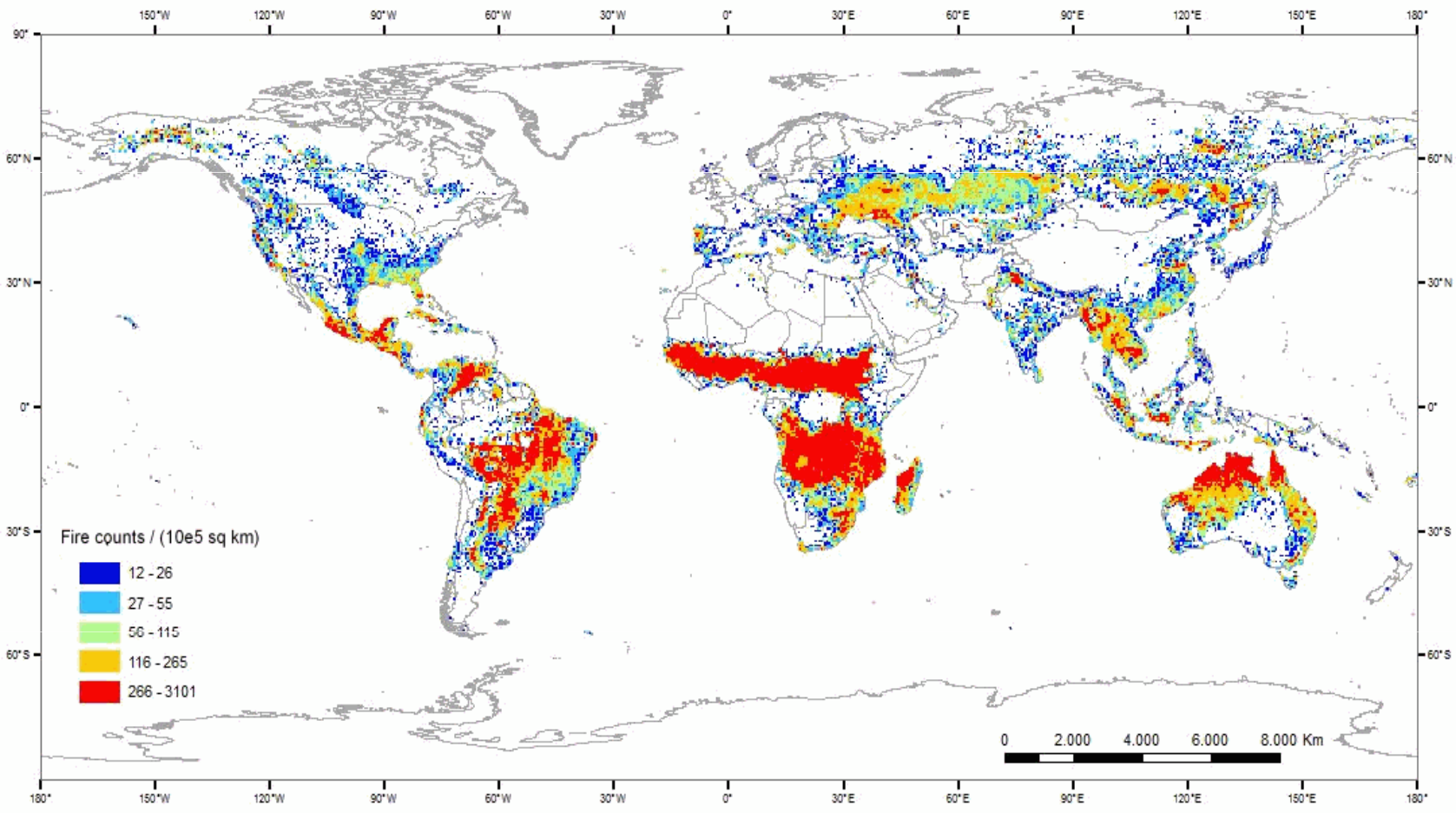
Fire_cci status

Emilio Chuvieco

Fire is a global phenomenon…



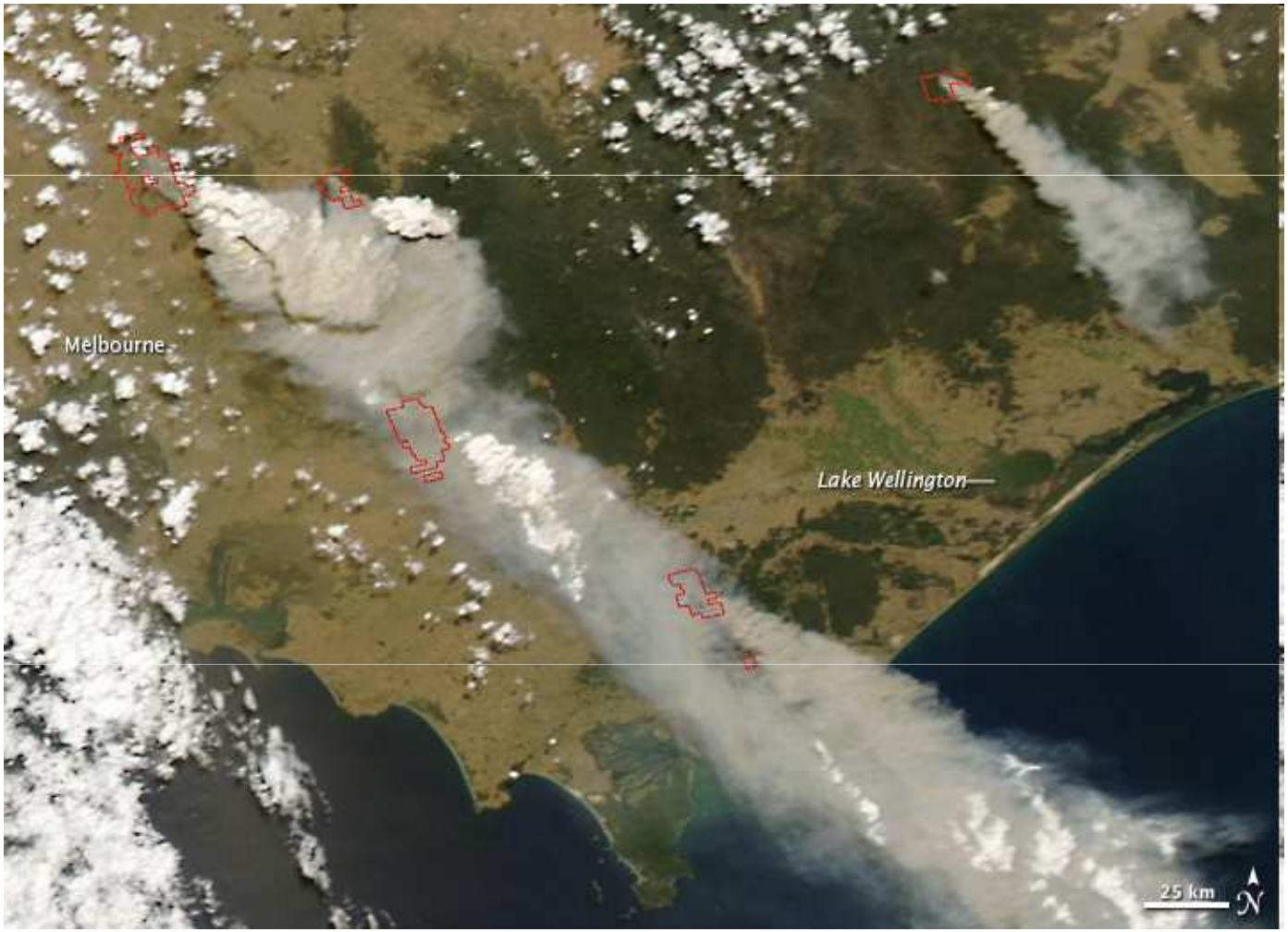
- Around 3.5 millon sq km are burned annually
- From MODIS hot-spot databases, 30% of the emerged world was observed to have some relevant fire activity (Chuvieco et al., 2008, GCB)

With critical regional implications… Greece, 2007

MERIS images
International Charter

84 people lost their lives
270.000 ha were burend
The fire destroyed 1,000 houses and 1,100 other buildings, and damaging hundreds more

Australia, 2009

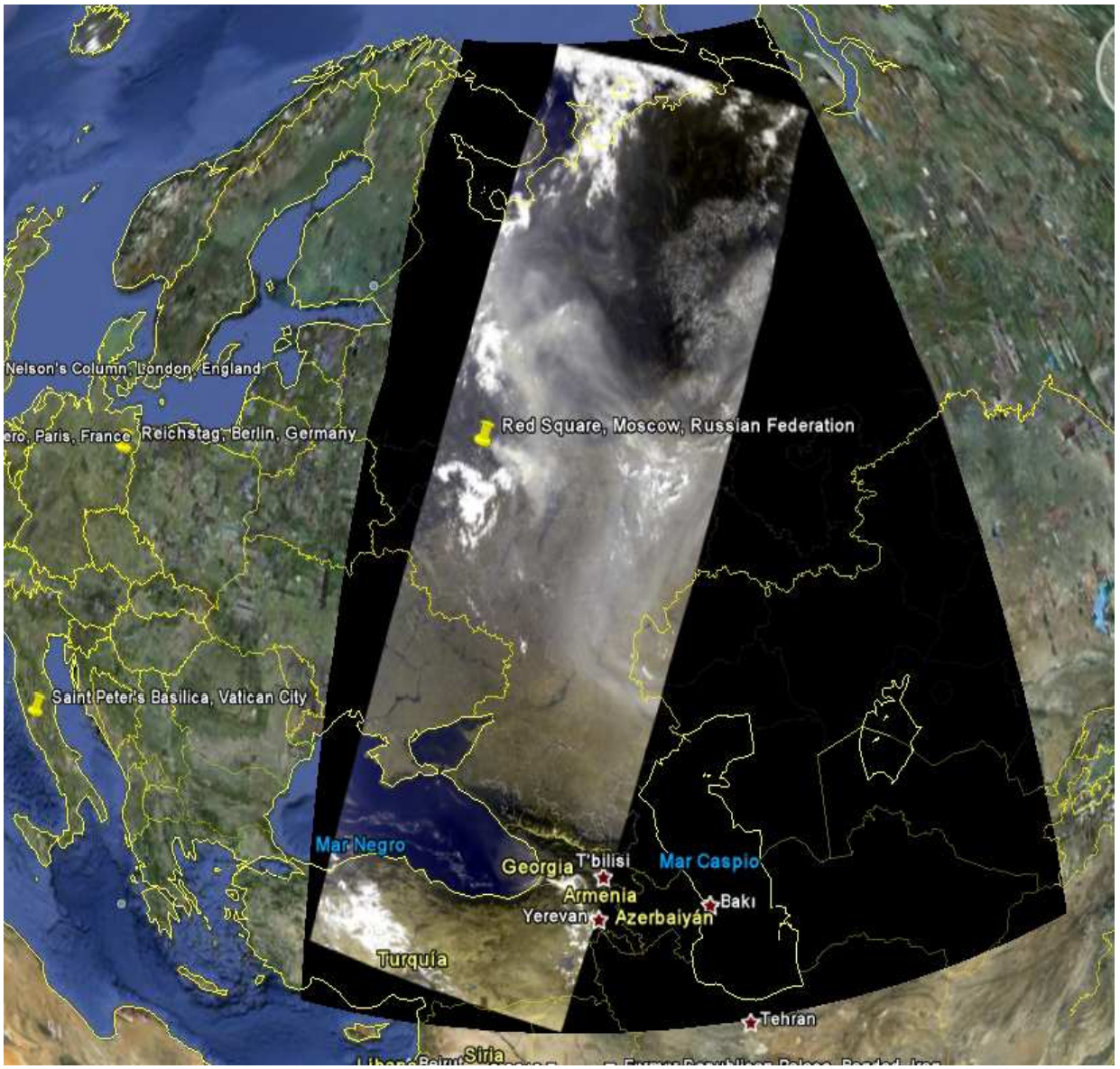


MODIS Images: visibleearth.nasa.gov

173 people died and 7,562 people were displaced. Over 3,500 structures destroyed

450,000 ha were burned

Russia, 2010



MERIS images.
August, 2010
Courtesy DLR

50 people were killed in the fires. Over 2,500 houses in 150 villages and towns were destroyed
6 m ha burned

Israel, 2010

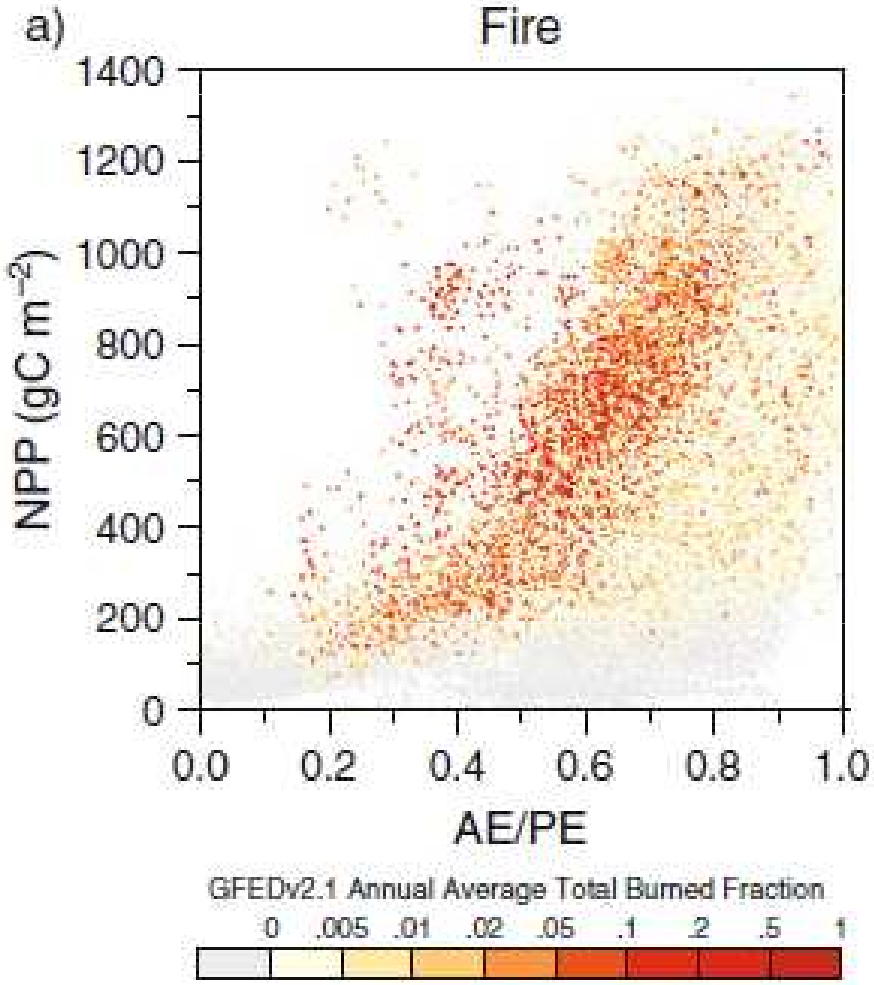
MODIS instrument from 3 December 2010. NASA Terra satellite, processed by the German Aerospace Center (DLR).

