Current status of the aerosol modeling and satellite observation in KMA

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Outline

- Introduction of ADAM-Haze model
- Simulation result of a severe haze case
- Satellite observation of aerosol in KMA
- Future Plan

History of Asian Dust Aerosol Model (ADAM)

2001 : Launching ADAM development

2002 : Test run at KMA Intranet

2005 : Posting at KMA Hompage

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)

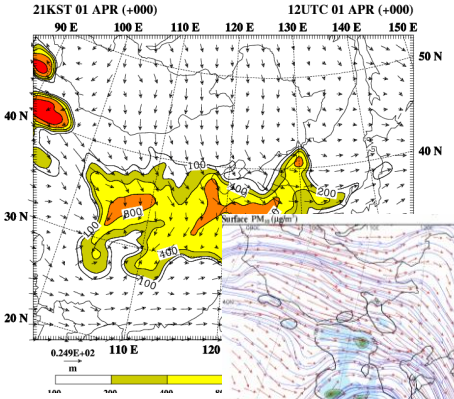
UM-ADAM2 operation (Four-seasons)

2011 : UM-ADAM2(N512) operation

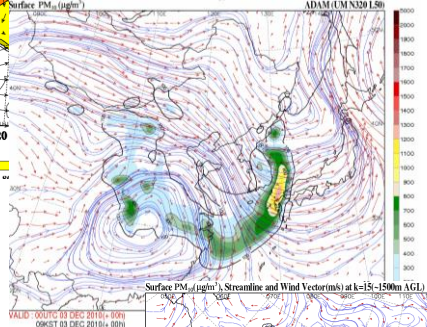
2014 : ADAM-Haze

(will be operational in 2015)

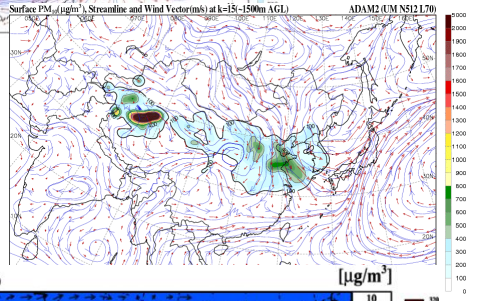
ADAM

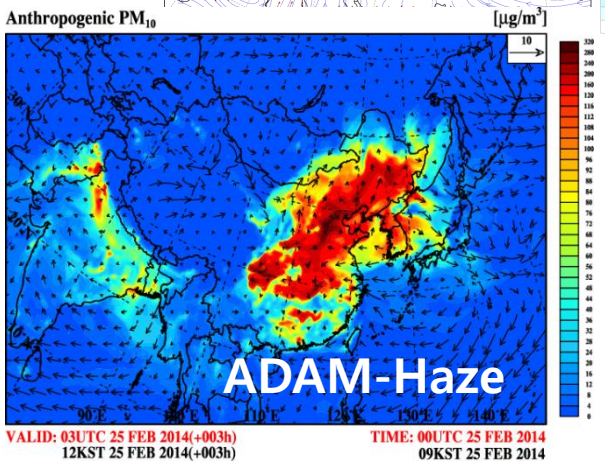


UM-ADAM

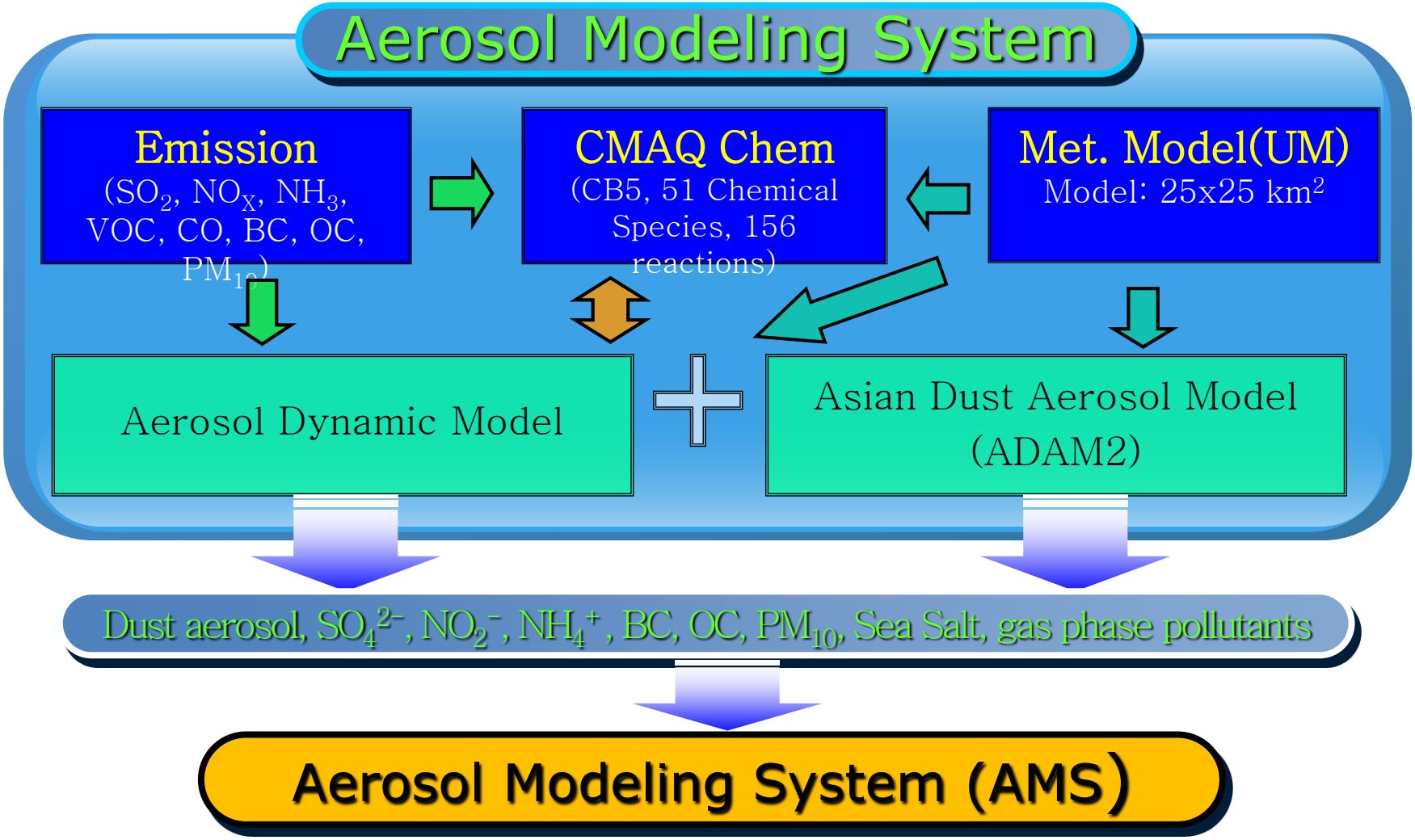


UM-ADAM2





Development of ADAM-Haze Model



Asian Dust : Sectional approach w/ 11 size bins
Haze : Modal approach
No interactions between the AD and Haze aerosols

