Global Biomass Burning Emissions Product (GBBEPx)

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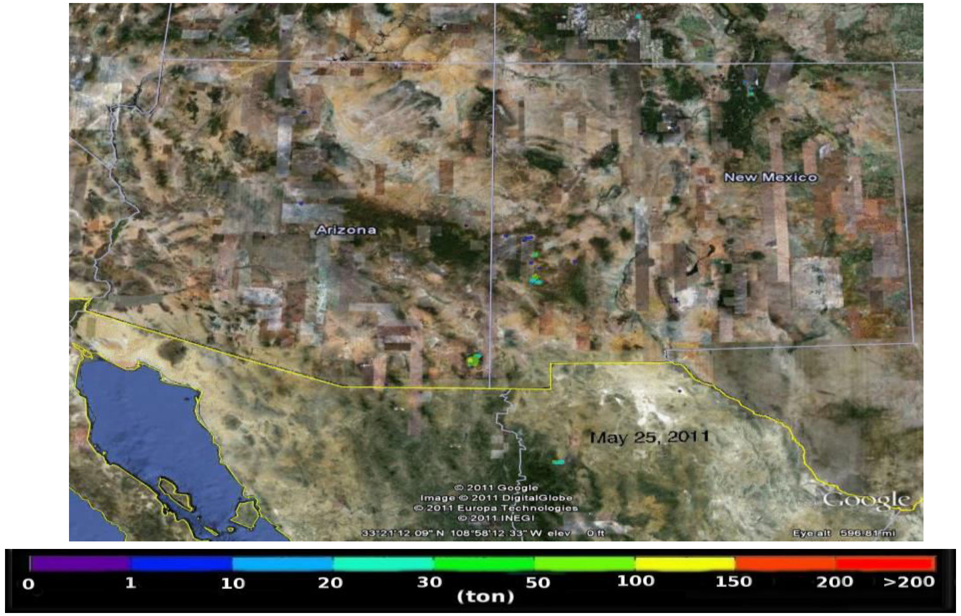
Funded by JCSDA, G-PSDI, and J-PSDI



Biomass Burning

- Fires release large amounts of aerosols into the atmosphere that have adverse affects on human health and economy
  - Long range transport of smoke from fires impacts air quality in downwind regions. Worldwide 250,000 premature deaths per year (Jacobson, JGR, 2014).
  - Impacts national parks, monuments, and transportation due to reduced visibility.

Ft. McMurray Fire, Canada, May 2016

Types of Fires

Air Quality Predictions

- Numerical models that predict air quality (ozone and PM2.5) need to know where the fires are located, how high is the aerosol loading being emitted, at what height is the plume injection, and the duration of the fire.
- Near real time information from satellites that models need
  - Fire location - ***yes***
  - Fire Radiative Power (a proxy to calculate emissions) - ***yes***
  - Fire duration (if satellite is in geostationary orbit) - ***yes***
  - Plume injection – ***no***
  - Aerosol composition - ***no***

Emissions Calculation

$$E_x = FRP \times \beta \times F$$

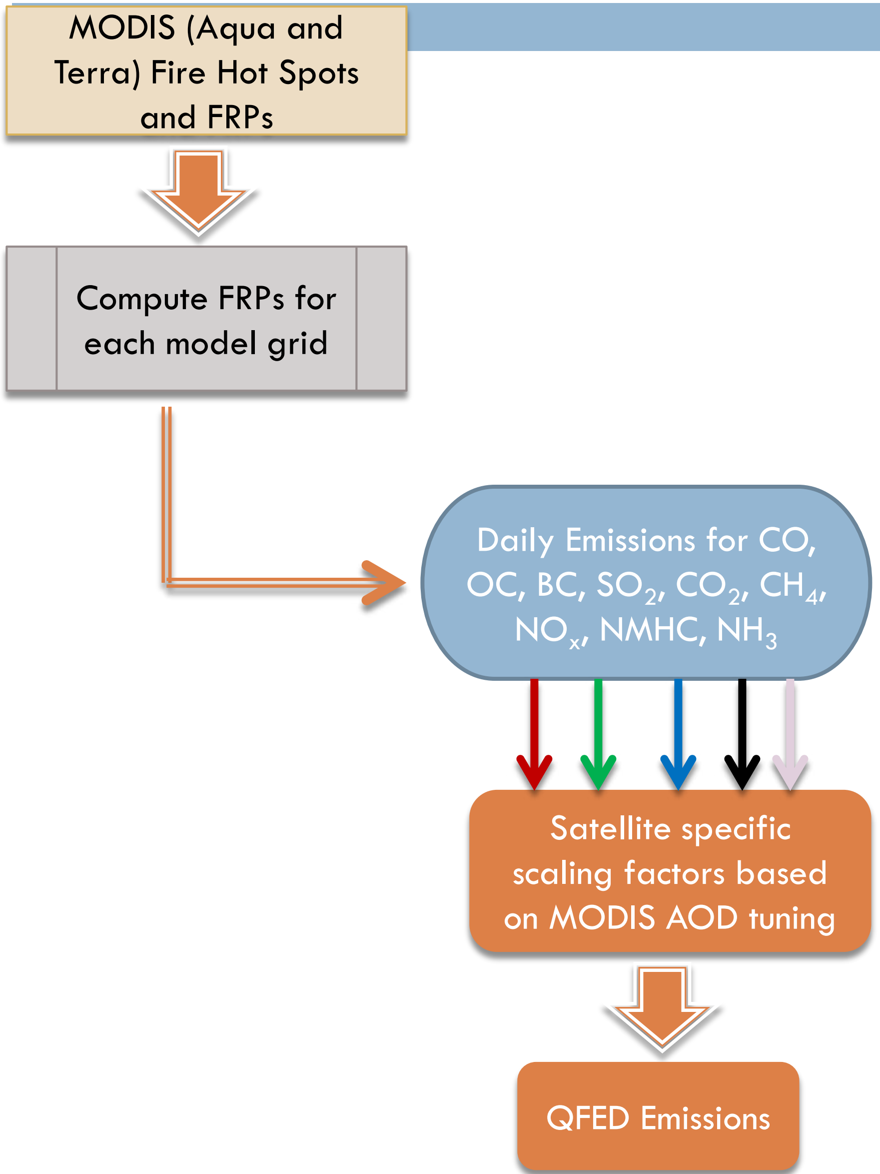
$$E_{fx} = \beta \cdot \frac{FRP}{A} \cdot F$$

E_x: biomass burning emissions (kg) of species x
S: burned area (km^2)
F: emission factors (g/Kg)
β: a combustion rate per unit energy (KgC/Joules)
A: area of the pixel

