

Agricultural Fire Emissions Inferred from VIIRS Are *Much Higher* Than Current Bottom-up Inventories - Case study in China

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Earth Observation**

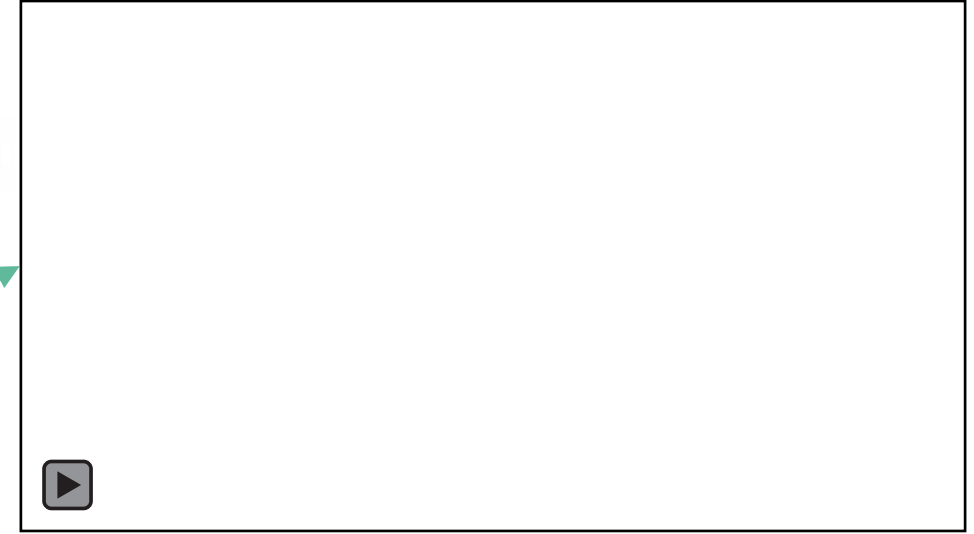
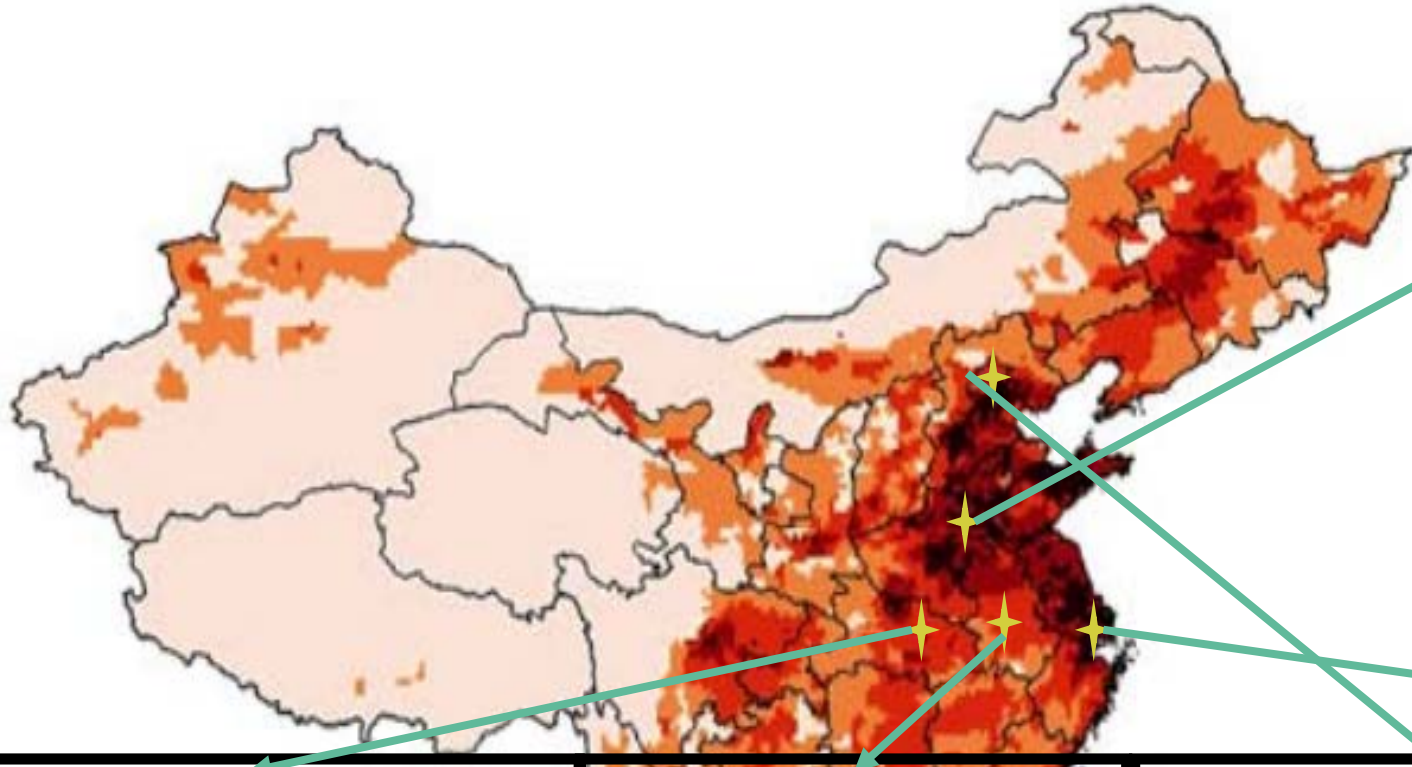
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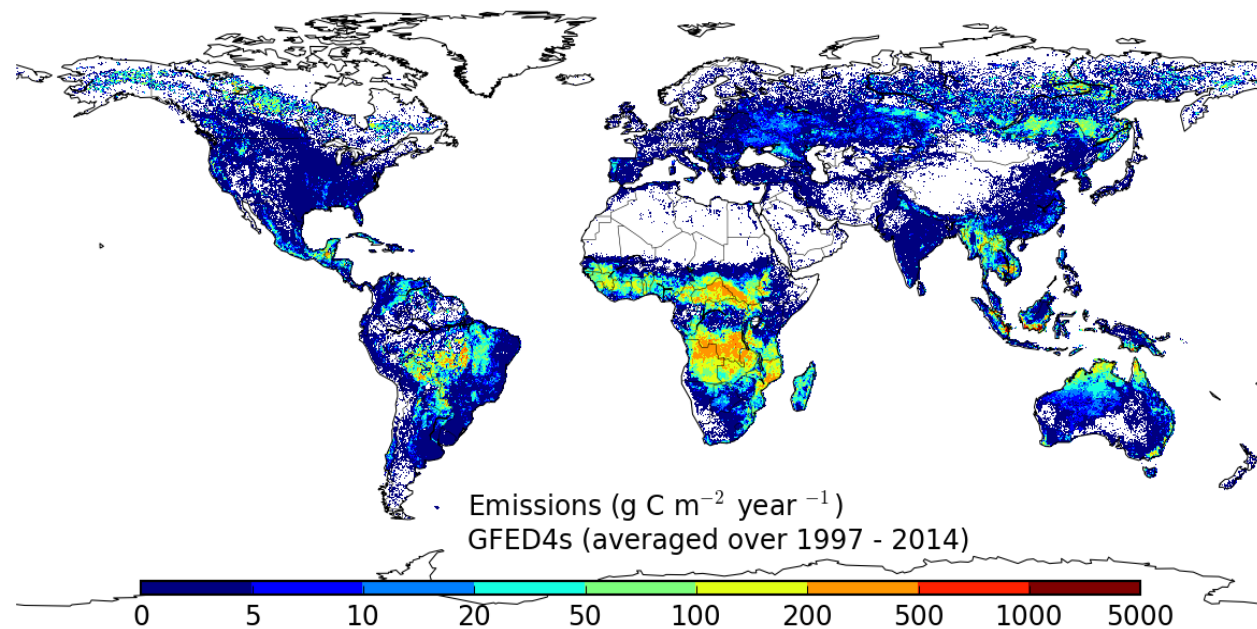


