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Comments on "Greenhouse effect in semi-transparent planetary atmospheres" by Ferenc M. Miskolczi

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Abstract—This commentary is meant to show that several relationships derived in *Miskolczi* (2007) are debatable and, in my opinion, based on untenable physics.

Key-words: greenhouse effect, radiative equilibrium

1. Introduction

As lecturer emeritus at the University of Wageningen, the Netherlands, I was involved in introductory courses of meteorology, and I used simple 'flat earth greenhouse' models to illustrate the optical effects of greenhouse gases on climate. In these models the atmosphere is replaced with a hypothetic 'glass-plate' with a prescribed spectral emissivity $\varepsilon(\lambda)$ as function of wavelength λ mimicking the optical properties of the different greenhouse gases as well as the so-called atmospheric window. In the context of computer-aided-learning (CAL), I developed a number of interactive CAL modules with which the students could simulate the climate on Earth or Mars by selecting themselves appropriate functions for $\varepsilon(\lambda)$. I always stressed that these CAL modules were meant to clarify a single aspect of the climate system, notably, the optical effects of greenhouse gases, and that they are too simple to describe the actual climate, let alone climate sensitivity. Recently, I came across the papers by *Ferenc Miskolczi* (2007, 2010; hereafter M07 and M10, respectively) and by *van Andel* (2010; hereafter VA10) forcing me to reconsider my understanding of the optical effects of greenhouse gases on climate. I was challenged by van Andel who wrote: *The Miskolczi theory is so different from the usual stream of thought on climate change, that many are either confused, or revolt or embrace this*

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theory without really having penetrated it. In this commentary I try to penetrate parts of the Miskolczi theory. It is my objective to show that at several points this theory is untenable.

2. Brief summary of M07

The novel laws derived in M07 are:

- Referring to Kirchhoff's law and analyzing sets of radiosonde data with a line-by-line radiation transfer model by *Miskolczi* and *Mlynczak* (2004), it is found that

$$A_A = E_D. \tag{1}$$

- Referring to hydrostatic equilibrium, the virial theorem and identifying E_U as the total internal kinetic energy of the atmosphere, it is stated that

$$E_U = S_U/2. \tag{2}$$

- By applying the principle of conservation of energy and arguing that $S_U - (F^0 + P^0)$ and $E_D - E_U$ represent two flux terms of equal magnitude, propagating into opposite directions, while using the same F^0 and P^0 as energy sources, it is concluded that

$$S_U - (F^0 + P^0) + E_D - E_U = F^0 + P^0. \tag{3}$$

- Next it is stated that the latter equation poses a strict criterion on the global average S_U:

$$S_U = 3OLR/2. \tag{4}$$

- Furthermore, according to M07 this leads to

$$S_U - (F^0 + P^0) = R, \tag{5}$$

where R is the *pressure of thermal radiation at the surface,* which, according to M07 is given by

$$R = S_U/3. \tag{6}$$

- By arguing that the *virial term* $S_V = S_T/2 - E_D/10$ forces the hydrostatic equilibrium while maintaining the radiative balance, it is stated that

$$S_U + S_T/2 - E_D/10 = 3OLR/2. \tag{7}$$

- According to M07, this leads to

$$S_U - (F^0 + P^0) = 6\ \mathrm{A}\ R/5. \tag{8}$$

- Finally, it is stated in M07 that, among others, the above yields

$$E_U / E_D = 3/5. \tag{9}$$

My comments concern these novel findings.

3. My comments

3.1. $A_A = E_D$

In a personal communication, dr. Miskolczi agreed that referring to Kirchhoff's law (and later in M10 to *Prevost*, 1791) can lead to misunderstandings, so I will not comment on these references, except that they are incorrect. The main evidence is to show that $A_A = E_D$ is provided by the calculations of A_A and E_D using the line-to-line radiation transfer model of *Miskolczi* and *Mlynczak* (2004). Arguing that there is *radiative exchange equilibrium between land-sea surface and atmosphere*, these calculations are performed using the boundary condition that the surface temperature equals the air temperature, t_A, at the lowest level in the radiosonde dataset, usually 1.5 or 2 m. Moreover, it is assumed that the surface is black for long-wave radiation. So, in the line-to-line calculations yielding A_A and E_D, the boundary conditions

$$S_U = \sigma t_a^4 \tag{10}$$

are used.

