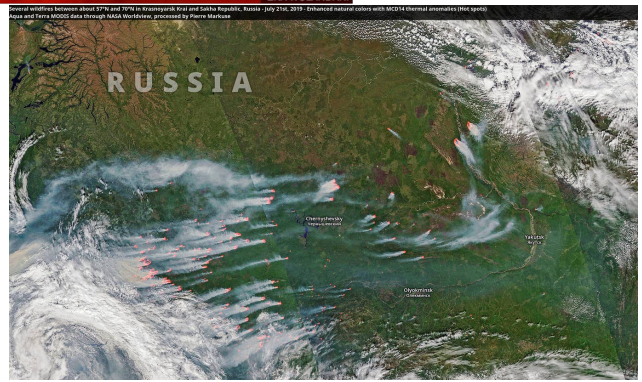
ESA Climate Change Initiative

Stephen Plummer

ESA Climate Office, ECSAT

Fire and Climate Change

2019 Jambi Indonesia - widespread forest fires turned sky red**,** smoky haze that can end up blanketing the entire South East Asian region.’

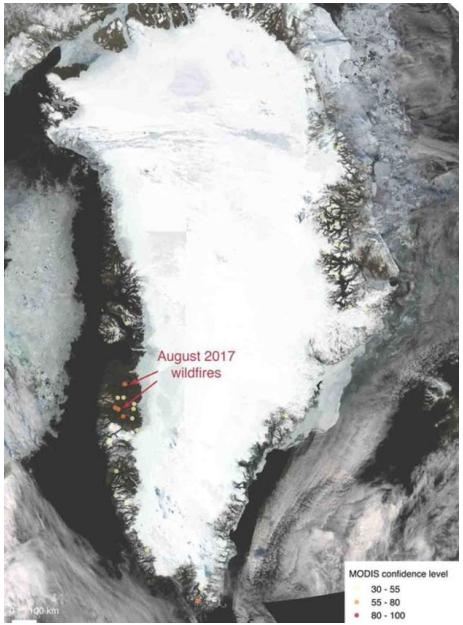


"Our house is burning. Literally. The Amazon - the lungs which produce 20% of our planet's oxygen - is on fire," Mr Macron tweeted

2019 – Krasnoyarsk

McKenzie River, Canada 2019

2017 - Greenland



Fire and Climate Change 2

2017 - Portugal deadliest forest fires.
Prime Minister Antonio Costa called it "the greatest tragedy we have seen in recent years in terms of forest fires".

