Comprehensive Concept of PM2.5 Forecast: A Case Study in Thailand

Air Quality and Noise Management Bureau

Pollution Control Department, Thailand

Biography (Sakda Tridech)

- Industrial Engineering, Kasetsart University (2005)
- MSc/Manufacturing Engineer, University of Hertfordshire, UK (2007)
- Ph.D./Advanced Manufacturing and Enterprise Engineering, Brunel University, UK (2012)
- 2012 – Present, Pollution Control Department (Environmentalist/ Director of Air Quality Model and Geographic Information Center)

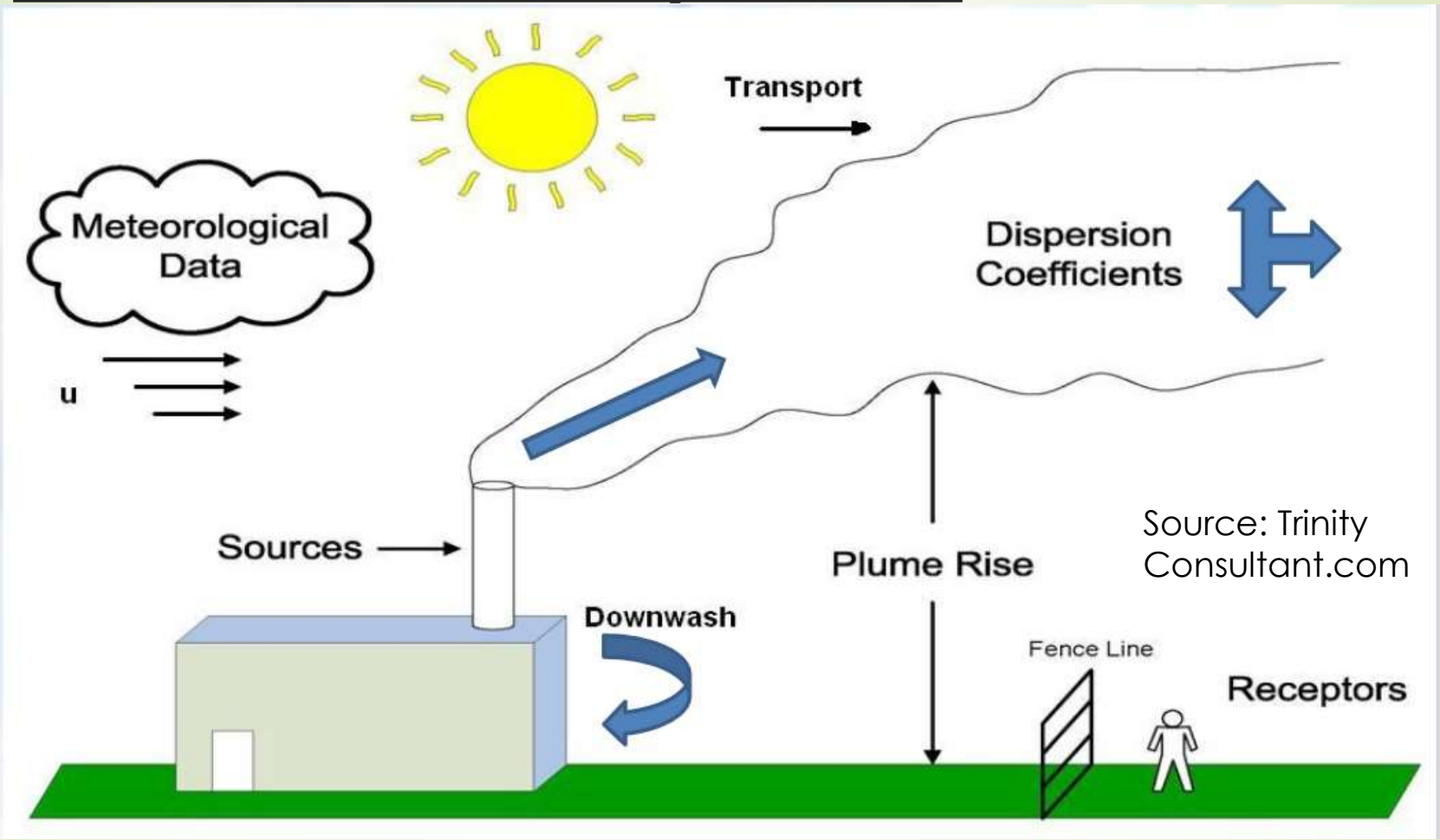
Contents

- Basic of Air Quality Model
- Essential Basic Needs
- Background of PM2.5 Problem in Thailand
- Chemical Transport Model
- Requirement for WRF-chem
- Model Configuration and input data
- Product Example
- Preliminary Evaluation
- Simple Box Model

Basic of Air Quality Model

- **Dispersion Modeling**: normally, this kind of model is used to simulate concentration of pollutant at specified ground level
- **Photochemical Modeling**: typically, this kind of model is used to simulate chemical reactive pollutant over large spatial scale
- **Receptor Modeling**: this kind of tool is used to quantify source contributions to receptor concentrations (Source: Air Quality Model US.EPA)

