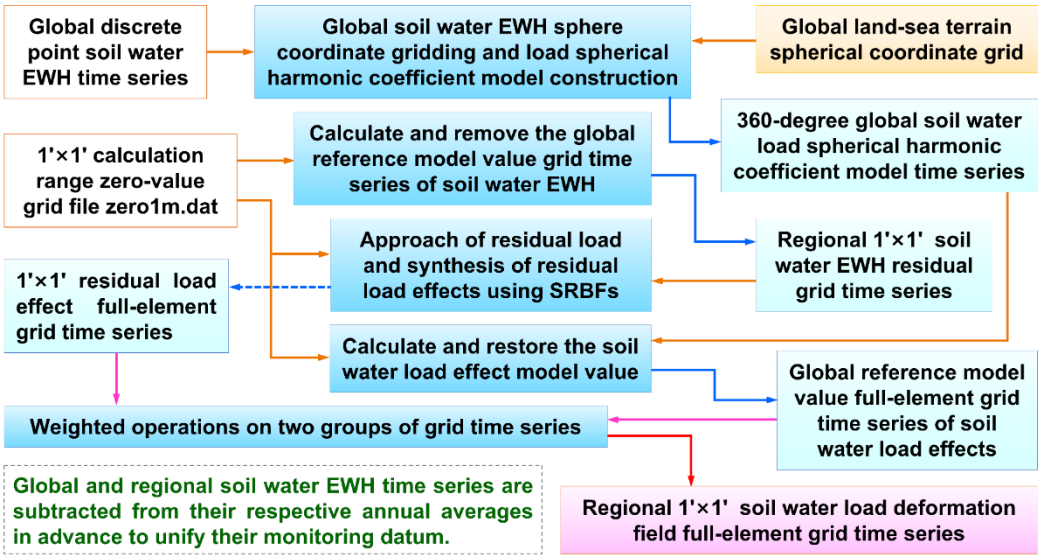
Complete computation processes of high-resolution regional load deformation field time series

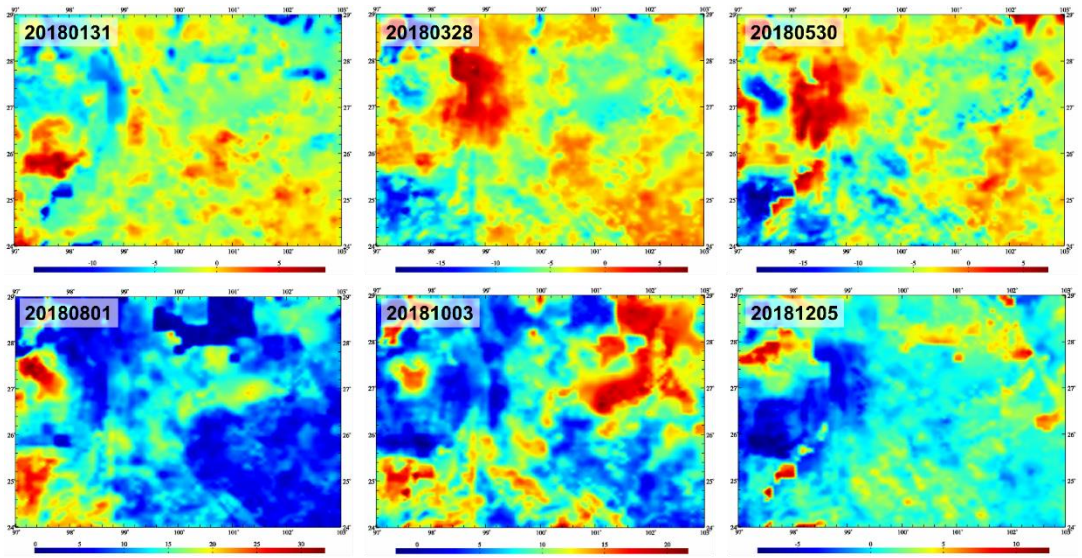
Taking the regional soil water variations as the example, the remove-restore scheme combined the global load spherical harmonic coefficient synthesis and regional residual load SRBF (spherical radial basis function) approach is employed to compute the high-precision and high-resolution regional load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

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.



