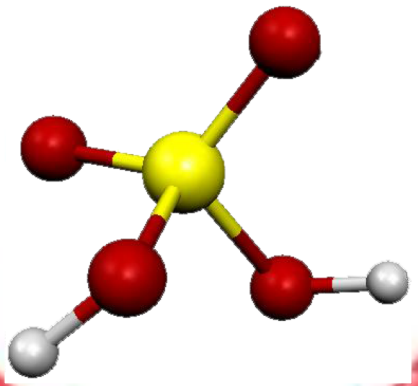
Sulphuric acid in world history



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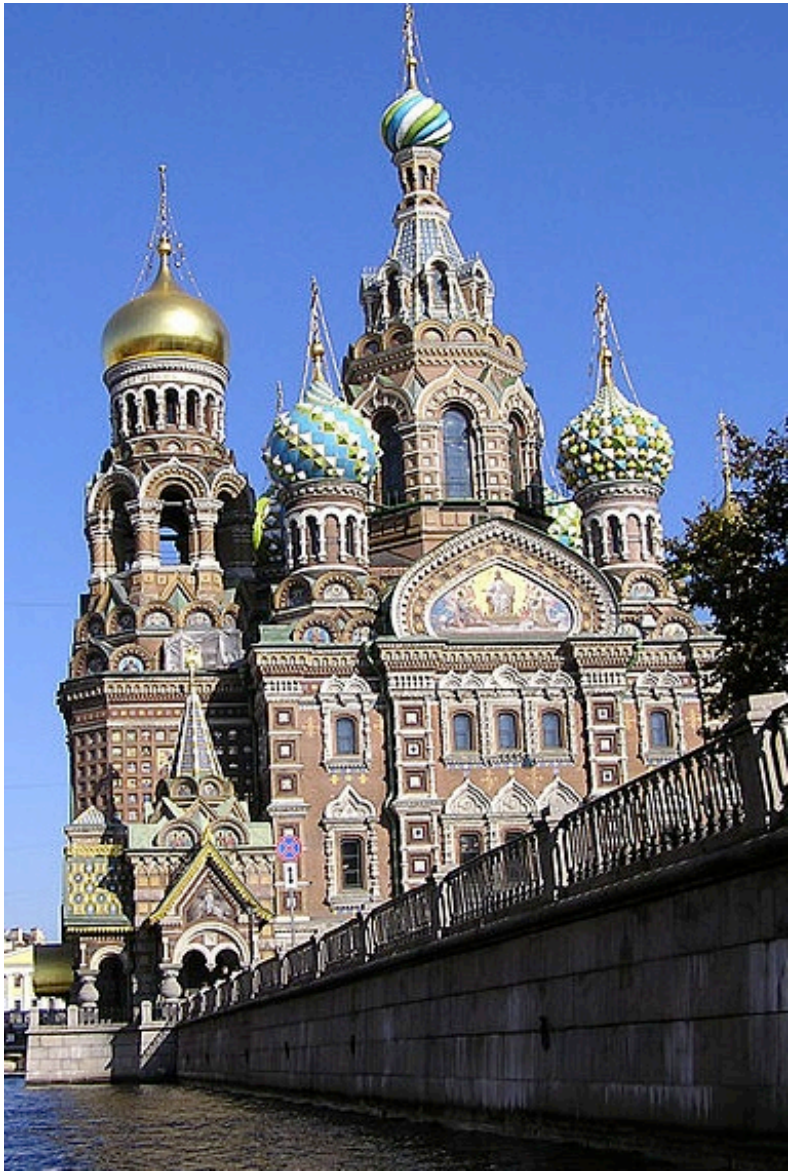
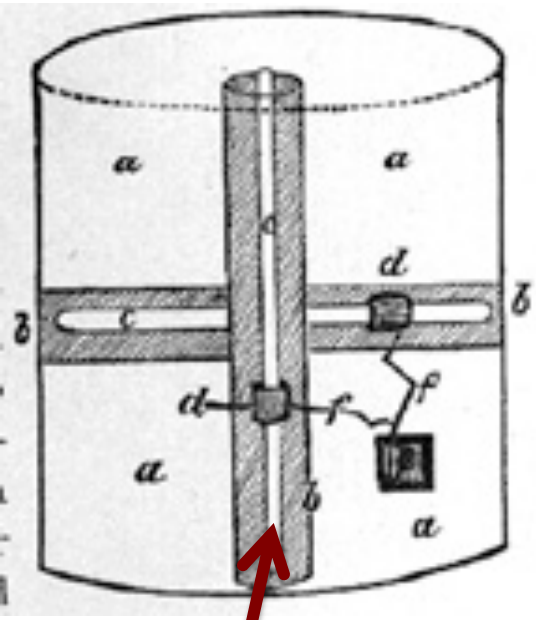
H_2SO_4

