SUPPORTING INFORMATION FOR

A new high-resolution N_2O emission inventory for China in 2008

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TABLE OF CONTENTS

Section S1: Methodology

Section S2: Data on activity data, EFs, and EPs

Section S3: Supplement results

Section S4: Supporting references

Section S1: Methodology

Text S1 Equations for N_2O emissions from each source

This part is converted and modified from 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

S1.1 Manure management systems (A1 and A2)

$$E_{MS} = \frac{44}{28} \cdot \sum_{T} \sum_{S} \left(MS_{(T,S)} \cdot EF_{3(T,S)} \right), \tag{S1a}$$

where

$$MS_{(T,S)} = LP_T \cdot Nex_{(T)} \cdot \eta_{(T,S)} \tag{S1b}$$

$$Nex_{(T)} = Nrate_{(T)} \cdot DAY_{(T)} / 1000 \tag{S1c}$$

and $MS_{(T,S)}$ is annual average N excretion in management system *S* for livestock species/category *T*, kg N·yr^{-1}; Livestock species/category considered in PKU-N_2O include swine, dairy cattle, other cattle, sheep, poultry, house, ass, and mule; N_T is number of head of species/category *T*; $Nex_{(T)}$ is annual average N excretion per head of species/category *T*, kg N·head^{-1}·yr^{-1}; $\eta_{(T,S)}$ is fractions of manure managed in each management system *S* for each livestock species/category *T*, %; $Nrate_{(T)}$ is N excretion rate for livestock species/category *T*, g N·head^{-1}·day^{-1}; $DAY_{(T)}$ is number of feeding day for livestock species/category *T*; $EF_{3(T,S)}$ is emission factor for direct N_2O emissions from manure management system S for livestock species/category *T*, kg N_2O-N·kg^{-1}; when *S*=1, $EF_{3(T,S)}$ is equal to the emission factor for direct N_2O emissions ($EF_{1(T,R)}$);44/28 is conversion coefficient of N_2O-N emissions to N_2O emissions.

S1.2 Synthetic fertilizers (A3)

$$E_{SF} = \frac{44}{28} \cdot \sum_{T} \sum_{R} \left[\left(NS_{(T,R)} + \alpha \cdot NC_{(T,R)} \right) \cdot EF_{1(T,R)} \right], \tag{S2}$$

where $NS_{(T,R)}$ and $NC_{(T,R)}$ are annual amounts of chemical and compound fertilizers for crop type T in county *R*, kg N·yr^{-1}; α is N content in compound fertilizer set as 30% kg·kg^{-1} suggested by Gao et al. [1], $EF_{1(T,R)}$ is emission factor for direct N_2O emissions from agricultural soils for crop type *T* in Agro-Climate Zone *R*, kg N_2O-N/kg N. The corresponding Agro-Climate Zone and other Administrative divisions (regions and provinces) of China are shown in **Figure S1** (http://en.wikipedia.org/wiki/Administrative_divisions_of_China and http://www.data.ac.cn/).

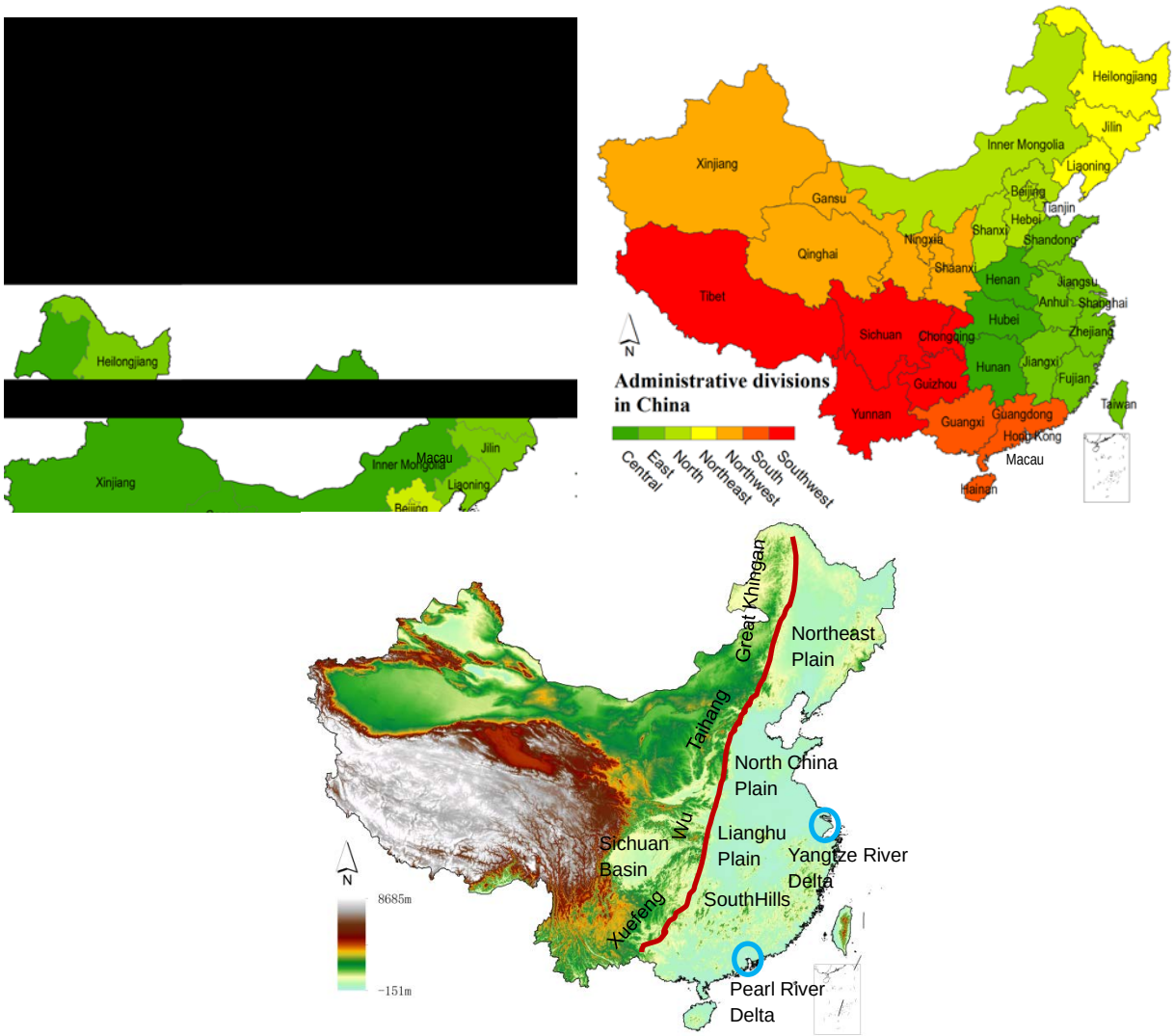

Figure S1. Administrative divisions (regions and provinces) of China

S1.3 Organic fertilizer (A4)

$$E_{ON} = \frac{44}{28} \cdot \sum_{T} \sum_{R} \left[\left(RP_{(T,R)} + LP_{(T,R)} + Crop_{(T,R)} \right) \cdot Nr_{(T,R)} \cdot \eta_T \cdot EF_{1(T,R)} \right], \quad \text{(S3)}$$

where $P_{(T,R)}$ is number of rural population, or livestock species/category *T* or productivity of oil plant *T* for cake fertilizers in county *R*, capita·yr^{-1} or head·yr^{-1} kg·yr^{-1}, oil plants considered in PKU-N_2O are divided into rapeseed, soybean, peanut, sesame, and the others; $Nr_{(T,R)}$ is annual average N excretion per head of species/category *T* for county *R*, or per capita of human, or N content in oil plant *T*, kg N·capita^{-1}, kg N·head^{-1} or kg N·kg^{-1}; $\eta_{(T)}$ is fraction of human or livestock excretion return to cropland, %.

S1.4 Crop residues (A5)

$$E_{CR} = \frac{44}{28} \cdot \sum_{T} \sum_{R} \left(Crop_{(T,R)} \cdot CRN_{(T,R)} \cdot EF_{1(T,R)} \right), \tag{S4a}$$

where

$$Crop_{(T,R)} = Yield_{(T,R)} \cdot DRY_T \cdot \left(1 - Burnt_{(T,R)} \cdot C_f\right) \cdot Renew_T , \tag{S4b}$$

$$CRN_{(T,R)} = R_T^{AG} \cdot N_T^{AG} \cdot \left(1 - Remove_{(T,R)}\right) + R_T^{BG} \cdot N_T^{AG} , \tag{S4c}$$

and $Crop_{(T,R)}$ is annual dry matter yield for crop *T* in county *R* excluding that burnt, kg·yr^{-1}; $Yield_{(T,R)}$ is annual fresh yield for crop *T* in region *R*, kg·yr^{-1}; Crop types considered in PKU-N_2O consist of rice, wheat, maize, barley, soybean (including other soybeans), potato (including other potato), peanut, rapeseed, sesame, other oilplants, sugarcane, millet, sorghum, highland barley, and alfalfa; DRY_T is dry matter fraction of crop *T*, %; $Burnt_{(T,R)}$ is area fraction of crop *T* burnt in region *R*, %; C_f is combustion factor, %; $Renew_{(T)}$ is fraction of total area under crop *T* that is renewed annually set as 1 in PKU-N_2O; R_T^{AG} is ratio of above-ground residues dry matter (d.m.) to $Crop_T$, %; N_T^{AG} is N content of above-ground residues for crop *T*, kg N·(kg d.m.)$^{-1}$; $Remove_{(T,R)}$ is fraction of above-ground residues of crop *T* removed annually in region *R*, %;

R_T^{BG} is ratio of below-ground residues dry matter to $Crop_T$, %; N_T^{AG} is N content of blew-ground residues for crop T, kg N·(kg d.m.)$^{-1}$.

S1.5 Mineralization of soil organic matter (A6)

$$E_{SOM} = \frac{44}{28} \cdot \sum_T \sum_R \left(1000 \cdot \Delta C_{(T,R)} \cdot \frac{1}{CN} \cdot EF_{1(T,R)} \right) \quad \text{(S5)}$$

where $\Delta C_{Mineral,LU}$ is annual loss of soil carbon for crop type *T* in grid *R* simulated and averaged by global ecosystem models (ORCHIDEE[2], LPJ[3], and LPJ-GUESS[4]) shown in **Figure S2**, tC·yr^{-1}; *CN* is C:N ratio extracted from Harmonized World Soil Database v1.2 [5].

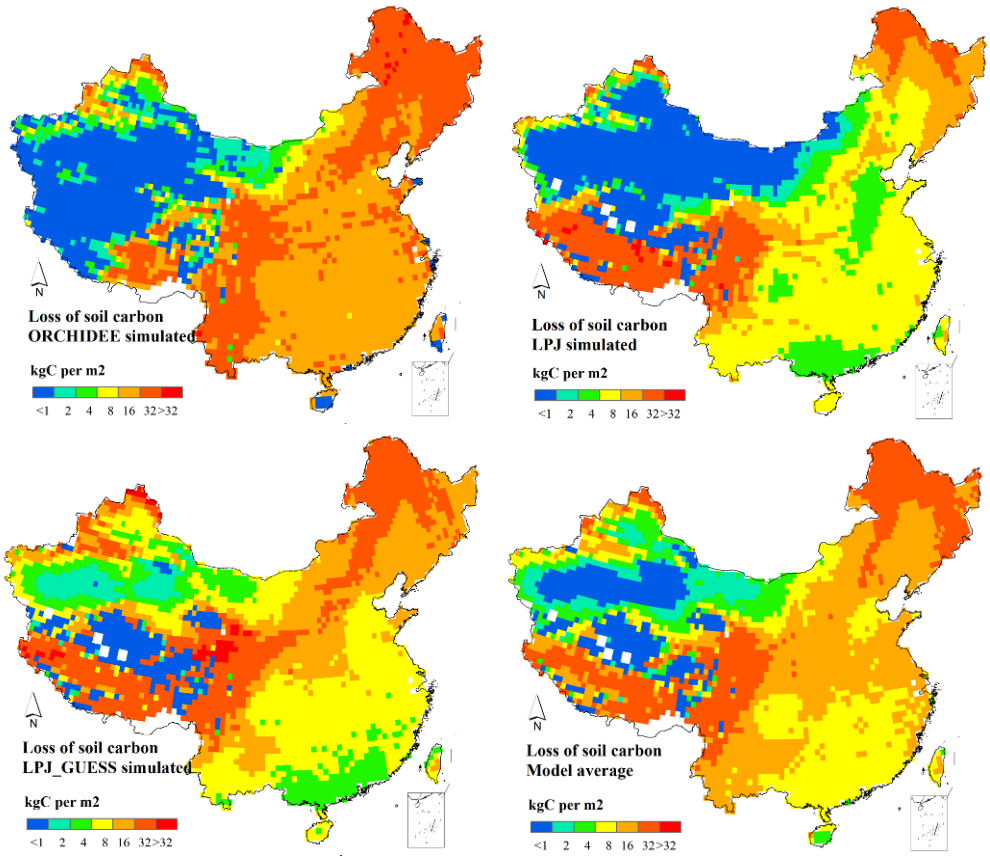

Figure S2 Results of annual soil carbon change (0.5°×0.5°) simulated and averaged by ORCHIDEE[2], LPJ[3], and LPJ-GUESS[4].

S1.6 Histosol management (A7)

$$E_{OS} = \frac{44}{28} \cdot \sum_{T} \sum_{R} \sum_{N} \left(Area_{(T,R,N)} \cdot EF_{2(T,R,N)} \right) \quad \text{(S6)}$$

where $Area_{(T,R,N)}$ is total annual area of drained/managed organic soils for vegetation type *T* with soil nutrient availability in climatic zone *R*, which is also extracted from Harmonized World Soil Database v1.2 based on FAO definition, ha; $EF_{2(T,R,N)}$ is emission factor for N_2O emissions from drained/managed organic soils, kg N_2O-N·ha^{-1}.

S1.7 Energy combustions and wildfires (including E1~E5, A8, L)

$$E_{EC} = \sum_{I} \sum_{T} \left(Fuel_{(T,I)} \cdot EF_{5(T,I)} \right) \quad \text{(S7a)}$$

$$E_{W} = \sum_{T} \left(W_T \cdot EF_{5T} \right) \quad \text{(S7b)}$$

where $Fuel_{(T,I)}$ is consumption of fuel *T* in energy sector *I* and W_T is dry matter burned of vegetation *T*. Energy sectors considered in PKU-N_2O include public electricity and heat production, manufacturing industries and construction, residential and other sectors, road transportation, rail transportation and other energy sources, TJ·yr^{-1}; $EF_{5(T,I)}$ is emission factor of Energy combustions, kg N_2O·TJ^{-1}, and $EF_{5(T,I)}$ is emission factor of wildfires, kg N_2O·(kg d.m. burned)$^{-1}$.

S1.8 Production of chemicals (including I1and I2)

$$E_{PC} = \frac{44}{28} \cdot \sum_{T} \left(P_{(T)} \cdot EF_{4(T)} \right) \quad \text{(S8)}$$

where $P_{(T)}$ is production of chemical industry *T*, t·yr^{-1}, chemical productions considered in PKU-N_2O include nitric acid (NAP) and Oxalic acid (OX); $EF_{4(T)}$ is emission factor for direct N_2O emissions from chemical industry *T*, kg N_2O-N·t^{-1}.

S1.9 Wastewater handling (W1)

$$E_{WH} = \frac{44}{28} \cdot \sum_{T} \left(TN \cdot EF_6 \right) \tag{S9a}$$

where

$$TN = \left(UP \cdot Protein \cdot F_{NPR} \cdot F_{NonCon} \cdot F_{Ind} \cdot \right) - N_{Sludge} \tag{S9b}$$

and *UP* is human population, in which only urban population is considered in PKU-N_2O since wastewater from rural region in China is mainly recycled for feeding or irrigation [2]; *Protein* is annual per capita protein consumption, kg·capita^{-1}·yr^{-1}; F_{NPR} is fraction of nitrogen in protein set as default (=0.16 kg N·kg protein [3]); F_{NonCon} is factor for non-consumed protein added to the wastewater set as 1.5 [4]; F_{Ind} is factor for industrial and commercial co-discharged protein into the sewer system set as 1.25 [4]; N_{Sludge} is nitrogen removed with sludge set as 0 [4]. Here domestic sewage from urban region was only considered due to the lifestyle in China's rural region where sewage would be generally reused or recycled for agricultural irrigation and animal feeding. EF_6 is emission factor from wastewater handling, kg N_2O-N·kgN^{-1}.

S1.10 Indirect emissions through atmospheric nitrogen deposition (ID1)

$$E_{AD} = \frac{44}{28} \cdot \left(NH_3\text{-}N + NO_x\text{-}N \right) \cdot EF_7 , \tag{S10}$$

where EF_7 is emission factor for indirect N_2O emissions through atmospheric nitrogen deposition, kgN_2O-N·kg^{-1}; NH_3-N and NO_x-N are N contents of NO_x and NH_3 emissions, kg N·yr^{-1}.

S1.11 Indirect emissions from N leaching and runoff (ID2)

$$E_{LR} = \sum_{T} \sum_{R} \left(N_{(T,R)} \cdot Leach_{(T,R)} \cdot EF_8 \right) , \tag{S11}$$

where $Leach_{(T,R)}$ is ratio of N loss by leaching/runoff to N applications on managed soils for crop

type T in region R, %; EF_8 is emission factor for indirect N_2O emissions by leaching/runoff, $kgN_2O\text{-}N \cdot kg^{-1}$.

Text S2 Methodology of spatial allocations of county-level PKU-N_2O to 0.1 degree grid

County-level N_2O emissions in 2008 were further allocated into 0.1 degree grid using various proxies recommended by previous works [6,67,71], with the exception of histosols management, fuel consumptions, and 14 major chemical companies for oxalic acid productions, for which emissions were directly determined to individual grids based on their geographic positions. Proxy dataset are obtained from Institute of Geographic Sciences and Natural Resources Research of Chinese Academy of Science or Human-Earth Systems Databases: http://www.data.ac.cn/.

Cropland was used as a proxy for direct and indirect emissions from crop residues, synethic and organic fertilizers. Grassland was used as a proxy for direct and indirect emissions from manure in pasture/range/paddock. Urban and built-up was used as a proxy for N_2O from product uses. Total population was used as a proxy for indirect emissions due to atmospheric depositions of NO_x. Rural population was used as a proxy for manure management systems. Urban population was used as a proxy for waste handling. The 0.5°×0.5° simulated N-mineralization in soil was simply re-sampled to 0.1°×0.1° for the year 2008.

Text S3 Methodology and results of provincial disaggregated regression analysis for fertilizers, livestocks, and crops

For comparison with actual county-level data, simulated data was estimated based on a set of provincial disaggregated regression models.

A range of parameters including total and rural populations, GDPs of various combinations, areas of cropland, grassland, forest, urban region, and rural region, annual mean/max temperature, annual mean precipitation, average slope were examined for their quantitative relationships with various types of fertilizers consumptions, livestock productions, and crop productions. Most parameters were not employed in the final models either because of an absence of quantitative relationships or the lack of full data sets by county.

Both linear and nonlinear regression models were tested for quantitative relationships [6]. For the most part, a univariate linear model was preferred for simplicity. However, a good regression could not be determined for poultry, rice, wheat, maize, soybeans, oilplants, and sorghum without including introduction of a nonlinear independent variable. Although regression models were developed by trial-and-error, the final format could be interpreted reasonably well. Regressions and statistical analysis were conducted using MATLAB® (Mathworks, Inc). Potatoes, highland barley, alfalfa, and other livestocks (horse, asses, and mules) were equally allocated into counties within each province, since the regression lines imperfectly fit the data. The regression results for activity data were listed as follows and **Figure S3**.

