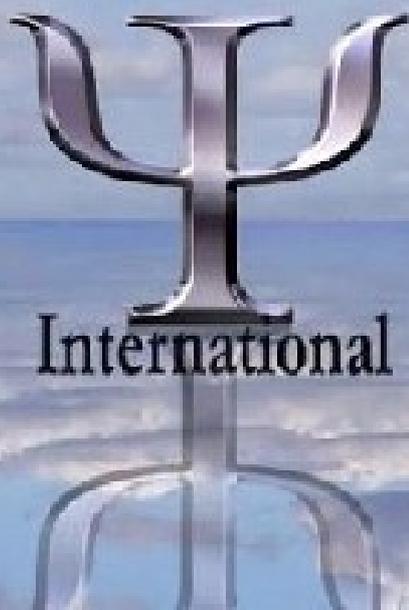


# Lessons from a chicken-wire stack on the Moon

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8 February 2019

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# Lessons from a chicken-wire stack on the Moon

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December 2014

updated January 2015 with appendix 1 (comparison with Miskolczi model)

## Introduction

In earlier papers [1,2,4] the author has analyzed the evacuation of heat from Earth using the one-stream formulation of heat flow by LW (long wave) radiation, simulating the traces of IR-active gases, those with more than two atoms per molecule, by means of a stack of grids of “black“ wires.

It has turned out in those papers that the Earth, in SS (steady state) conditions, evacuates heat from the surface not that much by means of LW radiation, as advocated by IPCC authors (International Panel of Climate Change) , but rather by means of convection from the surface to higher layers in the atmosphere, and only further on by LW radiation from IR-active gases to outer-space.

The diurnal variation of the heat evacuation from the surface depends a bit more on LW radiation [5].

In the present paper the radiation properties of the stack model are shown in more detail by putting the stack in a vacuum *i.e.* in an environment where convection is absent.

It is like a stack on the Moon: the other extreme, no convection only radiation!

The evacuation of heat from the surface through a stack in vacuum is by LW radiation only:

- from the surface to outer-space through the window of the stack, or
- from the surface to the grids of the stack, and
- between the lower and higher grids of the stack, and
- from the grids to outer-space.

These various paths will be analyzed in detail including the resulting temperature distribution.

It is emphasized that there is no heat transfer from the vacuum towards the stack. It means that the temperature distribution in the stack is completely defined by LW radiation from the surface and from warmer grids to colder ones. A SS temperature distribution is established such that the gauzes absorb and emit the same amount of heat. The SS temperature of a stack in vacuum is much lower than the measured temperature of the atmosphere of the Earth, defined by the environmental lapse rate.

In case of a stack in the atmosphere of the Earth, the heat capacity of the fine gauze which represent the traces of IR-active gases, is negligibly small as compared to the heat capacity of the bulk of the atmosphere, consisting of 99% O<sub>2</sub> and N<sub>2</sub>. As a result the gauzes in the atmosphere continue to be kept, by molecular collision (conduction), at the atmospheric temperature, corresponding to the measured environmental lapse rate ELR = -6.5 K/km. Due to the imposed lapse rate temperature distribution of the IR-active gases, there is an important mismatch between the smaller amount of absorbed heat by LW from the surface and lower layers with the larger amount emitted heat towards higher layers and outer-space, a mismatch which can only be balanced by mechanisms other than LW radiation: absorption of incoming SW radiation by aerosols and convection of latent and sensible heat, vertically by thermals, horizontally by winds. The process of LW radiation is analyzed by means of the finite element method (FEM). The listing of the corresponding MATLAB program is given in [6]. Indeed, the philosophy of Principia Scientific International, PSI, is to be transparent.

The tools which we develop are distributed freely such that everybody can experiment with them.

## Heat radiation through a stack of semi-transparent grids

We consider a stack of  $N-2$  grids of very thin wires.

The wires of the grids have a cross-section  $f \ll 1$ , defined by the diameter of the wire multiplied by its length per unit area. It is a function of the height  $z$  and it can be interpreted as an absorption coefficient.

In figure 1 the stack is depicted. The ground surface is at node 1, outer-space is at node  $N$ .

The nodal parameters are: height  $z_i$ , temperature  $T_i$ , absorption/emission  $f_i$ , and input fluxes  $q_i$ .

To facilitate the editing and the analysis we introduce alternative nodal parameters  $\theta_i$ :

$$\theta_i = \sigma T_i^4 \tag{1}$$

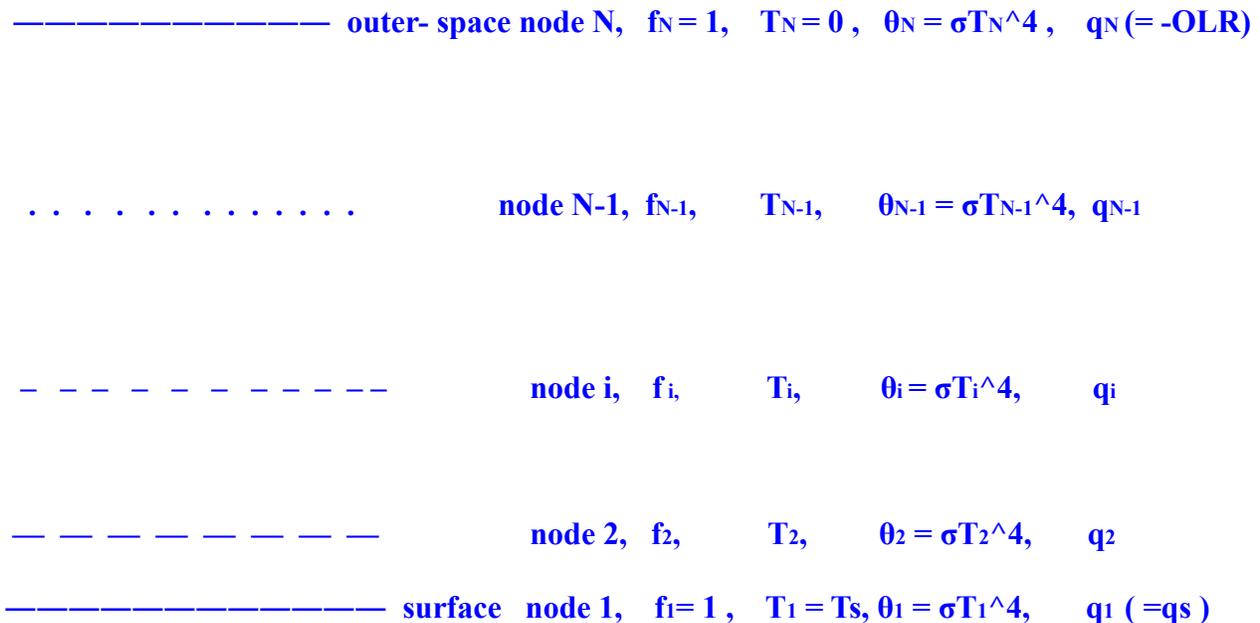
Where  $\sigma = 5.67 \text{ e-}8$  is the Stefan-Boltzmann constant.

