Air Quality Forecasting at Sub-City Scale by Combining Models, Satellites, and Surface Measures

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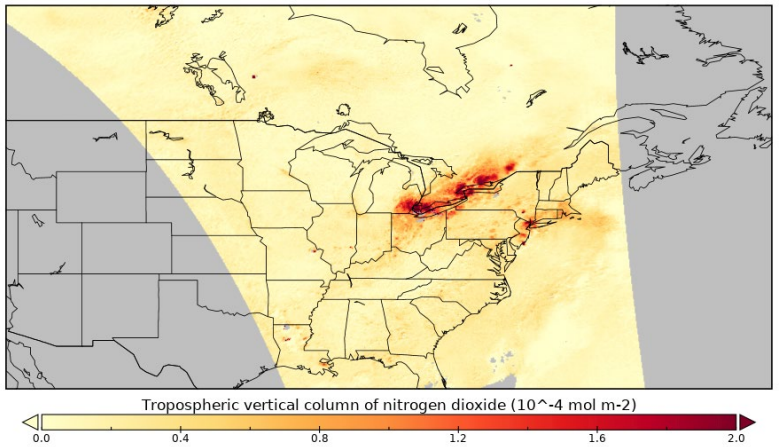
Air Quality Data Sources: Strengths & Weaknesses

regulatory monitoring

+ accurate
- expensive
? representativity

form the “backbone” of the monitoring system, but insufficient alone



satellite retrievals

+ regional coverage
- low time resolution
- column-integrated

good coverage, but need to be related to the ground-level situation

low-cost monitoring

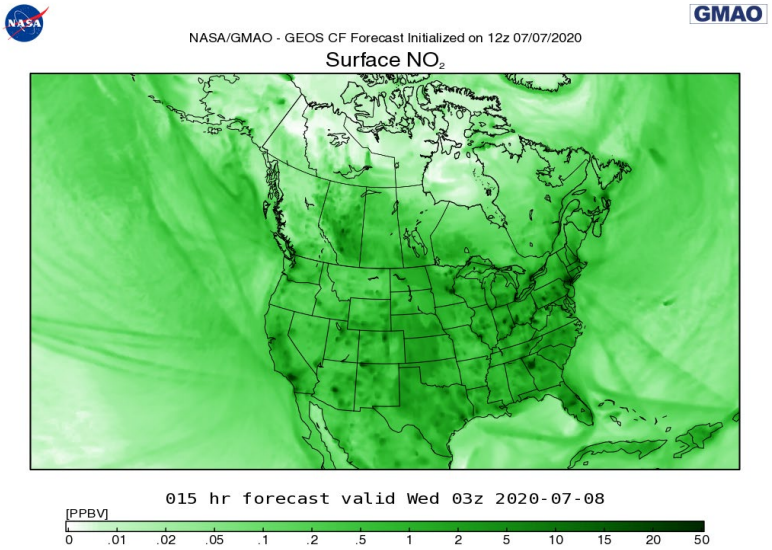
+ relatively inexpensive
+ dense/remote deployment
- greater noise and bias

calibration is an open issue, but leveraging network density can offset some of these shortcomings

simulation models

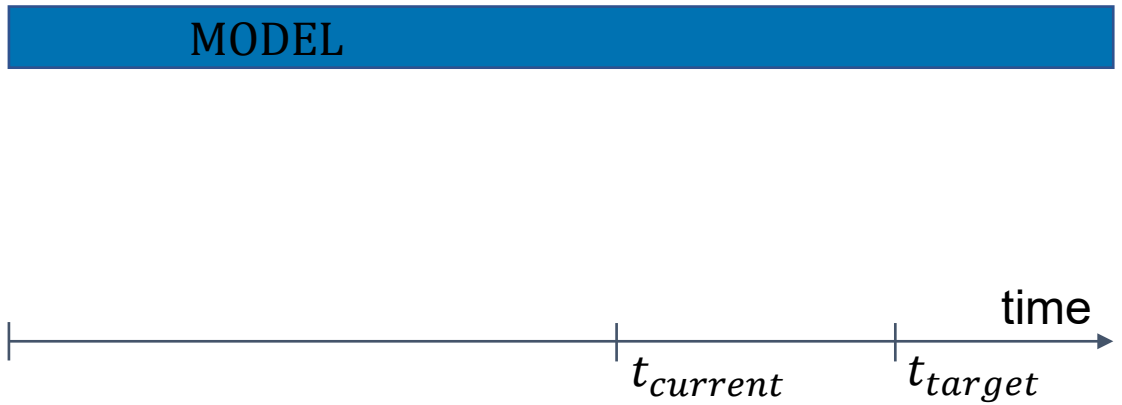
+ global coverage
+ forecasting
- limited resolution

the best tool for prediction, but need the support of other data sources for accuracy

