Biomass burning emission and impacts on air quality in Northeastern China

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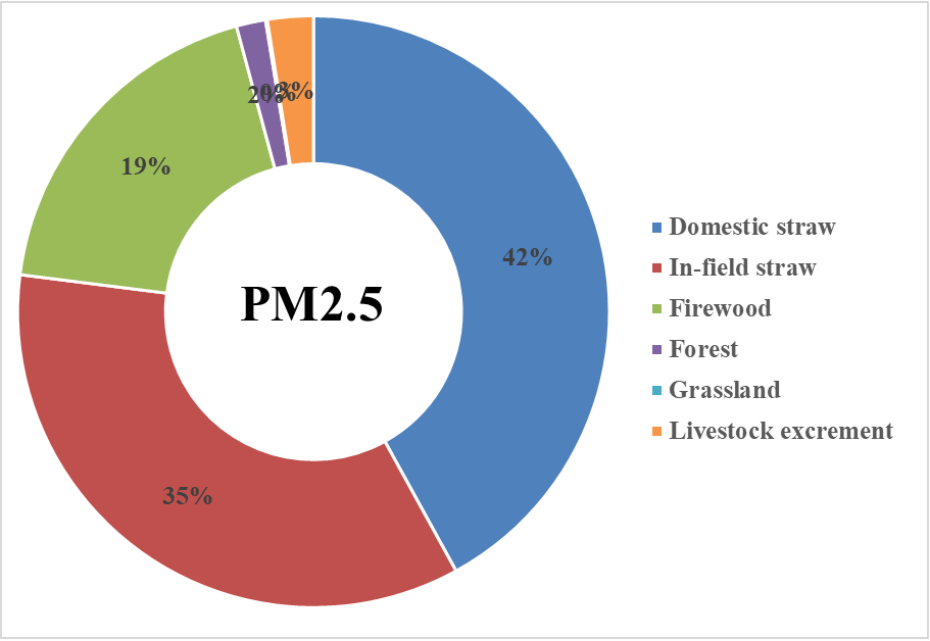
Biomass Burning in China

Biomass burning types:

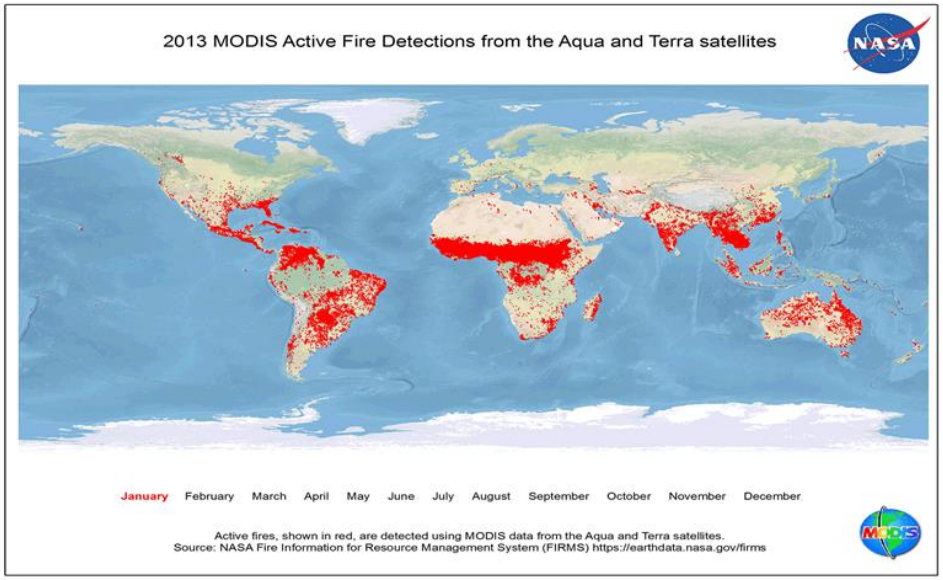
Forest fire; Grassland fire;

Agricultural straw burning;

wood combustion as fuel.



（Zhou et al., 2017 ACP）



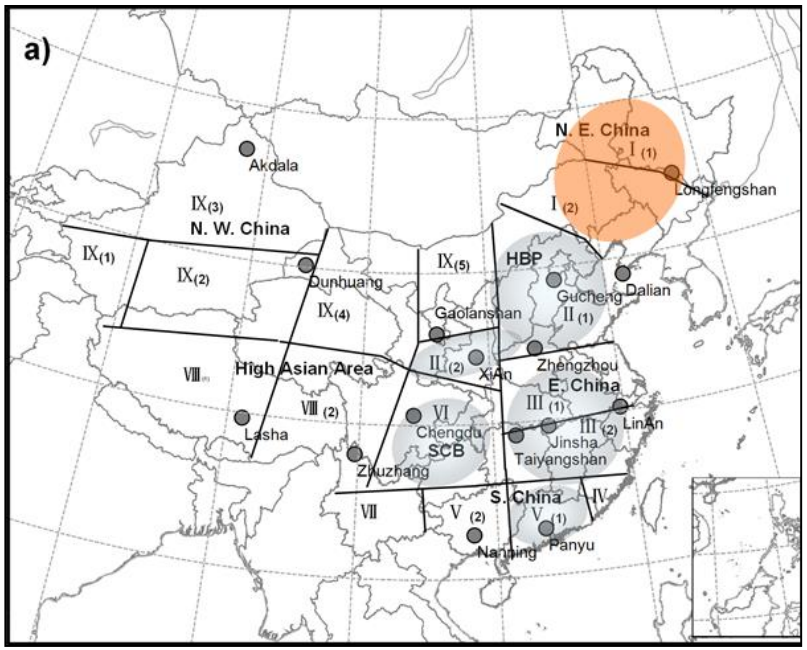
Wood and crop residues burning are the major sources in China (90%):

domestic burning (43%) ;