For heat transport between two fully opaque surfaces [3] we can write for  $T_i > T_j$  :

$$q(i \rightarrow j) = \sigma(T_i^4 - T_j^4) = \theta_i - \theta_j \quad q(j \rightarrow i) = 0 \tag{2}$$

The parameters  $\theta_i$  with dimension  $\text{W/m}^2$  represent temperatures but sometimes they have to be interpreted as heat flux. It follows from the context.

**Figure 1 A stack of semi-transparent grids**



The stack has  $N-2$  nodes with absorption coefficients  $f_i$ ,  $i=2:N-1$ .

The ground surface at node 1 has a surface temperature  $T_s$ .

Outer-space at node  $N$  at a temperature  $\text{zeroK} = 0$ .

Typical value for a height of 10 km is  $N = 40$ , more nodes do not increase the accuracy.

For the analysis of the heat transport by radiation through the semi-transparent grids, we use the finite element method, FEM.

Figure 2 gives the basic finite element [2].

**Figure 2 Basic finite element for heat radiation between grids i and j.**

$$q(j) \rightarrow \text{-----} f(j), \theta(j)$$

$$\text{element heat flux} \uparrow fe * (\theta(i) - \theta(j))$$

$$q(i) \rightarrow \text{-----} f(i), \theta(i)$$

Grids i and j are not necessarily adjacent, other grids can be in between.  
 The upward arrow for element heat flux is for  $\theta(i) > \theta(j)$ .  
 In case  $\theta(j) > \theta(i)$  the arrow of heat flux is downwards.

The nodal parameters are:

- absorption coefficients f
- to temperature related parameters  $\theta = \sigma T^4$
- thermal loads into the element q

The constitutive relation of this radiation finite element is represented by the effective absorption [2]:

$$fe = f(i) * \text{viewfactor}(i,j) * f(j) \tag{3}$$

The components (i, j) of the viewfactor matrix, express the window between two levels i and j, not necessarily adjacent. For adjacent grids (i,i+1) the corresponding viewfactor component = 1.

The basic radiation matrix for the finite element defined by nodes i and j in terms of the effective absorption fe of the element is shown below, giving a relation between the nodal parameters  $\theta$  and the nodal thermal loads  $q$ :

$$\begin{vmatrix} fe & -fe \\ -fe & fe \end{vmatrix} \begin{vmatrix} \theta_i \\ \theta_j \end{vmatrix} = \begin{vmatrix} q_i \\ q_j \end{vmatrix} \tag{4}$$

For a stack of N levels, including the ground level 1 and the outer-space level N, there are  $N(N-1)/2$  finite elements, which are assembled as shown in Figure 3, by superimposing elements.

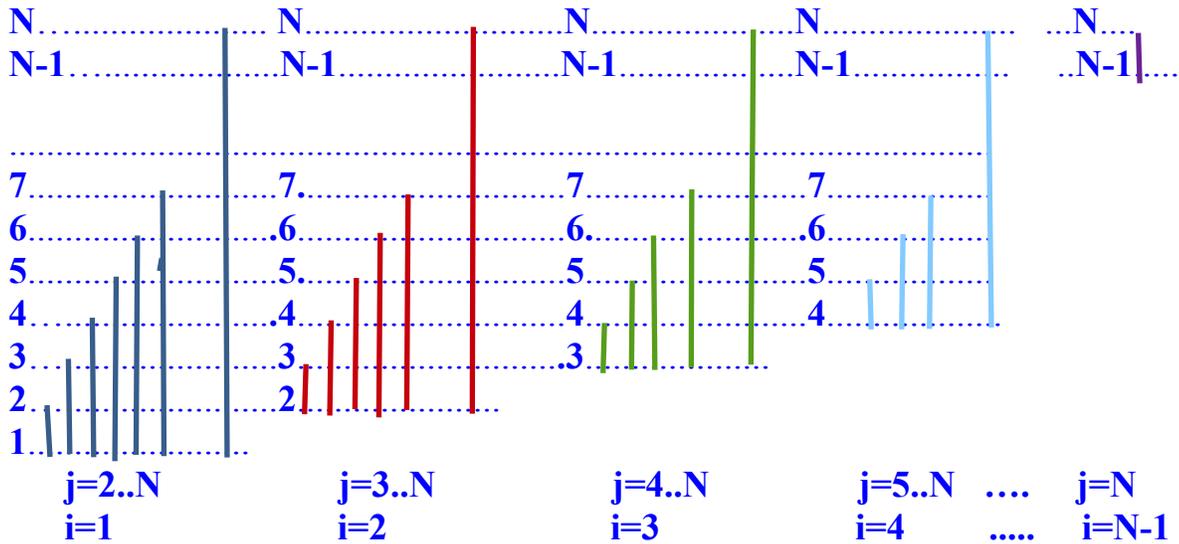
$$K * \theta = rhs \tag{5}$$

**K** : system matrix of order NxN, to be modified by boundary conditions.

**θ** : vector of unknowns,  $W/m^2$ , of order N

**rhs** : right hand side vector of fluxes q,  $W/m^2$ , into the system, of order N

**Figure 3 Illustrative scheme of  $N(N-1)/2$  finite elements (i, j) to be assembled by superimposing upon each other**



### Analysis of heat transport by radiation of a stack in vacuum

We consider the case that the stack of “black” wires is put in a vacuum.

It is like placing a chicken-wire stack on the Moon without an atmosphere, as if the Moon were surrounded by concentric, spherical, fine gauzes.

We consider a maximum height of 10 km which is small as compared to the radii of both the Earth and the Moon: by symmetry we can have a 1-D model. We take a surface temperature of  $T_s = 288 \text{ K} = 15 \text{ C}$ . Heat transfer occurs by LW radiation between the surface and the gauzes as well as an exchange of heat from the warmer gauzes to the cooler ones, and from the gauzes to outer-space.

Boundary conditions are necessary for the system equation (5).

We will use the method of Lagrange multipliers to impose the boundary condition at the surface node 1 and at the outer-space node N, respectively  $T_1 = T_s$  and  $T_N = 0$ , or  $\theta_1 = \sigma T_s^4$  respectively  $\theta_N = 0$ .