Agricultural Fire Emissions in China

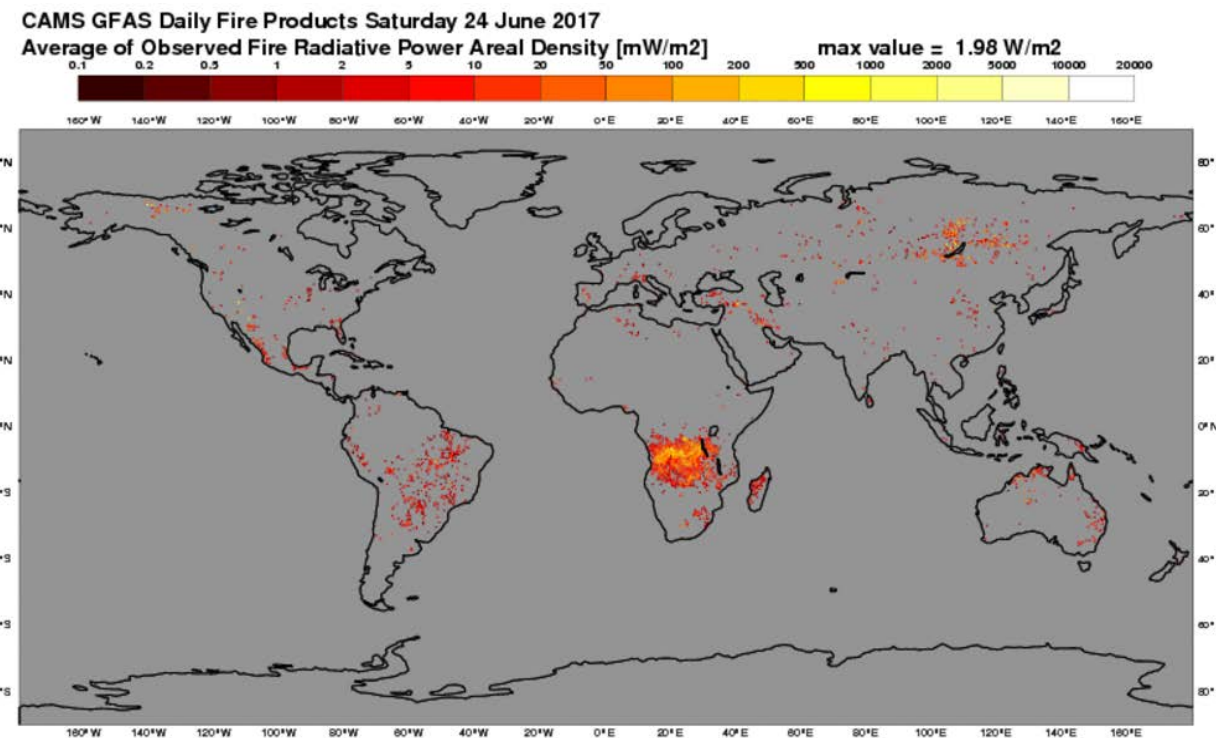




Current Fire Emissions Inventories: GFED vs GFAS



Global Fire Emissions Database (GFED)
[based on EO-burned area measures]



Global Fire Assimilation System (GFAS)
[based on EO-derived FRP measures]



Crop yield based approach

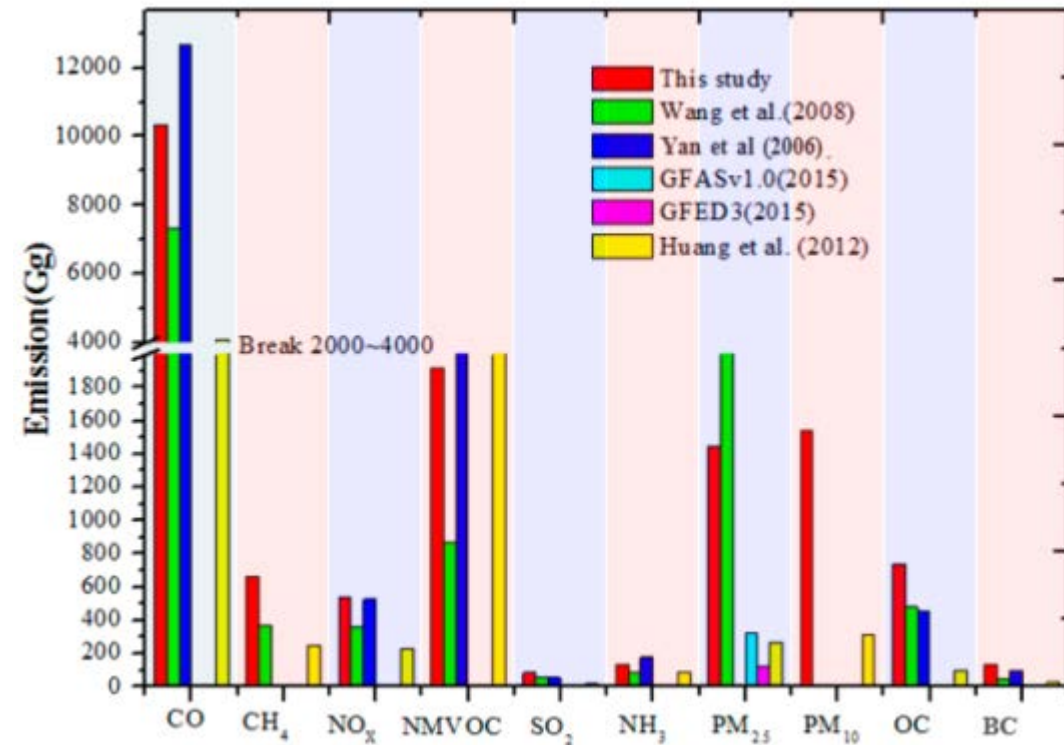
$$R = P \times N \times D \times B \times F$$

Table 2

Regional open burning ratio of agricultural wastes in China in 2006.^a

Zone	Provinces	Open burning ratio	Standard deviation
1	Yunnan, Guizhou, Jiangxi, Hubei, Sichuan, Chongqing	10.7%	3.34
2	Heilongjiang, Jilin, Liaoning, Inner Mongolia	11.8%	3.94
3	Xinjiang, Xizang, Qinghai, Gansu, Ningxia	16.4%	6.97
4	Shanxi, Henan, Shanxi, Hebei, Beijing, Tianjin, Shandong	16.5%	2.24
5	Jiangsu, Anhui, Zhejiang, Shanghai, Fujian	31.9%	5.07
6	Hunan, Guangdong, Guangxi, Hainan	32.9%	6.63

^a Wang and Zhang, 2008.



Qiu et al., 2016; EST

Crop Yield



Residue



Open air burning



Burning Efficiency



Emissions



VIIRS

Next Generation Environmental Monitoring from Space

Onboard the Suomi NPP Satellite, VIIRS provides superior imagery and data for next generation civil and military weather, climate and disaster monitoring.

