GRUNDLÆGGENDE OM PARTIKLER

Merete Bilde

Institut for Kemi, Aarhus University

MIN BAGGRUND

1994:	M.Sc. Chemistry Quantum chemistry	University of Copenhagen
1997:	PhD, Atmospheric Chemistry Ozone depleting substances	Risø National Laboratory/University of Copenhagen (DK) Ford Research Laboratories (MI), NCAR, Boulder (CO)
1998:	Post doc laser spectroscopy, droplets	Chemistry, University of Pittsburgh (PA)
1999-2000:	Post doc Organic aerosol, air quality	Chem. Eng. Carnegie Mellon University (PA)
2000-2012:	Ole Rømer Assoc. Res. Professor, Associate Professor, Professor Atmospheric Aerosols	University of Copenhagen (DK)
2013:	Professor Atmospheric Physical Chemistry	Aarhus University (DK)

OUTLINE

Introduktion

Partikler

Effekter: luftkvalitet, helbred, klima

Egenskaber

Størrelse

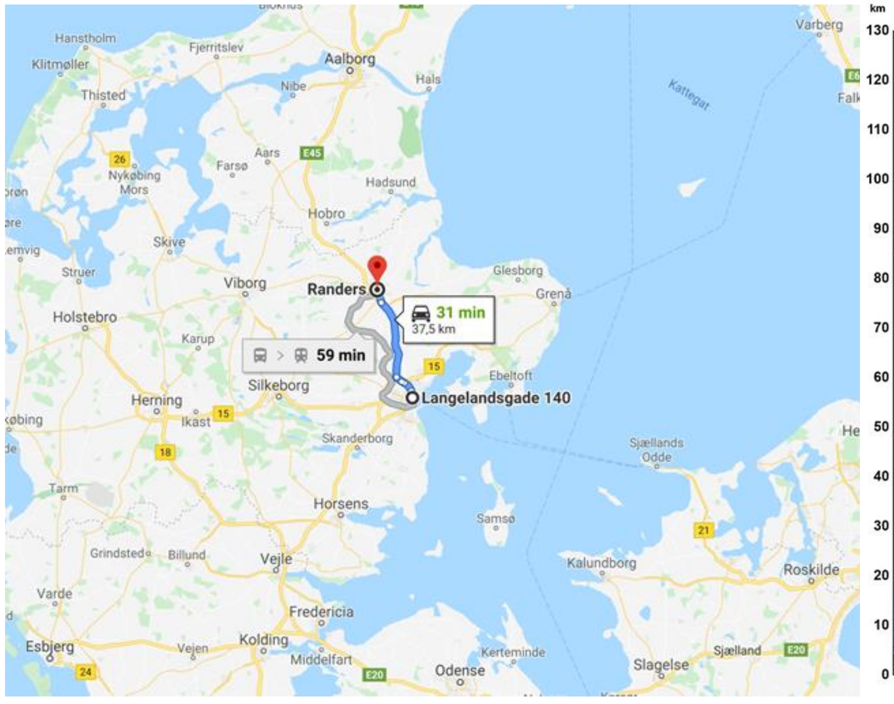
Facon, morphologi

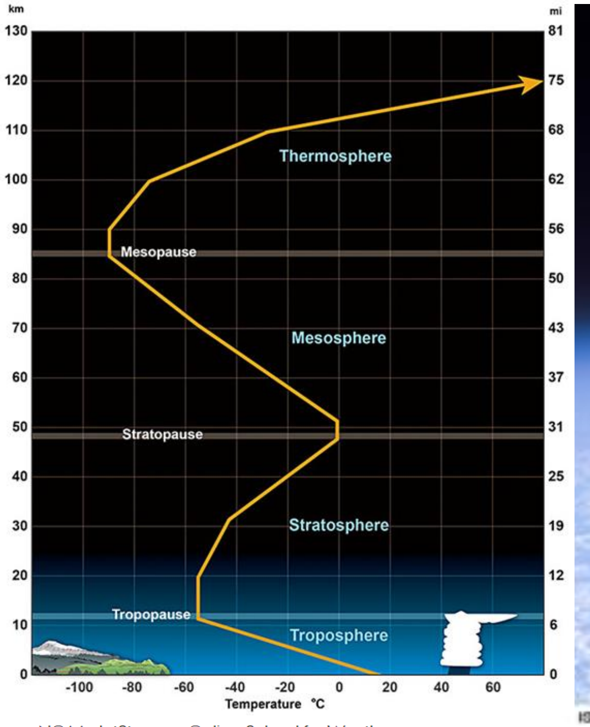
Fase

Optiske egenskaber

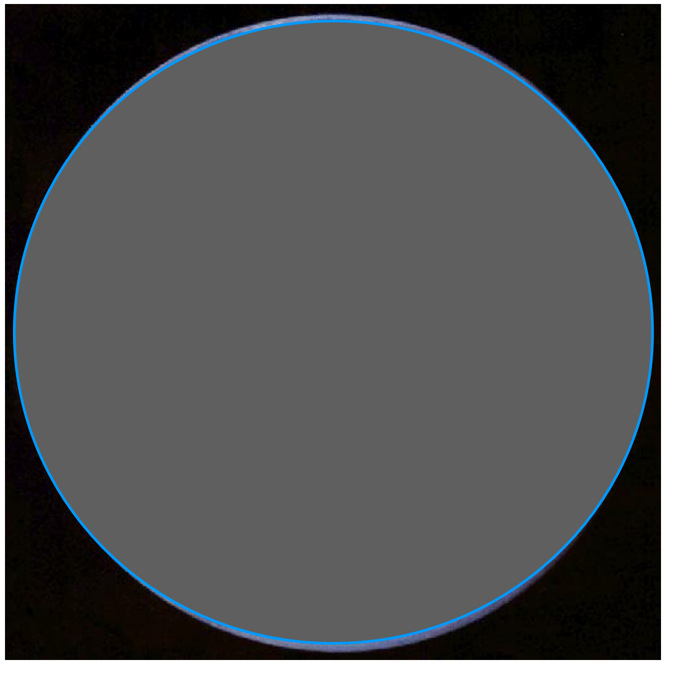
Kemisk sammensætning

Hvad gør vi på AU kemi





NOAA: JetStream - Online School for Weather

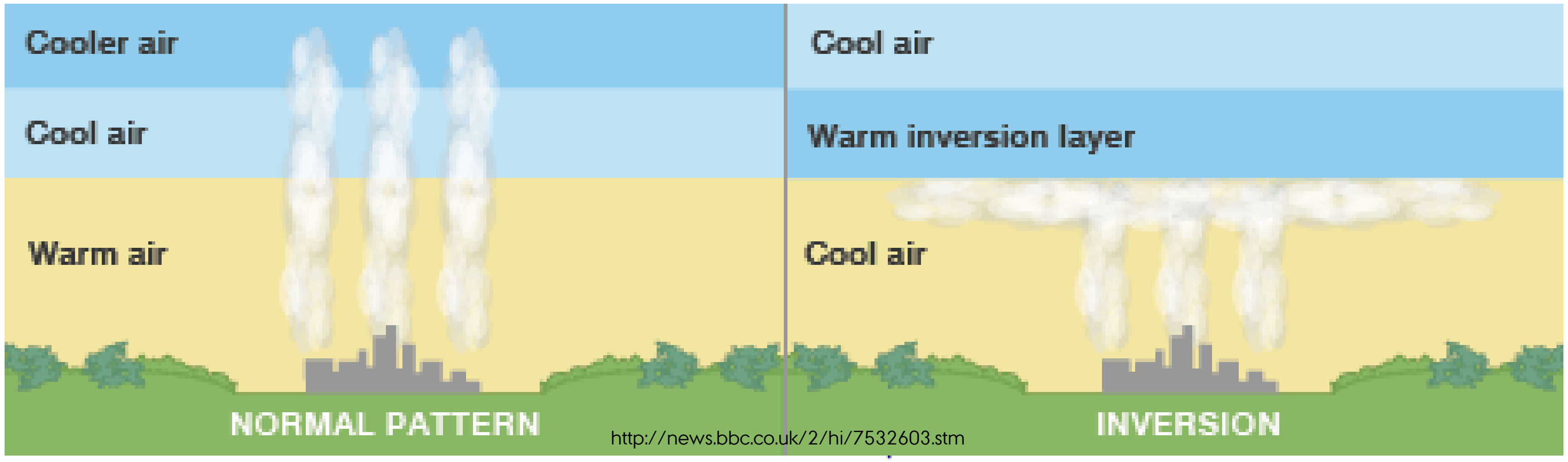


NASA NSSDC's Photo Gallery

GRÆNSELAG

Layer of atmosphere closest to the ground (up to 1km, lower at night), wind is influenced by friction.

INVERSION LAYER



http://meteora.ucsd.edu/~iacob/ml_formation.html

Weak mixing of pollutants

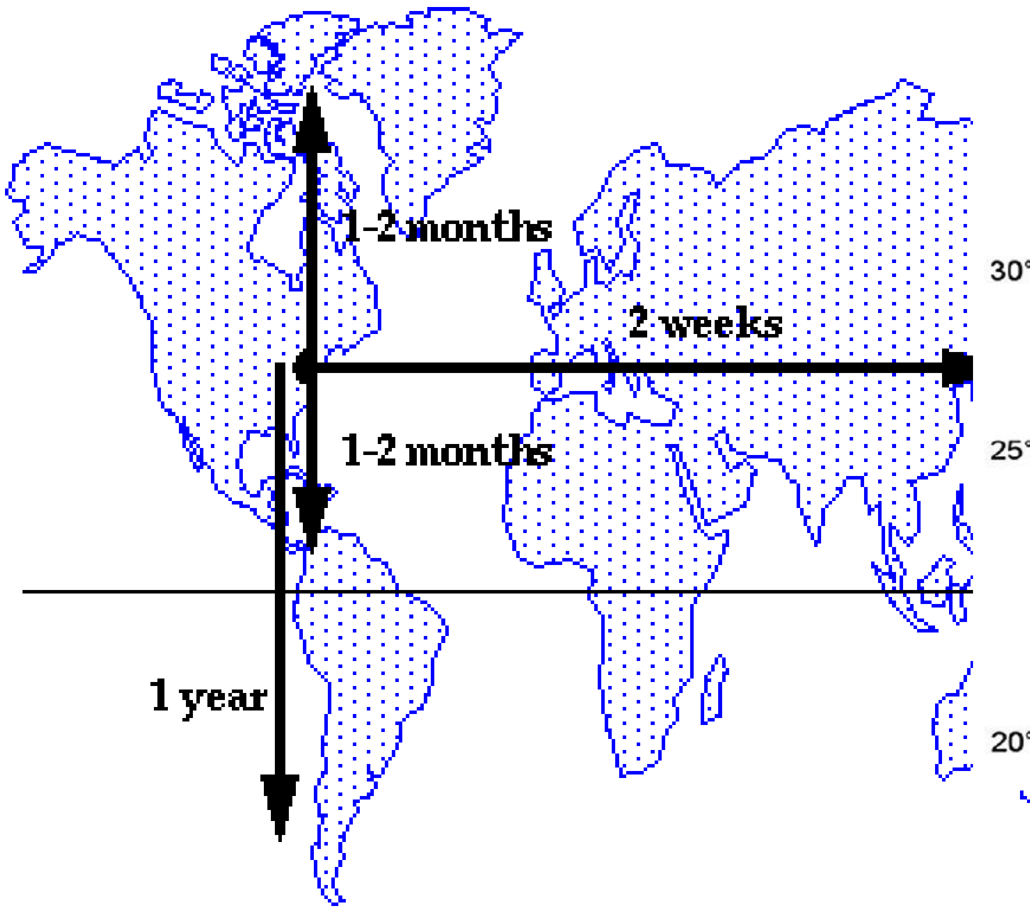
Important in severe smog events, e.g. London smog 1952, killed 4000 people.

