Data Fusion for Urban Air Quality Assessment & Forecasting

K. Emma Knowland & Carl Malings
Morgan State University, GESTAR-II
NASA Goddard Space Flight Center, Global Modeling & Assimilation Office

Project team members

PI: **K. Emma Knowland**[1,2]

Co-Is/Science PIs: **Carl Malings**[1,2] and **Nathan Pavlovic**[3]

Co-Is: **Christoph Keller**[1,2] and **Stephen Cohn**[2]

Collaborators: **Dan Westervelt**[4], **Sean Wihera**[5],

Randall Martin[6], **Sean Khan**[7], and **John White**[8]

(1) Morgan State University, GESTAR-II, USA.

(2) NASA Goddard Space Flight Center, Global Modeling and Assimilation Office, USA.

(3) Sonoma Technology, Inc., USA.

(4) Lamont Doherty Earth Observatory (LDEO), USA.

(5) Clarity Movement Co., USA.

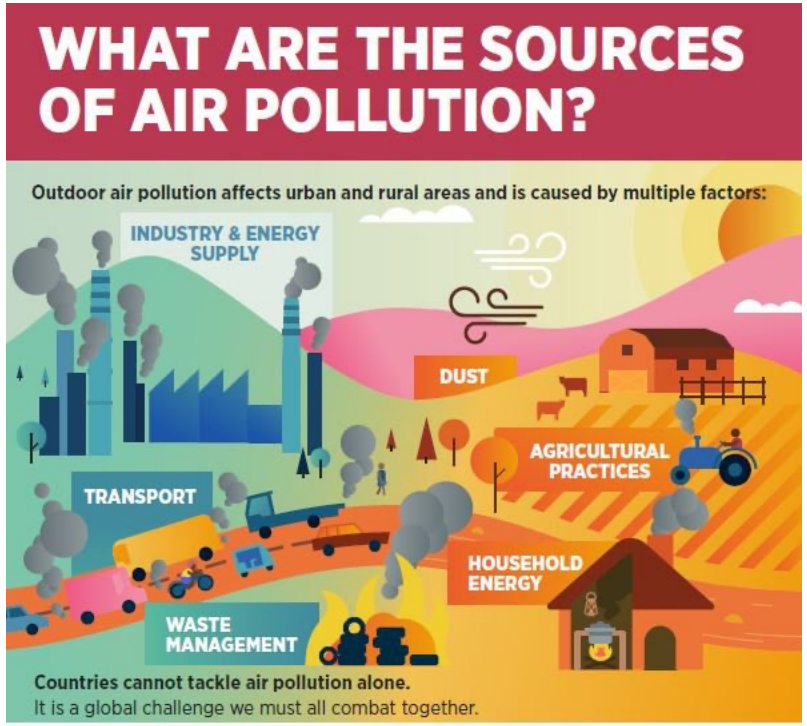
(6) Washington University in St. Louis, USA.

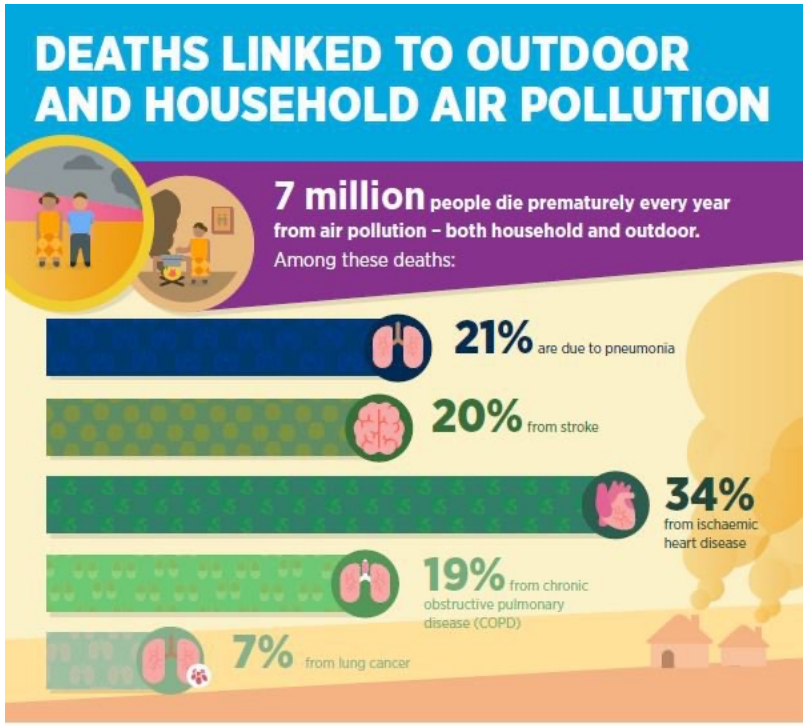
(7) United Nations Environment Programme (UNEP), UN.

(8) Environmental Protection Agency (EPA), USA.

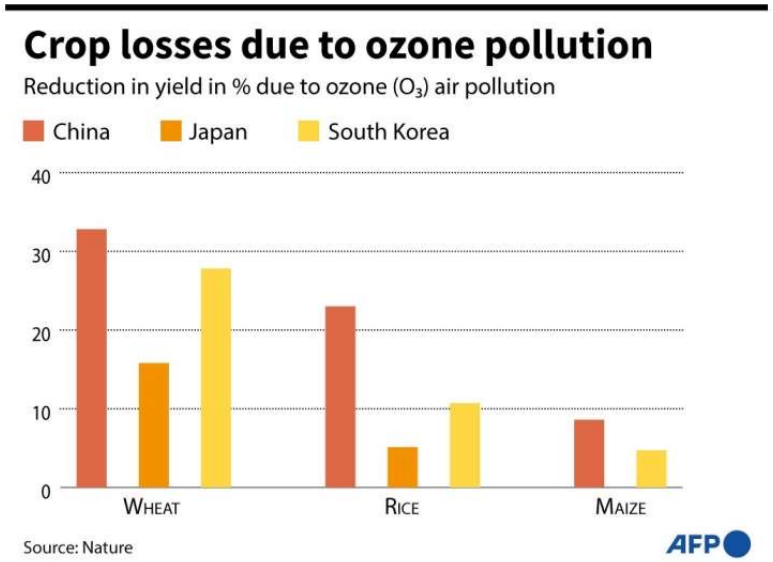
Email: k.e.knowland@nasa.gov
& carl.a.malings@nasa.gov

Background



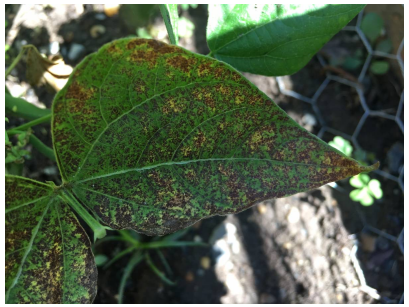


https://www.ccacoalition.org/en/news/world-health-organization-releases-new-global-air-pollution-data



https://phys.org/news/2022-01-ozone-pollution-asia-billions-lost.html





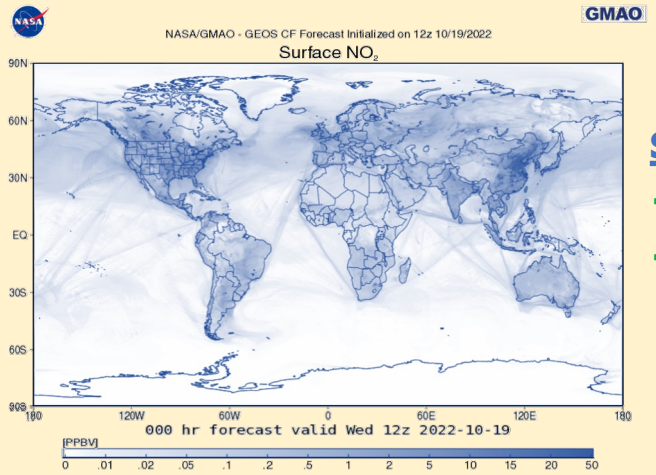
https://airquality.gsfc.nasa.gov/ozone-bioindicator-garden

- 1 of every 9 death is related to air pollution (WHO)
- $5 Trillion in welfare losses every year (World Bank)
- Locally up to 50% crop loss due to ozone

