

# CO<sub>2</sub> is not causing climate change

by  
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December 12, 2015  
updated December 2016

This is a PROM\* Paper  
and subject to ongoing review

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# CO<sub>2</sub> is not causing climate change

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Nov 2015

updated Dec 2015 and Dec 2016

## **Introduction**

In earlier papers of the author [1 to 7] on the subject, mathematical techniques with matrix notation are used. It has turned out that very few people could follow them up. The present version uses only the graphical results from those papers with explanations in plain language.

The title of this paper is clear, the traces of CO<sub>2</sub> in the atmosphere are not causing climate change and hardly any change of the surface temperature.

Climate changes are due to other physical phenomena, have always taken place and will continue to take place.

Moreover, CO<sub>2</sub> is not a poisonous gas, on the contrary, it has beneficiary properties for mankind because it is a fertilizer: if the CO<sub>2</sub> concentration would become less than half of the present 400 ppm (0.04%) the vegetation on the planet would disappear, and consequently also animals and human beings.

In nursery greenhouses the CO<sub>2</sub> concentration is augmented artificially to boost the growth of plants.

IPCC (International Panel of Climate Change) under the auspices of the UN , United Nations, continues on the other hand to herald that the traces of CO<sub>2</sub> are causing a devastating increase of the temperature of the planet.

UN lobbyists propose to the governments of the participating countries to stop the use of fossil fuel or drastically reduce the use of it.

It will kill the economy and the wealth which have been created since James Watt was observing the water cattle on the stove of his grandmother.

In earlier papers[1 to 7] the author has discussed the matter using mathematical techniques programmed on a computer of which the MATLAB listing is available [9] In this paper the mathematics are avoided: more people will read the message.

## **The so-called greenhouse effect, a misnomer**

The bulk of the atmosphere consists of 79 % nitrogen  $N_2$  and 20% oxygen  $O_2$ .

The remaining 1% are traces of other gases.

Gases consisting of molecules with three or more atoms, such as  $H_2O$  vapor,  $CO_2$ ,  $CH_4$ ,  $O_3$  etc, are IR-active (infra-red-active): they absorb and emit IR-radiation, also called LW (long wave) radiation, related to not too high temperatures.

The Sun at high temperature is emitting SW (short wave) radiation which is absorbed by aerosols in the atmosphere of the planet as well as by its surface.

Heat is evacuated from the surface only a little bit as LW radiation but mainly by convection of sensible and latent heat to higher altitudes and from thereon by emission from IR-active molecules to outer-space.

In the so-called greenhouse effect it is assumed that the atmosphere with traces of IR-active molecules trap the heat of outgoing LW radiation.

A comparison is made with greenhouses in nurseries.

That is a misnomer, those greenhouses remain warm because the glass roof is transparent for the incoming SW radiation from the Sun. The glass roof absorbs only a bit of the emitted LW ground radiation but, what is more important, the roof keeps the warm air inside the greenhouse. Heat losses by convection are avoided.

We will not use the misnomer anymore and speak about the atmospheric effect of traces of IR-active molecules.

## **A roof of chicken wire, not a single one but many layers of fine grids**

Replacing the glass roof by a gauze, allowing convection, brings us closer to reality in the simulation of the play between the surface of the planet and its atmosphere.

In particular a stack of grids can model the IR-active trace gases in the atmosphere, with convection from the surface and at higher altitudes the IR-active grids emit heat to outer-space.

The length per unit area of the wire of the grid, multiplied by the diameter is the dimensionless cross section "f", much smaller than 1, and the value can vary for the different grids in the stack. We call them the absorption coefficients of the grids. The sum of the different absorption coefficients of the grids is called  $f_{tot}$ , it is of the order of 0.83 indicating a window of 17 % through which a LW radiation from the surface goes straight towards outer-space.

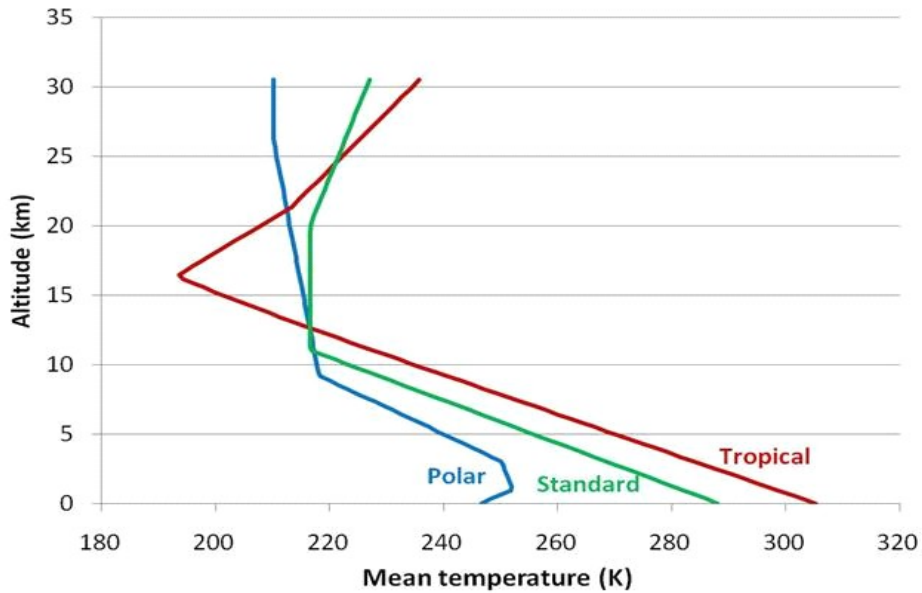
It has turned out that the heat transport through a stack of 40 grids over a height of 11 km, put on a surface at  $15\text{ C} = 288\text{ K}$ , simulates the evacuation of heat from the planet. The mechanism is not that much by radiation from the surface but rather by means of convection and evaporation to higher layers and from thereon by radiation to outer-space. The model defines the convection from a mismatch in radiation: the lower layers emit more heat to outer-space than they absorb from the surface and in steady state conditions the difference is to be attributed to convection of sensible and latent heat, vertically by thermals and horizontally by wind.

The grids representing the IR-active traces of water vapor and  $CO_2$  are not in vacuum but in an atmosphere of 79%  $N_2$  and 20%  $O_2$ .

The variation with height of the temperature the atmosphere is defined by gravity, the so-called lapse rates: the dry adiabatic lapse rate,  $dT/dz = DALR = - 9.8 \text{ K/km}$ , and the measured environmental lapse rate,  $dT/dz = ELR = - 6.5 \text{ K/km}$ .

**Figure 1** shows the measured profiles for different climate zones of the planet. We see that in the different climate zones the environmental lapse rates are more or less the same,  $ELR = -6.5 \text{ K/km}$ .