Russian emperor (tsar) Aleksander II





H_2SO_4

St Petersburg 13.3.1881

Kuninkaansaari explosion 1.8.1906

- Viapori revolt: Prelude of the Russian revolution
- Artillery of the imperial Russian troops hit a charcoal gunpowder store with a door left open
- 50 000 kg charcoal gunpowder

  (=black powder)

  2/3/15

  sulphur/carbon/saltpetre (KNO_3)
  - burning produces sulphur dioxide, which in turn produces sulphuric acid: characteristic smell of charcoal gunpowder

- tens of rebels died (?)
- turning point of the revolt (?)
- windows broken even in northern parts of downtown Helsinki (Kallio)

Atmospheric aerosols: tiny particles floating in the air

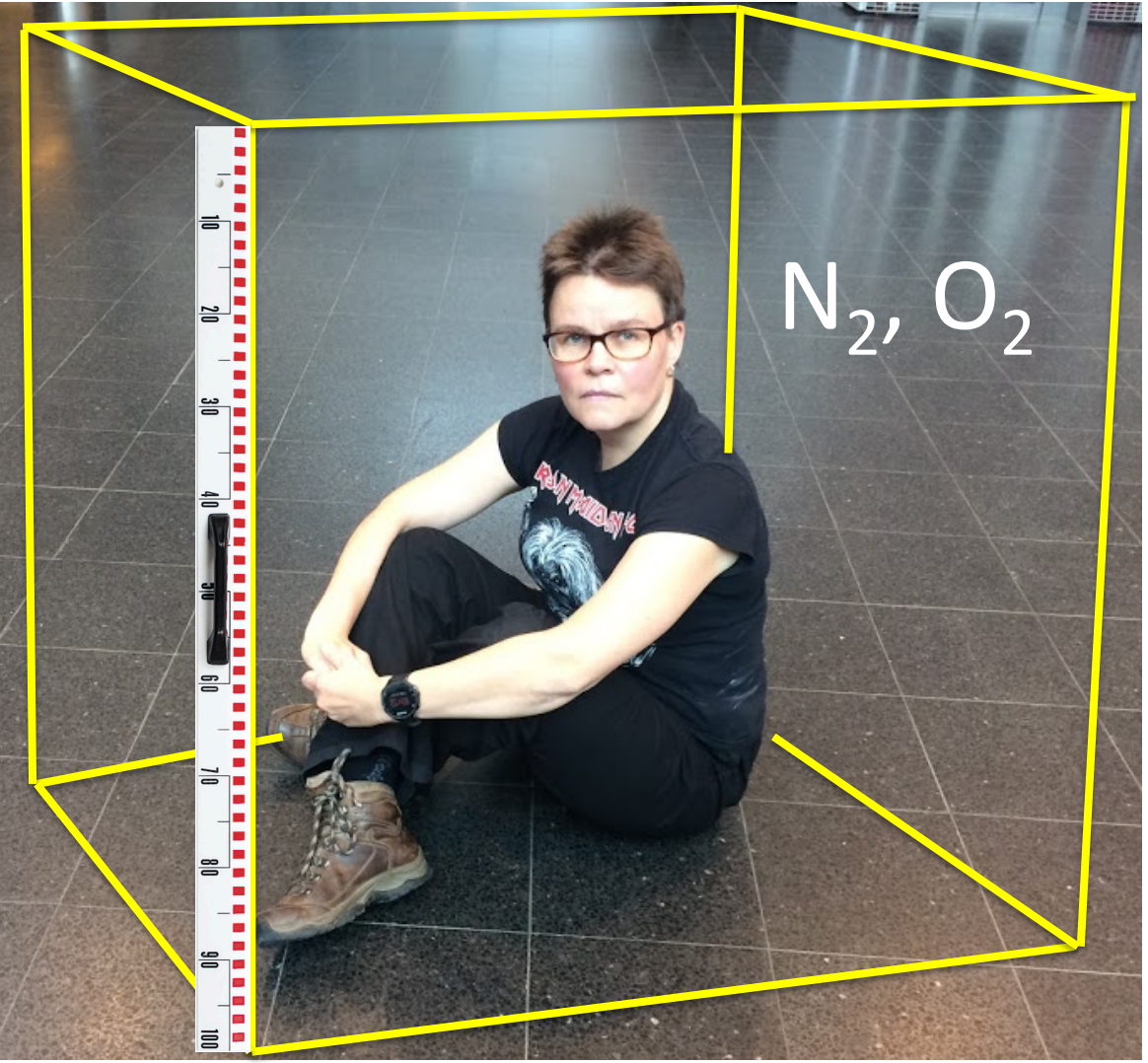
- Liquid or solid
- Diameter 1nm – 100µm

