Fire_cci

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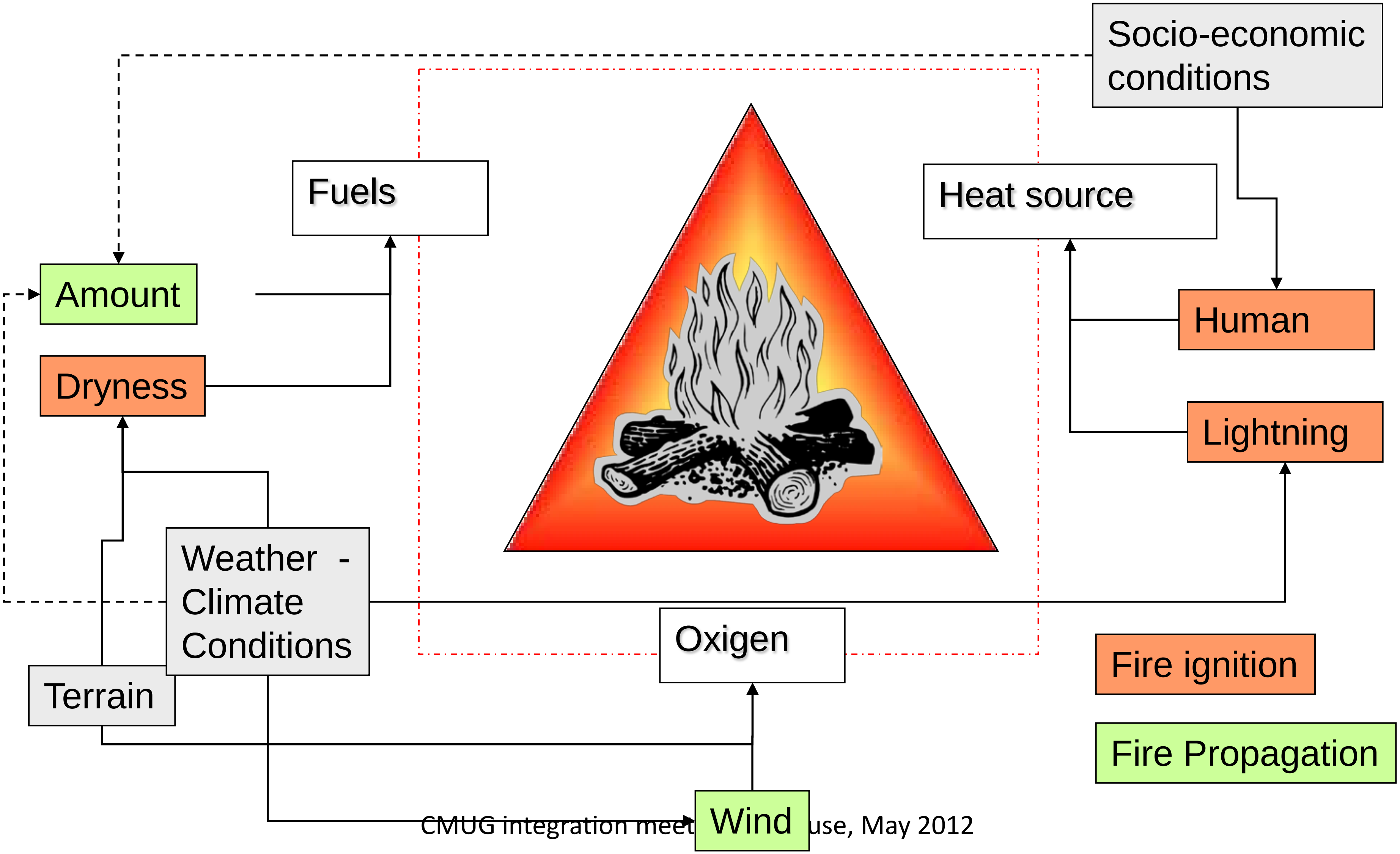
ToC

- Science challenges: main questions.
- Project response to those challenges
- Advances and difficulties
- Anticipated outcomes.

Science challenges

- What is the actual magnitude of fire impacts?
  - How much area is burned annually?
  - How much biomass is actually consumed?
  - What is the share of biomass burning in total GHG emissions?
  - 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?

Fire factors



Impacts of recent warming on fire occurrence

GEOPHYSICAL RESEARCH LETTERS, VOL. 33, L09703, doi:10.1029/2006GL025677, 2006

Recent changes in the fire regime across the North American boreal region—Spatial and temporal patterns of burning across Canada and Alaska

Eric S. Kasischke[1] and Merritt R. Turetsky[2]

Received 16 January 2005; accepted 29 March 2006; published 3 May 2006.

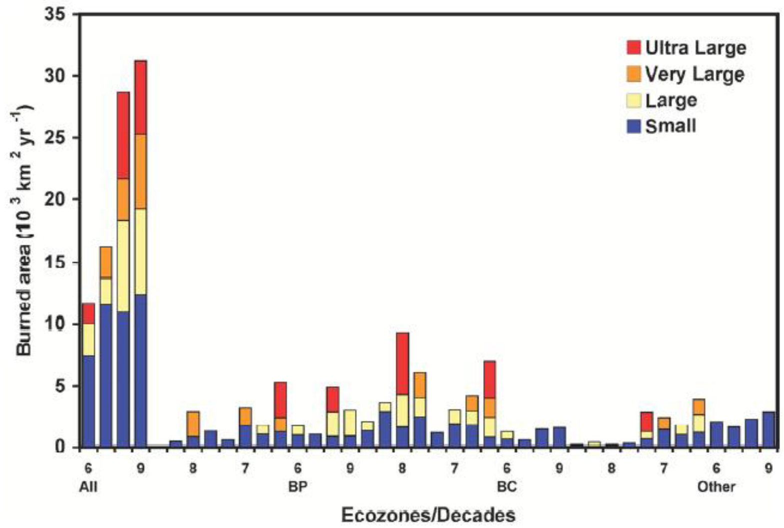
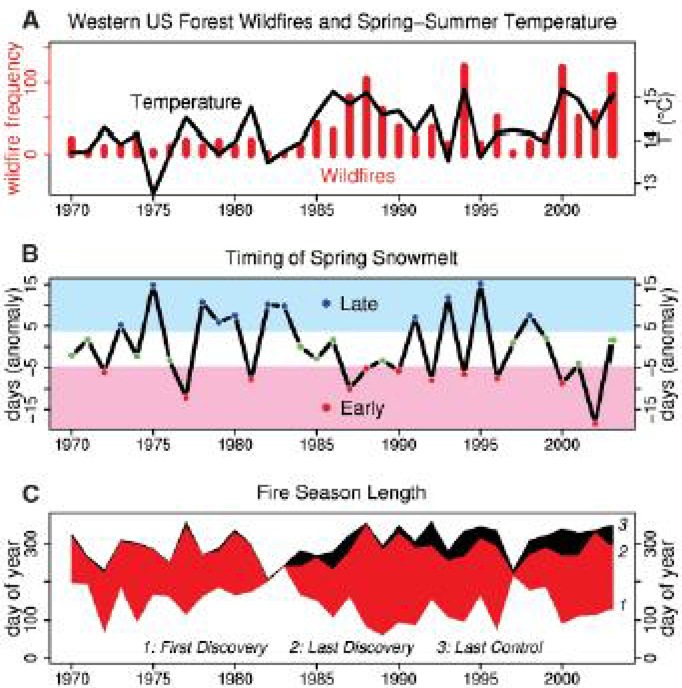


Figure 1. Decadal patterns in burned area across the NABR and in individual ecozones (on the x-axis, 6 = 1960s, 7 = 1970s, etc.; see Table 2 for the key to the ecozones).

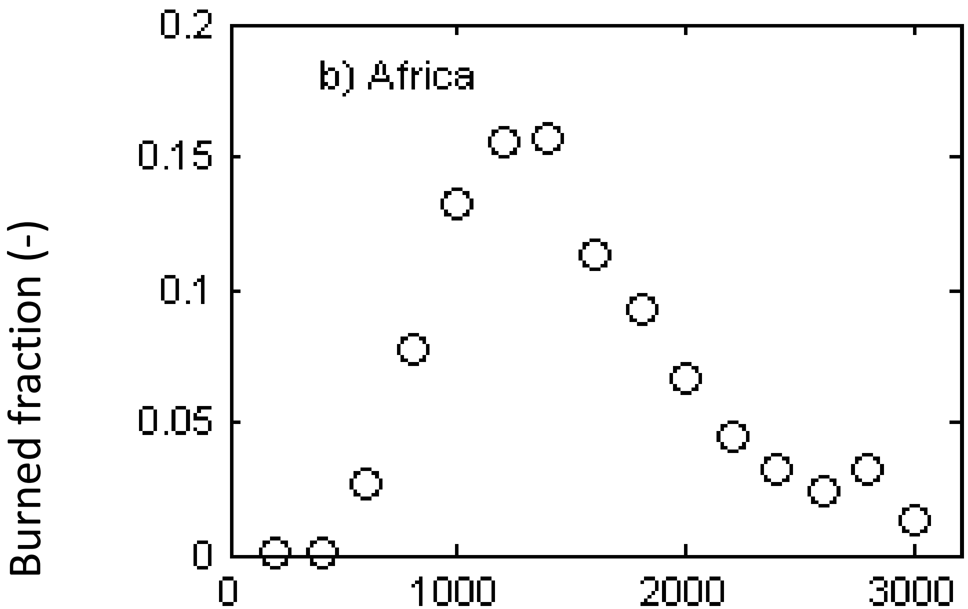


18 AUGUST 2006 VOL 313 SCIENCE www.sciencemag.org

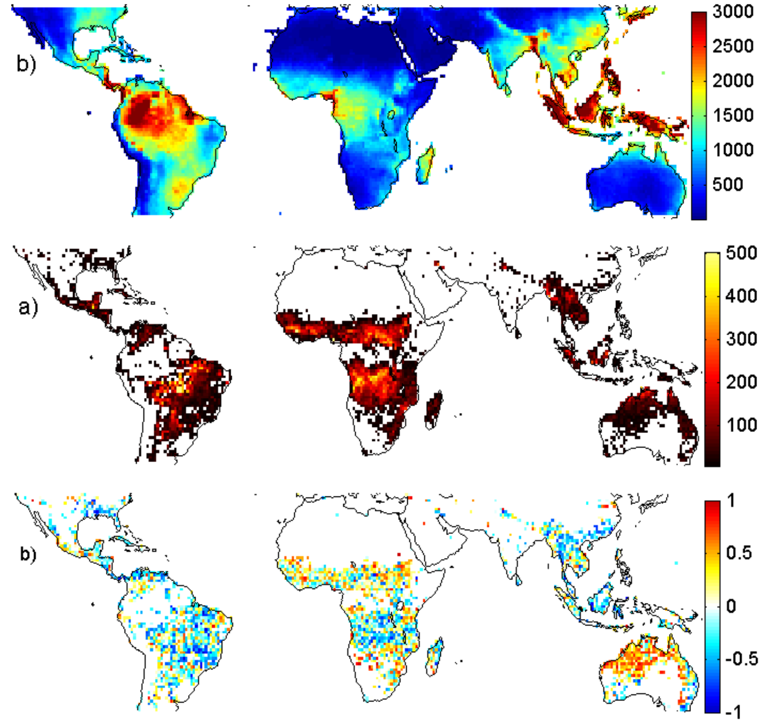
Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity

A. L. Westerling,[1,2]* H. G. Hidalgo,[1] D. R. Cayan,[1,3] T. W. Swetnam[4]

Fire and Rainfall in the Tropics



Mean annual precipitation (mm / year)



