Agriculture and Greenhouse Gas (GHG) Emissions

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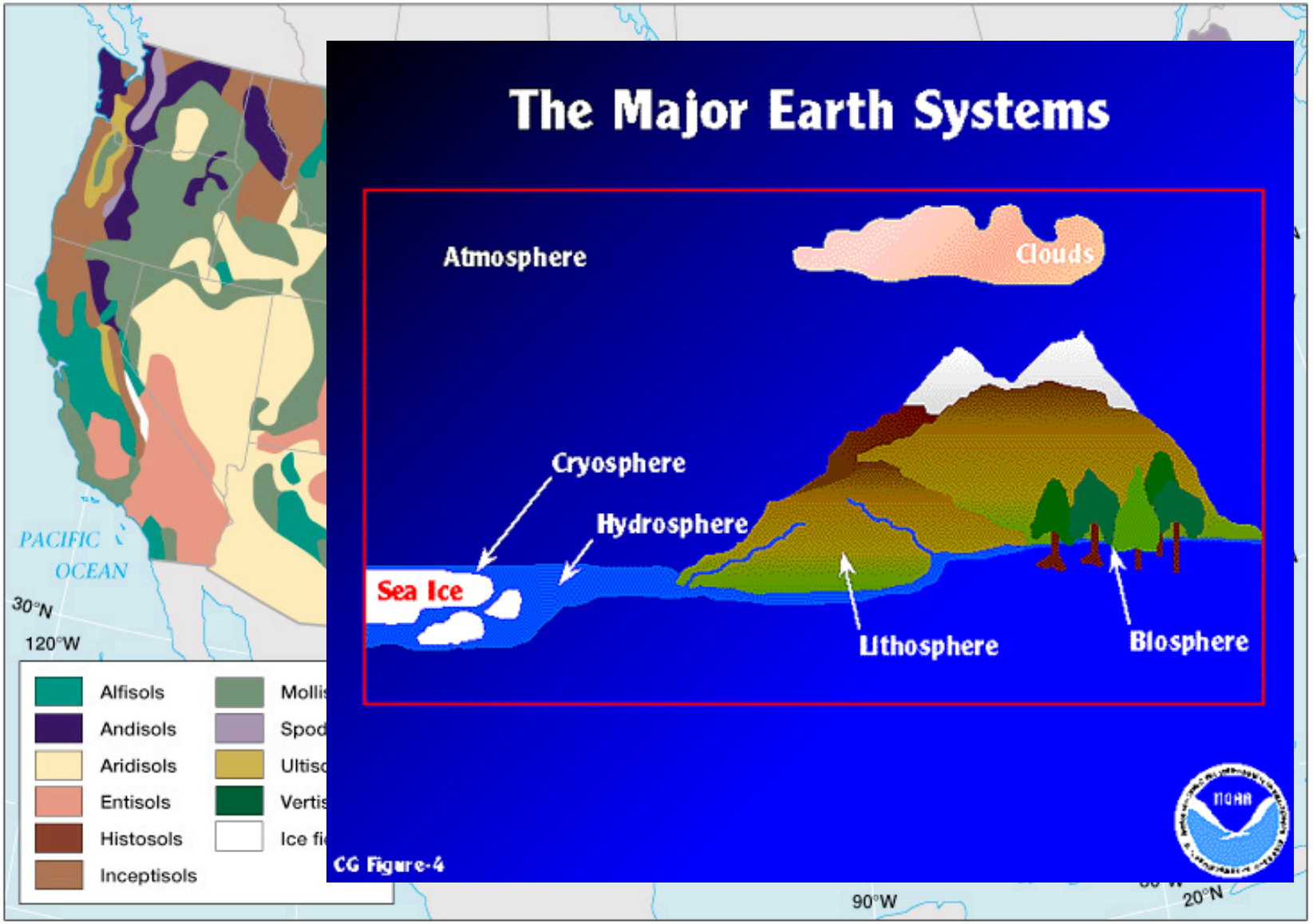
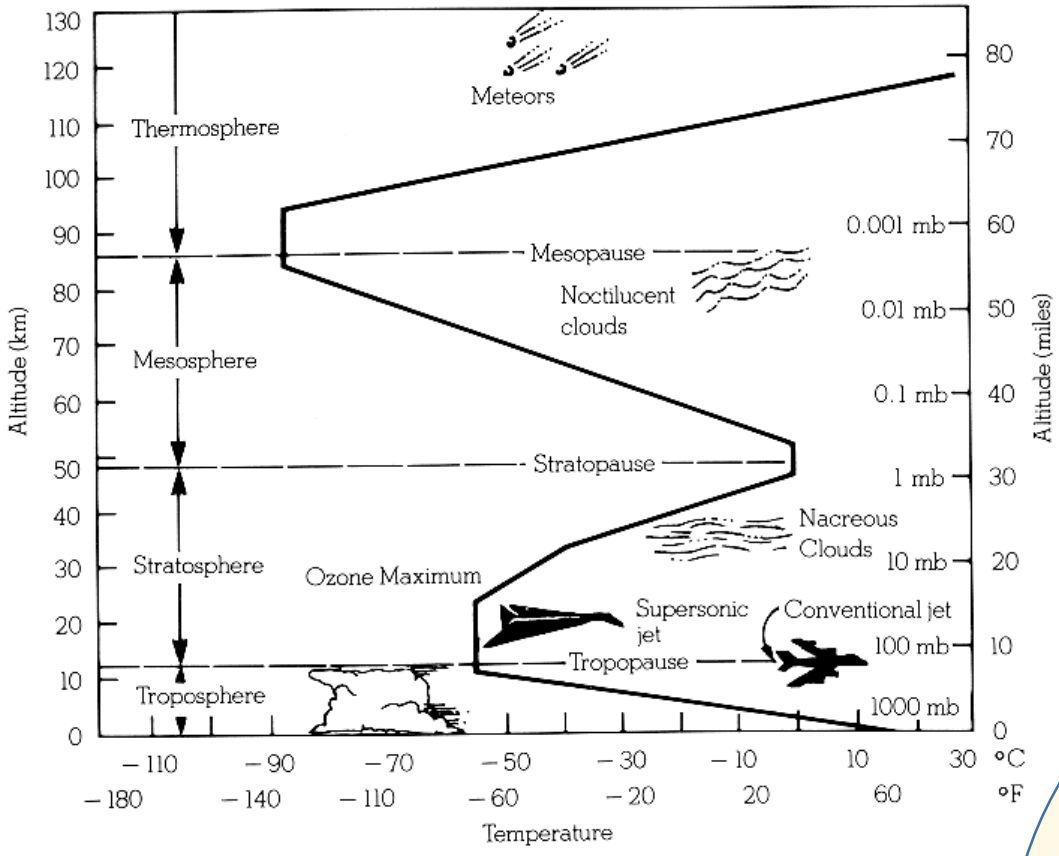
An overview of GHG emissions.

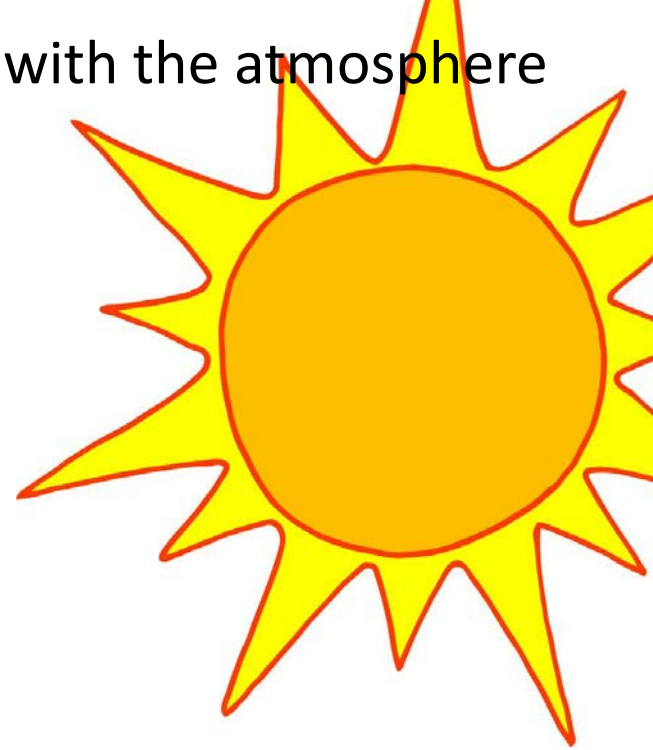
- What do we know from science?
- What are the GHG contributions from agriculture relative to other sources?
- What are the farm sources: crops/soil vs livestock?
- Options to mitigate GHG?


The Major Earth Systems
Atmosphere
Clouds
Cryosphere
Hydrosphere
Sea Ice
Lithosphere
Biosphere
CG Figure-4
PACIFIC
OCEAN
30°N
120°W
90°W
20°N
Alfisols
Andisols
Aridisols
Entisols
Histosols
Inceptisols


Meteors
Thermosphere
Mesopause
Noctilucent clouds
Mesosphere
Stratopause
Nacreous Clouds
Stratosphere
Ozone Maximum
Supersonic jet
Conventional jet
Tropopause
Troposphere
0.001 mb
0.01 mb
0.1 mb
1 mb
10 mb
100 mb
1000 mb
Altitude (km)
Altitude (miles)
Temperature
°C
°F

Earth's surface is warmer with the atmosphere

136 F to -49 F

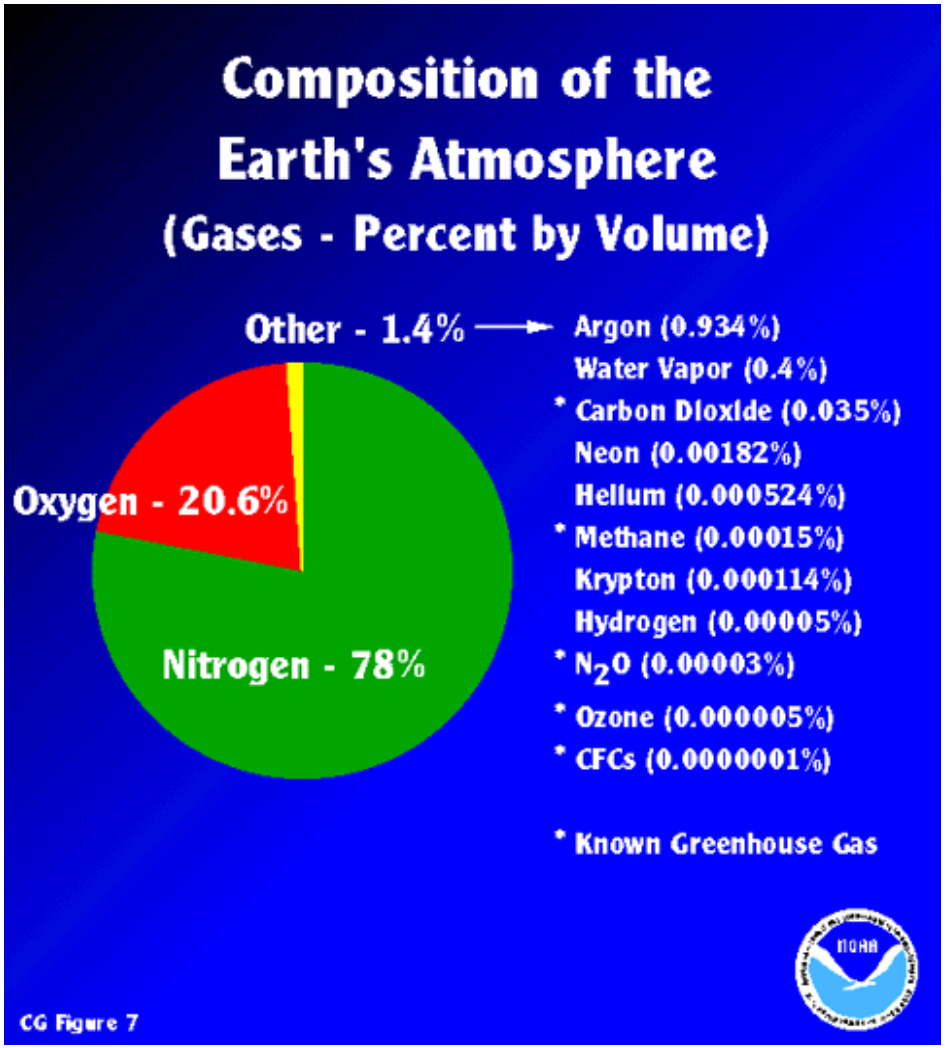


253 F to -243 F

The Earth surface receives "energy" from two sources

- The Sun
- The Atmosphere

The glass panels of the greenhouse (the atmosphere) lets in light but keep heat from escaping



