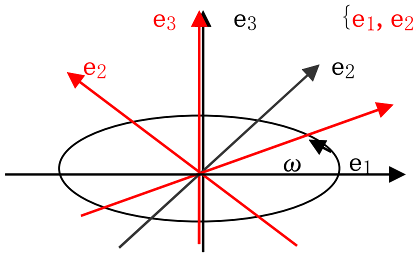
Appemdix_1:Dynamics in Rotational Coordinate. 2013-3-27,31,4/18

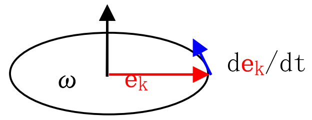
(1)coordinates: $\{e_1, e_2, e_3\}$ is inertia fixed coordinate(IC).

$\{e_1, e_2, e_3\}$ is non-inertia rotational coordinate(NC)

with **angular velocity vector** $\equiv \omega$.



Then note that $de_k/dt = \omega \times e_k$.



(2)position vector: $R = \Sigma_{k=1}^{3} R_k e_k$.

(3)velocity vector:

$V = dR/dt = \Sigma_{k=1}^{3}(dR_k/dt)e_k + \Sigma_{k=1}^{3} R_k (de_k/dt) = \Sigma_{k=1}^{3}(dR_k/dt)e_k + \Sigma_{k=1}^{3} R_k(\omega \times e_k)$

$= \Sigma_{k=1}^{3} V_k e_k + (\omega \times R) = V + (\omega \times R)$.

(4)**accelation vector** α:

$\alpha \equiv dV/dt = \Sigma_{k=1}^{3}(dV_k/dt)e_k + \Sigma_{k=1}^{3} V_k (de_k/dt) + (d\omega/dt \times R + \omega \times dR/dt)$

$= \Sigma_{k=1}^{3}(dV_k/dt)e_k + (\omega \times V) + d\omega/dt \times R + \omega \times \langle V + (\omega \times R)\rangle$

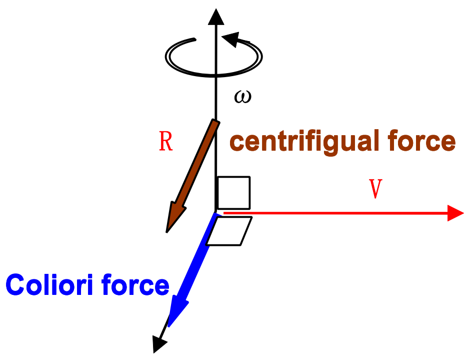
$= dV/dt + 2(\omega \times V) + \omega \times (\omega \times R) + d\omega/dt \times R$ "in climate science, $d\omega/dt = 0$".

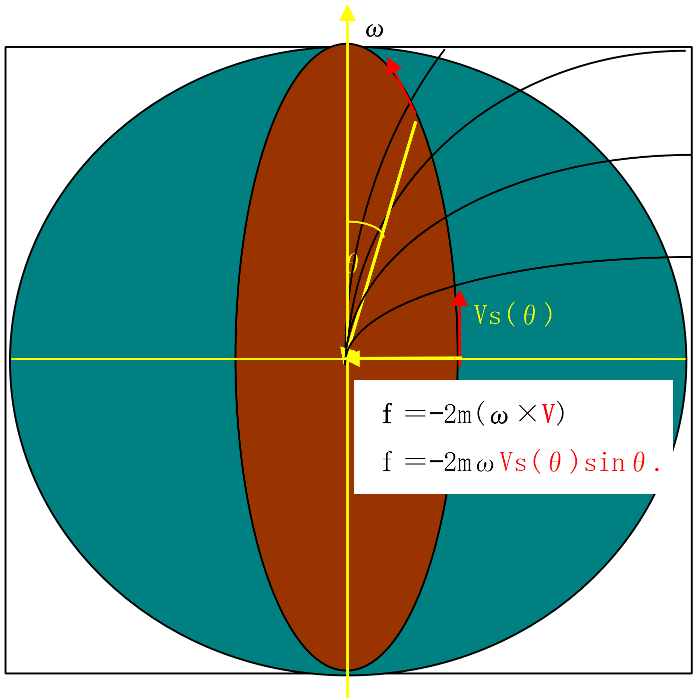
$f \equiv m dV/dt = m dV/dt + 2m(\omega \times V) + m\omega \times (\omega \times R)$.

(5)$f \equiv m dV/dt$、$f \equiv 0$, free motion in IC and Coliolis force in NC.

$f \equiv m dV/dt$ $f \equiv 0. \rightarrow 0 = m dV/dt + 2m(\omega \times V) + m\omega \times (\omega \times R)$.

$\rightarrow m dV/dt = -2m(\omega \times V) - m\omega \times (\omega \times R) \equiv$ **Coliori force** + **centrifigual force**.