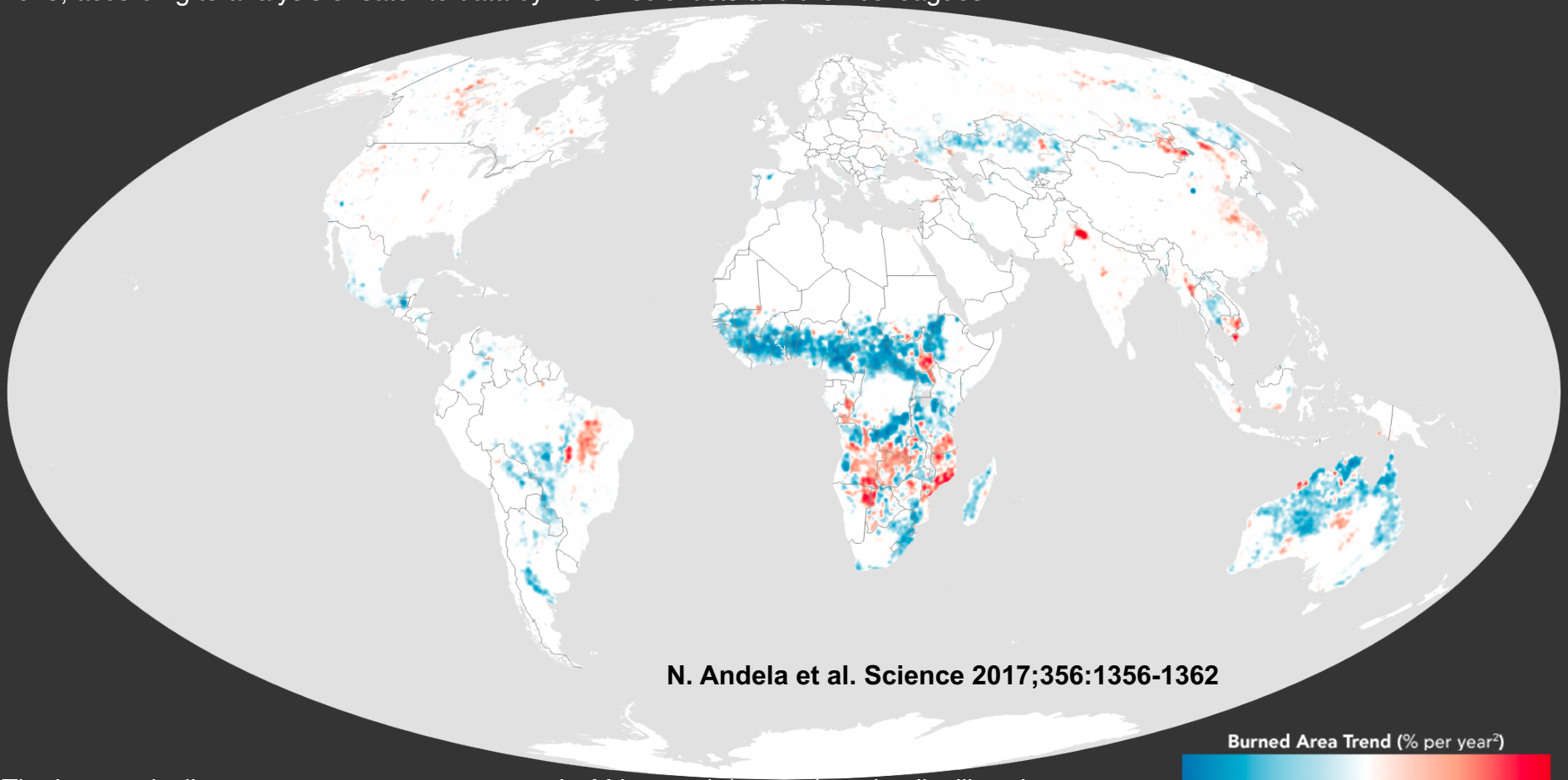
2018 – Saddleworth, UK

2018 - Mati, Athens

2019 – Evia, Greece

2019 – Central Portugal wildfires

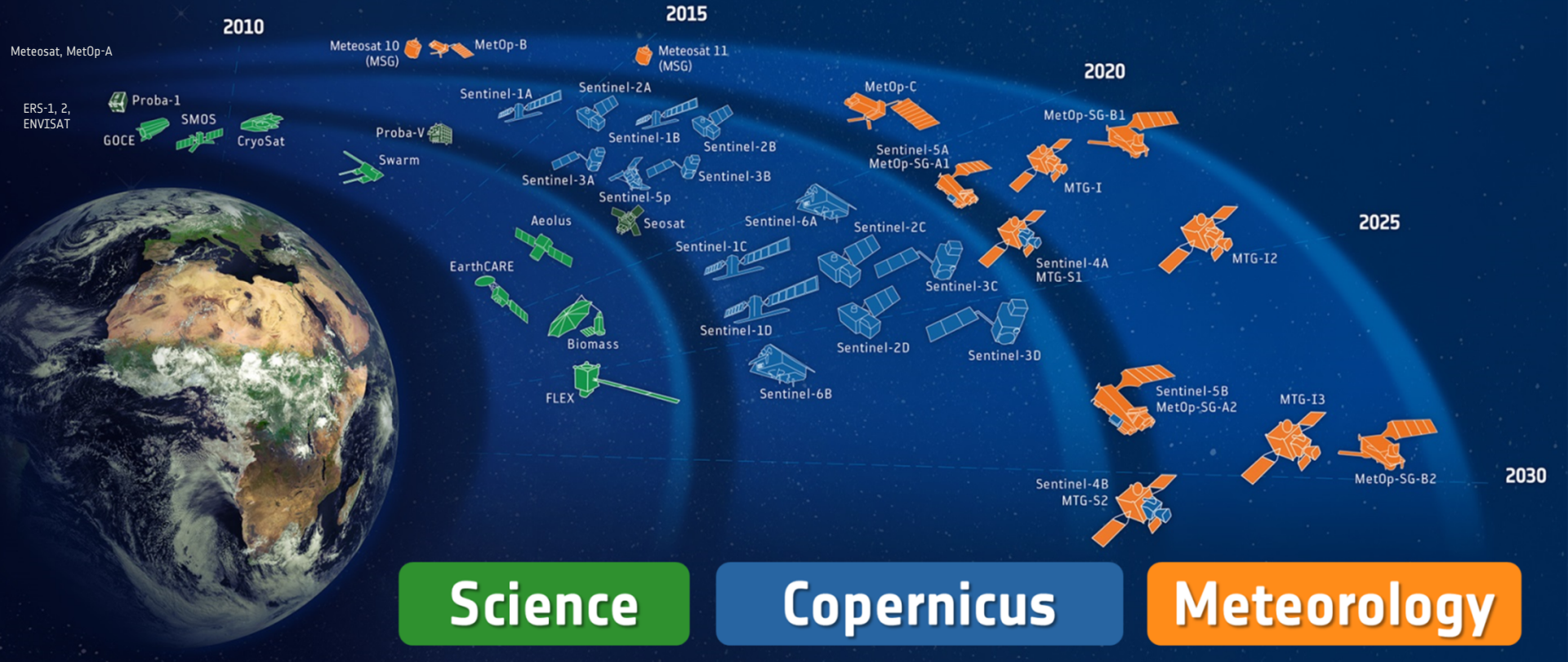
The global area of land burned each year declined by 24 percent between 1998 and 2015, according to analysis of satellite data by NASA scientists and their colleagues.



The largest decline was seen across savannas in Africa, and due to changing livelihoods.

