



# **Atmospheric Environment Monitoring and Research Activities at LAPAN**

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**Centre of Atmospheric Science & Technology  
National Institute of Aeronautics & Space  
Indonesia**

**Expert Group Meeting on Space-Derived Data for Air Pollution Monitoring  
Virtual Conference – August 7<sup>th</sup>, 2020**

# Outline

- Introduction to LAPAN and the Centre of Atmospheric Science & Technology
- Atmospheric Environment Research Group
- Facilities, Chemistry & Computation Laboratory
- Use of Satellite Data for Monitoring Air Pollution
- Development of Atmospheric Composition Information System (Srikandi)
- Response to Questioner
- Closing

# National Institute of Aeronautics & Space (LAPAN)

LAPAN is the Indonesian national institute responsible for administration, research, and development in the field of space and aeronautics (Law No. 21/2013 on Space). LAPAN conducts research, development, and application of space science and technology to support government program and national development.

## SCIENCE

Space and  
Atmospheric  
Sciences

## REMOTE SENSING

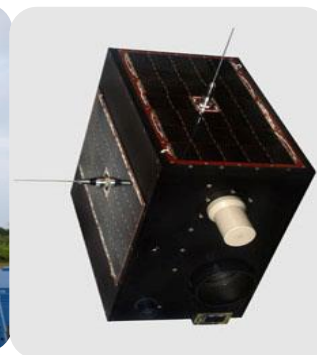
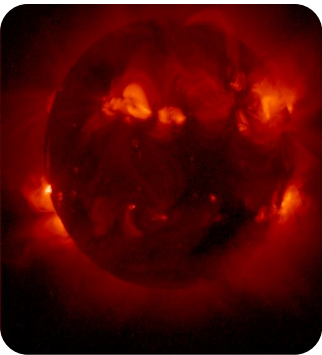
Remote Sensing  
Data, Technology,  
and Applications

## AEROSPACE TECHNOLOGY

Rocket, Satellite  
and Aircraft  
Technology

## SPACE POLICY

National &  
International  
Space Policy &  
Regulation



# Centre of Atmospheric Science & Technology

Atmospheric Science, Technology & Applications  
Based on Aeronautics & Space



Atmospheric Observation Technology

Space, airborne and ground-based atmospheric observation & technology development

Atmospheric Research & Modeling

Benefit for the Nation & Society

To use observation, prediction and knowledge through Decision Support Systems/Tools

Equatorial continent-maritime complexity challenge

DSS/T

Education

Data Base  
Model Base  
Knowledge Base  
HPC

To understand atmospheric dynamics, physics and chemistry in the equatorial continent-maritime and to improve prediction skill

Agriculture

Energy

Transport.

Environment

Health

Disaster Mgt.





# Atmospheric Environment Research Group

## Research Activities

- Atmospheric Environment Research Group observe the atmosphere to study atmospheric chemistry in Indonesia region including green house gases, ozone, aerosols, air pollution and quality, acid deposition, environmental health, forest fires, volcanic ash, etc.
- The group also study atmospheric chemistry models and validation to improve prediction skill.
- The results are used to develop a Decision Support System (DSS) to help authorities in the field of atmospheric environment and health management.

## Current Research Topics

- Atmospheric Composition, Ozone and Green House Gases
- Prediction of Trajectory of Forest Fire Haze and Volcanic Ash
- Air pollution due to Forest Fires
- Aerosols and Radiation Budget
- Development of Atmospheric Composition Information System
- Development of Peatland fires early warning system
- Collaboration with the Ministry of Environment and Forestry (KLHK) to validate and integrate air quality data derived from satellite with in situ air quality monitoring system

# Atmospheric Environment Observation Facilities



## Brewer Spectrophotometer

Measurement of UV, Ozone, SO<sub>4</sub>, NO<sub>2</sub> (stratosphere & troposphere, at morning & evening) and air mass.



