Climate change and use of fossil fuels

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Content

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Introduction

IPCC (Intergovernmental Panel on Climate Change) was founded in 1988 by WMO (World Meteorological Organization) and UNEP (United Nations Environmental Program) to "*provide the world with a clear scientific view on the current state of knowledge in climate change*". The basic claim of IPCC (hence forward the Basic Claim) is that increase of carbon dioxide in the atmosphere causes disastrous global warming. IPCC joints the Basic Claim an enormous number of catastrophic consequences (hence forward the Related Claims). IPCC doesn't guarantee correctness of its claims and by the disclaimer of IPCC's web site transfers all responsibility of implementation of its claims to the implementing national governments. In this document professor Sarkomaa and professor Ruottu (hence forward the Authors) prove that the Basic Claim, and accordingly the Related Claims are false.

IPCC argues its *claims* by consensus of more than 6000 researchers. In the Appendix 6 the Authors reveal the elementary errors of the calculation method of reference 13. The Basic Claim is based on calculations by climate models which apply hypothetical and heuristic quantities "climate sensitivity, clear sky radiative forcing and cloud feedback" These quantities prove univocally that the more than 6000 authors of IPCC's assessment reports don't understand mathematical theory of compound, momentum, energy and radiative transfer. *The mathematical theory of compound, momentum, energy and radiative transfer doesn't know, need or allow hypothetical or heuristic quantities hence their use in the climate models of IPCC's assessment reports is as such a fatal error.*

Authors of reference 11 state that in spite tens of years research *even the sign of cloud feedback is uncertain*. The Authors have asked Academic professor, professor of meteorology Timo Vesala and Director General of the Finish Meteorological Institute, professor Juhani Damski, to publish this knowledge. Both refused. Tens of years research of a fully heuristic cloud feedback which has no real counterpart and no objectively correct value is the most unfathomable blunder of modern science.

Even though cloud feedback doesn't exist, clouds have crucial influence on global mean temperatures via their contributions on spectral linear radiation coefficients of the atmosphere, (equations (4.1), (4.27), (4.28), (5.1)). If all linear radiation coefficients of clouds are set zero, the SRclimate model of Appendix 4 calculates about 100 W/m^2 increase of solar energy flux to the ground and about 13 ℃ increase of the mean temperature of the ground. This agrees with the generally known fact that when cloud comes in front of the sun temperature decreases. Thus, IPCC's climate change claim should be based on calculations with negative, instead of the positive cloud feedbacks. Accordingly, *IPCC's climate change claim is based on calculations by erroneous models and even by sign erroneous value of their cloud feedback*. In the Appendix 6 numerous other errors of climate models of IPCC's assessment reports and the theoretical foundations of the correct global climate model are presented.

IPCC's wrong claims have caused enormous economic and ecologic damage and humanitarian angst. They have directed public and private funding to research and implementing of economically noncompetitive and ecologically unsustainable technologies, caused demolishing of ecologically and economically useful power plants, increased unsustainable use of forests, and caused ignorant children's and adults' groundless angst worldwide. However, by far the most disastrous consequence of IPCC's claims is the worldwide endeavor to minimize carbon in the carbon cycle of nature and carbon dioxide in the atmosphere. This endeavor minimizes sustainable production of food and energy and diversity of the ecosystem and is leading to mankind's catastrophe when first oil, then natural gas and finally coal deplete during the next 50-150 years. All this senselessness is due to the Basic Claim.

In *Appendix 3* the Authors have proved that at each amount of carbon in the carbon cycle of nature there is an optimum carbon dioxide concentration of the atmosphere which maximizes photosynthesis of the ecosystem. This maximum can be increased only by recycling fossil carbon back to the carbon cycle. Mankind is fully dependent on fossil fuel resources and therefore all fossil fuels will be used. Mankind's vital challenge is sustainable supply of energy and food when first oil, then natural gas and finally coal deplete during the next 50-150 years. To mitigate the catastrophe mankind must start preparing to depletion of fossil fuels by increasing amount of photosynthetic biomass, primarily amount of forests, of the ecosystem. Theoretical foundation of maximizing mankind's sustainable supply of food and energy is presented in Appendix 3. Continuing of implementation of IPCC's wrong knowledge leads to mankind's catastrophe.

Summary

This document consists of 4 Chapters and 7 Appendix. The 4 chapters include popularly understandable reasoning which is based on exact physical and mathematical considerations of Appendix 1-7. In **Chapter 1**: 8 wrong claims regarding global mean temperatures, in **Chapter 2**: 4 wrong claims regarding biomass and fossil fuels and in **Chapter 3**: 5 wrong claims regarding consequences of increase of global mean temperature has been repealed. In **Chapter 4**: 7 crucially important conclusions of Appendix 2-7 have been presented.

Chapter 1: IPCC's wrong claims on global mean temperatures of the atmosphere

Claim 1.1: Increase of carbon dioxide in the atmosphere causes disastrous warming of the lower atmosphere

Repeal 1 of the claim 1.1

The basic quantity of radiative transfer is spectral radiance which is defined as radiative energy flux in a indefinitely small frequency range in indefinitely small solid angle through a indefinitely small surface perpendicular to the radiance. At any moment in every point there is only one spectral radiance which is univocal function of amounts of all compounds of all entities of the radiation closure and radiance on the boundaries of the closure (Equation (4.1)). Maximum value of spectral radiance is determined by Planck's law (Equation (5.1)). Thus, it is a fundamental and fatal error of all climate models of IPCC's assessment reports to divide radiative transfer in the atmosphere to "clear sky radiative forcing" and "cloud feedback".

The Basic Claim is based on calculations by climate models which apply hypothetical and heuristic quantities "climate sensitivity, clear sky radiative forcing and cloud feedback" These quantities prove univocally that the more than 6000 authors of IPCC's assessment reports don't understand mathematical theory of compound, momentum, energy and radiative transfer. *The mathematical theory of compound, momentum, energy and radiative transfer doesn't know, need or allow heuristic quantities hence their use in the climate models of IPCC's assessment reports is as such a fatal error.*

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real counterpart and no objectively correct value is the most unfathomable blunder of modern science.

Cloud feedback doesn't exist but clouds have crucial influence on global mean temperatures via their contributions on spectral linear radiation coefficients of the atmosphere, (equations (4.1), (4.27), (4.28), (5.1)). If all linear radiation coefficients of clouds are set zero, the SRclimate model of Appendix 4 calculates about 100 W/m^2 increase of solar energy flux to the ground and about 13 ℃ increase of the mean temperature of the ground. This agrees with the generally known fact that when cloud comes in front of the sun temperature decreases. Thus, IPCC's climate change claim should be based on calculations with negative, instead of the positive cloud feedbacks. Accordingly, *IPCC's climate change claim is based on calculations by erroneous models and even by sign erroneous value of their cloud feedback*. In the Appendix 6 numerous other errors of climate models of IPCC's assessment reports and the theoretical foundations of the correct global climate model are presented.

In Appendix 6 the Authors have proved that the only correct mathematical model for investigation of influence of carbon dioxide on global mean temperatures is the 1D time independent model. Its univocal heat and fluid dynamic and mathematical foundations, and on these foundations based SRclimate model, have been presented in Appendix 4 and 5.

The SRclimate model:

1. Satisfies conservation of elements, momentum and energy and compound and particle numbers balances of entities.
2. Is based on the perfectly verified laws of transfer of compounds, momentum and energy, including radiative transfer, between the entities.
3. Produces correct results for the present atmosphere and responses correctly to changes of all calculation parameter.
4. Thus, the SRclimate model satisfies all requirements of physically and mathematically correct global climate model.

Calculations by the SRclimate model of the Appendix 4 prove that influence of carbon dioxide on the global mean temperatures is insignificant. hence IPCC's claim 1.1 is wrong.

Repeal 2 of the claim 1.1

It is undisputable that increase of the thermodynamic mean temperature of the ground (hence forward the *Temperature*) increases gaseous, liquid and solid water, and accordingly spectral linear emission coefficients of the lower atmosphere (hence forward the *Linear Emission Coefficient*). Therefore, if increase of the *Linear Emission Coefficient* would increase the *Temperature*, the increase would continue until increase of the *Linear Emission Coefficient* would not increase the *Temperature*. This would happen when thermal radiation to the ground equals Planck's radiation (*Appendix* 5 equation (5.2)). Thus, the marginal increase of the *Linear Emission Coefficient* due to increase of carbon dioxide in the atmosphere doesn't increase significantly the mean temperature of the ground.[1] Due to the thermostatic properties of water, changes of carbon dioxide concentration of the atmosphere have insignificant influence on global mean temperatures of the atmosphere.

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[1] According to the corresponding reasoning the *Linear Emission Coefficient* must be large enough so that its decrease does not decrease the *Temperature*. If this were not true decrease of the *Temperature* would continue until the decrease would not decrease the *Temperature*. According to

Claim 1.2: Warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system, such as sea level rise, with associated impacts.

IPCC classifies this knowledge to category "**high confidence**". The claim 1.2 proves unfathomable ignorance on radiative heat transfer of the thousands of authors of IPCC's assessment reports.

From the carbon dioxide balance of the atmosphere it follows that carbon dioxide concentration in the atmosphere starts to decrease immediately when the outgoing carbon dioxide flow is greater than the incoming flow. In the global energy balances of the atmosphere, accumulation of energy is negligible in comparison with other energy flows hence global mean temperatures are independent of time. Accordingly, the insignificant warming influence of carbon dioxide would start to decrease immediately when the outgoing carbon dioxide flow became greater than the incoming flow.

Claim 1.3: NO_2 and CH_4 are hundreds of times "stronger greenhouse gases" than CO_2

The claim 1.3 proves unfathomable ignorance on radiative heat transfer of the thousands of authors of IPCC's assessment reports.

IPCC determines the "greenhouse gas strength" of compounds according to their indefinite "residence times" in the atmosphere. In this classification NO_2 is a more than 300 times stronger greenhouse gas than CO_2. "Residence time" has nothing to do with radiation. Only thermostatic state of the compounds matters. Concentration must be calculated by the compound balance, not by "residence times".

According to reference 14, NO_2 has in the atmosphere only 2 weak radiation bands with molar emission areas 0.0032 and 0.0002 m^2/mole. These together are about 10 % from the mean emission area of H_2O or CO_2. When in addition the mole fraction of NO_2 in the atmosphere is about $2 \cdot 10^{-8}$, NO_2 has practically no influence on the thermodynamic mean temperature of the ground.

According to reference 14, the emission ratio of CH_4 approaches zero in atmospheric temperatures, whereupon the mean molar emission area of CH_4 is practically zero. When in addition the mole fraction of methane in the atmosphere is about $1.7 \cdot 10^{-6}$, it has no influence on the radiation to the ground.

The influence of a "greenhouse gas compound" on the thermodynamic mean temperature of the ground does not depend only on its radiation properties, but also on the radiation properties of all other compounds of all entities and the beam length. Therefore, it is entirely wrong to classify compounds according their "greenhouse gas strengths". The only physically reasonable "greenhouse gas strength" is the linear emission coefficient of a compound of an entity. In the atmosphere the linear emission coefficients of NO_2 and CH_4 are insignificant and much less than the linear emission coefficient of carbon dioxide.

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the SRclimate model, this would happen when the thermodynamic mean temperature of the ground would be +6 °C, which would be disastrous for the mankind.

IPCC's senseless greenhouse gas classification has caused that the methane emission of cows has become one of the top research areas of universities worldwide.

Claim 1.4: Water vapor is not a greenhouse gas

The claim 1.4 proves unfathomable ignorance on radiative heat transfer of the thousands of authors of IPCC's assessment reports.

Even though water vapor differs from all other gases of the atmosphere by its thermostatic properties it is by far the "strongest greenhouse gas" of the atmosphere. In the lower atmosphere, mean linear emission coefficient of water vapor is about 27 times the linear emission coefficient of carbon dioxide.

Water is not only by far the "strongest greenhouse gas" but also by far the strongest "greenhouse liquid" and "greenhouse solid". In the lower atmosphere, sum of the linear emission coefficients of water droplets and particles is at least as large as the linear emission coefficient of water vapor. Everybody knows that during cool nights, when linear emission coefficient of water vapor is small, air temperature may vary up to 10 ℃, depending on cloudiness. Because the existing data is deficient, in the calculations of *Appendix* 4, the Authors have applied minimum realistic estimate of 1 m^2/mole for the mean molar emission area of liquid and solid water. Even with this minimum value, water in its three entities dominates fully thermal and solar radiation to the ground and thus the thermodynamic mean temperature of the ground.

Claim 1.5: Carbon dioxide in the atmosphere may increase the thermodynamic mean temperature of the ground by 2.1-4.1 ℃

According to the claim 1.5 increase of carbon dioxide in the atmosphere causes progressive increase of the global mean temperature of the lower atmosphere (the hockey stick theory). The hockey stick theory proves unfathomable ignorance on radiative heat transfer because influence of increase of linear emission coefficient on radiation isn't progressive but asymptotic.

The temperatures of the claim 1.5 are Equilibrium Climate Sensitivities (ECS) of calculations by the 3D coupled general circulation models. ECS is a hypothetical quantity which has no real counterpart. Dispersion of the ECS values has been explained to be mainly due to differences in the applied "cloud feedbacks". If calculated ECS values change 100 % with the applied cloud feedbacks, with other "cloud feedbacks" ECS- change could be from -5 to 5 ℃.
The clouds don't cause any temperature feedback but dominate the spectral linear radiation coefficients and hence both solar and thermal radiation in the lower atmosphere. The influence of clouds can't be accounted correctly by the heuristic cloud feedbacks, but it must be calculated according to the laws of radiative heat transfer as part of the heat and fluid dynamical model.
Claim 1.5 proves indisputably that the 3D coupled general circulation models are invalid for investigating the influence of carbon dioxide on the global mean temperatures.
Planck's radiation law (*Appendix* 5 equation (5.2)) determines the greatest possible spectral radiance a matter can emit at a certain temperature. In accordance with equation (5.1) in *Appendix* 5, emitted radiance approaches asymptotically Planck' radiation when the linear emission coefficient increases. Therefore, with the successive equal increases of the linear emission coefficient, any next increase of radiance is smaller than the increase from the previous increase of the linear emission coefficient. Consequently, also the next change of the thermodynamic mean temperature of the ground is smaller than the previous one. Because this is true for each frequency, it is true for the whole spectrum. This has been illustrated in figure 5 in *Appendix* 5.

According to references 5-8, the meteorological mean temperature of the ground has decreased by 0.5 ⁰C in spite the increase of carbon dioxide from 280 ppm to 410 ppm. However, according to IPCC, the thermodynamic mean temperature of the ground has increased by 1.1 ⁰C. Even if IPCC's knowledge were true, the next 130 ppm increase of carbon dioxide mole fraction would increase the thermodynamic mean temperature of the ground by less than 1.1 ⁰C. IPCC's claim of an up to 4 ⁰C increase of the thermodynamic mean temperature of the ground is in irreconcilable contradiction both with empirical facts and the theory of radiative heat transfer.

Claim 1.6: If the carbon dioxide flow to the atmosphere cannot be reduced, mankind will become extinct

This claim is univocally wrong, because carbon dioxide concentration in the atmosphere does not depend only on carbon dioxide flow to the atmosphere but on carbon dioxide flow *to* and *from* the atmosphere. This wrong claim is due to that nobody from the thousands of researchers of IPCC's assessment reports hasn't understood the mathematical theory of carbon dioxide concentration of the atmosphere. Physical and mathematical foundations of this theory and on the corresponding mathematical model (hence forward the SRcompound model) has been presented in Appendix 3.

From the carbon dioxide balance of the atmosphere it follows that carbon dioxide concentration in the atmosphere starts to decrease immediately when carbon dioxide flow to the atmosphere is smaller than carbon dioxide flow from the atmosphere. Calculations with the SRcompound model prove that this can be achieved even with the current carbon dioxide flow to the atmosphere by reducing use of forests (logging, etc.). When in addition influence of carbon dioxide in the atmosphere on global mean temperatures is insignificant claim 1.6 is entirely wrong.

Claim 1.7: If all fossil carbon were recycled back to the carbon cycle, the thermodynamic mean temperature of the ground would increase up to 4.1 ⁰C, and the temperatures in the polar areas up to 8 ⁰C

The claim 1.7 proves unfathomable ignorance of the thousands of authors of IPCC's assessment on the mathematical theory of the carbon dioxide concentration of the atmosphere. This theory has been presented in the Appendix 3.

If the global warming were due to increase of carbon dioxide in the atmosphere the warming would depend only on the amount of carbon dioxide in the atmosphere when all fossil carbon had been recycled back to the carbon cycle.

As shown in the *Appendix* 3, carbon dioxide concentration in the atmosphere when all fossil fuels have been depleted would depend on how the fossil fuels and photosynthetic biomass had been used before the depletion. All fossil fuels can be used without increasing the amount of carbon dioxide in the atmosphere. Accordingly, the thermodynamic mean temperature of the ground would not increase, even though IPCC's false claim 1.1 were true. The Authors proved in *Appendices* 4 and 5 that if carbon dioxide in the atmosphere increased by 130 ppm, it would increase the thermodynamic mean temperature of the ground by less than 0.02 ⁰C.
Claim 1.7 is entirely wrong.

Claim 1.8: The mean temperature of the ground has increased by 1.1 ⁰C due to increase of carbon dioxide in the atmosphere

In Appendix 7 the Authors have collected and analyzed empirical data on global and local temperatures. According to references 5 – 8, the change of the meteorological mean temperature of the ground has been -0.5 ⁰C during the past 120 years, but according to IPCC it has been +1.1 ⁰C. The difference between the empirical observations is up to 1.6 ⁰C.

Neither the temperature measurements of FMI support the claim that the mean temperature of the ground has increased by 1.1 ⁰C during the past 120 years. The temperature measurements of FMI prove that influence of carbon dioxide on temperatures of the lower atmosphere is so small that it totally vanishes to influences of other factors. It is not possible to recognize certainly influences of separate factors on empirical observations. Accordingly, even if the meteorological mean temperature of the ground has increased by 1.1 ⁰C during the past 120 years, it is wrong to claim that the increase is solely due to increase of carbon dioxide in the atmosphere.

Chapter 2: Wrong claim on biomass and fossil fuels

Claim 2.1: Photosynthetic biomass is a carbon-neutral fuel

Amount of carbon in the atmosphere depends only on incoming and outgoing carbon flows of the atmosphere. As shown in *Appendix* 2, use of photosynthetic biomass instead of any fossil fuel will increase carbon flow per produced energy to the atmosphere. Anybody with elementary knowledge on chemistry can confirm this. At the same time, use of photosynthetic biomass decreases carbon flow from the atmosphere. Anybody with common sense understands this. Therefore, regarding carbon dioxide concentration of the atmosphere, photosynthetic biomass is not carbon neutral but by far the most "carbon intensive" of all fuels.

	Biooil	Fossil oil
■ Flow	3.04E+06	1.56E+06
■ Difference	1.48E+06	0.00E+00
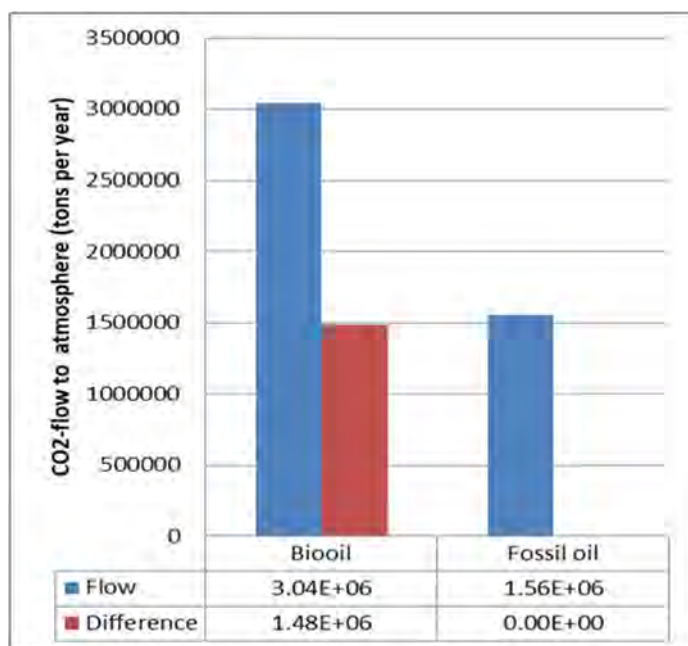
Figure 4 Carbon dioxide flows to the atmosphere from a plant producing 500 000 tons of traffic fuels from photosynthetic biomass. In the calculations it has been assumed that carbon dioxide flow of production process is 30 % of carbon dioxide flow of produced biofuel. Replacing fossil traffic fuels with "biofuels" more than doubles carbon dioxide flow to the atmosphere, and in addition reduces carbon dioxide flow from the atmosphere. Explanation why the governments which are committed to the Paris Climate Agreement support this economic and ecological foolishness is that the governments do not know what they are doing.

Table 1 Annual energies and carbon dioxide amounts of Finnish target logging (legend Wood), sum of all fossil fuels (legend Fossil), coal consumption (legend Coal), oil consumption (legend Oil),

and natural gas consumption (legend Natural gas). Annual consumption of fossil energies has been taken from the "Suomi lukuina 2014" publication of Tilastokeskus (Statistics Finland).

Energy source	Annual energy			Annual CO2 amounts
	PJ	MJ	kg/MJ	kg
Wood	678	6.78E+11	0.111	7.55E+10
Fossil	687	6.87E+11		5.37E+10
Coal	248	2.48E+11	0.095	2.36E+10
Oil	314	3.14E+11	0.074	2.32E+10
Natural gas	125	1.25E+11	0.055	6.88E+09
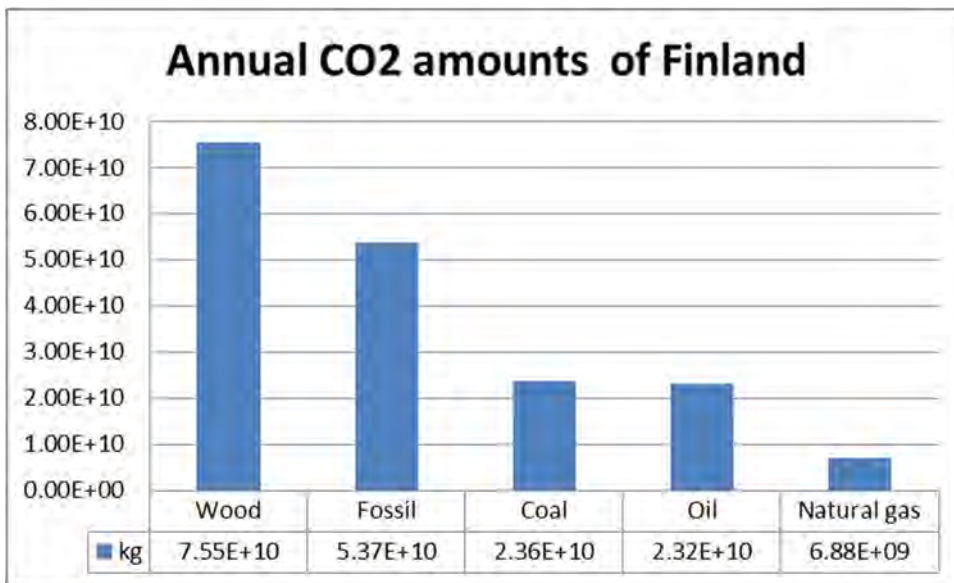
Figure 5 Annual carbon dioxide amounts of table 1 in graphical form.

Annual carbon dioxide amount of logging is 1.41 times the annual carbon dioxide amount of all fossil fuels together. In addition, logging reduces carbon dioxide flow from the atmosphere. Even though it is not possible to determine the influence of logging on the carbon dioxide concentration in the atmosphere quantitatively by thermostatic calculations, it is certain that it is much greater than influence of all fossil fuels together.

Claim 2.2: Fossil energy is nonrenewable

Claim 2.2 proves unfathomable ignorance of the thousand researchers of IPCC's assessment reports. When fossil carbon by oxidation has been recycled to the natural carbon cycle, it becomes source of endlessly renewable energy, exactly similarly as carbon of oxidized biomass. An advantage in comparison with carbon of biomass is that fossil carbon increases possibilities of the ecosystem to produce renewable energy and food. Claim 2.2 is entirely wrong.

Claim 2.3: In the natural cycle there is sufficiently carbon for an enormous growth of biomass without increasing the amount of fossil carbon in the cycle

This is the most serious of all misunderstandings of the thousands of researchers of IPCC's assessment reports. At each moment all carbon in the natural carbon cycle is in the seas, the atmosphere and biomass. From conservation of carbon it follows that if amount of carbon in the natural carbon cycle does not increase, and if the carbon in biomass increases, carbon in seas and the atmosphere decreases, decreasing the growth rate per area ($kg/m^2/s$) of biomass. In order to

maintain the growth per area of biomass, equal amount of carbon of the increased biomass must be increased to the atmosphere by oxidizing fossil fuels.

Calculations with SRcompound model prove, that IPCC's aim to minimize carbon in the carbon cycle and carbon dioxide in the atmosphere will lead to mankind's catastrophe when fossil fuels deplete.

Claim 2.4: Use of fossil fuels will inevitably increase the thermodynamic mean temperature of the ground

This claim includes implicitly the claim that the use of fossil fuels increases carbon dioxide concentration in the atmosphere inevitably, which in turn increases the thermodynamic mean temperature of the ground. From the conservation of carbon, it follows that the first claim is univocally wrong.

The amount of carbon in the atmosphere does not increase if the amounts of carbon in other entities of the ecosystem are increased by the amount of carbon from fossil fuels. In *Appendix* 3 the Authors prove that this is possible without decreasing present use of fossil fuels if forest logging is reduced. Because the use of fossil fuels does not inevitably increase the amount of carbon in the atmosphere, claim 2.4 is univocally wrong.

In *Appendices* 4 and 5, the Authors have shown that the influence of carbon dioxide on global mean temperatures is insignificant, whereupon claim 2.4 is wrong.

Chapter 3: Wrong claim on consequences of increase of the thermodynamic mean temperature of the ground

There is no scientific evidence that the 130 ppm increase of carbon dioxide in the atmosphere over the past 120 years (increase about 46 %) has had any harmful consequences. Neither is there any scientific ground to think that the next 130 ppm increase (a relative change of about 30 %) would have harmful consequences. On the contrary, in agreement with the theory in *Appendix* 3, increase of carbon dioxide in the atmosphere has increased rate of photosynthesis reaction and thus increased global growth of forests and corn[2]. Finland has gained remarkable benefits from increase of carbon dioxide in the atmosphere. Increase of carbon dioxide concentration in the atmosphere accelerates photosynthesis in the whole ecosystem, including corn fields. In the post-fossil fuel era, mankind's real challenge is supply of food and energy. In order to maximize them, amount of photosynthetic biomass (forests) and carbon dioxide concentration in the atmosphere must be increased. This is possible only by recycling fossil carbon back to the carbon cycle.

Claim 3.1: Increase of carbon dioxide in the atmosphere increases storms

Cyclones (hurricanes and typhoons) are born when vertical air flow approaches tangentially ascending air flow. Small changes of the mean temperature of the ground have practically no influence on the velocities of cyclones. Heavy rains, which are related to cyclones, are due to fast condensing of water vapor due to conversion of sensible energy into kinetic and potential energy. Even though carbon dioxide concentration in the atmosphere is the same, each cyclone has different velocities and precipitation. Influence of carbon dioxide concentration in the atmosphere has nothing to do with cyclones.

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[2] Large historical growth in global terrestrial gross primary production doi:10.1038/nature22030 J. E. Campbell

Navier-Stokes equations can be applied to calculate velocities in the atmosphere. In the atmosphere the viscous terms of Navier-Stokes equations, presenting diffusion transfer of momentum, are small in comparison with the terms of gravity and convective transport. Therefore, the only variable depending on temperature is density. Increase of one degree centigrade would cause 0.0035 relative decrease of density.

If Navier-Stokes equations are solved numerically for the same initial and boundary conditions, but with 1 °C temperature difference, the velocity differences would disappear completely within the errors of the numerical solution.

Integrating Navier-Stokes equations of one-dimensional flow gives Bernoulli's equation. According to Bernoulli's equation, velocity is proportional to the negative square root of density. In otherwise similar conditions, an increase of 1 °C would cause the relative increase of velocity of 0.002.

Even though small changes of temperature in the atmosphere have negligible influence on cyclones, influence of local temperature differences is crucial. Because influence of carbon dioxide concentration on temperatures of the atmosphere in general is insignificant, it would be absurd to claim that its influence on temperature differences in the atmosphere is significant.

Claim 3.2: Increase of carbon dioxide in the atmosphere raises sea level

Volume of sea water is expressed mathematically by equation (4)

$$V_s = \int_{A=0}^{A_s}(H_s - H_b)dA = \sum_{i=1}^{N}(\bar{H}_{si} - \bar{H}_{bi})\Delta A_i \tag{4}$$

V_s = volume of the seas

dA = differential area perpendicular to radius to the earth

A_s = area of the seas

ΔA_i = area i of sea surface

N = number of areas

H_s = local distance of sea surface from the center of the earth

$\bar{H}_{si}$ = mean distance of sea surface from the center of the earth in area ΔA_i

H_b = local distance of sea bottom from the center of the earth

$\bar{H}_{bi}$ = mean distance of sea bottom from the center of the earth in area ΔA_i

Physically essentially correct impression of the crust of the earth is that it is a thin solid layer which floats on the molten core of the earth. The crust of the earth, and consequently H_b changes continuously in the whole sea area. In Oulu region the sea level **descends** annually with respect to the ground by about 9 mm and in Hudson Bay area in Canada by about 13 mm. In 120 years, these annual descents correspond to 1080 and 1560 mm descents which prove that changes of the crust of the earth have remarkable influence on form of the sea bottom. Therefore, only from the measured change of the sea surface it cannot be concluded that volume of the seas has changed. According to IPCC's during the past 120 years sea level has **raised** 0.2 m only due to increase of volume of sea water.

In order to measure volume of sea water with relative accuracy of 0.001, ΔA_i should be less than 100 m^2, whereupon $\bar{H}_{si}$ and $\bar{H}_{bi}$ should be measured in more than $3.6 \cdot 10^{12}$ points. This is fully impossible. IPCC's claim requires that volume of sea water could be measured with the relative accuracy of about 0.00001, which is entirely impossible. Thus, the fact is that during the past 120 years the realized 130 ppm increase of CO_2 concentration has not caused detectable rise of sea

level. It would be absurd to claim that a 130 ppm increase of CO_2 concentration during the next 120 years would ascend sea level by 10-20 m.

Claim 3.3: Increase of carbon dioxide in the atmosphere causes disastrous refugee flows

Claims, that the present refugee flows, which are due to wars and living standard differences, are due to increase of carbon dioxide in the atmosphere, are lies. Nobody in the whole world has left his home because of the realized 130 ppm increase of carbon dioxide in the atmosphere. Next 130 ppm increase of carbon dioxide mole fraction would increase the thermodynamic mean temperature of the ground less than the realized increase. Therefore, it is absurd to claim that the next 130 ppm increase of carbon dioxide mole fraction would cause disastrous refugee flows.

Claim 3.4: Increase of carbon dioxide in the atmosphere increases dryness

This claim is absurd, because increase of the mean temperature of the ground increases both global and local raining. If *Claim 12* were true, it would indicate a decrease of the mean temperature of the ground. There is no scientific evidence that the realized 130 ppm increase of carbon dioxide in the atmosphere has increased global or local raining. This confirms that the realized 130 ppm increase of carbon dioxide in the atmosphere has not increased the thermodynamic mean temperature of the ground.

Claim 3.5: Smelting of polar ice influences oceanic streams

Claim 3.5 is predicated by the argument that smelting water decreases the density of water in polar areas. This claim can be invalidated by the Bernoulli's equation.

According to Bernoulli's equation, the driving force of a flow is the difference of total pressure between two points on the streamline. Total pressure is the sum of static, dynamic and hydrostatic pressures.

The sum of static and hydrostatic pressure on the surface of the ground is constant, but dynamic pressure, due to the rotation of the earth, depends on latitude. Tangential velocity on the equator surface is about 460 m/s, while on the poles it is zero. Consequently, the total pressure difference of water on the equator and on the poles is about 1080 bar. If the density of sea water decreased by 10 kg/m³ due to smelting polar ice, it would cause a mean hydrostatic pressure difference of about 1.5 bars in a 3 000 m deep water layer. The calculated results are approximate, but the order of magnitude is correct. Accordingly, hydrostatic pressure difference is fully insignificant in comparison with the dynamic pressure difference, and thus the effect of smelting polar ice on oceanic streams is insignificant.

Chapter 4: Conclusions of Appendix 2-7

Conclusion1: The influence of CO_2 on the thermodynamic mean temperature of the ground is insignificant

This has been proven popularly in chapter 1.1 and mathematically in Appendix 4 and 5.

Conclusion 2: The only realistic alternative for fossil energy is the energy of photosynthetic biomass

Global Fossil Fuel Consumption
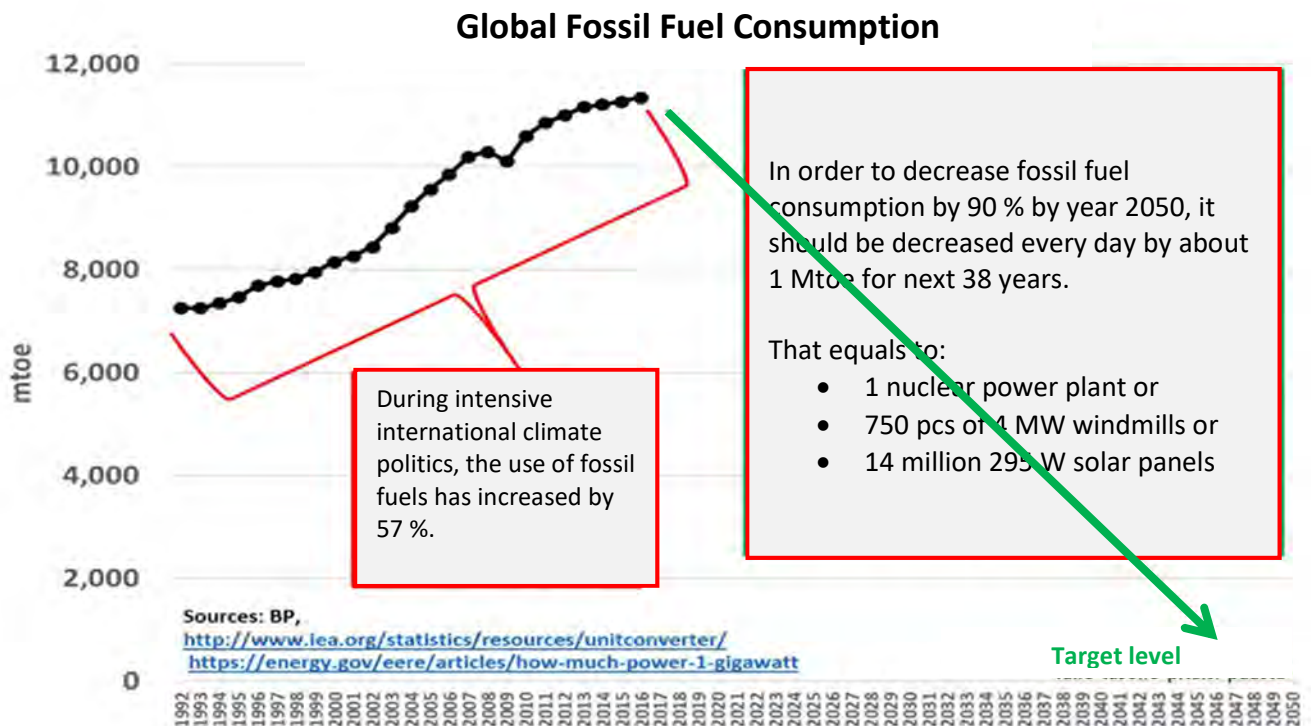
Figure 7 Professor Roger A. Pielke's figure of global consumption of fossil energy since 1992

In spite the fossil fuel hysteria, the use of fossil fuels is increasing because they cannot be replaced by nuclear, wind and solar energy. Professor Pielke's calculations prove that in order to reduce the use of fossil energy by 90 % by the year 2050, each day one 1 600 MWe nuclear power plant, or 750 pieces of 4 MWe wind power plants, or 14 million 295 We solar panels should be started up.

