Air pollution, atmosphere, biomonitoring, health human effects

PhD: HUAMAN DE LA CRUZ, Alex Ruben
Email contact: alebut2@hotmail.com

UPeU

CONTENTS

- Scientific knowledge about atmospheric pollutant
- Atmosphere: dynamics, structure and composition
- Sources of air pollution: primary and secondary pollutants
- Atmospheric aerosols: chemical characterization, composition, ion
- Biomonitoring and deposition of contaminants
- Effects of pollution on health

Scientific knowledge about atmospheric pollutant

H.H. Schrenk, Ph.D.,
1952
Research Director
Industrial hygiene
Foundation
Mcllon Institute,
Pittsburgh, Pa

THE AIR POLLUTION PROBLEM is concerned with the undesirable effects which are produced by excessive atmospheric pollutants. There are three basic effects: i) N**uinance, ii) economic, and iii) health**

NUINANCE

Much dirty

Unpleasant odor

Loss of visibility

Eye irritation

H. H. Schrenk Ph.D (1952) A Scientist Views the Air Pollution Problem, Air Repair

Scientific knowledge about atmospheric pollutant

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ECONOMIC

- Soiling of rugs
- Draperies
- Linens
- Clothes
- Loss of merchandise in stores
- Discoloring of paint
- Corrosion of stone
- Metals
- Injury to vegetation and livestock

H. H. Schrenk Ph.D (1952) A Scientist Views the Air Pollution Problem, Air Repair

Scientific knowledge about atmospheric pollutant

HEALTH EFFECTS

The air pollution can adversely affect health and was demonstrated by acute dramatic episodes.

EXAMPLES:

The air pollution can adversely affect health and was demonstrated by acute dramatic episodes.

The Weather
Cloudy preceded by rain this afternoon and tonight, Sunday slightly colder.

WILMINGTON NEWS-JOURNAL
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YOUR PURCHASE PUTS A PUNCH IN PROSPERITY!

NINETY-FOURTH YEAR, NO. 47 — PHONES Business Office, 2575 Editorial Department, 2576 — WILMINGTON, OHIO, SATURDAY, DECEMBER 6, 1930 — Eight Pages — PRICE THREE CENTS

64 LIVES SNUFFED OUT BY POISON FOG IN BELGIUM

City Zoning Ordinance Violators Face Arrest

BUILDERS MUST SECURE PERMIT FROM AUDITOR

MAP DRY REFERENDUM CAMPAIGN

WET BLOC HITS SNAG IN FIRST DRIVE ON DRYS

Suspects In Hillsboro Kidnap Plot Arrested

Pair Held in Florida Believed Kidnapers of Four-Year-Old Child In February, 1929

Barber Gets Chair

MYSTERY GAS CASTS PALL ON MEUSE VALLEY

Victims Choked To Death As Dread Vapors Roll Over Lowland Areas

AUTHORITIES ARE PUZZLED

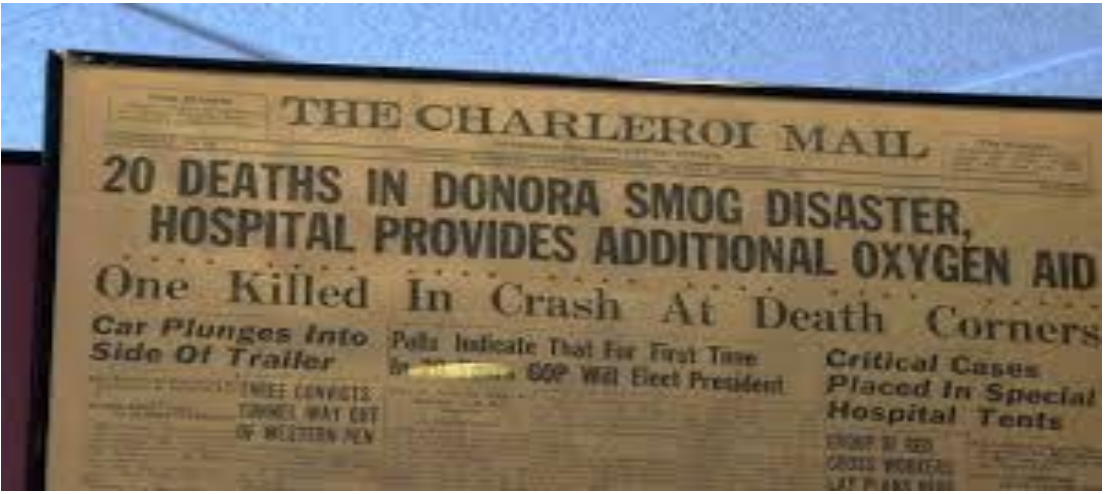
The **1930 (1 to 5 December) Meuse Valley** fog killed 60 people in **Belgium** owing to a combination of industrial air pollution (by Sulphur) and climatic conditions

Scientific knowledge about atmospheric pollutant

HEALTH EFFECTS

The air pollution can adversely affect health and was demonstrated by acute dramatic episodes.

EXAMPLES:



The 1948 (27 – 31 October) Donora smog killed 20 people and caused respiratory problems for 7,000 of the 14,000 people living in Donora, Pennsylvania

Hydrogen fluoride and sulfur dioxide

U.S. Steel´s Donora Zinc

Scientific knowledge about atmospheric pollutant

HEALTH EFFECTS

The air pollution can adversely affect health and was demonstrated by acute dramatic episodes.

EXAMPLES:

ACUTE EFFECTS

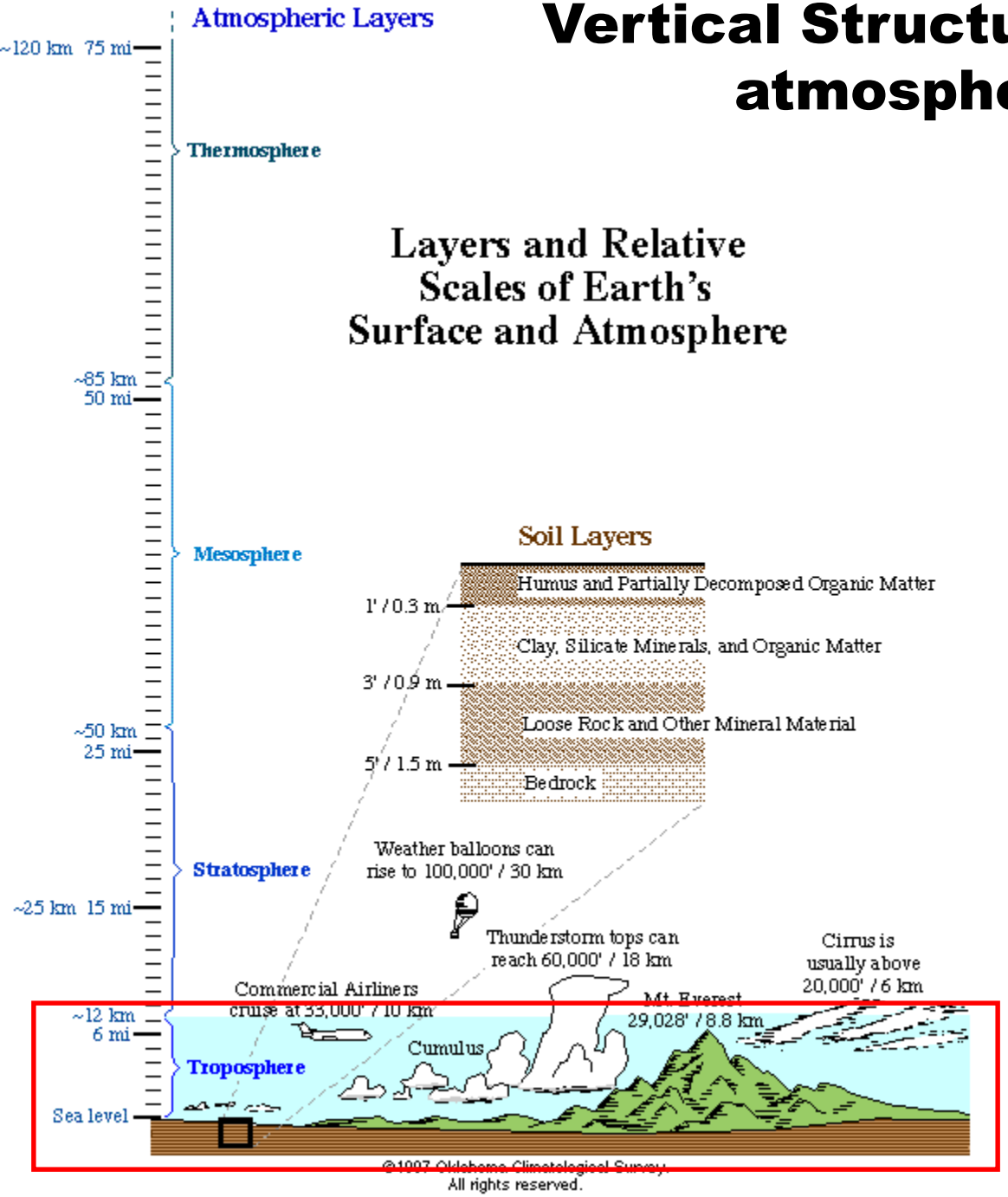
→ Poza Rica, Mexico, 1950 → Air Pollution

When? : November 24, 1950
Where? : Poza Rica, Mexico
Source: natural gas plant
Pollutants : accidental release of H_2S **(Acido sulfhídrico)**
Effect: respiratory distress and central nervous system damage
Death: 22 human deaths

ATMOSPHERE

The atmosphere is the blanket of air that surrounds the Earth.

Vertical Structure of the atmosphere



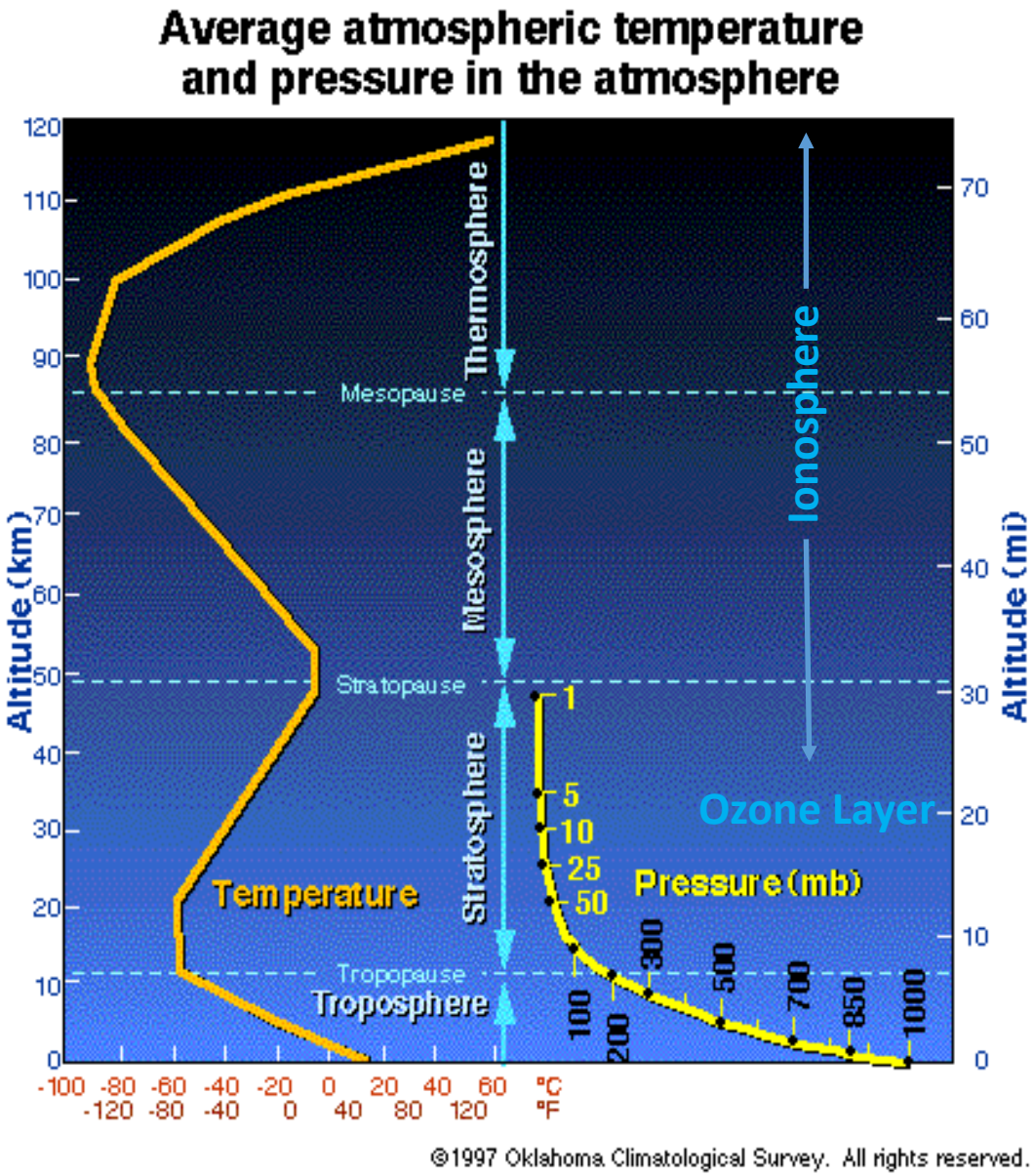
Principle

The changes in the atmosphere with height are results of specific physical conditions which exist on the earth and in its atmosphere

The vertical changes in temperature are important in constraining weather events to the lowest 10-12 km of the atmosphere.

Layer in which we live and is 90% of the total mass, contains almost of the Earths´s CO_2, H_2O vapor, clouds, air pollution, life-forms, and weather.

Vertical Structure of the atmosphere



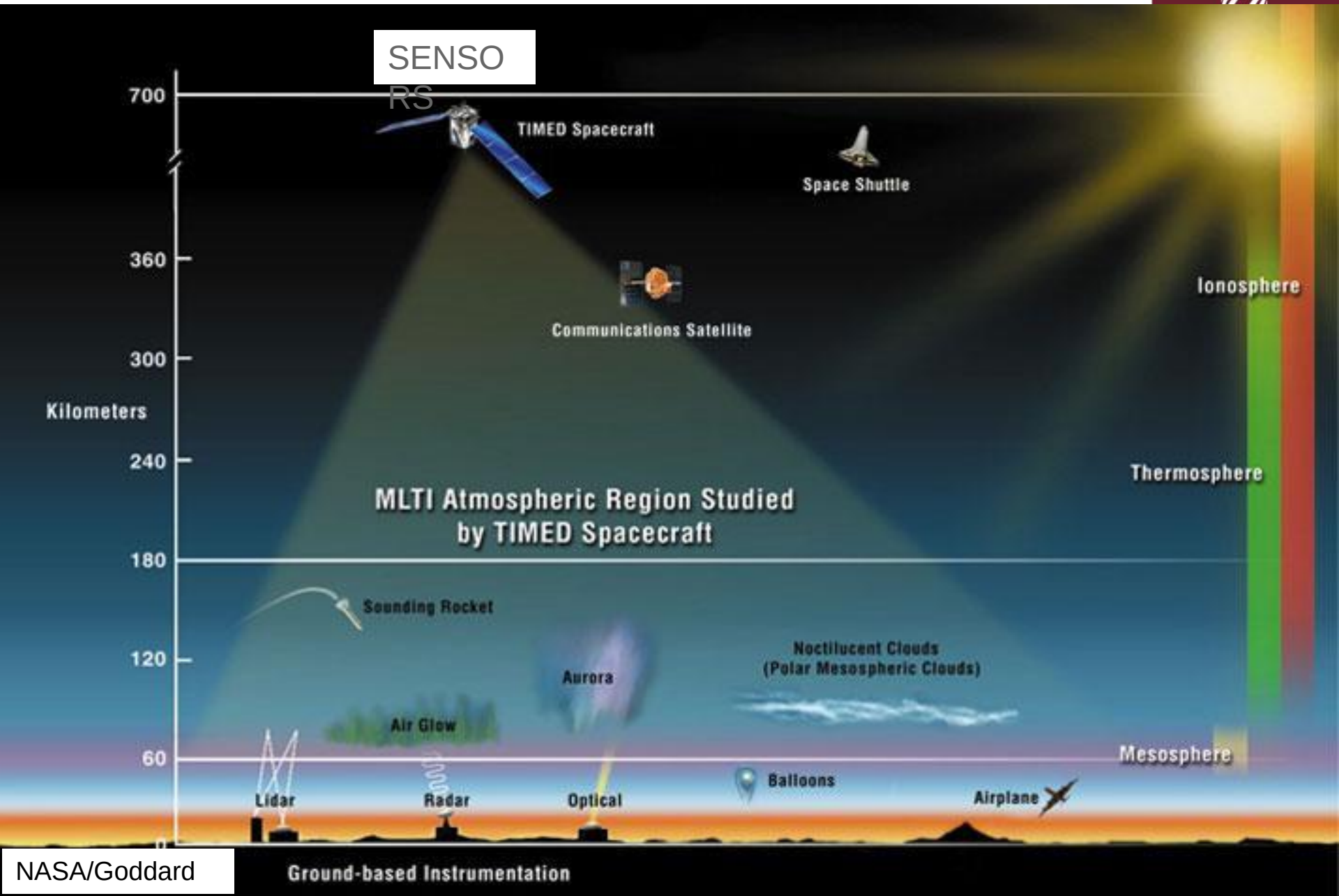
Ionosphere, there is a plasma. High energy solar radiation causes the atoms to ionize, separating free electrons from cations

Mesosphere, matter exists as atoms. There is sufficient energy in electromagnetic radiation from the sun to break the chemical bonds in molecules

Stratosphere, is home to the ozone layer. Chemical bonds between oxygen atoms in molecular oxygen (O2) break an in ozone (O3) break when the molecules absorb ultraviolet radiation. Re-forming those bonds releases heat energy so the temperature increases with altitude in this layer.

Troposphere, is the region of the atmosphere closest to the Earth and is the region of all weather events.

Vertical Structure of the atmosphere



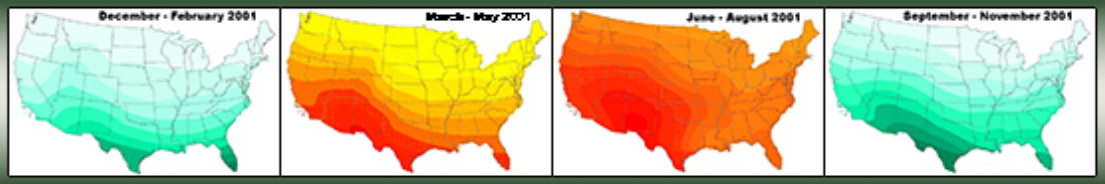
NASA/Goddard

Vertical Structure of the atmosphere

UV-B Monitoring and Research Program

Project Staff | Research Publications | Contact Us

USDA



Colorado State University

Home Overview Monitoring Network Data Download Effects Modeling

UV Irradiance Estimator

The UVMRP UV irradiance estimator provides values of the daily sum and daily maximum values of spectral irradiance at 300, 305, 311, 317, 325, 332 and 368 nm. Also available are the daily sum and daily maximum erythemal and Caldwell biologically weighted spectral irradiances and the UV index. All values may be obtained for user selected locations within the continental US for any date and time from 1997 through 2005 for clear sky conditions. The estimate is produced from the Tropospheric UV model (TUV) using data assimilated from NASA TOMS/OMI and MODIS satellites and NCEP NARR surface datasets. The model calculations have been compared to the USDA UVMRP data for quality assurance.

Users should select the date first. Then move the red marker to any location in the mainland United States to get the values for that date.

Supporting Information

Total Ozone Mapping Spectrometer(TOMS)

Tropospheric ultraviolet radiation model(TUV)

Estimation of UV index using the TUV modeling in the Metropolitan Area of Huancayo during years 2005 to 2019

The Ozone Monitoring Instrument (OMI) instrument can distinguish between aerosol types, such as smoke, dust, and sulfates, and measures cloud pressure and coverage, which provides data to derive tropospheric ozone

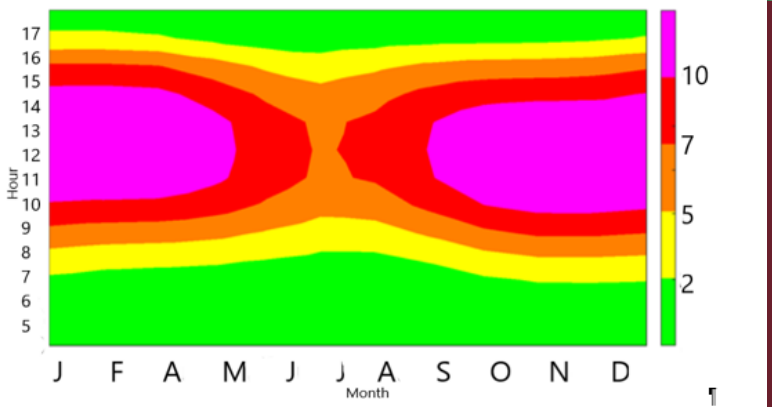


Figure 5. Monthly and hourly variation of UV index for the MAH during 2005 – 2019 using the TUV model and OMS categorization.

Vertical Structure of the atmosphere

Photochemical & Photobiological Sciences

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Cite this: *Photochem. Photobiol. Sci.*, 2017, **16**, 954

Ultraviolet solar radiation in the tropical central Andes (12.0°S)†

Luis F. Suárez Salas, [a] Jose L. Flores Rojas, *[b] Augusto J. Pereira Filho[c] and Hugo A. Karam[d]

Ultraviolet (UV) solar irradiance measurements performed in the central Andes, Huancayo, Peru (12.0°S, 75.3°W, 3313 m asl) at 1 min intervals between January 2003 and December 2006 were used to analyse daily, monthly, and annual cycles of UV solar irradiance. The measurements were performed using a GUV-511 multi-channel filter radiometer at four wavelengths: 305, 320, 340, and 380 nm. UV irradiance data under clear sky and all sky conditions were separated using a procedure based on calculation of normalized irradiance. In February, the highest hourly mean value at noon for the UV Index reached 18.8 for clear sky conditions and 15.5 for all sky conditions, with outlier peaks close to UVI = 28. In addition, the highest mean value for the daily erythemal dose was found also in February, reaching 7.5 kJ m^{-2} d^{-1} with a maximum outlier value close to 10.1 kJ m^{-2} d^{-1}. Comparisons between the clear sky GUV measurements and TUV model estimations were evaluated with statistical quantities showing values of R^2 close to 0.98. The total ozone column and trace gases were obtained from OMI. The aerosol parameters were obtained from MODIS. The enhancements due to clouds of spectral irradiance at 340 nm as compared to a cloudless sky reach maxima of 20%. These results indicate that tropical central Andes has among the highest incident ultraviolet solar radiation in the world.

