

Global Climate Model with Three Entities

March 2021

Seppo Ruottu and Pertti Sarkomaa

Content

Nomenclature	2
References	4
Introduction	4
Summary	6
Errors of IPCC's climate models	7
Error 1: There is no experimental evidence on existence of cloud feedbacks.....	7
Error 2: Cloud feedbacks do not exist.....	7
Error 3: IPCC's climate models calculate global surface temperature all wrong.....	7
Error 4: Quantities of climate change each other.....	7
Error 5: IPCC has understood correlation between global warming and clouds all wrong.....	7
Error 6: IPCC's climate models are 1-entity models.....	8
Error 7: Cloud feedback is a logical plunder	8
Plunder 1	8
Plunder 2	8
Error 8: Global surface temperature is argument of itself	8
Error 9: CO ₂ concentration, global surface temperature and clouds are arguments of each other ..	8
Error 10: IPCC's climate models are time dependent.....	8
Theory	9
Physical foundations of the model	9
Balance Equations of Global Climate	9
Compound Balances of Entities of the Atmosphere	9
Number balance equations of discrete entities.....	11
Momentum balance equations	11
Energy balances of the entities of the atmosphere	11
Energy balance of the surface of the ground.....	12
Energy Balance of Boundary Between Gas and Droplet.....	12
Numerical Calculations.....	13
Results.....	13

Linear emission coefficients of thermal radiation.....	13
Linear reflection and absorption coefficients of solar radiation	14
Intensities of solar radiation	14
Net energy flow densities in the atmosphere	15
Global surface temperatures.....	16
Net energy fluxes and temperatures of the surface of the ground	17
Temperature differences between droplet boundary and surrounding gas	18
Annual rain and volume fractions of clouds	18
Droplet densities and fluxes.....	19
Diameters and velocities of droplets.....	20

Nomenclature

A_d''' =droplet area density in the atmosphere (m^{-1})

Am_{sr} =molar reflection area of solar radiation of liquid water (m^2mole^{-1})

c_{dw} =coefficient of nucleation correlation (s^{-1})

d_d =droplet diameter (m)

D_d =diffusion coefficient in droplet entity d (m^2s^{-1})

D_g =diffusion coefficient of entity g (m^2s^{-1})

E_{ab} = irradiation from entity a to boundary b (W^1m^{-2})

E_{eb} = irradiation from entity e to boundary b (W^1m^{-2})

E_{gb} =irradiation from gas to boundary b (W^1m^{-2})

E_{db} = irradiation from droplet to boundary b (W^1m^{-2})

h_{ab} = heat transfer coefficient from entity a to boundary b ($W^1m^{-2}^{\circ}C^{-1}$)

h_{eb} = heat transfer coefficient from entity e to boundary b ($W^1m^{-2}^{\circ}C^{-1}$)

$h_{gb} = N_{ug} \lambda_g / d_d$ =heat transfer coefficient from entity g to boundary b ($W^1m^{-2}^{\circ}C^{-1}$)

$H_{mce}(T_b)$ = molar enthalpy of compound c of entity e at temperature T_b (J^1mole^{-1})

$H_{mca}(T_b)$ = molar enthalpy of compound c of entity e at temperature T_b (J^1mole^{-1})

$H_{mwg}(T_b)$ =molar enthalpy of gaseous water at temperature T_b (J^1mole^{-1})

$H_{mwd}(T_b)$ =molar enthalpy of liquid water at temperature T_b (J^1mole^{-1})

H_{wdg} =mole density ratio of compound w of boundary b between entities d and g (-)

K_{wgd} = compound transfer coefficient of compound w from entity g to entity d (m^1s^{-1})

K_{wdg} = compound transfer coefficient of compound w from entity d to entity g (m^1s^{-1})

$L_{mwg}(T_b) = H_{mwg}(T_b) - H_{mwd}(T_b)$ =molar enthalpy difference of water of boundary b (J^1mole^{-1})

M_{ab} = exitance from boundary b to entity a (W^1m^{-2})

M_{eb} = exitance from boundary b to entity e (W^1m^{-2})

M_{gb} =exitance from boundary b to entity g (W^1m^{-2})

M_{db} = exitance from boundary b to entity d (W^1m^{-2})

M_w =mole mass of water (kg^1mole^{-1})

n_{wg} = mole density of compound w of entity g (mole/m³)

n_{wd} = mole density of compound w of entity d (mole/m³)

n_d =droplet density of balance volume (m^{-3})

n_{wg} =mole density of water of entity g ($mole^1m^{-3}$)

\dot{N}''_{ceb} = mole flux of compound c from entity g to entity d ($mole^1m^{-2}s^{-1}$)

\dot{N}''_{wgd} = mole flux of water from entity g to entity d ($mole^1m^{-2}s^{-1}$)

$\dot{N}'''_d = c_{dw}n_{wg}$ =droplet source density ($m^{-3}s^{-1}$)

Nu_{gb} = Nusselt number of entity g of boundary b (-)

Sh_{gb} =Sherwood number of entity g of boundary b (-)

Sh_{db} =Sherwood number of entity d of boundary b (-)

T_a = temperature of entity a (°K)

T_b =temperature of boundary b (°K)

T_e = temperature of entity e (°K)

T_g = temperature of entity g (°K)

z = altitude (m^1)

v_{rd} =vertical droplet velocity (m^1s^{-1})

α_{gb} =absorption ratio of gas side of droplet boundary b (-)

ε_{gb} =emission ratio of gas side of droplet boundary b (-)

$\kappa_{bg} = \kappa_{gb}$ = compound transfer coefficient from entity g to the boundary b between entities g and d (m^1s^{-1})

$\kappa_{db} = \kappa_{bd}$ = compound transfer coefficient from entity d to the boundary b between entities g and p (m^1s^{-1})

ρ_d = mass density of droplets (kg^1m^{-3})

ρ_{se} = reflection ratio of solar radiation of the globe (-)

References

- (1) Climate Change 2013 - The Physical Science Basis - Summary for Policymakers, Technical Summary and Frequently Asked Questions
- (2) Mark D. Zelinka, David A. Randall, Mark J. Webb and Stephen A. Klein, Clearing clouds of uncertainty, NATURE CLIMATE CHANGE | VOL 7 | OCTOBER 2017 |
- (3) https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf
- (4) www.perttisarkomaa.fi/files/pertti.sarkomaa.ota.fi/climate/climate_change_and_use_of_fossil_fuels.pdf
- (5) Gröberg, Erk, Grigul: Grundgesetze der Wärmeübertragung, Springer 1955.
- (6) Kunii-Levenspiel: Fluidization Engineering, John Wiley & Sons, Inc., New York.London.Sydney.Toronto, 1962
- (7) W.Siebert: Zusammensetzung der von Werk und Baustoffen zurückgeforderten Wärmestrahlung. Tech. Physik, Vol 22, 1941
- (8) BP Statistical Review of World Energy 2019
- (9) Email discussions between Sectary-General of WMO Professor Petteri Taalas, General Director of FMI Professor Jussi Kaurola, Academic Markku Kulmala, Professor Ari Laaksonen, Professor Timo Vesala, Editor in chief Jouko Jokinen, President Sauli Niinistö, Professor Pertti Sarkomaa, Professor Seppo Ruottu. 18.02.2021 ... 1.3.2021