We obtain a system of  $N+2$  linear equations:

$$\mathbf{KL} * \mathbf{y} = \mathbf{rhsL} \quad (\mathbf{KL} \text{ matrix of order } (N+2)*(N+2) ) \quad (6)$$

$$\mathbf{y}' = | \theta_1, \theta_2, \dots, \theta_N, \lambda_1, \lambda_2 | \quad (\mathbf{y}' \text{ and } \mathbf{rhsL}' \text{ row vectors of order } N+2)$$

$$\mathbf{rhsL}' = | 0, 0, \dots, 0, \theta_s, 0 | \quad (\mathbf{y} \text{ and } \mathbf{rhsL} \text{ column vectors of order } N+2)$$

The unknown vector  $\mathbf{y}$  is obtained by inverting the matrix  $\mathbf{KL}$  and applying it to  $\mathbf{rhsL}$ :

$$\mathbf{y} = \text{inv}(\mathbf{KL}) * \mathbf{rhsL} \quad (7)$$

The temperatures are defined by:  $T_i = (y_i/\sigma)^{0.25}$ , for  $i=1:N$

The surface flux  $q_1 = \lambda_1 = y_{N+1}$  and the flux to outer-space  $q_N = -\lambda_2 = -y_{N+2}$ .

The MATLAB program is listed in [6] with comments on the technique of Lagrange multipliers.

We consider the case that the stack is placed on a surface with temperature  $T_s = T_1 = 288 \text{ K}$ .

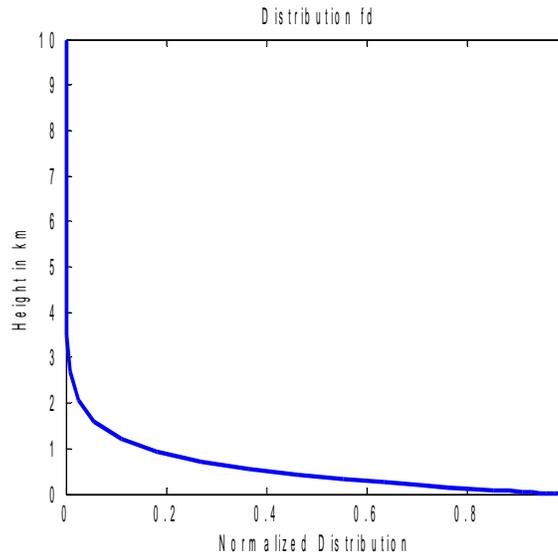
We assume a distribution of the absorption coefficients given by:

$$fd_i = \alpha * dz_i * \exp(-m * z_i / 5000) \text{ for } i=2:N-1 \quad (8)$$

where  $m$  is an input parameter. Figure 4 gives the distribution for  $m=9$ . An homogeneous distribution is obtained with  $m=0$ .

**Figure 4**

**Distribution of absorption coefficients for  $m=9$**



The constant  $\alpha$  is such that the function is normalized:

$$\sum_{i=2}^{i=N-1} fd_i = 1$$

For a total absorption  $f_{tot}$ , the absorption coefficients become:

$$f_i = f_{tot} * fd_i \text{ for } i=2:N-1, \quad f_1 = 1, \quad f_N = 1$$

We take a stack with an height of 10 km and 40 nodes, distributed according to geometrical series. The first grid is at a height  $z_2 = 5$  mm, the node  $N-2$  is at a height of 2.9 km below the last node  $N-1$  with  $z_{N-1} = 10$  km. Node  $N$  represents outer-space, to which a  $z$ -coordinate is given close to  $z_{N-1}$ , for plotting reasons only.

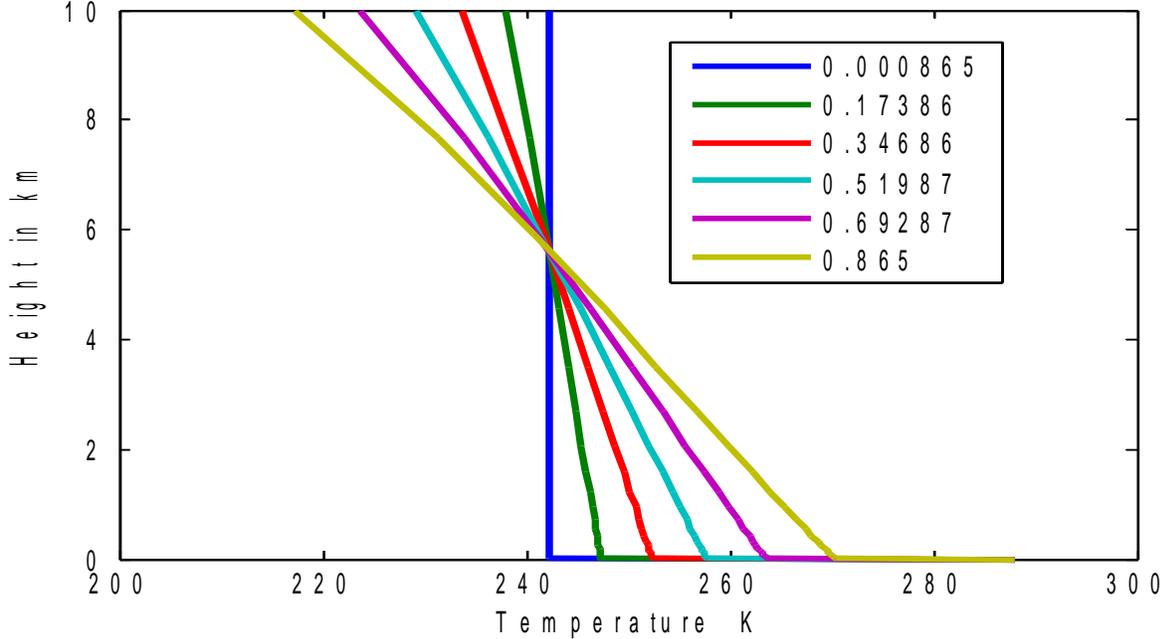
## Numerical results for a stack in vacuum

We start to demonstrate the stack-model in vacuum with an homogeneous distribution of the absorption coefficients  $f_i$  with  $m=0$  in (8). We take the surface temperature as 288 K, the global and annual mean, in order to show the difference with a stack in an atmosphere with convection mechanisms. The temperature related parameters are solved by inversion of the matrix  $\mathbf{KL}$  which contains the boundary conditions by constraints, using the technique of Lagrange multipliers. See the MATLAB program of which the listing, with line by line green comments, is given in a separate paper [6].

The results for temperatures and fluxes are given in figure 5 respectively in figure 6.