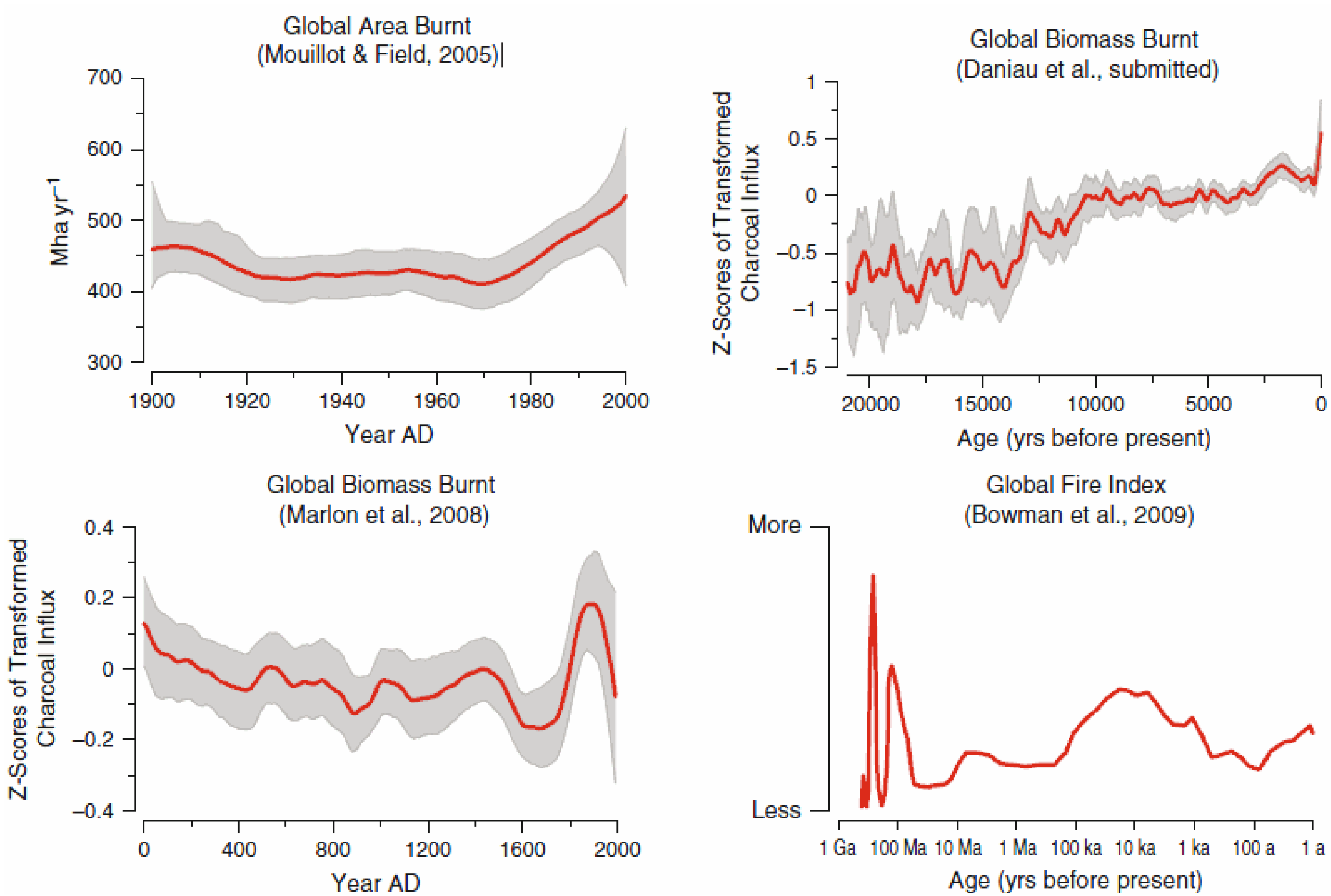
Not enough precipitation   Too much precipitation