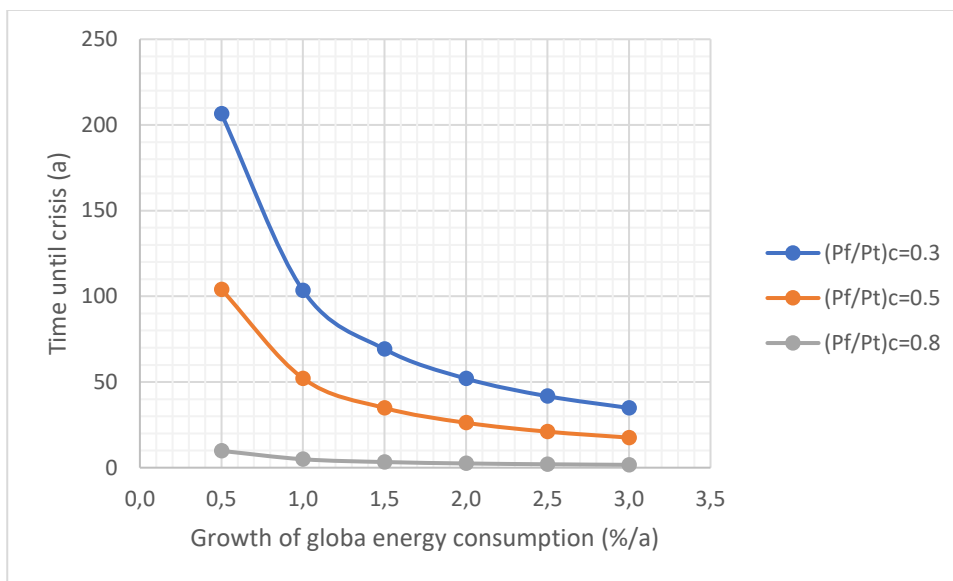
Introduction

IPCC was established in 1988 by the United Nations' bodies WMO and UNEP to prove the dogma that increase of CO₂ concentration in the atmosphere causes for mankind destructive increase of global surface temperature (hence forward Dogma). Dogma is based on assumption that *Subtle changes in cloud properties that accompany anthropogenic warming — cloud feedbacks — can strongly amplify or dampen that warming* (2).

The citate shows that even sign of cloud feedback is not known, existence of cloud feedback has not been verified empirically and conservation laws of physics categorically deny existence of cloud feedbacks so, cloud feedbacks do not go to physics but to religion. On pages 6...8 of this Report, ten by common sense understandable errors of IPCC's climate models have been shown each of which proves that Dogma is all wrong. Since the discussions of reference (9) WMO has known that Dogma is wrong. Because WMO still supports Dogma WMO misleads governments and citizens of its member states.

Dogma has caused enormous economic and egologic damage among others

1. by causing demolishing of energy technically necessary fossil power plants which increase photosynthesis of the ecosystem
2. by replacing them by billions of euros energy technically invalid and ecologically useless wind turbines
3. by distorting by legislation and political guidance competition between energies and technologies
4. by guiding R&D to economically and ecologically invalid projects
5. by distorting liberty of scientific research by funding which is reserved only for the Dogma supporting research
6. by emissions trade which can be parallelized with indulgence trade and by gigantic “carbon footprint” business which has no influence on climate
7. by causing worldwide angst of ignorant children and young people like Greta Thunberg who categorically believe in IPCC.



The global aim at replacing fossil energy is based on Dogma. Energy production of nuclear, wind and solar power plants cannot be matched with consumption of energy, so power grids need adjustable power which is presently based on fossil energy. The difference of power production which cannot be adjusted and power consumption of power grid P_t must be produced by adjustable power P_f . When present ratio P_f/P_t , critical power ratio $(P_f/P_t)_c$, annual growth of P_t are known, it is possible to calculate time until power grid ends up in crisis because of insufficiency of adjustable power. These calculations are presented by the above figure. During the previous 25 years global energy consumption has increased about 2% per year and from 2017 to 2018 about 2.4% (8). Presently $P_f/P_t=0.85$ and critical ratio $(P_f/P_t)_c=0.3\dots0.5$. By present growth of energy consumption times until global energy crises are 25...50 years.

Crisis can be delayed by increasing use of fossil fuels which aggravates the crises. The crisis is inevitable at the latest when fossil fuels deplete. Then sustainable global energy consumption is determined by global net growth of biomass. At each amount of carbon in the cycle of nature there is a CO_2 -concentration of the atmosphere which maximizes global net growth of biomass. To mitigate the crisis mankind must aim at 1) stopping growth of energy consumption 2) such use of fossil fuels and biomass which maximizes global net growth of biomass when fossil fuels deplete. When carbon of presently known fossil fuels has been recycled to the cycle of nature present global

power consumption can be replaced sustainably by the increase of photosynthesis of the ecosystem. So, the aim to stop use of fossil fuels by the year 2050 is senseless, unrealistic, and destructive for mankind and the ecosystem.

IPCC does not guarantee correctness of its information and by disclaimer of its website IPCC releases itself and accordingly WMO from legal responsibility of consequences of use of their false information but WMO and IPCC cannot release themselves from moral responsibility of their wrong information.

Summary

All quantities of global climate are determined by the surroundings of the atmosphere whereupon CO₂-concentration of the atmosphere, global surface temperature and clouds of global climate do not change each other, whereupon Dogma is per se all wrong. In the following chapter ten physically and mathematically undisputable errors of IPCC's climate models has been set out each of which makes that Dogma is all wrong. Errors 1 and Error 2 prove that Dogma is not based on physics but on beliefs. World Meteorological Organization does not deny Errors 1 ... 10 (9).

SRclimate model of reference (4) was updated to calculate droplet temperatures, droplet velocities, droplet diameters, water transfer between gas and droplets, volume fraction of droplets, droplet densities, droplet fluxes by applying the balance axiom and thermodynamics. In this research number of droplet and particle entities was limited to 1. Most part of thermodynamic parameters were found from published literature. The missing parameters were determined as follows.

1. Time mean vertical convective mixing velocities of gas entity were determined by matching global mean temperatures of the atmosphere at CO₂ concentration 300 ppm with temperatures of standard atmosphere.
2. It was assumed that nucleation rate of droplets is proportional to mole density of water vapor, so droplet source was calculated by equation $\dot{N}_d''' = c_{dw}n_{wg}$. Coefficient $c_{dw} = 1.54 \text{ mole}^{-1}\text{s}^{-1}$ was determined by matching calculated global annual rain with empirical data.
3. Molar absorption area of solar radiation of droplets $A_{msr} = 0.65 \text{ m}^2\text{mole}^{-1}$ was determined by matching solar radiation intensity to the ground with empirical data.
4. Reflection ratio of solar radiation of the ground $\rho_{se} = 0.2$ was determined by matching calculated net absorption of solar radiation on the ground with empirical data.
5. Difference of emission and absorption ratios of gas side of droplet boundary $(\varepsilon_{gb} - \alpha_{gb}) = \rho_{gb} = 0.15$ was estimated by matching calculated droplet densities with empirical data.

The updated SRclimate model calculates correctly, within uncertainty of experimental data, all quantities of gas, droplets, and particles of present global climate (figures and tables 1 ... 10) and responds logically to all changes of the surroundings of the atmosphere. This is scientifically undisputable proof that physical and mathematical foundations of the updated SRclimate model are correct.

Change of CO₂-concentration of the atmosphere of global climate does not change global surface temperature but they have causal correlation. This correlation was studied as follows. First physical parameters of items 1 - 5 were determined to produce correct global climate in surroundings of the atmosphere where CO₂ concentration of the atmosphere was 300 ppm. Then global climate was calculated in otherwise same surroundings but whose amounts of fossil fuels and biomass have changed so that CO₂ concentration of the atmosphere increases to 600 ppm. Calculations prove that

influence of the mentioned change on all other quantities of global climate would be so small that they could not be detected empirically.

Errors of IPCC's climate models

Thermodynamics is the field of physics which forms the theoretical foundation of mathematical modelling of climate. The following 10 errors of IPCC's climate models prove unfathomable ignorance of thermodynamics. Particularly *Cloud feedbacks* which in IPCC's climate models determine global warming. Each of the following by common sense understandable errors of IPCC's climate models prove that Dogma is all wrong.

