EMISSION OF GREENHOUSE GASES

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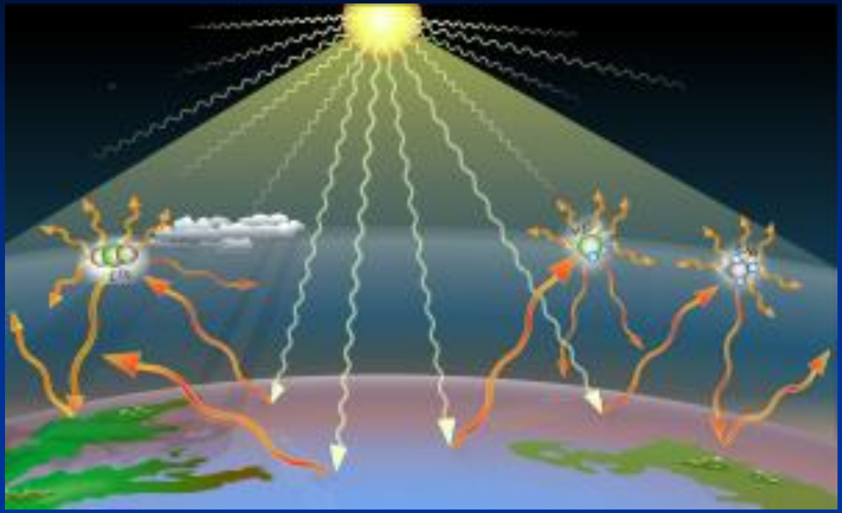
Greenhouse Gases

Nitrous oxide (N_2O)

Carbon dioxide (CO_2)

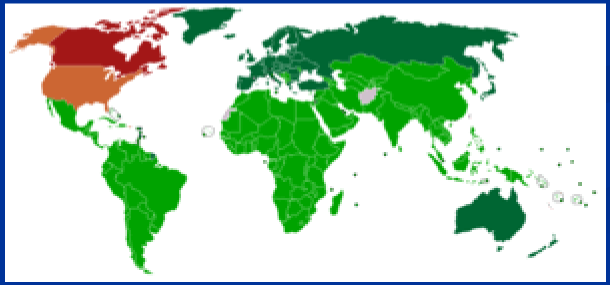


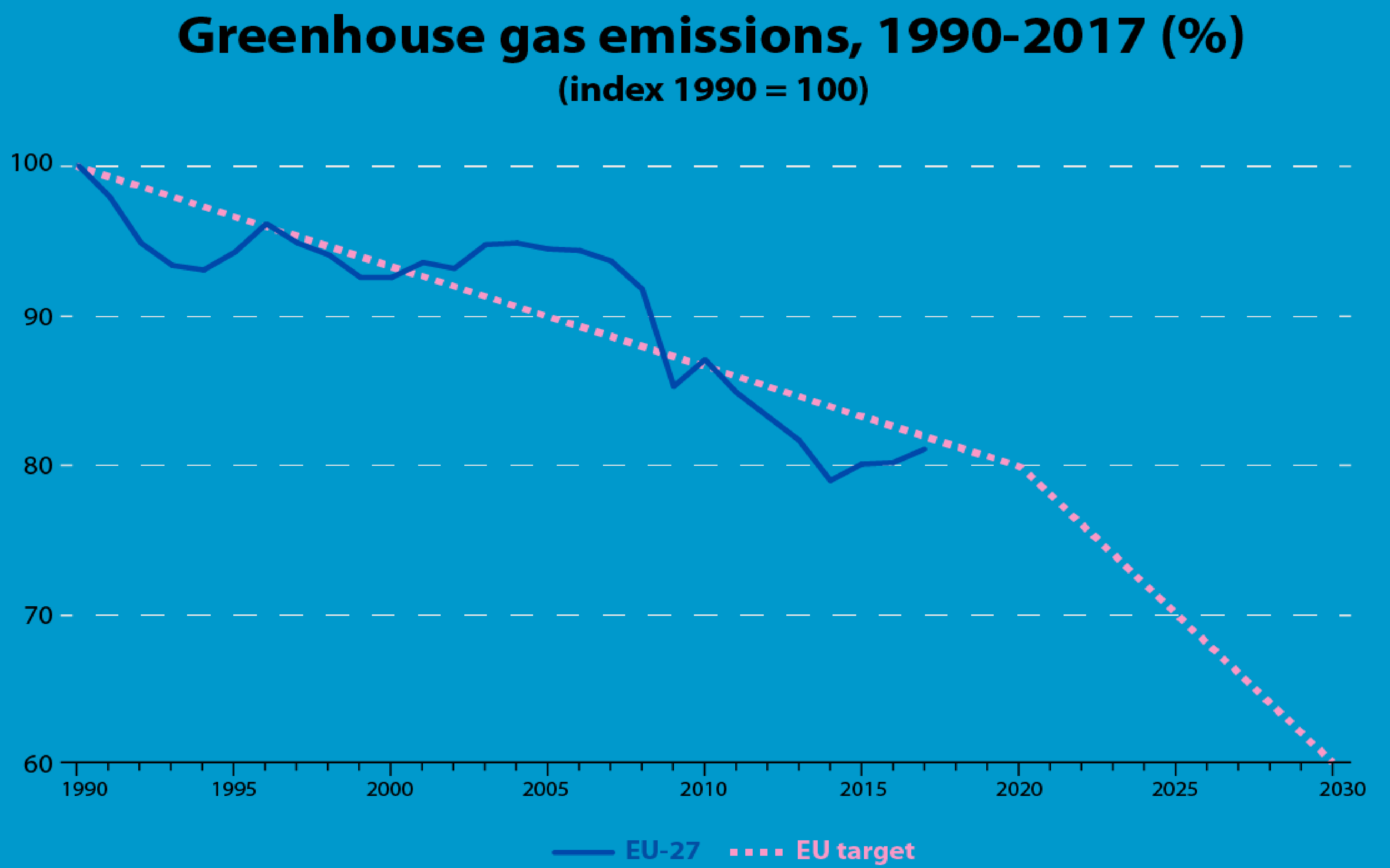
Fluorinated gases

Methane (CH_4)

Climate change is a threat to sustainable development. After years of extensive research, the scientific community agrees that man-made greenhouse gas (GHG) emissions are the dominant cause of the Earth's average temperature increases over the past 250 years (IPCC, 2014). Man-made GHG emissions are primarily a by-product of burning of fuels in power plants, cars or homes. Farming and waste decaying in landfills are also sources of GHG emissions.

