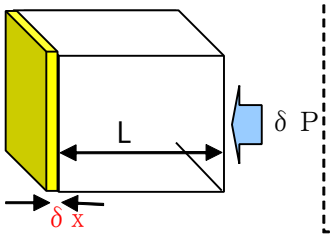
Cold Sea Water Upwelling(singular spot at warming offshore).2013/4/16.

Radical **convection** between cold and hot spot could cause **climate anormalies**.
Recently global ocean has been warming,while many of coastal offshore seems to be colder by **cold deep sea water upwelling** by ocean current colliding with coast.

Cold sea water is transfered from cold N&S zone through rather deep sea to hot equator and upwell at equator zone,which is caused by Heat&Mass-Imbalance with coliori force. These phenomena seems to become dominant for the regional climate in global warming. Because almost ocean surface is becoming warmer,while those upwelling sea water temperature unchanged.**Relatively temperature difference** between those would rise,which also would cause climate singularity in those regions.

(1)**Vitual Experiment**(,but not actual ocean fluid dynamics) : **Even a massive oncean volume could be displaced by slight pressure in very long time in virtual free space.**



$M=\rho V=\rho LS. \rightarrow M(dV/dt)=S\delta P. \rightarrow dV/dt=\delta P/\rho L.$
*this is a simple constant accelated motion dynamics.
$\delta x=(\delta P/\rho L)\int_0^t du \int_0^u dv=(\delta P/\rho L)t^2/2.$
Ocean mass is outrageous,while pressure variation δP is very small,however long time could reveal displacement $\delta x=1m.$

example) $L=6,38\times10^6 m$ (earth radius) $\times\pi/2$, $\rho=1000kg/m^3$. $\delta x=1m.$
$\delta P\sim1N/m^2. \rightarrow t=\sqrt{(2\delta x\rho L/\delta P)}=141575s,$
$\delta P=1\times10^{-4}N/m^2. \rightarrow t=1.41575\times10^7 s=164days.$
"Note,thus, even **a slight pressure** could be **macroscopic in ocean in long times**".

(2)By heat expansion in tropical ocean, what flows change $\delta(\rho V)$ in global would happen?. See (11). Heat expansion would reflect in pressure change $P\rightarrow P+\delta P$.

(3)**heat convenction** : ＊1atm=101325Pa
$P(x)=gx\rho$. pressure of depth=x.
$\delta P/P=\delta\rho/\rho. \rightarrow \rho\sim(1.0275(8℃)-1.0255(18℃))/1.0265)=0.002(10℃)$
$P(x=100m)\sim100atm=101325\times100=1\times10^7 N/m^2.$
$\delta P=1\times10^7 N/m^2\times0.001=10000N//m^2.$
$t=\sqrt{(2\delta x\rho L/\delta P)}=\sqrt{(2\times1m\times1000kg/m^3\times100m/10000N/m^2)}=4.5sec,$ ...bubble-upstream

⑷**state equation of sea water in 1st order approximation.**

http://www2.kobe-u.ac.jp/~iwayama/teach/gfd/2010/chap4.Pdf

$\rho = \rho\,[[1+\alpha\,(T-T_0)+\beta\,(s-s_0)+\gamma\,(P-P_0)]$.

⑸**What makes pressure P (surface force) in fluid dynamics.**

In general amateure without big computer on fluid-dyamics calculation,physical insights would be necessary. Following reviews might be usefull.

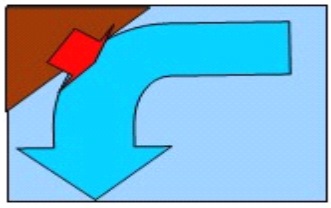
$D(\rho\,\mathbf{V})/Dt = \mu\,\nabla^2\mathbf{V} - \mathrm{grad}\,P + 2\rho\,\mathbf{V}\times\Omega + \rho\,\mathbf{g}$. <Fluid Equation>

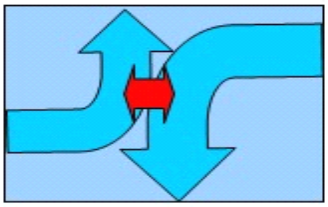
$-\mathrm{grad}\,P = D(\rho\,\mathbf{V})/Dt - 2\rho\,\mathbf{V}\times\Omega - \rho\,\mathbf{g}$.

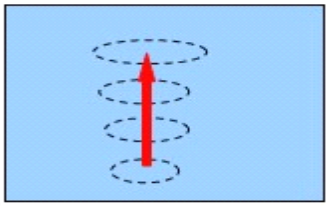
$-\mathrm{grad}\,\delta P = \delta\langle D((\rho\,\mathbf{V}))/Dt\rangle - 2\rho\,\delta\,\mathbf{V}\times\Omega - \delta\,\rho\,\mathbf{g}$.

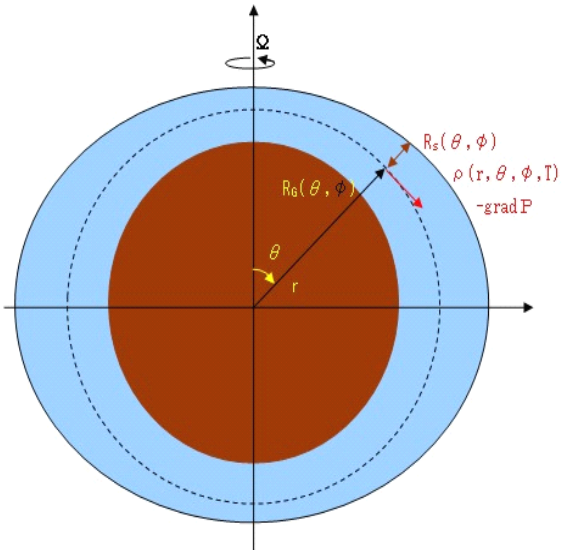
pressure change=kinetic reaction force+coliori change+density change in gravity.