Error 1: There is no experimental evidence on existence of cloud feedbacks.

Only empirically verified quantities and their interactions go to physics. Because cloud feedbacks have not been verified empirically cloud feedbacks and the cloud feedbacks exploiting Dogma do not go to physics but to religion.

Error 2: Cloud feedbacks do not exist.

Reference (2) defines cloud feedbacks as follows “*Subtle changes in cloud properties that accompany anthropogenic warming — cloud feedbacks — can strongly amplify or dampen that warming*”. This fully indefinite definition unveils unfathomable misunderstanding of meteorological society. All quantities of the atmosphere are continuous functions of time, so they change simultaneously not successively. Momentary changes are products of momentary changing rates and differential time. Conservation laws of physics state that only present quantities exist so, the momentary changing rates are only functions of present quantities whereupon cloud feedbacks do not exist.

Error 3: IPCC's climate models calculate global surface temperature all wrong.

Energy balance of surface of the ground states that ***energy flow to – energy flow from the surface of the ground = 0***. This physical condition which has been expressed mathematically in equation (3.3) determines global surface temperature. Because the energy flows are functions of present quantities, calculation of surface temperature of the ground by retroactive cloud feedbacks proves unfathomable physical backwardness.

Error 4: Quantities of climate change each other

All quantities of climate are determined by quantities of the surroundings of the atmosphere – the oceans, the biomass, the earth, the atmosphere surrounding universe. So, quantities of climate have causal correlations, but they do not change each other.

Error 5: IPCC has understood correlation between global warming and clouds all wrong

Clouds and global surface temperature of climate do not change each other but they have the following causal correlation: When global surface temperature increases, global vaporization of water increases whereupon global condensation and rain increase everywhere in the global atmosphere. When global cloudiness increases global reflection of solar radiation increases whereupon global solar radiation on the ground decreases. When global surface temperature decreases the correlation is the opposite. So, clouds do not “strongly amplify or dampen” but oppose all changes of global surface temperature.

Clouds play dominant role in the energy balance of the surface of the ground. Because the meteorological society understands the correlation between clouds and global surface temperature all wrong, it understands the correlation between CO₂-concentration of the atmosphere and global surface temperature all wrong.

Therefore IPCC claims absurdly that due to cloud feedback *"increase of CO₂ concentration from 300 ppm to 600 ppm would increase global surface temperature by 2-5 °C"* (1)(2)(3) and that *"removal of CO₂ from the atmosphere would plunge the Earth into a frozen state"* (3).

By selection of cloud feedback any global warming or cooling can be obtained for same change of CO₂ concentration. IPCC's Dogma is based on strongly positive cloud feedbacks (+0.007...+0.017 °C/ppmCO₂). Because IPCC does not know sign of cloud feedback (1)(2)(3), Dogma is IPCC's lie which IPCC's power, which is based on terror, demands.

Error 6: IPCC's climate models are 1-entity models.

Necessary and sufficient information for calculation of quantities of gas, droplets, and particles (hence forward Entities) of the atmosphere are the Balance Axioms of quantities of Entities of balance volumes of the atmosphere and their boundaries. These equations for global climate are presented in equations (1.1) ... (3.5). Because from IPCC's climate models the mentioned equations are missing, by IPCC's climate models calculated quantities of the atmosphere do not realize the Balance Axioms of quantities whereupon they are all wrong.

Error 7: Cloud feedback is a logical plunder

Plunder 1

Cloud feedback causes that influence of CO₂ on global surface temperature is not determined by CO₂ but by cloud feedback.

Plunder 2

Correct cloud feedback can be calculated only if correct global climate is known whereupon cloud feedback is not needed.

Error 8: Global surface temperature is argument of itself

In IPCC's climate models - via cloud feedback - global surface temperature is argument of itself, whereupon global surface temperature of IPCC's climate models does not have solution. Therefore, by selection of cloud feedback any global warming or cooling can be obtained for same change of CO₂ concentration as shown by IPCC's claims of chapter Error 5.

Error 9: CO₂ concentration, global surface temperature and clouds are arguments of each other

CO₂ concentration, global surface temperature and clouds of global climate are determined by the surroundings of the atmosphere whereupon CO₂ concentration, global surface temperature and clouds of global climate are not arguments of each other.

Error 10: IPCC's climate models are time dependent.

When influence of change of surroundings of the atmosphere on global climate is studied, global climate must be calculated in reference and changed surroundings assuming that both surroundings are independent of time. In time independent surrounding physical quantities of the atmosphere adopt steady state which must be calculated by time independent steady state balance equations. It

is per se senseless to calculate time independent quantities by time dependent equations. It leads inevitably to wrong results because influence of increase of CO₂ concentration on changing rate of local momentary surface temperature is less than $6.7 \cdot 10^{-7}$ in comparison with changing rate due to other factors. So, IPCC's climate models are per se mathematically all wrong.

Theory

Physical foundations of the model

All quantities of climate are determined by surroundings of the atmosphere -the earth, the oceans and the atmosphere surrounding universe. When climate is defined for period of hundreds of years it is determined primarily by the earth and the atmosphere surrounding universe. For period of 30 years climate is strongly influenced also by the oceans. For example, reported reduction of arctic ice cloud be due to changes of oceanic streams.

SRclimate model was derived as follows. The atmosphere was subdividing into balance volumes, balance equations of global climate were written for numbers, compounds, momentum and energy of gas, droplets, and particles (Entities) of the balance volumes and boundaries of the balance volumes and the Entities. Flows of the balance volumes and the boundaries were calculated by thermodynamic transfer equations. Mathematically SRclimate model is a group of algebraic equations. Arguments of the equations are quantities of the Entities of the balance volumes and the surroundings of the atmosphere. When quantities of the surroundings of the atmosphere are known, SRclimate model determines uniquely all quantities of climate.

Without significant error it can be assumed that droplet and particle entities change compounds, momentum, and energy only with gas entity. It is reasonable to assume that nucleation rate of droplets is proportional to mole density of water vapor. After nucleation droplets, due to condensation of water, grow when falling downwards. Condensation is calculated by basic principles of compound transfer. Velocity of droplets are calculated by verified terminal velocity correlations.

It is reasonable to assume that inside clouds relative humidity is 1. According to the 1. and 2. laws of thermostatics, condensation of water on droplets demands that surface temperature of droplet is smaller than temperature of the surrounding gas. Surface temperatures of droplets are calculated by energy balances of droplet boundaries. Temperature differences between droplets and surrounding gas are assumed to be primarily due to that emission ratio of thermal radiation of droplets, due to reflection, is larger than absorption ratio.

In this research disintegration of droplets was neglected. Mass flows of droplet entity is calculated by mass balance and number flows by number balance of droplet entity which together determine diameters of droplets.

Influence of changes of amounts of fossil and organic carbon on CO₂-concentration of the atmosphere was calculated by SRcompound model of reference (4).