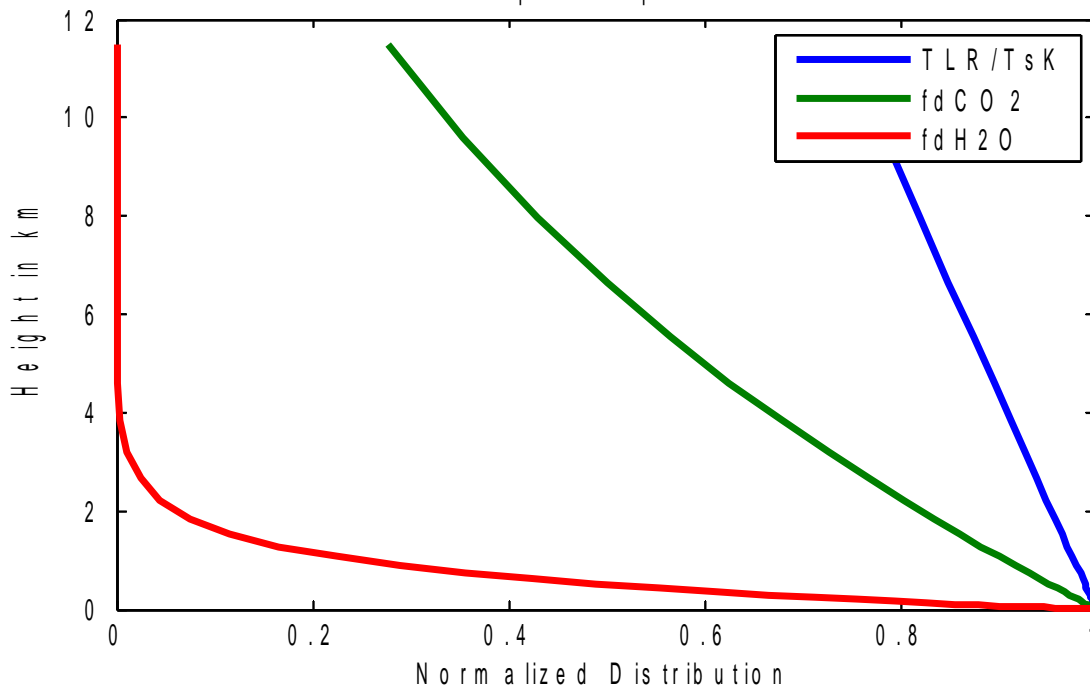
**Figure 1** from the Public Domain Aeronautical Software [13]



Other important input data are given in **figure 2**: the distribution of water vapor, which is the dominant IR-active gas, and of  $\text{CO}_2$  for a height up to 11 km.

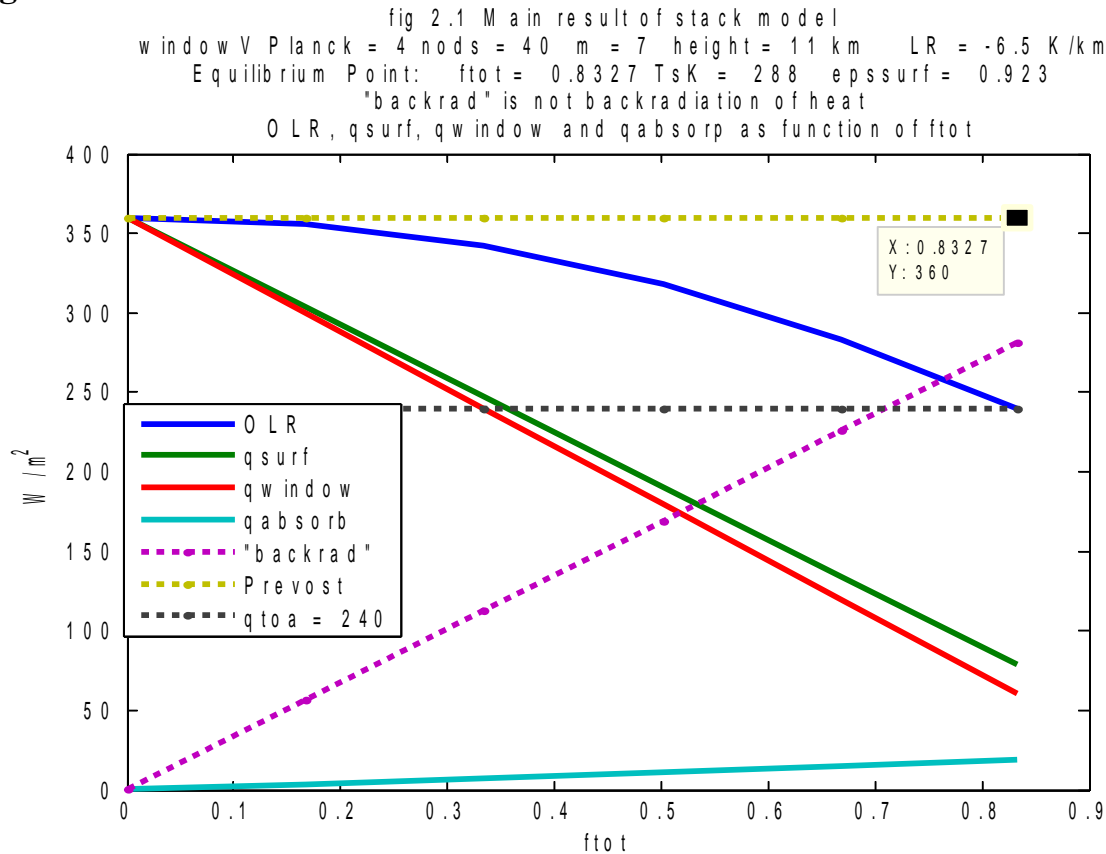
**Figure 2**

fig 5.5 Normalized Temperature, water vapor form = 7 and  $\text{CO}_2$  distribution in Atmosphere up to 10 km



In **figure 2** the temperature distribution is included for an environmental lapse rate  $dT/dz = ELR = -6.5 \text{ K/km}$  and a surface temperature of  $T_sK = 288 \text{ K}$ . The water vapor distribution is given by an exponential decay defined by a parameter “m” which has been validated by comparing the stack results with those of Ferenc Miskolczi[8].

**Figure3**



**Figure 3** gives the main results from the stack model for the standard atmosphere. It gives various fluxes for  $ftot$  values between  $ftot = 0$  and  $ftot = 0.8327$ . The latter value is determined by the model as the equilibrium point for the input parameters:

- OLR, outgoing LW radiation, at the top of the atmosphere,  $q_{toa}=240$ ,
- surface temperature  $T_sK=288$
- Stefan-Boltzmann constant  $\sigma = 5.67 \cdot 10^{-8}$
- LW surface emission coefficient  $\epsilon_{LW} = 0.923$ .

The horizontal dotted line, Prevost, represents the LW surface flux in case no IR-active molecules were present in the atmosphere:

Stefan-Boltzmann law gives:  $Prevost = \epsilon_{LW} \sigma (T_sK^4 - zeroK^4) = 360 \text{ W/m}^2$ .

The red line represents:  $q_{window} = (1-ftot) \cdot Prevost = 60 \text{ W/m}^2$ .

The difference between the blue line and the green line represents the mechanisms other than LW radiation. The blue line is defined by the emission at various heights by IR-active molecules to outer-space, at zeroK. The difference between green and red line represents the absorption from the surface at a temperature  $T_s=288 \text{ K}$ .

