Developments in greenhouse theory

"…by explaining a simple idea in its simplest form,
they may form the basis for further speculations."
K. Schwarzschild, 1906

Summary

— The classical approach to the greenhouse effect is incomplete, neglects fundamental principles;

— The underlying theory of global warming takes into account only a part of the physics;

— Greenhouse effect on the Earth is constrained by powerful negative energetic feedbacks;

— The atmosphere maintains a "saturated" greenhouse effect, controlled by water vapor content;

— Global warming theories seriously overestimate surface temperature sensitivity to greenhouse gas perturbations;

— Earth's greenhouse effect is working at its energetic top; steady further warming is very improbable;

— Venus: totally different (CO_2 atmosphere, closed cloud cover, volcanism) — no runaway greenhouse effect;

— The Kiehl-Trenberth global mean energy budget, adopted by IPCC 2007, is inaccurate, mistaken;

— Human activity may alter the absorbed solar energy by modifying planetary albedo (aerosols, land use change);

— GHG emission has no direct long-term consequence on the global mean energetic equilibrium;

— To those who want to disprove the theory, you are asked to plot your own dots on the "Atmospheric clear-sky Kirchhoff law" graph in the "Proof of the $A_A = E_D$ equality" section below.

Content

- Recent general view and the semi-infinite atmosphere
- Simple radiative transfer model of the Earth-atmosphere system
- Some facts - results of global scale LBL simulations
- Balance equations - Kirchhoff's law - virial theorem
- Transfer and greenhouse functions
- Radiative equilibrium in bounded atmosphere - correct solution
- Effect of a partial cloud cover – characteristic altitude
- Global average profiles, greenhouse sensitivity
- Planetary greenhouse effect in the view of the new theory
- Conclusions

References:

Quarterly Journal of the Hungarian Meteorological Service
Vol. 111, No. 1, January–March 2007, pp. 1–40

Greenhouse effect in semi-transparent planetary atmospheres

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J.T. Kiehl – Kevin E. Trenberth: Earth’s Annual Global Mean Energy Budget. BAMS - Bulletin of the American Meteorological Society, Vol. 78, No 2, February 1997.

Theses:

1. There are hitherto unrealized global average relationships between certain longwave flux components in the Earth's atmosphere;
2. The new relations directly link global mean surface temperature to outgoing longwave radiation;
3. The Earth's atmosphere optimally utilizes all available incoming energy; its greenhouse effect works on the possible energetic top;
4. The classical semi-infinite solution of the Earth's atmospheric radiative transfer problem does not contain the correct boundary conditions; it underestimates the global average near-surface air temperatures and overestimates the ground temperatures;
5. Recent models significantly overestimate the sensitivity of greenhouse forcing to optical depth perturbations;
6. Resolving the paradox of temperature discontinuity at the ground, a new energy balance constraint can be recognized;
7. The Earth's atmosphere, satisfying the energy minimum principle, is configured to the most effective cooling of the planet with an equilibrium global average vertical temperature and moisture profile;
8. The Earth-atmosphere system maintains a virtually saturated greenhouse effect with a critical equilibrium global average IR flux optical depth $tau_A = 1.87$; excess or deficit in this global average optical depth violates fundamental energetic principles;
9. As long as the Earth has the oceans as practically infinite natural sources and sinks of optical depth in the form of water vapor, the system is able to maintain this critical optical depth and the corresponding stable global mean surface temperature;

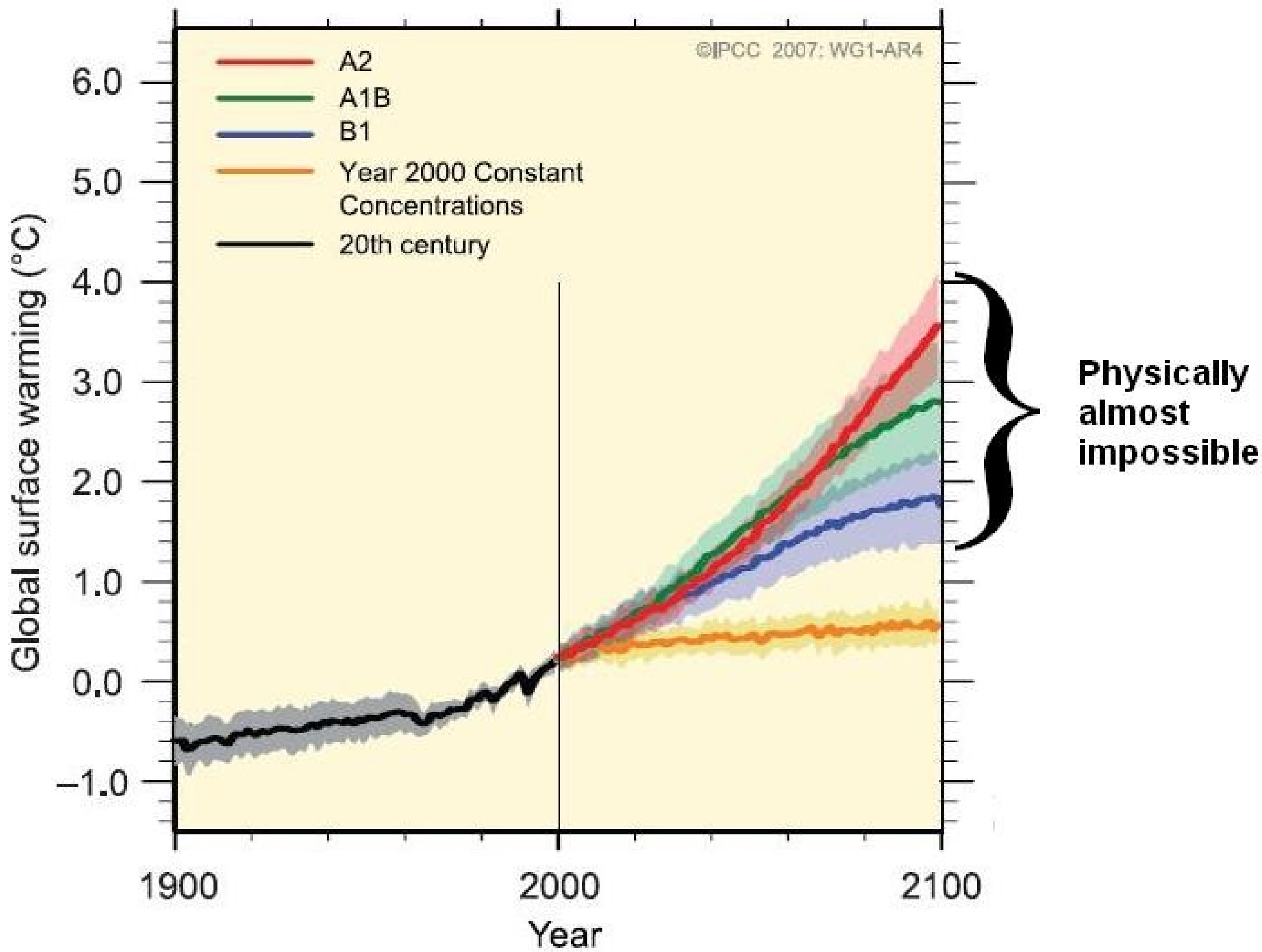
10. The new transfer and greenhouse functions, based on the finite, semi-transparent solution of the Schwarzschild-Milne equation with real boundary conditions adequately reproduce both the Earth's and the Martian atmospheric greenhouse effect;

11. The Kiehl-Trenberth 1997 global mean energy budget estimate (c.f. IPCC 2007 AR4 WG1 FAQ1.1. Fig.1.) is erroneous; the U.S. Standard Atmosphere (USST-76) does not represent the real global average temperature profile (not in radiative equilibrium, not in energy balance, not enough H2O); it should not be used as a single-column model for global energy budget studies;

12. The observed global warming on the Earth has nothing to do with the changes of atmospheric LW absorber concentrations; it must be related to changes in the total available incoming energy (solar, geothermal, ocean-atmosphere heat exchange, etc.); runaway greenhouse effect contradicts the energy conservation principle; global mean surface warming is possible only if the solar luminosity, the Earth-Sun distance and/or the planetary albedo changes;

13. The greenhouse sensitivity to a doubling CO2 is about 0.25 K, according to the exact solution of the semi-transparent radiation transfer problem in gravitationally bounded atmosphere.

The instrument of the above ascertainments is Ferenc Miskolczi's High-resolution Atmospheric Radiance-Transmittance line-by-line spectral code (HARTCODE) (Miskolczi *et al.*, 1990). The simulations were made on the Earth's Radiation Budget Experiment (ERBE 2004) Monthly Scanner Data Product of NASA Langley Research Center, and the TIROS Initial Guess Retrieval (TIGR) Global Radiosonde Archive (1983). Throughout these calculations, no gray-body approximation was assumed.



1. Introduction

An authentic summary of the underlying theory of global warming by a prominent scientist is this:

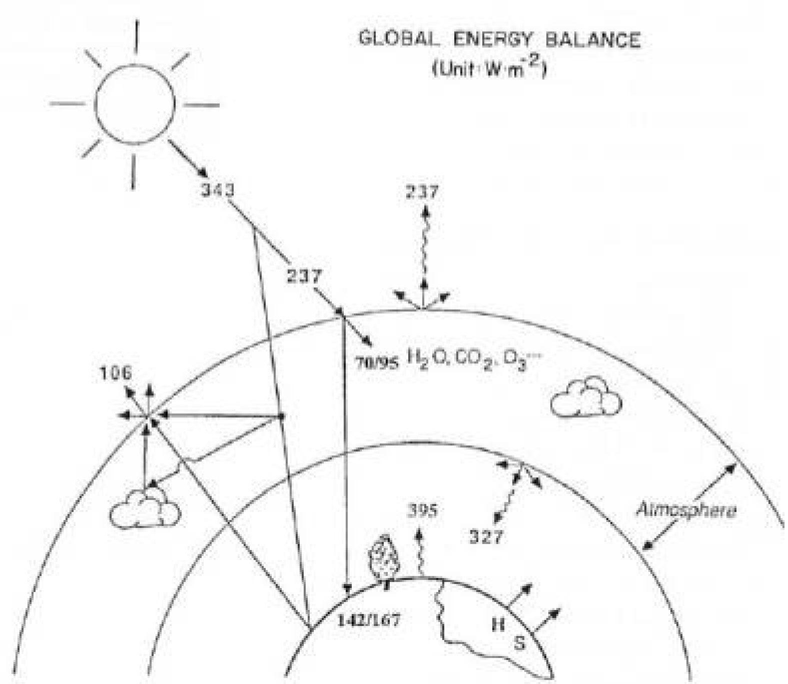


Figure 1. The global energy balance for annual mean conditions. The top of the atmosphere estimates of solar insolation (343 ± 2 W m^{-2}), reflected solar radiation (106 ± 3 W m^{-2}), and outgoing longwave radiation (237 ± 3 W m^{-2}) are obtained from satellite data. The other quantities include atmospheric absorption of solar radiation (in the range of 70 to 95 W m^{-2}); surface absorption of solar radiation (in the range of 142 to 167 W m^{-2}) downward longwave emission by the atmosphere (327 ± 15 W m^{-2}); upward longwave emission by the surface (390 ± 15 W m^{-2}); and H the latent, and S the sensible, heat fluxes from the surface.

”**Greenhouse Effect.**

Global energy budget: The greenhouse effect is best illustrated from the annual and global average radiative energy budget. The incoming solar radiation, the reflected solar radiation and the outgoing longwave radiation (OLR) to space (Fig.1) at the top of the atmosphere have been determined by satellite measurements.

Globally, 70% of the incoming solar radiation is absorbed by the earth-atmosphere system. The solar absorption heats the system, and the surface-atmosphere system cools by emitting OLR until it balances the absorbed solar radiation of 237 Wm^{-2}. Climate models are based on this fundamental principle of global radiation energy balance.

Reduction in the OLR: At a global average surface temperature of about 289 K, the globally averaged longwave emission by the surface is about 395 +/-5 Wm^{-2}, whereas the OLR is only 237 +/- 3 Wm^{-2} (Fig.1). Thus, the intervening atmosphere and clouds cause a reduction 158 +/-7 Wm^{-2} in the longwave emission to space, which is the magnitude of the total greenhouse effect (denoted by G) in energy units.

Without this effect the planet would be colder by as much as 33 K.