Balance Equations of Global Climate

Compound Balances of Entities of the Atmosphere

Amount of liquid water - clouds - in the atmosphere is negligible in comparison with water of the oceans, so it does not need to be included in entities of the ecosystem. However, because of its

crucial importance on radiation in the atmosphere it must be included in entities of the atmosphere. Momentary global balance of compound c of entity p of the atmosphere is.

$$\frac{\partial n_{pc}}{\partial t} = -\frac{\partial}{r^2 \partial r} (r^2 \dot{N}_{rcp}'') + \sum_{e=1}^{N_p} \dot{N}_{cep}''' + \sum_{r=1}^{N_r} v_{cr} \dot{R}_{rp}''' \quad (1.1)$$

$$c = 1 \cdots N_c, p = 1 \cdots N_e,$$

Compound amounts of entities of the ecosystem change so slowly that for time ranges of climate, changing rate of equation (1.1) is negligible in comparison with flows of compounds. Without significant error it can be assumed that reaction terms of compound balances (1.1) are negligible, that the only significant compound flow between entities is flow of water between entity gas and droplet entities. By neglecting convective mixing of droplets compound balance of compound w of droplet entity d is

$$0 = -\frac{\partial}{r^2 \partial r} (r^2 \varepsilon_d n_{wd} v_{rd}) + \dot{N}_{wgd}''' \quad (1.2)$$

Accounting that $\varepsilon_d = n_d \pi d_d^3 / 6$ equation (1.2) can be written as

$$0 = -\frac{\partial}{r^2 \partial r} (r^2 n_d \pi d_d^3 / 6 n_{wd} v_{rd}) + \dot{N}_{wgd}''' \quad (1.3)$$

n_d = droplet density (m⁻³)

n_{cw} = density of liquid water (m⁻³)

d_d = diameter of droplet (m)

v_{rd} = vertical velocity of droplet

Mole flow of compound w from entity g to entity d per surface of the ground (mole⁺¹s⁻¹m⁻²) is

$$\dot{N}_{wgd}''' = A_{gd}'' \frac{\kappa_{gb}}{1 + H_{wgd} \kappa_{gb} / \kappa_{bd}} (n_{wg} - n_{wd} H_{wgd}) \quad (1.4)$$

A_{gd}'' = surface between entity g and d (m⁺²) per surface of the ground (m⁺²)

n_{wg} = mole density of compound w of entity g (mole⁺¹m⁻³)

n_{wd} = mole density of compound w of entity d (mole⁺¹m⁻³)

$\kappa_{db} = \kappa_{bd}$ = compound transfer coefficient from entity d to boundary b (m⁺¹s⁻¹)

$\kappa_{gb} = \kappa_{bg}$ = compound transfer coefficient from entity g to boundary b (m⁺¹s⁻¹)

$H_{wgd} = n_{wgb} / n_{wdb}$ = Henry coefficient of water on boundary between entities g and d

$\kappa_{gb} = Sh_{gb} D_d / d_d$ = compound transfer coefficient from entity g to boundary b = κ_{bg}

Sh_{gb} = Sherwood number of entity g of boundary b

$$Sh_{gb} = 2 + 0.6 Re_{gb}^{0.5} Sc_g^{0.333} \quad (5)$$

$\kappa_{db} = Sh_{db} D_d / d_d$ = compound transfer coefficient from entity d to boundary b = κ_{bd}

Sh_{db} = Sherwood number of entity d of boundary b

$H_{wgd} = 1.98 \cdot 10^5 e^{-5112/T_b}/T_b$ = mole density of water in gas entity g /mole density of water in droplet entity d on boundary between the entities.

Boundary condition of equation (1.4) is $d_d(H_{max}) = n_d(H_{max}) = 0$.

Number balance equations of discrete entities

Number balance of droplet entity d is

$$0 = -\frac{d}{r^2 dr} [r^2(n_d v_{rd})] + \dot{N}_d''' \quad (1.5)$$

$\dot{N}_d''' = c_{dw} n_{wg}$ =rate of droplet nucleation per volume ($m^{-3}s^{-1}$)

$d = 1 - N_d$

Boundary condition of equation (1.5) is $n_d(H_{max}) = 0$.

Momentum balance equations

In the atmosphere molecular diffusion of momentum is negligible whereupon vertical momentum balance of entity p is

$$\frac{\partial \varepsilon_p \rho_p v_{rp}}{\partial t} = -\frac{\partial r^2(\varepsilon_p \rho_p v_{rp} v_{rp})}{r^2 \partial r} - \varepsilon_p \frac{\partial p}{\partial r} + \sum_{e=1}^{N_e} M_{ep}''' (v_{re} - v_{rp}) + \varepsilon_p \rho_p g_r \quad (2.1)$$

For time ranges of climate changing rates of momentum are negligible in comparison with the momentum flows and the only significant momentum flows of droplets are momentum flow from gas entity and from the globe (gravity). When in addition $v_{rg} = 0$ equation (2.1) simplifies to

$$v_{rd} = \varepsilon_d \rho_d g_r / M_{gd}'''$$

$M_{gd}''' =$ momentum transfer coefficient between entities g and d ($kg^+1m^{-3}s^{-2}$)

$\varepsilon_d =$ volume fraction of entity d

$\rho_d =$ mass density of entity d (kg^+1m^{-3})

$g_r =$ acceleration of gravity in direction of radius (m^+1s^{-2})

In range $0.4 < R_{ed} < 500$

$$v_{rd} = -\left[1.7(\rho_d - \rho_g)^2 / \rho_g / \mu_g\right]^{1/3} d_d \quad (6) \quad (2.2)$$

Energy balances of the entities of the atmosphere

For time ranges of climate changing rates of amount of energy is negligible in comparison with flows of energy where upon global energy balance of entity e is

$$0 = -\frac{\partial}{r^2 \partial r} \left[r^2 \left(E_{re}'' + \sum_{c=1}^{N_c} \dot{N}_{ce}'' H_{mec}(T_e) \right) \right] \quad (3.1)$$

$\dot{N}_{ce}'' =$ vertical mole flux of compound c of entity e

$E_{re}'' =$ net vertical irradiation of entity e (W^+1m^{-2})

$H_{mce}(T_e)$ = molar enthalpy of compound of entity e ($J^{+1}mole^{-1}$)

T_e = temperature of entity ($^{\circ}K$)

By summing equations (3.1) over all entities and by assuming that temperature differences between entities are negligible

$$0 = -\frac{\partial}{r^2 \partial r} [r^2 (E_r'' + \sum_{e=1}^{N_e} \sum_{c=1}^{N_c} \dot{N}_{ec}'' H_{mec}(T))] \quad (3.2)$$

E_r'' = net vertical irradiation ($W^{+1}m^{-2}$)

Energy balance of the surface of the ground

Global surface temperature T_b is determined by energy balance of the surface of the ground

$$h_{eb}(T_e - T_b) + \sum_{c=1}^{N_c} \dot{N}_{ceb}'' (H_{mce}(T_b) - H_{mca}(T_b)) + E_{eb} - M_{eb} + h_{ab}(T_a - T_b) + E_{ab} - M_{ab} = 0. \quad (3.3)$$

where e refers to the globe and a to the atmosphere.

Energy Balance of Boundary Between Gas and Droplet

Without significant error it can be assumed that only water penetrates from gas to droplet entities. Because energy does not accumulate to boundary b , energy balance of boundary b is (4)

$$h_{gb}(T_g - T_b) + \dot{N}_{wgb}'' H_{mwg}(T_b) + E_{gb} - M_{gb} + h_{db}(T_d - T_b) + \dot{N}_{wdb}'' H_{mwd}(T_b) + E_{db} - M_{db} = 0 \quad (3.4)$$

From steady state energy balance of a single droplet it follows

$$\frac{d \sum_{c=1}^{N_c} N_{cd} U_{mcd}}{dt} = \sum_{c=1}^{N_c} \dot{N}_{cbd} H_{mcd} + E_{db} - M_{db} + h_{db}(T_d - T_b) = 0$$

From steady state compound balance of a single droplet it follows

$$\frac{dN_{cd}}{dt} = \dot{N}_{cbd} = 0$$

By combining these equations, we get

$$E_{db} - M_{db} + h_{db}(T_d - T_b) = 0$$

By accounting that

$$\dot{N}_{wgb}'' + \dot{N}_{wdb}'' = 0,$$

$$M_{gb} = \varepsilon_{bg} M_{mb} + (1 - \alpha_{bg}) E_{gb},$$

$$E_{gb} \cong M_{mb}$$

energy balance of boundary b simplifies to

$$h_{gb}(T_g - T_b) + \dot{N}_{wgb}'' L_{mwg}(T_b) - (\varepsilon_{bg} - \alpha_{gb}) M_{mb} = 0 \quad (3.5)$$

$h_{gb} = Nu_{gd} \lambda_{gb} / d_d$, Nu_{gd} = Nusselt number of entity g of droplet entity d

$$Nu_{gd} = 2 + 0.6 Re_g^{0.5} Pr_g^{0.333} \quad (5)$$

T_g =temperature of gas, T_b = temperature of droplet boundary

Numerical Calculations

The atmosphere was divided into 5 lateral balance layers. Equations (1.2), (1.5), (2.2) were solved by SRclouds model which was combined with SRclimate model of reference (4). Quantities of global climate were calculated by SRclouds model as functions of temperatures of the atmosphere and used as initial values for calculations of new temperatures by SRclimate model. Simultaneous solutions of both models were obtained by method of successive substitutions.

