Session: B6 Oral presentation

Self-organization and resilience of Arctic mixed-phase clouds

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The Arctic climate system is particularly sensitive to climate change, with potentially dramatic consequences for the regional ecosystem. Arctic mixed-phase clouds, comprising both ice and supercooled liquid water, have been observed to occur frequently in all seasons and persist for many days at a time. Consequently they play an important role in regulating the flow of energy in the system. Due to the inherent instability of ice-liquid coexistence, the persistence of these clouds is remarkable. A conceptual model of Arctic mixed-phase clouds is described that points to the existence of numerous feedbacks acting at various timescales. This complex web of process interactions has made it difficult to assemble an overall picture of how these clouds persist. This uncertainty is reflected in the poor simulation of these clouds by numerical models at all scales, and suggests the need for a more integrated, systems-based methodology that complements existing strategies focused on untangling the web of process interactions. Such a "systems dynamics" approach has proven fruitful in understanding emergent behavior of complex systems in other fields of study. Based upon recent observations and modeling studies, various aspects of the persistent mixed-phase cloud state will be described in the context of system dynamics, including concepts such as self-organization, resilience, slow manifolds, and state selection. Implications for climate modeling and climate sensitivity will be discussed.