—Evolution equation of Global surface Temperature(EGT)with RF—'9/9/13,10/20,
erruntum:Global heat capacity C_G and the relations are corrected.

Our aim is estimating global temperature trend by GHG concentration change. Those factors are (1)constant solar ray input,(2)global radiative forcing(=RF) of atmosphere(GHGs rule trapp(with downward reradiation) and passing cooling radiation from the surface).The radiative ability is function of GHG concentration and albedo.(3)global dynamic surface temperatue(of equivalent global heat capacity).The last factor determine (RF)heat sink amount from (2).

RADIATION FORCING(the general formultion and the intepretation).

http://www.geocities.jp/sqkh5981g/RADIATION-FORCE.pdf

[0]:Global mean temperature as a function of albedo and GHG concentration:

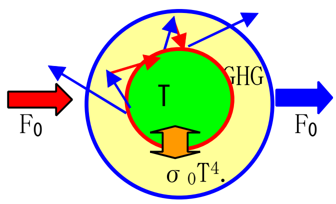
In this chapter,our discussion is asuumed a thermal equilibrium state,while discussion on radiative forcing(RF) is not such one,but in-equilibrium.

❶energy balance equation:input solar heat and cooling radiation output on earth:

<<(1)Stefan-Boltzmann low>>

$\pi R^2F_0(1-m)/(1-b)=4\pi R^2\sigma_0T^4$...(1) energy balance equaiton.

<<input power=output power>>



F_0=**1366**W/m²=original solar heat input at strat sphere.

$R_E=6.38X10^6$m=Earth radius, ; $\sigma_0=5.67X10^{-8}Wm^{-2}K^{-4}$.<Stefan Boltzmann>

m=albedo(≒0.4)=reflection(by white clouds,ice sheets)probability for F_0.

b(≒0.48)=1-a、a=passing probability of cooling radiation through GHG.

"b" is so to say a super black body factor rising temperature.

T(=273+15)℃=global mean temperature on the(almost ocean) surface.

(2)It's energy input & output budget equation at macro global surface of mean temperature T with substantial solar heat input=$\pi R^2F_0(1-m)/(1-b)$. $\pi R^2F_0(1-m)$ is original solar input onto the surface with reflection probability m(albedo). The factor a=(1−b) is passing(heat dissipating) probability into cosmic space of cooling radiation from global surface through GHG.b=(1-a) is trapp and downward re-radiation probability by GHG.Boundary(atmosphere vs global surface) radiative factor b is a function of each GHG component concentration.

(3)The output heat of cooling radiation(infrared ray) flow rate is $4\pi R^2\sigma_0T^4$ representing Stefan-Boltzmann low of radiation field with thermal matters.It's the equation in thermal steady equilibrium state.

❷Outflow releflection by GHG trapp with and without irreversible RF:

(1)Assumption on complete cooling radiation without radiative forcing.

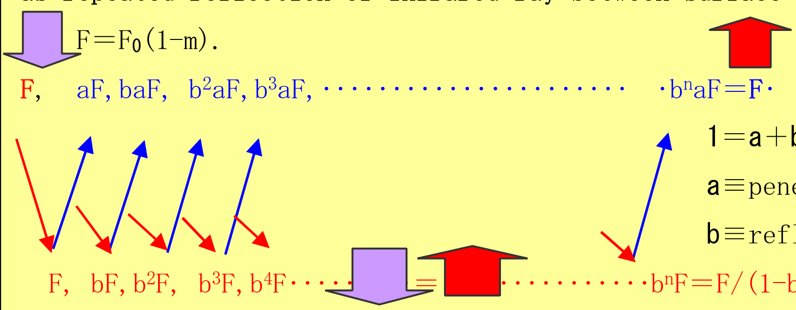
GHG almostly do'nt trapp input radiant ray, but do outflow of infrared ray. GHG gas on globe enforces infrared ray many times trial to penetrate through GHG in repeated reflection between globe surface and GHG. We define ray penetrating probability≡a≡1-b, then Fb is energy flow beign trapped and reflecting into the surface by GHG, thus the infinitive times repeating forms so called power series. Then note input=output=F(=F_0(1-m)) at top(equibrioum).

GHG EFFECT of EQI1IBRIUM STATISTICAL MODEL

as repeated reflection of infrared ray between surface and atomosphere

F=F_0(1-m). F=F_0(1-m)

F, aF, baF, b^2aF, b^3aF, ······················ ·b^naF=F·



1=a+b. <1≧a, b≧0>

a≡penetration probability.

b≡reflection probability.

F, bF, b^2F, b^3F, b^4F······= ···········b^nF=F/(1-b)=F_0(1-m)/(1-b)≡gF_0.

<http://www.fnorio.com/0040Greenhouse_effect1/Greenhouse_effect1.htm>

Sn=F+bF+b^2F+b^3F+b^4F+······+b^n F·····=F/(1-b).

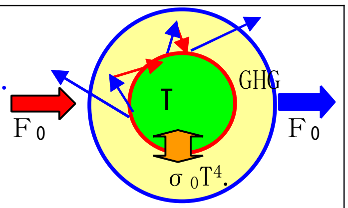
Rn=aF+baF+^{2}aF+^{3}aF+······+b^naF=aF(1+b+b^2+b^3+bF+······+b^n)=aF/(1-b)=F.

Thus input flow equivalentry increase by GHG<Green House Effect, or radiation force> as F{b+b^2+b^3+......+b^n+..}, where b is trapping probability. In anyway, major input energy never fail to escape from globe by many many trials.

<<generalized Stefan-Boltzmann low>>

$\pi R^2 F_0(1-m)/(1-b)=4\pi R^2 \sigma_0 T^4$...(1) energy balance equaiton.

<<input power=output power>>



Case for m=0.4.

T=15℃.→b=0.48, a=0.52.<now state>, g=1.15.

T=17℃.→b=0.49, a=0.51.<critical state>, g=1.18.

T(=273+15)℃=global mean temperature on the(almost ocean) surface.

(2)Note that **global mean temperature** is dominated only by two factors={m, b}. That is ALBEDO REFLECTION probability and GHG TRAPP probability. This fact is to become main factors also for policy making against climate change crisis.

❸Incomplete cooling radiation with radiative forcing in "T" transit.

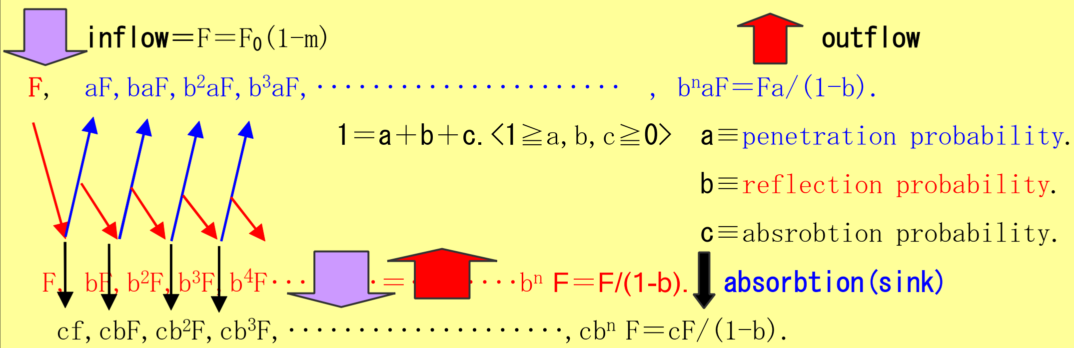
(1)Considering absorbtion(sink) in cooling ray radiation scattering in GHG.

$1=a+b+c\equiv$ {penetration+reflection+absorbtion} probability.