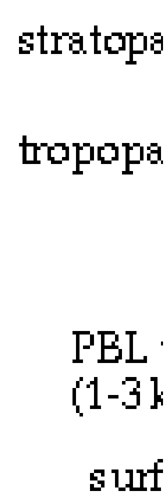
PRODUCTION AND REMOVAL PROCESSES

Production:
natural emissions
Anthropogenic emissions
Chemical reactions

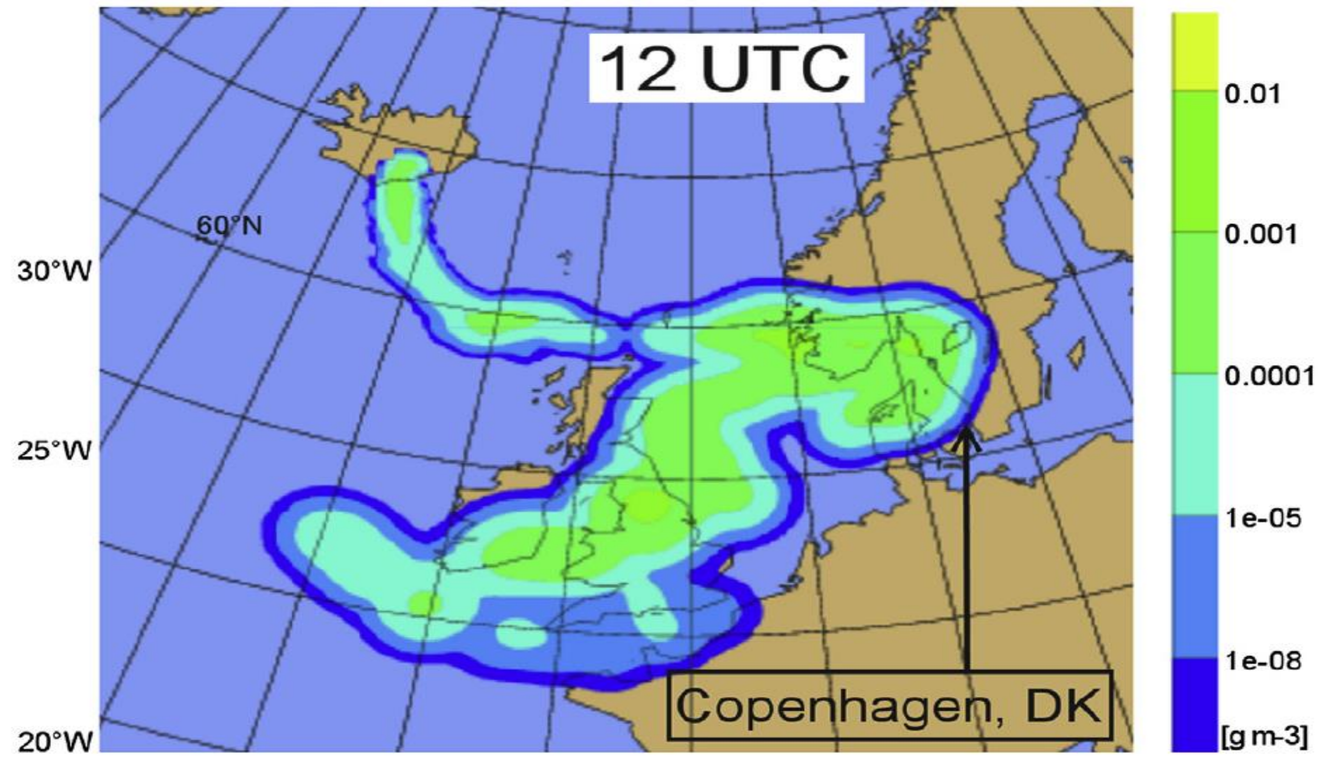
Removal:
Dry deposition
Wet deposition
Chemical reactions
Transport to stratosphere (or out of room)

Governing principle: conservation of mass
We can calculate lifetimes





Daniel Jacob: Introduction to
Atmospheric Chemistry



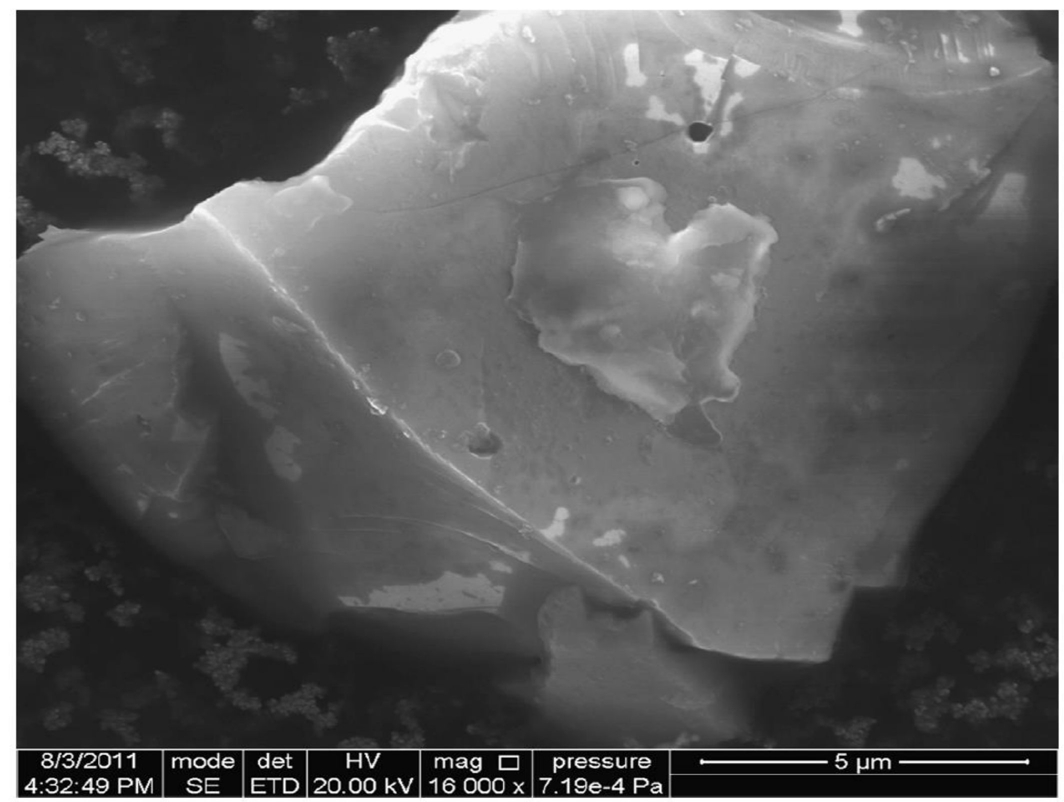


Fig. 6. Electron image showing the surface of a typical volcanic ash particle.

Lieke et al. Atmos Env. 2013

Time it takes for concentration to reach 1/e of its initial value

LIFE TIMES

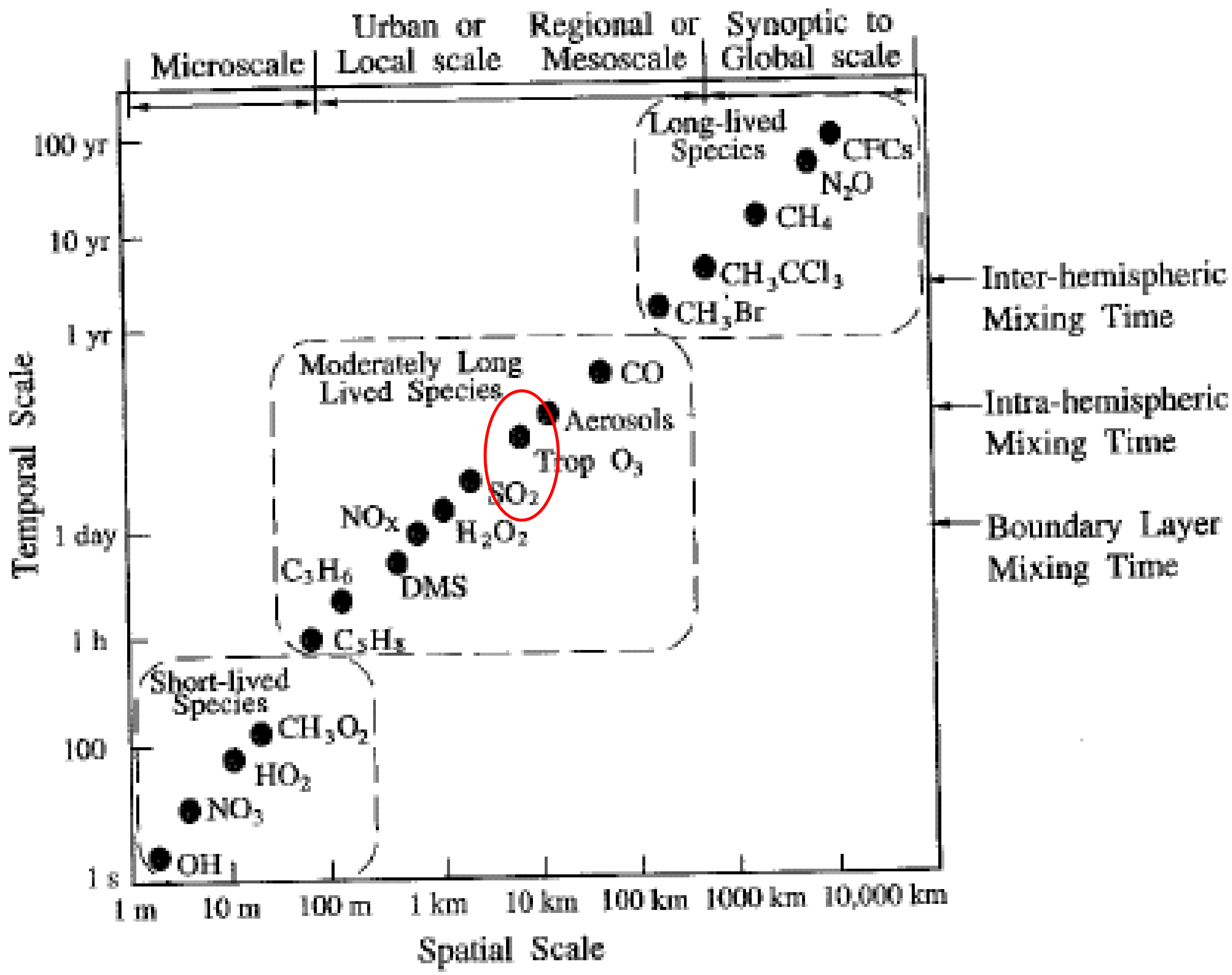


FIGURE 1.4 Spatial and temporal scales of variability for atmospheric constituents.

From: Seinfeld & Pandis: Atmospheric Chemistry and Physics

WHAT?

An aerosol is a collection of liquid or solid particles suspended in a gas (in the atmosphere the gas is air)

An aerosol is a multi-phase system

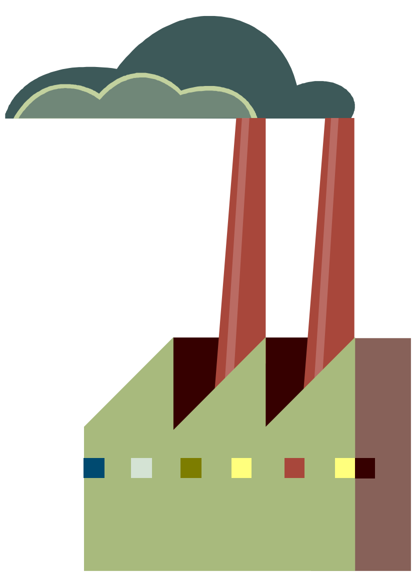
gas - liquid – solid

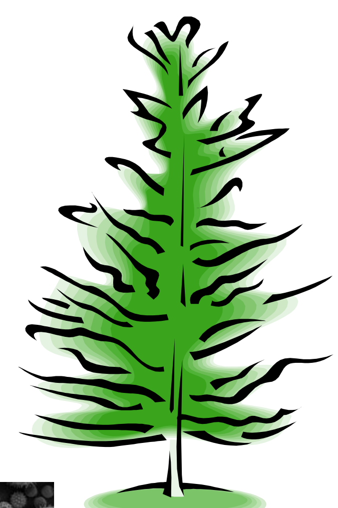
Atmospheric science ”slang”:

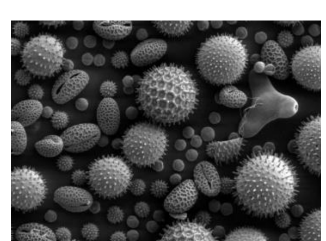
Aerosols, Particles, Particulate matter

WHERE DO THEY COME FROM?

- Primary
- Secondary

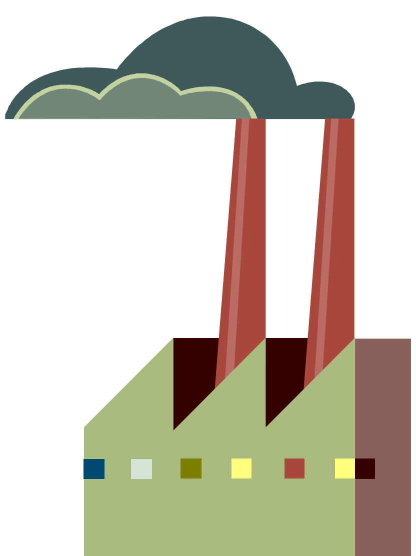


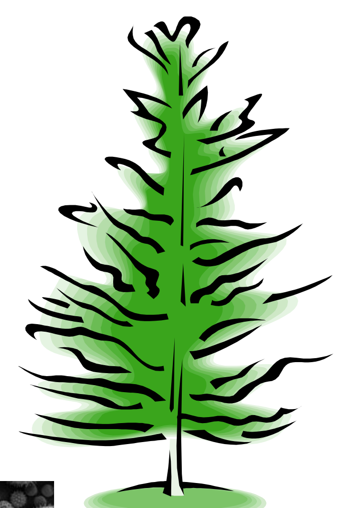


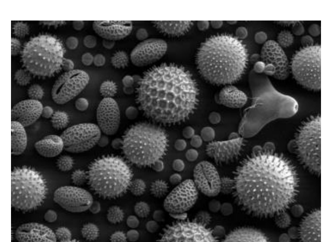


WHERE DO THEY COME FROM?