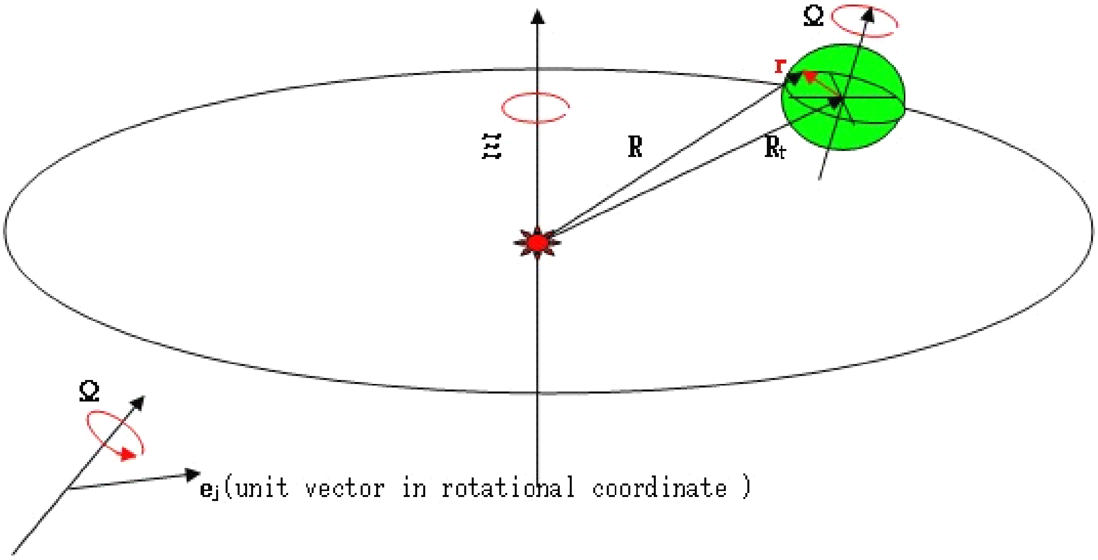
＊Earth centrifigual force(R=radius)

$= -\rho\, \omega \times (\omega \times R) \ll \rho g$

=gravity force,so it(0.34%) is

neglegible in geophysics.

(6)**Orbital Force**



$de_j/dt = \Omega \times e_j$.

Traveling=R_t and self-rotational coordinate=r:

$R \equiv r + R_t$.

$V \equiv dR/dt = dr/dt + dR/dt_t = d(r_j e_j)/dt + dR/dt_t = v + (\Omega \times r) + dR_t/dt$。

$d(r_j e_j)/dt = e_j dr_j/dt + r_j de_j/dt = e_j dr_j/dt + r_j(\Omega \times e_j)$.

$= v + (\Omega \times r)$.

$A \equiv d^2R/dt^2 = e_j d^2r_j/dt^2 + de_j/dt.\, dr_j/dt + dr_j/dt(\Omega \times e_j) + r_j(\Omega \times de_j/dt) + dR_t^2/dt^2$

$= e_j d^2r_j/dt^2 + 2dr_j/dt(\Omega \times e_j) + r_j(\Omega \times (\Omega \times e_j)) + dR_t^2/dt^2$.

$= e_j d^2r_j/dt^2 + 2(\Omega \times v) + (\Omega \times (\Omega \times r)) + dR_t^2/dt^2$.

$\alpha \equiv e_j d^2 r_j/dt^2 = A - 2(\Omega \times v) - (\Omega \times (\Omega \times r)) - dR_t^2/dt^2$.

$dR_t^2/dt^2 = E_j d^2R_{tj}/dt^2 + 2(\Xi \times v_t) + (\Xi \times (\Xi \times R_t))$

$e_j d^2 r_j/dt^2 = A - 2(\Omega \times v) - (\Omega \times (\Omega \times r)) - 2(\Xi \times v_t) - (\Xi \times (\Xi \times R_t))$.

$\Xi = \Omega/365$, while R_t=earth raidius×23500。 1:24h-23500:8760h// velocity ratio=1/24 : 23500/8760=1 : 64.4times, $\Xi V : \Omega v = 64.4/365 : 1 = 0.176 : 1$

Orbital coliori force is smaller than spin coliori one,but might be not neglegible.

Appemdix_2:

Large space and time scale view by scaling transformation(Reinolds analogy low) .

So called Chaos in fluid equation is due to friction term $\mu \nabla^2 u$, which causes long term weather prediction difficult.However a method could overcome the difficulty.

Fluid equation could be transformed into new space and time variables{x',t'} from {x,t} by $\{x \equiv Lx',\ t \equiv (L/U)t',\ \rho \equiv \rho';\ m \equiv L^3 m',\ \Omega \equiv \Omega'\}$

$u \equiv \partial x/\partial t = \partial(Lx')x/\partial((L/U)t') = u\,\partial x'/\partial t' = Uu'$.