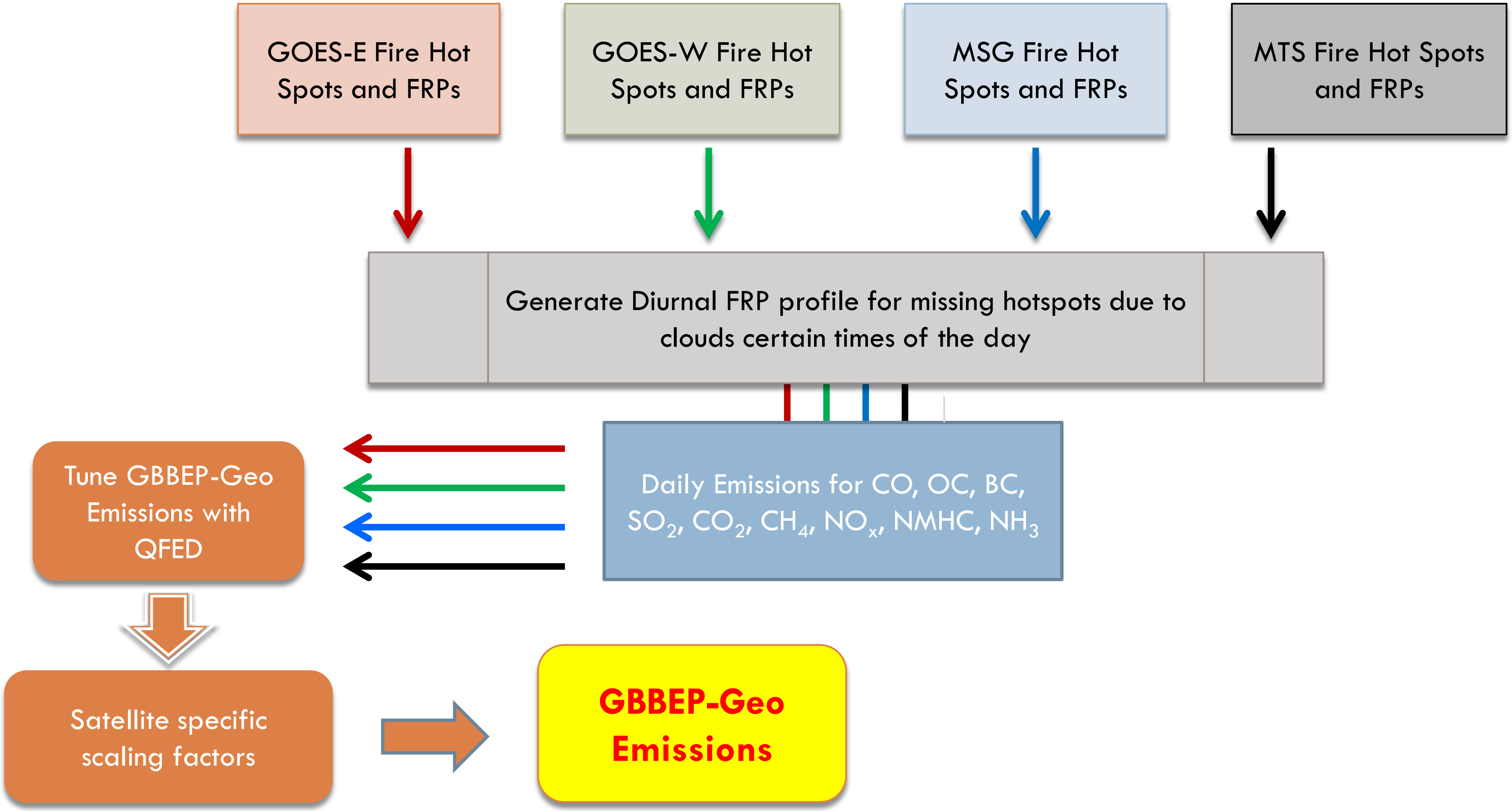
Emission Factors (g/kg) in computing GBBEP-Geo. LC1-forests, LC2-savanna, LC3-shrublands, LC4-grasslands, LC5-croplands.

	LC1	LC2	LC3	LC4	LC5	Average
PM2.5	12.3	7.35	9.3	5.4	5.8	8.04
CO	106.4	63.5	68	59	111	81.58
OC	7.74	4.6	6.6	2.6	3.3	4.97
BC	0.408	0.435	0.5	0.37	0.69	0.481
SO2	0.89	0.58	0.68	0.48	0.4	0.606
CO2	1586	1704	1716	1692	1537	1647.04
CH4	5.42	2.05	2.6	1.5	6	3.514
NOX	2	3.35	3.9	2.8	3.5	3.11
NMHC	4.9	3.4	3.4	3.4	7	4.42
NH3	2.152	0.845	1.2	0.49	2.3	1.3974

GBBEPx(1)


MODIS (Aqua and Terra) Fire Hot Spots and FRPs
Compute FRPs for each model grid
Daily Emissions for CO, OC, BC, SO_2, CO_2, CH_4, NO_x, NMHC, NH_3
Satellite specific scaling factors based on MODIS AOD tuning
QFED Emissions

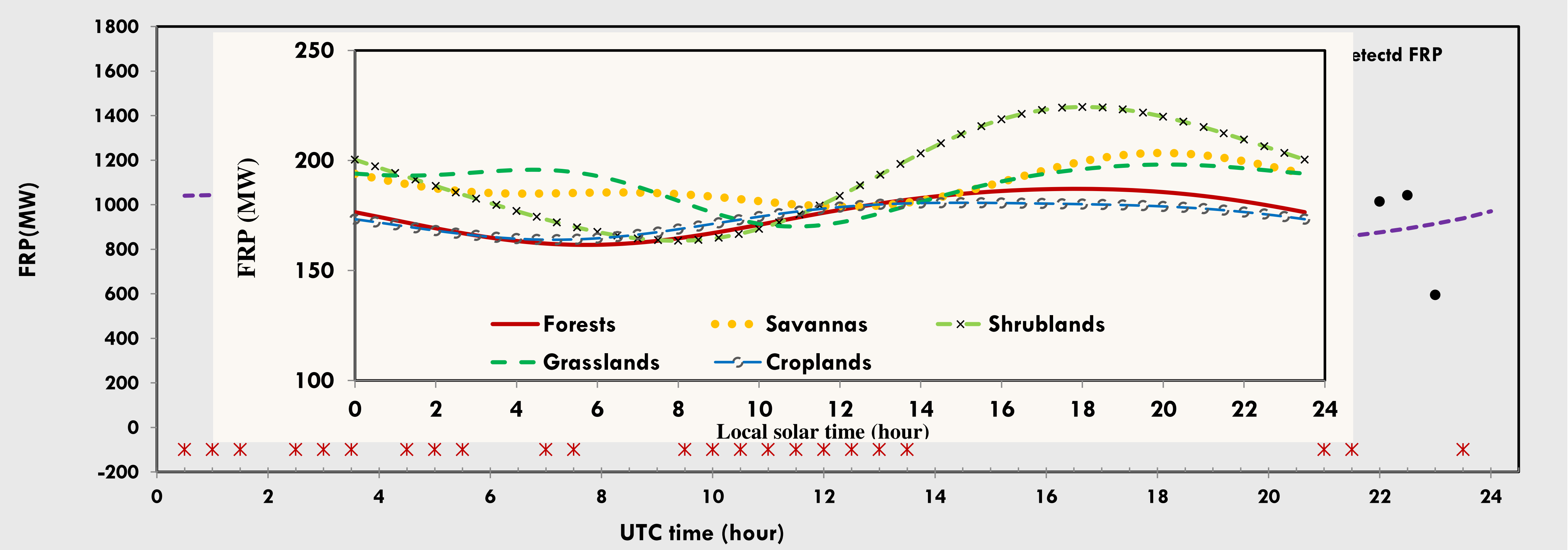
GBBEPx(2)


GOES-E Fire Hot Spots and FRPs
GOES-W Fire Hot Spots and FRPs
MSG Fire Hot Spots and FRPs
MTS Fire Hot Spots and FRPs
Generate Diurnal FRP profile for missing hotspots due to clouds certain times of the day
Daily Emissions for CO, OC, BC, SO_2, CO_2, CH_4, NO_x, NMHC, NH_3
Tune GBBEP-Geo Emissions with QFED
Satellite specific scaling factors
GBBEP-Geo Emissions

