Low-Cost Sensor Integration into City Scale Air Quality Forecasts

Dr. Carl Malings

NASA Goddard Space Flight Center & Morgan State University

GESTAR II Cooperative Agreement

Part 1: WMO Low-Cost Sensor Applications Report

Part 2: Ongoing Air Quality Forecast Project in Rio de Janeiro, incorporating Low-Cost Sensors

Integrating Low-cost Sensor Systems and Networks to Enhance Air Quality Applications

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Presented by Dr. Carl Malings

Morgan State University & NASA Goddard Space Flight Center

on behalf of the editors, authors, and contributors

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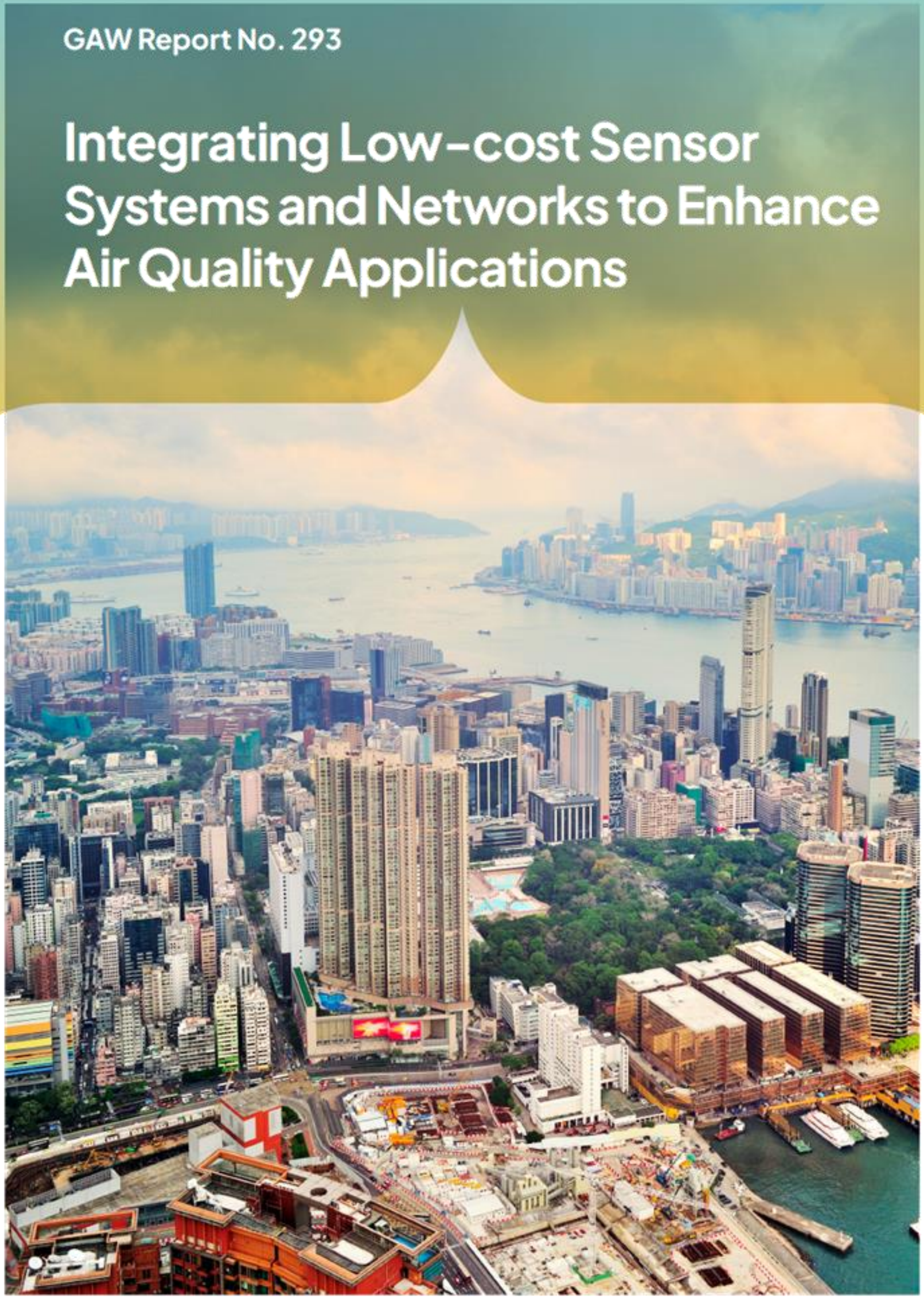
Executive Summary

- Despite challenges, low-cost sensors (LCS) represent a key tool for filling gaps in existing global and local air quality monitoring networks and contributing information for policy-relevant air quality products.
- Methods that use networks of LCS with tens to hundreds of sensors and combine LCS data with other information sources can provide a deeper insight into the causes and consequences of poor air quality.
- Known LCS data quality limitations should be explicitly accounted for in such application methods.
- LCS networks require physical and cyber infrastructure, technical capacity, community involvement, and institutional and financial support for effective sustained operations leading to positive societal impacts.