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



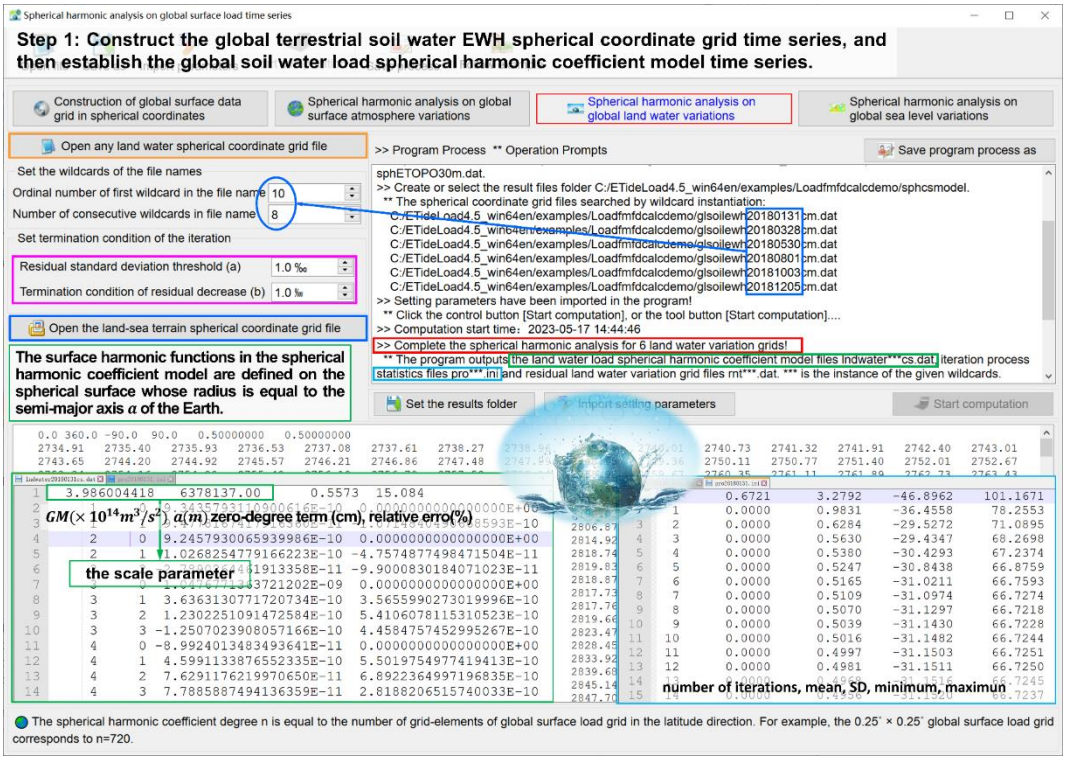
Regional 1′×1′ soil water equivalent water height (EWH, cm) grid time series

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

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

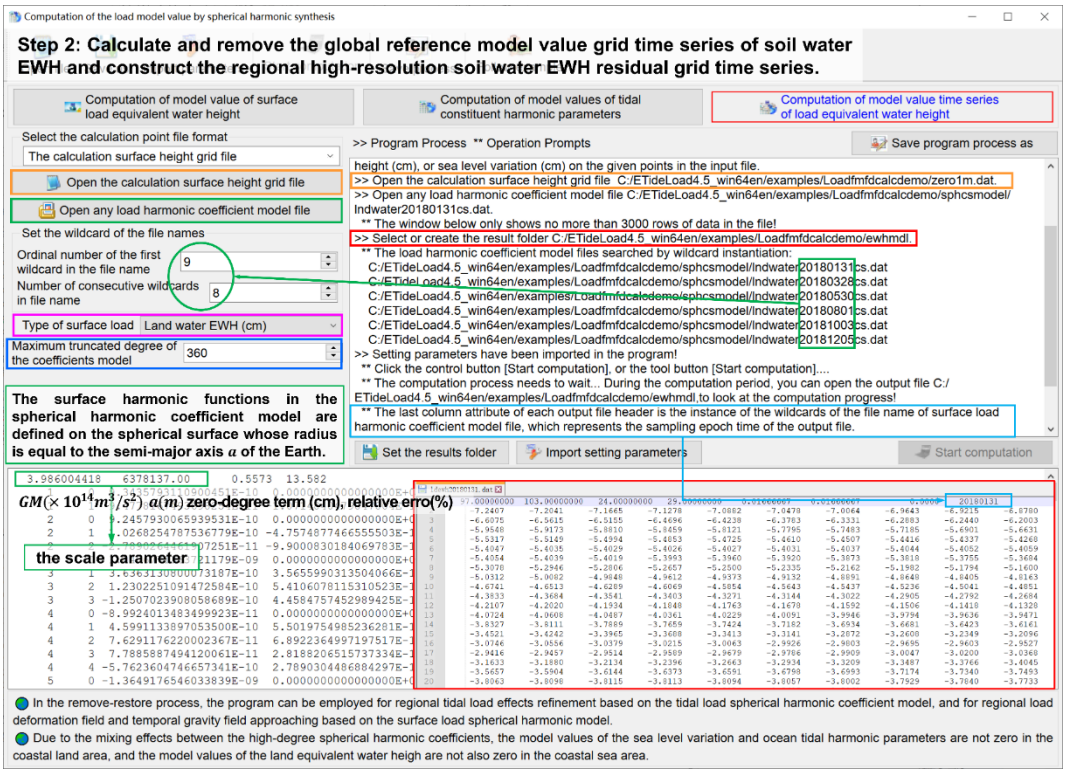
Call the function [Construction of global surface data grid in spherical coordinates], construct the global soil water EWH spherical coordinate grid time series glsoilewh*.dat from global soil water observations, where * is the sample epoch time and * = 20180131 represents January 31, 2018. The process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