## Air Quality Monitoring System (AQMS)

Measurement of SO<sub>2</sub>, CO, NO, NO<sub>x</sub>, CH<sub>4</sub>, NMHC.



## Mobile Air Quality Monitoring System

Measurement of CO, SO<sub>2</sub>, NO, NO<sub>x</sub>, Ozone, Particles (PM<sub>10</sub>)



## LIDAR

Measurement of Depolarization and Backscattering Ratios for Water Vapors and Aerosols.



## CO<sub>2</sub> Monitor

Measurement of CO<sub>2</sub> Concentration



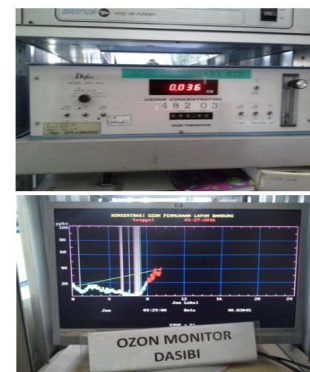
## Radiation Instrument

Measurement of UV-a, UV-b, global radiation, duration of solar radiation (LPM).



## PM<sub>2.5</sub> Monitor

Measurement of Particulate Matter 2.5



## Dasibi Ozone Monitor

Surface Ozone Measurement

# Chemistry Laboratory – Wet & Dry Deposition Monitoring

- Member of Acid Deposition Monitoring Network in East Asia (EANET) since 1999
- Accredited ISO/IEC 17025 since 2016 for measurement of:
  - a. Air Quality:  $\text{SO}_2$ ,  $\text{NO}_2$ ,  $\text{NH}_3$  and  $\text{O}_3$  using passive sampling method
  - b. Ambient air using filter pack method:
    - Gaseous  $\text{SO}_2$ ,  $\text{HNO}_3$ ,  $\text{NH}_3$ , and  $\text{HCl}$ ,
    - particulate  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{NH}_4^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Na}^+$ ,  $\text{K}^+$
  - c. Rainwater:  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{NH}_4^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Na}^+$ ,  $\text{K}^+$ , pH, Conductivity (EC) and dissolved trace metals (Pb, Cu & Cd)

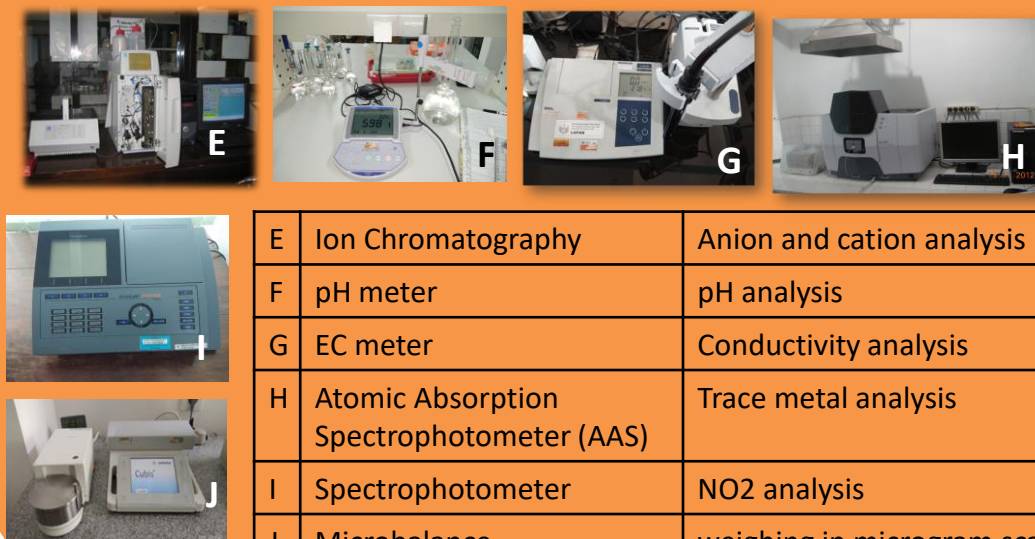


## Sampling Equipments



A	Wet sampler only	Rainwater sampling
B	Filter pack	Ambient air sampling
C	Mini Vol sampler	Particulate sampling
D	High Vol sampler	Particulate sampling

