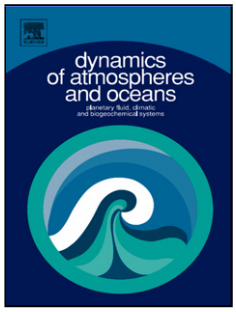

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Critical Transitions of Stratocumulus Dynamical Systems due to Perturbation in Free-Atmosphere Moisture

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Abstract

The bi-stable behavior of stratocumulus systems is here investigated in a 3D cloud-resolving model based on vector vorticity equations (VVM). This study demonstrates the response of the stratocumulus system to small perturbations of free atmospheric moisture under specified forcings of warm sea surface temperature (SST) and weak subsidence. A critical transition, indicated by the strong decoupling and large variation of cloud properties, separates fast dynamics from slow dynamics. During the fast process governed by the thermodynamic adjustment, the liquid water path (LWP) decreases with a decreasing cloud-top entrainment rate; on the other hand, during the slow process determined by the cloud-top inversion adjustment, LWP increases. The model exhibits two coexisting (cloudy and non-cloudy) quasi-stationary states through the fast process. A key process for the bifurcation is that the non-cloudy state shows the presence of active cumulus convection that allows the destruction of stratocumulus. The results suggest that the direct

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