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A systems approach to evolution of cloud fields

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Clouds and precipitation have a fundamental role in the Earth's energy balance, global atmospheric circulation and the water cycle. Clouds interact with solar and terrestrial radiation and cloud processes are key components in the thermodynamic balance of the climate system. Thus basic knowledge about cloud formation, lifetime and properties is critical to the understanding of climate change and the availability of fresh water.
Despite their importance, clouds still pose the largest uncertainty in climate research. As in many dynamical systems the clouds response to changes in the environmental conditions will not be linear. Some of the effects can be damped by negative feedbacks, resulting in relatively small changes in the average cloud properties, while others can result in an escalation of the cloud system into a different state, resulting in dramatic changes in lifetime, coverage, morphology and precipitation. Such a problem begs for a systems-view approach that seeks basic rules to define the "big picture" together with a detailed understanding of smaller scale processes.
We will show that in analogy to ecological systems, the cloud-rain system can be studied using principles from population dynamics. Solving a set of equations that link the evolution of clouds in time, rain formation and aerosol effects on these processes reveals rich solution space. We will discuss the theoretical insight gained from such approach and the link to reality.