MODULE I: HANDS-ON Session

Tasks:

- Familiarization of the Basic parts of the model (input.txt; what each fortran file contains; etc.)
- Practicing how to run the simulations using simple codes or buttons in suijin server
- Going through the inputs and the outputs of the model
- Checking the binaries

- driver files
  - driver.f
  - forcing.f
  - hydro.f
  - initpara3d.f
  - Maproj3d.f
  - model.f
  - onesource.f
  - sce.f
  - sib2_flux2d.f
  - soilinit.f
  - time_file.f
  - topoinit.f
  - WEBDHM.f
  - External Dependencies
    - comsibc.h
    - dims.inc
    - force.inc
    - globcst.inc
    - hydro.inc
    - initial.inc
    - lsmpar.inc
    - optvar.inc
    - pardif.h
    - phycst.inc
    - sce.inc
    - sfcphycst.inc

(1) Shuffle Complex Evolution

- *driver.f*
- *sce.f*
- *model.f*
- *sce.inc*
- *optvar.inc*

(2) WEB-DHM model

(a) Main program

- *WEBDHM.f*

(b) Initialization

- *initpara3d.f*
- *topoinit.f*
- *soilinit.f*

(c) Operation

- *time_file.f*
- *forcing.f*
- *maproj3d.f*

(d) Vertical process

- *sib2_flux2d.f*
- *onesource.f*

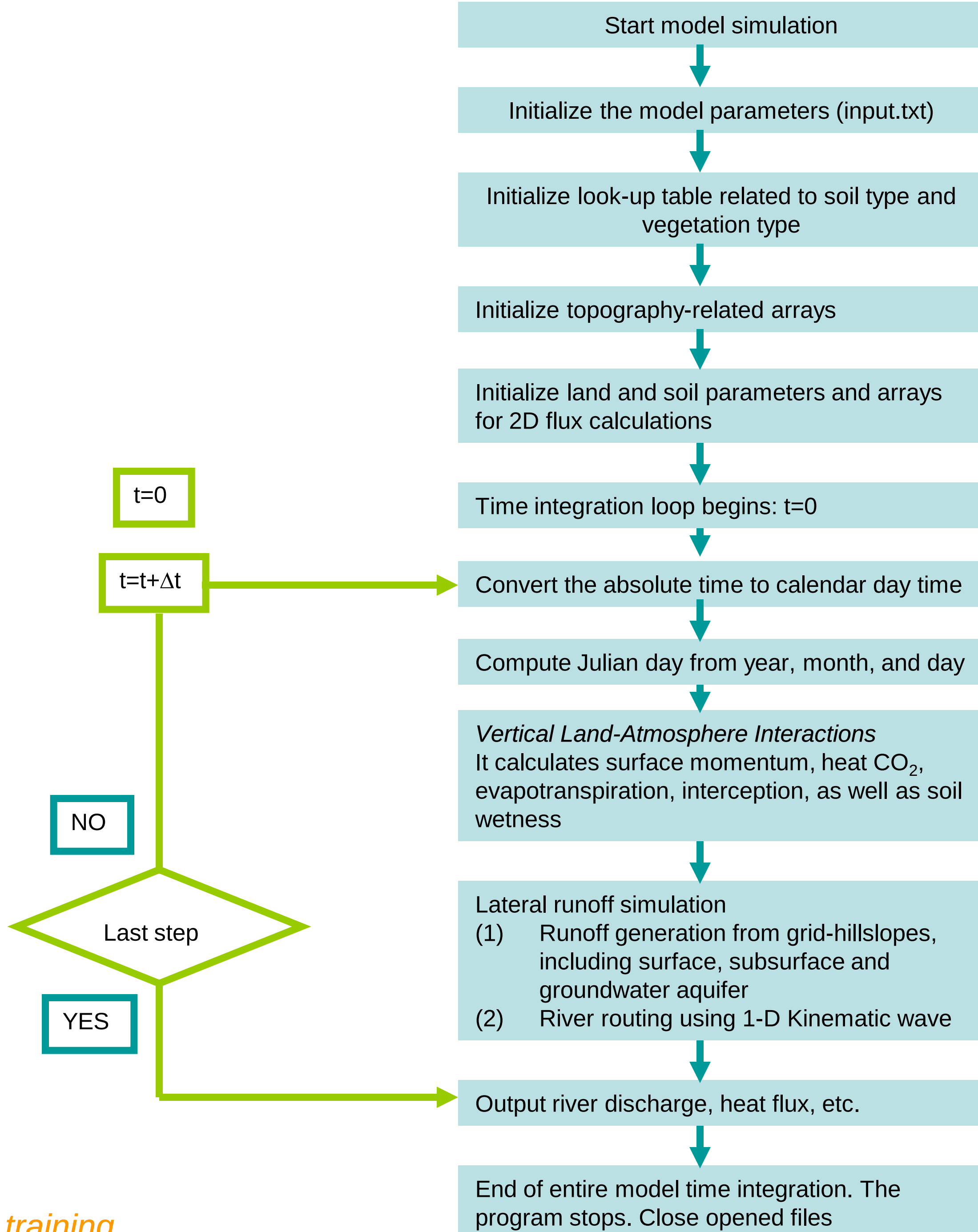
(e) Lateral process

- *hydro.f*

Slides courtesy of Lei Wang, 2010 WEB-DHM training

Flowchart of WEB-DHM

1. Initialize the model parameters. Most of them are global parameters passed through common blocks;
2. Initialize look-up table related to soil type and vegetation type;
3. Initialize topography-related arrays;
4. Initialize land and soil parameters and arrays for 2-dimensional flux calculation;
5. Time integration loop begins:
    a.) Convert the absolute time(sec) starting from 00:00:00 UTC, Jan. 1, 1960, to calendar day time;
    b.) Compute Julian day from year, month, and day start from 1 (Jan. 1) to 365, or 366 for leap year (Dec. 31);