78% nitrogen

20.6% oxygen

< 1% argon

} Not GHG

traces gases:
Ne, He, Kr, H,

Ozone (O_3)

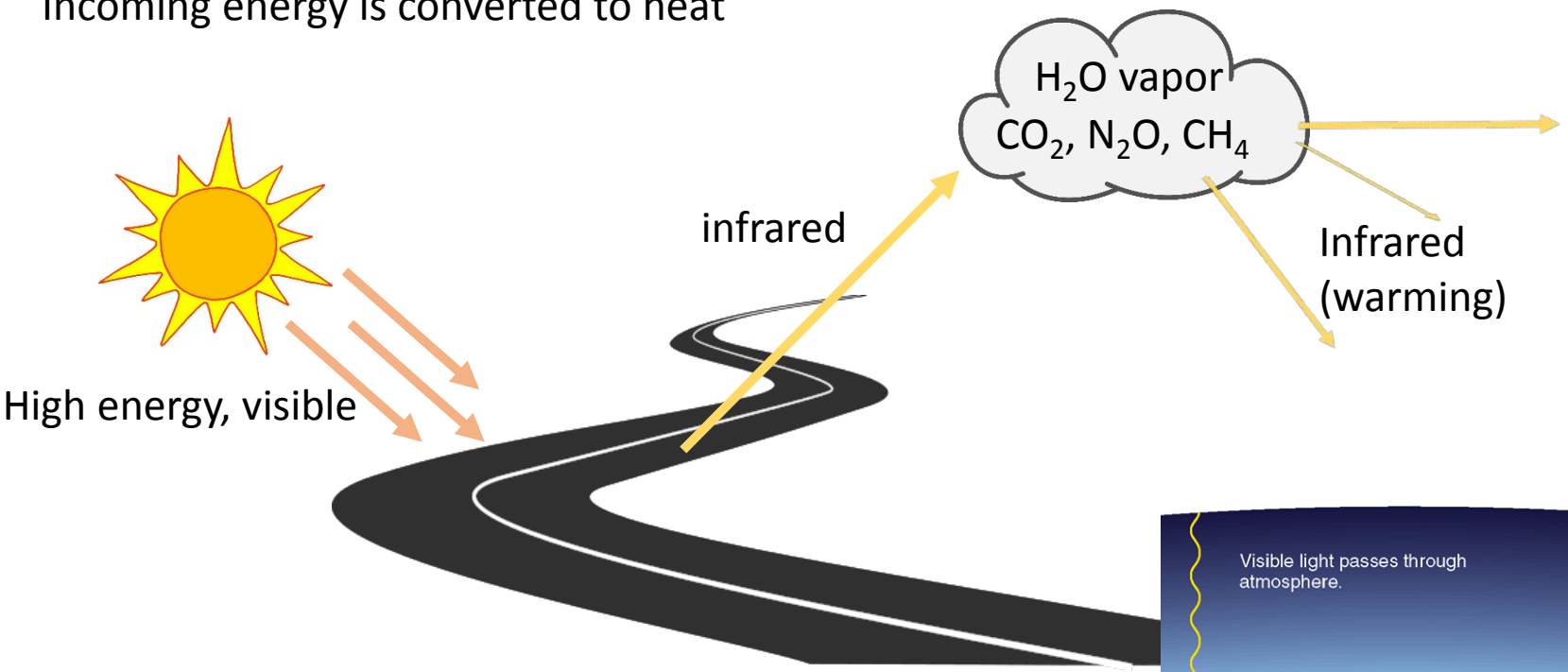
Water Vapor

Carbon Dioxide

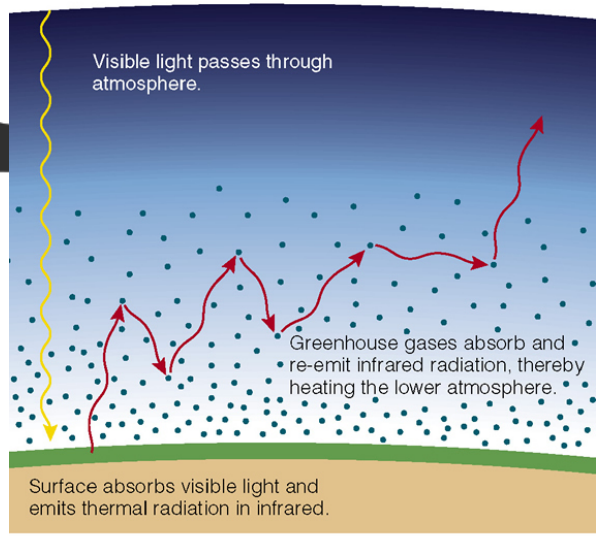
Methane, Nitrous Oxide

Chlorofluorohydrocarbons

Shortwaves – High Energy wavelengths hit the earth
Incoming energy is converted to heat



“Hot items” on earth emit infrared photons back to the atmosphere Infrared photons warm the greenhouse gases



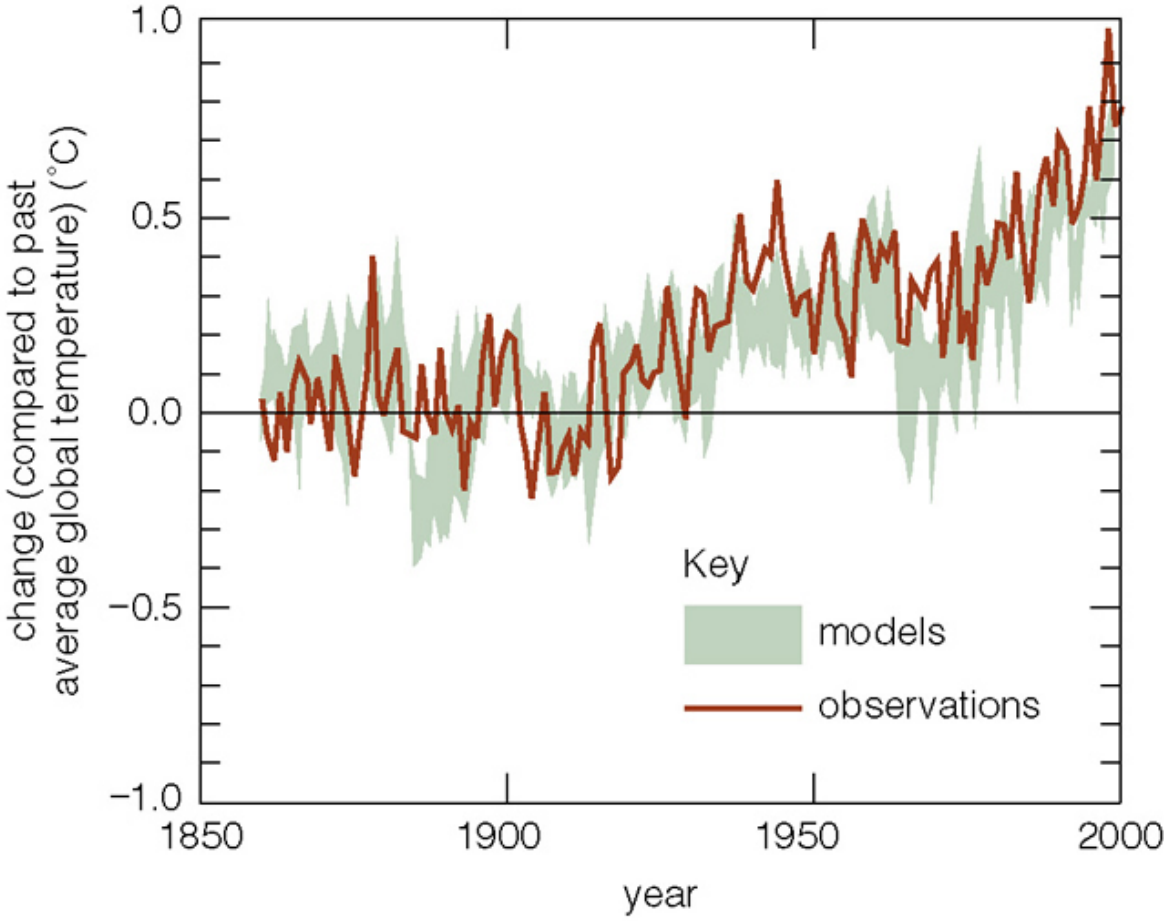
Greenhouse gases emit infrared back to earth
Greenhouse gases hold heat in atmosphere
Infrared would escape to space (without GHG)

The greenhouse effect: is the trapping of infrared photons by greenhouse gases (water vapor) in the atmosphere – warming the atmosphere and the earths surface.

The greenhouse effect: stabilizes temperatures on earth
The greenhouse effect: one of the most important natural process we have.

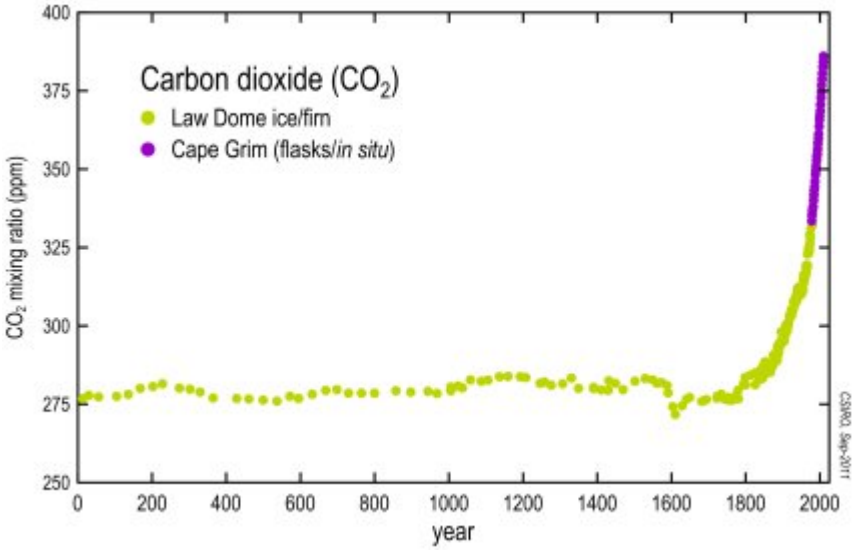
The greenhouse effect is a function of the amount of greenhouse gas that is trapping the infrared photons and warming the atmosphere and the earth surface.

