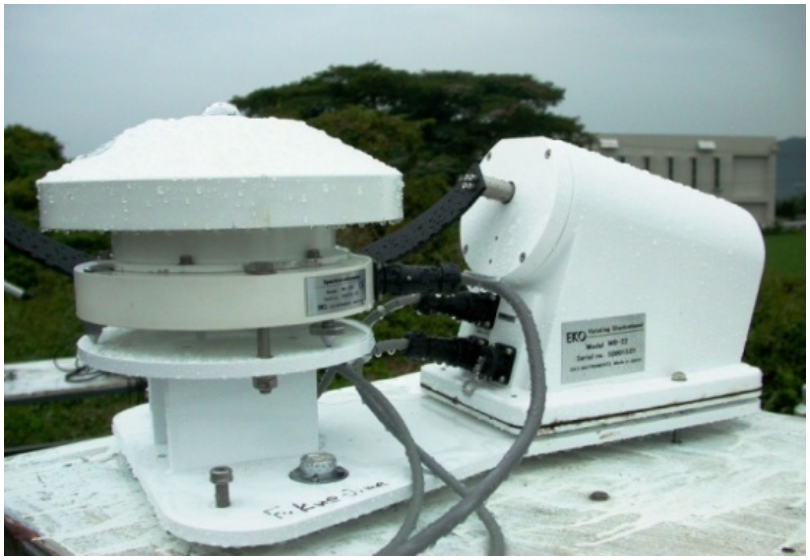
An example of aerosol analysis Using Spectro-pyranometer with shadow-band system



***Type*: MS-700 with shadow band**
***Manufacturer*: EKO Co., Ltd., Japan**

Two instruments for aerosol measurements

Instrument	Spectro-Pyranometer MS-700(EKO)	Sky radiometer POM-02(PREDE)
Wavelength	Grating(nm) 350 – 1000 continuous Res. 3nm	Int. Filter(nm) 315, 340, 380, 400, 500, 675, 870, 940, 1020, 1627, 2200, Dl:10nm
Main target	Aerosol, water vapor, PAR, Solar cell	Aerosol, cloud, ozone, water vapor
Measurement	Irradiance obs. Global & diffuse irradiance With shadow-band	Radiance obs. Direct & sky brightness With solar tracker
Analysis system	Currently developed	SKYRAD.pack V4.2 Level 2

Three points to be considered when estimating accurate SSA using direct/diffuse radiation

(1) Calibration – reference calibrated at MLO/NOAA
(2) Separation of direct/diffuse irradiance
(3) Accurate cosine characteristics of the sensor with diffuser

Calibration at the MRI

Use of collimation tube

Courtesy of Dr. A. Uchiyama（MRI/JMA）

(1) Calibration – reference calibrated at MLO/NOAA

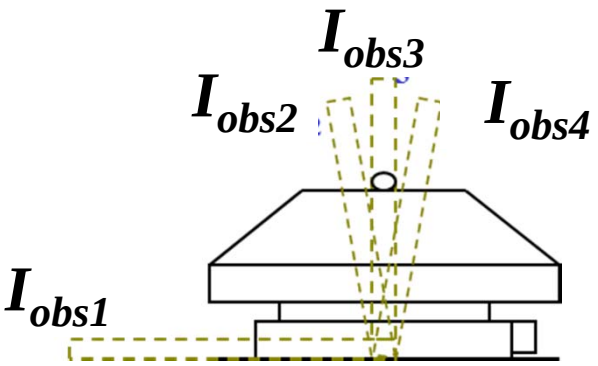
(2) Separation of direct/diffuse irradiance

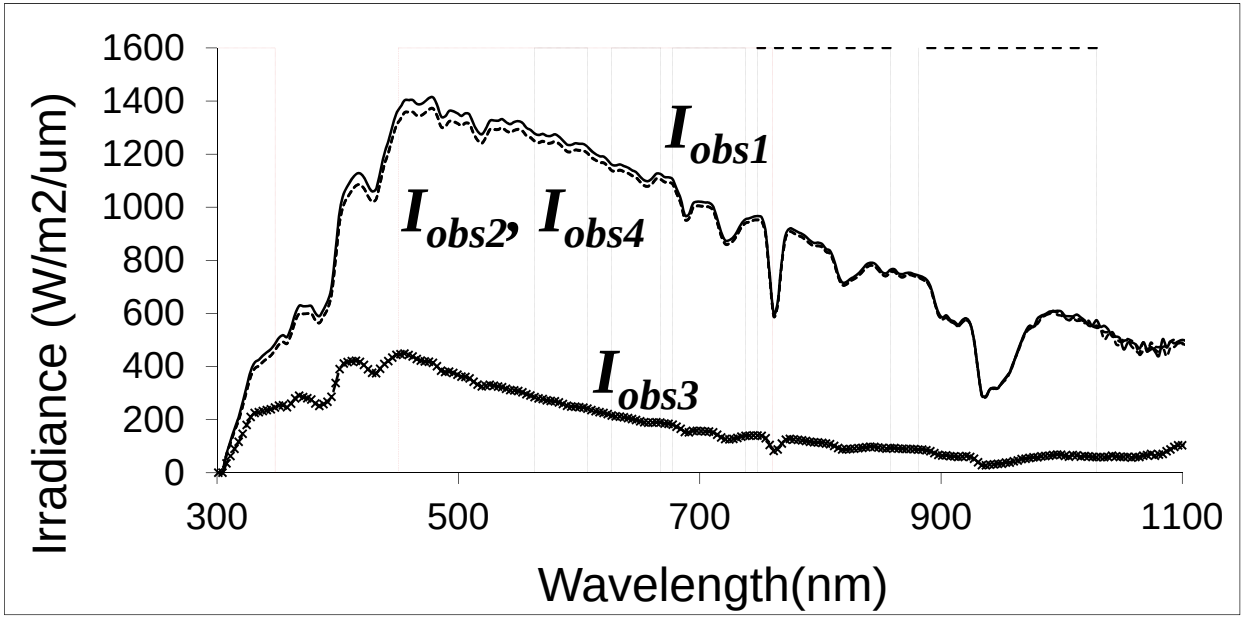
(3) Accurate cosine characteristics of the sensor with diffuser

