AMIE/DYNAMO Observations of Clouds During the Transition from Suppressed to Active MJO Conditions

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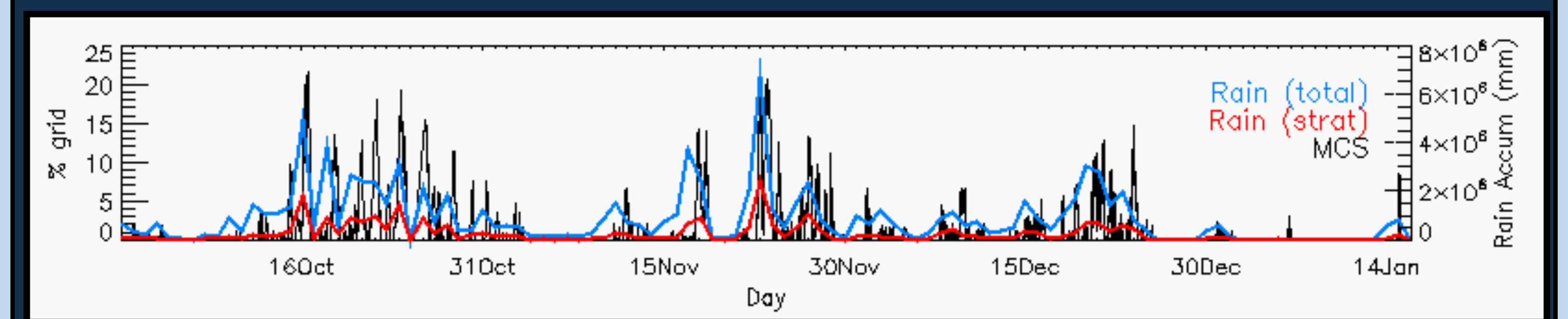
1. Objectives

Observational studies using data from AMIE/DYNAMO have described a transition of the precipitating cloud population over the Indian Ocean from one dominated by shallow, isolated cells toward deep mesoscale systems containing widespread stratiform echo. In particular, three active MJO periods were observed by the NCAR S-PolKa radar, between which suppressed conditions featured shallower convection under prevailing subsidence.

