Text exam ENV-320, Part Schmale

Question 1 (3 pnts)

Verify the following by showing all steps of your own calculation: The insolation in cloud-free conditions is about 1000 W m^{-2}, if the troposphere absorbs 50 % of it, then the tropospheric temperature will increase by 0.36 K h^{-1}.

Use the following values, while remembering that a Watt is defined as Joule per second:

- thickness of troposphere: 10 km
- average density of troposphere: 0.5 kg m^{-3}
- heat capacity of air: cp = 1005 J kg^{-1} K^{-1}

Question 2 (2 pnts)

Figure Q2 shows Earth's averaged outgoing longwave radiation. High clouds can be found along the equator, where the outgoing longwave radiation is relatively lower.

a) Explain in no more than 3 lines why high clouds are responsible for the relatively lower radiation (think of the Stefan-Boltzmann Law).

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b) Do high clouds cool or warm Earth?

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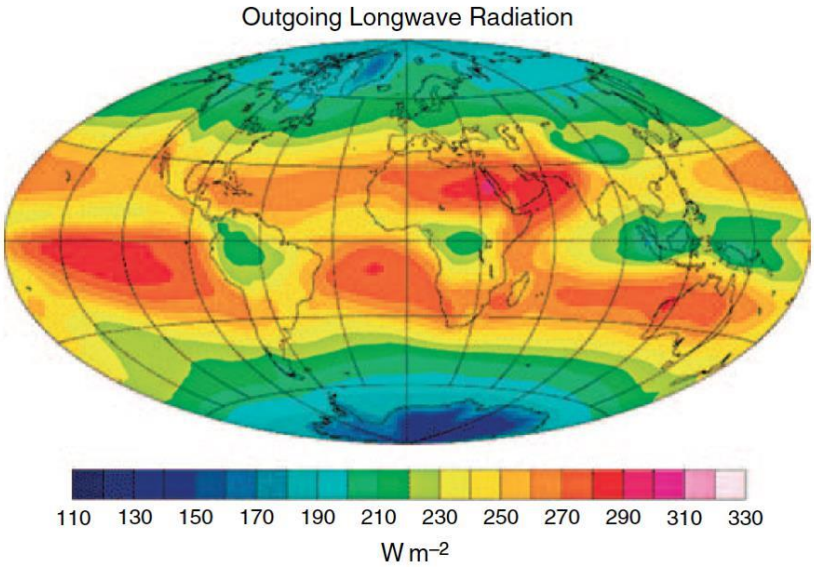

Figure Q2: Average outgoing longwave radiation from Earth in W m^{-2}.

Question 3 (2 pnts)

Why can sulfate aerosol, formed from SO_2 emitted from volcanoes into the stratosphere, remain there for years while the lifetime of sulfate aerosol in the troposphere is only several days? Answer in no more than 5 lines.

Question 4 (3 pnts)

a) Why is it so difficult to reduce ozone pollution in cities? Hint, make sure to include NO_x and VOCs in your argument. 5 lines

b) The rate of production of OH in the atmosphere depends on how $O(^1D)$ reacts further, i.e. it is quenched back to ground state or yields 2 OH from reaction with H_2O. The yield (εOH) can be calculated as in EQ1. Calculate εOH based on three different humidities, whereby ξH_2O = 0.0167*RH:

k_4	$2.2*10^{-10}$ cm^3 $molecule^{-1}$ s^{-1}
k_3	$2.9x10^{-11}$ cm^3 $molecule^{-1}$ s^{-1}
RH1	20 %
RH2	50%
RH3	80%

$$\varepsilon OH = \frac{2k_4 \xi H_2O}{k_3} \qquad \text{EQ1}$$

c) If our atmosphere were to become more humid, how would the lifetime of CH_4 with respect to OH change?

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Question 5 (1.5 pnts)

Figure Q5 shows two aerosol number concentration size distributions. Answer the following questions by focusing on the red boxes:

a) How many modes are there on 3 April?

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b) How many modes are there on 15 April?

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c) Are there more or less particles on 15 April compared to 3 April?

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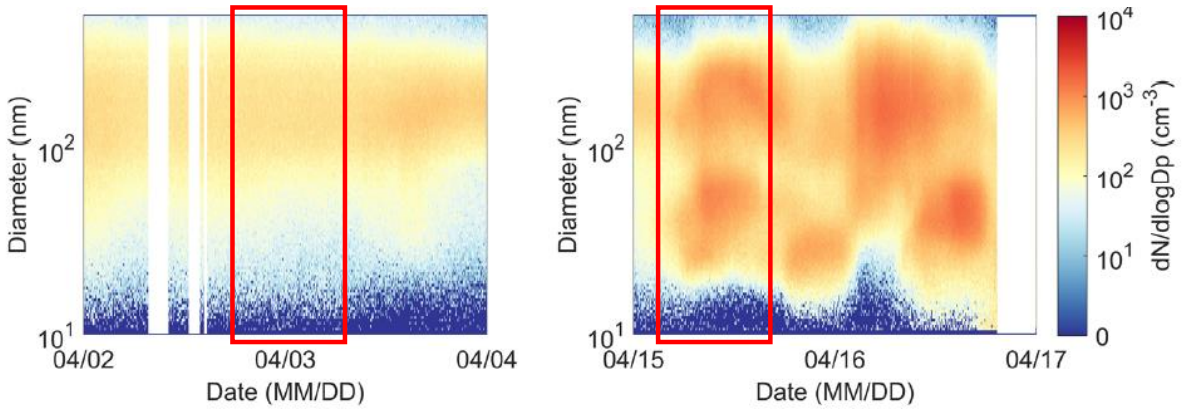

Figure Q5: Aerosol number concentration size distribution in the central Arctic in April 2020.