Why does the presence of gases reduce OLR? These gases (H_2O, CO_2, O_3, CH_4, N_2O and CFCs) absorb the longwave radiation emitted by the surface of the earth and re-emit it to space at the colder atmospheric temperatures. The ability of these gases to reduce the longwave energy escaping to space has been demonstrated clearly by satellite measurements shown in Figure 2. The upper boundary of the shaded region is the emission by the ocean surface, radiating at a temperature of 300 K, whereas the lower boundary is the radiation measured at satellite altitudes; the difference is the net energy absorbed within the atmosphere. Since the emission increases with temperature, the absorbed energy is much larger than the emitted energy, leading to a net trapping of longwave photons in the atmosphere. The fundamental cause for this trapping is that the surface is warmer than the atmosphere; by the same reasoning decrease of temperature with altitude also contributes to the trapping since radiation emitted by the warmer lower layers are trapped in the regions above.

Anthropogenic Enhancement of the Greenhouse Effect: By deduction (from the facts inferred above from Figures 1 and 2), an increase in a greenhouse gas such as CO_2 will lead to a further reduction in OLR. If the solar absorption remains the same, there will be a net heating of the planet.

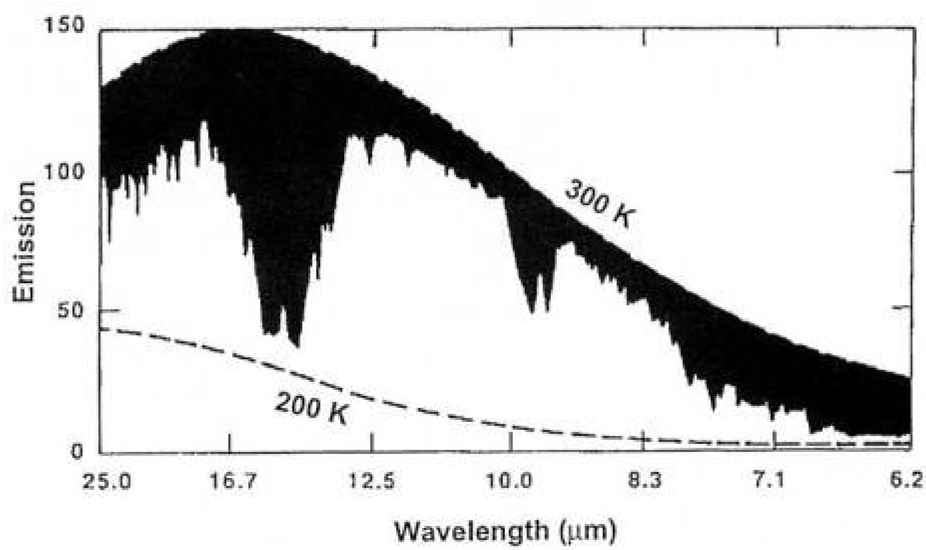


Figure 2. Sample spectra from the infrared interferometer spectrometer onboard Nimbus 3 satellite. The dashed lines indicate the outgoing longwave blackbody emission at the temperatures indicated. Emission is measured in arbitrary units. The scene is tropical Pacific Ocean under clear-sky conditions. (Adapted from (37)).

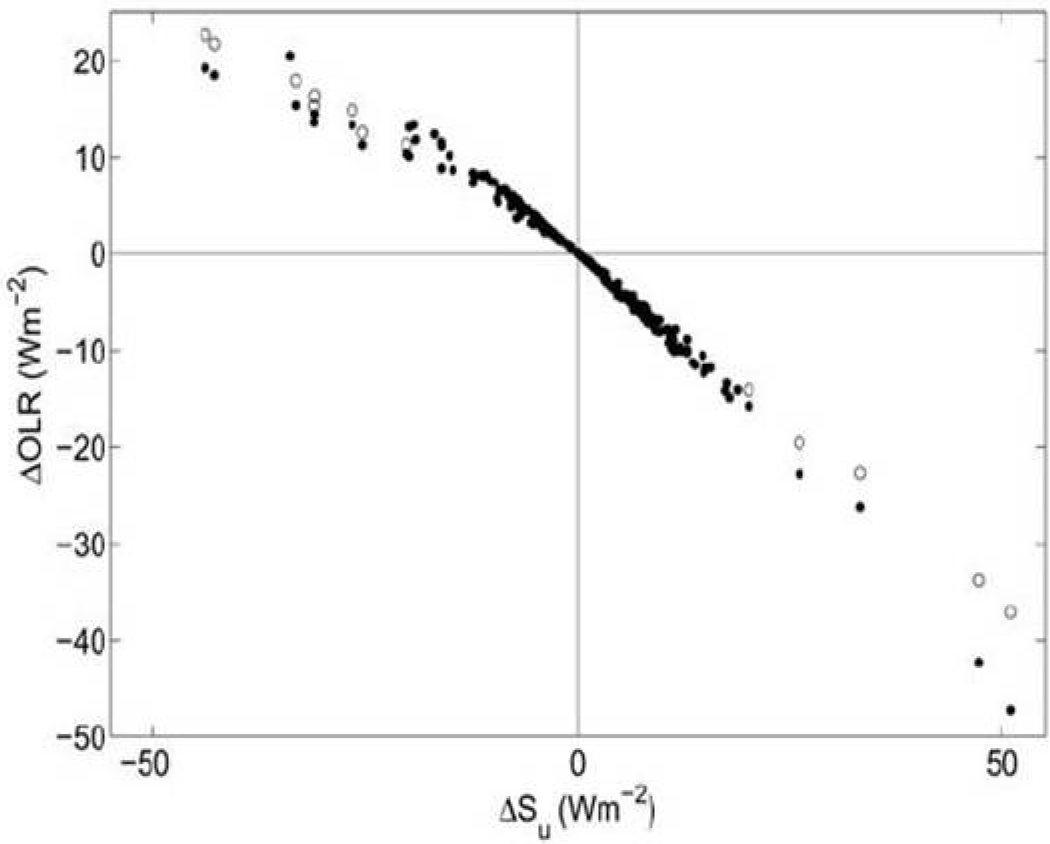
Global warming: *How will the planet restore global energy balance*? The surface-troposhere system should warm (in response to the excess energy) and radiate more longwave radiation to space until the OLR emission to space balances the absorbed solar radiation, i.e., the increase in OLR from warming compensates for the reduction in OLR due to trace-gas increase. **This is the underlying theory of global warming.** It relies on the fundamental Planck's law that the electromagnetic energy emitted by any body in local thermodynamic equilibrium increases with its temperature; the functional form of this increase is given by the so-called Planck function."

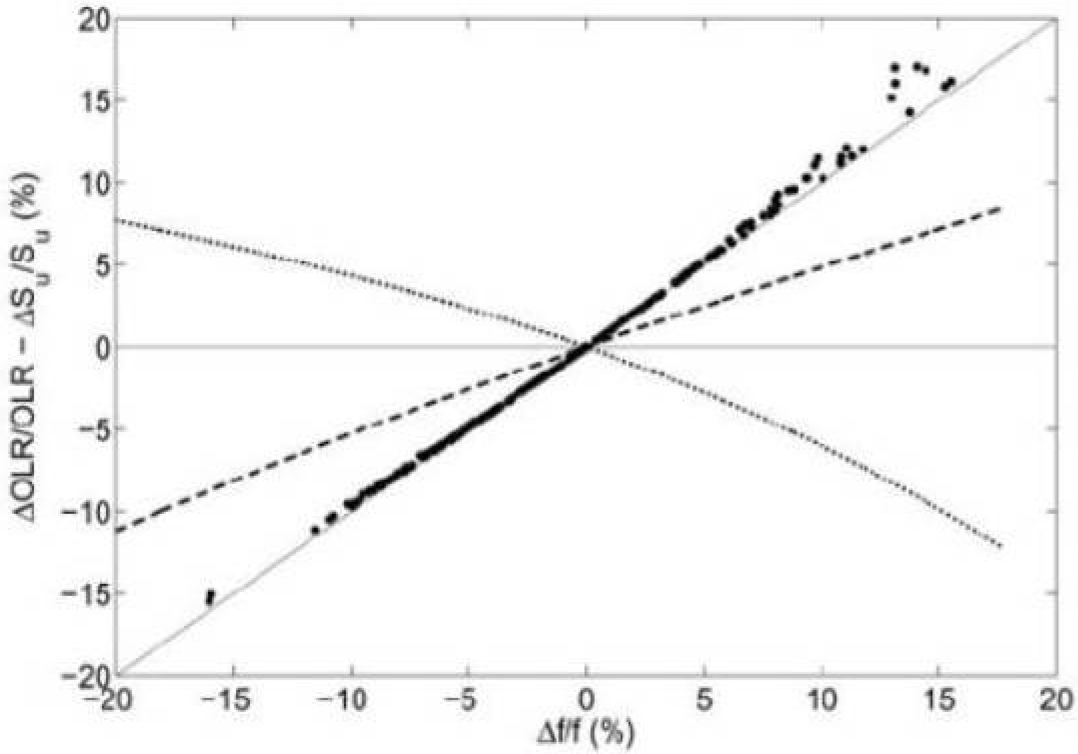
(End of quotation — *V. Ramanathan*: Trace-Gas Greenhouse Effect and Global Warming. Underlying Principles and Outstanding Issues. Volvo Environmental Prize Lecture. 1997.).

* * *

Spencer Weart in his **Discovery of Global Warming** 2008, presents the same concept :

> "Consider a layer of the atmosphere so high and thin that heat radiation from lower down would slip through. Add more gas, and the layer would absorb some of the rays. Therefore the place from which heat energy finally left the Earth would shift to a higher layer. That would be a colder layer, unable to radiate heat so efficiently. The imbalance would cause all the lower levels to get warmer, until the high levels became hot enough to radiate as much energy back out as the planet received."


20
10
0
−10
−20
−30
−40
−50
ΔOLR (Wm⁻²)
−50
0
50
ΔS_u (Wm⁻²)


ΔOLR/OLR − ΔS_u/S_u (%)
Δf/f (%)
20
15
10
5
0
−5
−10
−15
−20
−20
−15
−10
−5
0
5
10
15
20

We will show in the followings that the theory described above is wrong: it is incorrect in the sense that it is incomplete: it does not contain all the necessary energetic constraints.

There are not only two players in the balance, but three: besides the OLR, the surface temperature and the optical depth also must be compensated. It is not possible to elevate the surface temperature simply by further emissions; the greenhouse effect on the Earth is working on its possible energetic top. The surface temperature and the global mean LW optical depth are strictly connected to a given OLR by the S_U=3OLR/2 relationship. In functional form, S_U=OLR/f, where the f transfer function depends on the τ optical depth as f =2/(1+τ+exp(-τ)) and the corresponding theoretical equilibrium optical depth is τ =1.841 .

According to simulations by HARTCODE on the ERBE database, the Earth's actual global mean longwave optical depth (~1.87) is very close to this critical value defined by the f=2/3 relation.

As a consequence, it is not possible to compensate the decrease in f simply by elevating S_U in order to keep OLR fixed. We will show that all the three players are in accordance with each other: any relative temporary deviation from the equilibrium values of f, OLR and S_U must be compensated. This idea is shown on the next two graphs and proved in detail below.

