


GFED Fire Monitoring:
Improvements to Crop Residue Emissions

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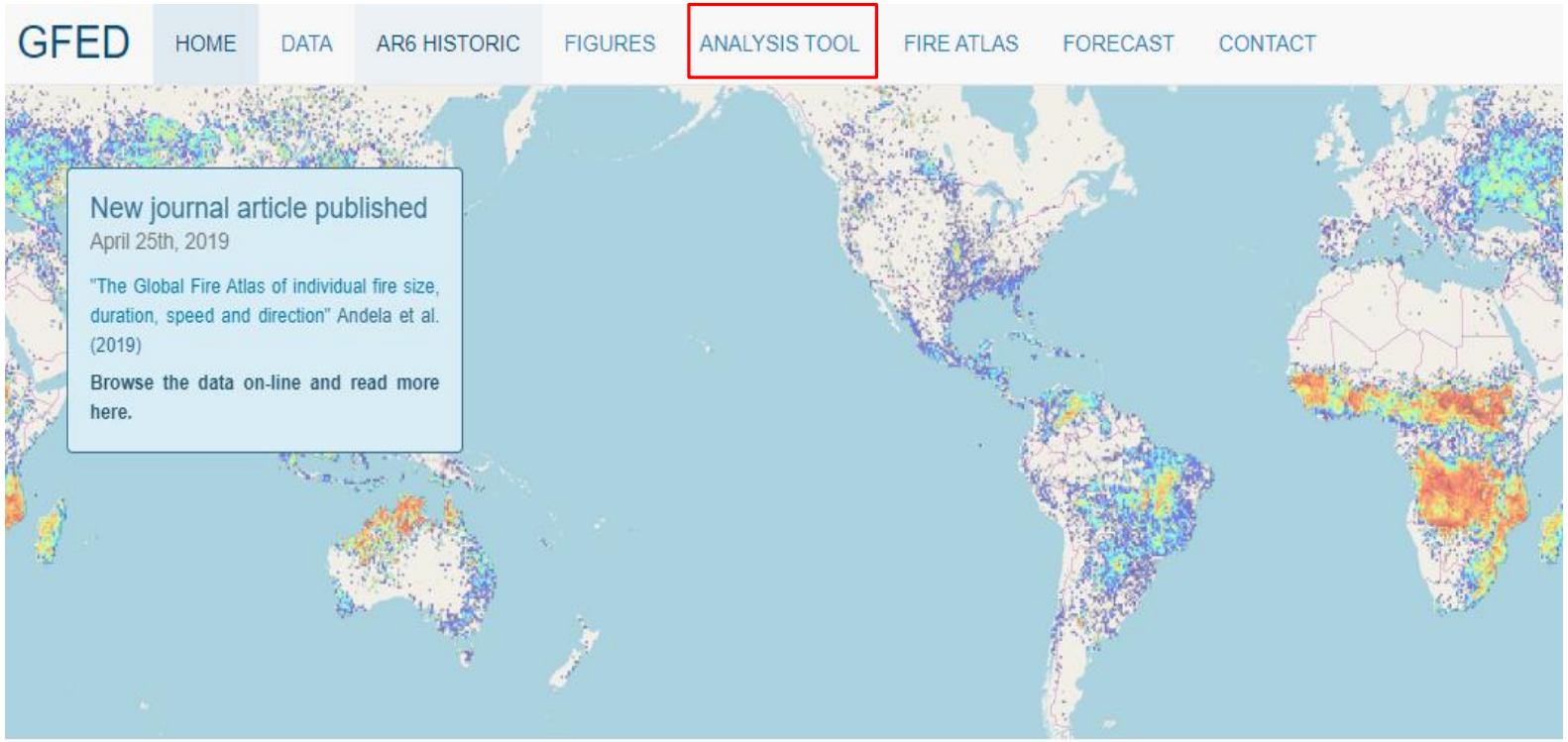
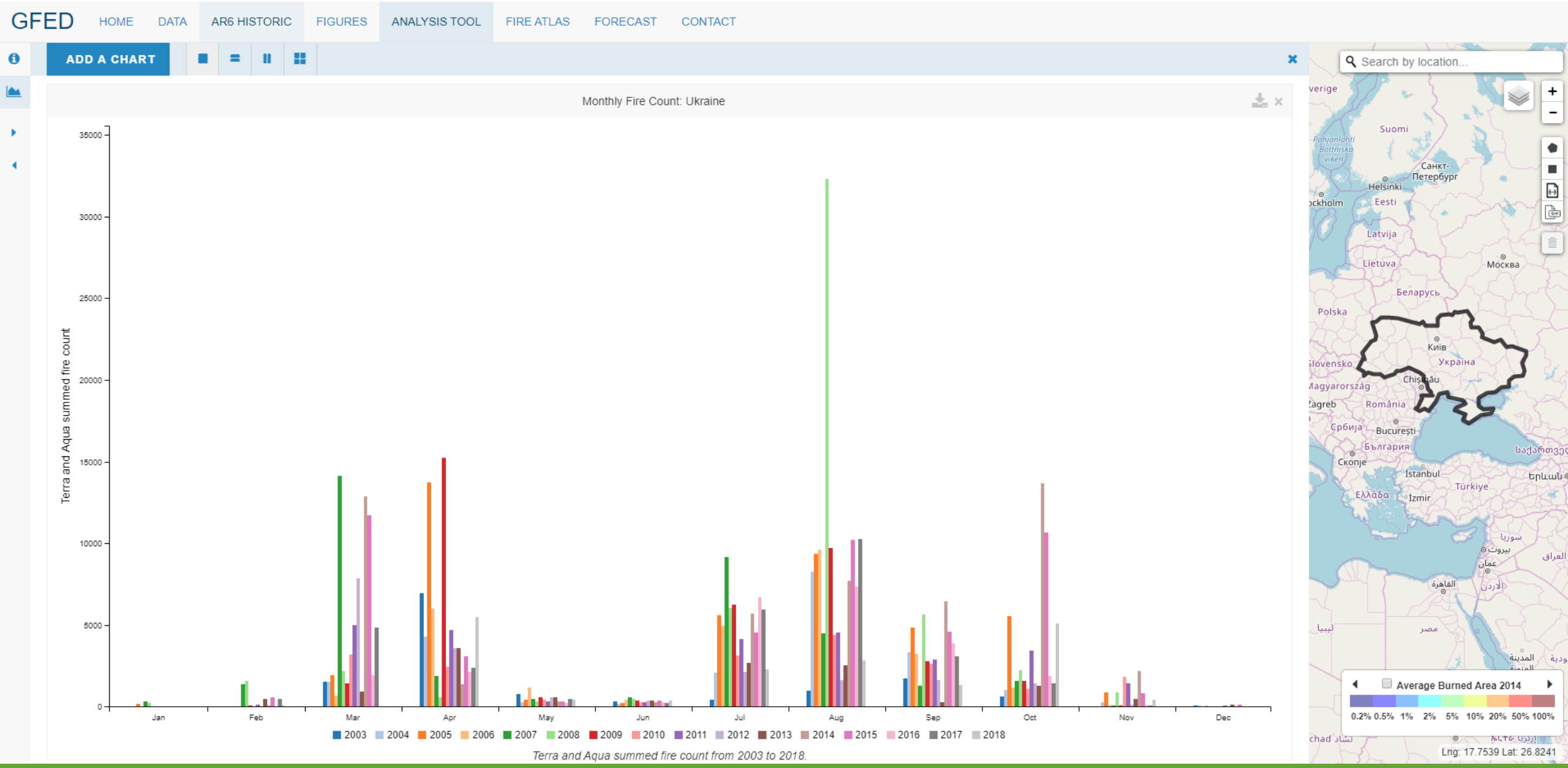
Global Fire Emissions Database (GFED)