$\alpha \equiv \partial u/\partial t = \partial(Uu')/\partial((L/U)t') = (U^2/L)\,\partial u'/\partial t' = (U^2/L)\,\alpha'$.

$P \equiv f/x^2 = m\alpha/x^2 = L^3 m'(U^2/L)\alpha'/(Lx')^2 = U^2 m'\alpha'/x'^2 = U^2 p'$.

$\partial P/\partial x = (U^2/L)\,\partial p'/\partial x'$.

$\rho \equiv m/x^3 = L^3 m'/(Lx')^3 = m'/x'^3 = \rho'$.

$\partial^2 u/\partial x^2 = \partial^2(Uu')/\partial(Lx')^2 = (U/L^2)\,\partial^2 u'/\partial x'^2$

$-2\rho\,\mathbf{\Omega}\times u = (U)2\rho'\,\mathbf{\Omega}'\times u'$

$\rho\{\partial u/\partial t + u.\mathrm{grad}u\} = -\mathrm{grad}P + \mu\nabla^2 u - 2\rho\,\mathbf{\Omega}\times u + \rho\mathbf{g}$.

$\rho'\{(U^2/L)\,\partial u'/\partial t' + (U^2/L)\ u'.\mathrm{grad}'u'\}$

$= -(U^2/L)\,\mathrm{grad}'P' + \mu(U/L^2)\nabla'^2 u' - (U)2\rho\,\mathbf{\Omega}\times u + g\rho'$.

$\rho'\{\partial u'/\partial t' + u'.\mathrm{grad}'u'\}$

$= -\mathrm{grad}'P' + (\mu/UL)\nabla'^2 u' - 2\rho'(L/U)\,\mathbf{\Omega}'\times u' + \rho'(L/U^2)\mathbf{g}$

$= -\mathrm{grad}'(P/U^2) + (\mu/UL)\nabla'^2 u' - 2\rho'(L/U)\,\mathbf{\Omega}\times u' + \rho'(L/U^2)\mathbf{g}$.

Then taking U=1,L=larger could make(μ/UL)≡μ' smaller(almost nothing friction force).

grad'u', **Pressure gradient, Coliori force** and **gravity** become larger.

This is to make fulid equation more causalitical one in **large space and time scale view**.

This might be a certification for global climate model calculation.

example) :

1m(man size)→$6\mathrm{x}10^6$m(earth size)⇒U≡1;L≡10^6.

$\mu = 1.307\mathrm{x}10^{-3}\mathrm{Ns/m^2}$) $\rightarrow \mu' = \mu/UL \fallingdotseq 0$.

$\rho'\{\partial u'/\partial t' + u'.\mathrm{grad}u'\} = -\mathrm{grad}'(P') - 2\rho'(L/U)\,\mathbf{\Omega}\times u' + \rho'(L/U^2)\mathbf{g}$.

In order to be **complete dynamic equation** ,left term need +u$\{\partial\rho/\partial t + u.\mathrm{grad}\rho\}$for force by density ρ' change.

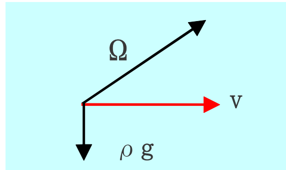
Appemdix_3:

spiral westery flow in the stationaly equation solution. 2013/3/23, 4/05

$\rho(v\cdot\nabla v)=-2\rho\,\Omega\times v-\nabla p+\rho g.$

Above **non-linear equation** could not be solved by analytical way,then author assumed following spriral flow solution and derived the correspondent **pressure force**.

(1)**The most simple solution.**



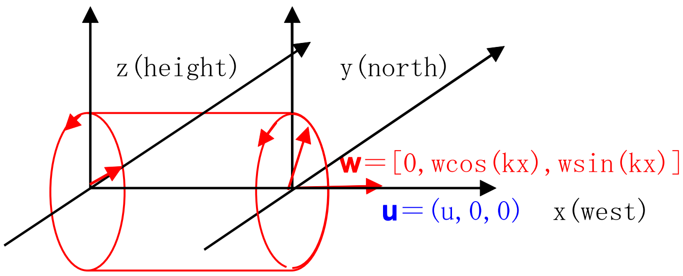
Assuming $\rho(v\cdot\nabla v)=0;\nabla p=0$ yield westery flow.

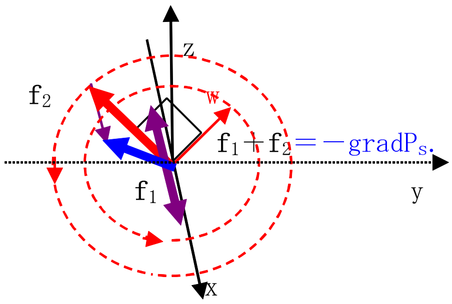
$0=-2\rho\,\Omega\times v+\rho g.$

v **coud be a westery jet stream** by downward force= ρg,

In the below,let's assume spiral flow component $w\equiv(0, w\cos(kx), w\sin(kx))$.

