Chemické znečištění životního prostředí – přístupy, problémy, řešení, porozumění

Prof. RNDr. Ivan Holoubek, CSc.

RECETOX, Masaryk University, Brno, CR / CzechGlobe AS CR / TOCOEN, s.r.o.

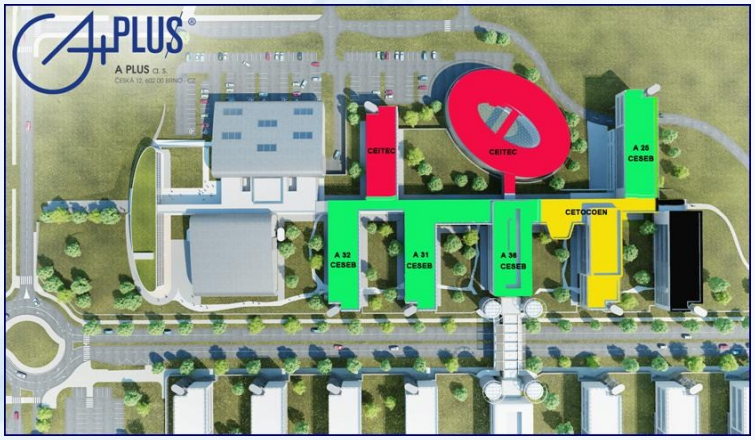
holoubek@recetox.muni.cz; http://recetox.muni.cz

holoubek.i@czechglobe.cz

Seminář odborníků

SKE, KHS, UK Praha, ČR, 09/04/2018

Centrum pro výzkum toxických látek v prostředí



Research centre
for toxic compounds
in the environment

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in the environment

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Centrum výzkumu globální změny AV ČR, v.v.i.

Research programmes and core facilities

Twelve working groups within the framework of four research programmes:

1) Environmental chemistry and modelling
2) Organic photochemistry and supramolecular chemistry
3) Protein engineering
4) Ecotoxicology

Three core facilities:

1) Trace Analytical Laboratories
2) GENASIS information system
3) ELSPAC database

Two centres facilitating collaboration with stakeholders (government, public, and private sector) marketing capacities and research outcomes:

1) National Centre for Persistent Organic Pollutants and the
2) Regional Centre for capacity-building and transfer of technology in CEE. more effective

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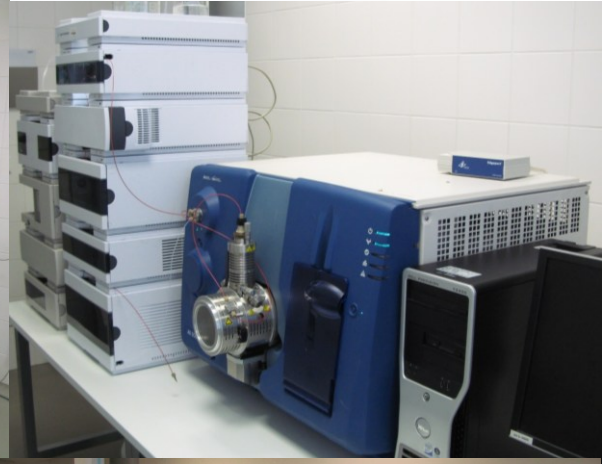
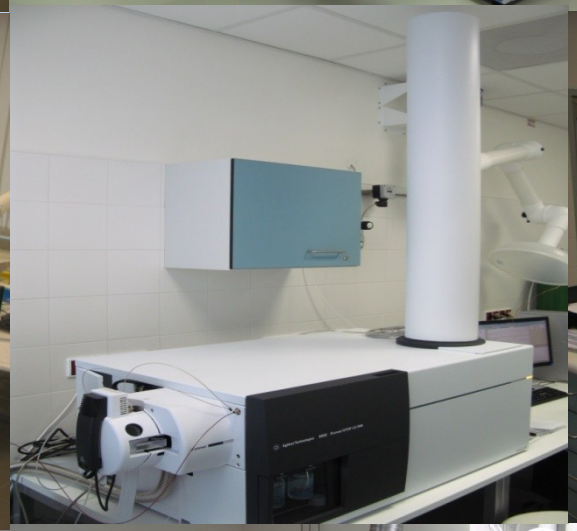
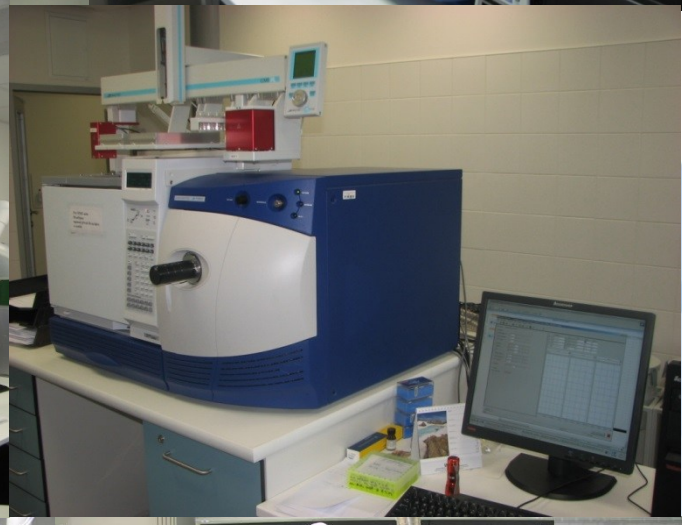
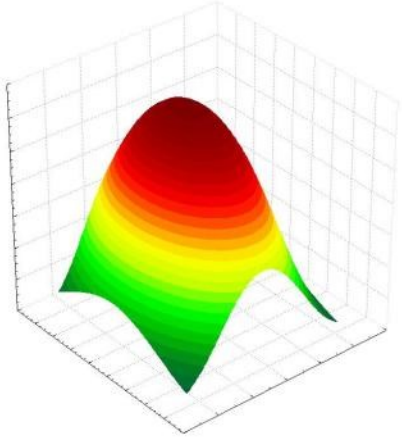



RECETOX education

Research Centre for Toxic Compounds in the Environment provides university education in the fields of Chemistry and Biology within all three levels of higher education, i.e. bachelor (BSc), master (MSc) and doctoral (PhD).

Ph.D. programmes
Environmental chemistry
Ecotoxicology
Master studies
Environmental chemistry
Ecotoxicology
Mathematical biology
Bachelor studies
Chemistry
Biology (Ecotoxicology)
Mathematical biology



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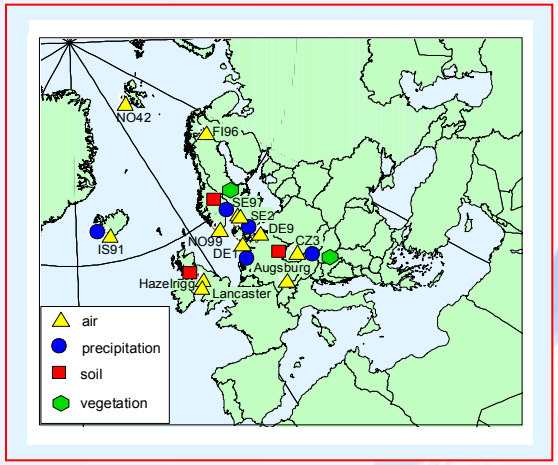
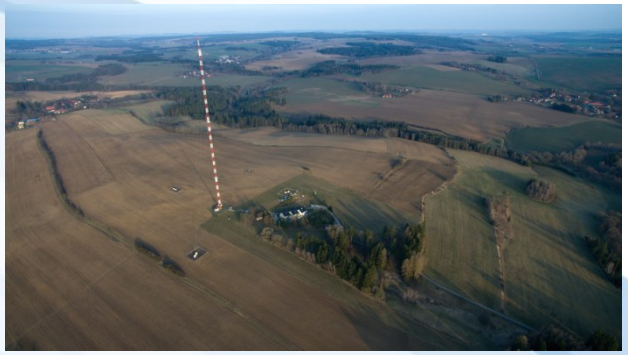
Superstation concept - Observatory Košetice, CR

EMEP POPs Network



Integrated POPs monitoring - Observatory Košetice – from 1988



Comparison of existing programmes (EMEP, GAPS, MONET) and approaches (active vs. passive)

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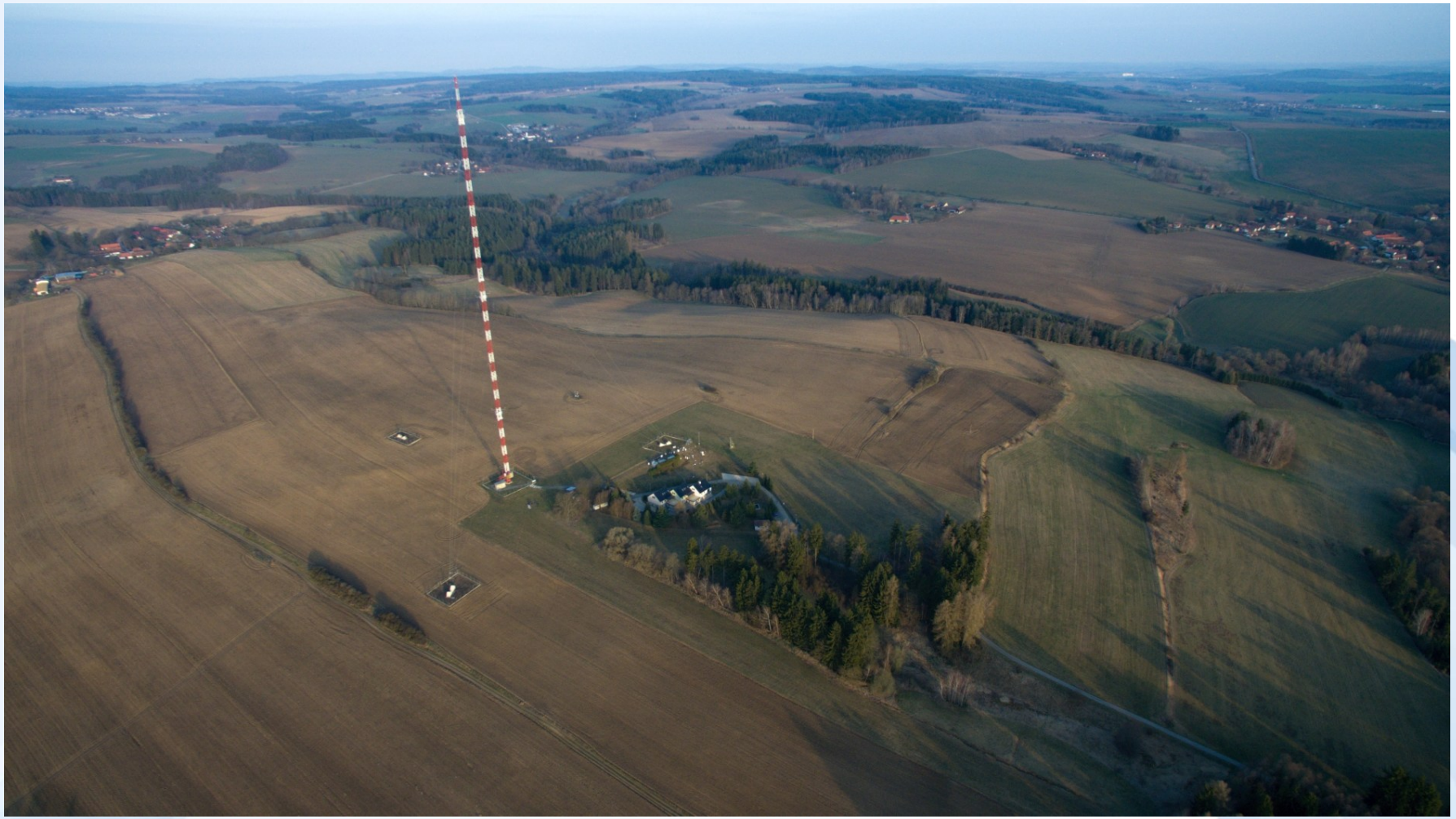
National Atmospheric Observatory (NAO) Košetice



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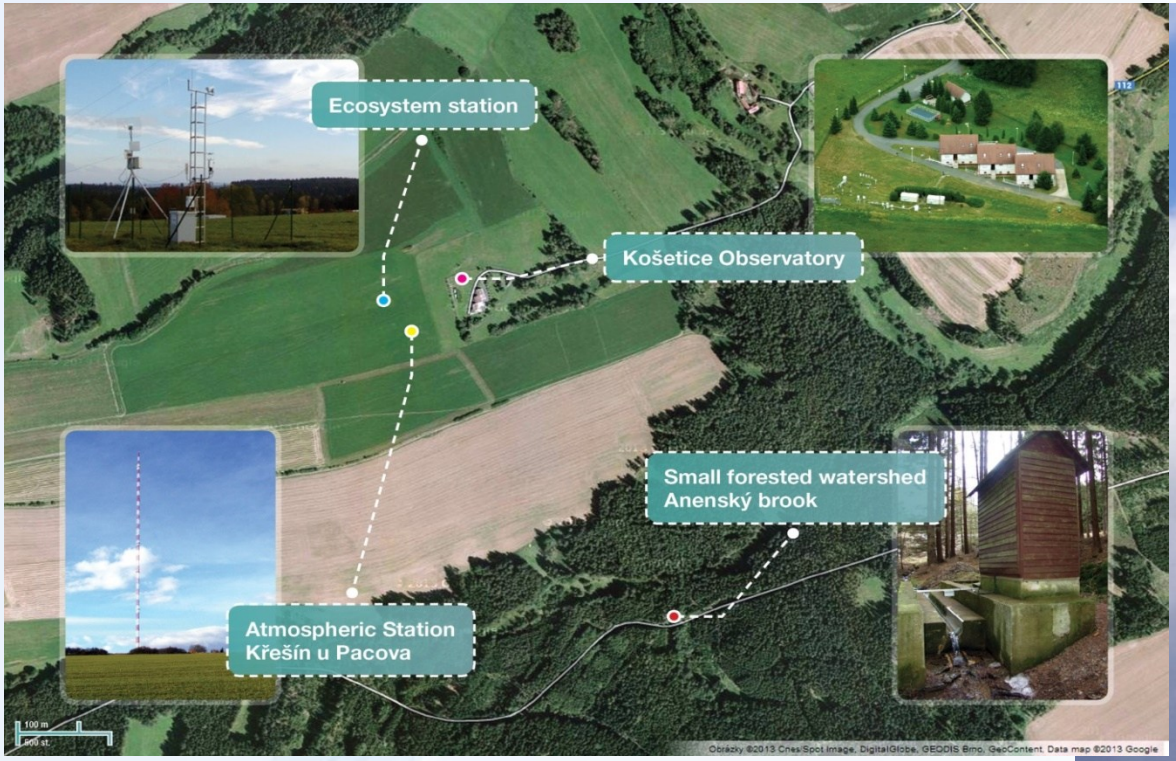

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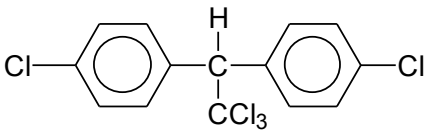
What I mean by understanding ??

- Understanding – physical-chemical properties – which one, sources, fate, effects
- Properties – chemical definition – persistence, reactivity hydrophility, hydrophobicity, lipophility, abiotic cummulation/bioaccumulation, long range transport
- Fate – transport, transformations, distribution, equilibria – understandig of environmental behaviour
- Effects – broad range, single compounds, toxic mixtures
- Determination/monitoring – phase distribution, properties
- Technologies – disposal, destruction, remediation
- Decision making process



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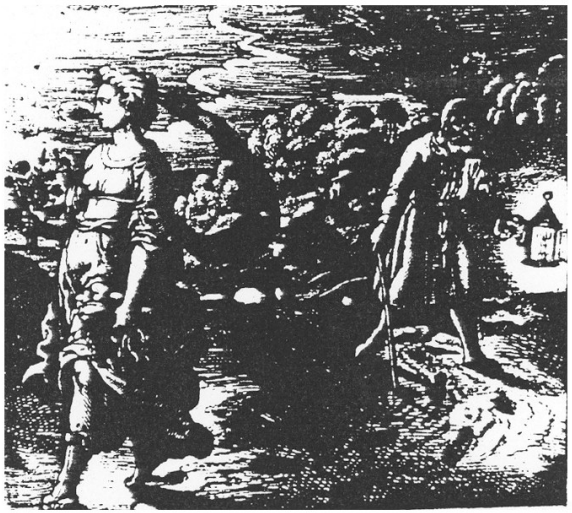
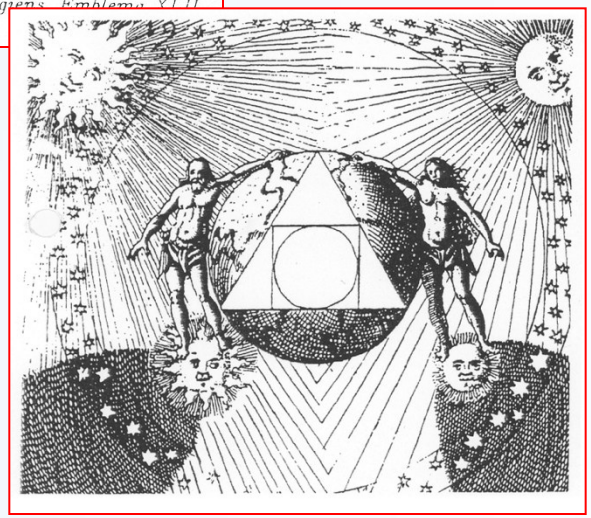
Problémy životního prostředí

Problémy životního prostředí

Historické kořeny



Obr. 1. „Tomu, kdos v chymii zběhlý, budiž příroda, rozum, zkušenost a četba vůdcem, holí, brýlemi a lampou.“ Adept kráčí ve stopách přírody, snaží se jí porozumět, ne zlepšovat. (Michael Maier, Atalanta Fugiens, Emblema XLII, 1618)



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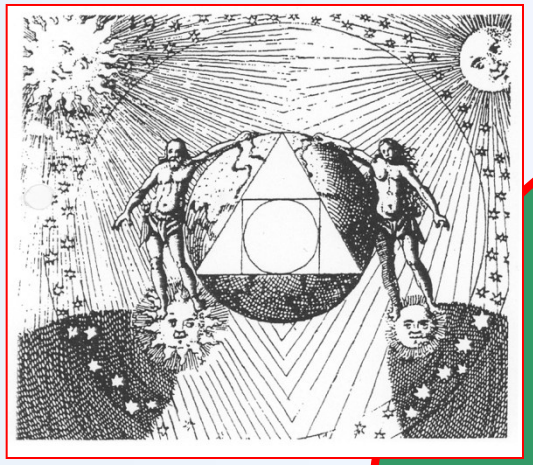
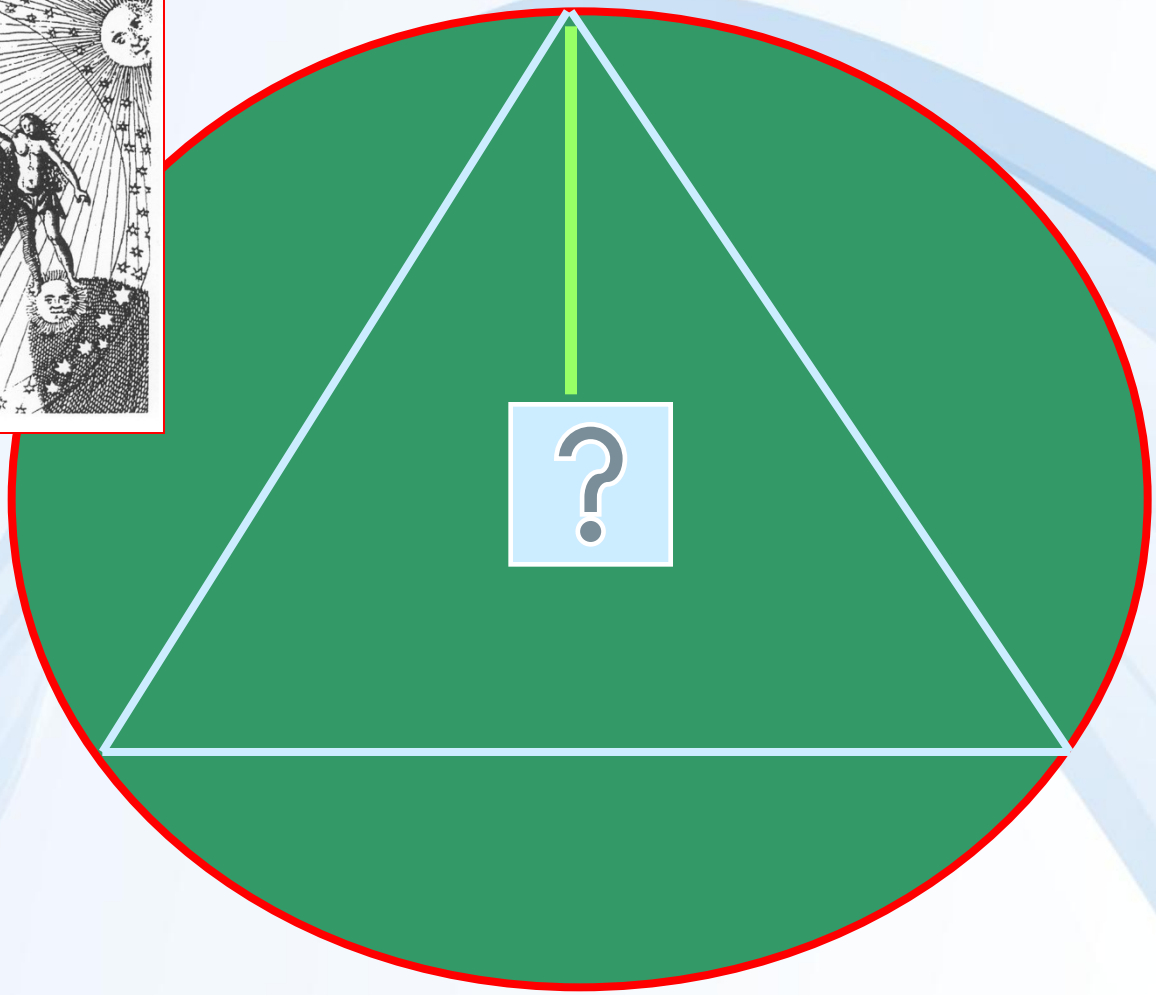
Koncepční přístup





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Nenechme se klamat povrchy - v hloubkách je veškerý zákon

Rainer Maria Rilke

Východiska

Aby někdo, kdo ví, že něco jest, také rozuměl, co to jest, k tomu jest nutno nahlédnouti v příčiny a důkladně je zkoumati.

