

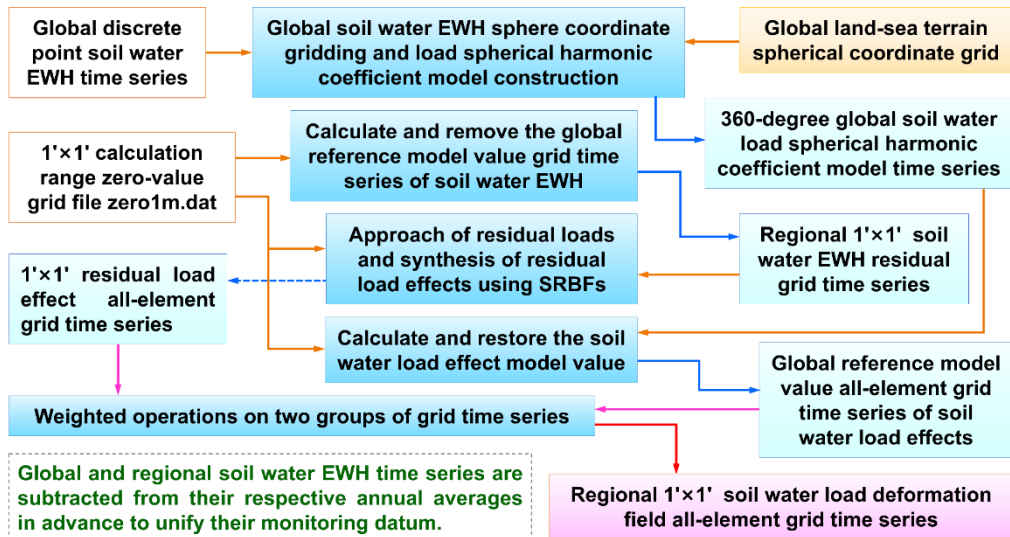
Complete computation processes of high-resolution regional load deformation field time series

Taking the regional soil water variations as the example, the remove-restore scheme combined the global load spherical harmonic coefficient synthesis and regional residual load SRBF (spherical radial basis function) approach is employed to compute the high-precision and high-resolution regional load deformation field all-element grid time series in the near-Earth space in the four steps.

The soil water here consists of soil water in 4 m shallow, wetland water, vegetation water, glaciers and snow mountain water, but does not include lakes, rivers and groundwater.

The global soil water equivalent water height (EWH) time series and the regional high-resolution soil water EWH time series are subtracted from their respective annual averages in advance to unify the global and regional soil water variation monitoring datum.

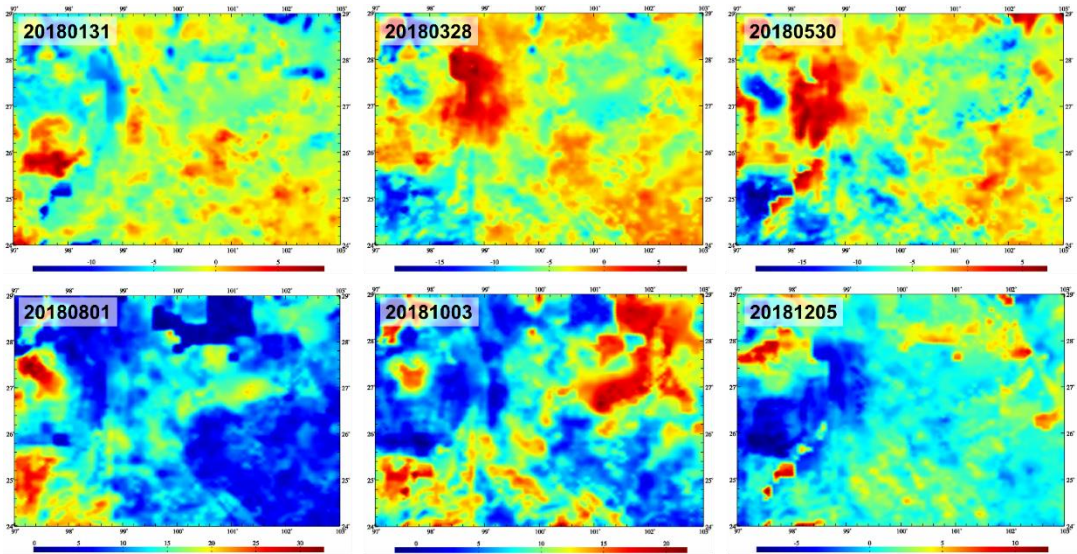
The complete computation process of high-resolution load deformation field all-element grid time series consists of four steps usually, namely global surface load spherical harmonic analysis, spherical harmonic synthesis for load deformation field, regional residual load SRBF approach and SRBF synthesis for residual load deformation field.



Complete computation processes of regional load deformation field all-element grid time series

Step 1: Construct the global soil water EWH spherical coordinate grid time series, and then establish the global soil water load spherical harmonic coefficient model time series.

Call the function [Construction of global surface data grid in spherical coordinates], construct the global soil water EWH spherical coordinate grid time series `glsollewh*.dat` from global soil water observations, where * is the sample epoch time and * = 20180131 represents January 31, 2018. The process is omitted in this example.



