－Radiative Forcing(RF) for Zero Dimensinal Model(part1)－　　 ' 10/4/26,5/2,3

The probability @ of outgoing infrared ray(cooling radiation from semi black body globe)is analyzed by a model of 1 dimensional GHGs atmosphere.

☞:The former page on RF has a fatal eror model,which must be abandoned.So this version is correcting one.However also it is extremely simplified due to zero heat capacity of atmosphere comparing with that of oceans(depth nearly 1000m).

[0]:Radiative forcing(RF) is a deficit heat amount for input and output on earth.
(1)Heat Budget Equation on globe.
If solar ray input and output cooling radiation($\equiv$CR) for globe were balanced, globe temperature T_G would not change.If the deficit($\equiv \delta$F)were, T_G would change. δF is defined as energy in(out)flow per unit area & time(watt/m^2.sec).If δF>0, T_G would rise as Heat Budget EQN.Note $\underline{T_G(t) \text{ is dominated by factors} \{m(t), @(t)\}}$. Our aim is to decrease $T_G(t)$ by making δF<0.This is possible as the principle.

Heat Budget EQN: $\Delta Q_G(t) \equiv$ input heat$-$output heat$\equiv 4 \pi R_G^2 \delta F(t) = C_G(dT_G(t)/dt)$.
$= \pi R_G^2 F_0(1-m(t)) - 4 \pi R_G^2 @(t) \sigma T_G(t)^4$. ....[0](1)

$I(0) \equiv \sigma T_G(t)^4$ is black-body radiation(cooling one$\equiv$CR)by globe without atmosphere(@(t)=1).Then GHGs of atmosphere causes backward flow $J(0)$ onto globe with rate $b(t) \equiv 1 - @(t) \equiv J(0)/I(0)$.

(Global heat capa)(T_G rise/sec)$= 4 \pi R_G^2$(deficit heat)$=$input heat$-$output heat.

(2)geophysical constants:
*$4 \pi R_G^2 \equiv$global surface area$\fallingdotseq 4 \pi (6.38 \times 10^6 m)^2$.
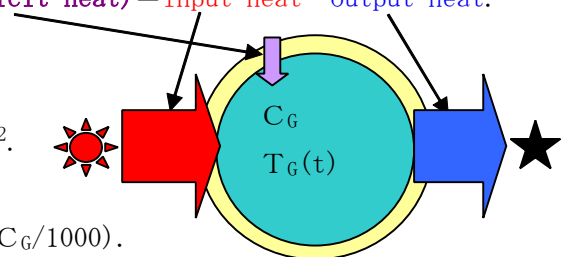*$C_G \equiv$global heat capacity$\fallingdotseq 1.29 \times 10^{24}$J/K.
(all oceans(1000m depth)without atmosphere$\fallingdotseq C_G/1000$).
*$F_0 \equiv$solar constant$= 1366$W/m^2.s
*$\sigma \equiv$SB constant for blackbody radiation$= 5.67 \times 10^{-8}$W/$m^2 K^4$.
*$m(t) \equiv$global albedo$\fallingdotseq 0.3$?.
*$@(t) \equiv$CR outgoing probability$\fallingdotseq 0.614$?.



<<0 dimensional global model>>
*yellow zone is atmosphere of GHGs.

In the later,we show @(t) is a function of GHG concentrations$\{C_j\}$which are operationable by us mankind.Albedo $m(t)$ may be also same possibility.

Concerned molecule gas global number "N" is defined in atmospehre volume V_A ($C = N v_0/ V_A \equiv$ gas concentration with molecure volume=v_0). Assume differential segment layers of atmosphere at height (x, x+dx). Then Sdx is differential volume and C Sdx is molecule volume with the area $=$ C S. Hence **mean collision cross section** of molecules at (x, x+dx) is C/unit area (or **all the global surface**).

x+dx $(1-\frac{1}{2}dx\,C)$ I (x)

dx

x $-\frac{1}{2}dx\,C$

input intensity I (x)
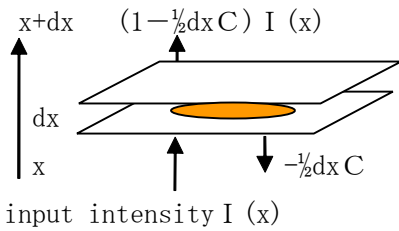
(1)direct passing probability$=1-dx\,C$
(2)trapped and upward-radiation$=\frac{1}{2}dx\,C$
(3)trapped and downward-radiation$=-\frac{1}{2}dx\,C$
(4)total passing probability$=1-\frac{1}{2}dx\,C$

Then note that collision beam on GHG are both upward I(x) and downward J(x).
Upper limit of integral domain in (5) need effective atmospheric height$\equiv$<H>.