The mismatch between the higher emission to outer-space and the lower absorption

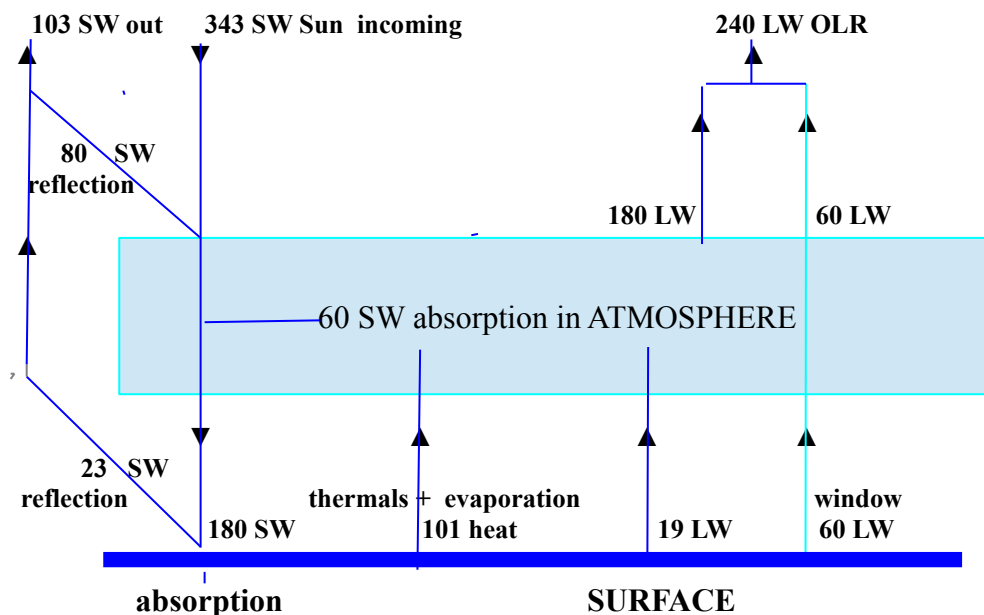
from the surface represents the heat transported by convection of thermals and of evaporation, as well as the heat due to SW absorption by aerosols in the atmosphere:  
 60 W/m<sup>2</sup> SW absorption in the atmosphere by aerosols, and  
 101 W/m<sup>2</sup> convection of sensitive and latent heat, vertically by thermals and horizontally by wind.

The outgoing LW radiation OLR = 240 W/m<sup>2</sup> of which 60 through the window and 180 emitted by the IR-active trace gases, mainly water vapor, around 0.1% by CO<sub>2</sub>. The stack model is a so-called one-stream formulation.

IPCC authors use the two-stream formulation of the Schwarzschild procedure, en vogue in astronomy and suggested to NASA by the late astronomer Carl Sagan.

**Figure 4** gives the global and annual mean heat budget, obtained by the one-stream formulation of the stack of grids, for the calculated equilibrium point: surface temperature of 288 K and total absorption coefficient  $f_{tot} = 0.8327$

**Figure 4 Global and annual mean heat budget in W/m<sup>2</sup>.  
 Stack Model with Miskolczi data, but without back-radiation.**



We see that in the one-stream formulation are absent the non physical so-called back-radiation of heat and thereby huge absorption in the atmosphere, typical variables used in the Schwarzschild procedure of 1906 and used by IPCC authors and others in similar global and annual mean budgets.

Back-radiation of heat does not exist, it would be a crime against the Second Law.

Those who claim that they have measured back-radiation of heat do not understand the instruments which have been sold to them. They measure frequencies which by means of the Wien displacement rule are converted, by a chip, to units in W/m<sup>2</sup>.

The surface does not emit the Prevost flux of 360 W/m<sup>2</sup>. IPCC authors use a value of 390 W/m<sup>2</sup>, obtained by taking the LW emission coefficient  $\epsilon_{LW} = 1$ . see [7].

The LW surface radiation is 79 W/m<sup>2</sup> of which 60 through the window straight to outer-space and only 19 LW flux to be absorbed by the atmosphere and emitted in higher layers to outer-space by IR-active molecules, those with 3 or more atoms.

From the annual global average 343 W/m<sup>2</sup> SW from the Sun, according to Ferenc Miskolczi, 80 and 23 are reflected by the atmosphere respectively by the surface and

60 are absorbed by aerosols in the atmosphere. The remaining 180 W/m<sup>2</sup> SW from the Sun are absorbed by the surface and re-emitted as 79 LW and 101 W/m<sup>2</sup> are leaving the surface as heat by thermals and evaporation.

The global annual mean heat balance as given above has been validated by defining input parameters from the data of the astronomer Ferenc Miskolczi [8] who uses the two-stream formulation, en vogue in astronomy. But Ferenc Miskolczi does not interpret back-radiation as a heat flux nor the Prevost type of LW surface radiation. In fact Ferenc Miskolczi claims that the two values are about equal.

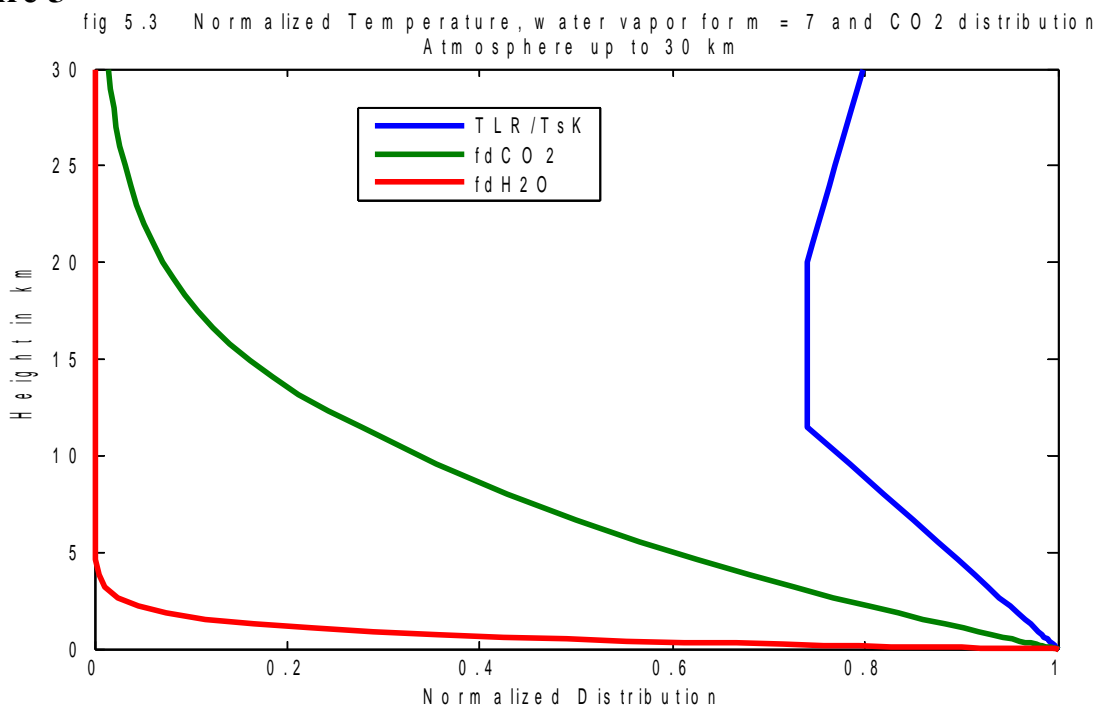
We found for the LW surface flux 79 W/m<sup>2</sup>, 60 through the window and 19 W/m<sup>2</sup> absorbed by the atmosphere and emitted again by IR-active molecules (H<sub>2</sub>O and CO<sub>2</sub>) to outer-space. We conclude that the stack model is validated by the data of Ferenc Miskolczi obtained by analyzing world wide weather balloon measurements using the spectroscopic line-by-line computer program HARTCODE.