Email: k.e.knowland@nasa.gov
& carl.a.malings@nasa.gov

Background

Global Data Sources

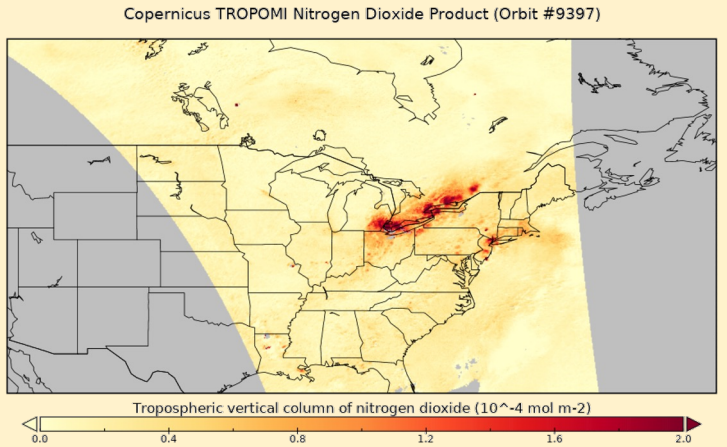


simulation models

+ global coverage
+ forecasting
- limited resolution
? updated emissions

satellite retrievals

+ global coverage
- low time resolution
- column-integrated
? relevant to surface





regulatory monitoring

+ accurate
- expensive
? representative

low-cost monitoring

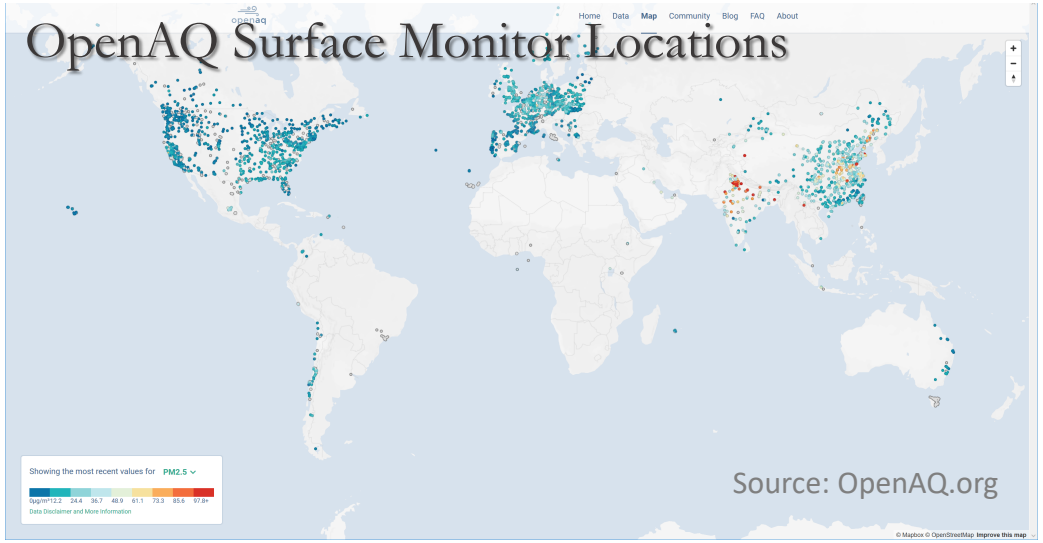
+ relatively inexpensive
+ dense/remote deployment
- greater noise and bias
? locally calibrated

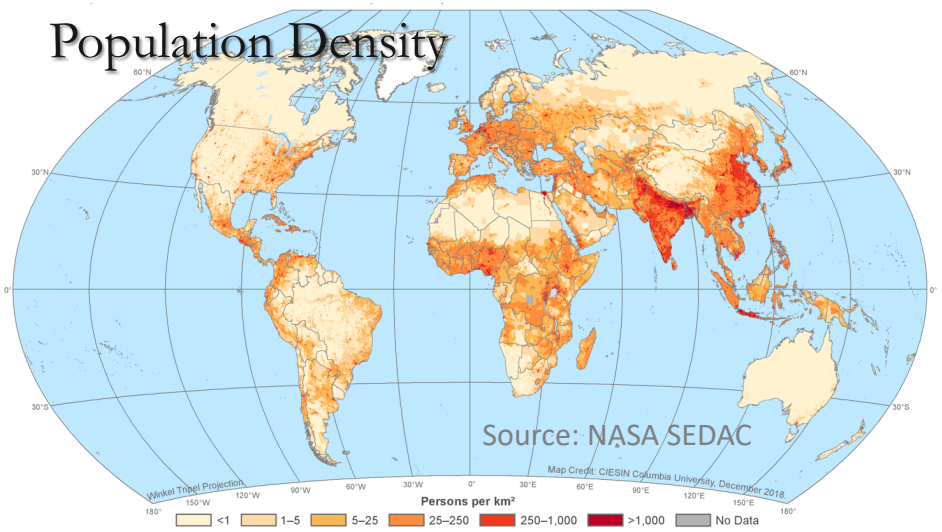


Local Data Sources

Email: k.e.knowland@nasa.gov
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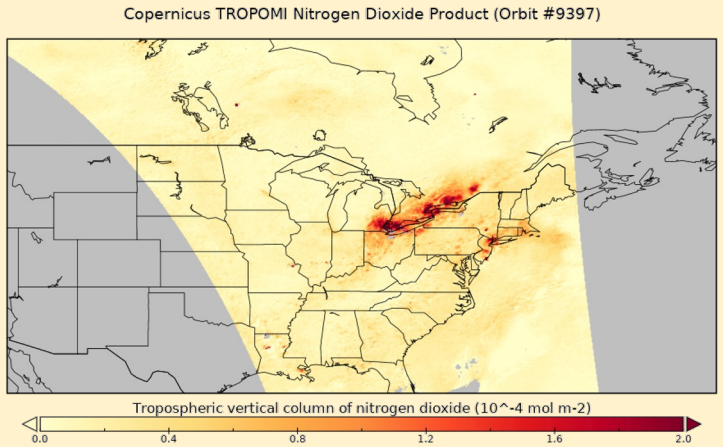
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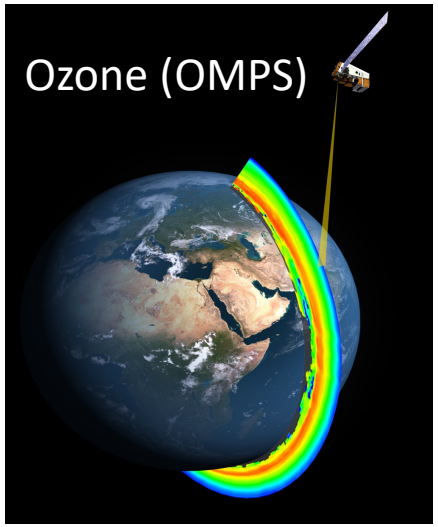
Background

Global Data Sources

satellite retrievals

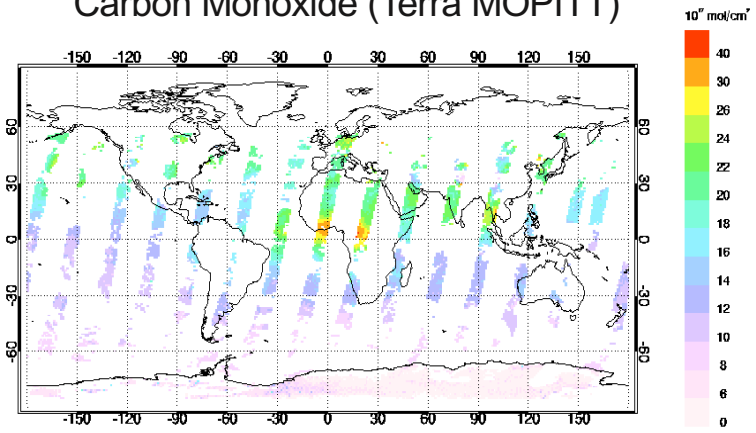
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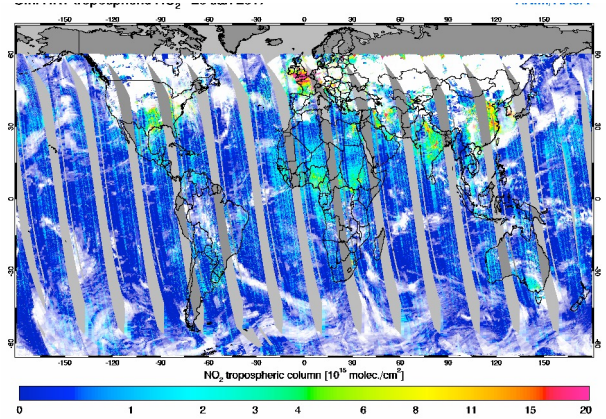
Source: www.nasa.gov