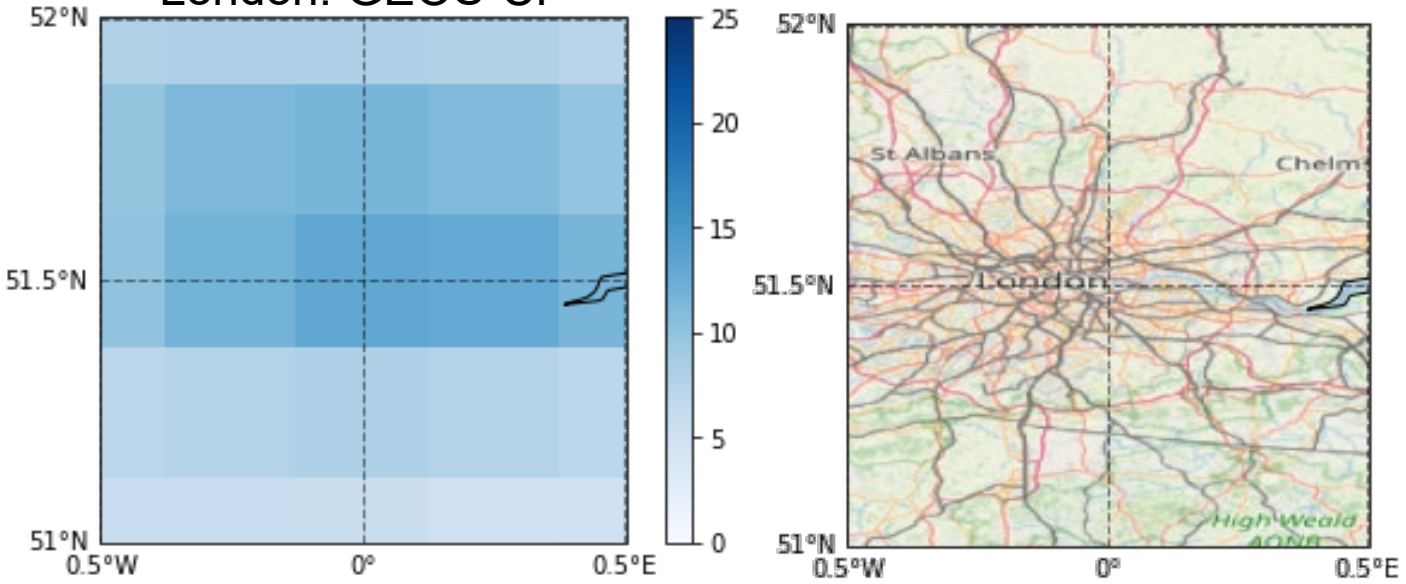


A Flexible Framework to Integrate these Data Sources

MODEL OUTPUT
- global coverage
- forecasting into the near-future



MODEL
London: GEOS-CF



Malings et al. 2021
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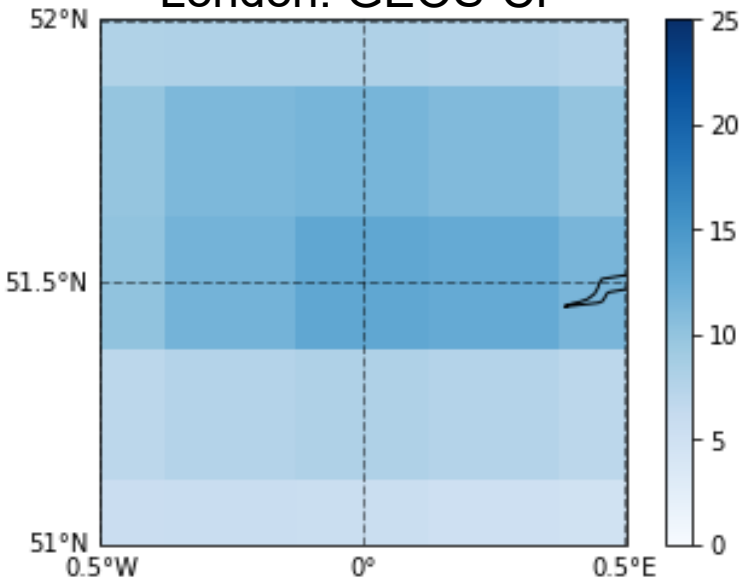
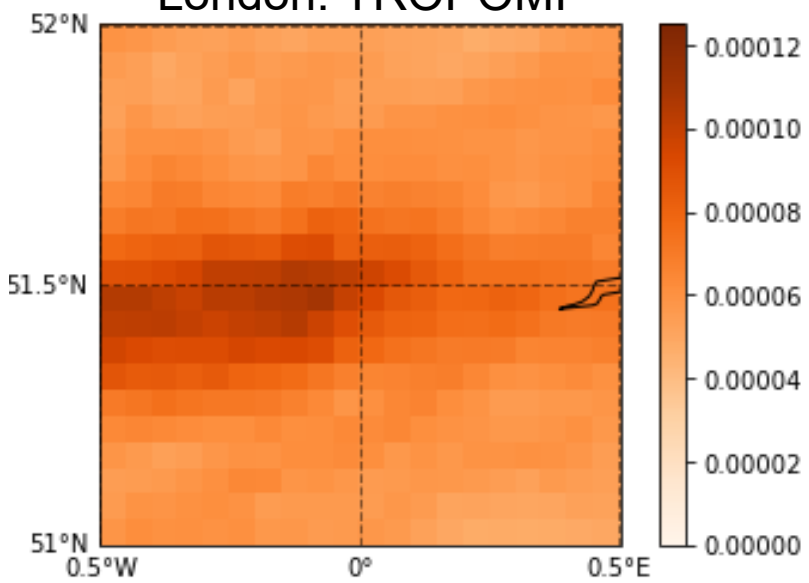


SATELLITE
London: TROPOMI



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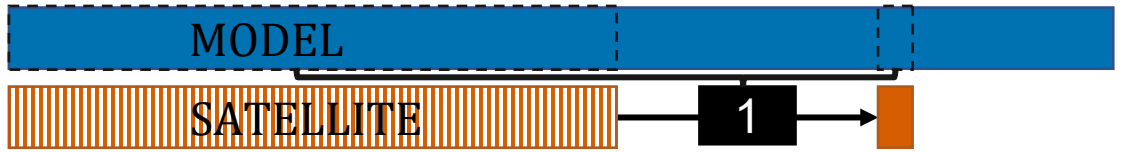
A Flexible Framework to Integrate these Data Sources

SATELLITE DATA
- downscaling
- surface-to-column ratios from model



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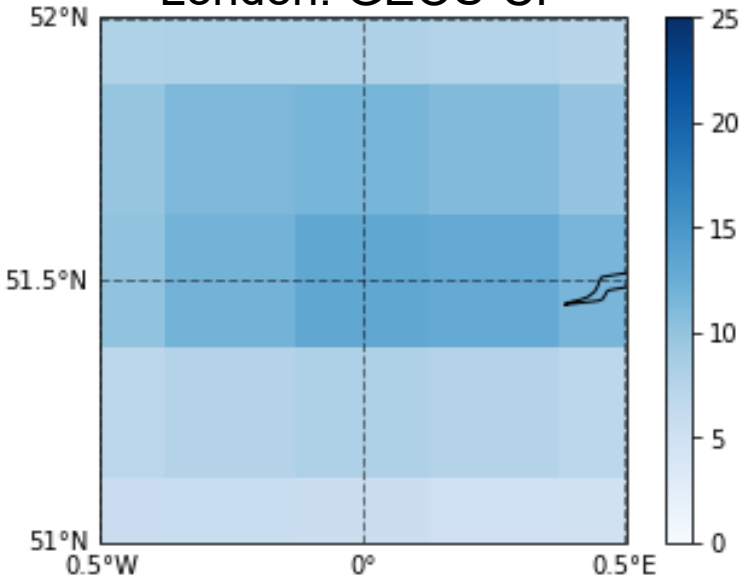
London: GEOS-CF



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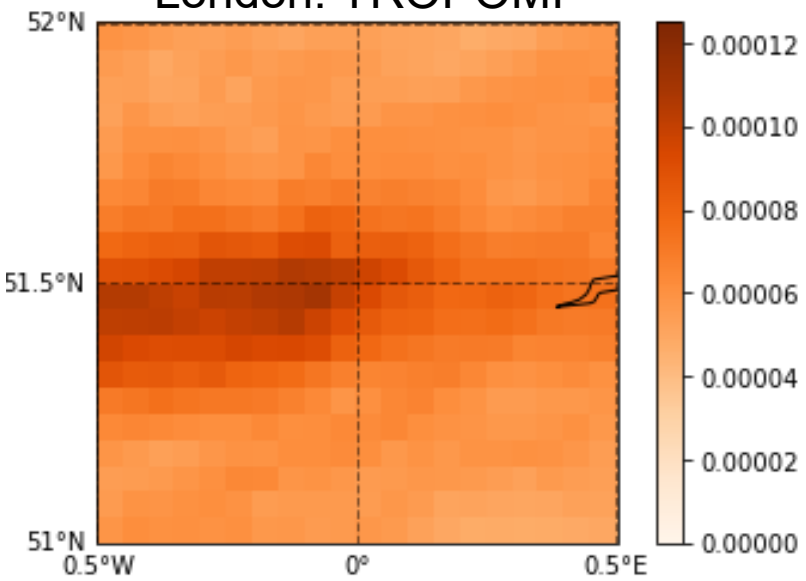
London: TROPOMI