Regional 1°×1° soil water equivalent water height (EWH, cm) grid time series

Call the function [Spherical harmonic analysis on global land water variations], input global land-sea terrain spherical coordinate grid sphETOPOn30m.dat (EWH automatically zero in sea area), whose resolution is not less than that of the soil water EWH grid, and establish the global soil water load spherical harmonic coefficient model time series Indwater*cs.dat form the global soil water EWH spherical coordinate grid time series glsolilewh*.dat.

Spherical harmonic analysis on global surface load time series

Step 1: Construct the global soil water EWH spherical coordinate grid time series, and then establish the global soil water load spherical harmonic coefficient model time series.

Construction of global surface data grid in spherical coordinates | Spherical harmonic analysis on global surface atmosphere variations | **Spherical harmonic analysis on global land water variations** | Spherical harmonic analysis on global land water variations

Open any land water spherical coordinate grid file | Save program process as | Surface load spherical harmonic analysis and

Set the wildcards of the file names

Ordinal number of first wildcard in the file name: 10
 Number of consecutive wildcards in file name: 8

Set termination condition of the iteration

Residual standard deviation threshold (a): 1.0‰
 Termination condition of residual decrease (b): 1.0‰

Open the land-sea terrain spherical coordinate grid file

The surface harmonic functions in the spherical harmonic coefficient model are defined on the spherical surface whose radius is equal to the equatorial radius a of the Earth.

Complete the spherical harmonic analysis for 6 land water variation grids!
 ** The program outputs the land water load spherical harmonic coefficient model files Indwater***.dat (iteration process statistics files pro***.ini) and residual land water variation grid files rmt***.dat. *** is the instance of the given wildcards.
 ** The file header of the Indwater***.dat: the geocentric gravitational constant GM ($\times 10^{14} \text{m}^3/\text{s}^2$), equatorial radius a (m) of the Earth, zero-degree term a_2C_{20} (cm) and relative error Θ (%). Where Θ is the residual standard deviation of the last step iteration as a percentage of the standard deviation of the original grid values, and GM are also known as the scale parameter of the spherical harmonic coefficient model in which the surface harmonic functions are defined on the spherical surface whose radius is equal to the equatorial radius of the Earth.
 >> Computation end time: 2024-10-23 09:54:12

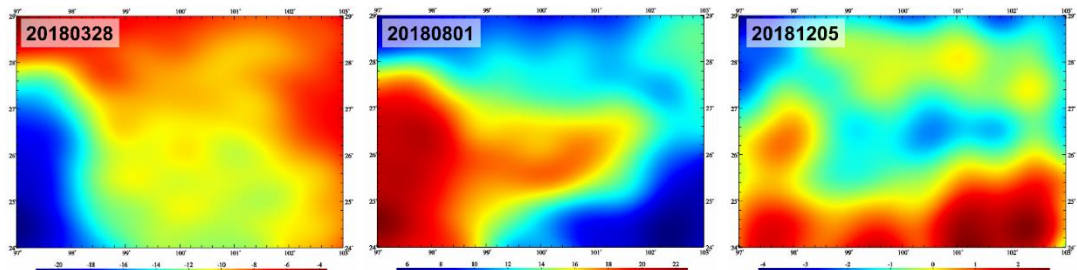
Set the results folder | Setting parameters | Start computation

0.0	360.0	-90.0	90.0	0.50000000	0.50000000	2734.91	2735.40	2735.93	2736.53	2737.08	2737.61	2738.27	2740.01	2740.73	2741.32	2741.91	2742.40	2743		
1	3.986004418	6378137.00	0.5573	15.084	89.14	2758.	1	0	0.6721	3.2792	-46.8962	101.1671	19.39	2758.	1	0	0.0000	0.9831	-36.4558	78.2553
2	$GM(\times 10^{14} \text{m}^3/\text{s}^2)$	$a(\text{m})$	zero-degree term (cm)	relative error (%)	59.53	2770.	2	1	0.0000	0.6284	-29.5272	71.0895	28.24	2783.	3	2	0.0000	0.5630	-29.4347	68.2698
3	1.0268254779166223E-10	9.2457930065939986E-10	0.0000000000000000E+00	0.0000000000000000E+00	35.93E-10	2806.	4	3	0.0000	0.5300	-30.4293	67.2374	35.05	2796.	5	4	0.0000	0.5247	-30.8438	66.8759
4	1.1913358E-11	-4.7574877498471504E-11	0.0000000000000000E+00	0.0000000000000000E+00	2914.	2819.	6	5	0.0000	0.5165	-31.0211	66.7593	14.55	2814.	7	6	0.0000	0.5109	-31.0974	66.7274
5	3.721202E-09	-9.9000830184071023E-11	0.0000000000000000E+00	0.0000000000000000E+00	2819.	2819.	8	7	0.0000	0.5070	-31.1297	66.7210	18.62	2819.	9	8	0.0000	0.5016	-31.1962	66.7244
6	3.5655990273019996E-10	5.4106078115310523E-10	0.0000000000000000E+00	0.0000000000000000E+00	2819.	2819.	10	9	0.0000	0.5016	-31.1962	66.7244	19.70	2819.	10	9	0.0000	0.5016	-31.1962	66.7244
7	1.2302251091472584E-10	4.4584757452995267E-10	0.0000000000000000E+00	0.0000000000000000E+00	2819.	2819.	11	10	0.0000	0.5016	-31.1962	66.7244	18.97	2819.	11	10	0.0000	0.5016	-31.1962	66.7244
8	3.1	3.6363130771720734E-10	3.5655990273019996E-10	5.4106078115310523E-10	18.97	2819.	12	11	0.0000	0.5016	-31.1962	66.7244	18.97	2819.	12	11	0.0000	0.5016	-31.1962	66.7244
9	2	1.2302251091472584E-10	4.4584757452995267E-10	5.4106078115310523E-10	18.97	2819.	13	12	0.0000	0.5016	-31.1962	66.7244	18.97	2819.	13	12	0.0000	0.5016	-31.1962	66.7244
10	3	-1.2507023908057166E-10	4.4584757452995267E-10	5.4106078115310523E-10	18.97	2819.	14	13	0.0000	0.5016	-31.1962	66.7244	18.97	2819.	14	13	0.0000	0.5016	-31.1962	66.7244

