

Bryan Duncan



Kevin Cromar



Ana Prados



# Integrating NASA Resources into the Standard Operating Procedures of Low-Moderate Income Countries (LMIC)

PI: Bryan N. Duncan (NASA)

Co-Is: Ana I. Prados (UMBC), Kevin R. Cromar (NYU)

*HAQAST Meeting, Salt Lake City, UT, October 20, 2023*

# Project Methodology

**Step 1:** Engaging a diverse set of stakeholders from the LMIC to gauge their individual needs and to identify common needs.

**Step 2:** Identify ways to “scale up” engagement to reach many stakeholders in the LMIC.

### Augmenting the Standard Operating Procedures of Health and Air Quality Stakeholders With NASA Resources

Bryan N. Duncan , Carl A. Malings, K. Emma Knowland, Daniel C. Anderson, Ana I. Prados, Christoph A. Keller, Kevin R. Cromar, Steven Pawson, Holli Ensz,

First published: 09 September 2021 | <https://doi.org/10.1029/2021GH000451>

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#### Abstract

The combination of air quality (AQ) data from satellites and low-cost sensor systems, along with output from AQ models, have the potential to augment high-quality, regulatory-grade data in countries with in situ monitoring networks and provide much needed AQ information in countries without them, including Low and Moderate Income Countries (LMICs). We demonstrate the potential of free and publicly available USA National Aeronautics and Space Administration (NASA) resources, which include capacity building activities, satellite data, and global AQ forecasts, to provide cost-effective, and reliable AQ information to health and AQ professionals around the world. We provide illustrative case studies that highlight how global AQ forecasts along with satellite data may be used to characterize AQ on urban to regional scales, including to quantify pollution concentrations, identify pollution sources, and track the long-range transport of pollution. We also provide recommendations to data product developers to facilitate and broaden usage of NASA resources by health and AQ stakeholders.

# Project Methodology

Focus of this presentation



**Step 1:** Engaging a diverse set of stakeholders from the LMIC to gauge their individual needs and to identify common needs.

**Step 2:** Identify ways to “scale up” engagement to reach many stakeholders in the LMIC.

Our methodology  
presented here

## GeoHealth

Review Article | [Open Access](#) |

### Augmenting the Standard Operating Procedures of Health and Air Quality Stakeholders With NASA Resources

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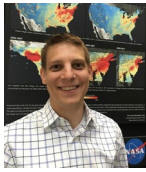
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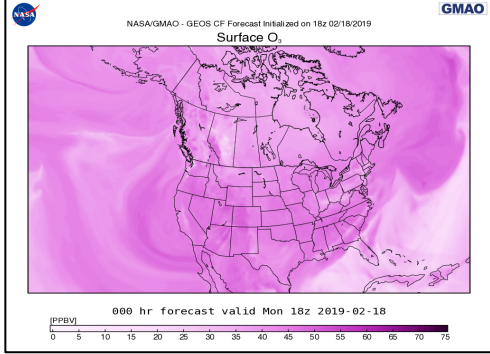
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**\*New HAQAST Work\***

## NASA AQ Forecast System



Forecasts via  
NASA Fluid &  
WRI Resource  
Watch

## Partners Decision Making



**Valeria Diaz**, Quito Air Quality Monitoring Coordinator, Environmental Secretariat, Ecuador



**Felipe Mandarino**, Instituto Pereira Passos, Rio de Janeiro City Government, Brazil



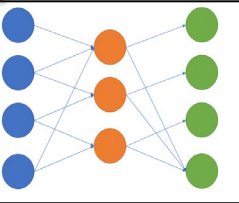
**Gabriel Okello & Kellen Nyamurungi Namusisi**, African Centre for Clean Air (ACCA), Kampala, Uganda

**Bolivia**

**Marcos Andrade, Karen Crespo, Armando Rodriguez**, Academics and Non-Profit in Bolivia (La Paz, Santa Cruz, Cochabamba)

