SEA-HAZEMON@TEIN Workshop on Internet of Things and Air Pollution Monitoring

17 - 20 September 2019, intERLab, AIT, Pathumthani, Thailand

Forest Fire, Smoke and Haze Situation in ASEAN

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Contents

- Satellites Related to Active Fire, Smoke and Haze Detection and Monitoring
- Fire, Smoke and Haze Situation in Upper ASEAN
- Fire, Smoke and Haze Situation in Lower ASEAN
- Conclusions and Challenges

Active Fire Detection Satellites

i. US Air Force-NOAA-DMSP-OLS Since 1970s (Nightlight) 1 km
ii. NOAA-AVHRR-NOAA-since 1980s (Weather) 1 km
iii. GOES-NOAA- since 1980s (Weather) 1 km
iv. Terra-MODIS-NASA-1999 (CC & AF) 1 km
v. Aqua-MODIS-NASA-2002 (CC & AF) 1 km
vi. Suomi-NPP-VIIRS-NASA/NOAA-2011 (CC & AF) Replacement of Aqua 375 and 750 m (VIIRS-JPSS-1/NOAA-20-2017)
vii. FireBird-DLR-2012 & 2014 (AF) 150 m
viii. Himawari-8-Jaxa 2015 (Weather) 1 km
ix. GCOM-C-SGLI-JAXA-2017 (CC & AF) Replacment of Terra 500 m
x. Sentinel-3-ESA-2018 (CC & Temperature) 1,000 m

CC = Climate Change; AF = Active Fire

Active Fire Detection Algorithms and Products

Instrument	Spatial resolution of active fire data	Geographic coverage	Satellite Orbit	Satellite / Agency
MODIS	1km	Global	Polar orbiting	Terra, Aqua/ NASA
GOES-E ABI	2km	75.2 ° W: North and South America	Geostationary	GOES/NOAA
GOES-W ABI	2km	135 ° W: Pacific Ocean, Hawaii, North and South America	Geostationary	GOES/NOAA
Himawari	2km	140.7 ° E: East Asia, Australia, Pacific Ocean	Geostationary	Advanced Himawari Imager (AHI), JAXA and JMA
Meteosat SEVIRI	3km	0 °: Europe, Africa, 41.E	Geostationary	Eumetsat
VIIRS (375m)	375m, 750m	Global	Polar orbiting	S-NPP, J-S1 / NASA/NOAA
NOAA AVHRR	1km	Global	Polar orbiting	POES / NOAA METOP / Eumetsat
SLSTR	1km	Global	Polar orbiting	Sentinel-3/ Eumetsat and ESA
HSRS	350 m	Global (but on demand products)	Polar Orbiting	Firebird Constellation / DLR

Polar Orbiting Instrument	Global coverage and Approximate Overpass time at the Equator
MODIS	Day and night global coverage every day for MODIS' on both Terra and Aqua (apart from at equator). Equatorial MODIS overpass is at approx. 10AM local time and again at 10 PM for MODIS / Terra, and 2PM and 2AM for MODIS/Aqua
VIIRS	Day and night global coverage every day from each VIIRS instrument. Equatorial VIIRS / SNPP overpass is at approx. 2PM and 2AM
AVHRR	Global coverage every day if LAC data available (apart from at equator). At the equator crossing times vary, for NOAA 16 it is approximately 2PM and 2AM.
SLSTR	Day and night global coverage every day when taking both operational SLSTR instruments together. Equatorial overpass is around 10PM and 10AM

Source: Draft of Active Fire by the Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) Fire Programme, March 2019.

Accuracy of Active Fire Products, Fire Hotspot or Hotspot

Field Validation by DNP

- MODIS Terra/Aqua 1,000 m Resolution 94.5% (2009)
- VIIRS Suomi NPP 375 m Resolution 98% (2016)
- FireBird 160 m Resolution 98% (2016)

Satellites Relevant to Fire, Smoke and Haze Monitoring

- **Active Fire Detection and Characterization (mid IR/ Thermal)**
  - AVHRR, GOES, DMSP, MSG, Himawari-8
  - MODIS (AM-Terra/PM-Aqua), AATSR, BIRD, ASTER
  - VIIRS (Suomi-NPP/NOAA-20)
  - DLR FireBIRD
  - Sentinel-3
- **Emission products (optical and sounding)**
  - **MODIS, MISR – Aerosol Optical Depth**
  - **AIRS, MOPITT, DLR FireBIRD – CO,**
  - **Sentinel-5 Precursor - AI, CO, CO_2, CH_4, NO_2, O_3, SO_2**

Satellites Relevant to Fire, Smoke and Haze Monitoring

- **Burned Area, Fire Danger, Post Fire Assessments (VIS, NIR)**
  - Coarse/moderate Resolution
    - AVHRR/METOP, MODIS, SeaWiFS, ATSR, VEGETATION, High Resolution
    - Landsat 8, SPOT, IRS, RapidEye
    - ASTER-Terra – high resolution optical and thermal
    - Radarsat, ALOS-2, Sentinel 1&2
  - Hyperspatial Resolution – Ikonos, QuickBird, WorldView, etc.

Current Capabilities of Satellites:

- Vegetation Type and fuel Condition
- Active Fire Detection
- Burned Area Estimation
- Burn Severity Condition
- Fire Radiative Power for fire emissions (GHGs)
- Aerosols for Smoke and haze monitoring

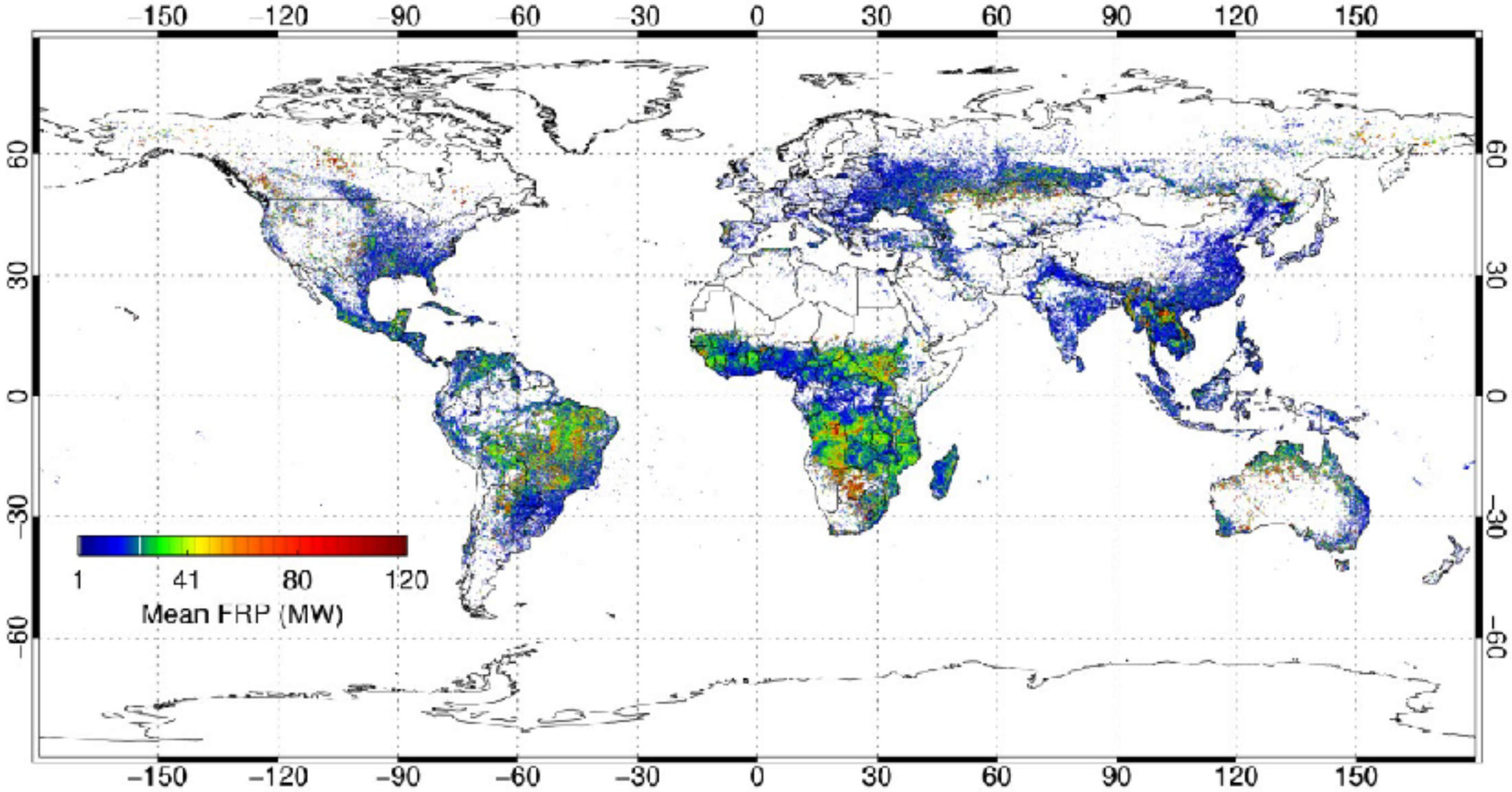


Figure 1. Global landscape fire geographic distribution and radiative 'strength', as derived from satellite Earth observation active fire (AF) remote sensing approaches.

Online AF Mapping and Data Delivery Systems

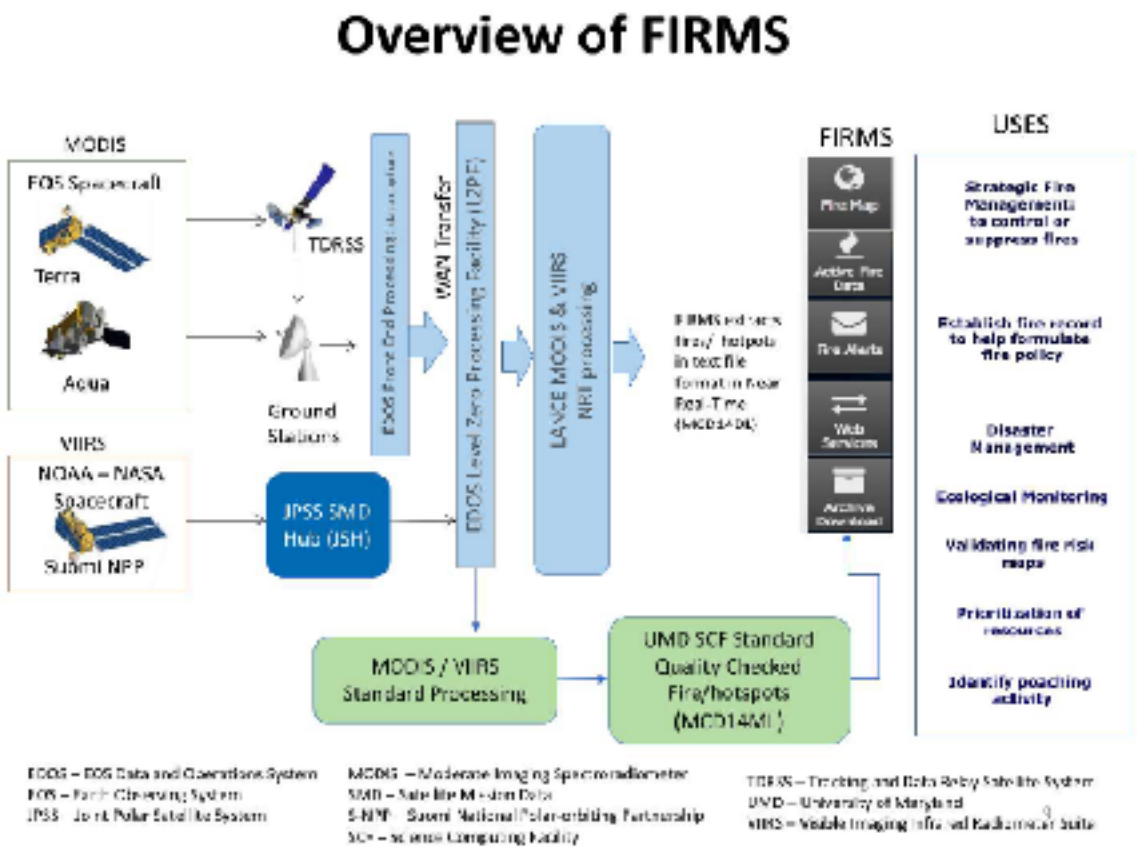


Figure 10: Overview of NASA's Fire Information for Resource Management System.

Source: Draft of Active Fire by the Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) Fire Programme, March 2019

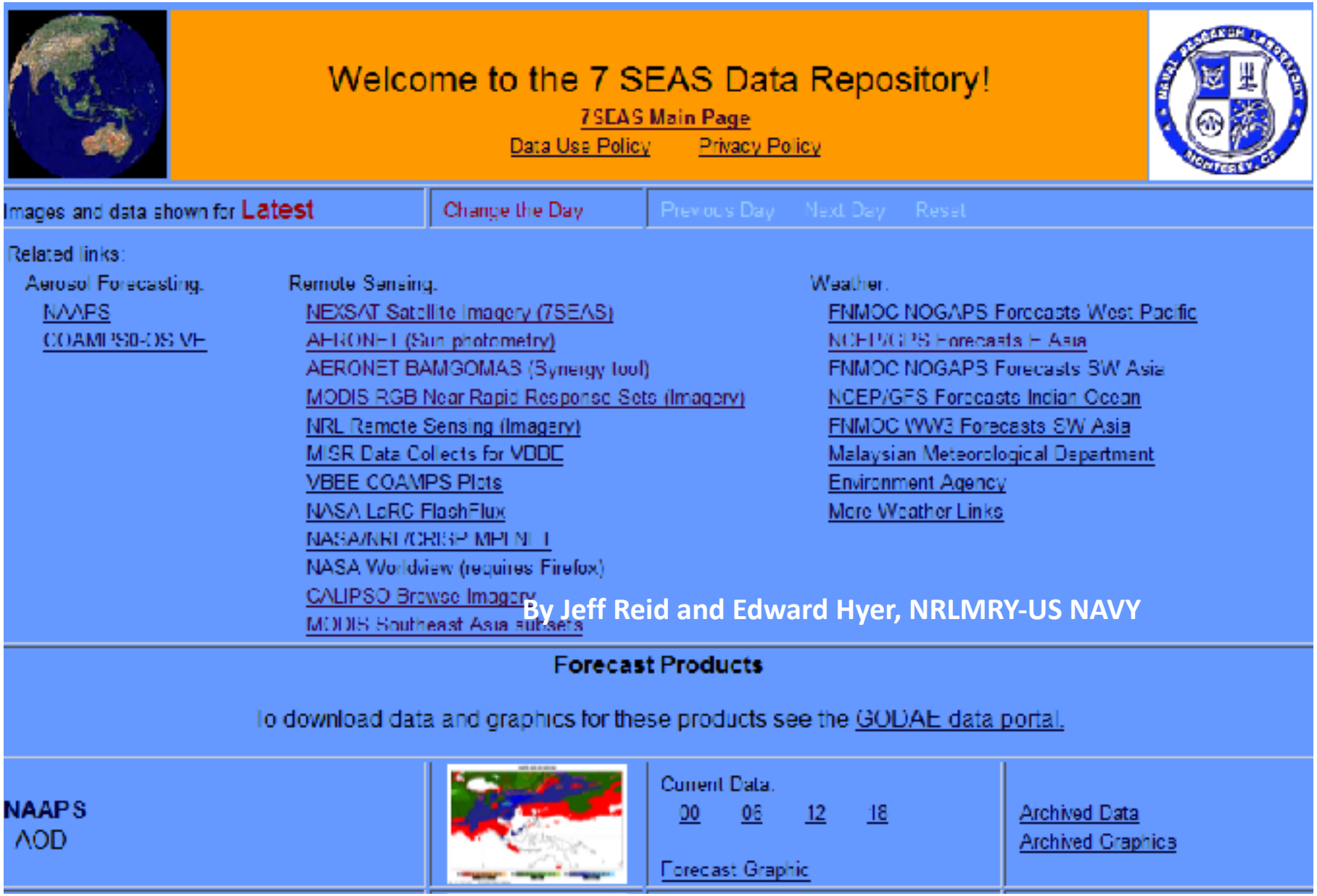
Fire Regimes and their Characteristics

- **More understanding of a diurnal cycle (24 hrs) of fires which directly related to human behavior or anthropogenic activities.**
- **Fuel load and its conditions such as moisture**
- **The size of burned areas corresponding to land cover**
- **FRP, heat release, intensity and fuel consumption**
- **Fire frequency and fire density (the count of active fire pixels detected per unit time and per unit area) to identify locations of shifting fire regimes that maybe associated with anthropogenic or climatic**

Source: Draft of Active Fire by the Global Observation of Forest Cover/Global Observation of Land Cover Dynamics (GOFC/GOLD) Fire Programme March 2012

Smoke and Haze Monitoring By 7 SEAS

Off-Line



Source: http://www.nrlmry.navy.mil/aerosol_web/7seas/7seas.html

Can see the original products at

https://www.usgodae.org//cgi-bin/datalist.pl?generate=summary

Global Ocean Data Assimilation Experiment

Home | Data Sets | L.A.S. | USGODAE | Projects | Links | News | Contacts

Data_Type	Parameter	Provider		
ALL	ALL	ALL	Go	Reset

USGODAE Data Catalog - Summary View

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To select individual data sets check the boxes below, then press "Go".

Go Reset

- Argo USGODAE GDAC
- COAMPS - Coupled Ocean Atmosphere Mesoscale Prediction System
- FAROP - Forecast of Aerosol Radiative Optical Properties
- NAVGEM -Navy Global Environmental Model
- NOGAPS -Navy Operational Global Atmospheric Prediction System
- NOGAPS ANGM - Navy Operational Global Atmospheric Prediction System Angular Momentum
- NOGAPS Computational Grids

Source: https://www.usgodae.org//cgi-bin/datalist.pl?generate=summary

Forecast Fire Danger Rating for Upper ASEAN and Thailand

Still DOWN!!

Geo-Informatics Division
Protected Area Development and Rehabilitation Office
Department of National Parks, Wildlife and Plant Conservation

By Manomaiphiboon, K., Tanpipat, V., Nhuchaiya, P., Jaroonrattanapak, N., Buaniam, C. (2017)

DNP | DNP GIS

Source: http://www2.dnp.go.th/gis/FDRS/FDRS.php/

การพยากรณ์ระดับชั้นอันตรายของไฟที่ความละเอียดสูง

Fine-Resolution Forecast Products of Fire Danger Rating

ค่าดัชนีไฟป่าประจำวันเพื่อปรับป้าย FDRS Table for Fire Risk Signs	เอเชียตะวันออกเฉียงใต้ตอนบน Upper Southeast Asia	คณะทำงาน Working Group	ข้อมูลประกอบ Supplemental Info
ภาคเหนือตอนบนของประเทศไทย Upper Northern Thailand	จังหวัดเชียงใหม่ Chiang Mai	เอกสารอ้างอิง Refererces	กิตติกรรมประกาศ Acknowledgements
ประเทศลาว Laos	ประเทศกัมพูชา Cambodia	รวมลิงค์ Useful Links	

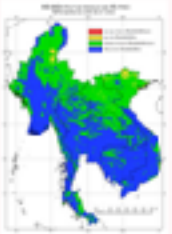
เอเชียตะวันออกเฉียงใต้ตอนบน

Upper Southeast Asia

6 ตุลาคม 2559
6 October 2016

ความละเอียดกริด 3 กม.
3 km Grid Resolution

ดัชนีการติดไฟ
FFMC

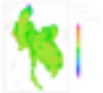


Google Earth KMZ

ดัชนีความรุนแรงไฟ
FWI

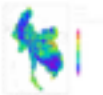
Google Earth KMZ

อุณหภูมิ
Temperature

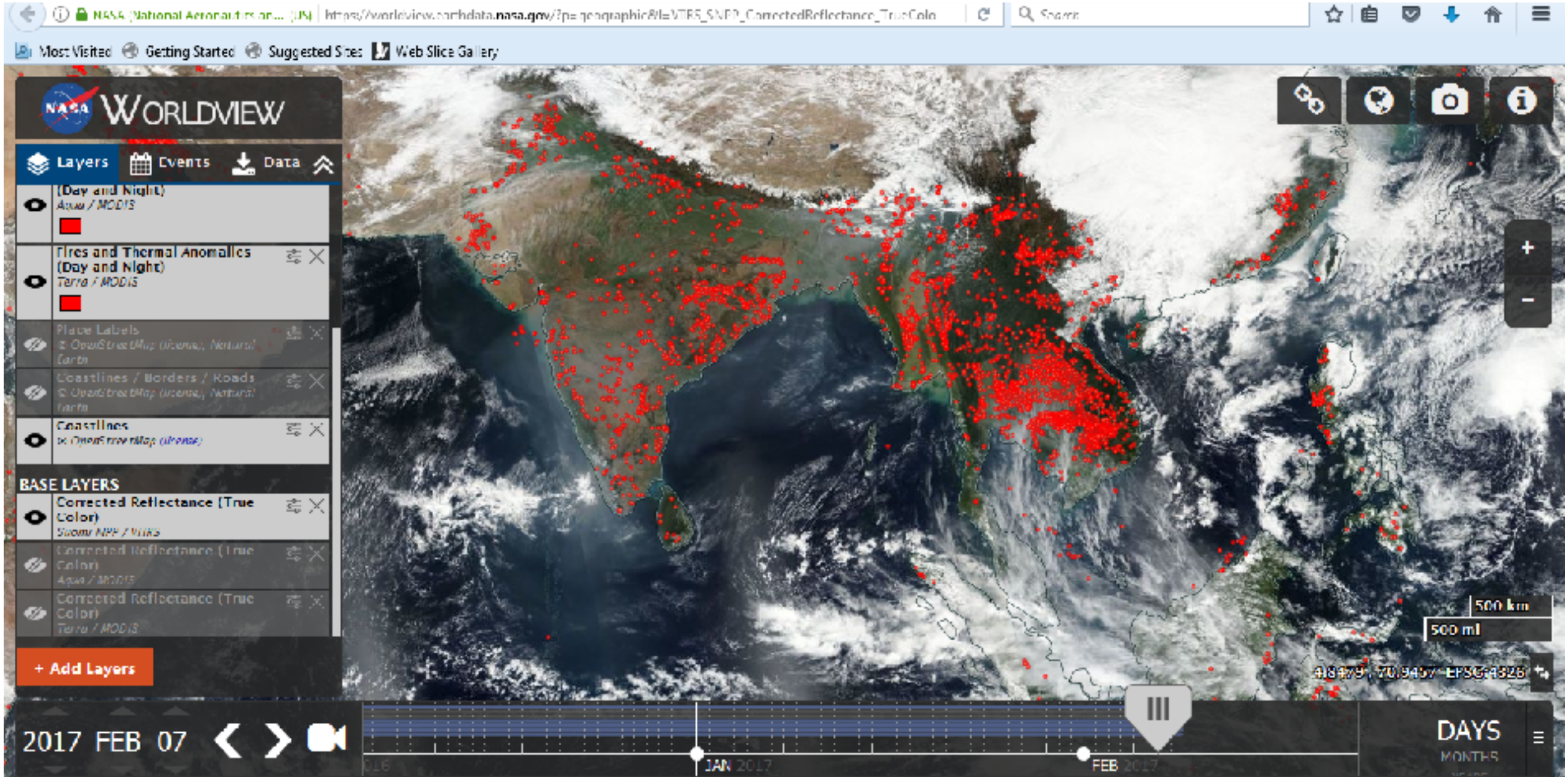


ความชื้นสัมพัทธ์
Relative Humidity

ความเร็วลม
Wind Speed



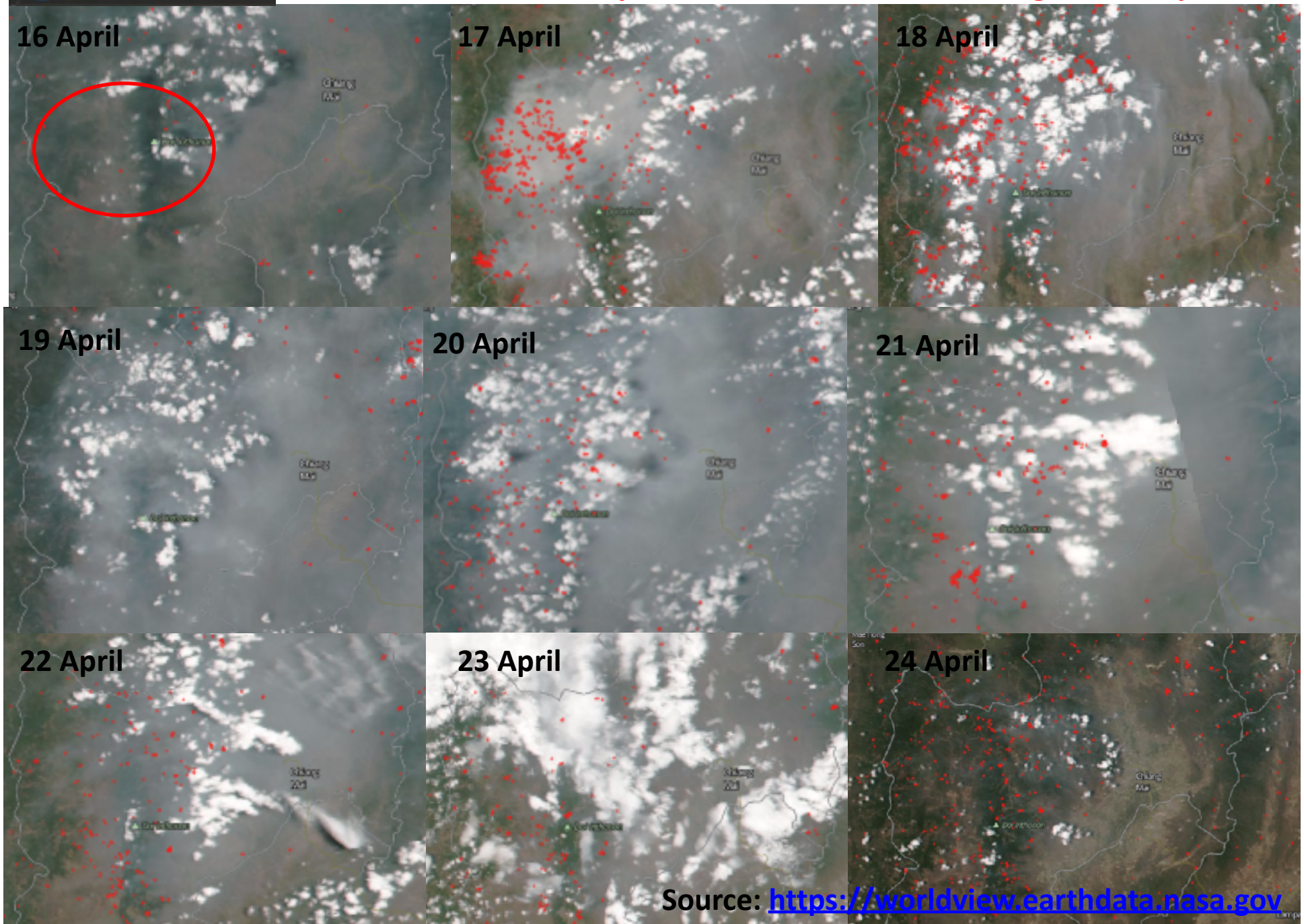
ฝน
Precipitation



Source: https://worldview.earthdata.nasa.gov/

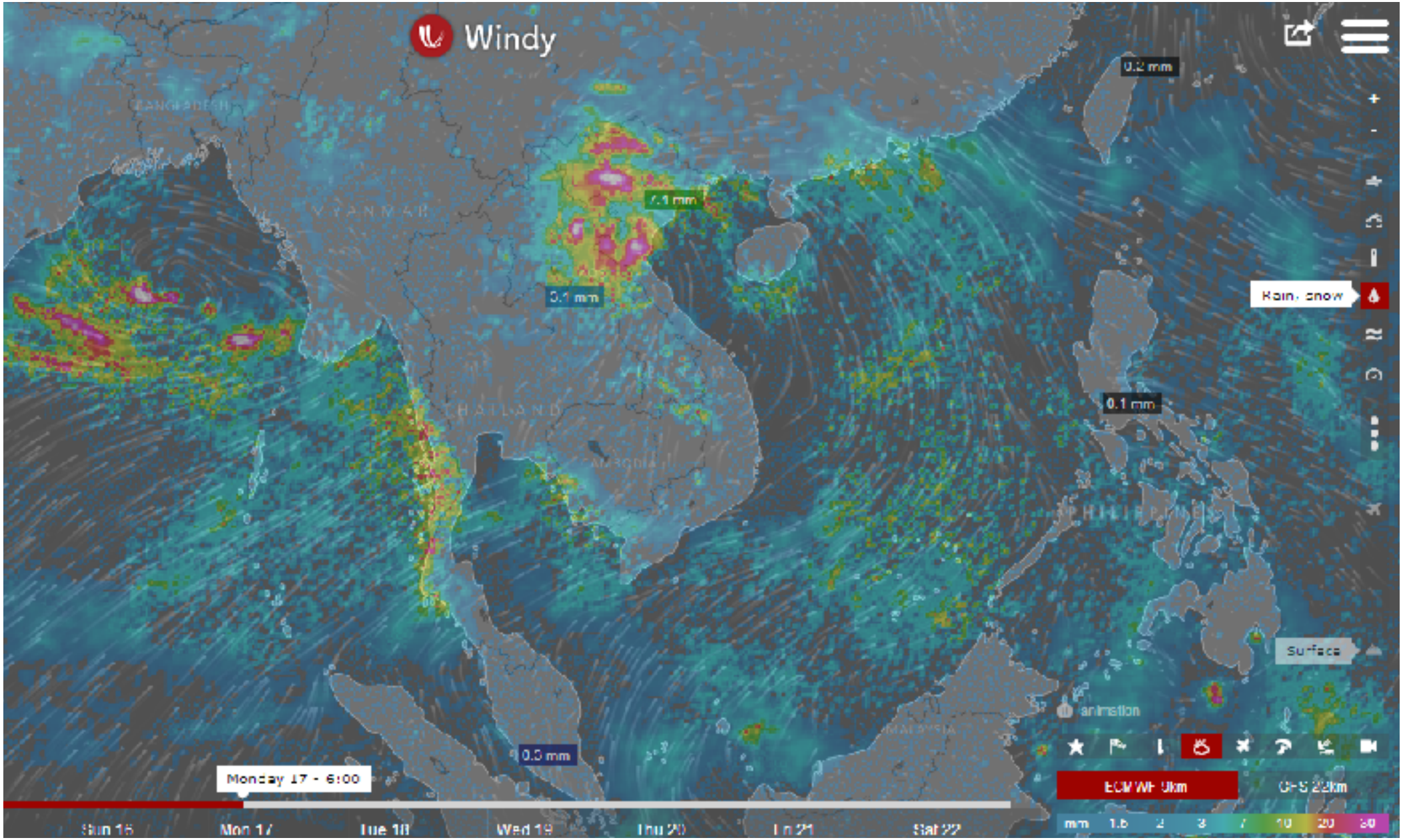
By Diane Davies, Minnie Wong, Gary Fu (NASA-LANCE-Earthdata-FIRMS)

Smoke and haze caused by fires in Maechaem area during 16 – 24 April 2016

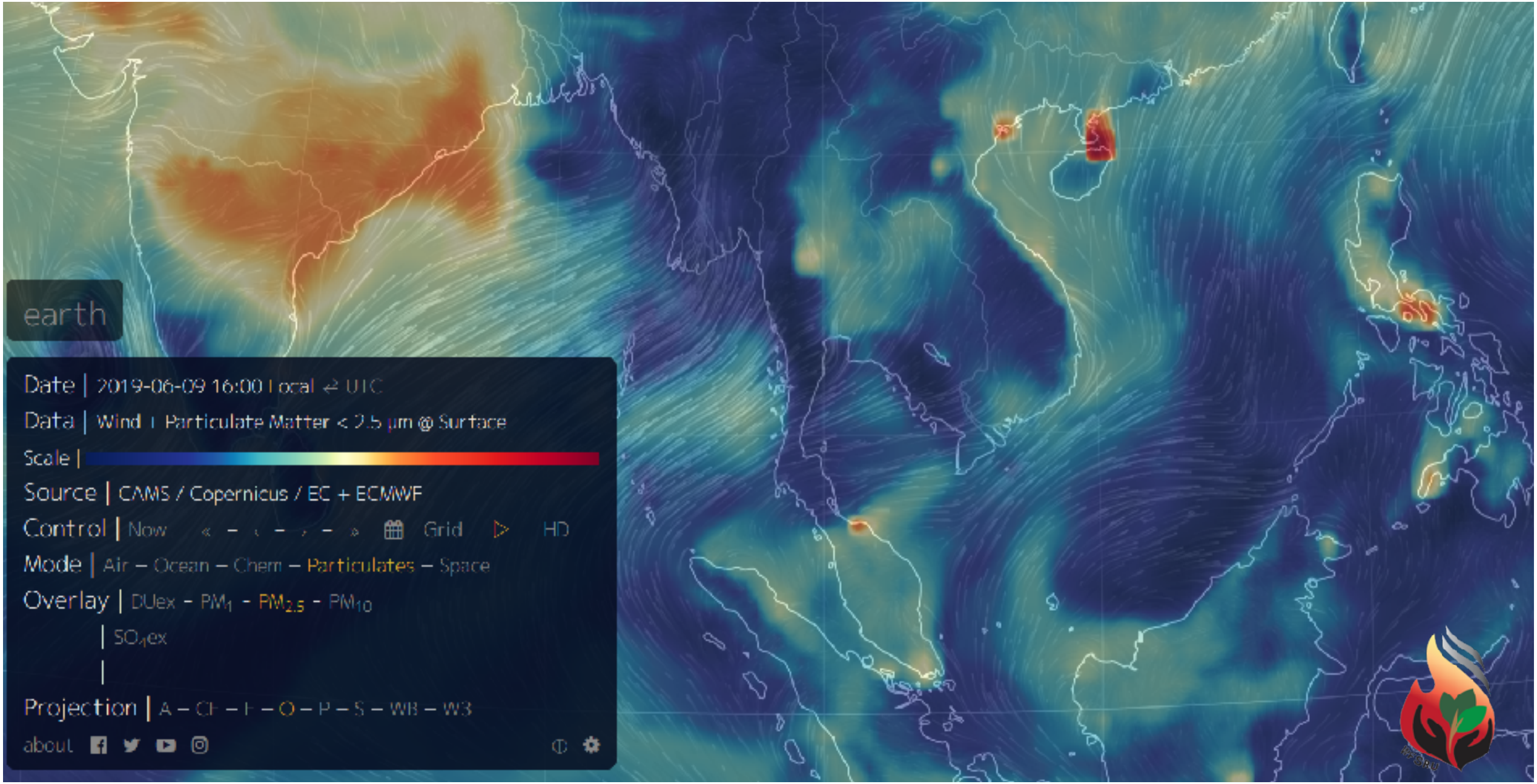


Source: https://worldview.earthdata.nasa.gov

Windy (wind, precipitation, PM2.5, etc.) (http://www.windyty.com)



Earth (CO, PM10, PM2.5, etc.) (https://earth.nullschool.net)



Upper ASEAN 2018 Smoke and Haze (Fire Emissions)

Past and Current Fire Smoke Emission Inventories

Satellite AF observations in the form of fire pixel counts (N_{pix}) are sometimes used as complementary input to emissions inventories to estimate burned area in an effort to improve its accuracy, extend estimates of burned area further into the past (van der We

estimates usin

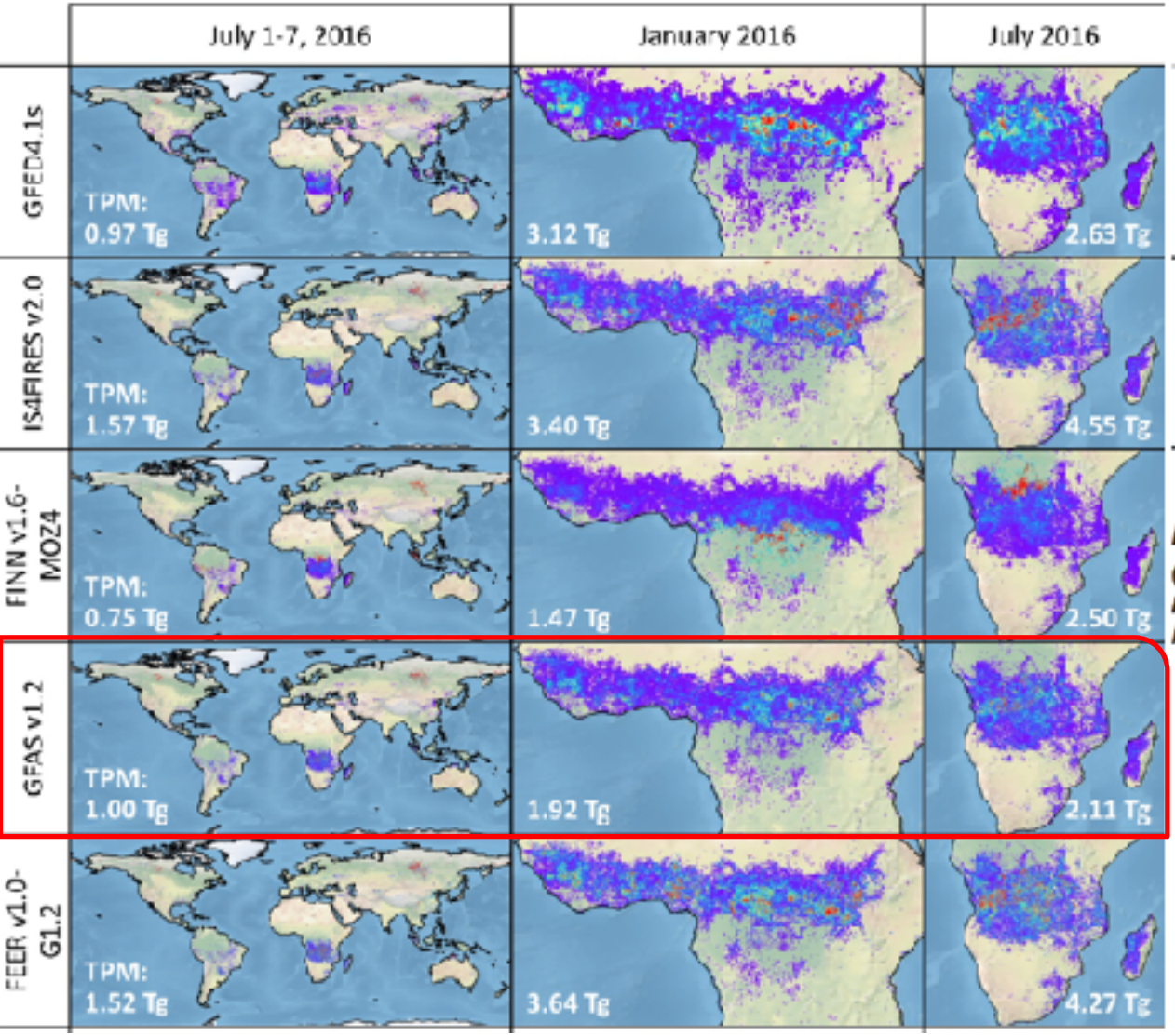
G1.2					Present	*2005; Ichoku and Ellison, 2014*
IS4Fires_v2.0	0.1 deg	3-hourly	FRP	C_e^x	2000–Present	*Sofiev et al., 2009; Soares et al., 2015*
QFED_v2.5	0.1 deg	Daily	FRP	C_e^x	2000–Present	*Darmenov and da Silva, 2015*