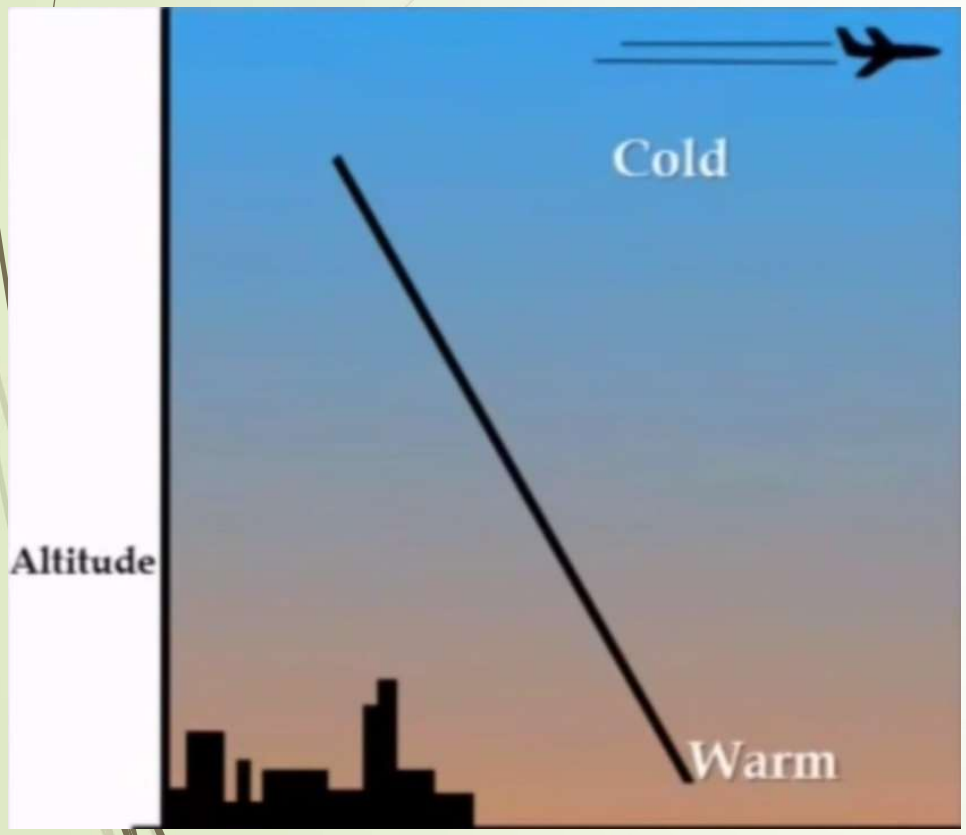
Basic of Air Quality Model

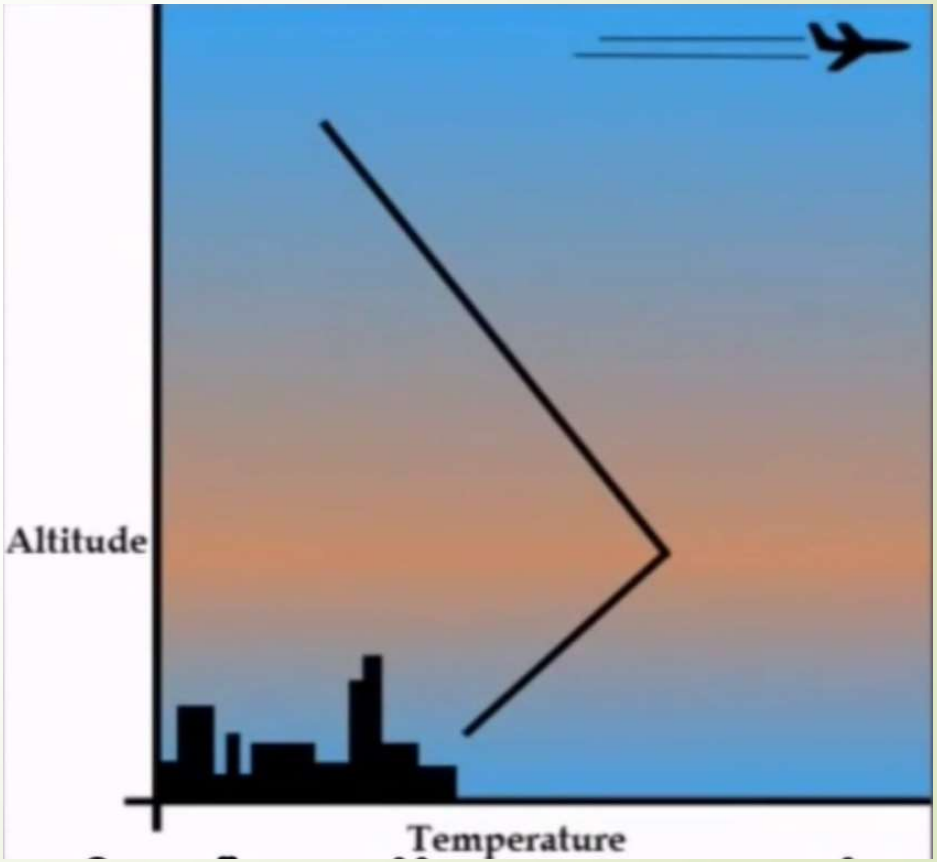


Source: Trinity Consultant.com

Essential Basic Needs

Meteorological mechanism and air pollution

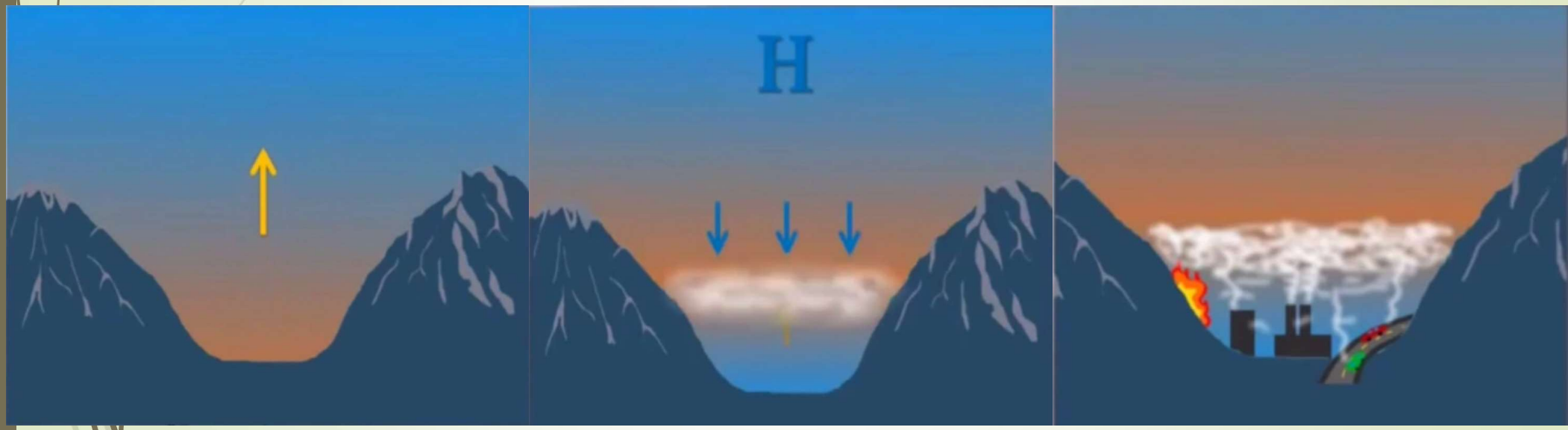




Source: National Weather Service/NOAA

Essential Basic Needs

Meteorological mechanism and air pollution



Source: National Weather Service/NOAA

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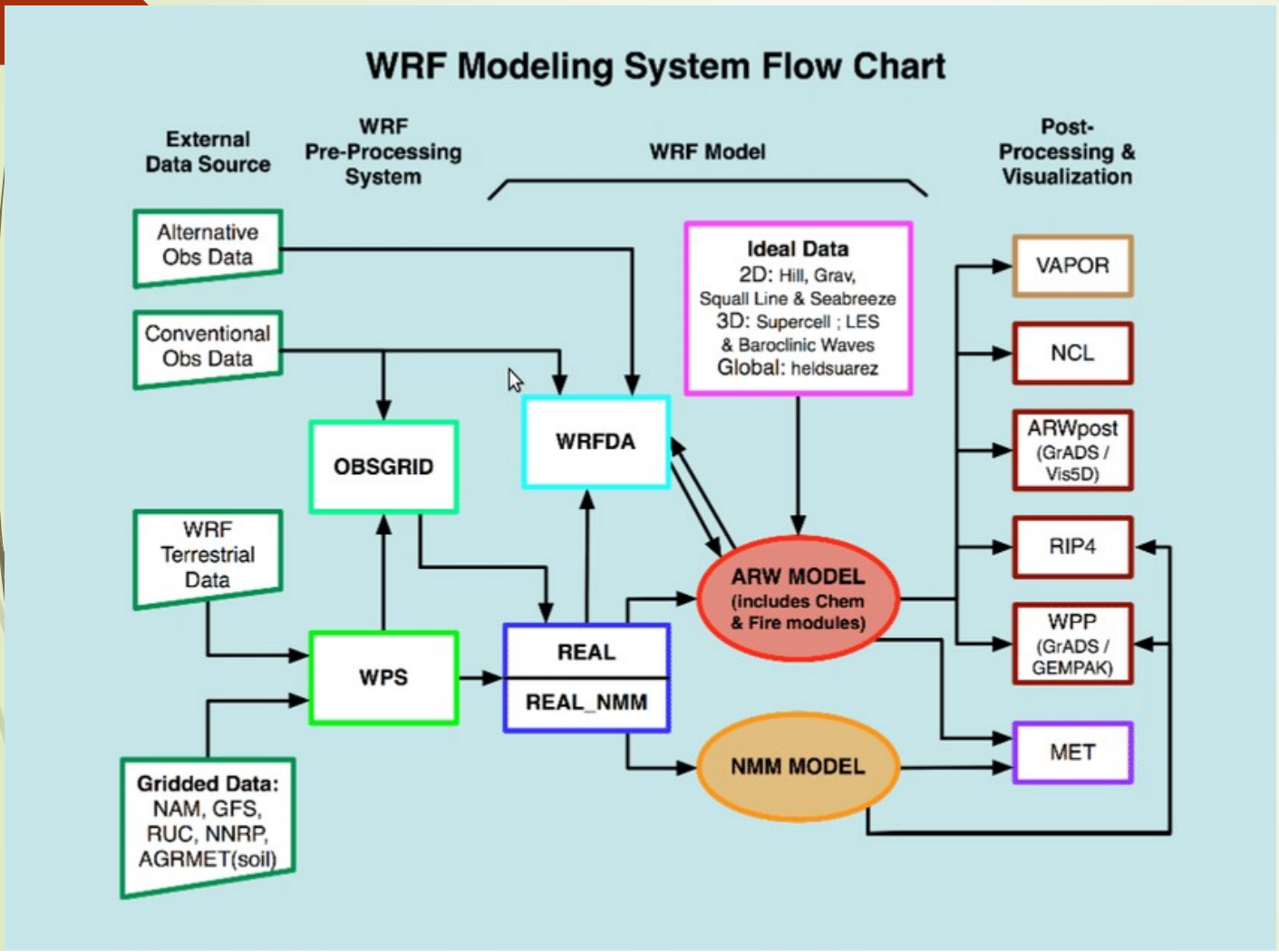
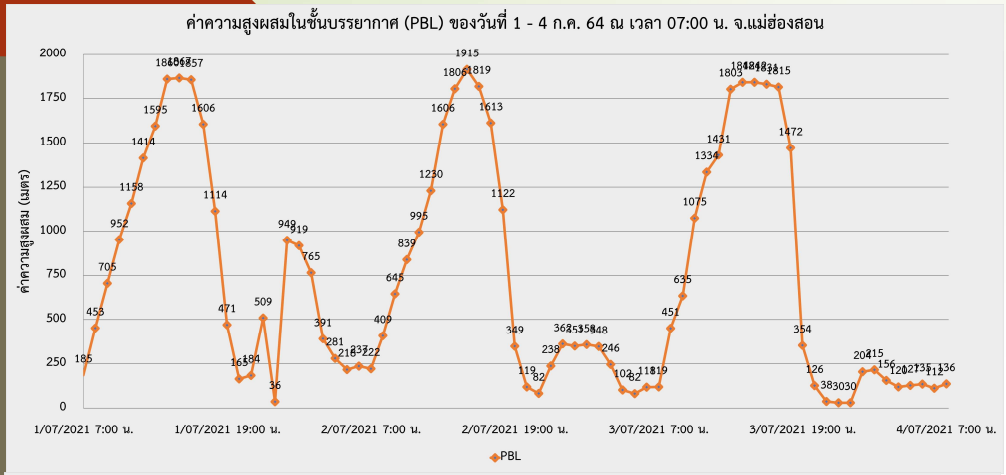
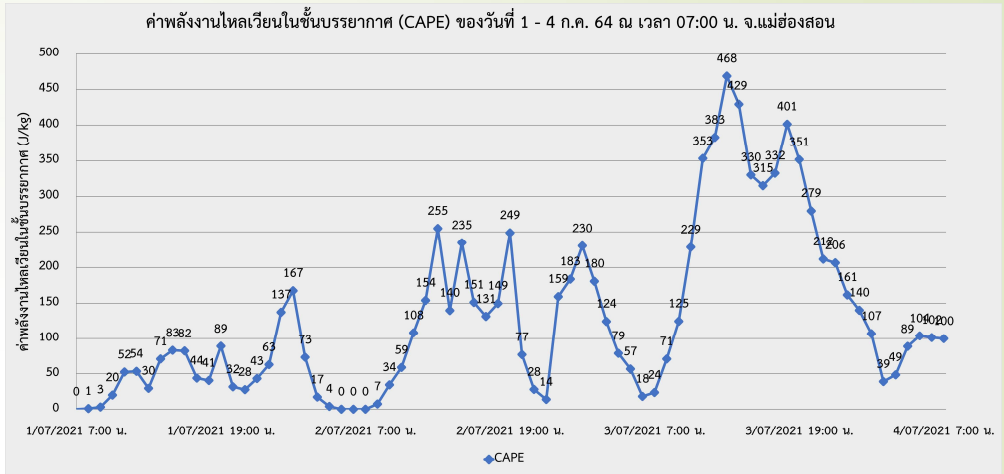