The degree number n of spherical harmonic coefficient model is equal to the number of global surface load cell-grids in the latitude direction. For example, the $0.25^\circ \times 0.25^\circ$ global surface load grid corresponds to $n=720$.

Step 2: Calculate and remove the global reference model value grid time series of soil water EWH and construct the regional high-resolution soil water EWH residual grid time series.

Call the function [Computation of model value time series of load equivalent water height], input the 1'x1' zero-value grid file zero1m.dat, which is employed to give the calculation range and the zero-value represents the calculation surface as the ground, let 'land water EWH (cm)' as the surface load type and the maximum calculation degree 360, calculate the global reference model value grid time series ldewh*.dat of soil water EWH from the global soil water load spherical harmonic coefficient model time series lndwater*.cs.dat.



Regional 1'x1' soil water EWH model reference value (cm) grid time series

Computation of the load model value using spherical harmonic synthesis

Step 2: Calculate and remove the global reference model value grid time series of soil water EWH and construct the regional high-resolution soil water EWH residual grid time series.

Computation of model value of surface load equivalent water height

Select the calculation point file format

The calculation surface height grid file

Open the calculation surface height grid file

Open any load harmonic coefficient model file

Set the wildcard of the file names

Ordinal number of the first wildcard in the file name: 9

Number of consecutive wildcards in file name: 8

Type of surface load: Land water EWH (cm)

Maximum truncated degree of the coefficients model: 360

The surface harmonic functions in the spherical harmonic coefficient model are defined on the spherical surface whose radius is equal to the equatorial radius a of the Earth.

Computation of model values of tidal constituent harmonic constants

Program Process ** Operation Prompts

Indwater20180131cs.dat.

** The window below only shows no more than 3000 rows of data in the file!

>> Select or create the result folder C:/E TideLoad4.5_win64en/examples/Loadmfedcalcdemo/ewhmdl.

** The load harmonic coefficient model files searched by wildcard instantiation:

C:/E TideLoad4.5_win64en/examples/Loadmfedcalcdemo/sphcsmodel/indwater20180131cs.dat

C:/E TideLoad4.5_win64en/examples/Loadmfedcalcdemo/sphcsmodel/indwater20180328cs.dat

C:/E TideLoad4.5_win64en/examples/Loadmfedcalcdemo/sphcsmodel/indwater20180503cs.dat

C:/E TideLoad4.5_win64en/examples/Loadmfedcalcdemo/sphcsmodel/indwater20180801cs.dat

C:/E TideLoad4.5_win64en/examples/Loadmfedcalcdemo/sphcsmodel/indwater20181003cs.dat

C:/E TideLoad4.5_win64en/examples/Loadmfedcalcdemo/sphcsmodel/indwater20181205cs.dat

>> Setting parameters have been imported into the program!

** Click the control button [Start computation], or the tool button [Start computation]...

** The computation process needs to wait... During the computation period, you can open the output file C:/E TideLoad4.5_win64en/examples/Loadmfedcalcdemo/ewhmdl, to look at the computation progress!

** The last column attribute of each output file header is the instance of the wildcards of the file name of surface load harmonic coefficient model file, which represents the sampling epoch time of the output file.

>> Computation start time: 2024-10-22 22:25:02

>> Complete the computation of the load EWH model values of 6 sampling epoch time!

Computation end time: 2024-10-22 22:43:12

Set the result folder Import setting parameters Start computation

3.966004418 6.378137.00 0.5573 13.582

$GM(\times 10^{14} m^3/s^2)$, $a(m)$, zero-degree term (cm), relative error(%)