Van der Werf, 2009

Trends in fire activity

Last century

Last millenia

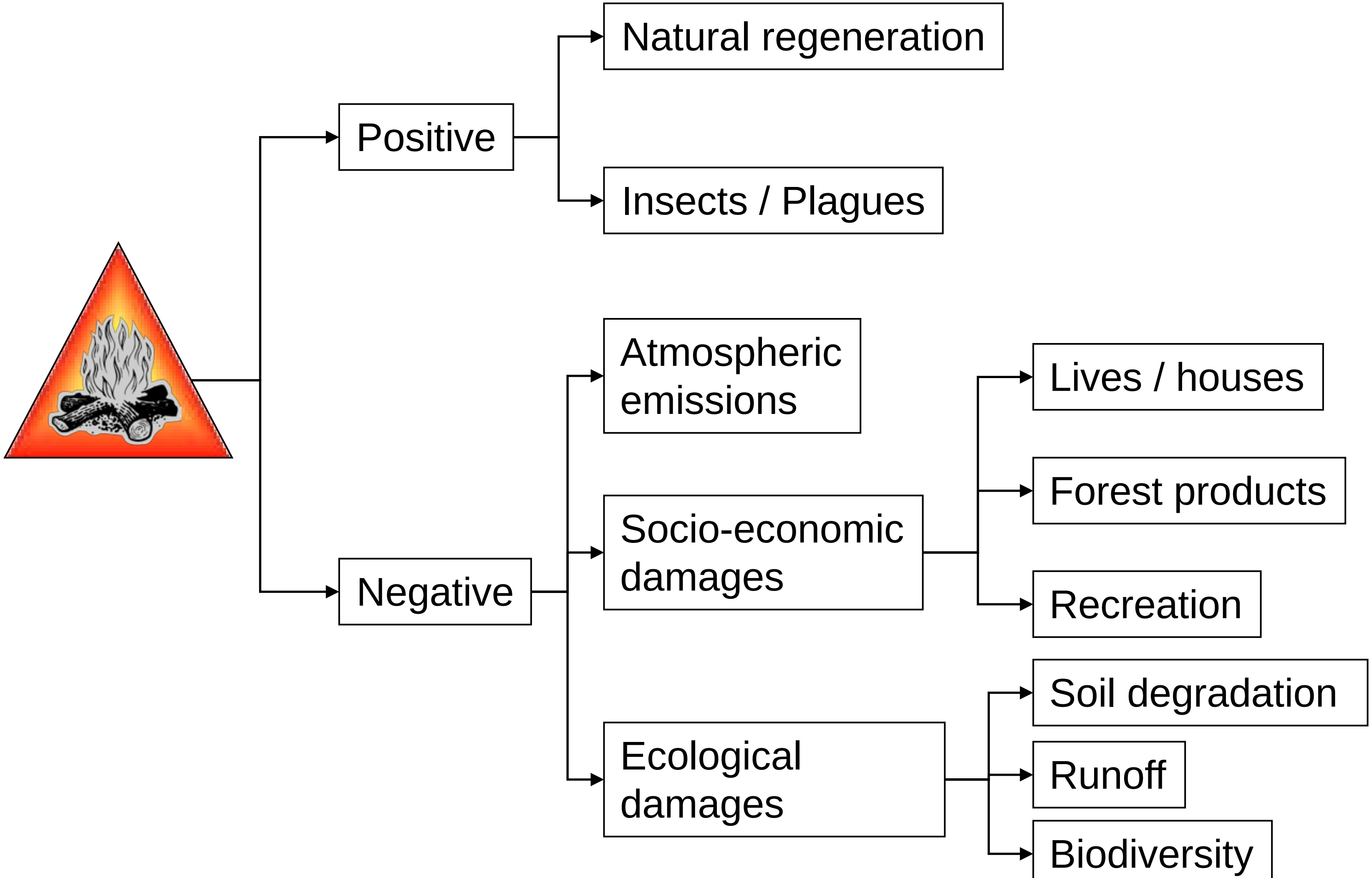


Last Ice age

< 100 Ma

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

Fire Impacts



Ecosystems' dependency of fire

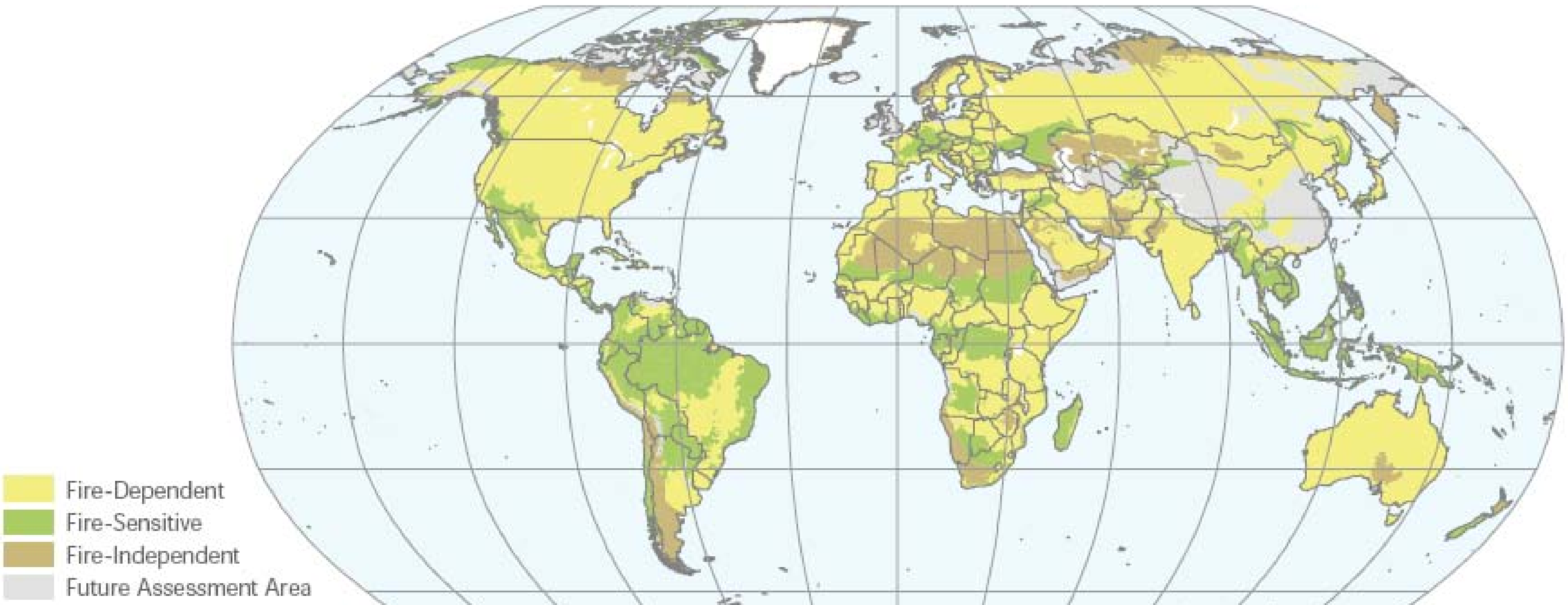


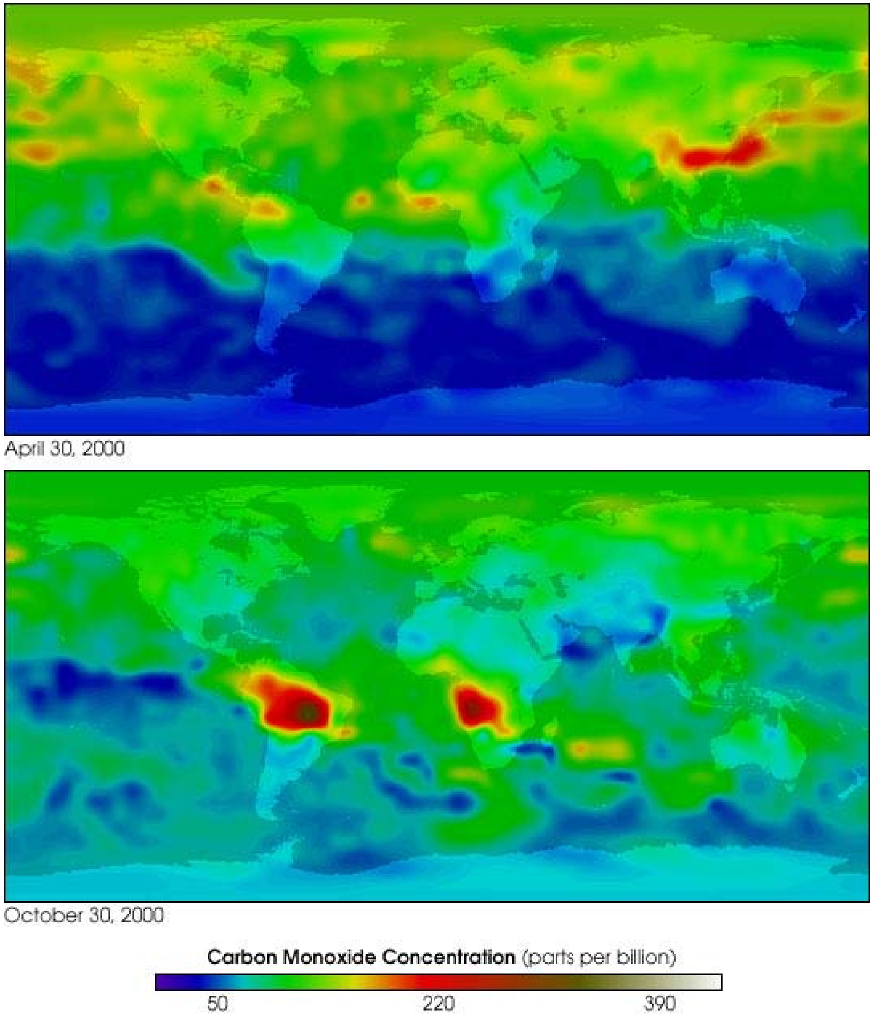
Figure 2. Global distribution of fire regime types.

Shlisky, A., J. Waugh, P. Gonzalez, M. Gonzalez, M. Manta, H. Santoso, E. Alvarado, A. Ainuddin Nuruddin, D.A. Rodríguez-Trejo, R. Swaty, D. Schmidt, M. Kaufmann, R. Myers, A. Alencar, F. Kearns, D. Johnson, J. Smith, D. Zollner and W. Fulks. 2007. Fire, Ecosystems and People: Threats and Strategies for Global Biodiversity Conservation. GFI Technical Report 2007-2. The Nature Conservancy. Arlington, VA.

Fire emissions:
Top down approach

Emissions are estimated as a function of gas concentrations or emitted energy

(Em=f(Fire Radiate Power))



Source: MOPITT

Fire emissions: Bottom-up approach

Emissions =

burned area

x

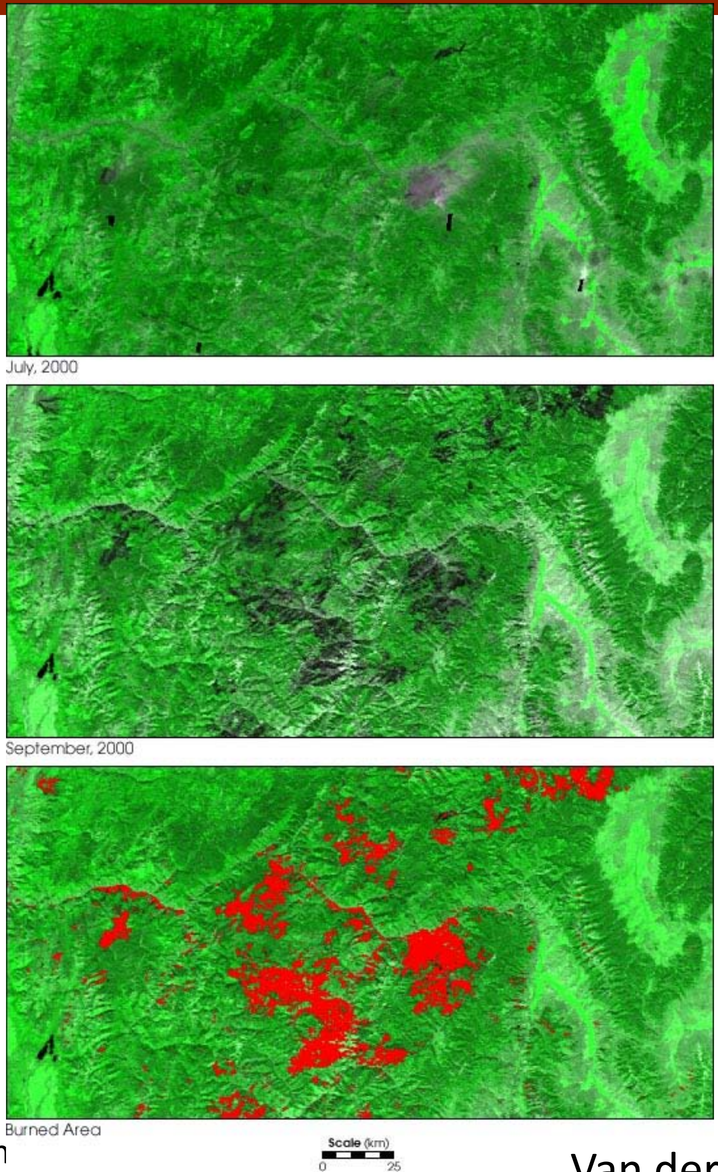
biomass

x

combustion completeness

X

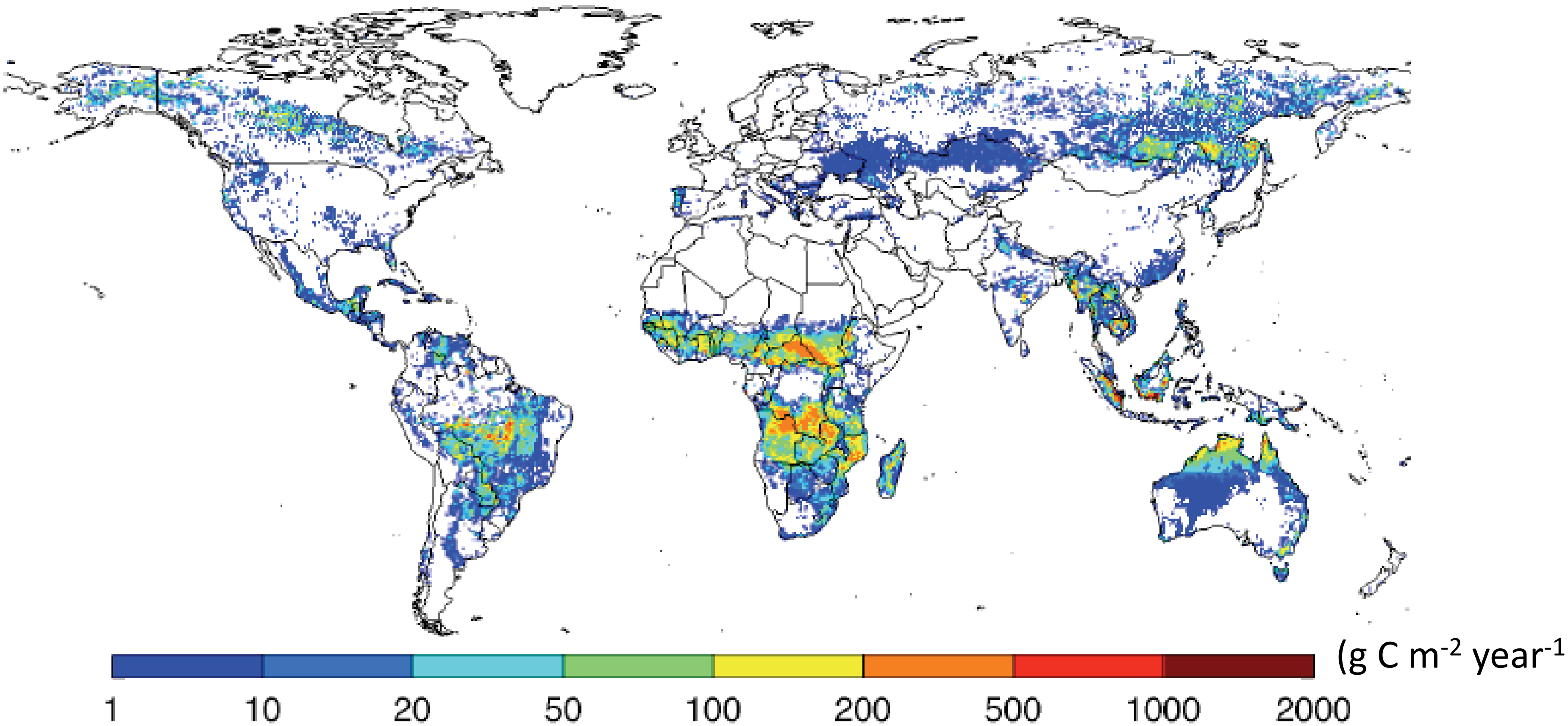
emission factors



CMUG integration

Van der Werf, 2009

C Average emissions from biomass burning (1997-2009)



Average carbon emissions over 1997–2009 were 2.0 PgC $year^{-1}$ with considerable interannual variability.

Van der Werf et al., 2010: Journal of Atmospheric Science, GFED v3

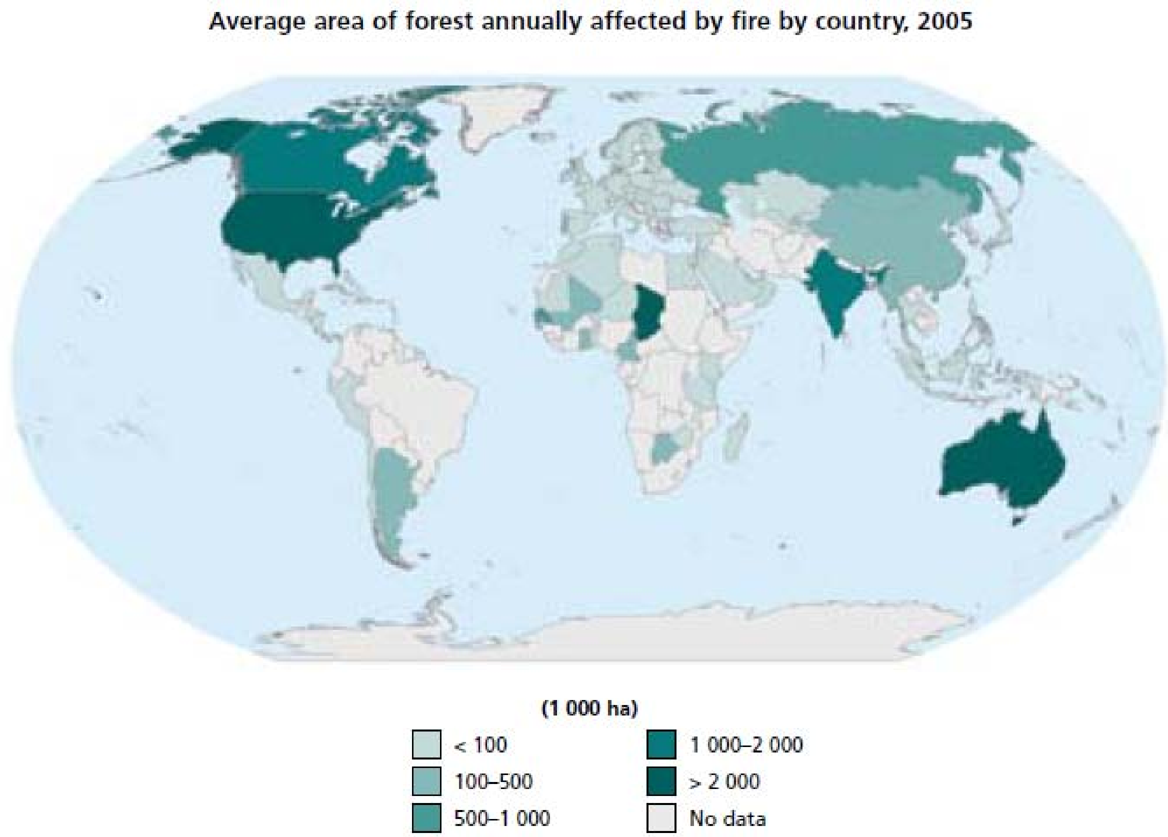
¿How much area is actually burned every year?

