Input & Output Data of CREST Model

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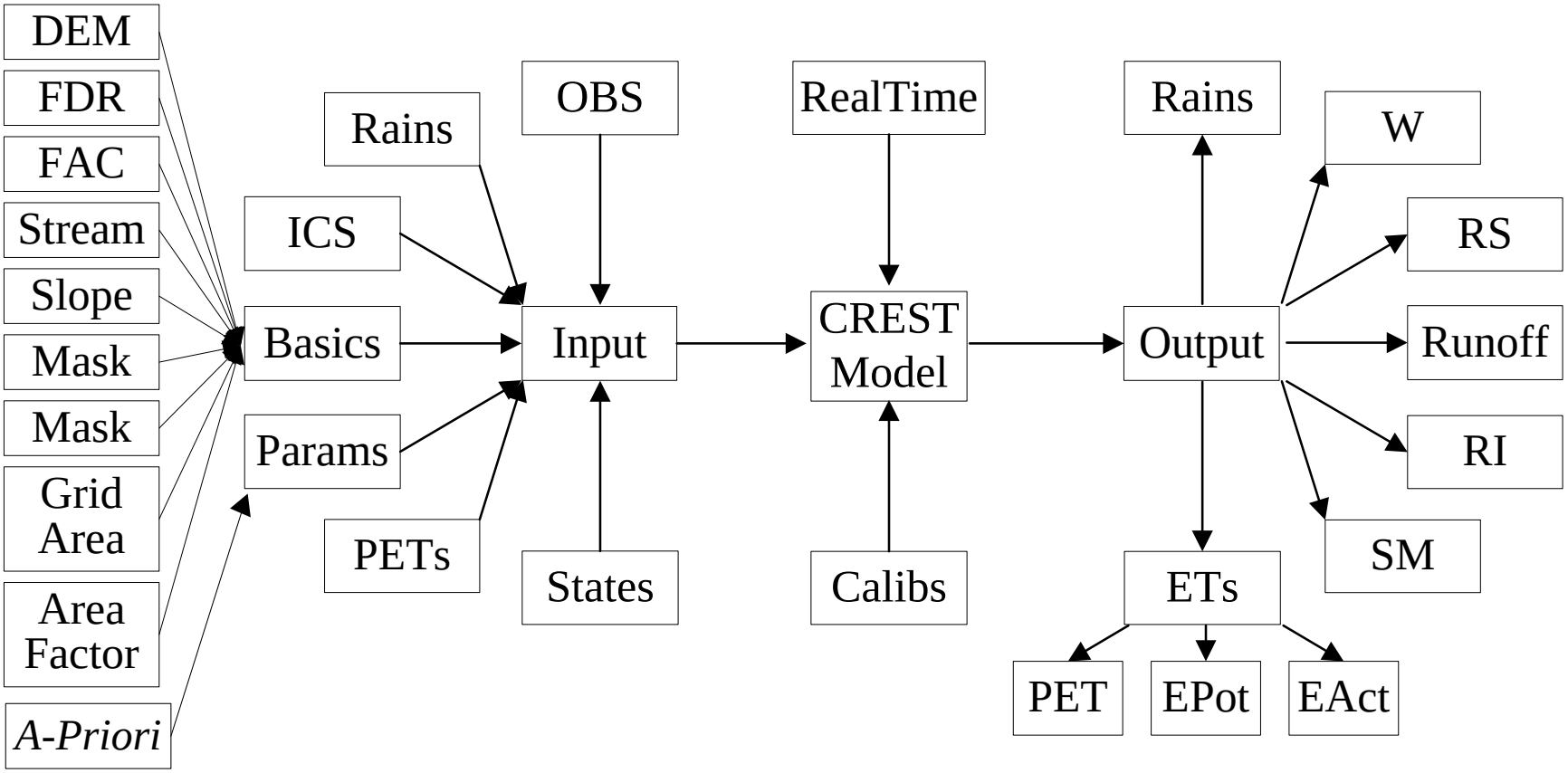
Programming Framework



Organization of the Files and Folders

Input(ProjectName.Project)

- Model Area Information
- Model Runtime Information
- Model Input & Output Directory and it's format
- OutPix Information
- Outlet Information
- Gridded State Variables
- Specified Date time

Input(ProjectName.Project)