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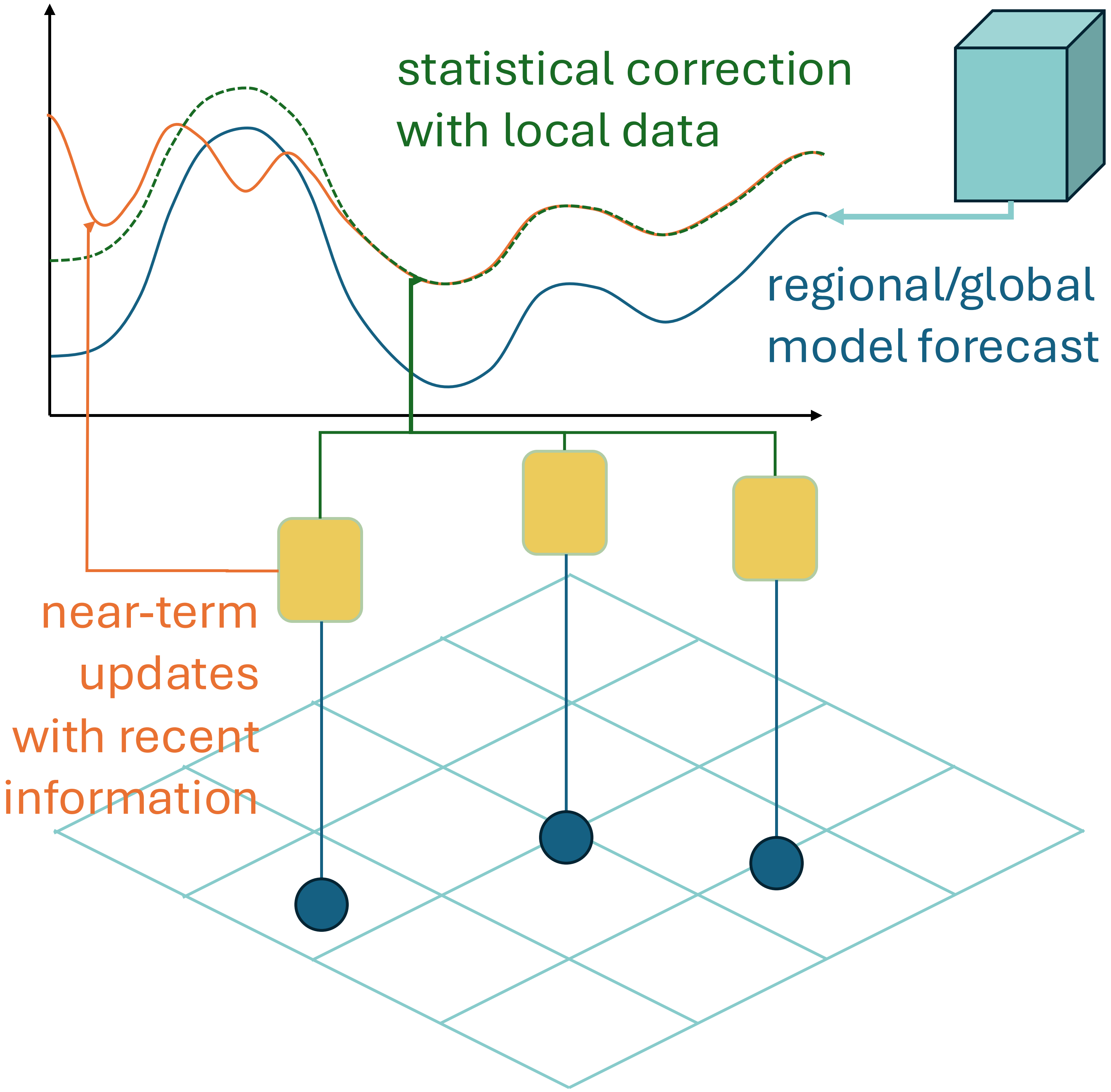
Chapter 7: Air Quality Forecasting

- LCS networks can improve ***short-term***, ***localized forecasting*** from regional or global air quality models, supporting advisories and warnings.
- Characterizing ***uncertainties*** in LCS data, including connections to meteorological factors, are key to their use in forecasting.
- LCS can provide data for ***evaluating model forecasts*** where RGM networks lack coverage.
- Latency, quality (i.e., accuracy and uncertainty) and ***spatial representativity*** of the LCS data are key factors for long-term performance forecast evaluations or near-real time validation.