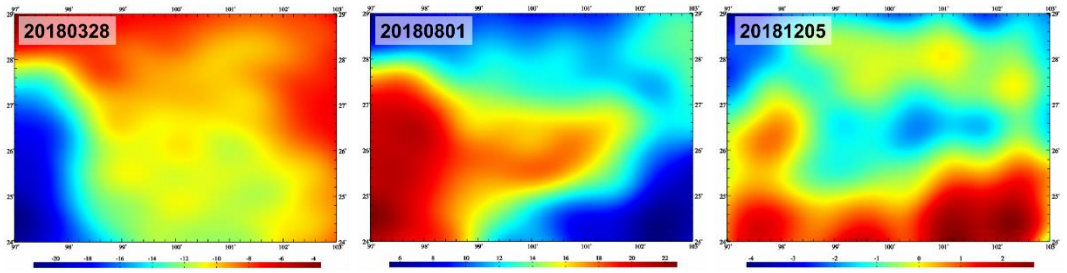
Call the function [Spherical harmonic analysis on global land water variations], input global land-sea terrain spherical coordinate grid sphETOPOnc30m.dat (EWH automatically zero in sea area), whose resolution is not less than the soil water EWH grid, and establish the global soil water load spherical harmonic coefficient model time series lndwater*cs.dat form the global soil water EWH spherical coordinate grid time series glsoilewh*.dat.



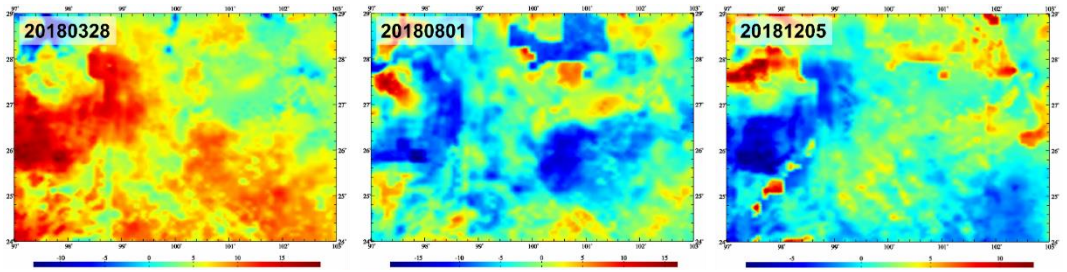
Step 2: Calculate and remove the global reference model value grid time series of soil water EWH and construct the regional high-resolution soil water EWH residual grid time series.