## Analytic Instruments



E	Ion Chromatography	Anion and cation analysis
F	pH meter	pH analysis
G	EC meter	Conductivity analysis
H	Atomic Absorption Spectrophotometer (AAS)	Trace metal analysis
I	Spectrophotometer	NO <sub>2</sub> analysis
J	Microbalance	weighing in microgram scale

# Computation Facilities

## DATA CENTER

Server and observation monitoring room, simulation/prediction system, database and storage.



**High Performance Computing (HPC) Server**

**Running Model Prediction**

Supermicro AMD Processors total 3 frontend, 49 compute nodes, 3240 cores, JBOD 2 x 135TB

**Database Server**

**Manage data (in-situ observation, satellite, etc)**

RDBMS Oracle and Postgre  
Capacity 150TB

**Storage Server**

**Distributed database and big data analysis**

Data Nodes: 20 Data Nodes  
CPU: 2 x Intel® Xeon® Gold 5118 Processor 12-core 2.30GHz  
16.50MB Cache (105W)  
Memory: 128GB  
Storage: 120TB  
Distributed Database System:  
Hadoop Cloudera  
Capacity: 1.8PB

**DSS Server**

**Web server of Decision Support System (DSS)**

Sadewa, Semar, Srikandi, Srirama, Santanu, Narada, Bisma, Baruna, Amarta, and Cakra



# HPC Capacity

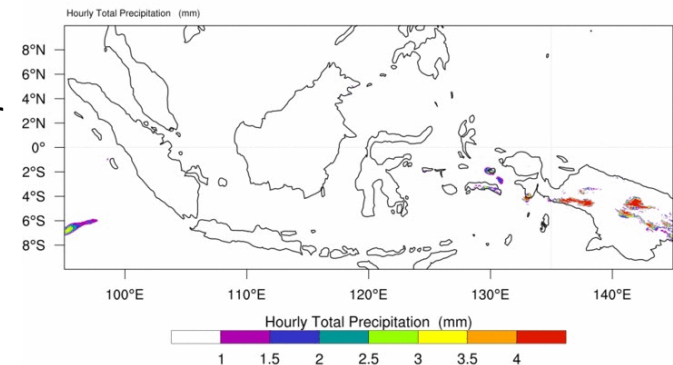


## Centre of Atmospheric Science and Technology HPC Cluster:

- Supermicro AMD Processor
- Open HPC
- 49 Nodes Server
- Total 3240 cores processor
- Disk Array 270 TB
- Hadoop Storage 1.8 PB
- Model: WRF-Chem

WRF 05km 2013-08-01

Valid: 2013-08-01: 01:00:00



OUTPUT FROM WRF V3.4.1 MODEL  
WE = 1001 ; SN = 401 ; Levels = 28 ; Dta = 5.55887km ; Physx Opt = 3 ; PBL Opt = 1 ; Cu Opt = 1

