

# Simulation, Modeling and Authoring of Glaciers

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Glaciers are some of the most visually arresting and scenic elements of cold regions and high mountain landscapes. Although snow-covered terrains have previously received attention in computer graphics, simulating the temporal evolution of glaciers as well as modeling their wide range of features has never been addressed. In this paper, we combine a Shallow Ice Approximation simulation with a procedural amplification process to author high-resolution realistic glaciers. Our multiresolution method allows the interactive simulation of the formation and the evolution of glaciers over hundreds of years. The user can easily

modify the environment variables, such as the average temperature or precipitation rate, to control the glacier growth, or directly use brushes to sculpt the ice or bedrock with interactive feedback. Mesoscale and smallscale landforms that are not captured by the glacier simulation, such as crevasses, moraines, seracs, ogives, or icefalls are synthesized using procedural rules inspired by observations in glaciology and according to the physical parameters derived from the simulation. Our method lends itself to seamless integration into production pipelines to decorate reliefs with glaciers and realistic ice features.