Call the function [Computation of model value time series of load equivalent water height], input the 1'×1' 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′×1′ soil water EWH model reference value (cm) grid time series

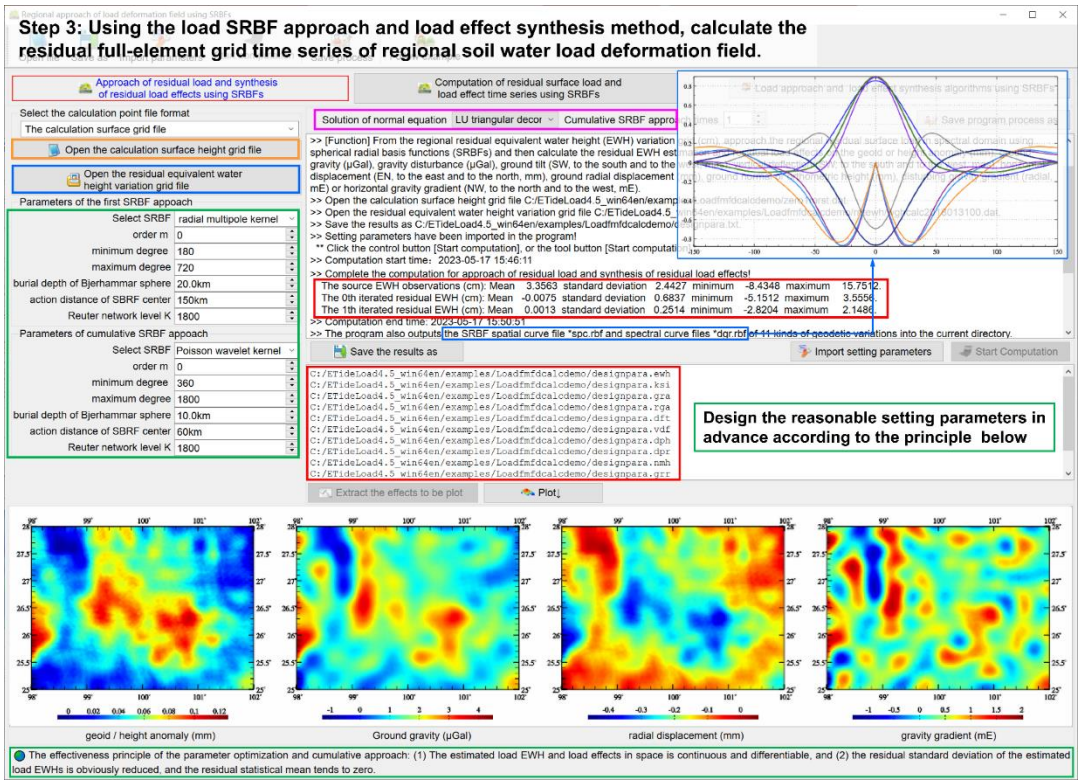


Regional 1′×1′ soil water EWH residual (cm) grid time series

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

Step 3: Determine the residual full-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'×1' zero-value grid file zero1mrst.dat removed the 1° edge area around the grid zero1m.dat, and generate the residual load effect full-element grid ttt.??? from regional 1'×1' 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.

