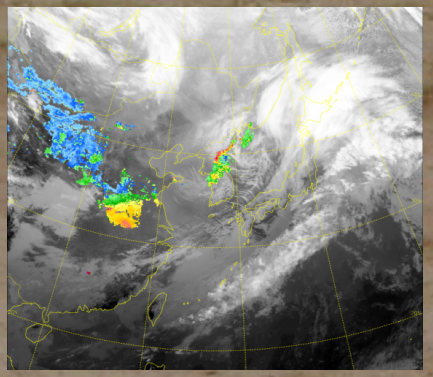
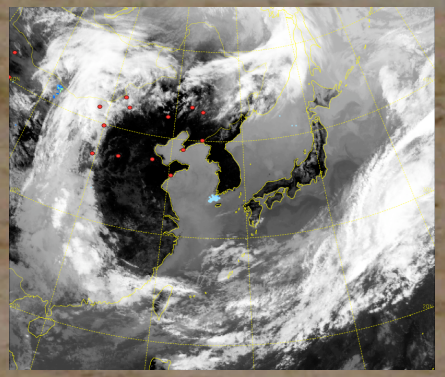
Asian Dust Early Warning System in Korea

Youngsin Chun





KMA Korea Meteorological Administration

Asian Dust Research Laboratory
National Institute of Meteorological Research, KOREA

Outline

1

Current status of “Hwangsa”

2

Monitoring network

3

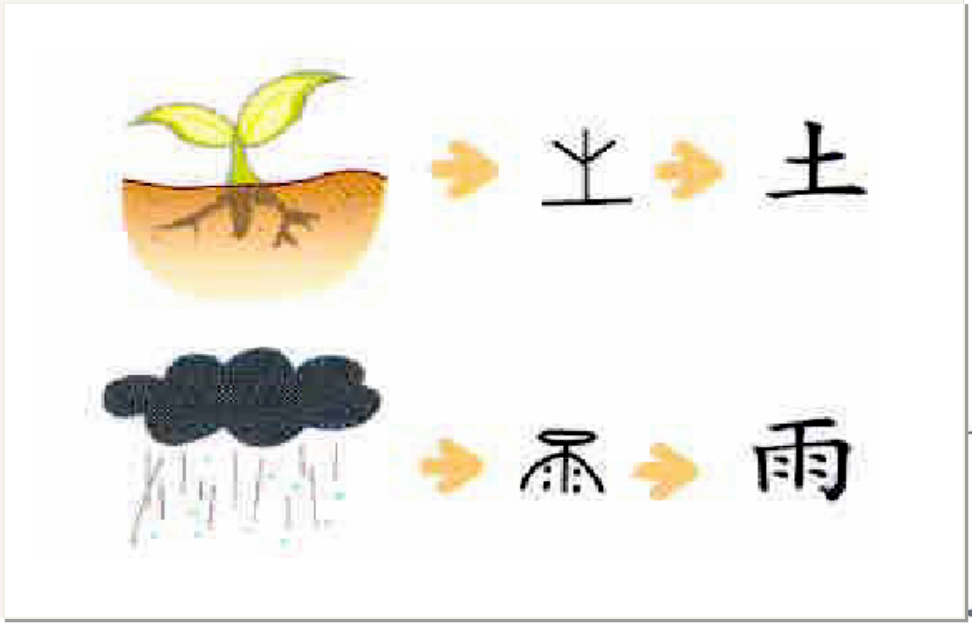
Early Warning system in KMA

Operation & Research

1-1 Historical record of dustfall in Korea

dustfall

흙비



AD 1818

書雲觀志 卷一 占候

後每更之下條列某變各記姓名以備考證若失候不啓者當該官勘罪每年正七月上旬

之類書啓如式又於風雲紀午前

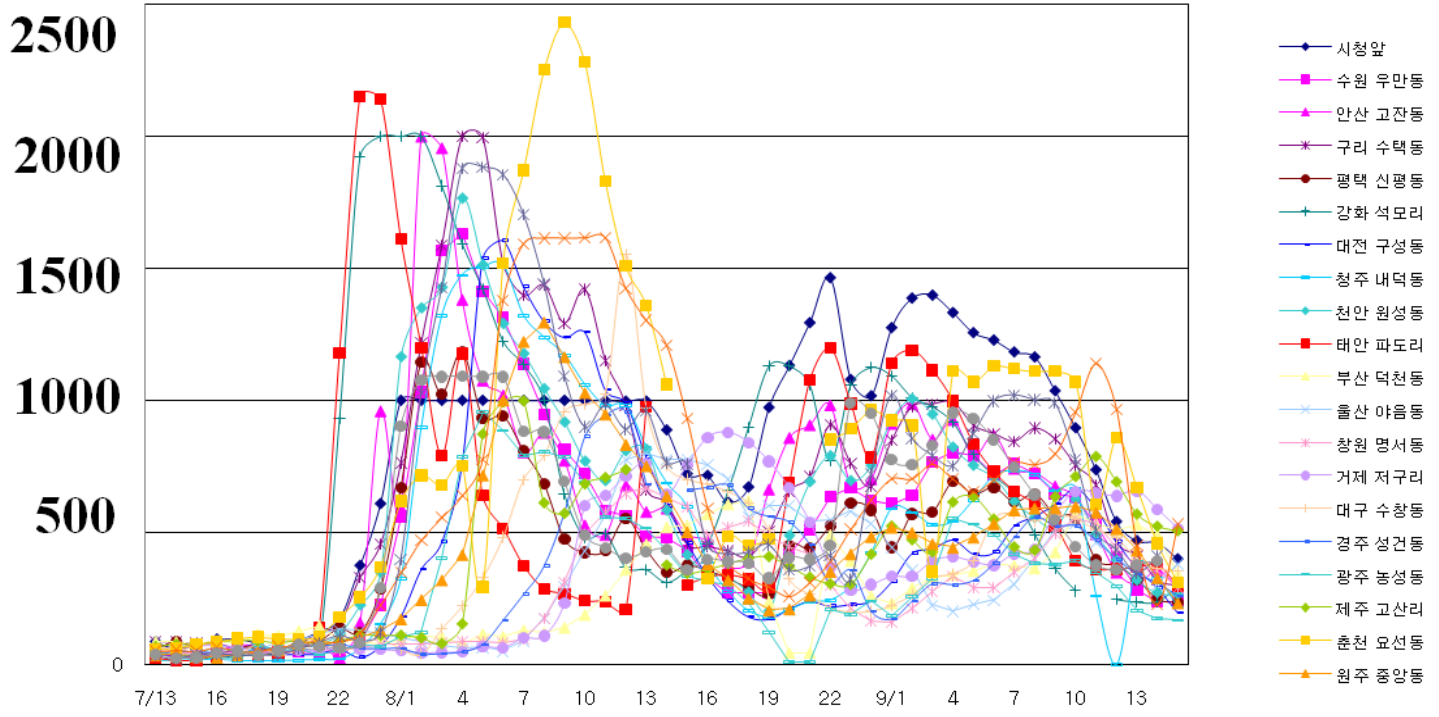
氣如火或上或下○虹在虹藏不見之後更某方有氣如火光虹始見之前凡計候自虹節日始下做此○某時虹見於某方雙虹則云雙虹○某時虹見於某方雷動聲之後始收○之雷始收之前○雷動在雷聲之後始收○之雷始收之前○雷動在雷聲之後始收○之雷始收之前○雷動在雷

1-2 “ Heavy dustfall ” in Seoul (2002 spring)

PM10

μg / m³

7~9 April



1-3 Early warning

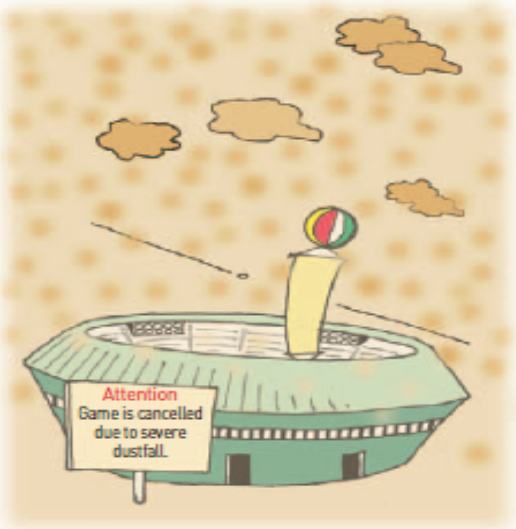
since April 2002

1. Advisory

An advisory is issued when the hourly average dust (PM10) concentration is expected to exceed 400 $\mu g/m^3$ for over two hours.

(500)

- Outdoor activities for the elderly, the young, and those with respiratory diseases are prohibited.
- Kindergarten and elementary school students should stay at home and are advised against from doing outdoor activities.
- Strenuous outdoor activities are prohibited.



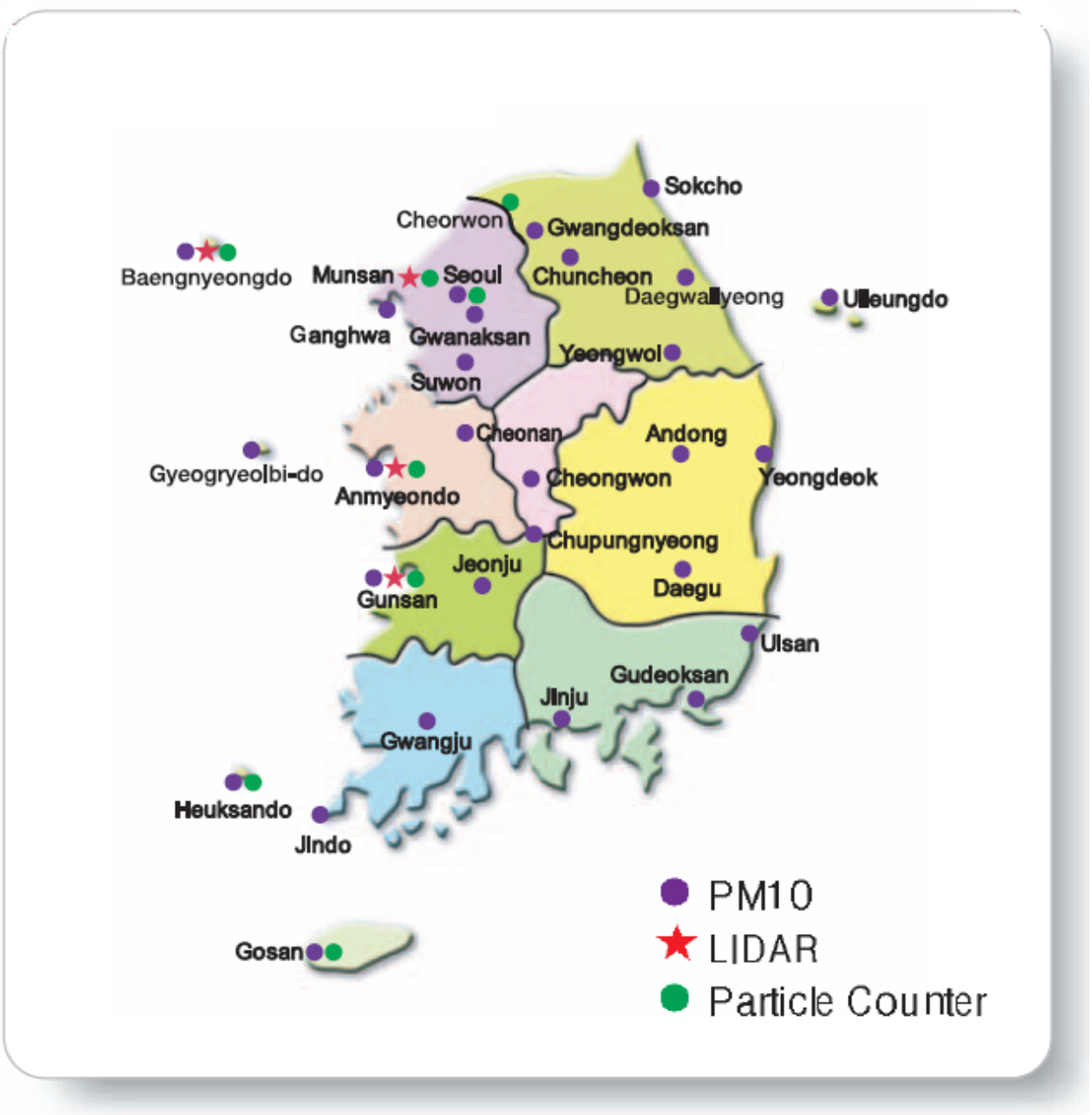
2. Warning

A warning is issued when the hourly average dust (PM10) concentration is expected to exceed 800 $\mu g/m^3$ for over two hours.

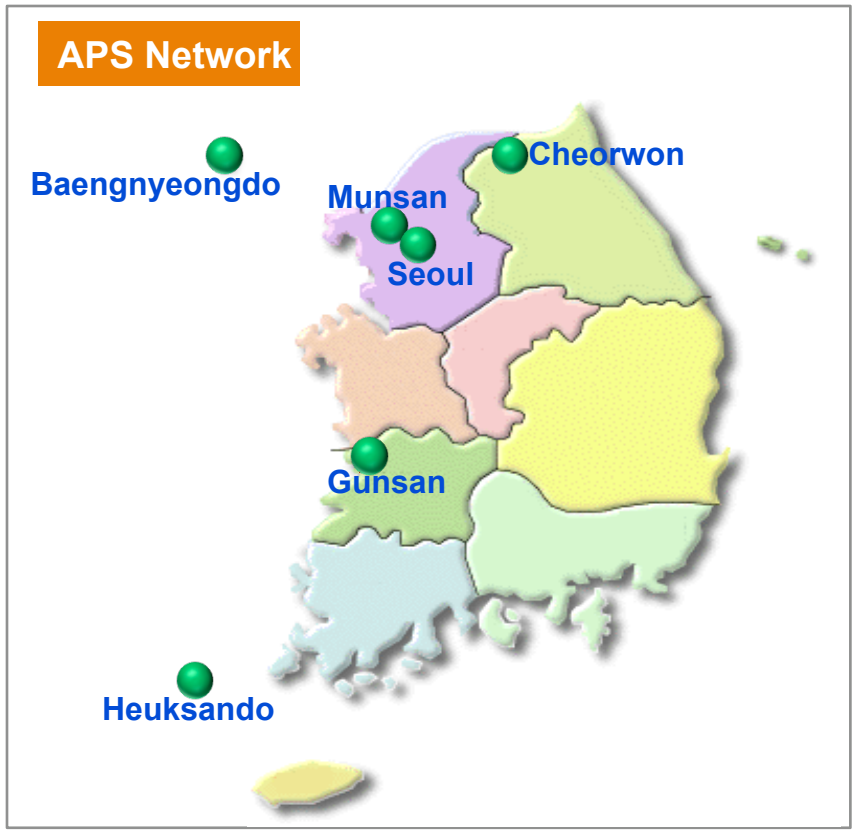
(1000)

- The elderly, the young, and those with respiratory diseases are prohibited from going outside.
- Kindergarten and elementary school students are advised against doing outdoor activities, and classes should be dismissed.
- Outdoor activities are prohibited.
- Outdoor sports events should be rescheduled.