(5)$C = V_C/V_A = N v_0/V_A =$particle number×molecule volume/volume V_A. 1ppm$=10^{-6}$/uv.
(a)Ideal gas has same number of molecules in same volume : $6.02 \times 10^{26}/22.4$litter.
＊molecure volume$\equiv v_0 = 22.4 \times 10^{-3} m^3/6.02 \times 10^{26} = 3.72 \times 10^{-29} m^3 = (3.34 \times 10^{-10} m)^3$.
＊Number of particles in 1ppm/$m^3 \equiv n_0 = 10^{-6}/3.72 \times 10^{-29} m^3 = 2.69 \times 10^{22}/m^3$.
  CO2 (385ppm) weight/$m^3 = (44g/6.02 \times 10^{26}) \times 385 \times 2.69 \times 10^{22}/m^3$.
(b)total air weight$\equiv M_T = P (g \times 1atm) \times 4\pi R_E^2/g = 1033kg \times 4\pi (6.38 \times 10^6 m)^2 = 5.28 \times 10^{17}kg$
(6)effective atmospheric height$\equiv$<H> : $V_A \equiv$<H>$\times 4\pi R_G^2$.
  Half the atmosphere is within 6 km of the surface, 90% is within 20 km.
<http://www.exo.net/~pauld/workshops/Greenhouse%20Effect/greenhouse.html>

The fundmental bad function of GHG is heat trapping without escaping to space.
We assume an atmosphere without heat capacity, that is, nothing heat reserving.
We assume also steady state flow of outgoing and incoming infrared ray radiation.
This assumption is due to **the zero dimensional global climate model**, where
substantila heat capcity is that of oceans C_G, while atmosphere is $C_G/1000$.
As the first step, we assume CR beam penetrating process without spectrum density.
Then {α dx} is differential heat trapping probability between (x, x+dx). Trapped
radiation has equal probability$=\frac{1}{2}\alpha$ dx for outgoing and incoming direction.

①**Outgoing flow** intensity I(x) from x to (x+dx):

(1)direct passing radiation＝(1-αdx)I(x).

(2)trapped and reradiation to space＝+½αdx)I(x).

(3)trapped and reradiation to globe＝-½αdx)I(x).

②**Backward flow** intensity -J(x) from (x+dx) to x:

(4)direct passing radiation＝-(1-αdx)J(x+dx).

(5)trapped and reradiation to space＝+½αdxJ(x+dx).

(6)trapped and reradiation to globe＝-½αdx)J(x+dx).
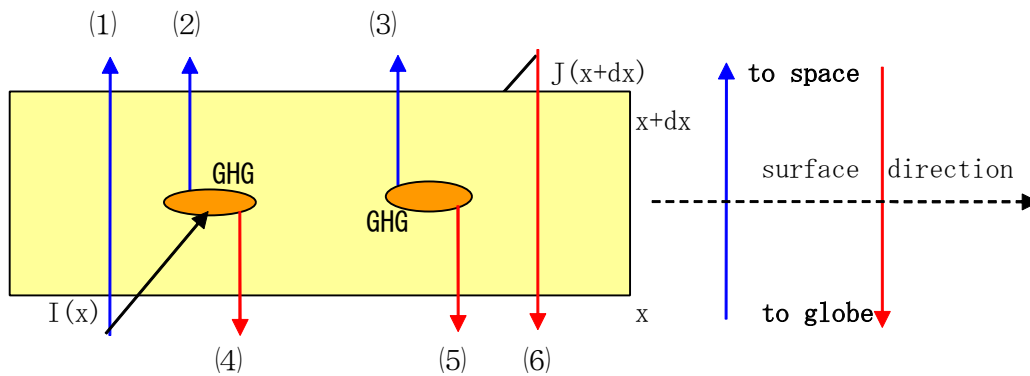
③**budget in space side(x+dx).**

K(x+dx)≡I(x+dx)−J(x+dx)＝(1-½αdx)I(x)+½αdxJ(x+dx)−J(x+dx)

I(x+dx)＝(1-½αdx)I(x)+½αdxJ(x+dx).

I(x)+dx(dI/dx)＝(1-½αdx)I(x)+½αdx〈J(x)+dx(dJ/dx)〉.

dx(dI/dx)＝-½αdxI(x)+½αdxJ(x). → dI/dx＝½α〈J(x)−I(x)〉.

④**budget in globe side(x).**

K(x)≡I(x)−J(x)＝I(x)−(1-½αdx)J(x+dx)+½αdxI(x)

J(x)＝(1-½αdx)J(x+dx)+½αdxI(x)＝(1-½αdx)〈J(x)+dx(dJ/dx)〉+½αdxI(x)

＝(1-½αdx)J(x)+(1-½αdx)dx(dJ/dx)+½αdxI(x).

0＝-½αdxJ(x)+dx(dJ/dx)+½αdxI(x).→ dJ/dx＝½α〈J(x)−I(x)〉.

⑤d〈J(x)−I(x)〉dx＝0. → J(x)−I(x)＝constant≡bI(0)−I(0)。

J(0)≡bI(0):GHG pseudo reflecting probability at surface。〈*b≡J(0)/I(0)〉.