2X longer
operational
lifetime

Calibrated
low light level
imagery

375 meter
visible-infrared
imagery at nadir

VIIRS
instrument

Fire detection
and monitoring

Vegetation index

Land and ice
temperature

Cloud
properties

Sun-synchronous
polar orbit

Ocean color

Sea surface
temperature

Ocean currents

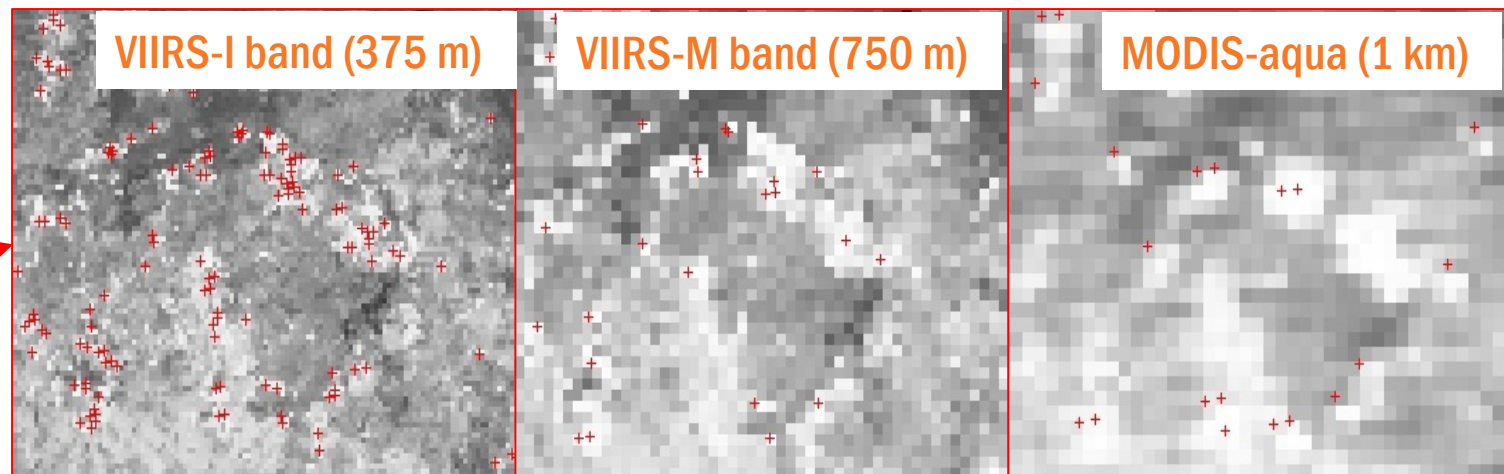
Aerosol
characteristics

Suomi NPP
Satellite

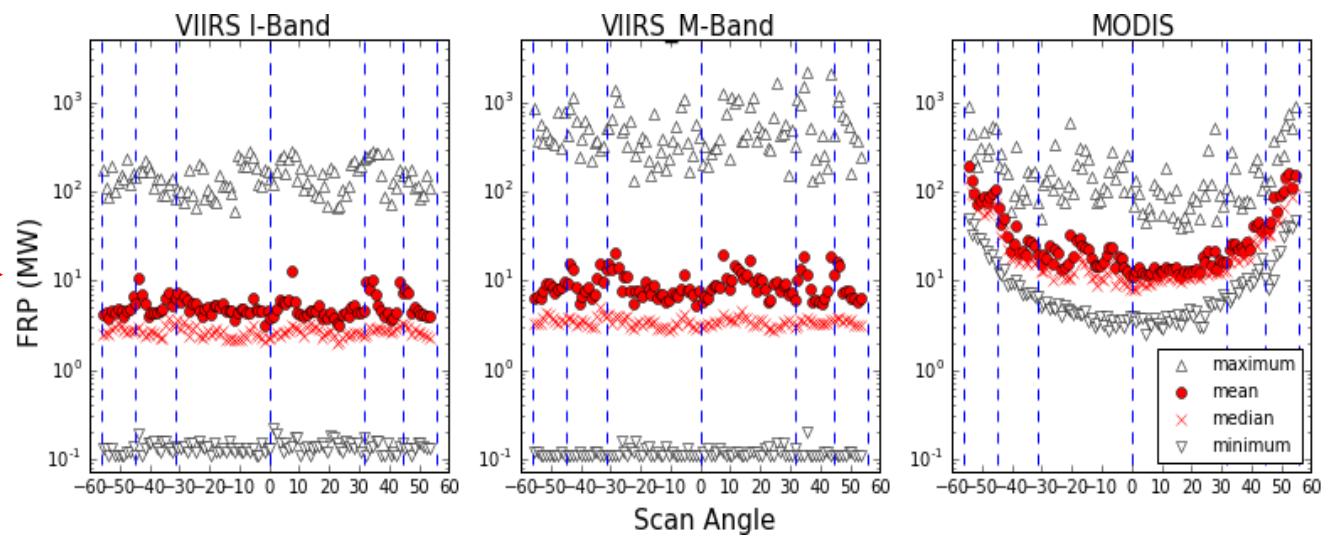
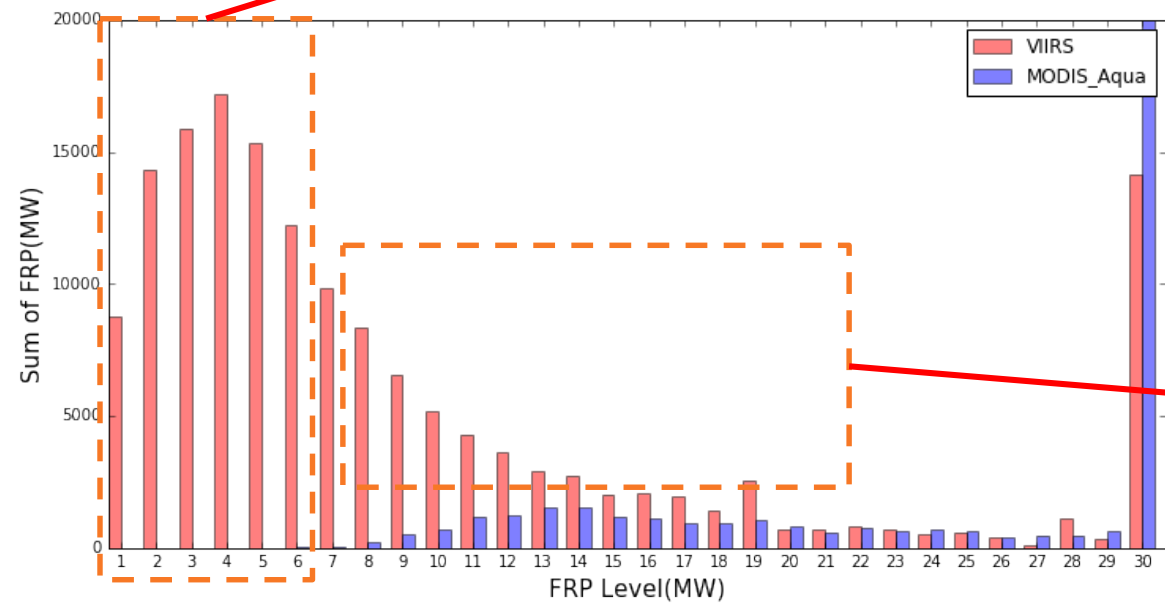
Images taken by VIIRS
on Nov. 21, 2011



Benefit of VIIRS-IM FRP



Middle Infrared imagery examples (red = fire detection)