2-1 KMA Monitoring Sites



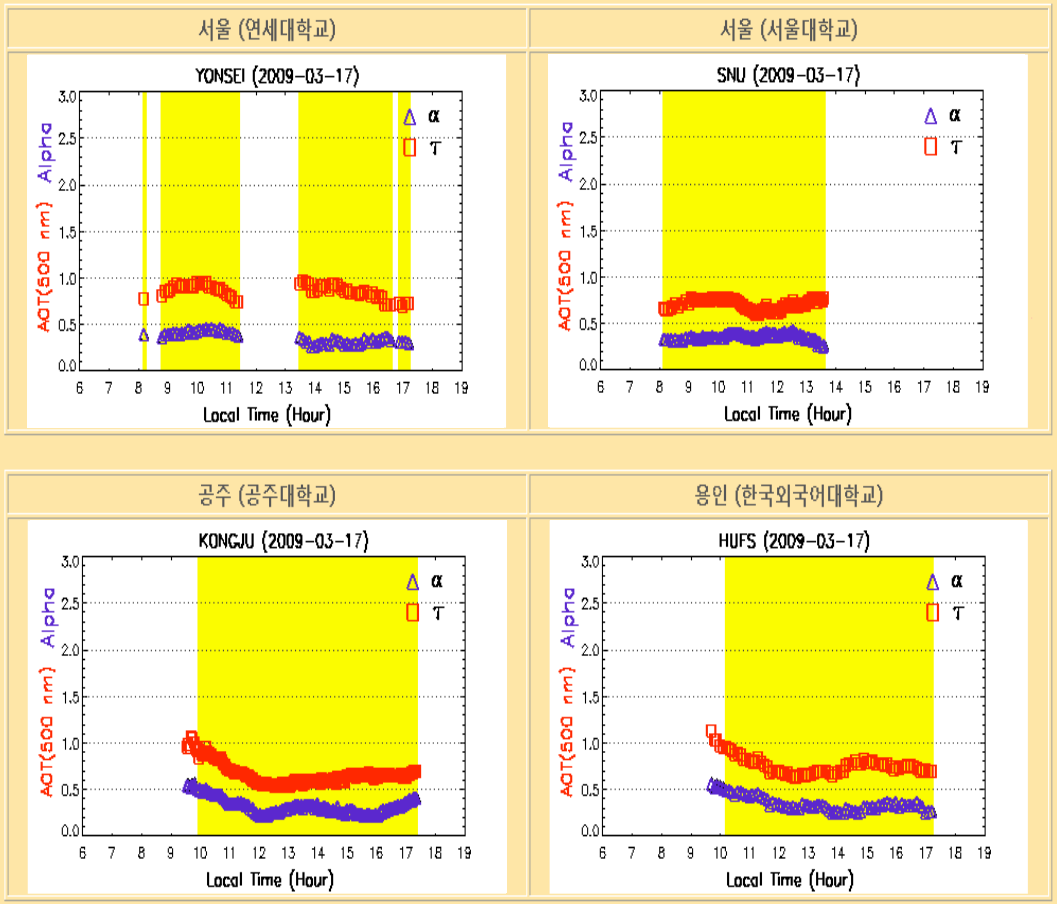
2-2 Aerosol Particle Sizer Network



- Physical properties of aerosol
- 0.25 - 32 μm, 31 channels
- PM10, PM2.5, PM1.0

2-3 Optical Observation

Skyradiometer Network

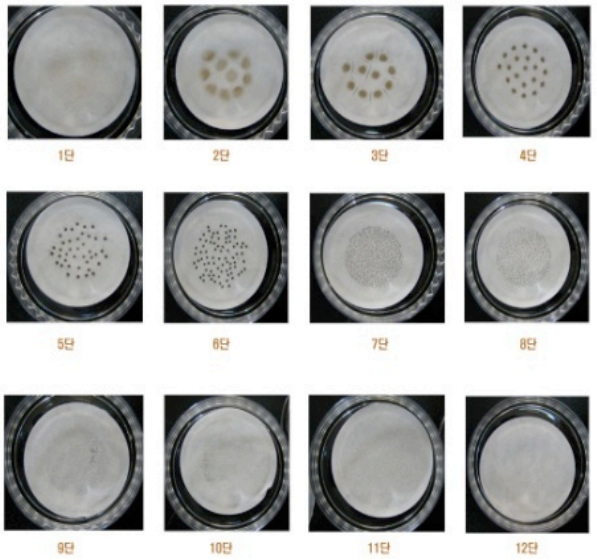


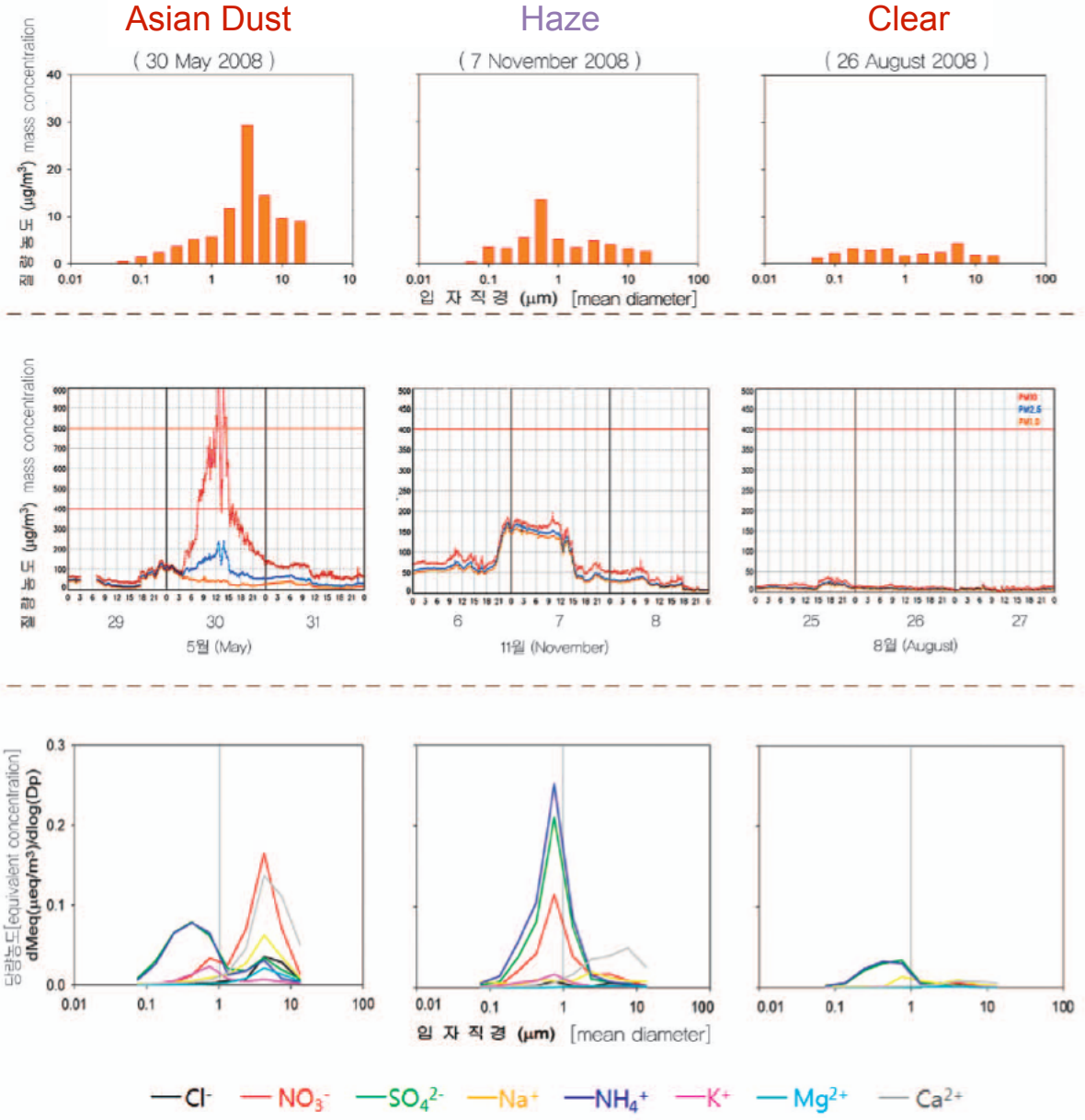
Cooperation with Prof. Sohn BJ (SNU)

- Detect Asian Dust in the higher altitude
- If Aerosol Optical Thickness > 0.5, and Angstrom Component < 0.5 then Asian Dust

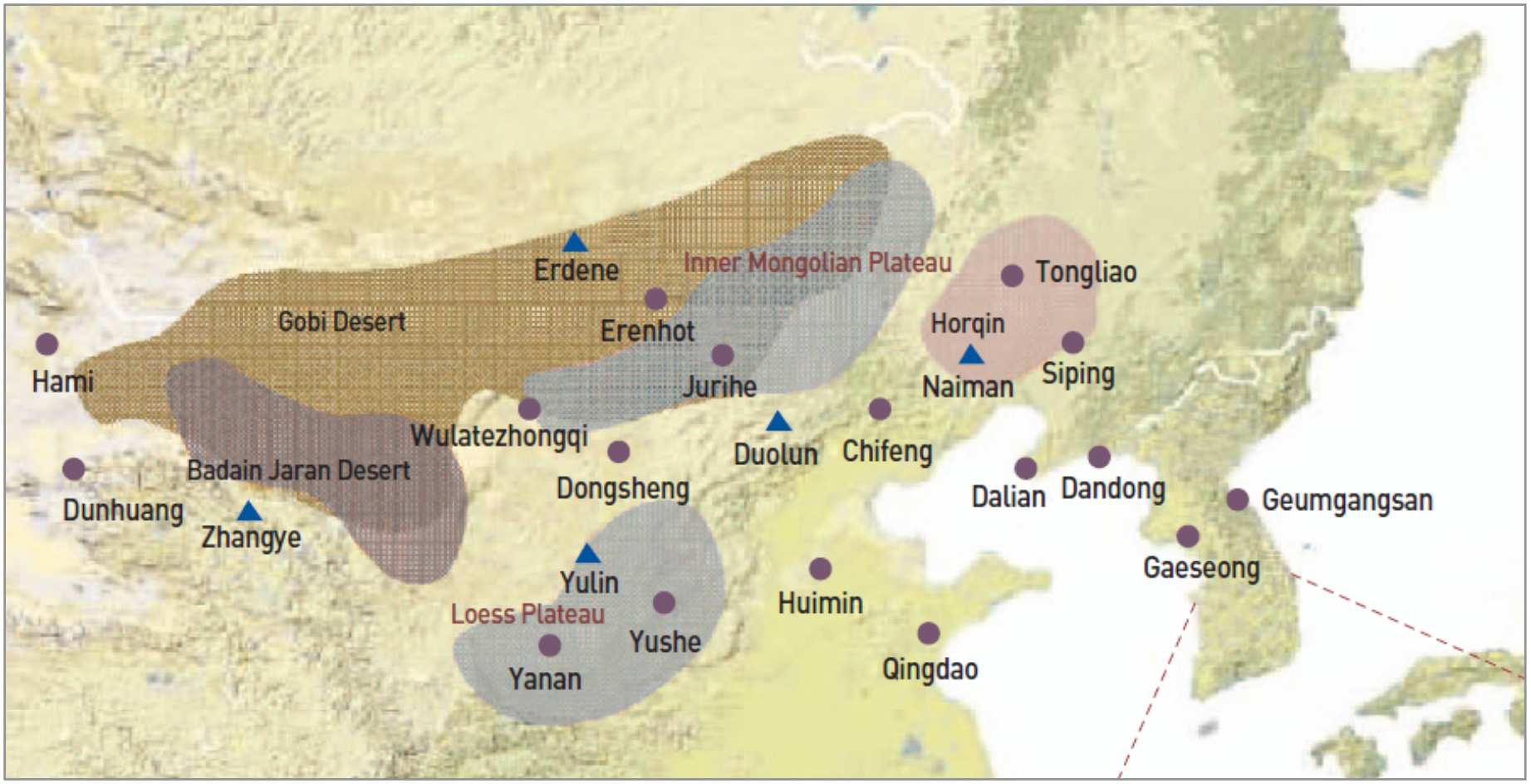
2-4 Seoul Hawngsa Monitoring Center

MOUDI 필터 [3호황사 : 16~17일 샘플링]



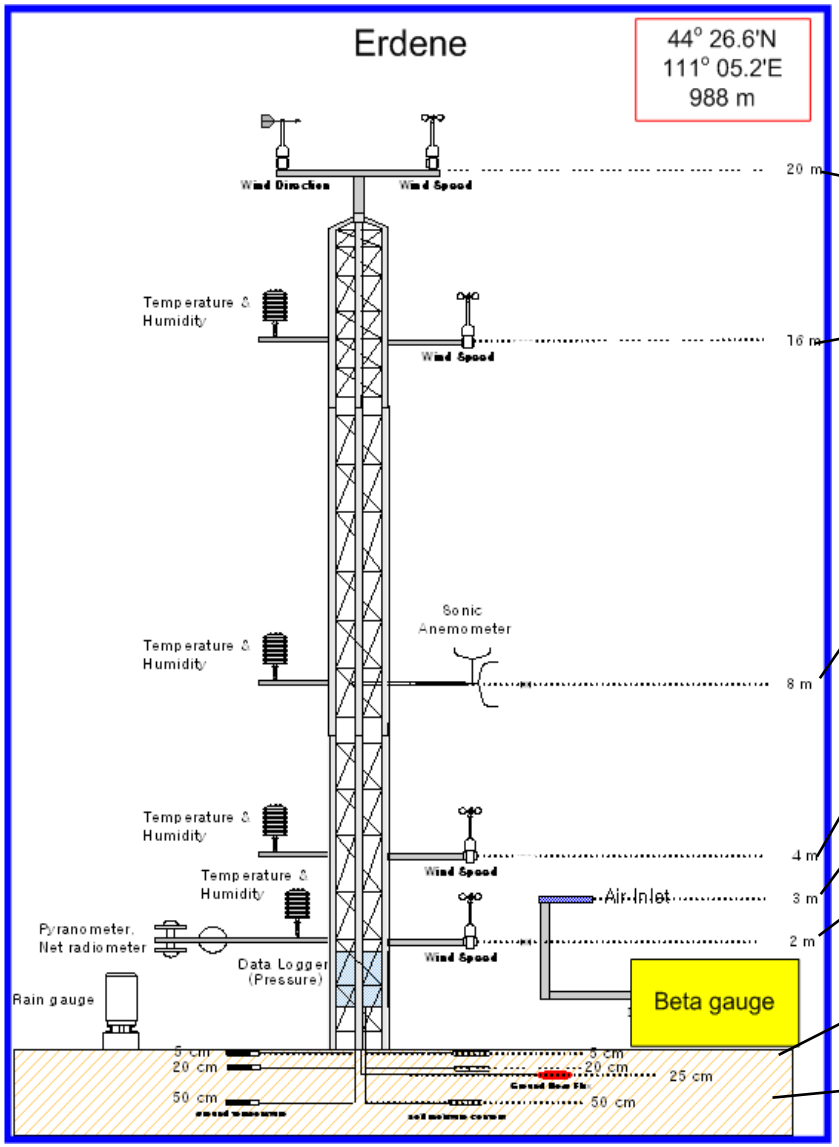


2-5 Cooperated with China Meteorological Admin.