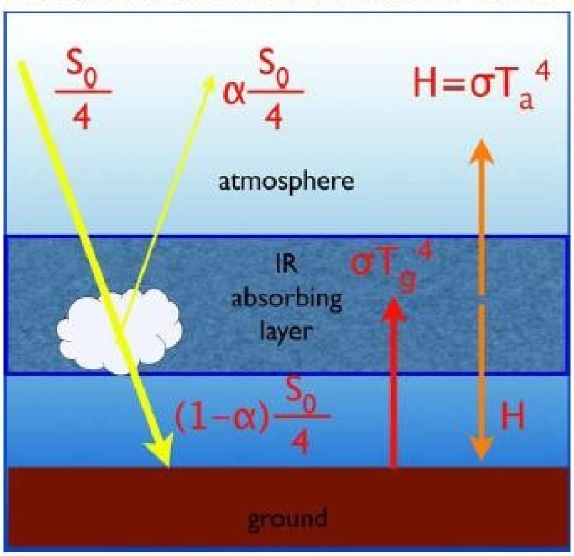
2. THE Structure of the theory

GENERAL VIEW AND THE SEMI-INFINITE ATMOSPHERE

RADIATIVE EQUILIBRIUM IN INFINITE MEDIUM (Eddington, 1916)

$$dB(\overline{\tau})/d\overline{\tau} = 3H/(4\pi) \quad B(\overline{\tau}) = 3H\,\overline{\tau}/(4\pi) + B_0 \quad B(\tilde{\tau}) = H(1+\tilde{\tau})/(2\pi)$$

OPAQUE HOMOGENEOUS ABSORBING LAYER



$\Delta S=5.35*\ln[co_2(t)/co_2(t_o)]$ (IPCC, 2001)

SURFACE TEMPERATURES

"...Assumption of infinite thickness involves little or no loss of generality..." (Milne,1922)

AIR $\quad t_A^4 = t_E^4(1+\tilde{\tau}_A)/2$

GROUND $\quad t_G^4 = t_E^4(2+\tilde{\tau}_A)/2$

THESE SOLUTIONS ARE MATHEMATICALLY INCORRECT

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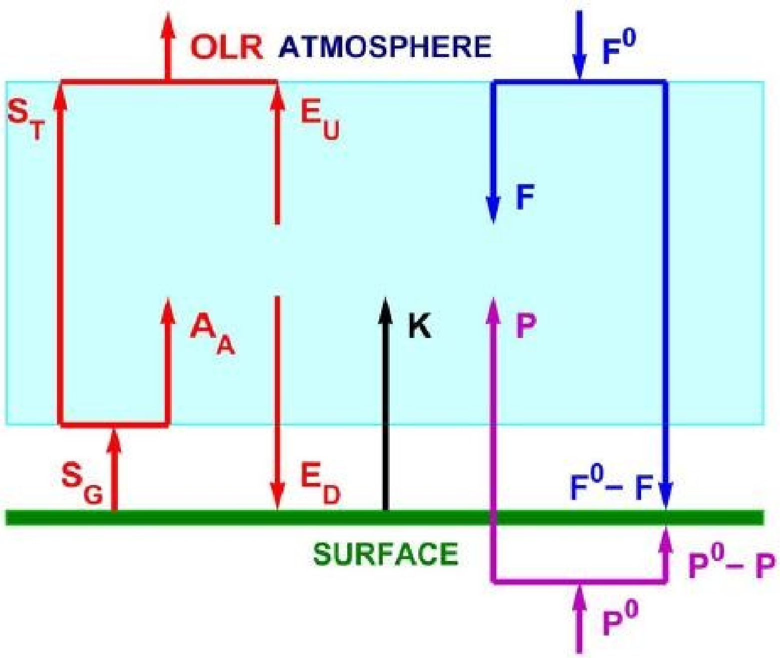
CLEAR-SKY RADIATIVE TRANSFER MODEL



Greenhouse effect:

$G = S_G - OLR$

$G_N = G / S_G$

All-sky measurements:

$S_G = 391\ Wm^{-2}$

$OLR = 235\ Wm^{-2}$

$G_N \sim 0.4$

QUESTIONS:

What are the theoretical relationships among the global average IR flux density terms ?

What can we learn from global scale simulations of IR fluxes ?

NET ATMOSPHERE (1) $F + P + K + A_A - E_D - E_U = 0$

NET SURFACE (2) $F^0 + P^0 + E_D - F - P - K - A_A - S_T = 0$

(3) $F^0 + P^0 = OLR$

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Radiative flux components in a semi-transparent clear planetary atmosphere. Short wave downward: F^0 and F; long wave downward: E_D; long wave upward: OLR, E_U, S_T, A_A, and S_G; Non-radiative origin: K, P^0 and P.

(From now, the S_G surface radiation is assumed to be equal to the S_U equilibrium blackbody radiation.)

According to high-resolution line-by-line computer simulations (HARTCODE), in the Earth's (as well as in the Martian) atmosphere the following rule is in effect:

$$\textbf{(4)}\quad A_A = E_D\ ,$$

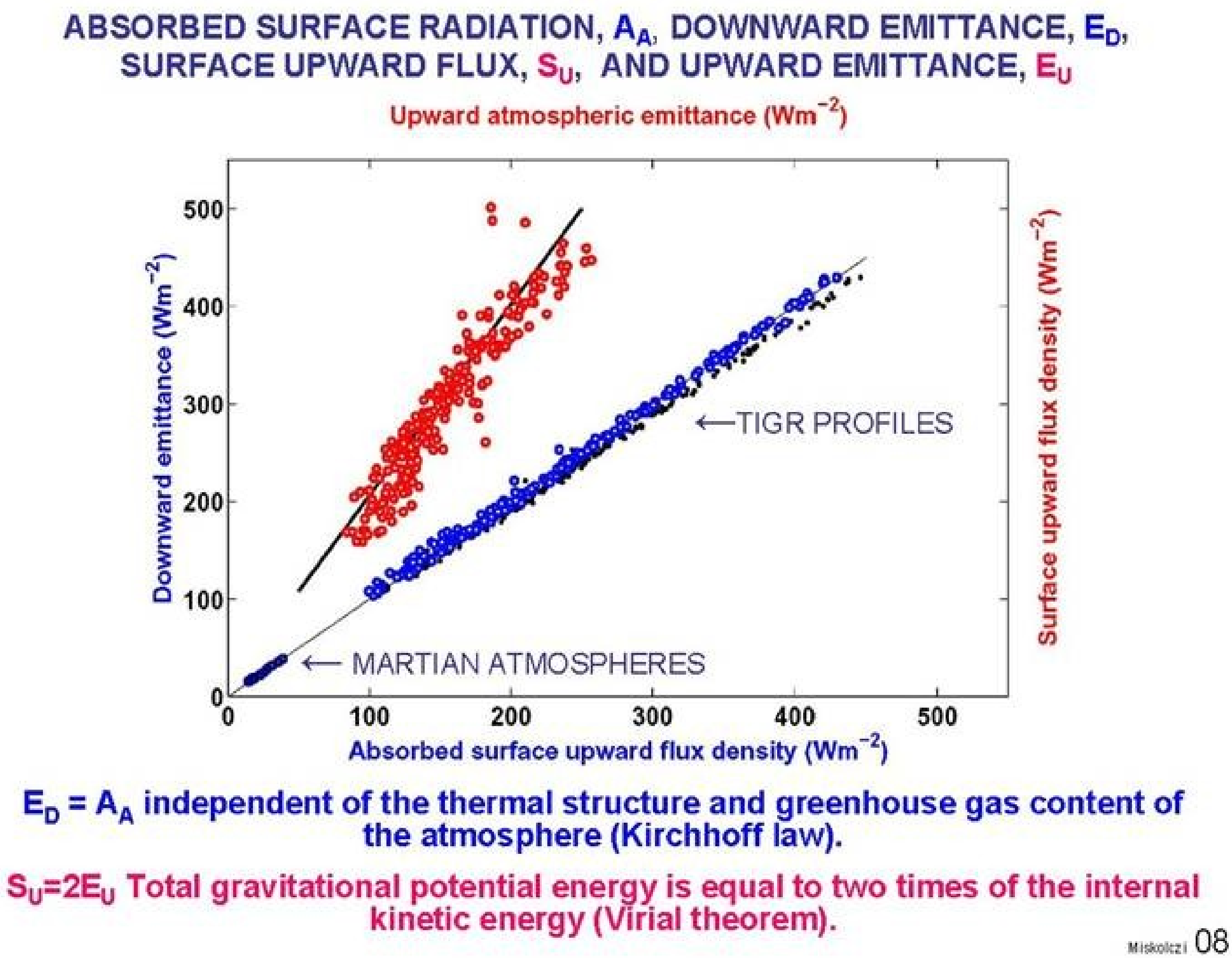
which is a consequence of Kirchhoff's law.

Furthermore, in the gravitationally bounded atmosphere, according to the virial theorem, we can write:

$$S_U = 2\,E_U$$

(we will incorporate this relation into the general solution).

Proof of A_A=E_D and S_U=$2E_U$:



Eq. **(4)** has the following two direct arithmetic consequences:

(5) $\mathbf{E_U = F + K + P}$ **,**

(6) $\mathbf{S_U - OLR = E_D - E_U \ (= G)}$ **.**

Eq. **(5)** says that the energetic source of the atmospheric upward emittance is not the LW absorption of the atmosphere
(contrary to the common view, as presented, for example, in the Introduction),
but mainly the atmospheric SW absorption (**F**) and the sensible and latent heat convection (**K**).

Eq. **(6)** describes two LW flux terms, opposite in direction, equal in size.
The left side is the net upward radiation, heating the atmosphere,
while the right side describes the atmosphere's reaction:
a net downward flux term, maintaining the energy balance on the ground.

[The derivation works in reverse order too.
Realizing the equality of the net ($S_U - OLR$) and ($E_D - E_U$) up- and downgoing LW flux terms,
and using the $S_U = A_A + S_T$ and $OLR = E_U + S_T$ definitions,
we immediately arrive at the $A_A = E_D$ equality.]

Eq. **(7)** below says that both of these flux terms utilize the same source of energy: the incoming SW flux from the Sun (F^0):

(7) $\mathbf{(S_U - OLR) + (E_D - E_U) = F^0 = OLR}$ **.**

In this case,

(8) $S_U = 3\ OLR / 2$ ——> $G = S_U - OLR = E_D - E_U = OLR / 2 = S_U / 3 = R$,

where R is the LW radiation pressure.

THEORETICAL RELATIONSHIPS BETWEN THE IR FLUX DENSITIES

Kirchhoff law: (4) $A_A = S_U A = S_U(1-T_A) = E_D$ $\quad T_A = \dfrac{S_T}{S_U} = 1 - A = e^{-\tilde{\tau}_A}$

Consequences: (5) $E_U = F + K + P$ UPWARD EMITTANCE

(6) $S_U - OLR = E_D - E_U = G$ GREENHOUSE FACTOR

(7) $S_U - OLR + (E_D - E_U) = OLR$ ENERGY CONSERVATION

Virial theorem and radiation pressure: $S_U = 2E_U$ $\quad R = \dfrac{S_U}{3}$

THEORETICAL TRANSFER AND GREENHOUSE FUNCTIONS

(8) $\dfrac{OLR}{S_U} = \dfrac{2}{3} \rightarrow f^+ = \dfrac{2}{3}$ $\quad S_U - OLR = R \rightarrow g^+ = \dfrac{1}{3}$ RADIATIVE BALANCE

↑

(9) $\dfrac{OLR}{S_U} = \dfrac{3+2T_A}{5} \rightarrow f^o = 1 - \dfrac{2A}{5}$ $\quad S_U - OLR = \dfrac{6A}{5}R \rightarrow g^o = \dfrac{2A}{5}$ GENERAL SOLUTION

↓

(10) $\dfrac{OLR}{S_U} = \dfrac{2+T_A}{3} \rightarrow f^* = 1 - \dfrac{A}{3}$ $\quad S_U - OLR = AR \rightarrow g^* = \dfrac{A}{3}$ THIN ATMOSPHERE

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That is:

— the G greenhouse factor equals to the R longwave radiation pressure at the ground;

— the global average surface greenhouse temperature is strictly connected to OLR;

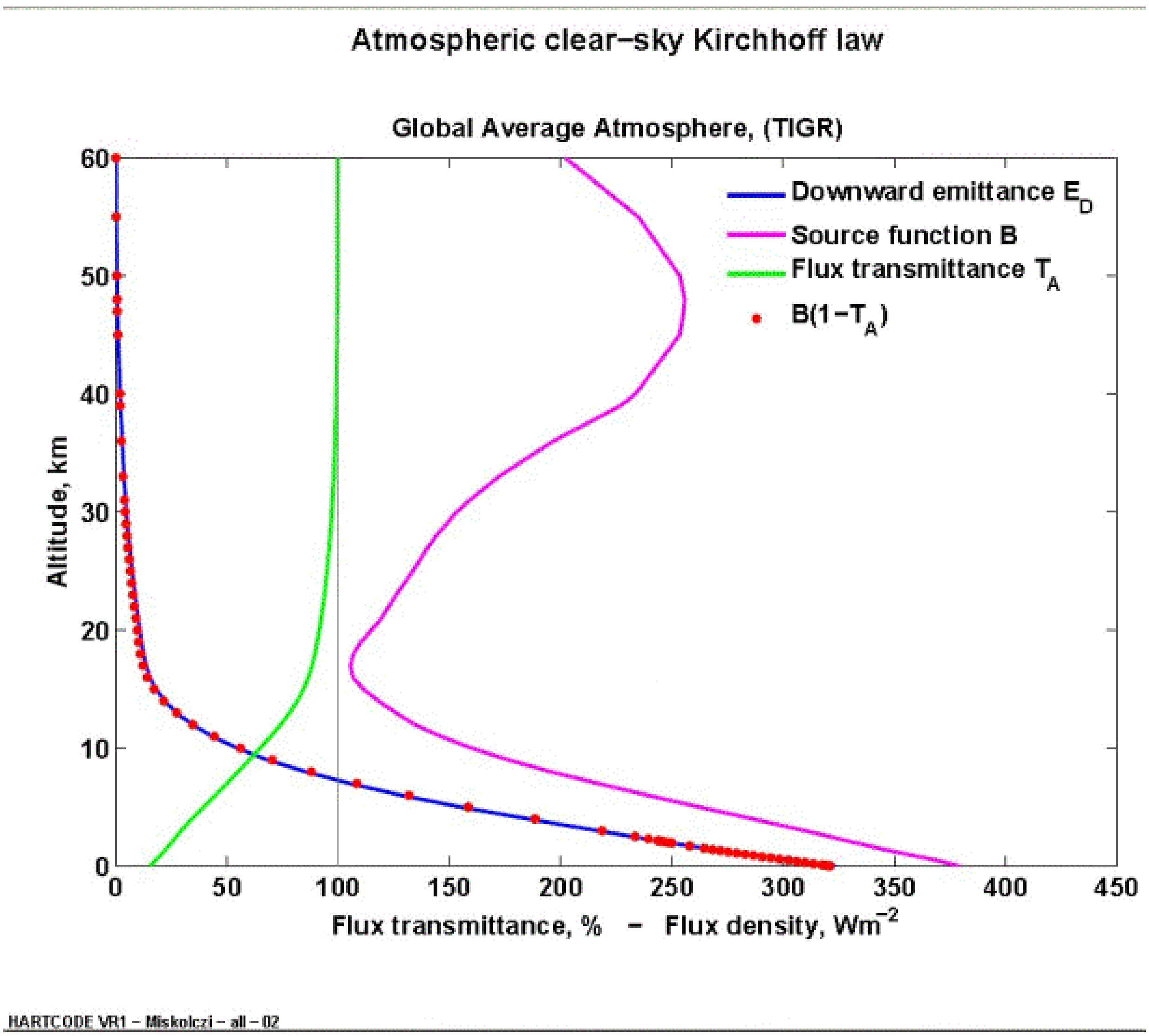
— the theoretical value of the $G/S_U = g_N$ normalized clear-sky greenhouse factor is

$$g_N = 1/3;$$

— on the Earth the greenhouse effect is constrained, there is no runaway global warming.

