Precipitation Observation Site in Central Texas for Ground-Validation of Satellite QPE

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ABSTRACT

High-fidelity satellite Quantitative Precipitation Estimation (QPE) relies on physical assumptions that require localized ground-level constraints. This specialized research field site, established at the University of Texas at San Antonio (San Antonio, Texas, USA) by the author, offers high-resolution surface precipitation measurements that can be used for satellite algorithm validation and the refinement of radar-based rainfall retrievals. The facility features a unique instrumental framework for characterizing microphysical and bulk precipitation quantities, complemented by a 10-m meteorological tower. The suite includes commercially established sensors — such as the OTT Parsivel² disdrometer, OTT Pluvio² weighing gauge, TB-4 tipping-bucket rain gauges, and 3D sonic anemometers — alongside unique research instruments developed by the author's laboratory: the High-speed Optical Disdrometer (HOD) for accurate raindrop size, shape, and fall speed observations and the Aerial Disdrometer for raindrop size distribution and fall speed measurements at different elevations. By providing necessary sub-pixel uncertainty quantification and microphysical constraints, the site has the potential to serve as a regional resource to refine surface rain rate retrievals from spaceborne observations. We will present the technical capabilities of this facility to invite collaborative endeavors aimed at advancing satellite QPE and other hydro-meteorological applications. This material is based upon work supported by the National Science Foundation under Grants No. AGS-1741250.

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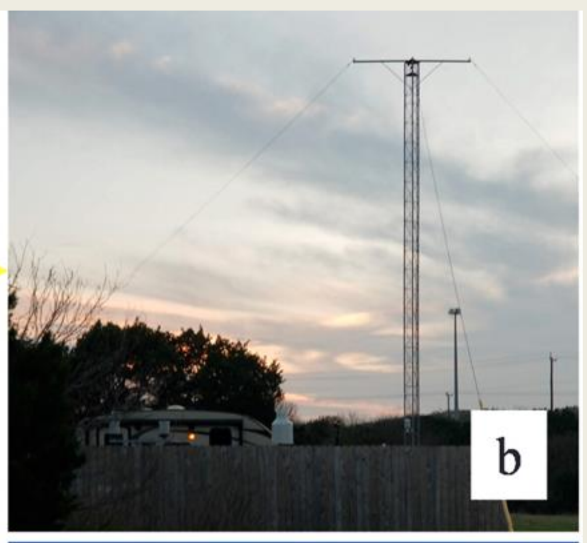
MOTIVATION

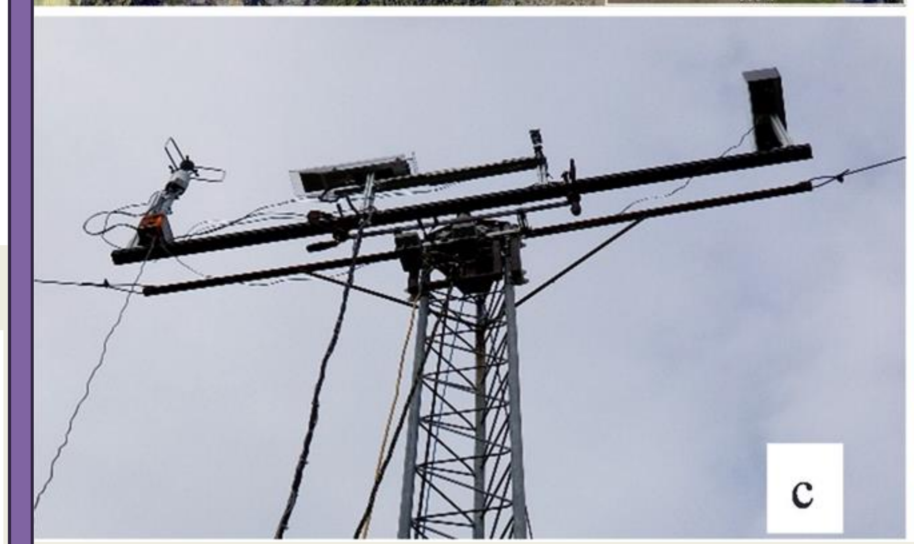
- High-fidelity satellite QPE relies on physical assumptions that require localized, ground-level constraints.
- Specialized field sites provide high-resolution surface measurements for satellite algorithm validation & radar-based rainfall retrieval refinement.
- **Convective & Flash Flood Hotspot:** Located in a region prone to severe convective storms and extreme rainfall events, San Antonio can be a critical, high-utility ground truth node.