ADAM-Haze Configuration

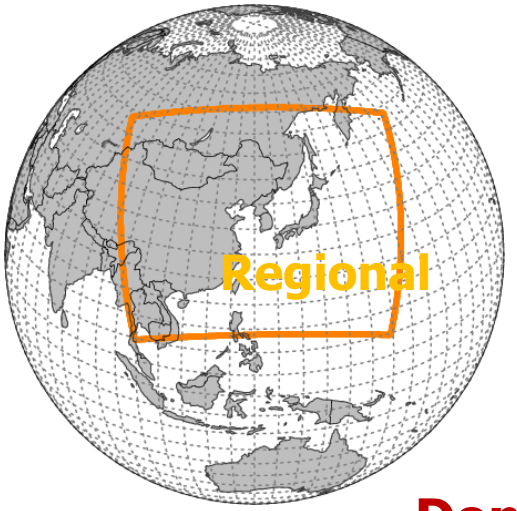
ADAM-Haze

- Meteorological Model (UM Global)
- Met. Interface, UM-MCIP

- Regional model
- Vertically 47 layers
- 25 km spatial resolution
- 340X220 horizontal grids

- 7days(168hr) forecasting (00, 12UTC)

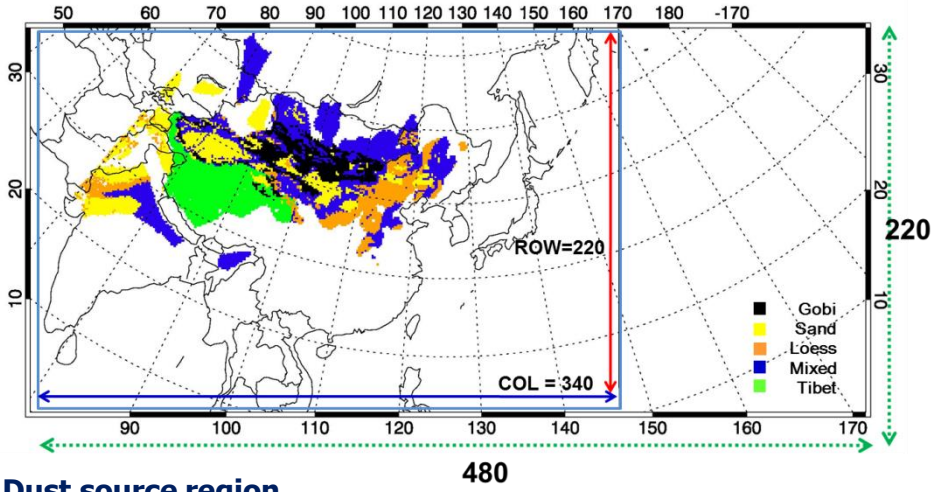
- Will be running in operational mode from this year (2015)



UM-Global

- **Horizontal ~ 25km (1024*768)**
- **Vertical : 70 layers (top = 80km)**
- **FCST Period (4 times/day) +252hrs (00/12UTC) +72hrs (06/18UTC)**
- **Initialized by 4dVAR**

Domain of ADAM-Haze



- **Dust source region**
  defined by dust occurrence statistics using 3hr SYNOP report for 1998~2006 period
  4 type soil classification ~ gobi, sand, loess, mixed

Emissions of Asian Dust

- **Emission parameterization**

(Park and In, 2004; Park and Lee, 2005; Lee, 2009; Park et al., 2010)

Emission flux

: $F \sim u_*^4$

: with log-normal size distribution

Meteorological condition for dust emission

: wind speed, relative humidity, ground temperature, precipitation

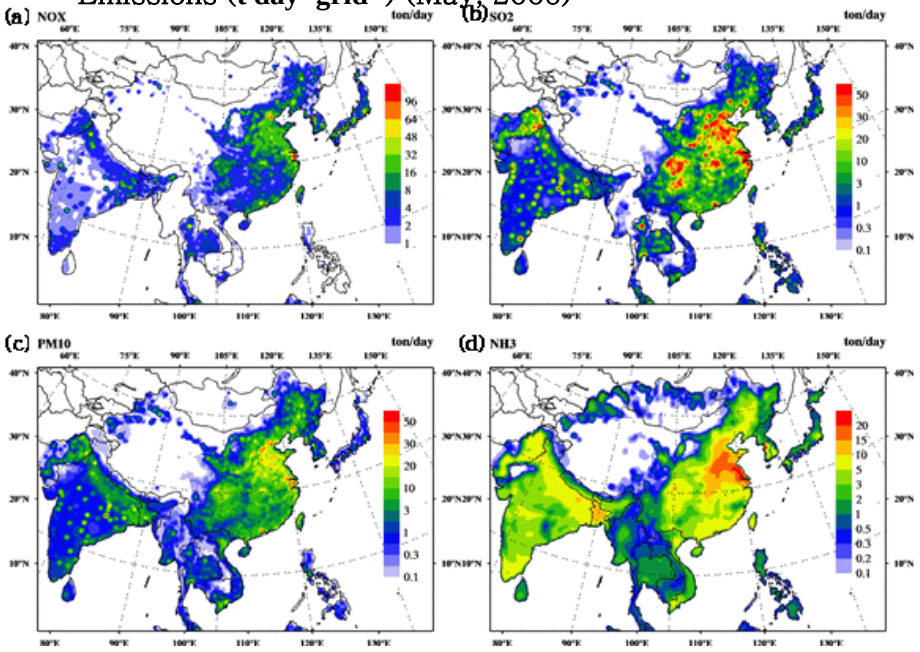
Reduction by Vegetation

: NDVI change → Reduction function

Emissions of Anthropogenic aerosols

East Asia

- Emissions ($t\ day^{-1}grid^{-1}$) (May, 2006)



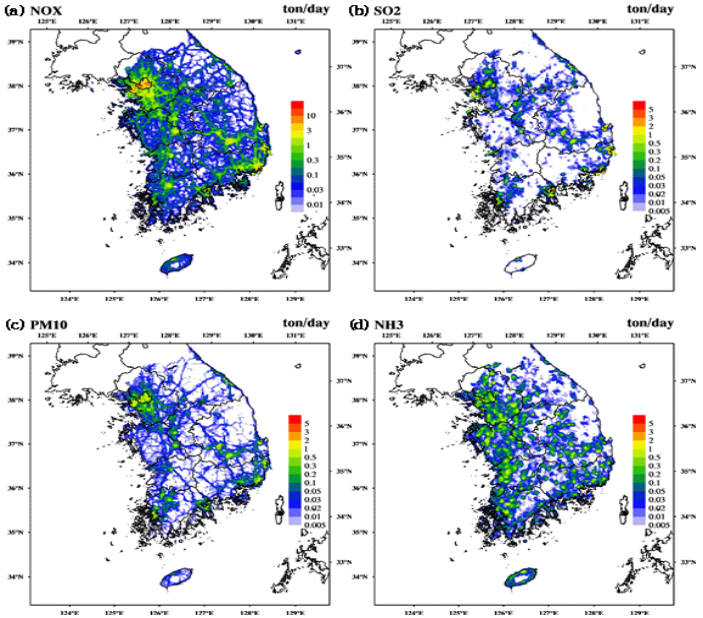
- **INTEX-B - (a) NOx, (b) SO_2 and (c) PM_{10}**
- **ACE-ASIA - (d) NH_3**

- INTEX-B (Intercontinental Chemical Transport Experiment-Phase B)
  - Area: From 13.0°S to 53.5°N, From 60.0°E to 157.5°E with 0.5° resolution
  - 4 emission types; transportation, residential, power, industry
  - 8 species; BC, Co, NOx, OC, PM10, PM25, SO2, VOC

- ACE-ASIA (Aerosol Characterization Experiments – ASIA)
  - Area: 12.75°S to 53.75°N, From 60.25°E to 157.75°E with 0.5° resolution
  - Monthly Data for March, July and December
  - 12 species; BC, CH4, CO2, Co, NH3, NOx, OC, PM10, PM25, SO2, REG(?)