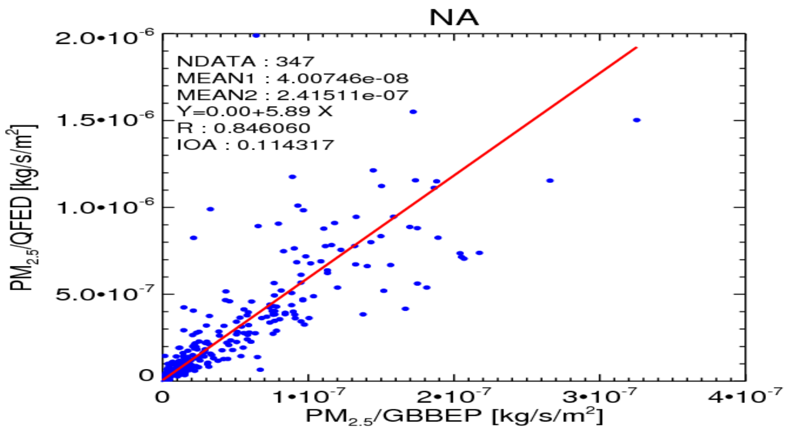
GBBEPx(2)

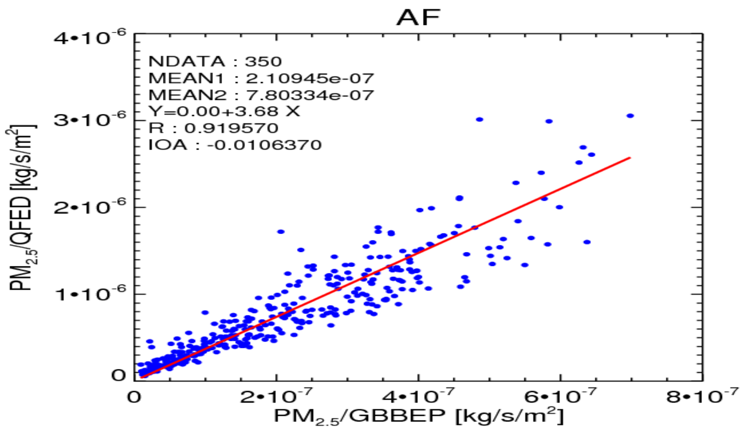
Generate Diurnal FRP profile for missing hotspots due to clouds certain times of the day

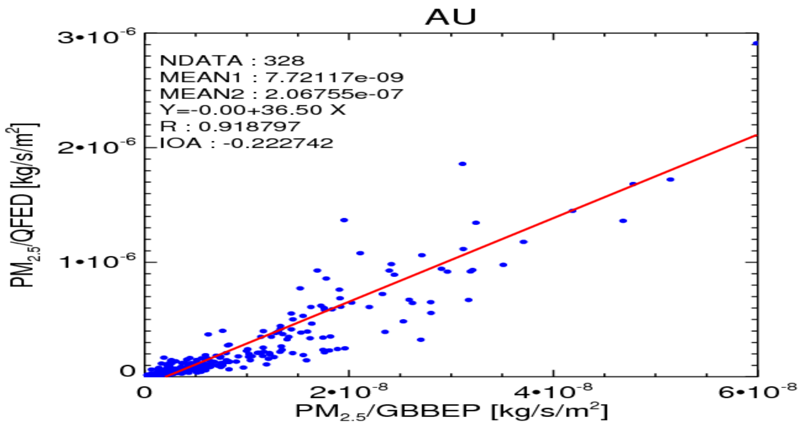
115.4°W , 44.49°N

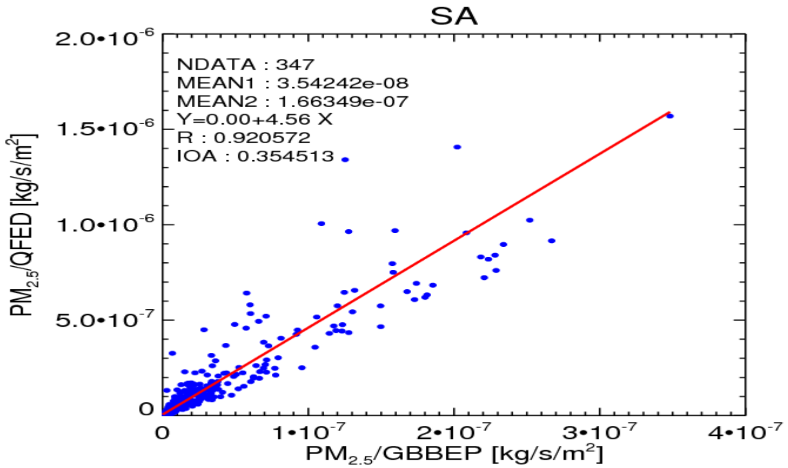


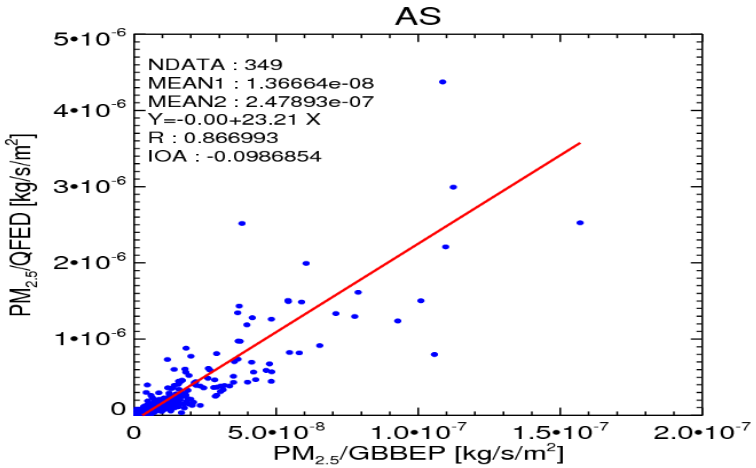
GBBEPx(2)











