MAR16-2015-007483

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Prototypes for the dynamics underlying precipitation and temperature extremes[1]

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Projecting changes in precipitation and temperature extreme events can be aided by a deeper understanding of the dynamics underlying such variations. For precipitation, this is closely connected to the interaction of fast, small-scale motions with variability of large-scale climate. Simple prototype models from the physics and applied math literature can point to analysis methods, connections among related quantities, and hypotheses for the dynamics, especially when the prototype models can be derived from climate-model equations. An overview will be provided including recent work with a number of collaborators. For distributions of precipitation-related variables, prototypes including Fokker-Planck solutions and first-passage problems for variations across an onset threshold yield insights into the form of present-day observed distributions and predictions for the form of the global warming change to evaluate in climate models. In distributions of water vapor and temperature, the widespread occurrence of non-Gaussian tails is likely explained in part by prototypes for tracer advection across a maintained gradient. The shape of these tails can have substantial implications for regional changes in probabilities of precipitation and temperature extremes with large-scale warming.

[1]Supported in part by the National Science Foundation