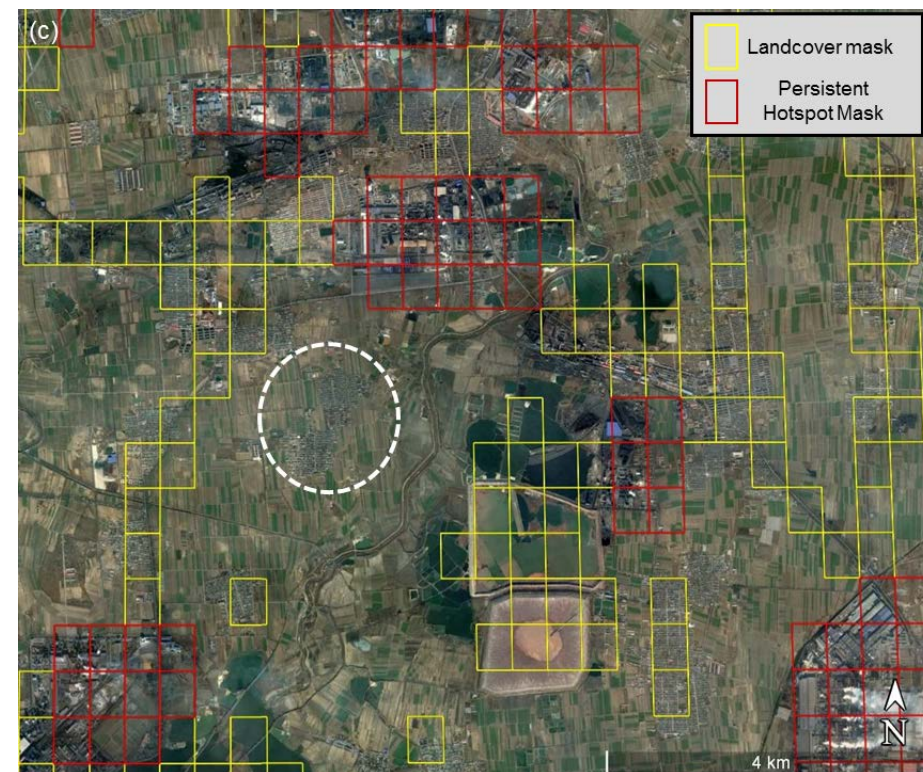




Known Issue of VIIRS-IM FRP

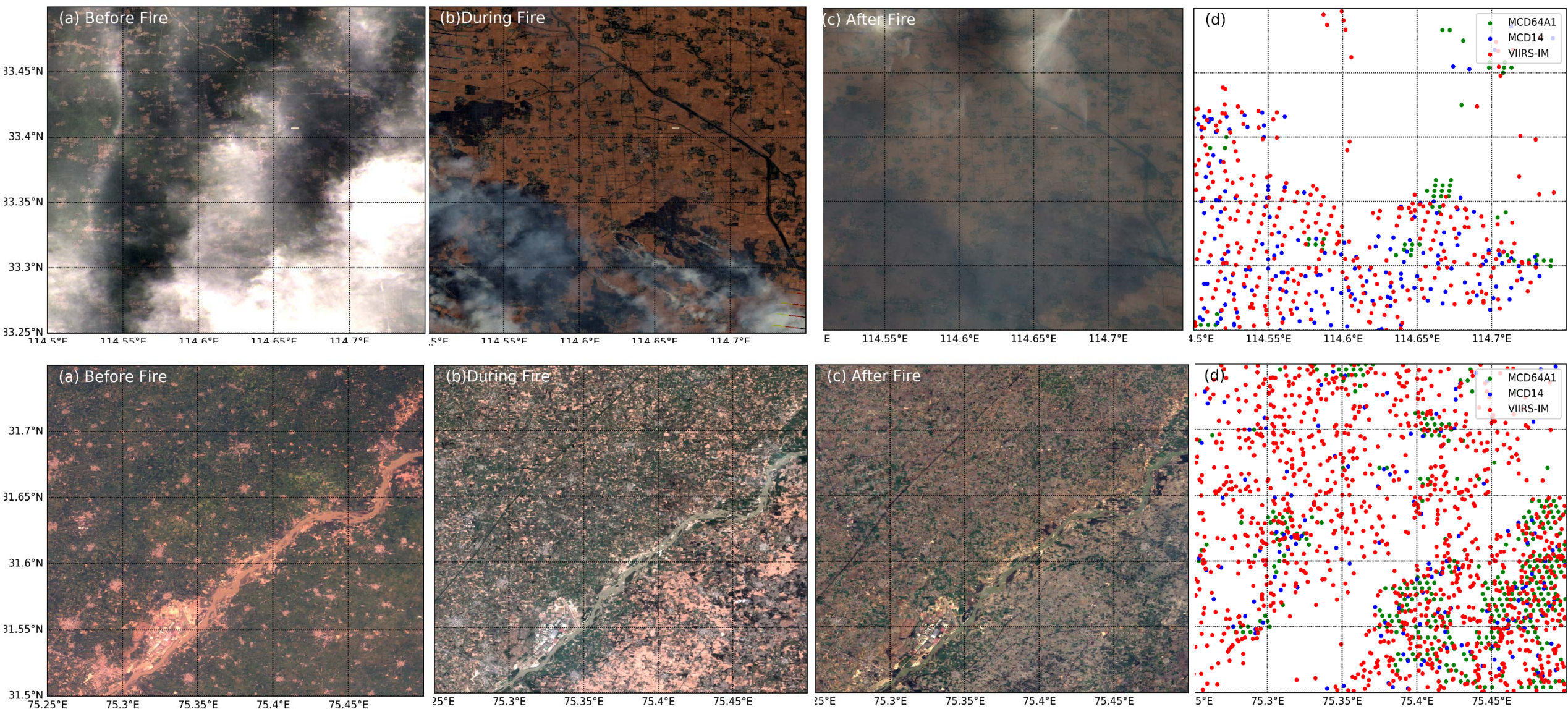
Issues: False fire detection caused by surface sun glints and/or high temperature roofs that are sub-pixel at scale of VIIRS.

Solution: 30 m land cover mask (% agricultural).
Persistent hotspot mask.