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

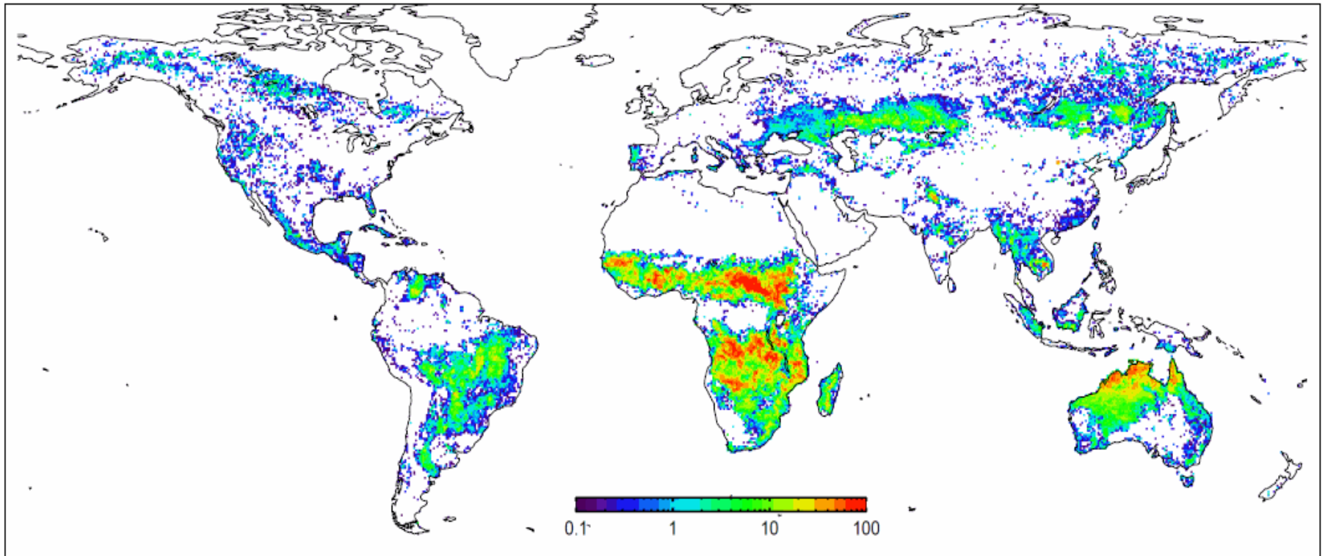
Different BA estimations

- FAO (FRA2010): 0.6 Mkm^2. Only 78 countries are covered.
- RS products:
  - L3JRC: 3.5 - 4.5 Mkm^2 (2000-07)
  - MCD45 c5: 3.3 - 3.6 Mkm^2 (2000–2006)
  - GFED v2: 2.97 – 3.74 Mkm^2 (2001–2004)
  - GFED v3: 3.39 - 4.31 Mkm^2 (1997-2009).

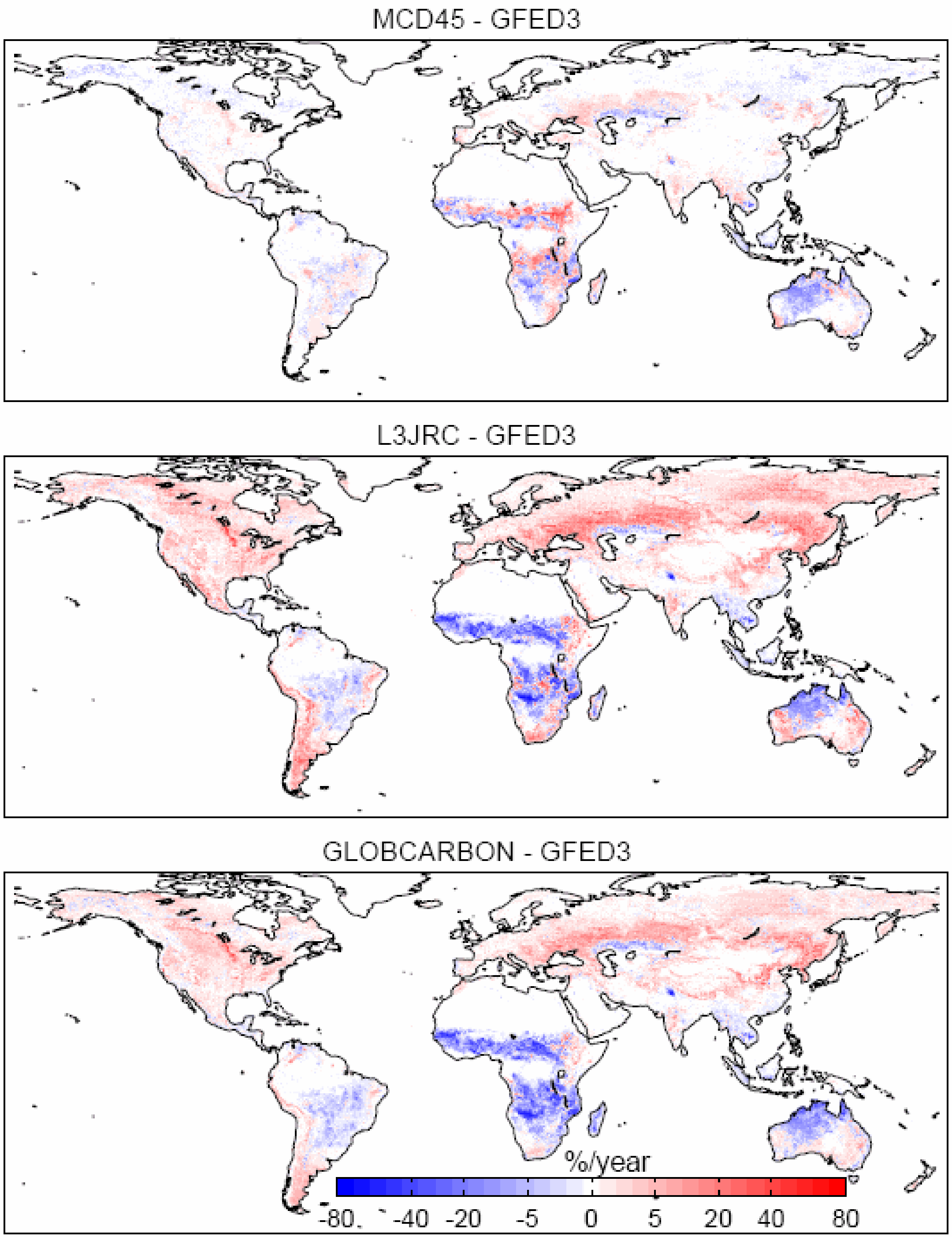
FRA2010



GVED v3



Uncertainty in BA estimation



% of BA from different satellite products

Red: over estimation

Blue: under estimation

(Giglio et al., 2010).

CMUG in

Scientific goals of fire_CCI

1. Refine definition of user requirements (GCOS are unrealistic and unfocused).
2. Improve current estimations of global burned area. Validate and intercompare BA global products.
3. Test improvements of climate-vegetation-carbon models with new BA data.

Project phases

1. Improve GCOS requirements: URD and PSD.
2. Generation of BA time series:
    1. Pre-processing.
    2. Burned Area Algorithm Development.
    3. Round-Robin exercise.
    4. Validation / intercomparison.
3. Integration with carbon-emission models.

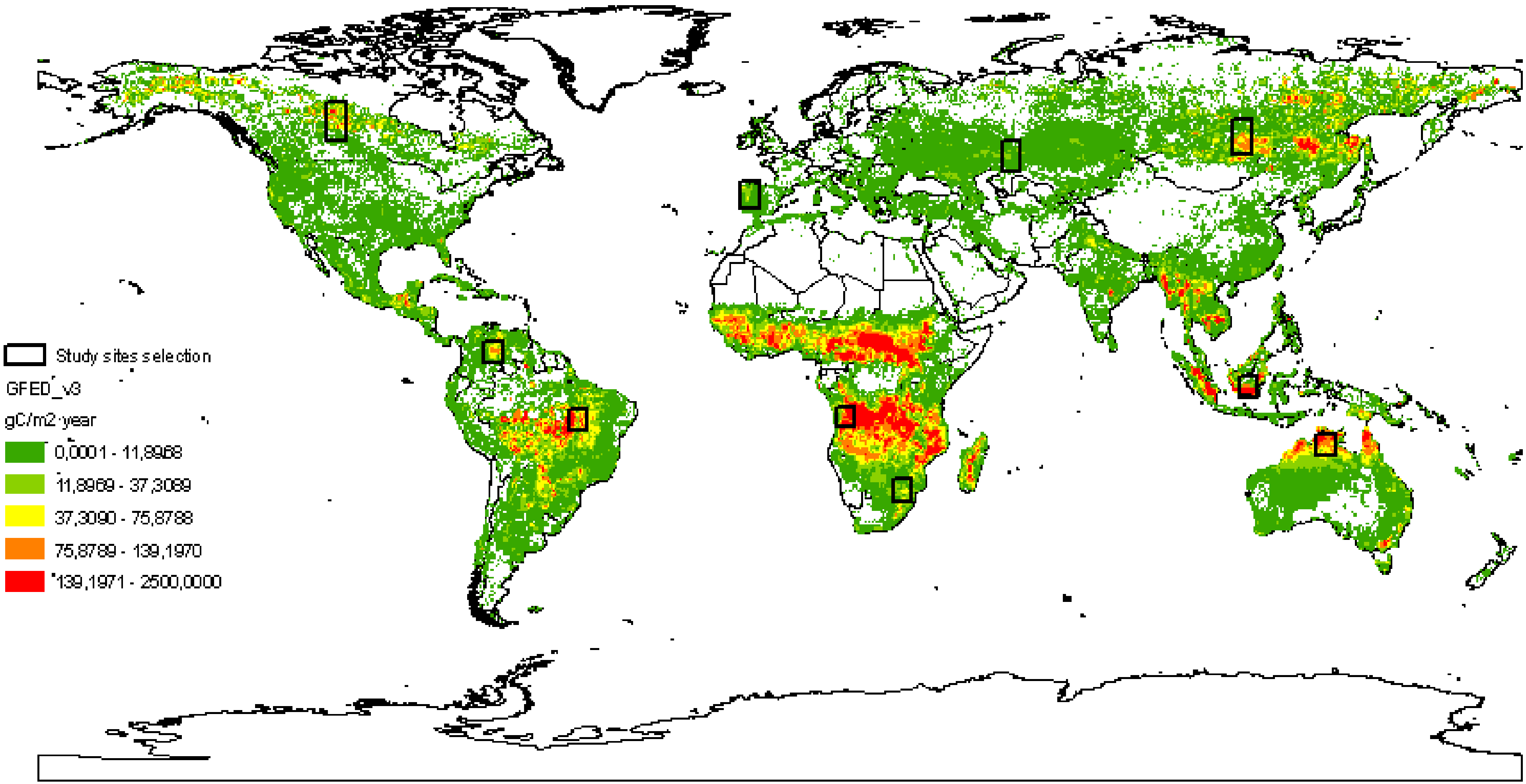
Relations with other CCIs

- Impacts of biomass burning on:
  - Aerosols / GHG / Clouds.
  - Land Cover.
- Factors affecting fire occurrence:
  - Temperature-rainfall trends, particularly heat waves and "El Niño" episodes (climate prediction)
  - Relations between fire and Tropical deforestation (land cover).