Carbon Monoxide (Terra MOPITT)



Source: www.acom.ucar.edu

Nitrogen Dioxide (Aura OMI)

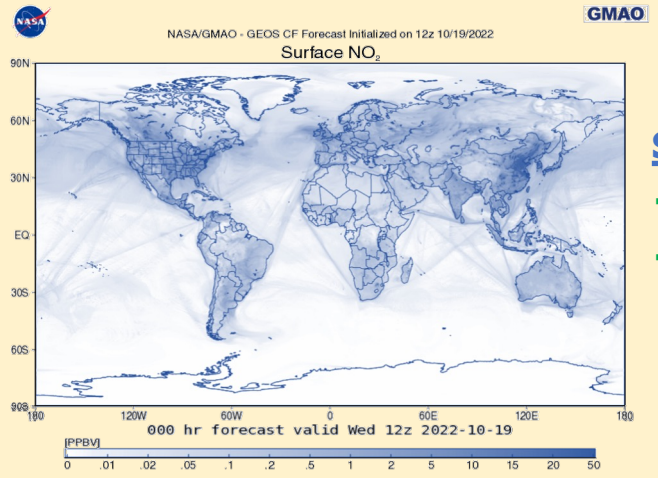


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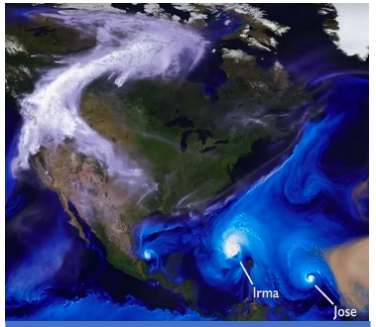
Background

Global Data Sources



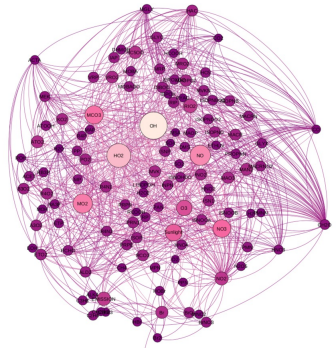
simulation models

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? updated emissions



GEOS weather forecast model

+



GEOS-Chem

NASA GEOS Composition Forecast System, "GEOS-CF"

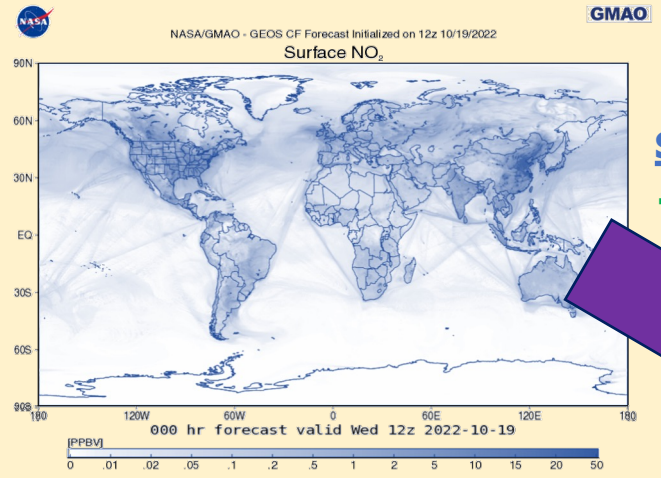
- Combines GEOS meteorology with GEOS-Chem chemistry
  - speciated & total **$PM_{2.5}$, NO_2, CO, SO_2, Ozone**
- **15 minute and hourly** temporal resolution
- 0.25 degree **(~25 km, 16 miles)** spatial resolution
- **Global coverage**
- Daily **5-day forecast** and estimates of previous day
- **https://gmao.gsfc.nasa.gov/weather_prediction/GEOS-CF**

Source: Keller, C., et al. (2021). "Description of the NASA GEOS Composition Forecast Modeling System GEOS-CF v1.0", DOI: 10.1029/2020MS002413

Email: k.e.knowland@nasa.gov
& carl.a.malings@nasa.gov

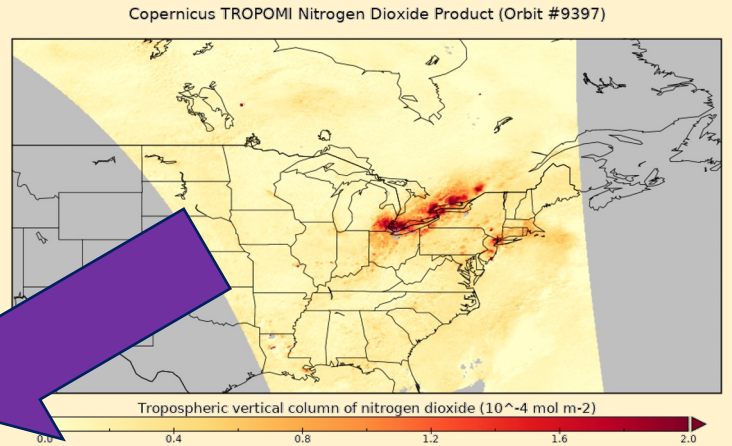
Background

Global Data Sources



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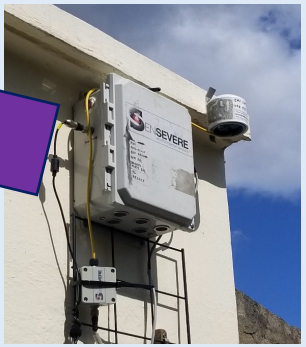


Urban-Scale Air Quality Estimation and Forecasting



regu itoring
- ate
- expensive
? representative

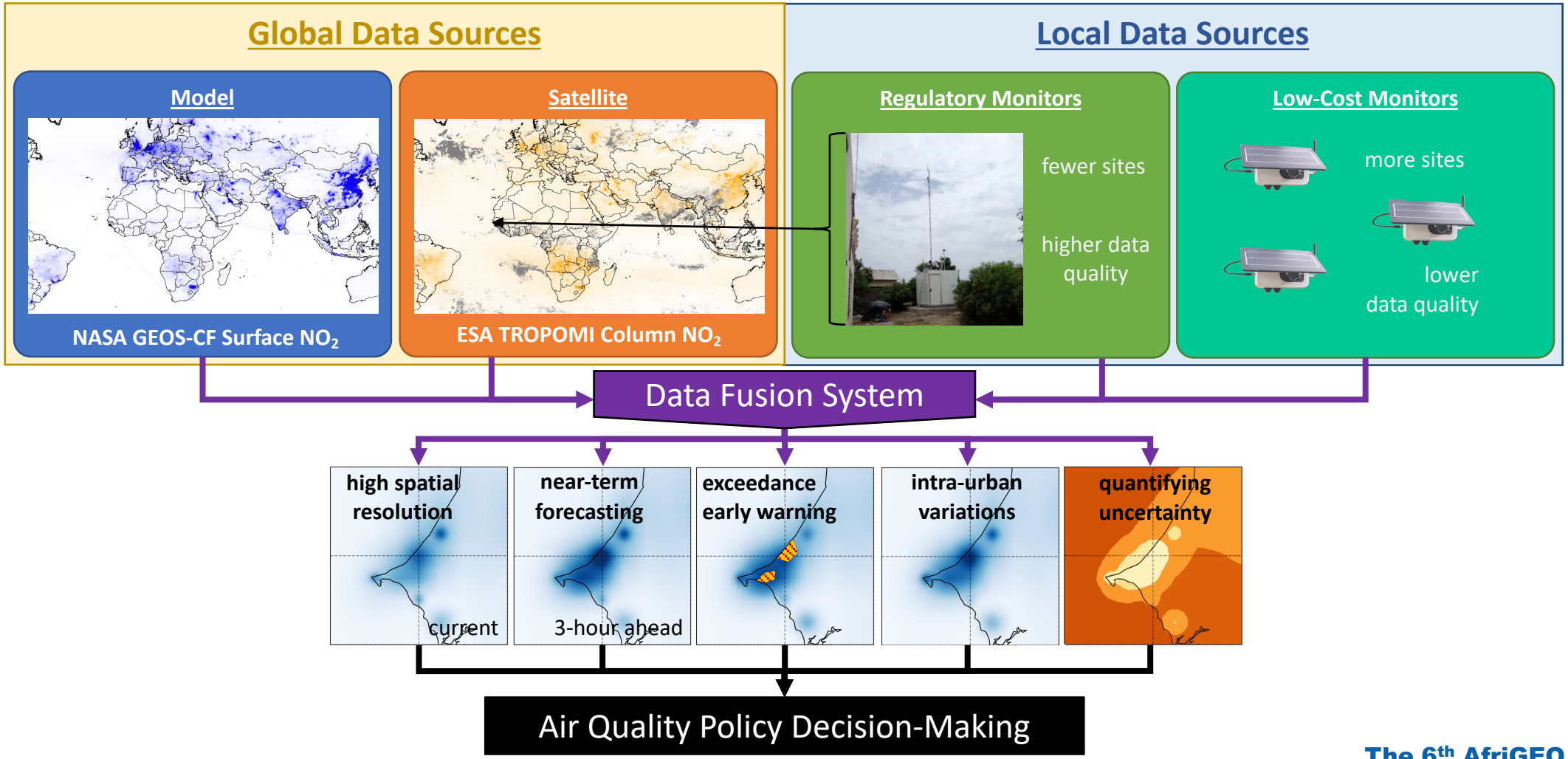
low-cost m
+ relatively inexpensive
+ dense/remote deployment
- greater noise and bias
? locally calibrated