Proof of the $A_A=E_D$ equality:

The curves are plotted using the TIGR radiosonde data product, whereas the atmospheric absorption,
$A_A = B - B(\exp(-tau_A))$, was computed by HARTCODE.



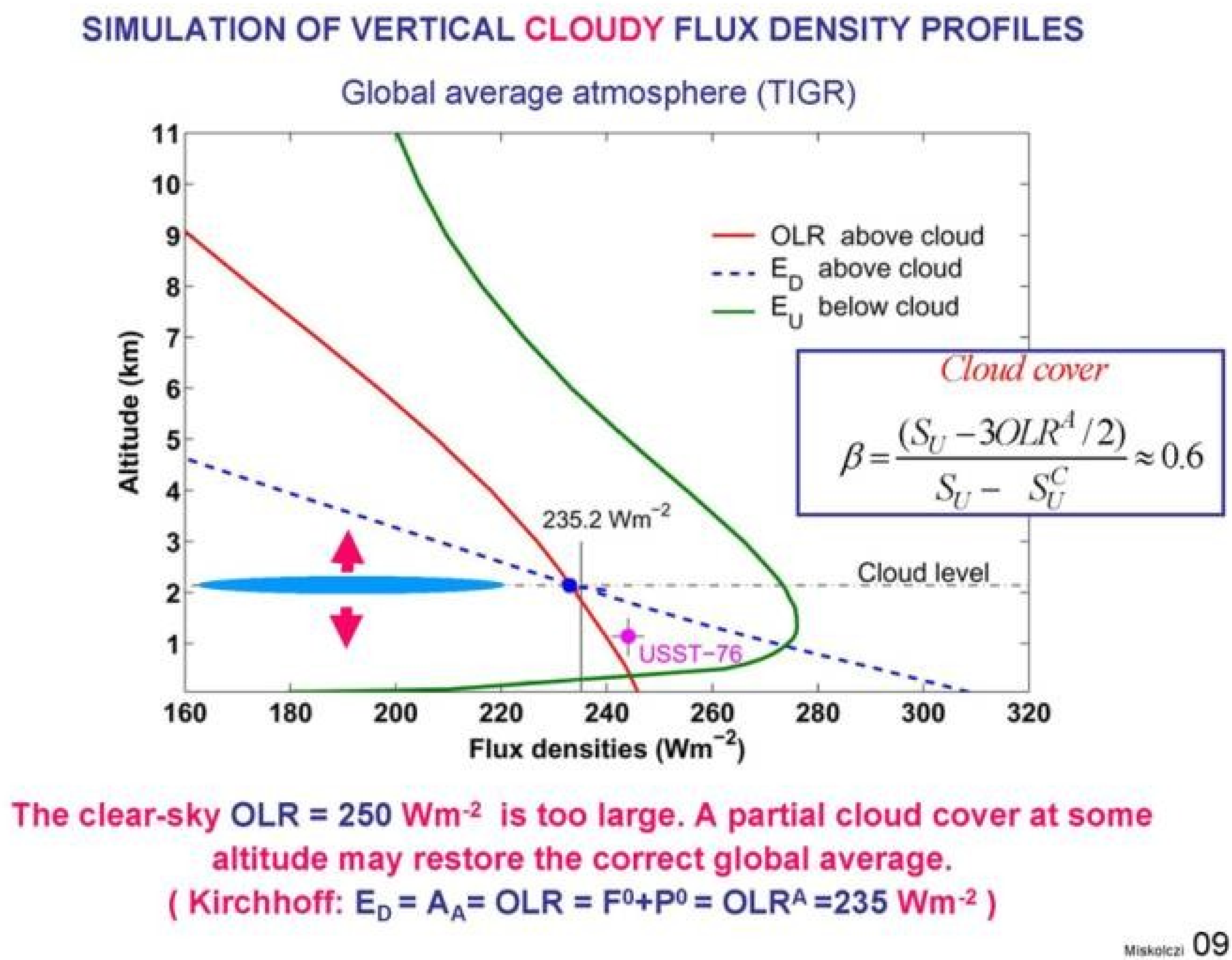
To those who assert anthropogenic global warming and the runaway greenhouse effect, you are asked to plot your own dots on the above graph.

"Anthropogenic global warming" here refers to global warming induced by greenhouse gas emissions of the mankind.—

There are several ways human activity may influence the climate system. Industrial heat generation contributes to the P^0 term. Aerosols may modify the system albedo; land use change and deforestation may alter the surface reflectivity, decreasing or increasing the amount of the available F^0 energy. Any of these initial variations may lead to surface temperature change, generating alterations in the ice cover, implying further albedo-temperature feedbacks, with unknown outcome.

Our statements are restricted here to the role of greenhouse gases in the climate system.

* * *



The law is in effect also in cloudy–sky conditions:

The role of clouds

The energy minimum principle requires that the K term should be maximized. This assumes $S_T \approx 0$, a planet with a completely opaque atmosphere and saturated greenhouse effect. On the Earth, according to the existence of the IR atmospheric window, this assumption cannot be fully satisfied. Earth has found the solution to this contradiction by fading out an equivalent amount of energy from the OLR by the help of a partial cloud cover.

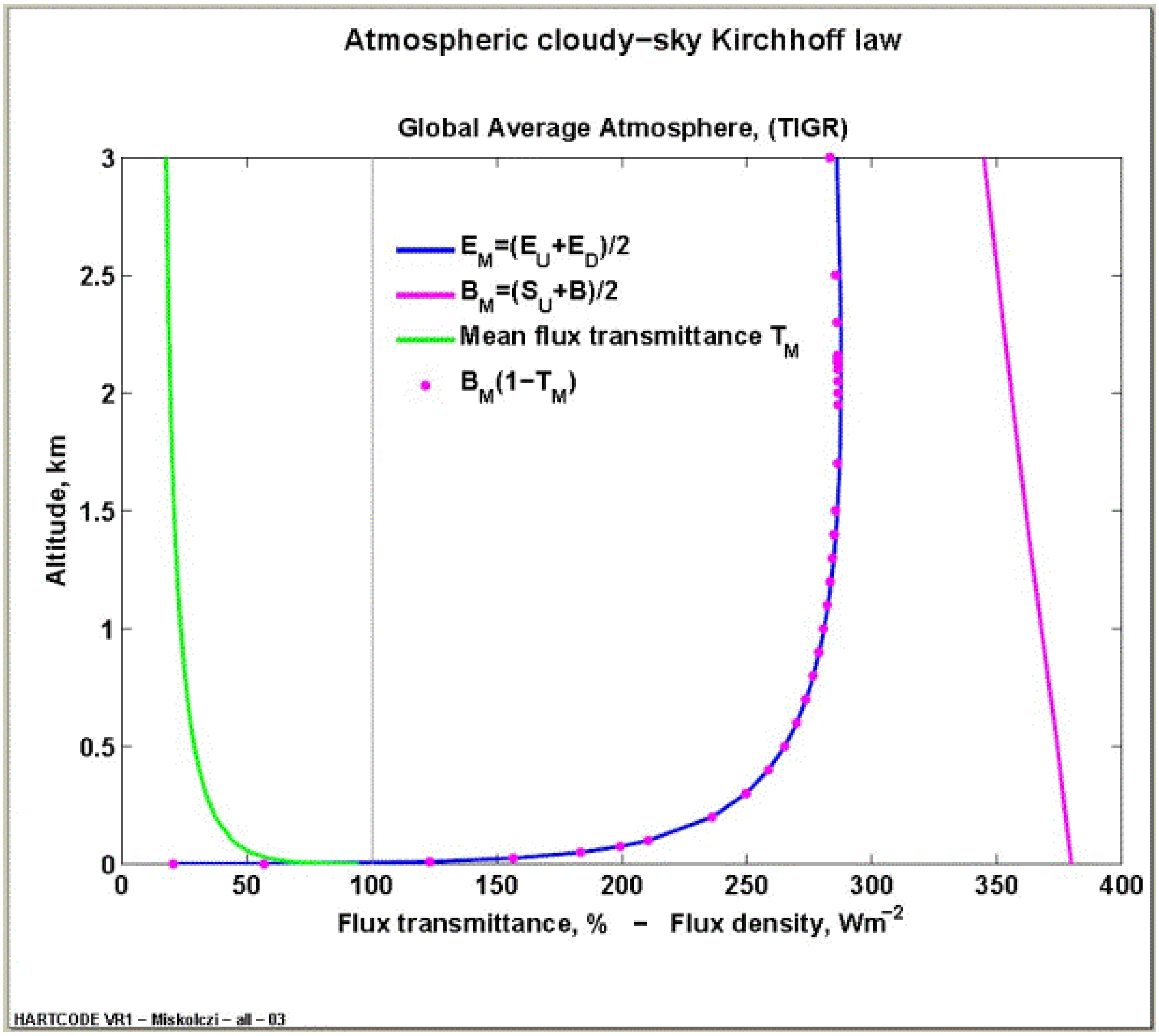
The LW heating effect of the existing global mean cloud cover is really almost the same as closing the atmospheric IR window (~ + 60Wm^{-2}), what depends on the average cloud altitude; while the SW cooling effect by increasing the planetary albedo is about ~ –75 Wm^{-2}, what is almost altitude-independent. The result is that high-level clouds typically heat the surface, low level clouds cool it. There is a mid-level altitude, where the global mean cloud cover is able to maintain the optimized cooling of the system by minimizing T_A and maximizing K, without disturbing the equilibrium surface temperature. (Note that the existing fractional cloud cover *cools* the Earth by about –15Wm^{-2}.)

The corresponding average cloud level is the altitude where the cloudy part of the atmosphere is able to subtract the necessary amount of S_T from the cloudy S_U to generate the all-sky OLR. The cloud "knows" that there is a cloudless part of the atmosphere — it is obvious that strict global average energetic constraints work in the background.

Our simulation shows that this altitude is around 2 km, in pretty good agreement with the global mean cloud level.

The average cloud cover fraction, β, should be calculated from the weighted averages of clear OLR and the cloudy OLR^C in the true all-sky OLR^A: $OLR^A=(1-\beta)OLR+\beta OLR^C$. The result is also shown on the graph below.

Note that the location of the maximum of E_U is very close to that altitude — the maximum in K is favourable for cloud-formation.