Tailored Forecasts  
via API

Machine  
Learning



## AQ Observations

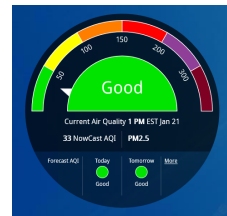


© 2012 Daniele Costantini / Wikimedia Commons

Surface AQ Data  
openaq

## Partner Applications

### AQ Forecasts & Alerts



from <https://www.airnow.gov>

### Mitigation Planning



Photo by [Patrick Hendry](#) on [Unsplash](#)

Data

## Satellite Data

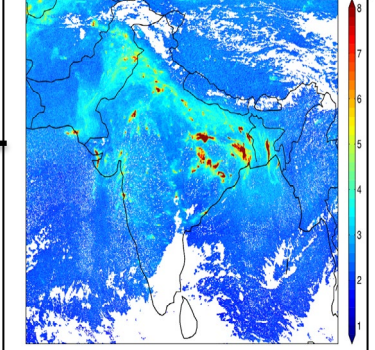


Image courtesy Lok Lamsal (NASA)



HAQI/ AQI  
Verification

## HAQI/AQI



Data

## Low-Cost Sensors



Photo from Clarity Movement  
<https://www.clarity.io/>

# Step 1: Working with Select Stakeholders in LMIC

## **We are engaging select stakeholders who have a range of:**

- expertise (none - intermediate) working with satellite data for AQ and health applications.
- financial resources (minimal - relatively well funded).
- experience with health and AQ issues (limited - many years).
- application needs (e.g., analysis of health impacts, raising awareness of the negative effects of air pollution)

# Diverse Stakeholder Needs & Abilities

## City Government of Rio de Janeiro

- **Experience with NASA:**
  - (> 5 y) Landslide detection and prediction.
  - (> 2 y) Christoph Keller (GMAO) on NASA AQ forecasts.
  - Little expertise using satellite data for AQ applications.
- **Capacity:** Relatively well funded, large group.
- **Primary interest from this HAQAST project:** Identifying links between health outcomes and specific pollutants (PM<sub>2.5</sub>, O<sub>3</sub>, NO<sub>2</sub>), including for gauging benefits of pollution reductions.
  - Kevin Cromar is building capacity within the Rio group to do this health analysis – monthly meetings.