Credits: Joshua Stevens/NASA's Earth Observatory

ESA-DEVELOPED EARTH OBSERVATION MISSIONS



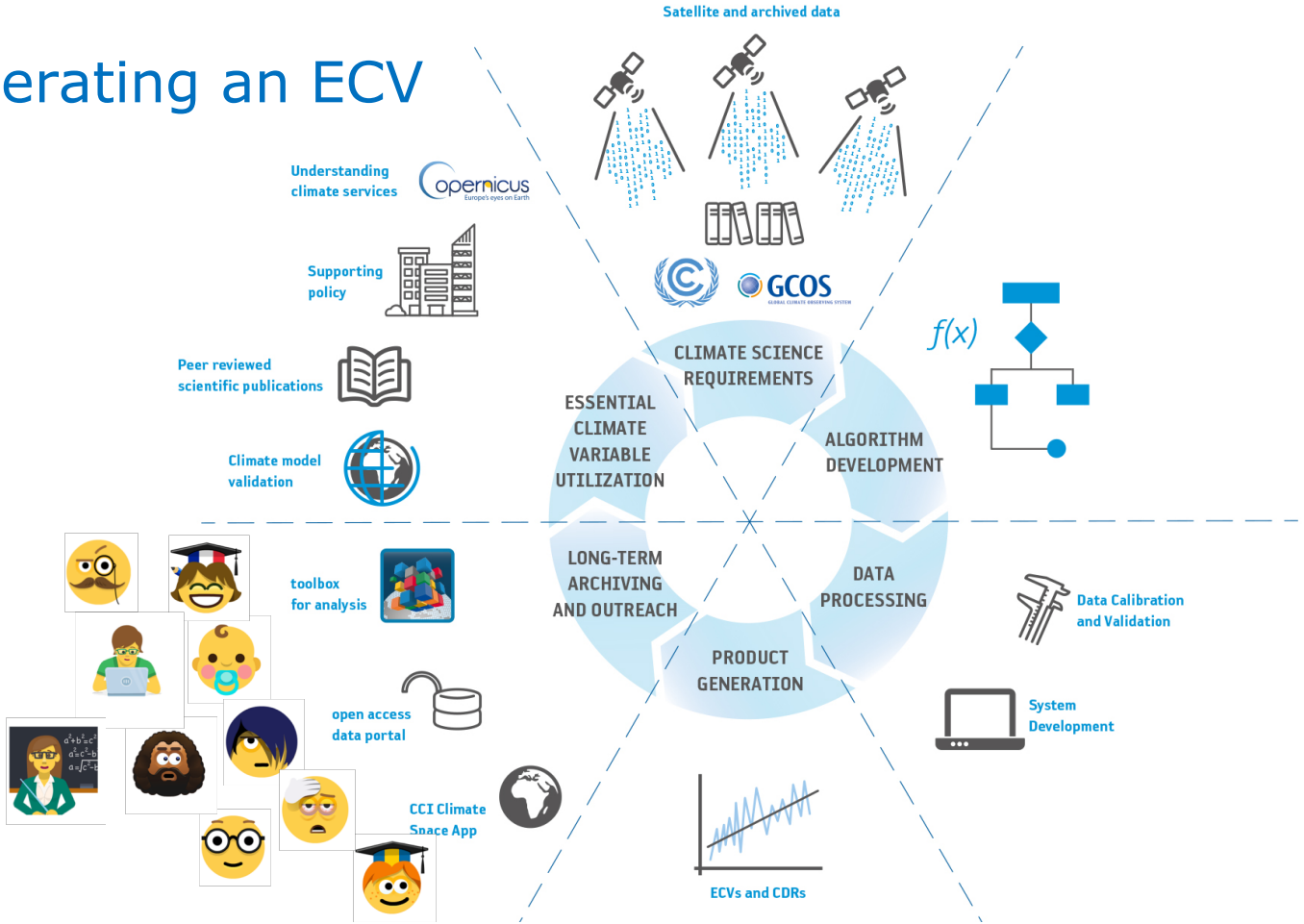
Science **Copernicus** **Meteorology**

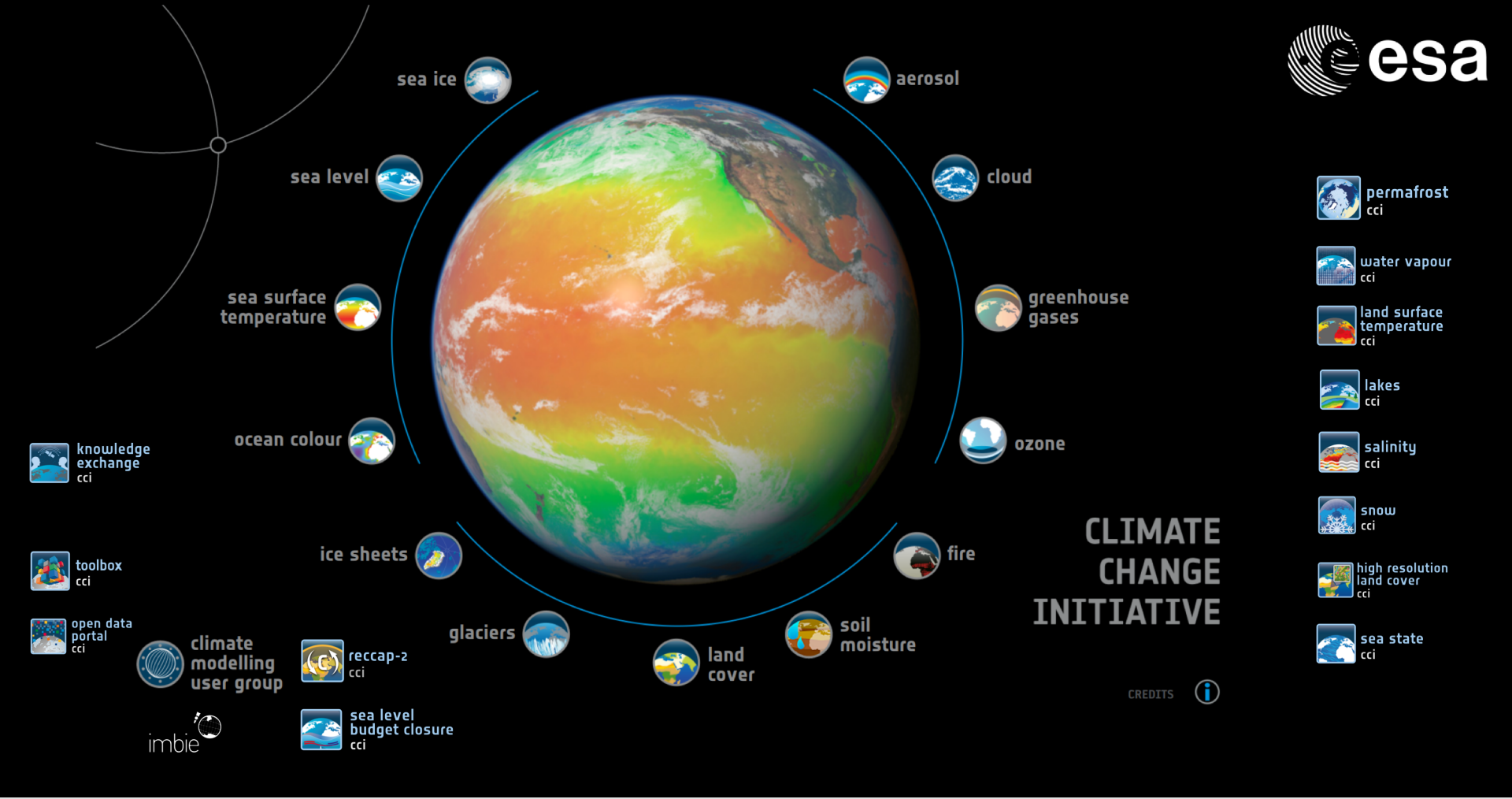
Climate Change Initiative - objective

*Realise the full potential of the **long-term global EO archives** that ESA, together with its Member states, has established over the last forty years.*

*... as a significant and timely contribution to the **ECV databases** required by the **United Nations Framework Convention on Climate Change***

Generating an ECV




esa
sea ice
aerosol
sea level
cloud
sea surface temperature
greenhouse gases
ocean colour
ozone
ice sheets
fire
glaciers
soil moisture
land cover
CLIMATE CHANGE INITIATIVE
permafrost cci
water vapour cci
land surface temperature cci
lakes cci
salinity cci
snow cci
high resolution land cover cci
sea state cci
knowledge exchange cci
toolbox cci
open data portal cci
climate modelling user group
reccap-2 cci
sea level budget closure cci
imbie
CREDITS
European Space Agency

C3S and CCI: Research to Operations

ESA continues to provide R&D for ECVs from CCI/+ that progressed into C3S – long-term plan being elaborated

GCOS-195		CCI	CCI+	uptake	C3S
Atmospheric surface					
4.3.1	Air temperature				
4.3.2	Wind speed and direction				
4.3.5	Precipitation				
4.3.6	Surface radiation budget				
Atmospheric upper air					
4.5.1	Air temperature				
4.5.2	Wind speed and direction				
4.5.3	Water vapour				
4.5.4	Cloud properties				
4.5.5	Earth radiation budget				
Atmospheric composition					
4.7.1	Carbon dioxide				
4.7.2	Methane				
4.7.3	Other long-lived greenhouse gases				
4.7.4	Ozone				
4.7.5	Aerosol				
Ocean surface					
5.3.1	Sea-surface temperature				
5.3.2	Sea-surface salinity				
5.3.3	Sea level				
5.3.4	Sea state				
5.3.5	Sea ice				
Ocean biogeochemistry					
5.3.7	Ocean colour				
5.3.8	Carbon dioxide partial pressure				
5.3.9	Ocean surface acidity				
Ocean sub-surface					
5.4.1	Temperature				
5.4.2	Salinity				
5.4.3	Current				
Land hydrology & cryosphere					
6.3.4	Lakes				
6.3.5	Snow cover				
6.3.6	Glaciers and ice caps				
6.3.7	Ice sheets				
6.3.8	Permafrost				
6.3.16	Soil moisture				
Land biosphere					
6.3.9	Albedo				
6.3.10	Land cover (including vegetation type)				
6.3.11	Fraction of absorbed photosynthetically active radiation				
6.3.12	Leaf area index				
6.3.13	Above-ground biomass				
6.3.15	Fire				
6.3.17.1	Land-surface temperature				