OBJECTIVES

- Introduce a specialized surface precipitation field site established by the author in San Antonio, Texas.
- Site features unique aerial & ground-based sensors developed in the author's lab alongside commercial instruments to capture rain & wind measurements suitable for satellite-based QPE studies.

FIELD SITE



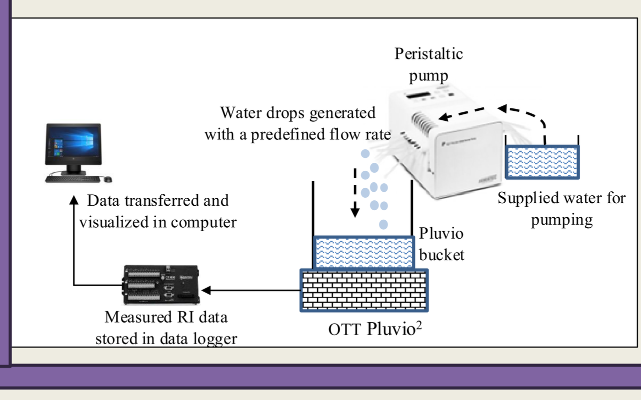


UTSA West Campus
San Antonio, Texas, USA

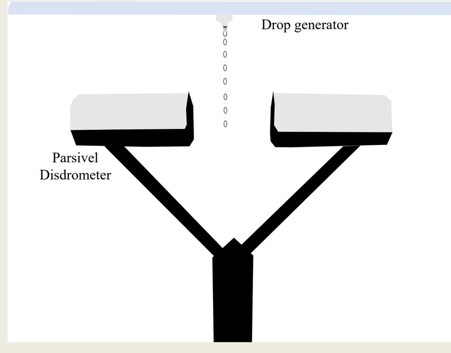
Coordinates & Elevation: 29°34′43.4′′N,98°37′50.0′′W at 296 meters above mean sea level.

Terrain: Flat, open suburban terrain with <4% land slope, free of tall trees or structural obstructions.

Infrastructure: Features a 10-m-tall meteorological tower and a camper trailer providing a dry working space.



Simplified schematics for experimental setups for assessing OTT-Pluvio² (left) and Parsivel² (right).



Controlled-Environment Support: Features dedicated experimental setups to complement our field monitoring activities.

UNIQUE INSTRUMENTATION & CAPABILITIES

Meteorological instrumentation developed in the author's lab and their capabilities.

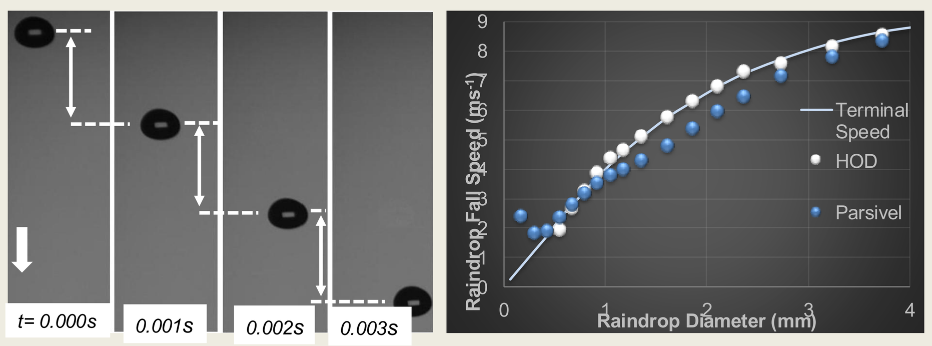
HIGH-SPEED OPTICAL DISDROMETER (HOD)

HOD system and main components: LED light (left), the sensor unit (middle), and the high-speed camera (right).

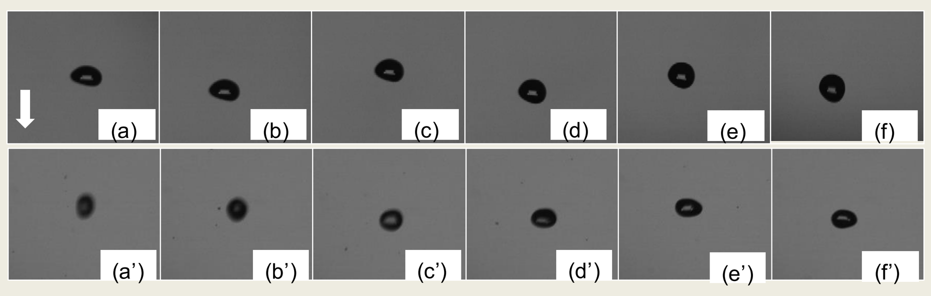
HOD CAPABILITIES

High-frequency sequential imaging of individual raindrops for unique precipitation microphysical observations.