*Dataset websites as of July 2018:

FINN (http://bai.acom.ucar.edu/Data/fire/);
FLAMBE (https://www.nrlmry.navy.mil/flambe/);
GFAS (http://gmes-atmosphere.eu/about/project_structure/input_data/d_fire/);
GFED (http://www.globalfiredata.org/);
FEER (https://feer.gsfc.nasa.gov/data/emissions/);
IS4Fires (http://is4fires.fmi.fi);
QFED (https://geos5.org/wiki/index.php?title=Quick_Fire_Emission_Dataset_(QFED));
GBBEP (http://www.ospo.noaa.gov/Products/land/gbbepx/)

Source: Draft of Active Fire by the Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) Fire Programme, March 2019

Past and Current Fire Smoke Emission Inventories



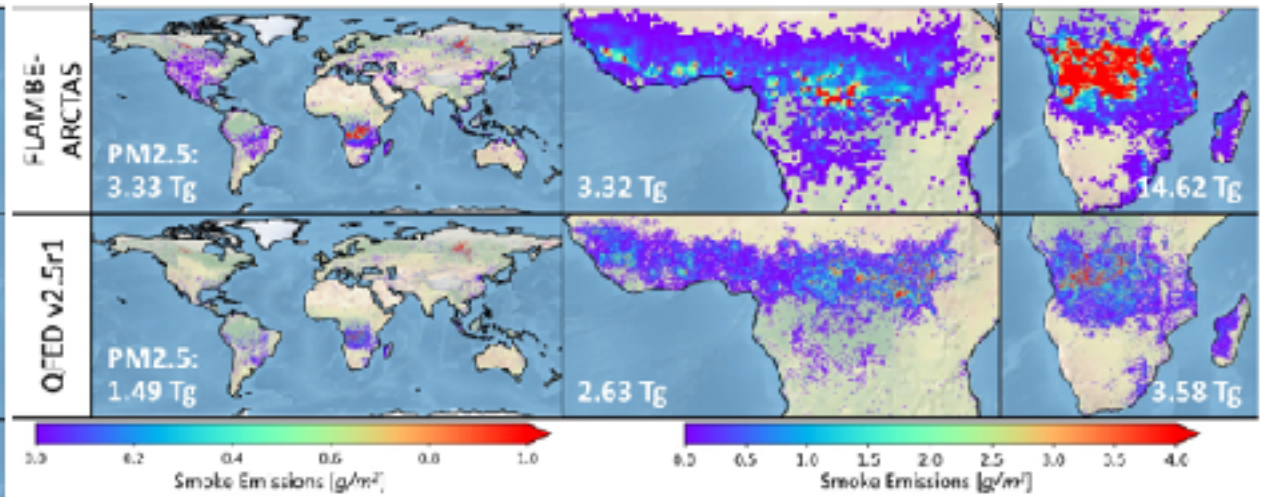


Figure X: Distributions of satellite-derived emissions of smoke total particulate matter (TPM) or particulate matter of 2.5 μm or less aerodynamic diameter (PM2.5) from different major global fire emissions datasets, namely: GFED_v4.1s, IS4FIRES_v2.0, FINN_v1.6-MOZ4, GFAS_v1.2, FEER_v1.0-G1.2, FLAMBE-ARCTAS, QFED_v2.5r1. Left column: July

https://apps.ecmwf.int/datasets/data/cams-gfas/

Source: Draft of Active Fire by the Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) Fire Programme, March 2019

European Commission

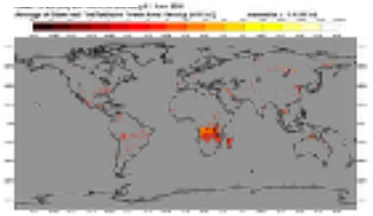
ECMWF
EUROPEAN CENTRE FOR MEDIUM RANGE WEATHER FORECASTS

Atmosphere Monitoring Service

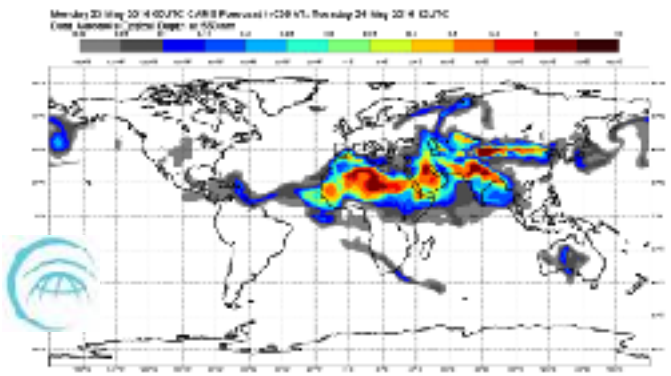
Copernicus
Europe's eyes on Earth

Space Agencies

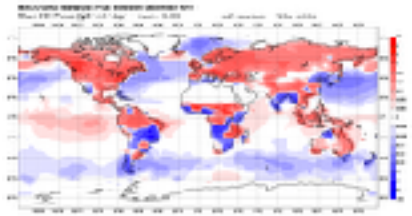
In situ observations



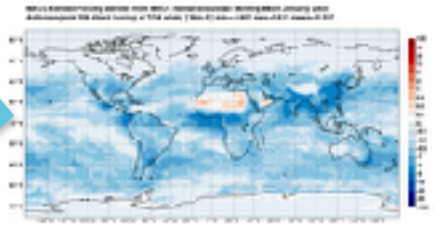
Fire emissions



Solar radiation

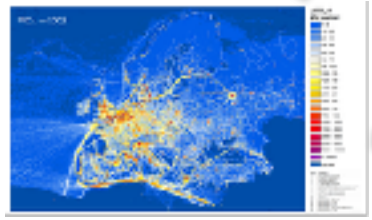


GHG fluxes

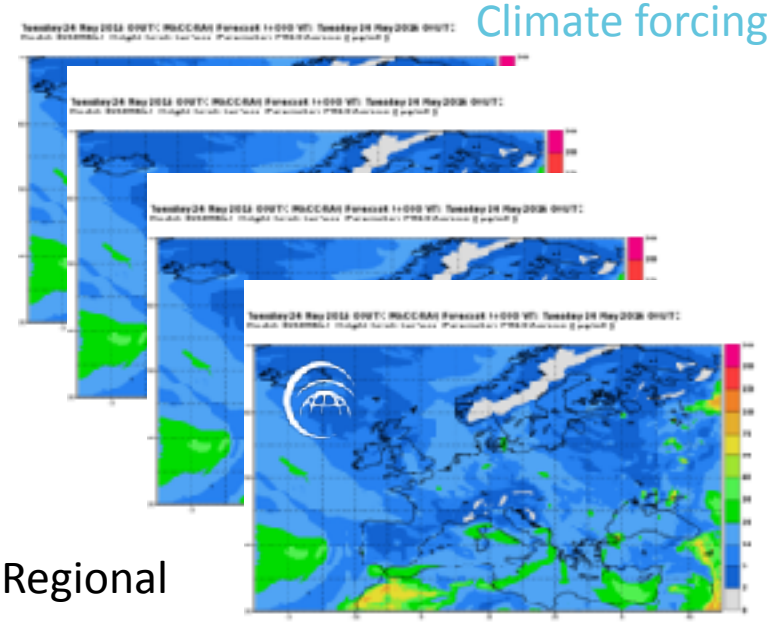


Climate forcing

Global

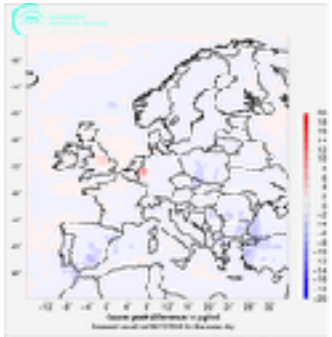


Anthropogenic emissions



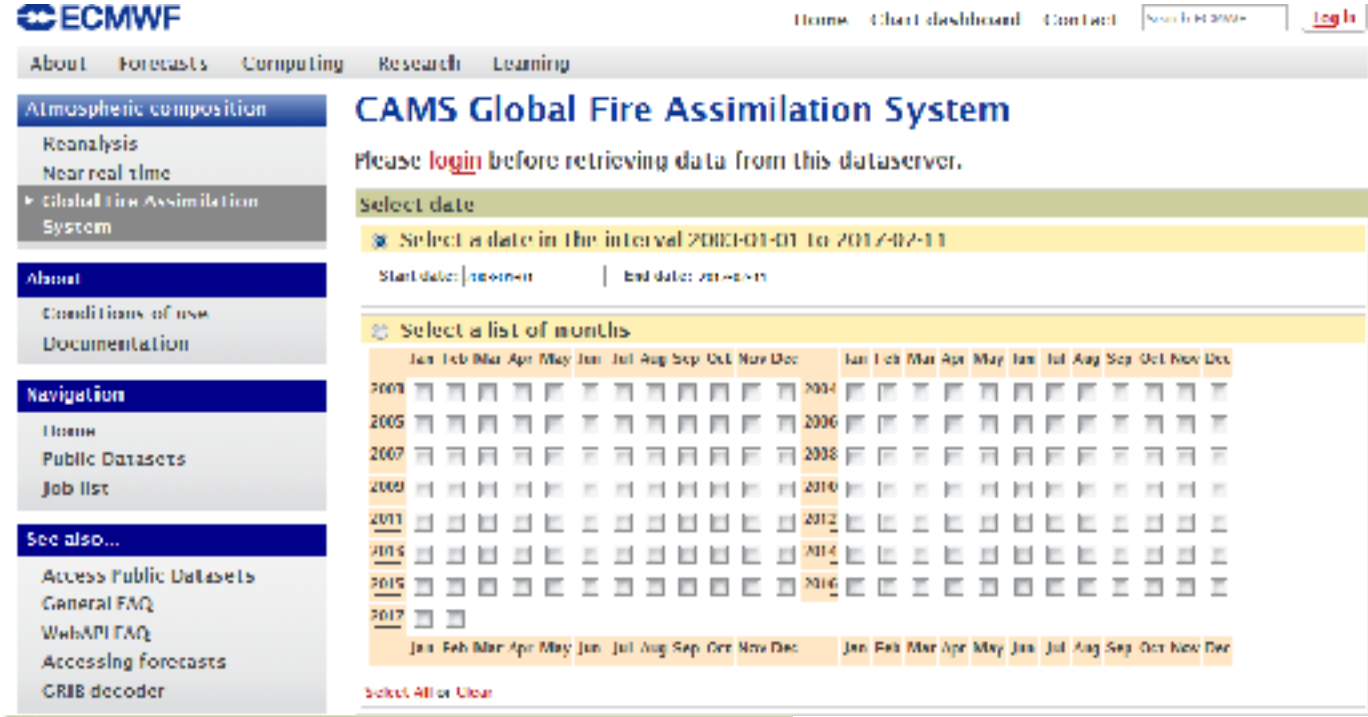
Regional

Policy



http://atmosphere.copernicus.eu/

WFSRU

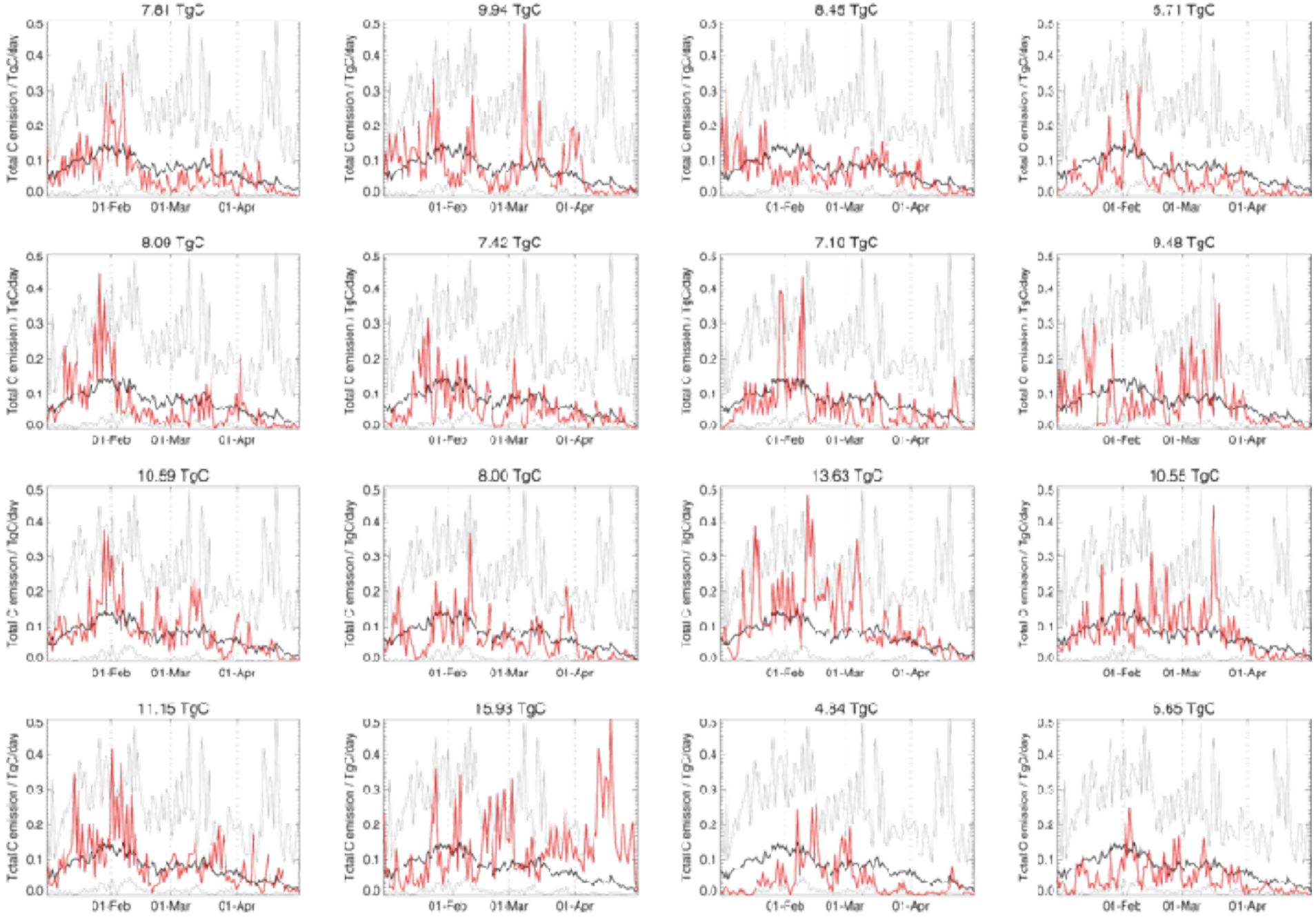


Source: http://apps.ecmwf.int/datasets/data/cams-gfas/

Fire Emissions

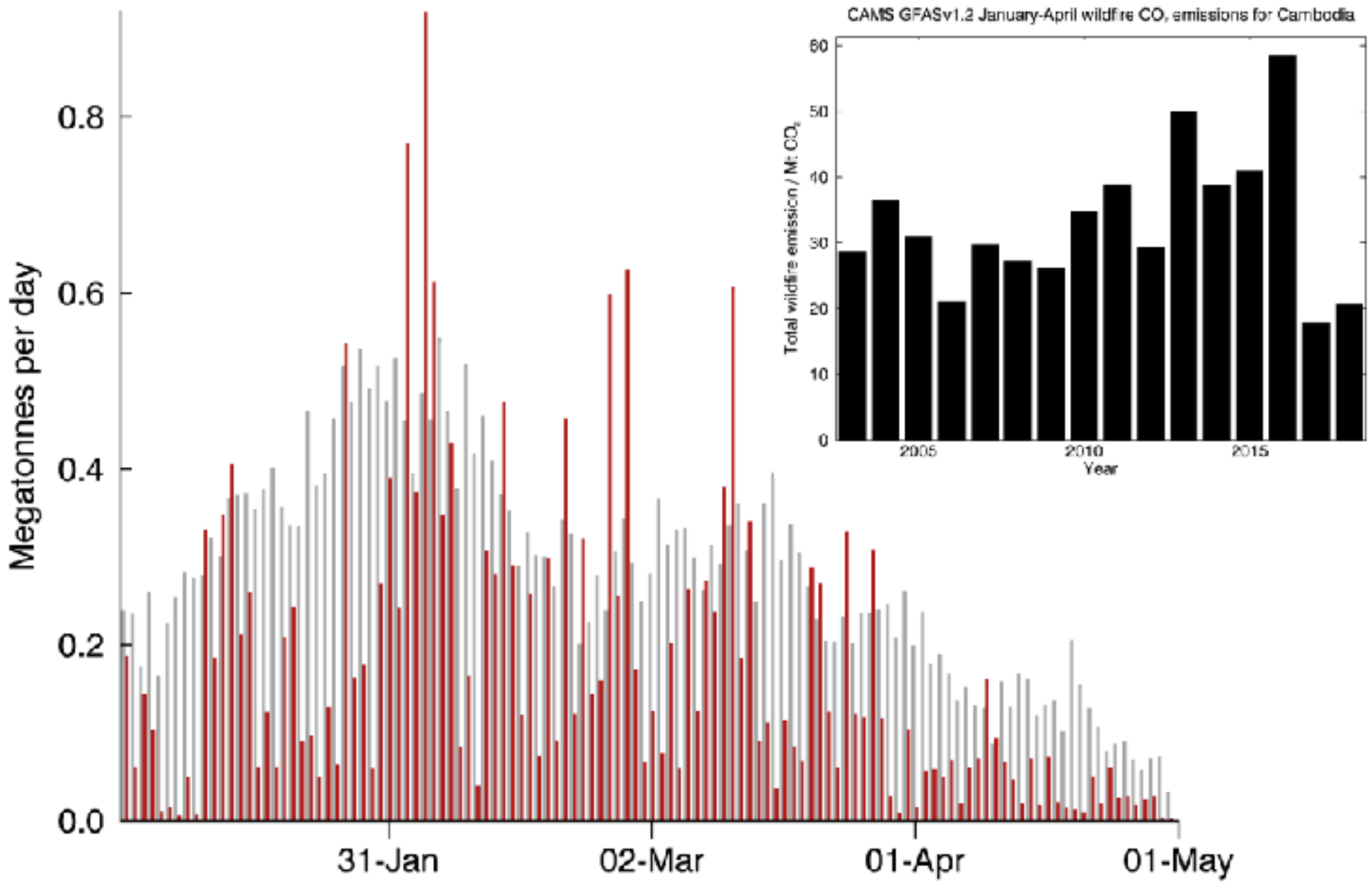
Source: http://www.globalfiredata.org/index.html