CCI achievements to date

450
European scientists

178
Institutions

21
ECVs

13 ECVs transferred to Copernicus

Open data

134
terabytes

100+
datasets

4.2
million files

14 Fellowships
4 Cross-ECV Projects
3 Outreach Projects

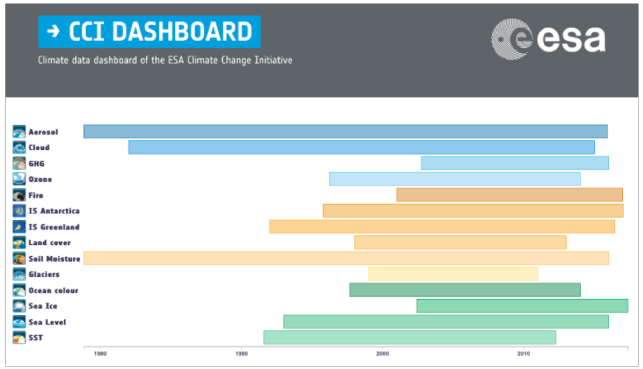
640
Peer-reviewed articles

IPCC AR5
28 Contributing authors
15 Papers, cited 60 times

SROCC and AR6 to come

Open access to CCI data products

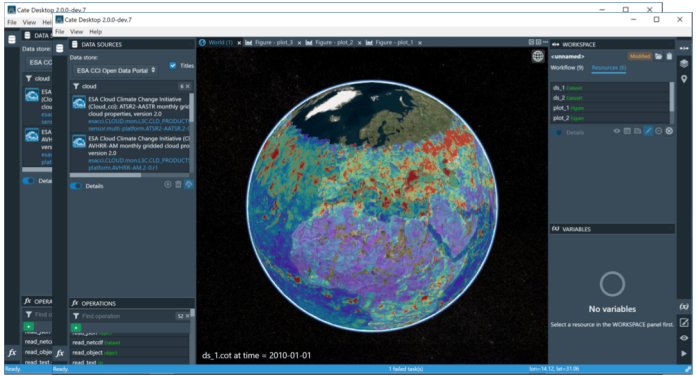
open data portal cci



- open access
- 14 ECVs
- >100 data sets

cci.esa.int/data

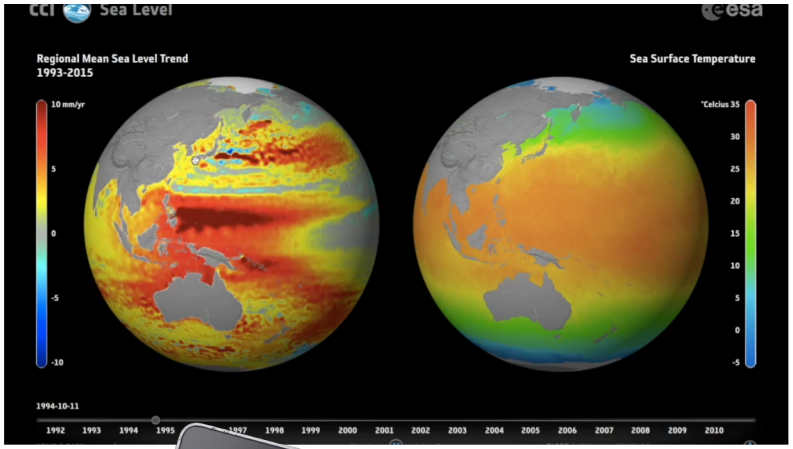
toolbox cci



- cci data analysis
- cci data manipulation

climatetoolbox.io

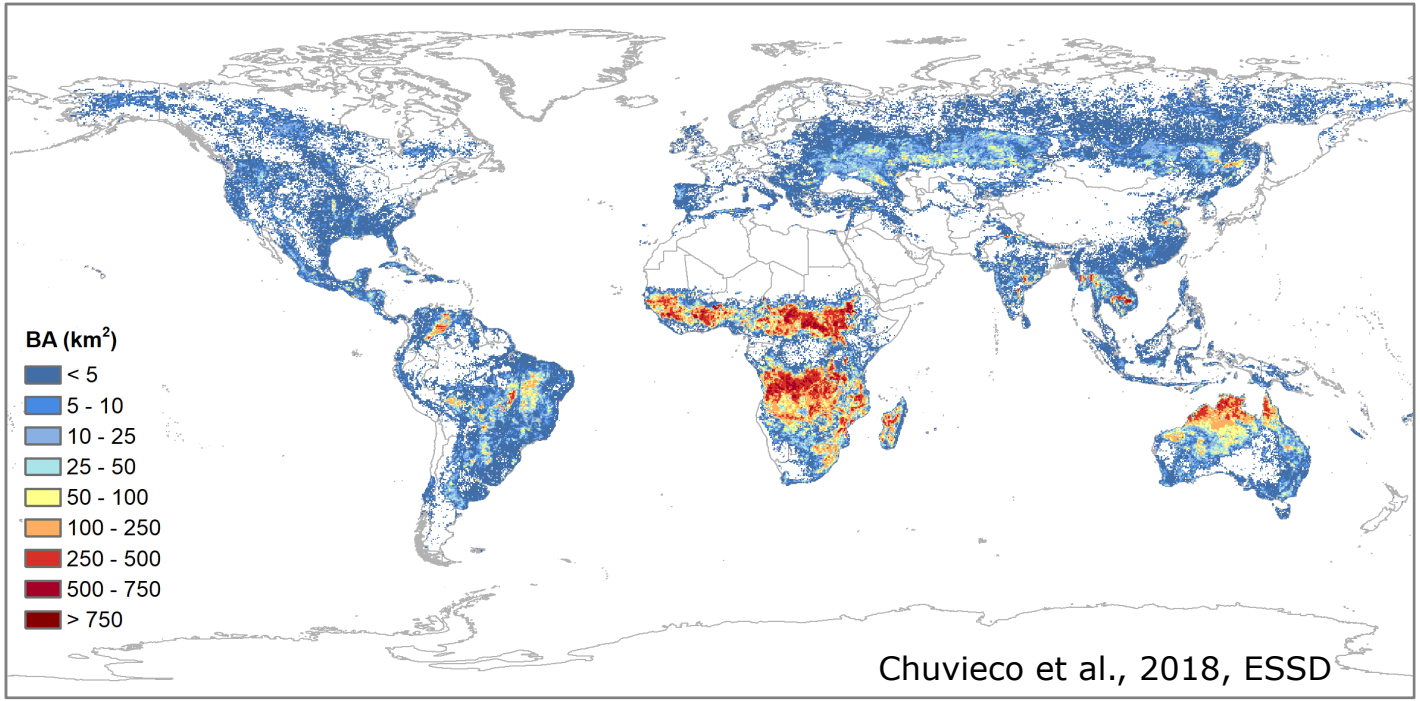
Outreach



Available on the App Store

Available at amazon apps

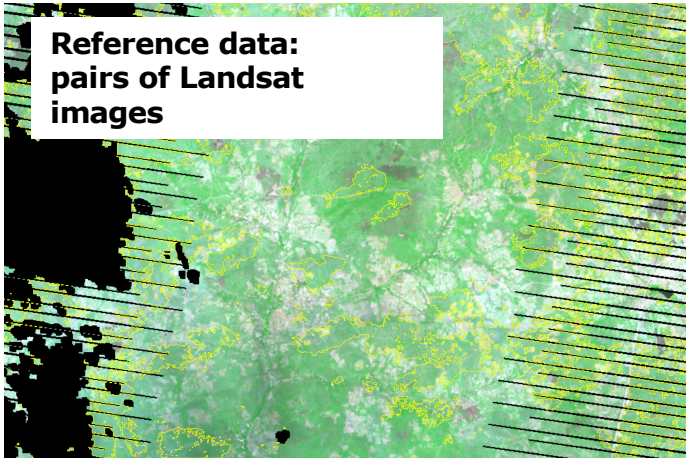
FireCCI51 (MODIS 250m + HS)
Average burned area



