Tomsk Polytechnic University
Institute of natural recourses
Geoecology and Geochemistry Department

Professional English

Lecture 1
«Basic concept of atmospheric aerosols»

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OUTLINE

1. Introduction
2. Terminology
3. Natural sources of aerosols.
4. Atmospheric aerosol types.

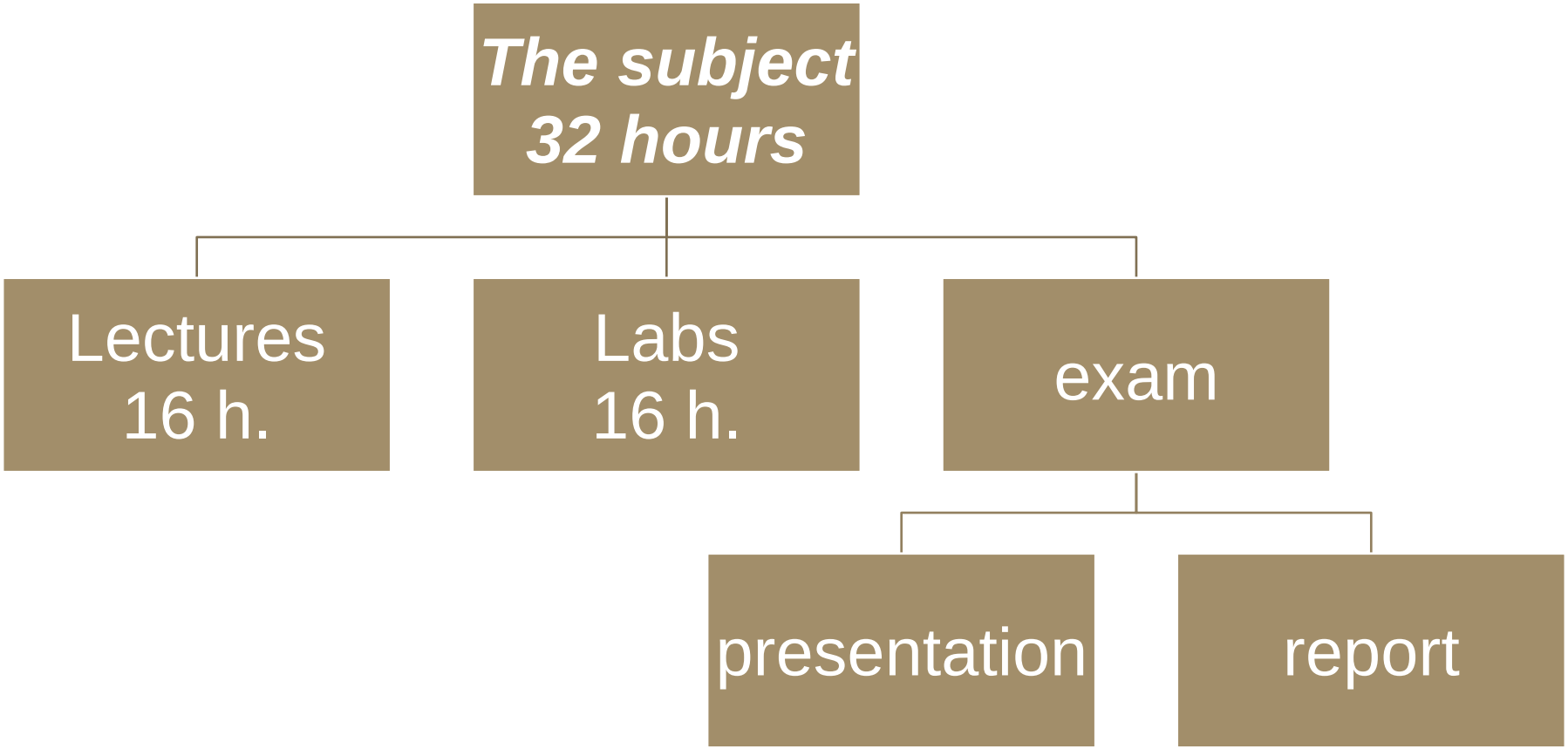
Introduction

Aim of the subject

- is to train specialists having advanced study of the different atmospheric aerosol characters at local, regional and global scale.

The tasks of the subject

- the terminology relating to the atmospheric aerosol,
- sources of aerosols, aerosol formation processes and aerosol classification,
- aerosol effects on climate change,
- local and remote sensing to measure aerosols,
- analytical support used to determine of chemical and mineral composition of aerosols,
- get practical skills in determination of anthropogenic and natural mineral composition in samples of dust aerosols,
- consider some issues concerned with ecological-geochemical assessment of the urban areas in Western Siberia on base of aerosol study.


The subject
32 hours
Lectures
16 h.
Labs
16 h.
exam
presentation
report

2. Terminology
Translate the words

- Hazes
- Mists
- Anthropogenic pollution
- trace elements
- To emit into the atmosphere
- Primary and secondary aerosols
- To originate/arise from
- Particulate matter
- Soot
- ultra fine
- Coarse
- Aerosol optical depth

Terminology

Легкий туман	Hazes
Густой туман	Mists
Техногенное загрязнение	Anthropogenic pollution
микроэлементы	trace elements
Выбрасывать в атмосферу	To emit into the atmosphere
Первичный и вторичный аэрозоль	Primary and secondary aerosols
Возникать, появляться	To originate/arise from
Твердые частицы	Particulate matter
сажа	Soot
мелкодисперсный	ultra fine
крупнодисперсный	Coarse
Аэрозольная оптическая толща	Aerosol optical depth

questions

3. Natural sources of aerosols

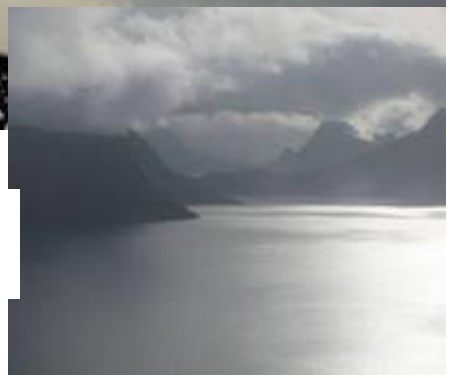
The atmospheric aerosol is defined as an assembly of liquid and solid particles suspended in a gaseous medium, usually air, long enough to enable observation and measurement. With sizes typically around 100 nm.