Local Data Sources

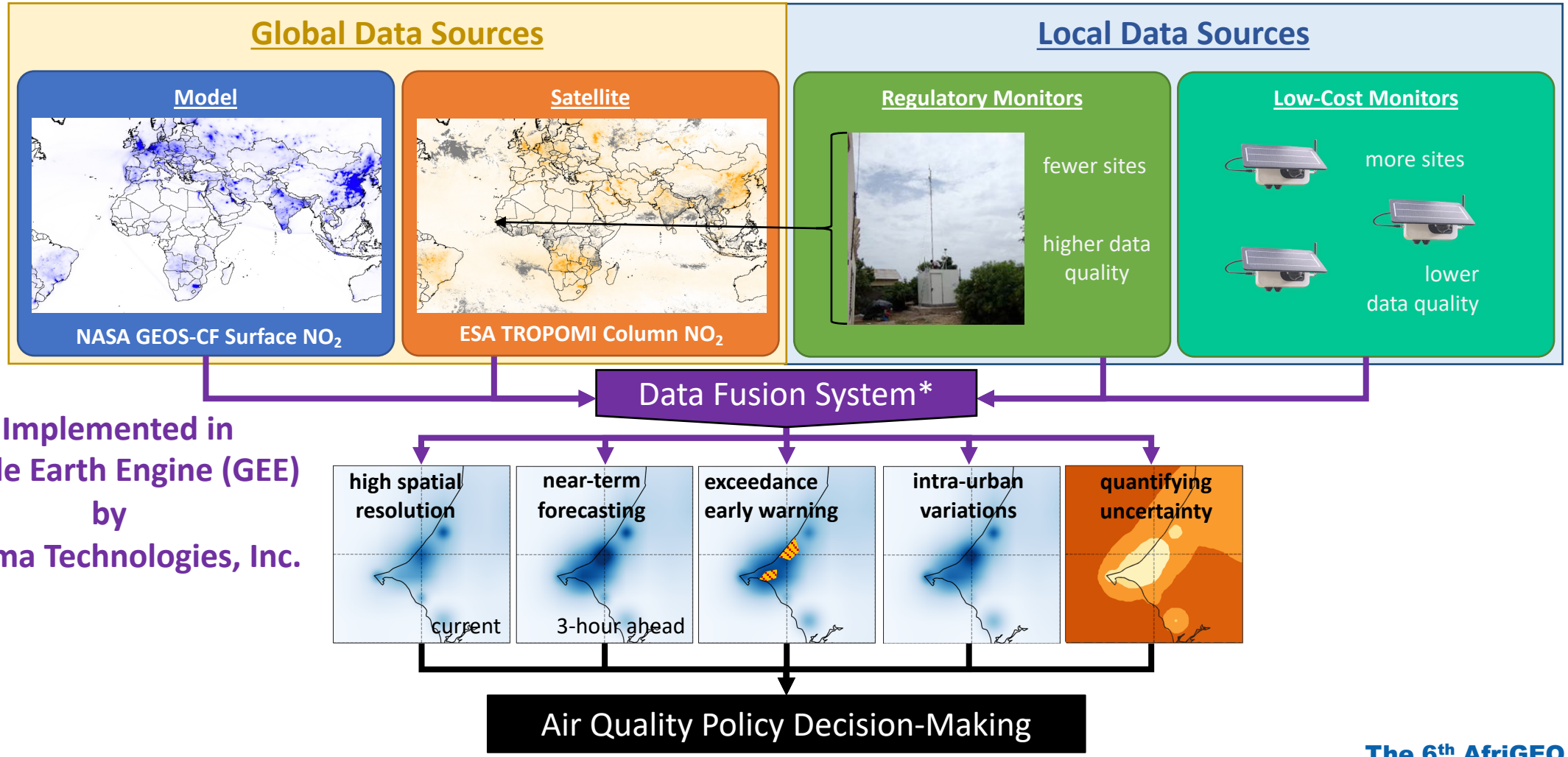
Email: k.e.knowland@nasa.gov
& carl.a.malings@nasa.gov

Objectives



Email: k.e.knowland@nasa.gov
& carl.a.malings@nasa.gov

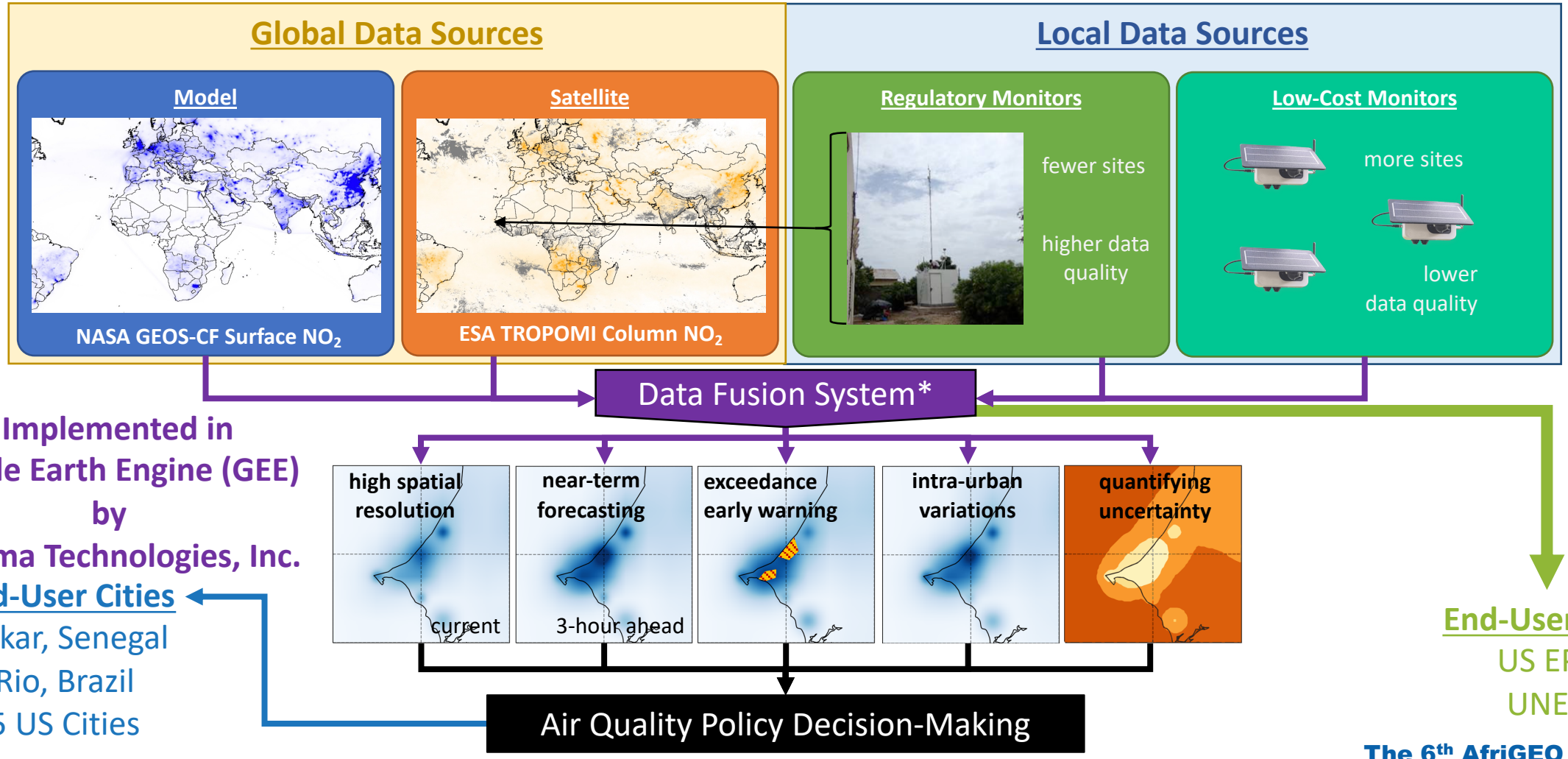
Implementation Plan



*Implemented in Google Earth Engine (GEE) by Sonoma Technologies, Inc.

