Global mapping of fire-affected area using multi-temporal MODIS data: the MCD45 product

D.P. Roy [a], L.Boschetti [b], C.O.Justice [b]

([a]) Geographic Information Science Center of Excellence, South Dakota State University; email: david.roy@sdstate.edu
([b]) Department of Geography, University of Maryland; email: luigi.boschetti@hermes.geog.umd.edu ; justice@hermes.geog.umd.edu

The algorithm

The algorithm developed for the MCD45 burned area product uses a bi-directional reflectance (BRDF) model-based change detection approach; it detects the approximate date of burning by locating the occurrence of rapid changes in daily MODIS reflectance time series. The algorithm maps the spatial extent of recent fires and not of fires that occurred in previous seasons or years. Because of the BRDF model incorporated in the algorithm, the production of one month of MCD45 requires the availability of 90 days of daily MODIS data (i.e. both the previous and the following month).

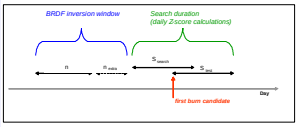
Requirements

- not a classification approach requiring training data or human intervention
- physically-based algorithm
- provides a route for the use of multiple data sources and observations of varying degrees of uncertainty within a rigorous modeling framework

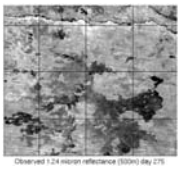
Algorithm's main characteristics:

- change detection approach applied independently per pixel to daily gridded MODIS 500m land surface reflectance time series
- thresholds defined by the noise characteristics of the reflectance data and knowledge of the spectral behavior of burned vegetation and spectrally confusing changes
- takes advantage of the temporal persistence of fire effects

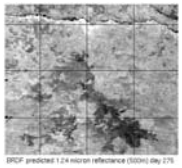
The bi-directional reflectance model-based expectation approach



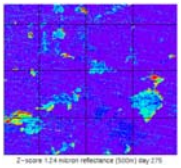
The BRDF model is applied to a window containing at least 7 observations over a duration of at least n and no more than $n + n_{extra}$ days. The BRDF model parameters are used to compute Z-scores for S_{search} subsequent days starting from the first day after the inversion window and, if a burn candidate is found, for the subsequent S_{test} days starting from the first burn candidate.



Observed MODIS reflectance day 275

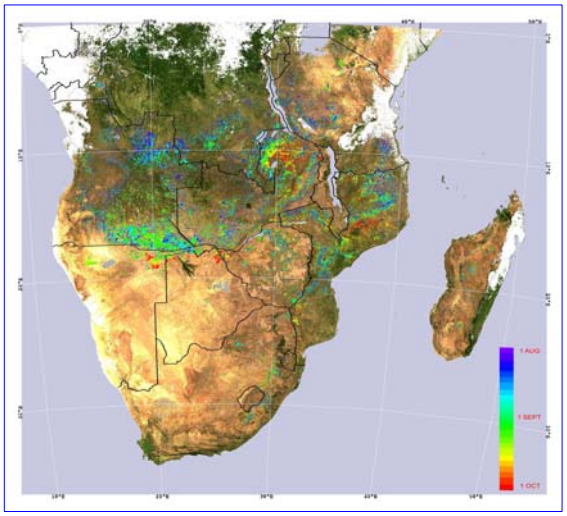


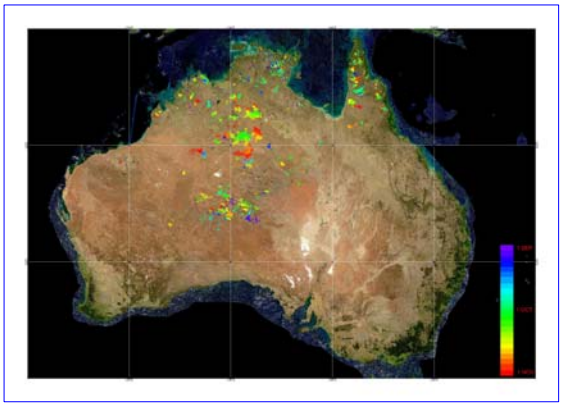
Predicted Day 275 reflectance modeled from previous 16 days observations



Z-score = predicted-observed/error (probability of change)

Sample products





MODIS burned areas overlaid on false colour MODIS composites (R=b6, G=b5, B=b2). The different colours indicate the approximate day of burning
LEFT: sub-equatorial Africa, August – October 2000.
TOP: Australia, September – October 2002.

Product specifications

The MCD45 burned area product is a Level 3 gridded 500m product, produced in the standard MODIS Land tile format in sinusoidal projection. Each tile has fixed earth-location, covering an area of approximately 1200 x 1200 km (10° x 10° at the equator). The product defines for each 500m pixel the approximate day of burning. It is a monthly product which is obtained processing combined MODIS-TERRA and MODIS-AQUA 500m land surface reflectance data.

Each product tile contains the following components:

- Per-pixel burning information
  - the approximate day of burning (1-366) or 0 (no burning detected)
  - codes to indicate no decision due to persistent missing, bad quality or cloudy data.
  - QA information.
- Mandatory and product-specific metadata

References

D.P. Roy, Jin, Y., Lewis, P.E., Justice, C.O, 2005, Prototyping a global algorithm for systematic fire affected area mapping using MODIS time series data, *Remote Sensing of Environment*., 97:137-162.

Roy D.P., Lewis P.E., Justice C.O., 2002, Burned area mapping using multi-temporal moderate spatial resolution data – a bi-directional reflectance model-based expectation approach. *Remote Sensing of Environment*, 83:263-286.