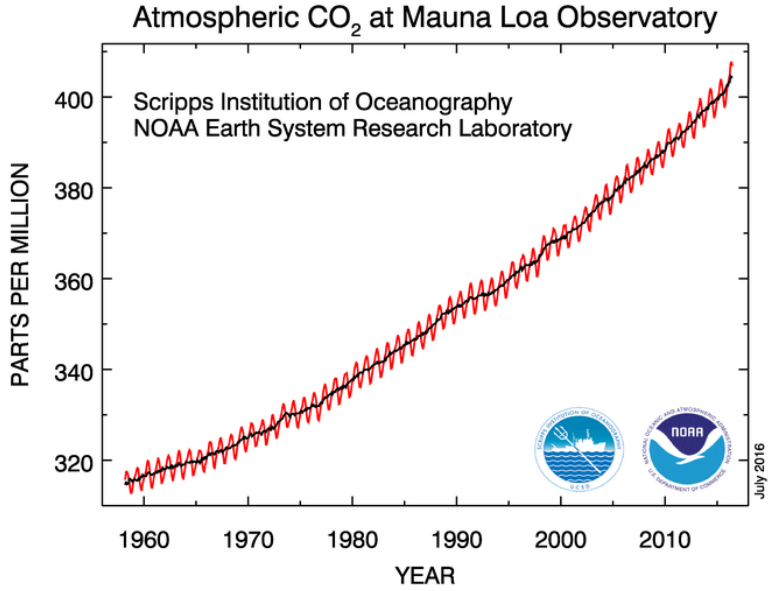
The greenhouse effect is good, an enhanced greenhouse effect has led to excess warming of the planet ..

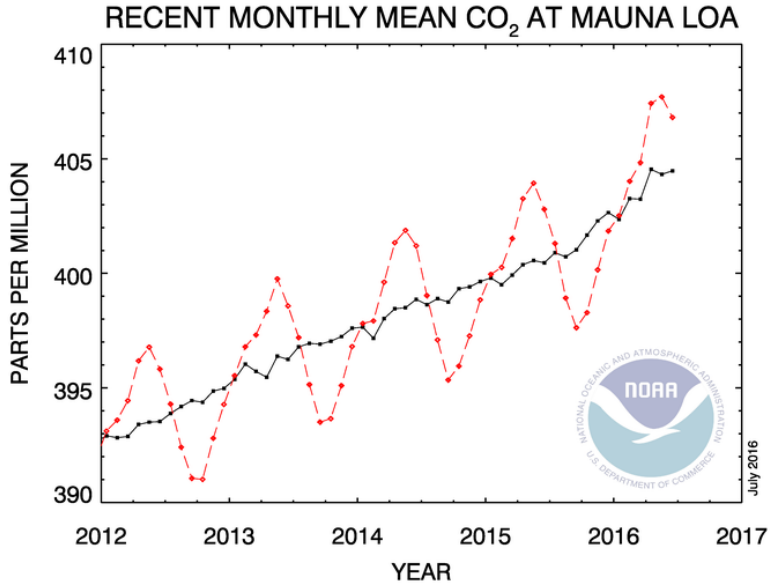


Earth's atmosphere in the last 100 years it is up about 1°C since 1900

CO_2 in PPM



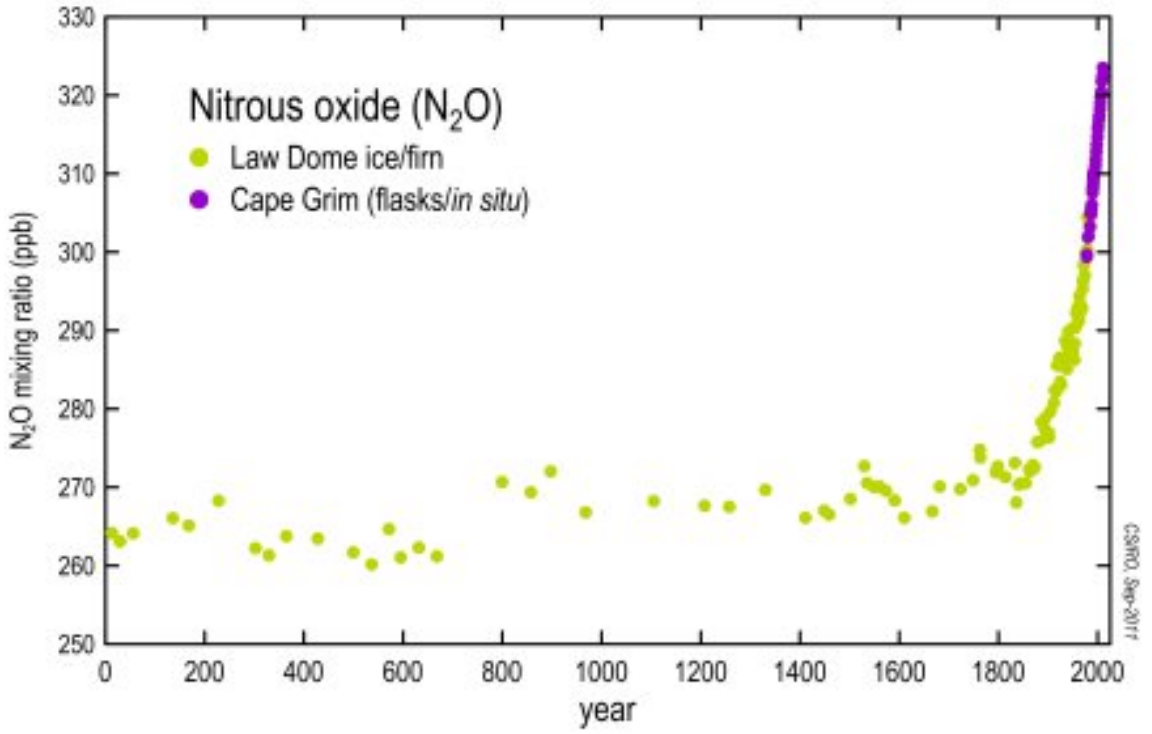




Cape Grim Greenhouse Gas Data

http://www.csiro.au/greenhouse-gases/

N_2O in PPB



Cape Grim Greenhouse Gas Data

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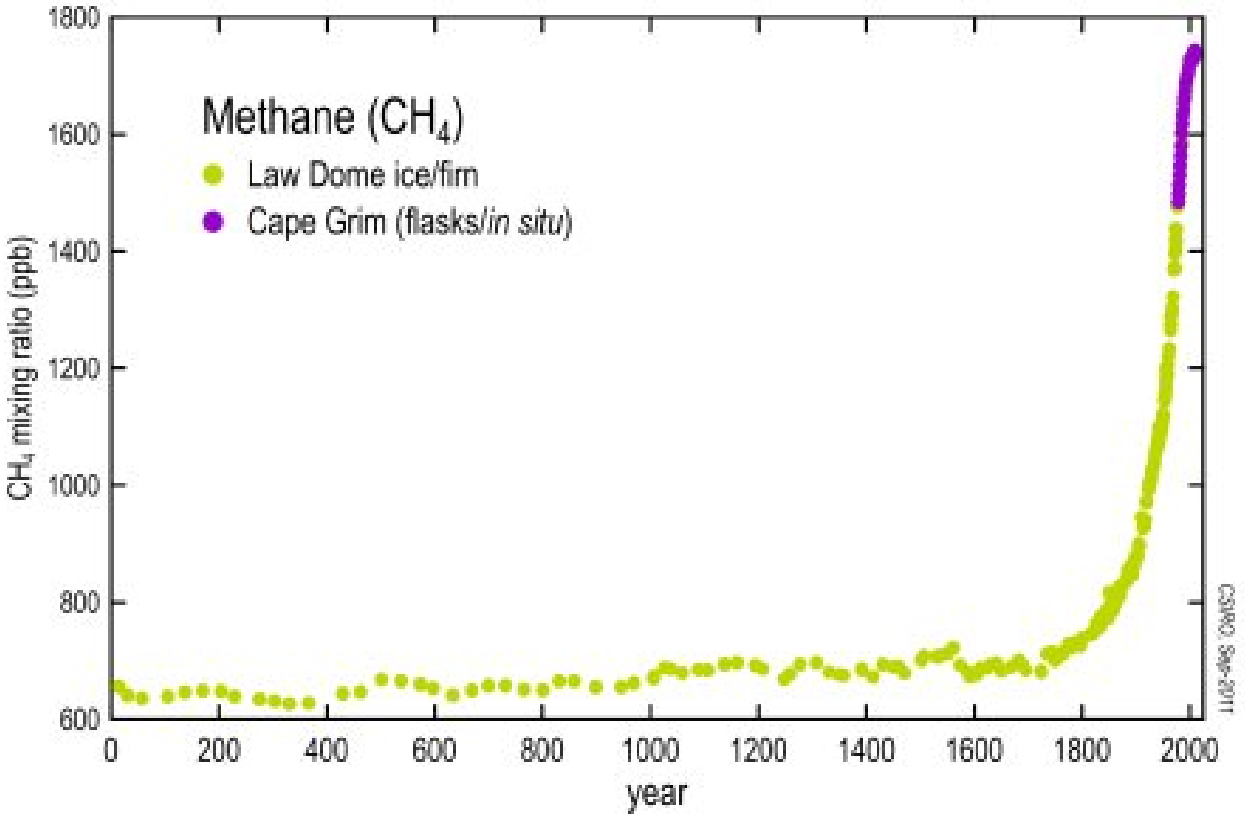
CH_4 in PPB



Cape Grim Greenhouse Gas Data

http://www.csiro.au/greenhouse-gases/

Constant level

Water Vapor ……. Up to 70% of GHE

Variable levels

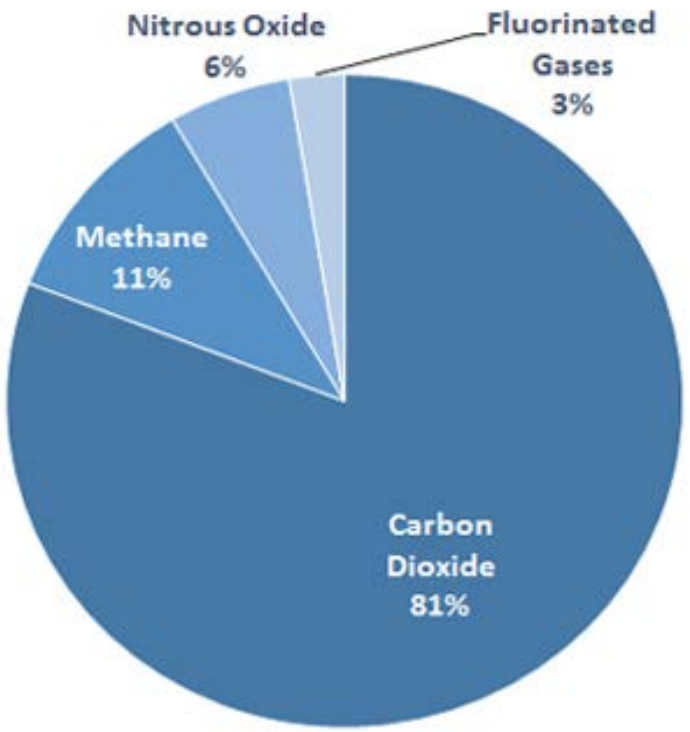
Carbon Dioxide

Methane

Ozone (O_3)