    c.) Perform one time step integration for all equations:
    On exit of this routine, all time dependent fields are advanced by one time step.
    d.) Update physical time.
6. End of entire model time integration. The program stops. Close opened files.



Slides courtesy of Lei Wang, 2010 WEB-DHM training

Input.txt

1. input.txt

```
&JOBNAME                                              ! Sets the route for each directory
    runname = ‘Your Basin'
    para_dir = '../input/parameter/'
    data_dir = '../input/data/'
    result1_dir = '../output/river/'
    result2_dir = '../output/spatial/'
    simulation_dir = '../output/simulation/'
 /
 &TIMESTEP
    initime = ‘1981-01-01.00:00:00'
    tstart  = 0.0                  ! start time (unit: second)
    tstop   = 631152000.0                    ! end  time (unit: second)
    dt_couple = 3600.0             ! time step (unit: second) for the coupled model
    dtlsm   = 3600.0               ! time step (unit: second) for land surface submodel
    dthydro = 3600.0               ! time step (unit: second) for hydrological submodel
 /
 &POSITION
    latsw  = 36.361870             ! latitude in south-west corner for target region
    latne  = 37.064548             ! latitude in north-east  corner
    lonsw  = 138.382611            ! longitude in south-west corner
    lonne  = 139.425050            ! longitude in north-west corner
    xsw  = 267228.286182           ! x-coordinate in south-west corner
    xne  = 358728.286182           ! x-coordinate in north-east corner
    ysw  = 4027010.423088          ! y-coordinate in south-west corner
    yne  = 4103010.423088          ! y-coordinate in north-east corner
 /
```

Folder location:/dias/groups/dias-4-4-08/AWCI_MEMBER_FOLDER/counrty/WEBDHM/source_past