This choice or assumption explains why it is found that $A_A = E_D$. Experience shows that E_D can be approximated accurately with

$$E_D = \varepsilon_{atm} \sigma t_a^4, \tag{11}$$

where ε_{atm} is an apparent emissivity of the atmosphere. Accurate radiation transfer will yield an E_D value for a given radiosonde sounding, so this can be written as $E_D = \varepsilon_{atm} \sigma t_a^4$. In fact, the model yields a value for ε_{atm}. If Eq. (10) is used as boundary conditions for the calculation of A_A with the same model, one will find (due to Kirchhoff's law applied to each absorption line) that $\varepsilon_{atm} = \alpha_{atm} = A$ (apparent emissivity equals the apparent absorptivity), by which one obtains $E_D = A_A$. In fact, evidence given in Fig. 2 in M07 supports this argument. For a surface emissivity of 0.96, E_D appears to be not equal to A_A, because now $S_U \neq \sigma t_a^4$.

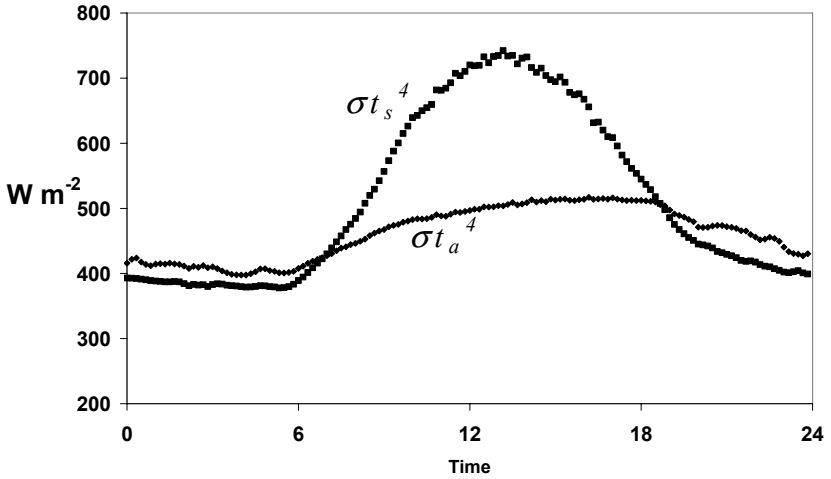

Fig. 1. Diurnal cycle of σt_a^4 and σt_s^4, observations during the MATDADOR field campaign in Arizona desert, t_s is observed with an IR-thermometer.

Is the boundary condition $S_U = \sigma t_a^4$ correct? I don't think so. In textbooks on micrometeorology (e.g., *Geiger*, 1971; *Oke*, 1987; *Garratt*, 1992) it is explained why, in general, the surface temperature is not equal to t_a. In a desert, the difference can exceed 40 °C, but also over grass in mid-latitude climate zones, the difference can be 5 to 10 °C. In the last decade, the sensors to measure surface temperature S_U and E_D are improved significantly, and in open literature many micrometeorological data sets collected over a wide range of surface types can be found. Several of these can be downloaded freely. Some of these are at my disposal and I have sent dr. Miskolczi some results showing clearly that $S_U \neq \sigma t_a^4$. One example is depicted in Fig. 2 of M07. Usually, S_U is greater than σt_a^4 during daytime. Although during nighttime the opposite occurs, the daily mean of the difference is not zero. See, for example, *Fig. 1*. Among others, this is due to non-linearity effects in atmospheric turbulence transfer and, not at least, because during daytime the surface is heated by solar radiation, whereas nighttime cooling is governed by entirely other physical processes. I conclude that, in general, $E_D \neq A_A$. The evidence provided in M07 to show that $E_D = A_A$ is based on the incorrect assumption that $S_U = \sigma t_a^4$. Consequently, all conclusions in M07 drawn from $E_D = A_A$ are untenable. Because in the later sections in M07 often the assumption that the surface temperature equals t_a is adopted, most results derived from that must be considered with caution also.

