An Open Framework for Global Tracking and Analysis of Satellite-Derived Precipitating Systems

Helvecio Bezerra Leal Neto[1], Daniel Vila[2]*, Alan Calheiros[1]

[1]Brazilian National Institute for Space Research (INPE)

[2]World Meteorological Organization – Regional Office for the Americas

*Presenter

Precipitating systems (PSs) organize a large fraction of the global water cycle, yet their life cycles and dynamic characteristics remain less systematically documented than grid-based precipitation statistics. We present pyForTraCC, an open-source Python framework derived from the ForTraCC methodology and extended for global tracking of satellite-derived precipitation features. The framework provides a modular pipeline for segmentation, clustering, and object tracking, supporting multi-threshold identification and explicit treatment of system merging and splitting, together with several displacement-vector estimation schemes including an optical-flow approach. We apply pyForTraCC to two widely used global precipitation products, GSMaP–MVK v8 from the Japan Aerospace Exploration Agency and GPM IMERG Final V07 from NASA's Global Precipitation Measurement mission, to produce a 2015–2024 global climatology (60°S–60°N) of PS occurrence, size, lifetime, seasonality, and genesis and dissipation regions. Results show that the framework efficiently processes large datasets and yields dynamically consistent tracks. The resulting global census reproduces known spatial patterns, with large, long-lived systems concentrated over tropical oceans and smaller, shorter-lived systems over land, while also highlighting differences between products in resolving short-lived features. Preliminary trend analysis indicates coherent regional changes in PS activity, including decreases over the equatorial Pacific and increases across monsoon regions and parts of the Southern Hemisphere midlatitudes. These results demonstrate the value of object-based tracking for advancing global precipitation diagnostics and enabling reproducible analyses of precipitating system behavior.

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