Please open this file in editpad Lite

```
&PROJECTION
    mapproj  =  3                    ! Type of map projection in the model grid;
                                              ! modproj = 0  No projection.
                                              !  = 1  Polar Stereographic projection.
                                     !  = 2  Lambert projection.
                                     !  = 3  Mercator projection.
    mpfctopt = 0                              ! Option parameter for map factor
                                     ! = 0, map factor set to 1
                                     ! = 1, map factor calculated according to mapproj
    trulat(1)= 0
    trulat(2)= 0
    trulon   = 141.0
    ctrlat   = 36.361870                      ! Latitude of the southwest corner of the physical model
                                                        domain (deg. N)
    ctrlon   = 138.382611                     ! Longitude of the southwest corner of the physical
                                                        model domain (deg. E)

    sclfct   = 0.9996                ! Map scale factor (generally it is set to 1.0) according
                                                        to your map projection
/
&GRID
    dx      = 500                             ! gridsize
    dy      = 500                             ! gridsize
    dzroot  = 0.2                             ! sublayer-thickness for root zone
    dzdeep  = 0.4                    ! Sublayer-thickness for deep soil
/
```

```
&MAPFILE                                  ! Define all the time-invariant spatial input
    gridarea_map   = 'cell_area.asc'                          ! grid area (dx*dy, unit: km2)
    elevation_map  = 'elevation.asc'                          ! elevation (m)
    slopelength_map= 'slope_length.asc'                       ! hillslope length (m)
    slopeangle_map = 'slope_angle.asc'                        ! slope angle (degree)
    soildepth_map  = 'tone_soil_depth.asc'                    ! depth of unsaturated zone (m)
    acquiferdepth_map = 'acquiferdepth.asc'                   ! groundwater aquifer depth (m)
    zref_map       = 'zwind.asc'                    ! Reference level for wind measurement
    met_alt_map    = 'met_alt.asc'                  ! Elevation for meteorological stations
    land_map       = 'land_use.asc'                 ! SiB2 land use type
    soil_map       = 'soil_unit.asc'                ! Soil type
    soil_code      = 'soil_code.txt'                ! Soil code          (grid: list soil.vat)
    soil_table     = 'soil_water_para.dat'          ! Soil water parameters
    met_map        = 'met_gauge.asc'                ! Thiessien polygons for meteor.
                                                    gauges
/
&TOPOGRAPHY                                         ! default value if no input data
   ele0     = 1000.0                                ! default elevation
   slope0   = 0.05                                  ! default slope
   length0  = 300.0                                 ! default hillslope length
   Ds0      = 4.0                                   ! default depth of unsaturated zone
   deldpth  = 4.0                                             ! = Dg - Ds (m)
   zwind0   = 10.0                                            ! default height for wind measurement
 /
```

```
&INITSOIL
    sfcdat  = 1                    ! Surface data input flag.
                                   ! = 0, use default value
                                   ! = 1, read from data file, if data file is not available, use default
    vegfromtype = 1                ! = 1, derive vegetation coverage from vegetation type
                                   ! = 0, use default value veg0, the option is used only for sfcdat = 1
     styp    = 2                   ! Soil type
     vtyp    = 9                   ! Vegetation type
     lai0    = 0.3                 ! Leaf Area Index
     veg0    = 0.5                 ! Vegetation coverage
     soilinit = 1                  ! Soil model variable initialization flag.
                                   ! = 0, default value
                                   ! = 1, Soil temperature variables are initialized by adding
                                   offsets to the surface air temperatue; while soil moisture
                                   variables are initialized from given saturation rates.
                                   ! = 2, from data file /simulation/ws**I_soil
                                   ! If inicon = 1, set soilinit = 2
     tslnd0   = 300.0              ! Initial ground-level soil potential temperature over land
     tscanp0  = 300.0              ! Initial canopy temperature
     tswtr0   = 300.0              ! Initial ground-level soil potential temperature over water
     tsoil0   = 300.0              ! Initial deep soil temperature
     vlcsfc0  = 0.0                ! Initial surface soil moisture
     vlcrt0   = 0.0                ! Initial root soil moisture
     vlcdp0   = 0.0                ! Initial deep soil moisture
```

```
wetcanp0 = 0.0          ! Initial canopy-intercepted water
wetg0    = 0.0          ! Initial ground-intercepted water
snowc0   = 0.0          ! Initial canopy-intercepted snow (m)
snowg0   = 0.0          ! Initial ground-intercepted snow (m)
tsprt    = 0.0          ! Offset of tsfc from surface air temperature
tcprt    = 0.0          ! Offset of tcanp from surface air temperature
t2prt    = 0.0          ! Offset of tsoil from surface air temperature
wgrat    = 0.7          ! Saturation rate of surface soil moisture
wrtrat   = 0.7          ! Saturation rate of root soil moisture
w2rat    = 0.85         ! Saturation rate of deep soil moisture
 /

 &LSMMODEL
 rstopt  = 0     ! option for surface resistance calculation.
                 ! = 0, identical surface resistance for momentum and heat transfer.
                 ! = 1, different surface resistance for momentum and heat transfer,
                          recommended for short vegetation.
 /
```

For the training:

- Open input.txt in a text editor (wordpad)
- Change: tstop = 631152000.0
- 20 years *365 days*24hours*60min*60 seconds = 86400
- This will enable us to run the model for 1 day

input.txt

```
&JOBNAME
     runname = 'Pampangga'
     para_dir = '../input/parameter/'
     data_dir = '../input/data/'
     result1_dir = '../output/river/'
     result2_dir = '../output/other/'
     simulation_dir = '../output/simulation/'
/
&TIMESTEP
     initime = '1982-01-01:00:00:00'
     tstart  = 0.0
     tstop   = 599616000.0
     dt_couple = 3600.0
     dtlsm   = 3600.0
     dthydro = 3600.0
```