CAMBODIA: 2003-2018, 01/01 - 30/04



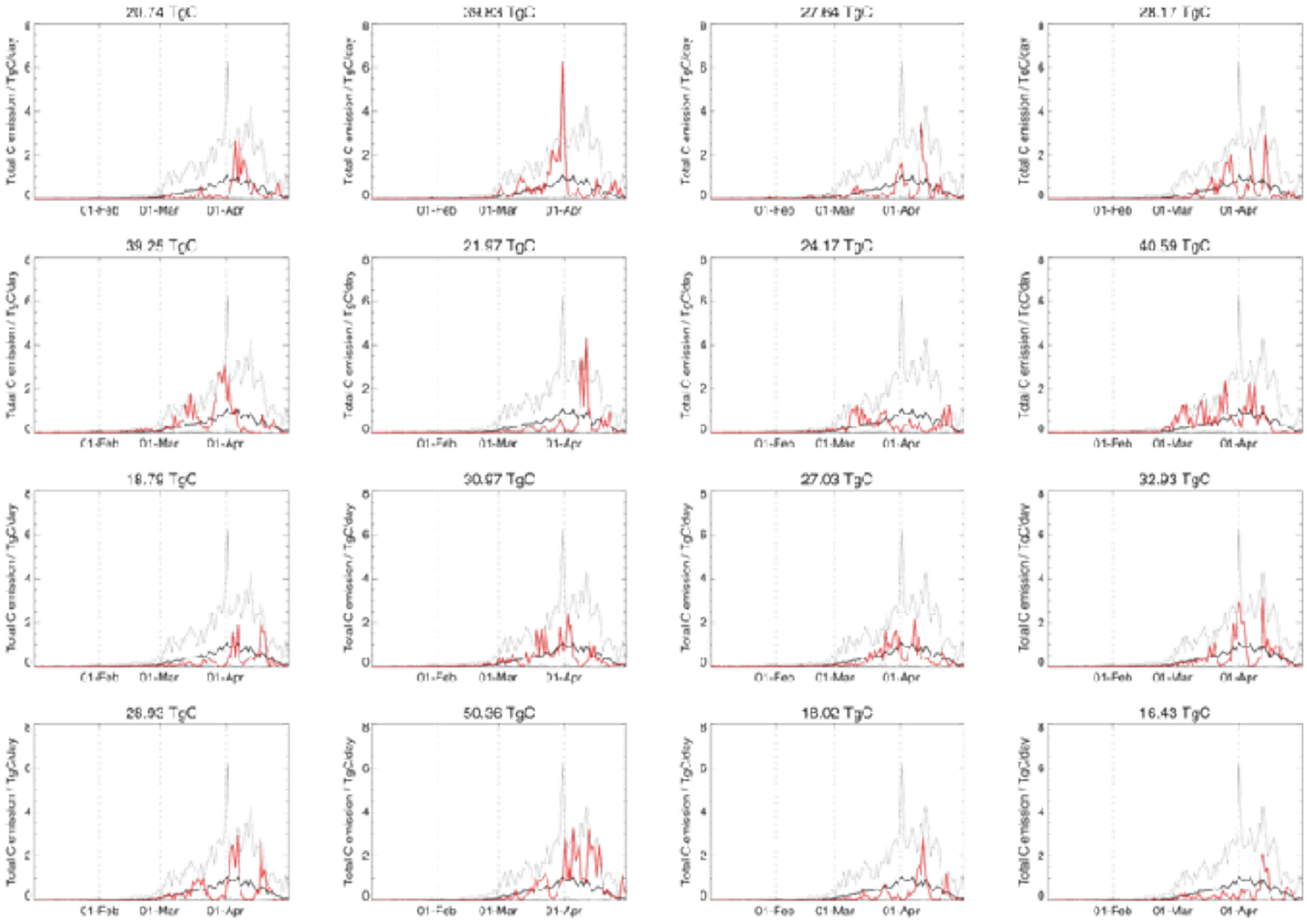
By Dr. Mark Parrington

CAMS Daily Fire CO_2 Emissions (GFASv1.2) for Cambodia

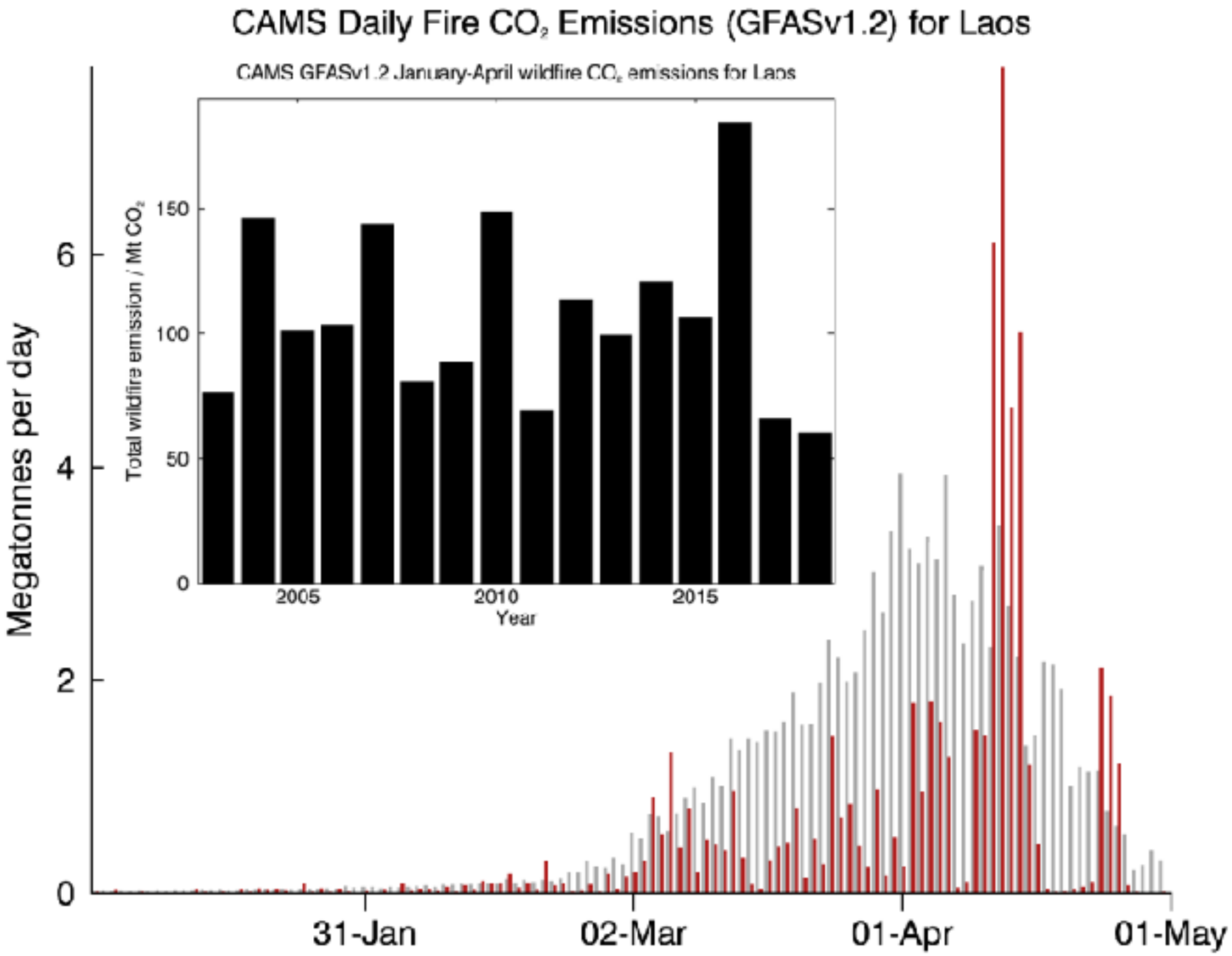


By Dr. Mark Parrington

LAOS: 2003-2018, 01/01 - 30/04

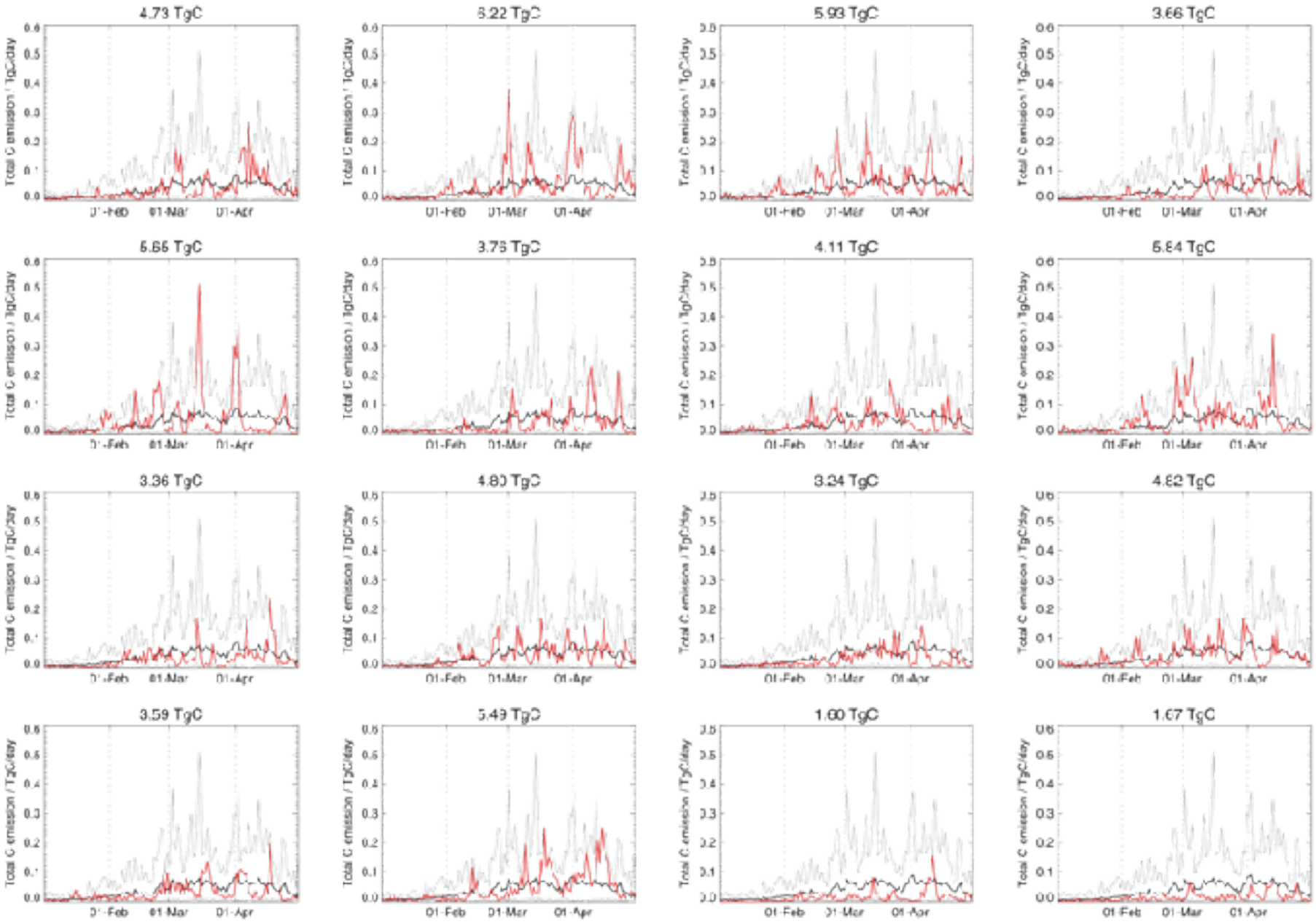


By Dr. Mark Parrington



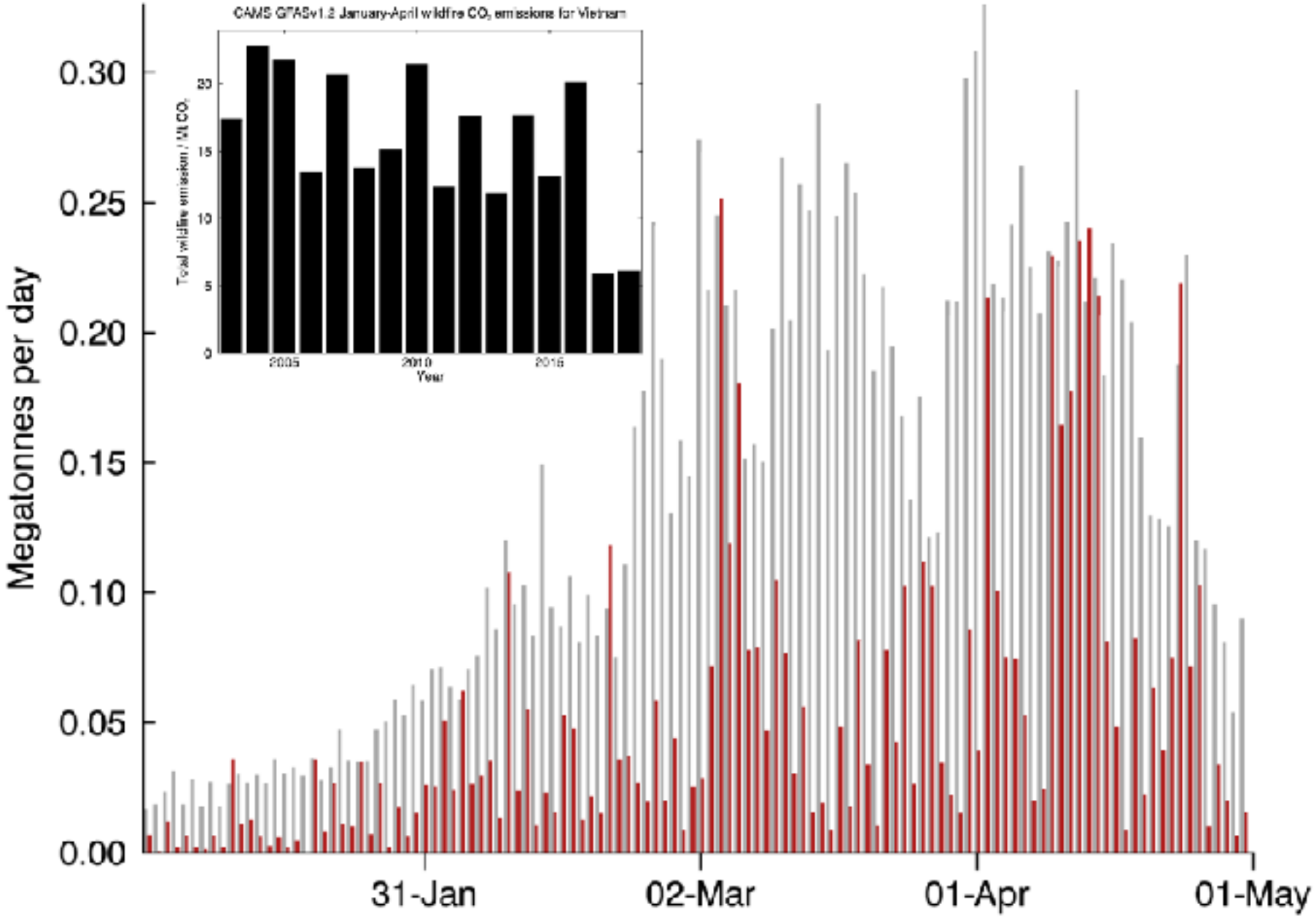
By Dr. Mark Parrington

VIETNAM: 2003-2018, 01/01 - 30/04



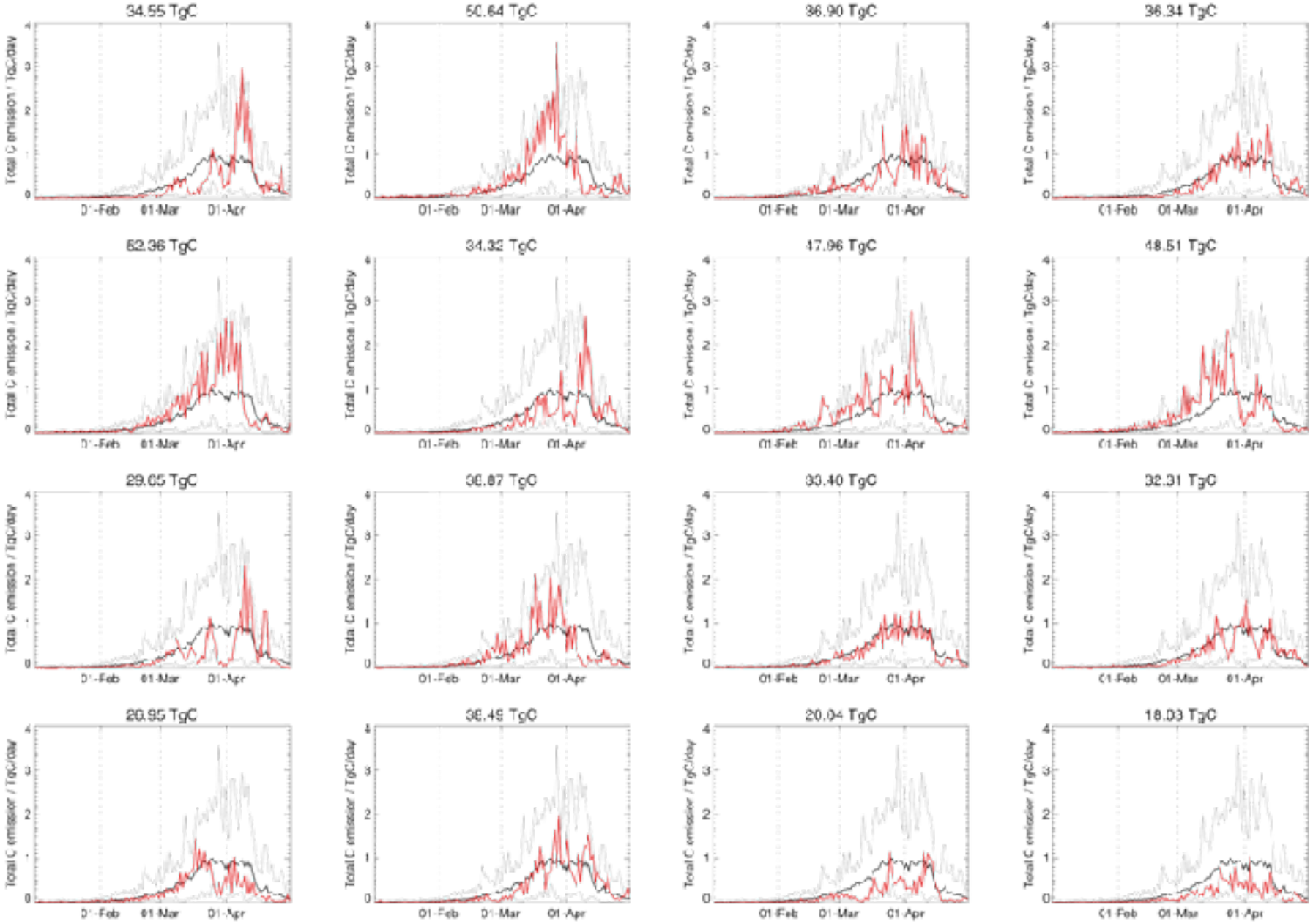
By Dr. Mark Parrington

CAMS Daily Fire CO_2 Emissions (GFASv1.2) for Vietnam

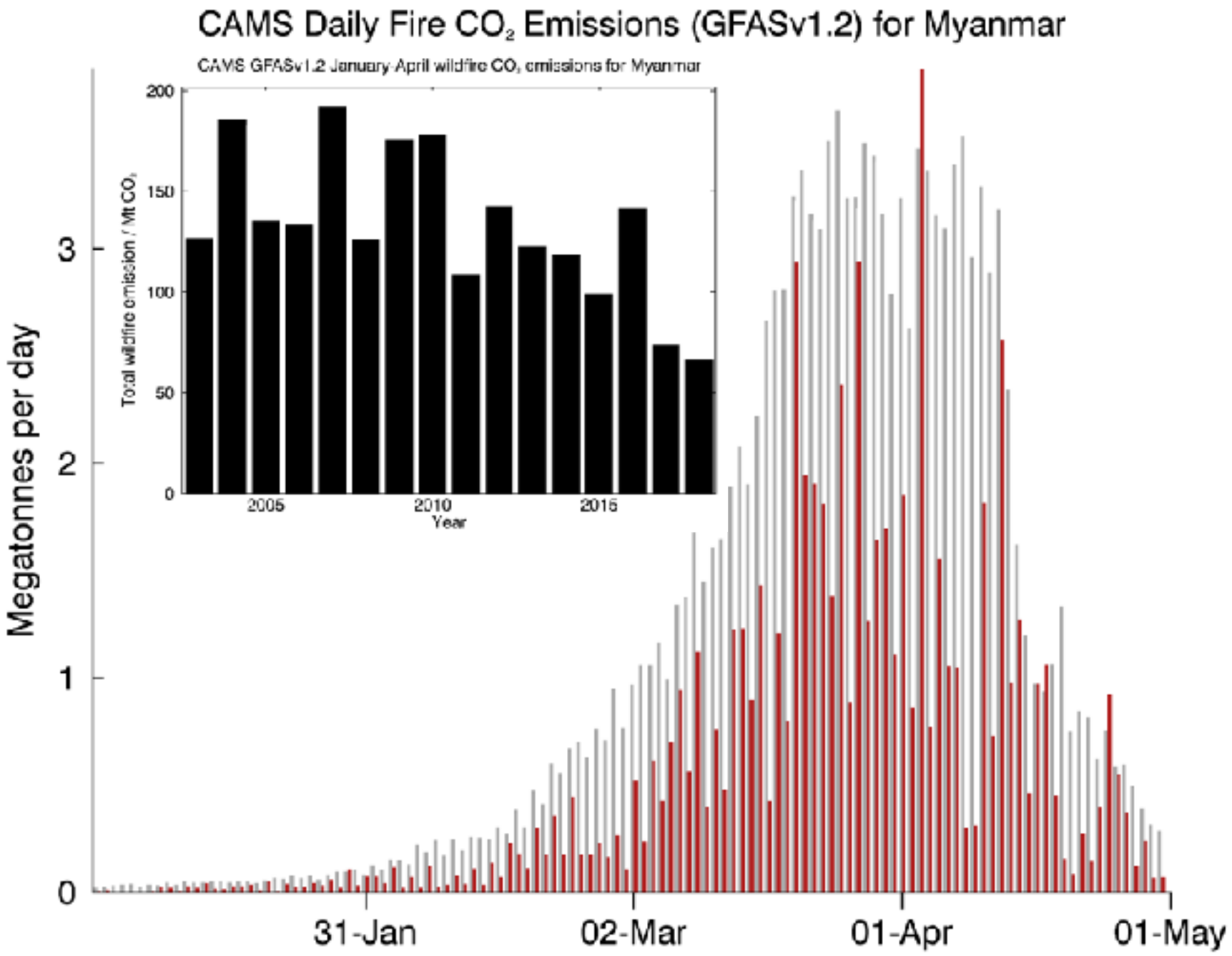


By Dr. Mark Parrington

MYANMAR: 2003-2018, 01/01 - 30/04

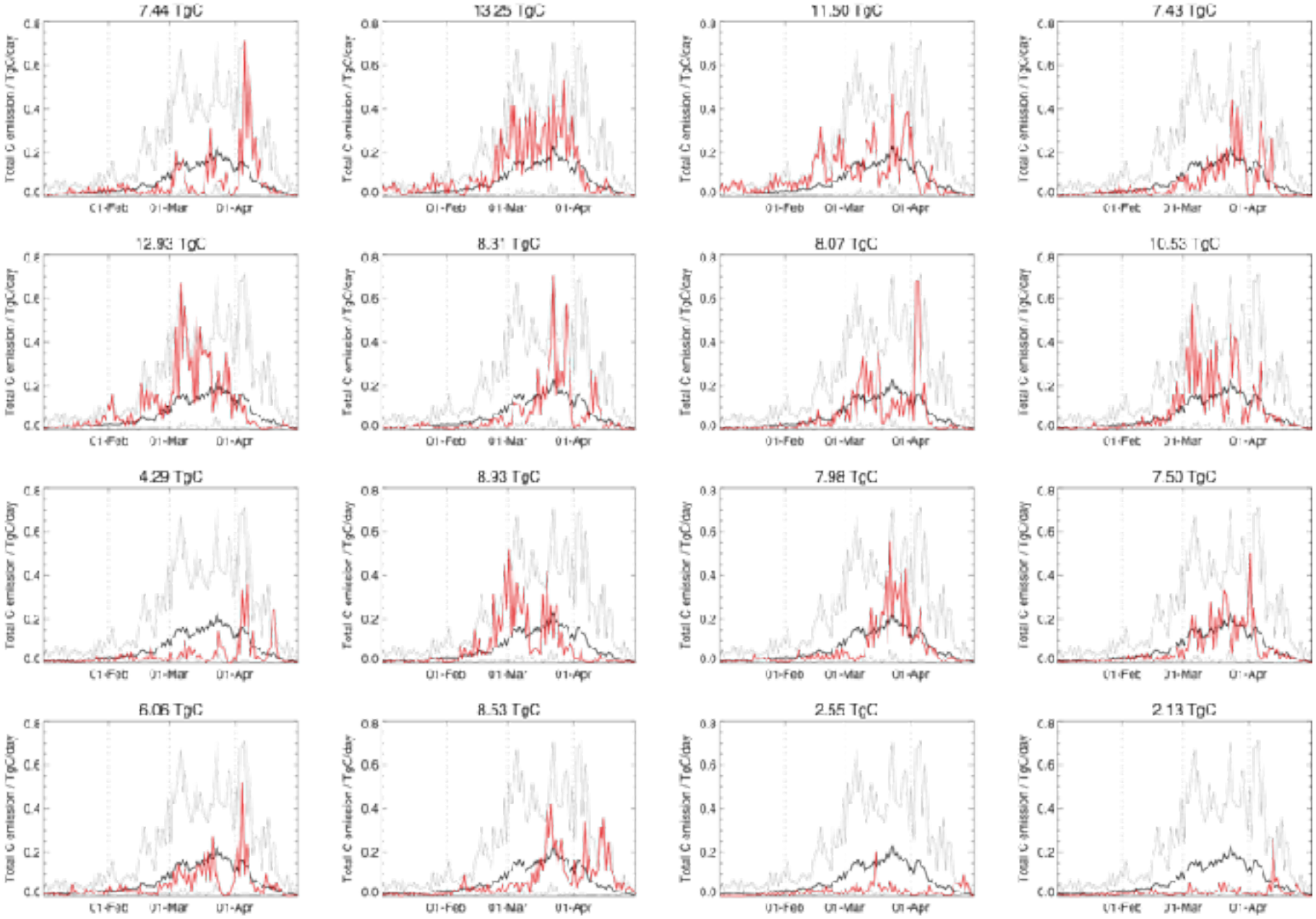


By Dr. Mark Parrington



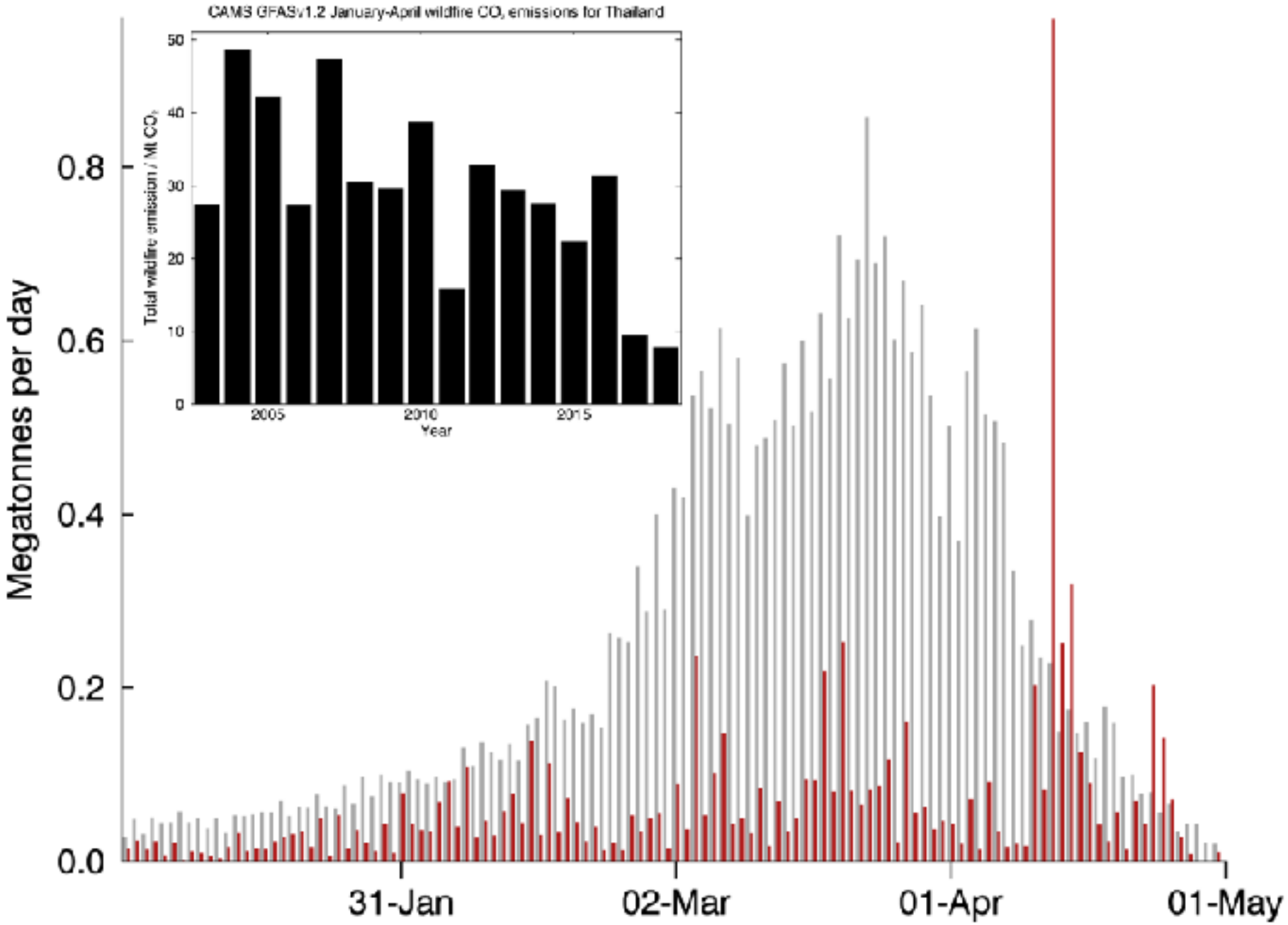
By Dr. Mark Parrington

THAILAND: 2003-2018, 01/01 - 30/04



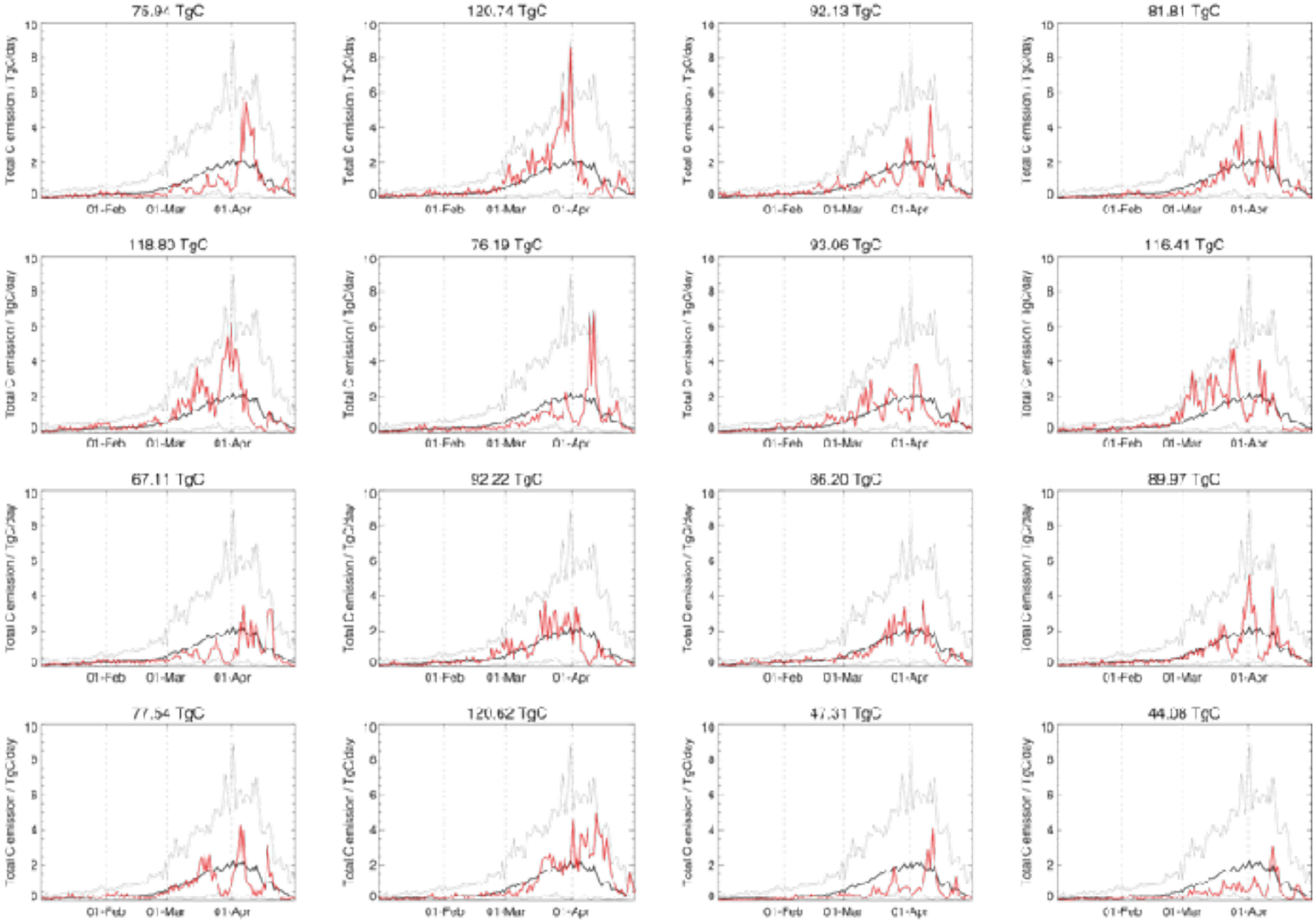
By Dr. Mark Parrington

CAMS Daily Fire CO_2 Emissions (GFASv1.2) for Thailand

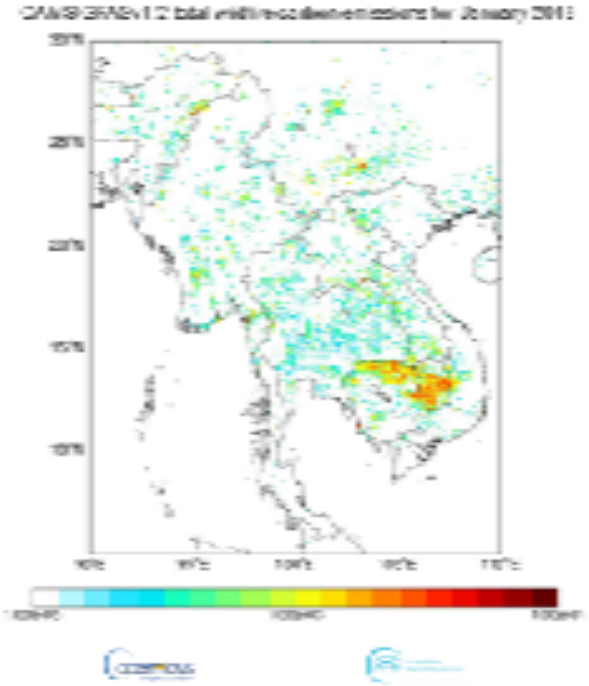


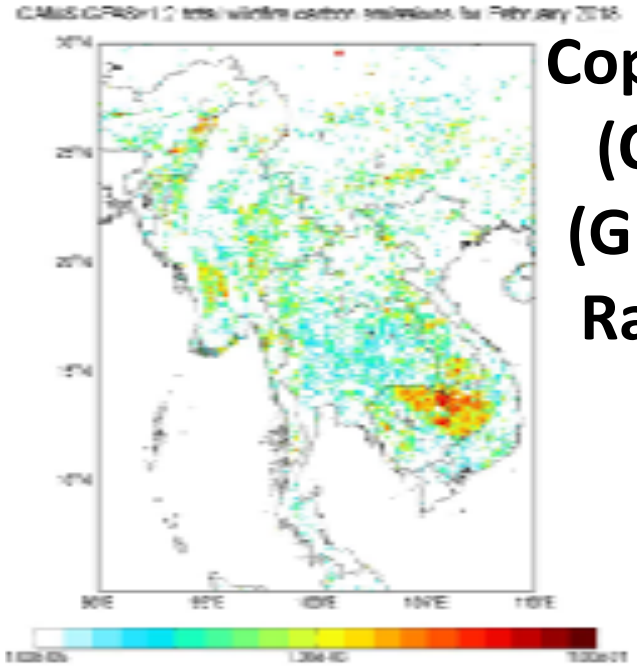
By Dr. Mark Parrington

Upper ASEAN countries: 2003-2018, 01/01 - 30/04



By Dr. Mark Parrington

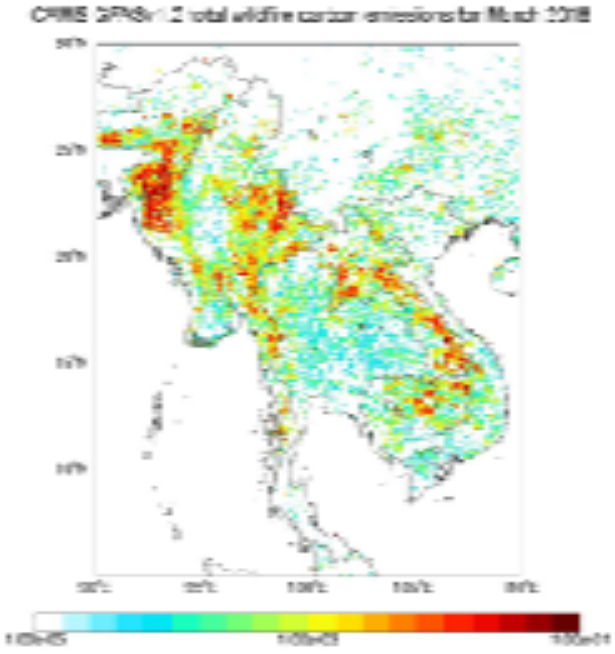


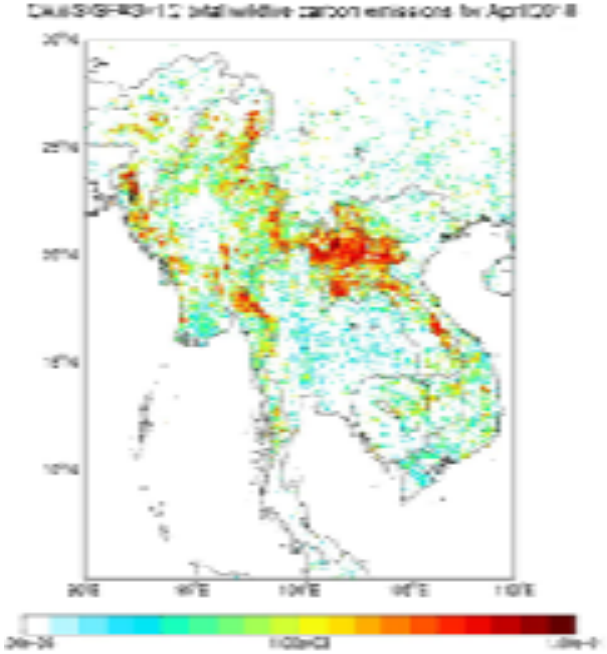


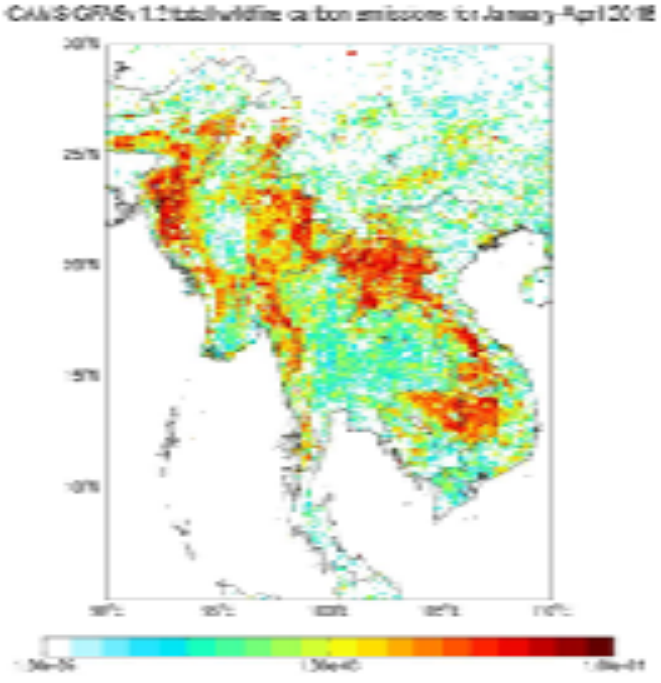
Copernicus Atmosphere Monitoring Service (CAMS), Global Fire Assimilation System (GFAS), The European Centre for Medium-Range Weather Forecasts (ECMWF) http://atmosphere.copernicus.eu/about-cams

Since 2015 fire season!

Dr. Mark Parrington, (mark.parrington@ecmwf.int)





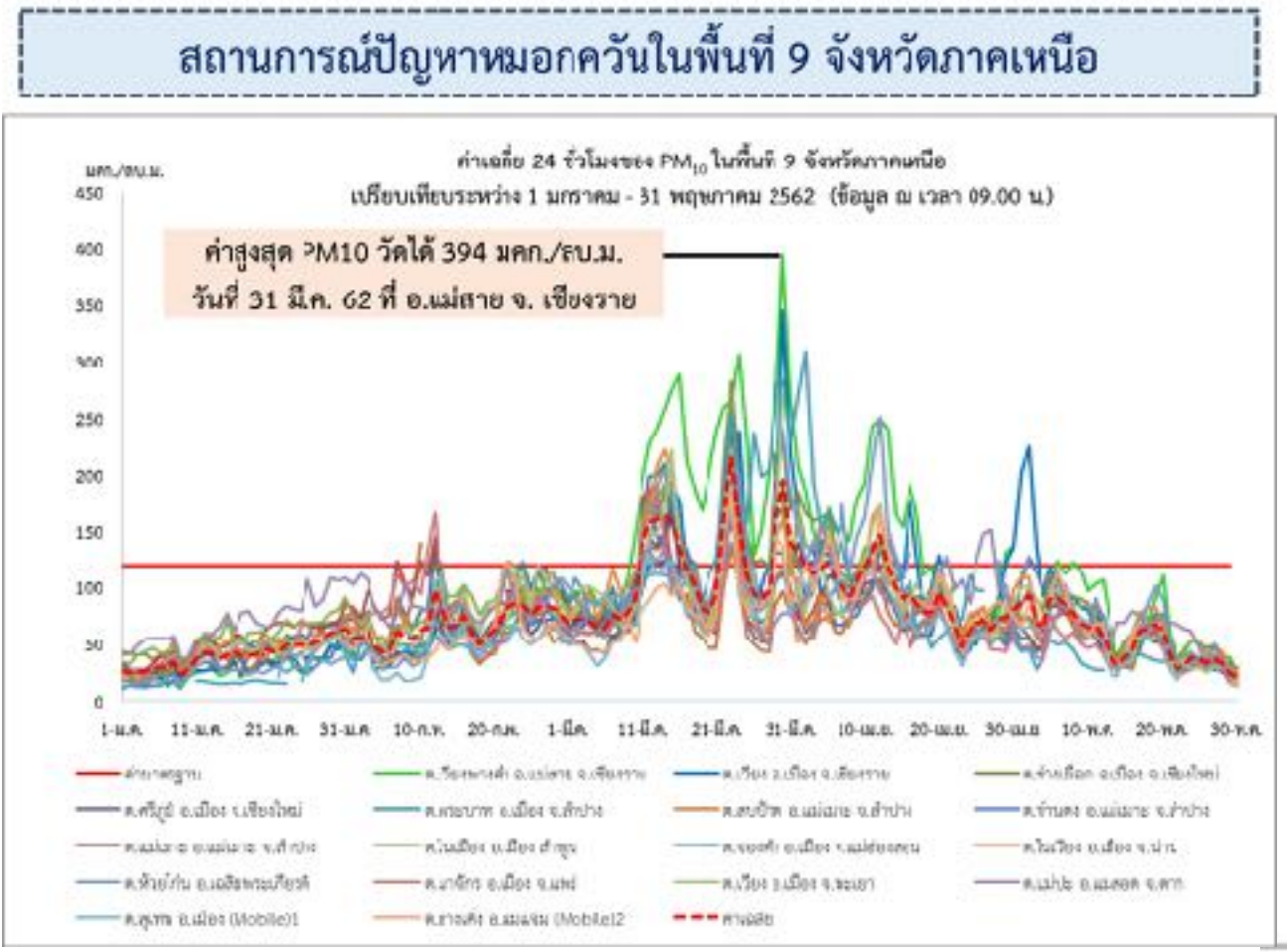


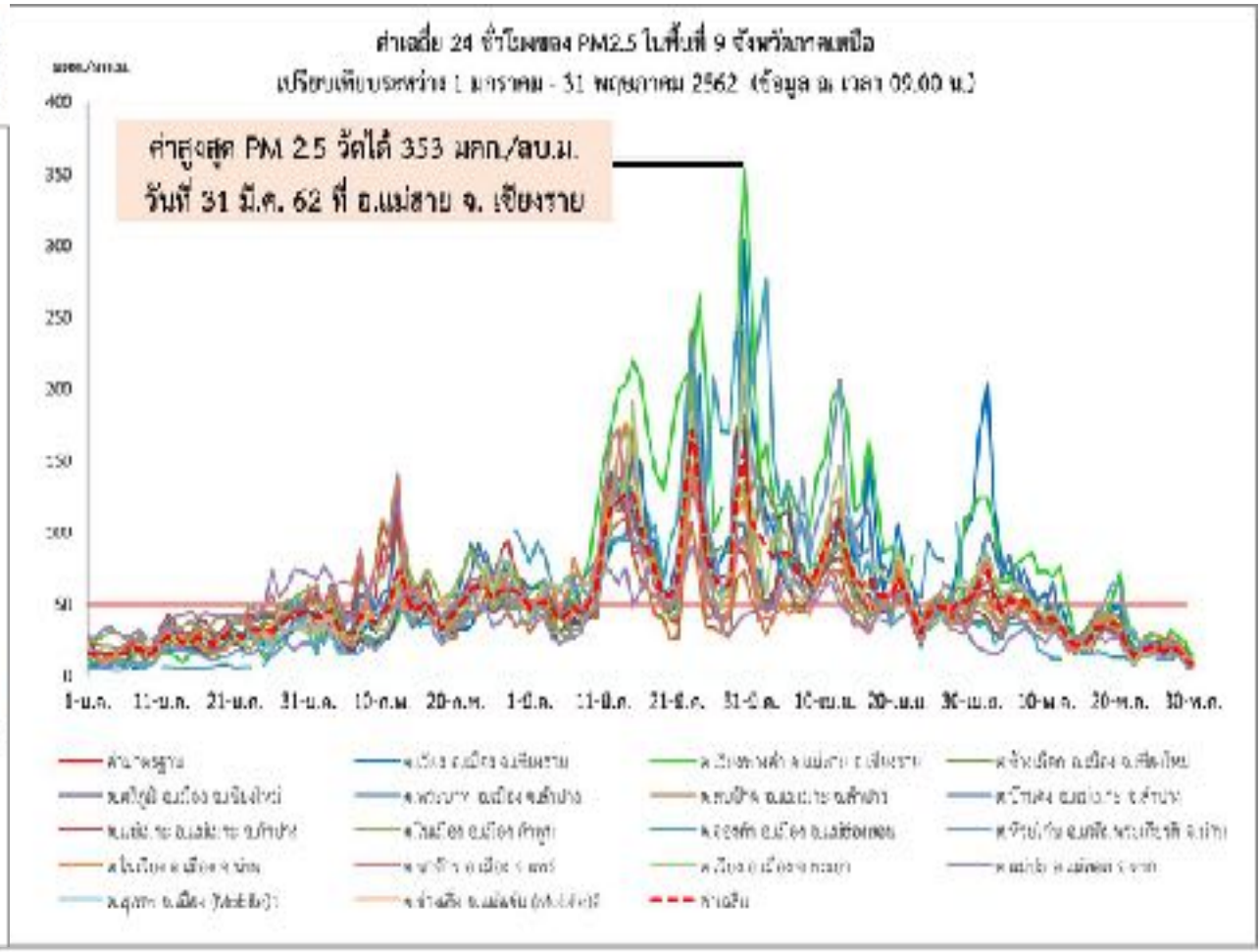
Northern Thailand and Upper ASEAN 2019 Smoke and Haze (Fire Emissions)

Northern Thailand 2019 Case Study

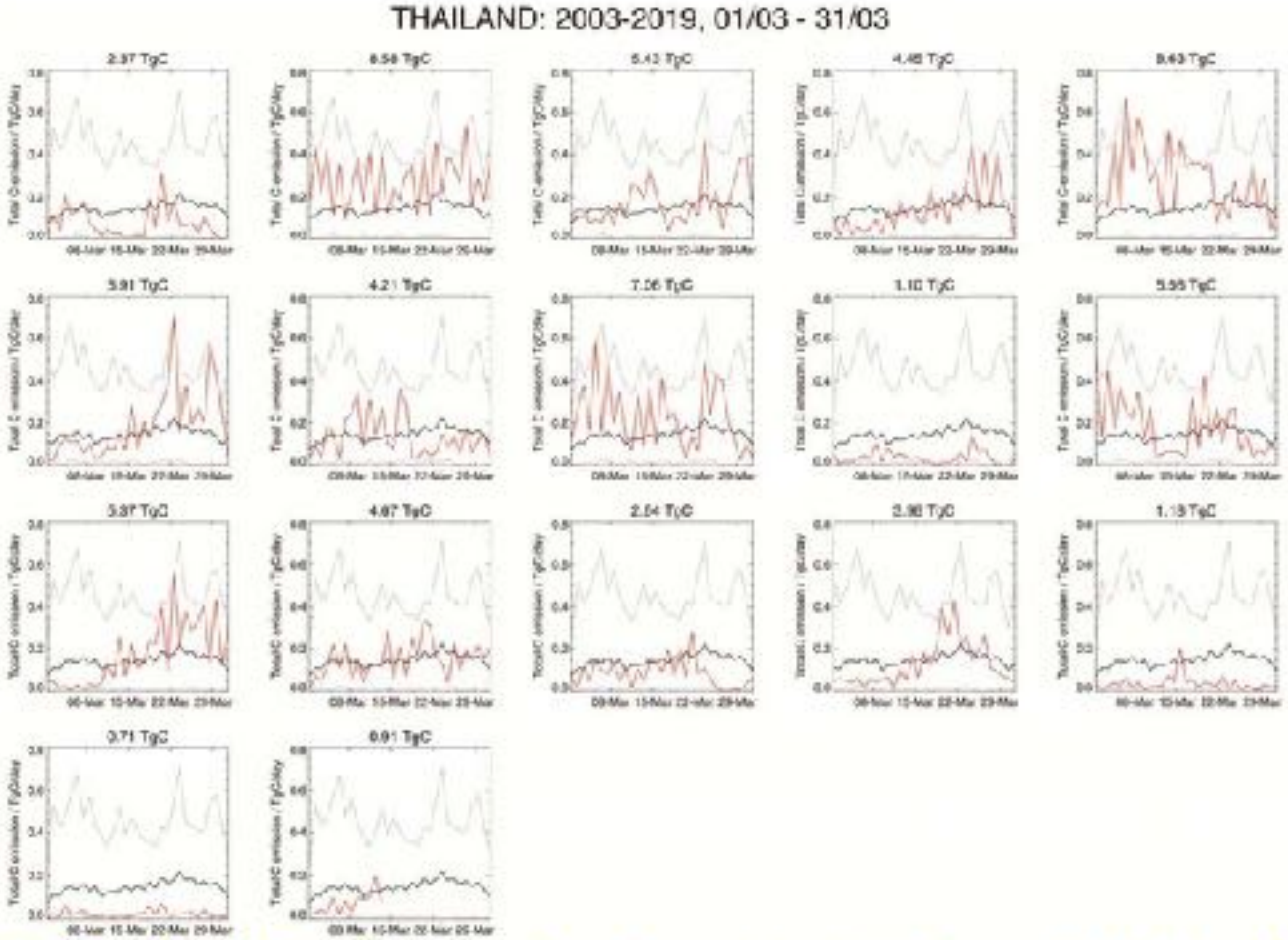
Source: Tiramonkong, June 2019

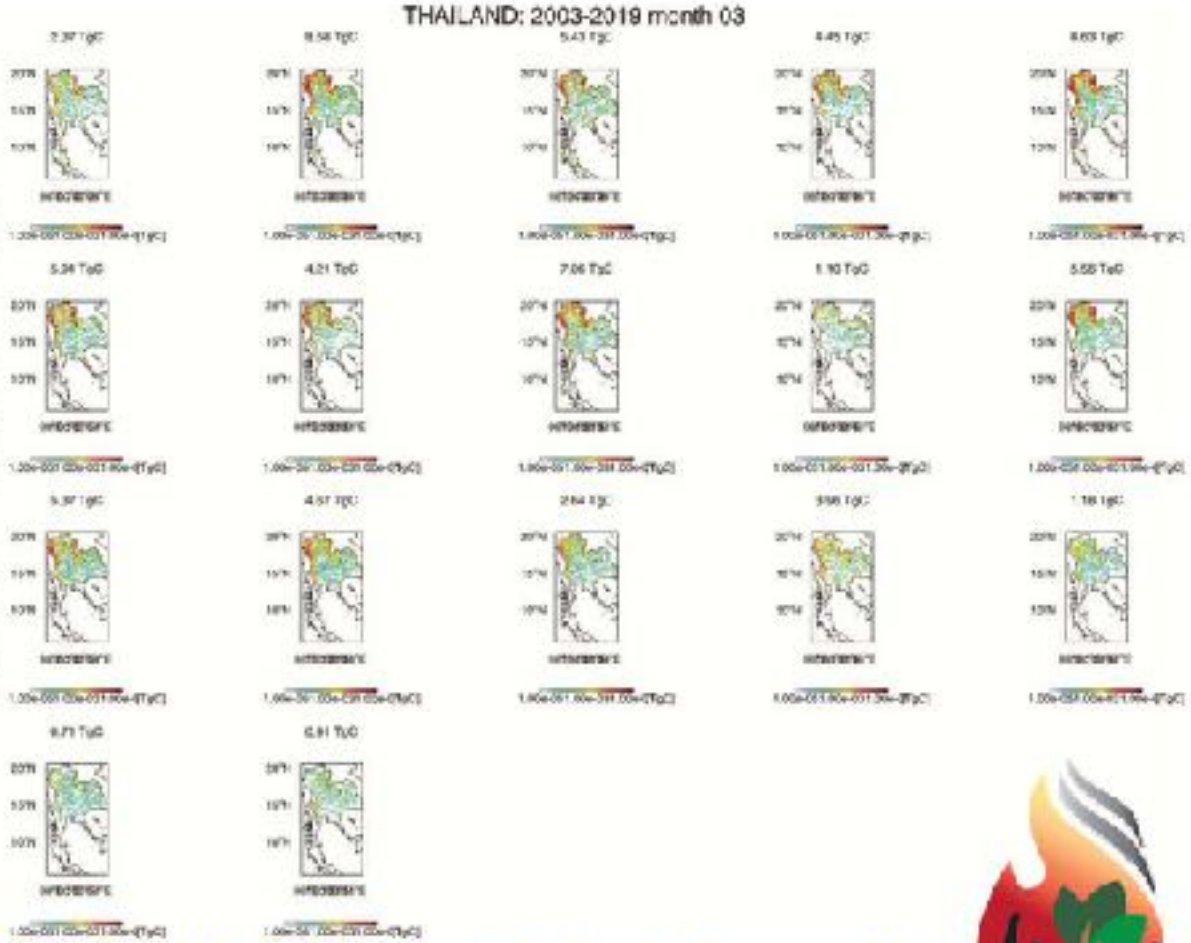
Northern Thailand 2019 Case Study





Source: Tiramonkong, June 2019





By Dr. Mark Parrington, (mark.parrington@ecmwf.int) and Dr. Claudia Vitolo (claudia.vitolo@ecmwf.int),

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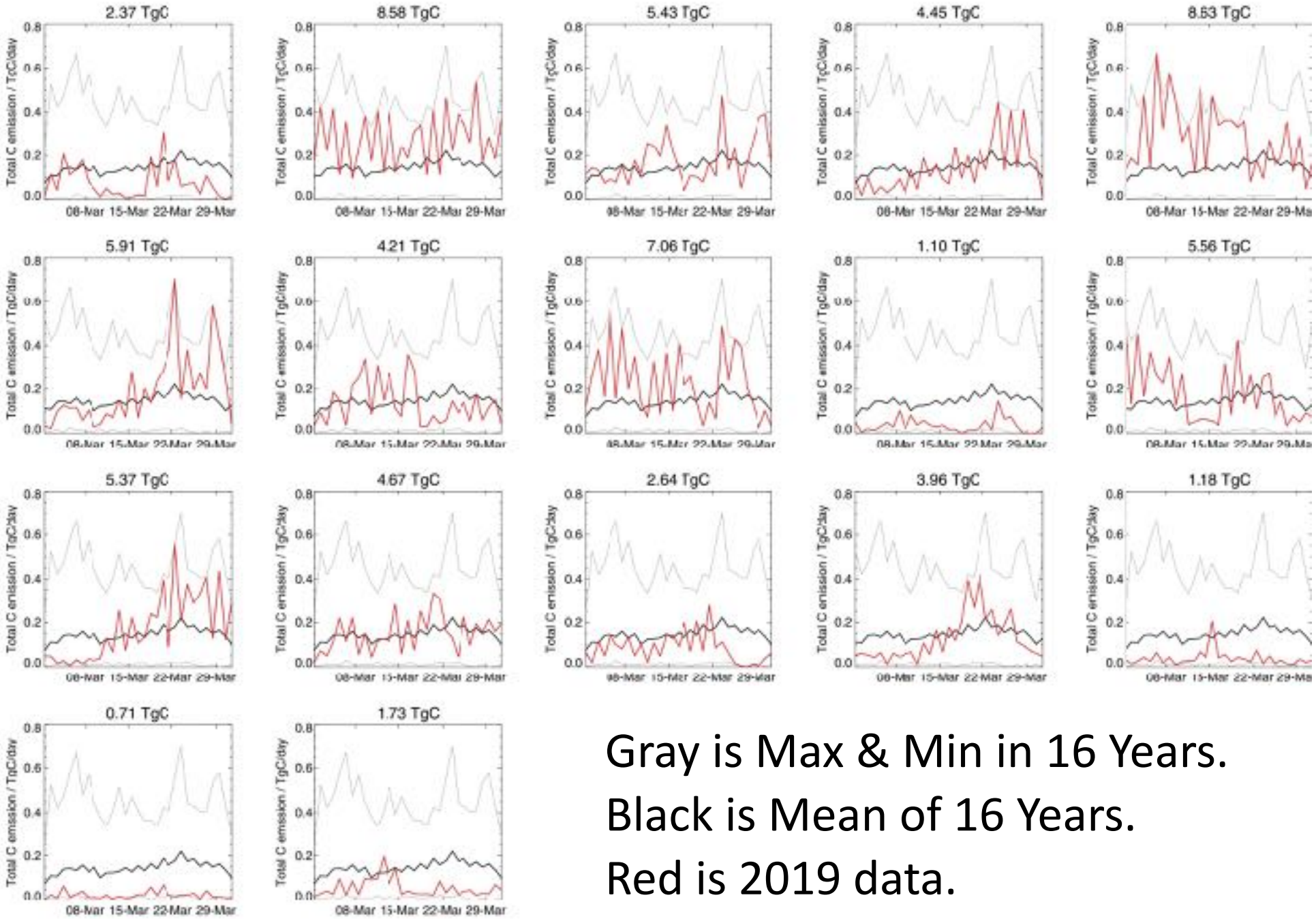
http://atmosphere.copernicus.eu/about-cams

Coorperated ince 2015 fire season! More details at https://atmosphere.copernicus.eu/impact-wildfires-asia.