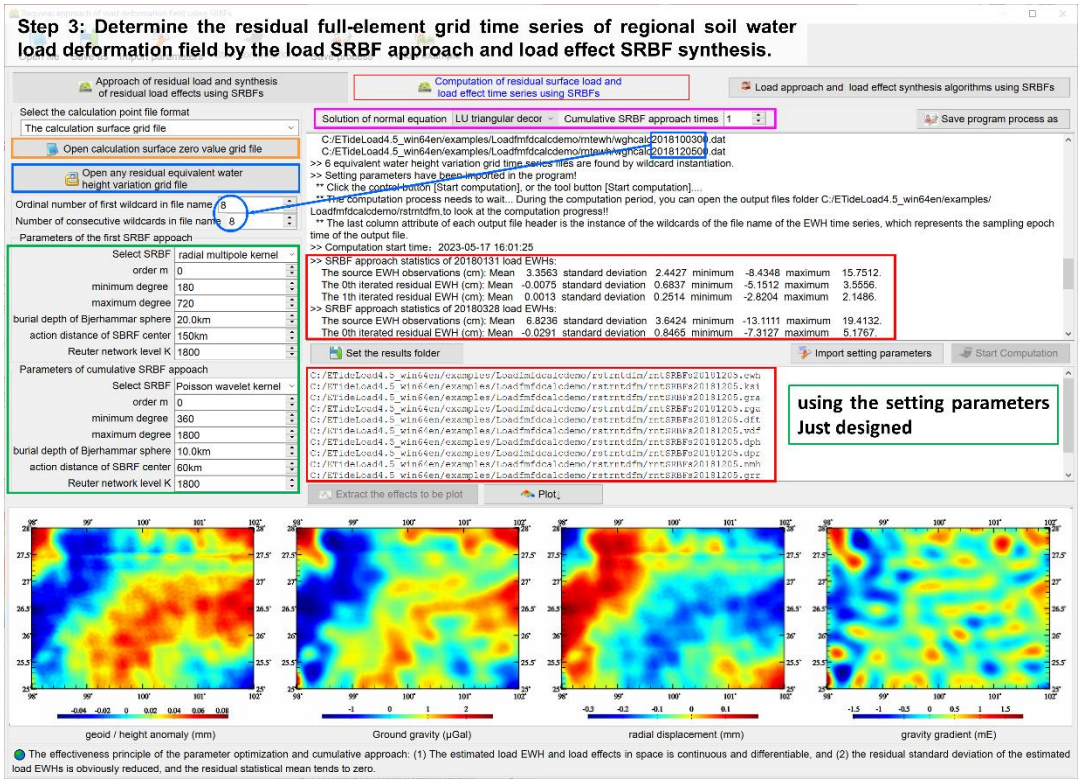


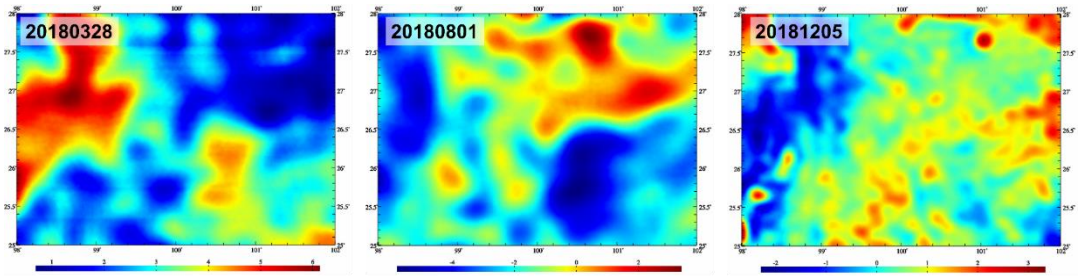
Call the function [Computation of residual surface load and load effect time series using SRBFs], input the 1'×1' zero-value grid file zero1mrst.dat, and generate the residual load effect full-element grid time series rntSRBFs***.??? from regional 1'×1' soil water EWH residual grid time series wghcalc*.dat 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, disturbing gravity gradient or horizontal gravity gradient.

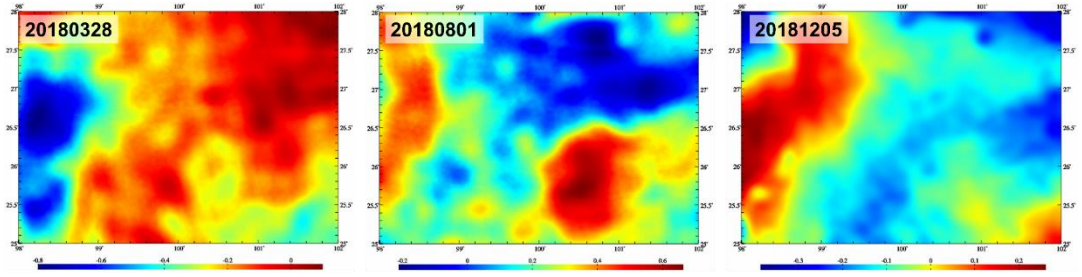
*** are the wildcards of the variation grid time series file names, whose instance can

identify the sampling epoch time of the load effects.

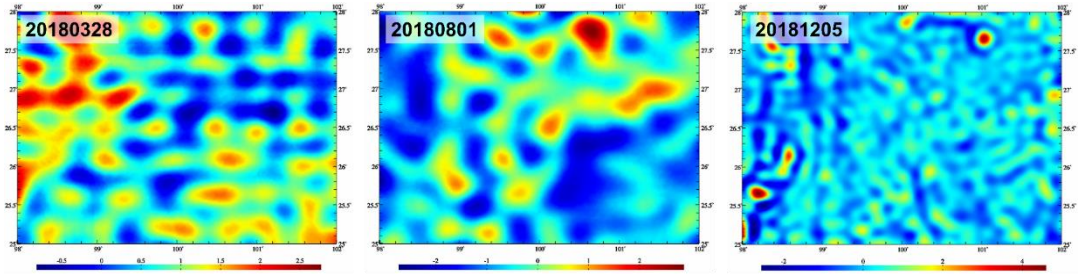




Regional 1′×1′ soil water residual load effect (μGal) grid time series on ground gravity