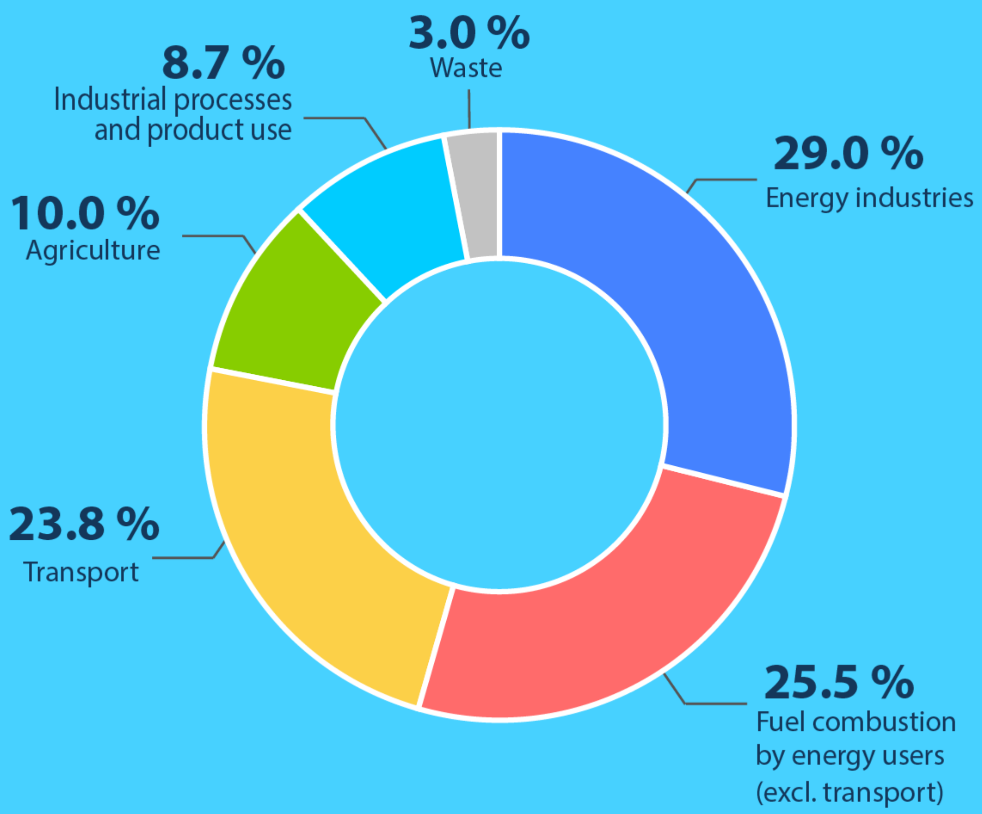
The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits state parties to reduce greenhouse gas emissions, based on the scientific consensus that (part one) global warming is occurring and (part two) it is extremely likely that human-made CO_2 emissions have predominantly caused it. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. There are currently 192 parties (Canada withdrew from the protocol, effective December 2012) to the Protocol.





Source: European Environment Agency
Data including international aviation and indirect CO_2 emissions, excluding land use, land use change and forestry

Share of EU greenhouse gas emission by source, 2017



Energy industries: *Emissions from fuel combustion and to a certain extent fugitive emissions from energy industries, for example in public electricity, heat production and petroleum refining.*

Fuel combustion by users (excl. transport): *Emissions from fuel combustion by manufacturing industries and construction and small scale fuel combustion, for example, space heating and hot water production for households, commercial buildings, agriculture and forestry.*

Transport: *Emissions from fuel combustion of domestic and international aviation, road transport, railways and domestic navigation.*

Agriculture: *This includes among others emissions from livestock-enteric fermentation – greenhouse gases that are produced when animals digest their food, emissions from manure management and emissions from agricultural soils.*

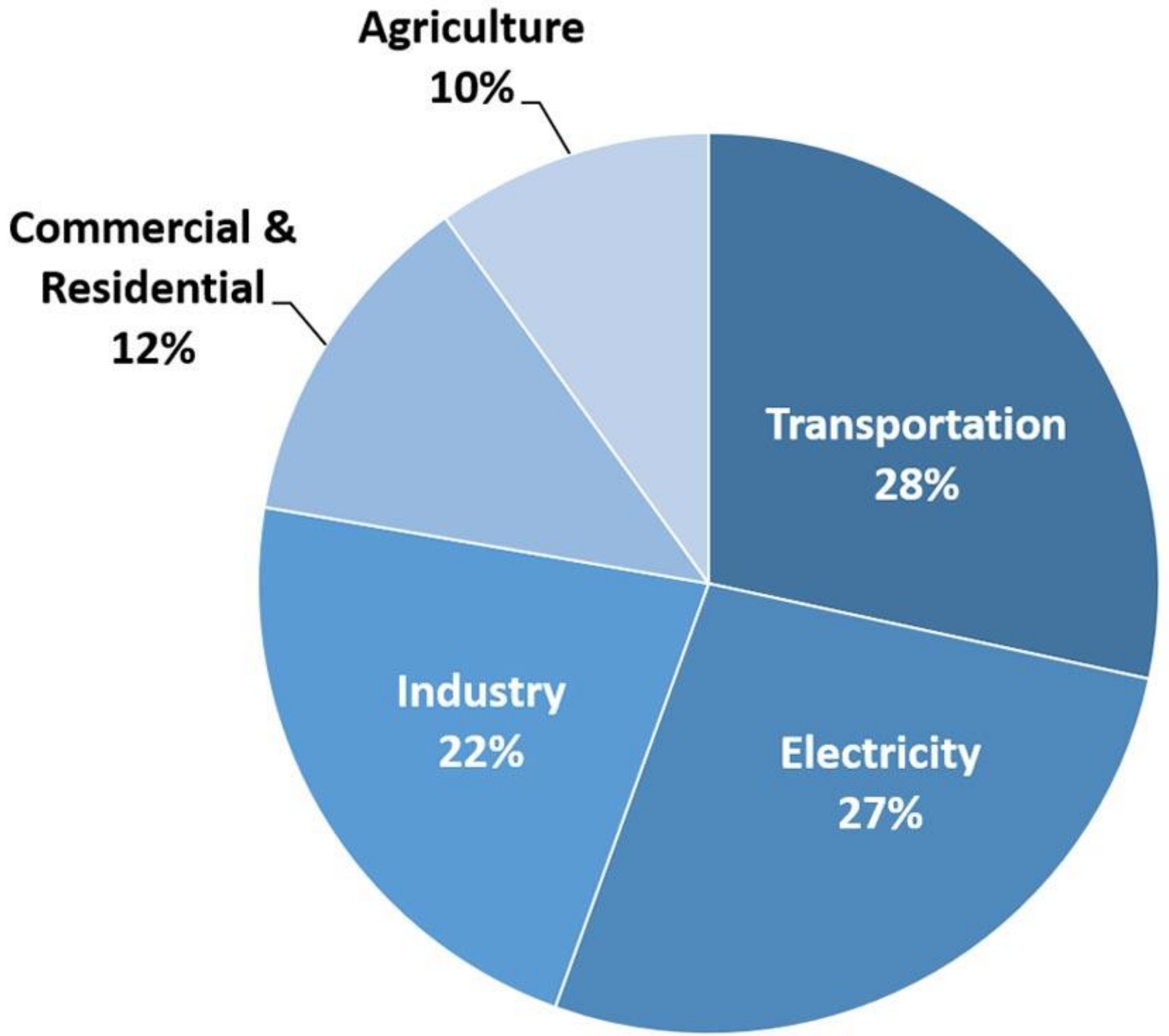
Industrial processes: *Emissions occurring from chemical reactions during the production of e.g.: cement, glass etc.*

