MASTER PROGRAM

FOR NEARSHORE COMMUNITY MODEL

Version 2005.4

Documentation and User's Manual

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April, 2005

Contents

1 Introduction

The master program controls the interaction between the wave, circulation and sediment transport modules. It also handles the interpolation (and possibly extrapolation) between the grids used by the different modules. The frequency with which each module is called is determined within the master program.

The basic framework of the master program assumes that there is a wave module which provides forcing for a circulation module while both the wave and circulation module provide driving to the sediment transport module. It is possible to run the wave module with inactive circulation and sediment transport modules. If there is other forcing (i.e. wind or surface heating) in the circulation module, it is possible to run the circulation module with an inactive wave module. The sediment transport module requires input from at least one of the other modules.

There is provision within the master program for further optional interactions between the modules. The currents (depth integrated or 3-dimensional (3D)) from the circulation module may be returned to the wave module where they act to refract the wave field. The sediment transport module may return updated topography to either or both of the other modules.

The master program can handle interpolation to either a structured or unstructured grid. The variables on the structured grid may be staggered in space. Velocities passed to and from the master program by the modules are interpolated as scalars (U and V) so that rotation into the directions defined by the rectilinear master grid must be done within the modules.

Output of basic fields interpolated to the master grid is handled by the master program. Other output such as time series or derived fields such as momentum balances may optionally be done by the modules. This optional output is on the grid particular to the module in question.

2 Master Program Outline

2.1 Functions of Master Program

The master program plays a role of "backbone" in the Nearshore Community Model. It is an interface, handling module coupling control, internal data transfer and interpolation/extrapolation between modules, as well as data input and output. The functions of the master program can be summarized as following

1. connection of three modules: i.e., wave module, circulation module and sediment transport module
2. time stepping control and model coupling control
3. model interaction control: one-way coupling or two-way coupling
4. internal data transfer between modules, interpolation or extrapolation between different computational grids if needed

5. data input and output

The master program does not handle input of data and parameters needed by specific modules. Each module should have its own input files.

2.2 Flow Chart and Pseudo-Code

The flow chart of the master program is shown in Figure 1.

A pseudo-code is described in the following

Program start
input depth, coordinates, and parameters needed by master program
calculate inter(extra)polation coefficients defined in "interp.h"
depth inter(extra)polation from mast_grid to module_grid
master program initialization
wave, circulation and sediment module initialization
time loop start
if it is time to call wave module
update inter(extra)polation info from circ and sedi module results if needed
call wave module
endif
if it is time to call circulation module
update inter(extra)polation info from wave and sedi module results if needed
call circulation module
endif
if it is time to call sediment module
update inter(extra)polation info from wave and circ module results if needed
call sediment module
endif
if it is time for output
call output subroutine
endif
time loop end
program end

2.3 Parameters and Pass Variables Between Modules

The parameters and pass variables are included in 'pass.h'.

The definitions of the parameters and pass variables are described as following.

1. Model Dimension
   - Nx_Max and Ny_Max: maximum grid numbers for master grid and all three modules
   - Nx_Mast and Ny_Mast: grid dimension of master grid
   - Nx_Wave and Ny_Wave: grid dimension of wave grid

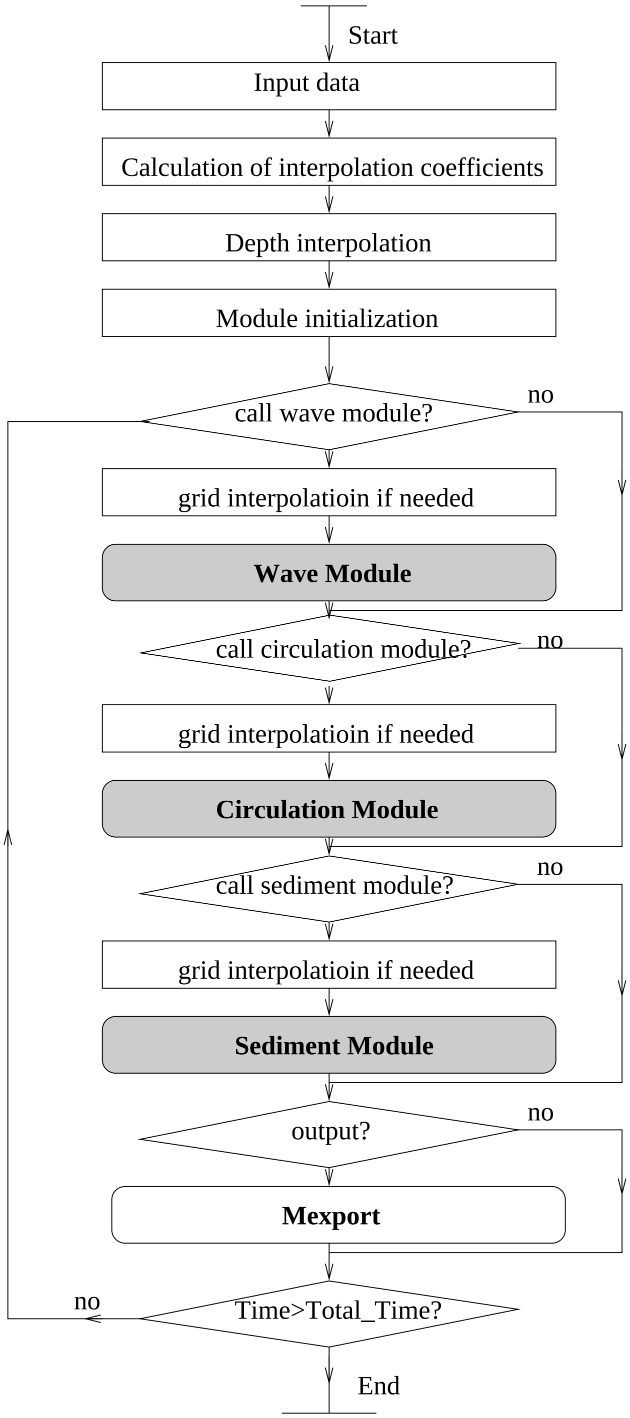

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Figure 1: Flow Chart

- Nx_Circ and Ny_Circ: grid dimension of circulation grid
- Nx_Sedi and Ny_Sedi: grid dimension of sediment grid

2. Wave Module
   - Pass_Sxx, Pass_Sxy, and Pass_Syy: radiation stresses
   - Pass_Sxx_body, Pass_Sxy_body, Pass_Syy_body: local radiation stresses (body part)
   - Pass_Sxx_surf, Pass_Sxy_surf, Pass_Syy_surf: local radiation stresses (surface part)
   - Pass_Wave_Fx, Pass_Wave_Fy: wave forcing
   - Pass_MassFluxU,Pass_MassFluxV: mass flux
   - Pass_Diss: dissipation caused by wave breaking
   - Pass_WaveNum: wave number
   - Pass_Theta: wave angle
   - Pass_ubott: bottom velocity
   - Pass_Height: wave height
   - Pass_C: phase velocity
   - Pass_Cg: group velocity
   - Pass_Period: wave period
   - Pass_ibrk: wave breaking index (1 - breaking, 0 - nonbreaking)
   - Intp_U_Wave and Intp_V_Wave: current velocity interpolated from the circulation module.
   - Intp_eta_Wave: surface elevation interpolated from the circulation module.

3. Circulation Module
   - Pass_U and Pass_V: depth-averaged velocity
   - Pass_Ub and Pass_Vb: bottom current velocity
   - Pass_eta: surface elevation (time-averaged)
   - Pass_d11, Pass_d12, Pass_e11, Pass_e12, Pass_f11 and Pass_f12: coefficients for calculation of vertical velocity profile (SHORECIRC)
   - Pass_fw: bottom friction coefficient
   - Pass_vt: turbulent eddy viscosity coefficient
   - Intp_Fx_Circ and Intp_Fy_Circ: short wave forcing interpolated from the wave module
   - Intp_ubott_Circ: bottom velocity interpolated from the wave module
   - Intp_Theta_Circ: wave angle interpolated from the wave module

- Intp_Sxx_Circ, Intp_Sxy_Circ, and Intp_Syy_Circ: radiation stresses interpolated from the wave module
- Intp_Sxx_Surf, Intp_Sxy_Surf, and Intp_Syy_Surf: local radiation stresses (surface part) interpolated from the wave module
- Intp_Sxx_Body, Intp_Sxy_Body, and Intp_Syy_Body: local radiation stresses (body part) interpolated from the wave module
- Intp_Height_Circ: wave height interpolated from the wave module
- Intp_Theta_Circ: wave angle interpolated from the wave module
- Intp_WaveNum_Circ: wave number interpolated from the wave module
- Intp_C_Circ: wave phase velocity interpolated from the wave module
- Intp_MassFluxU_Circ and Intp_MassFluxU_Circ: mass flux interpolated from the wave module
- Intp_Diss_Circ: energy dissipation interpolated from the wave module
- Intp_ibrk_Circ: wave breaking index interpolated from the wave module

4. Sediment Module

   - Pass_Dupdated: updated water depth
   - Pass_SediFluxcum_x: accumulated sediment flux (x component) calculated in the circulation module.
   - Pass_SediFluxcum_y: accumulated sediment flux (y component) calculated in the circulation module.
   - Intp_SediFluxcum_x: accumulated sediment flux (x component) interpolated from the circulation grid to sediment grid
   - Intp_SediFluxcum_y: accumulated sediment flux (y component) interpolated from the circulation grid to sediment grid
   - Intp_U_Sedi and Intp_V_Sedi: current velocity (depth averaged) interpolated from the circulation module.
   - Intp_Ub_Sedi and Intp_Vb_Sedi: bottom current velocity interpolated from the circulation module.
   - Intp_ubott_Sedi: bottom wave velocity interpolated from the wave module
   - Intp_eta_Sedi: surface elevation interpolated from the circulation module
   - Intp_fw_Sedi: bottom friction coefficient interpolated from the circulation module
   - Intp_vt_Sedi: viscosity coefficient interpolated from the circulation module

- Intp_Theta_Sedi: wave angle interpolated from the wave module
- Intp_Height_Sedi: wave Height interpolated from the wave module
- Intp_ibrk_Sedi: wave breaking index interpolated from the wave module

5. Coordinate System, Water Depth

- Depth_Mast: water depth on Mast_Grid, can be updated by the sediment module
- Depth_Wave: water depth on Wave_Grid, can be updated by the sediment module
- Depth_Circ: water depth on Circ_Grid, can be updated by the sediment module
- Depth_Sedi: water depth on Sedi_Grid, can be updated by the sediment module
- X_Mast and Y_Mast: (x,y) of Mast_Grid
- X_Wave and Y_Wave: (x,y) of Wave_Grid
- X_Circ and Y_Circ: (x,y) of Circ_Grid
- X_Sedi and Y_Sedi: (x,y) of Sedi_Grid

6. Other Variables

- U_wind_Mast and V_wind_Mast: wind speed on Mast_Grid
- U_wind_Circ and V_wind_Circ: wind speed on Circ_Grid
- U_wind_Wave and V_wind_Wave: wind speed on Wave_Grid

7. Control Parameters

- N_Interval_CallWave: step interval for calling wave module. If N_Interval_CallWave = -1, the model will never be called, and if N_Interval_CallWave = 0 for only initialization.
- N_Interval_CallCirc: step interval for calling circulation module. If N_Interval_CallCirc = -1, the model will never be called, and if N_Interval_CallCirc = 0 for only initialization.
- N_Interval_CallSedi: step interval for calling sediment module. If N_Interval_CallSedi = -1, the model will never be called, and if N_Interval_CallSedi = 0 for only initialization.
- N_Delay_CallSedi: time (steps) delay for calling sediment module.
- N_Interval_Output: step interval for output
- Total_Time: total simulation time (in seconds)
- Master_dt: time step in the master program

- Grid_Mast_Wave_Same: logical parameter indicating whether or not Mast_Grid and Wave_Grid are the same grid system. If the input file name is a null string, the master program will set the Wave_Grid as the same as the Mast_Grid.
- Grid_Mast_Circ_Same: logical parameter indicating whether or not Mast_Grid and Circ_Grid are the same grid system. If the input file name is a null string, the master program will set the Circ_Grid as the same as the Mast_Grid.
- Grid_Mast_Sedi_Same: logical parameter indicating whether or not Mast_Grid and Sedi_Grid are the same grid system. If the input file name is a null string, the master program will set the Sedi_Grid as the same as the Mast_Grid.
- Grid_Wave_Circ_Same, Grid_Wave_Sedi_Same, and Grid_Circ_Sedi_Same: logical parameters indicating relations between Wave_Grid and Circ_Grid, Wave_Grid and Sedi_Grid, and Circ_Grid and Sedi_Grid. Usually, if two grids or more than two grids are the same grid system, the Mast_Grid will be the same grid as the grid system. Grid_Wave_Circ_Same, Grid_Wave_Sedi_Same, and Grid_Circ_Sedi_Same will be judged out based on Grid_Mast_Wave_Same, Grid_Mast_Circ_Same, and Grid_Mast_Sedi_Same within the master program.
- Wave_Staggered, Circ_Staggered, and Sedi_Staggered: logical parameters indicating whether or not grid systems are staggered.
- Wave_Structured, Circ_Structured, and Sedi_Structured: logical parameters indicating whether or not grid system is structured.
- Grid_Extrapolation: logical parameter indicating whether or not value extrapolation is allowed between two grid systems. If Grid_Extrapolation = .false., the value which is supposed to be extrapolated will equal to the value at the nearest grid point.
- Wave_Curr_Interact, Wave_Bed_Interact, Curr_Bed_Interact: logical parameters indicating whether or not two-way coupling is needed between modules.

8. Control Parameters for Passing variables

   - Wave_To_Circ_Height: pass wave heights from the wave module to the circulation module
   - Wave_To_Circ_Angle: pass wave angles (degree) from the wave module to the circulation module
   - Wave_To_Circ_WaveNum: pass wave numbers from the wave module to the circulation module
   - Wave_To_Circ_C: pass wave phase velocities from the wave module to the circulation module
   - Wave_To_Circ_Radiation: pass radiation stresses from the wave module to the circulation module

- Wave_To_Circ_Rad_Surf: pass local radiation stresses (surface part) from the wave module to the circulation module
- Wave_To_Circ_Rad_Body:pass local radiation stresses (body part) from the wave module to the circulation module
- Wave_To_Circ_Forcing: pass short wave forcing from the wave module to the circulation module
- Wave_To_Circ_MassFlux: pass mass flux from the wave module to the circulation module
- Wave_To_Circ_Dissipation: pass wave energy dissipation from the wave module to the circulation module
- Wave_To_Circ_BottomUV: pass Bottom velocity from the wave module to the circulation module
- Wave_To_Circ_Brkindex: pass wave breaking index from the wave module to the circulation module
- Circ_To_Wave_UV: pass current velocity (depth averaged) from the circulation module to the wave module
- Circ_To_Wave_eta: pass surface elevation from the circulation module to the wave module
- Wave_To_Sedi_Height: pass wave height from the wave module to the sediment module
- Wave_To_Sedi_Angle: pass wave angle from the wave module to the sediment module
- Wave_To_Sedi_BottomUV: pass bottom velocity from the wave module to the sediment module
- Circ_To_Sedi_UV: pass current velocity from the circulation module to the sediment module
- Circ_To_Sedi_UVb: pass bottom current velocity from the circulation module to the sediment module
- Circ_To_Sedi_eta: pass surface elevation from the circulation module to the sediment module
- Circ_To_Sedi_UV3D: pass 3D current velocity from the circulation module to the sediment module
- Circ_To_Sedi_fw: pass bottom friction coefficient from the circulation module to the sediment module
- Circ_To_Sedi_UVquasi3D: pass coefficients of quasi-3D current profiles from the circulation module to the sediment module
- Sedi_To_Wave_Depth: pass updated water depth from the sediment module to the wave module
- Sedi_To_Circ_Depth: pass updated water depth from the sediment module to the circulation module

- Circ_POM: use POM as the circulation module, it helps to initialize logical variables
- Circ_SC: use SHORECIRC as the circulation module, it helps to initialize logical variables

9. Vector Rotation

   - Circ_Rotate_Angle: angle (°) between the vector reference direction on Circ_Grid and the geographic reference direction
   - Wave_Rotate_Angle: angle (°) between the vector reference direction on Wave_Grid and the geographic reference direction
   - Sedi_Rotate_Angle: angle (°) between the vector reference direction on Sedi_Grid and the geographic reference direction

2.4 Subroutines in Master Program

1. *readfile* reads in file names, grid dimensions, and model control parameters provided by 'minput.dat'. It also reads in water depth and (x,y) of grid points from file names given in 'minput.dat'. *readfile* is called by *master*.