Let`s begin…

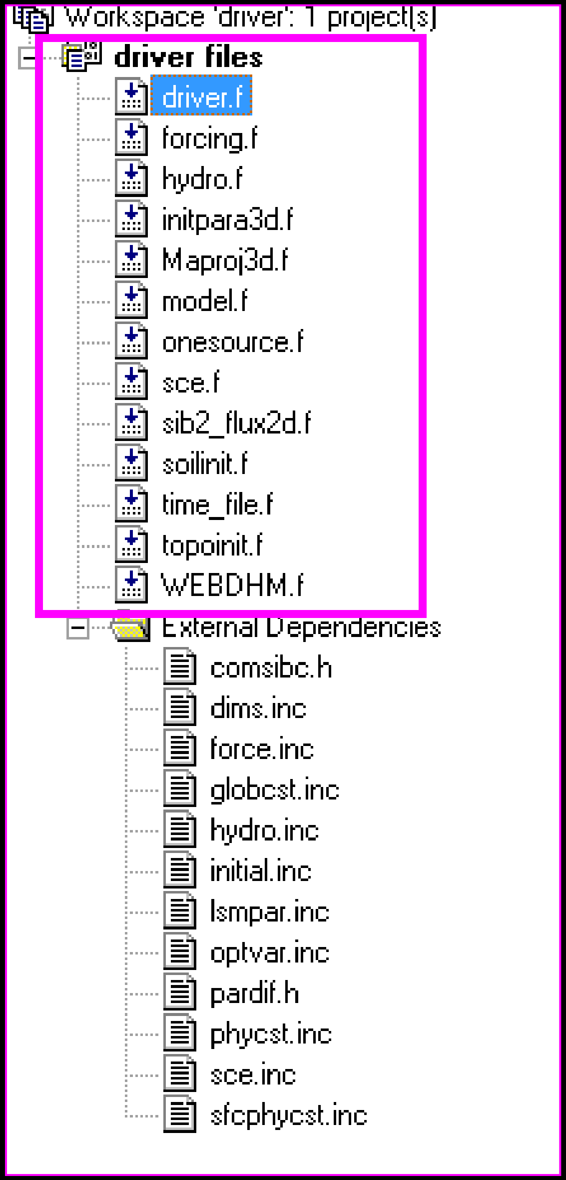
Open the folder by typing: cd

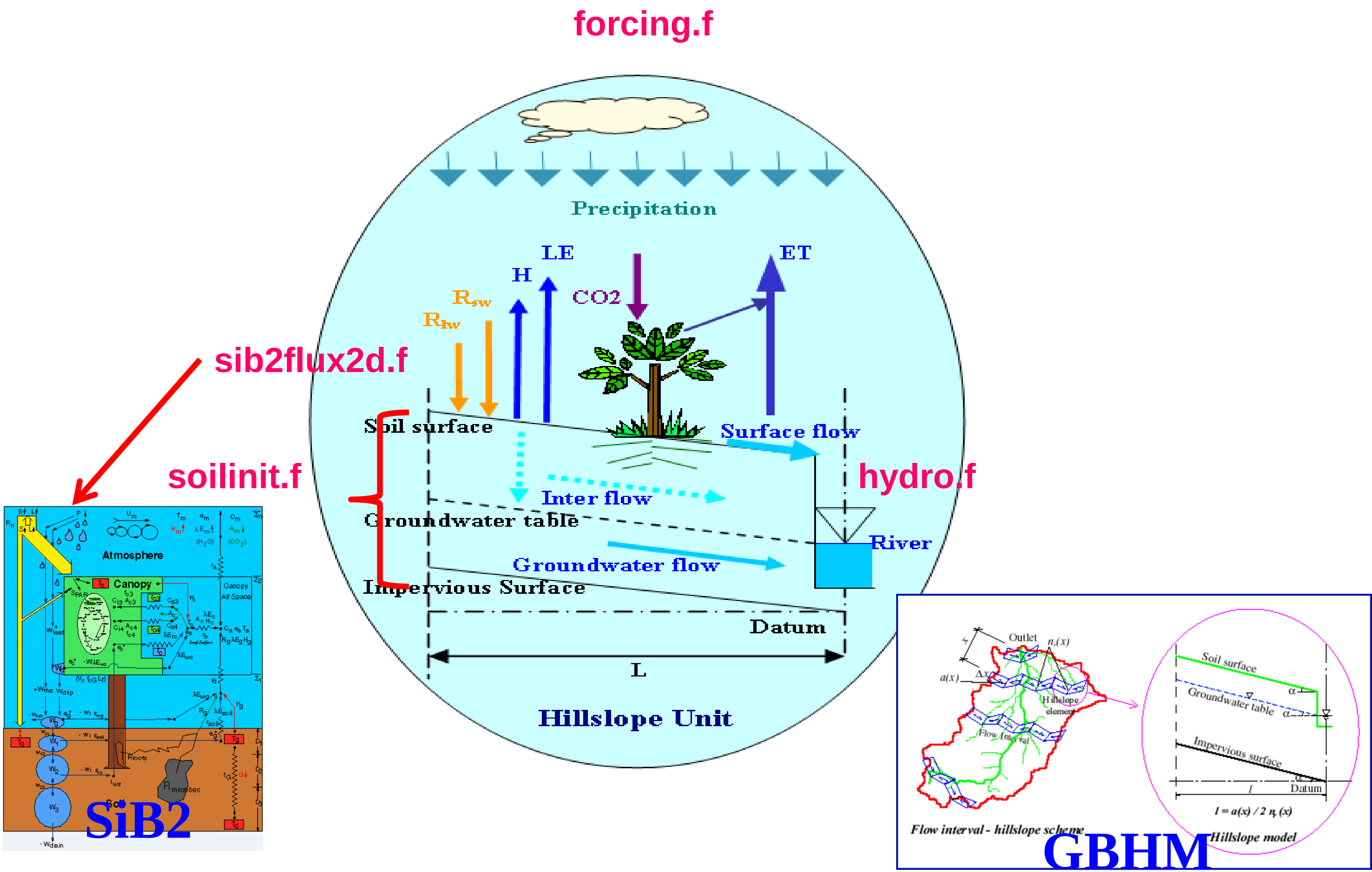
/dias/groups/dias-4-4-08/USER-country/country/WEBDHM/source_past