Fog

Fume, smoke

Smog

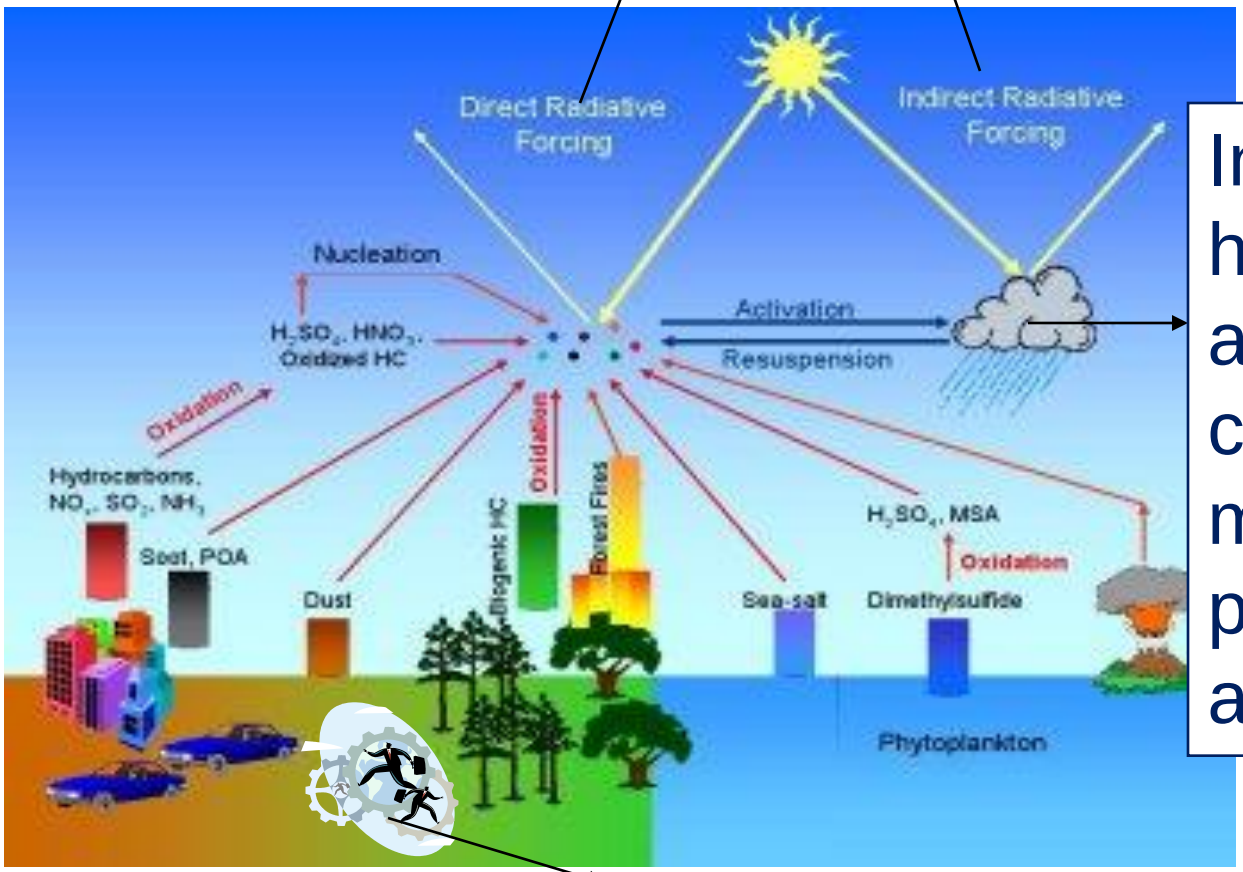
Hazes, mists



(Vincent, 1989; Wark and Warner, 1991; Baron and Willeke, 1993).

Atmospheric aerosols affect on environment quality

Changing the Earth's radiation balance



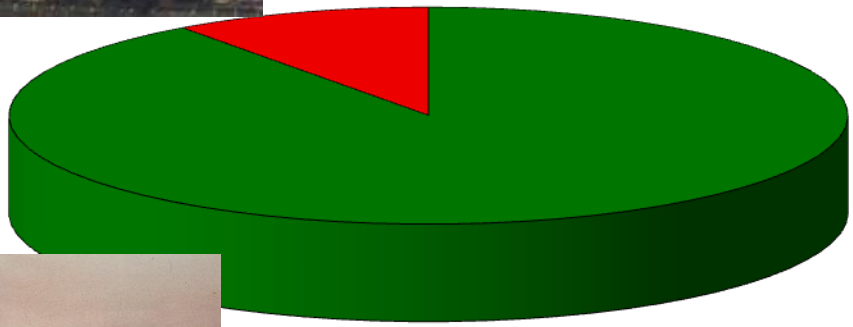
Influence on hydrology through aerosols impact on cloud microphysical processes and amount

Human health effects

(adapted from R. Zaveri)

Aerosol origin

Anthropogenic aerosols, 10%



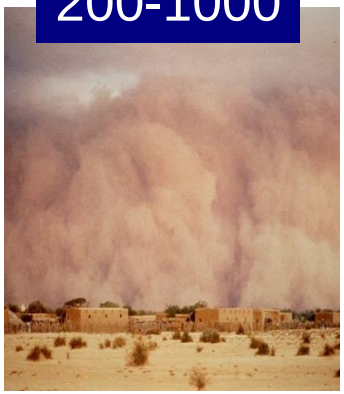
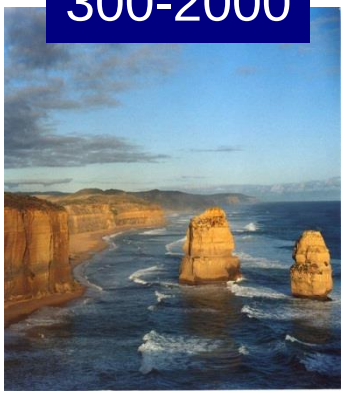
Natural aerosols, 90%

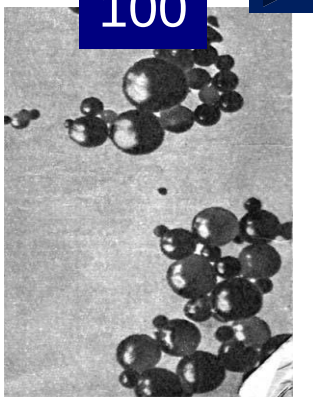
1. Primary aerosols
2. Secondary aerosols

Global emission estimates for primary aerosols, ml. t/year

Natural aerosols

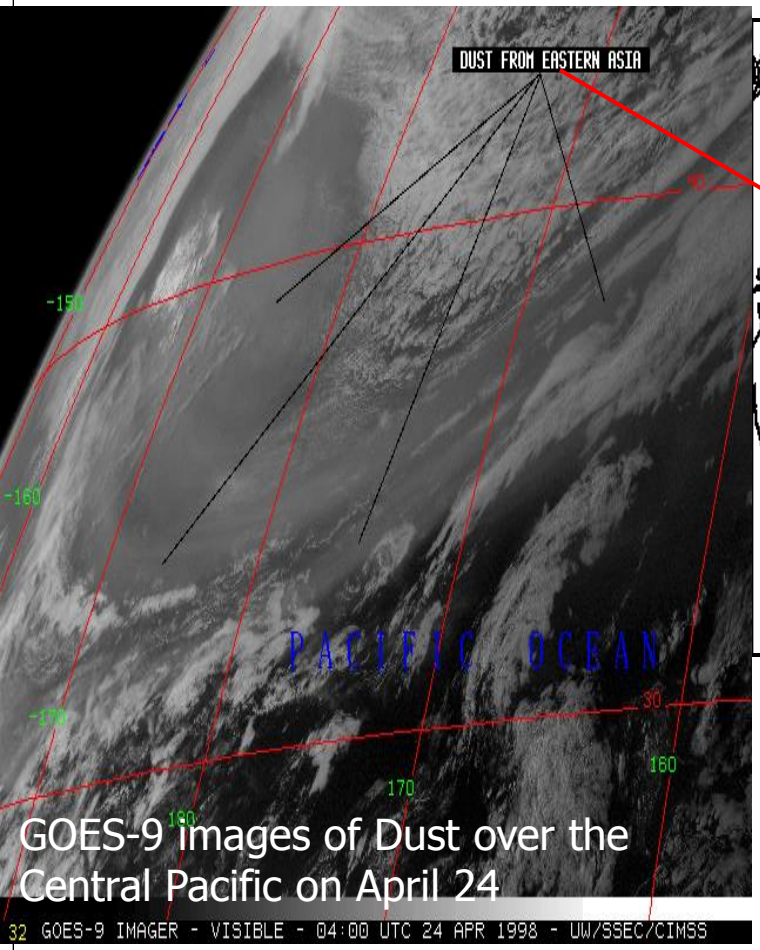
Soil dust	Sea spray	Volcanic dust	Forest and grassland fires, living vegetation	Cosmic dust
200-1000	300-2000	10-150	30-250	100