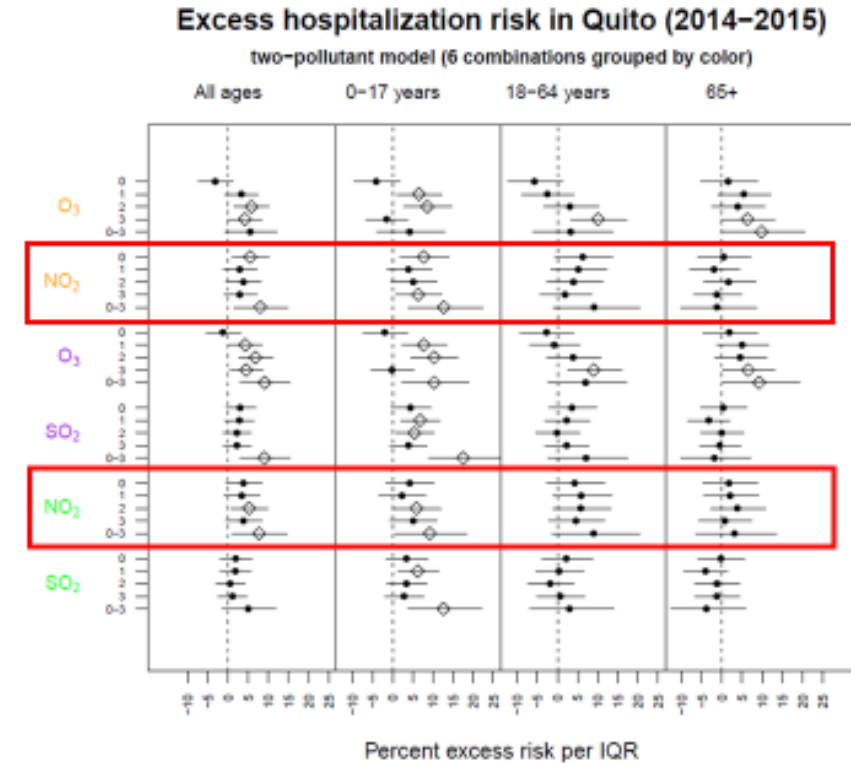
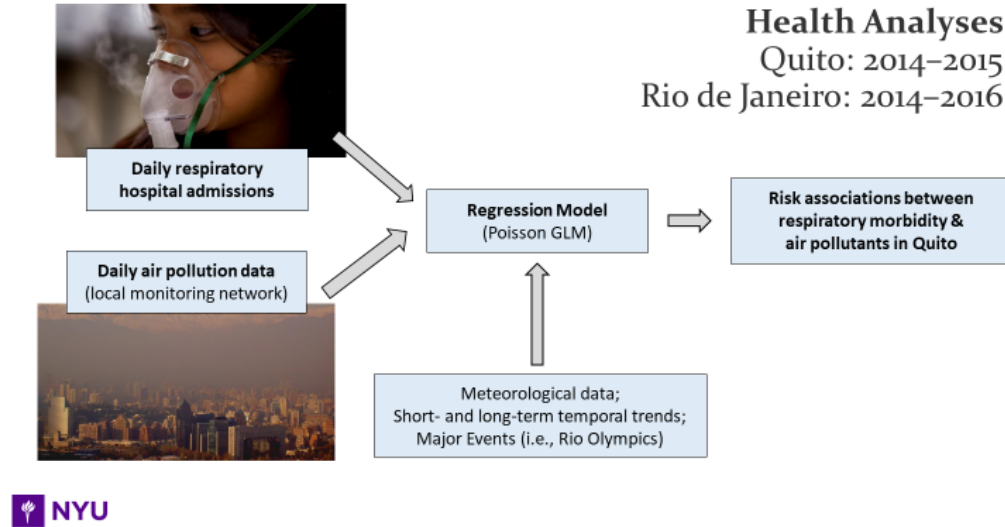
## City Government of Quito

- **Experience with NASA:** (> 2 y) Working with Christoph Keller (GMAO) on NASA AQ forecasts.
- **Capacity:** Very small group with limited funding.
- **Primary interest from this HAQAST project:** Identifying links between health outcomes and specific pollutants (PM<sub>2.5</sub>, O<sub>3</sub>, NO<sub>2</sub>), including for gauging benefits of pollution reductions. Potential of satellite data for their applications.
  - Kevin Cromar delivered his team's health analysis to them.
  - Ana Prados delivered a mini-training on using satellite data for health and AQ applications.



# Health Analyses: Quito and Rio

Upper management of the health and AQ agencies of both cities requested that we first show how air pollution affects health outcomes, using in situ monitor data.



**$NO_2$  associations persisted in two-pollutant models**

## Takeaways from Health Analyses

$NO_2$  is the strongest indicator of respiratory morbidity in both Latin American cities

Studies increase equity of global epidemiological literature

Directly benefits study populations by providing detailed risk information to local environmental managers