(2)**Eliptic Spiral Pipe Line Flow solution in fluid dyanamics.**





$u=(u,0,0).$

$w\equiv(0, w\cos(kx), w\sin(kx)).$

$*\ v=u+w=(u, w\cos(kx), w\sin(kx))$

$$\begin{cases}\text{grad}\,v_1=(0,0,0)\\ \text{grad}\,v_2=(-kw\sin(kx),0,0)\\ \text{grad}\,v_3=(kw\cos(kx),0,0)\end{cases}$$

$\rho\,v\cdot\text{grad}\,v=\rho\,uwk[0,-\sin(kx),\cos(kx)]\equiv F.$ << ρ driving force>>

The required force for space derivative accelation is spiral with axis x(west-ward).

$\rho\,v\cdot\text{grad}\,v=-2\rho\,\Omega\times(u+w)+\rho g-\text{grad}P_s=-2\rho\,\Omega\times w-\text{grad}P_s=F.$

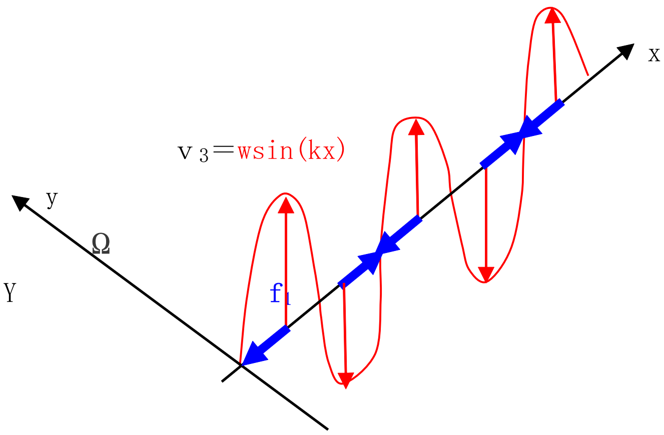
$-\text{grad}P_s=2\rho\,\Omega\times w+F=2\rho\,\Omega\times w+\rho\,uwk[0,-\cos(kx),\sin(kx)]$

$-\text{grad}P_s=[2\rho\,\Omega w\sin(kx),0,0]+\rho\,uwk[0,-\cos(kx),\sin(kx)]\equiv f_1+f_2.$

="vibration force by coliori on x axis" + "circulating force in yz plane"

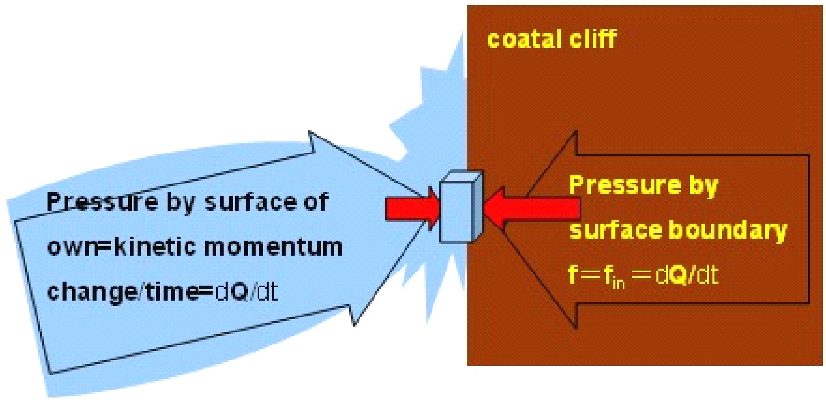
f_1≡**"vibration force by coliori on x axis"**

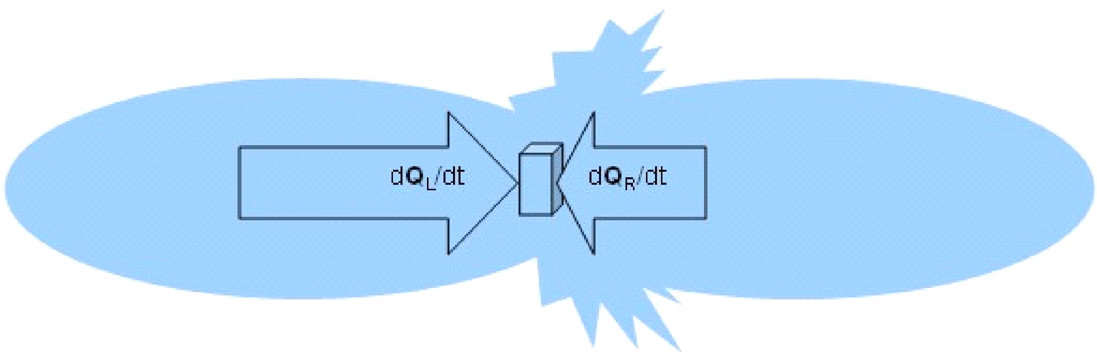
=updown velocity in z axis causes coliori force for the vibration in x axis.