2. *get_interpolation_coef* computes interpolation coefficients and save them in arrays in 'interp.h'. *get_interpolation_coef* is called by *master*. It calls *interpsame* and *interpolation*.

3. *interp_depth* interpolates water depth from Master-Grid to Wave-Grid, Circ-Grid, and Sedi-Grid. *interp_depth* is called by *master*. *interp_depth* calls *grid1_to_grid2*.

4. *interp_circ_wave* interpolates variables from Circ-Grid to Wave-Grid. *interp_circ_wave* is called by *master*. and it calls *grid1_to_grid2*.

5. *interp_sedi_wave* interpolates variables from Sedi-Grid to Wave-Grid. *interp_sedi_wave* is called by *master* and calls *grid1_to_grid2*.

6. *interp_wave_circ* interpolates variables from Wave-Grid to Circ-Grid. *interp_wave_circ* is called by *master* and calls *grid1_to_grid2*.

7. *interp_sedi_circ* interpolates variables from Sedi-Grid to Circ-Grid. *interp_sedi_circ* is called by *master* and calls *grid1_to_grid2*.

8. *interp_wave_sedi* interpolates variables from Wave-Grid to Sedi-Grid. *interp_wave_sedi* is called by *master* and calls *grid1_to_grid2*.

9. *interp_circ_sedi* interpolates variables from Circ-Grid to Sedi-Grid. *interp_circ_sedi* is called by *master* and calls *grid1_to_grid2*

10. *interpsame* calculates interpolation coefficients when two module grids are same. *interpsame* is called by *get_interpolation_coef*.

11. *interpolation* is used to get coefficients of interpolation or extrapolation between two grid systems. *interpolation* is called by *get_interpolation_coef*.
12. *grid1_to_grid2* makes interpolation/extrapolation from grid1 to grid2 based on interpolation coefficients.

    grid1_to_grid2 is called by *interp_depth*, *interp_circ_wave*, *interp_circ_wave*, *interp_sedi_wave*, *interp_wave_circ*, *interp_sedi_circ*, *interp_wave_sedi*, and *interp_circ_sedi*.
13. *SediModule* is the Sediment module. *SediModule* is called by *Master*.
14. *WaveModule* is the Wave module. *WaveModule* is called by *master*
15. *CircModule* is the Circulation module. *CircModule* is called by *master*
16. *Mexport* is for model output. *Mexport* is called by *Master*.
17. *MasterInit* initializes all pass variables. *MasterInit* is called by *master*.

2.5 Interpolation/Extrapolation between model grids

Interpolation or extrapolation is usually employed between a curvilinear grid and a rectangular grid. The program used here can also handle interpolation/extrapolation between two different curvilinear grids or two different rectangular grids.

A linear interpolation/extrapolation method is used in the program. We assume two grid systems, grid-1 and grid-2, which can be curvilinear grids or rectangular grids. As shown in Figure 2, the interpolation value at point A in grid-1 is evaluated by the values at three points, $1, 2$ and 3, of a triangle in grid-2 which surrounds point A. For extrapolation, point A is out of the triangle. Four triangle areas $S_{\alpha\beta\gamma}$, i.e., $S_{123}, S_{12A}, S_{31A}$ and S_{23A} are calculated using the following formula:

$$S_{\alpha\beta\gamma} = \begin{vmatrix} x_\alpha & y_\alpha & 1 \\ x_\beta & y_\beta & 1 \\ x_\gamma & y_\gamma & 1 \end{vmatrix} \tag{1}$$

where (x_α, y_α) represents coordinates of point $1, 2, 3$ and A. For interpolation, (α, β, γ) are counterclock wise for all the four triangles and thus $S_{\alpha\beta\gamma}$ are positive. For extrapolation, clock wise (α, β, γ) results in negative $S_{\alpha\beta\gamma}$. The following formula is used for both interpolation and extrapolation:

$$F_A = (F_1 S_{23A} + F_2 S_{31A} + F_3 S_{12A})/S_{123} \tag{2}$$

where F_1, F_2, F_3 and F_A represent any converted variables at point $1, 2, 3$ and A, respectively.

It should be mentioned that the extrapolation is usually used at domain boundaries and is only suitable for the case that domain boundaries are close to each other. To save computational time for interpolation/extrapolation, $S_{\alpha\beta\gamma}$ are stored when subroutine *get_interpolation_coef* is called.

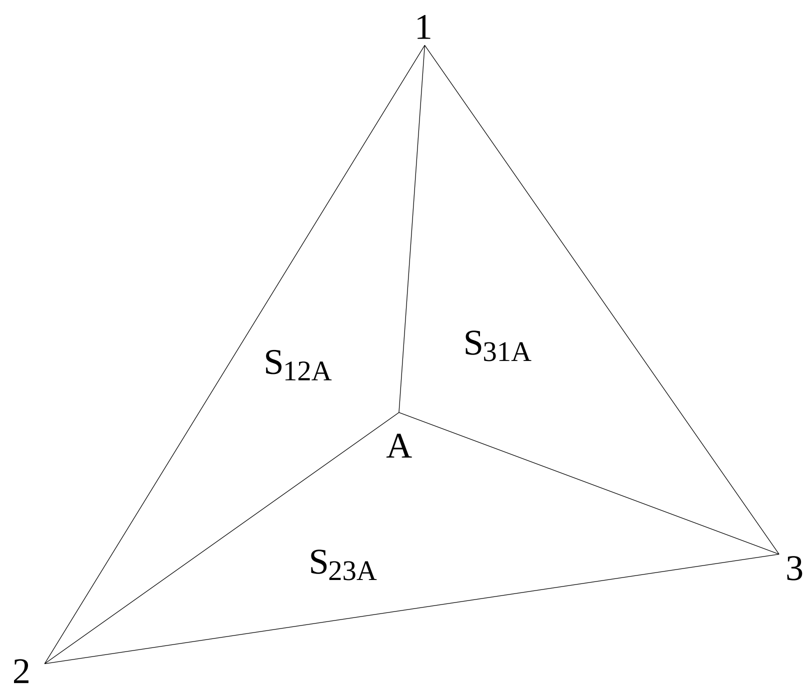

Figure 2: Interpolation triangle.

2.6 Input for Master Program

1. F_NAMES: definition of input and output file names.
   - f_depth - input file name for depth on Mast_Grid
   - f_xymast - input file name for (x,y) of Mast_Grid
   - f_xywave - input file name for (x,y) of Wave_Grid
   - f_xycirc - input file name for (x,y) of Circ_Grid
   - f_xysedi - input file name for (x,y) of Sedi_Grid
   - ...
2. GRIDIN: grid information.
   - Nx_Mast, Ny_Mast: Mast_Grid dimension
   - Nx_Wave, Ny_Wave: Wave_Grid dimension
   - Nx_Circ, Ny_Circ: Circ_Grid dimension
   - Nx_Sedi, Ny_Sedi: Sedi_Grid dimension
   - Grid_Mast_Wave_Same - logical parameter indicating whether Wave_Grid is the same as Mast_Grid
   - Grid_Mast_Circ_Same - logical parameter indicating whether Circ_Grid is the same as Mast_Grid
   - Grid_Mast_Sedi_Same - logical parameter indicating whether Sedi_Grid is the same as Mast_Grid
   - Wave_Staggered - logical parameter indicating whether Wave_Grid is staggered
   - Circ_Staggered - logical parameter indicating whether Circ_Grid is staggered
   - Sedi_Staggered - logical parameter indicating whether Sedi_Grid is staggered
   - Wave_Structured - logical parameter indicating whether or not Wave_Grid is structured.
   - Circ_Structured - logical parameter indicating whether or not Circ_Grid is structured.
   - Sedi_Structured - logical parameters indicating whether or not Sedi_Grid is structured
   - Grid_Extrapolation - logical parameter indicating whether or not value extrapolation is allowed between two grid systems.
3. INTERACTION: control parameters for one-way or two-way coupling between modules
   - Wave_Curr_Interact - logical parameter for two-way coupling between the wave and circulation modules

- Wave_Bed_Interact - logical parameter for two-way coupling between the wave and sediment modules
- Curr_Bed_Interact - logical parameter for two-way coupling between the circulation and sediment modules

4. PASSVARIABLES

   - Wave_To_Circ_Height - pass wave height from the wave module to the circulation module
   - Wave_To_Circ_Angle - pass wave angle from the wave module to the circulation module
   - Wave_To_Circ_WaveNum - pass wave numbers from the wave module to the circulation module
   - Wave_To_Circ_Radiation - pass wave phase velocity from the wave module to the circulation module
   - Wave_To_Circ_Radiation - pass radiation stresses from the wave module to the circulation module
   - Wave_To_Circ_Rad_Surf - pass local radiation stresses (surface part) from the wave module to the circulation module
   - Wave_To_Circ_Rad_Body -pass local radiation stresses (body part) from the wave module to the circulation module
   - Wave_To_Circ_Forcing - pass short wave forcing from the wave module to the circulation module
   - Wave_To_Circ_MassFlux - pass mass flux from the wave module to the circulation module
   - Wave_To_Circ_Dissipation - pass wave energy dissipation from the wave module to the circulation module
   - Wave_To_Circ_BottomUV - pass Bottom velocity from the wave module to the circulation module
   - Wave_To_Circ_Brkindex - pass wave breaking index from the wave module to the circulation module
   - Circ_To_Wave_UV - pass current velocity (depth averaged) from the circulation module to the wave module
   - Circ_To_Wave_eta - pass surface elevation from the circulation module to the wave module
   - Wave_To_Sedi_Height - pass wave height from the wave module to the sediment module
   - Wave_To_Sedi_Angle - pass wave angle from the wave module to the sediment module
   - Wave_To_Sedi_BottomUV - pass bottom velocity from the wave module to the sediment module

  - Circ_To_Sedi_SedFlux - pass sediment flux from the circulation module to the sediment module
  - Circ_To_Sedi_UV - pass current velocity from the circulation module to the sediment module
  - Circ_To_Sedi_UVb - pass bottom current velocity from the circulation module to the sediment module
  - Circ_To_Sedi_eta - pass surface elevation from the circulation module to the sediment module
  - Circ_To_Sedi_UV3D - pass 3D current velocity from the circulation module to the sediment module
  - Circ_To_Sedi_fw - pass bottom friction coefficient from the circulation module to the sediment module
  - Circ_To_Sedi_UVquasi3D - pass coefficients of quasi-3D current profiles from the circulation module to the sediment module
  - Sedi_To_Wave_Depth - pass updated water depth from the sediment module to the wave module
  - Sedi_To_Circ_Depth - pass updated water depth from the sediment module to the circulation module

5. VECTORROTATE
  - Circ_Rotate_Angle - angle (°) between the vector reference direction on Circ_Grid and the geographic reference direction
  - Wave_Rotate_Angle - angle (°) between the vector reference direction on Wave_Grid and the geographic reference direction
  - Sedi_Rotate_Angle - angle (°) between the vector reference direction on Sedi_Grid and the geographic reference direction

6. TIMEIN: time stepping control.
  - Total_Time - total computational time
  - Master_dt - time step in master program.
  - N_Interval_CallWave - interval steps for calling the wave module. N_Interval_CallWave=0 represents "never call the wave module" and N_Interval_CallWave¡0 for single initial call
  - N_Interval_CallCirc - interval steps for calling the circulation module. N_Interval_CallCirc=0 represents "never call the circulation module" and N_Interval_CallCirc¡0 for single initial call
  - N_Interval_CallSedi - interval steps for calling the sediment module N_Interval_CallSedi=0 represents "never call the sediment module" and N_Interval_CallSedi¡0 for single initial call
  - N_Delay_CallSedi - time (steps) delay for calling the sediment module
  - N_Interval_Output - interval steps for output

3 Link Master Program and Three Modules

3.1 Necessary Modifications of Three Modules

1. change the main program of each module into a subroutine
   (a) wave module - subroutine WaveModule()
   (b) circulation module - subroutine CircModule()
   (c) sediment module - subroutine SediModule()
2. include 'pass.h' in module subroutines in which you will use master-related variables such as Pass_xxx, Intp_xxx. Notice that, for some Fortran compilers, values of module variables may not be kept when returning to the master program. If it happens, try to include the module common blocks in the master program.
3. split each module code into initialization part and time integration part, if necessary.

   In the following example, *init_shorecirc* is the initialization subroutine of SHORECIRC. Master_Start is a switch parameter which varies between 1 and 0 in the master program. "Master_Start = 1" makes an initialization call and "Master_Start = 0" for a model time integration call. *ntime* is the internal loop number of the module and can be calculated by

   $$\text{ntime} = \text{Master\_dt}/\text{Module\_dt}$$

   ⟨*example*⟩≡

```
        subroutine CircModule()
          include 'pass.h'
          include 'arrays.h'

! ---  initialize module
          if (Master_Start.eq.1)then
            call init_shorecirc
          else

           ntime = Master_dt/Circ_dt

! time integration

            do 100 itstep = 1, ntime

              call predict_stage
              ...

  100      continue
```

```
    endif

      end
```

A module initialization subroutine should include variable initializations, module parameter input and output, and passing grid information or water depth (if needed for initialization). The following example is modifications in SHORECIRC

$\langle$*example*$\rangle$+≡

```
          nx=Nx_Circ
          ny=Ny_Circ

          do j=1,ny
          do i=1,nx
             x(i,j)=X_Circ(i,j)
             y(i,j)=Y_Circ(i,j)
          enddo
          enddo

          do j=1,ny
          do i=1,nx
              dr(i,j)=depth_circ(i,j)
          enddo
          enddo
```

Namelist	variable	type	default value
f_names	f_depth	character*255	' '
	f_xymast	character*255	' '
	f_xywave	character*255	' '
	f_xycirc	character*255	' '
	f_xysedi	character*255	' '
	f_name6	character*255	' '
	...		
	f_name16	character*255	' '

Table 1: Names for input files.

4. specify parameters in 'minput.dat'

   The file *minput.dat* is the input file that determines the behavior of the master program and thus the interactions between the various modules. The input files for the initial topography and each of the grids (master, wave, circulation and sediment transport) are specified as well as the description of these grids. The optional module interactions are determined and the variables to be passed to each module are listed. The frequency of module calls, the duration of the run and the output frequency are specified.

   In this file a wild card "*" may be used in file names or variable names to indicate that the statement applies to all variables of the same form. For example f_xy* refers to any of the variables f_xymast, f_xywave, f_xycirc and f_xysedi. In particular examples, the wild card "?" is used as well two indicate matching pairs as in: if f_xy? = " then Grid_Mast_?_Same is set .true.

   The file used the FORTRAN namelist input with six lists of variables .

   Names for input files as shown in Table 1, f_depth, water depth (topography) on master grid. f_xy*, locations of the xy pairs for the master grid, location of x y pairs for the wave, circulation and sediment modules respectively. If the grids are identical to the master grid the additional file names do not need to be specified. If file names are not specified the master grid is used and if f_xy? = " then Grid_Mast_?_Same is set .true..

