



Environmental Engineering

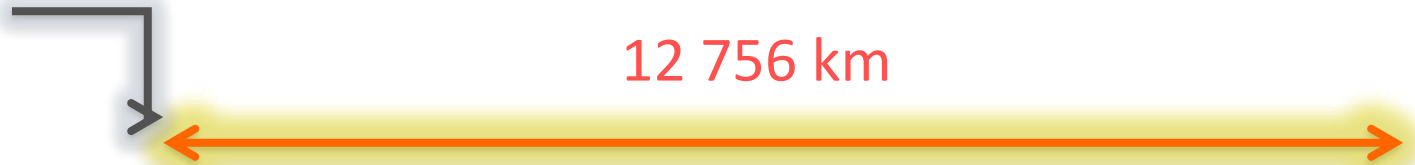
Atmosphere & pollution

- **atmosphere – definition, description, classification**
- **atmosphere pollution:**
 - sources
 - smog + inversion
- greenhouse effect
- ozone layer

What does ,atmosphere' mean ?

- 1: a particular environment or surrounding influence
- 2: a unit of pressure
- 3: the mass of air surrounding the Earth
- 4: the weather or climate at some place
- 5: the envelope of gases surrounding any celestial body
- 6: a distinctive but intangible quality surrounding a person or thing

~ 100 km



NASA: man above 80 km = astronaut

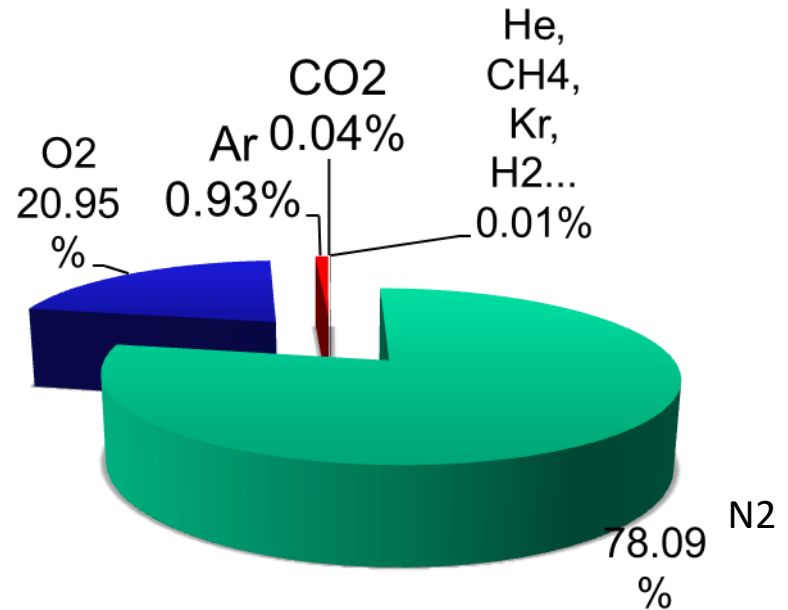
Karman's boundary in 100 km – above we do not use m asl, but the distance from a space object

Anacoustic zone: above 160 km. Low molecules density does not permit sound transmission

Atmosphere description

up to 16km 90% of particles, 30km 99%, 48km 99,9%, totally over 700km

Chemical content (clean air):



Atmosphere description - troposphere

Chemical content:

Variable components

(amounts vary over time and location)

Carbon dioxide (CO₂) 0.04%

Water vapour (H₂O) 0-4%

Methane (CH₄) *trace*

Sulphur dioxide (SO₂) *trace*

Ozone (O₃) *trace*

Nitrogen oxides (NO, NO₂) *trace*

Atmosphere description

Term ,clean air‘ – exists only in labs

- cannot be found in nature (there are always particles and pollution (even trace amounts) – cause of fires, volcanic activities....etc.)

Exosphere: only H and He,
no boundary with space

Thermosphere: few
molecules, temp up to
1000°C

Mesosphere: temp
decreases (down to -90°C)

Stratosphere: ozone layer
– absorbs UV => heated

Troposphere: most of air
mass, weather, temp
decreases with alt

Atmosphere pollution

Sources:

- **natural** (volcanic activity, fires, natural wind erosion, pollen dispersion, natural radioactivity...)

- **anthropogenic** (industry, transportation, power plants, agriculture, local heating, mining, sprays...)

Atmosphere pollution

Extent:

- **local** (chimneys, local fires...)
- **regional** (power plant)
- **global** (no boundaries – e.g. sand from the Sahara in the Alps)

More hazardous pollution is discharged into air than into landfills, waters and groundwater combined

Air pollution is leading cause of several diseases (and deaths).