FireCCI51 global product (4.65 Mkm2)≈ 10% > MCD64A1c6

Validation at the global BA product. Phase 2

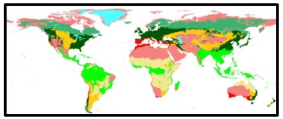
short sampling units



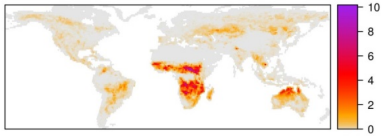
Stratified random sampling

Years, 2003-2014

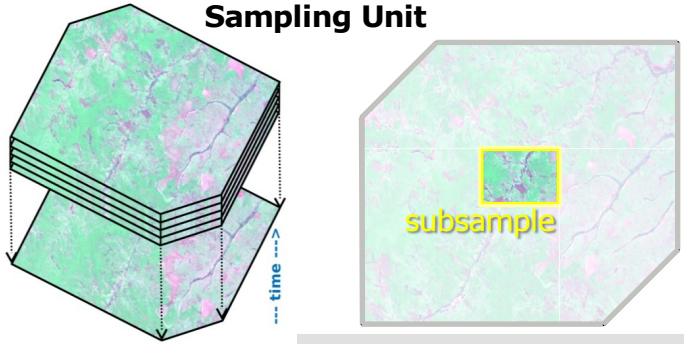
Biomes



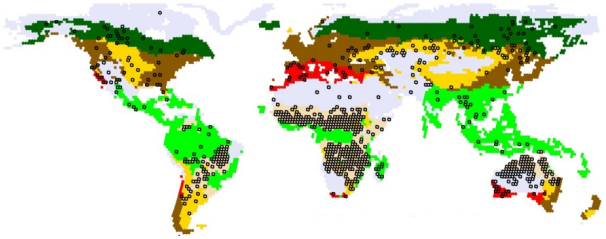
MCD64c5
BA



Sampling Unit

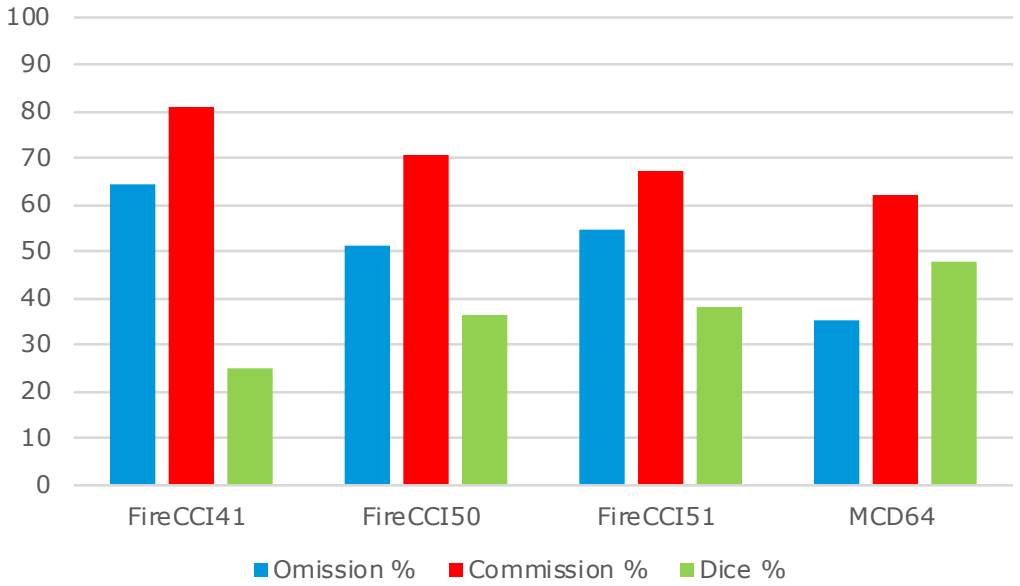


1200 sampling units, 100 each year



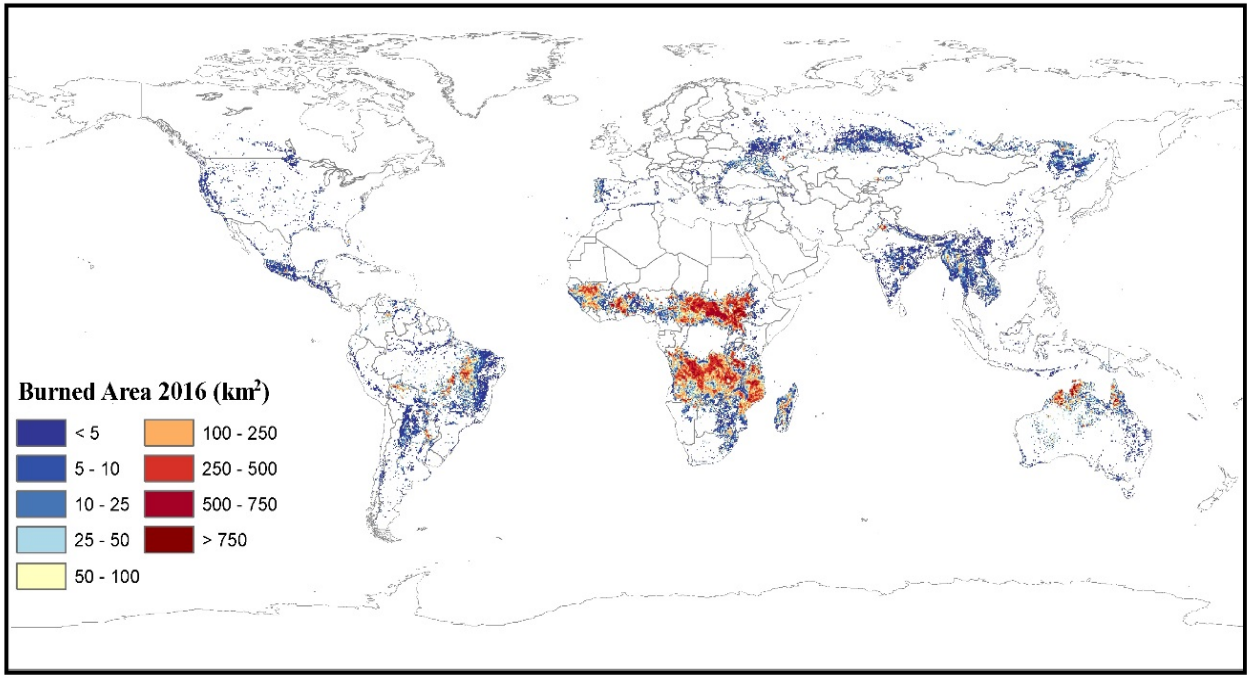
Accuracy of existing global BA products

CCI41 – MERIS 300m
CCI50/51 – MODIS 250m
MCD64 – MODIS official 500m



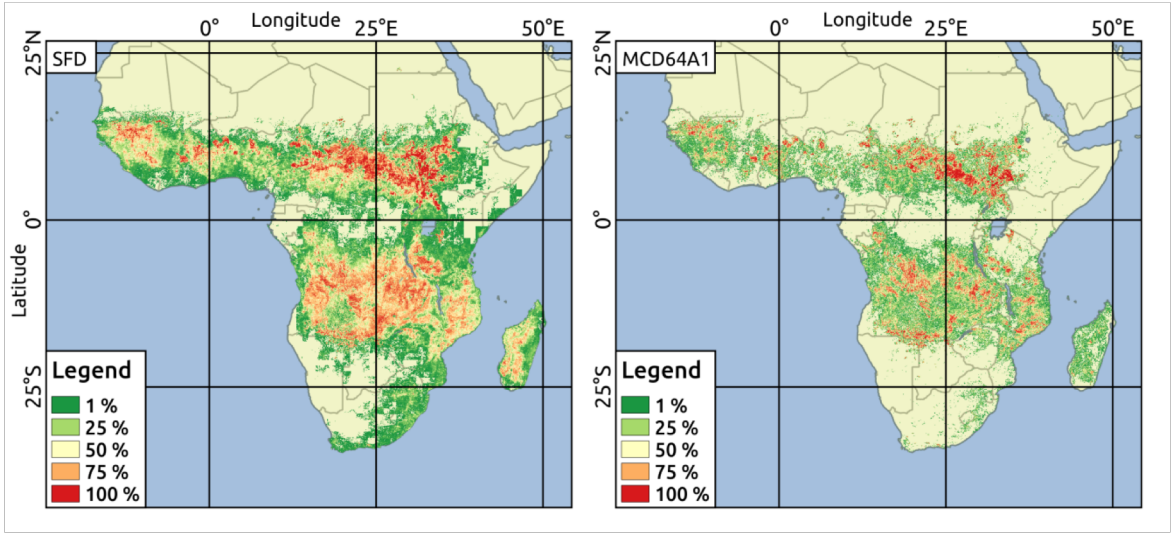
Estimated accuracy of each product based on a global sample of Landsat images 2003-2014 (products 250-500m)

AVHRR 5km products - FireCCILT10



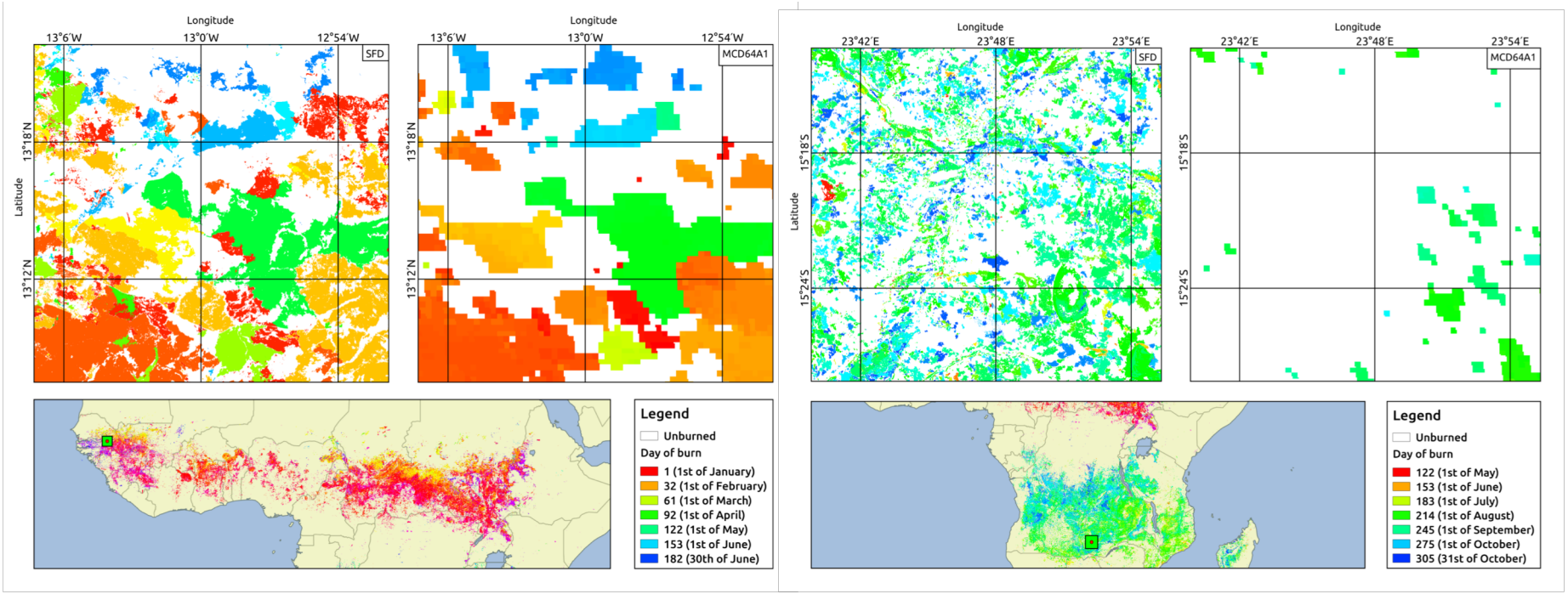
FireCCISFD11Product

- BA product derived from S2 imagery
- Temporal extension: from 1st January to 31st December 2016
- Spatial extension: Sub-Saharan Africa, upper boundary 25°N latitude
- Spatial resolution: 20 m
  - 3 layers:
    - Layer 1: day of first detection (1 to 366, 0 unburned)
    - Layer 2: confidence level (0 to 100)
    - Layer 3: Land Cover of burned pixels