An important point which Ferenc Miskolczi has made is that a mono-chromatic model describes the atmosphere very well, because water vapor is the dominant IR-active trace gas with resonance frequencies spread over the complete spectrum. That explains also why the mono-chromatic treatment in the present simple stack-model, but with 40 layers, gives excellent results. Ferenc Miskolczi [8] concludes from the analysis of weather balloon measurements that CO<sub>2</sub> hardly has any effect on the surface temperature.

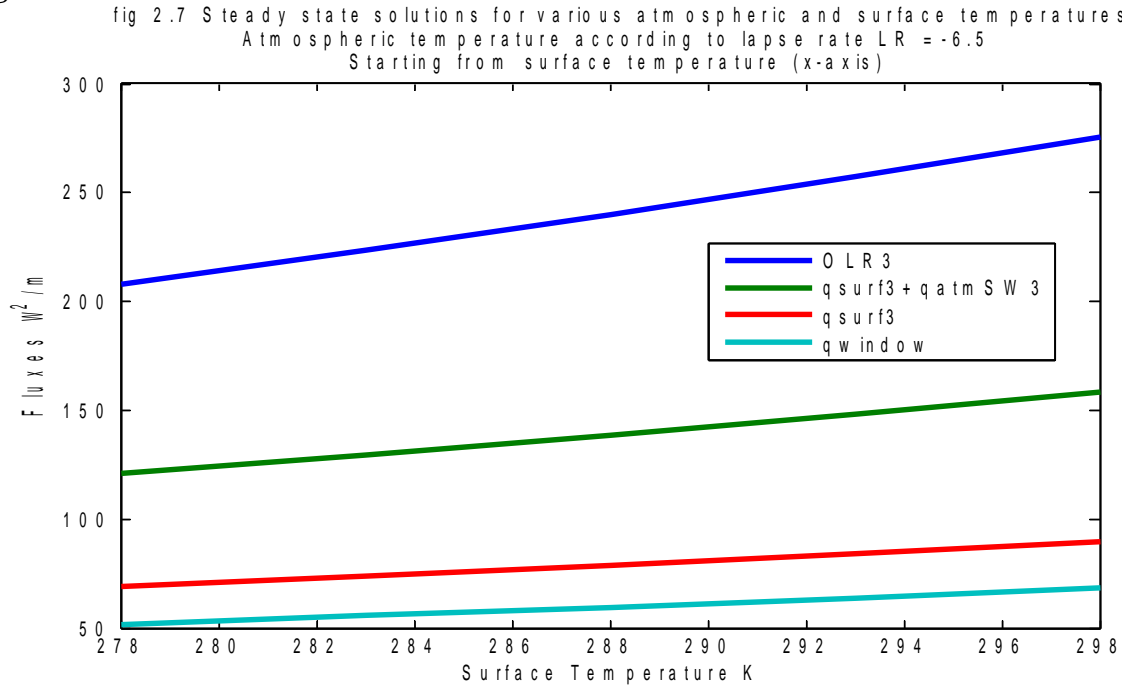
### Surface Temperature Sensitivity from CO<sub>2</sub>

In order to take into account any possible effect of CO<sub>2</sub>, the sensitivity study of the surface temperature from CO<sub>2</sub> is carried out on a model with a height of 30 km. Indeed for the global annual mean heat budget a model with a height of 11 km or even lower is sufficient since anyhow the effect of CO<sub>2</sub> is about 0.1% of the effect of water-vapor.

**Figure 5**

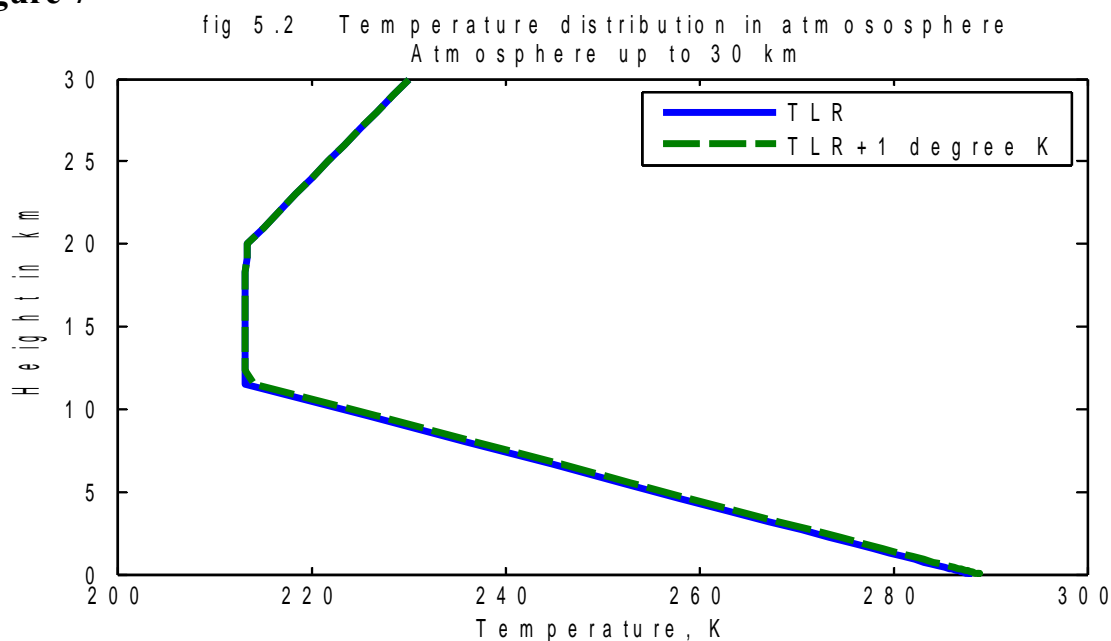


**Figure 5** gives the normalized H<sub>2</sub>O and CO<sub>2</sub> distributions up to 30 km high, as well as temperature distribution similar to the standard atmosphere given in **figure 1**. From **figure 1** the surface temperature for the different climate zones can be seen. **Figure 6** gives the variation of heat fluxes from the stack model for variations of the surface temperature around 288 K, with a constant environmental lapse rate of ELR = -6.5 K/km and water-vapor concentration corresponding to the global average. **Figure 6**



For doubling of the CO<sub>2</sub> concentration the variation of the surface temperature is much smaller. IPCC gives a variation of  $dT_{S_{2\times CO_2}} = 1\text{ C}$ , we will show that it is a factor 30 lower  $dT_{S_{2\times CO_2}} = 0.032\text{ C}$

In **figure 7** a small variation of 1 C is included as a dotted line, it can hardly be seen! **Figure 7**



We observe that **figure 1** and **figure 7** justify the assumption that in the sensitivity analysis the lapse rate can be kept constant.