- Primary, secondary
- Natural, man-made
- Good, bad







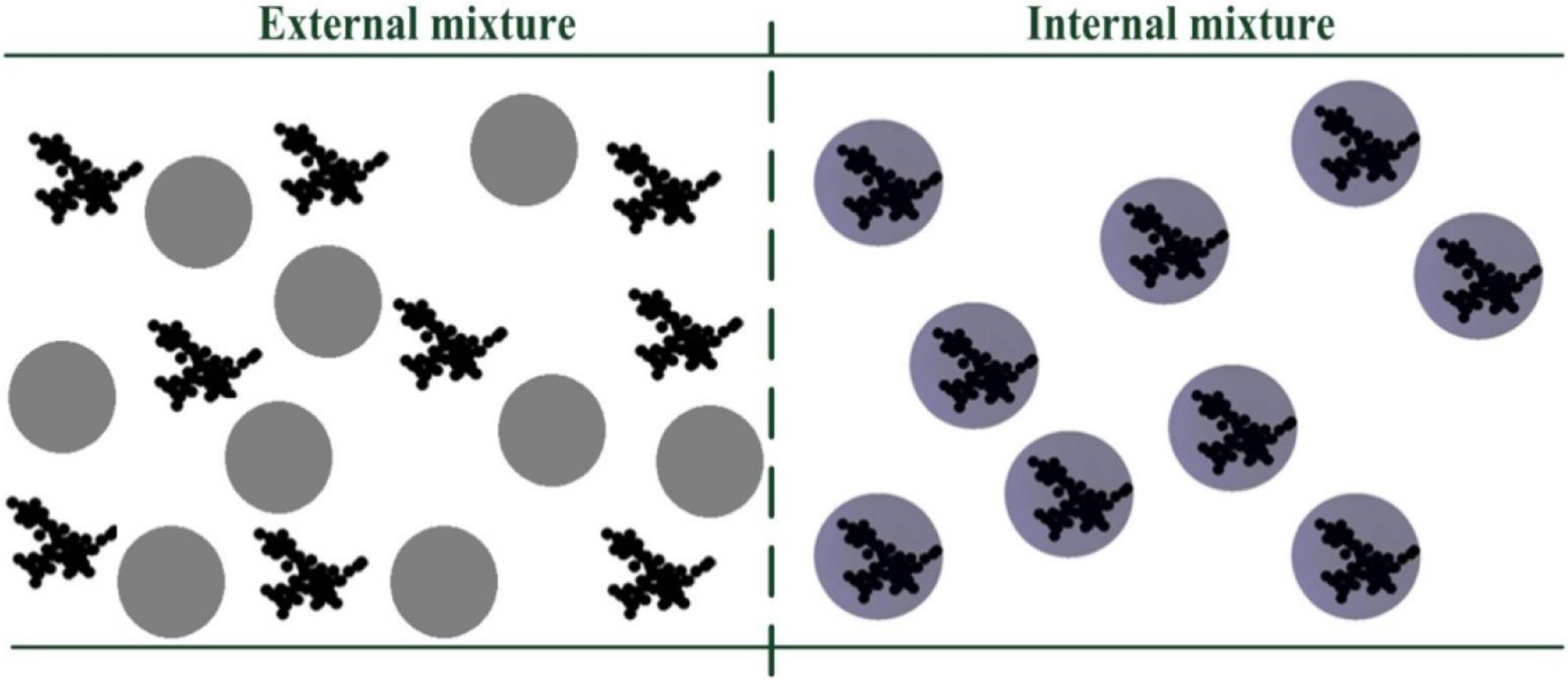
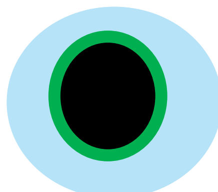


Fig. 1

Citation
Tianhai Cheng, Yu Wu, Xingfa Gu, Hao Chen, "Effects of mixing states on the multiple-scattering properties of soot aerosols," Opt. Express **23,** 10808-10821 (2015);
https://www.osapublishing.org/oe/abstract.cfm?uri=oe-23-8-10808

CHEMICAL AGEING

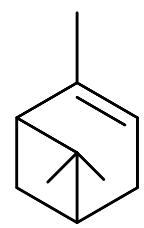
O_3

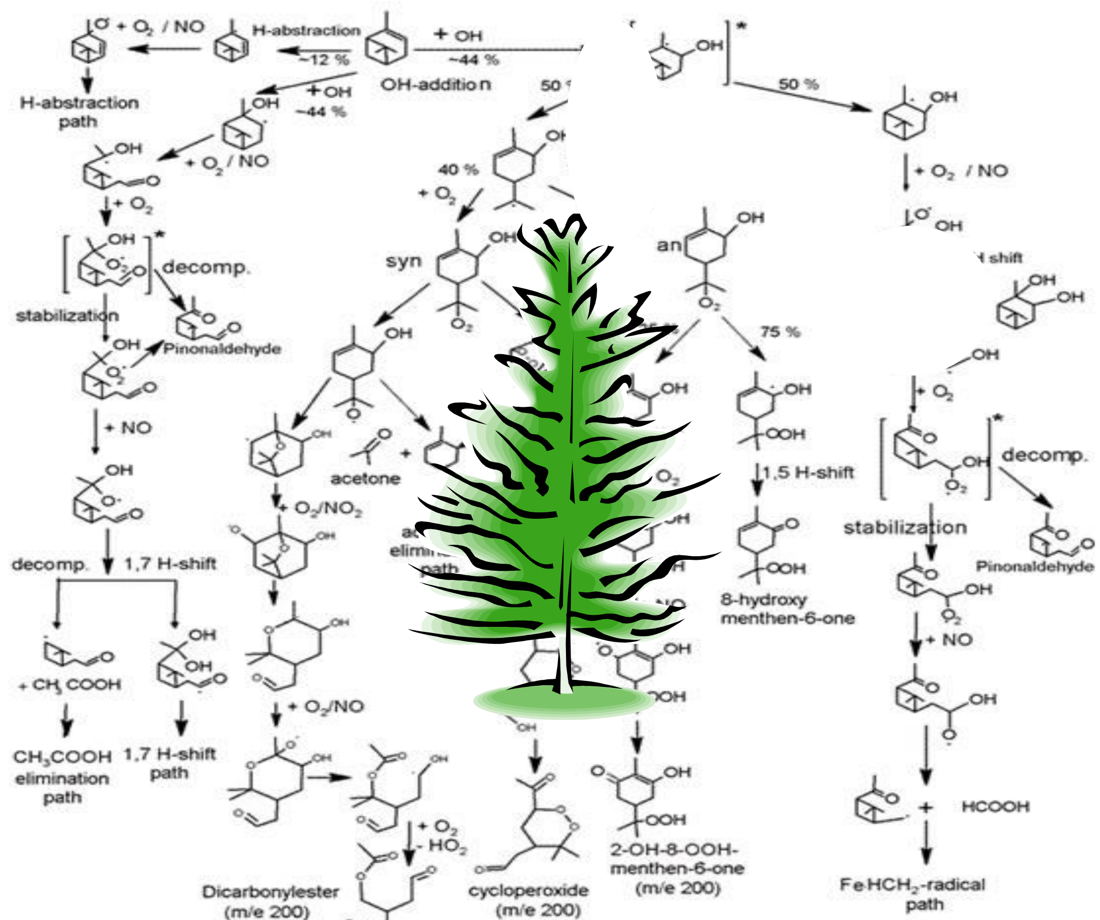


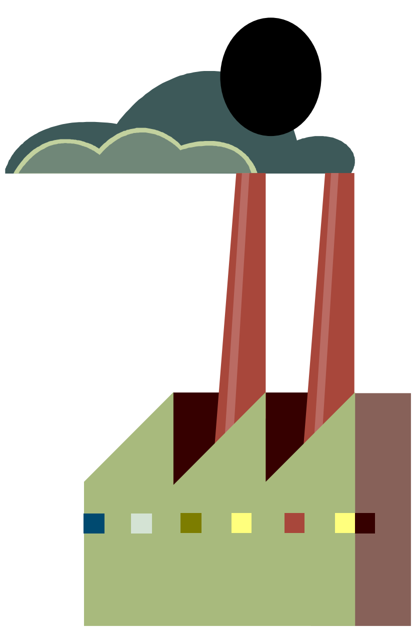
H_2O

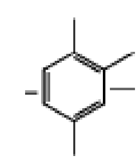
$O(^1D)$

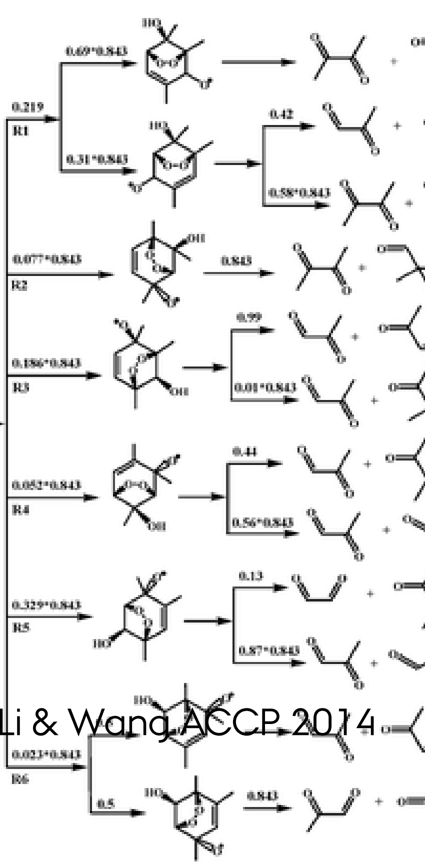
OH









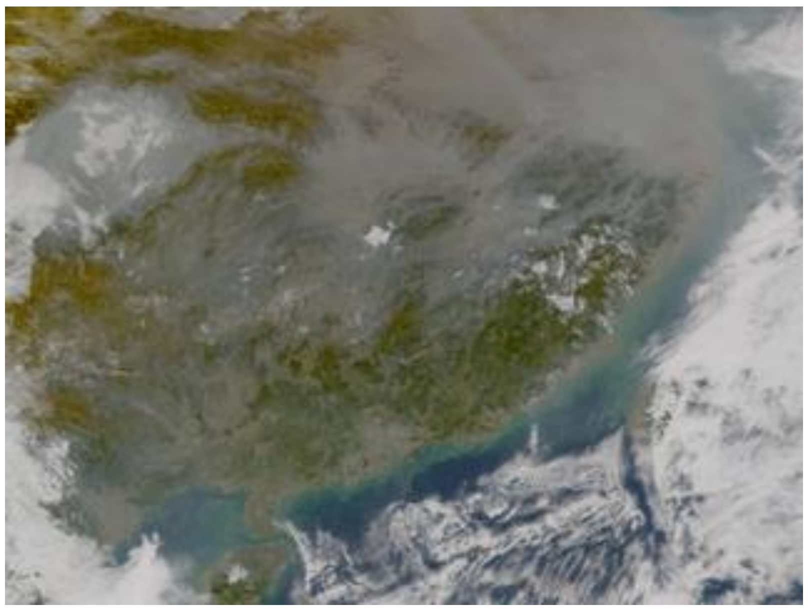


Li & Wang ACCP 2014

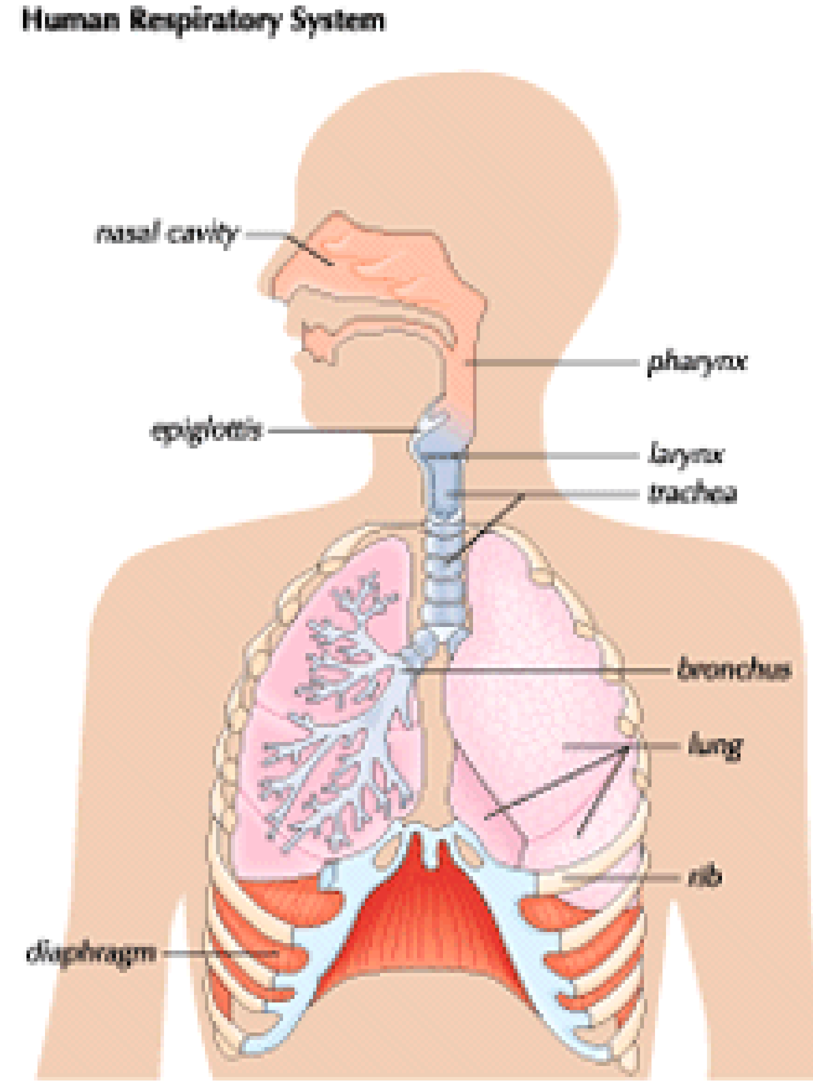
http://tropo.aeronomie.be/models/topics_res2_gasphase.html

WHY?