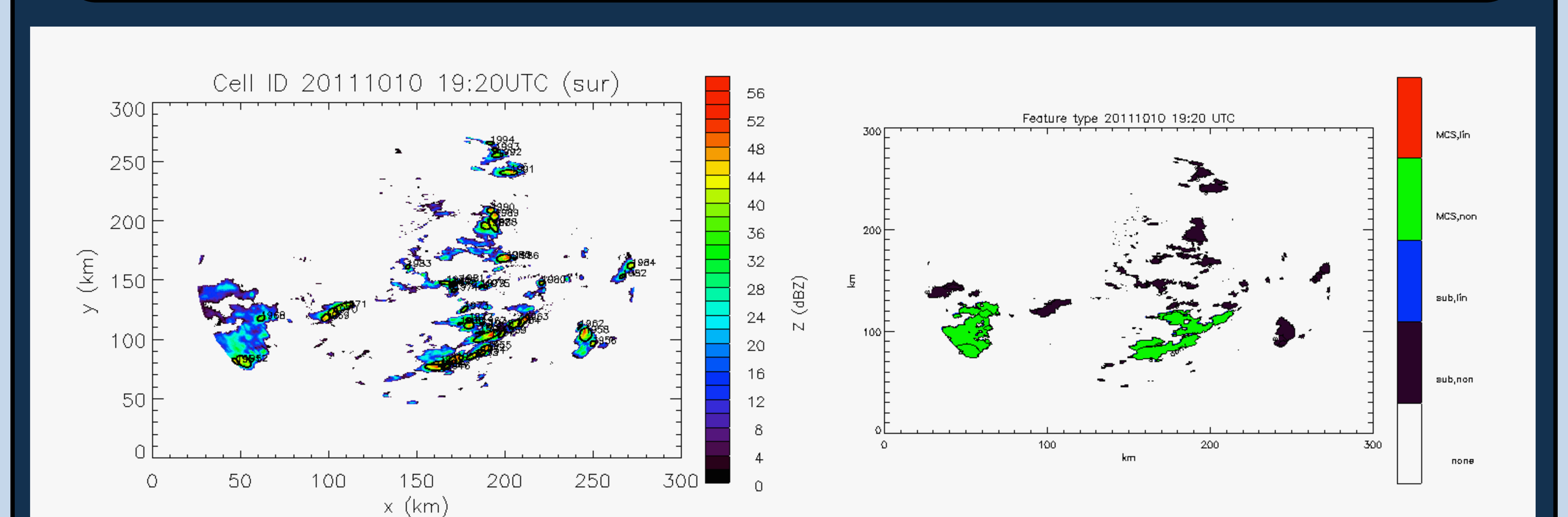


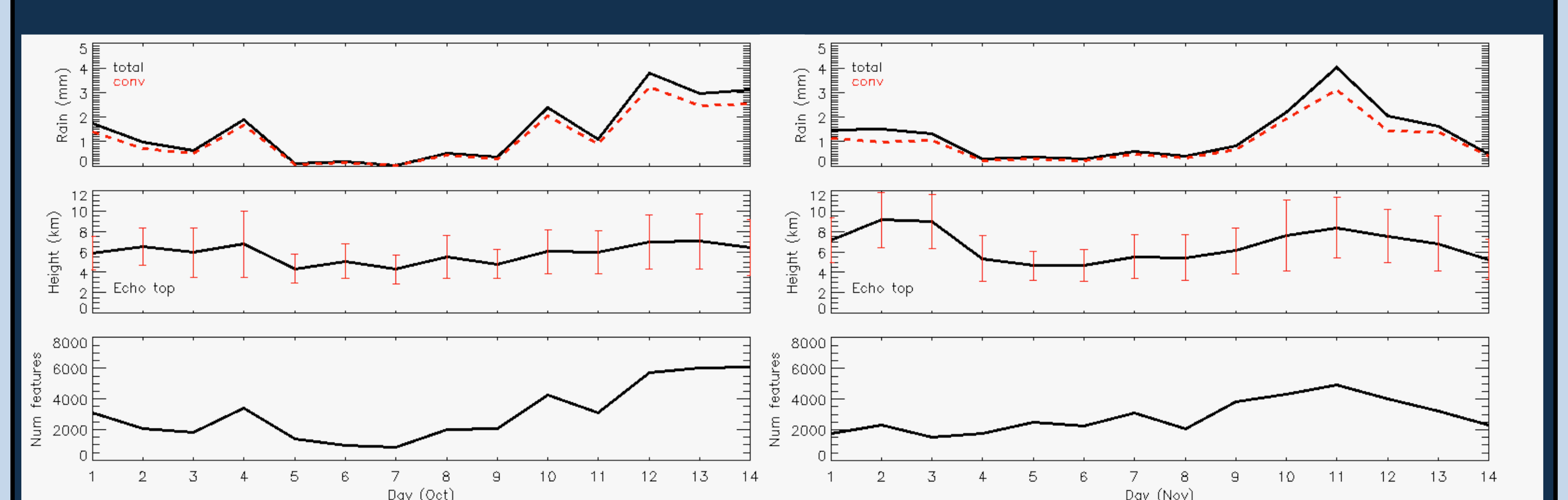
The AMIE/DYNAMO radar observations offer the opportunity to investigate the cloud population during this transition from suppressed to active conditions, including the nonprecipitating clouds that constitute the first stage of MJO convective initiation and the subsequent upscale growth. From a radar perspective, Our objectives are to describe:

1) Characteristics and boundary layer organization of nonprecipitating clouds
2) The role cold pools play in the transition toward a population of deeper convection
3) The evolution of the cloud population toward MCSs in the active periods

