



Alicia — AI-Powered Severe Weather Detection

Proof of Concept Results

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The Problem

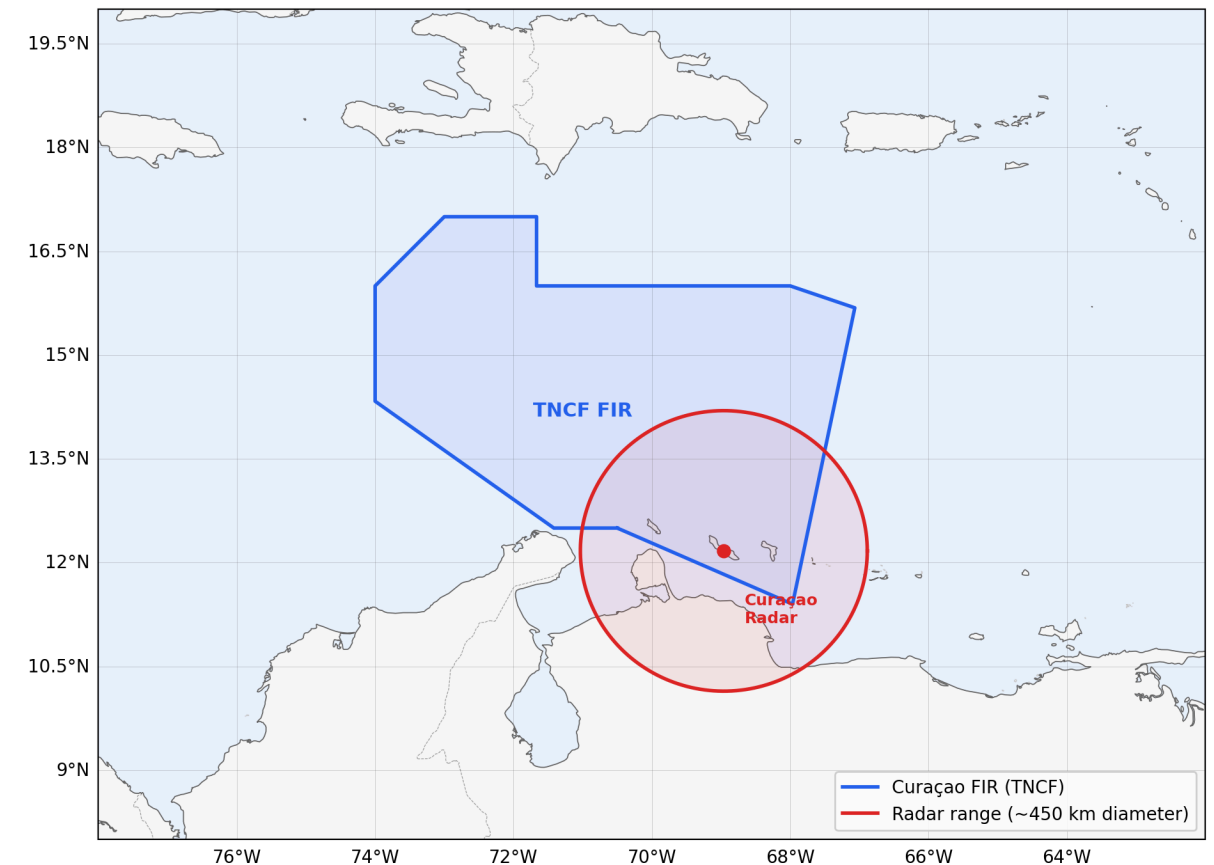
Our radar detects storms precisely — but only within **~225 km of Curaçao**.

Our FIR responsibility covers **most of the Caribbean**.
Storms develop far beyond radar range.

Satellite covers the entire region every 10 minutes — but it measures **cloud tops**, not precipitation.

The idea: Teach a model to recognize which cloud structures produce storms, by learning from **24,500 co-located satellite + radar observations**.