Website: https://www.globalfiredata.org/index.html



Monthly MODIS Active Fire Count: Ukraine (2003 – 2018)



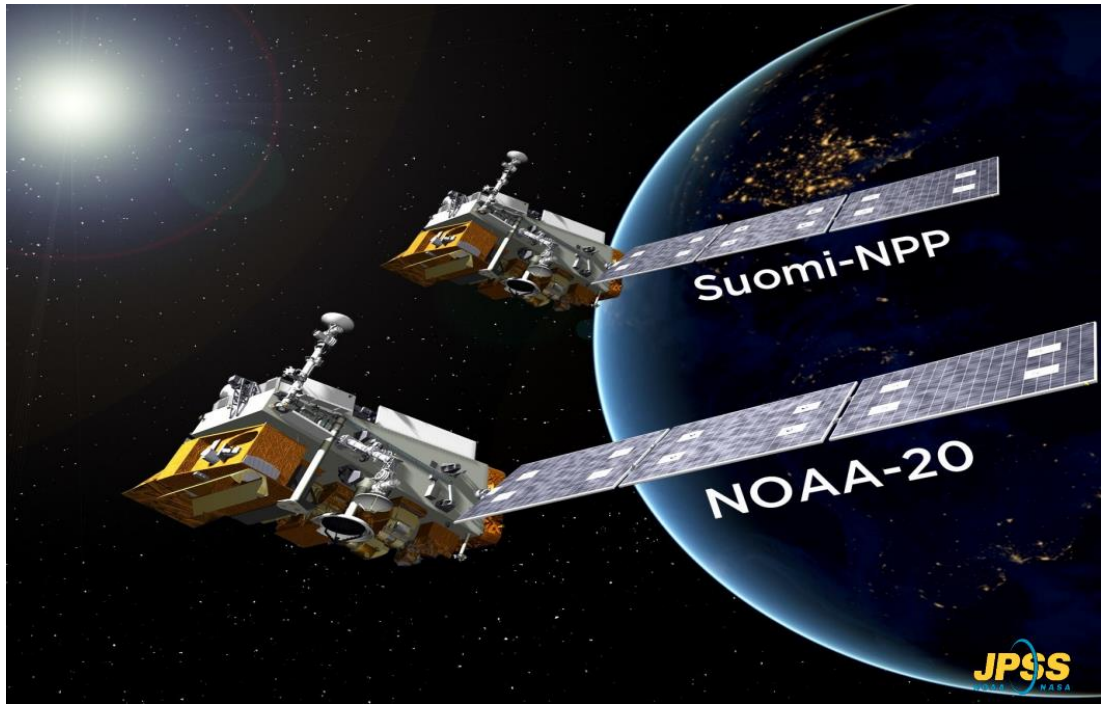
GFED Product History

Version	Spatial Resolution	Burned Area Approach	Notes
GFED v1 (2003)	1 degree	TRMM active fires calibrated to BA using a few MODIS BA tiles	Tropics, monthly for 1998-2004
GFED v2 (2006)	1 degree	MODIS active fires calibrated to BA	Global, monthly
GFED v3 (2010)	0.5 degree	Nearly complete MODIS BA from MCD64A1	Global, monthly, daily and 3-hourly deforestation fires
GFED v4 (2017)	0.25 degree	Wall-to-wall MODIS BA, augmented by a statistical approach to capture small fires	Fuel consumption constrained using obs. Improved emission factors from Akagi et al.
GFED v5 (2020/2021)	?	MODIS BA adjusted by Sentinel/Landsat BA	New emissions factors, **near real time**, validation with ILAMB and atm. CO