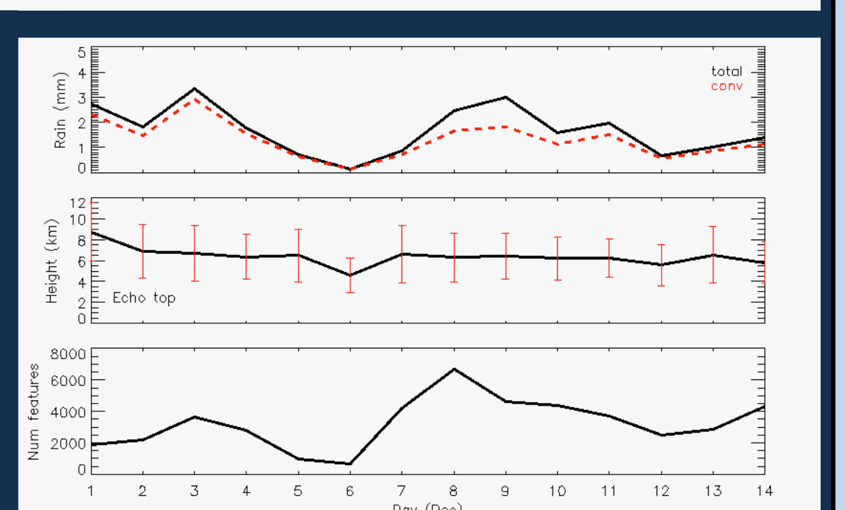
2. Suppressed periods

Precipitating features were automatically tracked based on S-PolKa reflectivity. Size thresholds were applied to differentiate isolated precipitating cells from those embedded within larger convective systems. A convective/stratiform partitioning algorithm was also applied to reflectivity data.





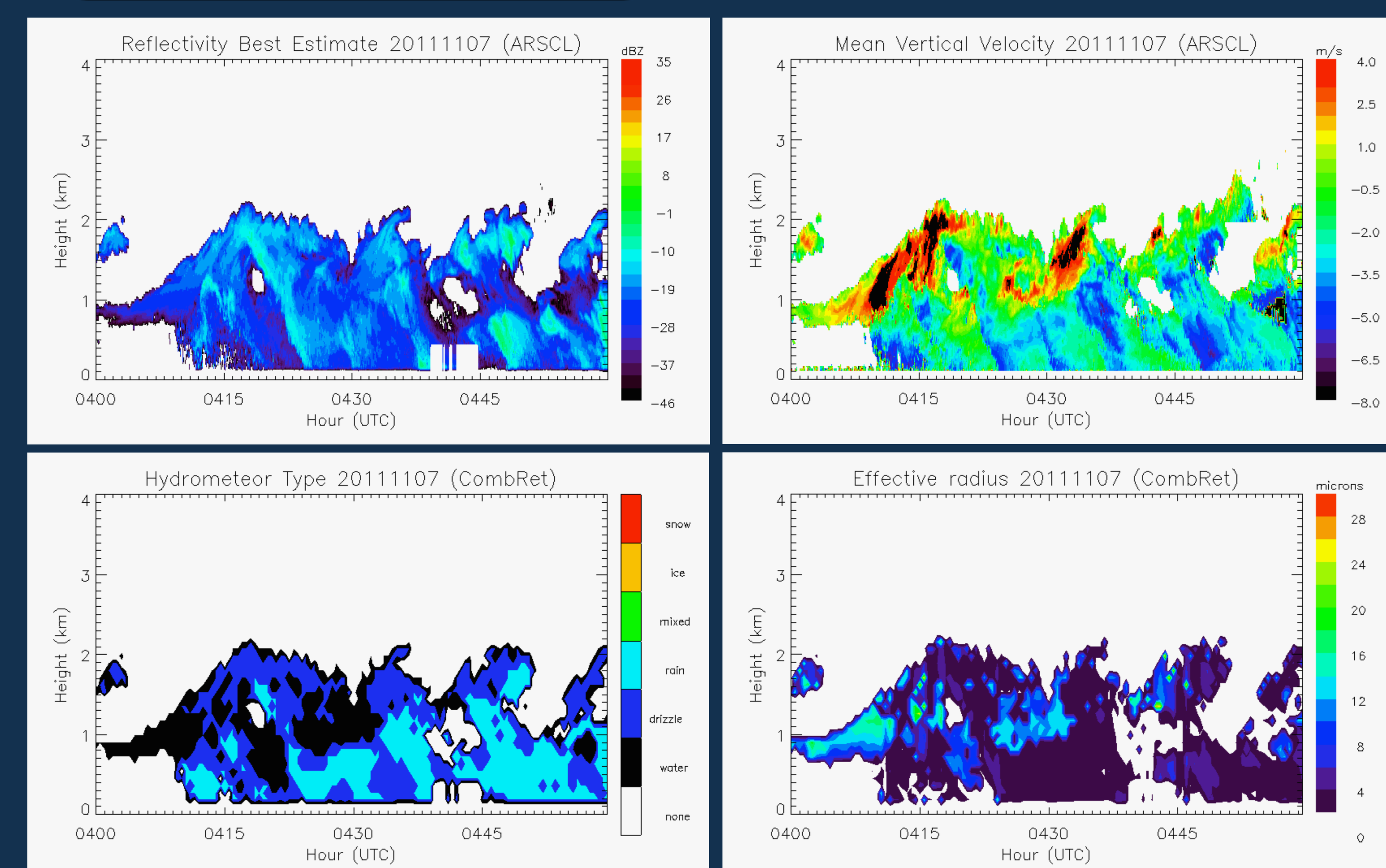
Increases in daily areal rainfall (with an increasing component from stratiform), mean echo-top height (max height of 0 dBZ), and number of precipitating features (15-dBZ threshold) are observed starting from the most suppressed periods in the early parts of each month up to the beginning of the active periods around the middle of each month. An exception is December where fast-moving squall lines dominate the scene after 7 Dec.