Waste: *Emissions from landfills, wastewater treatment and composting among others.*

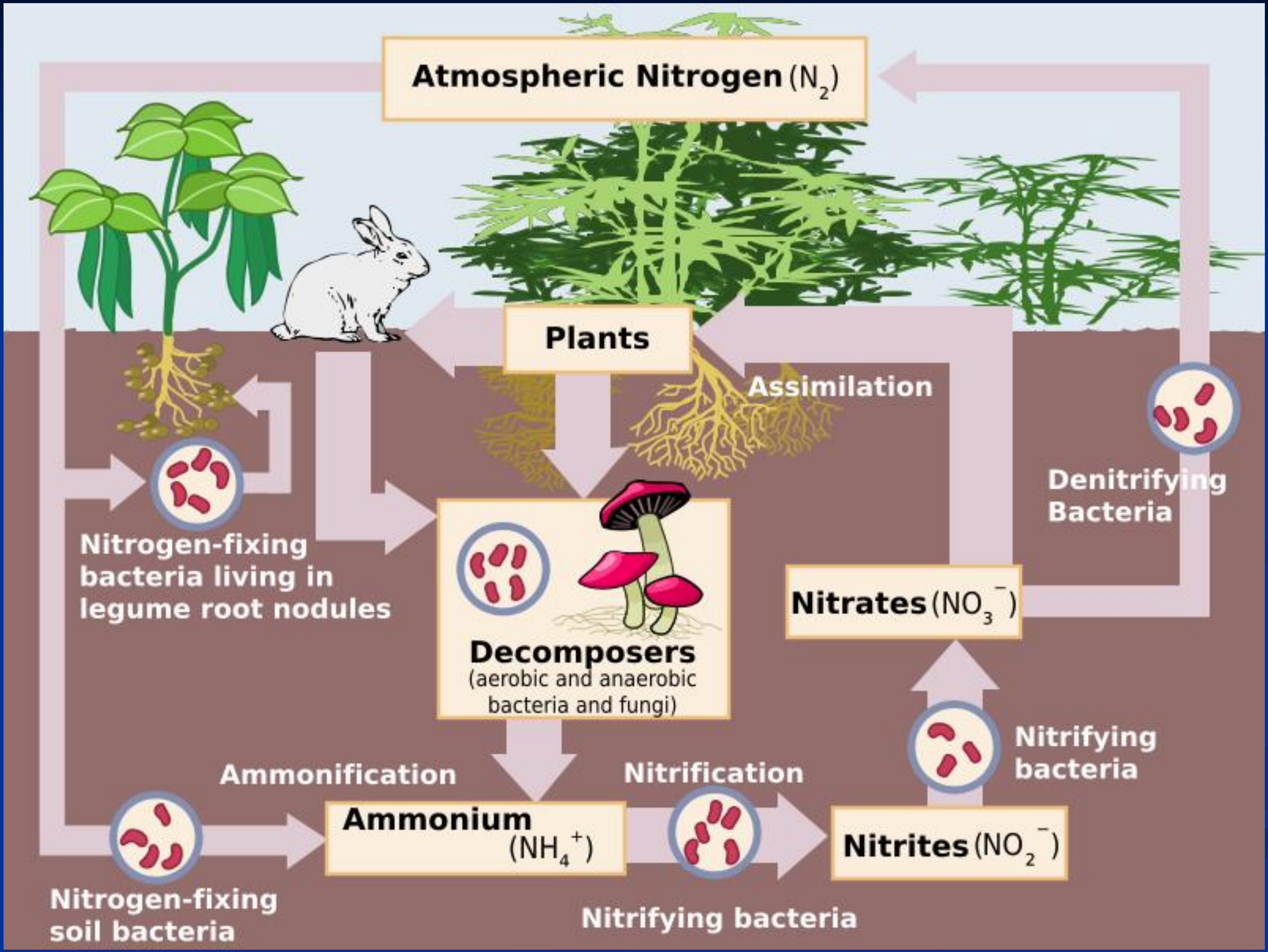
Data including international aviation, excluding indirect CO2 emissions and land use, land use charge and forestry.

Source: European Environment Agency

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2018



U.S. Environmental Protection Agency (2020). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018



Nitrogen cycle

(http://en.wikipedia.org/wiki/File:Nitrogen_Cycle.svg)

The next are applied by intervention of human:

- Nitrogen biogeochemical cycle
- Sensitive equilibrium is changed

↓

ecological problems

Results of intervention of humans:

- Intensive agriculture

  ↓

  N-gaseous losses

  NO_3^- - leaching

  soil acidification

- Use of fossil fuels
- Forest fire

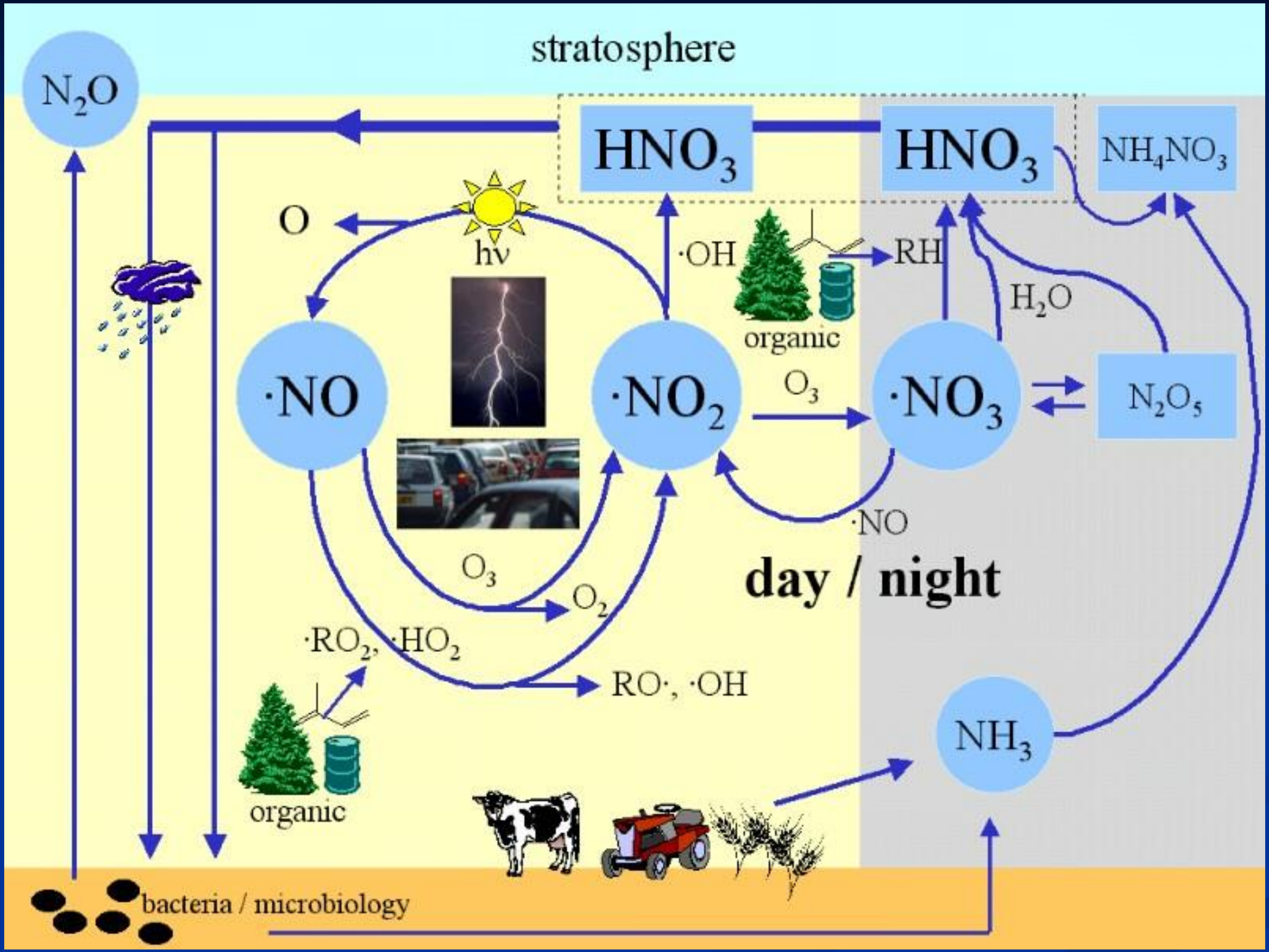
  ↓

  NO_x, N_2O emission

Environmental problems:

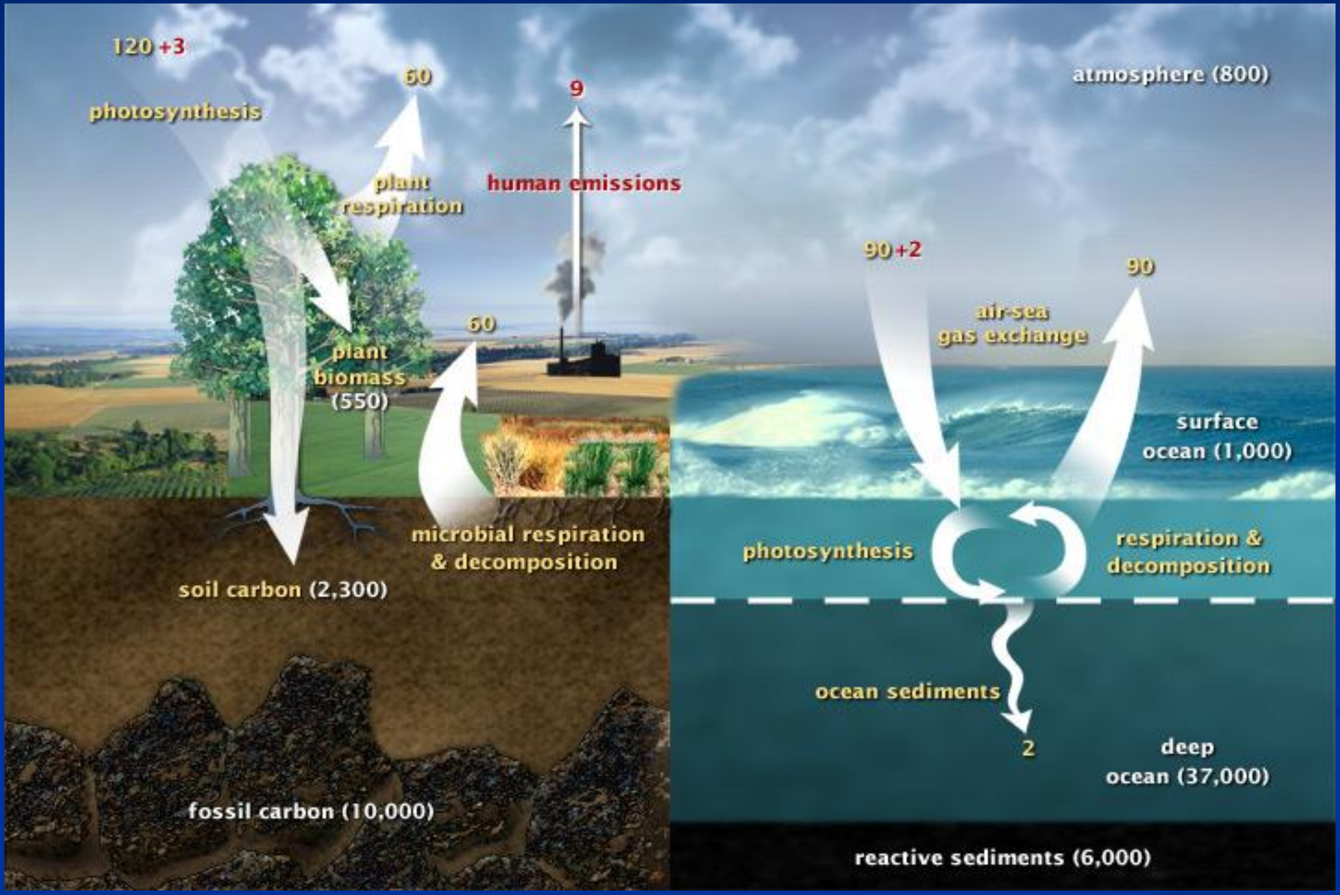
N_2O	NO_x	NO_3-N
greenhouse gas	acid rain	eutrophication
global warming	oxidize smog	contamination of under surface and surface water
	O_3	

