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Research Summary

Precipitation retrieval and product-evaluation scientist specializing in satellite algorithm development, diagnostic evaluation, and uncertainty analysis across infrared and microwave remote sensing, in situ observations, reanalysis data, and machine-learning retrieval methods. Current research addresses high-latitude precipitation retrieval and correction, multi-reference validation of ocean and polar precipitation products, geospatial machine learning, and rainfall monitoring in data-sparse regions, contributing to NASA-supported GPCP- and IMERG-relevant precipitation research at the University of Arizona. Doctoral research developed satellite-microwave-link rainfall retrieval methods for high-spatiotemporal-resolution mapping in data-sparse regions of Sub-Saharan Africa.

Professional Appointments

Postdoctoral Research Associate

2023 – Present

Department of Hydrology & Atmospheric Sciences, University of Arizona, Tucson, AZ

Supervisor: Prof. Ali Behrangi

- Key technical contributor to UA-HIPA, an AVHRR-based precipitation retrieval product for regions poleward of 55°; developed a physically informed limb-darkening correction for AVHRR infrared brightness temperatures to address cross-swath scan-geometry bias, and supported delivery of sample output files for NASA/GSFC and GPCP-facing evaluation.
- Built diagnostic evaluation tools assessing AVHRR-based precipitation estimates across latitude bands, seasons, surface types, and independent references.
- Contributed to GPCP Version 3.3 diagnostic evaluation and coauthored a submitted *Journal of Hydrometeorology* manuscript with members of the GPCP science team.
- Developing the Integrated Evaluation of Precipitation Products over Oceans (IEPPO) framework, comparing GPCP, IMERG, ERA5, and MERRA-2 against PAL, moored buoy, atoll, and OceanRAIN references across daily to climatological timescales.
- Lead analyst for an Antarctic precipitation benchmarking study using GRACE-based mass-budget constraints, ice-discharge estimates, and sublimation inputs to evaluate ERA5, GPCP v3.3, and GPM constellation precipitation estimates across IMBIE drainage basins, developed in collaboration with NASA/JPL scientists.

Visiting Scientist — EUMETSAT / H-SAF

2022 – 2023

European Organisation for the Exploitation of Meteorological Satellites, Darmstadt, Germany

- Conducted precipitation-product evaluation through EUMETSAT's Satellite Application Facility on Support to Operational Hydrology and Water Management (H-SAF), with emphasis on satellite precipitation products over Sub-Saharan Africa.
- Contributed to diagnostic evaluation, uncertainty characterization, and validation of operational precipitation products.

Doctoral Researcher

2016 – 2022

Department of Water Resources, University of Twente, Enschede, Netherlands

- Developed methods for high-spatiotemporal-resolution rainfall estimation by combining Meteosat Second Generation (MSG) SEVIRI cloud-top information with commercial microwave link rainfall observations.
- Built and evaluated rainfall-detection, rain-area identification, and gridded precipitation-estimation methods for data-sparse regions in Sub-Saharan Africa.
- Published peer-reviewed articles on CML-satellite fusion, satellite-supported rain-area detection, and near-real-time rainfall mapping.

- Presented this research at the KIT/HyMet CML Symposium and the EUMETSAT Meteorological Satellite Conference.

Education

Ph.D. — GIS & Earth Observation (Hydrometeorology / Water Resources)

2022

University of Twente, Faculty ITC, Enschede, Netherlands

Dissertation: *High-Spatiotemporal Resolution Rainfall Estimation from Satellite and Commercial Microwave Link Data.*

Supervisor: Prof. Bob Su (ITC/TU Delft); Co-supervisor: Prof. Ben Maathuis.

M.Sc. — GIS & Earth Observation (Water Resources & Environmental Management)

2016

University of Twente, Faculty ITC, Enschede, Netherlands

University of Twente ITC Excellence Scholarship (UTS-ITC), €20,000 — competitive merit-based funding awarded to internationally selected candidates.

B.Sc. — Environmental Science

2012

University of Cape Coast, Ghana

Selected Scientific Contributions

A. UA-HIPA — AVHRR High-Latitude Precipitation Retrieval

Key technical contributor to the University of Arizona–High-latitude Infrared-based Precipitation Analysis Version 2 (UA-HIPA), an AVHRR-based precipitation retrieval product for global regions poleward of 55°. The product uses AVHRR observations from NOAA and MetOp polar-orbiting satellites, reanalysis fields, and machine-learning retrieval methods to estimate rain and snow where conventional satellite sampling remains limited, and is being evaluated as a candidate improvement to the high-latitude component of future GPCP products.

