



Tananyag fejlesztés idegen nyelven

Prevention of the atmosphere

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Processes of environmental pollution (the emission) Pollutant in the air (gases I.)

Lecture 5
Lessons 13-15



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Lesson 13

Definition of environmental pollution. The environmental load. Processes of air contamination.

- emission
- transmission
- immission



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Environmental pollution: definition

The environmental pollution means special conditions in the atmosphere, when the crops, animals, humans and objects of virtue are harmed or interfere the quality of our life. The pollutant may originate from natural or artificial sources. In the environmental pollution (protection) the contaminant resulted of human activity are only considered as pollutant.

The pollution of a given site is determined by:

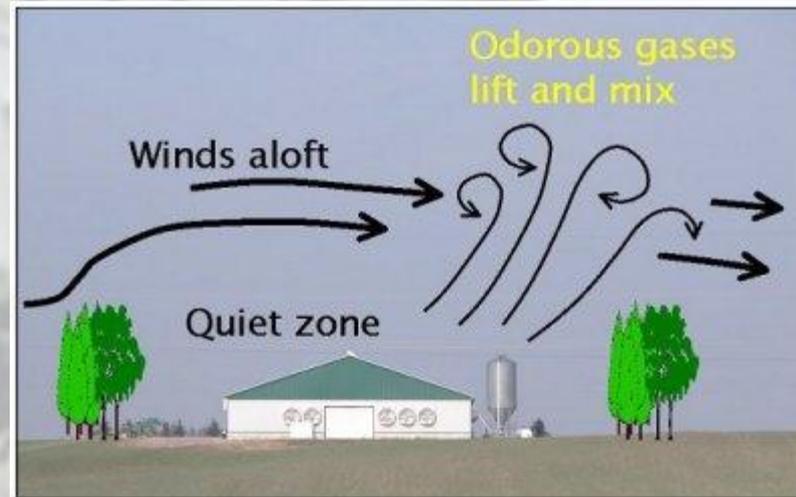
- The relevant emission characteristics
- State of the atmosphere (this subject was discussed in the previous two weeks)



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Fig. 43 The impact of atmospheric dispersion

The house located upwind and downwind of facilities manipulates air flow. Overhead winds lift particles and gases and help dilute and disperse pollutants.



www.omafra.gov.on.ca/.../facts/info_odours.htm



1. The pollutant release

- The relevant emission has important characteristics
 - Rate of emission
 - Physical and chemical features of environmental load

Both of them determine the amount and type of pollution.

The other source factors have also influence on pollution level:

- The properties of emission area
- Duration of the contamination
- The height of emission source (the level of contamination injection)



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Emission features

- The emission is the pollutant release into the atmosphere (followed by dispersion)
- This process is also regulated by weather circumstances (see earlier):
 - air motion transports the contaminant from the sources (crucial point!), causes dilution and dispersion of pollutant in the air.
 - Wind direction determines the pollutant path, what is in close connection with the extent of cross-wind spreading





- The surface roughness with wind speed determine the mechanical turbulence

Wind is responsible to downwind transports and pollutant dilution (see plume shapes and their content)

- turbulence mixes the contaminants
- temperature stratification determines the stability of the air

Close connection exists between elements of the weather; air temperature - vertical air motion – convection – buoyancy





2. Transmission of the pollutant

- After pollutant release, the gases and aerosols are dispersed into the atmosphere. On their pathway in the surrounding two different modifications may happen:
 - chemical reactions, and in most cases, they are followed by only one type of physical reaction (condensation)

The reactions are governed by the weather characteristics:

- Solar radiation
- Air temperature
- Air moisture (water vapor and droplets)
- Presence of other chemical substances



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3. Immission (ambient air quality)

Pollutant after atmospheric transportation and transformation forms the ambient air quality above a determined geographical place. This called as immission. Until the emission may be constant, the immission may vary on a very high extent due to capricious weather changes.

Focusing the impacts for human and other living organisms (crops and animals as well as microbes) the monitoring of immission has of primary importance.

It does not have the meaning that the emission could be neglected!





