



Contribution of N fertilization to N₂O emissions from croplands of China and mitigation options

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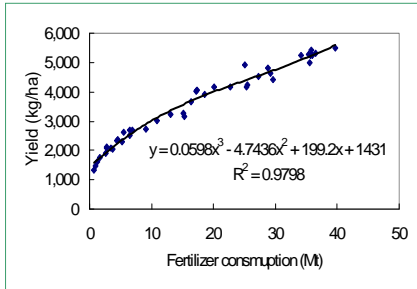
Outlines

- Introduction
- Processes of N₂O production
- N₂O emissions from croplands of China
- Mitigation options

Introduction

■ N fertilization plays a very important role in food security of China

■ N fertilization is an important source of N pollution in China

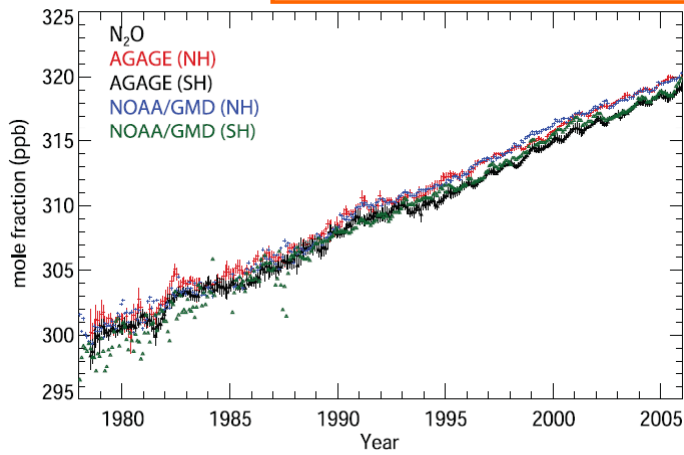


Relationship between food crop yield and chemical fertilizer consumption from 1961 to 2002 in China