THAILAND: 2003-2019, 01/03 - 31/03



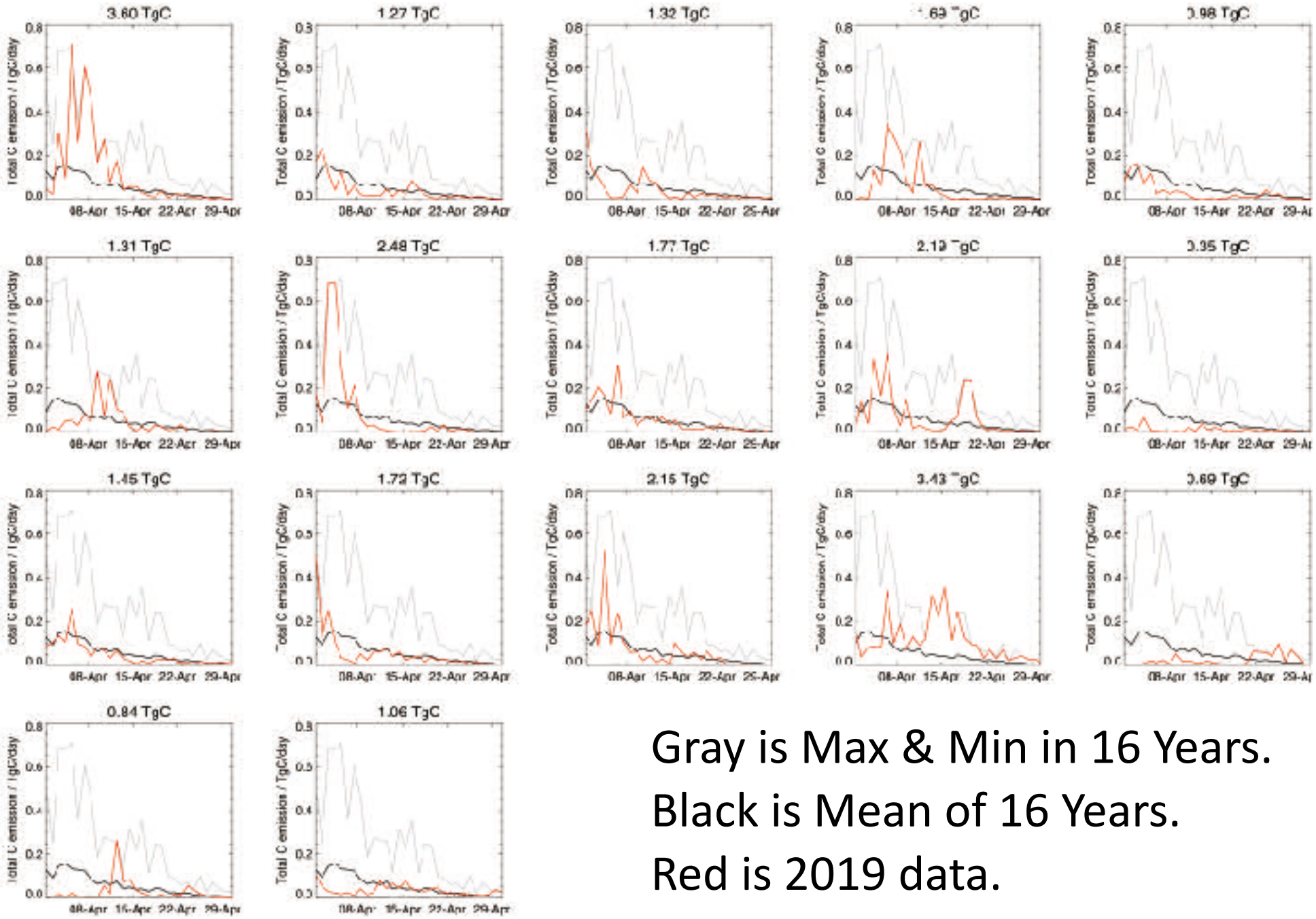
Gray is Max & Min in 16 Years.

Black is Mean of 16 Years.

Red is 2019 data.

Carbon Emission by Mark Parrington on CAMS-ECMWF

THAILAND: 2003-2019, 01/04 - 30/04



Gray is Max & Min in 16 Years.

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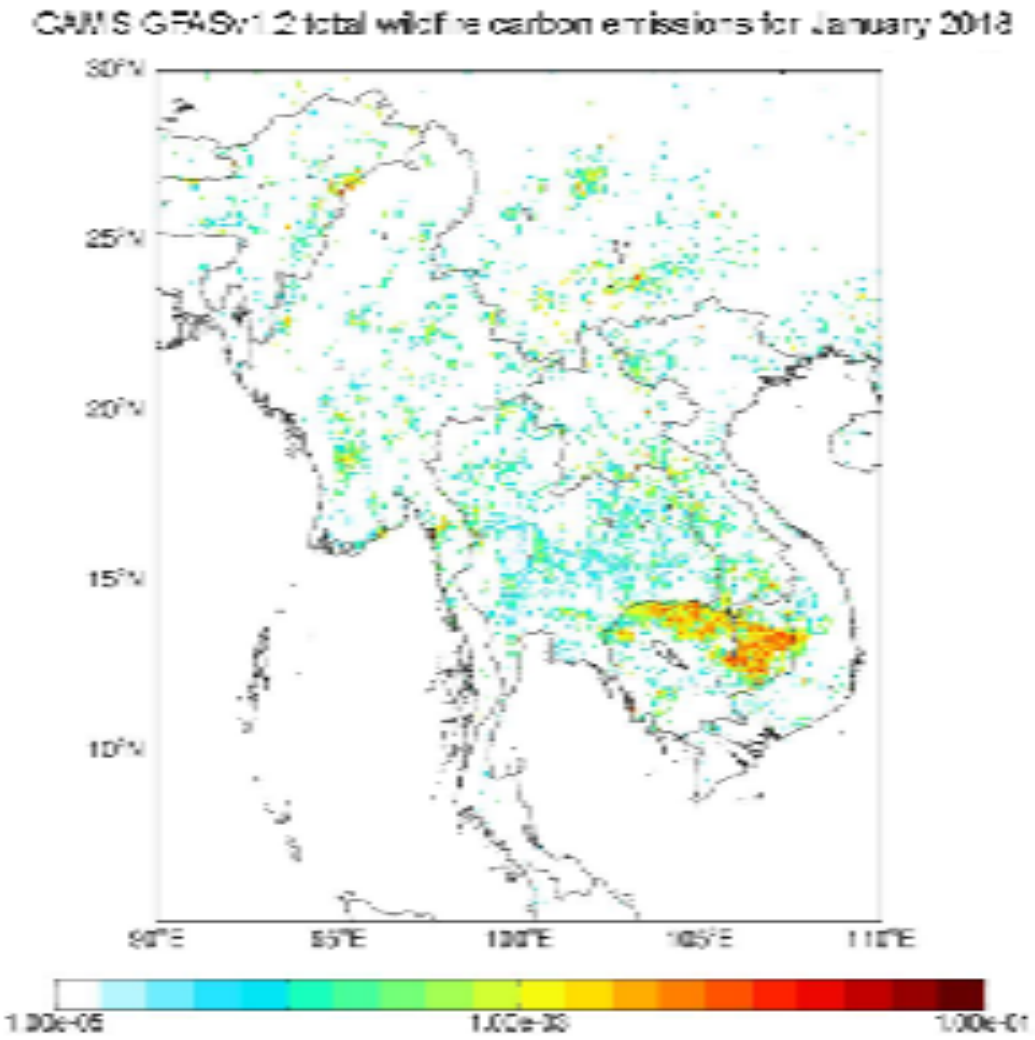
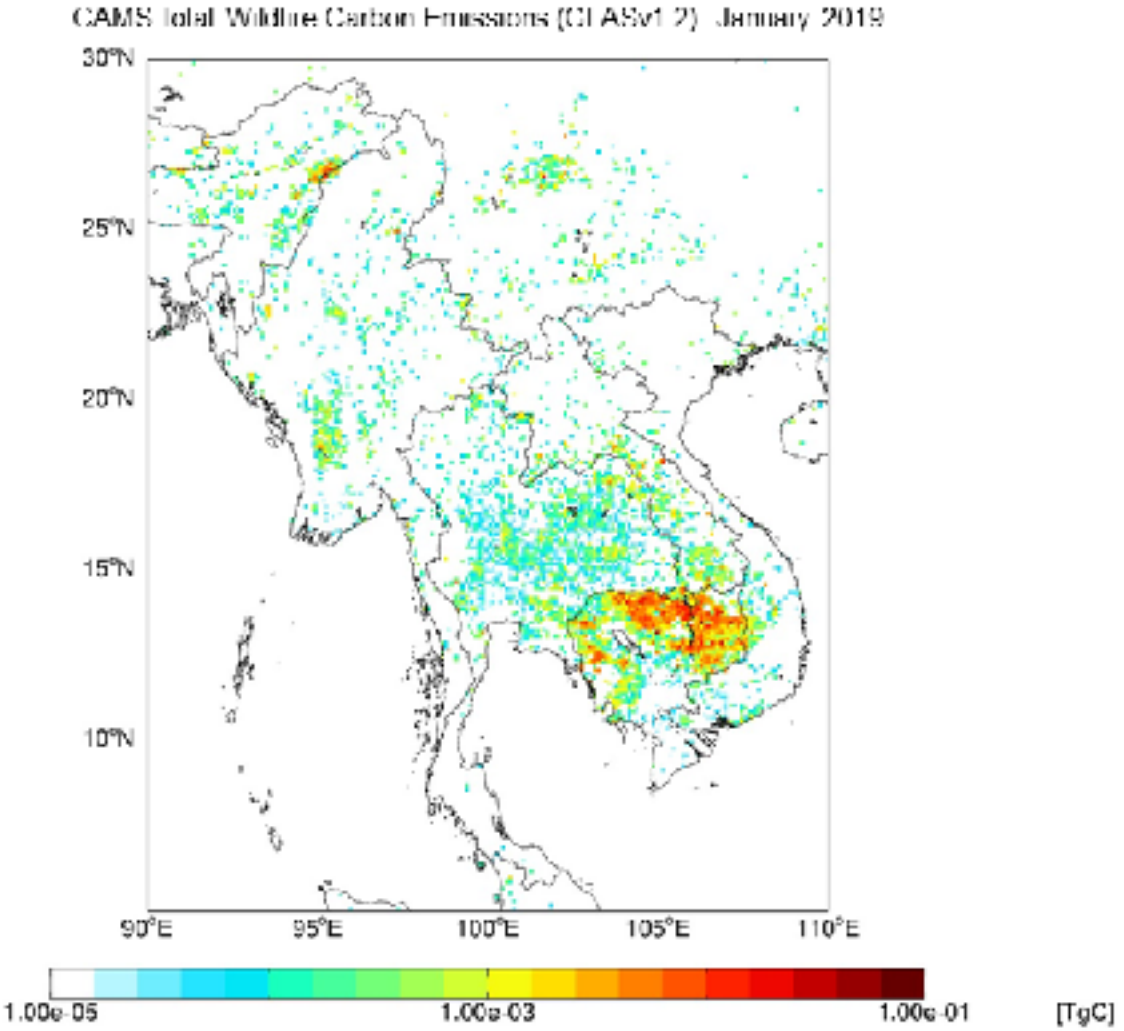
Carbon Emission by Mark Parrington on CAMS-ECMWF

Carbon Emission by Mark Parrington CAMS-ECMWF

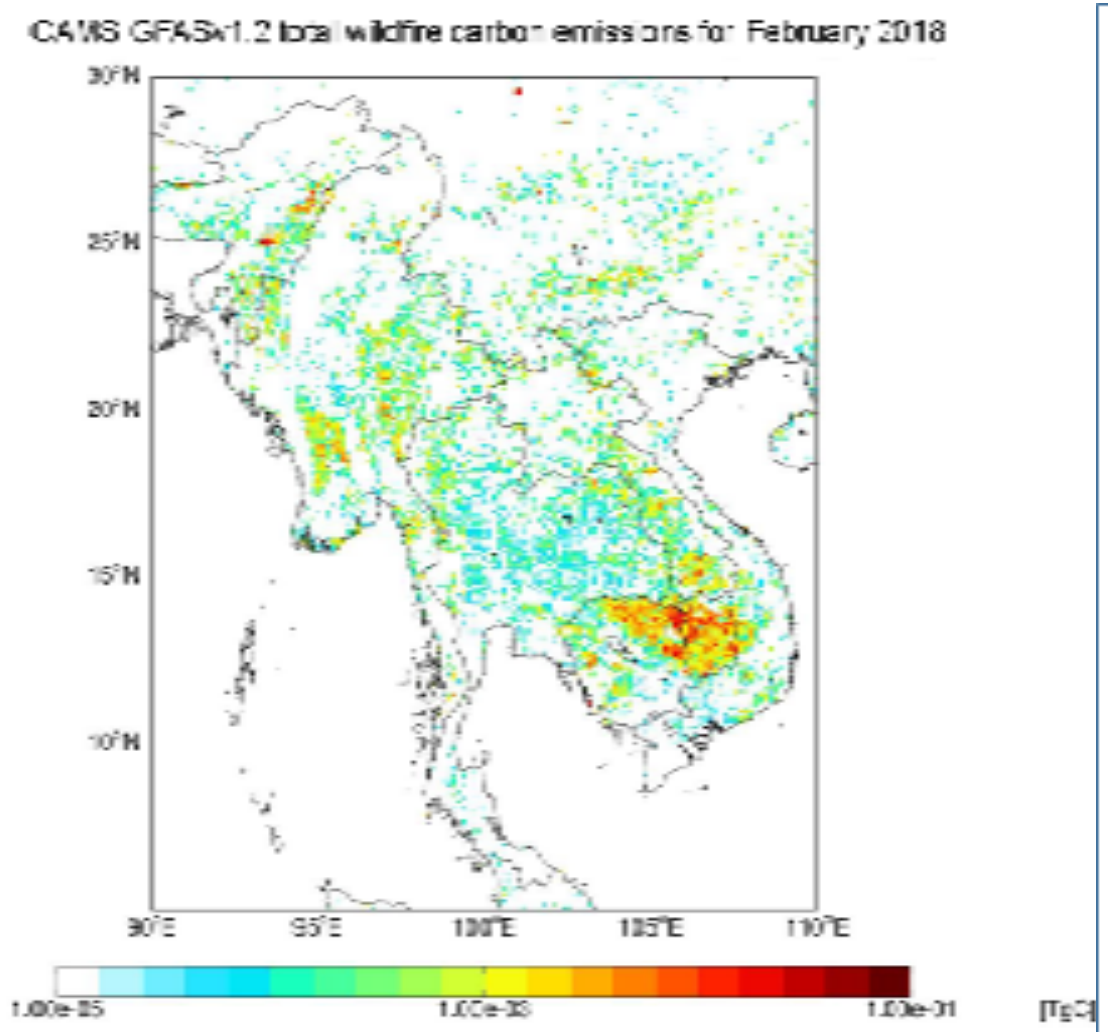
January's Carbon Emissions from Wildland Fires 2018 VS 2019

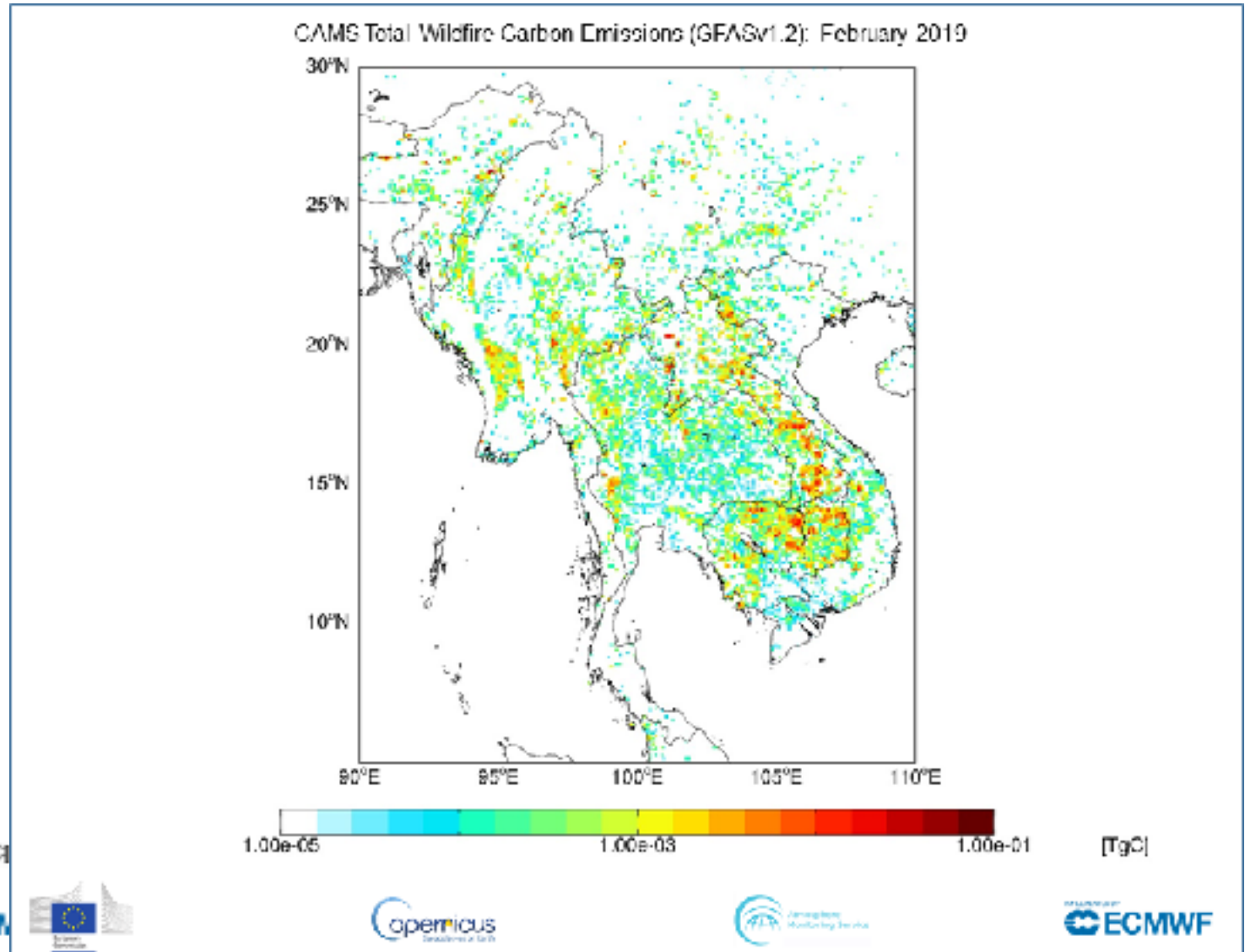




Carbon Emission by Mark Parrington CAMS-ECMWF

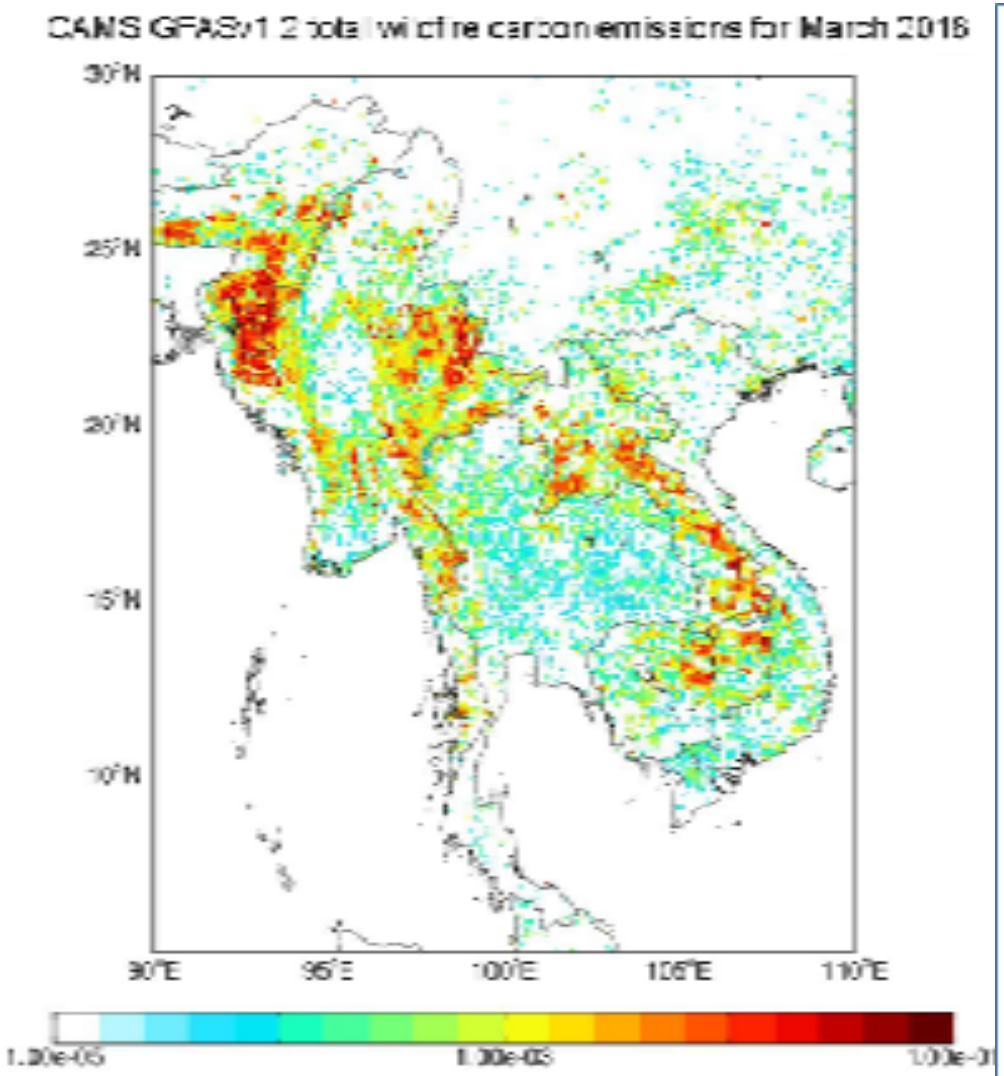
February's Carbon Emissions from Wildland Fires 2018 VS 2019

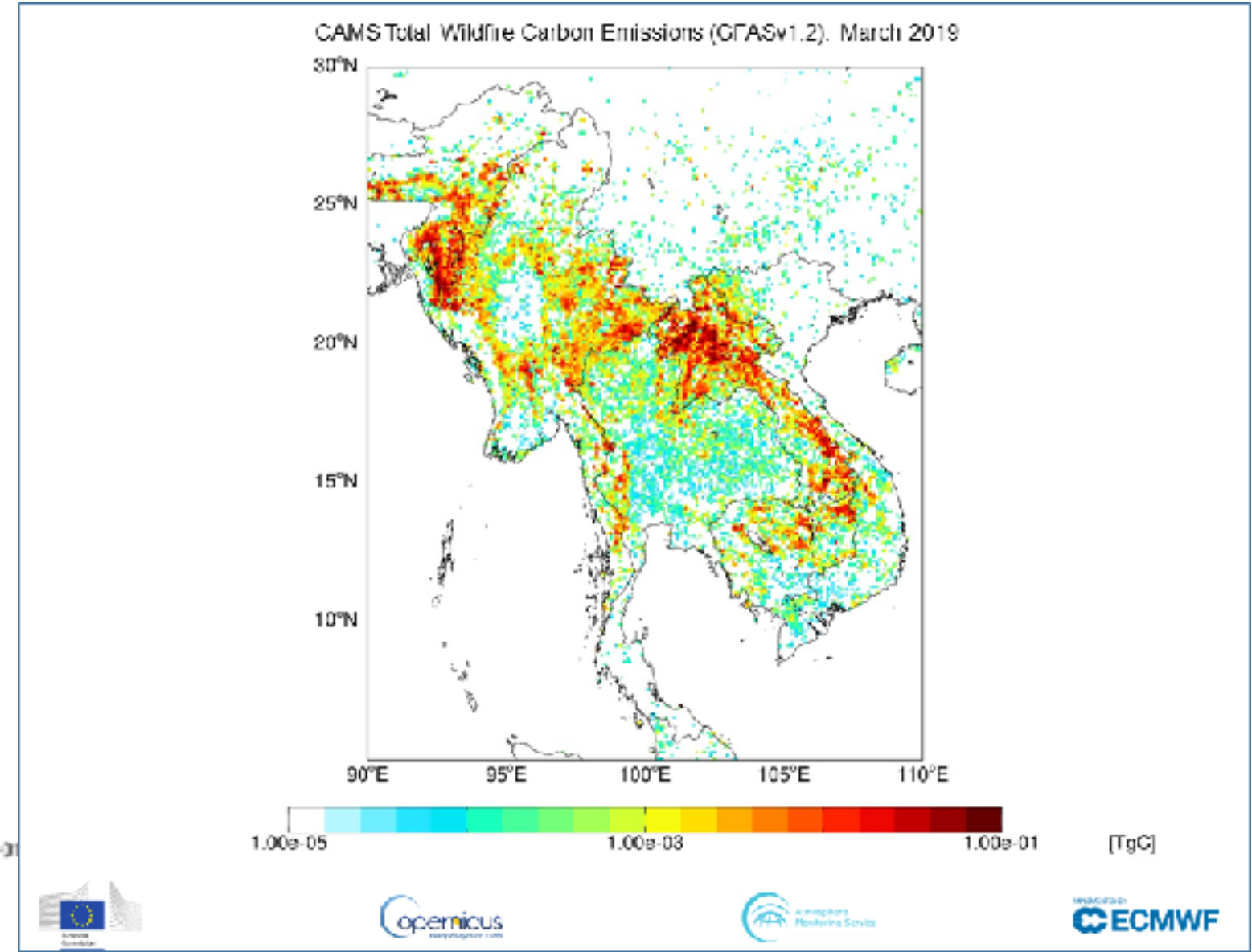




Carbon Emission by Mark Parrington CAMS-ECMWF

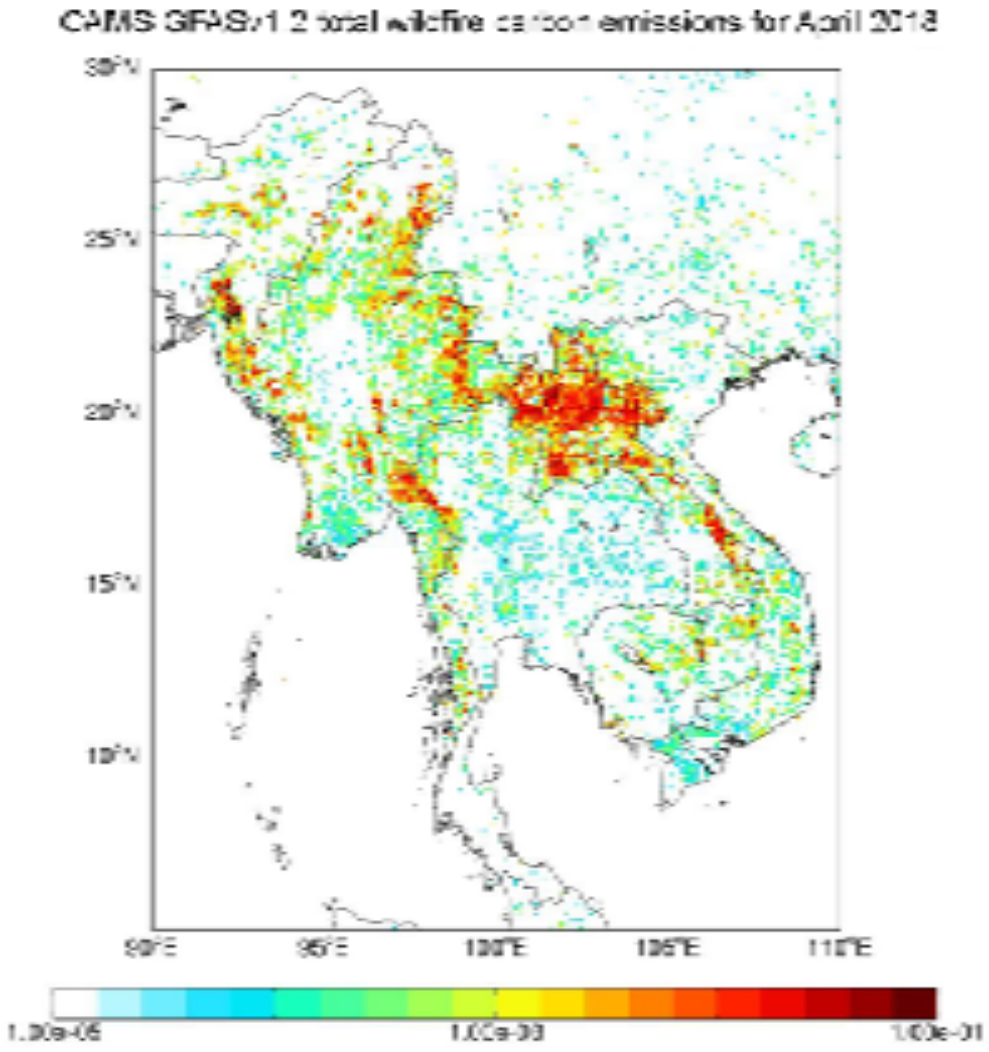
March's Carbon Emissions from Wildland Fires 2018 VS 2019

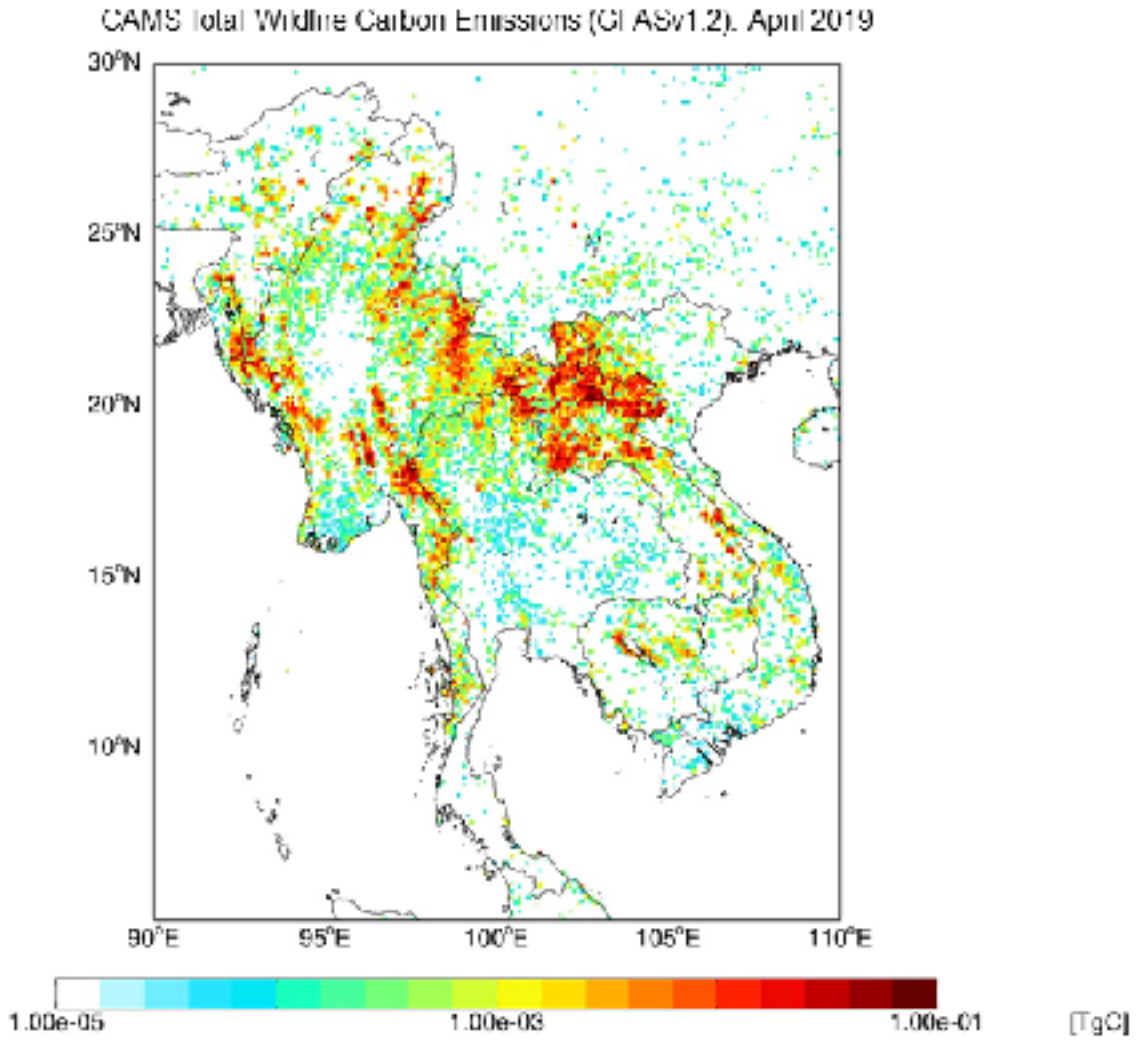




Carbon Emission by Mark Parrington CAMS-ECMWF

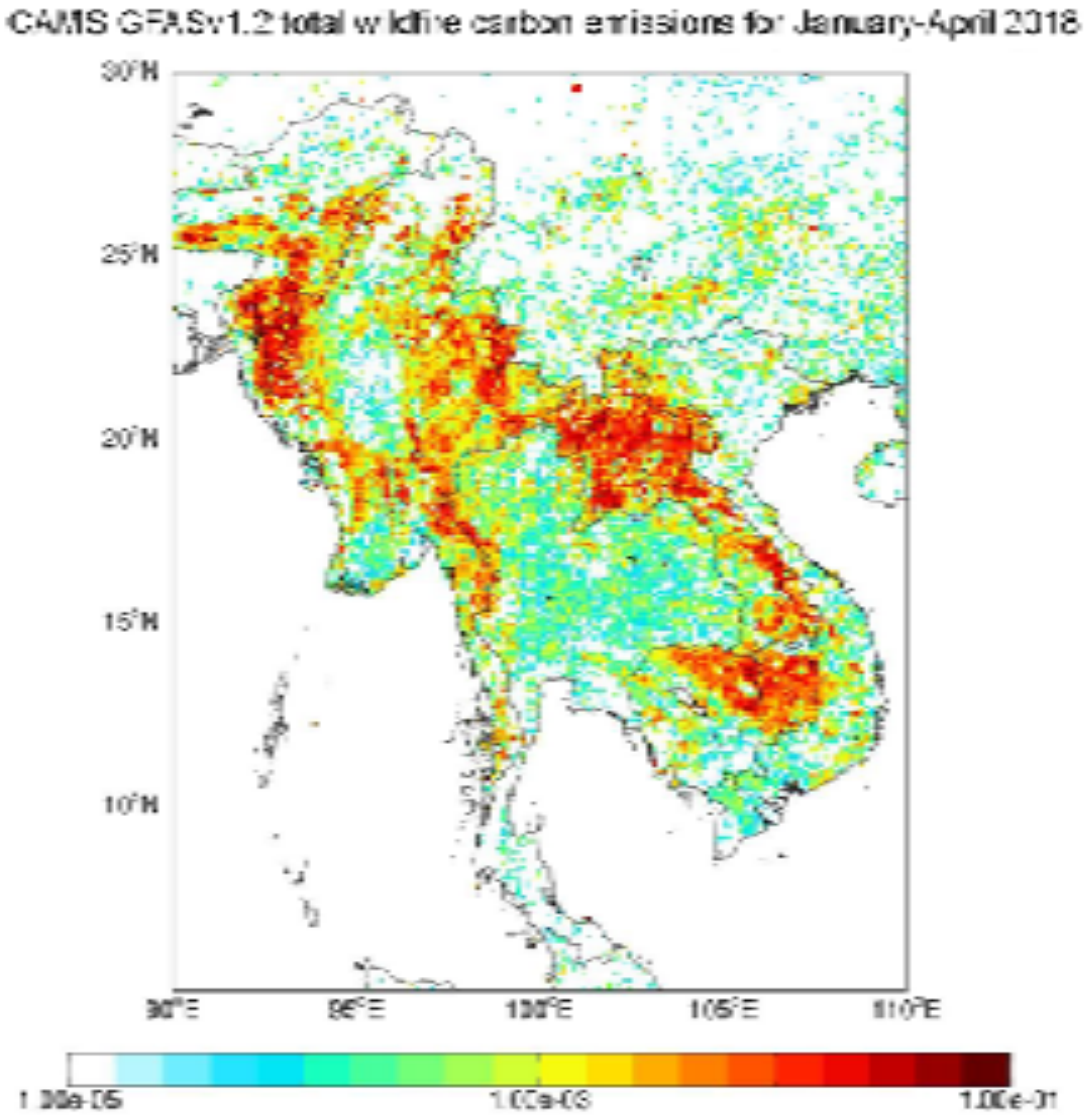
April's Carbon Emissions from Wildland Fires 2018 VS 2019

