Estimating the agricultural fertilizer NH_3 emission in China based on the bi-directional flux parameterization for air quality models

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Outline

- Review
- Improvement
- Results and Discussion
- Conclusion
- On-going work

Review

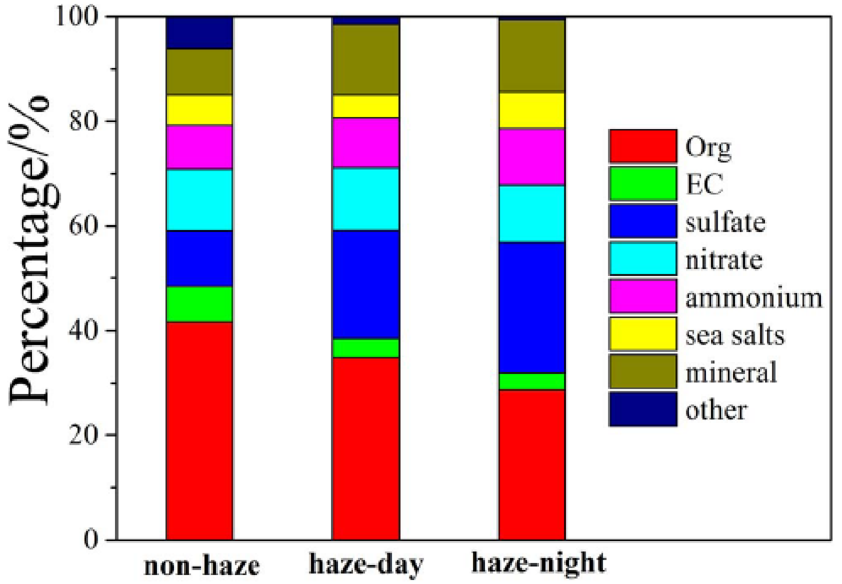


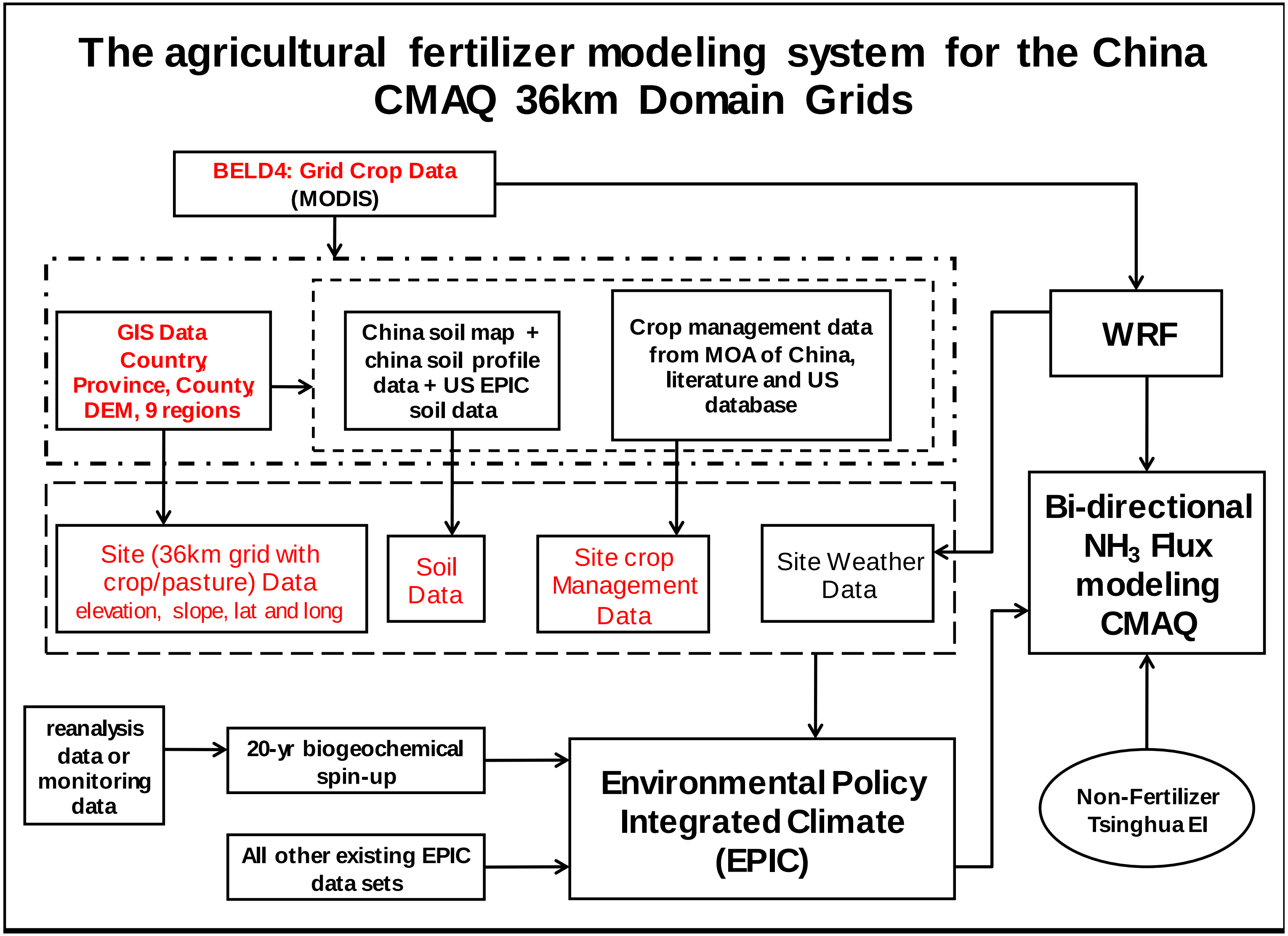
Figure 6 | Mass fraction of different chemical compositions in $PM_{2.5}$ in Beijing station. Non-haze, haze-day, and haze-night represent the sampling times of 12:00 on Jan. 9th, 12:00 on Jan. 12th, and 00:00 on Jan. 13th, 2013, respectively.

(source: He et al., Scientific Reports, 2010)

- Secondary non-organic aerosol (SNA) is major component of $PM_{2.5}$ in haze days
- NH_3 plays an important role in SNA formation process

- Anthropogenic source is easy to control compared with the agricultural emission; High uncertainties associated with agricultural emission inventories have been identified as one of the major challenges in air quality studies.
- Our goal is to find a way to develop an updated and detailed agricultural emission inventory in China(Mainly in fertilizer use)

Review method: Structure of the system for China



Source: FEST-C https://www.cmascenter.org/fest-c/documentation/1.2/html/

CMAQ Simulation

- Simulations using CMAQ v5.0.1
  - One week April and October in 2011 simulations
- Two model cases were simulated