Received 21st May 2016,
Accepted 2nd April 2017

DOI: 10.1039/c6pp00161k

rsc.li/pps

ATMOSPHERIC COMPOSITION

Gas name	Chemical Formula	Percent Volume (%)	**ppm
Nitrogen	N_2	78.084	780840
Oxygen	O_2	20.95	209500
Argon	Ar	**0.93**	9300
***Water**	H_2O	**2.5**	25000
***Carbon dioxide**	CO_2	**0.0397**	399
Neon	Ne	0.0018	18
Helium	He	0.000524	5.24
***Methane**	CH_4	0.000179	1.79
Krypton	Kr	0.000114	1.14
Hydrogen	H_2	0.000055	0.55
***Nitrous oxide**	N_2O	0.0000325	0.325
Carbon monoxide	CO	0.00001	0.1
Xenon	Xe	0.000009	0.09
***Ozone**	O_3	0.000007	0.07
Nitrous dioxide	NO_2	0.000002	0.02
Iodine	I	0.000001	0.01
Ammonia	NH_3	trace	trace

About 99%

1%

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*** considered relatively variable gases**
**** parts per million**

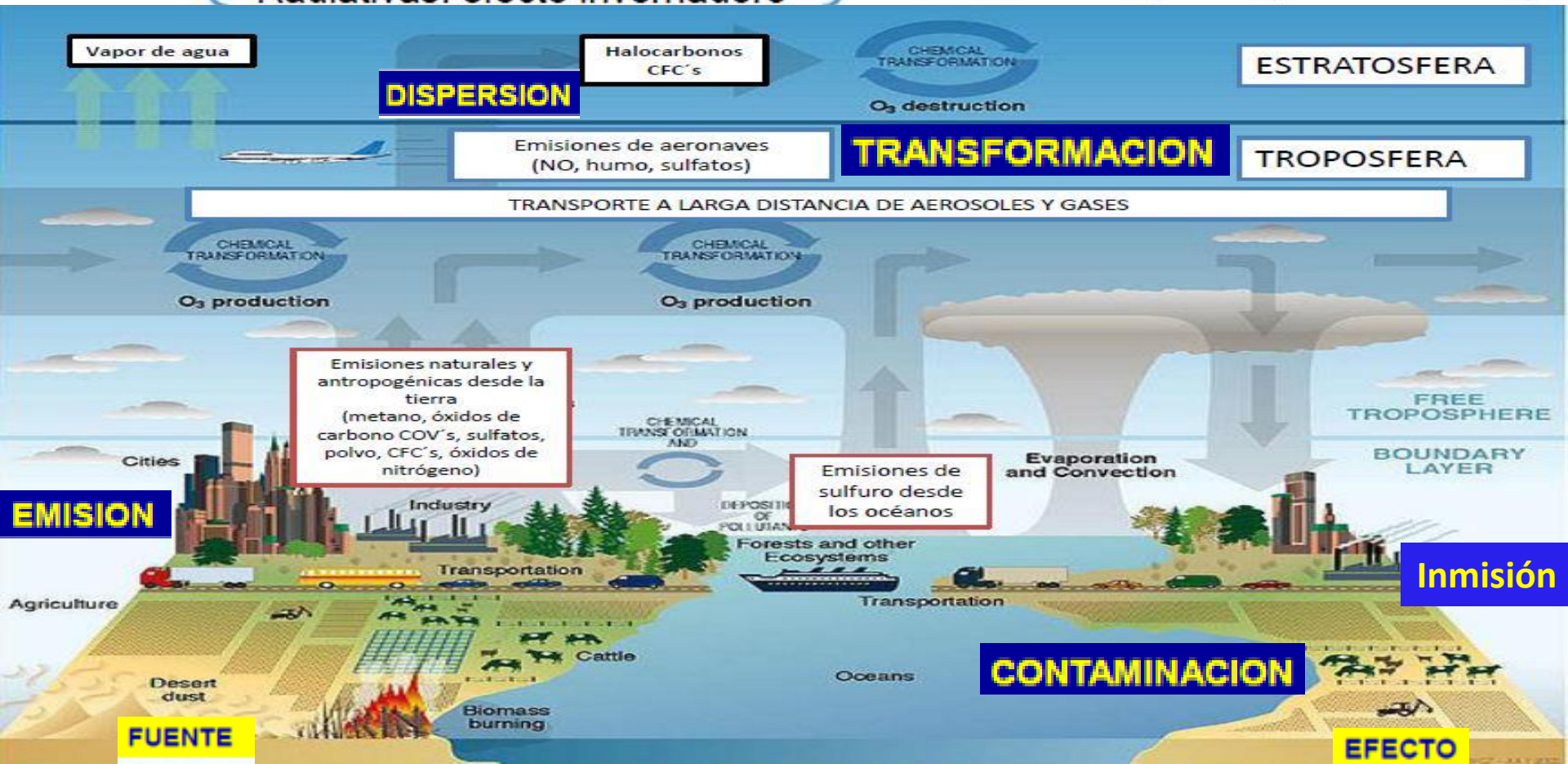
GREENHOUSE GASES

ATMOSPHERE - Dynamics

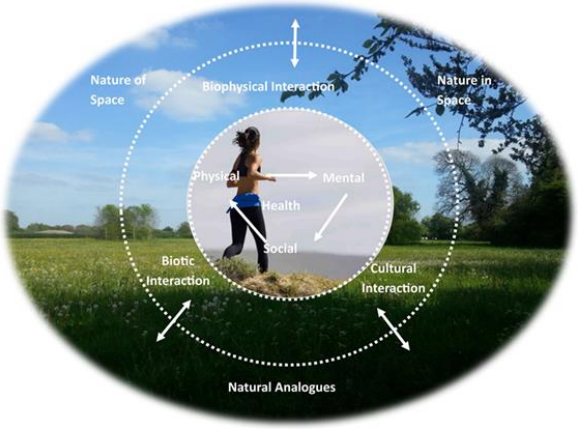
PROCESOS EN LA ATMOSFERA DE LAS EMISIONES

FISICOS
- Transporte : Viento
- Acumulación : Inversión Térmica
- Transformación : gas → MP
- Deposición Seca MP
- Radiativas: efecto invernadero

QUIMICOS
- Lluvia Acida
- Smog Fotoquímico
- Transformaciones fotoquímicos



Air Pollution



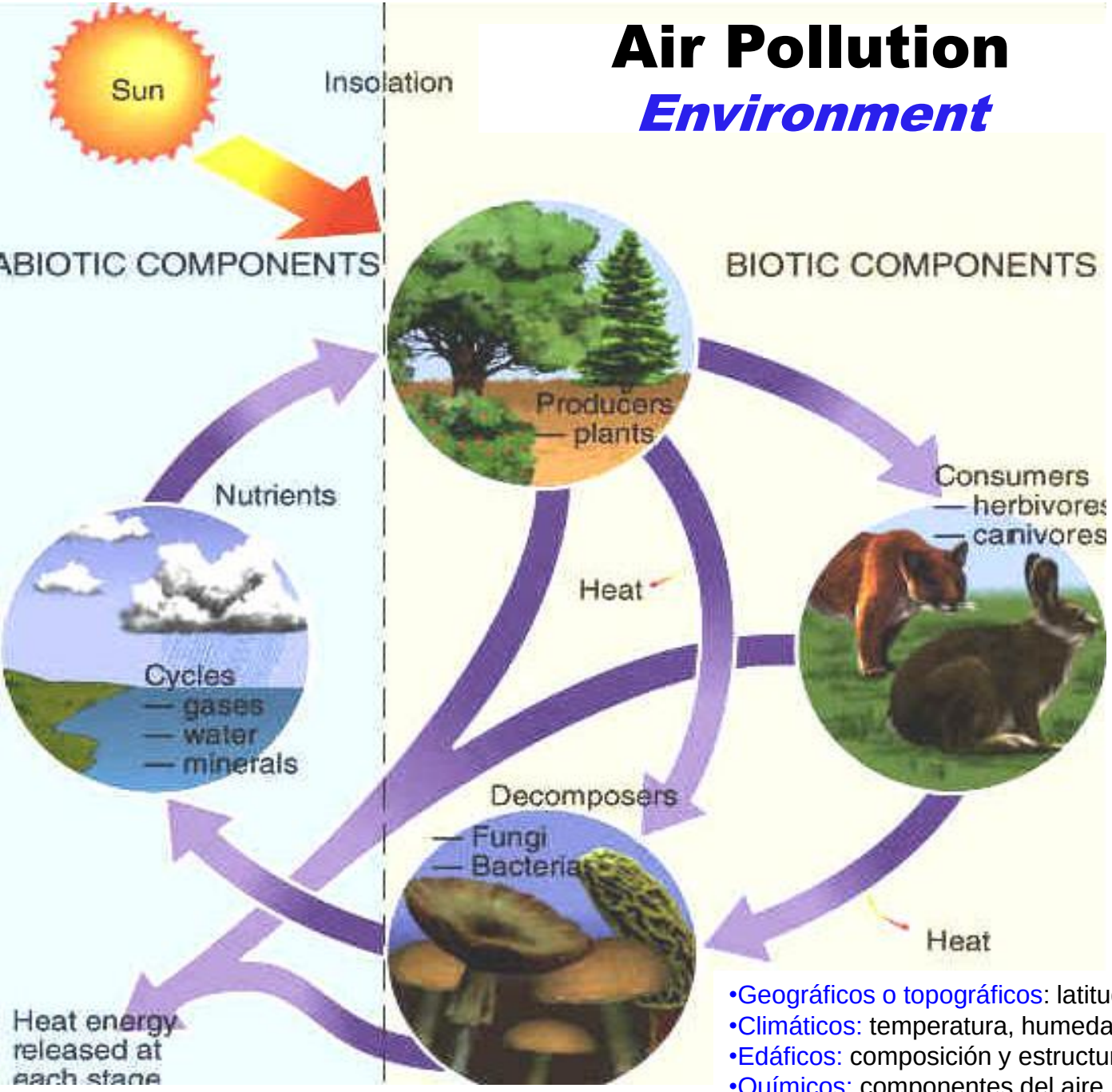
Interaction between human and their physical surrounding

Influence – based in human activities

POLLUTION!!!!

Air Pollution

Environment



unidad ecológica por la que fluyen materia y energía a través de la **cadena trófica**

Las interacciones entre la biocenosis y el biotopo limitan la distribución de las especies

SI ALGUNO DE ESTOS FACTORES LLEGASE A PRESENTAR FALTAS, LOS DEMAS FACTORES SE VERÁN AFECTADOS

- Geográficos o topográficos: latitud, orientación, pendiente, latitud...
- Climáticos: temperatura, humedad, viento, presión atmosférica...
- Edáficos: composición y estructura del suelo.
- Químicos: componentes del aire, del agua y del suelo

Air Pollution

Environment

POLLUTION!!!!!!

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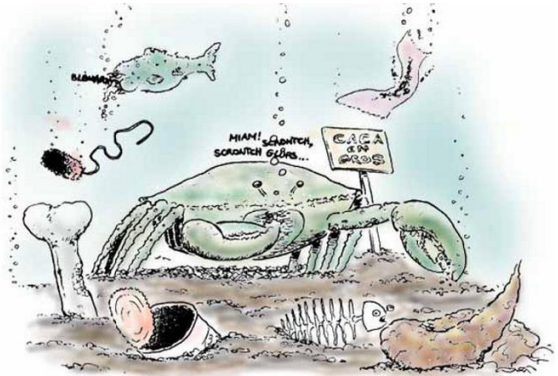
Air Pollution

Environment

POLLUTION

Presence or **introduction** into environment of substances harmful to humans and other living organisms.



Air Pollution

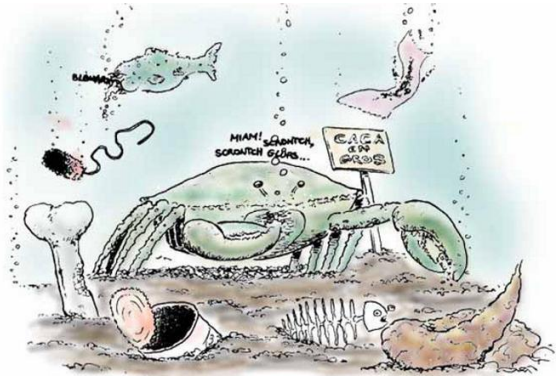
Environment

POLLUTION

Presence or **introduction** into environment of substances harmful to humans and other living organisms.

Pollutants

Solids, liquids, or gases produced in higher than usual concentrations that reduce the quality of our environment



Air Pollution

Environment

ENVIRONMENTAL POLLUTION

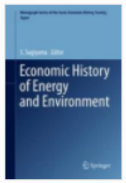
Occurs when changes in the physical, chemical, or biological constituents of the environment (air masses, temperature, climate, etc) are produced.

Air Pollution

Environment

SOURCES OF EXPOSURE

Springer Link



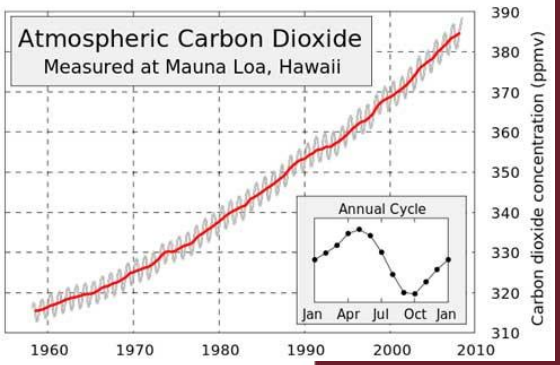
Economic History of Energy and Environment pp 85-109 | Cite as

The Problem of Air Pollution During the Industrial Revolution: A Reconsideration of the Enactment of the Smoke Nuisance Abatement Act of 1821

Air Pollution Has Been a Problem Since the Days of Ancient Rome

By testing ice cores in Greenland, scientists can look back at environmental data from millennia past

Methane gas has impacted our atmosphere since the Romans. (Illustration by Kim Rosen)



- Technological advances
- Growth economic

period 1760 to 1830 the Industrial

Air Pollution

Environment

SOURCES OF EXPOSURE

The majority of environmental pollutants are emitted through large-scale human activities such as the use of industrial machinery, power-producing stations, combustion engines, and cars.

Cars were estimated to be responsible for approximately **80% of today´s pollution** (Moller et al., 1994).

OTHERS

Lesser extent:

Field cultivation techniques
Gas stations
Fuel tanks heaters
Cleaning procedures

Natural sources:

Volcanic and soil eruptions
Forest fires

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Air Pollution

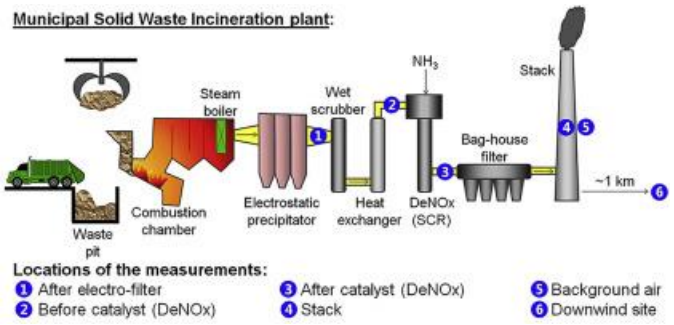
Environment

CLASSIFICATION OF AIR POLLUTANT

Sources producing pollution

A. Major sources - emission

- Power stations (e.g. coal)
- Refineries and Petrochemicals
- Chemical and Fertilizer industries
- Metallurgical
- Municipal incineration
- Etc.



Air Pollution

Environment

CLASSIFICATION OF AIR POLLUTANT

Sources producing pollution

B. Indoor area sources - emission

- Domestic cleaning activities
- Dry cleaners
- Printing shops
- Petrol stations
- Etc.

Air Pollution

Environment

CLASSIFICATION OF AIR POLLUTANT

Sources producing pollution

C. Mobile sources - emission

- Automobiles
- Cars
- Railways
- Airways
- Other type of vehicles

Air Pollution

Environment

CLASSIFICATION OF AIR POLLUTANT

Sources producing pollution

C. Natural sources – physical disasters - emission

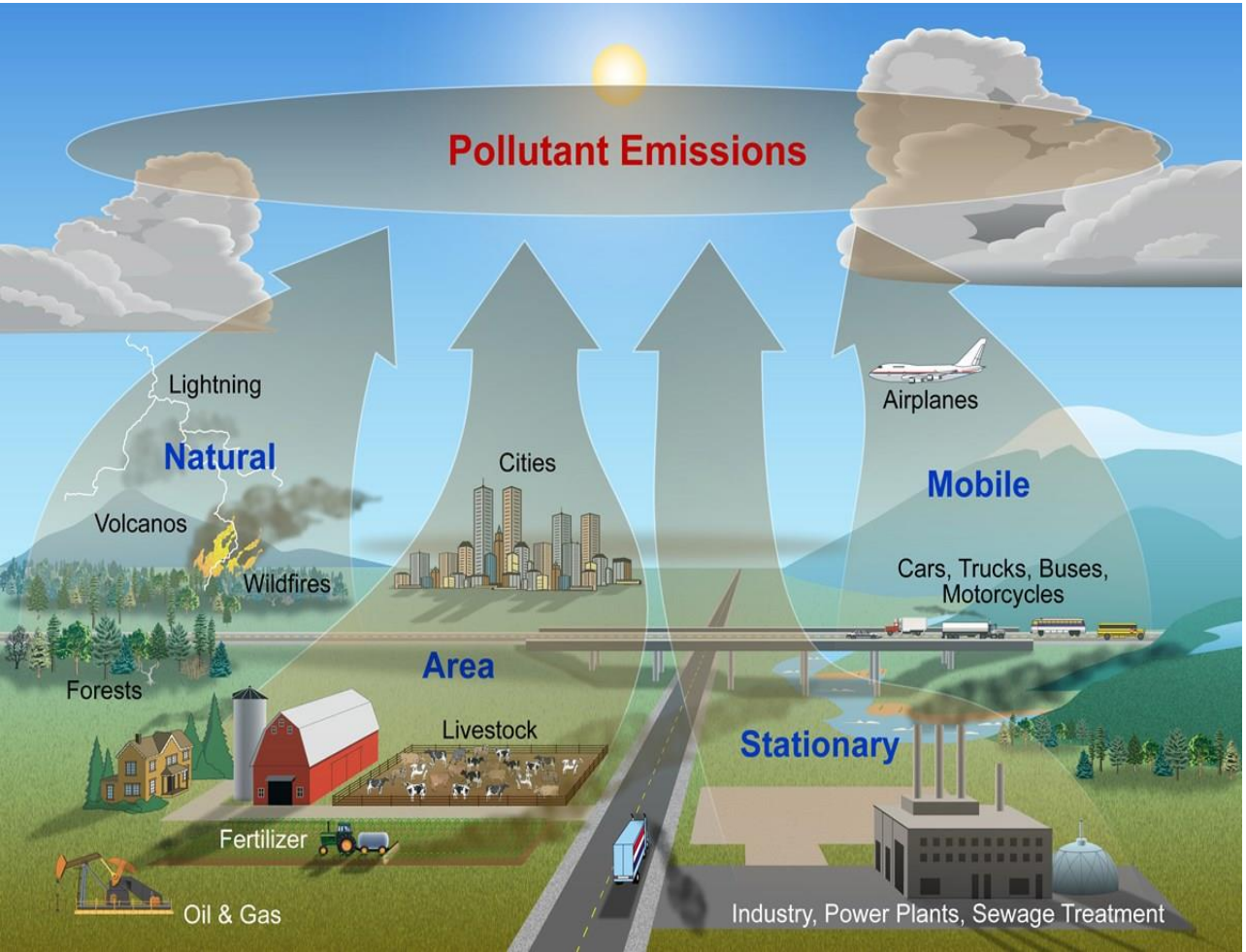
- Forest fire
- Volcanic erosion
- Dust storms
- Agricultural burning
- Sea salt aerosol

Air Pollution

Environment

CLASSIFICATION OF AIR POLLUTANT

Sources producing pollution



Air Pollution

Environment

CLASSIFICATION OF AIR POLLUTANT

According to the recipient of the pollution

A. Air Pollution

Presence of pollutants in the air in large quantities for long periods. Air pollutants are dispersed particles, hydrocarbons, CO, CO_2, NO, NO_2, SO_3, etc.

B. Water Pollution

Organic, inorganic, and biological charge at high levels that affect the water quality.

C. Soil Pollution

Occurs through release of chemicals or the disposal of wastes, such as heavy metals, hydrocarbons, and pesticides.

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Air Pollution

CLASSIFICATION OF AIR POLLUTANT

Based on origin

A. Primary air pollutants:

Materials than when released pose health risks in the unmodified forms or those emitted directly from identifiable sources.

B. Secondary air pollutants:

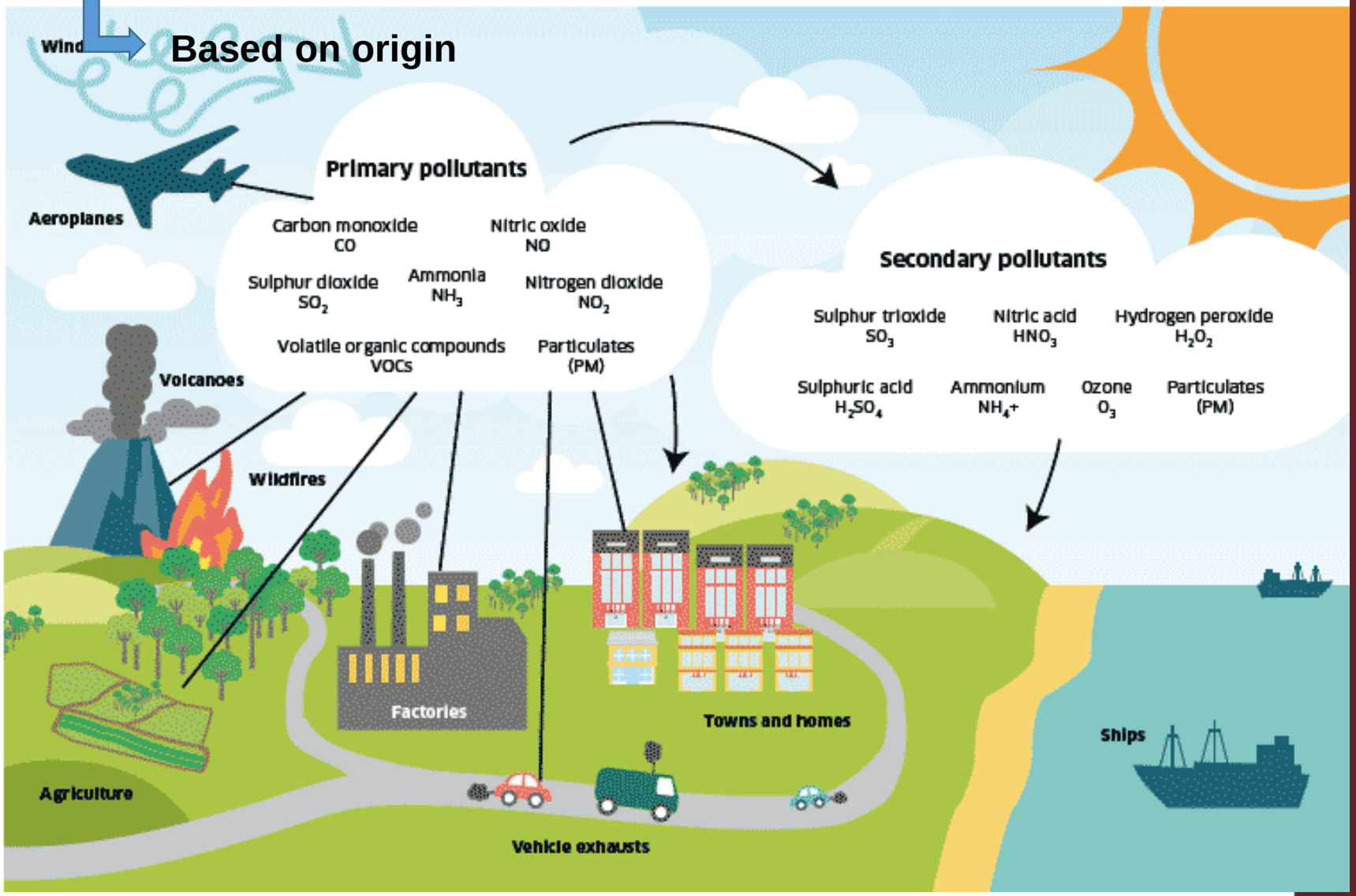
Primary pollutants interact with one other, sunlight, or natural gases to produce new, harmful compound