Results

Linear emission coefficients of thermal radiation

Table 1 Linear emission coefficients (1/m) of thermal radiation in the atmosphere at CO₂ concentration 300 ppm and 600 ppm as functions of altitude z (km).

z/km	CO2(300)	H2O(300)	Droplets(300)	Particles(300)	Total(300)	CO2(600)	H2O(600)	Droplets(600)	Particles(600)	Total(600)
0	3.76E-04	1.94E-02	3.31E-03	4.00E-05	2.32E-02	7.52E-04	1.92E-02	3.33E-03	4.00E-05	2.34E-02
1	3.31E-04	1.32E-02	1.72E-03	4.35E-05	1.53E-02	6.61E-04	1.32E-02	1.74E-03	4.35E-05	1.57E-02
3	2.74E-04	5.74E-03	3.76E-04	5.05E-05	6.44E-03	5.46E-04	5.84E-03	3.91E-04	5.05E-05	6.83E-03
5	2.22E-04	2.29E-03	4.07E-05	5.75E-05	2.61E-03	4.44E-04	2.36E-03	4.36E-05	5.75E-05	2.90E-03
7	1.77E-04	8.25E-04	4.36E-06	6.45E-05	1.07E-03	3.54E-04	8.56E-04	4.74E-06	6.45E-05	1.28E-03
10	1.23E-04	1.46E-04	0.00E+00	7.50E-05	3.45E-04	2.46E-04	1.50E-04	0.00E+00	7.50E-05	4.71E-04

Influence of CO₂ concentration on linear emission coefficients is so small that it vanishes within the line thickness of figure 1. This as such explains insignificance of CO₂ concentration on global mean temperatures. In addition, total linear emission coefficient in the lower atmosphere is so large at CO₂ concentration 300 ppm that thermal emission to the ground is very near Planck's radiation so increase of total linear emission coefficient does not increase significantly thermal emission to the ground. At altitudes less than 4 km Total linear emission coefficient is dominated by water vapor and droplets. Only at altitude more than 7 km CO₂ concentration has significant relative influence on Total linear emission coefficient.

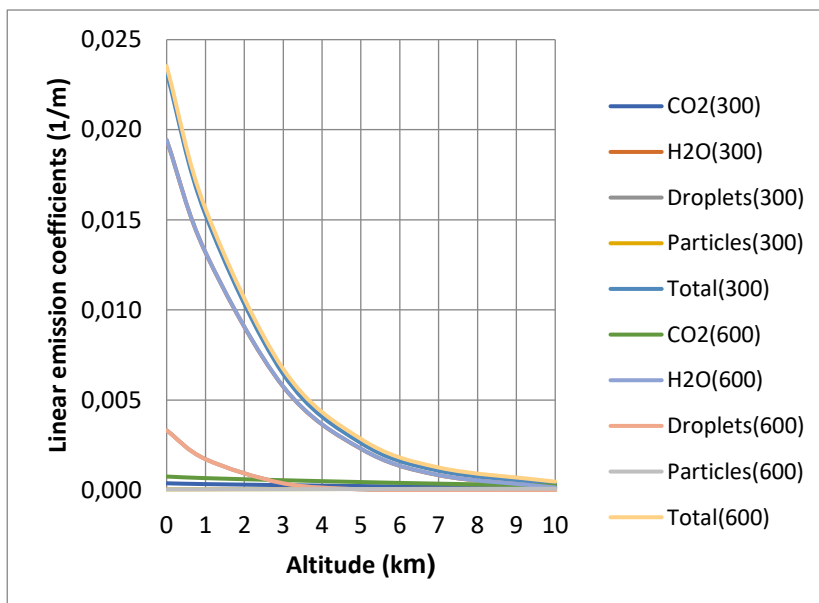


Figure 1 Graphical presentation of data of Table 1.

Linear reflection and absorption coefficients of solar radiation

Table 2 Linear reflection and absorption coefficient of solar radiation (1/m) at CO₂ concentration 300 ppm and 600 ppm as functions of altitude. Molar reflection area of solar radiation of droplets was determined by matching empirical and calculated solar radiation to the ground. By linear absorption coefficients of particles of figure 2 matching resulted in $Am_{sr} = 0.65 \text{ m}^2 \text{ mole}^{-1}$. Available experimental data on particle concentration and size distributions in the atmosphere was deficient and therefore linear absorption coefficients of figure 2 are approximate. Possible corrections of particle concentration and size distributions would influence mainly on molar linear absorption area of droplets.

z/km	linref(300)	linabs(300)	linref(600)	linabs(600)
0	7.18E-04	3.95E-05	7.21E-04	3.95E-05
1	3.72E-04	4.29E-05	3.77E-04	4.29E-05
3	8.14E-05	4.98E-05	8.48E-05	4.98E-05
5	8.81E-06	5.68E-05	9.45E-06	5.68E-05
7	9.45E-07	6.37E-05	1.03E-06	6.37E-05
10	0.00E+00	7.40E-05	0.00E+00	7.40E-05

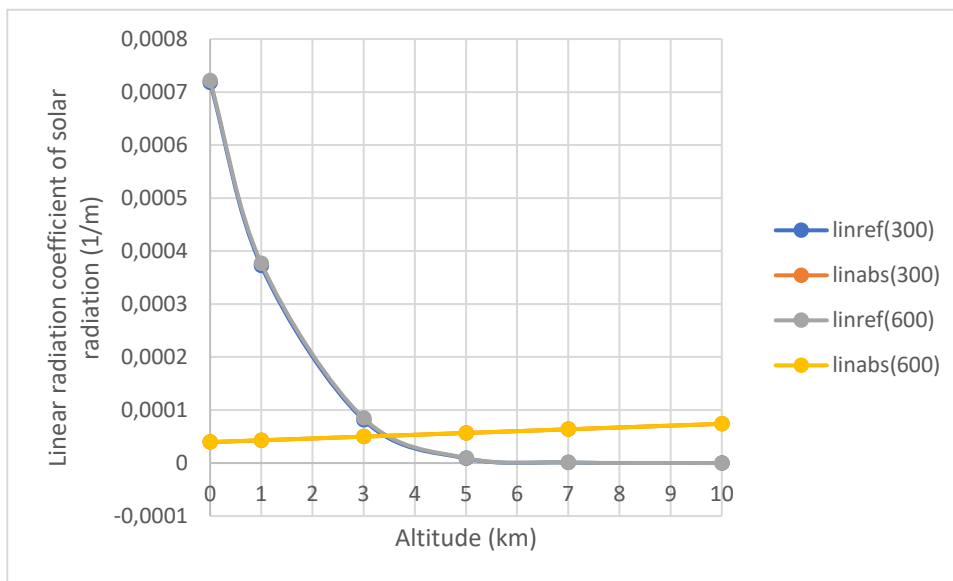


Figure 2 Graphical presentation of data of Table 2.