0 9.2467930069939531E-10 0.0000000000000000E+00

1 -1.0268254787536779E-11 -4.7574977466555503E-11

2 1.10268254787536779E-11 -9.9000830184069783E-11

3 1 3.6363133000073107E-10 3.5655990313504066E-10

2 1.2302251091472584E-10 5.4106078115310529E-10

3 3 -1.250702390858689E-10 4.4584754752989425E-10

4 0 -8.9924013483499923E-11 0.0000000000000000E+00

4 1 4.5991133897053500E-10 5.501975498523628E-10

4 2 7.6291176220002367E-11 6.8922364997197517E-11

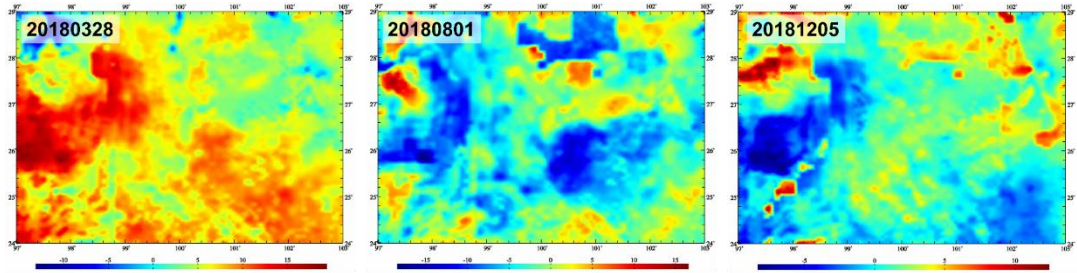
4 3 7.788587494120061E-11 2.8188206515737334E-10

Year	20180131	20180328	20180503	20180801	20181003	20181205
0	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
1	-7.2407	-7.2041	-7.1869	-7.1279	-7.1022	-7.0064
2	6.6276	6.5616	6.5156	6.4696	6.4238	6.3321
3	-8.9848	-8.9173	-8.8810	-8.8458	-8.8111	-8.7395
4	-9.3231	-9.3148	-9.3094	-9.3103	-9.3128	-9.3410
5	6.4047	6.4035	6.4029	6.4026	6.4027	6.4031
6	45.4254	45.4036	45.4019	45.3989	45.3960	45.3907
7	-5.3079	-5.2944	-5.2898	-5.2897	-5.2920	-5.3102
8	6.0312	6.0362	6.0448	6.0612	6.1032	6.1891
9	-4.6741	-4.6513	-4.6298	-4.6269	-4.6268	-4.6463
10	-4.3923	-4.3854	-4.3921	-4.3992	-4.4221	-4.4922
11	-4.2107	-4.2020	-4.1994	-4.1948	-4.1963	-4.1976
12	-3.9774	-3.9800	-3.9857	-3.9943	-4.0239	-4.0991
13	-3.7027	-3.7111	-3.7189	-3.7269	-3.7424	-3.7782
14	-3.4821	-3.4842	-3.4865	-3.4888	-3.5141	-3.5872
15	-3.2046	-3.2054	-3.2079	-3.2125	-3.2462	-3.3003
16	-2.8946	-2.8957	-2.8946	-2.8939	-2.9179	-3.0000
17	-2.5433	-2.5443	-2.5434	-2.5463	-2.5914	-2.6907
18	-2.1633	-2.1680	-2.1714	-2.1746	-2.2434	-2.3487
19	-1.7667	-1.7704	-1.7724	-1.7732	-1.8399	-2.0274
20	-1.3563	-1.3588	-1.3615	-1.3633	-1.4187	-1.5929

- In the remove-restore process, the program can be employed for regional tidal load effect refinement based on the tidal load spherical harmonic coefficient model, and for regional load deformation field refinement based on surface load spherical harmonic model.
- Due to the mixing effects between the high-degree spherical harmonic coefficients, the model values of the sea level variation and ocean tidal harmonic constants are not zero in the coastal land area, and the model values of the land equivalent water height are not also zero in the coastal sea area.

Call the function [Weighted operations on two groups of grid time series], subtract the soil water EWH model value grid time series ldewh***.dat from the 1'x1' soil water EWH grid

time series soilwh***.dat to generate the regional 1'x1' soil water EWH residual grid time series rntewh***.dat.



Regional 1'x1' soil water EWH residual (cm) grid time series

Step 3: Determine the residual all-element grid time series of regional soil water load deformation field by the load SRBF approach and load effect SRBF synthesis.

Call the function [Approach of residual load and synthesis of residual load effects using SRBFs], input the calculation result area 1'x1' zero-value grid file zero1mrst.dat removed the 1° edge area around the grid zero1m.dat, and generate the residual load effect all-element grid ttt.??? from regional 1'x1' soil water EWH residual grid rntewh***.dat at any epoch time to design the reasonable setting parameters according to the principle of parameter setting optimization and cumulative approach effectiveness given below the program interface.

Step 3: Using the load SRBF approach and load effect synthesis method, calculate the residual all-element grid time series of regional soil water load deformation field.

Approach of residual load and synthesis of residual load effects using SRBFs

Select the calculation point file format: The calculation surface grid file

Open the calculation surface height grid file

Open the residual equivalent water height variation grid file

Parameters of the first SRBF approach

- Select SRBF: radial multipole kernel
- order m: 0
- minimum degree: 180
- maximum degree: 720
- burial depth of Bjerhammar sphere: 20.0km
- action distance of SBRF center: 150km
- Reuter network level K: 1800

Parameters of cumulative SRBF approach

- Select SRBF: Poisson wavelet kernel
- order m: 0
- minimum degree: 360
- maximum degree: 1800
- burial depth of Bjerhammar sphere: 10.0km
- action distance of SBRF center: 60km
- Reuter network level K: 1800

Computation of residual surface load and load effect time series using SRBFs

Solution of normal equation LU triangular decor Cumulative SRBF approach

>> [Function] From the regional residual equivalent water height (EWH) variation spherical radial basis functions (SRBFs) and then calculate the residual EWH est gravity (μGal), gravity disturbance (μGal), ground tilt (SW, to the south and to the displacement (EN, to the east and to the north, mm), ground radial displacement (mE) or horizontal gravity gradient (NW, to the north and to the west, mE)

>> Open the calculation surface height grid file C:/ETideLoad4_5_win64en/examp

>> Open the residual equivalent water height variation grid file C:/ETideLoad4_5

>> Save the results as C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/Loadmfldcaldemo.para.dat

>> Setting parameters have been imported in the program!