Air Pollution

Environment

CLASSIFICATION OF AIR POLLUTANT

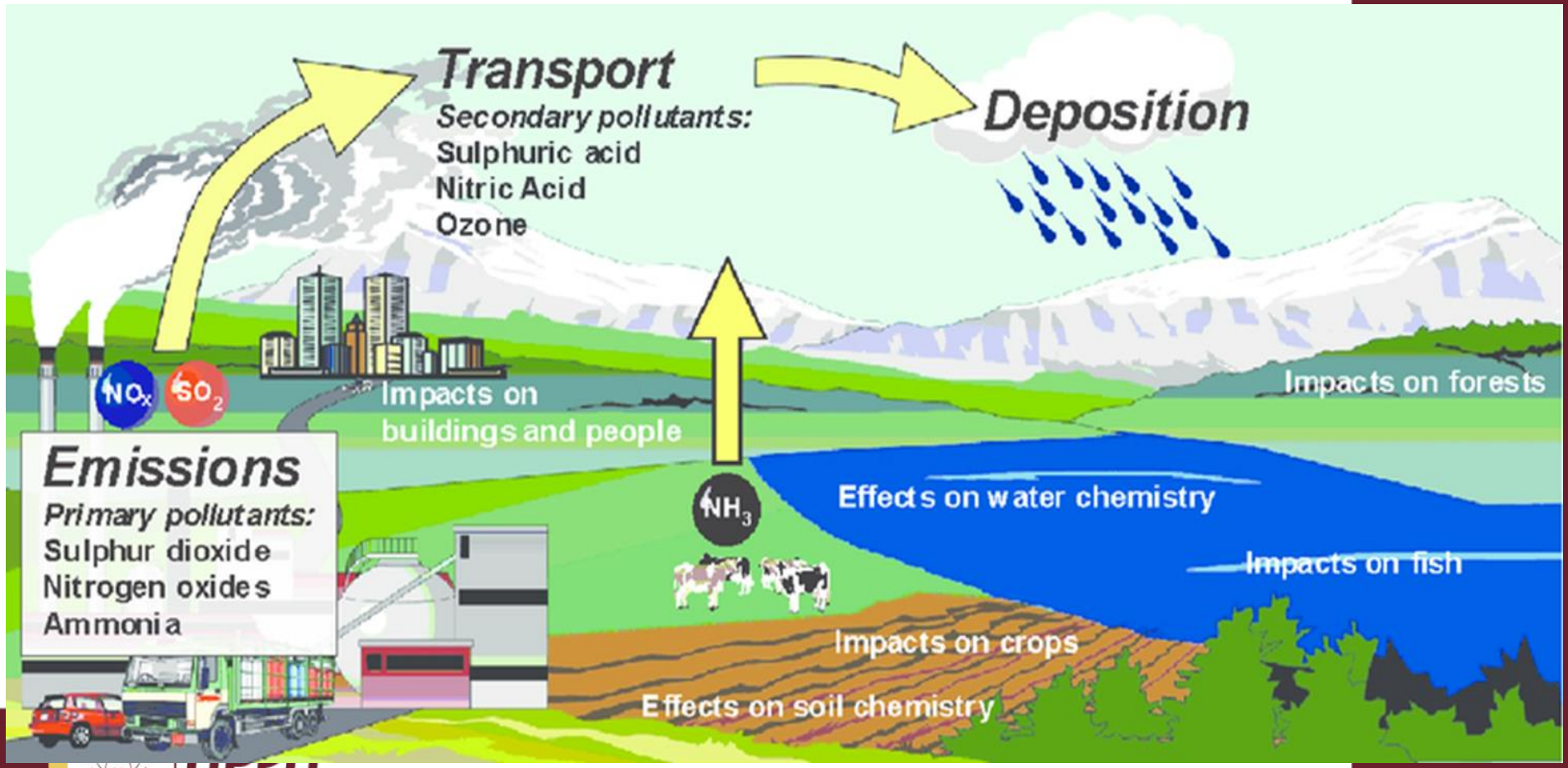
Based on origin



Air Pollution

Environment

CLASSIFICATION OF AIR POLLUTANT

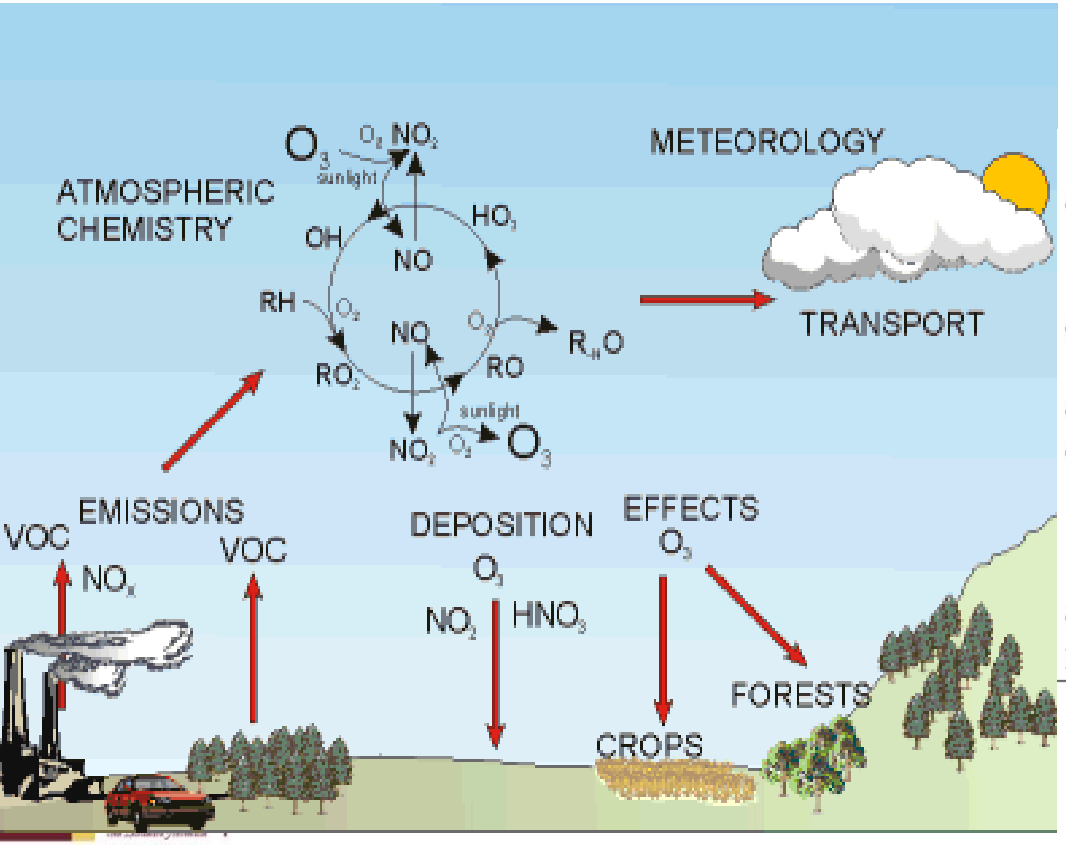


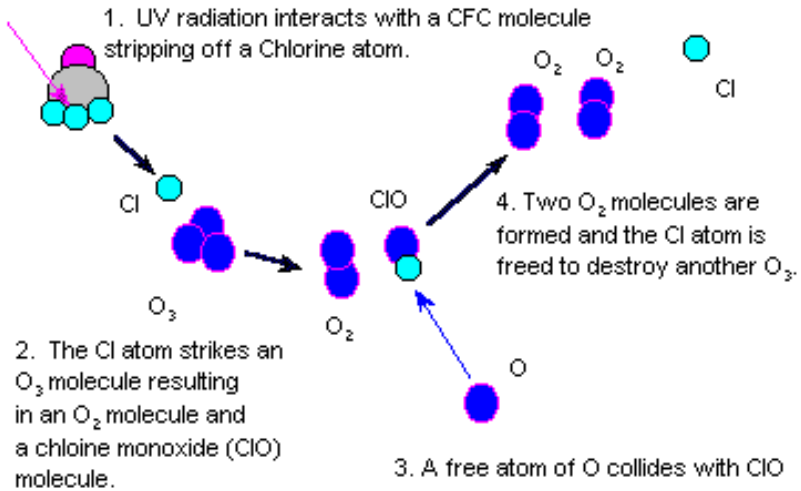
Air Pollution

Environment

CLASSIFICATION OF AIR POLLUTANT

- **Based on origin –**
  Tropospheric ozone formation





Tropospheric Ozone

Ozone from NO_x

$$NO_x + \text{radiations}\ (>380\ \text{nm}) \longrightarrow NO + O$$

$$O + O_2 \longrightarrow O_3$$

Ozone from carbon monoxide

$$CO + 2O_2 + h\nu \longrightarrow CO_2 + O_3$$

Ozone from methane

$$CH_4 + 4O_2 + 2h\nu \longrightarrow HCHO + H_2O + 2O_3$$

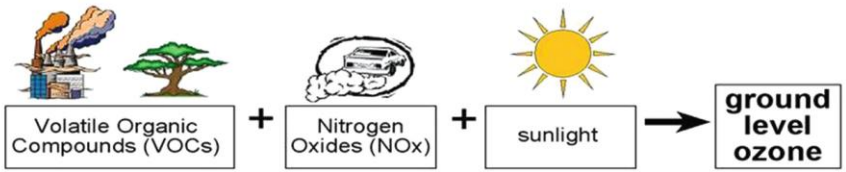
$$HCHO + h\nu \longrightarrow H + HCO\ (\lambda < 330\text{nm})$$

$$HCO + h\nu \longrightarrow H + CO\ (\lambda < 360\text{nm})$$

$$CO + 2O_2 + h\nu \longrightarrow CO_2 + O_3$$

Ozone from non methane hydrocarbons

$$RH + 4O_2 + 2h\nu \longrightarrow RCHO + H_2O + 2O_3$$



Air Pollution

CLASSIFICATION OF AIR POLLUTANT

Based type of origin

A. Radioactive and nuclear pollution

Releasing radioactive and nuclear pollutants into water, air, and soil during nuclear explosions and accidents from nuclear weapons, or handling or disposal of radioactive sewage

B. Noise pollution

Produced by machines, vehicles, traffic noises, and musical installations that are harmful to our hearing.

Air Pollution

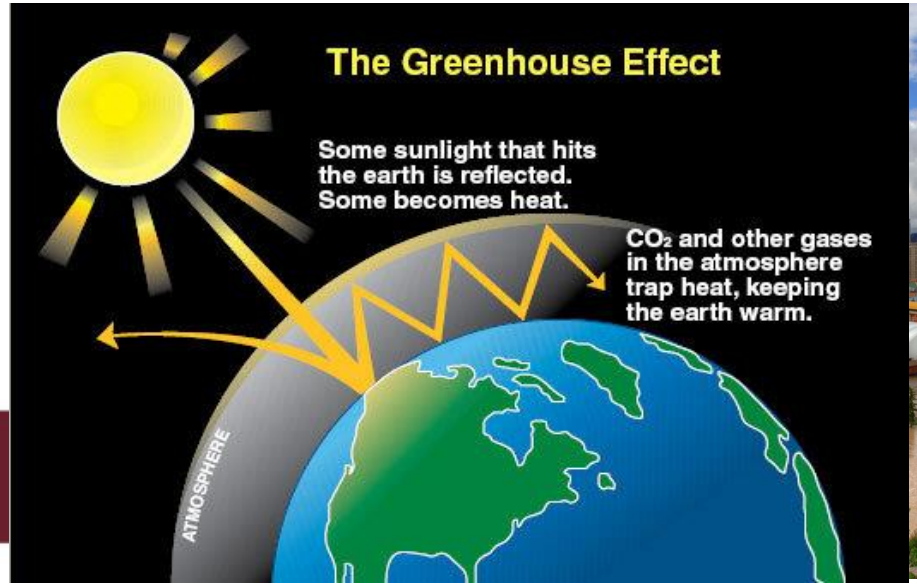
Environment

CLIMATE AND POLLUTION

Air pollution and climate change are closely related

Climate is the **other side** of the same **coin** that **reduces** the **quality** of our Earth

Pollutants as black carbon, methane, tropospheric ozone, and aerosols affect the amount of incoming sunlight, making the Earth temperature increased **(Global warming),** resulting in the melting of ice, icebergs, and glaciers.

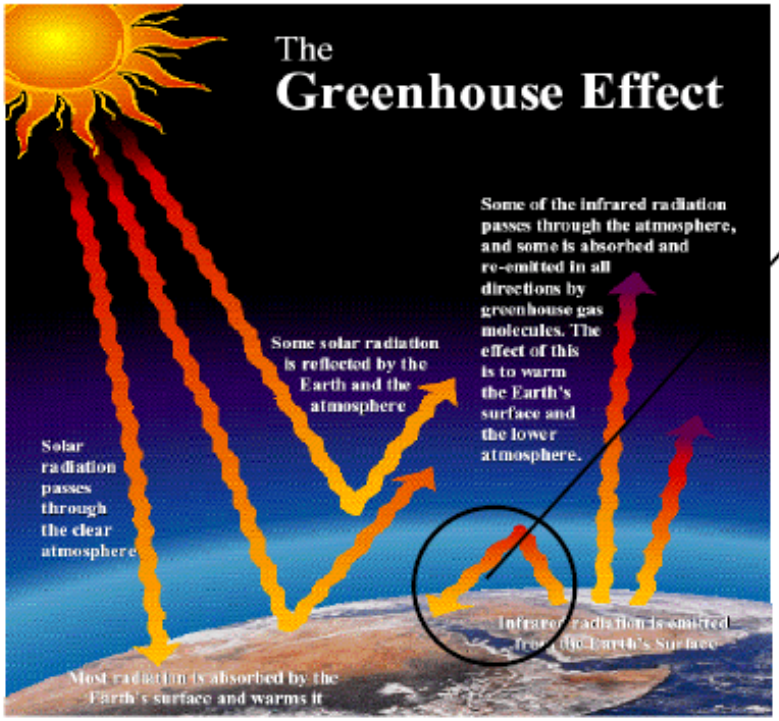


Air Pollution

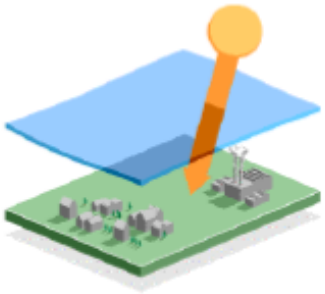
Environment

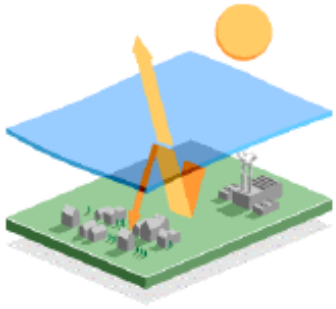
CLIMATE AND POLLUTION

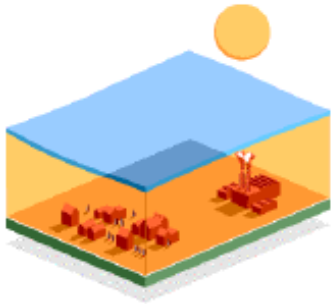
EFECTO INVERNADERO



Efecto Invernadero





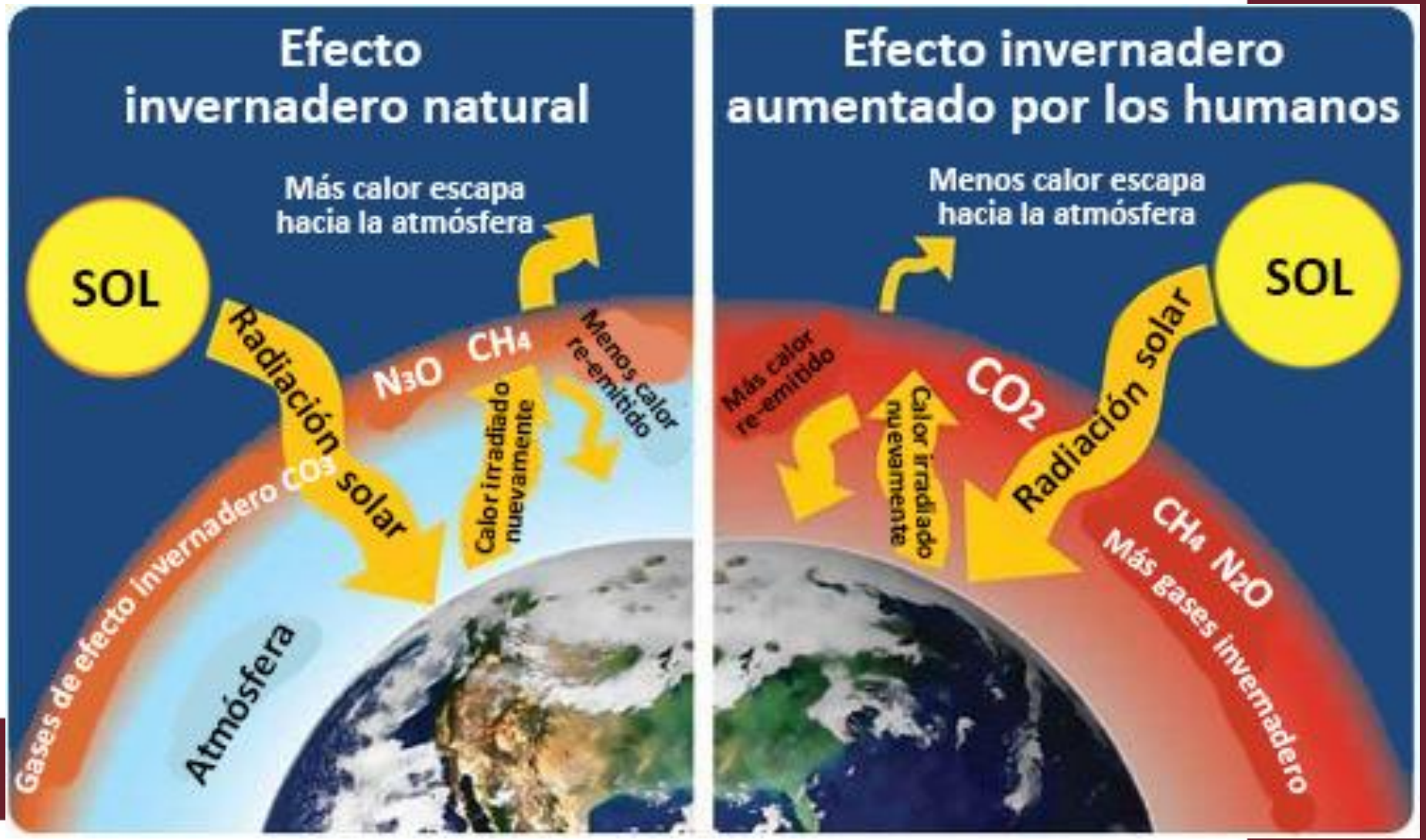


El efecto invernadero se produce en la atmósfera de forma natural debido a la presencia de vapor de agua, CO_2 y otros gases de efecto invernadero. Este efecto 'natural' es de responsable de que la temperatura en la superficie de la tierra sea 30°C superior a la que correspondería si no existiesen dichos gases

Air Pollution

Environment

CLIMATE AND POLLUTION

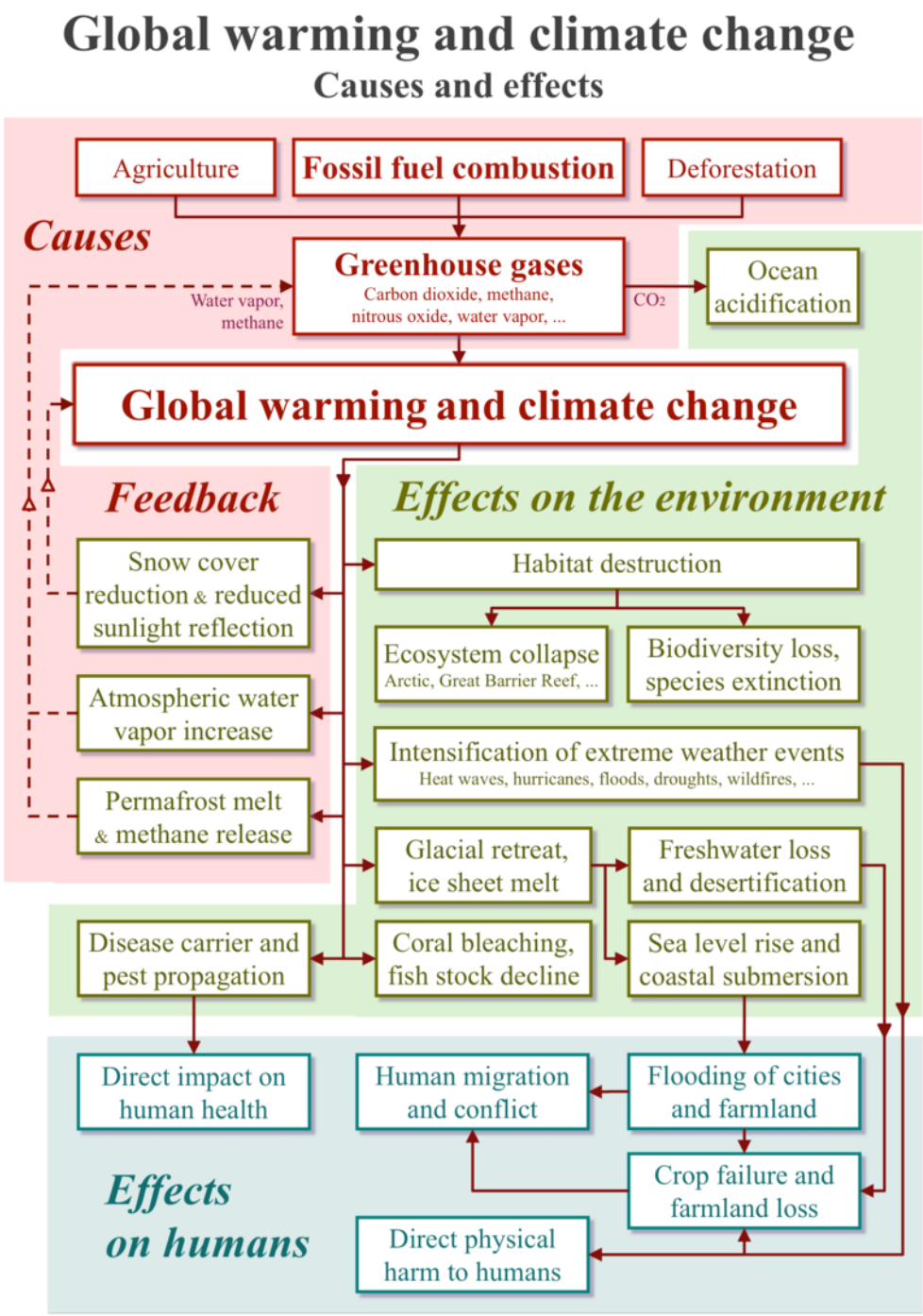


Air Pollution

Environment

CLIMATE AND POLLUTION

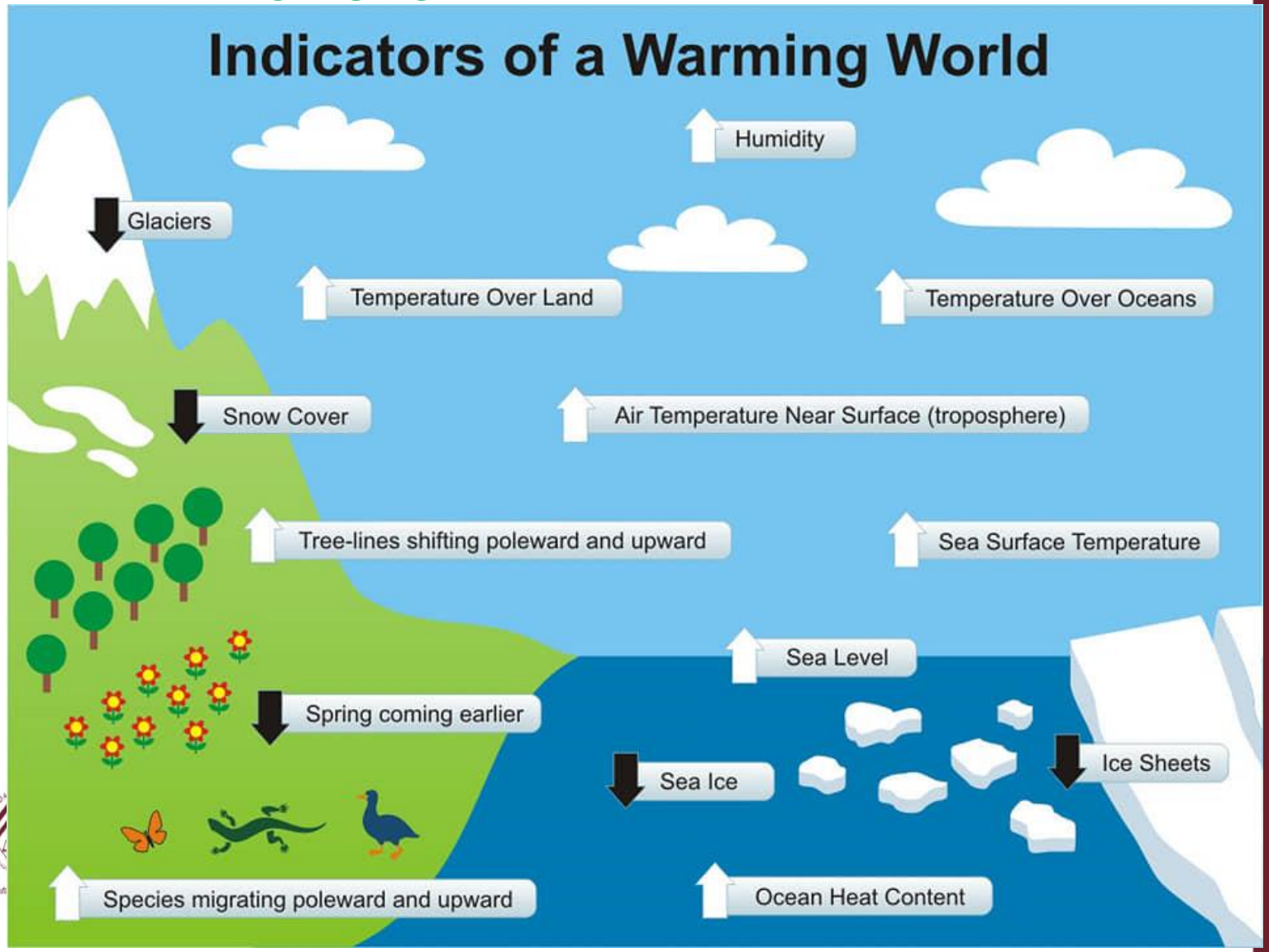
Aerosols compounds are tiny in size and considerably affect the climate. They are able to dissipate sunlight (the albedo phenomenon) by dispersing a quarter of the sun's rays back to space and have cooled the global temperature over the last 30 years (Schneider, 1989)



