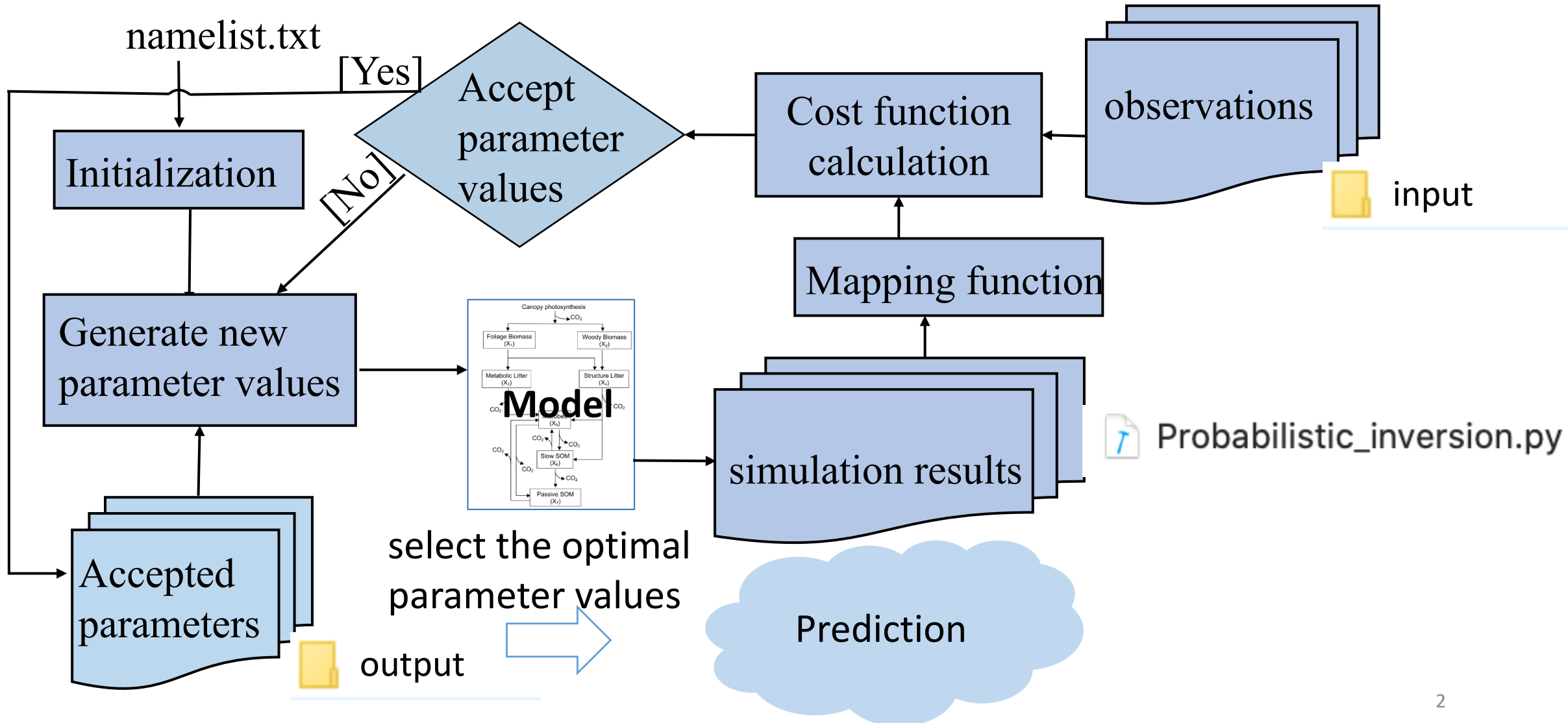


Introduction on Model Independent Data Assimilation module (MIDA)