f_2≡**"circulating force in yz plane"**

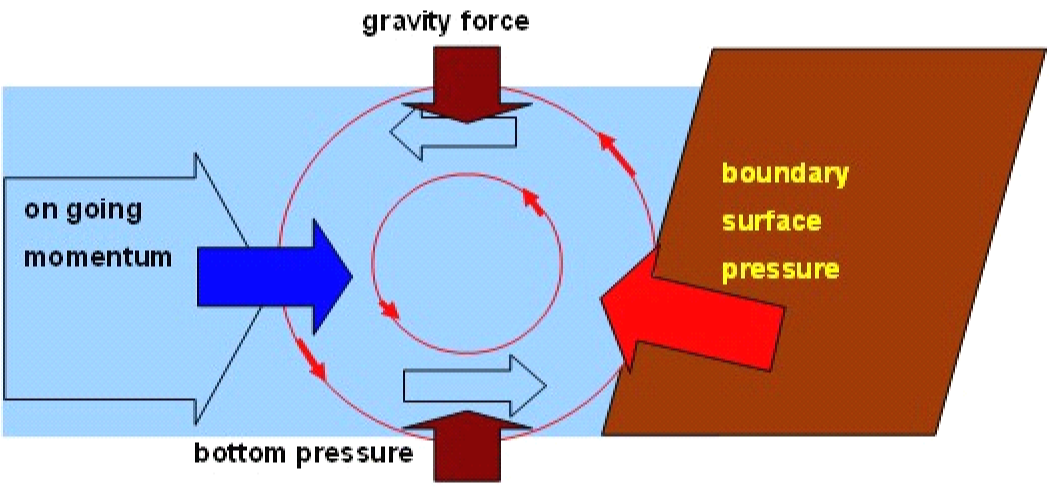
Pessure(plain force)on fluid has only two aspects of **suface boundary** and **surface of own**.