GHG EFFECT of non-EQULIBRUM STATISTICAL MODEL

as repeated reflection of infrared ray between surface and atomosphere

with suruface absorbtion in non-equibrium process.



(2)The energy conservation for input and output with sink.

Then energy conservation low is input $F=\{Fa/(1-b)+Fc/(1-b)\}$=output+sink.

$F=\pi R^2 F_0(1-m)=\pi R^2 F_0(1-m)a/(1-b)+\pi R^2 F_0(1-m)c/(1-b)$.

Input = output + absorbtion.

$4\pi R^2 \delta F_A(t)\equiv \pi R^2 F_0(1-m)c/(1-b)$.

(3)Dynamic global radiative forcing as a heat for absorberes :

$\delta F_A\equiv \frac{1}{4} F_0(1-m)c/(1-b)$. :Dynamic radiative forcing as global absorbtion energy.

Generally to tell, probability "c" is so neglegible(?) small against {a, b}.

However, it's fataly effective on inhabitants on globe.

$\pi R^2 F_0(1-m)=\pi(6.38\mathrm{X}10^6 m)^2 x 1366 W/m^2 x(1-0.4)=6.99x10^{16} W$. (bare heat input on globe)

$4\pi R^2 \Delta F_G=4\pi(6.38\mathrm{X}10^6 m)^2 x1.6W/m^2=8.18x10^{14} W$. (IPCC global radiation forcing).

$4\pi R^2 \sigma_0 T^4=4\pi(6.38\mathrm{X}10^6 m)^2 x5.67\mathrm{X}10^{-8} Wm^{-2}K^{-4} x(273+15)^4=2.0x10^{17} W$.

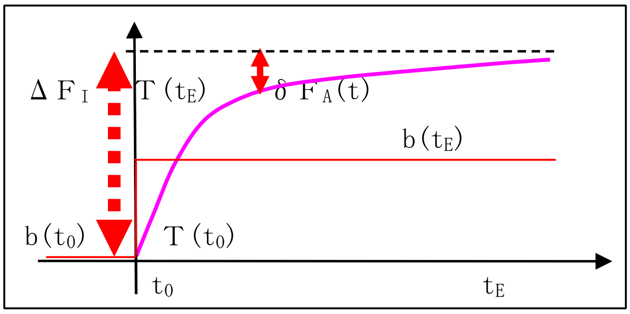
$K1\equiv[4\pi R^2 \Delta F_G]/[\pi R^2 F_0(1-m)]=0.0117$.

$K2\equiv[4\pi R^2 \Delta F_G]/[4\pi R^2 \sigma_0 T^4]\quad=0.0041$.

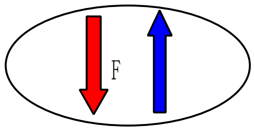
❹Instantaneous radiative forcing≡ $\Delta F_I(t_0;t_E)$ and Actual one≡ $\delta F_A(t)$:

(1)Instantaneous radiative forcing≡ $\Delta F_I(t_0;t_E)$:

Assuming pertubation $\{b(t_0)\rightarrow b(t_E)\}$ by step function rise of GHG concentration,



we could know the initial and final temperature by ❶(1). Then surface equal upward and downward flux could be calculated as follows. As temperature rise, the heat sink would be decreased to zero at last($t=t_E$ in equibrioum state).



(a)$\frac{1}{4}F_0(1-m)/(1-b(t_E))=\sigma_0 T^4(b(t_E))\equiv F(t_E)$.   <final equilibrium state>

(b)$\frac{1}{4}F_0(1-m)/(1-b(t_0))=\sigma_0 T^4(b(t_0))\equiv F(t_0)$.   <initial equilibrium state>

(c)$\Delta F_I(b(t_E),b(t_0))\equiv F(t_E)-F(t_0)=\frac{1}{4}F_0(1-m)\{1/(1-b(t_E))-1/(1-b(t_0))\}$.

Thus the difference of radiative forcing is a function of $\{b(t_0),b(t_E)\}$ or GHG concentration variation during (t_0,t_E).<<instantaneous RF>>

(2)Dynamic radiative forcing ≡ $\delta F_A(t)$ the actual one.

(a)$1=\underline{a(t_0)+b(t_0)=a(t_E)+b(t_E)}=\underline{a(t')+b(t')+c(t')}$. $(t_0<t'<t_E)$

(equibrioum state) (non-equibrioum state)

(b)GHG concentration rise shall be increasing $b(t')$ with $a(t')$ decreasing and with as $c(t')>0$.

$1=a(t_0)+b(t_0)=a(t)+b(t)=a(t')+b(t')+c(t')$.→ $b(t')+c(t')=1-a(t)$.

—(f)radiative forcing as irreversible process in change $\{b(t_0)\rightarrow b(t_E)\}$—.

As for an input, the outcomes are {passing, reinput, absorbtion}.

input→reflection by surface→a:passing → cosmic space

c:absorbtion(sink) GHG trapp →b:reinput

(lower temperature)

(3)Decision about unknown "c" by known trapp probability "b" or change in heat trapp probability "b" and absorbing probability "c":

$4\pi R^2 \int_{to}^{tE} du.\ \delta F_A(u) = 4\pi R^2 \int_{to}^{tE} du.\ c(u) F/(1-b(t_E)) = C_G[T(t_E) - T(t_0)] \equiv \Delta Q_G.$

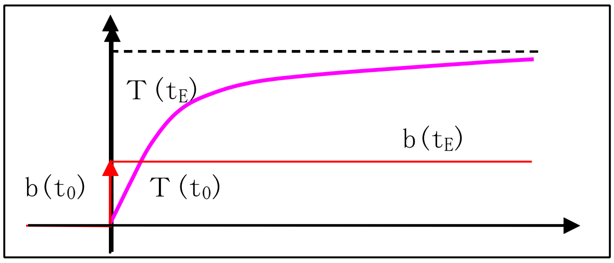
It's a global temperature rise of heat capacity C_G during $\{t_0, t_E\}$ due to "c".

(a) absorbtion probability of time function c(t) as functional of $b(t_E)$.

$\int_{to}^{tE} du.\ c(u) = \Delta Q_G(b(t_E), b(t_0))(1-b(t_E)/\pi R^2 F_0(1-m).$

c(u) and also related radiative forcing could not a constant, hence we assume an exponetial decay of relaxation process $\{T(t_0) \rightarrow T(t_E)\}$.

Assuming pertubation $\{b(t_0) \rightarrow b(t_E)\}$ by step function rise of GHG concentration,



and now having known initial and final temperature $\{T(t_0) \rightarrow T(t_E)\}$, necessary parameter is the global heat capacity time constant τ_G.

$\rightarrow c(t) \equiv c(t_0)\exp(-(t-t_0)/\tau_G). \rightarrow \int_{to}^{tE} du.\ c(u) = (c(t_0)/\tau_G)[1-\exp(-(t_E-t_0)/\tau_G)]$

$(c(t_0)/\tau_G)[1-\exp(-(t_E-t_0)/\tau_G)] = \Delta Q_G(b(t_E), b(t_0))(1-b(t_E)/\pi R^2 F_0(1-m).$

$* \ \tau_G = c(t_0)\pi R^2 F_0(1-m)/\Delta Q_G(b(t_E), b(t_0))(1-b(t_E)$

$= c(t_0)\pi R^2 F_0(1-m)/(1-b_E) C_G[F_0(1-m)/4\sigma_0]^{1/4}[(1-b_E)^{-1/4} - (1-b_0)^{-1/4}].$

$F_0(1-m)/4\sigma_0(1-b) = T^4.\ ;[T(t_E) - T(t_0)] \equiv [F_0(1-m)/4\sigma_0]^{1/4}[(1-b)^{-1/4} - (1-b)^{-1/4}].$

$\Delta Q_G(b(t_E), b(t_0)) = C_G[T(t_E) - T(t_0)] = C_G[F_0(1-m)/4\sigma_0]^{1/4}[(1-b_E)^{-1/4} - (1-b_0)^{-1/4}].$

$\delta F_A(t_0) = c(t_0)F_0(1-m)/(1-b(t_E)) = \frac{1}{4} F_0(1-m)\{1/(1-b(t_E)) - 1/(1-b(t_0))\}.$

$* c(t_0) = \frac{1}{4}\{1 - (1-b_E)/(1-b_0)\}.$

In order to utilize radiative forcing for estimation on temperature rise process, the intensity $c(t_0) \langle \Delta F_I(t_0; t_E) \rangle$ with time constant τ_G are necessary.