S. Korea

- Emissions ($t\ day^{-1}grid^{-1}$) (May, 2009)



(a) NOx, (b) SO_2,
(c) PM_{10}, (d) NH_3

※ **CAPSS(Clean Air Policy Supporting System) by KMOE (*gridded data)**
- Area: South Korea with 1 km resolution in TM (Transverse Mercator) coordinate
- 7 species; CO, NOx, SOx, TSP, PM10, VOC, NH3

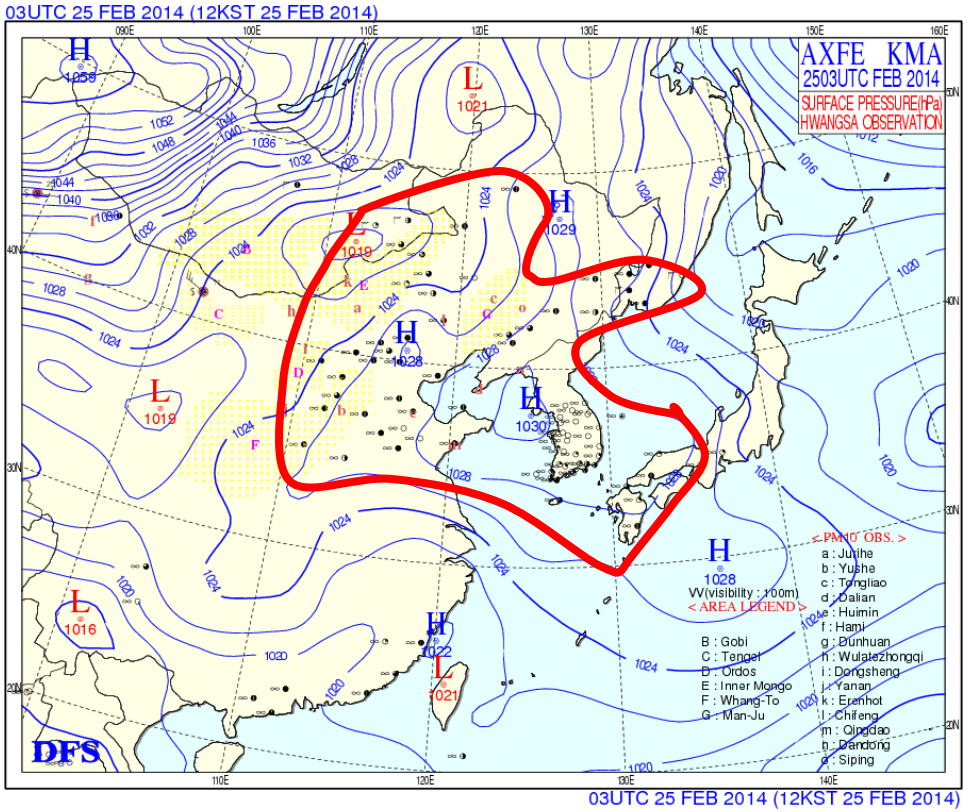
Inclusion of Biogenic emission?

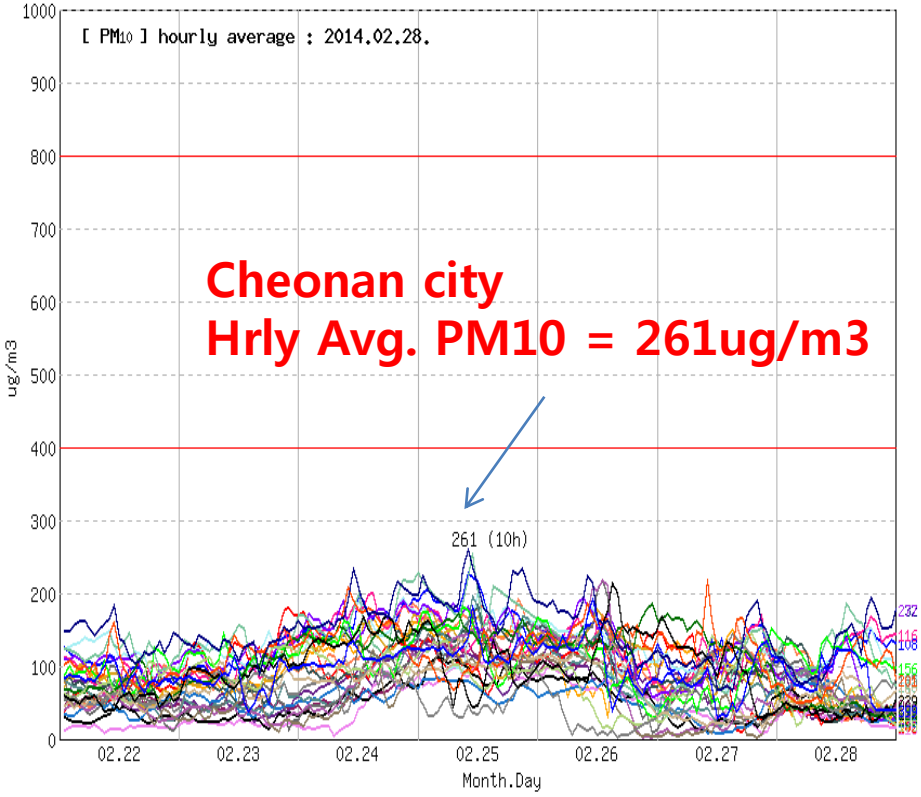
- In addition, the biogenic emissions will be included using the MEGAN developed by the WSU (now being tested !!)

