Case studies during GEMS Training in Korea

Comparison of GEMS - NO\textsubscript{2} and TROPOMI - NO\textsubscript{2} in Metro Manila from 1-15 May & 1-15 June 2022.
Action Plans after GEMS Training in Korea

- GEMS Products
  - Error Detection and Correction
  - Operational Air Quality Products
  - Data Analysis and Applications
Identifying Image Artifacts and Systematic Errors

SO$_2$ data from May 1 to May 5, 2022 (same time period, unprojected)

Can these artifacts be corrected from the L1 processing? Or quality flag would suffice for now?
Identifying Image Artifacts and Systematic Errors

O$_3$ data from May 1 to May 5, 2022 (same time period, unprojected)

NEXT STEP: Identify correction schemes (if possible) for these data anomalies
Correction of Image Artifacts and Systematic Errors

$O_3$ data from May 1 & May 2, 2022 (same time period, unprojected)
Correction of Image Artifacts and Systematic Errors
Reprojected O$_3$ data of May 1, 2022

Original O$_3$ Data

Gap-Filled/Corrected O$_3$ Data
Comparison of GEMS - NO$_2$ and TROPOMI - NO$_2$ in Metro Manila and Cebu City from 1-15 May & 1-15 June 2022.

**Improved visualization (less noisy) of GEMS-NO$_2$ maps and correlation with TRePOMI-NO$_2$ was achieved with (2x2) data binning and interpolation**

Note: Cloud fraction < 0.2 was only considered for high confidence correlation.

(Top Left) L2 GEMS-NO$_2$ Map of Philippines

(Bottom Left) Binned and Interpolated L2 GEMS-NO$_2$ Map of Philippines

(Top Right) Correlation of L2 GEMS-NO$_2$ & TROPOMI-NO$_2$ data on Cebu and Metro Manila

(Bottom Right) Correlation of Binned L2 GEMS-NO$_2$ & TROPOMI-NO$_2$ data on Cebu and Metro Manila
Next Steps...

- Propose and test schemes to address systematic data errors and artifacts in GEMS products (e.g. via machine learning and statistical methods)

- Correlation analyses of GEMS data products with other available satellite measurements; and cal-val of GEMS data products with available AERONET and Pandora data

- Identify other approaches to improve satellite-ground comparisons (e.g. kriging, distance-weighted)

- Incorporate more data (spatial and temporal) in the cal-val analyses to assess local and regional accuracy of GEMS data products

- Derivation of Surface PM from GEMS data
Looking at NO2 in Luzon, Philippines

Spatiotemporal variation of NO$_2$ in the PH as seen by GEMS. NO$_2$ movement points northwest.
Transport of $\text{NO}_2$

NO2 Column Amount - 20220511 - 0045

NOAA HYSPLIT MODEL
Backward trajectories ending at 0800 UTC 11 May 22
GDAS Meteorological Data

Source * at 16.02 N 120.15 E

Vertical Motion Calculation Method: Model Vertical Velocity

Meters AGL

Trajectory Direction: Backward  Duration: 48 hrs

Job ID: 129137  Job Start: Mon Aug 29 16:03:35 UTC 2022
Source lat.: 16.023840  lon.: 120.155723  hgt.s: 100, 500, 1000 m AGL

Column Amount NO2 (10^15 molecules cm^-2)
Transport of NO$_2$

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<tr>
<th>Comparison</th>
<th>Lag0</th>
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<th>Lag2</th>
<th>Lag3</th>
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<td>0.46</td>
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</table>
Biomass burning from rural Philippines are being observed from anecdotal evidences in Central Luzon, and there’s a need to consolidate the regional data on criteria gas pollutants (NO2, O3) in order to determine the extent of its impacts (DENR, 2020).

National Air Quality Status Report 2016-2018 (2020). Department of Environment and Natural Resources Quezon City, Philippines
Biomass Burning in Central Luzon

Using MODIS MCD64A1 Burned Area Product

Burned Areas in May 2022
Date of burning based on MCD64A1

Not much difference with observed NO2 and SO2 during days with burning and days without burning
Biomass burning in Central Luzon covers small area and cannot be detected much by GEMS coarse resolution.
Next Steps...

- Analysis of micro- and mesoscale circulations in Luzon using climate models and reanalysis data
- Implement Potential Source Contribution Function (PSCF) to identify sources of pollution to the target area from model and reanalyzed trajectories
- Further analysis of sensitivity of GEMS products to micro-scale biomass burning through multi-temporal aggregates of retrievals

![Map of PSCF in Lanzhou for winters of 2002 to 2008](image)

Thank You!

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