Fertilizers: $y = 0.1103x$ (agricultural GDP, 10^4 CNY), $R^2 = 0.8676$, $p<0.001$

Cattles (including dairy cattle): $y = 66.898x$ (Cropland area, km^2), $R^2 = 0.4749$, $p<0.001$

Sheeps (including goats): $y = 25.877x$ (Total area, km^2), $R^2 = 0.6129$, $p<0.001$

Swine: $y = 0.8165x$ (Rural population, person) – 994925, $R^2 = 0.7201$, $p<0.001$

Poultry: $y = 1.162E\text{-}10x^2 + 7.277E\text{-}04x$ (Agricultural GDP, 10^4 CNY) + 4.017E+03, $R^2 = 0.885$, $p<0.001$

Rice: $y = 2.22E\text{-}09x^2 + 9.79E\text{-}02x$ (Total population, person), $R^2 = 0.794$, $p<0.001$

Wheat (including barley): $y = 0.191\ x^2 + 4.436\ x$ (Rural area, km^2), $R^2 = 0.859$, $p<0.001$

Maize: $y = 1.19E\text{-}03x^2 + 4.21E+00x$ (cropland area, km^2), $R^2 = 0.811$, $p<0.001$

Soybeans: $y = 2.82E+04e^{3.76E\text{-}05x}$ (cropland area, km^2), $R^2 = 0.819$, $p<0.001$

Oilplants: y = 7.22E-10x^2 + 5.21E-03x (Rural population, person), R^2 = 0.862, p<0.001

Sorghum**:** y = 1281.33 x^2 - 65704.91 x (Maximum temperature, °C) + 794111.02, R^2 = 0.84, p<0.001

Millet: y = 2.84E-03x (Agricultural GDP, 10^4 CNY), R^2 =0.844, p<0.001

Sugarcane: y = 282,681.98 x (Maximum temperature, °C) - 5,037,146.91, R^2 = 0.63, p<0.001.

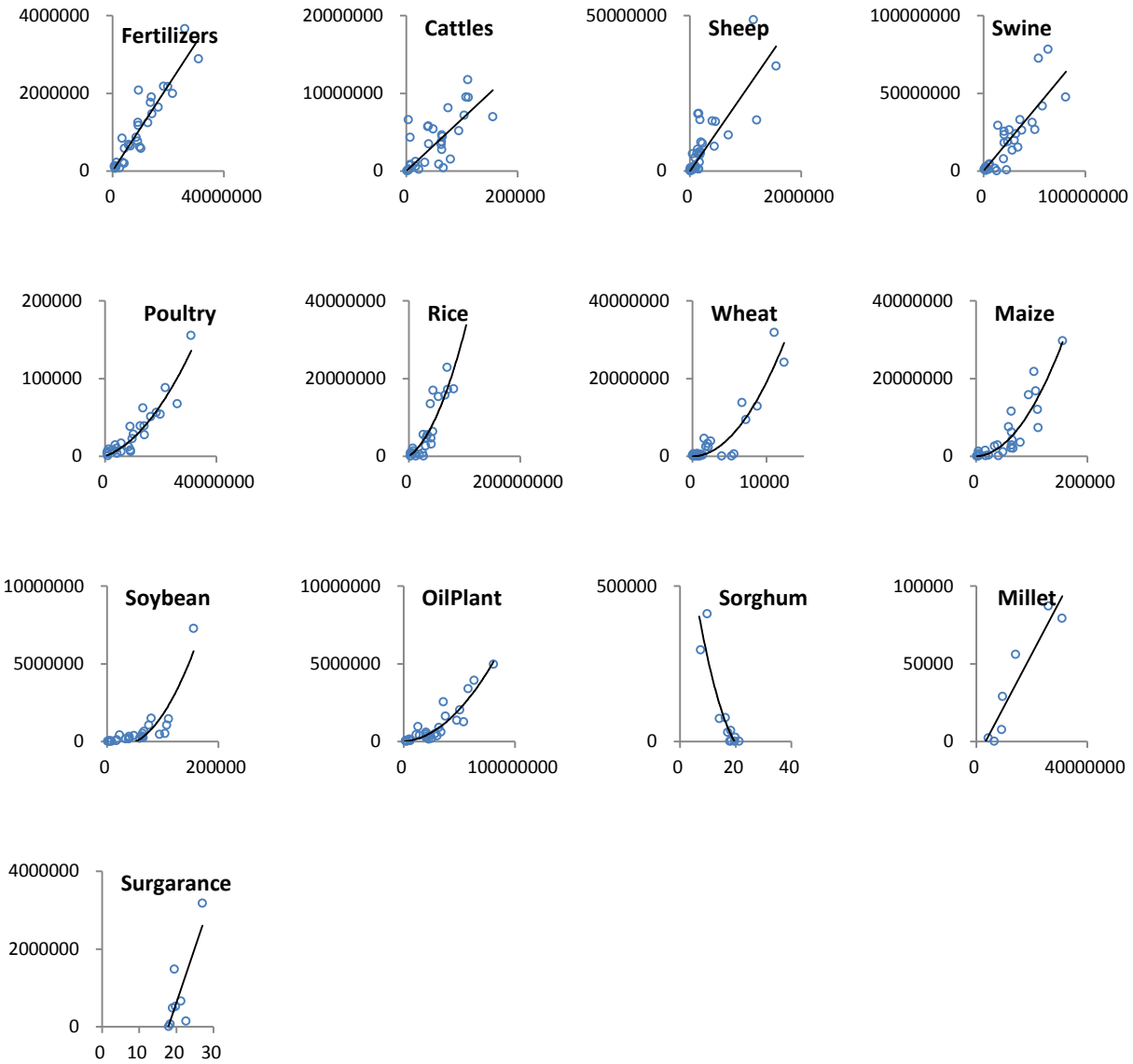

Figure S3. Dependences of activity data on predictive variables at province level

Section S2: Data on activity data, EFs, and EPs

Activity data. The data source of county-specific (county-average, raster-type, point source location) activity data for each source *S* and for each predictive variable *R* and related auxiliary data are shown in **Table S1**.

Table S1 Spatial resolutions and data sources of activity data and auxiliary data

No.	Activity data	Definition	Unit	Spatial resolution	Data source
1	$NS_{(T,R)}$	Total N straight	kg N·yr^{-1}	County	• Mainland China: 333 municipal Socioeconomic Statistics Yearbooks for 2859 counties [7] • Taiwan: Yearly Report of Taiwan's Agriculture for 23 counties [8] • Hong Kong Annual Digest of Statistics [9] • Macau Demographic Statistics [10]
2	$NC_{(T,R)}$	Total N compound	kg·yr^{-1}	County	
3	$Yield_{(T,R)}$	Fresh yield for crops	kg·yr^{-1}	County	
4	$LP_{(T,R)}$	Livestock number	head·yr^{-1}	County	
5	$RP_{(T,R)}$	Rural population	capita·yr^{-1}	County	
6	$UP_{(T,R)}$	Urban population	capita·yr^{-1}	County	
8	$Area_{(T,R)}$	Area of organic soils [c]	ha·yr^{-1}	1km	• Harmonized World Soil Database [5]
9	*NAP*	Nitric acid production	t·yr^{-1}	Point	• SRI Consulting [11] but corrected by provincial-level actual productions in 2008 from China Industrial Economic Statistical Yearbook [12]
10	*OAP*	Oxalic acid production	t·yr^{-1}	Point	• China Oxalic Acid Industry Research Report [13]
11	NO_x–N	N content of NO_x emissions	Gg·yr^{-1}	0.1°	• EDGAR v4.2[14]
12	NH_3–N	N content of NH_3 emissions	Gg·yr^{-1}	1km	• Re-calculated by using above activity data and methodology of Huang et al. [15]
13	$Fuel_{(T,I)}$	Amount of fuel consumptions	TJ·yr^{-1}	0.1°	• Extrapolating PKU-FUEL-2007[16] to 2008 by taking the ratio of provincial fuel consumptions between the year 2007 and 2008
14	W_T	dry matter burned of vegetation	km^2	0.1°	• Extrapolating PKU-FUEL-2007[16] to 2008 by taking the ratio of burned areas between the year 2007 and 2008 from Global Fire Emissions Database[17]
15	$\Delta C_{(T,R)}$	Loss of soil carbon	t C·yr^{-1}	0.5°	• Modeled by ORCHIDEE[2], LPJ[3], and LPJ-GUESS[4]
16	GDP	Gross Domestic Product	Million $	County	• Same as $NS_{(T,R)}$
17	LU	land use	km^2	1km	• Institute of Geographic Sciences and Natural Resources Research (IGSNRR) [18]
18	TEMP	Annual temperature	°C	Point	• http://cdc.cma.gov.cn/home.do
19	PRE	Annual mean precipitation	mm	Point	• http://cdc.cma.gov.cn/home.do
20	SLOPE	Average slope	-	1km	• IGSNRR[18]

The sum of regional/ sub-national data from local governments is quite different with national data from international organizations. The differences of activity data among county-level, national, and international statistics is shown in **Table S2**, where activity data that could be obtained in international statistics are only listed. For international results, synthetic fertilizers, as sum of total N straight and N compound, were derived from IFA, crops and livestocks were obtained from FAO (http://faostat.fao.org/), whereas population was obtained from UNSD (https://unstats.un.org/) and World Bank (http://data.worldbank.org/).

Table S2 Differences of activity data among county-level, national, and international statistics in 2008

Item	Unit	County-level	National	International
Synthetic fertilizers	Million tonne	28.6	28.7	34.0
Rice	Million tonne	196.4	191.9	193.3
Wheat	Million tonne	127.7	112.5	112.5
Barley	Million tonne	3.4	2.8	2.8
Maize	Million tonne	195.3	165.9	166.0
Soybeans	Million tonne	19.0	15.4	15.5
Potatoes	Million tonne	34.5	33.3	70.8
Rapeseed	Million tonne	8.5	12.1	12.1
Sesame seed	Million tonne	0.5	0.6	0.6
Millet	Million tonne	1.1	1.3	1.3
Sorghum	Million tonne	2.3	1.8	1.8
Cattle	Million head	127.8	105.8	106.1
Sheep	Million head	280.5	281.1	280.0
Horses	Million head	6.4	6.8	7.0
Asses	Million head	6.7	6.7	6.9
Mules	Million head	3.5	3.0	3.0
Pigs	Million head	698.2	610.0	446.7
Poultry	Billion head	15.1	10.2	5.4
Urban population	Million capita	462.6	467.2	622.8
Rural population	Million capita	891.7	884.6	702.3

The CV of each activity data is assumed to be equal to the absolute value of the average difference between a given dataset from China used in PKU-N_2O, and a

default global dataset (e.g. FAO, IFA, UNSD). A CV value of 0.2 is set for the following activities in absence of global datasets[15, 16]: productions of peanut, sugarcane, other oilplants, highland barley and alfalfa, loss of soil carbon, area of organic soils, nitric and adipic acid production, NH_3 and NO_x emissions, and dry matters burned of vegetation. The CV of energy consumption is set to 0.05 [19] (**Table S3**).

Table S3 Coefficients of variations (CVs) for each type of activity data

Activity data	CV	Activity data	CV
Synthetic fertilizer	9.2%	Cattle/dairy cattle	5.6%
Compound fertilizer	0.6%	Sheep	7.4%
Rice	1.3%	Swine	3.8%
Wheat	0.5%	Poultry	5.2%
Maize	0.9%	Horses	1.7%
Barley	4.9%	Asses	2.7%
Soybean	1.1%	Mules	3.1%
Potato	29%	Rural population	0.9%
Peanut*	20%	Urban population	1.3%
Rapeseed	0.5%	Loss of soil carbon	20%
Sesame	0.1%	Area of organic soils	20%
Other oilplants	20%	Nitric acid production	20%
Sugarcane	20%	Oxalic acid productions	20%
Millet	1.7%	NH_3 emission	20%
Sorghum	4.9%	NO_x emission	20%
Highland barley	20%	Energy consumptions	5.0%
Alfalfa	20%	Dry matter burned of vegetation	20%

EFs. 8 types of emission factors and their mean, standard deviation [SD], and sample size were assessed using published field measurements in China within the period from 1994 to 2013. For example, $EF_{1(T,R)}$ were compiled individually for different cultivation type (*T*) in 6 Agro-Climate Zone (*R*, Figure S2) based from 620 individual values from 73 experiment locations (**Figure S4**). Yet few of data was eliminated because of no control treatment in those experiments (**Table S4**).

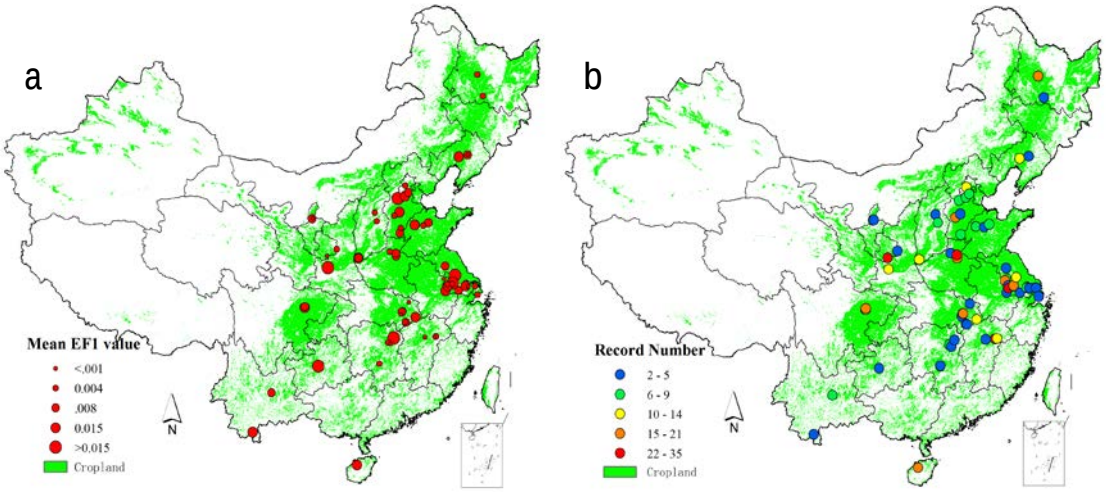

Figure S4 Geographic distributions of EFs observations in agricultural soils conducted in previous works in China. Panel a: locations and mean values of EFs, Panel b: record number.

Table S4 Emission factors (EFs) listed as mean (M) and Standard deviation (SD) and sample size (n).

EFs	Type *T*	Condition *R*	IPCC default	M	SD[×]	n	Ref.
$EF_{1(T,R)}$	1-Upland	1-Region I[*]	0.01	0.0065	0.179	65	20-38
		2- Region II	0.01	0.0149	0.264	45	39-54
		3- Region III	0.01	0.0079	0.234	134	21, 55-90
		4- Region IV	0.01	0.0157	0.428	158	67, 73, 91-155
		5- Region V	0.01	0.0086	0.439	14	156
		6- Region VI	0.01	0.0093	0.204	20	157, 158
	2-Paddy	1-Region I	0.003	0.0052	0.064	7	86, 159
		2- Region II	0.003	0.0161	0.346	11	39, 42, 43, 45, 46, 48, 49, 53, 54, 160
		3- Region III	0.003	0.0060	0.205	11	55, 57, 67
		4- Region IV	0.003	0.0114	0.256	145	67, 73, 80, 91, 94, 95, 100, 101, 103-105, 110, 114, 115, 117-119, 123-131, 133-135, 137-140, 142, 145-147, 149, 153-155, 161-177
		5- Region V	0.003	0.0059	0.314	4	178
		6- Region VI	0.003	0.0059	0.223	6	179
$EF_{2(T,R)}$	1-Cropland & Grassland	1-Temperate	8	5.8	0.5[§]	1	180
		2-Tropical (Cropland)	16	107	10.24	6	181
	2-Forest	1-Temperate & nutrient rich	0.6	1.00	0.202	9	182-184
		2- Temperate & nutrient poor	0.1	--	--	--	--
		3-Tropical	8	3.39	0.096	3	183
$EF_{3(T,S)}$	1-Cattle, poultry & pigs	1-Pasture/Range/Paddock	0.02	0.02	0.5	1	185
	2-Sheep & others	2-Pasture/Range/Paddock	0.01	0.01	0.5	1	185
	3-All animals	3-Uncovered anaerobic lagoon	0	--	--	--	--
		4-Liquid/Slurry	0.005	0.0051	0.5	1	186
		5-Solid storage	0.005	--	--	--	--
		6-Dry lot	0.02	0.03	0.147	3	187

		7-Daily spread	0	--	--	--	--
		8-Anaerobic digester	0	--	--	--	--
$EF_{4(T)}$	1-Adipic acid production		300	300	0.036	3	[185]
	2-Nitric acid production		5.1	4.9	0.5	1	[188]
$EF_{5(T, I)}$	1-Coal	1-Energy production	1.5	4.83	0.226	6	[189, 190]
		2-Industry	1.5	3.1	0.344	6	[190]
		3-Residential/commercial	1.5	0.87	0.5	1	[190]
		4-Rail transportation	1.5	1.5	0.5	1	[185]
	2-Petroleum	1-Energy production	0.6	0.6	0.5	1	[185]
		2-Industry	0.6	0.6	0.5	1	[185]
		3-Residential/commercial	0.6	0.6	0.5	1	[185]
		4-Rail transportation	28.6	28.6	0.5	1	[185]
		5-Road transportation	3.9	5.28	0.194	12	[191]
	3-Natural gas	1-Energy production	0.1	0.03	0.5	1	[189]
		2-Industry	0.1	0.03	0.5	1	[189]
		3-Residential/commercial	0.1	0.03	0.5	1	[189]
	4-Soil waste	1-Energy production	4	4	0.5	1	[185]
		2-Industry	4	--	--	--	--
		3-Residential/commercial	4	4	0.5	1	[185]
	5-Biomass	1-Energy production	4	4.35	0.217	9	[192, 193]
		2-Industry	4	--	--	--	--
		3-Residential/commercial	4	4.35	0.217	9	[192, 193]
		4-Agricultural	4	4.35	0.217	9	[192, 193]
	6-Biogas	1-Energy production	0.1	--	--	--	--
		2-Industry	0.1	0.1	0.5	1	[185]
		3-Residential/commercial	0.1	0.1	0.5	1	[185]
	7-Wildfires	1-Forest fires		0.21	0.10	3	[194]
		2-Savanna/Grassland fires		0.21	0.10	3	[194]
		3-Woodland fires		0.21	0.10	3	[194]
		4-peat fires		0.20	0.10	3	[194]
		5-deforestation		0.20	0.10	3	[194]

EF_6	Wastewater	0.05	0.0051	0.30	24[Δ]	--
EF_7	N deposition	0.01	Same as $EF1_{(T,R)}$			
EF_8	Rivers	0.0025	0.0022	0.261	21	[195, 196]
	Estuary	0.0025	0.0029	0.055	3	[197-199]
	Groundwater	0.0025	0.0014	0.422	18	[200-205]

[*] Region I: Xinjiang (XJ), Qinghai (QH), Tibet (TB), Shanxi (SX), Gansu (GS), Shaanxi (SAX), Inner Mongolia (IM), and Ningxia (NX); Region II: Heilongjiang (HLJ), Jilin (JL), and Liaoning (LN); Region III: Beijing (BJ), Tianjing (TJ), Hebei (HB), Henan (HN), and Shangdong (SD); Region IV: Zhejiang (ZJ), Shanghai (SH), Jiangsu (JS), Anhui (AH), Jiangxi (JX), Hunan (HUN), Hubei (HUB), Sichuan (SC),and Chongqing (CQ); Region V: Guangdong (GD), Guangxi (GX), Hainan (HN), Fujian (FJ), and Taiwan (TW); Region VI: Yunnan (YN) and Guizhou (GZ)[206]. Spatial distribution of Agri-Climate Zone is also shown in Figure S1.

[×] Standard deviation for logarithmic values of EFs

[§] A standard deviation was assigned as 0.5 if only one sample is available.

[Δ] Determined by EF_8 from river and estuary

EPs. 11 types EP are specified based on local statistics and literature data. Each EP name below is defined in Section S1. Manure management systems could be divided into five types: Manure in pasture/range/paddock (M1), slurry in intensive system (M2-S), drylot in intensive system (M2-D), slurry in extensive system (M3-S), drylot in extensive system (M3-D) [207-209]. $\eta_{(T,S)}$ defining the fraction of manure managed in each waste management system (*S*) for each livestock type (*T*) differs largely between provinces, animal types, and farm size in China [15, 210]. $\eta_{(T,S)}$ was calculated as a product of the percent of intensive (or extensive) livestock production system by the proportion of waste management systems *S*, where the former is from China's Animal Industry Yearbook [210] and the latter from Huang et al.[15] (**Table S5**). $Nex_{(T)}$ defining N excretion rate for each livestock species/category in different provinces is updated by National Pollution Source Survey database[207, 208] (**Table S6**). $Leach_{(T,R)}$ defining ratio of N loss by leaching/runoff to N applications on managed soils was obtained from long-term observations (362 samples for leaching at 55 experiment locations and 477 samples for runoff at 79 experiment locations, **Figure S5**) regrouped for each cultivation type and Agro-Climate Zone. The values of other EPs are listed and in **Table S8**.