Email: k.e.knowland@nasa.gov
& carl.a.malings@nasa.gov

Collaborators, Stakeholders and Users



***Implemented in Google Earth Engine (GEE) by Sonoma Technologies, Inc.**

End-User Cities

Dakar, Senegal

Rio, Brazil

5 US Cities

End-User Orgs

US EPA

UNEP

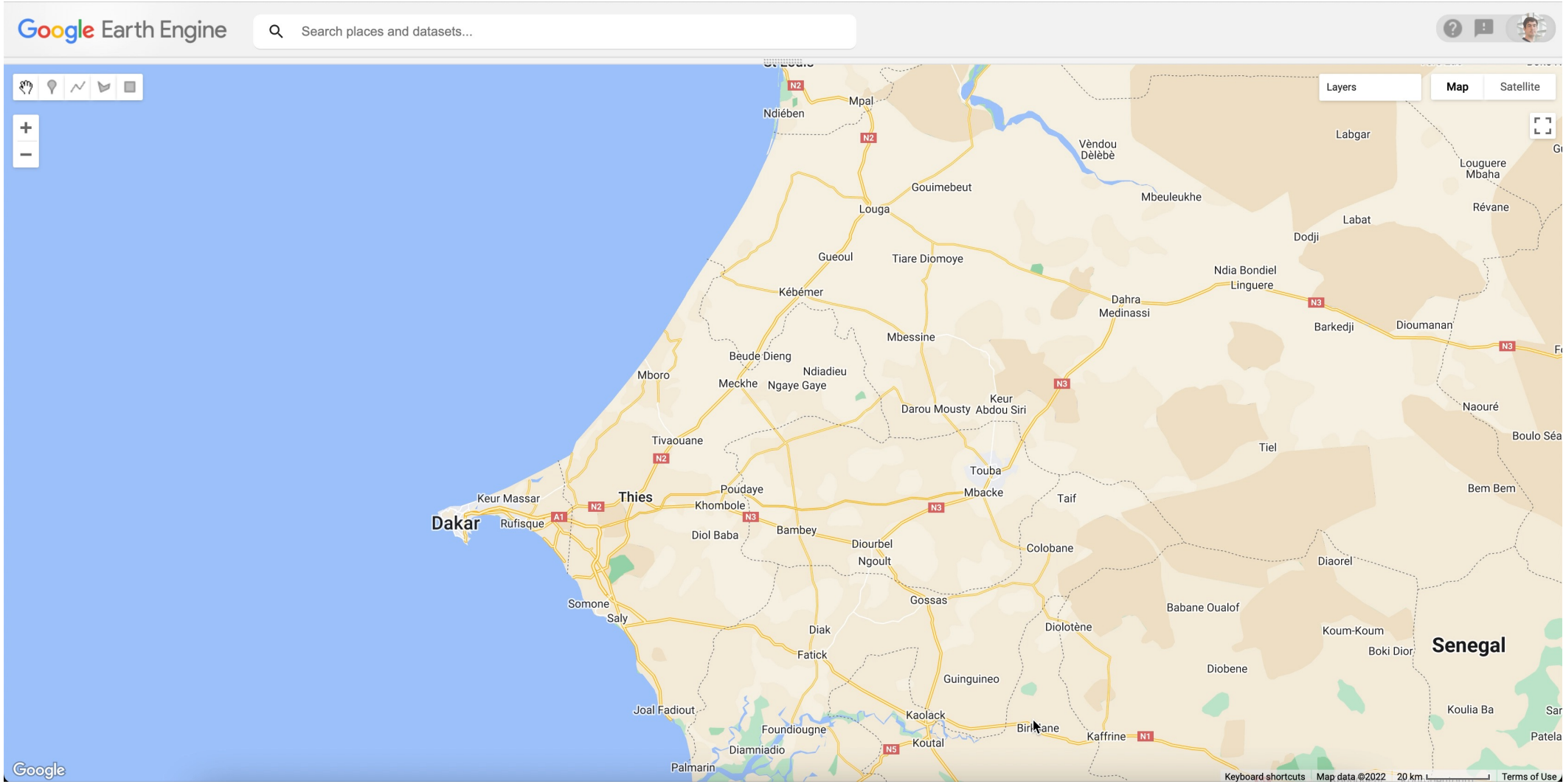
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Harnessing EO towards Resilient & Sustainable systems, communities & resources

The 6th AfriGEO Symposium

31st Oct – 5th Nov, 2022

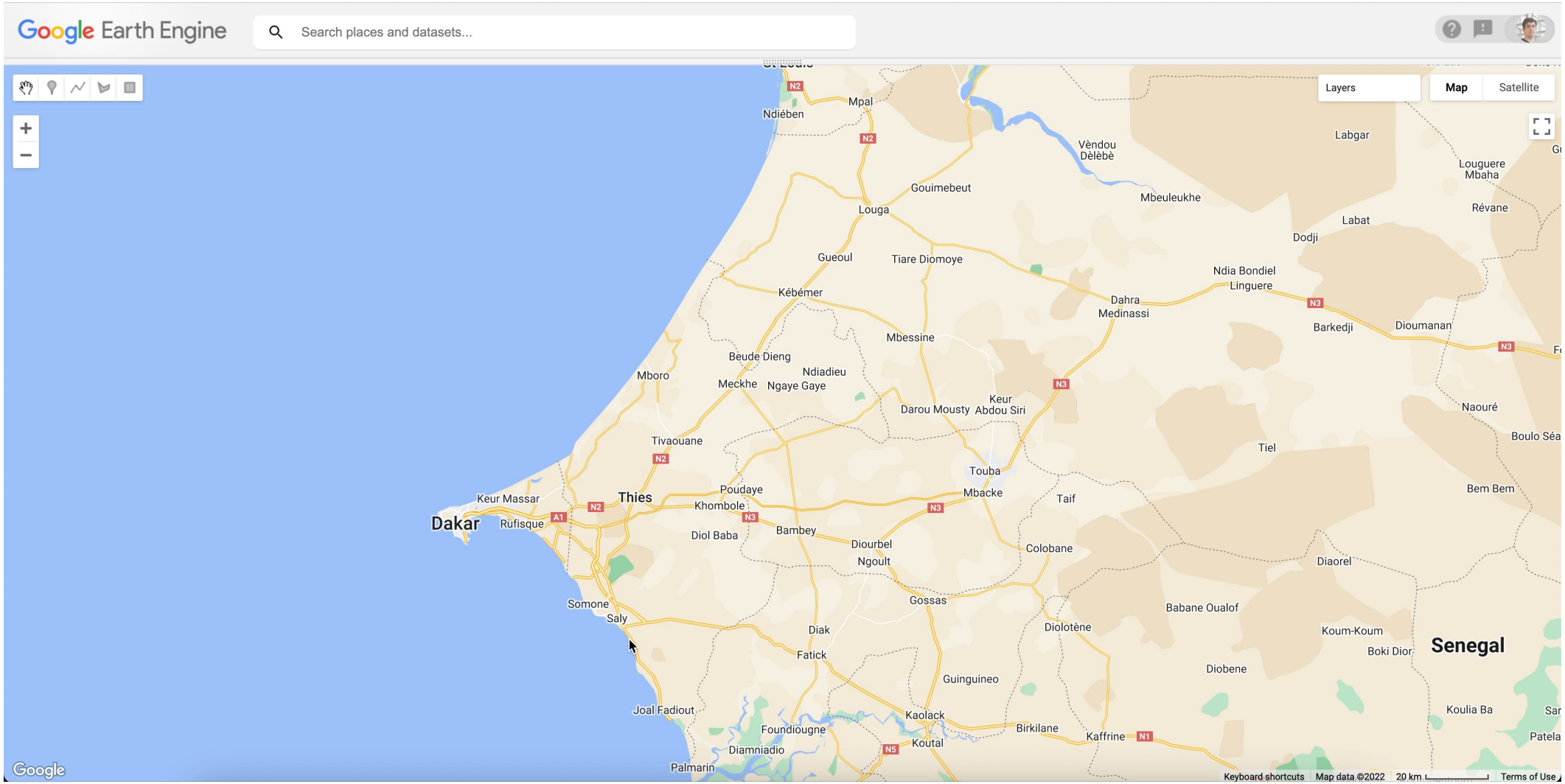
Preliminary Outputs



Email: k.e.knowland@nasa.gov
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Harnessing EO towards Resilient & Sustainable systems, communities & resources