B. AVHRR Limb-Darkening Correction Algorithm

Developed and implemented a physically informed limb-darkening correction for AVHRR infrared brightness temperatures, addressing cross-swath scan-geometry bias in the input data used for high-latitude precipitation retrieval. The correction framework is conditioned on latitude, season, cloud type, surface type, and scan geometry, and is integrated into the UA-HIPA production workflow.

C. CML–Satellite Rainfall Retrieval

Developed peer-reviewed methods combining commercial microwave link attenuation with MSG SEVIRI satellite observations for rainfall detection, estimation, and gridded rainfall mapping in data-sparse regions. This research line has informed an ongoing applied-implementation pathway with Rainboo BV, TAHMO, and TU Delft, including API-side testing and rainfall-map generation for African rainfall-monitoring applications.

D. GMAI Snow and Ice Cover Record Extension, 1980–1987

Developed and validated machine-learning and climatology-based methods using ERA5-derived surface variables to extend the Global Merged Analysis of Snow and Ice (GMAI) record back to 1980–1987. Published in *Earth and Space Science*, with the resulting dataset deposited in the University of Arizona Research Data Repository.

E. IEPPO — Multi-Reference Ocean Precipitation Validation Framework

Developing an integrated, sampling-aware ocean precipitation evaluation framework comparing GPCP, IMERG, ERA5, and MERRA-2 against complementary in situ references, including PAL, moored buoys, coral atolls, and OceanRAIN, across daily through climatological timescales while preserving differences in spatial scale, sampling, and observing regime.

F. Antarctic Snowfall Mass-Budget Benchmarking

Lead analyst for a physically constrained reassessment of Antarctic precipitation across IMBIE drainage basins using GRACE-based mass-storage change, ice discharge, basal melt, and sublimation inputs, evaluating ERA5, GPCP v3.3, and GPM constellation precipitation estimates against mass-budget-derived benchmarks, developed in collaboration with NASA/JPL scientists.

Selected Peer-Reviewed Publications & Data Products

Kumah, K. K., Zandi, O., & Behrangi, A. (2025). Retrospective mapping of global snow and ice cover beyond the satellite observational era. *Earth and Space Science*. DOI

Kumah, K. K., Maathuis, B. H. P., Hoedjes, J. C. B., & Su, Z. (2022). Near real-time estimation of high spatiotemporal resolution rainfall from cloud top properties of the MSG satellite and CML rainfall intensities. *Atmospheric Research*, 279. DOI

Kumah, K. K., Hoedjes, J. C. B., David, N., Maathuis, B. H. P., Gao, H. O., & Su, B. Z. (2021). The MSG technique: Improving commercial microwave link rainfall intensity by using rain area detection from Meteosat Second Generation. *Remote Sensing*, 13(16). DOI

Kumah, K. K., Maathuis, B. H. P., Hoedjes, J. C. B., Rwasoka, D. T., Retsios, B. V., & Su, B. Z. (2021). Rain area detection in South-Western Kenya by using multispectral satellite data from Meteosat Second Generation. *Sensors*, 21(10). DOI

David, N., Liu, Y., **Kumah, K. K.,** Hoedjes, J. C. B., Su, B. Z., & Gao, H. O. (2021). On the power of microwave communication data to monitor rain for agricultural needs in Africa. *Water*, 13(5), 730. DOI

Kumah, K. K., Hoedjes, J. C. B., David, N., Maathuis, B. H. P., Gao, H. O., & Su, B. Z. (2020). Combining MWL and MSG SEVIRI satellite signals for rainfall detection and estimation. *Atmosphere*, 11(9). DOI

Miyittah, M. K., Tsyawo, F. W., & **Kumah, K. K.** (2015). Suitability of two methods for determination of point of zero charge (PZC) of adsorbents in soils. *Communications in Soil Science and Plant Analysis*.

Submitted / In Preparation

Behrangi, A., **Kumah, K. K.,** et al. (Submitted). GPCP Version 3.3: A refined global view of precipitation from satellite and gauge observations. *Journal of Hydrometeorology*.

Zandi, O., Behrangi, A., **Kumah, K. K.,** et al. (Manuscript in preparation). University of Arizona–High-latitude Infrared-based Precipitation Analysis Version 2 (UA-HIPA): Algorithm development, evaluation, validation, and dataset documentation for GPCP/IMERG high-latitude precipitation assessment.

Kumah, K. K., et al. (Manuscript in preparation). An integrated multi-reference assessment of ocean precipitation products with PAL, buoys, atolls, and OceanRAIN (IEPPO).