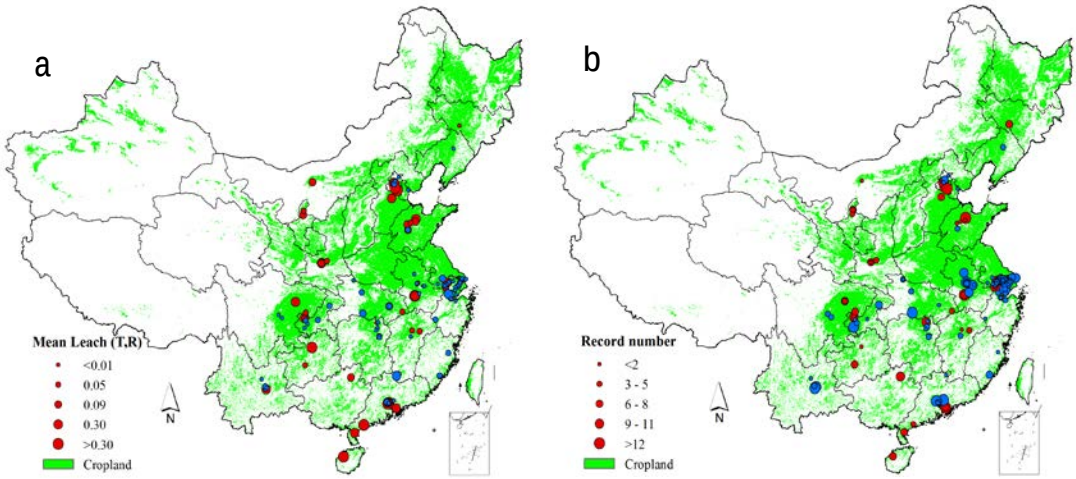

Figure S5 Geographic distributions of $Leach_{(T,R)}$ observations in agricultural soils.

Panel a: locations and mean values of EFs, Panel b: record number.

Table S5 $\eta_{(T,S)}$ for diverse livestock type in different province (Unit: %)[15, 210].

Type	Location *S*	M1	M2-S	M2-D	M3-S	M3-D
Cattle*	BJ	0.0	43.0	43.0	1.6	12.5
	TJ	0.0	19.3	19.3	6.8	54.7
	HB	15.1	22.9	22.9	4.3	34.9
	SX	2.3	11.4	11.4	8.2	66.7
	IM	70.0	7.0	7.0	1.8	14.3
	LN	12.2	15.2	15.2	6.3	51.1
	JL	29.8	18.8	18.8	3.6	29.0
	HLJ	51.2	12.9	12.9	2.5	20.5
	SH	0.0	49.4	49.4	0.1	1.2
	JS	0.0	34.2	34.2	3.5	28.2
	ZJ	0.0	12.3	12.3	8.3	67.1
	AH	0.0	8.9	8.9	9.1	73.2
	FJ	0.0	3.8	3.8	10.2	82.3
	JX	0.0	1.7	1.7	10.6	86.0
	SD	0.0	16.0	16.0	7.5	60.6
	HN	0.0	8.2	8.2	9.2	74.4
	HUB	0.0	5.2	5.2	9.9	79.7
	HUN	0.0	1.3	1.3	10.7	86.8
	GD	0.0	1.4	1.4	10.7	86.6
	GX	0.0	0.3	0.3	10.9	88.5
	HAN	0.0	0.4	0.4	10.9	88.4
	CQ	0.0	1.9	1.9	10.6	85.6
	SC	65.4	0.9	0.9	3.6	29.3
	GZ	0.0	0.4	0.4	10.9	88.4
	YN	0.0	0.6	0.6	10.9	87.9
	TB	71.3	0.0	0.0	3.2	25.5
	SAX	0.0	6.8	6.8	9.5	76.9
	GS	34.0	2.9	2.9	6.6	53.6
	QH	94.2	0.4	0.4	0.5	4.4
	NX	19.4	9.3	9.3	6.8	55.3
	XJ	69.3	6.9	6.9	1.9	15.0
Sheep	BJ	0.0	37.1	37.1	2.8	23.0
	TJ	0.0	26.2	26.2	5.2	42.4
	HB	7.2	16.0	16.0	6.7	54.2
	SX	4.5	18.8	18.8	6.4	51.5
	IM	77.3	11.3	11.3	0.0	0.2
	LN	27.6	18.7	18.7	3.9	31.2
	JL	30.0	27.4	27.4	1.7	13.6
	HLJ	41.2	18.5	18.5	2.4	19.4
	SH	0.0	12.5	12.5	8.3	66.8
	JS	0.0	15.5	15.5	7.6	61.4
	ZJ	0.0	16.9	16.9	7.3	58.9
	AH	0.0	11.9	11.9	8.4	67.9
	FJ	0.0	7.1	7.1	9.4	76.4
	JX	0.0	19.8	19.8	6.6	53.8
	SD	0.0	19.5	19.5	6.7	54.4
	HN	0.0	7.1	7.1	9.4	76.5
	HUB	0.0	16.6	16.6	7.3	59.5
	HUN	0.0	16.5	16.5	7.4	59.7
	GD	0.0	12.5	12.5	8.3	66.8
	GX	0.0	4.8	4.8	9.9	80.5
	HAN	0.0	3.8	3.8	10.2	82.2

	CQ	0.0	13.0	13.0	8.1	65.9
	SC	50.0	7.7	7.7	3.8	30.8
	GZ	0.0	4.0	4.0	10.1	82.0
	YN	0.0	2.6	2.6	10.4	84.5
	TB	67.8	0.0	0.0	3.5	28.7
	SAX	0.0	2.3	2.3	10.5	85.0
	GS	40.8	6.5	6.5	5.1	41.1
	QH	84.3	6.2	6.2	0.4	2.9
	NX	43.8	22.4	22.4	1.3	10.1
	XJ	47.9	20.0	20.0	1.3	10.9
Pig	BJ	0.0	32.1	32.1	3.9	32.0
	TJ	0.0	22.4	22.4	6.1	49.1
	HB	0.0	25.9	25.9	5.3	42.9
	SX	0.0	31.8	31.8	4.0	32.4
	IM	0.0	10.3	10.3	8.7	70.8
	LN	0.0	19.3	19.3	6.8	54.6
	JL	0.0	41.8	41.8	1.8	14.7
	HLJ	0.0	33.3	33.3	3.7	29.7
	SH	0.0	36.2	36.2	3.0	24.6
	JS	0.0	22.2	22.2	6.1	49.6
	ZJ	0.0	28.6	28.6	4.7	38.2
	AH	0.0	23.4	23.4	5.9	47.3
	FJ	0.0	32.1	32.1	3.9	31.9
	JX	0.0	30.6	30.6	4.3	34.6
	SD	0.0	29.0	29.0	4.6	37.5
	HN	0.0	40.2	40.2	2.2	17.5
	HUB	0.0	26.6	26.6	5.2	41.7
	HUN	0.0	23.9	23.9	5.8	46.5
	GD	0.0	36.4	36.4	3.0	24.3
	GX	0.0	14.2	14.2	7.9	63.7
	HAN	0.0	28.8	28.8	4.7	37.7
	CQ	0.0	10.9	10.9	8.6	69.6
	SC	0.0	14.3	14.3	7.9	63.6
	GZ	0.0	2.2	2.2	10.5	85.1
	YN	0.0	5.3	5.3	9.8	79.6
	TB	0.0	3.4	3.4	10.3	83.0
	SAX	0.0	24.9	24.9	5.5	44.8
	GS	0.0	14.4	14.4	7.8	63.5
	QH	0.0	10.4	10.4	8.7	70.6
	NX	0.0	17.4	17.4	7.2	58.1
	XJ	0.0	30.9	30.9	4.2	34.1
Poultry	BJ	0.0	0.0	46.6	5.9	47.5
	TJ	0.0	0.0	57.3	4.7	38.0
	HB	0.0	0.0	33.1	7.4	59.5
	SX	0.0	0.0	59.5	4.5	36.0
	IM	0.0	0.0	27.2	8.0	64.8
	LN	0.0	0.0	45.5	6.0	48.5
	JL	0.0	0.0	63.5	4.0	32.5
	HLJ	0.0	0.0	28.4	7.9	63.7
	SH	0.0	0.0	26.3	8.1	65.6
	JS	0.0	0.0	37.7	6.9	55.4
	ZJ	0.0	0.0	23.8	8.4	67.8
	AH	0.0	0.0	30.7	7.6	61.7
	FJ	0.0	0.0	68.3	3.5	28.2
	JX	0.0	0.0	10.2	9.9	79.9
	SD	0.0	0.0	51.8	5.3	42.9
	HN	0.0	0.0	51.6	5.3	43.1

HUB	0.0	0.0	45.7	6.0	48.3
HUN	0.0	0.0	11.2	9.8	79.0
GD	0.0	0.0	25.3	8.2	66.5
GX	0.0	0.0	28.0	7.9	64.1
HAN	0.0	0.0	15.5	9.3	75.2
CQ	0.0	0.0	11.0	9.8	79.2
SC	0.0	0.0	11.5	9.7	78.8
GZ	0.0	0.0	13.0	9.6	77.4
YN	0.0	0.0	15.6	9.3	75.1
TB	0.0	0.0	0.0	11.0	89.0
SAX	0.0	0.0	33.5	7.3	59.2
GS	0.0	0.0	16.8	9.2	74.0
QH	0.0	0.0	9.7	9.9	80.4
NX	0.0	0.0	24.8	8.3	66.9
XJ	0.0	0.0	61.4	4.2	34.4

* It is simply assumed to be applicable for horses, asses and mules.

Table S6 N excretion rate for each livestock species/category (Unit: gN·head^{-1}·day^{-1}).

Note: Data is available from National Pollution Source Survey database[207, 208]

Province	N excretion					
	Pig	Dairy cattle	Other cattle	Poultry	Sheep	Others
BJ	33.2	274.2	72.7	1.3	5.5	74.5
TJ	33.2	274.2	72.7	1.3	5.5	74.5
HB	33.2	274.2	72.7	1.3	5.5	74.5
SX	33.2	274.2	72.7	1.3	5.5	74.5
IM	33.2	274.2	72.7	1.3	5.5	74.5
LN	57.7	257.7	150.8	1.9	7.0	95.5
JL	57.7	257.7	150.8	1.9	7.0	95.5
HLJ	57.7	257.7	150.8	1.9	7.0	95.5
SH	25.4	214.5	153.5	1.0	5.1	69.3
JS	25.4	214.5	153.5	1.0	5.1	69.3
ZJ	25.4	214.5	153.5	1.0	5.1	69.3
AH	25.4	214.5	153.5	1.0	5.1	69.3
FJ	25.4	214.5	153.5	1.0	5.1	69.3
JX	25.4	214.5	153.5	1.0	5.1	69.3
SD	25.4	214.5	153.5	1.0	5.1	69.3
HN	44.7	353.4	65.9	0.7	6.0	82.3
HUB	44.7	353.4	65.9	0.7	6.0	82.3
HUN	44.7	353.4	65.9	0.7	6.0	82.3
GD	44.7	353.4	65.9	0.7	6.0	82.3
GX	44.7	353.4	65.9	0.7	6.0	82.3
HAN	44.7	353.4	65.9	0.7	6.0	82.3
CQ	19.7	214.5	104.1	0.7	6.1	83.4
SC	19.7	214.5	104.1	0.7	6.1	83.4
GZ	19.7	214.5	104.1	0.7	6.1	83.4
YN	19.7	214.5	104.1	0.7	6.1	83.4
TB	19.7	214.5	104.1	0.7	6.1	83.4
SAX	36.8	185.9	104.1	1.9	5.5	75.5

GS	36.8	185.9	104.1	1.9	5.5	75.5
QH	36.8	185.9	104.1	1.9	5.5	75.5
NX	36.8	185.9	104.1	1.9	5.5	75.5
XJ	36.8	185.9	104.1	1.9	5.5	75.5

Table S7 Ratio of N lost through leaching and runoff ($Leach_{(T,R)}$) listed as mean (M) and Standard deviation (SD) and sample size (n) (Unit: % for M). Note: a standard deviation was assigned as 0.5 if only one sample is available.

Path	Type *T*	Condition *R*	IPCC default	M	SD	n	Ref.
Runoff	1-Paddy	1-Region I	--	0.02	0.5	1	207
		2- Region II	--	0.40	0.5	24	211
		3- Region III	--	1.12	0.11	7	212
		4- Region IV	--	3.12	0.492	95	213-233
		5- Region V	--	1.09	0.179	28	234
		6- Region VI	--	1.09	0.179	15	207
	2-Non-paddy	1-Region I	--	0.30	0.358	3	235
		2- Region II	--	0.23	0.436	3	235
		3- Region III	--	0.35	0.585	65	236-239
		4- Region IV	--	1.61	0.795	170	213, 216, 218-220, 228, 231, 240-266
		5- Region V	--	0.83	0.279	27	267-270
		6- Region VI	--	0.56	0.408	39	271-274
Leaching	1-Paddy	1-Region I	--	8.25	0.07	4	275
		2- Region II	--	3.07	0.017	4	146
		3- Region III	--	3.07	0.017	4	146
		4- Region IV	--	0.27	0.581	30	276-282
		5- Region V	--	0.27	0.581	30	276-282
		6- Region VI	--	0.13	0.5	1	283
	2-Non-paddy	1-Region I	--	6.23	0.269	41	284-290
		2- Region II	--	0.37	0.316	6	291
		3- Region III	--	4.12	0.520	73	292-297
		4- Region IV	--	7.13	0.452	91	298-310
		5- Region V	--	6.40	0.334	68	311-321
		6- Region VI	--	1.03	0.550	10	283, 322, 323
Runoff + leaching	1-Paddy	1-Region I	30	8.27	0.570	--	--
		2- Region II	30	3.46	0.517	--	--
		3- Region III	30	4.18	0.127	--	--
		4- Region IV	30	3.39	1.073	--	--
		5- Region V	30	1.36	0.76	--	--
		6- Region VI	30	1.21	0.679	--	--
	2-Non-paddy	1-Region I	30	6.53	0.627	--	--
		2- Region II	30	0.61	0.752	--	--
		3- Region III	30	4.48	1.105	--	--
		4- Region IV	30	8.74	1.247	--	--
		5- Region V	30	7.23	0.613	--	--

6- Region VI	30	1.60	0.958	--	--

Table S8 Parameters listed as mean (M) and Standard deviation (SD). Note: SD was assigned as 20% of mean except for Burnt%, which is determined based on previous studies.

Parameter	Crop or location	IPCC Mean	M	SD	Ref.
DRY_T	1-Rice	0.89	0.85	0.170	324
	2-Wheat	0.89	0.87	0.174	324
	3-Maize	0.87	0.86	0.172	324
	4-Barley	0.89	0.87	0.174	324
	5-Millet	0.9	0.90	0.180	324
	6-Sorghum	0.89	0.90	0.180	324
	7-Soybean	0.91	0.86	0.172	324
	8-Other Soybean	0.91	0.86	0.172	324
	9-Potato	0.22	0.45	0.090	324
	10-Other potato	0.22	0.45	0.090	324
	11-Peanut	0.94	0.94	0.188	324
	12-Rapeseed	0.88	0.82	0.164	324
	13-Sesame	0.88	0.82	0.164	324
	14-Other oilplant	0.88	0.82	0.164	324
	15-Sugarcane	0.22	0.45	0.090	324
	16-Alfalfa	0.90	0.90	0.180	324
	17-Highland barley	0.88	0.87	0.174	324
Burnt%	1-BJ, SH	--	40	5.0	325
	2-TJ, JS, ZJ, FJ, GD, JL and HLJ	--	35	5.0	325
	3-SX, SAX, LN, HN, SD, HB, HN, JX, HUB, HUN and AH	--	25	5.0	325
	4-NX, GS, XJ, GX, SC, CQ, YN and GZ	--	15	5.0	325
	5-IM, QH and TB	--	5	5.0	325
C_f	1-Rice	0.8	0.89	0.178	324
	2-Wheat	0.9	0.86	0.172	324
	3-Maize	0.8	0.92	0.184	324
	4-Barley, millet, sorghum, alfalfa, highland barley	1.0	0.86	0.172	324
	5-Soybean/other Soybean	1.0	0.68	0.136	324
	6-Potato/other potato	1.0	0.68	0.136	324
	7-Peanut/ rapeseed/ sesame/other oilplant	1.0	0.82	0.164	324
	8-Sugarcane	1.0	0.68	0.136	324
$R_{AG(T)}$	1-Rice	0.95	0.9	0.18	326-330
	2-Wheat	1.51	1.1	0.22	326-330
	3-Maize	1.03	1.2	0.24	326-330
	4-Barley	0.98	1.6	0.32	326-330
	5-Millet	1.43	1.0	0.2	326-330
	6-Sorghum	0.88	2.0	0.4	326-330
	7-Soybean/other Soybean	0.93	1.0	0.2	326-330
	8-Potato/other potato	0.1	0.5	0.1	326-330
	9-Peanut	1.07	0.8	0.16	326-330
	10-Rapeseed/sesame/other oilplant	2.5	2.5	0.5	326-330
	11-Sugarcane	0.3	0.3	0.06	326-330
	12-Alfalfa	0.29	0.29	0.044	326-330

	13-Highland barley	0.98	1.6	0.32	326-330
$N_{AG(T)}$	1-Rice	7	9.1	1.82	326-330
	2-Wheat	6	6.5	1.3	326-330
	3-Maize	6	9.2	1.84	326-330
	4-Barley	7	5.6	1.12	326-330
	5-Millet	7	8.2	1.64	326-330
	6-Sorghum	7	12.5	2.5	326-330
	7-Soybean	8	18.1	3.6	326-330
	8-Other Soybean	8	24.5	4.9	326-330
	9-Potato	19	26.5	5.3	326-330
	10-Other potato	19	23.7	4.7	326-330
	11-Peanut	16	18.2	3.64	326-330
	12-Rapeseed	8.7	8.7	1.74	326-330
	13-Sesame/ other oilplant	8.7	8.2	1.64	326-330
	14-Sugarcane	11	11	2.2	326-330
	15-Alfalfa	27	27	5.4	185
	16-Highland barley	7	5.6	1.12	326-330
$R_{BG(T)}$	1-Rice	0.16	0.125	0.025	324
	2-Wheat	0.24	0.166	0.033	324
	3-Maize	0.22	0.17	0.034	324
	4-Barley	0.22	0.166	0.033	324
	5-Millet	0.24	0.166	0.033	324
	6-Sorghum	0.24	0.166	0.033	324
	7-Soybean/ Other Soybean	0.19	0.13	0.026	324
	8-Potato/ Other potato	0.2	0.05	0.010	324
	9-Peanut/Rapeseed/Sesame/Other oilplant	0.2	0.13	0.026	324
	10-Sugarcane	--	0.13	0.026	324
	11-Alfalfa	--	0.13	0.026	324
	12- Highland barley	--	0.15	0.030	324
$N_{BG(T)}$	1-Rice	7	Same as IPCC default		185
	2-Wheat	9			185
	3-Maize	7			185
	4-Barley	14			185
	5-Millet	7			185
	6-Sorghum	6			185
	7-Soybean/ Other Soybean	8			185
	8-Potato/ Other potato	14			185
	9-Peanut/ Rapeseed/ Sesame/ Other oilplant	16			185
	10-Sugarcane	8			185
	11-Alfalfa	19			185
	12- Highland barley	14			185
$Frac_{Remove(T)}$	AH	--	55.1	11.02	15, 331
	BJ	--	58.3*	11.66	15, 331
	CQ	--	51.6*	10.32	15, 331
	FJ	--	53.2	10.64	15, 331
	GS	--	71.5	14.3	15, 331
	GD	--	51.1	10.22	15, 331
	GX	--	52.2	10.44	15, 331
	GZ	--	55	11	15, 331
	HN	--	37	7.4	15, 331
	HB	--	44.7	8.94	15, 331
	HLJ	--	61.9	12.38	15, 331
	HN	--	60.2	12.04	15, 331
	HUB	--	61.9	12.38	15, 331
	HUN	--	16.8	3.36	15, 331

IM	--	60.9	12.18	[15, 331]
JL	--	62.1	12.42	[15, 331]
JS	--	60.9	12.18	[15, 331]
JX	--	32.9	6.58	[15, 331]
LN	--	67.4	13.48	[15, 331]
NX	--	85.4	17.08	[15, 331]
QH	--	61.9	12.38	[15, 331]
SAX	--	61.6	12.32	[15, 331]
SC	--	82.7	16.54	[15, 331]
SD	--	70.6	14.12	[15, 331]
SH	--	44.7	8.94	[15, 331]
SX	--	40.9	8.18	[15, 331]
TB	--	50.8	10.16	[15, 331]
TJ	--	56.6	11.32	[15, 331]
XJ	--	55.4	11.08	[15, 331]
YN	--	55.7	11.14	[15, 331]
ZJ	--	64.1	12.82	[15, 331]
TW	--	56.2	11.24	[15, 331]

Section S3: Supplement results

This section includes the results on uncertainty estimations of N_2O emissions in China (**Figure S6**), geographic distributions of differences of total N_2O emissions between PKU-N_2O and EDGAR v4.2 (**Figure S7**), and Sensitivity analysis of moving means on fixed subset size (**Figure S8**).