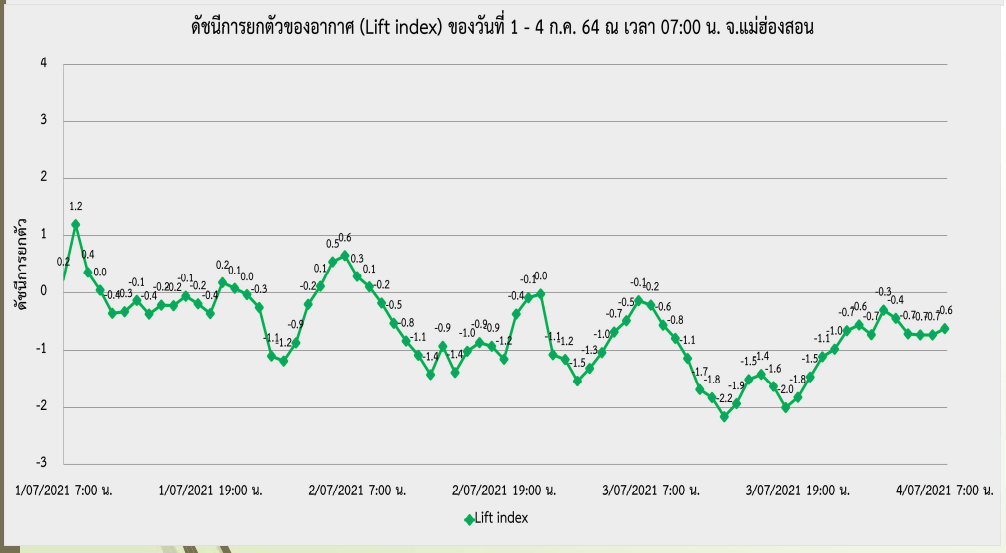
Weather Research Forecast Model

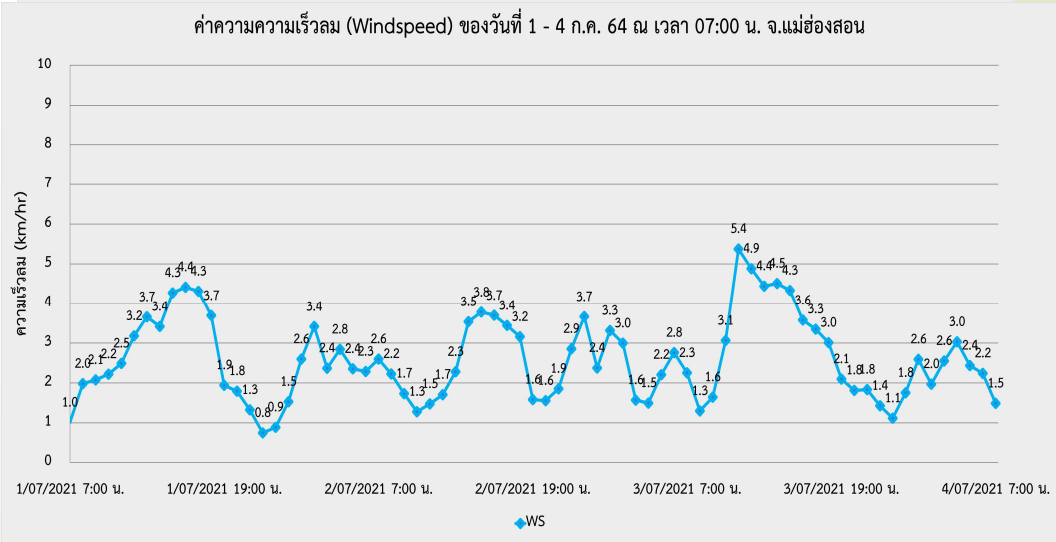
Numerical weather prediction system
Source: National Center for Atmospheric Research