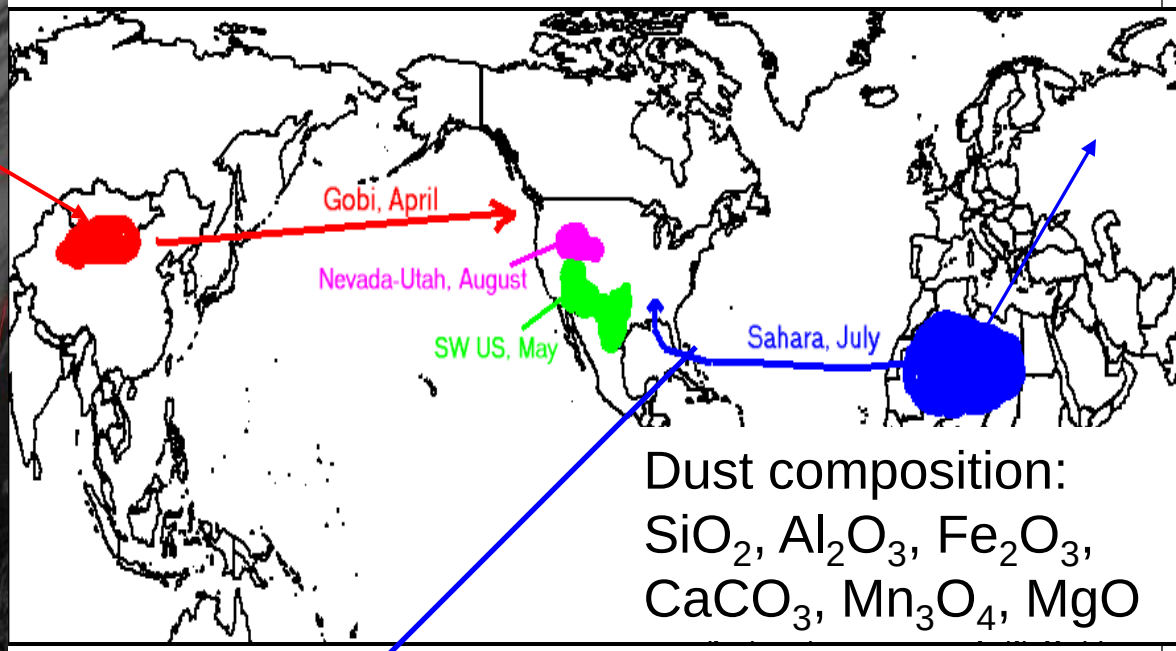



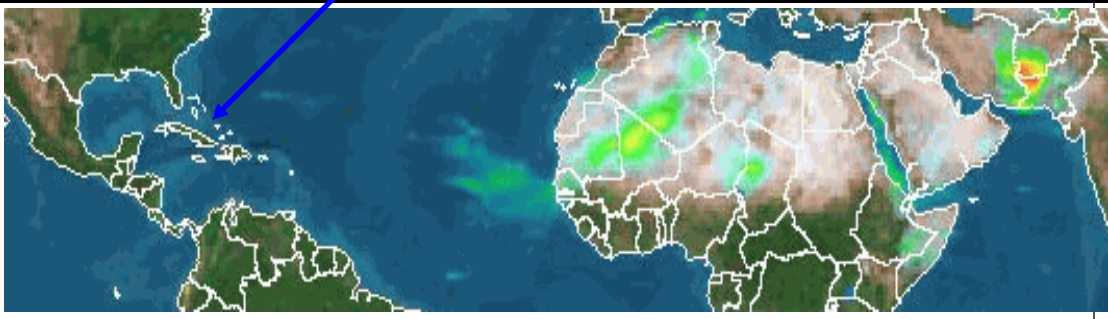



Представлен разброс имеющихся литературных данных по оценкам А.Х. Остромогильского и В.А. Петрухина, 1984

