

AIR QUALITY MONITORING IN MONGOLIA

E.DAVAANYAM and B.GANTSETSEG

07 August, 2020

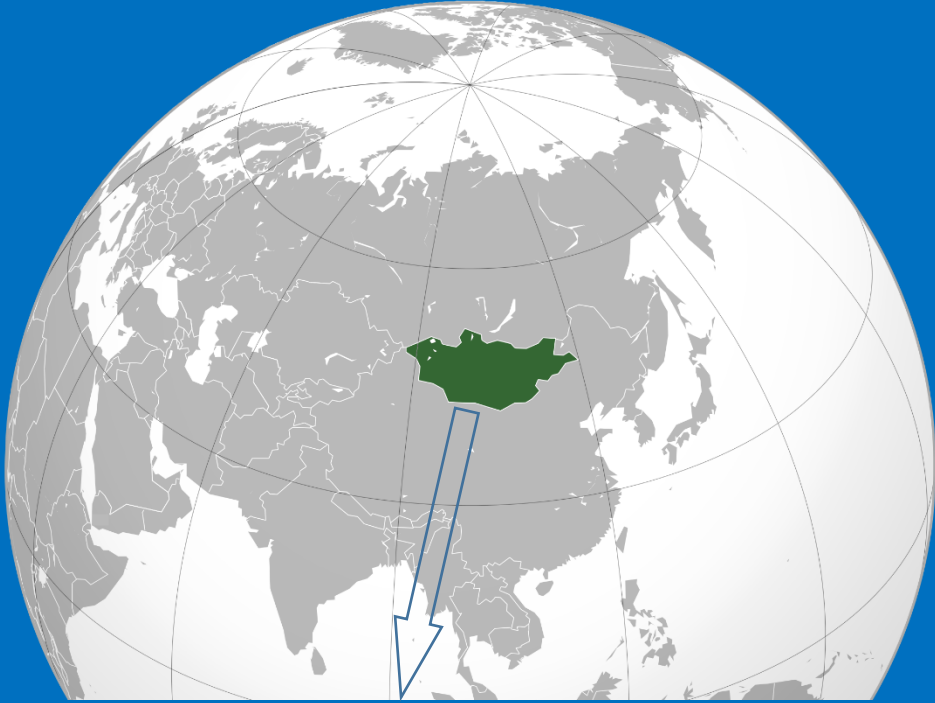
Ulaanbaatar city, Mongolia

Information and Research Institute of Meteorology, Hydrology
and Environment

Contents

- Main sources of air pollution in Mongolia
- Law and Policies on air pollution of Mongolia
- Air quality monitoring network in Mongolia
- Air quality measuring current methodology of Mongolia
- Air quality- ground monitoring data
- Air quality monitoring Data dissemination
- Model WRF-CMAQ/ADAM3-Haze
- Conclusion and Challenges

ULAANBAATAR, MONGOLIA



AREA

1.565 million km²

Population

3.2 million

Capital city

Ulaanbaatar

Average annual temperature

-0.4°C(2001-2019)

Monthly minimum temperature

-26.0°C (January)

Monthly maximum temperature

24.8°C(July)

Average annual precipitation

282.6 mm

Recorded extreme minimum temperature

-49.0°C (1954.02)

Recorded extreme maximum temperature

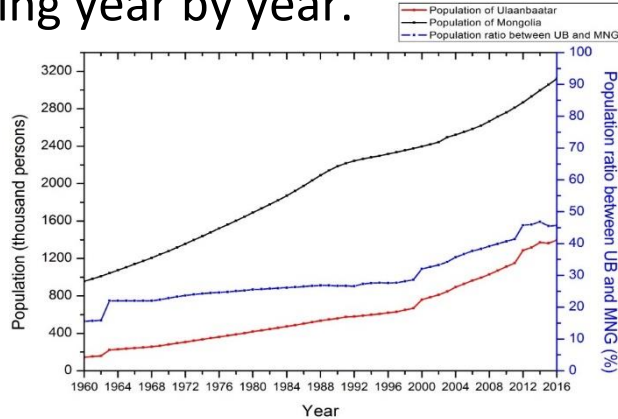
39.5°C (2005)



Causes of air pollution in Ulaanbaatar

Ulaanbaatar is the most polluted city because most people in our country live there.

- 1 The population concentration in the city is increasing year by year.



The migration resulting in a sharp increase in informal settlements.

- 3 Climate condition

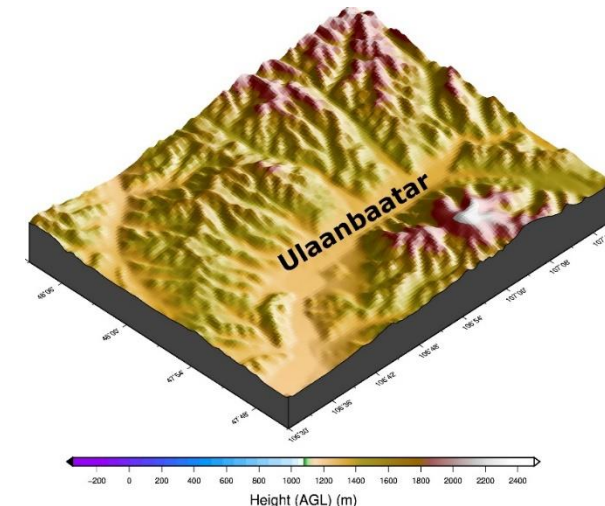
In Mongolia, the climate is **strongly continental**, with long cold winters and short, warm summers. During winter, Ulaanbaatar is the coldest capital in the world, having an average in January of -24.5°C (-12.1°F).

- 2 About 850,000 people live in Ulaanbaatar's **GER AREAS** and have poor access to urban services. A heavy reliance in these ger areas on coal for heating and energy generates large carbon dioxide emissions and air pollution, especially during winter.



- 4 Geographical location

The problem is located in lower mixing layer heights (lower than 200 m). It is coupled with geography surrounded by mountains, which restrict the vertical and horizontal dispersion of pollutants in the winter months.