Intensities of solar radiation

Table 3 Solar radiation intensities (W/m²) at CO₂ concentration 300 ppm and 600 ppm as functions of altitude. Sdw(300)= solar radiation intensity downwards at CO₂ concentration 300 ppm, Suw(300)= solar radiation intensity upwards upward at CO₂ concentration 300 ppm, D-U(300)= solar radiation intensity Downward – Upward at CO₂ concentration 300 ppm, Sdw(600)= solar radiation intensity downwards at CO₂ concentration 600 ppm, Suw(600)= solar radiation intensity upwards upward at CO₂ concentration 600 ppm, D-U(600)= solar radiation intensity Downward – Upward at CO₂ concentration 600 ppm.

z/km	Sdw(300)	Suw(300)	D-U(300)	Sdw(600)	Suw(600)	D-U(600)
0	1000	0	1000	1000	0	1000
1	900	0	900	900	0	900
3	700	0	700	700	0	700
5	500	0	500	500	0	500
7	300	0	300	300	0	300
10	100	0	100	100	0	100

0	140.23	28.05	112.18	139.32	27.86	111.45
1	190.62	56.29	22.15	189.61	56.26	21.89
3	258.13	70.65	53.16	257.39	71.20	52.85
5	289.53	68.87	33.17	289.35	69.54	33.62
7	308.91	64.85	23.40	308.88	65.50	23.57
10	340.00	58.56	37.38	340.00	59.18	37.44

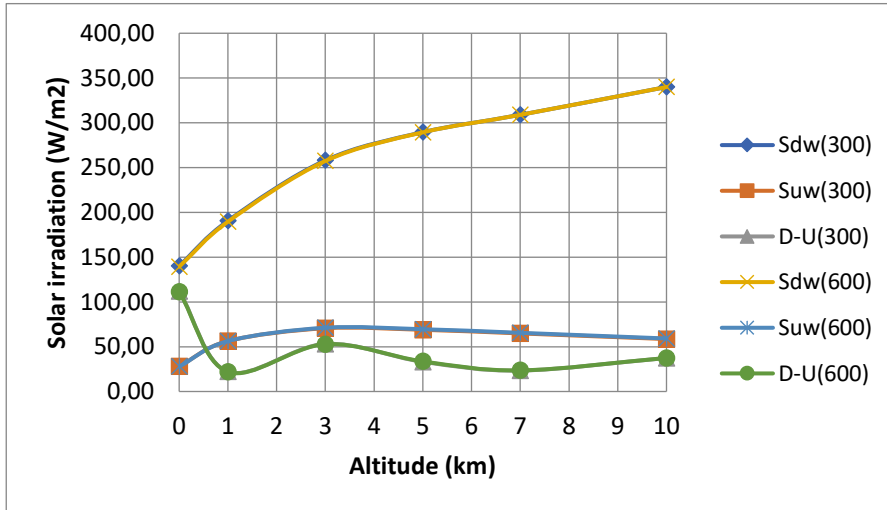


Figure 3 Graphical presentation of data of Table 3.

Net energy flow densities in the atmosphere

Table 4 Net energy flow densities (W/m^3) of the atmosphere at CO_2 concentrations 300 and 600 ppm as functions of altitude. Th(300)= thermal radiation at 300 ppm, So(300)= solar radiation at 300 ppm, Th(600)= thermal radiation at 600 ppm, So(600)= solar radiation at 600 ppm, Mi(300)= convective mixing at 300 ppm, Mi(600)= convective mixing at 600 ppm, Co(300)= condensing at 300 ppm, Co(600)= condensing at 600 ppm, Su(300)= sum of energy flows at 300 ppm, Su(600)= sum of energy flows at 600 ppm.

z/km	Th(300)	So(300)	Mi(300)	Co(300)	Su(300)	Th(600)	So(600)	Mi(600)	Co(600)	Su(600)
0										
1	-0.0307	0.0221	-0.0306	0.0391	0.00	-0.0307	0.0219	-0.0302	0.0390	0.00
3	0.0041	0.0266	-0.0469	0.0162	0.00	0.0038	0.0264	-0.0465	0.0163	0.00
5	0.0035	0.0166	-0.0234	0.0033	0.00	0.0034	0.0168	-0.0237	0.0035	0.00
7	-0.0083	0.0117	-0.0036	0.0002	0.00	-0.0071	0.0118	-0.0049	0.0002	0.00
10	-0.0270	0.0125	0.0146	0.0000	0.00	-0.0277	0.0125	0.0152	0.0000	0.00

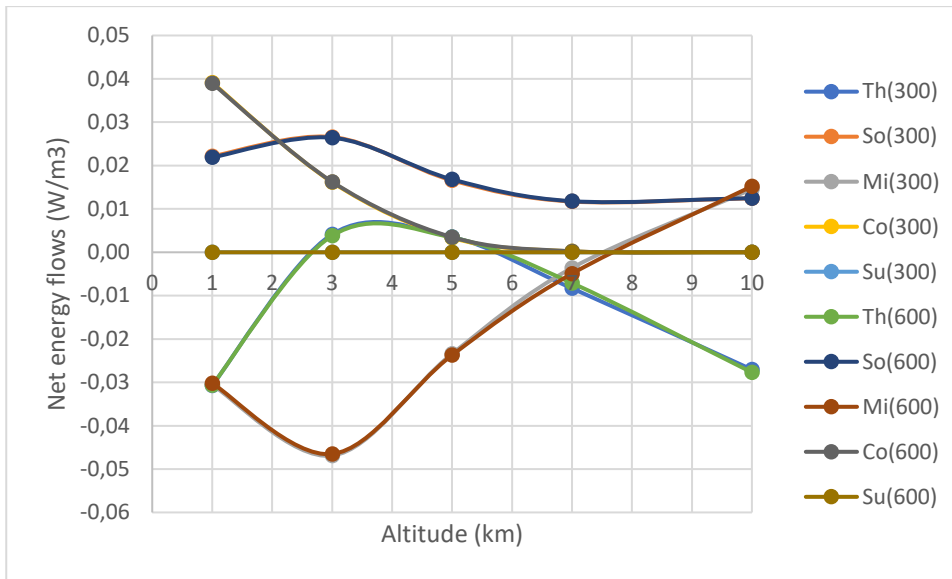


Figure 4 Graphical presentation of data of Table 4.

Global surface temperatures

Table 5. Global temperatures of the atmosphere at CO₂ concentration 0 ppm (Tg(000)), 300 ppm (Tg(300)), 600 ppm (Tg(600)) and Tg(300)-Tg(000) and Tg(600)-Tg(300) as functions of altitude. Calculations prove that influence of increase of CO₂ concentration on Tg(300)-Tg(000) and Tg(600)-Tg(300) depends strongly on altitude. Increase of CO₂ concentration from 0 to 300 ppm would cause 1.019 °C maximum temperature increase at altitude 7 km and increase from 300 ppm to 600 ppm would cause maximum temperature increase of 0.446 °C at altitude 7 km. However, at altitude 1 km increase of CO₂ concentration from 0 ppm to 300 ppm would increase global temperatures 0.107 °C and increase from 300 ppm to 600 ppm 0.022 °C.

z/km	Tg(000)	Tg(300)	Tg(600)	Tg(300)- Tg(000)	Tg(600)- Tg(300)
0	288.360	288.000	287.824	-0.360	-0.176
1	281.393	281.500	281.522	0.107	0.022
3	267.882	268.500	268.755	0.618	0.255
5	254.585	255.500	255.891	0.915	0.391
7	241.481	242.500	242.946	1.019	0.446
10	222.730	223.300	223.549	0.570	0.249