URD-PSD:
fire_cci production targets

- Temporal series of BA over 10 selected areas (500x500 km) (1995-2009):
  - Assure spatial accuracy and stability.
  - Consistency across multiple satellites
  - Demonstrate full-time series available.
- Global coverage for five years (1999, 2000, 2003, 2005 and 2008):
  - Demonstrate the semi-operational processing.
  - Ensemble chain, bulk processing of data.

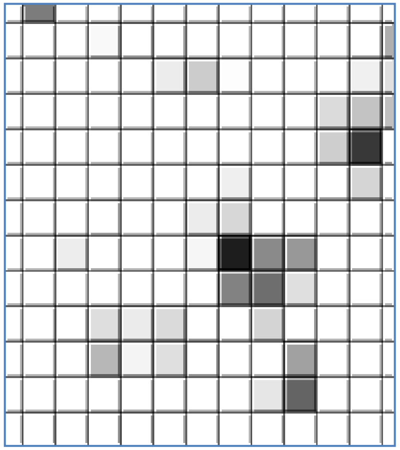
Study sites



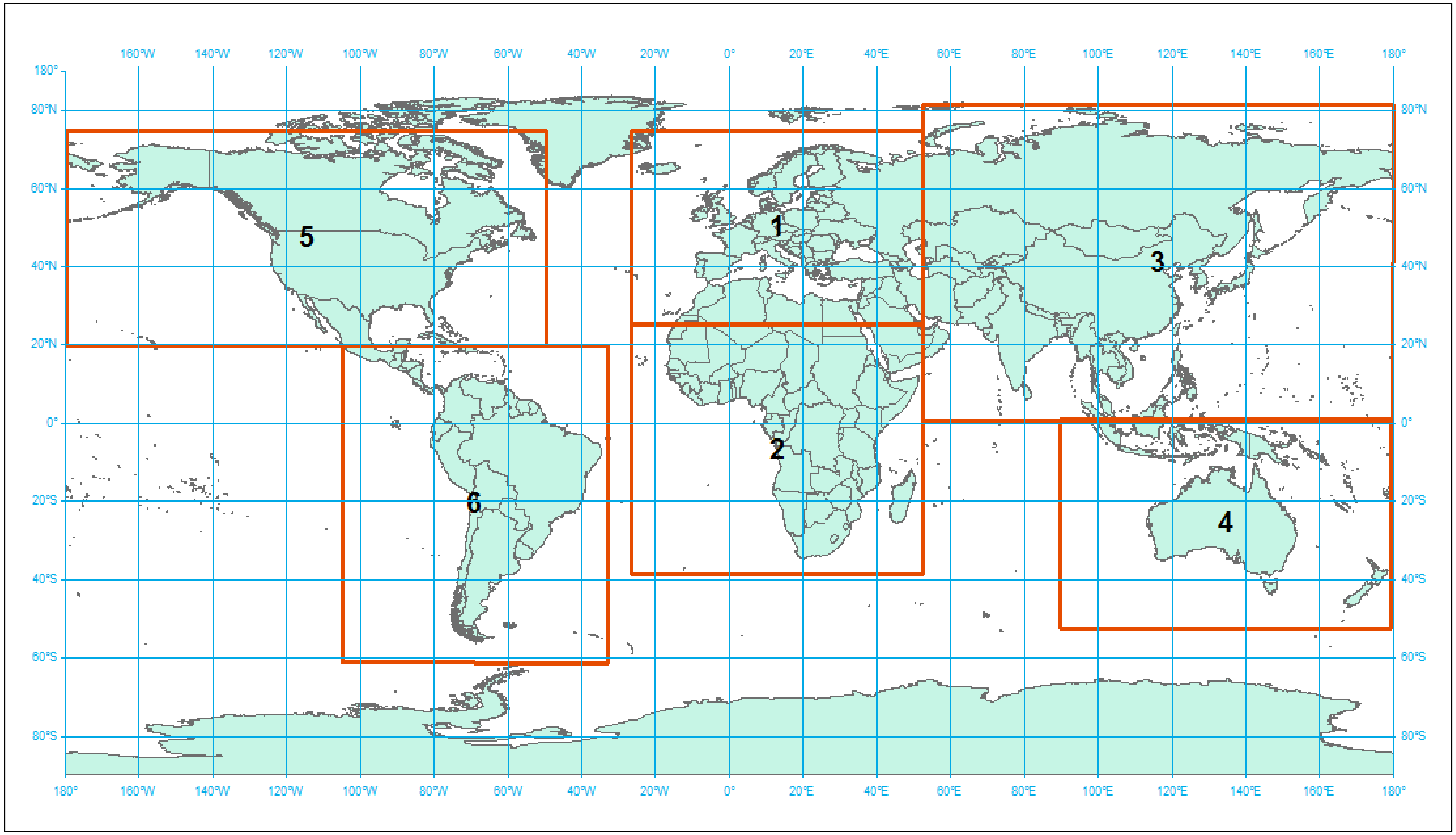
Study sites selection
GFED_v3
gC/m2·year
0,0001 - 11,8968
11,8969 - 37,3089
37,3090 - 75,8788
75,8789 - 139,1970
139,1971 - 2500,0000

Target products

- Burned pixels (mixing all three sensors whenever possible):
  - Monthly files with date of detection.
  - Auxiliary data: Confidence level, land cover, merging information
- Grid product:
  - 0.5 x 0.5 degree (CGM), 15 day temporal resolution.
  - Auxiliary data: Sum of burned area, Proportion of cell burned, Confidence level, % of cloud-free observations, fire distribution, Dominant vegetation burned

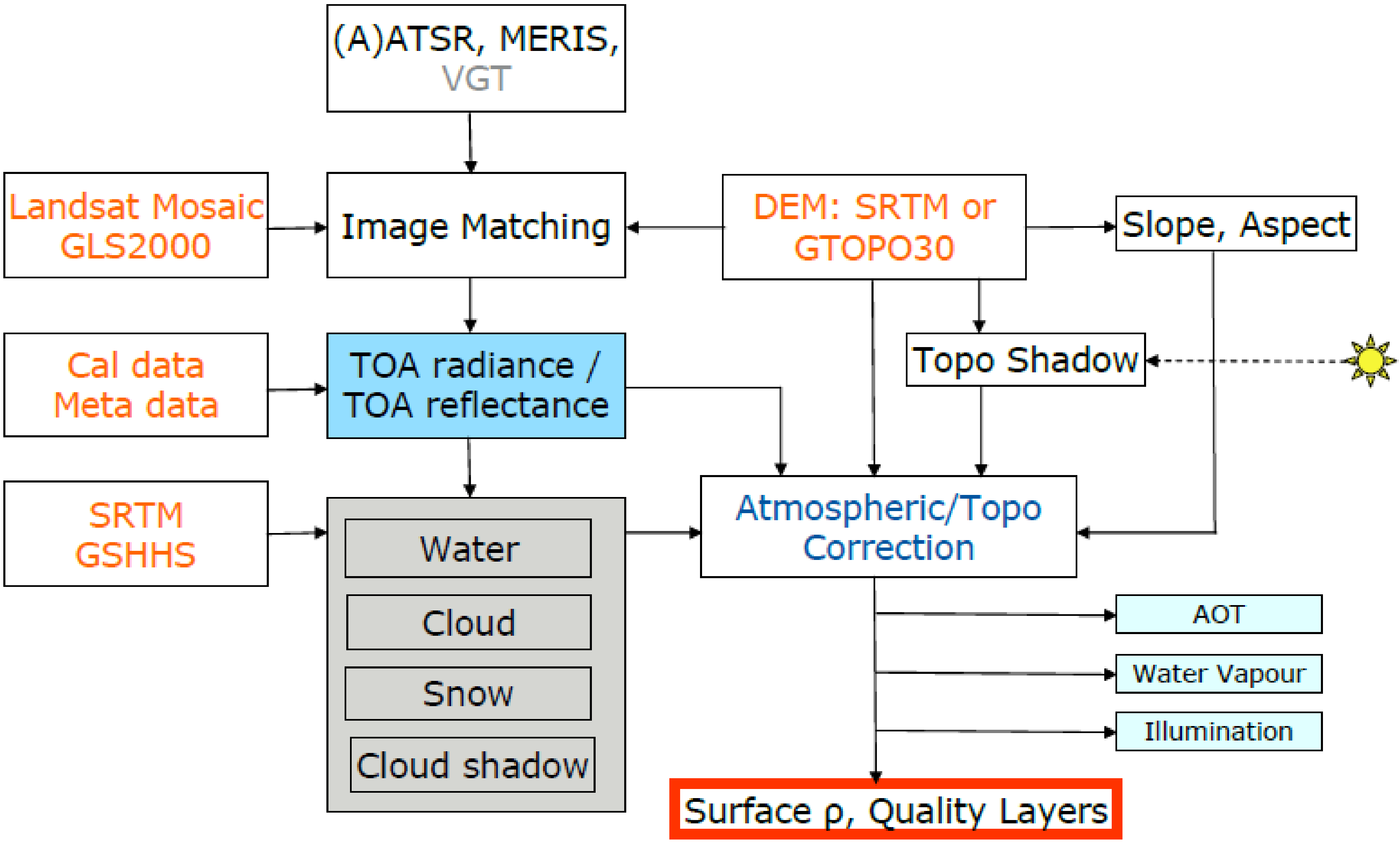


Tiles for the pixel product



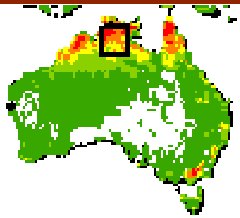
In addition to standard tiles, the user will have a web tool to interactively select his/her target site and apply for personal downloads