※ SMOKE(Sparse Matrix Operator Kernel Emissions)
※ MEGAN(Model of Emissions of Gases and Aerosols from Nature)

Case Study

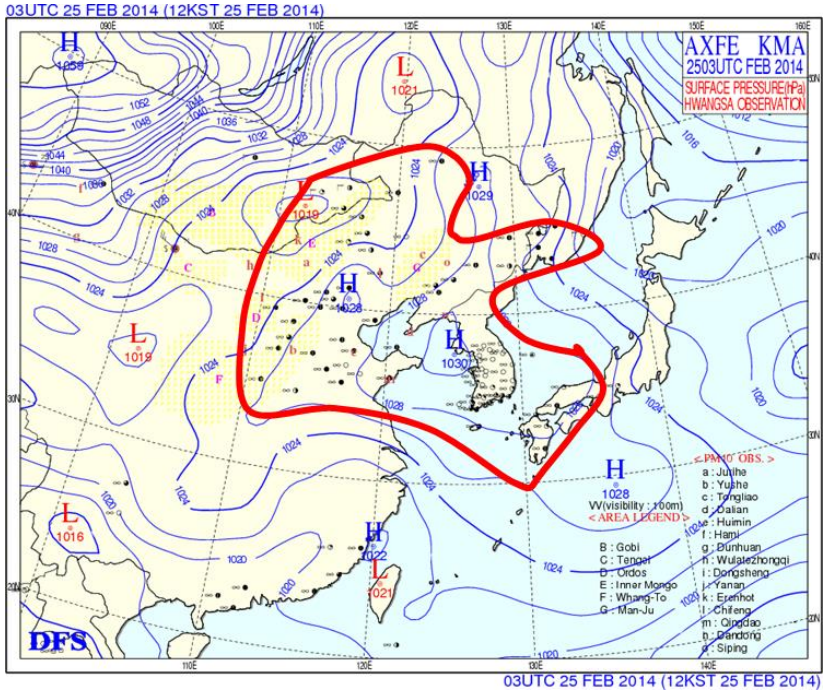
- Evaluation Period: Feb. 21~Mar. 2, 2014
- Strong and long-lasting haze case in S. Korea
- Huge societal impacts in both China and Korea

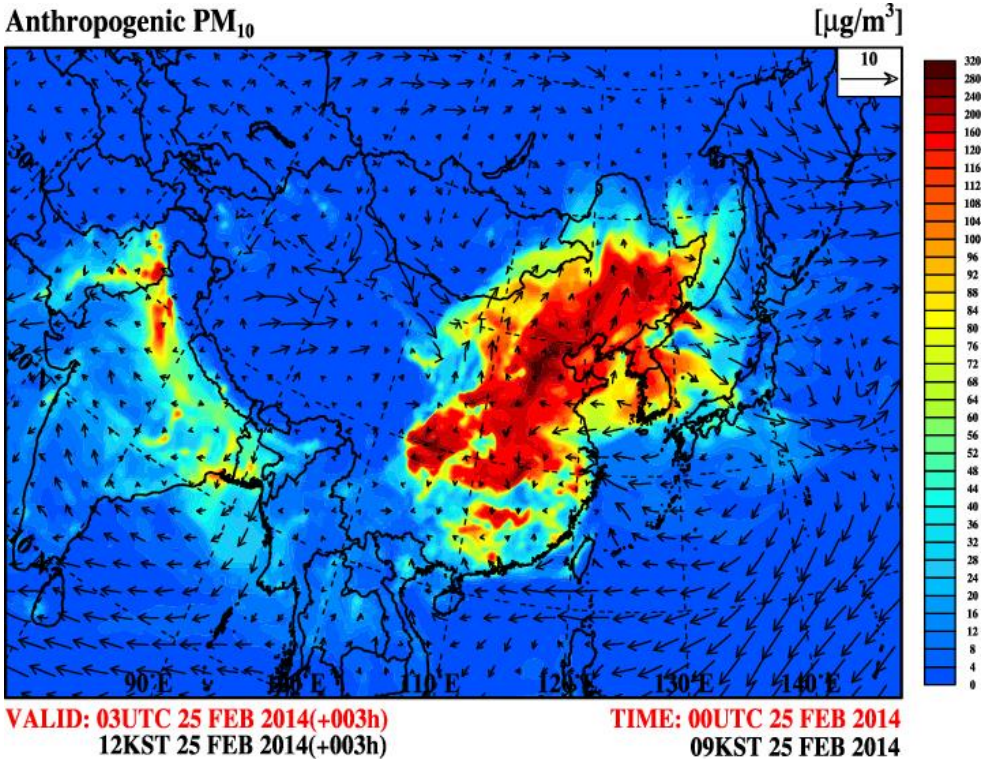




Predicted SFC PM10 & Haze Obs.