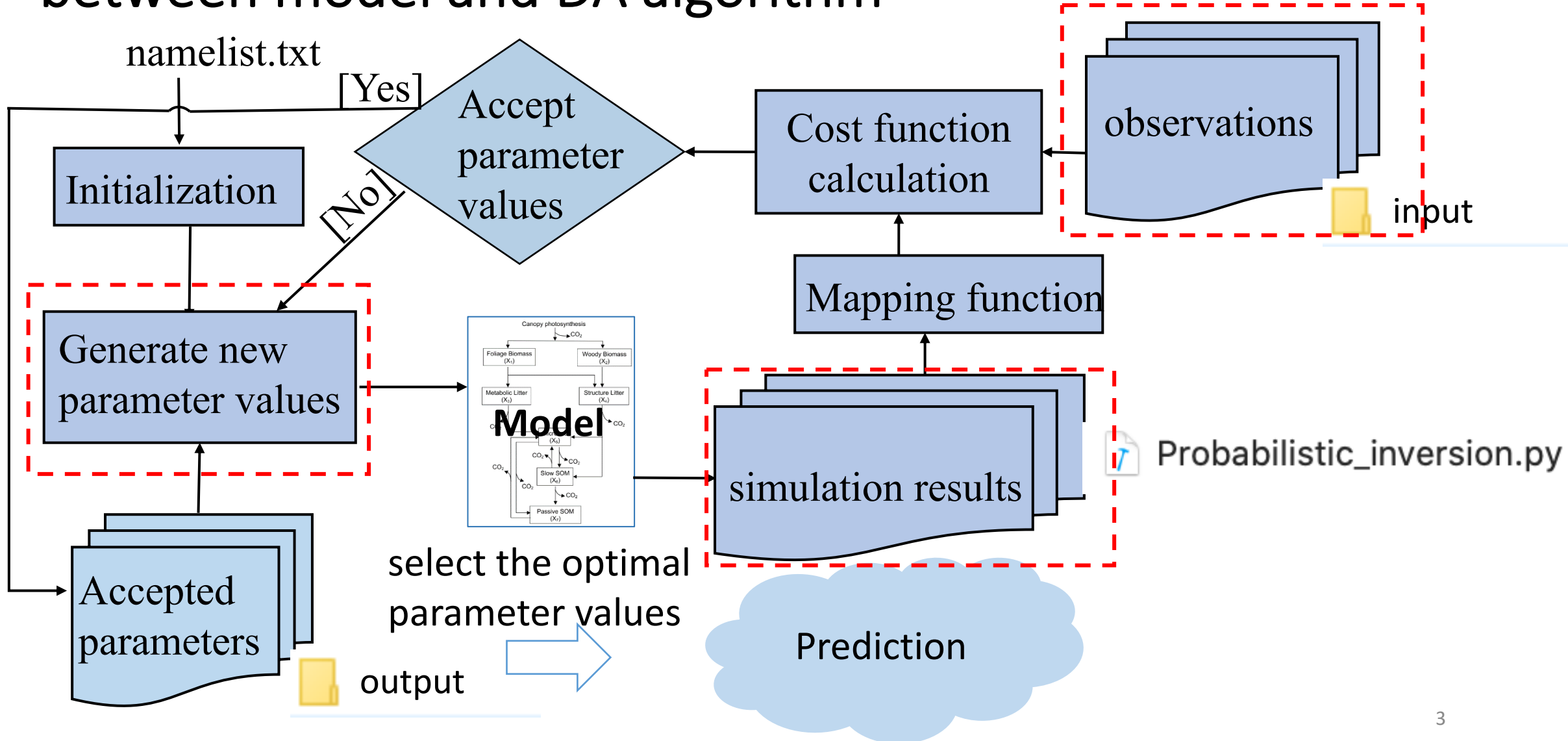
Xin HUANG

11/12/2020

Workflow of data assimilation



Standardizing the model-specific data exchanges between model and DA algorithm



Users only need to prepare a namelist.txt file

namelist.txt - Notepad

File Edit Format View Help

```
workPath='F:/Lab/Work/MIDA/Code/testGUI'
nsimu=20 ← The number of simulations in DA
J_default=1000000 ← The default mismatch in the first comparison in DA
ProposingStepSize=5 ← The jump size in proposing a new parameter value
paramFile='F:/Lab/Work/MIDA/Code/testGUI/param.csv'
paramCovFile=''
obsList='F:\Lab\Work\MIDA\Code\test\obsNEE.txt'
obsVarList=''
simuList='F:\Lab\Work\MIDA\Code\testGUI\simuNEE.txt,F:\Lab\Work\MIDA\Code\testGUI\simuNEE.txt'
paramValueFile='F:/Lab/Work/MIDA/Code/testGUI/paramValue.txt'
model='F:/Lab/Work/MIDA/Code/testGUI/testdalec.exe'
do_ConvergeTest=0 ← Whether do conduct GR convergence test or not
convergeTest_startsFile='F:/Lab/Work/MIDA/Code/testGUI/startsParam.csv'
outputConfigureFile='F:/Lab/Work/MIDA/Code/testGUI/config.txt'
DAresultsPath='F:/Lab/Work/MIDA/Code/testGUI/DAresults/'
outJ='mismatch_accepted.csv'
outC='parameter_accepted.csv'
outRecordNum='acceptedNum.csv'
outBestSimu='BestSimu/'
outBestC='bestParameterValues.csv'
outConvergenceTest='convergence.txt'
```

For Windows user, no need to install python or any library !

Users only need to prepare a namelist.txt file

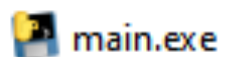
namelist.txt - Notepad

File Edit Format View Help

```
workPath='F:/Lab/Work/MIDA/Code/testGUI' ← Which directory to save DAresults
nsimu=20
J_default=1000000
ProposingStepSize=5
paramFile='F:/Lab/Work/MIDA/Code/testGUI/param.csv' ← Parameter range file