   Variables associated with computational grids are defined in Table 2. Nx_Mast, Ny_Mast, Nx_Wave etc. define the number of x and y points in the grid for the master program and each module (wave, circulation and sediment transport). The maximum value of the grid sizes Nx_Max and Ny_Max are set in the file pass.h. The logical variables Grid_Mast_Wave_Same define the relationship between the master grid (required to be rectilinear) and the grids for the modules. These are set to .true. if the respective grids are identical. The logical variables Wave_Staggered etc. are set true for grids in which different variables are at different points. The lo-

Namelist	variable	type	default value
gridin	Nx_Mast	integer	none
	Ny_Mast	integer	none
	Nx_Circ	integer	none
	Ny_Circ	integer	none
	Nx_Wave	integer	none
	Ny_Wave	integer	none
	Nx_Sedi	integer	none
	Ny_Sedi	integer	none
	Grid_Mast_Wave_Same	logical	.false.
	Grid_Mast_Circ_Same	logical	.false.
	Grid_Mast_Sedi_Same	logical	.false.
	Wave_Staggered	logical	.false.
	Circ_Staggered	logical	.false.
	Sedi_Staggered	logical	.false.
	Wave_Stag_huv(3)	integer	none
	Circ_Stag_huv(3)	integer	none
	Sedi_Stag_huv(3)	integer	none
	Wave_Structured	logical	.false.
	Circ_Structured	logical	.false.
	Sedi_Structured	logical	.false.
	Grid_Extrapolation	logical	.false.

Table 2: Grid information

Namelist	variable	type	default value
interaction	Wave_Curr_Interact	logical	.false.
	Wave_Bed_Interact	logical	.false.
	Curr_Bed_Interact	logical	.false.

Table 3: Interaction control.

cations of variables are described by the integer arrays Wave_Stag_huv. Variables located at the center of the grid cell are indicated by a value of 1, center of the cell left side is 2 and center of the grid bottom is 3. *_Stag_huv(1)=n determines the location of the water depth variable (as well as surface elevation and scalar fields). *_Stag_huv(2)=n determines the location of the across shore velocity u, *_Stag_huv(3)=n determines the location of the along shore velocity v. For example, the Arakawa c grid is given by *_Stag_huv(1)=1, *_Stag_huv(2)=2, *_Stag_huv(3)=3. The logical variables Wave_structured are set .true. if the grid is unstructured. Grid_Extrapolation is set .true. if extrapolation of values beyond the boundaries of a grid is desired.

Logical variables for model interaction control are defined as shown in Table 3. Wave_Curr_Interact is set .true. if the currents are passed to the wave module to include the refraction of the waves by the currents. Wave_Bed_Interact, Curr_Bed_Interact are set .true. if the water depth is updated by the sediment transport module and the results passed to the wave module or the circulation module respectively.

The variables shown in Table 4 define those that the master program is currently set up to pass for the first named module to the second. The last two are blanket definitions for the two currently implimented circulation modules. If either of these is set to true the appropriate list of *_to_Circ* variables are set true and consistence is checked that the circulation module can provide the Circ_to_* variables requested by the other modules. Note that not all modules of a particular either provides or needs the entire list of potential passed variables.

Table 5 shows the defined angle between the master grid and the grids of the various modules. This is spatially constant and is the angle between the direction of the vectors passed back to the master program by the circulation or wave modules and the direction given by the rectilinear master grid. These vector fields include velocities passed from the circulation and forcing terms and wave mass flux passed from the wave module. The wave direction array is changed by the appropriate constant value as it is passed to the other modules as well.

In Table 6, Total_Time is the duration of the model run in seconds. Master_dt is the time interval in seconds between calls to the most frequently called module. N_Interval_Call* is the number of Master_dt time steps be-

Namelist	variable	type	default value
passvariables	Wave_to_Circ_Height	logical	.false.
	Wave_to_Circ_Angle	logical	.false.
	Wave_To_Circ_WaveNum	logical	.false.
	Wave_To_Circ_C	logical	.false.
	Wave_To_Circ_Cg	logical	.false.
	Wave_To_Circ_Radiation	logical	.false.
	Wave_To_Circ_Rad_Surf	logical	.false.
	Wave_To_Circ_Rad_Body	logical	.false.
	Wave_To_Circ_Forcing	logical	.false.
	Wave_To_Circ_MassFlux	logical	.false.
	Wave_To_Circ_Dissipation	logical	.false.
	Wave_To_Circ_BottomUV	logical	.false.
	Wave_To_Circ_Brkindex	logical	.false.
	Circ_To_Wave_UV	logical	.false.
	Circ_To_Wave_eta	logical	.false.
	Wave_To_Sedi_Height	logical	.false.
	Wave_To_Sedi_Angle	logical	.false.
	Wave_To_Sedi_BottomUV	logical	.false.
	Circ_To_Sedi_UV	logical	.false.
	Circ_To_Sedi_UVb	logical	.false.
	Circ_To_Sedi_eta	logical	.false.
	Circ_To_Sedi_UV3D	logical	.false.
	Circ_To_Sedi_fw	logical	.false.
	Circ_To_Sedi_vt	logical	.false.
	Circ_To_Sedi_UVquasi3D	logical	.false.
	Sedi_To_Wave_Depth	logical	.false.
	Sedi_To_Circ_Depth	logical	.false.
	Waveupdat_for_Circ	logical	.false.
	Waveupdat_for_Sedi	logical	.false.
	Circupdat_for_Wave	logical	.false.
	Circupdat_for_Sedi	logical	.false.
	Sediupdat_for_Wave	logical	.false.
	Sediupdat_for_Circ	logical	.false.
	Circ_POM	logical	.false.
	Circ_SC	logical	.false.

Table 4: Logical variables for passing variables

Namelist	variable	type	default value
vectorrotate	Circ_Rotate_Angle	real	none
	Wave_Rotate_Angle	real	none
	Sedi_Rotate_Angle	real	none

Table 5: Vector rotation angles

Namelist	variable	type	default value
timein	Total_Time	real	none
	Master_dt	real	none
	N_Interval_CallWave	real	none
	N_Interval_CallCirc	real	none
	N_Interval_CallSedi	real	none
	N_Delay_CallSedi	real	none
	N_Interval_Output	real	none

Table 6: Time control variables

tween calls to the corresponding module. N_Delay_CallSedi is the number of Master_dt steps before the sediment is called. This allows the circulation and wave field to become established before the effect on sediment is calculated. N_Interval_Output is the number of Master_dt steps between master program output. Note that the internal time step for modules such as the circulation modules POM and ShoreCirc are set in the input files for the module and are not known by the master program. The number of steps to be calculated at each call to any module that uses time stepping is calculated within the module and given by: nstep=N_interval_Call? x Master_dt / ?_dt .

5. assign module variables to passing variables in your modules. The following are examples.

   (a) wave modules
   Pass_Sxx(i,j) = Sxx(i,j)
   Pass_Sxy(i,j) = Sxy(i,j)
   Pass_Syy(i,j) = Syy(i,j)
   Pass_MassFluxU(i,j) = Uflux(i,j)
   Pass_MassFluxV(i,j) = Vflux(i,j)
   Pass_Diss(i,j) = disp(i,j)
   Pass_ibrk(i,j) = indexbreak(i,j)
   Pass_Theta(i,j) = angle(i,j)
   Pass_Height(i,j)= height(i,j)
   Pass_ubott(i,j) = ub(i,j)

Pass_Cg(i,j) = Cg(i,j)
Pass_C(i,j) = C(i,j)

(b) circulation modules
Pass_U(i,j) = u(i,j)
Pass_V(i,j) = v(i,j)
Pass_fw(i,j) = fw(i,j)
Pass_vt(i,j) = vt(i,j)

(c) Sediment modules
Pass_Dupdated(i,j) = dep(i,j)

6. use variables passed and interpolated from other modules. The following are examples.

(a) Wave modules
ur(i,j)= Intp_U_Wave(i,j)
vr(i,j)= Intp_V_Wave(i,j)
dr(i,j) = Depth_Wave(i,j) + Intp_eta_Wave(i,j)

(b) Circulation modules
depcirc(i,j) = Depth_Circ(i,j)
s_xx(i,j) = Intp_Sxx_Circ(i,j)
s_xy(i,j) = Intp_Sxy_Circ(i,j)
s_yy(i,j) = Intp_Syy_Circ(i,j)
ub(i,j) = Intp_ubott_Circ(i,j)
wangle(i,j) = Intp_Theta_Circ(i,j)
wh(i,j) = Intp_Height_Circ(i,j)
Cw(i,j) = Intp_C_Circ(i,j)
Cgw(i,j) = Intp_Cg_Circ(i,j)
dissipation(i,j) = Intp_Diss_Circ(i,j)
ibrk(i,j) = Intp_ibrk_Circ(i,j)
fluxU(i,j) = Intp_MassFluxU_Circ(i,j)
fluxV(i,j) = Intp_MassFluxV_Circ(i,j)

(c) Sediment modules
currU(i,j) = Intp_U_Sedi(i,j)
currV(i,j) = Intp_V_Sedi(i,j)
bottU(i,j) = Intp_Ub_Sedi(i,j)
bottV(i,j) = Intp_Vb_Sedi(i,j)
wavebottu(i,j) = Intp_ubott_Sedi(i,j)
surface(i,j) = Intp_eta_Sedi(i,j)
bfric(i,j) = Intp_fw_Sedi(i,j)
vt(i,j) = Intp_vt_Sedi(i,j)

wave_angle(i,j) = Intp_Theta_Sedi(i,j)
wave_height(i,j) = Intp_Height_Sedi(i,j)
wave_ibrk(i,j) = Intp_ibrk_Sedi(i,j)

7. Makefile

   There is a generic Makefile for the Nearshore Community Model. Before you use the Makefile, please make sure the master program, the computional modules and dependences in your model directory. In the Makefile, you may need to choose a Fortran compiler and flags to the Fortran compiler. The following is a example to choose the Intel Fortran Compiler as the compiler and setup flags to the compiler.

   CFT = ifc
   FFLAGS = -O3 -w

   For users who want to use the existing modules, you can choose one module (set true, see the following example) from each module group (i.e., wave, circulation, and sediment module groups). When you choose the FUNWAVE module as a circulation module, don't choose any wave module from the wave module group (all wave modules should be set false). The following example shows a combination setup of REF/DIF-S, SHORECIRC, and BBB-sediment modules.

   # — wave module group
   REFDIFS = true
   REFDIF1 = false
   REFDIF_SNL = false
   WAVE_KENNEDY = false
   WAVE_HERBERS = false
   WAVE_TUBA = false

   # — circulation module group
   SHORECIRC = true
   CURVCIRC = false
   POM = false
   FUNWAVE = false

   # — sediment module group
   BBB = true
   HH = false
   RIB = false
   WAT = false

   # — master program, always true
   MASTSC = master.f

For users who want to add a new module into the Nearshore Community Model, you need to modify the Makefile as shown in the following example.

The new module is assumed as a wave module named "NewModule".

(a) add the module name in the block of the wave module group and set "true":
# — wave module group
NewModule = true

(b) list names of all the Fortran codes needed to be compiled (e.g., NewModule1.f NewModule2.f ...) in the source code block (don't list ".h") :
ifeq ($(NewModule),true)
WAVESC = NewModule1.f NewModule2.f ...
endif

(c) list dependences (e.g., NewModule1.f, NewModule2.f, pass.h NewParam.h ...) in the dependences block:
————————————————————
dependences:
————————————————————
NewModule1.o: NewModule1.f ... pass.h NewParam.h

3.2 Units

The International System of Units (SI) is used for all variables defined in pass.h. If a particular module was developed in other unit systems rather than the SI system, unit conversions are needed when variables pass between the master program and the module. The unit conversions should be implemented in the particular module.

3.3 Coordinate systems

The grid point locations for all computational grids, including the master grid, are given by the Cartesian (x,y) (meters) in geographical reference coordinates. Figure 3 shows an example of two computational grid systems in which Grid1 is represented by the curvilinear solid lines and Grid2 by the dashed lines. All grid point locations in both Grid1 and Grid2 are given by (x,y) values wherever the first grid point (i=1,j=1) is defined on each grid. The directions of vector variables in each module could be defined based on its own reference direction such as (u_1, v_1) on grid1 or (u_2, v_2) on grid2 as shown in Figure 3. But users should specify, in "minput.dat", the angles between the module reference direction and the geographical x - direction, e.g., θ_1 and θ_2 in Figure 3. For example, in "minput.dat", $Circ\_Rotate\_Angle = 10.$, which means the vector reference direction in the circulation module rotates 10° (counterclockwise) from the geographical reference direction. It should be mentioned that the vector reference direction in each module should be fixed and should not vary spatially even in a curvilinear coordinate system. They should neither be normal or tangential directions of curvilinear coordinate lines, nor be covariant or contravariant base directions. The vectors based on normal/tangential directions or covariant/contravariant directions should be converted before they are transfered into other grid systems.

The interpolation/extrapolation can be carried out between non-staggered and staggered grids, or staggered grid systems with different Arakawa types. The logical paramters " xxxx_Staggered" are used to represent if a system is a staggered grid system or not. The integer parameters such as "xxxx_Stag_huv" are used to represent Arakawa grid types. xxxx_Stag_huv is an integer array with three elements. The first element gives the location of water depth h or surface elevation ζ. The second and the third elements give the locations of velocity components u and v, respectively. For a grid element, we use '0', '1', '2', and '3' to represent the positions where variables are calculated as shown in Figure 4 (a). Figure 4 (b) - (d) show the examples of Arakawa grid definitions. For Arakawa-A, xxxx_Stag_huv = (0 0 0); Arakawa-B:xxxx_Stag_huv = (0 1 1); and Arakawa-C:xxxx_Stag_huv = (1 2 3). You could not use the standard Arakawa definition for variable passing. For example, when you use the POM module (Arakawa - C) in a curvilinear coordinate system, current velocity vector may be first interpolated into the grid nodes (location "0") and then passed into another module. The pre-interpolated veocity components are actually located at "0" position rather than at "2" and "3" positions. In this case, you may specify Circ_Stag_huv = (1 0 0).

Usually, only water depth, surface elevation and vectors such as current velocity, short wave volume flux and short wave forcing are passed and interpolated between staggered grid systems. For other passing variables such as wave height, wave angle, wave phase velocity, wave breaking index, radiation stresses, and etc., interpolation/extrapolation are carried out at grid nodes (location "0").

3.4 One Dimensional Grid

The master program allows to use one or more 1-D module/modules. The 1-D direction is assumed to be the x-direction (say onshore). For the 1-D module/modules, Ny_xxxx=1. When 1-D variables are interpolated/extrapolated into a 2-D grid, longshore uniform values are obtained on the 2-D grid. When 2-D variables are interpolated/extrapolated into a 1-D grid, longshore averaged values are used for the x-direction interpolation/extrapolation.

3.5 Unstructured Grid

For unstructured grids, 2-D arrays are also used for coordinate information and pass variables, as the same as in structured grid systems. If only 1-D arrays

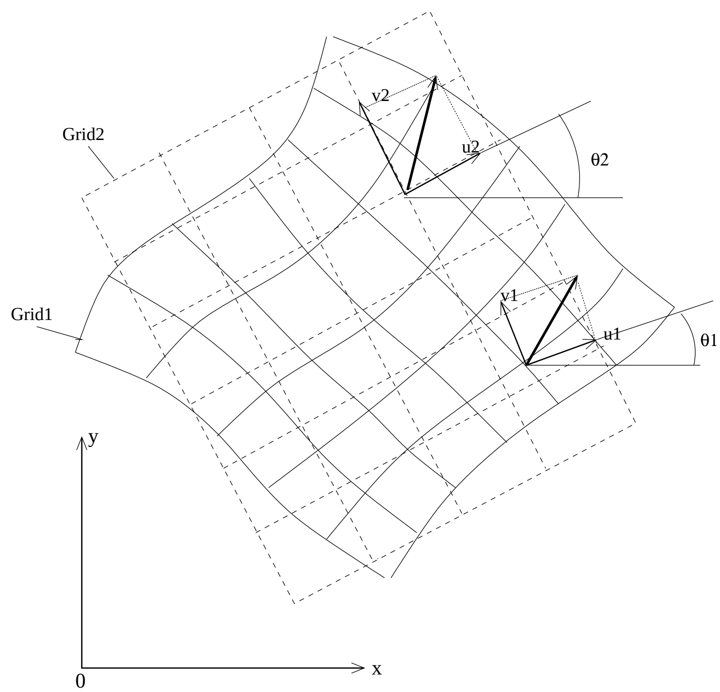

Figure 3: Example of module grids in geographical reference coordinates.