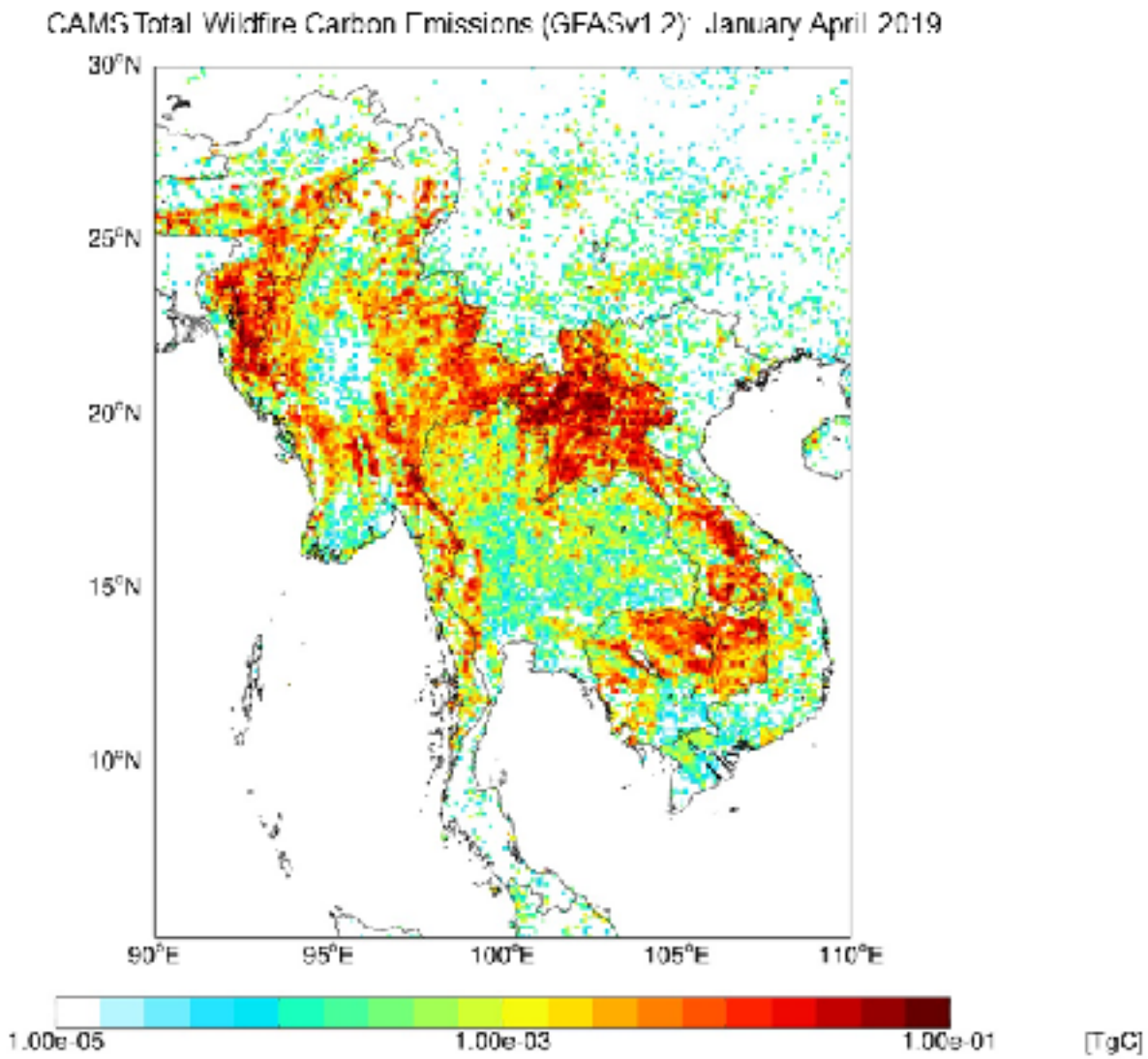


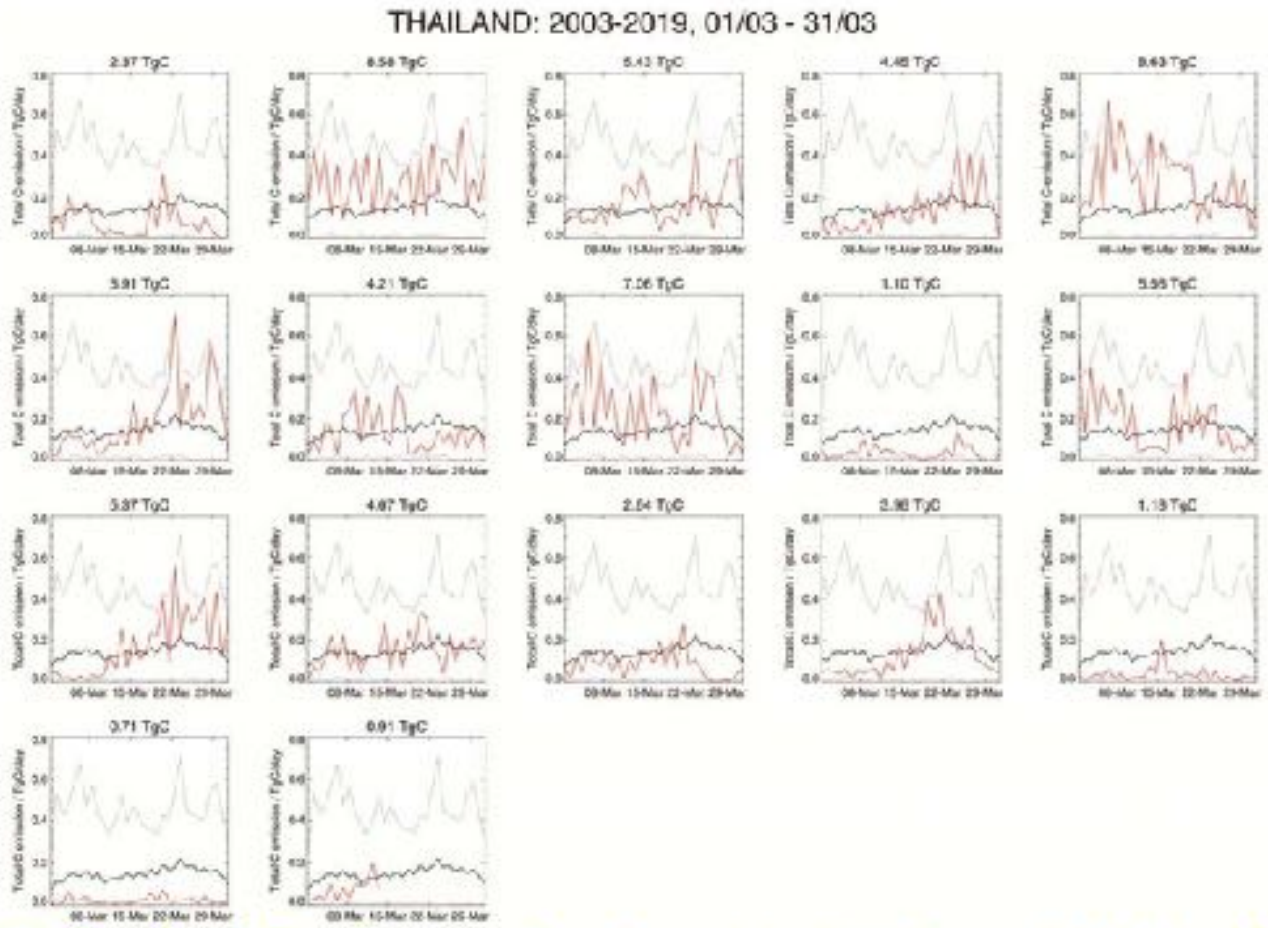


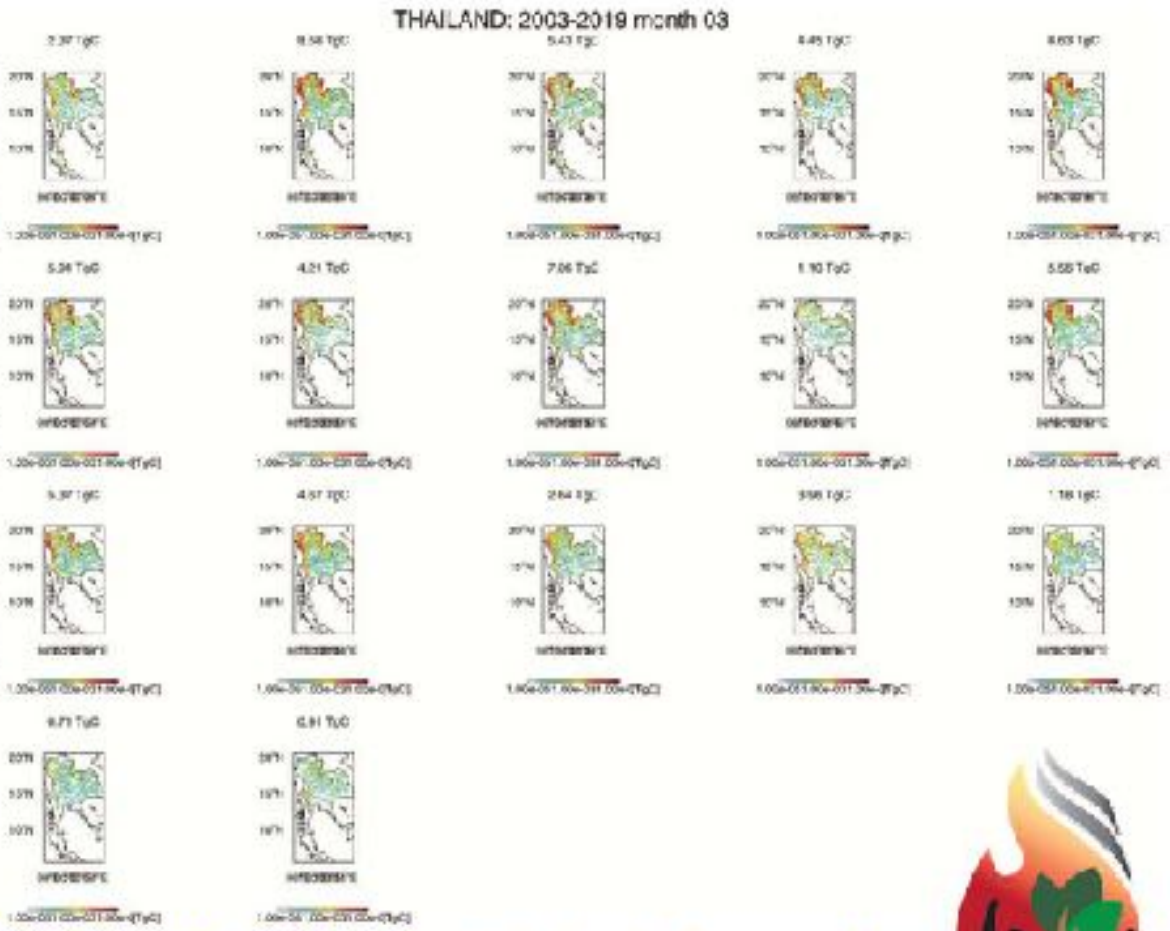
Carbon Emission by Mark Parrington CAMS-ECMWF

Jan-April's Carbon Emissions from Wildland Fires 2018 VS 2019









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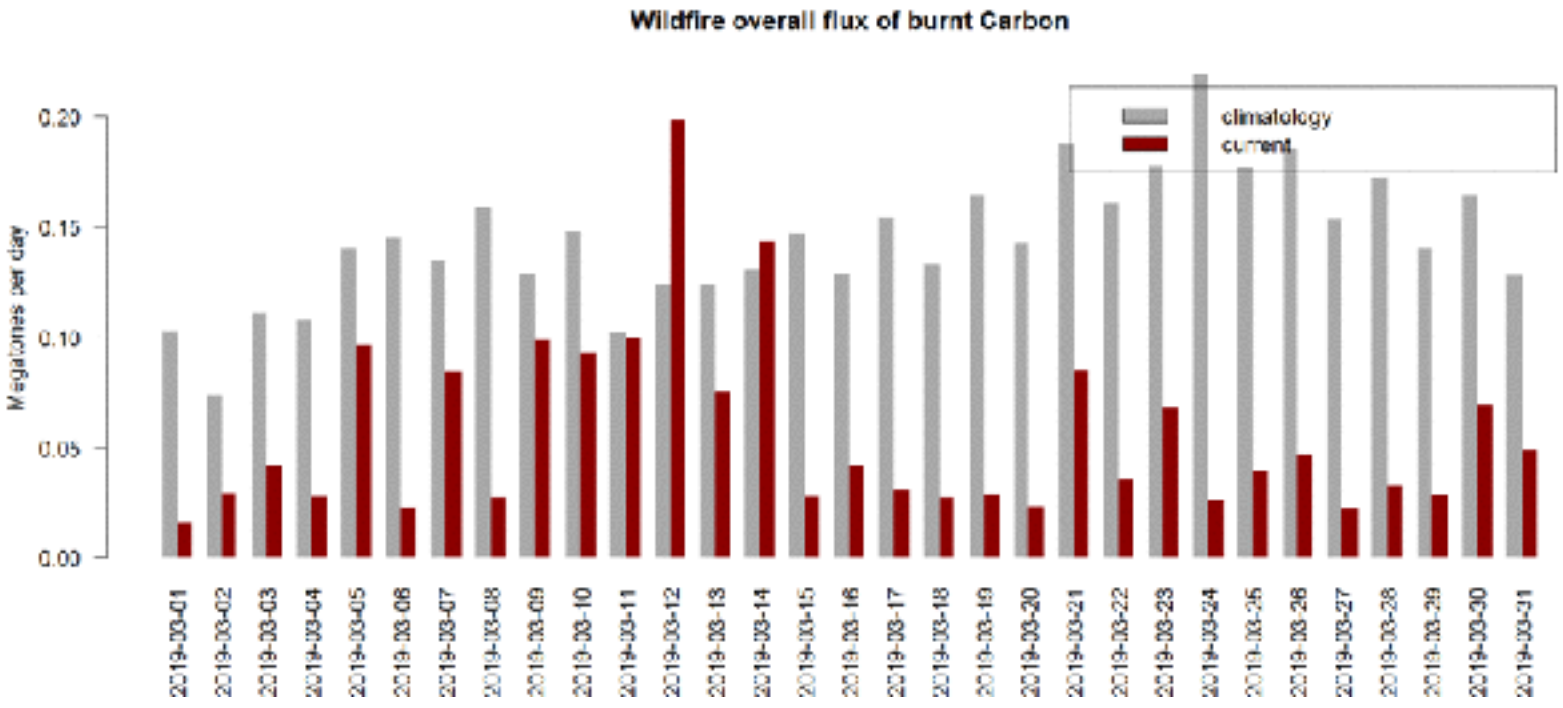
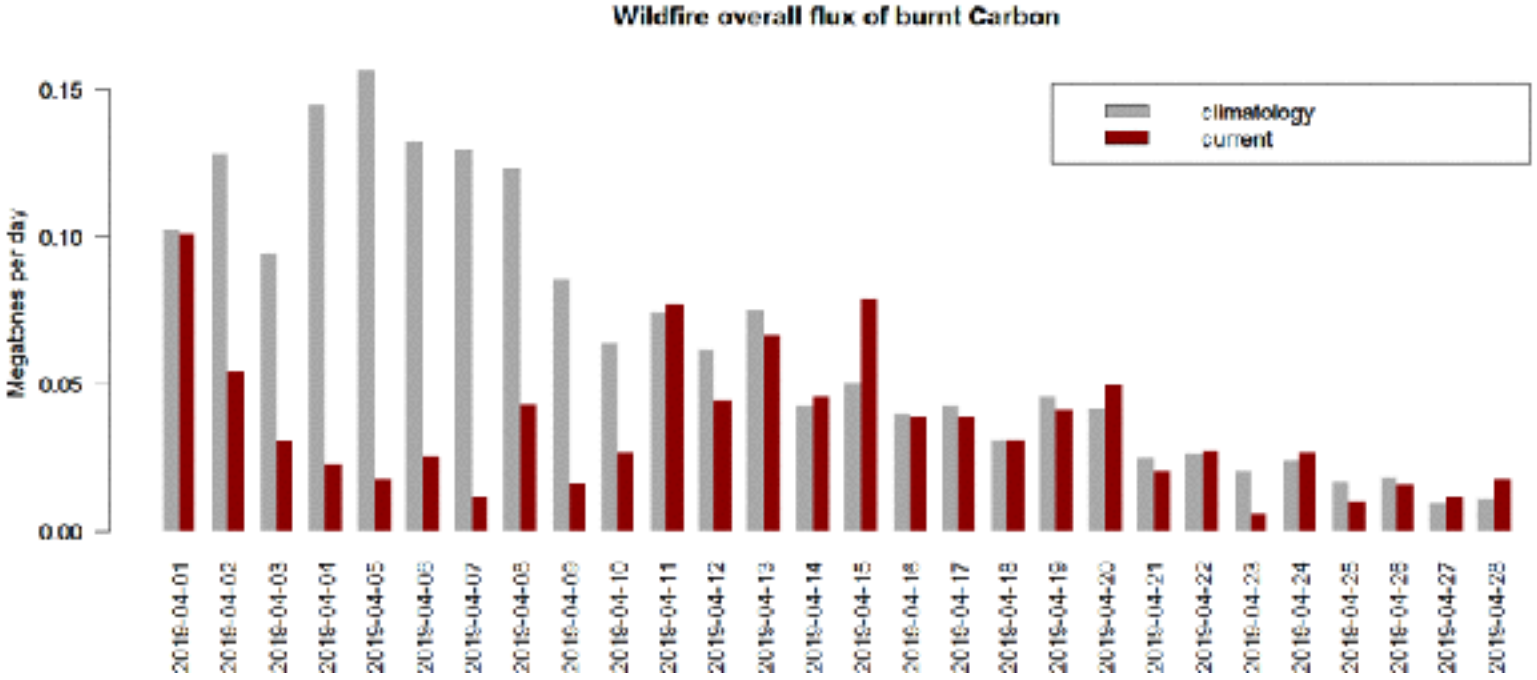
Coorperated ince 2015 fire season! More details at https://atmosphere.copernicus.eu/impact-wildfires-asia.

Current R-Code provided by Claudia (CAMS) can run country by country with month by month Carbon Emission data from CAMS-GFAS. You can get daily data from here: https://confluence.ecmwf.int/plugins/servlet/mobile?contentId=88247734#content/view/88247734





- Thailand during Jan-Apr 2019, carbon emission from active fires was not above 16 years (2003-2018) average, but the second half of Apr values were right at the average.
- Cambodia burned the most and more in Jan 2019 than 2018.
- Feb shifted to Lao PDR
- Mar, Lao PDR still burned more throughout the country.
- Apr shifted to Myanmar
- The whole Upper ASEAN, there were more carbon emission in 2019 than 2018.

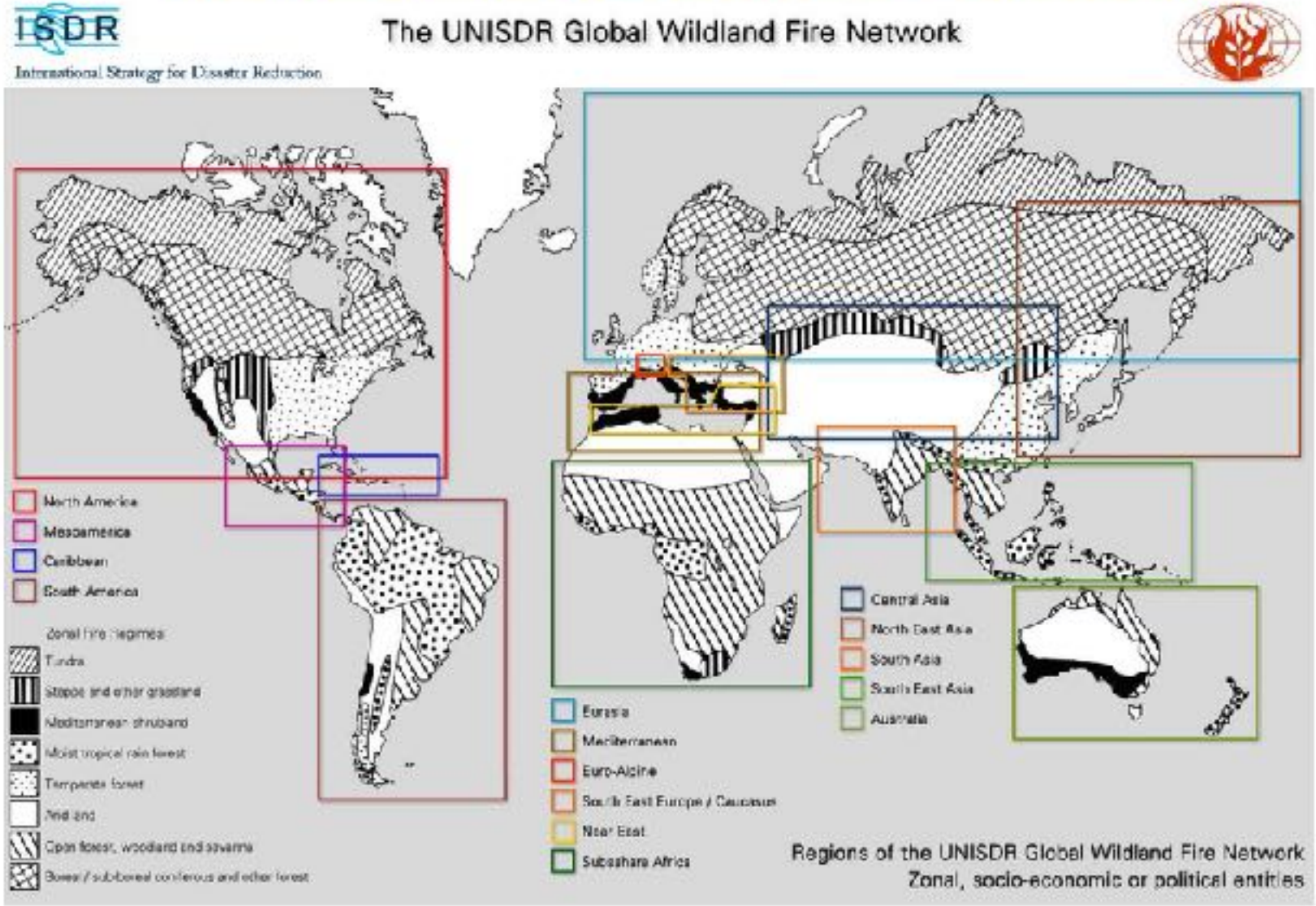
Source: https://atmosphere.copernicus.eu/impact-wildfires-asia

Establishment of Upper ASEAN Wildland Fire Research Center at Faculty of Forestry, Kasetsart University in 2017

1. **Fundamental fire research**: Fire Ecology, Fire Behavior, Fire Weather, Fire Emissions, Smoke and Haze behaviors
2. **Advanced tools for fire early warning, monitoring and impact assessment**: Fire Early Warning and Detection System
3. **The human dimension of vegetation fires**: Socio-economics of fire, Impact of fires on human health, security and private & public assets, and Community involvement and empowerment in fire management
4. **Fire management**: Fire investigation and fire statistical databases, Fire management information systems and planning and Training
5. **Fire management policies**
6. **Cross-boundary cooperation in fire management**

WFSRU is a part of Global Wildland Fire Network (GWFN) through the Global Fire Monitoring Center (GFMC) under UNISDR

http://gfmc.online/globalnetworks/globalnet.html

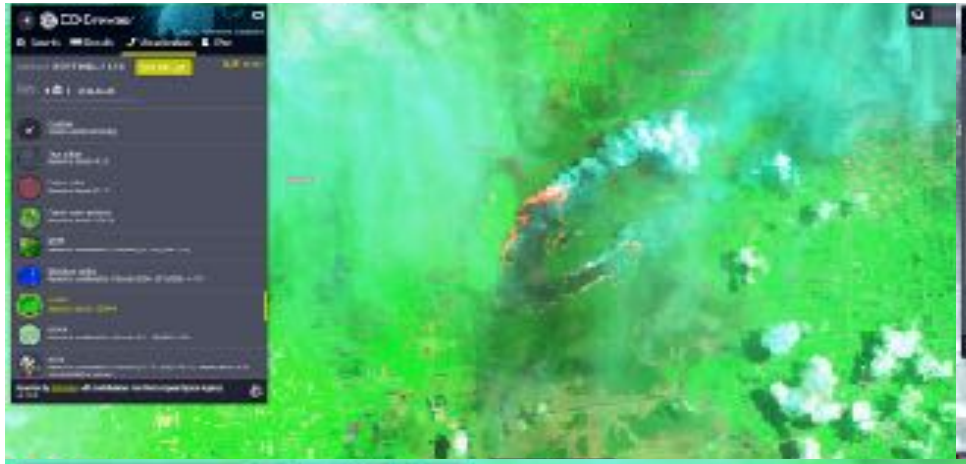


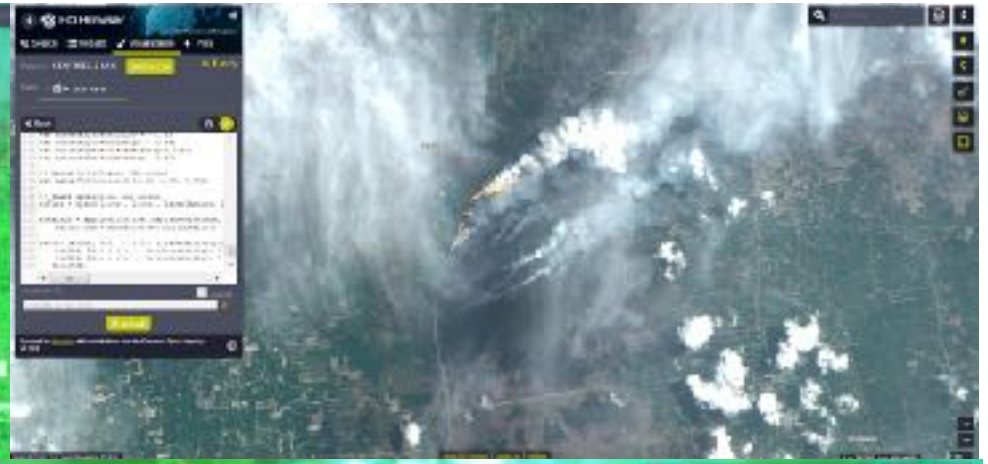
Sentinel-hub EO-Browser

https://pierre-markuse.net/2018/04/30/visualizing-wildfires-burn-scars-sentinel-hub-eo-browser/

Sentinel 2 5 August 2019

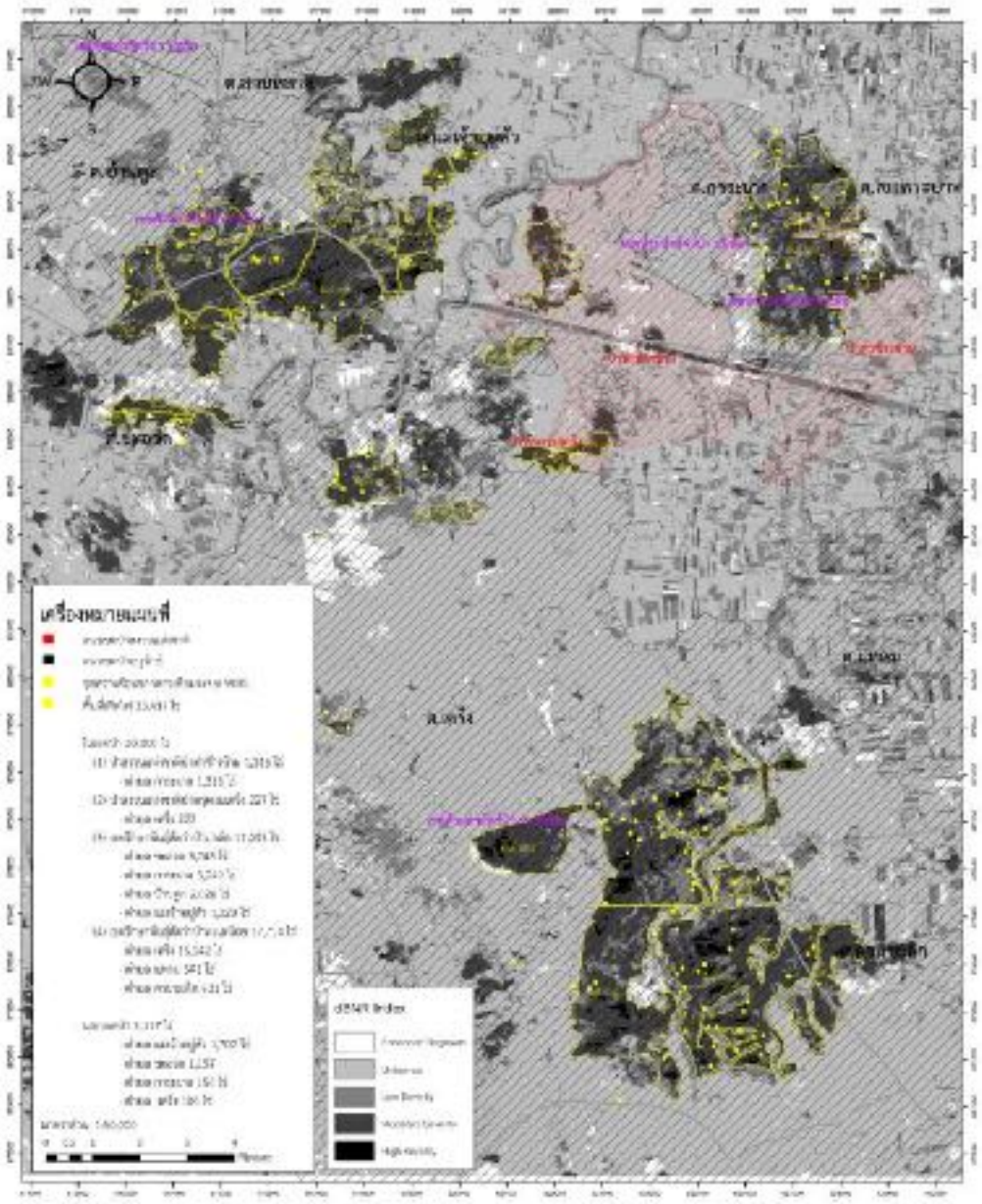
Sentinel-hub EO-Browser





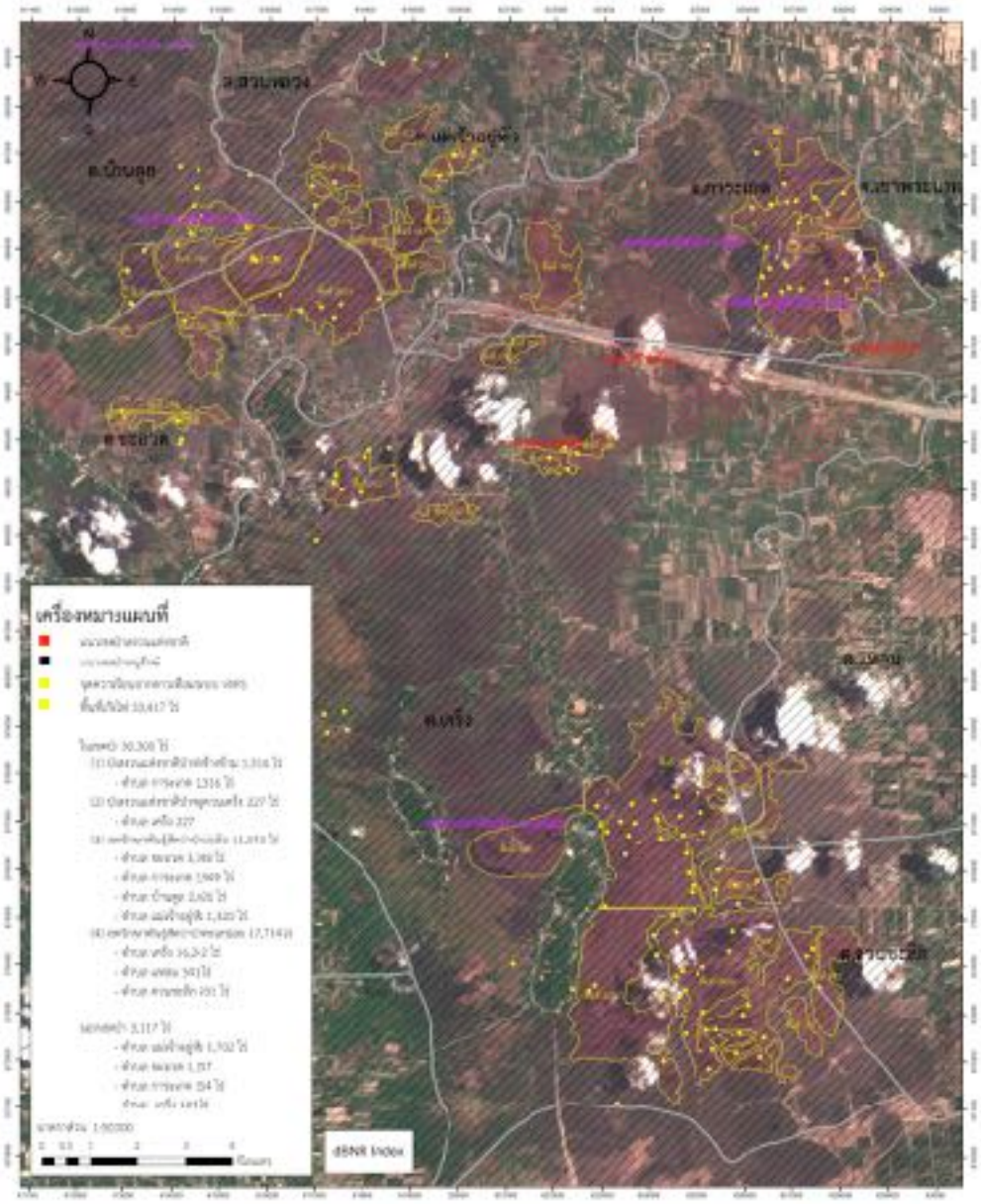
https://apps.sentinel-hub.com/eo-browser/?lat=8.00331&lng=100.12407&zoom=13&time=2019-07-31&preset=6-SWIR&datasource=Sentinel-2%20L1C

แผนที่ภาพถ่ายดาวเทียม Sentinel-2 L1C วันที่ 20 สิงหาคม 2562 (dBNR Index)
แสดงพื้นที่เกิดไฟป่าบริเวณป่าพรุควนเคร็ง จังหวัดนครศรีธรรมราช
ระหว่างวันที่ 29 กรกฎาคม - 20 สิงหาคม 2562