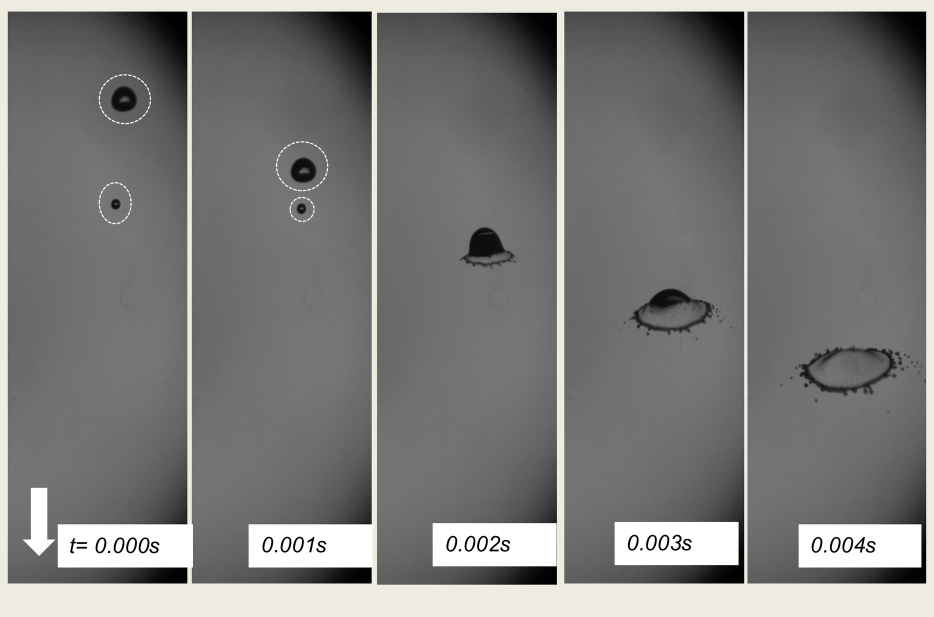
Accurate fall speed measurements via image processing