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Read the Report:
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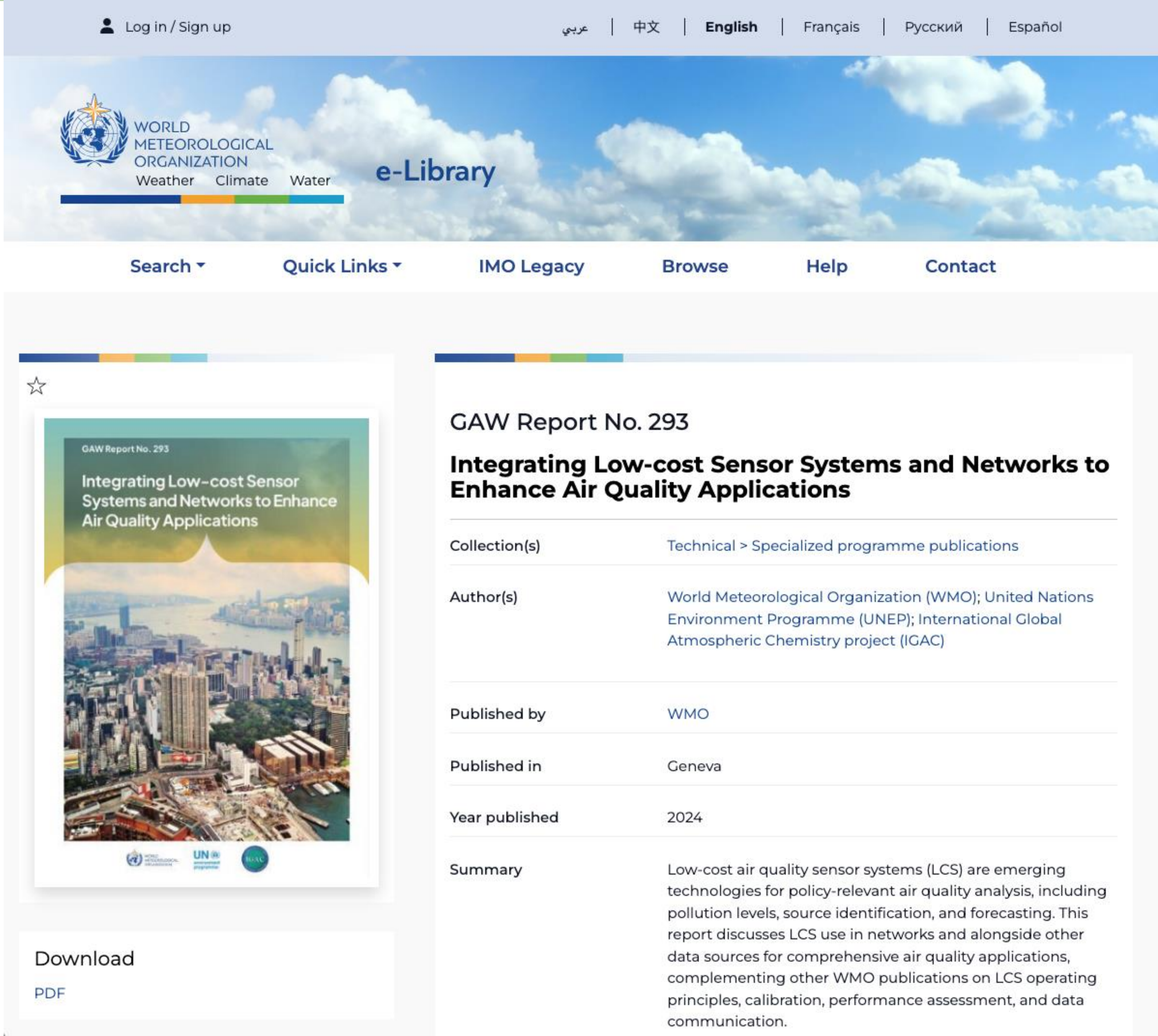

Partner

Scaling Data Fusion Tools to Support Local Air Quality Managers in Latin America

Carl Malings

Morgan State University & GESTAR-II cooperative agreement

NASA Global Modeling and Assimilation Office

Project Team: Nathan Pavlovic, Daniel King, Bryan Duncan, Megan Damon, Sina Hasheminassab, Daniel Westervelt, Sebastián Diez, Colleen Rosales, Russ Biggs, Felipe Mandarino, Vicente Lorca