Analysis of the FireCCISFD11

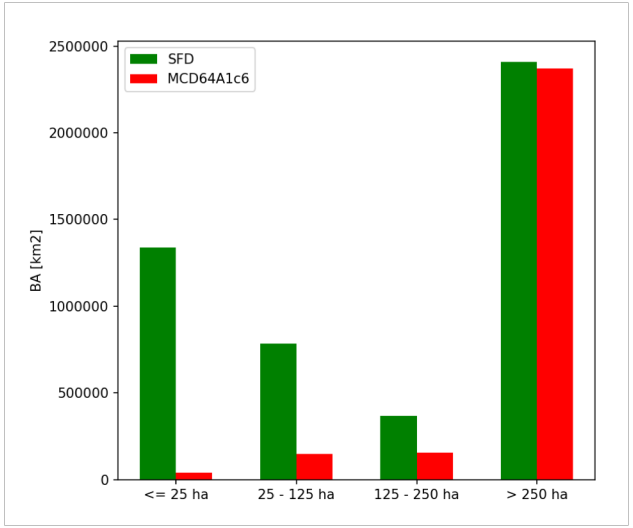
- Comparison in a sample sites from Senegal and Zambia

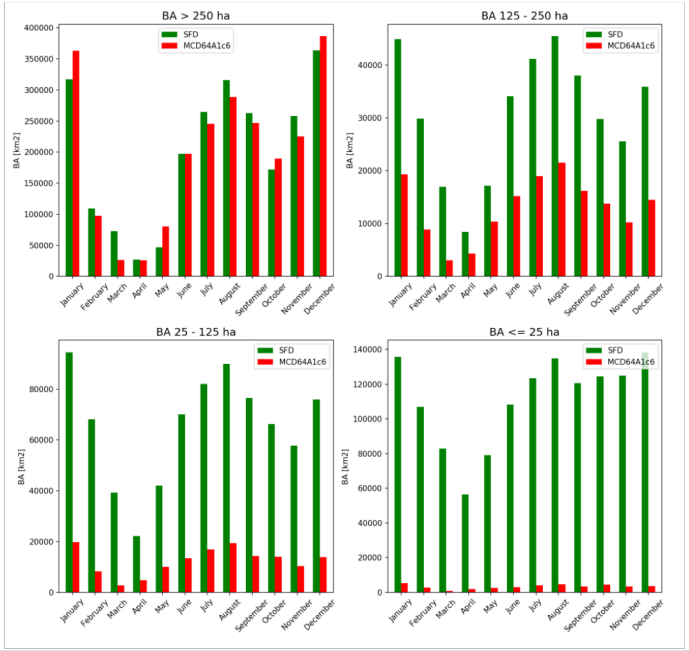


Analysis of the SFD

- Burned surface (Mkm^2) by patch size

Product	> 250 ha	125 – 250 ha	25 – 125 ha	≤ 25 ha	Total BA
FireCCISFD11	2.41	0.37	0.78	1.34	4.90
MCD64A1	2.37	0.16	0.15	0.04	2.72

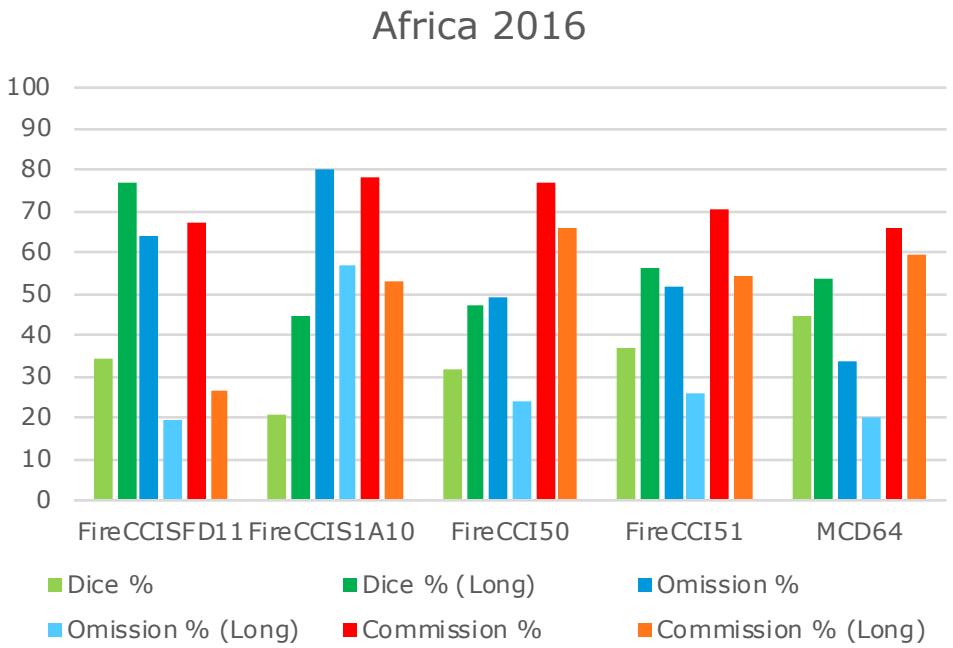




FireCCISFD11 ≈ 80% > MCD64A1c6.

By extrapolation global BA would be >6.6 Mkm^2 (double of what is commonly accounted for).

Accuracy of existing global BA products

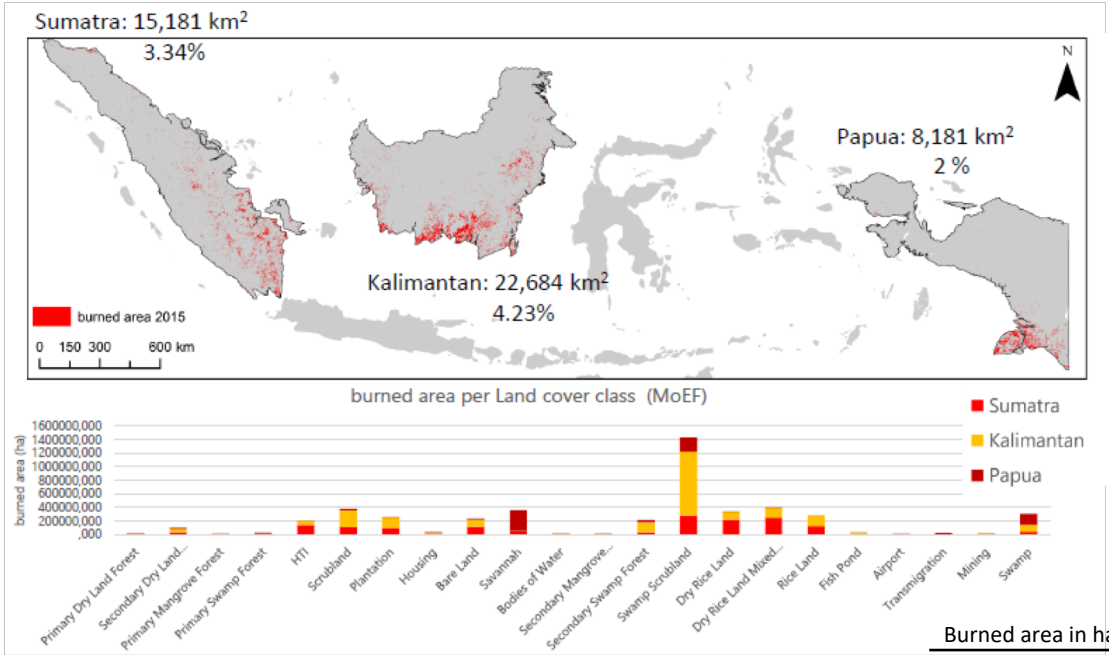


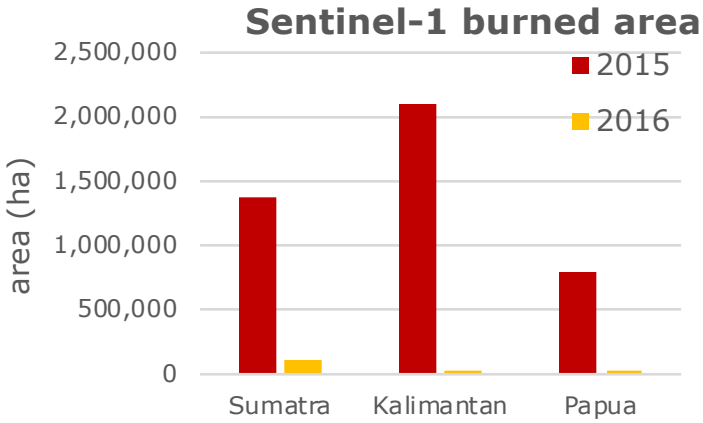
Estimated accuracy of each product based on a stratified sample of Landsat images 2016 using pairs (short) and multiple pairs (long) to adjust for overpass frequency.