Olkiluoto 3 nuclear power plant costs according to its deliverer Areva 8.5 billion euro. The construction permit for Olkiluoto 3 was applied in 2000 and admitted in 2005. The plant was planned to be ready in 2009, but now the expected start-up time is autumn 2019. Fission energy is not renewable, and the problem of safe deposit of radioactive waste has not been solved so far. Merely on this base it is certain that starting up one 1600 MWe nuclear power plant each day until the year 2050 is ecologically, economically and technically entirely impossible. Wind and solar power plants would require the construction of 100 % reserve fossil or bioenergy power plant capacity. The only realistic alternative for fossil energy is the energy of photosynthetic biomass.

Conclusion 3: Maximum global net growth of biomass can be increased only by recycling fossil carbon back to the carbon cycle

Only momentary compound balances can be written precisely, because the reaction rates and compound flows are functions of <u>momentary</u> compound amounts of entities. The compound amounts at other moments must be calculated by integrating momentary compound balance equations over the required time span. The general theory of thermodynamic and mathematic modelling of compound balances of the ecosystem is presented in *Appendix* 3.

The ecosystem consists of two continuous entities (the atmosphere and the seas) and a huge number of discrete entities. Via the continuous entities, all entities of the ecosystem are in interaction with

each other, whereupon the compound balances of all entities of the ecosystem must be solved simultaneously at each moment.

For applied calculations, the discrete entities of the ecosystem must be grouped into a finite number of entities with sufficiently similar properties. In the applied calculations in *Appendix* 3, the discrete entities are grouped into 7 entities, the number of compounds is 5, and the number of elements 5. The other applied assumptions are explained in *Appendix* 3. This simplest thermodynamically, biologically and mathematically valid ecosystem model leads to a group of 8 ordinary differential equations with their initial conditions and with 5 bounding conditions of the conservation of elements.

Calculations with the SRcompound model prove that for each amount of carbon in the cycle of nature (carbon in seas, atmosphere, biomass), there is a maximum net growth of photosynthetic biomass, which, at the same time, is the absolute maximum of lasting use of photosynthetic biomass. The maximum global net growth of biomass can be increased by, and only by, recycling fossil carbon back to natural circulation.

Conclusion 4: An increase in the use of photosynthetic biomass increases the amount of carbon dioxide in the atmosphere.

This fact, understandable by common sense, has been proved mathematically in *Appendices* 2 and 3. The use of photosynthetic biomass increases carbon dioxide flow to the atmosphere and decreases carbon dioxide flow from the atmosphere. The use of photosynthetic biomass always increases the amount of carbon dioxide in the atmosphere. If the use of photosynthetic biomass is permanently greater than the net growth, it will lead to an ecocatastrophe.

Conclusion 5: Fossil carbon can be recycled back to the carbon cycle without increasing the amount of carbon dioxide in the atmosphere.

The simplest proof of conclusion 5 follows from the conservation of carbon the carbon cycle. This proof is confirmed by the calculations in *Appendix* 3, which prove univocally that the carbon of presently known fossil fuels can be recycled back to nature without increasing the amount of carbon dioxide in the atmosphere by increasing the amount of photosynthetic and dead biomass in oceans and terrestrial areas. This can be done by reducing global logging. The only obstacle is the ignorance and short-sightedness of politicians.

Conclusion 6: In order to maximize sustainable use of photosynthetic biomass, fossil carbon must be recycled back to the carbon cycle

The Authors prove in *Appendix 3* that mankind's sustainable use of energy and food can be increased noticeably by recycling fossil carbon back to the carbon cycle.

With current fossil fuel consumption, fossil fuels will run out within the next 50-150 years. The necessary condition of sustainable replacing of fossil fuel is that in the ecosystem there is sufficiently photosynthetic biomass (primarily forests) and carbon dioxide in the atmosphere. Calculations in *Appendix* 3 prove that global measures to increase photosynthetic biomass (primarily forests) must be started urgently. IPCC's recommendation to minimize carbon in the carbon cycle and carbon dioxide in the atmosphere, is leading to mankind's catastrophe within the next 50-150 years.

Conclusion 7: Measures to minimize economic and ecologic harms of IPCC's wrong claim

The calculations in *Appendix* 3 prove that with the present use of forests, mankind is drifting towards a situation where there is not enough photosynthetic biomass to supply the required energy and food. In order to avoid this catastrophe, research on transition to the post-fossil fuel era must be started immediately. In this research, the influences of local and global use of fossil fuels and photosynthetic biomass (forests) on sustainable production of food and energy in the post fossil fuel era will be studied. The calculations in *Appendix* 3 prove that minimum time to increase amount of photosynthetic biomass, primarily forests, so much that the fossil fuels can be replaced sustainably by photosynthetic biomass is at minimum 150 years. Therefore, measures for transition to the post-fossil fuel era must be started immediately. As immediate measures replacing fossil fuels, especially traffic fuels with biomass-derived biofuels, and the demolishing of useful coal power plants must be stopped immediately.

Proposal for further research

1. Updating the SRcompound model
2. Updating the SRclimate model
3. Updating the calculation parameters of the SRcompound model
   3.1. Areal use, amounts, specific growth, specific mortality, biological oxidation and thermal oxidation of photosynthetic and dead biomass in terrestrial areas and seas.
4. Applied calculations of the SRcompound model
   4.1. Preliminary calculations where the number of biomass species and areal regions are fixed and the calculation parameters are fitted to experimental data.
   4.2. Final calculations where the economic and ecologic influences of selected scenarios are studied.
5. Updating the SRclimate model
   5.1. Updating the calculation parameters
6. Updating the SRclimate model into a multi entity model
7. Applied calculations of the SRclimate model
   7.1. Preliminary calculations where the number of entities is fixed and the calculation parameters are fitted to experimental data
   7.2. Final calculations where the thermodynamic mean temperatures of the ground are calculated for the scenarios of SRcompound calculations
8. Worldwide publishing of the research

Appendix 1: A concise introduction to the climate

Definitions
Whether is described by quantities like temperature, pressure, velocity, cloudiness, relative humidity and amount of rain which vary strongly daily. Climate is defined as the mean whether during a long period of time (50-100 years).

Climate can be defined by different quantities of whether. Climate areas are usually defined according to the mean temperature and precipitation. This kind of classification is applied in Köppen's and Thornthwaiten's climate systems.

The mean temperatures of the ground before the latest ice age
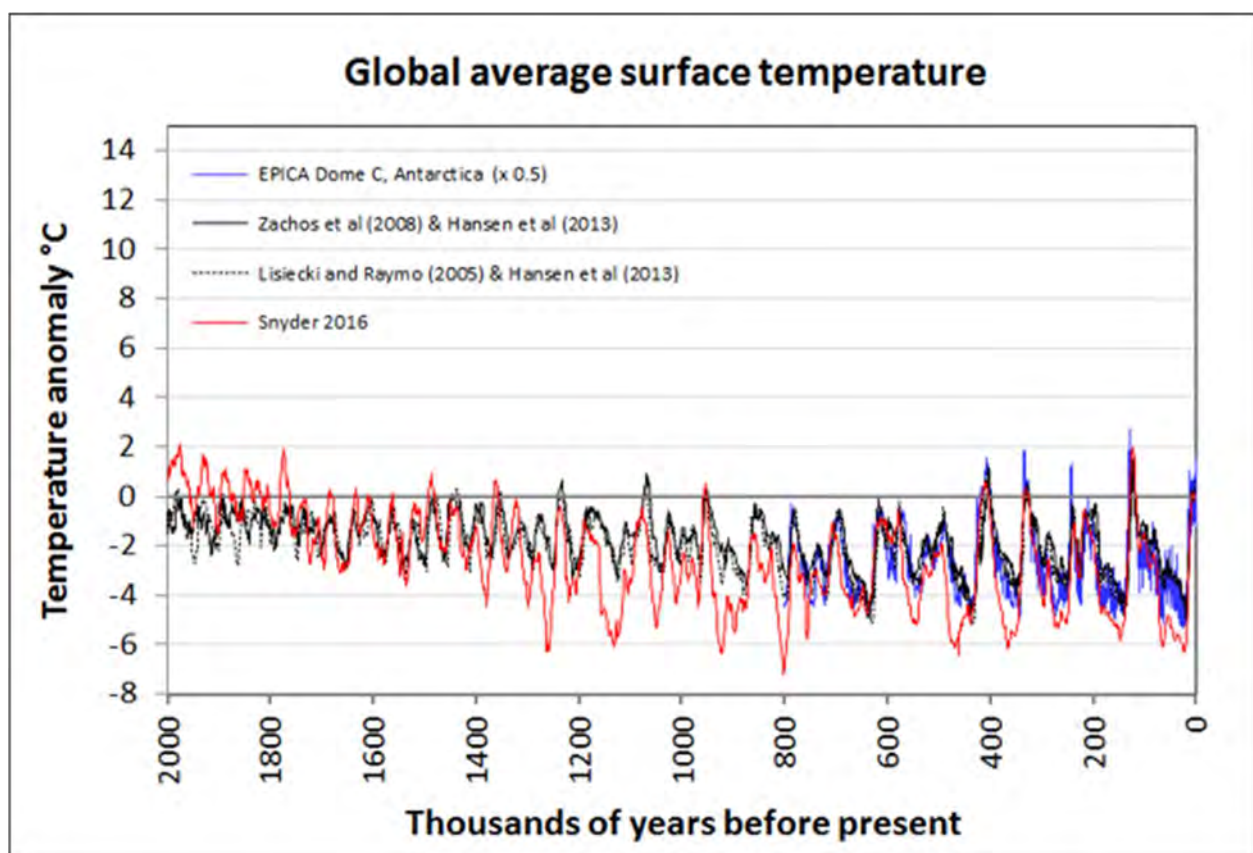
Figure 1 Figure shows that the mean temperature of the ground has been always varied and it is sure, that the variation is going to continue. During the latest 50 thousand years the mean temperature of the ground has increased about 6 ºC and that the increase is going on. On long term decreasing trend can be noticed which is due to inevitable decrease of nuclear reactions in the sun. The hundreds year trends are due to variation of surface temperature of the sun. These variations have nothing to do with CO_2 concentration in the atmosphere.

Summary of the global climate after the latest ice age
After the latest ice age, about 11550 years ago, started the age of Holocene. Holocene is divided into

- o   Old Holocene 11550-8000 years ago

    o   Atlantic Holocene from 8000 to 3800 ago

    o   New Holocene from 3800 forward

In the beginning of the Holocene the climate warmed rapidly. Maximum warming took place about 6800 years ago when the global mean temperature was 0.5-2 °C and in Finland mean temperature was 2-3 °C higher than at the present. After the Atlantic Holocene the atmosphere started to cool. During the small ice age AD 1300-1870 the global mean temperature decreased by about 0.4-0.6 °C. The coolest period was the 17th century. With about 100 years intervals there were very cold periods in 1650, 1770 and 1850. During the Holocene the global mean temperature has varied 1-2 °C with intervals of about 1500 years.

Variables which influence in the climate

The climate has always been varying and shall always vary because of the continuous changing of the internal and external variables of the ecosystem. In the following there is a simplified description of these variables and their influences.

The sun

By solving the partial differential equations of momentum and energy balance equations of the sun with present initial and boundary values simultaneously with the equation (4.1), it would be possible to calculate the solar radiance as function of time. Because of the lack of scientific knowledge this is not possible in the future to be seen. However, it is known that, owing to the nuclear reactions inside the sun, the equivalent radiation of the sun is equal to the radiation of a black circular surface with the radius of the sun at 6000 °K causing on a perpendicular surface of the outer atmosphere of the earth the irradiation of 1375 W/m^2. Radiation from the sun arrives the atmosphere within a narrow solid angle of about 6.85E-05 with the mean total radiance of 2.04E+07 W/m^2. Without remarkable error it can be assumed that the only radiance to the atmosphere is the solar radiance.

In the beginning of the 20th century it was observed that the solar eruptions caused magnetic disturbances and strong northern lights. The Russian Luna 1 measured the solar wind for the first time in 1959 and the existence of the solar wind was accepted finally in the 1960th. The solar wind is the consequence of solar eruptions in which hot plasma penetrates the surface of the sun like lava in volcanic eruptions in the earth. Temperature of the plasma in the solar eruptions is between 10000 °K and 20000 °K. Therefore, the solar eruptions influence strongly in the solar radiation and the global mean temperature in the atmosphere. Mean particle density of solar wind is 5E+6 m^{-3} and speed of the particles varies between 200 and 900 km/s. The composition of the solar wind is:

    o   95 % protons

    o   4 % completely ionized helium

    o   0.5 % other ions

    o   Solar wind is electrically neutral

    o   Mean energy of one proton is 1.60E-19 J (46000 °K)

    o   Mean energy of one electron is 2.72E-18 J (180000 °K)

Only a vanishingly small part of the energy and particles, released by the nuclear reactions of the sun, reach the earth as electromagnetic radiation and solar wind. The sun is the ultimate energy source of the atmosphere. Small changes in the flow field inside the sun influence remarkably in the temperature and velocity fields in the atmosphere and thus the global climate.

Without significant error it can be assumed that the gas compounds in the atmosphere do not absorb or reflect the solar radiation.

Liquid and solid water

Water particles in the atmosphere reflect about 30 % from the solar radiance back to the space. The reflection ratio depends strongly on the global mean temperature of the lower atmosphere and increases if the temperature increases and decreases in the opposite case. Reflection ratio depends also on location, form and quality of the clouds. This is only one mechanism by which water stabilizes the temperature of the lower atmosphere.

Solid particles

Penetration of the solar radiation into the lower atmosphere also is limited by amount and quality of solid particles in the atmosphere. The particle concentration in the atmosphere is due to volcanic eruptions, forest fires, traffic, industry and terrestrial dust. The atmospheric particles decrease global and areal mean temperatures. The aerosols act as condensing nucleus of water vapor and when the aerosols have grown big enough they fall to the earth as rain. By this mechanism water protects the ecosystem also from for the ecosystem too low temperatures of the lower atmosphere.

Volcanic eruptions raise dust and sulfur compounds, mainly SO_2, to height of 15 -25 km where the volcanic particles absorb solar radiation. SO_2 reacts with the water particles, which removes sulfur form the atmosphere and protect the ecosystem from too high SO_2 concentrations. It has been estimated that an average volcanic eruption increases the temperature in the stratosphere about 4-8 ^{o}K and decreases temperature in the lower atmosphere by about 0.3-1.1 ^{o}K during about 4 years after the eruption. The eruptions of Pinatubo, Chicon and Tampora influenced the climate remarkably. The eruption of volcano Laki in Island between June 1773 and February 1784 is estimated to have decreased the temperature in the Eastern parts of the North America for one winter by 4.8 ^{o}C and globally by 1 ^{o}C below the mean temperature of the previous 225 years. In the eruption of the volcano Roza, about 14 million years ago, about 700 km^3 of lava was released to the atmosphere in about seven days owing to that solar radiation to the earth decreased radically. The eruption of Roza has been estimated to have caused extinction of many species. The present warming of the lower atmosphere is partly due to decrease of volcanic particles in the atmosphere.

Vaporization and condensing of water

One more important stabilizing influence in the temperature of lower atmosphere of water is vaporization and condensation. Rain vaporizes on the surface of the earth and converts sensible energy into latent energy causing a remarkable cooling effect. Raising flows transport water vapor into the atmosphere where the latent energy is released causing remarkable warming effect. If the global mean temperature of lower atmosphere increases precipitation increases increasing the cooling. In the opposite case precipitation decreases decreasing cooling of the lower atmosphere. The annual global mean precipitation is about 1000 kg/m^2/a owing to the cooling effect of 79 W/m^2. Without this cooling the present ecosystem would not exist. Global reduction of forests, especially rainforests, has degreased vaporization and increased the mean temperature of the lower atmosphere locally and globally.

Nuclear reactions inside the earth

The earth has an iron nickel core which causes a strong magnetic field which protects the ecosystem from high frequency radiation and high energy particles from the sun. The magnetic core influences also the oceanic currents and in the atmosphere.

Gravitation

Gravitation of the celestial bodies, above all, the sun and the moon, influence the flow fields in the oceans and in the atmosphere.

Collisions of large bodies to the earth and the atmosphere

Collisions may cause and have caused unpredictable changes in the climate by influencing the oceanic and atmospheric currents and by increasing particles in the atmosphere.

The oceans

The oceans, the atmosphere and the terrestrial areas form an interacting unity. The slow and unpredictable changes of the oceanic currents influence strongly in the atmosphere. Because the heat transfer coefficient in water is hundreds of times the heat transfer coefficient in the air the smelting of ice in the polar areas is more sensible for the changes of the oceanic currents than for a small increase of global mean temperature of the lower atmosphere.

Mankind

During the past 150 years the mankind has influenced in the ecosystem by many harmful ways.

1. Decreased the forested area
2. Increased cultured and made-up areas
3. Decreased the amount of the photosynthetic and dead biomass
4. Decreased vaporization of water which has caused primarily areal but also global warming

The mankind has increased the amount of carbon in the carbon cycle which, together with the global decrease of the amount of photosynthetic and dead biomass, has caused the realized increase of CO_2 concentration in the atmosphere.

Absorbing and emitting gas compounds

Molar absorption area of gas compounds is function of temperature and frequency of radiation. For three and four atomic gases like H_2O, CO_2, SO_2, NO_2, CH_4 molar absorption area is greater for low frequency radiation than for high frequency radiation and the mentioned gases penetrate nearly all solar radiation but absorb and emit low frequency radiation. Linear absorption coefficient of a gas compound is product of molar absorption area and mole density of the compound and, without significant error, it can be assumed that the linear absorption coefficient of the equation (4.1) of the Appendix 4 is sum of the linear absorption coefficients of the compounds and the atmospheric particles. Mole densities of SO_2, NO_2, CH_4 are so small that their influence in the total linear absorption coefficient can be neglected without significant error.

When the linear absorption coefficients are calculated for water vapor and CO_2 in the conditions of present global lower mean atmosphere it is observed, that the linear absorption coefficient of water vapor and droplets is about 61 times the linear absorption coefficient of CO_2. The influence of CO_2 in the total linear absorption coefficient of the atmosphere vanishes within the uncertainty of the measured linear absorption coefficient of water vapor. Without significant error it can be said that the only greenhouse gas in the atmosphere is water vapor. By this reasoning alone it can be concluded that the influence of CO_2 on the global mean temperature of the lower atmosphere is negligible.

Appendix 2: Influence of replacing fossil energy with the energy of photosynthetic biomass on the CO₂ concentration in the atmosphere

Nomenclature

l_v =specific heat of vaporization of water in 25 °C =2,443 MJ/kg.

M_{CO2}=molar mass of CO₂

M_C=molar mass of carbon

m_{CO2} =mass of CO₂ produced in combustion

$m_{CO2,f}$ =mass of CO2 produced by an electric power plant (equation (2.4))

$\frac{m_v}{m_p}$ =mass of water divided by mass of dry ash-free mass of fuel

q_{ip} =specific heating value of dry ash-free fuel, when flue gas is cooled to 25 ºC and the produced water is in the gas entity

Q_n =output energy of process n

Q_e=produced electric energy

Q_w=energy to the boiler walls

Q_i = energy produced in combustion, when flue gas is cooled to 25 ºC and water is in the gas entity

$\eta_n = \frac{Q_n}{Q_{n-1}}$ =energy efficiency of process n (equation (2.2))

$\mu_{CO2,w,f}$ =CO₂ amount divide by energy to boiler wall

x_{Cp} = mass fraction of carbon in dry ash-free fuel

Introduction

In this appendix it is proved by thermostatic considerations that replacing of energy of fossil fuels by energy of photosynthetic biomass increases CO₂ concentration in the atmosphere. It is also shown that production of energy by from the photosynthetic biomass processed biofuel increases CO₂ concentration in the atmosphere more than if the equal amount of energy had been produced by direct combustion of the photosynthetic biomass which is needed to produce the biofuel.

Influence on the CO₂ flow to the atmosphere

One of the most flagrant misunderstandings of the greenhouse gas society is that biomass is "a carbon neutral fuel" which does not increase the CO₂ content of the atmosphere. Use of biomass doesn´t increase carbon in the cycle of nature but it increases carbon in the atmosphere per produced energy more than use of any fossil fuel. The amount of produced CO₂ divided by the amount of produced energy can be calculated unambiguously from equation (2.1) when the element composition and specific heating value of the fuel are known.

$$\mu = m_{CO2}/Q_i = \frac{M_{CO2}}{M_C}\left(x_{Cp}/\left(q_{ip} - \frac{m_v}{m_p}l_v\right)\right) \tag{2.1}$$

m_{CO2} =mass of CO₂ produced in combustion

Table 1. Calorimetric CO₂-amounts calculated from equation (2.1). For comparison, corresponding CO₂-amounts given by Statistics Finland (Tilastokeskus) and Motiva (Specialist in Energy and Material Efficiency) are presented, which within the dispersion of calculation parameters are the same as those calculated from equation (1).

Fuel	Specific lower heating value of dry ash-free fuel	Specific lower heating value /ash-free matter	Mass fraction of C in dry ash-free matter	Mass of water/Mass of dry ash-free matter	Specific heat of vaporization of water in 25 °C	Produced CO2/lower heating value (g/MJ)	Produced CO2/lower heating value (g/MJ)	Produced CO2/lower heating value (g/MJ)
	MJ/kg	MJ/kg			MJ/kg	Equation (1.1)	Tilastokeskus	Motiva
Pine	19.20	16.61	0.505	1.06	2.443	111.40	111.39	111.24
Coal	32.00	31.76	0.822	0.1	2.443	94.85	96.73	94.60
Oil	42.00	42.00	0.850	0	2.443	74.14	75.48	74.9
Natural gas	43.80	43.80	0.659	0	2.443	55.13	56.06	55.04

In general, if an energy conversion process consists of N sequential processes, the ratio of output energy Q_N and input energy Q_0 is

$$\frac{Q_N}{Q_0} = \frac{Q_N}{Q_{N-1}} \frac{Q_{N-1}}{Q_{N-2}} \ldots \frac{Q_1}{Q_0} = \prod_{n=1}^{N} \frac{Q_n}{Q_{n-1}} = \prod_{n=1}^{N} \eta_n \qquad (2.2)$$

Q_n =output energy of process n

Q_{n-1}=input energy of process n

Most part of the global electricity is produced in steam power plants which convert chemical energy of fuel to electric energy and heat. Steam boilers of these power plants are designed so that at nominal power the exit temperature of flue gas is about 150 °C, which means that the flue gas energy loss depends on the water content of the fuel and O_2 content of the flue gas. For technical reasons in combustion, the O_2 content of flue gas must be about 5 %. In figure 1 there are calorimetric CO_2 amounts and CO_2 amounts divided by energy to boiler walls $\mu_{CO2,w,f}$ for biomass with 50 % water content, coal, oil and natural gas.

	Biomass	Coal	Oil	Natural gas
■ Boiler	121.1	100.7	79.7	59.3
■ Calorimetric	111.4	94.9	74.2	55.1
■ Difference	9.7	5.8	5.5	4.2
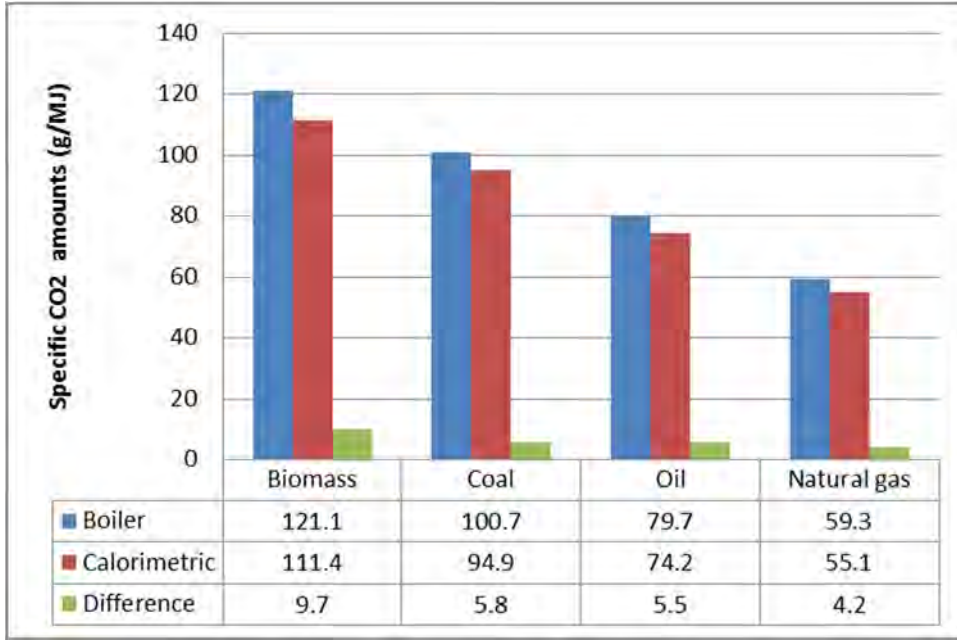
Figure 1 Mass of produced CO_2 divided by the energy to boiler walls Q_w when the flue gas temperature is 150 °C and the oxygen content of the flue gas is 5 %, and calorimetric specific CO_2-amounts (equation (2.1)). The specific CO_2 amount $\mu_{CO2,w,f}$ depends strongly on fuel and is for biomass much bigger for any fossil fuel.

In order to produce electric energy Q_e with a steam power plant the energy to the boiler walls Q_w must be

$$Q_w = \left(\frac{Q_w}{Q_e}\right) Q_e \qquad (2.3)$$

Q_e=produced electric energy

Q_w=energy to the boiler walls

CO_2-amount produced by a steam power plant which produces electric energy Q_e is

$$m_{CO2,f} = Q_w \mu_{CO2,w,f} = \left(\frac{Q_w}{Q_e}\right) Q_e \mu_{CO2,w,f} = \frac{Q_e \mu_{CO2,w,f}}{\eta_{ew}} \qquad (2.4)$$

Without significant error can be assumed that the ratio $\left(\frac{Q_w}{Q_e}\right)$ is independent of fuel.

If fossil fuel f (natural gas, gasoline, diesel or coal) is replaced by a biofuel which is processed from photosynthetic biomass the specific CO_2-amounts grow further. Replacement of energy of fossil fuel with energy of biofuel increases CO_2 amount to the atmosphere more than replacement of energy of fossil fuel with energy of biomass. If energy of fossil coal is replaced by energy of coal produced from biomass by pyrolysis mass of CO_2 produced by biofuel divided by mass of CO_2 produced by fossil coal can be even more than 2.

Influence on the CO₂ flow from the atmosphere
Everybody understands that photosynthetic biomass removes CO_2 from the atmosphere and dead biomass does not. Therefore, even the real specific CO_2 amounts in figure 1 underestimate the influence of replacing the energy of fossil fuels with the energy of photosynthetic biomass on CO_2 content in the atmosphere, because the replacement increases CO_2 flow to the atmosphere and decreases CO_2 flow from the atmosphere at the same time.

Figure 2 shows the tons of CO_2 per hectare per year which natural Finnish forest removes from the atmosphere as a function of the age of the forest. When photosynthetic biomass dies, its CO_2 removal from the atmosphere ends. If one hectare of the forest is felled at the age of 200 years, CO_2 flow from the atmosphere decreases by 57 tons/hectare/a. If the forest is felled earlier, the decrease of CO_2 flow from the atmosphere is less per hectare, but in order to produce the same energy, a bigger area must be felled.
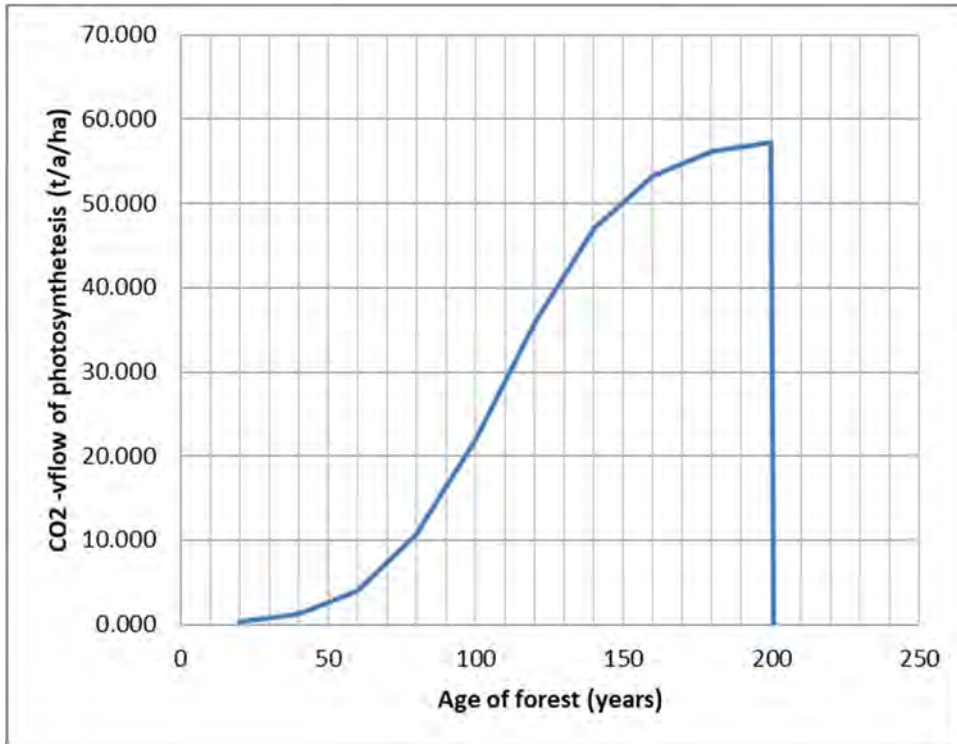
Figure 2 CO_2 amount/ hectare/year removed from the atmosphere by the wood of Finnish natural forest as a function of age.
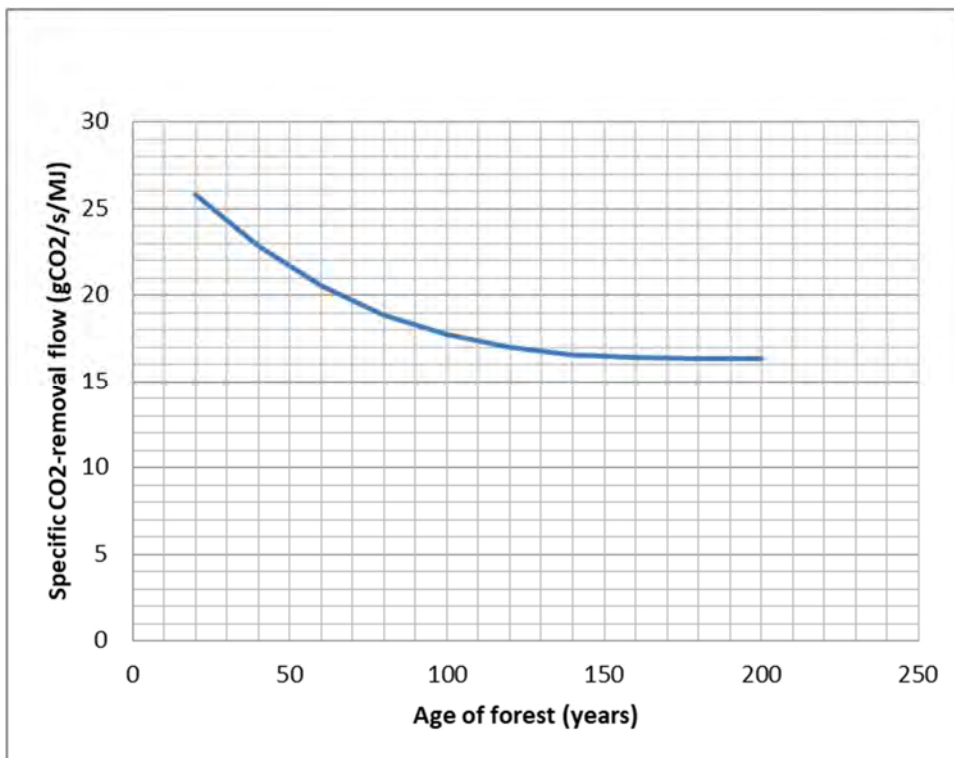
Figure 3 The CO_2 flow which wood removes from the atmosphere, divided by the released energy of wood as a function of age in Finnish natural forests (specific CO_2 flow), when the flue gas temperature is 150 °C and the oxygen content in the flue gas is 5 %.

Use of forest decreases CO_2 flow from the atmosphere by the using rate multiplied by the specific CO_2 flow. The specific CO_2 flow decreases when the age of wood increases. If CO_2 flow to the atmosphere caused by use of forest should be minimized, the age of used forest should be maximized. The specific CO_2 removal rate is directly proportional to the growth rate. Therefore, it is pointless to think that using fast-growing biomass would increase CO_2 concentration in the atmosphere less than the use of slowly growing biomass.

Net influence on the CO_2 flow to the atmosphere

On the aforesaid grounds it can be concluded that always when energy of fossil fuel is replaced by energy of photosynthetic biomass:

1. Increase of CO_2 flow to the atmosphere is the replaced power times the difference between the specific CO_2 amounts of fossil fuel and photosynthetic biomass (figure 1).
2. Decrease of CO_2 flow from the atmosphere is the replaced power times the specific CO_2 flow of photosynthetic biomass (figure 3).

The consequences of the replacement of the energy of fossil fuels by the energy of photosynthetic biomass cannot be predicted quantitatively without a mathematical model of element and compound balances of the ecosystem, but the following qualitative conclusions can be made:

3. Replacing the energy of fossil fuels by the energy of photosynthetic biomass increases the increasing rate of CO_2 concentration in the atmosphere.
4. If the use of photosynthetic biomass is less than the net growth of photosynthetic biomass, the ecosystem approaches an equilibrium where:
    4.1. CO_2 concentration in the atmosphere is bigger, and
    4.2. the amount of photosynthetic biomass is less than before the replacement.

5. If the use of photosynthetic biomass is permanently more than the net growth of photosynthetic biomass, the development will lead to an ecocatastrophe.

Appendix 3: Theoretical foundations of ecosystem models

Nomenclature

$H_{ypf} = n_{ybp}/n_{ybf}$=mole density ratio of compound y on boundary b between entities p and f. Quantities H_{ypf} are thermostatic properties which can be measured for each boundary and compound.

K_{ypf}= compound transfer coefficient of compound y from entity p to entity f

n_{yp}= density of compound y of entity p (mole/m³)

n_{yf}= density of compound y of entity f (mole/m³)

n_{yp}= density of compound y of entity p (mole/m³)

$\dot{N}_{ypf} = A_{pf}\dot{N}''_{ypf}$ = flow of compound y from entity p to entity f

$\frac{dN_{yf}}{dt}$= increasing rate of compound y of entity f (mole/s)

$\dot{N}_{ypf} = K_{ypf}n_{yp} - K_{yfp}n_{yf} = -\dot{N}_{yfp}$ = flow of compound y from entity p to entity f.

N_{ae}=number of element a of the ecosystem

N_{ap}= number element a of entity p

N_{yp}=number of compounds y in entity p

N_{Ce} = number of carbon atoms of the ecosystem.