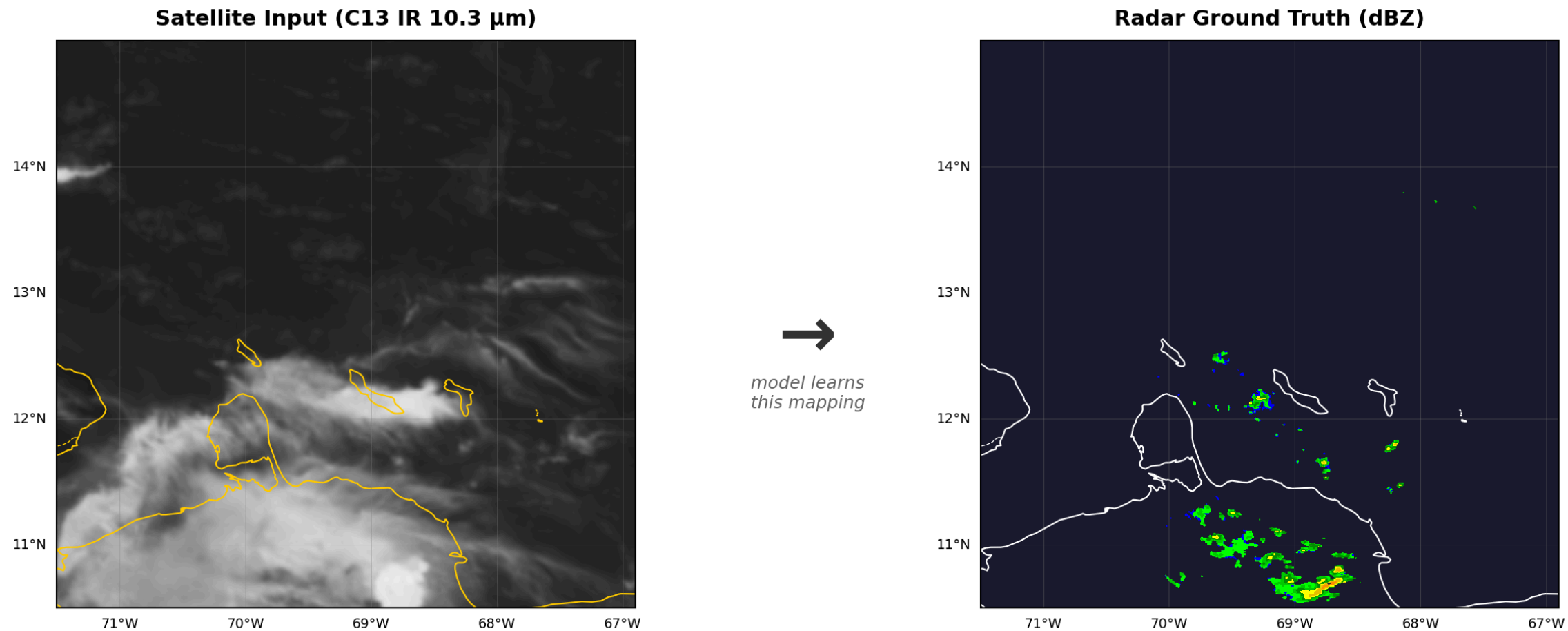
Where we have radar overlap → the model learns the mapping. Then it can predict beyond radar range.



What We Built

A neural network that translates **satellite observations** → **radar-like storm detection** across the full FIR.

- **Input:** 4 infrared + water vapor satellite channels, plus derived atmospheric indicators
- **Output:** Predicted storm intensity at **3.2× the satellite resolution**, covering the entire Caribbean



9 July 2025, 13:20 UTC — same moment, same area

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The Training Data

24,500 co-located observations — every 10 minutes where satellite and radar overlap, from July–November 2025.

Input	What it measures
IR window (10.3 μm)	Cloud top temperature — cold tops = tall clouds
3 water vapor channels (6.2–7.3 μm)	Moisture at different atmospheric levels
Derived differences	Convective signatures hidden in channel combinations
Lightning (GLM + ground sensors)	Direct thunderstorm indicator

Label: Actual radar reflectivity — what the radar measured at the same time and place. The model is scored against reality.

How We Measure Success

Not all metrics are equal — **99% of pixels are clear sky.**

A model that predicts “no storms anywhere” scores well on average error, but is useless.

We use storm-specific metrics:

Metric	What it measures	Analogy	Our best
POD	Of all real storms, how many did we find?	“Did we catch it?”	37%
FAR	Of all predictions, how many were wrong?	“False alarm rate”	79%
CSI	Combined skill — penalizes misses AND false alarms	“Overall score”	0.123

These are **pixel-level** metrics — every 625m grid cell is scored independently. At the level of storm systems, detection rates are substantially higher.