Comments

In any order

Convenient and flexible

```
################################################################################
# CREST Project File Format (Version more than 2.0)
################################################################################
Version          =     2.0
################################################################################
# MODEL AREA
################################################################################
NCols            =     81            # Number of columns
NRows            =     92            # Number of rows
xllCorner        =     89.0916666666657
yllCorner        =     27.0999999999996
CellSize         =     0.0083333333333333      #
NODATA_value     =     -9999.
################################################################################
# MODEL Run Time Information
################################################################################
TimeMark         =     d #y(year);m(month);d(day);h(hour);u(minute);s(second)
TimeStep         =     1
StartDate        =     20010101
LoadState        =     no
WarmupDate       =     20010101
EndDate          =     20011231
SaveState        =     no
################################################################################
# MODEL Directory
################################################################################
RunStyle         =     simu   # simu, cali_SCEUA, RealTime
################################################################################
BasicFormat      =     asc #asc,txt,biffit, dbif,ASBIMO,BIBIMO,TRMMRT,TRMMV6,NMQBIN
BasicPath        =     "E:\CREST_Workshop\CREST_Model\01-Wangchu_CREST_V6_Daily_Run\Basics\"
################################################################################
ParamFormat      =     asc
ParamPath        =     "E:\CREST_Workshop\CREST_Model\01-Wangchu_CREST_V6_Daily_Run\Params\"
################################################################################
StateFormat      =     asc
StatePath        =     "E:\CREST_Workshop\CREST_Model\01-Wangchu_CREST_V6_Daily_Run\States\"
################################################################################
ICSFormat        =     asc
ICSPath          =     "E:\CREST_Workshop\CREST_Model\01-Wangchu_CREST_V6_Daily_Run\ICS\"
################################################################################
RainFormat       =     biffit
RainPath         =     "E:\CREST_Workshop\CREST_Model\01-Wangchu_CREST_V6_Daily_Run\Rain\XXW_Wangchu_TRMMV6_Daily_"
################################################################################
PETFormat        =     biffit
PETPath          =     "E:\CREST_Workshop\CREST_Model\01-Wangchu_CREST_V6_Daily_Run\PET\XXW_Wangchu_FEWSPET_Daily_"
################################################################################
ResultFormat     =     asc
ResultPath       =     "E:\CREST_Workshop\CREST_Model\01-Wangchu_CREST_V6_Daily_Run\Results\"
################################################################################
CalibFormat      =     asc
CalibPath        =     "E:\CREST_Workshop\CREST_Model\01-Wangchu_CREST_V6_Daily_Run\Calibs\"
```

Basic Folder

- DEM Map(Any formats)(DEM.X)
- Flow Direction Map (FDR.X)

32	64	128
16		1
8	4	2

Many Software

8	1	2
7		3
6	5	4

CNT

- Flow Accumulation Map (FAC.X)
- Mask File (Mask.X)
- GridArea File (GridArea.X)
- AreaFac File (AreaFact.X)
- Slope Map (Slope.X/Slope.def)
- Stream Map (Stream.X/Stream.def)

.X can be any of these formats:

ASC
TXT
DBIF
BIFFIT
TRMMRT
TRMMV6
NMQBIN
ASBIMO
BIBIMO

ICS Folder

- InitialConditions.txt

```
1  ##########################################################################
2  # CREST Initial Conditions File Format (Version more than 2.0)
3  # For Example:
4  #    WU0Type             =      Uniform    # Uniform/Distributed
5  #    WU0                 =      24.230076
6  ##########################################################################
7
8  ##########################################################################
9  WU0Type             =      Uniform # The factor to modify the area of grid cells
10 WU0                 =      53.52593
11 ##########################################################################
12 SS0Type             =      Uniform # The factor to modify the area of grid cells
13 SS0                 =      5.899539
14 ##########################################################################
15 SI0Type             =      Uniform # The factor to modify the area of grid cells
16 SI0                 =      17.31128
17 ##########################################################################
```