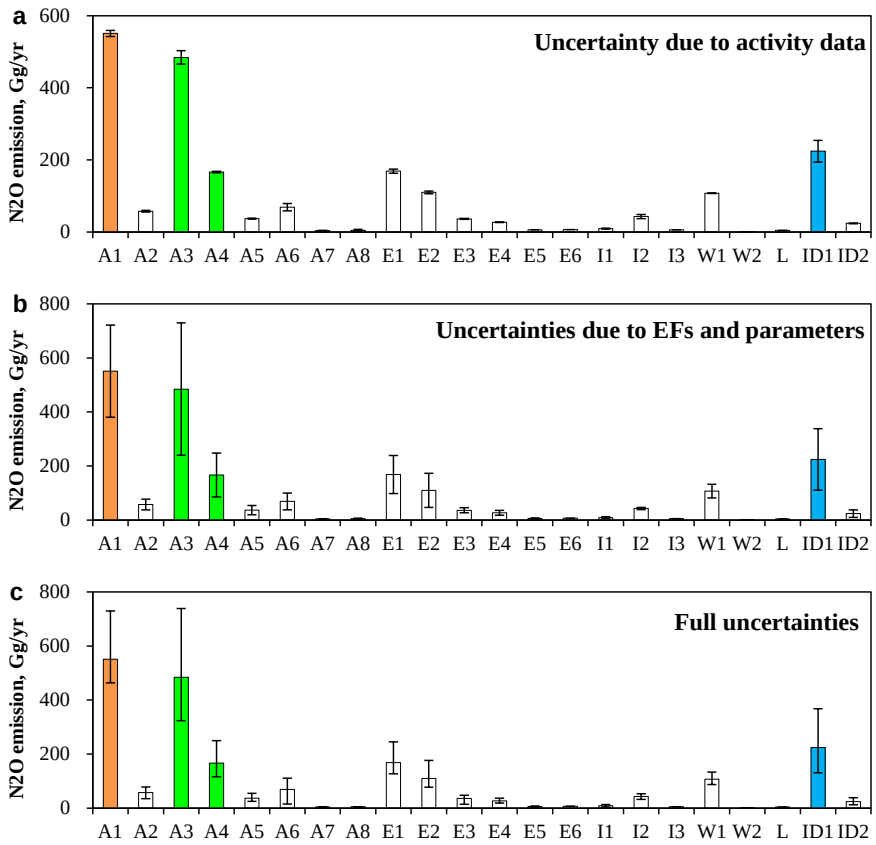

Figure S6 Uncertainty of N_2O emissions from emission sources using MC simulation. Note: the bars using the color represented the four emission sources with the highest uncertainties

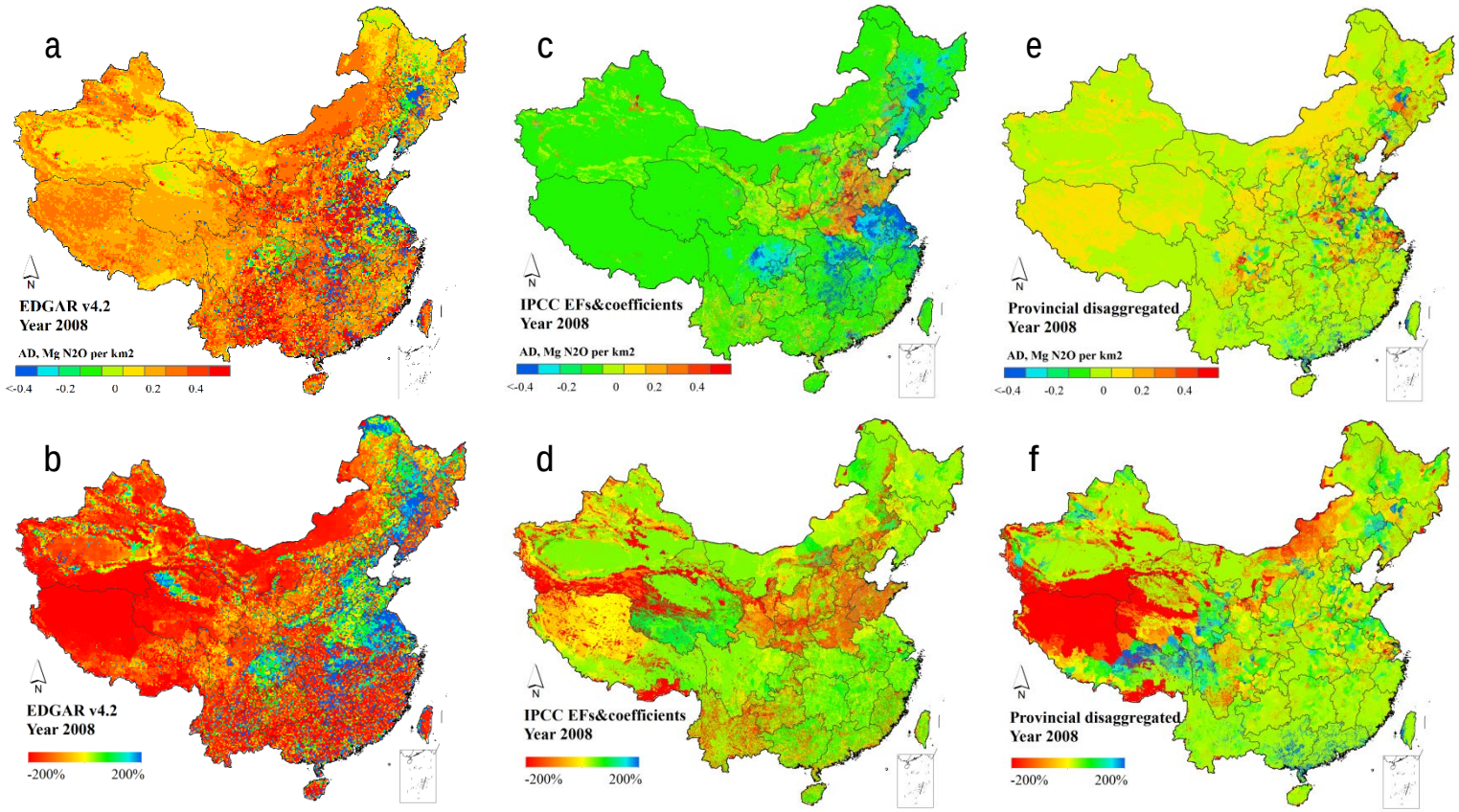

Figure S7 Geographic distributions of absolute and relative differences of total N_2O emissions between PKU-N_2O and EDGAR v4.2 (**a**, **b**), between PKU-N_2O and S1test based on IPCC's EFs and coefficients [185], (**c**, **d**) and between PKU-N_2O and S2 test estimated by province-level disaggregated algorithm [6], (**e**, **f**). Note: Absolute (AD) and relative differences (RD) are defined as AD= E_1–E_2 and RD=(E_1–E_2)/E_2, where E_1 and E_2 (>0) at 0.1°×0.1° resolution, are the emissions of each grid in EDGAR v4.2 and PKU-N_2O, respectively.

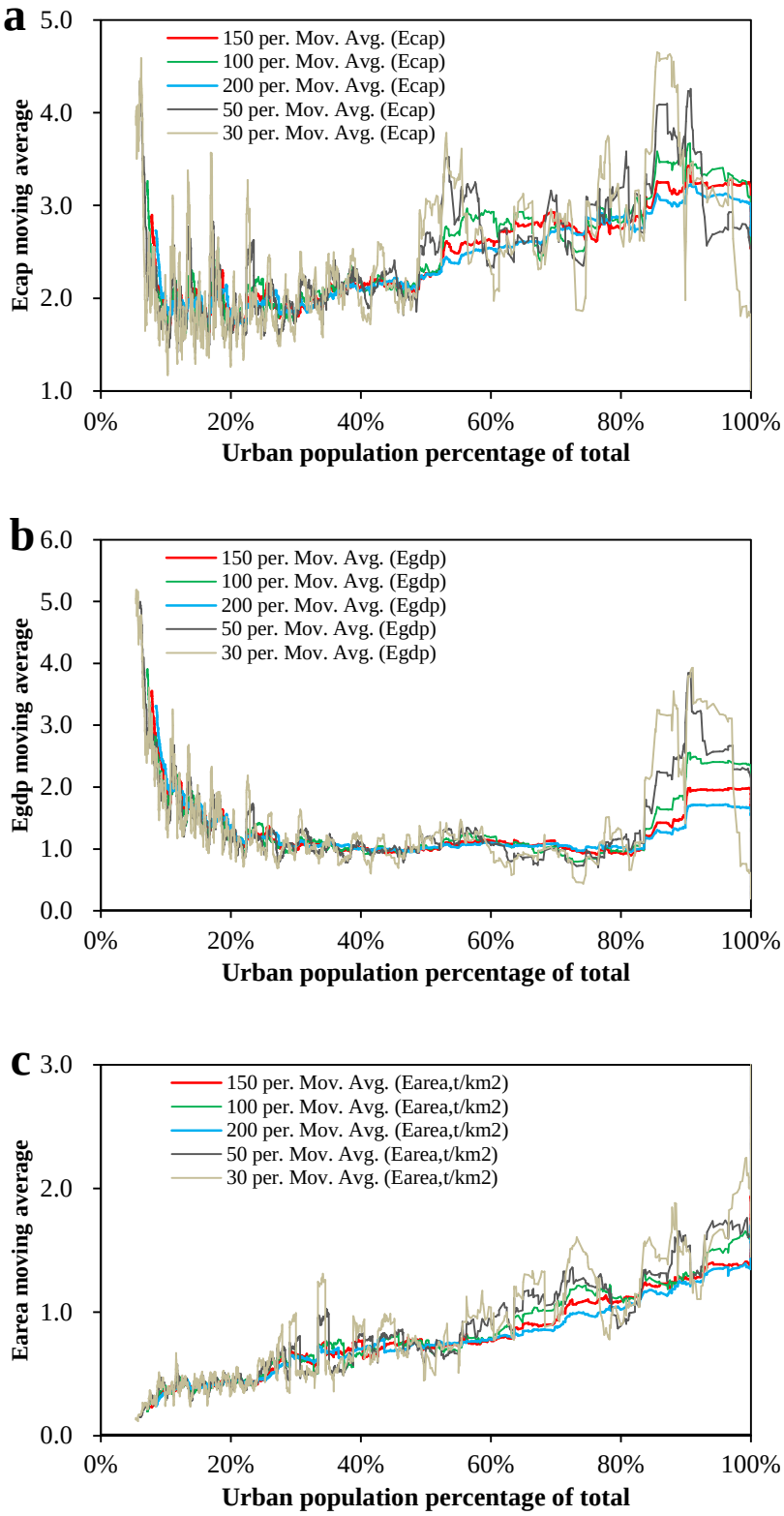

Figure S8 Sensitivity analysis of moving means on fixed subset size. (a) E_{cap}, kg per capita, (b) E_{gdp}, g per $ GDP, (c) E_{area}, t per km^2.

Section S4: Supporting references

1. Gao, B.; Ju, X. T.; Zhang, Q.; Christie, P.; Zhang, F. S., New estimates of direct N2O emissions from Chinese croplands from 1980 to 2007 using localized emission factors. *Biogeosciences* **2011,** *8*, (10), 3011-3024.
2. Piao, S. L.; Fang, J. Y.; Ciais, P.; Peylin, P.; Huang, Y.; Sitch, S.; Wang, T., The carbon balance of terrestrial ecosystems in China. *Nature* **2009,** *458*, (7241), 1009-U82.
3. Sitch, S.; Smith, B.; Prentice, I. C.; Arneth, A.; Bondeau, A.; Cramer, W.; Kaplan, J. O.; Levis, S.; Lucht, W.; Sykes, M. T.; Thonicke, K.; Venevsky, S., Evaluation of ecosystem dynamics, plant geography and terrestrial carbon cycling in the LPJ dynamic global vegetation model. *Global Change Biol* **2003,** *9*, (2), 161-185.
4. Smith, B.; Prentice, I. C.; Sykes, M. T., Representation of vegetation dynamics in the modelling of terrestrial ecosystems: comparing two contrasting approaches within European climate space. *Global Ecol Biogeogr* **2001,** *10*, (6), 621-637.
5. FAO/IIASA/ISRIC/ISSCAS/JRC, Harmonized World Soil Database (version 1.2). In IIASA, F. a., Ed. Laxenburg, Austria, 2012.
6. Zhang, Y. X.; Tao, S.; Cao, J.; Coveney, R. M., Emission of polycyclic aromatic hydrocarbons in China by county. *Environ Sci Technol* **2007,** *41*, (3), 683-687.
7. Bureau, M. S., *Municipal Socioeconomic Statistics Yearbooks (334 books)*. China Statistics Press: Beijing, 2009.
8. Council-of-Agriculture *Yearly Report of Taiwan's Agriculture* Department of Agriculture and Forestry of Taiwan Provincial Government: Taipei, Taiwan, 2008.
9. Hong-Kong-Census-and-Statistics-Department *Hong Kong Annual Digest of Statistics*; Hong Kong, 2008.
10. Macau-Statistics-and-Census-Service *Macau Demographic Statistics*; Macau, 2008.
11. SRI-Consulting, Chemical Economics Handbook: Nitric Acid. In 2006.
12. China-industrial-Newspaper-Office *China Industrial Economic Statistical Yearbook*; Beijing, 2009.
13. Beijing-Huajingzonghe-Consultant-Company *China Oxalic Acid Industry Research Report*; Beijing, 2008.
14. Emission-Database-for-Global-Atmospheric-Research-(EDGAR) Global Emissions EDGAR v4.2. http://edgar.jrc.ec.europa.eu/overview.php?v=42 (November 11, 2013),
15. Huang, X.; Song, Y.; Li, M. M.; Li, J. F.; Huo, Q.; Cai, X. H.; Zhu, T.; Hu, M.; Zhang, H. S., A high-resolution ammonia emission inventory in China. *Global Biogeochem. Cycles* **2012,** *26*, GB1030, doi:10.1029/2011GB004161.
16. Wang, R.; Tao, S.; Wang, W. T.; Liu, J. F.; Shen, H. Z.; Shen, G. F.; Wang, B.; Liu, X. P.; Li, W.; Huang, Y.; Zhang, Y. Y.; Lu, Y.; Chen, H.; Chen, Y. C.; Wang, C.; Zhu, D.; Wang, X. L.; Li, B. G.; Liu, W. X.; Ma, J. M., Black Carbon Emissions in China from 1949 to 2050. *Environ Sci Technol* **2012,** *46*, (14), 7595-7603.
17. Giglio, L.; Randerson, J. T.; van der Werf, G. R., Analysis of daily, monthly, and annual burned area using the fourth-generation global fire emissions database (GFED4). *J Geophys Res-Biogeo* **2013,** *118*, (1), 317-328.
18. Liu, J. Y.; Zhang, Z. X.; Xu, X. L.; Kuang, W. H.; Zhou, W. C.; Zhang, S. W.; Li, R. D.; Yan, C. Z.; Yu, D. S.; Wu, S. X.; Nan, J., Spatial patterns and driving forces of land use change in China

during the early 21st century. *J Geogr Sci* **2010,** *20*, (4), 483-494.

19. Wang, R.; Tao, S.; Shen, H. Z.; Wang, X. L.; Li, B. G.; Shen, G. F.; Wang, B.; Li, W.; Liu, X. P.; Huang, Y.; Zhang, Y. Y.; Lu, Y.; Ouyang, H. L., Global Emission of Black Carbon from Motor Vehicles from 1960 to 2006. *Environ Sci Technol* **2012,** *46*, (2), 1278-1284.
20. Chen, Y. Y. Characteristics of N_2O emission on soil-sunflower field after winter wheat in irrigation area of the upper Yellow River (in Chinese). Master, Chinese academy of agricultural sciences, 2012.
21. Guo, Y. D.; Wu, G.; Wu, X. P.; Wrn, R. Y., Influence of different fertilization modes to corn production and greenhouse gas emissions (in Chinese). *Journal of Shanxi Agricultural Sciences* **2012,** *40*, (10), 1067-1070.
22. Hao, B. W. N_2O emissions from saline of Shanxi in the southwest China (in Chinese). Master, Shanxi University, 2010.
23. Li, Z. G.; Zhang, R. H.; Yan, Z. Y.; Tian, C. Y., CH_4 and N_2O Fluxes from cotton fields different in farming practices in northwestern China (in Chinese). *Acta Pedologica Sinica* **2012,** *49*, (5).
24. Liang, D. L. Nitrous oxide losses of nitrogen fertilizer and influential factors on loess soil (in Chinese). Ph.D., Northwest sci-tech university of agriculture and forestry, 2003.
25. Liu, C.; Wang, K.; Zheng, X., Effects of nitrification inhibitors (DCD and DMPP) on nitrous oxide emission, crop yield and nitrogen uptake in a wheat-maize cropping system. *Biogeosciences* **2013,** *10*, (4), 2427-2437.
26. Liu, C. Y.; Wang, K.; Meng, S. X.; Zheng, X. H.; Zhou, Z. X.; Han, S. H.; Chen, D. L.; Yang, Z. P., Effects of irrigation, fertilization and crop straw management on nitrous oxide and nitric oxide emissions from a wheat-maize rotation field in northern China. *Agriculture Ecosystems & Environment* **2011,** *140*, (1-2), 226-233.
27. Liu, C. Y.; Zheng, X. H.; Zhou, Z. X.; Han, S. H.; Wang, Y. H.; Wang, K.; Liang, W. G.; Li, M.; Chen, D. L.; Yang, Z. P., Nitrous oxide and nitric oxide emissions from an irrigated cotton field in Northern China. *Plant and Soil* **2010,** *332*, (1-2), 123-134.
28. Liu, H. J. The effect and mechanism of nitrogen on farmland greenhouse gas emissions of corn interplanting peas (in Chinese). Master, Gansu agricultural university 2012.
29. liu, Y. T. Study on the Characteristics of Greenhouse Gases Fiux and its Simulation in Maize Field under Different Fertilization Management (in Chinese). Master, The Chinese Academy of Argricultural Sciences, 2008.
30. Liu, Y. T.; Li, Y. E.; Wan, Y. F.; Gao.Q.Z.; Qin.Z.B; Chen.D.L., Nitrous Oxide Emissions from Spring-maize Field Under the Application of Different Nitrogen and Phosphorus Fertilizer (in Chinese). *Journal of Agro-Environment Science* **2011,** *30*, (7), 1468-1475.
31. Meng, S. X. Emissions of nitrous oxide(N_2O) and nitric oxide(NO) from an irrigated cotton field in south Shanxi (in Chinese). Master, Huazhong agriculture university, 2011.
32. Meng, S. X.; Liu, C. Y.; Zheng, X. H.; Liang, W. G.; Hu, R. G., Effects of the applied amount of wheat straw on methane, carbon dioxide, nitrous oxide, and nitric oxide fluxes of a bare soil in south Shanxi (in Chinese). *Climatic and Environmental Research* **2012,** *17*, (4).
33. Pang, J. Z.; Wang, X. K.; Mu, Y. J.; Ouyang, Z. Y.; Liu, W. Z., Nitrous oxide emissions from an apple orchard soil in the semiarid Loess Plateau of China. *Biology and Fertility of Soils* **2009,** *46*, (1), 37-44.
34. Shi, P. Effects of long-term application of fertilizer on wheat yield and emission of the CO2 and N2O from soil in loess plateau (in Chinese). Master, Northwest A & F university, 2011.