VARIOUS SOURCES OF AIR POLLUTION IN ULAANBAATAR

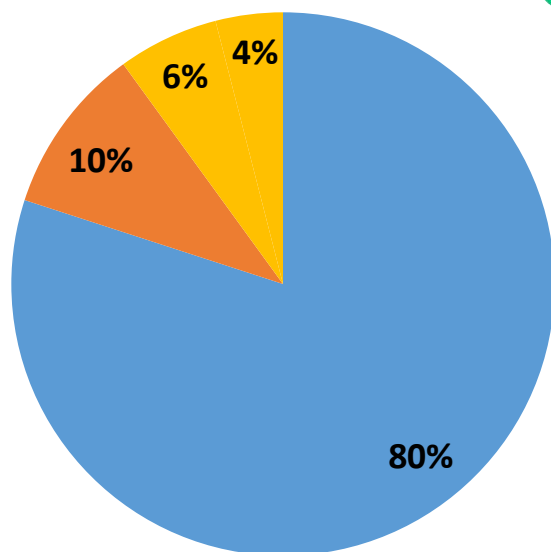
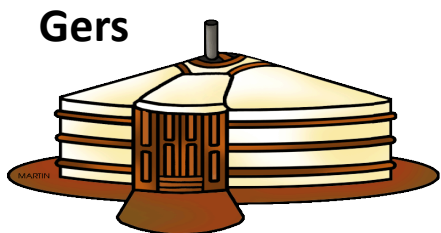
2016 Air pollution source inventory results

Industrial stoves >101kW 158
Power plants 3

Small coal stoves
<10kW 216,000
11-100kW

2,829

Mobile source:
339,626 vehicles



- Small heating stoves, 80%
- Mobile sources, 10%
- Large sources, 6%
- Other sources, 4%

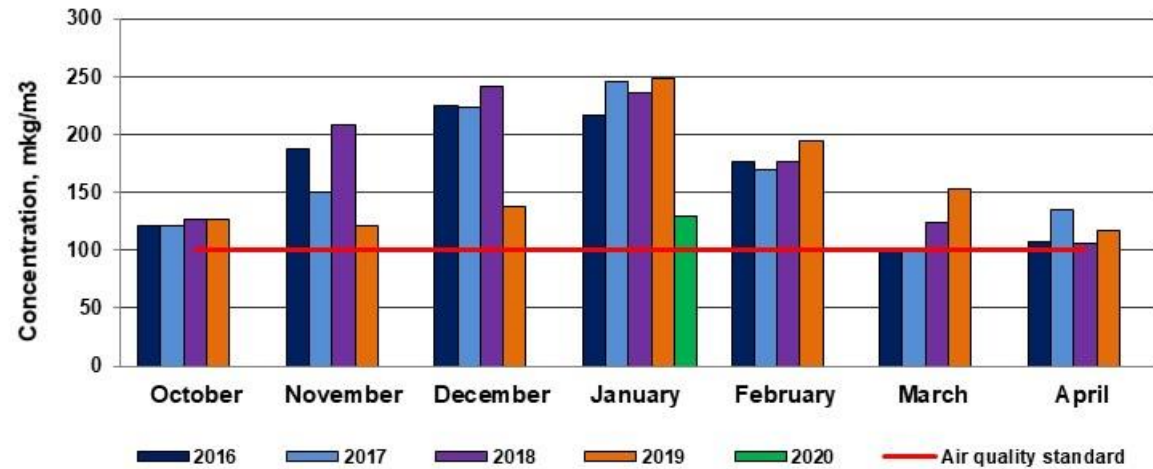
Ger area is the largest effect on ambient air quality in Ulaanbaatar city during heating season

MAJOR LAW AND POLICIES FOR AIR POLLUTION

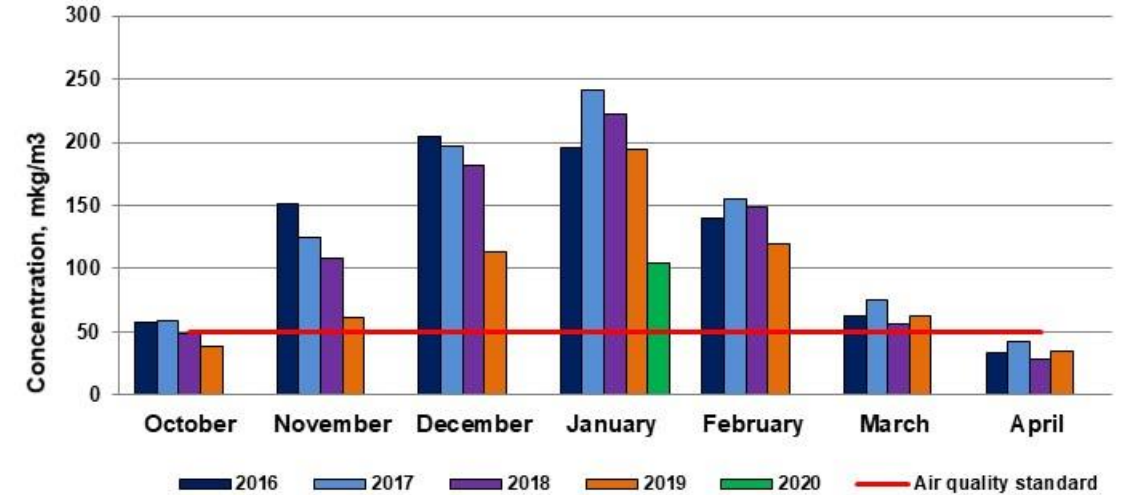
- **“Air law”** newly approved in 2010
 - Amendment on 2012, 2015
- **“Air pollution payment law”** firstly approved in 2010
 - Amendment on 2012, 2015
- **“National program for air and environmental pollution reduction”** approved in 2017
- **National standards for air quality and emission**
 - Renewing and newly establishing emission standard for various air pollution sources
- In May 2019, **prohibit the usage of raw coal** stated region by **Mongolian Government** in Ulaanbaatar.