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



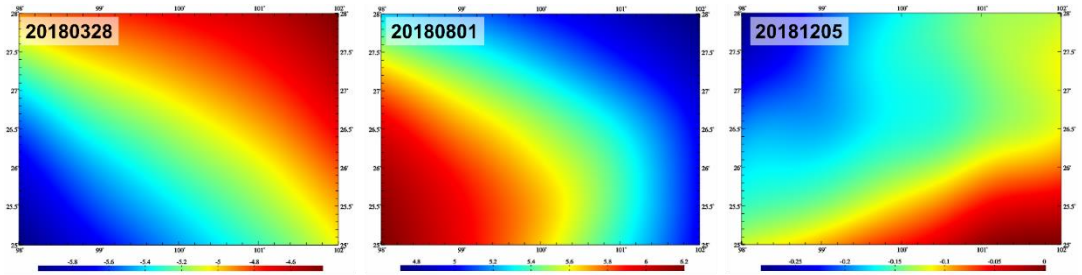
Regional 1′×1′ soil water residual load effect (mE) grid time series on gravity gradient

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 full-element grid time series.

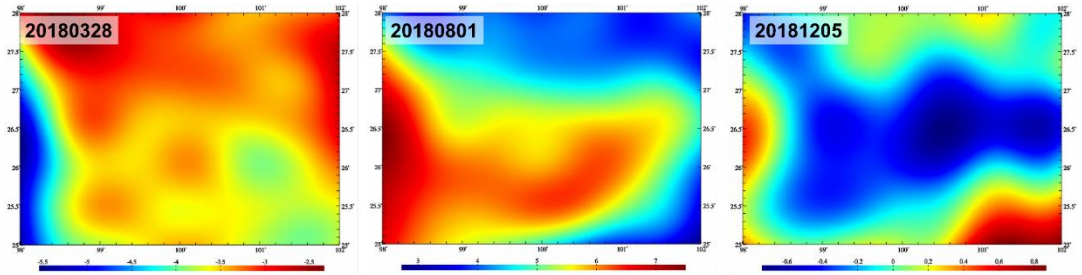
Call the function [Computation of load effect time series by spherical harmonic synthesis], input the calculation result area 1'×1' zero-value grid file zero1mrst, let 'land water EWH (cm)' as the surface load type and the maximum calculation degree is 360, calculate the global reference model value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

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 rntSRBFs***.??? of soil water load effects to generate the regional 1'×1' full-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, disturbing gravity gradient or horizontal gravity gradient.