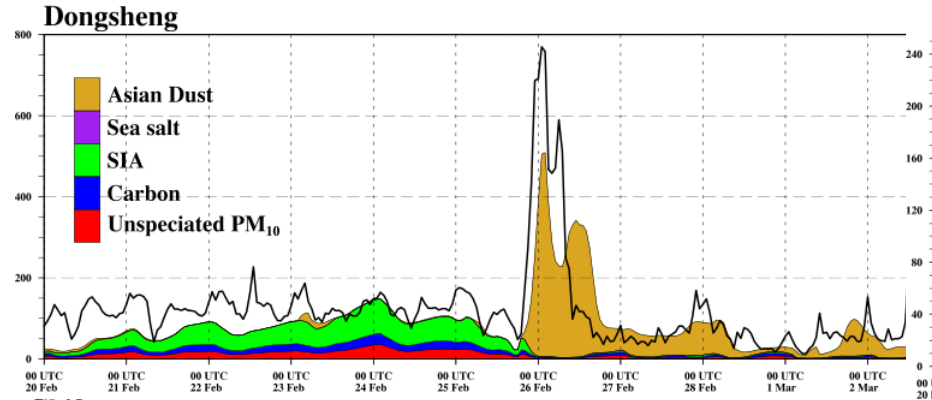
GTS

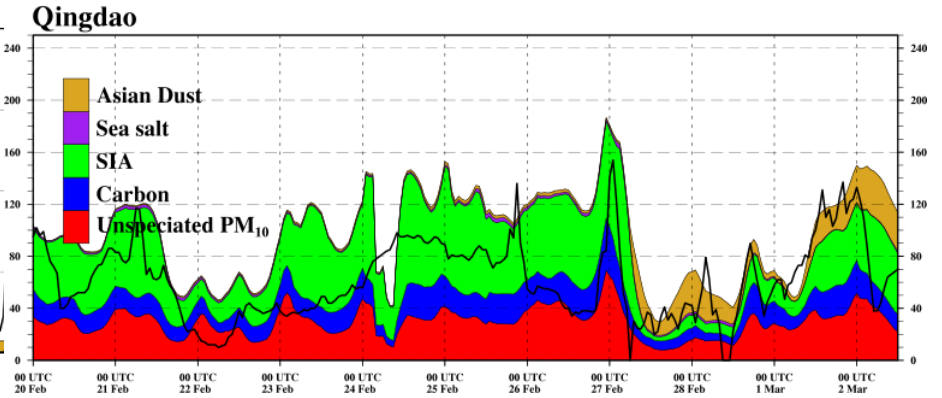


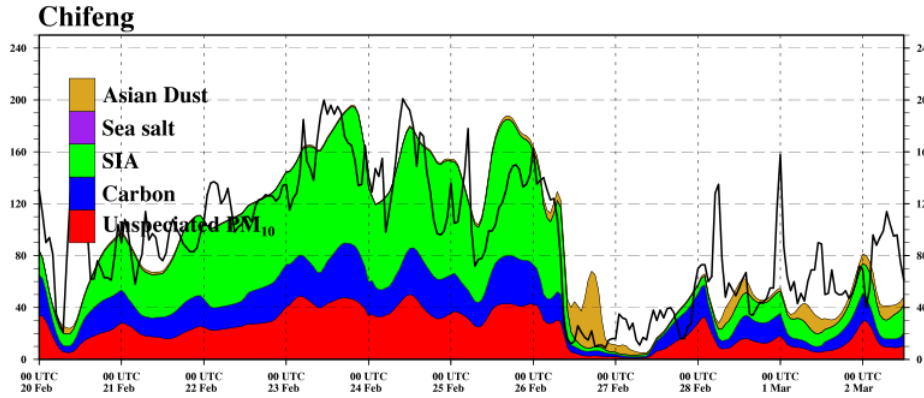


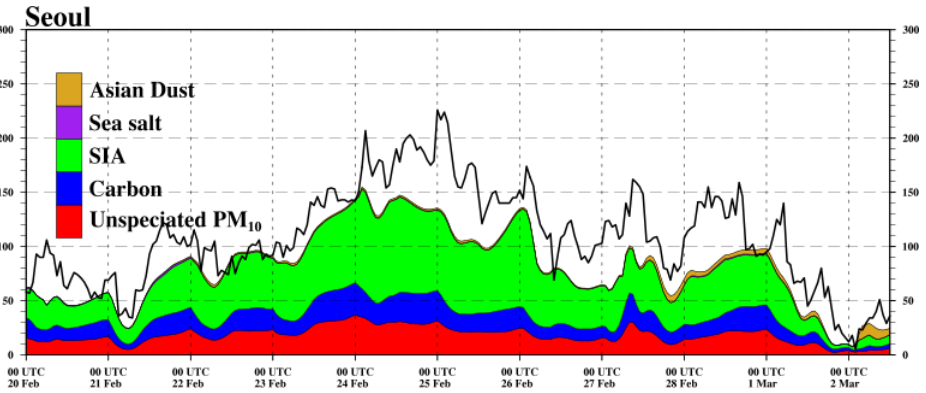
UM-CMAQ+CAPPS2008
Run by KMA

Time Series of Hrly Avg PM10



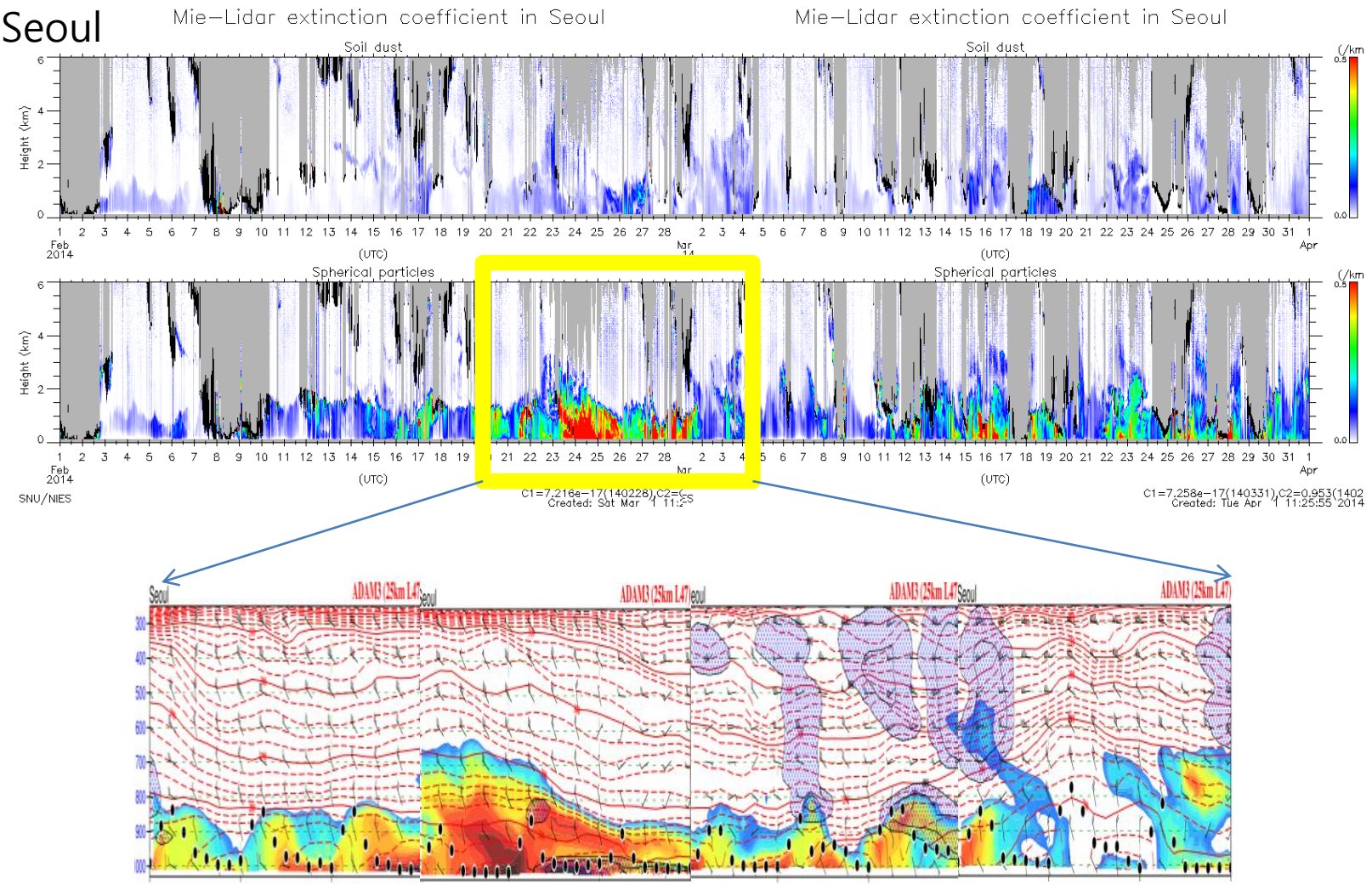






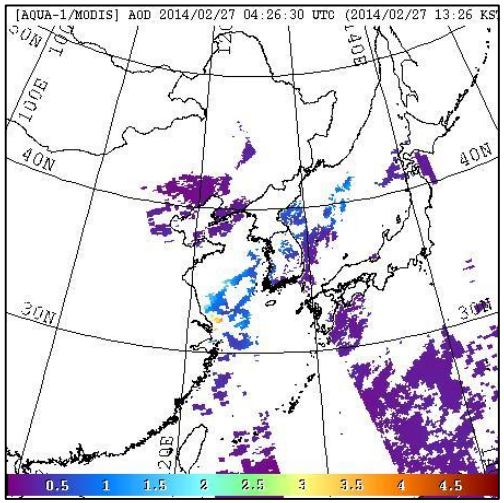
Vertical Distributions - LIDAR

@ Seoul

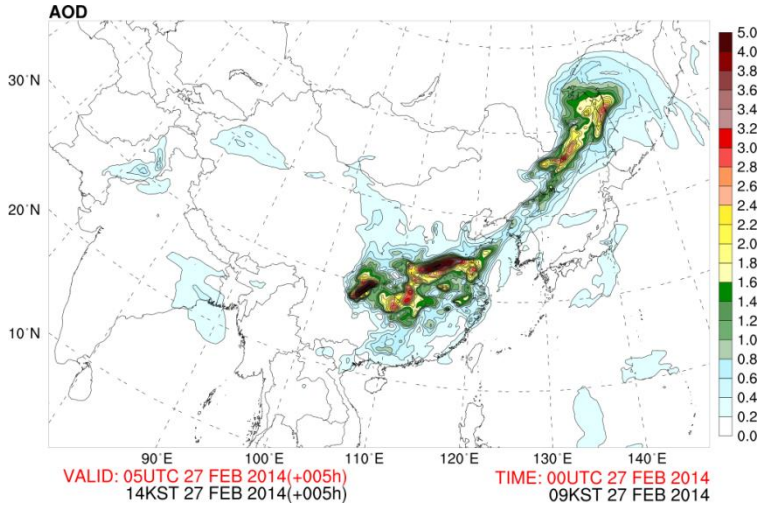


Horizontal Distributions-AOD

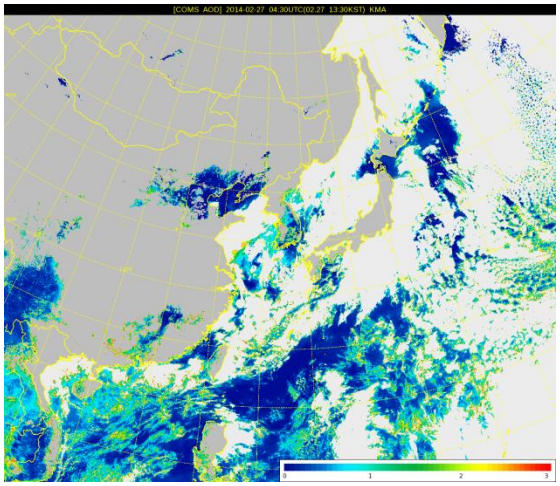
MODIS AOD @ 2014-02-27 13:26KST

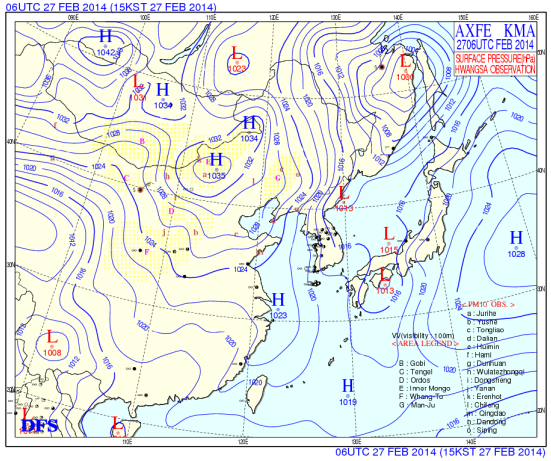


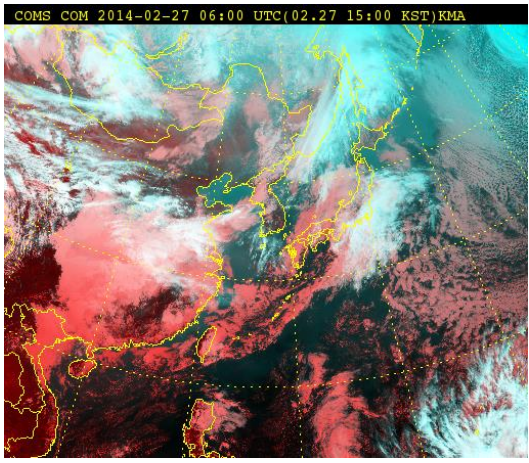
