―Arctic Methane Catastrophe Possibility <the General Feedback Circuit Model-(1)>― ’09/9/9,

A simple, but essential **criterion analysis on methan catastrophe** is intoroduced.
(Global year radiative force increase by CH4 eruption)/(melting heat for methan clathrate=MC)＝870. (melt amount≦1GtC).

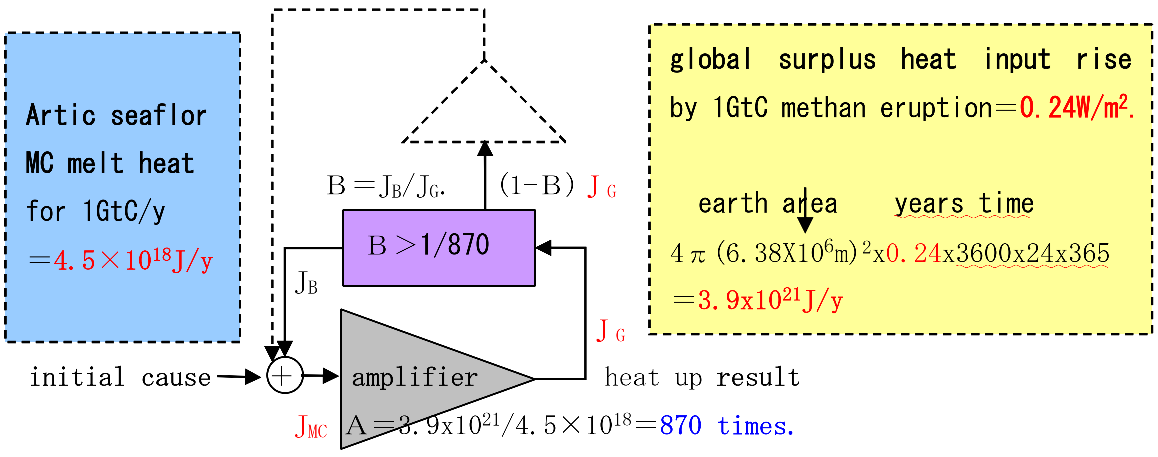
It's an **amplifier gain**＝A by CH4 eruption. So if **feedback loop loss** B≧1/870, then evil positive feedback could begin.
If surplus heat(for irrversible process such as melting)partitioning rate into Arctic J_B be 0.1, then 99% of J_B would be allowable not to hit MC, but 1% hitting could trigger the feedback. If over 3%, the process could be abrupt.
Then note that the criterion depends on the feedback time lag, of which estimation has no confidence. The fatal manmade bad effects is also no in the consideration. That is, the reality may be more severe.

[1]:The General Analysis on Positive Feedback in multi-pathes :

http://www.geocities.jp/sqkh5981g/FAQ-QL-MC-catastrophe.pdf

❶How much could the **dangerous degree** be estimated for methan catastrophe ?<the primitive circuit model>:
<<from eruption(causing instant golobal heat input rise by the GHG concetration jump) to heat back transfer taward melting target of methane clathrate in Arctic sea flor>>.

①Following paragraphe are **very coarse estimation**, but may be essential. Now let's review on positive feedback process. Result is fed back to enhance cause. For example, methan eruption(by heat input J_{MC} on MC at sea flor)cause heat input rise on globe J_G(**radiative forcing**). Amplified gain A＝J_G/J_{MC}.



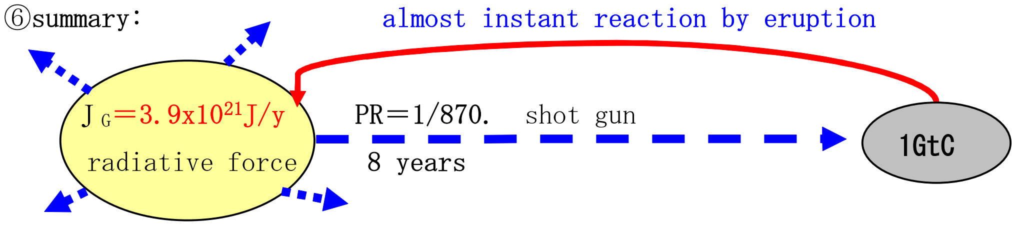
②The feedback partitioning(into MC in Arctic sea flor) ratio＝B. If J_B was larger than J_{MC}, then the system could run away without exterior initial cause input.