O_3: formation / decomposition



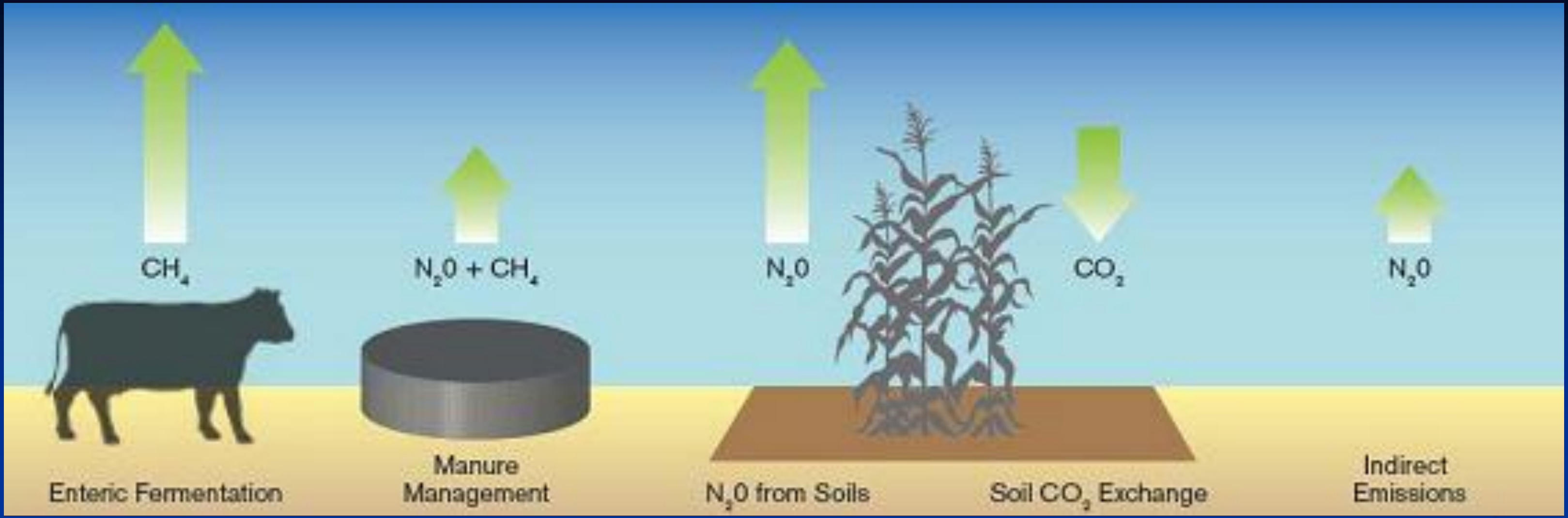
http://www.xplora.org/downloads/Knoppix/ESPERE/ESPEREdez05/ESPEREde/www.atmosphere.mpg.de/enid/0,55a304092d09/3__Ozone_and_nitrogen_oxides/-_NOx_kz.html (By Elmar Uherek)

Carbon cycle



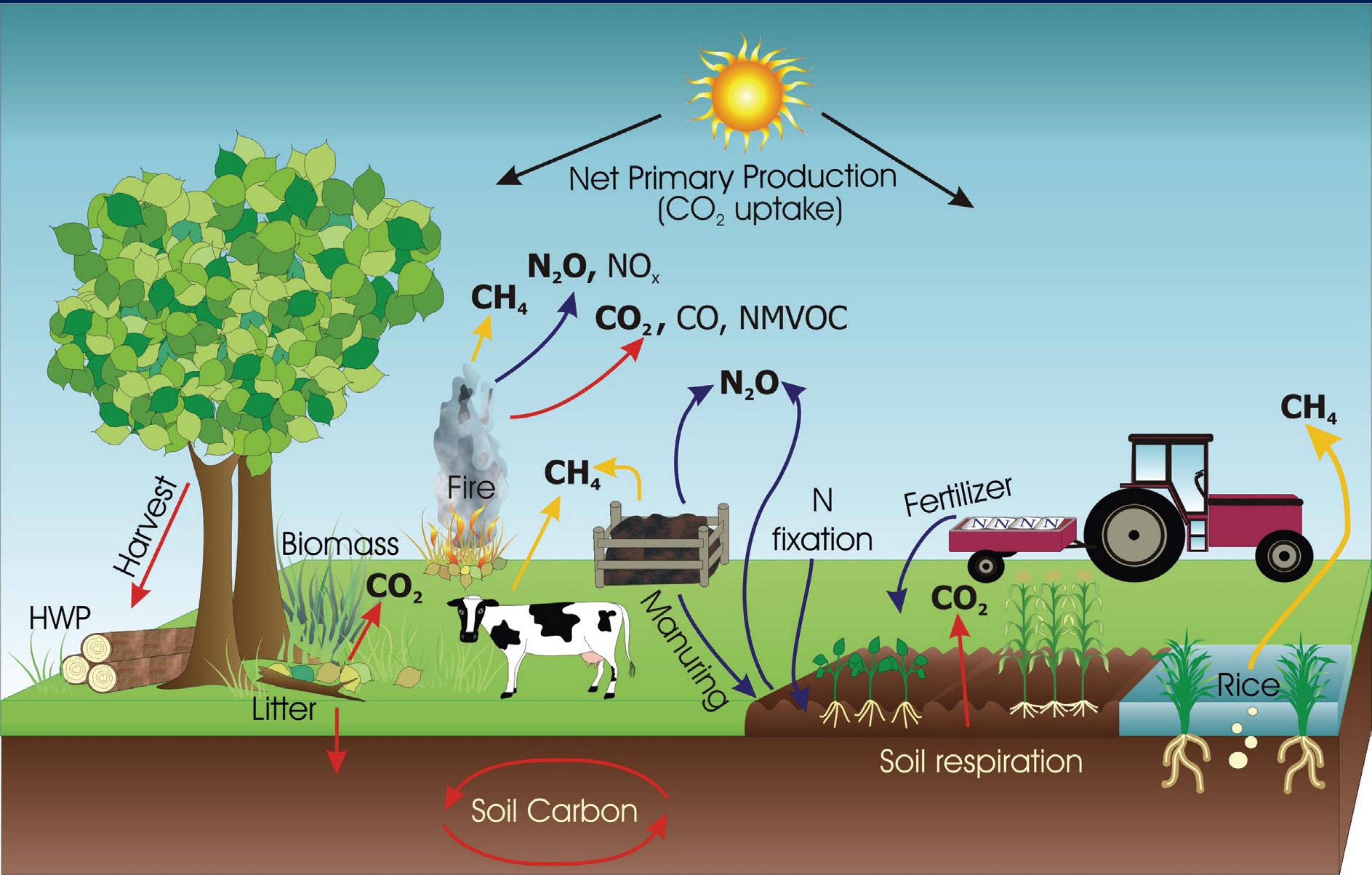
http://en.wikipedia.org/wiki/File:Carbon_cycle.jpg