Indonesia SAR analysis for 2015-2016

Sumatra 480,000 km² Kalimantan 536,000 km² Papua 320,000 km²

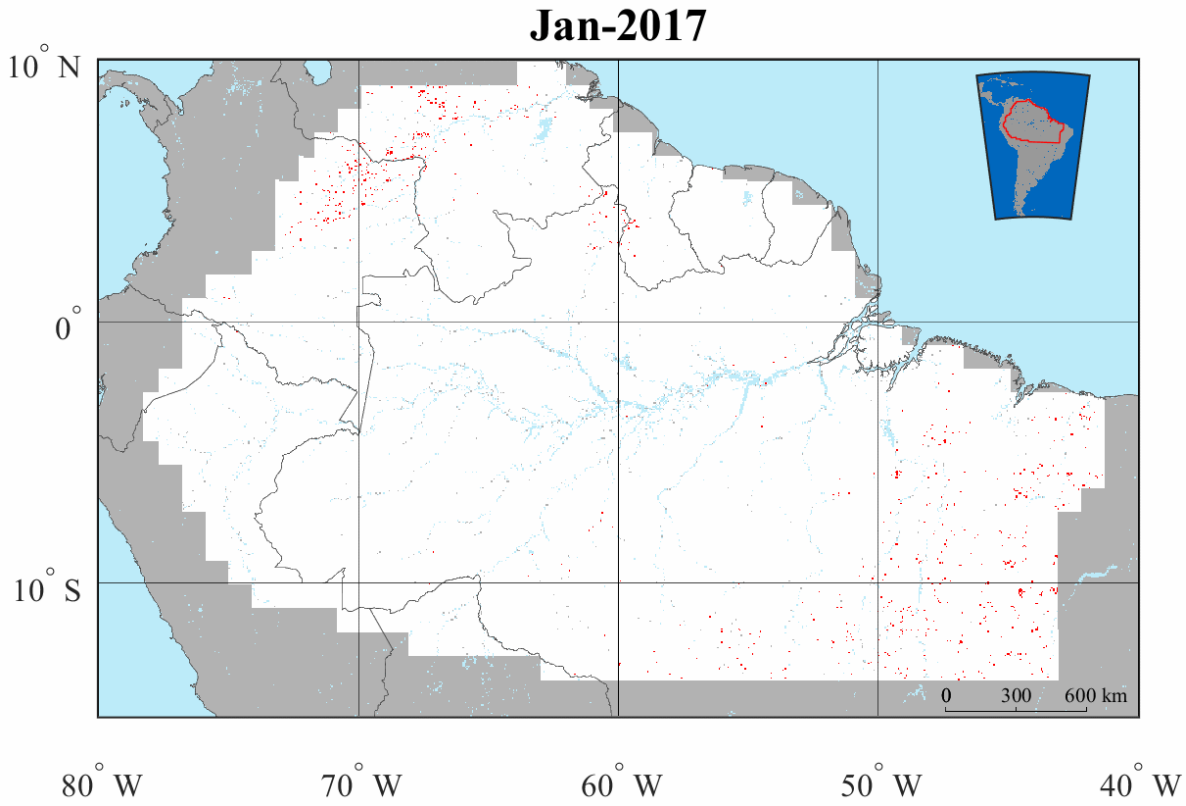
Lohberger et al., 2017





Burned area in ha	Sumatra	Kalimantan	Papua	Total
Year 2015	1,518,127	2,268,352	818,090	**4,604,569**
Year 2016	312,215	144,411	47,771	**504,396**
Total	1,830,342	2,412,763	865,861	5,108,965

Sentinel-1 - Amazon



Using time series of backscatter from Sentinel-1

Publications - 1

Contents lists available at SciVerse ScienceDirect
International Journal of Applied Earth Observation and Geoinformation
journal homepage: www.elsevier.com/locate/jag

Review

Ten years of global burned area products from spaceborne remote sensing—A review: Analysis of user needs and recommendations for future developments

Florent Mouillot [a,*], Martin G. Schultz [b], Chao Yue [c], Patricia Cadule [c], Kevin Tansey [d], Philippe Ciais [c], Emilio Chuvieco [e]

[a] IRD, UMR CEFE, 1919 route de mende, 34293 Montpellier Cedex 5, France
[b] Forschungszentrum Jülich GmbH, 52428 Jülich, Germany
[c] Laboratoire des Sciences du Climat et de l'Environnement, LSCE CEA CNRS UVSQ, UMR8212, 91191 Gif Sur Yvette, France
[d] University of Leicester, Department of Geography, University Road, Leicester LE1 7RH, United Kingdom
[e] University of Alcala, Department of Geography and Geology, Calle Colegios 2, 28801 Alcala de Henares, Spain

Remote Sensing of Environment 160 (2015) 114–121
Contents lists available at ScienceDirect
Remote Sensing of Environment
journal homepage: www.elsevier.com/locate/rse

Comparing the accuracies of remote sensing global burned area products using stratified random sampling and estimation

Marc Padilla [a,c,*], Stephen V. Stehman [b], Ruben Ramo [a], Dante Corti [a], Stijn Hantson [a], Patricia Oliva [a], Itziar Alonso-Canas [a], Andrew V. Bradley [c,d], Kevin Tansey [c], Bernardo Mota [e,f], Jose Miguel Pereira [e], Emilio Chuvieco [a]

[a] Environmental Remote Sensing Research Group, Universidad de Alcalá, Colegios 2, Alcalá de Henares, Spain
[b] Department of Forest and Natural Resources Management, College of Environmental Science and Forestry, State University of New York, Syracuse, NY 13210, USA
[c] Department of Geography, University of Leicester, Leicester LE1 7RH, United Kingdom
[d] Imperial College of London, Silwood Park Campus, SL5 7YP, United Kingdom
[e] Forest Research Centre, School of Agriculture, Technical University of Lisbon, 1349-017, Tapada da Ajuda St., Lisbon, Portugal
[f] Department of Geography, Kings College London, Strand, London WC2R 2LS, United Kingdom

Contents lists available at ScienceDirect
Remote Sensing of Environment
journal homepage: www.elsevier.com/locate/rse

Stratification and sample allocation for reference burned area data

Marc Padilla [a,*], Pontus Olofsson [b], Stephen V. Stehman [c], Kevin Tansey [a], Emilio Chuvieco [d]

[a] Centre for Landscape and Climate Research, Department of Geography, University of Leicester, UK
[b] Department of Earth and Environment, Boston University, USA
[c] Department of Forest and Natural Resources Management, College of Environmental Science and Forestry, State University of New York, Syracuse, NY, 13210, USA
[d] Environmental Remote Sensing Research Group, Department of Geology, Geography and Environment, Universidad de Alcalá, Spain

Contents lists available at ScienceDirect
Remote Sensing of Environment
journal homepage: www.elsevier.com/locate/rse

Validation of the 2008 MODIS-MCD45 global burned area product using stratified random sampling

Marc Padilla [a,*], Stephen V. Stehman [b], Emilio Chuvieco [a]

[a] Environmental Remote Sensing Research Group, Department of Geography and Geology, Universidad de Alcalá, 2 Colegios St, Alcalá de Henares, Spain
[b] Department of Forest and Natural Resources Management, College of Environmental Science and Forestry, State University of New York, Syracuse, NY 13210, USA

Remote Sens. **2014**, *6*, 2050-2068; doi:10.3390/rs6032050
OPEN ACCESS
remote sensing
ISSN 2072-4292
www.mdpi.com/journal/remotesensing