Tune GBBEP-Geo Emissions with QFED

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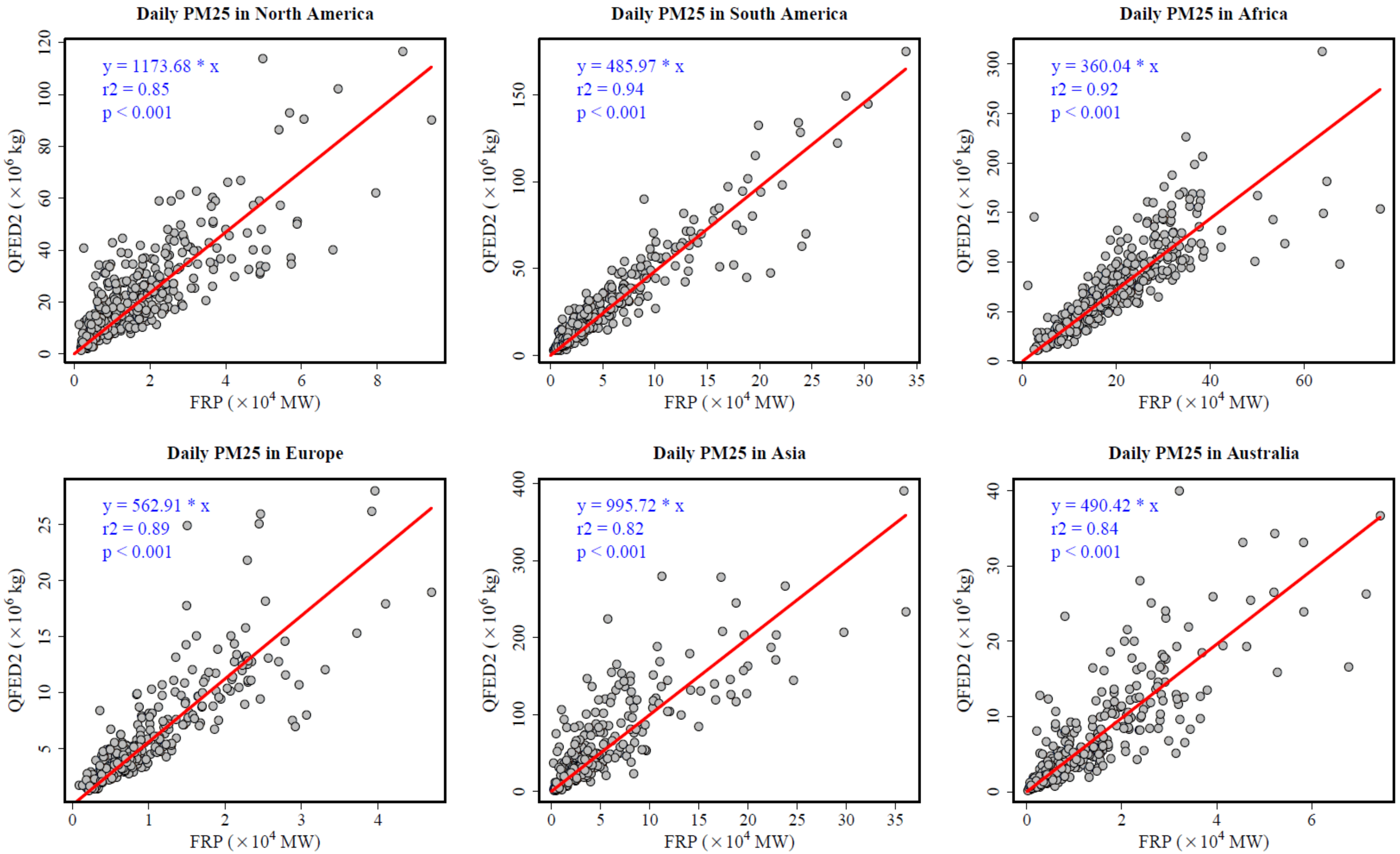
Satellite specific scaling factors

GBBEPx(3)