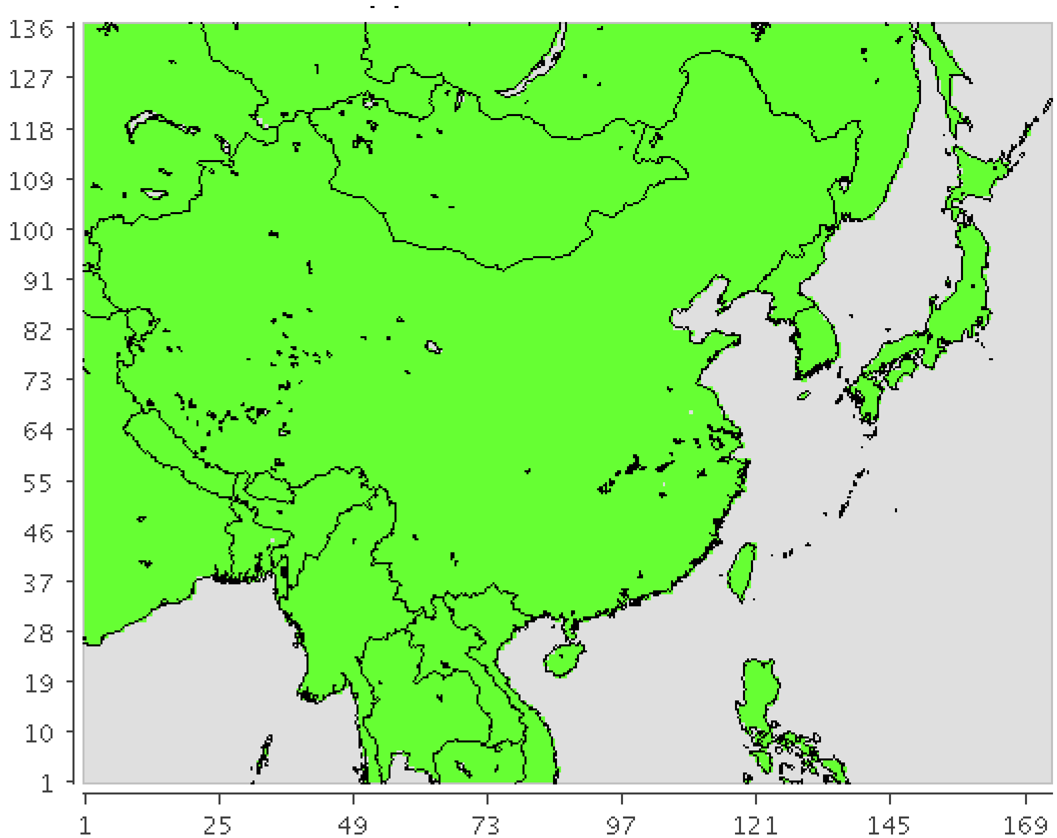
Base case

  - Emissions inventory from Tsinghua University
  - No bidirectional NH_3 exchange

Bidi case

  - Emissions inventory from Tsinghua University without NH_3 evasion from agricultural cropping sectors + FESTC NH_3 emission
  - Bidirectional NH_3 exchange

The Domain



Target Area

–The Whole China

Target Year

–2011

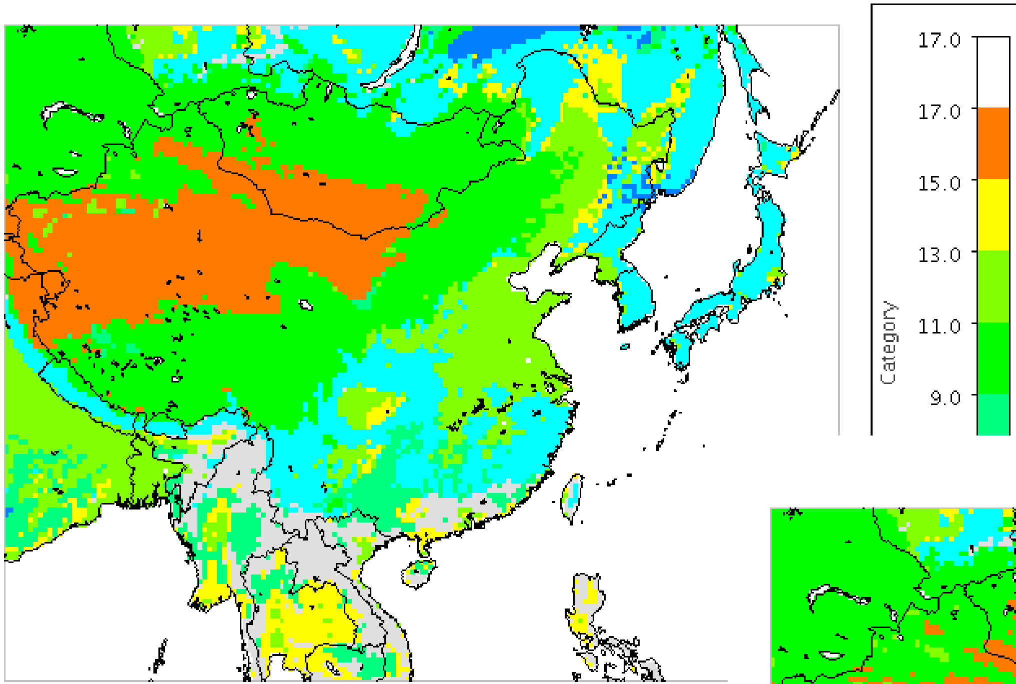
Horizontal

Resolution:

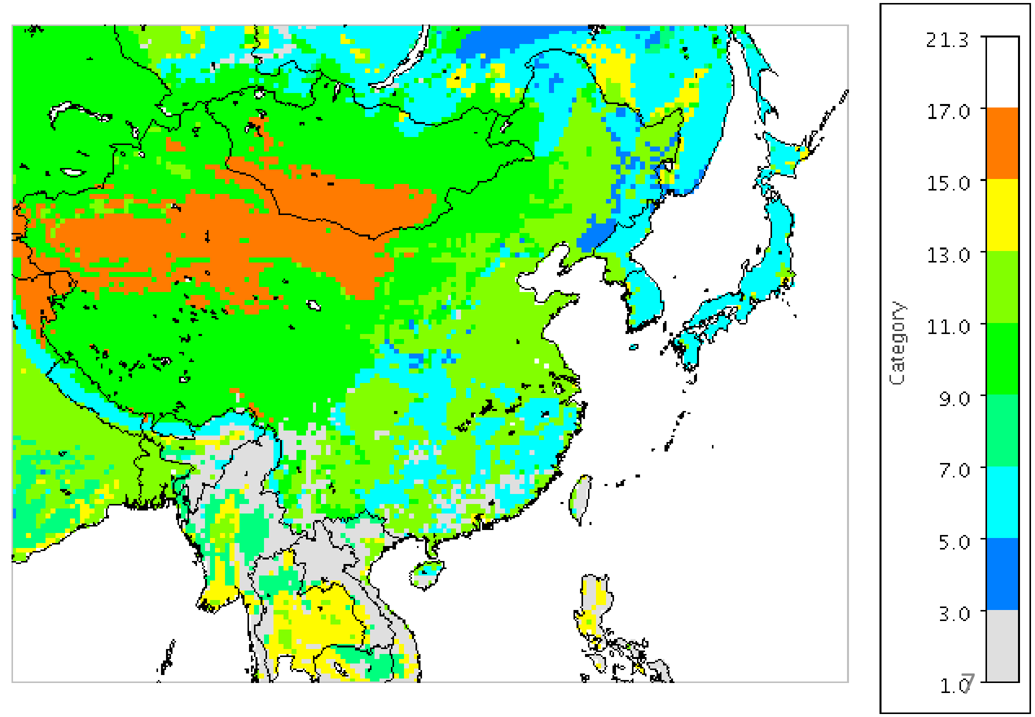
–36km×36km;