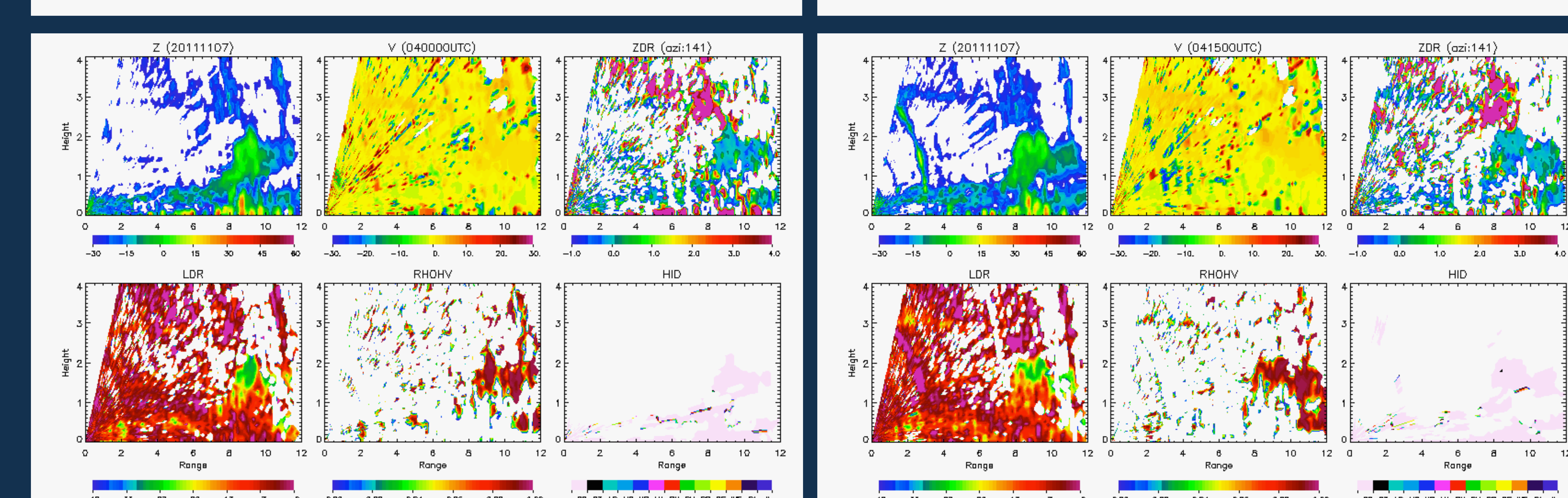


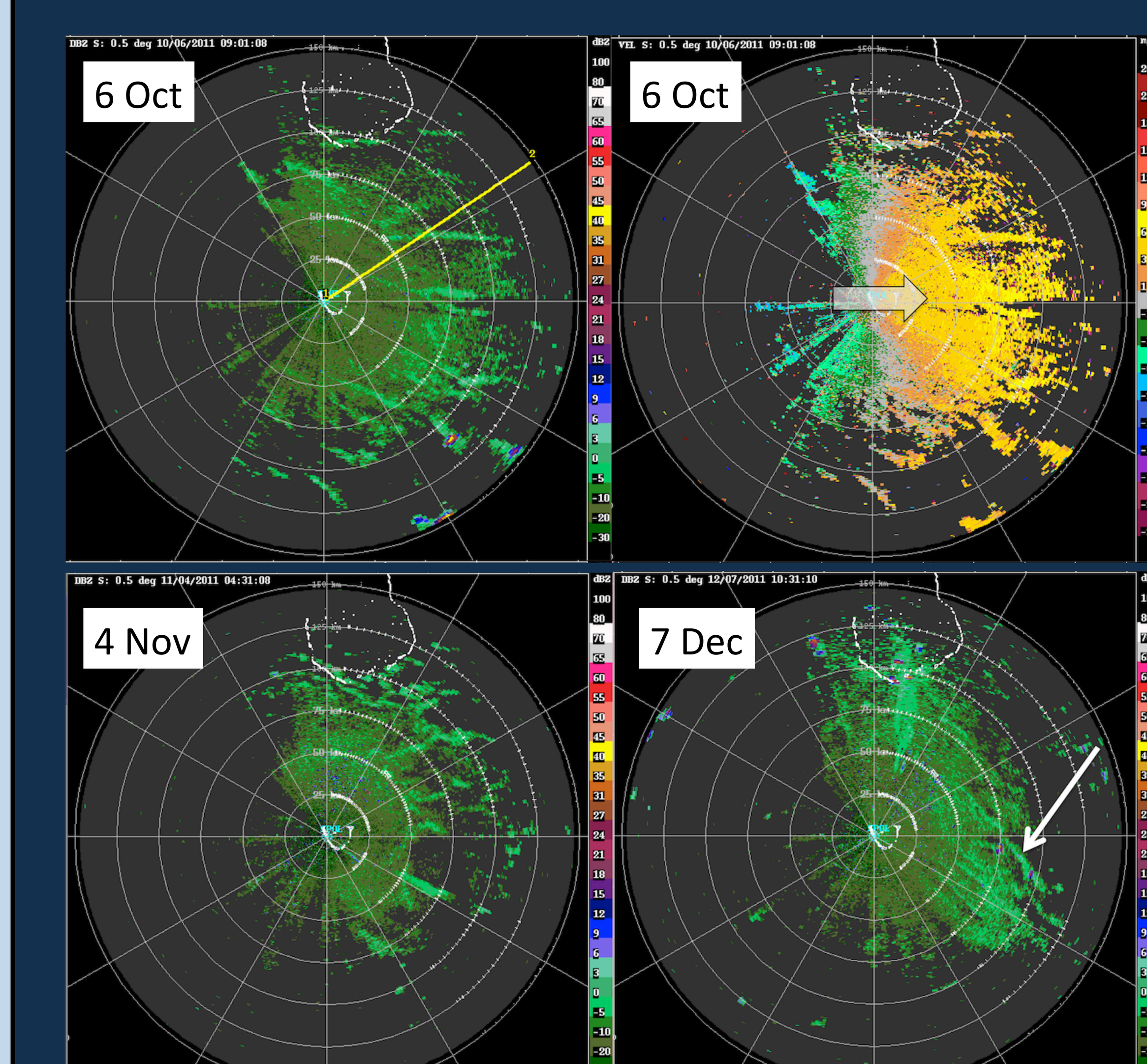
Examples from the early suppressed period and from times of peak rainfall, echo-top height, and number of features during the suppressed periods highlight this transition (including early, nonprecipitating echo) from a radar perspective.

3. Nonprecipitating clouds

S-PolKa RHIs over the KAZR site provided a means to evaluate a broad spectrum of clouds. Feng et al. [2014] compared data from S-PolKa, KAZR, and SMART-R and found that KAZR's shorter wavelength provided the best observations of shallow clouds. However, S-PolKa's high sensitivity (-24 dBZ at 10 km range), allowed for this S-band radar to reasonably detect nonprecipitating cumulus clouds (> 80%) within 30-50 km range. S-PolKa observations also allowed for an assessment of the horizontal patterning of the shallow nonprecipitating clouds, placing KAZR observations within a broader spatial context.