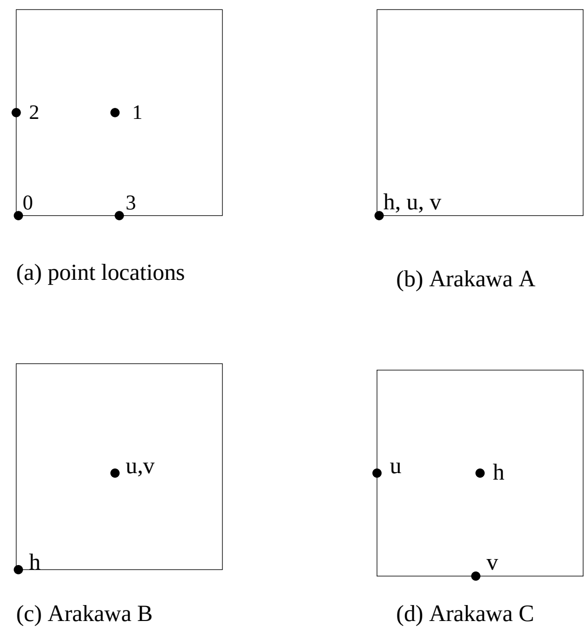

Figure 4: Staggered grid definition.

are defined in the module with a unstructured grid, Ny = 1 should be used in passing variables.

4 *noweb* Documentation of the Master Program

4.1 Main Program

The program calls three modules: WaveModule(), CircModule() and SediModule(). It also includes data input, calculation of interpolation/extrapolation coefficients, Pass_variables initialization, module initializations, and data output.

Master calls the following subroutines

1. *readfile*
2. *get_interpolation_coef*
3. *interp_depth*
4. *interp_circ_wave*
5. *interp_sedi_wave*
6. *interp_wave_circ*
7. *interp_sedi_circ*
8. *interp_wave_sedi*
9. *interp_circ_sedi*
10. *MasterInit()*
11. *WaveModule()*
12. *CircModule()*
13. *SediModule()*
14. *Mexport()*

⟨*⟩≡

```
c --------------------------------------------------------------------
      program master
      implicit none
      include 'pass.h'
      include 'interp.h'
      integer i,j
      integer master_steps
      real Time_Circ, Time_Wave, Time_Sedi, Time_Output
```

```
        data Time_Circ /0./, Time_Wave /0./, Time_Sedi /0./,
     &       Time_Output /0./

c --- read file

        call readfile

c --- calculate interpolation coefficients

        call get_interpolation_coef

c --- depth interplation/extrapolation

        call interp_depth

c ---   module Initialization and first call
c       the first call is for hot start

         Master_Start = 1

         call MasterInit()

c ---    wave
         if(N_Interval_CallWave.ge.0)call WaveModule()

c ---    circulation
         if(N_Interval_CallCirc.ge.0)call CircModule()

c ---    sediment
         if(N_Interval_CallSedi.ge.0)call SediModule()

c ---    set initialization switch
         Master_Start=-1

c ---   get Master_steps and ...

        Master_steps = Total_Time / Master_dt

        if(N_Interval_CallCirc.gt.0)then
          nCirc = N_Interval_CallCirc
        else
          nCirc= Master_steps+1
        endif

        if(N_Interval_CallWave.gt.0)then
          nWave = N_Interval_CallWave
```

```
        else
          nWave= Master_steps+1
        endif

        if(N_Interval_CallSedi.gt.0)then
          nSedi = N_Interval_CallSedi
        else
          nSedi= Master_steps+1
        endif

        nOut = N_Interval_Output

c ---   Do timestepping

        do 100 istep = 1, Master_steps

        Time_Master= (istep-1)*Master_dt

        write(*,*) 'Time = ',Time_Master, 's'

c --- call wave module

         if (N_Interval_CallWave.ge.0.and.mod(istep-1,nWave).eq.0) then

            if(Circupdat_for_Wave)then
               call interp_circ_wave
            endif

            if(Sediupdat_for_Wave)then
               call interp_sedi_wave
            endif

            call WaveModule()

            Circupdat_for_Wave = .false.
            Sediupdat_for_Wave =.false.
            Waveupdat_for_Circ = .true.
            Waveupdat_for_Sedi = .true.

         end if

c ---  call circulation module

         if (N_Interval_CallCirc.ge.0.and.mod(istep-1,nCirc).eq.0) then

         if(Waveupdat_for_Circ) then
```

```
              call interp_wave_circ
           endif

           if(Sediupdat_for_Circ) then
              call interp_sedi_circ
           endif

             call CircModule()

             Waveupdat_for_Circ = .false.
             Sediupdat_for_Circ = .false.
             Circupdat_for_Wave = .true.
             Circupdat_for_Sedi = .true.

           end if

c ---  call sediment module

           if(N_Interval_CallSedi.ge.0
     & .and.mod(istep-1,nSedi).eq.0.and.istep.ge.N_Delay_CallSedi)then

           if(Waveupdat_for_Sedi) then
              call interp_wave_sedi
           endif

           if(Circupdat_for_Sedi)then
              call interp_circ_Sedi
           endif

           call SediModule()

           Waveupdat_for_Sedi = .false.
           Circupdat_for_Sedi = .false.
           Sediupdat_for_Wave = .true.
           Sediupdat_for_Circ = .true.

           end if

c --- output

           if (mod(istep-1,nOut).eq.0) then
             call Mexport()
           end if

100        continue
c   ---    program end
```

```
 print*,'Program end'

end
```

4.2 Subroutine readfile

This subroutine reads in file names, grid dimensions, and model control parameters provided by 'minput.dat'. It also reads in water depth and (x,y) at grid points, from file names given in 'minput.dat'.

readfile is called by

1. *master*

⟨*⟩+≡
```
c -------------------------------------------------------------------
        subroutine readfile
        implicit none
        include 'pass.h'
        integer i,j

        namelist /f_names/ f_depth,f_xymast,f_xywave,f_xycirc,
     &                 f_xysedi,f_name6,
     &                 f_name7,
     &                 f_name8,f_name9,f_name10,f_name11,f_name12,
     &                 f_name13,f_name14,
     &                 f_name15,f_name16

     &           /gridin/ Nx_Mast, Ny_Mast, Nx_Circ,
     &                  Ny_Circ, Nx_Wave, Ny_Wave, Nx_Sedi, Ny_Sedi,
     &                  Grid_Mast_Wave_Same, Grid_Mast_Circ_Same,
     &                  Grid_Mast_Sedi_Same,
     &                  Wave_Staggered, Circ_Staggered,Sedi_Staggered,
     &                  Wave_Stag_huv,  Circ_Stag_huv, Sedi_Stag_huv,
     &                  Wave_structured, Circ_Structured,
     &                  Sedi_Structured,
     &                  Grid_Extrapolation

     &           /interaction/
     &                  Wave_Curr_Interact,
     &                  Wave_Bed_Interact,
     &                  Curr_Bed_Interact

     &           /passvariables/
     &               Wave_To_Circ_Height,
     &               Wave_To_Circ_Angle,
     &               Wave_To_Circ_WaveNum,
     &               Wave_To_Circ_C,
     &               Wave_To_Circ_Radiation,
     &               Wave_To_Circ_Rad_Surf,
     &               Wave_To_Circ_Rad_Body,
     &               Wave_To_Circ_Forcing,
```

```
     &               Wave_To_Circ_MassFlux,
     &               Wave_To_Circ_Dissipation,
     &               Wave_To_Circ_BottomUV,
     &               Wave_To_Circ_Brkindex,
     &               Circ_To_Wave_UV,
     &               Circ_To_Wave_eta,
     &               Wave_To_Sedi_Height,
     &               Wave_To_Sedi_Angle,
     &               Wave_To_Sedi_BottomUV,
     &               Circ_To_Sedi_SedFlux,
     &               Circ_To_Sedi_UV,
     &               Circ_To_Sedi_UVb,
     &               Circ_To_Sedi_eta,
     &               Circ_To_Sedi_UV3D,
     &               Circ_To_Sedi_fw,
     &               Circ_To_Sedi_vt,
     &               Circ_To_Sedi_UVquasi3D,
     &               Sedi_To_Wave_Depth,
     &               Sedi_To_Circ_Depth,
     &               Circ_POM, Circ_SC

     &           /vectorrotate/
     &                Circ_Rotate_Angle, Wave_Rotate_Angle,
     &                Sedi_Rotate_Angle

     &           /timein/ Total_Time,Master_dt, N_Interval_CallWave,
     &                  N_Interval_CallCirc,N_Interval_CallSedi,
     &                  N_Delay_CallSedi,
     &                  N_Interval_Output

        include 'ini_logical.f'

        open(1,file='minput.dat')

        read(1,nml=f_names)
        read(1,nml=gridin)
        read(1,nml=interaction)
        read(1,nml=passvariables)
        read(1,nml=vectorrotate)
        read(1,nml=timein)
        close(1)

C minimal consistency check
        if(Circ_POM .and. Circ_SC)then
          write(0,*)' Specify only one circulation module'
          stop
```

```
        endif
        if(Circ_POM)then
          Wave_To_Circ_Height = .true.
          Wave_To_Circ_Angle = .true.
          Wave_To_Circ_WaveNum = .true.
          Wave_To_Circ_C = .true.
          Wave_To_Circ_Cg = .true.
          Wave_To_Circ_MassFlux = .true.
          Wave_To_Circ_Dissipation = .true.
          Wave_To_Circ_BottomUV = .true.
          Circ_Staggered = .true.
C check
          Circ_Stag_huv(1)=1
          Circ_Stag_huv(2)=2
          Circ_Stag_huv(3)=3
        endif
c put definitions for other modules here so all pass flags are set
        if(Circ_POM)then
          if(Circ_to_Sedi_vt)then
            write(0,*)'vt not implimented in POM'
            stop
          endif
          if(Circ_to_Sedi_fw)then
            write(0,*)'fw not implimented in POM'
            stop
          endif
          if(Circ_To_Sedi_UVquasi3D)then
            write(0,*)'use UV3D with POM'
            stop
          endif
        endif

c --- read initial depth

        open(1,file=f_depth)
        do j=1,Ny_Mast
          read(1,*)(Depth_Mast(i,j),i=1,Nx_Mast)
        enddo
        close(1)

c --- read xy of master grid

        open(1,file=f_xymast)
        do j=1,Ny_Mast
          read(1,*)(X_Mast(i,j),i=1,Nx_Mast)
        enddo
```

```
        do j=1,Ny_Mast
          read(1,*)(Y_Mast(i,j),i=1,Nx_Mast)
        enddo
        close(1)

c --- read xy of wave module

        if(f_xywave.ne.' ')then
        open(1,file=f_xywave)
        do j=1,Ny_Wave
          read(1,*)(X_Wave(i,j),i=1,Nx_Wave)
        enddo
        do j=1,Ny_Wave
          read(1,*)(Y_Wave(i,j),i=1,Nx_Wave)
        enddo
        close(1)
        else
        do j=1,Ny_Wave
        do i=1,Nx_Wave
          X_Wave(i,j)=X_Mast(i,j)
          Y_Wave(i,j)=Y_Mast(i,j)
        enddo
        enddo
        Grid_Mast_Wave_Same = .true.
        endif

c --- read xy of circulation module

        if(f_xycirc.ne.' ')then
        open(1,file=f_xycirc)
        do j=1,Ny_Circ
          read(1,*)(X_Circ(i,j),i=1,Nx_Circ)
        enddo
        do j=1,Ny_Circ
          read(1,*)(Y_Circ(i,j),i=1,Nx_Circ)
        enddo
        close(1)
        else
        do j=1,Ny_Circ
        do i=1,Nx_Circ
          X_Circ(i,j)=X_Mast(i,j)
          Y_Circ(i,j)=Y_Mast(i,j)
        enddo
        enddo
        Grid_Mast_Circ_Same = .true.
        endif
```

```
c --- read xy of sediment module

        if(f_xysedi.ne.' ')then
        open(1,file=f_xysedi)
        do j=1,Ny_Sedi
          read(1,*)(X_Sedi(i,j),i=1,Nx_Sedi)
        enddo
        do j=1,Ny_Sedi
          read(1,*)(Y_Sedi(i,j),i=1,Nx_Sedi)
        enddo
        close(1)
        else
        do j=1,Ny_Sedi
        do i=1,Nx_Sedi
          X_Sedi(i,j)=X_Mast(i,j)
          Y_Sedi(i,j)=Y_Mast(i,j)
        enddo
        enddo
        Grid_Mast_Sedi_Same = .true.
        endif

c --- grid relations between wave-circ, wave-sedi, and circ-sedi

        Grid_Wave_Circ_Same = .false.
        Grid_Wave_Sedi_Same = .false.
        Grid_Circ_Sedi_Same = .false.

        if(Grid_Mast_Wave_Same.and.Grid_Mast_Circ_Same)
     &     Grid_Wave_Circ_Same = .true.

        if(Grid_Mast_Wave_Same.and.Grid_Mast_Sedi_Same)
     &     Grid_Wave_Sedi_Same = .true.

        if(Grid_Mast_Circ_Same.and.Grid_Mast_Sedi_Same)
     &     Grid_Circ_Sedi_Same = .true.

100      format(800f16.8)

        return
        end
```

4.3 Subroutine get_interpolation_coef

The subroutine computes interpolation coefficients and save them in arrays in 'interp.h'.