Land use

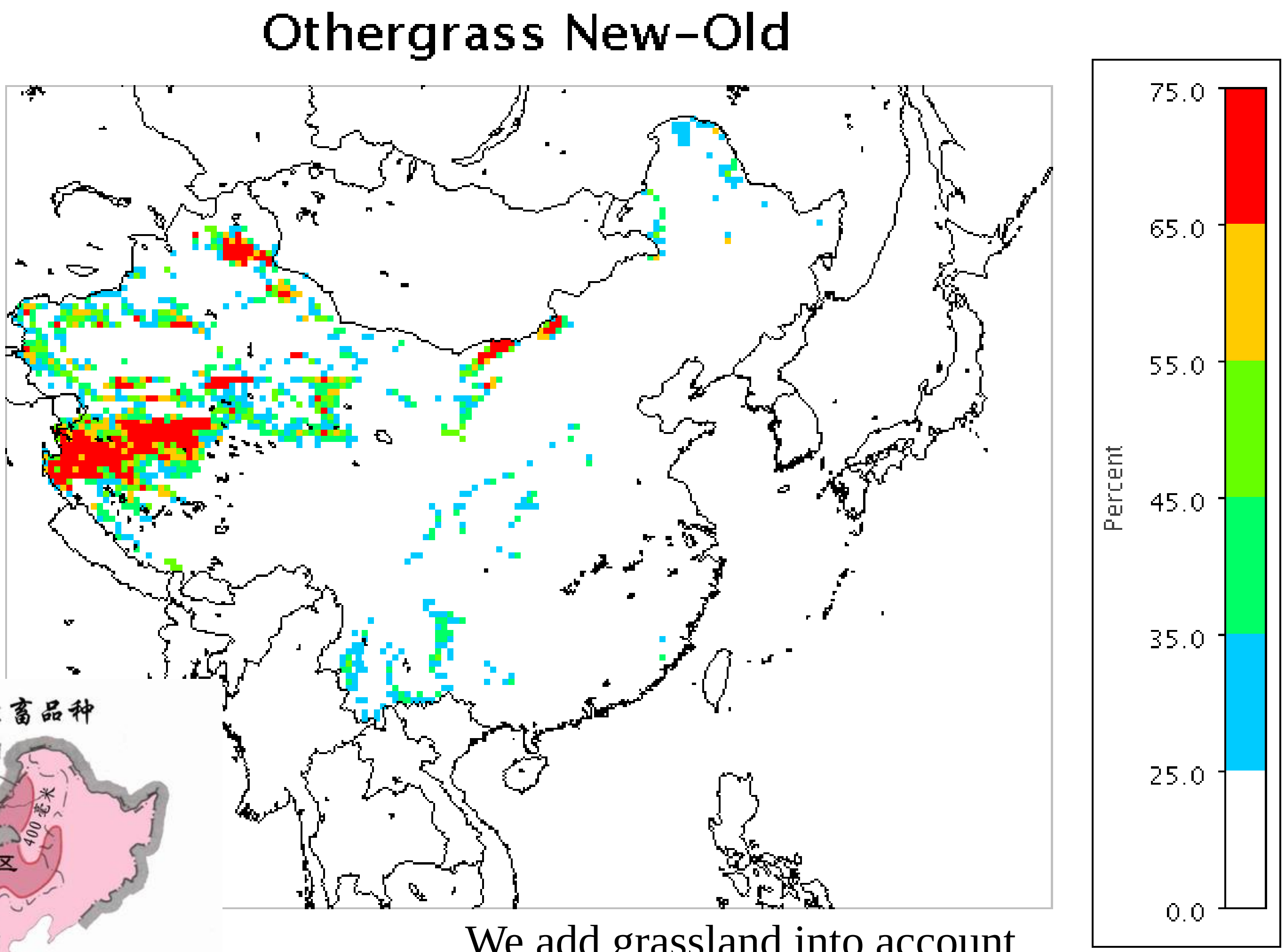
land use 2010



Land use 2011

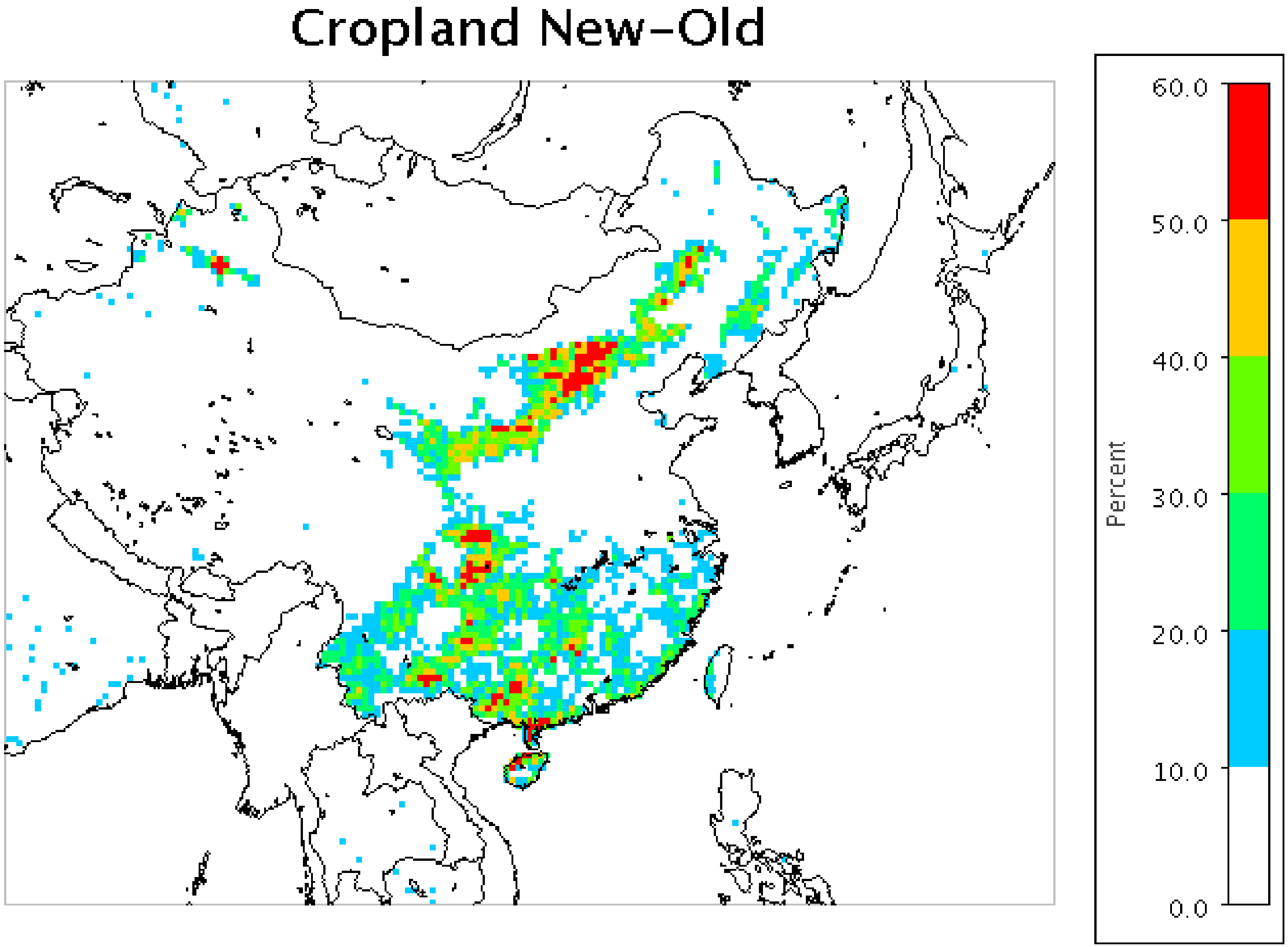


Difference between typical classes: grass land

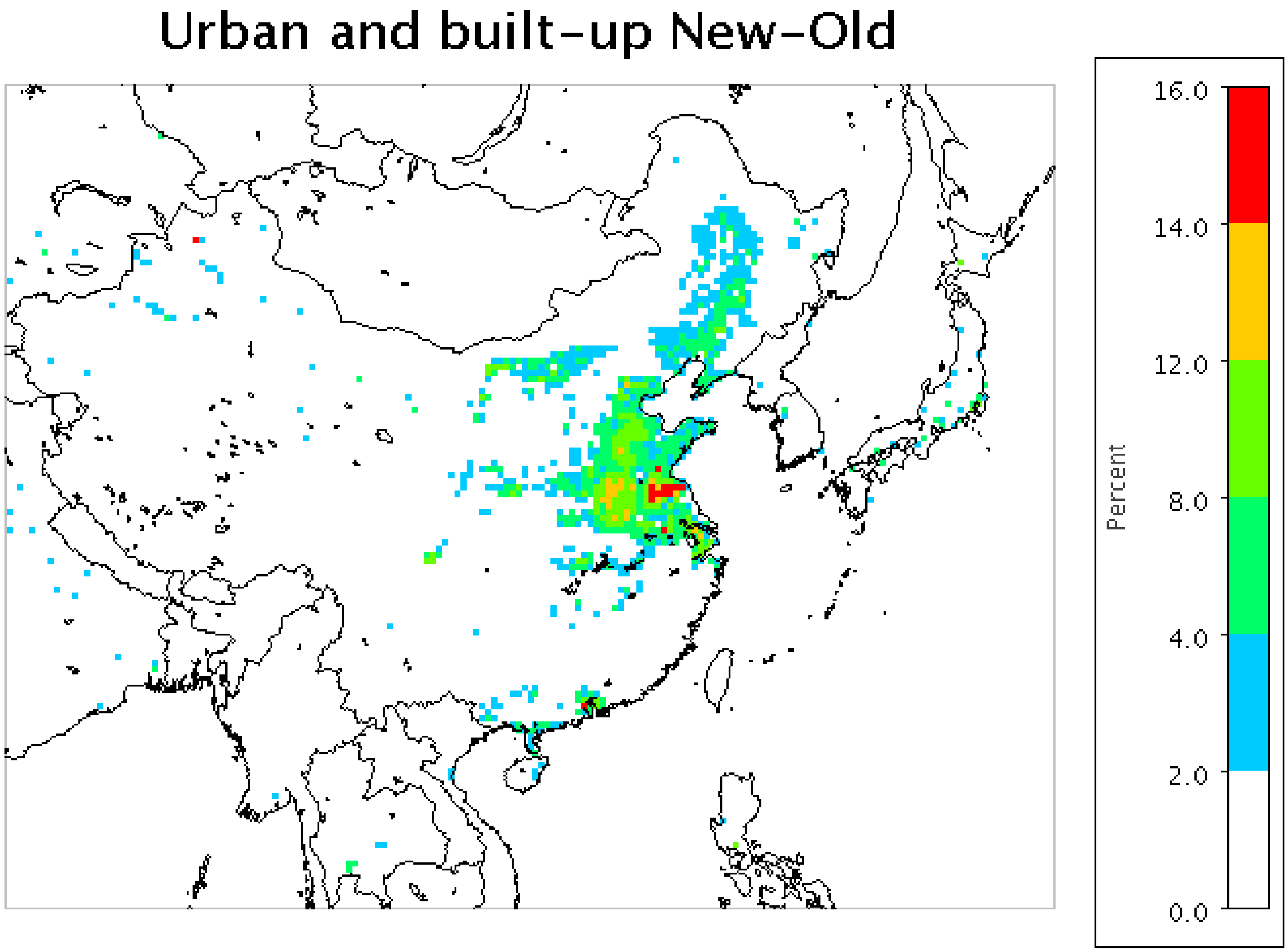


We add grassland into account this time， here Othergrass represent as grazing lands