The OLR variation with surface temperature as shown in **figure 6**, corresponding to the equilibrium point  $f_{tot} = 0.8327$ , contains an important data, namely the slope of OLR at the temperature  $T_s K = 288$ , given by the differential quotient:

$$dOLR/dT_s = 3.4 \text{ W/m}^2/\text{K} \quad (1)$$

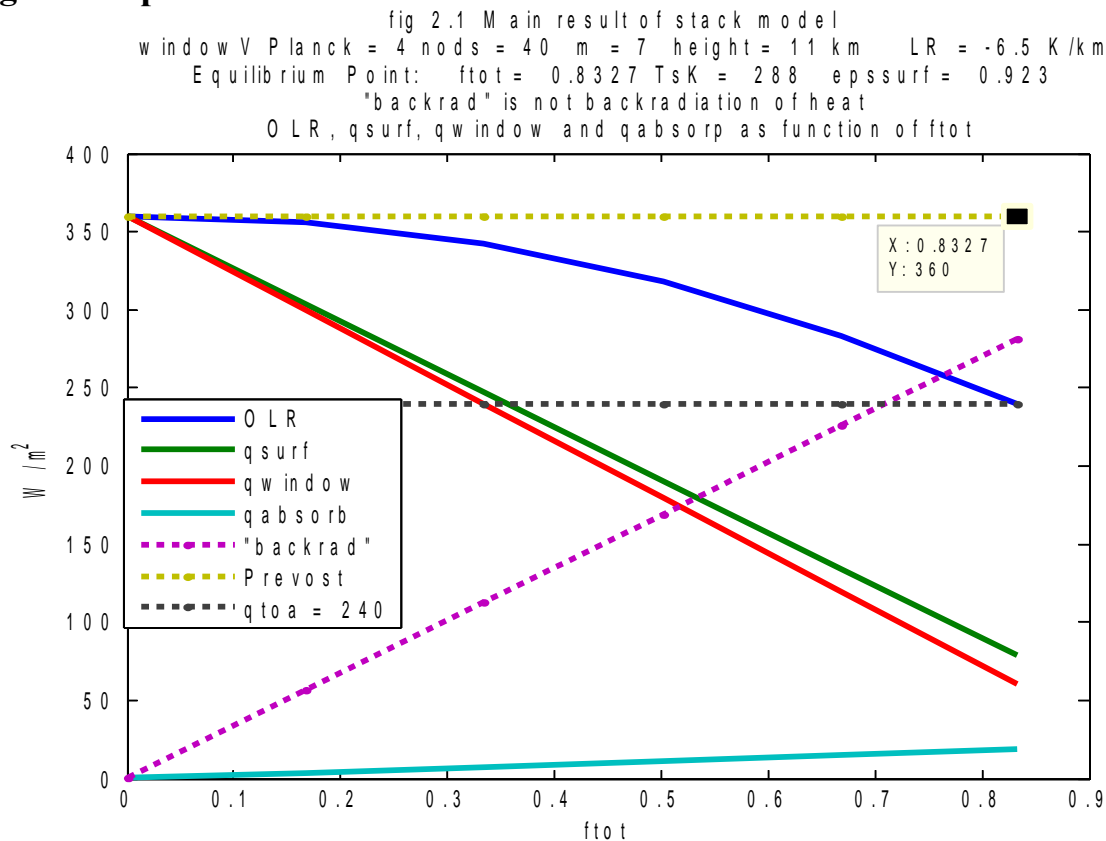
It is noted that this value is different from a value calculated by the derivative of the Prevost flux:

$$dPrevost/dT_s = 4 \cdot \epsilon_{LW} \cdot \sigma \cdot 288^3 = 5 \text{ W/m}^2/\text{K} \quad (1a)$$

The relation (1a) is sometimes used in simple models where the atmosphere consists of one layer. The more correct relation (1) defined by the stack model takes into account the temperature distribution in the atmosphere defined by the environmental lapse rate  $ELR = -6.5 \text{ K/km}$ .

Relation (1) corresponds to the equilibrium point of the atmosphere as given in **figure 3**, which for clarity is repeated here.

**Figure 3 repeated**



The difference of the fluxes Prevost and OLR,  $360 - 240 = 120 \text{ W/m}^2$ , is called forcing by IPCC, an unfortunate name. It is the decrease of the OLR from the value Prevost flux at  $f_{tot} = 0$ , due to the presence of IR-active molecules in the atmosphere. The value 120 represents the sum of forcing $H_2O$  and forcing $CO_2$ : forcing $tot$ . The atmospheric effect in temperature, assuming that the slope given by the

differential quotient **(1)** at the equilibrium point is valid for the complete interval from  $t_{\text{tot}}=0$  to  $t_{\text{tot}} = 0.8327$ , becomes:

$$\Delta T_{\text{SH}_2\text{O}+\text{CO}_2} = \text{forcing}_{\text{tot}} / (d\text{OLR}/dT_s) = 120/3.4 = 35.3 \text{ K} \quad (2)$$

The real value for the total atmospheric effect is calculated by calculating the surface temperature according to Stefan-Boltzmann, with  $\epsilon_{\text{LW}} = 0.923$ :

$$T_s = (240 / (\epsilon_{\text{LW}} \sigma))^{0.25} = 260 \text{ K}$$

The total atmospheric effect gives an increase of surface temperature:

$$\Delta T_{\text{SH}_2\text{O}+\text{CO}_2} = 288 - 260 = 28 \text{ K} \quad (2a)$$

For the IPCC value for LW emission coefficient  $\epsilon_{\text{LW}}=1$ , the surface temperature would become:

$$T_s = 240 / \sigma^{0.25} = 255 \text{ K}$$

The total atmospheric effect for  $\epsilon_{\text{LW}}=1$  gives an increase of surface temperature:

$$\Delta T_{\text{SH}_2\text{O}+\text{CO}_2} = 288 - 255 = 33 \text{ K} \quad (2b)$$

For the small variation of  $\text{CO}_2$  the corresponding small change of the surface temperature due to the atmospheric effect can be defined using the differential quotient **(1)**:

$$dT_{\text{SCO}_2} = \text{forcing}_{\text{CO}_2} / (d\text{OLR}/dT_s) \quad (2c)$$

We could stop now the analysis because it is sufficient to argue that the influence of  $\text{CO}_2$  is less than 0.1% of the total effect of the IR-active trace gasses  $\text{H}_2\text{O}+\text{CO}_2$  because the concentration of  $\text{CO}_2$  is about 1% of the concentration of water vapor and in the spectrum  $\text{CO}_2$  resonance frequency is a single line and water vapor has resonance frequencies along the total spectrum, giving another factor 10 or more: the effect of  $\text{CO}_2$  is around 0.1% of that of  $\text{H}_2\text{O}$ .

We continue, however, to give a further sensitivity analysis by means of the stack model and evaluate the  $\text{forcing}_{\text{CO}_2}$  in more detail.