Generation of BA time series: Preprocessing chain



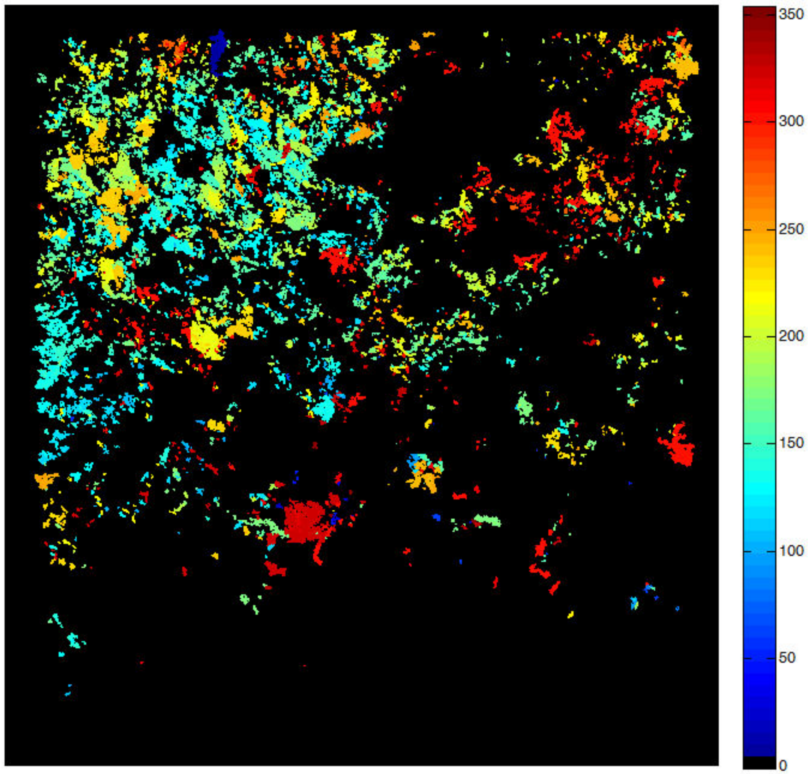
DLR, 2011

BA Algorithm MERIS FRS

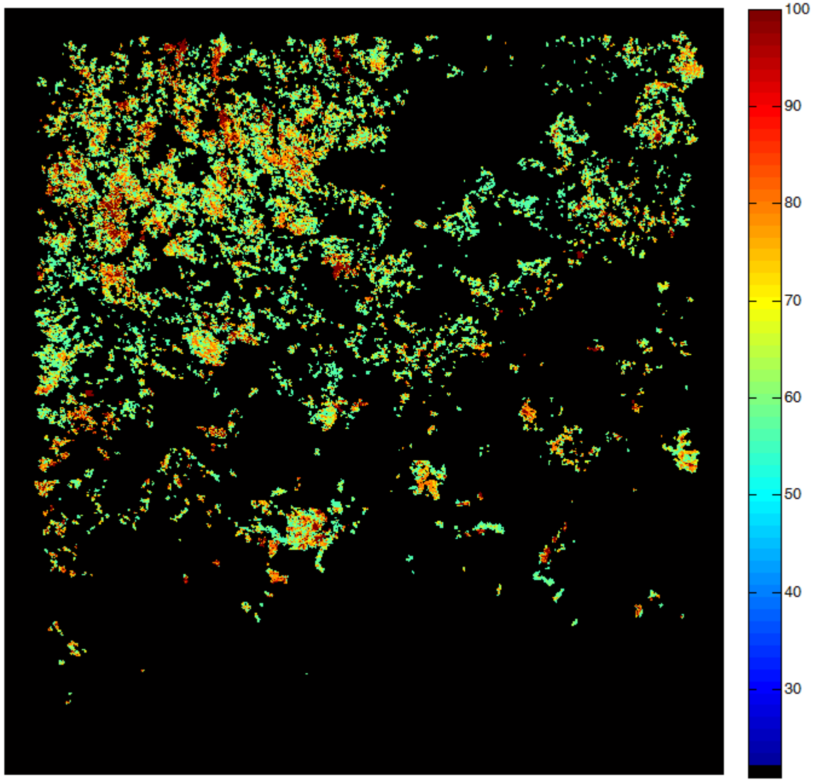


Australia – 2005

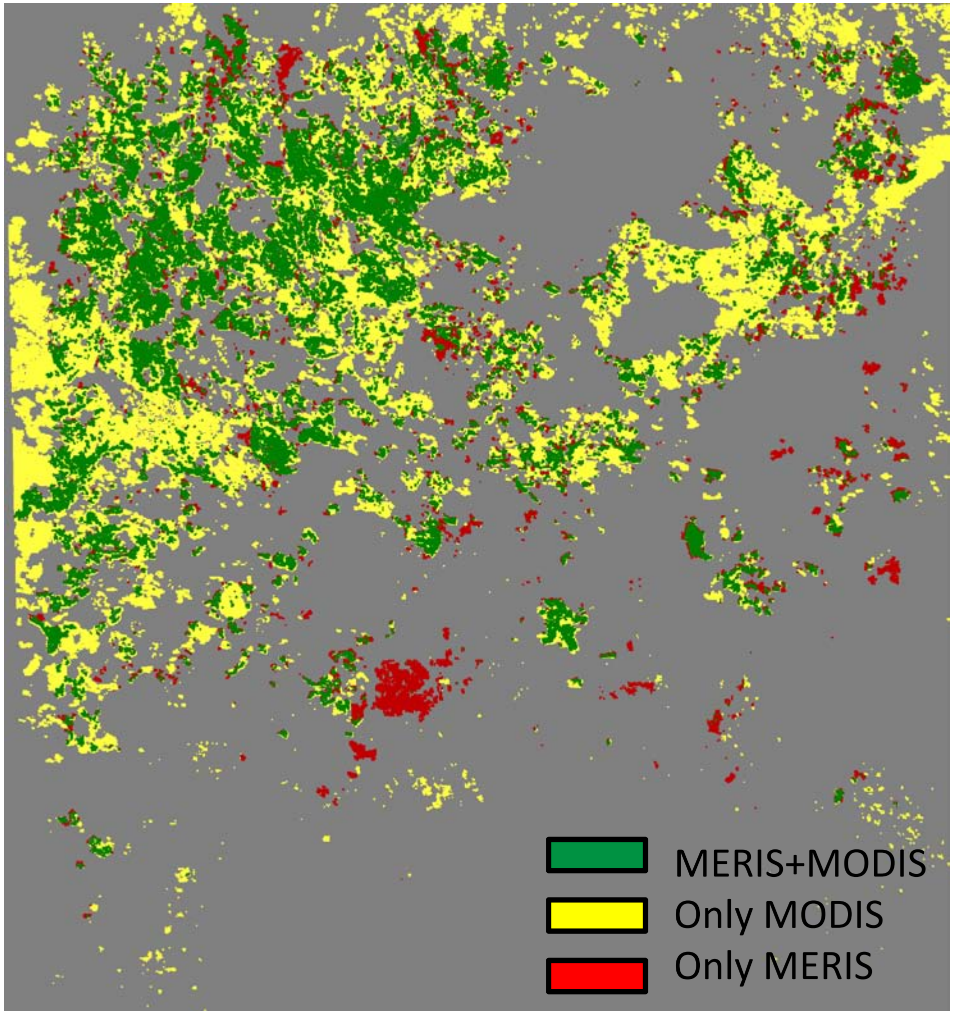
Burned Areas

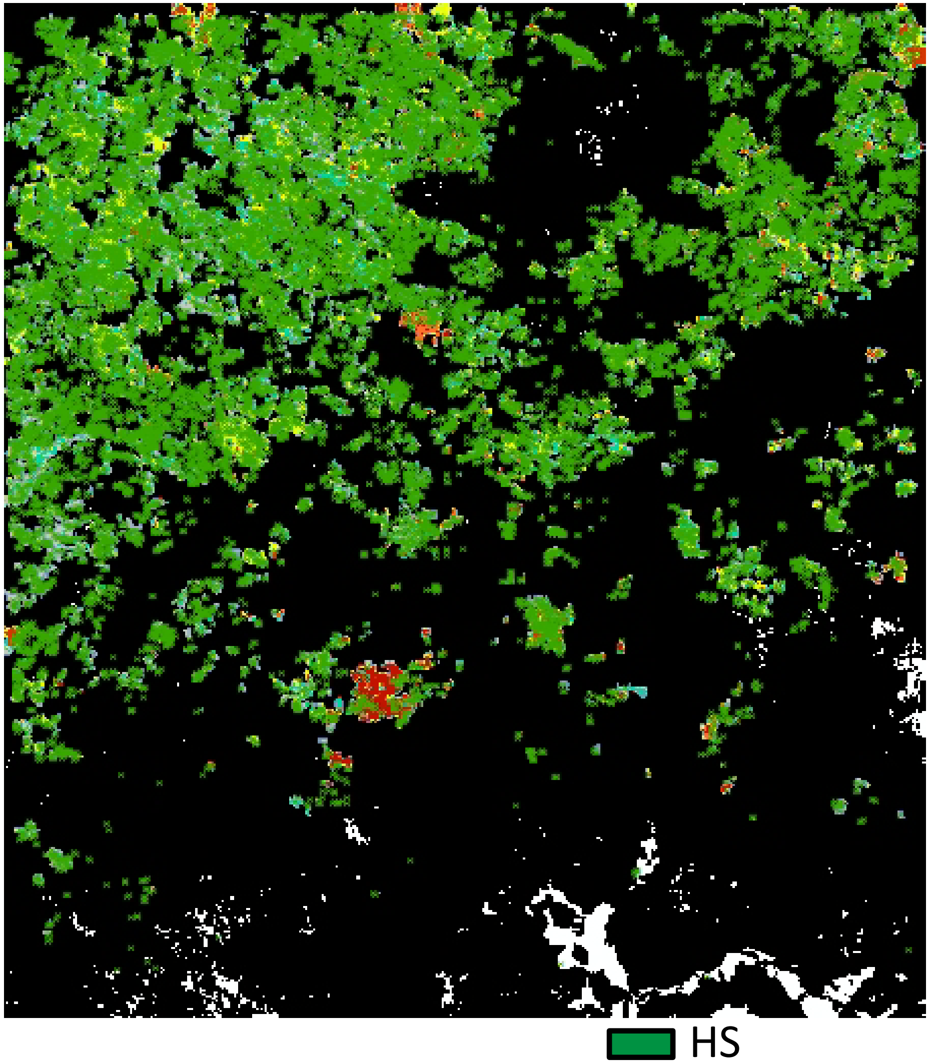


Confidence Level



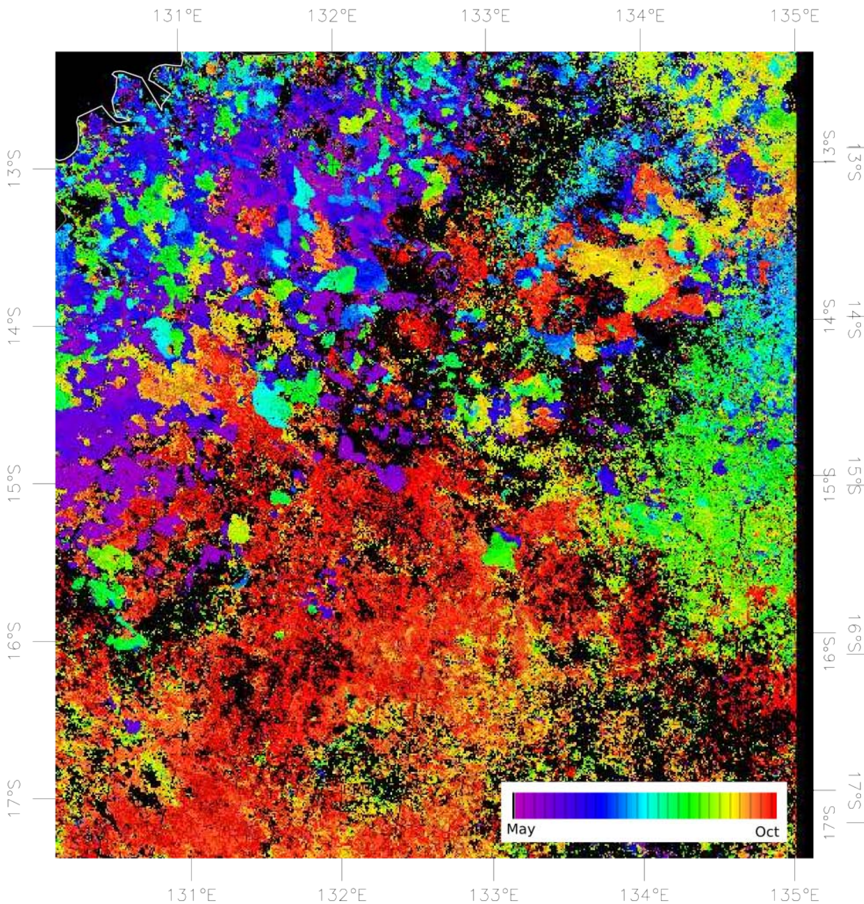
MERIS – MODIS BA and HS



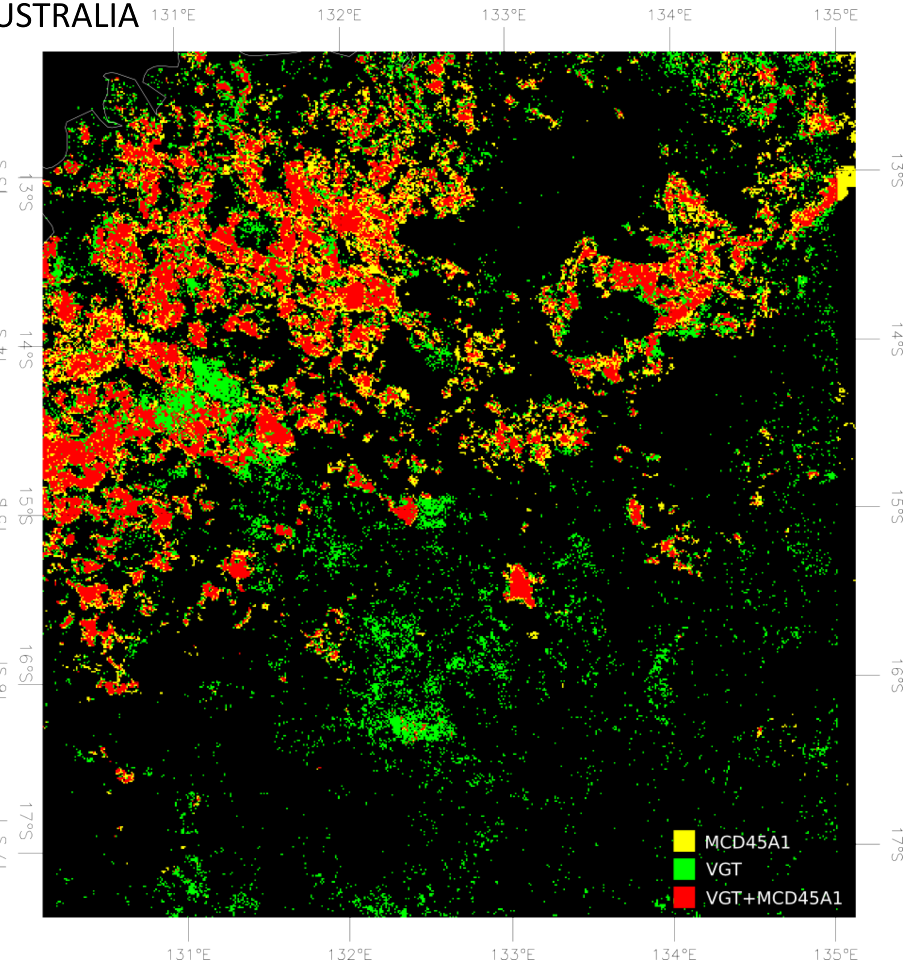


BA Algorithm VGT Results

AUSTRALIA



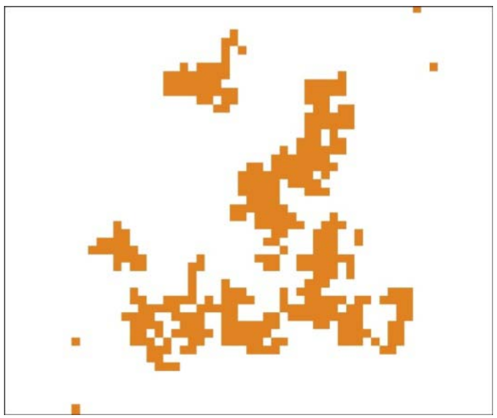
VGT detection dates



VGT vs MODIS

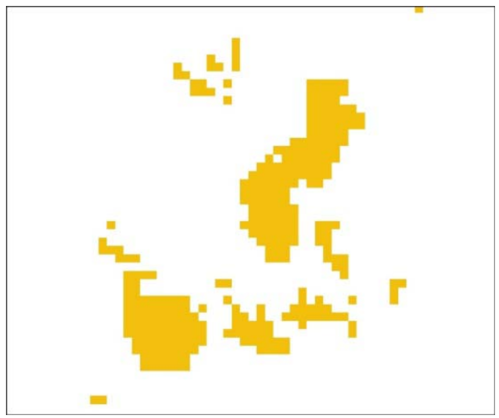
Final merged product: pixel