J. A. Komenský

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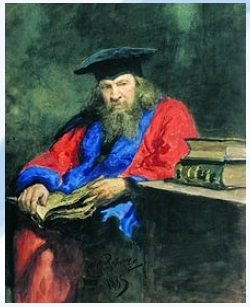
Přístupy

Vědecké zkoumání jevů má dva základní cíle – předvídání a užitečnost.

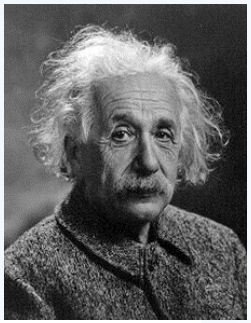
D. I. Mendělejev



All model are wrong, but some of them can be usefull

Čím lépe matematické zákony popisují realitu, tím jsou méně přesné, a čím jsou přesnější, tím hůře popisují realitu.

Albert Einstein



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Přístupy

"EKOLOGIE NENÍ VĚDA. S VĚDOU NEMÁ NIC SPOLEČNÉHO, JE TO IDEOLOGIE."
(24. 4. 1995, Aula UP v Olomouci)

„JÁ BYCH SE VSADIL, ŽE JSEM PŘEČETL STOKRÁT VÍC O EKOLOGICKÝCH TÉMATECH NEŽ JAKÝKOLIV EKOLOG O EKONOMII.“
(MF Dnes, 20.9. 2006)

„ŽÁDNÉ NIČENÍ PLANETY NEVIDÍM, NIKDY V ŽIVOTĚ JSEM NEVIDĚL A NEMYSLÍM, ŽE NĚJAKÝ VÁŽNÝ A ROZUMNÝ ČLOVĚK BY TO MOHL ŘÍCI.“
(odpověď "pana profesora" na otázku zda nevěří, že si ničíme svoji planetu, HN, 9. 2. 2007)

Přístupy

„ŽÁDNÉ NIČENÍ PLANETY NEVIDÍM, NIKDY V ŽIVOTĚ JSEM NEVIDĚL A NEMYSLÍM, ŽE NĚJAKÝ VÁŽNÝ A ROZUMNÝ ČLOVĚK BY TO MOHL ŘÍCI.“

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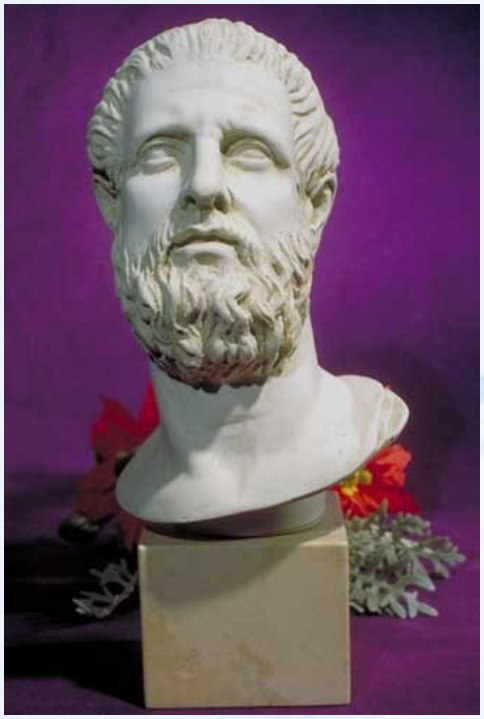
Chemicals in the environment: nothing new….



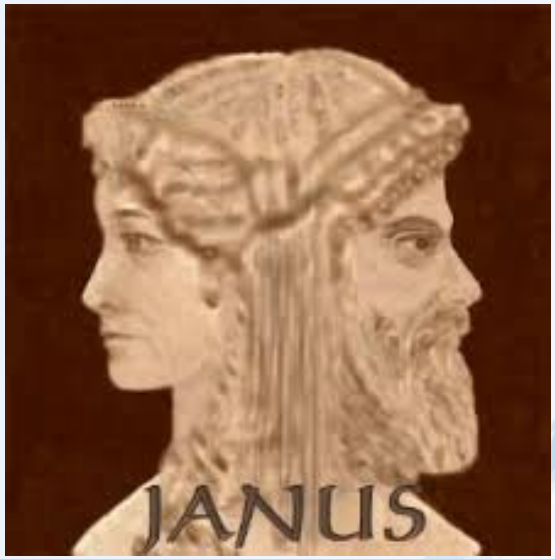
Hippocrates (460-377 BC)

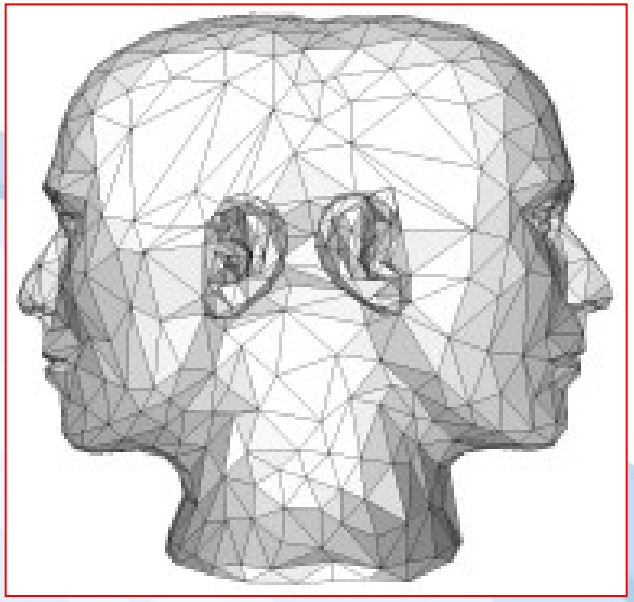
"Whoever wishes to investigate medicine properly should proceed thus…We must also consider the qualities of the waters, for they differ from one another in taste and weight, so also do they differ much in their quality"

So… Hippocrates appreciated the significance of human health in context of the characteristics of the natural environment

C. Janssen

Janus?





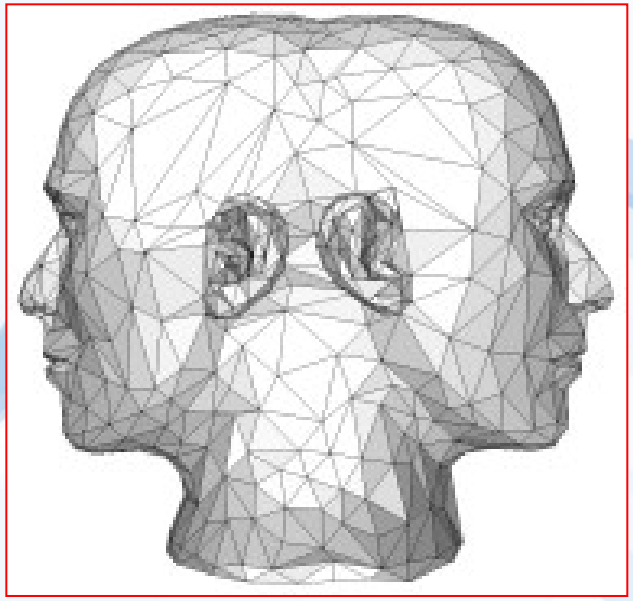
Ancient Roman god Janus was considered the god of the past, present and future, ensuring a good beginning of all things, the guardian of doors and gates, entrances and exits.

It was a symbol of change and transformation.

It is usually depicted with two faces, one of which old face looking back (in the past) and the other young face staring forward (into the future). Staring forward and backward also because one end is also the beginning of another.

Research ce
for toxic cor
in the enviro

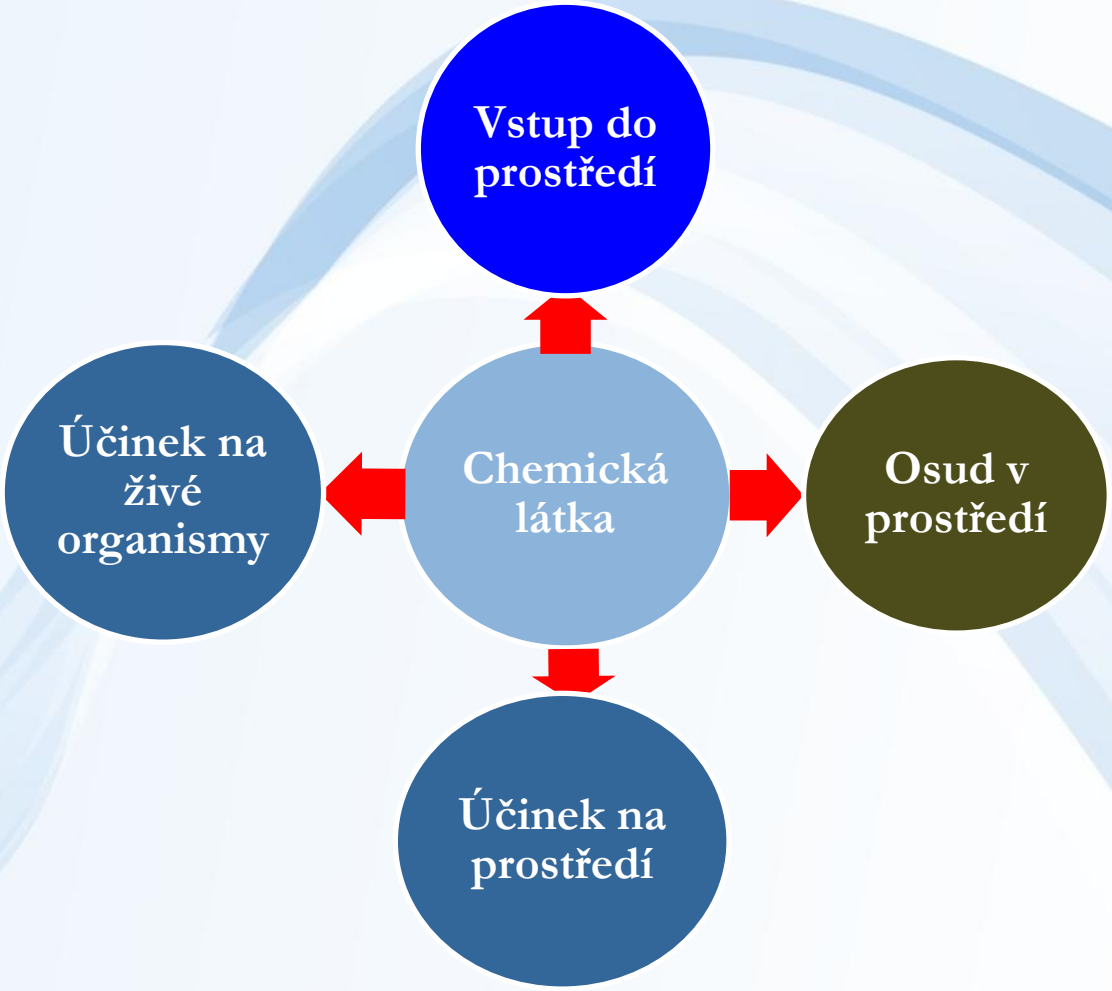
Janus/Chemistry



Benefits

Risk

Chemické látky v prostředí



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Chemické látky v prostředí

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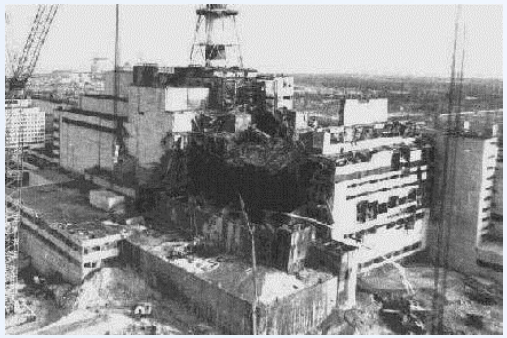
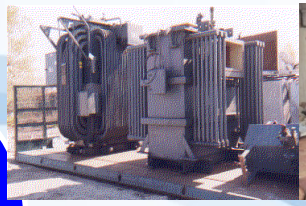
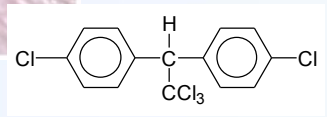




Vstup do prostředí

Chemická látka



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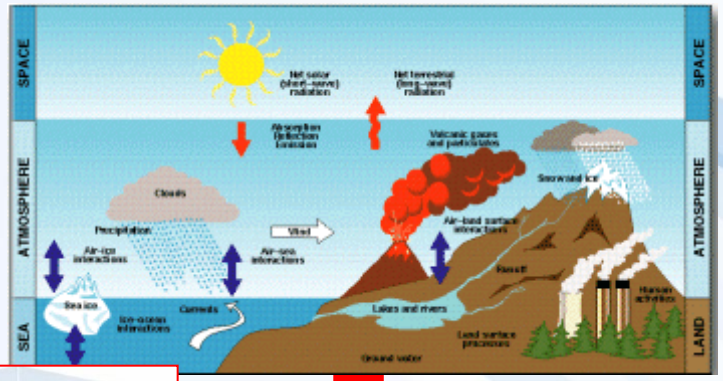
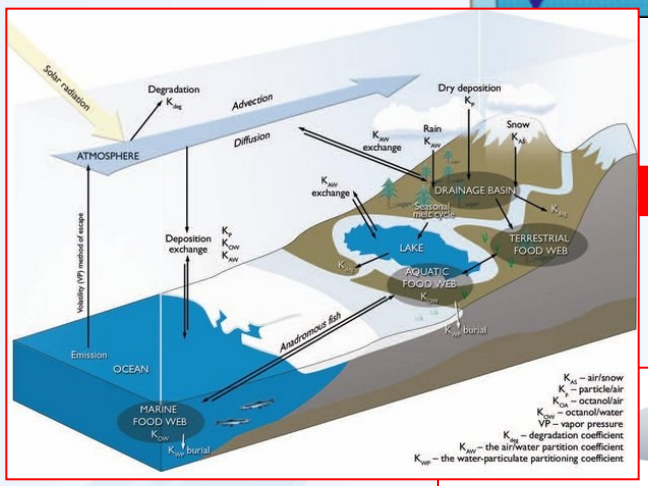
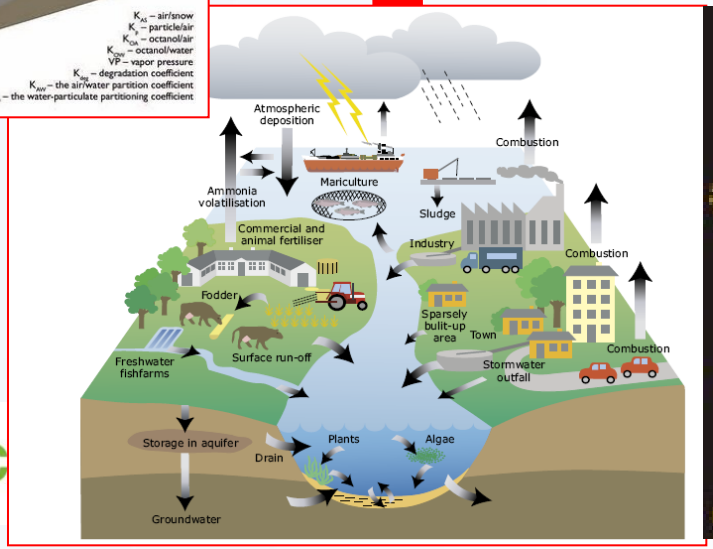




Chemická látka

Osud v prostředí



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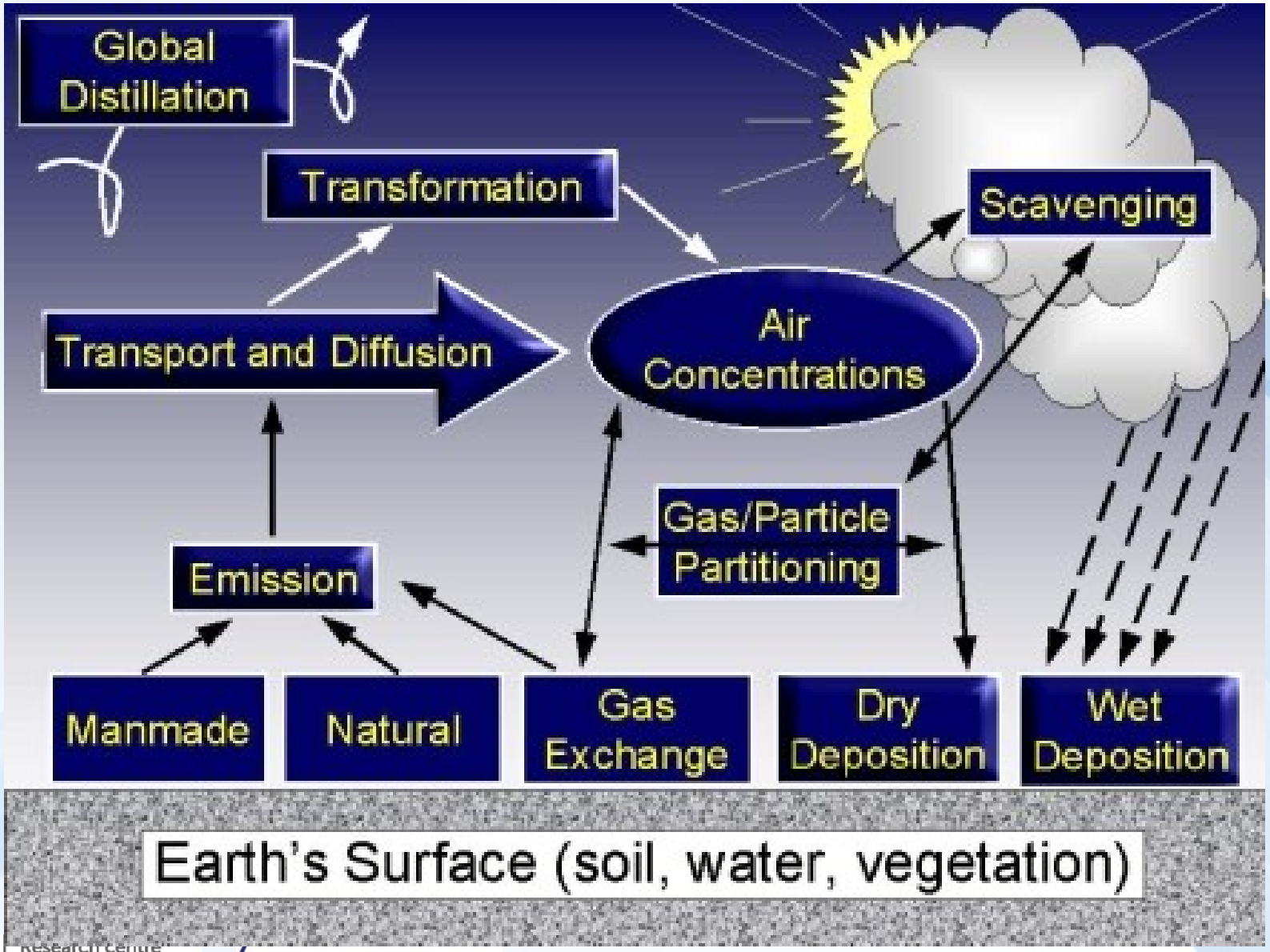
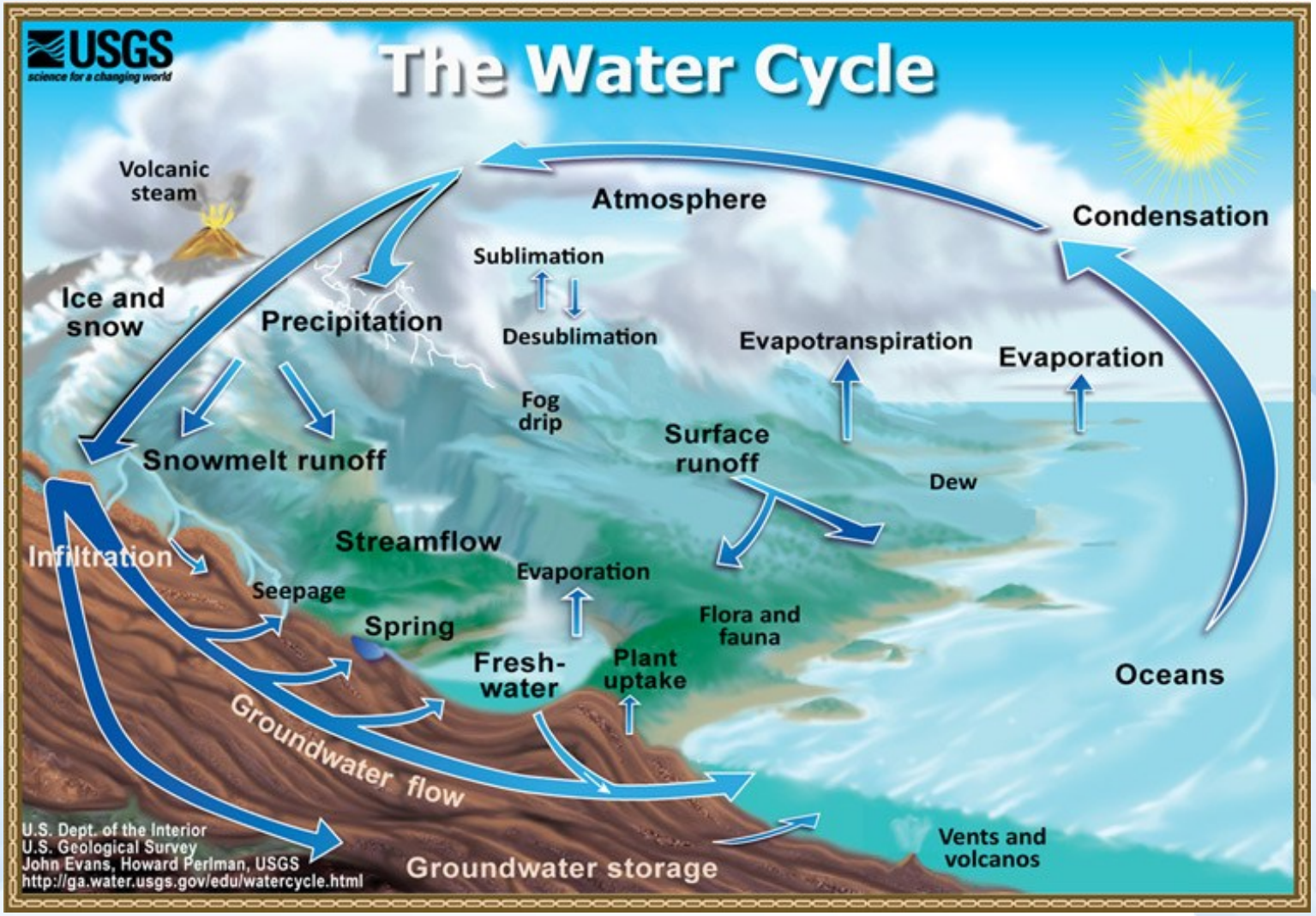
Environmental fate of chemicals



Fate of chemicals – global cycles



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Environmental fate

How well do we understand the sources, transport and transformations, it means fate of chemicals ?