AOD @ 2014-02-27 14:00KST



COMS AOD @ 2014-02-27 13:30KST







COMS Aerosol Products

- **COMS (**Communication, Ocean and Meteorological Satellite)
- Launching : 2010. 6. 27
- Location : 128°E (Geostationary)

MI (Meteorological Imager)

Kim, J. et al. (2008, IJRS)

- Wavelengths : visible (0.55-0.90 μm), IR1(10.3-11.3 μm), IR2(11.5-12.5 μm), WV (6.5-7.0 μm), NIR (3.5-4.0 μm)
- Horizontal res. : 1 km (VIS), 4 km (IR)
- Time interval : 15 min.
- Area : Global, Northern hemisphere

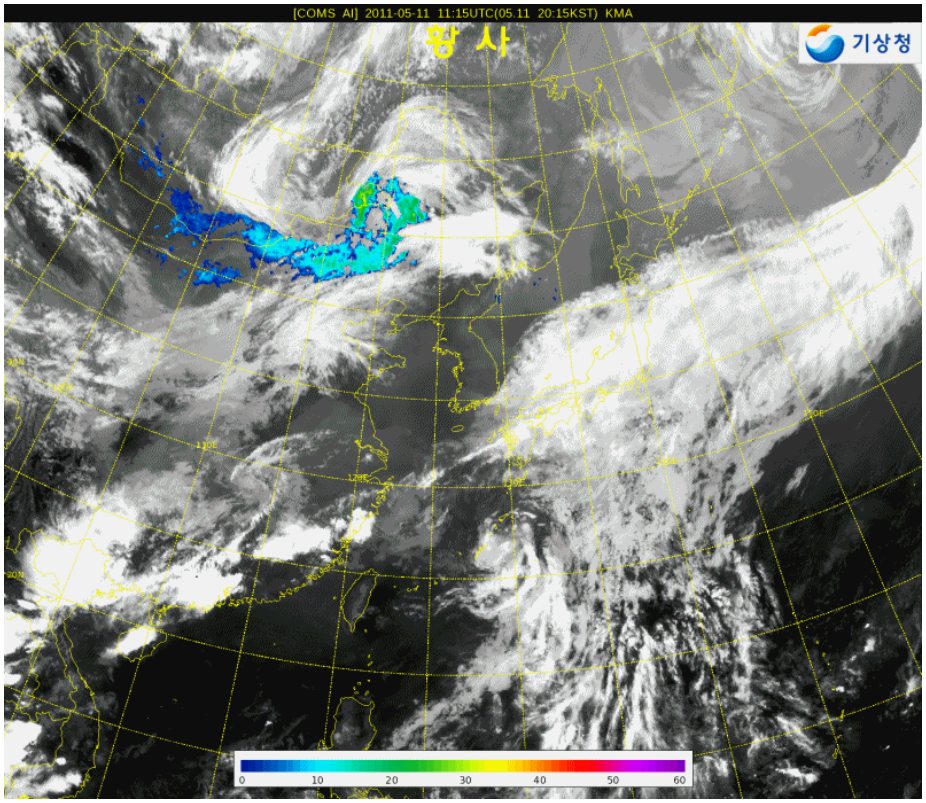
GOCI (Geostationary Ocean Color Imager)

Lee, J. et al. (2010, RSE)