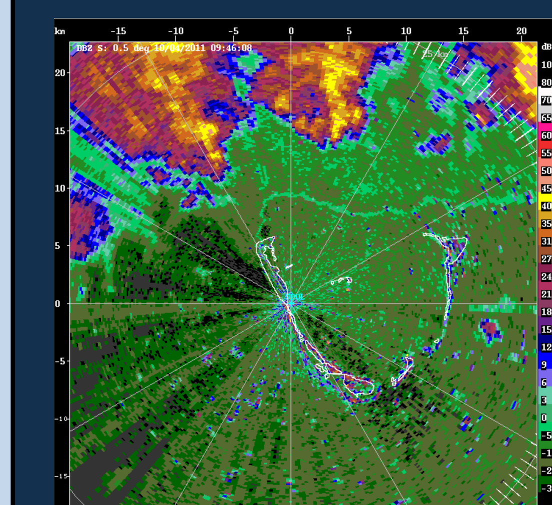


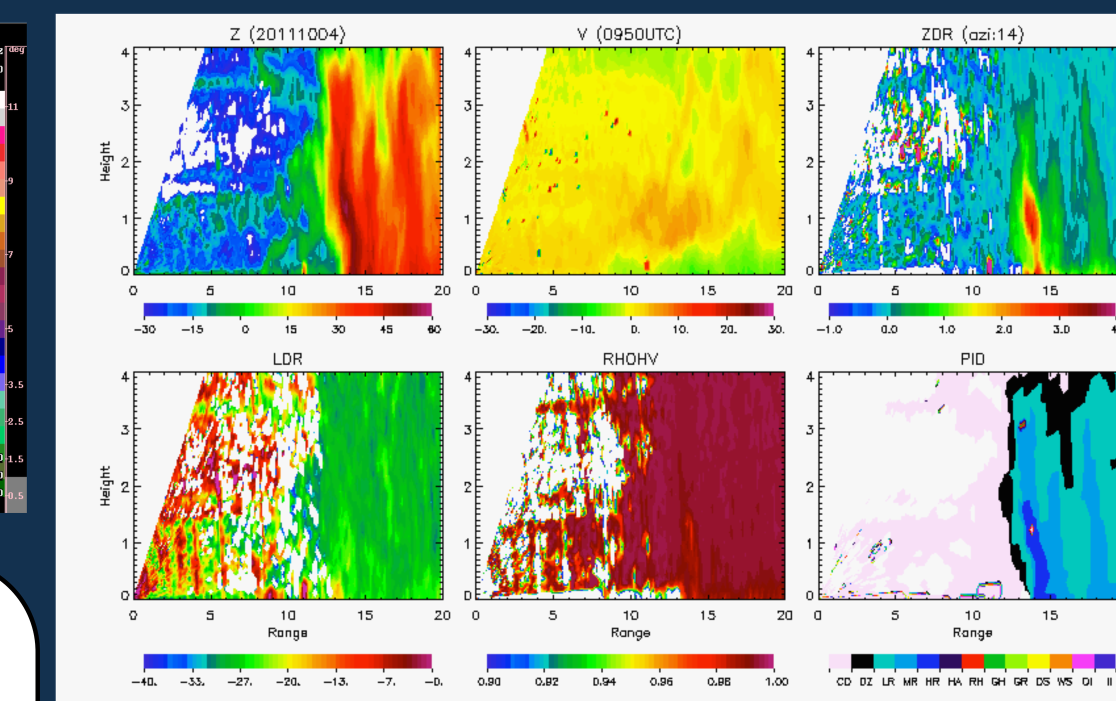
Observations of shallow nonprecipitating cumulus clouds oriented in parallel lines (horizontal convective boundary layer rolls) were common during morning hours of early suppressed periods for all three months.

Clouds also organized along open cells when low-level winds were weaker.