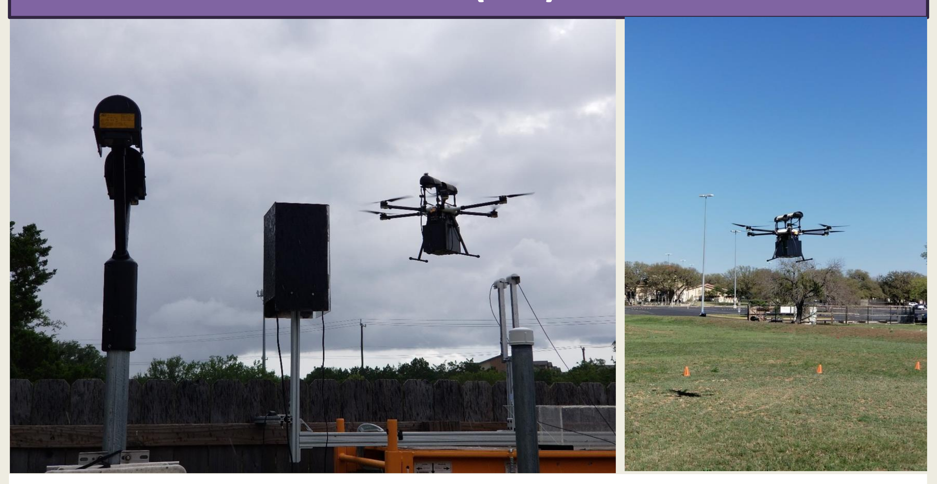
Raindrop oscillation observations



Raindrop collision observations

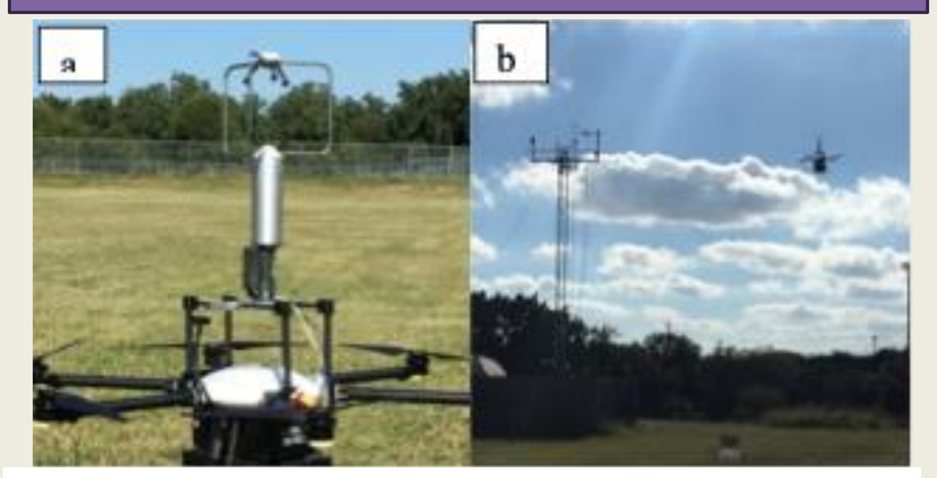


AERIAL DISDROMETER (AD)



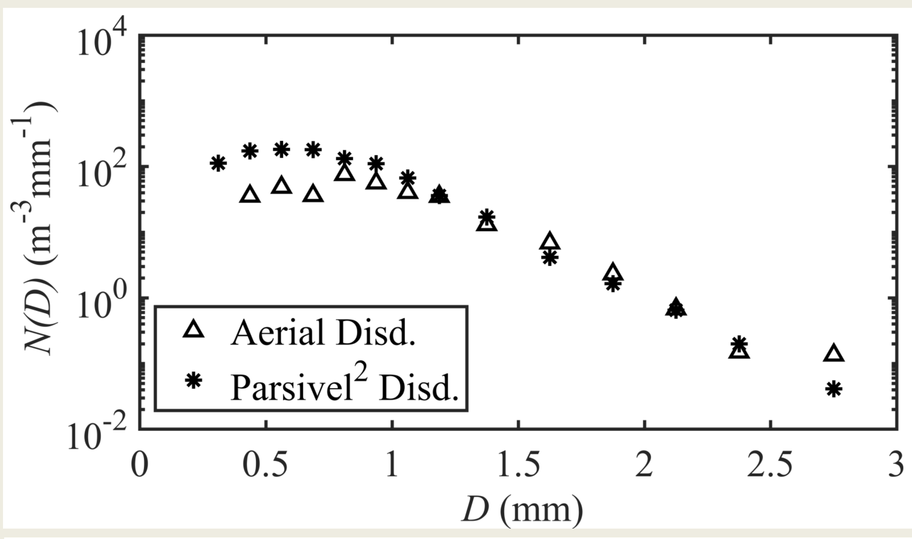
AD for aerial DSD and fall speed measurements.

AERIAL ANEMOMETER (AA)

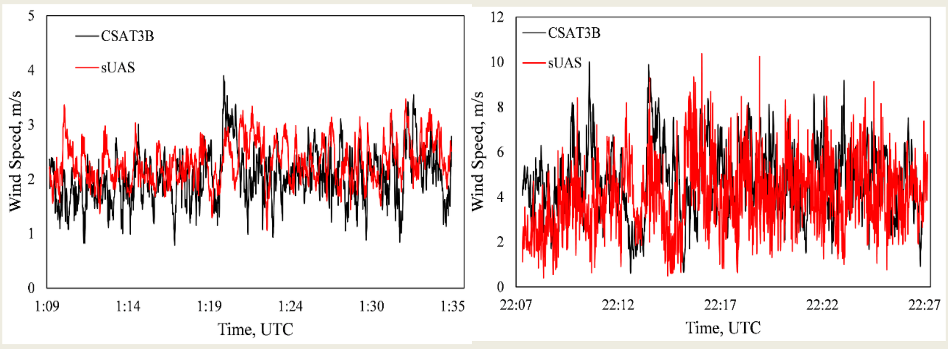


AA for aerial wind and turbulence measurements

AD & AA CAPABILITIES



Comparison of collocated DSD measurements by AD and Parsivel². Good agreements observed also for fall speed measurements.

