Mesoscale Dynamics Related to an Elongated Cloud over Tharsis Montes on Mars

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This study explores the atmospheric dynamics around Tharsis Montes on Mars, particularly focusing on the elongated cloud formation over Arsia Mons, during a specific season of the Martian year (300 to 320 Ls). We used a regional mesoscale model beginning with idealized simulations horizontal wind profiles represented by polynomial functions and simplified mountain models to replicate the expected atmospheric conditions, establishing a method for predicting cloud formation from the perspective of fluid dynamics, notably for the occurrence of strong updrafts by hydraulic jumps around the “head” of the Arsia Mons Elongated Cloud (AMEC). Key findings reveal that wind speed and the presence of high, flat-topped mountains significantly influence hydraulic jump events, which are also altitude-dependent. The study extends these methods to realistic Martian terrain and initial conditions generated by a General Circulation Model (GCM), highlighting the interaction between different volcanoes in this region, and replicating conditions seen in idealized simulations. Overall, this research explored the dynamical mechanisms crucial for forming the head of AMEC and the atmospheric prerequisites for cloud elongation, enhancing the understanding of mountainous cloud formations on extraterrestrial planets and informing future Mars observations and studies.

Keywords: Mars, Cloud, Hydraulic jump, Atmospheric dynamics

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