Atmospheric clustering, absorption and anti-greenhouse effect

To cite this article: A Galashev and Oksana Rakhmanova 2009 *IOP Conf. Ser.: Earth Environ. Sci.* **6** 282025

IOP Conf. Series: Earth and Environmental Science **6** (2009) 282025 doi:10.1088/1755-1307/6/8/282025

P28.19

Atmospheric clustering, absorption and anti-greenhouse effect

A Galashev, Oksana Rakhmanova

Institute of Industrial Ecology of Ural Branch of Russian Academy of Sciences, Yekaterinburg, Russian Federation

The Earth's atmosphere is a complex dynamic system, which protects the biosphere. One of the significant factors impacting Earth's radiation balance is the greenhouse effect. Its en-hancement is not only due to an increase in solar activity but also due to an increase in the con-tent of gases with pronounced radiation properties in the atmosphere. Water vapor and atmos-pheric gases, such as CO2, CH4, N2O, and others, have a decisive influence on the formation of thermal radiation fields. However, according to the Le Chatelier principle, there are opposite compensating proc-esses in the atmosphere. Clustering of greenhouse gases can be considered as one of these proc-esses. This work investigates the effect of a reduction of global temperature of the Earth's sur-face created by water clusters that form in the atmosphere. Currently there are several experi-mental works indicating the presence of an appreciable quantity of water clusters in the atmos-phere. The stability of water clusters that absorb molecules of other gases depends on the type and quantity of the attached molecules. In the troposphere water clusters are formed by vapor condensation as well as from the emissions of air-traffic. The essence of the antigreenhouse ef-fect is that due to clustering of the atmospheric water vapour, a huge number of the Earth's ra-diation absorption centres are lost. Thus a cluster as an uniform formation (one centre of absorp-tion) absorbs even less radiation energy than one water molecule. The antigreenhouse effect is defined as a difference of temperature changes created by water molecules that clusters consist of, and clusters themselves. Stability of water clusters in the atmosphere depends on the absorp-tion of the most widespread atmospheric gases by them ¨C i.e. nitrogen, oxygen, argon and carbon dioxide. The antigreenhouse effect can also be amplified because water clusters absorb the mole-cules of other greenhouse gases such as nitrous oxide, methane, ethane, and acetylene. Spectral characteristics of interaction with infrared radiation change due to atmospheric gas components¡¯ absorption. The process of X = {CO2, CH4, C2H6, N2O, N2, O2 molecules and O, Ar at-oms} absorption by water clusters is investigated by the molecular dynamics method. Water clusters were simulated using the improved interaction potential TIP4P for water and both rigid and flexible four-site models of the H2O molecules. The frequency spectra of dielectric permittivity for systems consisting of (H2O)n, (X)i(H2O)10, (X)i(H2O)20,, (X)1(H2O)n, (X)2(H2O)n clusters in the range 0 ¡Ü ¦Ø ¡Ü 3500 cm-1 are defined. The integral intensity of infrared radiation absorption decreases after the ab-sorption of oxygen and methane by water clusters and increases a little after the absorption of other greenhouse gases as well as nitrogen and argon (Fig.1). Moreover, absorption of nitrogen and argon causes some amplification of absorption by disperse systems of external infrared (IR) radiation in the field of frequencies determined by intramolecular vibrations. However, in this frequencies area there is an essential easing of the Earth's radiation. Absorption by cluster of almost all X mole-cules and atoms increases the power of their infrared radiation, but absorption of molecular oxygen and ethane reduces it. The clustering process is accompanied by the sharp reduction of a number of scattering centers. Amplification of integral absorption for disperse water systems containing dif-ferent atmospheric and greenhouse gases cannot compensate for these losses. Fig.2a (curve 1) shows the relative change in the integrated IR absorption intensity Itot upon the formation of the (H2O)20 cluster by means of successive addition of ¦¤n water molecules to the (H2O)2 dimer. Curve 2 re-flects the total relative intensity of the IR radiation absorption by the (H2O)10 cluster and five successively added dimmers, which combine to produce the (H2O)20 cluster. The introduction of hydrocarbon mole-cules can enhance the IR absorption by growing clusters (Fig.2b). The increase in Itot for water clusters combined with C2H2 and C2H6 molecules is 0.2-0.4 of the Itot value even at m>1, whereas, when wa-ter cluster is combined with CH4 molecules, such Itot values are achived at m>6. When one or two CH4 molecules are added to the (H2O)20 cluster, the antigreenhouse effect is enhanced since the relative integrated intensity of the IR absorption by the heterocluster decreases. However, finally, the incorpora-tion of hydrocarbon molecules in water clusters reduces the greenhouse effect due to a decrease in the number of absorbing centers. As a whole, the absorption of the main atmospheric and green-house gases by disperse water system causes the easing of the produced greenhouse effect which therefore causes an antigreenhouse effect.