Nitrous Oxide

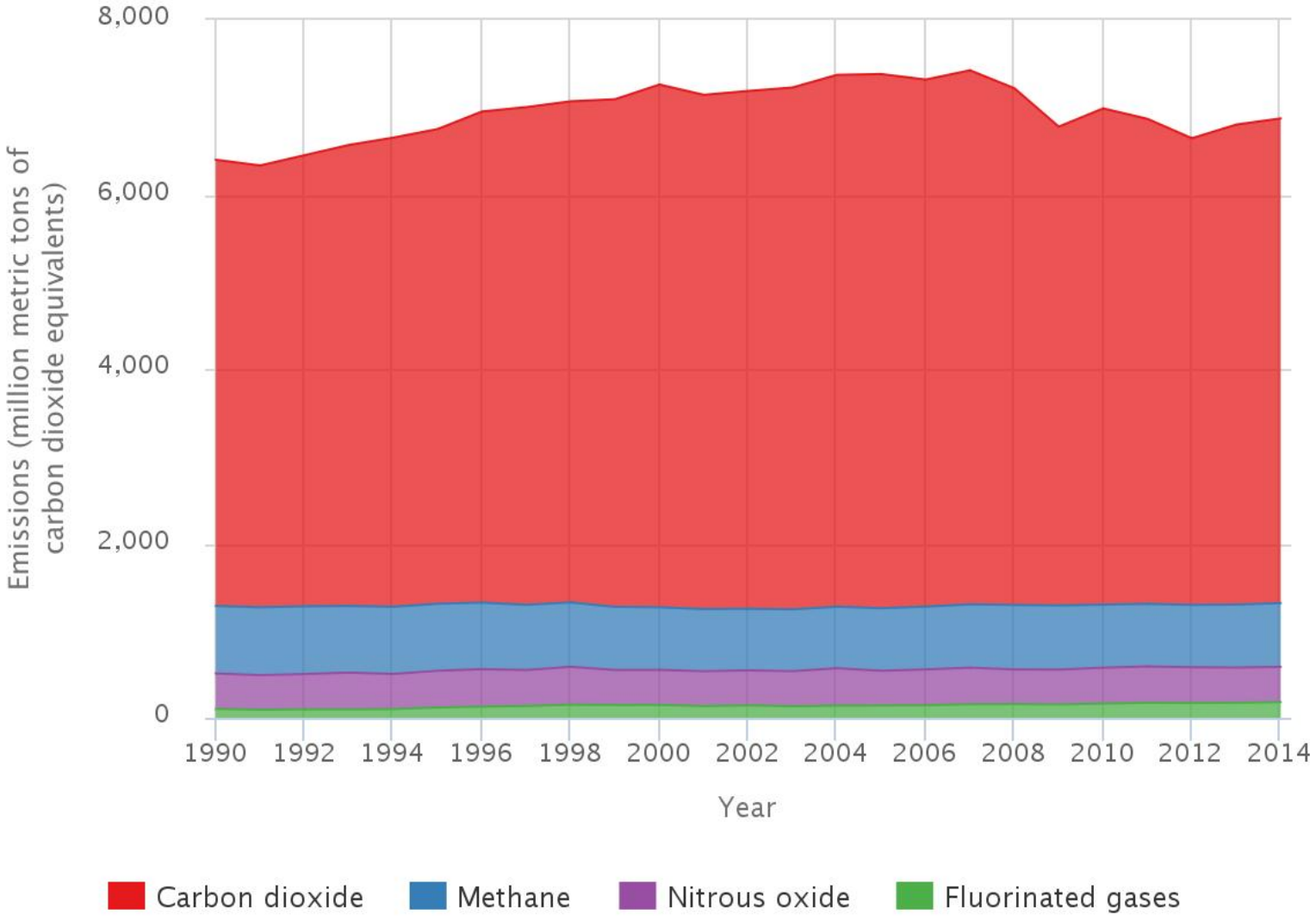
CFCs (Fluorinated Gases)



1 unit	Unit CO_{2e}
CO_2	1
CH_4	25
N_2O	298
SF_6	22800
CF_4	7390

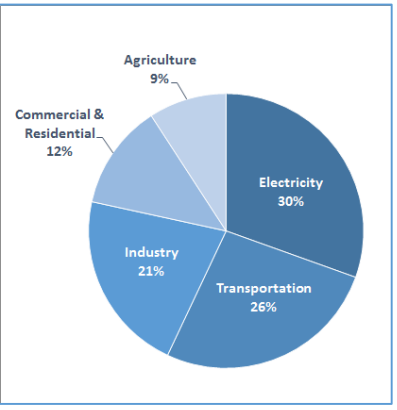
Equivalent units, data are expressed on units of CO_2
Related to holding heat

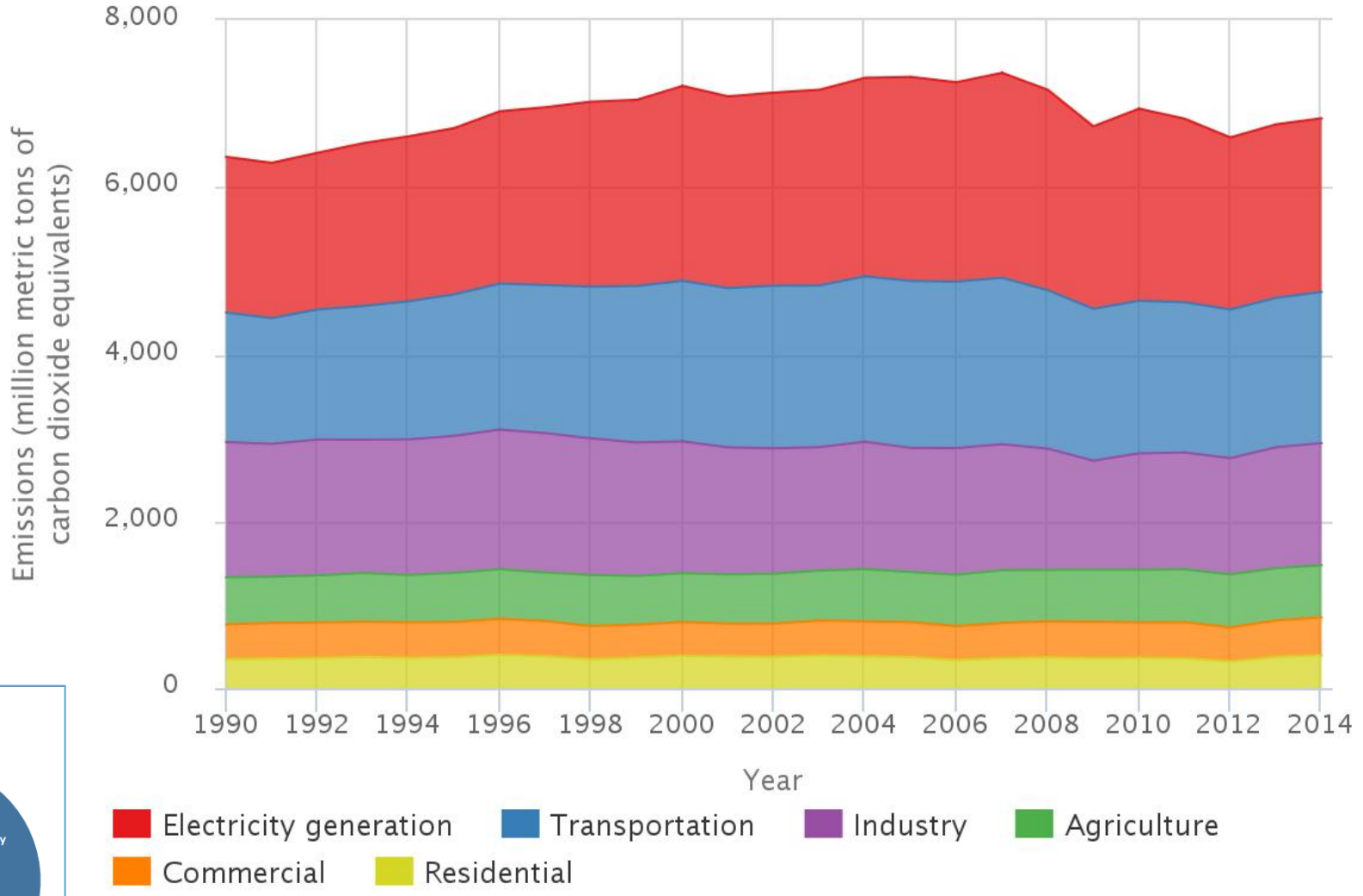
U.S. Greenhouse Gas Emissions by Gas, 1990–2014



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014.
http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