ATSR



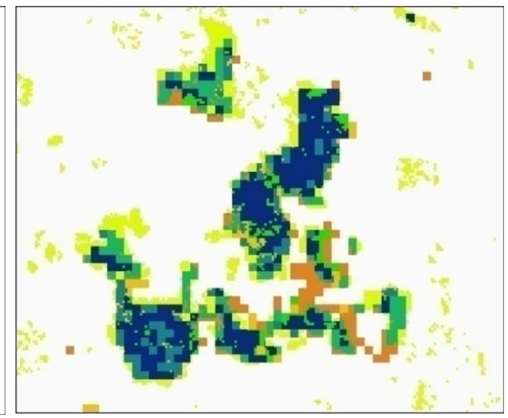
1km

SPOT



1km

ATSR/SPOT/M.FRS



100m

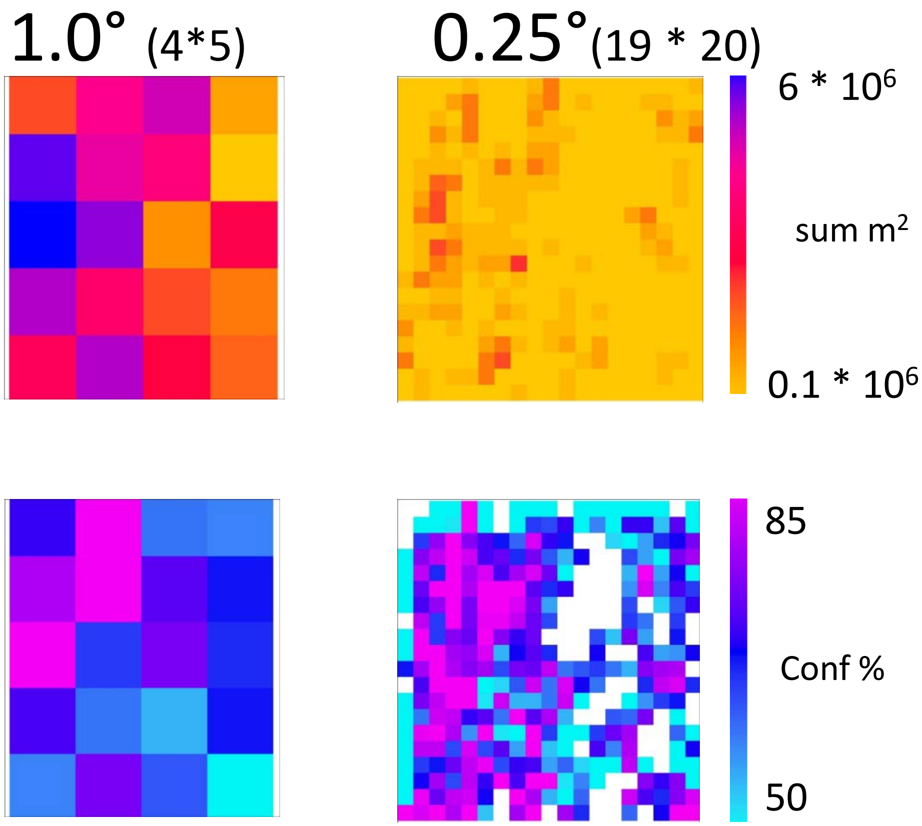
No burn
ATSR
SPOT
MERIS FRS
SPOT + ATSR
ATSR + MERIS FRS
SPOT + MERIS FRS
SPOT + ATSR + MERIS FRS

Grid outputs

Grid layer 1: Total sum area burned

Grid layer 2 (proportion burned) resembles layer 1

Grid layer 3: Confidence levels



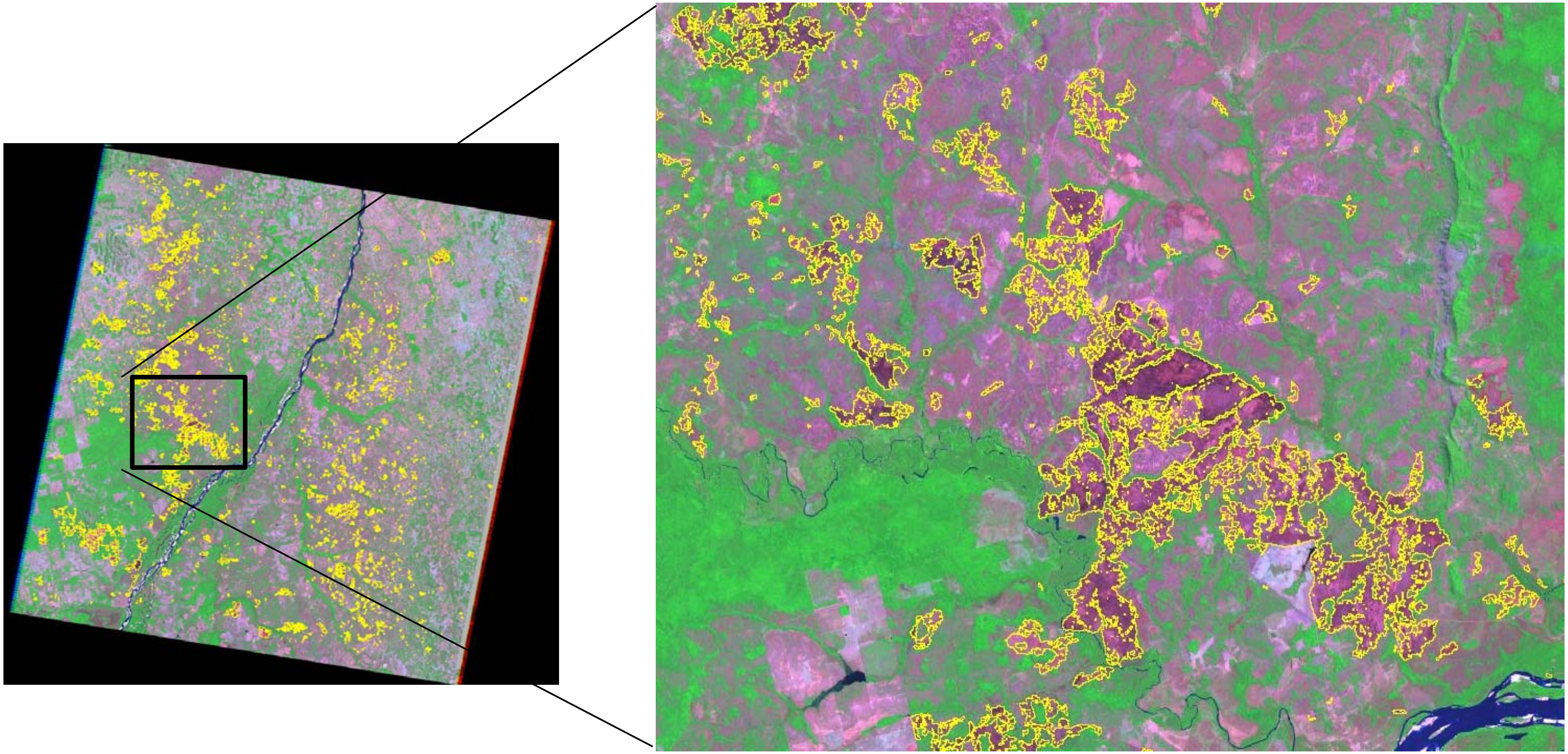
Currently only aggregation of ATSR and SPOT BA
(only recent delivery of MERIS FRS data with confidence levels)
Note different month from example shown in previous slide