35. Wang, J. Researches on greenhouse gases emission under different tillage from dry land farming (in Chinese). Master, Gansu agricultural university, 2011.
36. Xu, J. A study of fertilization and nitrous oxide losses on loss soil (in Chinese). Master, Northwest A & F university, 2008.
37. Xue, X. H. Effect of fertilization on nitrate leaching and greenhouse gases emission in the typical dry-land area (in Chinese). Ph.D., Chinese academy of sciences, 2010.
38. Zhu, Y. L.; Wu, J. S.; Han, J. G., Effects of clear plastic film mulching on soil N2O discharge flux (in Chinese). *Transaction of the CSAE* **2004,** *20*, (3), 222-225.
39. Chen, G. X.; Huang, G. H.; Huang, B.; Wu, J.; Yu, K. W.; Xu, H.; Xue, X. H.; Wang, Z. P., Emission of CH4 and N2O from rice paddy fields and effects of Azolla cultivation and fertilization (in Chinese). *Chinese Journal of Applied Ecology* **1995,** *6*, 378-382.
40. Chen, W. W.; Wang, Y. Y.; Zhao, Z. C.; Gu, J. X., Characteristics of nitrous oxide flux in spring wheat ecosystem in Sanjiang plain of northeast China (in Chinese). *Chinese Journal of Applied Ecology* **2007,** *18*, (2), 2777-2782.
41. Chen, X.; Cabrera, M. L.; Zhang, L.; Wu, J.; Shi, Y.; Yu, W. T.; Shen, S. M., Nitrous oxide emission from upland crops and crop-soil systems in northeastern China. *Nutrient Cycling in Agroecosystems* **2002,** *62*, (3), 241-247.
42. Gu, J. X.; Zheng, X. H.; Wang, Y. H.; Ding, W. X.; Zhu, B.; Chen, X.; Wang, Y. Y.; Zhao, Z. C.; Shi, Y.; Zhu, J., Regulatory effects of soil properties on background N2O emissions from agricultural soils in China. *Plant and Soil* **2007,** *295*, (1-2), 53-65.
43. Huang, G. H.; Chen, G. X.; Wu, J.; Huang, B.; Yu, K. W., A study on N 2O and CH4 emissions from a t ypical upland crop field i n t he northeastern China (in Chinese). *Chinese Journal of Applied Ecology* **1995,** *6*, 383-386.
44. Huang, G. H.; Chen, G. X.; Zhang, Z. M.; Wu, J.; Huang, B.; Van Cleemput, O., A study on N2O emission from maize fields and its mitigation measures (in Chinese). *Acta Environmental Sciences* **1998,** *18*, 344-349.
45. Li, L. J.; Han, X. Z.; You, M. Y.; Horwath, W. R., Nitrous oxide emissions from Mollisols as affected by long-term applications of organic amendments and chemical fertilizers. *Science of the Total Environment* **2013,** *452*, 302-308.
46. Liang, W.; Zhang, Y.; Yue, J.; Wu, J.; Shi, Y.; Huang, G. H., Effect of slow releasing nitrogen fertilizers on CH4 and N2O emission in maize and rice fields in black earth soil (in Chinese). *Chinese Journal of Ecology* **2004,** *23*, (3), 44-48.
47. Ni, K.; Ding, W. X.; Zaman, M.; Cai, Z. C.; Wang, Y. F.; Zhang, X. L.; Zhou, B. K., Nitrous oxide emissions from a rainfed-cultivated black soil in Northeast China: effect of fertilization and maize crop. *Biology and Fertility of Soils* **2012,** *48*, (8), 973-979.
48. Qiao, Y. F. The carbon and nitrogen conversion process affected by fertilization in Chinese mollisols (in Chinese). Master, Jilin agricultural university, 2012.
49. Shi, H. A. Impacts of management regimes on soil N2O emission from Mollisols in agroecosystem (in Chinese). Master, Northeast agriculture university, 2013.
50. Wang, C. Y.; Zheng, J. G.; Gu, J. X.; Wang, S. B.; Shi, Y.; Chen, X., N_2O emission flux from several dry crop sand impact factors in the lower reaches of Liaohe plain (in Chinese). *Journal of Agro-Environment Science* **2006,** *25*, (3), 557-663.
51. Yang, J. F.; Han, X. R.; Zhan, X. M.; Sun, S. S., Effects of different fertilization on N_2O emission in brown field (in Chinese). *Ecology and Environment* **2007,** *16*, (2), 560-563.

52. Yu, K. W.; Chen, G. X.; Yang, S. H.; Wu, J.; Huang, B.; Huang, G. X.; Xu, H., Role of several upland crops in N2O emmission from framland and its response to environmental factors (in Chinese). *Chinese Journal of Applied Ecology* **1995**, (04), 387-391.
53. Yue, J.; Liang, W.; Wu, J.; Shi, Y.; Huang, G. X., CH4 and N2O emissions from phaeozem rice field and their mitigative measures (in Chinese). *Chinese Journal of Applied Ecology* **2003**, (11), 2015-2018.
54. Yue, J.; Shi, Y.; Liang, W.; Wu, J.; Wang, C. R.; Huang, G. H., Methane and nitrous oxide emissions from rice field and related microorganism in black soil, northeastern China. *Nutrient Cycling in Agroecosystems* **2005,** *73*, (2-3), 293-301.
55. Cai, G. X.; Chen, D. L.; Ding, H.; Pacholski, A.; Fan, X. H.; Zhu, Z. L., Nitrogen losses from fertilizers applied to maize, wheat and rice in the North China Plain. *Nutrient Cycling in Agroecosystems* **2002,** *63*, (2-3), 187-195.
56. Cai, Y. J.; Ding, W. X.; Luo, J. F., Nitrous oxide emissions from Chinese maize-wheat rotation systems: A 3-year field measurement. *Atmospheric Environment* **2013,** *65*, 112-122.
57. Cai, Z. C.; Xing, G. X.; Shen, G. Y.; Xu, H.; Yan, X. Y.; Tsuruta, H.; Yagi, K.; Minami, K., Measurements of CH4 and N2O emissions from rice paddies in Fengqiu, China. *Soil Science and Plant Nutrition* **1999,** *45*, (1), 1-13.
58. Chen, H. Y. Greenhouse gases emissions and influencing factors from typical greenhouse vegetable fields in Beijing suburbs (in Chinese). Master, Chinese academy of agriculture sciences, 2012.
59. Cui, F.; Yan, G. X.; Zhou, Z. X.; Zheng, X. H.; Deng, J., Annual emissions of nitrous oxide and nitric oxide from a wheat-maize cropping system on a silt loam calcareous soil in the North China Plain. *Soil Biology & Biochemistry* **2012,** *48*, 10-19.
60. Diao, T. T.; Xie, L. Y.; Guo, L. P.; Yan, H. L.; Lin, M.; Zhang, H.; Lin, J.; Lin, E., Measurements of N2O emissions from different vegetable fields on the North China Plain. *Atmospheric Environment* **2013,** *72*, 70-76.
61. Ding, H.; Cai, G. X.; Wang, Y. S.; Chen, D. L., N2O emission from different crop-fluvo-aquic soil systems in the North China Plain (in Chinese). *Agro-Environmental Protection* **2001,** *20*, 7-9.
62. Ding, W. X.; Cai, Y.; Cai, Z. C.; Yagi, K.; Zheng, X. H., Nitrous oxide emissions from an intensively cultivated maize-wheat rotation soil in the North China Plain. *Science of the Total Environment* **2007,** *373*, (2-3), 501-511.
63. Ding, W. X.; Luo, J. F.; Li, J.; Yu, H. Y.; Fan, J. L.; Liu, D. Y., Effect of long-term compost and inorganic fertilizer application on background N2O and fertilizer-induced N2O emissions from an intensively cultivated soil. *Science of the Total Environment* **2013,** *465*, 115-124.
64. Dong, Y. H.; Ouyang, Z.; Li, P.; Zhang, L., Influence of long-term fertilization on greenhouse gas fluxes from agricultural soil (in Chinese). *Chinese Journal of Soil Science* **2007,** *38*, (1).
65. Dong, Y. L.; Ouyang, Z.; Li, Y. S.; Zhang, L., Influence of fertilization and environmental factors on CO_2 and N_2O fluxes from agricultural soil (in Chinese). *Journal of Agro-Environment Science* **2005,** *24*, (5), 913-918.
66. Hu, X. K.; Su, F.; Ju, X. T.; Gao, B.; Oenema, O.; Christie, P.; Huang, B. X.; Jiang, R. F.; Zhang, F. S., Greenhouse gas emissions from a wheat-maize double cropping system with different nitrogen fertilization regimes. *Environmental Pollution* **2013,** *176*, 198-207.
67. Hua, X.; Guangxi, X.; Cai, Z. C.; Tsuruta, H., Nitrous oxide emissions from three rice paddy fields in China. *Nutrient Cycling in Agroecosystems* **1997,** *49*, (1-3), 23-28.

68. Huang, J. X.; Chen, Y. Q.; Sui, P.; Gao, W. S., Estimation of net greenhouse gas balance using crop- and soil-based approaches: Two case studies. *Science of the Total Environment* **2013,** *456*, 299-306.
69. Huang, T.; Gao, B.; Christie, P.; Ju, X., Net global warming potential and greenhouse gas intensity in a double-cropping cereal rotation as affected by nitrogen and straw management. *Biogeosciences* **2013,** *10*, (12), 7897-7911.
70. Ju, X. T.; Lu, X.; Gao, Z. L.; Chen, X. P.; Su, F.; Kogge, M.; Romheld, V.; Christie, P.; Zhang, F. S., Processes and factors controlling N2O production in an intensively managed low carbon calcareous soil under sub-humid monsoon conditions. *Environmental Pollution* **2011,** *159*, (4), 1007-1016.
71. Kreye, C.; Dittert, K.; Zheng, X. H.; Zhang, X.; Lin, S.; Tao, H. B.; Sattelmacher, B., Fluxes of methane and nitrous oxide in water-saving rice production in North China. *Nutrient Cycling in Agroecosystems* **2007,** *77*, (3), 293-304.
72. Lin, M.; Guo, L. P.; Xie, L. Y.; Lin, J.; Zhang, H.; Yan, H. L., Characteristics and rules of CO2 and N2O in vegetable field (in Chinese). *Soil and Fertilizer Sciences* **2012**, (04), 11-17+38.
73. Mei, B. L.; Zheng, X. H.; Xie, B. H.; Dong, H. B.; Yao, Z. S.; Liu, C. Y.; Zhou, Z. X.; Wang, R.; Deng, J.; Zhu, J. G., Characteristics of multiple-year nitrous oxide emissions from conventional vegetable fields in southeastern China. *Journal of Geophysical Research-Atmospheres* **2011,** *116*.
74. Meng, L.; Ding, W. X.; Cai, Z. C., Long-term application of organic manure and nitrogen fertilizer on N2O emissions, soil quality and crop production in a sandy loam soil. *Soil Biology & Biochemistry* **2005,** *37*, (11), 2037-2045.
75. Pei, S. W. The effect of fertilization on greenhouse gas and nitrogen gas emissions from the field in North China plain (in Chinese). Master, Beijing forestry university, 2012.
76. Pei, S. W.; Zhang, Y. Y.; Liu, J. F.; Lun, X. X.; Mu, Y. J., N_2O exchange fluxes from wheat-maize crop rotation system in the north China plain (in Chinese). *Environmental science* **2012,** *33*, (10).
77. Song, W. Z.; Wang, S. B.; Zeng, J. H.; Wang, Z. P.; Zhang, Y. Y., Emission of nitrous oxide from dryland in northern China (in Chinese). *Advances in Environmental Science* **1997,** *5*, 49-55.
78. Sun, Y. L. Soil N_2O flux and its effective factors in the typical farmland in the north china plain (in Chinese). Master, Beijing forestry university, 2007.
79. Tian, S. Z.; Ning, T. Y.; Zhao, H. X.; Wang, B. W.; Li, N.; Han, H. F.; Li, Z. J.; Chi, S. Y., Response of CH4 and N2O Emissions and Wheat Yields to Tillage Method Changes in the North China Plain. *Plos One* **2012,** *7*, (12).
80. Wang, L. G.; Li, H.; Qiu, J. J., Characterization of emissions of nitrous oxide from soils of typical crop field in Huang-Huai-Hai plain (in Chinese). *Scientia Agriculture Sinica* **2008,** *41*, (4), 1248-1254.
81. Wang, S. B.; Su, W. H.; Song, W. Z.; Zeng, J. H.; Wang, Z. P.; Zhang, Y. M., Release of N_2O from N-fertilized corn fields (in Chinese). *Rural Eco-Environment* **1994,** *10*, (4), 12-14.
82. Wang, Y. Y.; Hu, C. S., Soil greenhouse gas emission in winter wheat/summer maize rotation ecosystem as affected by nitrogen fertilization in the Piedmont Plain of Mount Taihang, China (in Chinese). *Chinese Journal of Eco-agriculture* **2011,** *19*, (5), 1122-1128.
83. Xu, H.; Xing, G. X.; Cai, Z. C.; Tsuruta, H., Effects of soil t exture on N2O emission from wheat and cotton fields (in Chinese). *Agro-environmental Protection* **2000,** *19*, 1-3.
84. Yan, G. X.; Zheng, X. H.; Cui, F.; Yao, Z. S.; Zhou, Z. X.; Deng, J.; Xu, Y., Two-year simultaneous records of N2O and NO fluxes from a farmed cropland in the northern China plain with a reduced

nitrogen addition rate by one-third. *Agriculture Ecosystems & Environment* **2013,** *178*, 39-50.

85. Zeng, J. H.; Wang, Z. P.; Zhang, Y. Y.; Song, W. Z.; Wang, S. B.; Su, W. H., N2O flux from soil during wheat-maize rotation and estimation of total emis-sion (in Chinese). *Environmental Science* **1995,** *16*, 32-36.
86. Zhang, H. Gaseous loss and balance of nitrogen from paddy field in irrigation area of the upper Yellow River (in Chinese). Ph.D., Chinese academy of agricultural sciences, 2011.
87. Zhang, J. The exchanges of greenhouse gases and effect factors in winter wheat/green onion interplanting system (in Chinese). Master, Chinese academy of agricultural sciences, 2012.
88. Zhang, Y. Y.; Liu, J. F.; Mu, Y. J.; Pei, S. W.; Lun, X. X.; Chai, F. H., Emissions of nitrous oxide, nitrogen oxides and ammonia from a maize field in the North China Plain. *Atmospheric Environment* **2011,** *45*, (17), 2956-2961.
89. Zhang, Y. Y.; Liu, J. F.; Mu, Y. J.; Xu, Z.; Pei, S. W.; Lun, X. X.; Zhang, Y., Nitrous oxide emissions from a maize field during two consecutive growing seasons in the North China Plain. *Journal of Environmental Sciences-China* **2012,** *24*, (1), 160-168.
90. Zhang, Z. X.; Li, Y. E.; Hua, L.; Wan, Y. F.; Jiang, N. N., Effects of different fertilizer levels on N_2O flux from protected vegetable land (in Chinese). *Transaction of the CSAE* **2010,** *26*, (5), 269-275.
91. Cai, Z. C.; Xing, G. X.; Yan, X. Y.; Xu, H.; Tsuruta, H.; Yagi, K.; Minami, K., Methane and nitrous oxide emissions from rice paddy fields as affected by nitrogen fertilisers and water management. *Plant and Soil* **1997,** *196*, (1), 7-14.
92. Cao, B.; He, F. Y.; Xu, Q. M.; Yin, B.; Cai, G. X., Denitrification losses and N2O emissions from nitrogen fertilizer applied to a vegetable field. *Pedosphere* **2006,** *16*, (3), 390-397.
93. Cao, B.; Jin, X. X.; Cai, G. X.; Fan, X. H.; Sun, H. X., Effects of low rate nitrogen application on Brassica chinensis growth and N losses (in Chinese). *Plant Nutrition and Fertilizer Science* **2005,** *11*, (4), 519-523.
94. Chen, S. T.; Huang, Y.; Zou, J. W., Relationship between nitrous oxide emission and winter wheat production. *Biology and Fertility of Soils* **2008,** *44*, (7), 985-989.
95. Deng, J.; Zhou, Z. X.; Zheng, X. H.; Liu, C. Y.; Yao, Z. S.; Xie, B. H.; Cui, F.; Han, S. H.; Zhu, J. G., Annual emissions of nitrous oxide and nitric oxide from rice-wheat rotation and vegetable fields: a case study in the Tai-Lake region, China. *Plant and Soil* **2012,** *360*, (1-2), 37-53.
96. Fu, X. Q.; Li, Y.; Su, W. J.; Shen, J. L.; Xiao, R. L.; Tong, C. L.; Wu, J., Annual dynamics of N2O emissions from a tea field in southern subtropical China. *Plant Soil and Environment* **2012,** *58*, (8), 373-378.
97. Guo, Y. Q. Nitrogen transformation and N2O emissions from vegetable soil under different mode of agriculture production (in Chinese). Master, Nanjing Agricultural University, 2011.
98. Hou, H. J.; Peng, S. Z.; Xu, J. Z.; Yang, S. H.; Mao, Z., Seasonal variations of CH4 and N2O emissions in response to water management of paddy fields located in Southeast China. *Chemosphere* **2012,** *89*, (7), 884-892.
99. Huang, J. The study on process of carbon and nitrogen flux and their influencing factors in upland red soil under long-term fertilizations (in Chinese). Master, Hunan agricultural university, 2011.
100. Huang, M. W. Emission process of greenhouse gases and its mechanism from the paddy-wheat rotation agro-ecosystem (in Chinese). Master, East China normal university, 2007.
101. Ji, Y.; Liu, G.; Ma, J.; Zhang, G. B.; Xu, H.; Yagi, K., Effect of controlled-release fertilizer on mitigation of N2O emission from paddy field in South China: a multi-year field observation. *Plant*

and Soil **2013,** *371*, (1-2), 473-486.

102. Ji, Y. Z.; Ju, X. T.; Liu, X. Y.; Zhang, L. J.; Li, X.; Liu, N., Impact of different nitrogen application on nitrogen movement and gaseous loss of winter wheat field (in Chinese). *Journal of Soil and Water Conservation* **2010,** *24*, (3), 113-118.
103. Jiang, C. S. Study on emission of major greenhouse gases from agro-ecosystem in a central Sichuan hilly area of Southwest China (in Chinese). Ph.D., Chinese academy of sciences, 2005.
104. Jiang, C. S.; Wang, Y. S.; Zheng, X. H.; Zhu, B.; Huang, Y.; Hao, Q. J., Methane and nitrous oxide emissions from three paddy rice based cultivation systems in southwest China. *Advances in Atmospheric Sciences* **2006,** *23*, (3), 415-424.
105. Jiang, J. Y.; Hu, Z. H.; Sun, W. J.; Huang, Y., Nitrous oxide emissions from Chinese cropland fertilized with a range of slow-release nitrogen compounds. *Agriculture Ecosystems & Environment* **2010,** *135*, (3), 216-225.
106. Lan, T.; Han, Y.; Roelcke, M.; Nieder, R.; Cai, Z. C., Processes leading to N2O and NO emissions from two different Chinese soils under different soil moisture contents. *Plant and Soil* **2013,** *371*, (1-2), 611-627.
107. Li, C. F.; Cao, C. G.; Wang, J. P.; Ming, Z.; Yuan, W. L.; Ahmad, S., Nitrogen losses from integrated rice-duck and rice-fish ecosystems in southern China. *Plant and Soil* **2008,** *307*, (1-2), 207-217.
108. Li, C. F.; Cao, C. G.; Wang, J. P.; Zhan, M.; Yuan, W. L.; Ahmad, S., Nitrous Oxide Emissions from Wetland Rice-Duck Cultivation Systems in Southern China. *Archives of Environmental Contamination and Toxicology* **2009,** *56*, (1), 21-29.
109. Li, Y. Studies on mitigate nitrous oxide emission by crop rotation system and exert nitrification inhibitor DCD from vegetable field (in Chinese). Master, Huazhong agricultural university, 2012.
110. Liang, G. Q.; Zhou, W.; Xia, W. J.; Sun, J. W., Effect of optimized nitrogen application on N2O emission from paddy field under wheat-rice rotation system (in Chinese). *Plant Nutrition and Fertilizer Science* **2010,** *16*, (2), 304-311.
111. Lin, S.; Iqbal, J.; Hu, R. G.; Ruan, L. L.; Wu, J. S.; Zhao, J. S.; Wang, P. J., Differences in nitrous oxide fluxes from red soil under different land uses in mid-subtropical China. *Agriculture Ecosystems & Environment* **2012,** *146*, (1), 168-178.
112. Lin, S.; Iqbal, J.; Hu, R. G.; Wu, J. S.; Zhao, J. S.; Ruan, L. L.; Malghani, S., Nitrous oxide emissions from rape field as affected by nitrogen fertilizer management: A case study in Central China. *Atmospheric Environment* **2011,** *45*, (9), 1775-1779.
113. Liu, Z. Z. Effects of nitrogen application on N2O emission from vegetable (in Chinese). Master, Huazhong Agricultural University, 2007.
114. Ma, E. D.; Zhang, G. B.; Ma, J.; Xu, H.; Cai, Z. C.; Yagi, K., Effects of rice straw returning methods on N2O emission during wheat-growing season. *Nutrient Cycling in Agroecosystems* **2010,** *88*, (3), 463-469.
115. Ma, J.; Ma, E. D.; Xu, H.; Yagi, K.; Cai, Z. C., Wheat straw management affects CH4 and N2O emissions from rice fields. *Soil Biology & Biochemistry* **2009,** *41*, (5), 1022-1028.
116. Pang, X. B.; Mu, Y. J.; Lee, X. Q.; Fang, S. X.; Yuan, J.; Huang, D. K., Nitric oxides and nitrous oxide fluxes from typical vegetables cropland in China: Effects of canopy, soil properties and field management. *Atmospheric Environment* **2009,** *43*, (16), 2571-2578.
117. Peng, S. Z.; Hou, H. J.; Xu, J. Z.; Mao, Z.; Abudu, S.; Luo, Y. F., Nitrous oxide emissions from paddy fields under different water managements in southeast China. *Paddy and Water Environment*

2011, *9*, (4), 403-411.