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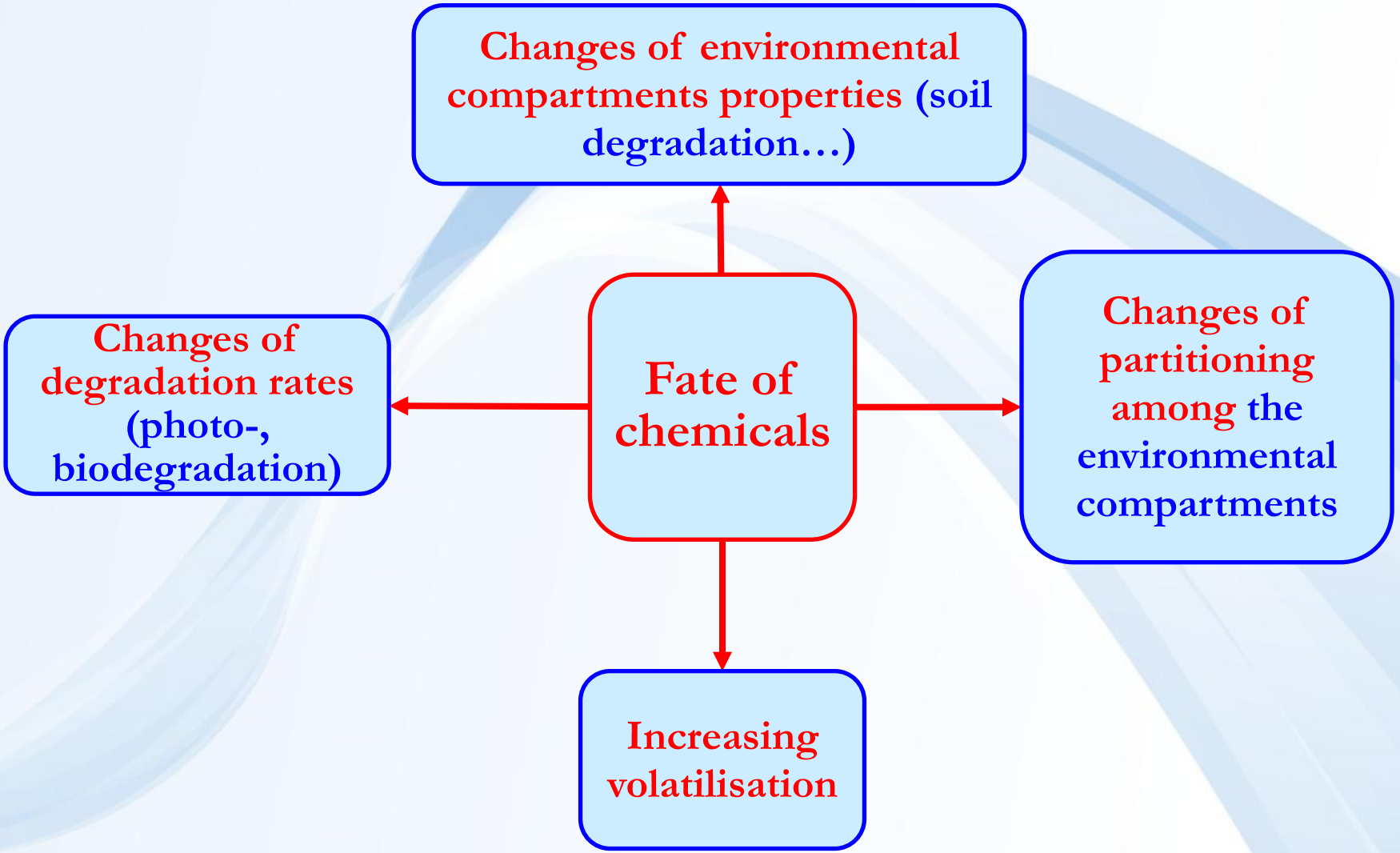
Impact on environmental fate of chemicals



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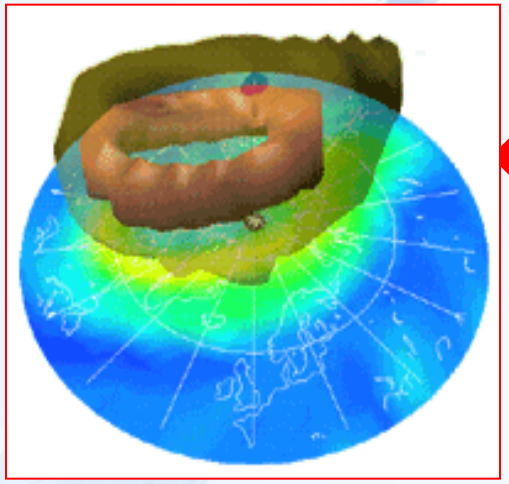
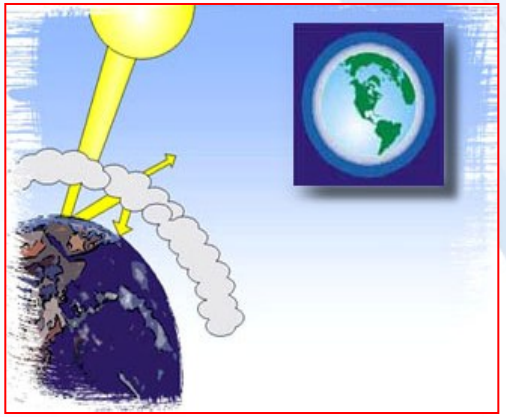
Chemické látky v prostředí



Chemická látka

Účinek na prostředí



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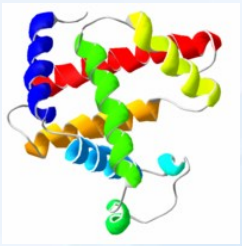
Chemické látky v prostředí

Účinek na živé organismy

Chemická látka



Toxicological relevant chemicals

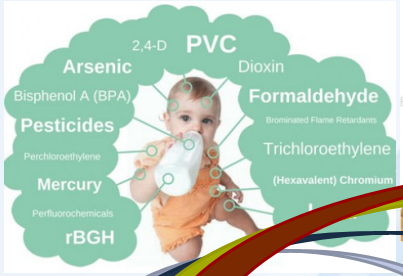
Pesticides

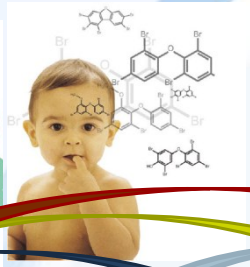
Products of combustion processes

Personnal care products (PCP)

Food packages

Wastes





Environmental occurrence= potenctial possibility of transfer to human organisms

We have to determine the level of exposure in all age categories including prenatal period

Health effects may be delayed until later in life

The Chemical Universe
Známý chemický vesmír

Známé látky:

- Více než 65 milionů chemických látek (org. + anorg.)
- Více než 62 milionů sekvencí
- Indexovány v CAS Registry
- ca 12 000 látek !!! denně

Komerčně dostupné látky - ca 14 milionů

ca 250 000 látek bylo/je celosvětově regulováno

To je pouze 1.8 % z komerčně dostupných látek a méně než 0.5 % ze známého množství chemických látek

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Chemické látky v prostředí

Prostředky osobní péče

(kosmetika, parfémy (~300), látky pro barvení a úpravu vlasů, UV-filtry)

(n=???)

Průmyslové chemikálie

(~ 80 000 registrovaných US EPA, ~ 4 000 neurotoxinů)

Farmaceutika

antibiotika, betablokátory, anti-epileptika, analgetika)

~ 50 000 produktů,

~ 2 900 účinných látek

Metabolity

Tenzidy, detergenty

(~ 800 látek)

Pesticidy

(herbicidy, insecticidy,fungicidy…)

~ 1 004 registrovaných účinných látek)

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Osobní kosmetika

THE Sun

Friday, 19 March 2010

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EXCLUSIVE

515 chemicals a day on a woman's face

By JANE HAMILTON

Published: 19 Nov 2009

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WOMEN slap 515 chemicals on their face and body every day - and many could be harmful.

Beauty-conscious girls use up to 13 products, most containing more than 20 ingredients, a new study found.

Some of the additives have been linked to cancer, hormone problems, skin conditions and allergies.

Slip, slap, stop ... women should be wary of the creams and lotions they apply every day

Research centre for toxic compounds in the environment

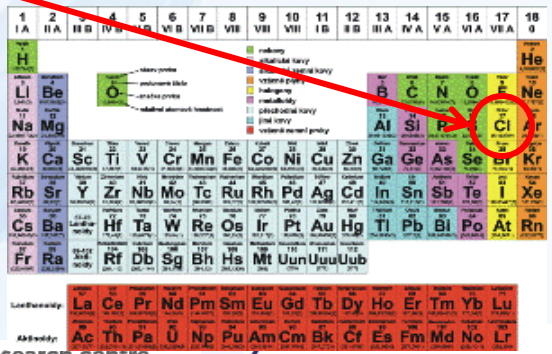
CzechGlobe
Centrum výzkumu globální změny AV ČR, v.v.i.

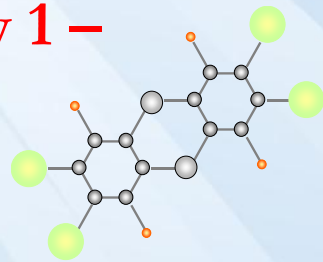
POPs (Persistent organic polutants)

☺ The group of most fascinating pollutants (Kevin C. Jones)

☹ Ghost of the past (Terry Bidleman)

God created 90 elements, man round 17, but Devil only 1 – chlorine (Otto Hutzinger)





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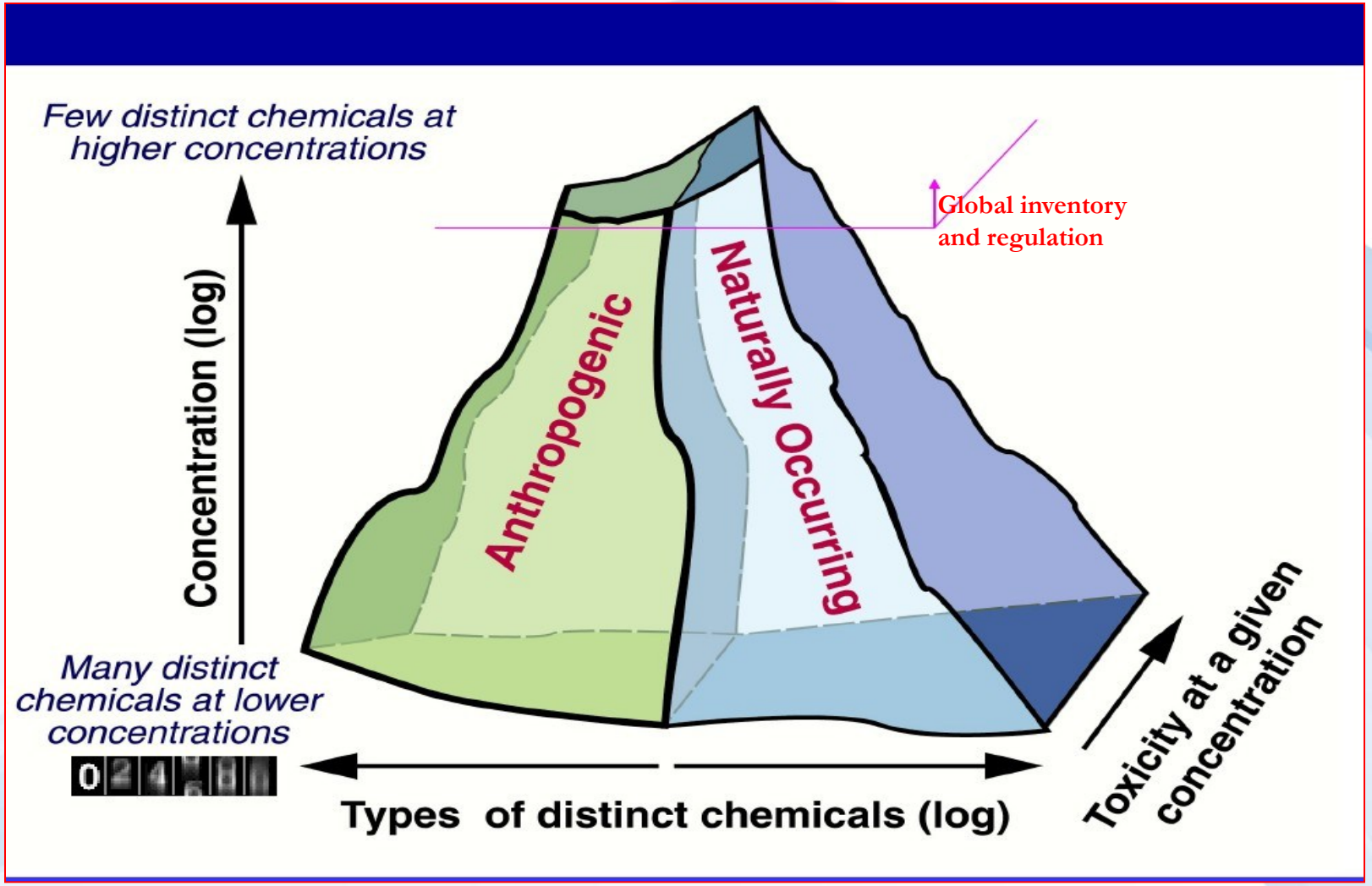
Znečištění prostředí



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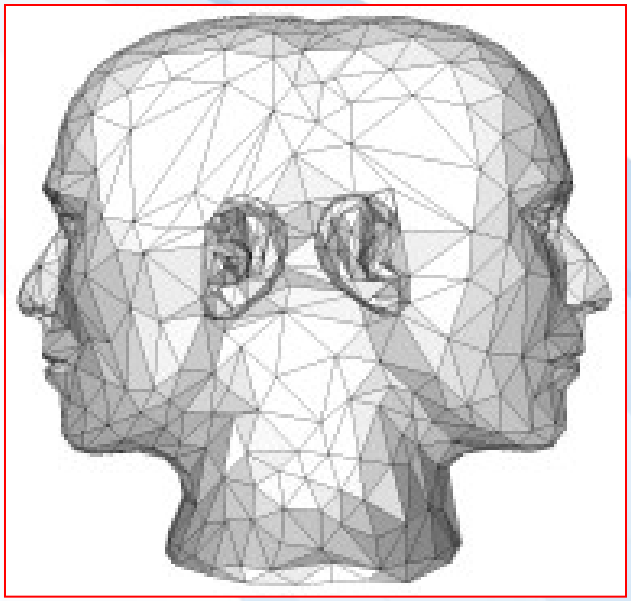
The status of chemistry in the modern society

Chemical products of 20. century:

- Antibiotics and other drugs
- Modern fertilizers and pesticides
- Polymers, composites
- Industrial chemicals

Chemical products of 20. century:

- DDT
- PCBs
- CFCs
- PBTs



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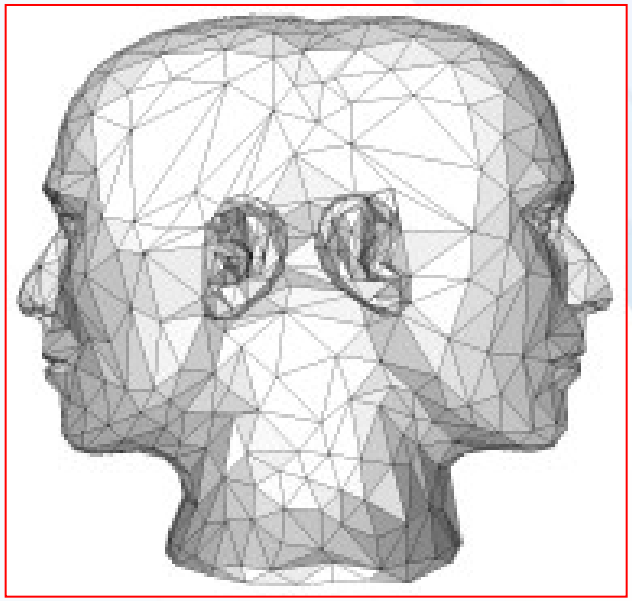
The status of chemistry in the modern society

Chemistry first fifty years of 20. century produced the substance and the second fifty years trying to cope with the consequences of this production.

The chemical industry is taken as a producer of significant quantities of hazardous substances affecting all abiotic and biotic components of the environment - a negative image of chemistry in society.



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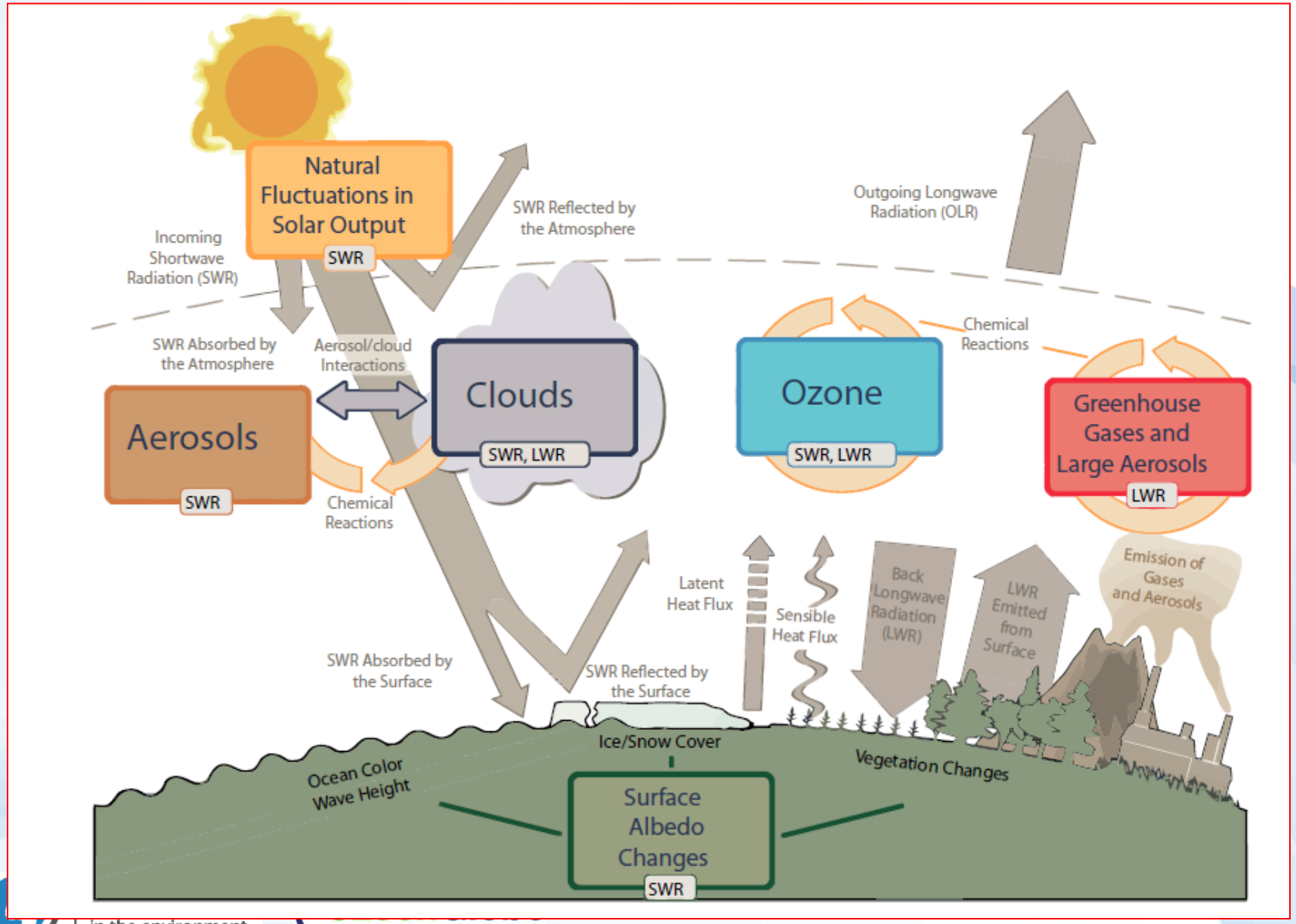
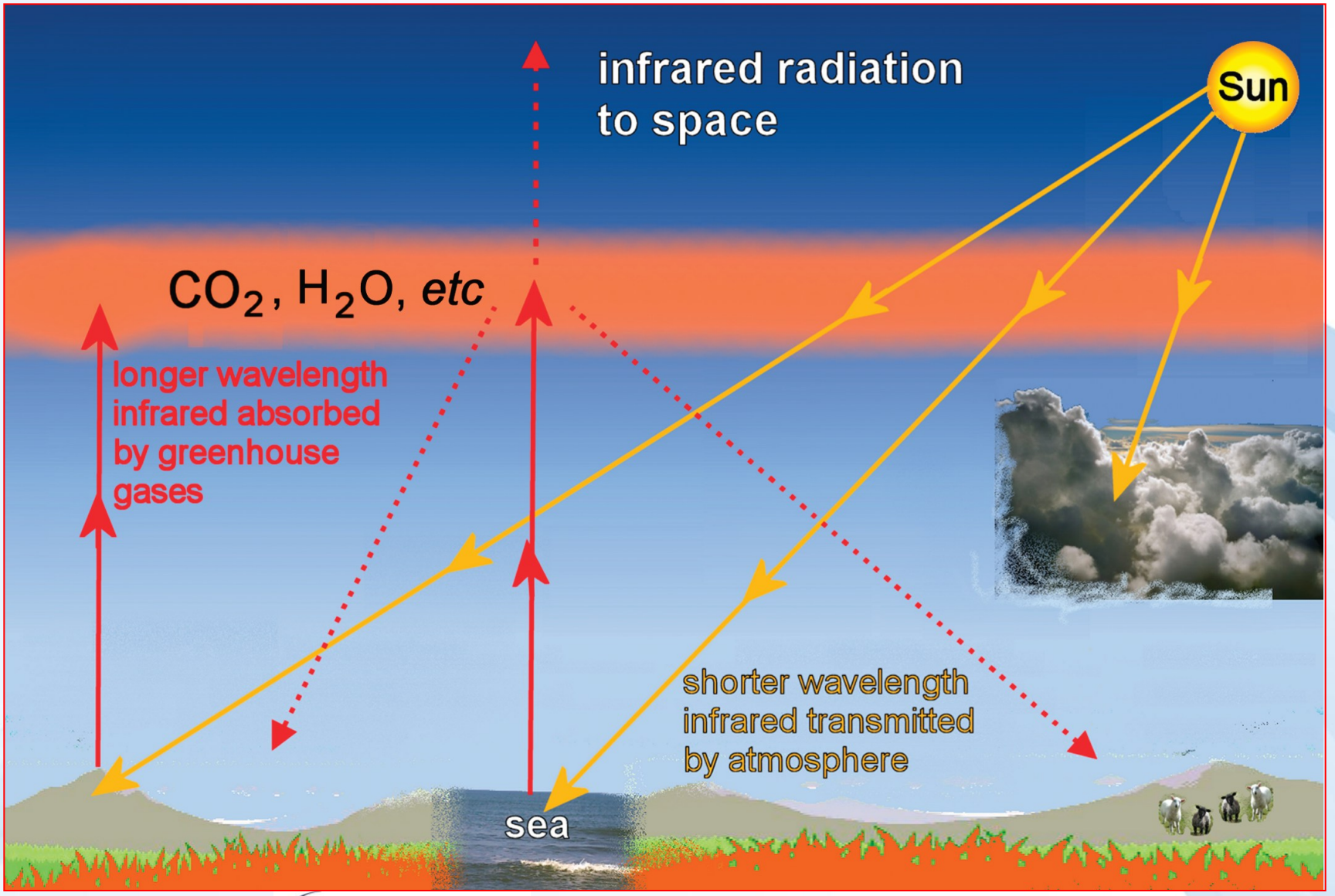
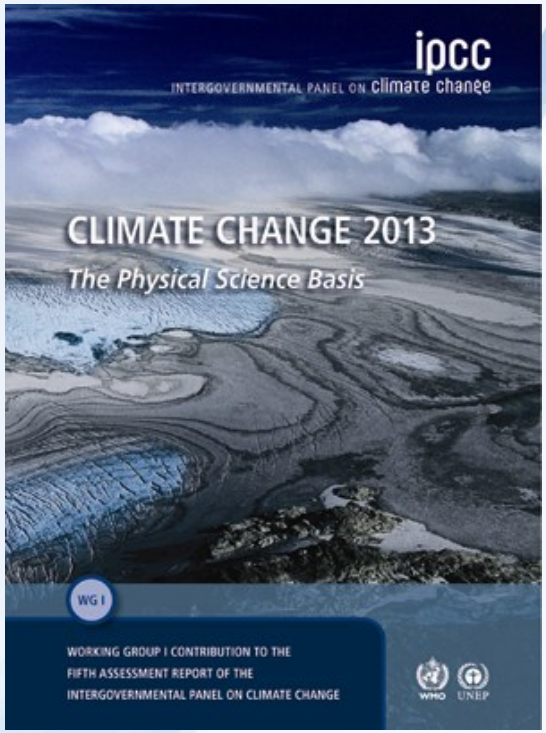
Problems of atmosphere