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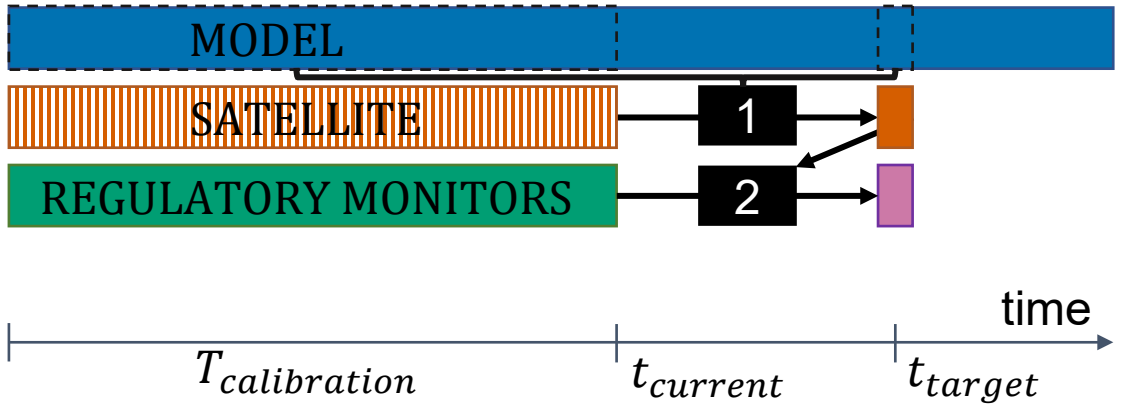
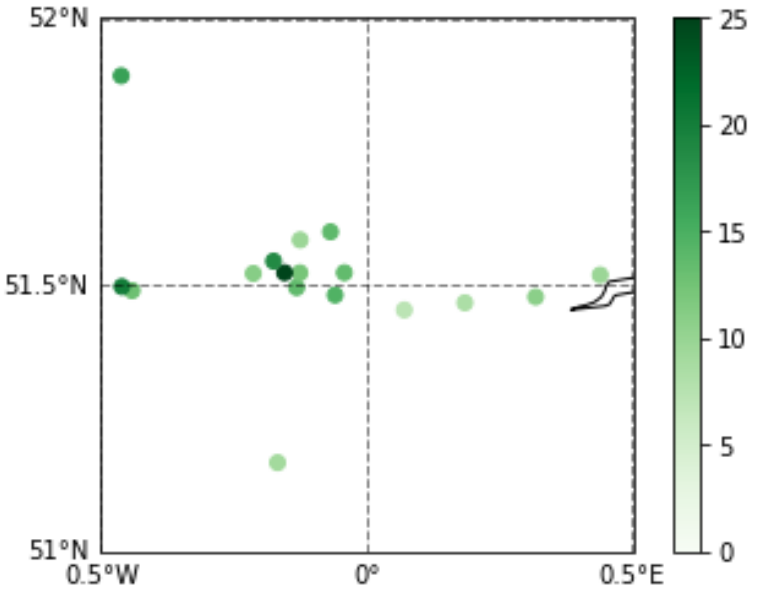
A Flexible Framework to Integrate these Data Sources

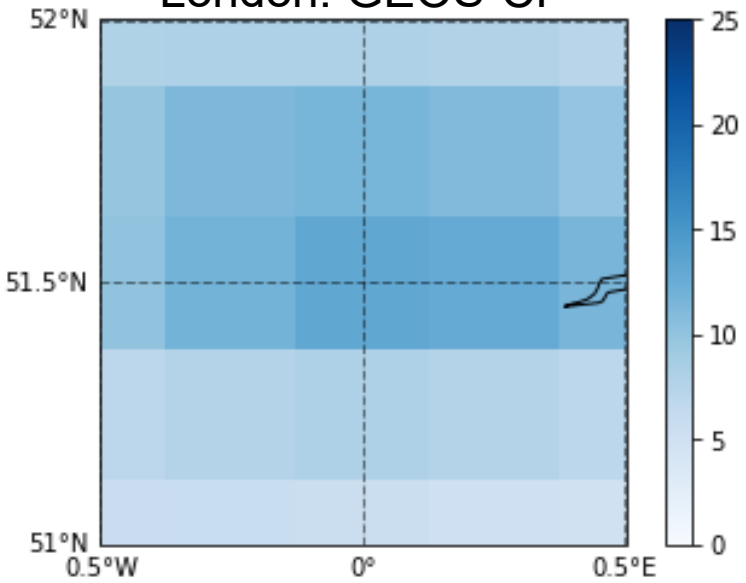
GROUND DATA
- bias-correction
- identify temporary & local impacts



REGULATORY MONITORS
London Air Quality Network



MODEL
London: GEOS-CF



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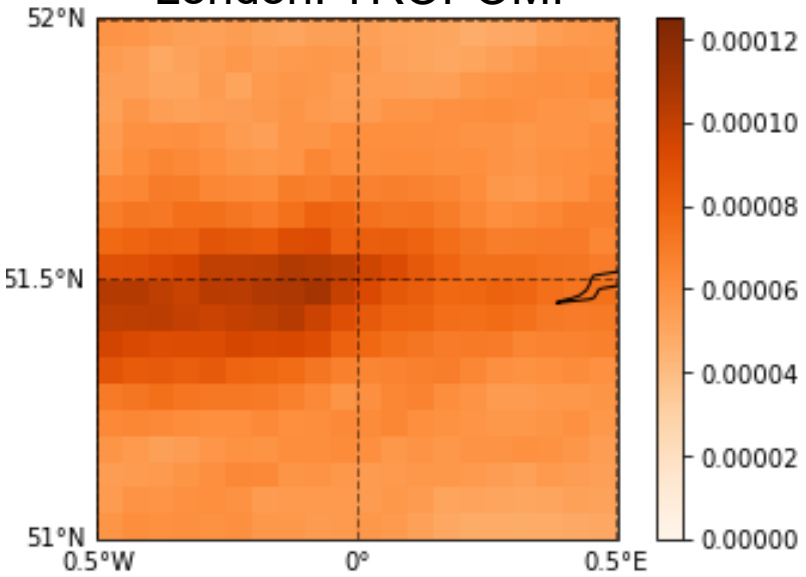