Mt. Carmel fire killed 42 persons

Science context

- Biomass burning is one the key factors of global land use/cover change. Critical impact on:
  - Global gas emissions.
  - Landscape pattern and vegetation species composition.
- Fires have also positive effects:
  - Natural selection.
  - Fuel clearing.
- Impacts of fires depend on whether they are adapted to “natural” fire regimes.

Fire needs biomass and dryness



Harrison, S. P., J. R. Marlon y P. J. Bartlein (2010): Fire in the Earth System, en Changing Climates, Earth Systems and Society (editado por J. Dodson). Springer Netherlands: 21-48.

Fire - Temperature

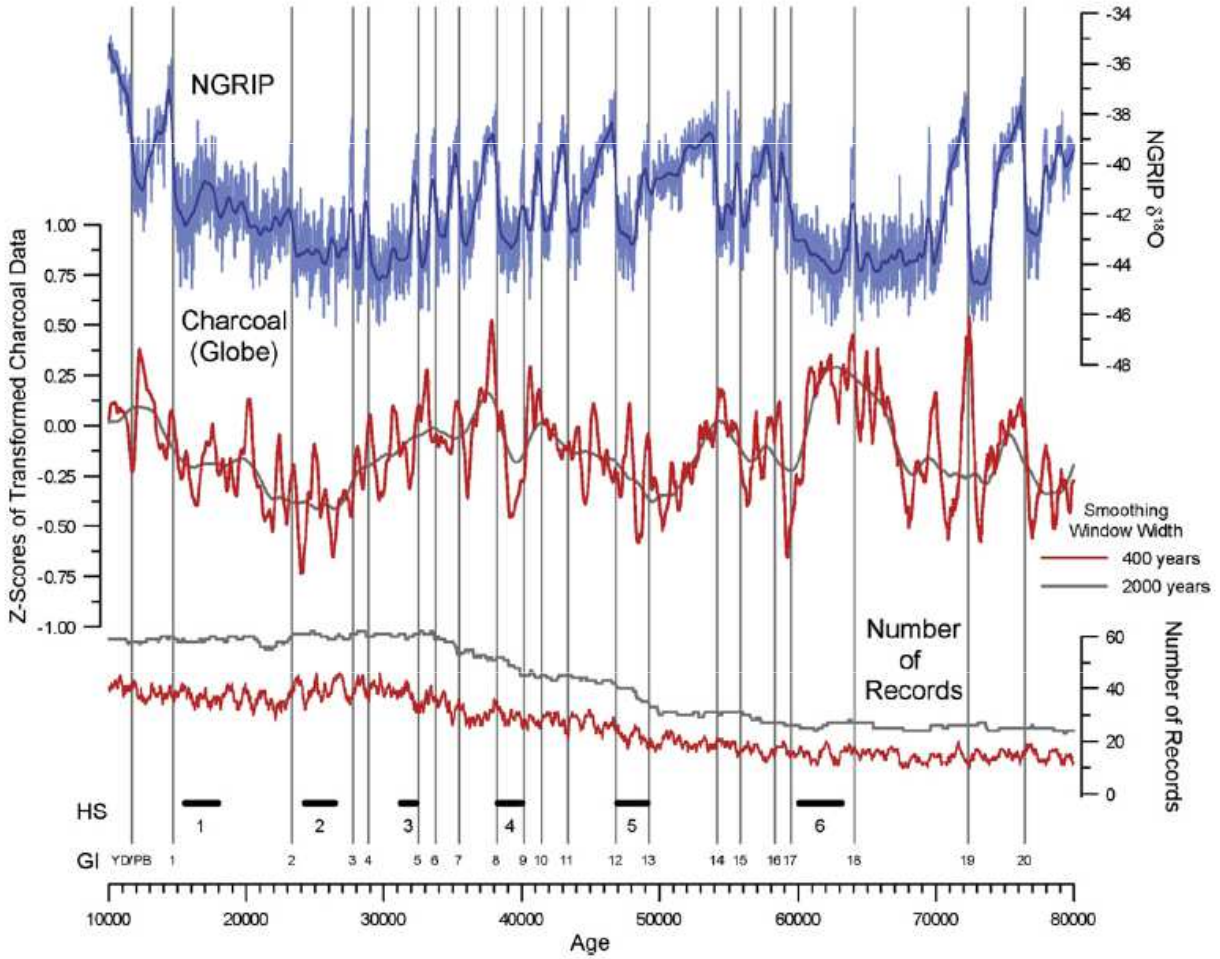


Fig. 4. Reconstruction of global biomass burning through the glacial. Charcoal data are summarized using a LOWESS curve (middle) with a 400-year half-window width (red), and to represent the long-term trend, a 2000-year window width (grey). The number of individual charcoal records that contribute to the summary curves is plotted at the bottom. For comparison with the charcoal curve, the 20-year sampling resolution NGRIP record (agecal. yr b1950) is shown, along with a 400-year smoothed curve (blue).

Daniau, A.L., Harrison, S.P., & Bartlein, P.J. (2010). Fire regimes during the Last Glacial. Quaternary Science Reviews, 29, 2918-2930.

Estimated future incidence

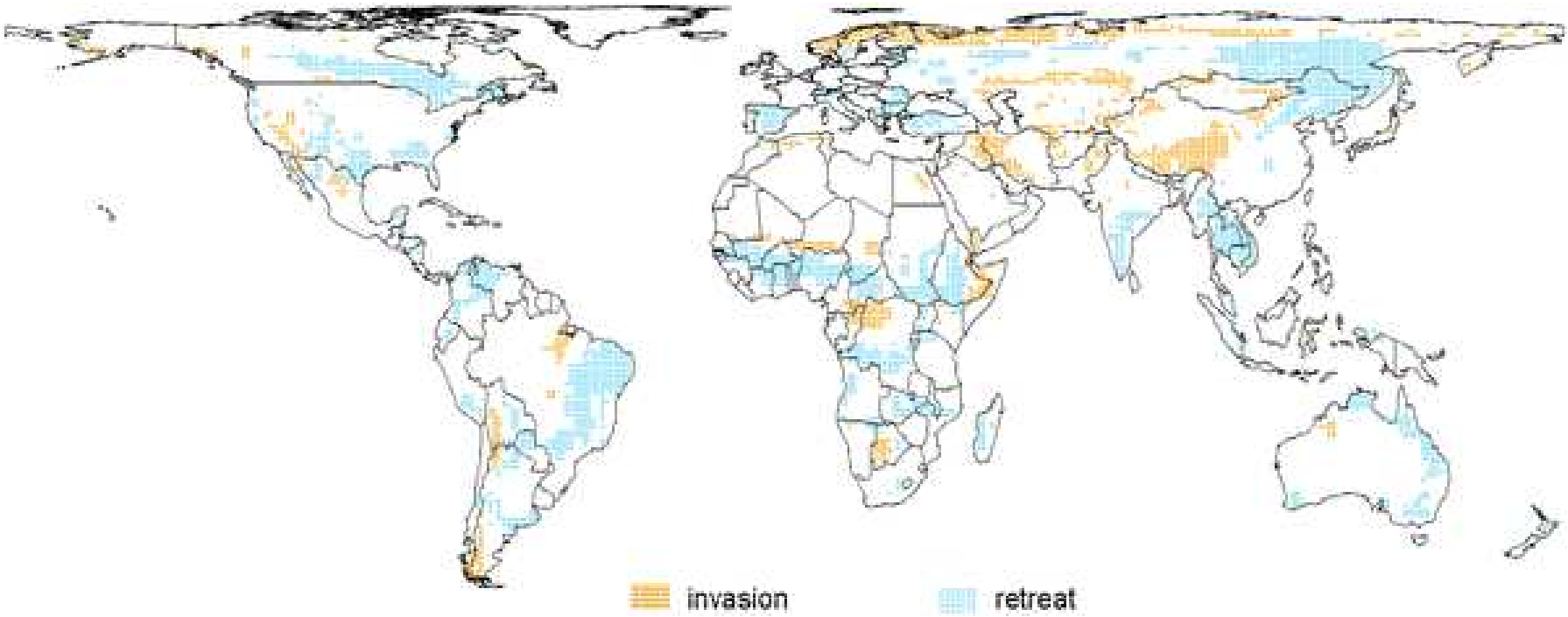
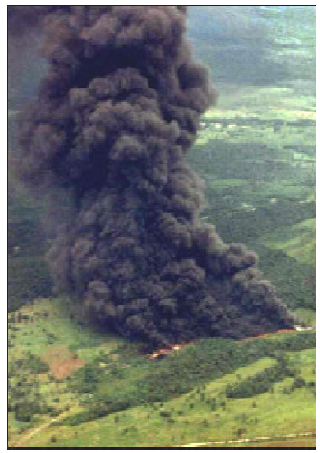


Figure 3. Potential invasion and retreat of fire. The invasion (orange) and retreat (blue) of fire projected by 2010–2039 under the A2 (mid-high) emissions scenario and based on the FIRENPP ensembles. Invasion was constrained to places with existing vegetation

Krawchuk et al., 2009, PLoS ONE.

Fire Impacts

- Positive
  - Natural regeneration
  - Insects / Plagues
- Negative
  - Atmospheric pollution
  - Socio-economic damages
    - Lives / houses
    - Forest products
    - Recreation
  - Ecological damages
    - Soil degradation
    - Runoff
    - Biodiversity



Impacts depend on fire regimes.

Critical questions in biomass burning analysis

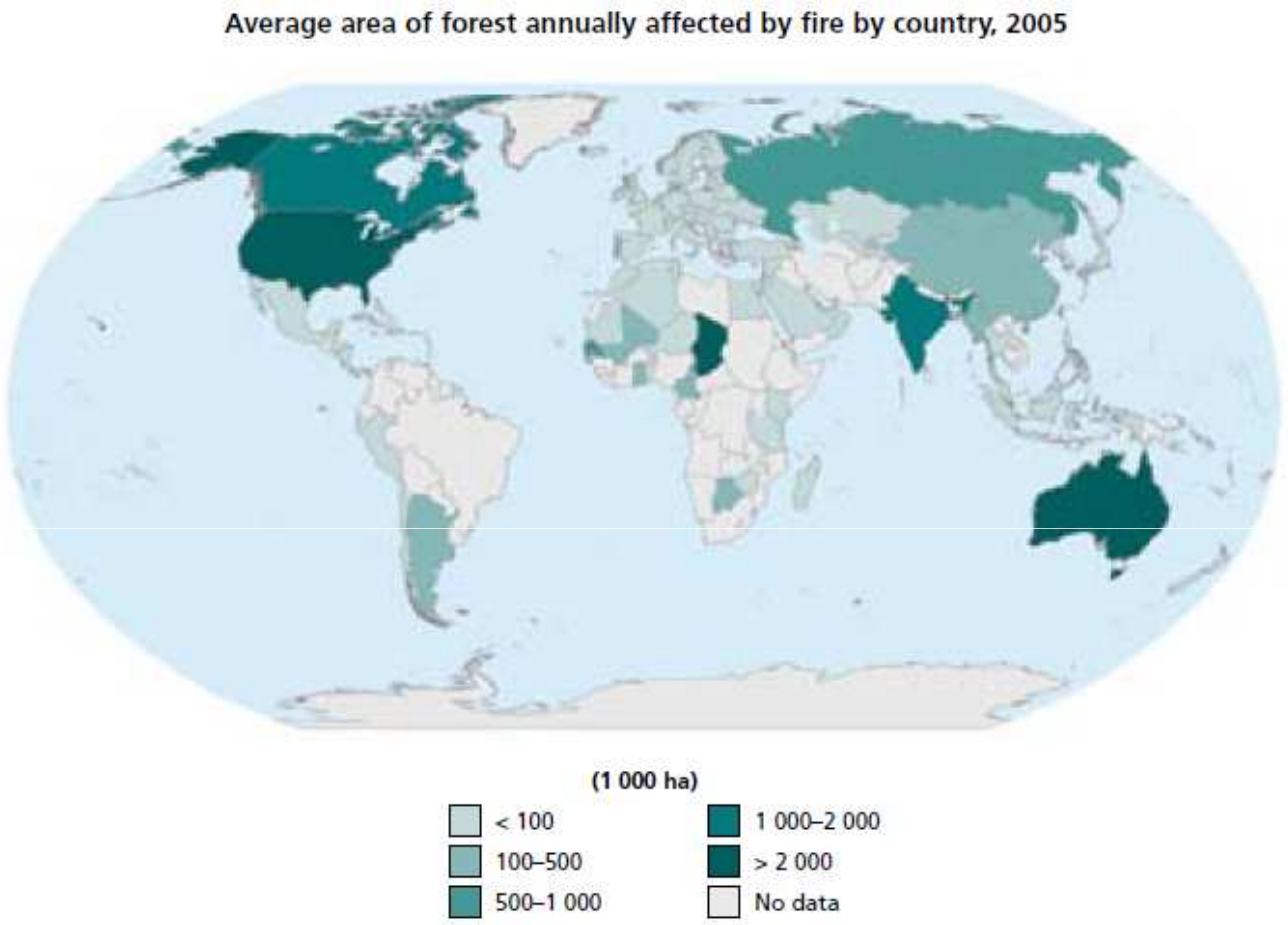
- What is the actual magnitude of fire impacts?
  - How much area is burned annually?
  - How much biomass is actually consumed?
  - What is the combustion efficiency (CO/CO_2)?
  - What is the role of fire in carbon accounting? Is biomass burning "carbon neutral"?
- What are the recent trends in fire activity?
- What factors are behind fire occurrence?

