1. Updating zs based on bed tilting is deactivated

|  |
| --- |
| *Edited part*  *flow\_timestep.F90*   Metronome simulation        if (par%metro\_period > 0.d0) then           par%metro\_dzb=(-par%metro\_omega\*par%metro\_amp1\*sin(par%metro\_omega\*par%t-par%metro\_phase1) &              -par%metro\_omega2\*par%metro\_amp2\*sin(par%metro\_omega2\*par%t-par%metro\_phase2)) \*par%dt  s%zb=s%zb+par%metro\_dzb\*(0.5d0\*par%metro\_basinlength-(s%xz-s%xz(1,1)))/(0.5d0\*par%metro\_basinlength)           ! !s%zs(2:s%nx,:)=s%zs(2:s%nx,:)+par%metro\_dzb\*(0.5d0\*par%metro\_basinlength-(s%xz(2:s%nx,:)-s%xz(1,1)))/(0.5d0\*par%metro\_basinlength)        endif |

1. ‘metro\_omega2’ is considered in defining the function of bed tilting

Tiding function is

metro\_period =

metro\_amp1 =

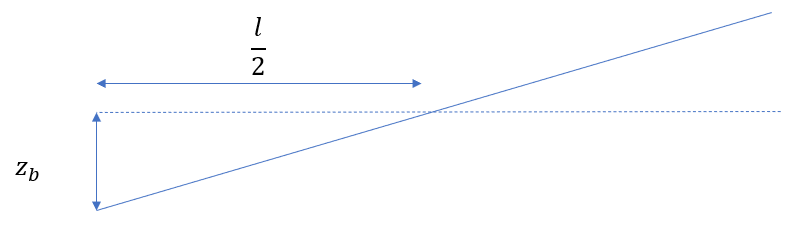
metro\_amp2 =

metro\_phase1 =

metro\_phase2 =

metro\_basinlength = *l*

metro\_period2 =



|  |
| --- |
| *Edited part*  *flow\_timestep.F90*   par%metro\_dzb=(-par%metro\_omega\*par%metro\_amp1\*sin(par%metro\_omega\*par%t-par%metro\_phase1) &              -par%metro\_omega2\*par%metro\_amp2\*sin(par%metro\_omega2\*par%t-par%metro\_phase2)) \*par%dt |

1. ‘num\_boundary\_layer\_water\_level’ is used to imposed the boundary conditions (water level) directly on defined layers of cells near sea and river boundaries.

|  |
| --- |
| *Edited part*  *flow\_timestep.F90*   s%zs(1:par%num\_boundary\_layer\_water\_level,1:s%ny+1) = s%zs01                           !\*\*\*\*\*----> Saeb        s%zs(s%nx-par%num\_boundary\_layer\_water\_level+1:s%nx+1,1:s%ny+1) = s%zs02 !s%zs0(1:2,:)            !\*\*\*\*\*----> Saeb |

1. ‘relaxtaion\_parameter’ is added to consider relaxation for velocity

|  |
| --- |
| *Edited part*  *flow\_timestep.F90*  do j=1,s%ny+1           do i=1,s%nx+1              !s%uu(i,j) = ((relaxtaion\_parameter)\*s%uu(i,j)) + ((1-relaxtaion\_parameter)\*uu\_old(i,j)) !\*\*\*\*\* Saeb              s%uu(i,j) = ((par%relaxtaion\_parameter)\*s%uu(i,j)) + ((1-par%relaxtaion\_parameter)\*uu\_previous\_time\_step(i,j)) !\*\*\*\*\* Saeb           end do        end do |

1. ‘dtset’ is added to limit maximum of time step

∆t=min(dtset, [](https://eu-prod.asyncgw.teams.microsoft.com/v1/objects/0-weu-d6-969dd2b4b6659229c8873541e569caaf/views/imgo)

|  |
| --- |
| *Edited part*  *timesteps.F90*  par%dt = min(par%dt, par%dtset)       !--->\*\*\*\* Saeb |

