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## The time-space exchangeability of satellite retrieved relations between cloud top temperature and particle effective radius

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**Abstract.** A 3-minute 3-km rapid scan of the METEOSAT Second Generation geostationary satellite over southern Africa was applied to tracking the evolution of cloud top temperature ( $T$ ) and particle effective radius ( $r_e$ ) of convective elements. The evolution of  $T$ - $r_e$  relations showed little dependence on time, leaving  $r_e$  to depend almost exclusively on  $T$ .

Furthermore, cloud elements that fully grew to large cumulonimbus stature had the same  $T$ - $r_e$  relations as other clouds in the same area with limited development that decayed without ever becoming a cumulonimbus. Therefore, a snap shot of  $T$ - $r_e$  relations over a cloud field provides the same relations as composed from tracking the time evolution of  $T$  and  $r_e$  of individual clouds, and then compositing them. This is the essence of exchangeability of time and space scales, i.e., ergodicity, of the  $T$ - $r_e$  relations for convective clouds. This property has allowed inference of the microphysical evolution of convective clouds with a snap shot from a polar orbiter. The fundamental causes for the ergodicity are suggested to be the observed stability of  $r_e$  for a given height above cloud base in a convective cloud, and the constant renewal of growing cloud tops with cloud bubbles that replace the cloud tops with fresh cloud matter from below.

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