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Atmospheric Convective Organization: Self-Organized Criticality or Homeostasis?

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Atmospheric convection has a tendency organized on a hierarchy of scales ranging from the mesoscale to the planetary scales, with the latter especially manifested by the Madden–Julian oscillation. The present talk examines two major possible mechanisms of self–organization identified in wider literature from a *phenomenological* thermodynamic point of view by analysing a planetary-scale cloud–resolving model simulation.

The first mechanism is *self–organized criticality*. A saturation tendency of precipitation rate with the increasing column–integrated water, reminiscence of critical phenomena, indicates self–organized criticality. The second is a self–regulation mechanism that is known as *homeostasis* in biology. A thermodynamic argument suggests that such self–regulation maintains the column–integrated water below a threshold by increasing the precipitation rate. Previous analyses of both observational data as well as cloud–resolving model (CRM) experiments give mixed results. A satellite data analysis suggests self–organized criticality. Some observational data as well as CRM experiments support homeostasis. Other analyses point to a combination of these two interpretations.

In this study, a CRM experiment over a planetary–scale domain with a constant sea–surface temperature is analyzed. This analysis shows that the relation between the column–integrated *total water* and precipitation suggests self–organized criticality, whereas the one between the column–integrated *water vapor* and precipitation suggests homeostasis. The concurrent presence of these two mechanisms are further elaborated by detailed statistical and budget analyses. These statistics are scale invariant, reflecting a spatial scaling of precipitation processes.

These self–organization mechanisms are most likely be best theoretically understood by the energy cycle of the convective systems consisting of the kinetic energy and the cloud–work function. The author has already investigated the behavior of this cycle system under a zero–dimensional configuration. Preliminary simulations of this cycle system over a two–dimensional domain will be presented.