* Click the control button [Start computation], or the tool button [Start computation]

>> Computation start time: 2023-05-17 15:46:11

>> Complete the computation for approach of residual load and synthesis of residual load effects!

The source EWH observations (cm): Mean 3.3563 standard deviation 2.4427 minimum -8.4348 maximum 15.7512

The 0th iterated residual EWH (cm): Mean -0.0075 standard deviation 0.6837 minimum -5.1512 maximum 3.5556

The 1th iterated residual EWH (cm): Mean 0.00113 standard deviation 0.2514 minimum -2.8204 maximum 2.1488

>> The program also outputs the SRBF spatial curve file "srbf.rf" and spectral curve files "dgr.rf" of 41 kinds of geodesic variations into the current directory.

Save the results as

Import setting parameters Start Computation

C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.evh
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.rst
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.pra
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.rga
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.dit
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.vdf
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.dph
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.dpr
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.nmh
C:/ETideLoad4_5_win64en/examples/Loadmfldcaldemo/designpara.gpr

Extract the effects to be plot Plot

Design the reasonable setting parameters in advance according to the principle below.

The effectiveness principle of the parameter optimization and cumulative approach: (1) The estimated load EWH and load effects in space is continuous and differentiable, and (2) the residual standard deviation of the estimated load EWHs is obviously reduced, and the residual statistical mean tends to zero.

Step 3: Determine the residual all-element grid time series of regional soil water load deformation field by the load SRBF approach and load effect SRBF synthesis.

Approach of residual load effects using SRBFs

Computation of residual surface load and load effect time series using SRBFs

Load approach and load effect synthesis algorithms using SRBFs

Select the calculation point file format

The calculation surface grid file

Open calculation surface zero value grid file

Open any residual equivalent water height variation grid file

Ordinal number of first wildcard in file name: 8

Number of consecutive wildcards in file name: 8

Parameters of the first SRBF approach

- Select SRBF: radial multipole kernel
- order m: 0
- minimum degree: 180
- maximum degree: 720
- burial depth of Bjerhammar sphere: 20.0km
- action distance of SRBF center: 150km
- Reuter network level K: 1800

Parameters of cumulative SRBF approach

- Select SRBF: Poisson wavelet kernel
- order m: 0
- minimum degree: 360
- maximum degree: 1800
- burial depth of Bjerhammar sphere: 10.0km
- action distance of SRBF center: 60km
- Reuter network level K: 1800

Solution of normal equation: LU triangular decoupling

Cumulative SRBF approach times: 1

Save program process as

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/mtehw/wghcalc/201810030.dat

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/mtehw/wghcalc/201812050.dat

>> 6 equivalent water height variation grid time series files are found by wildcard instantiation.

>> Setting parameters have been imported in the program!

>> Click the **compute** button [Start computation], or the tool button [Start computation]...

>> The computation process needs to wait. During the computation period, you can open the output files folder C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/ to look at the computation progress!

>> The last column attribute of each output file header is the instance of the wildcards of the file name of the EWH time series, which represents the sampling epoch time of the output file.

>> Computation start time: 2023-05-17 16:01:25

>> SRBF approach statistics of 20180131 load EWHs:

The source EWH observations (cm):	Mean	3.3563	standard deviation	2.4427	minimum	-8.4348	maximum	15.7512
The 0th iterated residual EWH (cm):	Mean	-0.0075	standard deviation	0.6837	minimum	-5.1512	maximum	3.5556
The 1th iterated residual EWH (cm):	Mean	0.0013	standard deviation	0.2514	minimum	-2.8204	maximum	2.1496

>> SRBF approach statistics of 20180328 load EWHs:

The source EWH observations (cm):	Mean	6.8236	standard deviation	3.6424	minimum	-13.1111	maximum	19.4132
The 0th iterated residual EWH (cm):	Mean	-0.0291	standard deviation	0.8465	minimum	-7.3127	maximum	5.1767

Get the results folder

Import setting parameters

Start Computation

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_ewh

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_ksi1

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_gra

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_rga

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_dft

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_vdf

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_dph

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_dpr

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_nmh

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_grr

C:/ET/IdLoad4_5_win64en/examples/Loadfmdcalcdemo/rstnrdm/rntSRBF20181205_hgd

Using the setting parameters just designed.