1. ‘reduced\_velocity\_activation’ and ‘reduced\_velocity\_activation’ are considered to reduce the velocity near sea and river boundaries virtually.

if (par%reduced\_velocity\_activation  == 1) then

      s%uu(1:par%num\_boundary\_layer\_water\_level,1:s%ny+1) =par%reduced\_velocity\_parameter\_boundary\_sea\_river\* s%uu(1:par%num\_boundary\_layer\_water\_level,1:s%ny+1)                !\*\*\*\*\*----> Saeb

      s%uu(s%nx-par%num\_boundary\_layer\_water\_level+1:s%nx+1,1:s%ny+1) = par%reduced\_velocity\_parameter\_boundary\_sea\_river \* s%uu(s%nx-par%num\_boundary\_layer\_water\_level+1:s%nx+1,1:s%ny+1)    !\*\*\*\*\*----> Saeb

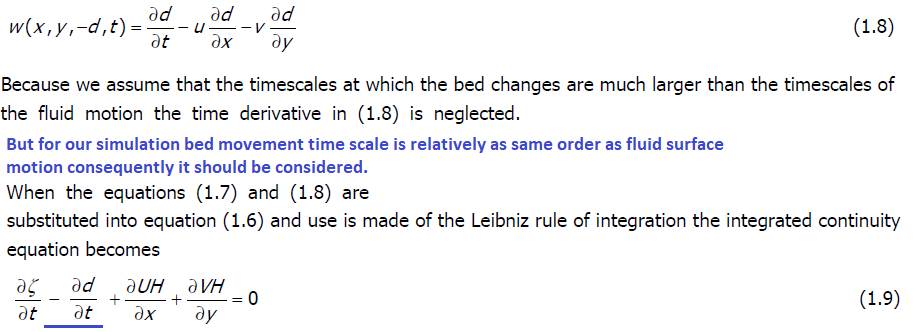
      endif

1. required variables are defined

*params.def*

1. updating continuity equation by considering bed movement

regarding the XBeach document



! Update water level using continuity eq.

!

metro\_dzb\_continuty=(par%metro\_omega\*par%metro\_amp1\*sin(par%metro\_omega\*par%t-par%metro\_phase1) &

-par%metro\_omega2\*par%metro\_amp2\*sin(par%metro\_omega2\*par%t-par%metro\_phase2))

 if (s%ny>0) then

   do j=jmin\_zs,jmax\_zs

     do i=imin\_zs,imax\_zs

      s%dzsdt(i,j) = (-1.d0)\*( s%qx(i,j)\*s%dnu(i,j)-s%qx(i1,j)\*s%dnu(i-1,j)  &

                  + s%qy(i,j)\*s%dsv(i,j)-s%qy(i,j-1)\*s%dsv(i,j-1) )\*s%dsdnzi(i,j) &

                  - s%infil(i,j) + s%rainfallrate(i,j)

d\_zb\_dt(i,j)=metro\_dzb\_continuty\*(0.5d0\*par%metro\_basinlength-(s%xz(i,j)-s%xz(1,1)))/(0.5d0\*par%metro\_basinlength)     !\*\*\*\*\*----> Saeb

            end do

         end do

         s%zs(imin\_zs:imax\_zs,jmin\_zs:jmax\_zs) = s%zs(imin\_zs:imax\_zs,jmin\_zs:jmax\_zs) &

            + (s%dzsdt(imin\_zs:imax\_zs,jmin\_zs:jmax\_zs)\*par%dt) - (d\_zb\_dt(imin\_zs:imax\_zs,jmin\_zs:jmax\_zs)\*par%dt)

      else

         j=1

         do i=imin\_zs,imax\_zs

            s%dzsdt(i,j) = (-1.d0)\*( s%qx(i,j)\*s%dnu(i,j)-s%qx(i-1,j)\*s%dnu(i-1,j) )\*s%dsdnzi(i,j) &

