Global Burnt Area Products

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Structure

- Why burnt area estimation is important
- Challenges to global burnt area mapping
- Data sets: Current
- Data sets: Future
The need for burnt area

\[ BB = A \times D \times \hat{\alpha} \times \hat{\beta} \]

- \( A \): area burned
- \( D \): biomass density
- \( \hat{\alpha} \): fraction of above-ground biomass
- \( \hat{\beta} \): burning efficiency

\[ G(X) = M \times P \times E \]

- \( G \): amount of gas \( X \) released
- \( M \): biomass loading per surface unit
- \( P \): % of biomass consumed
- \( E \): emission factor.

Seiler and Crutzen (1980)
Justification

The area consumed by fire at both continental and global scales is one of the parameters that create the greatest uncertainty in calculating the amount of biomass burned and gases (e.g. CO, CO2, CH4) emitted at these scales

(Scholes et al., 1996; Barbosa et al., 1999; Andreae and Merlet, 2001; Isaev et al., 2002; Conard et al., 2002)
The need for global products

- Regional/continental data computed using different methodologies
- Validation results differ or do not exist
- Source data for global products can be traced
- Data can be gridded and time composited
- Input data for GCMs and ecosystem models
Challenges

- BA cannot be derived from active fire products
  - Signal saturation
  - Diurnal signal (detected by MODIS)
  - Useful for detection of below-canopy fires
  - Possibly useful for the confirmation that a fire occurred but limited in the temporal sense

- Scientists try it though -
  - Giglio et al., ACPD, 5, 2005
  - BA is proportional to fire count
  - Vegetation cover data, size of active fire cluster
  - Lots of assumptions that cannot easily be verified
Challenges

- Fires occur in a number of different ecosystems
  - Intensity
  - Size
  - Production of ash
  - Flaming/smouldering
  - Time scale of scar visibility
  - Smoke/cloud cover
  - Leaf off conditions
  - Flooding
  - Annual variability
## Current BA products

<table>
<thead>
<tr>
<th>Product name</th>
<th>Resolution</th>
<th>Time step</th>
<th>Coverage</th>
<th>Period</th>
<th>Source</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBA2000</td>
<td>1 km</td>
<td>day</td>
<td>globe</td>
<td>2000</td>
<td>JRC</td>
<td>Tansey et al., 2004 JGR(109) &amp; Climatic Change (67) //www-gvm.jrc.it/fire/gba2000/index.htm</td>
</tr>
<tr>
<td>GLOBASCAR</td>
<td>1 km</td>
<td>day</td>
<td>globe</td>
<td>2000</td>
<td>ESA</td>
<td>Simon et al., 2004 JGR(109) //shark1.esrin.esa.it/ionia/FIRE/BS/ATSR/</td>
</tr>
</tbody>
</table>

Information provided by Jean-Marie Gregoire (JRC)
Inter-comparison of global fire products:
- World Fire Atlas (WFA)
- GLOBSCAR
- GBA2000

Boschetti et al., 2004
# Future BA products

<table>
<thead>
<tr>
<th>PRODUCT NAME</th>
<th>Resolution sensor product</th>
<th>Time step sensor product</th>
<th>Coverage</th>
<th>Period</th>
<th>Source</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GLOBCARBON</strong> ERS, ENVISAT, SPOT ATSR, AATSR, MERIS, VGT</td>
<td>1 km  8 km</td>
<td>day month</td>
<td>globe</td>
<td>1998-2003</td>
<td>ESA</td>
<td><a href="http://dup.esrin.esa.it/projects/summaryp43.asp">http://dup.esrin.esa.it/projects/summaryp43.asp</a></td>
</tr>
<tr>
<td><strong>VGT4Africa</strong> SPOT-VGT</td>
<td>1 km  1 km²</td>
<td>day 10 days</td>
<td>Africa</td>
<td>2005-</td>
<td>JRC</td>
<td><a href="http://www-gvm.jrc.it/tem/">http://www-gvm.jrc.it/tem/</a></td>
</tr>
<tr>
<td><strong>GEOLAND</strong> GLOBCARBON/VGT</td>
<td>1 km  1 km</td>
<td>day 10 days</td>
<td>Africa &amp; Eurasia</td>
<td>1998-2003</td>
<td>JRC</td>
<td><a href="http://www-gvm.jrc.it/tem/">http://www-gvm.jrc.it/tem/</a> Restricted access (GEOLAND)</td>
</tr>
<tr>
<td><strong>MODIS Burned Area</strong> TERRA, AQUA</td>
<td>500 m  500 m</td>
<td>day month</td>
<td>globe</td>
<td>2000-</td>
<td>UMD NASA</td>
<td><a href="http://modis-fire.umd.edu/products.asp#8">http://modis-fire.umd.edu/products.asp#8</a></td>
</tr>
</tbody>
</table>

Information provided by Jean-Marie Gregoire (JRC)
GlobCarbon

- GlobScar algorithm applied to (A)ATSR-2
- 3 GBA2000 algorithms to VGT data
  - 1 - Mexico & Australia
  - 2 – Africa
  - 3 – Remaining land areas
- Merging of the two BA products
- Confidence Rating Index
- 1998-
Results

Percentage of Confidence for Fire and Burnt Area detection (EPROP)

Australia Simulation
Mexico Simulation

January 1998

Information provided by Stephen Plummer (ESA-IGBP)
GlobCarbon - Results

Madagascar

Confidence Rating Index

- 63-74%
- 75-87%
- 88-100%

Sensor Agreement

- ATSR
- VGT
- Both

Information provided by Stephen Plummer (ESA-IGBP)
MODIS Algorithm

Developed for systematic automated global mapping

- Not a classification approach requiring training data or human intervention
- Takes advantage of the robustly calibrated, atmospherically corrected, cloud-screened, geo-located data provided by MODIS data
- Physically-based algorithm less dependent upon imprecise but noise tolerant classification techniques
- Provides a route for the use of multiple data sources and observations of varying degrees of uncertainty within a rigorous modeling framework

Algorithm

- 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

=> map 500m location and approximate day of burning

Information provided by David Roy (SD State University)
Australia 1km active fires 1 month 2002

Blue = beginning of month
Red = end of month

Information provided by David Roy (SD State University)
White vectors = ETM+ interpreted burned areas occurring between the two ETM+ acquisitions

Information provided by David Roy (SD State University)
European Global Daily BA Product

- University of Leicester initiative with
  - JRC – Technical Uni. of Lisbon – Catholic University of Louvain
- Improvement of a GBA2000 algorithm
- Multi-annual SPOT VGT data 1999-
- 1km² resolution
- Daily product – first date of detection
- Error sources are being addressed
Processing Module Inputs

- Input B2, B3 and MIR data for day x
- Intermediate composite products
  - B2, B3 and MIR
- Contaminated pixel mask
- Regional statistical algorithm
- First day of burn (FDOB) binary
  - Julian day
- View and solar angle information
- Land cover data
Processing Module Outputs

- Updated Intermediate composite products
  - B2, B3 and MIR
- Contaminated pixel mask
- Updated First day of burn (FDOB) binary
  - Julian day
- Probable burnt area product for day x
  - Summed with the existing burnt area product to give confidence indicator of burnt area
- Cloud cover frequency & gap frequency
PBA Daily Results

FDOB
Northern Australia
FDOB
Central Russia
Concerns over Results

- Canada and Russia – leaf off conditions
- This will be corrected using existing data
Questions

- Hard and soft classifications:
  - Does the user community want or know how to handle probability data?
  - Do they still need burnt or not burnt information?

- How do we combine burnt area data with fire severity data for improved emissions estimates?