paramCovFile='' ← Parameter covariance file
obsList='F:\Lab\Work\MIDA\Code\test\obsNEE.txt' ← The list of observation files
obsVarList='' ← The list of observation variance files
simuList='F:\Lab\Work\MIDA\Code\testGUI\simuNEE.txt,F:\Lab\Work\MIDA\Code\testGUI\simuNEE.txt' ← Simulation output files
paramValueFile='F:/Lab/Work/MIDA/Code/testGUI/paramValue.txt' ← File to save parameter values for one simulation
model='F:/Lab/Work/MIDA/Code/testGUI/testdalec.exe' ← Model executable file (.exe)
do_ConvergeTest=0
convergeTest_startsFile='F:/Lab/Work/MIDA/Code/testGUI/startsParam.csv' ← File to save different default parameter values
outputConfigureFile='F:/Lab/Work/MIDA/Code/testGUI/config.txt' ← Output configure file
DAresultsPath='F:/Lab/Work/MIDA/Code/testGUI/DAresults/' ← Directory to save DA results
outJ='mismatch_accepted.csv'
outC='parameter_accepted.csv'
outRecordNum='acceptedNum.csv'
outBestSimu='BestSimu/'
outBestC='bestParameterValues.csv'
outConvergenceTest='convergence.txt'
```

} Files to save DA results

Double click this file



Generate a namelist.txt file

Execute DA as a black box

DAmodule - A Generic Module for Data Assimilation

Help

Preparation of Data Assimilation

The number of simulations Select Work Path

	min	max	default
1			
2			
3			
4			
5			
6			

Load Files:

Observation File List

	file name
1	
2	
3	
4	
5	
6	

Observation Variance File List

	file name
1	
2	
3	
4	
5	
6	

Simulation Output File List

	file name
1	
2	
3	
4	
5	
6	

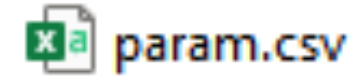
(Optional) Gelman-Rubin convergence test

Execution of Data Assimilation

Load Namelist File:

Choose variables to be print in DA: ☒ total mismatch ☒ acceptance rate ☐ delta_mismatch ☐ mismatch for each obs ☐ obs var