Air Pollution

Environment

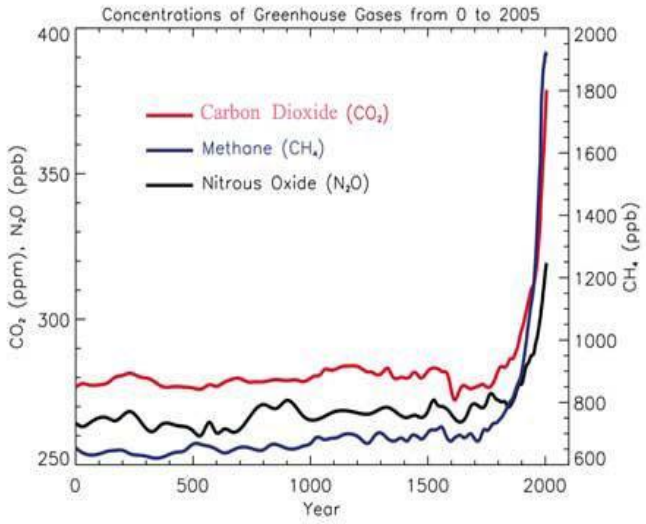
CLIMATE AND POLLUTION

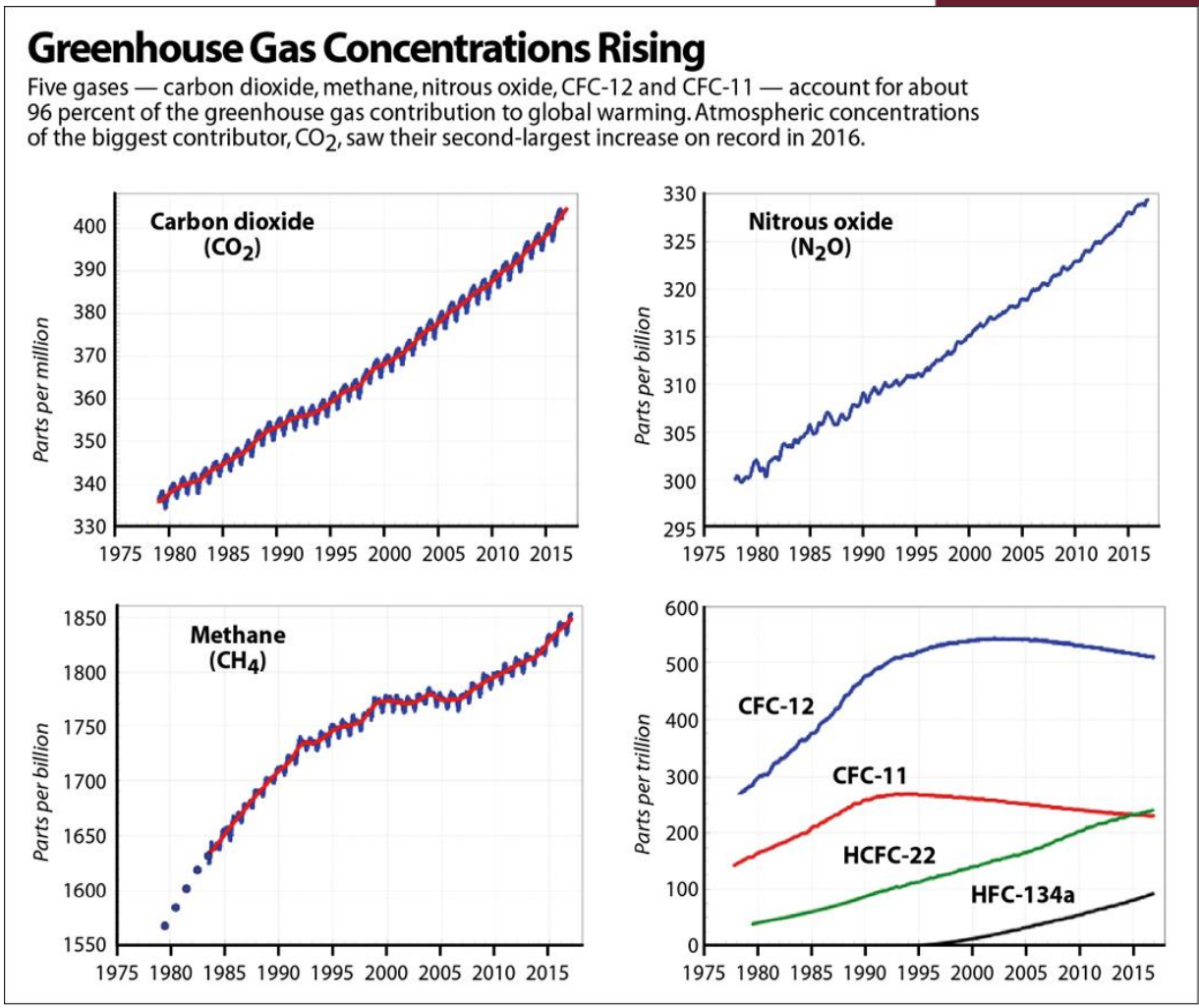


Air Pollution

Environment

CLIMATE AND POLLUTION





Air Pollution

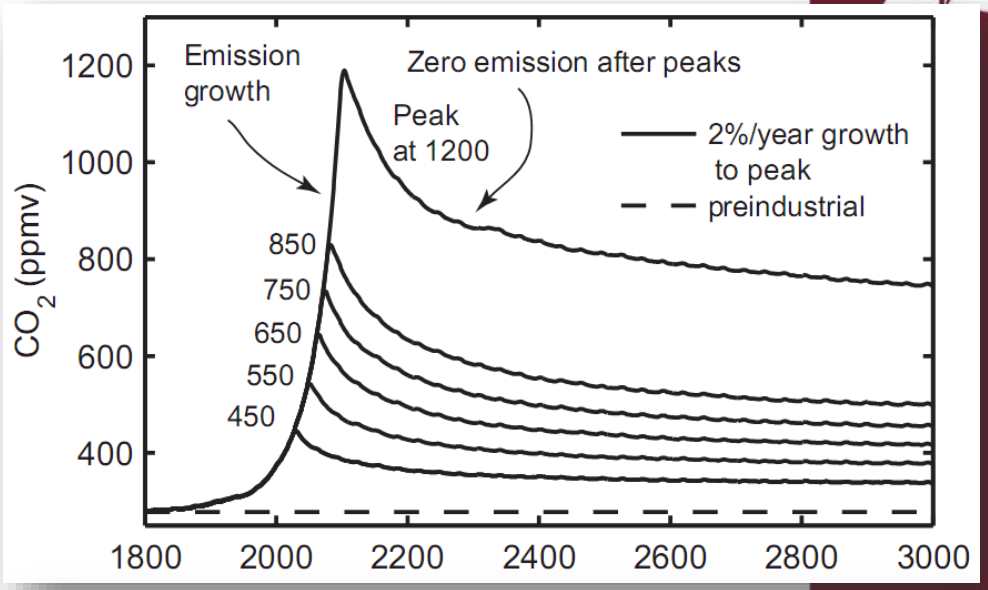
Environment

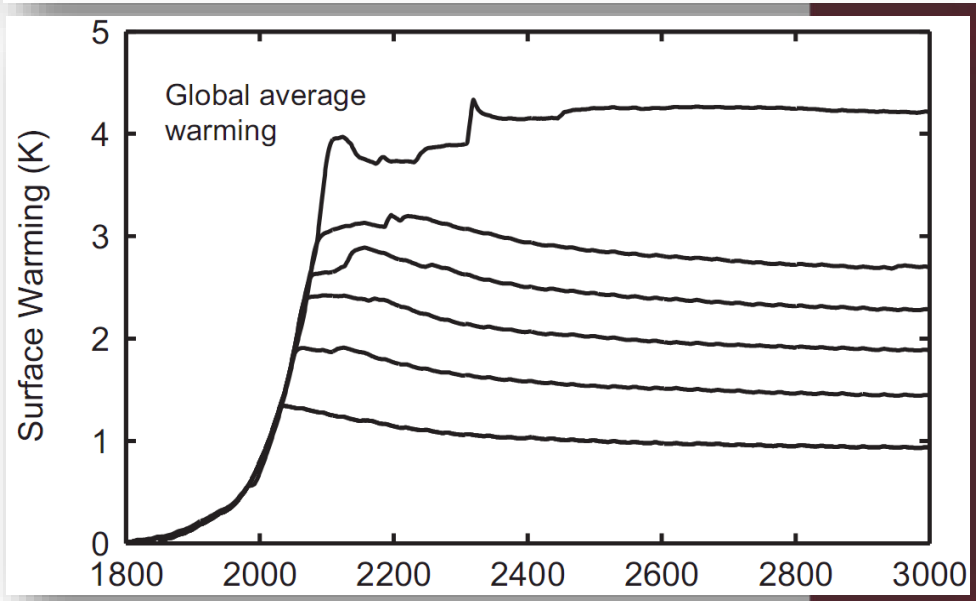
CLIMATE AND POLLUTION

How much time the CO_2 will affect the climate?

Susan Salomon PNAS Fev 2009

Note the scale: Till year 3000 ⟶





UPeU

Air Pollutants

Pollutants have differences in physical and chemical properties explaining the discrepancy in their capacity for producing toxic effects (Manisalidis et al., 2020)

Aerosols compounds have a **greater toxicity than gaseous compounds due** their **tiny size** (solid or liquid) in the atmosphere and because they **have a greater penetration capacity** (Colbeck et al., 2009; Incecik et al., 2014; Dámato et al., 2016)**.**

These particles (aerosols) are able to damage lungs and can even enter bloodstream, leading to the premature deaths of millions of people yearly (Ethical Unicorn, 2019)

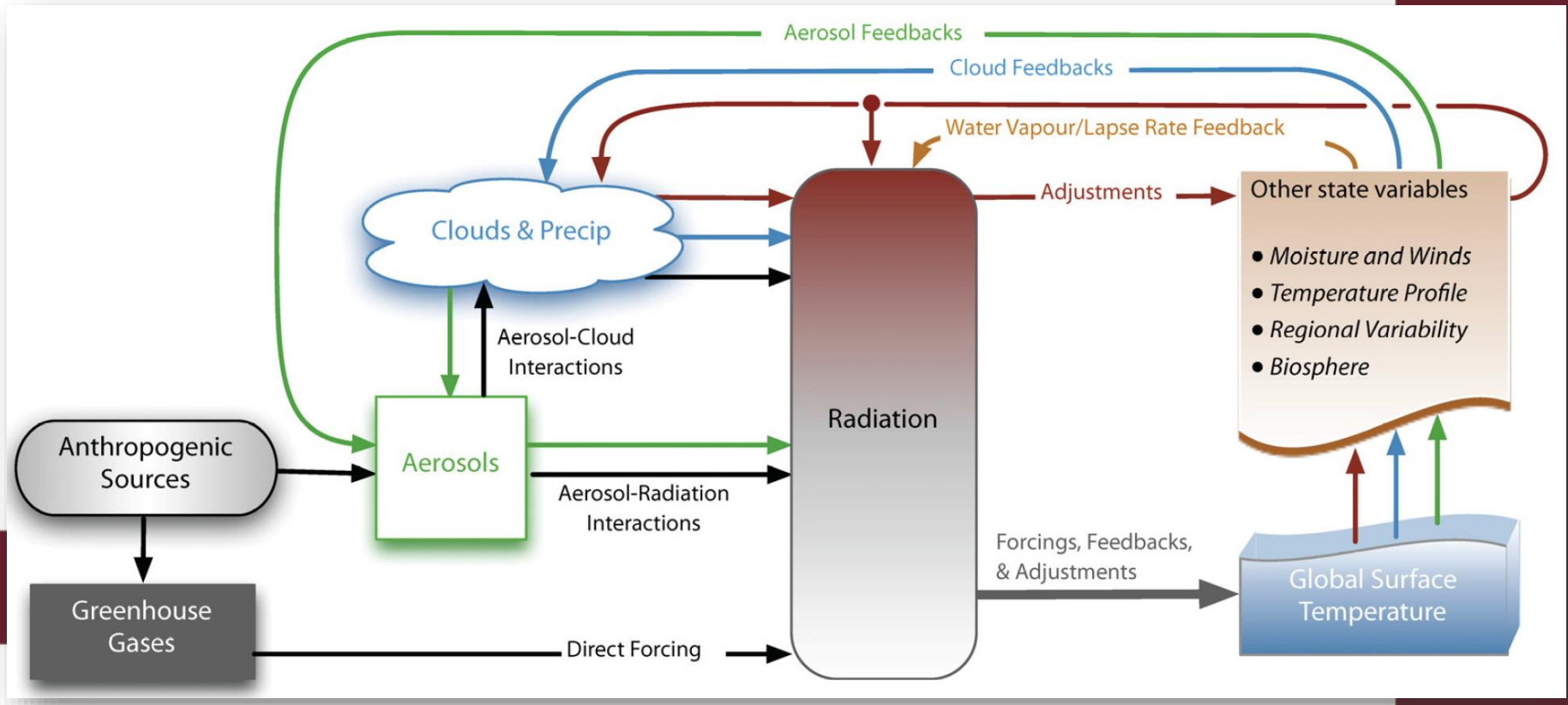
Gaseous compounds are eliminated more easily by our respiratory system (Ethical Unicorn, 2019)

Air Pollutants

Atmospheric aerosol or particulate matter

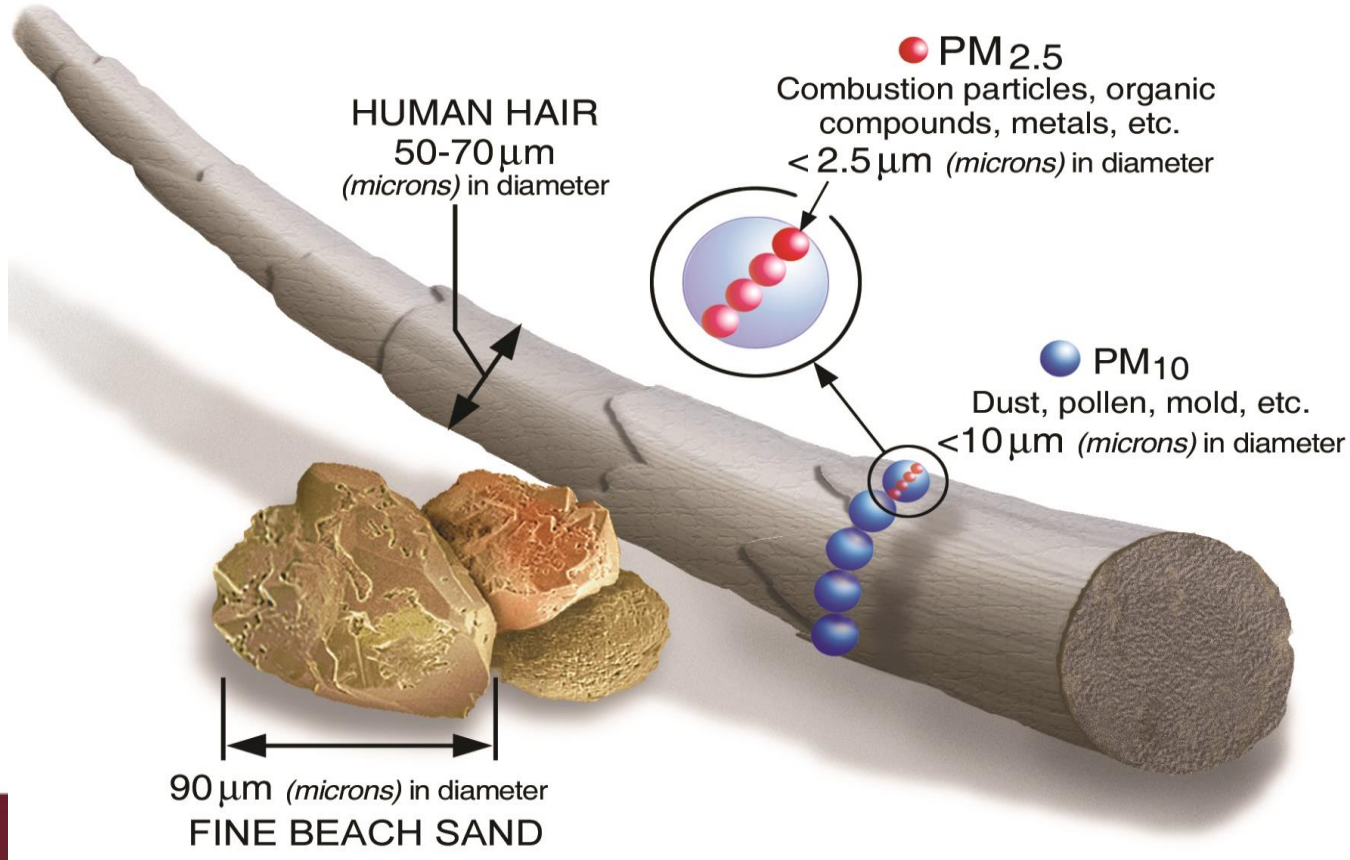
Feedbacks and forcing pathways involving clouds and aerosols

Forcing mechanisms are represented by black arrows; forcing agents are boxes with grey shadows, rapid forcing adjustments (also called rapid responses) are shown with brown arrows and feedbacks are other-coloured arrows.



Air Pollutants

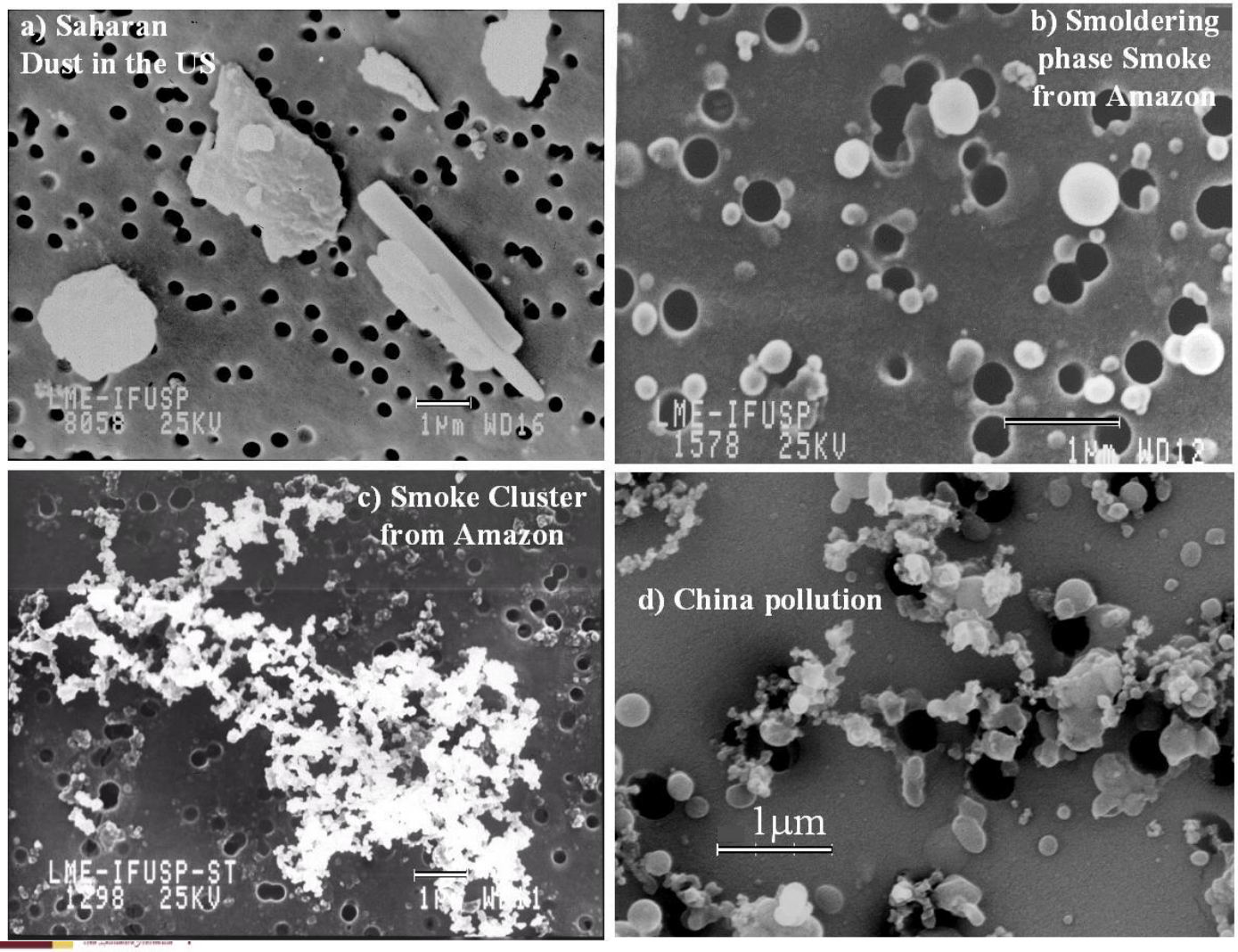
Atmospheric aerosol or particulate matter



PM is a complex mixture of airborne particles that differ in size, origin and chemical.

Air Pollutants

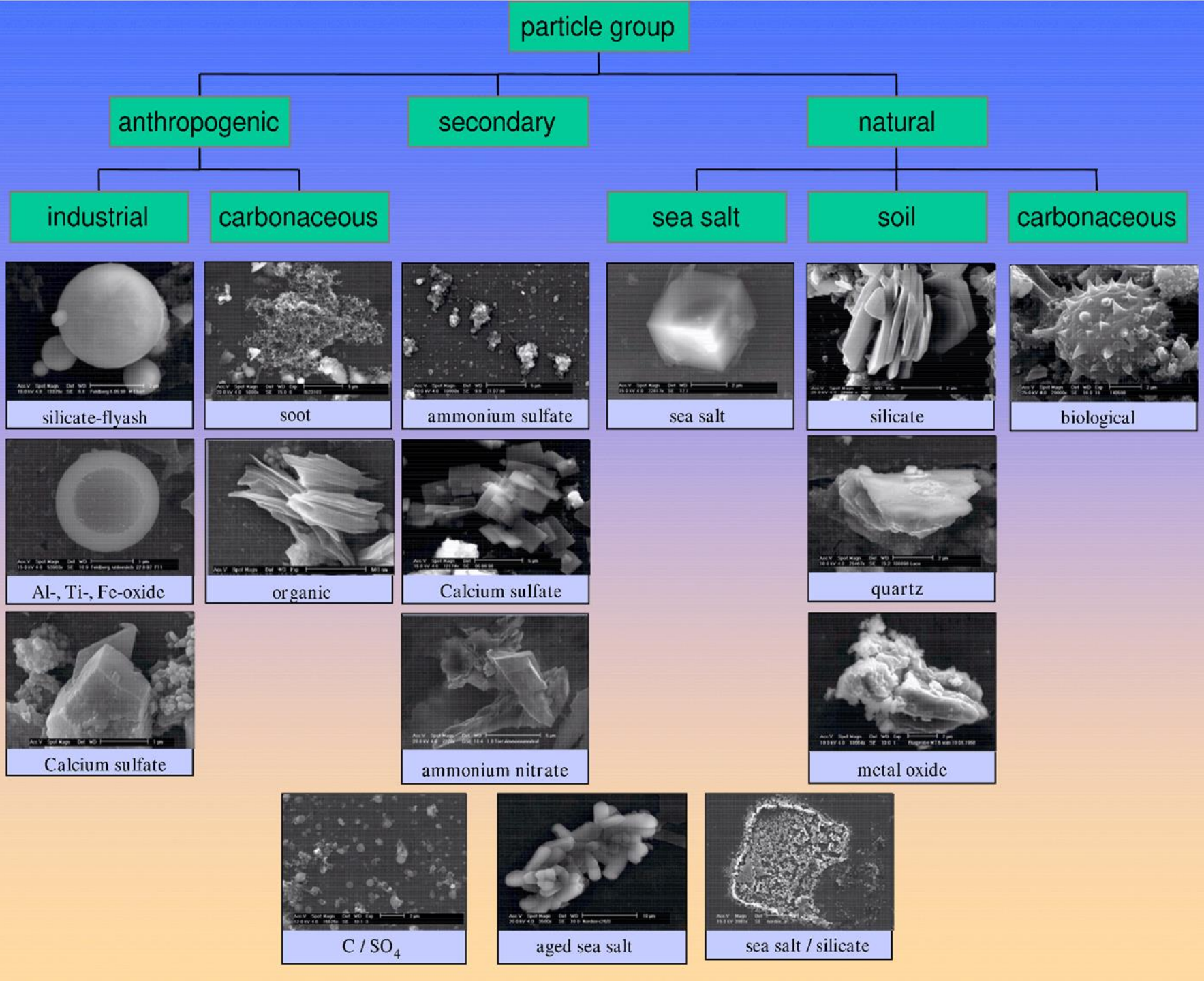
Atmospheric aerosol or particulate matter



The large diversity of aerosol particles

Scanning Electron Microscopy (SEM) characterization

José Vanderlei Martins photos


particle group
anthropogenic
secondary
natural
industrial
carbonaceous
sea salt
soil
carbonaceous
silicate-flyash
soot
ammonium sulfate
sea salt
silicate
biological
Al-, Ti-, Fe-oxide
organic
Calcium sulfate
quartz
Calcium sulfate
ammonium nitrate
metal oxide
C / SO4
aged sea salt
sea salt / silicate

Air Pollutants

Atmospheric aerosol or particulate matter

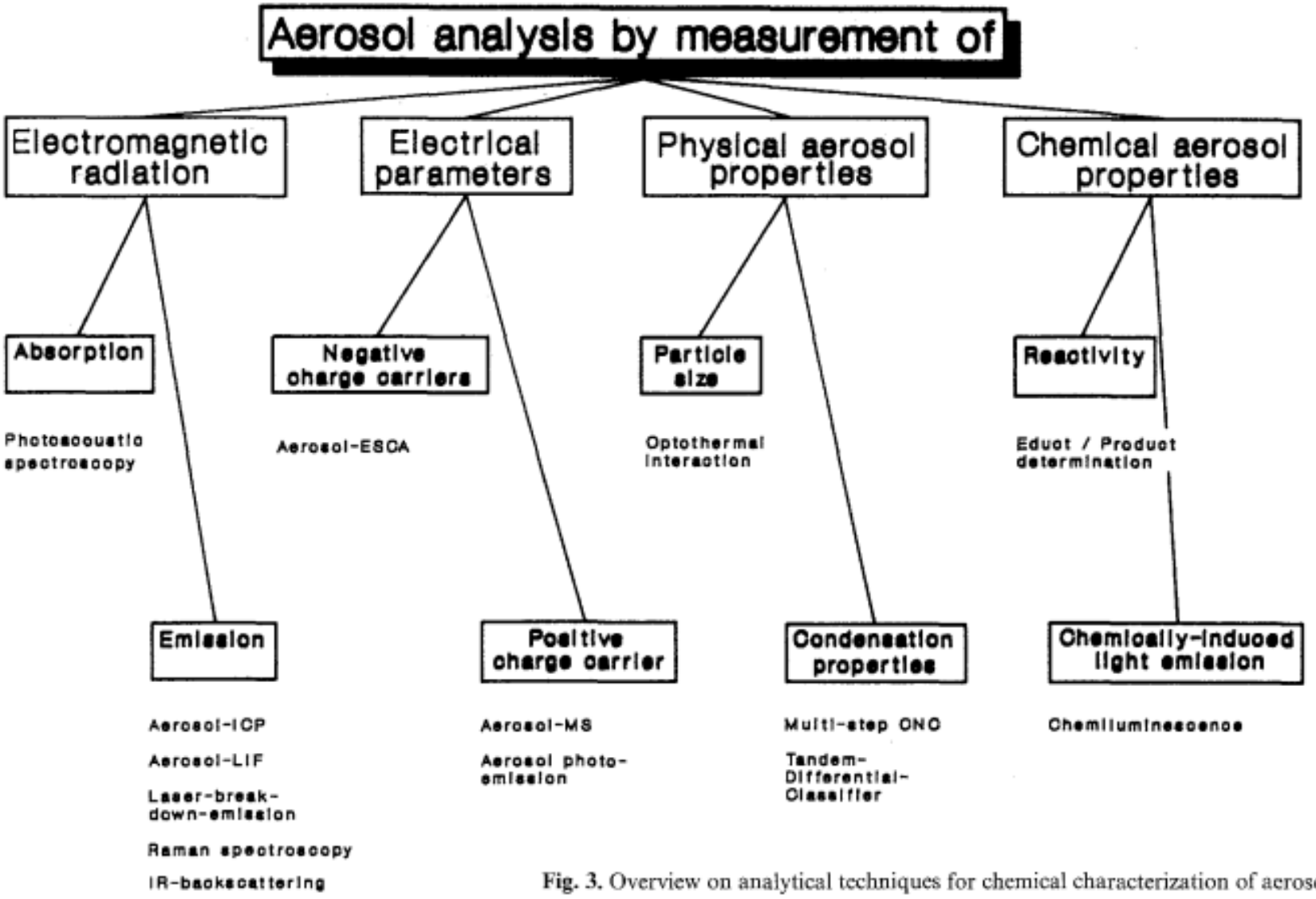


Fig. 3. Overview on analytical techniques for chemical characterization of aerosols

Air Pollutants

Atmospheric aerosol or particulate matter

The composition of PM depend on several factors.