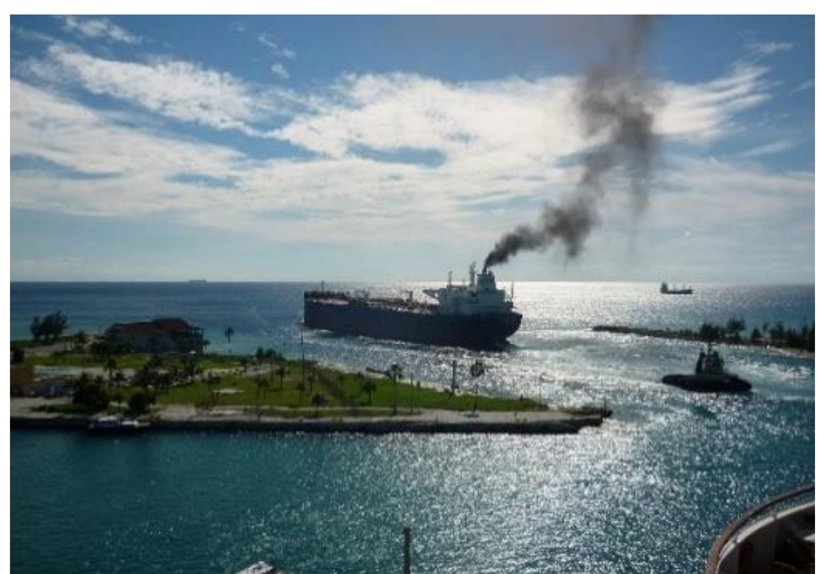
AIR QUALITY AND HEALTH



NASA ORBIMAGE



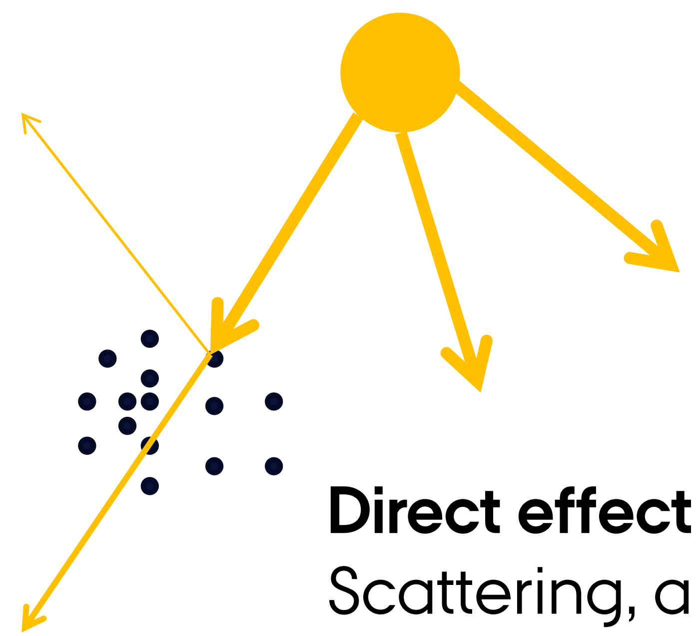
Encyclopædia Britannica online



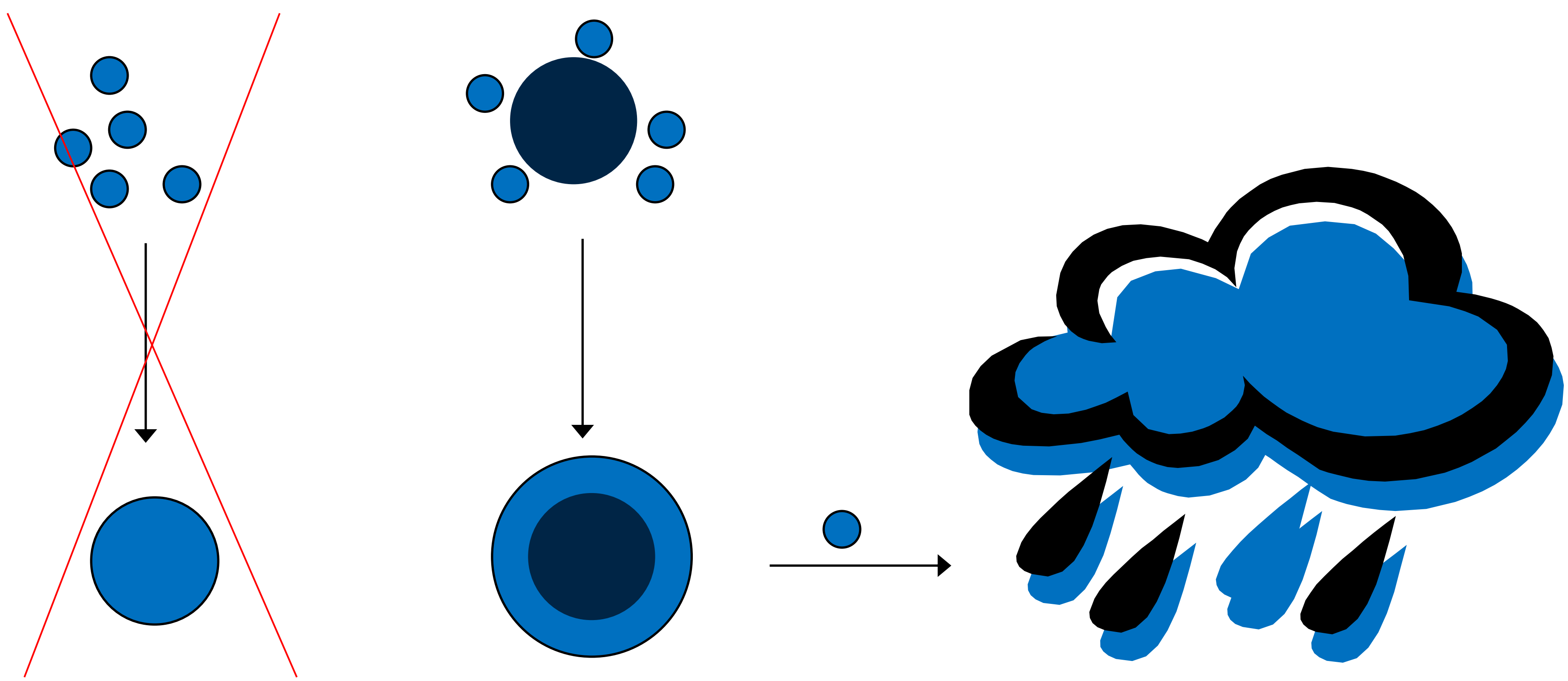
maritimejournal.com

WHY?