How much area is now burned?

- Inconsistencies between RS products and official forest fire statistics.
- Inconsistencies between RS products.
- Internal uncertainty of each RS product.

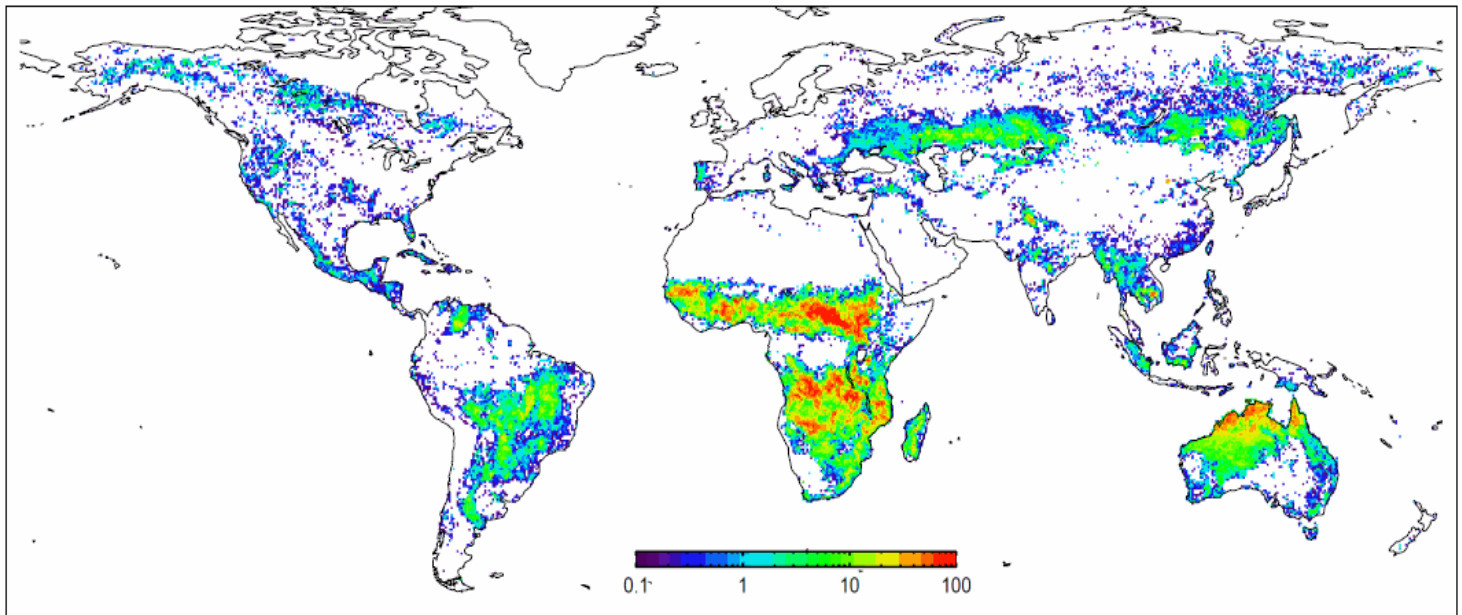
FRA2010

FAO (FRA2010): 0.6 Mkm².
Only 78 countries are covered.



GVED v3

Average 4 Mkm²



fire

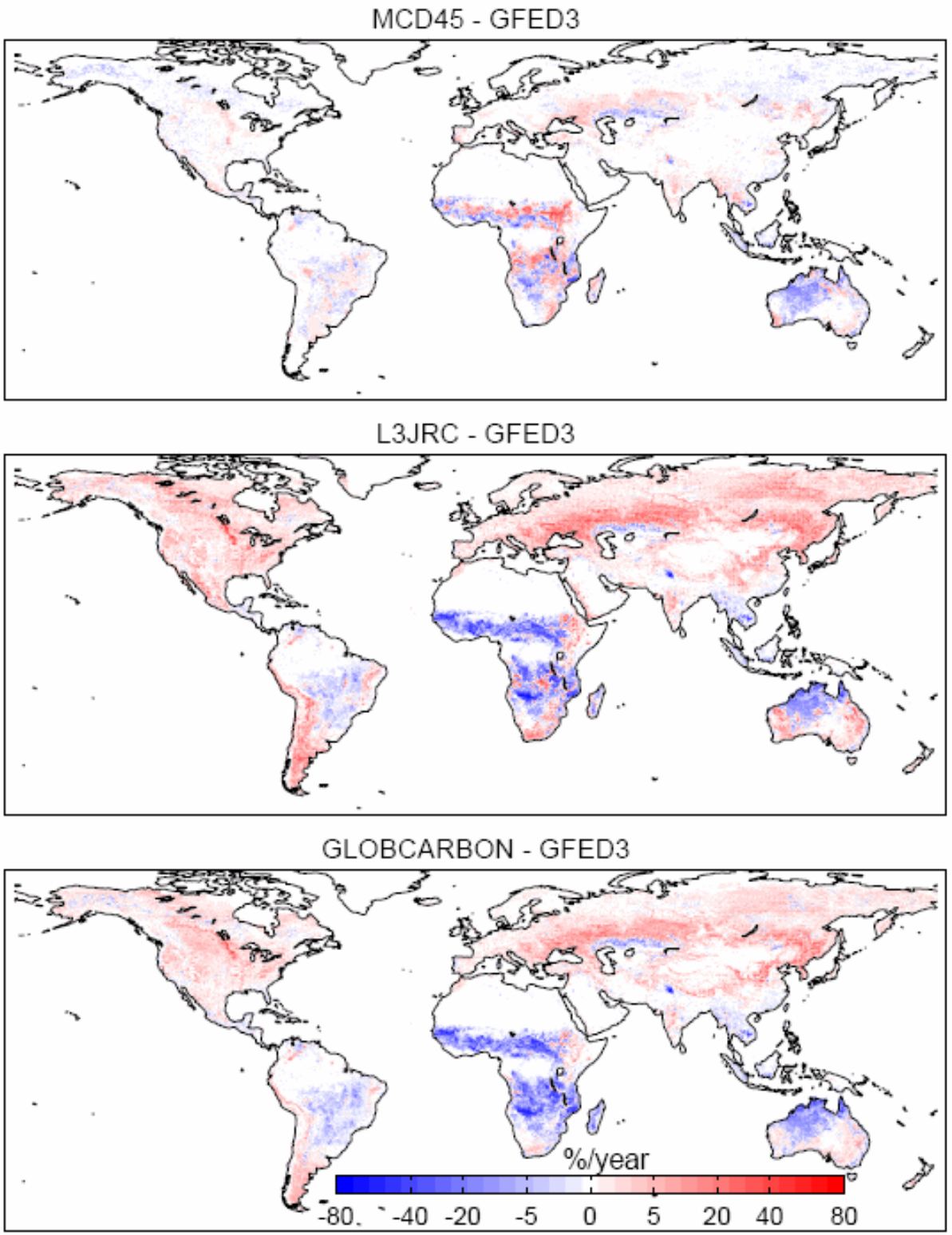
Different EO BA estimations

-L3JRC: 3.5 - 4.5 Mkm² (2000-07)
-MCD45 c5: 3.3 - 3.6 Mkm² (2000–2006)
-GFED v3: 3.39 - 4.31 Mkm² (1997-2009).

% of BA from different satellite products

Red: over estimation
Blue: under estimation

(Giglio et al., 2010).

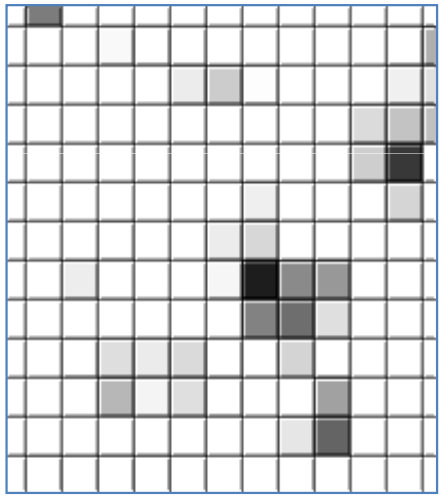


Objectives of fire_CCI

1. Refine definition of user requirements.
2. Improve current estimations of global burned area (based on European sensors: VGT-ATSR-MERIS).
3. Validate and intercompare existing BA global products.
4. Test improvements of climate-vegetation-carbon models with new BA data.

Target products

- Burned pixels (mixing all three sensors whenever possible):
  - Monthly files with date of detection.
  - Include confidence level and %cloud-free observations.
  - GeoTiff format
- Grid product:
  - 15-day files at 0.5 x 0.5 degree (CGM).
  - Include standard error and burned land cover.
  - NetCDF format.



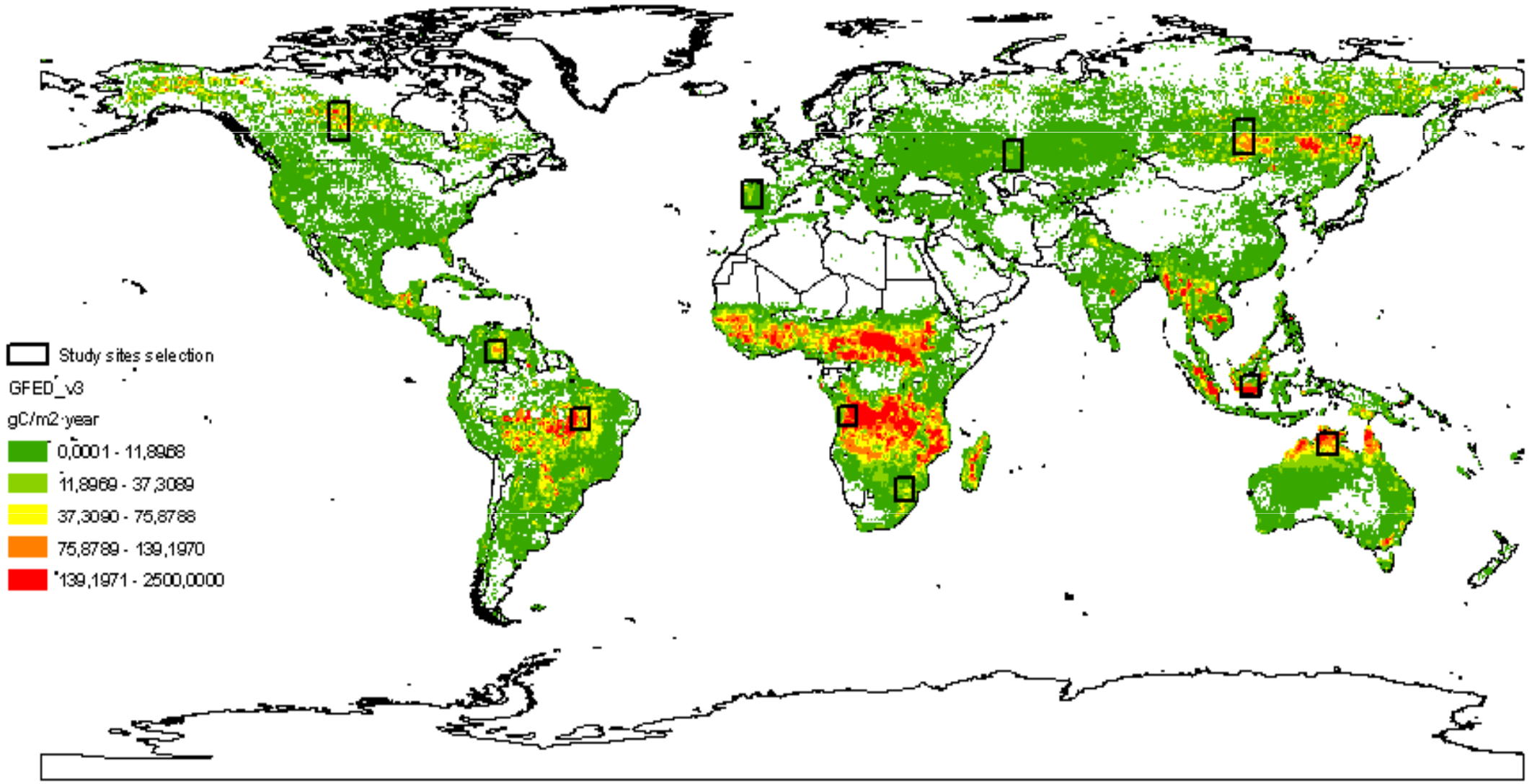
Production targets for Phase 1

Area	Product	Temporal series	Goal
Selected study sites (500x500 km)	Burned pixels and grid	1997-2009	Assure spatial accuracy and stability. Consistency across multiple satellites
Global	Burned pixels and grid	2005-2007-2008	Demonstrate global processor. Input for climate-carbon modelers.