- ❑ **Geographical area (soil composition)**
- ❑ **Meteorological variables (Speed and direction speed)**
- ❑ **Bordered area or not**
- ❑ **Human activities**
- ❑ **Large- transport pollutants**

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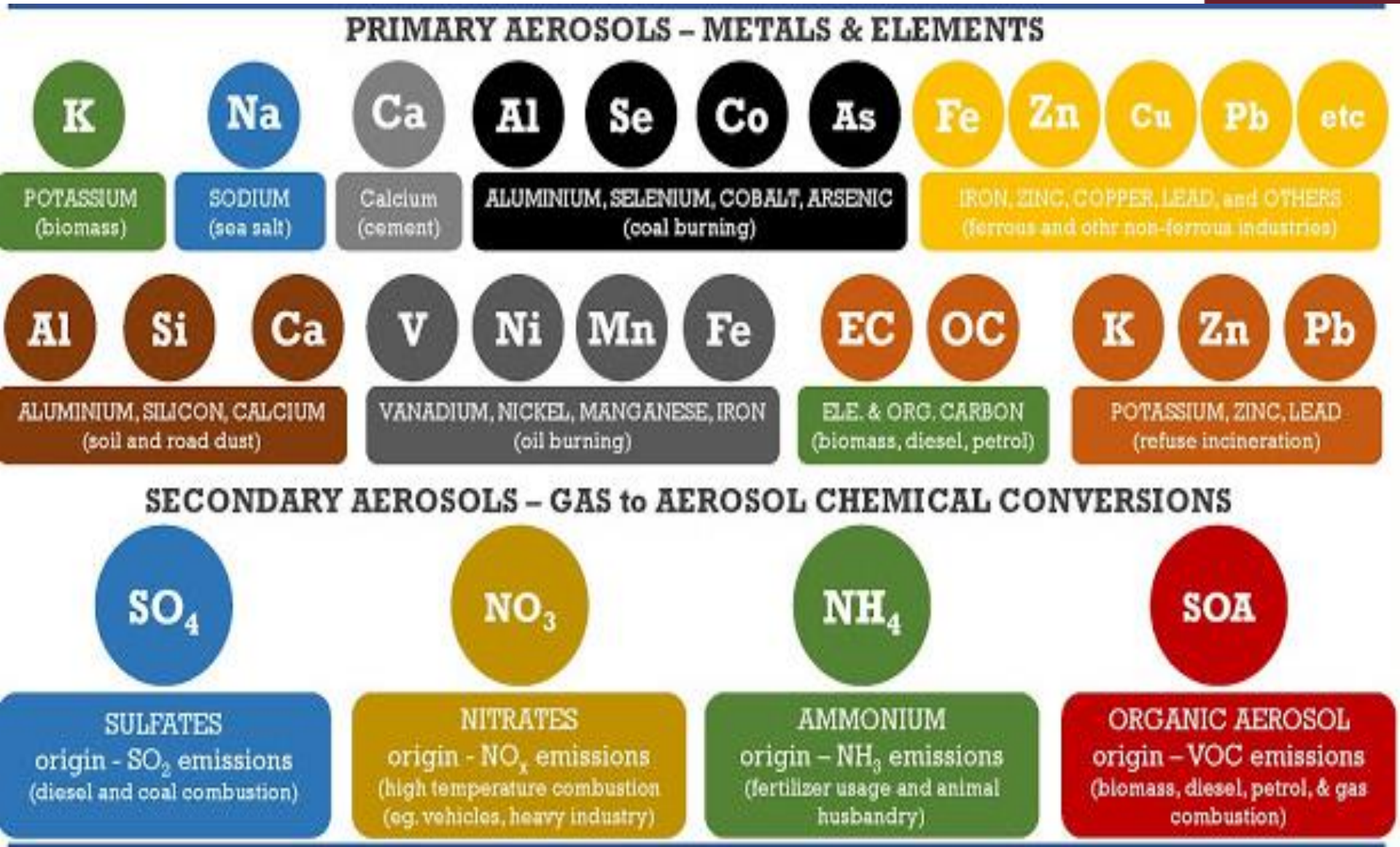
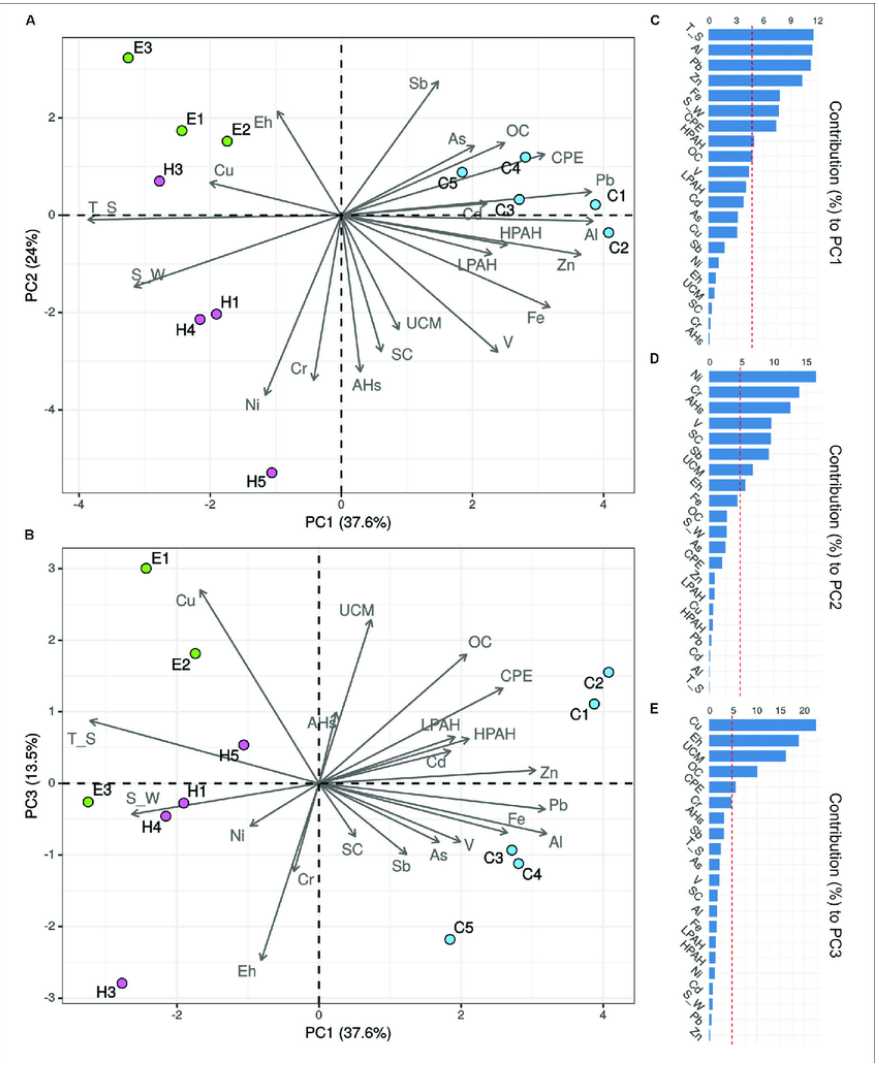
Air Pollutants

Atmospheric aerosol or particulate matter



Air Pollutants

Atmospheric aerosol or particulate matter – possible emission sources



PCA Principal component analysis

Dimensionality-reduction method

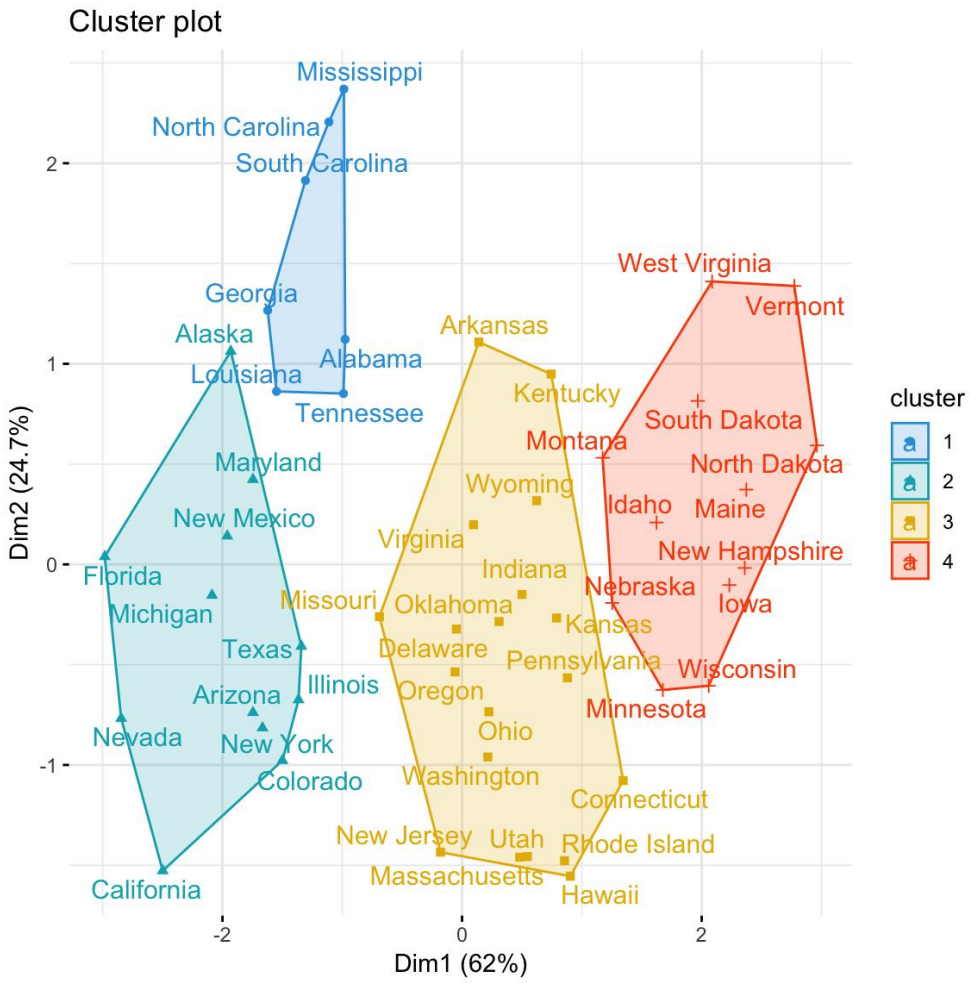
Transforming a large set of variables into a smaller one that still contains most of the information in the large set.

Table 3 Factor (Fa) loadings of the three extracted factors (principal component analysis, varimax standardized rotation) for *F. caperata* lichen samples (enrichment factor) and the respective communalities (comm). Loadings greater than 0.70 (shown in bold) are considered to be significant.

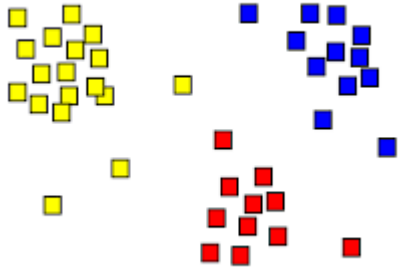
Element	Factors			
	Fa1	Fa2	Fa3	Comm
EF lichens				
Al	**0.80**	-0.11	-0.23	0.71
As	0.02	-0.15	**0.80**	0.66
Ba	**0.90**	0.28	-0.04	0.90
Ca	0.34	0.61	-0.15	*0.51*
Cd	0.01	-0.11	**0.90**	0.83
Cr	**0.84**	0.36	0.01	0.84
Cu	**0.85**	0.12	0.14	0.76
Fe	**0.87**	0.24	0.11	0.83
K	0.06	**0.87**	-0.10	0.78
Mn	0.22	0.11	0.60	*0.41*
Ni	**0.87**	-0.04	0.08	0.76
Pb	**0.76**	-0.29	0.25	0.73
Rb	-0.02	**0.77**	0.06	*0.59*
Sb	**0.86**	0.16	0.24	0.81
V	**0.87**	0.01	0.10	0.77
Zn	**0.92**	0.20	0.10	0.91
Eigenvalue	7.79	2.36	1.62	
% of total variance	0.47	0.14	0.13	
% of cumulative variance	0.47	0.61	0.74	

Air Pollutants

Atmospheric aerosol or particulate matter – possible emission sources



HCA
Hierarchical cluster analysis



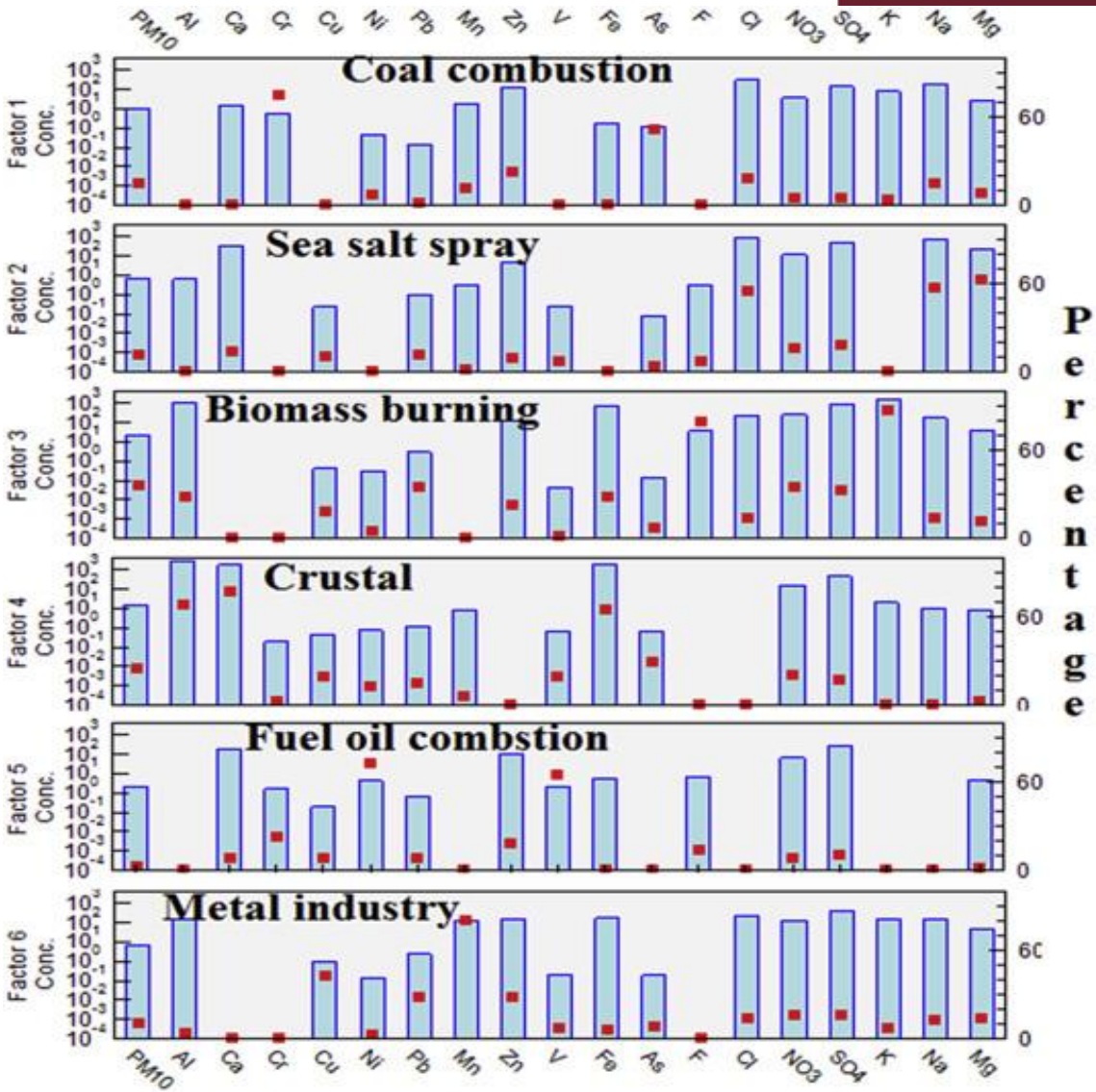
Air Pollutants

Atmospheric aerosol or particulate matter – possible emission sources

PMF
Positive Matrix Factorization Model

EPA United States Environmental Protection Agency

Source apportionment of PM
- ❑ Concentration pollutants
- ❑ Uncertainties



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Air Pollutants

Atmospheric aerosol or particulate matter – possible emission sources

PMF
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Source apportionment of PM
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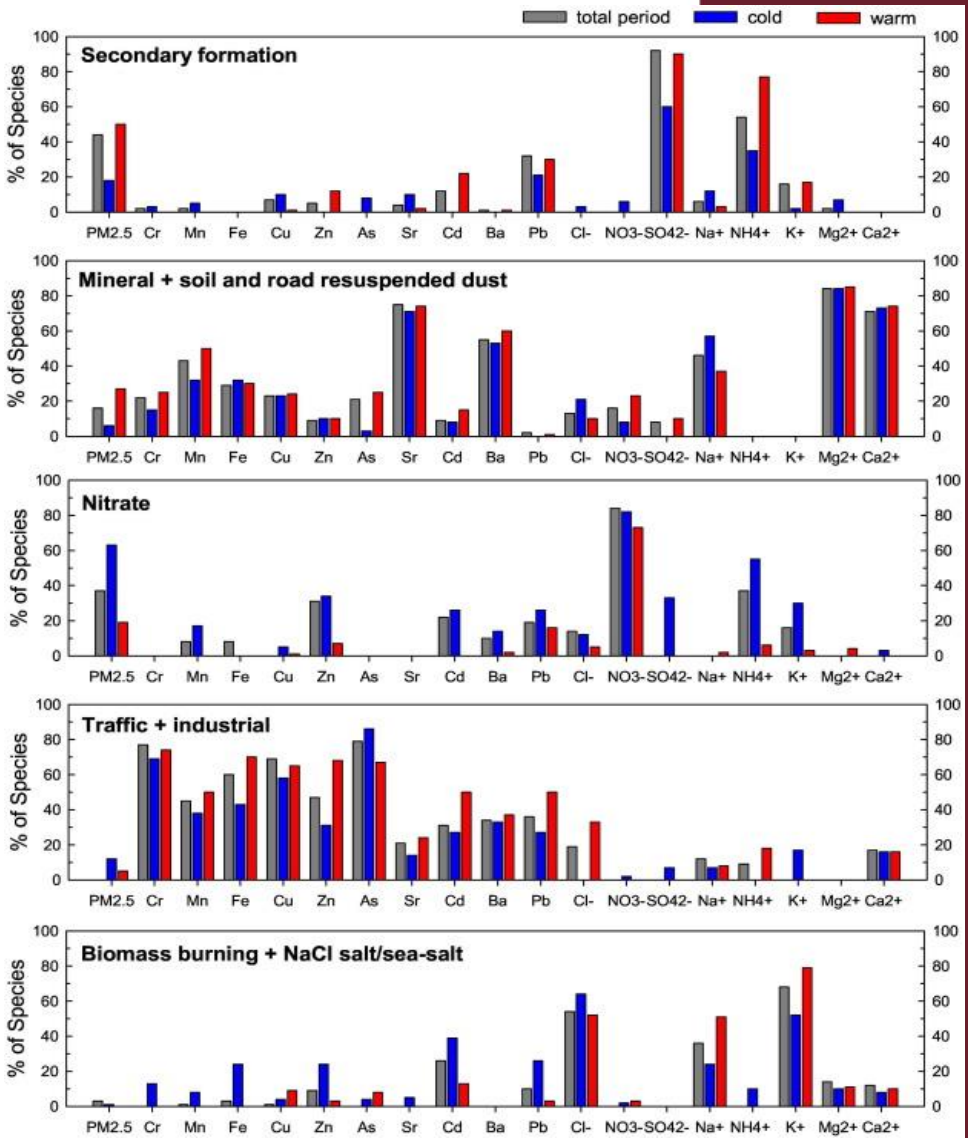
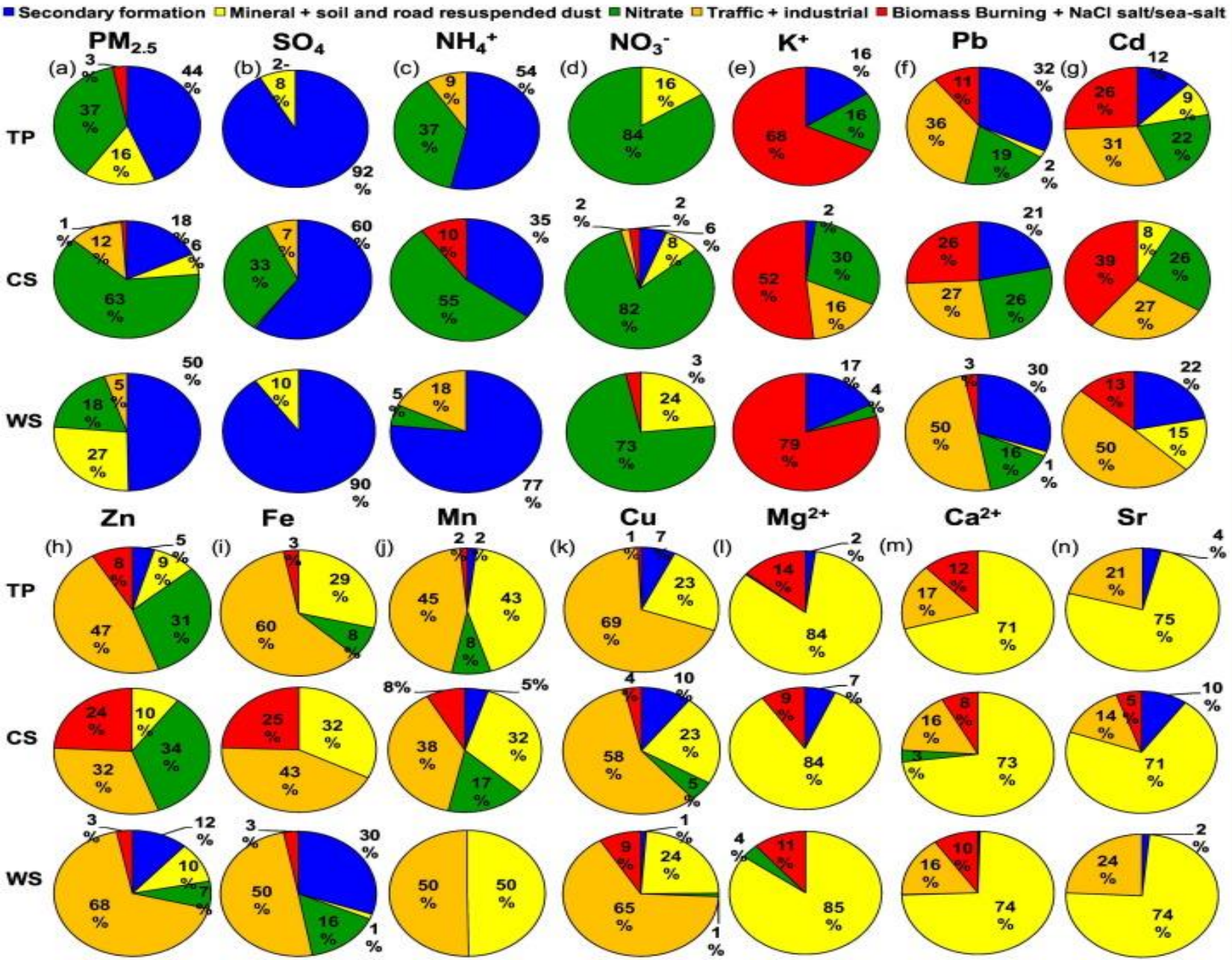


UPeU

Air Pollutants

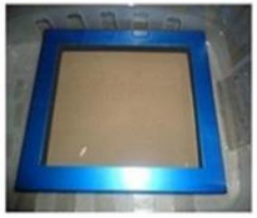


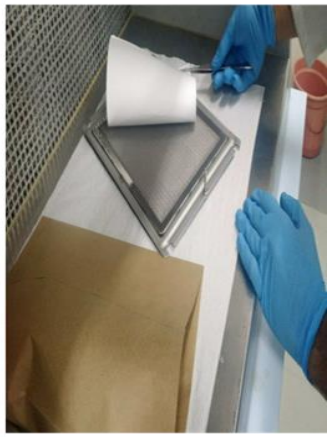
Biomonitoring

Biomonitoring is regarded as a means to assess trace element concentrations in aerosols and deposition (Wolterbeek, 2002)

This implies that the monitor should concentrate the elements of interest and quantitatively reflect its elemental ambient conditions (Wolterbeek, 2002)

TSP
PM_{10}
$PM_{2.5}$





Qualified Staff

Monitoring

- ❑ Some areas
- ❑ short time periods

Biomonitoring

Includes four concepts: biomarkers, bioindication, biointegration and bioaccumulation, which are articulated according to the levels of biological organization, what links up bio-surveillance (Hatje, 2015).

Is an appropriate tool for assessing the levels of atmospheric pollution, having **several advantages** compared with the use of direct measurements of contaminants (e.g., airborne particulate matter; atmospheric deposition, precipitation) (Smodis and Parr, 1999)

- **Related primarily to the permanent and common occurrence of chosen organisms in the field,**
- **Ease sampling,**
- **Trace element accumulation**
- **Provide a measure of integrated exposure over an extended period of time**
- **Biomonitoring remote areas without use expensive technical equipment**
- **Accumulate contaminants over the exposure time and concentrated them, facilitating analytical measurements**
- **Largescale biomonitoring studies**

Biomonitoring

Bio-organisms (Bioindicators or Biomonitors) are used to define the biosphere characteristics (Cuny, 2012).

Bioindicators

Provide information on the **quality**/health/degree of the environment.
A good bioindicator will indicate the presence of the pollutant.

Changes in the environment

Biological
Chemical
Behavioral
Physiological

→ **Bioindicators**

Biomonitoring

Bio-organisms (Bioindicators or Biomonitors) are used to define the biosphere characteristics.