(human hair thickeness/5000 - human hair thickeness x 2)

- Concentration

  1 – 100 000/cm^3 number

  0.1 – 100 µg/m^3 mass



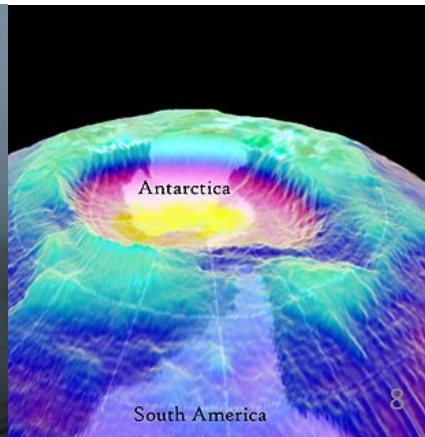
Condensed lecture room air

particles

Cooling net effect in climate change:
large uncertainties
direct effect & cloud formation seeds

Rain, health effects, visibility & atmospheric chemistry

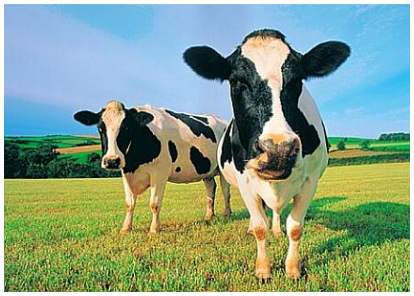
- Every raindrop has a particle as a nucleus
  - acidic particle → acid rain
- Health effects: lungs, cardiovascular system,…
- Visibility affects various forms of traffic
- Ozone destruction reactions on the surfaces of particles



