

Urban Environments Task Group: Jakarta as a Partner City

By Bryan Duncan (NASA)

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On March 28th, Bryan Duncan (NASA) met with the Deputy Governor for Spatial Planning and Environment, Mr. Oswar Muadzin Mungkasa (oswarmungkasa@jakarta.go.id; oswar.mungkasa63@gmail.com), at the Governor of DKI Jakarta Province Office to discuss an informal collaboration between NASA and the city government of Jakarta, Indonesia to determine the feasibility of using NASA satellite data for urban problems (e.g., air and water quality, sea-level rise, flooding, etc.). This meeting was arranged through the auspices of the NASA Goddard Space Flight Center (GSFC) internal task group, called Urban Environments, and was organized by the U.S. State Department upon the request of Duncan: Sarah Mathur (Health and Environment Affairs Officer/Economic Section) and Sri Murniati (Environment, Science, Technology & Health Specialist) were in attendance. Both parties (NASA, DKI Jakarta Province Office) agreed to move forward with an informal collaboration, with a first goal to focus on air quality. Duncan was tasked with developing a brief plan of the collaboration with DKI Jakarta Province Office. Hereafter, this proposed informal collaboration will be referred to as the “collaboration”.

Prof. Puji Lestari (pujilest@indo.net.id; Institut Teknologi Bandung), who has expertise in Indonesian pollution and a working relationship with Mr. Mungkasa, has agreed to work as an advisor for this collaboration.

Observing Air Pollution over Greater Jakarta (JABODETABEK = Jakarta, Bogor, Depok, Tangerang, and Bekasi) from Space

The primary strengths of satellite data for monitoring air pollution over Jakarta are spatial coverage and the data are free, while the main challenges are clouds and inferring surface values (i.e., at “nose level”). Recognizing these strengths and limitations, we propose the following tasks, which are identified with arrows (→).

I. Air Quality Trends

Several satellite datasets are useful for monitoring long-term changes in air pollution, even down to the sub-urban scale. They include nitrogen dioxide (NO₂), aerosol optical depth (AOD: used to infer surface fine particulate matter (PM_{2.5})), ammonia (NH₃), carbon monoxide (CO), and sulfur dioxide (SO₂). Lights at Night data may be useful for monitoring trends in energy usage. Monitoring long-term changes will allow Jakarta officials to determine the efficacy of pollutant emission controls and to identify where additional efforts are needed to improve air quality.

→We propose to create maps of the spatial distribution of pollutants as well as their trends. Several examples are shown here. We will work closely with DKI Jakarta personnel to interpret these spatial maps and trend plots. This interpretation will critically depend on the local expertise of these personnel, such as for micrometeorology that may affect pollutant trends (e.g., Kusumaningtyas et al., The recent state of ambient air quality in Jakarta, *Aerosol and Air Quality Research Journal*, Volume 18, Issue 4, 30 March 2018).

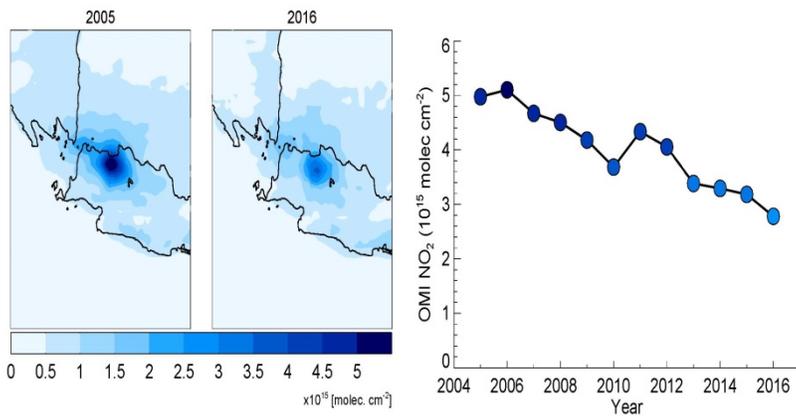


Figure. Nitrogen dioxide (NO₂) data from the NASA Aura Ozone Monitoring Instrument (OMI) show the effectiveness of emission control efforts to reduce this pollutant. From 2005 to 2016, levels dropped by about 40% in Jakarta.