What We Learned

50 controlled experiments — changing one variable at a time.

3 key findings.

Key Findings

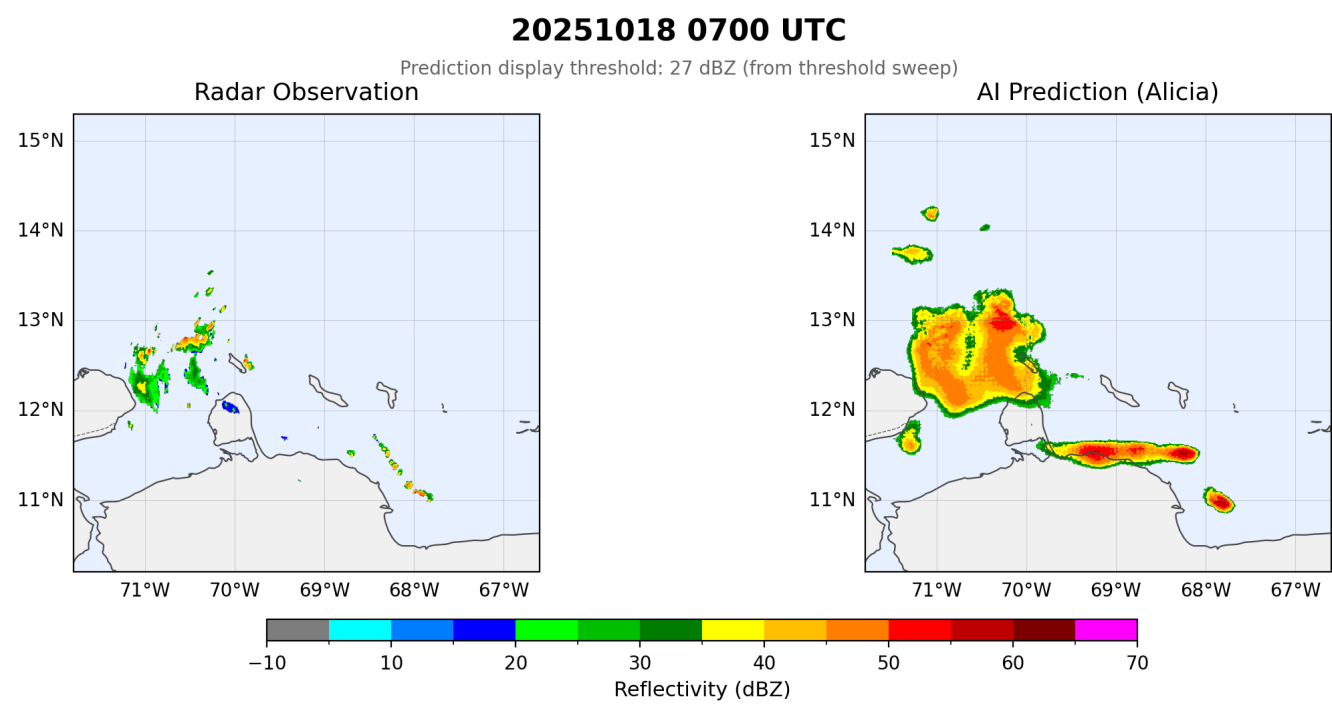
- 1. The training approach was critical** — standard methods fail on this data because storms are so rare (<1% of pixels). A specialized three-component training strategy was needed.
- 2. Multi-channel satellite input doubles detection skill** — a single infrared channel captures only ~40% of the model’s potential. Water vapor channels and derived atmospheric indicators are essential.
- 3. Physics-informed labels transform severe detection** — encoding storm vertical structure into the training target improved severe storm detection **3.5–7×** without any model changes.