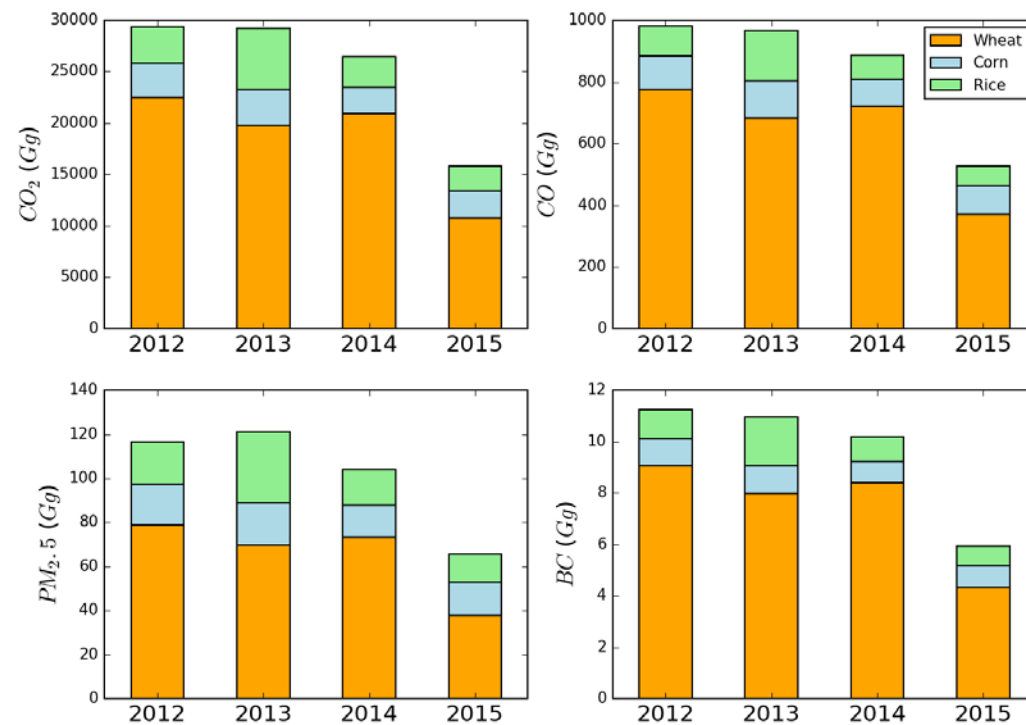
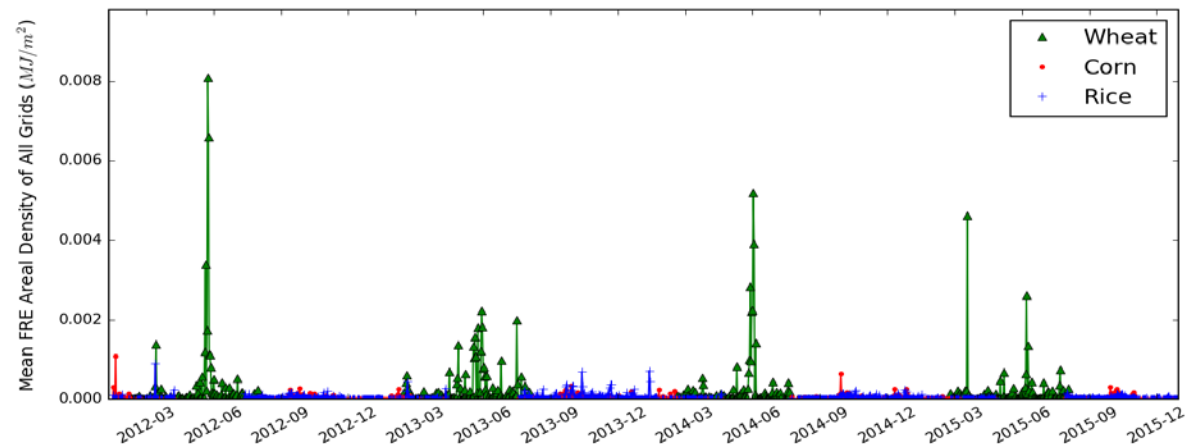
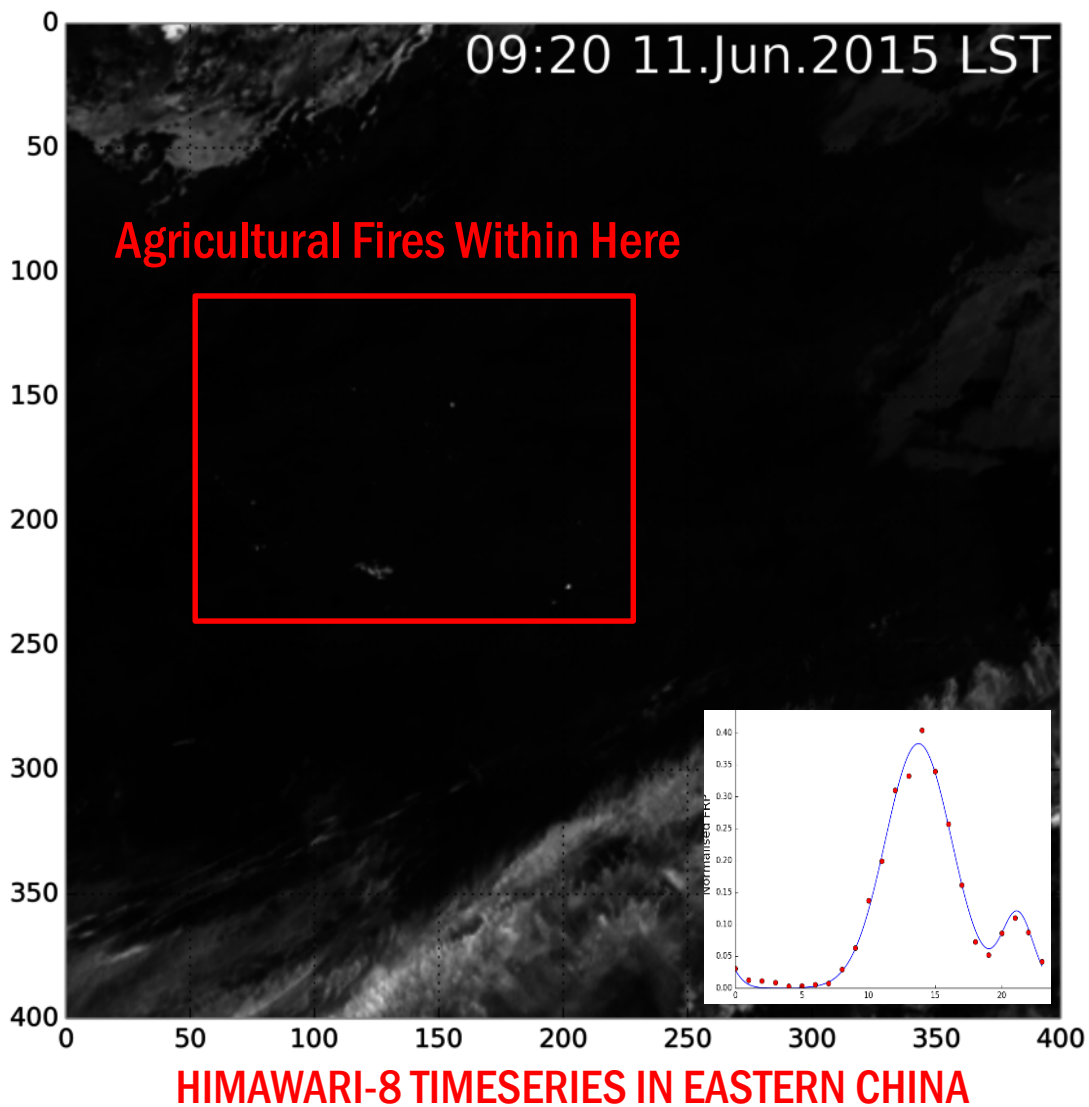
VIIRS-IM vs MODIS: Eastern China & India

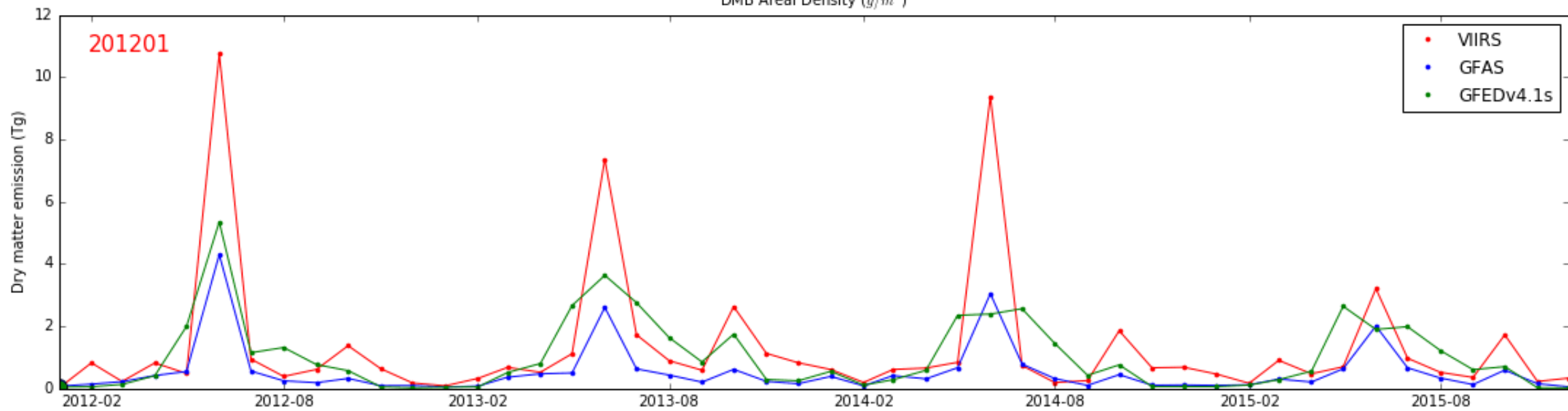
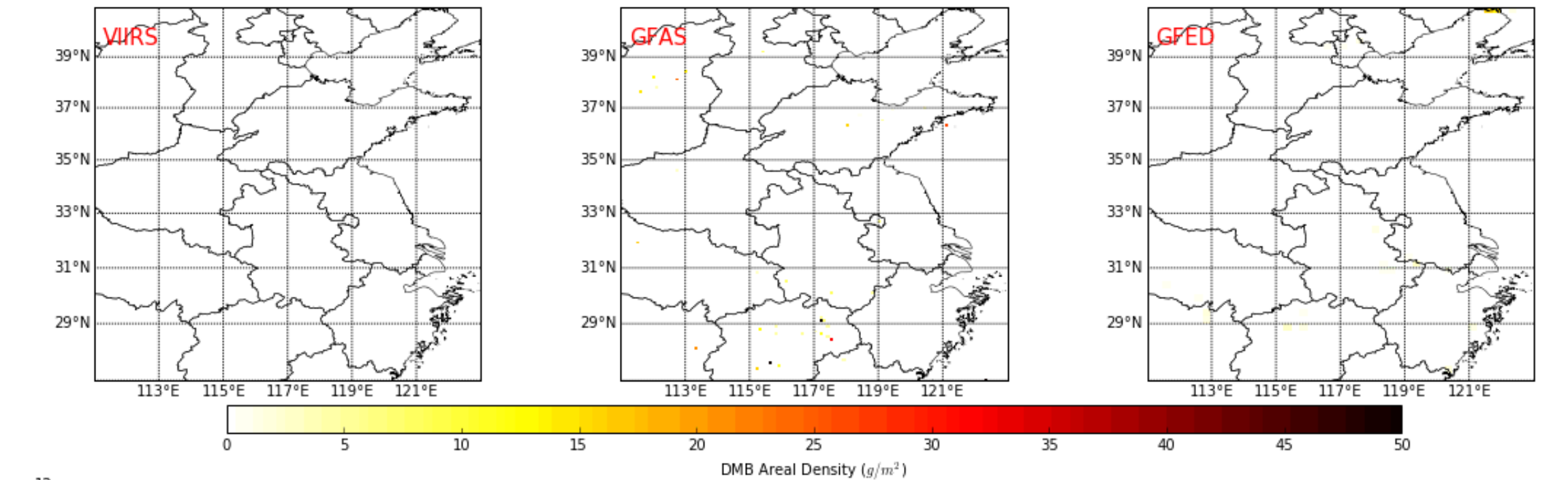