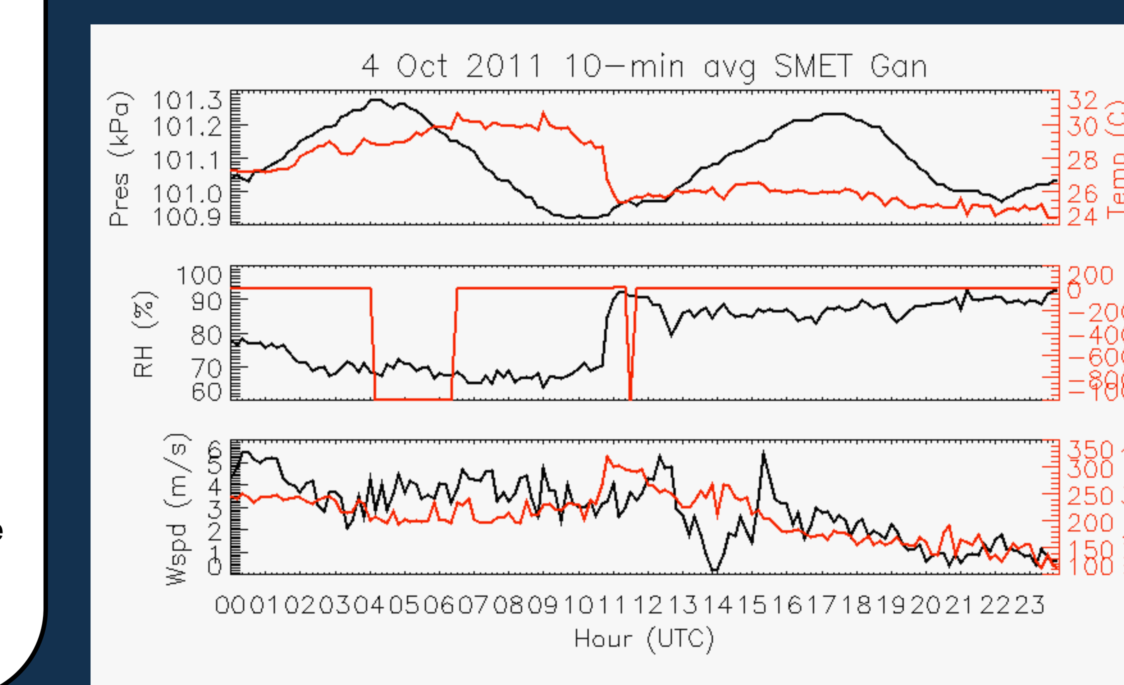
Convective initiation focused on these lines/ open cells during the afternoon.