Sahara Dust Cloud over America and Europe



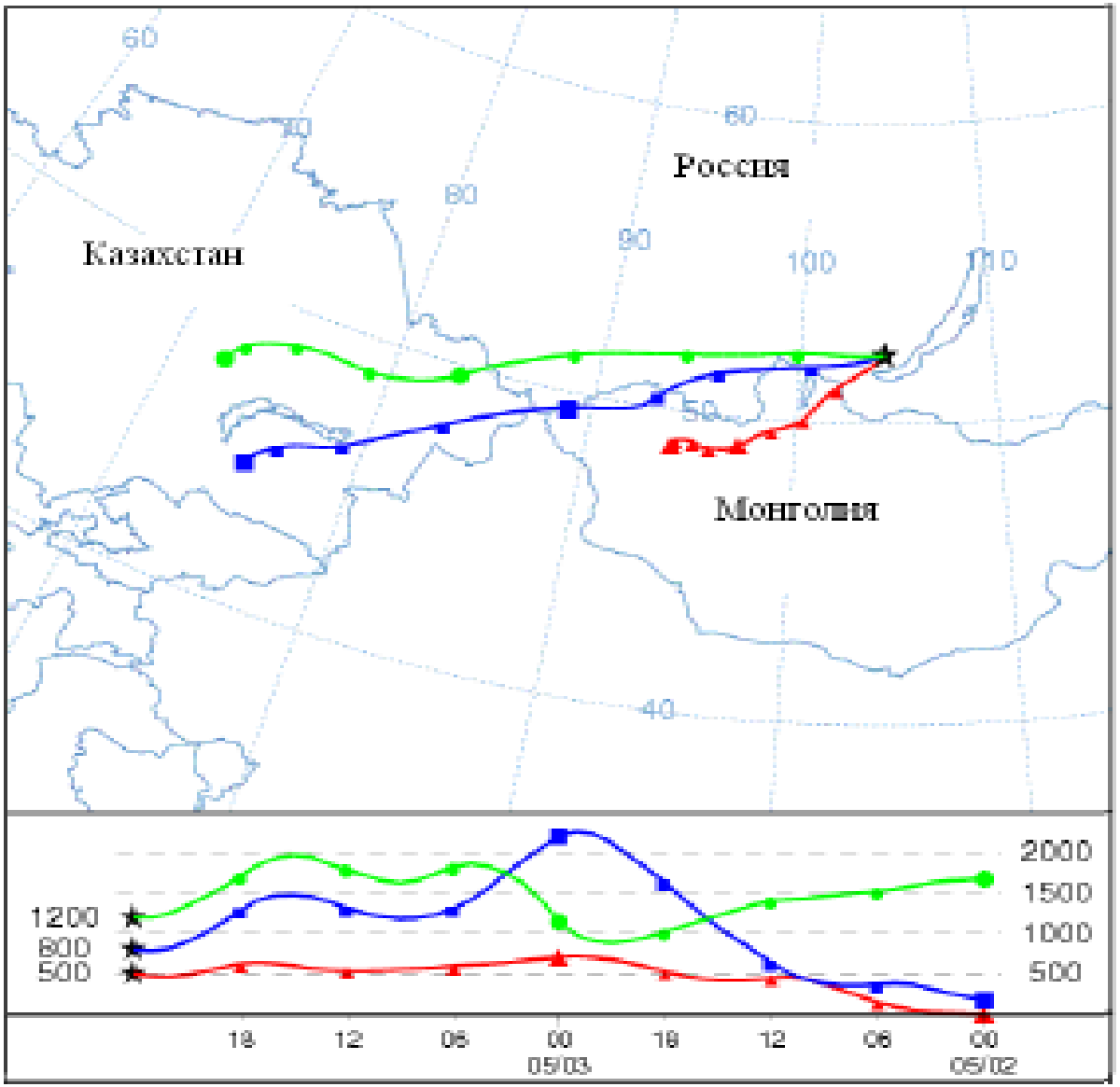




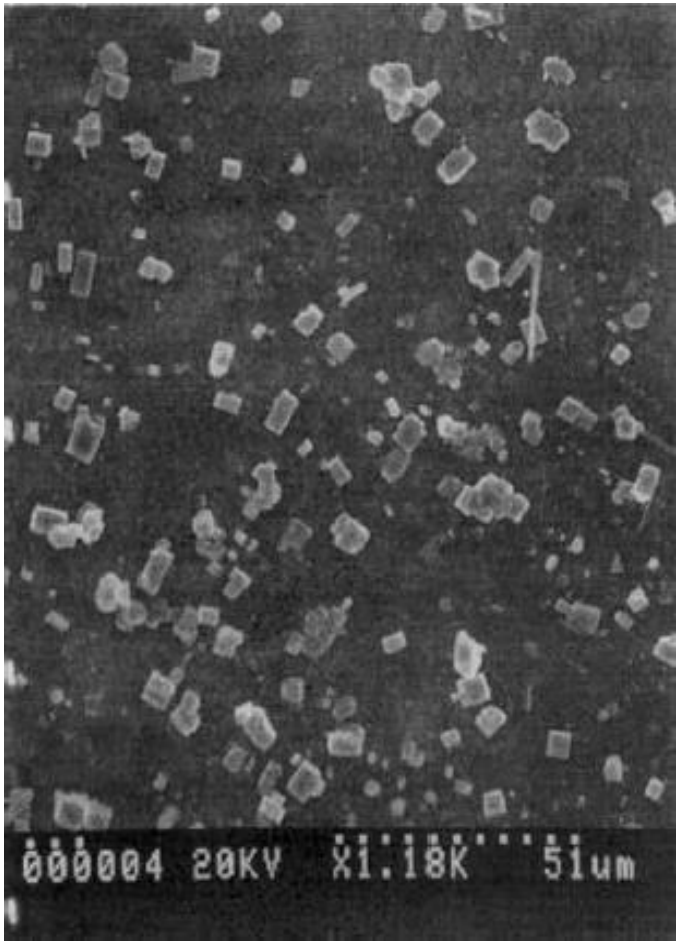
http://bravedefender.ru/post163388838/play

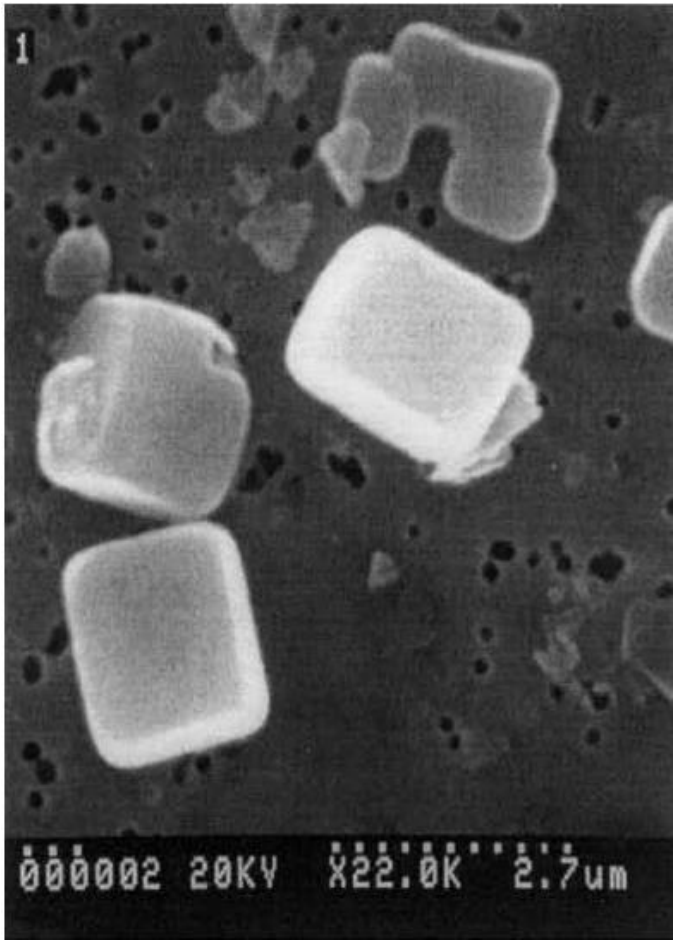
Rudolf B. Husar
CAPITA, Washington University

Asian Dust cloud over Baikal lake (Irkutsk city), 2009



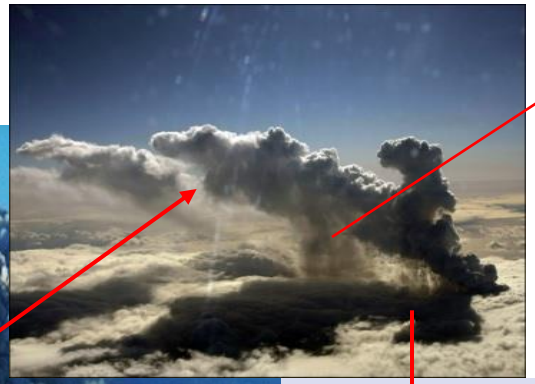
Scanning electron photographs of dried sea-salt particles for marine air conditions collected at Mace Head on the west coast of Ireland