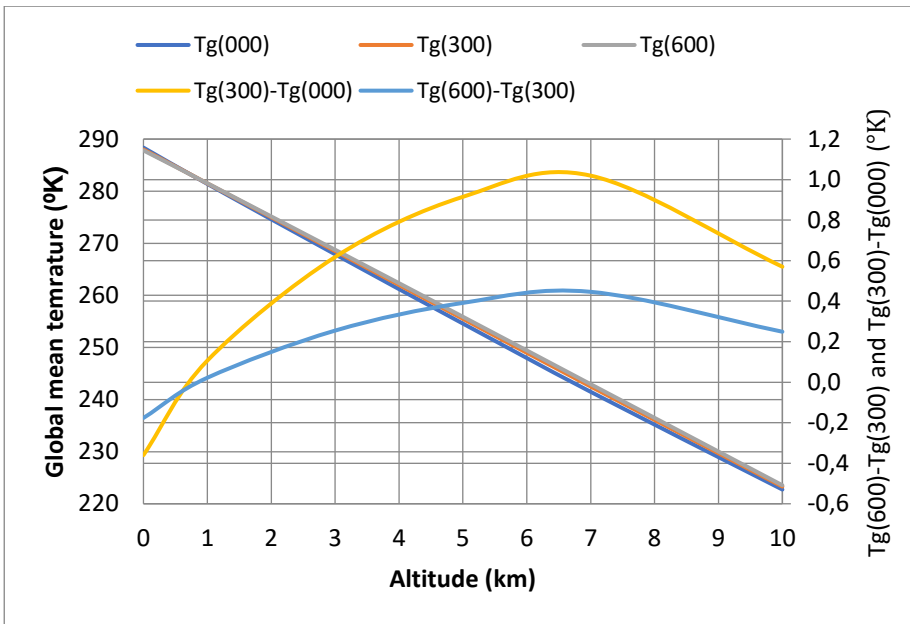


Figure 5 Graphical presentation of data of Table 5.

Net energy fluxes and temperatures of the surface of the ground

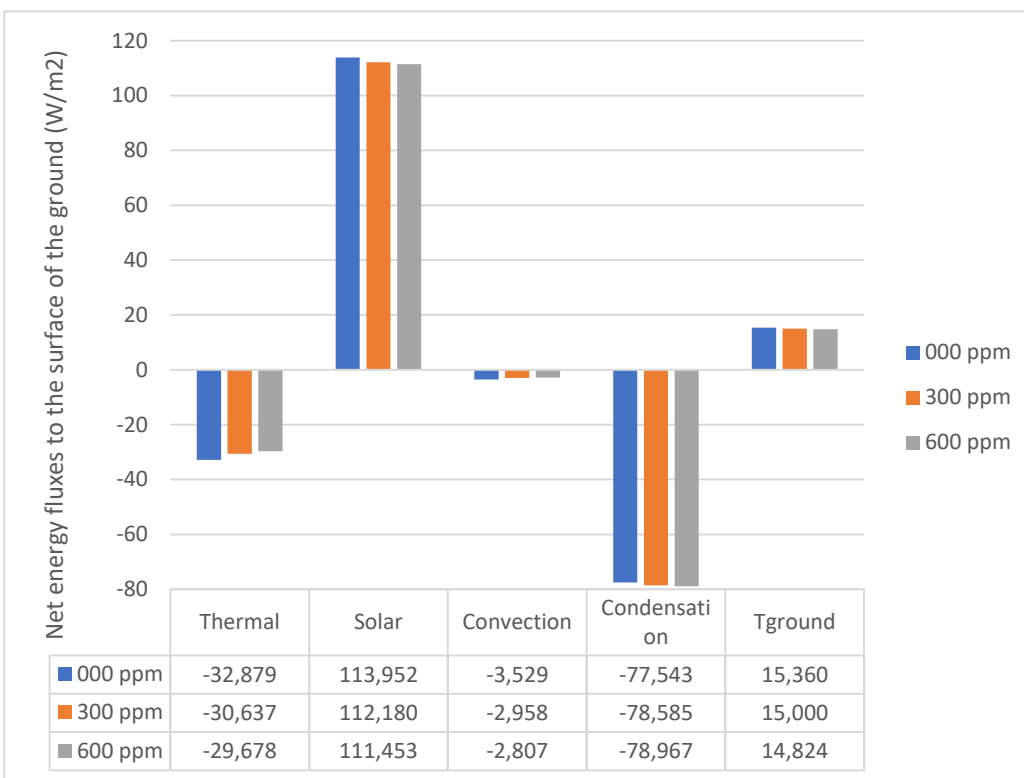


Figure 6 Net Energy fluxes (W/m^2) to the surface of the ground and global surface temperatures at CO₂ concentrations 0 ppm, 300 ppm and 600 ppm. The only positive net energy flow to the surface of the ground is due to solar radiation. It is balanced by net thermal radiation, convective energy flows and condensing energy flows. If CO₂ concentration in the atmosphere would increase from 300 ppm to 600 ppm global surface temperature would increase -0.18 °C.

Temperature differences between droplet boundary and surrounding gas

Table 7 Temperature of droplet boundary T_b – temperature of surrounding gas T_g at CO_2 concentration 300 ppm and 600ppm as functions of altitude. At minimum T_b-T_g is $-0.128\text{ }^\circ\text{C}$ so energy balances of the droplet entities are not needed.

z/km	$T_b(300)-T_g(300)$	$T_b(600)-T_g(600)$
0		
1	-0.074	-0.074
3	-0.081	-0.080
5	-0.128	-0.128
7	-0.092	-0.093
10	-0.054	-0.055

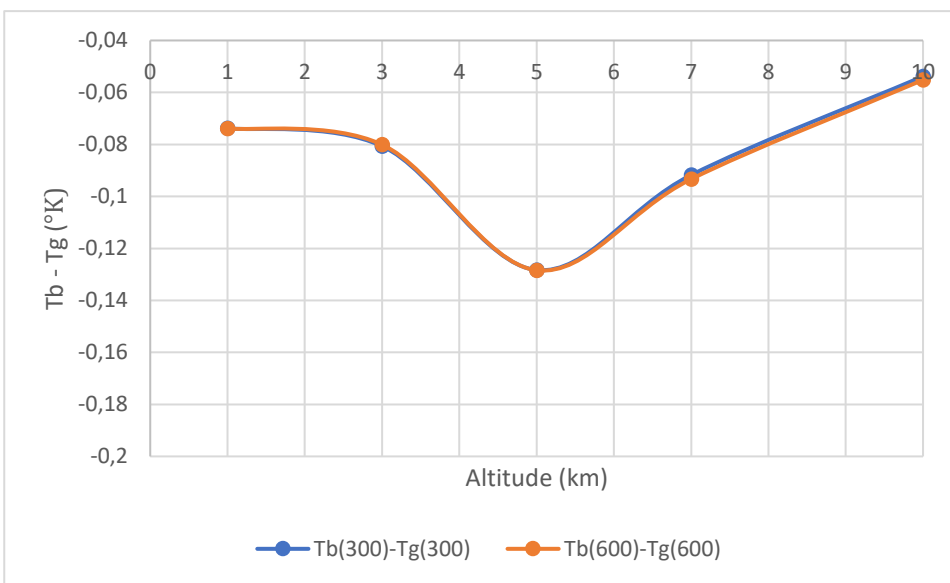


Figure 7 Graphical presentation of data of Table 7.