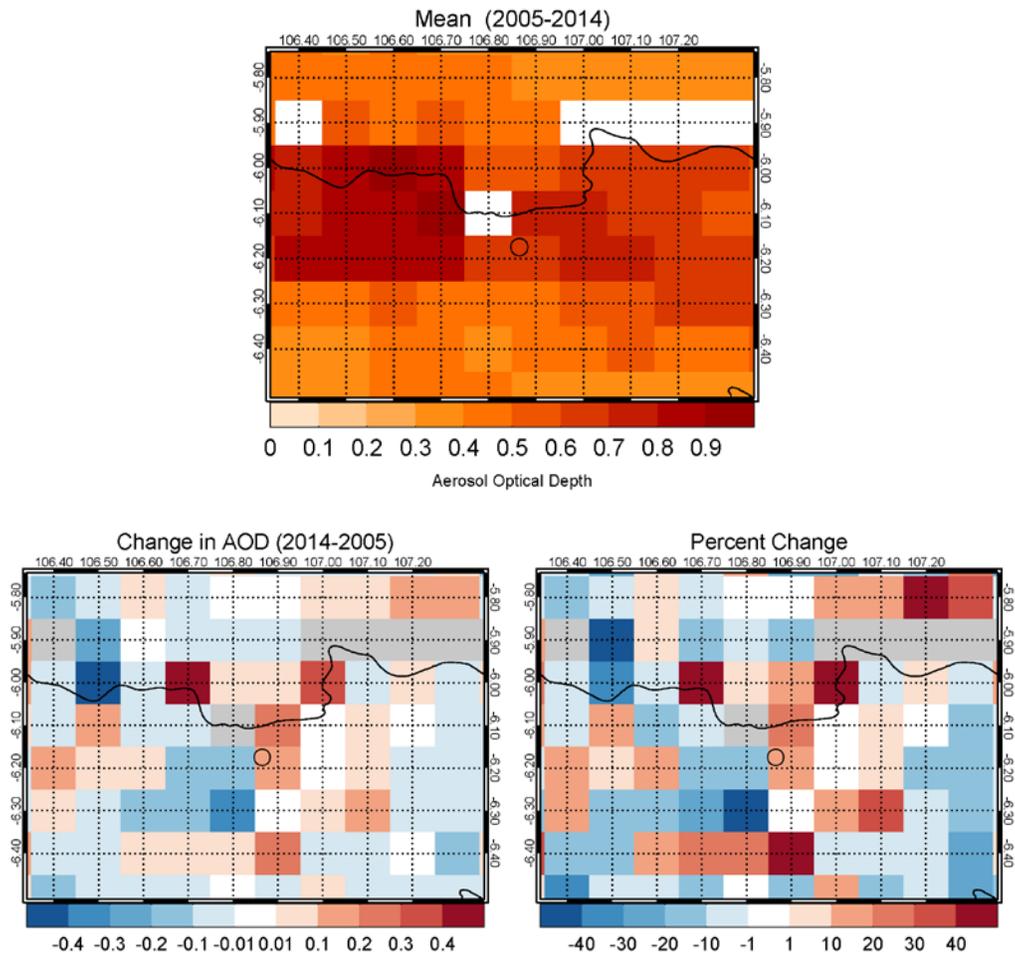


Figure. Data of aerosol optical depth (AOD), an indicator of particulate matter (e.g., dust, smoke), over Jakarta show that there are mixed changes in particulate matter in the city from 2005 to 2014. Each pixel is 10x10 km². The circle indicates the location of Central Jakarta. (top panel) The mean (2005 to 2014) distribution of AOD (unitless) over Jakarta and surrounding regions. (bottom panels) 2014 annual mean AOD minus 2005 annual mean AOD. The north

and central sides of the city show increases while the west and southwest side shows decreases. Absence of data is indicated by white (top panel) and gray (bottom panels). The AOD data are from the NASA Aqua MODIS instrument.

Looking forward, potential useful datasets include those from the new European Space Agency (ESA) TROPOMI satellite (launched October 2017), which will provide improved datasets as compared to OMI and will also provide methane (CH_4) and CO. For example, the spatial resolution of TROPOMI may allow us to grid air quality observations to $1 \times 1 \text{ km}^2$, which is much better than the current OMI data (e.g., $10 \times 10 \text{ km}^2$) and more useful for studies of urban areas. TROPOMI data will be released publicly by about September 2018.

→We propose to explore the potential of these new datasets for air quality applications in Jakarta.

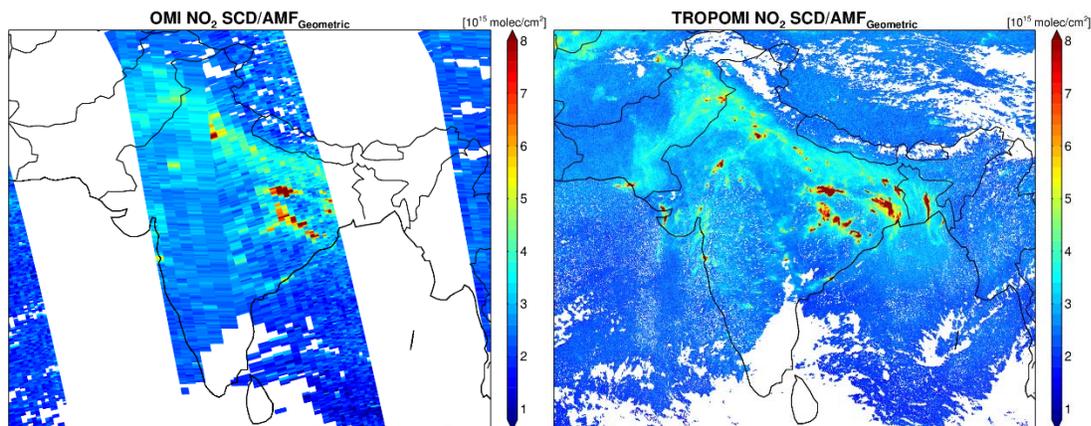


Figure. OMI NO_2 (left) and ESA TROPOMI NO_2 (right) on November 29, 2017, the “early look” data released by ESA. Unfortunately, most of Indonesia was covered by clouds on that day, but the potential of the TROPOMI data is obvious.