Difference between typical classes: crop land



Difference between typical classes: Urban



Crops

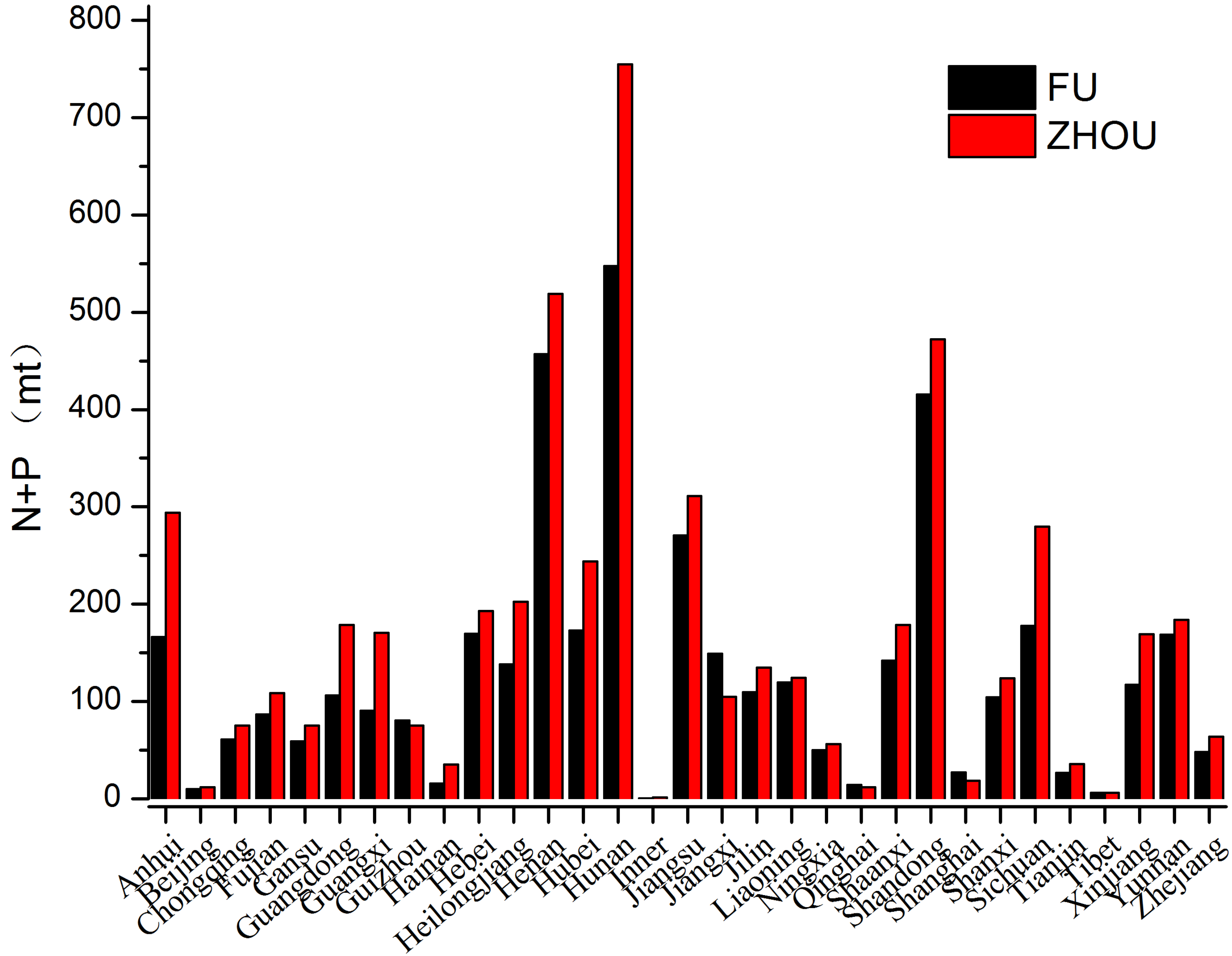
- Difference between typical crops:

➢ Othergrass

➢ Rice-rainfed ⟶ Rice-irr (early, middle,late)

