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Probabilistic Discrimination Between Liquid Rainfall Events, Hailstorms, Biomassburning and Industrial Fires

From C-Band Radar Polarimetric variables

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Introduction

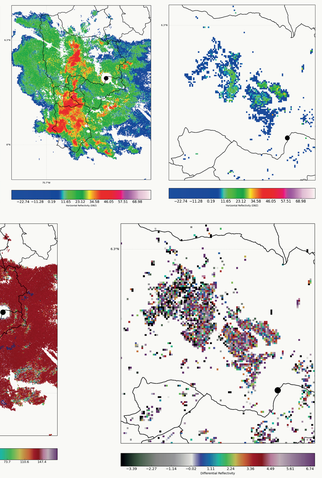
Polarimetric variables from a C-Band dual polarization weather radar have potential uses in particle classification due to their dependance on shape, spatial orientation, size and fall behavior. The main goal of this work is to identify and characterize the radar echoes associated with fire and hailstorm events in a tropical complex-topography region. In order to identify fire events, radar retrievals from typical liquid precipitation events were compared with those asssociated with fire events: Three forest fires and two chemical fires were identified in the study region (Áburra Valley, Colombia).

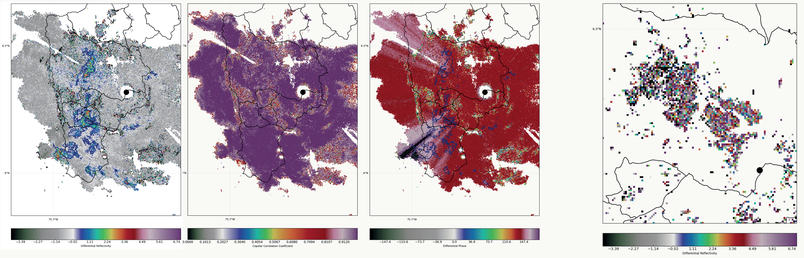
The methodology is extended to hailstorm cases. Complementary sensors like laser precipitation sensors (disdrometers) and meteorological weather stations were used to identify events with presence of solid precipitation.

Data

- C-Band radar data
- Ceilometer retrievals
- Disdrometer data
- Weather station records
- Fire events dates

Date (yyyy/mm/dd)	Fire type
2014/07/05	Chemical fire
2015/05/26	Chemical Fire
2015/06/25-27	Forest fire
2016/02/16	Forest fire
2017/02/08	Forest fire
2017/03/28	Chemical Fire
2017/07/08	Chemical fire
2017/08/18	Chemical fire





Polarimetric Variable Discrimination

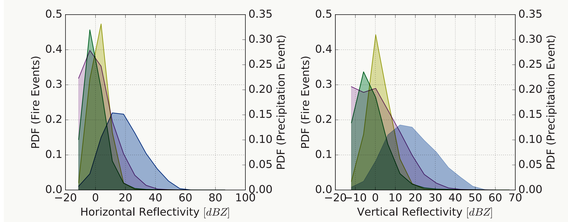


Figure 1.

Polarimetric Variable Discrimination

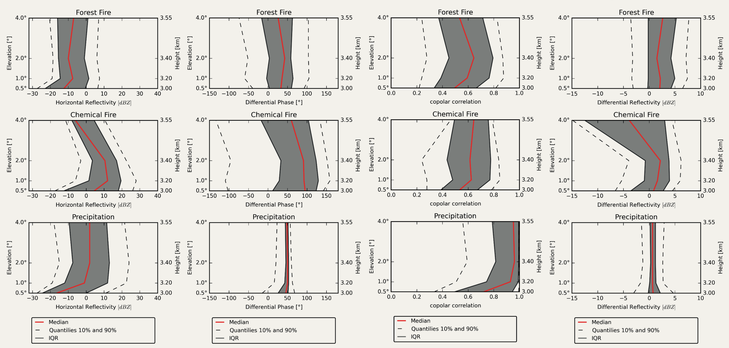


Figure 2.

