

ATS/CIRA Colloquium

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ATS 101 and Zoom

The Tomorrow.io Precipitation Constellation: Design Considerations and Expected Impact

On April 14, 2023, the Tomorrow-R1 Radar Pathfinder satellite launched aboard the SpaceX Transporter 7 mission. Tomorrow-R1 is the first of approximately 30 satellites that will make up the multi-modal Tomorrow.io precipitation constellation by the end of 2025, which will consist of 10-12 Smallsat Ka-band radars and up to 18 Cubesat microwave sounders. In order to optimize the design of this constellation, several factors were considered, including the relative capability of each sensor to detect and retrieve precipitation as well as the expected impact on short-term (0-3hr) precipitation nowcasts and NWP forecasts. To establish the value for nowcasts, the concept of the *time value* of a satellite-derived precipitation estimate is introduced: A more precise estimate (e.g, from radar), propagated by the nowcast, will exceed the baseline skill of real-time geostationary-derived precipitation estimates for a longer time period than a less precise estimate (e.g., from a sounder). These time value metrics drive the combined latency and revisit requirements of the Tomorrow.io constellation. In order to provide a common basis for establishing the skill of these sensors, the accuracy of precipitation retrievals from multi-channel geostationary satellite data, the TROPICS Pathfinder microwave sounder (a proxy for the Tomorrow.io microwave sounder), and the KaPR radar (a proxy for the Tomorrow.io radar) onboard the GPM Core Observatory was assessed using probabilistic machine learning techniques, including convolutional neural networks to take advantage of spatial information from the sounders and geostationary imagery. Although the hierarchy of precipitation accuracy was as expected (radars best, followed by sounders, then geostationary), the improvement offered by convolutional techniques is noteworthy: in many cases, the data-driven geostationary retrievals outperform products that incorporate passive microwave retrievals such as IMERG-Early and CMORPH, in agreement with other recent studies. These retrievals have been integrated into the Tomorrow.io platform and app, and will be further enhanced by data from the satellite constellation as it comes online.

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