Advantages over existing products:

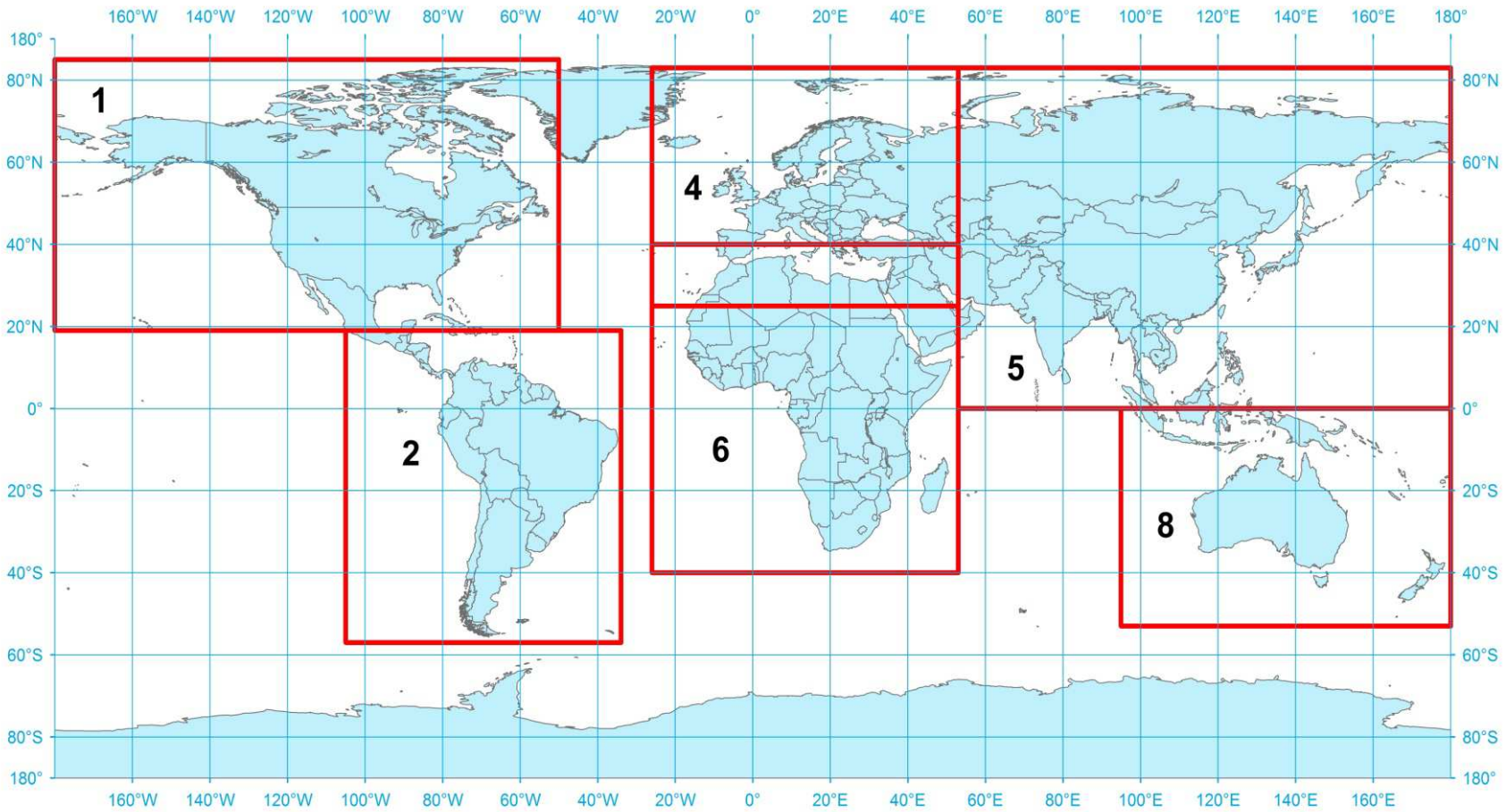
- Improved pre-processing.
- Extended time series.
- First global burned area product from MERIS.
- Merged product from three ESA sensors (VGT-ATSR-MERIS).
- Full validation and uncertainty characterization.

Target study sites



+ Global coverages for 2007-2009

Tiles for the global pixel product



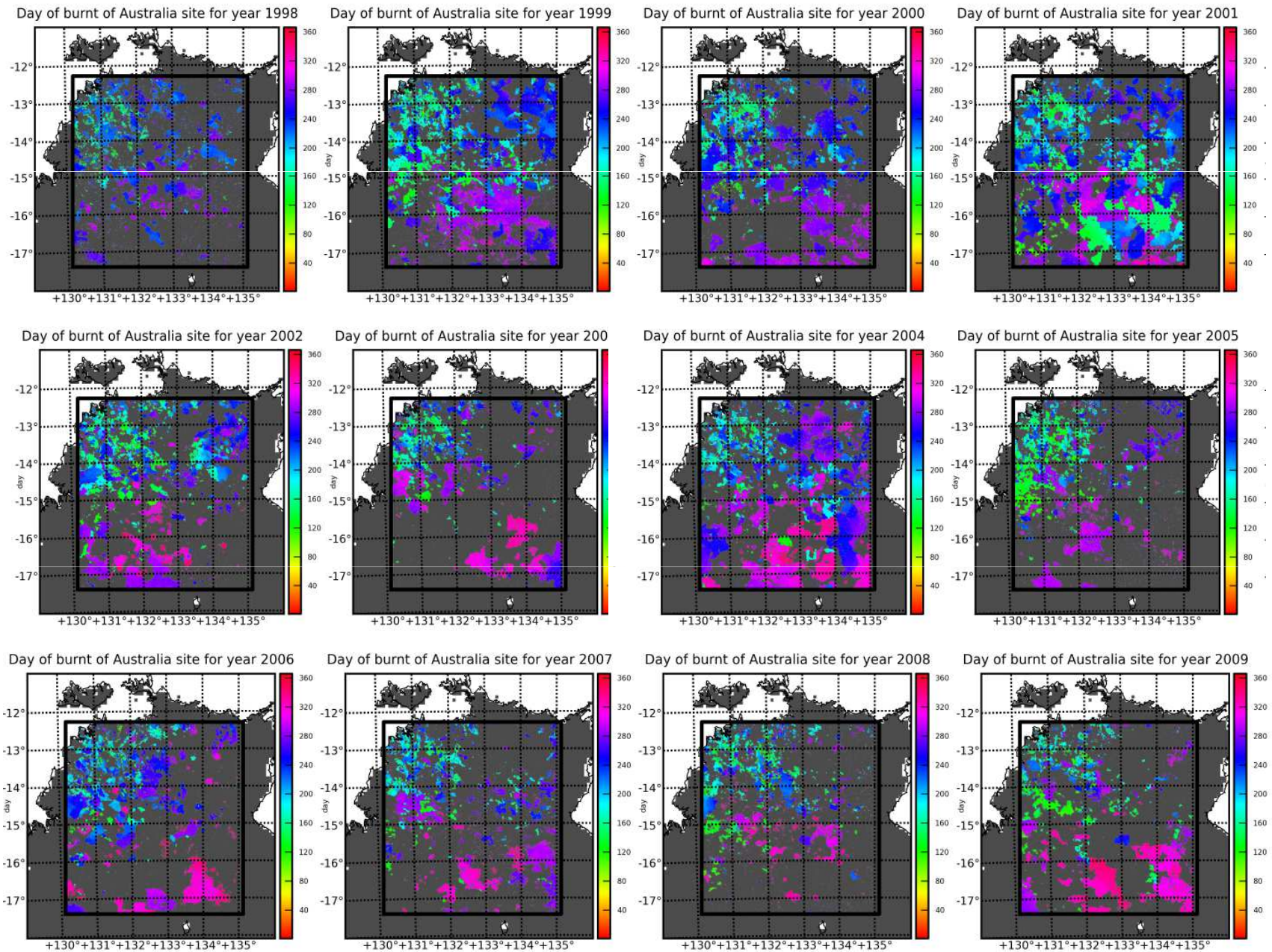
In addition to standard tiles, the user will have a web tool to interactively select his/her target site and apply for personal downloads

Current processing situation (2008)

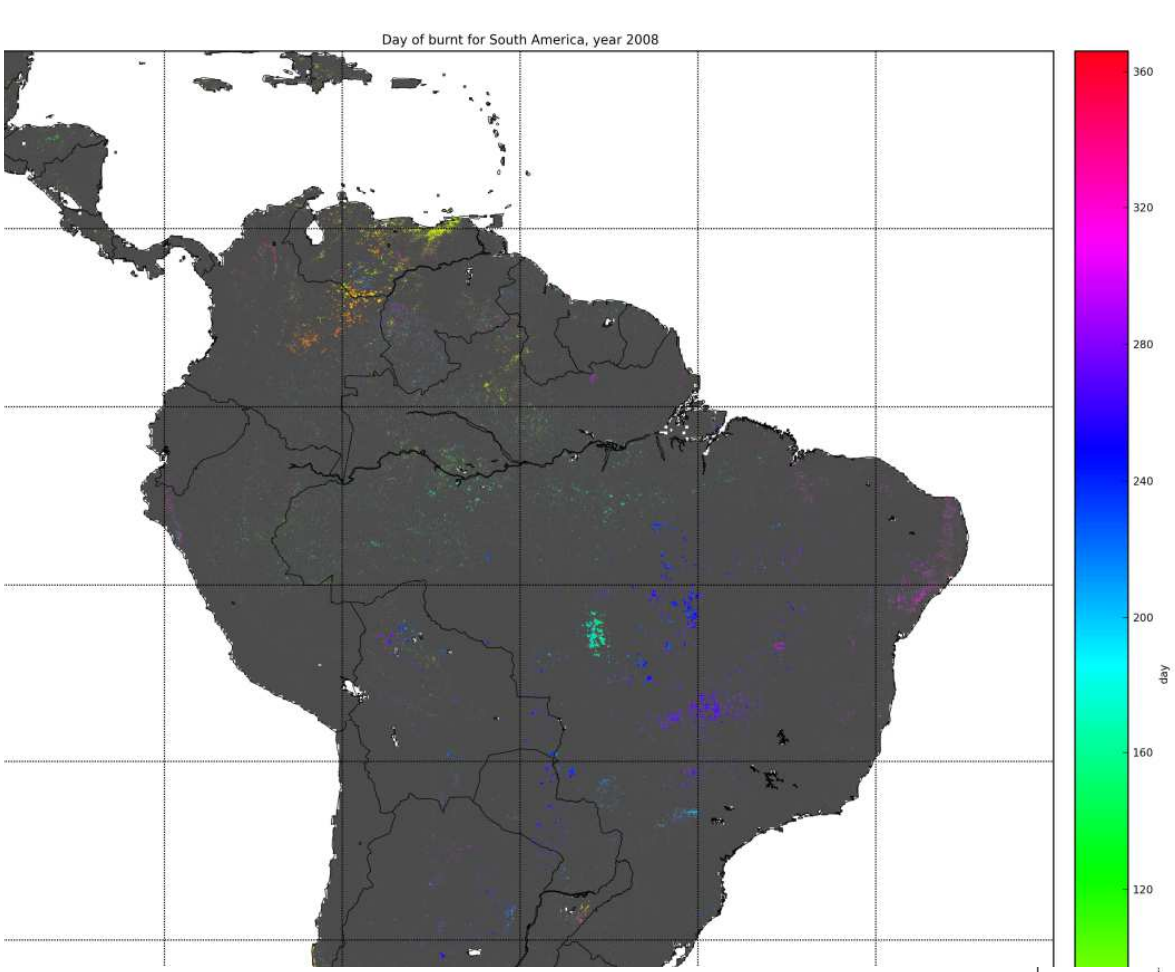
	Pre-processing	Burned Area	Merging
Study areas	☺	↺	↺
VGT global	☺	↺	✗
ATSR global	☺	↺	✗
MERIS global	◔	✗	✗