CLIMATE

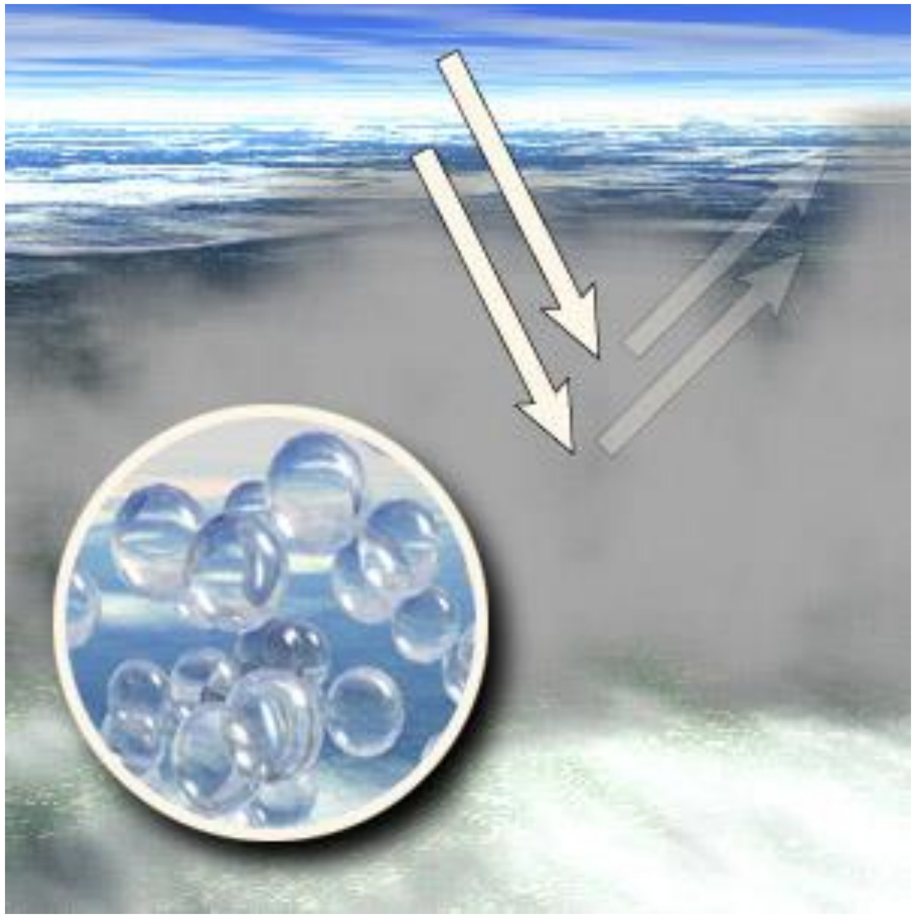


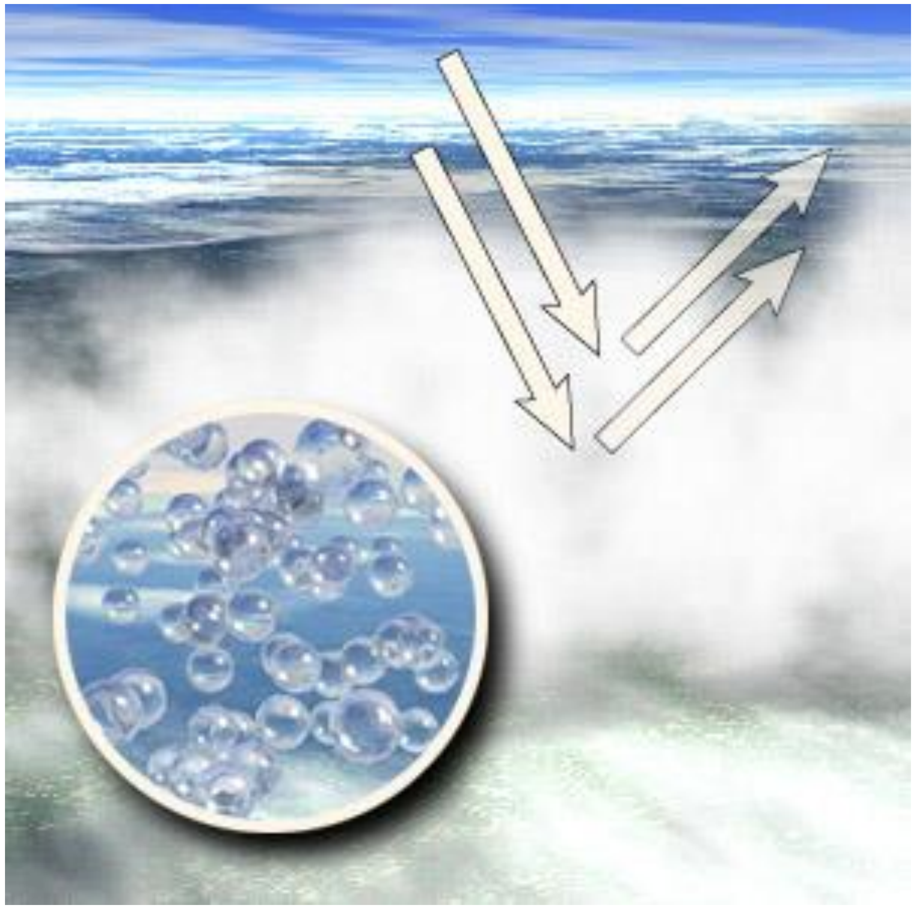
Direct effect:
Scattering, absorption



Indirect effect: Cloud condensation nuclei

INDIRECT EFFECT





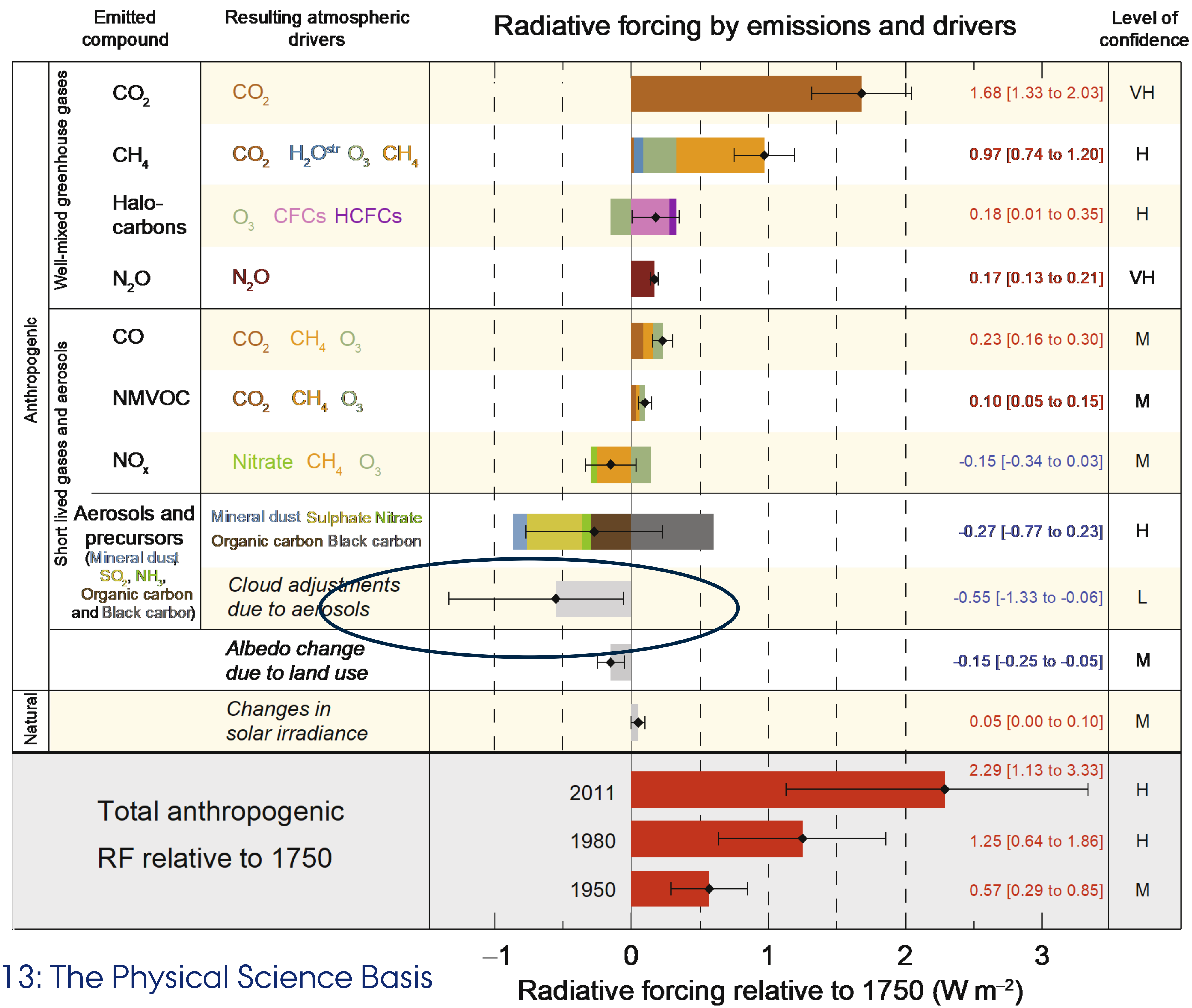
RH>100%

NASA SCIence Files™

Radiative properties, cloud lifetime, precipitation

Supersaturation of water, particles

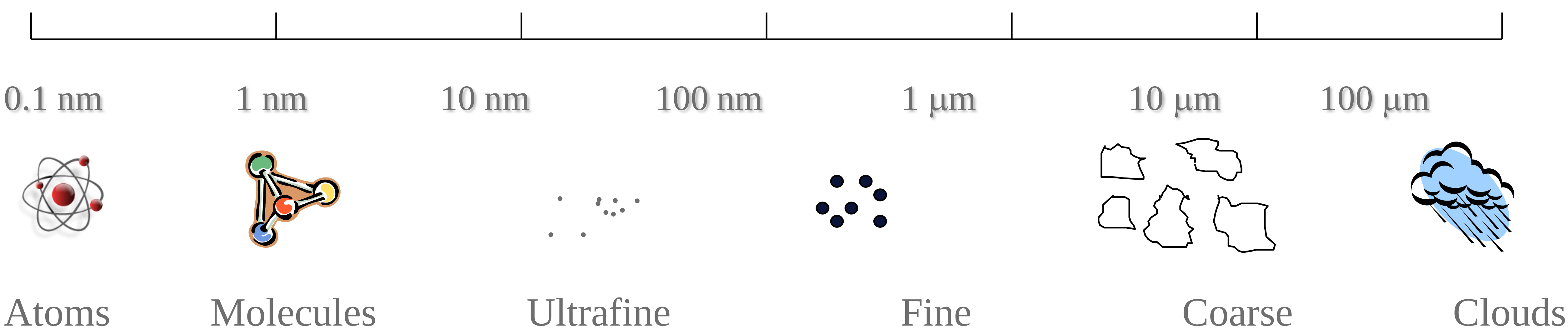
Photo credit: NASA, Visible Earth Image Gallery