118.Peng, S. Z.; Hou, H. J.; Xu, J. Z.; Yang, S. H.; Mao, Z., Lasting effects of controlled irrigation during rice-growing season on nitrous oxide emissions from winter wheat croplands in Southeast China. *Paddy and Water Environment* **2013,** *11*, (1-4), 583-591.

119.Qin, Y. M.; Liu, S. W.; Guo, Y. Q.; Liu, Q. H.; Zou, J. W., Methane and nitrous oxide emissions from organic and conventional rice cropping systems in Southeast China. *Biology and Fertility of Soils* **2010,** *46*, (8), 825-834.

120.Qiu, W. H. Studies on greenhouse gas nitrous oxide emission and its mitigation from vegetable field (in Chinese). Master, Huazhong agriculture university, 2011.

121.Qiu, W. H.; Liu, J. S.; Hu, C. X.; Zhao, C. S.; Sun, X. C.; Tan, Q. L., Effects of Nitrogen Application Rates on Nitrous Oxide Emission from a Typical Intensive Vegetable Cropping System (in Chinese). *Journal of Agro-Environment Science* **2010,** *29*, (11), 2238-2243.

122.Ruan, L. L. Greenhouse gases emissions from different land use types and their global warming potential at Xianning, Hubei, China (in Chinese). Master, Huazhong agricultural university, 2007.

123.Sun, G. F.; Zheng, J. C.; Chen, L. G.; He, J. J.; Zhang, Y. F., Effects of application of pig manure in combination with chemical fertilizers on CH4 and N2O emissions and their greenhouse effects in wheat field (in Chinese). *Journal of Ecology and Rural Environment* **2012,** *28*, (4), 349-354.

124.Sun, G. F.; Zheng, J. C.; Chen, L. G.; He, J. J.; Zhang, Y. F., Effects of pig manure and biogas slurry application on CH4 and N2O emission and their greenhouse effects on paddy field (in Chinese). *Journal of China Agricultural University* **2012,** *17*, (5), 124-131.

125.Sun, G. F.; Zheng, J. C.; Chen, L. G.; He, J. J.; Zhang, Y. F., Effects of chemical fertilizers substitution by biogas slurry on CH4 and N2O emissions and their greenhouse effects in wheat field (in Chinese). *Journal of Agro-Environment Science* **2012,** *31*, (8), 1654-1661.

126.Wang, H. Y.; Xing, G. X., Effect of nitrogen fertilizer rates on nitrous oxide emission from paddy field under rice-wheat rotation (in Chinese). *Journal of Agro-Environment Science* **2009,** *28*, (12), 2631-2636.

127.Wang, J. Y.; Jia, J. X.; Xiong, Z. Q.; Khalil, M. A. K.; Xing, G. X., Water regime-nitrogen fertilizer-straw incorporation interaction: Field study on nitrous oxide emissions from a rice agroecosystem in Nanjing, China. *Agriculture Ecosystems & Environment* **2011,** *141*, (3-4), 437-446.

128.Wang, J. Y.; Zhang, X. L.; Liu, Y. L.; Pan, X. J.; Liu, P. L.; Chen, Z. Z.; Huang, T. Q.; Xiong, Z. Q., Modeling Impacts of Alternative Practices on Net Global Warming Potential and Greenhouse Gas Intensity from Rice-Wheat Annual Rotation in China. *Plos One* **2012,** *7*, (9).

129.Wang, Y.; Hu, C.; Zhu, B.; Xiang, H.; He, X., Effects of wheat straw application on methane and nitrous oxide emissions from purplish paddy fields. *Plant Soil and Environment* **2010,** *56*, (1), 16-22.

130.Xia, W. J. Nitrogen cycling rice-wheat rotation system under optimized nitrogen management (in Chinese). Master, Chinese academy of agricultural sciences, 2011.

131.Xiong, M. H. Release flux of CO_2, N_2O from rice-rape rotation system in Chengdu plain (in Chinese). Master, Southwest university, 2006.

132.Xiong, Z. Q.; Xie, Y. X.; Xing, G. X.; Zhu, Z. L.; Butenhoff, C., Measurements of nitrous oxide emissions from vegetable production in China. *Atmospheric Environment* **2006,** *40*, (12), 2225-2234.

133.Xiong, Z. Q.; Xing, G. X.; H, T.; Shi, S. L.; Shen, G. Y., Nitrous oxide emissions from agricultural

soils as affected by winter cropping system (in Chinese). *Journal of Nanjing Agricultural University* **2002,** *25*, (4), 48-52.

134. Xiong, Z. Q.; Xing, G. X.; Tsuruta, H.; Shi, S. L., The effects of summer legume crop cultivation on nitrous oxide emission from upland farmland (in Chinese). *Science Agricultura Sinica* **2002,** *35*, (9), 1104-1108.

135. Yang, J. H. Effects of tillage and fertilization practices on nitrogen loss and efficiency in paddy soil (in Chinese). Master, Huazhong agricultural university, 2011.

136. Yao, Z. S.; Zheng, X. H.; Wang, R.; Xie, B. H.; Butterbach-Bahl, K.; Zhu, J. G., Nitrous oxide and methane fluxes from a rice-wheat crop rotation under wheat residue incorporation and no-tillage practices. *Atmospheric Environment* **2013,** *79*, 641-649.

137. Yao, Z. S.; Zheng, X. H.; Zhou, Z. X.; Xie, B. H.; Mei, B. L.; Gu, J. X.; Wang, D. Y., Nitrous oxide emission from winter wheat vegetable field in the Taihu region: A comparison case study (in Chinese). *Climatic and Environment Research* **2006,** *11*, (6).

138. Yao, Z. S.; Zhou, Z. X.; Zheng, X. H.; Xie, B. H.; Mei, B. L.; Wang, R.; Butterbach-Bahl, K.; Zhu, J. G., Effects of organic matter incorporation on nitrous oxide emissions from rice-wheat rotation ecosystems in China. *Plant and Soil* **2010,** *327*, (1-2), 315-330.

139. Yu, Y. J.; Gao, M. R.; Zhu, B., Comparison study on no emissions from field under wheat-maize rotation system and field under vegetable cultivation (in Chinese). *Acta Pedologica Sinica* **2012,** *49*, (1).

140. Yu, Y. J.; Wang, X. G.; Zhu, B., N2O emission from vegetable farmland with purple soil and the main factors influencing these emissions (in Chinese). *Acta Ecologica Sinica* **2012,** *32*, (6).

141. Yu, Y. J.; Zhu, B.; Jing, G. J., N_2O emission from soil-vegetable system and impact factors in Chengdu plain of Sichuan basin (in Chinese). *China Environmental Science* **2008,** *28*, (4), 313-318.

142. Zeng, Z. B. The effect of fertilization on soil mcrobial activity and N2O emissions of purple soil in hilly of the central Sichuan (in Chinese). Master, Sichuan agriculture university, 2011.

143. Zeng, Z. B.; Liu, X. F.; Li, D. B., N_2O emission characteristics of different fertilization treatments in wheat-maize rotation in hilly area of purple soil (in Chinese). *Journal of Anhui agricultural Sciences* **2012,** *40*, (28), 13777-13780.

144. Zhai, L. M.; Liu, H. B.; Zhang, J. Z.; Huang, J.; Wang, B. R., Long-Term Application of Organic Manure and Mineral Fertilizer on N2O and CO2 Emissions in a Red Soil from Cultivated Maize-Wheat Rotation in China. *Agricultural Sciences in China* **2011,** *10*, (11), 1748-1757.

145. Zhang, J. K. The emissions of CO_2 and N_2O from purple paddy soil farmland ecosystem under different tillage system (in Chinese). Master, Southwest University, 2011.

146. Zhang, J. S.; Zhang, F. P.; Yang, J. H.; Wang, J. P.; Cai, M. L.; Li, C. F.; Cao, C. G., Emissions of N2O and NH3, and nitrogen leaching from direct seeded rice under different tillage practices in central China. *Agriculture Ecosystems & Environment* **2011,** *140*, (1-2), 164-173.

147. Zhang, K. J.; Jiang, C. S.; Hao, Q. J.; Tang, Q. W.; Cheng, B. H.; Li, H.; Cheng, L. H., Effects of Tillage-Cropping Systems on Methane and Nitrous Oxide Emissions from Agro-Ecosystems in a Purple Paddy Soil (in Chinese). *Environmental Science* **2012**, (06), 1979-1986.

148. Zhang, Z. J. Research on emission fluxes of greenhouse gas in dry-land ecosystem of central Sichuan hilly area (in Chinese). Master, Southwest agricultural university, 2004.

149. Zhao, X.; Min, J.; Wang, S. Q.; Shi, W. M.; Xing, G. X., Further understanding of nitrous oxide emission from paddy fields under rice/wheat rotation in south China. *Journal of Geophysical*

Research-Biogeosciences **2011,** *116*.

150.Zheng, J. C.; Zhang, Y. F.; Chen, L. G.; Wang, Z. H., Nitrous oxide emissions affected by tillage measures in winter wheat under a rice-wheat rotation system (in Chinese). *Acta Ecologica Sinica* **2012,** *32*, (19), 6138-6146.

151.Zhou, M. H.; Zhu, B.; Butterbach-Bahl, K.; Wang, T.; Bergmann, J.; Bruggemann, N.; Wang, Z. H.; Li, T. K.; Kuang, F. H., Nitrate leaching, direct and indirect nitrous oxide fluxes from sloping cropland in the purple soil area, southwestern China. *Environmental Pollution* **2012,** *162*, 361-368.

152.Zhou, M. H.; Zhu, B.; Butterbach-Bahl, K.; Zheng, X. H.; Wang, T.; Wang, Y. Q., Nitrous oxide emissions and nitrate leaching from a rain-fed wheat-maize rotation in the Sichuan Basin, China. *Plant and Soil* **2013,** *362*, (1-2), 149-159.

153.Zou, J. W.; Huang, Y.; Jiang, J. Y.; Zheng, X. H.; Sass, R. L., A 3-year field measurement of methane and nitrous oxide emissions from rice paddies in China: Effects of water regime, crop residue, and fertilizer application. *Global Biogeochemical Cycles* **2005,** *19*, (2).

154.Zou, J. W.; Huang, Y.; Lu, Y. Y.; Zheng, X. H.; Wang, Y. S., Direct emission factor for N2O from rice-winter wheat rotation systems in southeast China. *Atmospheric Environment* **2005,** *39*, (26), 4755-4765.

155.Zou, J. W.; Liu, S. W.; Qin, Y. M.; Pan, G. X.; Zhu, D. W., Sewage irrigation increased methane and nitrous oxide emissions from rice paddies in southeast China. *Agriculture Ecosystems & Environment* **2009,** *129*, (4), 516-522.

156.Dong, Z. J. Study on the effects of banana growth and N2O emission on different type of nitrogen fertilizer (in Chinese). Master, Hainan university, 2010.

157.Lu, C. A.; Kong.L.M.; Hua, W. L.; Xia.T.Y.; Duan.Z.Y., N_2O emission from intensive celery field of Dianchi Watershed (in Chinese). *Journal of Agro-Environment Science* **2008,** *27*, (5), 1870-1875.

158.Xu, W. B.; Liu, G. S.; Hong, Y. T.; Li, C. S.; Chen, X. H., The first comparison of measured and DNDC modeled N_2O fluxes from upland soils in China (in Chinese). *Acta Mineralogica Sinica* **2002,** *22*, (3).

159.Zhang, H.; Yang, Z. L.; Luo, L. G.; Zhang, Q. W.; Yi, J.; Yang, S. Q.; Chen, Y. Y.; Wang, M., The feature of N_2O emission from a paddy filed in irrigation area of the Yellow River (in Chinese). *Acta Ecologica Sinica* **2011,** *31*, (21).

160.Chen, W. W.; Wang, Y. Y.; Zhao, Z. C.; Cui, F.; Gu, J. X.; Zheng, X. H., The effect of planting density on carbon dioxide, methane and nitrous oxide emissions from a cold paddy field in the Sanjiang Plain, northeast China. *Agriculture Ecosystems & Environment* **2013,** *178*, 64-70.

161.Chen, D. J.; Jiang, L. N.; Huang, H.; Toyota, K.; Dahlgren, R. A.; Lu, J., Nitrogen dynamics of anaerobically digested slurry used to fertilize paddy fields. *Biology and Fertility of Soils* **2013,** *49*, (6), 647-659.

162.Hou, X. L. Study soil carbon sequestration and emission mitigation under different fertilization (in Chinese). Master, Chinese academy of agricultural sciences, 2012.

163.Huo, M. X. Studies on the effects of type of N fertilizer on carbon and nitrogen fixization and allocation of banana plant and emission of N2O, NO from soil planted banana of plantation (in Chinese). Master, Hainan university

Agronomy institute, 2012.

164.Liu, Q. H.; Qin, Y. M.; Zou, J. W.; Guo, Y. Q.; Gao, Z. L., Annual nitrous oxide emissions from open-air and greenhouse vegetable cropping systems in China. *Plant and Soil* **2013,** *370*, (1-2),

223-233.

165.Liu, S. W.; Qin, Y. M.; Zou, J. W.; Liu, Q. H., Effects of water regime during rice-growing season on annual direct N2O emission in a paddy rice-winter wheat rotation system in southeast China. *Science of the Total Environment* **2010,** *408*, (4), 906-913.

166.Ma, J.; Li, X. L.; Xu, H.; Han, Y.; Cai, Z. C.; Yagi, K., Effects of nitrogen fertiliser and wheat straw application on CH4 and N2O emissions from a paddy rice field. *Aust J Soil Res* **2007,** *45*, (5), 359-367.

167.Peng, H.; Ji, X. H.; Tian, F. X.; Huo, L. J.; Zhu, J., Integrated effect of decreasing CH_4 and N_2O emission by Biochar incorported to paddy field on late rice (in Chinese). *Cology and Environment Sciences* **2011,** *20*, (11), 1620-1625.

168.Qing, X. B.; Li, Y. E.; Liu, K. Y.; Wan, Y. F., Methane and nitrous oxide emission from paddy field under differentfert ilization treatments (in Chinese). *Transactions of the CSAE* **2006**, (07), 143-148.

169.Shi, S. W.; Li, Y. E.; Qin, X. B.; Wan, Y. F.; Peng, H.; Ji, X. H., Effect of Rice Straw Incorporation of Later Rice Season on CH4 and N2O Emission and Grain yield from Following Early Rice Field (in Chinese). *Chinese Journal of Soil Science* **2011,** *43*, (2).

170.Xiong, Z. Q.; Xing, G. X.; Tsuruta, H.; Shen, G. Y.; Shi, S. L.; Du, L. J., Measurement of nitrous oxide emissions from two rice-based cropping systems in China. *Nutrient Cycling in Agroecosystems* **2002,** *64*, (1-2), 125-133.

171.Xiong.Z.Q.; Xing, G. X.; Tsuruta, H.; Shi, S. L.; Shen, G. Y.; Du, L. J., Nitrous oxide emissions from paddy soils as affected incorporation of leguminous green manure and fertilization during double-cropping rice-growing season (in Chinese). *ACTA Pedologica Sincia* **2003,** *40*, (5).

172.Xu, J. Z.; Peng, S. Z.; Hou, H. J.; Yang, S. H.; Luo, Y. F.; Wang, W. G., Gaseous losses of nitrogen by ammonia volatilization and nitrous oxide emissions from rice paddies with different irrigation management. *Irrigation Science* **2013,** *31*, (5), 983-994.

173.Xu, Y. C.; Shen, Q. R.; Li, M. L.; Dittert, K.; Sattelmacher, B., Effect of soil water status and mulching on N2O and CH4 emission from lowland rice field in China. *Biology and Fertility of Soils* **2004,** *39*, (3), 215-217.

174.Yang, S. H.; Peng, S. Z.; Xu, J. Z.; Luo, Y. F.; Li, D. X., Methane and nitrous oxide emissions from paddy field as affected by water-saving irrigation. *Physics and Chemistry of the Earth* **2012,** *53-54*, 30-37.

175.Zeng, Y. H. Effects of straw full incorporation on rice growth and soil fertility (in Chinese). Master, Jiangxi agriculture university, 2012.

176.Zheng, X. H.; Wang, M. X.; Wang, Y. S.; Shen, R. X.; Shangguang, X. J.; J.Heyer; M.Kogge; H.Papen; Jin, J. S.; Li, L. T., CH_4 and N_2O emissions from rice paddy fields in southeast China (in Chinese). *Scientia Atmospherica Sinica* **1997,** *21*, (2).

177.Zou, J. W.; Huang, Y.; Zong, L. G.; Wang, Y. S.; Sass, R. L., Integrated effect of incorporation with different organic manures on CH4 and N2O emissions from rice paddy (in Chinese). *Environmental science* **2003,** *24*, (4), 7-12.

178.Yang, J.; He, L. P.; Yang, Z.; Chen, Y. F.; Lv, X. J.; Wu, S. Z., Preliminary study of CH4 and N2O in Guangzhou late rice (in Chinese). *Journal of South China Agricultural University* **1997**, (03), 65-69+79.

179.Yang, G. M. Fluxes of CH_4, CO_2 and N_2O from paddy field in Xishuangbana, SW China (in Chinese). Master, Chinese academy of sciences, 2007.

180.Couwenberg, J.; Dommain, R.; Joosten, H., Greenhouse gas fluxes from tropical peatlands in

south-east Asia. *Global Change Biol* **2010,** *16*, (6), 1715-1732.

181.Takakai, F.; Morishita, T.; Hashidoko, Y.; Darung, U.; Kuramochi, K.; Dohong, S.; Limin, S. H.; Hatano, R., Effects of agricultural land-use change and forest fire on N2O emission from tropical peatlands, Central Kalimantan, Indonesia. *Soil Sci Plant Nutr* **2006,** *52*, (5), 662-674.

182.Liu, S.; Wang, C. K.; Xu, F., Soil effluxes of carbon dioxide, methane and nitrous oxide during non-growing season for four temperate forests in northeastern China (in Chinese). *Acta Ecologica Sinica* **2010,** *30*, 4075-4084.

183.Qi, Y. C.; Luo, J.; Dong, Y. S.; Zhang, S., N2O and CH4 emissions from dark taiga forest soil on Gongga mountain (in Chinese). *Science in China* **2002,** *32*, 934-941.

184.Shi, L. Y.; Mu, C. C.; Tian, X. M.; Sun, X. X.; Liu, X.; Cheng, W.; Feng, D. J.; Wu, Y. X.; Li, W. Z., N2O Emission and its driving factors from typical marsh and shrub swamp in Xiaoxing'an Mountains, Northeast China (in Chinese). *Acta Ecologica Sinica* **2011,** *31*, (16), 4799-4804.

185.IPCC *2006 IPCC Guidelines for National Greenhouse Gas Inventories*; National Greenhouse Gas Inventories Programme: IGES, Japan, 2006.

186.Li, N.; Dong, H. M.; Meng, H. L., Greenhouse gas emission from wastewater treatment facilities on swine farms in winter. *Transactions of the CSAE* **2006,** *22*, 202-206.

187.Lu, R. D.; Li, Y. E.; Shi, F.; Wan, Y. F., Effect of compost on the greenhouse gases emission from dairy manure. *Journal of Agro-Environment Science* **2008,** *27*, 1235-1241.

188.Yang, B.; Zhao, C. F., Research on pollution emission standard for Nitric acid production. *Environ. Pollut. Contr.* **2008,** *30*, 92-95.