BA VGT v1 maps

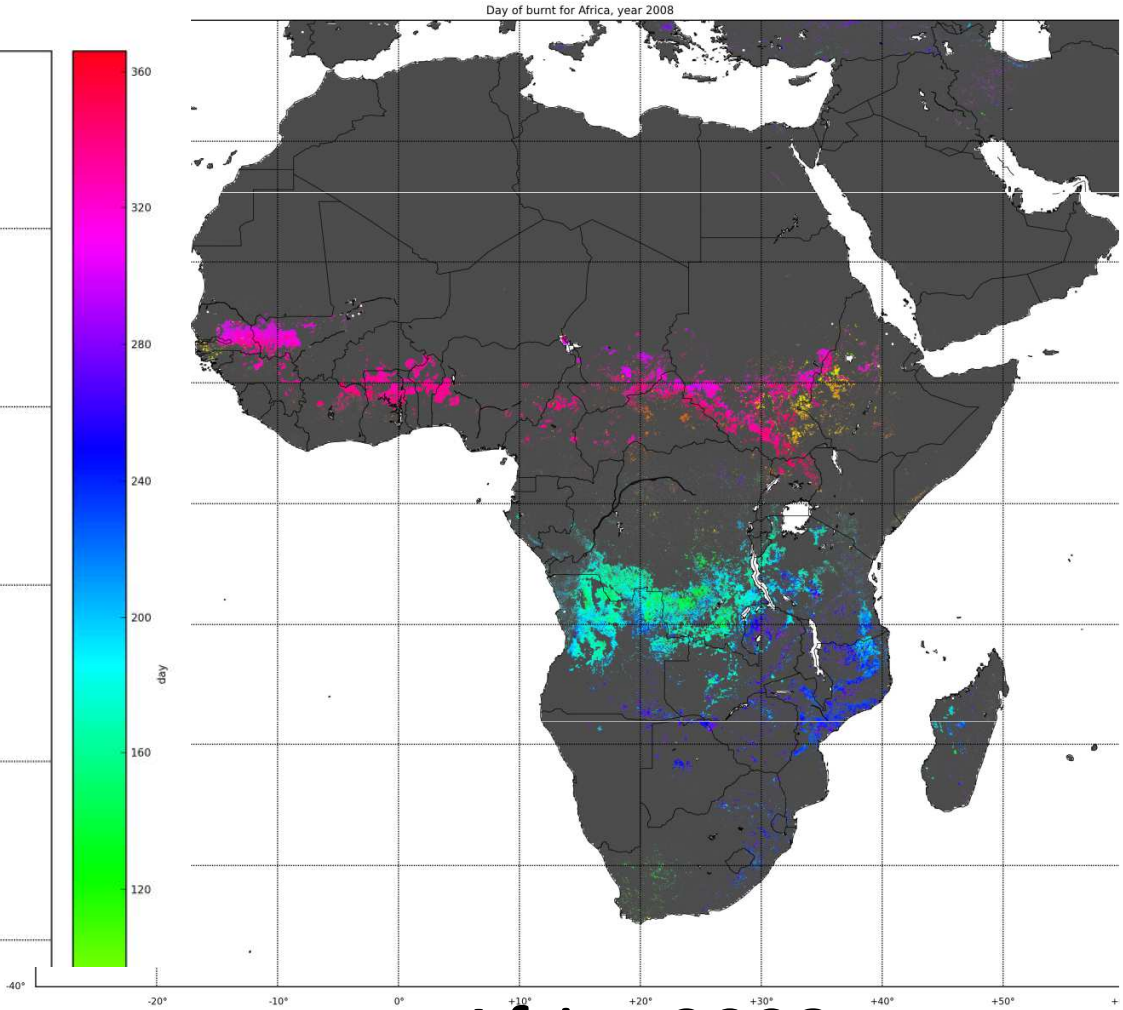
Australian site
VGT BA
1998 - 2009



BA VGT v1 results



South America 2008

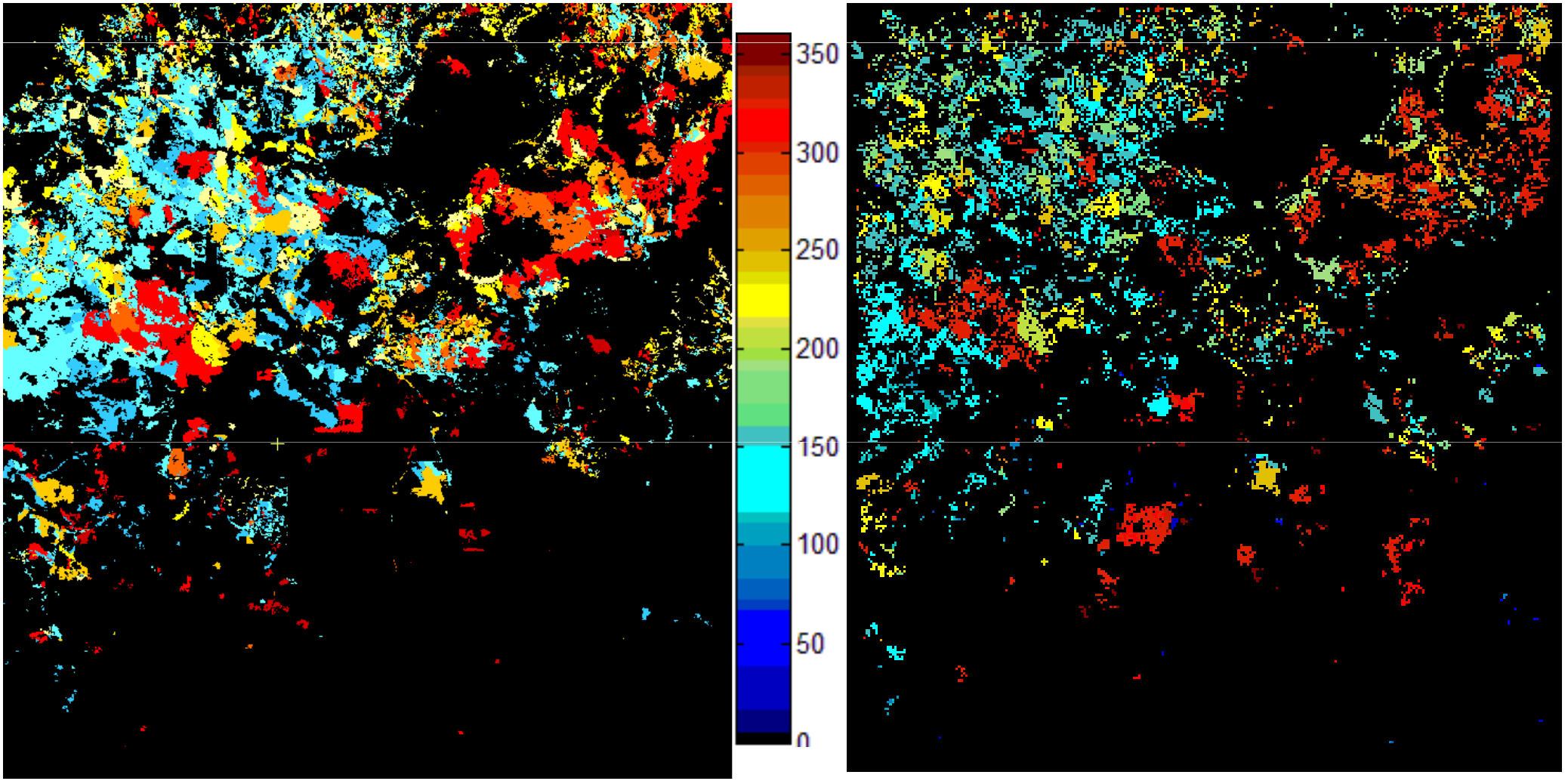


Africa 2008

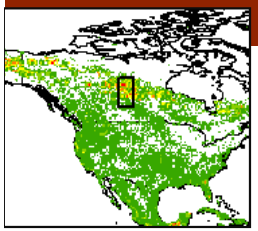
North Australian Fire Information comparison

NAFI

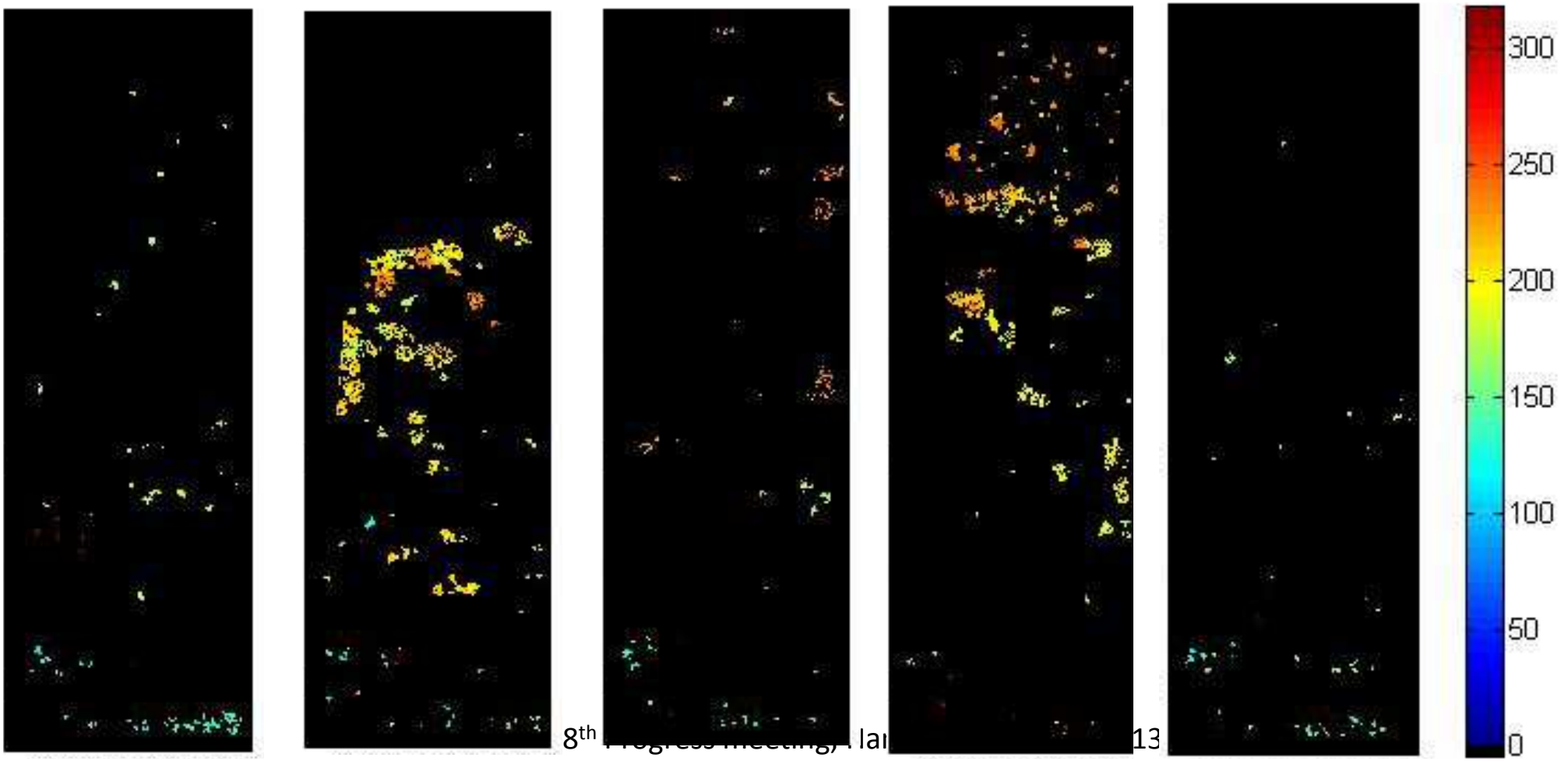
MERIS BA v1



MERIS v1: Boreal Forest Canada



2005 2006 2007 2008 2009

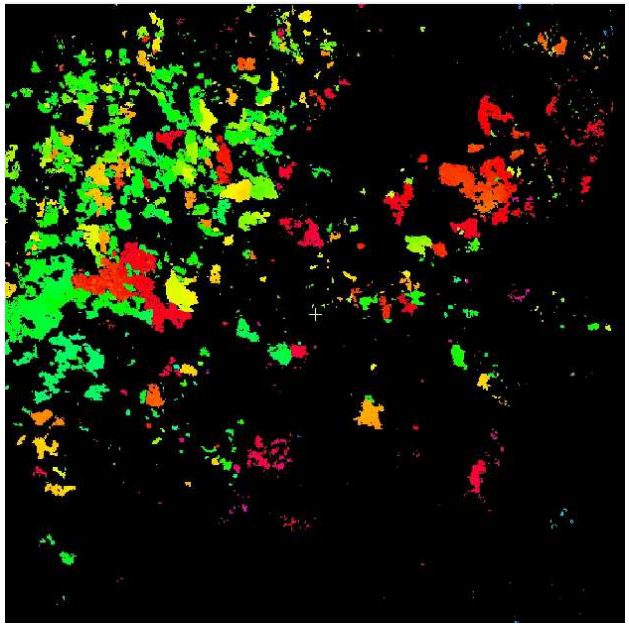


Discrimination problems found

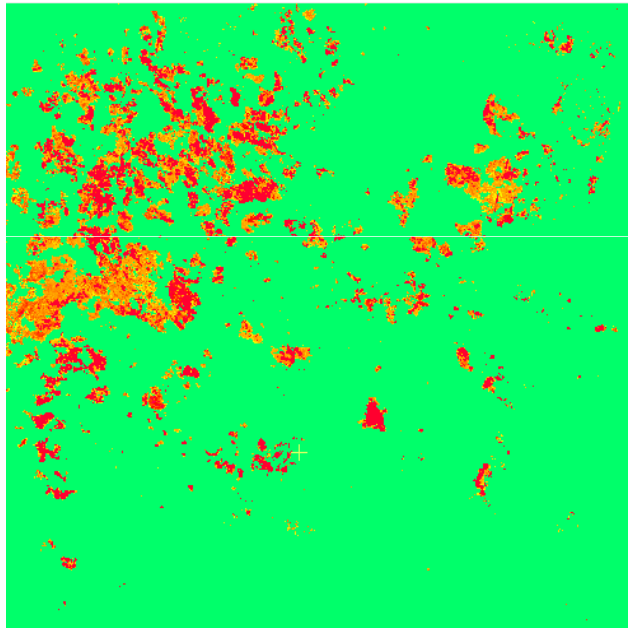
- MERIS:
  - Temporal resolution.
  - Spectral confusion: flooded.
- VGT:
  - Seasonal changes in agricultural areas.
  - Terrain radiometric effects.
  - Seasonality trends.

