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## New Developments for the U.S. Geological Survey Groundwater and Surface-Water Flow Model (GSFLOW)

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## New Developments for the U.S. Geological Survey Groundwater and Surface-Water Flow Model (GSFLOW)

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**Abstract:** The modular programming design of the U.S. Geological Survey Groundwater and Surface-Water Flow Model (GSFLOW) provides a flexible and extensible structure for exploration of integrated hydrologic science for historical and projected climate, land-use and water-use conditions, and alternative management scenarios. The modularized structure has facilitated development of 8 alternative methods for computing or specifying potential evapotranspiration, or the ability to choose 4 different groundwater solvers, among many other examples. Moreover, the modularized structure allows the user-community to develop and incorporate extensions through the addition or modification of the U.S. Geological Survey Modular Ground-Water Model (MODFLOW) Packages and the Precipitation-Runoff Modeling System (PRMS) and GSFLOW Modules and coupling with other models, such as has been done with MODSIM, the river basin management decision support system. Recent enhancements and extensions to GSFLOW include: (A) integration with MODSIM; (B) recently released options in PRMS, including temporally dynamic parameter and water-use specifications and simulation of spatio-temporal stream temperatures, glacier dynamics, lakes, and frozen-ground dynamics; and (C) recently released MODFLOW Packages, including the agriculture water use (AWU), seawater intrusion (SWI), subsidence (SWT), link with MT3DMS (LMT), and surface-water routing (SWR) Packages. In addition, the design of the new MODSIM-GSFLOW code allows users to run the model with any combination of MODSIM, MODFLOW, and PRMS simulation options, thus allowing model complexity to be readily adjusted based on study needs. Additionally, work has been done on pre- and post-processing tools, such as the GSFLOW-ARCPY package and the cascade routing tool (CRT).

**Keywords:** Hydrologic integrated modeling; MODSIM; GSFLOW; MODFLOW; PRMS.