Parameter range file



Columns with * are required

	A	B	C	D	E	F	G	H	I
1	No.	*Name	*DA or no	*Default	*Min	*Max	Full Name	Unit	Reference
2	1	c1	0	1.00E+02	1.00E+01	2.50E+02	Growing degree day threshold for leaf out	$^{\circ}C\ d$	
3	2	c2	1	2.00E+02	5.00E+01	5.00E+02	Growing degree day threshold for maximum LAI	$^{\circ}C\ d$	
4	3	c3	1	4.00E+00	2.00E+00	7.00E+00	Seasonal maximum leaf area index	-	
5	4	c4	1	5.00E+00	0.00E+00	1.00E+01	Temperature for leaf fall	$^{\circ}C$	
6	5	c5	1	1.00E-01	3.00E-02	9.50E-01	Rate of leaf fall	d^{-1}	
7	6	c6	1	7.00E+00	1.00E+00	2.00E+01	N use efficiency	-	
8	7	c7	1	2.00E-01	5.00E-02	5.00E-01	Growth respiration fraction	-	
9	8	c8	1	1.00E-04	5.00E-05	1.00E-02	Base rate for maintenance respiration	$\times 10^{-4}\ \mu mol\ m^{-2}\ d^{-1}$	
10	9	c9	1	2.00E+00	1.00E+00	4.00E+00	Maintenance respiration T-sensitivity	-	
11	10	c10	1	7.00E-01	1.00E-01	9.50E-01	Allocation to plant stem pool	-	
12	11	c11	1	5.48E-04	1.10E-04	2.74E-03	Root turnover time	$\times 10^{-4}\ d^{-1}$	
13	12	c12	1	5.48E-05	1.10E-05	2.74E-04	Stem turnover time	$\times 10^{-5}\ d^{-1}$	
14	13	c13	1	2.00E+00	1.00E+00	4.00E+00	Heterotrophic respiration T-sensitivity	-	
15	14	c14	1	1.37E-03	5.48E-04	5.48E-03	Base turnover for litter	$\times 10^{-3}\ \mu mol\ m^{-2}\ d^{-1}$	
16	15	c15	1	9.13E-05	2.74E-05	2.74E-04	Base turnover for soil organic matter	$\times 10^{-4}\ \mu mol\ m^{-2}\ d^{-1}$	
17	16	c16	1	1.00E-03	1.00E-04	1.00E-02	Decomposition rate	$\times 10^{-3}\ d^{-1}$	
18	17	c17	1	8.00E+01	2.00E+01	1.50E+02	Leaf mass per area	$gC\ m^{-2}$	
19	18	c18	1	5.00E+03	1.00E+03	1.50E+04	Initial value for stem C pool	$\times 10^3\ gC$	
20	19	c19	1	5.00E+02	1.00E+02	3.00E+03	Initial value for root C pool	gC	
21	20	c20	1	6.00E+02	5.00E+01	1.00E+03	Initial value for litter C pool	gC	
22	21	c21	1	7.00E+03	1.00E+03	2.50E+04	Initial value for soil organic C pool	$\times 10^3\ gC$	

Output configure file: design mapping function

Observation file, observation variance file, and simulation outputs are separated by hashtag #

```
config - Copy.txt - Notepad
File Edit Format View Help
#F:\Lab\Work\MIDA\Code\test\obsNEE.txt##F:\Lab\Work\MIDA\Code\testGUI\simuNEE.txt,F:\Lab\Work\MIDA\Code\testGUI\simuNEE.txt
simu_map[0:5844]=(simuList[0][0:5844]+simuList[1][0:5844])/2
```

Simulation output before mapping

Simulation output after mapping

It also supports other numerical calculations, such as mean, sum, subtraction, multiplication, division, etc.

simuList[0]: The first output file

simuList[1]: The second output file

simuList[0][0][0]

The first row

The first element in the first row

If the first output file has only 1 column, then simuList[0][0:500] indicates the first 1~500 elements

```
#obs/obsANPP_yr.txt##output/simu/simuANPP_yr.txt
```

```
simu_map[0:7]=simuList[0][[0,1,2,3,4,6,7]]
```