③Note that {heat input into Arctic=J_B/global heat surplus=J_G}＞10%.

④Then, if {heat input on MC/heat input into Arctic}＞1/87, run away could be triggered.

⑤A problem of time delay for feedbacking(heat transfer time into seaflor).
0.24W/m² by 1GtC eruption would be reserved constant at least 8 years of methan decay in atmosphere. Therefore time delay could be allowed as within 8 years. Direct solar ray input into arctic sea flor of 200m depth is in a year, while horizontal mean ocean heat transfer from equator to arctic may be a year less than 8 years. Vertical transfer into depth more than 300m may be few in a year.

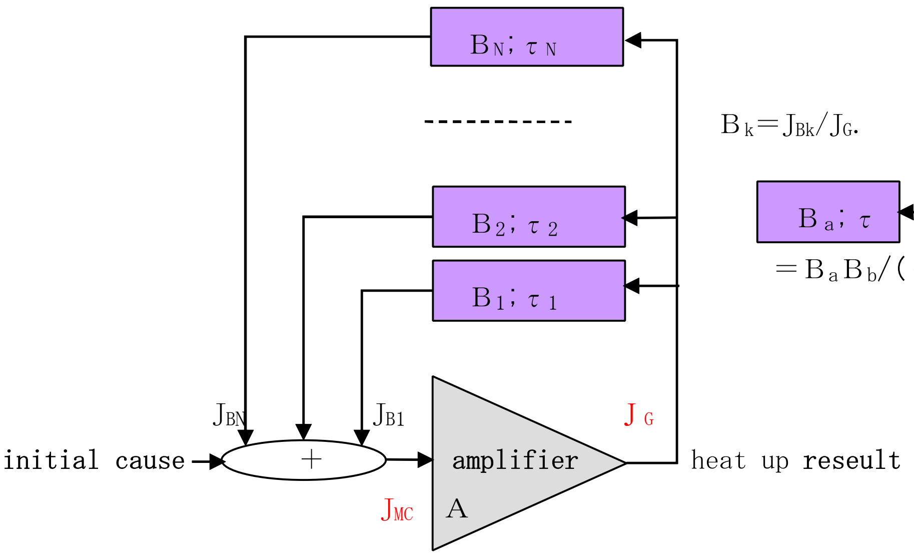
⑥summary:



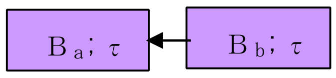
You could hit out the target with probability 869/870 within 8 years.

❷The General Analysis on Positive Feedback in multi-pathes :

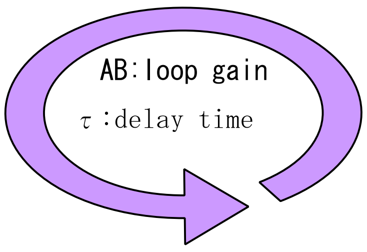
①circuit model:



$B_k = J_{Bk}/J_G.$



$= B_a B_b/(\tau_b + \tau_a)$



②rate equation for of R(t) melting MC amount.

(1) $dR(t)/dt = R(t)\langle A(t)\,\Sigma_{k=1}^{N} B_k(t) - 1\rangle / \{\Sigma_{k=1}^{N} B_k(u)\,\tau_k(t) / \Sigma_{k=1}^{N} B_k(u)\}.$

←→ ″Time change rate of R=R[loop gain−1]/(mean delay time in looping)″

(2) $R(t) = R(0)\exp[\int_0^t du.\,\langle A(u)\,\Sigma_{k=1}^{N} B_k(u) - 1\rangle / \{\Sigma_{k=1}^{N} B_k(u)\,\tau_k(t) / \Sigma_{k=1}^{N} B_k(u)\}].$

＊the criterion on becoming positive feedback is $\{A(u)\,\Sigma_{k=1}^{N} B_k(u) \geqq 1\}$.