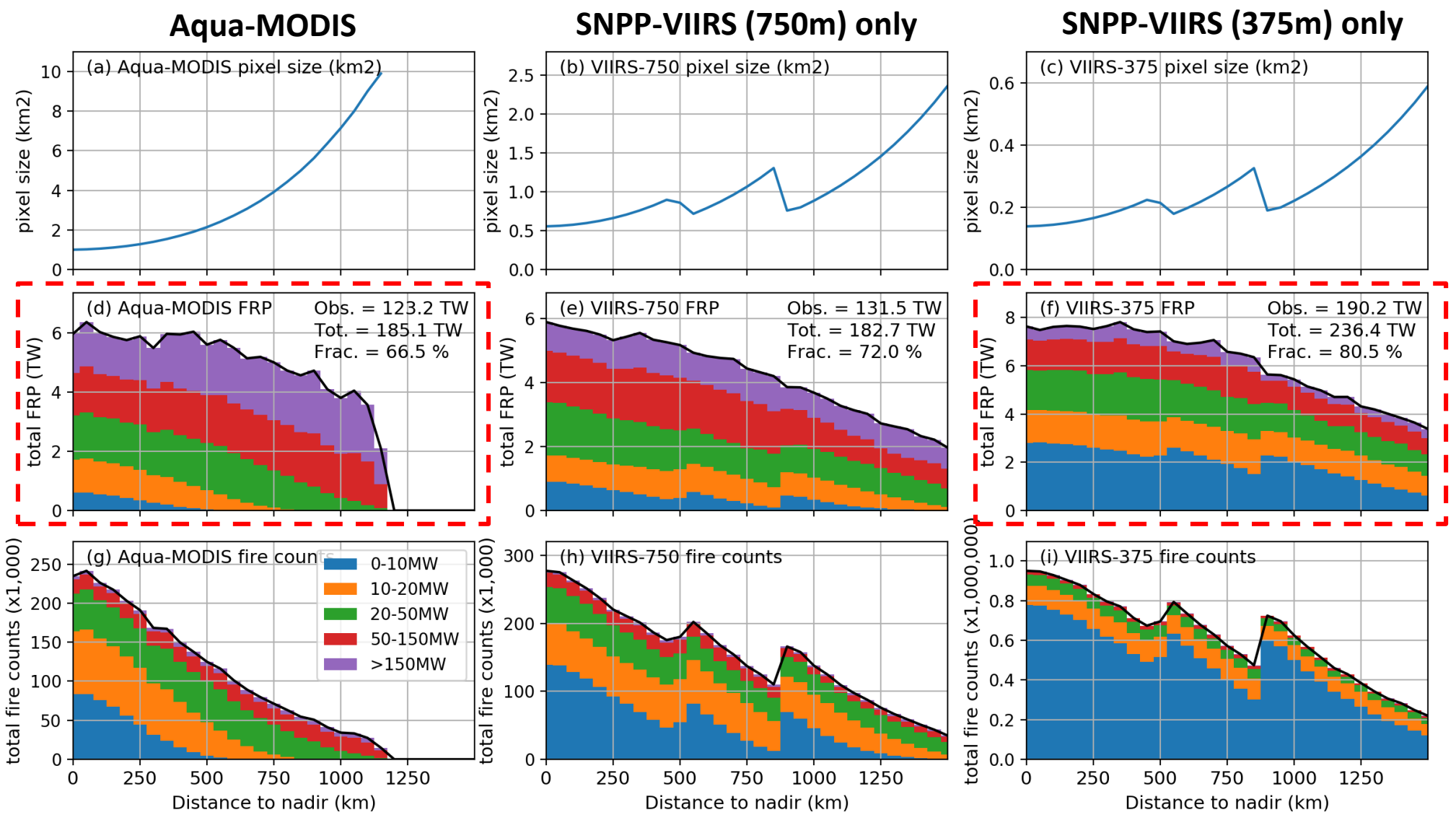
GFED5 – Ongoing Research Project

Near Real Time Component

- Led by NASA colleagues (Dr. Niels Andela)
- Based on VIIRS (Suomi-NPP and NOAA-20)
- Better captures/reduces day-to-day active fire variability caused by off-nadir scan angles
- Calibrated against VNP14IMGML
  - 375m active fire product