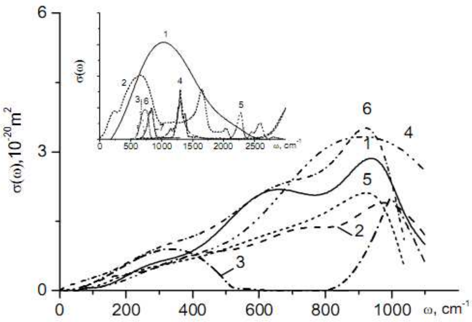

Fig.1. IR absorption spectra of systems: (*1*) – $(H_2O)_n$, (*2*) – $(CO_2)_i(H_2O)_{10}$, (*3*) – $(CH_4)_i(H_2O)_{10}$, (*4*) – $(N_2O)_i(H_2O)_{10}$, (*5*) – $(C_2H_2)_m(H_2O)_{20}$, (*6*) – $(C_2H_6)_m(H_2O)_{20}$, where $n = 10-20$, $i = 1-10$, $m = 1-6$. In the inset: 1 – the Earth's thermal radiation spectrum at 280 K, (*2-7*) – the experimental spectra of liquid water and gaseous CO_2, N_2O, CH_4, C_2H_2 and C_2H_6 respectively.

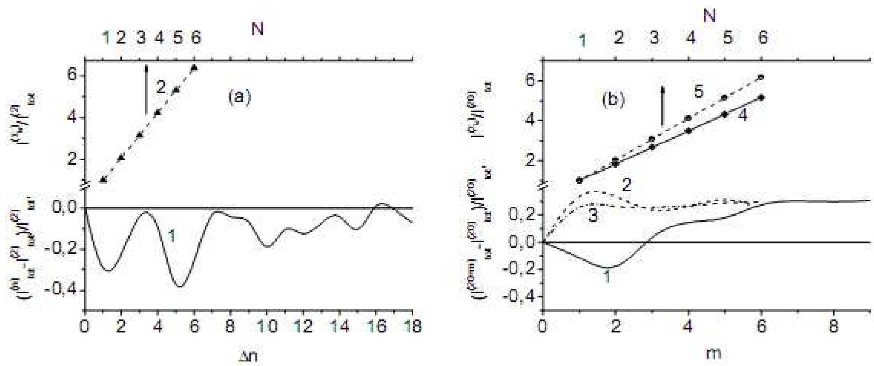

Fig.2. (a) Relative integrated intensity of the IR absorption by (*1*) the water dimmer that grows by adding Δn H_2O molecules and (*2*) total relative integrated intensity of absorption of N clusters: N_1 is $(H_2O)_{10}$ and $N_2 - N_6$ are $(H_2O)_2$ dimers; (b) relative integrated intensity of IR absorption by the $(H_2O)_{20}$ cluster adding m molecules of (*1*) – CH_4, (*2*) – C_2H_2, and (*3*) – C_2H_6 and total integrated intensity of absorption of N clusters: (*4*) – N_1 is $(CH_4)_8(H_2O)_{10}$ and $N_2 - N_6$ are $(H_2O)_2$ dimers; (*5*) – N_1 is $(CH_4)_3(H_2O)_{10}$ and $N_2 - N_6$ are $CH_4(H_2O)_2$ clusters.