→We propose to explore trends in air pollution using horizontal visibility reported at surface weather stations. Horizontal visibility is sometimes a useful proxy of aerosol extinction. Data going back to the 1970s are archived at the U.S. National Oceanic and Atmospheric Administration (NOAA), but originate from Indonesia’s synoptic network.

II. Partners and Potential Partners

Indonesian Scientists

- On March 23rd, Duncan met with Prof. Puji Lestari (pujilest@indo.net.id; Institut Teknologi Bandung), who has expertise in Indonesian pollution. Lestari is interested in the proposed collaboration and she has agreed to serve as an advisor on this collaboration.
- On March 26th, Duncan met with Prof. Bambang Saharjo (bhherosaharjo@gmail.com; Institut Pertanian Bogor) and Dr. Israr Albar (israralbar@gmail.com; Ministry of Environment and Forestry) to discuss potential collaborations on evaluating and improving the forecast system for predicting agricultural fire smoke transport.

- On March 27th, Duncan met with Ir. Halimurrahman, MT (halimurrahman@lapan.go.id, halimurrahman@yahoo.com), the Director for Center of Atmospheric Science and Technology of LAPAN (Indonesian Space Agency) to discuss restarting an ozonesonde station on Java. Though air quality issues were not discussed, this proposal may benefit from collaboration with LAPAN personnel, who collect an array of atmospheric observations.

NASA Personnel

- NASA Urban Environments task leads are Dr. Ben Poulter and Dr. Lesley Ott.
- GMAO personnel, who develop and operate the air quality forecast system, include Dr. Christoph Keller and Dr. Emma Knowland.
- Dr. Robert Field (robert.field@columbia.edu; GISS) uses horizontal visibility data to estimate trends in air pollution.

U.S. State Department

- U.S. Embassy personnel have expressed an interest in this collaboration and offered support to help facilitate its success. Primary POCs are Nathan Austin (austinnf@state.gov) and Sri Murniati (murniatix@state.gov).

III. Seeking Sources of Funding

Duncan has approached NASA management to discuss ways to secure non-NASA funds (e.g., foundations) for Jakarta city personnel to collaborate with NASA personnel, such as to ingest and disseminate NASA air quality forecasts to Jakarta citizens.

→We propose to explore securing NASA and non-NASA funds for DKI Jakarta Province Office for this collaboration.

- As an example, *Clarity Movement* (<https://clarity.io/>, for profit organization): Sean Wihera (sean@clarity.io) approached Duncan about the possibility of setting up a dense network of low-cost air quality sensors in Jakarta. Wihera wrote Mr. Mungkasa on April 30, 2018. The air quality sensors would come at no charge to Jakarta.

There are a number of NGOs operating in Jakarta for improving air quality, who may help to identify resources for this collaboration. Here are a few examples.

- *Komite Penghapusan Bensin Bertimbel* (KPBB = Joint Committee for Leaded Gasoline Phase-Out): Mr. Ahmad “Puput” Safrudin (puput@kpbb.org) has expressed an interest to work with us.
- *Vital Strategies* (<http://www.vitalstrategies.org/>): Sumi Mehta (smehta@vitalstrategies.org; Washington, DC office) and Nahid Rashid

(nrashid@vitalstrategies.org; Singapore office) met with Duncan and expressed an interest to help facilitate coordinated discussion (e.g., conference of NGOs operating in Southeast Asia) between NGOs and other potential partners which will, among other things, benefit this collaboration.

- *EPA International* (<https://www.epa.gov/international-cooperation/epa-efforts-asia-pacific-region>): Several EPA International personnel (e.g., Rakhi Kasat, kasat.rakhi@epa.gov; Katherine Buckley, Buckley.Katherine@epa.gov) have expressed an interest to work with NASA and to coordinate activities in Jakarta.

IV. Benefits & Transfer of Knowledge

NASA will benefit from this collaboration in the following ways:

- Evaluate and validate NASA satellite data with in situ air quality data over the Jakarta megacity.
- Demonstrate the use of high-resolution satellite imagery to aid urban planners with their air quality problems.
- Connect with the local expertise of Indonesian scientists and connect with Indonesian policy-makers and students.

DKI Jakarta Province Office will benefit from this collaboration in the following ways:

- Improve understanding of how air pollution has changed over time in Jakarta.
- Potential to provide Indonesian college students with opportunities to work with NASA data, models, and scientists.
- DKI Jakarta Province Office personnel receive guidance to access free NASA data (e.g., NASA ARSET, <https://arset.gsfc.nasa.gov/>).
- Access to free NASA educational materials intended for a wide audience, including school children, scientists, and policy makers (e.g., <https://aura.gsfc.nasa.gov/outreach/index.html>; <https://aura.gsfc.nasa.gov/airquality.html>)
- Others?

V. Timeline

→We propose to complete the majority of this work within one year.

→We propose to communicate via quarterly updates sent via email.