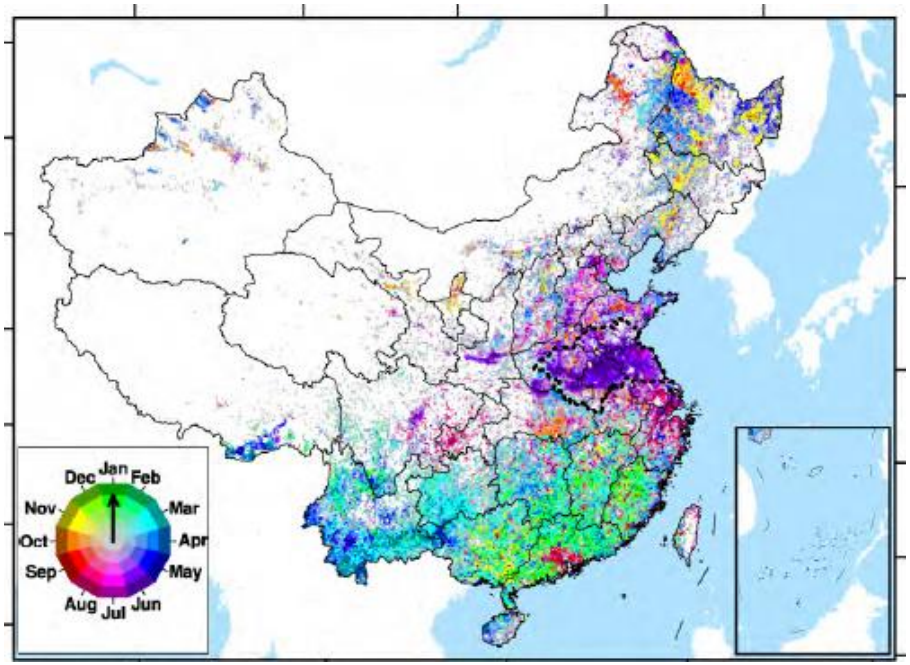
open field burning (30%);

Biomass Burning and Regional Haze in China

- **Spatial distribution:** from northeast to east of China
- **Temporal distribution:** primary peak in autumn
- **Aerosol characteristics:** high concentrations of $PM_{2.5}$, OC, EC

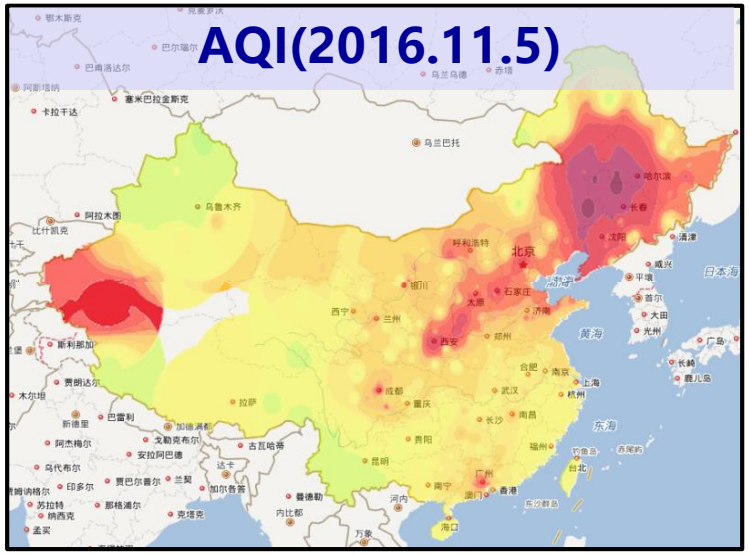


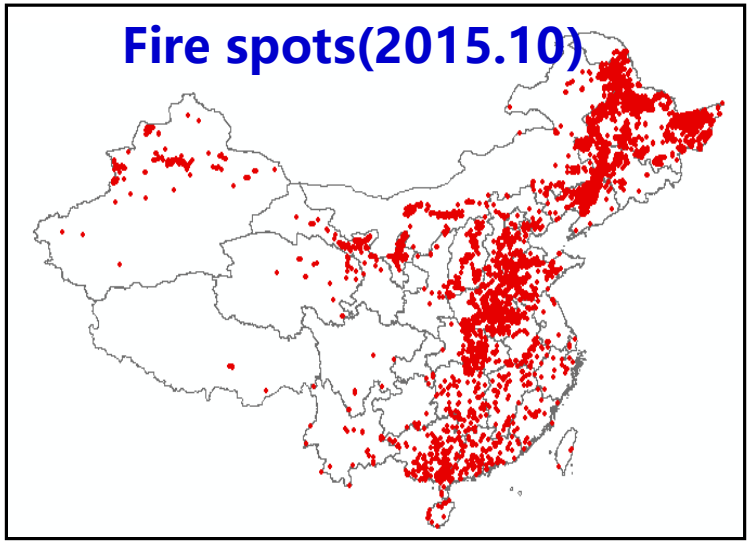
Haze distribution (Zhang et al., 2012)



China fire by month(Zhong et al., 2017)

Air Pollution in Northeastern China



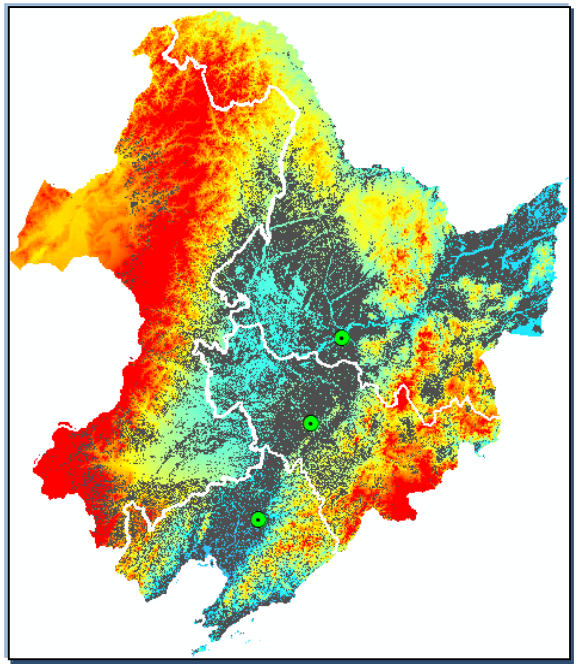


Time	City	AQI	Air Quality	$PM_{2.5}$
Autumn (2015.11)	Harbin	178	Moderately polluted	147
	Changchun	154	Moderately polluted	125
	Shenyang	167	Moderately polluted	145
Winter (2015.1)	Harbin	155	Moderately polluted	120
	Changchun	139	Mild pollution	104
	Shenyang	145	Mild pollution	109