Configuration	CSI@15 dBZ	CSI@35 dBZ	CSI@45 dBZ	POD
Single IR channel	0.050	—	—	24.6%
All satellite channels	0.119	0.038	0.005	35.3%
+ physics-based labels	0.123	0.068	0.035	36.7%

Visual Proof: Storm Detection

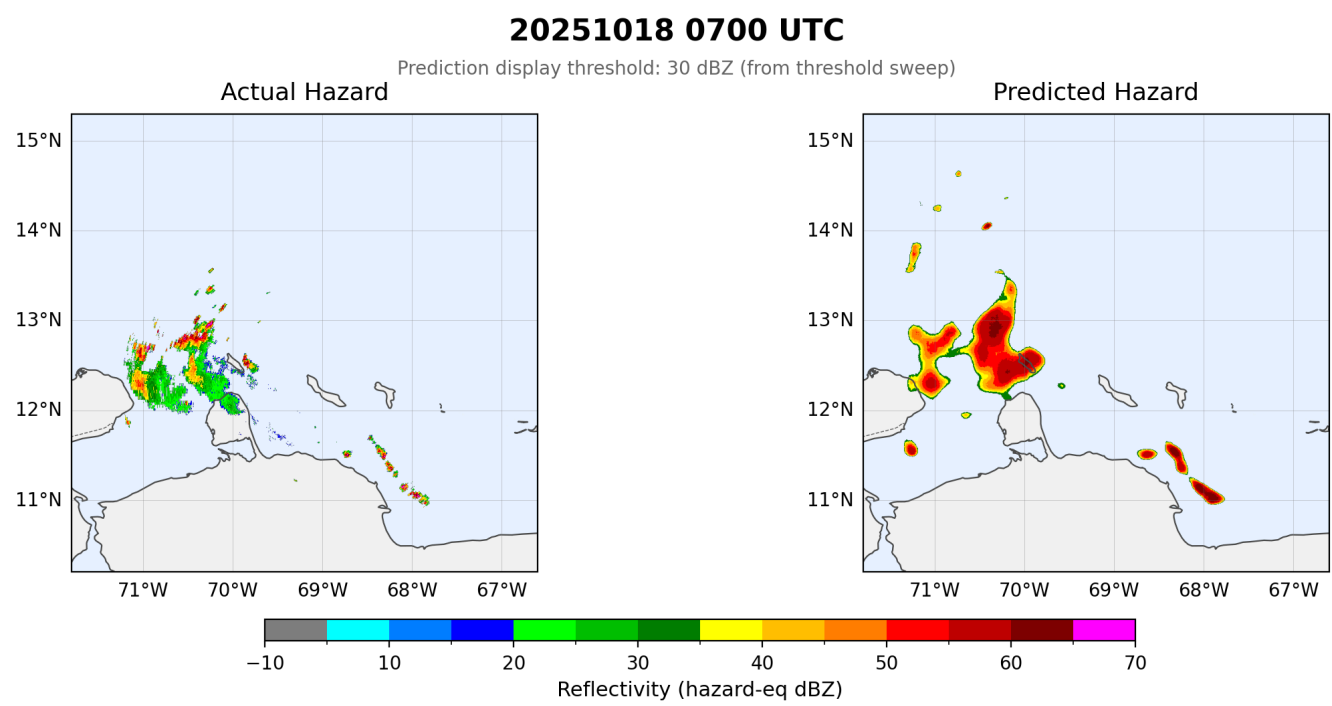
Same moment, same model — only the input changes.

Single IR channel (C13 only)



A broad, imprecise blob — cannot distinguish storm types.

Full model (best configuration)



Resolves individual storm cells and intensity structure.

