Table R1. Overview of Available Models for Fertilizer Emissions.

Reference	Fertilizer	Parameters	Model Type
Fenn and Kissel (1975)	Urea, nitrogen solutions	Time, temperature, application rate	Regression
Alkanani and Mackenzie (1992)	Urea, UAN	Temperature, thermodynamic force, wind velocity, soil surface roughness, adsorption and desorption rate constants	Mechanistic
Ismail et al. (1991)	Urea solution	Soil temperature, application rate, initial soil moisture content, soil pH, application depth	Regression
Kirk and Nye (1991)	Urea	Time, soil moisture content, diffusion factor in soil, vertical distance	Mechanistic
Roelle and Aneja (2002)	Hog slurry	Soil temperature	Regression
Sogaard et al. (2002)	Cattle and pig Slurry	Soil water content, air temp, wind speed, slurry type, dry matter content of slurry, TAN content of slurry, application method, application rate	Mechanistic
Huijsmans et al. (2003)	Slurry	Air temperature, application rate, application method, content of N in slurry, wind speed	Mechanistic
Vira et al. (2019)	Fertilizer and livestock waste	Temperature, precipitation, soil moisture, wind speed, spreading of TAN, application rate	Mechanistic

Table R2. Sensitivity test setting

Experiment	Calculation setting	Sensitivity (%)
base	$base \quad = CF_{wind} \times CF_{soil_T} \times CF_{soil_m} \times CF_{rain}$	
Sen_temp	$CF_{met1} = CF_{wind} \times (CF_{soil_T} \pm Std_{soilT}) \times CF_{soil_m} \times CF_{rain}$	$(CF_{met1} - base)/base$
Sen_mois	$CF_{met2} = CF_{wind} \times CF_{soil_T} \times (CF_{soil_m} \pm Std_{soilm}) \times CF_{rain}$	$(CF_{met2} - base)/base$
Sen_wind	$CF_{met3} = (CF_{wind} \pm Std_{wind}) \times CF_{soil_T} \times CF_{soil_m} \times CF_{rain}$	$(CF_{met3} - base)/base$
Sen_rain	$CF_{met4} = CF_{wind} \times CF_{soil_T} \times CF_{soil_m} \times (CF_{rain} \pm Std_{rain})$	$(CF_{met4} - base)/base$

Table R3. Ammonia emissions from different husbandry sources in Tibet and Xinjiang

	Free-intensive (Kg/year)	Grazing (Kg/year)
Tibet	1.01×10^8	1.12×10^7
Xinjiang	2.94×10^8	$1.29\times10_7$

TableR4. Livestock amount in Tibet and Xinjiang

Region	Livestock species	Free-intensive amount (ten thousand)	Grazing amount (ten thousand)
Tibet	Cow and Beef	421.13	262.8
	Sheep and Goat	981.92	632.5
Xinjiang	Cow and Beef	480.52	207.7
	Sheep and Goat	7351.15	1314.5

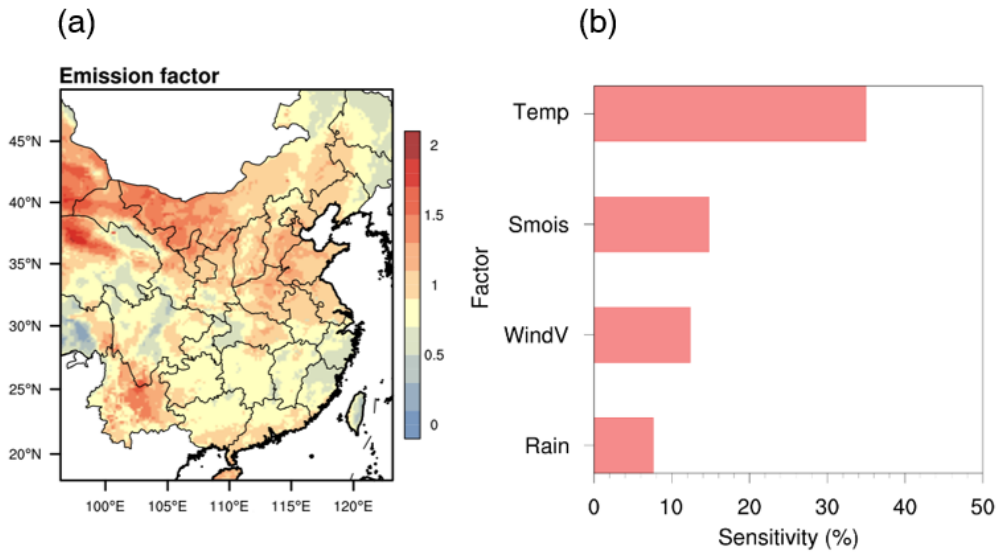

Figure R1. (a) The annual mean emission factor of ammonia in 2019 for eastern China. (b) The sensitivity of emission factors to different meteorological factors.