$N'''_{CO2,I}$= mole density of CO₂ in the atmosphere (mole/m³)

$N''_{Y,B}$= mole density of photosynthetic biomass in photosynthetic biomass entity B (mole/m²)

$\dot{R}_{rf} = \dot{R}^+_{rf} - \dot{R}^-_{rf}$=rate of reaction r – rate of inverse reaction of reaction r in entity f

T_{rf}= activation temperature of reaction r in entity f

T_f= temperature of entity f

Y= number of compounds

β_{ay}=number of element a of compound y

κ_{pb}= compound transfer coefficient of compound y from entity p to the boundary between entities f and p

κ_{fb}= compound transfer coefficient from entity f to the boundary between entities f and p

k_{rf} = coefficient of reaction rate correlation of reaction r in entity f

ω_{yrf}= exponent of compound y in reaction rate correlation of reaction r in entity f

ν_{yr}=coefficient of compound y (mole/reaction) in reaction r

Introduction

The only lasting foundation for analyzing the influences of replacing fossil energy with the energy of photosynthetic biomass is a mathematical model of the element and compound balances of the ecosystem. In the following, the main features of this model are presented. Mathematically the problem leads to a set of time-dependent differential equations which must be solved for the given initial conditions under the bounding conditions of the conservation of elements. The following mathematical treatment is based on the general theory of stochastic entity systems.

Climate change and use of fossil fuels

Summary

The mathematical theory of the ecosystem was verified by the developed SRcompound model by applying it for three global energy scenarios. The calculations showed that

1. The mathematical algorithms of the model converged fast and reliably
2. The calculated results responded logically to changes of energy scenarios
3. The calculations confirmed that always when fossil energy is replaced by an equal amount of energy of photosynthetic biomass, CO_2 concentration in the atmosphere increases.

The presented mathematical model has been applied to the following energy scenarios by using preliminary database.

Scenario 1:

The use of fossil fuels is constant until in the year 45 oil and the year 65 natural gas end. The energy of oil and natural gas is replaced by the energy of photosynthetic biomass. The use of coal is constant during the whole calculation period.

1. Legend Scenario 1 in figure 6 shows that CO_2 concentration in the atmosphere decreases until first the energy of oil and then the energy of natural gas are replaced by energy of photosynthetic biomass, which turns CO_2 concentration in the atmosphere into growth, but CO_2 concentration stabilizes to about 390 ppm.
2. Legend Scenario 1 in figure 7 shows that the amount of photosynthetic biomass increases until first the energy of oil and then the energy of natural gas are replaced by the energy of photosynthetic biomass, which for some years stops the increase of photosynthetic biomass, but the amount of photosynthetic biomass starts increasing g again around the year 90.
3. Legend Scenario 1 in figure 8 shows that the amount of dead biomass increases as well.

Scenario 2:

Otherwise same as scenario 1, but in year 90 the energy of coal is replaced by the energy of photosynthetic biomass.

1. Legend Scenario 2 in figure 6 shows that CO_2 concentration in the atmosphere behaves as in scenario 1, until in year 90 the energy of coal is replaced by the energy of photosynthetic biomass, which causes rapid increase of CO2 concentration.
2. Legend Scenario 2 in figure 7 shows that the amount of photosynthetic biomass behaves as in scenario 1, until in year 90 the energy of coal is replaced by the energy of photosynthetic biomass, which causes rapid decrease in the amount of photosynthetic biomass.
3. Legend Scenario 2 in figure 8 shows that when the energy of coal is replaced by the energy of photosynthetic biomass in year 90, the amount dead biomass starts to decrease.

Scenario 3:

The energy of all fossil fuels is replaced by the energy of photosynthetic biomass.

1. Legend Scenario 3 in figure 6 shows that CO_2 concentration in the atmosphere increases rapidly and approaches its maximum value.
2. Legend Scenario 3 in figure 7 shows that the amount of photosynthetic biomass decreases rapidly towards zero, which is reached near year 70.
3. Legend Scenario 3 in figure 8 shows that the amount of dead biomass decreases rapidly towards zero, which is reached near year 110.

The SRcompound model is based on the balance axiom, thermostatic correlations, universally valid laws of conservation of elements, and mathematics. Even though the parameters of the preliminary calculations must be confirmed, the trends of calculated results are correct. The vital result of the

research is that in order to avoid an ecocatastrophe, the replacing of fossil energy with bioenergy, especially the fossil traffic fuels, must be stopped immediately and global use of photosynthetic biomass (primarily forests) must be reduced to a level where the global amount of photosynthetic biomass increases. These measures must be implemented immediately.

Compound balances

The balance equation of compound y of entity f (part f of the ecosystem) can be expressed by equation (3.1)

$$\frac{dN_{yf}}{dt} = \sum_{p=1}^{N_e} \dot{N}_{ypf} + \sum_{r=1}^{N_r} \nu_{yr} \dot{R}_{rf} \qquad (3.1)$$

N_e =number of entities

N_r =number of reactions

$\frac{dN_{yf}}{dt}$= increasing rate of compound y of entity f (mole/s)

$\dot{N}_{ypf}$= flow of compound y from entity p to entity f

$\dot{R}_{rf} = \dot{R}_{rf}^+ - \dot{R}_{rf}^-$=net rate of reaction r in entity f

ν_{yr}=coefficient of compound y (mole/reaction) in reaction r

Diffusion compound flows between entities

Diffusion flow of compound y from entity f to entity p divided by the cross-section area can be calculated from equation (3.2)

$$\dot{N}''_{yfp} = \frac{n_{yf}H_{ypf}\kappa_{bp}\kappa_{fb} - n_{yp}\kappa_{pb}\kappa_{bf}}{H_{ypf}\kappa_{bp} + \kappa_{bf}} = K_{yfp}n_{yf} - K_{ypf}n_{yp} \qquad (3.2)$$

$K_{yfp} = \frac{H_{ypf}\kappa_{bp}\kappa_{fb}}{H_{ypf}\kappa_{bp} + \kappa_{bf}}$ = compound transfer coefficient of compound y from entity p to entity f

$K_{ypf} = \frac{\kappa_{pb}\kappa_{bf}}{H_{ypf}\kappa_{bp} + \kappa_{bf}}$ = compound transfer coefficient of compound y from entity f to entity p

n_{yf}= density of compound y of entity f (mole/m^3)

n_{yp}= density of compound y of entity p (mole/m^3)

κ_{pb}= compound transfer coefficient of compound y from entity p to the boundary between entities f and p

κ_{fb}= compound transfer coefficient from entity f to the boundary between entities f and p

$H_{ypf} = n_{ybp}/n_{ybf}$=mole density ratio of compound y on boundary b between entities p and f. Quantities H_{ypf} are thermostatic properties which can be measured for each boundary and compound.

$\dot{N}_{ypf} = A_{pf}\dot{N}''_{ypf}$ = flow of compound y from entity p to entity f

If compound transfer does not limit the reaction rate, as the case is in photosynthesis and biological oxidation, it can be assumed that $n_{ybp} = n_{yp}$ and $n_{ybf} = n_{yf}$. Then the ratio of the mole densities of compound y in entities p and f can be calculated from Henry-correlations $H_{ypf} = n_{yp}/n_{yf} = 1/H_{yfp}$.

Photosynthesis reaction rate correlations

Following the general reaction kinetic formulation, equation (3.3) can be written for the rate of reaction r (reactions per second) in entity f.

$$\dot{R}_{rf} = V_f \dot{R}_{rf}''' = N_f V_{mf} \dot{R}_{rf}''' = A N_f'' V_{mf} \dot{R}_{rf}''' = A N_f'' V_{mf} k_{rf} \prod_{y=1}^{N_c} n_y^{\omega_{yrf}} e^{T_{rf}/T_f} \quad (3.3)$$

k_{rf} = coefficient of reaction rate correlation of reaction r in entity f

ω_{yrf} = exponent of compound y in reaction rate correlation of reaction r in entity f

T_{rf} = activation temperature of reaction r in entity f

T_f = temperature of entity f

N_c = number of compounds

Conservation of elements

The number of compounds y N_{yp} is bound by the number of elements of the ecosystem N_{ae}, which is constant of nature. Conservation of element a can be expressed mathematically by equation (3.4):

$$N_{ae} = \sum_{p=1}^{P} \sum_{y=1}^{Y} \beta_{ay} N_{yp} = \sum_{p=1}^{P} N_{ap} \quad (3.4)$$

N_{ae} = number of element a of the ecosystem

N_{ap} = number element a of entity p

N_{yp} = number of compounds y in entity p

β_{ay} = number of element a of compound y

When the atmosphere is defined as entity 1, the conservation equation of carbon can be expressed by equation (3.5).

$$N_{C,1} = N_{Ce} - \sum_{p=2}^{P} N_{Cp} \quad (3.5)$$

N_{Ce} = number of carbon atoms of the ecosystem.

It follows from equation (3.5) that the amount of carbon in the atmosphere depends only on how much carbon there is in other entities of the ecosystem. Without a remarkable error it can be assumed that amount of carbon in the atmosphere is equal with the amount of CO_2. This means that the CO_2 content in the atmosphere is a state quantity.

Without remarkable error, it can be assumed that:

1. The amount of carbon of inorganic compounds is small in comparison with carbon in organic compounds, the atmosphere, fossil fuels and oceans.
2. The amount of carbon of inorganic compounds is independent of the amount of carbon of biomass and fossil fuels
3. CO_2 concentrations in the atmosphere and oceans are in thermostatic equilibrium.

On these grounds, it can be concluded without significant error that the CO_2 content of the atmosphere depends only on how much carbon there is in biomass and fossil fuels at any given moment.

Compound balances

The balance equation of compound y of homogenous entity B can be written as

$$\frac{dN_{yB}}{dt} = \sum_{p=1}^{P} \dot{N}_{y,p,B} + \sum_{r=1}^{R} \nu_{yr} \dot{R}_{rB}$$

When the above equation is applied to photosynthetic biomass, we can assume that the only reactions are photosynthesis and death of photosynthetic biomass. Compound flow densities through the boundary of photosynthetic biomass can be assumed to be so small that the compound densities on both sides of the boundary are in thermostatic equilibrium. Then the compound balances of photosynthetic biomass entity are simplified to the following form:

$$\frac{dN_{yB}}{dt} = \sum_{r=1}^{R} \nu_{yr} \dot{R}_{rB}$$

Growth, mortality, oxidation and use correlations

Reaction rate of photosynthesis reaction

Under certain nutrient, humidity and temperature conditions, the rate of photosynthesis reaction depends only on the CO_2 concentration of photosynthetic biomass and the amount of photosynthetic biomass. The amount of biomass per a terrestrial area (biomass density) is known or can be measured. The amount of biomass is biomass density multiplied by the terrestrial area. It is justified to assume that the rate of photosynthesis reaction decreases when the biomass density increases. Let us assume that the reaction rate coefficient of photosynthesis reaction $k_{y,B} = k_{y,B}^{*} N_{B}^{\prime\prime m_B} = k_{y,B}^{*} \left(\frac{N_B^{\prime\prime}}{N_{Y,B}^{\prime\prime}} N_{Y,B}^{\prime\prime} \right)^{m_B}$. Then, for reaction rate per terrestrial area $\dot{R}_{y,B}^{\prime\prime}$ of the photosynthesis reaction y of photosynthetic biomass entity B can be written as the following formula:

$$\dot{R}_{y,B}^{\prime\prime} = \frac{N_B^{\prime\prime}}{N_{Y,B}^{\prime\prime}} N_{Y,B}^{\prime\prime} V_{m,B} k_{y,B}^{*} \left(\frac{N_B^{\prime\prime}}{N_{Y,B}^{\prime\prime}} N_{Y,B}^{\prime\prime} \right)^{m_B} e^{T_{y,B}/T_B} N_{CO2,B}^{\prime\prime\prime \ \omega_{CO2,y,B}}$$

Mole ratio $\frac{N_B^{\prime\prime}}{N_{Y,B}^{\prime\prime}}$ can be assumed to be constant, and by combining the terms which are independent of compound amounts, into coefficient $K_{y,B}$, the following expression can be written for the reaction rate of photosynthesis reaction y of photosynthetic biomass entity B per terrestrial area:

$$\dot{R}_{y,B}^{\prime\prime} = K_{y,B} N_{Y,B}^{\prime\prime \ 1+m_B} N_{CO2,B}^{\prime\prime\prime \ \omega_{CO2,y,B}}$$

It can be assumed without significant error that on the boundary of photosynthetic biomass entity B compound concentrations are in thermostatic equilibrium, and equation (3.6) can be written.

$$\dot{R}_{y,B}^{\prime\prime} = K_{y,B}^{I} N_{Y,B}^{\prime\prime \ 1+m_B} N_{CO2,I}^{\prime\prime\prime \ \omega_{CO2,y,B}} \tag{3.6}$$

$N_{CO2,I}^{\prime\prime\prime}$ = mole density of CO_2 in the atmosphere (mole/m³)

$N_{Y,B}^{\prime\prime}$ = mole density of photosynthetic biomass in photosynthetic biomass entity B (mole/m²)

Mole flow of photosynthetic biomass compound Y per terrestrial area due to photosynthesis reaction (mole/s/m²) is

$$\dot{N}_{Y,B}^{\prime\prime} = \nu_{Y,y} \dot{R}_{y,B}^{\prime\prime} \ ; \ \nu_{Y,y} = \text{coefficient of the photosynthetic biomass compound in photosynthesis reaction.}$$

Natural dying rate of photosynthetic biomass

Under certain nutrient, humidity and temperature conditions, the dying rate density of photosynthetic biomass depends only on the amount of photosynthetic biomass per terrestrial area. Then equation (3.7) can be written for death reaction (inverse reaction of photosynthesis reaction) rate per terrestrial area.

$$\dot{R}_{k,B}^{\prime\prime} = K_{k,B} N_{Y,B}^{\prime\prime \ m_{k,B}} \tag{3.7}$$

The mole flow of dead biomass per terrestrial area due to death reaction (mole/m²) is

$\dot{N}''_{Y,B} = \nu_{Y,k} \dot{R}''_{k,B}$; $\nu_{Y,k}$= coefficient of dead biomass compound in death reaction

Use of photosynthetic biomass

The use of photosynthetic biomass can be assumed to be a known function of time

$$\dot{R}''_{k,B} = \dot{R}(t)''_{k,B} \tag{3.8}$$

Balance equation of photosynthetic biomass

With the above arguments, the balance equation of photosynthetic compound in the photosynthetic biomass entity can be expressed by equation 3.(9).

$$dN''_{Y,B}/dt = \nu_{Y,y} K_{y,B} N''_{y,B}{}^{1+m_{y,B}} N'''_{CO2,I}{}^{\omega_{CO2,y,B}} + \nu_{Y,k}\left(K_{k,B} N''_{Y,B}{}^{m_{k,B}} + \dot{R}(t)''_{k,B}\right) \tag{3.9}$$

Compound balances of the dead biomass entity

When photosynthetic biomass dies, it forms an equal amount of dead biomass with the same element composition (reaction 5 in table 2). However, because dead and photosynthetic biomass has entirely different biological properties, they must be treated as separate compounds.

Balance equation of dead biomass compound

Dead biomass compound K of dead biomass entity D is created by natural death and use of photosynthetic biomass and extinguished by biological and thermal oxidation. Applying the same reasoning as in equation (3.9), the balance equation of dead biomass compound K of dead biomass entity D can be expressed by equation (3.10)

$$dN''_{K,D}/dt = \nu_{K,k}\left(K_{k,B} N''_{Y,B}{}^{m_{k,B}} + \dot{R}(t)''_{k,B}\right) + \nu_{K,h}\left(K_{K,h} N''_{K,D}{}^{m_{K,h}} N'''_{O2,I}{}^{\omega_{O2,h,D}} + \dot{R}(t)''_{k,D}\right) \tag{3.10}$$

Verification of equation (9)

When the coefficient of the photosynthetic biomass compound in photosynthesis reaction is $\nu_{Y,y} = 1$ mole/reaction, and the coefficient of dead biomass compound in death reaction is $\nu_{K,k} = -1$ mole/reaction, equation (3.9) can be expressed by equation (3.11).

$$dN''_{Y,B}/dt = K_{y,B} N''_{y,B}{}^{1+m_{y,B}} N'''_{CO2,B}{}^{\omega_{CO2,y,B}} - \left(K_{k,B} N''_{Y,B}{}^{m_{k,B}} + \dot{R}(t)''_{k,B}\right) \tag{3.11}$$

The parameters of equation (3.11) have been determined by matching the calculated mole densities to Dr Ilvessalo's measurements in Finnish natural forests (use of photosynthetic biomass is zero).
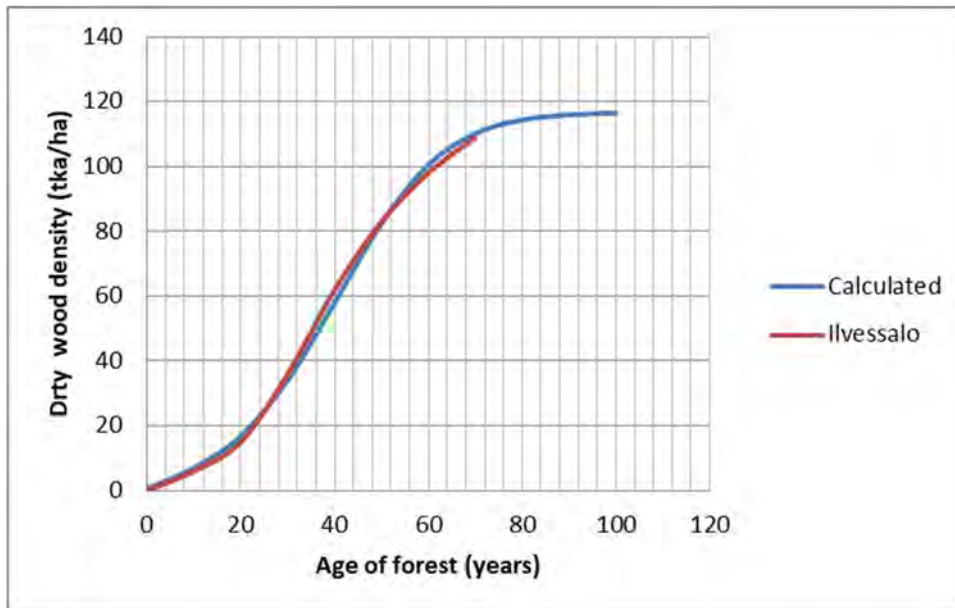
Figure 1 The measured amounts of dry spruce per hectare in a Finnish forest as function of the age of the forest and corresponding amounts calculated by equation (9). Excellent coincidence is achieved by the following parameters: $K_{y,B} = 1{,}31E - 6$, $K_{k,B} = 4{,}8E - 11$, $1 + m_{y,B} = 0{,}88$, $\omega_{CO2,y,B} = 1{,}0$, $m_{k,B} = 1{,}37$.
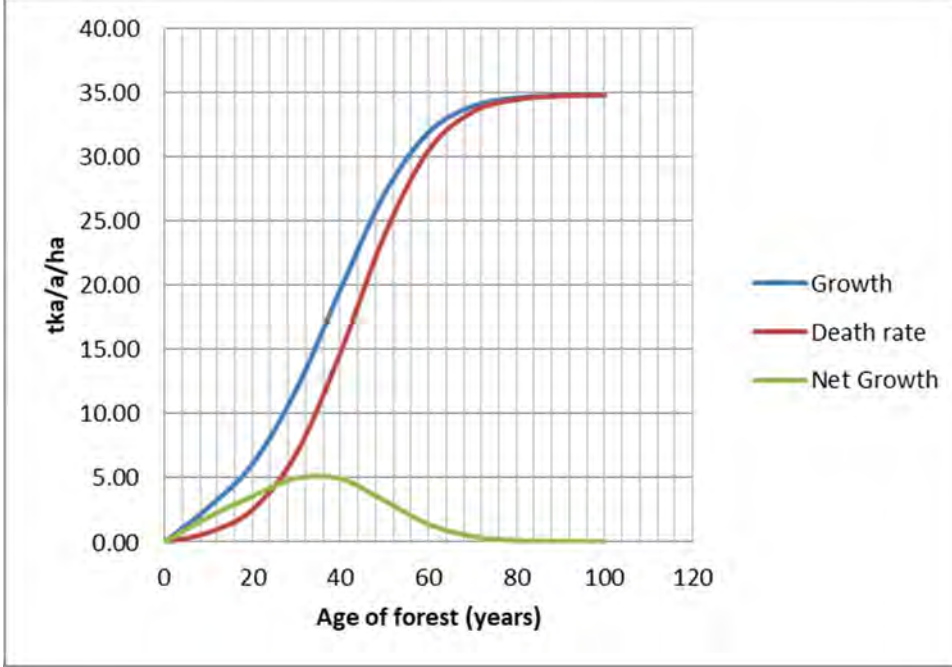
Figure 2 Annual growth, natural dying rate and net growth per hectare of a Finnish spruce forest as calculated from equation (3.11) and using the parameters shown in figure 1. Maximum net growth is achieved in the forest in less than 40 years, when the amount of wood is less than half of the amount of wood in the forest at the age of 100 years. Decrease of the average age of the forest increases CO_2 in the atmosphere.

Equation (3.11) can be expressed in a dimensionless form by using the following dimensionless variables.

$$N_{CO2,B}^{*} = N_{CO2,B}^{'''}/N_{CO2,B}^{'''}(0)$$

$$N_{Y,B}^{*} = N_{Y,B}^{''}/N_{Y,B}^{''}(0)$$

$$t^{*} = t\left(K_{y,B}N_{Y,B}^{''}(0)^{1+m_{y,B}}N_{CO2,B}^{'''}(0)^{\omega_{CO2,y,B}}\right)/N_{Y,B}^{''}(0)$$

$$K_{k,B}^{*} = K_{k,B}N_{Y,B}^{''}(0)^{m_{k,B}}/\left[K_{y,B}\left(N_{Y,B}^{''}(0)\right)^{1+m_{y,B}}\left(N_{CO2,B}^{'''}(0)\right)^{\omega_{CO2,y,B}}\right]$$

$$R(t^{*})_{Y,B}^{*} = \dot{R}(t)_{k,B}^{''}/\left[K_{y,B}\left(N_{Y,B}^{''}(0)\right)^{1+m_{y,B}}\left(N_{CO\ ,B}^{'''}(0)\right)^{\omega_{CO2,y,B}}\right]$$

Applying to the dimensionless form of equation (11) the parameters determined according to the measurements of Dr. Ilvessalo, we come to the dimensionless equation (3.12).

$$dN_{Y,B}^{*}/dt^{*} = N_{CO\ ,B}^{*}{}^{1{,}0}N_{Y,B}^{*}{}^{0{,}88} - 0{,}2N_{Y,B}^{*}{}^{1{,}37} - R(t^{*})_{Y,B}^{*} \qquad (3.12)$$

In the test calculations equation (3.13) is used as the bounding condition, which means that the carbon amounts of photosynthetic biomass and the atmosphere are constant.

$$N_{CO2,I}^{*} = 5{,}5 - 0{,}5N_{Y,B}^{*} \qquad (3.13)$$

In addition, we set $N_{CO2,B}^{*} = N_{CO2,I}^{*}$, which means that the Henry coefficient of CO_2 on the boundary between photosynthetic biomass and the atmosphere is 1. In order to verify the presented theory,

equation (3.12) has been solved numerically for 5 values of dimensionless use of photosynthetic biomass with equation (3.13) as the bounding condition. The initial condition is $\dot{N}(0)^*_{Y,B} = 1$. Dimensionless use $R(t^*)^*_{Y,B}$ is maintained zero until dimensionless time 12, after which the dimensionless use is set to the following values for the rest of the calculation time: 0, 0.2, 0.3, 0.35, 0.39. If the net growth goes to zero, also the use is set to zero for the rest of the calculation.
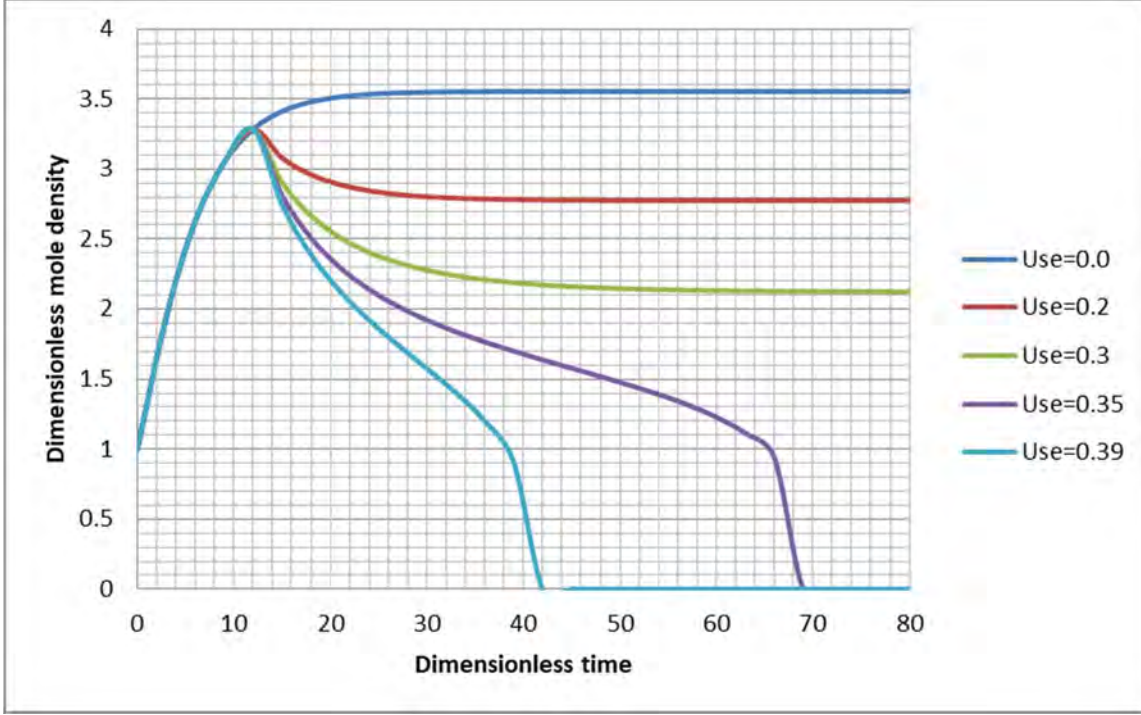
Figure 3 Calculated dimensionless photosynthetic mass densities as function of dimensionless time with dimensionless use as the parameter. If the use is less than maximum net growth, equilibrium is achieved where the net growth is equal to the use. When the use is permanently bigger than the maximum net growth, the photosynthetic biomass vanishes. When dimensionless use is 0.35, dimensionless biomass vanishes in dimensionless time 69. When dimensionless use is 0.39, dimensionless biomass vanishes in dimensionless time 43.
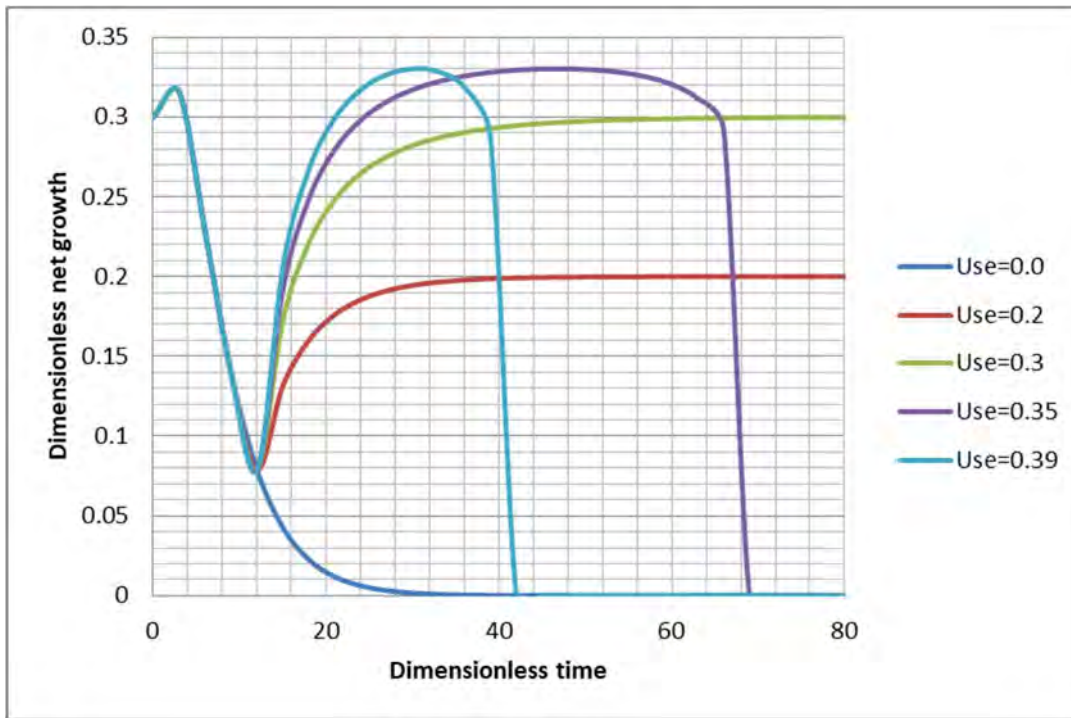
Figure 4 Calculated dimensionless net growth as a function of dimensionless time with dimensionless use as the parameter. In continuous state the net growth is equal to the use. When the use is permanently bigger than the maximum net growth, the amount of photosynthetic biomass goes to zero. When dimensionless use is 0.35, dimensionless net growth vanishes in dimensionless time 69. When dimensionless use is 0.39, dimensionless net growth vanishes in dimensionless time 43.
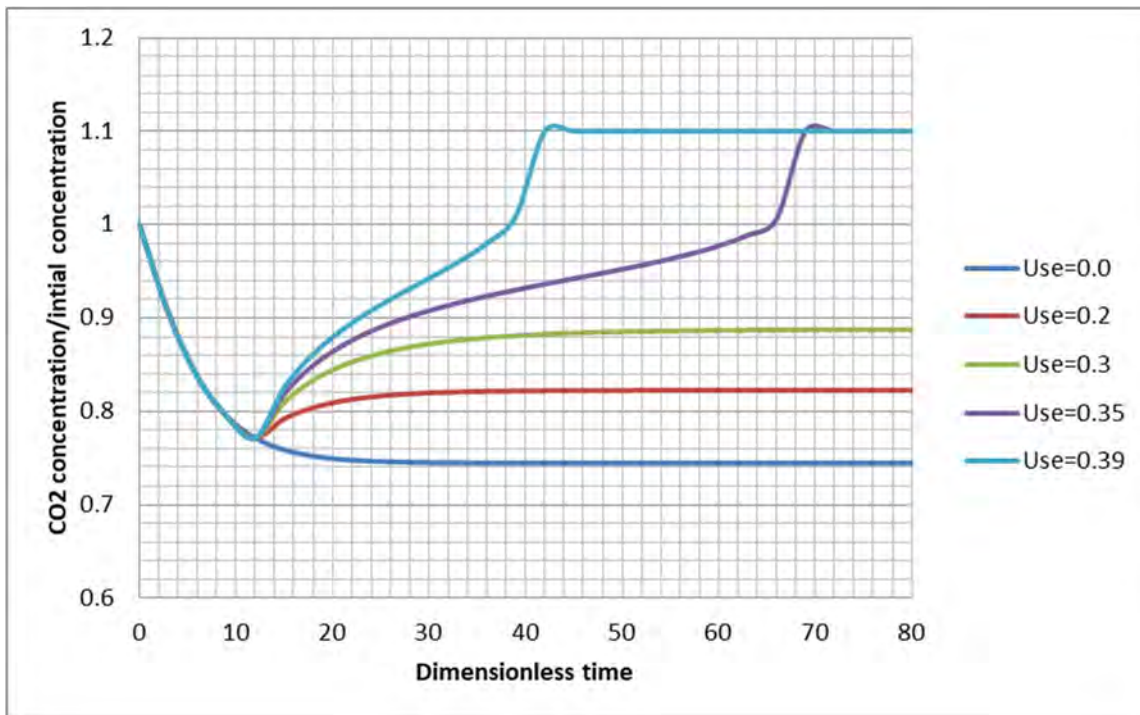
Figure 5 Dimensionless CO_2 content of atmosphere as a function of dimensionless time with dimensionless use as the parameter. CO_2 concentration of the atmosphere increases when

dimensionless use increases. When the use is permanently bigger than the maximum net growth, CO_2 concentration goes to the maximum, which with the applied parameters is 1.1.

Applied calculations of the element and compound balances of the ecosystem

Entities, compounds and reactions

The ecosystem is divided into 9 s (entities), which are named in Table 2. The atmosphere, water system (oceans, seas, lakes, rivers) and each fossil fuel is treated as one homogenous entity, but biomass is divided into terrestrial and underwater entities, which are divided further into photosynthetic and dead entities.

Table 2: Table presents names and amount of carbon (kg) of entities.

Photosynthetic plankton	Dead plankton	Water	Natural gas	Oil	Coal	Photosynthetic biomass	Dead biomass	Atmosphere
1	2	3	4	5	6	7	8	9
1.54E+15	7.70E+14	2.91E+14	1.01E+14	1.32E+14	1.05E+15	9.06E+14	3.62E+14	8.95E+14

Amounts of carbon in the atmosphere and fossil entities are well known. Amount of carbon in water entity is calculated assuming that well mixed water entity is in solubility equilibrium with the atmosphere at 15 °C. Amounts of carbon of photosynthetic and dead biomass are rough estimates and should be checked using best available scientific knowledge. The possible changes of the carbon amounts don't influence the validity conclusions 14- 20 because the CO_2 flows from the atmosphere don't depend on the absolute amounts of carbon in the entities. In the proposed research it may appear useful to add into the model one or more terrestrial and underwater entities like "living but not photosynthetic" entities.

Table 3: Names and numbering of compounds and reactions

Compound		Molar mass (g)	Reaction 1	Reaction 2	Reaction 3	Reaction 4	Reaction 5	Reaction 6	Reaction 7	Reaction 8	Reaction 9
H2O	1	18.02	125	72.00	20.34	-33.0		+33.0	-33.0		-33.0
CO2	2	44.01	62.5	67.00	75.93	-46.0		+46.0	-46.0		-46.0
O2	3	32.00	-125	-105.5	-85.6	+51		-51.	+51.0		-51.0
N2	4	28.01			0.56	-0.50		+0.5	-0.50		+0.50
SO2	5	64.06			0.24						
Natural gas	6	1000	-1.00								
Oil	7	1000		-1.00							
Coal	8	1000			-1.00						
Photosynthetic biomass	9	1000				+1	-1				

Dead biomass	10	1000		+1	-1
Photosyn thetic plankton	11	1000			+1	-1
Dead plankton	12	1000			+1	-1

Reactions 1, 2, 3 are oxidation reactions of natural gas, oil and coal. Reaction 4 is the photosynthesis reaction, reaction 5 the death reaction of photosynthetic biomass, and reaction 6 is the oxidation reaction of dead biomass. Reactions 4 and 6 are inverse reactions.

Table 4 Surfaces between the entities

	Photosynthetic plankton	Dead plankton	Water	Natural gas	Oil	Coal	Photosynthetic biomass	Dead biomass	Atmosphere
Entity	1	2	3	4	5	6	7	8	9
1	0	0	A_{31}	0	0	0	0	0	0
2	0	0	A_{32}	0	0	0	0	0	0
3	A_{13}	A_{23}	0	0	0	0	0	0	A_{93}
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	A_{97}
8	0	0	0	0	0	0	0	0	A_{98}
9	0	0	A_{39}	0	0	0	A_{79}	A_{89}	0

Because $A_{pf}=A_{fp}$, there remains 6 entity surfaces which deviate from zero. In addition to the surfaces in Table 4, entity 3 has the bottom surface and entity 9 an imaginary upper surface of the atmosphere. The compound flows through both surfaces are assumed to be zero.

In meteorology, the atmosphere is divided into overlapping zones which have different physical and chemical properties. It must be understood that changes in the atmosphere are continuous, and there is no exact boundary between the zones. The lowest zone, where vertical velocities dominate vertical mixing due to density differences and the gas compounds are well mixed, can be called the homosphere. In the zone above the homosphere, where molecule density and collision frequencies are small, concentrations of compounds with smaller molecule masses increase. This zone can be called the heterosphere. In the lower part of the heterosphere there is molecular and atomic oxygen and nitrogen, but in the upper part of the heterosphere mainly helium and hydrogen appear. At sufficient height, the molecule and atom densities approach zero. Mass transfer through this imaginary surface which forms the upper surface of entity 9 is zero.