Atmospheric cloudy−sky Kirchhoff law
Global Average Atmosphere, (TIGR)
$E_M=(E_U+E_D)/2$
$B_M=(S_U+B)/2$
Mean flux transmittance T_M
$B_M(1-T_M)$
Altitude, km
0
0.5
1
1.5
2
2.5
3
0
50
100
150
200
250
300
350
400
Flux transmittance, % − Flux density, Wm^{-2}
HARTCODE VR1 – Miskolczi – all – 03

TRANSFER FUNCTION IN SEMI-TRANSPARENT BOUNDED RADIATIVE EQUILIBRIUM ATMOSPHERE – GENERAL SOLUTION

RADIATIVE EQUILIBRIUM IN FINITE MEDIUM

$dB(\bar{\tau})/d\bar{\tau} = 3H/(4\pi)$ $\quad B(\bar{\tau}) = 3H\,\bar{\tau}/(4\pi) + B_0$ $\quad H = \pi\left[\bar{I}^{+}(\bar{\tau}) - \bar{I}^{-}(\bar{\tau})\right]$

Boundary conditions

$\tilde{\tau}_A$ and $S_G = \pi B_G$

$$\pi B_0 = \frac{\frac{H}{2}\left[1 + \tilde{\tau}_A e^{-\tilde{\tau}_A} + e^{-\tilde{\tau}_A}\right] - \pi B_G e^{-\tilde{\tau}_A}}{1 - e^{-\tilde{\tau}_A}}$$

Transfer function

$f = 2/(1 + \tau_A + T_A)$

$$\pi B(\tilde{\tau}) = \frac{H}{2A}\left[\frac{2}{f} - (\tilde{\tau}_A - \tilde{\tau})A\right] - \frac{\pi B_G T_A}{A}$$

Energy minimum principle

$\pi dB_0(\tilde{\tau}_A)/d\tilde{\tau}_A = 0$

$$S_U = \frac{OLR}{f} \rightarrow t_G^4 = \frac{t_E^4}{2}(1 + \tau_A + T_A)$$

The surface temperature depends also on the flux transmittance T_A.

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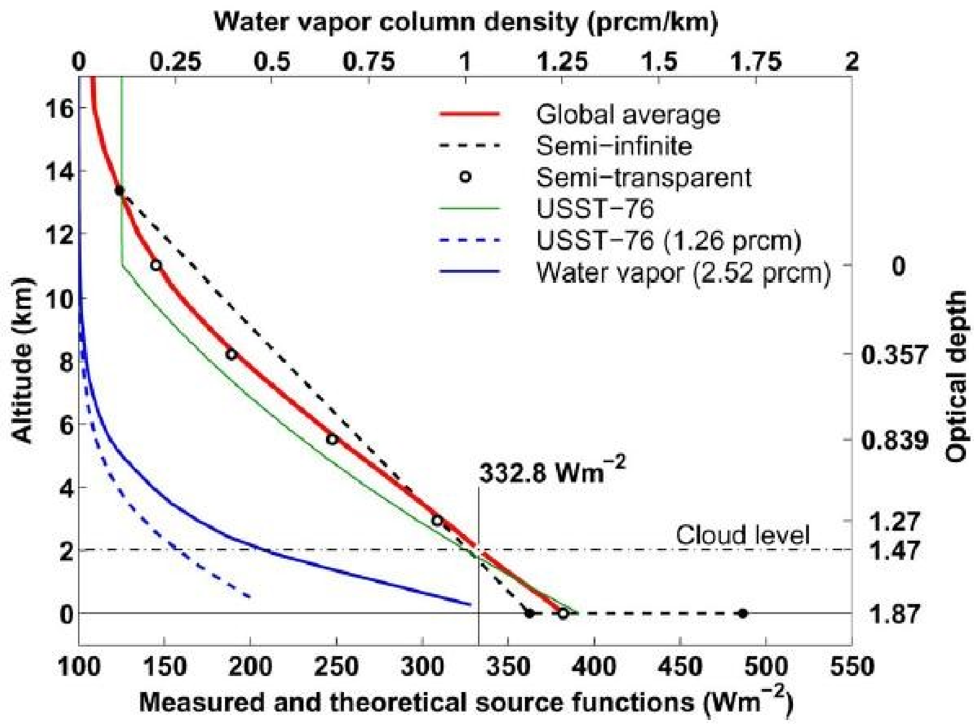
THE GENERAL SOLUTION OF THE GREENHOUSE PROBLEM

(REAL BOUNDARY CONDITIONS, ALL THE EXISTING ENERGETIC CONSTRAINTS):

3. Proofs and consequences of the theory

GLOBAL AVERAGE ATMOSPHERES



The USST-76 atmosphere is not adequate for global radiative budget studies. (Not in radiative equilibrium, not in energy balance, H_2O amount is small)

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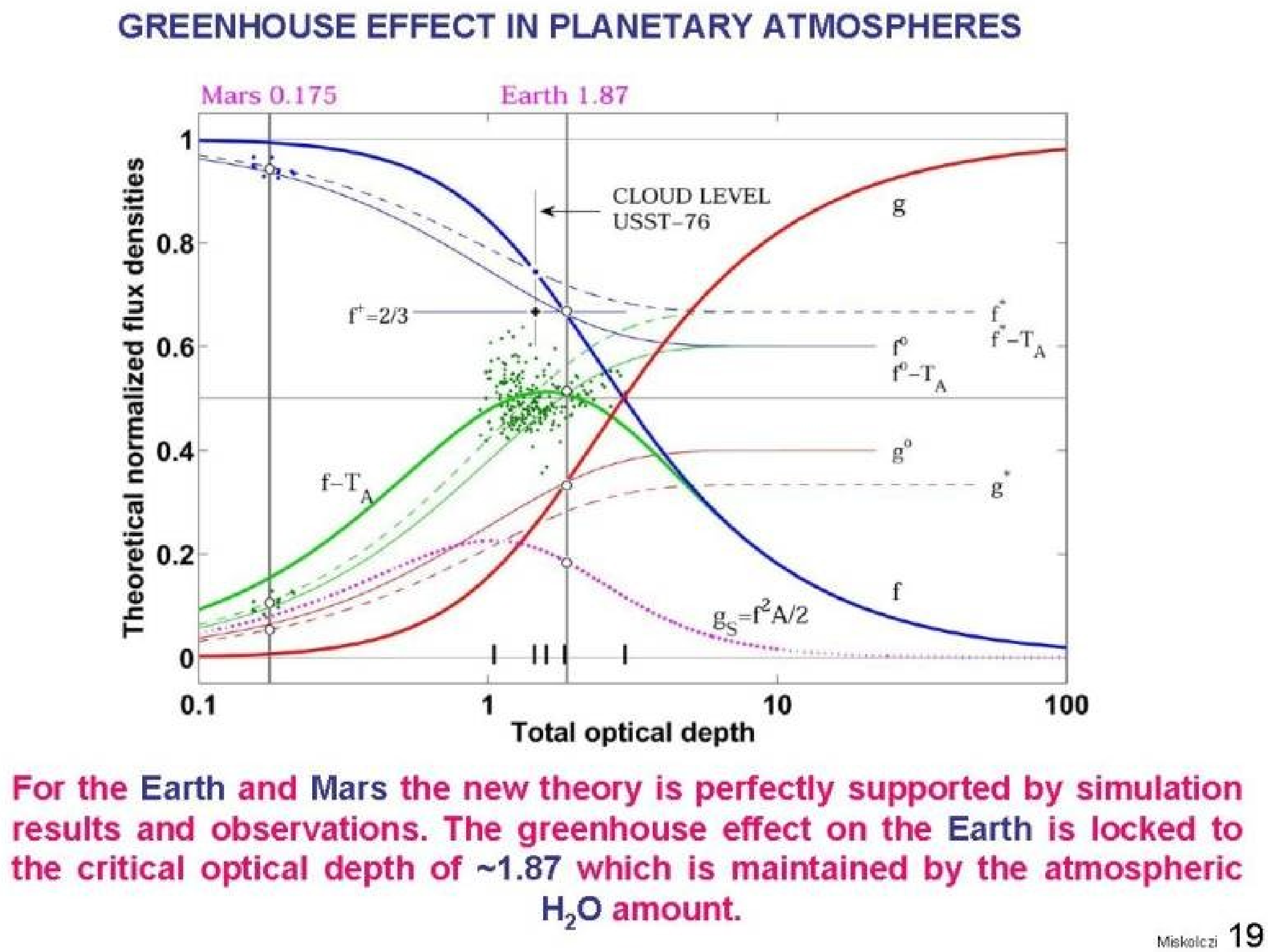
Above: Theoretical and measured source functions profiles, and the global average H_2O profile. The solid lines were computed from 228 selected all sky radiosonde observations. The black dots and the dashed line represent the semi-infinite approximation with the temperature discontinuity at the ground. The open circles were computed from Eq. (21). The optical depth values of 0.357, 0.839, 1.28, 1.47 and 1.87 correspond to $\hat{\tau}_{E_U}$, $\hat{\tau}_C$, $\hat{\tau}_{E_D}$, $\bar{\tau}_A^C \approx \bar{\tau}_A^{US}$ and $\bar{\tau}_A^E$ respectively. The dash-dot line is the approximate altitude of an assumed cloud layer where the $OLR^A = E_D = OLR$.

The figure below shows that the Earth has a controlled greenhouse effect with a stable global average $\tilde{\tau}_A^E = 1.87 \approx \tilde{\tau}^+ \approx \tilde{\tau}^\circ$, $g(\tilde{\tau}_A^E) = 0.33 \approx g^+ \approx g^\circ(\tilde{\tau}_A^E)$, and $g_S(\tilde{\tau}_A^E) \approx 0.185$. As long as the $F^0 + P^0$ flux term is constant and the system is in radiative balance with a global average radiative equilibrium source function profile, global warming looks impossible. Long term changes in the planetary radiative balance is governed by the $F^0 + P^0 = S_U(3/5 + 2T_A/5)$, $OLR = S_U f$ and $F^0 + P^0 = OLR$ equations. The system is locked to the $\tilde{\tau}_A^\circ$ optical depth because of the energy minimum principle prefers the radiative equilibrium configuration ($\tilde{\tau}_A < \tilde{\tau}_A^\circ$) but the energy conservation principle constrains the available thermal energy ($\tilde{\tau}_A > \tilde{\tau}_A^\circ$). The problem for example with the highly publicized simple 'bucket analogy' of greenhouse effect is the ignorance of the energy minimum principle (*Committee on Radiative Forcing Effects on Climate Change, et al.*, 2005).

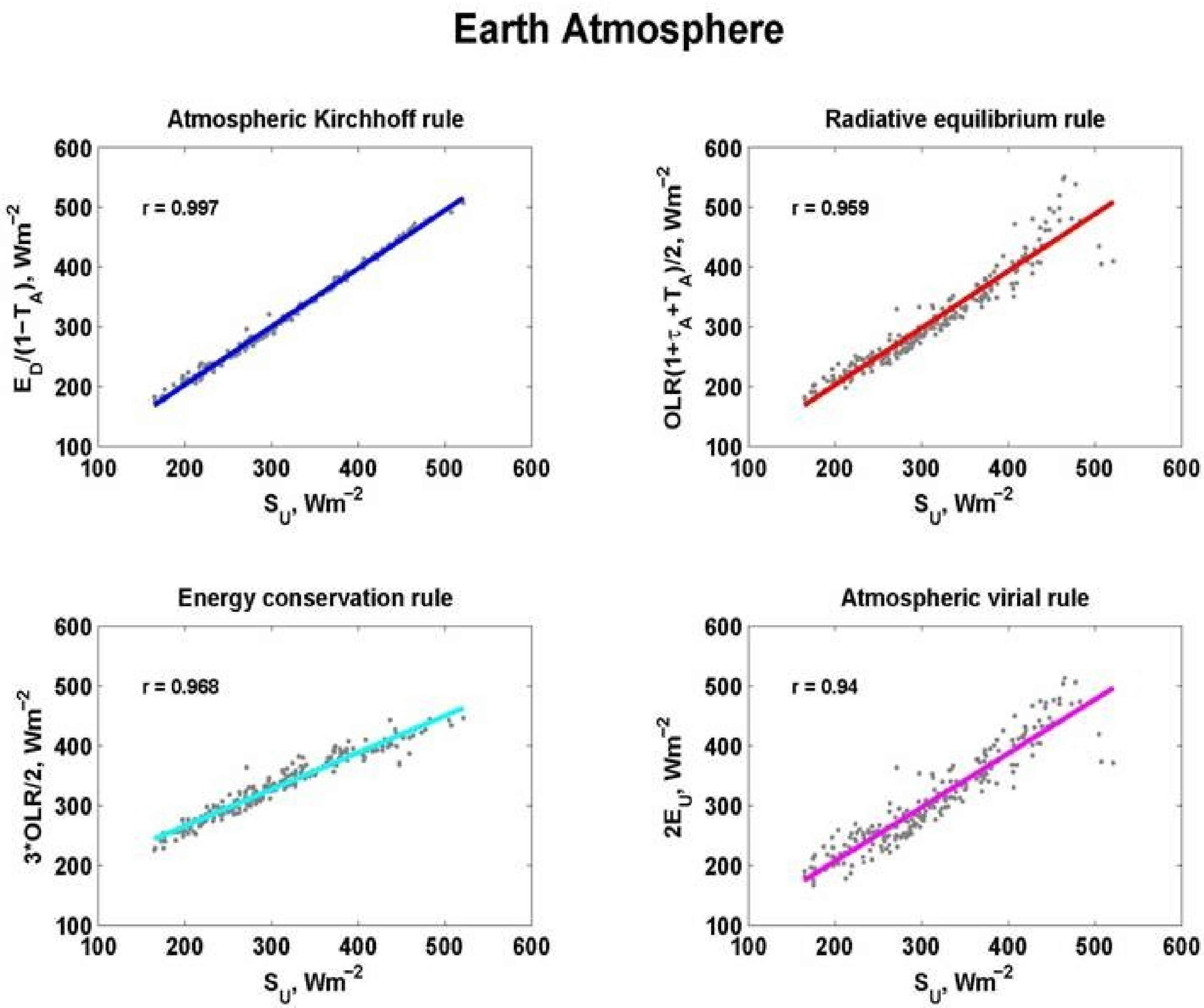
Theoretical relative radiative flux ratio curves. Open circles are computed planetary averages from simulations. The individual simulation results of E_U/S_U are shown as gray dots for the Earth and black dots in the lower left corner for the Mars. The black dots in the upper left corner are the simulated OLR/S_U for Mars. The g_S curve is the theoretical greenhouse sensitivity function for the Earth. The five short vertical markers on the zero line at the positions of 1.05, 1.42, 1.59, 1.84, and 2.97 are (from left to right) the locations of $\tilde{\tau}_A^S$, $\tilde{\tau}_A^C \approx \tilde{\tau}_A^{US}$, $\tilde{\tau}_A^U$, $\tilde{\tau}_A^+ \approx \tilde{\tau}_A^\circ$, and $\tilde{\tau}_A^L$ optical depths, respectively.