Farms emitted 6 billion tonnes of GHGs in 2011, or about 13 percent of total global emissions. That makes the agricultural sector the world's second-largest emitter, after the energy sector (which includes emissions from power generation and transport).



Most farm-related emissions come in the form of methane (CH_4) and nitrous oxide (N_2O). Cattle belching (CH_4) and the addition of natural or synthetic fertilizers and wastes to soils (N_2O) represent the largest sources, making up 65 percent of agricultural emissions globally. Smaller sources include manure management, rice cultivation, field burning of crop residues, and fuel use on farms. At the farm level, the relative size of different sources will vary widely depending on the type of products grown, farming practices employed, and natural factors such as weather, topography, and hydrology.

Farming emissions come from a variety of sources that differ depending on the type of farm.



Long-term field experiment

(Keszthely, Hungary)

At field scale a long-term field trial was performed with a crop rotation of potato - wheat - wheat - maize - maize. Treatments of sole FYM (farmyard manure), or equivalent NPK fertilisers, their combination, or straw incorporation, as well as unfertilised control plot were selected for analyses. The soil was a Eutric Cambisol with low organic matter and P, and medium K content; pH $_{KCl}$ was 7.1. Soil samples of the different plots were used in the meso- and microcosm trials as well.

Mean annual temperature and precipitation were 10.4 °C and 654 mm, respectively.

Localization of the long-term experiment:

46°40’ N; 17°15’ E

Selected treatments of the long-term experiment

Treatment no.	Farmyard manure (FYM)	Mineral NPK (eqv.)	Supplementary mineral fertilizer (N, P_2O_5, K_2O) (kg/ha/5 year)	Total N, P_2O_5, K_2O (kg/ha/year)	Maize stalk or wheat straw	Codes of treatments
1.	-	-	-	-	-	Control
2.	1 #(2)	-	-	44, 38, 49	-	1 FYM
3.	2 #(2)	-	-	88, 76, 98	-	2 FYM
4.	3 #(2)	-	-	132, 114, 147	-	3 FYM
5.	-	1 eqv.	-	44, 38, 49	-	1eqv
6.	-	2 eqv.	-	88, 76, 98	-	2eqv
7.	-	3 eqv.	-	132, 114, 147	-	3eqv
8.	1 #(1)	-	640, 360, 660	172, 110, 181	-	1FYM+NPK
9.	-	1 eqv.	640, 360, 660	172, 110, 181	-	1eqv+NPK
10.	-	1 eqv.	640, 360, 660	172, 110, 181	+	1eqv+NPK +St

Legends: 1FYM(5) = 35 t ha^{-1} farmyard manure in 5 years, distributed in the first and third year; 1eqv = mineral NPK equivalent to 35 t ha^{-1} FYM in 5 years, N distributed yearly, PK in the first and third year; Straw(St)= wheat straw and maize stalk ploughed in

Some treatments of field experiment

Grain yield of maize (2010)

Number of treatments	Grain yield (tha^{-1}, 85,5% dry matter)
1.	5.18
2.	5.44
3.	5.49
4.	6.30
5.	5.69
6.	6.70
7.	8.18
8.	10.56
9.	11.90
10.	10.65
$SzD_{5\%}$	1.72

Long term field experiment: the highest grain yield of maize was found in 8, 9, 10 treatments.

Analytical methods of gas measurements

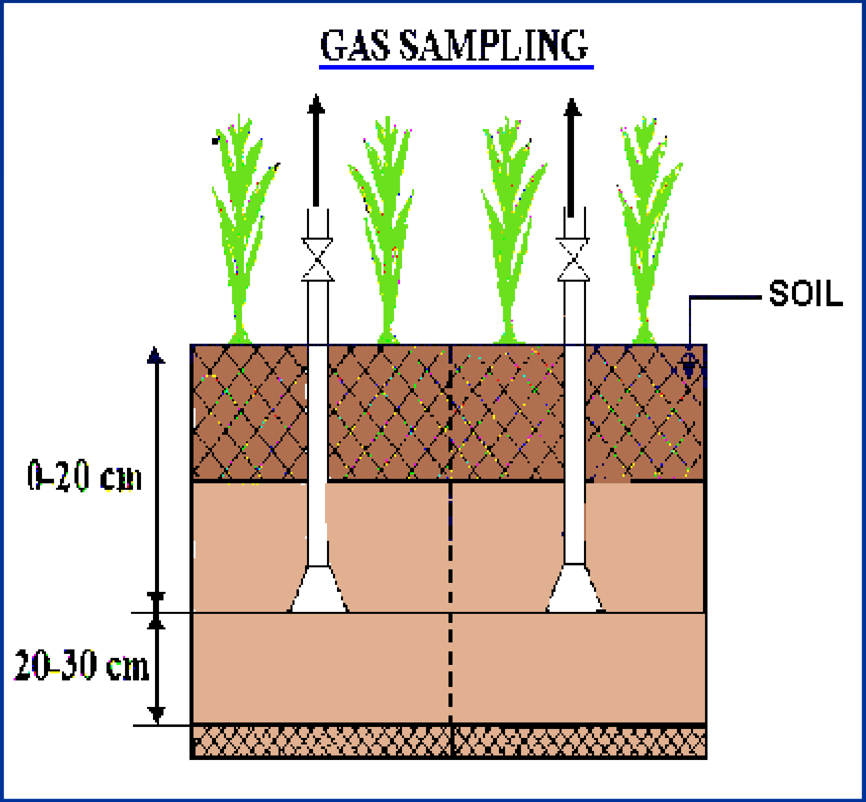
(Szent István University, Gödöllő, Hungary)

A gas-tight syringe was used to transfer 0.250 cm^3 gas sample directly into a gas chromatograph (HP 5890) equipped with Porapak Q column. Carbon dioxide was detected by thermal conductivity and N_2O was detected by electron capture detector. Each sample was analysed three times using external standards and one point linear calibration. The NO emission was measured using a chemiluminescent detector (ANTEK 7050).