189.Wu, X. W.; Zhu, F. H.; Yang, J. T.; Zhou, D. B.; L., Y.; Teng, N.; Yi, Y. P., Measurements of Emission Factors of Greenhouse Gas (CO2, N2O) from ThermalPower Plants in China (in Chinese). *Res. Environ. Sci.* **2010,** *23*, 170-176.

190.Zhao, R. L.; Zhao, H. T.; Peng, M. S., The monitoring and estimated total volume of N2O from coal in China (in Chinese). *Chinese Journal of Environmental Science* **1996,** *4*, 11-13.

191.Yao, Z. L.; Wang, Z. D.; Wang, X. T.; Zhang, Y. Z.; Shen, X. B.; Yin, H.; He, K. B., An emission inventory of non-conventional pollutants from vehicles in typical cities (in Chinese). *Environ. Pollut. Contr.* **2011,** *33*, 96-101.

192.Cao, M. Q.; Zhuang, Y. H., Determination of nitrous oxide during biomass burning and its distribution (in Chinese). *Environ. Chem.* **1994,** *13*, 395-400.

193.Liu, L. H.; Jiang, J. Y.; Zong, L. G., Emission Inventory of Greenhouse Gases from Agricultural Residues Combustion: A Case Study of Jiangsu Province (in Chinese). *Environ. Sci.* **2011,** *32*, 1242-1248.

194.van der Werf, G. R.; Randerson, J. T.; Giglio, L.; Collatz, G. J.; Mu, M.; Kasibhatla, P. S.; Morton, D. C.; DeFries, R. S.; Jin, Y.; van Leeuwen, T. T., Global fire emissions and the contribution of deforestation, savanna, forest, agricultural, and peat fires (1997-2009). *Atmos Chem Phys* **2010,** *10*, (23), 11707-11735.

195.Yan, W. J.; Yang, L. B.; Wang, F.; Wang, J. N.; Ma, P., Riverine N2O concentrations, exports to estuary and emissions to atmosphere from the Changjiang River in response to increasing nitrogen loads. *Global Biogeochemical Cycles* **2012,** *26*.

196.Yang, L. B.; Yan, W. J.; Ma, P.; Wang, J. N., Seasonal and diurnal variations in N2O concentrations and fluxes from three eutrophic rivers in Southeast China. *J Geogr Sci* **2011,** *21*, (5), 820-832.

197.Chen, C. T. A.; Wang, S. L.; Lu, X. X.; Zhang, S. R.; Lui, H. K.; Tseng, H. C.; Wang, B. J.; Huang, H. I., Hydrogeochemistry and greenhouse gases of the Pearl River, its estuary and beyond. *Quatern*

Int **2008,** *186*, 79-90.

198.Xu, J. R.; Wang, Y. S.; Wang, Q. J.; Yin, J. P., Nitrous oxide concentration and nitrification and denitrification in Zhujiang River Estuary, China. *Acta Oceanol Sin* **2005,** *24*, (3), 122-130.

199.Zhang, G. L.; Zhang, J.; Liu, S. M.; Ren, J. L.; Zhao, Y. C., Nitrous oxide in the Changjiang (Yangtze River) Estuary and its adjacent marine area: Riverine input, sediment release and atmospheric fluxes. *Biogeosciences* **2010,** *7*, (11), 3505-3516.

200.Reay, D. S.; Smith, K. A.; Edwards, A. C.; Hiscock, K. M.; Dong, L. F.; Nedwell, D. B., Indirect nitrous oxide emissions: revised emission factors. *Environmental Science* **2005,** *2*, 153-158.

201.Sawamoto, T.; Nakajima, Y.; Kasuya, M.; Tsuruta, H.; Yagi, K., Evaluation of emission factors for indirect N2O emission due to nitrogen leaching in agro-ecosystems. *Geophys Res Lett* **2005,** *32*, (3).

202.Weymann, D.; Well, R.; Flessa, H.; von der Heide, C.; Deurer, M.; Meyer, K.; Konrad, C.; Walther, W., Groundwater N2O emission factors of nitrate-contaminated aquifers as derived from denitrification progress and N2O accumulation. *Biogeosciences* **2008,** *5*, (5), 1215-1226.

203.Hiscock, K. M.; Bateman, A. S.; Muhlherr, I. H.; Fukada, T.; Dennis, P. F., Indirect emissions of nitrous oxide from regional aquifers in the United Kingdom. *Environ Sci Technol* **2003,** *37*, (16), 3507-3512.

204.Jahangir, M. M. R.; Johnston, P.; Khalil, M. I.; Hennessy, D.; Humphreys, J.; Fenton, O.; Richards, K. G., Groundwater: A pathway for terrestrial C and N losses and indirect greenhouse gas emissions. *Agr Ecosyst Environ* **2012,** *159*, 40-48.

205.Reay, D. S.; Edwards, A. C.; Smith, K. A., Importance of indirect nitrous oxide emissions at the field, farm and catchment scale. *Agr Ecosyst Environ* **2009,** *133*, (3-4), 163-169.

206.Zheng, X. H.; Han, S. H.; Huang, Y.; Wang, Y. S.; Wang, M. X., Re-quantifying the emission factors based on field measurements and estimating the direct N(2)O emission from Chinese croplands. *Global Biogeochem. Cycles* **2004,** *18*, (2).

207.State-Council-of-China The first national pollution source survey: nutrient loss ratio of agricultural fertilizer (in Chinese). http://cpsc.mep.gov.cn/ (November 12, 2013),

208.MEP/NSB/MOA, National Pollution Source Survey Database. In Beijing, 2008.

209.Zhang, W. F.; Dou, Z. X.; He, P.; Ju, X. T.; Powlson, D.; Chadwick, D.; Norse, D.; Lu, Y. L.; Zhang, Y.; Wu, L.; Chen, X. P.; Cassman, K. G.; Zhang, F. S., New technologies reduce greenhouse gas emissions from nitrogenous fertilizer in China. *P Natl Acad Sci USA* **2013,** *110*, (21), 8375-8380.

210.Ministry-of-Agriculture-of-China, *China Animal Industry Yearbook*. China Agricuture Press: Beijing, 2009.

211.Chen, S. F., Meng, F. Q., Wu, W. L., Wang, K., Nitrogen Loss Characteristics via Runoff in Typical Rice Planting Area in North-east China under Different Planting Managements (in Chinese). *Chinese Journal of Eco-Agriculture* **2012,** *20*, (6), 728-733.

212.Chen, Y., Zhao, L., Yang, Y., Sun, C. Y., Zhang, X. L., Preliminary Study on Characteristics of Nitrogen and Phosphorus Runoff Losses from Rice Fields in Hai River Basin, China (in Chinese). *Journal of Agro-Environment Science* **2011,** *30*, (2), 328-333.

213.Gao, J., He, R. J., Yu, L. H., Zhou, J., Li, W., Mu, Z. J., Wei, S. Q., Research on Water and Runoff Loss of Nitrogen and Phosphorus from the Typical Agricultural Watersheds in Three Gorges Reservoir Area: A Case Study in Huolong, Yunyang County (in Chinese). *Environment and Ecology in the Three Gorges* **2012,** *34*, (2), 6-12.

214.Huang, S. F., Shen, G. X., Tang, H., Lu, Y. T., Nitrogen Losses in Paddy Fields in Shanghai Suburbs (in Chinese). *Environmental Pollution and Control* **2005,** *27*, (9), 651-653.

215.Jiao, S. J., Hu, X. M., Pan, G. X., Zhou, H. J., Xu, X. D., Effects of Fertilization on Nitrogen and Phosphorus Runoff Loss from Qingzini Paddy Soil in Taihu Lake Region During Rice Growth Season (in Chinese). *Chinese Journal of Ecology* **2007,** *26*, (4), 495-500.

216.Li, K., Si, M. X., f., Ding, S. Q., Chen, Z., Effects of Controlled Release Fertilizer on Loss of Nitrogen and Phosphorus from Farmland (in Chinese). *Journal of Anhui Agricultural Sciences* **2012,** *40*, (25), 12466-12470.

217.Liang, X. Q., Tian, G. M., Li, H., Chen, Y. X., Zhu, S., Study on Characteristic of Nitrogen and Phosphorus Loss from Rice Field by Natural Rainfall Runoff (in Chinese). *Journal of Soil and Water Conservation* **2005,** *19*, (1), 59-63.

218.Liu, H. J., Zhang, J. C., Chen, L. G., Xue, X. H., Effects of Straw-returning on Annual Overland Runoff NPK Loss in Farmland (in Chinese). *Ecology and Environmental Sciences* **2012,** *21*, (6), 1031-1036.

219.Luo, W. B., Hong, L., Characteristics of Nitrogen Losses in Surface Runof f from Farmland (in Chinese). *Journal of Irrigation and Drainage* **2011,** *30*, (4), 53-56.

220.Mao, G. F., Lu, M., Huang, M. W., Liu, M., Nitrogen loss in rice-wheat cropping farmland and its control measures (in Chinese). *Acta Agriculture Shanghai* **2006,** *22*, (4), 86-92.

221.Qiu, D. S., Shen, S. Y., Liu, M., Zhou, H. J., Xu, J. H., Nitrogen and phosphorus loss in growing season of wetland rice (in Chinese). *Shanghai Agricultural Science and Technology* **2009**, (2), 21-23.

222.Shi, L. H., Ji, X. H., Li, H. S., Tian, F. X., Peng, H., Liu, S. B., Nitrogen and Phosphorus Losses from Surface Runoff under Different Application in the Double Cropping Rice Fields in Hunan (in Chinese). *Chinese Journal of Agrometeorology* **2010,** *31*, (4), 551-557.

223.Wang, J., Guo, X. S., Wang, Y. Q., Ding, S. W., Effects of Conservation Tillage and Balanced Fertilization on Nitrogen Loss from Paddy Field and Rice Yields in Chaohu Region (in Chinese). *Journal of Agro-Environment Science* **2010,** *29*, (6), 1164-1171.

224.Wang, X. Y., Wang, Y., Tian, X. H., Ma, G. H., Effects of NMUrea on Nitrogen Runoff Losses of Surface Water and Nitrogen Fertilizer Efficiency in Paddy Field (in Chinese). *Transactions of the Chinese Society of Agricultural Engineering* **2011,** *27*, (1), 106-111.

225.Wang, X. Z., Gao, R., Qian, X. Q., Feng, K., Zhu, J. G., Nitrogen Loss via Runoff from Paddy Field Using the Large Catchment Area in Taihu Region (in Chinese). *Journal of Agro-Environment Science* **2007,** *26*, (3), 831-835.

226.Wen, Y., Zhang, H. L., Xie, J. W., Cao, L. K., Studies on the Nitrogen Loss from Rice Field with Different Fertilizer Treatments (in Chinese). *Bulletin of Science and Technology* **2011,** *27*, (4), 549-553.

227.Xia, X. J., Hu, Q. Y., Zhu, L. Q., Chen, C. Q., Bian, X. M., Study on Dynamic Changes of Nitrogen and Phosphorus in Surface Water of Paddy Field and Runoff Loss in Taihu Region (in Chinese). *Journal of Soil and Water Conservation* **2011,** *25*, (4).

228.Zhang, D. Q., He, R. J., Zheng, J., Liu, Y. Y., Fei, J. L., Mu, Z. J., Wei, S. Q., Investigation on Water Quality and Runoff Loss of Nitrogen and Phosphorus from the Typical Agricultural Watersheds in Three Gorges Reservoir Area (in Chinese). *Environment and Ecology in the Three Gorges* **2011,** *33*, (5), 1-5.

229.Zhang, J. Z., Lei, Q. L., Zuo, Q., Zhang, J. L., Wang, Q. B., Fan, X. P., Liu, H. B., Nitrogen Loss

Characteristics with Runoff under Simulated Rainfall Conditions in Paddy Field of Taihu Lake Region (in Chinese). *Hubei Agricultural Sciences* **2009,** *48*, (11), 2688-2692.

230.Huang, D. F., Li, W. H., Wang, L. M., Lin, X. J., Fan, P., Qiu, X. X., Effects of Water and Fertilizer Managements on Yield, Nutrition Uptake of Rice and Loss of Nitrogen and Phosphorus by Runoff from Paddy Field (in Chinese). *Journal of Soil and Water Conservation* **2013,** *27*, (2), 62-66.

231.Zhang, M. K., Wang, Y., Huang, C., Characteristics of Nitrogen and Phosphorus Runoff Losses from Croplands with Different Planting Patterns in A Riverine Plain Area of Zhejiang Province, East China (in Chinese). *Chinese Journal of Applied Ecology* **2011,** *22*, (12), 3211-3220.

232.Zhu, P. P., Chang, Z. Z., Zheng, J. C., Chen, L. G., Nitrogen and phosphorus loss through runoff and their economic benefits in wetland rice of Lake Taihu Watershed (in Chinese). *Jiangsu Agricultural Sciences* **2007**, (3), 216-218.

233.Xue, L. H., Yu, Y. L., Yang, L. Z., Nitrogen Balance and Environmental Impact of Paddy Field Under Different N Management Methods in Taihu Lake Region (in Chinese). *Environmental Sciences* **2011,** *32*, (4), 1133-1138.

234.Zeng, Z. B., Ai, S. Y., Yao, J. W., Li, M. J., Tang, M. D., Yu, D. N., Effect of fertilization on nitrogen runoff from early paddy field in the Pearl River Delta Region (in Chinese). *Guangdong Agricultural Sciences* **2010,** *9*, 27-30.

235.Zhou, L. F., Hao, L. P., Zhang, Y. L, Characteristics of Nitrogen Loss Through Surface Flow and Interflow in Different Fertilization of Farmland in Liaoning Hunhe Basin (in Chinese). *Journal of Soil and Water Conservation* **2012,** *26*, (4), 69-73.

236.Huang, M. X., Zhang, S., Zhang, G. L., Zhang, X. M., Losses of Nitrogen in Overland Flow from Farmland in Beijing under Simulated Rainfall Conditions (in Chinese). *Acta Geographica Sinica* **2003,** *58*, (147-154).

237.Wang, X. Y., Wang, Y. X., Wang, X. F., Wang, Z. G., Wang, Q. P., Hu, Q. J.. Cai, X. G., The Character of Nutrient Loss and Land Use in A Small Watershed of Miyun Reservoir (in Chinese). *Research of Environmental Sciences* **2003,** *16*, (1), 30-33.

238.Wang, Y. H., Qiu, X. K., Hu, G. Q., Dong, Y. J., Effect of Controlled Release Fertilizer on Nitrogen and Phosphorus Runoff Losses from Farmland in Slope Field (in Chinese). *Journal of Soil and Water Conservation* **2011,** *25*, (2), 10-14.

239.Zhao, L., Tang, Z. J., Feng, S. Y., Zhang, Z. J., Experimental Study on Effect of Nitrogen Loss under Water Erosion in Dry Faimland Soil (in Chinese). *Journal of Soil and Water Conservation* **2010,** *24*, (5), 79-82.

240.Bu, J. D., Fan, X. P., Tian, Y. B., Qiao, F., Yu, Y. F., Zhang, F. L., Effect of Different Application Level of N on the Forms and Losing Amount of N in the Runoff of Cotton Field (in Chinese). *Hubei Agricultural Sciences* **2009,** *48*, (5), 1092-1095.

241.Bi, L., Tan, Q. L., Hu, C. X., Li, D. B., Guo, Y. C., Zhang, S. W., Sun, X. C., Effect of Nutrient Management on Loss of Nitrogen and Phosphorus from Citrus Orchard of Danjiangkou Reservoir Area (in Chinese). *Journal of Huazhong Agricultural University* **2011,** *30*, (4), 474-478.

242.Hu, Z. P., Zheng, X. M., Huang, Z. C., Mao, G. F., Chen, Z. L., Nitrogen and Phosphorus Loss by Surface Runoff in Farmland in Shanghai (in Chinese). *Chinese Journal of Soil Science* **2007,** *38*, (2), 310-313.

243.Huang, L. H., Shen, G. X., Qian, X. Y., Gu, H. R., Qiu, Z. Q., Nitrogen Loss in Sandy Pear Orchard and Vegetable Field and Impact Factors (in Chinese). *Journal of Agro-Environment Science* **2008,** *27*, (2), 687-691.

244.Huang, S. F., Lu, Y. T., Shen, G. X., Tang, H., Nitrogen Losses from Dry Farming Fields in Shanghai Suburbs (in Chinese). *Rural Eco-Environment* **2005,** *21*, (2), 50-53.

245.Huang, Z. C., Zheng, X. M., Yao, C. X., The Study of Nonirrigated Farmland Nitrogen and Phosphorus Loss with Surface Runoff in Shanghai (in Chinese). *Yunnan Geographic Environment Research* **2007,** *19*, (1), 6-10.

246.Jiao, P. J., Wang, S. L., Xu, D., Wang, Y. Z., Effect of Crop Vegetation Type on Nitrogen and Phosphorus Runoff Losses from Farmland in One Rainstorm Event (in Chinese). *Journal of Hydraulic Engineering* **2009,** *40*, (3), 296-302.

247.Li Q. L., W. C. F., Zeng, X. Y., Ai, P., Li, C. Y., Influence of Nature Rainfall on Nitrogen and Phosphor Loss in Slope Land of Purple Soil (in Chinese). *Journal of Irrigation and Drainage* **2010,** *29*, (2), 76-80.

248.Li, R. L., Zhang, Y. C., Zeng, Y., Liu, Z., Yan, R. R., Effect of Rainstorm on the Export of Farmland Nitrogen with Surface Runoff in Hilly of Tai of Lake Basin (in Chinese). *Journal of Agro-Environment Science* **2009,** *28*, (6), 1185-1190.

249.Liu, X. K., Xue, J. H., Wu, Y. B., Nitrogen and Phosphorus Losses Mechanisms from Agro-forestry System under Simulated Rainfall Conditions (in Chinese). *Journal of Nanjing Forestry University (Natural Science Edition)* **2012,** *36*, (2), 117-120.

250.Liu, X. Q., Ma, Y. H., Wang, G. L., Sun, L., Wang, L. T., Zhu, X. H., Hu, S. B.,Nitrogen and phosphorus loss from soybean-wheat rotation croping system in Anhui province (in Chinese). *Agro-Environment & Development* **2011**, (5), 121-124.

251.Liu, Y., Tao, Y., Wang, K. Y., Zhang, G. S., Chen, S. S., Chen, F., Nitrogen and Phosphorus Loss Characteristics on Sloping Land Runoff in Citrus Orchard with Different Mulching Practices in the Danjiangkou Reservoir Area (in Chinese). *Resources and Environment in the Yangtze Basin* **2010,** *19*, (11), 1340-1344.

252.Ma, Y. H., Xie, X. Y., Ma, Z. W., Wang, G. L., Sun, X. W., Hu, S. B., Shi, R. G., Huang, W. X., Zhu, H. Y., Zhu, X. D., Wang, T. C., Nitrogen and Phosphorus Runoff from Garden Plots in Anhui Province (in Chinese). *Journal of Soil and Water Conservation* **2012,** *26*, (3), 12-17.

253.Peng, S. C., Chen, X. Y., Hu, M. Y., Dai, J. P., Nitrogen and Phosphorus Loss Characteristics from upland in Changsha city (in Chinese). *Hunan Agricultural Sciences* **2009**, (6), 61-64.

254.Qian, X. Y., Shen, G. X., Huang, L. H., Wang, S. B., Characteristics of Nitrogen and Phosphorus Losses with Rainfall-Runoff from Sandy Dry Field in Chongming Dongtan (in Chinese). *Journal of Soil and Water Conservation* **2010,** *24*, (2), 11-14.

255.Zhang, Y. L., Li, H. E., Zhang, X. C., Xiao, B., Soil Mineral Nitrogen Loss in Surface Runoff and Sediment as Affected by Slope Gradient on Loess Slope (in Chinese). *Bulletin of Soil and Water Conservation* **2007,** *27*, (2), 14-17.

256.Wang, C. M., Jiang, Z. G., Zhao, Y. W., Nitrogen and Phophorus Runoff in the Typical Vegetable Fields in Tai Lake basin (in Chinese). *Journal of Soil and Water Conservation* **2011,** *25*, (4), 36-40.

257.Wang, J. W., Sun, J. L., Zhang, Q. C., Yang, W. Y., Preliminary Study on Surface Runoff Nitrogen and Phosphorus Loss in the West Lake Tea Plantation Ecosystem (in Chinese). *Acta Agriculturae Zhejiangensis* **2012,** *24*, (4), 676-679.

258.Wang, J., Guo, X. S., Wang, Y. Q., Effects of Straw Mulch and Balanced Fertilization on Nitrogen Loss from Farmland in Chaohu Lake Region (in Chinese). *Chinese Journal of Soil Science* **2011,** *42*, (2), 331-335.