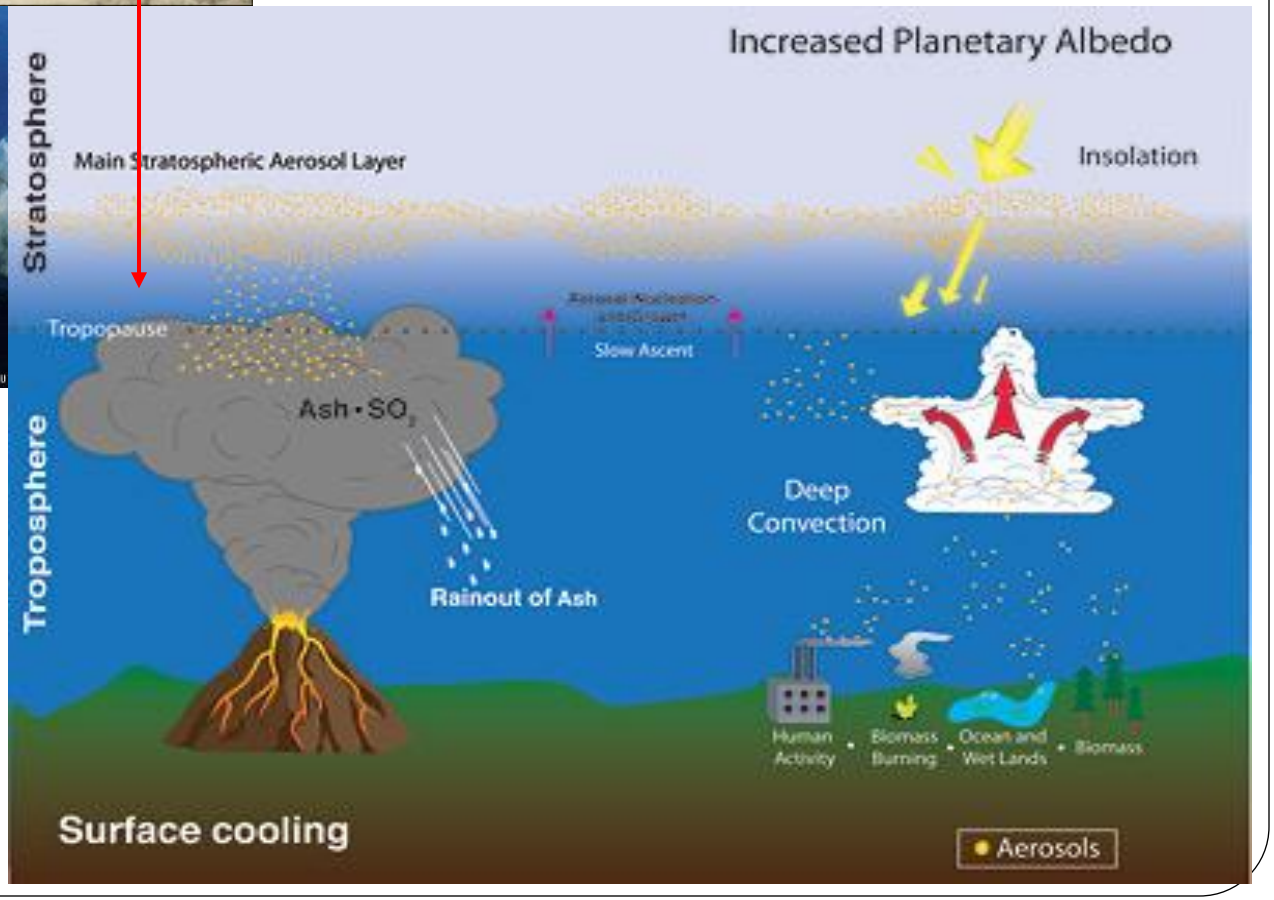


(Chamaillard et al., 2003)

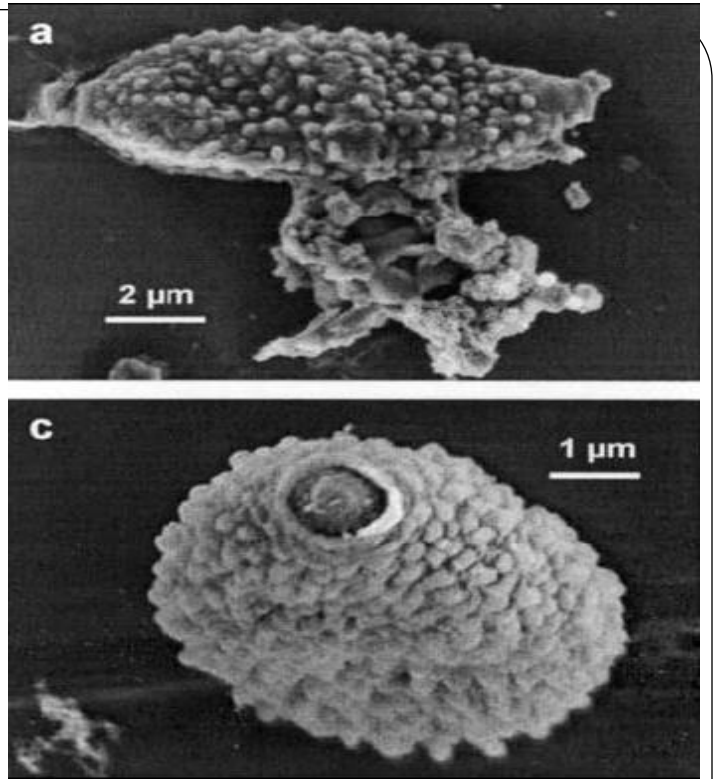
Volcanic aerosols



- water-insoluble mineral particles,
- silicates,
- metallic oxides such as SiO_2, Al_2O_3 and Fe_2O_3



