CISESS

Cooperative Institute for Satellite Earth System Studies

Persistent Microwave Storm Analysis by GOES-18 Optical-Flow Advection

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Problem statement

- GOES-18 ABI observes the eastern Pacific every 10 minutes, but thermal infrared images can only sense cloud tops, not internal storm structure.
- Polar-orbiting microwave (MW) imagers (AMSR2, AMSR3, WSF-M) can “see” the internal structure of storms, but they provide only snapshots in time.

Objective

- Use GOES-derived cloud motion to transport each microwave snapshot forward in time until the next observation arrives, providing a continuously updated MW field.

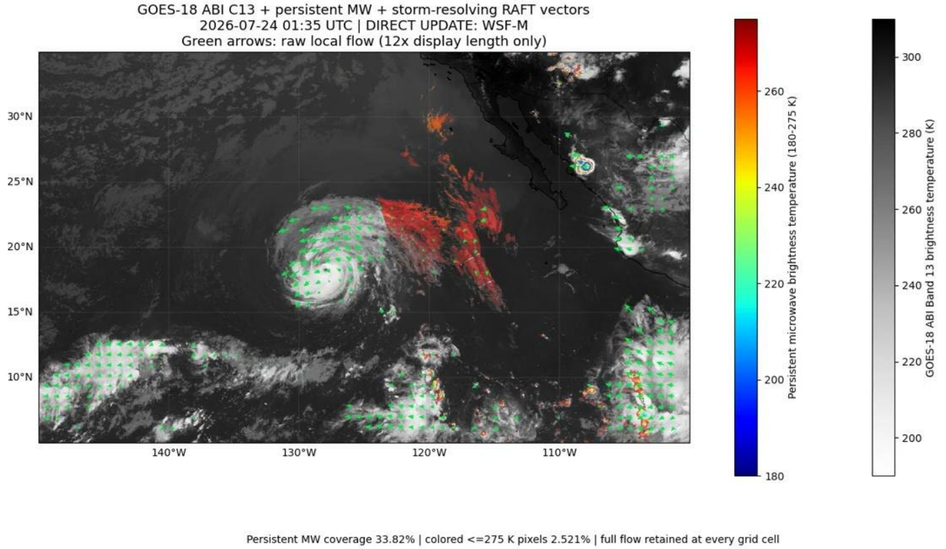


Figure 1:

Figure 1 —2026-07-24 01:35 UTC, direct update from WSF-M. Gray: ABI C13 infrared. Color: persistent microwave Tb (180–275 K). Green: raw local flow, 12× display length only.

Ingest

1,152 GOES-18 NetCDF files (19.7 GiB), 24–31 July 2026, 10-minute images.

Estimate flow

RAFT-Small (TorchVision, CPU) on consecutive ABI C13 frames gives dense u(x,y), v(x,y).

Warp

Existing microwave pixels shift to x+u, y+v —a geometric move, not a Tb prediction.

Refresh

A new swath replaces the prediction exactly in overlap and adds coverage elsewhere.

Gate

Validity checks reject invalid frames; microwave is held across GOES gaps.

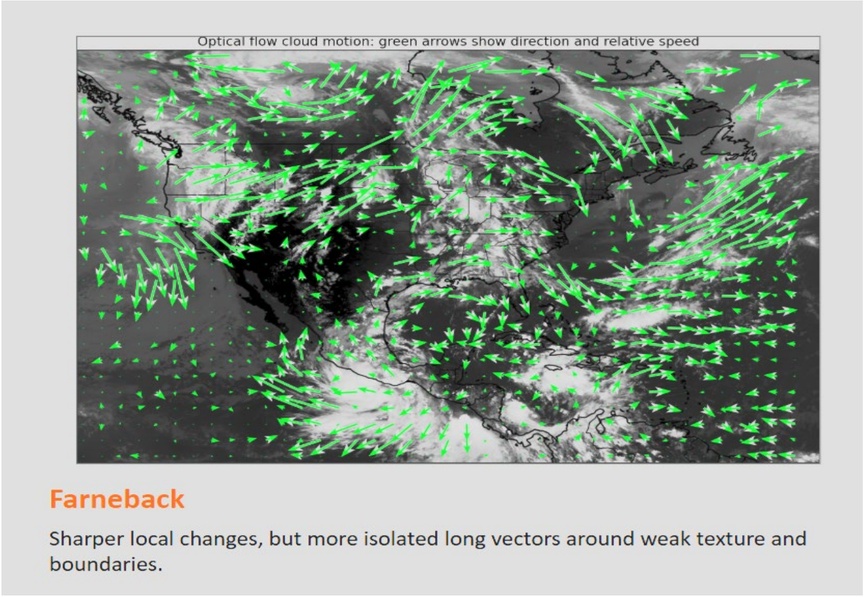


Figure 2: Comparison between Farneback and RAFT vector algorithms for visualizing GOES-19 Cloud motion.

Key findings

- Final analysis coverage reached 99.86% after the first overpasses and stayed continuous across all 7 day boundaries.
- 163 direct microwave update frames from three sensors accumulated coverage instead of flashing; maximum replacement error was 0 K.
- RAFT-Small preserved storm-scale circulation better than an OpenCV dense-flow baseline, which looked more spatially averaged.
- One all-NaN GOES frame produced a false ~148-cell median displacement; validity gating reduced it to 1.39 cells.

Conclusion and future work

- The result is a persistent image analysis, not a wind retrieval: flow is displacement in grid pixels, and advection cannot create or intensify storm structure.
- Best current use is a Stage 1 geometric motion prior for a later physics-aware correction model.
- Validate transported forecasts against held-out microwave swaths by storm, lead time, and sensor.
- Train Stage 2 U-Net residuals for growth, weakening, and newly formed structure; add uncertainty and physical units.