259.Xi, Y. G., Chen, R. B., Xu, X., Wang, H., Wei, Q., Li, J. Y., Study on N, P Loss through Runoff inWhea t Field of Tai Lake Reg ion and Countermea sures (in Chinese). *Acta Agricultural Jiangxi* **2010,** *22*, (5), 106-109.

260.Xiao, Q., Zhang, W. L., Wang, Q. B., Wu, S. X., Nitrogen Losses under Simulated Rainfall Condition in Rice-wheat Rotation of Taihu Lake Watershed Plain (in Chinese). *Plant Nutrition and Fertilizer Science* **2005,** *11*, (6), 731-736.

261.Yang, H. Y., Zhao, X. R., Zeng, X. Z., Pu, B., Wang, C. T., Effects of Different Farming Systems on Nitrogen and Phosphorus Loss from Surface Runoff in Purple Hilly Region in Sichuan (in Chinese). *Ecology and Environmental Sciences* **2009,** *18*, (6), 2344-2348.

262.Yao, J., Tang, C. X., He, B. H., Effects of Different Fertilization Level on N-losses alone with Surface Runoff on Slope Land of Purple Soil (in Chinese). *Research of Soil and Water Conservation* **2010,** *17*, (2), 54-57.

263.Yu, Q. G., Ye, J., Ma, J. W., Sun, W. C., Wang, Q., Jiang, L. N., Fu, J. R., Chen, Y., Effects of Different Nitrogen Applied Levels on Nitrogen Runoff Loss in Oilseed Rape Fields (in Chinese). *Journal of Soil and Water Conservation* **2011,** *25*, (3), 22-26.

264.Yu, Q. G., Ye, J., Ma, J. W., Sun, W. C., Zou, P., Fu, J. R., Yin, J. Z., Xu, J. X., Effects of Green Manure Planting on Nitrogen and Phosphorus Runoff Losses in Mountainous Orchard (in Chinese). *Journal of Soil and Water Conservation* **2012,** *26*, (2), 6-11.

265.Yu, Y. L., Xue, L. H., Yang, L. Z., Nitrogen Use Efficiency and Loss from Runoff and Leaching in Wheat Season with Rice-wheat Rotation System Under Different Nitrogen Management Methods in Taihu Lake Region, China (in Chinese). *Journal of Agro-Environment Science* **2011,** *30*, (12), 2475-2482.

266.Zhang, Y. P., Rong, X. M., Liu, Q., Xie, G. X., Huang, T., Wu, W., Effect of Combination of Organic and Inorganic Fertilization on Crop Nutrient Rate, Nitrogen and Phosphorus Loss in Dry Land (in Chinese). *Journal of Soil and Water Conservation* **2013,** *27*, (3), 44-48.

267.Ning, J. F., Xu, P. Z., Yang, S. H., Zou, X. Z., Luo, W. J., Chen, Y., Sun, L. L., Wei, L., Wu, J. L., Effect of Combined Application of Organic and Inorganic Fertilization on Soil Nitrogen Runoff in Vegetable Field (in Chinese). *Journal of Soil and Water Conservation* **2011,** *25*, (3), 17-23.

268.Wang, J., Chen, N. C., Zhan, Z. S., Xie, Y. H., Lu, Y. H., Ke, Y. S., Xu, S. G., Influence of Different Plangting Methods on Runoff Losses of Nitrogen in Tobacco Field Soil (in Chinese). *Journal of Soil and Water Conservation* **2010,** *24*, (5), 68-73.

269.Wu, X. B., Chen, S. Y., Study on the Nitrogen and Phosphrous Losses Pollution from Nonirrigated Lateritic Red Earth (in Chinese). *Journal of Zhanjiang Ocean University* **1999,** *19*, (2), 58-62.

270.Zhang, W., Ai, S. Y., Yao, J. W.. Li, M. J., Yang, L. J., Nitrogen and Phosphorus Loss Characteristics from vegetable cropland in Guangzhou city (in Chinese). *Agro-Environment & Development* **2009**, (3), 73-78.

271.Li, Y. J., Wang, K. Q., Song, W. F., Guo, S. H., Li, T. X., Li, Y. J., Nitrogen Loss in the Farmland Surface Runoff under the Natural Rainfall Conditions (in Chinese). *Research of Soil and Water Conservation* **2010,** *17*, (4), 19-23.

272.Liu, J. X., Jia, Q. H., Tian, S., Yang, Y., Guo, Y. Z., Effect of Cropping and Fertilization Manners on Nitrogen Loss from Sloping Land in Yunnan (in Chinese). *Journal of Yunnan Agricultural University* **2009,** *24*, (4), 586-602.

273.Tang, Z. X., Wang, K. Q., Functions of Grass Strip Treasures Controlling Runoff and Sediment Yields, Nitrogen and Phosphorys in the Sloping Farmland (in Chinese). *Journal of Soil and Water*

Conservation **2012,** *26*, (4), 17-22.

274.Gong, W., Zhan, H. Z., Li, Y. M., Zhang, W. L., Cao, X. Y., Study on nitrogen loss from different chicken manure application level under the in-situ simulated rainfall condiions in dianchi lake watershed of yunnan province (in Chinese). *Soil and Fertilizer Sciences in China* **2010,** *5*, (2), 16-20.

275.Liu, R., Li, Y., Zhang, A., Wang, F., Zhao, T., Chen, C., Hong, Y., Yang, Z., Effect of Postponing N Application on Rice Yield and N Losses in Yellow River Irrigation Area(in Chinese). *Journal of Soil and Water Conservation* **2012,** *26*, (2), 16-20.

276.Liu, D., Nie, J., Xiao, J., Study on15N Labeled Rice Controlled Release Fertilizer in Increasing Nitrogen Utilization Efficiency(in Chinese). *Acta Laser Biology Sinica* **2002,** *11*, (2), 87-92.

277.Lu, M., , Liu, M., Mao, G., Huang, M., Qu, F., Study on Nitrogen Leaching of Paddy Soil in the Field Experiments(in Chinese). *Journal of East China Normal University (Natural Science)* **2006**, (4), 71-77.

278.Tian, Y. H.; Yin, B.; Yang, L. Z.; Yin, S. X.; Zhu, Z. L., Nitrogen runoff and leaching losses during rice-wheat rotations in Taihu Lake Region, China. *Pedosphere* **2007,** *17*, (4), 445-456.

279.Wang, X., Gao, R., Zhu, J., Cai, Z., Hosen, Y., Nitrogen loss via runoff and leaching from employ of different urea bleeds in paddy season(in Chinese). *China Environmental Science* **2004,** *24*, (5), 600-604.

280.Li, K., Si-Ma, X., Ding, S., Chen, Z., Effects of Controlled Release Fertilizer on Loss of Nitrogen and Phosphorus from Farmland(in Chinese). *Journal of Anhui Agricultural Sciences* **2012,** *40*, (25), 12466 -12470.

281.Zheng, S., Liu, D., Nie, J., Dai, P., Xiao, J., Fate and recovery efficiency of controlled release nitrogen fertilizer in flooding paddy soil(in Chinese). *Plant Nutrition and Fertilizer Science* **2004,** *10*, (2), 137-142.

282.Ji, X., Zheng, S., Shi, L., Liao, Y., Effect of fertilization on nutrient leaching loss from different paddy soils in Dongting Lake area(in Chinese). *Acta Pedologica Sinica* **2008,** *45*, (4), 663-671.

283.Xu, C., Wang, Z., Yin, X., Cai, X., Study on Nitrogen Leaching in Soils of Different Land Utilization Type in Dachong Watershed(in Chinese). *Guizhou Agricultural Sciences* **2012,** *40*, (4), 146-150.

284.Xi, J., Zhou, J., Leaching and transforming characteristics of urea-N added by different ways of fertigation(in Chinese). *Plant Nutrition and Fertilizer Science* **2003,** *9*, (3), 271-275.

285.Fu, J., Yang, Y., Cao, J., Inner Mongolia typical farmland fertilizer nitrogen leaching loss status quo of the research(in Chinese). *China Agricultural Technology Extension* **2010,** *10*, 44-47.

286.Zhao, Y., Zhang, X., Luo, J., Chen, X., Ji, H., Zhang, W., Effect of fertilization on nitrogen leaching loss from soil and nutrients utilization by tomato and cucumber in greenhouse(in Chinese). *Plant Nutrition and Fertilizer Science* **2011,** *17*, (2), 374-383.

287.Gao, Z., Yang, X., Zhou, J., Wang, X., Wang, H., Forms and Amounts of Nitrogen in Leachates Affected by Different Fertilizations after one Wheat-maize Rotation(in Chinese). *Journal of Agro-Environment Science* **2010,** *29*, (8), 1624-1632.

288.Li, Y., Feng, H., Wu, S., Effect of Straw Returning after Comminution and Amination on Soil Nutrient Leaching Loss(in Chinese). *Journal of Soil and Water Conservation* **2010,** *24*, (1), 12-15.

289.Zhou, J. B.; Xi, J. G.; Chen, Z. J.; Li, S. X., Leaching and transformation of nitrogen fertilizers in soil after application of N with irrigation: A soil column method. *Pedosphere* **2006,** *16*, (2), 245-252.

290.Lu, K., Optimized Management of Nitrogen Fertilizer and Strategies for Reducing Nitrogen Leaching loss in Greenhouse vegetable Field in Taihu Lake region(in Chinese). *Nanjing Forestry University, MS Dissertation* **2011**.

291.Wang, L., Zhao, L., Zhu, P., Gao, H., Peng, C., Effects of Different Fertilizer Application Regimes on NO3--N and NH4+-N in Black Soil during Spring Maize Growing Season(in Chinese). *JOURNAL OF NORTHEAST FORESTRY UNIVERSITY* **2009,** *37*, (12), 85-87.

292.Li, Z., Dong, S., Wang, K., Zhang, J., Liu, P., Wang, Q., Liu, C., In situ study on influence of different fertilization strategies for summer maize on soil nitrogen leaching and volatilization(in Chinese). *Plant Nutrition and Fertilizer Science* **2007,** *13*, (6), 998-1005.

293.Liu, H., Li, Z., Zhang, W., Lin, B., Study on N use efficiency of chinese cabbage and nitrate leaching under open field cultivation(in Chinese). *Plant Nutrition and Fertilizer Science* **2004,** *10*, (3), 286-291.

294.Liu, J., Ma, L., Jia, Z., Zhang, T., Yu, H., Leaching Characteristics of Nitrogen in Fluvo-aquic Soil After Applying Urea(in Chinese). *JOURNAL OF NORTHEAST FORESTRY UNIVERSITY* **2010,** *38*, (5), 71-73.

295.Liu, J., Study on Nitrogen Leaching Regulations on Three Textures of Soil(in Chinese). *Beijing Forestry University, MS Dissertation* **2010**.

296.Chen, S., Wu, W., Hu, K., Du, Z., Chu, Z., Characteristics of nitrate leaching in high yield farmland under different irrigation and fertilization managements in North China Plain(in Chinese). *Transactions of the CSAE* **2011,** *27*, (2), 65-73.

297.Li, H., Qiu, J., Gao, C., Wang, L., Simulation of potential nitrate leaching in croplands of typical watershed around Bohai Bay using DNDC model(in Chinese). *Transactions of the CSAE* **2012,** *28*, (13), 127-134.

298.Lu, L., Wang, D., Li, X., Zhang, R., Comparison of Nutrient Release Characteristics from Coated controlled /slow-release Fertilizers(in Chinese). *Journal of Anhui Agricultural Sciences* **2011,** *39*, (21), 12735-12738.

299.Yu, Q., Chen, Y., Zhang, Q., Li, H., Lian, Q., Tian, P., Effect of DMPP on Inorganic Nitrogen Leaching Loss from Vegetable Soil(in Chinese). *Journal of Soil and Water Conservation* **2006,** *20*, (4), 40-43.

300.Wang, T., Luo, G., Zhu, B., Luo, Z., Zhang, J., Effects of Fertilization on Nitrogen Leaching from Hillslope Cropland of Purple Soil(in Chinese). *Journal of Agro-Environment Science* **2009,** *28*, (4), 716-722.

301.Zhou, J., Cui, J., Hu, F., Wang, G., Ma, Y., N-loss through volatilization, runoff and leaching from red soil planted with Digitaria Ischaemum(in Chinese). *Acta Pedologica Sinica* **2007,** *44*, (6), 1076-1082.

302.Liu, H., Zhao, J., Wang, Z., Yang, D., Effects of Nitrogen Fertilizer Rate and Combined Application of Organic Manure and Chemical Fertilizer on Nitrogen Utilization Efficiency in Summer Maize(in Chinese). *Chinese Agricultural Science Bulletin* **2011,** *27*, (12), 77-81.

303.Min, J.; Shi, W. M.; Xing, G. X.; Zhang, H. L.; Zhu, Z. L., Effects of a catch crop and reduced nitrogen fertilization on nitrogen leaching in greenhouse vegetable production systems. *Nutrient Cycling in Agroecosystems* **2011,** *91*, (1), 31-39.

304.Wang, T., Zhu, B., Kuang, F., Zhang, J., Wang, Z., Zhou, M., Effects of a combination of organic and inorganic fertilization on nitrogen leaching from purple soil with sloping cropland(in Chinese). *Acta Scientiae Circum stantiae* **2010,** *30*, (4), 781-788.

305.Wang, H., Zhou, J., Lei, Z., Zhao, M., Leaching of Different Forms of Nitrogen and Dissolved Organic Carbon of Organic Manure in Soil Column(in Chinese). *Journal of Agro-Environment Science* **2008,** *27*, (4), 1364- 1370.

306.Lu, K., Min, J., Li, M., Shi, W., Xie, Y., Effect of Nitrogen Fertilizer Application Rates on Annual Nitrogen Leaching Loss from Protected Vegetable Production System in Tai Lake Region, China(in Chinese). *Journal of Agro-Environment Science* **2012,** *31*, (4), 706-712.

307.Zhu B, Z. M., Kuang F, Wang T, Measurement and simulation of nitrogen leaching loss in hillslope cropland of purple soil (in Chinese). *Chinese Journal of Eco-Agriculture***2013,** *21*, (1), 102-109.

308.Yao, L., Study on the Fate of Nitrogen in Different Nutrient Management in Mustard /Maize Tuber Rotation System(in Chinese). *Southwest University, MS Dissertation* **2012**.

309.Wei, S., Effects of Different Nutrient Management on Nitrogen Leaching Loss from Purple Soil(in Chinese). *Southwest University, MS Dissertation* **2010**.

310.Lu, R., Shi, Z., Lai, Q., Nutrient degradation in red soils Ⅲ:nutrient leaching losses from red soils and plants(in Chinese). *Chinese Journal of Soil Science* **2000,** *31*, (4), 156-165.

311.Du, J., Gou, C., Cui, Y., Qu, D., Effects of Water Retaining Agent on Ammonia Volatilization and Nutrient Leaching Loss from N, P and K Fertilizers(in Chinese). *Journal of Agro-Environment Science* **2007,** *26*, (4), 1296-1301.

312.Ning, J., Cao, J., Zou, X., Yang, S., Chen, Y. Effects of Different Nitrogen Fertilizers on the Growth of Leaf-used Lettuce and Soil Nitrogen Leaching(in Chinese).

313.Zeng, S., Wu, Q., Chen, S., Wei, Z., Effects of Combined Fertilization on the Leaching Regimes of Nitrogen and Phosphorus in Latosolic Red Soil(in Chinese). *Journal of Soil and Water Conservation* **2008,** *22*, (3), 82-86.

314.Du, J., Wu, Y., Tian, J., Wang, Y., Cui, Y., Effect of Several Controlled/Slow-Release Fertilizers on Decreasing Ammonia Volatilization and N Leaching(in Chinese). *Journal of Soil and Water Conservation* **2007,** *21*, (2), 49-52.

315.Zeng, S., Wu, Q., Hou, H., Qiu, J., Effects of Simulated Acid Rain on Nitrogen and Phosphorus Leaching Characteristics in Latosolic Red Soils with Application of Organic Compound Fertilizer(in Chinese). *Journal of Soil and Water Conservation* **2007,** *21*, (6), 16-21.

316.Cang, H., Xu, L., Li ,Z., Ren, H., The leaching of non-point source N and P from latosol in dry land of Leizhou peninsula. *Ecology and Environment(in Chinese)* **2005,** *14*, (5), 715-718.

317.Zeng, S., Wu, Q., Leaching characteristics of nitrogen and phosphorus in inorganic compound fertilizer from latosolic red soil in South China. *Chinese Journal of Applied Ecology(in Chinese)* **2007,** *18*, (5), 1015-1020.

318.Ning, J., Zou, X., Yang, S., Wei, L., Wu, J., Effects of combined application of organic and inorganic nitrogen fertilizer on the soil nitrogen leaching and the growth of leaf-used lettuce(in Chinese). *Transactions of the CSAE* **2007,** *23*, (11), 95-100.

319.Zhong, X., Zhu, Y., Liu, J., Qin, A., Influence of Bamboo- Charcoal Coating on N Leaching and Effectiveness of Fertilizers(in Chinese). *Journal of Agro-Environment Science* **2006,** *25*, (supp.), 154- 157.

320.Yi, X., Tang, S., Zhang, Z., He, K., Luo, Z., Several crop potted simulation research of Nitrogen Leaching(in Chinese). *JOURNAL OF SOUTH CHINA UNIVERSITY OF TROPICAL AGRICULTURE* **2001,** *7*, (3), 5-9.

321.Li, X., Wang, D., Zhang, Y., Huang, X., Liao, Z., Effects of Lignin on the Nitrogen Migration, Transformation and Accumulation of Compound Fertilizer Coated with Lignin in Multimedia

Environment(in Chinese). *Journal of Agro-Environment Science* **2005,** *25*, (2), 458- 463.

322.Gao, H., Huang, L., Zhang, Q., Xu, L., Nitrogen Leaching Under Different Rainfall Intensities for Agricultural Soils- Laboratory Experiments and Numerical Modeling Using LEACHM(in Chinese). *Journal of Agro-Environment Science* **2008,** *27*, (4), 1346- 1352.

323.Deng, Y., Liang, Y., Yuan, L., Huang, J., Study on the Nutrient Leaching and Utilization in Tobacco-grown Soil(in Chinese). *Journal of Soil and Water Conservation* **2009,** *23*, (2), 21-24.

324.Zheng, X. H.; Xie, B. H.; Liu, C. Y.; Zhou, Z. X.; Yao, Z. S.; Wang, Y. H.; Wang, Y. L.; Yang, L. X.; Zhu, J. G.; Huang, Y.; Butterbach-Bahl, K., Quantifying net ecosystem carbon dioxide exchange of a short-plant cropland with intermittent chamber measurements. *Global Biogeochemical Cycles* **2008,** *22*, (3).

325.Cao, G. L.; Zhang, X. Y.; Gong, S. L.; Zheng, F. C., Investigation on emission factors of particulate matter and gaseous pollutants from crop residue burning. *J Environ Sci-China* **2008,** *20*, (1), 50-55.

326.Li, Q. K., Zhu, Z. L., Yu, T. R., *Fertilizer Problems in Agri-culture Development of China (in Chinese)*. Jiangxi Science and Technology Press: Nanjing, 1998.

327.Liu, X. L., Xu, J. X., Wang, F. H., Zhang, F. S., Ma, W. Q., Estimation parameters of nitrogen balance in stock farming system of China (in Chinese). *Chin. J. Appl. Ecol.* **2006,** *17*, 417-423.

328.Lu, R. K., Liu, H. X., Wen, D. Z., Qin, S. W., Zheng, J. Y., Wang, Z. Q., Study on nutrient cycling and balance in Chinese typical agro-ecosystem, II. The farmland nutrient receive parameters (in Chinese). *Chin. J. Soil. Sci.* **1996,** *27*, 151-154.

329.Lu, R. K., Liu, H. X., Wen, D. Z., Qin, S. W., Zheng, J. Y., Wang, Z. Q., Study on nutrient cycling and balance in Chinese typical agro-ecosystem. III, The status of nutrient cycling and balance in whole country and typical region (in Chinese). *Chin. J. Soil. Sci.* **1996,** *27*, 193-196.

330.National-Extension-Center-of-Agriculture-Technique, *Chinese Organic Fertilizer Nutrient Records (in Chinese)*. China Agricultural Press: Beijing, 1999.

331.Gao, X., Ma, W. , Analysis on the current status of utilization of crop straw in China (in Chinese). *J. Huazhong Agric. Univ.* **2002,** *21*, 242-247.