- Real time data sharing of PM10

2-6 Cooperation with Mongolia



20m : Wind Speed, Direction

16m : Wind Direction, Temperature, Humidity

8m : Sonic anemometer, Temperature, Humidity

4m : Wind Direction, Temperature, Humidity

3 m : PM10 concentration

2m : Wind Speed, Temperature, Humidity, Solar & Net radiation, Pressure

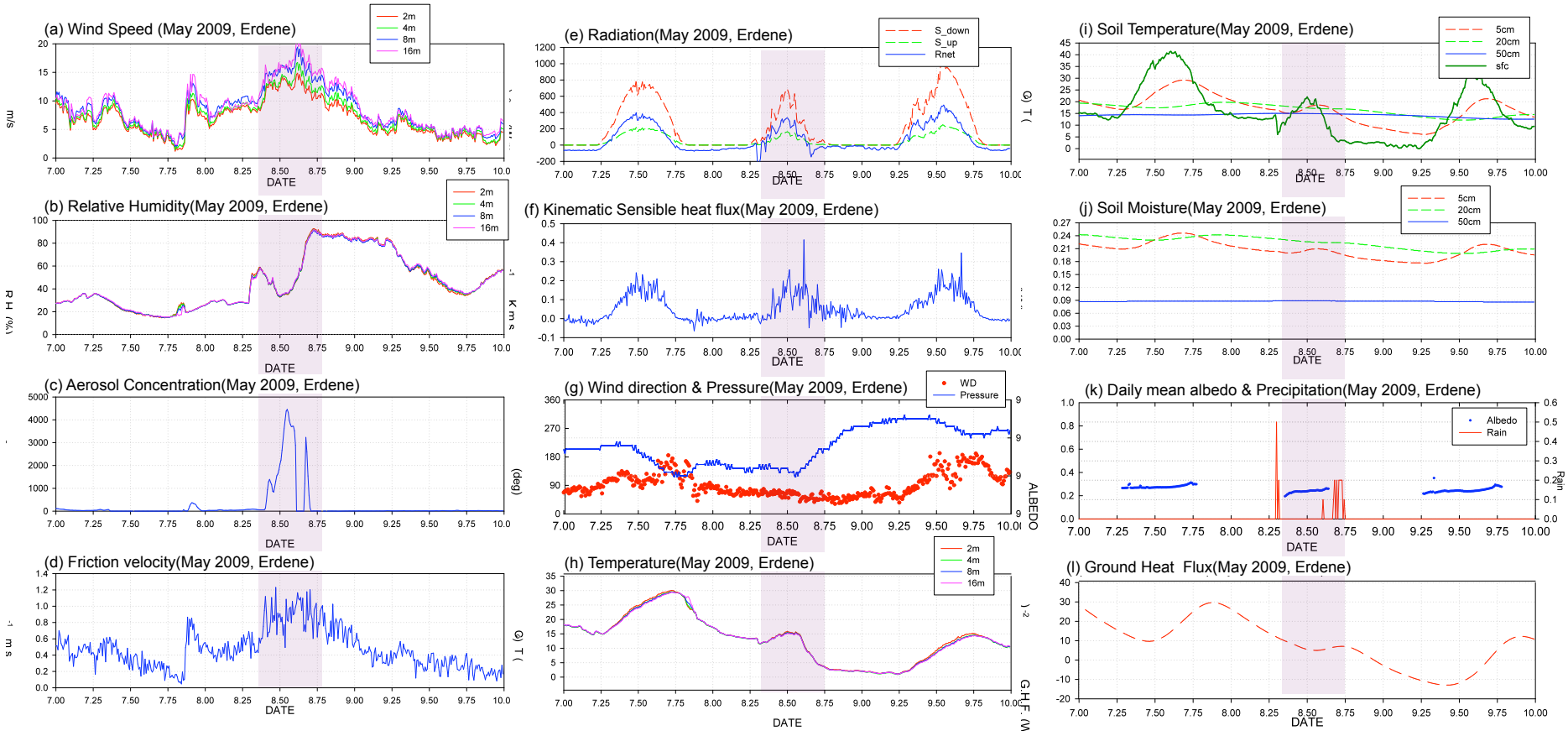
Surface : Rain gauge

Soil temperature : 5, 20, 50 cm
moisture : 5, 20, 50 cm
heat flux : 25 cm

Cooperation with Prof. Soon-Ung Park (CAEM)

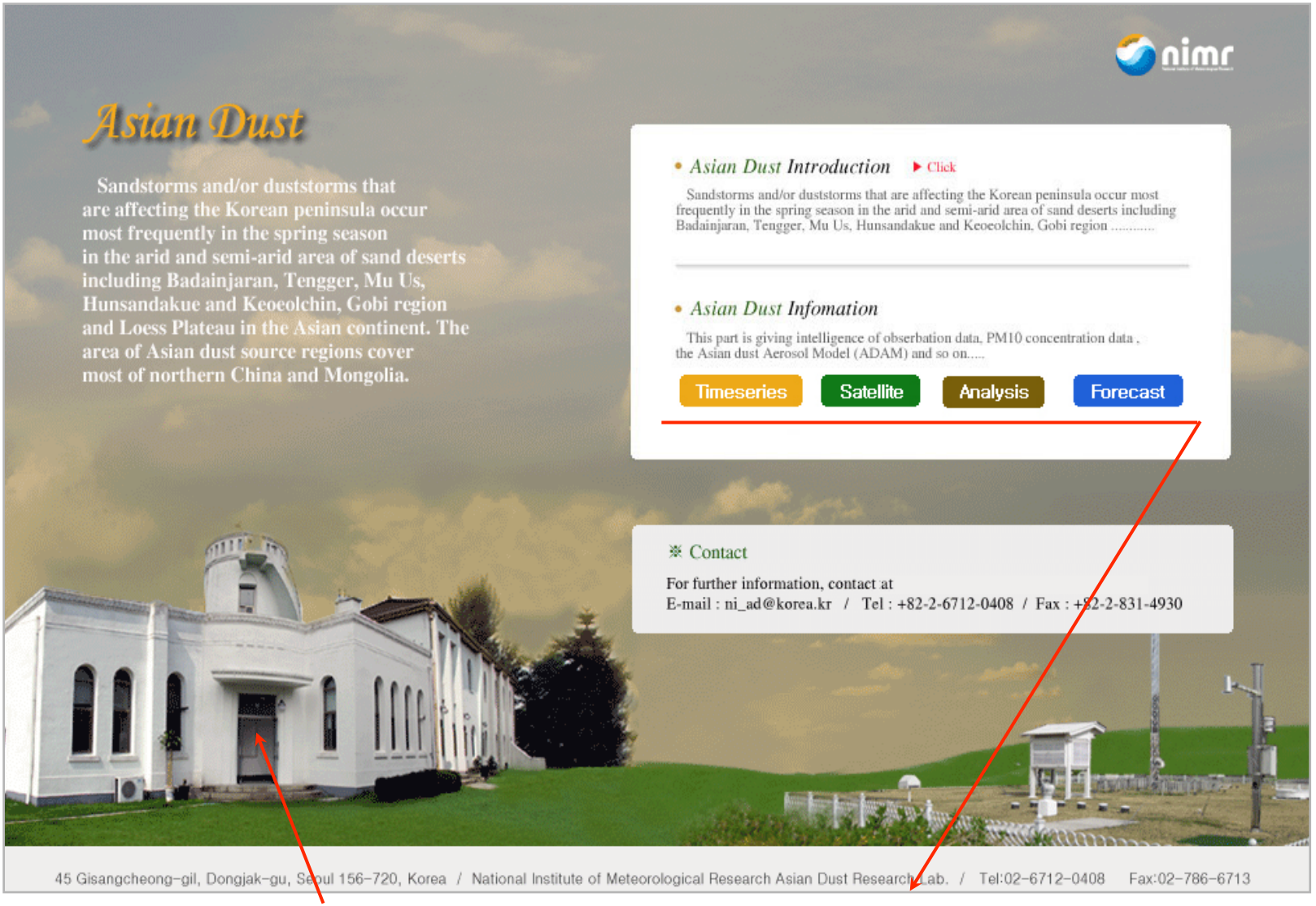
2-7 Dust storm monitoring tower in Mongolia (Erdene)

Cooperation with
Prof. S. U. Park (CAEM)



- Real time monitoring of SDS & meteorological condition for forecasting
- Parameterization of Dust Amount from meteorological data for ADAM

3-1 Early Warning system



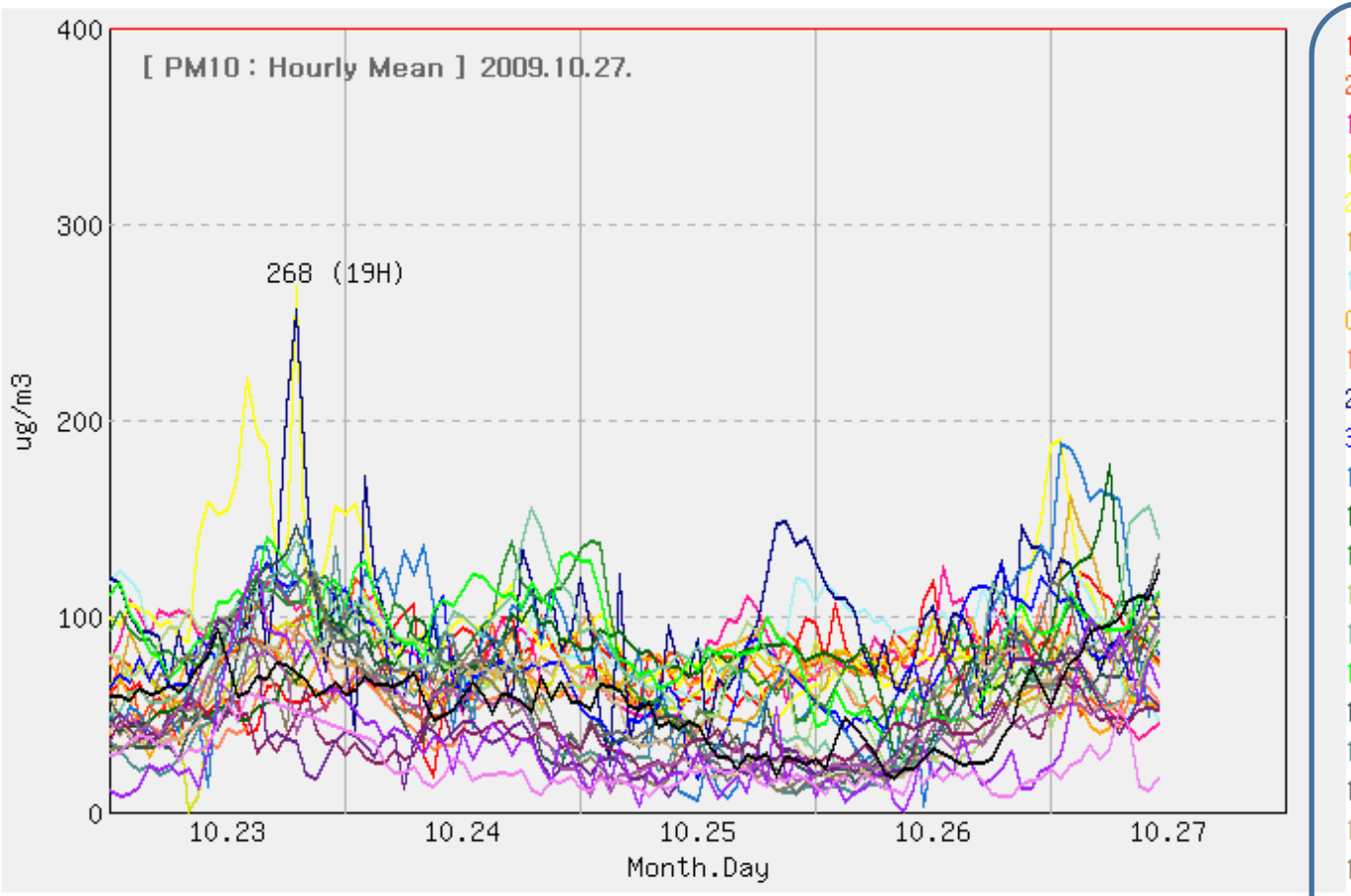
Seoul Hwangsa Monitoring Center

Menu Buttons (4 items)
Time Series / Satellite
Analysis / Forecast

Asian Dust Information / Timeseries

Print

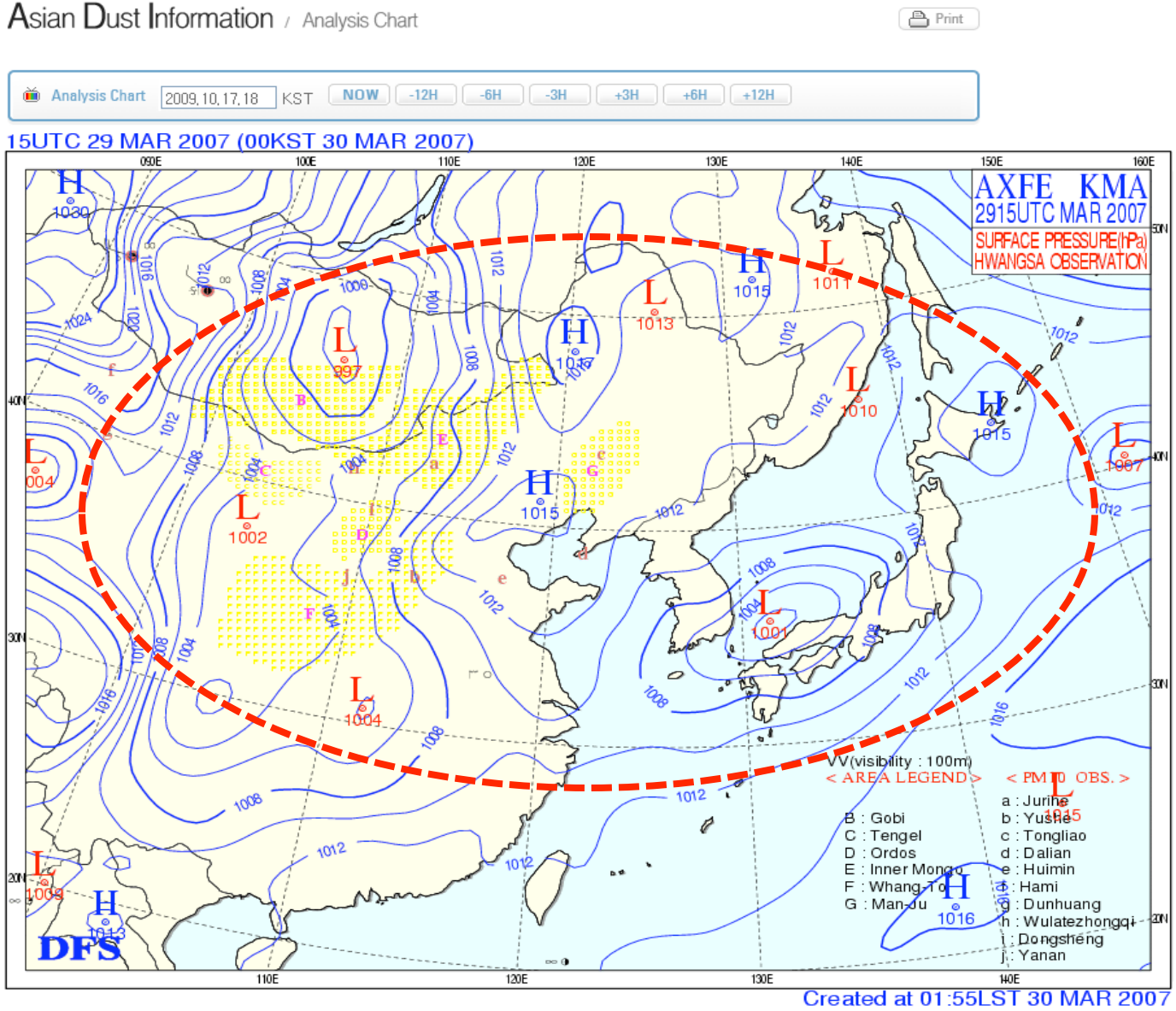
Analysis Chart [All] Timeseries 2009.10.27. NOW -3D -2D -1D +1D +2D +3D