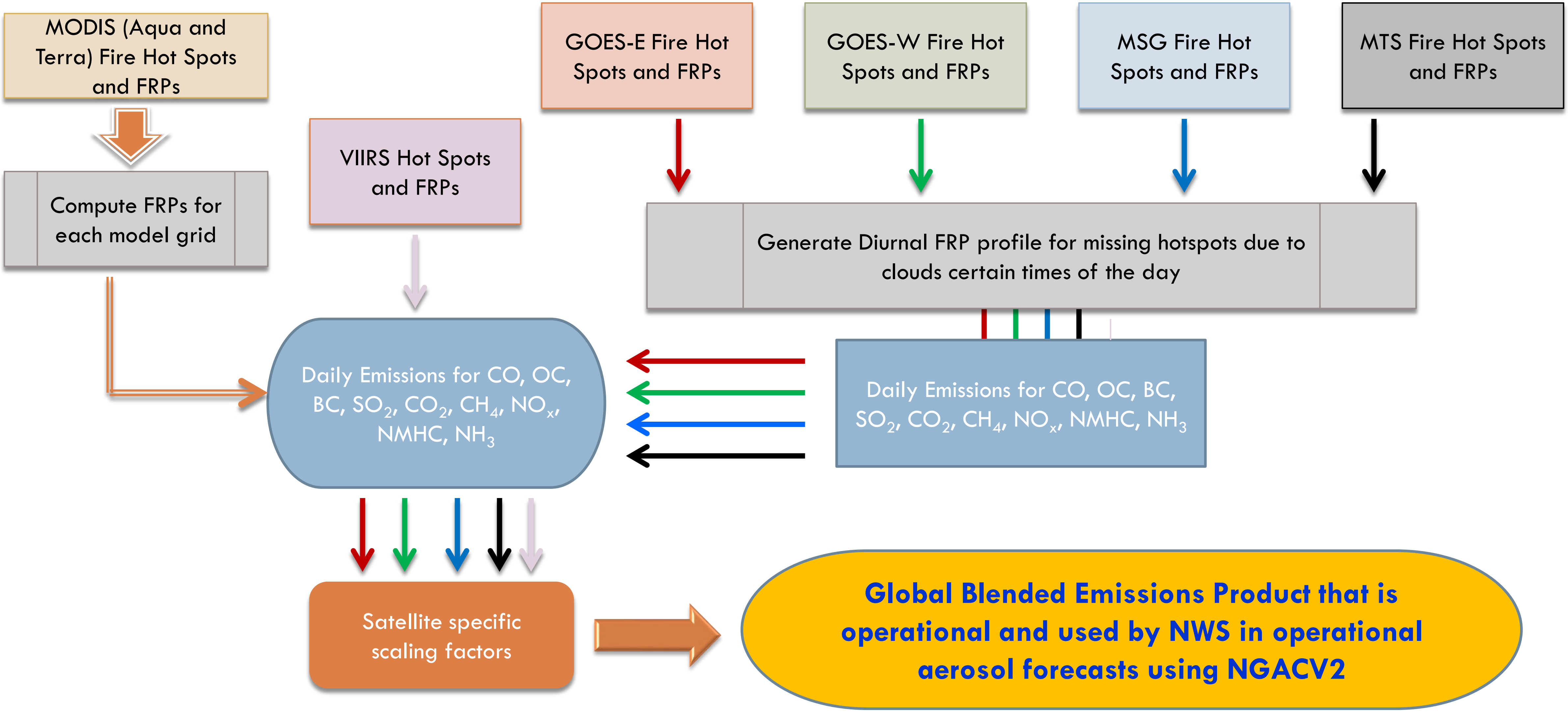
VIIRS Hot Spots and FRPs

Regress VIIRS FRPs with QFED Emissions

Daily Emissions for CO, OC, BC, SO_2, CO_2, CH_4, NO_x, NMHC, NH_3



GBBEPx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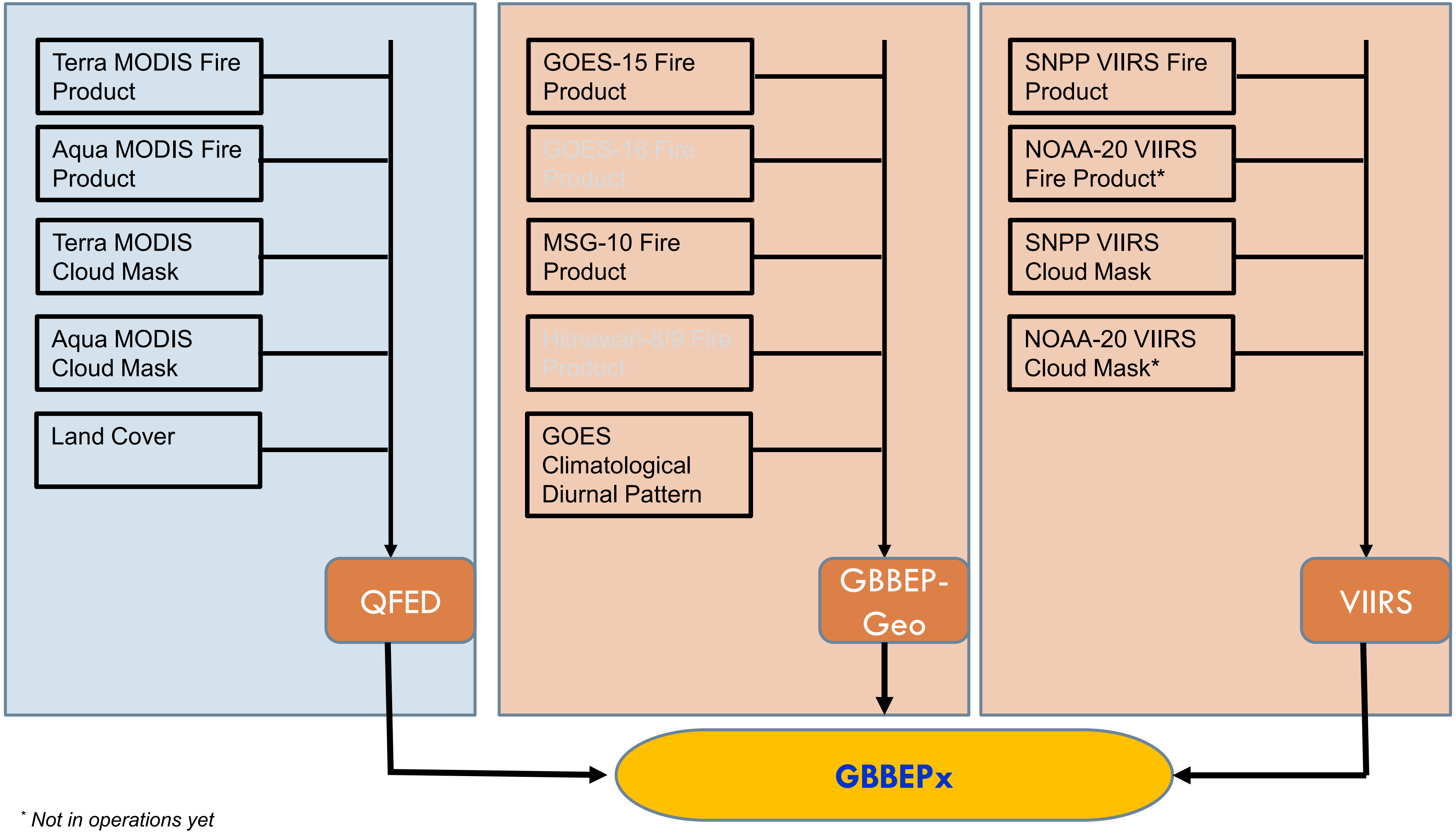
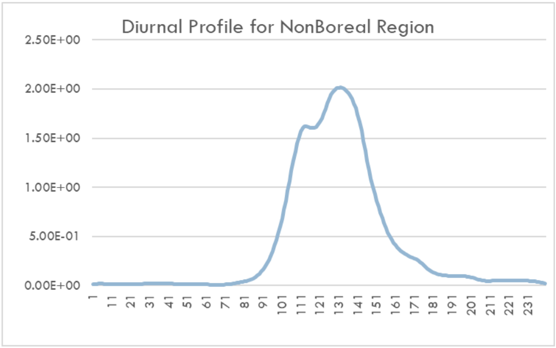
Satellite specific scaling factors
Global Blended Emissions Product that is operational and used by NWS in operational aerosol forecasts using NGACV2

GBBEPx



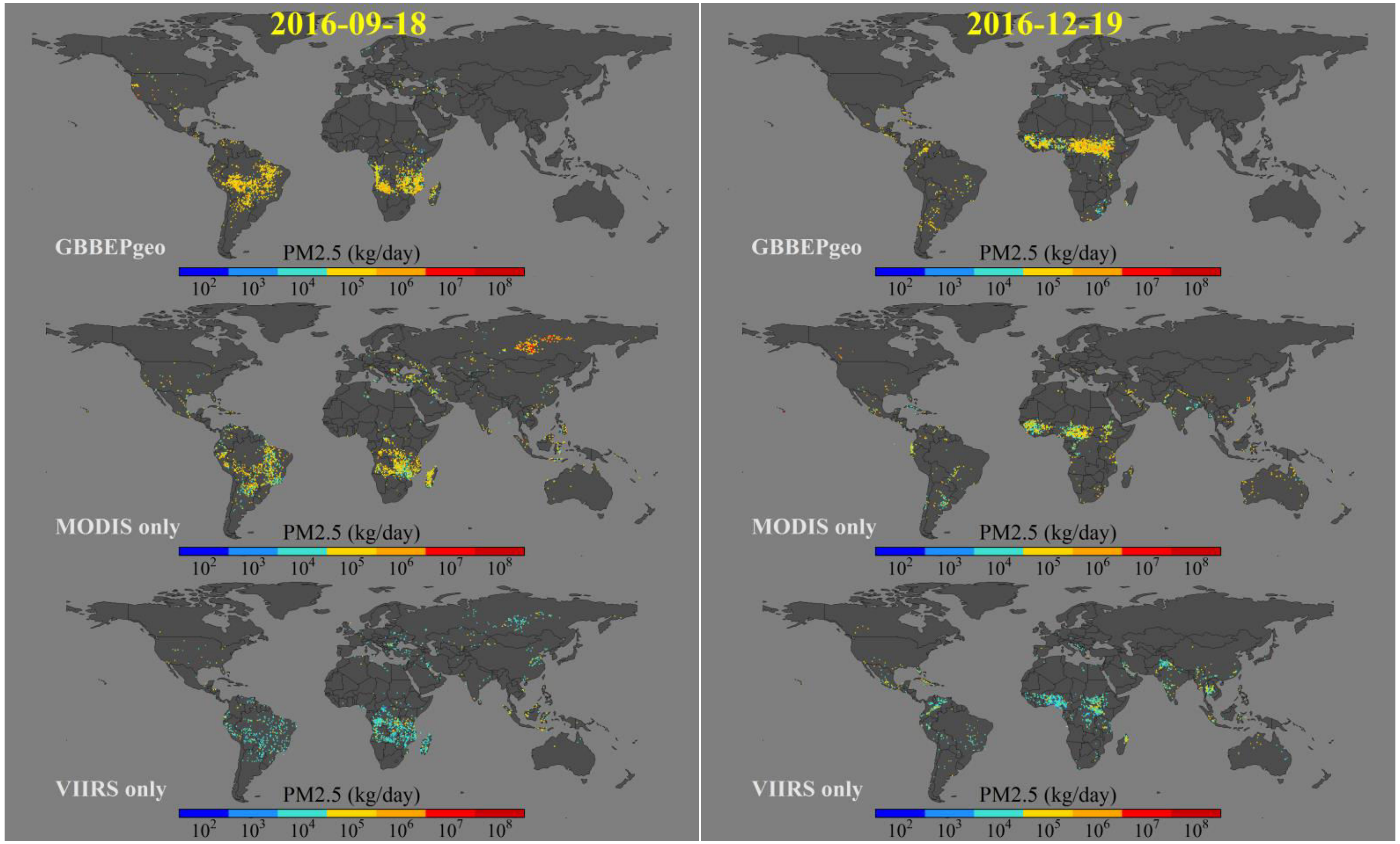
GBBEPx is an output of daily emissions, an average of QFED, GBBEP-Geo, VIIRS.