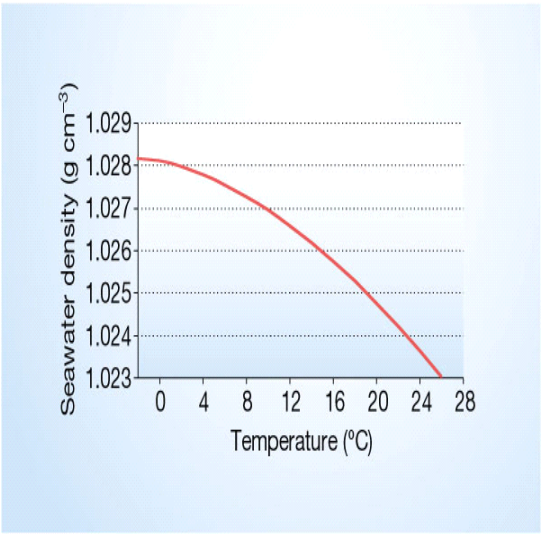
That is,fluid kinetic change(such as **flows collision,** or **flow bending by boundary topography of coast**)(pressure as surface force) and **heat convection**(volume force of $\delta\,\rho$)could cause pressure change= $\delta\,P$.Above all,**coliori force**(volume force) seems **dominant** in ocean current dynamics.











http://www.nature.com/nature/journal/v428/n6978/fig_tab/428031a_F1.html

(6)**Driving Forces for Ocean Current:**

Amateure has no computer for fluid-dynamics,so qualitical insight would be necessary.

(a)**all kind of forces are expressed in right terms of NS equation.**

$D(\rho \mathbf{V})/Dt = \mu \nabla^2 - \mathrm{grad}\,P + 2\rho \mathbf{V} \times \Omega + \rho \mathbf{g}$.

$\mu \nabla^2$ =friction between adjacent fluid,and may be neglegible in macro-scale.

$-\mathrm{grad}\,P$ =surfacial pressure,

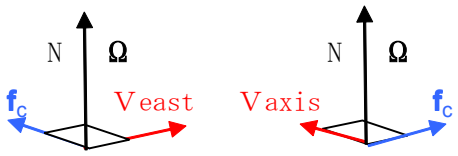
$2\mathbf{V} \times \Omega$ =Coliori force.

$+ \rho \mathbf{g}$=gravity force(earth and moon(tide)).Cetrifigual force is neglegible ??.

(b)**free running** $\mathbf{V}$=constant for time and space**:**

$0 = D(\rho \mathbf{V})/Dt = \rho \{\partial \mathbf{V}/\partial t + \mathbf{V}.\mathrm{grad}.\mathbf{V}\}$.

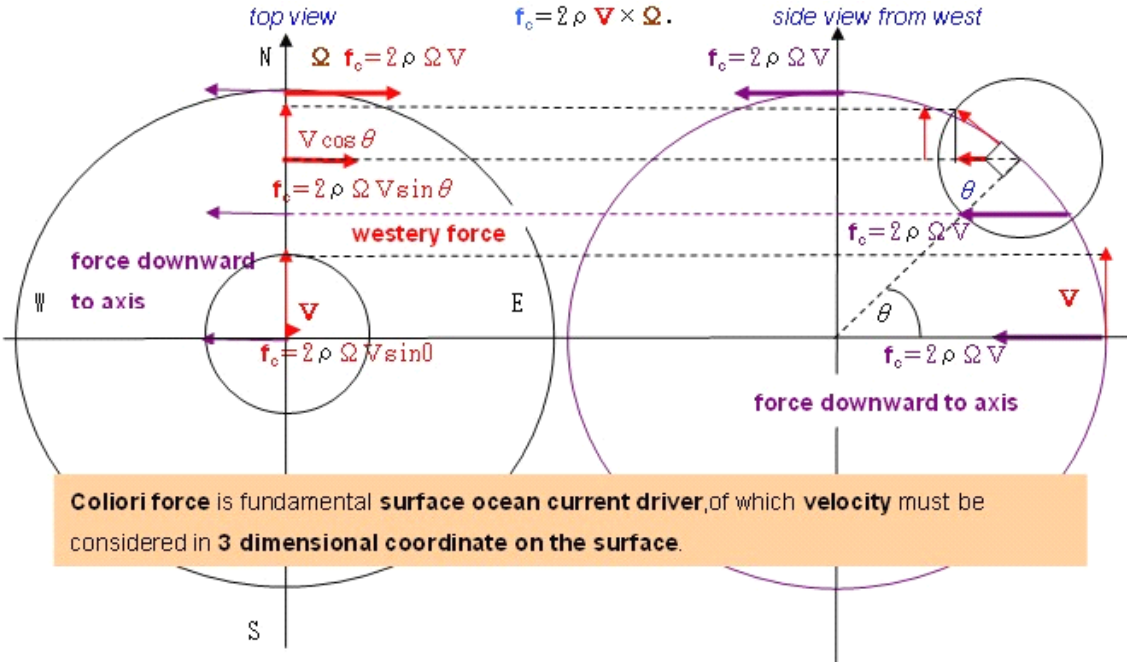
＊almost time,ocean current is free running **without force**,but always with $2\rho \mathbf{V} \times \Omega$.



the toward is gravity-direction for Veast, and westward for Vaxis(north).

(c)**Coliori force with coastal pressure as guide ditch for ocean current.**

the complete understanding for currents form equator to north pole..



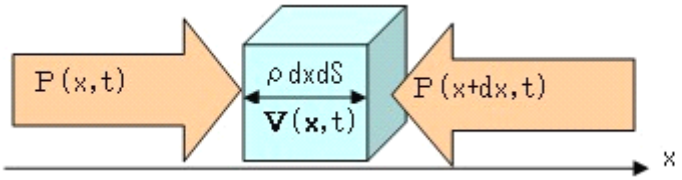
Coliori force is fundamental **surface ocean current driver**,of which **velocity** must be considered in **3 dimensional coordinate on the surface**.

(d)**gravity force:** $-\mathrm{grad}\,P-\rho g=0$. in most of case.<<$g=9.8\mathrm{m/sec}^2$>>

$-\partial P/\partial z=-\rho g$. $P(z)=\rho gz$. (z=depth from sea surface, atmospheric hight)

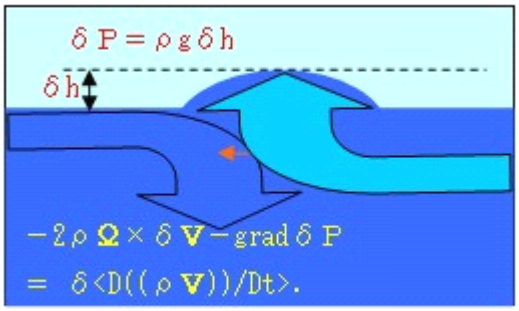
＊note pressure is no directional for any surface.