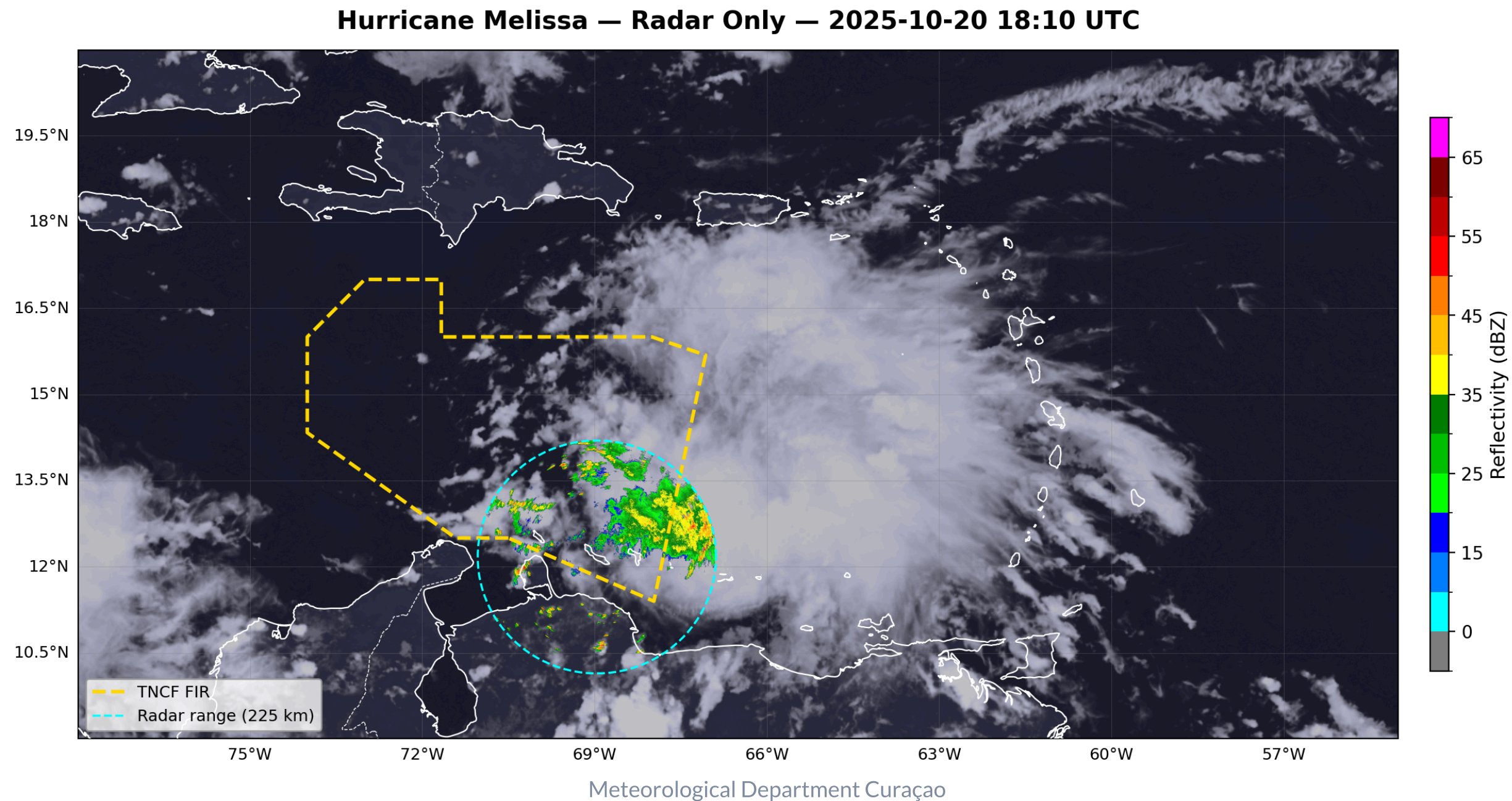
Real-World Use Case

Hurricane Melissa — October 20, 2025

Category 1 hurricane passing through the Curaçao FIR.