GESTAR II

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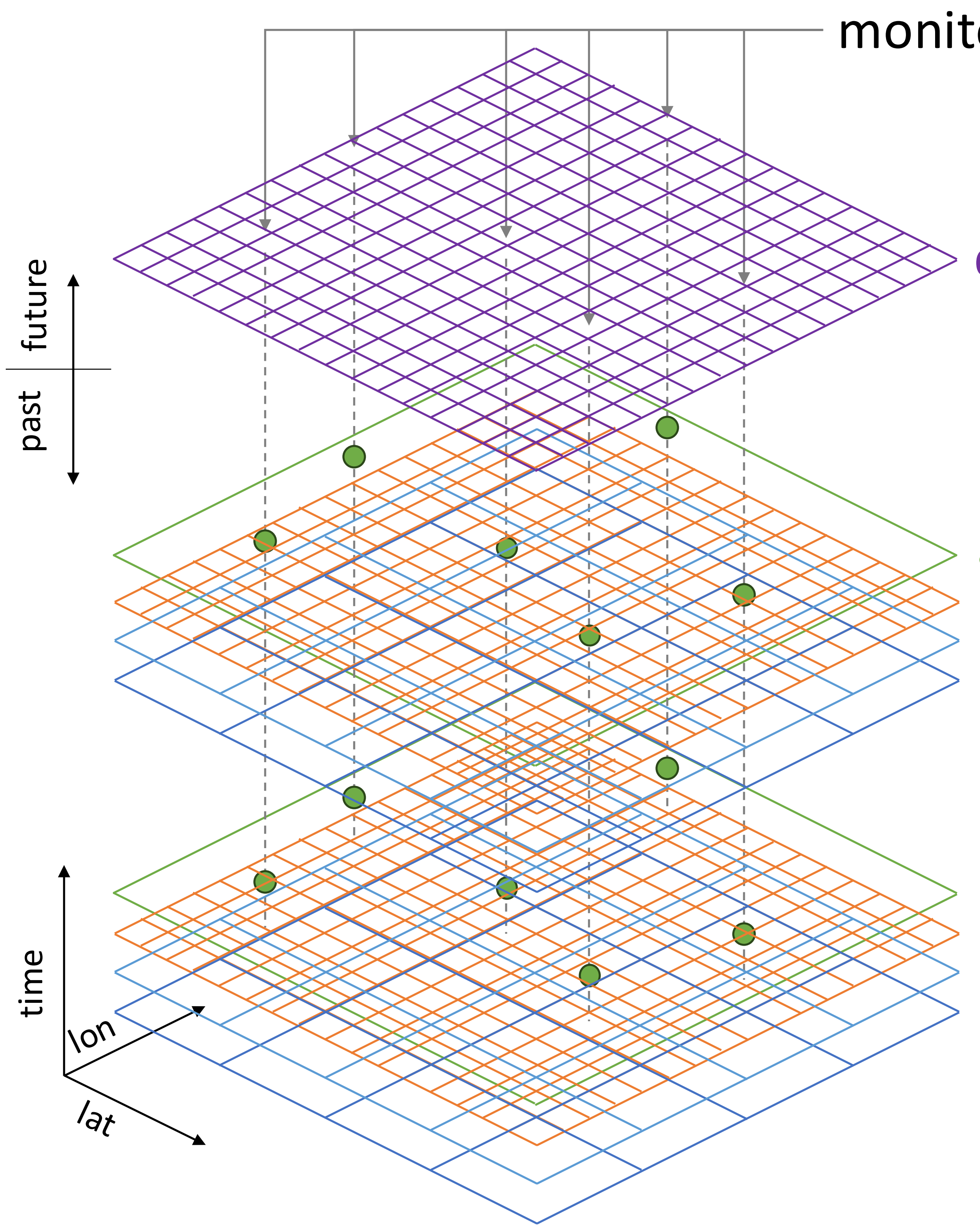
Air Quality Data Fusion – Methodology



Combine model (NASA GEOS-CF), satellite (TROPOMI, MODIS, VIIRS), and local air quality monitor data to produce regional air quality forecasts using uncertainty-aware data fusion