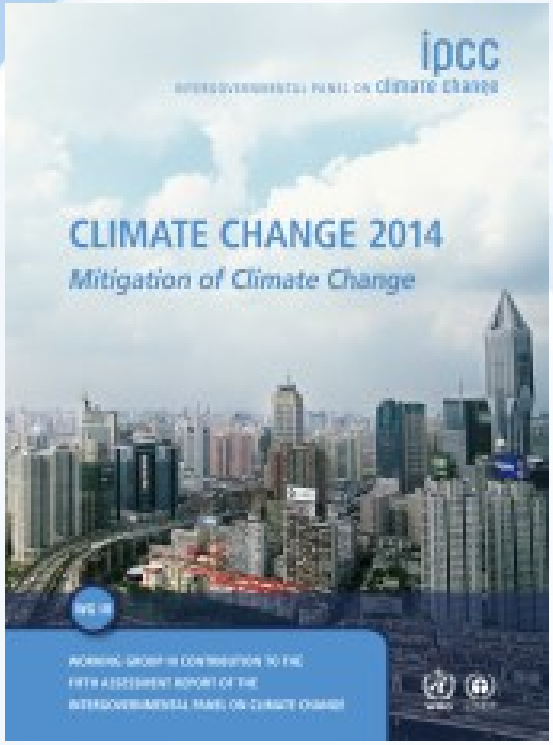


Greenhouse effect



IPCC Intergovernmental Panel on Climate Change





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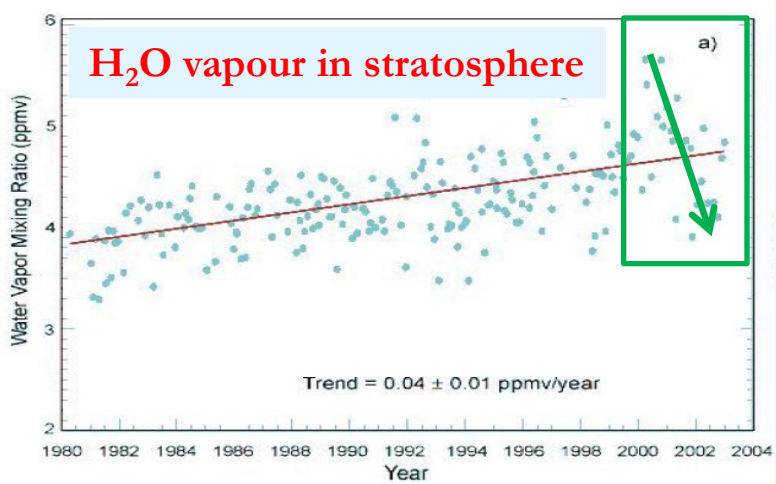
Greenhouse gases (GHG)

- **Natural**
  - Water vapour, CO_2, CH_4
- **Antropogennic**
  - CO_2, CH_4, N_2O, PFC, HFC, SF_6
- ***Indirect and precursors***
  - NO_x, CO, NMVOC, SO_2, O_3



Water vapour

- **Combine effect**
  - evaporation
  - clouds
  - feedback
- **Participation on the natural greenhouse effect » 65-85 %**
  - Effect of vapour pressure is probably underestimated – 1/3 of temperature increasing from 1990
  - Changes of tmperature of oceanic surface water (?)

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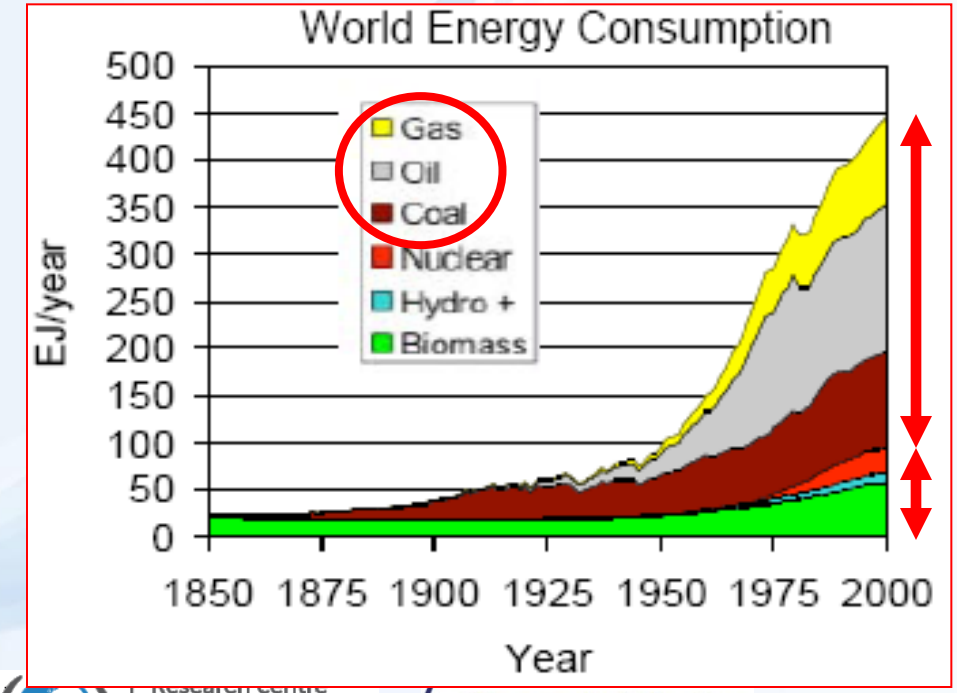
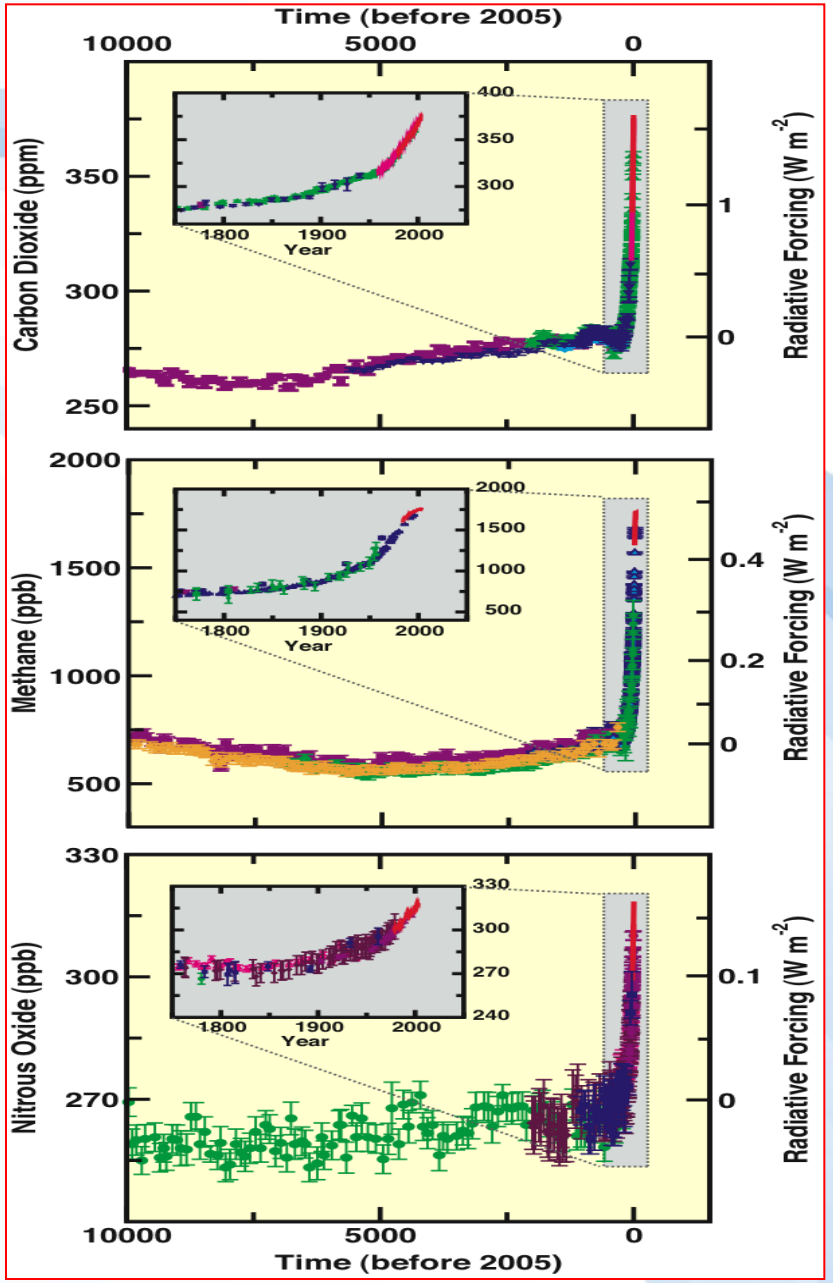
Emisions vs. Concentration of GHG

- Energetics
- Industry
- Transport
- Agriculture
- Deforestation
- Waste

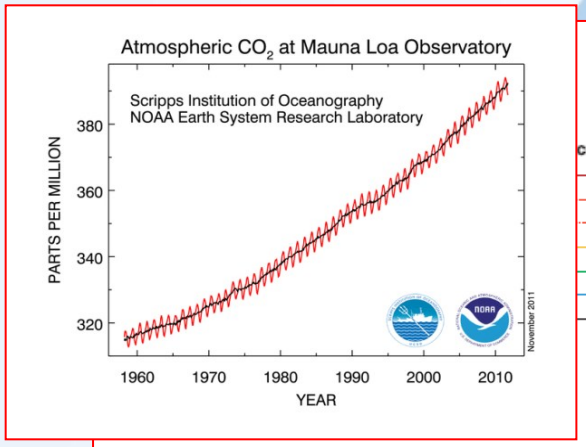
IPCC AR4 (2007)

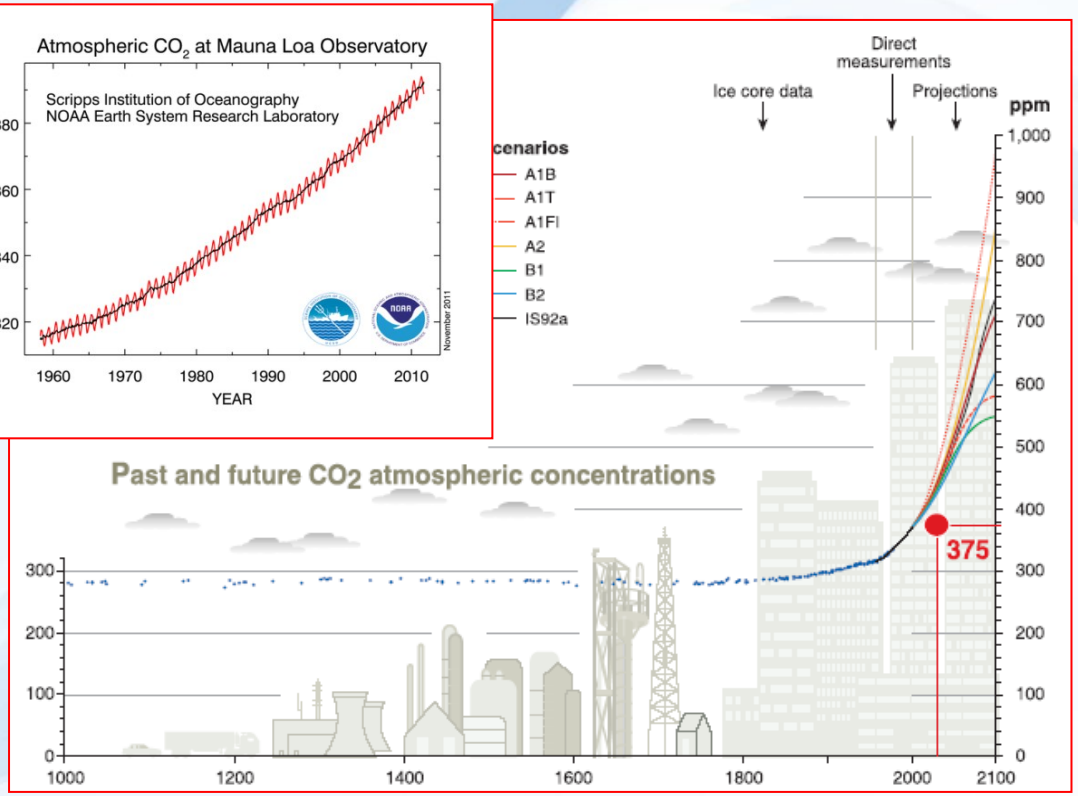


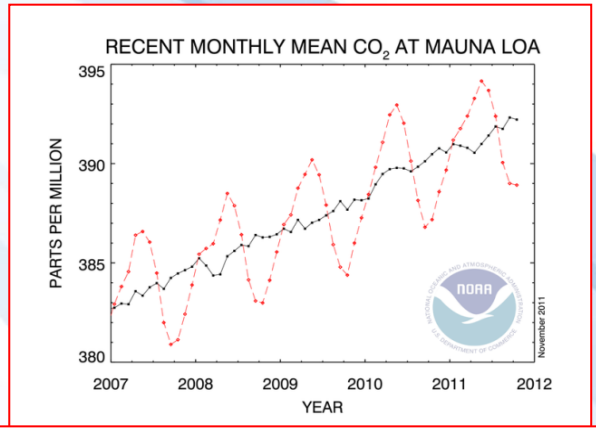


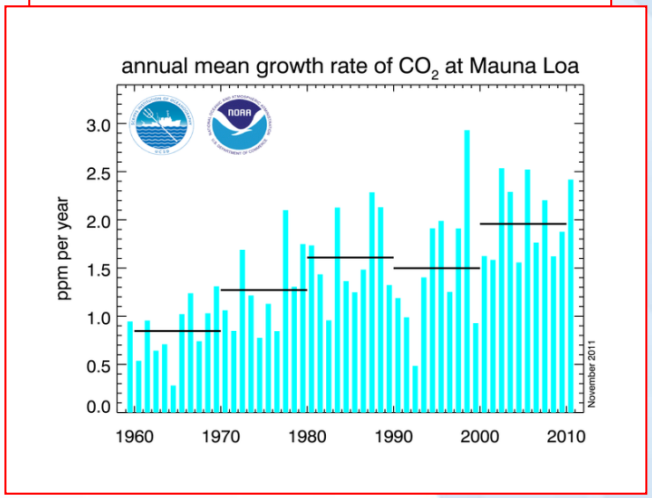
Atmospheric concentration of CO_2

- an increase of approximately 25% over the last 50 years
- an increase of approximately 40% over the last 200 years
- trend in annual growth of around 2 ppm, or approximately 0.5% / year









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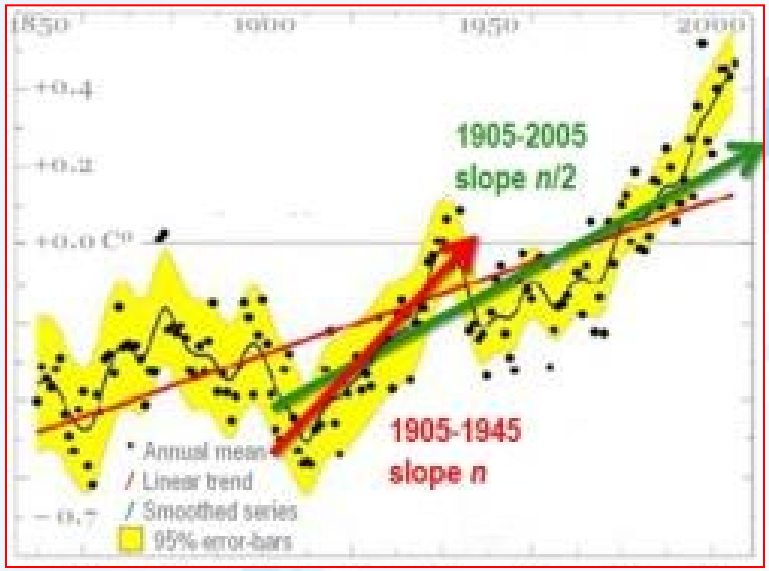
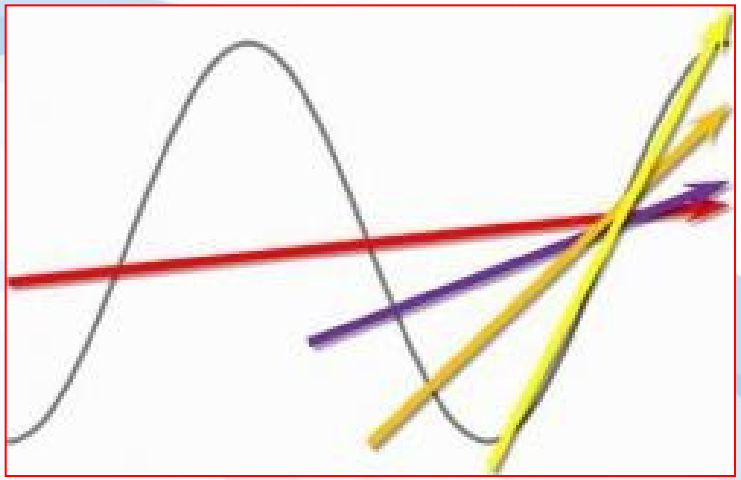
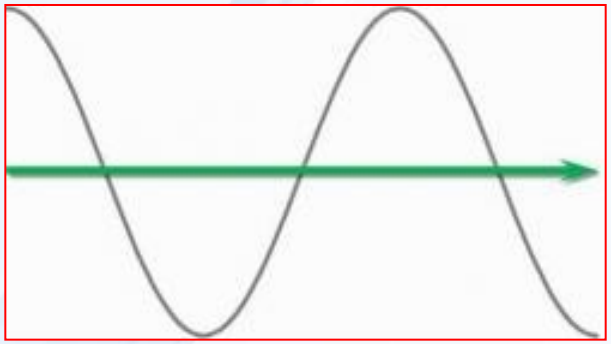
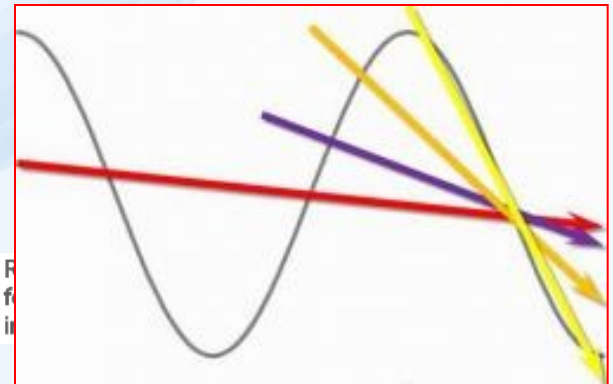
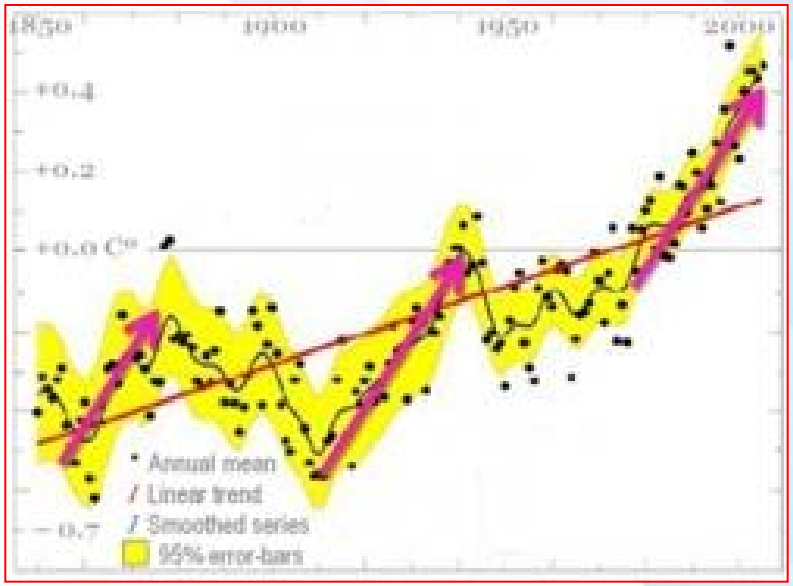
Trends – reality or statistical devilry ?