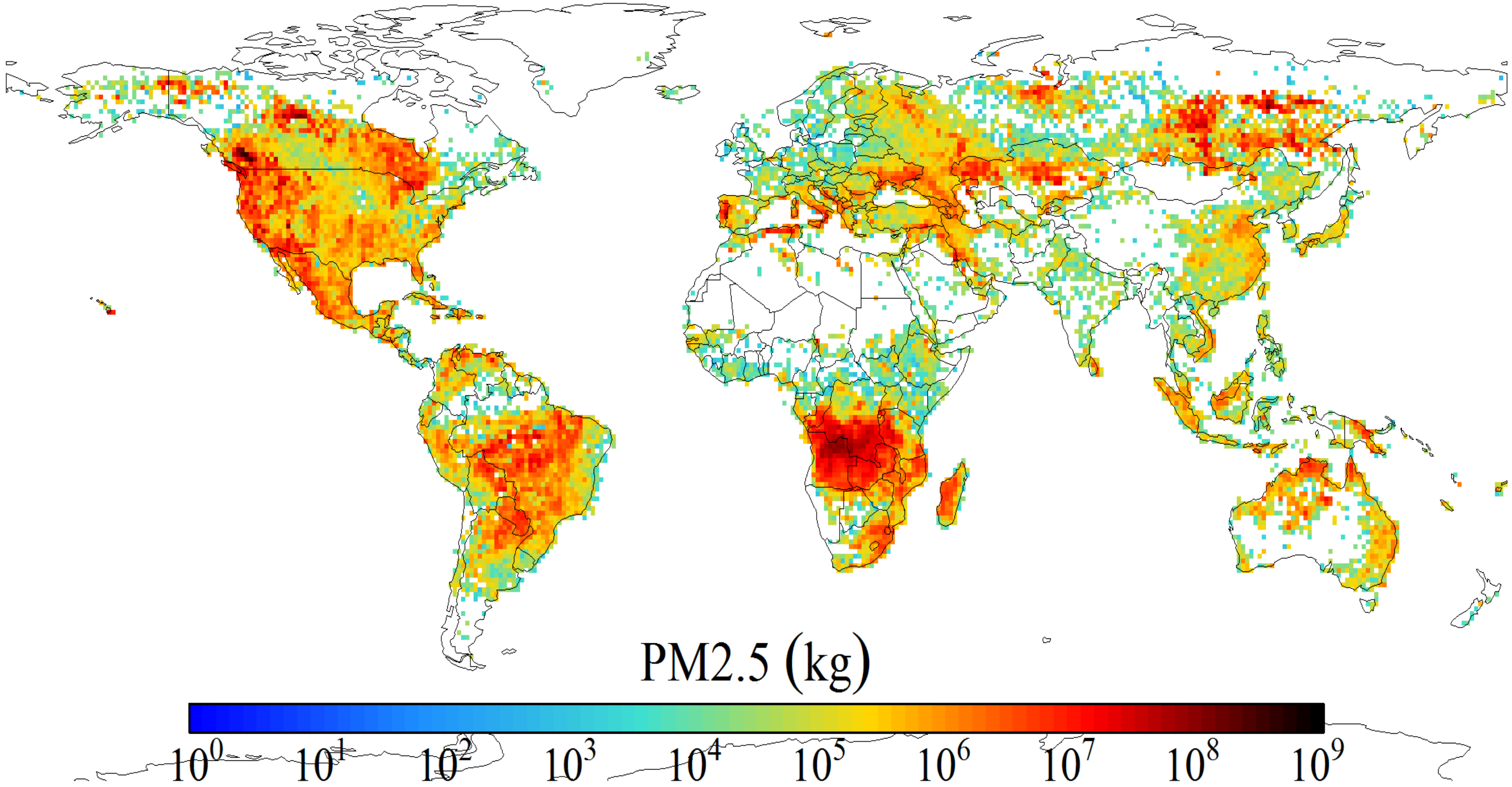
* *Not in operations yet*

Two examples of fire emissions:

- geostationary satellites only
- MODIS only
- VIIRS only



Total PM2.5 (June 15 – August 15 2017



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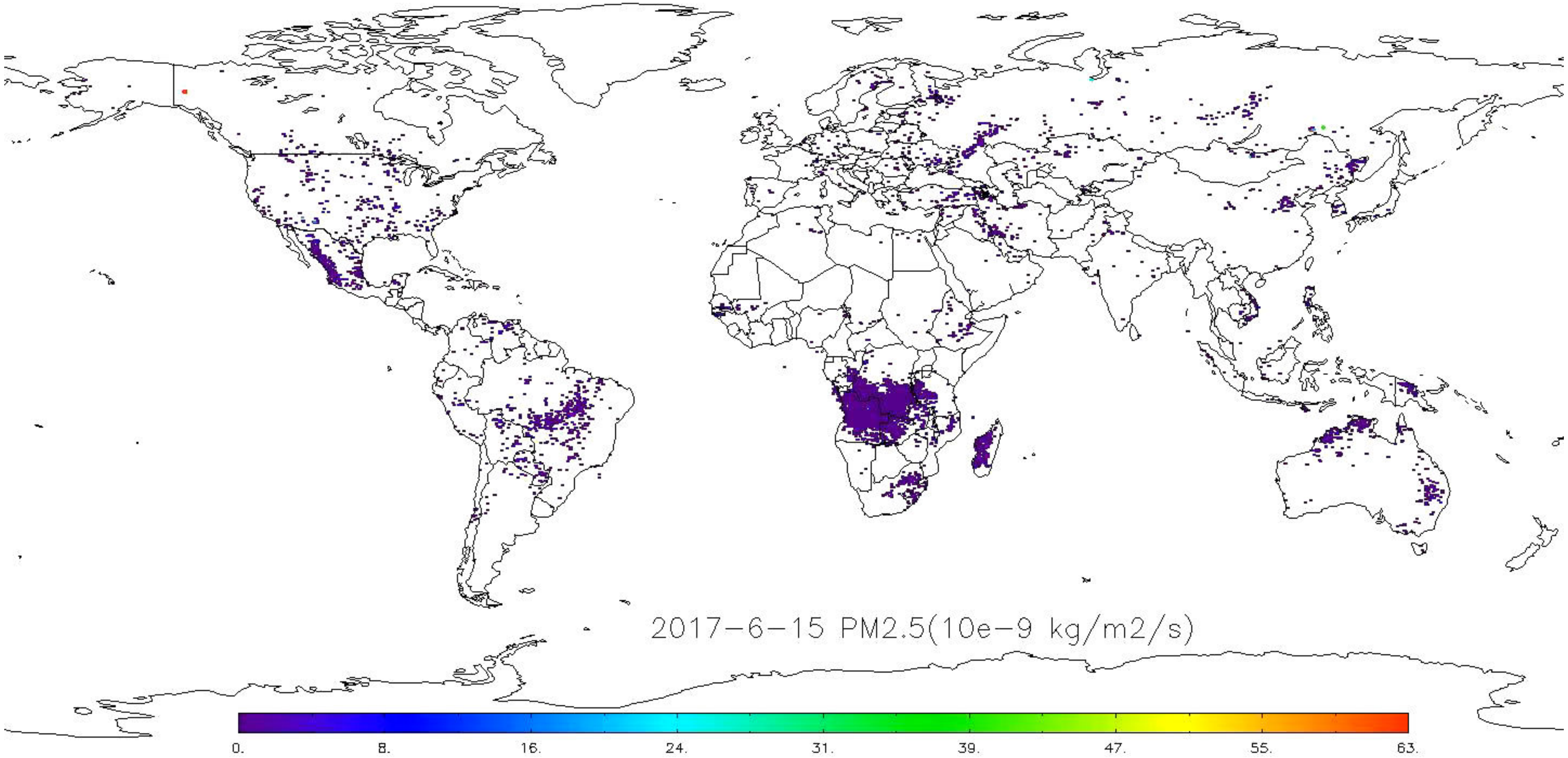
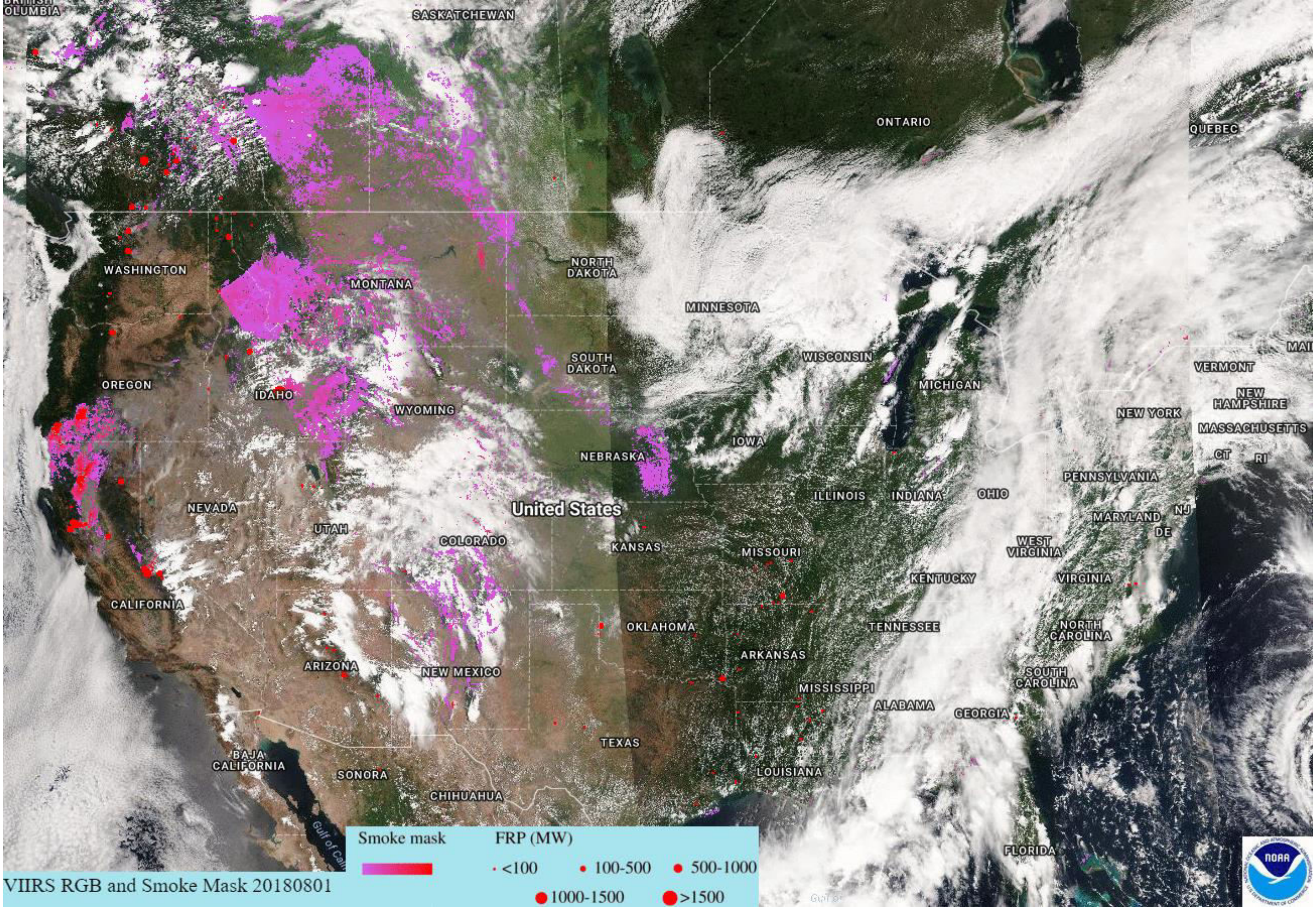
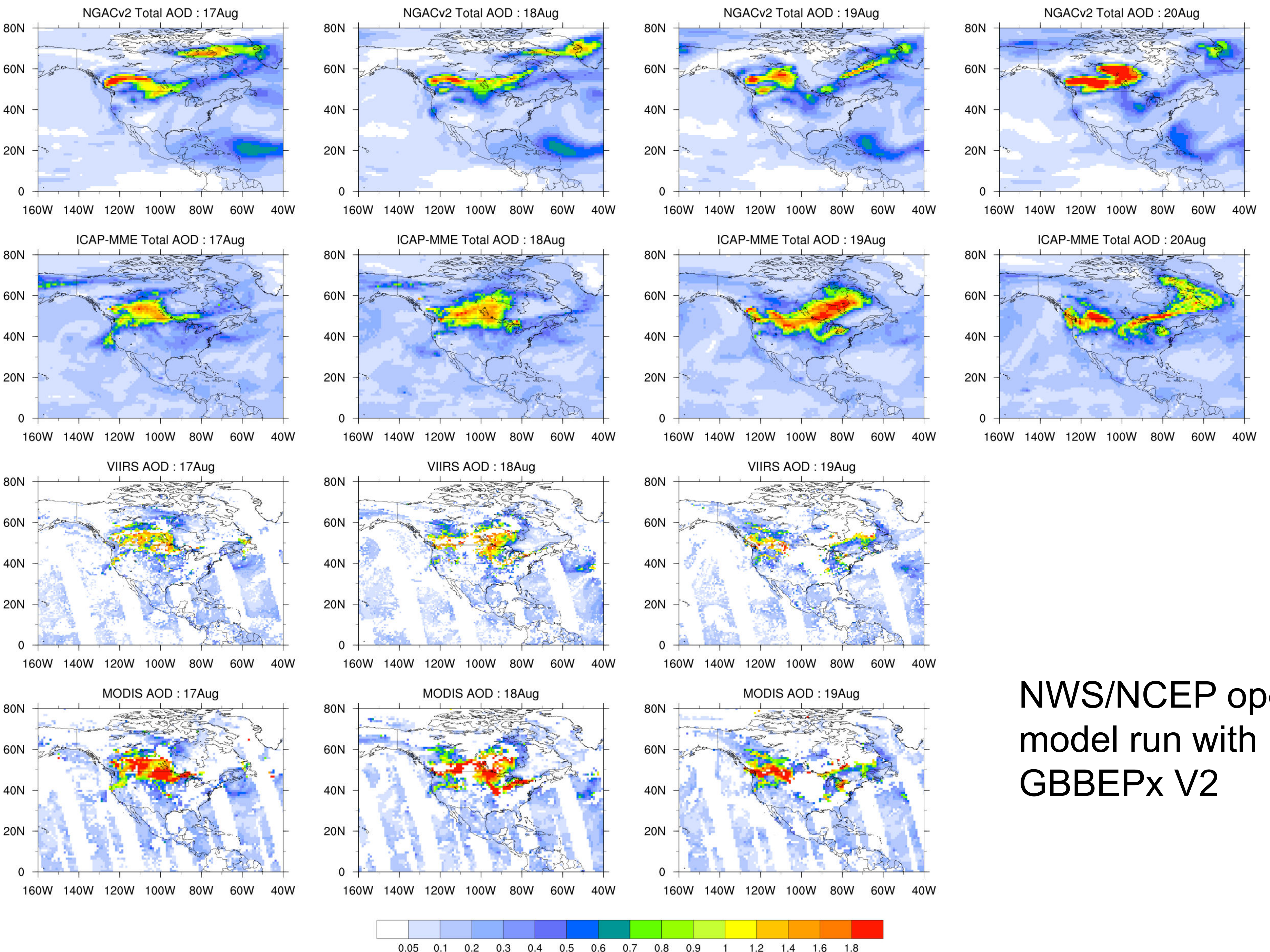