2013 – 2018 global mean

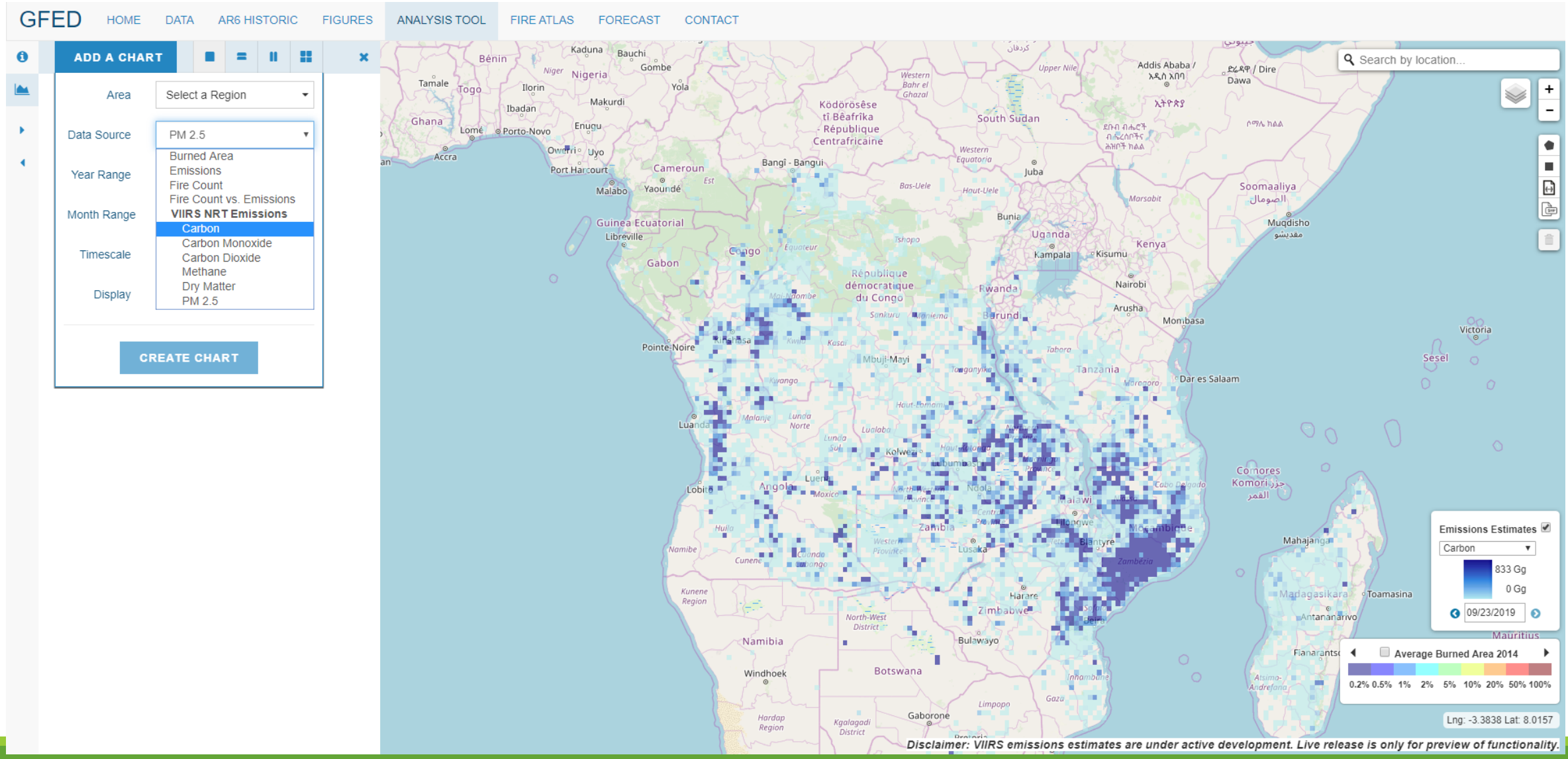


VIIRS 375 observed more FRP due to small omission of small fires

Combining both VIIRS sensors – only use data up to 750km off-nadir thereby reducing scan angle effect

Created by Niels Andela

Updated GFED NRT Analysis Tool (under development)