Biological aerosols



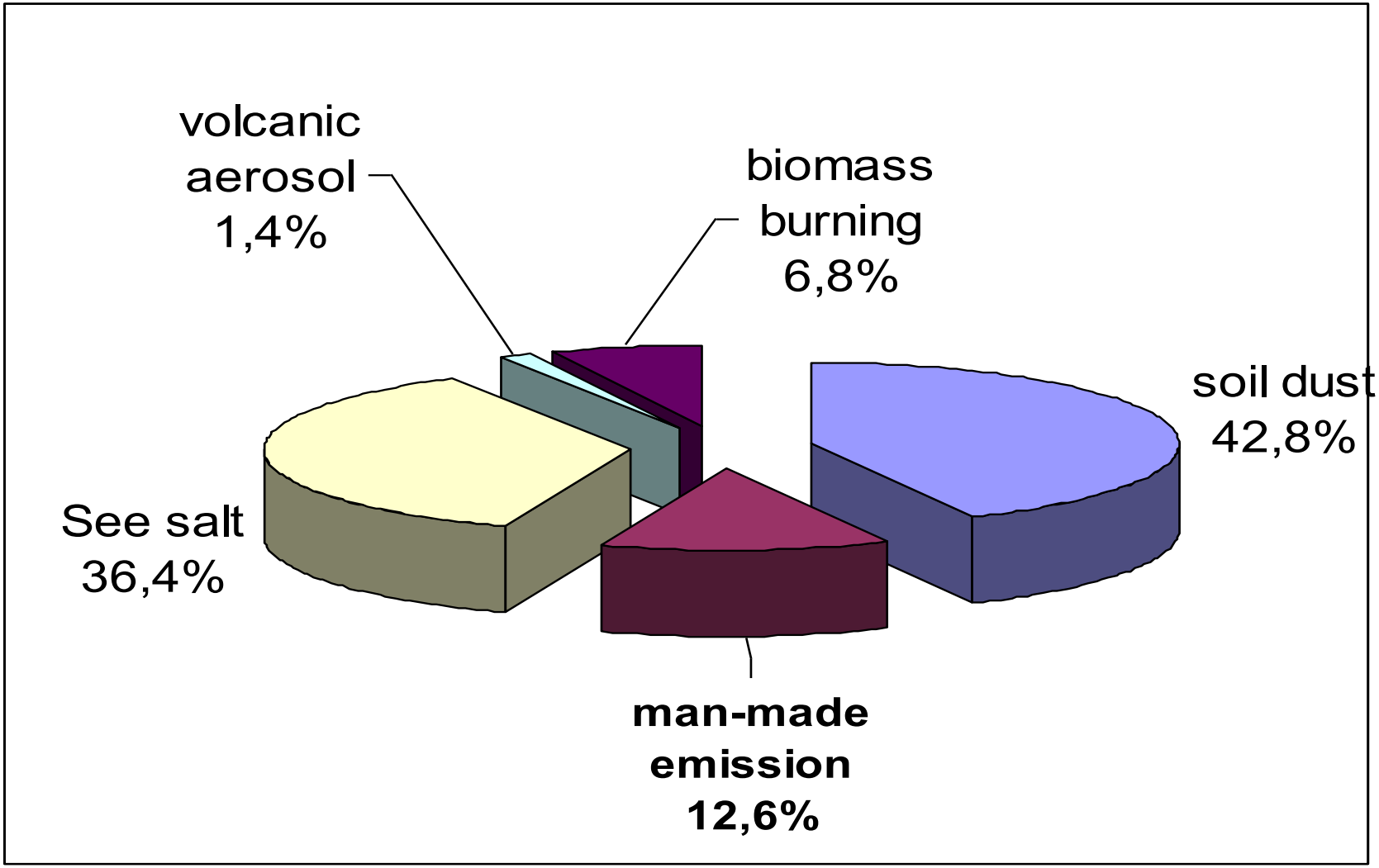
Scanning electron photographs

Table 1.3. Sizes of biological particles

Biological particles	Radius, µm
Viruses	0.05–0.15
Bacteria	0.1–4.0
Fungal spores	0.5–15.0
Pollen	10.0–30.0

(Wittmack et al., 2005)

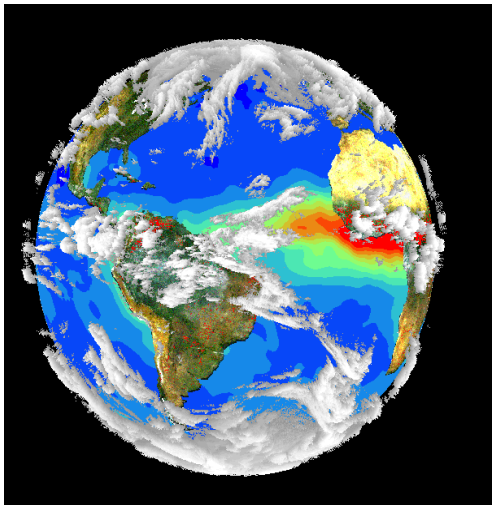
Global balance of aerosol sources in 1980-s (Kiehl and Rodne, 1995)



4. Atmospheric aerosol types

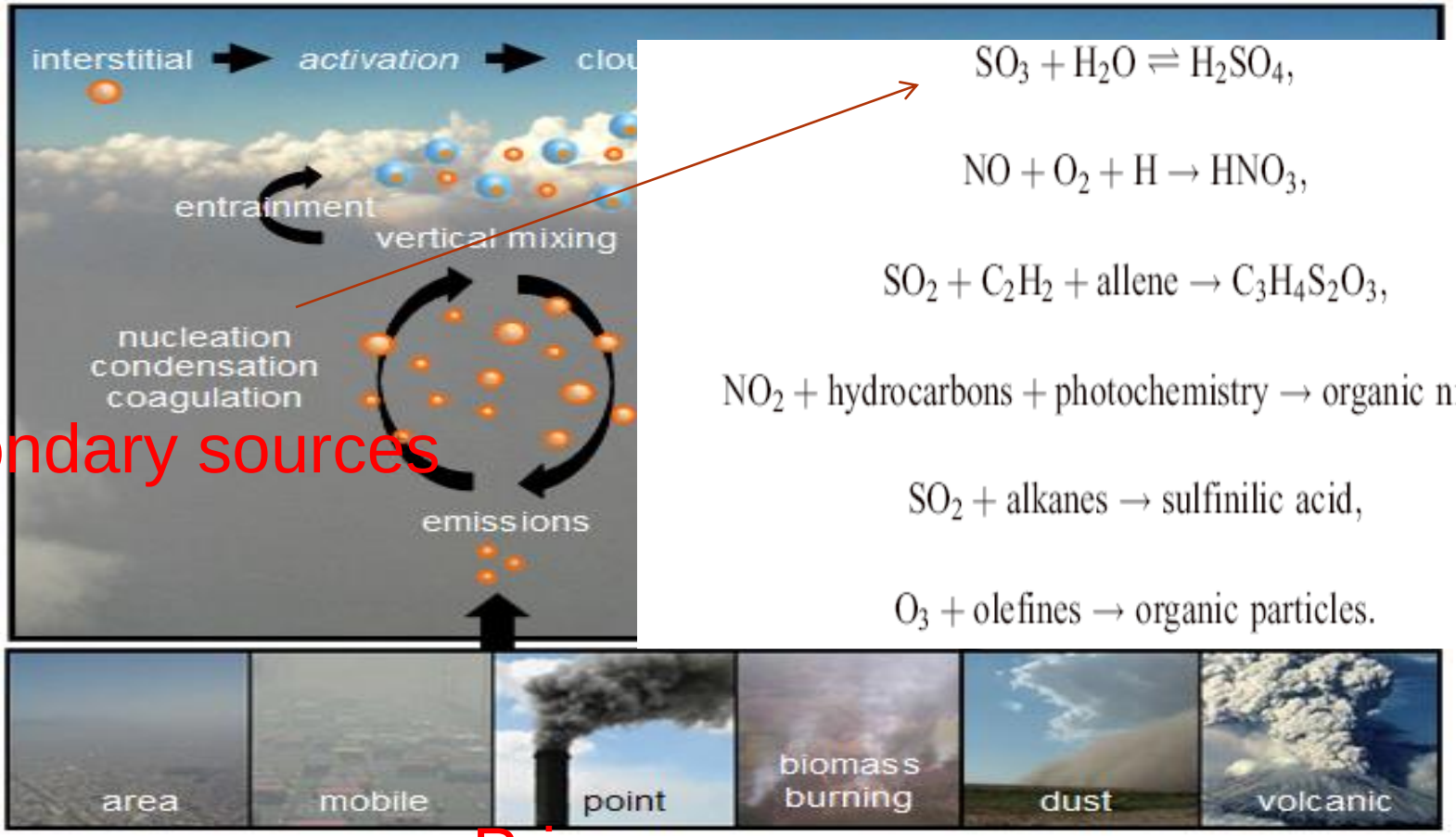
Aerosol types

- marine
- terrestrial
- mixed



Secondary aerosols

are formed after chemical conversion in the atmosphere, which generally involves gases, pre-existing aerosols and water vapor.