Reliable Henry correlations exist only for surface $A_{39}=A_{93}$. Without significant error, Henry correlations of Table 5 can be applied for surfaces $A_{97}, A_{98}, A_{13},$ and A_{23} .

Table 5 Henry correlations of entity boundaries

Compound	Coal	Oil	Organic	Natural gas	CO2	H2O	H2	SO2	O2	N2
Boundary										
A_{93}	0	0	0	0	$H_{5,9,3}$	$H_{6,9,3}$	$H_{7,9,3}$	$H_{8,9,3}$	$H_{9,9,3}$	$H_{10,9,3}$
A_{97}	0	0	0	0	1	0	0	0	0	0
A_{98}	0	0	0	0	0	0	0	0	1	0
A_{39}	0	0	0	0	$\dfrac{1}{H_{5,9,3}}$	$\dfrac{1}{H_{6,9,3}}$	$\dfrac{1}{H_{7,9,3}}$	$\dfrac{1}{H_{8,9,3}}$	$\dfrac{1}{H_{9,9,3}}$	$\dfrac{1}{H_{10,9,3}}$
A_{13}	0	0	0	0	1	0	0	0	0	0
A_{23}	0	0	0	0	0	0	0	0	1	0

Calculation of the amounts of compounds in the photosynthetic biomass and plankton entities

The photosynthetic biomass entity and plankton entity contain photosynthetic biomass compounds and compounds 1-5 in table 3. The concentrations of compounds 1-5 are assumed to be in thermostatic equilibrium on the entity boundaries. When concentrations in the atmosphere are known, concentrations in adjacent entities can be calculated from Henry correlations. The amount of the photosynthetic biomass compound is calculated from equation (3.10) by applying it to photosynthetic biomass and photosynthetic plankton.

Calculation of the amounts of compounds in the dead biomass and plankton entities

The dead biomass entity and plankton entity contain dead biomass compounds and compounds 1-5 in table 3. The concentration of compounds 1-5 are assumed to be in thermostatic equilibrium on the entity boundaries. When the concentrations in the atmosphere are known, concentrations in adjacent entities can be calculated from Henry correlations. The amount of the dead biomass compound is calculated from equation (3.10) by applying it to dead biomass and dead plankton.

Calculation of amounts of compounds in the natural gas entity

The natural gas entity is assumed to contain only compound 6 in table 3. The only reaction in entity 4 is reaction 1. The rate of reaction1 is determined by use of natural gas. The compound balance of compound 6 of entity 4 can be written as

$$dN_{6,4}/dt = -\dot{N}(t)_{1,4} \tag{3.14}$$

Calculation of the amounts of compounds in the oil entity

The oil entity is assumed to contain only compound 7 in table 3. The only reaction in entity 5 is reaction 2. The rate of reaction 2 is determined by the use of oil. The compound balance of compound 7 in entity 5 can be written as

$$dN_{7,5}/dt = -\dot{N}(t)_{12,5} \tag{3.15}$$

Calculation of the amounts of compounds of the coal entity

The coal entity is assumed to contain only compound 8 in table 3. The only reaction in entity 6 is reaction 3. The rate of reaction 3 is determined by use of coal. The compound balance of compound 8 in entity 6 can be written as

$$dN_{8,6}/dt = -\dot{N}(t)_{3,6} \tag{3.16}$$

Calculation of the amounts of compounds in the water entity

The mole density of compound 1 of table 3 is assumed to be known in the water entity 3. The concentrations of compounds 1-5 are assumed to be in thermostatic equilibrium on the entity boundaries between entity 3 and entity 9. It is assumed that there are no reactions in entity 3. When the compound concentrations in the atmosphere are known, corresponding concentrations in the water entity can be calculated by using Henry coefficients.

Calculation of the amounts of compounds in the atmosphere

It can be assumed without significant error that the amounts of biomass and fossil fuels in the atmosphere are insignificant, and that only compounds 1-5 appear in the atmosphere in significant amounts. The concentration of compound 1 (water) in the atmosphere and water entity can be assumed to be in thermostatic equilibrium, and the remaining unknown variables are the amounts of compounds 2-5, which can be calculated from the conservation of elements C, H, O, N, and S.

$$N_{CO2,9} = N_{C,tot} - \sum_{f=1}^{8} N_{C,f} \tag{3.17}$$

$$N_{H2,9} = \left(N_{H,tot} - \sum_{f=1}^{8} N_{H,f}\right)/2 \tag{3.18}$$

$$N_{O2,9} = \left(N_{O,tot} - \sum_{f=1}^{8} N_{O,f}\right)/2 \tag{3.19}$$

$$N_{N2,9} = \left(N_{N,tot} - \sum_{f=1}^{8} N_{N,f}\right)/2 \tag{3.20}$$

$$N_{SO2,9} = N_{S,tot} - \sum_{f=1}^{8} N_{S,f} \tag{3.21}$$

The presented 7 differential equations with the bounding conditions (3.17) - (3.21) together with the equilibrium conditions form a mathematically closed system of equations which determines the 12 compound concentrations of the 9 entities as functions of time for known initial conditions.
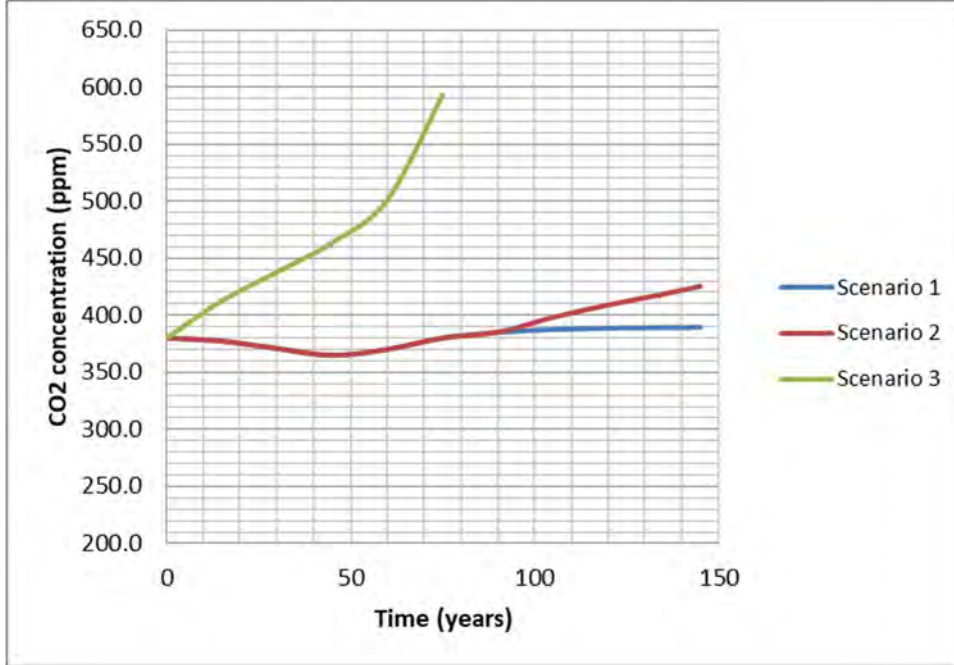
Figure 6 CO_2 concentrations in the atmosphere in scenarios 1, 2 and 3. Scenario 1 leads to a steady state where all the carbon of oil and natural gas and 75 % of the carbon of coal have been returned to the cycle of nature, and where CO_2 concentration in the atmosphere has increased from the initial 380 ppm to 390 ppm. When the energy of coal is replaced in year 90 by the energy of photosynthetic biomass, CO_2 concentration starts to increase but might have stabilized if the

calculation had been continued. When in scenario 3 all fossil energy is replaced by the energy of photosynthetic biomass, the development leads to an ecocatastrophe in about 70 years.
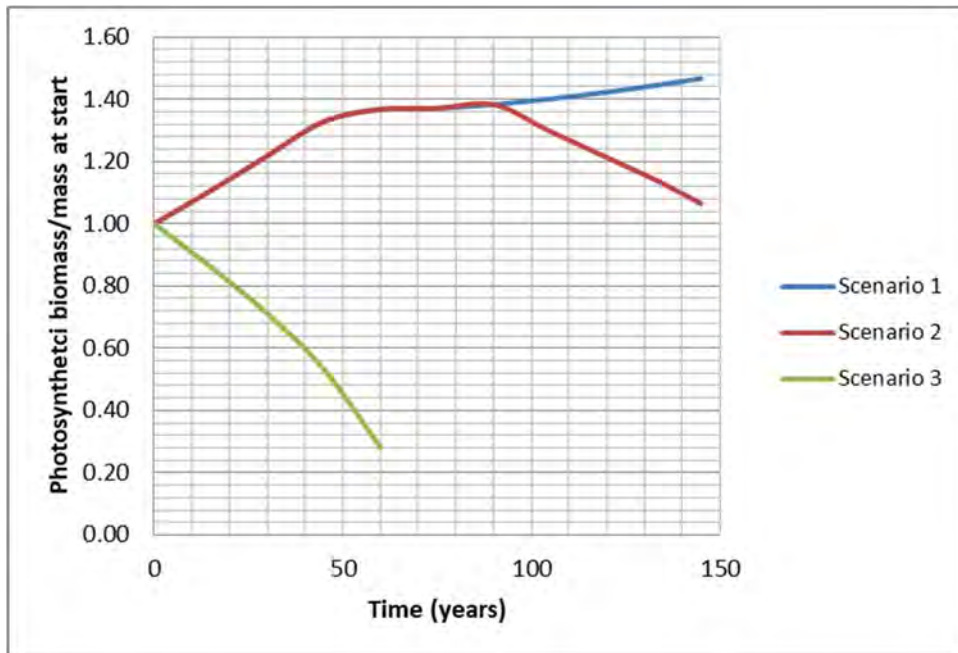
Figure 7 Relative amounts (amount per initial amount) of photosynthetic biomass in scenarios 1, 2 and 3 as a function of time. In Scenario 1amount of photosynthetic biomass increases rapidly as long as use of natural gas, oil and coal continues as presently. When first oil and then natural gas finishes increasing rate slows down but continues. When coal in Scenario 2 is replaced by photosynthetic biomass in the year 90 amount of photosynthetic biomass starts to decrease.
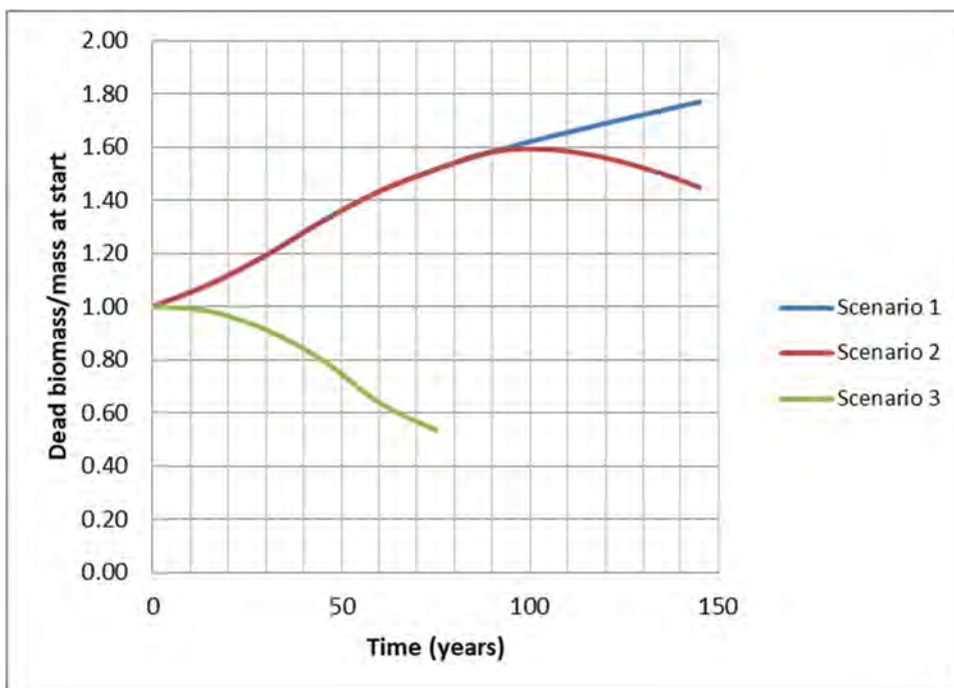
Figure 8 Relative amounts (amount per initial amount) of dead biomass in scenarios 1, 2 and 3 as a function of time. In scenario 1, the amount of dead biomass continues increasing during the whole calculation period. When the energy of coal is replaced by the energy of photosynthetic biomass in

year 90, the amount of dead biomass starts decreasing, but might have stabilized if the calculation had been continued. When in scenario 3 all fossil energy is replaced by the energy of photosynthetic biomass, also the amount of dead biomass vanishes in about 110 years.

Appendix 4: Theoretical foundations of climate model

Nomenclature

a_s^+ =linear absorption coefficients of solar radiation in the direction the radius of the earth

a_s^- =linear absorption coefficient of solar radiation in opposite direction to the radius of the earth

a_{vp} =spectral linear absorption coefficient =spectral linear emission coefficient of entity p

$a = \sum_{p=1}^{N_p} a_p$ =total linear absorption coefficient of all entities (equation (4))

a_a = total linear absorption coefficient

a_e = total linear emission coefficient

a_{pi} =total linear absorption coefficient of entity p in differential volume ∂V_i

A_{fpi} =surface between entity f and entity p in i

$d\Omega$ = solid angle of solar radiation

$d_{vp} = \left(a_{vp} + s_{vp}\right)$ = spectral linear dissipation coefficient of entity p

$I_s^+(x)$ = radiation intensities of solar radiation in the direction the radius of the earth

$I_s^-(x)$ = radiation intensities of solar in opposite direction to the radius of the earth

$H_{myp}\left(\overline{T}_{pi}\right)$ =total molar enthalpy of compound y of entity p at global time mean temperature

H_{ypfi} =Henry coefficient of compound y on the side of entity p on the boundary between entity p and p

$L_m(x)$ = radiance of black radiation in point x

$L_v(x)$ =spectral radiance at distance x

$L_{mv}(T_p)$ = spectral black radiance

$L_v(x, \varphi, \psi)$ =spectral radiance from direction (φ, ψ) to point x

M_{mf2} =black radiation intensity of entity f in ∂V_2

n_{yfi} =global time mean mole density of compound y of entity f in i

n_{ypi} =global time mean mole density of compound y of entity p in i

N_p = number of entities in the atmosphere

$\dot{N}''_{y,p,r_i}$ =global time mean mole flow density of compound y of entity p through spherical surface i

$\dot{Q}_{s,i}$ =global time mean absorption of solar radiation energy flow in i

r_g =radius of the earth

$r_{1,2}^2$ =square of the distance between ∂V_1 and ∂V_2

r_s^+ = linear reflection coefficients of solar radiation in the direction the radius of the earth

r_s^- = linear reflection coefficients of solar radiation in opposite direction to the radius of the earth

$s_{vp}(x, \varphi, \psi)$ =spectral scattering coefficient of entity p for radiance from direction (φ, ψ) to direction x in point x

$s_{vp} = \int_{\psi=0}^{\pi} \int_{\varphi=0}^{2\pi} s_{vp}(x, \varphi, \psi)sin\varphi d\varphi \, d\psi$ =spectral scattering coefficient of entity p

t_a = averaging time

T_p =temperature of entity p

$T(t, r_g, \varphi, \psi)$= temperature in a point (r_g, φ, ψ) the moment t

T_{fbi} = global time mean temperature of surface of entity f in i

T_i =global time mean temperature in i

$\overline{T}_{pbi}$ = global time mean temperature of surface of entity p in i

x = distance from the upper surface of the atmosphere to the ground along the line connecting the center of globe and the center of the sun.

α_{fb} =heat transfer coefficient from entity f to boundary b

$\mathcal{A}'''_{p\partial V_1 f \partial V_2} \partial V_1$ = total radiation surface from entity p of differential volume ∂V_1 to entity f of of differential volume ∂V_2

$\mathcal{A}_{fj,pi}$ =radiation surface from entity f in layer j to entity p in layer i

κ_{fbi} =compound transfer coefficient from entity f to entity boundary b in i

κ_{pbi} =compound transfer coefficient from entity p to entity boundary b in i

λ_{pi} =thermal conductivity of entity p in i

$\tau_{1,2}$= total penetration ratio for radiation from ∂V_1 to ∂V_2 =$\tau_{2,1}$

Introduction

IPCC's dogma that increase of carbon dioxide in the atmosphere causes catastrophic climate change has had enormous economic and ecologic influences. Therefore, it is vitally important to verify IPCC's dogma.

The atmosphere is a mixture of gas, droplets and solid particles (hence forward the Entities). Compound, momentum, energy and number balances of the Entities form the only physically and mathematically relevant foundation of climate models. However, in IPCC's 3D time-dependent models, compound, momentum, energy and number balances of the Entities are replaced by total mass, momentum and energy balances of the Entities and number balances are totally missing. In addition, radiative energy transfer of the 3D time-dependent models has been modelled incorrectly whereupon the models are physically and mathematically wrong. The following calculation proves that IPCC's 3D time-dependent models per se can't be used to investigate the influence of carbon dioxide on global mean temperatures.

The atmosphere is a steady transient system where **daily mean** time derivatives of local temperatures may be up to 40 °C/day and **momentary** derivatives even larger. If IPCC's knowledge about 1.2 °C increase of global mean temperature solely due to increase of carbon dioxide in the atmosphere, would true, the realized 120 ppm increase of carbon dioxide concentration corresponds to 0.01 °C/ppmCO$_2$ increase of global mean temperature due to carbon dioxide concentration. The causal influence of carbon dioxide, which is due to the marginal increase of the linear emission coefficient, is at any moment equal in the whole lower atmosphere.

If carbon dioxide concentration in the atmosphere is assumed to increase 1 ppm/year the warming rate of the lower atmosphere due to carbon dioxide would be $2.7 \cdot 10^{-5}$ °C/day. This warming rate is so small that it totally vanishes within the physical and mathematical errors of momentary temperatures of the time dependent climate models hence the time dependent climate models per se

can't be used to investigate the influence of carbon dioxide on global mean temperatures. Accordingly, the only relevant mathematical model to investigate the influence of carbon dioxide on the global mean temperature of the atmosphere is the 1D global time-independent climate model.

Summary

The heat and fluid dynamical and mathematical foundations of 1D global climate model is presented in this paper. Because IPCC's claim neglects temperature differences between the Entities the developed climate model (hence forward the SRclimate model) is simplified accordingly and applied to investigate the influence of carbon dioxide on the global mean temperatures. The investigation proves that the influence of carbon dioxide on the global mean temperatures is insignificant.

Thermal radiation

The atmosphere is a mixture of gas and solid and liquid particles (hence forward entity or entities). The number of entities is so large that it is not possible to treat separately each entity. Therefore, in the mathematical modelling entities must be divided into a finite number of entity groups with sufficiently similar properties. The atmospheric particles are so small that in the theory of the radiative heat transfer they can be treated in the similar manner than gas. Spectral radiance is, by definition, radiative energy flux through differential perpendicular surface in narrow solid angle and frequency range. The complete form of the spectral radiance equation is

$$\frac{dL(\nu,x)}{dx} = -\sum_{p=1}^{N_p} d_{vp} L(\nu,x) + \int_{\psi=0}^{\pi} \int_{\varphi=0}^{2\pi} L(\nu,x,\varphi,\psi) s_p(\nu,x,\varphi,\psi) sin\varphi d\varphi \, d\psi + \sum_{p=1}^{N_p} a_p(\nu) L_{mv}(\nu,T_p)$$

In this presentation the concept entity is defined generally as part of the entity which is separated from the rest of the entities by discontinuity of compound densities.

N_p = number of entities in the atmosphere

$d_{vp} = \left(a_p(\nu) + s_{vp}\right)$ = spectral linear dissipation coefficient of entity p

$a_p(\nu)$ =spectral linear absorption coefficient =spectral linear emission coefficient of entity p

$s_{vp} = \int_{\psi=0}^{\pi} \int_{\varphi=0}^{2\pi} s_p(\nu,x,\varphi,\psi) sin\varphi d\varphi \, d\psi$ =spectral scattering coefficient of entity p

$L(\nu,x)$ =spectral radiance at distance x

$L_{mv}(\nu,T_p)$ = spectral black radiance

$L(\nu,x,\varphi,\psi)$ =spectral radiance from direction (φ,ψ) to point x

$s_p(\nu,x,\varphi,\psi)$ =spectral scattering coefficient of entity p for radiance from direction (φ,ψ) to direction x in point x

T_p =temperature of entity p in point x

If scattering is remarkable mode of radiation the equation of spectral radiance becomes very complicated for mathematical treatment. Fortunately, without remarkable error it can be assumed that in the atmosphere $a_{vp} \gg s_{vp}$ whereupon in the atmosphere the equation of spectral radiance simplifies to

$$\frac{dL_v(x)}{dx} = \sum_{p=1}^{N_p} a_p(\nu) \left[-L_v(x) + L_{mv}(T_p)\right] \qquad (4.1)$$

For collision broadened emission lines

$$a_p(v) = \sum_{c=1}^{N_{pc}} \sum_{l=1}^{N_{pcl}} \varepsilon_p n_{pc} \frac{A_{pcl}}{\left((v-v_l)/\Delta v_{pcl}\right)^2 + 1} \tag{4.2}$$

ε_p =volume fraction of entity p

$A_{pcl}(v)$ =spectral emission area of line l of compound c of entity p

n_{pc} =mole density of compound c of entity p

N_{pcl} =number of emission lines of compound c of entity p

N_{pc} =number of compounds of entity p'

A_{pcl}, v_l and Δv_{pcl} are line parameters

In entity system like atmosphere equation (4.2) can't be used to calculate spectral linear emission coefficients of entities and a different approach must be taken.

By integrating equation (4.1) over the whole spectrum it follows

$$\frac{dL(x)}{dx} = \sum_{p=1}^{N_p}\left[-a_{ap}L(x) + a_{ep}L_m(T_p)\right] = \sum_{p=1}^{N_p} a_{ep}\left[-\frac{a_{ap}}{a_{ep}}L(x) + L_m(T_p)\right] \tag{4.3}$$

$$L(x) = \int_{v=0}^{\infty} L_v(x)dv$$

$$a_{ap}L(x) = \int_{v=0}^{\infty} a_p(v)L_v(x)dv$$

a_{ap} = mean linear absorption coefficient of entity p

$$a_{ep}L_m(T_p) = \int_{v=0}^{\infty} a_p(v)L_{mv}(T_p)dv$$

a_{ep} = mean linear emission coefficient of entity p

If the spectral distribution of radiance doesn't differ essentially from spectral distribution of black radiation $a_{ap} = a_{ep} = a_p$.

In the atmosphere temperature differences between water droplets and dry air are so large that in accurate modelling of radiative transfer equation (4.3) should be used. Because the aim is to study the influence of CO_2 on the mean temperature of the ground, the temperature differences between gas and droplets can be neglected.

Assuming further that temperature differences between entity are insignificant and by integrating equation (4.3) along a homogenous path from 0 to x we get

$$L(x) = L(0)e^{-ax} + L_m(1 - e^{-ax}) = L(0)\tau(x) + L_m\varepsilon(x) \tag{4.4}$$

$a = \sum_{p=1}^{N_p} a_p$ = total linear absorption coefficient of all entities

The first term of the equation (4.4) presents the penetration of radiance from $x = 0$ to x and the second term thermal emission from $x = 0$ to x.

The total emission ratio of gaseous H_2O and CO_2 has been measured by Hottel, Mangelsdorf and Smith. Hottel's, Mangelsdorf's and Smith's measured total emission ratios are presented as a function of temperature and optical path length which is defined as product of pressure and path length. However, the product of pressure and length is a physically foggy concept and it is physically more informative to present the emission ratio as function of molar absorption area A_m and mole density n. The equivalent mean molar absorption areas can be calculated from Hottel's, Mangelsdorf's and Smith's measured mean emission ratios from the equation

$$A_m = \frac{ln(1-\varepsilon)}{nx} \tag{4.5}$$

Emission ratio of solid surfaces

If the linear absorption coefficient is very large the penetration of radiance is negligible in comparison with emission owing to that the radiance from this kind of material is only due to emission of a thin nearly isothermal surface layer. For this kind of mediums can be defined the spectral emission ratio $\varepsilon_v(\varphi, \psi)$ as

$$\varepsilon_v(\varphi, \psi) = \frac{L_v(\varphi, \psi)}{L_{mv}}$$

For diffuse materials the spectral emission ratio is independent of direction and for diffuse and mean materials also independent of frequency whereupon $L(\varphi, \psi) = \varepsilon L_m$ is independent of direction.

Radiation surfaces

Let us consider radiation in a system with several entities at different temperatures. Total radiation energy flow to entity p of differential volume ∂V_1 from entity f of a differential volume ∂V_2 is

$$\partial \dot{Q}_{p\partial V_1, f\partial V_2} = M_{mf2} \frac{a_{p1}a_{f2}}{r_{1,2}^2} \tau_{1,2} \partial V_2 \partial V_1 = \mathcal{A}'''_{p\partial V_1 f\partial V_2} M_{mf2}\partial V_1 \qquad (4.6)$$

a_{p1}=equivalent mean linear absorption coefficient of entity p in differential volume ∂V_1

a_{f2}= equivalent mean linear absorption coefficient of entity f in differential volume ∂V_2

$r_{1,2}^2$=square of distance between ∂V_1 and ∂V_2

$\tau_{1,2}$= equivalent mean penetration ratio of radiation from ∂V_2 to ∂V_1

$\mathcal{A}'''_{p\partial V_1 f\partial V_2}\partial V_1$ = equivalent mean radiation surface of entity p of differential volume ∂V_1 to entity f of of differential volume ∂V_2 =$\mathcal{A}'''_{f\partial V_2 p\partial V_1}\partial V_2$

M_{m2}=black radiation intensity of entity f in ∂V_2

In this research balance volumes are volumes between concentric spherical surfaces. In spherical coordinate system radiation energy flow to entity p of differential volume ∂V_1 from entity f of a differential volume ∂V_2 is

$$\partial \dot{Q}_{fdV_2, pdV_1} = M_m(T_{fb2}) \sin\varphi_1 d\varphi_1 d\psi_1 dr_1 \frac{\tau_{1,2}}{r_{1,2}^2} a_{2p}a_{1p}r_1^2 r_2^2 \sin\varphi_2 d\varphi_2 d\psi_2 dr_2 \qquad (4.7)$$

Let us define the total radiation surface from entity f of the volume between spherical surfaces r_j and r_{j+1} to entity p of the volume between spherical surfaces r$_i$ and r_{i+1} by the equation

$$\mathcal{A}_{fj,pi} = \int_{r_1=r_j}^{r_{j+1}} \int_{\psi_2=0}^{2\pi} \int_{\varphi_2=0}^{\pi} \int_{r_1=r_i}^{r_{i+1}} \int_{\psi_1=0}^{2\pi} \int_{\varphi_1=0}^{\pi} \frac{\tau_{1,2}}{r_{1,2}^2} a_{2f}a_{1p}r_1^2 r_2^2 \sin\varphi_2 d\varphi_2 d\psi_2 \sin\varphi_1 d\varphi_1 d\psi_1 dr_1 dr_2$$

Penetration ratio $\tau_{1,2} = \tau_{2,1}$ owing to that the expression $\frac{\tau_{1,2}}{r_{1,2}^2} a_{2f}a_{1p}r_1^2 r_2^2$ is symmetric regarding the index 1 and 2 owing to $\mathcal{A}_{fj,pi} = \mathcal{A}_{pi,fj}$.

Now the global time mean energy flow to entity p of volume i from entity f of j can be written as

$$\dot{Q}_{fj,pi} = \mathcal{A}_{fj,pi} M_{mfj}$$
$$M_{mfj} = \sigma T_{fj}^4$$

Now absorption of global time mean irradiation to entity p in volume i from radiation of all entities f of all volumes j can be written as

$$\dot{Q}_{a,pi} = \sum_{j=1}^{N_v} \sum_{f=1}^{N_p} \mathcal{A}_{fj,pi} M_{mfj}$$

Total emission of thermal radiation of entity p of ∂V_i is

$$\dot{Q}_{e,pi} = M_{mpi} \sum_{j=1}^{N_v} \sum_{f=1}^{N_p} \mathcal{A}_{fj,pi}$$

$$M_{mpi} = \sigma T_{pi}^4$$

Net radiative energy flow to entity p volume i is

$$\dot{Q}_{rpi} = \sum_{j=1}^{N_v} \sum_{f=1}^{N_p} \mathcal{A}_{fj,pi} M_{mfj} - M_{mpi} \sum_{j=1}^{N_v} \sum_{f=1}^{N_p} \mathcal{A}_{fj,pi}$$

If temperature differences between entities can be neglected equation (9) simplifies to

$$\dot{Q}_{rpi} = \sum_{j=1}^{N_v} \mathcal{A}_{j,pi} (M_{mj} - M_{mi})$$

Radiation from all entities of volume j to all entities of volume I is

$$\dot{Q}_{rji} = \sum_{j=1}^{N_v} \sum_{p=1}^{N_p} \mathcal{A}_{j,pi} (M_{mj} - M_{mi}) = \sum_{j=1}^{N_v} \mathcal{A}_{ji} (M_{mj} - M_{mi})$$

$\mathcal{A}_{ji}$ =radiation surface from volume j to volume i =$\mathcal{A}_{ij}$

Because the relevant height of the atmosphere is small in comparison with the radius of the earth the spherical s can be replaced by planar surfaces with the same area and height. Then the radiation surface from volume i to volume k is calculated from

$$\mathcal{A}_{ik} = A_i 2 \int_0^1 \left[1 - e^{-a_i H_i / \cos\Theta} \right] \prod_{j=i+1}^{k-1} e^{-a_j H_j / \cos\Theta} \left[1 - e^{-a_k H_k / \cos\Theta} \right] \cos\Theta \, d\cos\Theta \quad (4.8)$$

Radiation surface from the surface of the earth, to volume k is calculated from

$$\mathcal{A}_{1k} = A_1 2 \int_0^1 \prod_{j=i+1}^{k-1} e^{-a_j H_j / \cos\Theta} \left[1 - e^{-a_k H_k / \cos\Theta} \right] \cos\Theta \, d\cos\Theta \quad (4.9)$$

Energy balance of entity p of volume between spherical surfaces i and $i + 1$

Without remarkable error it can be assumed a) that global mean accumulation rate of energy and b) thermal conduction are negligible in comparison with other terms of global energy balance of entity p. Accordingly, energy balance of entity p in volume i can be written as

$$0 = \dot{Q}_{cpi} + \sum_{f=1}^{N_p} \dot{Q}_{f(fp)i} + \sum_{f=1}^{N_p} \dot{Q}_{rfpi} + \dot{Q}_{spi} \quad (4.10)$$

$\dot{Q}_{cpi} = 4\pi r_i^2 \sum_{y=1}^{N_y} \dot{N}_{yp,i}'' H_{myp}(T_{pi}) - 4\pi r_{i+1}^2 \sum_{y=1}^{N_y} \dot{N}_{yp,i+1}'' H_{myp}(T_{pi+1})$=net convective energy flow to entity p in volume i

$\dot{Q}_{f(fp)i} = A_{fpi} \left[\alpha_{fbi}(T_{fi} - T_{(fp)i}) + \sum_{y=1}^{N_y} \dot{N}_{yf(fp)i}'' H_{myf}(T_{(fp)i}) \right]$ = energy flows from entity f to entity p in volume i by convection and compound transfer

$\dot{Q}_{rfpi} = A_{fpi}(E_{f(fp)i} - M_{(fp)fi})$ =radiative energy flow to entity p through surface between entity f and p in volume i

$E_{f(fp)i} = \sum_{j=1}^{N_v} \sum_{f=1}^{N_p} \mathcal{A}_{fj,pi} M_{(fp)fi}$= irradiation from entity f to surface (fp) between entity f and p in volume i

$\mathcal{A}_{fj,pi}$ = radiation surface from entity f of volume j to entity p of volume i

$\alpha_{f(fp)}$ =heat transfer coefficient from entity f to boundary between entities f and p

T_{fi} =temperature of entity f

$T_{(fp)i}$ =temperature of boundary between entity f and p

$\dot{N}''_{yf(fp)i}$ =mole flow density of compound y from entity f to boundary between entity f and p

$H_{myf}(T_{(fp)i})$ =molar total enthalpy of compound y of entity f on boundary between entity f and p

$M_{(fp)fi}$ =reflection and emission (exitance) from boundary between entity f and p to entity f

Exitance from surface (fp) to entity p is

$$M_{p(fp)i} = \varepsilon_{p(fp)i}M_{mp(fp)i} + (1 - \varepsilon_{p(fp)i})\sum_{j=1}^{N_v}\sum_{f=1}^{N_p} \mathcal{A}_{fj,pi}M_{(fp)fi} \qquad (4.11)$$

Equations (11) from group of linear equations for solution of exitances $M_{p(fp)i}$.

Because boundary between entities f and p is immaterial it does not accumulate energy whereupon energy boundary condition between entities f and p is

$$\dot{Q}''_{f(fp)i} + \dot{Q}''_{p(fp)i} = 0 \qquad (4.12)$$

Equations (10), (11) and (12) together form mathematically closed group of equations for solution of temperatures of entities and boundaries between entities.

Energy balance of volume between spherical surfaces i and $i + 1$

By summing equations (4.10) over all entities p we get

$$0 = 4\pi r_i^2 \sum_{p=1}^{N_p}\sum_{y=1}^{N_y} \dot{N}''_{yp,i}H_{myp}(T_{pi}) - 4\pi r_{i+1}^2 \sum_{p=1}^{N_p}\sum_{y=1}^{N_y} \dot{N}''_{yp,i+1}H_{myp}(T_{pi+1}) +$$

$$\sum_{j\neq 1}^{N_v} \mathcal{A}_{j,i}(M_j - M_i) + \sum_{p=1}^{N_p} \dot{Q}_{sp,i} \qquad (4.13)$$

$$M_j = \sigma T_j^4 \qquad (4.14)$$

Exitance of the ground can be calculated from equation

$$M_e = \varepsilon_e M_{me} + (1 - \varepsilon_e)\sum_{j=1}^{N_v} \mathcal{A}_{je}M_j \qquad (4.15)$$

Equations (4.13), (4.14) and (4.15) form mathematically closed group of equations for solution of temperatures of volumes and surface of the ground. Because solution of equations (4.10), (4.11) and (4.12) require too much unknown physical data equations (4.13), (4.14) and (4.15) are used to study influence of carbon dioxide on the global mean temperatures of the atmosphere.