Preliminary Outputs



Calibration

Model

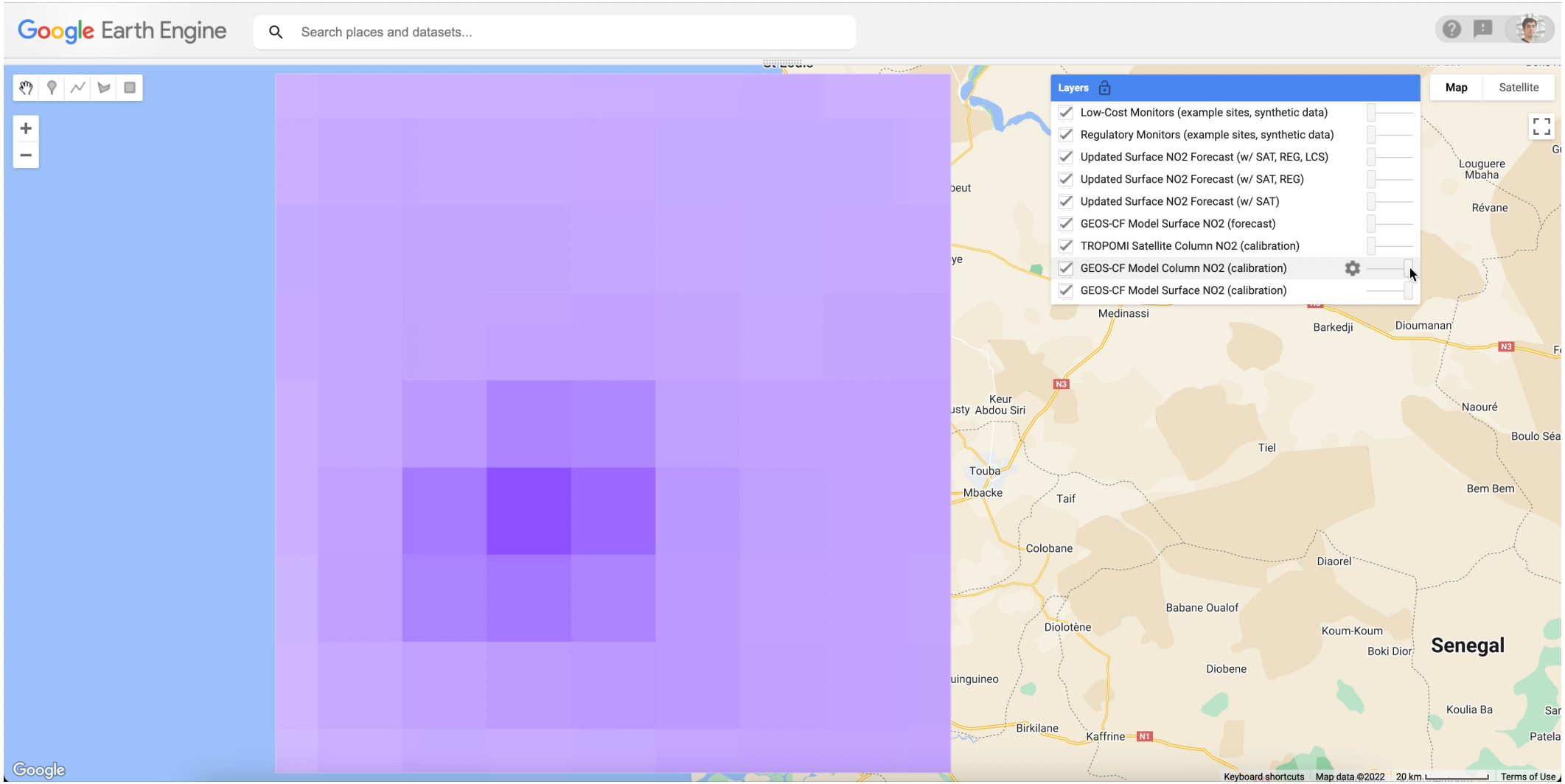
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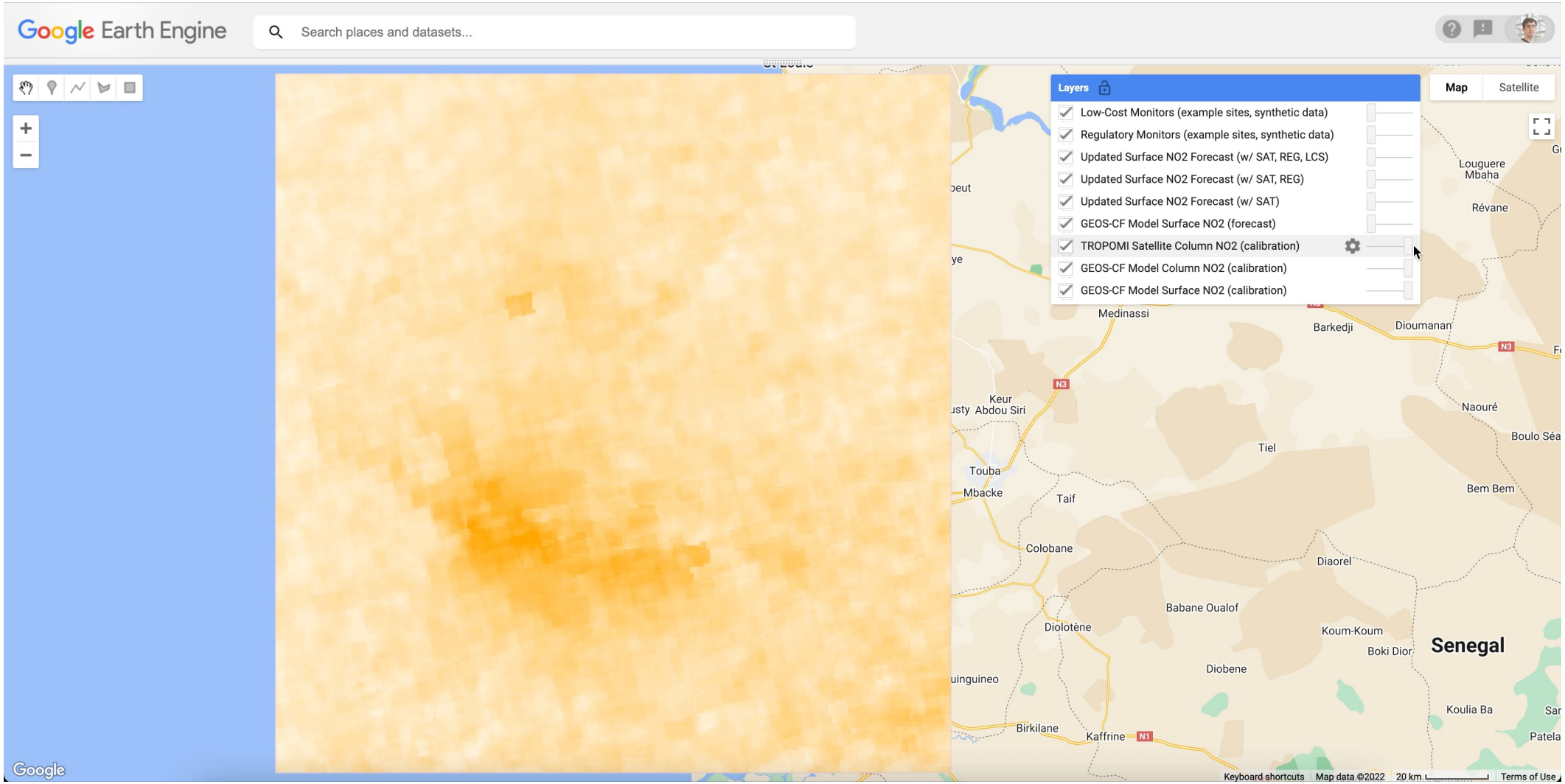
Calibration