The analysis gives results, which contradict explicitly IPCC authors.[12]

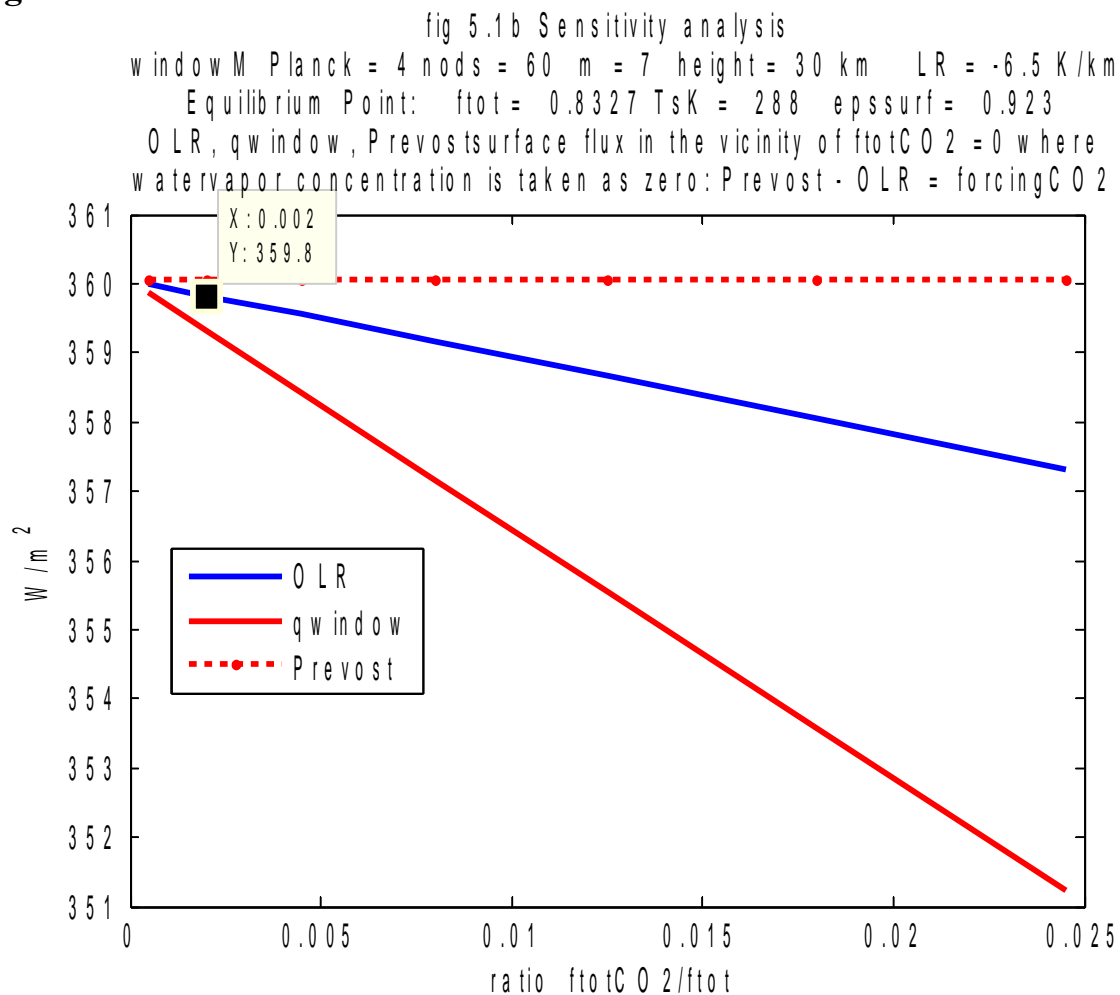
We consider in **figure 8** stacks representing only CO<sub>2</sub> and with concentrations of CO<sub>2</sub> on the planet, the present one and exaggerated future ones, not in absolute values but as ratio of the atmospheric effect of CO<sub>2</sub> and the effect of the total one, including water vapor.

We see in **figure 8** fluxes, OLR, window and Prevost like in **figure 3** but now not for water-vapor but only for a CO<sub>2</sub> concentration from  $f_{totCO_2}/f_{tot} = 0.0005$  to  $0.0245$ , or from 0.05% to 2.45% of the present  $f_{tot}$ , defined above as the present equilibrium point, mainly consisting of water vapor.

In **figure 8**, the difference Prevost-OLR represents now the forcing<sub>CO<sub>2</sub></sub> for a atmospheric effect of only CO<sub>2</sub>, varying between 0.05% and 2.45% of the total effect, including water-vapor.

The IPCC value lies around 2.45%, we conclude it is a factor 25 lower: 0.1%.

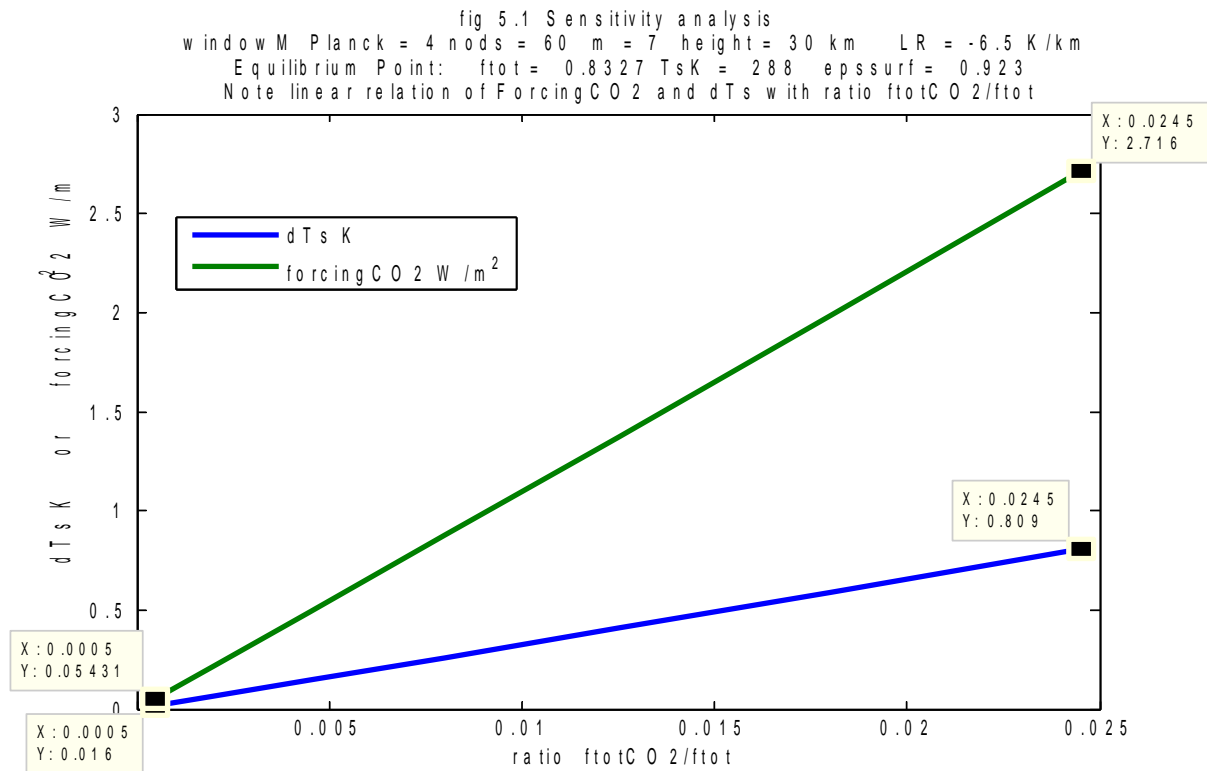
**Figure 8**



Note the straight blue line for OLR.