4. Deposition

The contaminant is falling out of the atmosphere in the process of deposition. It depends on the state of the atmosphere as well. There are two ways of atmospheric deposition:

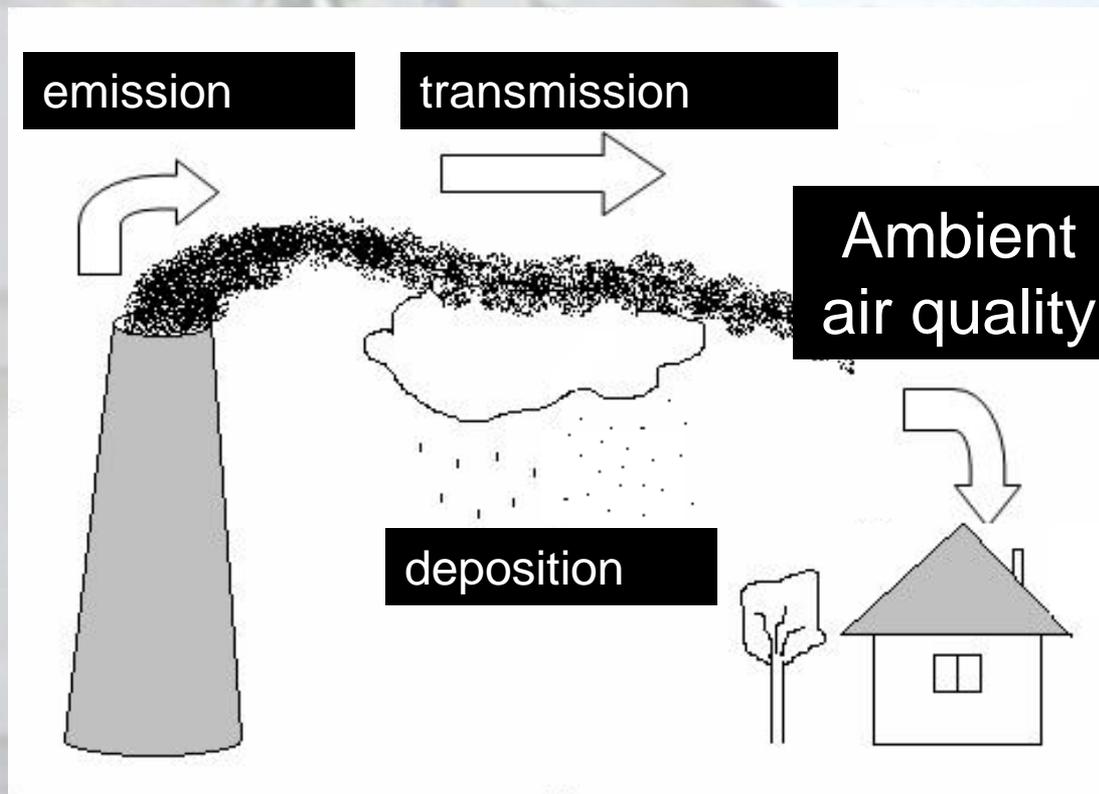
- dry deposition (without precipitation event)
- wet deposition assuming rainfall

The deposition is the process, when the pollutants leave the air, the atmosphere may be cleaned

In the process of deposition the contaminant reaches the surface (ground, oceans, seas). The cleaning is true in the point of view of the atmosphere only. The pollutants may pose problems on the surface.



Fig. 44 Progress of pollutants. The weather included each!