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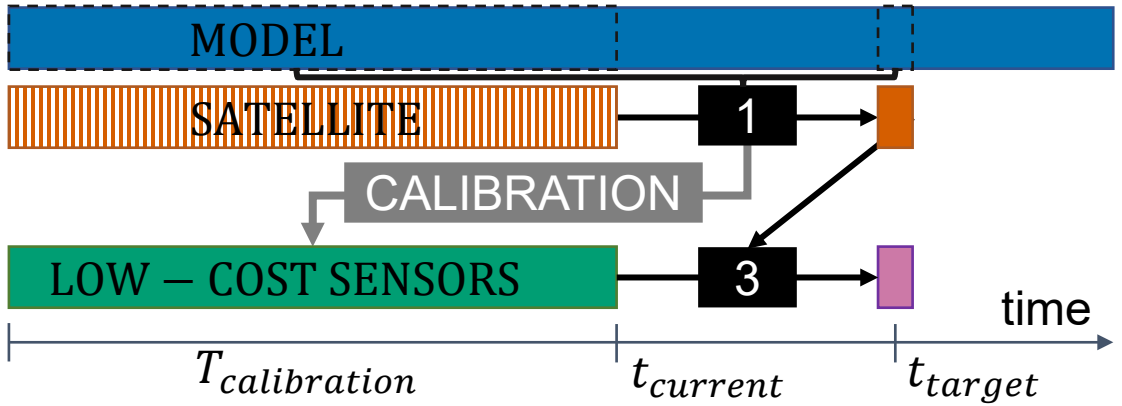
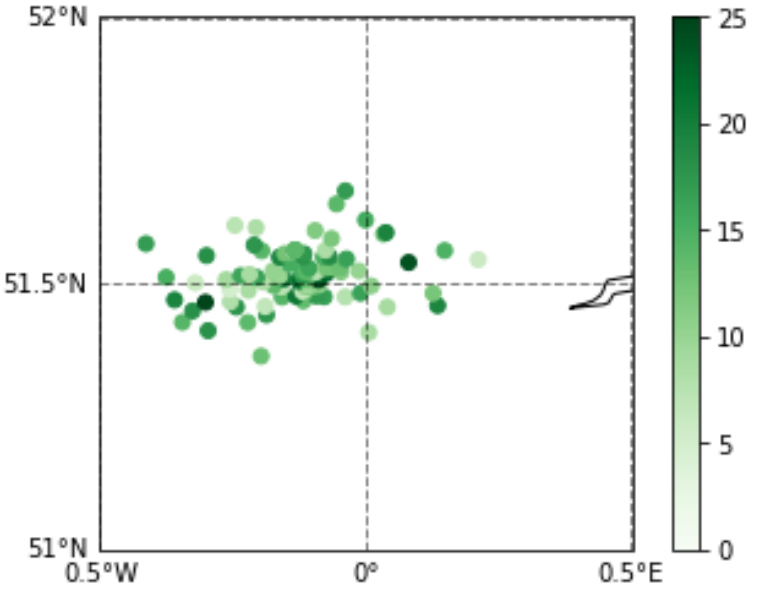
A Flexible Framework to Integrate these Data Sources

GROUND DATA
- bias-correction
- identify temporary & local impacts
- in-situ calibration from model & satellite