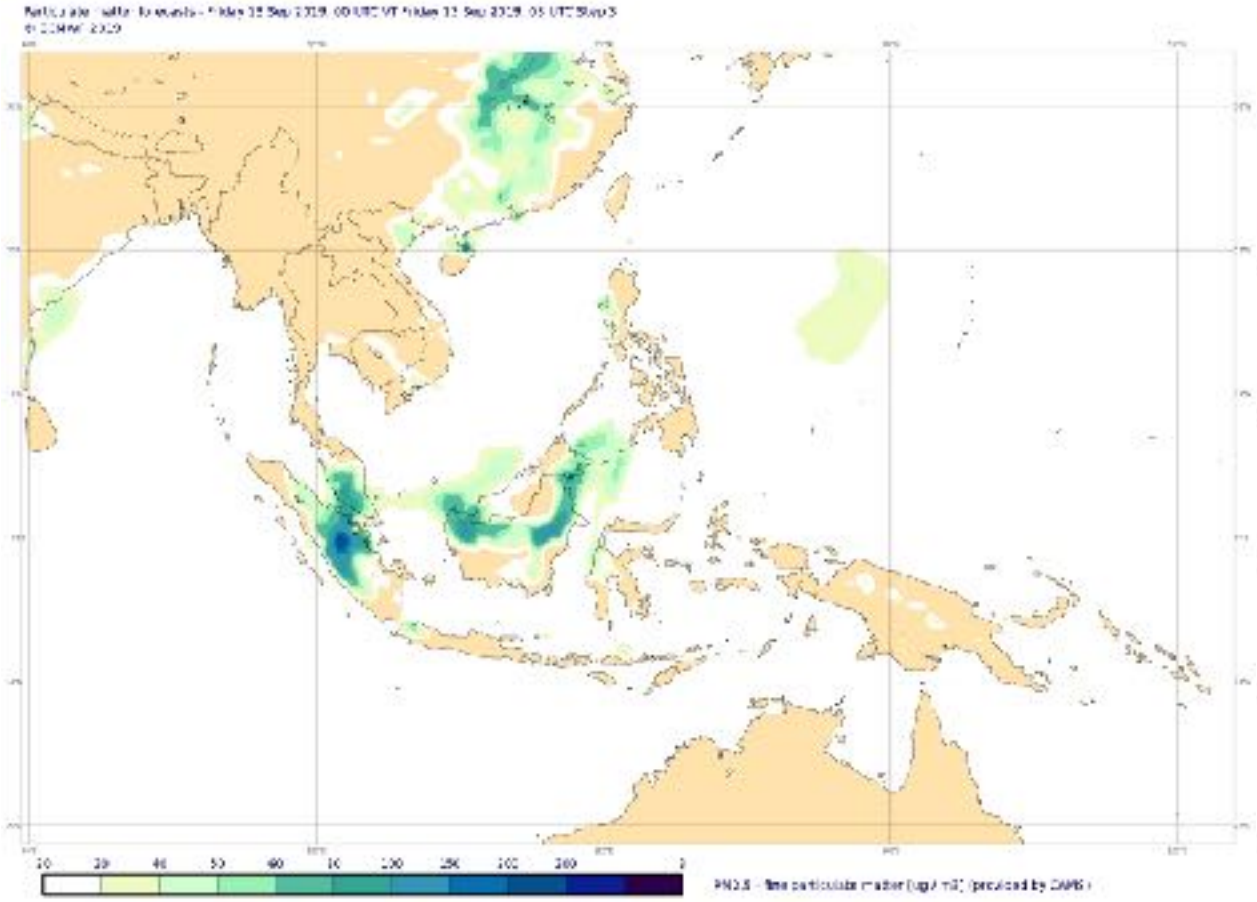


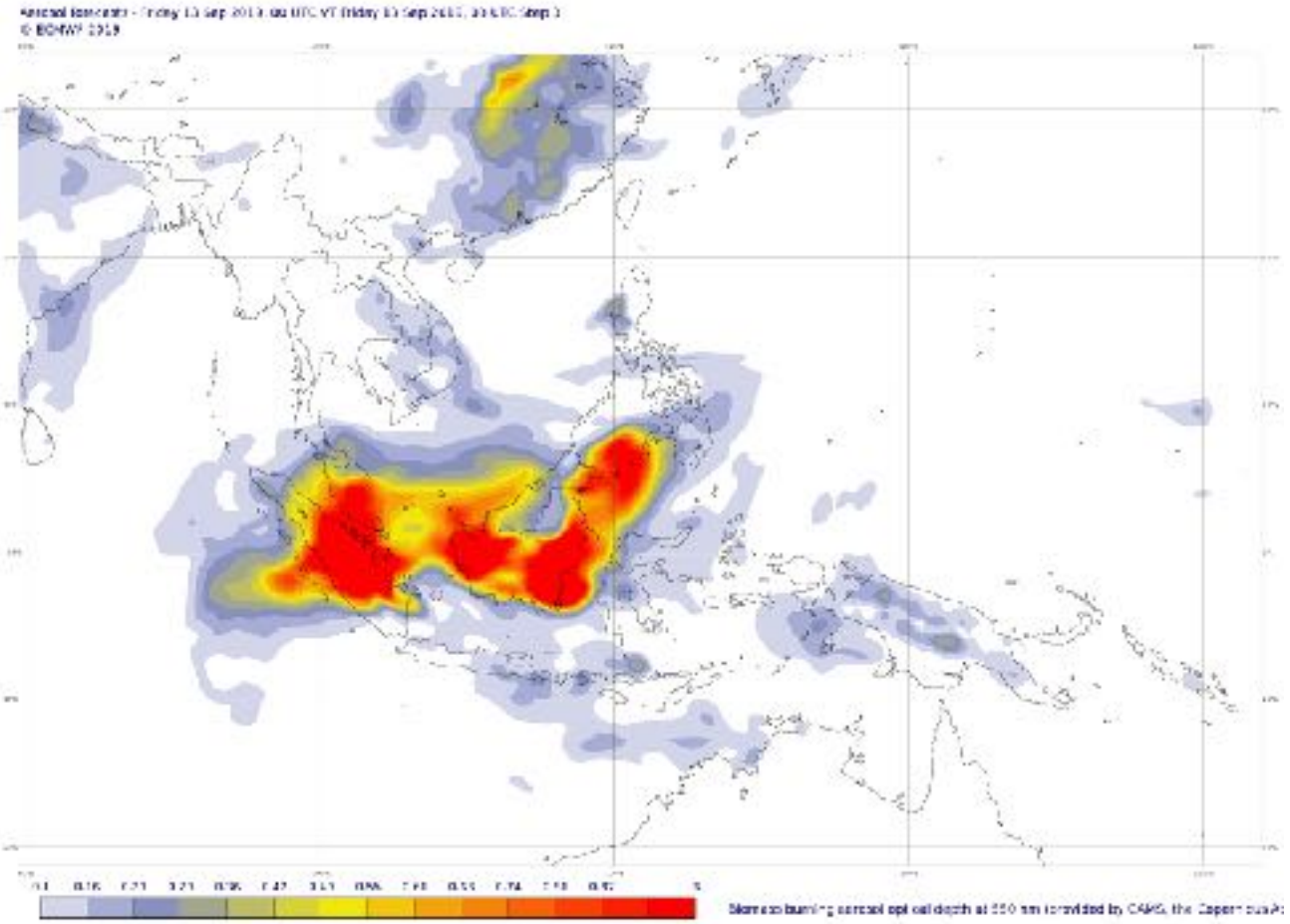
Source: RFD

แผนที่ภาพถ่ายดาวเทียม Sentinel-2 L1C วันที่ 20 สิงหาคม 2562 (True Color)
แสดงพื้นที่เกิดไฟป่าบริเวณป่าพรุควนเคร็ง จังหวัดนครศรีธรรมราช
ระหว่างวันที่ 29 กรกฎาคม - 20 สิงหาคม 2562

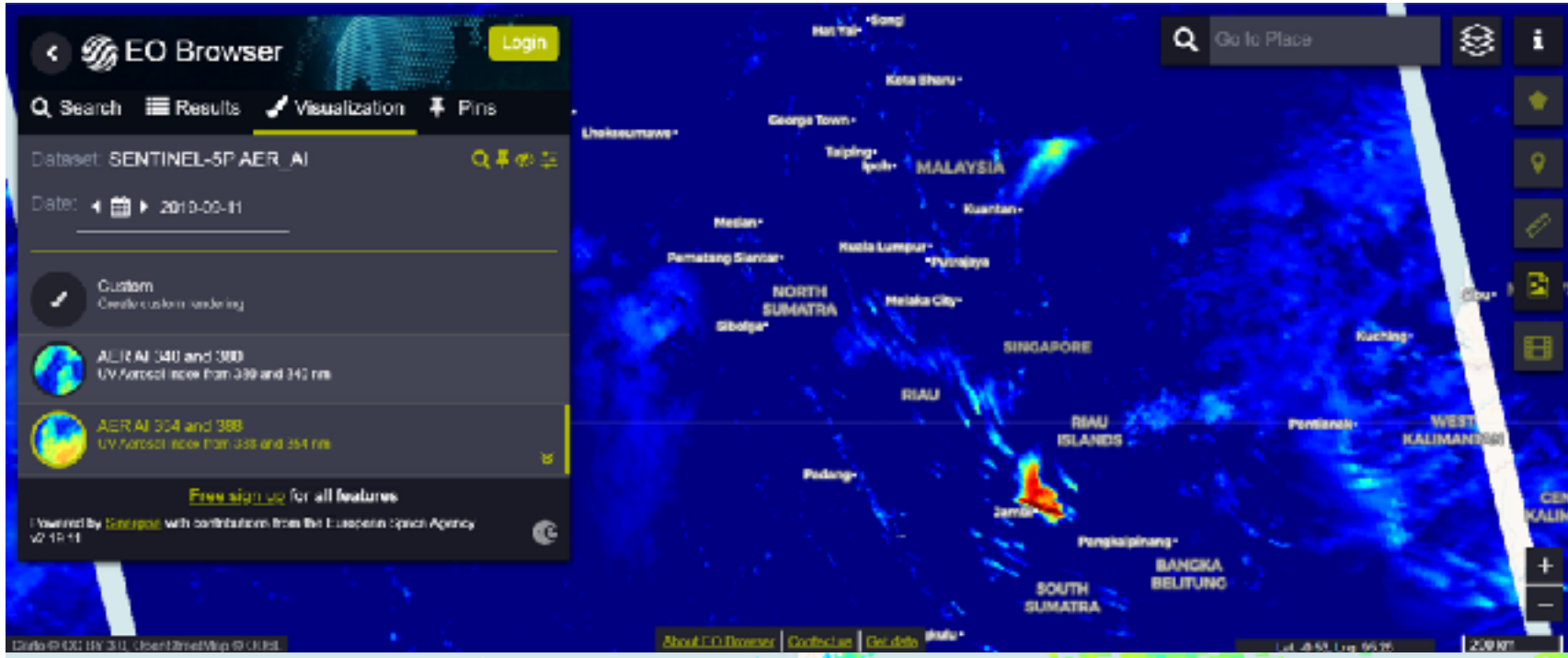


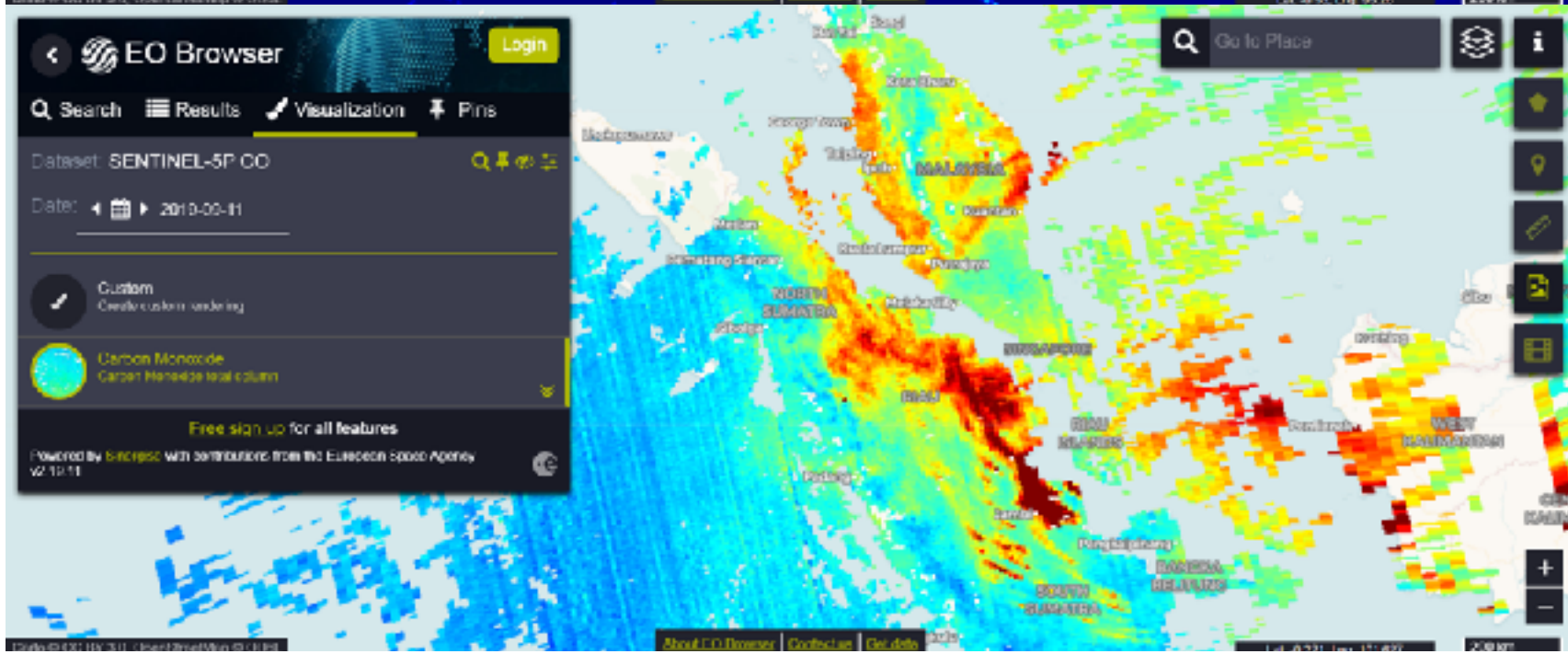
Lower ASEAN 2019 Smoke and Haze



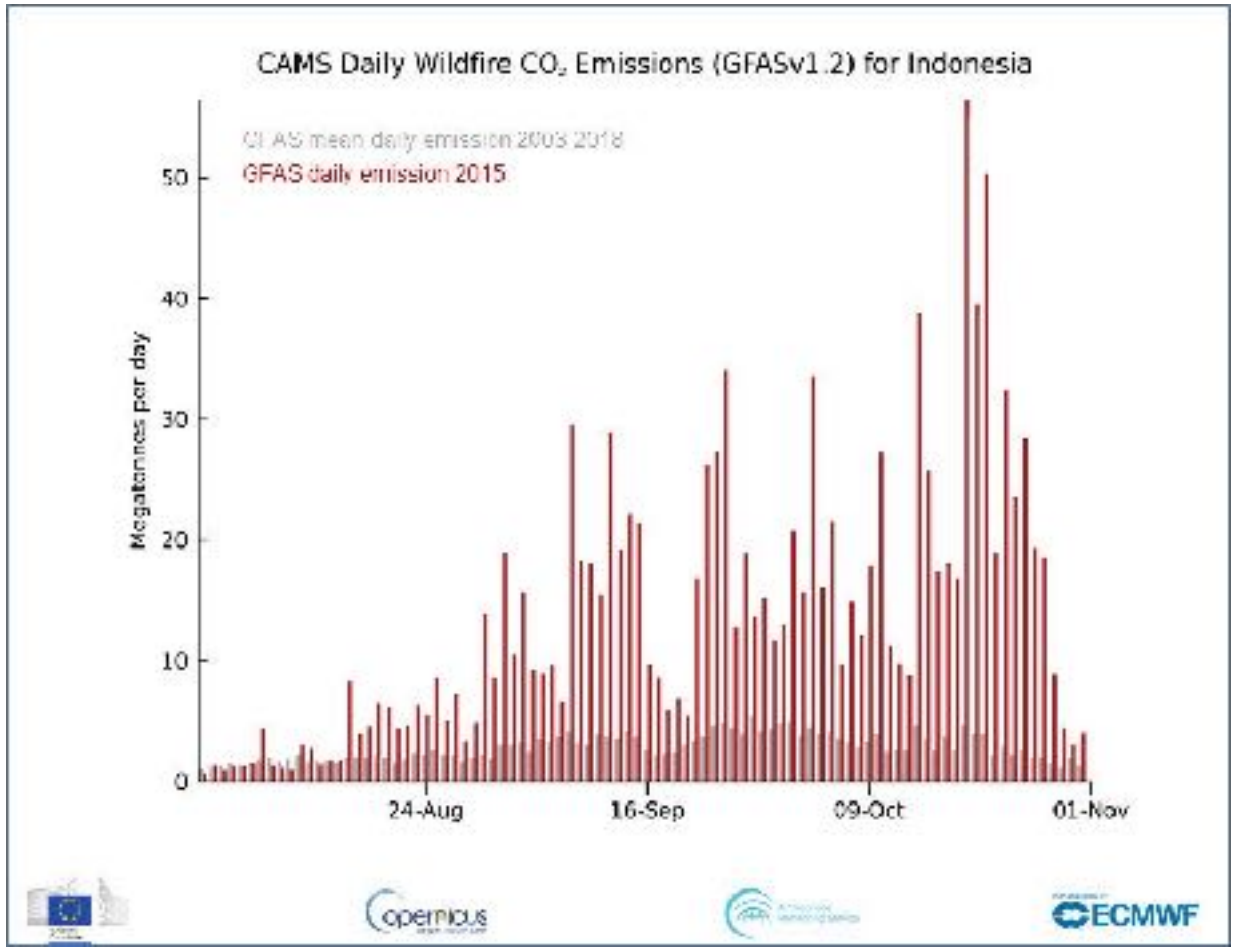


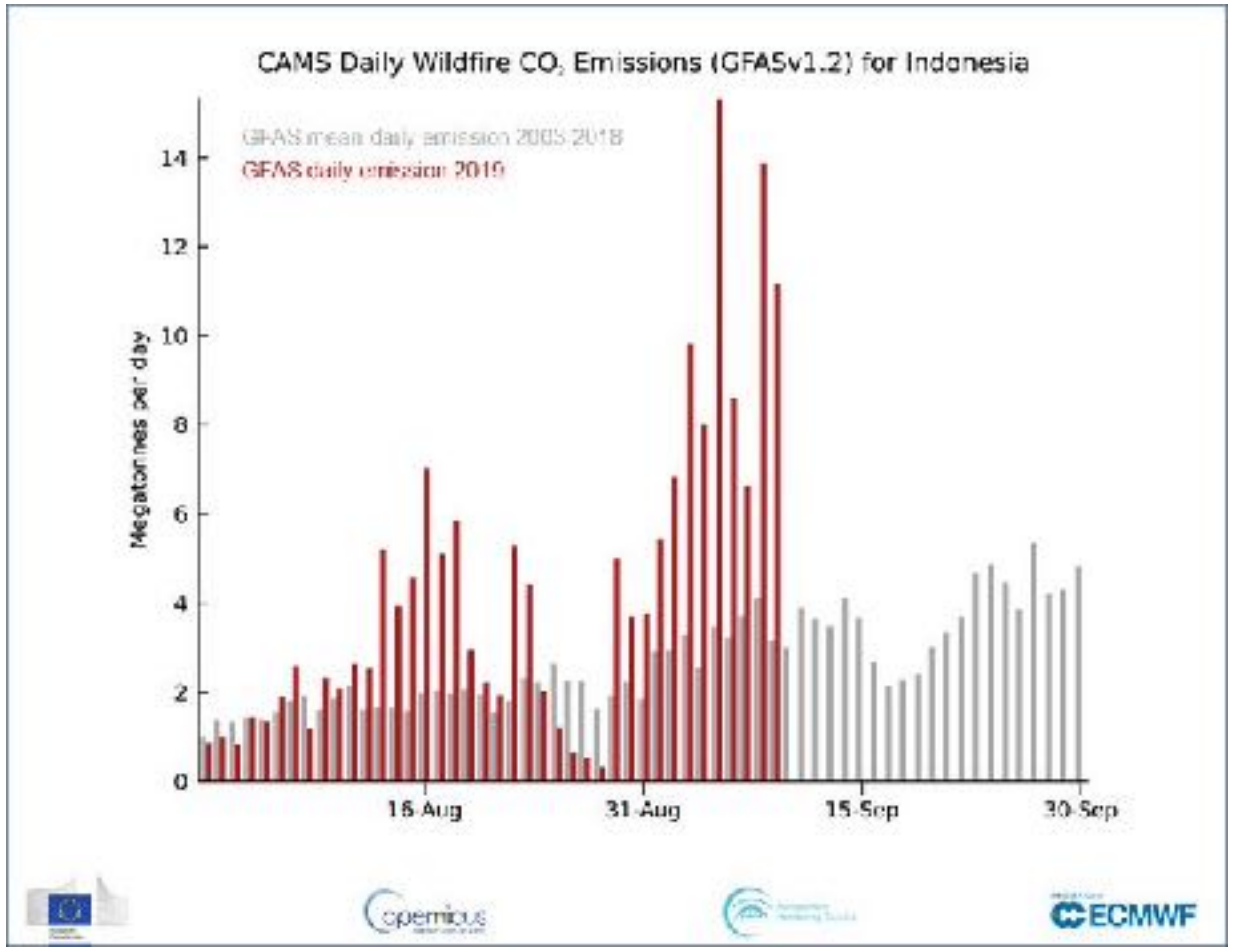
Source: https://atmosphere.copernicus.eu/charts/cams/

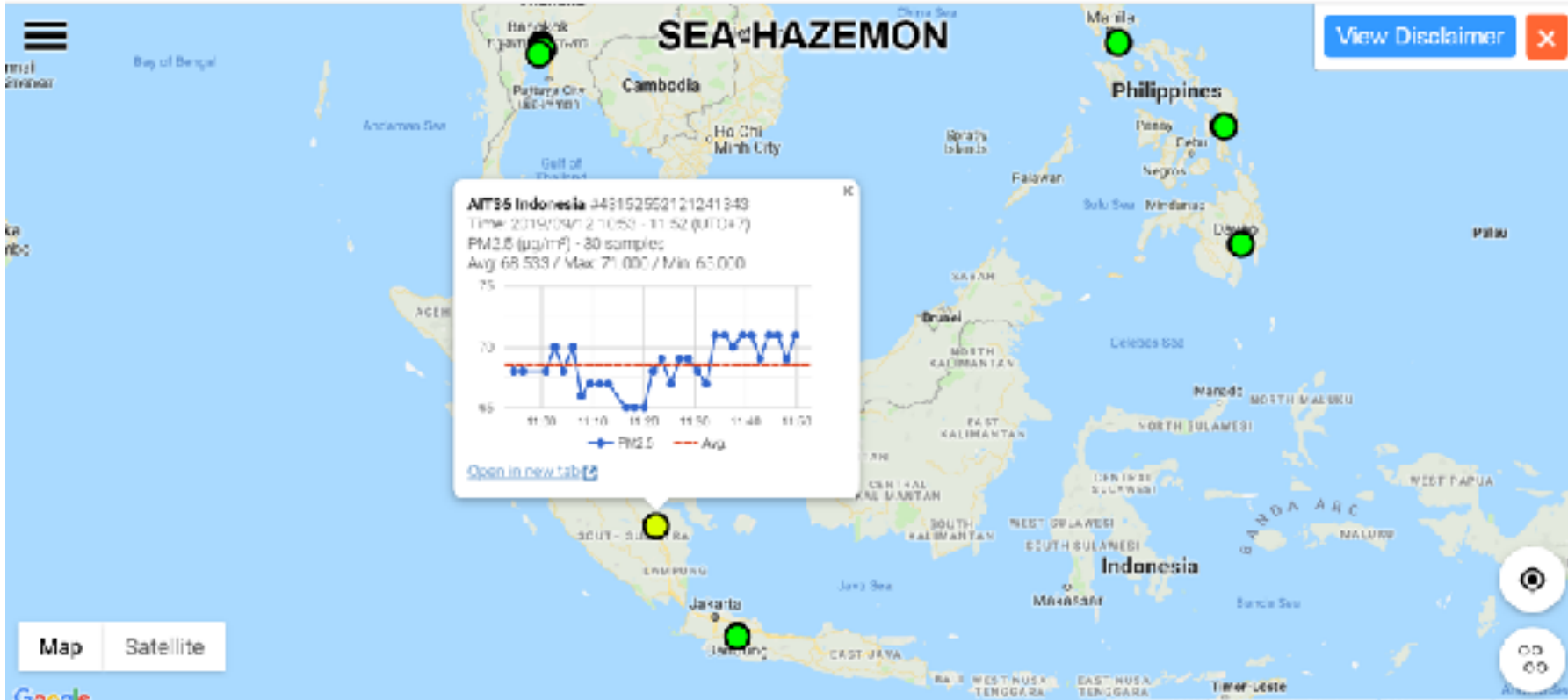




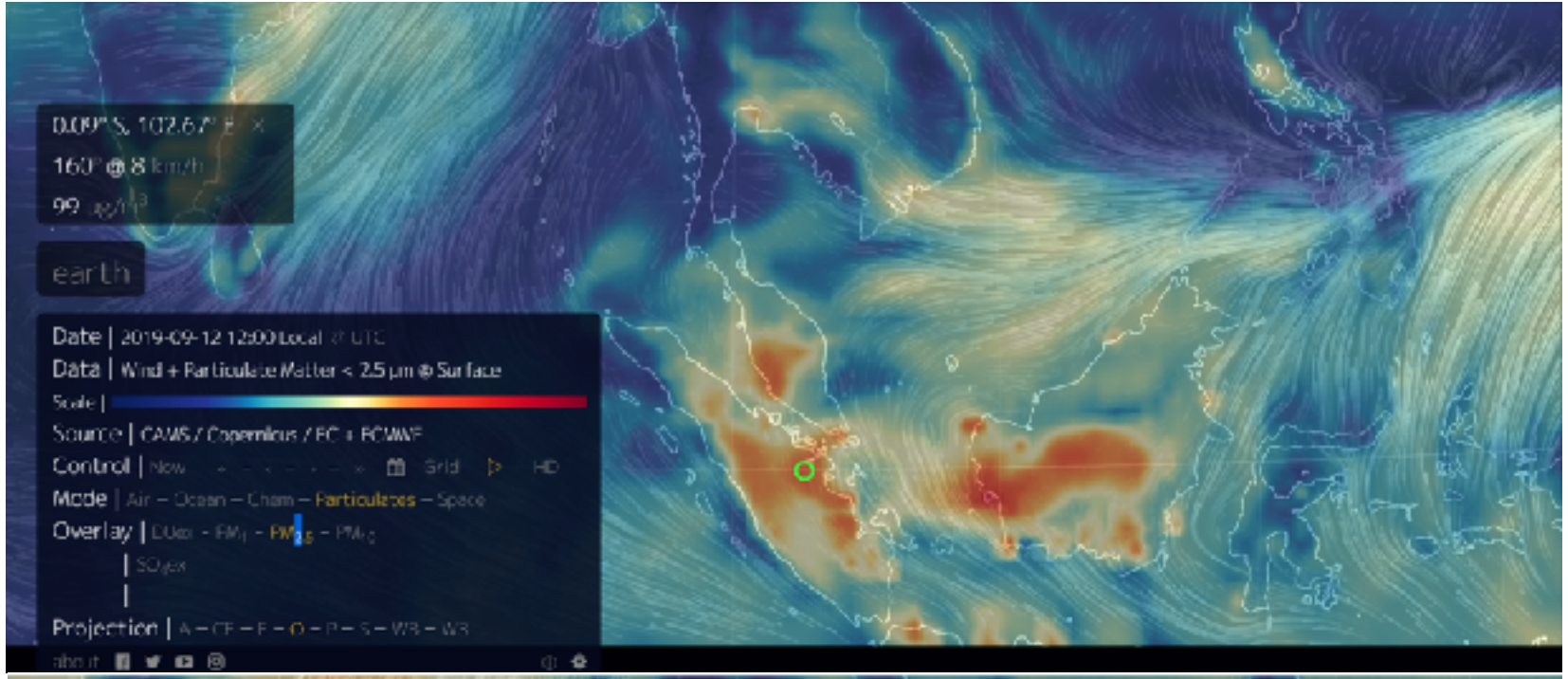
Source: https://apps.sentinel-hub.com/eo-browser/

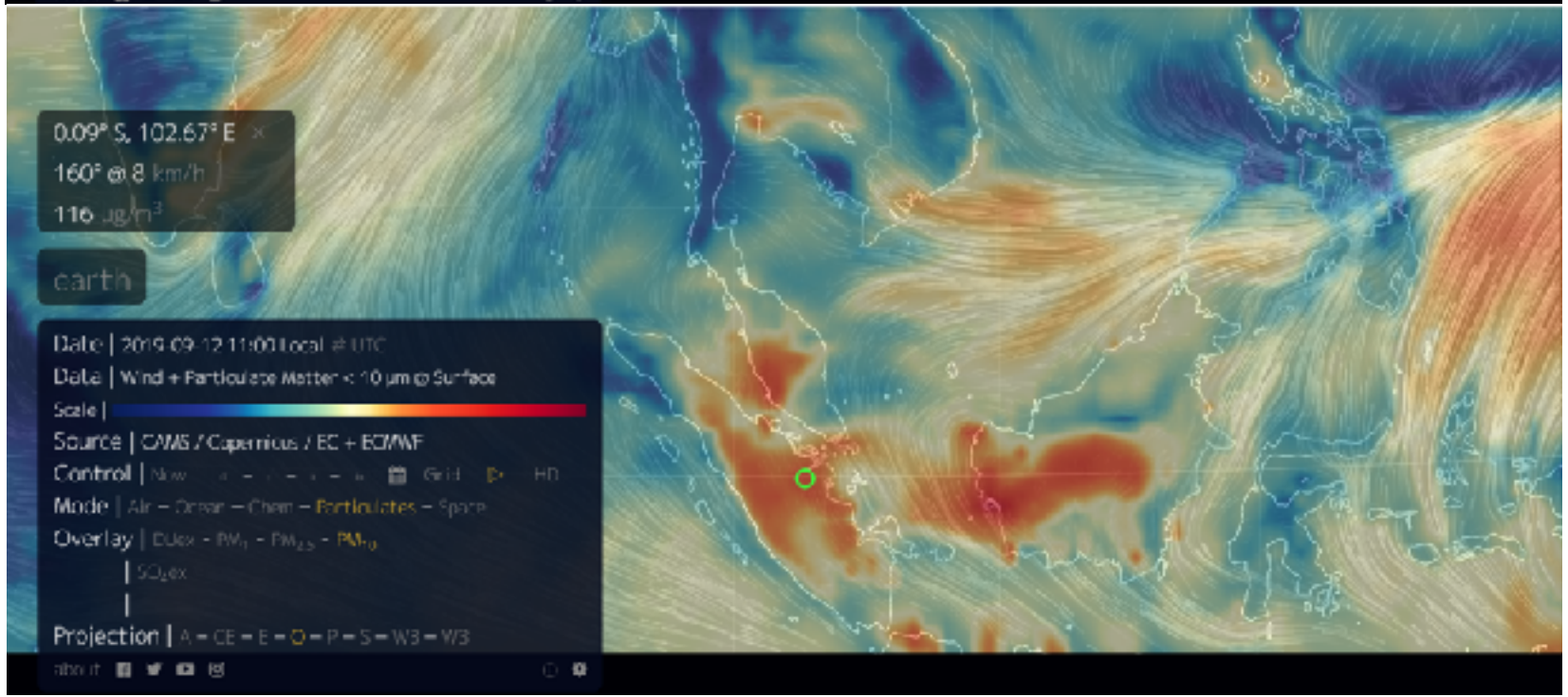

CAMS Daily Wildfire CO_2 Emissions (GFASv1.2) for Indonesia
GFAS mean daily emission 2003-2018
GFAS daily emission 2015
Megatonnes per day
0
10
20
30
40
50
24-Aug
16-Sep
09-Oct
01-Nov
ECMWF


CAMS Daily Wildfire CO_2 Emissions (GFASv1.2) for Indonesia
GFAS mean daily emission 2003-2018
GFAS daily emission 2019
Megatonnes per day
0
2
4
6
8
10
12
14
16 Aug
31 Aug
15 Sep
30 Sep
ECMWF

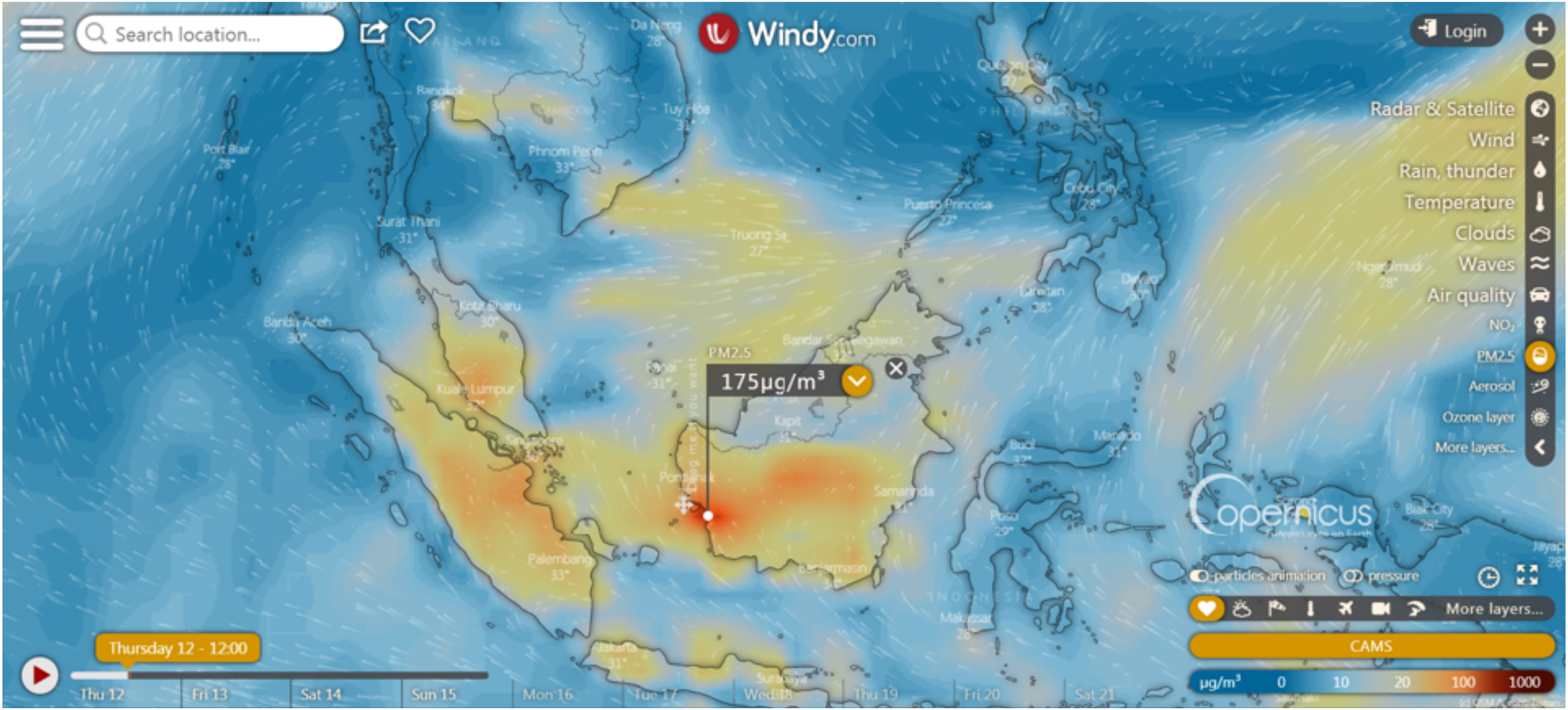


Source: https://canarin.net/seahazemon/v2/map.html



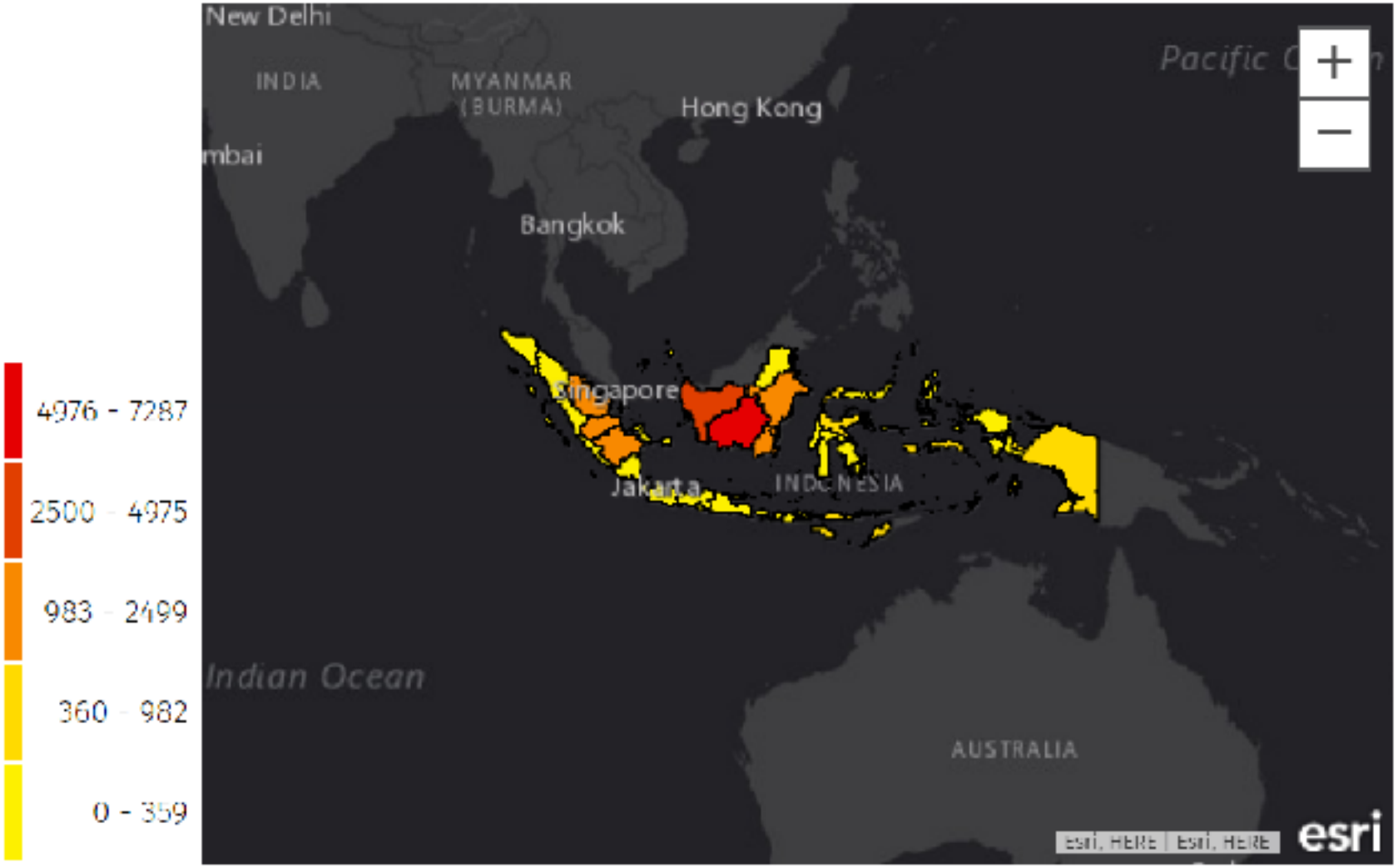


Source: https://earth.nullschool.net/



Source: https://www.windy.com/

GREATEST NUMBER OF FIRE ALERTS BY PROVINCE 1 SEP 2019 - 11 SEP 2019



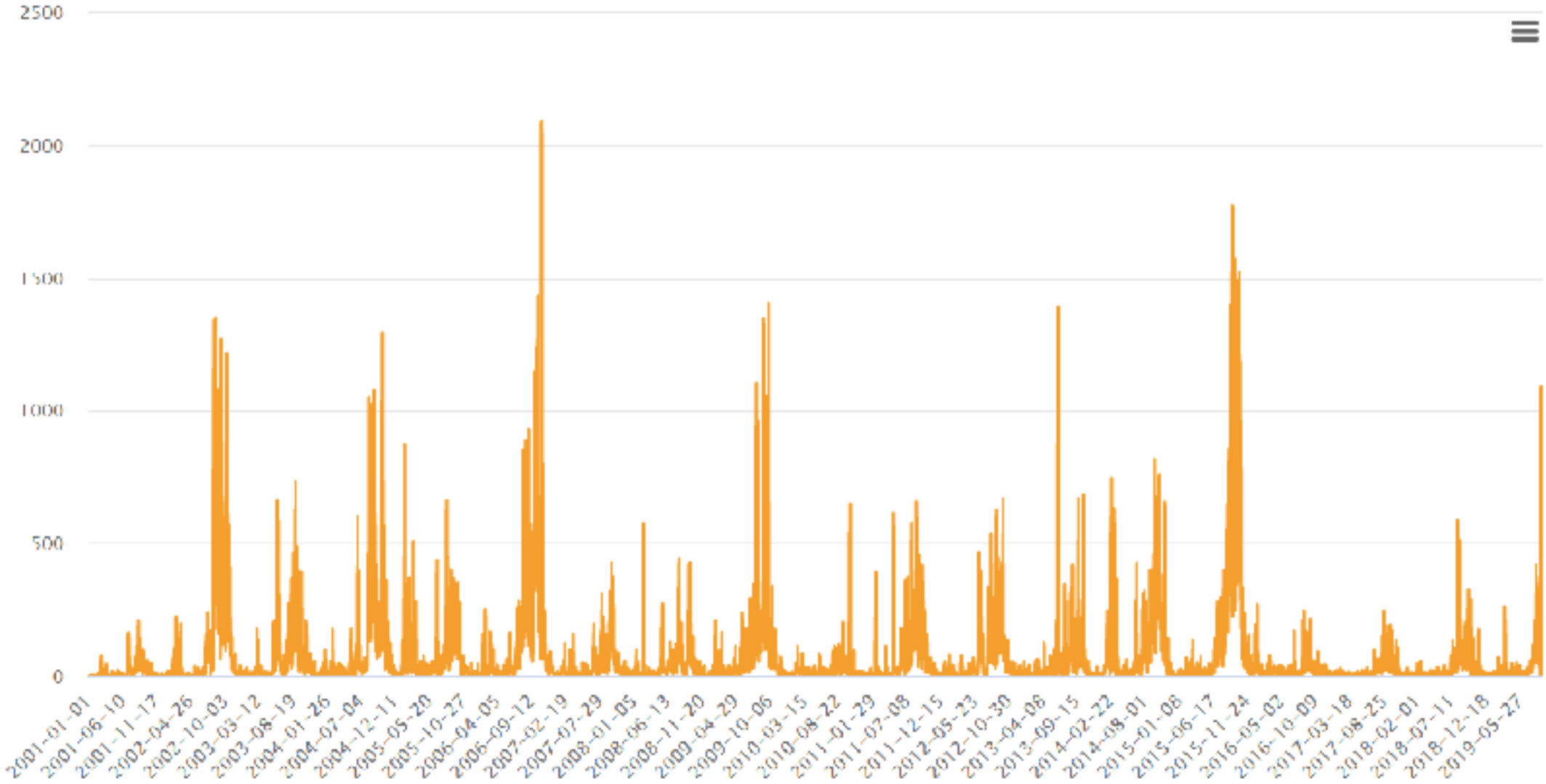
Province	#
Kalimantan Tengah	7287
Kalimantan Barat	4975
Jambi	2499
Sumatera Selatan	1990
Riau	1862
Kalimantan Timur	1558
Kalimantan Selatan	982
Maluku	626
Papua	610
Nusa Tenggara Timur	592