GFED5 – Ongoing Research Project

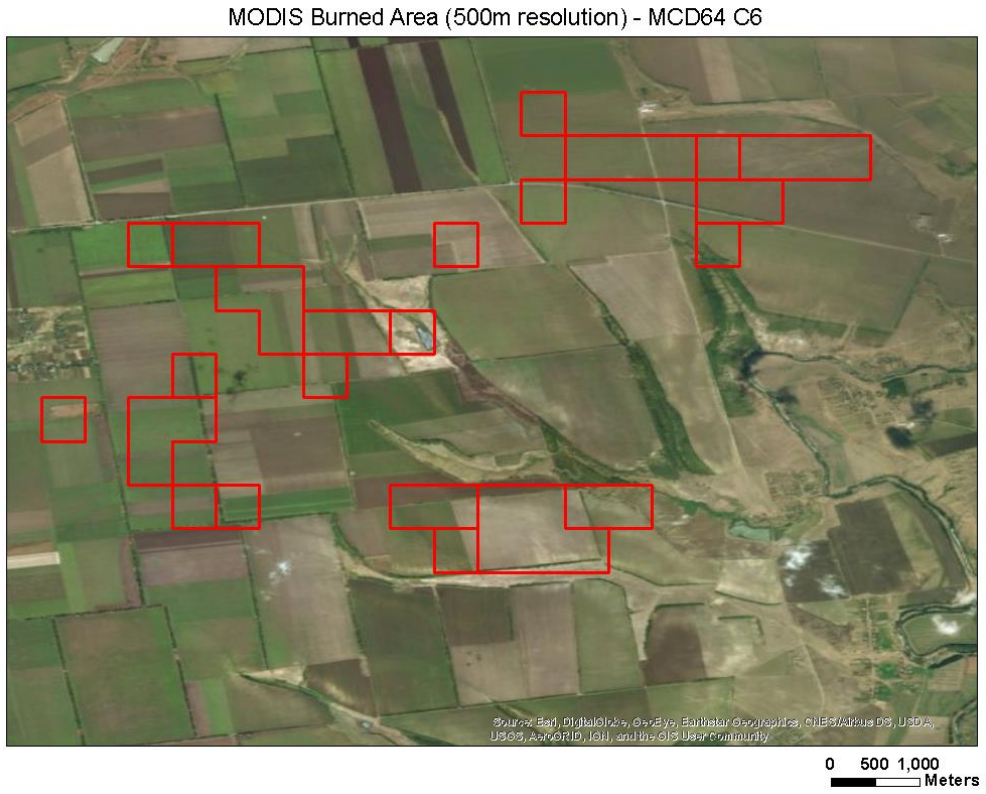
Improved Spatial Resolution

- GFED4 = MCD64 (500m) burned area product
- GFED4s = MCD64 with Small Fire scaling factor
- GFED5 = Coarser BA product (likely MCD64) will be calibrated against Landsat/Sentinel (30m) BA

- GFED4 = 0.25 degree spatial resolution
- GFED5 < 0.25 degree spatial resolution

GFED5 Improvements – Ongoing Research

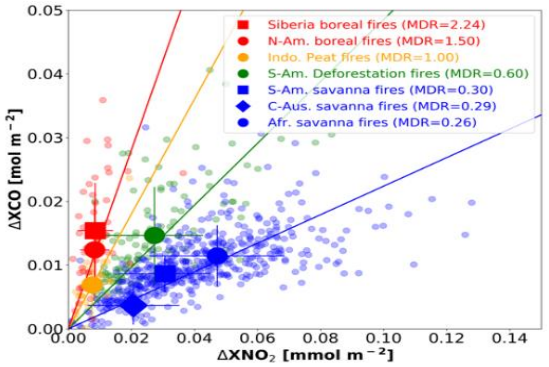
Improved burned area resolution = improved emission estimates



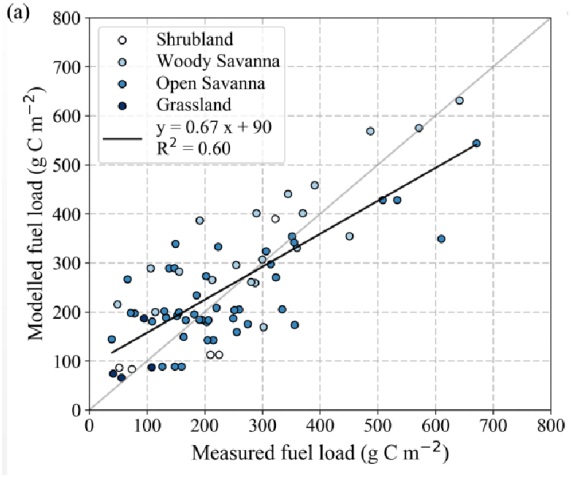
GFED5 – Ongoing Research Project

Fuel Consumption and Emission Factors Improvements

- Led by Dr. Guido van der Werf et al. (Vrije Universiteit Amsterdam)
- For all major land cover types



Van der Velde et al. (in prep)



Van Wees and van der Werf (in press)

Crop Residue Burning Improvements

Led by University of Maryland

Complete overhaul of current crop residue burning representation in GFED/CASA

Agricultural Waste ----> Crop Type Specific Information

Improved representation of cropland “burned area”

- Global BA products are not suitable
- But…..we require a global method

Emissions Calculation using Satellites

Emissions = A x PB x FL x CF x EF

- A* = Planted area
- PB* = Percent of the surface burned
- FL = Fuel load (amount of straw and stubble available to burn)
- CF = Combustion factor (completeness of combustion)
- EF = Emissions factor of a trace gas species

*Modifications from standard GOCF-GOLD/IPCC-AFOLU equations by Lasko and Vadrevu (2018) to account for lack of reliable burned area data at the field scale