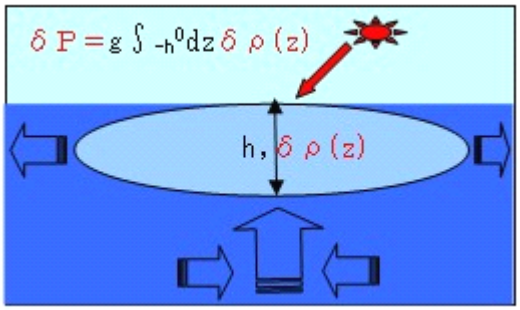
(e)**longitudinal surfacial pressure(acoustic sound-like):**<this is rather shaky>

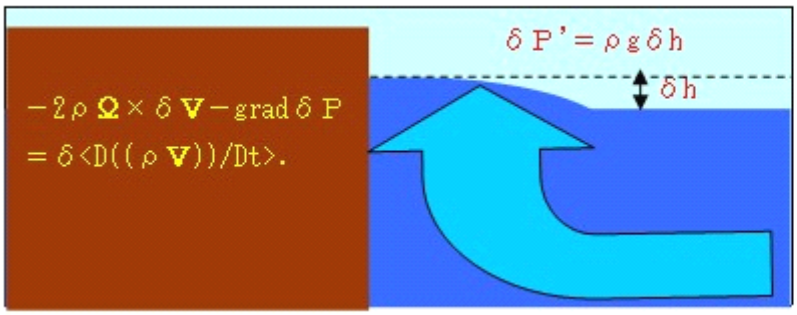


$df_x=\partial(\rho V_x dxdS)/\partial t+\rho\,\mathbf{V}\cdot\mathrm{grad}\,V_x=ds[P(x)-P(x+dx)]=dSdx(-\partial P/\partial x)$.

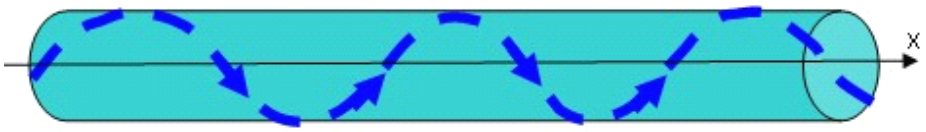
(f)**force by current collision and upward force by heat expansion,etc.**







Following is due to stational **herical flow solution** of non-linear NS equation in 1 dimension.



(g)**transversal elliptic pressure-like force: upwelling**

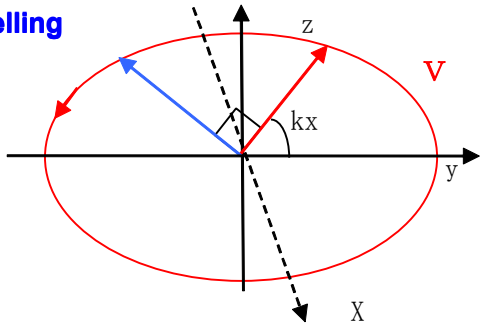
$\mathbf{V} \equiv [u, Y\cos(kx), Z\sin(kx)]$.

$\mathrm{grad}\,V_1 = [0, 0, 0]$.

$\mathrm{grad}\,V_2 = [-kY\sin(kx), 0, 0]$.

$\mathrm{grad}\,V_3 = [kZ\cos(kx), 0, 0]$.

$\mathbf{f} = \mathbf{V}\,\mathrm{grad}\,\mathbf{V} = uk[0, -Y\sin(kx), Z\cos(kx)]$.



(h)**transversal elliptic pressure-like force:downwelling**

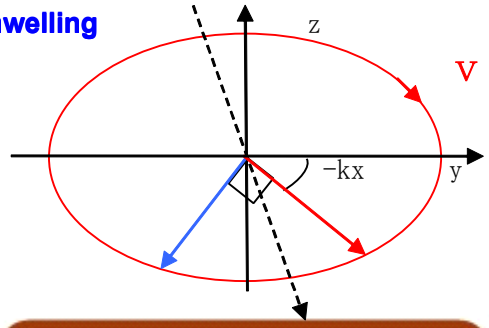
$\mathbf{V} \equiv [u, Y\cos(-kx), Z\sin(-kx)]$.

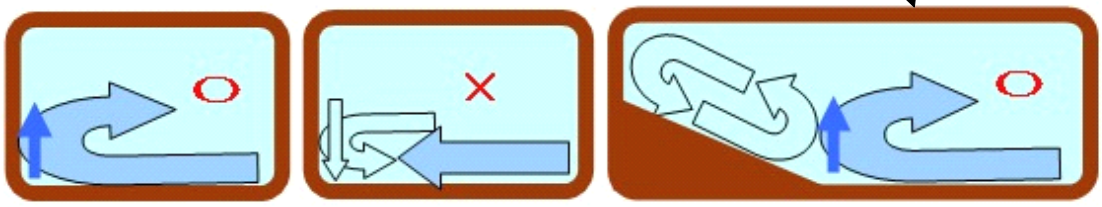
$\mathrm{grad}\,V_1 = [0, 0, 0]$.

$\mathrm{grad}\,V_2 = [kY\sin(-kx), 0, 0]$.

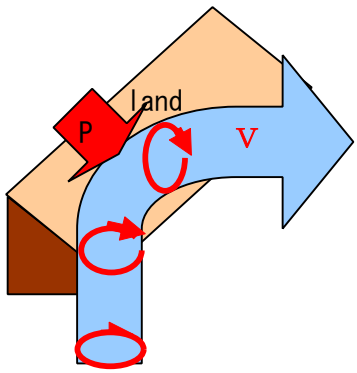
$\mathrm{grad}\,V_3 = [-kZ\cos(-kx), 0, 0]$.

$\mathbf{f} = \mathbf{V}\,\mathrm{grad}\,\mathbf{V} = -uk[0, -Y\sin(-kx), Z\cos(-kx)]$.