$SO_3 + H_2O \rightleftharpoons H_2SO_4$,

$NO + O_2 + H \rightarrow HNO_3$,

$SO_2 + C_2H_2 + \text{allene} \rightarrow C_3H_4S_2O_3$,

$NO_2 + \text{hydrocarbons} + \text{photochemistry} \rightarrow \text{organic nitrates}$,

$SO_2 + \text{alkanes} \rightarrow \text{sulfinilic acid}$,

$O_3 + \text{olefines} \rightarrow \text{organic particles}$.

Secondary sources

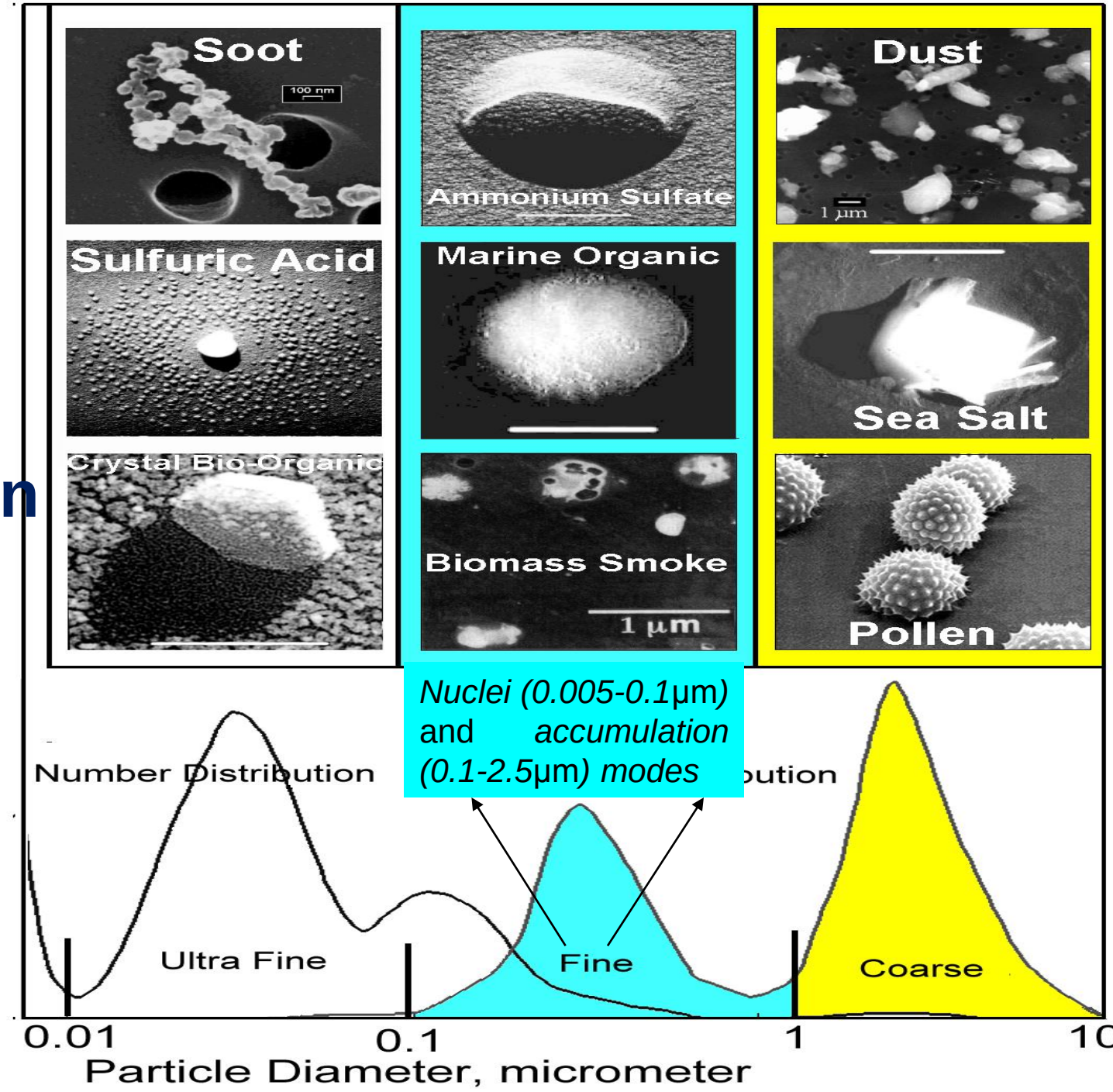
Primary sources

Global emission estimates for secondary aerosols

Secondary aerosol types	Mass, ml t/year
Natural source	
Sulfates	130-200
Ammonium hydrate	80-270
Nitrates	60-430
Organic matter from biogenic volatile organic compounds	75-200
Anthropogenic source	
Sulfates	75-200
Nitrates	30-35
Organic from anthropogenic volatile organic compounds	15-90

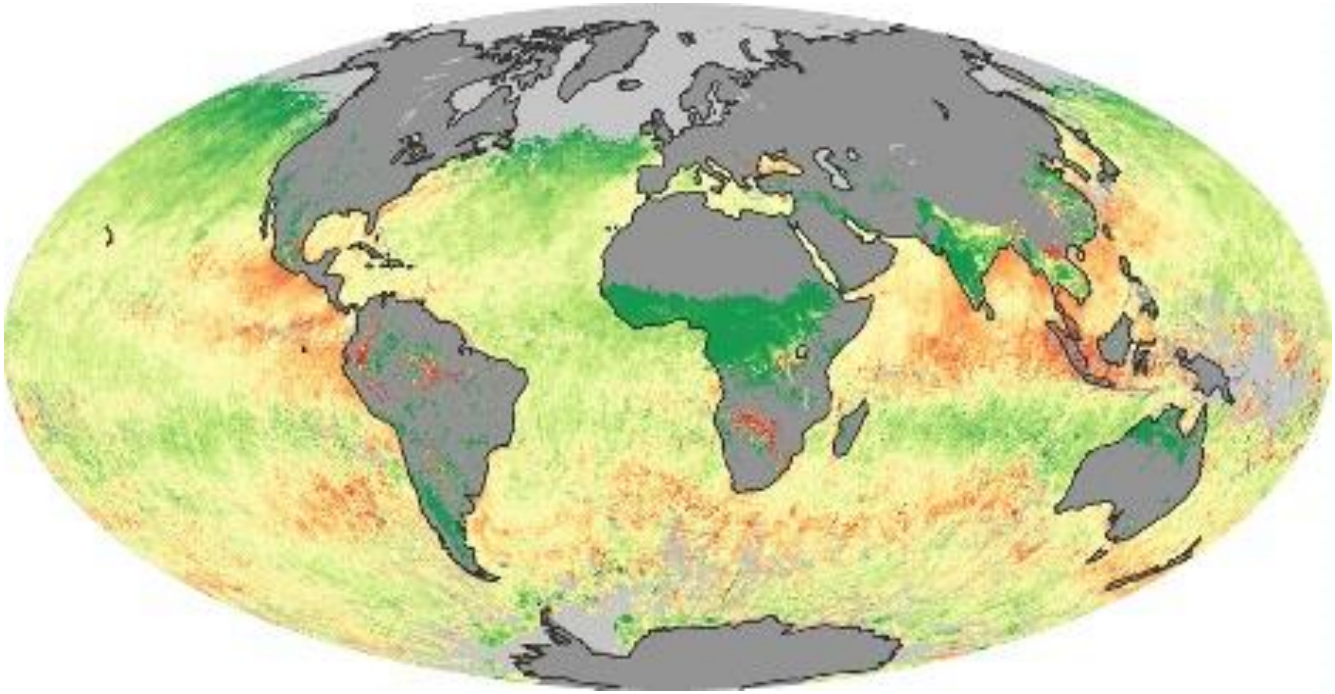
Представлен разброс имеющихся литературных данных по оценкам А.Х. Остромогильского и В.А. Петрухина, 1984