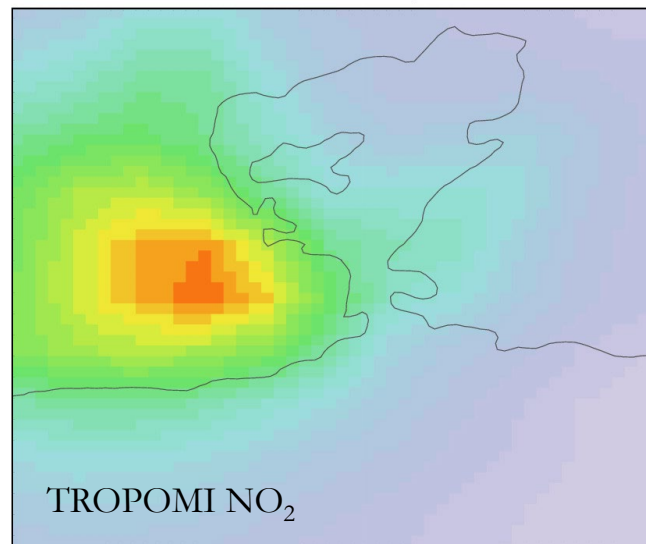
Provide baseline information to inform future studies involving satellite-model data applications for broader collaborative project

# Focus of Efforts for the Quito and Rio

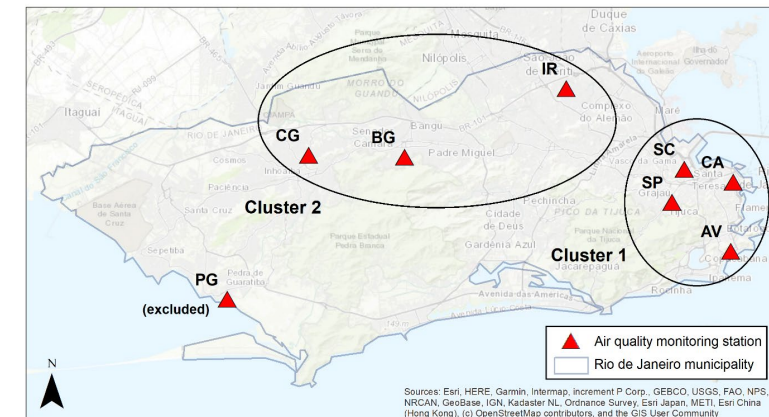
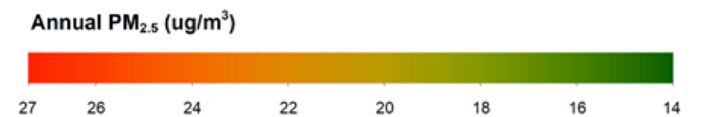
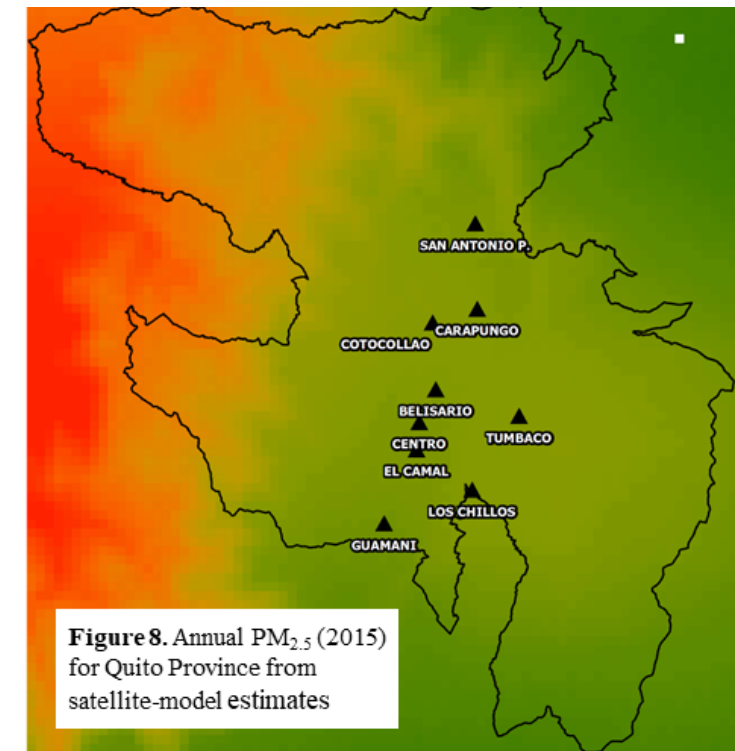
We are focusing on:

- siting monitors.
- assessing current air quality indices and comparing to NYU's health air quality index (HAQI).
- urban pollution monitoring.