MEASUREMENT RESULTS OF MAJOR AIR POLLUTANTS

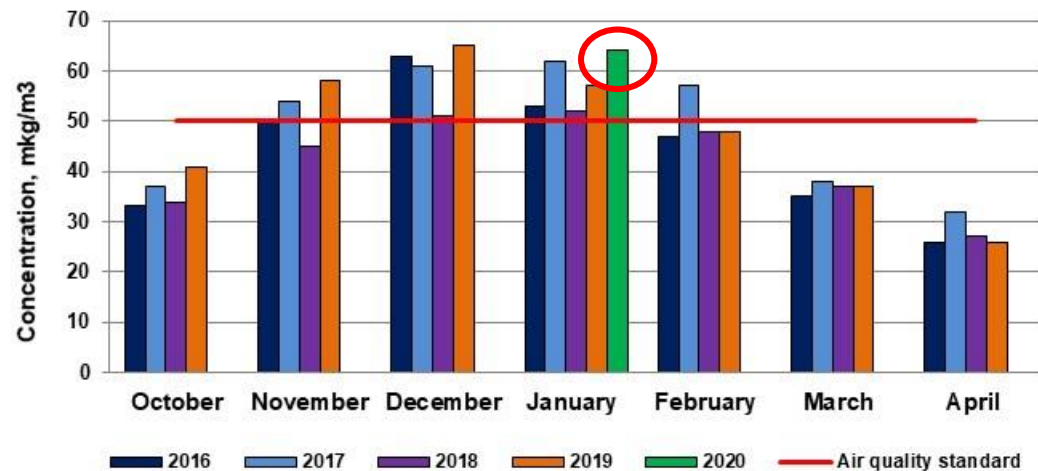
PM10



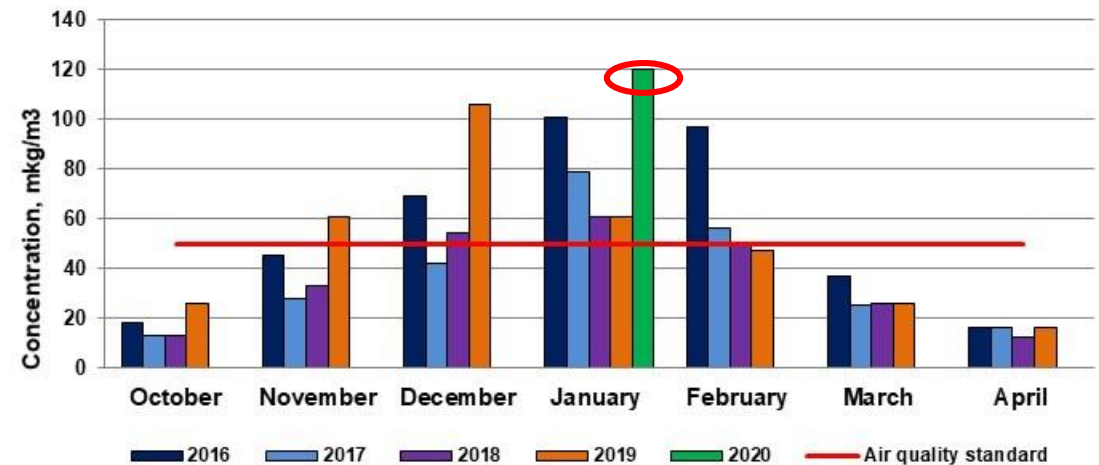
PM2.5



NO2



SO2



AIR QUALITY MONITORING NETWORK IN MONGOLIA

**There are 40 stations
in Mongolia.**



MEASURING UP TO 6 PRIMARY POLLUTANTS:

SO_2 , NO_x , CO , O_3 , PM_{10} , $PM_{2.5}$

No	Name	Location	Started year	SO2	NOx	CO	PM10	PM2.5	O3	Time interval
1	UB-1	47°53'38,44" 106°52'57,54"	2010							Avg 15 min
2	UB-2	47°54'55,46" 106° 53'39,60"	2010							Avg 15 min
3	UB-3	47° 55'04,73" 106° 50'53,02"	2018							Avg 15 min
4	UB-4	47° 55'02,65" 106° 56'14,97"	2010							Avg 15 min
5	UB-5	47°55'58,45" 106°55'16,96"	2010							Avg 15 min
6	UB-6	47°54'48,42" 106°58'19,31"	2009							Avg 24 hour
7	UB-7	47°54'20,22" 106°50'32,97"	2010							Avg 15 min
8	UB-8	47°51'57,43" 107°07'05,77"	2010							Avg 15 min
9	UB-11	47°57'05,15" 106°54'14,66"	2010							Avg 24 hour
10	UB-12	47°57'14,50" 106°55'15,70"	2009							Avg 30 min
11	Zuragt	47°55'46,95" 106°53'19,08"	2009							Avg 30 min
12	Tolgoit	47°55'20,96" 106°47'41,37"	2009							Avg 30 min
13	Nisekh	47°51'50,25" 106°46'44,68"	2009							Avg 30 min
14	Amgalan	47°54'48,61" 106°59'52,59"	2009							Avg 30 min
15	BayanKhoshuu	47°57'27,12" 106°49'21,47"	2016							Avg 30 min

North to South: ~15 km
West to East: ~ 30 km



**There are 15 stations
in Ulaanbaatar.**

AIR QUALITY MONITORING USING METHODOLOGY

Present

13 Automatic stations

O342e - UV photometry LED based Ozone analyzer

US-EPA - Automated Equivalent Method : EQOA-0515-225

CO12e – Gaz filter correlation carbon monoxide analyzer

US-EPA - Automated Reference Method : RFCA-0915-228

AF22e - UV Fluorescent SO₂ analyzer

US-EPA - Automated Equivalent Method : EQSA-0802-149

AC32e - Chemiluminescent NO-NO_x & NO₂ analyzer

PM10 and PM2.5 -Suspended particulate beta gauge monitor

<http://www.environnement-sa.com/>



2010

13 Automatic stations

2010

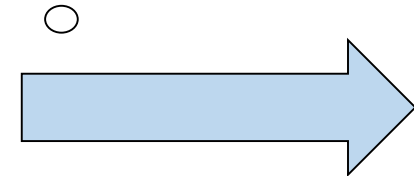
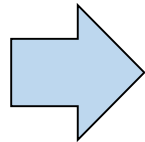
27 stations