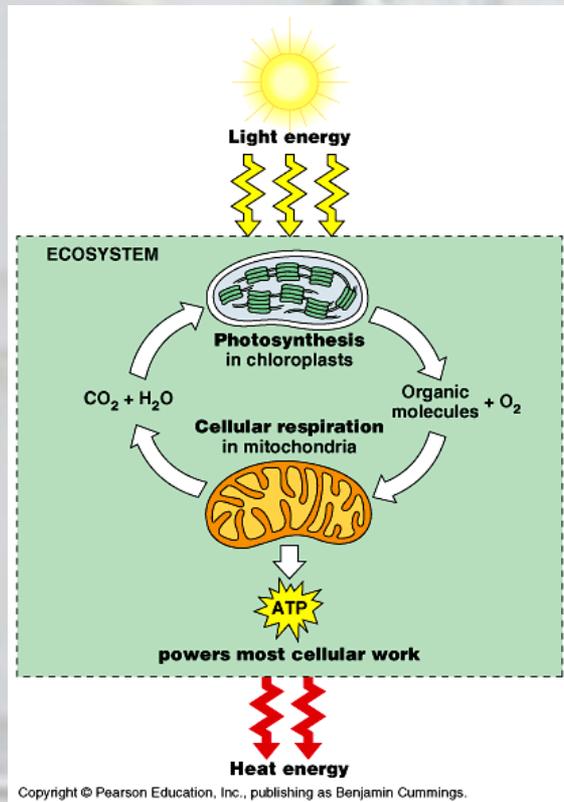




- Some natural sources are essential to keep life (carbon-dioxide for photosynthesis; nitrogen compounds to crop metabolism etc.). Every gas of antropogenic origin may become as a pollutant, when its concentration increases above a threshold limit.
- Atmosphere is an excellent substance for dispersal in comparison to soil or water. But after releasing the contaminant into the air, it is impossible to re-capture it! In atmospheric pollution we need to protect the release of contaminant into the free air. After emission there is no way the recover the pollutant.



Fig. 45 Scheme of carbon assimilation: the photosynthesis



Carbon dioxide is not a pollutant, but it is the basic material in assimilation process

http://www.soulcare.org/images/photosynthesis_respiration_diagram.gif



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Lesson 14

Air pollutant groups: gaseous materials with their features. SO_2 and NO_x I.



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- **Control of the atmospheric pollution should always be preventive!**

The family of the air pollutants

1. Gases

a) ***The sulfur compounds***

SO₂: a colorless gas with a disagreeable , suffocating odor. It is a harmful gas due to it's corrosive impact. Sulfur content in fossil fuels is very high; its range from 0.1% up to 5% in coal or oil by-products. In natural gas up to 40% (when immediately extracted from the well; however, the sulfur is efficiently removed during the processing of gas before distribution).



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Therefore, natural gas combustion is not the most important source of atmospheric sulfur

The use of coal was the largest sulfur source in the historical times (two to three decades ago). Mainly in the developed countries the switch from coal to gas declined the rate of SO₂ emission

Significant sources of sulfur dioxide emissions are in descending order

- Energy Production
 - Electric power generation
 - Petroleum refining



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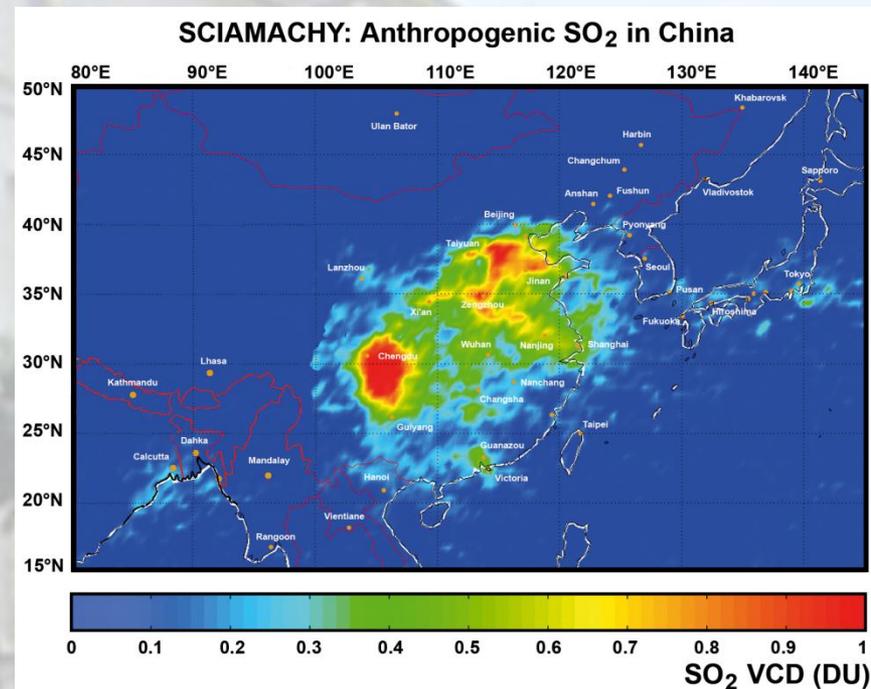


- Other combustion
 - Commercial and residential use
 - Combustion for industry use
 - Production processes
 - Extraction and distribution of fossil fuels
 - Transport
 - Road transport
 - Other transport (such as aviation, ships, trains).
- The biggest sulfur dioxide emitters are: US, China and Russia.