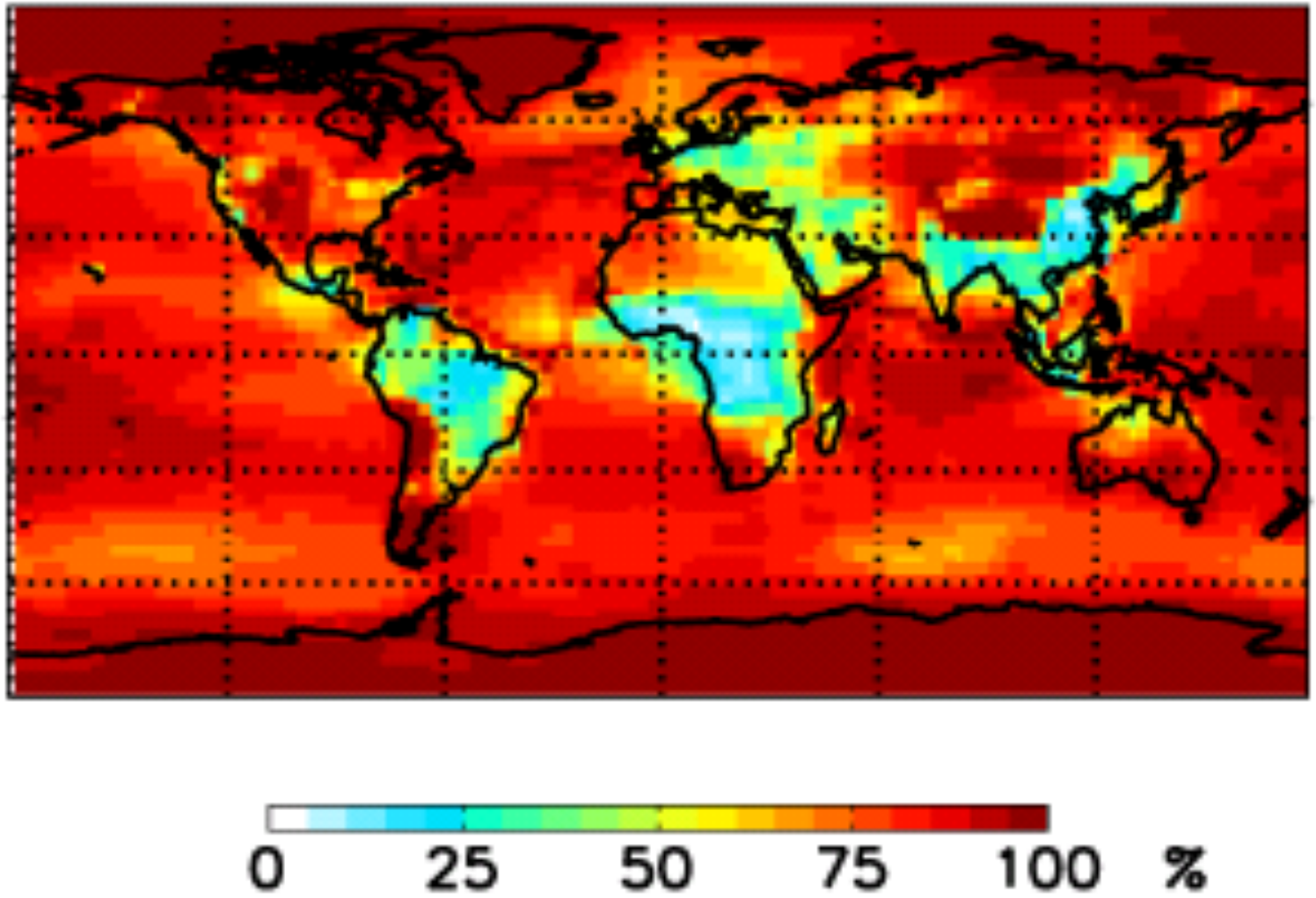
Particle sources

Nature
&
Human activities

Ready made particles
&
born from vapours

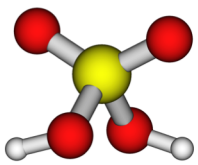


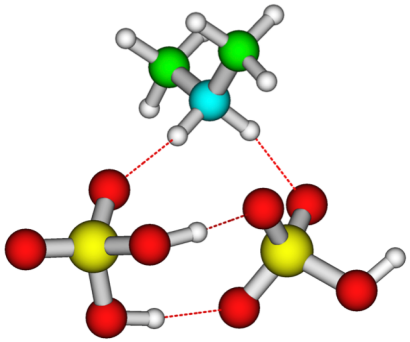
Particles born in the air



GLOMAP, Joonas Merikanto

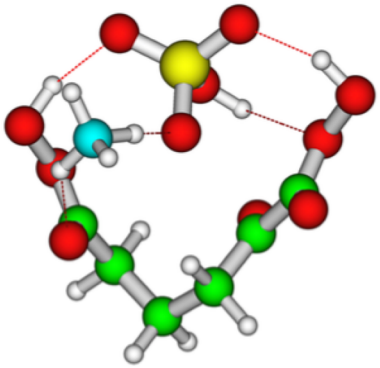
Sulphuric acid often a key compound in particle formation