U.S. Greenhouse Gas Emissions by Economic Sector, 1990–2014





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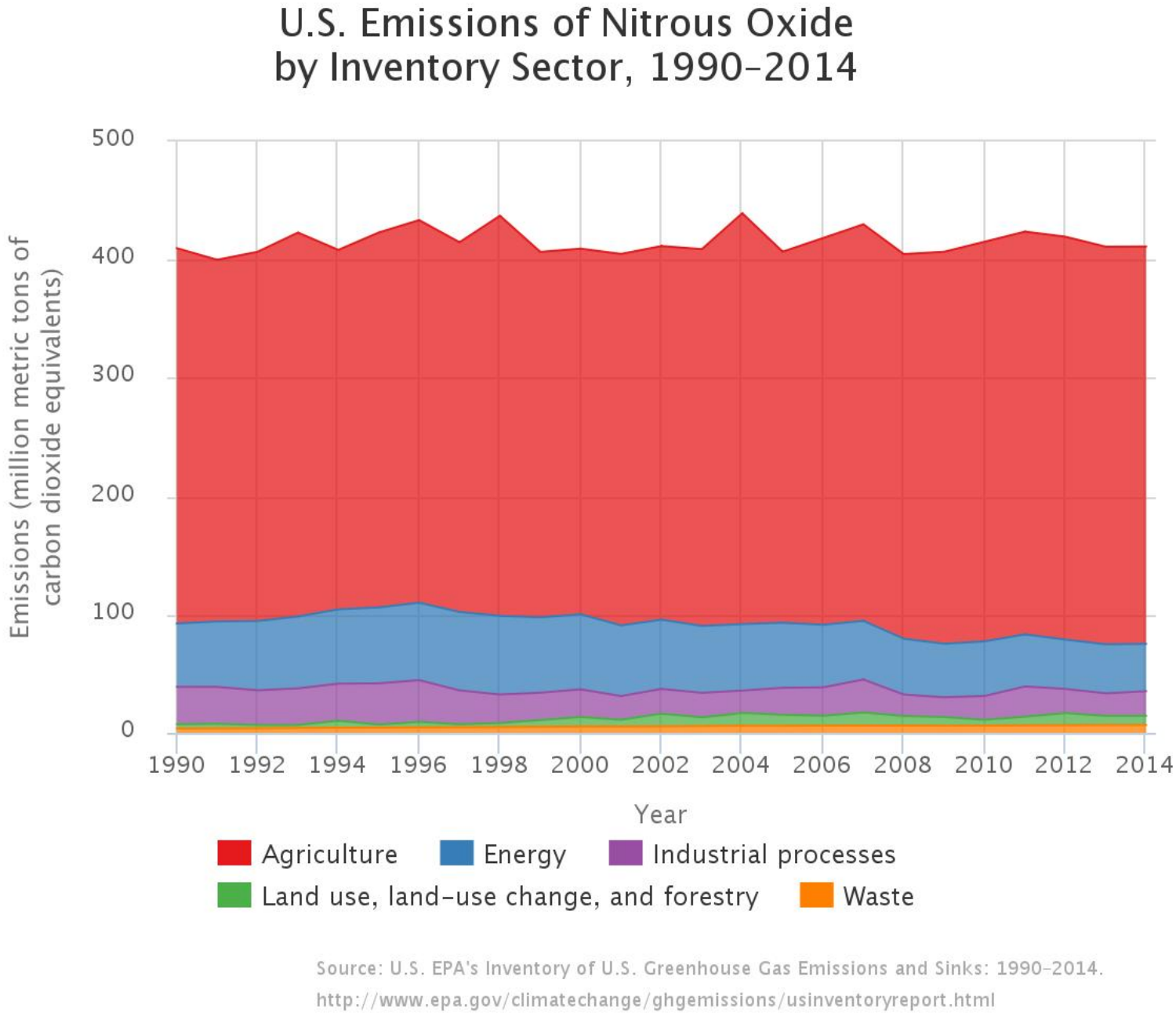
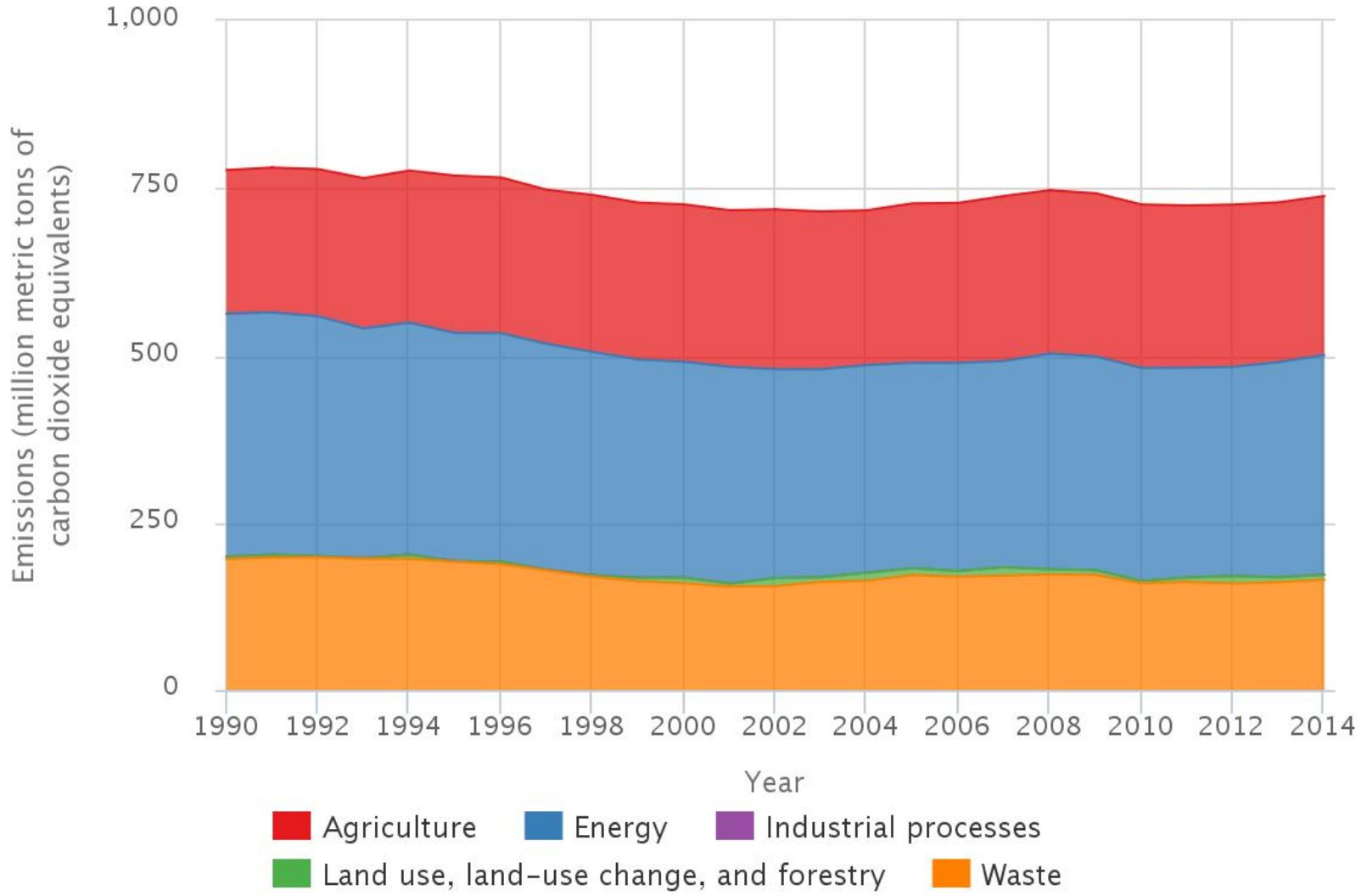


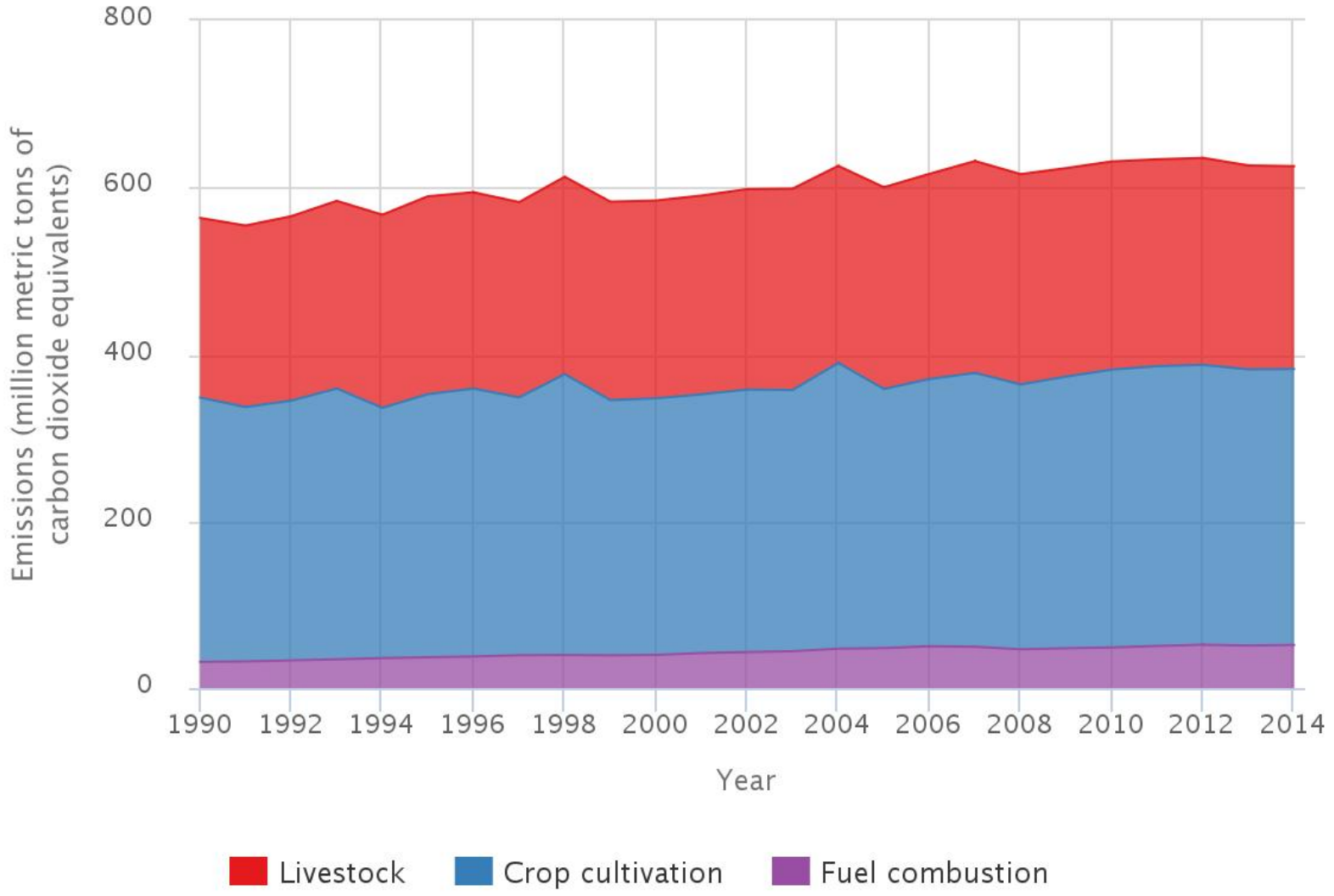
Agriculture dominates N_2O production

U.S. Emissions of Methane by Inventory Sector, 1990–2014



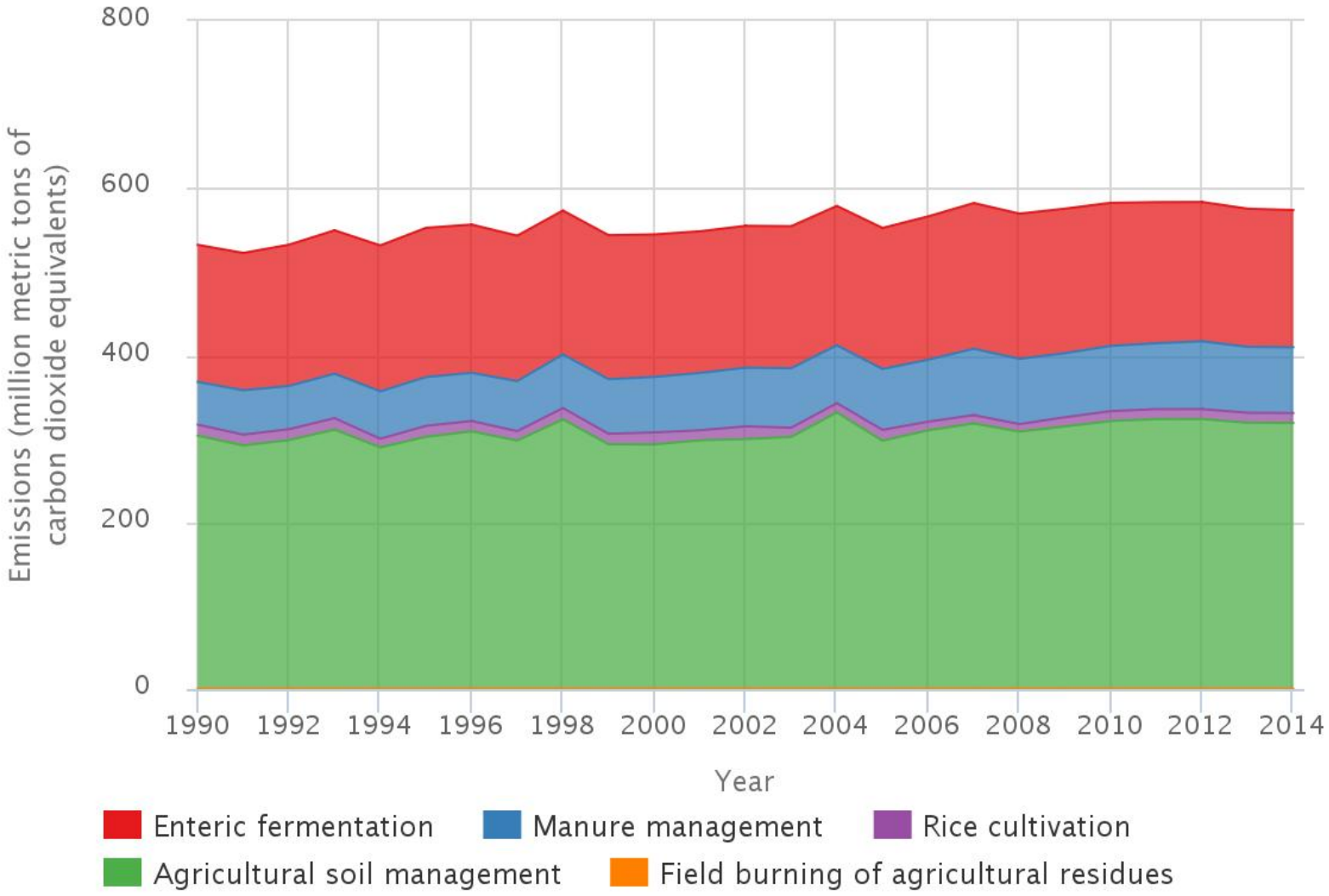
Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014.
http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