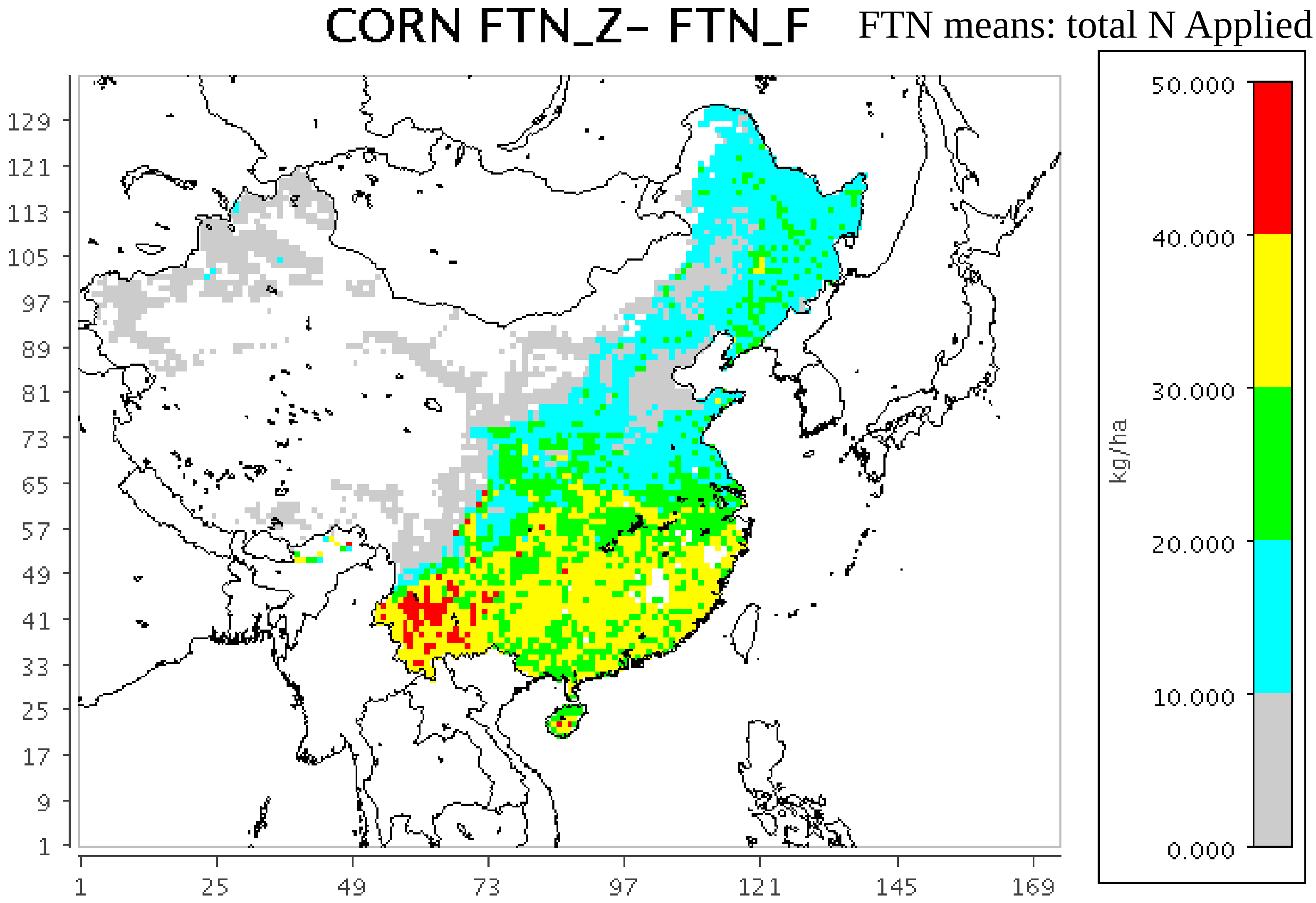
Results and Discussion

- EPIC

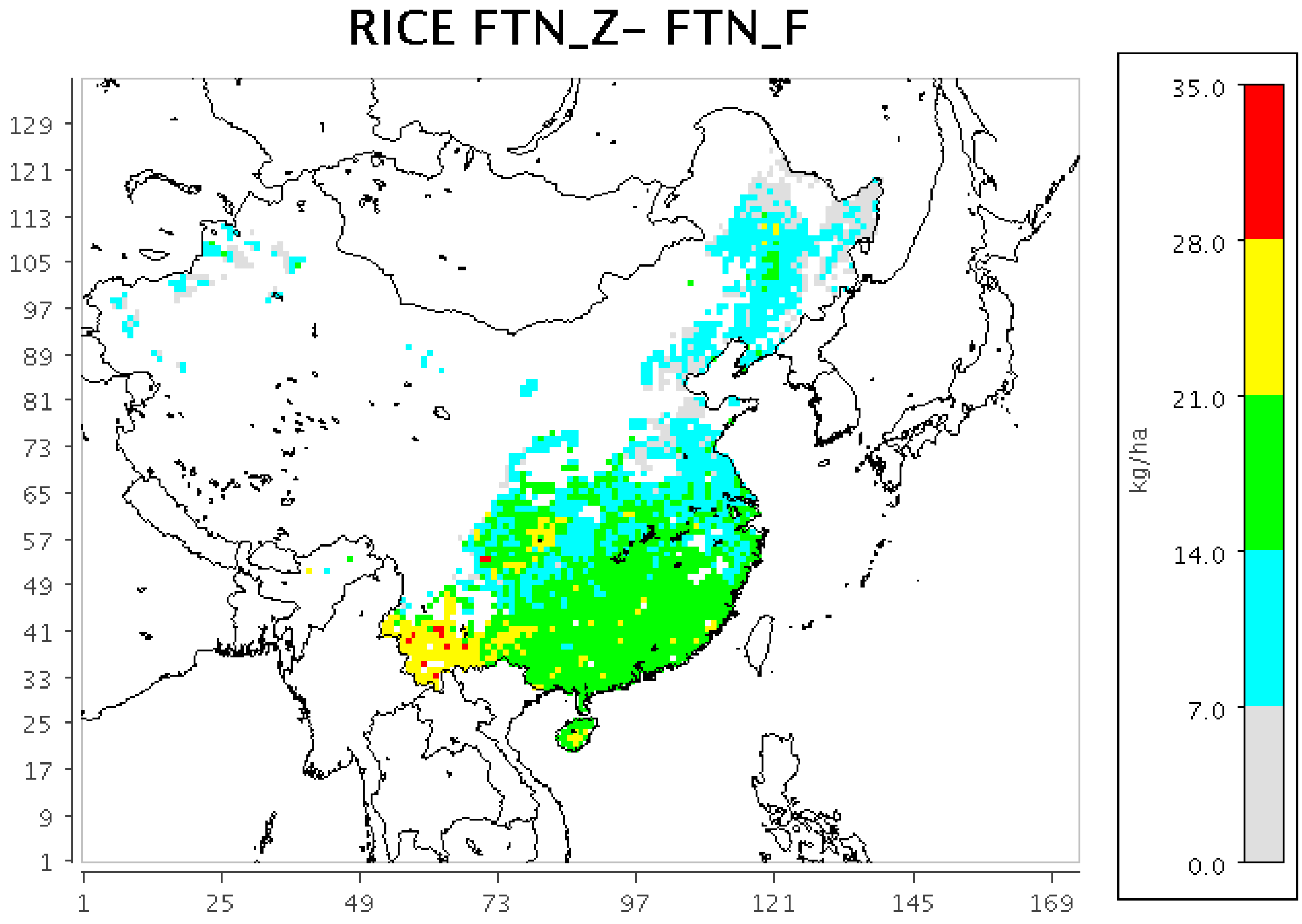


Results and Discussion

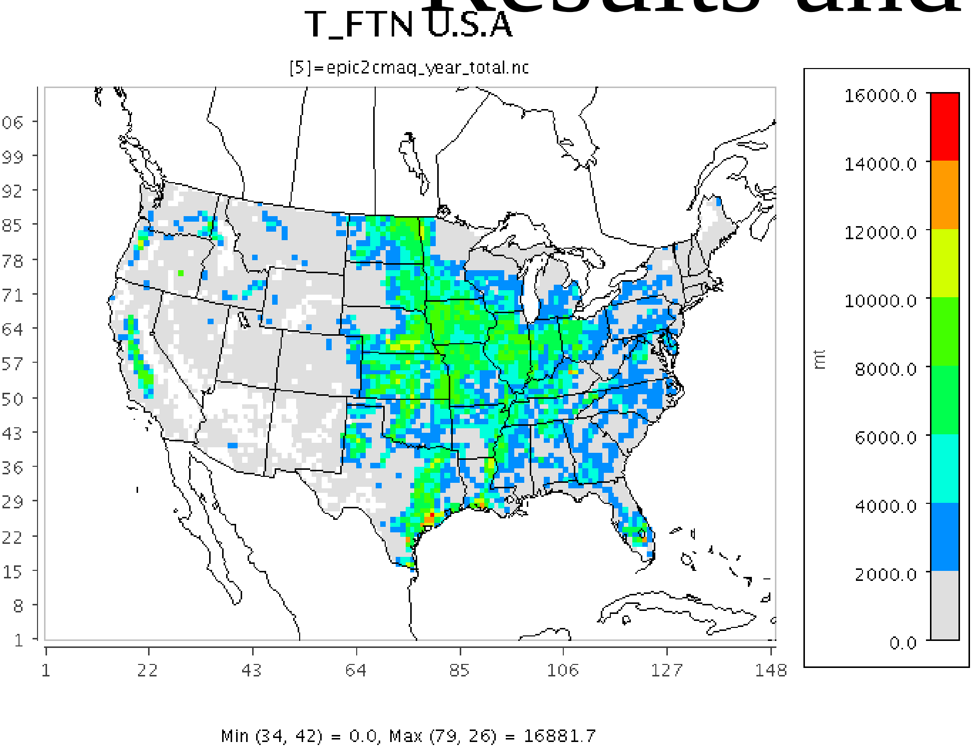
FTN means: total N Applied

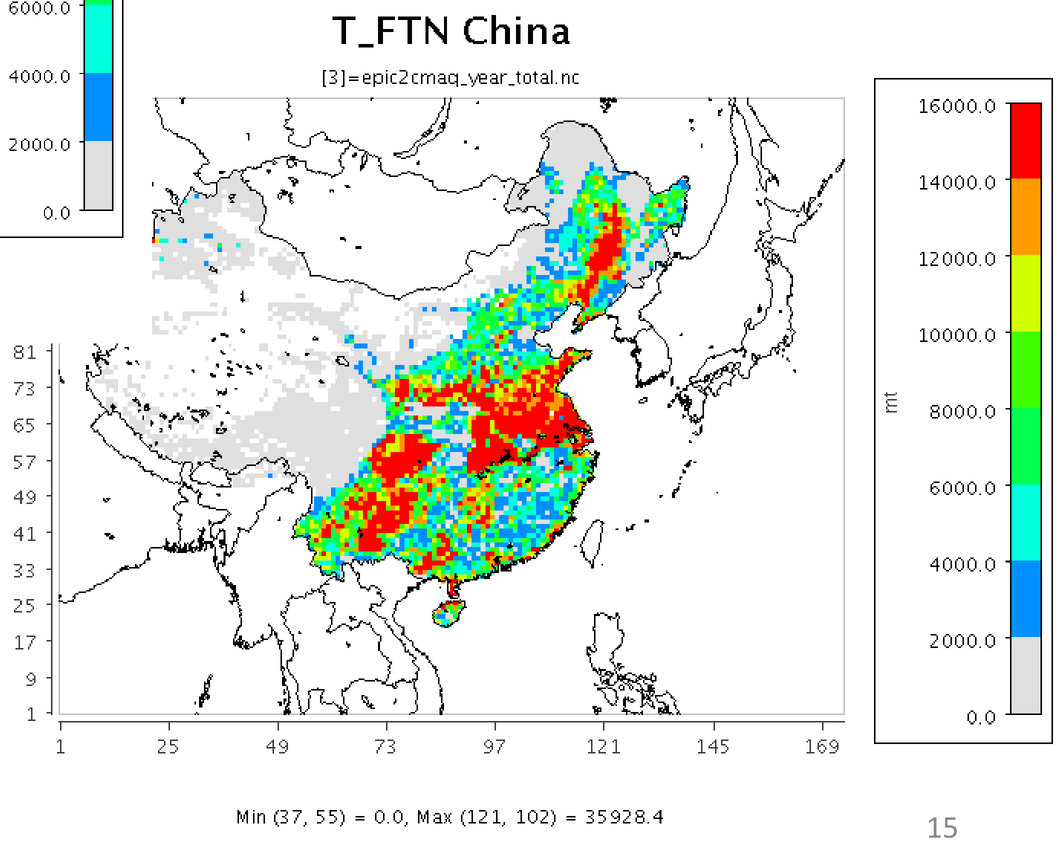


Results and Discussion



Results and Discussion