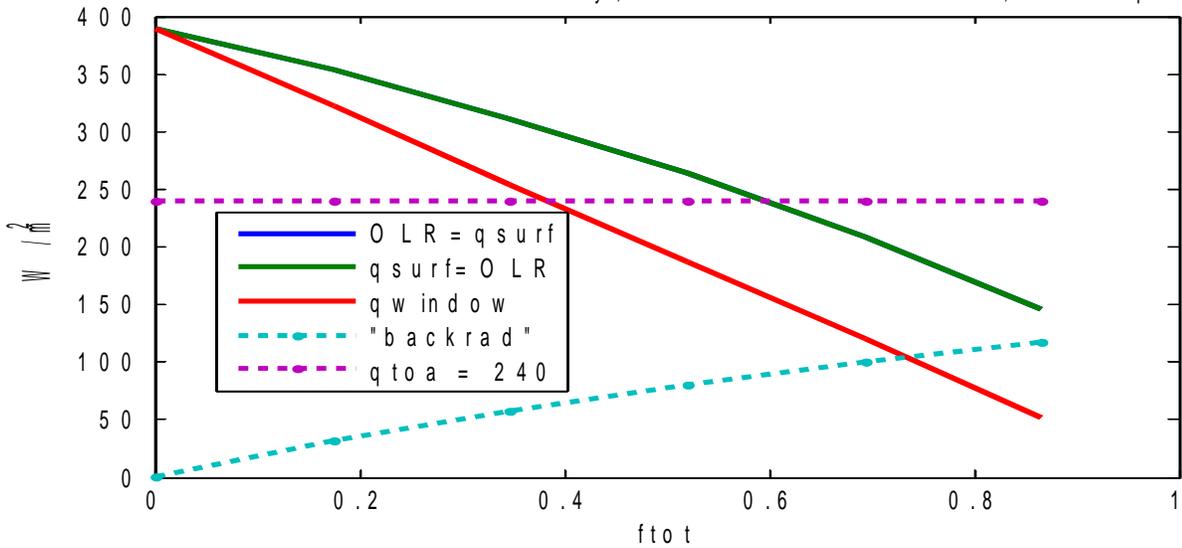
**Figure 5 Temperatures in an homogeneous stack (m=0) in vacuum**

fig 1.1 Stack in vacuum. Or no interaction with O<sub>2</sub> and N<sub>2</sub>  
 window M = 1 nods = 40 m = 0 height = 10 LR = -6.5 TsK = 288 epssurf  
 Temperature of IR-active trace gas for various ftot, compared to ELR T



**Figure 6 Fluxes through an homogeneous (m=0) stack in vacuum**

fig 1.2 Stack in vacuum. Or no interaction with O<sub>2</sub> and N<sub>2</sub>  
 window M = 1 nods = 40 m = 0 height = 10 LR = -6.5 TsK = 288 epssurf  
 "backrad" is not backradiation of heat  
 Fluxes due to radiation only, no interaction with air, OLR = qsurf



Temperatures in figure 5 and fluxes in figure 6 are given for different values of the total absorption coefficient ftot of the homogeneous stack.

The blue curve in figure 5 is the temperature for  $f_{tot} = 0.0$  (00865) for which we see from figure 6:

$$OLR = q_{surf} = q_{window} = \sigma T_s^4 = 390 \text{ W/m}^2. \quad (9)$$

The flux through the window:  $q_{window} = (1 - f_{tot}) \sigma T_s^4$  (It is a straight line from 390 down to 53).

For  $f_{tot} = 0.865$ :

$$OLR = 146.2 \text{ W/m}^2$$

We see that for the homogeneous stack in vacuum and  $f_{tot} = 0.865$ , the outgoing long wave radiation is reduced to 30% .

The blue curve in figure 5 represents the temperature for a very low concentration of IR-active molecules, it is the case that a tiny shell of emitter/absorbent, is put between the surface, at temperature  $T_s$ , and outer-space, at temperature zeroK. The SS temperature  $T$  of that thin shell of absorbent, placed between the surface and outer-space, follows from “absorption=emission” :

$$\begin{aligned} \sigma(T_s^4 - T^4) &= \sigma(T^4 - \text{zeroK}^4) & (10) \\ T^4 &= 0.5 * T_s^4 \\ T &= (0.5)^{0.25} * 288 = 242.2 \text{ K} \end{aligned}$$

The dotted turquoise curve is not back-radiation of heat: it would be a crime against the Second Law. The green **qsurf** curve which in vacuum is equal to OLR, represents the heat flow radiated by the surface and is represented by the sum of the heat fluxes in elements with nodes (1,j):

$$q_{surf} = \sum_{j=2}^{j=nods} f(1) * \text{viewfactor}(1, j) * f(j) * (\theta(1) - \theta(j)) \quad (11)$$

The hypothetical back-radiation is represented by the turquoise terms:

$$\text{“backrad”} = \sum_{j=2}^{j=nods} f(1) * \text{viewfactor}(1, j) * f(j) * \theta(j) \quad (12)$$

We see indeed that according to the one-stream formulation the dotted turquoise terms correspond to the negative term of the Stefan-Boltzmann law for a pair of emitters/absorbents as given in (2). IPCC authors call the term back-radiation, they sell it to the general public as back-radiation of heat! From colder temperatures at height  $z(j)$  to the warmer surface temperature  $T_s$  : a crime against the Second Law. See [3] for an engineering proof that back-radiation of heat cannot exist.

To study in more detail the differences between vacuum and atmosphere, we consider a stack in vacuum with a distribution of the parameters  $f_i$  representing the distribution of IR-active trace gases in the atmosphere on the planet Earth.