Fig. 46 Average SO₂ column densities over eastern China (2003)

SCIAMACHY's improved spatial resolution permits to identify localized emissions due to anthropogenic activities (Image: M. Van Roozendael, IASB-BIRA)



http://atmos.caf.dlr.de/projects/scops/sciamachy_book/sciamachy_book_figures/chapter_10/fig_10_5.jpg



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The natural sources of sulfur dioxide:

The *reduced forms* of sulfur compounds are as follows:

- hydrogen sulfide (H_2S) – source is bacterial actions (soil life)
- carbon disulfide (CS_2)
- carbonyl sulfide (COS)





In the *organic forms*:

- methyl mercaptan (CH_3SH) – very toxic gas
- dimethyl sulfide (DMS) (CH_3SCH_3)
- dimethyl disulfide (DMDS) (CH_3SSCH_3)

Most of these gases get oxidized soon into sulfur dioxide in the atmosphere. Later on sulfurous (H_2SO_3) and sulfuric acids are formed.





In the nature: soil and vegetation produce
 H_2S ;

and SO_2 is emitted by the volcanoes

The human made emission rate is at about
80%, while the natural source contributes
the remaining 20%.

The SO_2 is the main reason of producing
acid rains.





b) Nitrogen oxides and ammonia

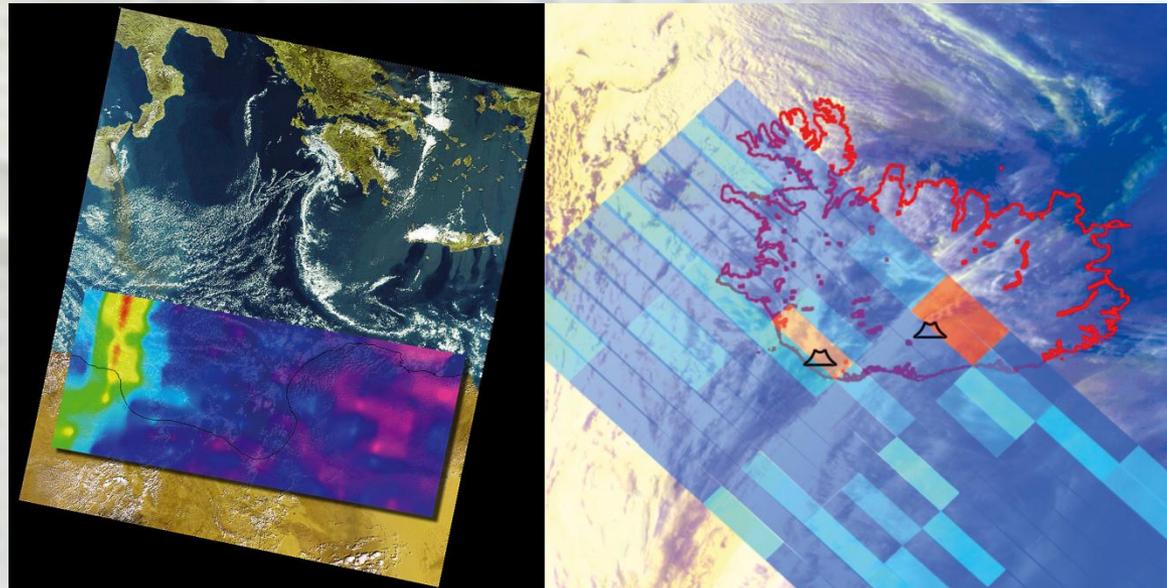
They are coming from combustion of all fossil fuels (mainly from coal or gas fired power stations) and from

- transport (motor vehicles)

Oil and coal nitrogen content is about 0.5–1.5%, the natural gas contains a little less nitrogen.