2000

4 stations

1979

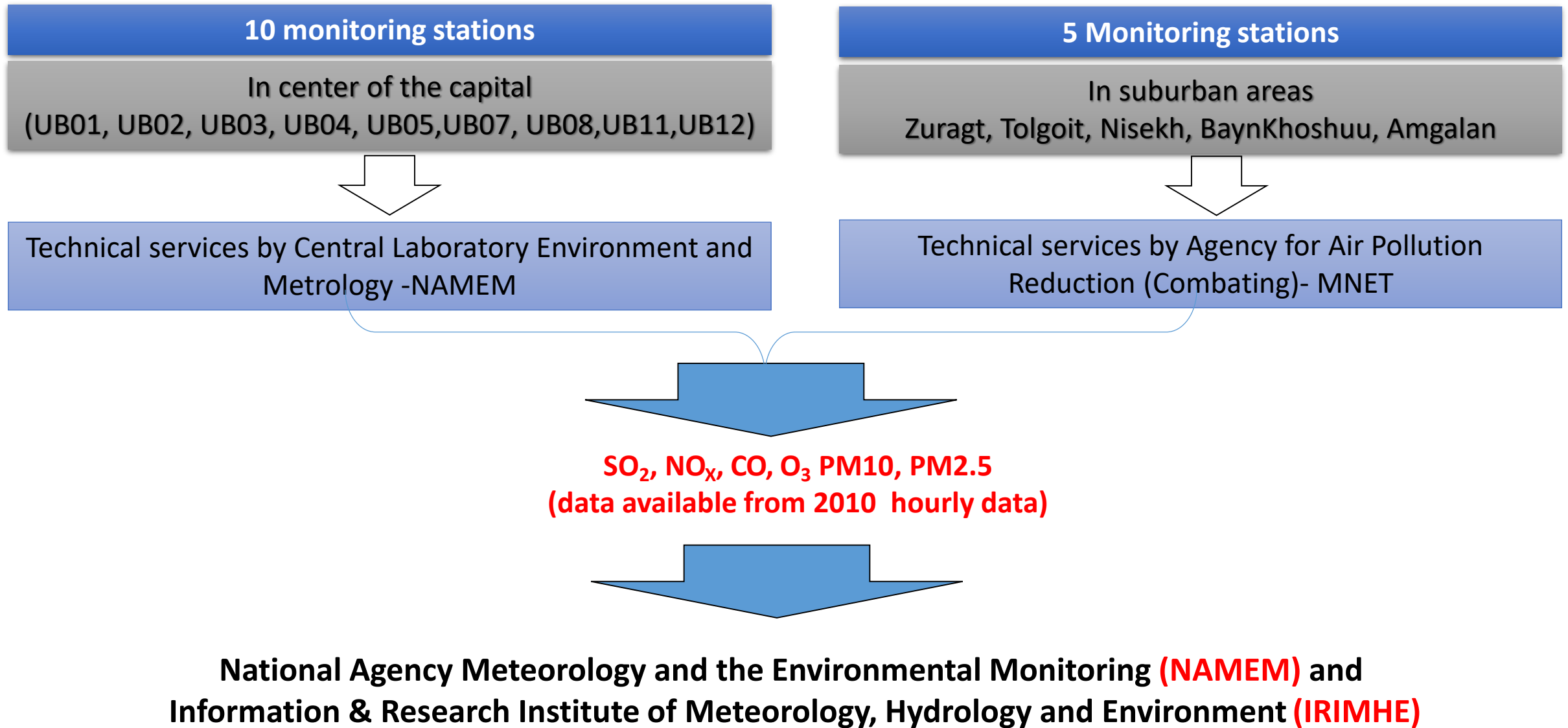
1 station



WET CHEMICAL METHOD

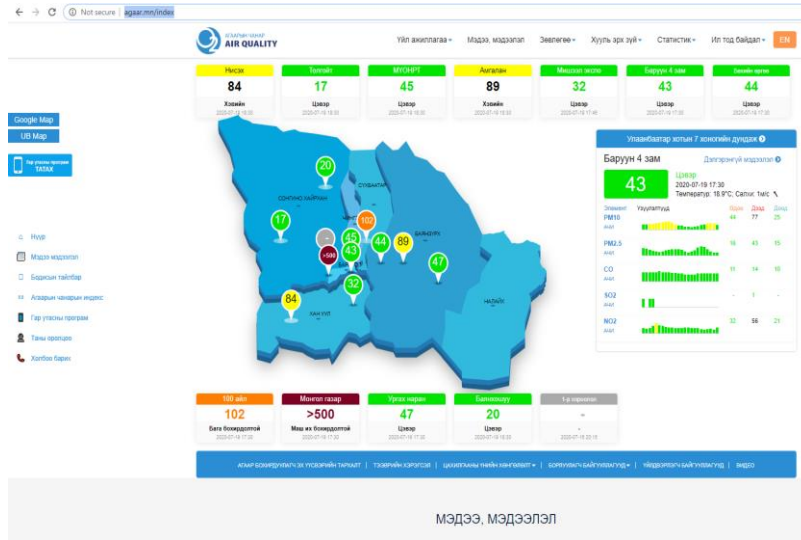


AIR QUALITY - GROUND MONITORING DATA



AIR QUALITY - GROUND MONITORING DATA DISSEMINATION

Web-based air quality-ground monitoring data



Air quality monitoring Mobile application



Agaar.mn

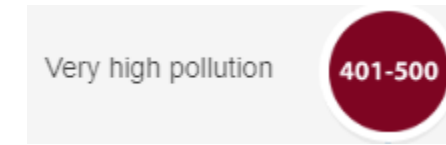
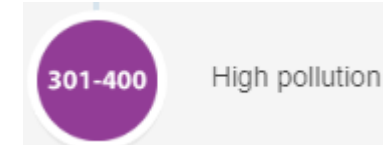
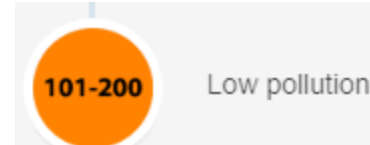
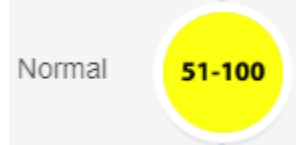
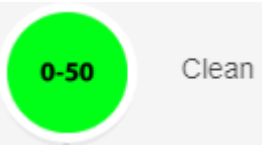
Агаарын чанарын мэдээг иргэдэд түгээх гар утасны програм

- ✓ Агаарын чанарын мэдээ
- ✓ Мэдээ, мэдээлэл
- ✓ Зөвлөгөө
- ✓ Агаар бохирдуулах бодисын тайлбар
- ✓ Агаарын чанарын индексийн тайлбар