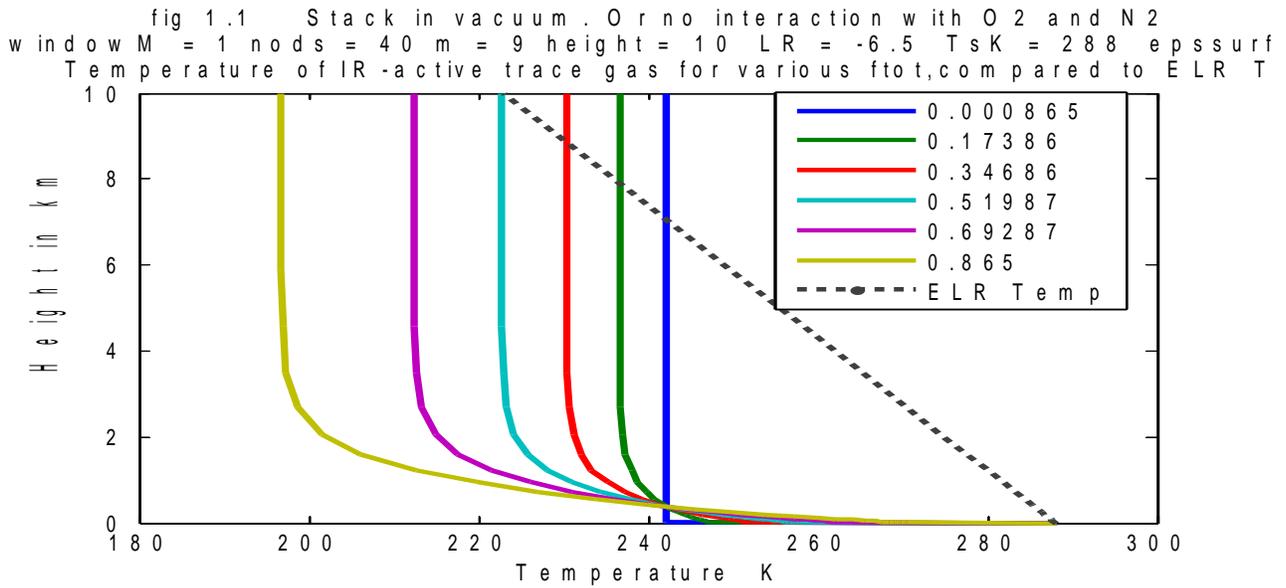
In figures 7 and 8 the same curves are presented as in figure 5 and 6 but for a value  $m=9$  which was found in [1] to give results similar to K&T values, but without back-radiation and thereby huge absorption in the atmosphere.

The distribution of the emitters/absorbents in the stack for  $m=9$  is given in figure 4.

In figure 7 is included, as a dotted line, the measured temperature distribution on the planet Earth, which can be represented by the environmental lapse rate  $ELR = -6.5 \text{ K/km}$ .

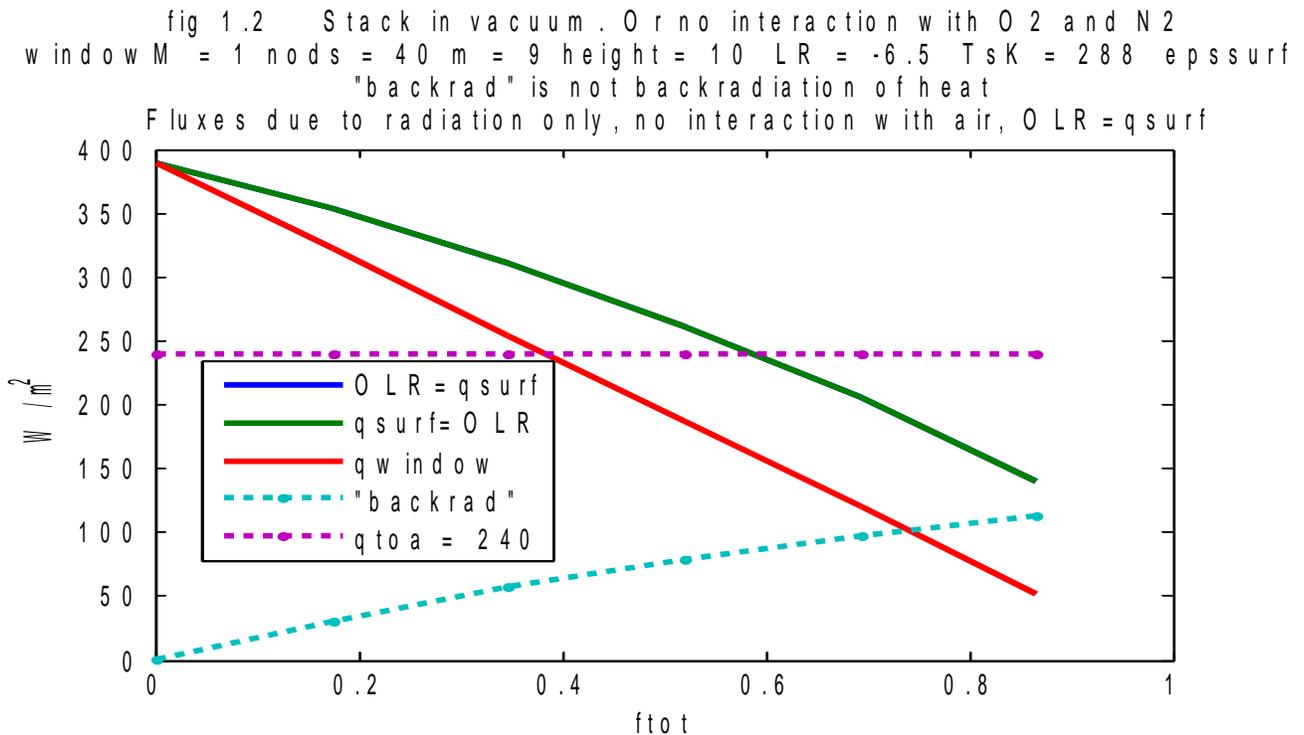
We see that the IR-active gases in a vacuum, or so to speak without heat transfer with the bulk of 99%  $O_2$  and  $N_2$ , are much cooler than the dotted curve representing the measured environmental lapse rate.

**Figure 7 Temperatures of a stack in vacuum with the absorption distribution like on Earth (m=9)**



The blue curve represents the temperature for a low concentration of IR-active gases, 242.2 K (10). For the stack with  $ftot = 0.865$  in a vacuum, temperatures are much lower than the atmospheric temperature in a real Earth. *It means that the IR-active gases are not hot due to radiation from the earth, to heat up the atmosphere. It is the other way around, the IR-active gases are kept warm by the atmosphere, despite the strong radiation to outer space. We come back to that issue further on.* The flux distribution for a stack in vacuum, with absorption distribution for  $m=9$ , is given in figure 8.

**Figure 8 Fluxes through a stack in vacuum with absorption distribution like on Earth (m=9)**



The flux values of figure 8 for the Earth-like distribution of  $f_i$  according to  $m=9$ , are more or less equal to the flux values of figure 6 for a homogeneous distribution with  $m=0$ . Radiation in vacuum does not depend on distances and the distribution of the IR-active particles in vacuum has no influence on the flux from the surface  $q_{surf}$ , which, in vacuum, is equal to the outgoing LW radiation, OLR.

### Stack in the atmosphere of the Earth

The scope of this paper is to show that the alarming messages of IPCC, that the planet would warm up due to IR-active gases with three or more atoms per molecule like  $CO_2$ , are false.

The evacuation of the heat, which the Sun sends to Earth, is mainly by convection, from the surface of the planet to higher layers in the atmosphere. Through the so-called atmospheric window, about  $53 \text{ W/m}^2$  is going straight to outer-space bypassing the IR-active trace gases.