VIIRS-IM FRP based FRE/Emission Estimates

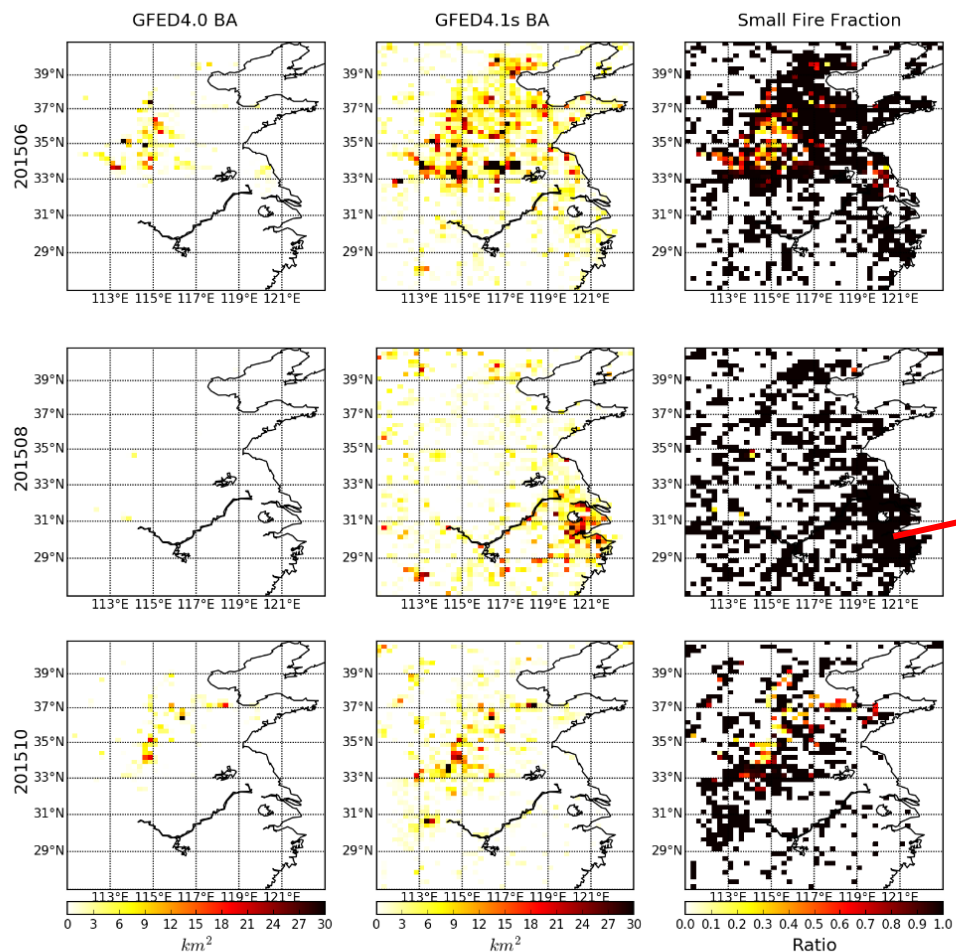
24 hrs of imagery (every 10 minutes)