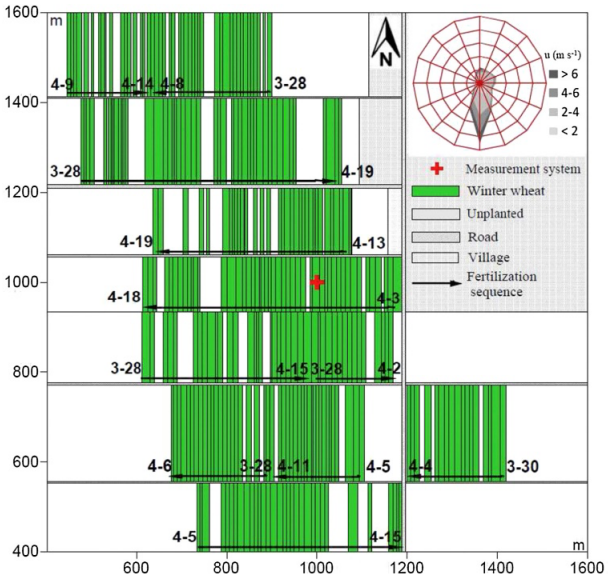

Figure R2. Illustrations of the application area. The approximate fertilization sequence is indicated by arrows and dates (month-day) (Huo et al., 2015).

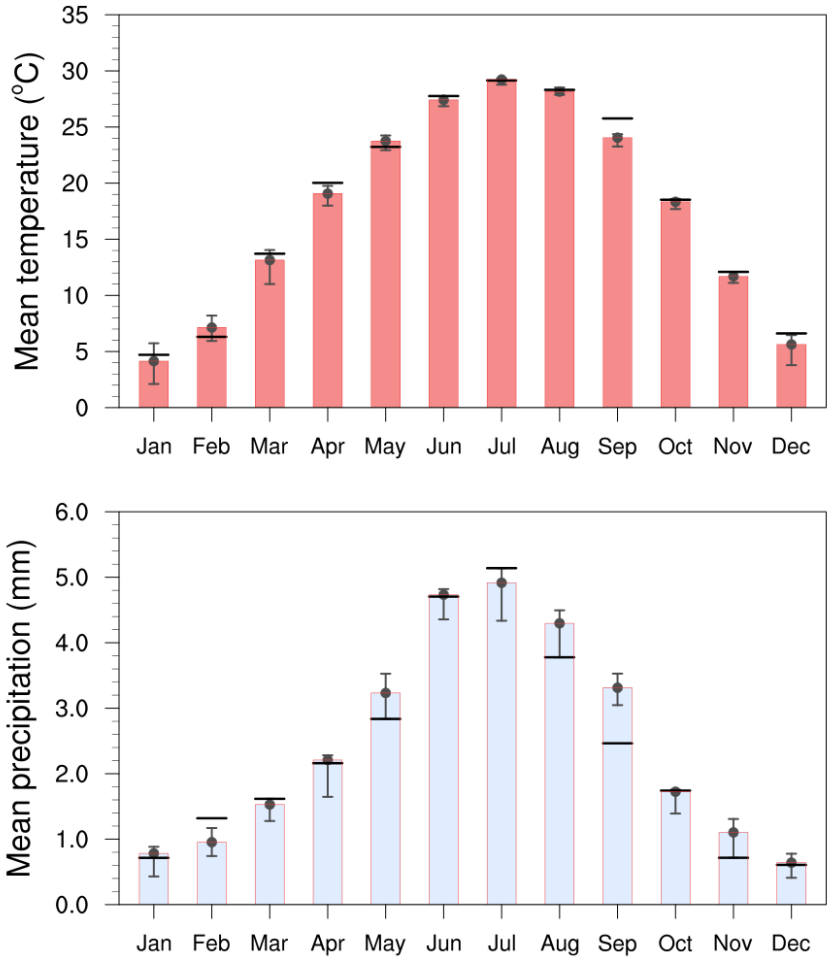

Figure R3. (a) Seasonal pattern of monthly averaged near surface temperature in eastern China (18°N–50°N, 95°E–131°E) during 2010-2019. The lower and upper points of vertical lines show the 25th and 75th percentiles, respectively. The black horizontal line represents mean value in 2019. (b) is same as (a) but for mean precipitation.