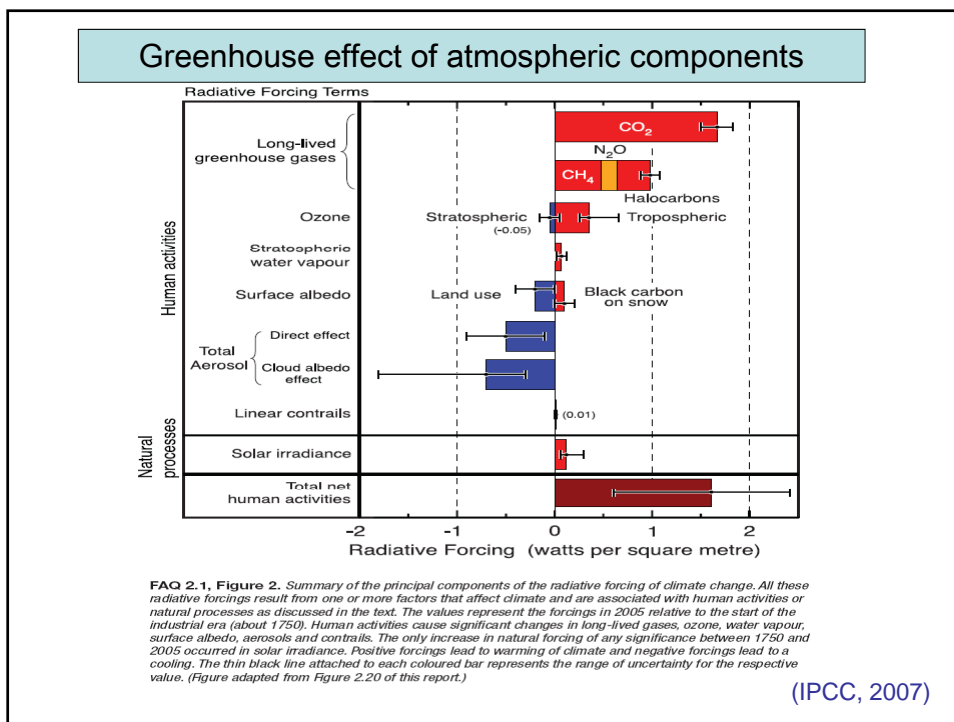
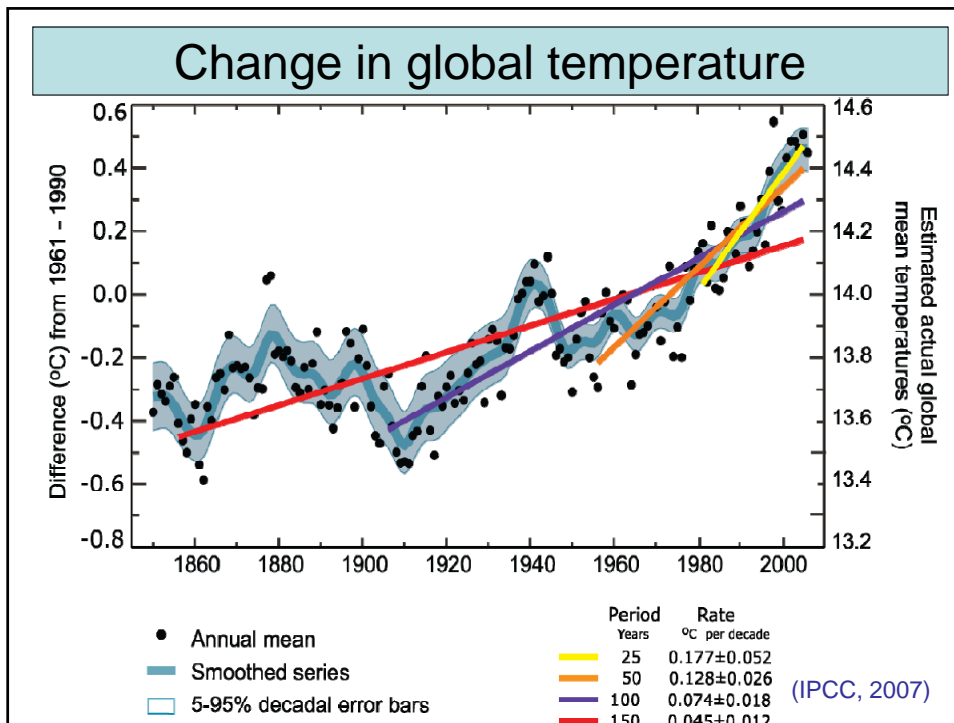
- Nitrate accumulation in groundwater
- Eutrophication of water body
- Nitrogenous gas emission
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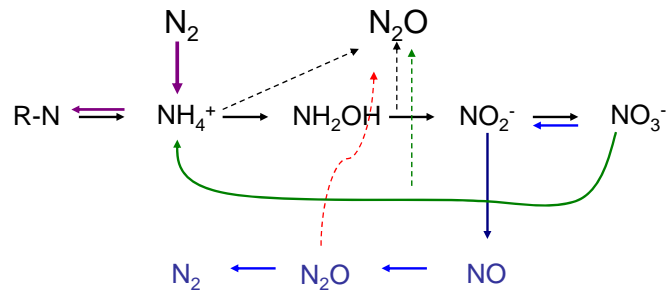
Agriculture contributes around 60% of atmospheric N₂O sources (IPCC, 2007)