Fig. 47 Two European volcanic eruptions with SO₂ emissions (Mt. Etna on the left; and Grimsvötn, on the right side). See discussion on next slide!



http://atmos.caf.dlr.de/projects/scops/sciamachy_book/sciamachy_book_figures/chapter_10/fig_10_6.jpg



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- The SCIAMACHY nadir measurement of Mt. Etna is overlaid on a MERIS image showing that the plumes of SO₂ and visible ash match well (Fig. 42).
- In the Iceland image (right) detected SO₂ emission at Grimsvötn is indicated by the red pixel. The second faint SO₂ enhancement in the south of Iceland is caused by the Katla volcano. The underlying visible image stems from AVHRR/NOAA-12.
- (Images: Mt. Etna – DLR-IMF, Iceland – DLR-DFD and IUP-IFE, University of Bremen)





Lesson 15

Air pollutant groups: gaseous materials with their features NO_x II. The ammonia



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Most of *nitrogen oxides*' are the production of the atmospheric nitrogen (N_2) and oxygen (O_2) fixation (in the combustion chamber). There are two types of them:

- nitric oxide (NO), or nitrogen monoxide, and
- nitrogen dioxide (NO_2)

The sum of these two compounds is the NO_x .

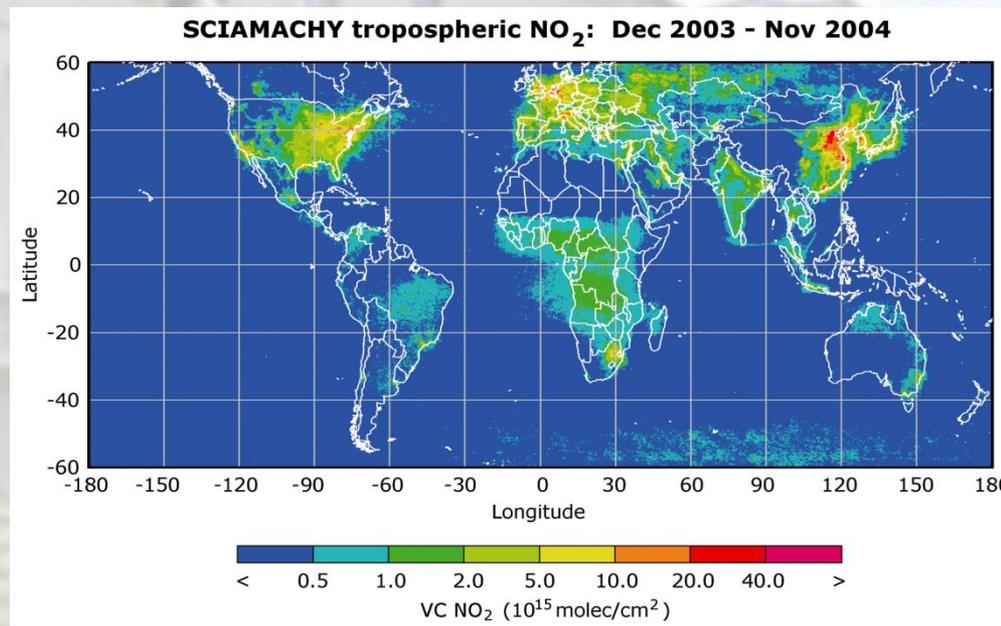
The NO has no color. The nitrogen dioxide is a yellow-reddish-brown color gas with an irritating odor.

- Fuel combustion always produces both of them, but majority of NO_x is in the form of NO. This compound is oxidizing further in the atmosphere soon.