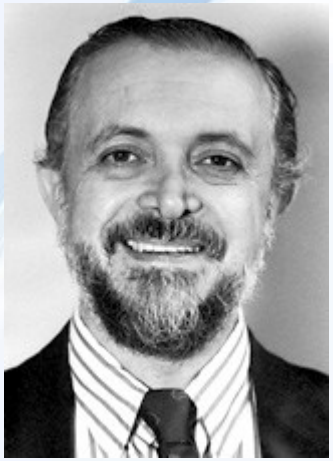




Catalytic effect of freons

- 1995 Nobel price:

Paul Crutzen, Mario Molina, Sherwood Rowland



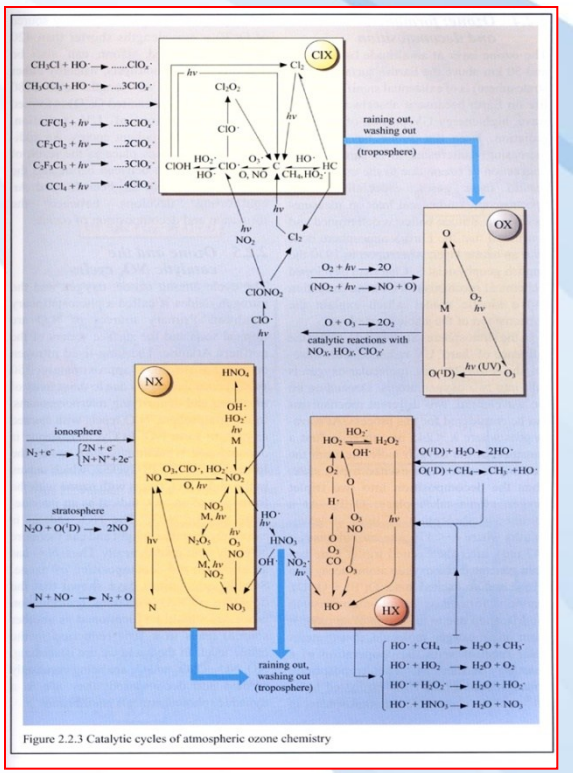


Figure 2.2.3 Catalytic cycles of atmospheric ozone chemistry

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Catalytic ef

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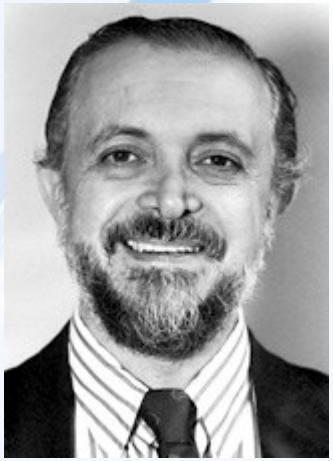

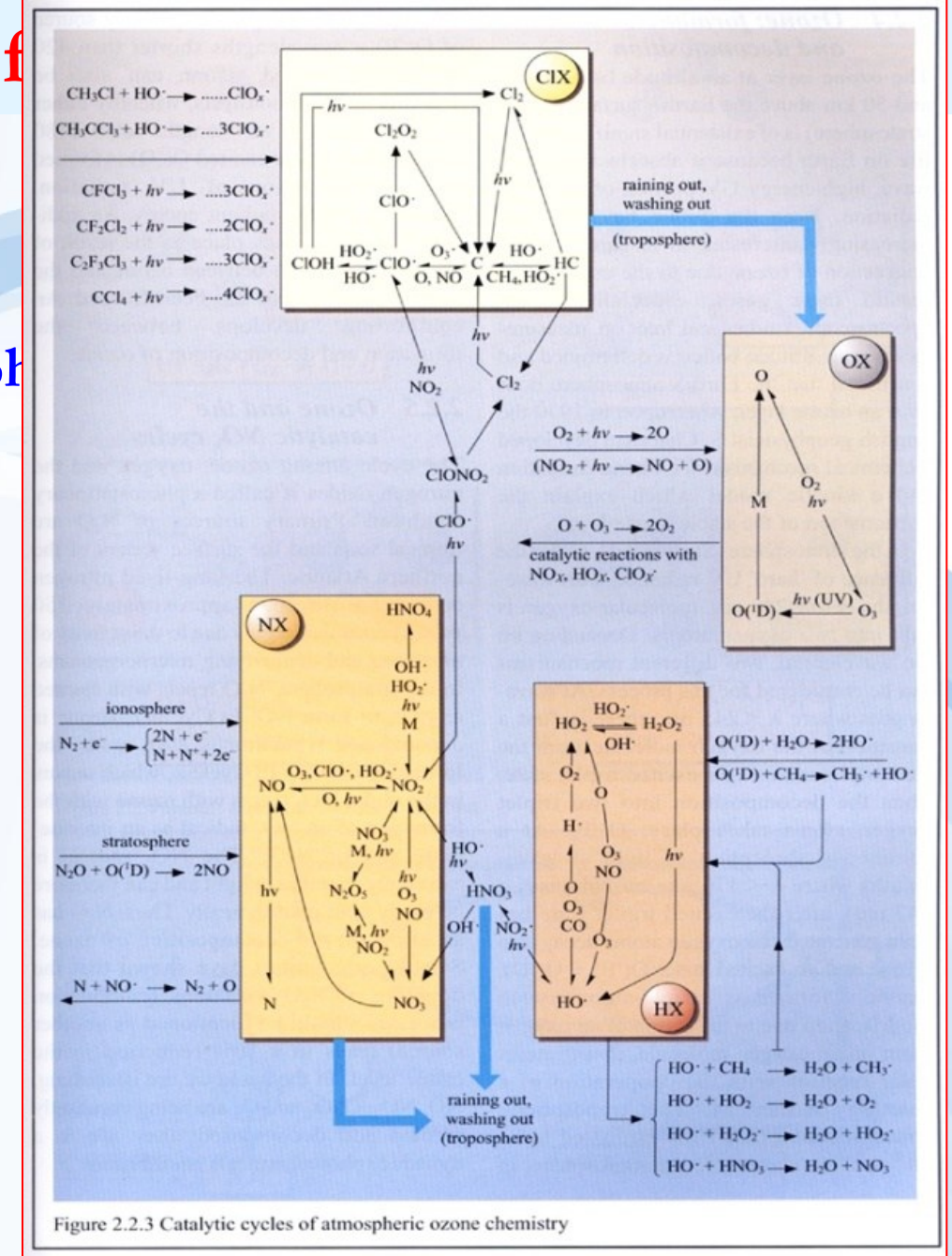

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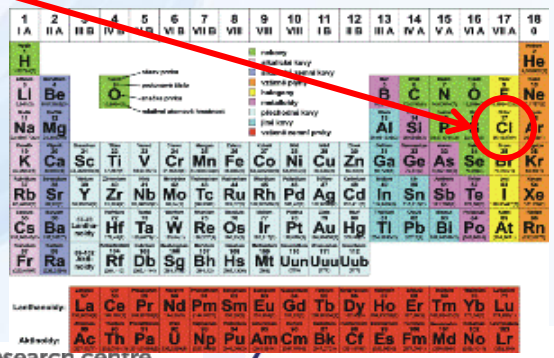
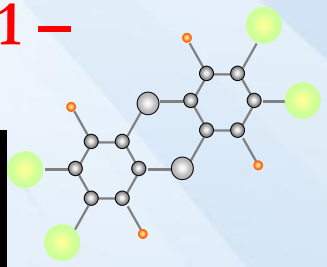
God created 90 elements, man round 17, but Devil only 1 – chlorine (Otto Hutzinger)





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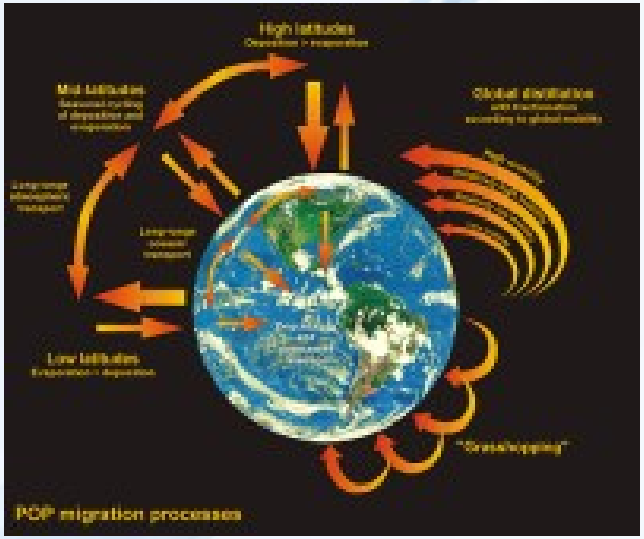
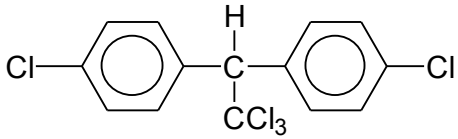
Persistent Organic Pollutants

- Persistent = Resistant to chemical, biochemical, photochemical degradation
- Long life-time in the environment (years)
- Physical properties which support a high degree of mobility in the environment – high potential to long range transport





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The most important effects of POPs

- Bioaccumulation in biota and food chains
- Induction of AHH receptors
- Neurotoxicity
- Imunotoxicity
- Endocrinne disruption:
  - Estrogens/antiestrogens
  - Antiandrogens
  - Thyroid hormones

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POPs free world/products

Protecting human health and the environment from persistent organic pollutants

www.pops.int

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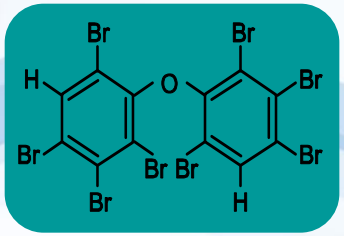
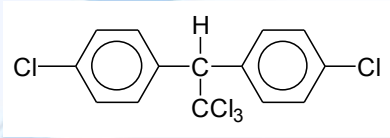
Persistent Organic Pollutants

Main groups:

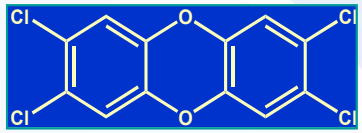
- Technical chemicals



- Pesticides



- Industrial by-products



- Wastes

- Obsolete POPs

- Contaminated sites

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What are we talking about ?

- Unintentional releases
- Releases to air, water, soil, waste, products

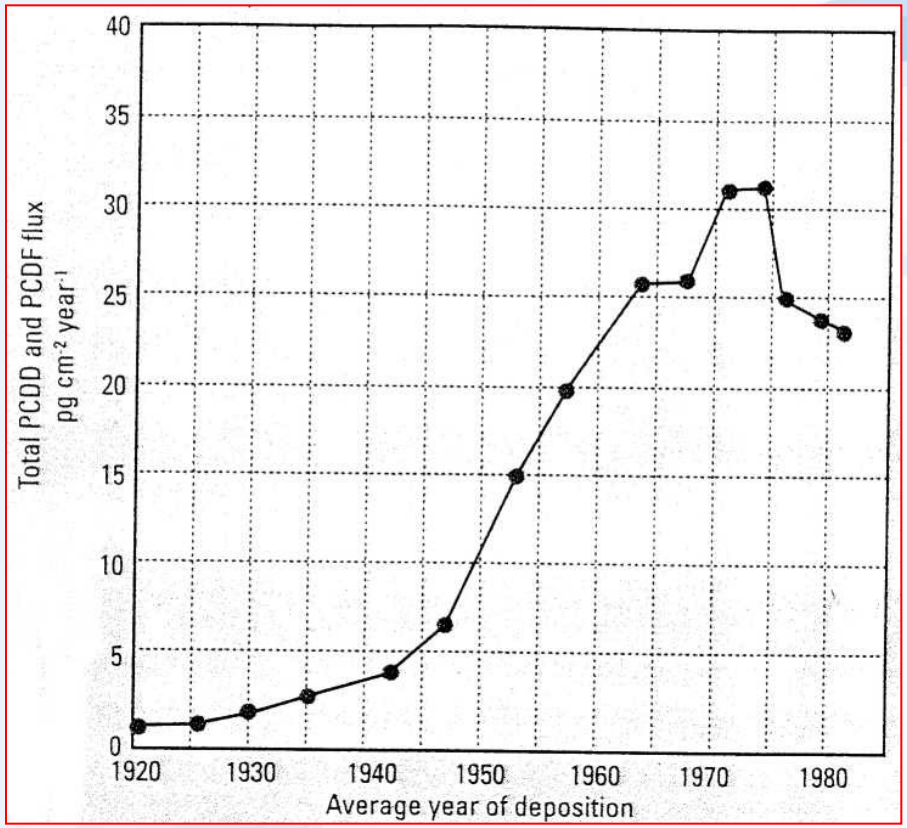
Of the 5.7 million tons of pollutants released, main part of them were of chemicals considered persistent, bioaccumulative or toxic

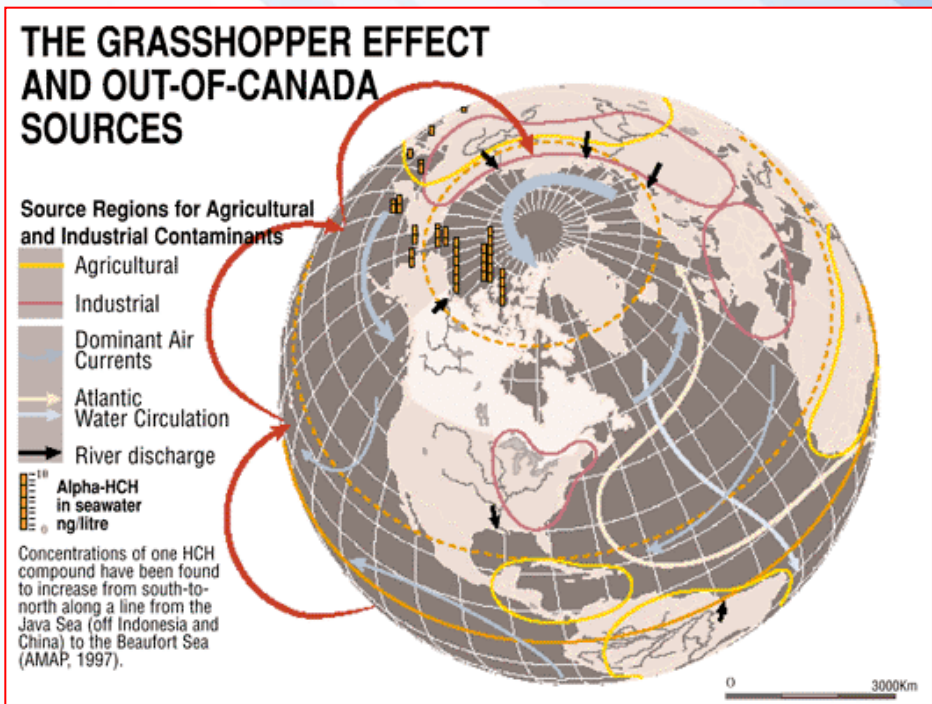
970 000 tons were known or suspected carcinogens and

857 000 tons were of chemicals that are considered reproductive or developmental toxicants.

(UNEP Chemicals, 2012)

Historical trends of environmental levels of PCDDs/Fs





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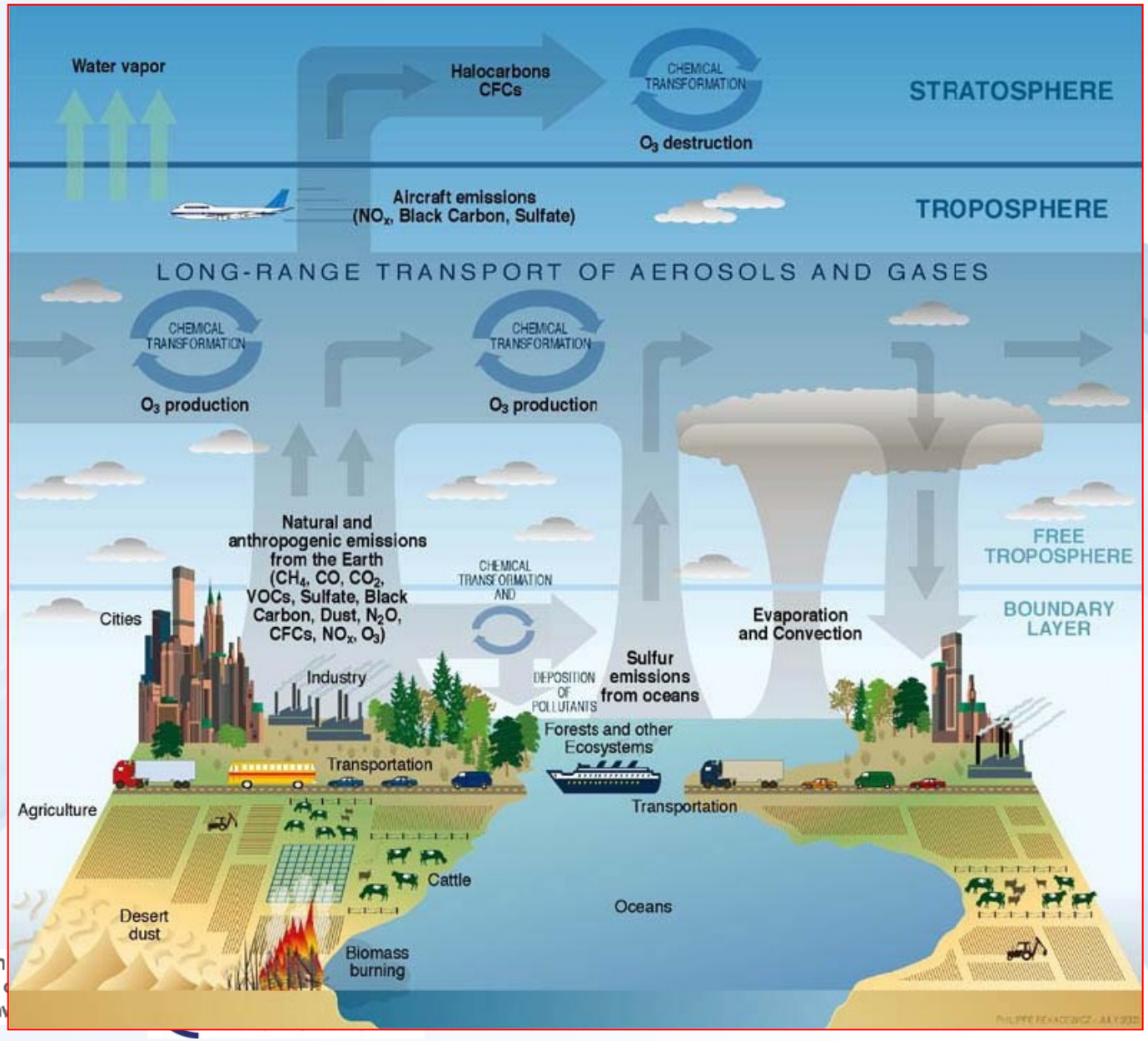
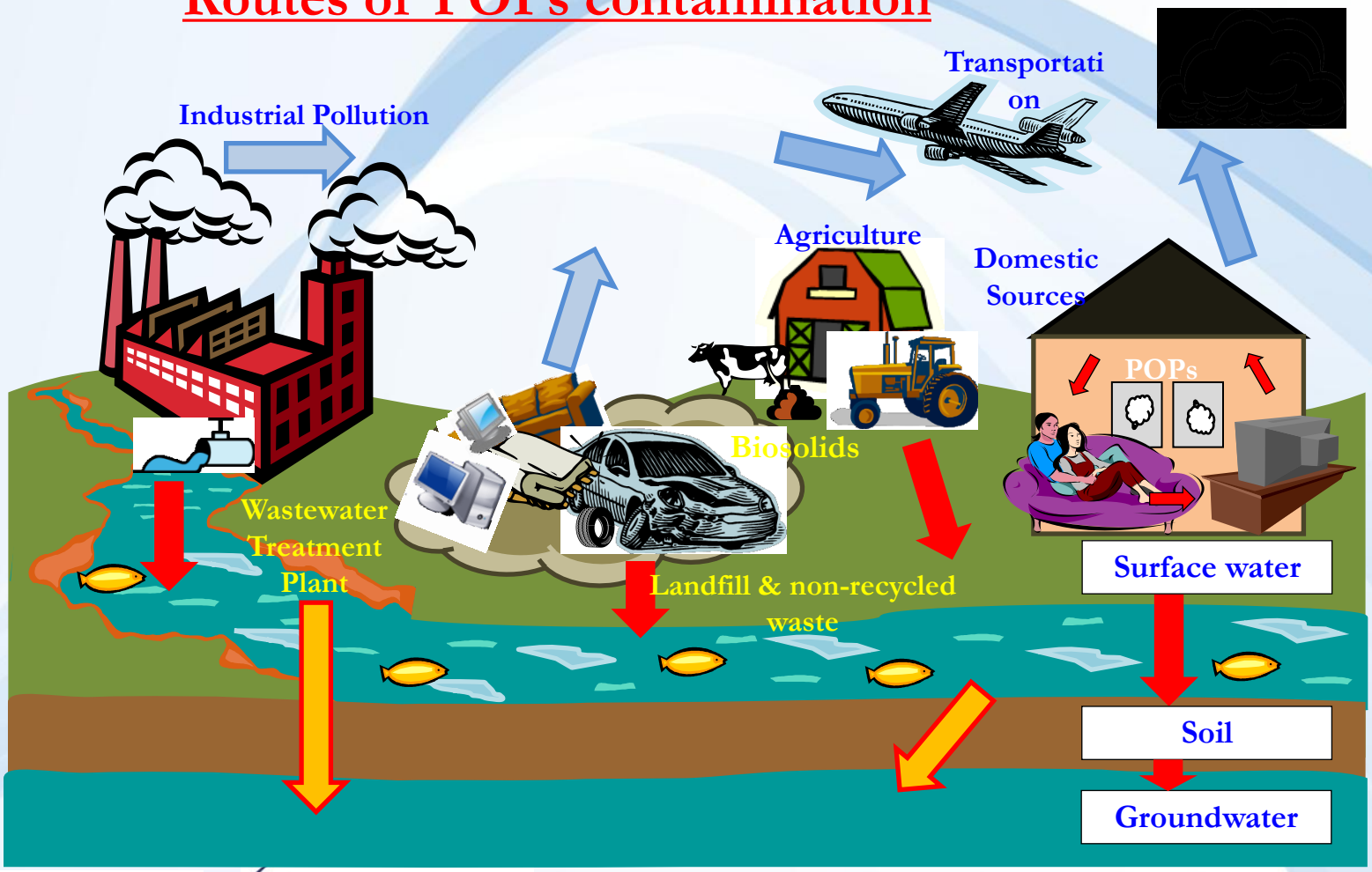
Long-range transport of aerosols and gases