GC (HP 5890), Gödöllő, Hungary

Mesocosm scale: Pot experiment

(Keszthely, Hungary)

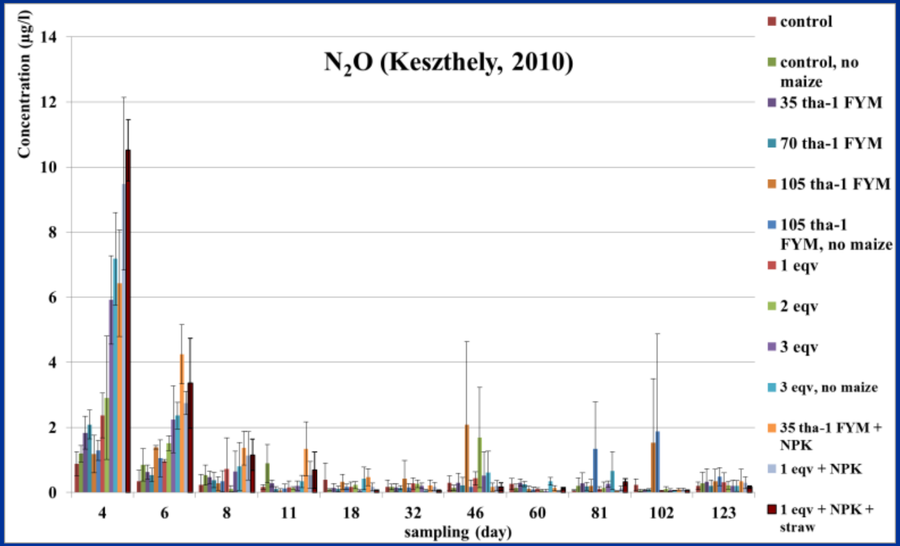


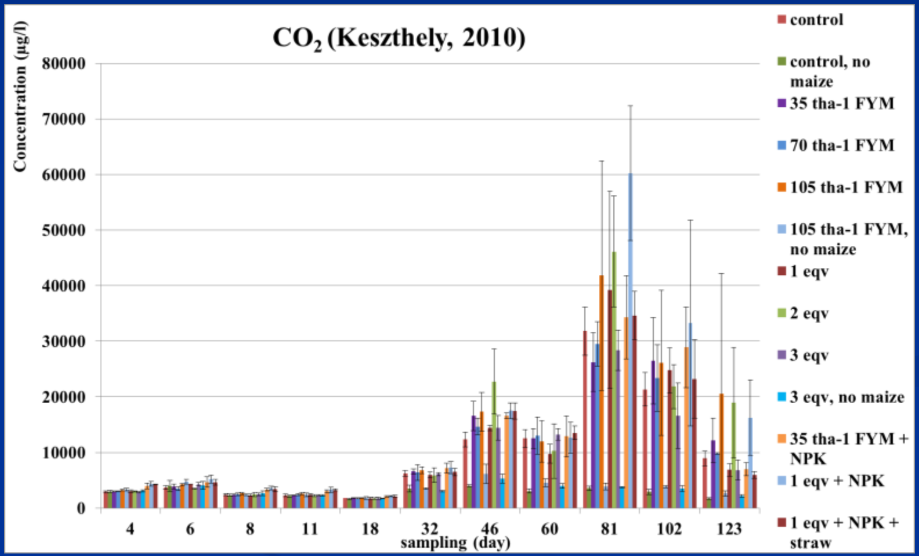
Four maize test plants were grown in large plastic pots (diameter: 40 cm, depth: 40 cm, filled with 45 kg absolute dry soil taken from the field plots of the selected treatments) in the closed section of a greenhouse until full maturity. Gas traps of 1.8 dm^3 volume were laid at a depth of 20 cm into the soil. The experiment was conducted in 3 repetitions in randomized block design. The plants were watered, maintaining the optimal water supplying capacity of the test soils during the whole experimental period.

In the greenhouse (Keszthely, Hungary)

