Modeling earth climate system with dynamic area fraction models.

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Abstract. We formulate an approach to modeling climate as a dynamical system Involving coupled ordinary differential equations. The novelty of this Approach lies in treating spatial variability implicitly but Dynamically, as this model does not include space explicitly. This idea Enables us to treat the physics of transport of energy and water in a more Sophisticated fashion than would be possible in other 0-dimensional spatial Models, e,g.,. Box models. We dynamically parameterize space by grouping regions of similar values for Characteristics of interest. Local changes in such characteristics (eg. Temperature, precipitation) can be dynamically modeled through energy Balance, while the feedbacks to the growth and decay of regions can be Represented by growth rates and death rates dependent upon the local Characteristics. Dynamic area fraction models (dafms) are well-suited to The study of zeroth- or first-order changes in local variables, due to Their relative simplicity and hence their relative analytical tractibility. We demonstrate the use of dafms with a heirarchy of models of increasing Complexity, beginning with the well known "daisyworld" model of watson and Lovelock (tellus, 1983) and culminating in a climate model with two species Of earth-like plants, a hydrological cycle, an ocean, and ice caps.