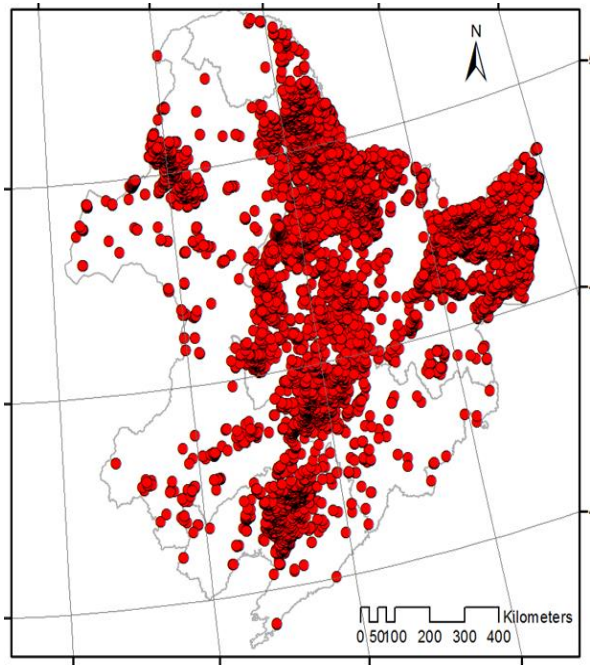
Northeast China has often been reported to suffer from heavy air pollution during post-harvest seasons (early October to late November).

Biomass Burning in Northeastern China

Topography



Fire points



Burning emission

- **Straw yield: 160Tg/year, account for 20% in China**
- **Utilization: less than 60%, (open field burning: 20-30%)**

Biomass Burning Emission Inventory

$$E = FRE \times \beta \times F$$

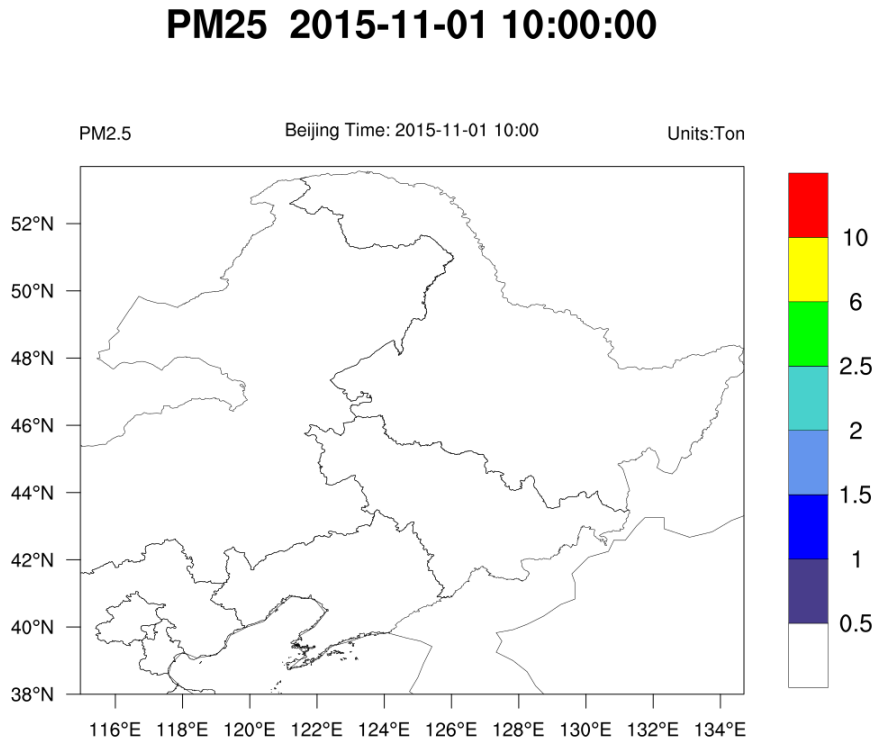
$$FRE = \int_{t1}^{t2} FRP\,dt$$

FRE -- fire radiative energy (MJ)

FRP –- fire radiative power (MW)

β -- biomass combustion rate (kg/MJ)

EF -- emission factor (g/kg)



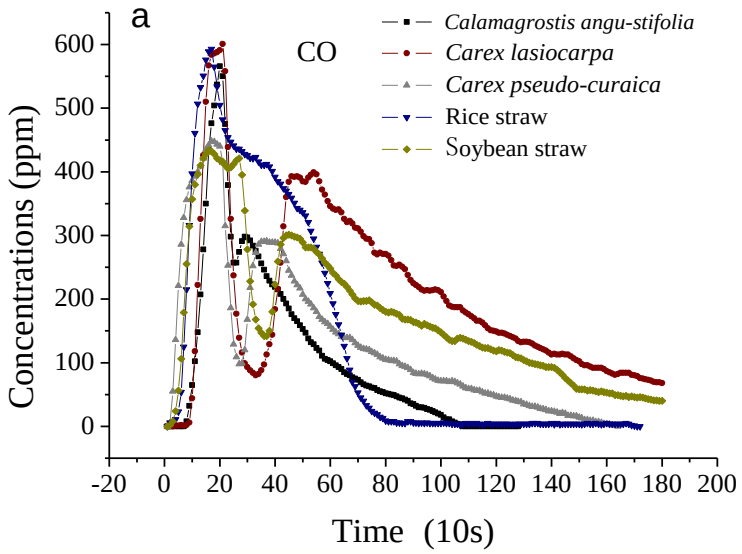
- **Multi-source satellite data: MODIS, VIIRS, Himawari-8**
- **Localization parameters: time series, species composition, emission factors**

