Self-organized patterns and resilience in the aerosol-cloud-precipitation system

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We explore the underlying principles of self-organization in cloud systems. Two boundary layer cloud systems are addressed: stratocumulus and mixed phase Arctic stratus. For stratocumulus, precipitation and its drivers determine whether cloud fields take on a more reflective closed cellular state or a less reflective open-cellular state. Similarly for mixed-phase Arctic stratus, both microphysical and meteorological parameters determine a preference for either a cloudy state, or alternatively a radiatively clear state. For both cloud systems we use satellite imagery, surface remote sensing and high resolution numerical models to explore the preference for one of these two states.

Much like other complex, coupled systems, the process-level, local interactions between elements that make up the aerosol-cloud-precipitation system generate system-wide patterns, or "emergent" behavior. We will explore the manner in which these process-level interactions manifest themselves in emergent behavior or self-organizing patterns. We will show how this self-organization leads to resilience, or alternatively instability of the system and discuss transitions between states. Finally, we will consider alternate conceptual models that may in some cases be able to capture the emergent properties of the complex system with minimal computational expense.