Biomonitors

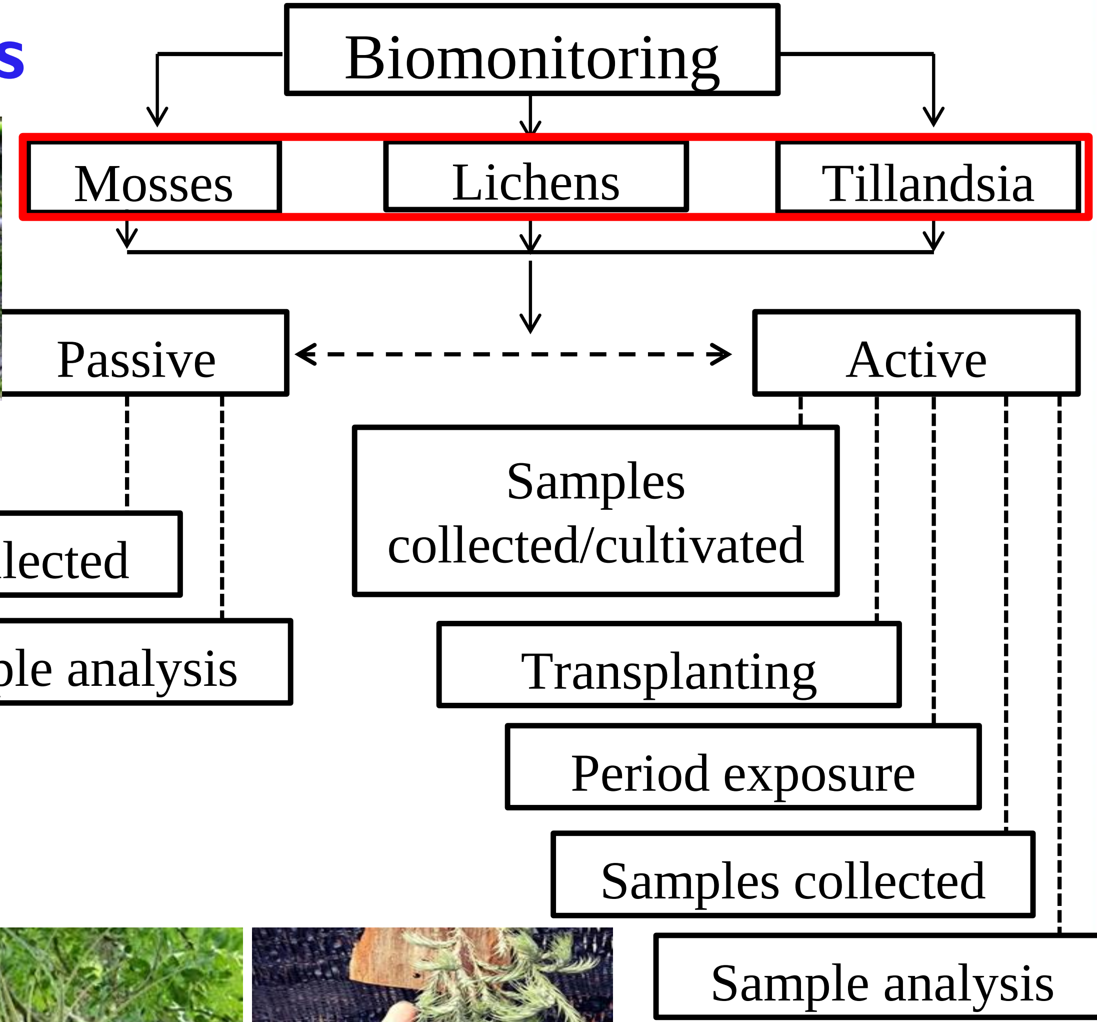
Are organisms that accumulate contaminants in their tissues and can be used to yield a relative measure of the total amount of contaminants in the environment integrated over a period of time.

- Polluted areas can be identified
- Applying appropriate statistical tools, information can be obtained possible pollution sources.

Biomonitoring

Biomonitoring Methods

BIOMONITORS



Bags

Biomonitoring

BIOMONITORS

- **Characteristics:**
- Accumulate pollutants without being killed
- wide geographical distribution
- Perennial,
- Resistant extreme conditions
- sedentary, scarce mobility, easy to collect and identify and
- Representative of area

Biomonitoring

BIOMONITORS

	Lichen	Tillandsia
Perennial	✓	
Distribution	✓	
resistant	✓	
Bioaccumulator	✓	

They do not cuticle or stoma, thus the different contaminants are absorbed over the entire surface of the organism.

Bromeliaceae family , its stems and leaves are covered by thricomes that absorb water and nutrients directly from the atmosphere

Biomonitoring

Trace element biomonitoring in the Peruvian Andes metropolitan region using *Flavoparmelia caperata* lichen

Biomonitoring

Objectives

- To use *Flavoparmelia caperata* lichen as a biomonitor to evaluate the pollution levels of different sites located in the MAH;
- Provide quantitative information concerning the concentration of some trace elements;
- Determine its possible sources of pollution

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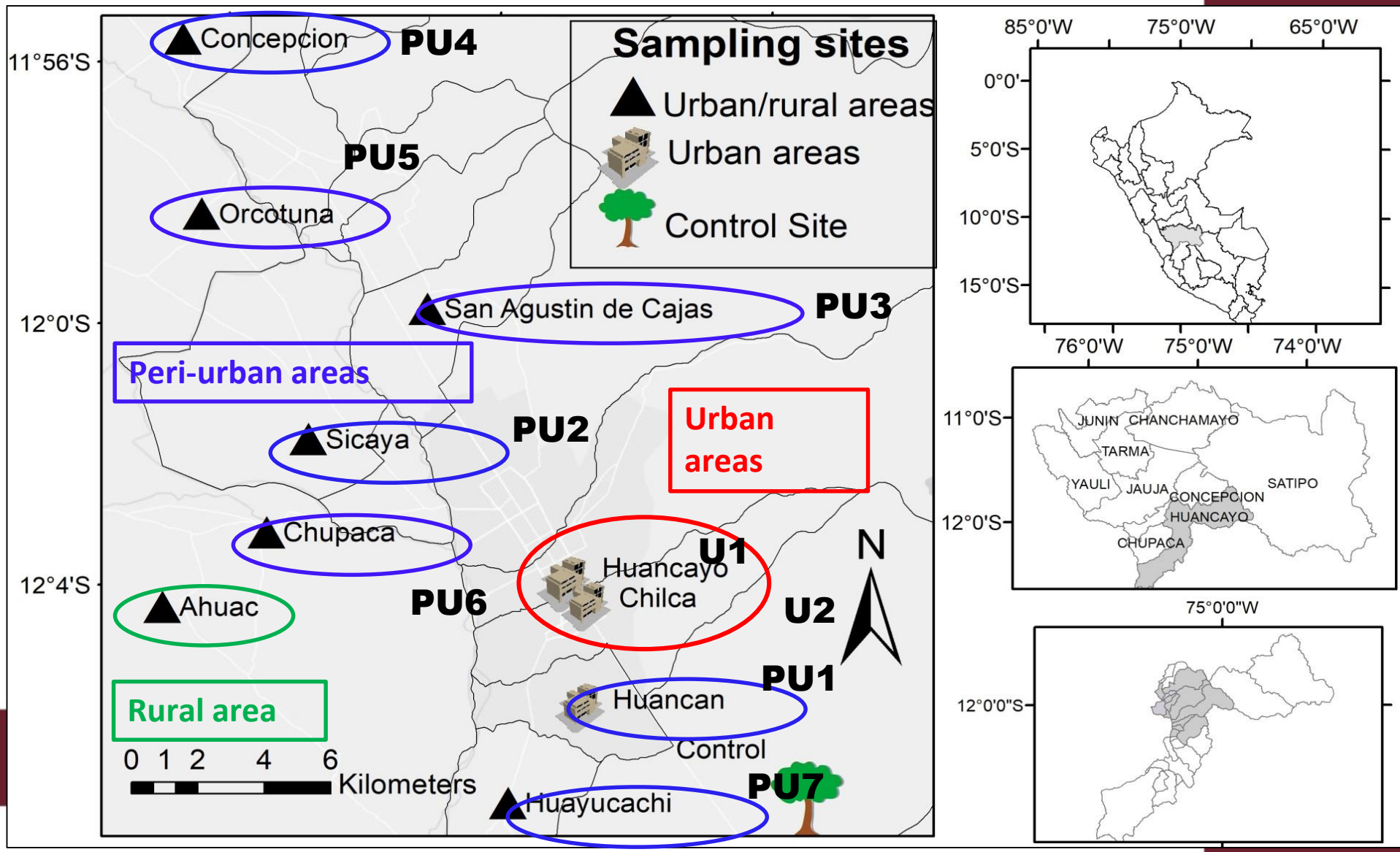
Biomonitoring

Study area



Biomonitoring

Study area

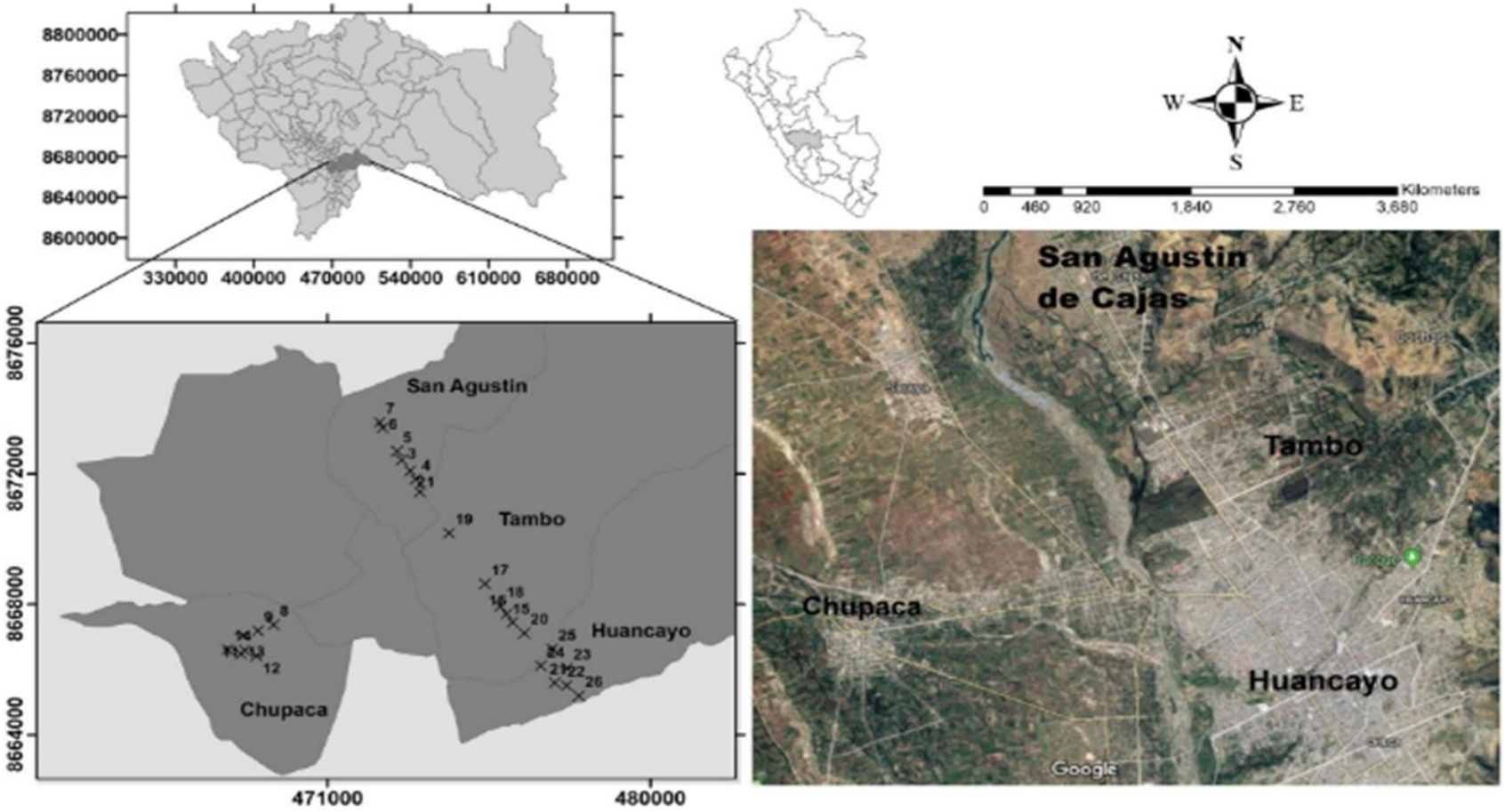
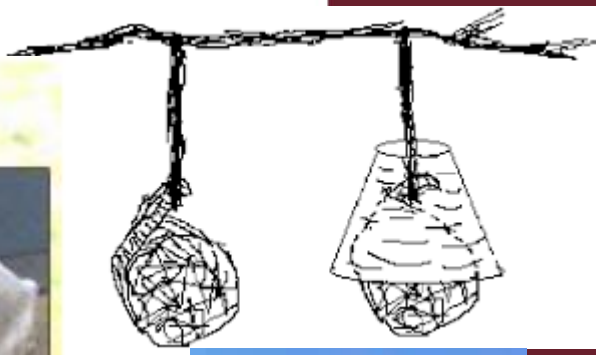


Figure 1. Biomonitoring exposure sites in the Metropolitan area of Huancayo, Peru. The Map was prepared with Arc GIS 10.0 software.

Biomonitoring

Methodology



Biomonitoring

Methodology

Active Biomonitoring

Clean area

Non -contaminated

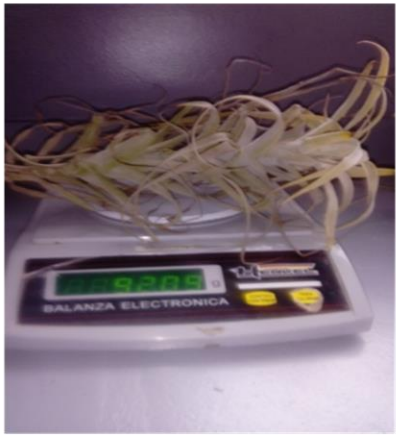
Samples collected

UPeU

Biomonitoring

Methodology

Pre-treatment



Manually cleaned, weighted to normalize

Transplanting

UPeU

Biomonitoring

Methodology

Pre-treatment

Manually cleaned, drying, grounded, and carried to Brazil.

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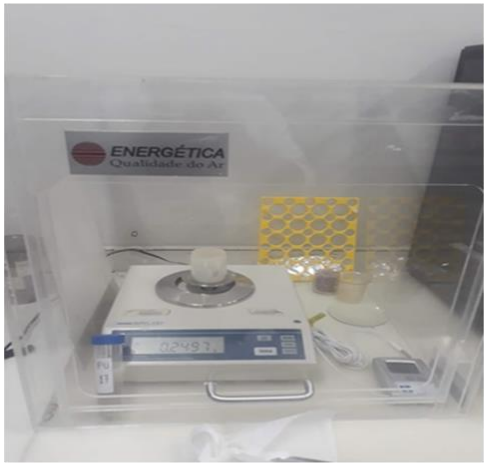
Biomonitoring

Methodology

Chemical Analysis



Weighted (3X), add acids, decomposition (digestion).

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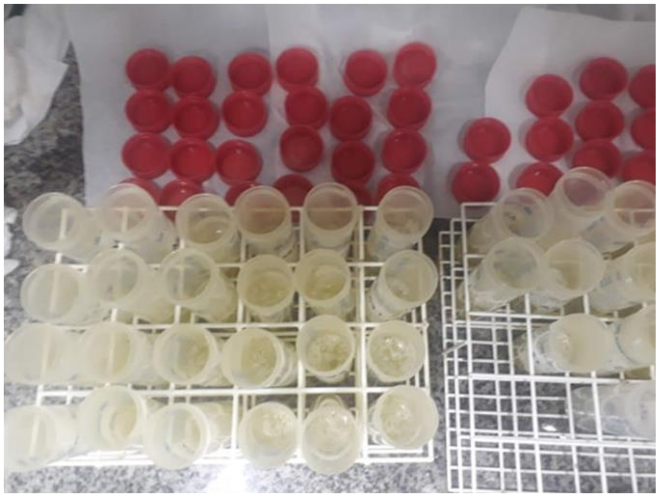
Biomonitoring

Methodology

Chemical Analysis



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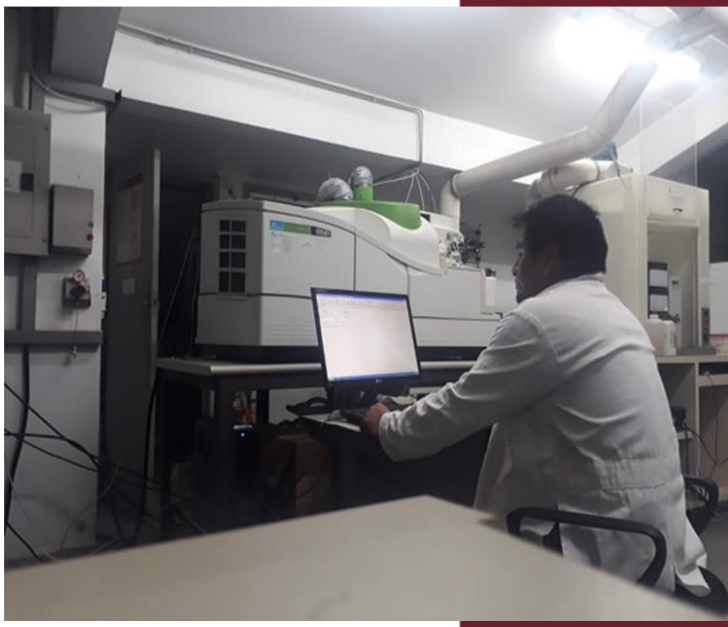
Biomonitoring

Methodology

Chemical Analysis

ICP-MS

Quantification trace elements



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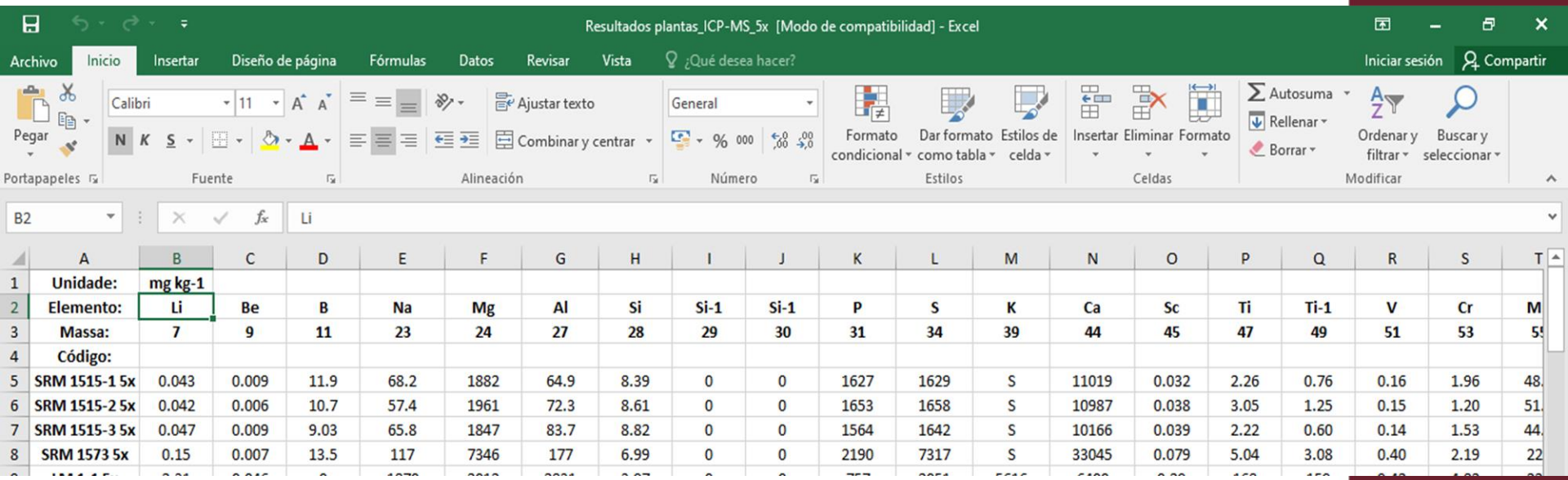
Biomonitoring

Methodology

RESULTADOS

RESULTS 65 elements measured by ICP-MS



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Unidade:	mg kg-1																		
2	Elemento:	Li	Be	B	Na	Mg	Al	Si	Si-1	Si-1	P	S	K	Ca	Sc	Ti	Ti-1	V	Cr	M
3	Massa:	7	9	11	23	24	27	28	29	30	31	34	39	44	45	47	49	51	53	5
4	Código:																			
5	SRM 1515-1 5x	0.043	0.009	11.9	68.2	1882	64.9	8.39	0	0	1627	1629	S	11019	0.032	2.26	0.76	0.16	1.96	48
6	SRM 1515-2 5x	0.042	0.006	10.7	57.4	1961	72.3	8.61	0	0	1653	1658	S	10987	0.038	3.05	1.25	0.15	1.20	51
7	SRM 1515-3 5x	0.047	0.009	9.03	65.8	1847	83.7	8.82	0	0	1564	1642	S	10166	0.039	2.22	0.60	0.14	1.53	44
8	SRM 1573 5x	0.15	0.007	13.5	117	7346	177	6.99	0	0	2190	7317	S	33045	0.079	5.04	3.08	0.40	2.19	22

UPeU

Biomonitoring

Methodology – statistical analysis

C:/Users/US/OneDrive/2016-II/Thesegraduate/Rtreatment - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Untitled1* | PCAFactoMiner.R | clusterobjandvariables.R | ANOVA.R | Barplotwit

```
1  pcaEF <- read.table("pcaEF.csv", header = TRUE, sep = ",", dec=".")
2
3  #PACKAGE psych with VARIMAX
4  ###http://renatabrandt.github.io/EBC2015/PCA.html
5  library(psych)
6
7  log.ir <- log(pcaEF[,2:17]) # skewness transformation
8  #to treat the skweness of the dataset or Box an Cox transforation
9  ir.names <- pcaEF[,1]
10 # Apply PCA - scale.=TRUE is highly advisable, but default is FALSE
11
12 ## to determine previously the number of principal components
13 fa.parallel(log.ir, fa="pc", show.legend = T,
14             main = "Screen plot with parallel analysis")
15 ### answer or result obtained
16 #Parallel analysis suggests that the number
17 #of factors =  NA  and the number of components =  3
18
19 library(GPArotation) # iF the number of components is
```

17:54 (Top Level) R Script

Console C:/Users/US/OneDrive/2016-II/Thesegraduate/Rtreatment/

```
Data]

>
>
> library(psych)
Warning message:
package 'psych' was built under R version 3.3.3
> log.ir <- log(pcaEF[,2:17]) # skewness transformation
> ir.names <- pcaEF[,1]
> fa.parallel(log.ir, fa="pc", show.legend = T,
+             main = "Screen plot with parallel analysis")
Parallel analysis suggests that the number of factors =  NA  and the number of
components =  3
> library(GPArotation) # iF the number of components is
>
```

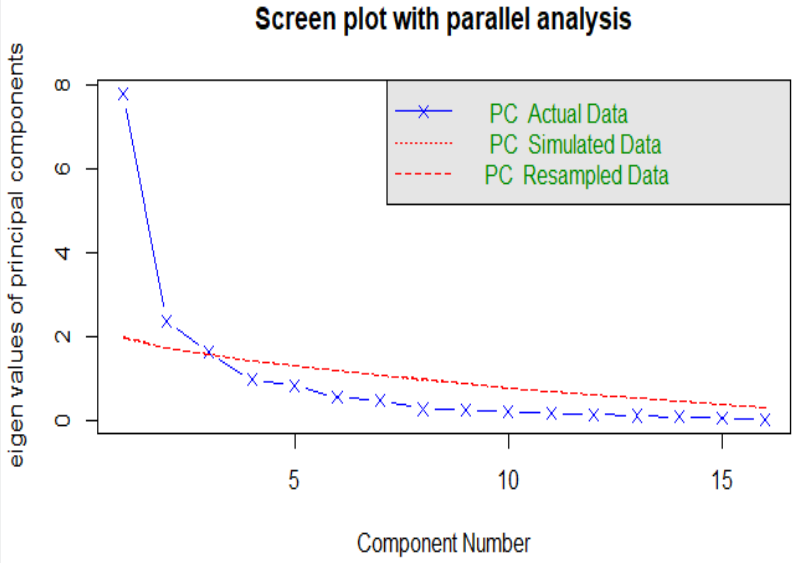
Environment | History

Import Dataset | List | Global Environment

Data	
log.ir	63 obs. of 16 variables
pcaEF	63 obs. of 17 variables
Values	
g	List of 9
ir.names	Factor w/ 10 levels "AH","C","Ch",..: 5 5 5 5 5 5 5 4 4 4…

Files | Plots | Packages | Help | Viewer

Zoom | Export | Publish



Biomonitoring

Methodology

Table 2. Comparison of mean values (± standard deviation) with µg g^{-1} dry weight (DW) and results of the analysis of variance (ANOVA) of the trace elements measured in F. caperata lichen at monitoring sites and control site from the metropolitan area of Huancayo, Junín, Peru.

Element	CS N=5	U1 N=7	U2 N=5	PU3 N=6	R N=6	PU6 N=7	PU1 N=6	PU2 N=6	PU5 N=6	PU4 N=8	PU7 N=6	ANOVA p-value [a]
Al (%)	.44±0.02 f	0.61±0.02 b	0.66±0.02 a	0.59±0.02 c	0.52±0.02 e	0.61±0.02 b	0.61±0.02 b	0.58±0.02 c	0.52±0.02 e	0.54±0.02 d	0.58±0.02 c	***
As	3.7±0.4 d	4.0±0.5 d	3.8±0.6 d	4.7±0.5 c	4.2±0.6 d	5.2±0.5 b	4.7±0.6 c	4.2±0.5 d	4.2±0.4 d	6.2±0.7 a	5.2±0.4 b	***
Ba	26±3 g	79±2 a	71±3 b	46±2 e	38±2 f	78±2 a	62±3 c	47±2 e	39±3 f	52±3 d	51±3 d	***
Ca (%)	.07±0.05 d	1.41±0.04 e	1.48±0.06 e	1.11±0.06 f	1.00±0.06 c	1.31±0.05 a	1.34±0.07 b	0.98±0.04 c	0.95±0.03 c	1.29±0.05 a	1.04±0.03 d	***
Cd	.13±0.04 e	0.34±0.04 d	0.31±0.04 d	0.43±0.05 c	0.34±0.05 d	0.56±0.06 a	0.46±0.05 b	0.43±0.03 c	0.49±0.04 b	0.58±0.04 a	0.45±0.05 c	***
Cr	3.8±0.4 g	9.6±0.4 b	9.4±1.0 b	7.2±0.3 d	5.8±0.3 f	10±0.5 a	7.9±0.5 c	6.7±0.4 e	6.5±1.0 e	7.1±0.4 d	7.1±0.5 d	***
Cu	5.0±0.4 f	9.6±0.5 a	9.0±0.6 b	7.4±0.5 d	4.9±0.7 f	9.3±0.5 a	8.3±0.8 c	5.7±0.3 e	4.9±0.4 f	8.9±0.7 b	7.9±1.0 c	***
Fe (%)	.20±0.02 f	0.36±0.02 a	0.33±0.01 b	0.29±0.02 c	0.23±0.02 e	0.35±0.02 a	0.31±0.02 c	0.24±0.02 e	0.26±0.02 d	0.30±0.02 c	0.28±0.02 d	***
K (%)	.47±0.03 b	0.56±0.02 d	0.54±0.02 d	0.43±0.02 e	0.60±0.02 a	0.60±0.03 a	0.49±0.04 b	0.47±0.01 b	0.51±0.03 c	0.52±0.02 c	0.45±0.01 e	***
Mn	60±3 e	85±3 d	81±4 d	90±2 b	81±3 d	103±4 a	88±6 b	98±3c	86±4 d	86±2 d	83±3 d	***
Ni	2.4±0.3 d	3.7±0.4 a	3.7±0.3 a	3.5±0.3 a	2.8±0.2 b	3.7±0.3 a	3.7±0.2 a	3.2±0.3 c	2.9±0.2 b	3.2±0.2 c	3.3±0.2 c	***
Pb	8.7±1.2 e	26±3 b	26±3 b	22±3 c	8.7±2 e	19±4 d	25±3 b	22±3 c	17±3 d	32±4 a	22±3 c	***
Rb	9±2 c	13±2 a	12±2 a	9±1 c	13±3 a	14±3 a	10±2 c	9±2 c	9±2 c	13±3 b	10±2 c	***
Sb	.91 ± 0.06 e	1.81±0.16 a	1.67±0.17 a	1.30±0.15 b	0.82±0.09 d	2.05±0.18 a	1.81±0.40d	1.10±0.12 b	1.02±0.13 d	1.91±0.17 a	1.50±0.13 c	***
V	3.7±0.5 f	8.1±0.6 b	9.6±0.4 a	5.5±0.3 d	3.5±0.2 f	8.5±0.3 b	7.0±0.7 c	5.2±0.2 d	4.8±0.4 e	5.9±0.3 d	5.5±0.5 d	***
Zn	50±4 g	141±5 a	136±6 a	78±5 d	61±4 f	140±8 a	115±4 b	69±4 e	66±5 e	110±6 b	96±4 c	***

[a] Values on each horizontal line followed by the same letter do not differ significantly (p=0.05), N=number of individual lichen samples collected in each site.
* Significant at 0.05 probability level. ** Significant at 0.01 probability level. *** Significant at 0.001 probability level.

