0.882 x⁻¹

Great Sandy Desert, Dampierland (32555 km²)
R² = 0.922  n = 1297  y = 0 + 0.996 x⁻¹

Great Victoria Desert (10818 km²)
R² = 0.865  n = 431  y = -0.004 + 0.83 x⁻¹

Pilbara, Gascoyne, East (462 km²)
R² = 0.797  n = 16  y = -0.085 + 0.868 x⁻¹

Pilbara, Gascoyne, West (32381 km²)
R² = 0.76  n = 1310  y = -0.001 + 0.572 x⁻¹
Australia (C5)

Great Sandy Desert, Bot Plain (28338 km²)
$R^2 = 0.608$, $n = 1129$, $y = 0.002 + 0.882 x^{\cdot 1}$

Cape York Peninsula (32026 km²)
$R^2 = 0.847$, $n = 805$, $y = -0.001 + 0.727 x^{\cdot 1}$

Great Sandy Desert (32781 km²)
$R^2 = 0.608$, $n = 1306$, $y = 0.001 + 0.035 x^{\cdot 1}$

Great Victoria Desert (10818 km²)
$R^2 = 0.865$, $n = 431$, $y = -0.004 + 0.83 x^{\cdot 1}$

Great Sandy Desert, Dampierland (32555 km²)
$R^2 = 0.922$, $n = 1207$, $y = 0 + 0.996 x^{\cdot 1}$

Pilbara, Gascoyne, East (402 km²)
$R^2 = 0.797$, $n = 16$, $y = -0.085 + 0.868 x^{\cdot 1}$

Pilbara, Gascoyne, West (32881 km²)
$R^2 = 0.76$, $n = 1310$, $y = -0.001 + 0.572 x^{\cdot 1}$
Australia (bug fixed)
Burned Area Algorithm Refinement

Changes in the algorithm

C5 code:
assumption that Band 6 reflectance drops post-fire. Not the case in some forest areas.

Greece August 2007
Burned Area Algorithm Refinement
Changes in the algorithm

C5 code:
assumption that
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reflectance drops
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Not the case in
some forest
areas.

Greece August
2007
Comparison with polygons by the European Forest Fire Service
Europe (C5)
Europe (C5)

- Crete (20227 km²)
  \[ R^2 = 0.252, n = 1198, y = 0.006 + 0.568 x^{-1} \]

- Crete (1303 km²)
  \[ R^2 = 0.335, n = 256, y = 0.011 + 0.33 + x^{-1} \]

- Southern France (12953 km²)
  \[ R^2 = 0.877, n = 518, y = 0.291 + 0.098 x^{-1} \]

- Spain / Portugal (3353 km²)
  \[ R^2 = 0.877, n = 1238, y = 0.003 + 1.18 x^{-1} \]

- Spain / Portugal (2052 km²)
  \[ R^2 = 0.868, n = 915, y = 0.001 + 0.675 x^{-1} \]

- Calabria - Apulia (ASTER) (11932 km²)
  \[ R^2 = 0.662, n = 73, y = 0.004 + 1.021 x^{-1} \]

- Calabria - Pollino (ASTER) (2559 km²)
  \[ R^2 = 0.524, n = 94, y = 0 + 0.53 x^{-1} \]
Europe (B6 off)
The path forward:

• Collection 5.1 reprocessing of the MODIS Aqua Terra time series using Collection 5 inputs and improved code (bug fixed and minor improvements).

• Processing start end of Spring 2010

• Stage 2 Validation to be completed globally by the end of 2010

• All independent reference data to be made available to the community via the MODIS fire web site

• Temporal validation will be advocated for inclusion in future versions of the CEOS Cal/Val protocol