# Location of Lapan Stations

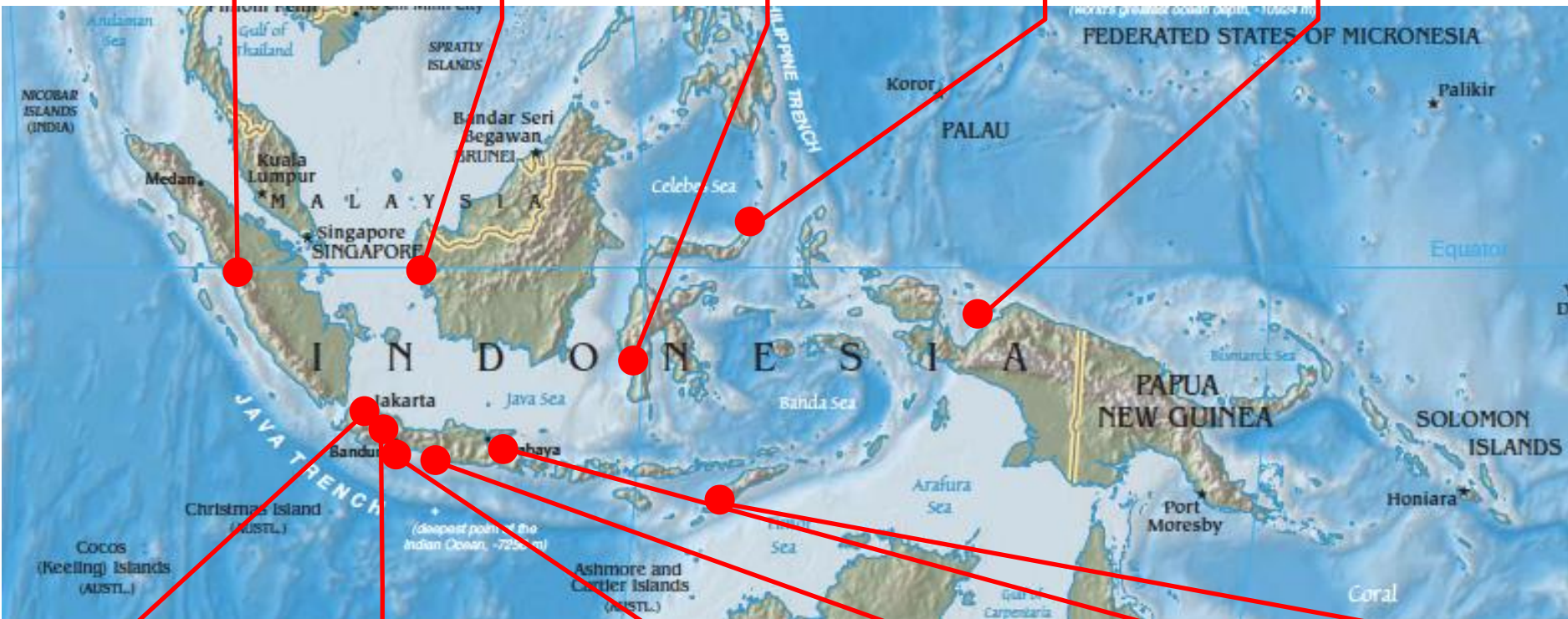
Kototabang

Pontianak

Pare Pare

Manado

Biak



Jakarta

Rumpin

Rancabungur

Pekayon

Bandung

Tanjungsari

Pameungpeuk

Yogyakarta

Watukosek

Kupang



# Equatorial Atmosphere Radar at Kototabang, West Sumatra

Collaboration between LAPAN Indonesia – RISH Kyoto University Japan



X-Band  
radar



Radio Acoustic  
Sounding System



Radio  
meter



Optical  
Rain  
Gauge



Disdro  
meter



Micro Rain  
Radar



Lidar



Locations of AQMS Stations operated by the Ministry of Environment & Forestry (KLHK)



Location of SPM, Rain Water Chemistry and Surface Ozone Measurement operated by the Agency for Meteorology Climatology and Geophysics (BMKG)