Or open the folder in Filezilla

Fortran files

driver.f –codes used to drive the sce
forcing.f – codes for reading meteorological parameters into the model
hydro.f —codes used for reading and writing hydrological parameters into and from the model
initpara3d.f —codes used for reading initial parameter conditions
maproj3d.f –codes used to read map projections (in the simulations these are projected in UTM)
model.f – model operator for the cost function
onsource.f – used in Sib2 calculations
sce.f – codes for the Shuffle complex evolution
sib2flux2d.f – codes for the sib2. It calculates surface momentum, heat, evapotranspiration and runoff.
soilinit.f – codes for initializing soil parameters. This is where calibration of of the soil parameters are done
time_file.f – codes for the time stamps used in the codes
topoinit.f – codes for initializing the model variables of topography
WEBDHM.f – puts everything together. Codes for coupling Sib2 with a grid-based hydrological model





forcing.f
sib2flux2d.f
soilinit.f
hydro.f
Precipitation
LE
ET
H
CO2
R_{sw}
R_{lw}
Soil surface
Surface flow
Inter flow
Groundwater table
River
Groundwater flow
Impervious Surface
Datum
L
Hillslope Unit
Atmosphere
Canopy
SiB2
Outlet
Flow interval - hillslope scheme
Soil surface
Groundwater table
Impervious surface
Datum
Hillslope model
GBHM

The External dependencies

dims.inc

Define dimension size:

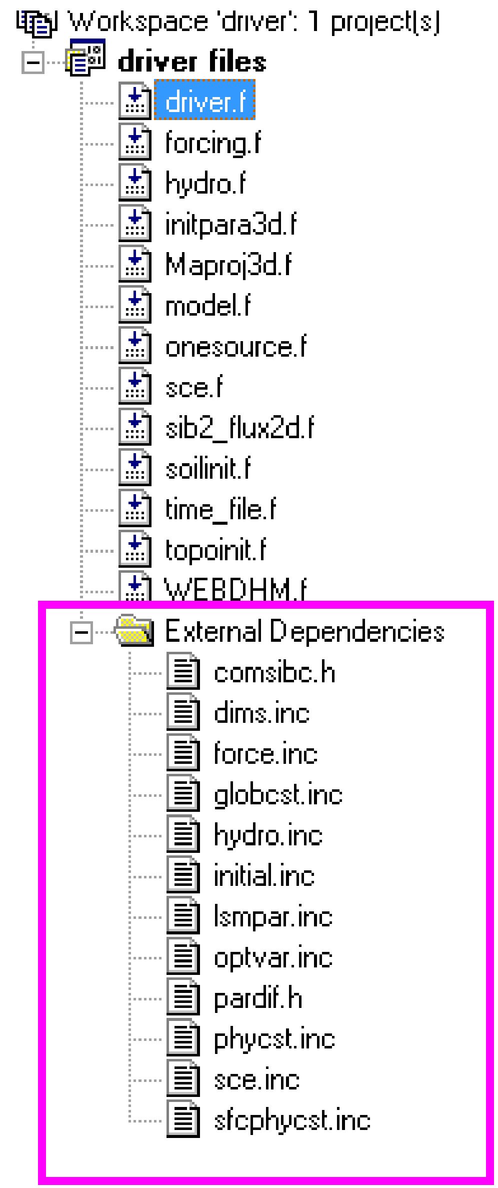
```
integer nx                    ! number of grids in x-dir.
integer ny                    ! number of grids in y-dir.
integer nvtyps                ! number of vegetation types in one grid
integer nz                    ! number of grids in z-dir of soil model
integer nmet                  ! number of met-gauge
parameter (nx = 183, ny= 152, nz = 24, nvtyps = 1, nmet = 7)
```

hydro.inc

Set parameters for simulation:

```
parameter (inisub=24)
parameter (finsub=40)
parameter (nfg = 4)
parameter (inicon = 0)
```

integer nfg ! number of flow discharge gauges
integer inicon ! flag for reading data from simulation foler
! = 0, Give arbitrary value
! = 1, Import from data file
integer inisub ! start subbasin
integer finsub ! end subbasin



lsmpar.inc

Set the number of soil types (ns):

```
integer      nv               ! Number of vegetation types
integer      ns               ! Number of soil types
PARAMETER (nv = 10, ns = 5)            !Ns should be modified in different catchment:
                                       !Ns = numsoil is the actual number of soil type
```