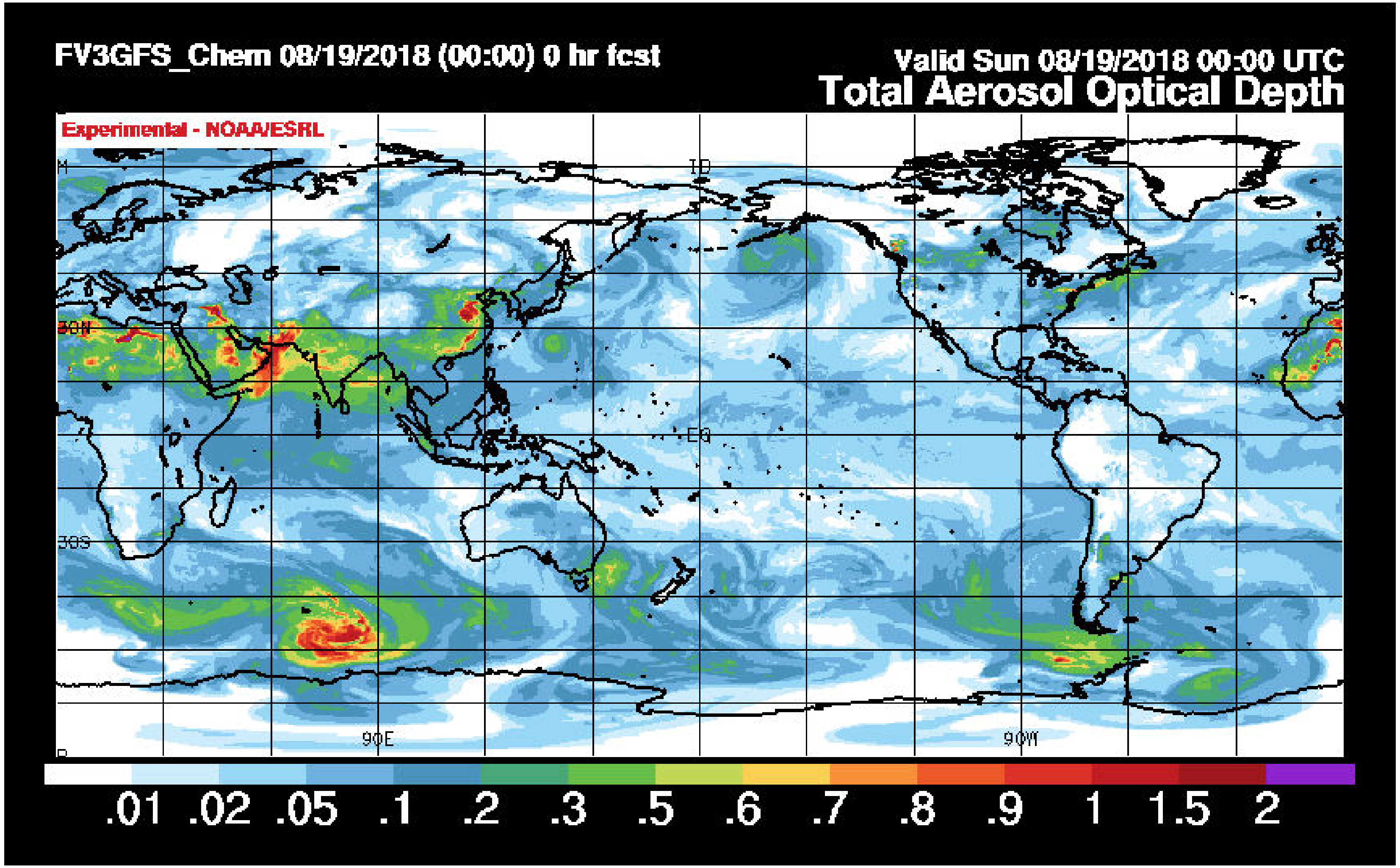
VIIRS RGB and Smoke Mask 20180801

Date : 17-20th August,2018 (Total AOD at 550nm)



NWS/NCEP operational model run with GBBEPx V2

FV3GFS-Chem Simulated AOD



Courtesy of NOAA/ESRL

- FV3GFS_Chem is the Next Generation Global Prediction System (NGGPS) for aerosols
- We are currently adapting GBBEPx file format to FV3 grid so it can be tested

Conclusions

- GBBEPx is an operational product currently being used by operational NGAC v2 aerosol model at NCEP
- Plans underway to add NOAA-20 fire emissions to GBBEPx
- Despite repeated proposal submissions to PSDI to replace legacy GOES and MTSAT with GOES-16/17 and Himawari-8/9 fire emissions, no funding
- GBBEPx sample data were provided to HRRR-smoke model for testing
- GBBEPx output is being adapted for FV3 grid for testing purposes
- Algorithm/product has been published in multiple journal articles

1. Li, F., Zhang, X., Kondragunta, S., Csiszar, I., 2018, Comparison of fire radiative power estimates from VIIRS and MODIS observations. *Journal of Geophysical Research-Atmosphere*, https://doi.org/10.1029/2017JD027823.
2. Li, F., Zhang, X., Kondragunta, S., Roy, D.P., 2018, Investigation of the fire radiative energy biomass combustion coefficient - a comparison of polar and geostationary satellite retrievals over the Conterminous United States. *Journal of Geophysical Research-Biogeoscience*, 132, 722-739. https://doi.org/10.1002/2017JG004279.
3. Huang, R., Zhang, X., Chan, D., Kondragunta, S., Russell, A.G., Odman, M.T., 2018, urned Area Comparisons between Prescribed Burning Permits in Southeastern USA and two Satellite-derived Products. *Journal of Geophysical Research-Atmosphere*, https://doi.org/10.1029/2017JD028217
4. Zhang, X., Kondragunta, S., and Roy, D.P., 2014. Interannual variation in biomass burning and fire seasonality derived from geostationary satellite data across the contiguous United States from 1995 to 2011. *Journal of Geophysical Research-Biogeosciences,* http://dx.doi.org/10.1002/2013JG002518.
5. Zhang, F., Wang, J. Ichoku, C., Hyer, E., Yang, Z., Ge, C., Su, S., Zhang, X., Kondragunta, S., Kaiser, J., Wiedinmyer, C., and da Silva, A., 2014. Sensitivity of mesoscale modeling of smoke direct radiative effect to the emission inventory: A case study in northern sub-Saharan African region. *Environmental Research Letters*, **9,** 075002, http://dx.doi.org/10.1088/1748-9326/9/7/075002.
6. Zhang, X., Kondragunta, S., Ram, J., Schmidt, C., Huang,H-C, 2012. Near Real Time Global Biomass Burning Emissions Product from Geostationary Satellite Constellation. *Journal of Geophysical Research-Atmosphere,* http://dx.doi.org/10.1029/2012JD017459.