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Development, verification and validation of a three-dimensional groundwater flow model for ESM

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Groundwater is one of the important water resources in the world and Groundwater flow is linked with surface water strongly. Many studies on groundwater are conducted in a local scale or focused on affect-ing surface water in a global scale. In current Earth System Model, fixed and constant one-dimensional vertical grid is used in unsaturated zone. In real world, the thickness of unsatu-rated zone depends on the climate and it is considered that there are limitations of runoff process expression especially in humid mountainous area. In this study, we developed three-dimensional groundwater flow model as ESM which can represent the variably saturated flow and groundwa-ter storativity. Since, this model is eventually coupled with Land Surface Model, it is possible to track the underground water flow using boundary conditions of recharge and surface water level.

We verified accuracy of the code using one & two-dimensional infiltration problem, three-dimensional groundwater pumping problem, and hillslope problem. Our model was com-pared with other researchers results, experimental data, analytical solutions. In consequence, our model was able to get accurate results. Subsequently, we conducted validation in Central valley, California, USA. The reason of chose this region is that this region is a semi-arid region, ground-water is used for irrigation and well pumping data is accessible. Over the world, groundwater use is more important in arid or semi-arid region than in humid area, and also highly utilized as agri-cultural water. Central valley has representativeness of groundwater use. In addition, the famous groundwater model, MODFLOW, was used to evaluate water resource management in this region. As well as MODFLOW, we calibrated hydraulic conductivity with 24 observation sites during 1961 - 2003 to validate. 156 observation points excluded 24 calibration points were used as vali-dation in same period. In the near future, we will confirm the difference between one-dimension and three dimensions setting of the unsaturated zone with respect to runoff process.