Compound balances

Compound balance of compound y of entity p in volume i is

$$4\pi r_i^2 \dot{N}''_{yp,i} - 4\pi r_{i+1}^2 \dot{N}''_{yp,i+1} + \sum_{f=1}^{N_p} A_{fpi}\left(n_{yfi}\frac{H_{ypfi}\kappa_{fbi}\kappa_{pbi}}{(\kappa_{fbi}+H_{ypfi}\kappa_{pbi})} - n_{ypi}\frac{\kappa_{fbi}\kappa_{pbi}}{(\kappa_{fbi}+H_{ypfi}\kappa_{pbi})}\right) = 0$$
$$(4.16)$$

$\sum_{f=1}^{N_p} A_{fpi}\left(n_{yfi}\frac{H_{ypfi}\kappa_{fbi}\kappa_{pbi}}{(\kappa_{fbi}+H_{ypfi}\kappa_{pbi})} - n_{ypi}\frac{\kappa_{fbi}\kappa_{pbi}}{(\kappa_{fbi}+H_{ypfi}\kappa_{pbi})}\right) =$ flow of compound y from entity f to p in volume i

A_{fpi} =surface between entity f and p in volume i

n_{yfi} =global time mean mole density of compound y of entity f in volume i

n_{ypi} =global time mean mole density of compound y of entity p in volume i

κ_{fbi} =compound transfer coefficient from entity f to entity boundary b in volume i

κ_{pbi} =compound transfer coefficient from entity p to entity boundary b in volume i

$H_{ypf} = \frac{n_{yp}}{n_{yf}}$ = Henry coefficient of compound y on the side of entity p on boundary between entity p and f

H_{ypfi} =Henry coefficient of compound y on the side of entity p on the boundary between entity p and f in i

Definition of the global mean temperature of the lower atmosphere

The exact definition of the arithmetic global time mean temperature $T_{a,g}$ is

$$T_{a,g} = \frac{1}{4\pi t_a} \int_{t=0}^{t_a} \int_{\psi=0}^{2\pi} \int_{\varphi=0}^{\pi} T(t, r_g, \varphi, \psi) \, sin\varphi d\varphi d\psi \, dt \qquad (4.16a)$$

$T(t, r_g, \varphi, \psi)$= temperature in a point (r_g, φ, ψ) the moment t

r_g=radius of the earth

t_a = averaging time

If the global annual mean temperature should be calculated using time derivatives of local temperatures, local temperatures at moment τ should be calculated from equation

$$T(t, R_g, \varphi, \psi) = \int_0^t \frac{\partial T(\tau, R_g, \varphi, \psi)}{\partial \tau} d\tau$$

The accurate formula of the annual global mean temperature of the atmosphere is then

$$T_{a,g}(t, R_g, \varphi, \psi) = \frac{1}{4\pi t_a} \int_{t=0}^{t_a} \int_{\psi=0}^{2\pi} \int_{\varphi=0}^{\pi} \int_0^t \frac{\partial T(\tau, R_g, \varphi, \psi)}{\partial \tau} d\tau \, sin\varphi d\varphi d\psi \, dt \qquad (4.17)$$

It is entirely impossible to study theoretically the influence of CO_2 on the mean temperature of the ground starting from the local momentary partial differential equations[3].

The measured annual global mean temperature which is presented in connection with the climate change is a weighted sum of number of measured local annual mean temperatures. This kind of annual global mean temperature is a rough approximation of the accurate annual global mean temperature and depends among others on the choice of measuring points, applied weight factors and during the past 100 years remarkably increased use of energy. In this research the global time mean temperature of the atmosphere is defined as the solution of the equation (4.13)

Equations (4.13), (4.14) and (4.15) are derived by applying exact mathematics and best available scientific knowledge and the employed necessary simplifications are based on profound understanding of physical consequences of the simplifications.

Assumptions

The properties of the gas entity of the atmosphere (Table 1) have been taken from the source: U.S. Standard Atmosphere, U.S. Government Printing Office, 1962. According to the mentioned source the relative humidity of the atmosphere decreases from the 0.75 on the surface of the earth to 0.31 at the height of 10 km. Mole fraction of CO2 is up to 10 km independent of the height.

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[3] The time derivatives $\frac{\partial T(t, R_g, \varphi, \psi)}{\partial t}$ should be calculated for each time step from a huge number of compound, momentum and energy balance partial differential equations which all, even at their best, are only rough approximations of the reality. The solutions should be made using numerical approximations of the partial differential equations. The erroneous numerical predictions should be used as initial values for next time step which would cause accumulation of errors. When the time integration (4.18) should be taken at least to 100 years in order to simulate changes of global time mean temperature the accumulating error would completely degenerate the calculated results.

Table 1 Properties of the Standard Atmosphere up to the height of 10 km.

Standard atmosphere					Partial pressure		Mole density	
Height	Temperature	Pressure	Density	rH2O	H2O	CO2	H2O	CO2
m	Kelvin	J/m3	kg/m3		J/m3	J/m3	mol/m3	mol/m3
0	288,00	1,03E+05	1,250	0,7500	1277,055	29,847	0,5348	0,0125
1000	281,50	8,85E+04	1,100	0,7063	799,0875	25,675	0,3423	0,0110
3000	268,50	6,99E+04	0,910	0,6188	291,2331	20,264	0,1308	0,0091
5000	255,50	5,41E+04	0,740	0,5313	95,6637	15,689	0,0451	0,0074
7000	242,50	4,10E+04	0,590	0,4438	27,7343	11,881	0,0138	0,0059
10000	223,13	2,62E+04	0,410	0,3125	3,2074	7,6059	0,0017	0,0041

Entities
Table 2

Name	Gas	Liquid	Solid	Earth	
Identification number	1	2	3	4	
Number of entities	1	1	1	1	
Equation of state	$n = p/(RT)$	$n = 55556$	$n = 1$	$n = 1$	mole/m^3

Compounds of the entities
Table 3

Compounds	Air	CO_2	H_2O	Solid	
Mole mass	0.029	0.044	0.018	1000	kg/m^3

Table 4 Henry correlations $H_{ypf} = n_{yp}/n_{yf}$ of compounds y of boundaries between entities f and p. Because a entity does not have a common boundary with itself the Henry coefficients H_{ypp} can be neglected. Because the entity 4 has common boundary only with the 1 the Henry coefficients of entity boundaries 24, 42, 34, 43 can be neglected.

		Compound		
Boundary	Solid	CO_2	H_2O	Air
12	1	$H_{CO2,1,2}$	$H_{H2O,1,2}$	$H_{Air,1,2}$
13	0	0	0	0
14	0	∞	∞	∞
21	1	$H_{CO2,2,1}$	$H_{H2O,2,1}$	$H_{Air,2,1}$
23	0	1	1	1
24				
31	∞	∞	∞	∞

32	∞	1	1	1
34				
41	∞	0	0	0
42				
43				

The Henry correlations $H_{y,1,2} = 1/H_{y,2,1}$ are known thermostatic functions of temperature. The other Henry correlations are approximations which are valid for the purposes of this research.

In this research the compound flows $\overline{\dot{N}}_{y,p,i}$ are calculated by adapting the vertical global time mean mixing coefficient by minimizing the sum of square of errors of measured and from the equation (15) calculated global time mean temperatures. Without remarkable error it can be assumed that in the atmosphere the only compound which penetrates a entity boundary is water, which penetrates only the boundary between gas and liquid entity. In this research the compound densities are taken as known values. Liquid and gas entity are assumed to be composed of H2O, CO2 and Air. When vertical mixing correlation of gas entity is known the water flow from gas entity to liquid entity in the s can be calculated from the equation (4.18).

$$\dot{N}_{H2O,1,2,i} = \dot{N}_{H2O,1,i} - \dot{N}_{H2O,1,i+1} \tag{4.18}$$

$\dot{N}_{H2O,1,2,i}$ =water flow from entity 1 to entity 2 in volume i

Because $\dot{N}_{H2O,1,2,i} = -\dot{N}_{H2O,2,1,i}$ by summing the balance equation of gas and liquid water the liquid water flow (rain) through surface i can be calculated from the equation (4.19)

$$\dot{N}_{H2O,2,i} = \dot{N}_{H2O,1,i+1} + \dot{N}_{H2O,2,i+1} - \dot{N}_{H2O,1,i} \tag{4.19}$$

When liquid water flows $\dot{N}_{H2O,2,i}$ are known the global time mean volume fractions of water $\varepsilon_{w,2,i}$ in the s can be calculated from

$$\dot{N}_{H2O,2,i} = A_i \varepsilon_{w,2,i} n_{H2O,2,i} v_{2,i} \tag{4.20}$$

$v_{2,i}$ =global time mean velocity of entity 2 in surface i. Terminal velocities $v_{2,i}$ are calculated from terminal velocity correlation.

Energy boundary condition of the surface of the earth
From the equation the equation (11) we get for energy boundary conditions on the surface of the earth

$$\alpha_{1e}(T_1 - T_e) + \sum_{y=1}^{N_y} \dot{N}''_{y1e} H_{my}(T_e) + E_{1,e} - M_{e1} + \alpha_{4,e}(T_4 - T_e) + \sum_{y=1}^{N_y} \dot{N}''_{y4e} H_{my4}(T_e) + E_{4e} - M_{e4} = 0 \tag{4.21}$$

Without remarkable error can be assumed that on the surface of the earth:

1. the linear absorption coefficient in earth (entity 4) is so large that radiation does not penetrate in entity 4
2. the emission and reflection ratio for solar and thermal radiation are diffuse
3. the only compound which penetrates the boundary e in remarkable amount is water

The surface e is in this research defined as an equivalent surface of the earth which is composed of land, water and photosynthetic and dead biomass. Even though also CO_2 and O_2 penetrate the surfaces e the contribution of these compound flows on the equation (4.20) is negligible in comparison with the contribution of water. With the assumptions 1-3 and accounting that $\dot{N}''_{H2O1e} = -\dot{N}''_{H2O4e}$ the boundary condition (4.21) simplifies to

$$\alpha_{1e}(T_1 - T_e) + \dot{N}''_{H2O1e}\big(H_{mH2O}\,(T_e) - H_{mH2O4}(T_e)\big) + E_{1,e} - M_{e1} + \alpha_{4,e}(T_4 - T_e) = 0$$

$$(4.22)$$

$\dot{N}''_{H2O1e}$ = global time mean raining rate density (kg/m²/s) to the boundary e

$$E_{1,e} = \sum_{j=1}^{N_b} \mathcal{A}_{je}\, M_{mj} + E_{s,e} \tag{4.23}$$

$$M_{e1} = \rho_{et} \sum_{j=1}^{N_b} \mathcal{A}_{je}\, M_{mj} + \rho_{es} E_{s,e} + \varepsilon_e M_{me} \tag{4.24}$$

Solar radiation

Without significant error it can be assumed that the only radiance arriving in the atmosphere is solar radiance, which arrives in a narrow solid angle of about 6.85E-05 with the mean total radiance of 2.04E+07 W/m² corresponding to the irradiation of 1395 W/m² on a perpendicular surface at the distance of the earth from the sun. The solid angle of solar radiation to the earth is practically constant on the whole surface of the sun.

Unlike the thermal radiation solar radiation takes place in so small solid angle that the radiation can be assumed to be parallel. Thus, for the radiation intensities from the sun to the ground $I_s^-(x)$ and in the opposite direction $I_s^+(x)$ can be written equations

$$dI_s^+(x)/dx = a_s^+ I_m(x) - (a_s^+ + r_s^+)I_s^+(x) + r_s^- I_s^-(x) \tag{4.25}$$

$$dI_s^-(x)/dx = a_s^- I_m(x) - (a_s^- + r_s^-)I_s^-(x) + r_s^+ I_s^+(x) \tag{4.26}$$

$$I_s(x) = d\Omega L_s(x)$$

$d\Omega$ = solid angle of solar radiation

x = distance from the upper surface of the atmosphere to the ground along the line connecting the center of globe and the center of the sun.

a_s^+ and a_s^- =linear absorption coefficients of solar radiation in the direction the radius of the earth and in the opposite direction

r_s^+ and r_s^- = linear reflection coefficients of solar radiation in the direction the radius of the earth and in the opposite direction

$I_s^+(x)$ and $I_s^-(x)$ = radiation intensities of solar radiation in the direction the radius of the earth and in the opposite direction

$L_m(x)$ = radiance of black radiation in point x

Because in the atmosphere $L_m \ll L_s$ equations (4.25) and (4.26) can be simplified to

$$dI_s^+(x)/dx = -(a_s^+ + r_s^+)I_s^+(x) + r_s^- I_s^-(x) \tag{4.27}$$

$$dI_s^-(x)/dx = -(a_s^- + r_s^-)I_s^-(x) + r_s^+ I_s^+(x) \tag{4.28}$$

Boundary condition on the ground is

$$I_s^+(0) = \rho_0^+ I_s^-(0) \tag{4.29}$$

Boundary condition on the upper surface of the atmosphere is

$$I_s^-(H) = 340\ W/m^2 \tag{4.30}$$

From equations (4.27) … (4.28) the influence of clouds and particles on the distribution of solar radiation in the atmosphere and on the ground can be calculated.

In equations (4.27) ⋯ (4.28) the unknown parameters are the linear absorption and reflection coefficients a_s^+ , a_s^- , r_s^+ , r_s^+ and the reflection ration of the ground ρ_a^+ of solar radiation. In the

lack of better knowledge, because $I_s^-(0)$, $I_s^+(0)$, $I_s^+(H)$ are kown coefficients a_s^+ , a_s^- , r_s^+ , r_s^+ and ρ_a^+ can be determined by the method of trial and error.

When the radiation intensities $I_s^+(x_i)$ and $I_s^+(x_{i+1})$ and $I_s^-(x_i)$ ja $I_s^-(x_{i+1})$ are solved from equations (4.27)···(4.28) absorption of solar radiation between the spherical surfaces i+1 and i , $\Delta\dot{Q}_{i+1/2}''$ can be calculated from equation.

$$\Delta\dot{Q}_{i+1/2}'' = I_s^+(x_i) + I_s^-(x_{i+1}) - I_s^+(x_{i+1}) - I_s^-(x_i) \qquad (4.31)$$

Absorption of solar radiation on the ground is

$$\Delta\dot{Q}_0'' = (1 - \rho_0^+)I_s^-(0) \qquad (4.32)$$

ρ_0^+ =reflection ratio of solar radiation of the ground

Application of the theory with CO_2 concentrations 400 ppm and 500 ppm
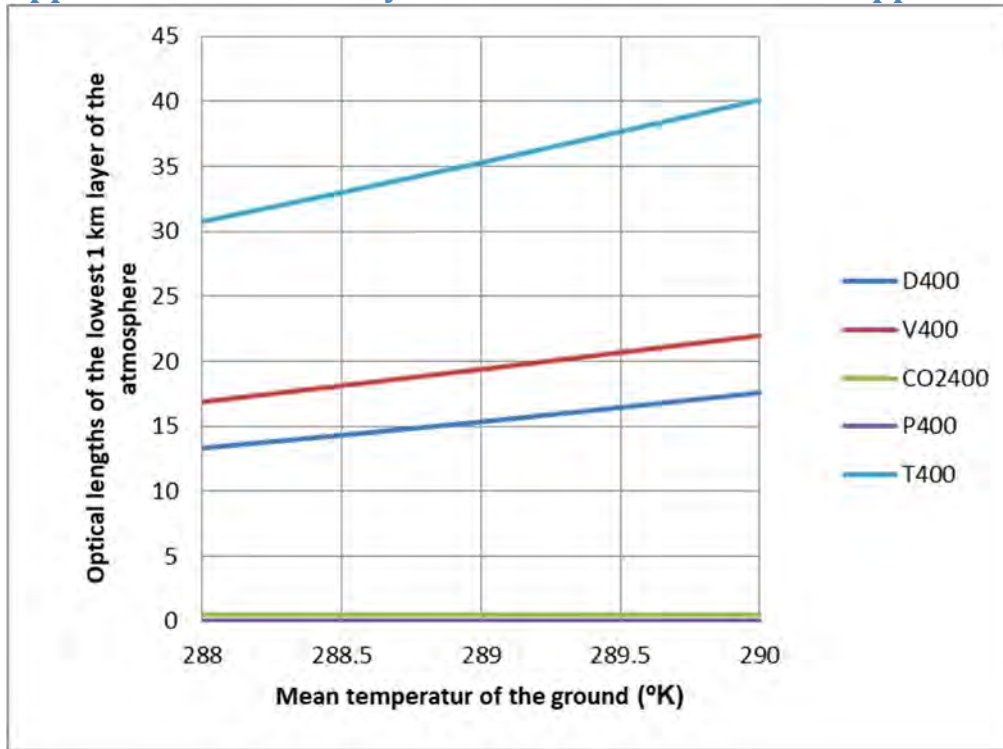

Figure 1 Figure presents with SR-model calculated linear emission coefficients of the atmosphere as functions of the mean temperature of the ground.

Curve T400 presents total optical length of the lowest 1 km layer in the atmosphere with CO_2 mole fraction 400 ppm

Curve V400 presents linear emission coefficient of water vapor in the lowest 1 km layer of the atmosphere with CO_2 mole fraction 400 ppm

Curve D400 presents linear emission coefficient of water droplets in the lower atmosphere with CO_2 mole fraction 400 ppm

Curve CO2400 presents linear emission coefficient of CO_2 in the lower atmosphere with CO_2 mole fraction 400 ppm

Curve P400 presents linear emission coefficient of solid particles in the lower atmosphere with CO_2 mole fraction 400 ppm

From figure 1 it can be concluded that

1. Optical length in the lower atmosphere is fully dominated by optical lengths of water vapor and droplets.
2. The mean surface temperature of the ground has strong influence on optical lengths of water vapor and droplets but practically no influence on optical length of carbon dioxide.
3. If increase of optical length of the lower atmosphere would increase the mean temperature of the ground the increase would continue until increase of optical length would not increase the mean temperature of the ground. This would happen, when the thermal emission to the ground would be black radiation (Appendix 5 equation (5.2)).
4. The logical consequence is that, due to the thermostatic properties of water, the linear emission coefficient in the lower atmosphere increases until its increase doesn't increase thermal radiation to the ground.
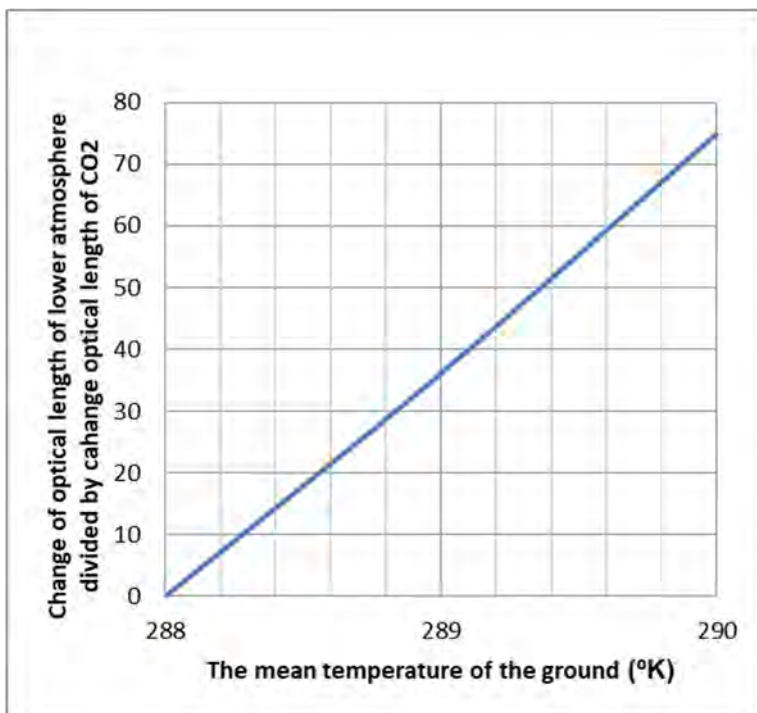

Figure 2 Figure presents (change of linear emission coefficient of lower atmosphere) divided by (change of linear emission coefficient of CO_2 when CO_2 mole fraction increases from 400 ppm to 500 ppm) as function of the mean temperature of the ground.

Figure 2 shows that if the mean temperature of the ground would increase 1 °C the increase of temperature would increase optical length in the lowest 1 km of the atmosphere about 37 times the increase which would follow from increase of CO_2 mole fraction from 400 ppm to 500 ppm.
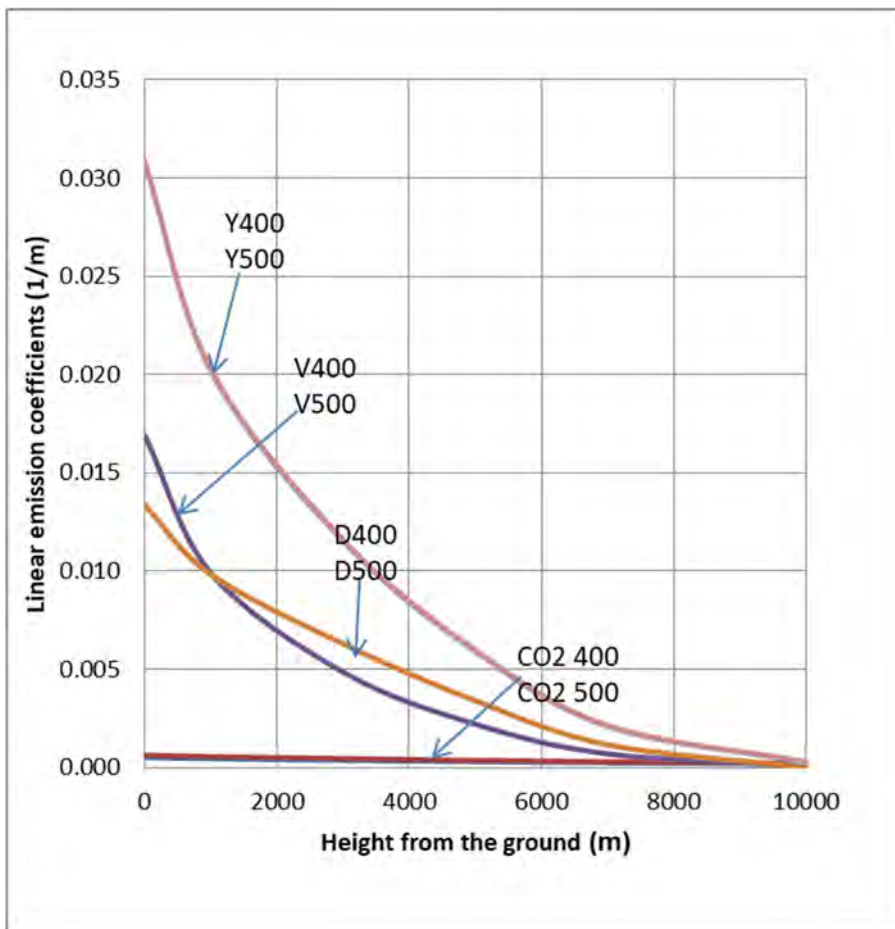
Figure 3 Figure presents the linear emission coefficient of water vapor, water droplets and CO_2 with CO_2 mole fractions 400 and 500 ppm as function of distance from the ground:

Curve CO2 400: Linear emission coefficient of CO_2 with mole concentration 400 ppm

Curve CO2 500: Linear emission coefficient of CO_2 with mole concentration 500 ppm

Curve H2O 400: Linear emission coefficient of H_2O with mole concentration 400 ppm

Curve H2O 500: Linear emission coefficient of H_2O with mole concentration 500 ppm

Curve D400: Linear emission coefficient of water droplets with mole concentration 400 ppm

Curve D500: Linear emission coefficient of water droplets with mole concentration 500 ppm

Curve Y400ppm: Linear emission coefficient of lower atmosphere with CO_2 concentration 400 ppm

Curve Y500ppm: Linear emission coefficient of lower atmosphere with CO_2 concentration 500 ppm

The influence of change of CO_2 mole fraction from 400 ppm to 500 ppm on the linear emission coefficients of figure 3 is so small, that it vanishes within the line thickness of the curves.

Figure 3 shows the ingenuity of the cooling mechanism of the ground. The linear emission coefficient of water vapor and water droplets decreases steeply when the height increases but the linear emission coefficient of CO_2 only gently. In the lower atmosphere the linear emission coefficient is so large that its increase doesn't increase thermal radiation to the ground. Instead, in the upper atmosphere, where linear emission coefficient is small, increase of CO_2 concentration increases thermal emission to the space. Thermal emission to the outer space strengthens also the convective transport of water vapor to upper atmosphere and its condensation there. As a

consequence, increase of CO_2 concentration doesn't increase the mean temperature of the ground but decreases temperature in the upper atmosphere.

Vaporization of liquid water on the ground converts sensible energy into latent energy of water vapor which due to the vertical mixing is conveyed to upper atmosphere where in the condensation released latent energy exits the atmosphere as thermal radiation. This vertical energy transfer mechanism has crucial importance for temperatures of the atmosphere and the ground. It cools the ground by about 80 W/m2 and decreases temperature of the upper atmosphere.
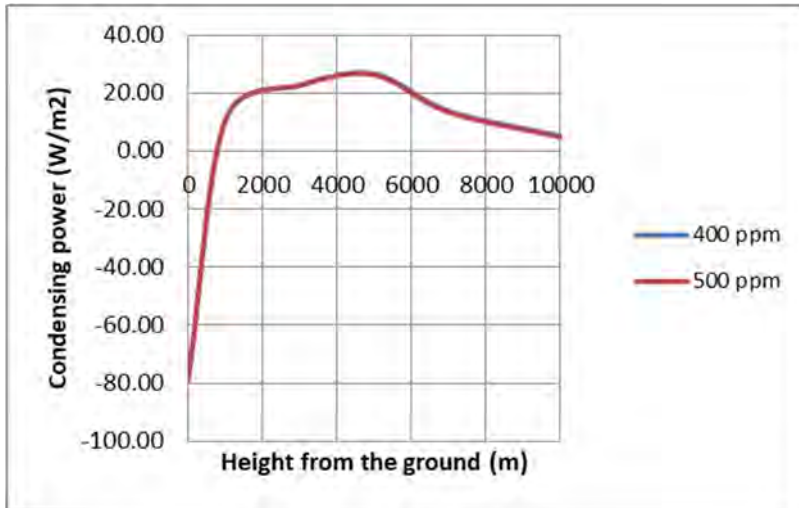

Figure 4 Figure presents with SRclimate model calculated condensation power densities with CO_2 concentrations 400 ppm and 500 ppm as functions of height from the ground.
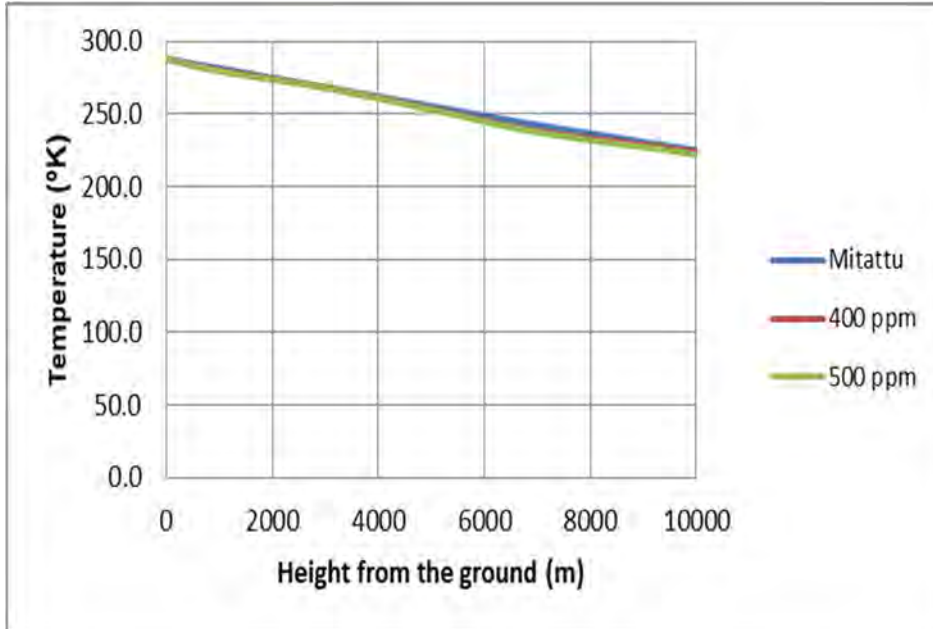

Figure 5 Figure presents with SR-model calculated temperatures and the temperatures of the standard atmosphere from the ground to the height of 10 km. The calculated temperatures are equal with the temperatures of the standard atmosphere within accuracy of the measured values.
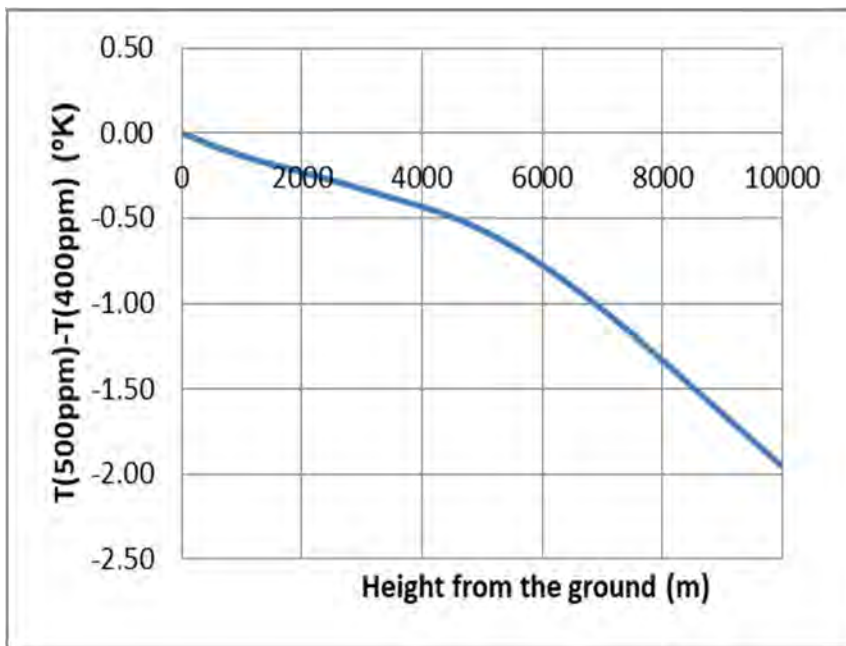
Figure 6 Figure presents with SR-model calculated temperature change when CO_2 concentration in the atmosphere increases from 400 ppm to 500 ppm. The result of figure 6 may feel surprising but it is logical consequence of the steep vertical gradient of the linear emission coefficient in the atmosphere (See figure 3). The influence of CO_2 concentration on the mean temperature of the ground is negligible but about 2 $^\circ$C in the upper atmosphere.

Figure 7 Figure presents with SR-model calculated global annual rain as function of height from the ground. Influence of CO_2 concentration on the annual rain is marginal.

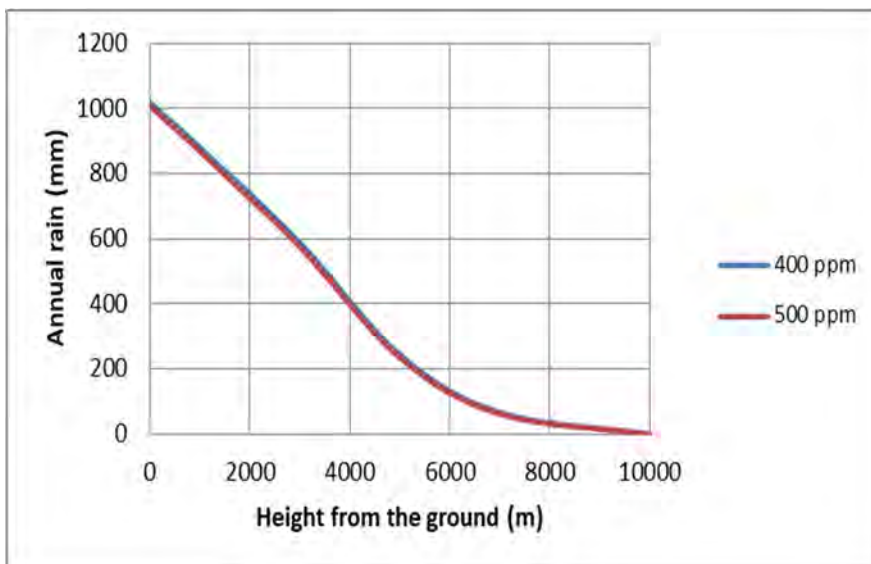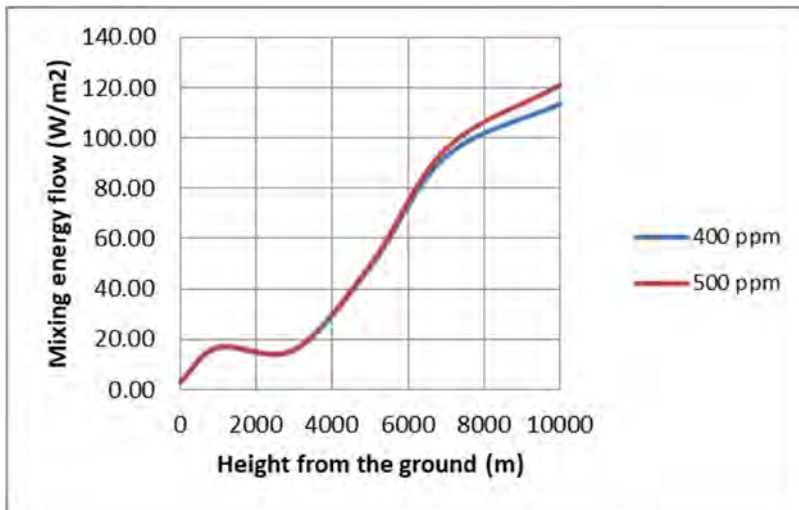Figure 8 Figure presents with SR-model calculated vertical energy flow densities due to the vertical mixing with CO_2 concentration 400 ppm and 500 ppm as functions of height from the ground. Same mixing velocity profile has been used for both CO_2 concentrations. Increase of carbon dioxide concentration increases vertical energy flow in the upper atmosphere because it increases temperature gradient in the upper atmosphere.

Figure 9 Figure presents with SR-model calculated absorption intensities of solar radiation in the direction of the radius of the earth and in the opposite direction with CO_2 concentrations 400 ppm and 500 ppm. The differences vanish within the line thicknesses,

Figure 10 Figure presents with SR-model calculated thermal irradiation intensities to the (T) and thermal radiation intensities from the (L) with CO2 concentrations 400 ppm and 500 ppm. Irradiation intensities exceed the black radiation intensities because the irradiation comes from two opposite directions.
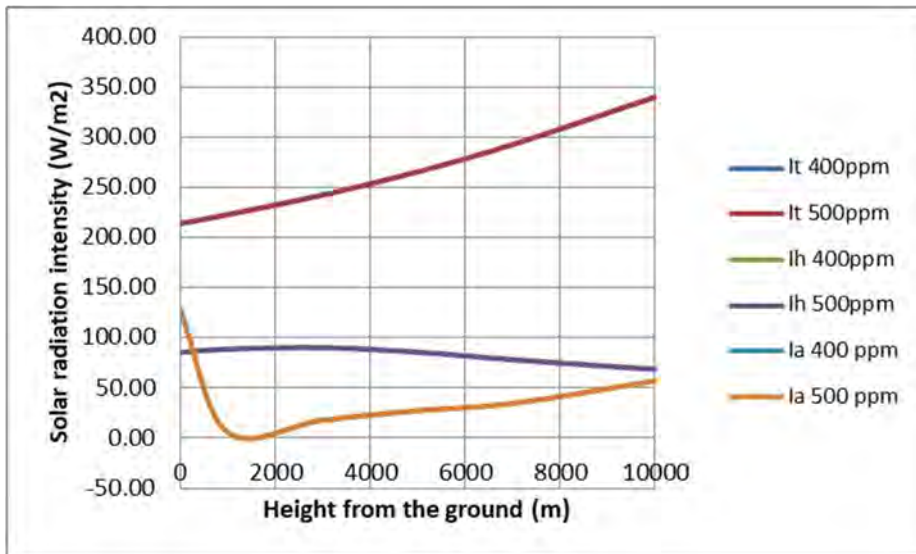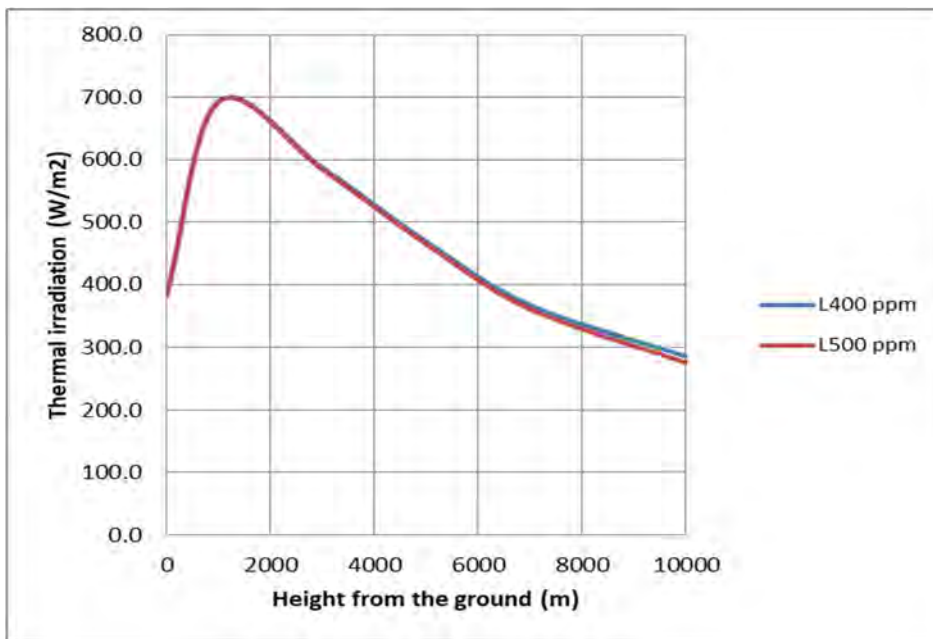
Influence of deforestation on the mean temperature of the ground

In order to get an idea about the influence of deforestation on the mean temperature of the ground the following calculations were made. Annual vaporization (mm/a) was calculated assuming that vaporization of seas and ground depend on the mean temperature of the ground and that vaporization of forests is proportional to area of forest divided by area of the ground. Specific vaporization of wood (vaporization/volume of wood) was assumed to be 216 kg/m^3/day, amount of wood/area of forest was assumed to be 0.02 m^3/m^2. Other calculation parameters appear from table 5. In this manner annual rain could be calculated for each value of area of forests per area of ground when the mean temperature of the ground was calculated using SRclimate model. A mathematically closed method for calculation of the mean temperature of the ground as function of area of forests per area of ground was achieved when with the SRclimate model calculated annual rain was set equal to the annual rain which was calculated in the above explained manner. Results of the calculations are represented in figure 11.