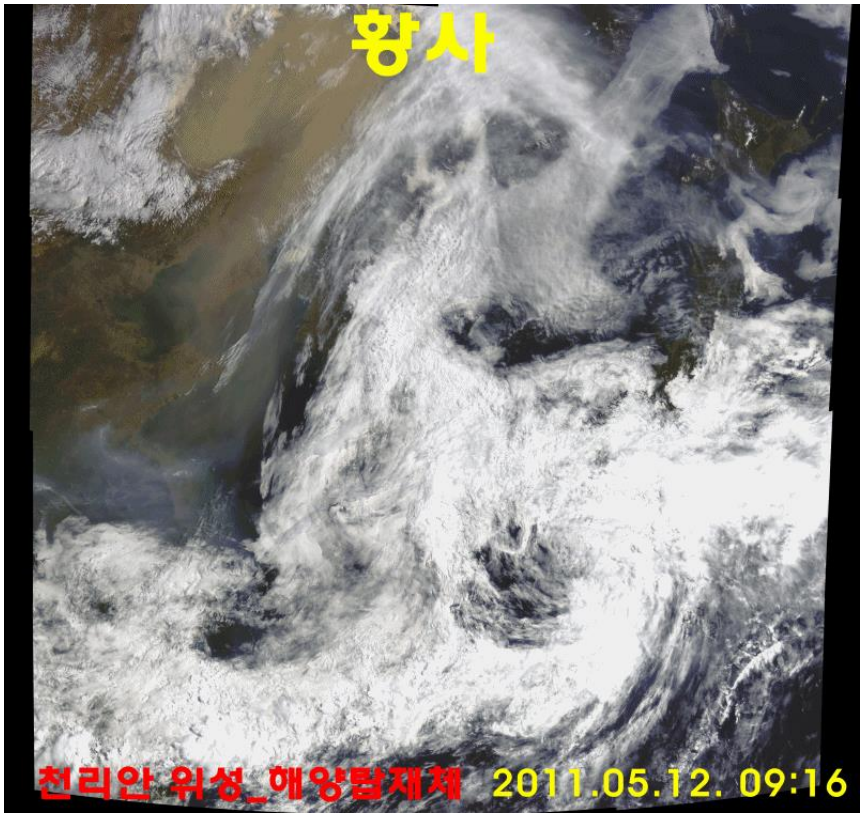
- Wavelengths : 412, 443, 490, 555, 660, 680, 745, 865 nm
- Horizontal res. : 500 m x 500 m
- Time interval : 1 hr
- Area : Eastern Asia

COMS dust products

COMS AI
2011. 5.11. 20:15 ~ 5.12. 16:45

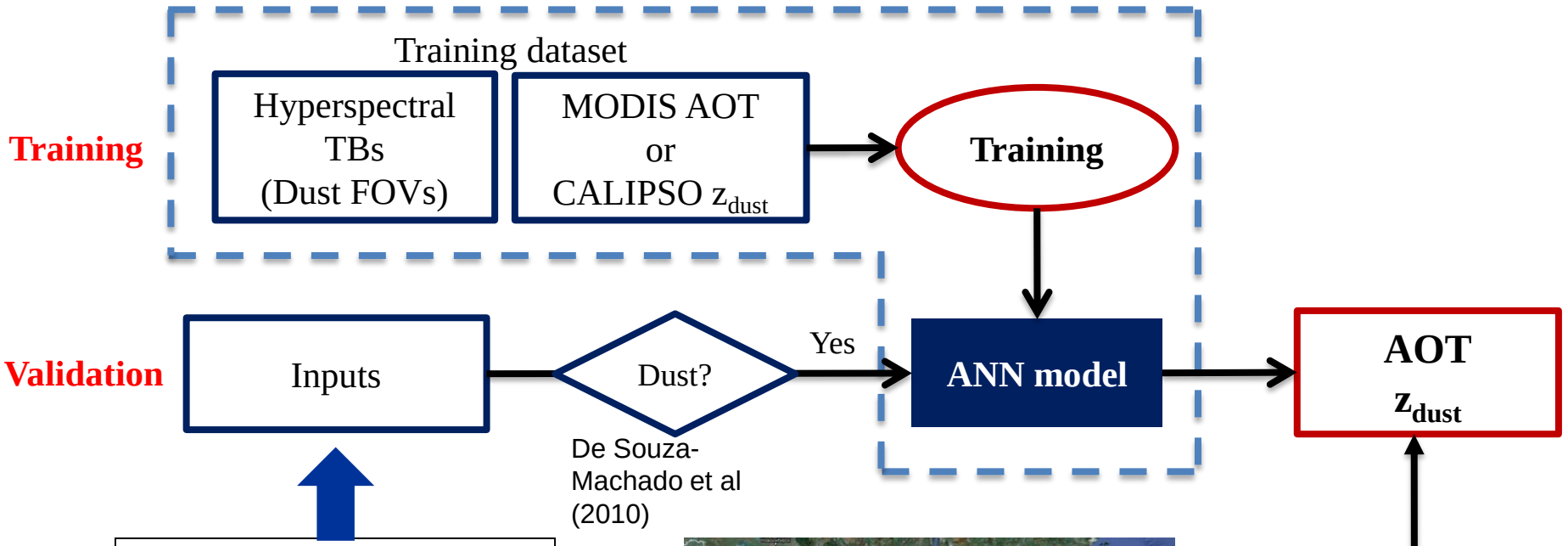


COMS/GOCI
2011. 5.12. 09-16시



Preliminary

AOT, Dust height (AIRS)



AIRS Inputs:

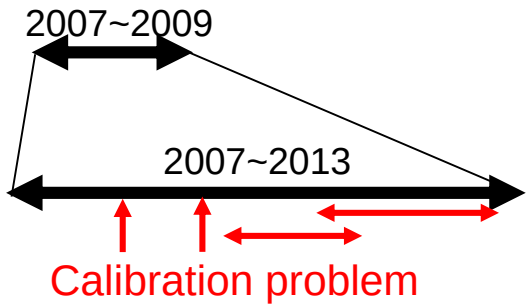
1. TBs
2. Surface elevation
3. $1/\mu$ ($\mu = \cos\theta_{sat}$)

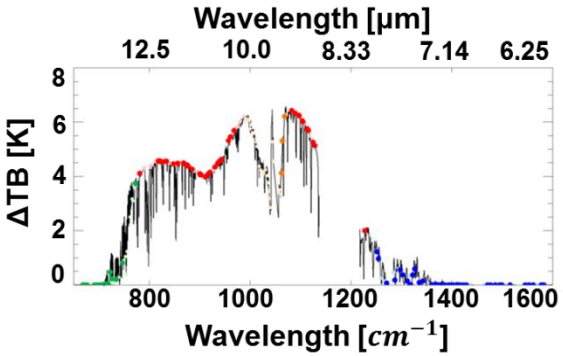
Domain: East Asia region
15˚N~55˚N, 70˚E~150˚E

Han, H. et al. (2013, JGR)

AIRS Dust Aerosol Products

Channel selection





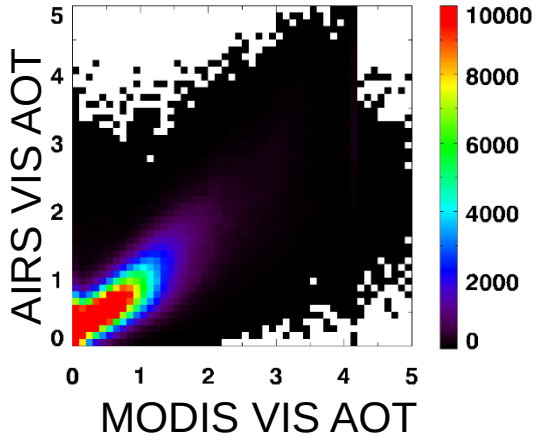
WIN : 130 → 52
CO2 : 31 → 21
WV : 44 → 35
O3 : 29 → 3
TOT : 234 → 111