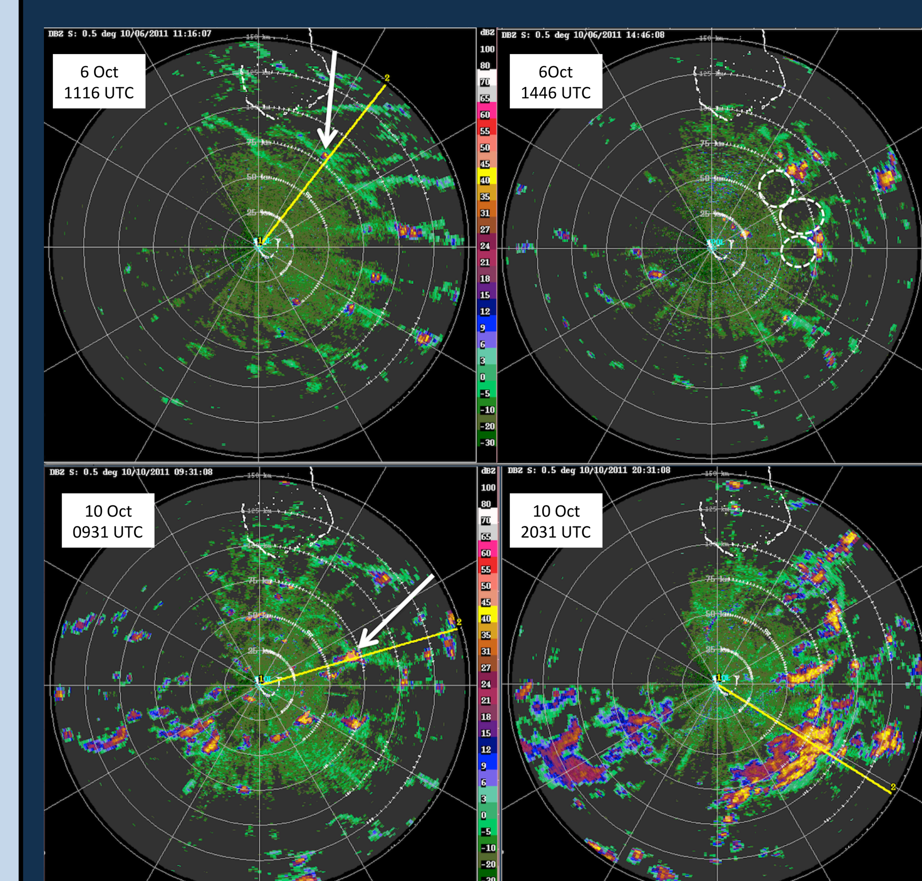
4. Cold pools



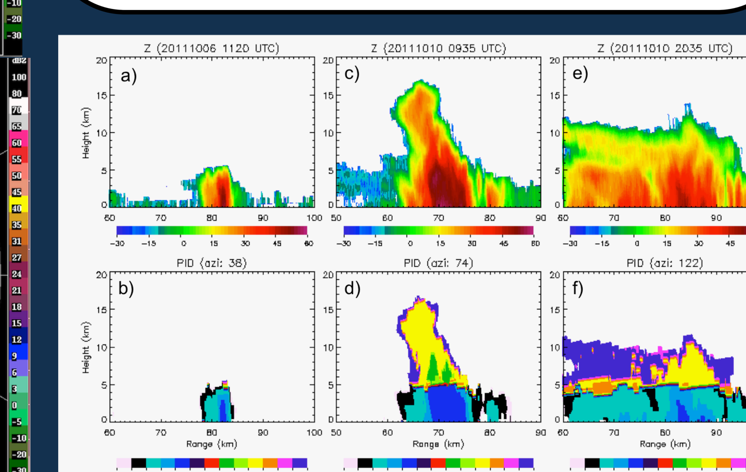


Cold pool properties were documented by the AMIE surface met station (e.g., small decrease in temperature). Outflow boundaries were seen on radar as distinct fine lines ahead of larger convective clusters or as circles of enhanced reflectivity bounding echo-free regions from isolated convective cells. These data sets allow for cold pool characteristics to be related back to the precipitating cells that produced them, as well as the subsequent cells that may initiate along those boundaries.



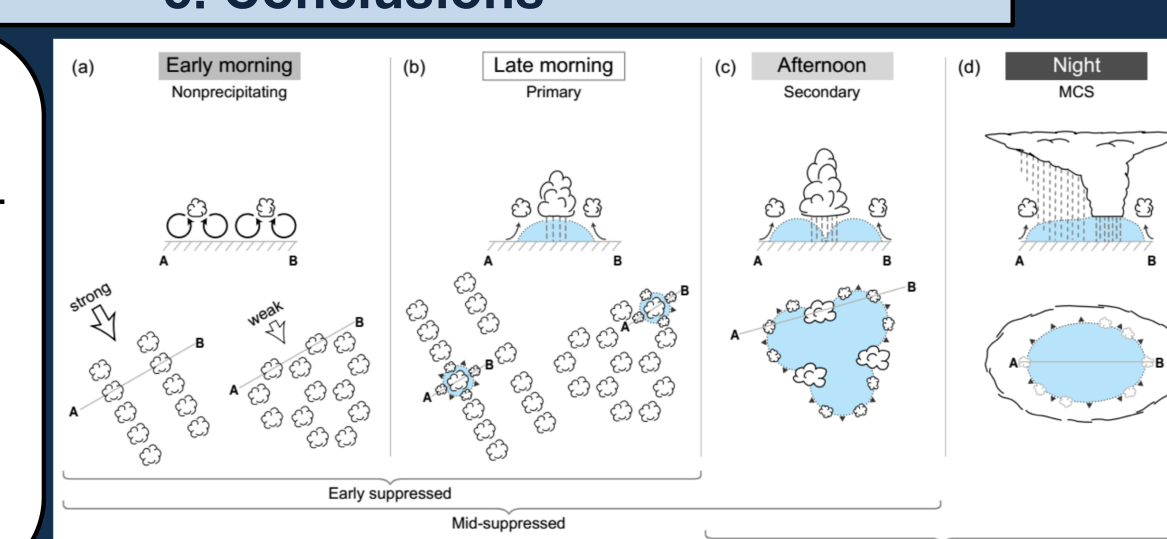


Precipitating cells that formed along horizontal convective rolls/open cells produced cold pools that led to subsequent convective initiation. Convection that formed along intersecting cold pools boundaries during late afternoon of the later days within suppressed periods were deeper and occurred in larger clusters, consistent with a recent modeling study (Feng et al. 2015)



5. Conclusions

Nonprecipitating clouds observed by S-PolKa (confirmed by KAZR) organize into lines/open cells. Precipitating cells produce cold pools (confirmed by surface met data) that initiate further convection. Deepening and upscale growth of convection promoted by intersecting boundaries, leading to MCSs by active phase.



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