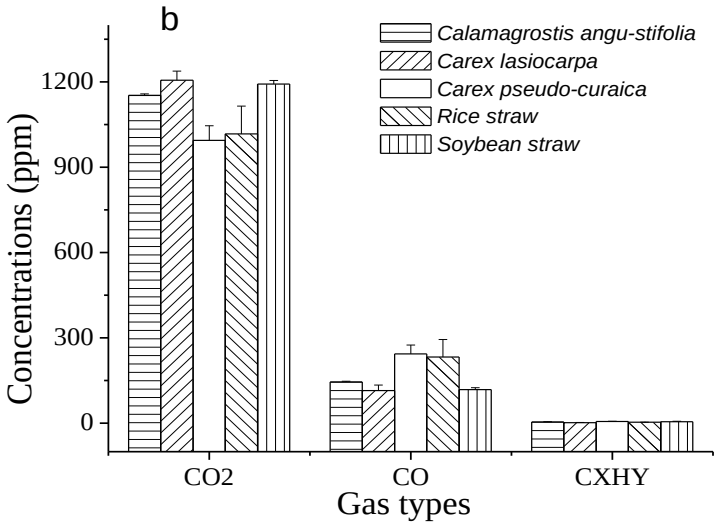
Determination of Emission Factors

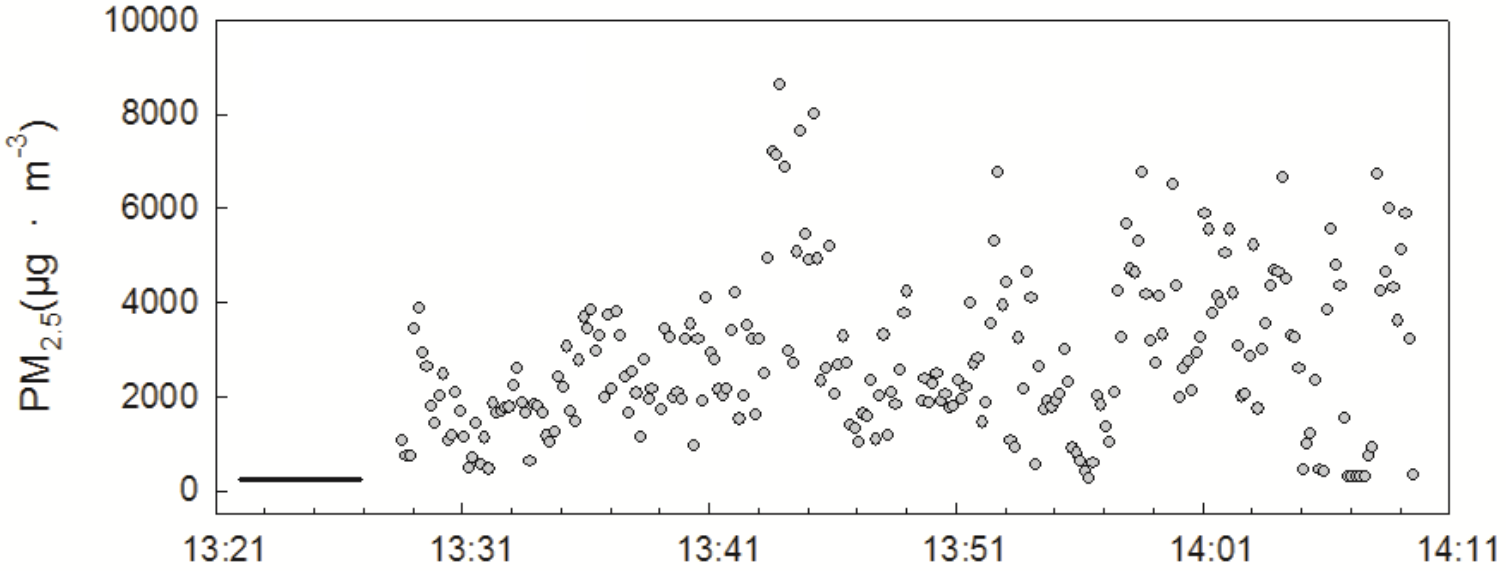
- **Measured**: prescribed open field burning，laboratory simulated burning
- **Reference**: published papers; technical guide for the air pollutant emission inventories