In total, 28 sites

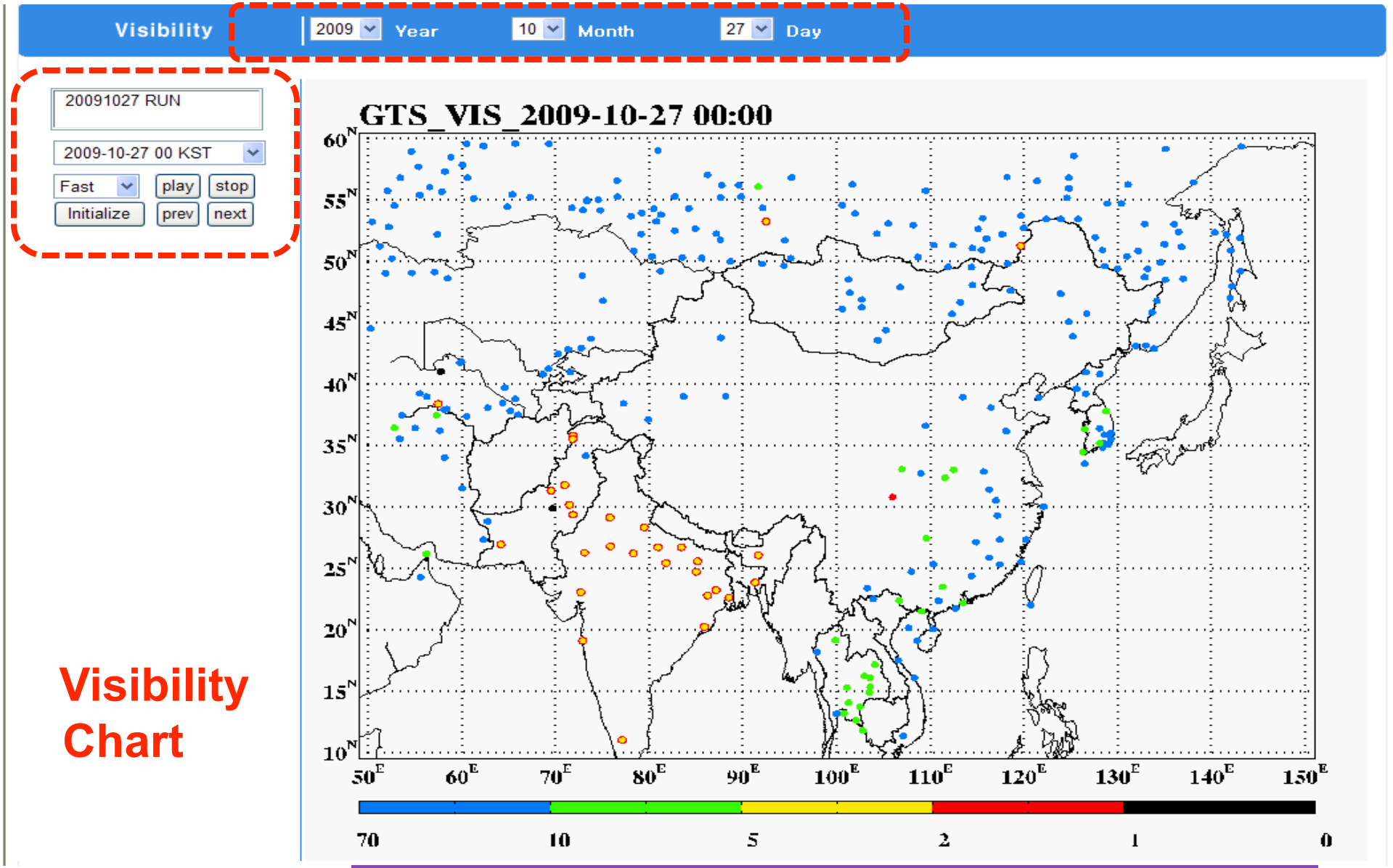
102 Baengnyeongdo
201 Ganghwa
116 Gwanaksan
108 Seoul
229 Gyegryelbi-do
132 Anmyon-do
119 Suwon
094 Gwangdeoksan
101 Chuncheon
232 Cheonan
399 Ceongwon
135 Chupungnyeong
169 Heuksando
140 Gunsan
175 Jindo
146 Jeonju
156 Gwangju
121 Yeongwol
136 Andong
143 Daegu
192 Jinju
160 Pusan
090 Sokcho
100 Daegwallyeong
152 Ulsan
277 Yeongdeok
115 Ulleungdo
185 Gosan

[Hourly average of PM10 concentrations in Korea]



Hwangsa Weather Chart

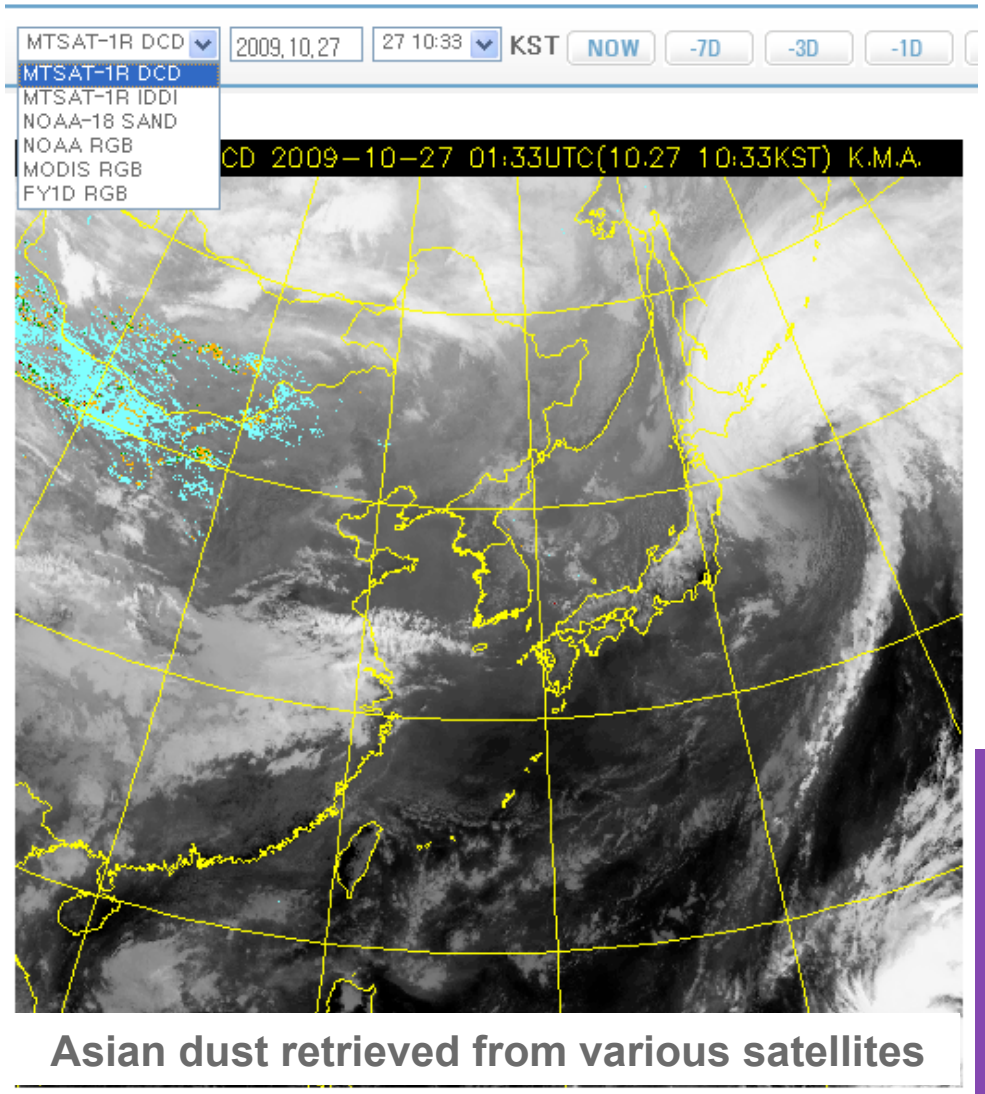
- Dust information obtained through naked eye observation which was collected via WMO GTS every 3 hours.
- This is very useful in recognizing the geographical location of dust plume.
- The data cannot be correct during the nighttime.