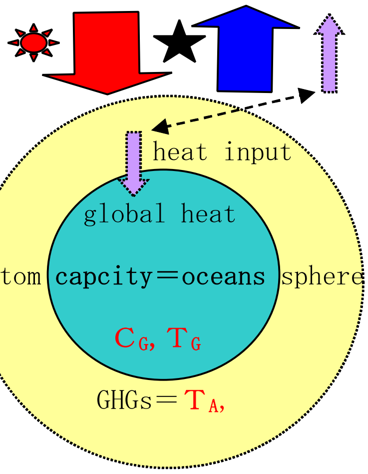
As was known in above, discussion at here has not a dynamical principle.

[1]: The heat flow imbalance of global surfaces in macroscopic meaning :

(1)the fundamental scheme:

Our intension is not to mention local weather forcasting, but prediction on long years global climate trend. So it's an averaged something without the abnormaly in time and volume. Consequently macroscopic variable could become available.

$F_0/4$ $F_0/4-\delta F_0$(deficit)



-The two of global temperature-

(a)Instantaneous atmospheric temperature $\equiv T_A$,

where T_A is final equilibrium one.

$4\pi R^2(1/4)F_0(1-m)/(1-b)=4\pi R^2\sigma_0 T_A{}^4$.

(b)Current global heat capa C_G temperature $\equiv T_G$.

(c)Heat input as radiative forcing $\equiv \delta F_0$.

$C_G\ (dT_G(t)/dt)=4\pi R^2\delta F_0(t)$

$=4\pi R^2\sigma_0(T_A{}^4-T_G(t)^4)$.

(2)Radiative imbalance between global heat capacity and GHG the radiative heat.

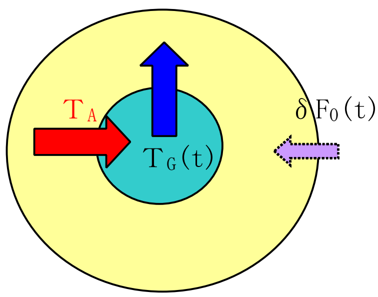
Heat capacity of land and atomosphere is less as 1/1000 of oceans. So it could not be a representative of global temperature. After all, heat deficit at the cosomic gate(strtsphere) δF_0 is flow into ocean of heat capacity $\equiv C_G$. If $T_A=T_G$, dynamic radiative forcing(RF) $\delta F_0=0$(equilibrium) by balance of radiation of T_A and T_G. If $T_A>T_G$, dynamic radiative forcing(RF) $\delta F_0>0$(inequilibrium) due to imbalance. Those pseudo blackbody radiation imbalance may be as follows.

$\delta F_0(t)=\sigma\ (T_A{}^4-T_G(t)^4)$.........(2)

(3)Evolution equation of Global surface Temperature(EGT):

$$C_G\ (dT_G(t)/dt)=4\pi R_E{}^2\sigma\ (T_A(t)^4-T_G(t)^4).$$

$Q_G\ (t)=C_G T_G(t)=$is global heat amount in global heat capacity C_G. So its time derivative is heat input per unit time. It must be equal with (inflow−outflow) at the global surface of C_G. Each flow amount is dominated as **super blackbody radiation** of $\sigma_0 T^4$ with T.



(4)Temperature of pseudo blackbody radiation for atmosphere:

Let imagin radiation flux density of $F=\sigma T^4$, of which temperature would be observed as T.

(5)Reexamination:radiative temperature of atmosphere the curiousness:

A temperature is concept in equlibrium state, so in non-equilibrium one, we had to assume local equilibrium as the assumption. In actual macroscopic climate system in years change would be so slow to enable the assumption. Note $\sigma T_G(t)^4 \gg \delta F_0(t)$.

$C_G\ (dT_G(t)/dt) = 4\pi R^2 \delta F_0(t)$。

—heat budget diagram—

$F_0/4$ →	no heat reserve super black-body Atmosphere equilibrium T_A	→ $\sigma T_G(t)^4 + \delta F_0(t)$		C_G of Globe non-equilibrium $T_G(t)$ blackbody rad
$F_0/4 - \delta F_0(t)$ ←		← $\sigma T_G(t)^4$	←	

$\sigma T_A(t)^4 \equiv \delta F_0(t) + \sigma T_G(t)^4.\ \rightarrow\ \delta F_0(t) = \sigma(T_A^4 - T_G(t)^4)$.........(6)

In the below, we assume step function change of GHG concentration from initial time t_0 to final time t_E. In this interval, G could radiate and sink $\sigma T_G(t)^4$.

Also blackbody $T_G(t)$ would be changed by heat input(output) $\delta F_0(t)$ due to GHG concentration change, while T_A must be constant due to nothing heat reserve (output=input) during the interval. But it must that $T_A = T_G(t_0)$ and $T_A = T_G(t_E)$ due to equilibrium-ness between G & A at time t_0 and t_E. It's very curious !.
It's not a simple black body, but be a **pseudo** one of (6).

A with GHG has two kind of temperature, one is ordinal thermal one observed by thermometer, the other is radiative temperature represented by (6). Atmosphere radiation($\sigma T_A(t)^4$) are that of own molecular transit energy($\sigma T_G(t)^4$) with adding solar ray penetratiion of ($\delta F_0(t)$).

[2]:Estimation of the EGT solution:

(1)physical constants around EGT.

EGT is non-linear, but its derivative directly be calculated from right side term. At first, we could prove being of an inertia temperature rise with certain delay, even though we have fixwed past GHG concentration. Therefore we need more(80%) carbon reduction rate than that of {sink=emit} balanced amount of about 60%.

<C_G≒$1.4\mathrm{x}10^{24}$J/k(ocean depth=1000m)>.

$R_E=6.38\mathrm{X}10^6$m=Earth radius,

σ_0=<Stefan Boltzmann=$5.67\mathrm{X}10^{-8}\mathrm{Wm}^{-2}\mathrm{K}^{-4}$.>.

$$*dT_G(t)/dt=(4\pi R_E^2\sigma_0/C_G)(T_A^4-T_G(t)^4)\equiv K_G(T_A^4-T_G(t)^4).$$

$K_{G/t}\equiv(4\pi R_E^2\sigma_0/C_G)=2.9\mathrm{x}10^6/C_G(d)=2.2\mathrm{x}10^{-17}$(d=1000m),

(a)The ocean heat capacity $C_o=5.3\mathrm{X}10^{24}$J/K by linear estimation.

<http://hypertextbook.com/facts/2001/SyedQadri.shtml>. ocean volume=$1.37\mathrm{X}10^9\mathrm{km}^3$.

ocean weight of density 1=$1.4\mathrm{X}10^9\mathrm{kX}(10^5\mathrm{cm})^3=1.4\mathrm{X}10^{24}$g. specific heat of sea water =3.85(pure water4.18)J/gK. C_o=3.85J/gKX$1.4\mathrm{X}10^{24}$g=$5.3\mathrm{X}10^{24}$J/k.