get_interpolation_coef is called by

1. *master*

It calls

1. *interpsame*
2. *interpolation*

⟨*⟩+≡
```
c ---------------------------------------------------------------

      subroutine get_interpolation_coef
      implicit none
      include 'pass.h'
      include 'interp.h'
      integer i,j

c ---   Mast-Wave
      if(Grid_Mast_Wave_Same) then
        call interpsame(Nx_Wave,Ny_Wave,Sc_01,S1_01,S2_01,S3_01,
     .          nx1_01,ny1_01,nx2_01,ny2_01,nx3_01,ny3_01)
      else
       write(*,*)'Grid_Mast & Grid_Wave are different, calc coef...'
        call interpolation
     .   (Nx_Mast,Ny_Mast,X_Mast,Y_Mast,
     .    Nx_Wave,Ny_Wave,X_Wave,Y_Wave,Sc_01,S1_01,S2_01,S3_01,
     .    nx1_01,ny1_01,nx2_01,ny2_01,nx3_01,ny3_01)
      endif

c ---   Mast-Circ
      if(Grid_Mast_Circ_Same) then
        call interpsame(Nx_Circ,Ny_Circ,Sc_02,S1_02,S2_02,S3_02,
     .          nx1_02,ny1_02,nx2_02,ny2_02,nx3_02,ny3_02)
      else
       write(*,*)'Grid_Mast & Grid_Circ are different, calc coef...'

        call interpolation
     .   (Nx_Mast,Ny_Mast,X_Mast,Y_Mast,
     .    Nx_Circ,Ny_Circ,X_Circ,Y_Circ,Sc_02,S1_02,S2_02,S3_02,
     .    nx1_02,ny1_02,nx2_02,ny2_02,nx3_02,ny3_02)
      endif
```

```
c ---   Mast-Sedi
        if(Grid_Mast_Sedi_Same) then
          call interpsame(Nx_Sedi,Ny_Sedi,Sc_03,S1_03,S2_03,S3_03,
     .          nx1_03,ny1_03,nx2_03,ny2_03,nx3_03,ny3_03)
        else
         write(*,*)'Grid_Mast & Grid_Sedi are different, calc coef...'
          call interpolation
     .    (Nx_Mast,Ny_Mast,X_Mast,Y_Mast,
     .     Nx_Sedi,Ny_Sedi,X_Sedi,Y_Sedi,Sc_03,S1_03,S2_03,S3_03,
     .     nx1_03,ny1_03,nx2_03,ny2_03,nx3_03,ny3_03)
        endif

c ---   Circ-Wave
        if(Grid_Wave_Circ_Same) then
          call interpsame(Nx_Wave,Ny_Wave,Sc_21,S1_21,S2_21,S3_21,
     .          nx1_21,ny1_21,nx2_21,ny2_21,nx3_21,ny3_21)
        else
         write(*,*)'Grid_Wave & Grid_Circ are different, calc coef...'
          call interpolation
     .    (Nx_Circ,Ny_Circ,X_Circ,Y_Circ,
     .     Nx_Wave,Ny_Wave,X_Wave,Y_Wave,Sc_21,S1_21,S2_21,S3_21,
     .     nx1_21,ny1_21,nx2_21,ny2_21,nx3_21,ny3_21)
        endif

c ---   Sedi-Wave
        if(Grid_Wave_Sedi_Same) then
          call interpsame(Nx_Wave,Ny_Wave,Sc_31,S1_31,S2_31,S3_31,
     .          nx1_31,ny1_31,nx2_31,ny2_31,nx3_31,ny3_31)
        else
         write(*,*)'Grid_Wave & Grid_Sedi are different, calc coef...'
          call interpolation
     .    (Nx_Sedi,Ny_Sedi,X_Sedi,Y_Sedi,
     .     Nx_Wave,Ny_Wave,X_Wave,Y_Wave,Sc_31,S1_31,S2_31,S3_31,
     .     nx1_31,ny1_31,nx2_31,ny2_31,nx3_31,ny3_31)
        endif

c ---   Wave-Circ
        if(Grid_Wave_Circ_Same) then
          call interpsame(Nx_Circ,Ny_Circ,Sc_12,S1_12,S2_12,S3_12,
     .          nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12)
        else
         write(*,*)'Grid_Wave & Grid_Circ are different, calc coef...'
          call interpolation
     .    (Nx_Wave,Ny_Wave,X_Wave,Y_Wave,
     .     Nx_Circ,Ny_Circ,X_Circ,Y_Circ,Sc_12,S1_12,S2_12,S3_12,
     .     nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12)
```

```
      endif

c --- Sedi-Circ
      if(Grid_Circ_Sedi_Same) then
        call interpsame(Nx_Circ,Ny_Circ,Sc_32,S1_32,S2_32,S3_32,
     .        nx1_32,ny1_32,nx2_32,ny2_32,nx3_32,ny3_32)
      else
       write(*,*)'Grid_Circ & Grid_Sedi are different, calc coef...'
        call interpolation
     .   (Nx_Sedi,Ny_Sedi,X_Sedi,Y_Sedi,
     .    Nx_Circ,Ny_Circ,X_Circ,Y_Circ,Sc_32,S1_32,S2_32,S3_32,
     .    nx1_32,ny1_32,nx2_32,ny2_32,nx3_32,ny3_32)
      endif

c --- Wave-Sedi
      if(Grid_Wave_Sedi_Same) then
        call interpsame(Nx_Sedi,Ny_Sedi,Sc_13,S1_13,S2_13,S3_13,
     .        nx1_13,ny1_13,nx2_13,ny2_13,nx3_13,ny3_13)
      else
       write(*,*)'Grid_Wave & Grid_Sedi are different, calc coef...'
        call interpolation
     .   (Nx_Wave,Ny_Wave,X_Wave,Y_Wave,
     .    Nx_Sedi,Ny_Sedi,X_Sedi,Y_Sedi,Sc_13,S1_13,S2_13,S3_13,
     .    nx1_13,ny1_13,nx2_13,ny2_13,nx3_13,ny3_13)
      endif

c --- Circ-Sedi
      if(Grid_Circ_Sedi_Same) then
        call interpsame(Nx_Sedi,Ny_Sedi,Sc_23,S1_23,S2_23,S3_23,
     .        nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23)
      else
       write(*,*)'Grid_Circ & Grid_Sedi are different, calc coef...'
        call interpolation
     .   (Nx_Circ,Ny_Circ,X_Circ,Y_Circ,
     .    Nx_Sedi,Ny_Sedi,X_Sedi,Y_Sedi,Sc_23,S1_23,S2_23,S3_23,
     .    nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23)
      endif

100   continue

      return
      end
```

4.4 Subroutine interp_depth

The subroutine interpolates water depth from Master-Grid to Wave-Grid, Circ-Grid, and Sedi-Grid.

interp_depth is called by

1. *master*

interp_depth calls

1. *grid1_to_grid2*

⟨*⟩+≡
```
c -------------------------------------------------------------

        subroutine interp_depth
        implicit none
        include 'pass.h'
        include 'interp.h'
        integer i,j

        call grid1_to_grid2(Nx_Mast,Ny_Mast,Nx_Wave,Ny_Wave,
     &                      Sc_01,S1_01,S2_01,S3_01,
     &                      nx1_01,ny1_01,nx2_01,ny2_01,nx3_01,ny3_01,
     &                      Depth_Mast,Depth_Wave,
     &                      .false.,0,Wave_Staggered,Wave_Stag_huv(1))

        call grid1_to_grid2(Nx_Mast,Ny_Mast,Nx_Circ,Ny_Circ,
     &                      Sc_02,S1_02,S2_02,S3_02,
     &                      nx1_02,ny1_02,nx2_02,ny2_02,nx3_02,ny3_02,
     &                      Depth_Mast,Depth_Circ,
     &                      .false.,0,Circ_Staggered,Circ_Stag_huv(1))

        call grid1_to_grid2(Nx_Mast,Ny_Mast,Nx_Sedi,Ny_Sedi,
     &                      Sc_03,S1_03,S2_03,S3_03,
     &                      nx1_03,ny1_03,nx2_03,ny2_03,nx3_03,ny3_03,
     &                      Depth_Mast,Depth_Sedi,
     &                      .false.,0,Sedi_Staggered,Sedi_Stag_huv(1))


c --- test interpolatoin
c        call output(Nx_Mast,Ny_Mast,1,Depth_Mast)
c        call output(Nx_Circ,Ny_Circ,2,Depth_Circ)

        return
        end
```

4.5 Subroutine interp_circ_wave

The subroutine interpolates variables from Circ-Grid to Wave-Grid.

interp_circ_wave is called by

1. *master*

interp_circ_wave calls

1. *grid1_to_grid2*

⟨*⟩+≡

```
c --------------------------------------------------------------

      subroutine interp_circ_wave
      implicit none
      include 'pass.h'
      include 'interp.h'
      real Tmp1, Tmp2, tht
      integer i,j

      if (Wave_Curr_Interact) then

        if(Circ_To_Wave_UV) then


      call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Wave,Ny_Wave,
   &                    Sc_21,S1_21,S2_21,S3_21,
   &                    nx1_21,ny1_21,nx2_21,ny2_21,nx3_21,ny3_21,
   &                    Pass_U,Intp_U_Wave,
   &                    Circ_Staggered,Circ_Stag_huv(2),
   &                    Wave_Staggered,Wave_Stag_huv(2))

      call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Wave,Ny_Wave,
   &                    Sc_21,S1_21,S2_21,S3_21,
   &                    nx1_21,ny1_21,nx2_21,ny2_21,nx3_21,ny3_21,
   &                    Pass_V,Intp_V_Wave,
   &                    Circ_Staggered,Circ_Stag_huv(3),
   &                    Wave_Staggered,Wave_Stag_huv(3))


           if((Circ_Rotate_Angle-Wave_Rotate_Angle).ne.0)then
             do j=1,Ny_Wave
             do i=1,Nx_Wave
               Tmp1=Intp_U_Wave(i,j)
               Tmp2=Intp_V_Wave(i,j)
               tht=(Circ_Rotate_Angle-Wave_Rotate_Angle)*3.14159/180.
                Intp_U_Wave(i,j)=Tmp1*cos(tht)- Tmp2*sin(tht)
```

```
             Intp_V_Wave(i,j)=Tmp1*sin(tht)+ Tmp2*cos(tht)
          enddo
          enddo

        endif
     endif

     if(Circ_To_Wave_eta)then

   call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Wave,Ny_Wave,
&                     Sc_21,S1_21,S2_21,S3_21,
&                     nx1_21,ny1_21,nx2_21,ny2_21,nx3_21,ny3_21,
&                     Pass_eta,Intp_eta_Wave,
&                     Circ_Staggered,Circ_Stag_huv(1),
&                     Wave_Staggered,Wave_Stag_huv(1))

     endif

   endif

   return
   end
```

4.6 Subroutine interp_sedi_wave

The subroutine interpolates variables from Sedi-Grid to Wave-Grid.

interp_sedi_wave is called by

1. *master*

interp_sedi_wave calls

1. *grid1_to_grid2*

⟨*⟩+≡

```
c -------------------------------------------------------------

      subroutine interp_sedi_wave
      implicit none
      include 'pass.h'
      include 'interp.h'
      real Tmp1,Tmp2,tht
      integer i,j


      if (Wave_Bed_Interact) then
        if(Sedi_To_Wave_Depth)then
      call grid1_to_grid2(Nx_Sedi,Ny_Sedi,Nx_Wave,Ny_Wave,
     &                     Sc_31,S1_31,S2_31,S3_31,
     &                     nx1_31,ny1_31,nx2_31,ny2_31,nx3_31,ny3_31,
     &                     Pass_Dupdated,Depth_Wave,
     &                     Sedi_Staggered,Sedi_Stag_huv(1),
     &                     Wave_Staggered,Sedi_Stag_huv(1))
        endif
      endif

      return
      end
```

4.7 Subroutine interp_wave_circ

The subroutine interpolates variables from Wave-Grid to Circ-Grid.

interp_wave_circ is called by

1. *master*

interp_wave_circ calls

1. *grid1_to_grid2*

⟨*⟩+≡

```
c ---------------------------------------------------------------

        subroutine interp_wave_circ
        implicit none
        include 'pass.h'
        include 'interp.h'
        real Tmp1, Tmp2, tht
        integer i,j

c --- wave height

        if(Wave_To_Circ_Height)then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                     Sc_12,S1_12,S2_12,S3_12,
     &                     nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                     Pass_Height,Intp_Height_Circ,
     &                     Wave_Staggered,0,
     &                     Circ_Staggered,0)

        endif

c --- wave angle

        if(Wave_To_Circ_Angle)then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                     Sc_12,S1_12,S2_12,S3_12,
     &                     nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                     Pass_Theta,Intp_Theta_Circ,
     &                     Wave_Staggered,0,
     &                     Circ_Staggered,0)

             if((Wave_Rotate_Angle-Circ_Rotate_Angle).ne.0)then
               do j=1,Ny_Circ
               do i=1,Nx_Circ
```

```
              tht=Wave_Rotate_Angle-Circ_Rotate_Angle
              Intp_Theta_Circ(i,j)=Intp_Theta_Circ(i,j)+tht
            enddo
            enddo
          endif

        endif


c --- wave number

        if(Wave_To_Circ_WaveNum)then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_WaveNum,Intp_WaveNum_Circ,
     &                    Wave_Staggered,0,
     &                    Circ_Staggered,0)

        endif

c --- wave C

        if(Wave_To_Circ_C)then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_C,Intp_C_Circ,
     &                    Wave_Staggered,0,
     &                    Circ_Staggered,0)

        endif

c --- radiation stress (depth-average form)

        if(Wave_To_Circ_Radiation)then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_Sxx,Intp_Sxx_Circ,
     &                    Wave_Staggered,0,
     &                    Circ_Staggered,0)
```

```
      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_Sxy,Intp_Sxy_Circ,
     &                    Wave_Staggered,0,Circ_Staggered,0)

      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_Syy,Intp_Syy_Circ,
     &                    Wave_Staggered,0,Circ_Staggered,0)

      endif

c --- radiation stress - surface

      if(Wave_To_Circ_Rad_Surf)then

      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_Sxx_surf,Intp_Sxx_surf,
     &                    Wave_Staggered,0,Circ_Staggered,0)

      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_Sxy_surf,Intp_Sxy_surf,
     &                    Wave_Staggered,0,Circ_Staggered,0)

      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_Syy_surf,Intp_Syy_surf,
     &                    Wave_Staggered,0,Circ_Staggered,0)

      endif

c --- radiation stress - body

      if(Wave_To_Circ_Rad_Body)then

      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_Sxx_body,Intp_Sxx_body,
```

```
     &                      Wave_Staggered,0,Circ_Staggered,0)

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                      Sc_12,S1_12,S2_12,S3_12,
     &                      nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                      Pass_Sxy_body,Intp_Sxy_body,
     &                      Wave_Staggered,0,Circ_Staggered,0)

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                      Sc_12,S1_12,S2_12,S3_12,
     &                      nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                      Pass_Syy_body,Intp_Syy_body,
     &                      Wave_Staggered,0,Circ_Staggered,0)

        endif


c --- short wave forcing

        if(Wave_To_Circ_Forcing)then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                      Sc_12,S1_12,S2_12,S3_12,
     &                      nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                      Pass_Wave_Fx,Intp_Fx_Circ,
     &                      Wave_Staggered,Wave_Stag_huv(2),
     &                      Circ_Staggered,Circ_Stag_huv(2))

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                      Sc_12,S1_12,S2_12,S3_12,
     &                      nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                      Pass_Wave_Fy,Intp_Fy_Circ,
     &                      Wave_Staggered,Wave_Stag_huv(3),
     &                      Circ_Staggered,Circ_Stag_huv(3))

             if((Wave_Rotate_Angle-Circ_Rotate_Angle).ne.0)then
               do j=1,Ny_Circ
               do i=1,Nx_Circ
                 Tmp1=Intp_Fx_Circ(i,j)
                 Tmp2=Intp_Fy_Circ(i,j)
                 tht=(Wave_Rotate_Angle-CIrc_Rotate_Angle)*3.14159/180.
                  Intp_Fx_Circ(i,j)=Tmp1*cos(tht)- Tmp2*sin(tht)
                  Intp_Fy_Circ(i,j)=Tmp1*sin(tht)+ Tmp2*cos(tht)
               enddo
               enddo
             endif
```

```
        endif

c ---  mass flux

        if(Wave_To_Circ_MassFlux) then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_MassFluxU,Intp_MassFluxU_Circ,
     &                    Wave_Staggered,Wave_Stag_huv(2),
     &                    Circ_Staggered,Circ_Stag_huv(2))

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_MassFluxV,Intp_MassFluxV_Circ,
     &                    Wave_Staggered,Wave_Stag_huv(3),
     &                    Circ_Staggered,Circ_Stag_huv(3))

             if((Wave_Rotate_Angle-Circ_Rotate_Angle).ne.0)then
               do j=1,Ny_Circ
               do i=1,Nx_Circ
                 Tmp1=Intp_MassFluxU_Circ(i,j)
                 Tmp2=Intp_MassFluxV_Circ(i,j)
                 tht=(Wave_Rotate_Angle-CIrc_Rotate_Angle)*3.14159/180.
                  Intp_MassFluxU_Circ(i,j)=Tmp1*cos(tht)- Tmp2*sin(tht)
                  Intp_MassFluxV_Circ(i,j)=Tmp1*sin(tht)+ Tmp2*cos(tht)
               enddo
               enddo
             endif

        endif

c --- wave dissipation

        if(Wave_To_Circ_Dissipation) then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                    Sc_12,S1_12,S2_12,S3_12,
     &                    nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                    Pass_Diss,Intp_Diss_Circ,
     &                    Wave_Staggered,0,Circ_Staggered,0)

        endif
```

```
c --- wave bottom velocity

        if(Wave_To_Circ_BottomUV) then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                      Sc_12,S1_12,S2_12,S3_12,
     &                      nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                      Pass_ubott,Intp_ubott_Circ,
     &                      Wave_Staggered,0,Circ_Staggered,0)

        endif

c ---  break index

        if(Wave_To_Circ_Dissipation) then

        call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Circ,Ny_Circ,
     &                      Sc_12,S1_12,S2_12,S3_12,
     &                      nx1_12,ny1_12,nx2_12,ny2_12,nx3_12,ny3_12,
     &                      Pass_ibrk,Intp_ibrk_Circ,
     &                      Wave_Staggered,0,Circ_Staggered,0)

        endif

        return
        end
```