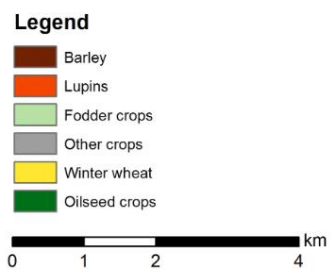
Crop Type Maps

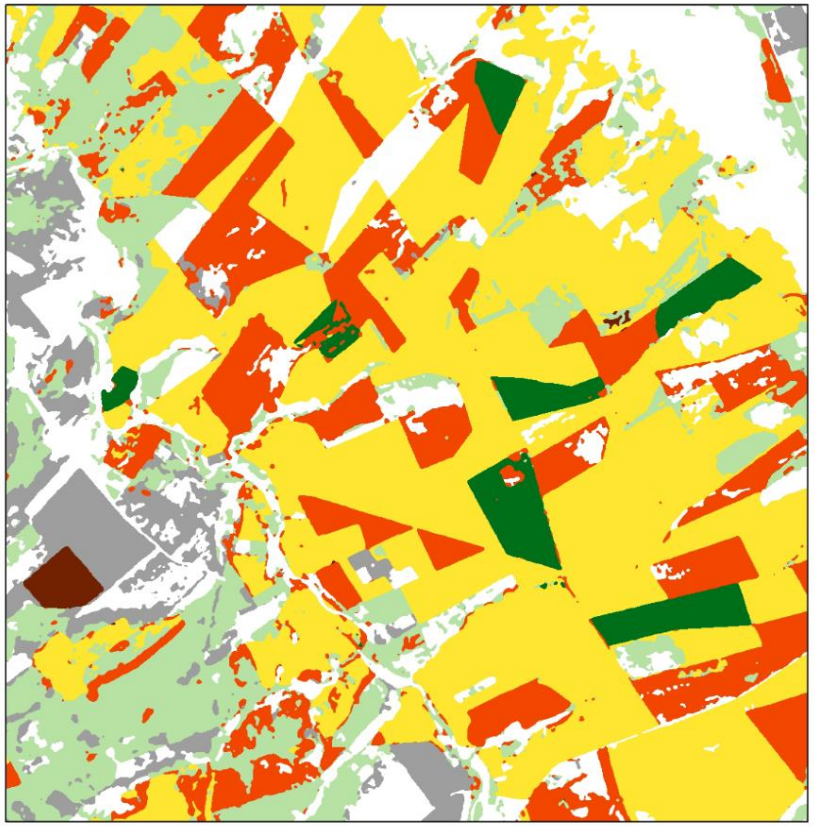
Identify crop types using satellites

Crop type is important to accurately calculate emissions from burning

Crop type impacts emission factor

Example from southern Africa





http://www.esa-sen2agri.org/products/crop-type-map

Emission Coefficients

GFED4 Emission Factors

```
# SAVA: Savanna, grassland, and shrubland fires
# BORF: Boreal forest fires
# TEMF: Temperate forest fires
# DEFO: Tropical deforestation & degradation
# PEAT: Peat fires
# AGRI: Agricultural waste burning
#
# SPECIE            SAVA     BORF     TEMF     DEFO     PEAT     AGRI
#                  ------------------------------------------------
DM                  1000     1000     1000     1000     1000     1000
C                 488.273  464.989  489.416  491.751  570.055  480.352
CO2                 1686     1489     1647     1643     1703     1585
CO                    63      127       88       93      210      102
CH4                 1.94     5.96     3.36     5.07     20.8     5.82
NMHC                 3.4      8.4      8.4      1.7      1.7      9.9
H2                   1.7     2.03     2.03     3.36     3.36     2.59
NOx                  3.9      0.9     1.92     2.55        1     3.11
N2O                  0.2     0.41     0.16      0.2      0.2      0.1
PM2.5               7.17     15.3     12.9      9.1      9.1     6.26
TPM                  8.5     17.6     17.6       13       13     12.4
TPC                    3     10.1     10.1     5.24     6.06     3.05
OC                  2.62      9.6      9.6     4.71     6.02      2.3
BC                  0.37      0.5      0.5     0.52     0.04     0.75
```

AGRI based off Akagi et al., 2011 crop residue biome

Table 5
Emission coefficient for agricultural residue burning.