IPCC, 2013: The Physical Science Basis

PROPERTIES

- **Size**
- Morphology
- Phase
- Optical properties
- Chemical composition

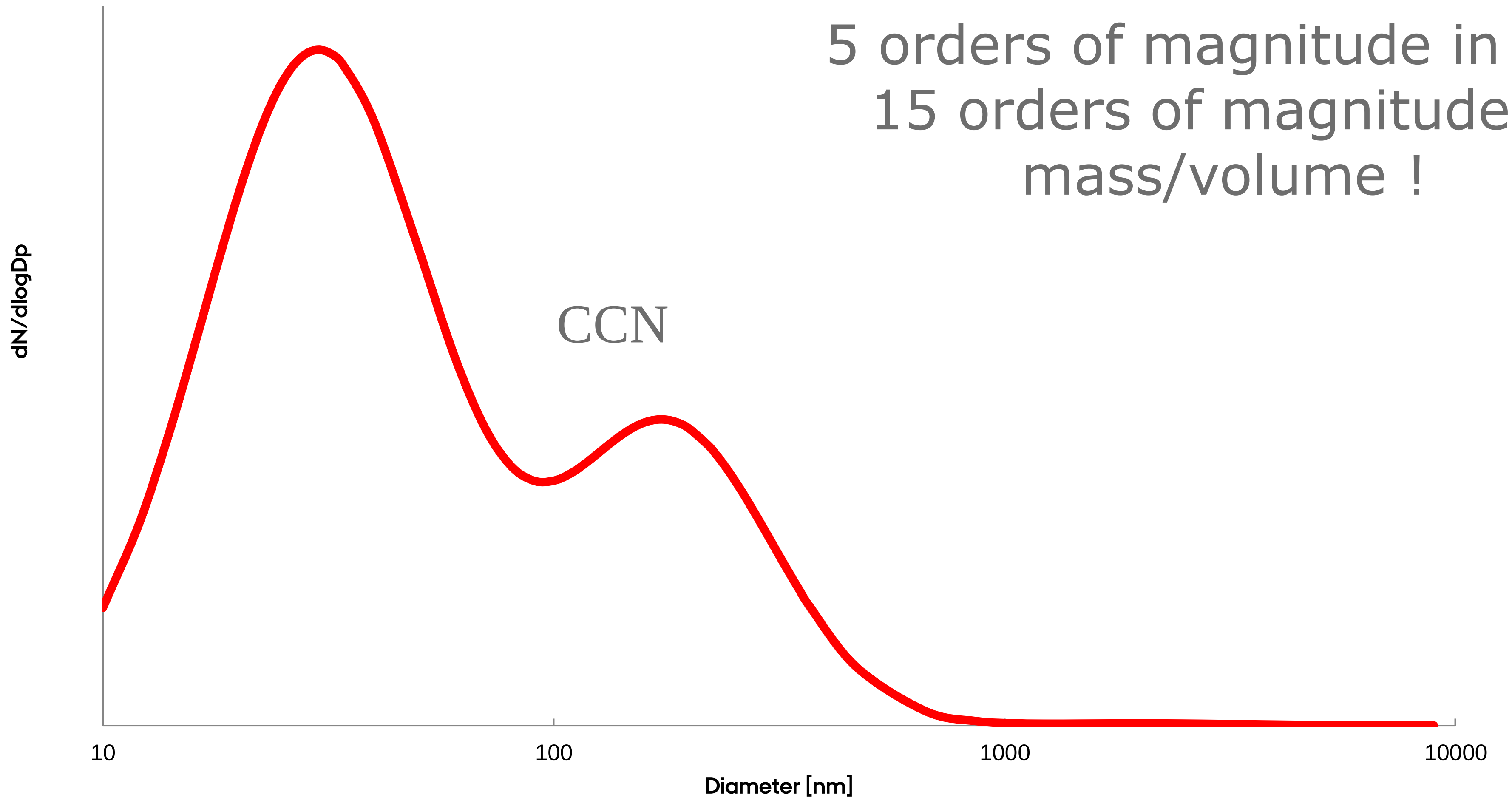


TYPICAL NUMBER SIZE DISTRIBUTION

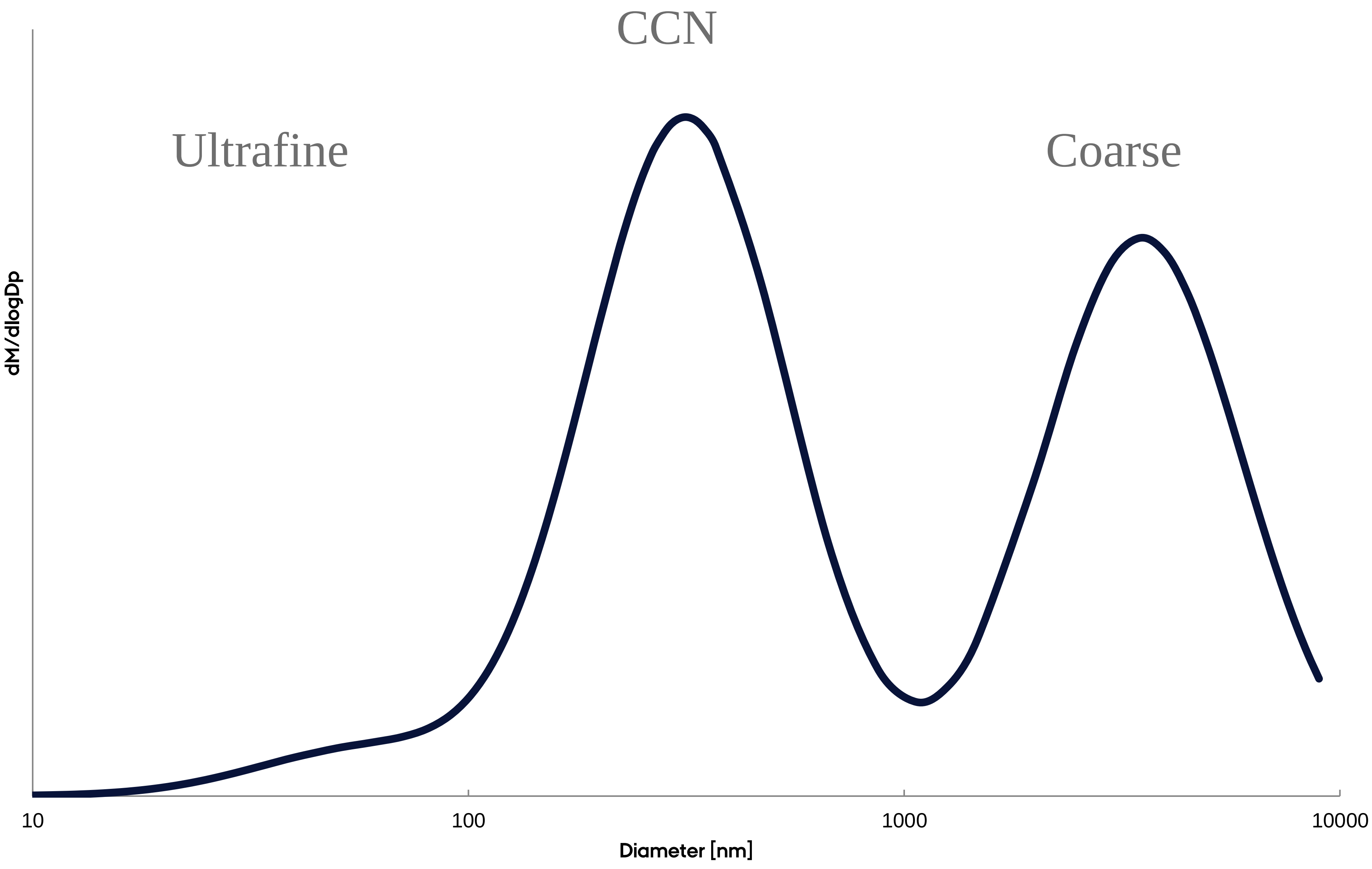
Ultrafine

Volume of sphere: $V = \pi/6 \cdot D_p^3$

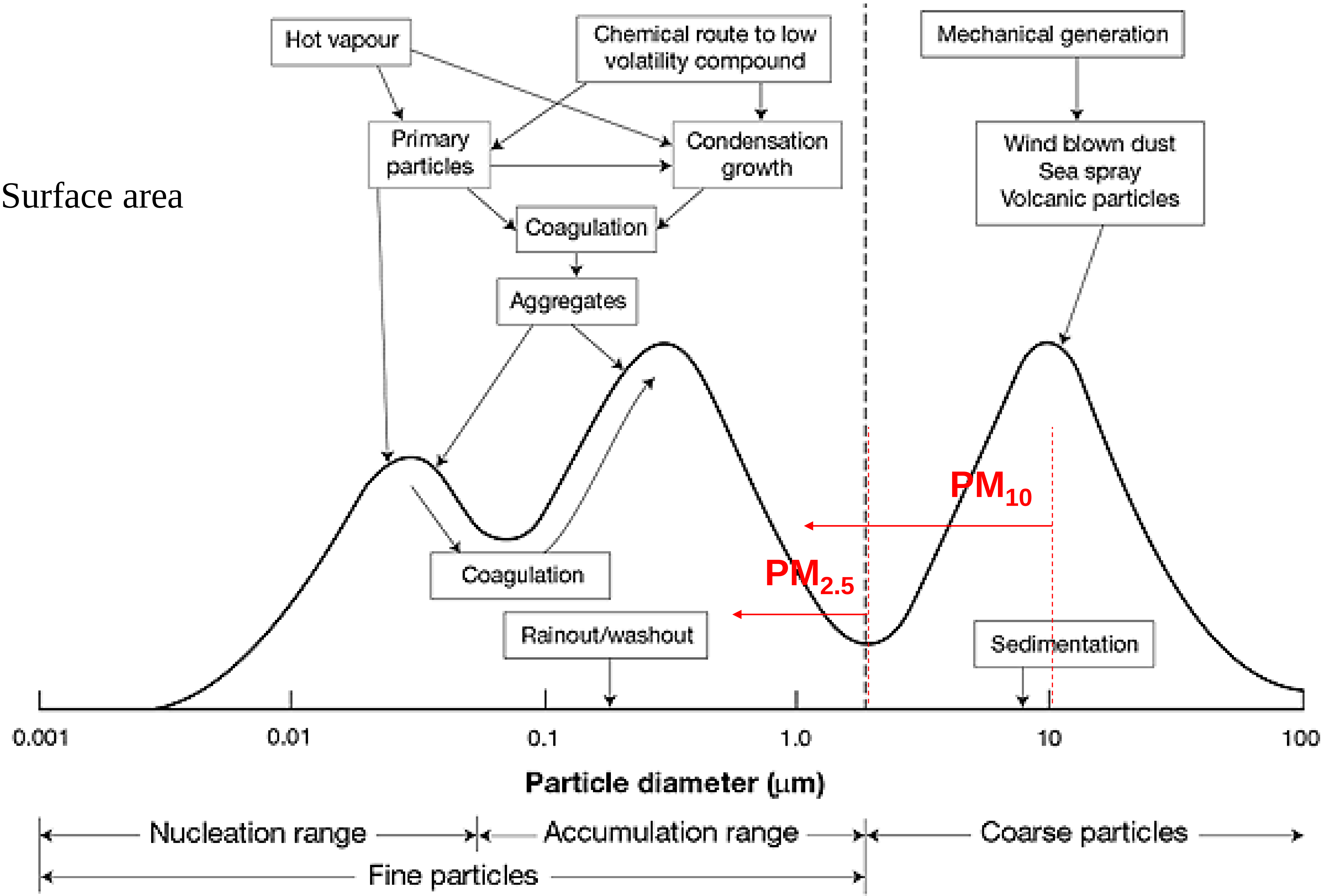
5 orders of magnitude in size
15 orders of magnitude in mass/volume !



MASS DISTRIBUTION



Surface area



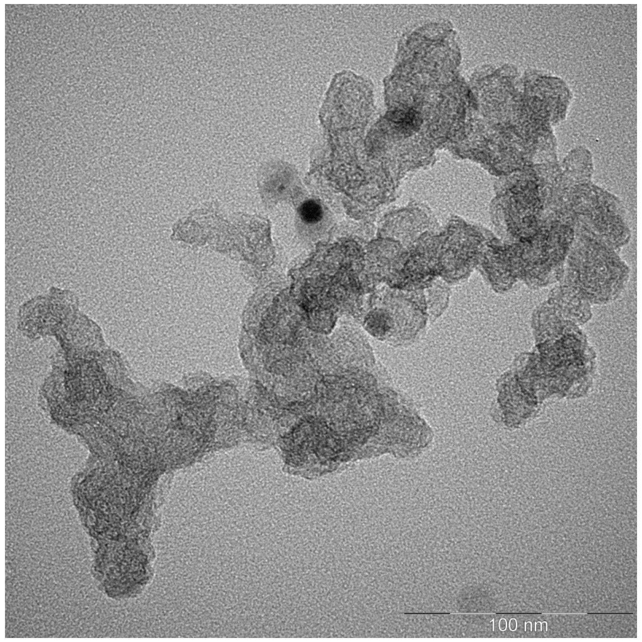
Lifetimes!

Seinfeld and Pandis

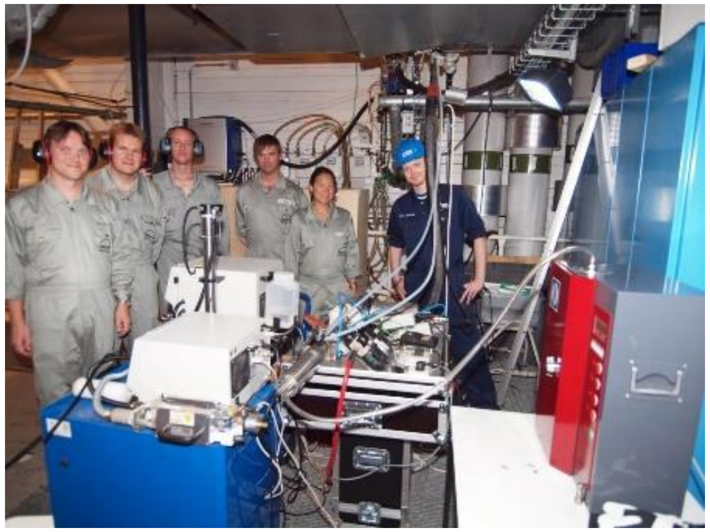
PROPERTIES

- •Size
- •**Morphology**
- •Phase
- •Optical properties
- •Chemical composition

Pöshl et al.



Lieke et al Aerosol Sci & Technol 2013



PROPERTIES

- •Size
- •Morphology
- **•Phase**
- •Optical properties
- •Chemical composition

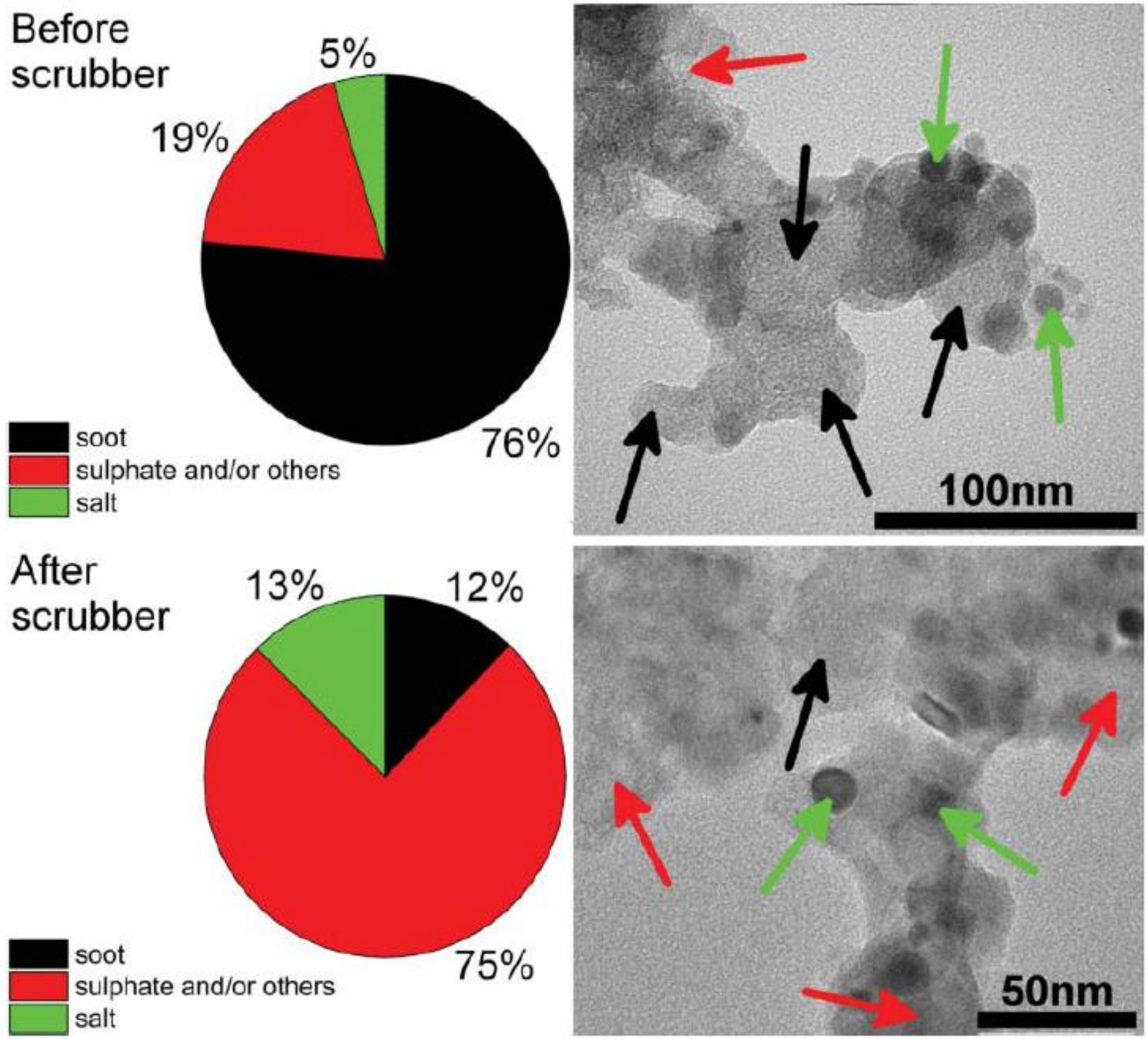


FIG. 4. TEM images of the different phases mixed in particles (right images). The colored arrows indicate the phases used in the relative abundance diagrams before (upper left, total of 428 particles) and after scrubber (lower left, total of 396 particles).