4.8 Subroutine interp_sedi_circ

The subroutine interpolates variables from Sedi-Grid to Circ-Grid.

interp_sedi_circ is called by

1. *master*

interp_sedi_circ calls

1. *grid1_to_grid2*

⟨*⟩+≡

```
c -----------------------------------------------------------------

      subroutine interp_sedi_circ
      implicit none
      include 'pass.h'
      include 'interp.h'
      real Tmp1,Tmp2,tht
      integer i,j


      if (Curr_Bed_Interact) then

      if(Sedi_To_Circ_Depth)then

      call grid1_to_grid2(Nx_Sedi,Ny_Sedi,Nx_Circ,Ny_Circ,
     &                    Sc_32,S1_32,S2_32,S3_32,
     &                    nx1_32,ny1_32,nx2_32,ny2_32,nx3_32,ny3_32,
     &                    Pass_Dupdated,Depth_Circ,
     &                    Sedi_Staggered,Sedi_Stag_huv(1),
     &                    Circ_Staggered,Circ_Stag_huv(1))
      endif

      endif

      return
      end
```

4.9 Subroutine interp_wave_sedi

The subroutine interpolates variables from Wave-Grid to Sedi-Grid.

interp_wave_sedi is called by

1. *master*

interp_wave_sedi calls

1. *grid1_to_grid2*

⟨*⟩+≡
```
c --------------------------------------------------------------

      subroutine interp_wave_sedi
      implicit none
      include 'pass.h'
      include 'interp.h'
      real Tmp1,Tmp2,tht
      integer i,j

      if(Wave_To_Sedi_Height)then

      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Sedi,Ny_Sedi,
     &                    Sc_13,S1_13,S2_13,S3_13,
     &                    nx1_13,ny1_13,nx2_13,ny2_13,nx3_13,ny3_13,
     &                    Pass_Height,Intp_Height_Sedi,
     &                    Wave_Staggered,0,Sedi_Staggered,0)

      endif

      if(Wave_To_Sedi_Angle)then

      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Sedi,Ny_Sedi,
     &                    Sc_13,S1_13,S2_13,S3_13,
     &                    nx1_13,ny1_13,nx2_13,ny2_13,nx3_13,ny3_13,
     &                    Pass_Theta,Intp_Theta_Sedi,
     &                    Wave_Staggered,0,Sedi_Staggered,0)

           if((Wave_Rotate_Angle-Sedi_Rotate_Angle).ne.0)then
             do j=1,Ny_Sedi
             do i=1,Nx_Sedi
               tht=Wave_Rotate_Angle-Sedi_Rotate_Angle
               Intp_Theta_Sedi(i,j)=Intp_Theta_Sedi(i,j)+tht
             enddo
             enddo
           endif
```

```
      endif

      if(Wave_To_Sedi_BottomUV)then

      call grid1_to_grid2(Nx_Wave,Ny_Wave,Nx_Sedi,Ny_Sedi,
   &                      Sc_13,S1_13,S2_13,S3_13,
   &                      nx1_13,ny1_13,nx2_13,ny2_13,nx3_13,ny3_13,
   &                      Pass_ubott,Intp_ubott_Sedi,
   &                      Wave_Staggered,0,Sedi_Staggered,0)


      endif

      return
      end
```

4.10 Subroutine interp_circ_sedi

The subroutine interpolates variables from Circ-Grid to Sedi-Grid.

interp_circ_sedi is called by

1. *master*

interp_circ_sedi calls

1. *grid1_to_grid2*

⟨*⟩+≡
```
c ---------------------------------------------------------------

        subroutine interp_circ_sedi
        implicit none
        include 'pass.h'
        include 'interp.h'
        real Tmp1,Tmp2,tht
        integer i,j


c --- Sediment Flux
        if(Circ_To_Sedi_SedFlux)then

        call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                     Sc_23,S1_23,S2_23,S3_23,
     &                     nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                     Pass_SedFluxCum_x,Intp_SedFluxCum_x,
     &                     Circ_Staggered,Circ_Stag_huv(1),
     &                     Sedi_Staggered,Sedi_Stag_huv(1))

        call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                     Sc_23,S1_23,S2_23,S3_23,
     &                     nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                     Pass_SedFluxCum_y,Intp_SedFluxCum_y,
     &                     Circ_Staggered,Circ_Stag_huv(1),
     &                     Sedi_Staggered,Sedi_Stag_huv(1))


             if((Circ_Rotate_Angle-Sedi_Rotate_Angle).ne.0)then
               do j=1,Ny_Sedi
               do i=1,Nx_Sedi
                 Tmp1=Intp_SedFluxCum_x(i,j)
                 Tmp2=Intp_SedFluxCum_y(i,j)
                 tht=(Circ_Rotate_Angle-Sedi_Rotate_Angle)*3.14159/180.
                  Intp_SedFluxCum_x(i,j)=Tmp1*cos(tht)- Tmp2*sin(tht)
                  Intp_SedFluxCum_y(i,j)=Tmp1*sin(tht)+ Tmp2*cos(tht)
```

```
              enddo
              enddo
            endif
        endif

c --- UV
        if(Circ_To_Sedi_UV)then

        call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                    Sc_23,S1_23,S2_23,S3_23,
     &                    nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                    Pass_U,Intp_U_Sedi,
     &                    Circ_Staggered,Circ_Stag_huv(2),
     &                    Sedi_Staggered,Sedi_Stag_huv(2))


        call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                    Sc_23,S1_23,S2_23,S3_23,
     &                    nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                    Pass_V,Intp_V_Sedi,
     &                    Circ_Staggered,Circ_Stag_huv(3),
     &                    Sedi_Staggered,Sedi_Stag_huv(3))

            if((Circ_Rotate_Angle-Sedi_Rotate_Angle).ne.0)then
              do j=1,Ny_Sedi
              do i=1,Nx_Sedi
                Tmp1=Intp_U_Sedi(i,j)
                Tmp2=Intp_V_Sedi(i,j)
                tht=(Circ_Rotate_Angle-Sedi_Rotate_Angle)*3.14159/180.
                 Intp_U_Sedi(i,j)=Tmp1*cos(tht)- Tmp2*sin(tht)
                 Intp_V_Sedi(i,j)=Tmp1*sin(tht)+ Tmp2*cos(tht)
              enddo
              enddo
            endif
        endif

c -- Ub Vb
        if(Circ_To_Sedi_UVb)then

        call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                    Sc_23,S1_23,S2_23,S3_23,
     &                    nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                    Pass_Ub,Intp_Ub_Sedi,
     &                    Circ_Staggered,Circ_Stag_huv(2),
     &                    Sedi_Staggered,Sedi_Stag_huv(2))
```

```
        call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                    Sc_23,S1_23,S2_23,S3_23,
     &                    nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                    Pass_Vb,Intp_Vb_Sedi,
     &                    Circ_Staggered,Circ_Stag_huv(3),
     &                    Sedi_Staggered,Sedi_Stag_huv(3))

             if((Circ_Rotate_Angle-Sedi_Rotate_Angle).ne.0)then
               do j=1,Ny_Sedi
               do i=1,Nx_Sedi
                 Tmp1=Intp_Ub_Sedi(i,j)
                 Tmp2=Intp_Vb_Sedi(i,j)
                 tht=(Circ_Rotate_Angle-Sedi_Rotate_Angle)*3.14159/180.
                  Intp_Ub_Sedi(i,j)=Tmp1*cos(tht)- Tmp2*sin(tht)
                  Intp_Vb_Sedi(i,j)=Tmp1*sin(tht)+ Tmp2*cos(tht)
               enddo
               enddo
             endif
        endif

c --- eta

        if(Circ_To_Sedi_eta)then

        call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                    Sc_23,S1_23,S2_23,S3_23,
     &                    nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                    Pass_eta,Intp_eta_Sedi,
     &                    Circ_Staggered,Circ_Stag_huv(1),
     &                    Sedi_Staggered,Sedi_Stag_huv(1))

        endif

c ---  fw

        if(Circ_To_Sedi_fw)then

        call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                    Sc_23,S1_23,S2_23,S3_23,
     &                    nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                    Pass_fw,Intp_fw_Sedi,
     &                    Circ_Staggered,0,Sedi_Staggered,0)

        endif
```

```
c --- vt

      if(Circ_To_Sedi_vt)then

      call grid1_to_grid2(Nx_Circ,Ny_Circ,Nx_Sedi,Ny_Sedi,
     &                    Sc_23,S1_23,S2_23,S3_23,
     &                    nx1_23,ny1_23,nx2_23,ny2_23,nx3_23,ny3_23,
     &                    Pass_vt,Intp_vt_Sedi,
     &                    Circ_Staggered,0,Sedi_Staggered,0)

      endif


      if(Circ_To_Sedi_UV3D)then
      print*,'not done yet'

      endif


      if(Circ_To_Sedi_UVquasi3D)then
      print*,'not done yet'

      endif



      return
      end
```

4.11 Subroutine interpsame

The subroutine calculates interpolation coefficients when two module grids are same.

interpsame is called by

1. *get_interpolation_coef*

⟨*⟩+≡

```
c ----------------------------------------------------------------

      subroutine interpsame
     . (m_grid2,n_grid2,Sc,S1,S2,S3,
     .  nx1,ny1,nx2,ny2,nx3,ny3)

      implicit none
      include 'pass.h'
      integer i,j

! ---   (i,j) of three points surrounded
      integer nx1(Nx_Max,Ny_Max)
     .        ,ny1(Nx_Max,Ny_Max)
     .        ,nx2(Nx_Max,Ny_Max)
     .        ,ny2(Nx_Max,Ny_Max)
     .        ,nx3(Nx_Max,Ny_Max)
     .        ,ny3(Nx_Max,Ny_Max)

! ---  areas of the four triangles, area will be negative
!      if an order is clockwise
!       Sc -- triangle 1,2,3
!       S1 -- triangle 2,3,c
!       S2 -- triangle 3,1,c
!       S3 -- triangle 1,2,c

      real Sc(Nx_Max,Ny_Max)
     .    ,S1(Nx_Max,Ny_Max)
     .    ,S2(Nx_Max,Ny_Max)
     .    ,S3(Nx_Max,Ny_Max)

! ---   m(x direction) and n(y direction)
      integer m_grid2,n_grid2

      do j=1,n_grid2
      do i=1,m_grid2
        Sc(i,j)=1.
        S1(i,j)=1.
```

```
  S2(i,j)=0.
  S3(i,j)=0.
  nx1(i,j)=i
  ny1(i,j)=j
  nx2(i,j)=1
  ny2(i,j)=1
  nx3(i,j)=1
  ny3(i,j)=1
enddo
enddo

return
end
```

4.12 Subroutine interpolation

This subroutine is used to get coefficients of interpolation or extrapolation between two structured grid systems. Any grid of two or both of two grids can be curvilinear or rectangular. The routine can deal with the case that one grid does not exactly overlap another grid. For the no-overlapped the grid points, extrapolations may be carried out if extrapolation is allowed, i.e., Grid_Extrapolation = .true.. To save time, all necessary arrays are stored in arrays in 'interp.h'.

The interpolation/extrapolation theory can be found in Section 1.2.

1. Formulas:

   (a) calculation of triangle area:

   $$S = 0.5 * (x1 * y2 - x2 * y1 + x2 * y3 - x3 * y2 + x3 * y1 - x1 * y3)$$

   if (1,2,3) is counterclock wise, $S > 0$, otherwise, $S < 0$

   (b) interpolation/extrapolation:

   $$var_c = (S1 * var_1 + S2 * var_2 + S3 * var_3)/Sc$$

2. Arguments

   (a) m_grid1 – grid number of grid1 in x direction
   (b) n_grid1 – grid number of grid1 in y direction
   (c) m_grid2 – grid number of grid2 in x direction
   (d) n_grid2 – grid number of grid2 in y direction
   (e) var_grid1 – variables in grid1
   (f) var_grid2 – variables converted in grid2