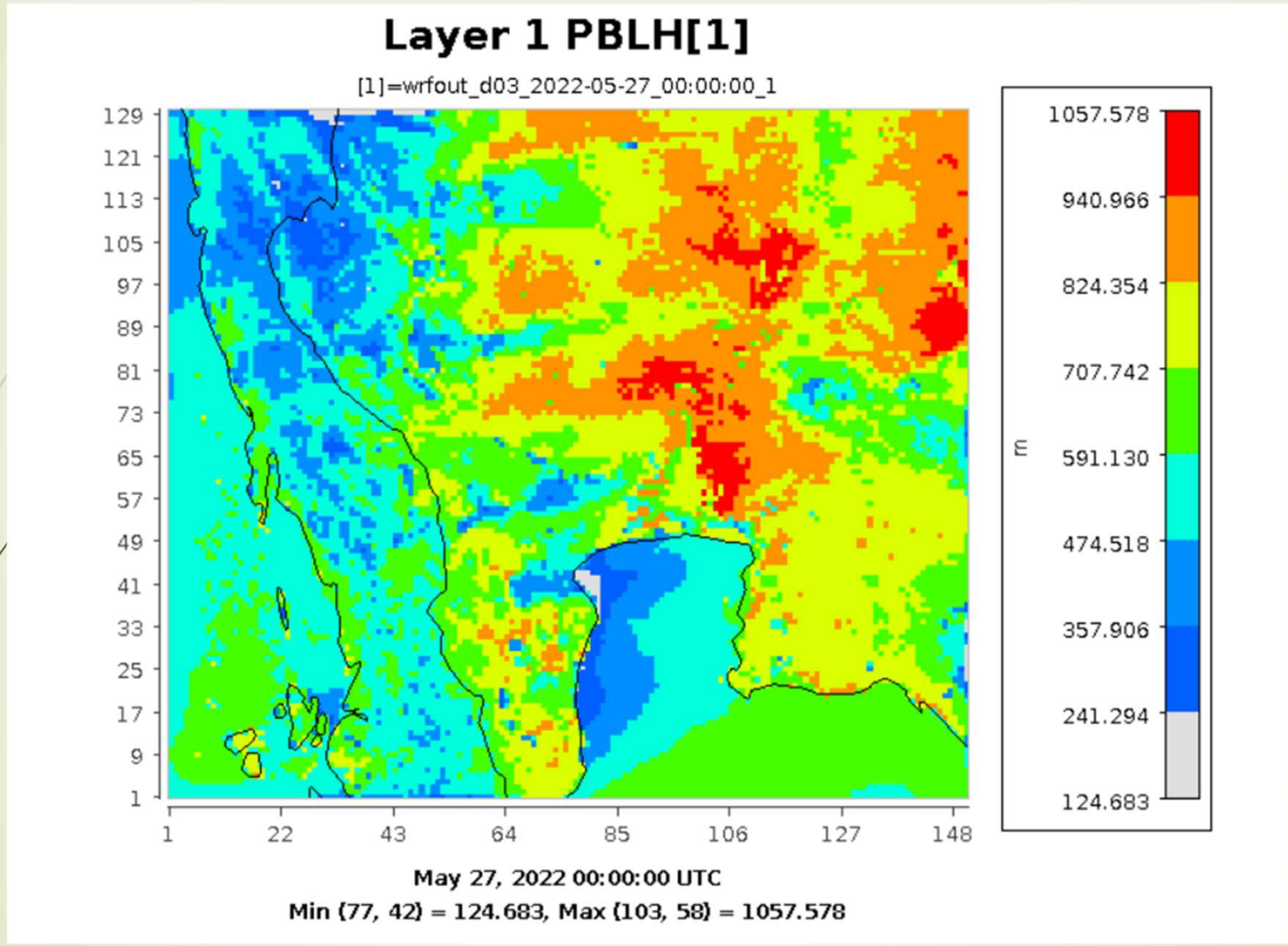
Essential Basic Needs







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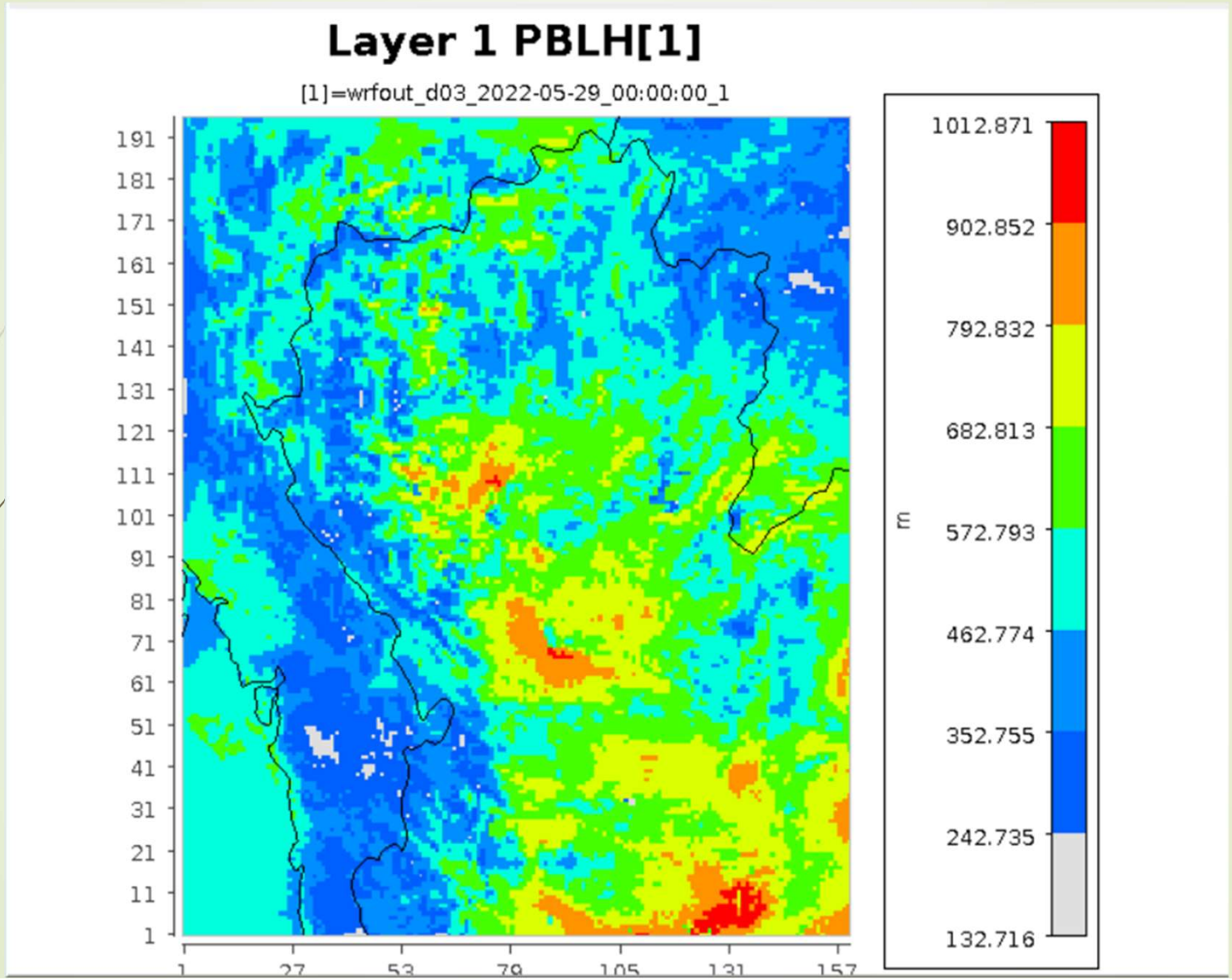
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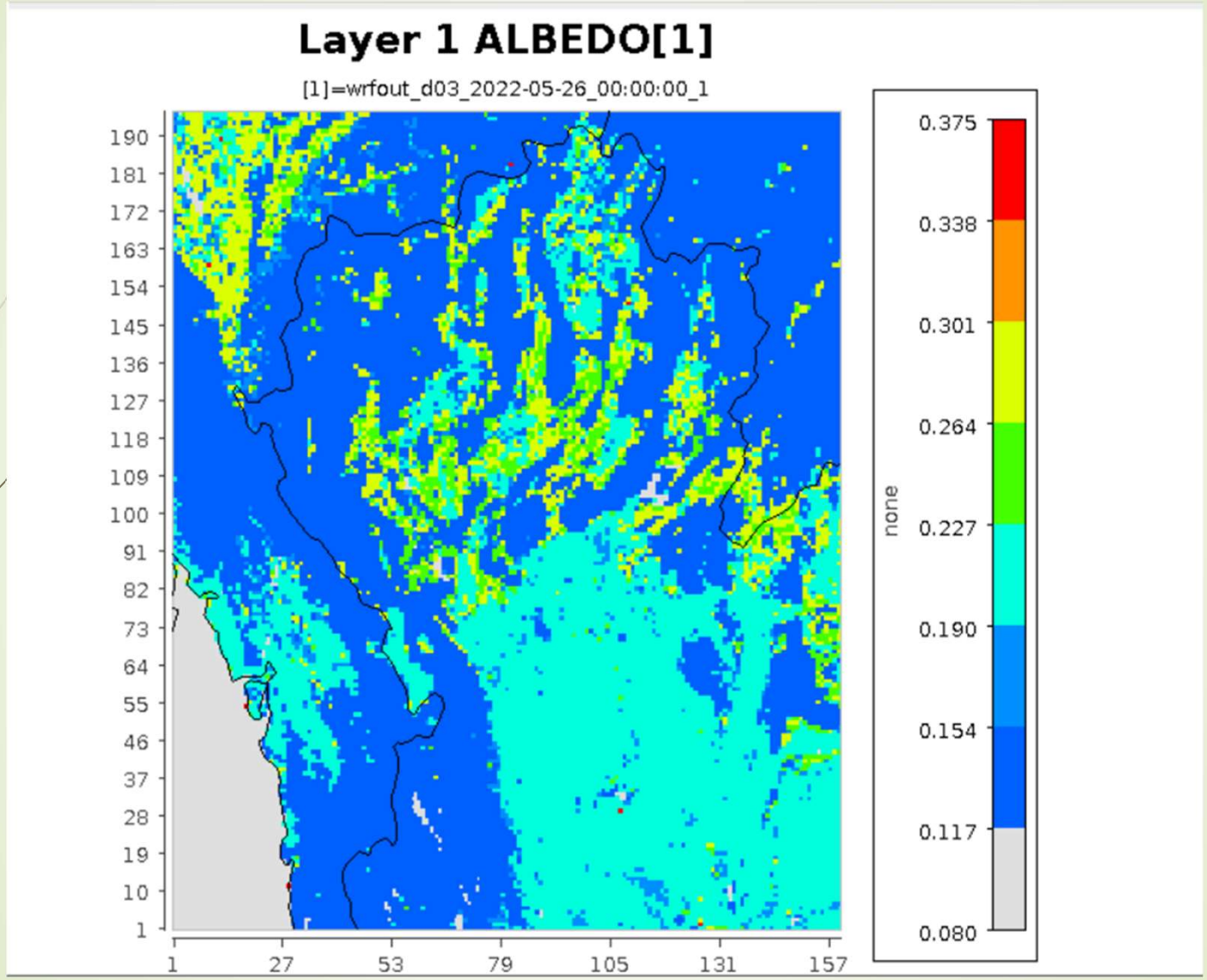
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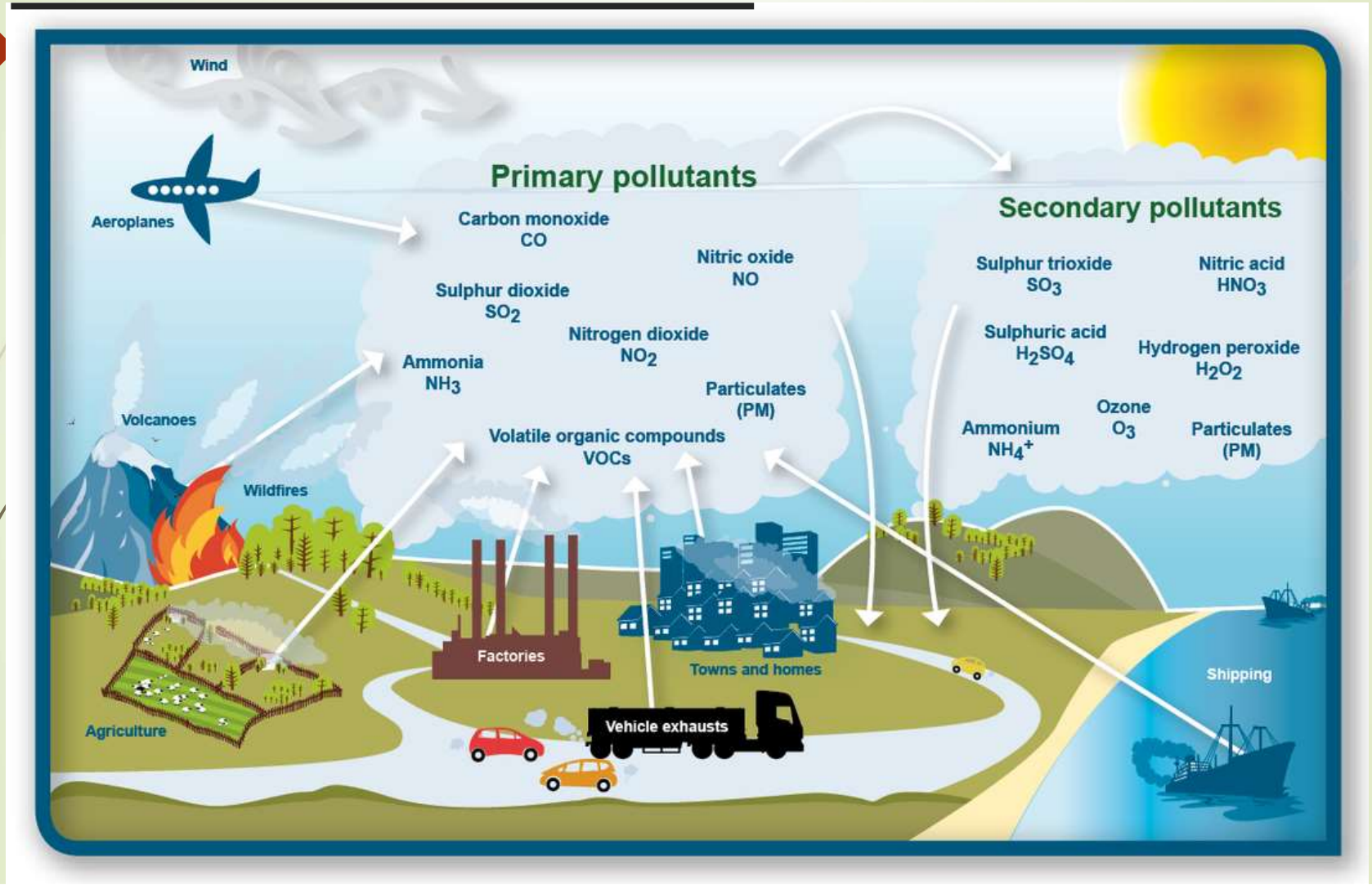
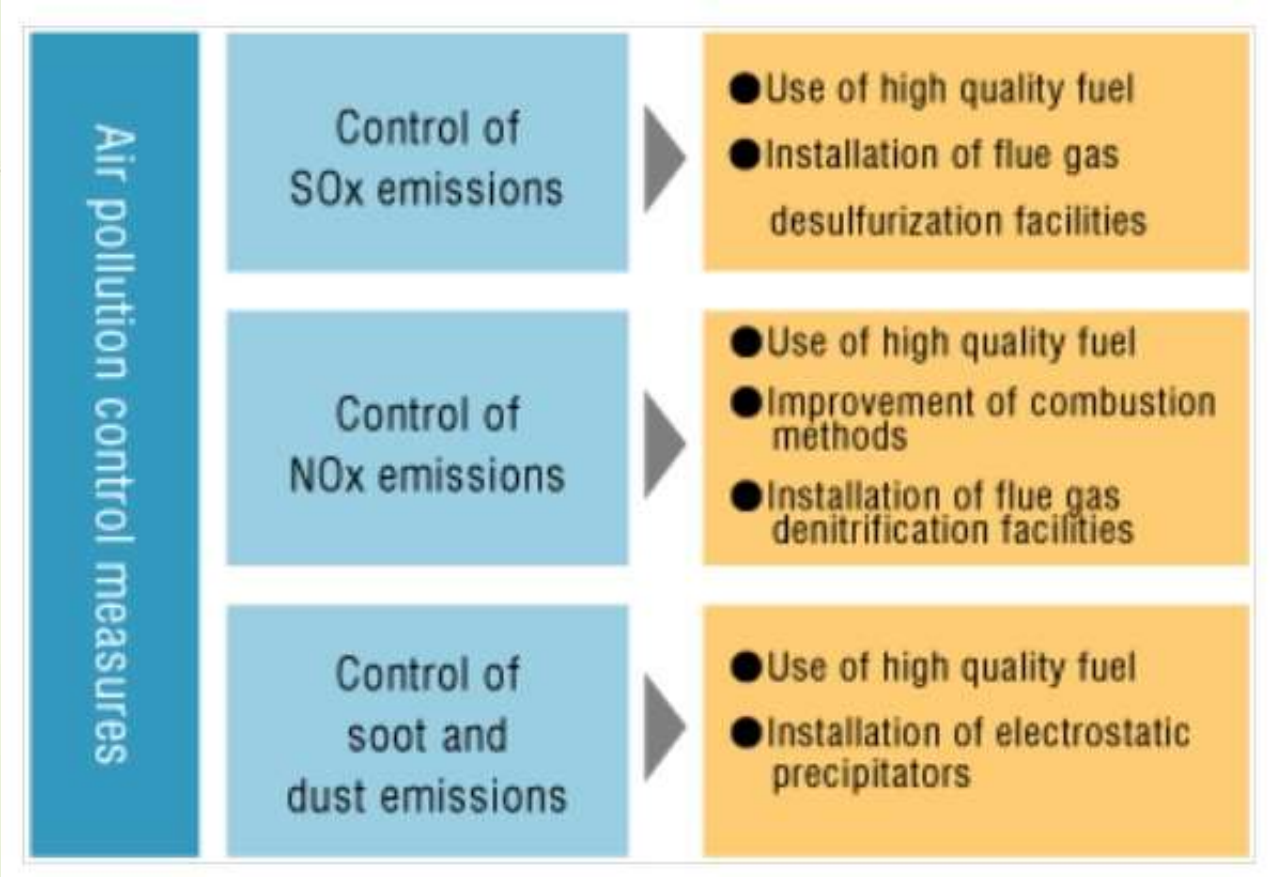
Essential Basic Needs