Pixel output: Merged product v1 (Australia)

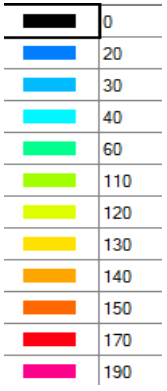
Day of detection

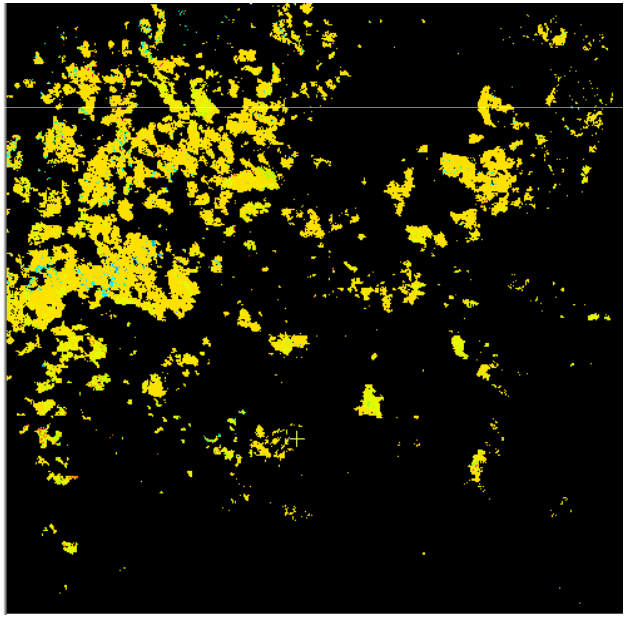


Confidence Level



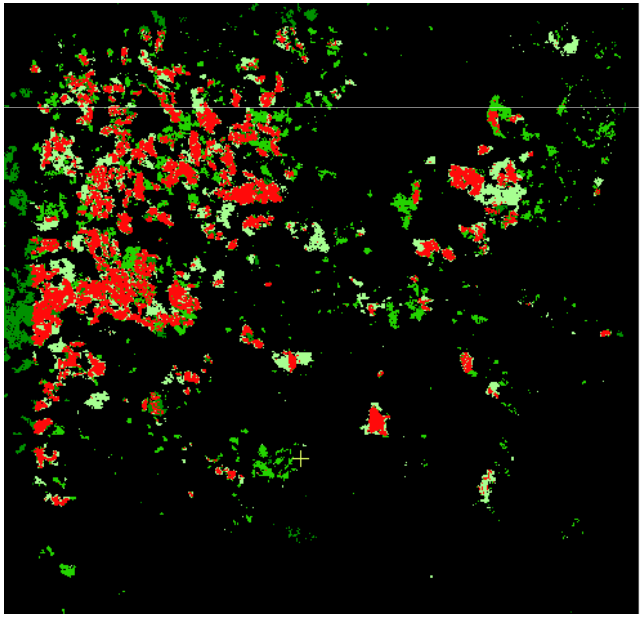
Land Cover Type





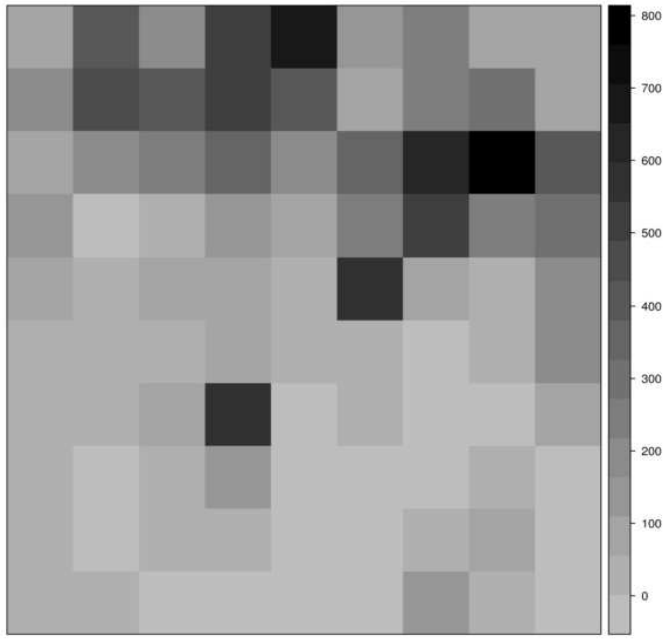
Sensor detecting

None
VGT + ATSR
ATSR + MERIS
VGT + MERIS
VGT + ATSR + MERIS

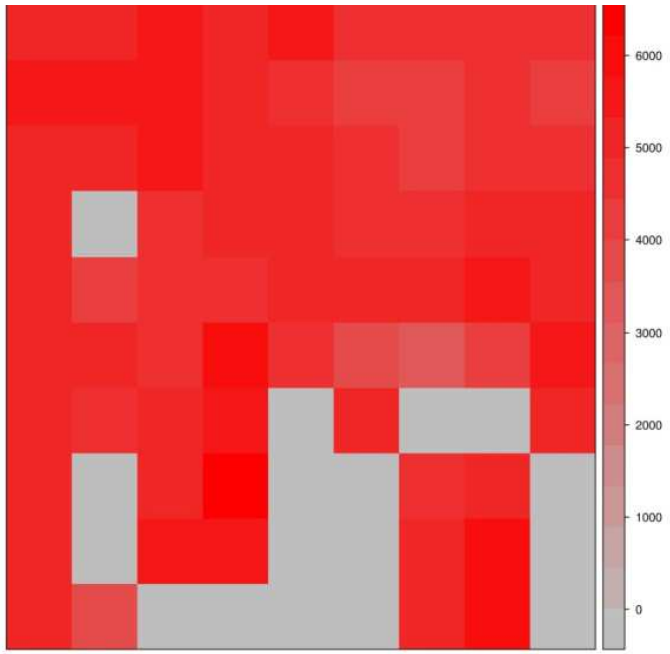


Grid output v1 (Australia)

Total burned area (km2)

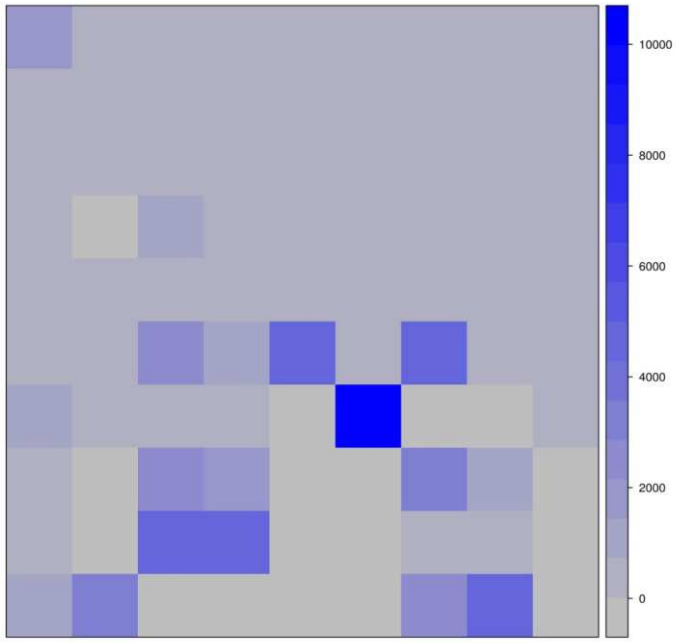


Standard Error

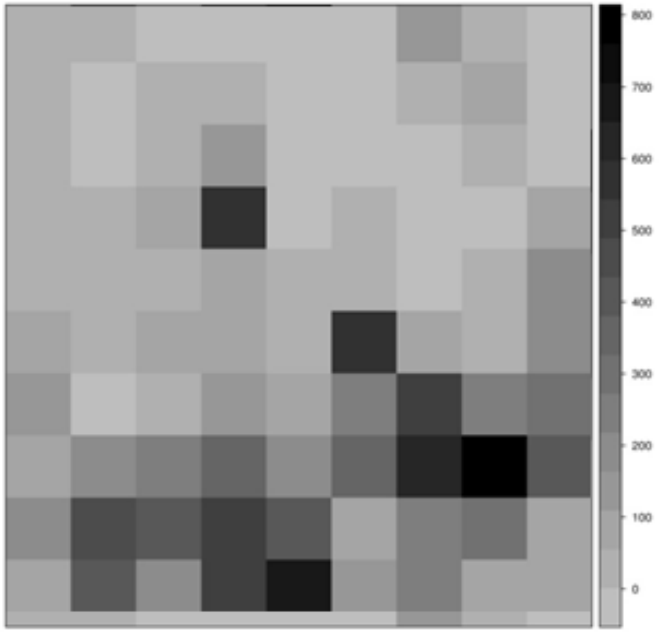


Homogeneity index

Mean fire size / total area burned

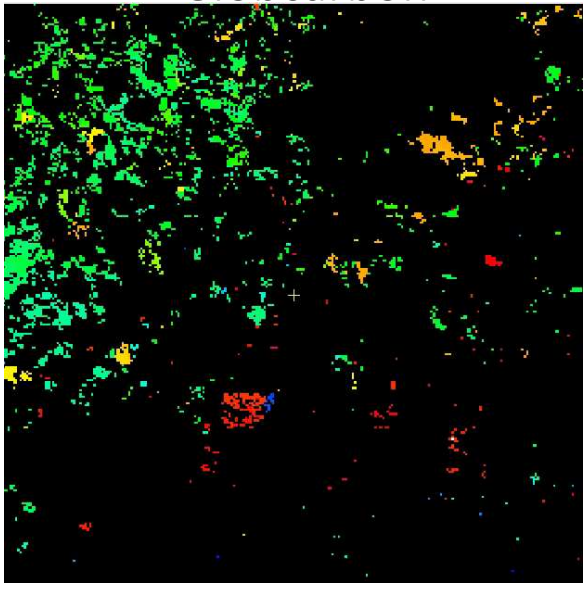


Area burned of Land cover X

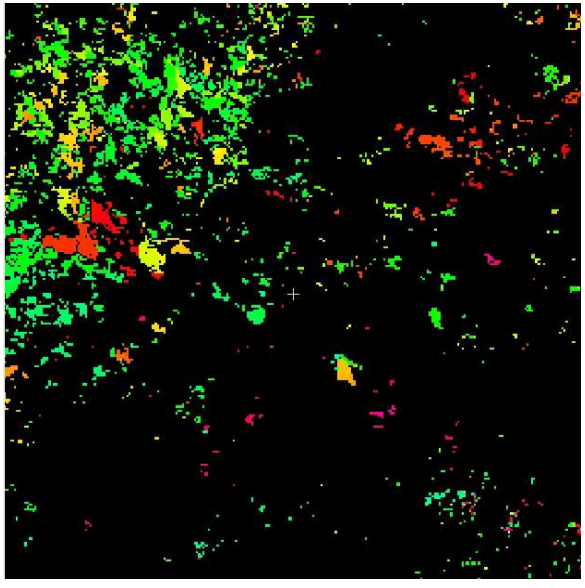


Intercomparison analysis (2005, Australia)

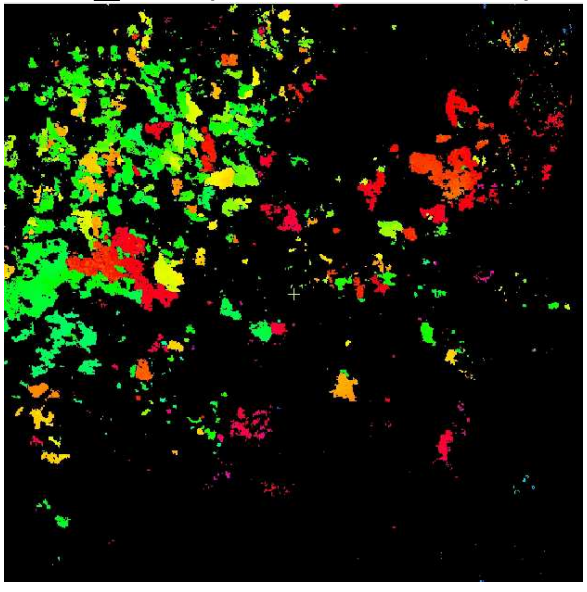
Globcarbon



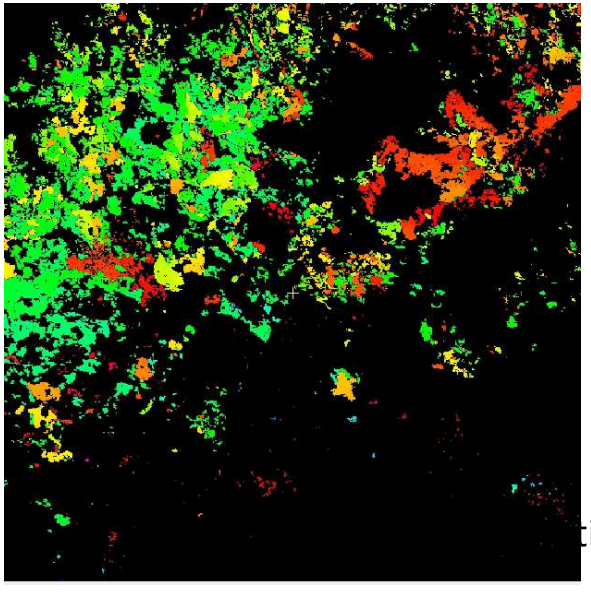
L3JRC



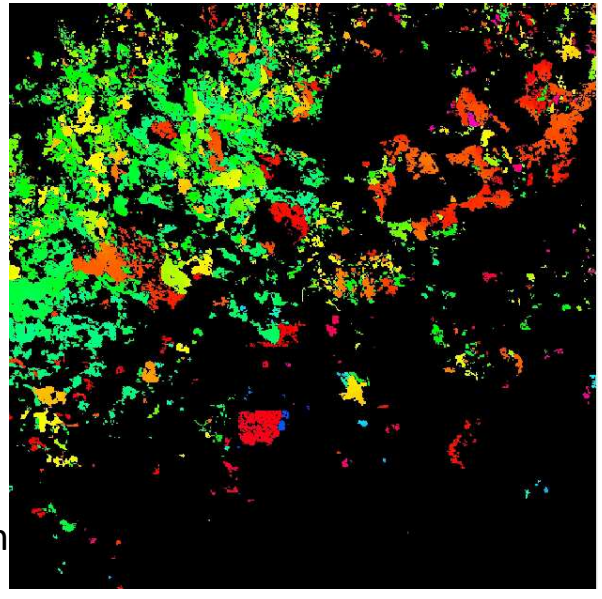
Fire_CCI (**PRELIMINARY**)