(b)average depth of ocean=3796m、solar ray reaching depth=200m、then

roughly estimated active heat capa of ocean ≒$5.3\mathrm{X}10^{24}$J/KX200/4000≒$2.6\mathrm{X}10^{23}$J/K.

(c)Annual Effective global heat capacity C_G derived by NASA.

<http://www.ecd.bnl.gov/steve/pubs/HeatCapacity.pdf>.

Effective global heat capacity. $C_e=10^9\mathrm{Jm}^{-2}\mathrm{K}^{-1}$ x0.53±0.22

$C_G=4\pi R^2\mathrm{x}0.53\mathrm{x}10^9\mathrm{Jm}^{-2}\mathrm{K}^{-1}=4\pi(6.38\mathrm{X}10^6\mathrm{m})^2\mathrm{x}0.53\mathrm{x}10^9\mathrm{Jm}^{-2}\mathrm{K}^{-1}=2.7\mathrm{x}10^{23}$J/K.

(d)Long term effective global heat capaity C_G derived by radiative forcing.

$$*\ \delta F_0(t)=\sigma(T_A(t)^4-T_G(t)^4).$$

$$*\ (4\pi R_E^2\sigma_0/C_G)\equiv K_G=[dT_G(t)/dt]/(T_A^4-T_G(t)^4)=\sigma[dT_G(t)/dt]/\delta F_0(t).$$

$$\rightarrow\ C_G=4\pi R_E^2(\sigma_0/\sigma)<\delta F_0(t)>/<dT_G(t)/dt>≒4\pi R_E^2\,\delta F_0(t)/[dT_G(t)/dt].$$

$$C_G=4\pi(6.38\mathrm{x}10^6\mathrm{m})^2\mathrm{x}<1.6\mathrm{Wm}^{-2}>/[0.02\mathrm{K}/3600\mathrm{x}24\mathrm{x}365]=1.29\mathrm{x}10^{24}\mathrm{J/K}.$$

It's about 1000m depth by observed data of {δF_0 & dT_G/dt}.

(e)time to year/variable transform:1 year=3600x24x365sec=$3.15\mathrm{x}10^7$s.

$K_{G/y}\equiv K_{G/t}\mathrm{x}3600\mathrm{x}24\mathrm{x}365=7.09\mathrm{x}10^{-10}$.

(2) : Final temperture rise T_A with fixed GHG concentration of past time t_0 the estimation by observed current temperature＝287.5K with the time derivative ＝0.03～0.05K/y. <thermodynamical temperature 273K≡0℃>.

＊ $dT_G(t)/dt=(4\pi R_E^2\sigma_0/C_G)(T_A^4-T_G(t)^4)\equiv K_G(T_A(m(t),b(t))^4-T_G(t)^4)$...EGT.
$K_G\equiv(4\pi R_E^2\sigma_0/C_G)=7.09\times10^{-10}$: <$C_G$＝global heat capacity＝oceans of depth 200m>

＊ $\sigma_0 T_A(m(t),b(t))^4=F_0(1-m(t))/4(1-b(t))$.<pseudo-final equilibrium temperature>
<b＝heat flux trapp probability of GHG、m＝albedo>

(a)a virtual fitting solution value with fixed $T_A(m,b)$=constant :

T(1750)＝(273+13.7)＝286.7 ; T(2008)＝(273+14.5)＝287.5 ;

288.7	286.7	286.9	287.1.	287.3	287.5
dT/dt	.074	.061	0.047	.034	0.020

☞☠:Caution that the actual trend(dT_G/dt) is obviously increasing as time goes on.That is,it is due to more increasing of $T_A(m(t),b(t))$ due to "b" of GHG rise and albedo "m" decreasing.It measns a going more away of "our reliefe".

(b)Inertia temperature rise .

$T_A=\{[(dT_G(t)/dt)/K_G]+T_G(t)^4\}^{1/4}$.
The final temperature＝{current trend/K_G＋(now temperature)^4}$^{1/4}$.

current value : $T_G(t)$＝277.5. $K_G=4\pi R_E^2\sigma_0/C_G=7.09\times10^{-10}$:.

dT_G/dt ＼ K_G	K_G(d=1000m)＝7.09×10^{-10}:	
0.0177(IPCC)	recent 25 years trend、but now value is far from it !	
0.02K/y	T_A＝277.83(+0.33K)	
0.03	277.99(+0.5K)	
0.04	278.16(+0.66K)	
0.05	278.32+0.82K)	

(3)Process time estimation: $\langle K_G = 4\pi R_E^2 \sigma_0 / C_G = 7.09\times10^{-10} : \rangle$

(a)given $T_A(t)$ the virtual final temperature as function of $\{m(t), b(t)\}$.

$dT_G(t)/dt = K_G(T_A(t)^4 - T_G(t)^4). \rightarrow dt/dT_G = 1/K_G(T_A(t)^4 - T_G(t)^4)$.

(b)fixed $T_A(t_0) > T_G(t) > T_G(t_0)$. $t - t_0 = \int_{TA(t0)}^{TA(t)} dT_G/K_G(T_A(t_0)^4 - T_G^4)$.

integral formula

$1/(Q^4 - X^4) = (1/2Q^4)[1/(1+(X/Q)^2)] + (1/4Q^3)\langle 1/(X+Q) - 1/(X-Q)\rangle$.

$\int dX/(Q^4 - X^4) = (1/2Q^3)\,\mathrm{Tan}{-1}(X/Q) + (1/4Q^3)\ln\langle |X+Q|/|X-Q|\rangle$.

$t - t_0 = \int_{TG(t0)}^{TG(t)} dT_G/K_G(T_A(t_0)^4 - T_G^4)$;

$T_G(t)/T_A(t_0)$, $T_G(t_0)/T_A(t_0)$, $|T_G(t)+T_A(t_0)|/|T_G(t_0)+T_A(t_0)| \fallingdotseq 1$ at near 287.5K.

$t - t_0 = (1/4K_G T_A(t_0)^3)\{2\langle \mathrm{Tan}{-1}(T_G(t)/T_A(t_0)) - \mathrm{Tan}{-1}(T_G(t_0)/T_A(t_0)\rangle$
$+ \ln\langle |T_G(t)+T_A(t_0)|/|T_G(t)-T_A(t_0)|\rangle - \ln\langle |T_G(t_0)+T_A(t_0)|/|T_G(t_0)-T_A(t_0)|\rangle\}$

$(1/4K_G T_A(t_0)^3) = 15y. \rightarrow t - t_0 \fallingdotseq 15.\ln\langle |T_G(t_0)-T_A(t_0)|/|T_G(t)-T_A(t_0)|\rangle \equiv 15W$.

$T_G(t_0) - T_A(t_0) \equiv 1$.

$\vert T_G(t)-T_A(t_0)\vert$	$W=\ln\langle 1/\vert T_G(t)-T_A(t_0)\vert\rangle$	$(t-t_0)$ y
0.9		1.6
0.8		3.4
0.5		10.4
0.2		24.32

$T_G(t_0) - T_A(t_0) \equiv 2$.

$\vert T_G(t)-T_A(t_0)\vert$	$W=\ln\langle 2/\vert T_G(t)-T_A(t_0)\vert\rangle$	$(t-t_0)$ y
1.9		0.75
1.8		1.6
1.5		4.3
1.0		10.4
1.5		20.8

$T_G(t_0)-T_A(t_0)\equiv 3.$

$\|T_G(t)-T_A(t_0)\|$	$W=\ln\langle 3/\|T_G(t)-T_A(t_0)\|\rangle$	$(t-t_0)y$
2.9		0.5
2.8		1.1
2.5		2.8
2.0		6.1
1.0		16.5

While 0.5℃ rise took (10,5,2.5)years, T_G is heading to (1,2,3)℃ rise.