Leave an empty line between different configurations

```
#obs/obsNEE_d.txt##output/simu/simuNEE_d.txt
```

```
simu_map[0:250]=simuList[0][[5,7,11,12,13,14,16,23,28,29,38,45,46,75,86,87,88,90,93,94,96,98,100,109,110,112,116,117,118,120,126,127,128,133,135,137,140,144,151,158,162,190,196,2666,2668,2669,2670,2682,2683,2688,2689,2691,2693,2715,2717,2719,2725,2744,2753,2776,2777,2785,2787,2803,2805,2806,2830,2831,2837,2849,2863,2865,2879]]
```

```
#obs/obs_sw2p5_d.txt##output/simu/simu_sw2p5_d.txt
```

```
simu_map[0:2201]=simuList[0][[132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,167,168,169,19,410,411,412,413,414,415,416,417,418,419,420,421,422,423,424,425,426,427,428,429,430,431,432,433,434,435,436,437,438,439,440,441,442,443,444,445,446,447,448,449,450,451,452,46,723,724,725,726,727,728,729,730,731,732,733,734,735,736,737,738,739,740,742,743,744,745,746,747,748,749,750,751,752,753,755,756,757,758,759,760,762,763,764,765,766,767,768,7161,1162,1163,1164,1165,1166,1167,1168,1169,1170,1171,1172,1173,1174,1175,1176,1177,1178,1179,1180,1181,1182,1183,1184,1185,1186,1187,1188,1189,1190,1191,1192,1193,1194,1195,11367,1368,1369,1370,1371,1372,1373,1374,1375,1376,1377,1378,1379,1380,1381,1382,1383,1384,1385,1386,1387,1388,1389,1390,1391,1392,1393,1394,1395,1396,1397,1398,1399,1400,1401,1609,1610,1611,1612,1613,1614,1615,1616,1617,1618,1619,1620,1621,1622,1623,1625,1626,1627,1628,1629,1630,1631,1632,1633,1634,1635,1637,1638,1639,1640,1641,1642,1643,1644,16459,1861,1862,1863,1864,1865,1866,1867,1868,1869,1870,1871,1872,1873,1874,1875,1876,1877,1878,1879,1880,1881,1882,1883,1884,1885,1886,1888,1889,1890,1891,1892,1893,1895,1896,18982,2083,2084,2085,2086,2087,2088,2089,2090,2091,2092,2093,2094,2095,2096,2098,2100,2101,2102,2103,2104,2105,2106,2107,2109,2110,2111,2112,2113,2114,2115,2116,2117,2118,2122,21340,2341,2342,2343,2344,2345,2346,2347,2348,2349,2350,2351,2352,2353,2354,2355,2356,2357,2358,2360,2361,2362,2363,2364,2365,2366,2367,2368,2369,2370,2371,2373,2374,2375,2376,22593,2595,2596,2597,2598,2599,2600,2601,2603,2604,2605,2606,2607,2608,2610,2611,2612,2613,2614,2615,2616,2617,2618,2619,2620,2621,2623,2627,2628,2630,2632,2633,2635,2672,2673,2858,2859,2860,2861,2863,2864,2865,2866,2867,2868,2869,2870,2871,2872,2873,2874,2875,2877,2878,2879,2880,2881,2882,2883,2884,2885,2886,2887,2888,2889,2890,2891,2892,2893,2894
```


```
#obs/obs_sw12p5_d.txt##output/simu/simu_sw12p5_d.txt
```

```
simu_map[0:2913]=simuList[0][[132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,167,168,169,14,415,416,417,418,419,420,421,422,423,424,425,426,427,428,429,430,431,432,434,435,436,437,438,439,440,441,442,443,444,445,447,448,449,450,451,452,453,454,455,456,457,458,459,40,731,732,733,734,735,736,737,738,739,740,742,743,744,745,746,747,748,749,750,751,752,753,755,756,757,758,759,760,762,763,764,765,766,767,768,769,770,771,772,774,776,777,779,77,1168,1169,1170,1171,1172,1173,1174,1175,1176,1177,1178,1179,1180,1181,1182,1183,1184,1185,1186,1187,1188,1189,1190,1191,1192,1193,1194,1195,1196,1197,1198,1199,1200,1201,12073,1374,1375,1376,1377,1378,1379,1380,1381,1382,1383,1384,1385,1386,1387,1388,1389,1390,1391,1392,1393,1394,1395,1396,1397,1398,1399,1400,1401,1402,1403,1404,1405,1406,1407,14615,1616,1617,1618,1619,1620,1621,1622,1623,1625,1626,1627,1628,1629,1630,1631,1632,1633,1634,1635,1637,1638,1639,1640,1641,1642,1643,1644,1645,1646,1647,1648,1649,1650,1651,11867,1868,1869,1870,1871,1872,1873,1874,1875,1876,1877,1878,1879,1880,1881,1882,1883,1884,1885,1886,1888,1889,1890,1891,1892,1893,1895,1896,1897,1898,1899,1900,1901,1902,1903,2089,2090,2091,2092,2093,2094,2095,2096,2098,2100,2101,2102,2103,2104,2105,2106,2107,2109,2110,2111,2112,2113,2114,2115,2116,2117,2118,2122,2123,2124,2125,2126,2127,2130,21316,2347,2348,2349,2350,2351,2352,2353,2354,2355,2356,2357,2358,2360,2361,2362,2363,2364,2365,2366,2367,2368,2369,2370,2371,2373,2374,2375,2376,2377,2378,2379,2380,2381,2382,23800,2601,2603,2604,2605,2606,2607,2608,2610,2611,2612,2613,2614,2615,2616,2617,2618,2619,2620,2621,2623,2627,2628,2630,2632,2633,2635,2672,2673,2674,2675,2676,2677,2678,2679,26865,2866,2867,2868,2869,2870,2871,2872,2873,2874,2875,2877,2878,2879,2880,2881,2882,2883,2884,2885,2886,2887,2888,2889,2890,2891,2892,2893,2894,2895,2897,2898,2899]]
```

```
#obs/obs_sw22p5_d.txt##output/simu/simu_sw22p5_d.txt
```

```
simu_map[0:2188]=simuList[0][[132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,167,168,169,15,416,417,419,420,421,422,423,424,425,426,427,428,429,430,431,432,434,435,436,437,438,439,440,441,442,443,444,445,447,448,449,450,451,452,453,454,455,456,457,458,459,460,461,45736,737,738,739,740,742,743,744,745,746,747,748,749,750,751,752,753,755,756,757,758,759,760,762,763,764,765,766,767,768,769,770,771,772,774,776,777,779,780,781,782,783,784,7
```