U.S. Greenhouse Gas Emissions from the Agriculture Sector, 1990–2014



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014.
http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

U.S. Greenhouse Gas Emissions from Agricultural Activities, 1990–2014



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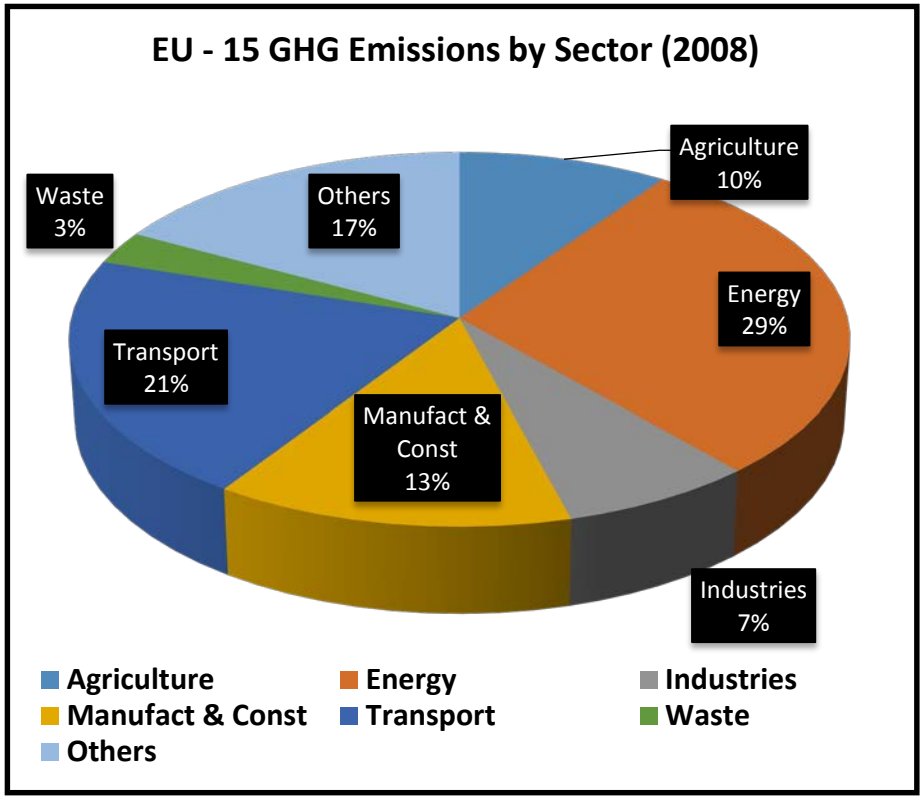
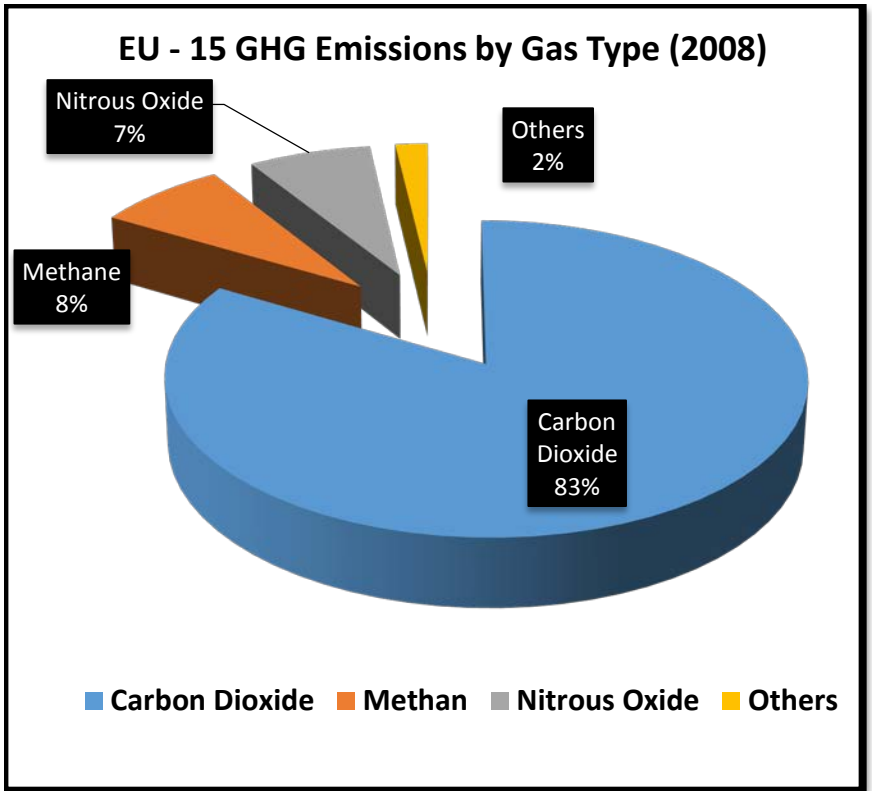
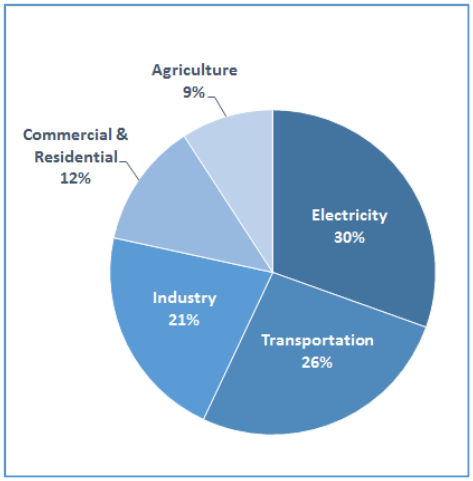
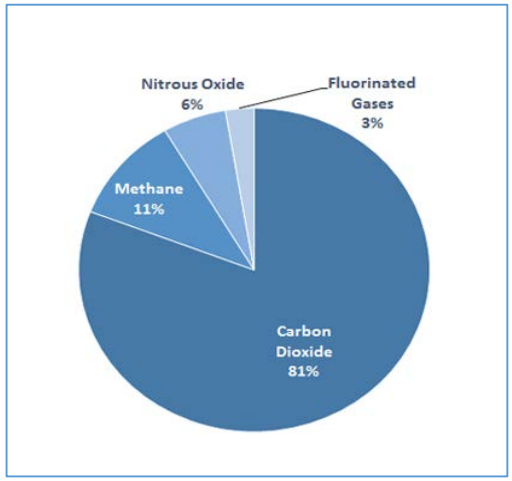




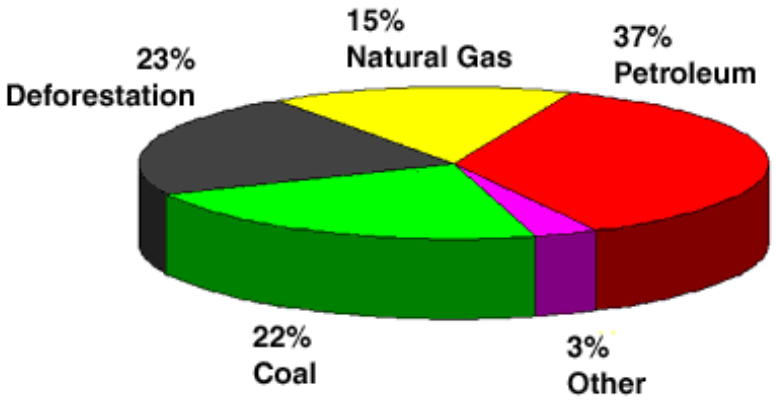
Data Source: European Environment Agency (EEA) 2008





Carbon dioxide

- **Human / animal / microbial respiration**
- **Industrialization**
- **Burning of fossil fuels (coal, petrol, diesel, and kerosene)**
- **Burning of forest (lesser trees)**
- **CO_2 is now $^1/_3$ more than before Industrial Revolution**
- **60% of the enhanced greenhouse effect**



Methane

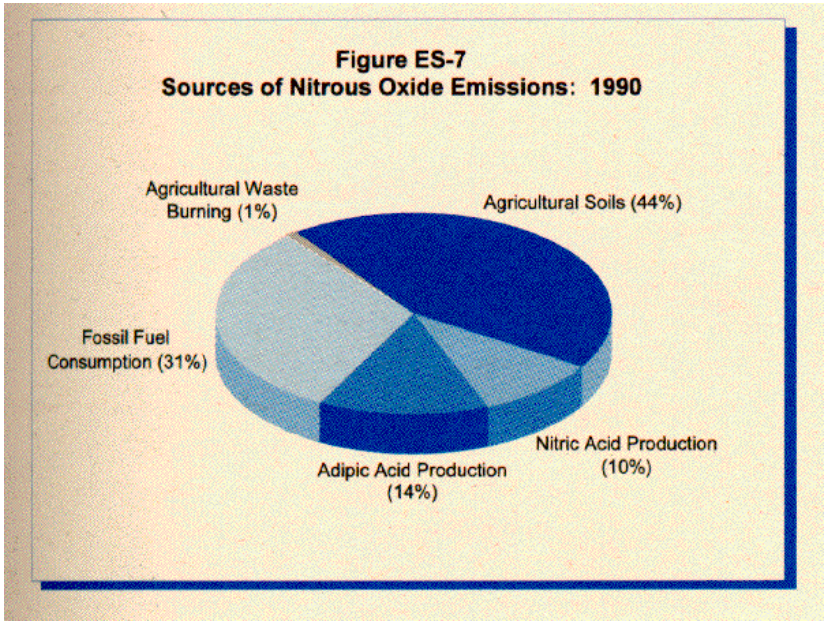
Atmosphere lifespan: 10-12 years. (Less than other greenhouse gases

Livestock and rice production have led to an increase in atmospheric methane.

Other sources are the extraction of fossil fuels, landfill sites and the burning of biomass.