Particle size distribution



Yunge, 1965
Uitby

Data of aerosol size distribution from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite



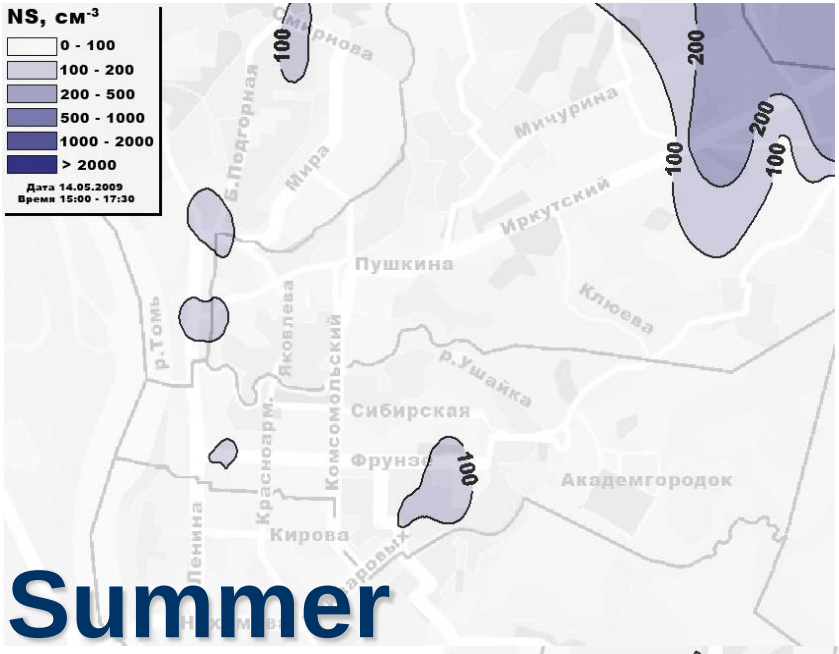
Green - coarse particles
Red – fine and ultra fine particles
Yellow - mixture of the particles

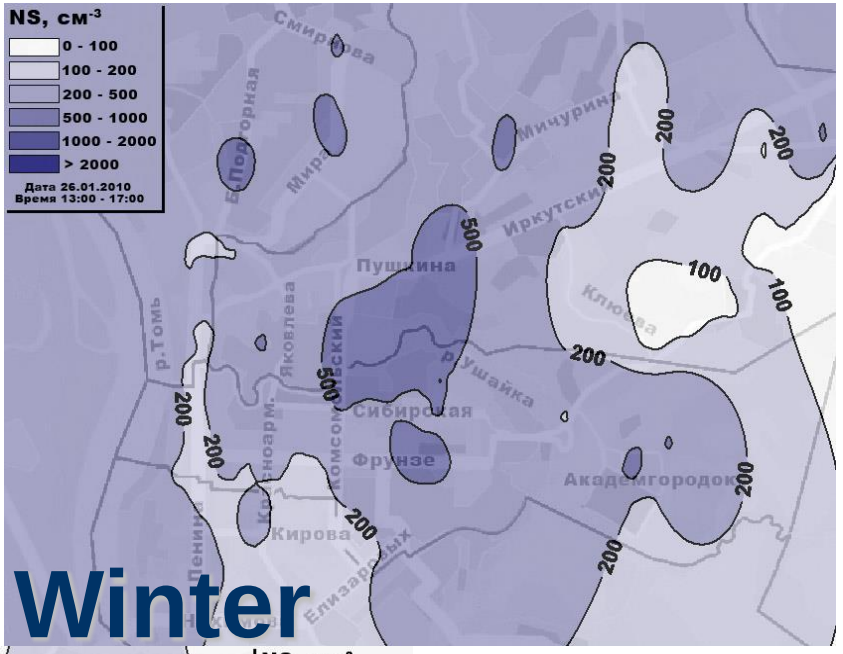
Observed period monthly 2005-2008

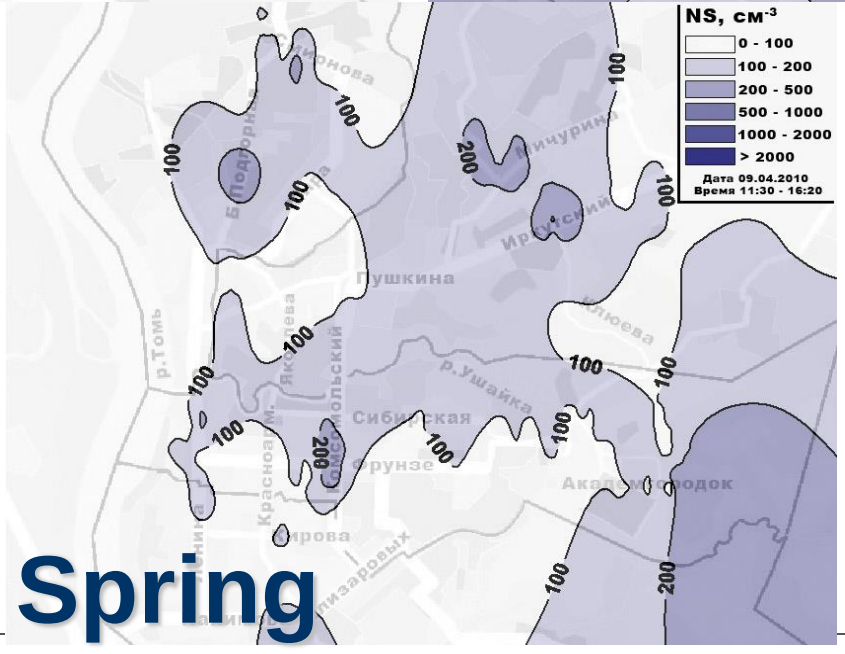
http://earthobservatory.nasa.gov/GlobalMaps/

Ultrafine aerosol concentration in Tomsk-city, 2009, sm^{-3}

Particle size: 1,3 < r < 15 μm







Ужегова Н.В., Белан Б.Д., Антохин П.Н., Жидовкин Е.В., Ивлев Г.А., Козлов А.В., Фофонов А.В. – ИОА СО РАН

Aerosol lifetime in the atmosphere

The stratospheric lifetime of **coarse particles** is only about 1–2 months, **ultrafine modes** is 2 years.

Residence times of particles in the troposphere vary only from a few days to a few weeks.