Contaminated sites

Routes of POPs contamination



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Summary of chemical problems

Primary releases – A, W, S, B

Secondary contamination – A, W, SED, S, B

Chemical world

POPs

Products

Wastes

Production, use

Contaminated sites

Remediation

Damir Sagolj / Reuters

EFFECTS, IMPACTS, RISKS

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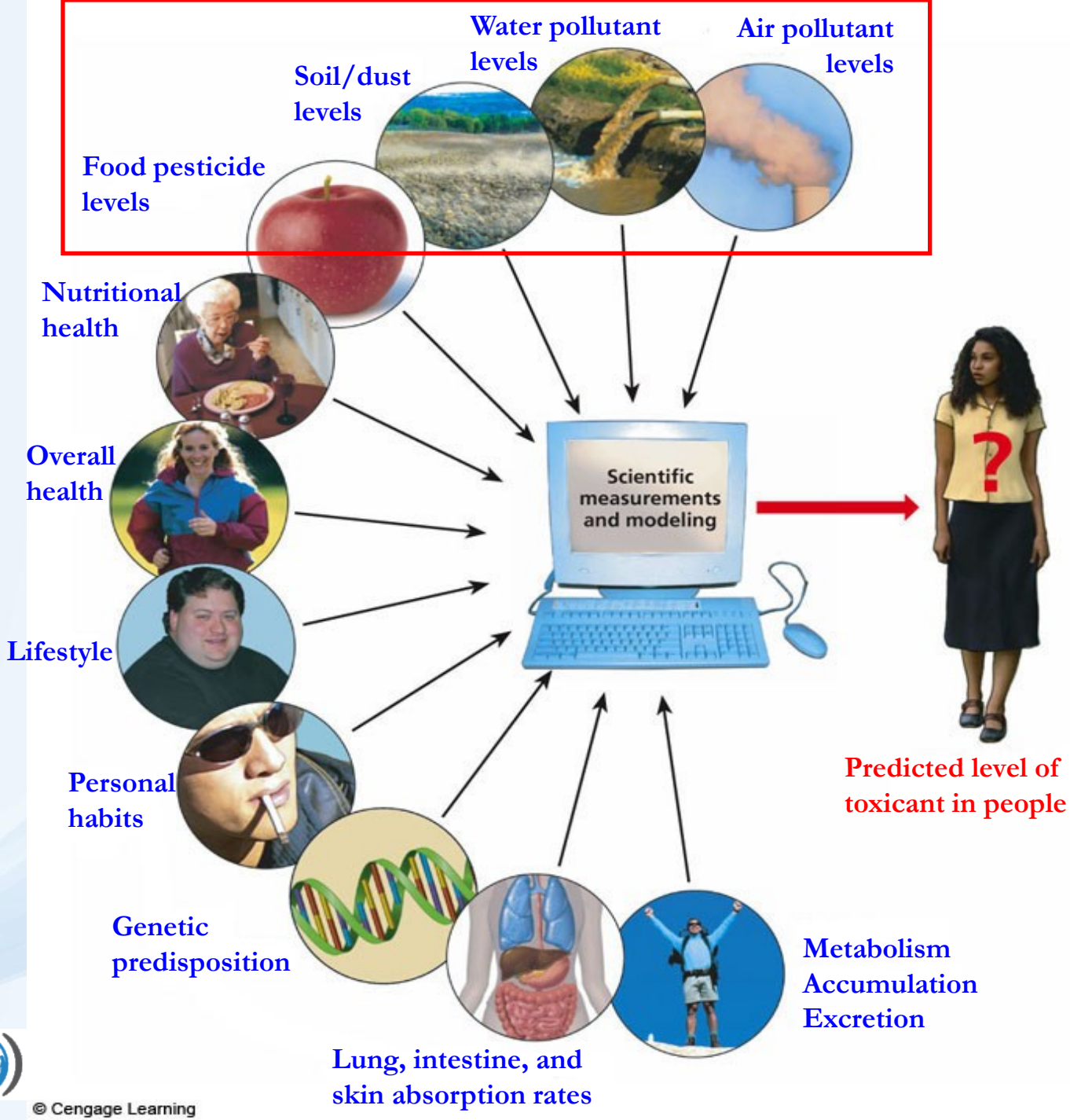

World Health Organization

UNEP
United Nations Environment Programme

State of the Science of Endocrine Disrupting Chemicals - 2012

Edited by
Åke Bergman, Jerrold J. Heindel, Susan Jobling, Karen A. Kidd and R. Thomas Zoeller

IOMC INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS
A cooperative agreement among FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD

EEA Technical report | No 2/2012

The impacts of endocrine disrupters on wildlife, people and their environments

The Weybridge+15 (1996–2011) report

ISSN 1725-2237

Academy of Finland

eu2006.fi

European Commission

European Environment Agency

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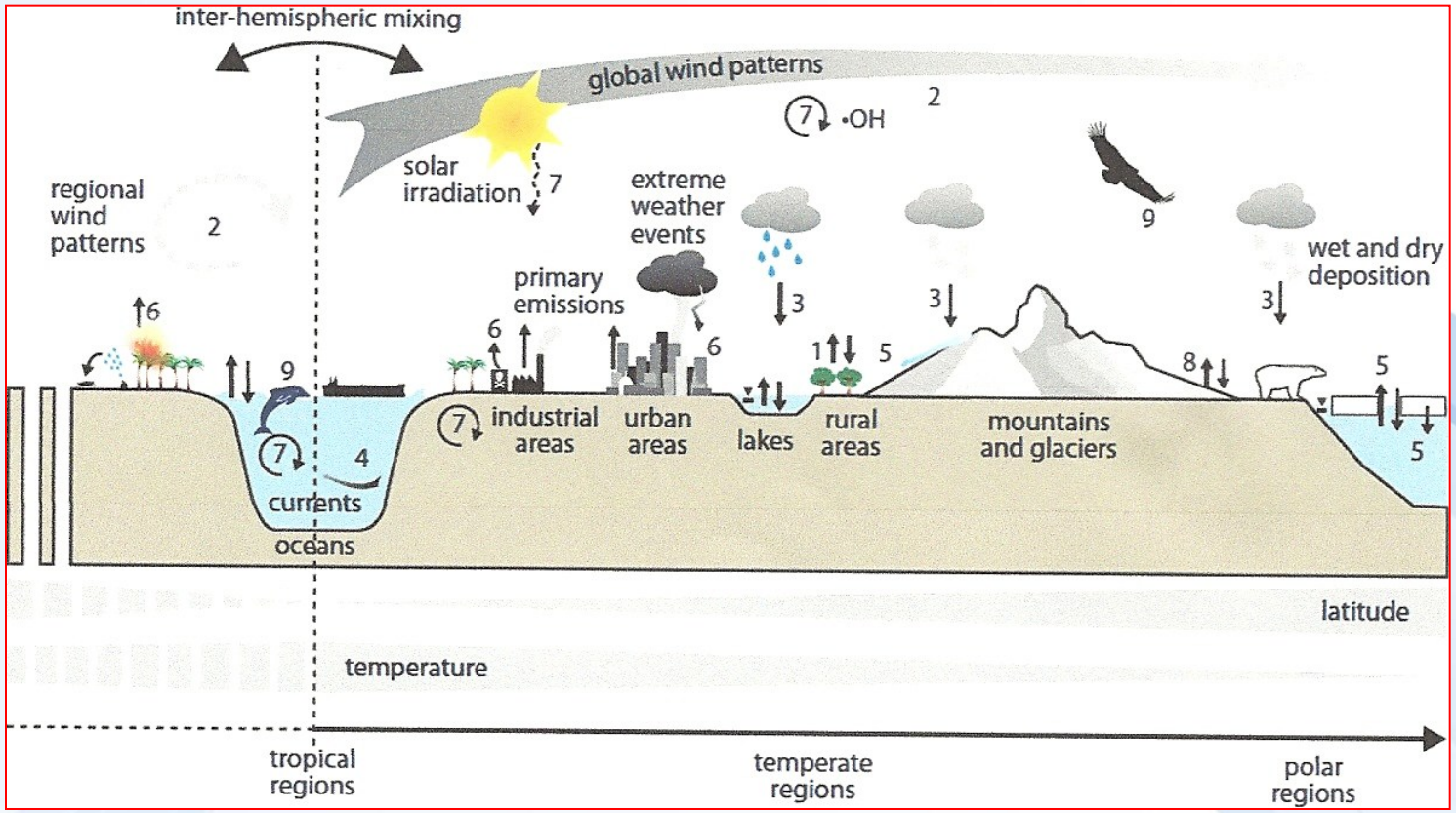
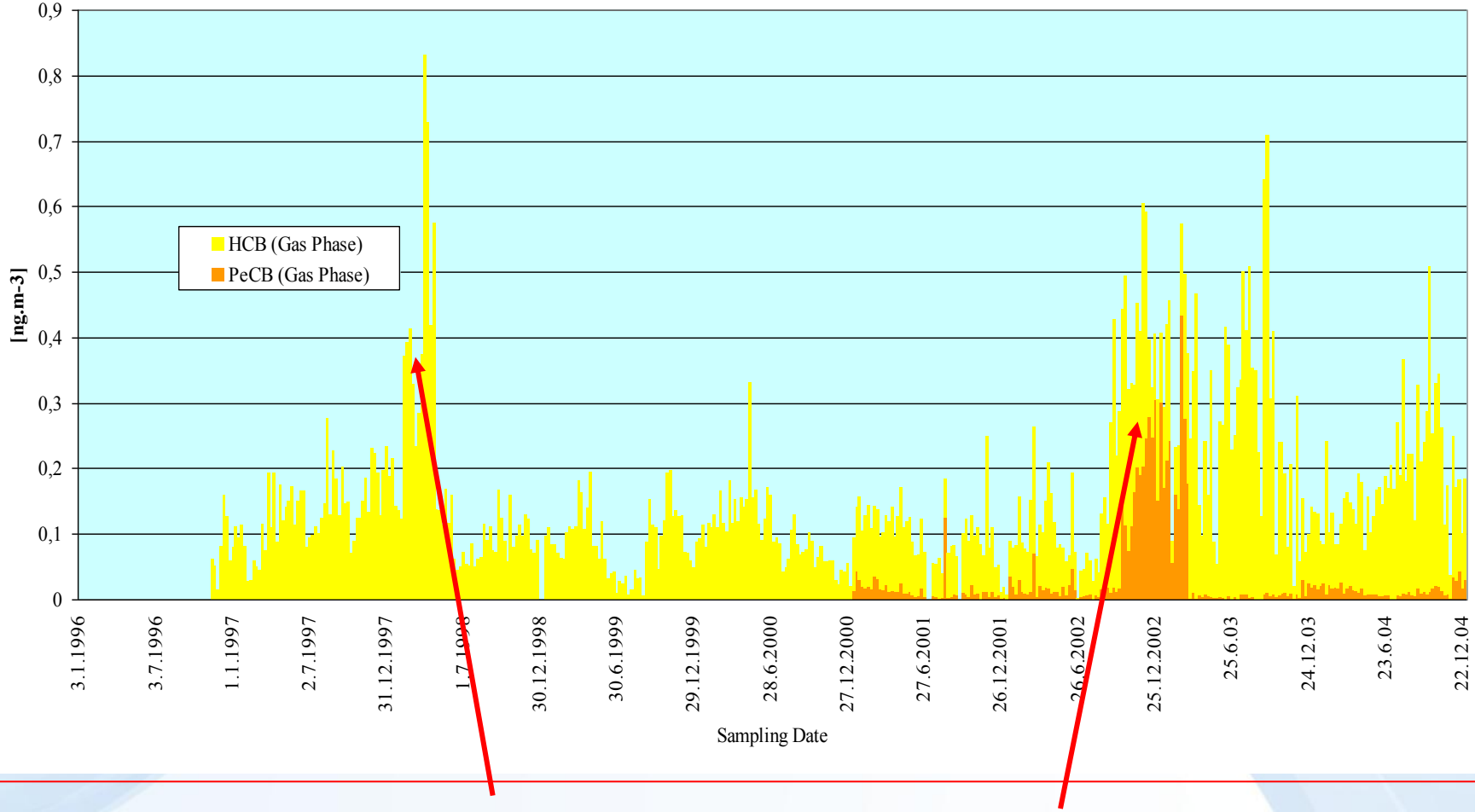
Climate change and POPs – Predicting the impacts



Conceptual representation of key factors influencing the environmental fate and transport of POPs under a climate change scenario. Numbers in the Figure correspond to enumerated items in the text, including climate-change-induced modifications in (1) strength of secondary re-volatilization sources, (2) wind fields and wind speed, (3) precipitation, (4) ocean currents, (5) melting of polar ice caps and mountain glaciers, (6) frequency of extreme events, (7) degradation and transformation of chemicals, (8) environmental partitioning of chemicals, and (9) biotic transport of chemicals. Note that the processes depicted for the Northern hemisphere are the same in the Southern hemisphere.

HCB and PeCBz in ambient air, observatory Košetice, temporal trends, medians, weekly sampled, 1996 - 2004 [ng.m^{-3}]



Effects of floods, Moravia, 1997 and in South and Central Bohemia, 2002

Holoubek et al., 2007

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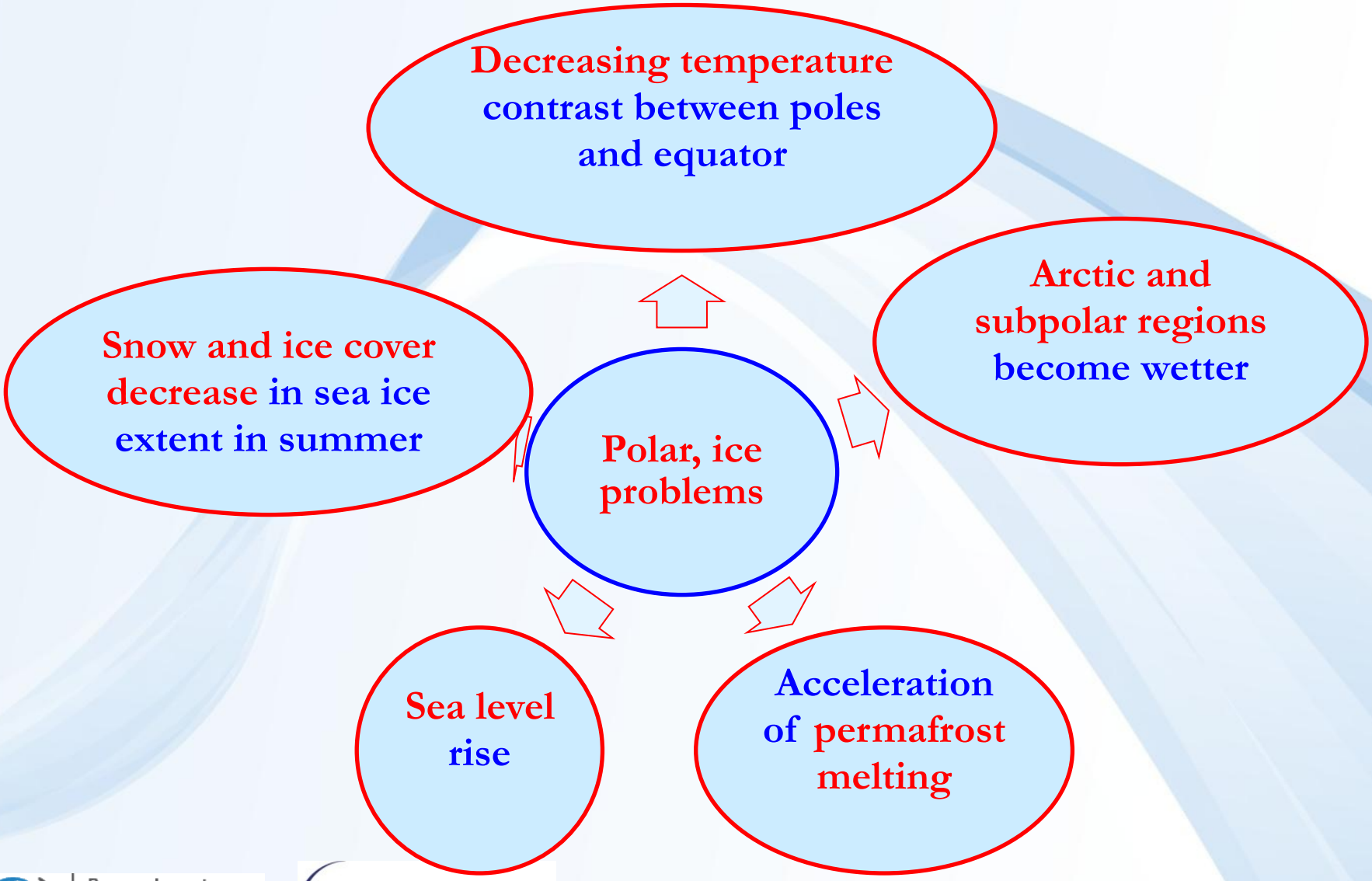
Climatic changes – impacts and consequences



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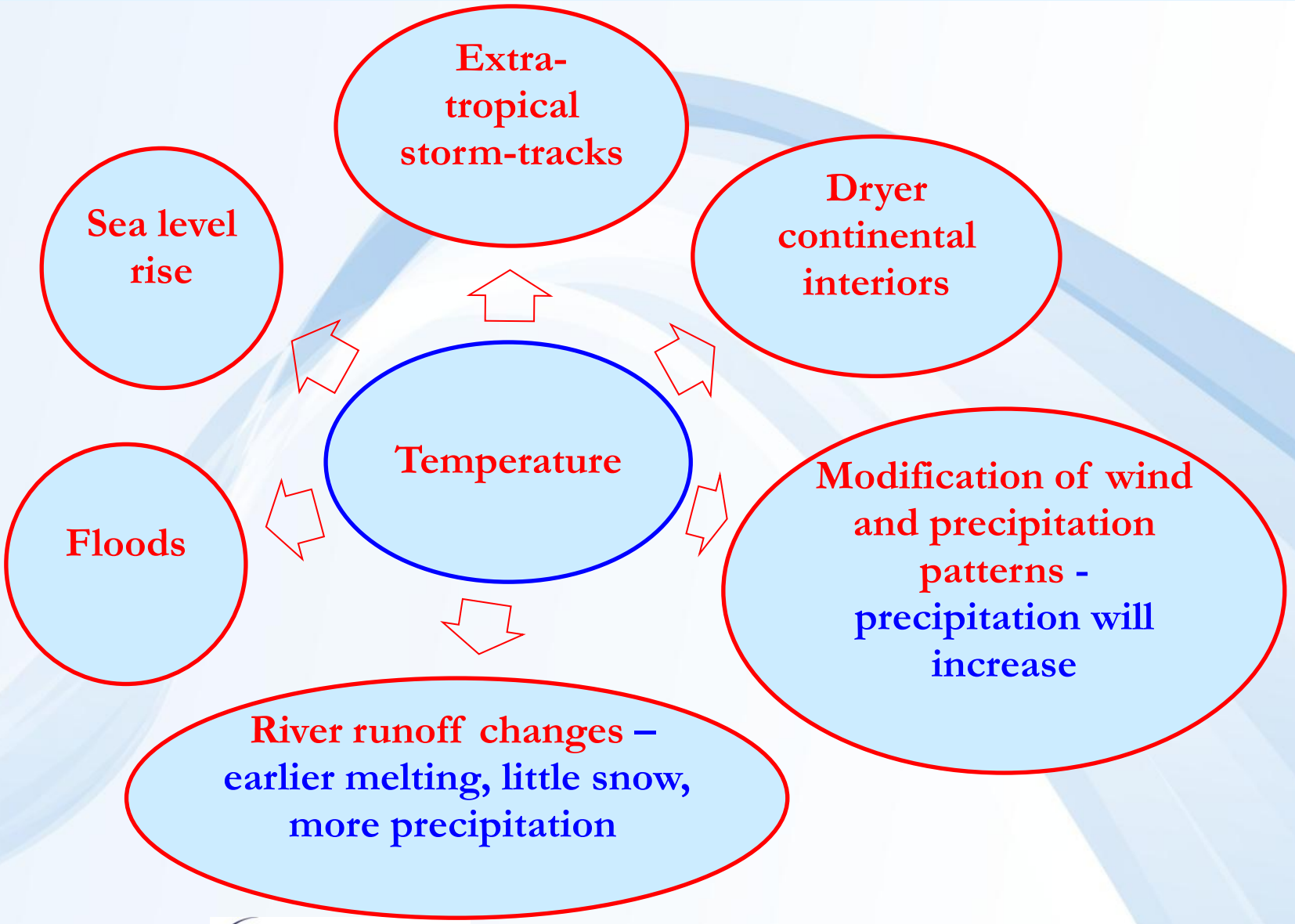

