

# Developing an Earth System Model of Past and Future Climates at the NASA Goddard Institute for Space Studies

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In addition to increasing resolution within both the atmosphere and ocean models, GISS is working to increase the complexity of model physics and add prognostic budgets of forcings that were externally prescribed for the IPCC 4th Assessment Report simulations. Prognostic budgets allow a variable to evolve consistently with its effect upon climate. This is especially important when several forcings are predicted simultaneously and affected by a climate anomaly forced by all species together. For example, the use of a single wet deposition scheme for all aerosols results in a consistent dependence of each aerosol upon model rainfall, that is jointly perturbed by all aerosol species. Prognostic budgets of cloud and aerosol properties are especially important for the indirect effect, where additional feedbacks and interactions between variables are still being recognized, and empirical relations potentially oversimplify the calculation and preclude important feedbacks. GISS has been working to increase the number of prognostic aerosol and chemical species, which has necessitated the development of other prognostic budgets including interactive vegetation and ocean biology, for example. The full model is typically tested by comparison to observations within the twentieth century, but examples of paleoclimate are used as an independent model test. These ideas are illustrated with examples of interactions between forcings related to the American Dust Bowl, 20th century variations in aerosol and chemical composition, solar variability (including the feedback upon ozone chemistry), and freshwater discharge at the 8.2 kyear event.

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