Annual rain and volume fractions of clouds

Table 8 Annual rain (mm) and volume fraction of droplets at CO_2 concentrations 300ppm and 600 ppm as functions of altitude. $\text{Rain}(300)$ =rain at CO_2 concentration 300 ppm, $\text{Rain}(600)$ =rain at CO_2 concentration 600 ppm, $\text{vf}(300)$ =volume fraction of clouds at CO_2 concentration 300 ppm, $\text{vf}(600)$ =volume fraction of clouds at CO_2 concentration 600 ppm. Increase of CO_2 concentration from 300 ppm to 600 ppm increases both rain and volume fractions but the changes could not be detected empirically.

z/km	Rain(300)	Rain(600)	vf(300)	vf(600)
0	991.30	996.24	1.99E-08	2.00E-08
1	497.61	504.52	1.03E-08	1.04E-08
3	89.91	94.40	2.26E-09	2.35E-09
5	5.93	6.48	2.44E-10	2.62E-10
7	0.41	0.46	2.62E-11	2.85E-11
10	0.00	0.00	0.00E+00	0.00E+00

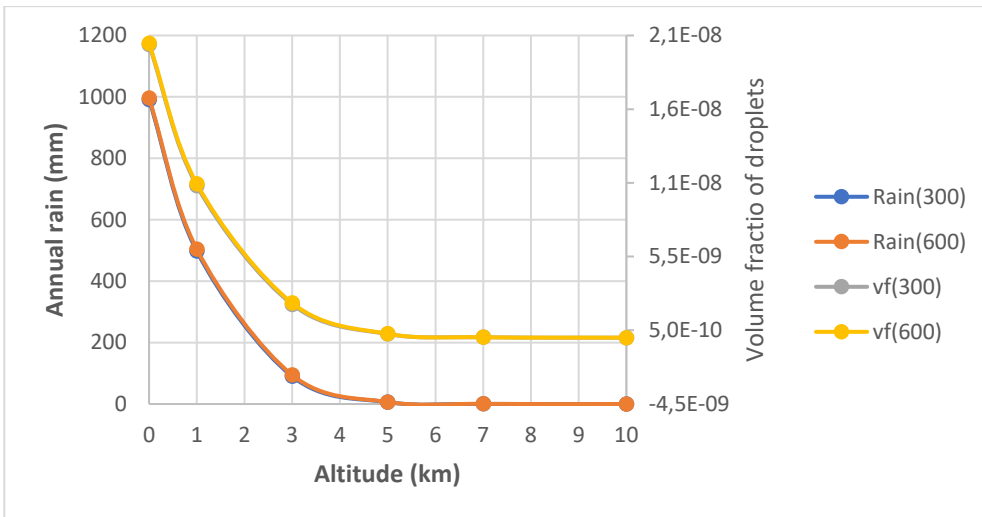


Figure 8 Graphical presentation of data of Table 8.

Droplet densities and fluxes

Table 9. Droplet number density ($1/m^3$) and droplet flux ($1/s/m^2$) at CO_2 concentrations 300ppm and 600 ppm as functions of altitude. Upwards fluxes are positive. Rain(300) = rain at CO_2 concentration 300 ppm, Rain(600) = rain at CO_2 concentration 600 ppm, vf(300) = volume fraction at CO_2 concentration 300 ppm, vf(600) = volume fraction at CO_2 concentration 600 ppm,

z/km	den(300)	den(600)	flux(300)	flux(600)
0				
1	7.43E+02	7.46E+02	-1.18E+03	-1.18E+03
3	5.27E+02	5.32E+02	-8.07E+02	-8.16E+02
5	2.52E+02	2.56E+02	-3.19E+02	-3.27E+02
7	1.51E+02	1.53E+02	-1.16E+02	-1.20E+02
10	7.97E+01	8.09E+01	-3.95E+01	-4.10E+01

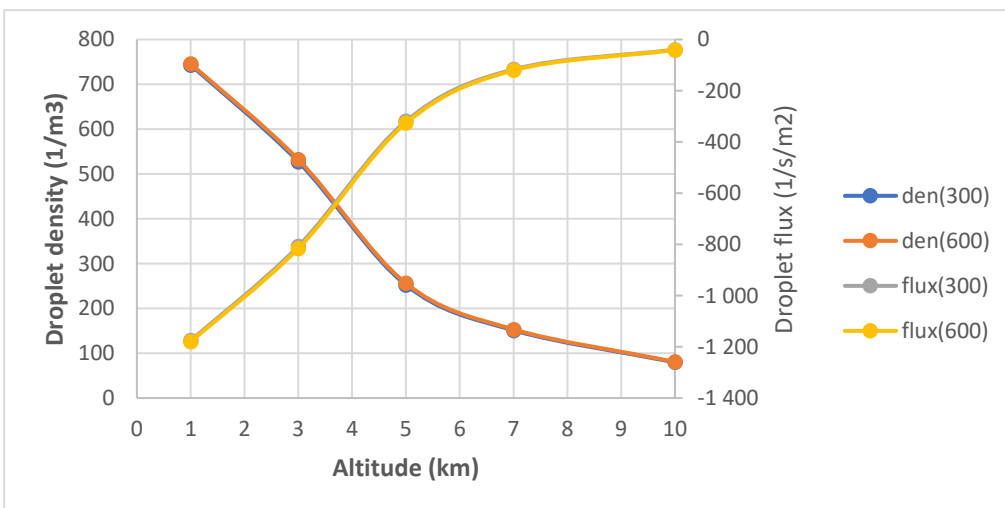


Figure 9 Graphical presentation of data of Table 9.

Diameters and velocities of droplets

Table 10. Droplet diameter (mm) and droplet velocity (m/s) at CO₂ concentrations 300ppm and 600 ppm as functions of altitude. Upwards velocities are positive. d(300) = diameter at CO₂ concentration 300 ppm, d(600) = diameter at CO₂ concentration 600 ppm, v(300) = velocity at CO₂ concentration 300 ppm, v(600) = velocity at CO₂ concentration 600 ppm,

z/km	d(300)	d(600)	v(300)	v(600)
0				
1	3.71E-01	3.71E-01	-1.58E+00	-1.58E+00
3	3.34E-01	3.35E-01	-1.53E+00	-1.53E+00
5	2.57E-01	2.60E-01	-1.26E+00	-1.28E+00
7	1.46E-01	1.48E-01	-7.70E-01	-7.85E-01
10	8.56E-02	8.76E-02	-4.95E-01	-5.07E-01

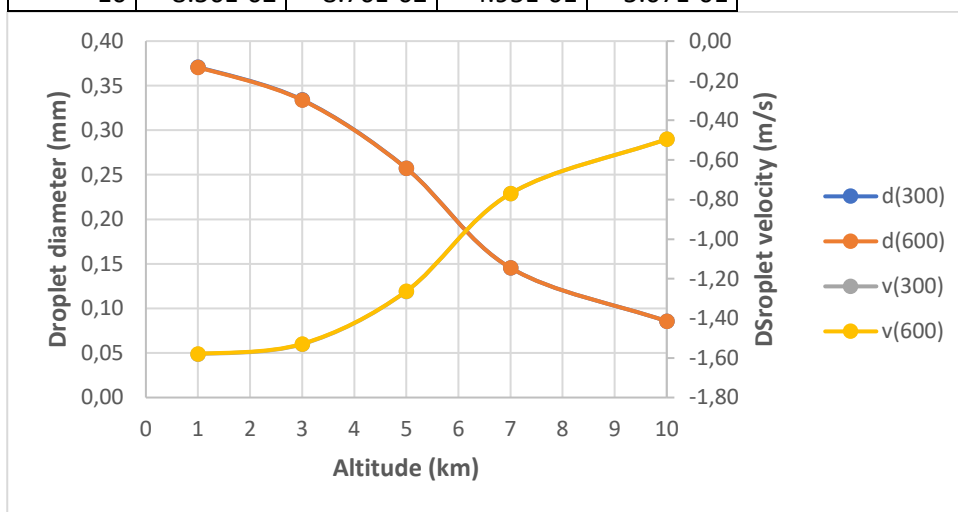


Figure 10 Graphical presentation of data of Table 10.