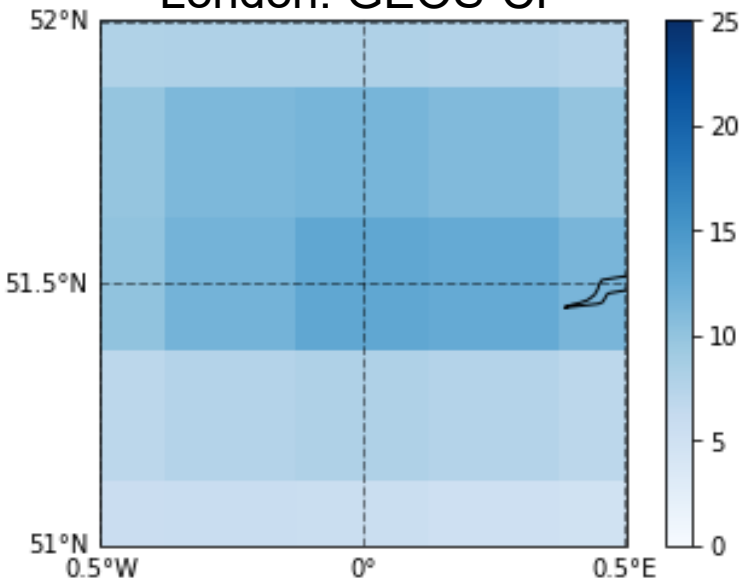
LOW-COST SENSORS

Breathe London Network



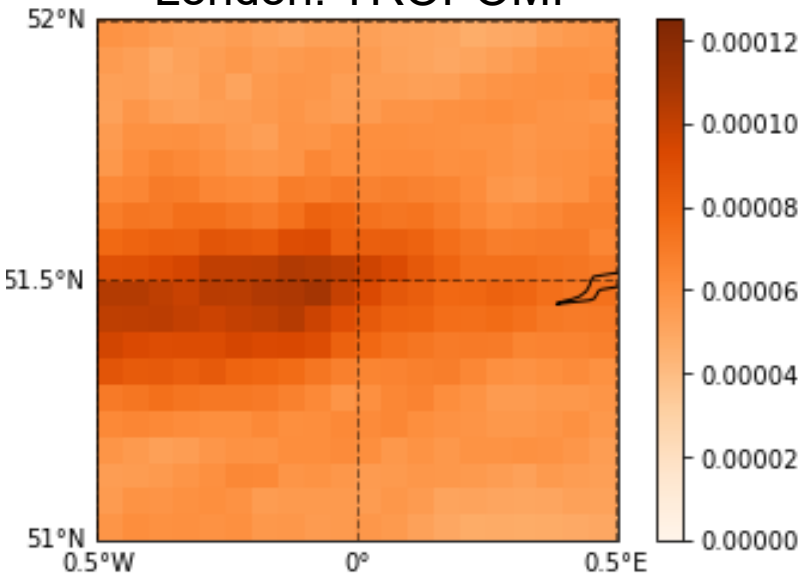
MODEL

London: GEOS-CF



SATELLITE

London: TROPOMI



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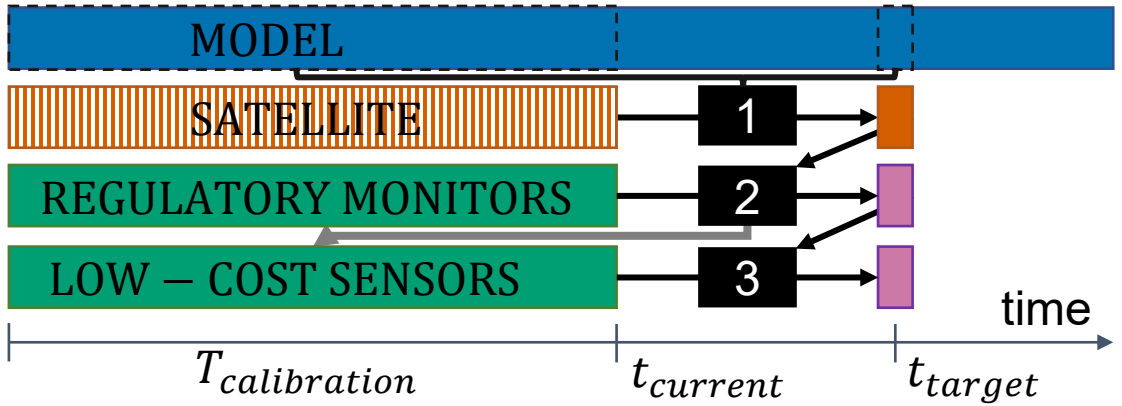
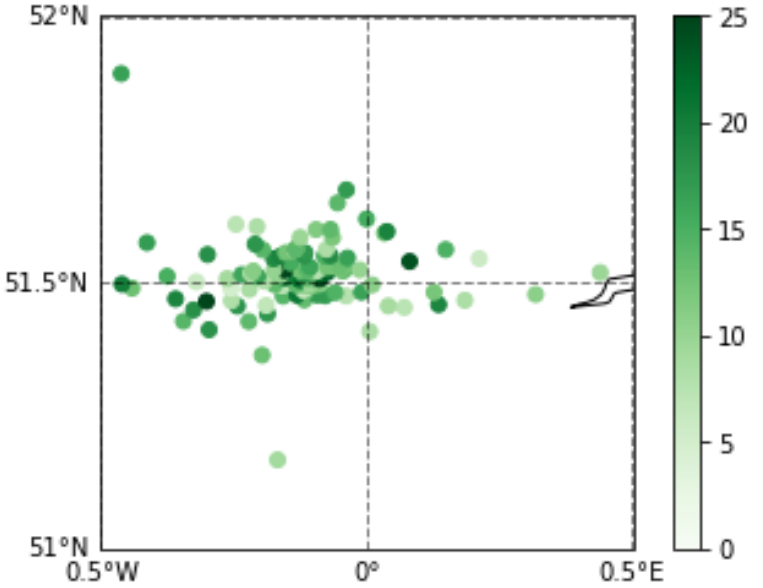
A Flexible Framework to Integrate these Data Sources

GROUND DATA
- bias-correction
- identify temporary & local impacts
- calibrate lcs from regulatory monitors



ALL GROUND MEASURES
London Air Quality Network
Breathe London Network



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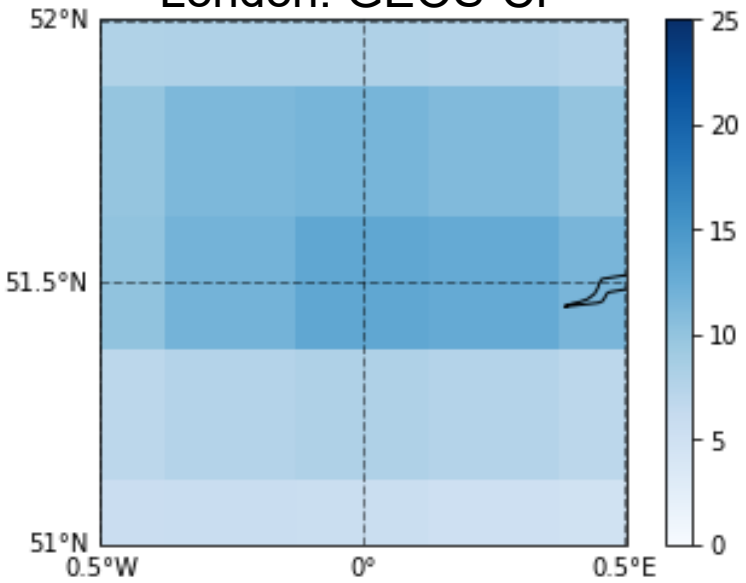

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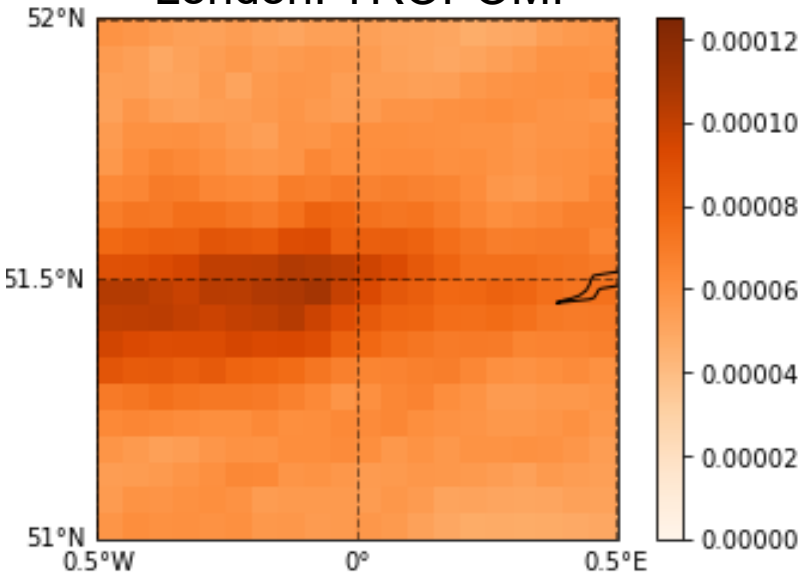

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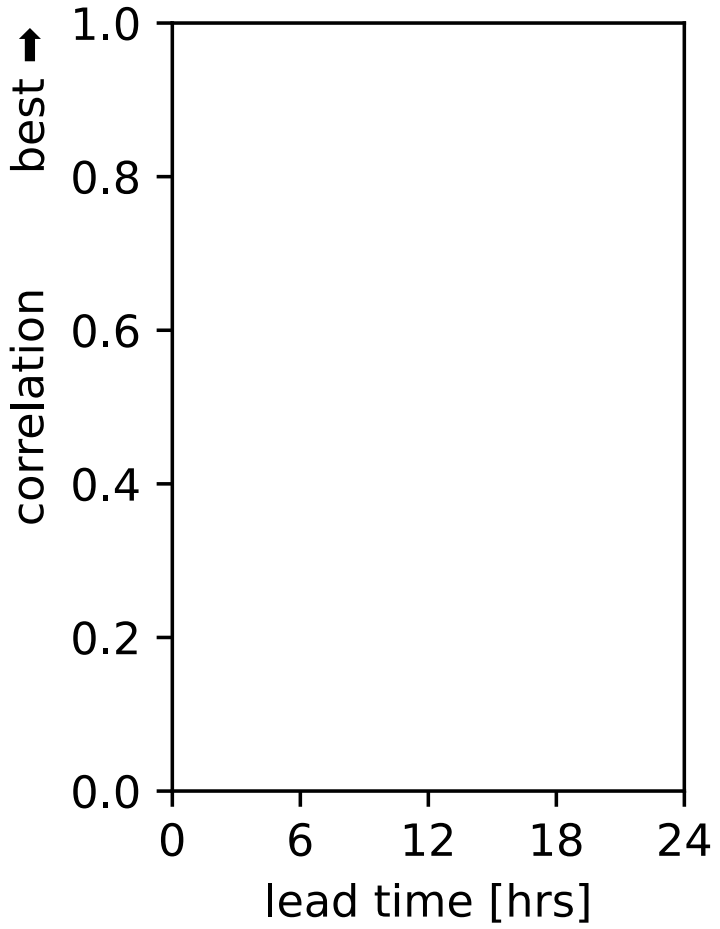
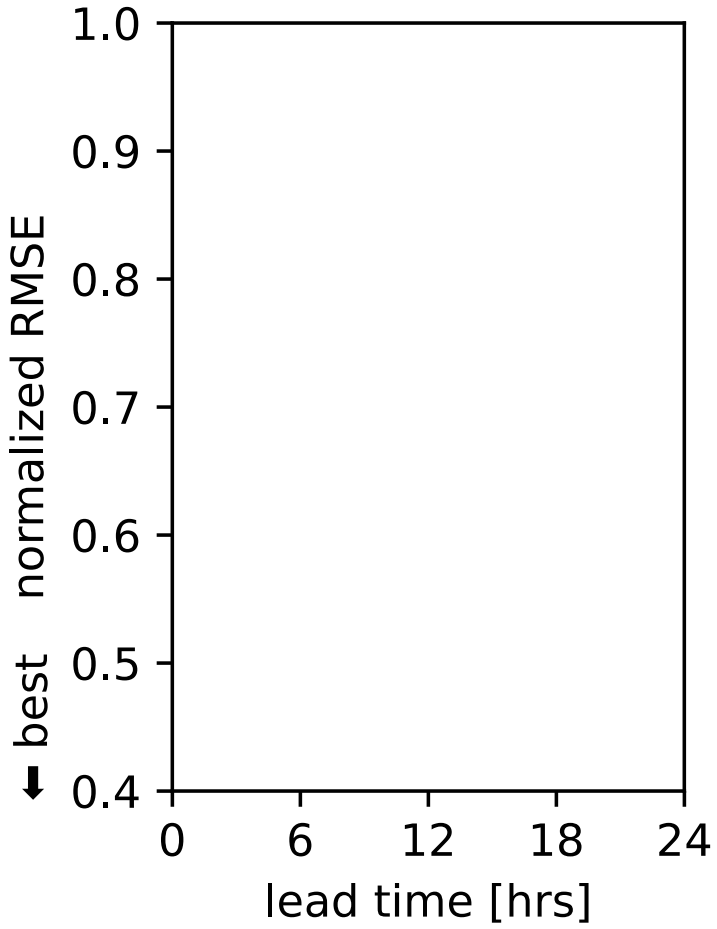
Case Study: benefits of integrating multiple data sources