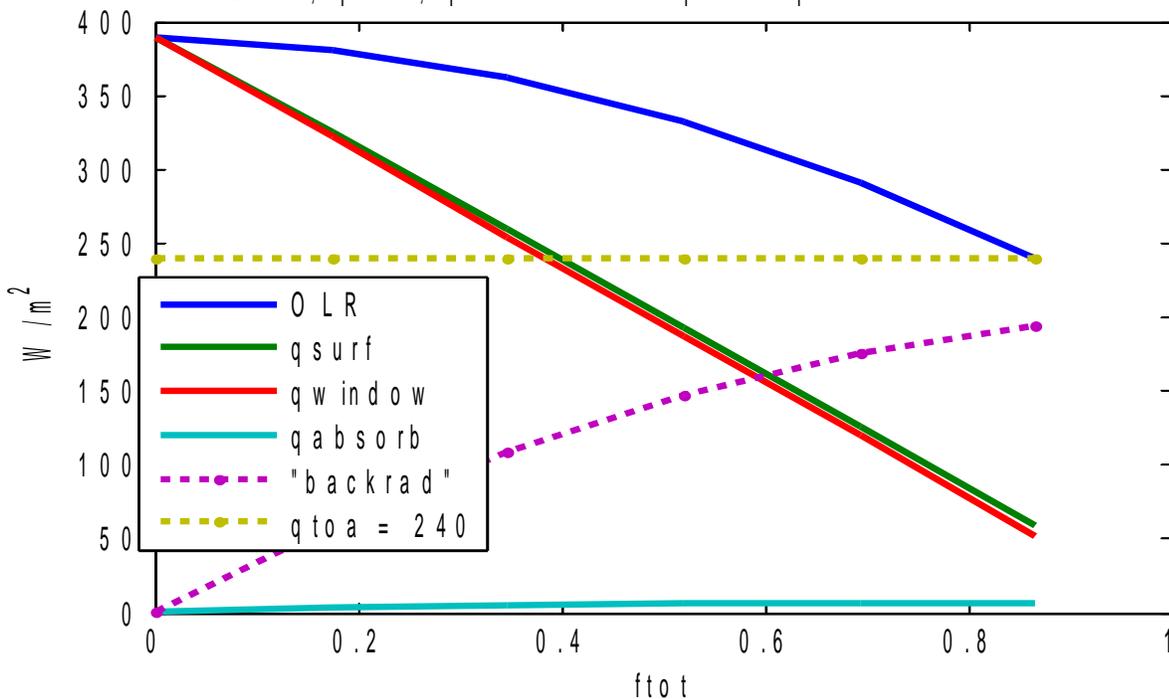
From higher levels the remaining heat leaves the planet by emission from IR-active gases.

In the foregoing section a stack of "black" grids, with absorption coefficients equal to the IR-active trace gases on Earth, was placed in a vacuum, so to speak on the Moon. With an absorption distribution of the stack ( $m=9$ ,  $f_{tot} = 0.865$ ) the outgoing radiation was reduced to 30%, from  $390 \text{ W/m}^2$  for the assumed surface temperature of  $288 \text{ K}$ , to  $146 \text{ W/m}^2$ , according to figure 8.

The same stack ( $m=9$ ,  $f_{tot}=0.865$ ) put in an atmosphere with measured lapse rate  $ELR = -6.5 \text{ K/km}$  and heat exchange between the stack and the bulk of 99%  $O_2$  and  $N_2$ , gives the result for fluxes in figure 9 with  $OLR=240 \text{ W/m}^2$ . We see that  $q_{surf}$  is very close to  $q_{window}$ , a difference of only  $6 \text{ W/m}^2$  is emitted by the surface to be absorbed by the atmosphere.

**Figure 9 Fluxes in stack with heat exchange between the grids and the bulk of  $O_2$  and  $N_2$**

fig 2.1 Main result of stack model  
 window M = 1 n o d s = 4 0 m = 9 height = 1 0 L R = -6.5 T s K = 2 8 8 e p s s u r f  
 "backrad" is not backradiation of heat  
 O L R , q s u r f , q w i n d o w and q a b s o r b as function of f t o t



The difference between the blue curve ( $OLR=240$ ) and the green curve ( $q_{surf}=59$ ),  $181\text{W/m}^2$ , are mechanisms other than LW radiation for a value of  $f_{tot}=0.865$ : convection of sensitive and latent heat and absorption by aerosols in the atmosphere from incoming SW radiation from the Sun.

The dotted curve “back-rad” in figure 9 is not back-radiation of heat as argued already for a similar curve in figure 6 with the relations (9) and (10). This hypothetical value of back-radiation for a stack in the atmosphere ( $m=9$ ,  $f_{tot}=0.865$ ) is seen to be  $200\text{W/m}^2$ .

IPCC authors give as their back-radiation of heat, calculated by means of a Schwarzschild procedure an hypothetical value of about  $320\text{W/m}^2$ . In [4] the author has compared the stack model with the Schwarzschild procedure and concluded that the only difference was the viewfactor matrix.

In figure 7 the temperature for an environmental lapse rate  $ELR = -6.5\text{K/km}$  is given as a dotted line for reasons of comparison. The detailed heat exchange between the stack and the bulk of the 99%  $O_2$  and  $N_2$  can be omitted: each molecule of the stack is surrounded by 2500 other molecules of air. The stack, although cooled by emission as shown in figure 7, will remain at the measured temperature of the surrounding air. For that reason it is not necessary to solve the system equation  $KL*y = rhsL$  by inverting the matrix:  $y = inv(KL)*rhsL$ , as indicated in (6) and (7). It would be necessary to know the non-prescribed  $rhsL$  consisting of mechanisms other than LW radiation, which is not obvious.

Instead, we write equation (5) in a reversed order:

$$q = K*\theta \tag{13}$$

$K$  : system matrix of order  $N \times N$

$\theta$  : vector of  $N$  known temperature parameters:  $\theta = \sigma(T+ELR*z)^4$ ,  $\text{W/m}^2$

$q$  : to be calculated fluxes  $q$  into the system, of order  $N$ ,  $\text{W/m}^2$

The calculated vector  $q$  consists of terms  $q(1)=LW$  surface flux,  $q(N)= -OLR$ . The remaining terms  $q(i)$ ,  $i=2:N-1$  represent heat input at the various stations due to mechanisms other than LW radiation: convection of latent and sensible heat and absorption by the atmosphere of incoming SW radiation.

## Is a stack model representative for the heat evacuation on a real Earth

In the forgoing sections we only have shown results of the evacuation of heat from the planet by a stack of “black” grids in an atmosphere of 99%  $O_2$  and  $N_2$ .