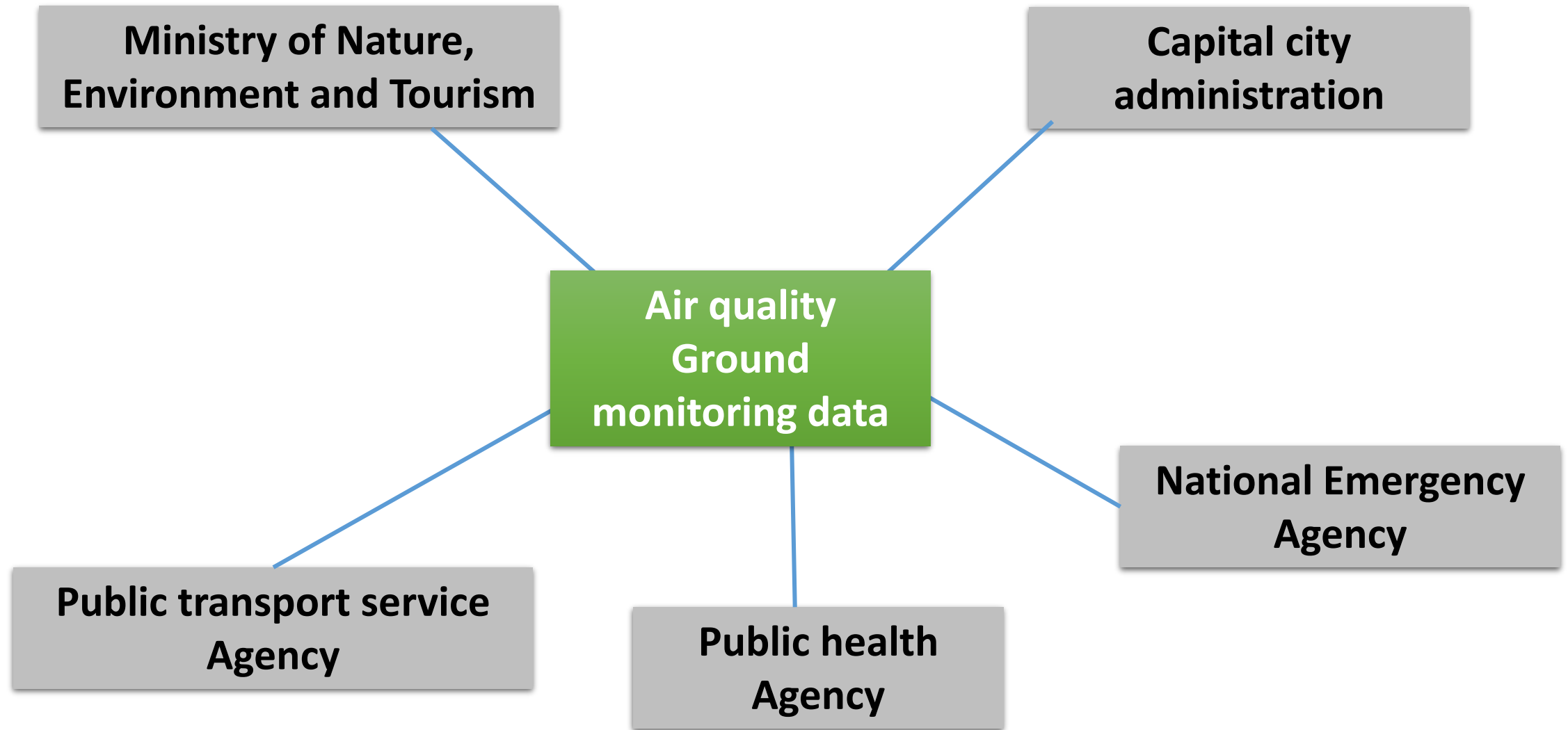


<http://agaar.mn/index>

In wintertime **public disseminated** annually about air quality monitoring by 6 indexes in markets, shops, and other places, where people crowded.



AIR QUALITY - GROUND MONITORING DATA DISSEMINATION



MODEL

WRF-CMAQ/ADAM3-Haze

WRF-CMAQ/ADAM3-Haze

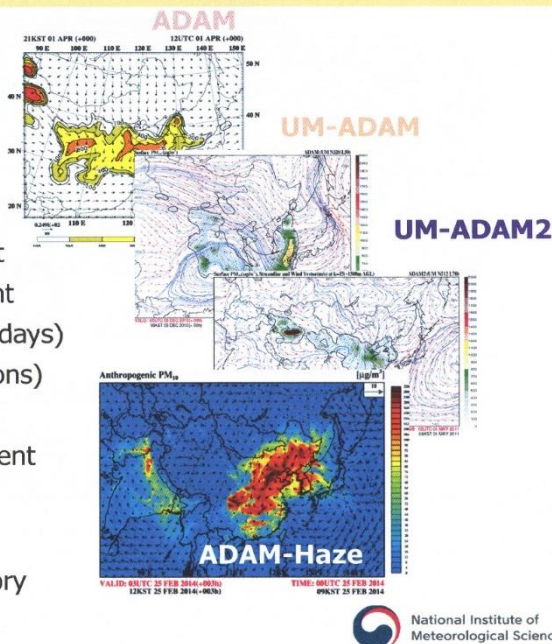
ADAM3-Haze

High Resolution (1km) ADAM3 for Ulaanbaatar

Development history of ADAM

1. Overview of ADAM

- 2001 : Launching ADAM development
- 2002 : Test run at KMA Intranet
- 2005 : Posting at KMA Homepage
- 2006 : Test run at KMA's supercom
- 2007 : ADAM operation
- 2008 : Improvement of vegetation effect
- 2009 : Launching UM-ADAM development
- 2010 : UM-ADAM operation(2 days → 3 days)
UM-ADAM2 operation (Four-seasons)
- 2011 : UM-ADAM2(N512) operation
- 2014 : Launching ADAM-Haze development
- 2015 : ADAM-Haze operation
Applying optimal interpolation
- 2016 : Improvement of emission inventory

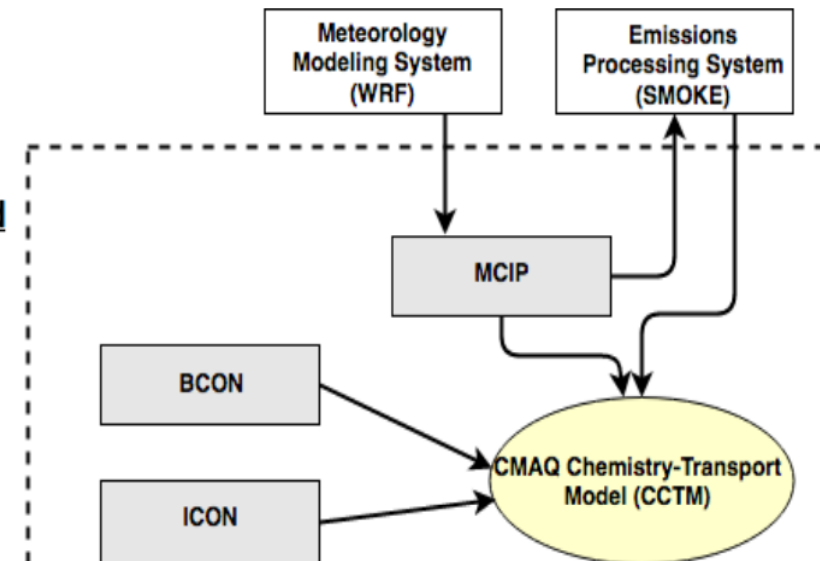


- The initial conditions processor **ICON**
- The boundary conditions processor **BCON**
- The Meteorology-Chemistry Interface Processor **MCIP**
- The CMAQ Chemistry-Transport Model **CCTM**