Extract the effects to be plot

Plot

geoid / height anomaly (mm)

Ground gravity (µGal)

radial displacement (mm)

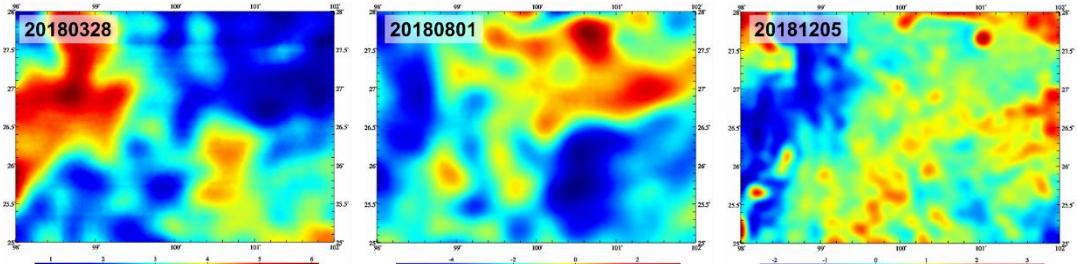
gravity gradient (mE)

The effectiveness principle of the parameter optimization and cumulative approach: (1) The estimated load EWH and load effects in space is continuous and differentiable, and (2) the residual standard deviation of the estimated load EWHs is obviously reduced, and the residual statistical mean tends to zero.

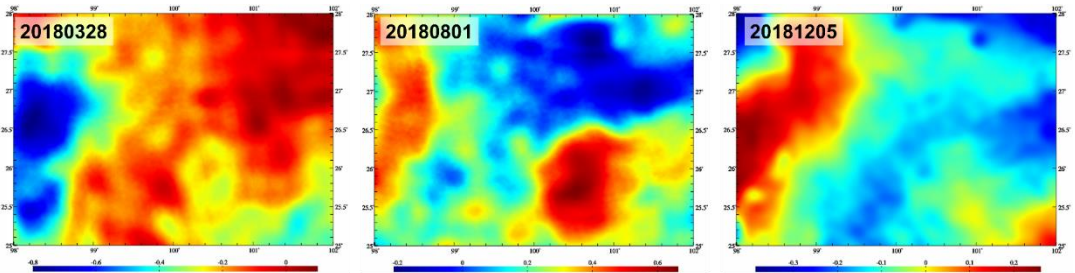
Call the function [Computation of residual surface load and load effect time series using SRBFs], input the 1'x1' zero-value grid file zero1mrst.dat, and generate the residual load effect all-element grid time series rntSRBFs***.??? from regional 1'x1' soil water EWH residual grid time series wghcalc*.dat with the setting parameters above.

Where ??? = ewh, ksi, gra, rga, dft, vdf, dph, dpr, nmh, grr or hgd, respectively, representing the grid file of the residual EWH estimation and residual load effects on the height anomaly, ground gravity, gravity disturbance, ground tilt, vertical deflection, horizontal displacement, radial displacement, normal or orthometric height, radial gravity gradient or horizontal gravity gradient.

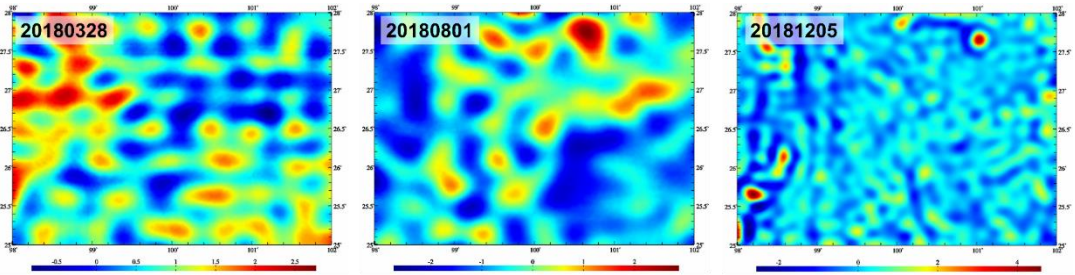
*** are the wildcards of the soil water EWH residual grid time series file names, whose instance can identify the sampling epoch time of the residual load effects.



Regional 1'x1' soil water residual load effect (µGal) grid time series on ground gravity



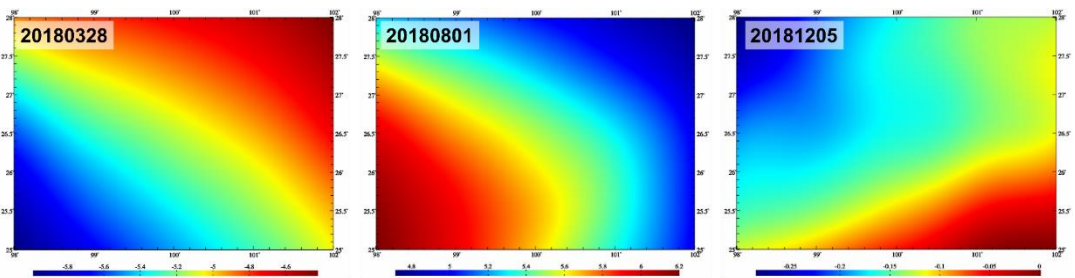
Regional 1'x1' soil water residual load effect (mm) grid time series on ground ellipsoidal height



