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In search of ghost cold pools and moisture rings

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Past work with numerical models has suggested that convectively generated cold pools can play a fundamental role in the triggering of new convection, even in situations of low wind shear, through their determination of the boundary layer moisture field (although cold pool collisions can still add a dynamic element to this thermodynamic picture). The models show cold pool spreading until they were almost fully recovered in temperature, with very limited gust front wind velocities, but exhibiting a ring of higher moisture and associated moist static energy where new convection triggers. Due to their limited dynamical activity at the front, we refer to these near-recovered events as "ghost cold pools".

Despite the growing interest in this cold pool mechanism, a definitive observation of systematic moisture rings in cold pools observations is lacking. Part of the reason for this could be the tendency for observation-based work to focus on intense cold pool events. Even the recent work of Kirsch et al (2021), which intended to document weaker cold pools, used a temperature drop threshold of 2 degrees C; still too large to identify ghost cold pools.

Here we introduce a new method to detect ghost cold pools fronts, using a wavelet decomposition of temperature data from the tropical western Pacific ARM site to identity cold pool candidates, which are then subject to a quality control process based on the Bordoni change-point analysis and a low-pass filtering technique to reject turbulent fluctuations falsely identified as cold pools. This new technique is shown to reliably identify cold pools fronts with temperature drops as little as 0.2 degrees C (close to instrument sensitivity) even in daytime highly turbulent conditions, an order of magnitude smaller than any previous observational work, thus enabling us to document the statistics of ghost cold pools. Using this new technique we show that moisture rings are ubiquitous in ghost cold pools over tropical oceans and we will document how the structure of the cold pool changes as a function of the cold pool age.

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