Essential Basic Needs



Source: https://www.mrgscience.com/ess-topic-63-photochemical-smog.html

Background of PM2.5 problem in Thailand

Point source and area source/ critical area in Thailand

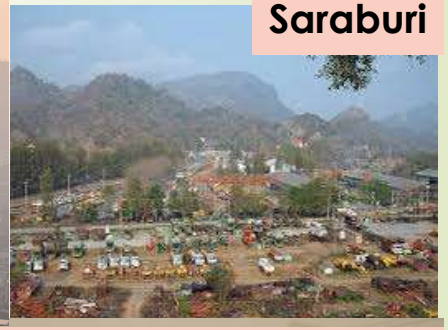
Industrial Pollution

Transportation

Burning Area

BMR

Rayong



Saraburi

Northern Part of Thailand

ศูนย์แก้ไขปัญหามลพิษทางอากาศ (ศกพ.)
Center for Air Pollution Mitigation (CAPM)

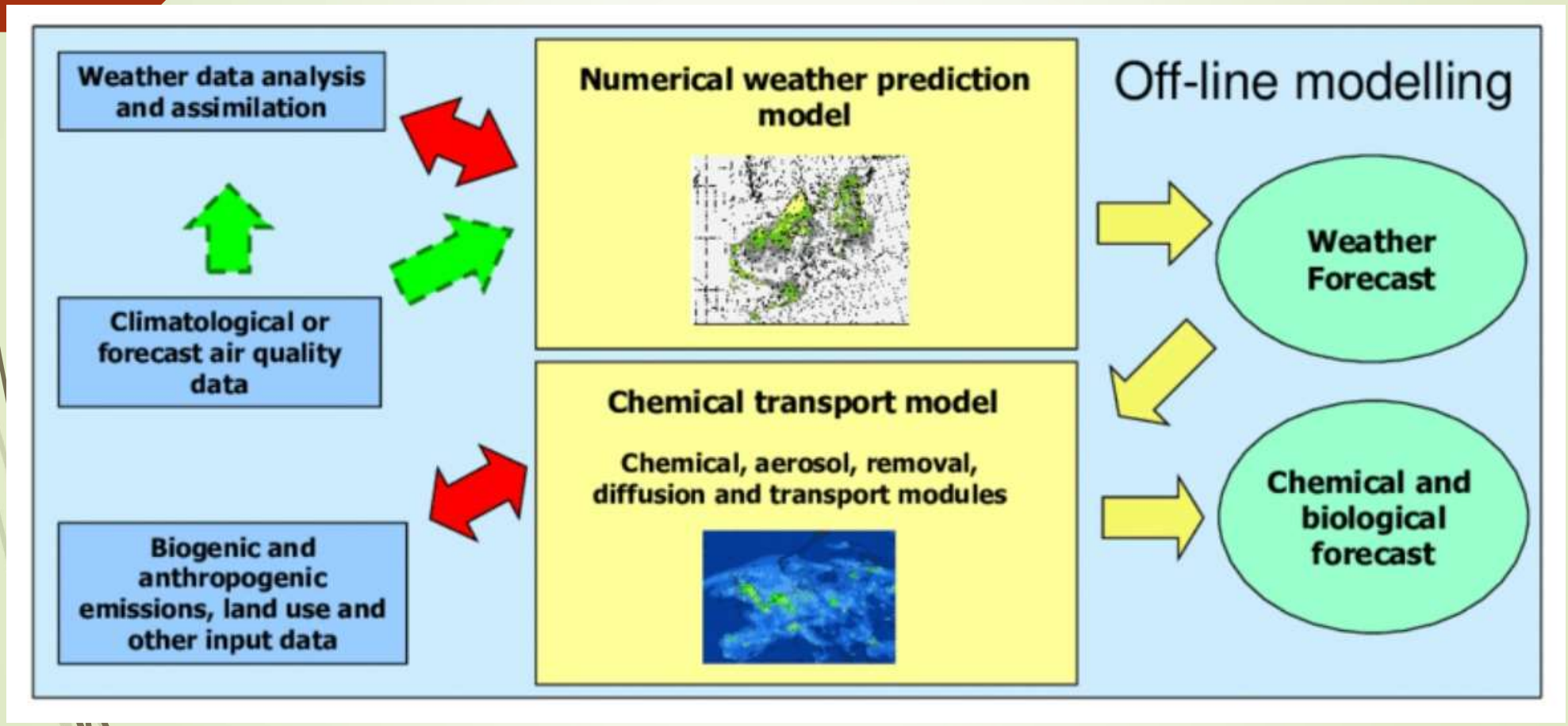
Director General of Pollution Control Department

Director of CAPM

Intensive Policy from The Government

1. Knowledge transfer for public sector including source of PM2.5 and meteorological conditions for the phenomena
2. Establish sub-committee for PM2.5 prevention
3. Forest fuel management
4. Establish volunteer network for fire prevention
5. Drive afforestation project and fire prevention project
6. Transfer fire prevention and control to local government organization
7. PM2.5 forecast 3 days in advance
8. Apply satellite image for PM2.5 daily situation report
9. Develop forecasting system and decision-making support system (in the form of application)
10. Forest fuel management using decision-making support system
11. Promote public awareness for open burning reduction
12. Promote cooperation between neighboring countries for prevention of transboundary haze

Chemical Transport Model



Source: Kukkonen 2011

Requirement for WRF-chem

Compiler

PGI® COMPILERS & TOOLS

OS

ubuntu

CentOS

redhat

Work Station

Workstation

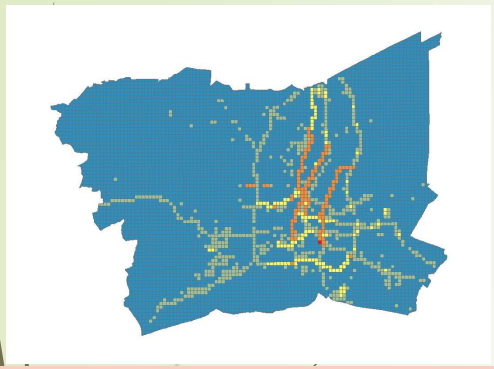
High performance computing

- Installed at NECTEC/NSTDA
- UNIX based
- 4320 Cores
- 750 TB Space Capacity
- WRF/WRF-chem ready
- Remote based

Processing time comparing PCD and TARA

Work Station	Cores	Simulation Time
PCD (data center)	24	7 Hours
TARA (memory)	192	1 Hour
TARA (compute)	160	50 mins – 1 Hour
TARA (compute)	200	45 mins

PCD forecasting process

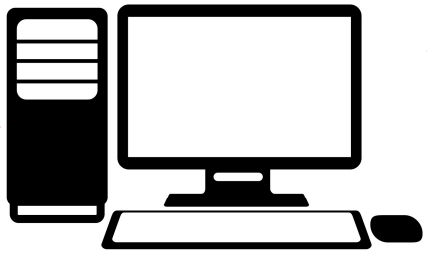


Emission from Top-Down Method

Met Data

Geographic data

Input



Work Station

remote

PCD server

simulation

Validation with observation data
Using statistical tools

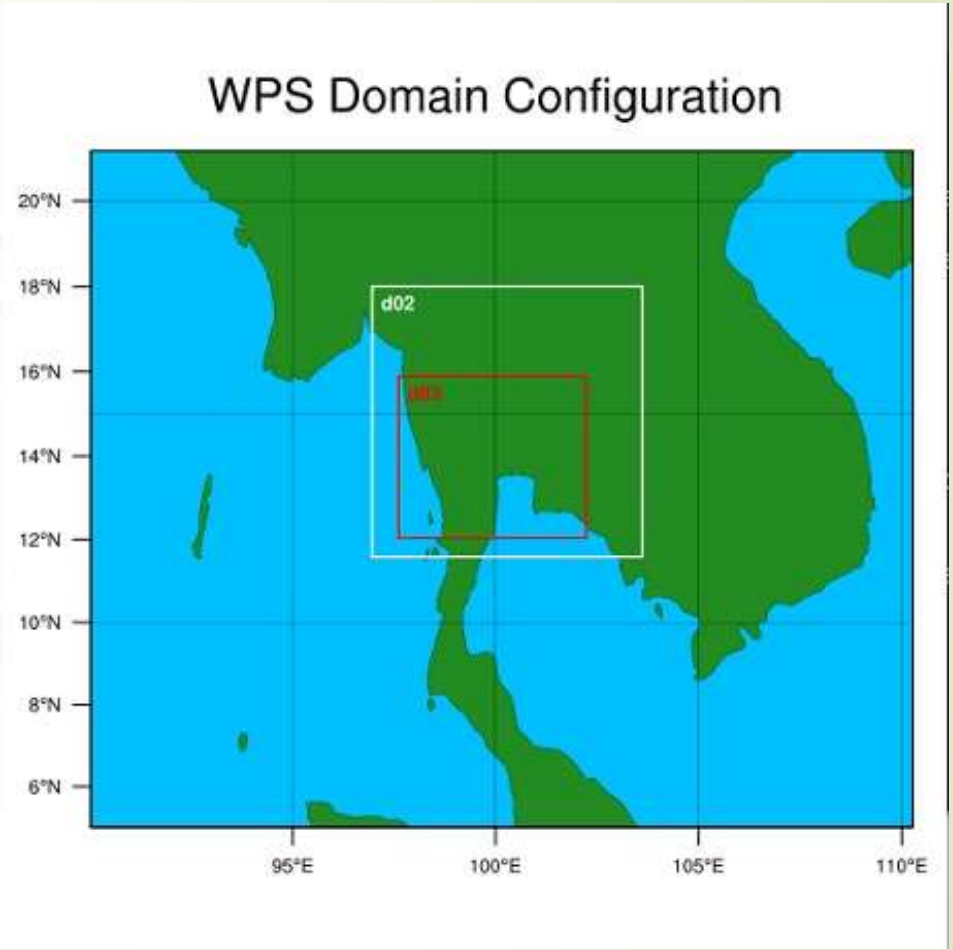
Weather Research
Forecast Model
(WRF/WRF-chem)