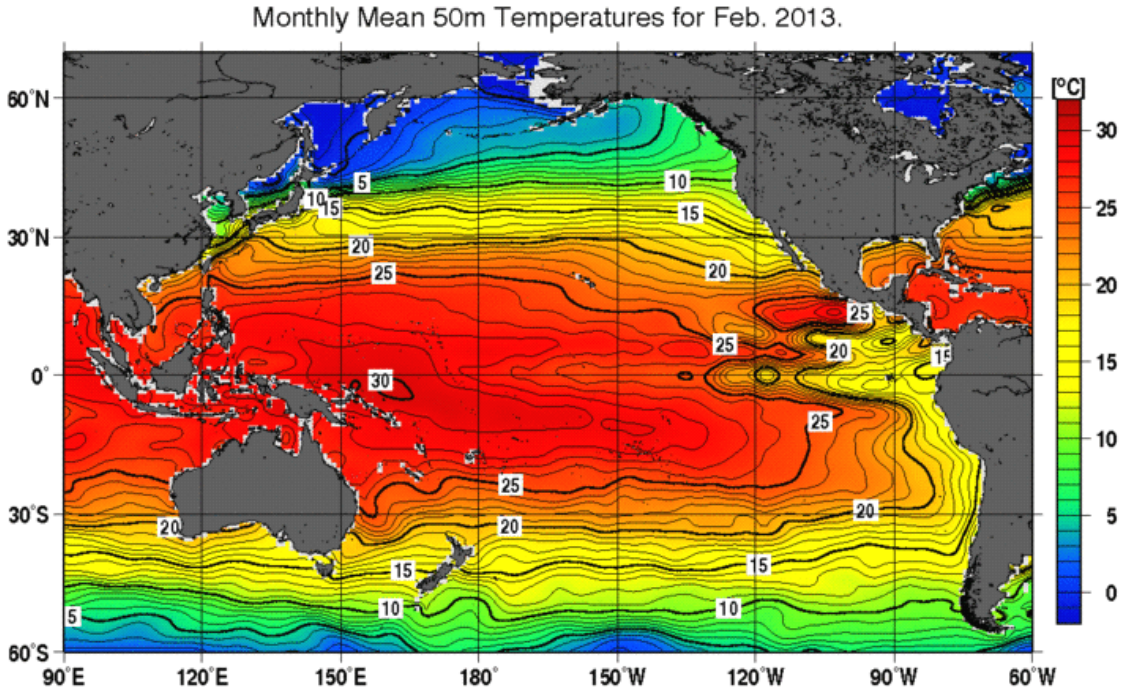


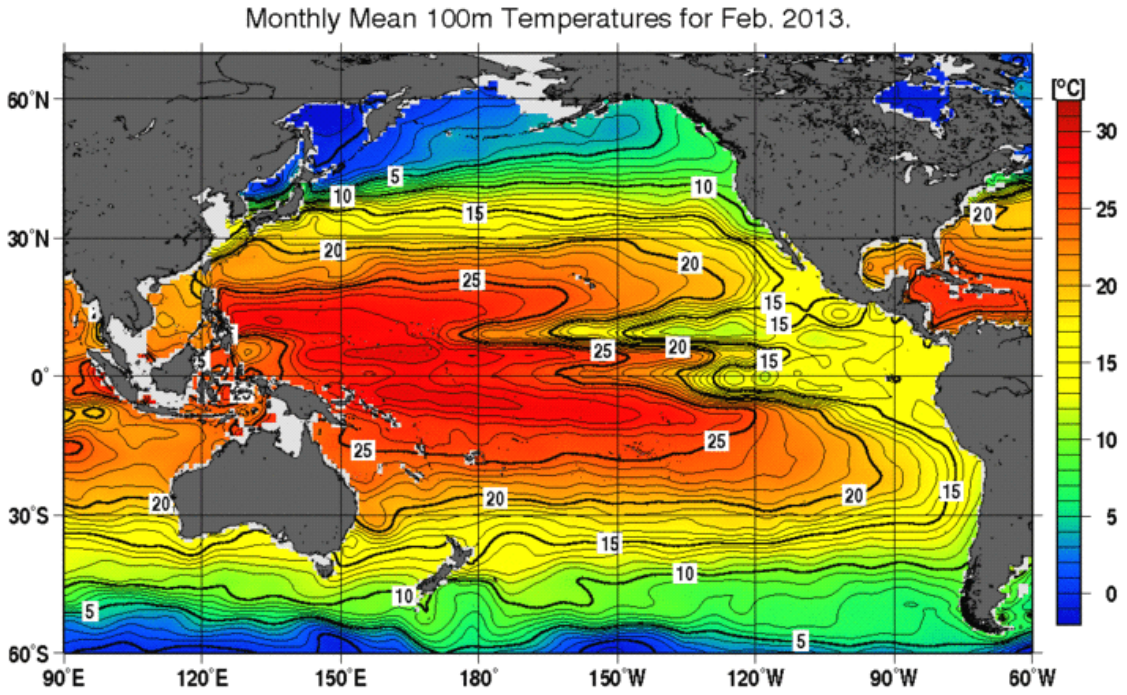
Then ocean heavy lower layer may be likely to go straight to coast,while light upper layer would turn at first.Which is nothig, but upwelling of cold water in lower layer.