*Is such a chicken wire stack representative for an atmosphere with traces of IR-active gases, with 3 or more atoms per molecule such as  $H_2O$  vapor,  $CO_2$ ,  $CH_4$ ,  $O_3$  ...?*

This question has been discussed in the very first paper on the stack model [1], at that time derived by writing finite difference equations, now replaced by finite elements.

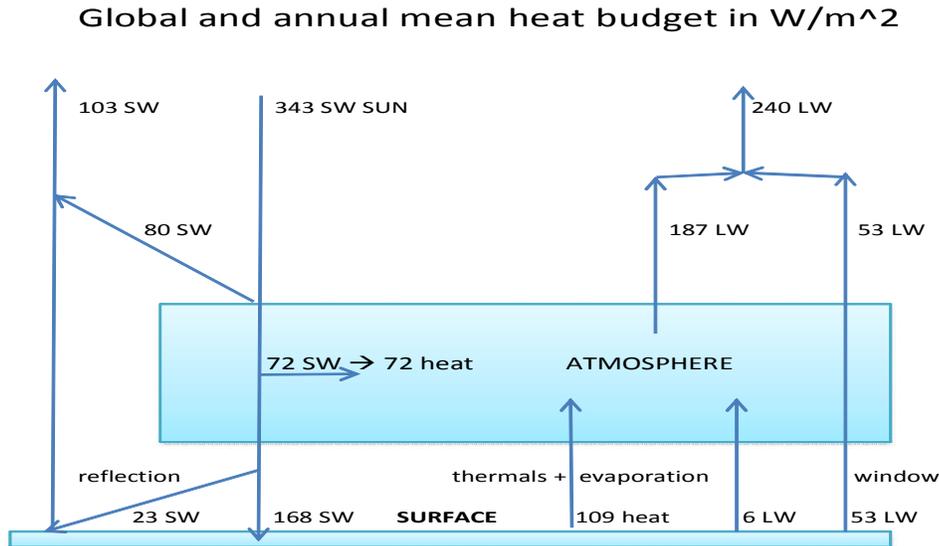
The parameter “ $m$ ” of the distribution of the absorption (8) has been varied in a parameter study, until for  $m=9$  the results coincided with those of IPCC authors, but **without** the back-radiation and **without** the huge absorption in the atmosphere [1]. The distribution for  $m=9$  is given in figure 4.

K&T type diagrams have been replaced by that of figure 10, based on the results of figure 9, giving the global and annual energy balance [1,2].

We see that the LW radiation from the surface is equal to  $59\text{W/m}^2$  of which  $53\text{W/m}^2$  through the window and only  $6\text{W/m}^2$  from the surface to be absorbed in the atmosphere.

The remaining of the incoming SW radiation  $168 - 59 = 109$  are leaving the surface by convection of latent and sensible heat. Together with the incoming  $72$  SW absorbed by aerosols in the atmosphere, the heat emitted by IR-active gases from the atmosphere to outer-space is  $187 \text{ W/m}^2$ . Together with the  $53 \text{ W/m}^2$  through the window, in total  $240 \text{ W/m}^2$ . In **appendix 1** a comparison is given with the numbers of Ferenc Miskolczi [9].

**Figure 10 Global and annual mean heat budget (stack model , K&T data without back-radiation)**



The sensitivity studies in [1,2] are based on figure 9 and indicate for doubling  $\text{CO}_2$  from  $0.04\%$  to  $0.08\%$  a surface temperature increase of  $0.03 \text{ K}$ .

That is the final result of the effort to analyze the evacuation of heat from the Earth to outer-space:  $\text{CO}_2$  is not the reason of climate variations.

$\text{CO}_2$  is a fertilizer to increase crops in order to feed the increasing world population.

See the paper of Carl Brehmer [8].

## Conclusion

The stack model in vacuum shows a temperature distribution far below the temperature measured in the atmosphere. This fact indicates that on planet Earth the bulk of the atmosphere,  $99\%$   $\text{O}_2$  and  $\text{N}_2$  transfers heat to the IR-active trace gases, represented by the stack.

This is in flagrant contradiction with IPCC authors who claim that the IR-active trace gases are heating up the atmosphere!

It is simply not true, the atmosphere with a measured temperature distribution, represented by the environmental lapse rate, keeps the IR-active gases warm despite the emission to outer-space.

As a consequence of keeping the trace gases warm at the temperature of the bulk of the atmosphere, the absorption of heat in the lower layers of the atmosphere remains lower due to higher temperatures.

The emission to higher layers and to outer-space becomes bigger.

The mismatch between emission and absorption is delivered to the various stations of the stack by convection of latent and sensible heat from the surface and the SW absorption by the atmosphere.

The contribution of LW radiation in the evacuation of heat from the surface is low, only  $6 \text{ W/m}^2$  by absorption in the atmosphere and  $53$  through the window straight towards outer-space.

The sensitivity analysis in [1] and [2] shows a surface temperature increase of the planet Earth of  $0.03 \text{ C}$  for doubling  $\text{CO}_2$  from  $0.04\%$  to  $0.08\%$ .

## 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.

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- [6] <http://www.tech-know-group.com/papers/Reynen-MATLAB-listing.pdf>
- [7] <http://claesjohnson.blogspot.fr/>
- [8] [http://tech-know-group.com/essays/Greenhouse\\_Gases\\_Promote\\_Life.pdf](http://tech-know-group.com/essays/Greenhouse_Gases_Promote_Life.pdf)
- [9] <http://www.org/des/paperInfo.aspx?ID=21810>