Biomass type	CH_4	CO_2	CO	Reference
Emission factor (g/kg)				
Agricultural residue	2.70	1515 ± 177	92 ± 84	[44]
Wheat straw	7.37 ± 2.72		156 ± 22	[45]
Rice straw	5.32 ± 3.08		82 ± 20	[45]
Wheat straw	3.55 ± 2.66	1787 ± 35	28 ± 20	[43]
Wheat stubble			21.1 ± 1.9	[89]
Wheat fire			38.20	[89]
Wheat			44.1 ± 7.4	[89]
Wheat			59.00	[89]
Wheat			35.00	[89]
Cereal waste		1400	35.00	[53]
Wheat residue	2.62–8.97	959–1320	61.1–179	[86]
Wheat residue	0.59–2.04	1540–1615	26–64	[87]
Wheat straw	0.41		34.65	[88]
Default emission ratio				
Agricultural residue	0.01		0.06	[20]

Example taken from:
http://wgbis.ces.iisc.ernet.in/energy/paper/rser_carbon_footprint/methods.htm

Local Information Needed

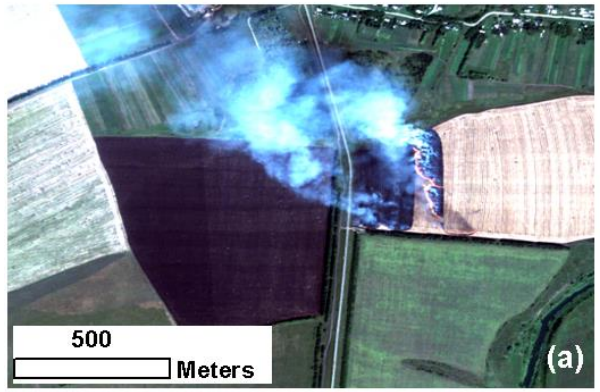
Field level information to help improve fire mapping and emissions calculations in cropland

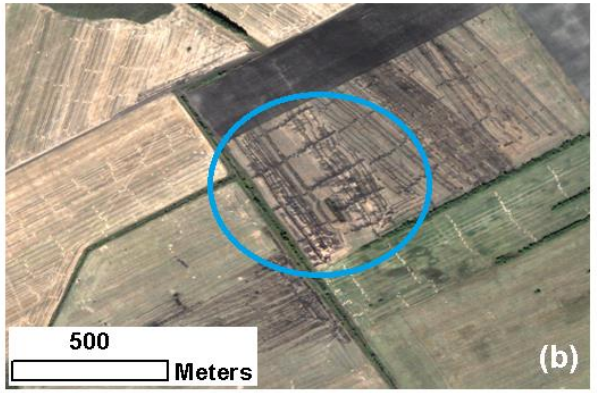
1) Causes of burning

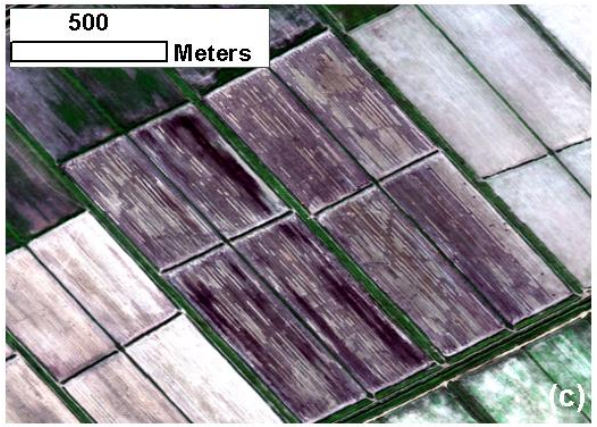
2) Why are some fields only partially burned?

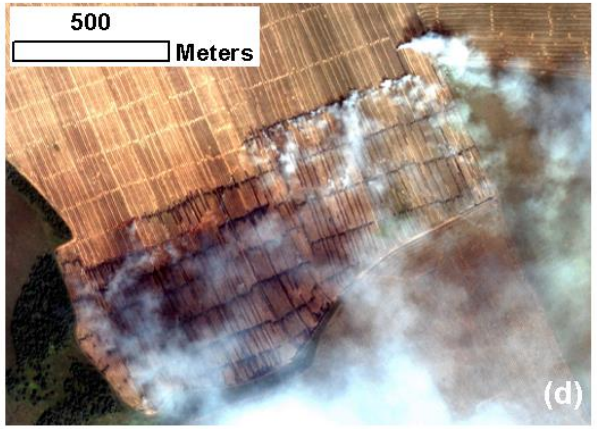
3) How quickly do you till/plow after burning?

4) How do you burn your fields?









Source: Kelley O'Neal

Thank You