               - s%infil(i,j) + s%rainfallrate(i,j)

            d\_zb\_dt(i,j)=metro\_dzb\_continuty\*(0.5d0\*par%metro\_basinlength-(s%xz(i,j)-s%xz(1,1)))/(0.5d0\*par%metro\_basinlength)     !\*\*\*\*\*----> Saeb

         end do

         s%zs(imin\_zs:imax\_zs,1) = s%zs(imin\_zs:imax\_zs,1)+(s%dzsdt(imin\_zs:imax\_zs,1)\*par%dt) - (d\_zb\_dt(imin\_zs:imax\_zs,1)\*par%dt)

      endif !s%ny>0

**User adjustments**

By using the following keywords in *params.txt* file, we could activate or deactivate the corresponding modification

* *num\_boundary\_layer\_water\_level*, range 0 to 99

It defines the number of cell layers in sea and river side boundaries to impose water level directly.

If it sets 0, this option is deactivated.

* *reduced\_velocity\_parameter\_boundary\_sea\_river*, range 0 to 1

virtually reduces the velocity at sea and river sides. It is an option to consider reservoir effect.

The keyword for activating this option is *reduced\_velocity\_activation*. *reduced\_velocity\_activation* =0 deactivate and *reduced\_velocity\_activation* =1 activate this option.

* *relaxation\_parameter,* range 0 to 1

It relaxes the velocity all over the geometry

+

is current time step velocity and is the previous time step velocity

* *reduced\_velocity\_activation*, range (0 or 1)

activate or deactivate *reduced\_velocity\_parameter\_boundary\_sea\_river*

*reduced\_velocity\_activation* =0 deactivate and *reduced\_velocity\_activation* =1 activate this option.

* *zs\_updating\_with\_zb\_activation*, range (0 or 1)

it activates or deactivates water level updating with bed level moving.

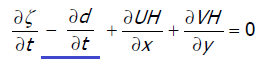
*zs\_updating\_with\_zb\_activation* = 1 consider updating water surface by bed movement (Dano approach), *zs\_updating\_with\_zb\_activation* = 0 ignore the mentioned updating.

* *vy\_zero\_boundary\_sea\_river\_activation*, range (0 or 1)

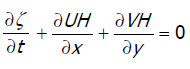
*vy\_zero\_boundary\_sea\_river\_activation* =1, y velocity direction zero at *num\_boundary\_layer\_water\_level*-th cells of sea and river side boundaries.

* *countinuty\_with\_Dzb\_activation*, range (0 or 1)

*countinuty\_with\_Dzb\_activation* =1 consider bed motion derivatives in time in continuity equation as



*countinuty\_with\_Dzb\_activation* =0 ignore bed motion derivatives in time in continuity equation



* *zero\_gradient\_u\_activation,*

*zero\_gradient\_u\_activation* =1 set zero gradient for velocity in x direction at sea and river boundaries. *zero\_gradient\_u\_activation* = 0 deactivates this option.

* *impicit\_iteration\_threshold* range (0,1,2,3,…)

number of iterations for correction-solution continuity and momentum equations inside each time step. It implements implicit simulation based on Gauss-Seidel method.

if *impicit\_iteration\_threshold* = 0 it converts to explicit approach.

* *Dirichlet\_water\_level\_activation* range (0 or 1)

*Dirichlet\_water\_level\_activation =1,* activate imposing the water level time series boundary conditions

* *water\_level\_loc\_file* defines the location of boundary to impose water level boundary condition. It works as same as *disch\_loc\_file*
* *water\_level\_timeseries\_file* defines time series of water level at boundaries. It works as same as *disch\_timeseries\_file.*
* *num\_boundary\_layer\_water\_level = 1.* Number of layers of mesh to impose water level boundary conditions. It should be set 1 at least to involve imposed boundary conditions in solving continuity and momentum equation.