Fig. 48 Global survey of *tropospheric* NO₂



http://atmos.caf.dlr.de/projects/scops/sciamachy_book/sciamachy_book_figures/chapter_10/fig_10_1.jpg



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- Discussion of the previous Fig. (43)
At about yearly mean of NO_2 for the whole world were figured on the image
The investigated period was from December 2003 to November 2004
 - the industrialised regions in the northern hemisphere and
 - regions of biomass burning in the southern hemisphere can be followed sharply
 - highest concentrations were observed around Japan

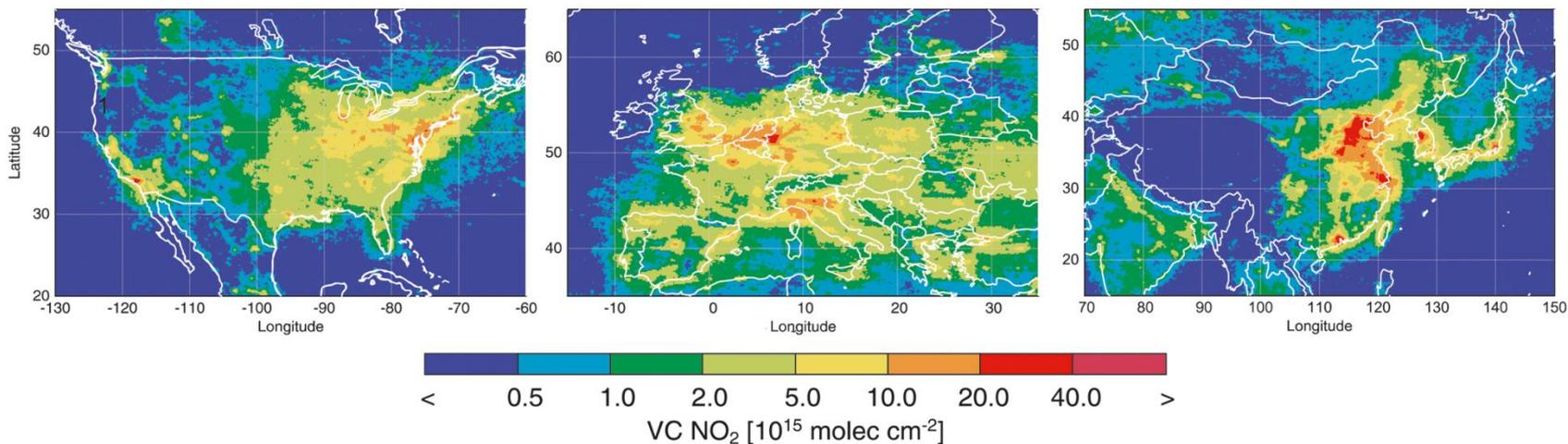
(Image taken by A. Richter, IUP-IFE, University of Bremen)





Fig. 49 Mean tropospheric NO₂ densities

SCIAMACHY tropospheric NO₂: Dec 2003 - Nov 2004



http://atmos.caf.dlr.de/projects/scops/sciamachy_book/sciamachy_book_figures/chapter_10/fig_10_2.jpg



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The image 44 contains NO_2 changes for the industrialised part of the world.

The first graph is for the United States;
the second for Europe and
the third one for Asia

Increase in data of the United States and China
between December 2003 and November 2004
are obvious.

(Image: A. Richter, IUP-IFE, University of Bremen)





Transportation (mainly motor vehicles) is by far the largest contributor of nitrogen emission, in contrast to the earlier discussed sulfur dioxide, where transport contributes only a small extent to atmospheric contamination.

Antropogenic sources of NO_x (for developed countries):

- Road and other transports (combustion under pressure and heat)
- Energy Production
 - Electric power generation
 - Petroleum refining





- Fertilization (small extent)
- Combustion for industry use
- Production processes
- Burning of fossil fuels

Natural sources of NO_x

Organic decomposition produces it both in water or land ecosystems. Less information is available on soil properties as natural source of nitrogen oxides.

The prevailing nitrogen oxide type in soils seems to be the N_2O . It acts as a green house gas also.