interpolation is called by

1. *get_interpolation_coef*

⟨*⟩+≡

```
! -----------------------------------------------------------------
        subroutine interpolation
     .  (m_grid1,n_grid1,x_grid1,y_grid1,
     .   m_grid2,n_grid2,x_grid2,y_grid2,Sc,S1,S2,S3,
     .   nx1,ny1,nx2,ny2,nx3,ny3)

        implicit none
        include 'pass.h'
        integer i,j

! ---   types, interpolation -- 0, extrapolation -- 1
```

```
        integer ntype(Nx_Max,Ny_Max)

! ---   (i,j) of three points surrounded
        integer nx1(Nx_Max,Ny_Max)
     .         ,ny1(Nx_Max,Ny_Max)
     .         ,nx2(Nx_Max,Ny_Max)
     .         ,ny2(Nx_Max,Ny_Max)
     .         ,nx3(Nx_Max,Ny_Max)
     .         ,ny3(Nx_Max,Ny_Max)

! ---  areas of the four triangles, area will be negative
!      if an order is clockwise
!       Sc -- triangle 1,2,3
!       S1 -- triangle 2,3,c
!       S2 -- triangle 3,1,c
!       S3 -- triangle 1,2,c

        real Sc(Nx_Max,Ny_Max)
     .      ,S1(Nx_Max,Ny_Max)
     .      ,S2(Nx_Max,Ny_Max)
     .      ,S3(Nx_Max,Ny_Max)

! ---   m(x direction) and n(y direction)
        integer m_grid1,n_grid1,m_grid2,n_grid2

! ---   x, y and variables of grid1 and grid2
        real x_grid1(Nx_Max,Ny_Max),y_grid1(Nx_Max,Ny_Max)
     .      ,var_grid1(Nx_Max,Ny_Max)
     .      ,x_grid2(Nx_Max,Ny_Max),y_grid2(Nx_Max,Ny_Max)
     .      ,var_grid2(Nx_Max,Ny_Max)

        real x1,y1,x2,y2,x3,y3,area1,area2,area3,area,dist,
     .       dist_init

        integer ii,jj,nx_near,ny_near

! ---  control parameter, the initial -- 0
        integer Iconv
        data Iconv /0/

! --- for 1-D case

        if(n_grid2.eq.1.or.n_grid1.eq.1)then

          j=1
          do i=1,m_grid2
```

```
            x1=x_grid2(i,j)
            jj=1
            do ii=1,m_grid1-1
            x2=x_grid1(ii,jj)
            x3=x_grid1(ii+1,jj)
            area1=x1-x2
            area2=x3-x1
            if(area1.ge.0.and.area2.ge.0)then
            nx1(i,j)=ii+1
            nx2(i,j)=ii
            S1(i,j)=area1
            S2(i,j)=area2
            Sc(i,j)=area1+area2
            ntype(i,j)=0
            goto 1100
            endif
            enddo ! ii

            ntype(i,j)=1

 1100       continue

          enddo ! i

          j=1
          do i=1,m_grid2
          if(ntype(i,j).eq.1)then
            jj=1
            x1=x_grid1(1,jj)
            x2=x_grid1(m_grid1,jj)
            x3=x_grid2(i,j)
            if(abs(x3-x1).lt.abs(x2-x3))then
              nx1(i,j)=2
              nx2(i,j)=1
              S1=x3-x1
              S2=x_grid1(2,jj)-x3
              Sc=x_grid1(2,jj)-x1
            else
              nx1(i,j)=m_grid1-1
              nx2(i,j)=m_grid1
              S1=x2-x3
              S2=x3-x_grid1(m_grid1-1,jj)
              S3=x2-x_grid1(m_grid1-1,jj)
            endif

           endif ! ntype=1
```

```
        enddo ! i

      else

! --- find the triangle includes the points in grid2

      do j=1,n_grid2
      do i=1,m_grid2
        x1=x_grid2(i,j)
        y1=y_grid2(i,j)
        do jj=1,n_grid1-1
        do ii=1,m_grid1-1

          x2=x_grid1(ii+1,jj)
          y2=y_grid1(ii+1,jj)
          x3=x_grid1(ii,jj+1)
          y3=y_grid1(ii,jj+1)
          area1=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

          x2=x_grid1(ii,jj+1)
          y2=y_grid1(ii,jj+1)
          x3=x_grid1(ii,jj)
          y3=y_grid1(ii,jj)
          area2=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

          x2=x_grid1(ii,jj)
          y2=y_grid1(ii,jj)
          x3=x_grid1(ii+1,jj)
          y3=y_grid1(ii+1,jj)
          area3=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

          if(area1.ge.0.and.area2.ge.0.and.area3.ge.0)then
            ntype(i,j)=0
            nx1(i,j)=ii
            ny1(i,j)=jj
            nx2(i,j)=ii+1
            ny2(i,j)=jj
            nx3(i,j)=ii
            ny3(i,j)=jj+1
            S1(i,j)=area1
            S2(i,j)=area2
            S3(i,j)=area3

            x1=x_grid1(nx1(i,j),ny1(i,j))
            y1=y_grid1(nx1(i,j),ny1(i,j))
```

```
    x2=x_grid1(nx2(i,j),ny2(i,j))
    y2=y_grid1(nx2(i,j),ny2(i,j))
    x3=x_grid1(nx3(i,j),ny3(i,j))
    y3=y_grid1(nx3(i,j),ny3(i,j))
    Sc(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

    goto 110
  endif

  x2=x_grid1(ii+1,jj)
  y2=y_grid1(ii+1,jj)
  x3=x_grid1(ii+1,jj+1)
  y3=y_grid1(ii+1,jj+1)
  area1=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

  x2=x_grid1(ii+1,jj+1)
  y2=y_grid1(ii+1,jj+1)
  x3=x_grid1(ii,jj+1)
  y3=y_grid1(ii,jj+1)
  area2=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

  x2=x_grid1(ii,jj+1)
  y2=y_grid1(ii,jj+1)
  x3=x_grid1(ii+1,jj)
  y3=y_grid1(ii+1,jj)
  area3=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

  if(area1.ge.0.and.area2.ge.0.and.area3.ge.0)then
    ntype(i,j)=0
    nx1(i,j)=ii
    ny1(i,j)=jj+1
    nx2(i,j)=ii+1
    ny2(i,j)=jj
    nx3(i,j)=ii+1
    ny3(i,j)=jj+1
    S1(i,j)=area1
    S2(i,j)=area2
    S3(i,j)=area3

    x1=x_grid1(nx1(i,j),ny1(i,j))
    y1=y_grid1(nx1(i,j),ny1(i,j))
    x2=x_grid1(nx2(i,j),ny2(i,j))
    y2=y_grid1(nx2(i,j),ny2(i,j))
    x3=x_grid1(nx3(i,j),ny3(i,j))
    y3=y_grid1(nx3(i,j),ny3(i,j))
    Sc(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)
```

```
          goto 110
        endif

        ntype(i,j)=1

      enddo
      enddo

110   continue

    enddo
    enddo


! --- find the nearest point in grid1 for grid2-points with ntype=1
!     these points will be used for extrapolation

    do j=1,n_grid2
    do i=1,m_grid2

      if (ntype(i,j).eq.1)then

!       -- find the nearest point

        x1=x_grid2(i,j)
        y1=y_grid2(i,j)
        x2=x_grid1(1,1)
        y2=y_grid1(1,1)
        dist_init=(x1-x2)*(x1-x2)+(y1-y2)*(y1-y2)
        nx_near=1
        ny_near=1

        do jj=2,n_grid1-1
        do ii=2,m_grid1-1
          x2=x_grid1(ii,jj)
          y2=y_grid1(ii,jj)
          dist=(x1-x2)*(x1-x2)+(y1-y2)*(y1-y2)
          if(dist.lt.dist_init)then
            dist_init=dist
            nx_near=ii
            ny_near=jj
          endif
        enddo
        enddo
```

```
!           -- calculate four areas -- S1, S2, S3, Sc
!              choose the nearest triangle by using the sign of the area

            x2=x_grid1(nx_near+1,ny_near)
            y2=y_grid1(nx_near+1,ny_near)
            x3=x_grid1(nx_near,ny_near+1)
            y3=y_grid1(nx_near,ny_near+1)
            area=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

            if(area.ge.0)then

              nx1(i,j)=nx_near
              ny1(i,j)=ny_near
              nx2(i,j)=nx_near+1
              ny2(i,j)=ny_near
              nx3(i,j)=nx_near
              ny3(i,j)=ny_near+1

            else

              nx1(i,j)=nx_near
              ny1(i,j)=ny_near+1
              nx2(i,j)=nx_near+1
              ny2(i,j)=ny_near
              nx3(i,j)=nx_near+1
              ny3(i,j)=ny_near+1

            endif

! --- if no extrapolation is allowed , evaluated variable will equal
!     to the variable at neast grid point

            if (Grid_Extrapolation) then
              x2=x_grid1(nx2(i,j),ny2(i,j))
              y2=y_grid1(nx2(i,j),ny2(i,j))
              x3=x_grid1(nx3(i,j),ny3(i,j))
              y3=y_grid1(nx3(i,j),ny3(i,j))
              S1(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

              x2=x_grid1(nx3(i,j),ny3(i,j))
              y2=y_grid1(nx3(i,j),ny3(i,j))
              x3=x_grid1(nx1(i,j),ny1(i,j))
              y3=y_grid1(nx1(i,j),ny1(i,j))
              S2(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

              x2=x_grid1(nx1(i,j),ny1(i,j))
```

```
        y2=y_grid1(nx1(i,j),ny1(i,j))
        x3=x_grid1(nx2(i,j),ny2(i,j))
        y3=y_grid1(nx2(i,j),ny2(i,j))
        S3(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

        x1=x_grid1(nx1(i,j),ny1(i,j))
        y1=y_grid1(nx1(i,j),ny1(i,j))
        x2=x_grid1(nx2(i,j),ny2(i,j))
        y2=y_grid1(nx2(i,j),ny2(i,j))
        x3=x_grid1(nx3(i,j),ny3(i,j))
        y3=y_grid1(nx3(i,j),ny3(i,j))
        Sc(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

      else

        S1(i,j)=1.
        S2(i,j)=0.
        S3(i,j)=0.
        Sc(i,j)=1.

      endif

    endif
  enddo
  enddo

  endif ! for n_grid ?= 1

  return
  end
```

4.13 Subroutine interpolation_nonstruc

This subroutine is used to get coefficients of interpolation or extrapolation between two grid systems in which one or two grids are non-structured grids. For non-structured grid, 2-D arrays are still used such as x(m_grid1,n_grid1), and n_grid1 = 1. The interpolation/extrapolation value is obtained from the values at three nearest points on grid1. To save time, all necessary arrays are stored in arrays in 'interp.h'.

The interpolation/extrapolation theory can be found in Section 1.2.

1. Formulas:

   (a) calculation of triangle area:

   $$S = 0.5 * (x1 * y2 - x2 * y1 + x2 * y3 - x3 * y2 + x3 * y1 - x1 * y3)$$

   if (1,2,3) is counterclock wise, $S > 0$, otherwise, $S < 0$

   (b) interpolation/extrapolation:

   $$var_c = (S1 * var_1 + S2 * var_2 + S3 * var_3)/Sc$$

2. Arguments

   (a) m_grid1 – grid number of grid1 in x direction
   (b) n_grid1 – grid number of grid1 in y direction
   (c) m_grid2 – grid number of grid2 in x direction
   (d) n_grid2 – grid number of grid2 in y direction
   (e) var_grid1 – variables in grid1
   (f) var_grid2 – variables converted in grid2

interpolation is called by

1. *get_interpolation_coef*

⟨*⟩+≡

```
! ----------------------------------------------------------------
        subroutine interpolation_nonstruc
     .  (m_grid1,n_grid1,x_grid1,y_grid1,
     .   m_grid2,n_grid2,x_grid2,y_grid2,Sc,S1,S2,S3,
     .   nx1,ny1,nx2,ny2,nx3,ny3)

        implicit none
        include 'pass.h'
        integer i,j

! ---   (i,j) of three points surrounded
```

```
        integer nx1(Nx_Max,Ny_Max)
     .         ,ny1(Nx_Max,Ny_Max)
     .         ,nx2(Nx_Max,Ny_Max)
     .         ,ny2(Nx_Max,Ny_Max)
     .         ,nx3(Nx_Max,Ny_Max)
     .         ,ny3(Nx_Max,Ny_Max)

 ! ---  areas of the four triangles, area will be negative
 !      if an order is clockwise
 !       Sc -- triangle 1,2,3
 !       S1 -- triangle 2,3,c
 !       S2 -- triangle 3,1,c
 !       S3 -- triangle 1,2,c

        real Sc(Nx_Max,Ny_Max)
     .      ,S1(Nx_Max,Ny_Max)
     .      ,S2(Nx_Max,Ny_Max)
     .      ,S3(Nx_Max,Ny_Max)

 ! ---   m(x direction) and n(y direction)
        integer m_grid1,n_grid1,m_grid2,n_grid2

 ! ---   x, y and variables of grid1 and grid2
        real x_grid1(Nx_Max,Ny_Max),y_grid1(Nx_Max,Ny_Max)
     .      ,var_grid1(Nx_Max,Ny_Max)
     .      ,x_grid2(Nx_Max,Ny_Max),y_grid2(Nx_Max,Ny_Max)
     .      ,var_grid2(Nx_Max,Ny_Max)

        real x1,y1,x2,y2,x3,y3,area1,area2,area3,area,dist,
     .       dist_init,dist_1,dist_2,dist_3

        integer ii,jj,nx_near,ny_near,nx_near_1,ny_near_1,
     .     nx_near_2,ny_near_2,nx_near_3,ny_near_3

 ! ---  control parameter, the initial -- 0
        Integer Iconv
        data Iconv /0/

 ! --- find the nearest three points on grid1
 !     these points will be used for interpolation/extrapolation

        do j=1,n_grid2
        do i=1,m_grid2

 !  --- find the farest point first
```

```
            x1=x_grid2(i,j)
            y1=y_grid2(i,j)
            x2=x_grid1(1,1)
            y2=y_grid1(1,1)
            dist_1=(x1-x2)*(x1-x2)+(y1-y2)*(y1-y2)
            nx_near_1=1
            ny_near_1=1

            do jj=1,n_grid1
            do ii=1,m_grid1
              x2=x_grid1(ii,jj)
              y2=y_grid1(ii,jj)
              dist=(x1-x2)*(x1-x2)+(y1-y2)*(y1-y2)
              if(dist.gt.dist_1)then
                dist_1=dist
                nx_near_1=ii
                ny_near_1=jj
              endif
            enddo
            enddo

            nx_near_2=nx_near_1
            ny_near_2=ny_near_1
            nx_near_3=nx_near_1
            ny_near_3=ny_near_1
            dist_2=dist_1
            dist_3=dist_1

! ---   find nearest three points

            do jj=1,n_grid1
            do ii=1,m_grid1
              x2=x_grid1(ii,jj)
              y2=y_grid1(ii,jj)
              dist=(x1-x2)*(x1-x2)+(y1-y2)*(y1-y2)
              if(dist.lt.dist_1)then
                dist_1=dist
                nx_near_1=ii
                ny_near_1=jj
              elseif(dist.lt.dist_2)then
                dist_2=dist
                nx_near_2=ii
                ny_near_2=jj
              elseif(dist.lt.dist_3)then
                dist_3=dist
                nx_near_3=ii
```

```
              ny_near_3=jj
            endif
          enddo
          enddo

!         -- calculate four areas -- S1, S2, S3, Sc


            nx1(i,j)=nx_near_1
            ny1(i,j)=ny_near_1
            nx2(i,j)=nx_near_2
            ny2(i,j)=ny_near_2
            nx3(i,j)=nx_near_3
            ny3(i,j)=ny_near_3


            x2=x_grid1(nx2(i,j),ny2(i,j))
            y2=y_grid1(nx2(i,j),ny2(i,j))
            x3=x_grid1(nx3(i,j),ny3(i,j))
            y3=y_grid1(nx3(i,j),ny3(i,j))
            S1(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

            x2=x_grid1(nx3(i,j),ny3(i,j))
            y2=y_grid1(nx3(i,j),ny3(i,j))
            x3=x_grid1(nx1(i,j),ny1(i,j))
            y3=y_grid1(nx1(i,j),ny1(i,j))
            S2(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

            x2=x_grid1(nx1(i,j),ny1(i,j))
            y2=y_grid1(nx1(i,j),ny1(i,j))
            x3=x_grid1(nx2(i,j),ny2(i,j))
            y3=y_grid1(nx2(i,j),ny2(i,j))
            S3(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

            x1=x_grid1(nx1(i,j),ny1(i,j))
            y1=y_grid1(nx1(i,j),ny1(i,j))
            x2=x_grid1(nx2(i,j),ny2(i,j))
            y2=y_grid1(nx2(i,j),ny2(i,j))
            x3=x_grid1(nx3(i,j),ny3(i,j))
            y3=y_grid1(nx3(i,j),ny3(i,j))
            Sc(i,j)=0.5*(x1*y2-x2*y1+x2*y3-x3*y2+x3*y1-x1*y3)

      enddo
      enddo

      print*,'two grids are different, calculate interp coef..'
```

```
return
end
```

4.14 Subroutine grid1_to_grid2

The subroutine makes interpolation/extrapolation from grid1 to grid2 based on interpolation coefficients.

grid1_to_grid2 is called by

1. *interp_depth*
2. *interp_circ_wave*
3. *interp_circ_wave*
4. *interp_sedi_wave*
5. *interp_wave_circ*
6. *interp_sedi_circ*
7. *interp_wave_sedi*
8. *interp_circ_sedi*