- FTN means: total N Applied (mt)

Topleft : U.S.A 36km

Bottomright: China 36km

CHINA： 375 (10kt）

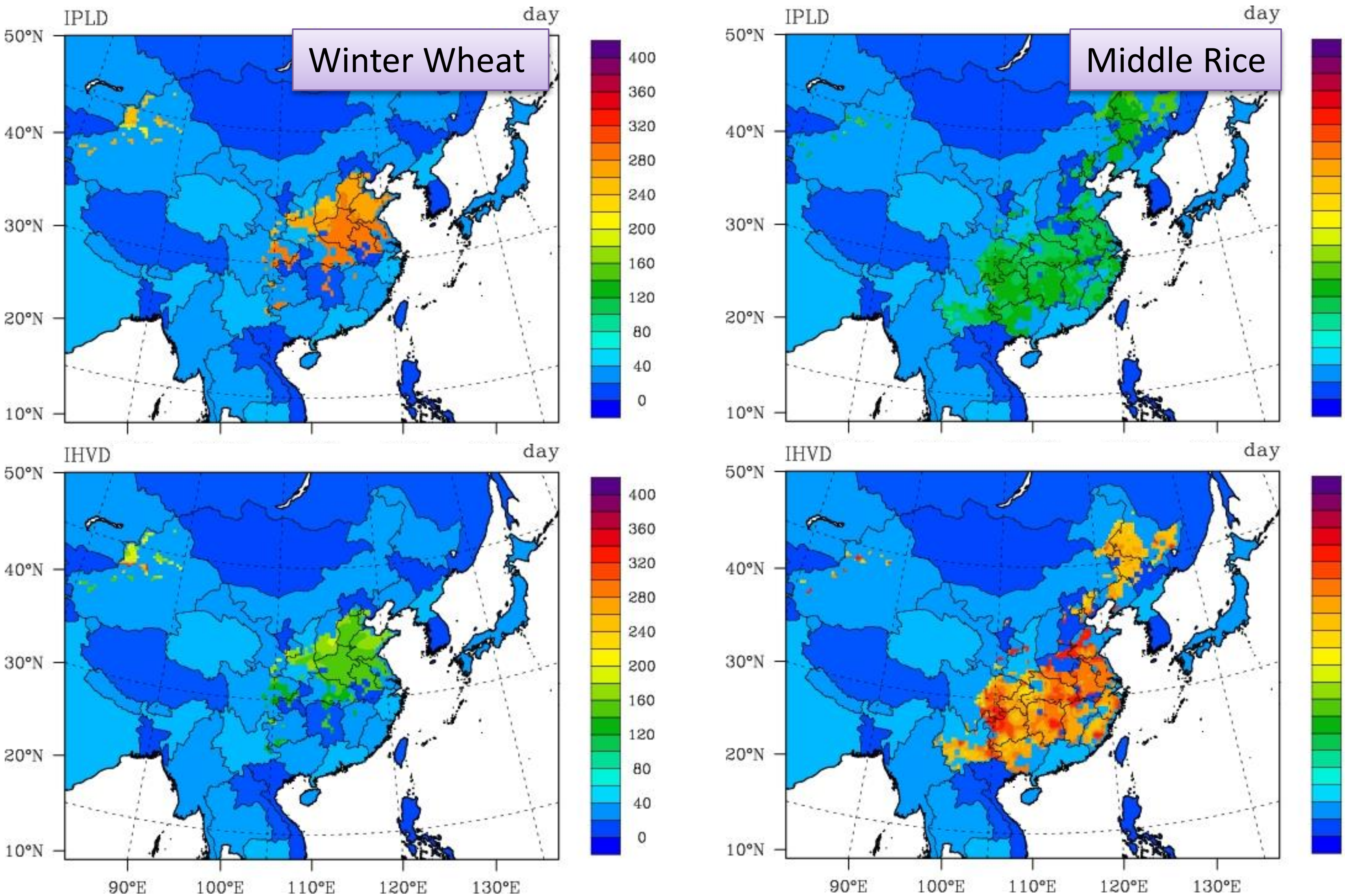
U.S.A : 98 (10kt)

Results and Discussion

Table 1. Compare of the fertilizer consumption in each province between this study and statistical data. (Unit: 10kt)