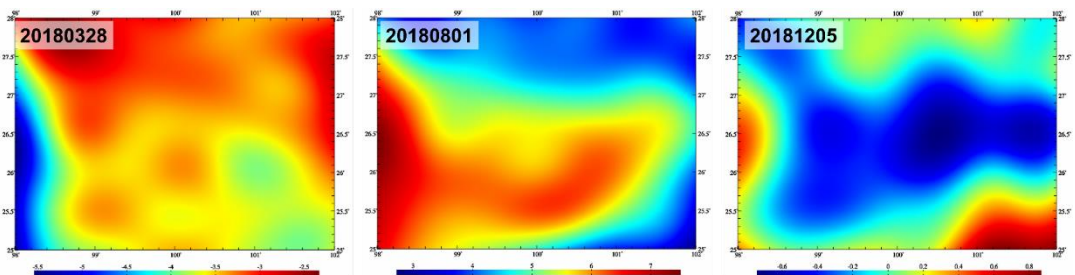
Regional 1'x1' soil water residual load effect (mE) grid time series on gravity gradient

Step 4: Calculate and restore the soil water load effect model value grid time series and generate the regional high-resolution soil water load effect all-element grid time series.

Call the function [Computation of load effect time series by spherical harmonic synthesis], input the calculation result area 1'x1' zero-value grid file zero1mrst, let 'land water EWH (cm)' as the surface load type and the maximum calculation degree is 360, calculate the global reference model value grid time series loadfmdl***.???. of soil water load effects from the global soil water load spherical harmonic coefficient model time series Indwater*cs.dat.



Regional 1'x1' soil water load effect model value (mm) grid time series on geoid



Regional 1'x1' soil water load effect model value (µGal) grid time series on ground gravity

Step 4: Calculate and restore the soil water load effect model value grid time series, and generate the regional high-resolution soil water load effect all-element grid time series

Computation of various load effects by spherical harmonic synthesis | Computation of various load effects of Earth satellite or outside solid Earth | **Computation of load effect time series by spherical harmonic synthesis** | Algorithm formulas

Select the calculation point file format: [The calculation surface height grid file] | The type of surface load: Land water EVH | Save program process as

Open the land surface height grid file | Open any load harmonic coefficient model file

Set the wildcard of the file names
 Ordinal number of the first wildcard in the file name: 9
 Number of consecutive wildcards in the file name: 8

Select the type of effects
 geoid or height anomaly (mm)
 ground gravity (μGal)
 gravity disturbance (μGal)
 ground tilt (SW, mas)
 vertical deflection (SW, mas)
 horizontal displacement (EN, mm)
 ground radial displacement (mm)
 ground normal or orthometric height (mm)
 disturbing gravity gradient (radial, $10\mu\text{E}$)
 horizontal gravity gradient (NW, $10\mu\text{E}$)

Maximum truncated degree of the coefficient model: 360 | Set the result folder | Import setting parameters | Start computation

Output files list:
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20180131_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20180328_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20180530_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20180801_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20181003_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20181205_ks1

Plot1

Operations on geodetic time series with same specifications

Open | Save as | Import parameters | Start computation | Save process | Follow example

Weighted operations on two record time series with same specifications | Construction of record time series from batch discrete point files | **Weighted operations on two groups of grid time series** | Weighted operations on two groups of vector grid time series

Open any grid time series file of the group 1 | Program Process | Operation Prompts | Save program process as

Set the wildcard of the file names
 Ordinal number of the first wildcard in the file name: 9
 Number of consecutive wildcards in the file name: 8

Open any grid time series file of the group 2
 Set the wildcard of the file names
 Ordinal number of the first wildcard in the file name: 9
 Number of consecutive wildcards in the file name: 8

Select operation mode
 Plus +
 The first weight: 1.00 | The second weight: 1.00

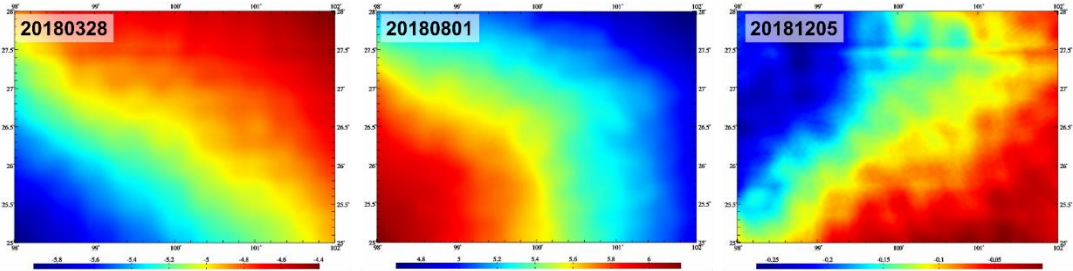
Operation Prompts:
 >> Create or select the results folder C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/ks1.
 ** The grid time series files of the group 1 searched by wildcard instantiation:
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20180131_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20180328_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20180530_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20180801_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20181003_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/loadfmdl20181205_ks1
 ** The grid time series files of the group 2 searched by wildcard instantiation:
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/mSRBFs20180131_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/mSRBFs20180328_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/mSRBFs20180530_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/mSRBFs20180801_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/mSRBFs20181003_ks1
 C:/ETideLoad4_5_win64en/examples/Loadmfdfcacldemo/rstmdtfdm/mSRBFs20181205_ks1
 >> Setting parameters have been imported in the program!
 ** Click the control button [Start computation], or the tool button [Start computation]...
 >> Computation start time: 2023-05-17 16:50:16
 >> Complete the weighted operations of two groups of grid time series files! There are 6 pairs of grid time series files operated.
 >> Computation end time: 2023-05-17 16:50:16