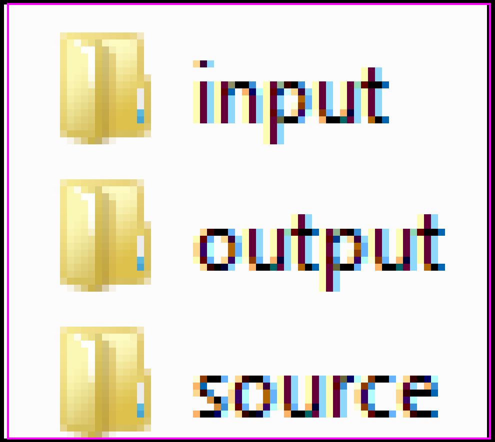
optvar.inc

Set the number of time-series values (e.g., discharge) for Shuffle Complex Evolution (SCE) calibration:

```
integer   nobsmax   !  max. number of input data
parameter (nobsmax = 720)
integer   nobs      !  actual number of input data
real q_obs(nobsmax), q_sim(nobsmax)
```

Model Organization

- Consists of 3 folders:
  - input
    - data
    - parameters
  - source
  - output
    - simulation
    - output
    - river
- Codes are written in Fortran and C++



Inputs of the model

Input folder:

Data Folder: (dynamic parameters)
- LAI and FPAR
- Meteorological Data
- Rainfall

**Mostly tabular or in binary*

Parameter Folder: (static parameters)
- Soil and soil parameters
- Land use
- Basin area and grid size
- Slope
- Bedslope
- Basin subdivisions
- River morphology

*Mostly text files (.asc) or tabular

Please open and check by yourself how it looks like for your basin…

Definition of Terms:
dynamic: time dependent variables
static: assumed constant in the simulation (simplification)

Input data

INPUTS	SAMPLE SOURCES:	TYPE CONSIDERED (*dynamic* or *static*)
Biophysical parameters:		
LAI and FPAR	AVHRR; MODIS	dynamic
Soil	FAO soil map; local soil map	static
Land use	USGS Land Use Map, local maps	static
elevation	Local data; AsterDEM, GDEM	static
Meteorological Parameters:		
Rainfall	Local data; satellite data (TRMM; GsMap); integrated observed data (Aphrodite);	dynamic
Long wave radiation	Reanalysis data (JRA 25; JP 10; NCEP);Local data	dynamic
Short wave radiation	Reanalysis data (JRA 25; JP 10; NCEP);Local data	dynamic
humidity	Reanalysis data (JRA 25; JP 10; NCEP);Local data	dynamic
Air temperature	Reanalysis data (JRA 25; JP 10; NCEP);Local data	dynamic

How to run the WEB-DHM (3 ways)

- Consists of 3 basic steps after debugging (*finding all the errors*): in Visual Compact Fortran (VCF):

1) compile (Ctrl + F7)
2) build (F7)
3) execute (Ctrl + F5)

- In Intel Fortran: needs a bit of reformatting of the source codes location in the folders but steps are similar to VCF:

1) compile
2) build
3) Execute

- In F90 using Unix: consists of 2 steps:

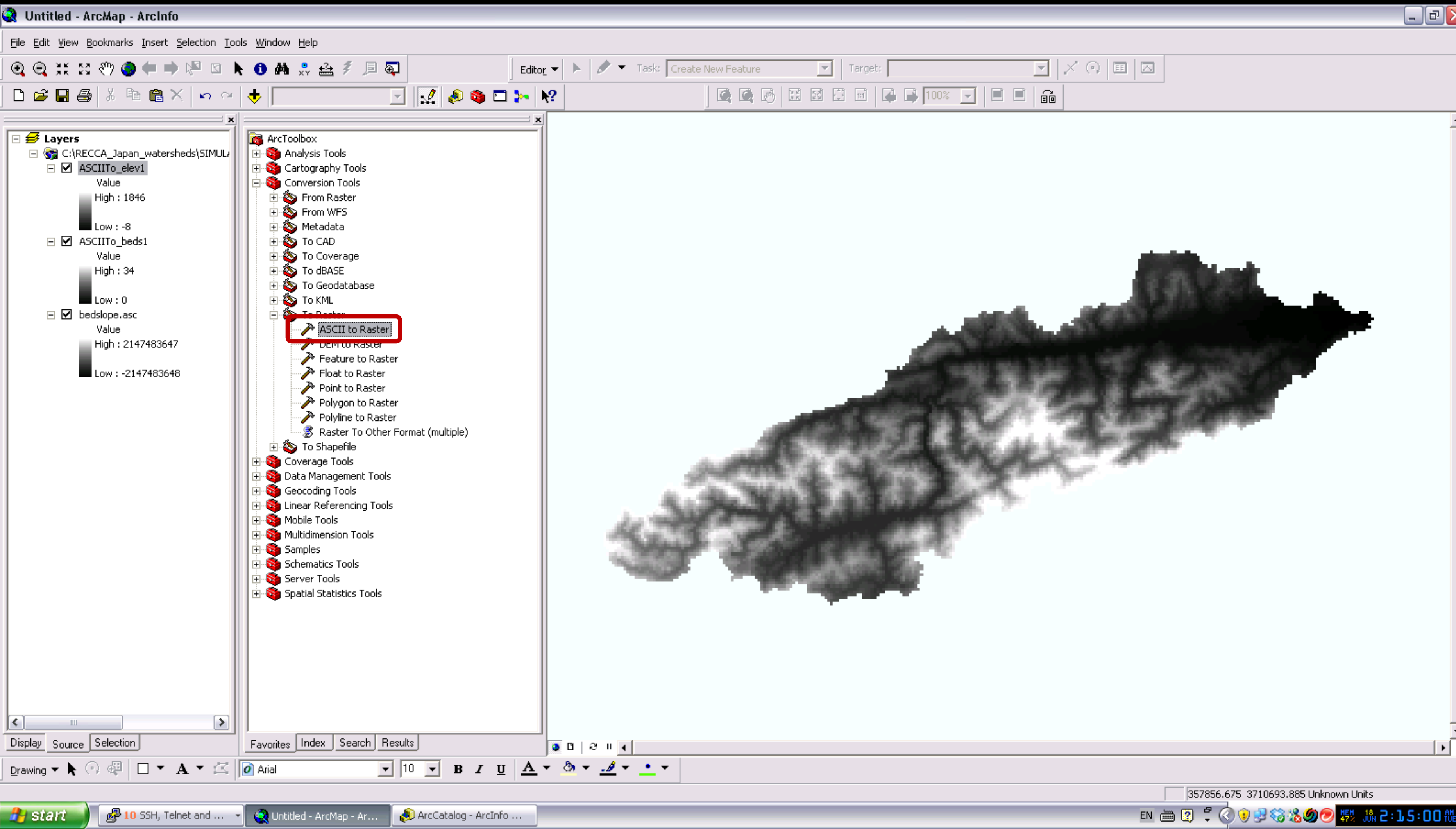
1) Type in “make clean; make ”
2) type in “./webSCE”