(4)The approximated solution $T_G(t)$ with $T_A(t)$ as the ZERO EMISSION TEMPERATURE.

Even though the ZERO CARBON EMISSION of most sink rate=1.5ppm/y seems risky.

(a)the global carbon budget:

http://www.globalcarbonproject.org/carbonbudget/07/files/GCP_CarbonBudget_2007.Pdf

fiscal(man made+natural)emitt and (oceans+land)sink by photosyntheis.

+man made emission	=7.5(8.5)PgC/y	$P=10^{15}$. C is carbon standard。
+natural emission	=1.5PgC/y.	For example)
—Oceans sinks	=2.3PgC/y	CH_4=16g, but C=12g.
—Land sinks	=2.6PgC/y	CO_2=44g, but C=12g.
+atmospheric accuumulation	=4.2PgC/y	

crrent concentration rise : 4.2GtC=1.9ppm/y.

current manmade emit : 7.5GtC=3.6ppm/y.

net natural sink : 4.9GtC−1.5GtC=3.4GtC=1.5ppm/y.(MAX value of ZERO EMIT)

(b)current leading temperature T_A=287.8(+0.3K)with 385ppm CO_2 by $dT_G(t)/dt$=

0.02~0.03K/y.

(c)coarse linear estimation on T_A(385ppm-1.5xY) the policy target at each year Y.

For the simplicity, leading temperaute T_A is assumed as linear function of ppm.

Then 286.7(1750)K and 280ppm(1750) are equilibrium temperature and the

concentration in 1750(Prior industrial revolution).

T_A(385ppm-(1.5ppm/y)Y)=287.8-Y(287.8−286.7)x(1.5ppm/y)/⟨385ppm-280ppm⟩.

=287.8−1.1x1.5Y/105=287.8-0.016Y.

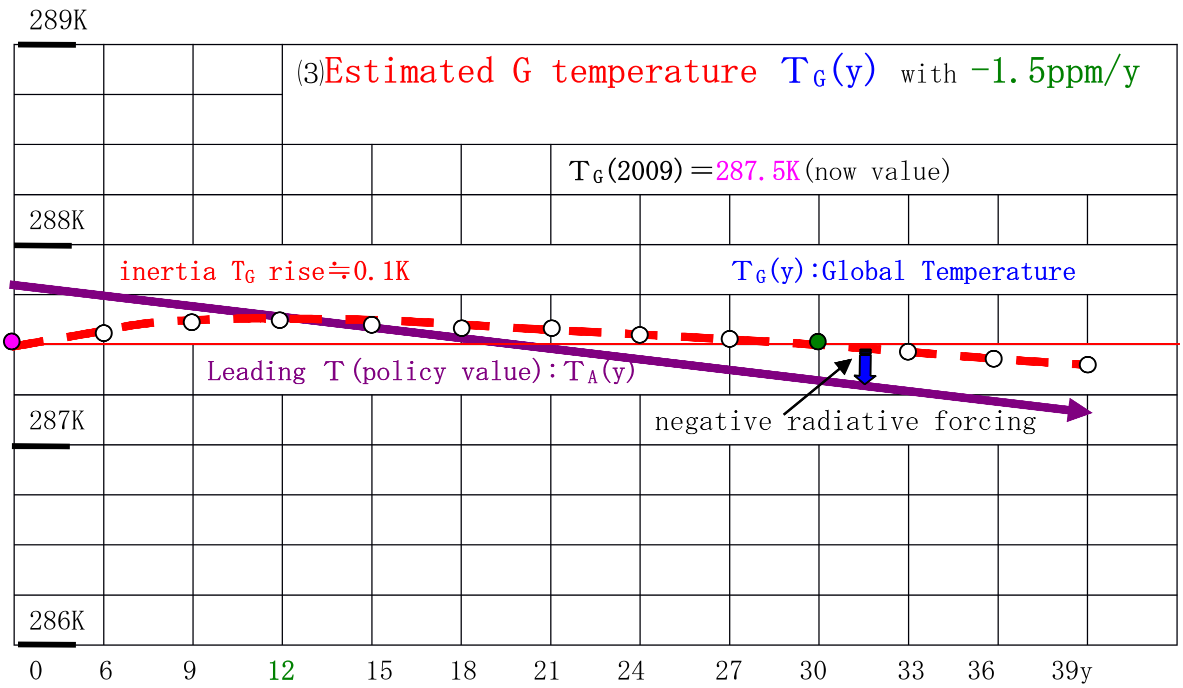
⑸discrete integral of coarse approximantion on $T_G(t)$ with the ZERO EMISSION.

$T_G(t+\Delta t)=T_G(t)+\Delta t(dT_G(t)/dt)=T_G(t)+\Delta t.K_G(T_A(t)^4-T_G(t)^4)$.

$\Delta t=3.0y(\Delta C=4.5ppm)$; $\Delta T=-0.016x3=-0.048K$.

	385ppm	380.5	376	371.5	367	362.5	358	353.5
Δy=3	0y	3	6	9	12	15	18	21
T_A	287.8	287.75	287.70	287.66	287.61	287.56	287.51	287.46
dT/dy	0.02K/y	0.0128	0.0067	0.0027	-.0013	-.0047	-.0067	-.0088
T'=dT+T	T_G=287.5	287.56	287.60	287.61	287.63	287.62	287.61	287.59

	349	344.5	340	335.5	331	326.5	322	317.5
Δy=3	24	27	30	33	36	39	42	45
T_A	287.42	287.37	287.32	287.27	287.22	287.18	287.13	287.08
dT/dy	-.0094	-.0101	-.0121	-.0128	-.0135	-.0134	-.0141	-.0148
T'=dT+T	287.56	287.53	287.50	287.46	287.42	287.38	287.34	287.30



(6){dT/dy=0.02K/y, T_A=287.8} is coservative、let's try {dT/dy=0.03K/y, T_A=288}.

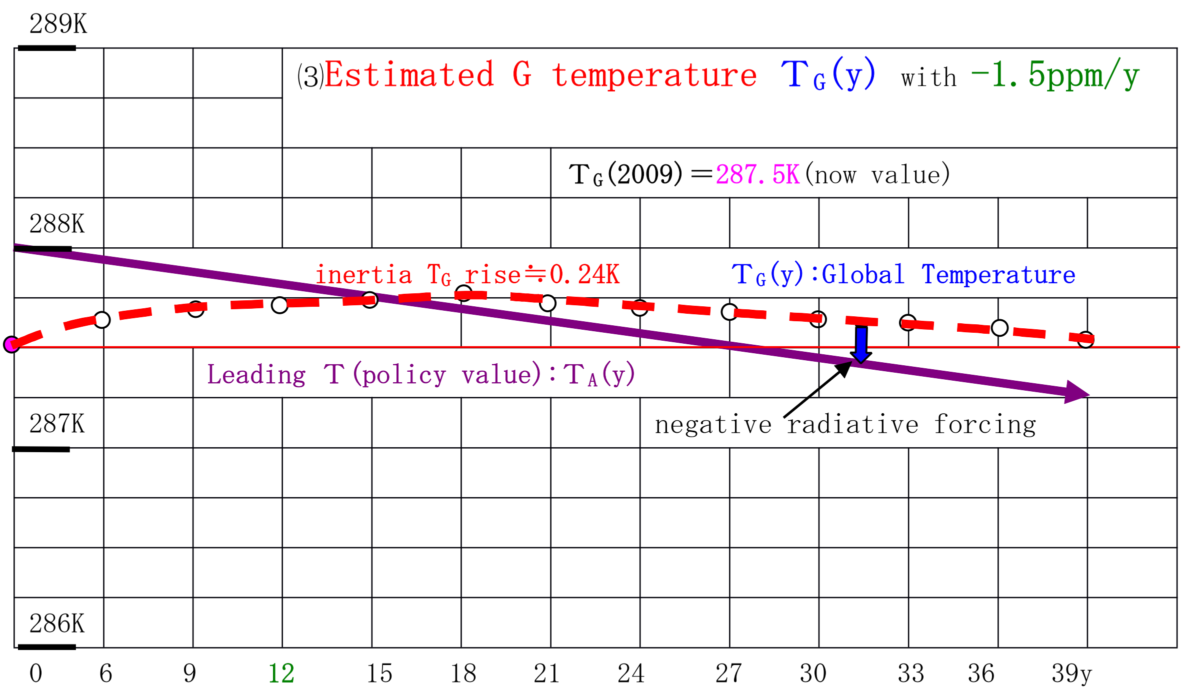
T_A(385ppm−(1.5ppm/y)Y)=288.0−Y(288.0−286.7)x(1.5ppm/y)/<385ppm−280ppm>.