Biomonitoring

Methodology

Enrichment Factor

$$EF_E\,(\%) = \frac{CE_A - CE_{CS}}{CE_{CS}}\, x\, 100$$

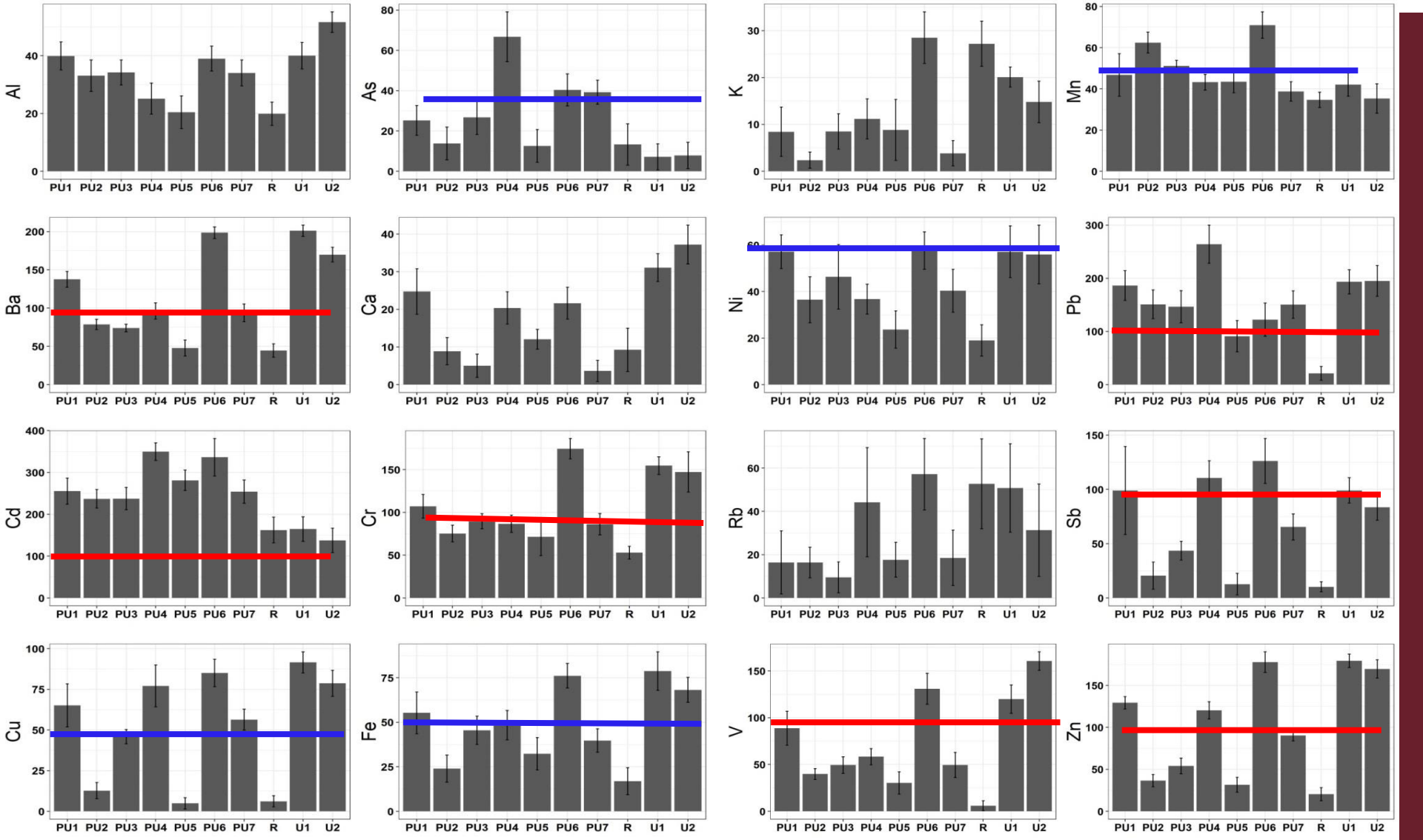
EF > 100 Significant Enrichment (twice the control site)

50 < EF < 100 moderately enriched

EF < 50 normal conditions

Biomonitoring

Methodology



Biomonitoring

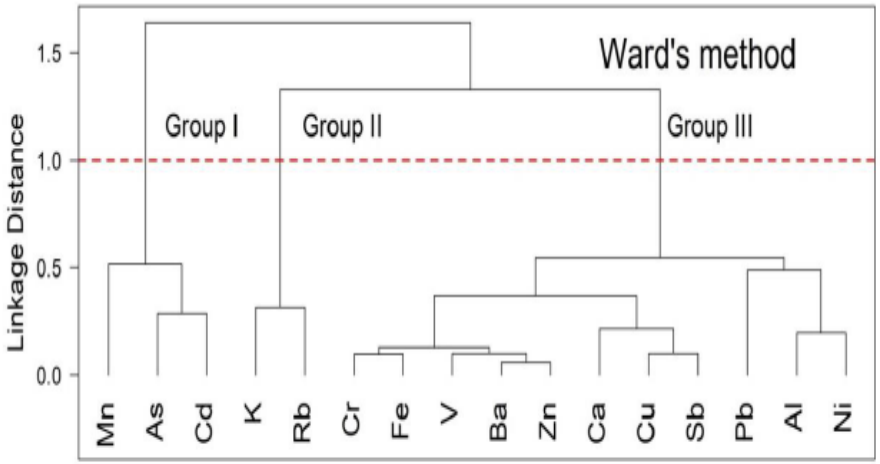
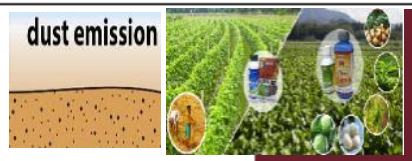


Figure 3.3 Results of the hierarchical cluster analysis (dendrogram) of the trace element concentrations measured in F. caperata.

Table 3 Factor (Fa) loadings of the three extracted factors (principal component analysis, varimax standardized rotation) for *F. caperata* lichen samples (enrichment factor) and the respective communalities (comm). Loadings greater than 0.70 (shown in bold) are considered to be significant.

Element	Factors			
	Fa1	Fa2	Fa3	Comm
EF lichens				
Al	**0.80**	-0.11	-0.23	0.71
As	0.02	-0.15	**0.80**	0.66
Ba	**0.90**	0.28	-0.04	0.90
Ca	0.34	0.61	-0.15	*0.51*
Cd	0.01	-0.11	**0.90**	0.83
Cr	**0.84**	0.36	0.01	0.84
Cu	**0.85**	0.12	0.14	0.76
Fe	**0.87**	0.24	0.11	0.83
K	0.06	**0.87**	-0.10	0.78
Mn	0.22	0.11	0.60	*0.41*
Ni	**0.87**	-0.04	0.08	0.76
Pb	**0.76**	-0.29	0.25	0.73
Rb	-0.02	**0.77**	0.06	*0.59*
Sb	**0.86**	0.16	0.24	0.81
V	**0.87**	0.01	0.10	0.77
Zn	**0.92**	0.20	0.10	0.91
Eigenvalue	7.79	2.36	1.62	
% of total variance	0.47	0.14	0.13	
% of cumulative variance	0.47	0.61	0.74	



Biomonitoring
Paper published!!!

Bulletin of Environmental Contamination and Toxicology
https://doi.org/10.1007/s00128-021-03185-9

Atmospheric Metal Biomonitoring Along a Highway Near Atlantic Rainforest Environmental Protection Areas in Southeastern Brazil

Karmel Beringui[1] · Alex Rubén Huamán De La Cruz[1,2,3] · Luiz Francisco Pires Guimarães Maia[4] · Adriana Gioda[1]

Received: 30 August 2020 / Accepted: 10 March 2021

Abstract
Vehicles are quite possibly the main sources of particulate matter, and their emissions can cause damage to surrounding ecosystems. Traditional atmospheric monitoring, however, is expensive. Therefore, airborne biomonitoring is an alternative method that allows for air quality assessment. In this study, we evaluated air quality at a federal highway (BR-040) close to Atlantic Rainforest remnants by quantifying metals in biomonitor tissues by ICP-MS. *Tillandsia usneoides* and *Tillandsia stricta* plants were relocated to the investigation zone and collected after five months of exposure. Metal concentration profiles were evaluated using statistical analyses, namely exposure-to-reference (ER) ratios and enrichment factors (EF). Results indicate that V, Cr, Fe, Cu, Zn and Sn enrichment were observed in all study sites. The EF for Cr, Mn, Pb, Ni, Co, Cu, Zn, Cd, and Sn ranged from high to very high, indicating anthropogenic sources. Both species were effective atmospheric biomonitors, proving to be an important tool, mainly in areas where conventional monitoring is not possible.

Keywords Air pollution · Bioaccumulation · *Tillandsia* · Trace elements

Biomonitoring
Paper published!!!

Bulletin of Environmental Contamination and Toxicology
https://doi.org/10.1007/s00128-021-03143-5

Check for updates

Biomonitoring of Potentially Toxic Elements in Two Polluted Areas from Lurigancho-Chosica Using the genus *Tillandsia latifolia* and *T. purpurea* as Biomonitor

Alex Rubén Huamán De La Cruz[1] · Hérica Yauri Molina[1] · Xiomara Rosa Vilca Monrroy[1] · Karmel Beringui[1,2] · Andres Camargo Caysahuana[3] · Julio Angeles Suazo[4] · Nancy Curasi Rafael[1] · Adriana Gioda[2] · Ide Gelmore Unchupaico Payano[5]

Received: 7 September 2020 / Accepted: 5 February 2021

Abstract
In the present study, an urban and industrial area were evaluated through a biomonitoring study employing the *Tillandsia purpurea* and *T. latifolia* species as a biomonitor. Plants were collected from a non-contaminated area and transplanted and exposed for three months into study areas to determine metal accumulation. Sixteen elements (Al, As, Ba, Ca, Cd, Co, Cr,

Biomonitoring
Paper published!!!

An Acad Bras Cienc (2020) 92(1): e20180813 DOI 10.1590/0001-3765202020180813
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Printed ISSN 0001-3765 I Online ISSN 1678-2690
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CHEMICAL SCIENCES

Air quality biomonitoring of trace elements in the metropolitan area of Huancayo, Peru using transplanted *Tillandsia capillaris* as a biomonitor

ALEX RUBÉN H. DE LA CRUZ, RODOLFO FRANKLIN O. AYUQUE, RONY WILLIAM H. DE LA CRUZ, JAVIER L. LÓPEZ-GONZALES & ADRIANA GIODA

Abstract: The air quality and distribution of trace elements in a metropolitan area of the Peruvian Andes were evaluated using transplanted epiphytic *Tillandsia capillaris* as biomonitors. Biomonitors were collected from the non-contaminated area and exposed to five sites with different types of contamination for three months in 2017. After exposure, the content of twenty-one elements were determined by ICP-MS analysis. Datasets were evaluated by one-way ANOVA, exposed-to-baseline (EB), hierarchical cluster analysis (HCA) and principal component analysis (PCA). Results showed significant differences among sampling sites for several elements. According to EF ratios for Ba, Cr, Cu, Pb, Sb, and Zn EB ratios value greater than 1.75 were found around urban areas, indicating anthropogenic influence, which can be attributed to vehicular sources. The highest values of As and Cd were found in areas of agricultural practices, therefore their presence could

Biomonitoring
Paper published!!!

Article

http://dx.doi.org/10.21577/0103-5053.20180174

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Printed in Brazil - ©2018 Sociedade Brasileira de Química

Biomonitoring of Toxic Elements in Plants Collected Near Leather Tanning Industry

Alex R. H. De La Cruz,[a] *Lorreine D. S. C. Ferreira,*[a] *Vinicius P. Andrade*[a] *and Adriana Gioda**,[a]

[a]*Departamento de Química, Pontifícia Universidade Católica do Rio de Janeiro, Rua Marquês de São Vicente, 225, 22451-900 Gávea, Rio de Janeiro-RJ, Brazil*

The present work aimed the study of atmospheric deposition of toxic elements near to a tannery industry by collecting black material deposited on leaf surfaces of cinnamon trees (*Cinnamomum zeylanicum*). Elements such as As, Ba, Cr, Cu, Fe, Ni, Pb, Sb, V, and Zn were analyzed by inductively coupled plasma mass spectrometry (ICP-MS). For comparison purpose, black particles deposited on the leaf surface of lemon trees (*Citrus lemon*) collected away from the tannery industry were also analyzed. Results showed that the amount of toxic elements found in the black particles collected near tannery area was significantly higher than the amount of those measured in the comparison site. Enrichment factors (EF) of As and Cr were markedly impacted by anthropogenic emissions, whereas the other elements were moderately/slightly

Biomonitoring
Paper published!!!

Chemosphere 210 (2018) 849–858

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Trace element biomonitoring in the Peruvian andes metropolitan region using *Flavoparmelia caperata* lichen

Alex Rubén Huamán De La Cruz [a, b], Jusber Kevin Huamán De La Cruz [c], Daniel Alvarez Tolentino [d], Adriana Gioda [a, *]

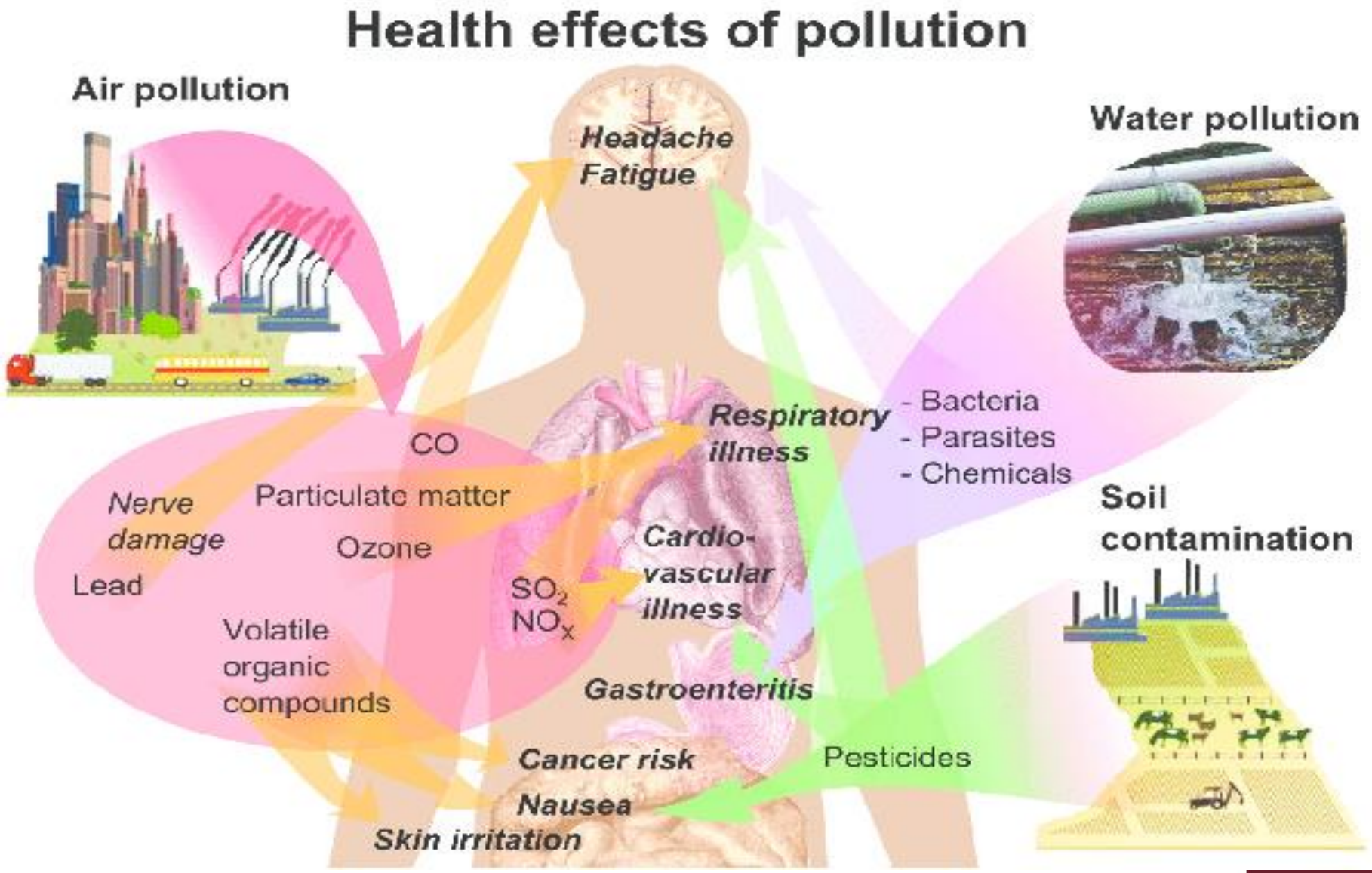
[a] Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Department of Chemistry, Rio de Janeiro, Brazil
[b] National University of Centre of Peru (UNCP), Faculty of Chemical Engineering, Av. Mariscal Ramón Castilla Km. 5. No 3809, El Tambo, Huancayo, Peru
[c] National University of Centre of Peru (UNCP), Faculty of Nursing, Av. Mariscal Ramón Castilla Km. 5. No 3809, El Tambo, Huancayo, Peru
[d] Alas Peruanas University (UAP), Faculty of Environmental Engineering, Av. Coronel Parra s/n Paradero 5, Pilcomayo, Huancayo, Peru

HIGHLIGHTS

- Lichens, used as biomonitors of air pollution in a Peruvian mountain city, were analyzed by spectroscopic techniques.
- Sixteen trace elements measured were treated by means of chemometric tools.
- Urban and peri-urban areas are similarly affected by atmospheric deposition.
- Influence of vehicular traffic emissions were observed in the biomonitors.

Air Pollutants

Effects of pollution on health



AIR POLLUTION EFFECTS
on Human Body

1 Brain, Eyes, Throat
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam iaculis massa.

2 Lungs
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam iaculis massa.

3 Liver
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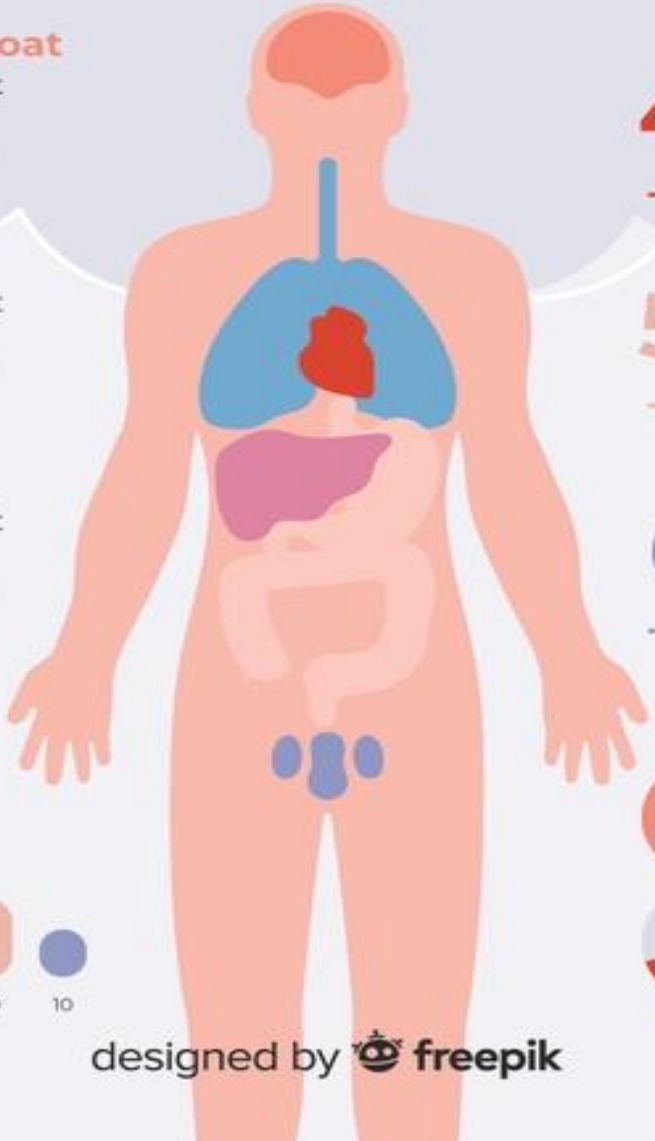
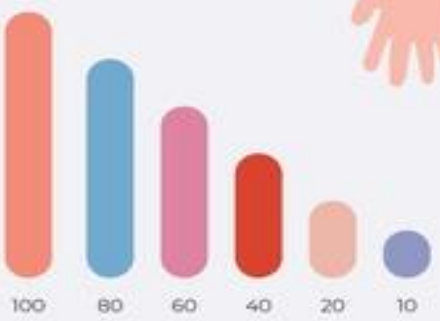
4 Hearth
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam iaculis massa.