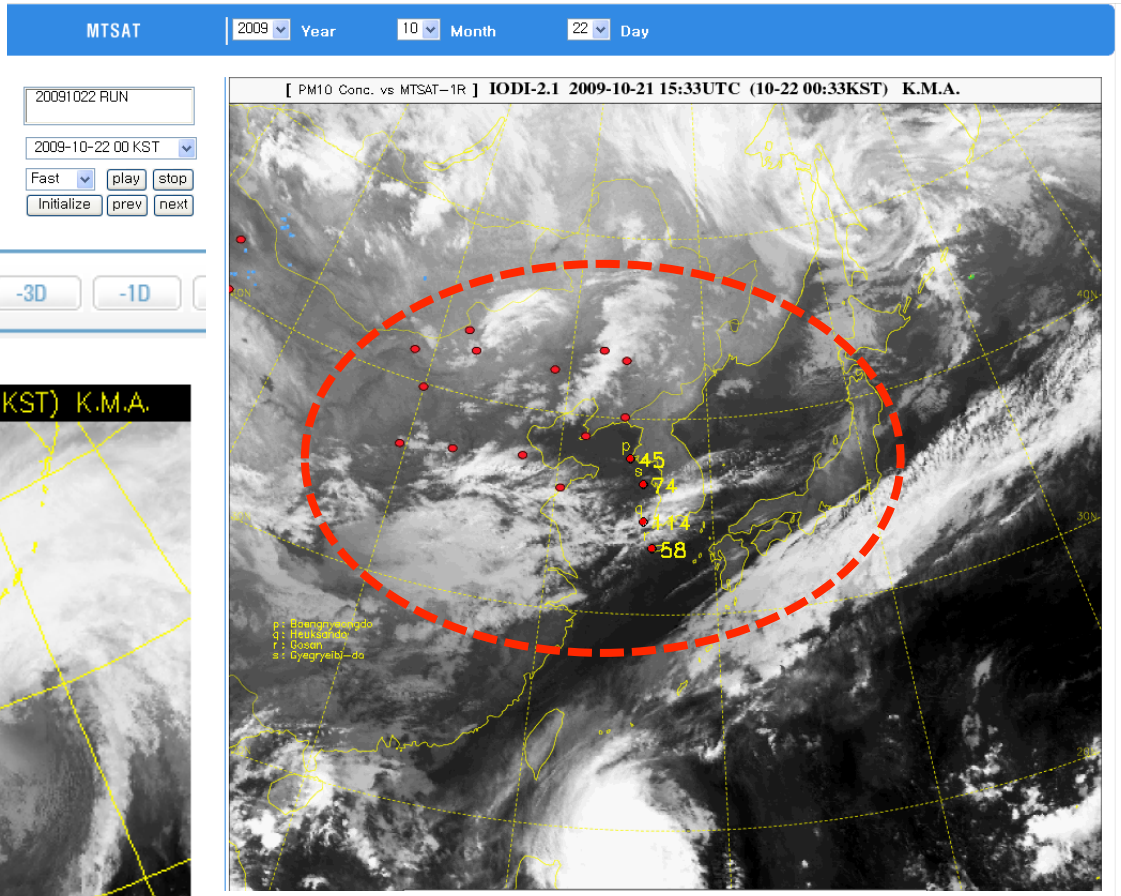
Visibility Chart

The visibility info in the WMO code in 3 hr intervals

Satellite Images

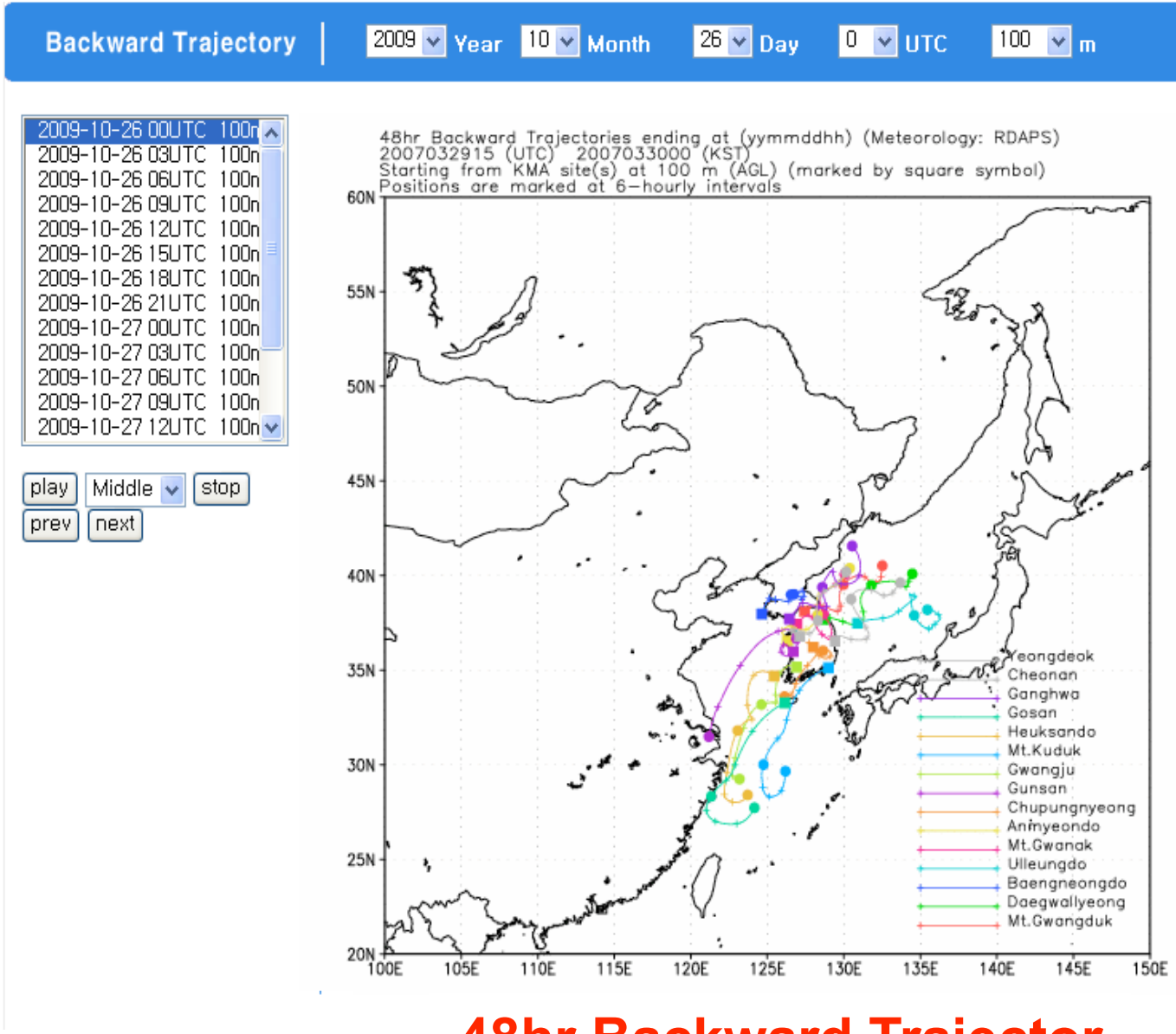


Asian dust retrieved from various satellites



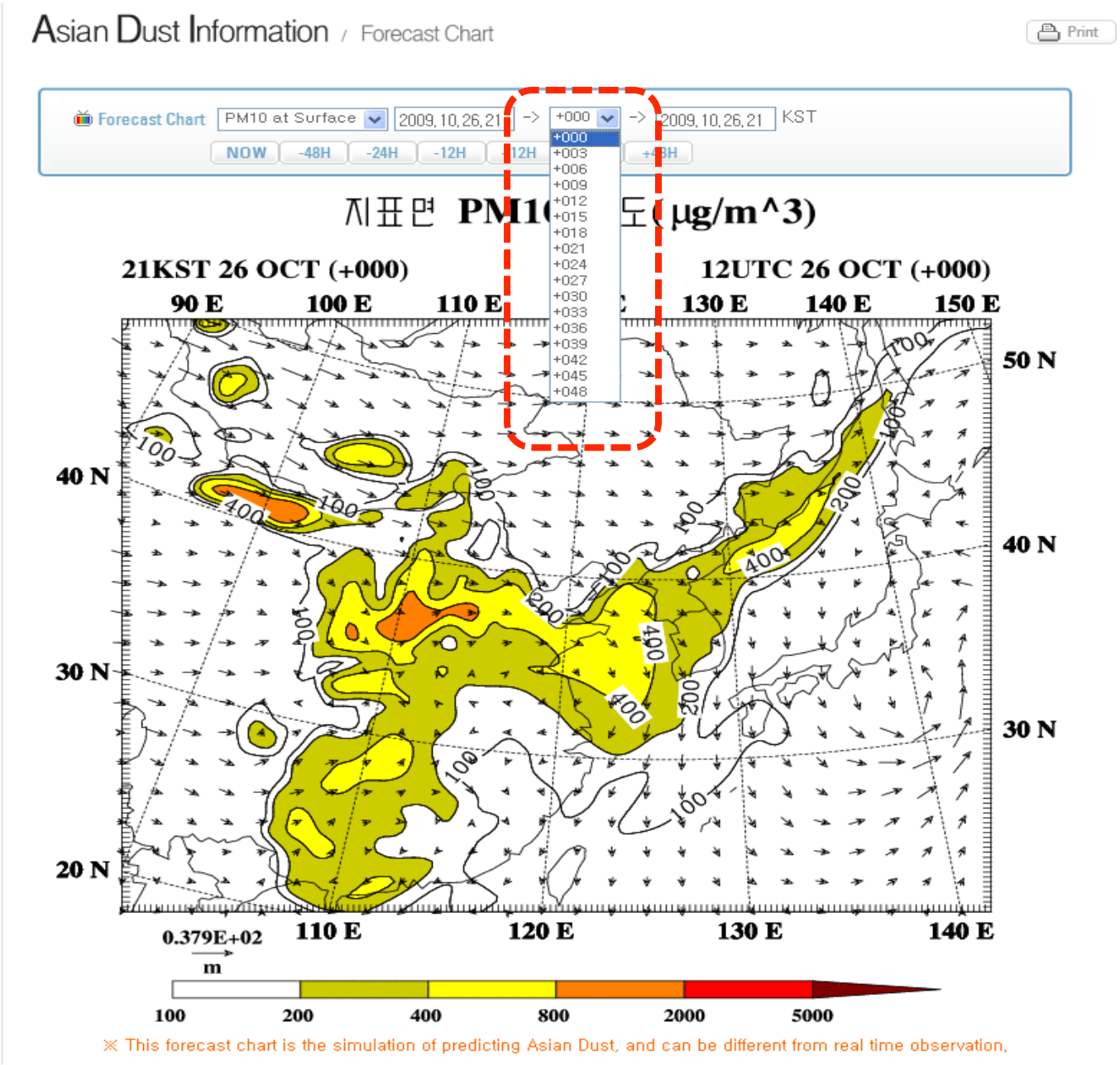
Satellite Images combined with PM10 in Korea

- Dust plumes are not well detected by the satellite observations.
- The dust plume confined in the PBL is seldom observed via satellite detection.



48hr Backward Trajectory Chart

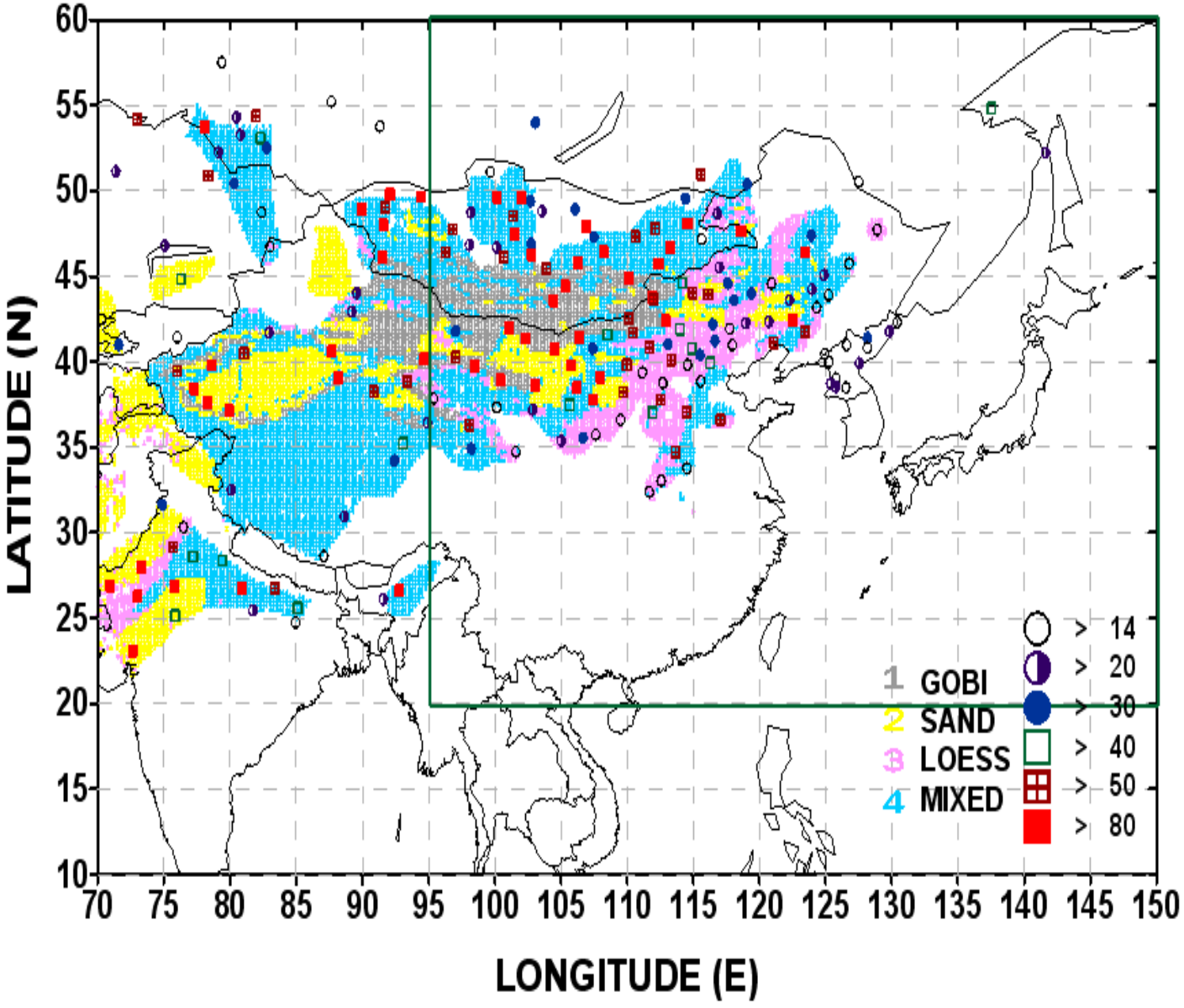
- The backward air trajectories are dramatically changed along with the passage of dust plume.
- The backward trajectory analysis is useful in identifying the source region of dust plume.
- Using NOAA/HYSPLIT Model



Asian Dust concentration Forecast

- Asian Dust and Aerosol Model (ver. 1) is used for dust forecasting in KMA .
- ADAM is driven by the KMA's regional operational weather model,

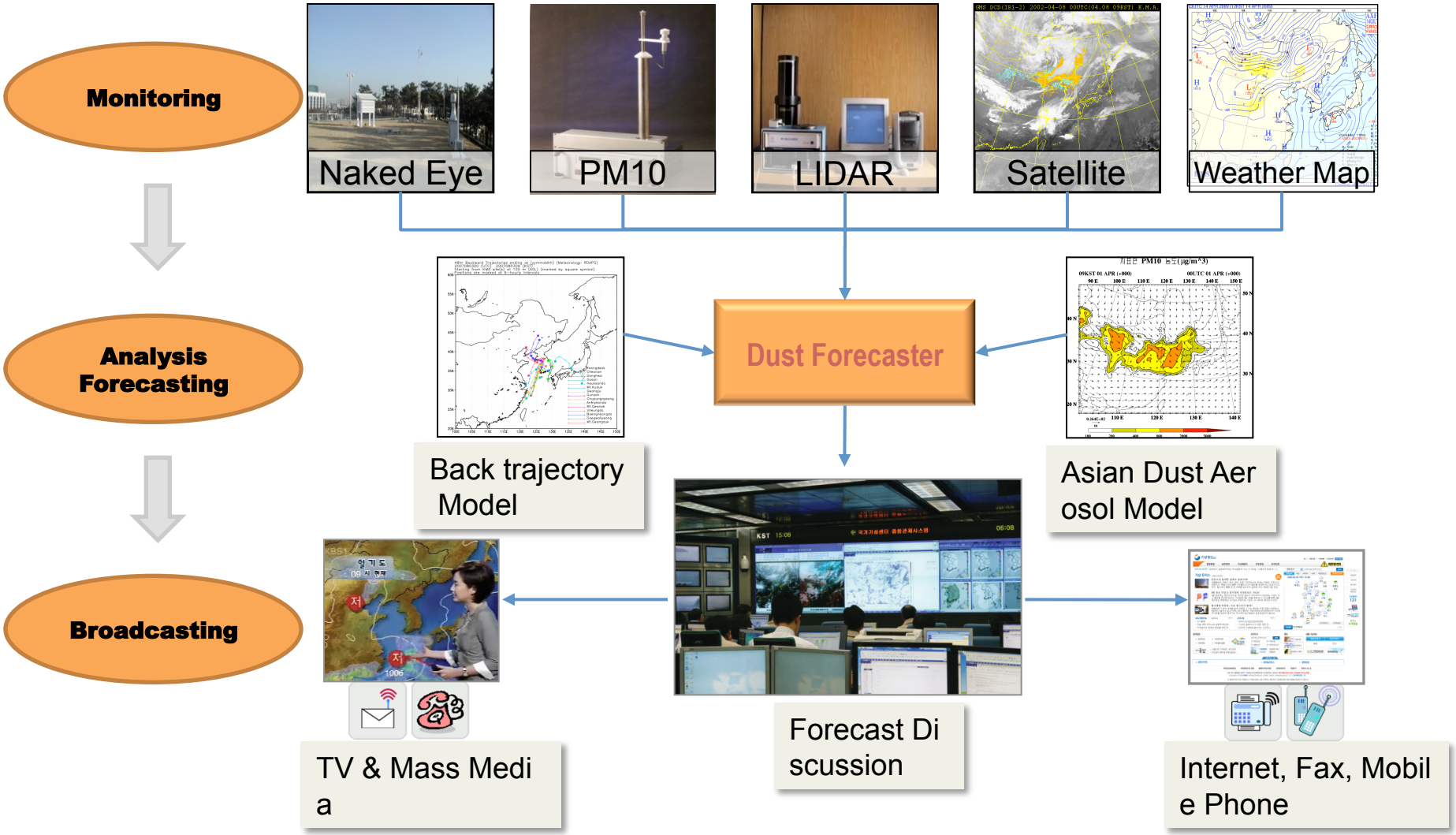
  RDAPS(Regional Data Assimilation and Prediction System) which was developed based on the MM5, twice a day at 00 and 12UTC.
- The surface chart of PM10 concentrations is provided in 3hr intervals.



Expansion of ADAM domain

- By early 2010, KMA plans to adopt UKMO's UM(Unified Model) system as the new global and regional weather forecasting system.
- Using the Global UM output operated at the KMA, we extend the model domain of ADAM to enable it to cover some parts of Central, South, and Southeast Asia. (UM-ADAM)
- we plan to replace the current ADAM with ADAM ver. 2 in the year 2010.