Validation

Dust AOT

Training
- Period: Jan 2007 – Dec 2007

Validation
- Period: Jan 2003 – Dec 2013 (except 2007)
- Statistics:
  Corr. coeff.: 0.83 → 0.84
  RMSE: 0.41 → 0.39

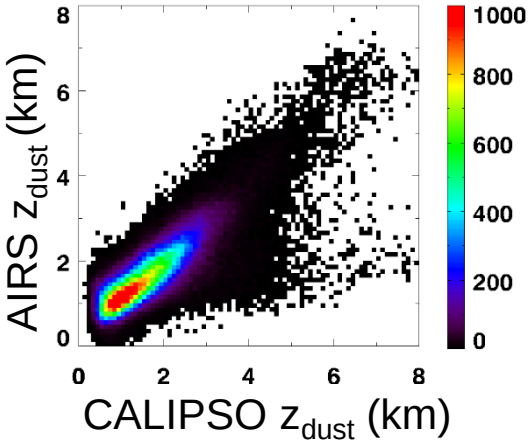


Dust Height

Training
- Period: Jan 2007 – Dec 2008

Validation
- Period: Jan 2009 – Dec 2013

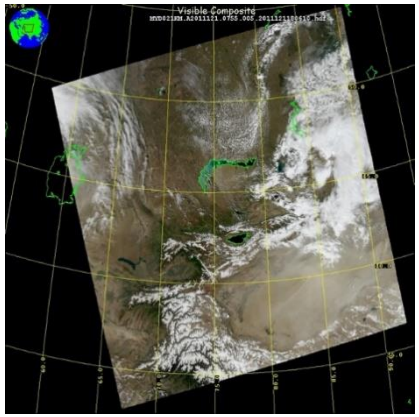
- Statistics:
  Corr. coeff.: 0.77 → 0.81
  RMSE: 0.56→ 0.51



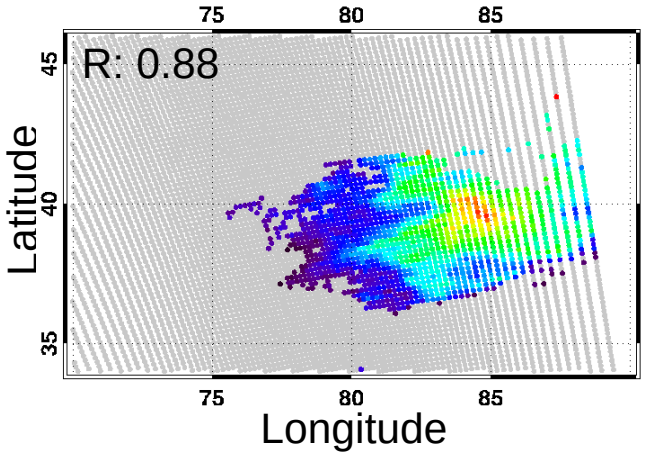
Han, H. et al. (2013, JGR)

AIRS Dust Aerosol Products
(1 May 2011)

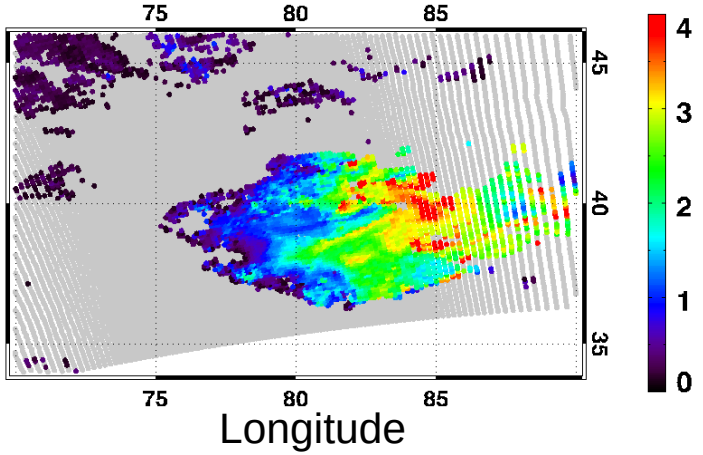
MODIS true color image



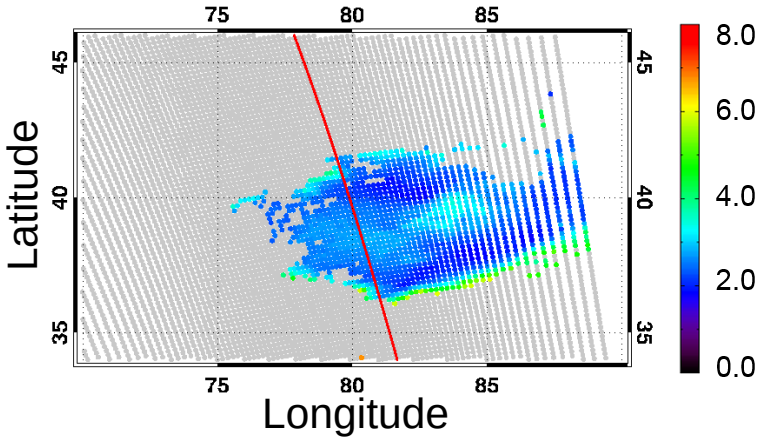
AIRS VIS AOT



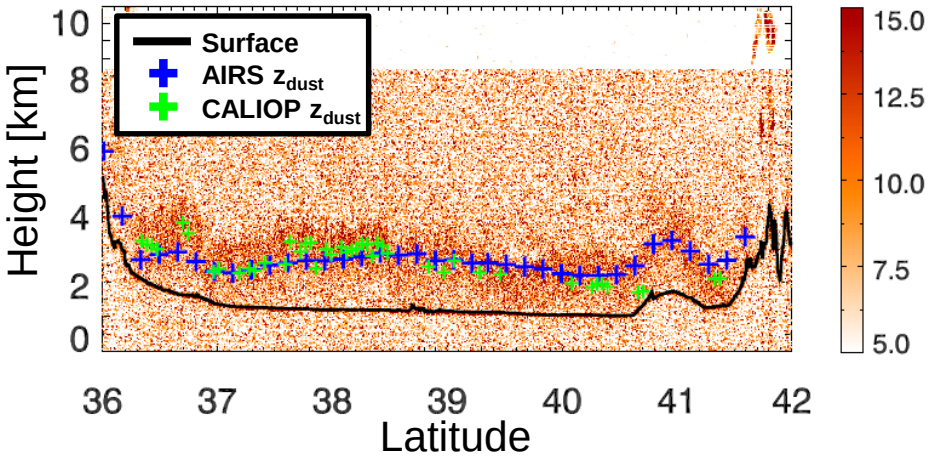
MODIS VIS deep blue AOT



AIRS dust height [km]



CALIOP total attenuated backscatter 532 nm



Summary

- **ADAM-Haze** model will be used operationally in 2015.
- **ADAM-Haze** has a capability to forecast not only dust aerosol but also anthropogenic aerosols.
- More elaborate modification is needed to upgrade.
  For example, new emission inventory, Inclusion of Biogenic emission(MEGAN), coagulation and chemical reaction process, etc.
- COMS aerosol products (AI, AOT) is used for dust monitoring, and AIRS products (AOT, Height) algorithm is developed.