The forcing<sub>CO<sub>2</sub></sub> being the difference between Prevost and OLR in an atmosphere without water vapor increases linearly.

**Figure 9** CO<sub>2</sub> surface temperature sensitivity and corresponding forcingCO<sub>2</sub>



In **figure 9** are given dT<sub>sCO<sub>2</sub></sub> and forcingCO<sub>2</sub> as function of the ratio ftotCO<sub>2</sub>/ftot.

IPCC values are around the 0.809 for a ratio of CO<sub>2</sub> effect/H<sub>2</sub>O effect of 2.45%

We have argued above that the ratio is around 0.1% with dT<sub>s2xCO<sub>2</sub></sub> = 0.032 K.

The green line is the forcingCO<sub>2</sub> in W/m<sup>2</sup> for a CO<sub>2</sub> concentration from zero towards the assumed present one, represented by the ratio ftotCO<sub>2</sub>/ftot. Because of the linearity it is also the effect of doubling the CO<sub>2</sub> from the present 400 ppm to 800 ppm, as it is from 0 ppm to 400 ppm and it would be from 500 ppm to 900 ppm etc.

The discussion comes down to two points:

- (1) The effect of the present concentration as ratio of the total atmospheric effect expressed by the ratio ftotCO<sub>2</sub>/ftot.

IPCC claims that the effect of CO<sub>2</sub> represents around 2.5% of the total, while a ratio of 0.1% , which is a factor 25 lower, is more realistic: the 0.04 % CO<sub>2</sub> concentration is a factor 100 smaller than the water vapor concentration, and CO<sub>2</sub> has only a few resonance frequency lines and water vapor has many resonance frequencies bands spread over the complete spectrum.

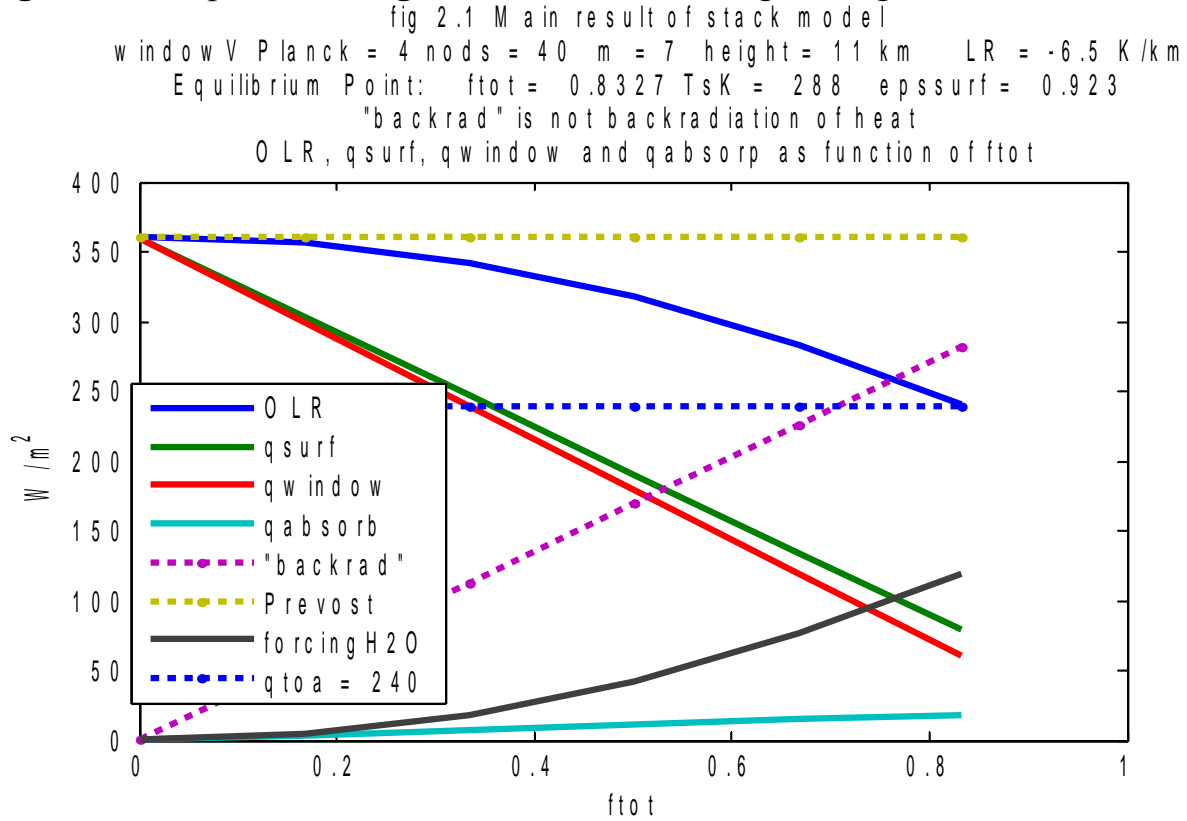
- (2) The stack model shows that for the small quantities of CO<sub>2</sub> , the forcingCO<sub>2</sub> is a linear function of the CO<sub>2</sub> concentration, and for very high CO<sub>2</sub> concentrations the deviation from linearity tends to be upwards and not downwards as would follow from the faulty IPCC correlation.

**The faulty correlation from IPCC for radiative forcing:  $\Delta F = \alpha \ln(C/C_0)$**

The same linearity of the forcing for small CO<sub>2</sub> concentrations is seen for small values of forcingH<sub>2</sub>O.

In **figure 10** we repeat **figure 3** , but now including the curve forcingH<sub>2</sub>O represented by forcingH<sub>2</sub>O = Prevost-OLR.

**Figure 10**, a repetition of **figure 3** but now including forcingH<sub>2</sub>O = Prevost-OLR



We see that forcingH<sub>2</sub>O is a kind of upward parabola, but for smaller values the derivative becomes not zero, there is a linear variation, in the same way as for the small values of CO<sub>2</sub> and corresponding forcingCO<sub>2</sub>.

IPCC authors [12] speak of a logarithmic behavior of forcingCO<sub>2</sub>:

$$\Delta F = \alpha \ln(C/C_0) \tag{3}$$

According to [12] IPCC started with a value  $\alpha = 6.3$  from James Hansen but later corrected, according to [12], by putting  $\alpha = 5.35 \text{ W/m}^2$ .

The correlation (3) with  $\alpha = 5.35$  and for doubling CO<sub>2</sub> ( $C/C_0 = 2$ ) gives:

$$\Delta F = 5.35 * \ln(2) = 3.7 \text{ W/m}^2 \tag{3a}$$

This change in forcingCO<sub>2</sub> gives according to the relation (2) a surface temperature increase:

$$\Delta T_s = 3.7/3.4 = 1.1 \text{ C} \tag{3b}$$

But the Hanssen relation (3) is suspicious.

First of all the forcing $CO_2$  from the present concentration is much lower, it corresponds to a ratio  $ftotCO_2 / ftot$  of 0.1% and not 2.5%, as argued earlier.

The discussion between 0.1% and 2.5% has to be dealt with in discussions between MODTRAN and the line-by-line HARTCODE experts.

Such discussion has already taken place at NASA, but Ferenc Miskolczi was not allowed to publish his HARTCODE results because they contradicted other NASA results, based on MODTRAN. Ferenc Miskolczi offered his resignation from NASA, and published the HARTCODE results in Hungary, his native country.