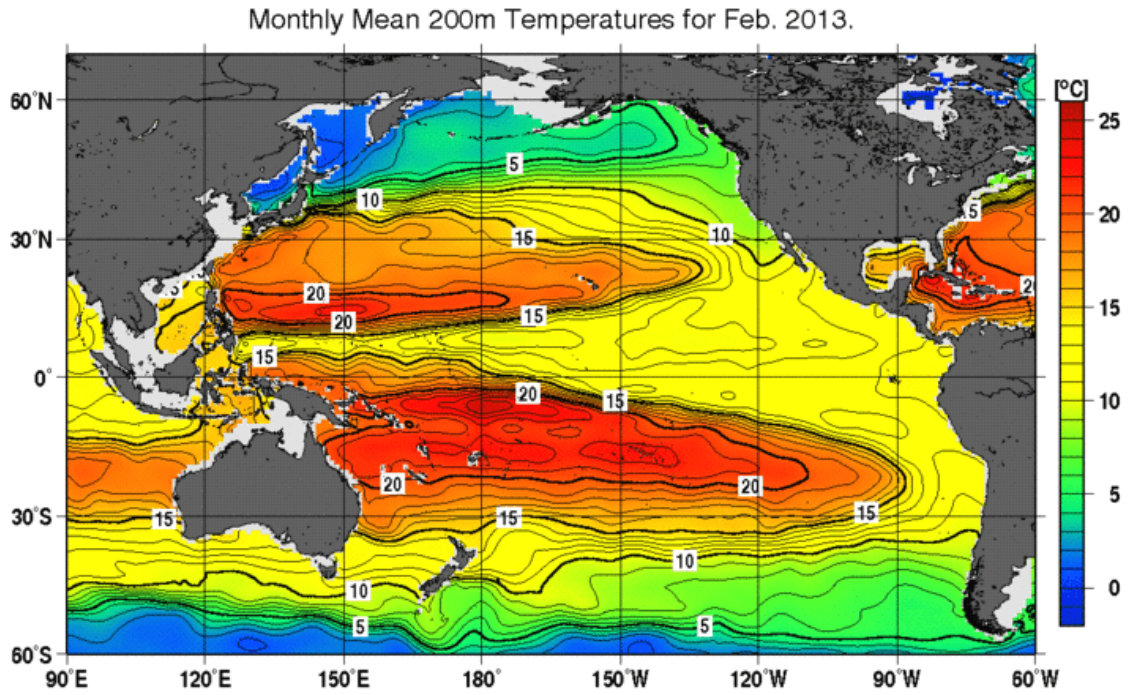
(7)**Monthly Mean 50,100,200,400m Temperature for 2013_February**

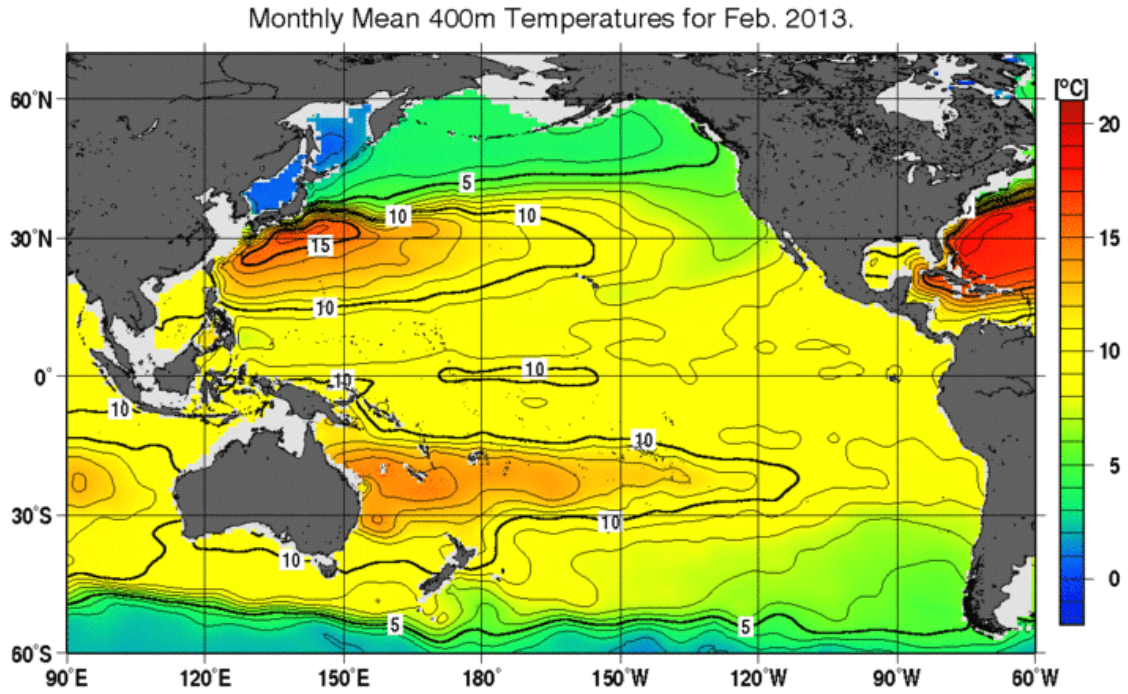
http://www.data.kishou.go.jp/db/kaikyo/monthly/subt_pac.html





As upper layer is wamer than lower one.so upper layer has lower mass density,while lower one has higher one,which drives force for **upwelling pressure**.Especially note **West Ecuador**(equator) is stating point of **equator current**,also which induce massive **upwelling**.