Rio de Janeiro, Brazil



Data source: van Donkelaar et al. (2021)



# Diverse Stakeholder Needs & Abilities

## African Centre for Clean Air (multinational & non-governmental who influence government)

- **Experience with NASA:**
  - Varied, but generally very limited.
- **Capacity:** Varied, but generally very limited.
- **Primary interest from this HAQAST project:** Two ACCA leads have articulated numerous interests (e.g., LCS, health impacts, AQ monitoring, siting industry), but focusing efforts now on raising awareness of NASA resources.
  - Ana Prados delivered a mini-training on using satellite data for health and AQ applications to two ACCA leads.
  - Next Step: Planning future mini-training to any interested ACCA members.
  - Health analysis request very likely.



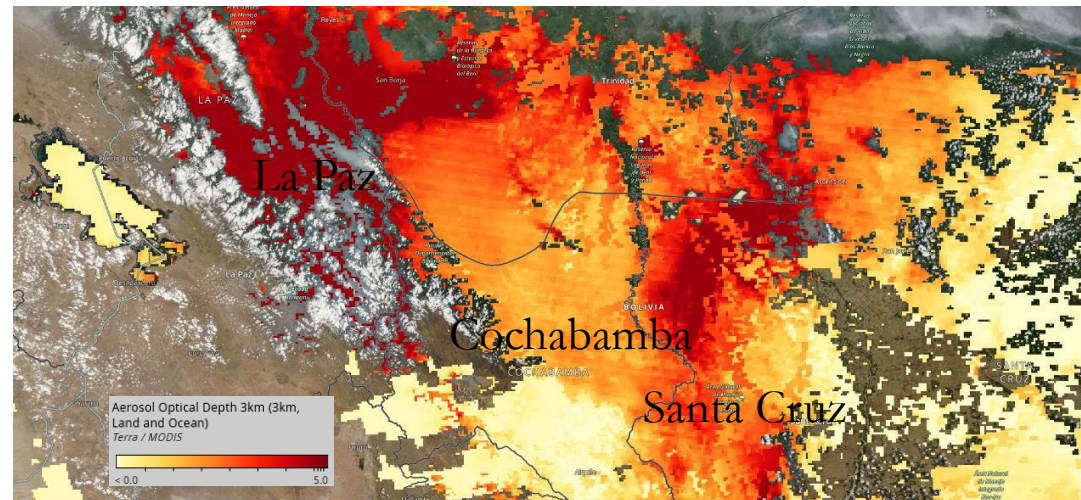
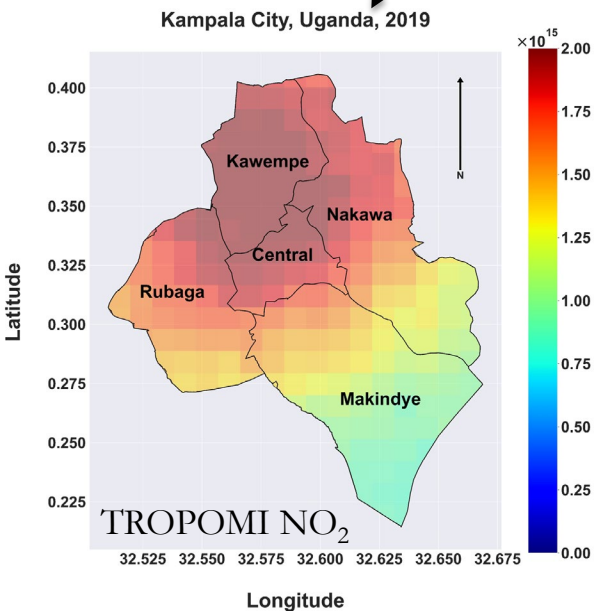
## Bolivia (planning with university and non-profit partners to reach government)