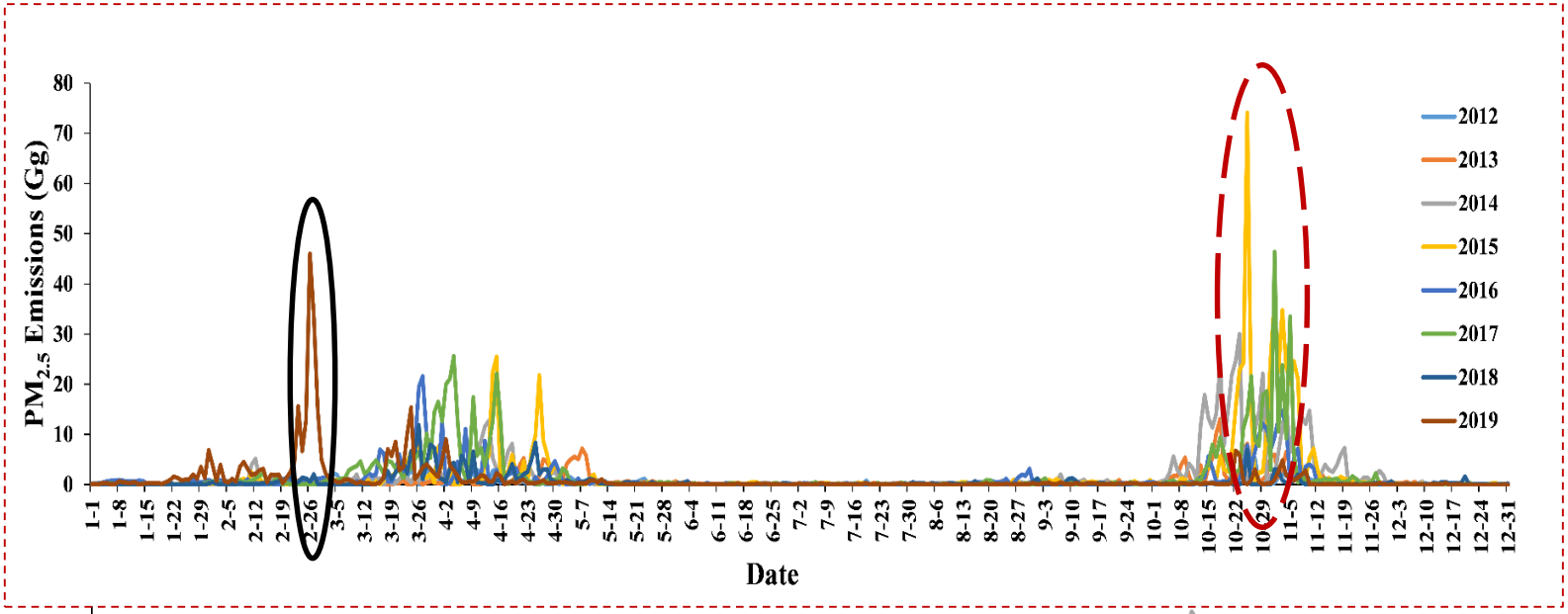

Emission Characteristics

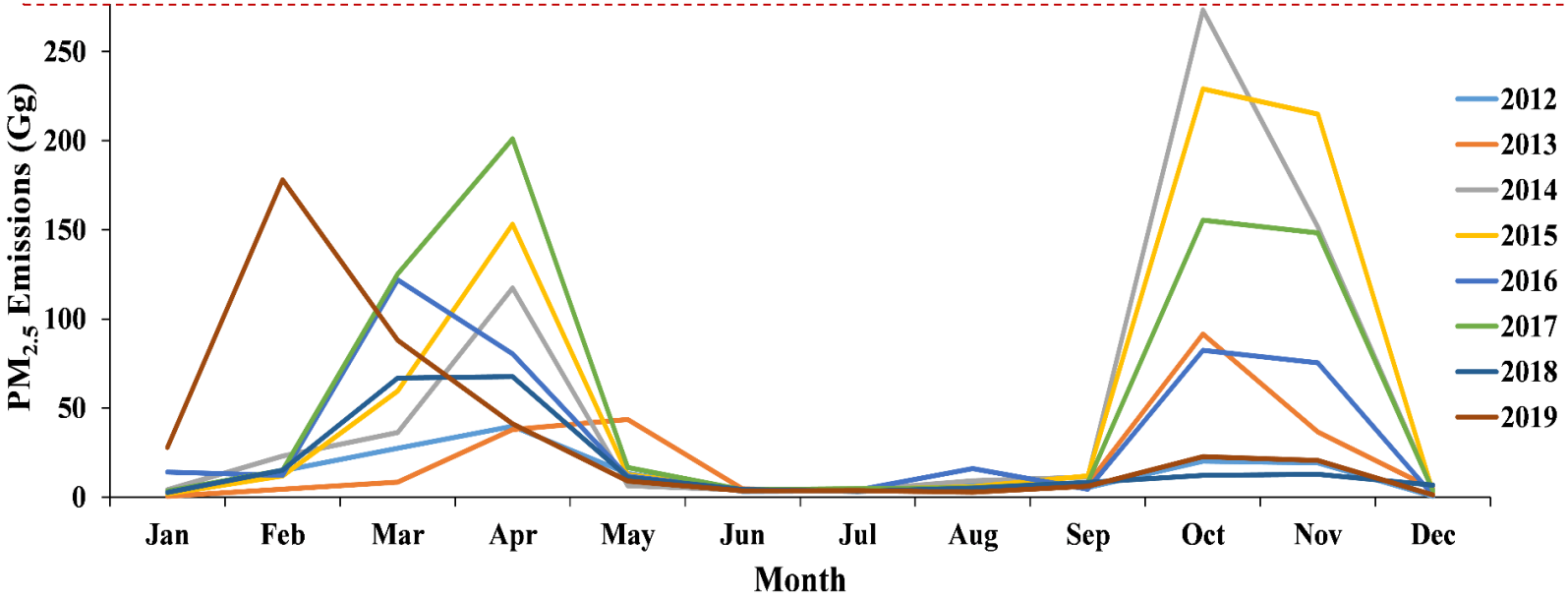






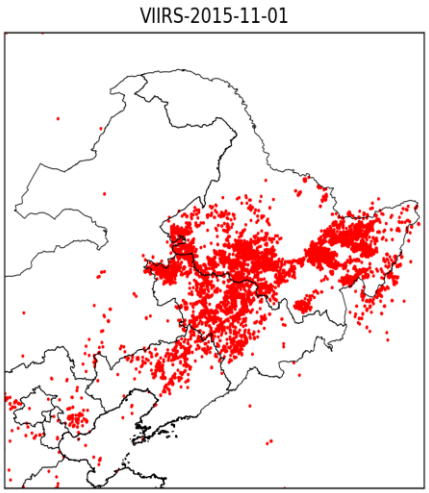
Temporal Distribution of Burning Emissions