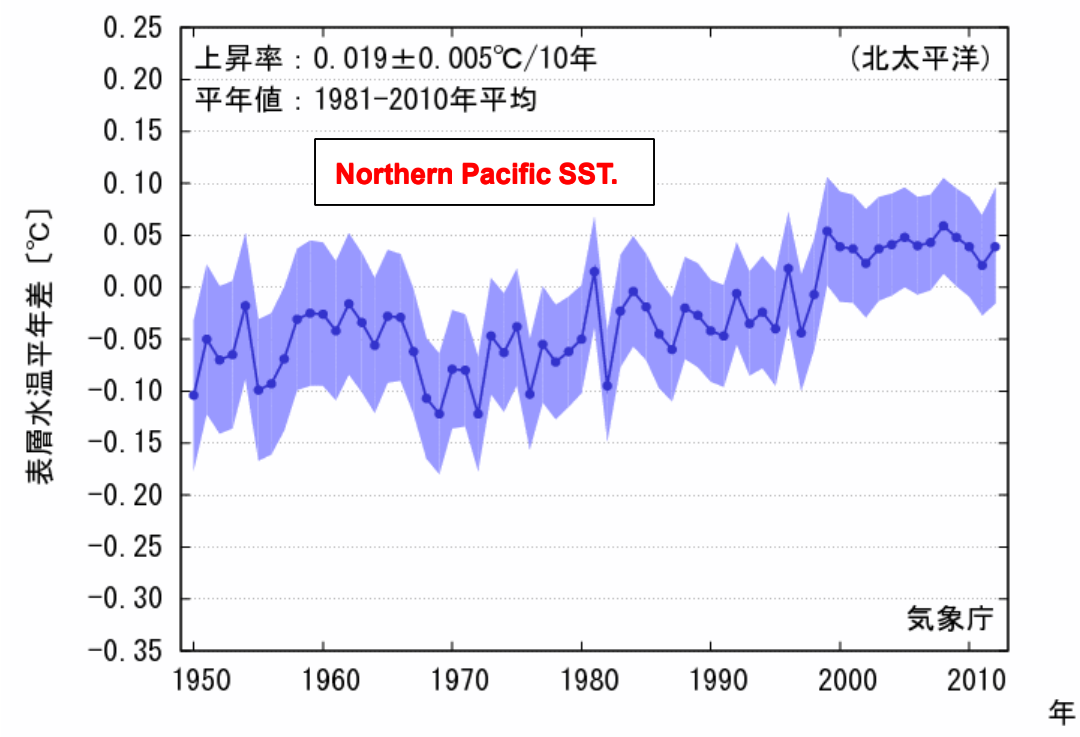




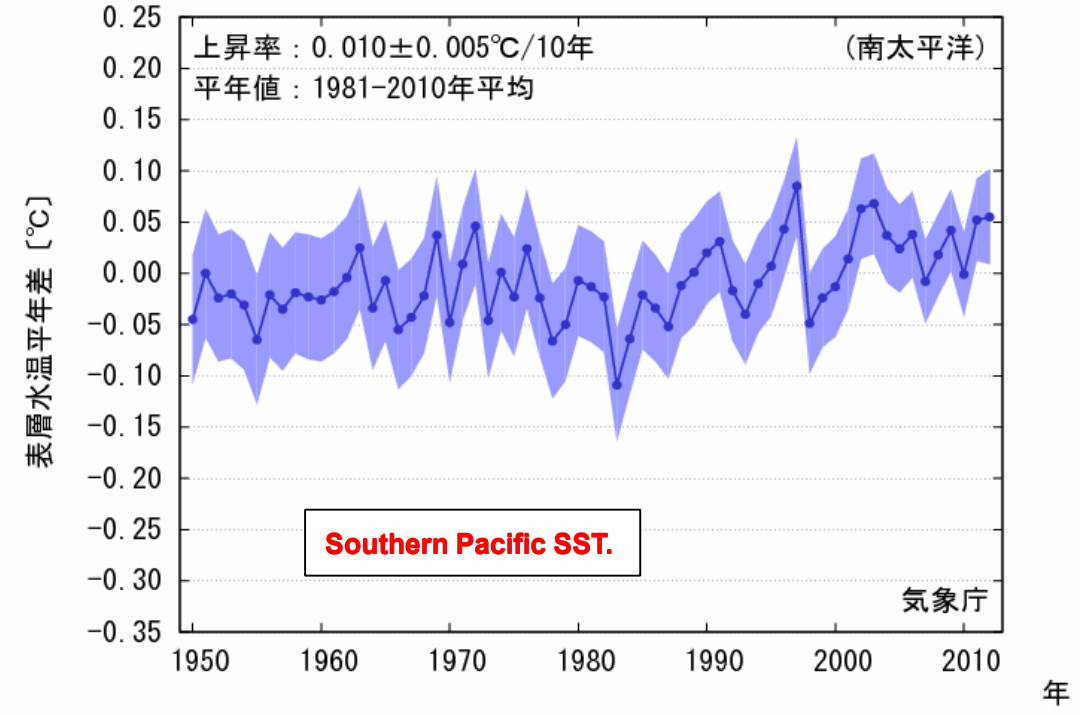
Also upwelling from 400m(10℃) to 200m(15℃) can be seen.

⑻**Each ocean SST**(Sea Surfece Temperature)**,long trend of heat reseving variation.**

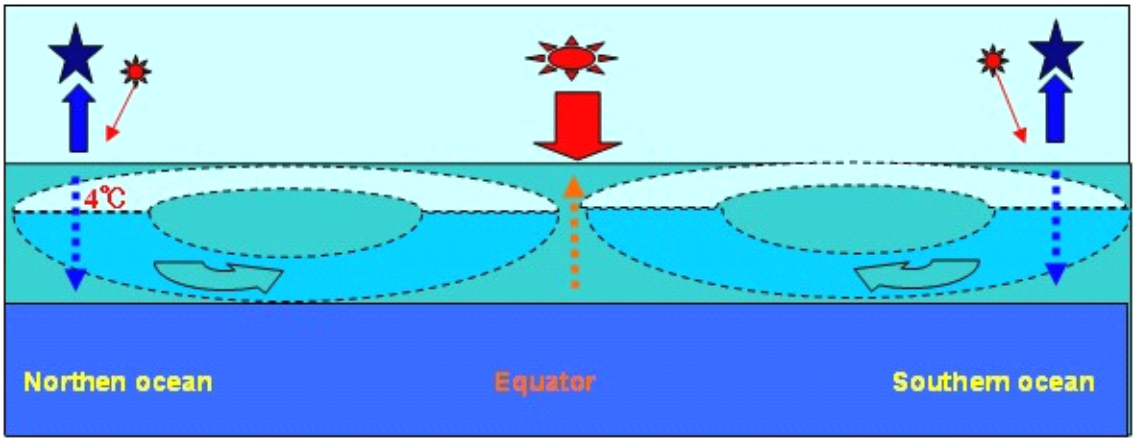
http://www.data.kishou.go.jp/db/mar_env/results/ohc/ohc_region.html

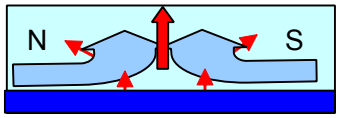


Southern Pacific SST



⑼Note you could see that cold northern pacific temperature is more rise(0.019/10yr),while that of hot southern pacific is less rise(0.010/yr).This fact is nothing but that heat input from Southern into Northern pacific is more,while Southern paicific has cold input by **lower cold layer upwelling**(transfered from N&S cold region).