Region		Sea	Dry land	Forest	
Volume fraction of water on region boundary		1.00E+00	1.00E-02	1.00E+00	
Mole density of water on region boundary in re	mol/m3	5.56E+04	5.56E+02	5.00E+04	
Surface temperature	ºK	288.02	288.02	288.02	
Henry-coefficient of water		1.34E-05	1.34E-07	6.70E-06	
Saturated pressure	J/m3	1793.44	17.93	1793.44	
Saturated mole density on surface in air	mole/m3	0.749	0.007	0.000	
Mean mole density of water on surface in air	mole/m3	5.24E-01	8.99E-04	0.00E+00	5.25E-01
Mole density of water on region boundary in ai	mol/m3	7.44E-01	7.44E-05	3.35E-01	
Mole density of water in atmosphere	mole/m3	5.33E-01	5.33E-01	5.33E-01	
Compound transfer coefficient	m/s	9.09E-03	1.50E-04	9.84E-03	
Thickness of boundary layer	m	3.30E-03	2.00E-01	3.05E-03	
Diffusion coefficient in air	m2/s	3.00E-05	3.00E-05	3.00E-05	
Area of forests/Area of land		0.00E+00	0.00E+00	6.00E-01	
Area of region/Area of globe		7.00E-01	1.20E-01	1.80E-01	1.000
Volume of wood in region	m3/m2	0.00E+00	0.00E+00	2.00E-02	
Specific vaporization of region	kg/m3/d	0.00E+00	0.00E+00	2.16E+02	
	kg/m2/d	0.00E+00	0.00E+00	4.33E+00	
	mol/m2/s	1.97E-03	-7.88E-05	2.78E-03	
	mm/a	1.12E+03	-4.5E+01	1.58E+03	
Global vaporization density	mm/a	781.05	-5.37	284.47	1060.15

Table 5

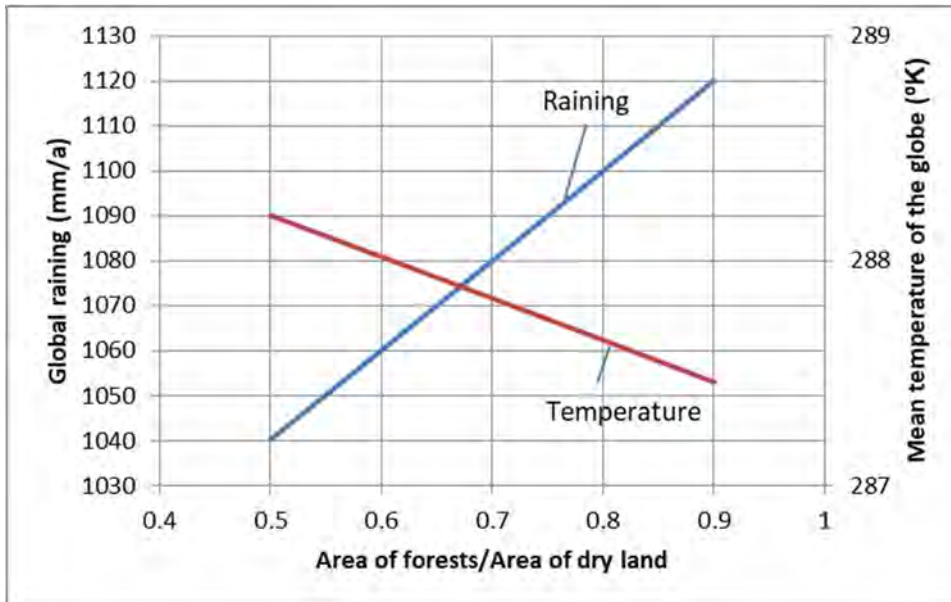Figure 11 Figure represents global annual raining as function of area of forests per area of the ground. If ratio of area of forests/area of dry land would decrease from 0.9 to 0.5 the mean temperature of the ground would increase about 0.67 ºC. In spite of increase of the mean

temperature of the ground annual raining would drop from 1120 mm/a to about 1040 mm/a due to the decrease of vaporization of forests.

Appendix 5: Mathematical considerations on the influence of carbon dioxide upon the mean temperature of the ground

Nomenclature

$a(v, x)$ =spectral linear emission coefficient = spectral linear absorption coefficient (m^{-1})

$a_{pci}(v) = n_{pc}A_{pci}(v)$ =linear emission coefficient of line i of compound c of entity p

$\bar{a}_e$ =mean linear emission coefficient

$\bar{a}_a$ =mean linear absorption coefficient

$A(v)$ =spectral emission area $(m^2/mole)$

$A_{pci}(v)$ =emission area of line i of compound c of entity p

$\bar{A}_{pc}$ =mean absorption area of compound c of entity p

c =velocity of light (m/s)

c_{1v} =1.47·10^{-50} Ws^4m^{-2}

c_{2v}= 4.80·10^{-11} $^\circ Ks$

$\bar{d}_p$=mean particle diameter

D_a =compound diffusion coefficient of water in air (3e-5 m^2/s)

E_{ag} =thermal irradiation from the atmosphere to the ground (W/m^2)

f_{vd}=volume fraction of droplets

f_{vg}=volume fraction of gas

h =Planck constant

k =Boltzmann constant, compound transfer coefficient

l =beam length (m)

l_{min} = minimum beam length of the lowest 1km layer of the atmosphere =1000 m

$L_v(v, x)$ =spectral radiance in point x (Ws/m^2)

$L_{mv}(v, T)$ = black radiance at temperature T and frequency v

$L_{mH2O}(T_s)$ =molar vaporization enthalpy at temperature T_s (44000 J/mole)

$L(x)$ =local total radiance

n_{pc} =mole density of compound c of entity p $(mole/m^3)$

$n_{sH2O}(T_s)$ =saturated mole density of water at temperature T_s

N_p =number of entities

N_{pc} =number of compounds of entity p

N_{pcl} =number of emission lines of compound c of entity p

r_{aH2O} =relative humidity of air

T = absolute temperature

T_{mean} = arithmetic mean temperature of the lowest 1km layer of the atmosphere =285 $^\circ$K

T_a =temperature of dry air

T_s =temperature of droplet

x =coordinate

α =heat transfer coefficient

$\beta = h\nu/kT$

$\delta_h = \alpha/\lambda_a$ =thickness of temperature boundary layer in air

$\delta_c = k/D_a$ = thickness of compound boundary layer in air

$\bar{\varepsilon}_{pc}$ =total emission ratio of compound c of entity p

λ =wavelength (m)

λ_a =thermal conductivity of air (0.025 W/m2/°C)

φ =angle between direction of radiance and the radius of the earth

θ =angle in plane perpendicular to the radius of the earth

ν =frequency (s^{-1})

$\Delta\nu_{pci}$ =line width parameter of line i of compound c of entity p (equation 6)

Introduction

Prevailing understanding is that increase of carbon dioxide concentration in the atmosphere causes disastrous global warming has had enormous political, economic and ecological consequences. In this connection it seems to be forgotten that Planck's law of radiation states the maximum which any media can emit, and that emitted radiance approaches exponentially this maximum when linear emission coefficient approaches infinity. If linear emission coefficient in the lower atmosphere is large enough, even though increase of carbon dioxide concentration increases marginally linear emission coefficient in the atmosphere, increase of radiation to the ground and thus to global warming is insignificant. In the following this matter is considered using the basic laws of radiative energy transfer.

Summary

Influence of carbon dioxide on the mean temperature of the ground was studied with the following methods.

1. Applying 1-entity radiance equation.
2. Applying SRclimate model
3. Applying 2-entity radiance equation.

All methods prove equivalently that the influence of increase of carbon dioxide concentration on the mean temperature of the ground is insignificant.

Theoretical backgrounds

The basic physical concept of radiative heat transfer is spectral radiance which is defined as radiative energy flow density through an indefinitely small perpendicular surface in an indefinitely narrow solid angle and frequency range. Maximum emitted spectral radiance $L_{m\nu}$ can be calculated from Planck's law as function of temperature and frequency. The mathematical theory of radiative heat transfer is based on equation (1) which defines the spectral linear emission coefficient $a(\nu)$. From the second law of thermostatics it follows that spectral linear absorption coefficient = spectral linear emission coefficient.

$$dL_\nu(\nu,x)/dx = a(\nu,x)\big(L_{m\nu}(\nu,x) - L_\nu(\nu,x)\big)$$

$$(5.1))$$

$a(\nu,x)$ =spectral linear emission coefficient = spectral linear absorption coefficient

$L_\nu(\nu, x)$ =spectral radiance in point x

$L_{m\nu}(\nu, x)$ = black radiance in point x and frequency ν

According to Planck's law

$$L_{m\nu}(\nu, T) = \frac{dL_m}{d\nu} = -\frac{dL_m}{d\lambda}\frac{d\lambda}{d\nu} = \frac{c_{1\nu}\nu^3}{e^{c_{2\nu}\nu/T}-1} \tag{5.2}$$

$c_{1\nu}$ =1.47·10⁻⁵⁰ Ws⁴m⁻²

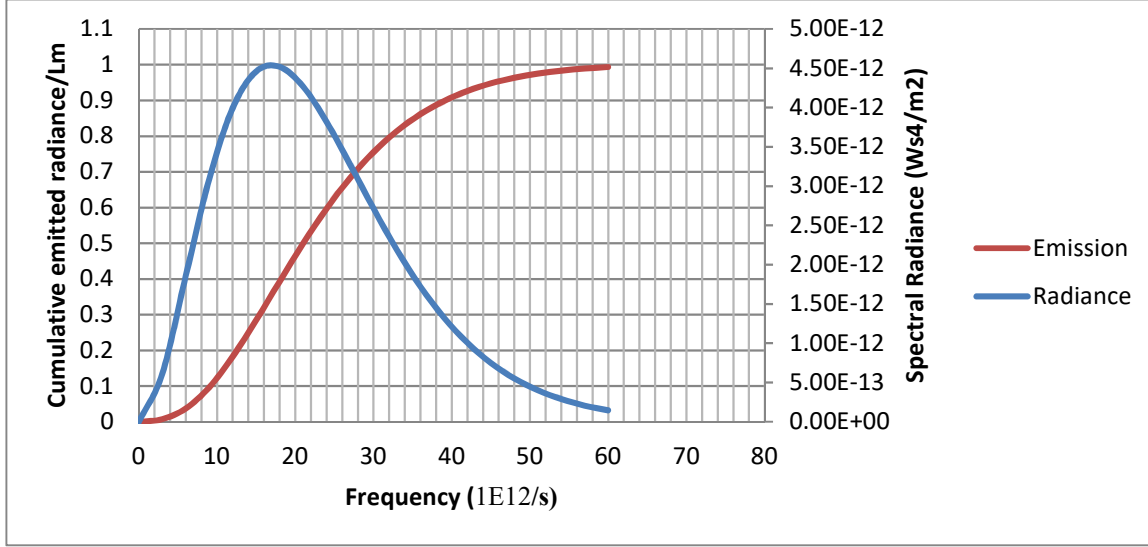$c_{2\nu}$=4.80·10⁻¹¹ °Ks

$d\lambda/d\nu = -c\nu^{-2}$

Figure 1 Black radiance $L_{m\nu} = dL_m/d\nu$ and cumulative relative black radiance $\int_0^\nu L_{m\lambda}d\nu/L_m$ as function of wave length at 288 °K. $L_m = \sigma T^4/\pi$. Maximum of $L_{m\nu}$ at 288 °K is at frequency $17.2 \cdot 10^{12}$ s⁻¹, midpoint of emitted energy is at frequency $21 \cdot 10^{12}$ s⁻¹ and practically all energy is at frequency range $\nu < 60 \cdot 10^{12}$ s⁻¹.

When equation (5.1)) is integrated along a homogenous path from 0 to l we get

$$L_\nu(0) = L_\nu(l)e^{-a(\nu)l} + L_{m\nu}(T)\left(1 - e^{-a(\nu)l}\right) \tag{5.3}$$

Radiative emission takes place at all frequencies so that emission has sharp maximums at certain frequencies which are called line centers. Total emission at frequency ν is sum of contributions of all lines. We define emission area of line i of compound c of entity p by formula (5.4)

$$a_{pci}(\nu) = n_{pc}A_{pci}(\nu) \tag{5.4}$$

For low temperature thermal radiation generally applied formula of $A_{pci}(\nu)$ is the Lorenz formula

$$A_{pci}(\nu) = \frac{A_{pci}}{\left((\nu-\nu_i)/\Delta\nu_{pci}\right)^2 + 1} \tag{5.5}$$

In accordance with equation (5.5) each emission line of each compound of each entity influences the spectral emission area of all frequencies. For spectral linear emission area due to all emission lines i of all compounds c of entity p we get

$$A_{pc}(\nu) = \sum_{i=1}^{N_{pcl}} A_{pci}(\nu) = \sum_{i=1}^{N_{pcl}} \frac{A_{pci}}{\left((\nu-\nu_i)/\Delta\nu_{pci}\right)^2 + 1} \tag{5.6}$$

Spectral linear emission coefficient of all lines i of all compounds c of all entities p is

$$a(v) = \sum_{p=1}^{N_p} \sum_{c=1}^{N_{pc}} \sum_{i=1}^{N_{pcl}} \frac{n_{pc}A_{pci}}{\left((v-v_{pci})/\Delta v_{pci}\right)^2 + 1} \tag{5.7}$$

A_{pci} =maximum emission area of line i of compound c of entity p

N_p =number of entities

N_{pc} =number of compounds of entity p

N_{pcl} =number of emission lines of compound c of entity p

A_{pci} =emission area of line i of compound c of entity p at $v = v_i$

Δv_{pci} =line width parameter of line i of compound c of entity p

Effective linear emission coefficient of equation (5.7) is at each frequency v sum of linear emission coefficients of all emission lines of all compounds of all entities. From equation (5.3) it follows that spectral emission from the atmosphere to the ground depends only on effective spectral emission coefficient $a(v)$ and is fully independent of contributions of individual emission lines. At all frequencies carbon dioxide in the atmosphere has only an insignificant contribution on the effective spectral linear coefficient, which is dominated by water vapor, water particles, solid particles.

Equations (5.1)), (5.2), (5.7) with relevant boundary conditions determine thermal radiation to the ground. Unfortunately, equation (5.7) cannot be used to calculate the spectral linear emission coefficients because spectral linear emission areas of emission lines of compounds of the entities are not known. Fortunately, there is a possibility to overcome this problem because the mean temperature of the ground doesn't depend on the spectral composition of thermal radiation to the ground. Therefore, it suffices to calculate the energy equivalent mean linear emission coefficient in the atmosphere. It could be calculated from equation (5.13) by measuring $L(0), L(l), T, l$ in the atmosphere. Because such data is not available the energy equivalent mean linear emission coefficient in the atmosphere must be calculated using available data. In the following we derive the equations for calculating of total thermal radiation to the ground making use of the measured mean emission ratios.

By defining $\beta = vh/kT$ we can write $L_{mv}(v,T)$ as

$$L_{mv}(v,T) = \frac{c_{1v}v^3}{e^{c_{2v}v/T}-1} = c_{1v}\left(\frac{kT}{h}\right)^3 \frac{\beta^3}{e^{-\beta}-1}$$

By integrating from $v = 0$ to ∞ we get the Stefan-Boltzmann's radiation law

$$L_m = c_{1v}\left(\frac{kT}{h}\right)^4 \int_0^\infty \frac{\beta^3}{e^{-\beta}-1} d\beta = c_{1v}\left(\frac{k}{h}\right)^4 \int_0^\infty \frac{\beta^3}{e^{-\beta}-1} d\beta \, T^4 = \frac{\sigma}{\pi}T^4$$

For Lorenz lines the energy equivalent mean emission area of compound c of entity p is

$$\bar{A}_{pc} = \frac{1}{L_m}\sum_{i=1}^{N_{pcl}} A_{pci} \int_0^\infty \frac{L_{mv}(T,v)dv}{\left((v-v_i)/\Delta v_{pci}\right)^2+1} = \sum_{i=1}^{N_{pcl}} A_{pci}f\left(T, v_{pci}, \Delta v_{pci}\right)$$

$$f\left(T, v_{pci}, \Delta v_{pci}\right) = \left(\int_0^\infty \frac{x^3}{e^{-x}-1}dx\right)^{-1} \int_0^\infty \frac{x^3 dx}{(e^{-x}-1)\left[\left((xkT/h-v_{pci})/\Delta v_{pci}\right)^2+1\right]}$$

For the energy equivalent mean linear emission coefficient due to all compounds of all entities can now be written equation (5.8)

$$\bar{a}_e = \sum_{p=1}^{N_p} \sum_{c=1}^{N_c} n_{pc}\bar{A}_{pc} \tag{5.8}$$

By integration of equation (5.1)) from $v = 0 \; to \; \infty$ we get

$$\int_{v=0}^{\infty} dL_v(x)/dx \ dv = \int_{v=0}^{\infty} a(v,x)L_{mv}(T)dv - \int_{v=0}^{\infty} a(v,x)L_v(x) \ dv$$

By integrating equation (5.1)) over the whole spectrum it follows

$$dL(x)/dx = \bar{a}_e L_m(x) - \bar{a}_a L(x) \tag{5.9}$$

$$L(x) = \int_{v=0}^{\infty} L_v(x)dv \tag{5.10}$$

$$\bar{a}_e = \int_{v=0}^{\infty} a(v,x)L_{mv}(T)dv \ /L_m(T) \tag{5.11}$$

$$\bar{a}_a = \int_{v=0}^{\infty} a(v,x)L_v(T)dv \ /L(T) \tag{5.12}$$

By integrating equation (5.9) along a homogenous path from $x = 0$ to l we get for total radiance at $x = 0$

$$L(0) = L(l)e^{-\bar{a}_a l} + L_m(T)(1 - \bar{a}_a/\bar{a}_e \ e^{-\bar{a}_e l}) \tag{5.13}$$

The first term of equation (5.13) presents transmitted total radiance from $x = l$ and the second term total emission from $x = 0 \ to \ l$. Equation (13) could be used to determine effective linear emission and absorption coefficients in the atmosphere. Because in Author's knowledge this data doesn't exist, we do the following. When equation (5.13) is applied to compound c entity p we get equation (5.14)

$$\bar{\varepsilon}_{pc} = 1 - (\bar{a}_{apc}/\bar{a}_{epc})e^{-\bar{a}_{epc}l} = 1 - (\bar{a}_{apc}/\bar{a}_{epc})e^{-n_{pc}\bar{A}_{pc}l} \tag{5.14}$$

Because in the atmosphere $(L_v(T)/L_{mv}(T)) < 1$ from equation (11) it follows that $(\bar{a}_a/\bar{a}_e) < 1$. In the lower atmosphere radiation spectrum is so near the spectrum of black radiation that without remarkable error we can set $(\bar{a}_a/\bar{a}_e) = 1$. Use of this approximation leads to correct emission and to small underestimation of absorption.

From equation (5.14) we get for the total emission area $\bar{A}_{pc}$ of compound c of entity p

$$\bar{A}_{pc} = \frac{\bar{a}_{epc}}{\bar{a}_{apc}} \frac{ln(1-\bar{\varepsilon}_{pc})}{n_{pc}l} \tag{5.15}$$

When the energy equivalent total emission ratio of compound c of entity p $\bar{\varepsilon}_{pc}$ is known corresponding energy equivalent total emission area $\bar{A}_{pc}$ can be calculated from equation (5.15). In the lower atmosphere radiance towards the ground is so near black radiance that without significant error it can be assumed that $\frac{\bar{a}_e}{\bar{a}_a} = 1$ hence

$$\bar{A}_{pc} = \frac{ln(1-\bar{\varepsilon}_{pc})}{n_{pc}l} \tag{5.16}$$

The energy equivalent mean emission ratios of several gas compounds and particles are reasonably well known. Further we replace all particle entities by one equivalent particle entity p and all droplet entities by one equivalent droplet entity d. Then equation (5.8) simplifies to

$$\bar{a} = \sum_{c=1}^{N_{pc}} n_{pc}\bar{A}_{pc} + \sum_{c=1}^{N_{dc}} n_{dc}\bar{A}_{pc} + \sum_{g=1}^{N_{gc}} n_{gc}\bar{A}_{gc} \tag{5.17}$$

For particles we assume that $\sum_{c=1}^{N_{pc}} n_{pc}\bar{A}_{pc} = n_p \ \pi\bar{d}_p^2/4$. By assuming further that the only radiating compound of droplet entity is H_2O and the only radiative compounds of gas entity g are H_2O and CO_2 equation (5.17) can be written as

$$\bar{a} = n_p \ \pi\bar{d}_p^2/4 + f_{vd}n_{dH2O} \frac{ln(1-\bar{\varepsilon}_{dH2O})}{n_{dH2O}l} + f_{vg}n_{gH2O} \frac{ln(1-\bar{\varepsilon}_{gCO2})}{n_{gCO2}l} + f_{vg}n_{gCO2} \frac{ln(1-\bar{\varepsilon}_{gH2} \ )}{n_{gH2O}l}$$
$$\tag{5.18}$$

f_{vd}=volume fraction of droplets and f_{vg}=volume fraction of gas

Without remarkable error we can assume that $f_{vg} = 1$ whereupon equation (5.18) simplifies to

$$\bar{a} = n_p \, \pi \bar{d}_p^2/4 + f_{vd} 5.56 \cdot 10^4 \frac{ln(1 - \bar{\varepsilon}_{dH2O})}{n_{dH2O} l} + n_{gH2O} \frac{ln(1 - \bar{\varepsilon}_{gCO2})}{n_{gCO2} l} + n_{gCO2} \frac{ln(1 - \bar{\varepsilon}_{gH2O})}{n_{gH2O} l}$$

(5.19)

n_p =particle concentration in the atmosphere (1/m^3) and $\bar{d}_p$=mean particle diameter

Studies by 1-entity radiance equation

Without significant error in the lowest 1 km layer of the atmosphere the global mean values of the atmosphere can be replaced by the arithmetic mean value of the value on the ground and at the altitude of 1 km. An example of the errors due to this approximation is given in table 1.

T_{ground} °K	T_{1km}	T_{mean}	$Mm_{Tground}$	Mm_{T1km}	Mm_{mean}	Mm_{Tmean}	Ratio
288.0	282.0	285.0	390.08	358.57	374.33	374.08	0.9993

Table 1 If in the calculations the mean black radiation intensity $((Mm_{Tground} + Mm_{Tmean})/2)$ is replaced by the black radiation intensity at the arithmetic mean temperature (Mm_{Tmean}) the relative error is about 0.000664. Therefore, we can apply aforesaid theory to calculate total emission from this layer to the ground.

By integrating equation (13) over the half solid angle and setting $\bar{a}_a/\bar{a}_e = 1$ it follows

$$\int_{\varphi=0}^{2\pi} \int_{\theta=0}^{\pi/2} L(0) sin\theta cos\theta d\theta \, d\varphi = E_{ag} = \int_{\varphi=0}^{2\pi} \int_{\theta=0}^{\pi/2} L(l) e^{-\bar{a}_e l/cos\theta} sin\theta cos\theta d\theta \, d\varphi +$$
$$\int_{\varphi=0}^{2\pi} \int_{\theta=0}^{\pi/2} L_m(T_{mean})\left(1 - e^{-\bar{a}_e l/cos\theta}\right) sin\theta cos\theta d\theta \, d\varphi$$

(5.20)

E_{ag} =thermal irradiation from the atmosphere to the ground (W/m^2)

T_{mean} = arithmetic mean temperature of the lowest 1km layer of the atmosphere =285 °K

$\bar{a}_e$=linear emission coefficient of the lowest 1km layer of the atmosphere (m^{-1})

l = height of the layer (m)

$1 - e^{-\bar{a}_e l/cos\theta} = \varepsilon(\theta, \bar{a}_e l) = 1 - \tau(\theta, \bar{a}_e l)$. $\varepsilon(\theta, \bar{a}_e l)$= emission ratio and $\tau(\theta, \bar{a}_e l)$= penetration ratio in angle θ between the beam and normal of the layer. Thus the first term on the right side of equation (5.20) is penetrated and second term emitted irradiation intensity to the ground.
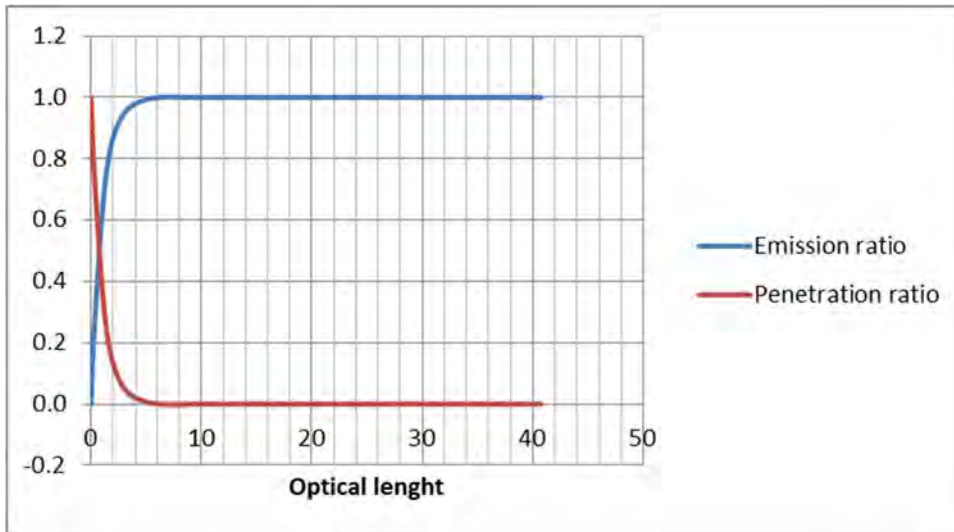
Figure 2 Figure presents emission ratio and penetration ratio as function of optical length.

As shown by figure 2, emission ratio approaches 1 and penetration ratio approaches 0 when $\bar{a}_e l/cos\theta$ approaches∞. If optical length $\bar{a}_e l/cos\theta > 4$, its increase has insignificant influence on irradiation intensity to the ground. Now we calculate the linear emission coefficient and corresponding optical length in the lowest 1 km layer of the atmosphere using equation (5.19).

		Droplets	Vapor	carbon diox	Particles	Total
Mole density	mole/m3	0.01	0.65	0.02	0.00	
Emisson area	m2/mole	1.00	0.03	0.03	250.00	
Linear emisson coefficient	1/m	0.01	0.02	0.00	0.00	
Optical length	Total	13.34	16.90	0.50	0.03	30.77

Table 2 Optical lengths of thermal radiation in the lowest 1 km layer of the atmosphere.

The calculated optical length of droplets is nearly as larger than the optical length of water vapor. This result is supported by the crucial influence of clouds on temperature of the ground during cool nights when the optical length of the atmosphere is mainly due to carbon dioxide and droplets. During such nights the temperature of the ground varies about 10 °C depending on the amount of droplets (clouds) in the atmosphere. It is very probable that the molar emission area of water of table 2 even underestimates the molar emission area of water. From the above explained reasons the possible underestimation doesn't cause remarkable error to the final results. This is true also regarding the possible inaccuracy of the molar emission area of particles.
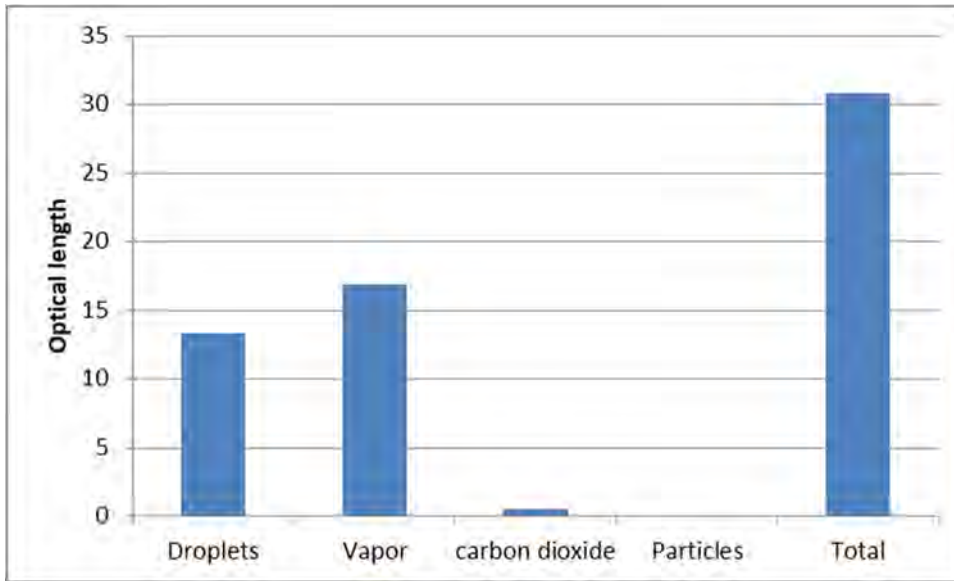

Figure 3 Optical lengths of table 2.

We define the mean beam length l_{mean} by equation

$$\int_{\varphi=0}^{2\pi} \int_{\theta=0}^{\pi/2} L_m(T_{mean})(1 - e^{-\bar{a}_e l_{mean}})sin\theta cos\theta d\theta \, d\varphi = \int_{\varphi=0}^{2\pi} \int_{\theta=0}^{\pi/2} L_m(T_{mean})\left(1 - e^{-\bar{a}_e l/cos\theta}\right)sin\theta cos\theta d\theta \, d\varphi$$

From the above equation we get for the ratio of mean beam length and height of planar layer l_{mean}/l equation (5.22)

$$l_{mean}/l = -\frac{1}{\bar{a}_e l} ln\left[2 \int_{\theta=0}^{\pi/2} e^{-\bar{a}_e l/cos\theta} sin\theta cos\theta d\theta\right] \tag{5.22}$$

By derivation of equation (5.21) we get

$$dE_{eg}/d(\bar{a}_e l_{mean}) = \sigma T_{mean}^4 e^{-\bar{a}_e l_{mean}} \tag{5.23}$$

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For small changes of optical length we get for the change of thermal irradiation to the ground

$$dE_{eg} = \sigma T_{mean}^4 e^{-\bar{a}_e l_{mean}} d(\bar{a}_e l_{mean}) = \sigma T_{mean}^4 e^{-\bar{a}_{epdv} l_{mean}} e^{-\bar{a}_{eCO2} l_{mean}} d(\bar{a}_e l_{mean})$$

If only carbon dioxide concentration changes we get

$$dE_{eg} = \sigma T_{mean}^4 e^{-\bar{a}_{epdv} l_{mean}} e^{-\bar{a}_{eCO2} l_{mean}} d(\bar{a}_{eCO2} l_{mean}) \qquad (5.24)$$

$\bar{a}_{epdv}$ =sum of mean linear emission coefficient of particles, droplets and water vapor

$\bar{a}_{eCO2}$ = mean linear emission coefficient of carbon dioxide

Equation (5.24) is crucially important for understanding of influence of increase of carbon dioxide concentration in the atmosphere on emission to the ground. As shown by figure 4 the influence decreases exponentially when optical length $\bar{a}_{epdv} l_{mean}$ increases. If $\bar{a}_{epdv} l_{mean}$ is large enough the influence is zero.

In the lowest 1 km layer of the atmosphere the mean emission coefficient $\bar{a}_{epdv}$ is 0.027 m^{-1} and l_{mean}/l is 1.1 corresponding to mean optical length $\bar{a}_{epdv} l_{mean} \approx 30$. If carbon dioxide concentration increases from 400 ppm to 500 ppm $d(\bar{a}_{eCO2} l_{mean}) \approx 0.125$. From equation (24) we get for increase of emission from the atmosphere to the ground 2.41E-12 W/m^2 which is practically zero. Therefore increase of carbon dioxide concentration in the atmosphere doesn't increase the mean temperature of the ground.
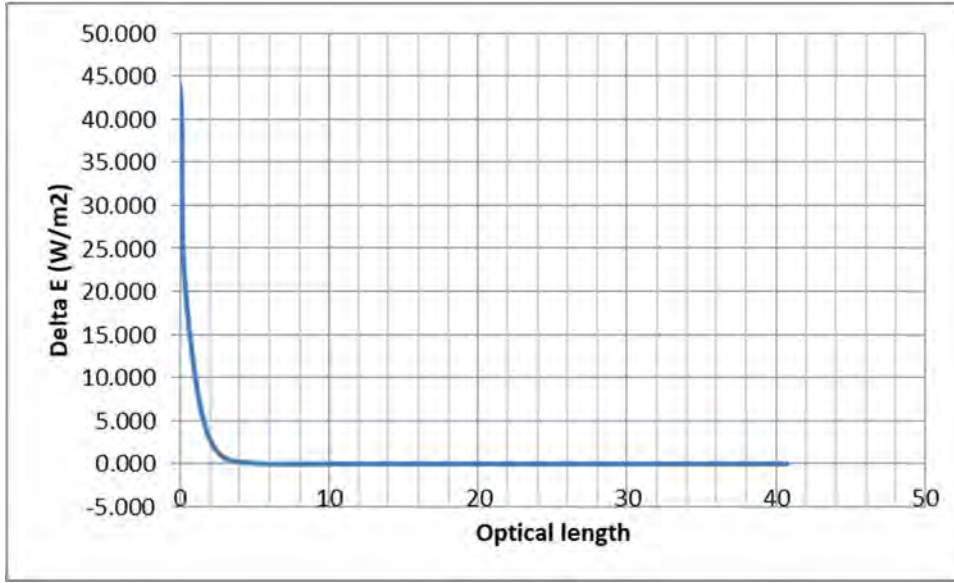

Figure 4 Influence of increase of carbon dioxide concentration in the atmosphere from 400 ppm to 500 ppm on the thermal emission to the ground as function of $\bar{a}_{epdv} l_{mean}$. Because $\bar{a}_{epdv} l_{mean}$ in the lowest 1 km layer of the atmosphere is about 30 the influence of increase of carbon dioxide concentration is practically zero.