=288.0−1.3x1.5Y/105=288.0−0.0186Y.

Δt=3.0y,(ΔC=4.5ppm); ΔT=−0.0186x3=−0.056K.

	385ppm	380.5	376	371.5	367	362.5	358	353.5
Δy=3	0y	3	6	9	12	15	18	21
T_A	288.0	287.94	287.89	287.83	287.78	287.72	287.66	287.61
dT/dy	0.03K/y	0.024	0.0155	0.0081	0.0034	−.0014	−.0054	−.0074
T'=dT+T	T_G=287.5	287.59	287.66	287.71	287.73	287.74	287.74	287.72

	349	344.5	340	335.5	331	326.5	322	317.5
Δy=3	24	27	30	33	36	39	42	45
T_A	287.55	287.50	287.44	287.38	287.33	287.27	287.22	287.16
dT/dy	−.010	−.011	−.013	−.015	−.015	−.017	−.017	−.017
T'=dT+T	287.70	287.67	287.64	287.60	287.56	287.52	287.47	287.42



[3]:supplemental commenet:

(1)The actual $T_G(t)$ is almost exponetial increasing which means that the **leading temperature** $\equiv T_A(m(t),b(t))$ is becoming more far from the current $T_G(t)$. If the estimated leading temperature T_A be aheading0.5℃, it be too terribly risky. Then a possible relief may be the maximum carbon sink rate=1.5ppm/y(ZERO EMIT). Even though, there would be possible natural spontaneous emit during temperature rise, so the final reliefe may be nothing without global scaling forestization with rapid growing vegetations and pray God. Global climate-engineering ?, the action and the reaction ?.

(2)According to a coarse approximation of segmented integral calculation on EGT, it could scarecly recover current temperature 287.5K by taking 30 years with the maximum canbon sink rate 1.5ppm/y(the CARBON ZERO EMISSION). Then the max inertia temperature rise is ≒0.1^0.3K?, while we could only pray for nothing unfortunate. If possible safety temperature rise margin(PSTRM) be 0.1~0.3℃ for preventing starting full dress positive feedback of natural spontaneous GHG emission, the current state is terribly risky !!!.

(3)GHG concentrations={$C_k(t)$} and super black body factor≡b(t):<revised>.
http://www.geocities.jp/sqkh5981g/RADIATION-FORCE.pdf
The result mentioned in above page was revised !. Current radiative forcing $\delta F_0(t)$ is fuction of b(t) which is also function of each GHG components concentrations {$C_k(t)$}.→ $b(t)=b(C_k(t))$. This is the problem to be solved in general.

$\frac{1}{4}F_0(1-m(t))/(1-b(t))=\sigma_0 T_A^4(m(t),b(t))\equiv F(t)$.

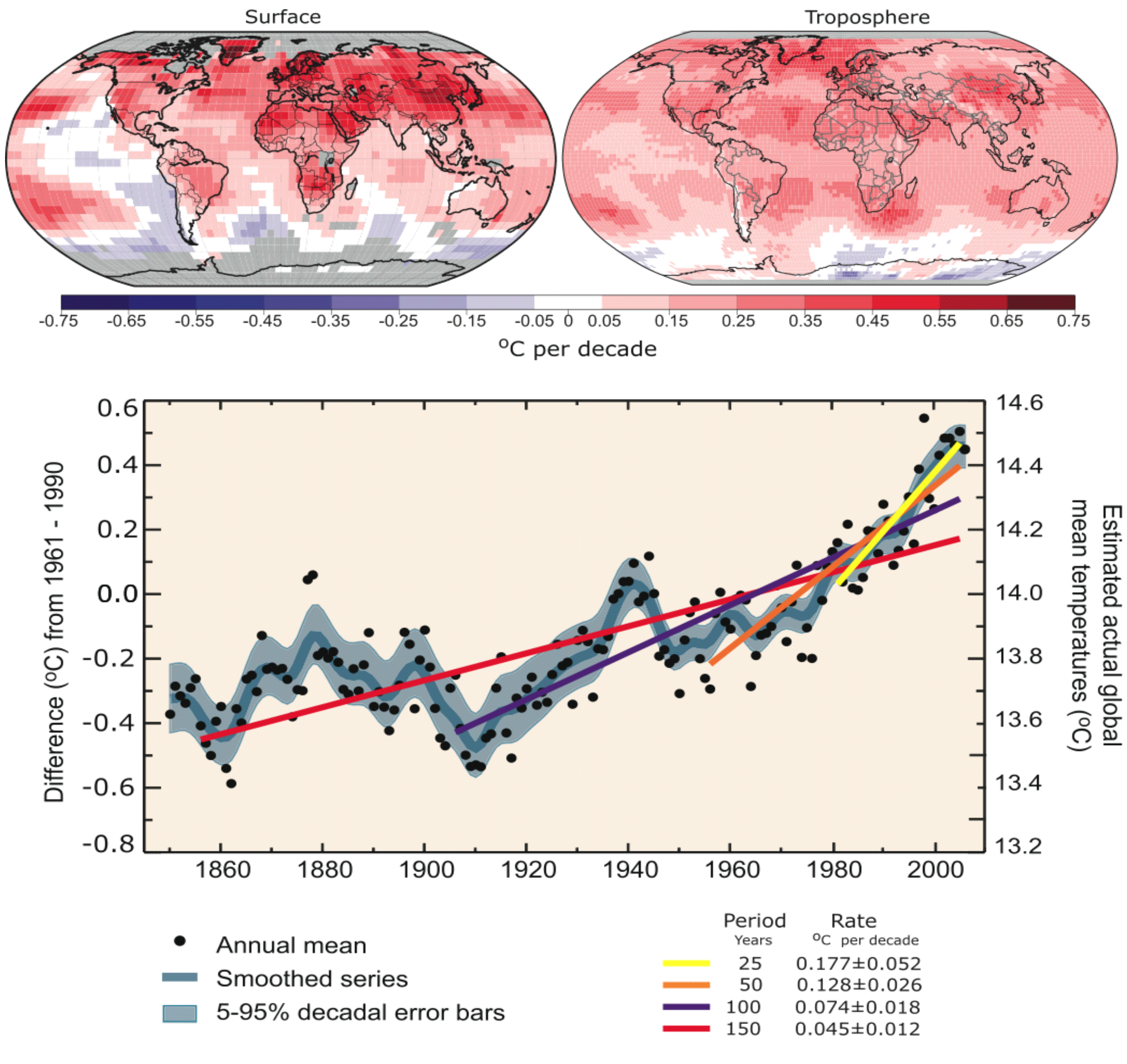
$C_G\ (dT_G(t)/dt)=4\pi R^2\,\delta F_0(t)=4\pi R^2\sigma_0(T_A(t)^4-T_G(t)^4)$.