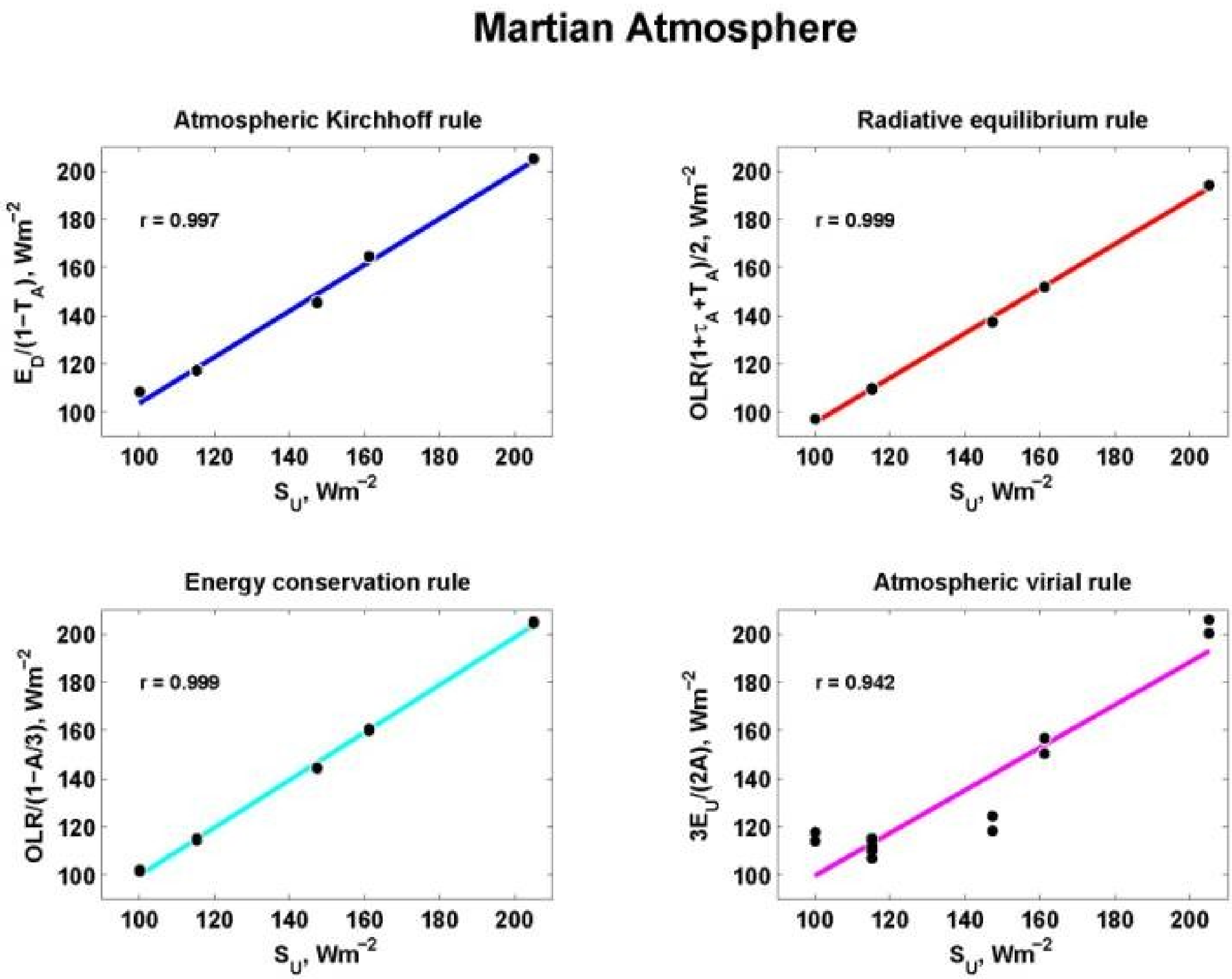


The $f = f(\tau) = 2 / (1 + \tau + \exp(-\tau))$, $f - T_A$ ($T_A=\exp(-\tau)$) and $g = g(\tau) = 1 - f(\tau)$ transfer, atmospheric upward emittance, and greenhouse functions are theoretical normalized flux components, representing OLR/ S_U, E_U/S_U and $(S_U\text{-OLR})/S_U$, respectively. The f^o, $f^o - T_A$, and g^o functions are calculated from the general solution Eq. (9) above. For atmospheres where $T_A \approx 1/6$ (as in the case of Earth), Eq. (9) takes the form of the radiative balance equation Eq. (8): S_U=3OLR/2 —> $f^+ = 2/3$, $g^+ = 1/3$, and $G = S_U - \text{OLR} = R$. The f^*, $f^* - T_A$, and g^* functions are calculated from Eq. (10) of the Miskolczi 12 slide above, representing thin atmospheres (as of the Mars). The g_S function describes the greenhouse sensitivity to optical depth perturbations, and is expressed by the derivative of g: $g_S = dg/d\tau$. Its maximum is at τ_A=1.0465, therefore positive optical depth perturbations in the real atmosphere are coupled with reduced greenhouse effect sensitivity.

Proofs of Kirchhoff, radiative equilibrium, energy conservation and virial rules

for planetary atmospheres:





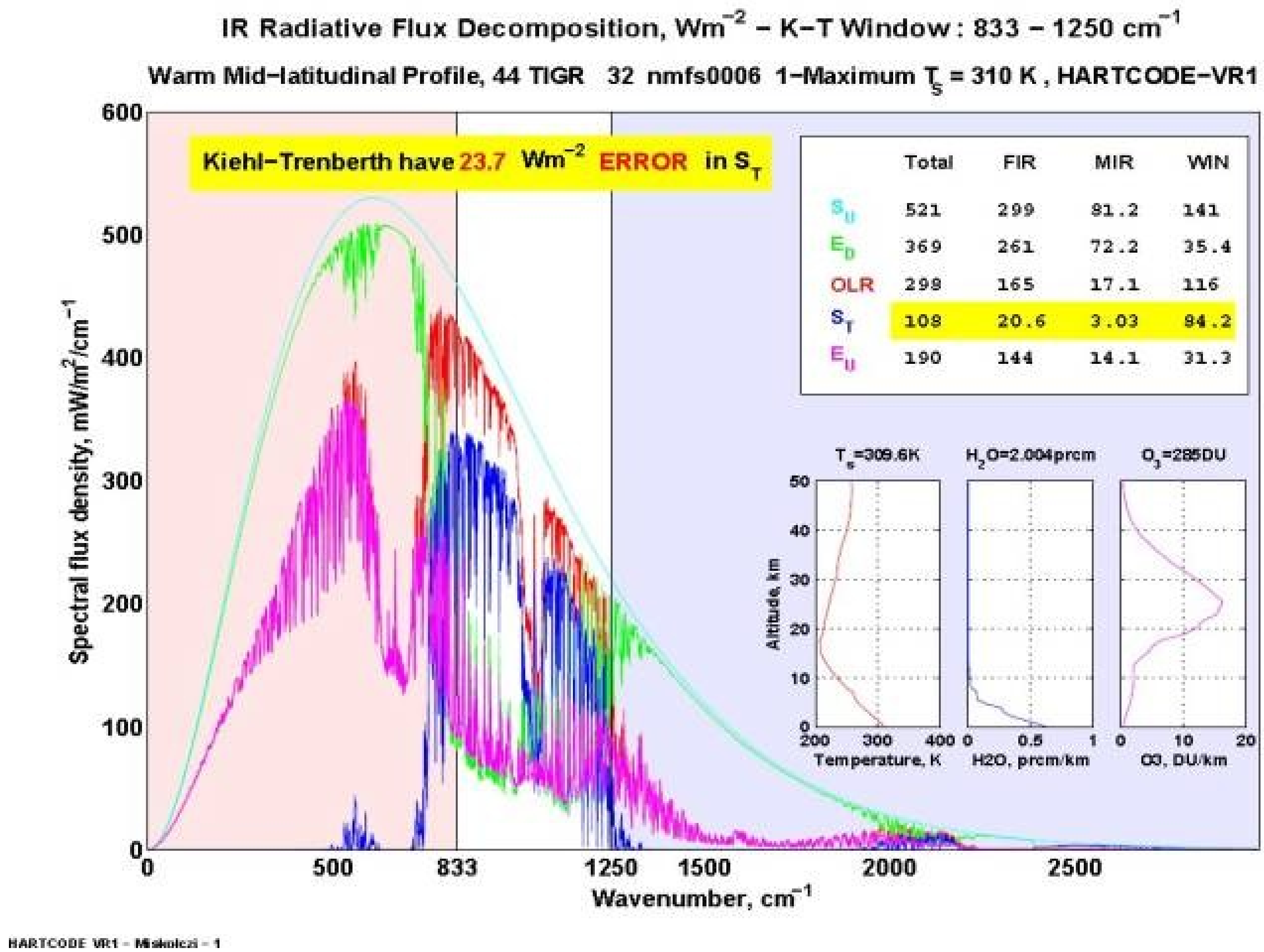
On the above basis, regardless one interprets the

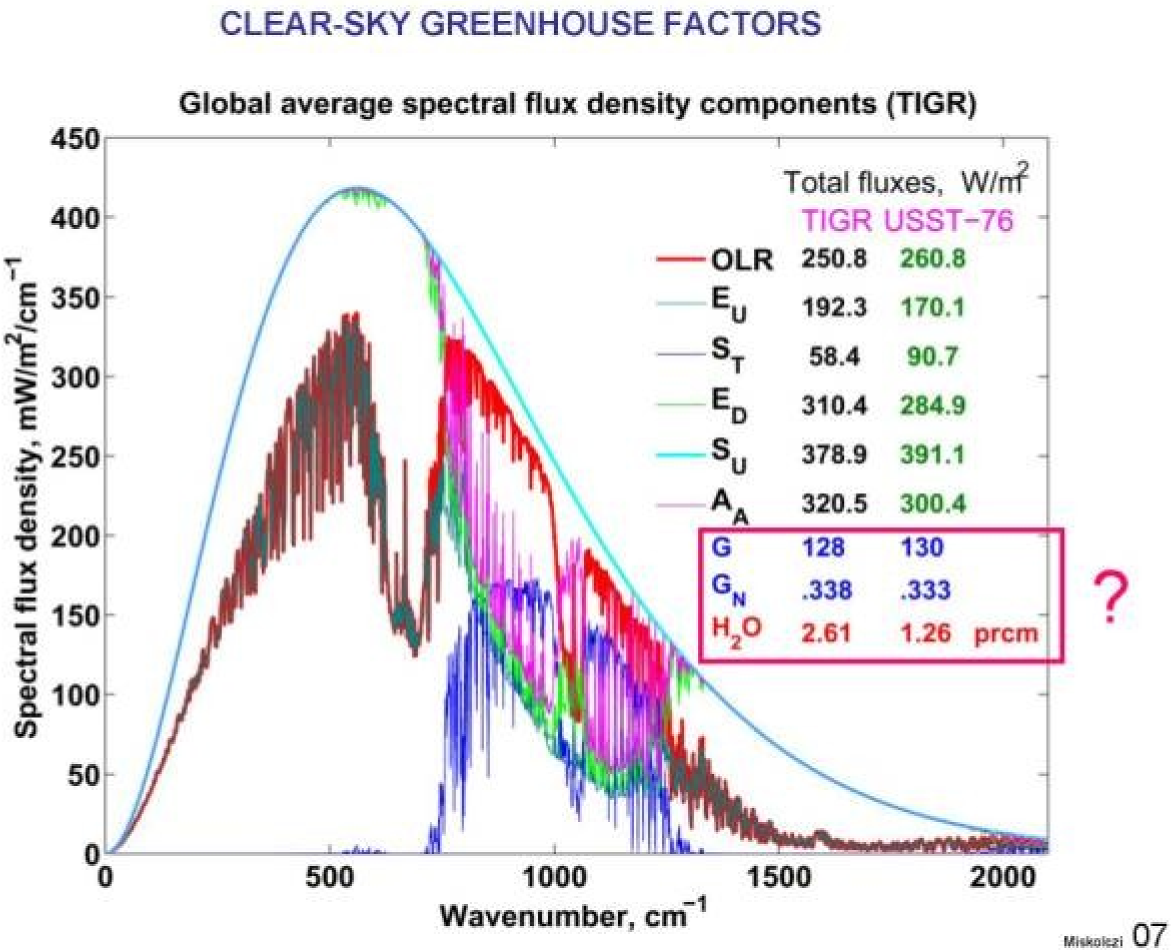
S_U=3OLR/2, S_U=E_D / (1 – T_A), S_U=2E_U and S_U=OLR/*f*

relations as laws of theoretical physics or as simple empirical facts, they must be taken into account in every valid planetary atmospheric radiative transfer calculation.