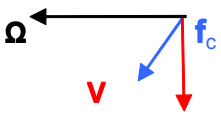


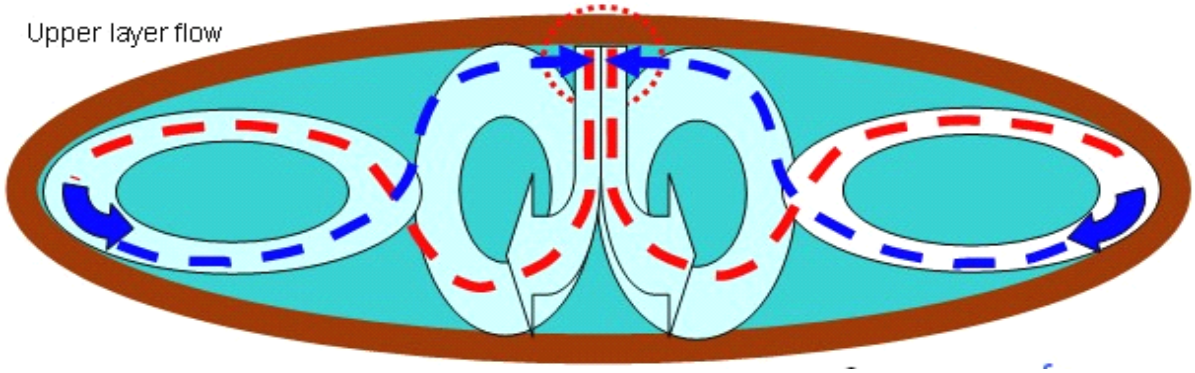


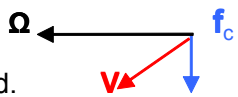
Upwelling force at equator is upward momentum change from S&N current momentum collison. -gradP=**V.**grad**V**.

Upwelling force at equator is also sea water density gradient by sunheat. Equator current from east to west is driven by coliori force＝f_c on upwelling velocity(**V**) .

$f_c=2\rho \mathbf{V}\times\mathbf{\Omega}$.



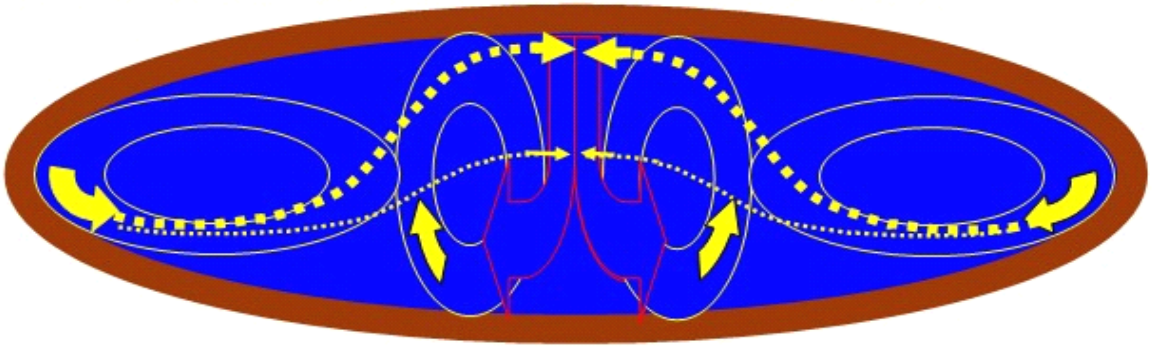




Note westward velocity is also driven by coliori foce of downward.

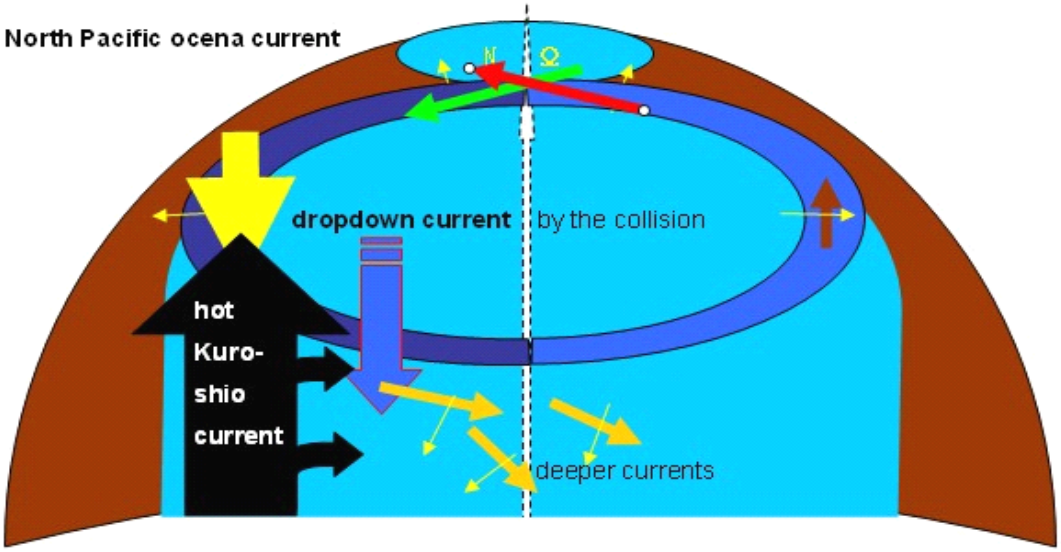
Which may be cancelled with upward force of upwelling ??.

Lower layer flow in Pacific Ocean(author's coarse guessing,but **not authorized**)



Downwelling mechanism at N(&S) zone may has something symmetry for upewelling at equator. One of **downwelling force** at N(&S) zone is density gradient by heat disipation. Another Is coliori force on westward velocity mentioned in just above.Then the downward velocity generates eastward coliori force force for counter-clockwise circulation(N).

⑽**Downwelling of cold sea water in pacific ocean**(author's coarse guessing)



The counter clockwise current generate coliori force toward anti-center.Those near coast(upper side of the ring),thereby,flows along coast by pressure balance between the outerward coliori force(yellow arrows) and responding opposite force from coast face. **Then east side coast become lowest sea water temperature with heaviest weight(4℃) with falling down toward sea bottom**.Moreover,**collision with wamer Kuroshio-current** would override on colder pacific ocean current,which causes **futher downwelling force**. The downwelling currents,then,directs toward east(larger yellow arrows).
Those has been going on toward equator.See fig of

Monthly Mean 400m Temperature for 2013_February(4)**.**The colder and warmer currents collision may be chaotic in dynamic view point,so the current after the collision may become more random orient to cause weak,but wide directional currents.