Source:https://fires.globalforestwatch.org/map/

FIRE ALERT COUNT JAN 1, 2001 - PRESENT

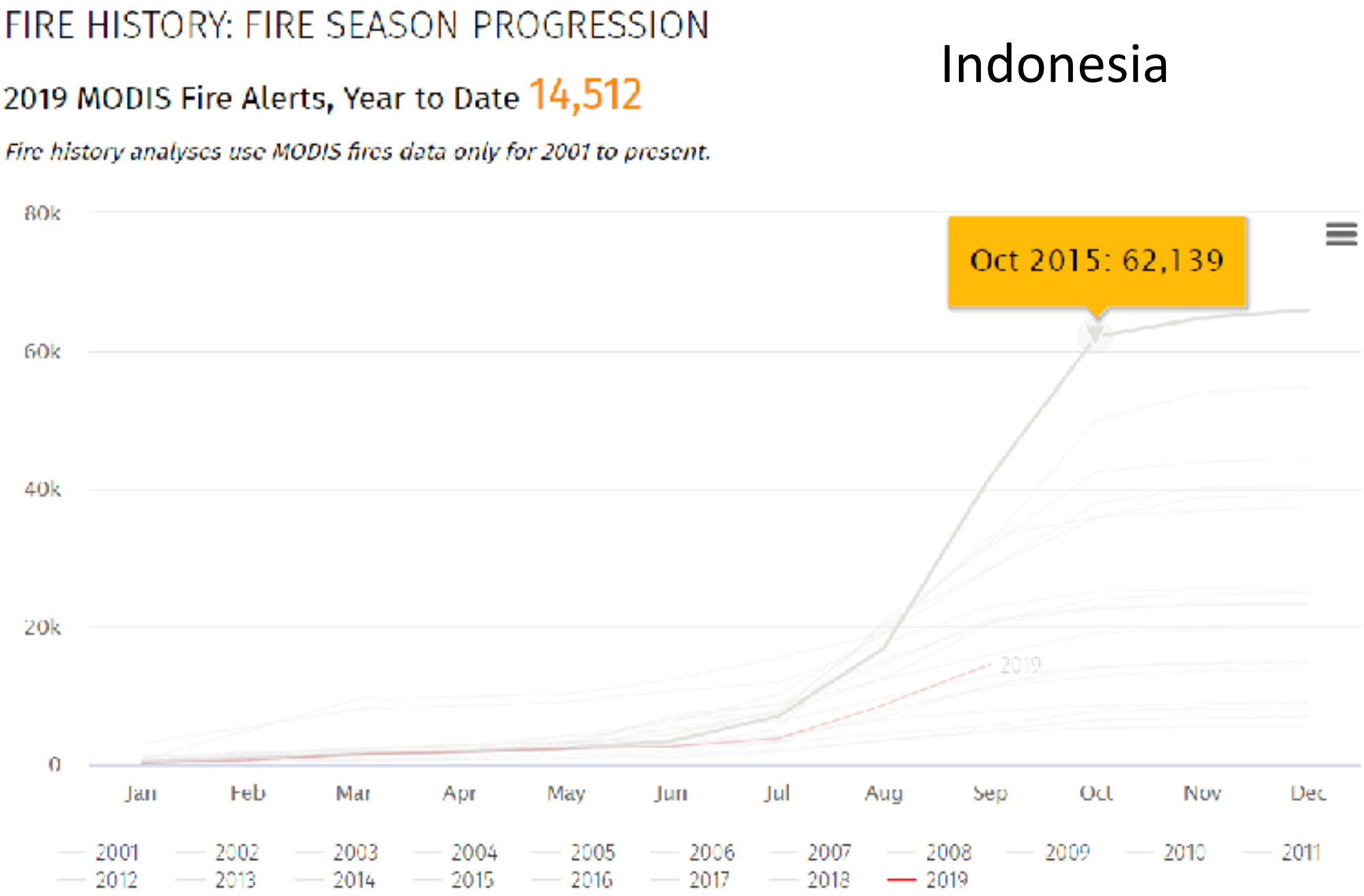
MODIS fire alerts

Click and drag in the plot area to zoom in



Source: https://fires.globalforestwatch.org/map/

Indonesia

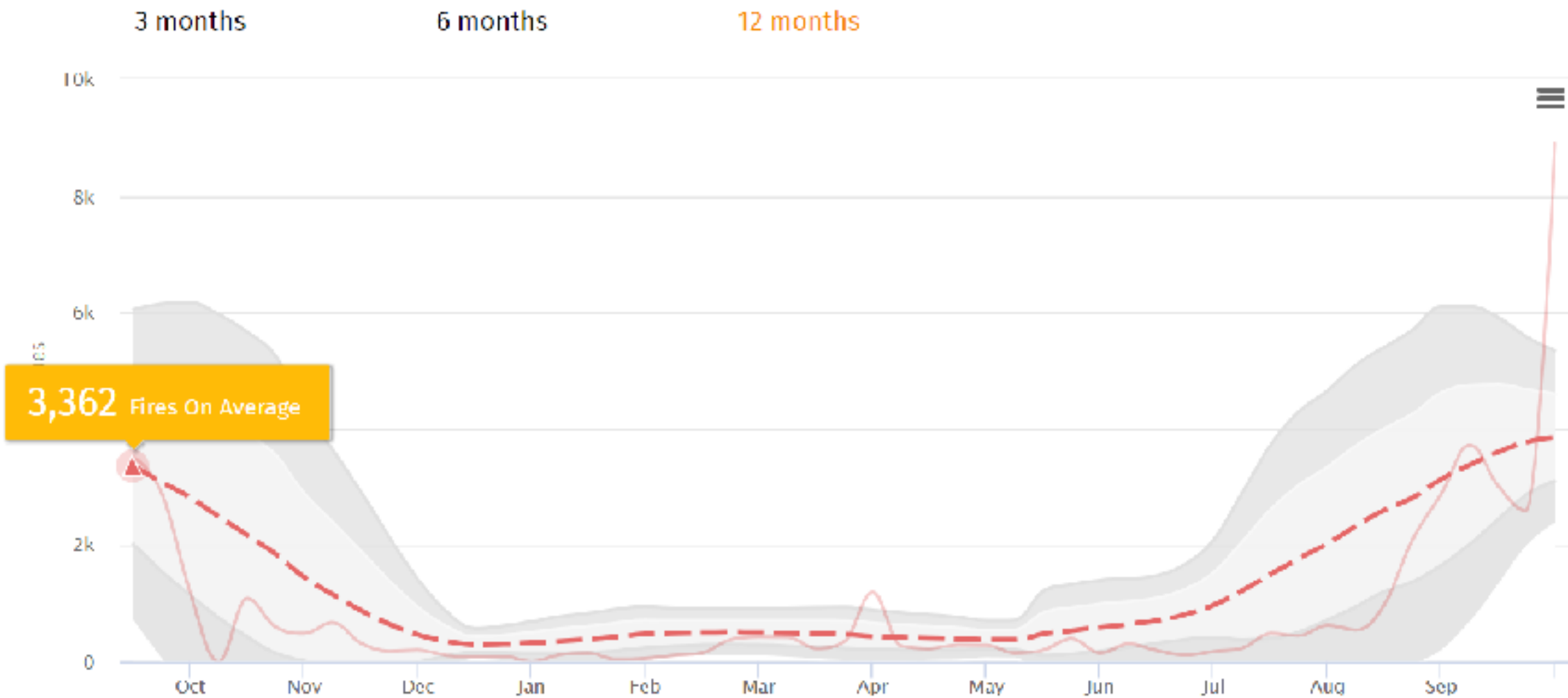


Source: https://fires.globalforestwatch.org/map/

Region: **Indonesia**

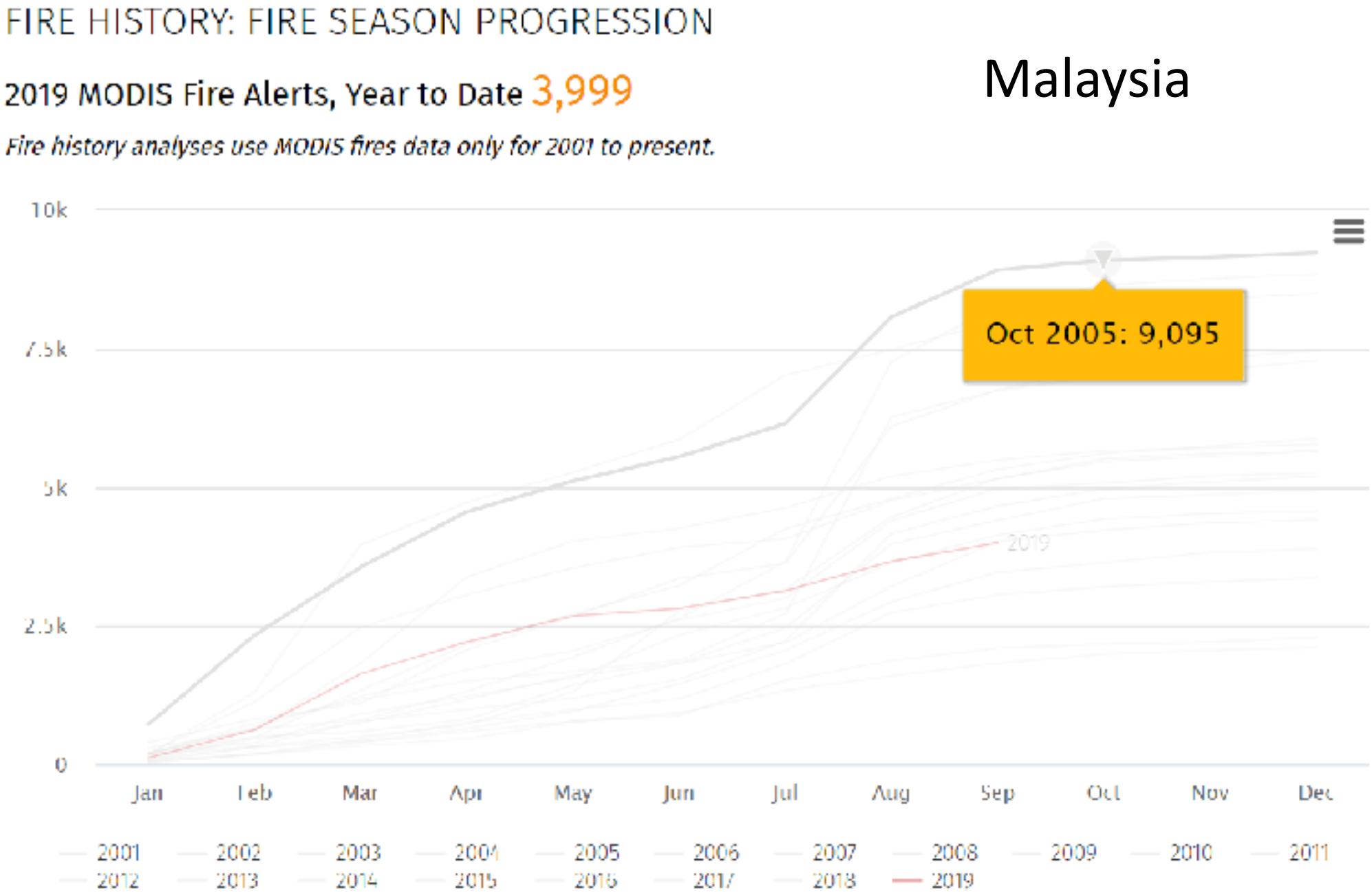
There were 8,903 **MODIS** fire alerts reported in the week of **September 2, 2019**. This was Unusually High compared to the same week in previous years.

Unusual fire history analyses use MODIS fires data only for 2001 to present.



Source: https://fires.globalforestwatch.org/map/

Malaysia



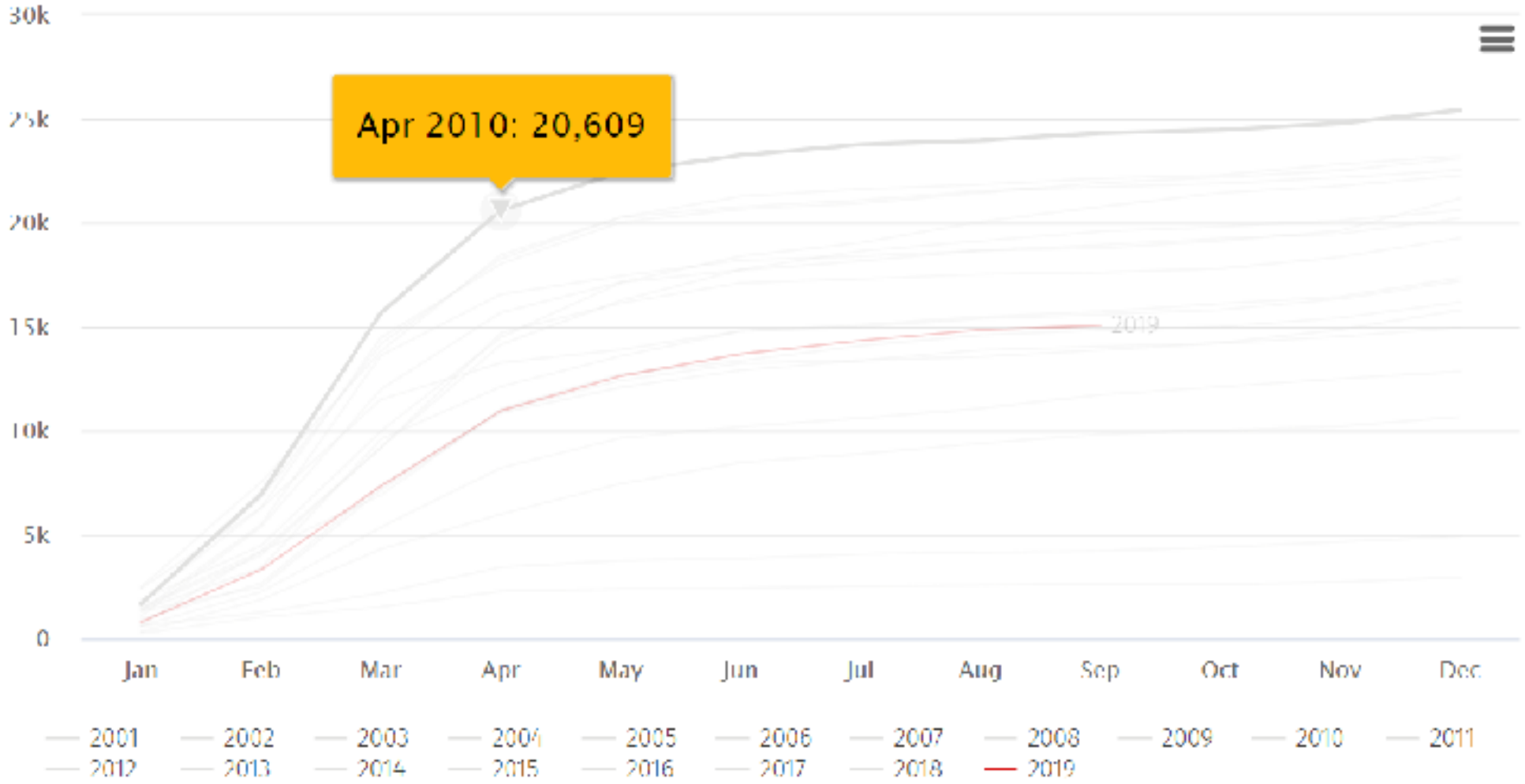
Source: https://fires.globalforestwatch.org/map/

Vietnam

FIRE HISTORY: FIRE SEASON PROGRESSION

2019 MODIS Fire Alerts, Year to Date 15,064

Fire history analyses use MODIS fires data only for 2001 to present.



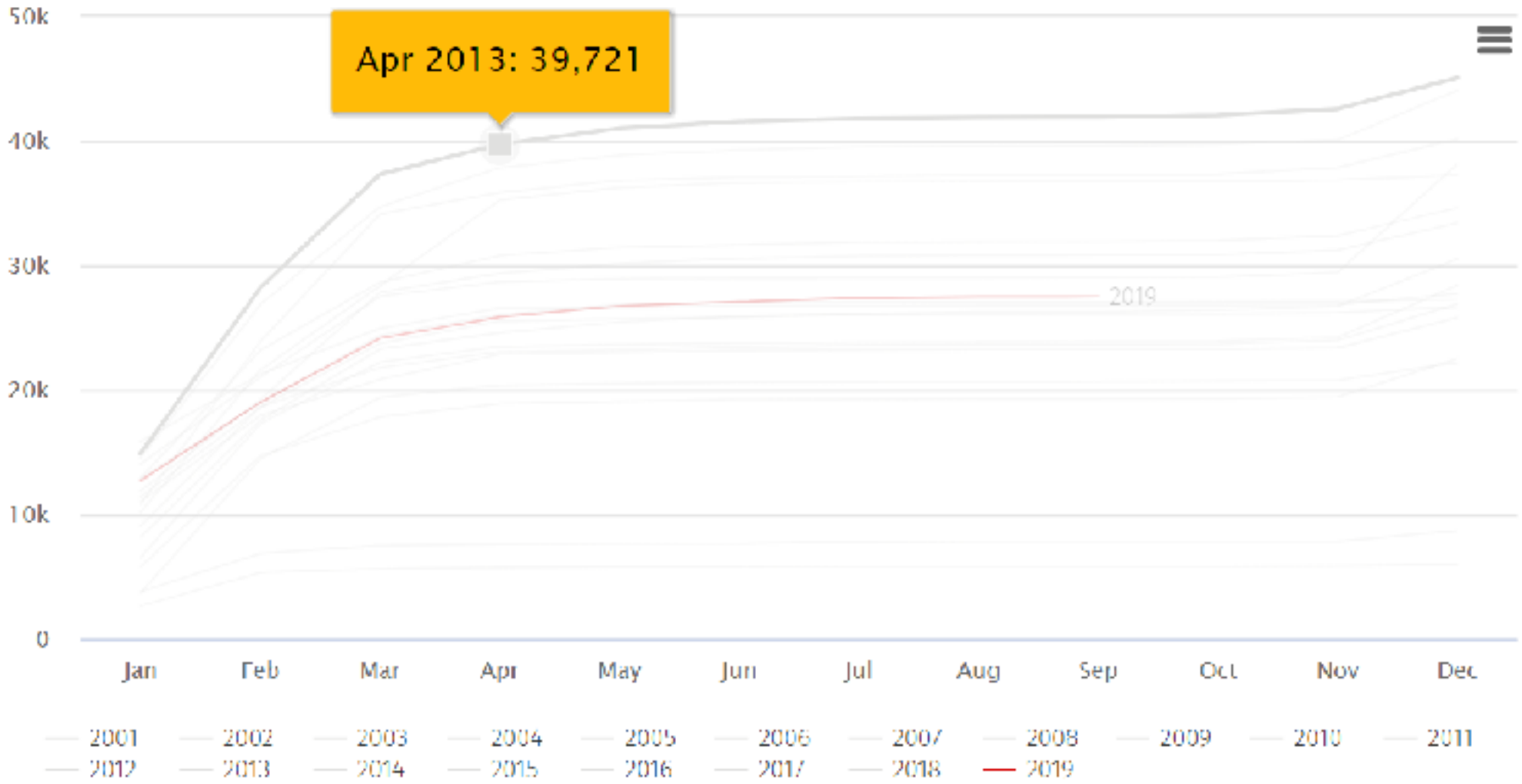
Source: https://fires.globalforestwatch.org/map/

Cambodia

FIRE HISTORY: FIRE SEASON PROGRESSION

2019 MODIS Fire Alerts, Year to Date 27,495

Fire history analyses use MODIS fires data only for 2001 to present.



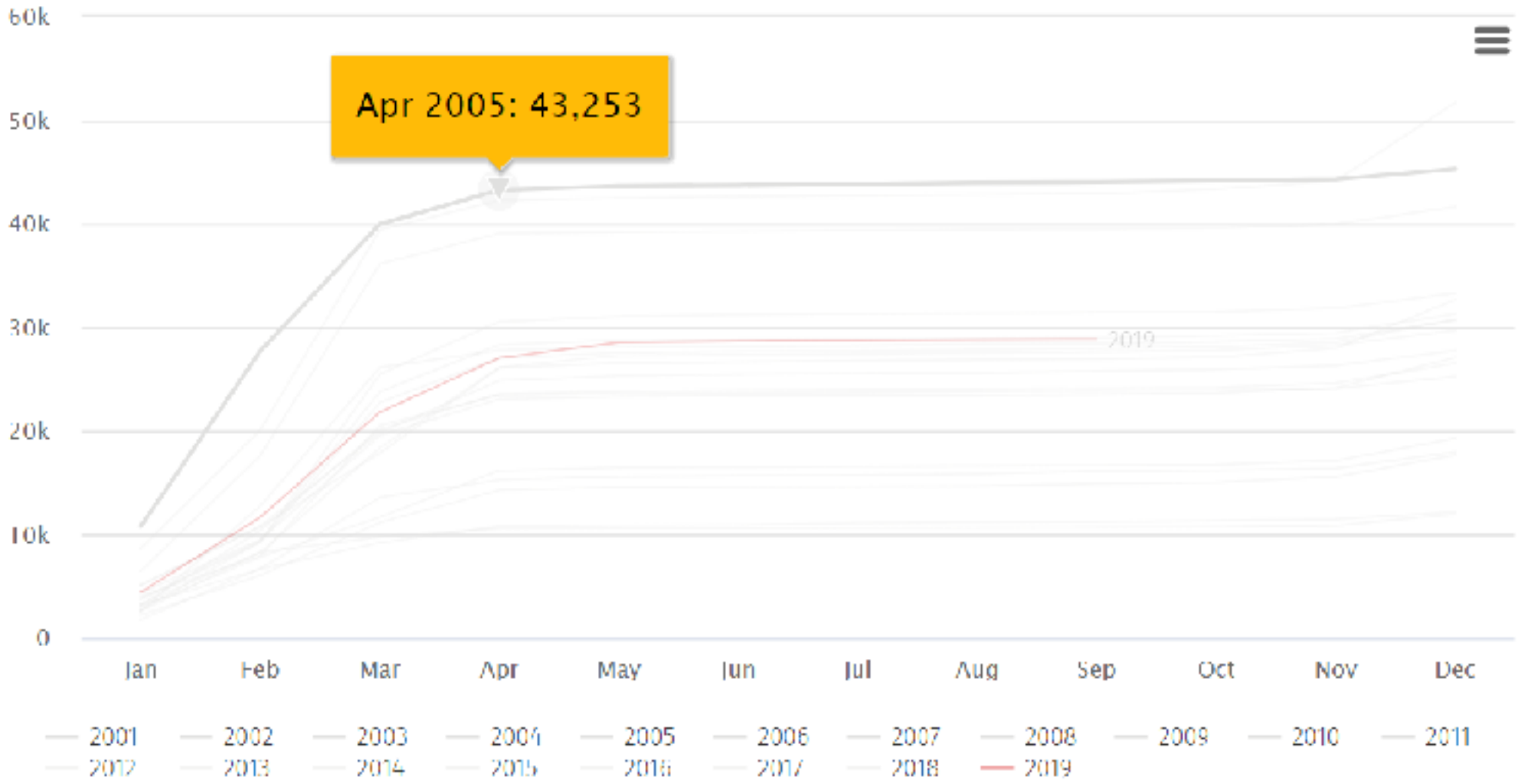
Source: https://fires.globalforestwatch.org/map/

Thailand

FIRE HISTORY: FIRE SEASON PROGRESSION

2019 MODIS Fire Alerts, Year to Date 28,862

Fire history analyses use MODIS fires data only for 2001 to present.



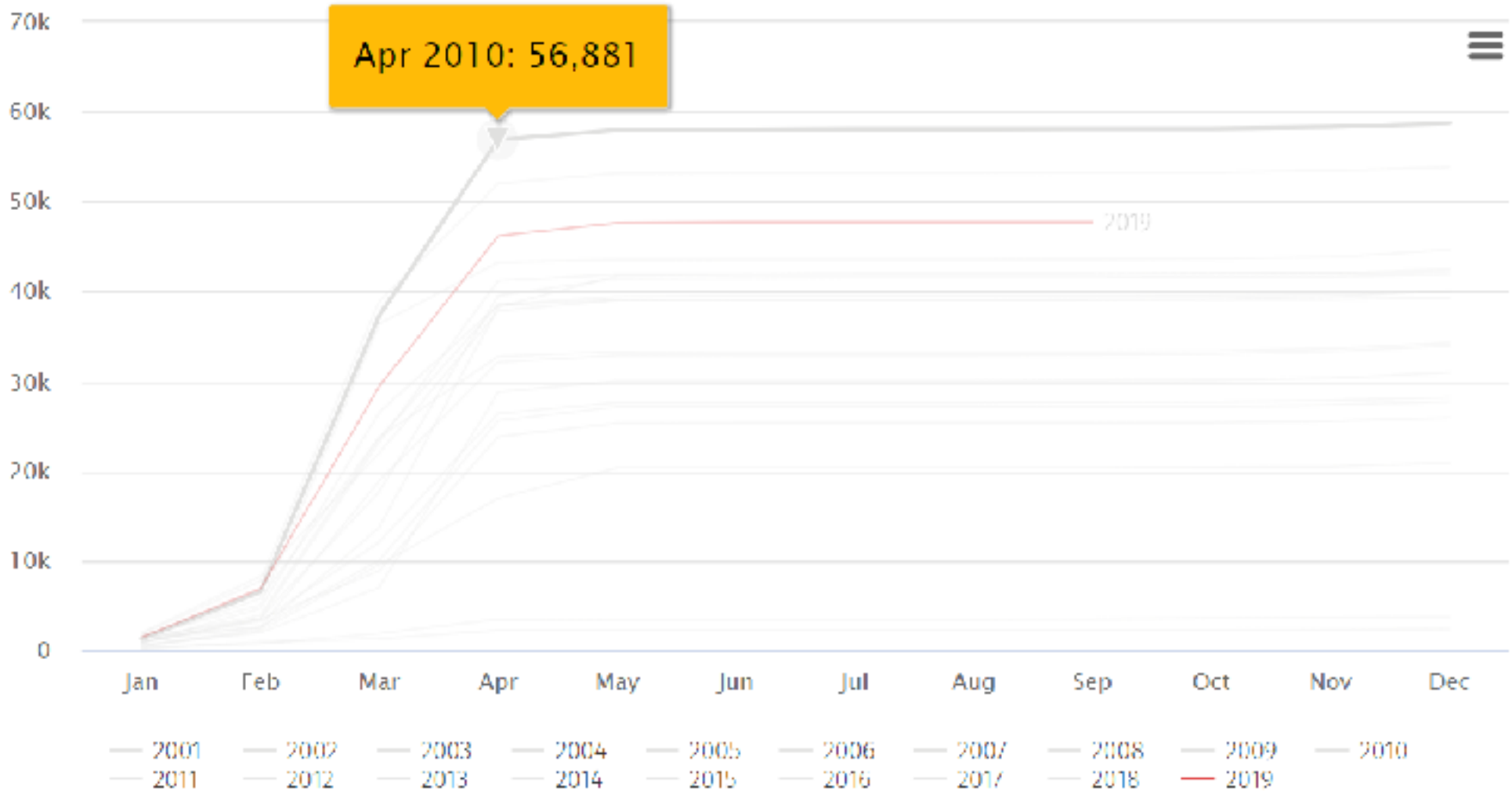
Source: https://fires.globalforestwatch.org/map/

Lao PDR

FIRE HISTORY: FIRE SEASON PROGRESSION

2019 MODIS Fire Alerts, Year to Date 47,688

Fire history analyses use MODIS fires data only for 2001 to present.



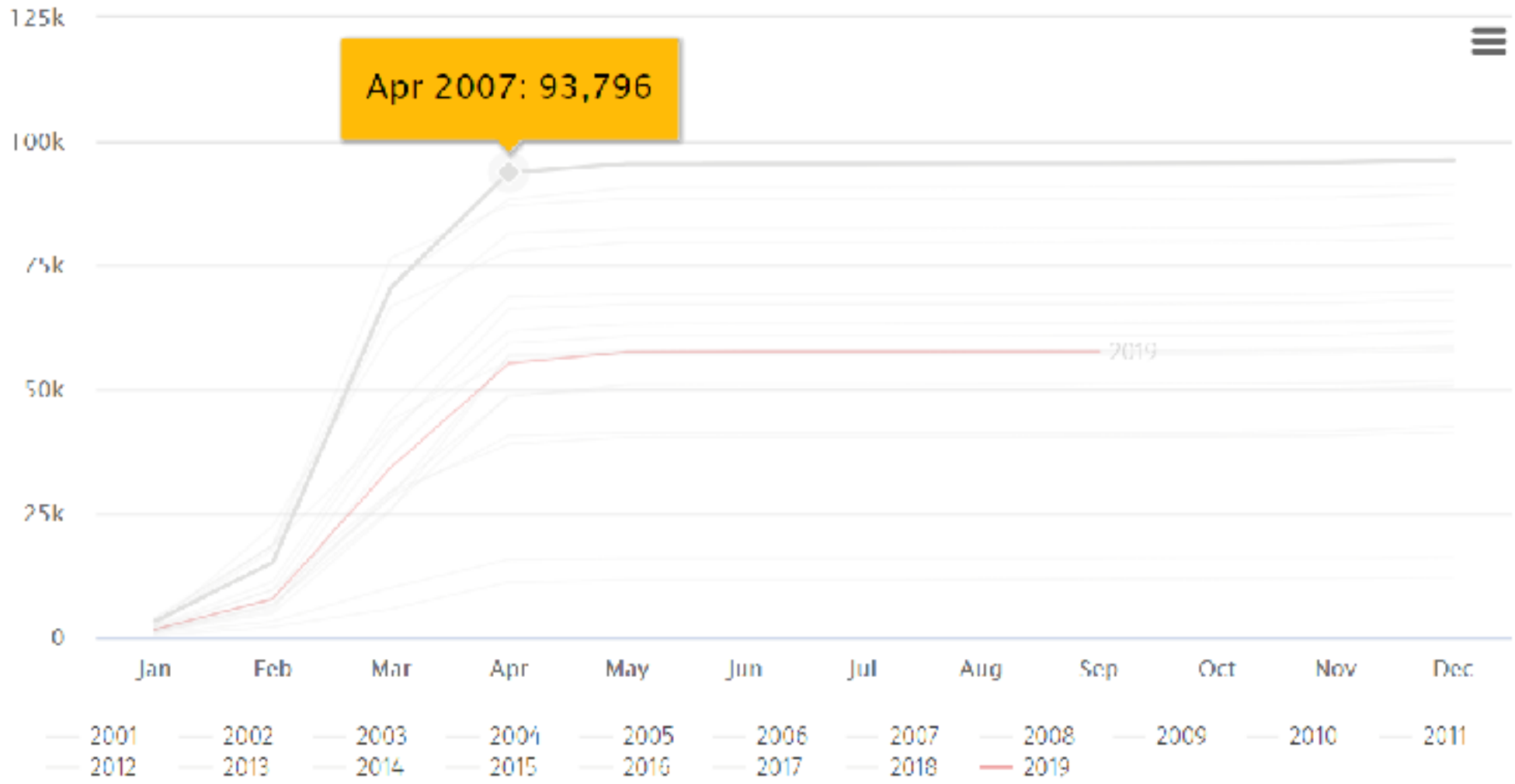
Source: https://fires.globalforestwatch.org/map/

Myanmar

FIRE HISTORY: FIRE SEASON PROGRESSION

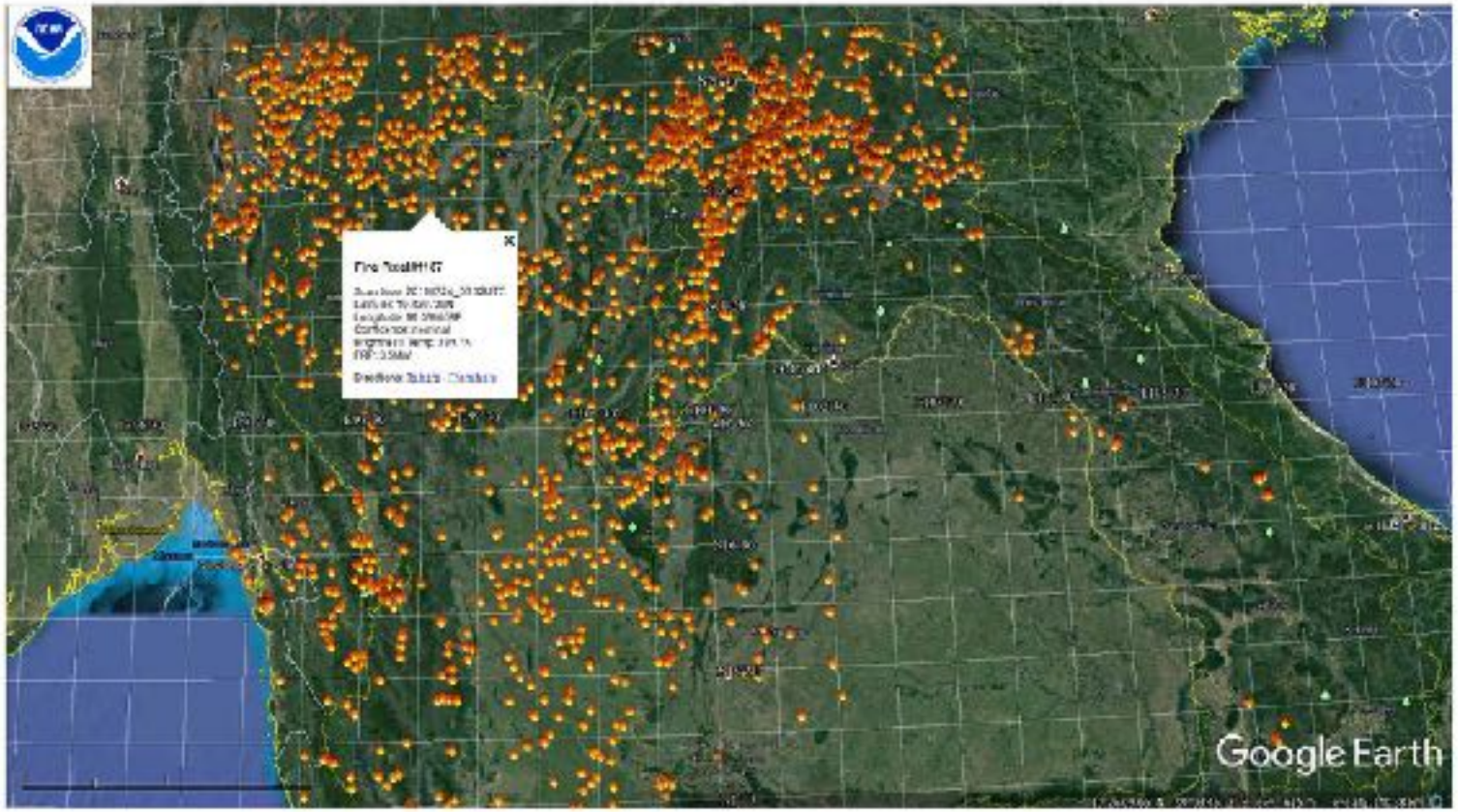
2019 MODIS Fire Alerts, Year to Date 57,626

Fire history analyses use MODIS fires data only for 2001 to present.