Produced when sulphur containing compounds oxidize

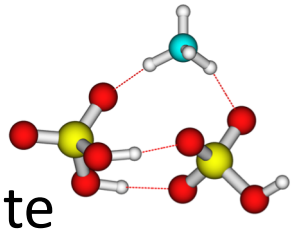
- fossil fuel, volcanoes and plankton
- one oxidation step from a gas happy in the gas phase to a gas very eager to turn to liquid or solid



$(C_6H_8O_7)(H_2SO_4)(NH_3)$

Need help from other vapours

- base compounds, ammonia and various amines
  - decomposing organisms, animal excreta, industry
- organic compounds

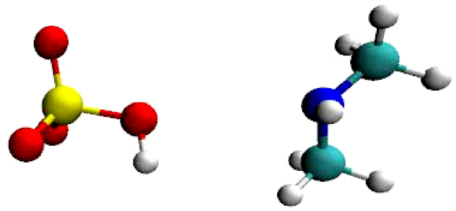


in some environments particles form without H_2SO_4

Sulphur containing particles cool the climate

Molecular dynamic simulations

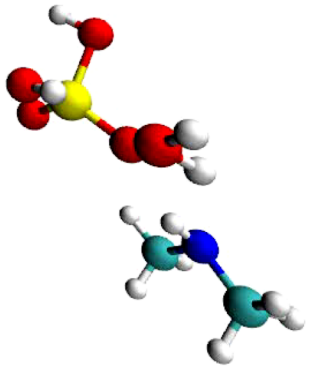
Sulphuric acid + dimethylamine 5 ps of simulation with a timestep of 0.5 fs



PBE-D3//aug-TZV2P, 400 Ry cut off, box 20Åx20Åx20Å /Ville Loukonen

Molecular dynamic simulations, now with water

Sulphuric acid + water + dimethylamine 7 ps of simulation with a timestep of 0.5 fs



PBE-D3//aug-TZV2P, 400 Ry cut off, box 20Åx20Åx20Å /Ville Loukonen

Constantinopol, May 1453

Constantinus XI

Hagia Sofia

- church 537-
- mosque 1453-
- museum 1934-

Mehmet the Conqueror

Constantinopol
Tambora
Kuwae
Suomi (Finland)
Sverige (Sweden)
Norge (Norway)
Россия (Russia)
Polska (Poland)
Deutschland (Germany)
Italia (Italy)
Türkiye (Turkey)
Монгол Улс (Mongolia)
中国 (China)
日本 (Japan)
대한민국 (South Korea)
العراق (Iraq)
ایران (Iran)
افغانستان (Afghanistan)
پاکستان (Pakistan)
India
ليبيا (Libya)
مصر (Egypt)
السعودية (Saudi Arabia)
ประเทศไทย (Thailand)
Niger
تشاد Tchad (Chad)
السودان (Sudan)
Nigeria
Ethiopia
Kenya
DR Congo
Tanzania
Angola
Namibia
Botswana
Madagasikara (Madagascar)
South Africa
Indian Ocean
Indonesia
Papua New Guinea
Australia
New Zealand