J(x)＝I(x)+I(0)〈b−1〉≡I(x)−@I(0)。〈*@≡1−b.:passing probability to space〉.

dI/dx+½α I(x)＝½α〈I(x)−@I(0)〉.dI/dx+½α I(x)＝½αI(x)−½α@I(0).

dI/dx＝-½α@I(0).   I(x)＝-½α@I(0)x+C.

I(x)＝-½α@I(0)x+I(0)＝I(0)[1-½α@x].

0＝J(H)＝I(x=H)−@I(0)＝I(0)[1-½α@H]−@I(0),where "H" is effective height.

@＝[1-½α@H]。@(1+½αH)＝1。1+½αH＝1/@。½αH＝(1/@−1)。→α＝2(1/@−1)/H。

$I(x)=I(0)[1-(1-@)(x/H)]$. $J(x)=I(x)-@I(0)=I(0)[1-(1-@)(x/H)]-@I(0)$
$=I(0)\{[1-(1-@)(x/H)]-@\}=I(0)\{[(1-@)-(1-@)(x/H)]\}=I(0)(1-@)[1-(x/H)]$.

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⑥**Outgoing and backward intensity with** $\{\alpha,@\}$.

(1)$I(x)=I(0)[1-(1-@)(x/H))]$.

(2)$J(x)=I(0)(1-@[1-(x/H)])$.

(3)$\alpha=2(1/@-1)/H$.

(4)$@=1/(1+\alpha H/2)$.

（図：右上に座標軸。$I(0)$ から始まる青線が右下 $@I(0)$ へ。$J(0)=@I(0)$ から始まる赤線が右下へ。横軸 x=0 から x=H。）

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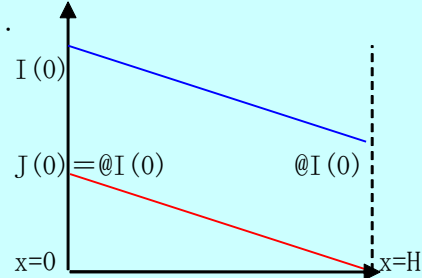
[3]:GHGs concentration $\{C_j\}$ **with molecule spectrum window function**$\{S_j(\nu)\}$.

@ is determined by cross sectin α/unit area. α is function of GHG concentration $\{C_j|j=1,2,\ldots,N\}$ with the molecule spectrum window function $\{S_j(\nu)|j=1,2,\ldots,N\}$ $S_j(\nu)$ is spectral **absorbtion** function of a molecule of kind $\{j\}$ spectroscopy.

(1)$d\nu I(x;\nu)C_jS_j(\nu)\equiv$differential flux $d\nu I(\nu)$ trapping probability on molecule$\{j\}$

$I(x)\rightarrow d\nu I(x;\nu);J(x)\rightarrow d\nu J(x;\nu)$;

$\alpha(\nu)\equiv\Sigma_{j=1}^{N}C_jS_j(\nu)$, 《**assumption on linear sum of concentration**》

$@(\nu)\equiv1/(1+\alpha(\nu)H/2)$.

(2)$dI(x,\nu)/dx=\frac{1}{2}\alpha(\nu)\langle J(x;\nu))-I(x(;\nu))\rangle$;

$dJ(x,\nu)/dx=\frac{1}{2}\alpha(\nu)\langle J(x;\nu))-I(x;\nu f)\rangle$.

(3)$I(x;\nu)=I(0;\nu)[1-\langle1-@(\nu)(x/H)\rangle]$.

$I(x)\equiv\int_0^\infty d\nu I(x;\nu)=\int_0^\infty d\nu I(0;\nu)[1-\langle1-@(\nu)(x/H)\rangle]$.

$I(0)\equiv\int_0^\infty d\nu I(0;\nu)=\int_0^\infty df I(0;\nu)$.

Now we take into account of time dependency of $\{I(t),C_j(t)\}$.

$I(t;H)\equiv\int_0^\infty d\nu I(t;H;\nu)=\int_0^\infty d\nu I(t;0;\nu)@(t;\nu)\equiv@(t)\int_0^\infty d\nu I(t;0;\nu)$

$=\int_0^\infty d\nu I(t;0;\nu)/[1+(H/2)\Sigma_{j=1}^{N}C_j(t)S_j(\nu)]$.

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(4):**CR passing probability**〈macroscopic pasm≡@(t)〉.

@(t)$\equiv I(t;H)/I(t;0)$

$=\int_0^\infty d\nu I(t;0;\nu)/[1+(H/2)\Sigma_{j=1}^{N}C_j(t)S_j(\nu)]／\int_0^\infty d\nu I(t;0;\nu)$.

The main factor of GHG effect is represented by @(t),which is time function of time dependent GHG concentration$\{C_j(t)\}$ with outgoing flux $I(x=0)$.The global warming depends on both main factor$\{m(t),@(t)\}$.@(t) is evidently a decreasing function of heat trapping gass concentration$\{C_j(t)\}$increasing,which in turn causes $T_G(t)$ rise in [0](1)〈Equation of Global Temperature≡EGT〉.