Strengths / Limitations

RGM relatively dense

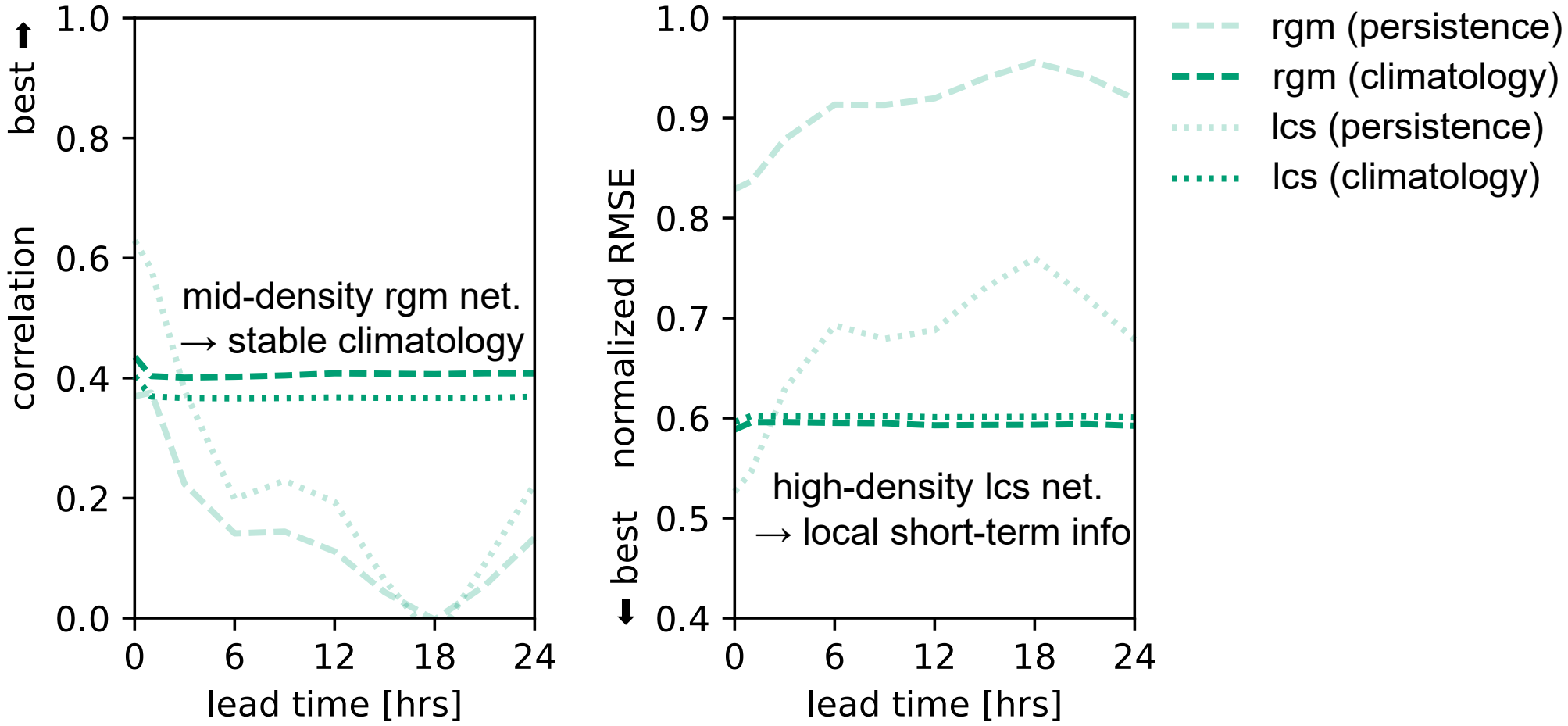
LCS used here are well-calibrated

Emissions data likely very accurate
→ better model performance

Assessing average network metrics
→ results @ individual sites will vary

forecasting results for ***London, October & November 2019***
cross-validation: leave-one-site-out, considering only regulatory sites
plotted results represent ***average metrics*** across validation sites

