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Decomposition of land surface displacement observed by InSAR into land subsidence caused by groundwater abstraction and natural motion of crust

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Monitoring land subsidence with InSAR technique is expected to provide important information for a calibration of groundwater flow/land subsidence model and decision-making in the groundwater management. However, the observed displacement possibly includes the motion caused not only by known groundwater abstraction but also natural displacements such as crustal motion. Because these unknown components are not considered in the usual groundwater flow/land subsidence model, it is not easy to use the observed data for inverse analysis.
We present a new analysis method to separately estimate known and unknown components with a simultaneous calibration of physics-based land subsidence model. This method consists of the iteration of the following three steps. In the first step, the known component is estimated from the land subsidence model with assumed parameters and the difference of calculated result and observed data is estimated as the unknown component with the least square analysis to reduce random noise. In the next step, the spatial roughness of unknown components is evaluated from the sum of rotational energy of local gradient. In the final step, the model parameters are modified to reduce the spatial roughness of unknown components. The concept of this step is based on the prior assumption that the crustal deformation is smooth in space relative to land subsidence cone caused by groundwater abstraction. This method is tested by the synthetic data composed of land subsidence from the assumed groundwater abstraction, the assumed sudden and long-term displacement like earthquake and post seismic motion, and the random noise error. The proposed method successfully separated the land subsidence caused by groundwater abstraction and other components, and exactly found the model parameters used in making synthetic land subsidence data.