1815 Tambora eruption, Indonesia
1816 ‘year without summer’ in Northern hemisphere

Mary Shelley: Frankenstein

John William Polidori:
First ‘modern’ vampire story

+ Percy Bysshe Shelley and Lord Byron

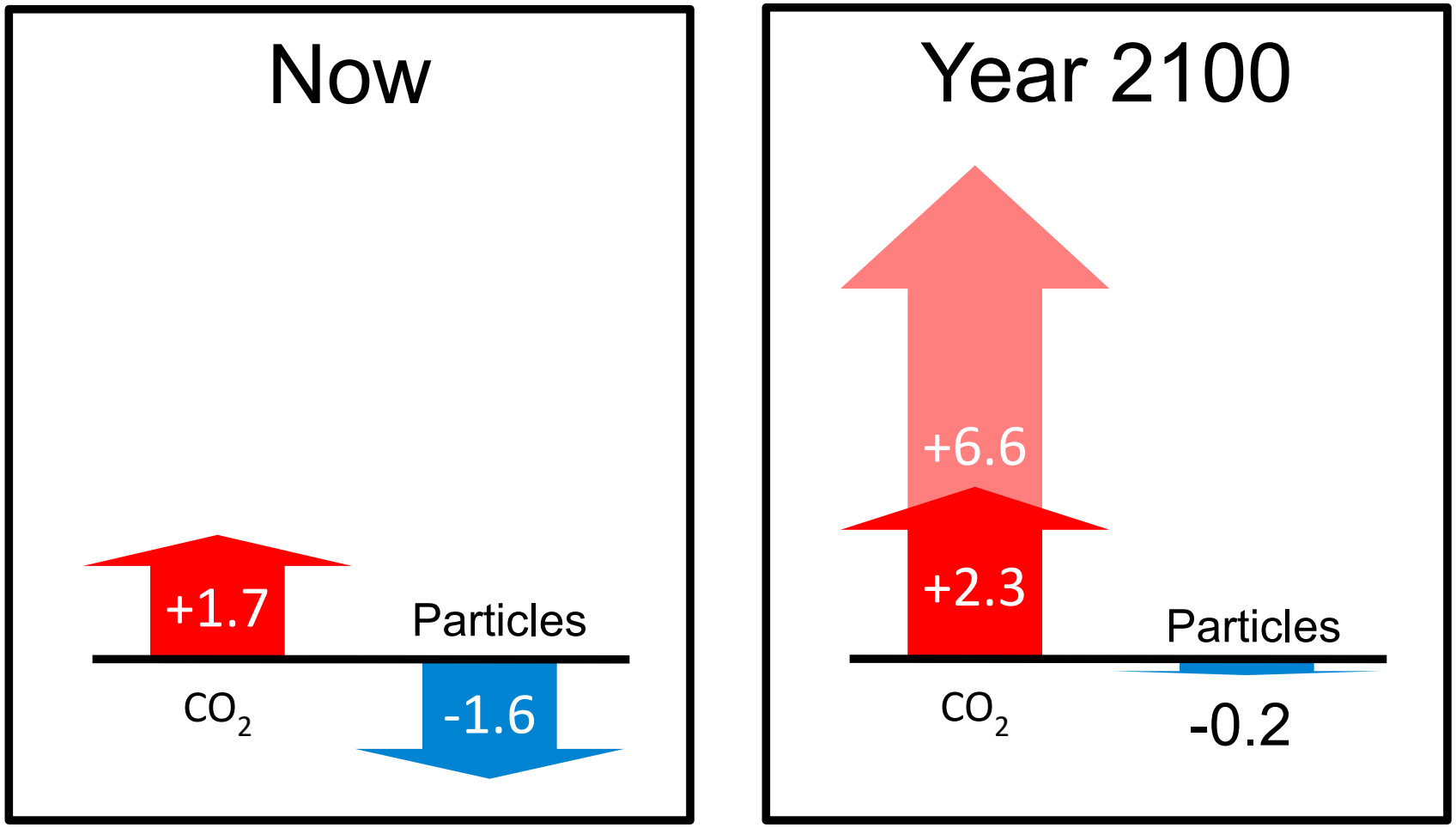
Chichester canal. J.M.W Turner (1828)

Acid rain

London Underground 1863 -

Wasa-ship in Stockholm: sank 1628, brought up 1961

Reduction in the particle concentrations: good for air quality, but removes a cooling effect



Warming/cooling effect of human activities W/m^2