Source: https://fires.globalforestwatch.org/map/

NOAA-National Environmental Satellite, Data, and Information Service, NESDIS (https://www.nesdis.noaa.gov/)

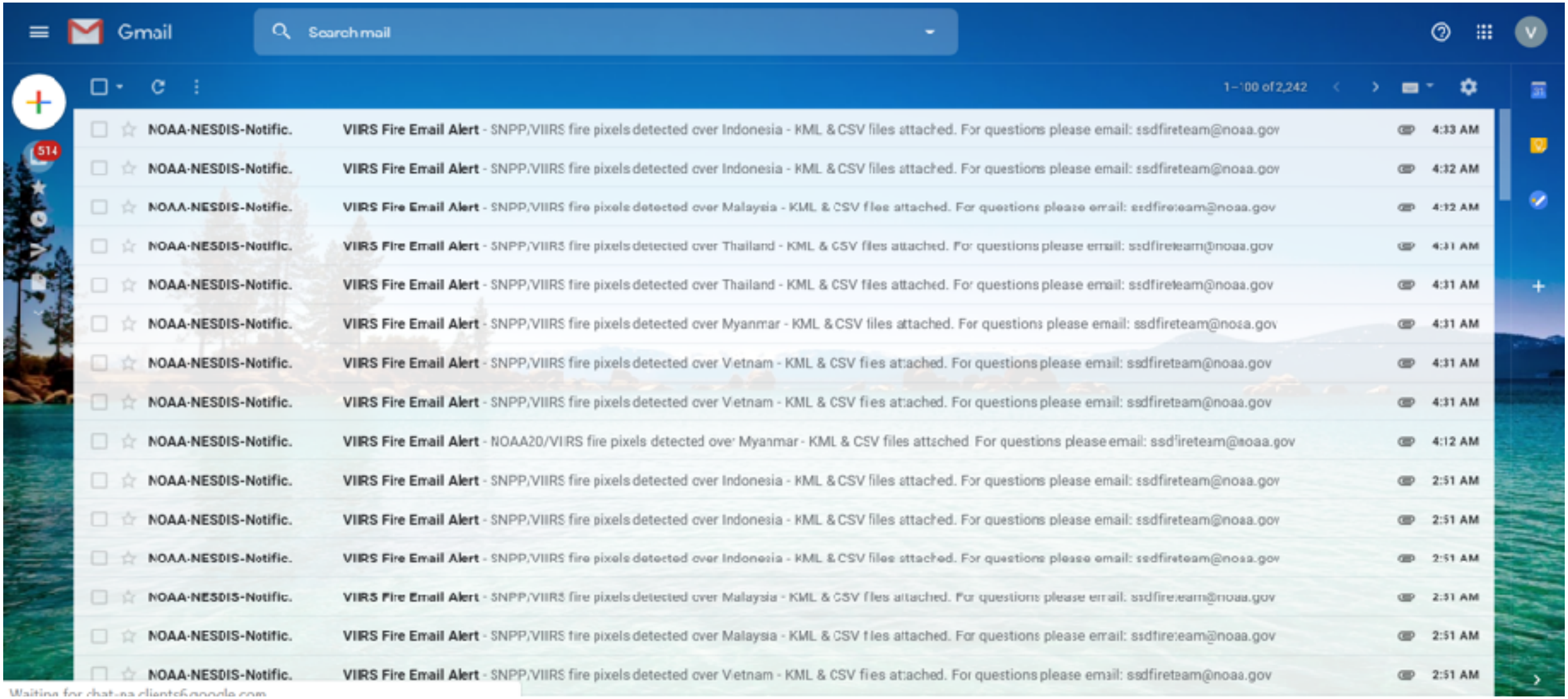


Reduce latency time from NASA 3 hrs to 1 hr or so for both **Suomi-NPP and NOAA-20** as Dr. Wilfrid Schroeder is the PI of Global VIIRS Active Fire Products began 14 Mar 19

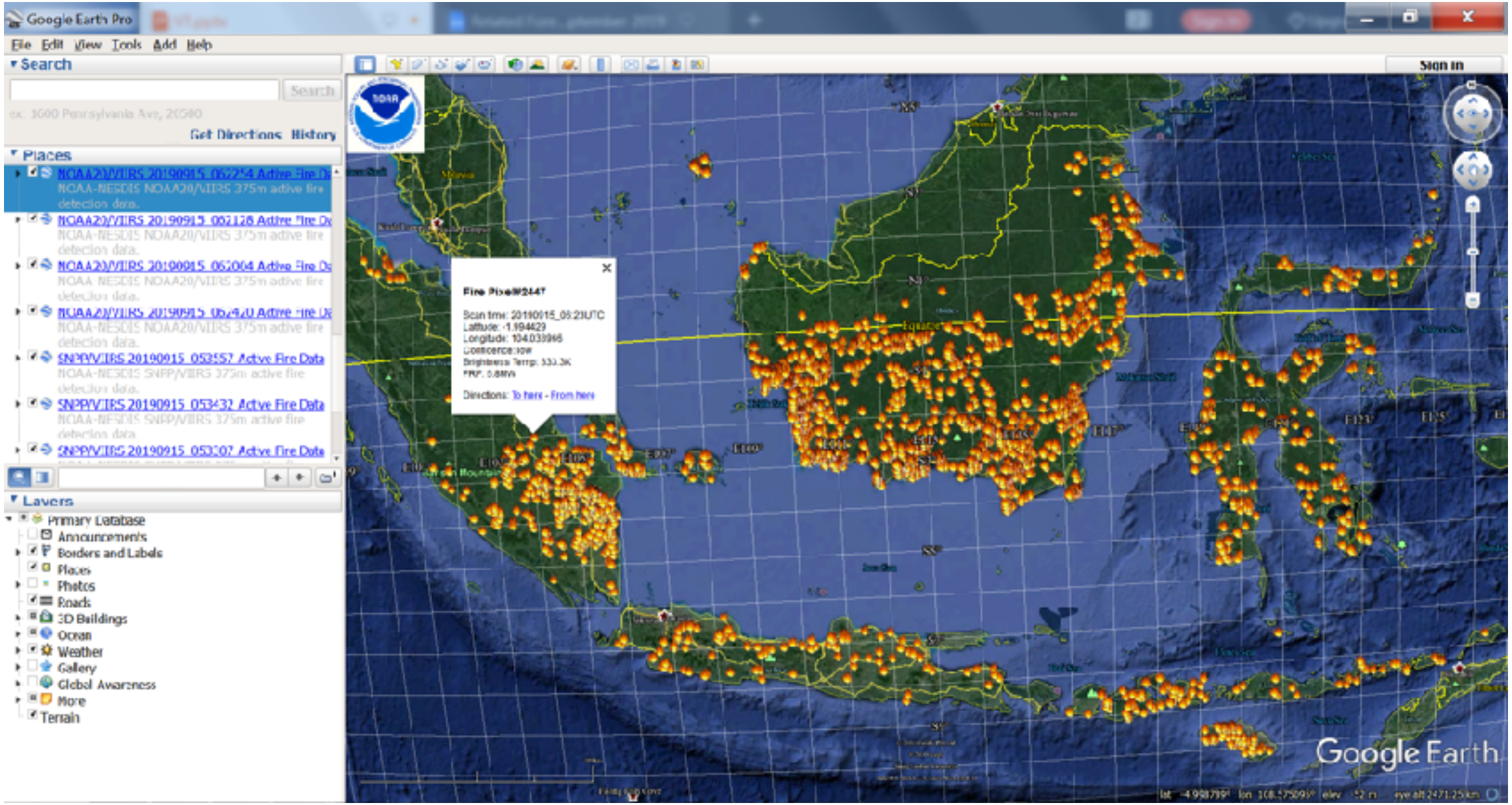
Dr. Wilfrid Schroeder (wilfrid.schroeder@noaa.gov)
Dr. Davida Streett (davida.streett@noaa.gov)

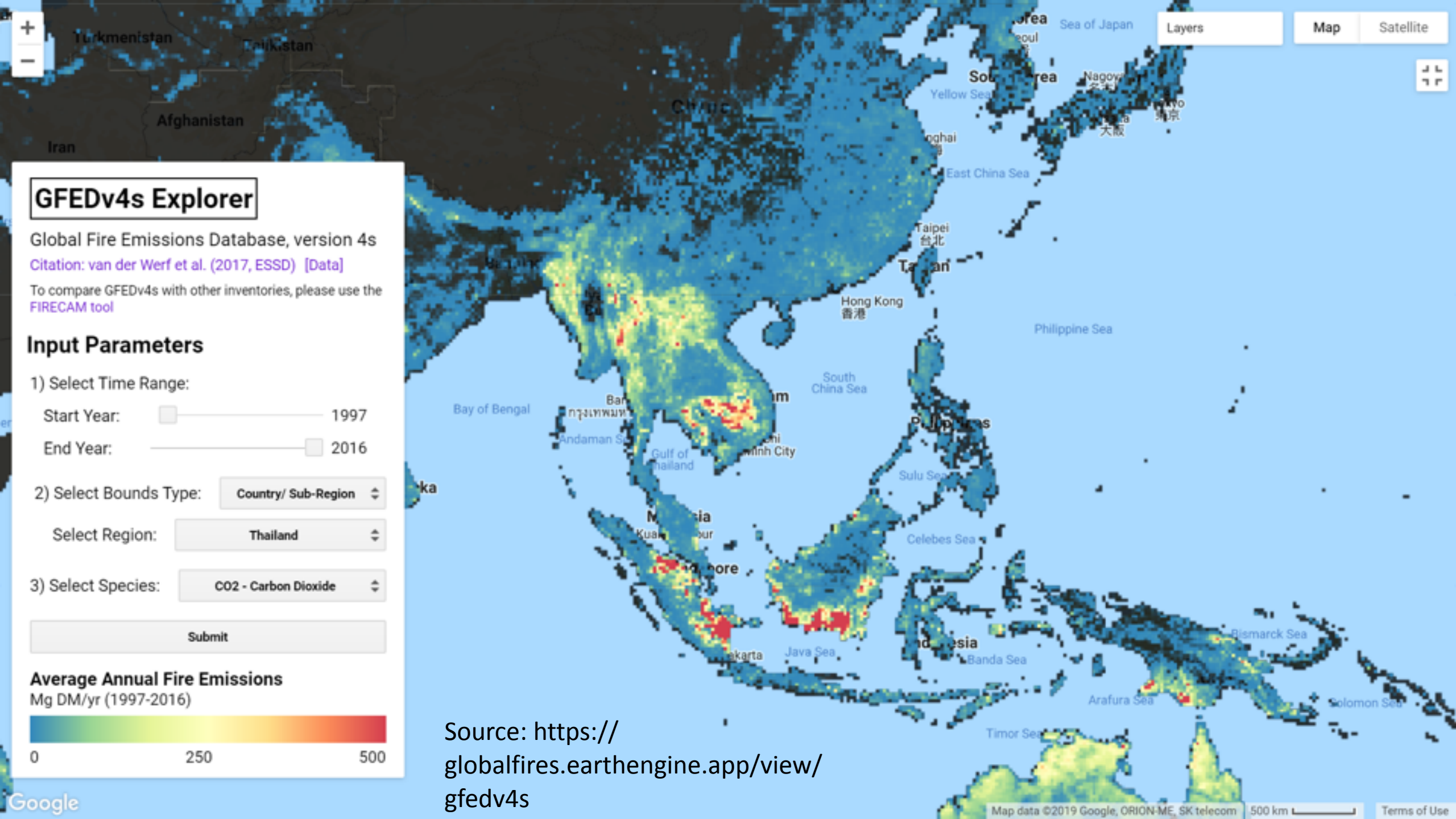
On the 11th September 2019, NOAA bagan a full alert email system for Thailand, Cambodia, Myanmar, Lao PDR, Vietnam, Malaysia, and Indonesia

Daily Email Alerts



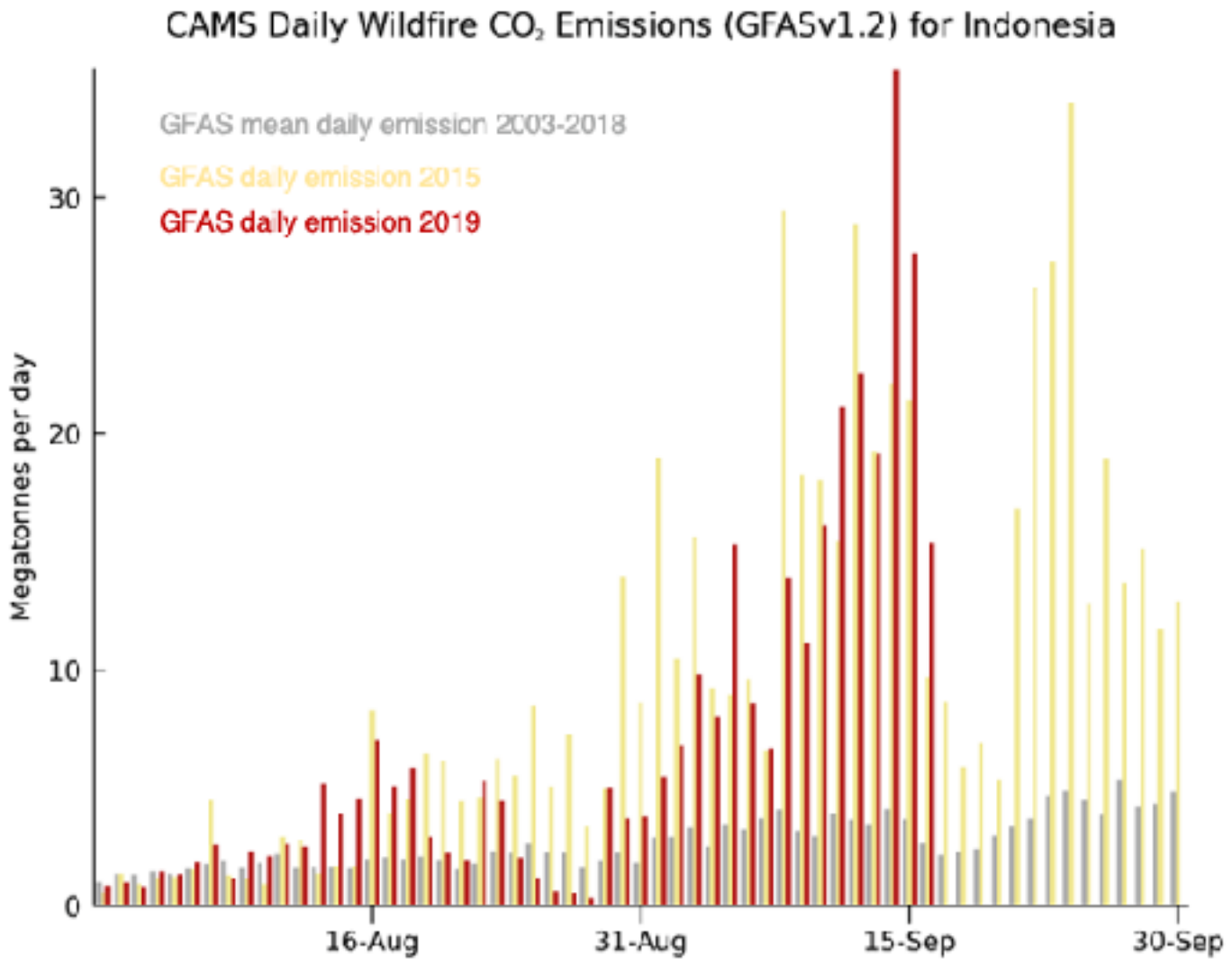
Alert Email Delivery Time reduces significantly from above 3 hours to 1 hour for Suomi NPP and 35-50 minutes in case of NOAA-20!!!





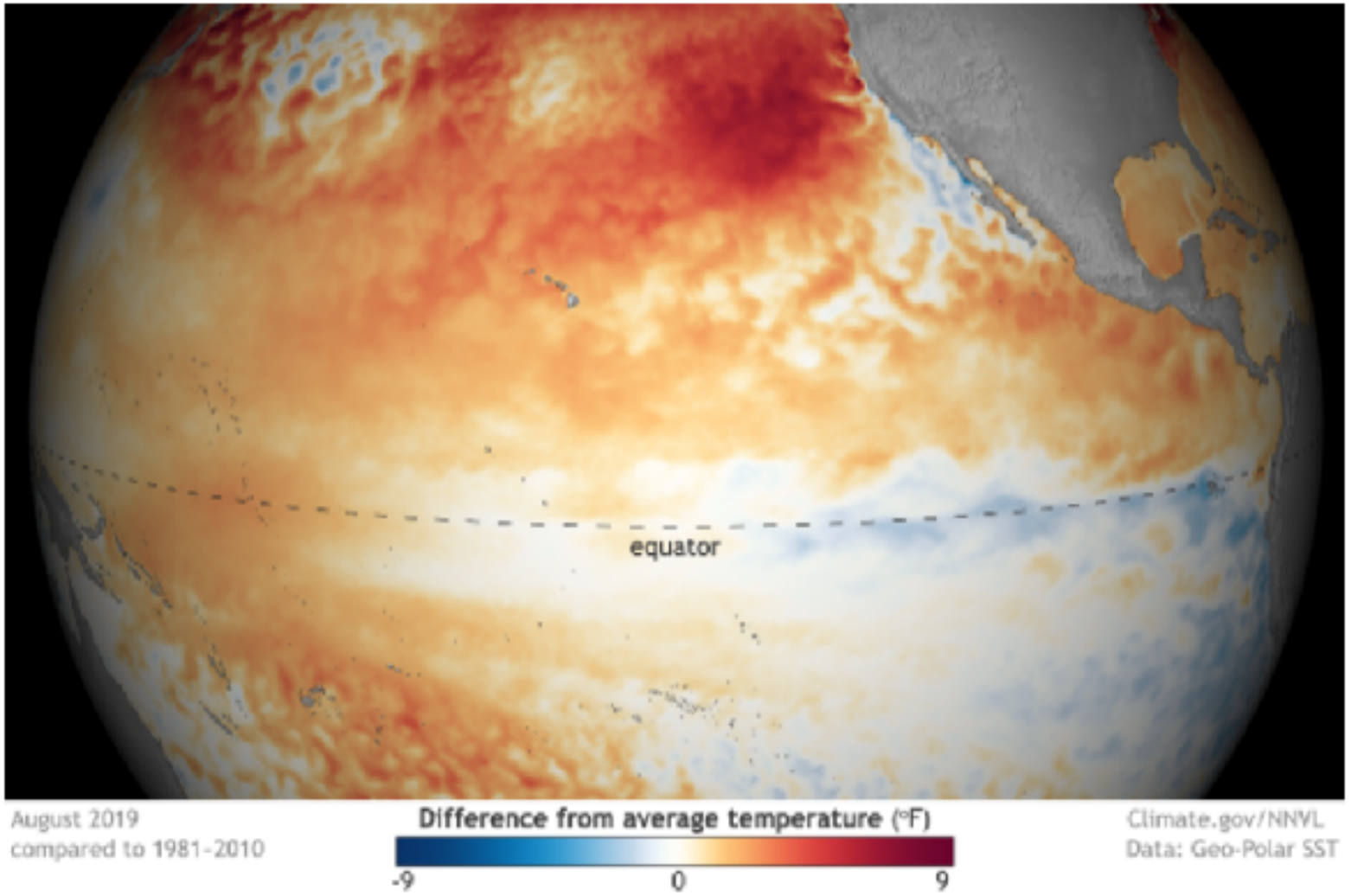
Source: https://globalfires.earthengine.app/view/gfedv4s

As requested... August to September daily estimated fire emissions for #Indonesia comparing **2019 (red)** to **2015 (yellow)** and **the 2003-2018 mean (grey)** showing that the current magnitude is comparable to corresponding period of 2015. Source: https://t.co/sLQDwhAy8e (Mark Parrington's Twit)



El Niño & La Niña (El Niño-Southern Oscillation)

Current Status | What is ENSO? | U.S. Impacts | Global Impacts | ENSO Blog



ENSO: Not Active

The El Niño of 2019 is over, and neutral conditions have returned to the tropical Pacific. Of the three possible outcomes—El Niño, La Niña, or neutral—forecasters give neutral the highest odds (75% chance) of lasting through winter.

More ENSO status information

Latest official ENSO update

Latest ENSO blog update

(image at left) Difference from average sea surface temperatures at the equator in the tropical Pacific in August 2019.

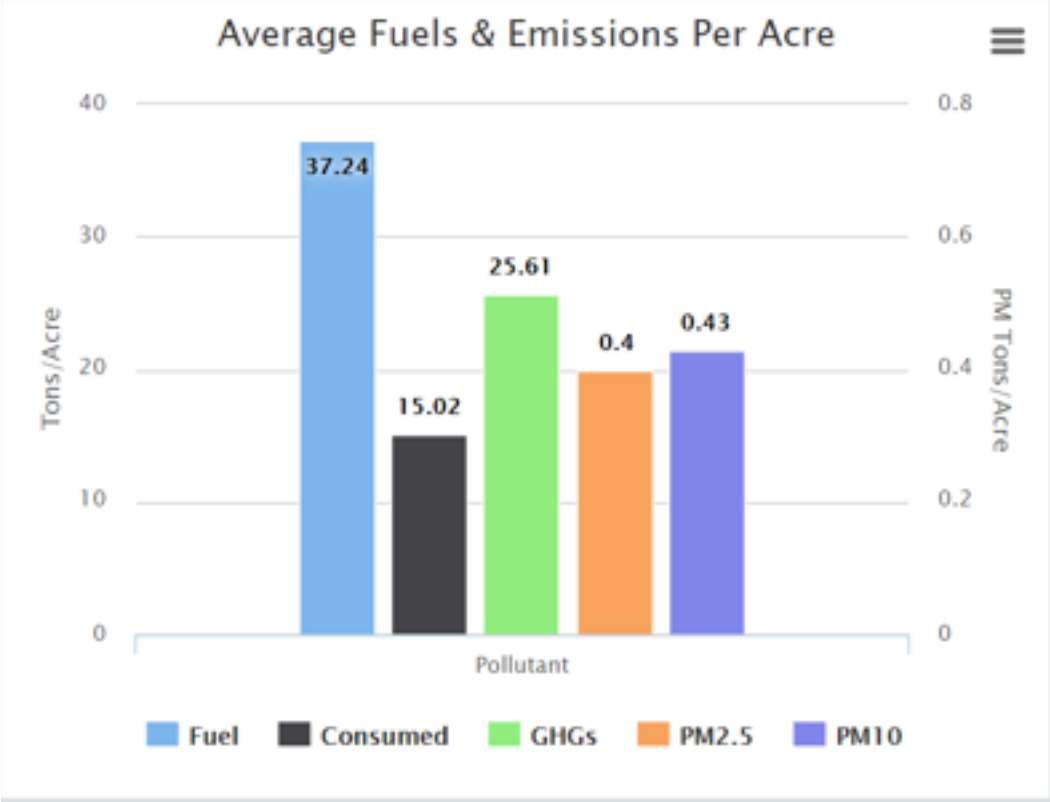
Source: https://www.climate.gov/enso

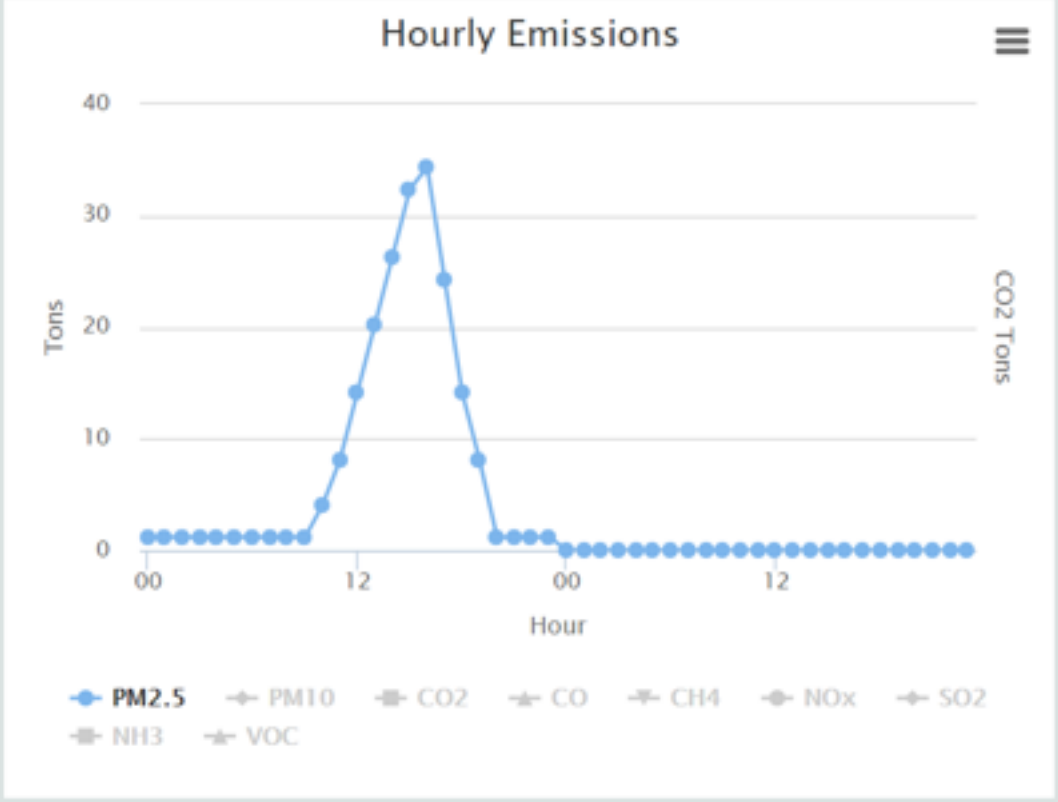
BlueSky Playground
3.0 Alpha

Emissions Inputs | Emissions Results | Meteorology Inputs | Dispersion Inputs | Dispersion Results

New Run
Run ID: 15d7dea586f1a2

Report Title	Playground Report: 9/15/2019	**Reporter**	Chai
Fuelbed	52 - Douglas-fir-Pacific ponderos...	**Date**	9/15/2019
Latitude	99.0000 degrees	**Longitude**	102.0000 degrees
Size	500 acres	**Fire Type**	Wildfire





Source: https://pgv3.airfire.org/playground/v3/emissionsresults.php?scenario_id=15d7dea586f1a2

pgv3.airfire.org/playground/v3/emissionsresults.php?scenario_id=15d7dea586f1a2

Apps | API tutorials | Goo... | Imported | Smoke BlueSky Play... | LT-GEE Guide | EMAPRLAB-IAN - E... | LCMS Data Explorer | ไฟป่า : การติดตามสถา... | Orbiting watchtowe...

BlueSky Playground
3.0 Alpha

Emissions Inputs | Emissions Results | Meteorology Inputs | Dispersion Inputs | Dispersion Results

New Run
Run ID: 15d7dea586f1a2

Total Consumption and Emissions

Consumption	tons/acre
Duff	0.63
Flaming	10.26
Smoldering	2.74
Residual	2.03
Total	15.02

	BTU/ft^2
Heat	5517.32

Emissions	tons
$PM_{2.5}$	202.16
PM_{10}	217.09
CO	811.59
CO_2	10856.63
GHGs	12804.20
CH_4	45.44
NO_x	9.03
VOC	266.42
NH_3	6.92
SO_2	9.19

Run VSMOKE | Run HYSPLIT

Source: https://pgv3.airfire.org/playground/v3/emissionsresults.php?scenario_id=15d7dea586f1a2

Lackings and Challenges

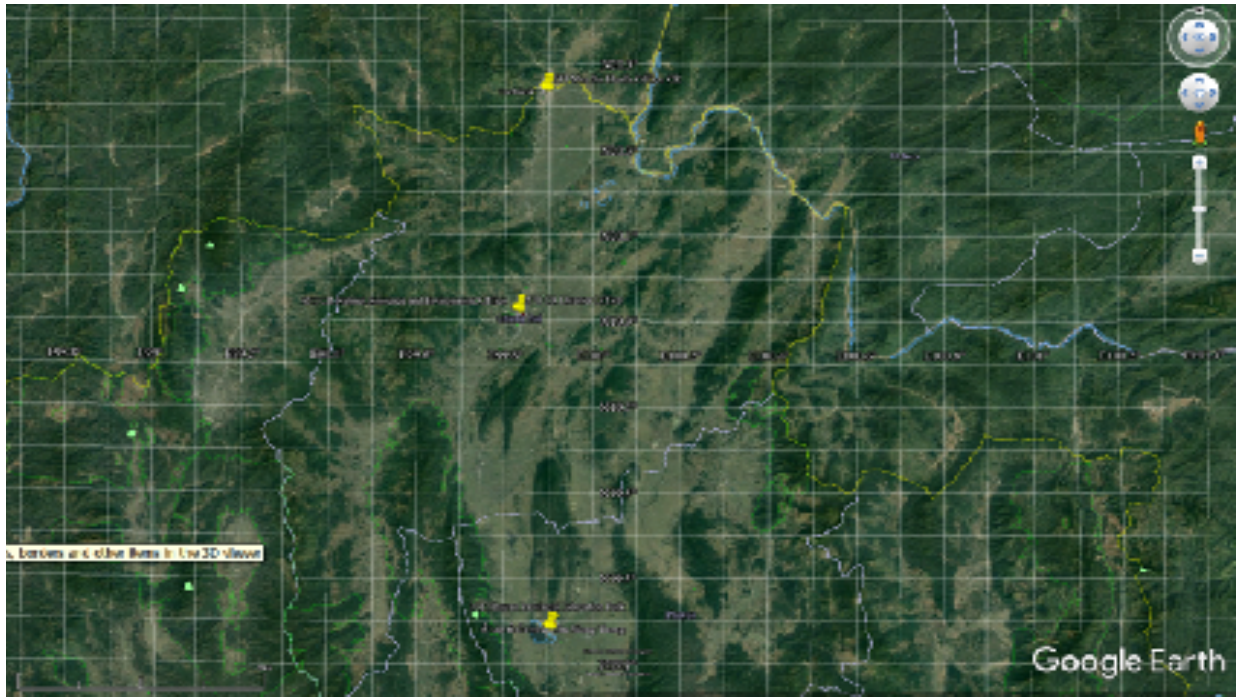
- **# of AF detected does not reflect how much burned areas really are, but its distribution can tell a bit of fire ignited behavior or fire regime**
- **Lacking** utilization of fundamental knowledge of fire, smoke and haze science including tools and advanced technologies based on scientific proves as the part of Control, Management and Planning (strengthen Science-Policy Interface – SPI)
- **Need** to continue study on active fire, smoke and haze behavior especially **FIRE WEATHER**
- AFSH do not really been recognized as a problem in the Upper ASEAN, so the real commitment to do what have been agreed on the table at ASEAN Level is not there (Critical to have players who really want to solve problems with authority in hand, etc.)
- In Upper ASEAN, ONLY Thailand has direct government offices to

Lackings and Challenges

- **No real continuous efforts**, pay more attention when bad incidents or episodes occur which is not good enough.
- **Not much of knowledge sharing/exchange, lesson learnt or problems solving** NEED effective communicate channel!
- "**Fire Prevention**" is still the main key!!! **As indeed, it is in fact a socio-economic issue!!!**
- **Smoke and haze is a transboundary issue, a true commitment with strong and solid international collaboration is really needed in order to reduce the problem! Need to expand the real working network through all possible collaborations (Very Difficult)!!**
- **Not enough air quality measurement stations to reflect the real smoke and haze situation, SEAS-HAZEMON 2nd Phase Project**

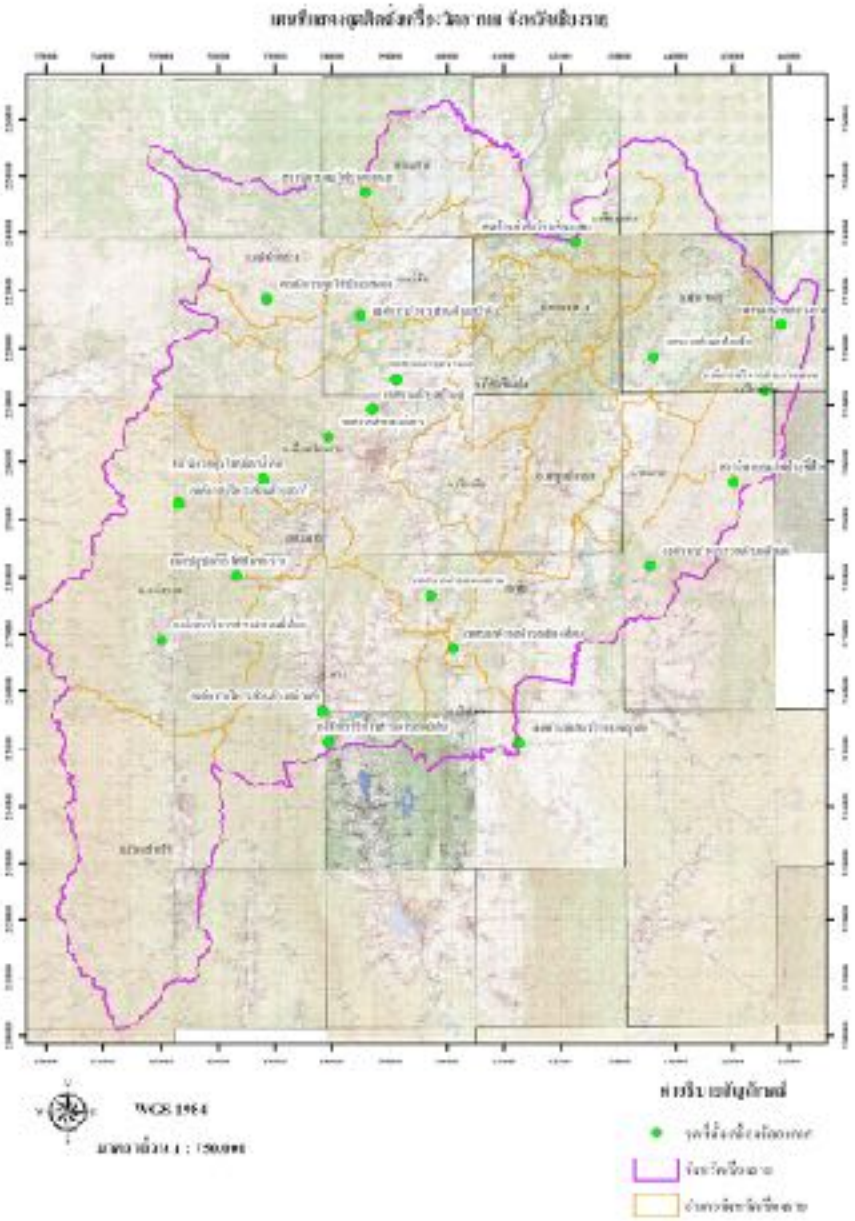
Proposed areas to install sensors are along country border of Chiangrai and Payao Province in DNP's and RFD's connections

Source: https://www.google.com/maps/



PCD Stations

Selected Locations for Installation within Chiangrai Province



ลำดับที่	สถานที่	ตำบล	อำเภอ	จังหวัด	X	Y
1	องค์การบริหารส่วนตำบลกรีดอย	กรีดอย	แม่สรวย	เชียงราย	550157	2168848
2	องค์การบริหารส่วนตำบลสวี	สวี	แม่สรวย	เชียงราย	563104	2192701
3	ศูนย์ปฏิบัติการไฟป่าเชียงราย	แม่สรวย	แม่สรวย	เชียงราย	563166	2180080
4	สถานีควบคุมไฟป่าลำน้ำกก	แม่ต๋ำ	เมืองเชียงราย	เชียงราย	567821	2196987
5	เทศบาลตำบลแม่ข้าว	แม่ข้าว	เมืองเชียงราย	เชียงราย	579395	2204402
6	เทศบาลตำบลบ้านดู่	บ้านดู่	เมืองเชียงราย	เชียงราย	587022	2209145
7	เทศบาลตำบลนางแล	นางแล	เมืองเชียงราย	เชียงราย	591166	2214596
8	เทศบาลตำบลดอยลาน	ดอยลาน	เมืองเชียงราย	เชียงราย	597146	2176747
9	องค์การบริหารส่วนตำบลป่าตึง	ป่าตึง	แม่ลาว	เชียงราย	584944	2225685
10	เขตห้ามล่าสัตว์ป่าเชียงแสน		เชียงแสน	เชียงราย	622508	2238153
11	เทศบาลตำบลห้วยสัก	ห้วยสัก	เชียงคำ	เชียงราย	636189	2218463
12	เทศบาลตำบลม่วงยาย	ม่วงยาย	เวียงแก่น	เชียงราย	658458	2223960
13	องค์การบริหารส่วนตำบลปอ	ปอ	เวียงแก่น	เชียงราย	663558	2212528
14	สถานีควบคุมไฟป่าภูชี้ฟ้าฯ		เทิง	เชียงราย	660272	2196181
15	องค์การบริหารส่วนตำบลตับเต่า	ตับเต่า	เทิง	เชียงราย	635591	2181880
16	เทศบาลตำบลตำบลเชียงเคี่ยน	เชียงเคี่ยน	เทิง	เชียงราย	601085	2167374
17	เขตห้ามล่าสัตว์ป่าทับทิมสยาม		ปัวแดง	เชียงราย	612801	2150873
18	องค์การบริหารส่วนตำบลงวงลำ	งวงลำ	พาน	เชียงราย	578345	2156467
19	องค์การบริหารส่วนตำบลเมืองพื้น	เมืองพื้น	พาน	เชียงราย	579364	2151045
20	สถานีควบคุมไฟป่าดอยคูงฯ		แม่ฟ้าหลวง	เชียงราย	585790	2247095
21	สถานีควบคุมไฟป่าแม่ฟ้าหลวง		แม่ฟ้าหลวง	เชียงราย	568651	2228548