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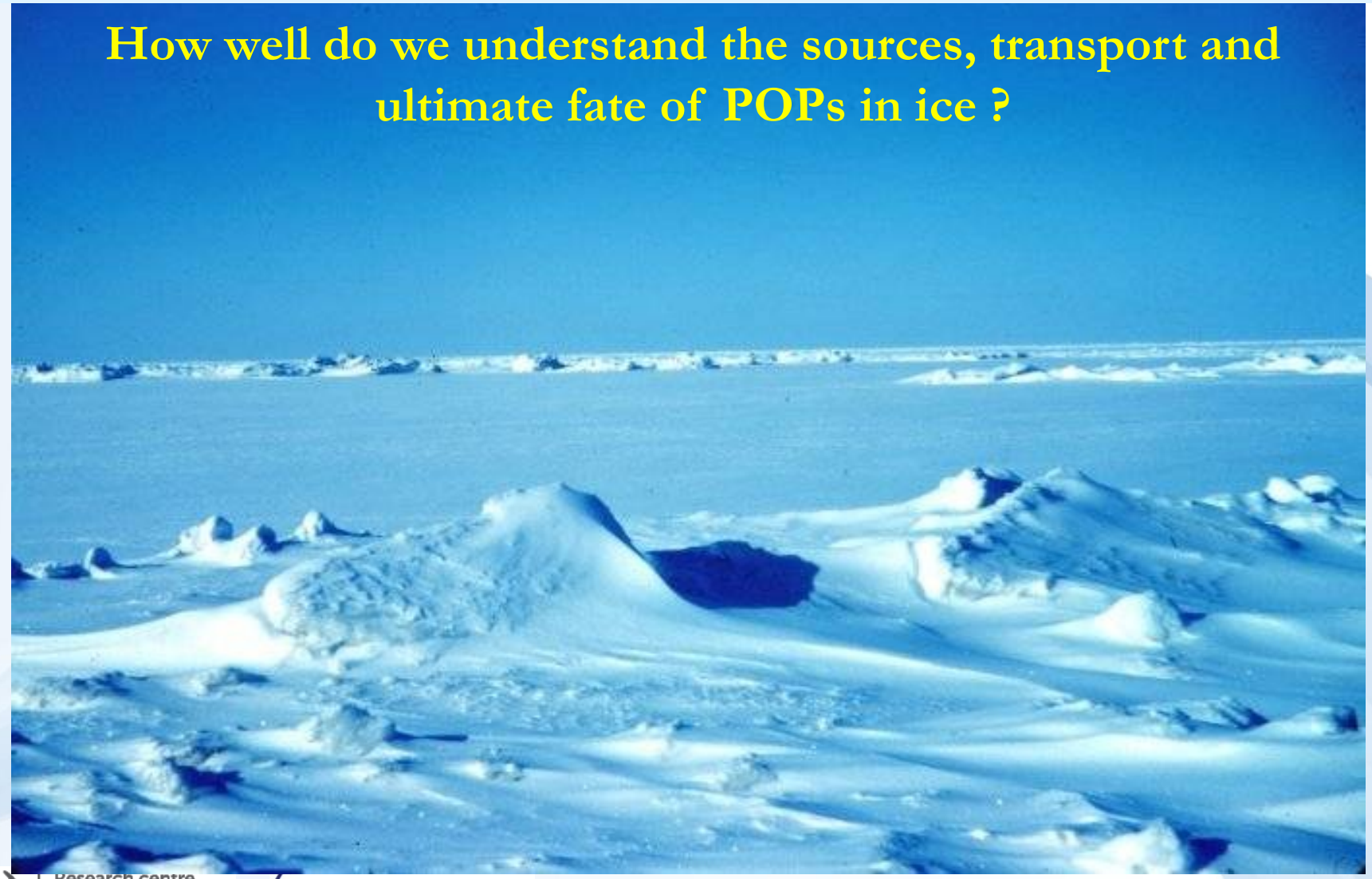
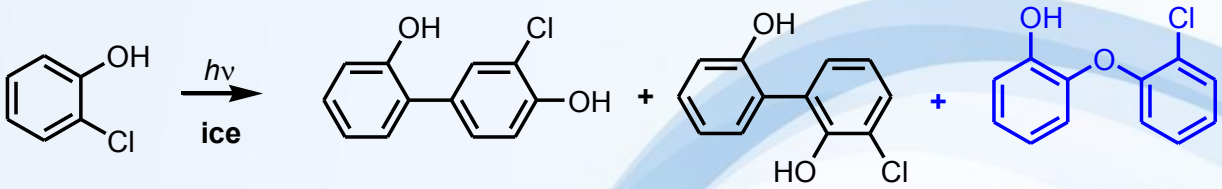
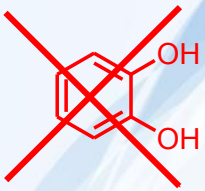
Photochemistry of organic pollutants in solid matrices

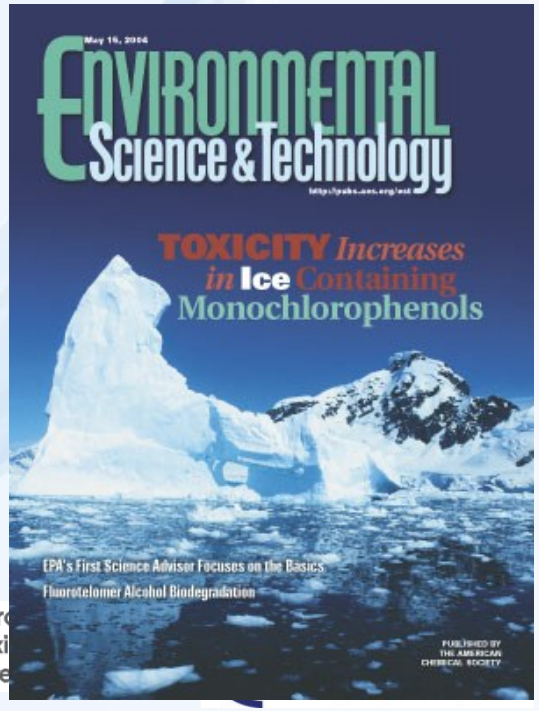


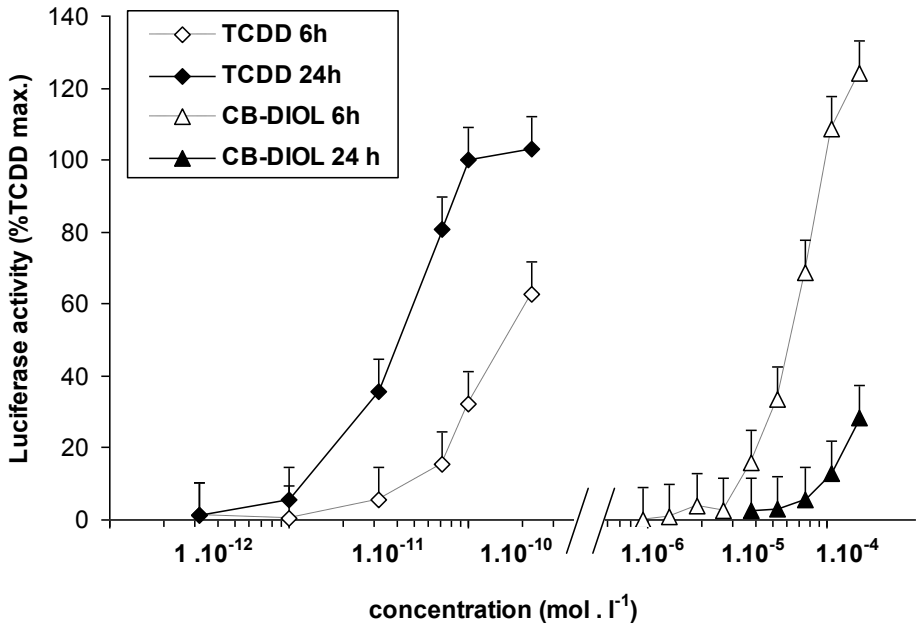
Toxicity increases in ice upon photolysis



no photosolvolysis:

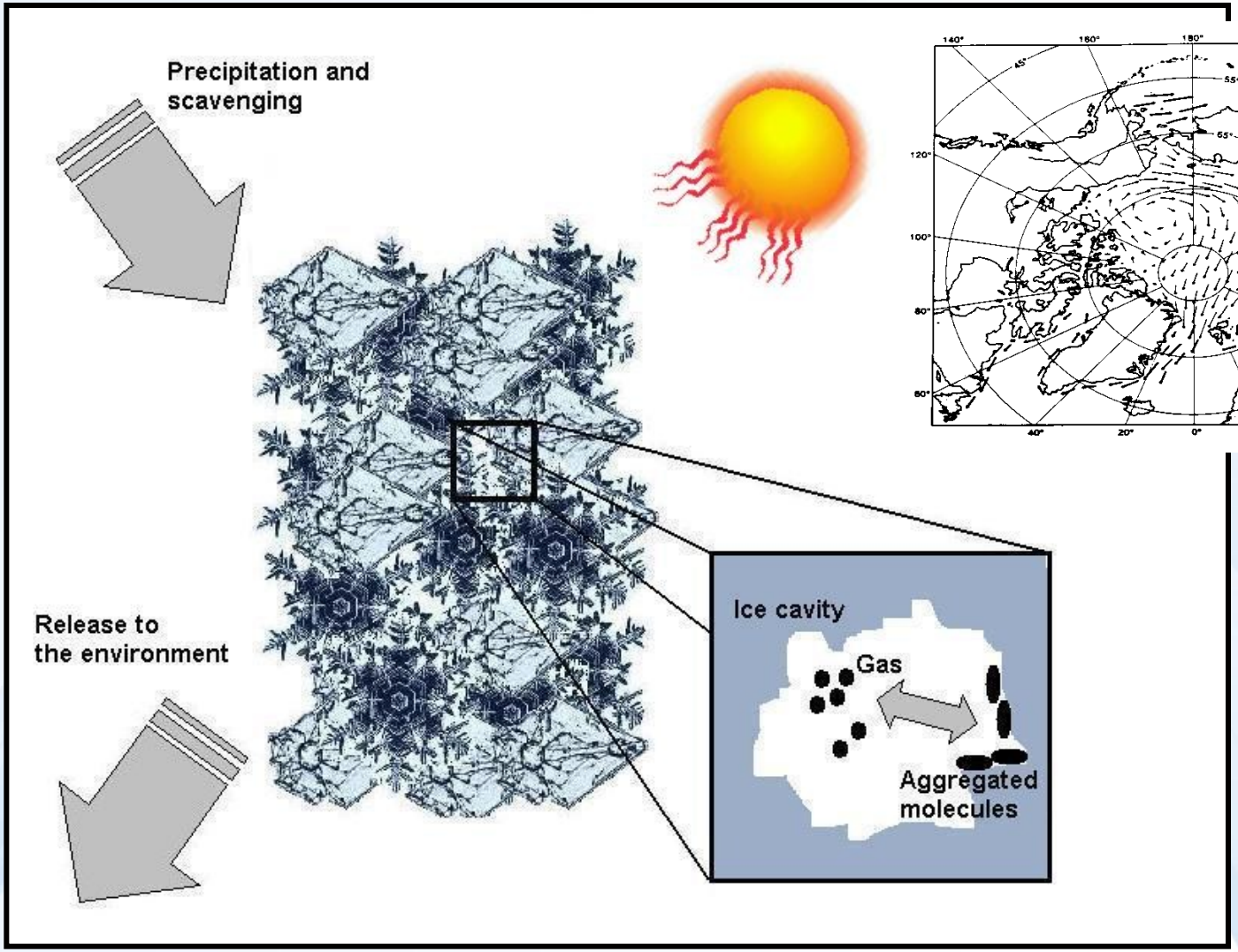


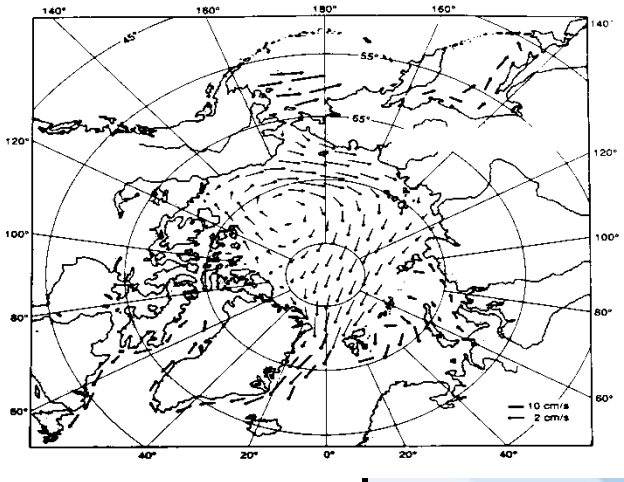




Induction of dioxin-like toxicity by photoproducts of *p*-chlorophenol in water ice *(comparison with the toxic potency of 2,3,7,8-TCDD)*

Environmental consequences





Klán P., Holoubek I.: *Chemosphere*, 2002, 46, 1201-1210

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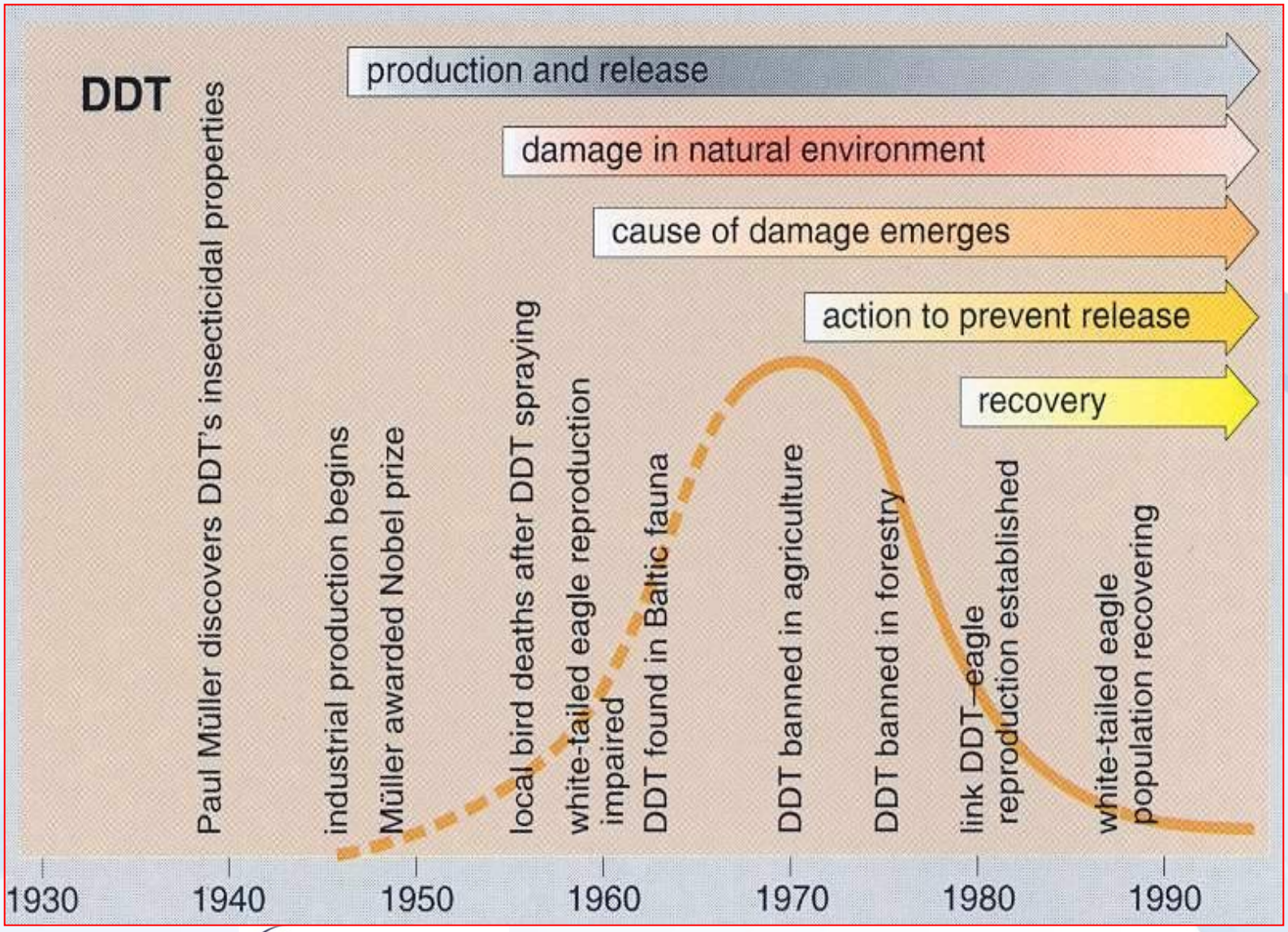
DDTs - history



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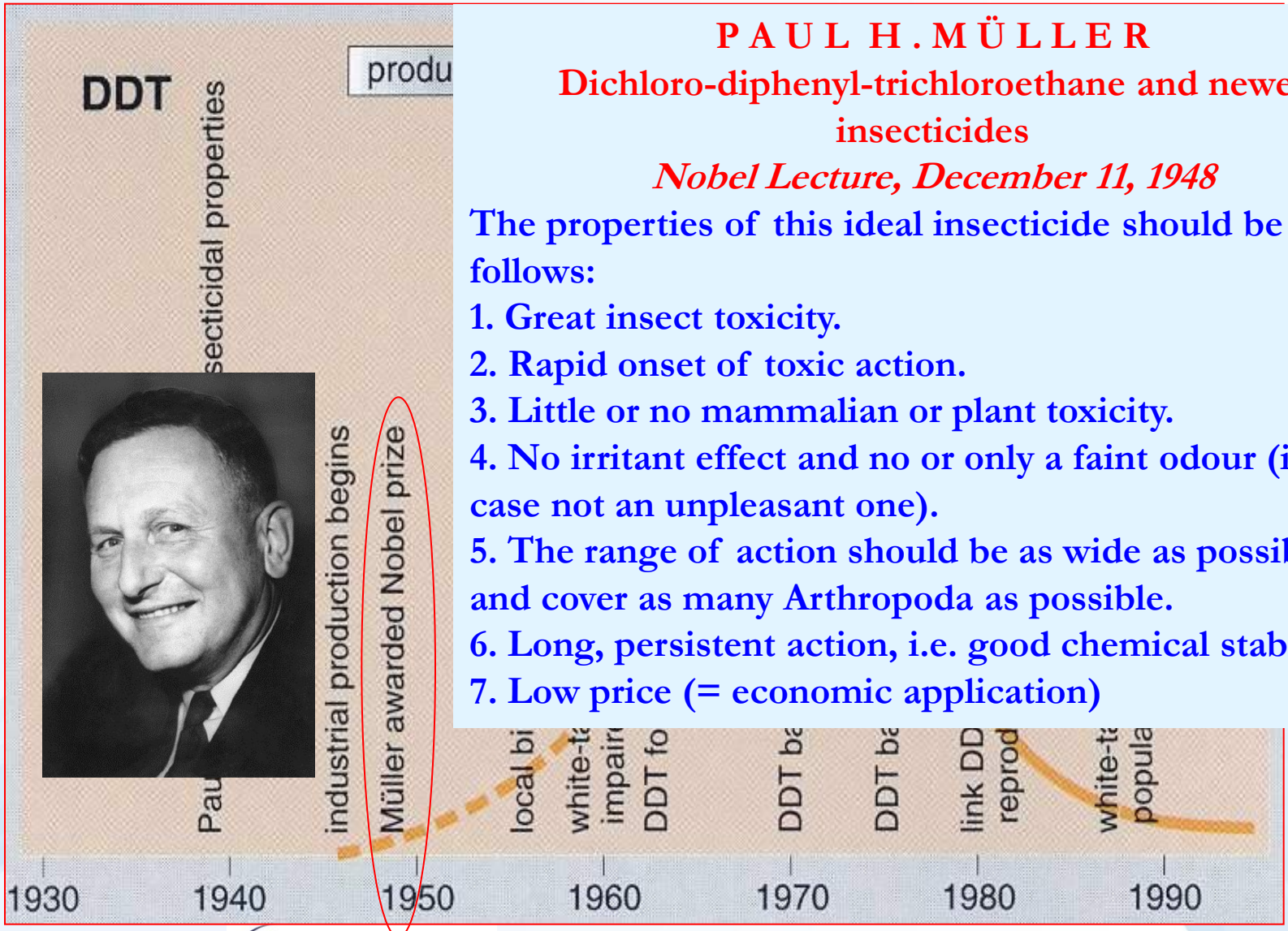

P A U L H . M Ü L L E R

Dichloro-diphenyl-trichloroethane and newer insecticides

Nobel Lecture, December 11, 1948

The properties of this ideal insecticide should be as follows:

1. Great insect toxicity.

2. Rapid onset of toxic action.

3. Little or no mammalian or plant toxicity.

4. No irritant effect and no or only a faint odour (in any case not an unpleasant one).

5. The range of action should be as wide as possible, and cover as many Arthropoda as possible.

6. Long, persistent action, i.e. good chemical stability.

7. Low price (= economic application)

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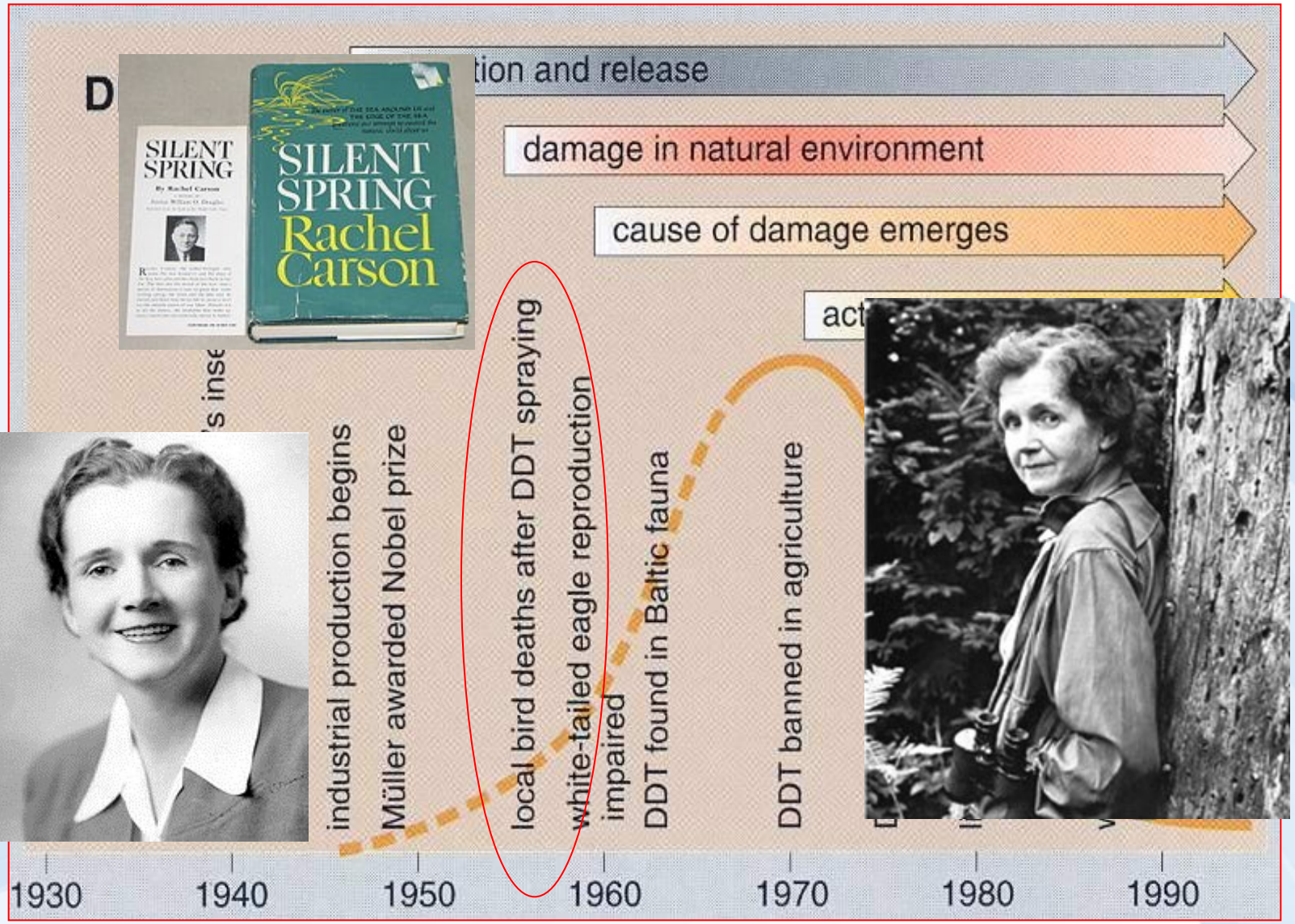