# Satellite Derived Data used for Air Pollution and Atmospheric Composition Monitoring

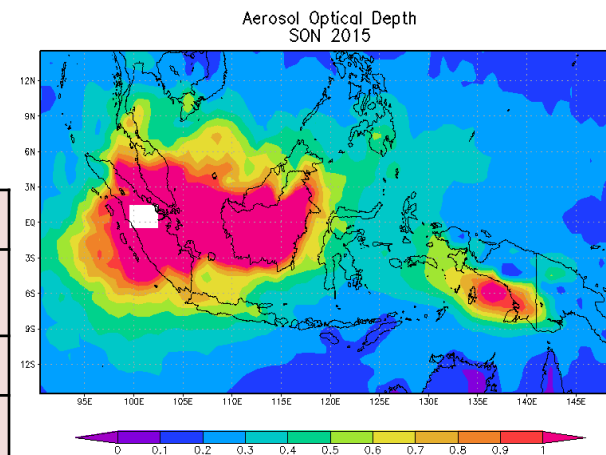
Satellite	Parameter	Importance
AURA – OMI 2004 – recent data	Total ozone (ozone layer) UV Index Radiative Cloud Faction Aerosol Index	to investigate the ozone layer condition in Indonesia, public health, as air pollution indicator
AQUA – AIRS 2002 – recent data	CO <sub>2</sub> Ozone CO CH <sub>4</sub> RH water vapor temperature	as Green House Gases (CO <sub>2</sub> , ozone in troposfer, CH <sub>4</sub> , water vapor). in the surface, CO and ozone act as air pollution indicator.
AURA-MLS 2005 – recent data	Ozone ClO BrO	to investigate the ozone layer condition and Ozone Depleting Substances (ODS) in Indonesia and it's correlation.

# Use of Satellite Data to Monitor Aerosol, Radiation & Surface Air Temperature in Indonesia

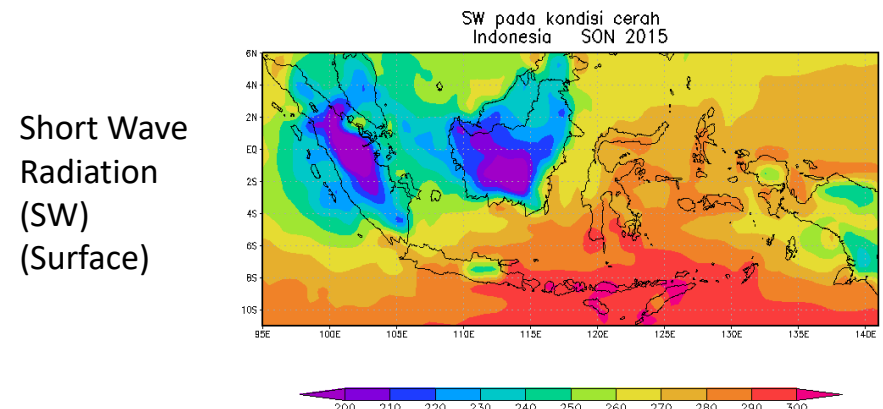
## Satellite TERRA



Launch period	18 Desember 1999
Orbit	705 km, 10:30 a.m. descending node (Terra) sun-synchronous, near-polar, circular
Orbital period	98.8 minutes (Terra)
Sensor	ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) <b>CERES (Clouds and the Earth's Radiant Energy System)</b> MISR (Multi-angle Imaging SpectroRadiometer) <b>MODIS (Moderate-resolution Imaging Spectroradiometer)</b> MOPITT (Measurements of Pollution in the Troposphere)
MODIS Spatial resolution	$10 \times 10$

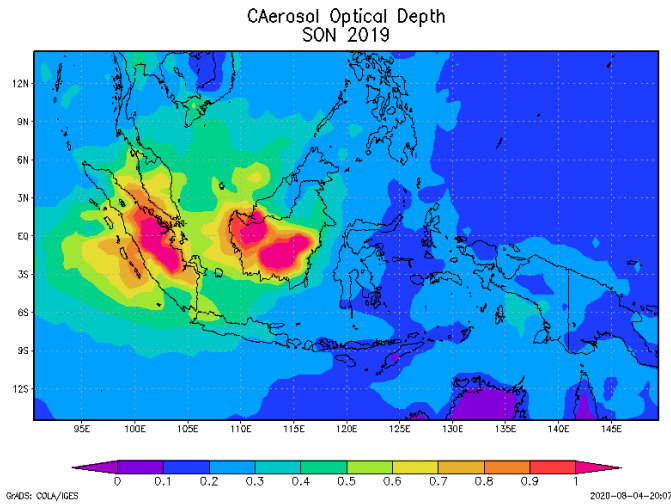


Aerosol optical depth (AOD)