Forecasting System

Domain Configuration

Domain Configuration (BMR)

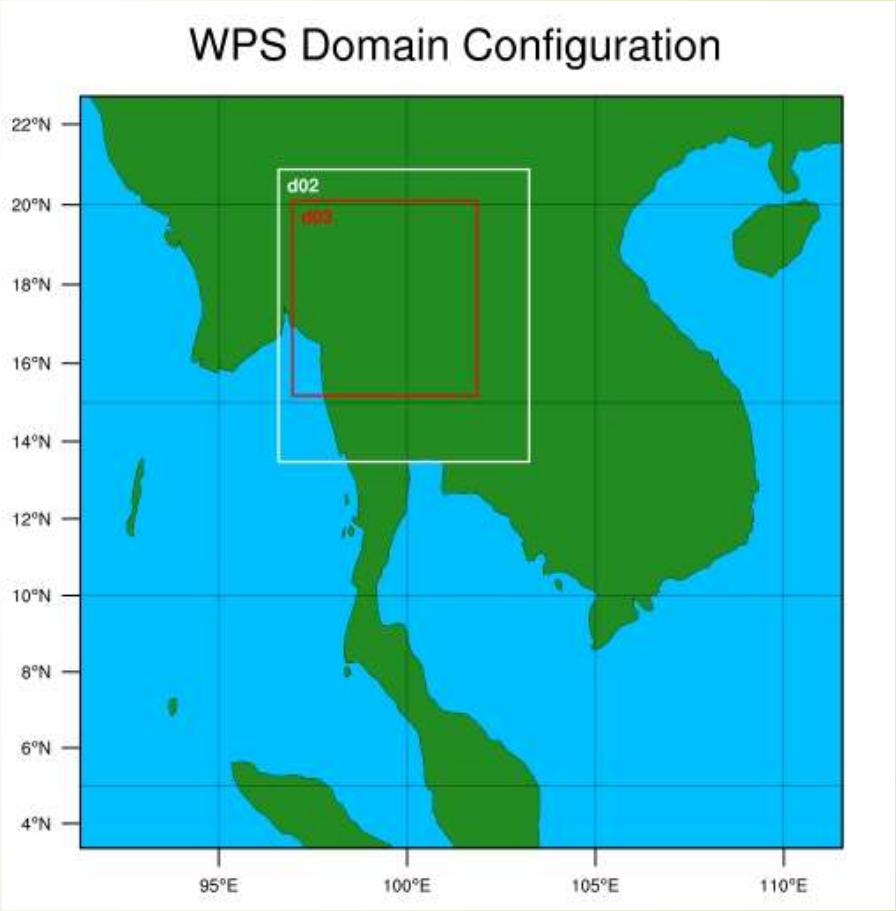
- Mother Domain: cover territory of Thailand with resolution 30x30 km
- Target Domain: cover BMR with resolution 3x3km



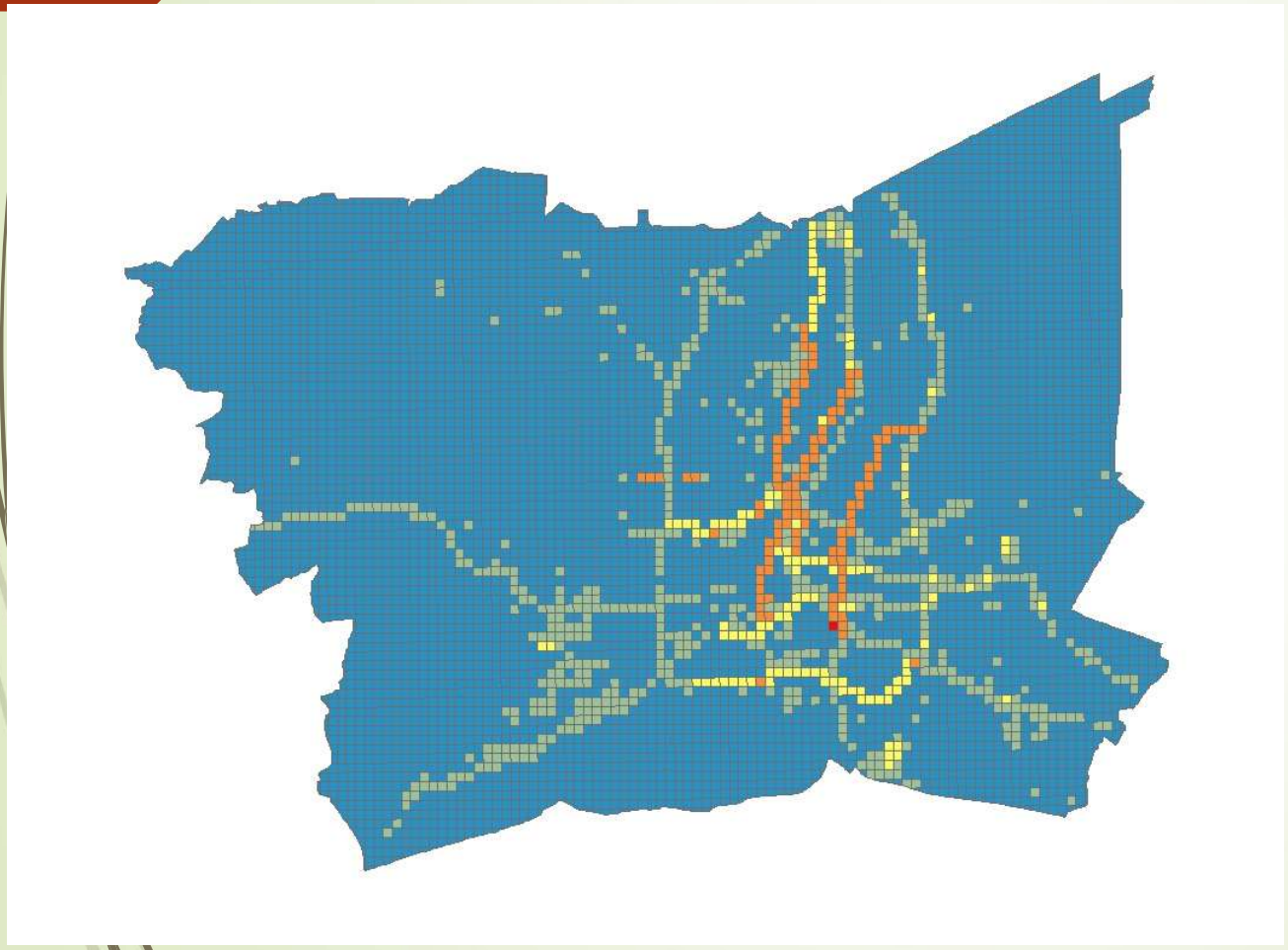
Domain Configuration

Domain Configuration (North)

- Mother Domain: cover territory of Thailand with resolution 30x30 km
- Target Domain: cover BMR with resolution 3x3km