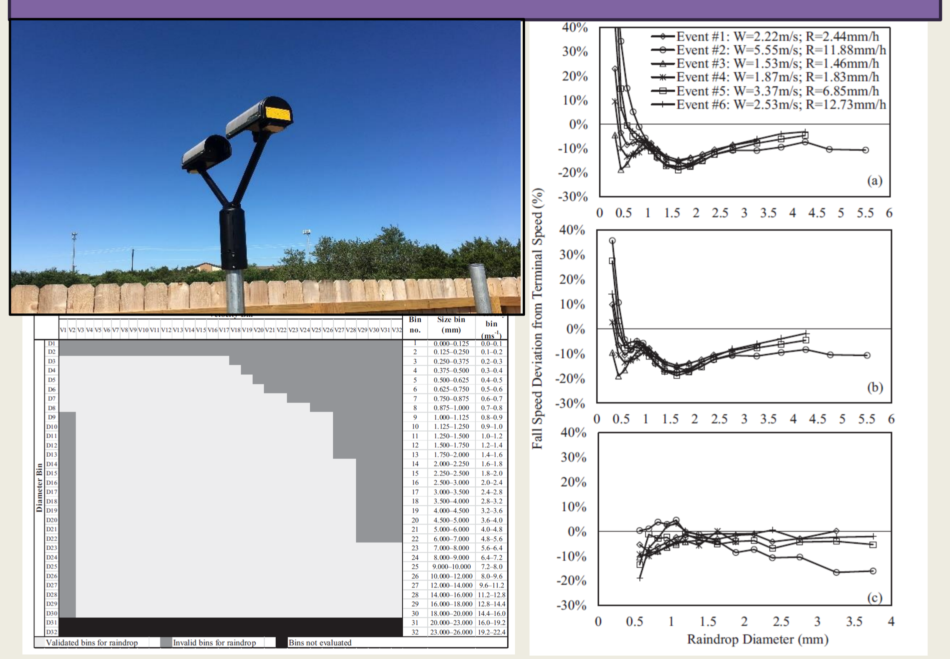


Wind speed measurements by the AA and their comparison with measurements by an anemometer on the meteorological tower.

INSTRUMENT ASSESSMENT

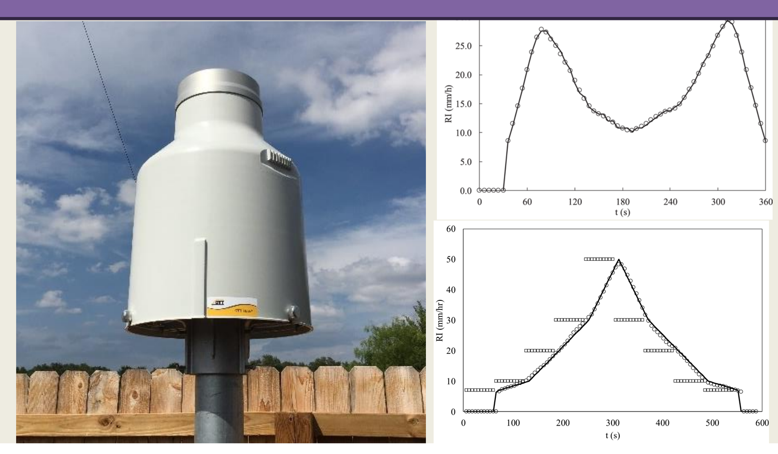
Equipped also with standard instruments and capabilities include assessment of meteorological instrumentation.

OTT – PARSIVEL²



Assessment of Parsivel² measurements and identification of its internal algorithm.

OTT – PLUVIO²



Assessment of Pluvio² measurements and identification of its internal algorithm.

CONCLUSIONS

Our field site integrates standard monitoring and advanced, unique observational capabilities by pairing commercial instrumentation with custom-developed, high-fidelity sensors. This framework establishes a dedicated site to capture high-resolution precipitation microphysics within the atmospheric boundary layer that can be utilized for satellite and radar QPE validation.

ACKNOWLEDGEMENTS

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REFERENCES

- Saha, R., Testik, F.Y., 2023, *JTech*, 40 (5), 557-573.
- Saha, R., Testik, F.Y., Testik, M.C., 2021, *JTech*, 38 (4).
- Testik, F.Y., Rahman, M.K., 2016, *JTech*, 33 (2), 231-243.
- Bolek A., Testik, F.Y., 2022 AIAA Forum & 2026 JTech (under review)