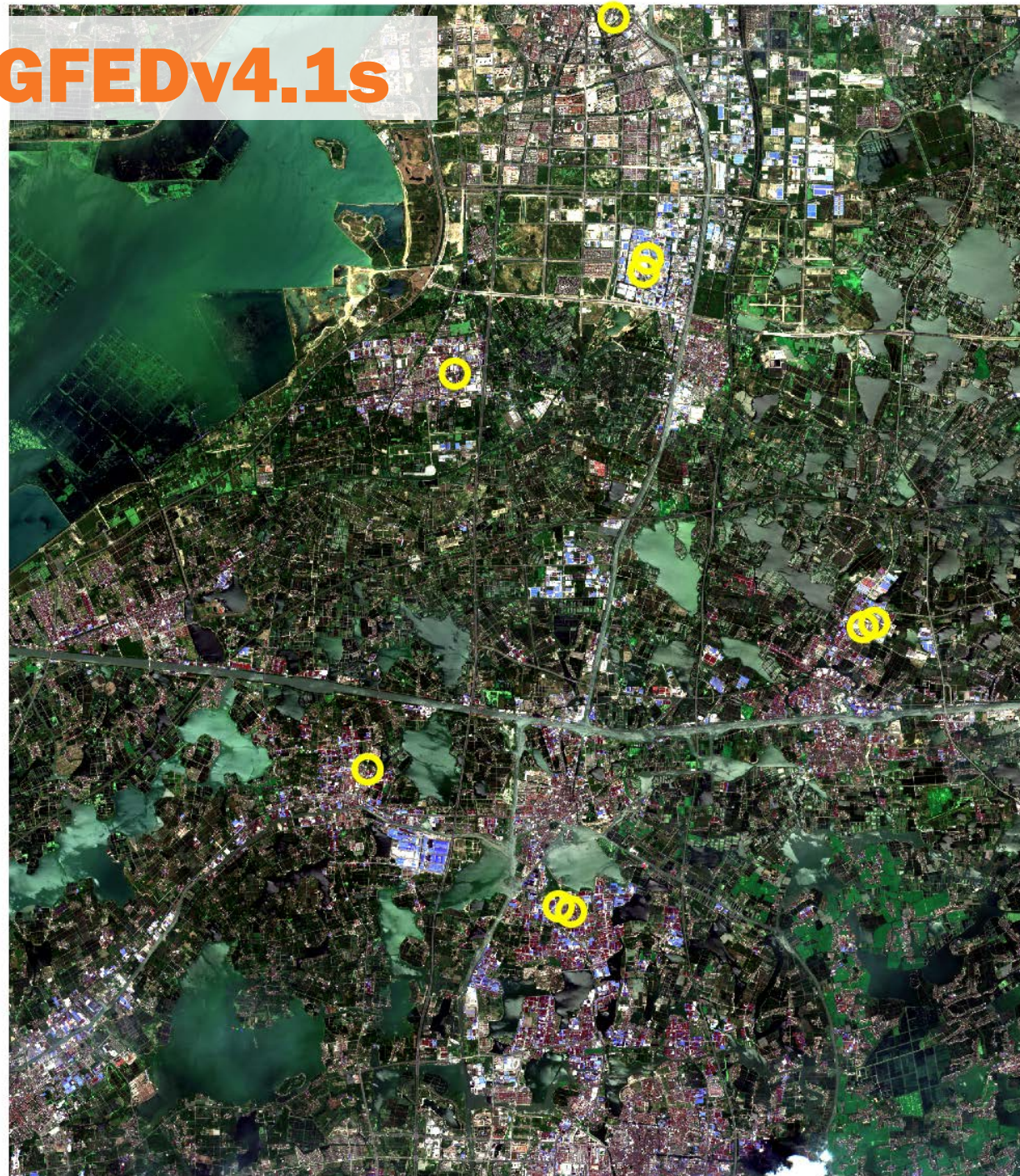




“Small Fire” Boosting of GFEDv4.1s

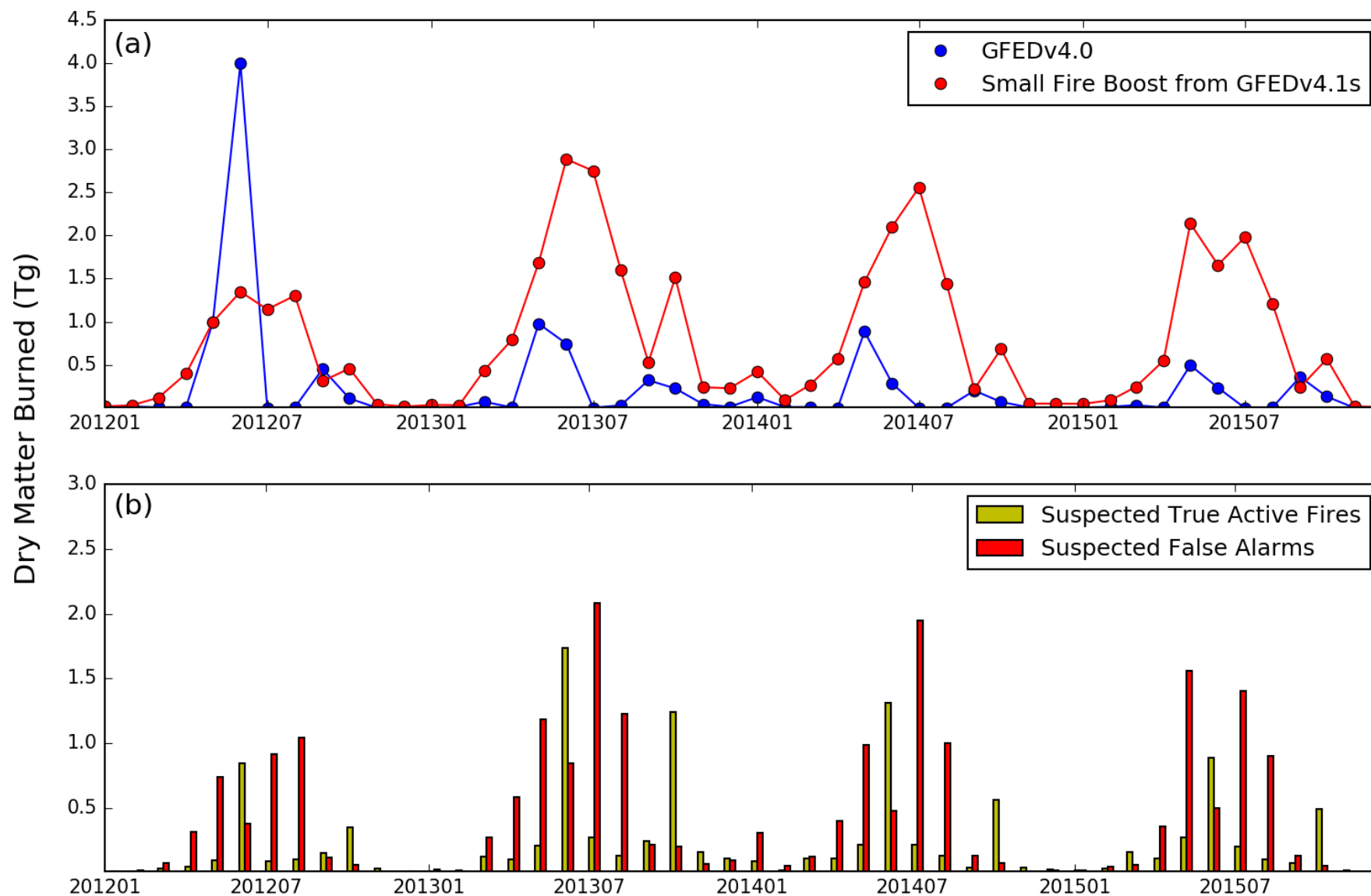


False detection of active fires by MODIS.
Superimposed on Sentinel-2 true colour imagery.





Small Fire Boosting of GFEDv4.1s



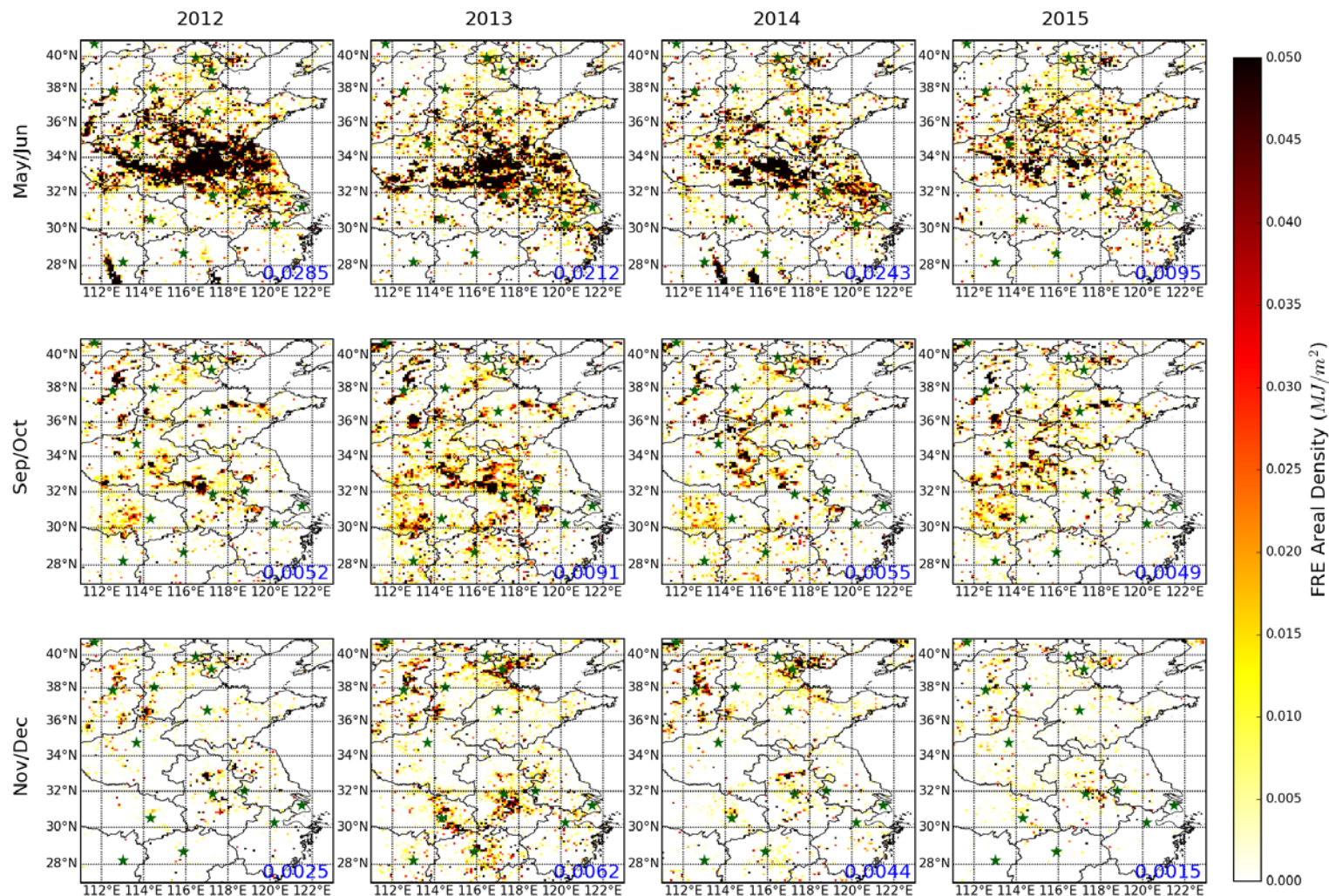
Conclusion:

The attempt (in GFED4.1s) at adjusting emissions for the impact of “small” fires introduces significant errors into this very widely used inventory.