Nitrous Oxide

- Burning fossil fuels and wood
- Use of fertilizers
- Soil processes
- Sewage treatment plants
- Long lifetime in the atmosphere



Soil

Soil is Complex:

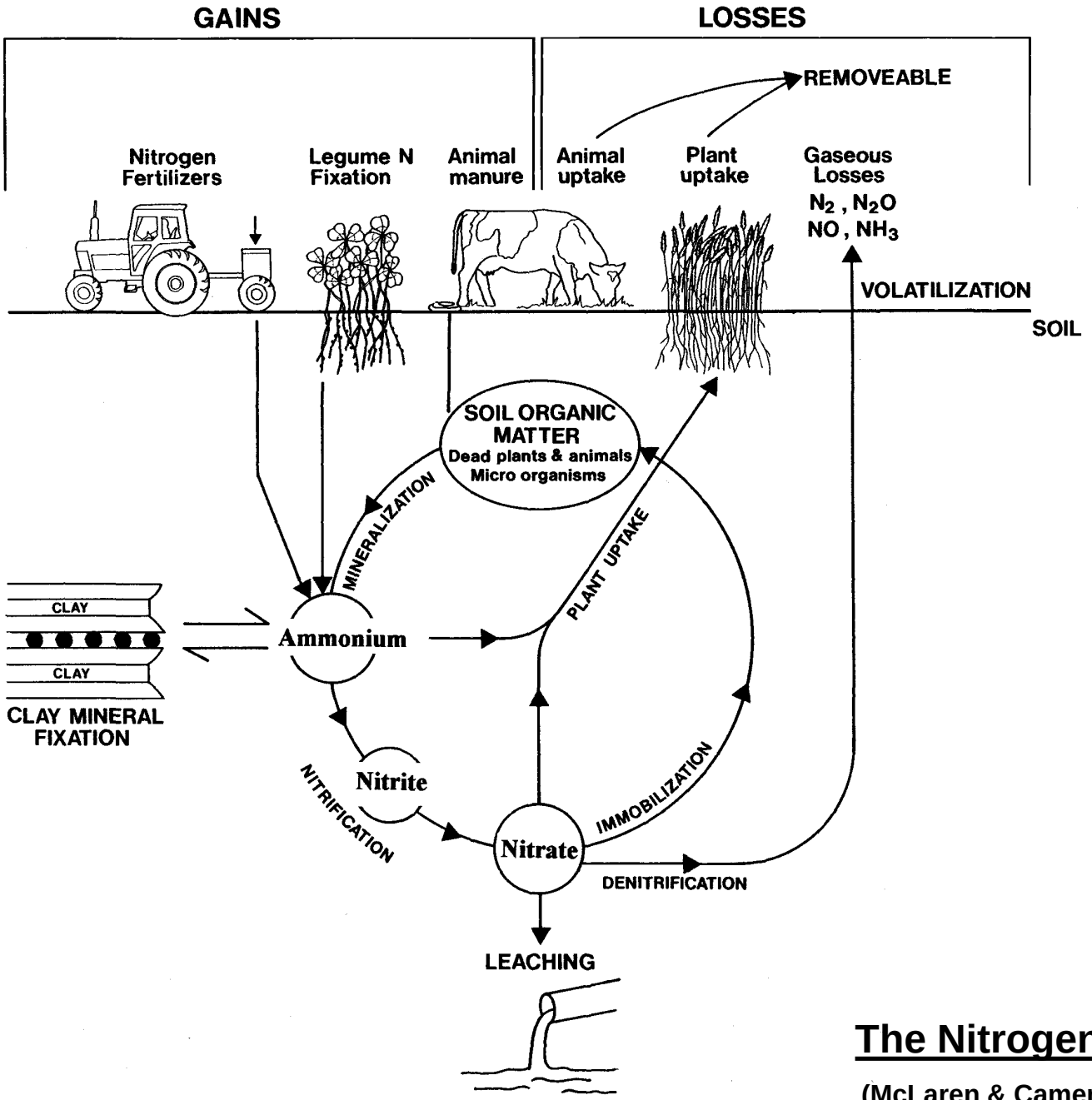
Hard to separate the biology
from their environment

1,000,000,000 bacteria/g soil
7,000,000,000 people on Earth
~ 453,000,000,000 bacteria /lb soil

>7,000 “Species”/g soil
The “collection” changes every few M

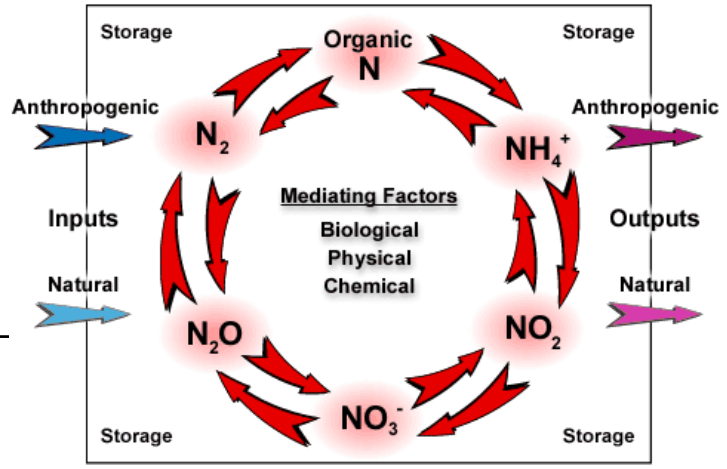
The cells are small 0.5- 2 μm

Undescribed as to the total
number of potential functions
in the system



The Nitrogen Cycle

(McLaren & Cameron, 1996)



Nitrosomonas

Ammonium + oxygen (NH_4^+) → Nitrite

Nitrous oxide gas loss

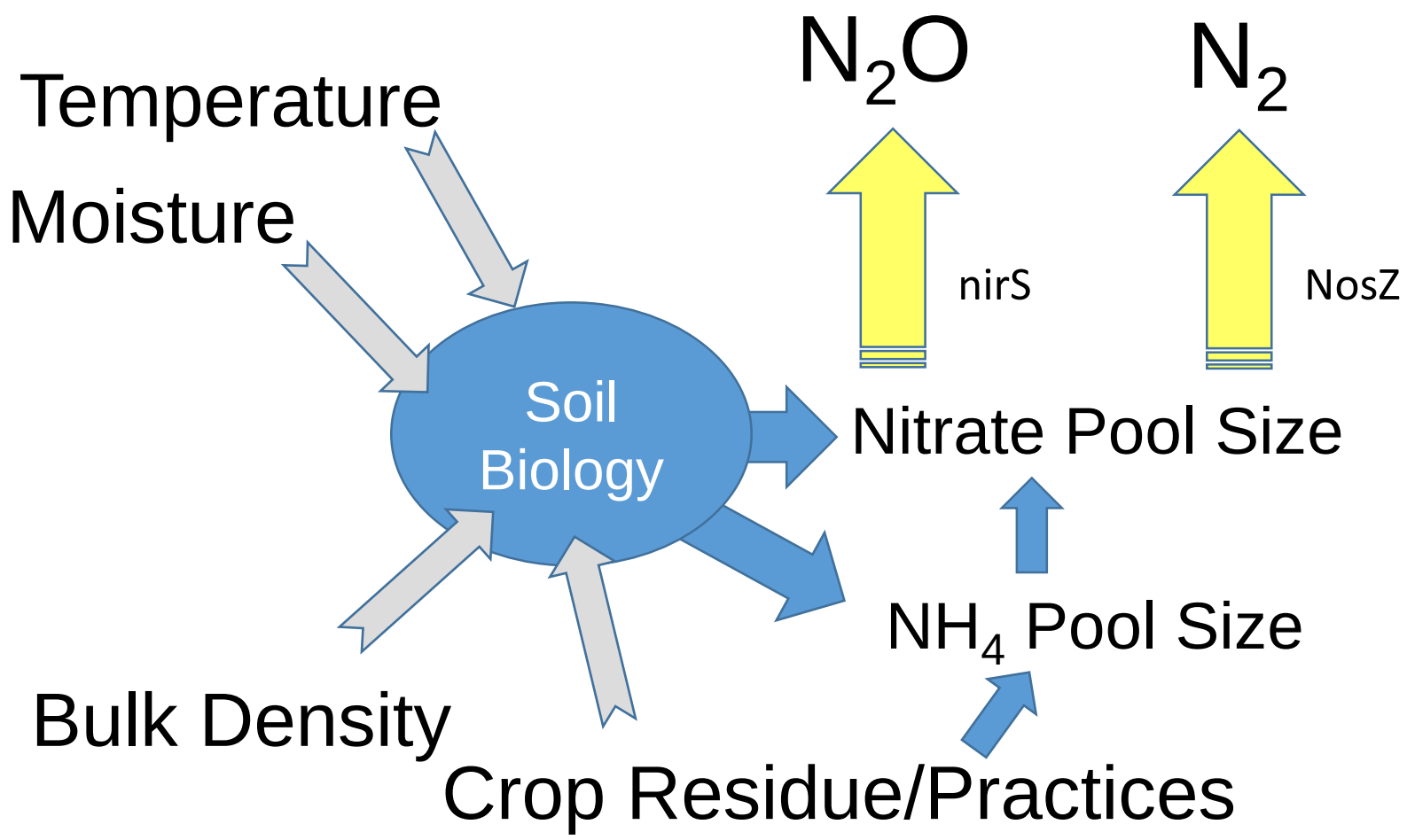
Nitrobacter

Nitrite + oxygen → Nitrate (NO_3^-)