＊the amplifier gain A is not linear, but is almost linear=870 times below input level 1GtC melt.

(1) Amplified gain $A \equiv J_G/J_{MC}$ is non-linear for input $J_{MC} = A$(radiative forcing function of CH4 density), which could be derived following formula in (2) with (5).

(2) radiative forcing calculator formula for CH3 with NO.

radiative forcing ΔF measn global heat input rise (W/m^2) by concerned GHG concentration rise of M_0(<u>1750</u>)→M change. That is, methan eruption $\Delta M = (M - M_0)$ causes global surplus heat of $J_G \equiv \Delta Q = 4\pi R_E^2 x \Delta F x 3600x24x365$ in a year(AMP output power). Then note, AMP input power is melting heat for ΔMx440KJ/Kg$= J_{MC}$.

http://ja.wikipedia.org/wiki/%E6%94%BE%E5%B0%84%E5%BC%B7%E5%88%B6%E5%8A%9B

M=CH4 concentration(ppb)、N=that of NO(N_0=310 ppb)、

Methan radiative forcing rise function by M_0→M change with NO=N_0.

$\Delta F = 0.036[\sqrt{M} - \sqrt{M_0}] - \{f(M, N_0) - f(M_0, N_0)\}] \equiv 0.036[\sqrt{M} - \sqrt{M_0}] - \Delta f$。

$f(M, N) = 0.47\ln\{1 + 2.01x10^{-5}x(MN)^{0.75} + 5.31x10^{-15}M(MN)^{1.52}\}$

(3) Methane weight 10GtC and the concentration=4720ppb、

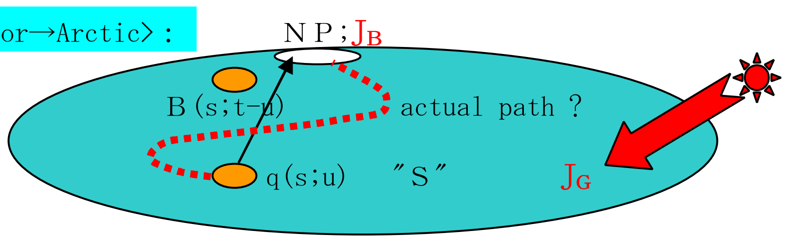
(4) the initial methane concentration M(<u>1750</u>)=700ppb≡M_0 in 1750.　M(<u>2000</u>)=1770ppb=5Gt(CH_4=16g)=3.75GtC(C=12g) in 2000.

(5) Methan clathrate melting heat/kg=440KJ/Kg.　J_{MC}(10GtC)$= 4.5 \times 10^{18}$J/y.

❸Feeedback Pathes:

heat path ″k″		$B_k = J_{Bk}/J_G.$	τ_k
1:	Insolation input on Arctic ocean(L_A)→MC in Arctic seaflor		instant
2:	Insolatin input into ocenas→exterior ocean heat input Aritic(L)→MC		L/v≒0.5y
3:	Atmospheric heat input into Arctic ocean?→MC in Arctic seaflor		
4:	heat output in phase transit of supercooling water?→MC in Arctic seaflor	XXXXXXX	

(1)Heat transfer coarse modeling in ocean circulation<B_S(equator→Arctic)>:



$J_B = \oiint ds \int_0^{t=1} du\, B_S(s;t-u)\, q(s;u) = B_S(s*;t-u*) \oiint ds \int_0^{t=1} du\, q(s;u)$

$J_B \equiv B_S*(\tau) J_G$. :feedback energy flow

$J_G \equiv \oiint ds \int_0^{t=1} du\, q(s;u)$:Total insolation input into oceans.

$B_S(s*;t-u*) \equiv B_S*(\tau)$.

q(s;u) is heat input density on area and time elements ds.dt from J_G. $B_S(s;t-u)$ is heat patitioning rate from position and time=(s,u)into Arctic at time t.It's a model of **linear transfer function**(of partitioning rate B_S with time delay τ).