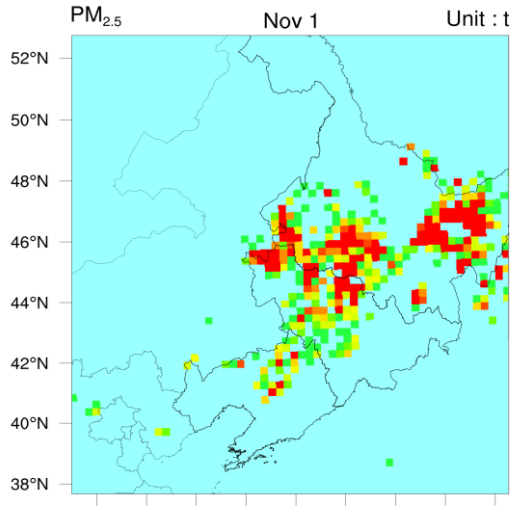




Spatial Distribution of Burning Emissions

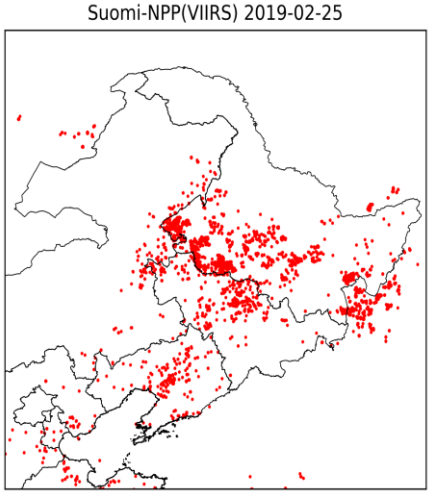
Autumn

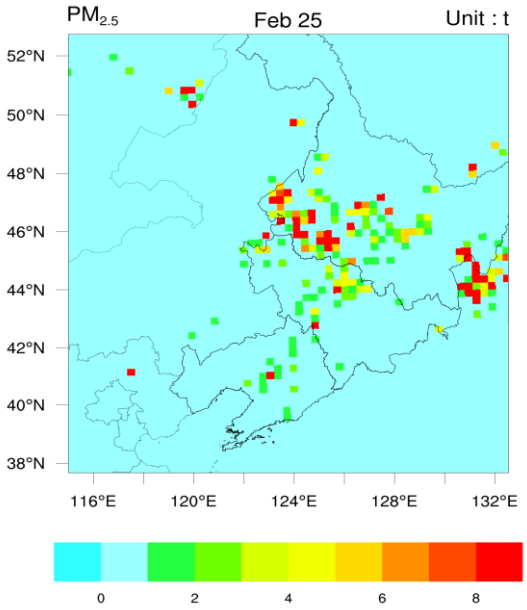




- **Sanjiang Plain**
- **Songnei Plain**
- **North of Liaoning**

Spring



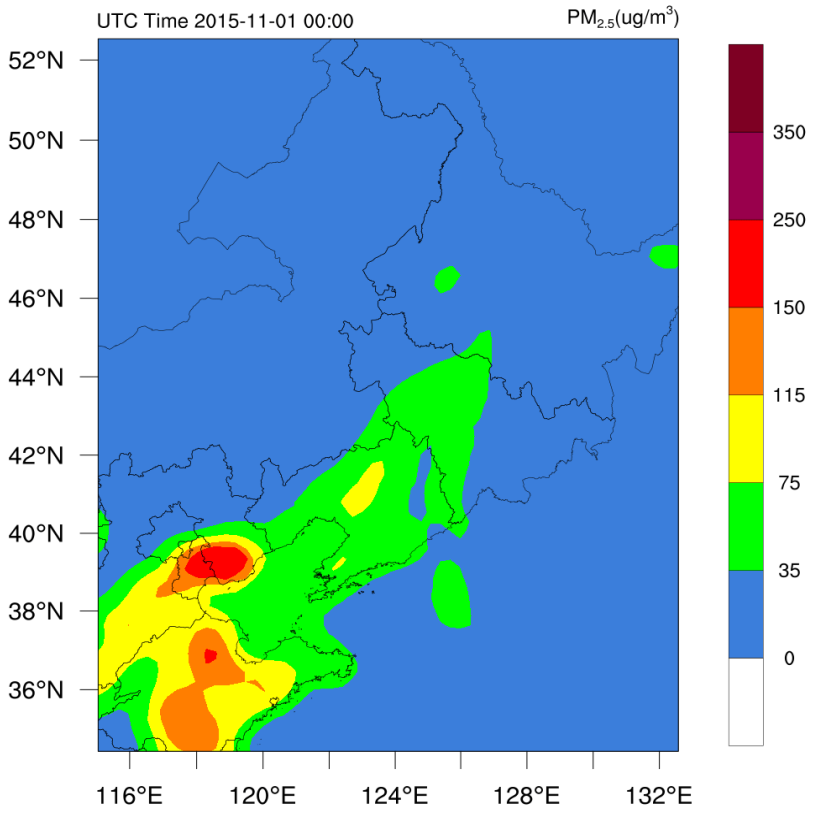


- **Sanjiang Plain**
- **Harbin-Daqing-Suihua**

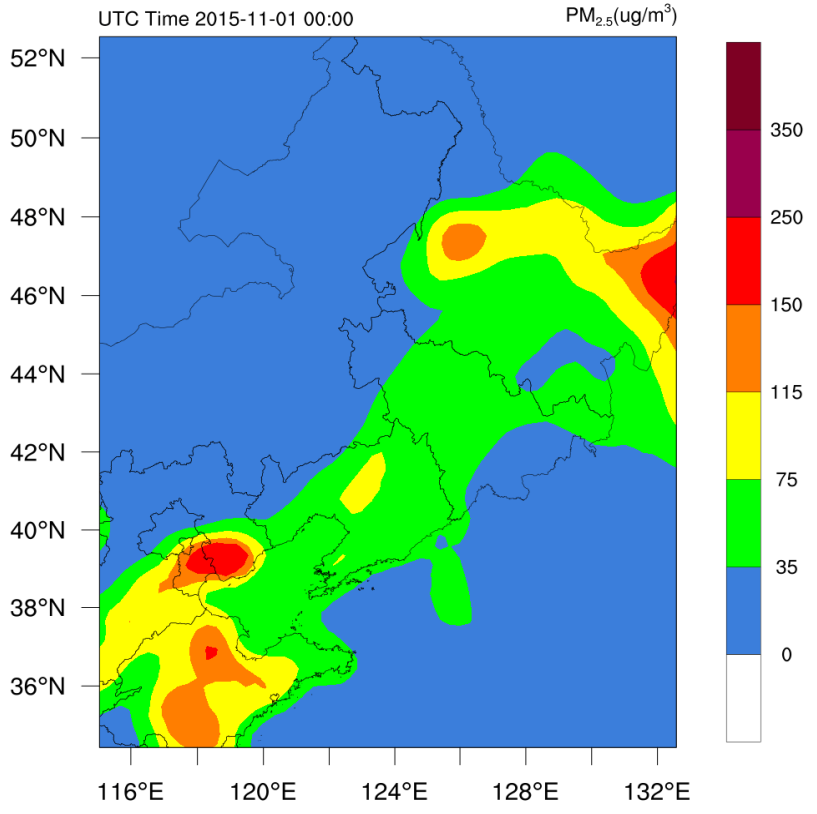
Effects of Autumn Burning on Air Quality