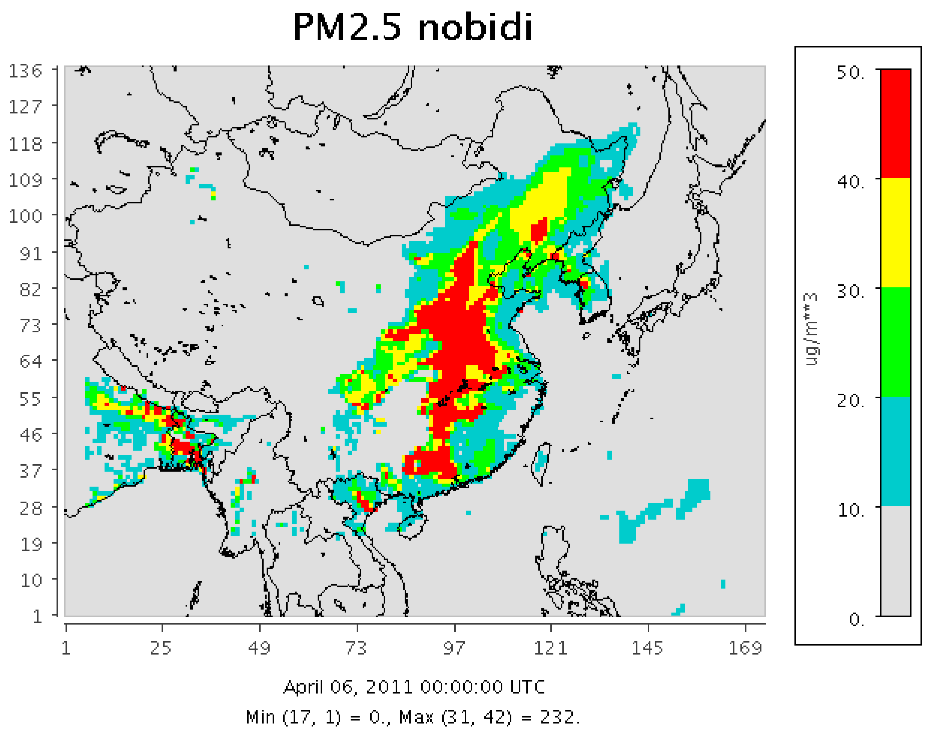
Province	N	P	N_{2011}	P_{2011}	Province	N	P	N_{2011}	P_{2011}
Anhui	229.7	64.4	319.8	112.1	Jiangsu	237.2	73.9	341.1	179.5
Beijing	7.8	4.2	13.7	6.9	Jiangxi	80.8	23.8	137.6	43.4
Chongqing	44.1	30.9	91.8	49.3	Jilin	95.2	39.4	182.8	66.9
Fujian	80.9	27.6	121.0	47.7	Liaoning	84.6	39.7	140.1	68.3
Gansu	57.2	17.9	85.3	37.9	Ningxia	38.2	17.7	37.9	17.7
Guangdong	126.3	52.4	237.3	100	Qinghai	8.3	3.7	8.8	3.5
Guangxi	128.4	41.9	237.2	69.9	Shaanxi	107.3	71.4	196.8	87.7
Guizhou	54.1	20.9	86.5	46.5	Shandong	373.6	98.6	475.3	162.6
Hainan	27.4	7.8	46.4	13.8	Shanghai	12.0	6.4	11.8	6.2
Hebei	141.3	51.5	322.9	153.1	Shanxi	84.6	39.3	110.4	40.0
Heilongjiang	142.7	59.8	214.9	77.4	Sichuan	151.1	128.8	248.0	129.6
Henan	373.7	145.3	655.2	243.9	Tianjin	24.4	11.4	11.8	3.9
Hubei	154.9	89.1	350.8	156.4	Tibet	4.8	1.5	4.7	1.9
Hunan	142.5	612.2	236.6	110.4	Xinjiang	83.7	85.5	167.6	78.7
Hong Kong	0.6	0.5	1.2	0.4	Yunnan	100.5	83.2	184.6	97.5
Inner Mongolia	71	12.0	177.2	80.5	Zhejiang	42.1	21.6	92.2	52.5

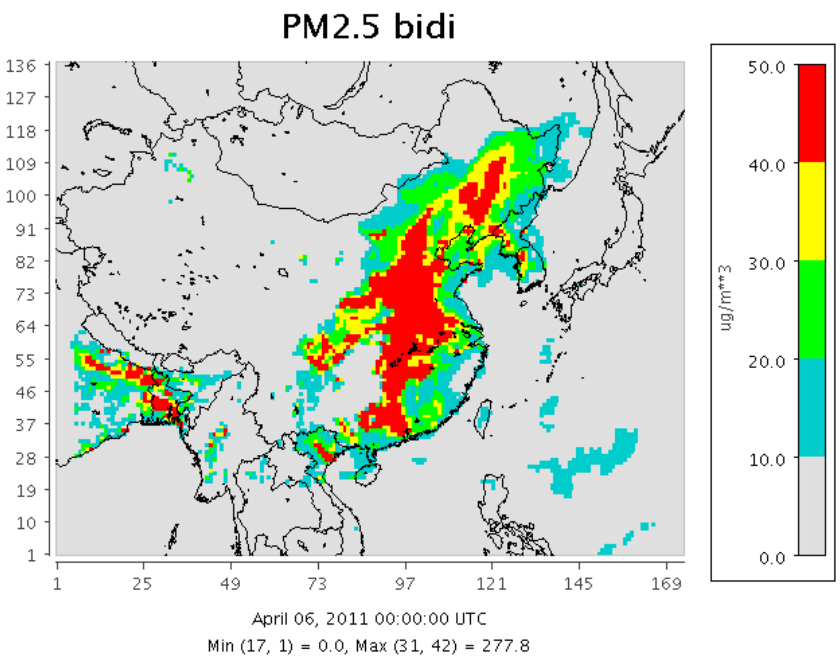
EPIC Output --- Plant and Harvest Time



Results and Discussion

- CMAQ
- $PM_{2.5}$= ASO4I+ ASO4J+ ANO3I+ ANO3J+ ANH4I+ ANH4J+ ANAI+ ANAJ+ ACLI+ ACLJ+ AECI+ AECJ+ AOTHRI+ AOTHRJ+ AFEJ+ ASIJ+ ATIJ+ ACAJ+ AMGJ+ AMNJ+ AALJ+ AKJ