Article

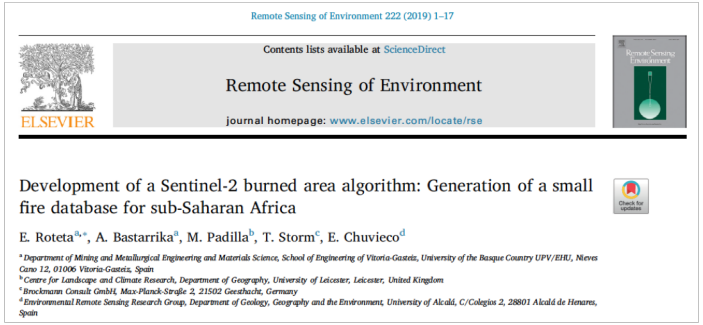
Assessing the Temporal Stability of the Accuracy of a Time Series of Burned Area Products

Marc Padilla [1,*], Stephen V. Stehman [2], Javier Litago [3] and Emilio Chuvieco [1]

1 Department of Geology, Geography and Environment, University of Alcalá, C/ Colegios 2, Alcalá de Henares 28801, Spain; E-Mail: emilio.chuvieco@uah.es
2 Department of Forest and Natural Resources Management, College of Environmental Science and Forestry, State University of New York, Syracuse, NY 13210, USA; E-Mail: svstehma@syr.edu
3 Departamento de Estadística y MGA, ETSI Agrónomos, Universidad Politécnica de Madrid, Ciudad Universitaria, Madrid 28040, Spain; E-Mail: javier.litago@upm.es

* Author to whom correspondence should be addressed; E-Mail: marc.padilla@uah.es; Tel.: +34-91-885-4482; Fax: +34-91-885-4439.

Publications - 2



Remote Sensing of Environment 222 (2019) 1–17

Contents lists available at ScienceDirect

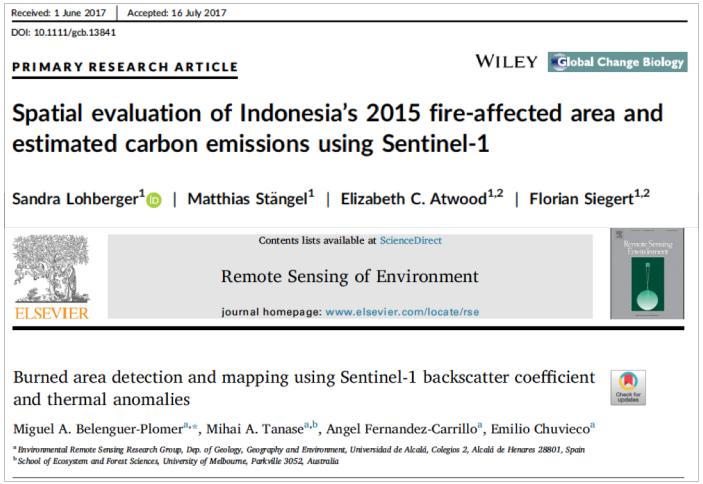
Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Development of a Sentinel-2 burned area algorithm: Generation of a small fire database for sub-Saharan Africa

E. Roteta[a,*], A. Bastarrika[a], M. Padilla[b], T. Storm[c], E. Chuvieco[d]

[a] Department of Mining and Metallurgical Engineering and Materials Science, School of Engineering of Vitoria-Gasteiz, University of the Basque Country UPV/EHU, Nieves Cano 12, 01006 Vitoria-Gasteiz, Spain
[b] Centre for Landscape and Climate Research, Department of Geography, University of Leicester, Leicester, United Kingdom
[c] Brockmann Consult GmbH, Max-Planck-Straße 2, 21502 Geesthacht, Germany
[d] Environmental Remote Sensing Research Group, Department of Geology, Geography and the Environment, University of Alcalá, C/Colegios 2, 28801 Alcalá de Henares, Spain



Received: 1 June 2017 | Accepted: 16 July 2017

DOI: 10.1111/gcb.13841

PRIMARY RESEARCH ARTICLE

WILEY Global Change Biology

Spatial evaluation of Indonesia's 2015 fire-affected area and estimated carbon emissions using Sentinel-1

Sandra Lohberger[1] | Matthias Stängel[1] | Elizabeth C. Atwood[1,2] | Florian Siegert[1,2]

Contents lists available at ScienceDirect

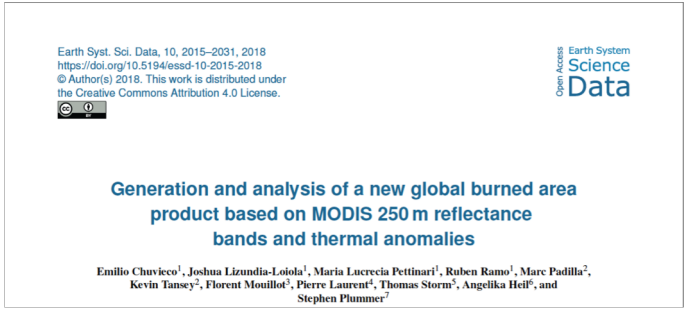
Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Burned area detection and mapping using Sentinel-1 backscatter coefficient and thermal anomalies

Miguel A. Belenguer-Plomer[a,*], Mihai A. Tanase[a,b], Angel Fernandez-Carrillo[a], Emilio Chuvieco[a]

[a] Environmental Remote Sensing Research Group, Dep. of Geology, Geography and Environment, Universidad de Alcalá, Colegios 2, Alcalá de Henares 28801, Spain
[b] School of Ecosystem and Forest Sciences, University of Melbourne, Parkville 3052, Australia



Earth Syst. Sci. Data, 10, 2015–2031, 2018
https://doi.org/10.5194/essd-10-2015-2018
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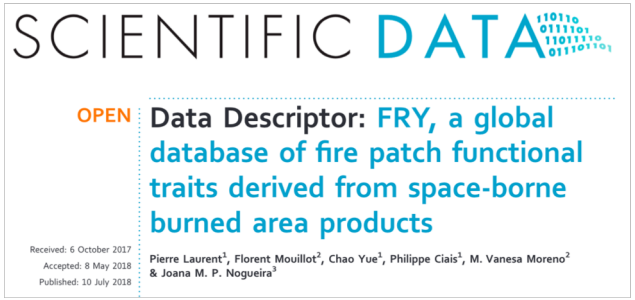
Earth System Science Data

Generation and analysis of a new global burned area product based on MODIS 250 m reflectance bands and thermal anomalies

Emilio Chuvieco[1], Joshua Lizundia-Loiola[1], Maria Lucrecia Pettinari[1], Ruben Ramo[1], Marc Padilla[2], Kevin Tansey[2], Florent Mouillot[3], Pierre Laurent[4], Thomas Storm[5], Angelika Heil[6], and Stephen Plummer[7]



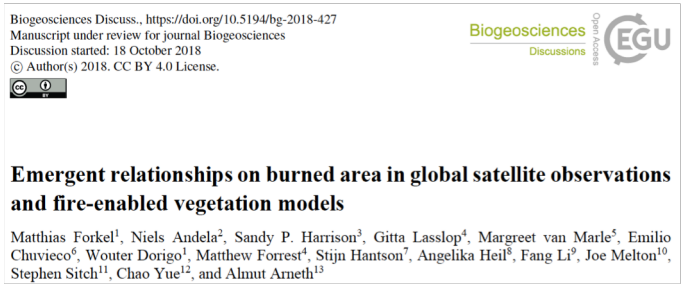
SCIENTIFIC DATA

OPEN

Data Descriptor: FRY, a global database of fire patch functional traits derived from space-borne burned area products

Received: 6 October 2017
Accepted: 8 May 2018
Published: 10 July 2018

Pierre Laurent[1], Florent Mouillot[2], Chao Yue[1], Philippe Ciais[1], M. Vanesa Moreno[2] & Joana M. P. Nogueira[3]



Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-427
Manuscript under review for journal Biogeosciences
Discussion started: 18 October 2018
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Biogeosciences Discussions

Emergent relationships on burned area in global satellite observations and fire-enabled vegetation models

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