OBS Folder

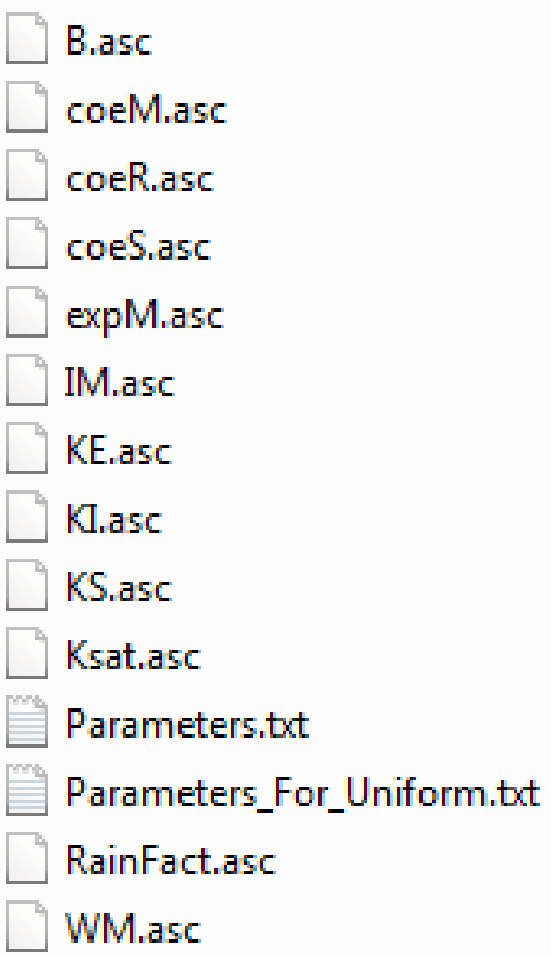
- Wangchu_Obs.csv (Using .csv format by Excel)
- **Station Name + "_Obs.csv"**
- Date Column depends on the run options
  for example:
  Year + Month + Day + Hour + Minute + Second
- Runoff Column: "m^3/s"

Date	Wangchu
20010101	27
20010102	27
20010103	26.944
20010104	26.02
20010105	25.913
20010106	25.106
20010107	25.05
20010108	25.055
20010109	24.477
20010110	24.67
20010111	25.05
20010112	25.45
20010113	24.988
20010114	24.85
20010115	24.734
20010116	24.671
20010117	24.169
20010118	23.5
20010119	23.527
20010120	23.781
20010121	23.78
20010122	23.766
20010123	23.535
20010124	24.217
20010125	24
20010126	24.51
20010127	24.706
20010128	24
20010129	23.944
20010130	24.615
20010131	25.125
20010201	25.159
20010202	25.32
20010203	24.393
20010204	23
20010205	21.855
20010206	21.479
20010207	22.096
20010208	22.479
20010209	23.124
20010210	23.213

Params Folder

- Both Uniform and Distributed

```
6  ##########################################################################################
7  RainFactType     =     Uniform # The factor to modify the precipitation field
8  RainFact         =     1.17449673260939
9  ##########################################################################################
10 KsatType         =     Distributed #
11 Ksat             =     1.0    #2.839552
12 ##########################################################################################
13 WMType           =     Distributed #
14 WM               =     1.0    #129.945648
15 ##########################################################################################
16 BType            =     Uniform #
17 B                =     0.634463911311414    #0.25
18 ##########################################################################################
19 IMType           =     Uniform #
20 IM               =     0.199989285206877    #1.0
21 ##########################################################################################
22 KEType           =     Uniform #
23 KE               =     0.142383452593136    #0.845182
24 ##########################################################################################
25 coeMType         =     Uniform  #Overland flow speed multiplier
26 coeM             =     144.705860894636    #58.89378
27 ##########################################################################################
28 expMType         =     Uniform #
29 expM             =     0.5
30 ##########################################################################################
31 coeRType         =     Uniform #
32 coeR             =     1.08305683656247    #0.728891
33 ##########################################################################################
34 coeSType         =     Uniform #
35 coeS             =     0.272617234911895    #0.627904
36 ##########################################################################################
37 KSType           =     Uniform #
38 KS               =     1.1    #0.414064
39 ##########################################################################################
40 KIType           =     Uniform #
41 KI               =     0.214756818157274      #0.215441
42 ##########################################################################################
```



State Folder

We use the states to store the current conditions, so next time, the model can be run using this conditions

- This folder contains the state variables' files, these files will be created after running the model. such as

  when LoadState = "yes"

  "State_StartDate_SS0.X"

  "State_StartDate_SI0.X"

  "State_StartDate_W0.X"

  When SaveState = "yes"

  "State_EndDate_SS0.X"

  "State_EndDate_SI0.X"

  "State_EndDate_W0.X"