Further more it is clear that the logarithmic correlation cannot be correct, the slope should not decrease for increasing  $CO_2$  levels.

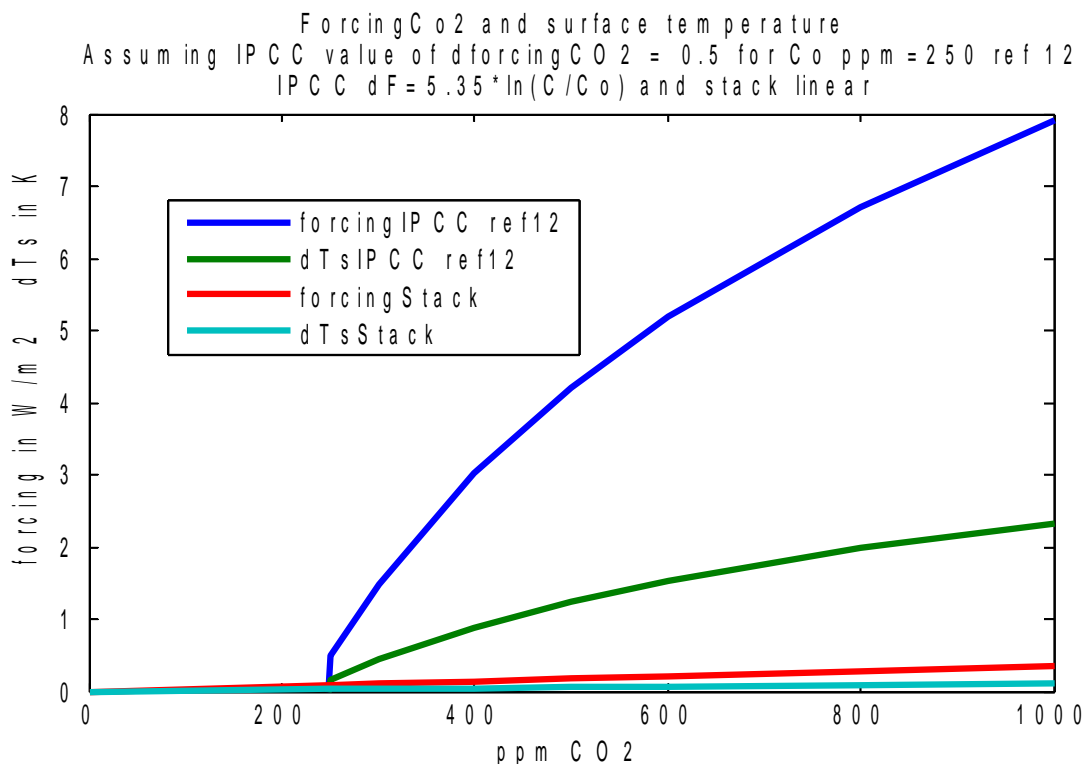
**Figure 11** summarizes the discussion.

It gives the logarithmic correlation for the forcing $CO_2$  (3a), taken from [12].

Included are the corresponding surface temperatures increases, according to (2).

The stack values are also given, linear and a factor 25 lower for the present  $CO_2$  concentrations, as already given on a different scale in **figure 9**.

**Figure 11**



The IPCC starting point and the logarithmic correlation seem to have been defined by the spectroscopic MODTRAN computer program. The errors probably are due to the artificial broadening of the  $CO_2$  line. Also the use, inside MODTRAN, of the two-stream Schwarzschild procedure from 1906 can be the reason

In the first paper on the stack model [1] it has been shown on examples with slabs that the two-stream formulation of Schwarzschild gives the correct temperature

distribution but spurious absorption of a factor 2 in two slabs and a factor 2N for a stack of N slabs. Claes Johnson [11] found that for a homogeneous medium the Schwarzschild procedure even does not give correct temperatures.

## CONCLUSION

The earlier papers on the subject have been replaced by a kind of presentation around 12 slides. It is hoped that a broader group of people receives the message. CO<sub>2</sub> is a fertilizer, it will give increased vegetation to feed the growing world population.

The doubling of the CO<sub>2</sub> concentration from 400 ppm to 800 ppm will give an increase of the surface temperature of  $dTs = 0.032$  C. A further increase towards the optimum of 1600 ppm, from the agricultural point of view, gives a surface temperature increase of  $dTs = 0.1$  C.

IPCC authors seem to have misinterpreted the results of the spectroscopic broad-band computer program MODTRAN.

Instead Ferenc Miskolczi uses the spectroscopic line-by-line program HARDCODE and find hardly any influence of CO<sub>2</sub> on the surface temperature.

### Conclusion after updates

The Hanssen relation (3) was used as back-ground slogan on national TV of France by IPCC, during the December 2015 COP21 in Paris, to indoctrinate the general public:

$$\Delta F = \alpha \ln(C/C0)$$

James Hanssen , in December 2015, called the Paris COP21 a fraud, in an interview when he was back in the US.

He was right, the relation used as an IPCC COP21 slogan in France is suspicious. It was already suspicious in 1988 when James Hanssen presented it during a Congressional Hearing in the Science Rayburn building in Washington DC, under suspicious conditions on a hot day with air condition not working and open windows!

### Acknowledgment

The author wants to thank in particular [Claes Johnson](#) who inspired him to write this paper. The author interpreted his ideas by writing Stefan-Boltzmann always for a **pair** of surfaces: it opens the concept of standing waves.

The efficient help of [Hans Schreuder](#) to edit and to host my papers on his site and give them a broader distribution is appreciated as well as the suggestions by the peer reviewers which Hans has called upon.

Thanks also to John O'Sullivan at [Principia Scientific International](#) for the publication

of this paper.

## References

- [1] [http://www.tech-know-com/papers/IR-absorption\\_updated.pdf](http://www.tech-know-com/papers/IR-absorption_updated.pdf)
- [2] [http://principia-scientific.org/publications/PROM/PROM\\_REYNEN\\_Finite\\_Element.pdf](http://principia-scientific.org/publications/PROM/PROM_REYNEN_Finite_Element.pdf)  
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- [4] [http://www.tech-know-group.com/papers/Prevost\\_no\\_back-radiation-v2.pdf](http://www.tech-know-group.com/papers/Prevost_no_back-radiation-v2.pdf)
- [5] <http://www.tech-know-group.com/papers/vacuum.pdf>
- [6] <http://www.tech-know-group.com/papers/sensitivity.pdf>
- [7] [http://www.tech-know-group.com/papers/surface\\_emission.pdf](http://www.tech-know-group.com/papers/surface_emission.pdf)
- [8] <http://www.seipub.org/des/Download.aspx?ID=21810>
- [9] <http://www.tech-know-group.com/papers/Reynen-MATLAB-listing.pdf>
- [10] <http://claesjohnson.blogspot.fr/>
- [11] <http://claesjohnson.blogspot.fr/search/label/Schwarzschild>
- [12] [http://folk.uio.no/gunnarmy/paper/myhre\\_grl98.pdf](http://folk.uio.no/gunnarmy/paper/myhre_grl98.pdf)
- [13] <http://www.pdas.com/hotcold.html>