Results and Discussion

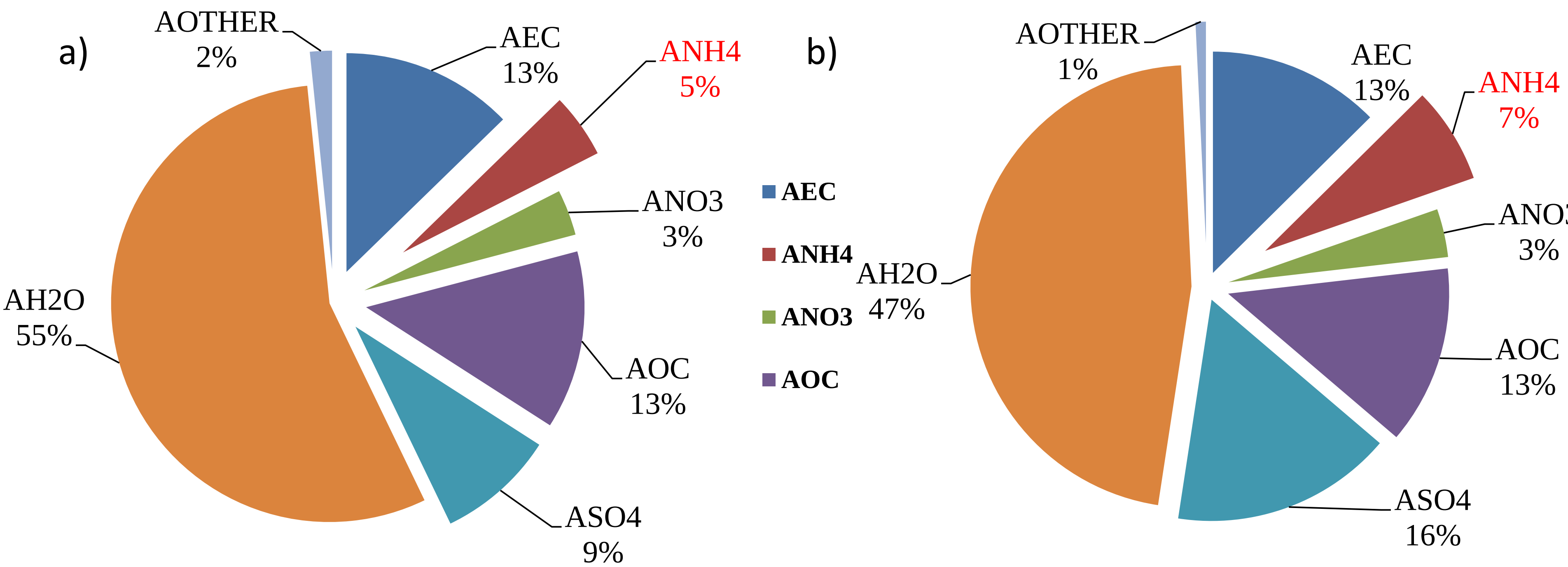
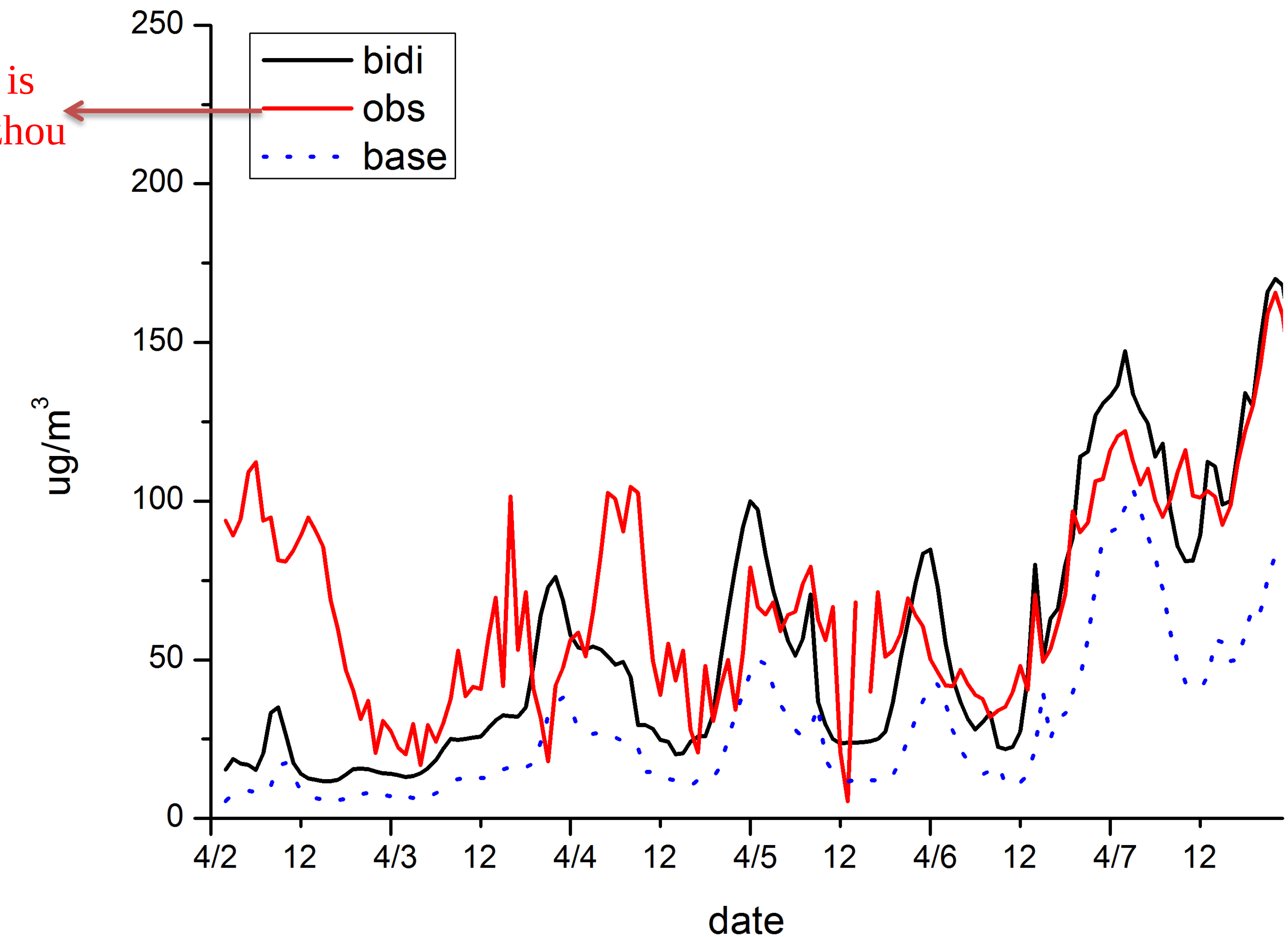


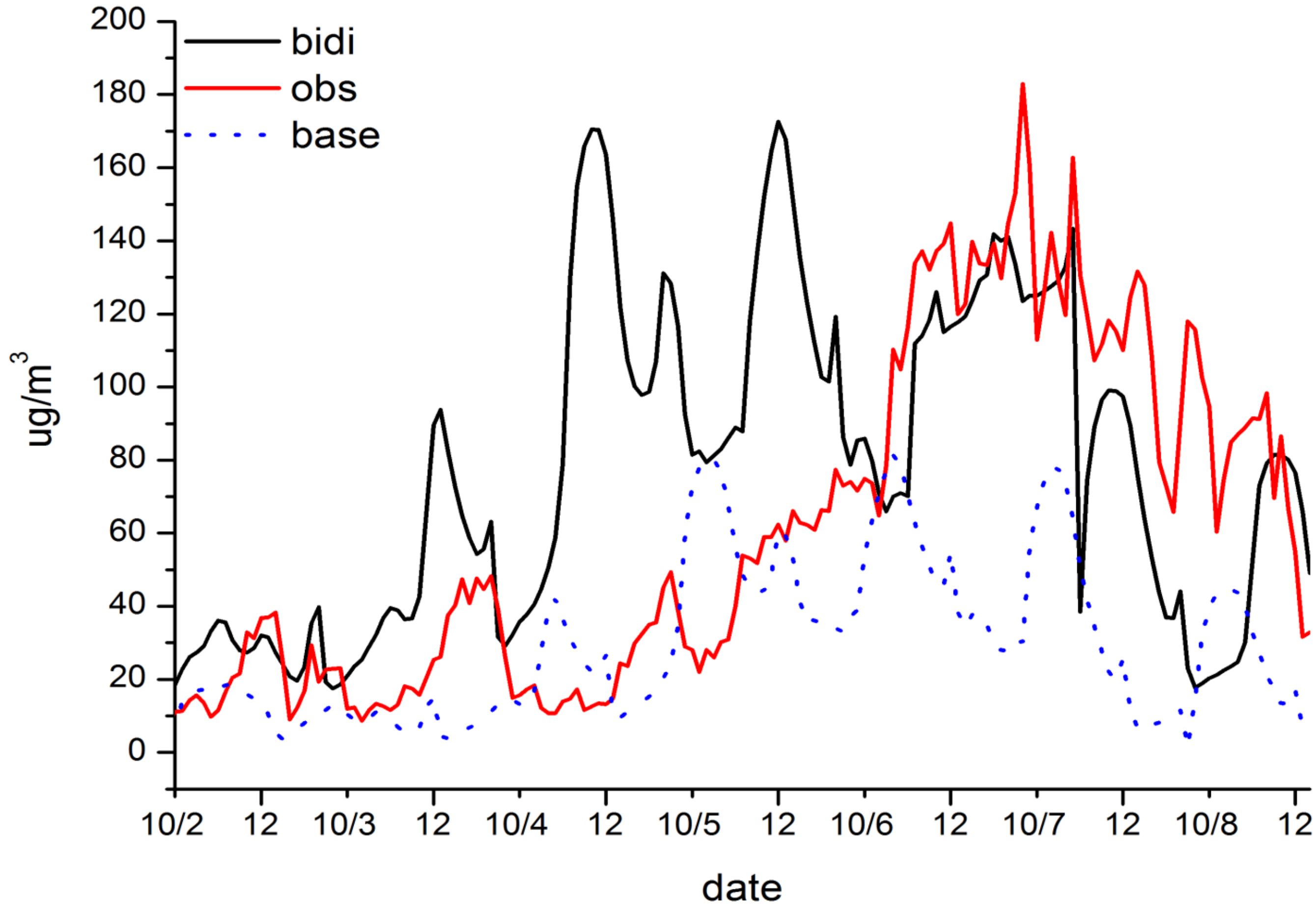
Figure Pie charts of chemical compositions of $PM_{2.5}$ a)base case b) bidi

Results and Discussion: April

Obs data is from Suzhou (2011)



Results and Discussion: October



Conclusion

- The improved FESTC model can give us an agriculture emission inventory of the whole china for each year you want .

- Base on the CMAQ case study, agricultural emissions(NH_3) are critical to determine the relationship of $PM_{2.5}$ with its precursors and to understand $PM_{2.5}$ formation mechanism.

On going work

- The whole months simulation
- Further evaluating the model results and estimate the impact of major agricultural emission on $PM_{2.5}$ and future air quality
- Further applying this system (e.g. climate change, guide agricultural production)

THANK YOU !