Change in atmospheric N₂O concentration



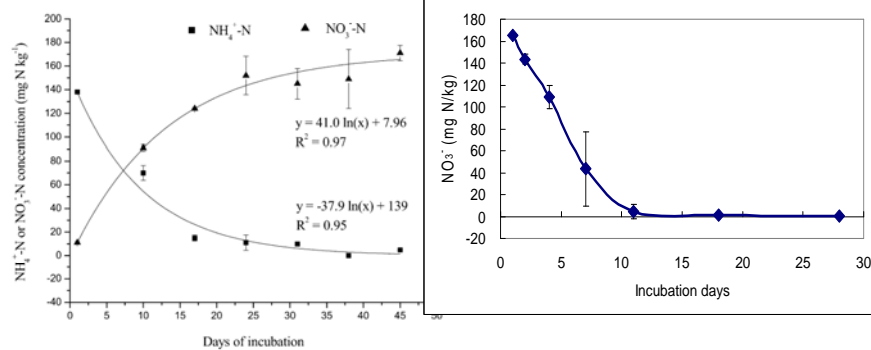
Processes of N₂O production



The processes producing N₂O

- Nitrification
- Denitrification
- DNRA

For most soils, nitrification and denitrification are substrate-dependent

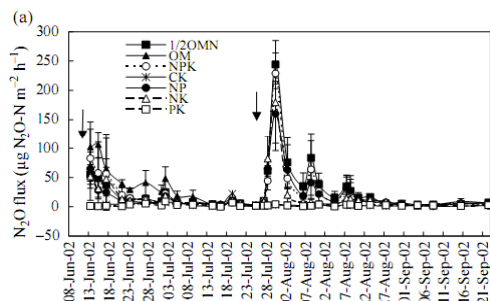


Under aerobic conditions
(Wang et al., 2005)