Polarimetric Variable Discrimination

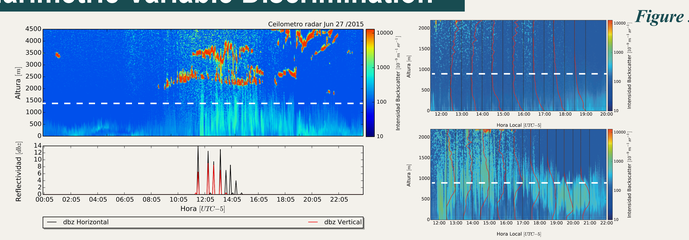


Figure 3.

Characterization of rainfall events with disdrometer

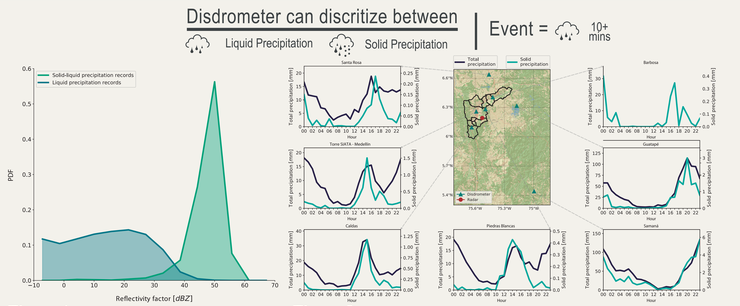


Figure 4.

Reflectivity distribution: solid vs. liquid precipitation.

Figure 5.

Diurnal cycle of total and solid precipitation for different disdrometers

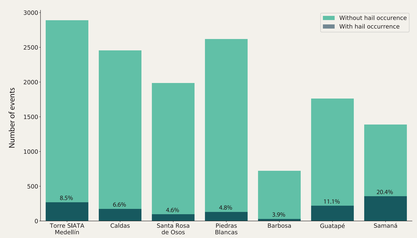
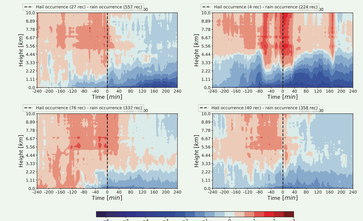


Figure 6.

Number of events with and without hail occurrence for each disdrometer.

Component Analysis For Temperature



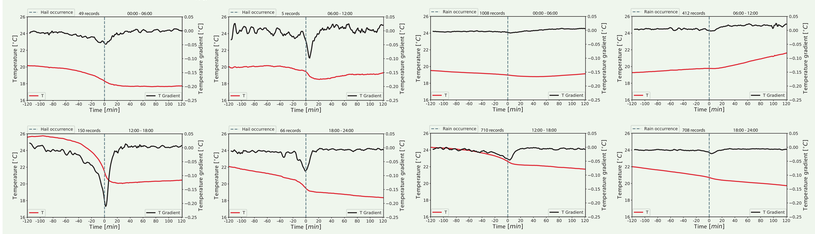
Zero corresponds to the time at the maximum rainfall intensity of each event considered.

Figure 7.

Difference in atmospheric temperature between events with and without hail occurrence for different hours of the day

Figure 8.

Surface temperature and its gradient before and after a rainfall maximum intensity. Left: With hail occurrence. Right: Only liquid rain.



Weather radar signatures

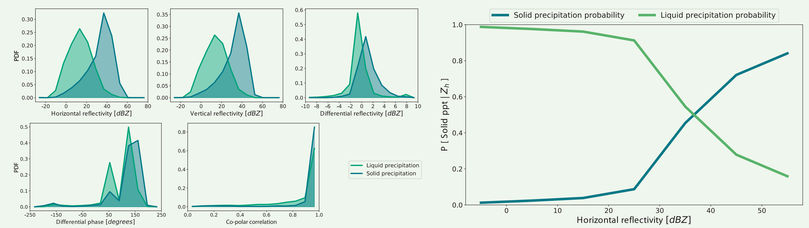


Figure 9.

Distributions of polarimetric radar variables for events with and without hail fall.

Figure 10.

Probabilistic discrimination between solid and liquid precipitation using Bayes' theorem for horizontal reflectivity.

Conclusions

C-Band radar polarimetric variables are useful for probabilistic discrimination between chemical and forest fires and hailstorm events. In particular, probability density functions of differential reflectivity and copolar correlation for different events/particles/hydrometeors are significantly different

Rainfall events with hail occurrence are associated with a sharp near surface air temperature decrease (likely generating cool pools). This change is more drastic in afternoon hours.

Acknowledgements

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