Set the results folder | Import setting parameters | Start computation

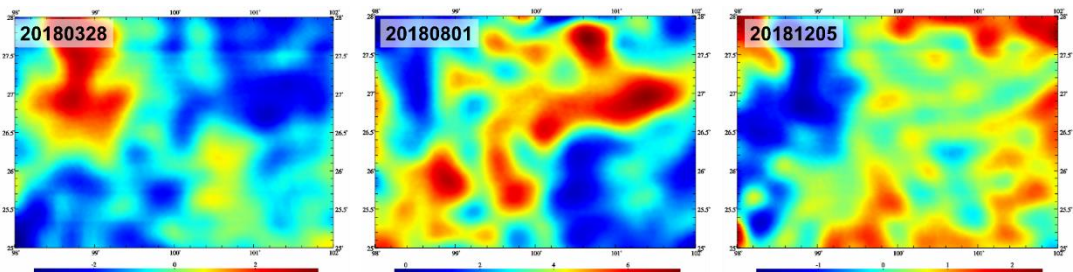
Call the function [Weighted operations on two groups of grid time series], directly add the reference model value grid time series loadfm***.??? to the residual grid time series

rintSRBFs***.??? of soil water load effects to generate the regional 1'x1' all-element grid time series soilloadfm***.??? of soil water load effects.

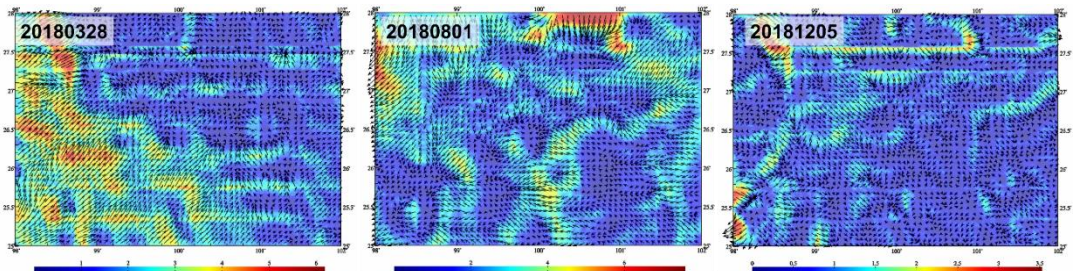
Where ??? = ksi, gra, rga, dft, vdf, dph, dpr, nmh, grr or hgd, respectively, representing the grid file of the soil water load effects on the height anomaly, ground gravity, gravity disturbance, ground tilt, vertical deflection, horizontal displacement, radial displacement, normal or orthometric height, radial gravity gradient or horizontal gravity gradient.



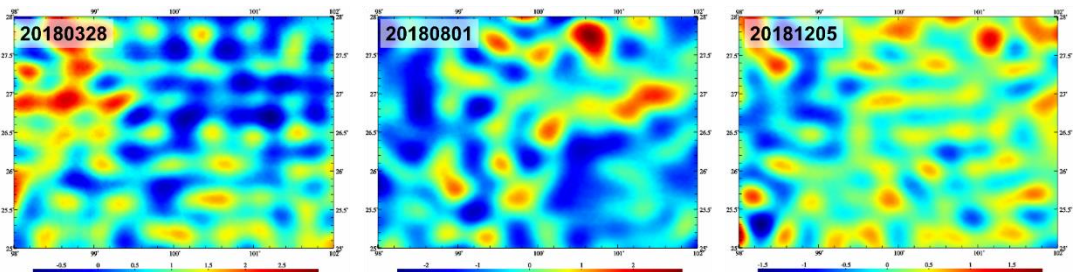
Regional 1'x1' soil water load effect (mm) grid time series results on geoid



Regional 1'x1' soil water load effect (µGal) grid time series results on ground gravity



Regional 1'x1' soil water load effect (mas) vector grid time series results on ground tilt



Regional 1'x1' soil water load effect (mE) grid time series results on gravity gradient

*** are the wildcards of the variation grid time series file names, whose instance can

identify the sampling epoch time of the load effects.

According to the same processes above, you can compute regional atmosphere or sea level variation load deformation field all-element grid time series.

ETideLoad4.5's algorithm of the load approach and load effect synthesis using SRBFs can effectively solve the troubles of high-degree oscillation and poor convergence of load Green's function and the spectrum leakage and singularity of load Green's function integral in the near area around the calculation point.

The all-element load deformation field approached can be employed to accurately calibrate the key payloads of geodetic satellite, verify the satellite geodetic monitoring ability and improve effectively the monitoring performance, reliability and accuracy level.

The regional load deformation field approached can be employed for the epoch reduction of various high-precision observations such as GNSS, leveling and gravity, which can support the realization and coordinated maintenance of heterogeneous geodetic datum.

It is the basic and lowest requirement for the deep fusion of multi-source heterogeneous data and collaborative monitoring of various heterogeneous geodetic technologies for the reduction of monitoring epoch and unification of monitoring datum based on surface load deformation field.