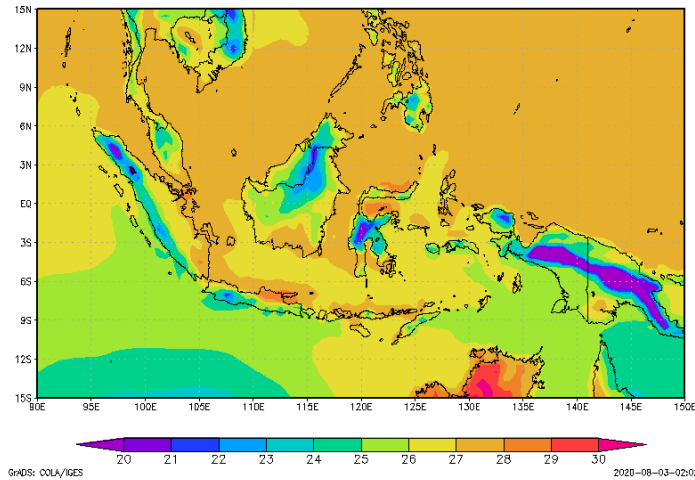


Short Wave  
Radiation  
(SW)  
(Surface)

Aerosol optical depth (AOD)



Temperatur udara permukaan  
SON 2019



Temperatur  
udara  
permukaan

## Satellite Aqua



Launch period	4 May 2002
Orbit	705 km, 1:30 p.m. ascending node (Aqua), sun-synchronous, near-polar, circular
Orbital period	98.4 minutes (Aqua)
Sensor	<p>AMSR-E – Advanced Microwave Scanning Radiometer-EOS.</p> <p><b>MODIS – Moderate Resolution Imaging Spectroradiometer.</b></p> <p>AMSU-A – Advanced Microwave Sounding Unit.</p> <p><b>AIRS – Atmospheric Infrared Sounder.</b></p> <p>HSB – Humidity Sounder for Brazil since 2/5/2003.</p> <p><b>CERES – Clouds and the Earth's Radiant Energy System.</b></p>
MODIS Spatial resolution	1° X 1°

# Atmospheric Composition Information System (Srikandi)

## Features

Monitoring of daily air quality estimated results from satellites: PM<sub>2.5</sub> (AOT VIIRS-SNPP), NO<sub>2</sub> (TROPOMI-Sentinel5P), and SO<sub>2</sub> (OMPS-SNPP) (*on going research*)