Kumah, K. K., et al. (Manuscript in preparation). Revisiting Antarctic snowfall using a mass-budget approach: Evaluation against ERA5, GPCP v3.3, and GPM constellation satellites.

Open Dataset

Kumah, K. K., Zandi, O., & Behrangi, A. (2024). Global snow and ice cover (1980–1987): Extended GMASI dataset. University of Arizona Research Data Repository. DOI

Selected Conference Presentations

EGU General Assembly 2026 — Vienna, Austria

April 2026

European Geosciences Union

- Behrangi, A., G. Huffman, R. F. Adler, Y. Song, **K. K. Kumah,** D. T. Bolvin, E. J. Nelkin, & G. Gu. The newly released Global Precipitation Climatology Project (GPCP) V3.3 daily and monthly products and the future plans. EGU26-5885.

AGU Fall Meeting 2025 — New Orleans, LA

December 2025

American Geophysical Union

- Zandi, O., S. Pfreundschuh, **K. K. Kumah,** & A. Behrangi. University of Arizona–High-latitude Infrared-based Precipitation Analysis Version 2 (UA-HIPA).
- Behrangi, A., G. Huffman, R. F. Adler, Y. Song, **K. K. Kumah,** D. T. Bolvin, E. J. Nelkin, & G. Gu. The newly released GPCP V3.3 daily and monthly products and the future plans.

AGU Fall Meeting 2024 — Washington, D.C.

December 2024

American Geophysical Union

- **Kumah, K. K.**, Zandi, O., & Behrangi, A. On the retrospective mapping of global snow and ice cover beyond the satellite observational era. Session: Cryosphere / Artificial Intelligence.
- Zandi, O., **Kumah, K. K.**, & Behrangi, A. Developing a novel long-term IR-based precipitation product from AVHRR in high latitudes through a double machine learning strategy. H13U-04.

EUMETSAT Meteorological Satellite Conference 2022 — Brussels, Belgium

September 2022

European Organisation for the Exploitation of Meteorological Satellites

- **Kumah, K. K.** High spatial and temporal resolution rainfall estimation from cloud top properties of MSG using random forest algorithm trained with microwave-link-derived rainfall. Oral presentation, Paper #107, Session S07-B.

KIT/HyMet CML Symposium 2019 — Garmisch-Partenkirchen, Germany

June 2019

Karlsruhe Institute of Technology Campus Alpin

- **Kumah, K. K.** Combining microwave links and Meteosat Second Generation data for rainfall studies in Kenya. Short presentation.
- **Kumah, K. K.** Opportunistic use of commercial microwave links and Meteosat Second Generation data for rainfall studies in Kenya. Poster presentation.

Professional Service

Peer Reviewer — *Scientific Journals*: *Journal of Hydrometeorology*; *Hydrology and Earth System Sciences*; *Earth System Science Data*; *Remote Sensing*; *Journal of Geophysical Research: Atmospheres* (invited) — manuscripts on CML rainfall mapping, high-temporal-resolution rain-event detection, global precipitation climate data records, geostationary QPE, and sub-daily precipitation extremes.

Grant Proposal Reviewer: Swiss National Science Foundation (SNSF) — external expert reviewer, SmartSense proposal on high-resolution rainfall sensing using CML and acoustic sensors.

Working Group Membership: COST Action CA20136 SmartSense — Working Group 3 member, European research network on opportunistic precipitation sensing.

Media Recognition

APS Physics Magazine (American Physical Society), 2021 — featured in *Mobile Phone Signals Hold Real-Time Rainfall Information*, on the use of mobile-phone network signals for rainfall monitoring.

myScience News / *University of Twente ITC*, 2022 — featured in *ITC Algorithm Detects Rainfall in Rural Africa*, covering doctoral rainfall-estimation research and its application in data-sparse regions.

Skills

Programming & Scientific Computing: Python, NumPy, Pandas, Xarray, Dask, scikit-learn, Matplotlib, Cartopy, NetCDF/HDF5/GRIB/GeoTIFF, Git, Linux/HPC batch workflows, reproducible data pipelines.

Remote Sensing & GIS: AVHRR, MSG SEVIRI, MODIS, GPM IMERG, GRACE, Rasterio, Rioxarray, GeoPandas, GDAL, ArcGIS/QGIS, raster reprojection, large-scale resampling.

Machine Learning & Retrieval Methods: Random Forest, XGBoost, neural networks, feature engineering, cross-validation, uncertainty diagnostics, double-machine-learning retrieval strategies for satellite precipitation.

Data Products & Validation: Multi-sensor validation, bias correction, climate data records, PDF/CDF analysis, precipitation-product diagnostics, interannual variability, trend statistics, production-style processing workflows.