MODEL FRAMEWORK AND PRELIMINARY RESULTS OF THE REGIONAL MODFLOW GROUND-WATER FLOW MODEL OF COASTAL GEORGIA, SOUTH CAROLINA, AND FLORIDA

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Abstract. The Georgia Coastal Sound Science Initiative (CSSI) is a series of scientific studies commissioned by the Georgia Environmental Protection Division (GaEPD) in an effort to protect the Floridan aquifer system from saltwater intrusion. As part of the CSSI, the U.S. Geological Survey (USGS), in cooperation with GaEPD, is developing numerical models of the regional ground-water-flow system in a 37,300-square-mile (96,600-square-kilometer) area of coastal Georgia, and adjacent parts of South Carolina and Florida (Fig. 1). The models simulate three-dimensional transient ground-water flow in the upper and lower Brunswick aquifers and the Floridan aquifer system, and are calibrated for the period 1980–2000. Following calibration, the models will be used to simulate the effects of various pumping scenarios on ground-water supplies, which will aid in the management of coastal ground-water resources.

One of the models being developed simulates single-density ground-water flow throughout the coastal area using MODFLOW-2000 (Harbaugh and others, 2000; Hill and others, 2000). Hydrogeologic information—including site data for the altitude of tops of aquifers and confining units, vertical and horizontal hydraulic conductivity data, and storage coefficient data—was used to construct the model framework. The model is bounded above by a source-sink, or specified-head, layer representing the water-table surface (layer A4). Below the source-sink layer (A4), the model consists of three actively simulated aquifer layers, in order of increasing depth: the Brunswick aquifers (layer A3) (consisting of the upper and lower Brunswick aquifers), the Upper Floridan aquifer (layer A2), and the Lower Floridan aquifer (layer A1); and three actively simulated layers representing the confining units above each of the simulated aquifer units, layers C3, C2, and C1 (Table 1). All of the units extend across the entire modeling area, except the following: the known and definable aerial extent of the Brunswick aquifers limits the extent of layer A3 to counties closest to the coast, and along the coast between Camden and Chatham Counties; and the Lower Floridan aquifer is not present in the southwestern portion of the modeling area, thus layer A1 is not present there. The Upper Floridan aquifer is comprised of several aerial zones, based on hydrogeologic features (for example, the Gulf Trough) and lithologic changes in the updip parts of the Floridan aquifer system (Krause and Randolph, 1989; Miller, 1986; Peck and others, 1999), and on hydrologic property data distribution. Each model layer is discretized into 73 rows and 69 columns of 3.1- by 3.1-mile (5.0- by 5.0-kilometer) model grid cells.

Table 1. Relation of model layers to hydrologic units

Model layer	Hydrologic unit
A4	Surficial aquifer
C3	Brunswick confining unit
A3	Brunswick aquifers
C2	Upper Floridan confining unit
A2	Upper Floridan aquifer
C1	Lower Floridan confining unit
A1	Lower Floridan aquifer

The lateral model boundaries are no flow, specified head, or head dependent (Cauchy conditions), depending on location. Selected cells in layers other than A4, representing areas most likely to receive direct recharge, are designated as source-sink boundary cells. Cells at model boundaries where flow is assumed to be parallel to the boundary or at hydrogeologic divides are designated as no-flow boundary cells. Offshore boundary conditions are being determined by comparing model results using different types of boundary conditions with results of variable density models. The bottom boundary under layer A1 is a no-flow boundary.

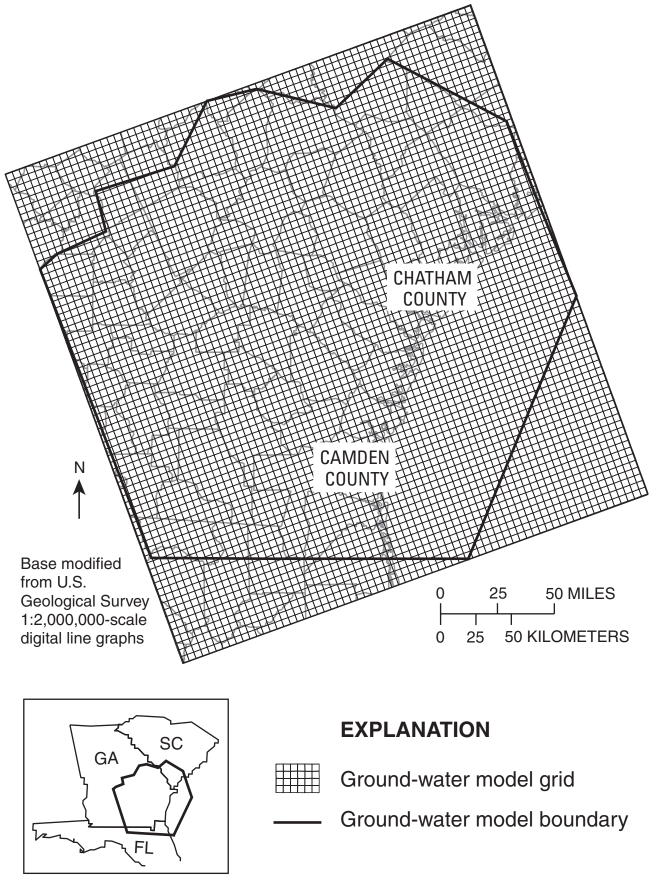

Figure 1. MODFLOW ground-water flow model area, grid and boundary.

Water-use data are used to apply stresses to the hydrologic system during 1980–2000 (Taylor and others, 2003). The transient model is calibrated from 1980 to 2000 with 1-year time steps. Initial heads are determined from estimated predevelopment heads using a steady-state model calibrated to 2000 data, with no pumpage stresses applied. Ground-water level data and hydrograph separation stream baseflow estimates are used to calibrate the model.

Preliminary modeling efforts have focused on determining the sensitivity of the model to input parameters over their expected ranges and determining the dominant physical controls on the aquifer units.

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