CMAQ Modeling System Flow Chart

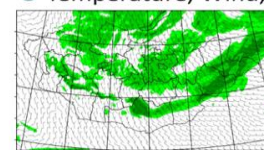
Options Selected

Case
Grid (Domain and Size)
Projection
Vertical Structure
Chemical Mechanism

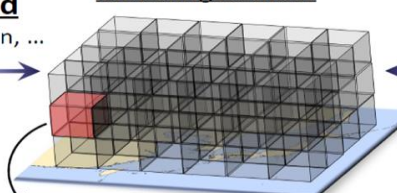


Meteorological Field

- Temperature, Wind, Rain, ...



Modeling Domain



Emission Data

- NO_x, SO_x, VOC, PM, ...

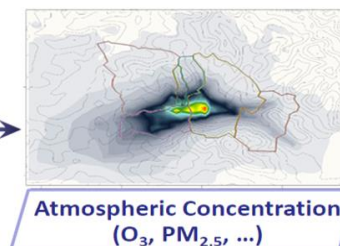


Boundary Concentration

- Global Simulation
- Parent Domain

- Advection/Diffusion
- Gas/Aerosol/Liquid-phase Reactions
- Dry/Wet Depositions
- Anthropogenic/Natural Emissions

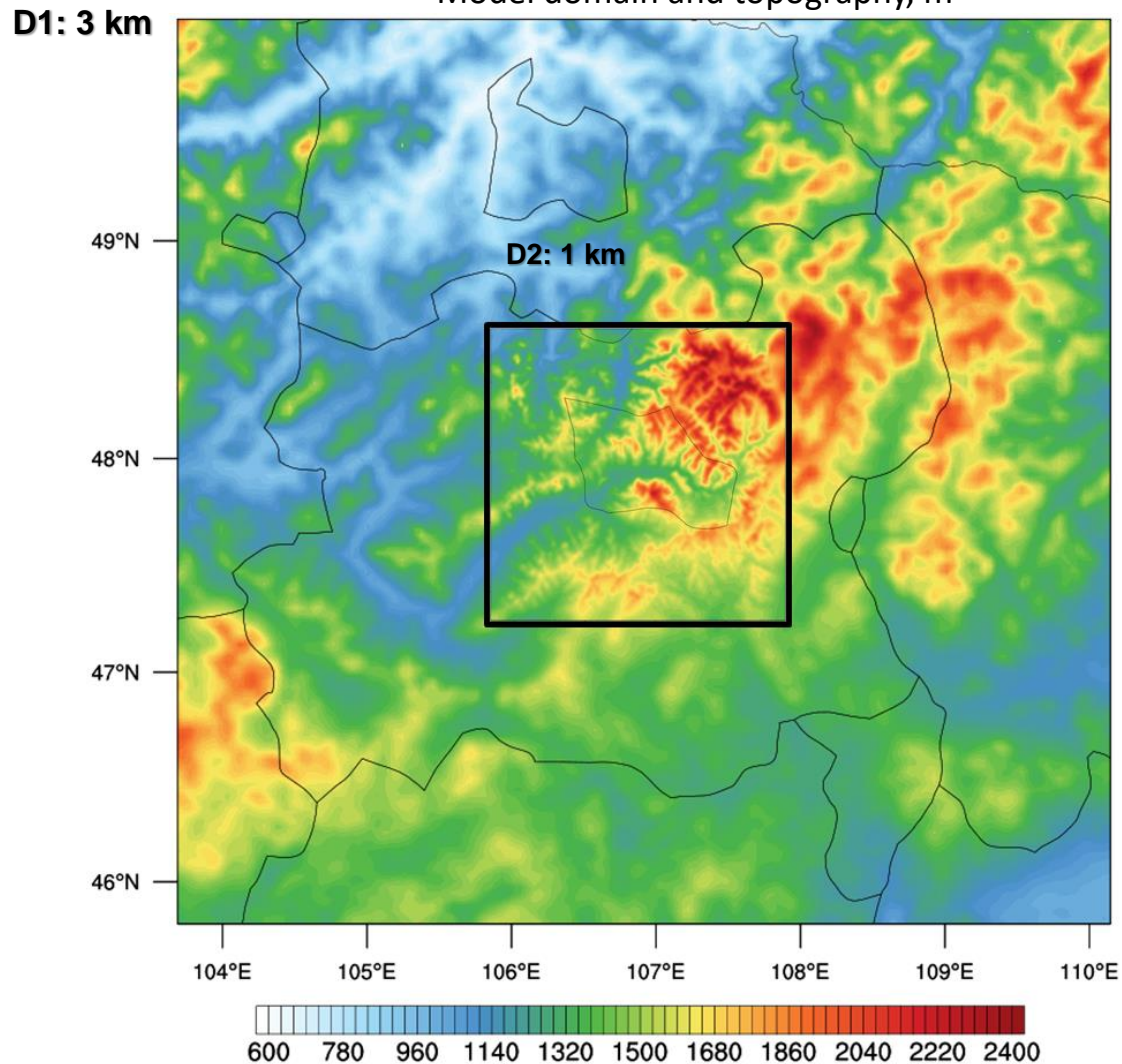
Chemical Transport Model



CMAQ (Community Multiscale Air Quality model)¹⁾

WRF-CMAQ/ADAM3-Haze

Model domain and topography, m



Domain size:

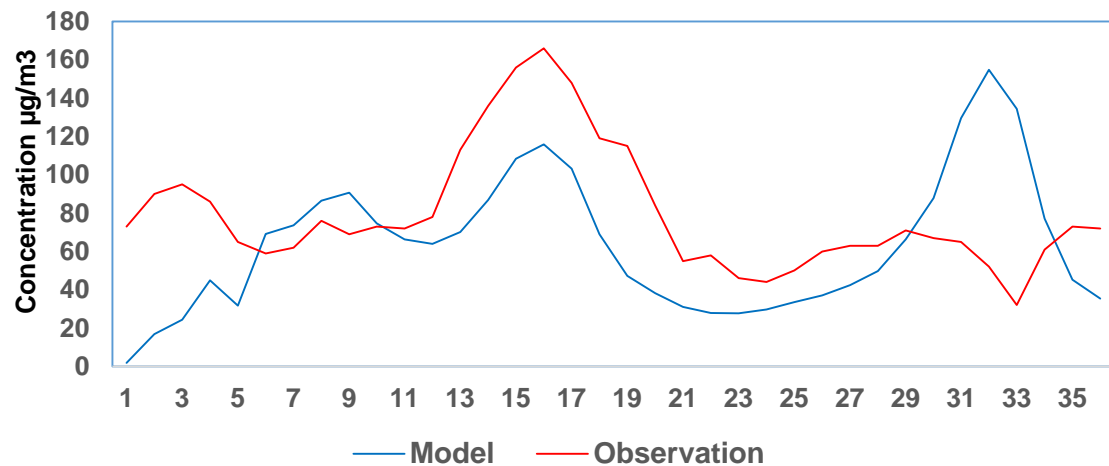
3 km: 151x151x31

1 km: 151x151x31

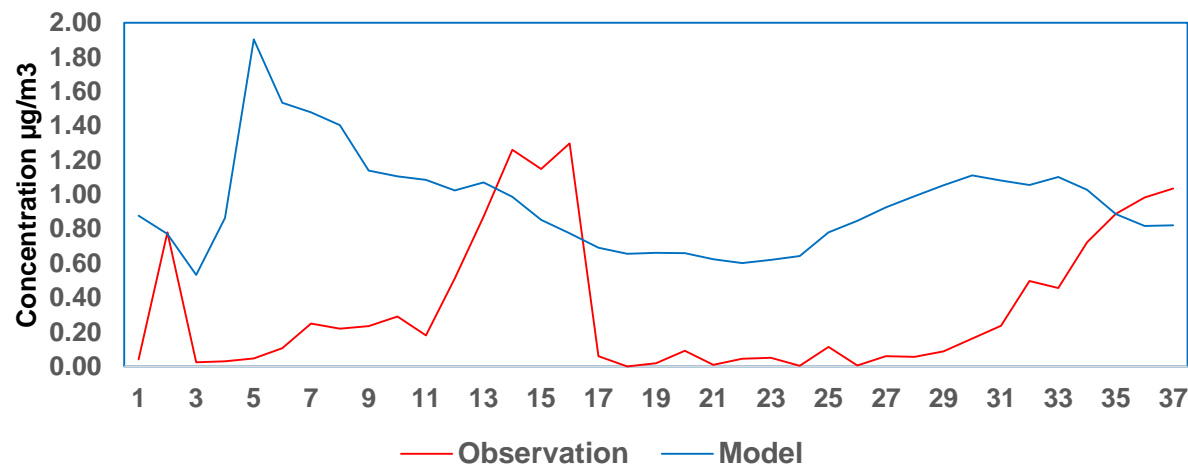
Name	Selection
Model and version	WRF-Chem v3.4.1
Dynamic core	Advanced Research WRF (ARW)
Horizontal grid resolution (size)	D1: 3x3 km (151x151 grid) D2: 1x1 km (151x151 grid)
Vertical levels	31
Initial and lateral boundary conditions	NCEP FNL reanalysis data (1 degree)
Simulation length	36 hours
Time step	D1:18 seconds D2: 6 seconds
Physics schemes	
Cloud microphysics	WRF Single-Moment 6-class scheme
Shortwave radiation	Dudhia scheme
Longwave radiation	RRTM scheme
PBL physics	Yonsei University scheme
Land Surface Physics	Noah Land Surface Model
Surface Layer Physics	MM5 similarity
Cumulus Parameterization	Kain-Fritsch scheme
Emission data	
HTAP + UBmod (modified data)	
1. Provided by Hikari Shimadera (Osaka University)	