Surface Measures Only: benefits from density v. stability



forecasting results for ***London, October & November 2019***

cross-validation: leave-one-site-out, considering only regulatory sites

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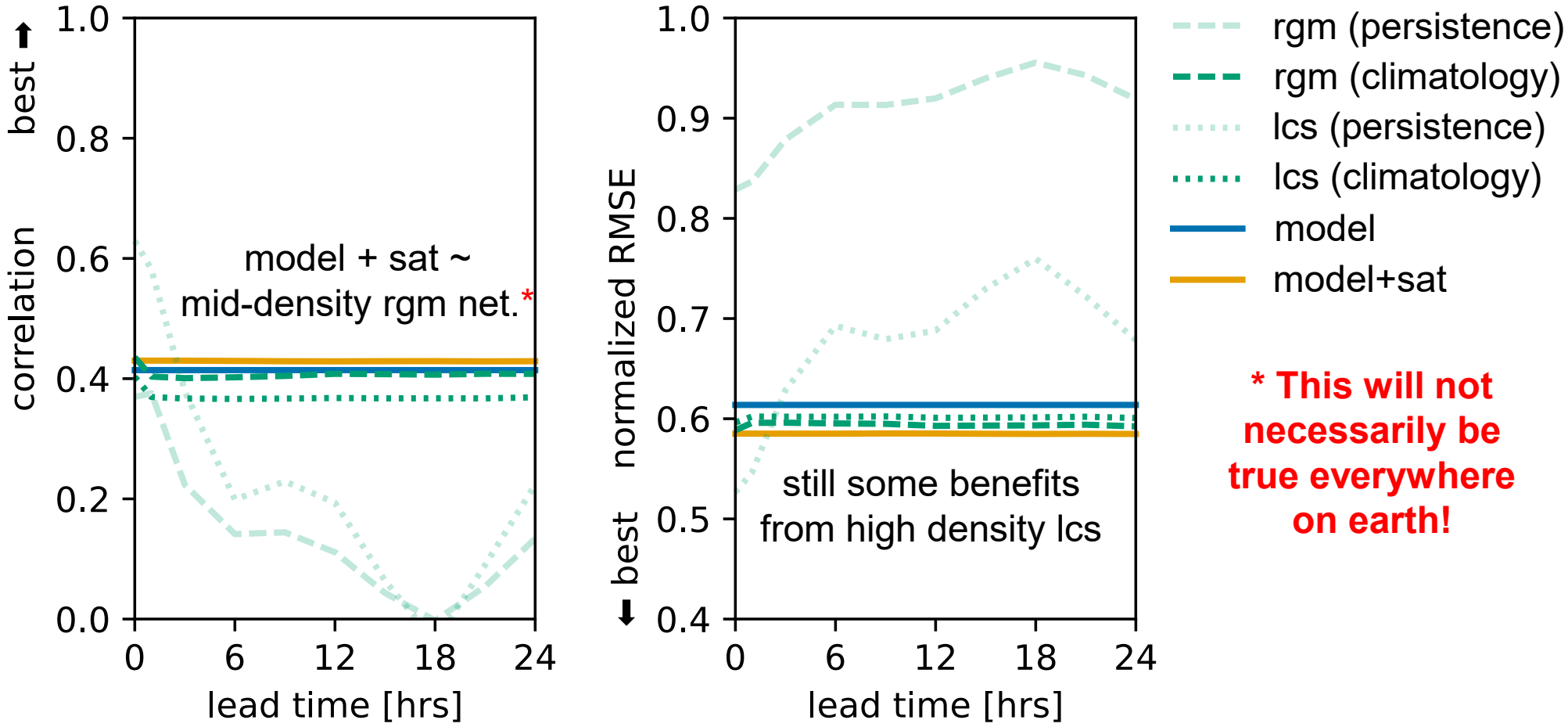
Models & Satellites: as good as RGM (in this case)



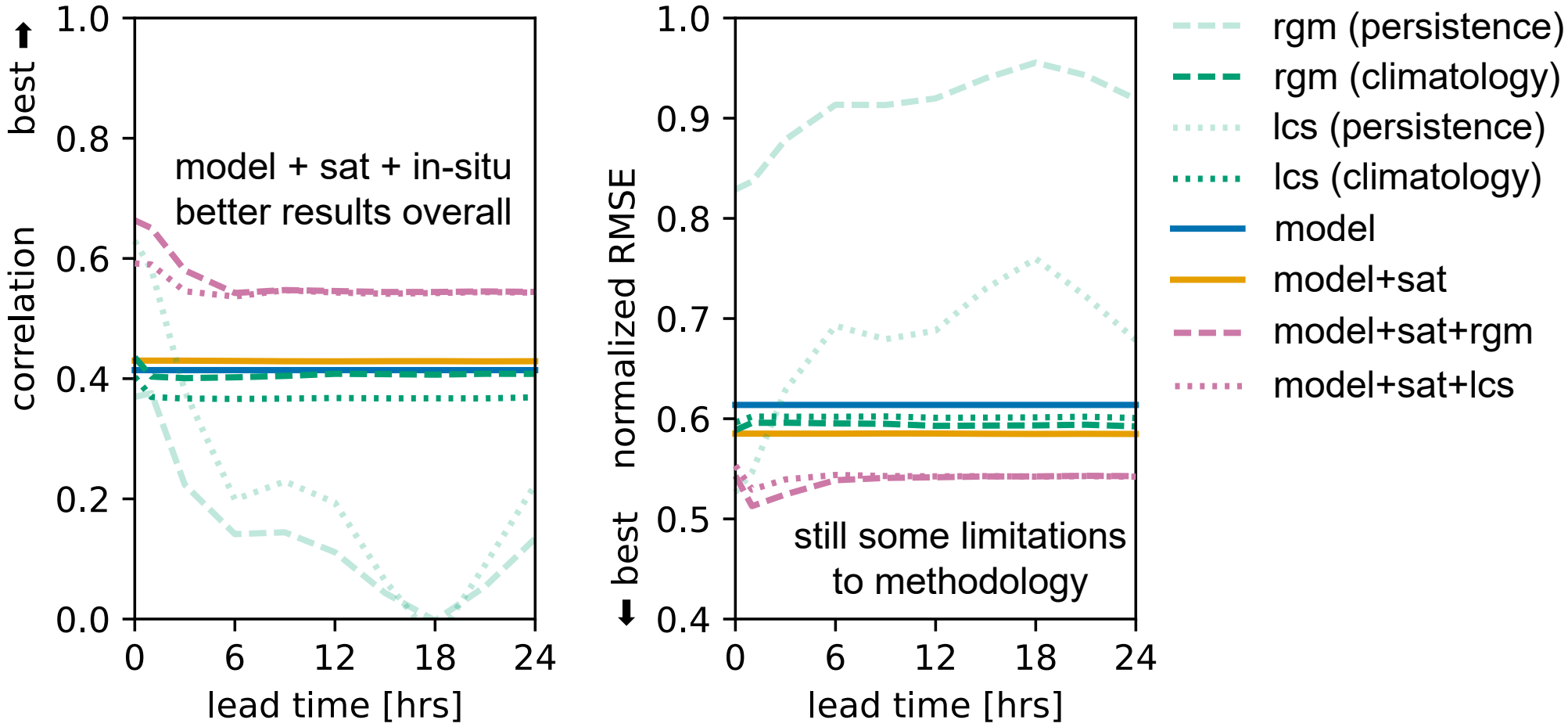
*** This will not necessarily be true everywhere on earth!**

forecasting results for ***London, October & November 2019***

cross-validation: leave-one-site-out, considering only regulatory sites

plotted results represent ***average metrics*** across validation sites

All Data Together: best results (with room for improvement)