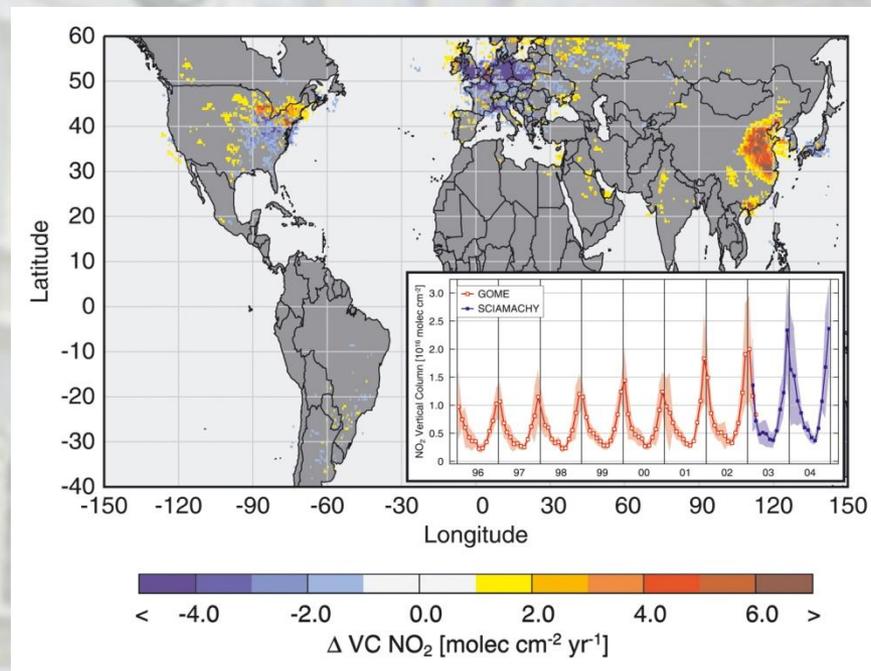
They contribute to the acid rain and photochemical smog!



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Fig. 50 Change in global tropospheric NO₂ concentrations from 1996-2002.



http://atmos.caf.dlr.de/projects/scops/sciamachy_book/sciamachy_book_figures/chapter_10/fig_10_3.jpg



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The inset illustrates how NO_2 concentrations have risen in China from 1996-2004. It is almost a decade period from the close-past.

While 'old'; industrialised countries were able to stop the increase of NO_2 emissions, the economical growth in China turns out to be a strong driver for pollution

(Image: A. Richter, IUP-IFE, University of Bremen)





Ammonia is a colorless irritative gas. Agriculture, in the form of urine of animals is by far the largest antropogen source of ammonia emission.

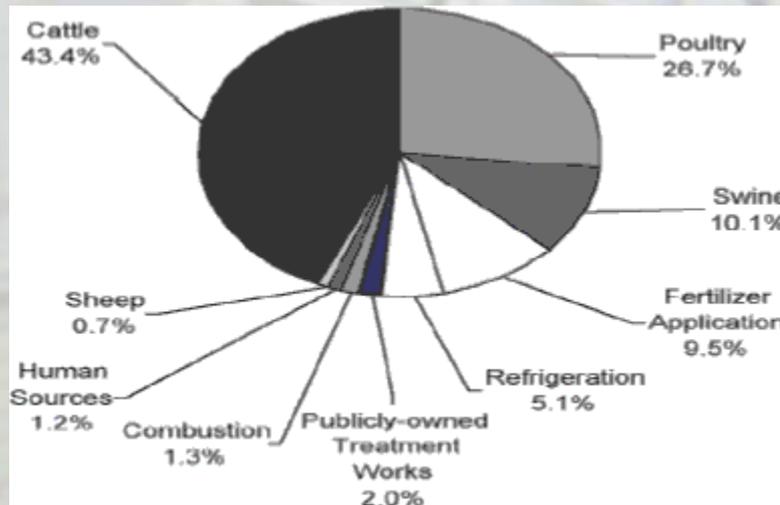
Antropogen sources are:

- Livestock farming – more than 50% of all ammonia emissions (decomposition of urea from large animal wastes and uric acid from poultry wastes)
 - Fertilization process
- Natural sources
- water ecosystems (oceans, wetlands etc.)
 - Vegetation cover
 - Biomass and other burnings



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Fig. 51 Sources of ammonia emission



Dramatic rise in air ammonia concentration in areas of intensive agriculture were observed. Estimates indicate that animal agriculture accounts for 50 to 85% of total ammonia volatilization.

www.thepoultrysite.com/articles/738/ammonia-e...



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Thank you for attention!



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