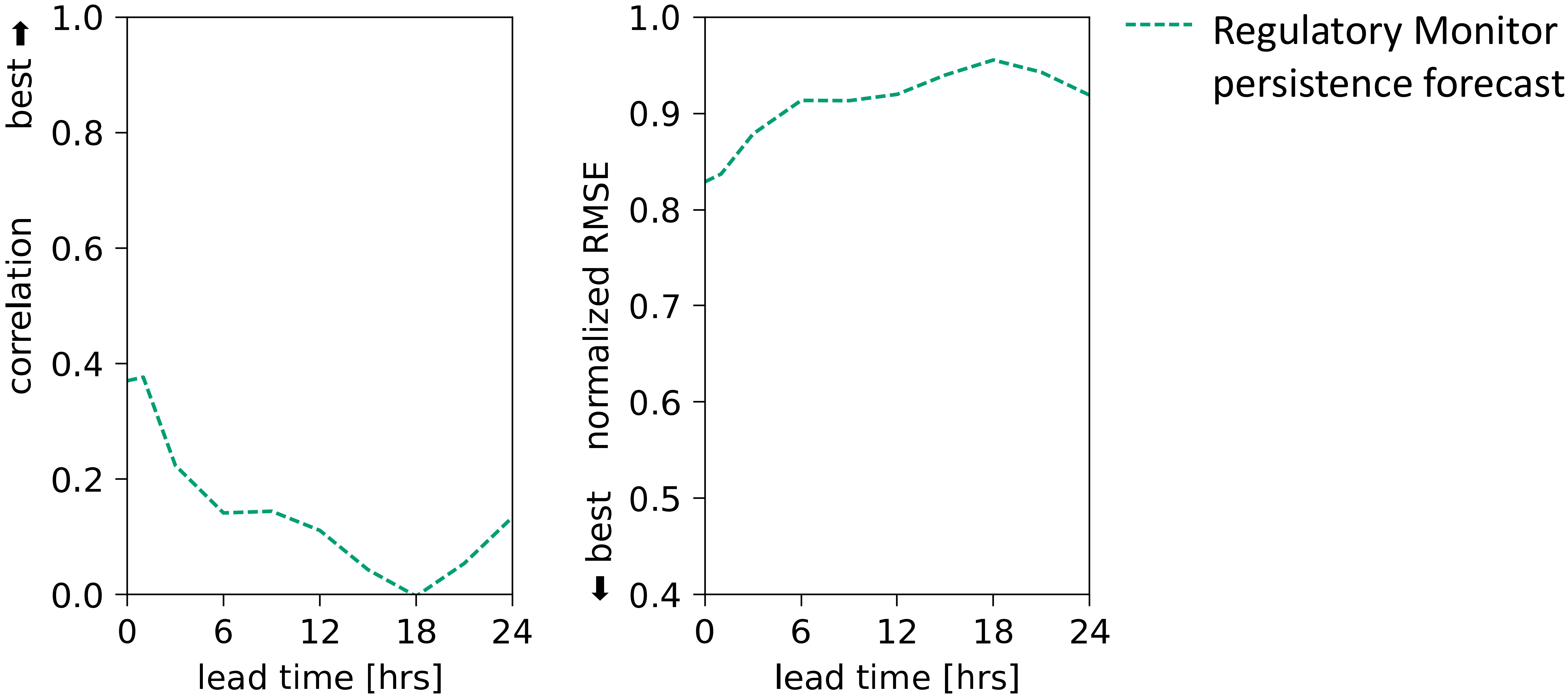
Low-Cost Sensor Integration Strategy:

- Generate initial city-scale forecast with model, satellite, and regulatory-grade monitor data
- Refine forecast locally using recent, nearby low-cost sensor data (following city-specific low-cost sensor calibration)

Source: Malings et al., 2024

carl.a.malings@nasa.gov

Results of Past Work (using London NO_2 data)