forecasting results for ***London, October & November 2019***

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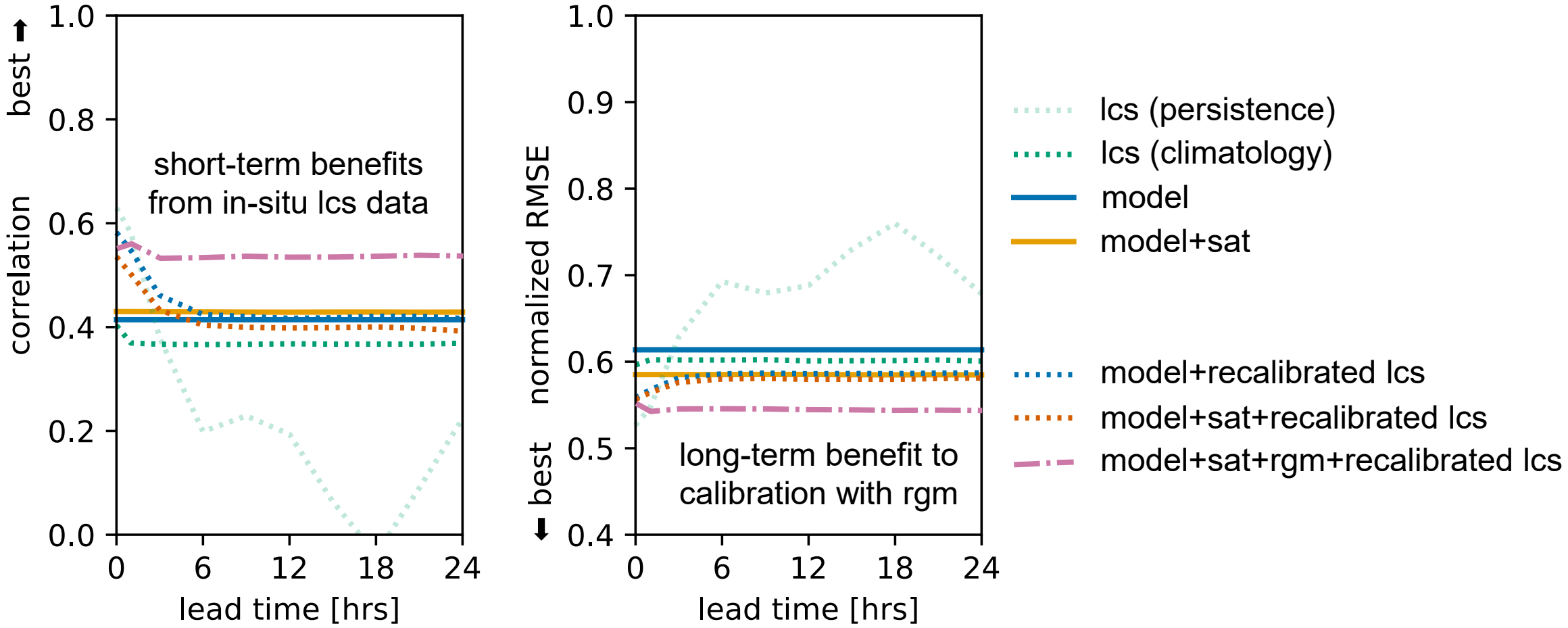
Potential to calibrate LCS with models, satellites and/or RGM



forecasting results for ***London, October & November 2019***

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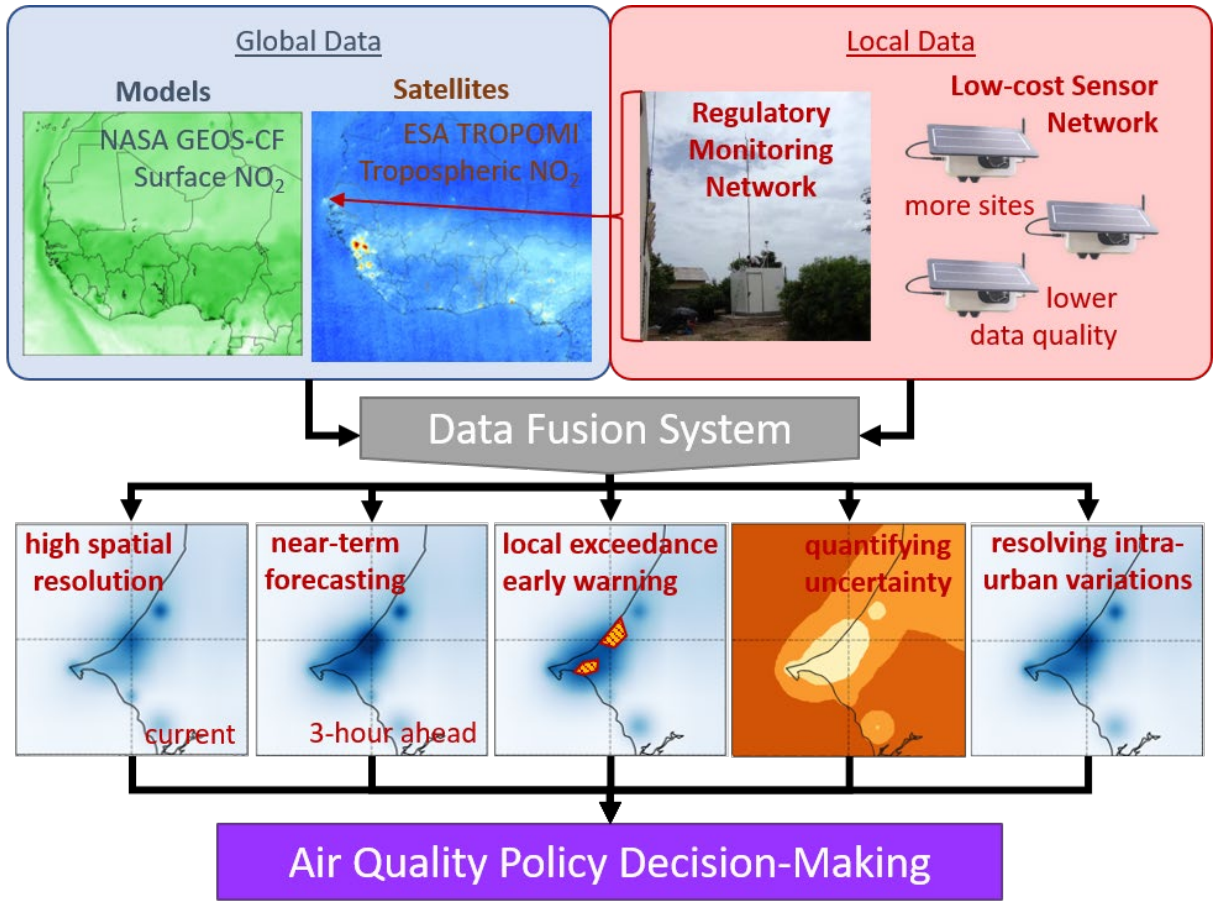
Ongoing & Future Work



NASA Earth Science Applications: Health and Air Quality

Supporting local government public health and air quality decision-making with a sub-city scale air quality forecasting system from data fusion of models, satellite, in situ measurements, and low-cost sensors.

Cities:
Dakar, **Senegal**
Rio de Janeiro, **Brazil**
Charleston, Denver, Boulder, Gulfport, Portland, **USA**

Collaborators:
US EPA
UN Environment Programme
Sonoma Technology, Inc.
Clarity Movement, Co.
Columbia University, WUSTL