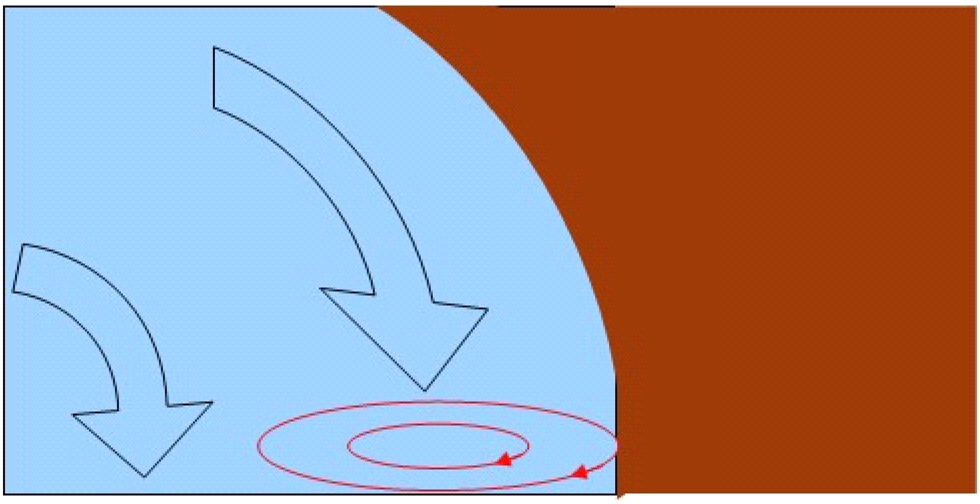


f_2≡**"circulating force in yz plane"**

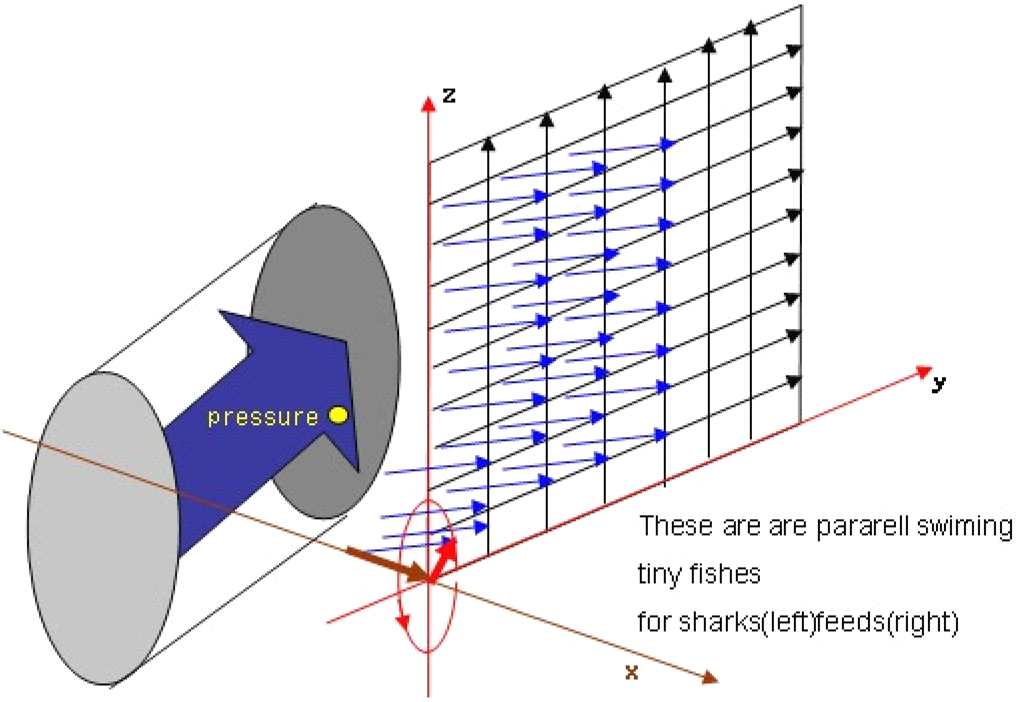
<<side view>>



<top view>>



"The image of the 1 dimensional solution"



(3)Eliptic Rotation Solution:

Reference:沿岸海域の物質分散(4)-潮流楕円の鉛直構造-

柳哲雄、西井正樹、樋口明生、京大防災研究所年報代２６号 B-2(S58.4).

http://www.dpri.kyoto-u.ac.jp/dat/nenpo/no26/26b2/a26b2p39.pdf#search='%E6%B2%BF%E5%B2%B8%E6%B5%B7%E5%9F%9F%E3%81%AE%E7%89%A9%E8%B3%AA%E5%88%86%E6%95%A3%284%29%E6%BD%AE%E6%B5%81%E6%A5%95%E5%86%86%E3%81%AE%E9%89%9B%E7%9B%B4%E6%A7%8B%E9%80%A0'

$\mathbf{u} = (u, 0, 0)$.

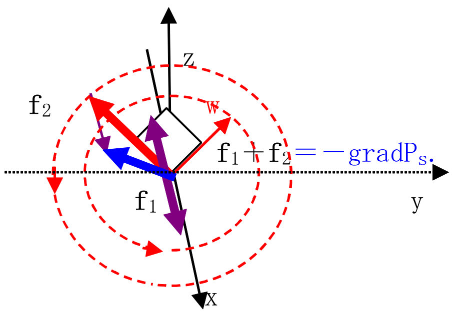
$\mathbf{w} \equiv (0, Y\cos(kx), Z\sin(kx))$.

$\mathbf{v} = \mathbf{u} + \mathbf{w} = (u, Y\cos(kx), Z\sin(kx))$.

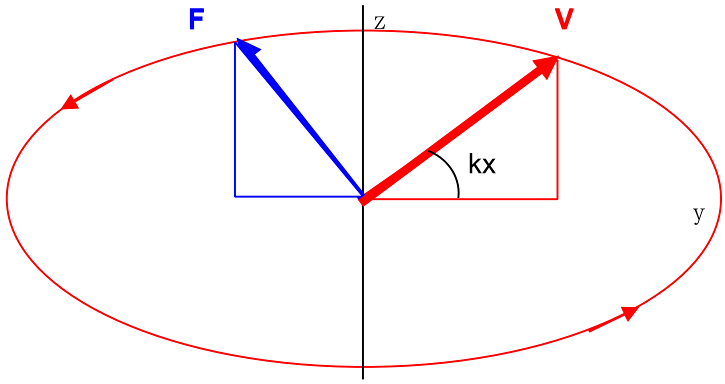
$\mathrm{grad}\, v_1 = (0, 0, 0)$

$\mathrm{grad}\, v_2 = (-kY\sin(kx), 0, 0)$

$\mathrm{grad}\, v_3 = (kZ\cos(kx), 0, 0))$



$\rho\, \mathbf{v}\cdot\mathrm{grad}\,\mathbf{v} = \rho uk[0, -Y\sin(kx), Z\cos(kx)] \equiv \mathbf{F}$.



The required force for space derivative accelation is spiral with axis x(west-ward).