☞:The definition "radiative forcing of climate betweenn 1750 and 2005(1.6W/m²)" by IPCC is not correct. But "betweenn 1750 and 2005"→"at now" is correct. (=1.6W/m²) could be observed by between satelite and the ground.
http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf(p136).
If actual (δF_0=1.6W/m²) were different, the situation became serious.

Appenndix1：Global Temperature & Carbon concentration Record by IPCC.

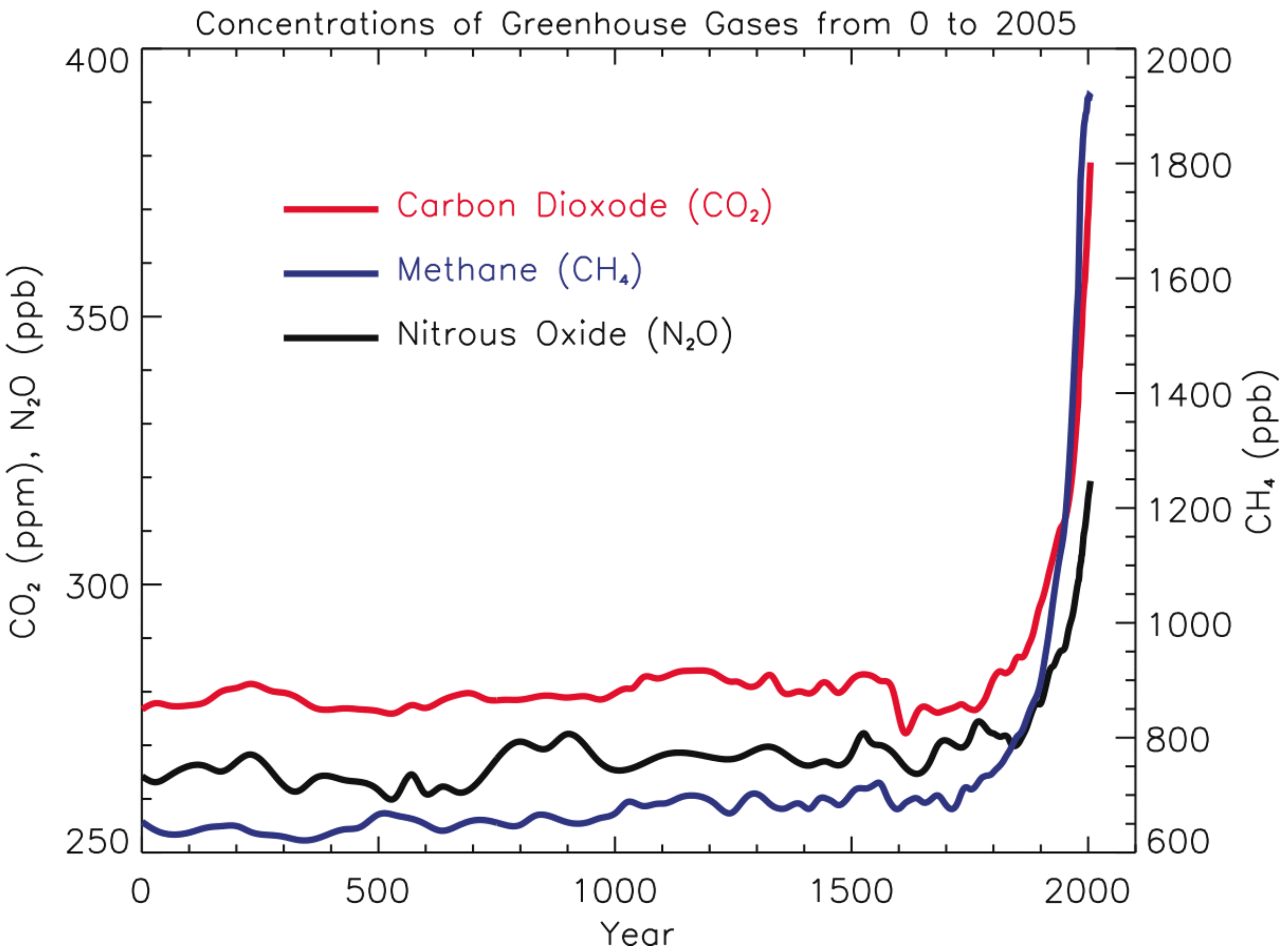
IPCC Working Group I;Technical Summary;FINAL FIGURES

Historical Record of Global Temperature(p7)

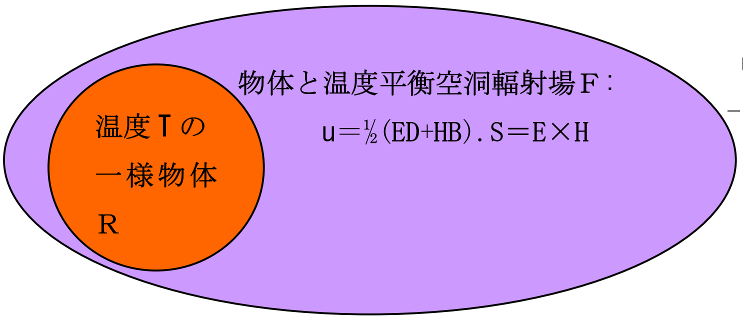


IPCC Working Group I;Technical Summary;FINAL FIGURES

Historical Record of Global Carbon concentration(p26)



付録２：Plank 分布と非黒体 Stefan-Boltzman 定数:(rev'09/10/7)



$u=\frac{1}{2}(ED+HB).\ S=E\times H$

$-\partial_t\langle\oint dv\frac{1}{2}(ED+HB)\rangle=\oint dS(E\times H)$

(1)R物性固有の温度T輻射密度分布：$R(E;T)=R(E=h\nu;T),\ 1=\int_0^\infty dE R(E=h\nu;T)$.

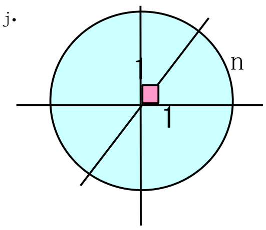
(2)energy 密度：$\rho=\int_0^\infty dE\cdot E\cdot R(E=h\nu;T)\equiv\sigma_R T^4$。

(3)Plank 分布：$R_0(E;T)=D(E)/(\exp(\beta E)-1)=(8\pi E^2/c^3h^3)/(\exp(\beta E)-1)$.

(a)電磁場縮退度 D(E)の算出：<L＝2r 球体空洞での$\lambda=c/\nu$の電磁場姿態数を勘定>。

(b)立方体$L=(\lambda_j/2)n_j$. $\langle n_j=1,2,3,\ldots\ldots\ldots\ldots(j=1,2,3)\rangle$; $\nu_j=c/\lambda_j$.

$\nu=(c/2L)\sqrt{[n_j^2+n_j^2+n_j^2]}=(c/2L)n.\quad ;n_j^2+n_j^2+n_j^2=n^2$.



(c)振動数$\nu\sim\nu+d\nu$にある姿態度数$=D(\nu)d\nu$を勘定する。

「半径 n の球体の 1/8 の内部の格子点と進行後退波 2 個を勘定。

格子点は単位体積に付き、一個の勘定になる。だから」

$N_n(\nu)=\underline{(1/4)}(4/3)\pi n^3=(1/4)(4/3)\pi(2L\nu/c)^3=(8/3)\pi(L\nu/c)^3$.