3-2 Early Warning System



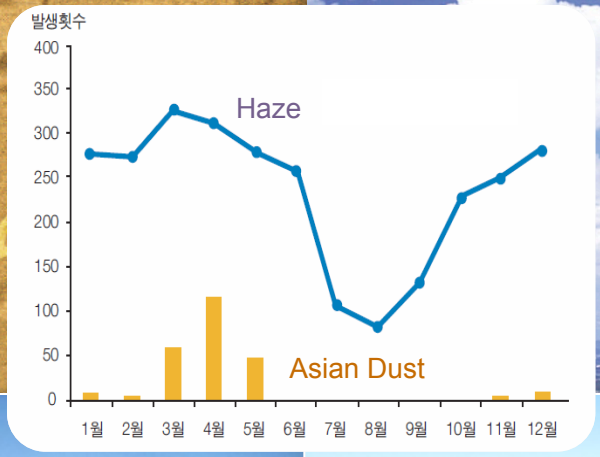
Asian Dust

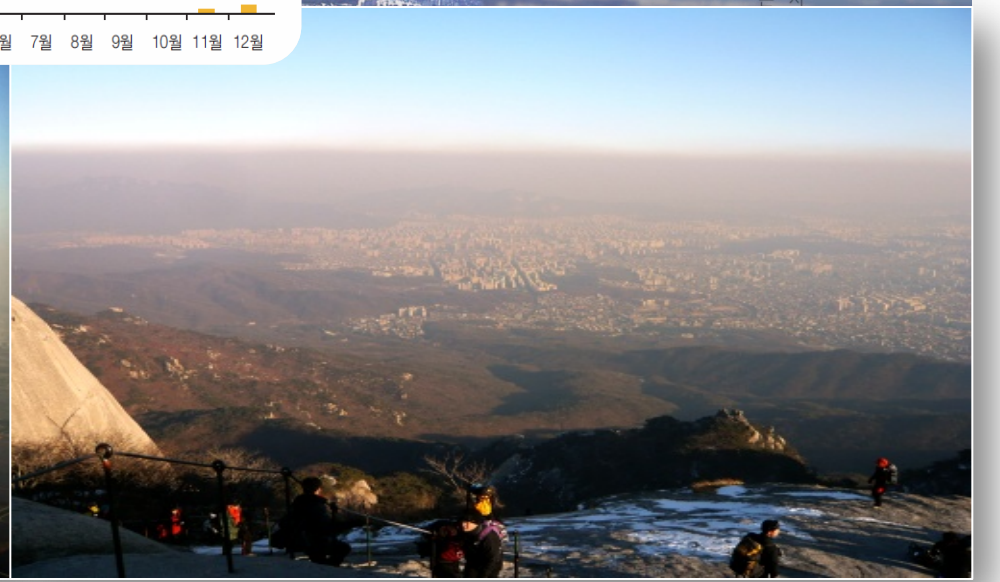
Haze

연무

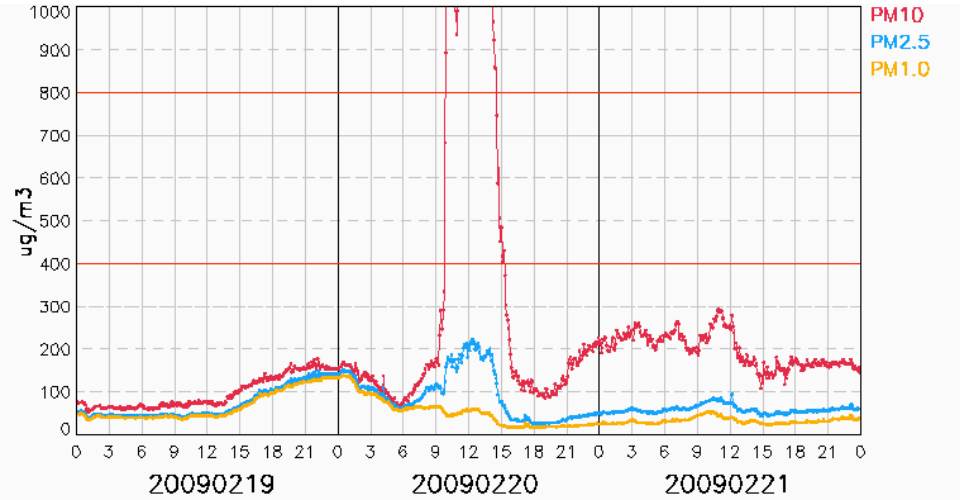
煙霧

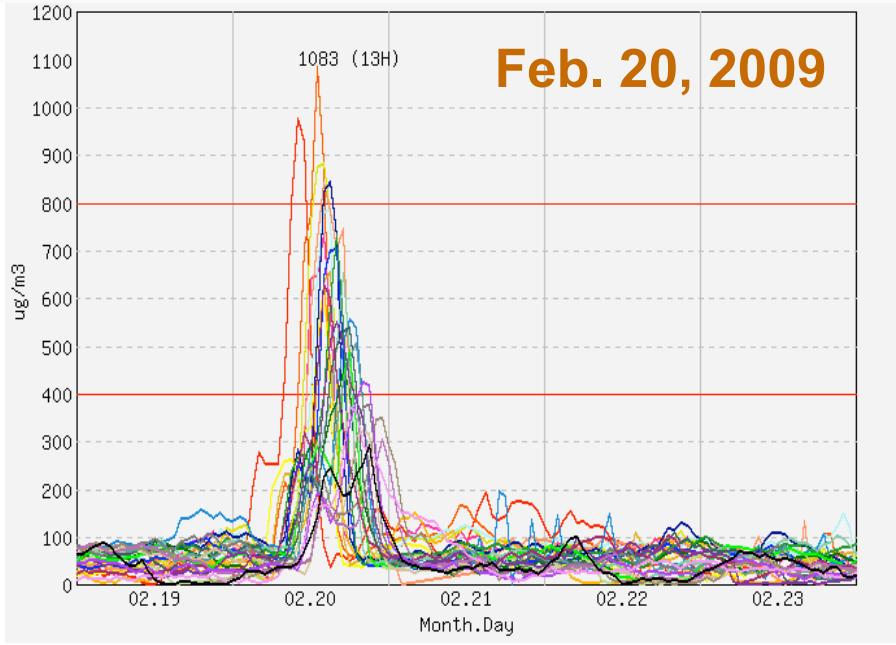
공기 중에 떠 있는 미세한 먼지
안개 낀 것처럼 뿌옇게 보이는



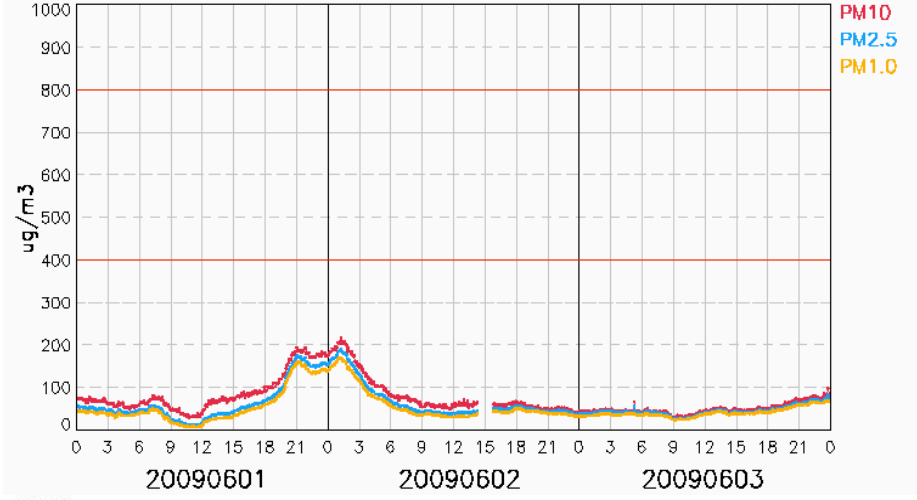


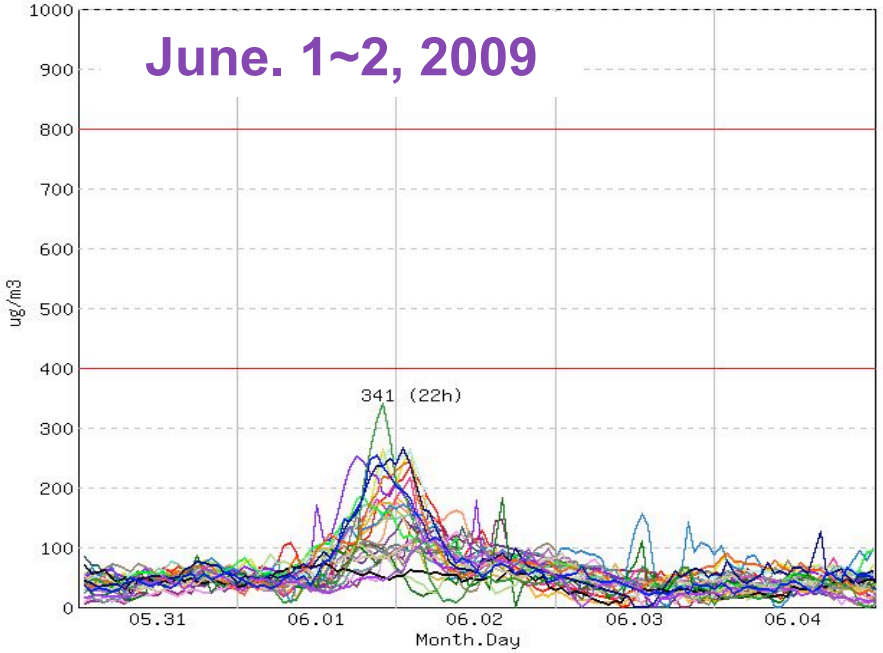
Seoul PM10 >> PM2.5





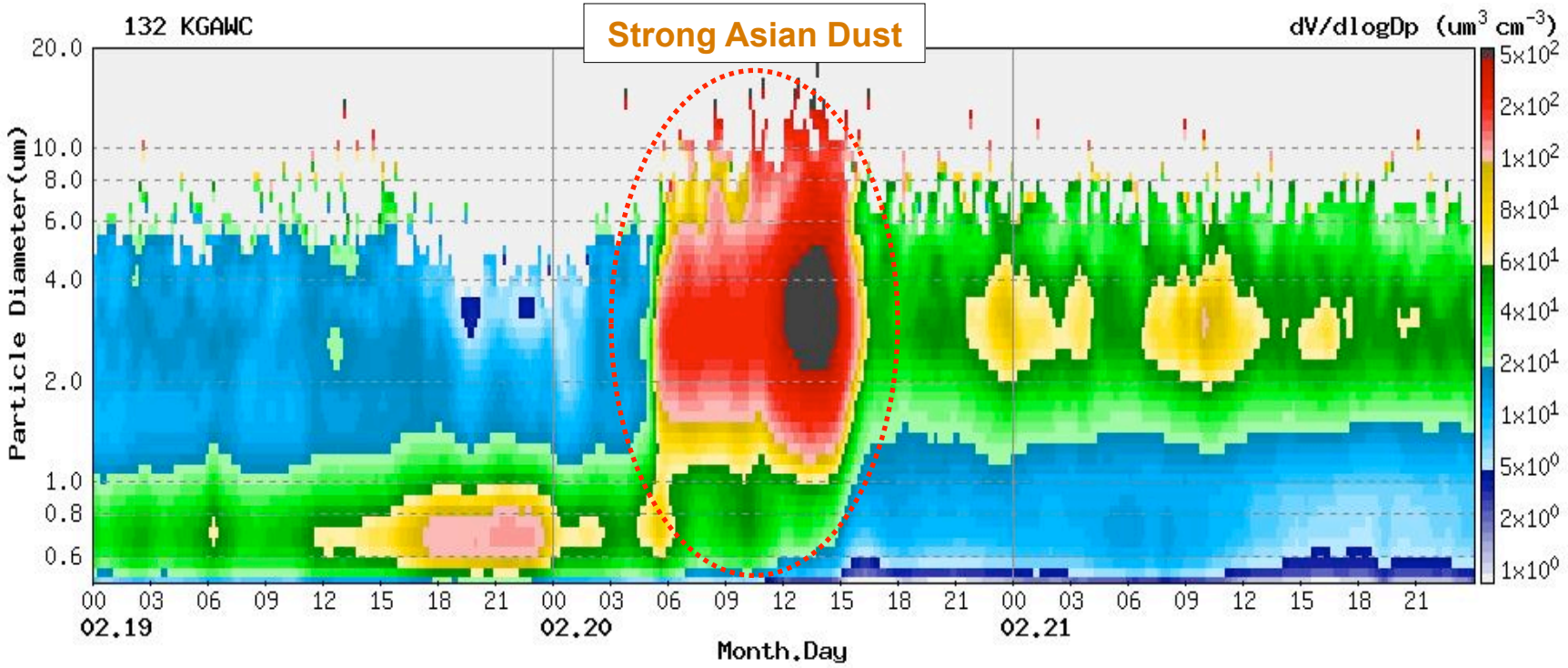
Seoul PM10 > PM2.5





Typical temporal variation of hourly average of PM10 concentrations in Korea during Asian dust and haze period

Asian Dust (February 19~21, 2009)

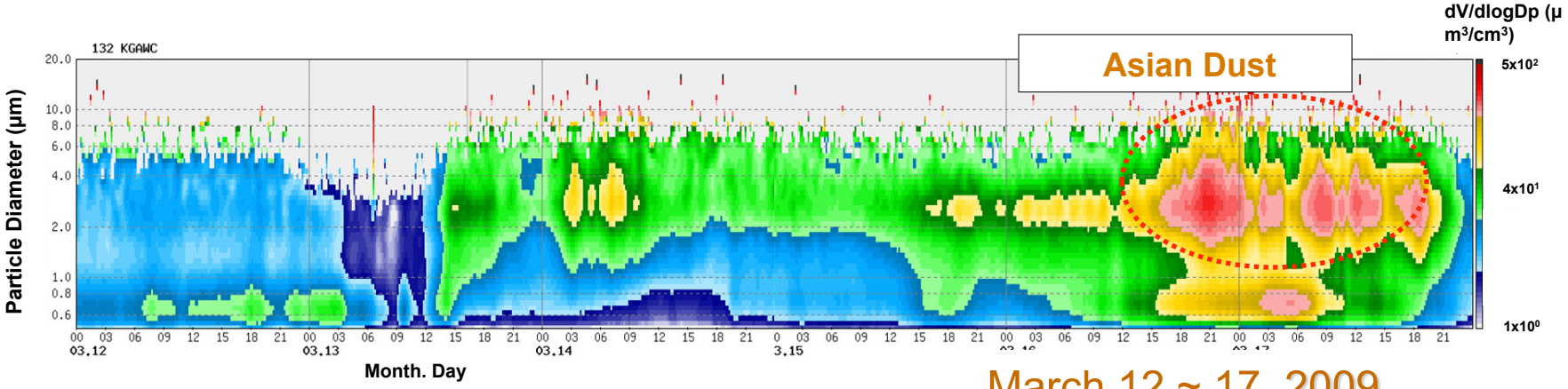


Anmyeon-do, Korea

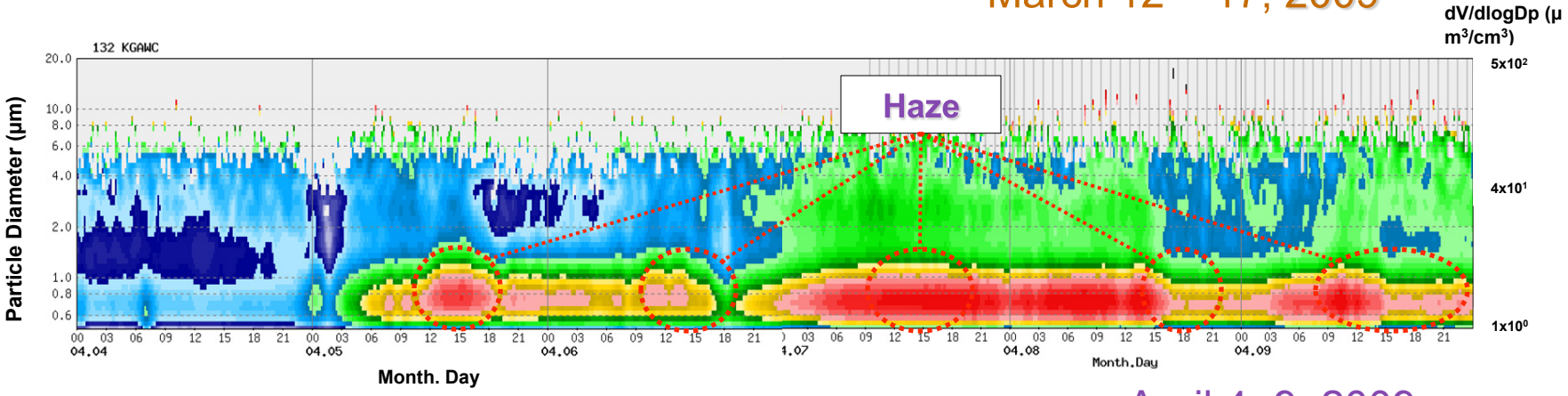
Asian Dust & Haze (Anmyeon-do, Korea)

Distinction of "Asian Dust" and "Haze": Measured by Aerodynamic Particle Sizer, TSI