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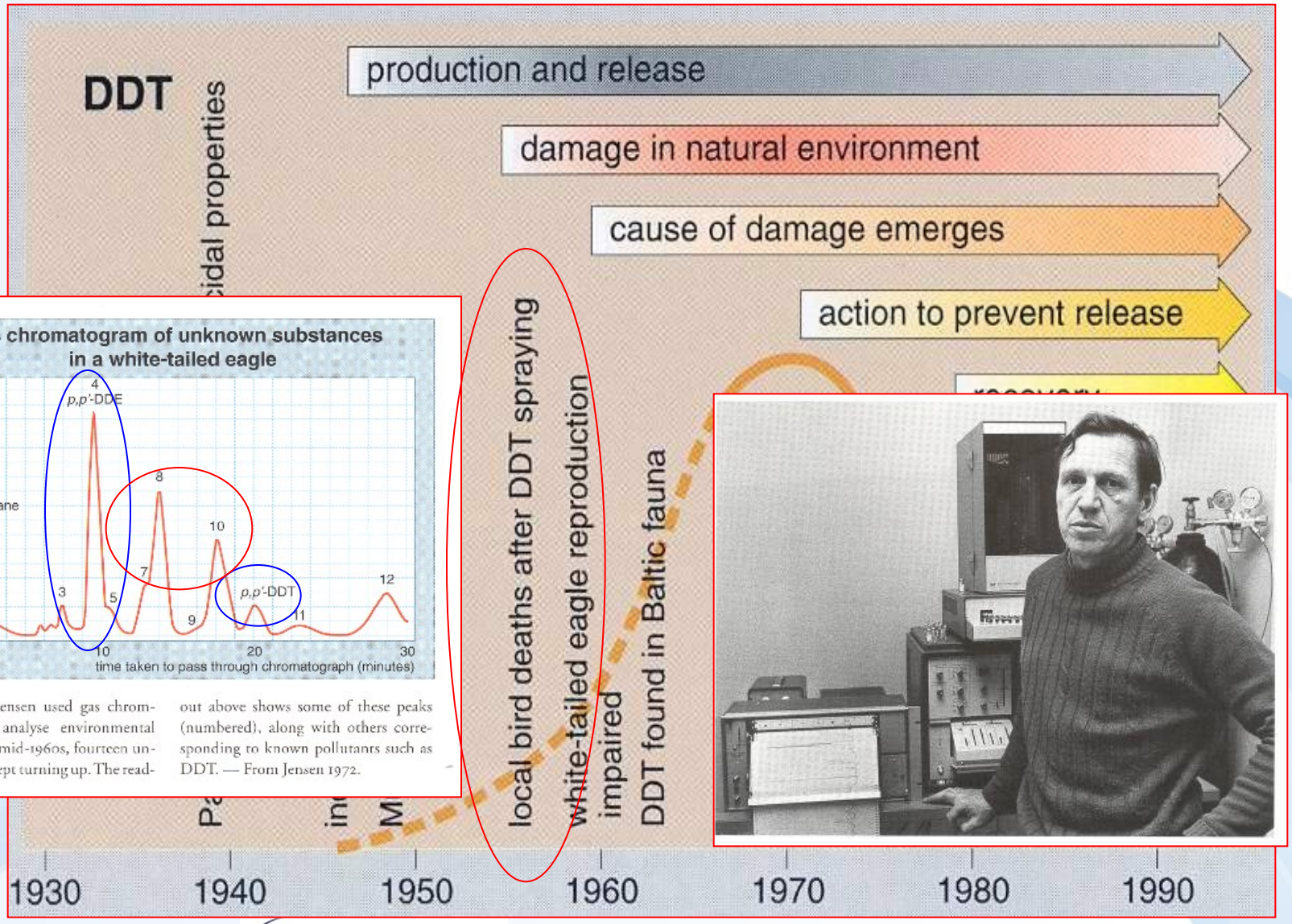

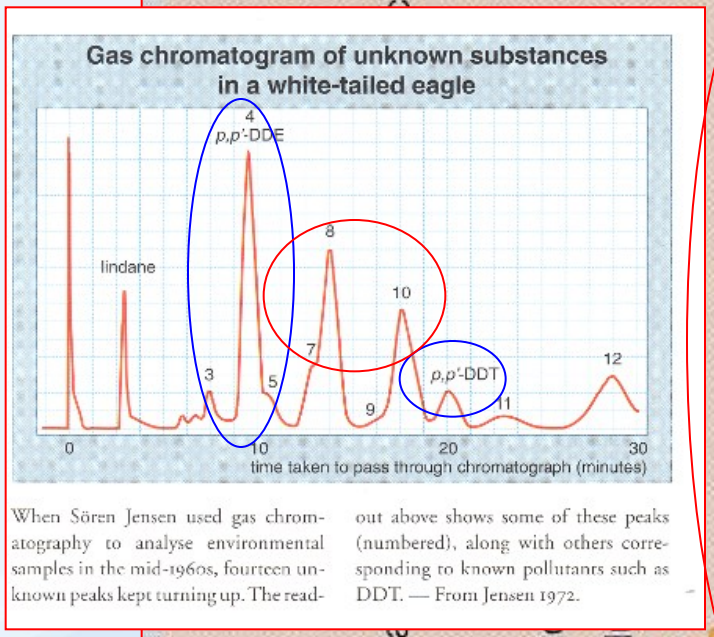

When Sören Jensen used gas chromatography to analyse environmental samples in the mid-1960s, fourteen unknown peaks kept turning up. The readout above shows some of these peaks (numbered), along with others corresponding to known pollutants such as DDT. — From Jensen 1972.

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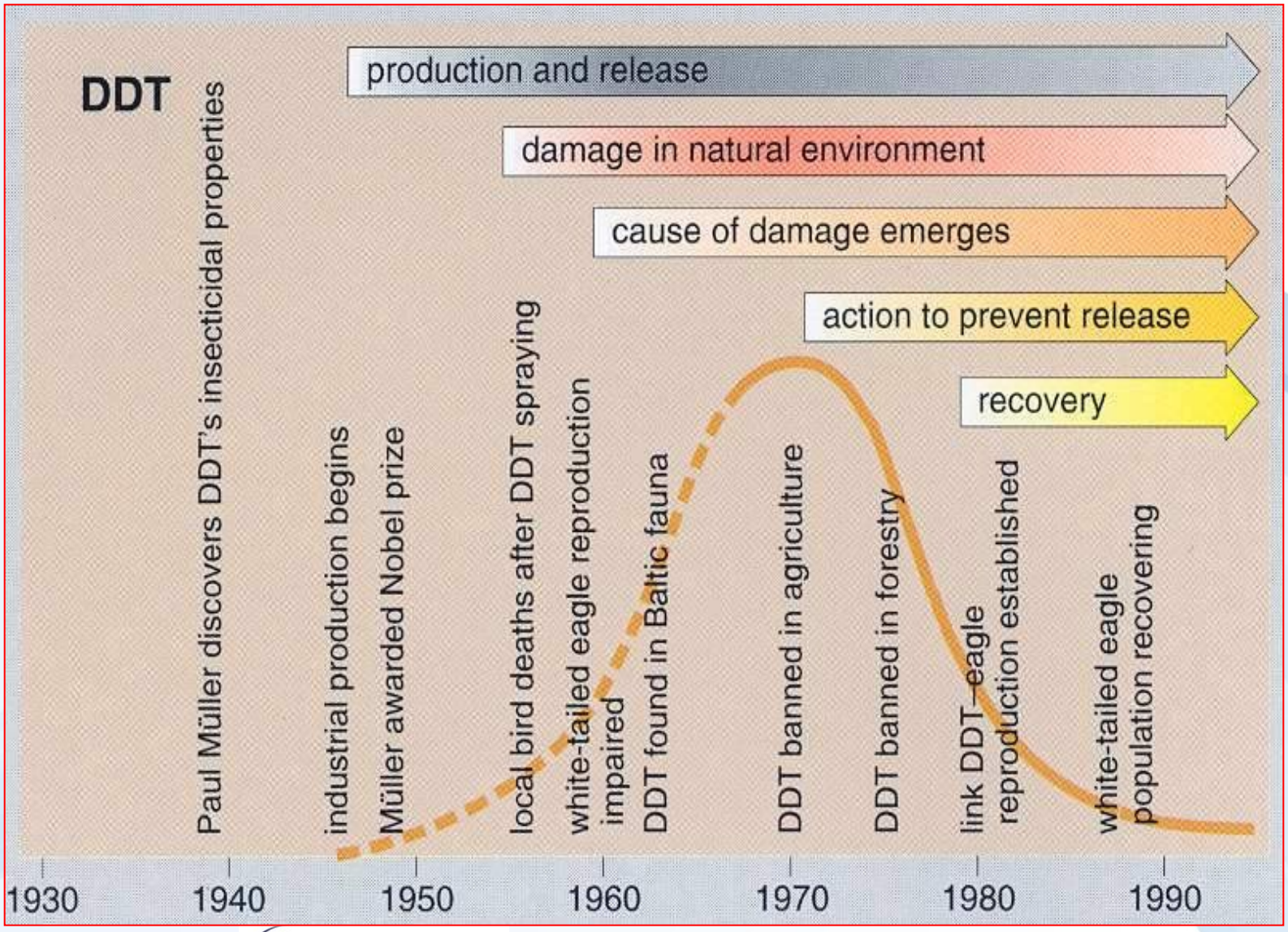

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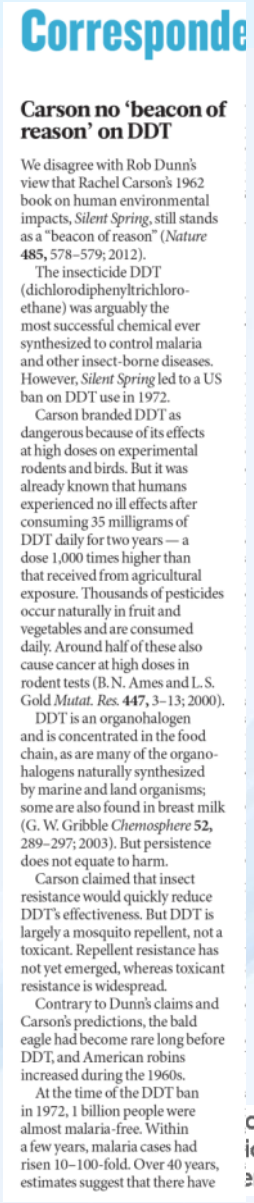
28 Jun 2012 – *Nature*. International weekly journal of science. Search *Go* ... Silent Spring, still stands as a "beacon of reason" (*Nature* 485, 578–579; 2012)



Corresponde

Carson no 'beacon of reason' on DDT

We disagree with Rob Dunn's view that Rachel Carson's 1962 book on human environmental impacts, *Silent Spring*, still stands as a "beacon of reason" (*Nature* **485,** 578–579; 2012).

The insecticide DDT (dichlorodiphenyltrichloroethane) was arguably the most successful chemical ever synthesized to control malaria and other insect-borne diseases. However, *Silent Spring* led to a US ban on DDT use in 1972.

Carson branded DDT as dangerous because of its effects at high doses on experimental rodents and birds. But it was already known that humans experienced no ill effects after consuming 35 milligrams of DDT daily for two years — a dose 1,000 times higher than that received from agricultural exposure. Thousands of pesticides occur naturally in fruit and vegetables and are consumed daily. Around half of these also cause cancer at high doses in rodent tests (B. N. Ames and L. S. Gold *Mutat. Res.* **447,** 3–13; 2000).

DDT is an organohalogen and is concentrated in the food chain, as are many of the organohalogens naturally synthesized by marine and land organisms; some are also found in breast milk (G. W. Gribble *Chemosphere* **52,** 289–297; 2003). But persistence does not equate to harm.

Carson claimed that insect resistance would quickly reduce DDT's effectiveness. But DDT is largely a mosquito repellent, not a toxicant. Repellent resistance has not yet emerged, whereas toxicant resistance is widespread.

Contrary to Dunn's claims and Carson's predictions, the bald eagle had become rare long before DDT, and American robins increased during the 1960s.

At the time of the DDT ban in 1972, 1 billion people were almost malaria-free. Within a few years, malaria cases had risen 10–100-fold. Over 40 years, estimates suggest that there have

Supplementary information to:

Carson no 'beacon of reason' on DDT

Full list of co-signatories to a Correspondence published in Nature 486, 473 (2012); http://dx.doi.org/10.1038/486473a.

Tony Trewavas *Institute of Molecular Plant Science, University of Edinburgh, UK. trewavas@ed.ac.uk*

Chris Leaver *University of Oxford, UK.*

Bruce Ames *Children's Hospital, Oakland, California, USA.*

Peter Lachmann *University of Cambridge, UK.*

Richard Tren *Africa Fighting Malaria, Washington DC, USA.*

Roger Meiners *University of Texas-Arlington, Texas, USA.*

Henry I. Miller *Hoover Institution, Stanford University, California, USA.*

Andrew Morriss *University of Alabama, USA.*

C. S. Prakash *Tuskegee University, Alabama, USA.*

C. Kameswara Rao *Foundation for Biotechnology Awareness and Education, Bangalore, India.*

Donald Roberts *Uniformed Services University of the Health Sciences, Bethesda, Maryland, USA*

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At the time of the DDT ban in 1972, 1 billion people were almost malaria-free. Within a few years, malaria cases had risen 10–100-fold. Over 40 years, estimates suggest that there have been 60 million to 80 million premature and unnecessary deaths, mainly children, as a result of misguided fears based on poorly understood evidence.

Tony Trewavas* *University of Edinburgh, UK. trewavas@ed.ac.uk*

**On behalf of 11 co-signatories (see go.nature.com/2hfmok).*

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Increases of malaria

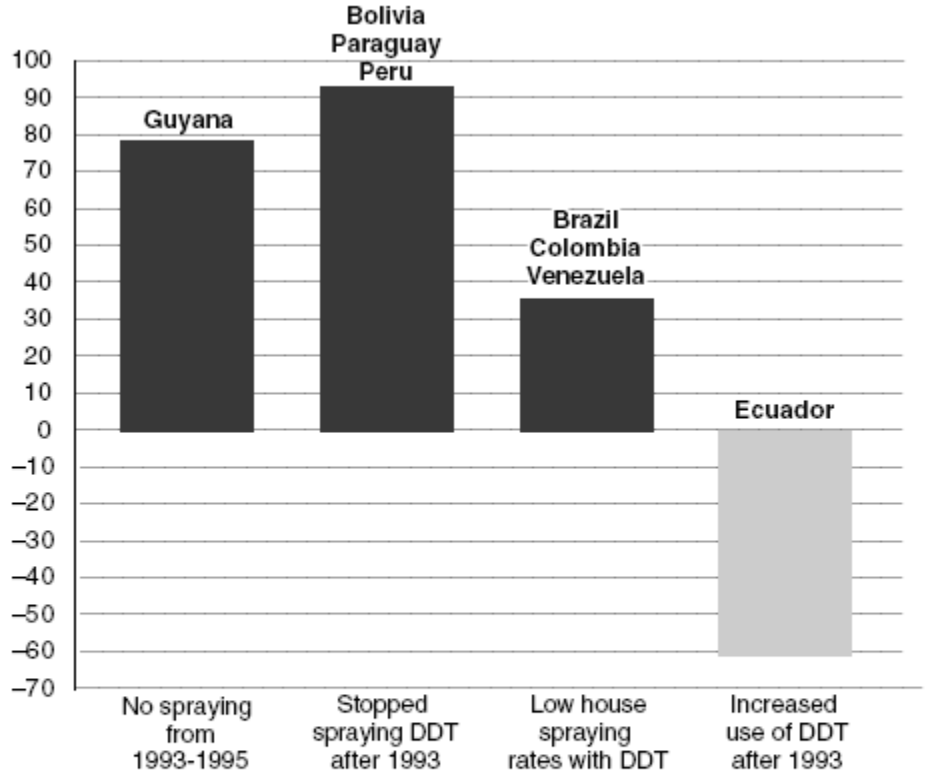

FIGURE 1
INCREASES IN MALARIA FOR COUNTRIES IN SOUTH AMERICA, 1993-1995, PERCENT INCREASE IN NUMBERS OF CASES

Source: Adapted from D. Roberts et al., *Emerging Infectious Diseases*, July-September 1997, p. 300.

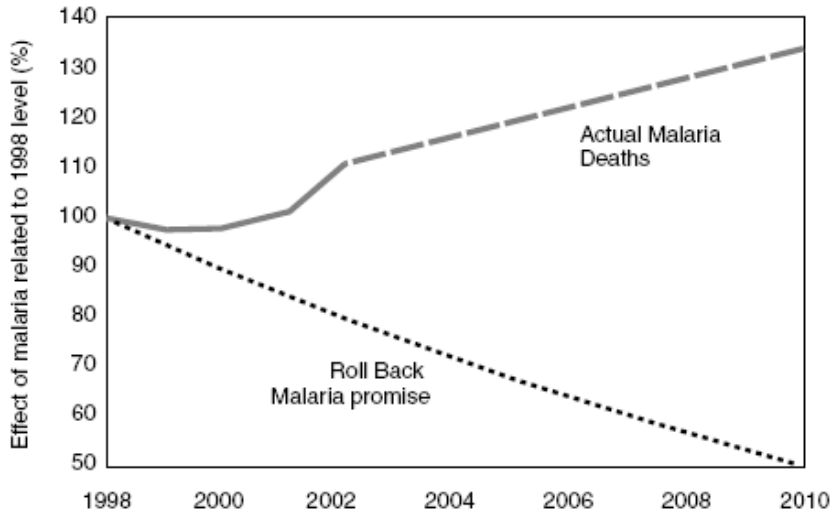

FIGURE 2
MALARIA DEATHS SINCE ROLL BACK MALARIA PROGRAM, AS PERCENTAGEOF 1988 LEVEL

The Roll Back Malaria program, a partnership of WHO and UN organizations, has pointedly avoided any use of DDT, and has been an abysmal failure. Since the RBM founding in 1998, deaths from malaria have steadily increased.

Source: Adapted from the *British Medical Journal*, May 8, 2004.

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The Truth is Out There

DDT saved more lives than any other substance - originally used against diseases transmitted by insects and significantly suppressed the typhus epidemic in Naples (2nd World War).

DDT later used against mosquito vectors of malaria, yellow fever and other tropical diseases - has saved millions of lives.

DDT and other insecticides have become a threat to a large area began to be used for increasing crop yields.

These substances require controlled use, but their general ban led to a lot of death and disease in tropical countries, where there was and there is no equally effective means against malaria.

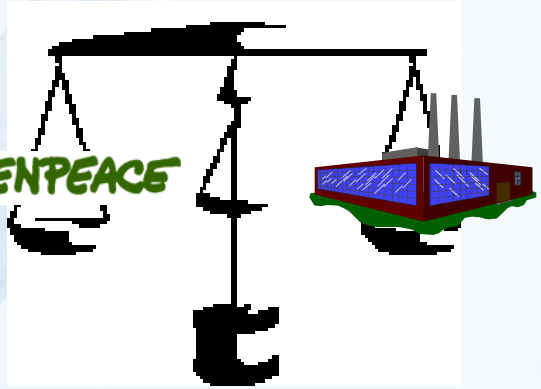
The Truth is Out There

Publish or perish

The case of the missing…

Focusing on creating an environment where researchers are still seeking support, quickly discovered that research of negative (harmful, toxic, ..) properties of the substance X brings fame and money.

What is the real impact of a transfer of scientific knowledge into practice and realization?



Academic scientist

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Chemical (POPs) hystery, panic

What we need ?

- Available, realiable, accurate, clear, comprehensible information concerning to POPs problems

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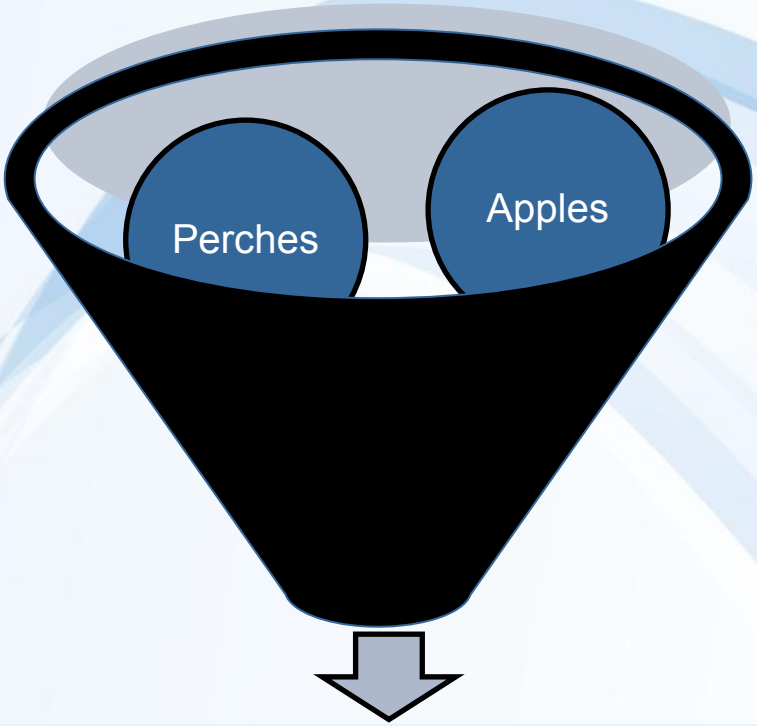
Try to mix together



The truth, half-truth, half-lie, untruth, falsehood
Scientific truth, political correctness, politically forgivable, acceptable lie

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Conclusions ?

Most of the problems of chemical pollution of the environment that we have and we must now laboriously addressed was caused by a combination of our ignorance, the lack of regulatory mechanisms, the absence of relevant laws and last but not least, our hubris and arrogance leading to the belief that the nature of a show.

Broad and effective international co-operation

Problems are global, transboundary, long-term

It is impossible to solve these problems without very broad international co-operation on the political, academic, industrial, public, economical, social level.

Reality of world – a lot of obstacles – political, historical, religious without the chance to real progress or very formal and ineffective.

Global hills of chemical problems

in the environment

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What have to be done/What can be done/What was done ?

Let's call a spade a spade

Life is short. There is no time to leave important words unsaid.

Paolo Coelho

Thanks for your attention

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