M. Horváth

Gas production (N_2O, CO_2) during the mesocosm experiment



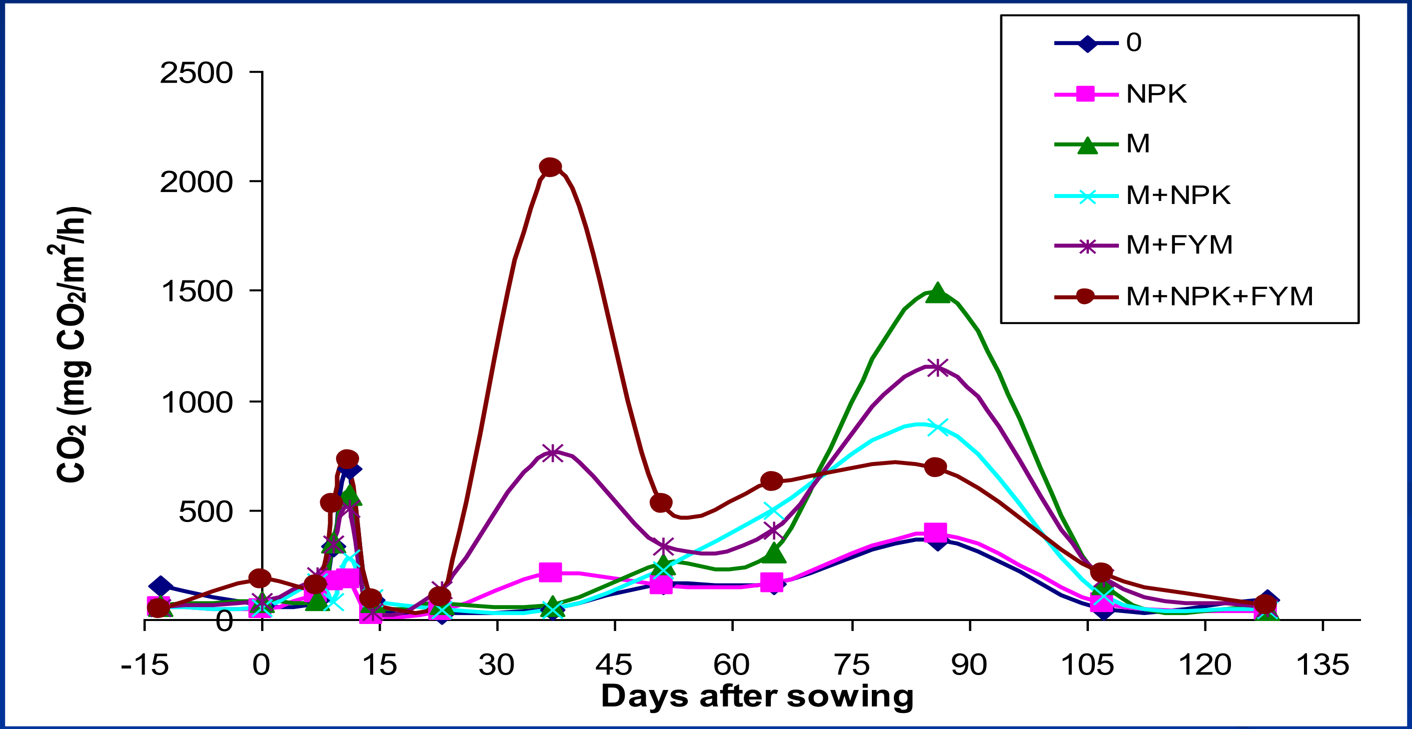


The highest gas production was found in treatments with combination of mineral fertilisers and manure.

Soil Column experiment (Institute for Soil Sciences and Agricultural Chemistry)

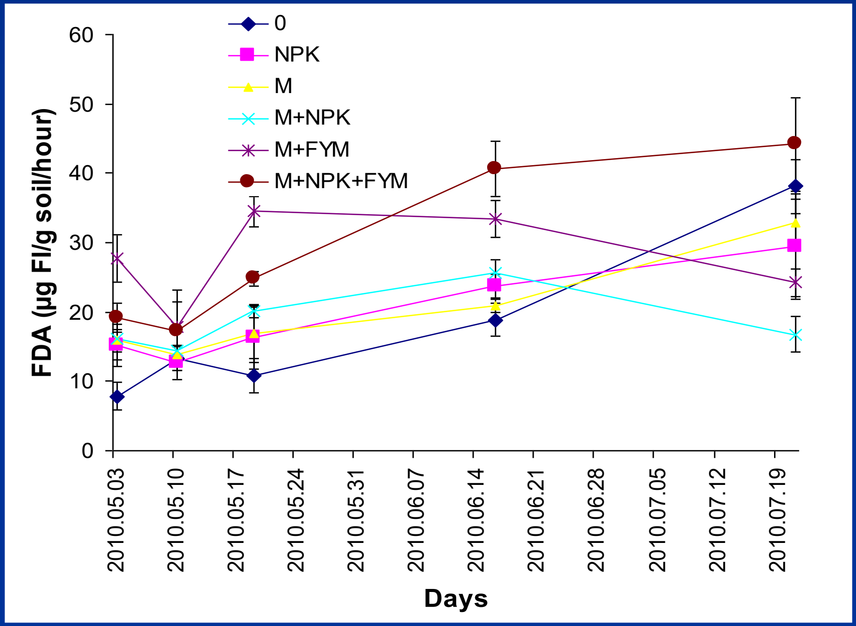
Sampling of gas and surface CO_2 flux from soil columns during the vegetation season from 13 April to 1 September

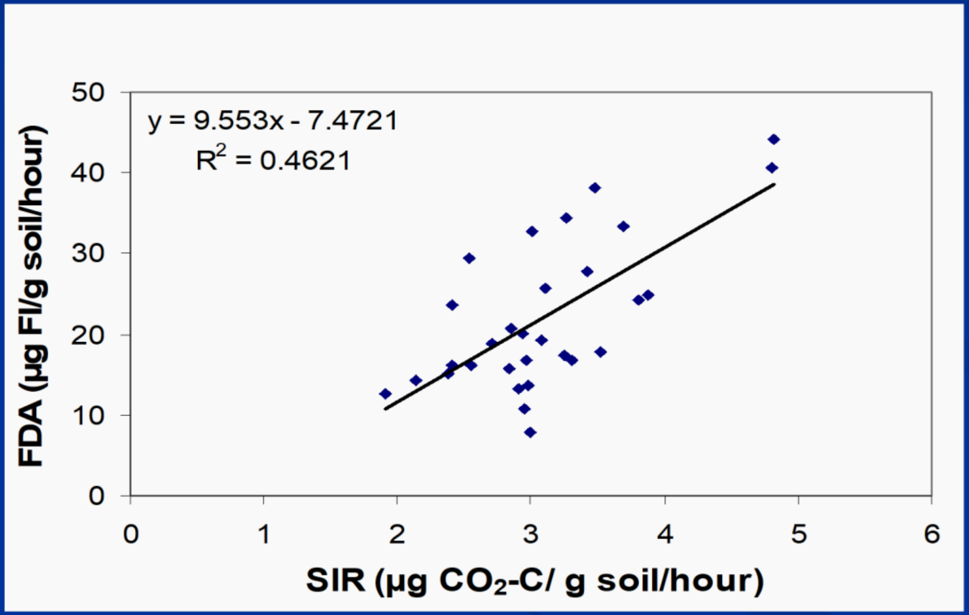
Surface CO_2 flux from soil columns during the vegetation season from 13th April till 1st September (0 = control; NPK = NPK treatment; M = presence of maize plant; FYM= farmyard manure)



The highest CO_2 flux was found between 0-65th days in the combined NPK+FYM treatment.

Fluorescein-diacetate hydrolysing (FDA) activity in surface soil samples during the vegetation season (0 = control; NPK = NPK treatment; M = presence of maize plant; FYM= farmyard manure) and linear regression between SIR and FDA in all soil samples in soil column experiment.





The highest, SIR and FDA were found in the combined NPK+FYM treatment. Treatments had significant effects on surface CO_2 flux, SIR and FDA, and they were in correlation with each other.

Conclusions

On the basis of the presented data it can be concluded that the conditions of formation and emission of CO_2 and N_2O gases are different in the uncultivated and cultivated agricultural soils and these processes are significantly influenced by the presence of plants and microbiological activity of the soil. Therefore, real estimation of GHG emissions from agricultural soils can be obtained in such joint experimental systems as it was presented in this lecture.

Acknowledgements

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Thank you for your kind attention!