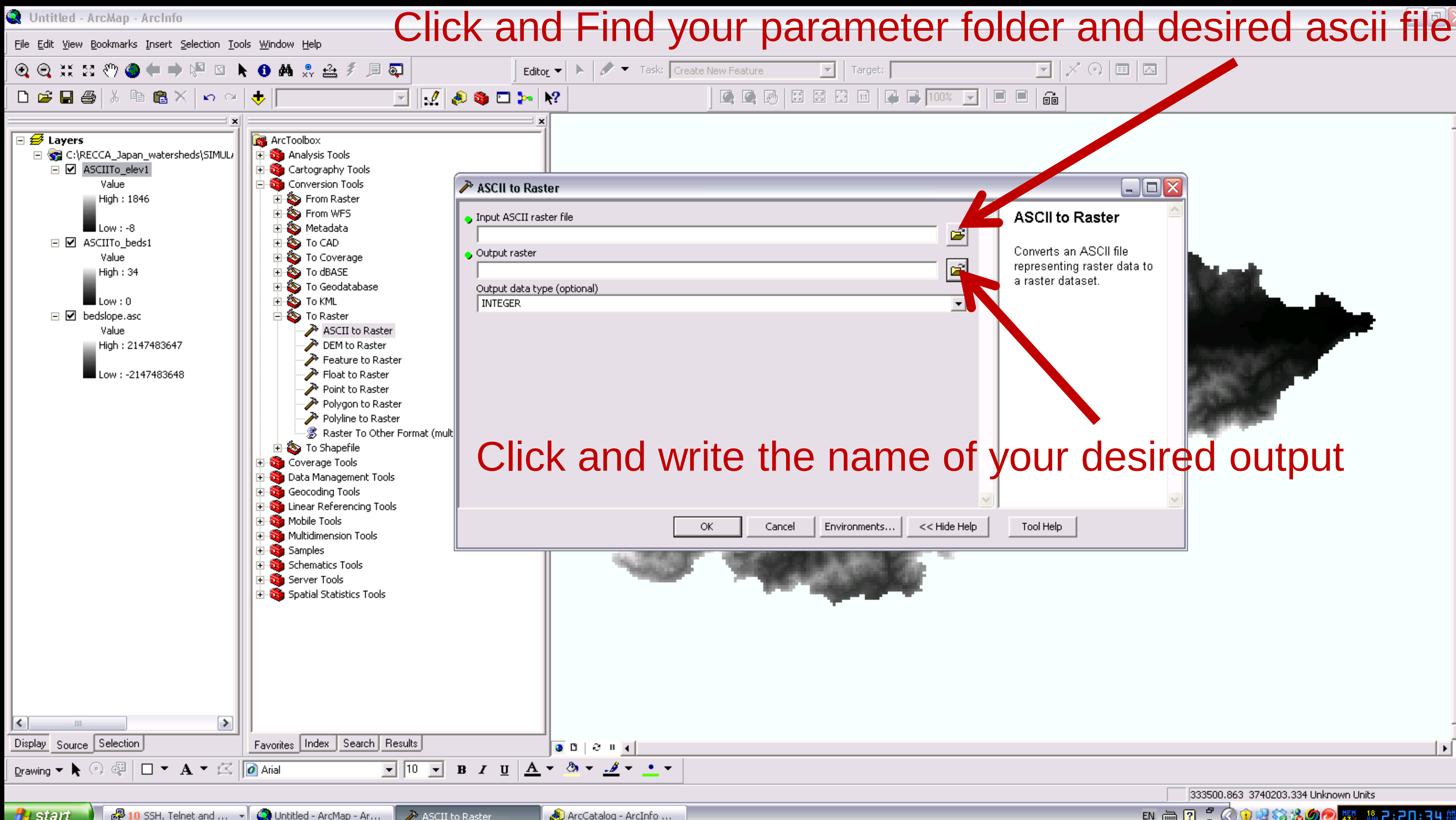
Let`s practice…

Let's Play…

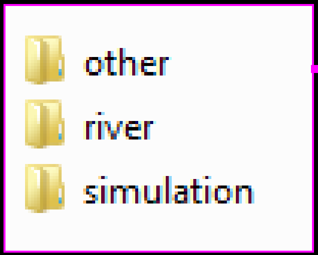
1. Copy WEBDHM/input/parameter folder of your WEB-DHM into the desktop
2. Convert ascii files to raster (grid) and view the static parameters in ArcMap/Arc Catalog

By clicking: ArcToolbox—Conversion tools—To Raster—ASCII to Raster




Click and Find your parameter folder and desired ascii file
Click and write the name of your desired output
Untitled - ArcMap - ArcInfo
ASCII to Raster
Input ASCII raster file
Output raster
Output data type (optional)
INTEGER
ASCII to Raster
Converts an ASCII file representing raster data to a raster dataset.
OK
Cancel
Environments...
<< Hide Help
Tool Help
ArcToolbox
Analysis Tools
Cartography Tools
Conversion Tools
From Raster
From WFS
Metadata
To CAD
To Coverage
To dBASE
To Geodatabase
To KML
To Raster
ASCII to Raster
DEM to Raster
Feature to Raster
Float to Raster
Point to Raster
Polygon to Raster
Polyline to Raster
To Shapefile
Coverage Tools
Data Management Tools
Geocoding Tools
Linear Referencing Tools
Mobile Tools
Multidimension Tools
Samples
Schematics Tools
Server Tools
Spatial Statistics Tools
Layers
ASCIITo_elev1
High : 1846
Low : -8
ASCIITo_beds1
High : 34
Low : 0
bedslope.asc
High : 2147483647
Low : -2147483648

Outputs folder:



Other folder:

•Hydrological parameters that are selected by the modeler:

rainfall, discharge, air temperature, ground temperature, pressure, soil moisture at the surface, at the root zone, at the deep soil zone, evapotranspiration fluxes and groundwater level

* Please open *file*.hourly (e.g. outlet.hourly) to view the text files for the basin average values

River folder:

Basin average hourly river discharge at selected outlet points

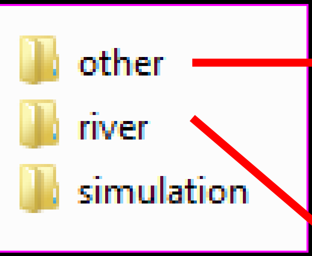
Simulation folder:

Initialization of soil parameters on the sub-basins

Initialization of the discharge on each sub-basin

OUTPUT DATA: Text files

- **Where are they?**