WRF-CMAQ/ADAM3-Haze

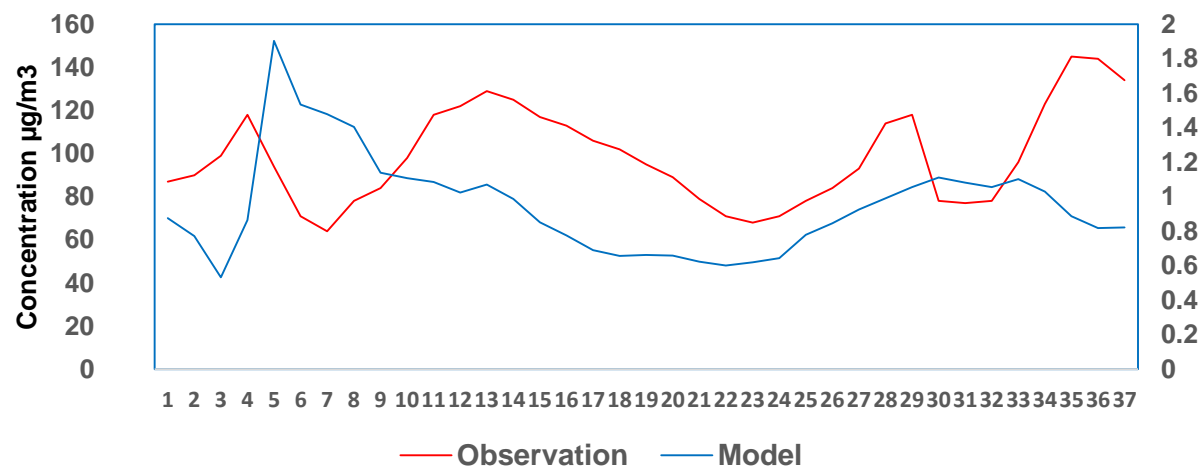
PM10
UB04 Monitoring station



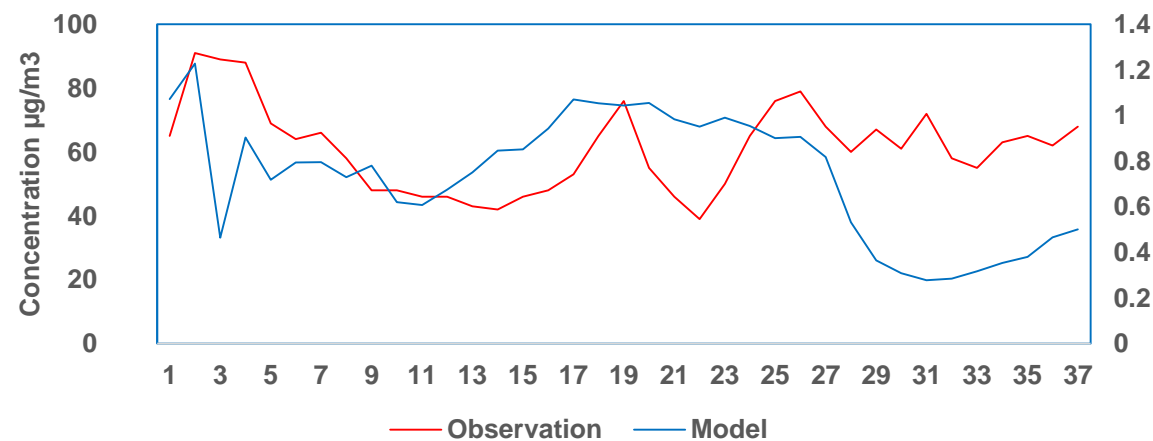
CO
UB03 Monitoring station



NO2
UB02 Monitoring station



SO2
UB08 Monitoring station



HTAP harmonized emissions database 2008-2010

- Components

BC, PM10, PM2.5, CO, SO2, NMVOC, OC, NH3, Nox

- Resolution

0.1° x 0.1°

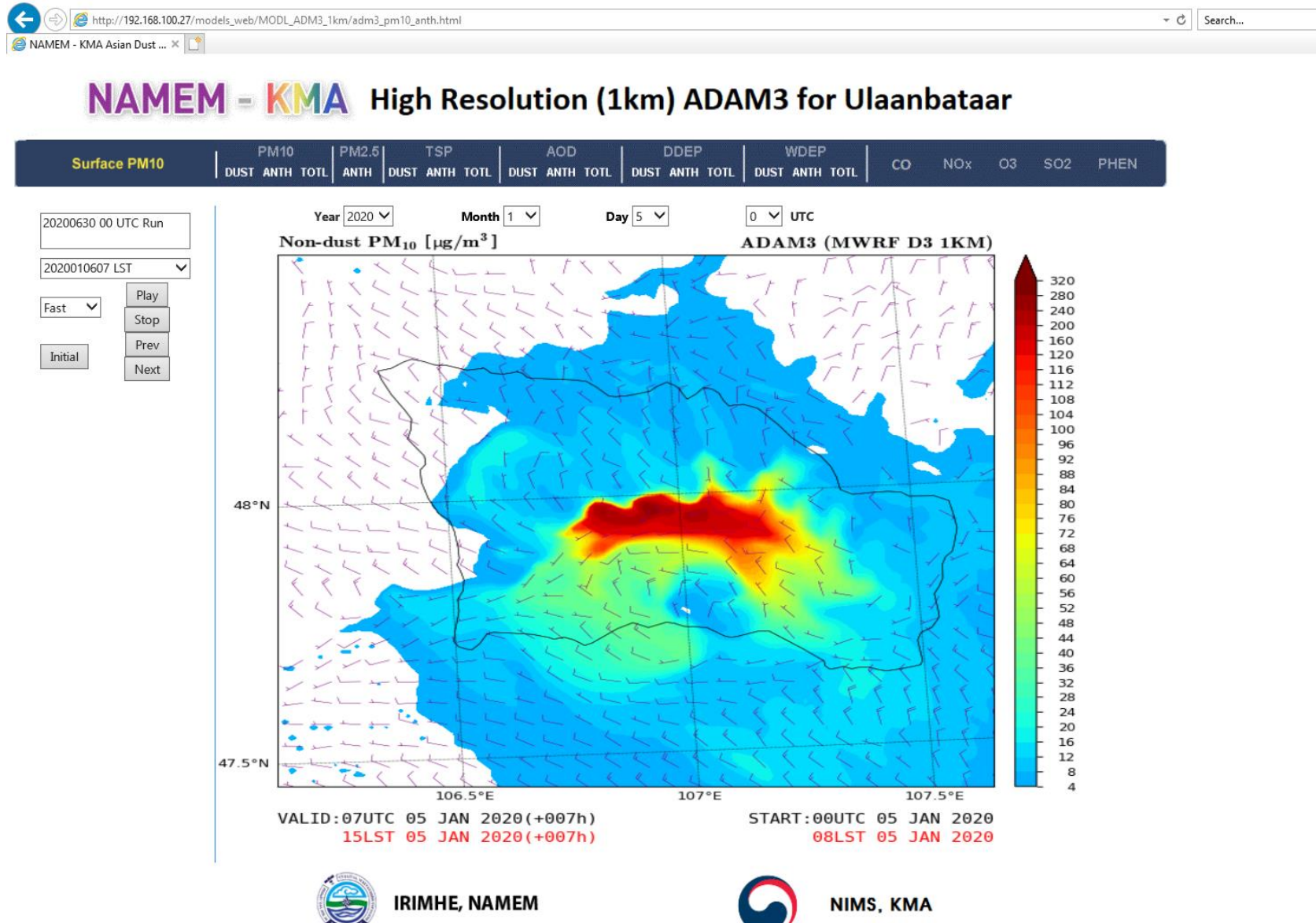
Since 2019, we have been testing this model on air pollution forecast.

In this model, we are using a harmonized gridded air pollution emission dataset in 2010. In the future, if we can opportunity to use real-time satellite data, we will be able to put that information in initial condition of model and use it directly.

HTAPv2_emission

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WRF-CMAQ/ADAM3-Haze



Source: http://192.168.100.27/models_web/MODL_ADM3_1km

CONCLUSIONS

- We are collecting very limitation air quality monitoring data. Because ground-based monitoring has limitations, due to monitoring stations are mostly concentrated in densely populated Ulaanbaatar city and very narrow spatial coverage.
- Satellite data can fill in information gaps left by ground-data collected through monitoring stations.
- We need more capacity building for this field.
- Required to expand the scope of application of air quality monitoring data
- To improve air quality monitoring facility (equipment) (The breakdown is common happening due to outdated parts of existing air quality monitoring stations. Therefore, there are cases of news interruptions.)- (Pandora is a UV/VIS spectrometer)
- In the further, air pollution is besides the capital of Mongolia other in centers of 21 provinces becoming a problem in the winter time. It needs to increase the air quality monitoring network.

Thank you very much for your attention

Contacts:

E.DAVAANYAM (Air quality monitoring expert, IRIMHE)

davaanyam.enkh@gmail.com

B.GANTSETSEG (Remote sensing engineer, IRIMHE)

bgantsetseg@yahoo.com