Agglomerated particle

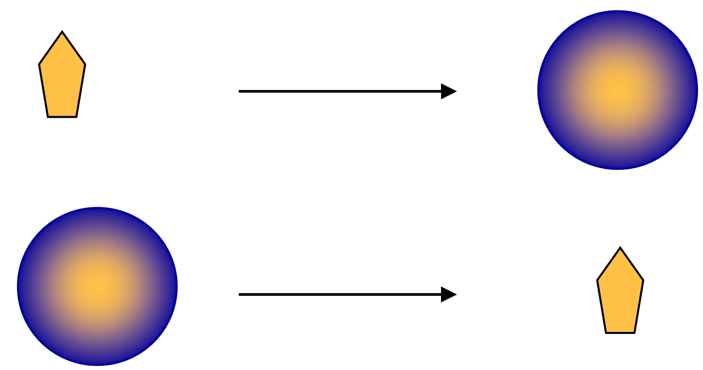
phase size > 100 nm

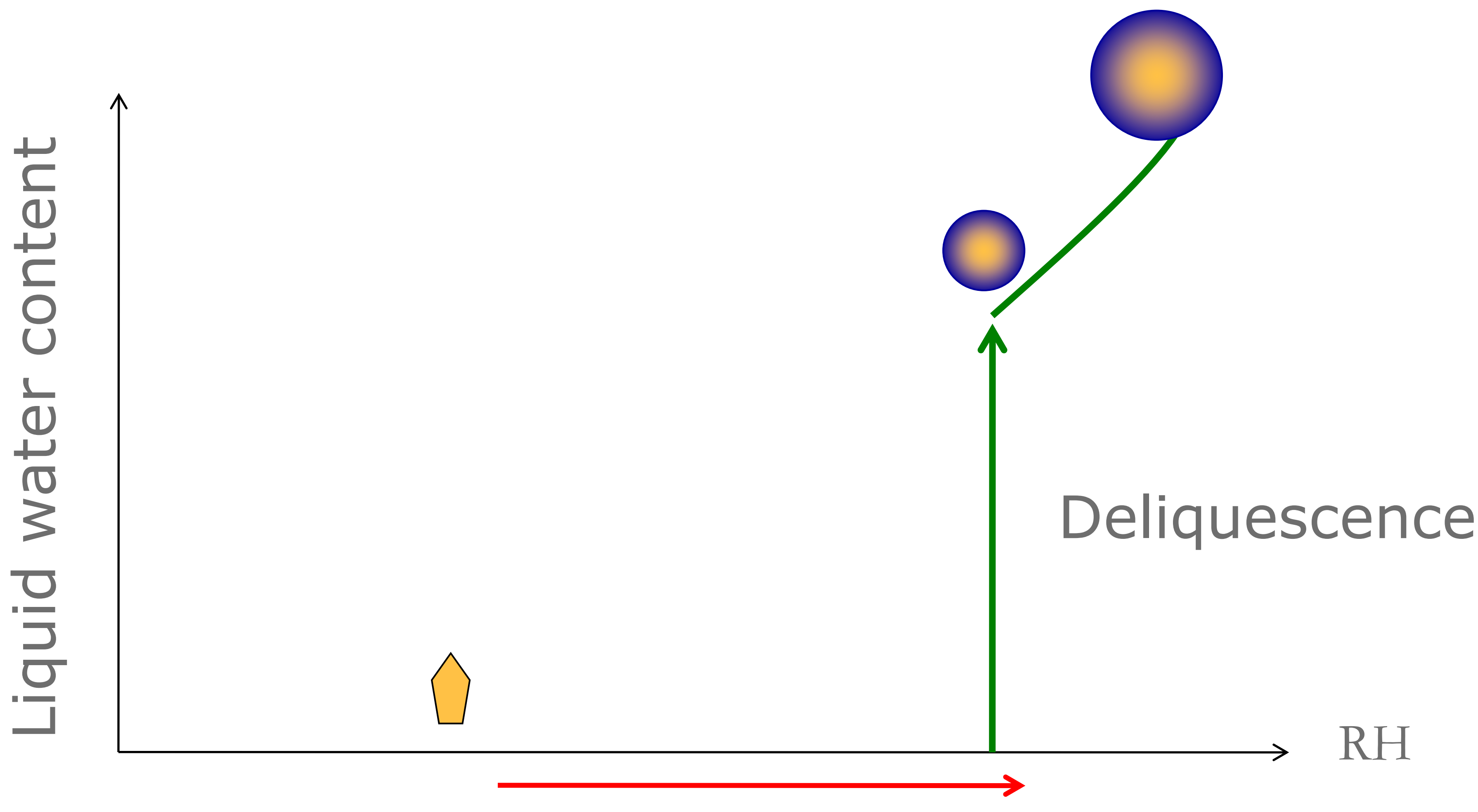
Lieke et al. 2013

AEROSOL PHASE CHANGES

Deliquesence

Efflorescence

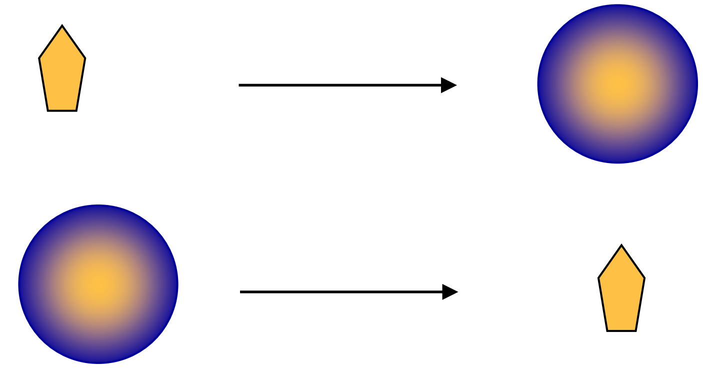


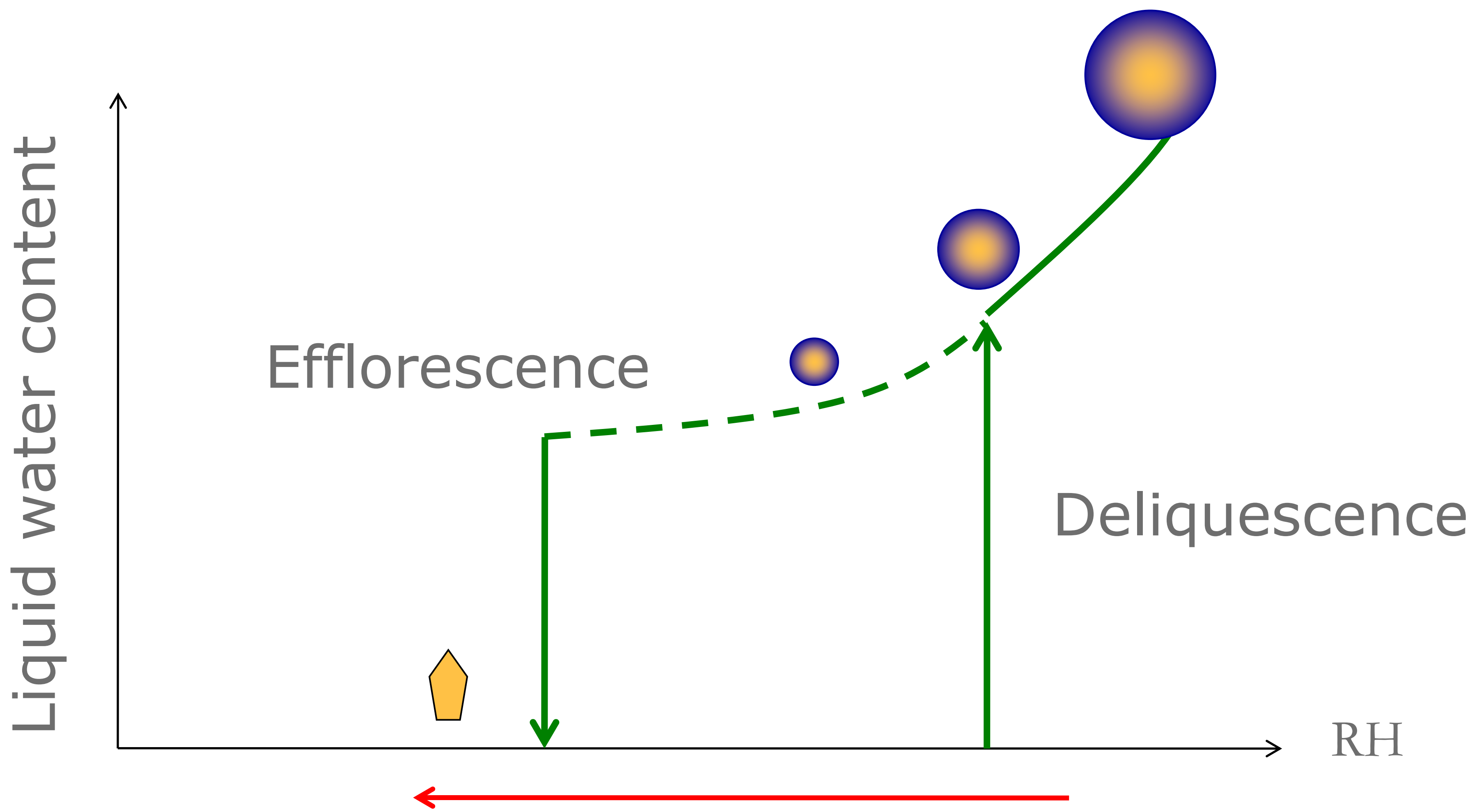


AEROSOL PHASE CHANGES

Deliquesence

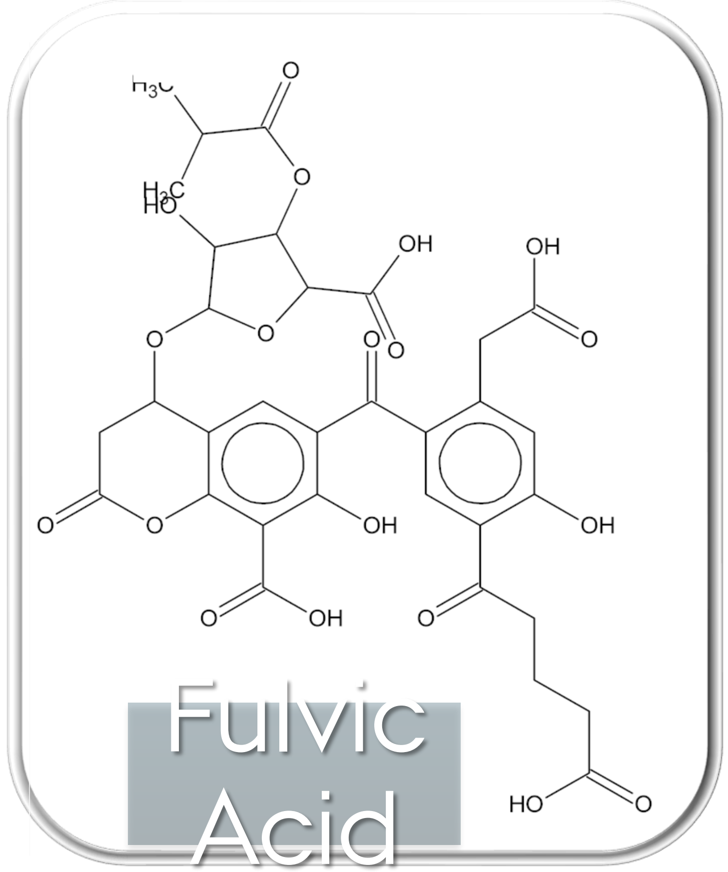
Effloresescence

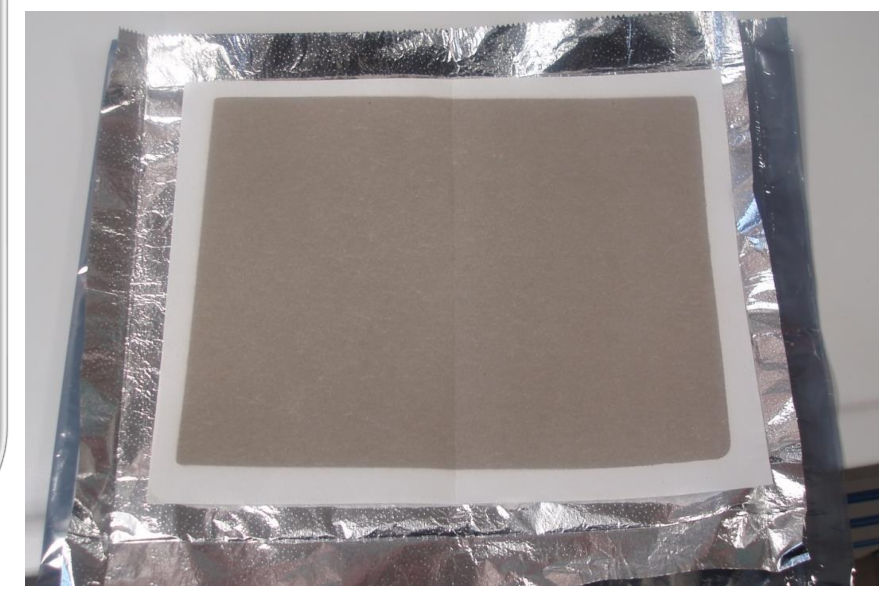




PROPERTIES

- Size
- Morphology
- Phase
- **Optical properties**
- Chemical composition





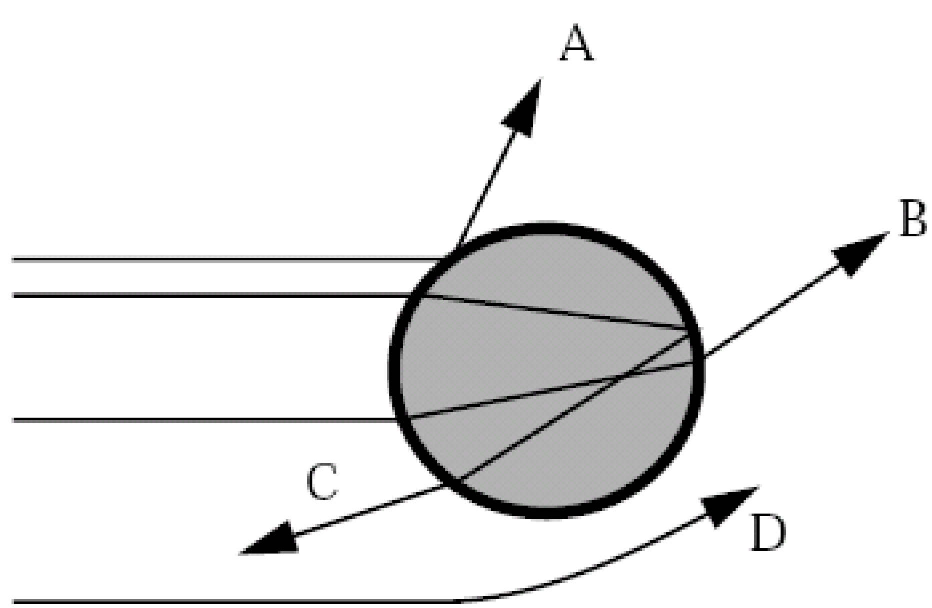
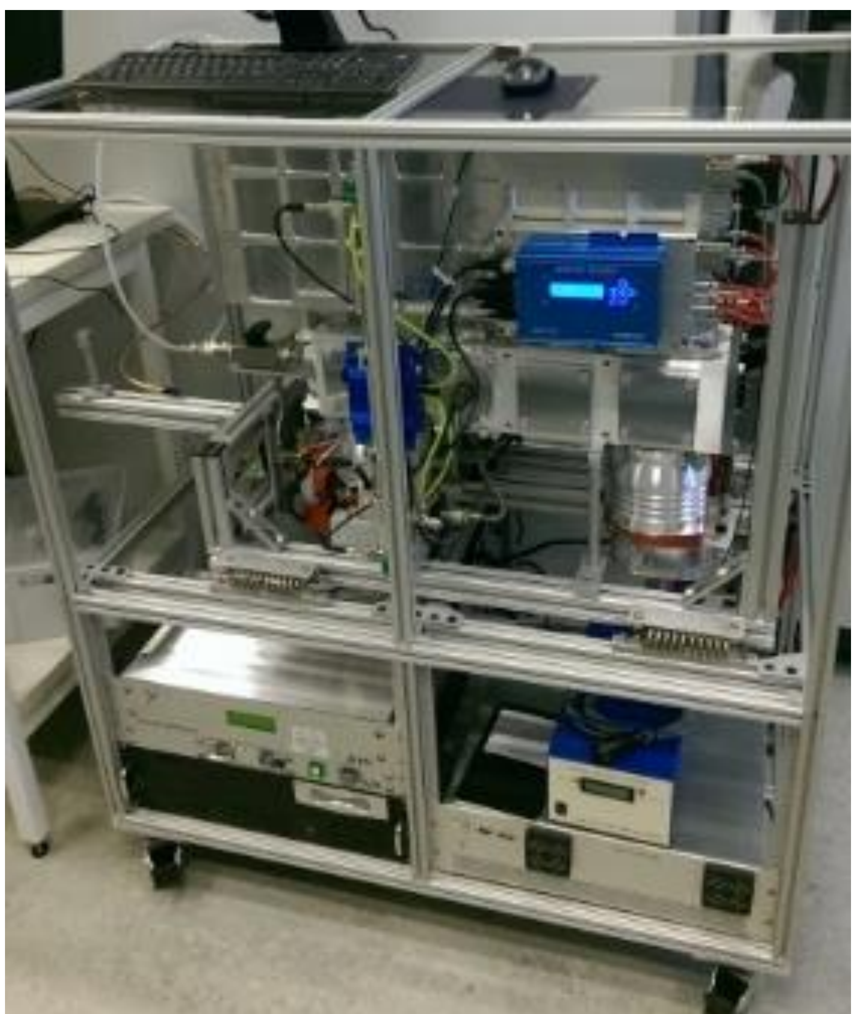