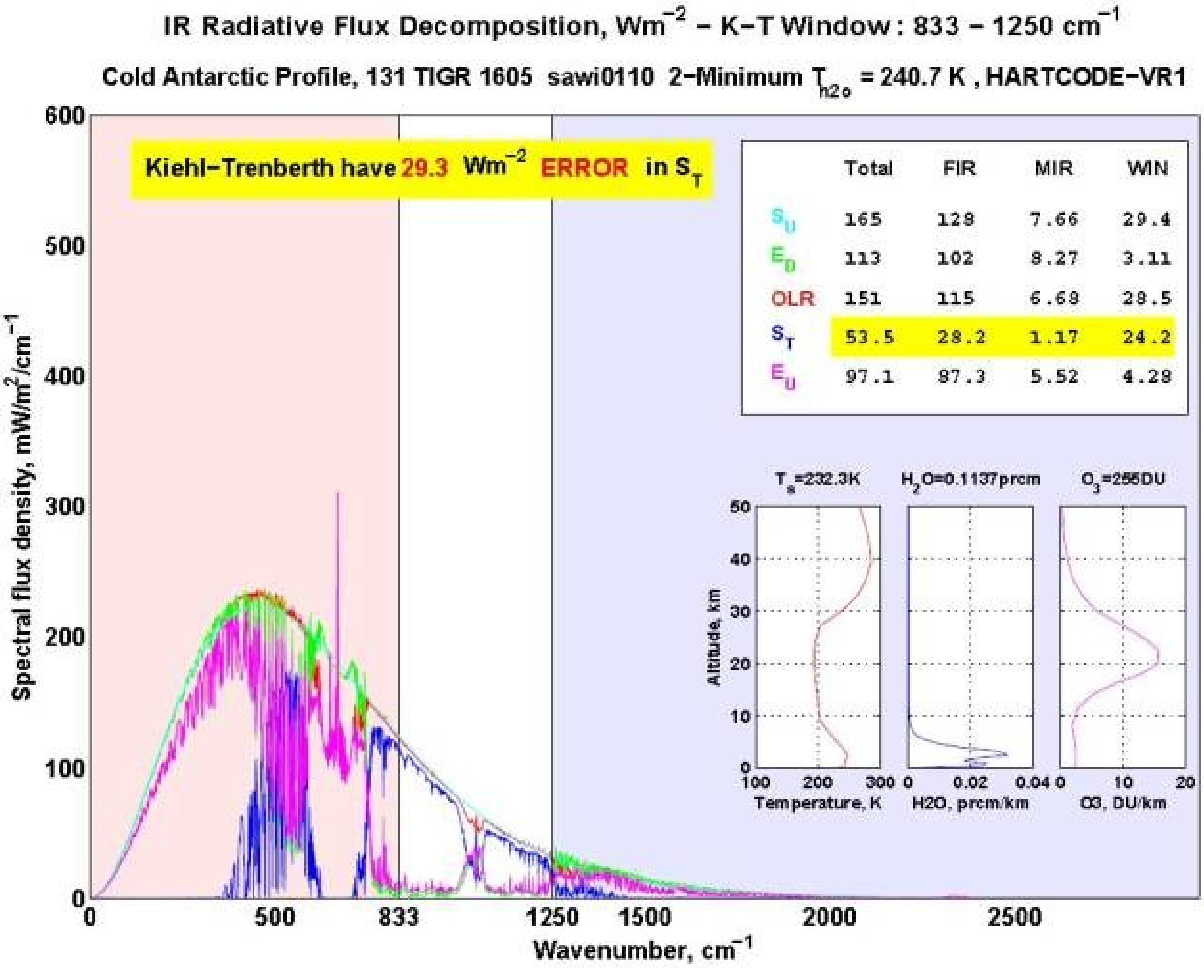
Proofs of errors in the Kiehl- Trenberth distribution:

The three graphs below cast deep questions on the credibility of the Kiehl-Trenbert 1997 radiation budget, adopted by IPCC 2007.





The two most important points here are these:

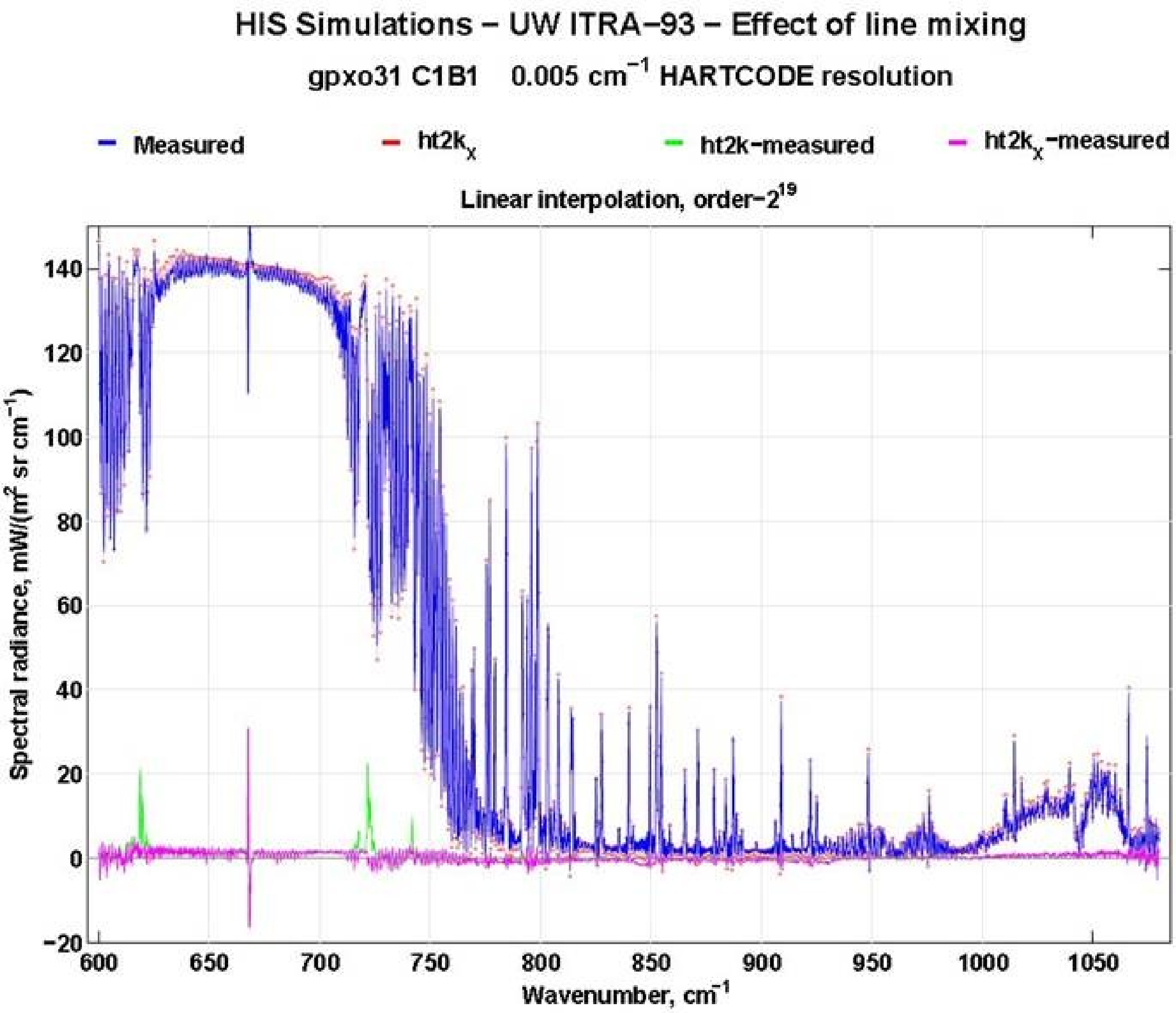


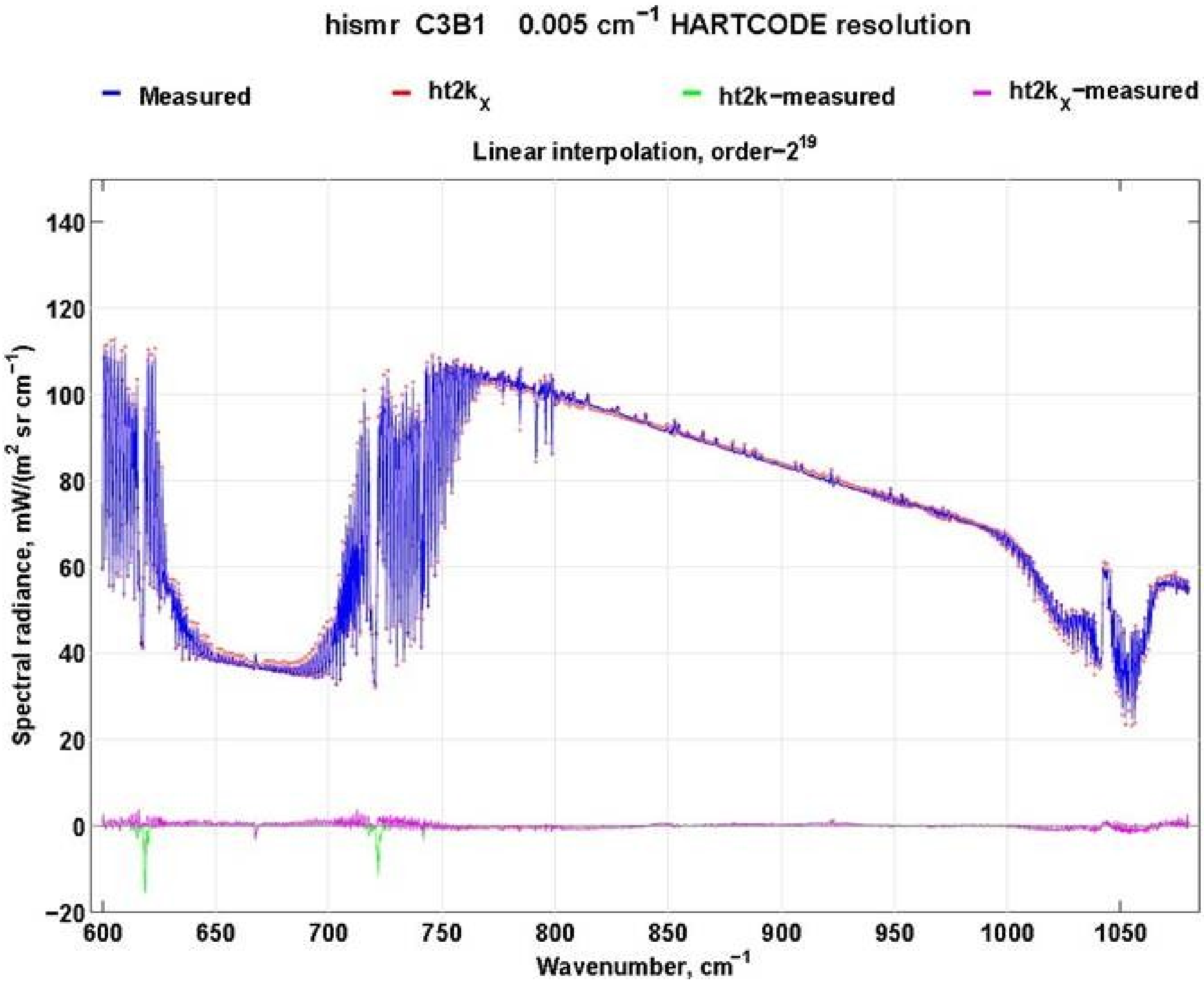
HARTCODE VR1 – Miskolczi – 2

1. The green numbers in the Miskolczi07 slide above were calculated on the USST-76 profile by HARTCODE. The Kiehl-Trenberth window region is 833 – 1250 cm^{-1}. As simulations show, a significant amount of the transmitted flux is originated from outside this range, introducing more than 100% error into their estimate in the far infrared at the artic profile.