Studies by SRclimate model

In order to study the sensitivity of calculated mean temperature of the ground on linear emission coefficients of solid particles, water particles and water vapor $\bar{a}_{epdv}$ the following calculations were carried out. From equation (5.19) calculated linear emission coefficients of particles, water droplets and water vapor were multiplied successively by 1, 0.5, 0.2, 0.1, 0.075, 0.05, 0.001, 0.0005. For each value of the multiplier carbon dioxide concentration in the atmosphere was varied from 100 to 700 ppm. Multiplier of linear emission coefficient of carbon dioxide was 1 in all calculations.
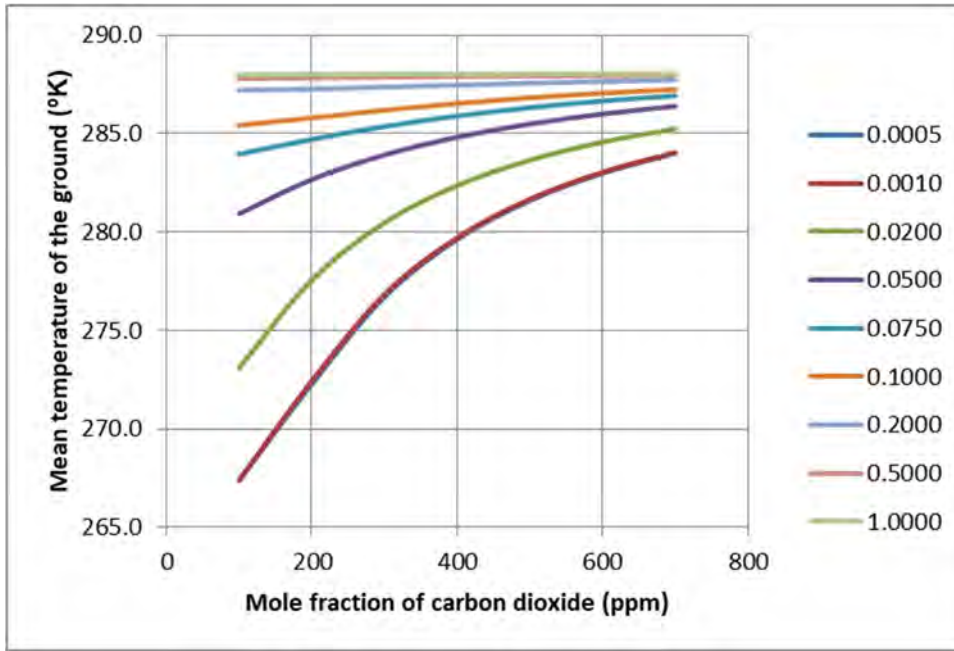
Figure 5 Results of the sensitivity calculations.

The calculations prove that the influence of increase of carbon dioxide concentration depends strongly on the multiplier. When the multiplier is smaller than 0.001 whereupon radiation is due to carbon dioxide only, at small carbon dioxide concentrations, increase of carbon dioxide concentration has strong influence on the mean temperature of the ground. When the carbon dioxide concentration increases its influence on the mean temperature of the ground decreases and the mean temperature of the ground approaches asymptotically 288°K. When the multiplier increases the influence of carbon dioxide decreases but with all values of the multiplier the mean temperature of the ground approaches asymptotically 288°K. When the multiplier is larger than 0.5, increase of carbon dioxide concentration has practically no influence on the mean temperature of the ground. This is the case in the atmosphere.

Studies by 2-entity radiance equation

Temperature difference between dry air and droplets
In all present climate models temperature of the atmosphere is defined as mean value of temperatures of gas and droplet. However, in more accurate climate models this temperature difference should and could be accounted.

In the atmosphere vaporization rate is so small that without significant error energy balance of droplet surface can be approximated by equation (5.25)[4]

$$T_a - T_s + \frac{D_a \delta_h}{\lambda_a \delta_c}(r_{aH2O} - 1)n_{sH2O}(T_s)L_{mH2O}(T_s) = 0 \qquad (5.25)$$

T_a =temperature of dry air

T_s =temperature of droplet

$n_{sH2O}(T_s)$ =saturated mole density of water at temperature T_s

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[4] Equation (25) is a simplified version of equation (11) of Appendix 4.

r_{aH2O} =relative humidity of air

D_a =compound diffusion coefficient of water in air (3e-5 m^2/s)

λ_a =thermal conductivity of air (0.025 W/m2/^{o}C)

$\delta_h = \alpha/\lambda_a$ =thickness of temperature boundary layer in air

α =heat transfer coefficient

$\delta_c = k/D_a$ = thickness of compound boundary layer in air

k =compound transfer coefficient

$L_{mH2O}(T_s)$ =molar vaporization enthalpy at temperature T_s (44000 J/mole)

From equation (5.25) it follows that

- temperature difference between air and droplets doesn't depend on absolute values of heat and compound transfer coefficients but only on their ratio which is near 1 in all cases,
- temperature difference between air and droplets can be zero only if $r_{aH2O} = 1$,
- always when $r_{aH2O} < 1$ there is temperature difference between air and droplets.

When T_a, δ_h/δ_c and r_{aH2O} are fixed surface temperature of droplets can be calculated from equation (5.25).
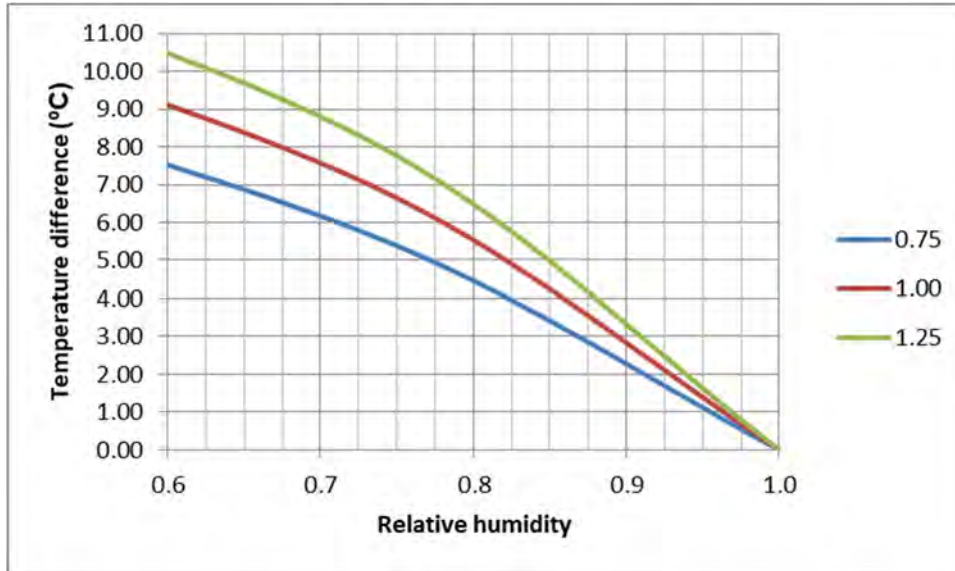
Figure 6 Figure presents from equation (5.25) calculated temperature difference between dry air at 15 ^{o}C and droplets as function of relative humidity and boundary layer thickness ratio δ_h/δ_c as parameter.

According to standard atmosphere relative humidity in the lower atmosphere is 0.75 which with boundary layer thickness ratio 1 corresponds to temperature difference of about 7 ^{o}C. The temperature difference is so large that it should be accounted in climate models.

The reported global mean temperatures of the atmosphere are temperatures of dry air and neglect temperature differences between dry air and droplets and particles. Accordingly, in the calculations of figure 3 and 4 it has been assumed that the atmosphere is locally isothermal.

Two entity radiance equation

As show by figure 6, in lower standard atmosphere local temperature difference between droplets and gas is several °C whereupon 1-entity assumption is erroneous and instead of radiance equation (5.1)) equation (5.26) should be used.

$$dL_v(v,x)/dx = a_g(v,x)L_{mv}\left(v,T_g(x)\right) + a_d(v,x)L_{mv}(v,T_d(x)) - [a_g(v,x) + a_d(v,x)]L_v(v,x)$$

$$(5.26)$$

By integrating equation (5.26) over the whole spectrum it follows

$$dL(x)/dx = \bar{a}_{eg}L_m\left(T_g(x)\right) + \bar{a}_{ed}L_m(T_d(x)) - \bar{a}_a L(x) \qquad (5.27)$$

$$L(x) = \int_{v=0}^{\infty} L_v(x)dv$$

$$\bar{a}_{eg} = \int_{v=0}^{\infty} \bar{a}_g L_{mv}\left(T_g(x)\right)dv \,/L_m\left(T_g(x)\right)$$

$$\bar{a}_{ed} = \int_{v=0}^{\infty} \bar{a}_d L_{mv}(T_d(x))dv \,/L_m\left(T_g(x)\right)$$

$$\bar{a}_a = \int_{v=0}^{\infty}[a_g(v,x) + a_d(v,x)]L_v(x)dv \,/L(x)$$

By defining effective emission temperature as follows

$$L_m(T_e(x)) = \left[\bar{a}_{eg}L_m\left(T_g(x)\right) + \bar{a}_{ed}L_m(T_d(x))\right]/[\bar{a}_{eg} + \bar{a}_{ed}]$$

Equation (5.27) can be written as

$$dL(x)/dx = \bar{a}_e L_m(T_e(x)) - \bar{a}_a L(x) \qquad (5.28)$$

By integrating equation (5.28) along a homogenous path from $x = 0$ to l we get for total radiance at $x = 0$

$$L(0) = L(l)e^{-\bar{a}_a l} + L_m(T_e)(1 - \bar{a}_a/\bar{a}_e\, e^{-\bar{a}_e l}) \qquad (5.29)$$

In the lowest 1 km layer of the atmosphere equation (5.29) simplifies to

$$\pi L(0) = M_m(T_e) = \bar{a}_{eg}/[\bar{a}_{eg} + \bar{a}_{ed}]\, M_m(T_g) + \bar{a}_{ed}/[\bar{a}_{eg} + \bar{a}_{ed}]\, M_m(T_d) \qquad (5.30)$$
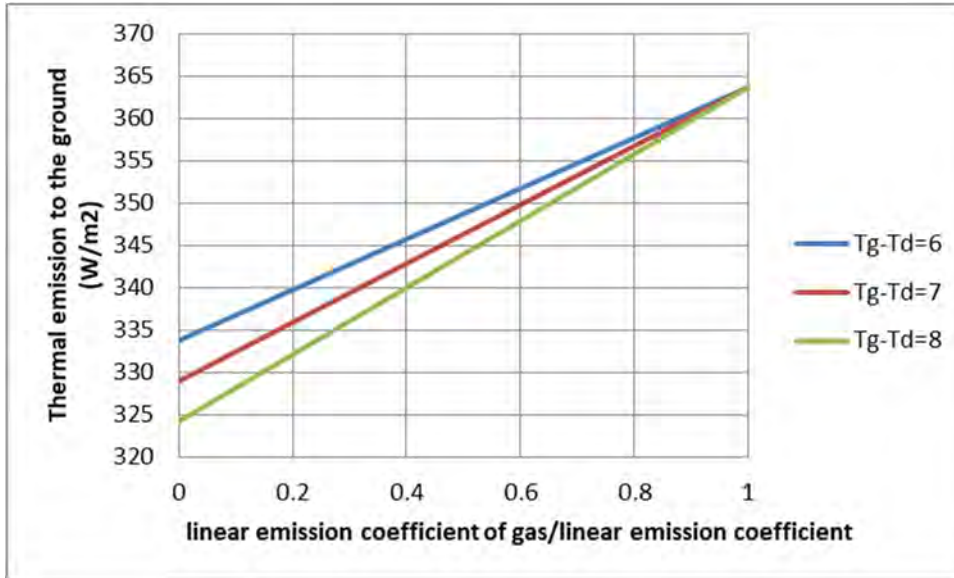
Figure 7 From equation (5.30) calculated thermal emission intensity from the atmosphere to the ground. As argument is linear emission coefficient of gas divided by total linear emission coefficient and as parameter temperature difference between dry air and water droplets.

Thermal emission intensity from the atmosphere to the ground is about 345 W/m^2 which corresponds to from equation (5.30) calculated value when linear emission coefficient of gas divided by the total linear emission coefficient is between 0.4 and 0.55 and temperature difference between dry air and droplets is between 6 and 8 ⁰C. These conditions are satisfied by from equation (5.19) and (5.25) calculated values within the uncertainty of measured data. Because thermal radiation to the ground is practically black radiation, increase of carbon dioxide concentration in the atmosphere has insignificant influence on the mean temperature of the ground.

Appendix 6: Theoretical foundations of climate models

Introduction

The only direct influence of increase of carbon dioxide in the atmosphere on the global mean temperature of the ground (hence forward the Temperature) is due to the slight increase of thermal radiation to the ground. The Temperature resists its increase by increasing vaporization of water from the ground and by decreasing solar radiation to the ground. Necessary condition for correct calculation of influence of carbon dioxide on the Temperature is that a) influence of carbon dioxide on thermal radiation to the ground and b) influence of increase of the Temperature on vaporization from the ground and on solar radiation to the ground are calculated correctly. The climate models of IPCC's assessment reports don't satisfy these conditions.

Equation (6.19) expresses mathematically the physical self-evidence that in each point of its path the spectral radiance (radiative energy flux in infinitely small solid angle and in infinitely small frequency range) is influenced by sum of linear emission coefficients of all compounds of gas, droplets, particles (hence forward the Entities) of the atmosphere. Therefore, influence of increase of carbon dioxide in the atmosphere on radiation to the ground must be calculated by accounting simultaneously the influences of carbon dioxide and clouds. In climate models of IPCC's assessment reports these influences are separated into clear sky "radiative forcing" and "cloud feedback" which is a fatal error.

Reference 11 state that even the sign of cloud feedback isn't known. When influence of carbon dioxide on thermal radiation to the ground is calculated correctly applying the profoundly verified radiance equation (6.19), cloud feedback isn't needed. Tens of years research of entirely needless "cloud feedback" is the most unfathomable blunder of modern science.

The global mean temperature of the ground resists its changes by changing vaporization of water from the ground and solar radiation to the ground. These mechanisms compensate the marginal increase of thermal radiation to the ground due to increase of carbon dioxide in the atmosphere, so that increase of global mean temperature remains negligible.

If carbon dioxide concentration in the atmosphere would continue increasing 1 ppm/year the causal contribution of the increase on the time derivatives of the lower atmosphere would be $2.7 \cdot 10^{-5}$ °C/day. This warming rate is so small that it totally vanishes within the natural variations of the atmospheric temperatures and the physical and mathematical errors of the time dependent climate models. Accordingly, time dependent climate models can't be per se used to investigate the influence of carbon dioxide on global mean temperatures.

Possibly for this reason, instead of increase of global mean temperature, hypothetical concept of "climate sensitivity" has been calculated in the IPCC's assessment reports. The hypothetical climate sensitivity has no physical counterpart. It is erroneous also because instead of present climate, the influence of carbon dioxide is compared with calculated climate at 300 ppm carbon dioxide concentration.

Cloud formation in the atmosphere is due to local temperature differences between gas and droplets. Accordingly, cloud formation can't be calculated correctly by the 3D time-dependent climate models of IPCC 's assessment reports which per se neglect local temperature differences between the Entities.

As shown by equations (6.1) – (6. 10) mathematical modelling of global atmosphere must be based on steady state compound, momentum, energy and number balances of the Entities. These equations are presented in this Appendix which together with their time-dependent boundary conditions on the ground and on the outer surface of the atmosphere, present the only physically and

mathematically correct set of equations for correct calculation of influence of carbon dioxide on the Temperature.

Global climate models
3-D time dependent climate models

Local climate is determined by local time mean velocities, amounts of compounds, temperatures and particle numbers of the Entities, which must be calculated by balance equations of the entities. These equations are presented mathematically by equations (6.1).

$$\frac{\partial x_p(r,\theta,\vartheta,t)}{\partial t} = X_p[x_e(r,\theta,\vartheta,t)] \tag{6.1}$$

$X_p[x_e(r,\theta,\vartheta,t)]$ = function which determines dependence of local and momentary time derivative on of quantity $x_p(r,\theta,\vartheta,t)$ on momentary state of the entities of the atmosphere.

$x_e(r,\theta,\vartheta,t)$ = quantity x of entity e in point $(r,\theta,\vartheta,)$ at moment t

Equations (6.1) must be written for each quantity x of each entity p

<u>Arithmetic</u> time mean global value of quantity x of entity e in location (r) is

$$\bar{\bar{x}}_e(r) = \frac{1}{4\pi(t_{i+1}-t_i)} \int_{\theta=0}^{\pi} \int_{\vartheta=0}^{2\pi} \int_{t=t_i}^{t_{i+1}} x_e(r,\theta,\vartheta,t)dt \, \sin\theta d\theta d\vartheta$$

Because 3-D time-dependent climate models produce only discrete momentary local values $T_e(r,\theta_i,\vartheta_j,t_k)$ integral (6.2) must be calculated numerically. If $\bar{\bar{x}}_e(r) = \bar{\bar{T}}_e(r)$ =time mean global temperature of entity e at radius r must be calculated by equation (6.3)

$$\bar{\bar{T}}_e(r) \cong \frac{1}{4\pi(t_{i+1}-t_i)} \sum_{i=1}^{N_i} \sum_{j=1}^{N_j} \sum_{k=1}^{N_k} T_e(r,\theta_i,\vartheta_j,t_k)\sin\theta_i \Delta\theta\Delta\vartheta\Delta t \tag{6.2}$$

In order to have a reasonably accurate numerical approximate for $\bar{\bar{T}}_e(r)$ for $t_{i+1} - t_i = 20$ years, in the equator horizontal grid size should not exceed 1 km and time step 1 hour hence

$N_i \approx 40000, N_j \approx 40000, N_k \approx 175000$

Numerical approximate (6.2) of arithmetic time mean global temperature $\bar{\bar{T}}_e(r)$ would include $2.8 \cdot 10^{14}$ numerically erroneous terms whose momentary local temperatures $T_e(r,\theta_i,\vartheta_j,t_k)$ would not have any correlation to real momentary local temperatures. The insignificant influence of carbon dioxide would totally vanish within the numerical errors of calculated momentary local temperatures and numerical errors of equation (6.2). <u>Accordingly, the 3-D time-dependent climate models can't be used for calculation of influence of carbon dioxide on global mean temperatures.</u>

3-D time independent climate models

By integrating equation (6.1) from moment $t = t_i$ to moment $t = t_{i+1}$ equation (6.3) is obtained.

$$x_p(r,\theta,\vartheta,t_{i+1}) - x_p(r,\theta,\vartheta,t_i) = \int_{t=t_i}^{t_{i+1}} X_p[x_e(r,\theta,\vartheta,t)]dt \tag{6.3}$$

Time mean local values $\bar{x}_e(r,\theta,\vartheta)$ are defined by equation

$$\frac{1}{t_{i+1}-t_i} \int_{t=t_i}^{t_{i+1}} \frac{\partial}{\partial t} \bar{x}_p(r,t)dt = X_p[\bar{x}_e(r,\theta,\vartheta)]$$

Equation (6.3) can now be written as

$$\frac{x_p(r,\theta,\vartheta,t_{i+1})-x_p(r,\theta,\vartheta,t_i)}{t_{i+1}-t_i} = X_p[\bar{x}_e(r,\theta,\vartheta)]$$

When $t_{i+1} - t_i$ approaches infinite, equations (6.3) simplify to

$$0 = X_p[\bar{x}_e(r,\theta,\vartheta)] \tag{6.4}$$

Equations (6.4) with correct boundary conditions local time mean quantities of the entities. However, equations (6.4) can't be used because local time mean convective mixing coefficients of the entities (equation (6.12)) aren't known. The only relevant climate model for studying the influence of carbon dioxide on global mean temperatures is 1-D time independent model which is presented in the following chapter.

1-D time-independent global climate models

Unlike numerical integration of the 3-D time-dependent global climate models, analytical integration of equations (6.1) doesn't cause mathematical error. By integrating equation (6.1) over the whole solid angle equation (6.5) is obtained.

$$\frac{\partial}{\partial t}\int_{\vartheta=0}^{2\pi}\int_{\theta=0}^{\pi}x_p(r,\theta,\vartheta,t)sin\theta d\theta d\vartheta = \int_{\vartheta=0}^{2\pi}\int_{\theta=0}^{\pi}X_p[x_e(r,\theta,\vartheta,t)]sin\theta d\theta d\vartheta \quad (6.5)$$

Thermostatic momentary global mean values $\bar{x}_e(r,t)$ are defined by equation

$$X_p[\bar{x}_e(r,t)] = \frac{1}{4\pi}\int_{\vartheta=0}^{2\pi}\int_{\theta=0}^{\pi}X_p[x_e(r,\theta,\vartheta,t)]sin\theta d\theta d\vartheta$$

Momentary global balance equation of x_p is then

$$\frac{\partial}{\partial t}\bar{x}_p(r,t) = X_p[\bar{x}_e(r,t)] \quad (6.6)$$

By integration equation (6.6) from moment $t=t_i$ to moment $t=t_{i+1}$ equation (6.7) is obtained.

$$\bar{x}_p(r,t_{i+1}) - \bar{x}_p(r,t_i) = \int_{t=t_i}^{t_{i+1}}X_p[\bar{x}_e(r,t)]dt \quad (6.7)$$

Time mean global values $\bar{\bar{x}}_e(r)$ are defined by equation (6.8)

$$\frac{1}{t_{i+1}-t_i}\int_{t=t_i}^{t_{i+1}}\frac{\partial}{\partial t}\bar{x}_p(r,t)dt = X_p[\bar{\bar{x}}_e(r)] \quad (6.8)$$

Equation (6.7) can now be written as

$$\frac{\bar{x}_p(r,t_{i+1})-\bar{x}_p(r,t_i)}{t_{i+1}-t_i} = X_p[\bar{\bar{x}}_e(r)] \quad (6.9)$$

When $t_{i+1}-t_i$ approaches infinite, equations (6.9) simplify to

$$0 = X_p[\bar{\bar{x}}_e(r)] \quad (6.10)$$

Accordingly, the time mean global quantities of the atmosphere can calculated correctly only by solving the steady state balance equations (6.10) of the atmosphere with boundary conditions of the ground and the outer surface of the atmosphere which depend on time.

Global momentum balances of entities

Diffusion momentum transfer of all entities of the atmosphere is negligible in comparison with convective transfer. In global vertical momentum balances influence of rotation of the earth disappears hence momentary global vertical momentum balance is

$$\frac{\partial \varepsilon_p\rho_p v_{rp}}{\partial t} = -\frac{\partial}{r^2\partial r}\left[r^2\left(\varepsilon_p\rho_p v_{rp}v_{rp}\right)\right] - \varepsilon_p\frac{\partial p}{\partial r} + \sum_{e=1}^{N_e}M_{ep}'''(v_{re}-v_{rp}) + \varepsilon_p\rho_p g_r \quad (6.11)$$

By integrating momentary momentum balance from moment t_i to moment t_{i+1} follows

$$\int_{t=t_i}^{t_{i+1}}\frac{\partial \varepsilon_p\rho_p v_{rp}}{\partial r}dt = -\int_{t=t_i}^{t_{i+1}}\frac{\partial}{r^2\partial r}\left[r^2\left(\varepsilon_p\rho_p v_{rp}v_{rp}\right)\right]dt - \int_{t=t_i}^{t_{i+1}}\varepsilon_p\frac{\partial p}{\partial r}dt + \int_{t=t_i}^{t_{i+1}}\sum_{e=1}^{N_e}M_{ep}'''(v_{re}-v_{rp})dt + \int_{t=t_i}^{t_{i+1}}\varepsilon_p\rho_p g_r dt$$

Momentary vertical fluxes can be expressed as follows

$$\varepsilon_p \rho_p v_{rp} v_{rp} = \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \bar{v}_{rp} + \left(\varepsilon_p \rho_p v_{rp} v_{rp} - \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \bar{v}_{rp} \right) = \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \bar{v}_{rp} + \hat{\varepsilon}_p \hat{\rho}_p \hat{v}_{rp} \hat{v}_{rp}$$

$\bar{\varepsilon}_p$ =time mean volume fraction of entity p

$\bar{\rho}_p$ = time mean density of entity p

$\bar{v}_{rp}$ = time mean radial velocity of entity p

$\hat{\varepsilon}_p$ =momentary fluctuation of volume fraction of entity p

$\hat{\rho}_p$ = momentary fluctuation of density of entity p

$\hat{v}_{rp}$ = momentary fluctuation of radial velocity of entity p

Time mean thermodynamic pressure is defined as follows

$$\varepsilon_p \frac{\partial p}{\partial r} = \bar{\varepsilon}_p \frac{\partial \bar{p}}{\partial r}$$

Time mean momentum transfer coefficient is defined as follows

$$\sum_{e=1}^{N_e} M_{ep}'''(v_{re} - v_{rp}) = \sum_{e=1}^{N_e} \bar{M}_{ep}'''(\bar{v}_{re} - \bar{v}_{rp})$$

Time mean density is defined as follows $\varepsilon_p \rho_p g_r = \bar{\varepsilon}_p \bar{\rho}_p g_r$

By integrating the above terms from time t_i to t_{i+1}

$$\int_{t=t_i}^{t_{i+1}} \frac{\partial}{r^2 \partial r} \left[r^2 \left(\bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \bar{v}_{rp} + \hat{\varepsilon}_p \hat{\rho}_p \hat{v}_{rp} \hat{v}_{rp} \right) \right] dt = \int_{t=t_i}^{t_{i+1}} \frac{\partial}{r^2 \partial r} \left[r^2 \left(\bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \bar{v}_{rp} \right) \right] dt + \int_{t=t_i}^{t_{i+1}} \frac{\partial}{r^2 \partial r} \left[r^2 \left(\hat{\varepsilon}_p \hat{\rho}_p \hat{v}_{rp} \hat{v}_{rp} \right) \right] dt$$

We define vertical convective mixing coefficient of entity p by equation

$$\int_{t=t_i}^{t_{i+1}} \hat{\varepsilon}_p \hat{\rho}_p \hat{v}_{rp} \hat{v}_{rp} dt = -\frac{\partial D_{rp} \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp}}{\partial r} (t_{i+1} - t_i) \tag{6.12}$$

Now the time mean vertical momentum balance of entity p can be written as

$$\frac{1}{(t_{i+1}-t_i)} \int_{t=t_i}^{t_{i+1}} \frac{\partial \varepsilon_p \rho_p v_{rp}}{\partial r} dt = -\frac{\partial}{r^2 \partial r} \left[r^2 \left(\bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \bar{v}_{rp} - \frac{\partial D_{rp} \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp}}{\partial r} \right) \right] - \bar{\varepsilon}_p \frac{\partial \bar{p}}{\partial r} + \sum_{e=1}^{N_e} \bar{M}_{ep}'''(\bar{v}_{re} - \bar{v}_{rp}) + \bar{\varepsilon}_p \bar{\rho}_p g_r$$

When $(t_{i+1} - t_i)$ approaches infinite time mean vertical momentum balance of entity p simplifies to

$$0 = -\frac{\partial}{r^2 \partial r} \left[r^2 \left(\bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \bar{v}_{rp} - \frac{\partial D_{rp} \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp}}{\partial r} \right) \right] - \bar{\varepsilon}_p \frac{\partial \bar{p}}{\partial r} + \sum_{e=1}^{N_e} \bar{M}_{ep}'''(\bar{v}_{re} - \bar{v}_{rp}) + \bar{\varepsilon}_p \bar{\rho}_p g_r \tag{6.13}$$

$\bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \bar{v}_{rp}$ =time mean convective vertical momentum flow density of entity p

$-\frac{\partial D_{rp} \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp}}{\partial r} = -D_{pr} \frac{\partial \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp}}{\partial r} - \bar{\varepsilon}_p \bar{\rho}_p \bar{v}_{rp} \frac{\partial D_{pr}}{\partial r}$ = vertical momentum flow density of entity p due to time mean vertical <u>convective</u> mixing

D_{pr} =time mean radial mixing coefficient of entity p (m²/s). Unlike molecular diffusion coefficient convection diffusion coefficient is strongly direction dependent

$-\bar{\varepsilon}_p \frac{\partial \bar{p}}{\partial r}$ = time mean vertical momentum flow density to entity p due to pressure gradient of gas entity

$\sum_{e=1}^{N_e} \bar{M}_{ep}'''(\bar{v}_{re} - \bar{v}_{rp})$ = time mean vertical momentum flow density to entity p from other entities

$\bar{\varepsilon}_p \bar{\rho}_p g_r$ = time mean vertical momentum flow density to entity p due to gravity

For entity gas time mean vertical convection velocity $\bar{v}_{rp} \cong 0$ hence equation (6.13) simplifies to

$$0 = -\bar{\varepsilon}_g \frac{\partial \bar{p}}{\partial r} + \sum_{e=1}^{N_e} \bar{M}_{eg}''' \bar{v}_{re} + \bar{\varepsilon}_g \bar{\rho}_g g_r \qquad (6.14)$$

For droplet and particle entities convective transfer and mixing can be neglected. Without remarkable error can be assumed that droplet and particle entities exchange momentum only with gas entity. hence

$$0 = -\bar{\varepsilon}_p \frac{\partial \bar{p}}{\partial r} - \bar{M}_{gp}''' \bar{v}_{rp} + \bar{\varepsilon}_p \bar{\rho}_p g_r \qquad (6.15)$$

By summing equations (6.14) and (6.15) the total momentum balance equation (6.16) is obtained.

$$0 = -\frac{\partial \bar{p}}{\partial r} + \sum_{e=1}^{N_e} \bar{\varepsilon}_p \bar{\rho}_p g_r \qquad (6.16)$$

$$\bar{\rho}_p = \bar{\rho}_p(T_p, \bar{p}, n_{cp})$$

Equations (6.14) - (6.16) form a mathematically closed system of equations for solution of vertical velocities, pressure and densities of entities.

Global compound balances of entities

In the atmosphere influence of chemical reactions on compound balances can be neglected hence by similar reasoning as in previous chapter, time mean global balance of compound c of entity p is

$$0 = -\frac{\partial}{r^2 \partial r}\left[r^2\left(\bar{\varepsilon}_p \bar{n}_{cp}\left(\bar{v}_{rp} - \frac{\partial \bar{D}_{pr}}{\partial r}\right) - \bar{D}_{pr}\frac{\partial \bar{\varepsilon}_p \bar{n}_{cp}}{\partial r}\right)\right] + \sum_{e=1}^{N_e} \bar{N}_{cep}''' \qquad (6.17)$$

$-\frac{\partial}{r^2 \partial r}\left[r^2\left(\bar{\varepsilon}_p \bar{n}_{cp}\left(\bar{v}_{rp} - \frac{\partial \bar{D}_{pr}}{\partial r}\right) - \bar{D}_{pr}\frac{\partial \bar{\varepsilon}_p \bar{n}_{cp}}{\partial r}\right)\right]$ = time mean net flow density (mole/s/m³) due to convection and convective mixing of compound c of entity p in radial direction

$\bar{v}_{rp}$ =time mean radial velocity of entity p

$\bar{N}_{cep}''' = \frac{\bar{n}_{ce}\bar{H}_{cpe}\kappa_{bp}\kappa_{eb} - \bar{n}_{cp}\kappa_{pb}\kappa_{be}}{\bar{H}_{cpe}\kappa_{bp} + \kappa_{be}}$ =time mean compound flow density (mole/m³/s) of compound c from entity e to entity p

$\bar{n}_{ce}$= time mean mole density of compound y of entity f (mole/m³)

$\bar{n}_{cp}$= time mean mole density of compound y of entity p (mole/m³)

κ_{pb}= compound transfer coefficient from entity p to the boundary between entities e and p

κ_{eb}= compound transfer coefficient from entity e to the boundary between entities e and p

$\bar{H}_{cpe} = \bar{n}_{cbp}/\bar{n}_{cbe}$ =mole density ratio of compound y on boundary b between entities p and f. Because mole density gradients on entity boundaries are infinite local thermostatic equilibrium prevails on the boundaries. Accordingly, quantities $\bar{H}_{cpe}$ are thermostatic properties which can be determined empirically for each compound and boundary.