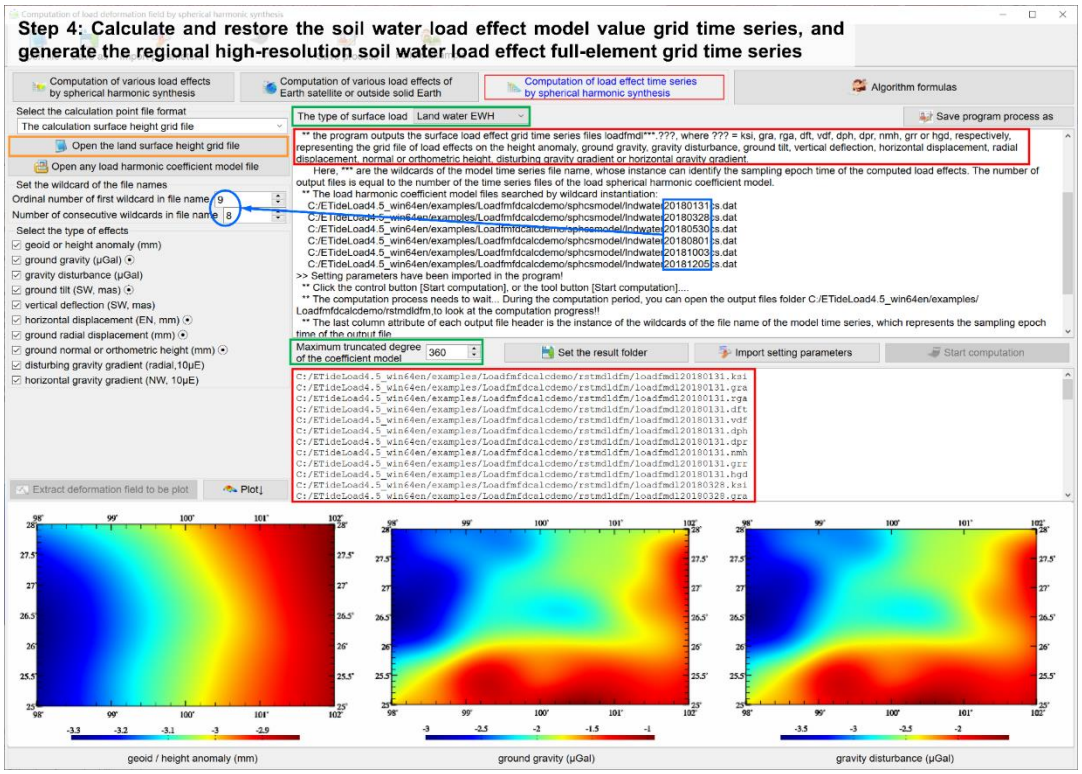


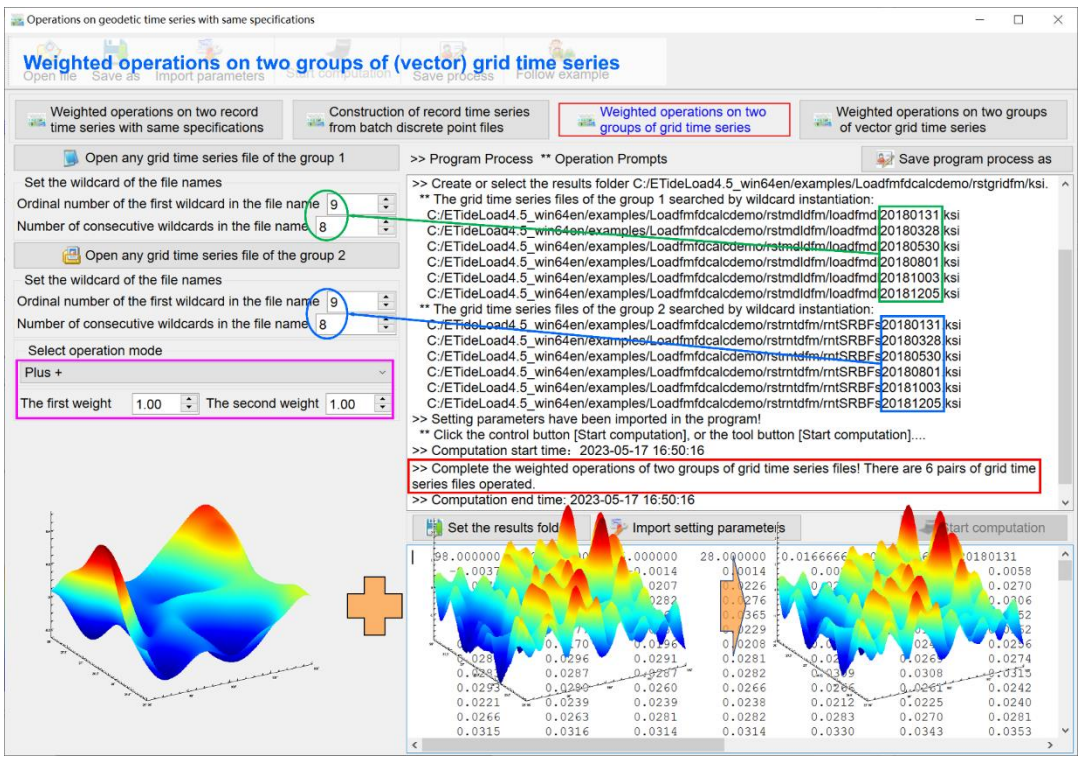
Regional 1′×1′ soil water load effect model value (mm) grid time series on geoid