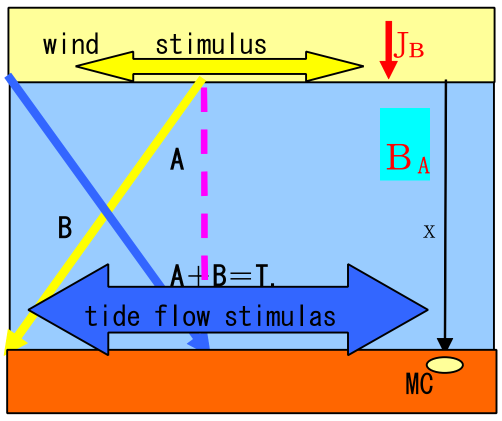
(2)A coarse modeling of heat transfer from ocean upper mixed layer into target MC at seaflor<B_A(upper NP sea → sea flor)>:

http://www.geocities.jp/sqkh5981g/PSEUDO-DIFFUSION-BY-TURBULANCE.pdf.

(a)Our concern depth of Arctic ocean is limited **within 200m～1300m** where MC could be.Its rather shallow depth where author assume monotonous distribution of ocean tubulance by both tidal flow in deeper and sea surface wind in shallower. An ocean covection with warmer upper layer and colder lower layer never transfer heat from up into bottom.

(b)Pseudo diffusion processs by exponetial function distribution $q(x;t) \equiv (1/\nu_0 t)\exp(-x/\nu_0 t)$.

→ $\langle x\rangle = 1/\lambda = (\nu_0 t)$。Average depth at time t with 37% heat flow passing. $\langle x\rangle = 2/\lambda = (2\nu_0 t)$ with 14% hfp.



(c)The problem of hitting probability on target MC by heat input.

In our scheme of B_A,it had been already counted in.

More details could be seen in the following.

http://www.geocities.jp/sqkh5981g/target-hitting-probability.pdf.

(3)Actual observed data:

Those are most weak point in this report.After all,author could not find reliable data for those parameter{$B*(\tau)$}.

[2]:Conclusion by data assumped values.

	A(radiative force gain) =Er(M)/Em(M).	? $B = B_S$(equator → NP(Arctic)) × B_A(upper NP sea → sea flor).	? $\tau = \tau_S + \tau_A$.	$(AB-1)/\tau \equiv K$.	$\exp[\int_0^1 du.\, K]$
10MtC	$870 = 3.9\mathrm{x}10^{19}$J/y/$4.5\times10^{16}$J/y	0.10x0.01=0.001	0.5y+0.5y	(0.87-1)/1=0.	-
		0.10x0.012=0.0012	0.5y+0.5y	(1.0-1)/1=0.	1
		0.10x0.03=0.003	0.5y+0.5y	(2.6-1)/1=1.6	5
		0.10x0.03=0.003	0.5y+1.0y	(2.6-1)/1.5=1.0	2.7
		0.10x0.03=0.003	0.5y+1.5y	(2.6-1)/2=0.8	2.2
100MtC	$870 = 3.9\mathrm{x}10^{20}$J/y/$4.5\times10^{17}$J/y	0.10x0.01=0.001	0.5y+0.05y	(0.87-1)/0.5=0.	-
		0.10x0.03=0.01	0.5y+1.0y	(2.6-1)/1.5=1.07	3
1GtC	$870 = 3.9\mathrm{x}10^{21}$J/y/$4.5\times10^{18}$J/y	0.10x0.01=0.001	0.5y+0.05y	(0.87-1)/0.5=0.	-
		0.10x0.03=0.03	0.5y+0.5y	(2.6-1)/1=1.6	5
10GtC	$580 = 2.6\mathrm{x}10^{22}$J/y/$4.5\times10^{19}$J/y				

☞:全球余剰不可逆化熱の北極海分配が 0.1=10%を仮定、北極入力不可逆化熱=B_A の 99%は海洋水温上昇等に消費しても OK,
だが 1%が MC に当たると正帰還。勿論海底の何処にどの程度分布かが大問題、なほ北極にも小型ハリケンがあると言う。
危険な海洋攪乱に作用、臨界間じかならば Berign strait を閉じてタイムラグを大きくする方法もある。