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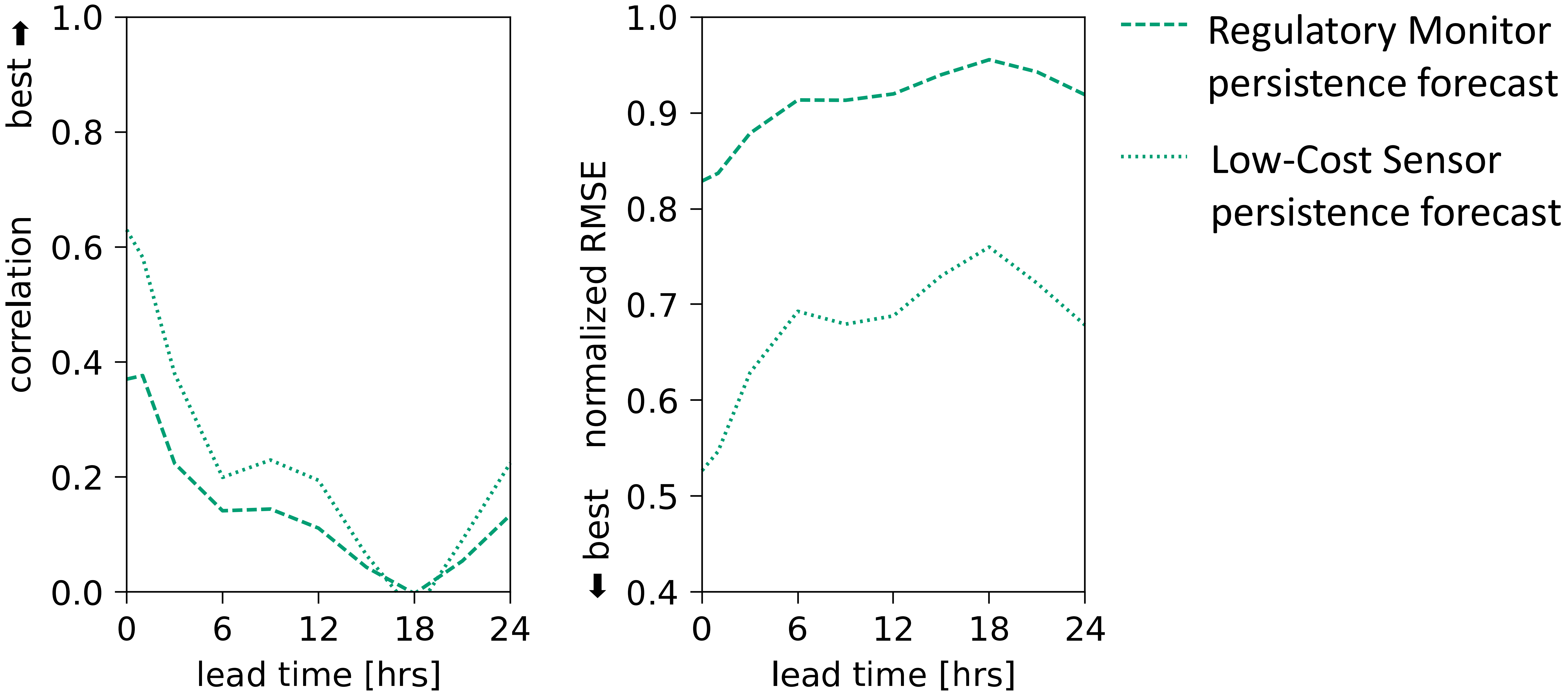

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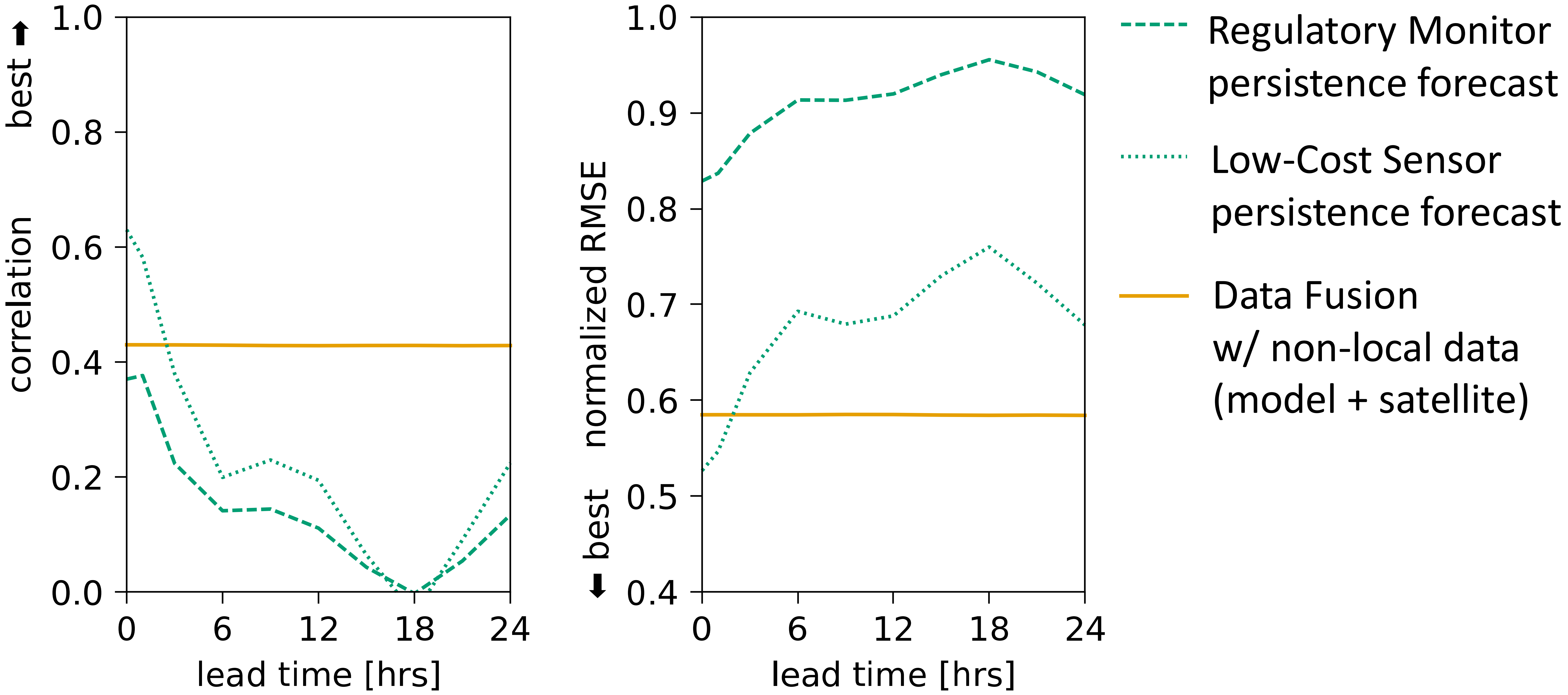