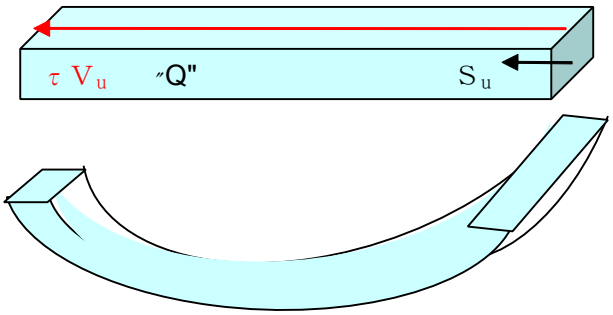
Temporal conclusion:

Heat exchange between cold pole zone to hot Equator has been accelating.

Cold heat in pacific ocean may be transfered under lower layer from **Northern Paciific to Equator** within 1000m layer current,of which **time constant** may be within **decade(?)**.

Because surface layer current form EQ to Northern Pacific takes few years$\equiv \tau$,then the ciculation amount flow Q in upper layer and lower one must be **contienous**(incoming$=$ outgoing/cycle).Therefore those time constant and flow velocity should be related as follows.

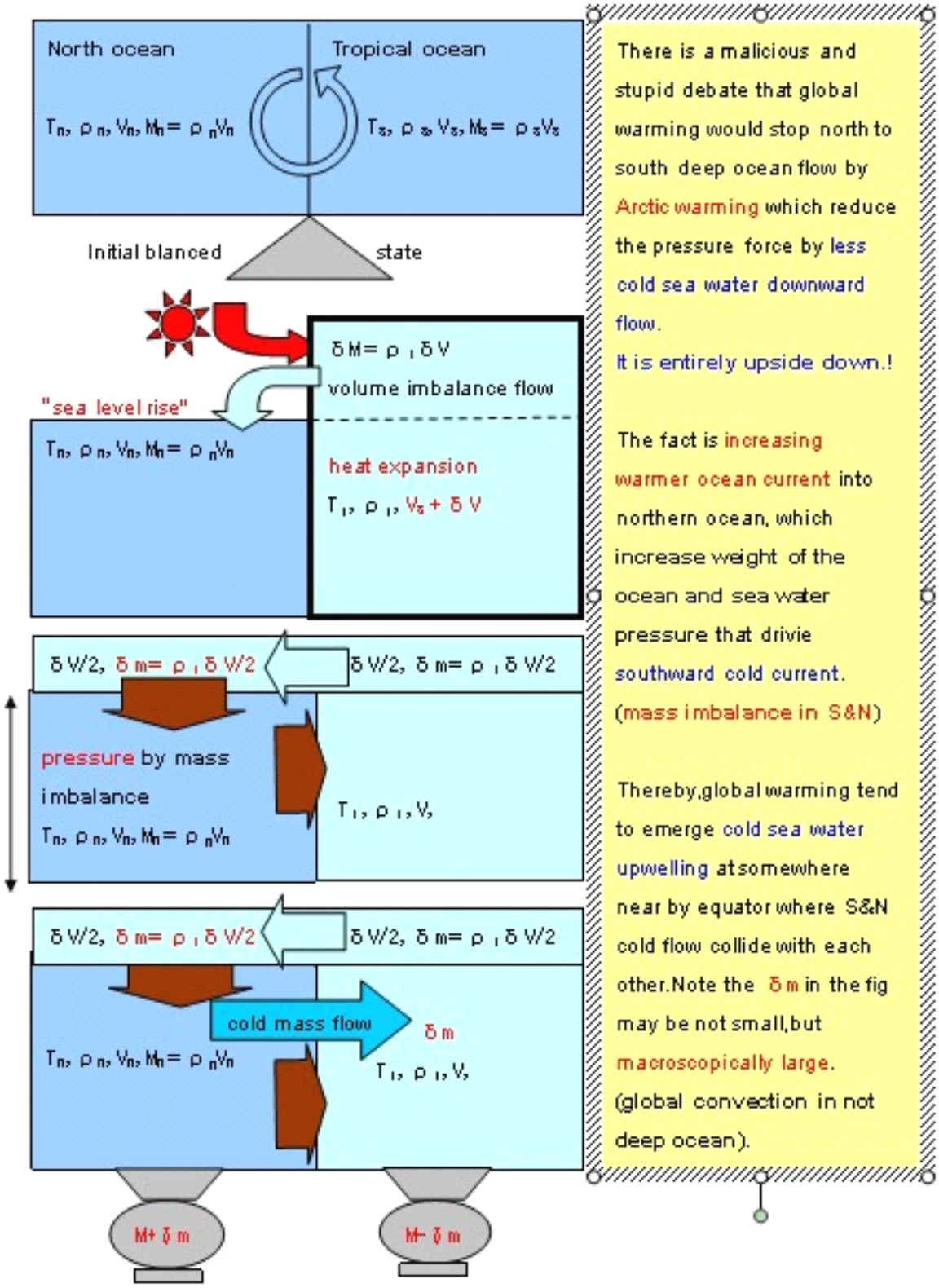
S is cross section of flow.**Total flow amount in one cycle** $Q=\tau\langle V_u S_u\rangle=\tau\langle V_L S_L\rangle$.



V_u may be 2 year from equator to north.If $S_u=1$ and $S_L=10$, then V_u may be 2 decades.

Also note recent years atmospheric heat exchange between cold pole zone to hot Equator has been accelating by Arctic ocean warming,which has been causing severe **heat wave** in summer while severe **cold wave** in winter by increasing pusshing force on cold air mass at Arctic. Climate has been becoming wild. Also in oceans,heat exchange between cold and hot zone would be accelated by global warming deepened.

⑾**Heat expansion and mass imbalance causes convection flow by pressure gradient.**<<The extremly coarse,but simple explanation>>



There is a malicious and stupid debate that global warming would stop north to south deep ocean flow by Arctic warming which reduce the pressure force by less cold sea water downward flow.
It is entirely upside down.!

The fact is increasing warmer ocean current into northern ocean, which increase weight of the ocean and sea water pressure that drivie southward cold current. (mass imbalance in S&N)

Thereby,global warming tend to emerge cold sea water upwelling atsomewhere near by equator where S&N cold flow collide with each other.Note the δm in the fig may be not small,but macroscopically large. (global convection in not deep ocean).