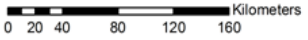


MCD45



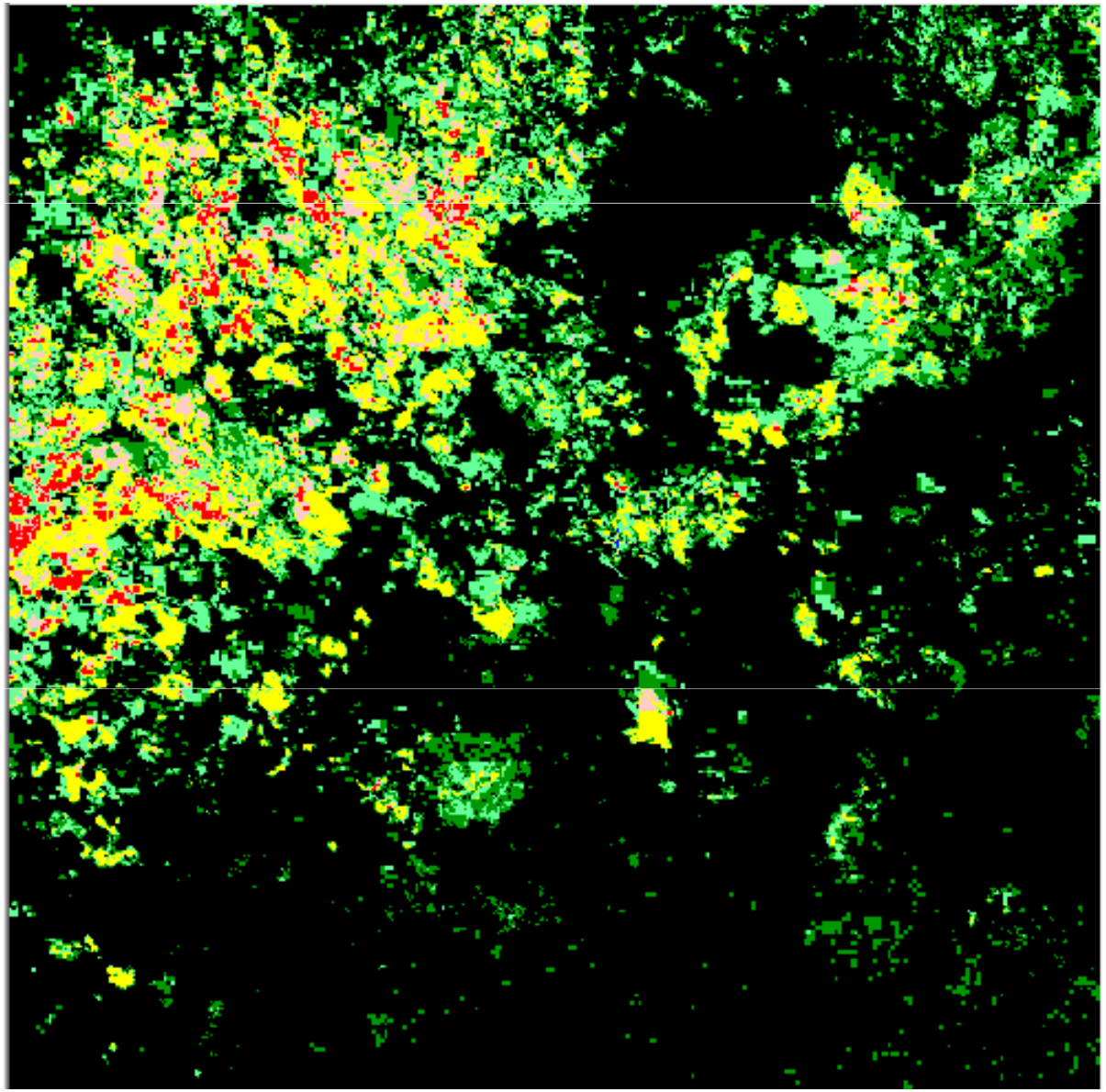
MCD64

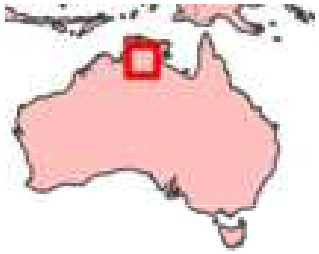




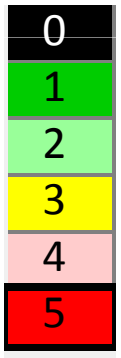
cting, Ham

Intercomparison analysis (2005, Australia)

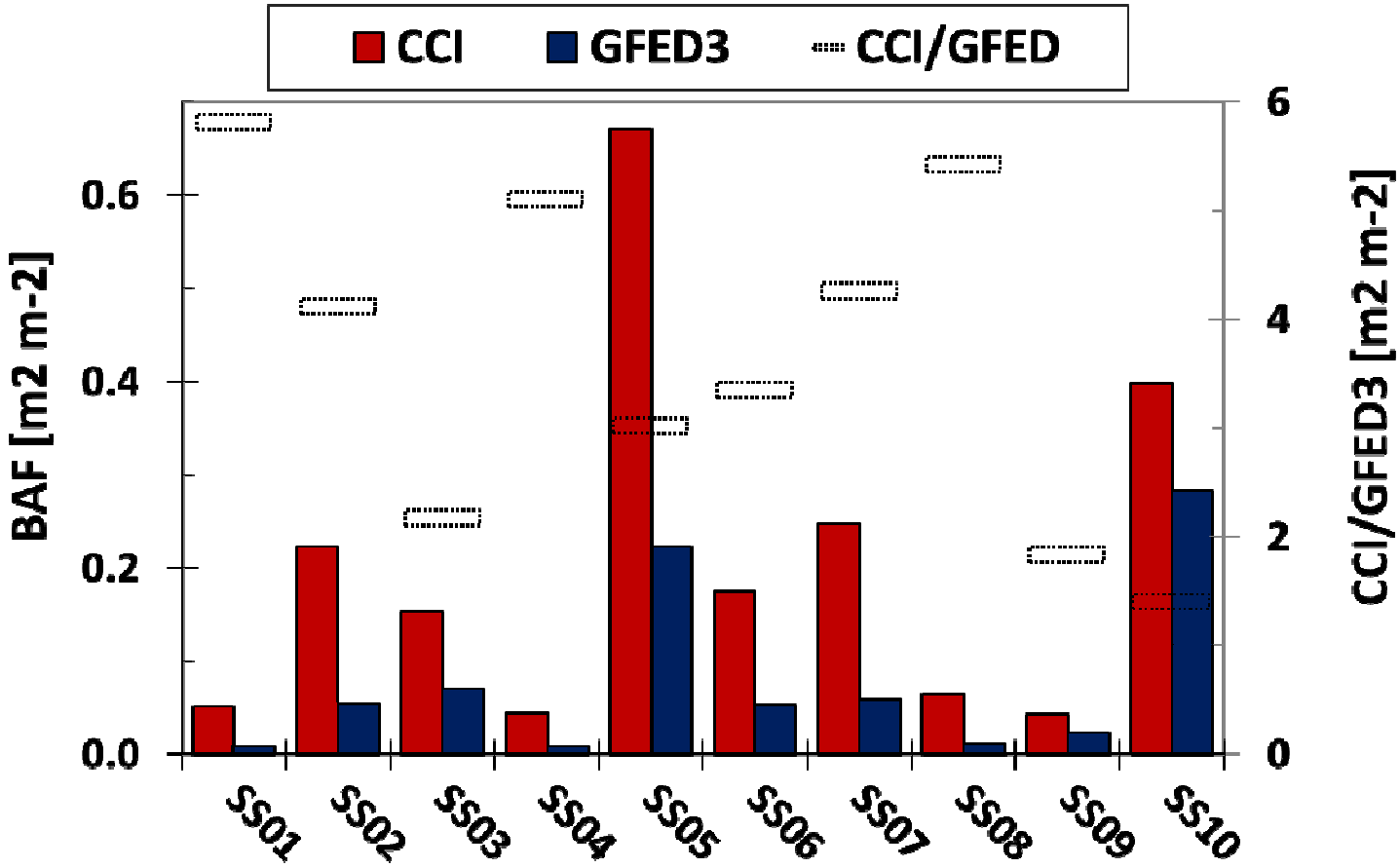




Products detecting BA pixels



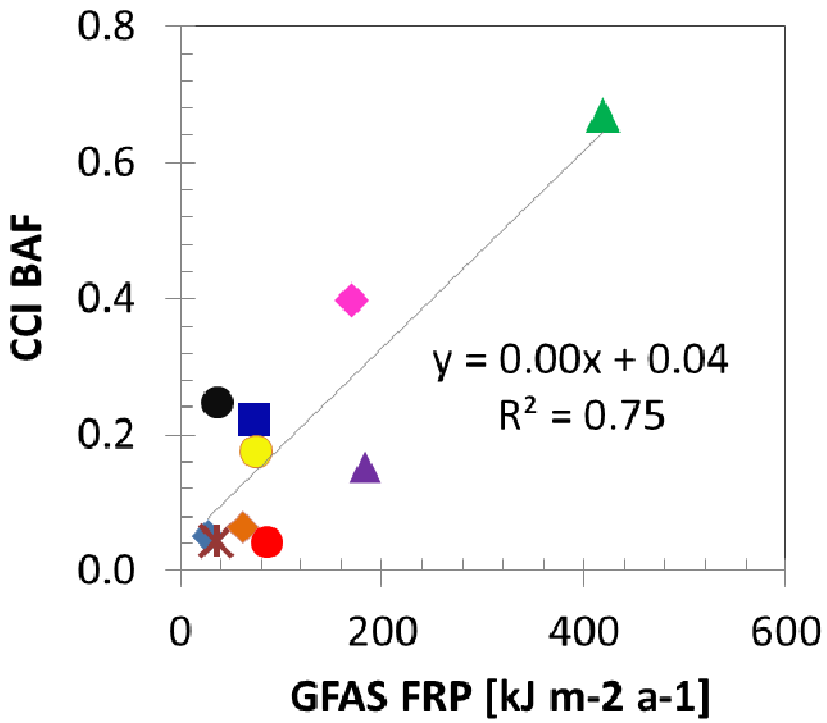
BA fraction (2003-2009)



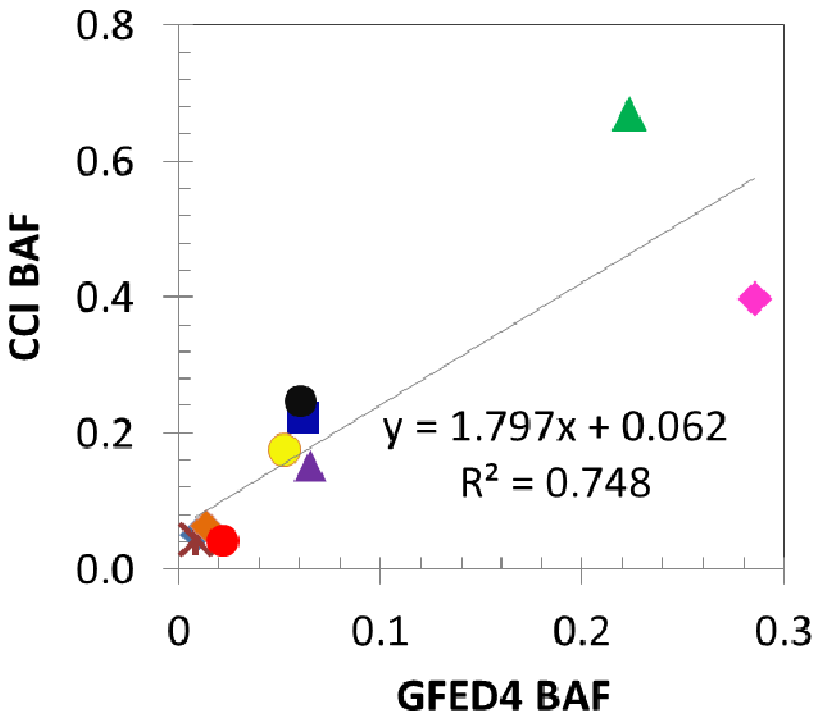
→ In all test sites, CCI BA higher than GFED3/4