Model

Satellite

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Preliminary Outputs



Calibration

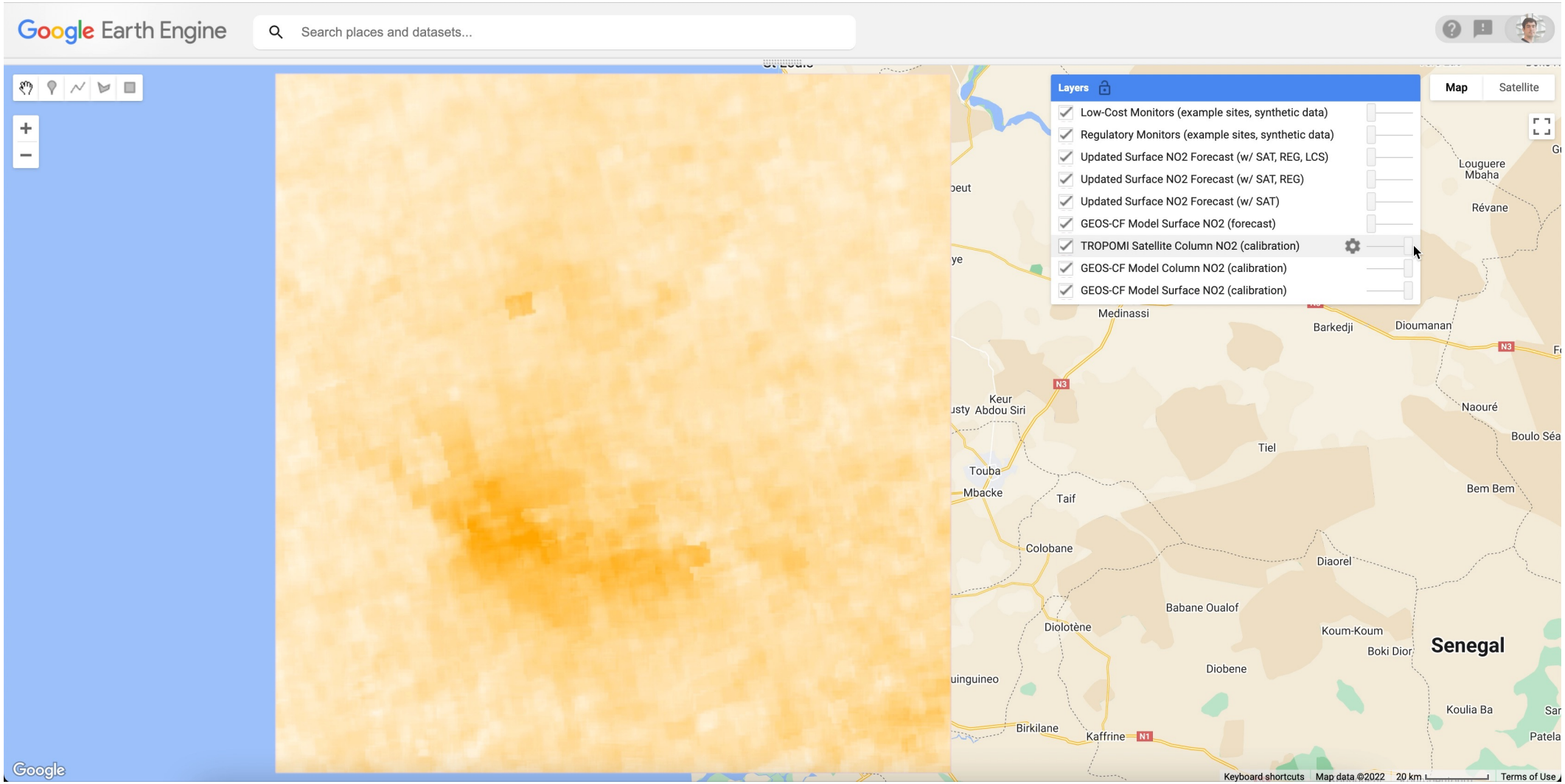
Model

Satellite

Calibrated Relationship

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Preliminary Outputs



Calibration

Model

Satellite

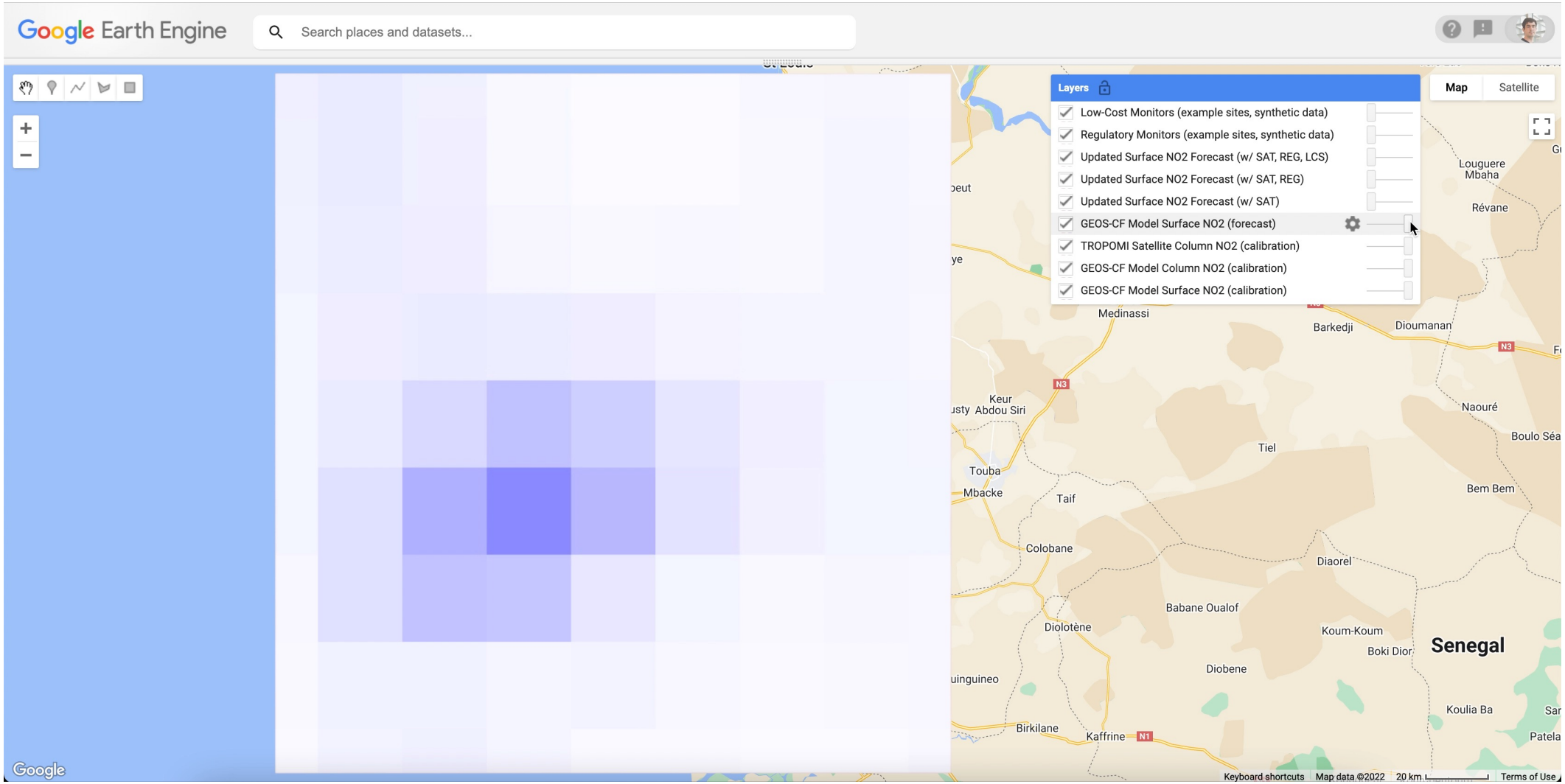
Calibrated Relationship

Application

Model Forecast

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& carl.a.malings@nasa.gov

Preliminary Outputs



Calibration

Model

Satellite

Calibrated Relationship

Application

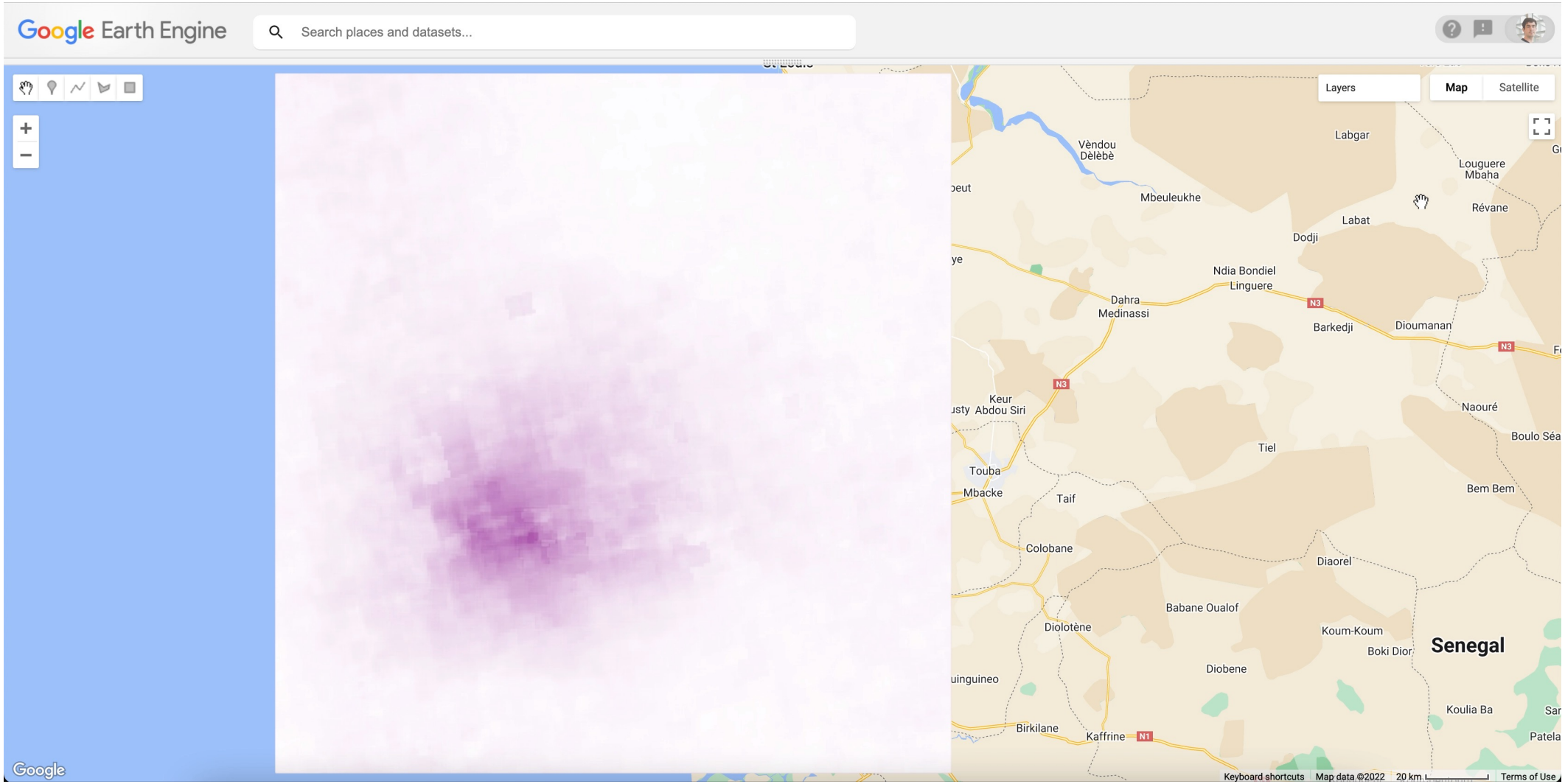
Model Forecast

Data Fusion Estimate

