# RECENT ADVANCES IN PALEOCLIMATE MODELING: CLOSING THE GAP ON MODEL-DATA COMPARISONS

THOMPSON*, Starley L., National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307

Modeling paleoclimates is necessary for testing our understanding of the comprehensive climate system. Recently developed comprehensive climate models provide powerful tools for interpreting geological observations and identifying the physical mechanisms responsible for climate change. The evolution of powerful computers over the last few decades has allowed development of three-dimensional Atmospheric General Circulation Models (AGCMs), which simulate climate by solving fundamental physical equations for conservation of mass, energy, momentum, moisture, and the equation of state relating atmospheric pressure, density, and moisture. However, climate is the result of interactions between the atmosphere, cryosphere, biosphere, and the solid-earth. These elements interact in complex ways, each operating on a different time scale, with feedback mechanisms either amplifying or dampening the signal. The AGCMs have been useful to examine paleoclimatic sensitivity to changes in these elements by comparing model outputs with paleoclimatic proxy data.

The GENESIS Earth System Model, developed over the last four years by the Climate Change Research section (Climate and Global Dynamics division) at NCAR, has an AGCM as its core component, coupled to a 50 m mixed-layer ocean model, a sea ice model, and multi-layer models of soil and snow. A Land-Surface-Transfer (LSX) scheme accounts for the physical effects of vegetation. Recent advances of the GENESIS Earth system modeling effort include: 1) the successful coupling of an Equilibrium Vegetation Ecology (EVE) model with GENESIS, providing interactive simulations of the climate and potential vegetation; 2) the development of an Ocean General Circulation Model (OGCM) forced by AGCM output; and 3) the inclusion of an ice-sheet mass balance model. Proxy Formation Models (PFMs) have been developed to predict the formation of certain climate sensitive sediments (evaporites), providing a quantitative method of paleoclimate validation. The recently developed comprehensive approach to paleoclimate modeling has resulted in improved climate simulations that are in better agreement with the geologic record. Application of the latest generation of the GENESIS Earth system model will be discussed, including recent work on the Holocene (6k BP), the Last Glacial Maximum (21k BP), the Last Interglacial-Glacial transition (116k BP) and the Late Cretaceous (80Ma and 65 Ma).

Future advances, presently under development, include: 1) an OGCM coupled to the AGCM component of GENESIS; 2) a dynamical ice sheet model; 3) an interactive atmospheric chemistry model; and 4) a dynamical terrestrial biosphere model that accounts for the cycling of carbon.

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