5 Skin
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam iaculis massa.

6 Reproduction
Lorem ipsum dolor sit amet, consectetaur adipiscing elit. Etiam iaculis massa.

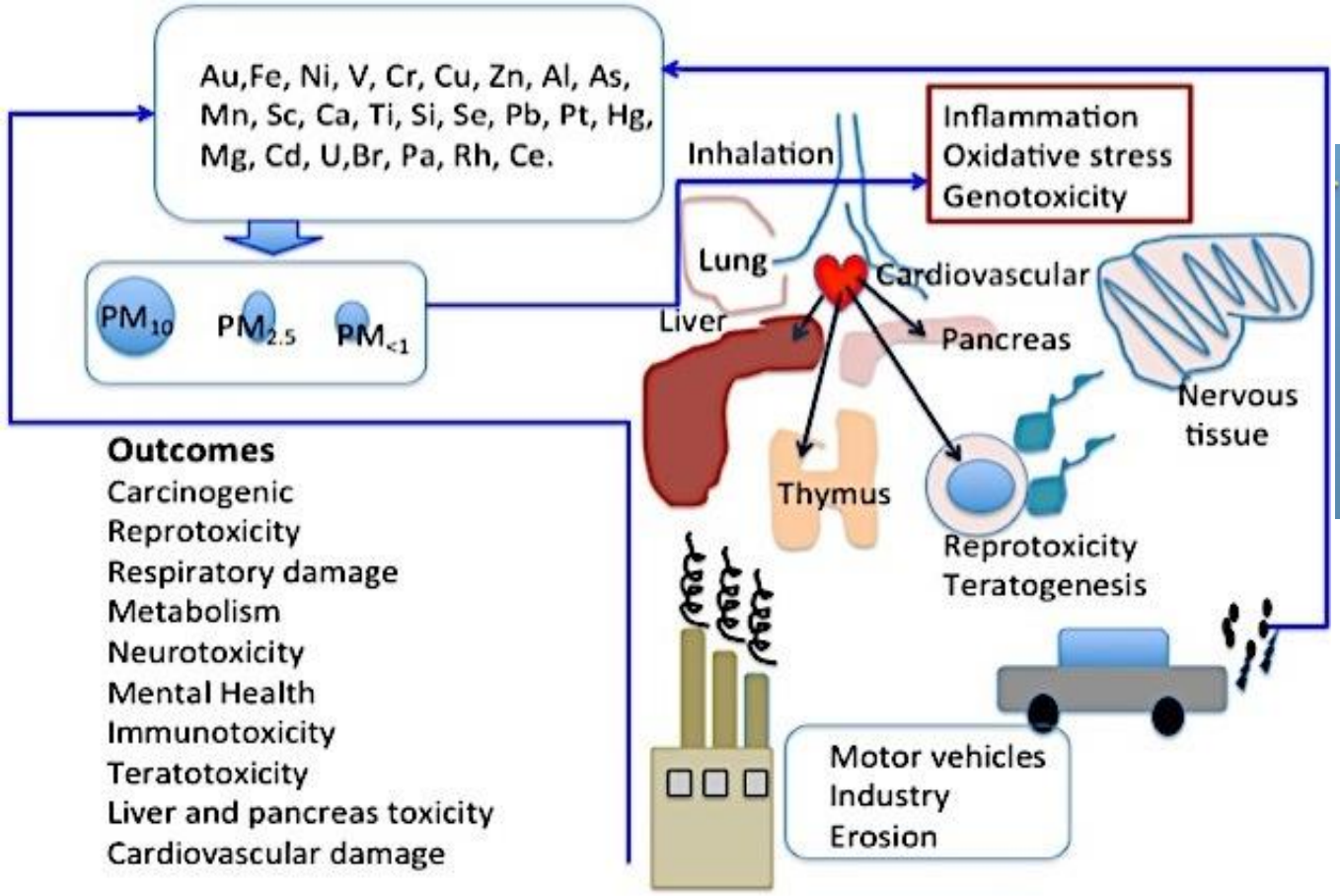


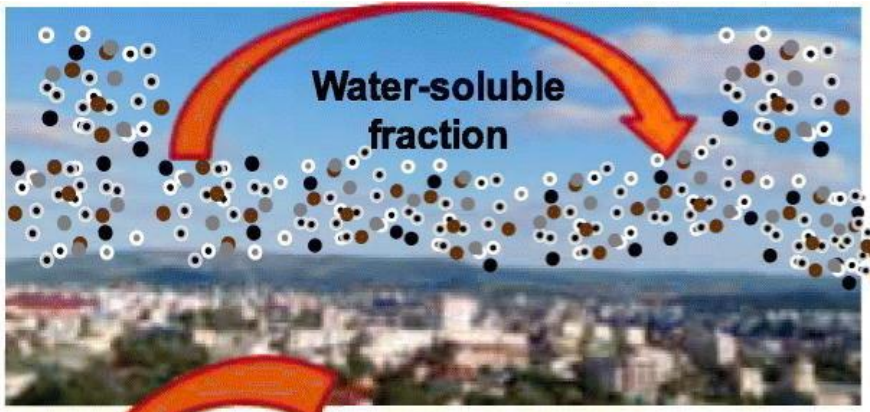


Air Pollutants

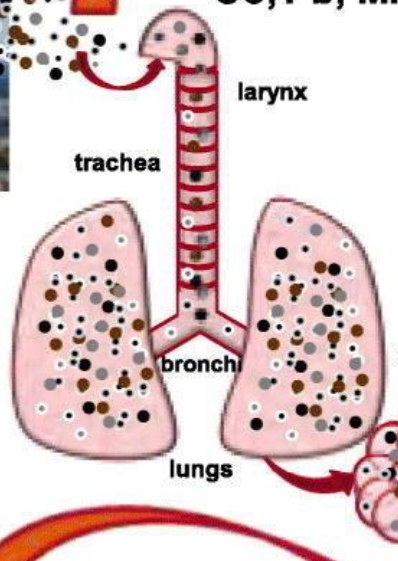
Effects of pollution on health

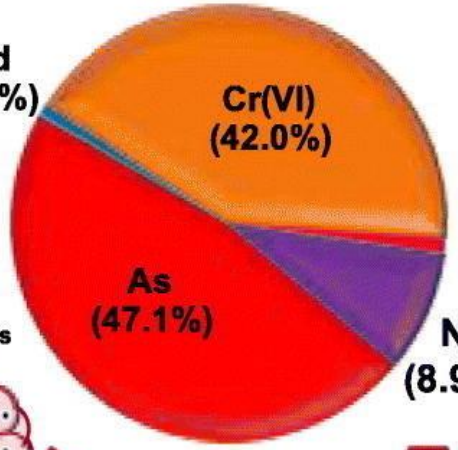
Health effects of Metals in Particulate Matter





As, Ba, Cd, Cr(VI),
Co, Pb, Mn, Mo, Ni





Health risk
assessment

PMF, CWT and
bivariate polar plot
approaches

AMOS

air traffic

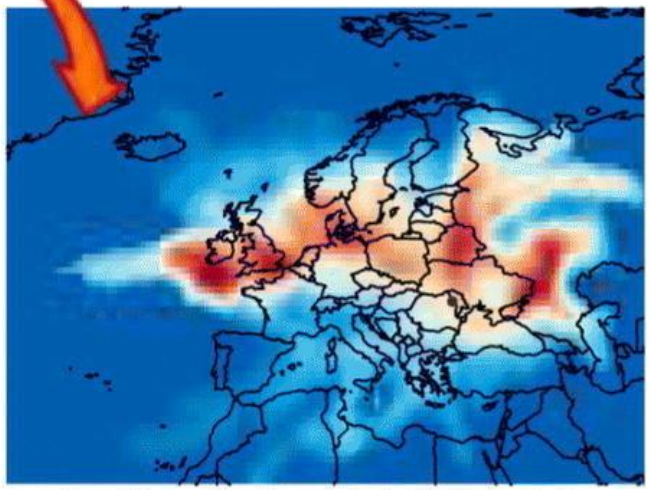
biomass
burning

road traffic

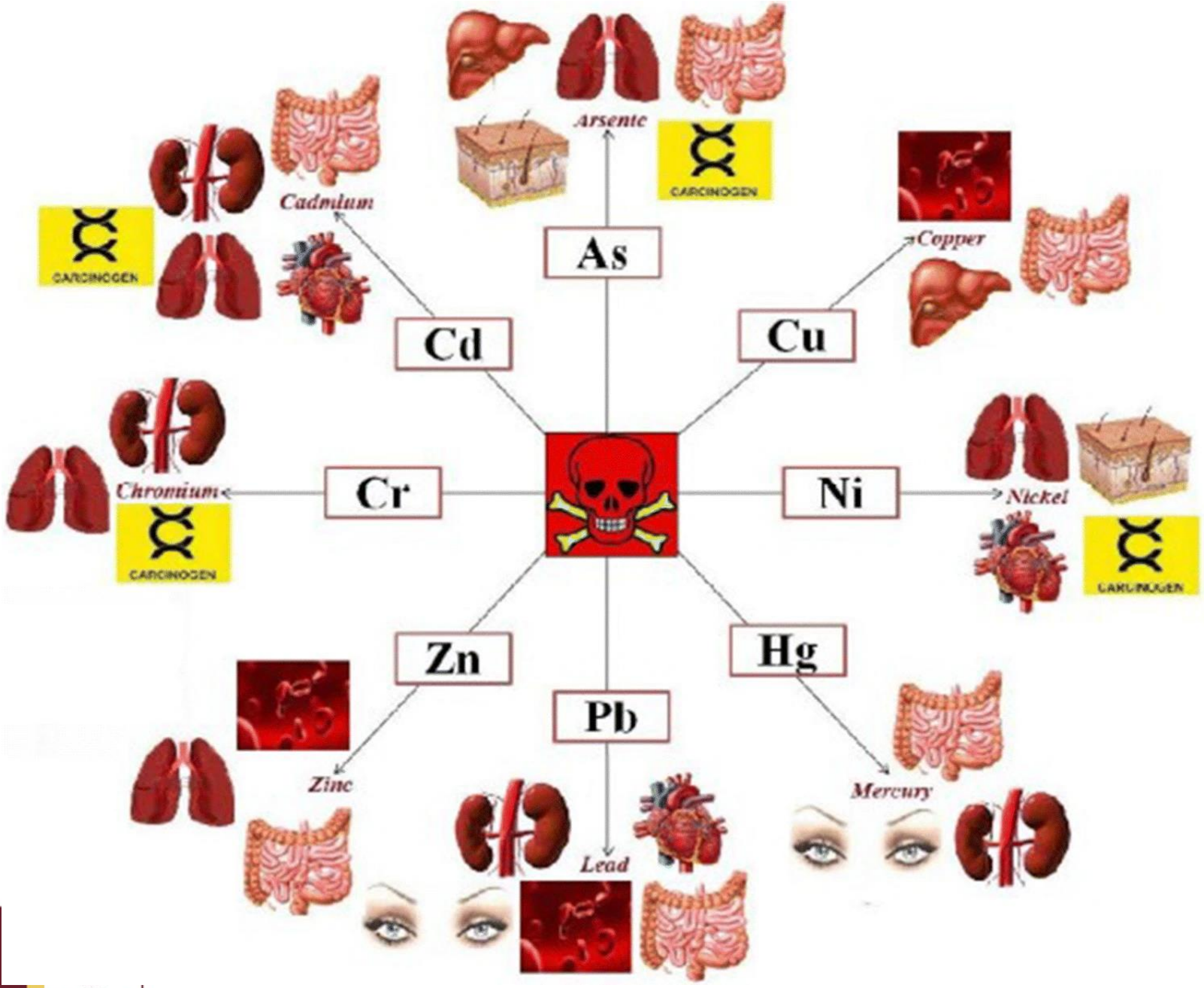
power and
heating plant

building construction

road dust



traffic + industrial CWT plot



Effect of heavy metal ions to human health

Air Pollutants

Effects of pollution on health

Standard level of criteria air pollutants and their sources with health impact based on the United States Environmental Protection Agency

Air pollutants®	Major source of emission	Averaging time	Standard level	Health impact target organs
Particle pollutants				
$PM_{2.5}$	Motor engines, industrial activities, smokes	24 h	35 μg/m³	Respiratory and cardiovascular diseases, CNS and reproductive dysfunctions, cancer
PM_{10}		24 h	150 μg/m³	
Ground-level ozone	Vehicular exhaust, industrial activities	1 h	0.12 mg/m³	Respiratory and cardiovascular dysfunctions, eye irritation
Carbon monoxide	Motor engines, burning coal, oil and wood, industrial activities, smokes	1 h	35 mg/m³	CNS and cardiovascular damages
Sulfur dioxide	Fuel combustion, burning coal	1 h	75 μg/m³	Respiratory and CNS involvement, eye irritation
Nitrogen dioxide	Fuel-burning, vehicular exhaust	1 h	100 μg/m³	Damage to liver, lung, spleen, and blood
Lead	Lead smelting, industrial activities, leaded petrol	3 months average	0.15 μg/m³	CNS and hematologic dysfunctions, eye irritation
Polycyclic aromatic hydrocarbons*	Fuel combustion, wood res, motor engines	1 year	1 ng/m³	Respiratory and CNS involvement, cancer

*Air quality standards according to the European Union; ®$PM_{2.5}$ is stand for PM of 2.5 μ or less. PM_{10} is stand for PM of 10 μ or more. PM = Particulate matter, CNS = Central nervous system

UPeU

Air Pollutants

Effects of pollution on health

Ochsner J. 2019 Spring; 19(1): 4.
Published online Spring 2019. doi: 10.31486/toj.19.0011
PMCID: PMC6447209
PMID: 30983893

Growing Evidence for the Impact of Air Pollution on Depression

Naureen A. Ali, BSc[1] and Adeel Khoja, MBBS, MSc[2]

TO THE EDITOR Go to:

The World Health Organization (WHO) estimates that 9 of every 10 people worldwide inhale polluted air, and exposure to polluted air is accountable for 7 million deaths annually.[1] Studies have associated the adverse effects of air pollution with respiratory, cardiovascular, and neurovascular diseases.[2] Air pollutants can also cause serious neurocognitive effects—ranging from behavioral variations to neurodegenerative disorders—that ultimately can have devastating effects on mental health.[3,4] WHO has taken the initiative to include mental health in the domain of noncommunicable diseases (NCDs), as mental health is a strong risk factor for NCDs.[5]

ELSEVIER

Environmental Research
Volume 193, February 2021, 110601

Particulate matter pollution and risk of outpatient visits for psychological diseases in Nanjing, China

Sarah R. Lowe [a, 1], Ce Wang [b, c, 1] ✉, Yiqun Ma [d, e], Kai Chen [d, e] ✉

Air Pollutants

Effects of pollution on health

Human Reproduction, Vol.33, No.6 pp. 1071–1078, 2018
Advanced Access publication on April 5, 2018 doi:10.1093/humrep/dey076

human reproduction

ORIGINAL ARTICLE *Infertility*

Association between ambient air pollution and pregnancy rate in women who underwent IVF

S.A. Choe[1,2], Y.B. Jun[3], W.S. Lee[1,4], T.K. Yoon[1,2,*], and S.Y. Kim[5,*]

[1]Department of Obstetrics and Gynecology, School of Medicine, CHA University [2]CHA fertility center, Seoul station, Jung-gu, Seoul 04637, Korea [3]Department of Statistics, Seoul National University, Gwanak-gu, Seoul 08826, Korea [4]Fertility Center of CHA Gangnam Medical Center, Gangnam-gu, Seoul 06135, Korea [5]Department of Cancer Control and Population Health, Graduate School of Cancer Science and Policy, National Cancer Center, Goyang, Gyeonggi-do, 10408, Korea

*Correspondence address. Department of Obstetrics and Gynecology, School of Medicine, CHA University; CHA fertility center, Seoul station, Jung-gu, Seoul 04637, Korea. Tel: +82-2-2002-0300; Fax: +82-2-2002-0427; E-mail: tkyoon@chamc.co.kr (T.K.Y.); Department of Cancer Control and Population Health, Graduate School of Cancer Science and Policy, National Cancer Center, Goyang, Gyeonggi-do, 10408, Korea. Tel: +82-31-920-2745; E-mail: sykim@ncc.re.kr (S.Y.K.)

Submitted on August 9, 2017; resubmitted on March 1, 2018; accepted on March 16, 2018

STUDY QUESTION: Are the concentrations of five criteria air pollutants associated with probabilities of biochemical pregnancy loss and intrauterine pregnancy in women?

SUMMARY ANSWER: Increased concentrations of ambient particulate matter (PM_{10}), nitrogen dioxide (NO_2), carbon monoxide (CO) during controlled ovarian stimulation (COS) and after embryo transfer were associated with a decreased probability of intrauterine pregnancy.

WHAT IS KNOWN ALREADY: Exposure to high ambient air pollution was suggested to be associated with low fertility and high early pregnancy loss in women.

STUDY DESIGN, SIZE, DURATION: Using a retrospective cohort study design, we analysed 6621 cycles of 4581 patients who underwent one or more fresh IVF cycles at a fertility centre from January 2006 to December 2014, and lived in Seoul at the time of IVF treatment.

PARTICIPANTS/MATERIALS, SETTING, METHODS: To estimate patients' individual exposure to air pollution, we computed averages of hourly concentrations of five air pollutants including PM_{10}, NO_2, CO, sulphur dioxide (SO_2) and ozone (O_3) measured at 40 regulatory monitoring sites in Seoul for each of the four exposure periods: period 1 (start of COS to oocyte retrieval), period 2 (oocyte retrieval to embryo transfer), period 3 (embryo transfer to hCG test), and period 4 (start of COS to hCG test). Hazard ratios (HRs) from the time-

Air Pollutants

Effects of pollution on health

REPRODUCTION

REVIEW

Reproduction in a polluted world: implications for wildlife

Lucinda C Aulsebrook[1], Michael G Bertram[1,2], Jake M Martin[1], Anne E Aulsebrook[3], Tomas Brodin[2], Jonathan P Evans[4], Matthew D Hall[1], Moira K O'Bryan[1], Andrew J Pask[3], Charles R Tyler[5] and Bob B M Wong[1]

[1]School of Biological Sciences, Monash University, Victoria, Australia, [2]Department of Wildlife, Fish, and Environmental Studies, Swedish University of Agricultural Sciences, Umeå, Sweden, [3]School of BioSciences, The University of Melbourne, Victoria, Australia, [4]School of Biological Sciences, The University of Western Australia, Perth, Australia and [5]Biosciences, College of Life and Environmental Sciences, University of Exeter, Exeter, UK

Correspondence should be addressed to L C Aulsebrook; Email: lucinda.aulsebrook@monash.edu

Abstract

Environmental pollution is an increasing problem for wildlife globally. Animals are confronted with many different forms of pollution, including chemicals, light, noise, and heat, and these can disrupt critical biological processes such as reproduction. Impacts on reproductive processes can dramatically reduce the number and quality of offspring produced by exposed individuals, and this can have further repercussions on the ecology and evolution of affected populations. Here, we illustrate how environmental pollutants can affect various components of reproduction in wildlife, including direct impacts on reproductive physiology and development, consequences for gamete quality and function, as well as effects on sexual communication, sexual selection, and parental care. We follow with a discussion of the broader ecological and evolutionary consequences of these effects on reproduction and suggest future directions that may enable us to better understand and address the effects of environmental pollution.

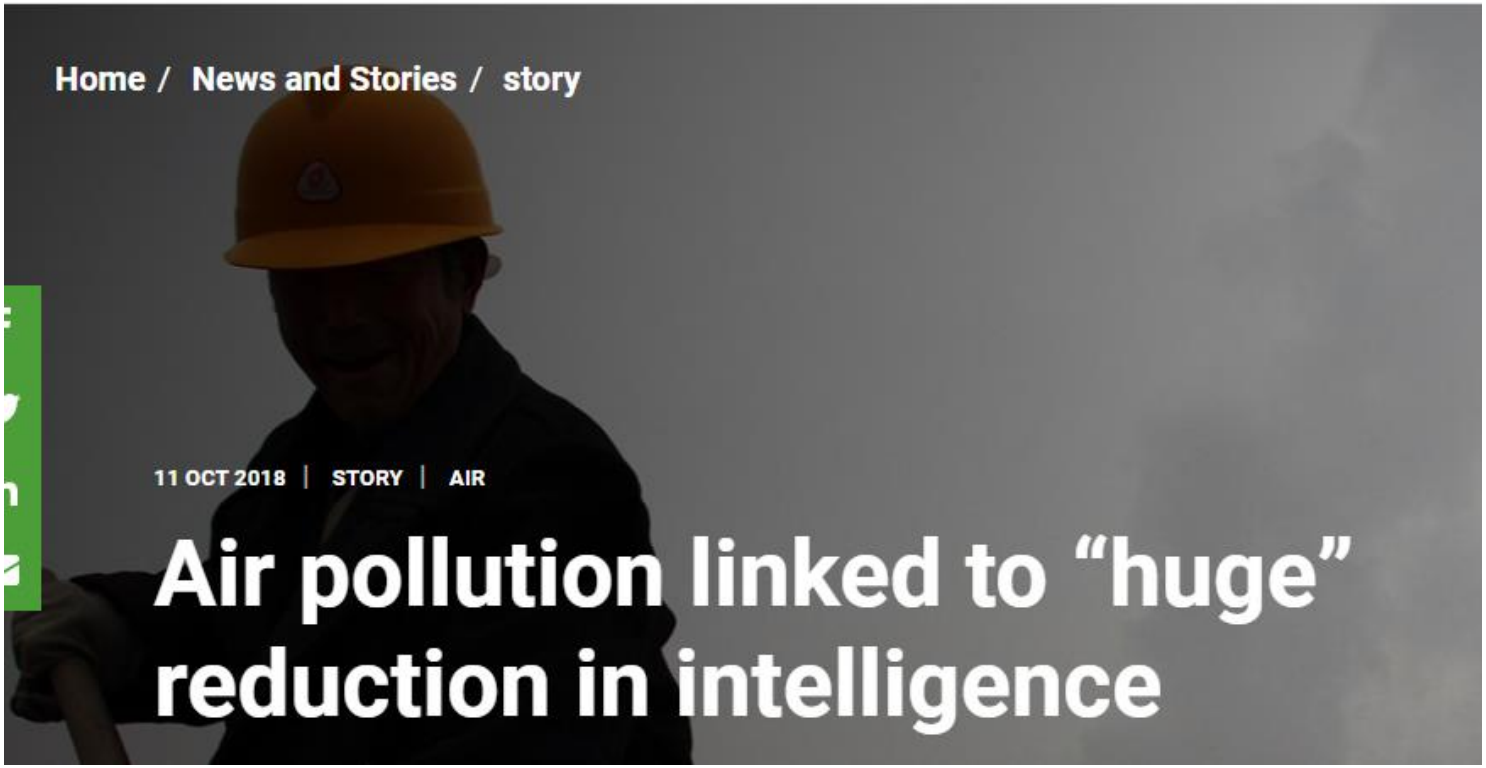
Reproduction (2020) **160** R13–R23

Air Pollutants

Effects of pollution on health

UN environment programme

Who we are Where we work



UPeU

Air pollution can have a "huge" negative effect on cognitive intelligence – especially amongst older men – according to a study released this past August

Air Pollutants

Teen Exposure to Air Pollution Could Reduce IQ Levels Long Term

By Claudia Boyd-Barrett • Jan 31, 2018

A new study suggests air pollution may have adverse effects on the brain structure or brain

Living in a polluted area as a pre-teen and teenager may have long-lasting, detrimental effects on a person's ability to reason and problem solve, a new study suggests

Air Pollutants

Effects of pollution on health

How will air quality effects on human health, crops and ecosystems change in the future?

Erika von Schneidemesser[1], Charles Driscoll[2], Harald E. Rieder[3] and Luke D. Schiferl[4]

Review

Cite this article: von Schneidemesser E, Driscoll C, Rieder HE, Schiferl LD. 2020 How will air quality effects on human health, crops and ecosystems change in the future? *Phil. Trans. R. Soc. A* **378**: 20190330.
http://dx.doi.org/10.1098/rsta.2019.0330

Accepted: 28 July 2020

Future air quality will be driven by changes in air pollutant emissions, but also changes in climate. Here, we review the recent literature on future air quality scenarios and projected changes in effects on human health, crops and ecosystems. While there is overlap in the scenarios and models used for future projections of air quality and climate effects on human health and crops, similar efforts have not been widely conducted for ecosystems. Few studies have conducted joint assessments across more than one sector. Improvements in future air quality effects on human health are seen in emission reduction scenarios that are more ambitious than current legislation. Larger impacts result from changing particulate matter (PM) abundances than ozone burdens. Future global health burdens are dominated by changes in the Asian region. Expected future reductions in ozone outside of Asia will allow for increased crop production. Reductions in PM, although associated with much higher uncertainty, could offset some

What is a Journal

Table 1

Penetrability according to particle size.

Particle size	Penetration degree in human respiratory system
>11 μm	Passage into nostrils and upper respiratory tract
7–11 μm	Passage into nasal cavity
4.7–7 μm	Passage into larynx
3.3–4.7 μm	Passage into trachea-bronchial area
2.1–3.3 μm	Secondary bronchial area passage
1.1–2.1 μm	Terminal bronchial area passage
0.65–1.1 μm	Bronchioles penetrability
0.43–0.65 μm	Alveolar penetrability

Manisalidis et al., 2020

What is a Journal

Table 2

Types and sizes of particulate Matter (PM).

Type		PM diameter [μm]
Particulate contaminants	Smog	0.01–1
	Soot	0.01–0.8
	Tobacco smoke	0.01–1
	Fly ash	1–100
	Cement Dust	8–100
Biological Contaminants	Bacteria and bacterial spores	0.7–10
	Viruses	0.01–1
	Fungi and molds	2–12
	Allergens (dogs, cats, pollen, household dust)	0.1–100
Types of Dust	Atmospheric dust	0.01–1
	Heavy dust	100–1000
	Settling dust	1–100
Gases	Different gaseous contaminants	0.0001–0.01

Manisalidis et al., 2020

Solutions

More efficient use of energy

Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today
- Nearly a quadrupling of zero- and low-carbon energy supply from renewable energy by 2050

Improved carbon sinks

- Reduced deforestation and improved forest management and planting of new forests
- Bio-energy with carbon capture and storage

Lifestyle and behavioural changes

AR5

Energy production

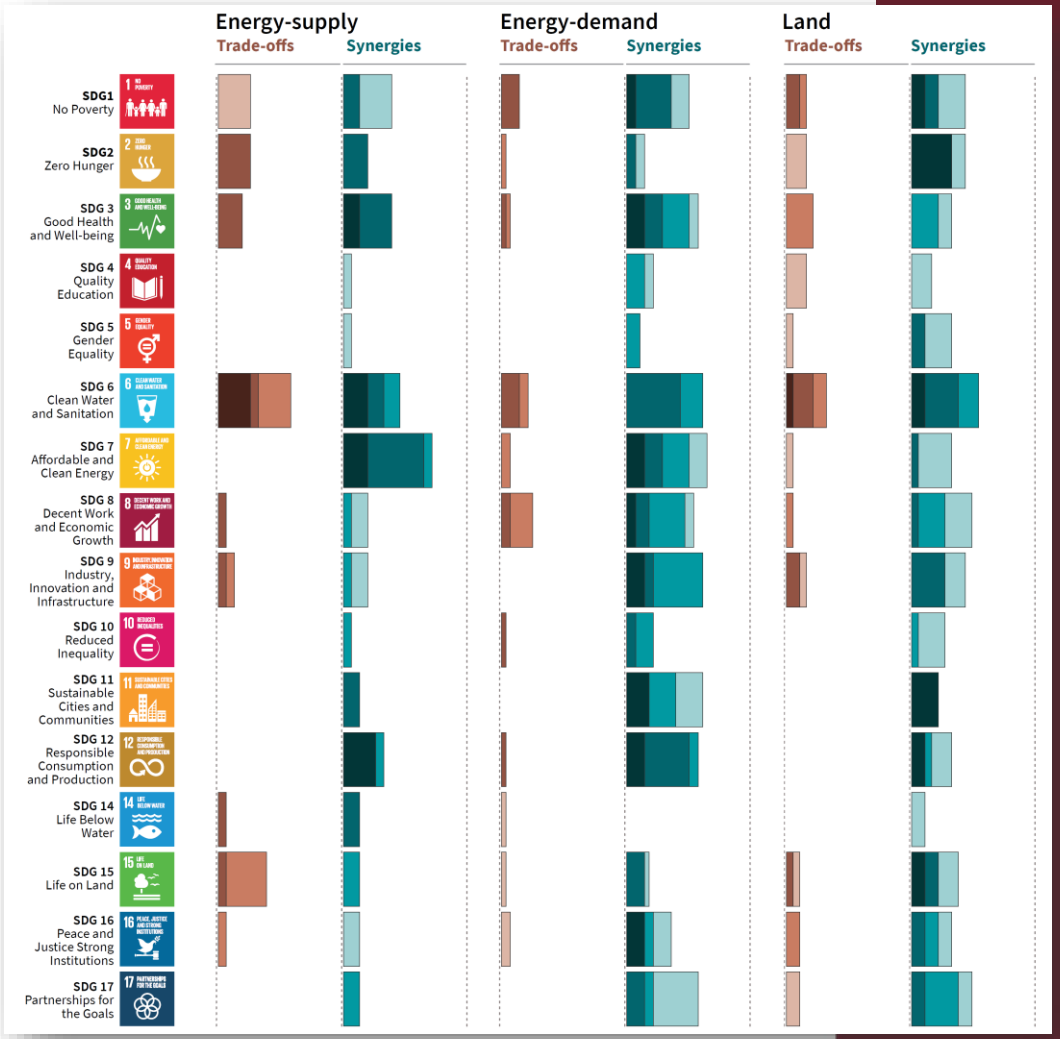
Transportation

Agriculture

Biofuels?

UN 17 goals to transform our world

Mitigation options and sustainable development using SDGs



IPCC SR1.5, 2018

THANKS

UPeU