⟨*⟩+≡

```
! ---------------------------------------------------------------

       subroutine grid1_to_grid2
     .     (m_grid1,n_grid1,m_grid2,n_grid2,
     .      Sc,S1,S2,S3,nx1,ny1,nx2,ny2,nx3,ny3,
     .      var_grid1,var_grid2,grid1_stag,ntype_grid1,
     .      grid2_stag,ntype_grid2)


       implicit none
       include 'pass.h'
       integer i,j

       real Sc(Nx_Max,Ny_Max)
     .     ,S1(Nx_Max,Ny_Max)
     .     ,S2(Nx_Max,Ny_Max)
     .     ,S3(Nx_Max,Ny_Max)
       integer nx1(Nx_Max,Ny_Max),ny1(Nx_Max,Ny_Max)
     .     ,nx2(Nx_Max,Ny_Max),ny2(Nx_Max,Ny_Max)
     .     ,nx3(Nx_Max,Ny_Max),ny3(Nx_Max,Ny_Max)
     .     ,ntype_grid1,ntype_grid2

! ---  x, y and variables of grid1 and grid2
       real var_grid1(Nx_Max,Ny_Max)
     .     ,var_grid2(Nx_Max,Ny_Max)
     .     ,tmp(Nx_Max,Ny_Max),tmpa(Nx_Max,Ny_Max),tmpb
```

```
! ---   logical parameters for staggered grid
        logical grid1_stag, grid2_stag

! --- others
        integer m_grid1,n_grid1,m_grid2,n_grid2

        do j=1,n_grid1
        do i=1,m_grid1
          tmp(i,j)=var_grid1(i,j)
        enddo
        enddo


! ---   for staggered grid1

        if (grid1_stag.and.ntype_grid1.ne.0)then

          if(n_grid1.eq.1)then
            write(*,*)'stagered type defined wrong for 1D grid'
            stop
          endif
! ---      ntype=1

          if(ntype_grid1.eq.1)then

          if(n_grid1.eq.1)then
            write(*,*)'stagered type defined wrong for 1D grid'
            stop
          endif

            do j=2,n_grid1-1
            do i=2,m_grid1-1

             tmp(i,j)=0.25*(var_grid1(i-1,j-1)+var_grid1(i,j-1)
     &                      +var_grid1(i,j)+var_grid1(i-1,j))

            enddo
            enddo

            do i=2,m_grid1-1
              tmp(i,1)=2.*var_grid1(i,2)-var_grid1(i,3)
              tmp(i,n_grid1)=2.*var_grid1(i,n_grid1-1)
     &                             -var_grid1(i,n_grid1-2)
            enddo
            do j=1,n_grid1
```

```
             tmp(1,j)=2.*var_grid1(2,j)-var_grid1(3,j)
             tmp(m_grid1,j)=2.*var_grid1(m_grid1-1,j)
     &                              -var_grid1(m_grid1-2,j)
           enddo
         endif
 ! ---    ntype=2
         if(ntype_grid1.eq.2)then

         if(n_grid1.eq.1)then
           write(*,*)'stagered type defined wrong for 1D grid'
           stop
         endif

           do j=2,n_grid1-1
           do i=1,m_grid1
            tmp(i,j)=0.5*(var_grid1(i,j)+var_grid1(i,j-1))
           enddo
           enddo

           do i=1,m_grid1
             tmp(i,1)=0.5*(3.*var_grid1(i,1)-var_grid1(i,2))
             tmp(i,n_grid1)=0.5*(3.*var_grid1(i,n_grid1-1)
     &                              -var_grid1(i,n_grid1-2))
           enddo
         endif
 ! ---    ntype=3
         if(ntype_grid1.eq.3)then
           do j=1,n_grid1
           do i=2,m_grid1-1
            tmp(i,j)=0.5*(var_grid1(i,j)+var_grid1(i-1,j))
           enddo
           enddo

           do j=1,n_grid1
             tmp(1,j)=0.5*(3.*var_grid1(1,j)-var_grid1(2,j))
             tmp(m_grid1,j)=0.5*(3.*var_grid1(m_grid1-1,j)
     &                              -var_grid1(m_grid1-2,j))
           enddo
         endif

       endif

 ! --- interpolation/extrapolation

       if(n_grid1.eq.1)then
```

```
          do j=1,n_grid2
          do i=1,m_grid2
            var_grid2(i,j)=1./Sc(i,1)*(S1(i,1)*tmp(nx1(i,1),1)
     &                   +S2(i,1)*tmp(nx2(i,1),1))
          enddo
          enddo

          elseif(n_grid2.eq.1)then

          do j=1,n_grid1
          do i=1,m_grid1
           tmpa(i,j)=tmp(i,j)
          enddo
          enddo

          do i=1,m_grid1
            tmpb=0.
            do j=1,n_grid1
             tmpb=tmpb+tmpa(i,j)
            enddo
             tmp(i,1)=tmpb/n_grid1
          enddo

          j=1
          do i=1,m_grid2
            var_grid2(i,j)=1./Sc(i,j)*(S1(i,j)*tmp(nx1(i,1),1)
     &                   +S2(i,j)*tmp(nx2(i,1),1))
          enddo

          else

          do j=1,n_grid2
          do i=1,m_grid2

              var_grid2(i,j)=(S1(i,j)*tmp(nx1(i,j),ny1(i,j))
     .                     +S2(i,j)*tmp(nx2(i,j),ny2(i,j))
     .                     +S3(i,j)*tmp(nx3(i,j),ny3(i,j)))
     .                     /Sc(i,j)

          enddo
          enddo

          endif              ! ngrid.eq.1

 ! ---  for staggered grid2
```

```
        if (grid2_stag.and.ntype_grid2.ne.0)then
        do j=1,n_grid2
        do i=1,m_grid2
          tmp(i,j)=var_grid2(i,j)
        enddo
        enddo

! ---  ntype_grid2 = 1
          if(ntype_grid2.eq.1)then
            if(n_grid2.eq.1)then
              write(*,*)'wrong staggered grid type for 1-D case'
              stop
            endif

            do j=1,n_grid2-1
            do i=1,m_grid2-1
              var_grid2(i,j)=0.25*(tmp(i,j)+tmp(i+1,j)
     &                       +tmp(i+1,j+1)+tmp(i,j+1))
            enddo
            enddo
          endif
! ---  ntype_grid2 = 2
          if(ntype_grid2.eq.2)then
            if(n_grid2.eq.1)then
              write(*,*)'wrong staggered grid type for 1-D case'
              stop
            endif


            do j=1,n_grid2-1
            do i=1,m_grid2
              var_grid2(i,j)=0.5*(tmp(i,j)+tmp(i,j+1))
            enddo
            enddo
          endif
! ---  ntype_grid2 = 3
          if(ntype_grid2.eq.3)then
            do j=1,n_grid2
            do i=1,m_grid2-1
              var_grid2(i,j)=0.5*(tmp(i,j)+tmp(i+1,j))
            enddo
            enddo
          endif

        endif
```

```
        return
        end
```

4.15 Subroutine output

The subroutine output a variable to the file named 'data'//file_name//'.dat'. It is used to test the code.

⟨*⟩+≡

```
! ---------------------------------------------------------------
        subroutine output(mp,np,num_file,varb)

        implicit none
        include 'pass.h'
        integer i,j
        real varb(Nx_Max,Ny_Max)
        character*2 file_name
        integer nm_first,nm_second,nm_third,nm_fourth,np,mp,
     &         num_file

        nm_first=mod(num_file/1000,10)
        nm_second=mod(num_file/100,10)
        nm_third=mod(num_file/10,10)
        nm_fourth=mod(num_file,10)

        write(file_name(1:1),'(I1)')nm_third
        write(file_name(2:2),'(I1)')nm_fourth
c        write(file_name(3:3),'(I1)')nm_third
c        write(file_name(4:4),'(I1)')nm_fourth

        open(2,file='data'//file_name//'.dat')
        do j=1,np
        write(2,100)(varb(i,j),i=1,mp)
100     format(801f16.8)
        enddo
        close(2)

        return

        end
```

4.16 Subroutine SediModule

The subroutine is the Sediment module.

SediModule is called by

1. *Master*

⟨*⟩+≡

```
c -----------------------------------------------------------------
        subroutine SediModulesample()
        implicit none
        include 'pass.h'
        integer i,j

        if(Master_Start.eq.1)then

          print*,'Sediment module initialization ...'
        else
         print*, 'call Sediment module ...'
        endif

        return
        end
```

4.17 Subroutine Mexport

The subroutine is for model output.

Mexport is called by

1. *Master*

⟨*⟩+≡

```
c --------------------------------------------------------------

        subroutine  Mexport()
        implicit none
        include 'pass.h'
        integer i,j
        integer nm_first,nm_second,nm_third,nm_fourth,num_file
        character*4 file_name

        num_file=(istep-1)/N_Interval_Output
        print*,'mexport routine  plot num=', num_file

        nm_first=mod(num_file/1000,10)
        nm_second=mod(num_file/100,10)
        nm_third=mod(num_file/10,10)
        nm_fourth=mod(num_file,10)


        write(file_name(1:1),'(I1)')nm_first
        write(file_name(2:2),'(I1)')nm_second
        write(file_name(3:3),'(I1)')nm_third
        write(file_name(4:4),'(I1)')nm_fourth

        if(f_name11.ne.' ')then
        open(2,file=f_name11(1:2)//file_name//'.out')
          do j=1,Ny_Circ
            write(2,111)(Pass_Theta(i,j),i=1,Nx_Circ)
          enddo
        close(2)
        endif

        if(f_name12.ne.' ')then
        open(2,file=f_name12(1:2)//file_name//'.out')
          do j=1,Ny_Circ
            write(2,111)(Pass_Height(i,j),i=1,Nx_Circ)
          enddo
        close(2)
        endif
```

```
if(f_name13.ne.' ')then
open(2,file=f_name13(1:2)//file_name//'.out')
  do j=1,Ny_Circ
    write(2,111)(Depth_Circ(i,j),i=1,Nx_Circ)
  enddo
close(2)
endif

if(f_name14.ne.' ')then
open(2,file=f_name14(1:2)//file_name//'.out')
  do j=1,Ny_Circ
    write(2,111)(Pass_U(i,j),i=1,Nx_Circ)
  enddo
close(2)
endif

if(f_name15.ne.' ')then
open(2,file=f_name15(1:2)//file_name//'.out')
  do j=1,Ny_Circ
    write(2,111)(Pass_V(i,j),i=1,Nx_Circ)
  enddo
close(2)
endif

if(f_name16.ne.' ')then
open(2,file=f_name16(1:2)//file_name//'.out')
  do j=1,Ny_Circ
    write(2,111)(Pass_eta(i,j),i=1,Nx_Circ)
  enddo
close(2)
endif

if(f_name9.ne.' ')then
open(2,file=f_name9(1:2)//file_name//'.out')
  do j=1,Ny_Circ
    write(2,111)(Pass_Ub(i,j),i=1,Nx_Circ)
  enddo
close(2)
endif

if(f_name10.ne.' ')then
open(2,file=f_name10(1:2)//file_name//'.out')
  do j=1,Ny_Circ
    write(2,111)(Pass_Vb(i,j),i=1,Nx_Circ)
  enddo
close(2)
```

```
        endif


        if(f_name7.ne.' ')then
        open(2,file=f_name7(1:2)//file_name//'.out')
          do j=1,Ny_Circ
            write(2,111)(Intp_MassFluxU_Circ(i,j)/depth_circ(i,j),
     &                       i=1,Nx_Circ)
          enddo
        close(2)
        endif

        if(f_name8.ne.' ')then
        open(2,file=f_name8(1:2)//file_name//'.out')
          do j=1,Ny_Circ
            write(2,111)(Intp_MassFluxV_Circ(i,j)/depth_circ(i,j),
     &                        i=1,Nx_Circ)
          enddo
        close(2)
        endif

 111    format(500f16.6)


        return
       end
```

4.18 Subroutine WaveModule

The subroutine is the Wave module.

WaveModule is called by

1. *Master*

⟨*⟩+≡

```
c -----------------------------------------------------------
        subroutine WaveModulesample()
        implicit none
        include 'pass.h'
        integer i,j

        if(Master_Start.eq.1)then

        print*,'wave module initialization ...'

c          write(*,*)'Do you want to run refdifs? Yes=1'
c         read(*,*)ikey
c         if(ikey.eq.1)then
c            call refdifs
c         else
c            call load_wave
c          endif

        else

        print*, 'call wave module ...'
c         call refdifs

        endif

        return
        end
```

4.19 Subroutine CircModule

The subroutine is the circulation module.

CircModule is called by

1. *Master*

⟨*⟩+≡

```
  c ----------------------------------------------------------
          subroutine CircModulesample()
          implicit none
          include 'pass.h'
          integer i,j

          if(Master_Start.eq.1)then

          print*,'circulation module initialization ...'

          else

          print*, 'call circulation module ...'

          endif

          return
          end
```

4.20 Subroutine MasterInit

The subroutine initializes all pass variables.

MasterInit is called by

1. *Master*

⟨*⟩+≡
```
c --------------------------------------------------------
      subroutine MasterInit
      implicit none
      include 'pass.h'
      integer i,j

      do j=1,Ny_Max
      do i=1,Nx_Max
        Pass_Sxx(i,j)=0.
        Pass_Sxy(i,j)=0.
        Pass_Syy(i,j)=0.

        Pass_Sxx_body(i,j)=0.
        Pass_Sxy_body(i,j)=0.
        Pass_Syy_body(i,j)=0.

        Pass_Sxx_surf(i,j)=0.
        Pass_Sxy_surf(i,j)=0.
        Pass_Syy_surf(i,j)=0.

        Pass_Wave_Fx(i,j)=0.
        Pass_Wave_Fy(i,j)=0.

        Pass_MassFluxU(i,j)=0.
        Pass_MassFluxV(i,j)=0.
        Pass_MassFlux(i,j)=0.

        Pass_Diss(i,j)=0.
        Pass_WaveNum(i,j)=0.
        Pass_Theta(i,j)=0.
        Pass_ubott(i,j)=0.
        Pass_Height(i,j)=0.
        Pass_C(i,j)=0.
        Pass_Cg(i,j)=0.
        Intp_U_Wave(i,j)=0.
        Intp_V_Wave(i,j)=0.
        Intp_eta_Wave(i,j)=0.
        Pass_ibrk(i,j)=0
```

```
Pass_U(i,j)=0.
Pass_V(i,j)=0.
Pass_Ub(i,j)=0.
Pass_Vb(i,j)=0.
Pass_eta(i,j)=0.

Pass_d11(i,j)=0.
Pass_d12(i,j)=0.
Pass_e11(i,j)=0.
Pass_e12(i,j)=0.
Pass_f11(i,j)=0.
Pass_f12(i,j)=0.

Pass_fw(i,j)=0.
pass_vt(i,j)=0

Intp_Fx_Circ(i,j)=0.
Intp_Fy_Circ(i,j)=0.
Intp_ubott_Circ(i,j)=0.
Intp_Theta_Circ(i,j)=0.
Intp_Sxx_Circ(i,j)=0.
Intp_Sxy_Circ(i,j)=0.
Intp_Syy_Circ(i,j)=0.
Intp_Sxx_Surf(i,j)=0.
Intp_Sxy_Surf(i,j)=0.
Intp_Syy_Surf(i,j)=0.
Intp_Sxx_Body(i,j)=0.
Intp_Sxy_Body(i,j)=0.
Intp_Syy_Body(i,j)=0.
Intp_MassFluxU_Circ(i,j)=0.
Intp_MassFluxV_Circ(i,j)=0.
Intp_Diss_Circ(i,j)=0.
Intp_ibrk_Circ(i,j)=0.

Pass_Dupdated(i,j)=Depth_Sedi(i,j)
Intp_U_Sedi(i,j)=0.
Intp_V_Sedi(i,j)=0.
Intp_Ub_Sedi(i,j)=0.
Intp_Vb_Sedi(i,j)=0.
Intp_ubott_Sedi(i,j)=0.
Intp_eta_Sedi(i,j)=0.
Intp_fw_Sedi(i,j)=0.
Intp_vt_Sedi(i,j)=0.
Intp_Theta_Sedi(i,j)=0.
Intp_Height_Sedi(i,j)=0.
Intp_ibrk_Sedi(i,j)=0.
```

```
enddo
enddo

 Pass_period = 1.

return
end
```

5 Frequently Asked Questions

1. If I have only two modules coupled, e.g., WaveModule and CircModule, how to set the model?

   Set N_Interval_CallSedi = -1 and make an empty subroutine SediModule as below

   ```
   subroutine SediModule()

   end
   ```

2. when three modules use three different grid systems, does the master program cost a lot of time during data transfer and interpolation?

   Because all the interpolation/extrapolation coefficients are obtained in the model initialization, the master program does not cost too much time during time integration. The interpolation/extrapolation is actually operated based on a simple formula given by Equ. (2).

3. Can I use a unstructured grid?

   Yes. See **Unstructured Grid** in 2.4.

4. If the three modules are in the same grid system, do I still need to provide three grid files?

   No. You may only provide Mast_Grid file and set null strings at module-grid-name locations in minput.dat. For example, set F_xycirc = ' '

5. How to pass a new variable from a module to another?

   We listed some possible passing variables in pass.h. The names for passing variables are standard long names such as 'Pass_MassFlux'. If you want to pass a new variable that is not in the list, you may add it in pass.h and modify the code in the corresponding subroutine interp_xxxx_xxxx. Please also inform us the modification for code updating.

6. How to tell the master program I want to pass a variable from one module to another?

   We use pass-control parameters, e.g., Wave_To_Circ_MassFlux, listed in minput.dat to control which variable will be transfer from a module to another. For example, Wave_To_Circ_MassFlux = .true. means the short wave flux will be passed (interpolated) from the wave module to the circulation module.

7. Where to input water depth?

   Water depth should be input in the master program and on Mast_Grid. The water depths on module grids are then obtained by interpolations from the Mast_Grid. We do not recommend reading water depth in a specific module since the water depth would be updated by the sediment module.

8. When passing a vector defined by tangential or normal direction in curvilinear coordinates, can the master program handle the vector rotation?

   No. You should rotate the vector into the reference geographic coordinate system before passing it. See **Coordinate systems** in 2.3.

9. Can we pass the contravariant radiation stresses when we use a curvilinear model?

   No. The master program does not handle the transformation of second-order tensors. It is suggested that the short wave forcing be calculated using the contravariant radiation stresses and then interpolated into other modules.