Other characteristics detected from EO

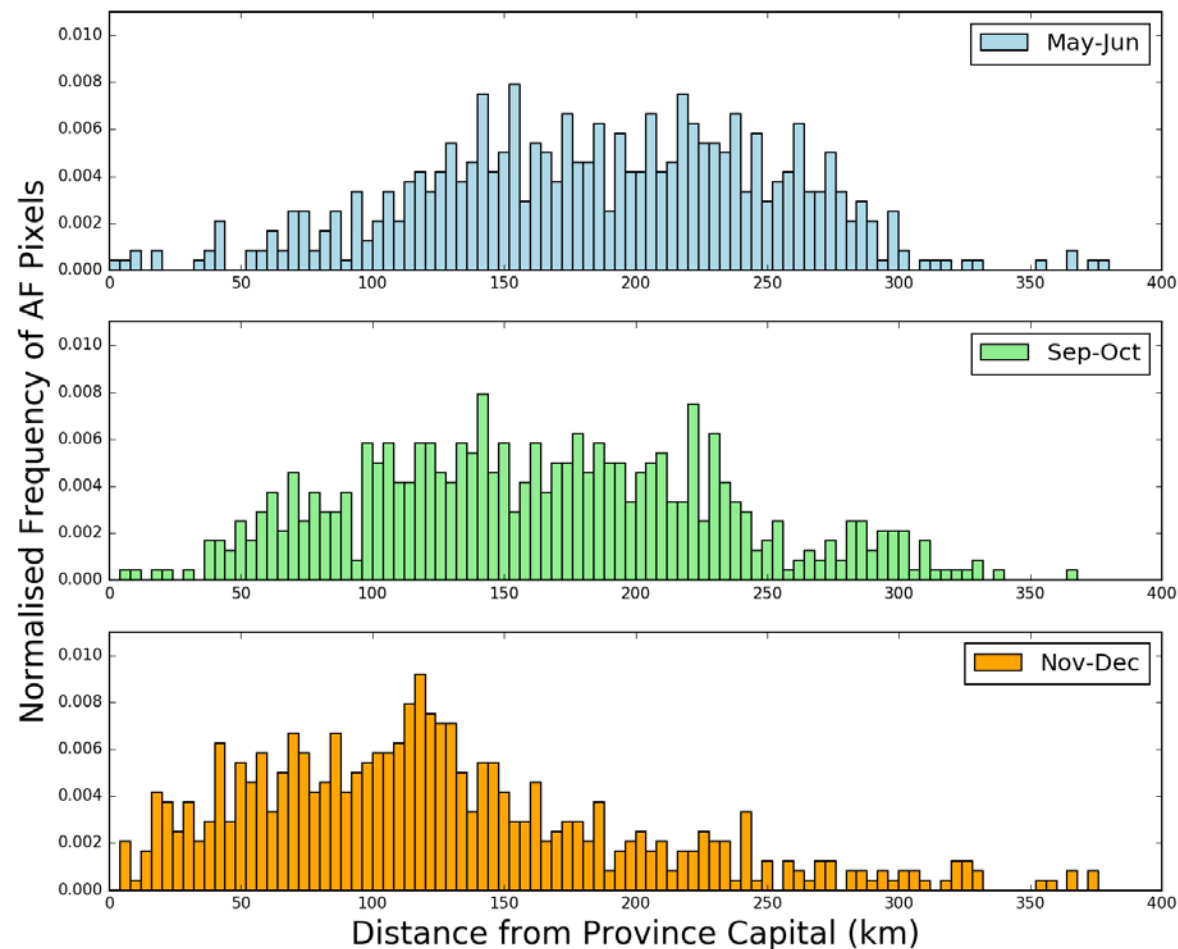
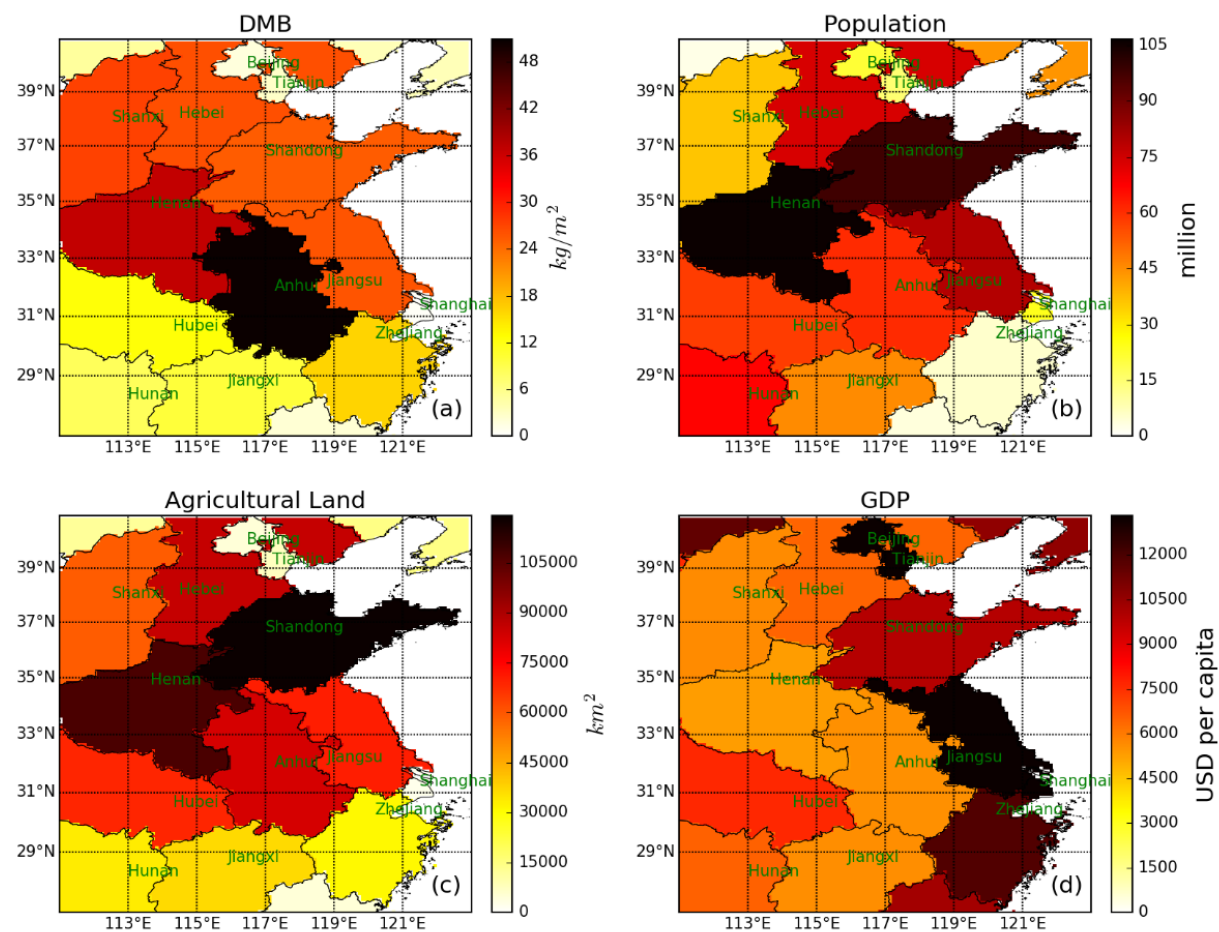
- 🔥 A third burning season (Nov/Dec)
- 🔥 19 - 36% of pollution temporal transfer from autumn (Sep/Oct)





Other characteristics detected from EO

- 🔥 Dry Matter Burned (DMB) is inversely correlated with GDP per capita ($r^2 = 0.72$)
- 🔥 Geographical shift might also be linked with fire prohibition policies: greater distance, less resources





Summary

- 🔥 A High Spatio-temporal Resolution Agricultural Burning Smoke Emissions Product in Eastern China.
- 🔥 DMEs from VIIRS product are much higher than GFAS/GFED 4.1s.
- 🔥 The attempt (in GFED4.1s) at adjusting emissions for the impact of “small” fires introduces significant errors into this very widely used inventory.
- 🔥 The newly identified winter burning season (Nov-Dec) is likely the caused by the delayed burning of parts of autumn harvest due to local fire prohibition policies.