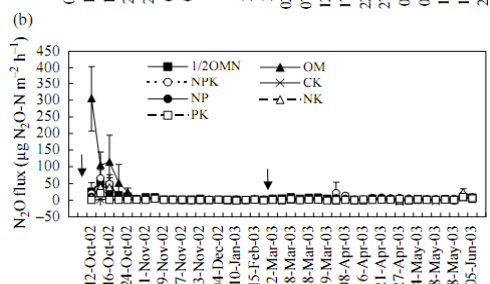
Under anaerobic conditions

N₂O fluxes from uplands of China

Maize-season

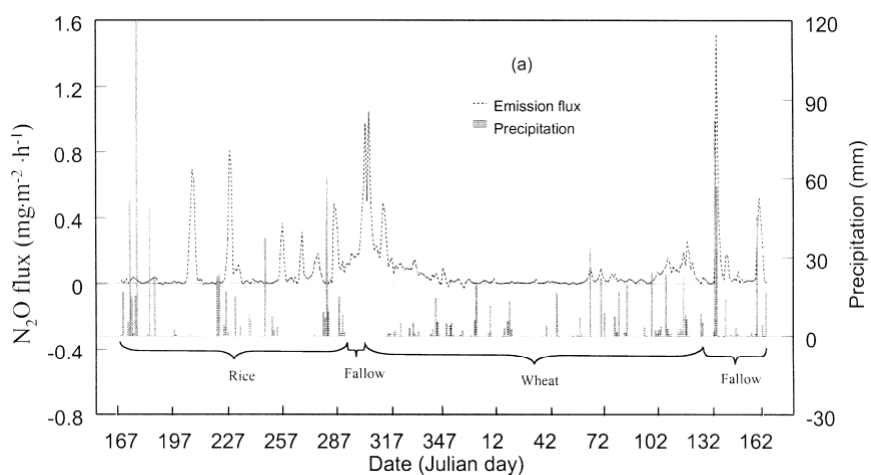


Wheat-season



Meng et al., 2005

N₂O fluxes from rice-based ecosystems of China

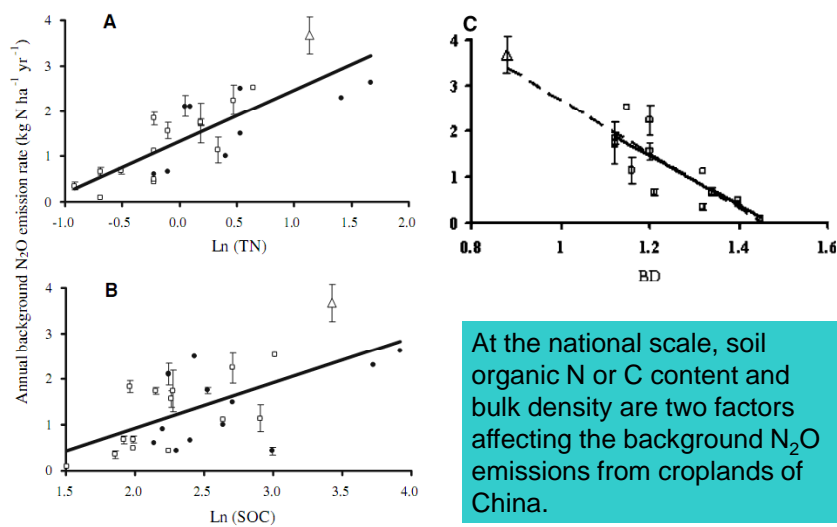


Zheng et al., 2000

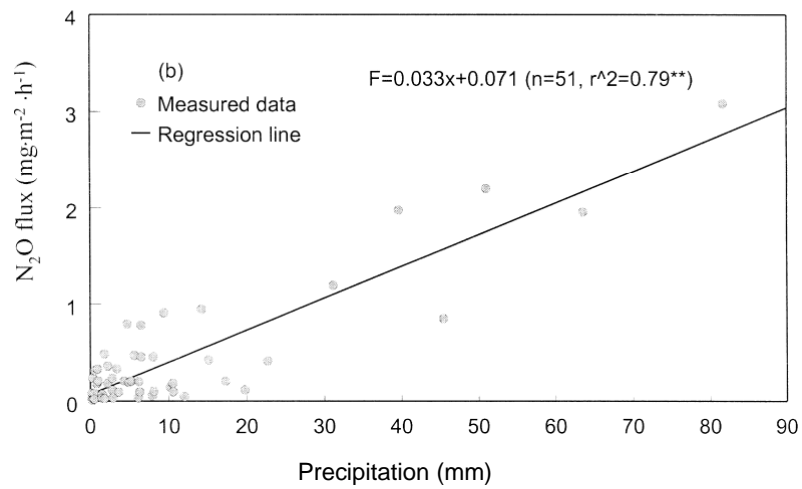
- N application rate is a key factor controlling N₂O emissions from croplands
- Thus, N₂O emissions are estimated by N application rate in the IPCC Guidelines from National Greenhouse Gas Inventories
- Generally, N₂O emission is less from rice fields than from uplands at the same N application rate

IPCC Guidelines	Emission factor	
	Uplands	Rice fields
1996 GL	1.25%	
GPG 2000	1.25%	
2006 GL	1.0%	0.3%

Factors affecting background N₂O emissions from croplands of China

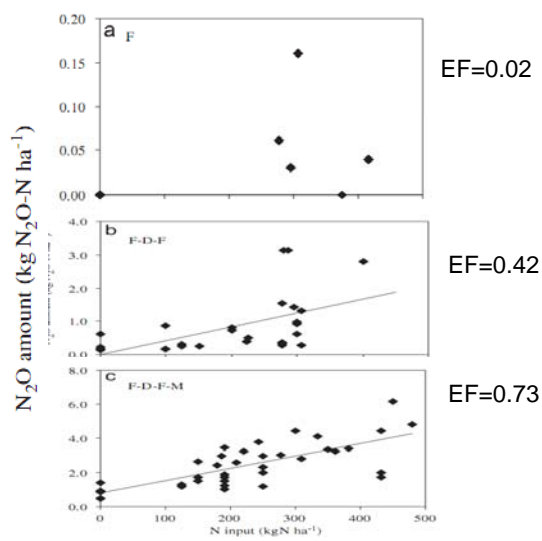


(Gu et al., 2007)



Relationship between N_2O flux and precipitation (Zheng et al., 2000)

Relationships between N_2O emission and N application rate at different water regimes of rice fields



Data from the measurements in China (Zou et al., AE, 2007)

Crucial factors affecting N₂O emissions from croplands at national scale of China

■ Uplands

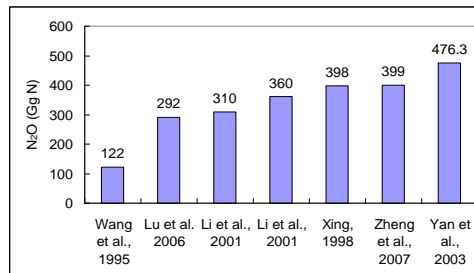
- Background N₂O emission
 - Soil organic N or C content
 - Soil bulk density
- Fertilizer-induced N₂O emission
 - Application rate
 - Precipitation

■ Rice fields

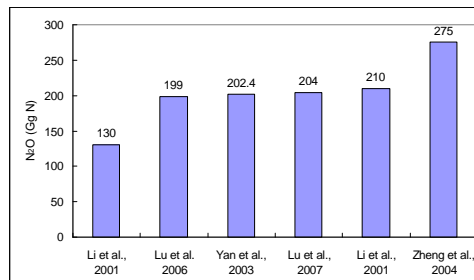
- Background N₂O emissions
 - water regime
- Fertilizer-induced N₂O emissions
 - Water regime
 - application rate