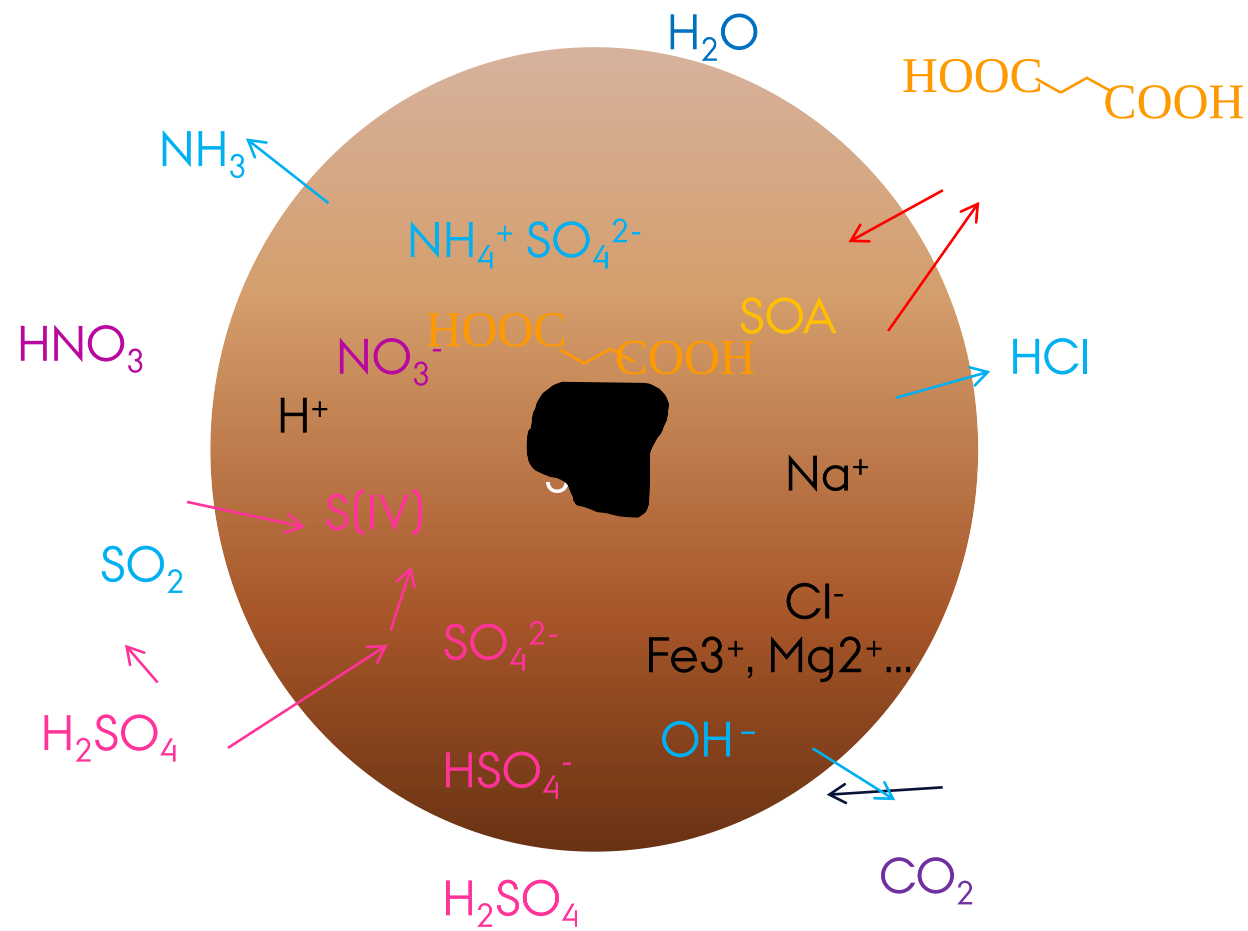
Figure 8-3 Scattering of a radiation beam: processes of reflection (A), refraction (B), refraction and internal reflection (C), and diffraction (D).

Jacob, D: Introduction to atmospheric chemistry

PROPERTIES

- Size
- Morphology
- Phase
- Optical properties
- **Chemical composition**





Off-line and on-line methods

WHAT DO WE DO?

- Laboratory studies
- Field studies
- Modelling studies

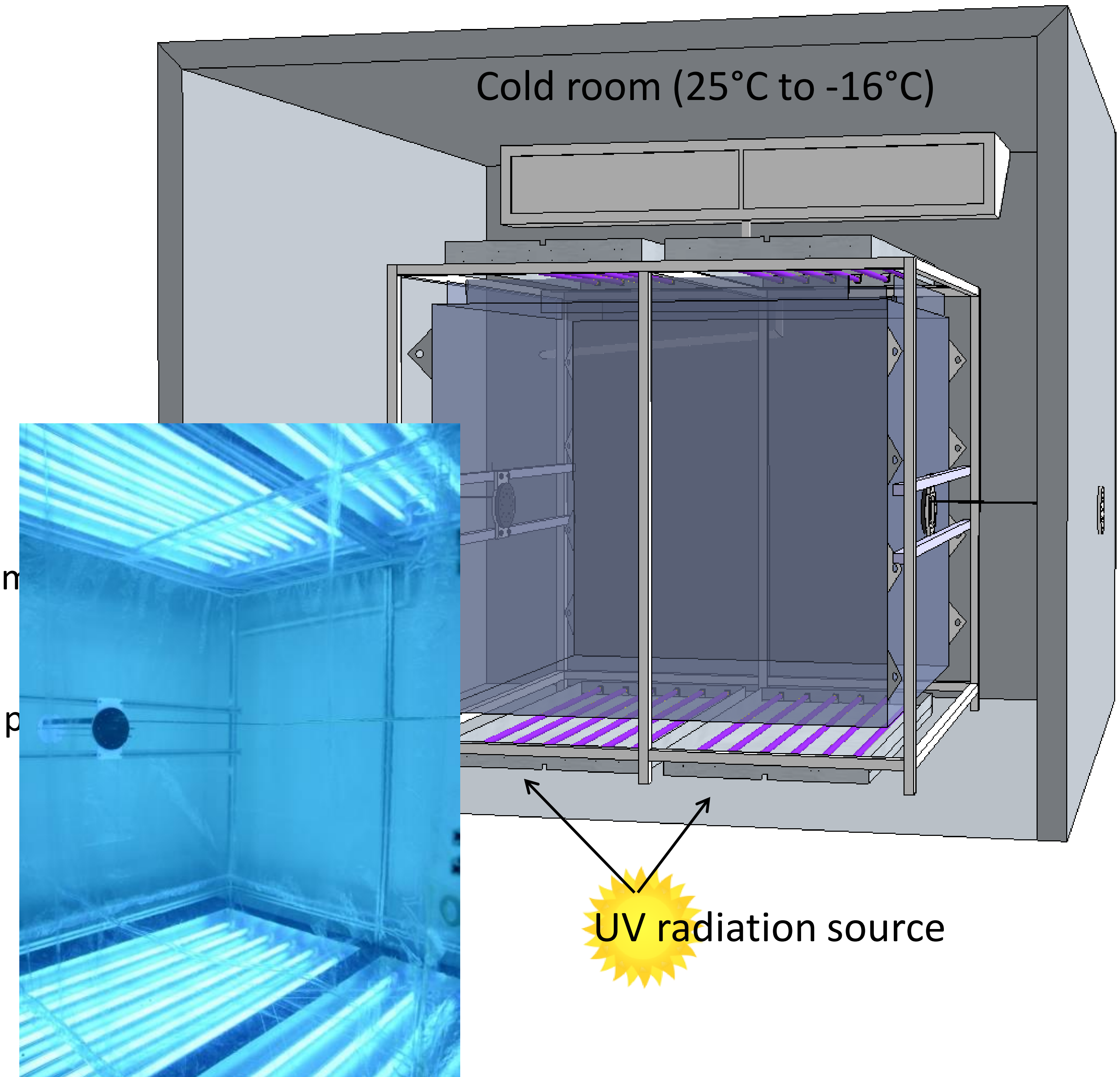
Chamber studies

Temperature controlled cold room:
+25 °C to -16°C

Teflon bag (125 µm FEP Teflon):
1.63 x 1.63 x 1.85 m (H x W x L) -> 5m

Inlet and Outlet:
7 x 6mm + 2 x 10mm stainless steal p

UV light exposure:
Costumed made UV-B lights to simulateatmospheric radiation conditions.



Formation and analysis of laboratory-generated particles form α-pinene

SMPS

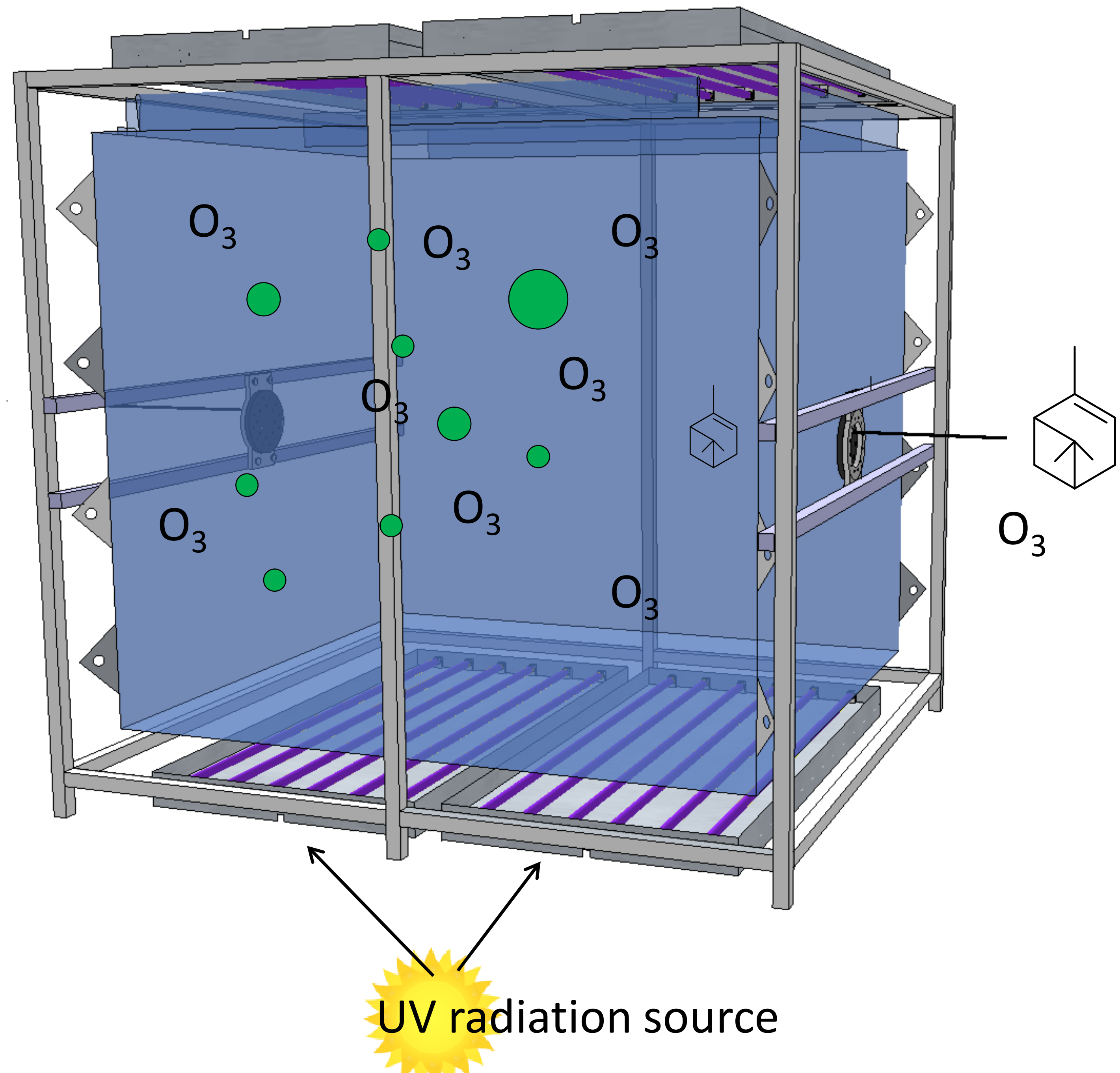
AMS

GC-FID

O_3 monitor

CCN

PTR-MS



TAK FOR OPMÆRKSOMHEDEN

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