Input Emission Dataset



Pollutant: PM2.5
BMR: Resolution 1KM

Developed by

JGSEE

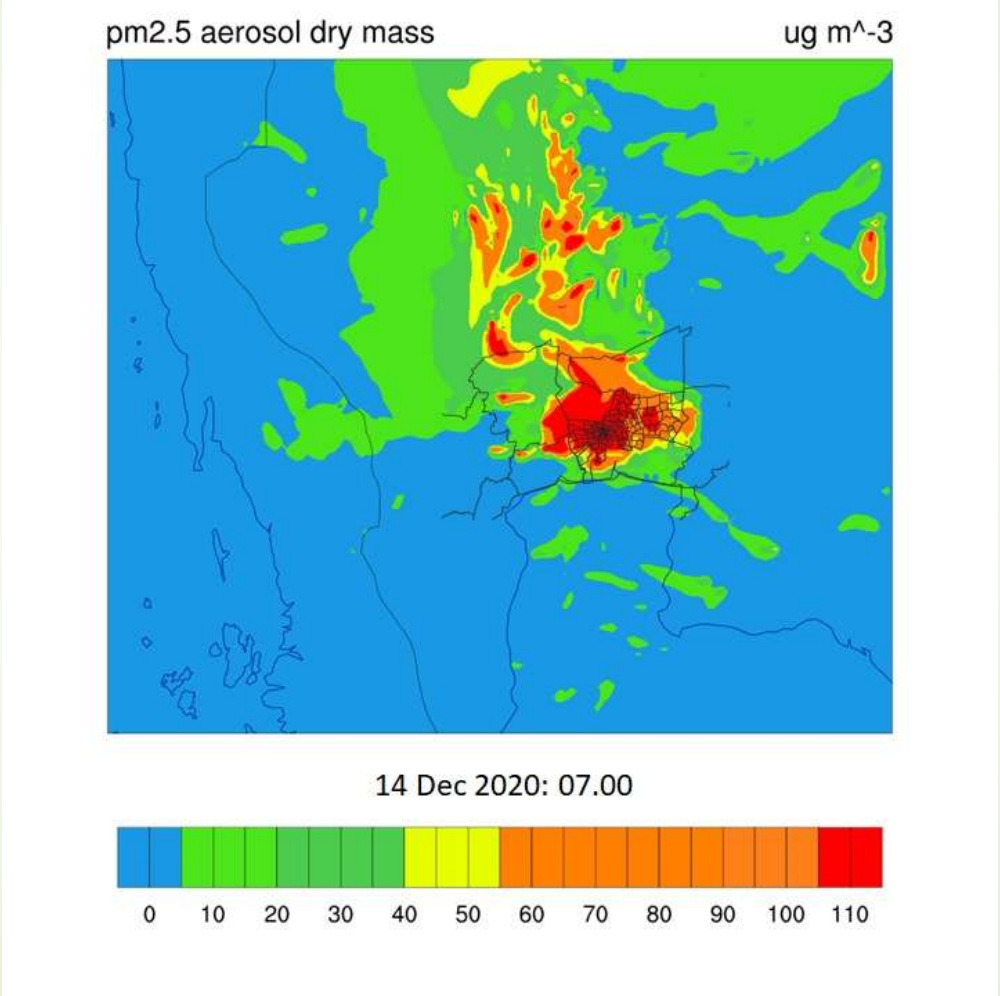
Meteorological Dataset

ECMWF

EUROPEAN CENTRE FOR MEDIUM RANGE WEATHER FORECASTS

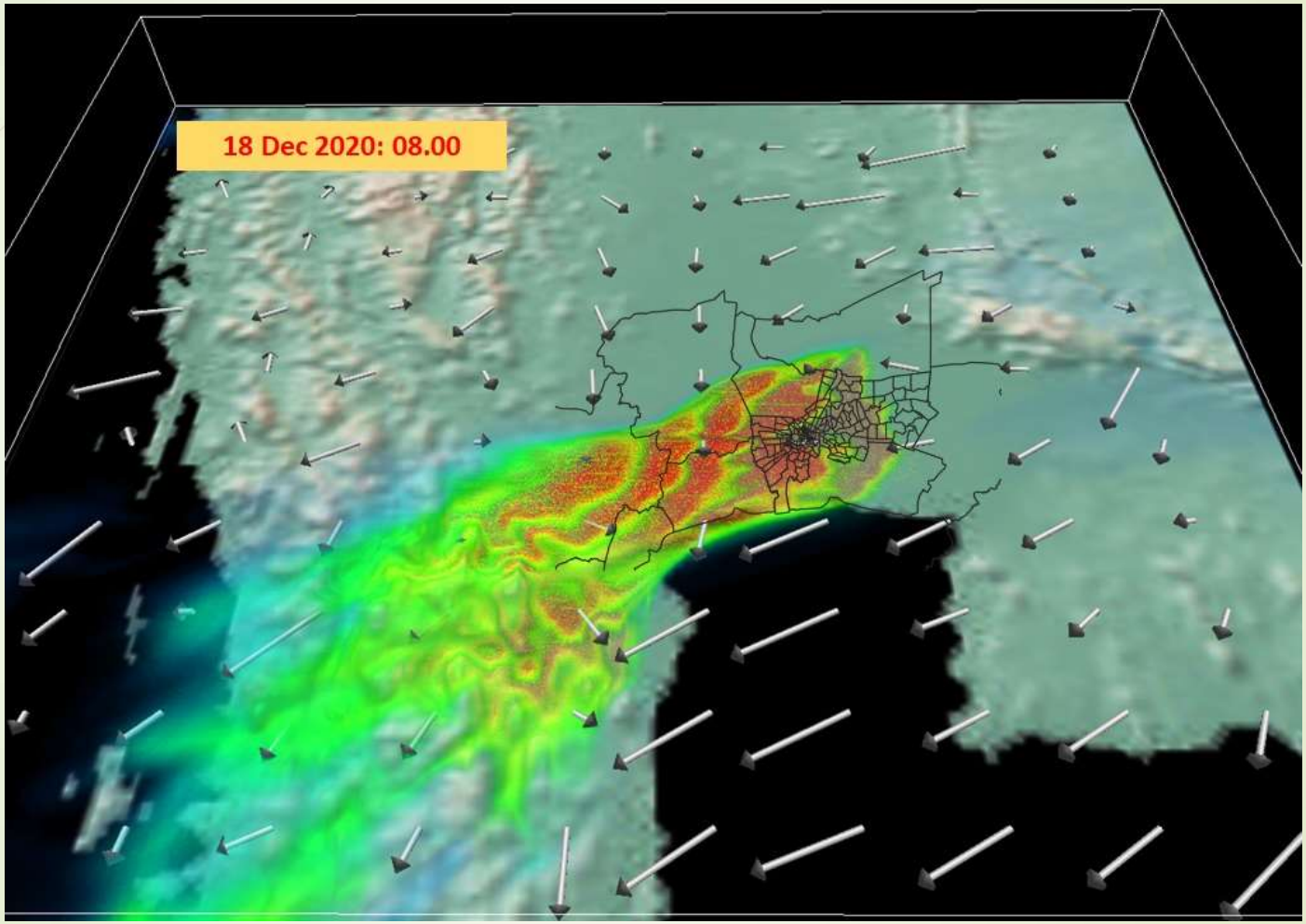
Product Example

BMR

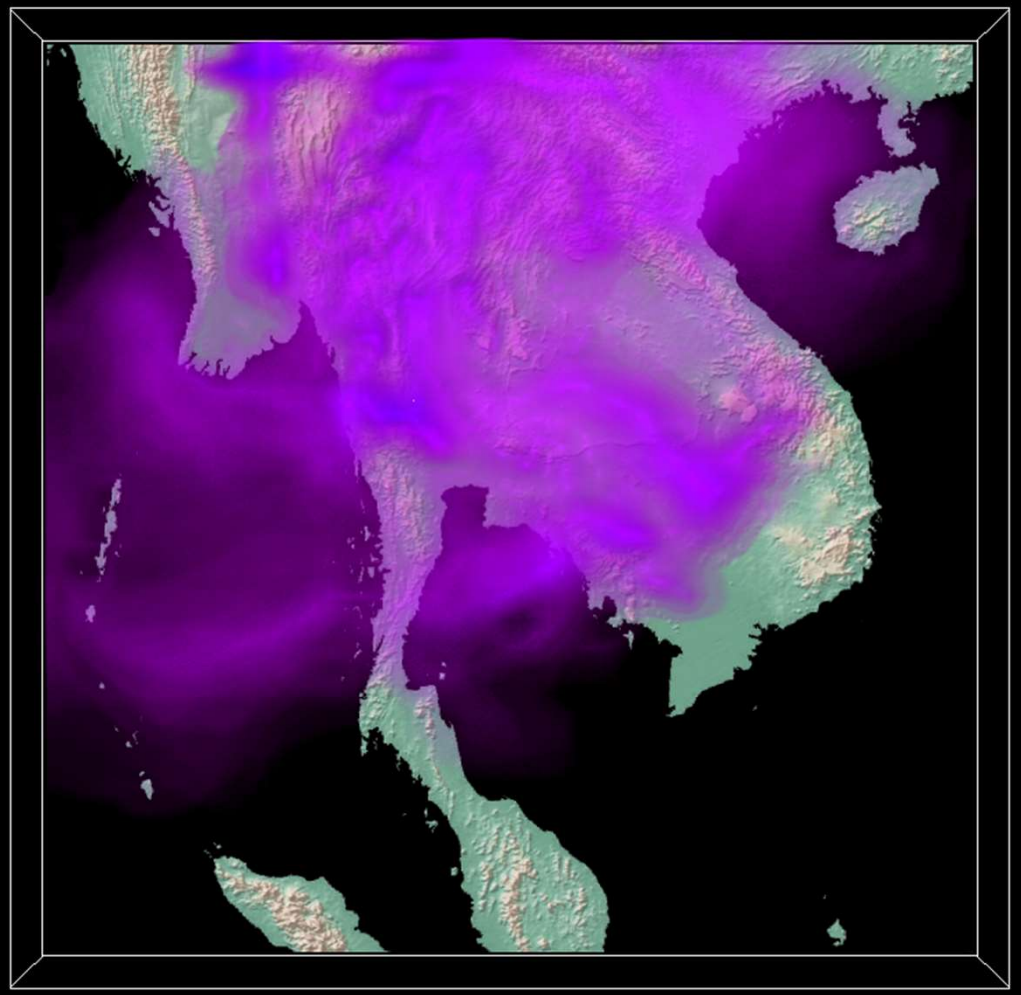


Product Example

BMR

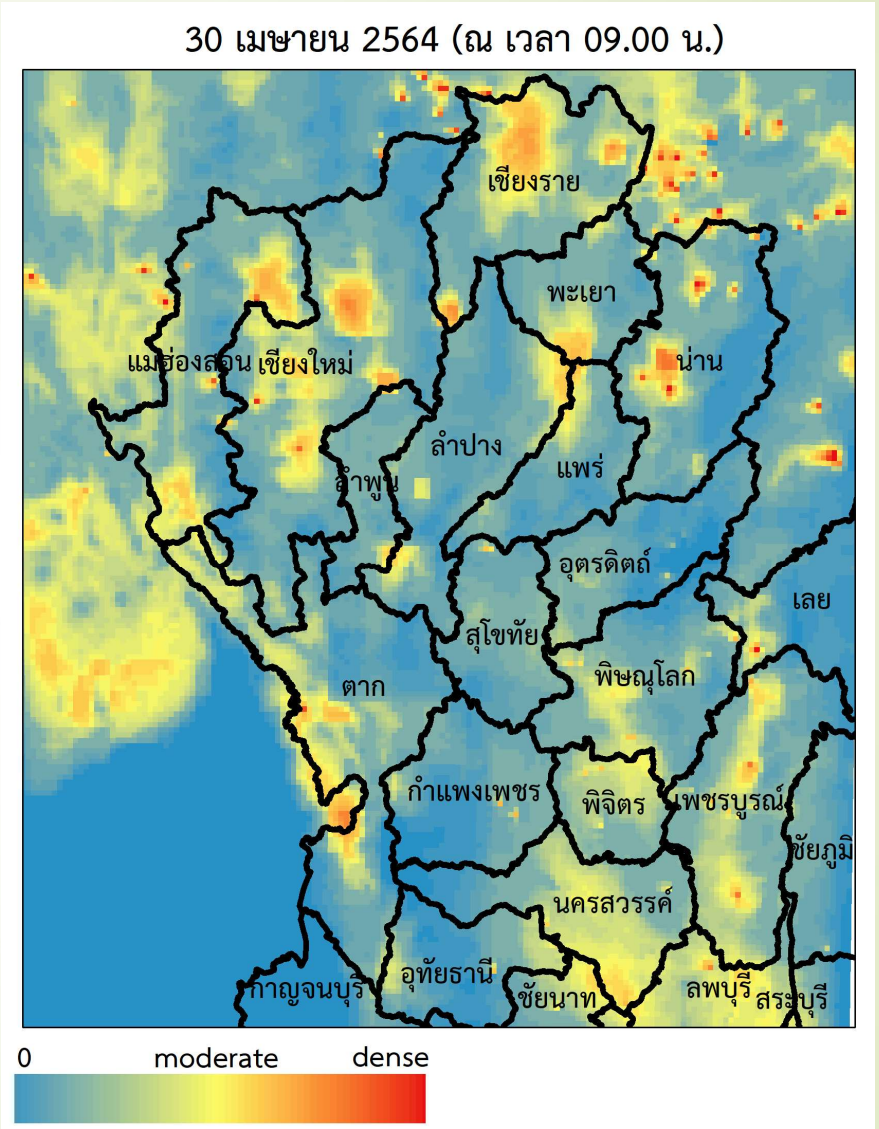


Results



Product Example

The Northern Part of Thailand



กรุงเทพมหานคร
พรุ่งนี้
4 ก.พ.
คาดการณ์สถานการณ์ฝุ่นละออง ในพื้นที่ กรุงเทพฯ 7 วันข้างหน้า
กรุงเทพเหนือ (หลักสี่ จตุจักร)
กรุงธนใต้ (บางแค หนองแขม บางบอน)
กรุงเทพกลาง (พญาไท ดินแดง ห้วยขวาง)
กรุงเทพตะวันออก (คลองสามวา มีนบุรี สะพานสูง)
กรุงธนเหนือ (ตลิ่งชัน บางกอกน้อย ทวีวัฒนา)
กรมควบคุมมลพิษ
POLLUTION CONTROL DEPARTMENT
ศกพ.
