



# **Unsupervised Characterization of Anomalies in CMLs** and Their Relation to Weather

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## **1. Introduction**

- Signal changes in CMLs due to weather are often misclassified as faults.
- It's Hard to distinguish between meteorological effects and real malfunctions (e.g., hardware issues).
- This Leads to unnecessary maintenance and missed environmental insights.
- We investigate a method to detect and classify faults in CMLs, and relate them to weather events

#### 2. Data

### **Study Regions**



Figure 1: Study regions and link distributions across French Guiana, St. Martin, Martinique, and Guadeloupe, with marked weather station locations.

### **5. Results & Conclusions**

Fault segments were detected using ML tools trained on unlabeled data. Start/end points were identified using learned reconstruction thresholds.

~650 Commercial Microwave Links (CMLs) from: St. Martin, French Guiana, Martinique, Guadeloupe

• 15-min TX/RX power readings

penSense

- Up to 1.5 years of data per link
- Includes metadata: frequency, path length, location

# 3. Validation

- Rain data from NOAA matched to CML regions
- Only **moderate+ rain events** (>10 mm/day) included
- Rain events **temporally aligned** with detected anomalies
- Used to validate correspondence between signal disruptions and precipitation

# 4. Methodology

We developed an unsupervised pipeline consisting of:

Ŧ Predrocessing



Figure 2: Example of detected fault segments using autoencoder reconstruction error.





Figure 4: Rainfall overlap fraction across fault clusters.





Figure 3: Visualization of clustered fault segments.

K=6 | Silhouette Score: 0.3

- **Blue** & **Orange:** Localized/technical faults **Red** & **Brown**: Likely regional, weather-driven faults
  - **Purple**: Mixed—strong domain features, unclear rain match
- **Green**: Neutral or borderline behavior

Our approach enables automated, interpretable fault classification in CMLs, supporting both infrastructure diagnostics and weather sensing.

## **Physical and Signal Features**

- **Domain-Based Features:** Help identify whether a fault is lacksquareregional (e.g., weather-related).
- **Signal Characteristics:** Describe signal structure and dynamics.

## References

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