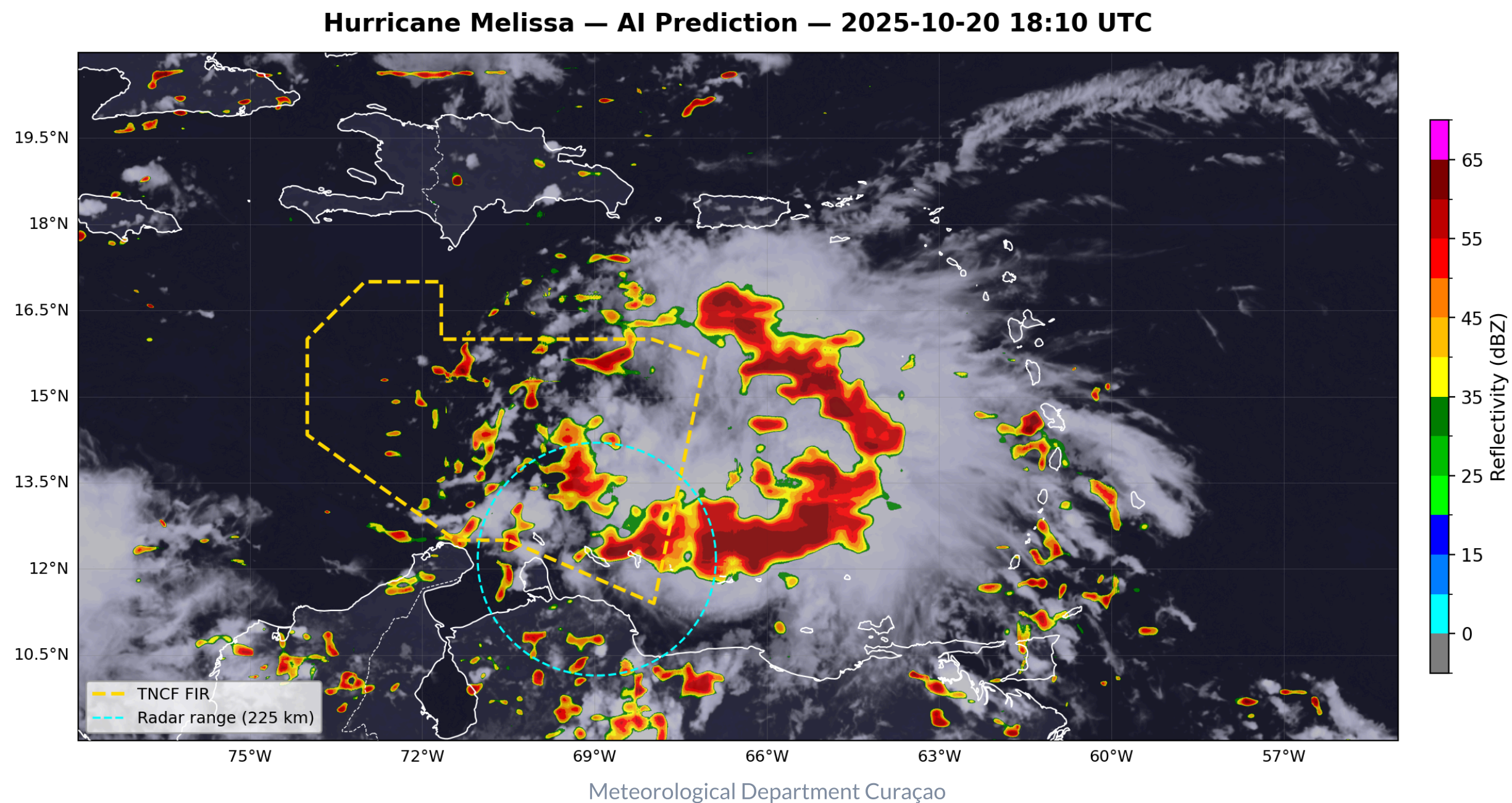
Hurricane Melissa: What Forecasters See Today

The radar covers a **225 km circle**. The rest of the hurricane — and the FIR — is invisible.



Hurricane Melissa: What Alicia Sees

The AI extends storm detection from a 225 km circle to the **entire Caribbean**, using satellite observation.



Comparison with Published Research

Study	Venue	Data	RMSE (dBZ)
SRViT (Stockwell et al.)	ICML 2024	Continental US, 3500 km radar network	3.09
EF Sat2Rad (Kucuk et al.)	AMS 2024	Continental US	—
Alicia (this work)	—	Single C-band radar, tropical Caribbean	3.47

- Our accuracy is **within 12%** of the current state of the art — using a simpler architecture trained on a single radar
- Published studies use the US MRMS network (thousands of radars, continent-wide). We train on **one radar** in the tropics
- Our severe detection metric (CSI@45) addresses a gap not evaluated in either published study

What's Next

Near-term improvements:

- Combine best findings from all 50 experiments into a single optimized model
- Clean training labels using dual-polarization radar data (may reduce false alarm rate)
- Expand training dataset with additional stormy season data

Project phases:

Phase	Goal	Status
1. Storm detection	Satellite → pseudo-radar for full FIR	POC complete
2. Lightning prediction	Predict thunderstorm areas from satellite alone	Development
3. Nowcasting	Predict storm evolution 0–6 hours ahead	Planned
4. Warning production	Draft SIGMETs, aerodrome + flood warnings	Planned

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