- **Asian Dust: 2~6 μm**
- **Haze: ≤ 1 μm**

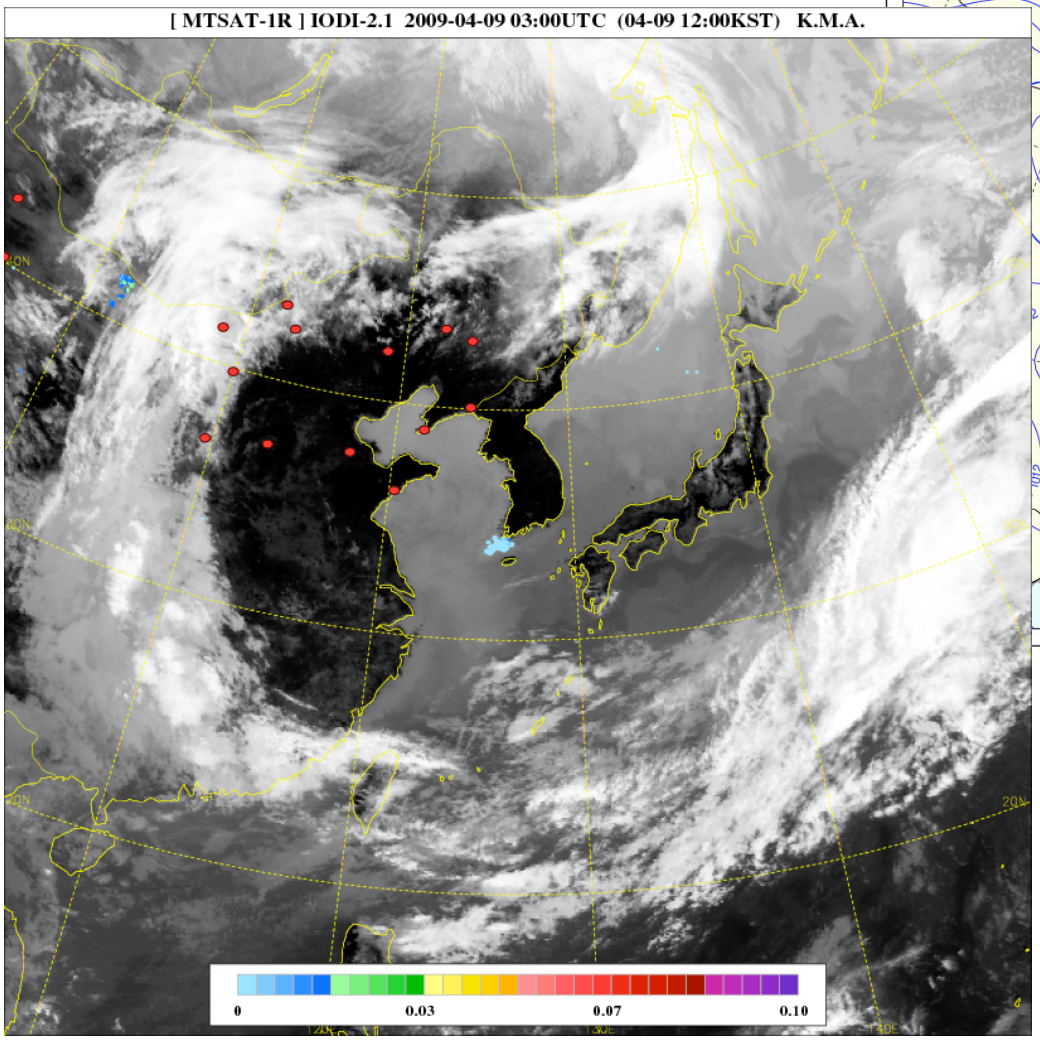


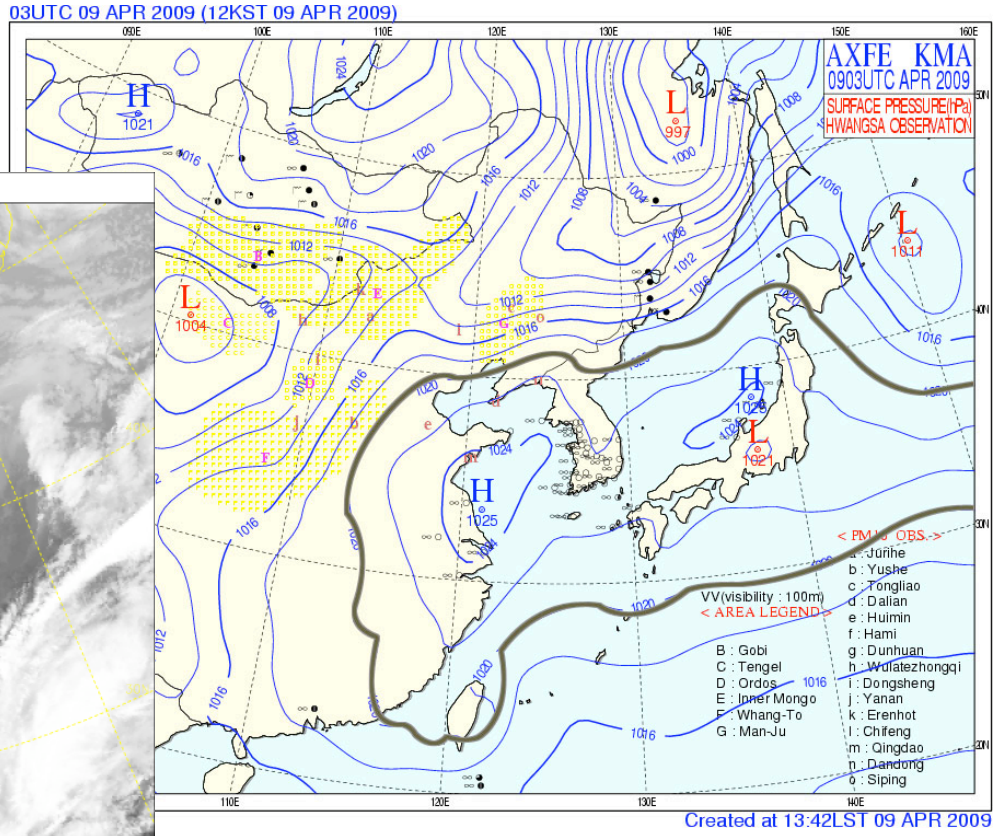
March 12 ~ 17, 2009



April 4~9, 2009

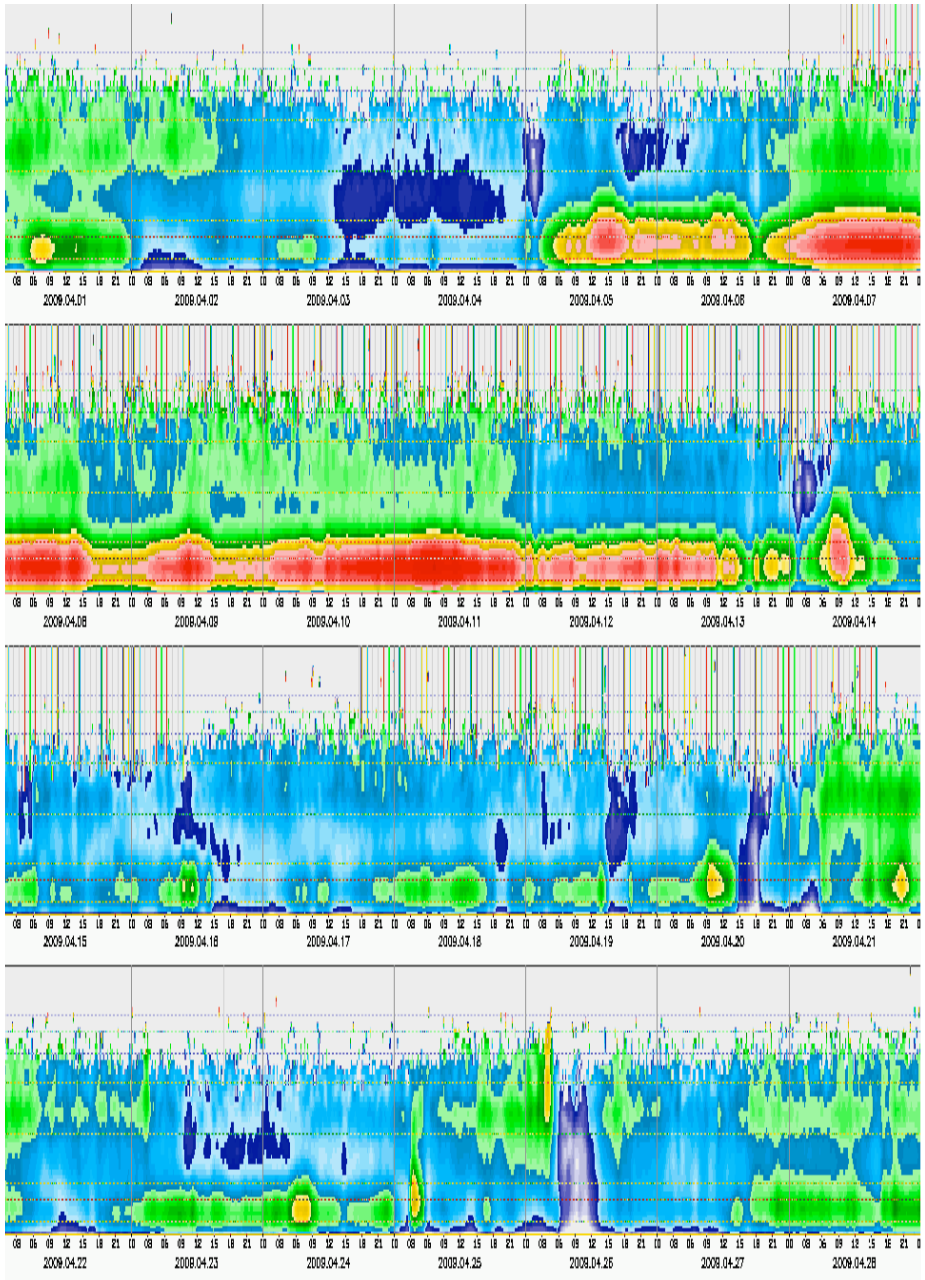
Haze in April 2009



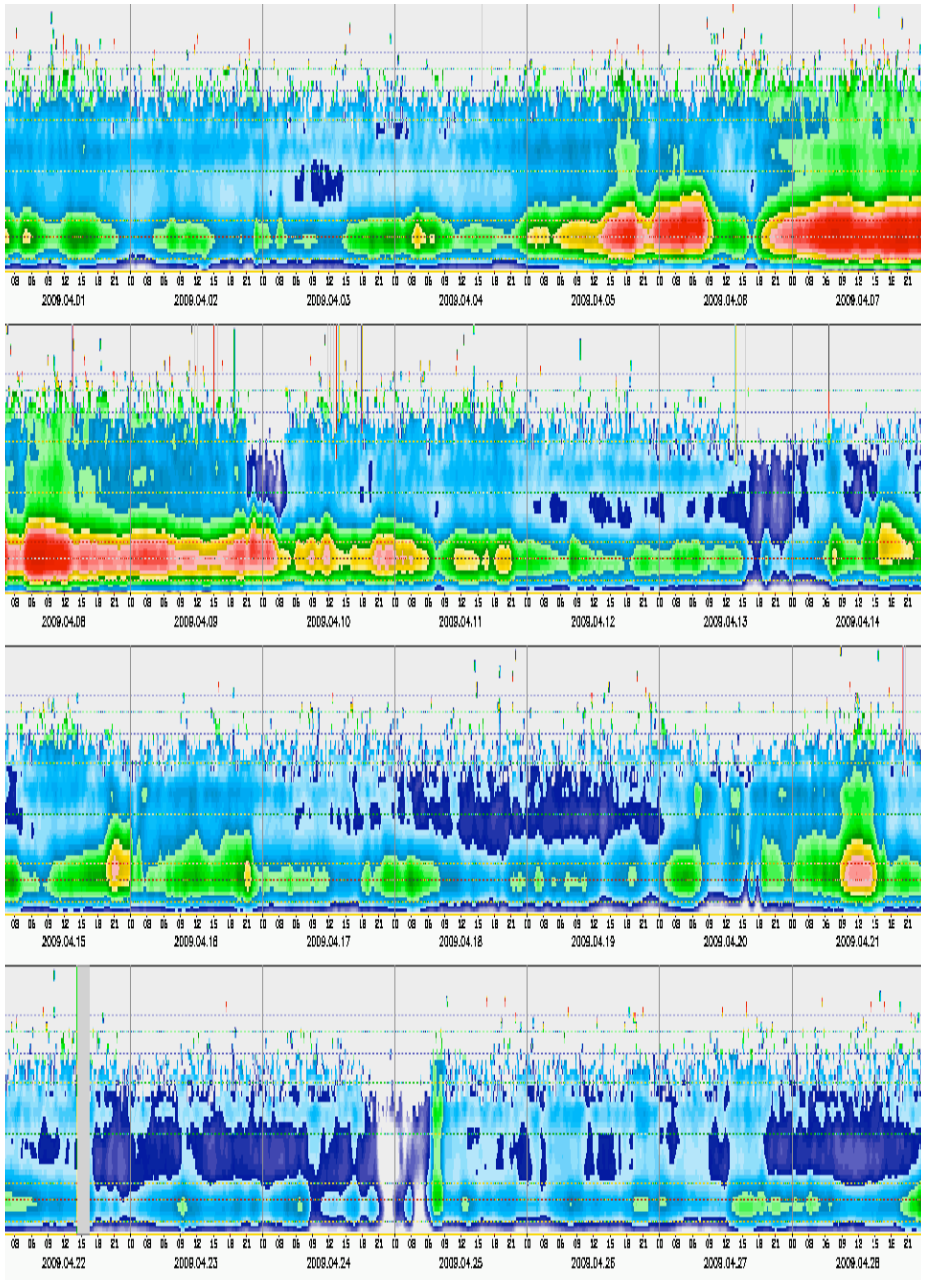


April 2009

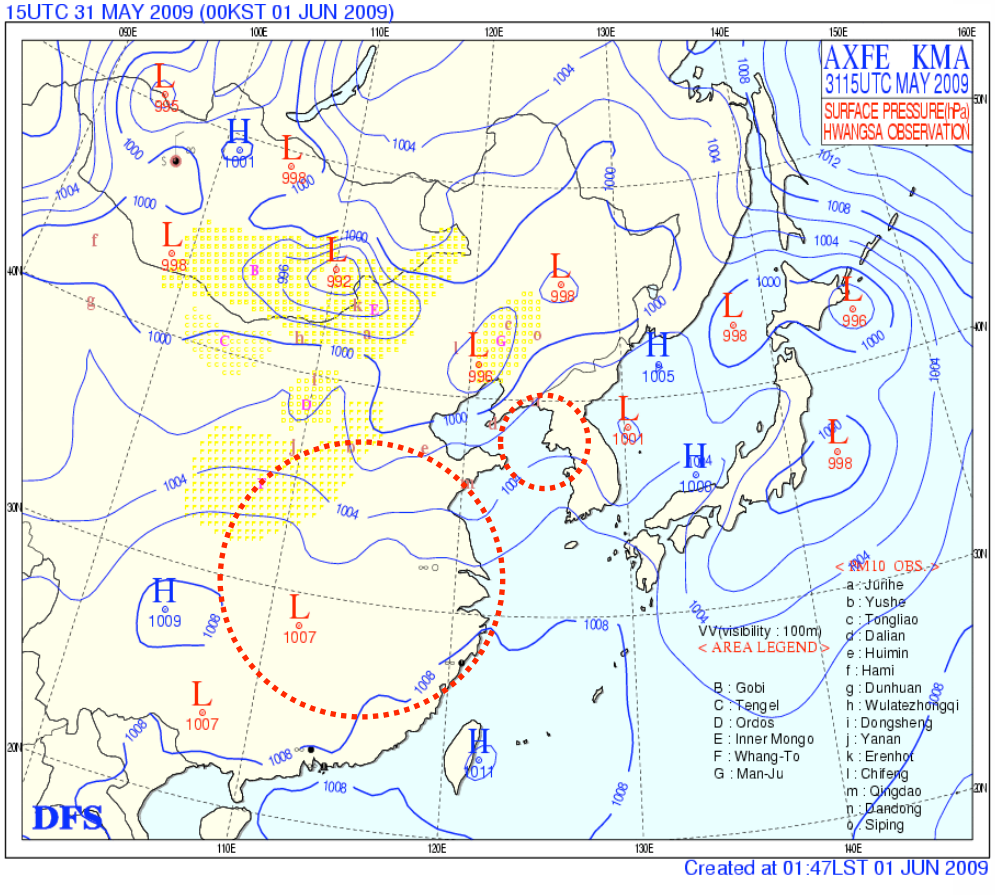
Anmyeondo

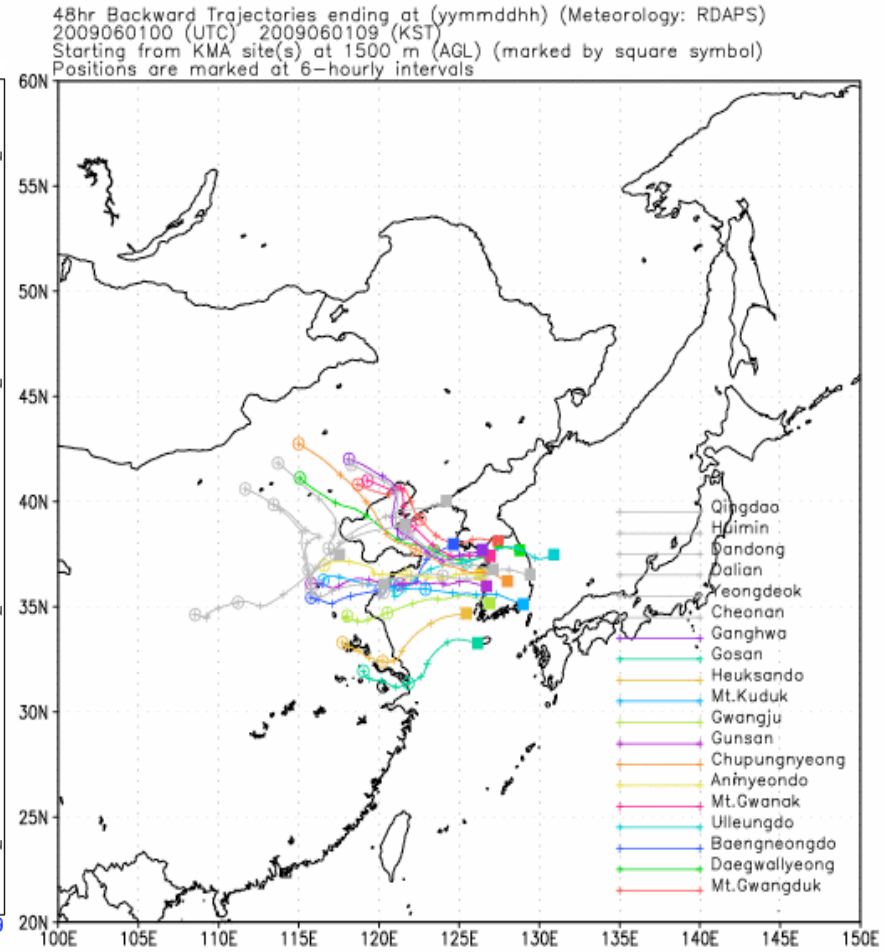


Gosan

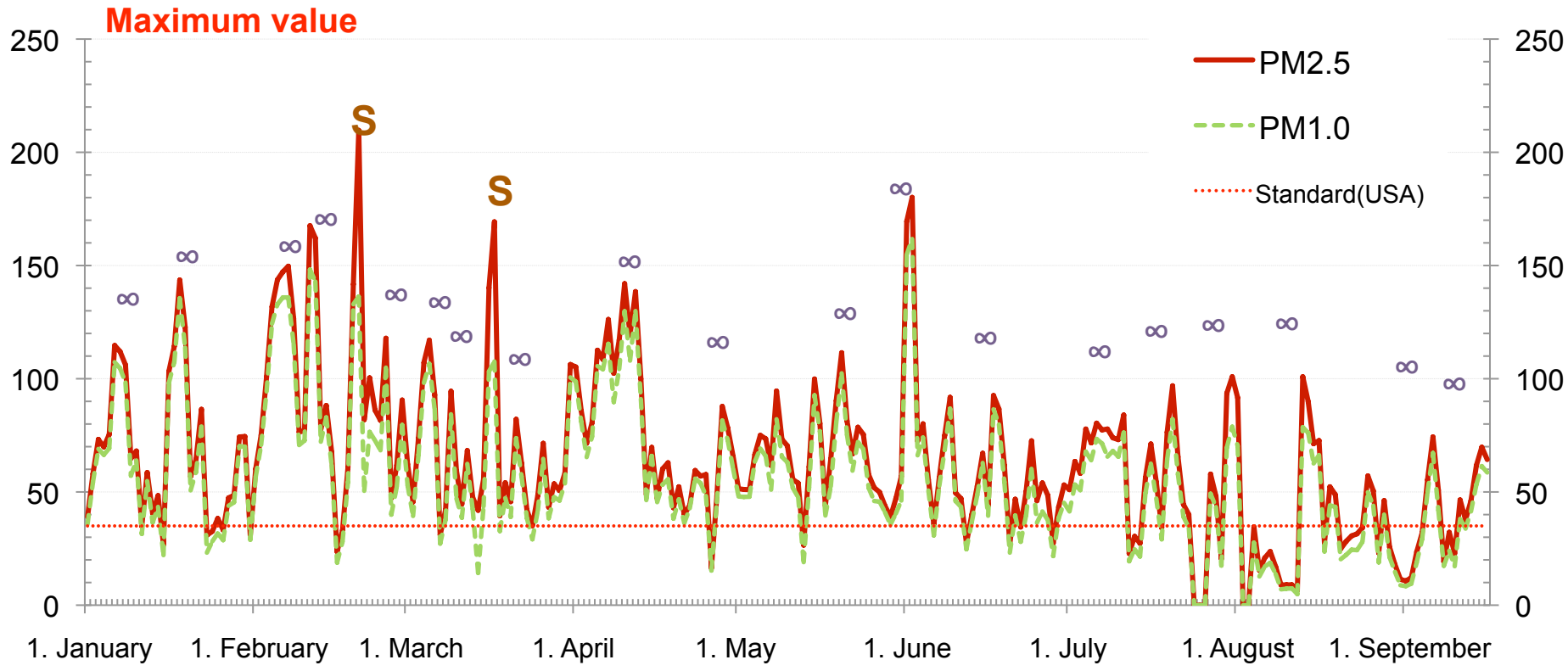


June 2009∞


15UTC 31 MAY 2009 (00KST 01 JUN 2009)
AXFE KMA
3115UTC MAY 2009
SURFACE PRESSURE(hPa)
HWANGSA OBSERVATION
VV(visibility : 100m)
< AREA LEGEND >
B : Gobi
C : Tengel
D : Ordos
E : Inner Mongo
F : Whang-To
G : Man-Ju
< KMA OBS >
a : Jurihe
b : Yushe
c : Tongliao
d : Dalian
e : Huimin
f : Hami
g : Dunhuan
h : Wulatezhongqi
i : Dongsheng
j : Yanan
k : Erenhot
l : Chifeng
m : Qingdao
n : Dandong
o : Siping
DFS
Created at 01:47LST 01 JUN 2009


48hr Backward Trajectories ending at (yymmddhh) (Meteorology: RDAPS)
2009060100 (UTC) 2009060109 (KST)
Starting from KMA site(s) at 1500 m (AGL) (marked by square symbol)
Positions are marked at 6-hourly intervals
Qingdao
Huimin
Dandong
Dalian
Yeongdeok
Cheonan
Ganghwa
Gosan
Heuksando
Mt.Kuduk
Gwangju
Gunsan
Chupungnyeong
Anmyeondo
Mt.Gwanak
Ulleungdo
Baengneongdo
Daegwallyeong
Mt.Gwangduk

Seoul, Jan ~ Sep 2009



Asian Dust Early Warning Procedure in KMA

1 Monitoring the Asian Dust episode in source regions with eye measurement and PM10 measurement using the Mongolia and China Joint Asian Dust Monitoring Networks.

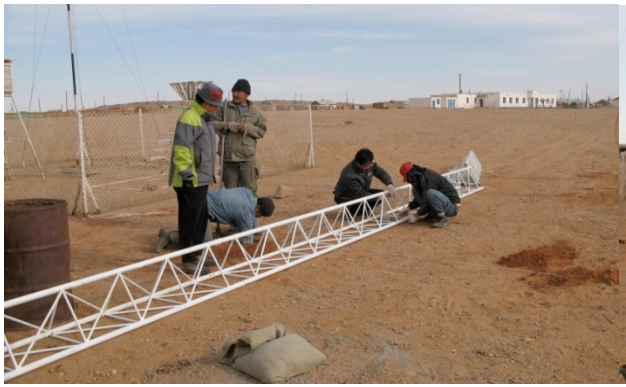