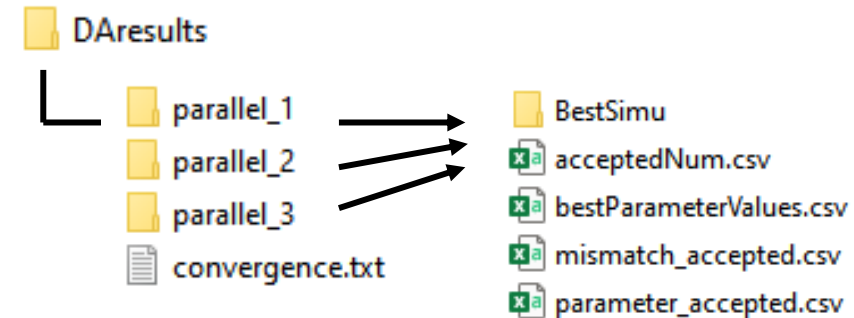
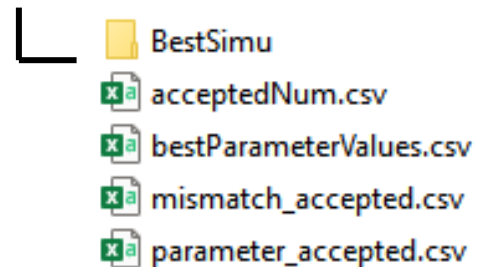
Other files and directories

 startsParam.csv

Startpoints for G-R convergence test

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	No.	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	c13	c14	c15	c16	c17	c18	c19	c20	c21
2	1	105.1309	2.839987	0.193418	0.158113	11.66496	0.105493	0.009615	3.954602	0.146143	0.000553	0.000202	3.960053	0.002837	0.000263	0.006813	63.5075	3879.09	2605.999	155.344	16378.58
3	2	218.3501	2.6955	5.985055	0.383145	16.8642	0.351139	0.001436	2.031584	0.6097	0.000797	0.000209	3.795885	0.002548	0.000143	0.001411	53.23819	3128.142	465.9033	204.6317	8713.531
4	3	387.8899	3.282272	5.537324	0.828357	13.00717	0.390381	0.006971	3.170149	0.576586	0.002693	0.000189	2.453999	0.004744	7.66E-05	0.001885	52.07577	8019.628	792.7809	570.9104	1687.686
5																					

 DResults in the working path indicated in namelist.txt



Please refer to video tutorials in the
Video/ folder

Thank you