Validation

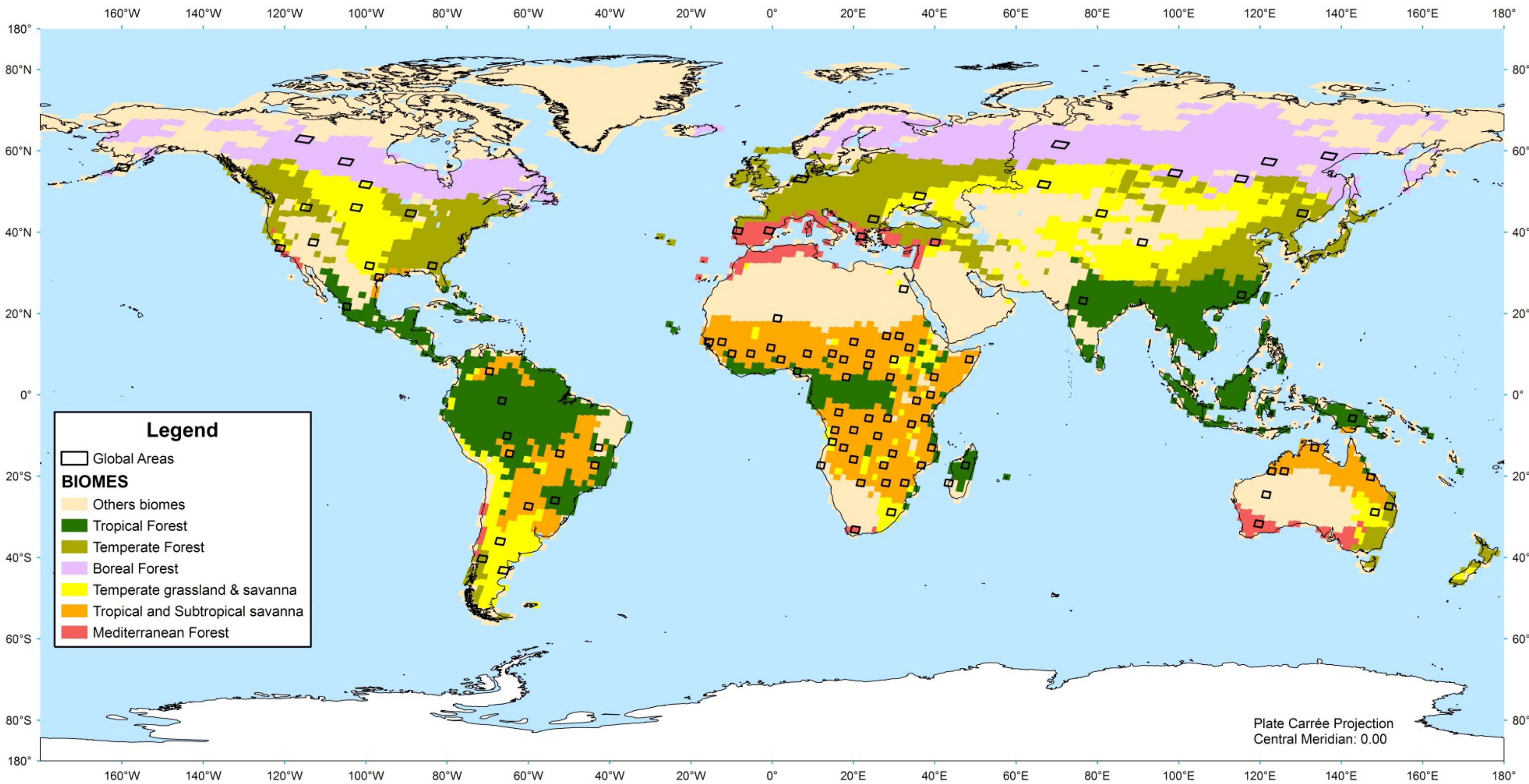
- Standard CEOS Validation protocol.
- Landsat-TM/ETM+ multitemporal change detection:
  - Temporal validation: study sites.
  - Spatial validation: stratified random sampling.
- Validation metrics:
  - Accuracy (agreement global-reference data).
  - Error balance (over-under estimation).
  - Temporal consistency.

Examples

- Brasil

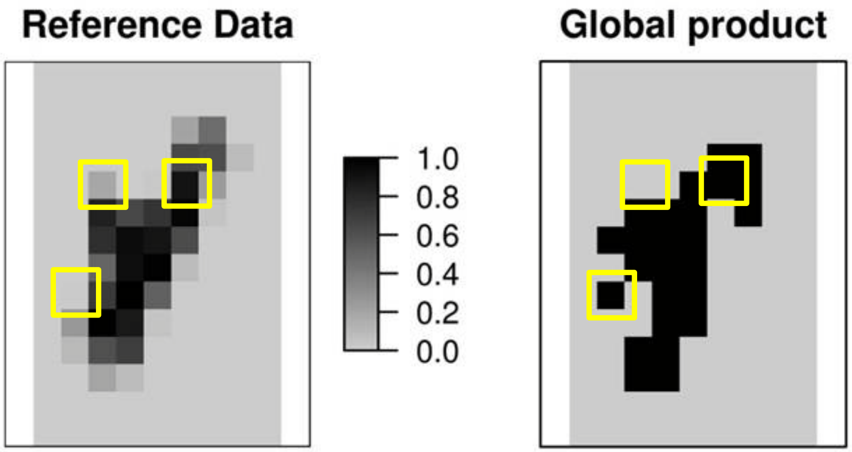


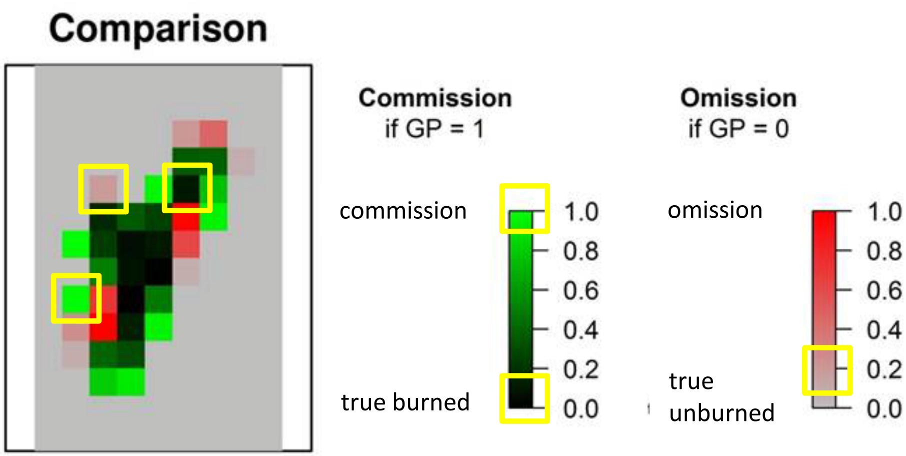
Global validation



Fuzzy error matrix

Fuzzy approach





Error matrix

Global product	Reference data: Burned	Reference data: Unburned	Global total
Burned	p_{11}	p_{12}	p_{1+}
Unburned	p_{21}	p_{22}	p_{2+}
Reference Total	p_{+1}	p_{+2}	$p=1$

R-R exercise: BA algorithms/products tested

Acronym	Sensor	Developer
GBS_ATSR	ATSR	Globcarbon project
ISA_ATSR	ATSR	Instituto Superior de Agronomia within the CCI project
UL_VGT	Vegetation	University of Leicester within the R-R exercise
IFI_VGT	Vegetation	Globcarbon project
UTL_VGT	Vegetation	Globcarbon project
ISA_VGT	Vegetation	Instituto Superior de Agronomia within the CCI Project
UAH_MERIS	MERIS	University of Alcalá within the CCI project

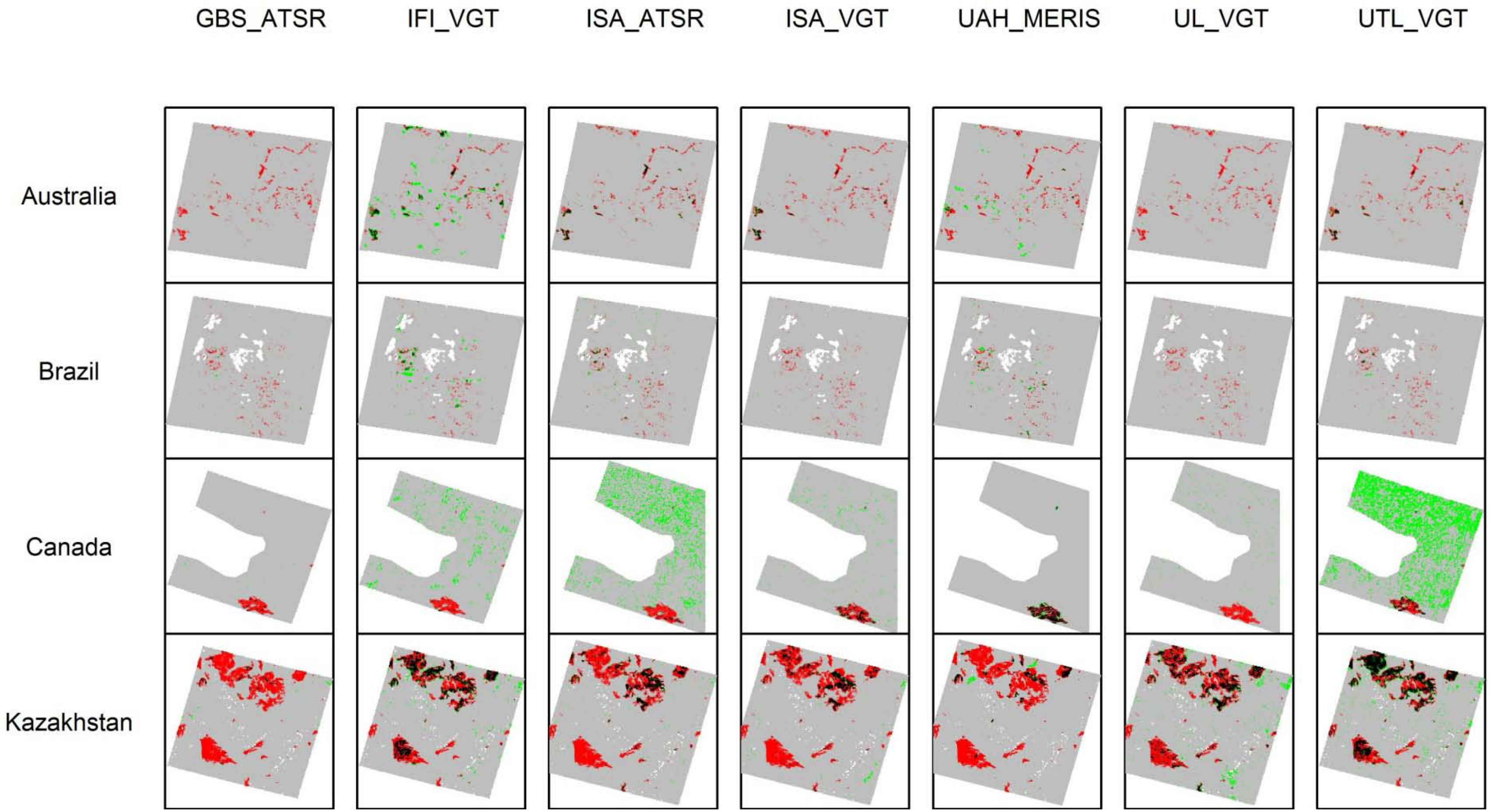
Selection of algorithms

- Algorithms were compared in pairs
- Ranking based on the number of times (study sites) one algorithm was significantly better than another (t-test at $p<0.05$)
- Example

Metric X	Algorithm A	Algorithm B
Algorithm A	-	Number of sites where A is better than B
Algorithm B	Number of sites where B is better than A	-

R-R results

- BA algorithms/products tend to underestimate (red areas), with exceptions (green areas)



Main challenges of fire_CCI

- Data volume:
  - More than 70,000 scenes for study sites have been processed.
  - Global processing is not feasible with current processing power.
- Data availability:
  - Temporal series are scarce with MERIS FRS.
  - ATSR geometrical problems.

Main challenges of fire_CCI

- BA mapping is competitive:
  - None of the input sensors was designed for BA mapping.
  - Little experience with ESA sensors. None for MERIS, partial for VGT and ATSR (Globcarbon and L3JRC)
  - MODIS products are well considered by science community.
- Time constrains, particularly for BA algorithms.