Calibs Folder

This folder contains all the configuration and values of calibration for the model using **Calibrations.txt File**

```
##########################################################################################
# CREST Calibrations File (Version more than 2.0)
##########################################################################################
iseed                =              -3
maxn                 =              10000
kstop                =              10
pcento               =              0.0001
ngs                  =              2
##########################################################################################
NCalibStations       =              1
IsColRow             =              no     # yes: use Col& Row; No: Lan & Lati
##########################################################################################
[Station 1 Begin]
Name_1                 =                Wangchu
Value_1                =                1
Long_1     =    89.530485
Lati_1     =    27.108927
RainFact_1           = 0.5    0.95     1.2
Ksat_1               = 0.5    1.00     1.2
WM_1                 = 0.5    1.00     1.2
B_1                  = 0.05   0.25     1.5
IM_1                 = 0.0    0.05     0.2
KE_1                 = 0.1    0.95     1.5
coeM_1               = 1.0    90.0     150
#expM_1              = 0.1    0.95     2
coeR_1               = 1.0    2.00     3.0
coeS_1               = 0.001  0.95     1
KS_1                 = 0.0    0.50     1.0              # Min    Value    Max
KI_1                 = 0.0    0.50     1.0
[Station 1 End]
```

Calibs Folder-**Calibrations.txt File**

- The statement in the "Calibrations.txt" file can be listed in any order, but the keywords should not be changed. The format of the statement (including project file, parameters file and the calibrations file) is, for example:

  - **Keyword = Value**
  - The statement appearing on the same line should be space- or tab-separated.
  - Comment lines must have a pound sign, #, in the first column.
  - Comment for the statement in the line must be placed after **Value** and be sure to leave at least one space or tab between the **Value** and the Comments.
  - Keyword is not case sensitive.

Rain and PET

- Any formats

  ASC
  TXT
  DBIF
  BIFFIT
  TRMMRT
  TRMMV6
  NMQBIN
  ASBIMO
  BIBIMO

- Clip the area automatically when the data area is different with the research area

Output & Post-Process

You can turn the options for grid outputs in the project file

- Output the Basin Outlet's data (Rainfall, PET, Soil moisture are the watershed average, and the streamflow is for the outlet)
- Output the all the pixels/locations data (**OutPix**) include its upstream area's Rain and PET
- Output the state variables' data
- Output the specified data time's data
- Automatically compute the **NSCE, Bias and CC** when basin outlet and any pixels in this basin have the observation data
- The output data files use their data type as prefix

Output & Post-Process

- GOVar_Rain_20011228.asc
- GOVar_Rain_20011229.asc
- GOVar_Rain_20011230.asc
- GOVar_Rain_20011231.asc
- OutDT_EAct_20010101.asc
- OutDT_EPot_20010101.asc
- OutDT_ExcI_20010101.asc
- OutDT_ExcS_20010101.asc
- OutDT_PET_20010101.asc
- OutDT_R_20010101.asc
- OutDT_Rain_20010101.asc
- OutDT_RI_20010101.asc
- OutDT_RS_20010101.asc
- OutDT_SM_20010101.asc
- OutDT_W_20010101.asc
- Outlet_Wangchu_Mask.asc
- Outlet_Wangchu_Results.csv
- Outlet_Wangchu_Results_Statistics.csv