Email: k.e.knowland@nasa.gov
& carl.a.malings@nasa.gov

Harnessing EO towards Resilient & Sustainable systems, communities & resources

Preliminary Outputs



Calibration

- Model
- Satellite
- Regulatory Monitor

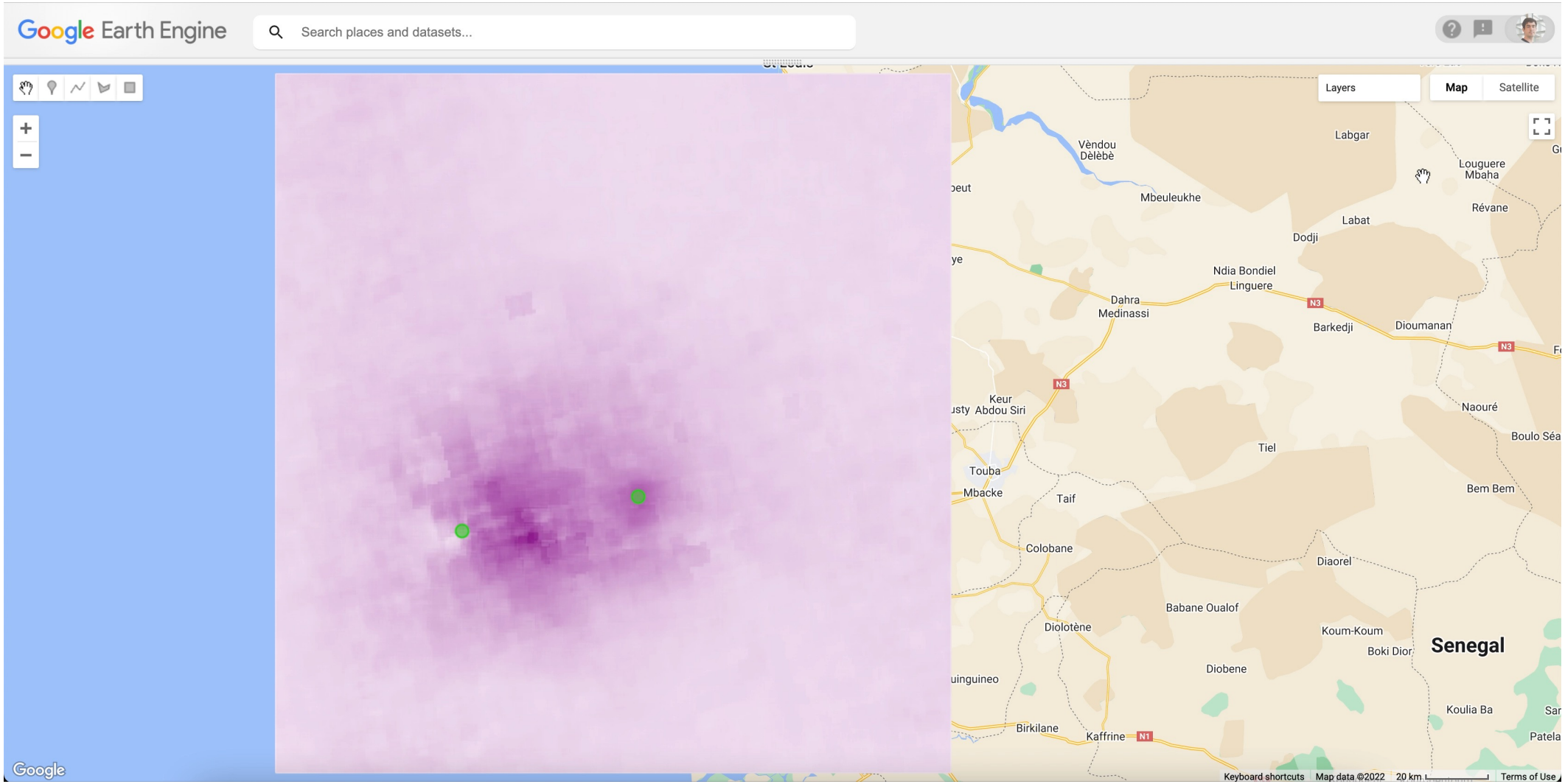
→ Calibrated Relationship

Application

- Model Forecast → ★
- Data Fusion Estimate

Email: k.e.knowland@nasa.gov
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Preliminary Outputs



Calibration

- Model
- Satellite
- Regulatory Monitor
- Low-Cost Monitor

Calibrated Relationship

Application

- Model Forecast
- Data Fusion Estimate

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Thank you
Questions?