5 ก.พ.
พื้นที่เฝ้าระวัง
กรุงเทพตะวันออก (คลองสามวา มีนบุรี)
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6 ก.พ.
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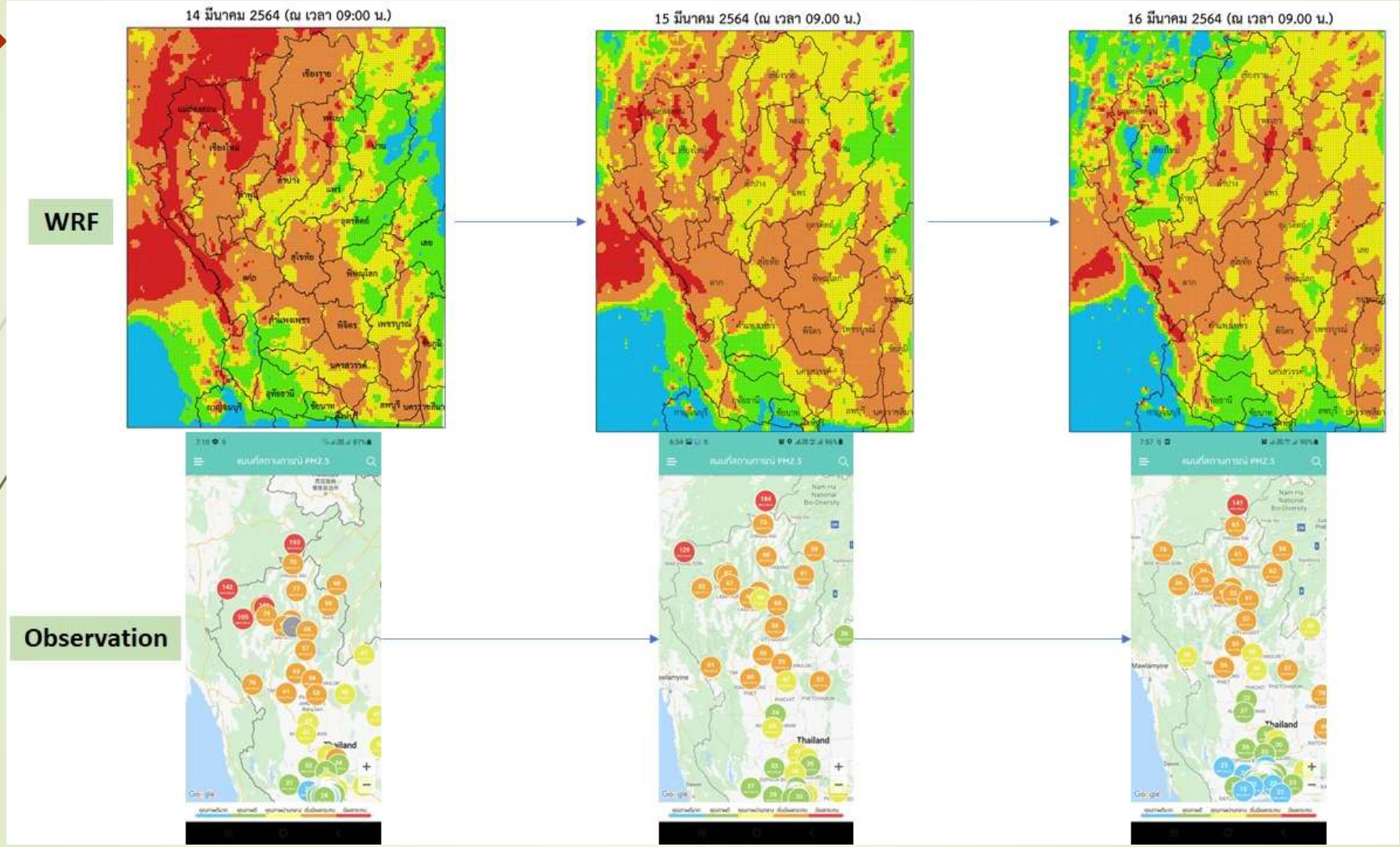
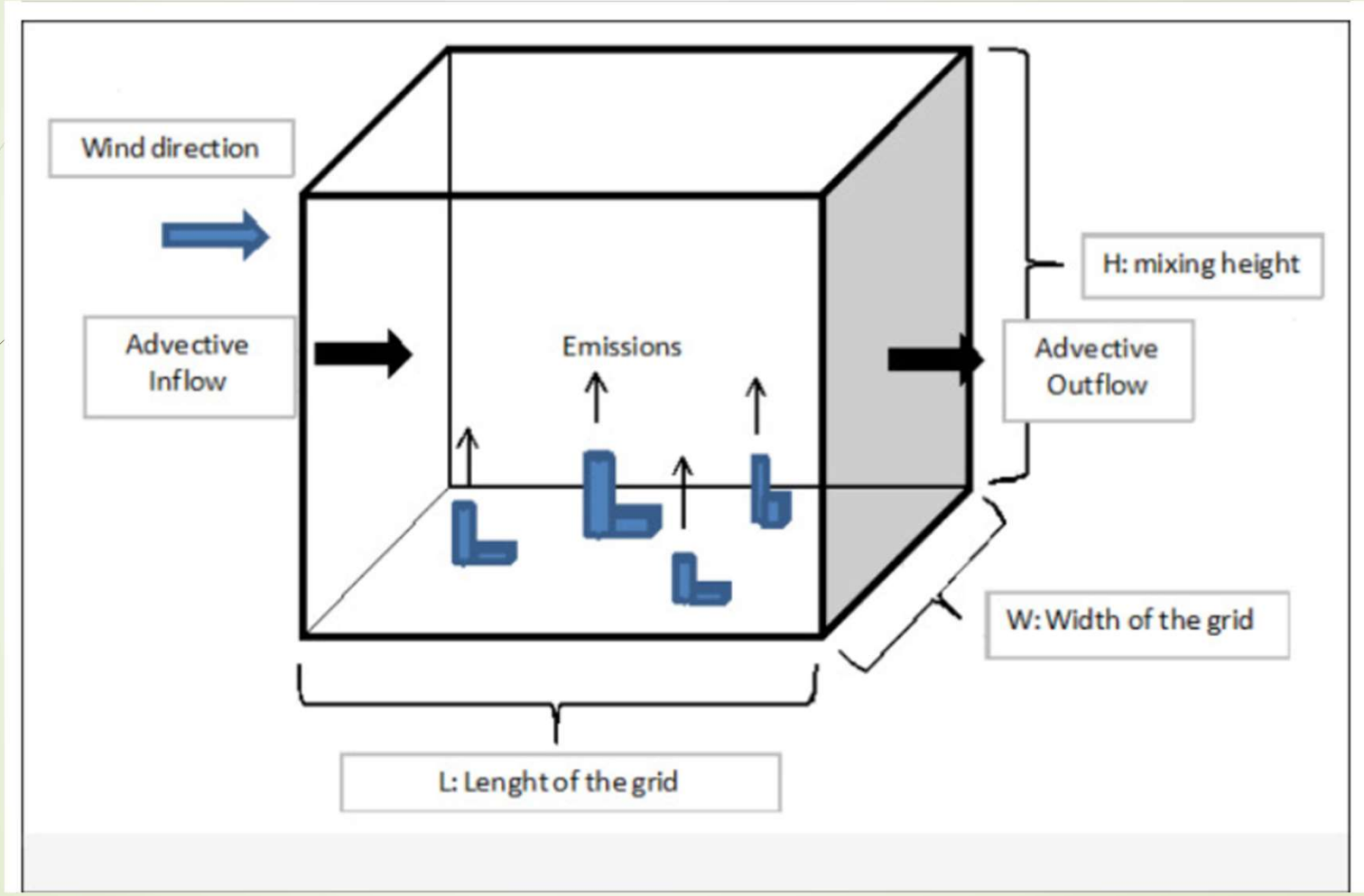
คุณภาพอากาศ
ดีมาก
ดี
ปานกลาง
เริ่มมีผลต่อสุขภาพ
มีผลต่อสุขภาพ
AppStore
PlayStore
1650
สายด่วนมลพิษ

Preliminary evaluation



Simple Box Model



Future works

- Expand boundary of target domain
- Improve resolution and accuracy
- Find optimal solution for supporting short and long term haze free strategic planning
- Update emission inventory

References

- Air Quality Modeling: https://www.epa.gov/scram/air-modeling-meteorological-grid-models
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Thank You