Equations (6.17) must be written for all compounds c of all entities p and solved with equations of state of entities p as bounding conditions.

$$\sum_{c=1}^{N_c} \bar{n}_{cp} = \bar{F}_{np}[\bar{T}_p, \bar{p}, \bar{n}_{cp}]$$

For gas entity g equation of state is

$$\sum_{c=1}^{N_c} \bar{n}_{cp} = \frac{\bar{p}}{R\bar{T}_g}$$

Global energy balances of entities

In spherical coordinates time mean global energy balance of entity p is

$$0 = -\frac{\partial}{r^2 \partial r}\left[r^2 \sum_{c=1}^{N_c}\left(\bar{\varepsilon}_p\bar{n}_p\left[\bar{v}_{rp} - \frac{\partial \bar{D}_{rp}}{\partial r}\right] - \bar{D}_{rp}\frac{\partial \bar{\varepsilon}_p\bar{n}_p}{\partial r}\right)\bar{H}_{mpc}\right] + \sum_{e=1}^{N_e}\dot{Q}'''_{ep} + \dot{Q}'''_{nrp}$$

$$(6.18)$$

$$\bar{H}_{mpc} = H_{mpc}(T_p) + M_c g_r r = H_{mpc}(T_B) + \left(H_{mpc}(\bar{T}_p) - H_{mpc}(T_B)\right) + M_c g_r r$$

$\sum_{c=1}^{N_c}\left(\bar{\varepsilon}_p\bar{n}_p\left[\bar{v}_{rp} - \frac{\partial \bar{D}_{rp}}{\partial r}\right] - \bar{D}_{rp}\frac{\partial \bar{\varepsilon}_p\bar{n}_p}{\partial r}\right)\bar{H}_{mpc}$ =time mean enthalpy flux in direction r

$\sum_{e=1}^{N_e}\dot{Q}'''_{ep} = \bar{G}'''_{eb}(\bar{T}_e - \bar{T}_b) + \sum_{c=1}^{N_c}\dot{N}'''_{ceb}\bar{H}_{mecb}$ =time mean energy flows from entity e to entity p

When spectral radiance $\bar{L}(v,\alpha,\beta,r)$ is known global net radiative energy flux (W/m³) to entity p at radius r is

$$\bar{Q}'''_{nrp} = \int_{\beta=0}^{2\pi}\int_{\alpha=0}^{\pi}\int_{v=0}^{\infty}\left(\bar{L}(v,\alpha,\beta,r) - \bar{L}_{mp}(v,r)\right)\bar{a}_p(v,r)dvcos(\alpha)sin(\alpha)d\alpha d\beta$$

$$=\int_{\beta=0}^{2\pi}\int_{\alpha=0}^{\pi}\int_{v=0}^{\infty}\bar{L}(v,\alpha,\beta,r)\,\bar{a}_{ap}(v,r)dvcos(\alpha)\,sin(\alpha)d\alpha d\beta - \pi\int_{v=0}^{\infty}L_m(v,r)\bar{a}_{ep}(v,r)dv =$$

$$\int_{\beta=0}^{2\pi}\int_{\alpha=0}^{\pi}\bar{L}(\alpha,\beta,r)\,\bar{a}_{ap}(v,r)cos(\alpha)\,sin(\alpha)d\alpha d\beta - \sigma\bar{T}_p^4(r)\bar{a}_{ep}(v,r)$$

$\bar{L}_{mp}(v,r)$ =radiance of Planck's radiation of phase p at frequency v at radius r

$\bar{L}(\alpha,\beta,r)$ =global mean total radiance in direction (α,β) at radius r

$\sigma\bar{T}_p^4(r)$ =black radiation intensity of entity p at radius r

σ =Stefan Boltzmann constant (5.67.10⁻⁸ W/(m²K⁴))

$\bar{a}_{ap}(r)$ =global mean total linear absorption coefficient of entity p at radius r

$\bar{a}_{ep}(r)$ =global mean total linear emission coefficient of entity p at radius r

In the atmosphere radiation is so near Planck's radiation that without remarkable error can be stated

$$\bar{a}_{ap}(r) = \bar{a}_{ap}(r) = \bar{a}_p(r)$$

Radiative energy transfer in the atmosphere
Absorption of spectral radiation

Molar absorption area of compound c of entity e A_{maec} is defined as area perpendicular to radiance from which compound c absorbs the radiance. In differential volume $dV = dAds$ spectral absorption area of compound c of entity e is

$$dA_{vaec} = dA\varepsilon_e n_{ec} A_{mvaec}ds$$

dA =differential surface perpendicular to radiance

ds =differential distance in direction of radiance

ε_e =volume fraction of entity e

n_{ec} =mole density of compound c of entity e

From spectral radiance through surface dA spectral radiance $dA_{va}L_v$ is absorbed. From radiance balance of volume $dAds$ follows that $dA_{va}L_v = dL_v dA$, hence

$$dL_{va} = \left(\sum_{e=1}^{N_e}\sum_{c=1}^{N_c}\varepsilon_e n_{ec} A_{mvaec}\right)dL_v = a_{va}L_v ds$$

$a_{va} = \sum_{e=1}^{N_e}\sum_{c=1}^{N_c}\varepsilon_e n_{ec} A_{mvaec}$ =spectral linear absorption coefficient

Emission of spectral radiation

Molar emission area of compound c of entity e A_{meec} is defined as area perpendicular to radiance from which compound c emits Planck's radiance. In differential volume $dV = dAds$ spectral emission area of compound c of entity e is

$$dA_{veec} = dA\varepsilon_e n_{ec} A_{mveec} ds$$

Due to spectral emission radiance through surface dA increases by $\sum_{e=1}^{N_e} dA_{ve} L_{mve}(\bar{T}_e)$. From radiance balance of volume $dAds$ follows that $dA_{ve}L_v = dL_{ve}dA$, hence

$$dL_{ve} = \left(\sum_{e=1}^{N_e}\sum_{c=1}^{N_c} \bar{\varepsilon}_e \bar{n}_{ec} A_{mveec}\right) L_{mve}(\bar{T}_e)ds = \bar{a}_{va} L_{mve}(\bar{T}_e)ds$$

$\bar{a}_{va} = \sum_{e=1}^{N_e}\sum_{c=1}^{N_c} \bar{\varepsilon}_e \bar{n}_{ec} A_{mveec}$ =spectral linear absorption coefficient

Spectral radiance equation of the atmosphere

Net increase of spectral radiance in differential distance in direction of radiance dL_v is emission minus absorption. If temperatures of entities are different radiance equation is

$$\frac{dL_v}{ds} = \sum_{e=1}^{N_e} a_{ve} L_{mve} - a_{va} L_v \tag{6.19}$$

From second law of thermostatics follows that in isothermal cavities $L_v = L_{mve} = L_{mv}$, because otherwise net energy transfer without temperature difference would occur. Accordingly, in isothermal cavities

$$\sum_{e=1}^{N_e}\sum_{c=1}^{N_c} \varepsilon_e n_{ec} A_{mveec} - \sum_{e=1}^{N_e}\sum_{c=1}^{N_c} \varepsilon_e n_{ec} A_{mva} \quad = \sum_{e=1}^{N_e}\sum_{c=1}^{N_c} \varepsilon_e n_{ec}(A_{mveec} - A_{mveec}) = 0 \tag{6.20}$$

Equation (6.20) is always true only if $A_{mveec} = A_{mveec}$, hence in all isothermal cavities

$$a_{ve} = a_{va} = a_v \tag{6.21}$$

Because spectral molar absorption coefficients are thermostatic properties equation (6.21) is always true. When local temperature differences of entities are negligible radiance equation (6.19) simplifies to equation (6.22) which has been presented for example in reference: Tekniikan käsikirja 8. painos 1. osa, K.J.Gummerus Osakeyhtiö, Jyväskylä 1965, (Professor Henrik Ryti)

$$\frac{dL_v}{ds} = a_v(L_{mv} - L_v) \tag{6.22}$$

Global mass balance of the atmosphere

By multiplying equations (6.17) by molar mass of compound c and by summing the multiplied equations over all compounds of all entities total mass balance (6.23) is obtained.

$$0 = -\frac{\partial}{r^2 \partial r}\left[r^2 \sum_{c=1}^{N_c}\sum_{e=1}^{N_e}\left(\bar{\varepsilon}_e \bar{n}_{ce}\left(\bar{v}_{re} - \frac{\partial \bar{D}_{er}}{\partial r}\right) - \bar{D}_{er}\frac{\partial \bar{\varepsilon}_e \bar{n}_{ce}}{\partial r}\right)M_c\right] + \sum_{p=1}^{N_e}\sum_{c=1}^{N_c}\sum_{e=1}^{N_e}\bar{N}_{cep}''' M_c \tag{6.23}$$

Because $\bar{N}_{cep}''' = \bar{N}_{cpe}'''$, $\sum_{p=1}^{N_e}\sum_{c=1}^{N_c}\sum_{e=1}^{N_e}\bar{N}_{cep}''' = 0$ Thus the steady state total mass balance of the atmosphere simplifies to

$$0 = -\frac{\partial}{r^2 \partial r}\left[r^2 \sum_{c=1}^{N_c}\sum_{e=1}^{N_e}\left(\bar{\varepsilon}_e \bar{n}_{ce}\left(\bar{v}_{re} - \frac{\partial \bar{D}_{er}}{\partial r}\right) - \bar{D}_{er}\frac{\partial \bar{\varepsilon}_e \bar{n}_{ce}}{\partial r}\right)M_c\right] \tag{6.24}$$

Exact solution of the vertical mass balance (6.2) is

$$\sum_{c=1}^{N_c}\sum_{e=1}^{N_e}\left(\bar{\varepsilon}_e \bar{n}_{ce}\left(\bar{v}_{re} - \frac{\partial \bar{D}_{er}}{\partial r}\right) - \bar{D}_{er}\frac{\partial \bar{\varepsilon}_e \bar{n}_{ce}}{\partial r}\right)M_c = 0 \tag{6.25}$$

Global number balances of entities of the atmosphere

$$0 = -\frac{\partial}{r^2 \partial r}\left[r^2 \left(\bar{N}_d'''\left(\bar{v}_{rd} - \frac{\partial \bar{D}_{dr}}{\partial r}\right) - \bar{D}_{dr}\frac{\partial \bar{N}_d'''}{\partial r}\right)\right] + \bar{S}_d''' \tag{6.26}$$

$$-\frac{\partial}{r^2\partial r}\left[r^2\left(\bar{N}_d'''\left(\bar{v}_{rd}-\frac{\partial\bar{D}_{dr}}{\partial r}\right)-\bar{D}_{dr}\frac{\partial\bar{N}_d'''}{\partial r}\right)\right]=\text{global mean net particle flow density (m}^{-3}\text{s}^{-1})\text{ to entity}$$
d

$\bar{N}_d'''$ =particle density of discrete entity d (m^{-3})

$\bar{S}_d'''$ =source of particles of entity d (m^{-3}s^{-1})

Equations must be written for all discrete entities.

1-D time dependent climate model of IPCC's assessment reports

In the calculation method of reference 1 equation (6.27) is used to calculate global mean temperatures of the atmosphere.

$$\rho c_p\frac{\partial T}{\partial t}=-\frac{\partial}{\partial z}(F) \tag{6.27}$$

$F=\int_{\theta=0}^{\pi}\int_{\vartheta=0}^{2\pi}\int_{\nu=0}^{\infty}L_\nu(\nu,\theta,\vartheta)d\nu\cos(\theta)\sin(\theta)\,d\theta d\vartheta$ =vertical radiative flux

θ = angle between the radius of earth and ray

ϑ = angle in the plane perpendicular to the radius of earth

$L_\nu(\nu,\theta,\vartheta)$ = spectral radiance in direction θ,ϑ

Spectral radiance $L_\nu(\nu,\theta,\vartheta)$ must be calculated for each direction θ,ϑ from equation (6.22).

When the mathematical model of reference 1 (equation (6.27)) is compared with the correct mathematical model (equations (6.11) – (6.26) the erroneousness of calculation method of reference 1 is obvious.

At least from daily weather forecasts everybody knows that atmospheric temperatures are dominated by atmospheric flows but according to equation (6.27) atmospheric temperatures are fully independent of atmospheric flows. In calculation of global mean temperature of the atmosphere error of equation (6.27) corresponds to that weather forecast would be made without considering atmospheric flows, whereupon temperatures of weather forecasts would be entirely wrong. Accordingly, global mean temperatures which are calculated by equation (6.27) entirely wrong. ***Latest from this everybody understands that equation (6.27) is entirely wrong***. In addition, net vertical radiative flux F has been calculated erroneously because the dominating influence of atmospheric droplets and particles on net vertical radiative flux has been neglected.

Mathematically erroneousness of equation (6.27) can be proved as follows. By simple calculation of order of magnitude, it can be proved that accumulation of energy is insignificant in global energy balances of the atmosphere whereupon mathematical solution of equation (6.27) is

$$F(z)=F(0) \tag{6.28}$$

Solution of equation (6.28) leads to entirely wrong atmospheric temperatures whereupon equation (6.27) is proved also mathematically to be entirely wrong. When in addition entirely wrong equation (6.27) has been solved entirely incorrectly, calculation method of reference 1 can be made to produce any result as shown by IPCC's Basic Claims. Reference 1 proves that its authors, authors of its references and reviewers of IPCC's assessment reports don't understand heat and fuid dynamics.

3D time-dependent climate models of IPCC assessment reports

For a big surprise of professor Sarkomaa and professor Ruottu (hence forward the Authors) their discussions with the Finnish Meteorological Institute and meteorologists of Helsinki University revealed that meteorologists don't understand theoretical foundations of radiative energy transfer and cloud formation. References 11 and 13 of IPCC's assessment reports prove that their authors, authors of their references and reviewers of IPCC's assessment reports don't understand heat and fluid dynamics.

The only physically correct foundation of 3-D time-dependent climate models are the 3-D time dependent compound, momentum, energy and number balances of the atmosphere with correct initial and boundary conditions. However, in all about the 40 3-D time-dependent climate models of IPCC's assessment reports:

1. momentum equations of entities have been replaced by one momentum equation
2. compound balance equations of entities are missing
3. energy equations of entities have been replaced by one energy equation
4. number balance equations of entities are missing

The 3-D time-dependent climate models of IPCC's assessment reports are physically rough approximations of the atmosphere.

Condensation and vaporization of water in the atmosphere (cloud formation) is due to local temperature differences between droplets and surrounding gas. Accordingly, cloud formation can't be calculated correctly by the climate models of IPCC's assessment reports which per se neglect local temperatures between gas and droplets. When in addition radiative energy transfer is calculated wrong the climate models of IPCC's assessment reports are invalid for calculation of influence of carbon dioxide on the global mean temperature of the ground.

It is per se senseless to investigate influence of carbon dioxide on global mean temperature by 3-D time-dependent climate models, because the time integration of the model equations should be continued until the time mean derivatives of global mean temperatures are zero. After an enormous numerical labor the same global mean temperatures would be obtained than by direct solution corresponding 1-D time-independent climate model.

The atmosphere is a steady transient system where daily mean time derivatives of local temperatures are up to 40 °C/day and momentary derivatives even larger. If IPCC's claim about 1.2 °C increase of global mean temperature is true and solely due to increase of carbon dioxide in the atmosphere, the realized 130 ppm increase of carbon dioxide concentration corresponds to about 0.01 °C/ppmCO_2 increase of global mean temperatures of the ground. The causal influence of carbon dioxide on global mean temperatures, which is due to the marginal increase of the linear emission coefficient of the atmosphere, is at any moment locally essentially equal in the whole lower atmosphere. If carbon dioxide concentration in the atmosphere is assumed to increase 1 ppm/year the warming rate of the lower atmosphere due to carbon dioxide would be $2.7 \cdot 10^{-5}$ °C/day. This warming rate is so small that it totally vanishes within the natural variations of local temperatures and the physical and mathematical errors of the time dependent climate models. This situation persists endlessly hence <u>the 3D time-dependent equations are per se invalid for investigation of the influence of carbon dioxide on global mean temperatures</u>.

SRclimate model

IPCC's claim per se neglects the local temperature differences of entities which causes that compound amounts and compound flows of the entities (among other clouds) can't be calculated from the basic laws of heat and fluid dynamics.

In the SRclimate model this problem has been overcome by using the empirically known compound densities of the atmosphere and by calculating the global mean convection velocities of gas by fitting the calculated global mean temperatures to the empirical data. When the global mean convection velocities of gas are known clouds, condensation and annual raining can be calculated by water balance of the atmosphere. In order to calculate global mean volume fraction of clouds, global mean velocity of droplets has been estimated to be 0.15 m/s. Numerical calculations prove that the global mean temperatures of the lower atmosphere are extremely sensitive to the vertical global mean gas velocities. Increase of the vertical global mean vertical gas velocity in the lower atmosphere from 3 mm/s to 4 mm/s decreases the global mean temperature of the ground nearly 3 °C. This implies that vertical global mean vertical gas velocities can't be calculated by numerical solution of 3D time-dependent Navier- Stokes equations. **The SRclimate model of the Appendix 4:**

5. **Satisfies conservation of elements, momentum and energy and compound and particle numbers balances of entities.**
6. **Transfer of compounds, momentum and energy between the entities, including radiative transfer, are based on the perfectly verified laws of heat and fluid dynamics and radiative transfer.**
7. **Produces correct results for the present atmosphere and responses correctly to changes of all calculation parameter.**
8. **Thus, the SRclimate model satisfies all requirements of physically and mathematically correct global climate model.**

The SRclimate model produces correct results with CO_2 concentration 400 ppm. If CO_2 concentration is increased to 500 ppm, the only consequence is about a 0.005 relative increase of the linear emission coefficient in the lower atmosphere. Because already with CO_2 concentration 400 ppm, thermal radiation to the ground is very near Planck's radiation, the influence of a minimal increase of linear emission is insignificant. When in addition water compensates effectively for such an insignificant change, the increase of CO_2 concentration to 500 ppm would increase the thermodynamic mean temperature of the ground by less than 0.02 °C. This influence could not be detected in meteorological mean temperatures of the ground.

When influence of carbon dioxide on global mean temperatures of the atmosphere is investigated by the SRclimate model, calculations prove that the influence is negligible.

Appendix 7: Empirical temperature observations

By the **thermodynamic** mean temperature of the ground the Authors mean the temperature defined by the energy balance of the ground (page 16, equation (4), *Appendix* 4, equation (21)). The thermodynamic mean temperature of the ground is univocally determined by:

1. Solar radiation to the ground
2. Solar radiation from the ground
3. Thermal radiation to the ground
4. Thermal radiation from the ground
5. Convective sensible and latent energy flow to the ground
6. Convective sensible and latent energy flow from the ground
7. Energy consumption on the ground.

For meteorological purposes, various regional and global mean temperatures are calculated from measurements at weather stations. Examples are regional and global momentary, one year and several years **meteorological** mean temperatures of the ground. The meteorological mean temperatures of the ground depend on local and global weather, which varies in short time periods. Energy flows 1-7 and therefore the thermodynamic mean temperature of the ground change slowly, whereas the meteorological mean temperatures of the ground vary on both sides of the thermodynamic mean temperature of the ground.

By selecting weather stations and by giving different weights for their temperatures, different meteorological mean temperatures are obtained. This is shown by the great difference of changes of meteorological mean temperature of the ground according to references 5-8 on one hand and IPCC on the other.

Figure 1 in *Appendix* 1 proves that in the time scale of a million years, the mean temperature of the ground is descending, but in the time scale of a hundred thousand years, the temperature varies about 3 ºC on both sides of the million-year trend. The million-year trend is due to a decrease of nuclear reactions in the sun, and the hundred thousand -year variations are due to variation of the mean surface temperature of the sun.
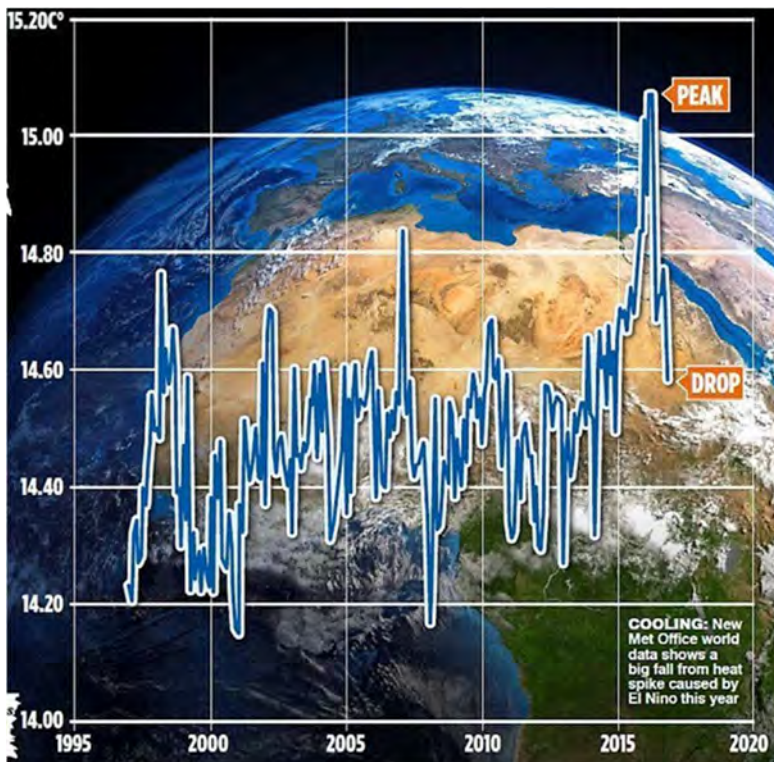
Figure 1 Meteorological mean temperatures of the ground during the years 1997 -2017, according to the British Meteorology Institute. The changes of successive temperatures in figure 1 can be explained by changes in local weathers and the trends in a few-year periods by changes of global weathers, which are due to changes of oceanic streams. The increase of the meteorological mean temperature which started around 2015 has been explained by the El Nino phenomenon. By 2017, the meteorological mean temperature of the ground has returned near the long time average. Figure 1 proves that the changes of oceanic streams have caused the meteorological mean temperature of the ground to vary nearly by 1 ⁰C during the years 1997-2017. The 20-year meteorological mean temperature of the ground in figure 1 is about 14.5 ⁰C.

When professor Arrhenius published his research "On the Influence of Carbonic Acid upon the Temperature of the Ground" in April 1897, the meteorological mean temperature of the ground was 15 ºC.

According to the reference U. S. Standard Atmosphere, 1962, U. S. Government Printing Office, Washington 25, D. C., the meteorological mean temperature of the ground was 15 ºC.

According to an article of the American Meteorological Society from the year 2009 (Earth's Global Energy Budget, by Kevin E. Trenberth, John T. Falluso, and Jeffrey Kiehl), the meteorological mean temperature of the ground was 15 ºC [5].

According to references 5 – 8, the change of the meteorological mean temperature of the ground has been -0.5 ⁰C during the past 120 years, but according to IPCC it has been +1.1 ⁰C. The difference is 1.6 ⁰C.

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[5] FMI sent this article to the Authors for information about the correct energy flows and mean temperatures of the surface of the ground.

In the following, the Authors show that FMI's temperature measurements are in inevitable contradiction with IPCC's claim about 2.2 °C warming of northern areas.
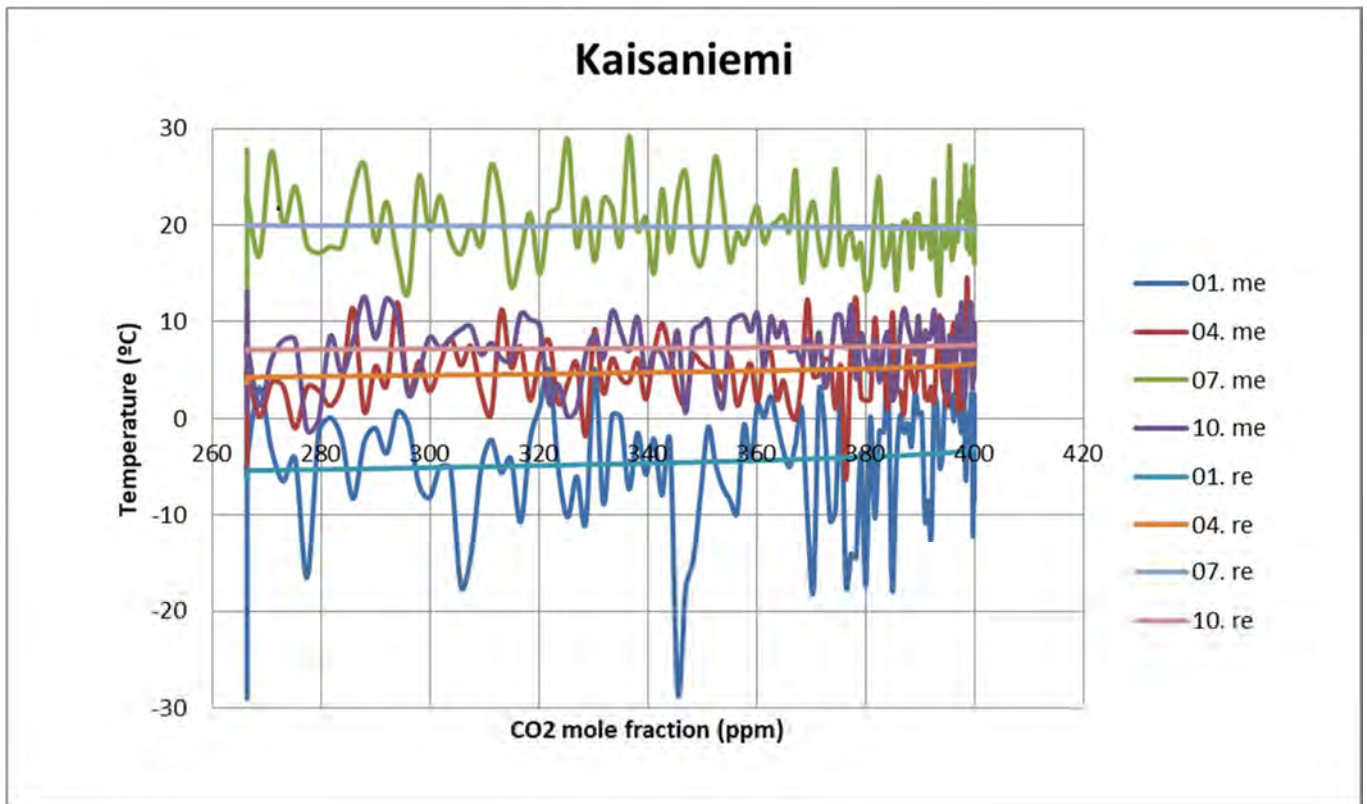

Figure 1a Temperatures measured by FMI (legend me) and their regression lines (legend re) in Kaisaniemi, Helsinki on 15.1., 15.4., 15.7. and 15.10. at 2 pm as a function of carbon dioxide mole fraction in the atmosphere.

In figure 1a, the change of regression line 01.re is up to 4.2 °C. Regression lines 04.re and 10.re also indicate an increasing temperature. Instead, regression line 07.re indicates a 0.4 °C temperature decrease. Qualitatively, these trends can be explained by increased energy consumption near the weather station, but quantitatively the changes are inaccurate. The about 0.4 °C decrease of regression line 07.re is statistically relevant proof that the influence of carbon dioxide on the mean temperature of the ground is negligible.
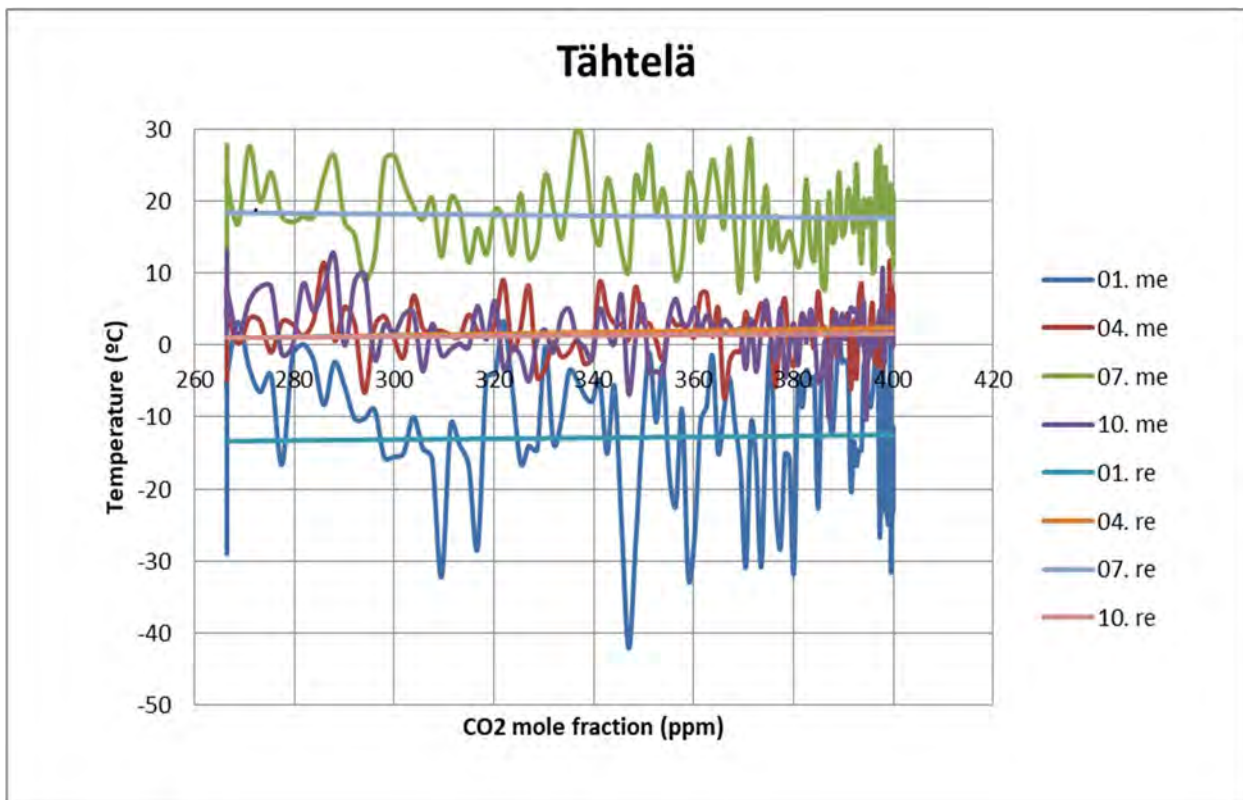
Figure 1b Temperatures measured by FMI (legend me) and their regression lines (legend re) in Tähtelä, Sodankylä on 15.1., 15.4., 15.7., 15.10. at 2 pm as a function of carbon dioxide mole fraction in the atmosphere.

In figure 1b, the change of regression line 04.re indicates a 1.3 ℃ increase, but regression line 01.re a 0.6 ℃ and regression line 07.re a 0.22 ℃ decrease. In Tähtelä the changes of regression lines are smaller than in Kaisaniemi, even though according to IPCC's claims they should be greater because Tähtelä is located about 800 km North from Kaisaniemi. The about 0.22 ℃ decrease of regression line 07.re is statistically relevant proof that the influence of carbon dioxide on the mean temperature of the ground is negligible.
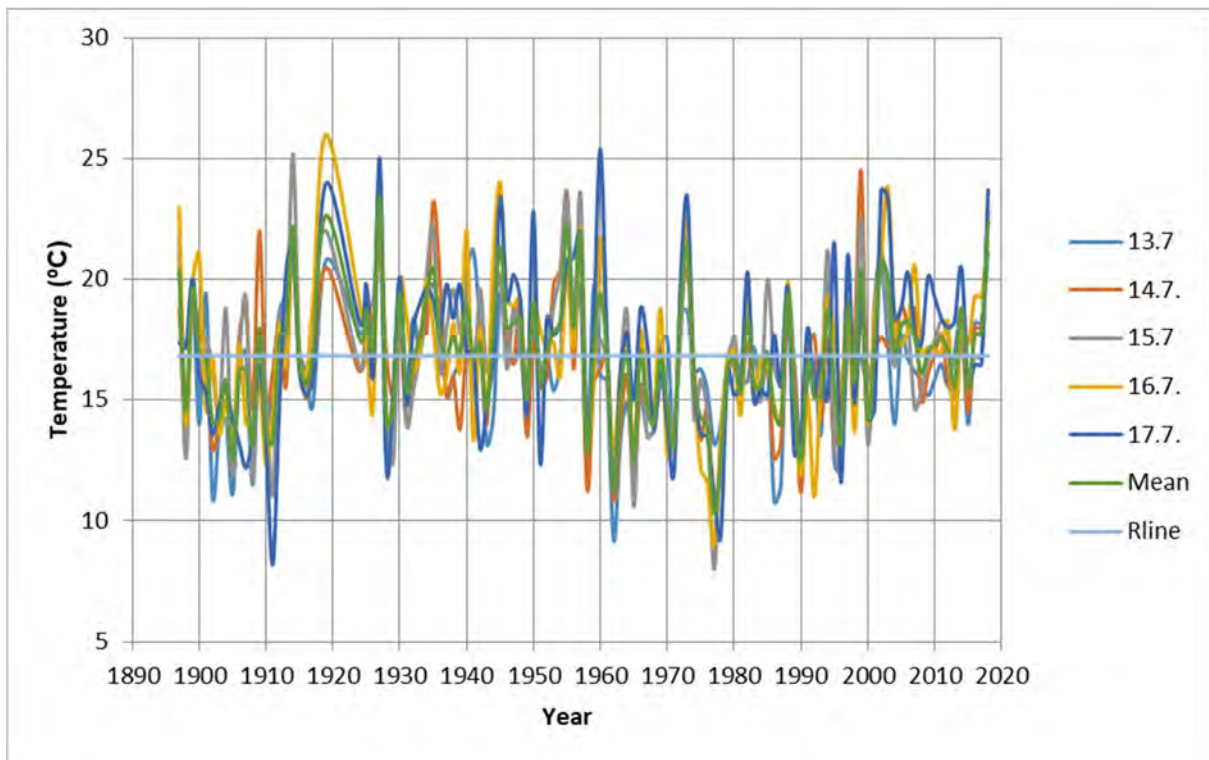
Figure 1c Temperatures measured by FMI in Valassaari, Mustasaari on 13.7.-17.7. at 2 pm, their mean values and a regression line fitted to the mean values in the years 1897-2018.

The Authors have selected the time series of Valassaari, Mustasaari because the use of energy near the weather station has negligible influence on the temperatures. In figure 1c, no indications of causal influence of carbon dioxide can be noticed, and the slope of the regression line is zero. The temperatures in figure 1c do not indicate an increase of the thermodynamic mean temperature of the ground. If IPCC's claim about +2.2 ⁰C increase of mean temperatures in Northern areas were true, it would show in figure 1c. The temperature trends of the figure are due to changes of global weather, most probably changes of the Gulf Stream.

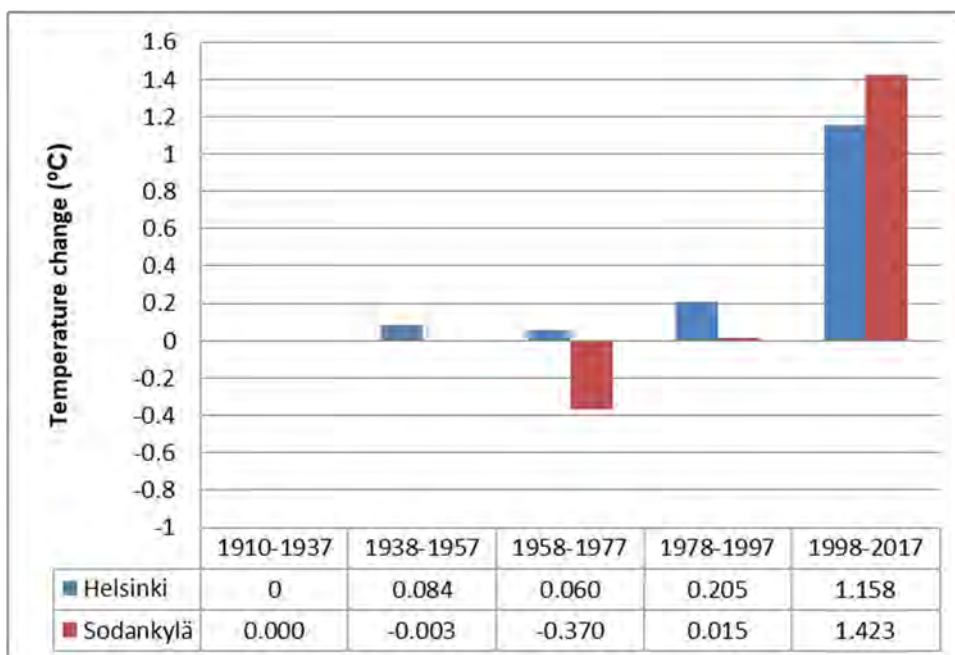|	1910-1937	1938-1957	1958-1977	1978-1997	1998-2017
■ Helsinki	0	0.084	0.060	0.205	1.158
■ Sodankylä	0.000	-0.003	-0.370	0.015	1.423

Figure 1d Changes of 20-year averages of annual mean temperatures, measured by FMI, in Helsinki and Sodankylä. In Helsinki, all changes are positive. In Sodankylä, the sign of changes varies. Before the period 1998-2017 the changes are much smaller than during the period 1998-2017. The change of period 1998-2017 differs from earlier changes radically both in Helsinki and in Sodankylä. Because each 20-year average includes 4300 annual mean temperatures and at least 17200 separate measurements, the changes are statistically reliable indications of real changes in the ecosystem, most probably changes of the Gulf Stream, which would explain also the observed changes of artic sea ice. However, the explanation cannot be the causal influence of continuous increase of carbon dioxide concentration in the atmosphere. Figures 1, 1a, 1b, 1c, 1d prove concordantly and univocally that the influence of carbon dioxide on the thermodynamic mean temperature of the ground is entirely insignificant.

It is not possible to verify influences of individual variables on measured changes by mathematical statistics. Figures 1, 1a, 1b, 1c prove that the temperature of the surface of the ground varies due to changes of local and global weather so much that the influence of carbon dioxide totally vanishes into those variations.

If the thermodynamic mean temperature of the ground had increased during the past 120 years, it would have shown in the meteorological mean temperatures of sources 5-8. **The empirical data of references 5-8 repeal IPCC's claim of influence of carbon dioxide on the thermodynamic mean temperature of the ground**. Therefore, IPCC has been obliged to define a different meteorological mean temperature of the ground which supports IPCC's claim about global warming.

The world's highest temperature, +57.8 °C, was measured in Libya already 96 years ago, and the world's lowest temperature, -93.2 °C, in the Antarctica only 8 years ago. The measured data in figures 1a, 1b, 1c is in irreconcilable contradiction with IPCC's claim that the mean temperature in arctic areas has increased during the past 120 years by about 2.2 °C.

Figures 1, 1a, 1b, 1c, 1d   prove that the influence of CO_2 is so small that it vanishes within the influences of changes of local and global weather.

Figure 1 in *Appendix* 1 proves that the thermodynamic mean temperature of the ground has varied during the past 50 000 years by about 6 °C due to changes in the sun, and it is entirely certain that the changing will continue endlessly. Therefore, even if the thermodynamic mean temperature of the ground had increased during the past 120 years, it is groundless to claim that the increase is only due to an increase of carbon dioxide concentration in the atmosphere.

The growth ring research in reference 19 doesn't indicate correlation between CO_2 concentration in the atmosphere and climate and references 5-10 don't indicate global warming of the lower atmosphere during the past 120 years. Instead the growth ring research proves statistically valid correlation between volcanic eruptions and changes of oceanic flows and solar activity and climate. The mathematical theory of *Appendix 4 and 5* is in complete accordance with these empirical observations.