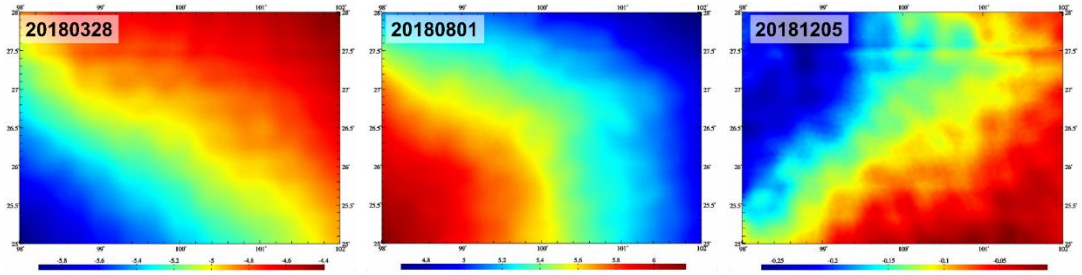
Regional 1′×1′ soil water load effect model value (μGal) grid time series on ground gravity

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

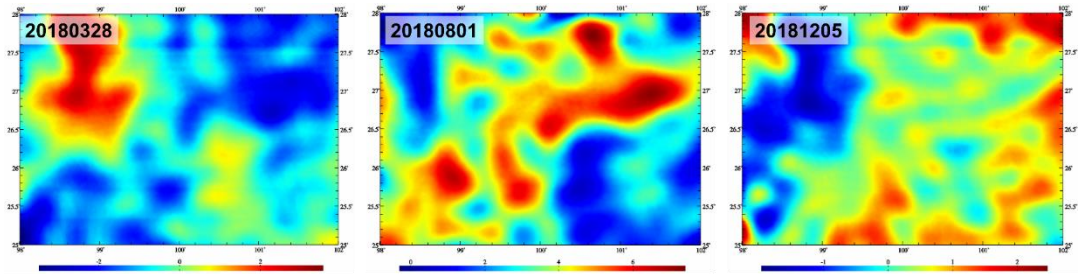




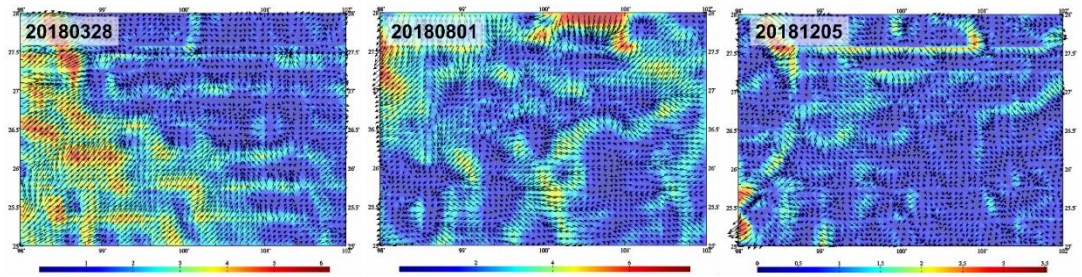
According to the same processes above, you can compute regional atmosphere or sea level variation load deformation field full-element grid time series.



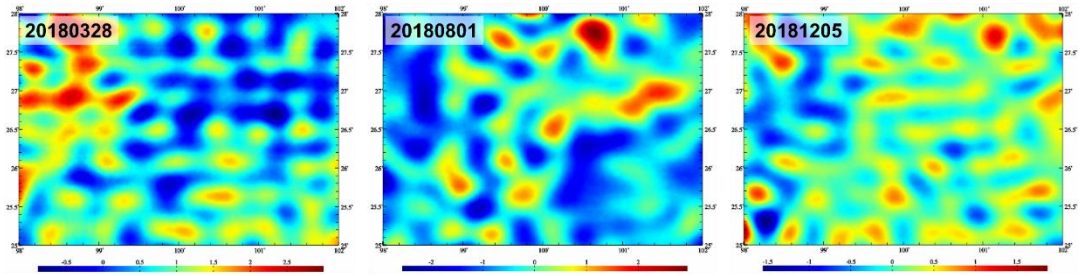
Regional 1′×1′ soil water load effect (mm) grid time series results on geoid



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



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



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

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

The full-element load deformation field approached can be used to accurately calibrate

the key payloads of geodetic satellite, verify the satellite geodetic monitoring ability, and effectively improve the monitoring performance, reliability, and accuracy level.

The regional load deformation field approached can be used 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 of deep fusion of multi-source heterogeneous data and collaborative monitoring of multiple heterogeneous technologies in geodesy to use the surface load deformation field for the unification of monitoring epoch reduction and monitoring datum.