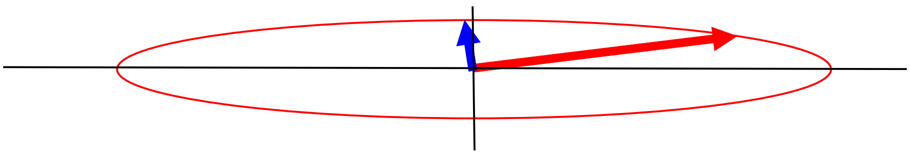
$\rho\, \mathbf{v}\cdot\mathrm{grad}\,\mathbf{v} = -2\rho\,\boldsymbol{\Omega}\times(\mathbf{u}+\mathbf{w}) + \rho g - \mathrm{grad}P_s = -2\rho\,\boldsymbol{\Omega}\times\mathbf{w} - \mathrm{grad}P_s$.

$\mathbf{F} \equiv \rho uk[0, -Y\sin(kx), Z\cos(kx)] = -2\rho\,\boldsymbol{\Omega}\times\mathbf{w} - \mathrm{grad}P_s$.

$-\mathrm{grad}P_s = 2\rho\,\boldsymbol{\Omega}\times\mathbf{w} + \rho uk[0, -Y\sin(kx), Z\cos(kx)]$

$-\mathrm{grad}P_s = [2\rho\,\Omega Z\cos(kx), 0, 0] + \rho uk[0, -Y\sin(kx), Z\cos(kx)] \equiv f_1 + f_2$.

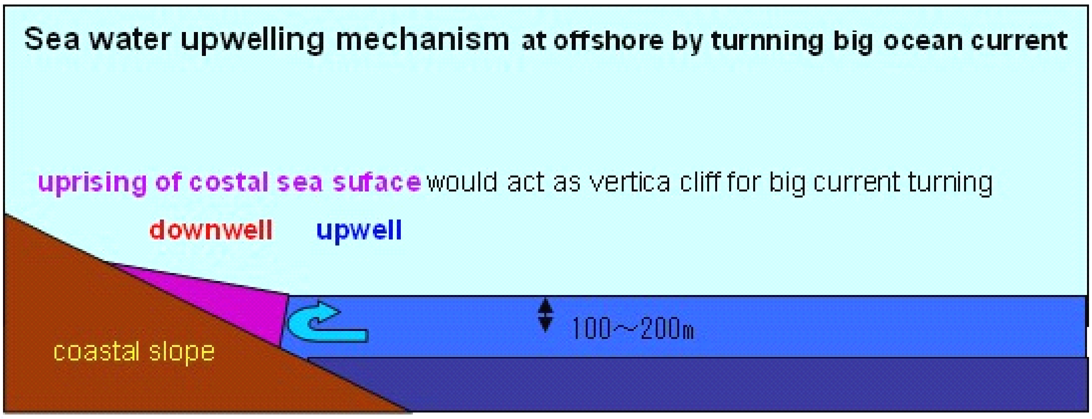
"plate wave pulling an pushig in beach slope may be driven by fllowing extreme eliptic"

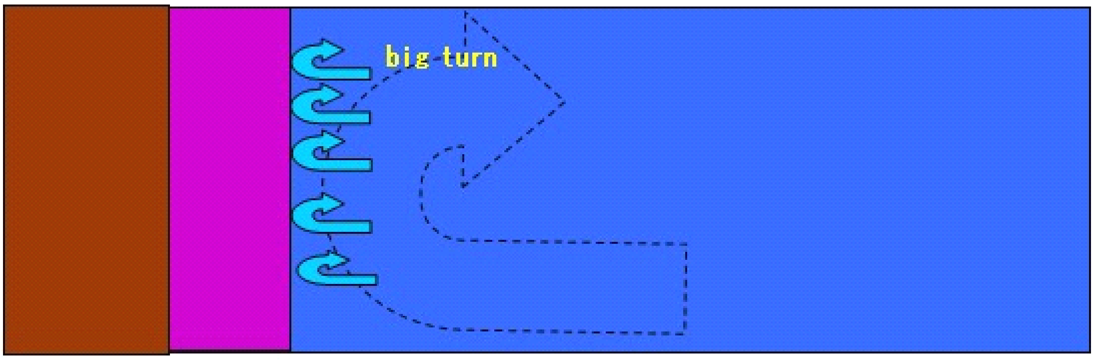


Updown force is due to boundary pressure and gravity in very small angle of beach slope.

Note:**Curveliner kinetic motion with cetrifugitive force at circular-rate center.**

$ds = r d\theta . \rightarrow d\theta / ds = 1/r.$ $\rho\, \mathbf{v} \cdot \mathrm{grad}\, \mathbf{v} = f = \rho v^2 / r = 2E_k / r.$





Appemdix_4:Non linear solution by segment linearlization approximation.

(1)**Simple example**.

At first,as for **linear(partial)differential equation**,solution is possible by anyhow.Then any non-linear equation can be expanded to linear segments as for the small variation formulation. Taking small variation of "f" yield following linear equation in general.

$0 = G(f(t), f'(t), f''(t), \ldots\ldots f^{(n)}(t) \equiv df^n/dt^n)$.