carl.a.malings@nasa.gov

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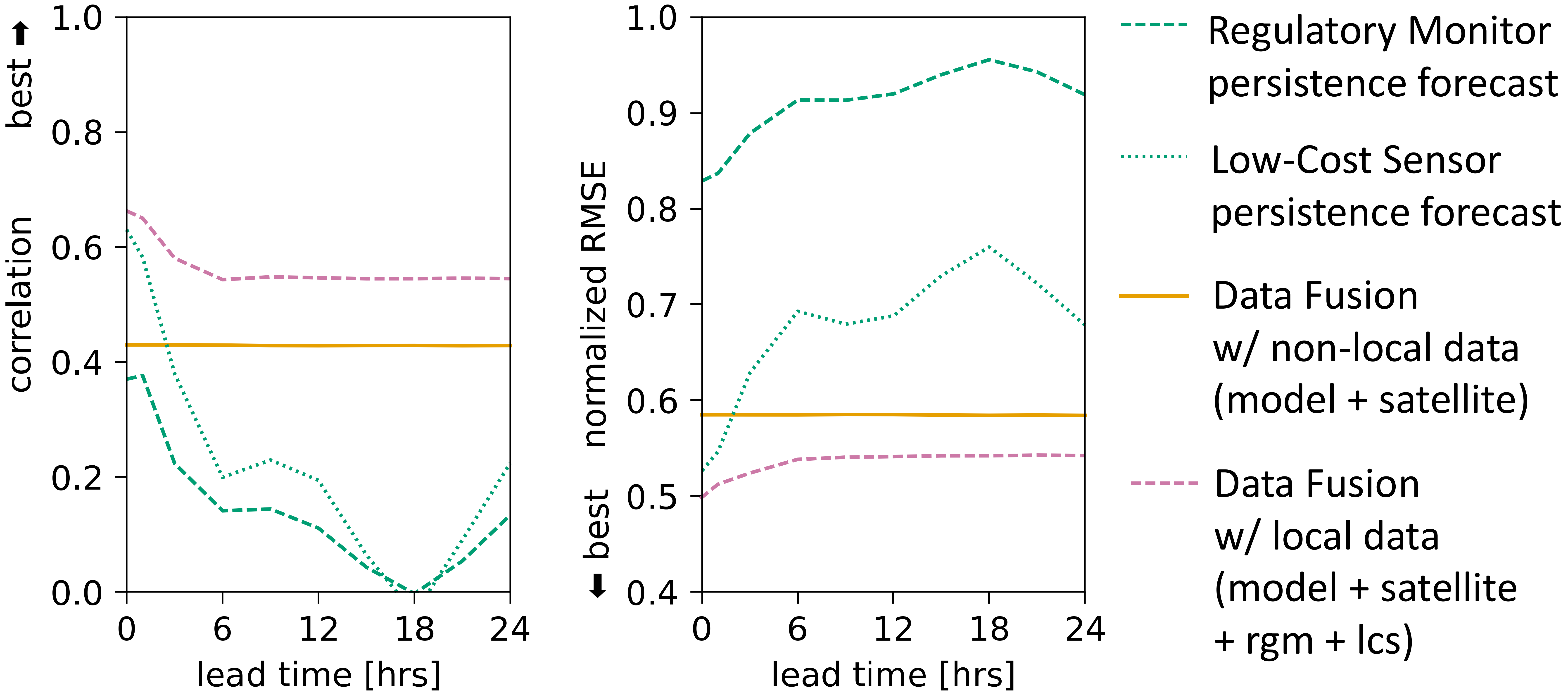
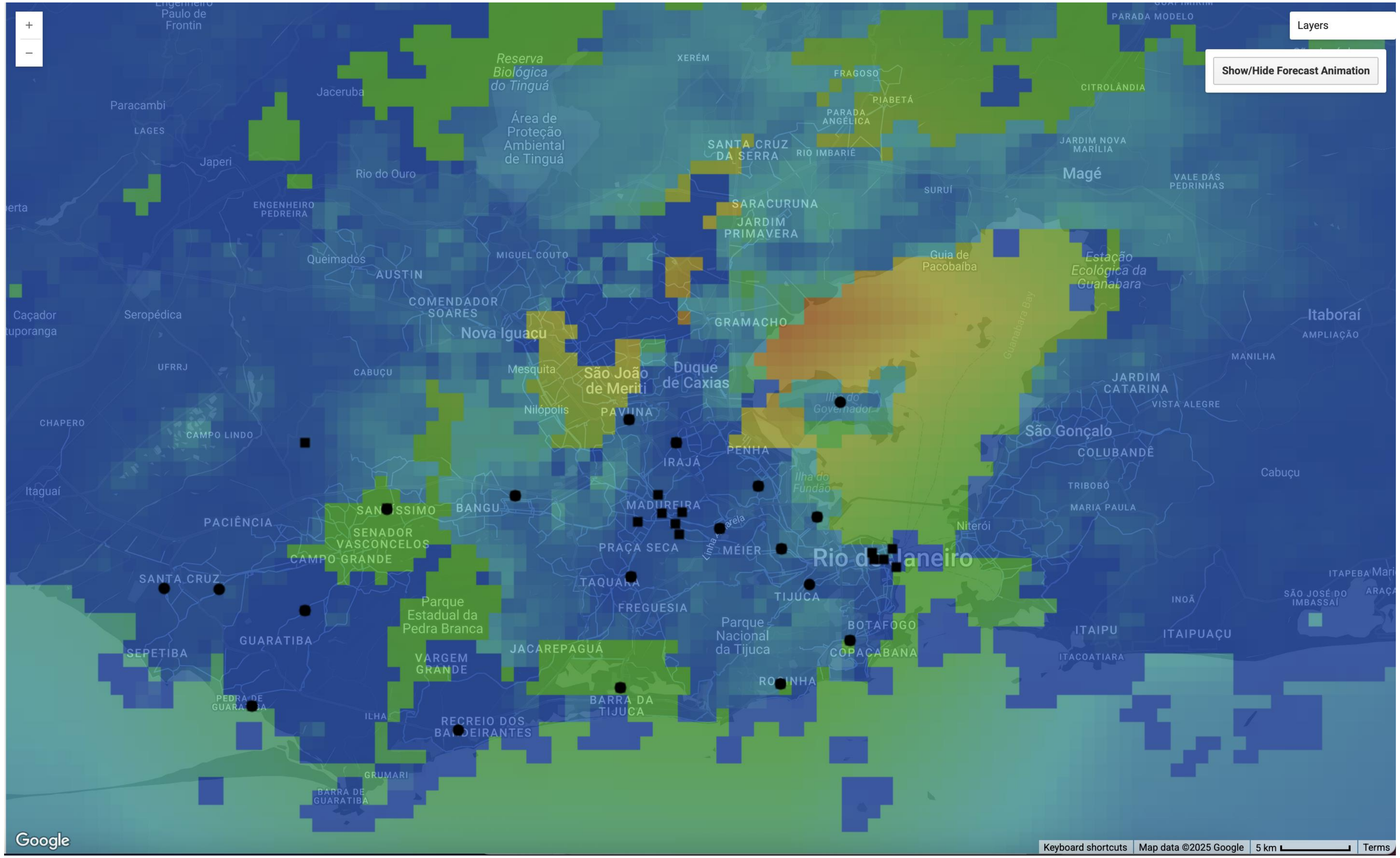


carl.a.malings@nasa.gov

Operational Implementation in Google Earth Engine



Work in Progress…

Only 1 regulatory $PM_{2.5}$ monitor for the city!

Recently supplemented with 25+ low-cost sensors

Local performance evaluation and calibration in progress

Preliminary qualitative assessment: more realistic $PM_{2.5}$ patterns when low-cost sensor data are considered.

Partner

carl.a.malings@nasa.gov

Thank You!