2. Kiehl-Trenberth admit that they manipulated the USST-76 atmosphere and the global average H_2O amount in there. Even if the USST-76 atmosphere was in radiative balance, their 12 per cent reduction of the H_2O column amount (from 1.43 to 1.26) certainly will destroy it. This is equivalent to reducing the CO_2 to one eights of its current value. The global average H_2O is around 2.5 and not 1.25. It is not valid to consider a globally balanced radiation budget with only half of the most important GHG in it.

Proof of HARTCODE's ability to quantitatively analyze Fourier interferometer spectra:




hismr C3B1 0.005 cm⁻¹ HARTCODE resolution
Measured
ht2kx
ht2k−measured
ht2kx−measured
Linear interpolation, order−2^19
Spectral radiance, mW/(m² sr cm⁻¹)
Wavenumber, cm⁻¹
140
120
100
80
60
40
20
0
−20
600
650
700
750
800
850
900
950
1000
1050

4. Building up the theory: historical reconstruction

1. Recognition that the classical, semi-infinite solution of the Schwarzschild-Milne equation for planetary atmospheres does not contain the correct boundary conditions.
2. The exact, finite, semi-transparent solution with the real boundary conditions resolves the long-standing "temperature discontinuity at the ground" paradox.
3. Common surface and near-surface air temperatures ($t_S=t_A$) make possible to utilize Kirchhoff's Law: two systems in thermal equilibrium exchange energy by absorption and emission in equal amounts: $A_A=S_U(1-T_A)=E_D$, where T_A is the atmospheric flux transmittance: $T_A=S_T/S_U=\exp-(\tau_A)$.
4. $A_A=E_D$ arithmetically leads to the equality: $(S_U–OLR)–(E_D–E_U)=0$. The left side is the net upgoing LW flux heating the atmosphere, the right side is the net downgoing LW flux, heating the ground.
5. These two net flux densities utilize the same source of energy: the incoming available SW flux of the Sun, F^0. Therefore we can write: $(S_U–OLR)+(E_D–E_U)=F^0=OLR$.
6. Equations in 4. and 5. directly yield the $S_U=3OLR/2$ fundamental relationship.
7. Writing 6. into functional form: $S_U=OLR/f$, where the dependence of the f transfer function on the τ_A optical depth is given by the exact solution mentioned in point 2.: $f(\tau_A)=2/(1+\tau_A+\exp(-\tau_A))$.
8. "Fine tuning" of the theory: the atmosphere is gravitationally bounded: the virial theorem must hold: $S_U=2E_U$. Real measurements: the Earth's and the Martian atmospheres satisfy the virial theorem.
9. Another direct consequence of $A_A=E_D$ is the $E_U=F+K+P$ relation. The energetic source of the upward atmospheric radiation is independent of the atmospheric LW absorption; its source is the atmospheric SW absorption and the sensible and latent heat conduction and convection.
10. Energy minimum principle —> the demand of most effective cooling of the Earth —> the role of clouds + another derivation of the $f(\tau_A)$ function. Determination of the global mean cloud cover (β~0.6) and the average cloud altitude (~2.05 km).
11. Computer simulations by HARTCODE on the ERBE and TIGR data sets: proofs of the theory.
12. Regardless of the names and laws referred to in their derivation, the equations of Dr. Miskolczi given in the points 3.-9. above are original and proved to be valid.

(Goody-Yung: Atmospheric Radiation — Theoretical Basis, Oxford University Press, 1989:

"The paper by Milne can be looked upon as the start of the 'modern' era.")

5. Conclusions

— Any relative deviation from the equilibrium values of f, OLR and S_U must be balanced;

— The greenhouse effect on the Earth is constrained to a critical equilibrium optical depth of ~1.87;
— Greenhouse sensitivity calculations based on the classical equations are wrong;

— The exact solution gives 0.25 K surface temperature increase to CO_2-doubling

The classical approximation leads to the mathematically incorrect $S_A=OLR(1+\tau_A)/2$ and $S_G=OLR(2+\tau_A)/2$ relations (S_A is the near-surface air temperature, S_G is the ground temperature). Increased τ_A yields higher surface temperatures to keep OLR fixed —> global warming.

The correct solution gives $S_U=3OLR/2=OLR(1+\tau_A+(\exp(-\tau_A))/2$, hence τ_A is locked to the equilibrium value of ~1.84 —> global warming simply by increasing τ_A is not possible. The actual measured optical depth for the Earth is very close to this critical value (=1.87).

In other words:

Conventional view: increase in GHG (CO_2 emissions, for example) —> more absorption —> decrease in OLR —> increase in S_U to compensate —> rising temperature at the ground.

This study: increase in GHG (CO_2 emissions, for example) —> more absorption —> decrease in OLR —> increase in S_U to compensate —> rising temperature at the ground —> increase of K:
↓ ↗ increased E_U —> compensated OLR.
more intense cooling of the surface —> balanced S_U —> equilibrium surface temperature —> decrease in GHG (more rainfall, less H_2O) —> equated optical depth.

Note that there was a positive *temperature—water vapor* feedback in the old approach. Higher surface temperatures led to elevated evaporation, and the extra moisture in the air was assumed to capture more heat. While the existence of this vicious cycle on local scales is apparent, it does not work on global scale according to energetic constraints. Increases in K lead to an intensified hydrological cycle, more precipitation, and the global mean temperature driven back to its energetically prescribed $S_U=3OLR/2$ equilibrium value.

EVOLUTION OF GREENHOUSE EFFECT

2^*CO_2 — > ΔT_S K

Arrhenius	1896	5.5
Arrhenius	1906 (after learning Stefan-Boltzmann law)	1.6
Hansen	1984 (without feedbacks)	1.2
Hansen	1984 (including feedbacks)	4.8
IPCC	1995 (including feedbacks)	3.8
IPCC	2001 (including feedbacks)	3.5
Houghton	2005 (without feedbacks)	1.2
IPCC	2007 (including feedbacks)	3.3
Monckton	2007 (including feedbacks)	0.6
Miskolczi	2007 (semi-transparent atmosphere)	0.3

CONCLUSIONS

- Applying Kirchhoff's law, $E_D=A_A$, and the virial theorem, $S_U=2*E_U$, a general radiative balance equation was established for semi-transparent planetary atmospheres: $S_U+S_T/2-E_D/10=3OLR/2$.
- For atmospheres in radiative equilibrium the relationship between the OLR and S_U was also established by the correct mathematical solution of the bounded atmosphere problem: $S_U=OLR/f=OLR/(1-g)$.
- The runaway greenhouse effect is physically impossible. All normalized greenhouse factors are bounded.
- Large scale simulation results show that the Earth's average clear-sky temperature profile closely satisfies both equations. The average Martian atmosphere is not in radiative equilibrium, it follows only the balance equation for thin atmospheres: $S_U+S_T/2=3OLR/2$.
- The Earth's global average flux optical depth is 1.87 which is consistent with the theoretical flux optical depth expectations of the energy balance requirement and the requirement of the most efficient cooling of the system, 1.86, and 1.84.
- Planetary radiation budget studies should relay on real global average atmospheres (problems with the USST-76).

CONCLUSIONS (Cont.)

- With a partial cloud cover the Earth-atmosphere system is in the state of a virtually saturated greenhouse effect without changing the optimal clear-sky flux optical depth and violating the energy balance equation: $g^0=0.4$, $S_U=5$ OLR/3~391=5*235/3 Wm^{-2}.

- The Earth's atmosphere is configured for the most efficient IR cooling of the planet with a critical global average flux optical depth. As long as the Earth has the oceans as unlimited sources and sinks of optical depth, this critical equilibrium optical depth is maintained by the more or less chaotic general circulation of atmosphere and ocean currents. Excess or deficit in the global average optical depth will violate either the energy conservation principle or the energy minimum principle.

- The observed global warming has nothing to do directly with the greenhouse effect, it must be related to changes in the total absorbed solar radiation, F^0, or the dissipated heat from other natural or anthropogenic sources of thermal energy, P^0.

- For climate simulations GCMs should be conditioned with the real physical laws of the planetary greenhouse effect.

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Dr. Miskolczi's complete presentation at the International Conference on Climate Change, New York, organized by The Heartland Institute, can be found here.

6. Discussion and interpretation

Einstein said, "God does not play dice" — particularly not in classical, macroscopic, planetary physics, we might add.

The average surface temperature of an astronomical body in an energetically controlled environment must be unequivocally determined.

It is nonsense to think that a system 'waits' for our CO2-emissions to elevate its temperature if otherwise the energetic conditions make possible to rise and the necessary resort (a practically infinite reservoir of greenhouse gases in the form of water vapor in the oceans) is at its hands.

The system is locked to a given critical equilibrium global average optical depth, because the energy minimum principle prefers the most effective cooling, forcing smaller-then-critical tau-s, while the energy conservation principle is limiting the available thermal energy when it is trying to go higher than the critical tau.

The result is a dynamic play around the equilibrium value. But any long-term shift in the planet's surface temperature is impossible as long as the sum of the incoming available SW and LW heating ($F^0 + P^0$) is constant.

We may be able to modify this constant, by altering the planet's surface, or polluting the air with aerosols, hence changing the planetary albedo; or with our industrial energy generation or heat release.

But the planetary greenhouse effect is not a free variable. Releasing GHG-s into the air does nothing directly to the long term global average energy balance. It disturbs the maintained state of equilibrium for a while, but then the system recovers itself from the imbalance. The whens and the hows are worthy to investigate.

* * *

The title of this page is: Proofs of the Miskolczi theory.—But strictly speaking, it is not a 'theory'. Rejecting the earlier approaches to greenhouse effect, Miskolczi makes no assumptions regarding the nature of radiative transfer, but begins with a few empirical facts, and from these deduces new physical relationships between certain atmospheric flux components. Those who want to debate or refute his results, must disprove the facts.

7. Endnote

One may ask why Dr. Miskolczi did not publish his work in a high-reputation journal.

The author actually tried. Here are some examples of the reviewer's comments:

TELLUS-B:

”There is lack of understanding of the physics of atmospheric infra red radiative transfer, which is impacting the quality of the discussions as well as the outlandish claims by the author that his work requires revaluation of radiative-convective equilibrium models...”

Journal of Quantitative Spectroscopy and Radiative Transfer:

”The overall concluding statement that ‘the existence of a stable climate requires a unique surface upward flux density and a unique optical depth of 1.841’ makes absolutely no sense at all. An atmosphere can be in stable radiative equilibrium for any LW optical depth, but the equilibrium surface temperature will monotonically depend on the value of the optical depth....”

Journal of Geophysical Research – Atmospheres:

“After consideration of the thematic scope of the above submitted, I am sorry to inform you that I do not believe it is suitable for publication in JGR-Atmospheres and I do not regard it as being of sufficient interest to the readership. …”

These were the views of some prominent scientists, chosen by the editors….

And finally:

Applied Optics: Withdrawn by NASA.

Dr. Miskolczi's reaction to this latter event was fast and adequate; here is the copy of his letter of resignation.

Letter of Resignation

This letter is to inform you that I wish to terminate my employment with the AS&M Inc., effective from 1st of January, 2006.

Unfortunately my working relationship with my NASA supervisors eroded to a level that I am not able to tolerate. My idea of the freedom of science can not coexist with the recent NASA practice of handling new climate change related scientific results. More than three years ago, I presented to NASA a new view of greenhouse theory and pointed out serious errors in the classical approach of assessment of climate sensitivity to greenhouse gas perturbations. Since then my results were not released for publication. Since my new results have far reaching consequences in the general atmospheric radiative transfer, I wish to be no part in withholding the above scientific information from the wider community of scientists and policymakers.

I am very grateful to the AS&M Inc. for the friendly and honest working environment that I enjoyed for many years. I wish to thank for all the help and encouragement that I received from my colleagues and supervisors at AS&M.

Sincerely,

Dr. F. Miskolczi

Contact miklos.zagoni@gmail.com

enddoc