$0 = \delta f(t) \cdot \partial G/\partial f + \delta f'(t) \cdot \partial G/\partial f' + \cdots + \delta f^{(n)}(t) \cdot \partial G/\partial f^{(n)}$.

Solution in small interval $[t_0 \leqq t \leqq t_0 + \Delta t]. \rightarrow \delta f = \delta f(t)$; with initial condition $f(t_0), f'(t_0), \ldots, f^{(n)}(t_0)$ are as folows.

Next step are $f(t_0+\Delta t) = f(t_0) + \delta f(t_0+\Delta t)$.

$f(t_0+2\Delta t) = f(t_0+\Delta t) + \delta f(t_0+2\Delta t)$.

....

$f(t_0+N\Delta t) = f(t_0+(N-1)\Delta t) + \delta f(t_0+N\Delta t)$.

Thus solution $f(t_0 \leqq t \leqq t_0+N\Delta t)$ could be derived by small segments$\{\delta f(t_0+k\Delta t)\}$

(2)**Segment Linearlization of non-linear NS eqn by small variation expression.**

$*D(\rho V)/Dt \equiv [\rho(t+dt, x(t+dt))V(t+dt, x(t+dt)) - \rho(t, x(t))V(t, x(t))]/dt$.

$= [\partial \rho/\partial t + \langle V.\text{grad}\rho\rangle]V + \rho[\partial V/\partial t + \langle V.\text{grad}V\rangle]$.

$*D(\rho V)/Dt = \mu \nabla^2 V - \text{grad}P - 2\rho \boldsymbol{\Omega} x V + \rho \mathbf{g}$.

$\delta[D(\rho V)/Dt] =$

$[\partial \delta \rho/\partial t + \langle \delta V.\text{grad}\rho\rangle + \langle V.\text{grad}\delta \rho\rangle]V$

$+ [\partial \rho/\partial t + \langle V.\text{grad}\rho\rangle]\delta V + \rho[\underline{\partial \delta V/\partial t} + \langle \delta V.\text{grad}V\rangle + \underline{\langle V.\text{grad}\delta V\rangle}]$

$+ \delta \rho[\partial V/\partial t + \langle V.\text{grad}V\rangle] = \underline{\mu \nabla^2 \delta V} - 2\rho \boldsymbol{\Omega} x \delta V - \text{grad}\delta P + \delta \rho \mathbf{g}$..

$\rho[\partial \delta V/\partial t + \langle V.\text{grad}\delta V\rangle] = +\mu \nabla^2 \delta V$

$- \rho\langle \delta V.\text{grad}V\rangle - [\partial \rho/\partial t + \langle V.\text{grad}\rho\rangle]\delta V - 2\rho \boldsymbol{\Omega} x \delta V - \langle \delta V.\text{grad}\rho\rangle V$

$- \delta \rho[\partial V/\partial t + \langle V.\text{grad}V\rangle] - [\partial \delta \rho/\partial t + \langle V.\text{grad}\delta \rho\rangle]V - \text{grad}\delta P + \delta \rho \mathbf{g}$.

Thus **NS eqn** could be segment linearlizaed.Also linear partial equations had been solved by approximation of time and space segmentization into linear algebric simuletaneous equations.This is told **algorithm** for solving differential equation by software tools.

Appemdix_5:Le Chaterier's Principle.

Thermodymac is due to only two most reliable principles of 1st and 2nd low.Once the violation had occured,someone could make free energy machine,but none could do. This is great general conclusion of the thermodynamics which states that,

If a system is in stable state,then any spontaneous change in its parameters must bring about prcess which tend to restore the sytem equibrium.

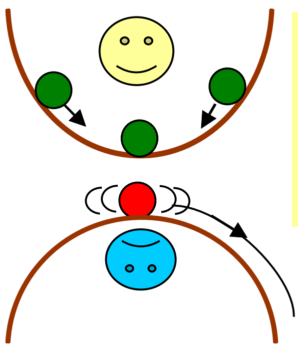
L.E Reichl,A modern Course in Statistical Physics,1987,Texas.

For example,input heat on equibrium state earth(1750),then what had happned ?.The syteme must respond to decrease input influence. For increasing output heat from earth,

＊temperature rise to enhance cooling radiation to space(an example **strong draughts**).

＊hot ocean causes strong evapolation which turn to **strong storm with strong rain**.

＊**the deep meaning of "stability" in (thermo)dynamics**.



Note upper fig means stability of ball dynamics in bottom position where restoring force would occure,while lower fig means unstability of ball dynamics,which tend to cause drop down accelation by small fluctuational force at the top position.

＊＊**Political health needs overwhelm restoring democracy movement.**

A force to restore healthy political state is decisive.Then people must recoginize what is healthy(the stability point at bottom one(good and naive the lowest),but not top one(wicked the highest)).