- **Experience with NASA:** Academic and non-profit partners have ample experience with satellite remote sensing.
- **Capacity:** Varied for university contacts, but very limited in government.
- **Primary interest from this HAQAST project:** Focus on stakeholders in Santa Cruz who are interested in using satellite NO<sub>2</sub> and aerosol datasets to monitor urban air pollution and smoke transport.
  - Ana Prados developed three 1-hour webinars, co-delivered and co-designed with collaborators and tailored to regional needs. There were several hundred attendees from academic, government, and private sector organizations. Topics: overview of air quality applications of remote sensing, and access to aerosol datasets. Post-webinar surveys showed a strong interest in combining satellite observations with existing ground-based networks (low-cost sensors, etc.)

# Focus of Efforts for the ACCA & Bolivia

We are focusing on:

- raising awareness. →
- using satellite data and model output to characterize the transboundary transport of pollution from agricultural fires and some wildfires.
- urban pollution. ↘



## Seminario Nivel II: Monitoreo Satelital de la Calidad del Aire en Bolivia

Fecha: 7 de junio, 10 AM (hora local Bolivia)

Duración: 1 hora (incluye periodo de preguntas/respuestas)

[Enlace de Inscripción](#)

### Objetivos del Aprendizaje

- Conocer los instrumentos satelitales y tipos de datos disponibles para el monitoreo de las partículas
- Conocer herramientas donde encontrar imágenes de la calidad del aire
- Descargar conjuntos de datos para la detección de las partículas

### Próximos Seminarios

- Nivel II (gases traza): Septiembre/octubre 2023
- Nivel III: Noviembre 2023

Profesores: Dra. Ana Prados (UMBC/NASA) y Dra. Mariel Friberg (UMD/NASA)

Seminario en español. Se recomienda previamente haber asistido al seminario de Nivel I o [escuchar la grabación del mismo](#)

Para mas información únase al [grupo de WhatsApp](#)



## **Step 2:** Scaling up Engagement to all Stakeholders in LMIC

**Merging lessons learned from High-Income stakeholders with those from our work in the LMIC (i.e., Step 1), we are working to:**

- develop methodologies to broaden the use of NASA resources by AQ and health stakeholders, especially for stakeholders with limited financial resources (e.g., in LMIC).
- make recommendations to the NASA Applied Sciences Program on what NASA can further do to broaden data use in the LMIC as well as many resource-starved stakeholders in high-income countries.

# Enabling Stakeholder Access and Utilization of Data Products for Health and AQ Applications (First Steps)

To enable broader usage of processed (L3/4) data products, we recommend that data product developers work in consultation with health and AQ stakeholders to address the following:

- Validation
- Assessment of Uncertainties and Errors
- Documentation
- Ease-of-Access
- Data Product Recommendations
- Mechanism for Stakeholder Feedback

**TT Goal:** Begin first steps to making a prototype of a “guidance directory” for health and AQ stakeholders.



- **Guidance Directory:** Health and AQ stakeholders often request a “guidance directory” of the data, tools, documentation, and other resources that are best suited to their AQ management challenges. This guidance directory would include all of the elements above in a “one-stop shop” environment, focusing on the L3/4 products known to be most useful to decision-making agencies.



Hosted by NASA's Goddard Earth Sciences (GES) Data and Information Services Center (DISC)  
(<https://disc.gsfc.nasa.gov/>)

# Broadening the Use of NASA Resources: Capacity Building + **Processed Data Products**

## *Processed Data Products (L3-L4):*

- Surface PM<sub>2.5</sub>, NO<sub>2</sub> Concentrations
- Health Air Quality Index
- Lights at Night
- AQ Forecasts/Bias-Corrected Forecasts
- Etc.