$dN_n/d\nu=8\pi(L/c)^3\nu^2.\rightarrow\quad D(\nu)=(dN_n/d\nu)/L^3=8\pi\nu^2/c^3$.

(d)完全黒体輻射分布：　$R(\nu)d\nu=d\nu\cdot 8\pi\nu^2/c^3(\exp(h\nu/kT)-1)$.

$R(E)dE=dE\cdot 8\pi E^2/h^3c^3(\exp(\beta E)-1)$.

(e)$\rho=\int_0^\infty dEER(E)=\int_0^\infty dE\cdot 8\pi(\beta E)^3/h^3(\beta c)^3(\exp(\beta E)-1)$

$=\langle 8\pi/h^3\beta^4c^3\rangle[\int_0^\infty d(\beta E)\cdot(\beta E)^3/(\exp(\beta E)-1)]=[\pi^4/15]\langle 8\pi/h^3\beta^4c^3\rangle$

(e)完全黒体物質と温度平衡にある輻射場 energy 密度：

$\rho=[8\pi^5/15]T^4k_B^4/h^3c^3=(7.56\mathrm{X}10^{-16}\mathrm{Jm^{-3}K^{-4}})T^4=\frac{1}{2}(ED+HB)$.

$\sigma_0=[8\pi^5/15]k_B^4/h^3c^3=7.562\mathrm{X}10^{-16}\mathrm{Jm^{-3}K^{-4}}$. <Stefan-Boltzmann 定数>

(f)輻射場 energy 流密度：

$(E\times H)=j=(1/4)c\rho$ (従来論) $=\sigma_0T^4$.　　　　<(11/48)$c\rho$ (筆者 2008)>.

http://www.geocities.jp/sqkh5981g/cu11D48.pdf

$\sigma_0=(c/4)\sigma_0=[2\pi^5/15]k_B^4/h^3c^2=5.67\mathrm{X}10^{-8}\mathrm{Jm^{-3}K^{-4}}$. <大勢の Stefan-Boltzmann 定数>

MKSA 単位：$c=3.00\mathrm{X}10^8\mathrm{ms^{-1}}$; $h=6.63\mathrm{X}10^{-34}\mathrm{Js}$. ; $k_B=1.38\mathrm{X}10^{-23}\mathrm{Jdeg^{-1}}$. F(太陽定数)＝1368W/m^2.

(g)非黒体輻射：空中等の SB 定数(真空中とほぼ同じ)：

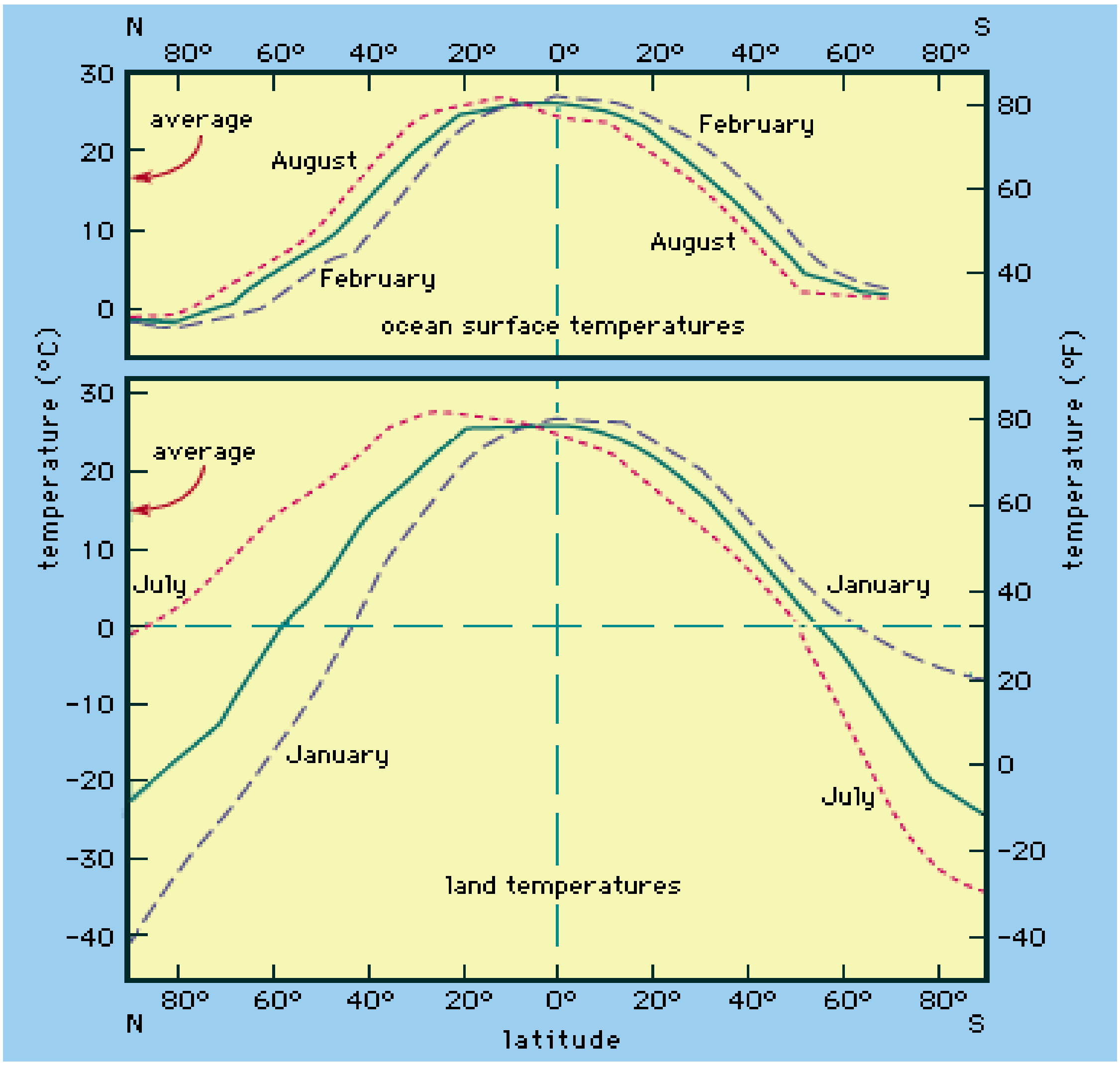
$c=2.99792459\mathrm{X}10^8\mathrm{ms^{-1}}$; $=1/\sqrt{(\varepsilon_0\mu_0)}$. $c_a=2.99704764\mathrm{X}10^8\mathrm{ms^{-1}}$; $=1/\sqrt{(\varepsilon_0\mu_0)}$.

$(c_a/c)^3=1.00087$, SB 定数は水蒸気があると波長短縮で大きくなり得る !!

＊水中の光速度(比誘電率 80.4)。

Appendix 3：The Current Averaged Globala Ocean Temperature.

http://www.britannica.com/EBchecked/topic/424285/ocean/67078/Temperature-distribution



-postscritpt(ver5:'09/11/20)-

This is also a cut and try paper in re-examination for radiative forcing.

In "version 5",the serous factors are corrected.

C_G＝$1.29x10^{24}$J/K ?.← $2.7x10^{23}$J/K.

K_G＝$7.09x10^{-10}$?.←$3.5x10^{-10}$.

dT_G/dy＝0.02～0.03K/y ?.← 0.05K/y.

and the conclusions such as prediction on global temperature are largely corrected.Before long(?),more-revised version would be presented.

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