ABSTRACT

Global climate models (GCMs) allow geologists to test physical explanations for the formation and modification of climate-related features on planetary bodies with an atmosphere. This method of analysis depends upon two data sources: the GCM itself and a catalog of features under investigation. A proof-of-concept analysis is tested on gullies (small erosional channels) and their formation by means of climate-change conditions identifying the transient presence of liquid water, over time, on Mars southern hemisphere. The end-to-end GCM/data integration pipeline includes three primary components: (1) generation of a file geodatabase with coded domains of all imaged gullies in the southern hemisphere of Mars from the Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) images (2) incorporation of three GCM simulations into ArcGIS that quantitatively predict surface conditions over one martian year under three different starting conditions, and (3) the integration of the geodatabase and GCM simulations to create dynamic visualizations of surface conditions over time with respect to gullies along with the quantitative extraction of temperature/pressure values at gully sites to test whether or not liquid water could be transiently stable at these locations. Results show that the formation of gullies by liquid water is unlikely under present atmospheric conditions at most locations, but is predicted to have occurred under more favorable orbital scenarios thought to have occurred in the recent geologic past of Mars. If these correlations are valid, this increases the potential of primitive biology having existed in the recent history of Mars. More broadly, this technique represents a potentially valuable tool within a GIS environment for increasing confidence in data/model comparisons at global, hemispheric and regional scales.