→ On average, CCI BA 2.5 times higher than GFED3/4

Inter-site variations



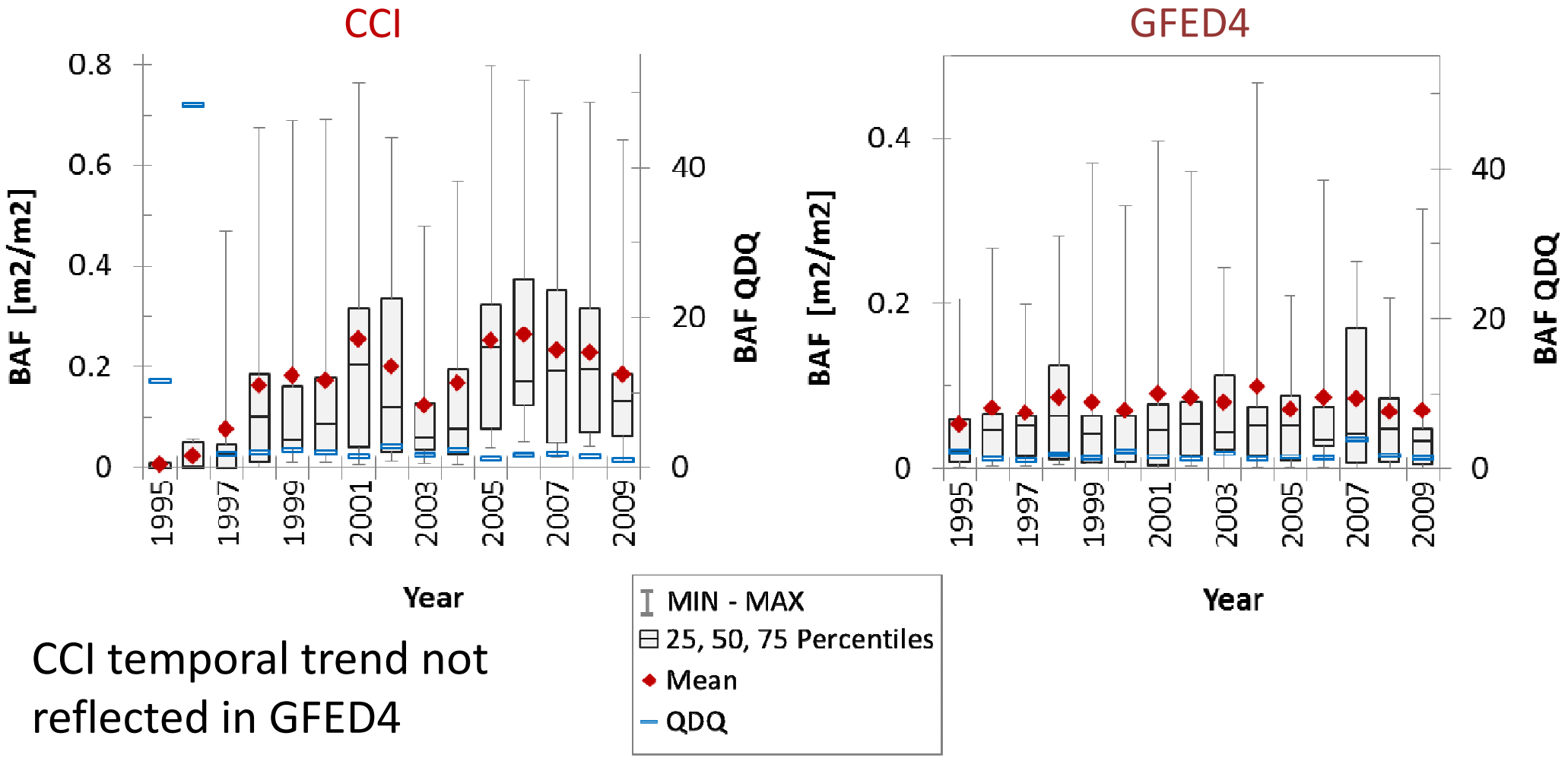
SS	Region
1	Canada
2	Colombia
3	Brazil
4	Portugal
5	Angola
6	South Africa
7	Kazakhstan
8	Borneo
9	Russia
10	Australia



CCI BAF variations between sites are reflected to

- 73% by variations in GFAS FRP → CCI captures inter-site variations
- 67% by variations in GFED4 BAF observed by independent product

Temporal stability



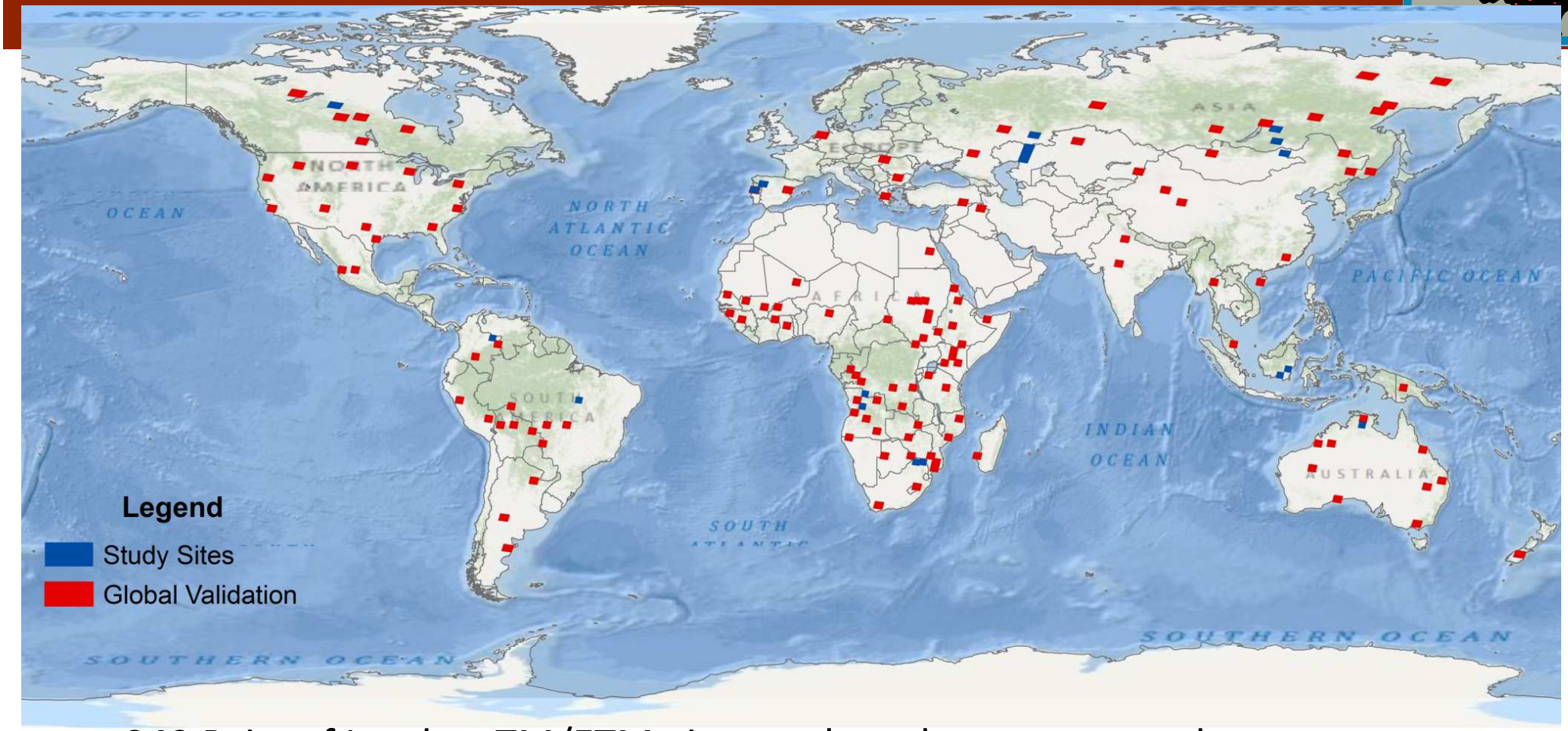
CCI temporal trend not reflected in GFED4

→ Stability over time questionable

Progress of the last 6 months

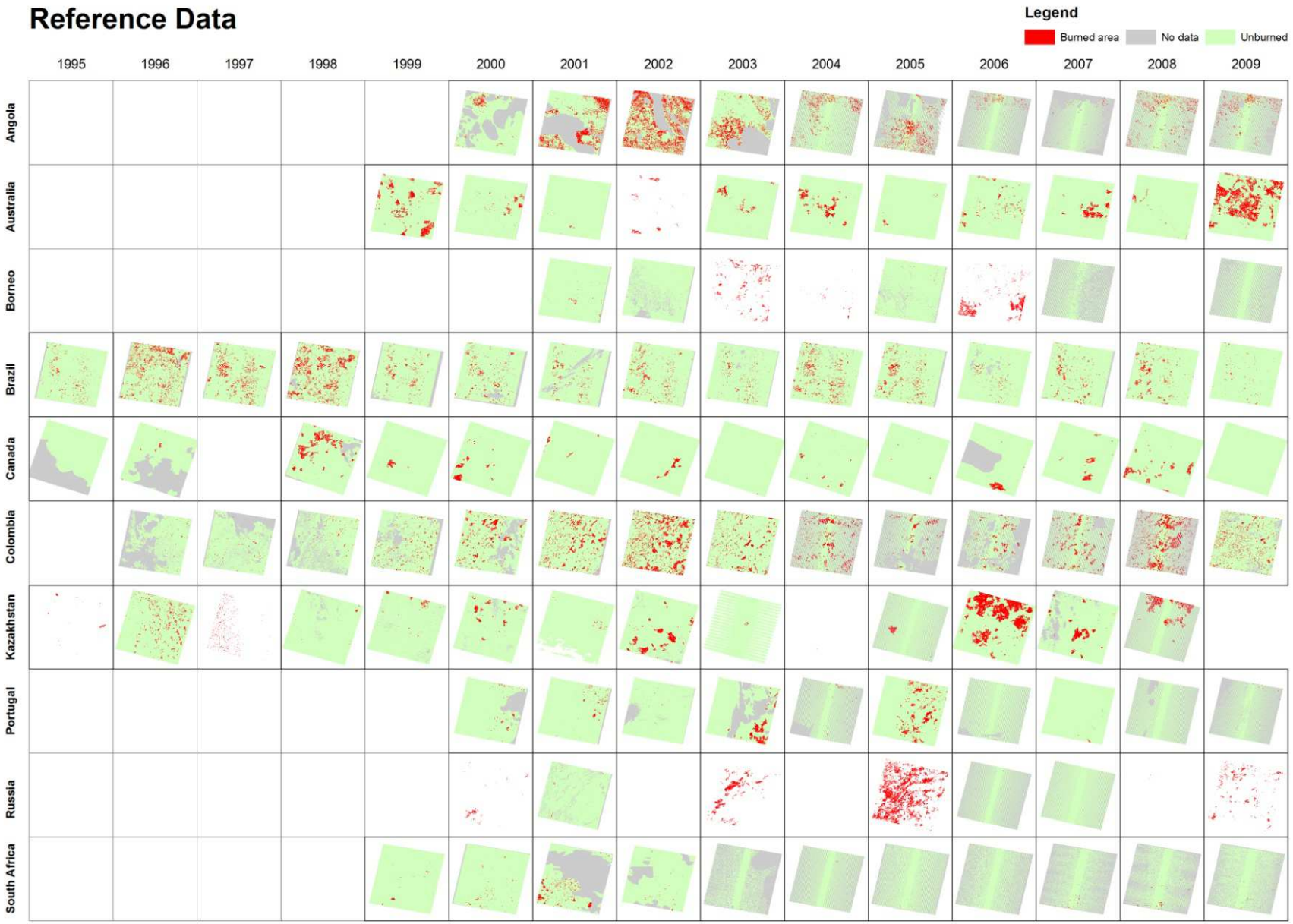
- 3rd CCI CMUG Integration Meeting – 3 – 5 June, 2013 - MPI-M Hamburg.
- Organization of a Latin American validation workshop.
- Conferences attended:
  - European Space Expo (Madrid), February 2013.
  - GOFC-GOLD Wageningen, April 2013
  - Brazilian Remote Sensing Symposium, April 2013.

Validation



- 242 Pairs of Landsat TM/ETM+ images have been processed to generate validation files:
  - 130 pairs for spatial validation (red).
  - 112 pairs for temporal validation (blue).
- All files are documented following standard CEOS Cal-Val guidelines.

Temporal validation



Biome distribution

Biomes	Frames	Fire perimeters	Burned area (km²)
Tropical Forest	42	50.157	24.475
Temperate grasland	29	3.467	13.189
Others biomes	8	384	89
Temperate Forest	16	1.223	186
Mediterranean Forest	18	2.327	5.230
Tropical Savanna	94	89.365	74.971
Boreal Forest	35	1.071	8.040
Total	**242**	**147.994**	**126.180**

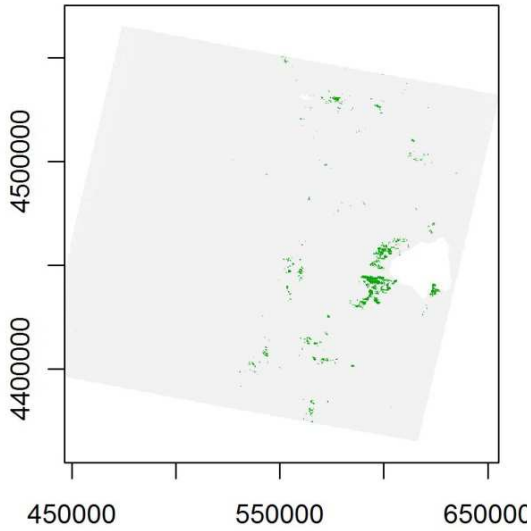
Approach to estimate uncertainty

- Probability of burned area, Pbu_{ij}, at each pixel i at time t.
- Regression model from the BA reference data for study sites:

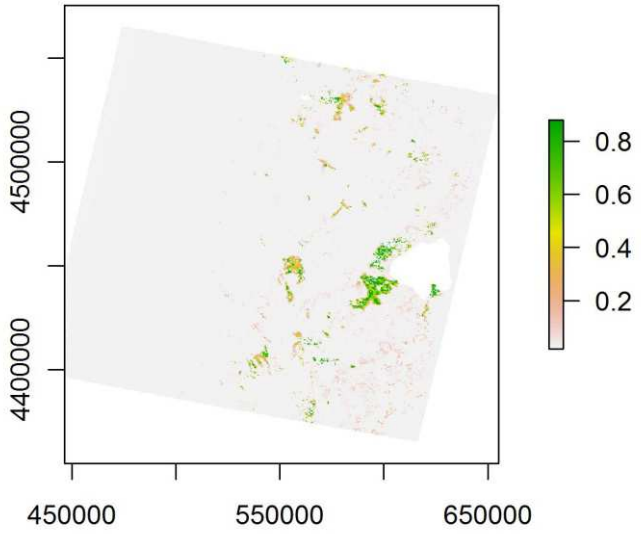
$$Pbu_{it} = \mathrm{Prob}(Y_{it} = 1, \theta_{it})$$

  - Where Y_{it} is a binary response with Y_{it} = 1 (when reference is burned) or 0 otherwise.
- Computed from logistic regression (GLM or GAM).

BA product



Uncertainty (*Pbu*)



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- Mouillot, F., Schultz, M.G., Yue, C., Cadule, P., Tansey, K., Ciais, P., & Chuvieco, E. (2013). Ten years of global burned area products from spaceborne remote sensing - A review: Analysis of user needs and recommendations for future developments. *International Journal of Applied Earth Observation and Geoinformation, in press.*