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A proposal on accounting for the non-radiative heat fluxes in the atmospheric transfer of thermal photons

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The key parameter for radiative transfer is the *mean value* of photons' free path length and not its *variance*, which can therefore be formally set to zero. Then the photon mean free path length l counted from an arbitrary point to the point of the next collision is related to the mean free path length l_c between two consequent collisions as $l = l_c/2$. If one divides the atmosphere into n adjacent layers of thickness l_c each, then photons absorbed within layer k ($1 \leq k \leq n$) are only those photons that were emitted within the upper $(k-1)$-th and lower $(k+1)$-th neighbouring layers. A photon emitted at point z' within layer k ($0 \leq z' \leq l_c$) will reach layer $(k-1)$ if only the angle between the vector of its propagation and the vertical axis does not exceed ϑ, where $\cos\vartheta = z'/l_c = \mu$. Radiative flux F_k emitted by layer k to the upper (+) and lower (–) hemispheres is $F_k^{\pm} = 2\pi I_k l_c \int_0^1 \mu d\mu = \pi I_k l_c$, where I_k is the intensity of isotropic radiation of a unit volume of the greenhouse substance in a unit solid angle. But only two thirds of this flux, $F_k \int_0^{l_c} dz' \int_{z'/l_c}^1 \mu d\mu = (2/3)F_k$, reach the neighbouring layer $(k-1)$ and are absorbed there. The energy conservation law for layer k can be written as $H_{k+1} - H_k = -A_k$, $H_k \equiv (2/3)(F_k^+ - F_{k-1}^-)$, where $A_k > 0$ is the power of latent and sensible heat transformed into thermal photons within layer k. In the continuous representation in terms of optical depth $\tau = k/2$ ($\tau_s \equiv n/2$) these equations become $dH(\tau)/d\tau = -A(\tau)$, $dF^+(\tau)/d\tau = (3/4)H(\tau)$, $H(\tau) = F^+(\tau) - F^-(\tau)$, $A = \sum_{k=1}^n A_k = \int_0^{\tau_s} A(\tau)d\tau$, $A(\tau) = (1/2)A_k$, yielding a previously undescribed relationship between H and A. Changing variables to $x \equiv \tau/\tau_s$ and $a(x) \equiv \tau_s A(x)/A$ and performing the integration, one obtains $F^+(\tau_s) = (1 + K\tau_s)F_e$, $K = (3/4)(\alpha + \beta\gamma)$; $\alpha \equiv H(\tau_s)/F_e$, $\beta \equiv A/F_e$, $\alpha + \beta = 1$, $\gamma \equiv \int_0^1 xa(x)dx$, $\int_0^1 a(x)dx = 1$, F_e is thermal flux leaving to space. Eddington's approximation for radiative equilibrium remains formally valid for the case of non-radiative fluxes as well, if coefficient K at τ_s is changed as proposed.