# Appendix 1

## Comparison of stack model and Miskolczi model

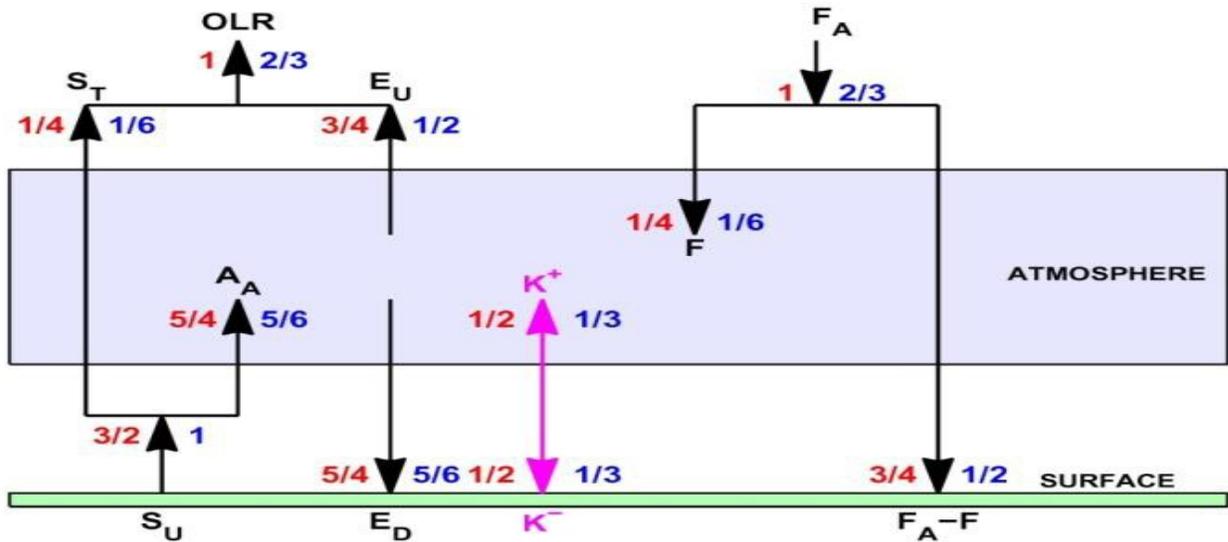
In a recent paper [9] by Ferenc Miskolczi, FM, a global average energy budget has been presented. It is reproduced here as figure A1, a copy of figure 24 in [9].

FM uses the two-stream formulation of LW radiation and comes up with huge absorption in the atmosphere, huge back-radiation, and huge surface flux! Like IPCC authors.

Figure A1 copied from figure 24 of [9].

### Global average radiative equilibrium structure with constant $\tau_A$

$$T_A = S_T / S_U = 1 / 6, \tau_A = 1.792 \quad g = 0.3240 \sim 1/3$$

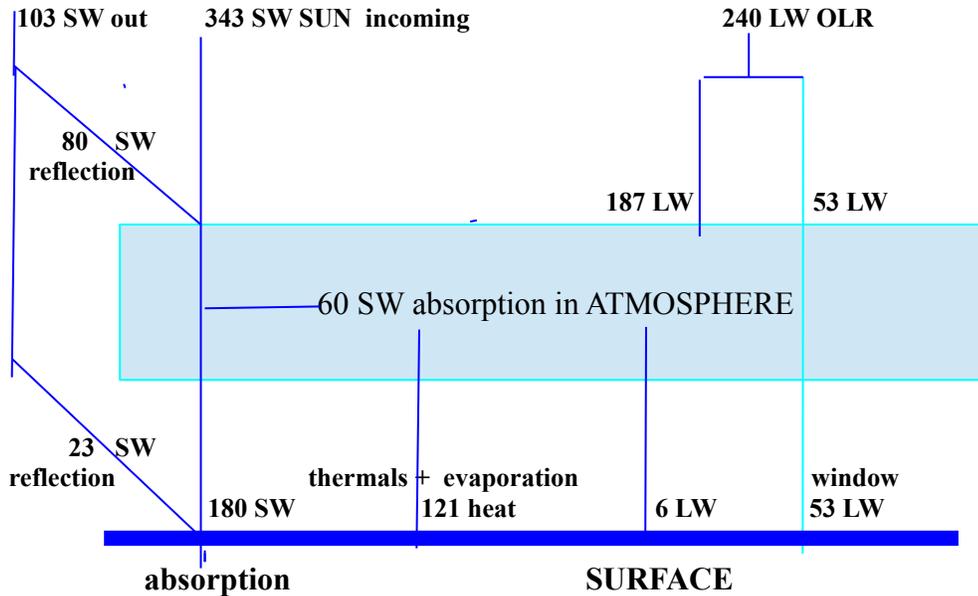


In figure A1 the red numbers correspond to *normalized value*  $OLR=1$  and the blue figures to  $S_U = 1$ . The red numbers are multiplied with 240 to obtain in Table A1 real FM fluxes in  $W/m^2$  for a comparison with the corresponding numbers of the global energy budget of the stack model, given in figure 10 of the main text. It are the results of the stack model with experimental data taken from K&T but putting back-radiation to zero and replacing the atmospheric absorption and the surface flux with those of the stack[1]. Table A1 gives also stack results with the FM experimental data.. The only difference is between the two is the SW absorption in the atmosphere, 72 for K&T and 60 for FM and the SW absorption in the surface 168 for K&T and 180 for FM.

Table A1 fluxes	fig A1	W/m <sup>2</sup>	W/m <sup>2</sup>	W/m <sup>2</sup>
		FM	stack +K&T	stack +FM
Outgoing LW Radiation	OLR	(1) 240	240	240
Incoming SW at TOA	FA	(1) 240	240	240
Flux through window	ST	(1/4) 60	53	53
Atmospheric Absorption	AA	(5/4) 300	6	6
Back-radiation	ED	(5/4) 300	0	0
Convection	K	(1/2) 120	109 = 187 -6 -72	121 = 187 -6 -60
SW absorption in atmosphere	F	(1/4) 60	72	60
SW absorption in surface	FA-F	(3/4) 180	168	180
LW surface flux	SU	(3/2) 360	59	59

In figure A2 is given the global and annual mean heat budget with the experimental data according to FM from figure A1 and table A1.

**Figure A2 Global and annual mean heat budget in  $W/m^2$ .  
Stack Model with Miskolczi data but without back-radiation.**



### Conclusion of appendix1

We see for the FM model huge absorption in the atmosphere, huge back-radiation of heat, and huge LW surface flux, all typical consequences of the two-stream formulation, similar to K&T diagrams of IPCC authors, as discussed in [1].

In [1,2,4] the author has shown that the two-stream formulation gives correct temperature distribution but spurious absorption. It should be avoided, also to interpret experimental results of temperature and moisture. Although FM uses names like back-radiation, atmospheric absorption, and LW surface flux, he does not call figure A1 a global energy budget but *global average radiative equilibrium*.

It seems indeed that FM does not give a physical interpretation to back-radiation, atmospheric absorption and surface flux of the Prevost type, typical quantities from the Schwarzschild two-stream formulation. It is a pity that FM, with a background as astronomer, continues to apply the two-stream formulation to debug the huge experimental data of atmospheric temperature and moisture content, obtained by weather balloons from all over the planet.

The stack model is using the temperature of the measured environmental lapse rate and a heuristic distribution of traces of IR-active gases which has been validated [1] by means of results from K&T type global energy budgets, and now also from the FM *global average radiative equilibrium*.

Indeed, the comparison in Table A1 with the numbers from FM, but ignoring

- back-radiation,
- huge atmospheric absorption
- huge LW surface flux

is another validation of the stack model.

Anyhow, both the FM model and the stack model show that doubling  $CO_2$  concentrations hardly has any effect on the surface temperature.  $CO_2$  is not causing climate changes.