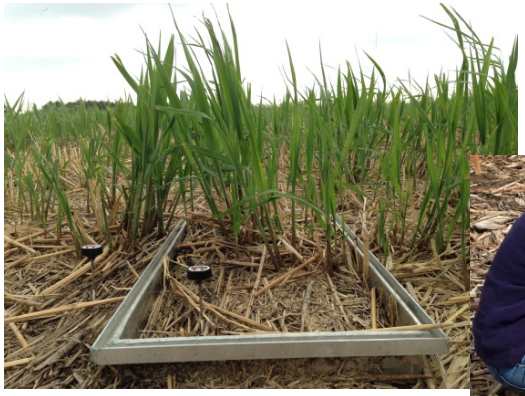
Nitrate leaching loss

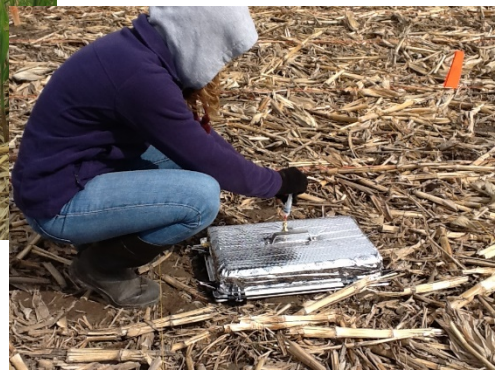
Multiple exit points for Nitrous Oxide

GHG Formation in Soil



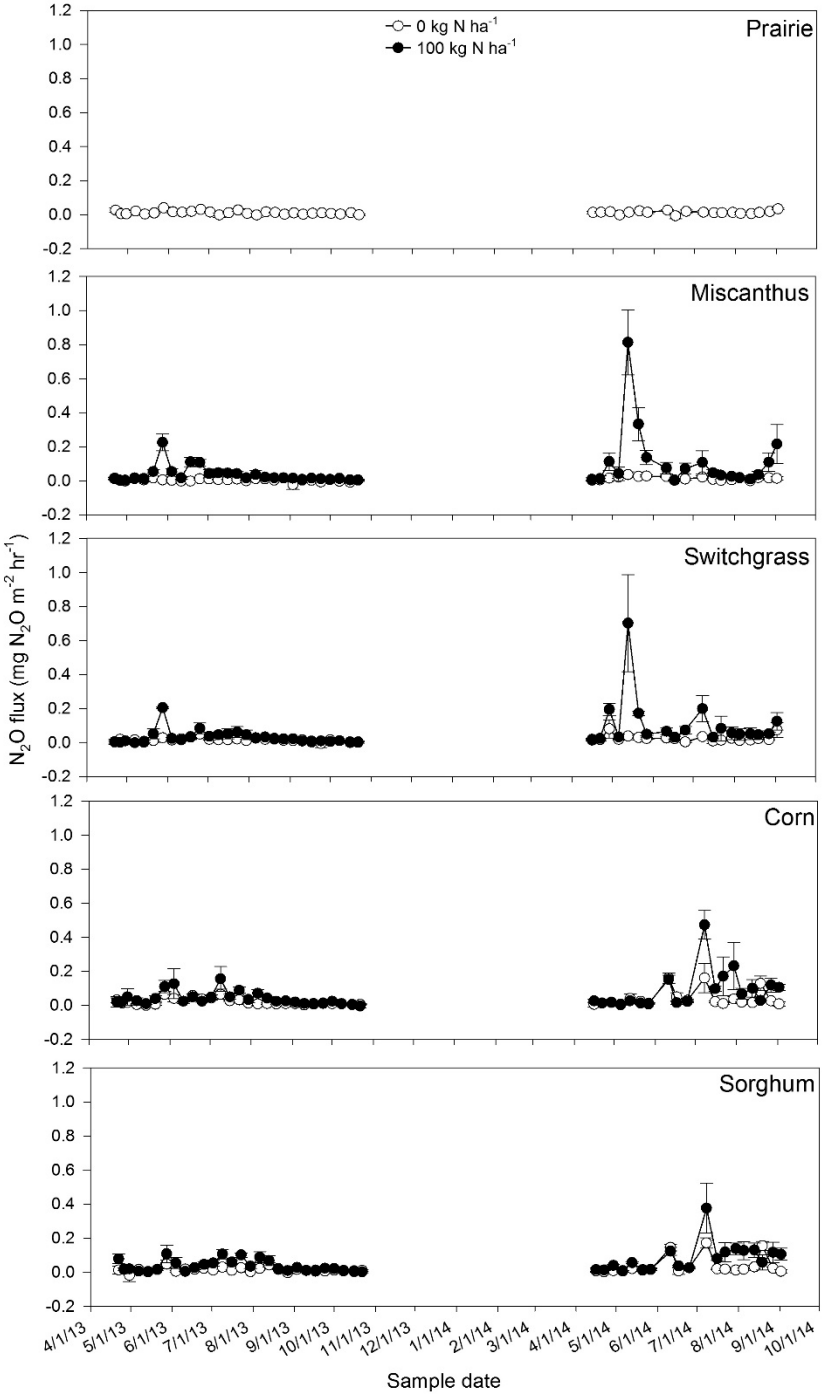
One N_2O equivalent to >300 units of CO_2.



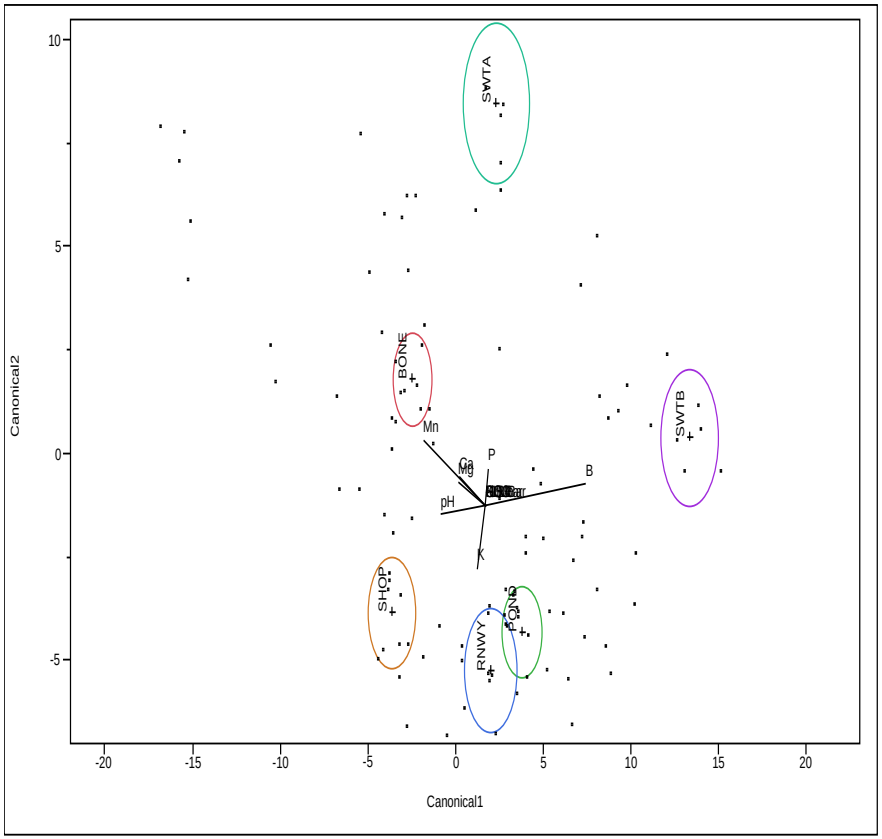


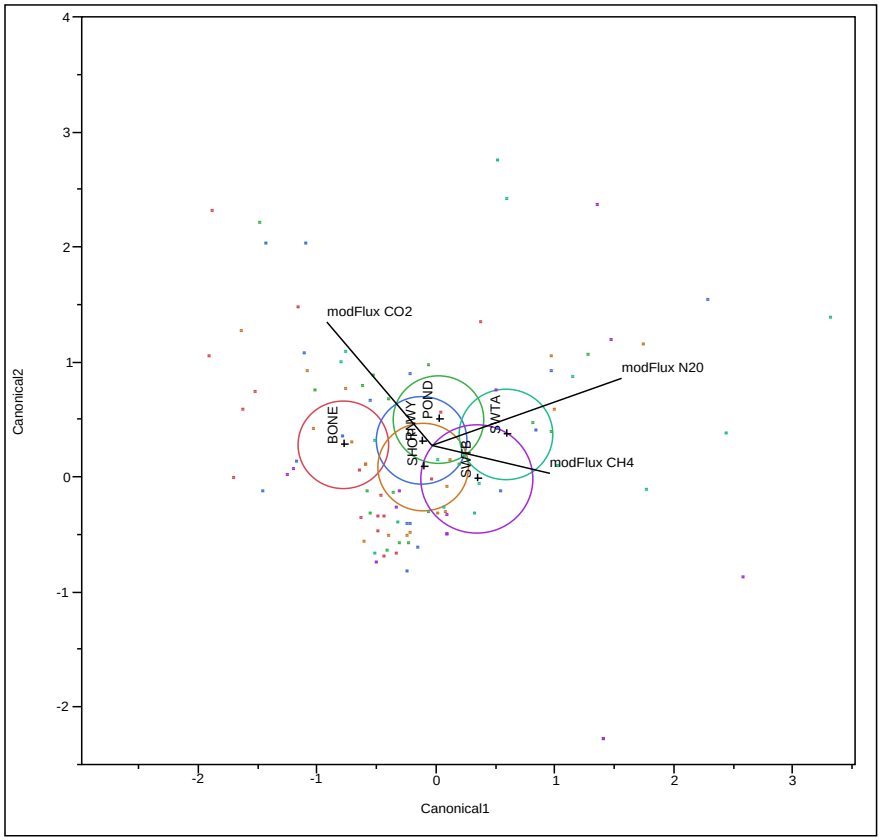
Infield N_2O trap

In lab N_2O analysis



Cover Crops and N_2O generation





BONE = cover crop (bean-corn rotation at start)

RNWY = cover crop (corn-corn rotation at start)

POND = cover crop (corn-bean rotation at start)

SHOP = cover crop (corn-corn rotation at start)

SWTA = control no cover (bean-corn rotation at start)

SWTB = control no cover (corn-bean rotation at start)

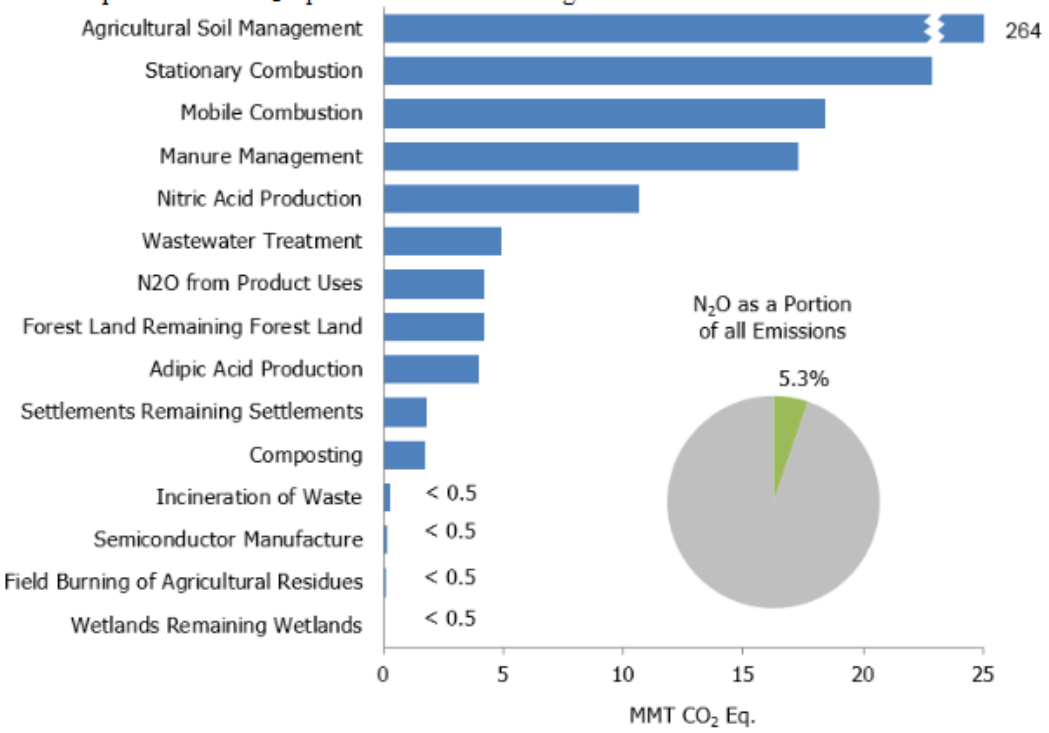
On Farm Locations

Applying “more than enough N” is no longer cheap “insurance”.
Applying “more than enough N” is also not environmentally friendly.

High N fertilizer costs and environmental impacts should encourage growers to critically evaluate their N management program, including application rate, fertilizer material, and timing.

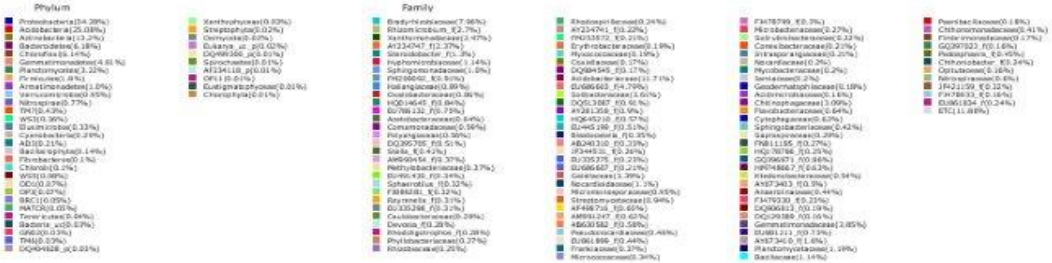
Figure ES-9: 2013 Sources of N_2O Emissions

Note: Emissions values are presented in CO_2 equivalent mass units using IPCC AR4 GWP values.



(Exiting)	**TN load (kg/yr)**	**TP load (kg/yr)**
Illinois	255,337,000	15,043,000
Indiana	212,421,000	6,742,000
Iowa	290,402,000	15,558,000

Average composition of selected communities



BONE419

SWTA415