Mortality due to air pollution

- 91 % of world population breathes air exceeding the WHO guideline limits (in over 90 % of European cities)
- 4.2 million die each year due to polluted ambient air (WHO)
 - More than any other pollution (such as water, soil, food)
 - More than in car accidents
- 3.8 million due to polluted indoor air (WHO)
 - Mostly cooking
(kerosene, solid fuels, open fires)

One has to distinguish between:

Emission – pollutants **emitted** from the sources of pollution, they **characterize the sources**
(SO₂) [kg.h⁻¹] – **primary pollutants**

Immission – the emissions which have reacted with the atmosphere, they characterize the
state of the atmosphere (H₂SO₄) [kg.m⁻³] - **secondary pollutants**

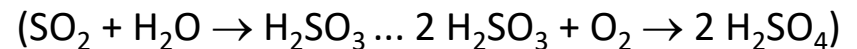
Polluting the air – the process of entering pollutants in the atmosphere

Polluted air – the air containing pollutants

Major air pollutants

Sulphur oxides (SO_x)

- Industrial and domestic combustion of fossil fuels, electricity generation, naturally during volcanoes eruption (99 % from human sources)
- SO₂ – invisible, sharp smell, poisonous, 18 % of all air pollution
- Main component in killer smog
- Reacts easily ! – formation of sulfuric acid, sulfurous acid and sulfate particles

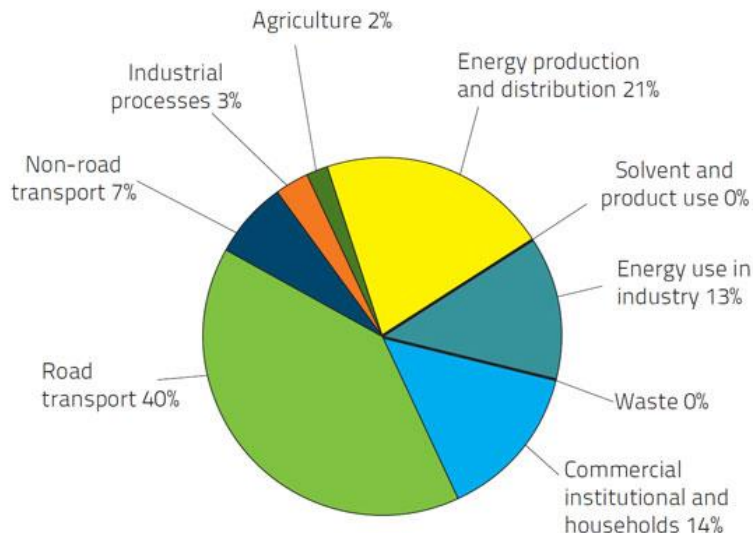


ACID RAIN – kills vegetation and fish

Major air pollutants

Nitrous oxides (NO_x , N_2O)

- Both naturally and anthropogenically (transportation, power plants,...)
- Reactive, contributes to acid rain (HNO_3), ground ozone, during smog situations
- Respiratory problems, N_2O is greenhouse gas



Major air pollutants

Ozone (O_3)

- very unstable, pale blue, stinks, toxic
 - Stratospheric ozone is positive (blocking UV radiation)
 - Tropospheric (ground) ozone negative – toxicity
- Not emitted directly, created by chemical reaction (NO_x , VOC, sunlight)
- Typically sunny days in urban areas
- Breathing related health problems
- Harms vegetation (forests, crops)
- Degradation of certain materials (paints, rubber, plastics...)

Major air pollutants

Particulate matter (PM₁₀, PM_{2.5})

- Also called aerosols or floating dust
- Soil erosion, desert sand, sea salt, pollen, volcanic ash, wildfires X black carbon from combustion, abrasion of tyres and brakes, agriculture
- Respiratory problems, lodge deep in lungs, heart diseases, asthma
- Problematic in cities, smog
- Reduced visibility (haze)
- Environmental damage (absorb chemicals and carry them)
- Abrasion of structures



SMOG – combination of several factors



METEOROLOGICAL INVERSION

- ,negative‘ meteorological situation – cold air under warm
- inverse progress of the temperature gradient
- low horizontal and vertical convection
- emissions and clouds in the ground layer
- depends also on morphology
- may cause smog
- it is a natural process

Smog

→ „*smoke & fog*“ (known since 1911) – specific state of the atmosphere

→ **mix of particulates and gases**

Smog

- Type **London** – **reductive**; high moisture, inversion, temperatures around 0°C, SO₂ → emission from the industry
- Type **Los Angeles** – **photo-chemical**; sun, NO_x, ground ozone, emission from the traffic -> brown haze

„Reducing light“

http://www.earthobservatory.nasa.gov/IOTD/view.php?id=5865&eocn=image&eoci=related_image

Smog reduces the amount of light entering the Earth's surface (reduction during the 2.½ 20. cent of 10%)

- it influences the plant growth, evaporation...



Pollution prevention and mitigation

Quite obvious...

Pollution prevention and mitigation

- Environment must not be treated as free resource and rubbish tip
- Limitation and prevention of emission of the harmful substances at the source
- Technological innovations, recycling, optimal location of the pollution sources...

- Transboundary issue – conventions and treaties (e.g. EU Clean Air Policy)

- In many aspects the situation has improved, in some it has not – depends on country/region

Sick Building Syndrome

We spend 18-19h daily indoors

→ dry air, chemicals from plastics, bacteria, ionization, dust - concentration often higher than outside

When people feel unwell for no apparent reason

- allergy
- asthma
- Headache, irritated eyes
- High blood pressure
- Depressions, neurosis, immunity problems



SBS - solutions

Good design (space, materials, furniture...)

Technology: air cleaners, ventilation...

Vegetation

...