  - These files are located in the output folder under the sub-folder river and other



  - **/output/other:** consists of the other parameters either from the inputs (basin average inputs or derived parameters based on the inputs) or from the simulations of hydrological parameters
  - **/output/river:** consists of basin average values for discharge (in our training, these are set at the basin outlets and/or sub-basin outlets)
- **What are they?**
  - These are basin average files (set by the user at the basin outlet for this training) within the model source codes
  - For this training these are: rainfall, discharge, air temperature, ground temperature, pressure, soil moisture at the surface, at the root zone, at the deep soil zone, evapotranspiration fluxes and groundwater level

OUTPUT DATA: BINARY FILES

- **Where are they?**
  - These files are located in the output folder under the sub-folder “other”
  - **/output/other:** consists of other parameters either from the inputs (basin average inputs or derived parameters based on the inputs) or from the simulations of hydrological parameters
  - **/output/other:** consists of binary spatial distribution average values for rainfall, discharge, soil moisture at the surface, soil moisture at the root zone, and groundwater

- **What are they?**
  - These are grid by grid monthly average files specified (flagged) within the model source codes
  - For this training these are: rainfall, discharge, soil moisture at the surface, at the root zone, and groundwater level

When do we play with these?
Answer: Later in the drought training and tomorrow

Operationalization of the Model (Creating input files and modifying the codes for spatial distribution)

- For this training all input files are in tabular, text files and/or binary files
- Spatial distribution of parameter files are in simple binary format

Note: Unfortunately data preparation of this part will be discussed in a more detailed training (5-10 days) next time…