Outlet_Wangchu_Results.csv - Microsoft Excel

	DateTime	Rain	PET	EPot	EAct	W	SM	RS	RI	ExcS	ExcI	R	RObs
2	1/1/2001 0:00	0.405	1.039	0.148	0.105	88.587	0.537	4.557	3.733	0.07	0.073	1.745	27
3	1/2/2001 0:00	0	1.291	0.184	0.099	88.488	0.536	3.193	3.703	0	0	34.854	27
4	1/3/2001 0:00	0.048	1.185	0.169	0.077	88.425	0.535	1.412	3.662	0.003	0.003	61.165	26.944
5	1/4/2001 0:00	0	1.125	0.16	0.086	88.339	0.535	0.527	3.609	0	0	47.322	26.02
6	1/5/2001 0:00	0.015	1.156	0.165	0.094	88.259	0.534	0.18	3.548	0	0	34.724	25.913
7	1/6/2001 0:00	0.012	1.28	0.182	0.091	88.169	0.534	0.058	3.478	0	0	28.701	25.106
8	1/7/2001 0:00	0.006	1.194	0.17	0.089	88.081	0.533	0.018	3.402	0	0	26.705	25.05
9	1/8/2001 0:00	0.003	1.125	0.16	0.083	87.998	0.532	0.006	3.319	0	0	26.32	25.055
10	1/9/2001 0:00	0	1.213	0.173	0.092	87.906	0.532	0.002	3.23	0	0	26.38	24.477
11	1/10/2001 0:00	0	1.213	0.173	0.092	87.814	0.531	0.001	3.136	0	0	26.469	24.67
12	1/11/2001 0:00	0.001	1.213	0.173	0.091	87.723	0.531	0	3.038	0	0	26.485	25.05
13	1/12/2001 0:00	0.009	1.213	0.173	0.087	87.636	0.53	0	2.936	0	0	26.425	25.45
14	1/13/2001 0:00	0.004	1.213	0.173	0.089	87.547	0.53	0	2.831	0	0	26.313	24.988
15	1/14/2001 0:00	0.004	1.213	0.173	0.089	87.458	0.529	0	2.722	0	0	26.168	24.85
16	1/15/2001 0:00	0.001	1.213	0.173	0.09	87.368	0.529	0	2.612	0	0	26.001	24.734
17	1/16/2001 0:00	0.023	1.213	0.173	0.093	87.29	0.528	0.003	2.501	0.004	0.004	25.816	24.671
18	1/17/2001 0:00	0.015	1.213	0.173	0.083	87.207	0.528	0.003	2.387	0	0	25.609	24.169
19	1/18/2001 0:00	0.005	1.213	0.173	0.09	87.119	0.527	0.002	2.273	0	0	25.823	23.5
20	1/19/2001 0:00	0.013	1.213	0.173	0.093	87.036	0.527	0.002	2.159	0.002	0.002	25.426	23.527
21	1/20/2001 0:00	0.018	1.213	0.173	0.083	86.955	0.526	0.002	2.046	0	0	24.95	23.781
22	1/21/2001 0:00	0.017	1.213	0.173	0.091	86.873	0.526	0.002	1.933	0.001	0.001	24.698	23.78
23	1/22/2001 0:00	0	1.213	0.173	0.091	86.783	0.525	0.001	1.822	0	0	24.195	23.766
24	1/23/2001 0:00	0.042	1.213	0.173	0.098	86.716	0.525	0.005	1.713	0.005	0.005	23.645	23.535
25	1/24/2001 0:00	0.005	1.213	0.173	0.088	86.628	0.524	0.003	1.606	0	0	23.08	24.217
26	1/25/2001 0:00	0.063	1.213	0.173	0.109	86.572	0.524	0.004	1.503	0.004	0.004	22.486	24
27	1/26/2001 0:00	0.01	1.213	0.173	0.085	86.487	0.523	0.002	1.402	0	0	21.872	24.51
28	1/27/2001 0:00	0.019	1.213	0.173	0.096	86.408	0.523	0.001	1.304	0.001	0.001	21.185	24.706
29	1/28/2001 0:00	0.002	1.213	0.173	0.089	86.319	0.522	0	1.21	0	0	20.456	24
30	1/29/2001 0:00	0.002	1.213	0.173	0.089	86.23	0.522	0	1.12	0	0	19.693	23.944
31	1/30/2001 0:00	0	1.213	0.173	0.09	86.14	0.521	0	1.034	0	0	18.898	24.615
32	1/31/2001 0:00	0	1.213	0.173	0.09	86.05	0.521	0	0.953	0	0	18.076	25.125
33	2/1/2001 0:00	0.067	0.677	0.096	0.054	86.04	0.521	0.009	0.878	0.012	0.012	17.234	25.159
34	2/2/2001 0:00	0.115	1.996	0.284	0.153	85.958	0.52	0.02	0.808	0.015	0.015	16.407	25.32

Outlet_Wangchu_Results_Statistics.csv - Microsoft Excel

	A	B
1	NSCE	0.730208
2	Bias(%)	-2.59318
3	CC	0.867715
4		
5		

Evaluation indices

- Nash-Sutcliffe Coefficient of Efficiency

$$NSCE = 1 - \frac{\sum_{i=1}^{n}\left(R_{obs,i} - R_{sim,i}\right)^2}{\sum_{i=1}^{n}\left(R_{obs,i} - \overline{R_{obs}}\right)^2}$$

- Relative Bias (%) was used to assess the systematic bias of runoff

$$Bias = \left[\frac{\sum_{i=1}^{n} R_{sim,i} - \sum_{i=1}^{n} R_{obs,i}}{\sum_{i=1}^{n} R_{obs,i}}\right] \times 100$$

- The correlation coefficient (CC) is used to assess the agreement between simulated runoff and observed runoff

$$CC = \frac{\sum_{i=1}^{n}\left(R_{obs,i} - \overline{R_{obs}}\right)\left(R_{sim,i} - \overline{R_{sim}}\right)}{\sqrt{\sum_{i=1}^{n}\left(R_{obs,i} - \overline{R_{obs}}\right)^2 \sum_{i=1}^{n}\left(R_{sim,i} - \overline{R_{sim}}\right)^2}}$$

Thanks for your attention!

Any questions?