Estimated N₂O emissions from croplands of China

Total emission ranges from 122 to 476 Gg N per year



Fertilizer-induced emission ranges from 130 to 275 Gg N per year

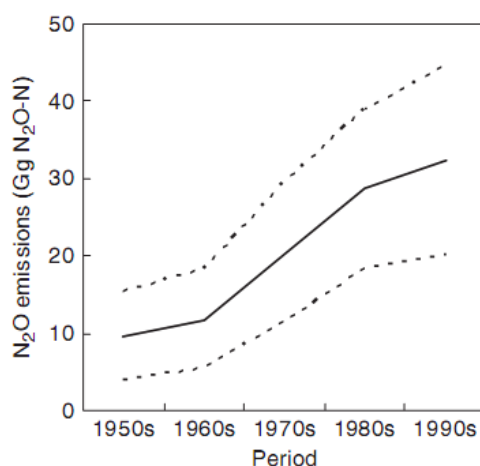


Contributions of rice fields and fertilizer-induced N₂O emissions to total emissions from croplands of China

Reference	Rice fields to total (%)	Fertilizer-induced to total (%)
Xing, 1998	8.8	
Li et al., 2001		41.9 (Model)
		58.3 (IPCC)
Yan et al., 2003		42.5 (IPCC)

China is the unique country that synthetic fertilizer-induced N₂O dominates total N₂O emissions from croplands in East, Southeast and South Asia (Yan et al., 2003)

N₂O emissions from rice fields during rice growing season were estimated to increase from 9.6 Gg N in 1950s to 32.3 Gg N in 1990s



Estimated N₂O emissions from rice fields during rice growing season from 1950s to 1990s (Zou et al., 2009)

Mitigation options

- Prevention of excess application of N fertilizers
- Prevention of unnecessary irrigation of uplands or drainage of rice fields. But drainage of rice fields enables to mitigate CH₄ emission

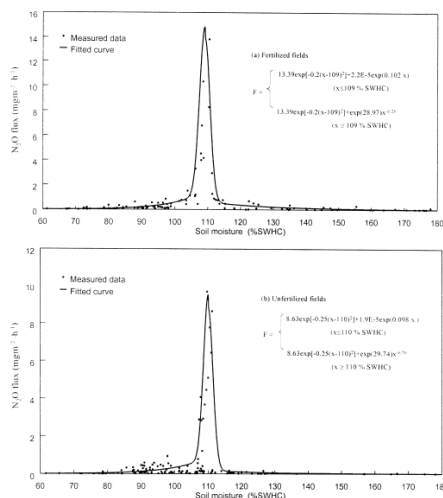
CH₄ emissions scaling factors for water regimes during the rice growing period

Water regime	Scaling factor
Continuously flooded	1
Intermittently flooded-- single aeration	0.60
Intermittently flooded-- multiple aeration	0.52

IPCC, 2007

Mitigation options

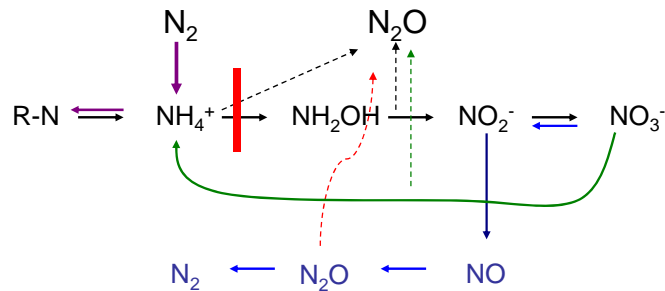
- Reduction of the duration of soil moisture around saturation



Dependence of N₂O emission on soil moisture (Zheng et al., 2000)

Mitigation options

- Application of nitrification inhibitors: **less debate on mitigation effect**



Mitigation options

- Mitigation options which are less confirmed
 - Controlled or slow released fertilizers
 - No- or mini-tillage
 - Incorporation with crop residues
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- Effects of any mitigation options on N_2O emissions from croplands should be assessed not only in short-term, but also in long-term.
- Trade-off relationships between N_2O and other greenhouse gas emission should be assessed.

Any strategy which increases the efficiency of fertilizer N use will reduce emissions of N₂O (Mosier et al., 1996)

Thank you