Indonesia atmospheric composition information system

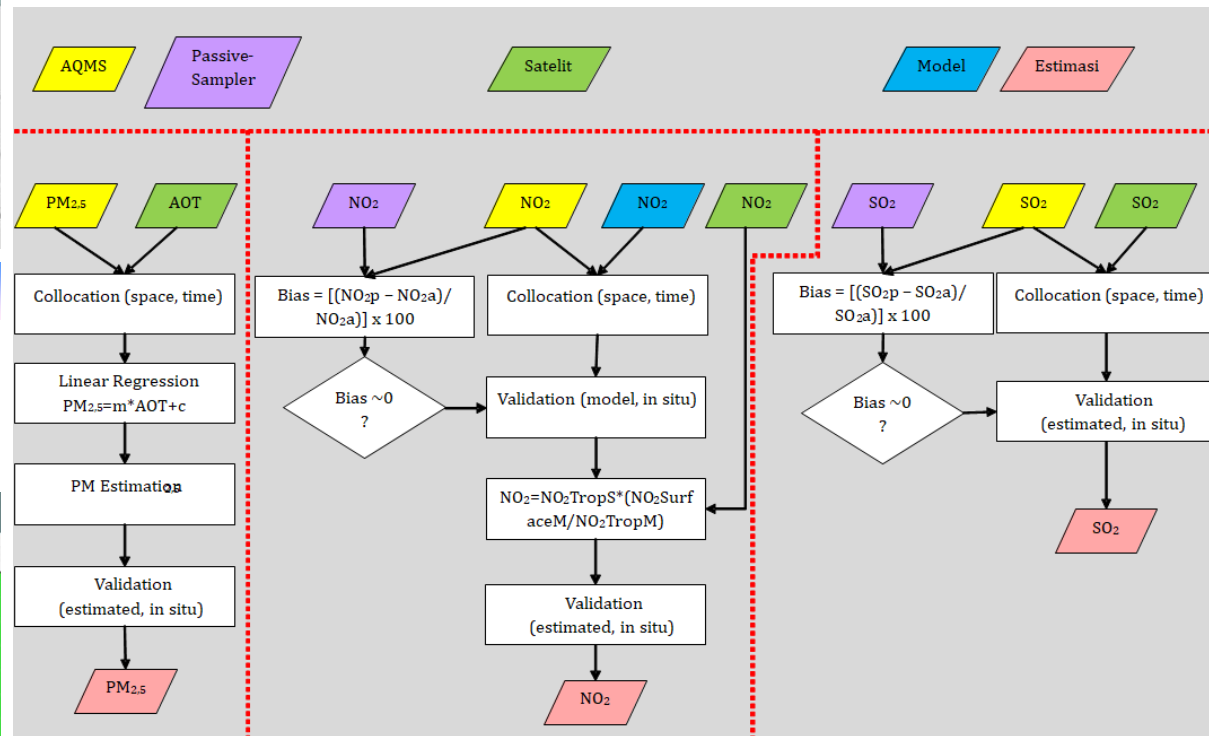
<http://srikandi.sains.lapan.go.id/>

Collaboration MoEF and LAPAN



**SRIKANDI**  
Sistem Informasi Komposisi Atmosfer Indonesia  
Lembaga Penerbangan dan Antariksa Nasional

## Methodology



## Features

Predictions for the parameters of the air quality index (PM<sub>2.5</sub>, PM<sub>10</sub>, O<sub>3</sub>, CO, NO<sub>2</sub>, and SO<sub>2</sub>) every hour for next 24 hours using WRF-Chem version 3.6.1 and CAMS Output.





# Response to Questioner (GEMS Data Sharing)

- GEMS Products
  - GEMS product priority: NO<sub>2</sub>, SO<sub>2</sub>, O<sub>3</sub>, Aerosol, UVI, HCHO, CHOCHO, Cloud, Surface Reflectance
- GEMS Processing
  - Center of Remote Sensing Data and Technology of LAPAN might be interested in radiometric/geometric calibration
  - Center of Atmospheric Science and Technology is interested on receiving and using GEMS products.
- GEMS Application
  - GEMS application priority: AQ Monitoring, AQ Forecast, Urban Pollution, Emission Hotspot/Climate Change, Long Range Transport, Public Health, Top Down Emission, Crop Yield, and Emission Inventory.

# Response to Quesioner (Pandora Global Network)

- Pandora
  - Focus on Air Pollution Monitoring
- PGN
  - In principle agree on joining PGN and following open data policy
- Other activities/needs
  - GEMS coverage over Indonesia Region
  - Capacity Building/Education/Training
  - Research Collaboration & Publication
  - Observation Technology Development
  - Revitalization of Equipments

# Closing

- LAPAN welcome and intend to participate and collaborate in the New Project Proposal on Building Partnership for Geospatial Air Pollution Information, developed by UNESCAP together with NIER of the Republic of Korea, and the Korea International Cooperation Agency.
- The new project initiative is very relevant to our research and development activities at the Centre of Atmospheric Science and Technology, and aligned with our vision to contribute to national wellbeing through monitoring and prediction of atmospheric environment and health.
- LAPAN is also interested in utilizing the GEMS data, which will provide a vantage point for monitoring air quality over Indonesia continuously with unprecedented higher spatial and temporal resolution.



**Thank you**

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**Center of Atmospheric Science & Technology  
National Institute of Aeronautics & Space**