CMAQ simulation

without fire



with fire

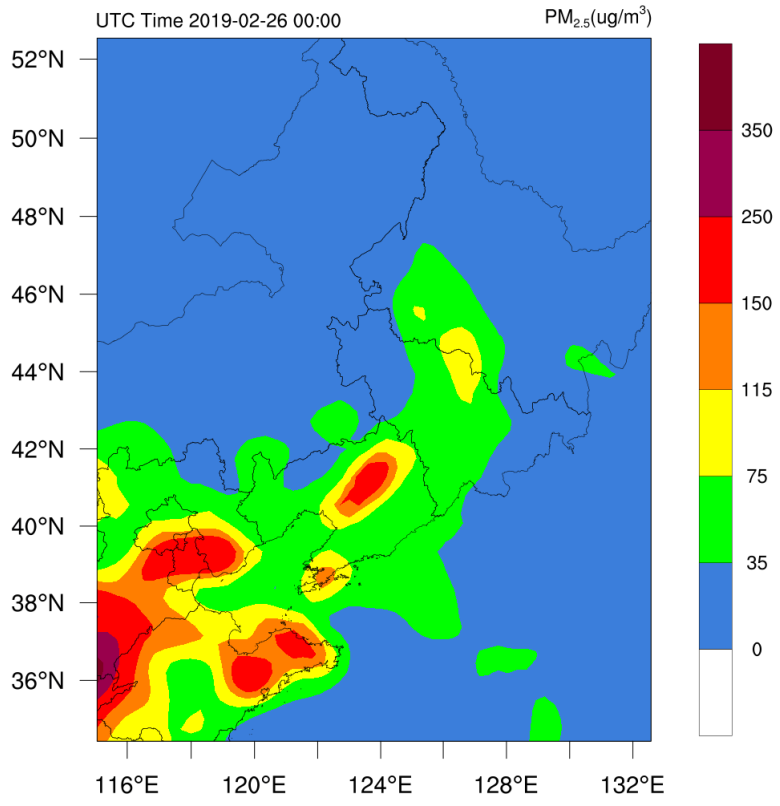


The contribution of biomass burning on $PM_{2.5}$ concentration is 52.7% in autumn

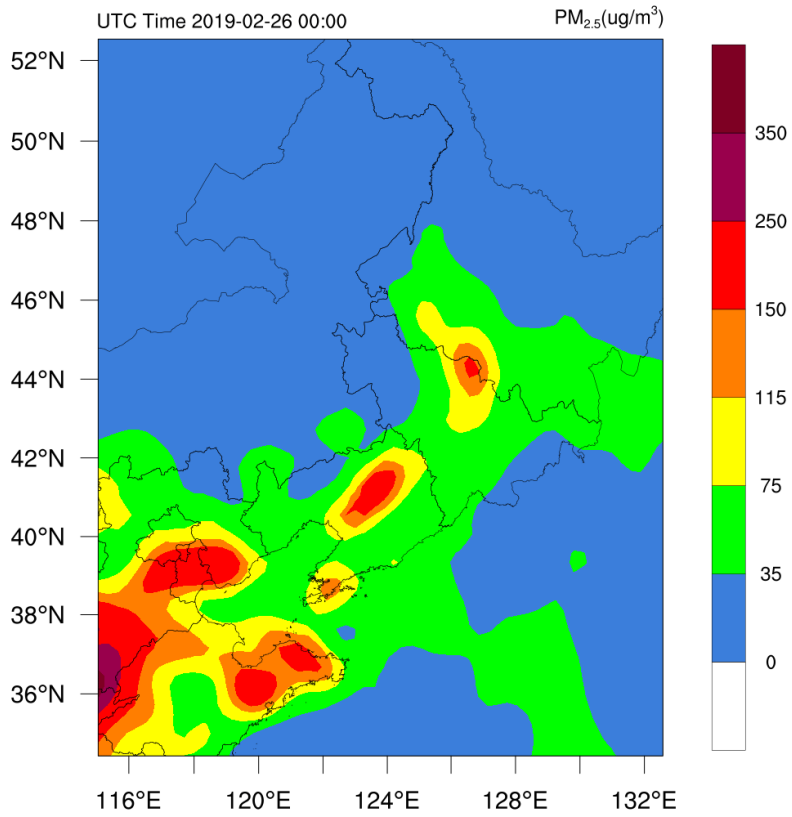
Effects of Spring Burning on Air Quality