3.2. Comment on virial theorem and $E_U = S_U/2$

Firstly, I would like to remark that $E_U = S_U/2$ cannot be true in general. Suppose that the atmosphere consists of 20% O_2 and 80% N_2, so solely of diatomic gases, then there is no LW absorption or emission, so $E_U = 0$, whereas, because most

surface have emissivity close to 1, S_U will be greater than 0 due to solar heating. I give this simple example also to introduce my comment on the statement in M07: "*the total internal kinetic energy of the atmosphere, which – according to the virial theorem – hydrostatic equilibrium balances the total gravitational potential energy*", because the actual atmosphere consists primarily of O_2 and N_2, so of diatomic gases. The virial theorem is developed in astrophysics, where it is applied to, e.g., gaseous stars. Without any explanation, the virial theorem is applied to the atmosphere in the gravitation field of the Earth, which is quiet different from the gaseous star case. In stars one has to account for gravitation forces between different layers, whereas in the atmosphere these can be ignored, because they are much smaller than the gravitation force by the Earth. Thus, application of a virial theorem to climate topics is questionable. Anyhow, the virial theorem applied to gaseous stars deals with the potential and internal energy. In textbooks (*Holton*, 1979; *Iribarne* and *Godson*, 1986) one can find that for the atmosphere, in a gravity field that thermodynamic principles lead to $P=(\eta-1)U$, where P is the potential energy, U is the internal energy, and η is the ratio of specific heat at constant pressure and constant volume. Because U can be linked to *the total internal kinetic energy*, I presume that this is meant in M07. But for diatomic atmospheres $P=\frac{2}{5}U$, so P is not equal to U. This result was also found recently by *Toth* (2010). Let us ignore this factor 2/5 and also the question whether horizontal and vertical atmospheric motions of 'air parcels' are included in what is denoted as *total kinetic energy* (these are NOT covered by *U,* see, e.g., *Toth*, 2010), my main criticism concerns the fact that, without a single clue, in M07 U is linked to E_D. Note that E_D originates from LW radiation emission by three-atomic gases, and the above 'virial theorem' applies to diatomic atmospheres. I conclude that the derivation in M07 of $E_U = S_U/2$ is so unclear that, for the time being, it must be considered not to be based on the first physical principle. The same applies to all further formulas in M07 derived from the virial theorem and $E_U = S_U/2$.

3.3. Comments on $S_U - (F^0 + P^0) + E_D - E_U = F^0 + P^0$ and term R

This equation is based on the following arguments: "$S_U - (F^0 + P^0)$ and $E_D - E_U$ *represent two flux terms of equal magnitude, propagating into opposite directions, while using the same* F^0 *and* P^0 *as energy sources. The first term heats the atmosphere and the second term maintains the surface energy balance. The principle of conservation of energy dictates that*: $S_U - (F^0 + P^0) + E_D - E_U = F^0 + P^0$". I am sorry, this is entirely unclear to me. The conservation law has been applied before. Moreover, I cannot follow the algebra with which next leads to $S_U = 3OLR/2$ and $S_U - (F^0 + P^0) = R$. With $(F^0 + P^0) = OLR$ and $G = S_U - OLR$ the latter yields $R = G$.

The term R was introduced in M07 as *the pressure of thermal radiation at the surface.* Firstly, I have problems with the units. R is a pressure (force per m^2), whereas all other terms are energy flux densities??? But more importantly, in astrophysics one have to account for pressure of radiation indeed, but this pressure (*Jeans*, 1961, page 37) is given by $P_{rad} = \frac{1}{3} aT^4$, with $a = 4\sigma/c$, where c is the speed of light. In M07 it is stated that $R = \frac{1}{3}\sigma T^4$, which is greater than P_{rad} by a factor of $c/4$! The correct expression shows that LW radiation effects on atmospheric pressure can be ignored entirely. Consequently, any statement referring to P_{rad} must be considered inappropriate to explain atmospheric phenomenon. Statements such as "*G will always be equal to the radiation pressure of the ideal gas and the atmosphere will have a constant optical depth*" (page 8 in M07) and "*Formally, in the presence of a solid or liquid surface, the radiation pressure of the thermalized photons is the real cause of the greenhouse effect, and its origin is related to the principle of the conservation of the momentum of the radiation field.*" are incorrect.

3.4. Further comments

The algebra or physics leading to Eqs. (7) – (9) are not clear to me. In Eq. (7), suddenly the virial term $S_T/2 - E_D/10$ is introduced. Where does this come from? According to Eq. (4) this term is zero. Moreover, I do not understand the way Eqs. (8) and (9) are derived.

Acknowledgement — In content I disagree with his thoughts, but I would like to thank *dr. Miskolczi* for inspiring novel ideas about our climate system.

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