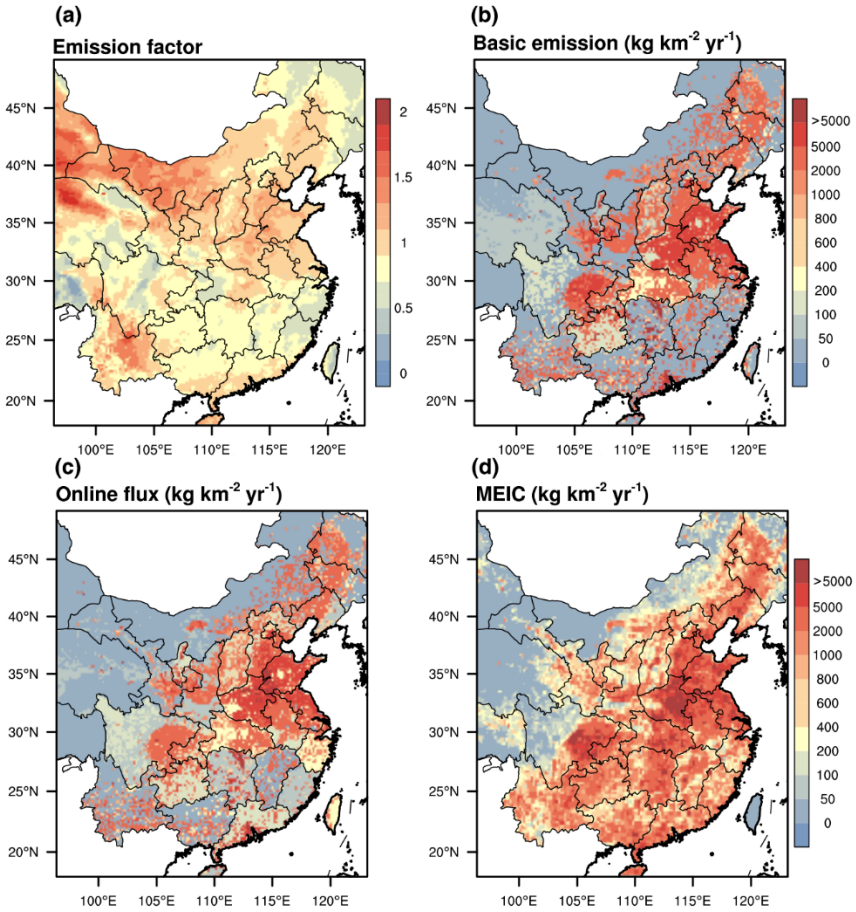

Figure R4. (a) The annual mean emission factor of ammonia in 2019 for east China; (b) the spatial distribution of basic NH_3 emission in 2019; (c) online NH_3 emission in 2019; (d) traditional MEIC NH_3 emission inventory in 2019.

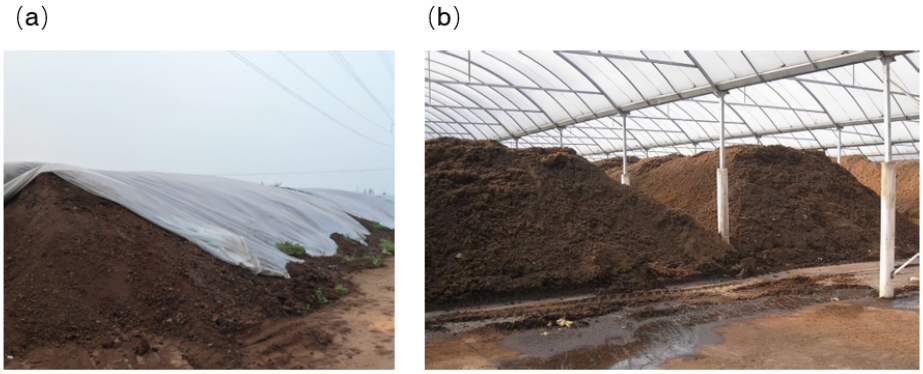

Figure R5. (a) Piles of manure covered with plastic sheeting; (b)Manure composts in greenhouse.

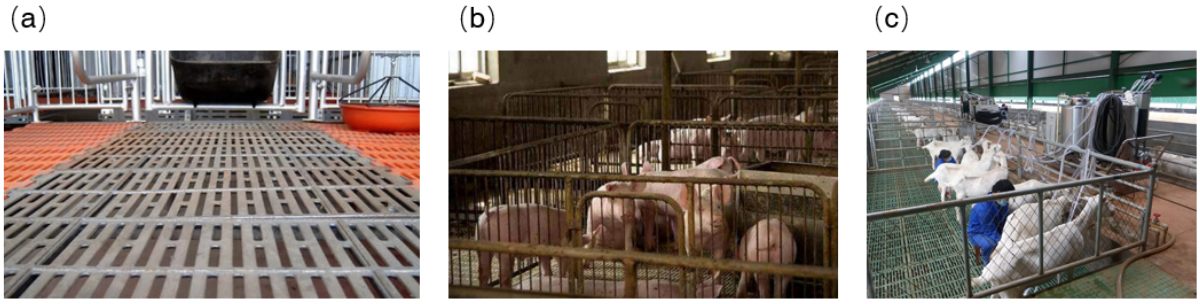

Figure R6. (a) Slit floor in a farm house; (b)pigs on slit floor; (c) goats on slit floor.

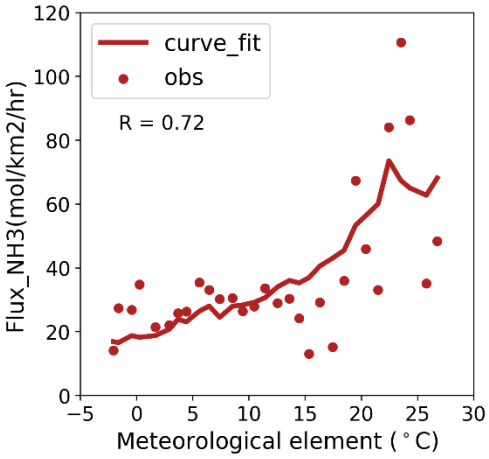

Figure R7. Results of fitting meteorological parameters to ammonia emission fluxes