CMAQ simulation

without fire

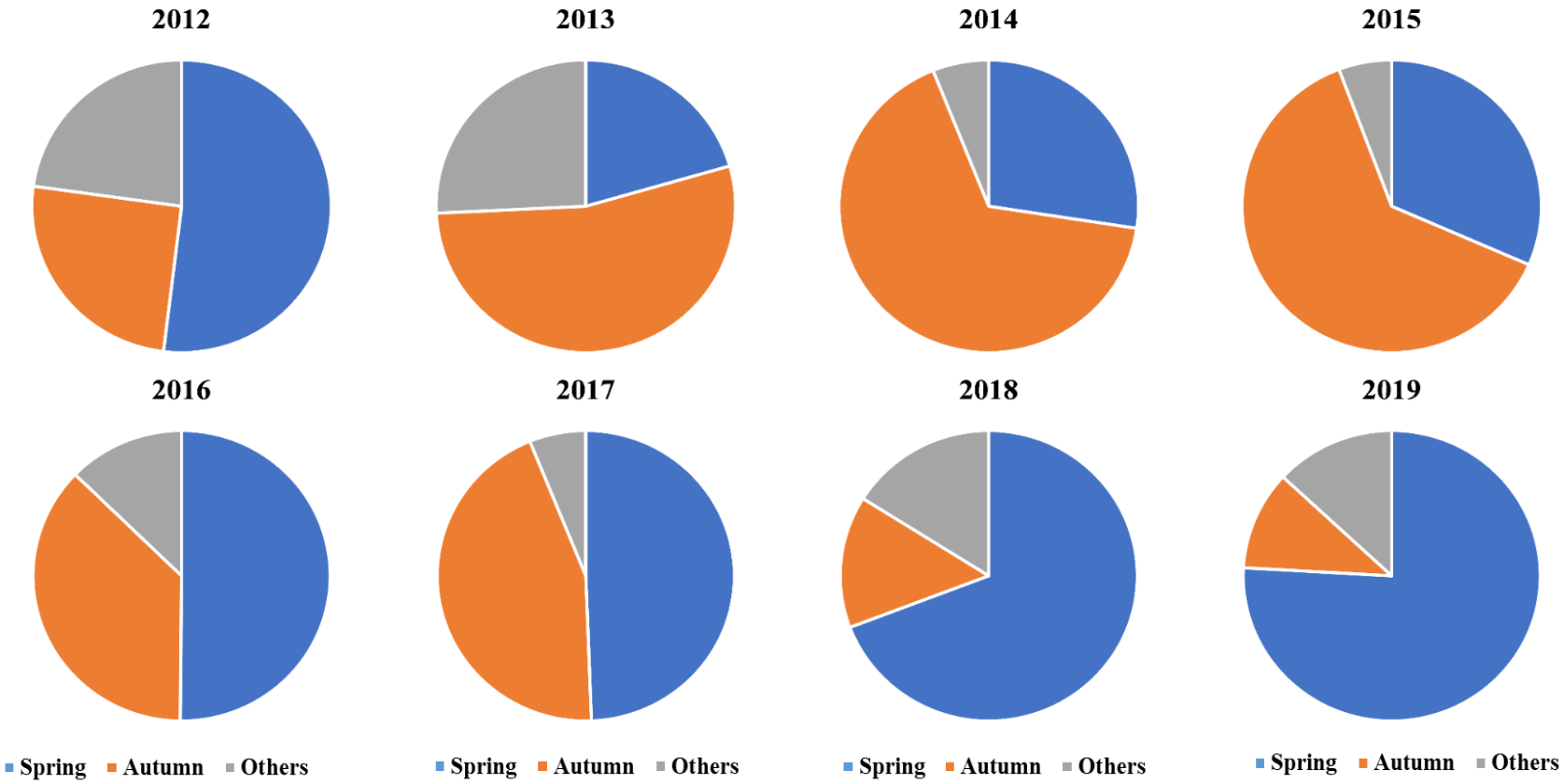


with fire



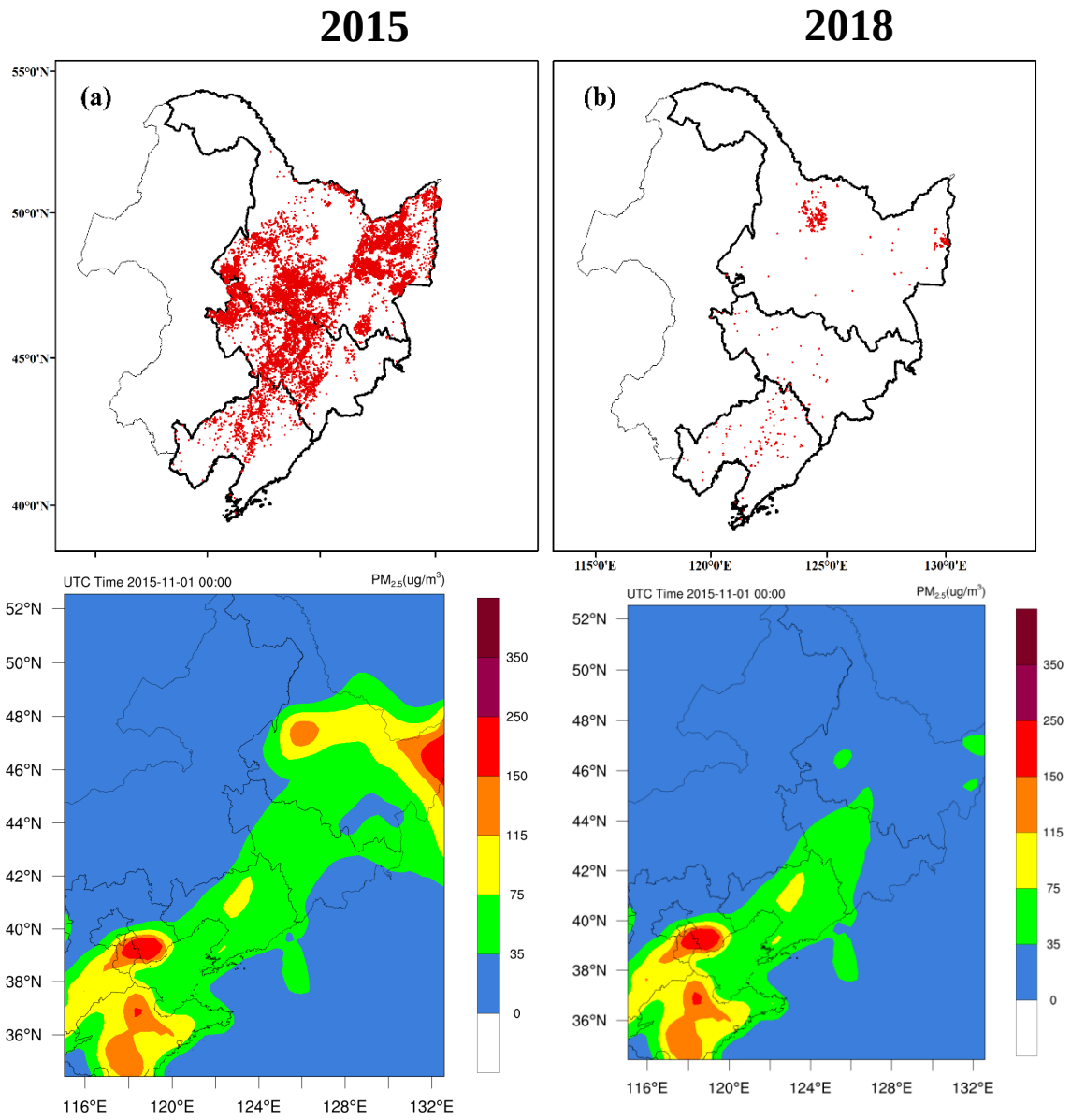
- **The contribution of biomass burning on $PM_{2.5}$ concentration is 24.6% in spring.**
- **Spring burning has less effects on air quality, due to lower PBL and cold season.**

Seasonal Variability of Biomass Burning Emissions



- The burning season changed from autumn to spring.
- From 2013 to 2019, the emission of $PM_{2.5}$ from spring burning increased year by year.

Impact of Burning Ban on Fire Emissions



- About 48% $PM_{2.5}$ concentration decreased following the implementation of government controls.
- Government management can effectively reduce the $PM_{2.5}$ concentrations and control heavy haze pollution events.

Conclusion

- **Higher levels of aerosol and pollutant gases emissions were concentrated in the Songnen Plain and Sanjiang Plain, the main grain producing areas in this region.**
- **There were two emission peaks observed: after harvesting (October to November) and before planting (March to April).**
- **Modeling results showed that open biomass burning contributed to 52.7% of $PM_{2.5}$ concentrations during a regional haze episode over Northeastern China.**
- **The burning ban enforced in 2018 have caused the $PM_{2.5}$ concentrations decreased by 48.1% during the post-harvest season over this region.**

Thanks for your attention!

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