2 Investigating the horizontal distribution of Asian Dust using weather charts and satellite images.

3 Estimating the movement of air parcel containing Asian Dust within 72 Hours with 3-hour interval.

4 Simulating the trajectories, and concentrations of Asian Dust with a super computer.

5 Identify the path and vertical distribution of Asian Dust with PM10 concentrations (28 sites)

▶ Finally, We inform the Asian Dust Forecasting results to the public through the mass media, internet, and Short Message Service in order to prevent the Asian Dust damages.



Summary

KMA has started a web site to provide operational and research products related to Asian dust as of October 2009

http://sds-was.nimr.go.kr/support.html

Currently, it contains following items:

- Forecast chart (twice a day at 00 and 12 UTC)
- PM10 concentrations at 28 sites in Korea (Chart & Table, every hour)
- Asian Dust Satellite Images (almost every 30 mins)
- Analysis Charts

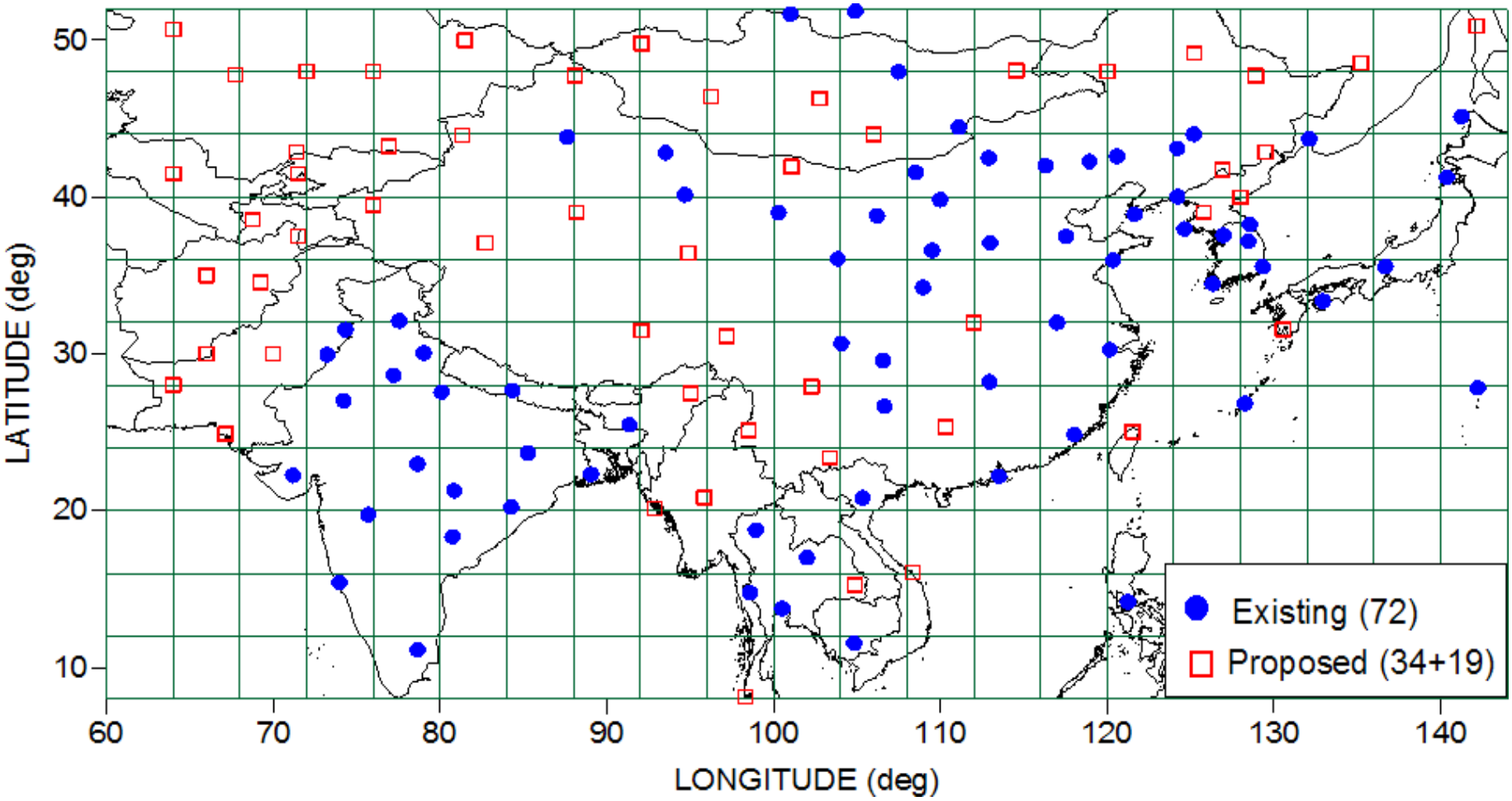
- Asian Dust Weather Chart (every 3 hours)
- Visibility in GTS code (every 3 hrs)
- 48hr backward trajectories at observations sites in Korea
- Satellite images combined with PM10 concentrations

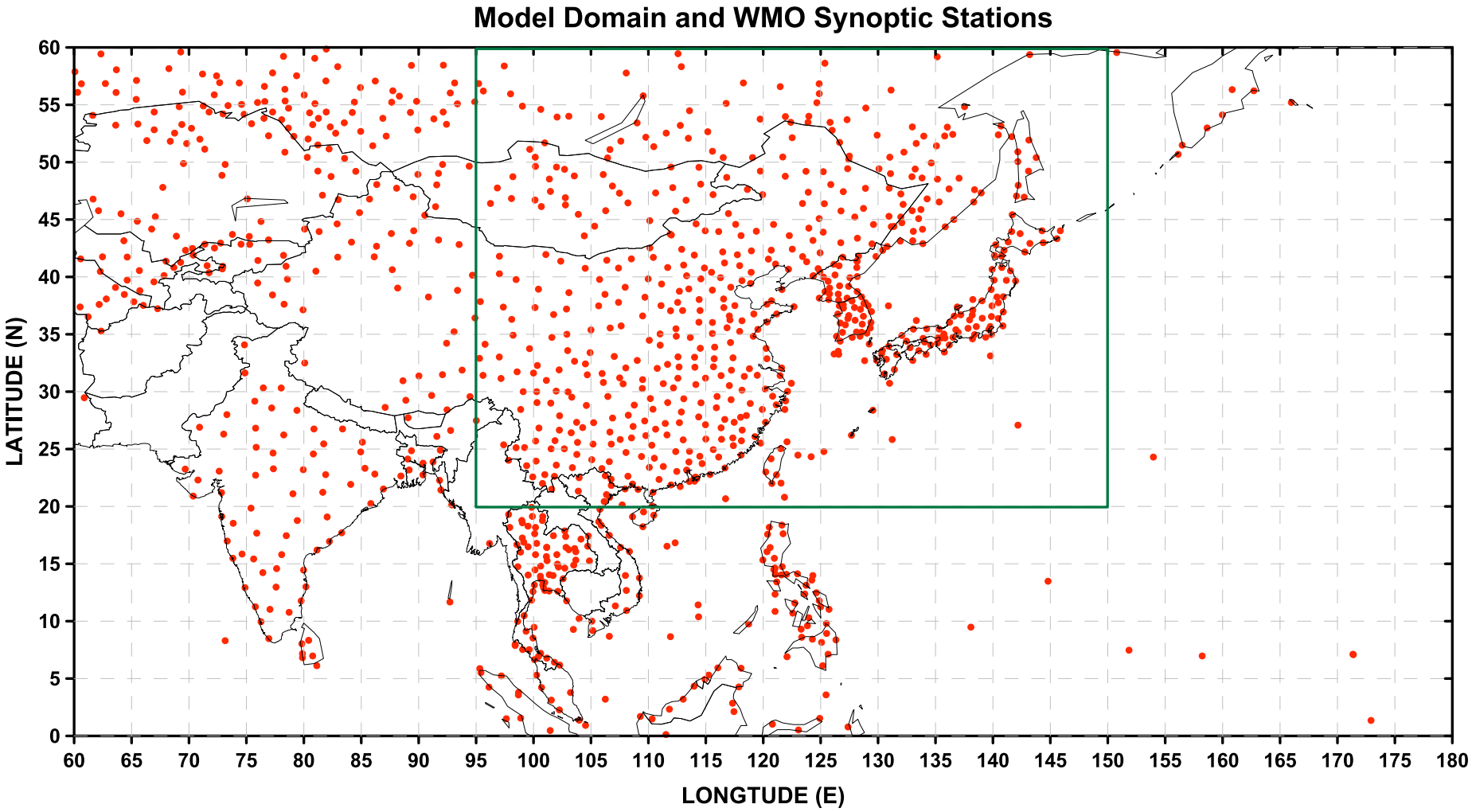
To achieve better understanding of Asian dust and Haze, the cooperative data sharing among the countries is indispensable.

WMO SDS-WAS Asia Node

- 28-30 October 2009 - S e o u l , K O R E A

Proposed integrated monitoring surface network





◆ East Asia (95-150E, 20-60N) → Asia (60-180E, 0-60N)