$$\gamma_1 F_{dir} \cos(\theta_0) = \frac{I_{obs\,2} + I_{obs\,4}}{2} - I_{obs\,3}$$

$$\gamma_2 F_{dif} = I_{obs1} + I_{obs\,3} - \frac{I_{obs\,2} + I_{obs\,4}}{2}$$

$$\gamma_2(\theta_0, \varphi_0) F_{dif\,.\lambda}(\theta_0, \varphi_0) = \int_{\varphi}\int_{\theta} \gamma_1(\theta, \varphi) I_{\lambda}(\theta, \varphi; \theta_0, \varphi_0) \cos(\theta) \sin(\theta) d\theta d\varphi$$





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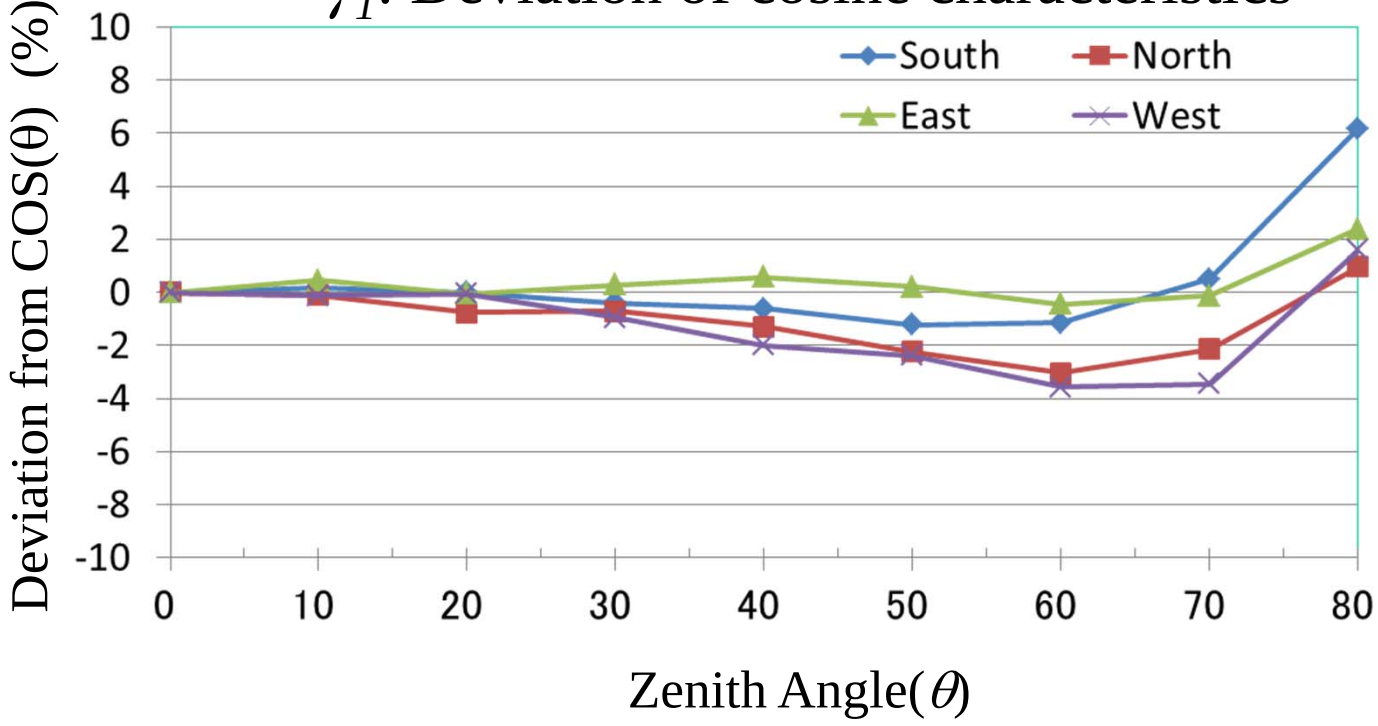
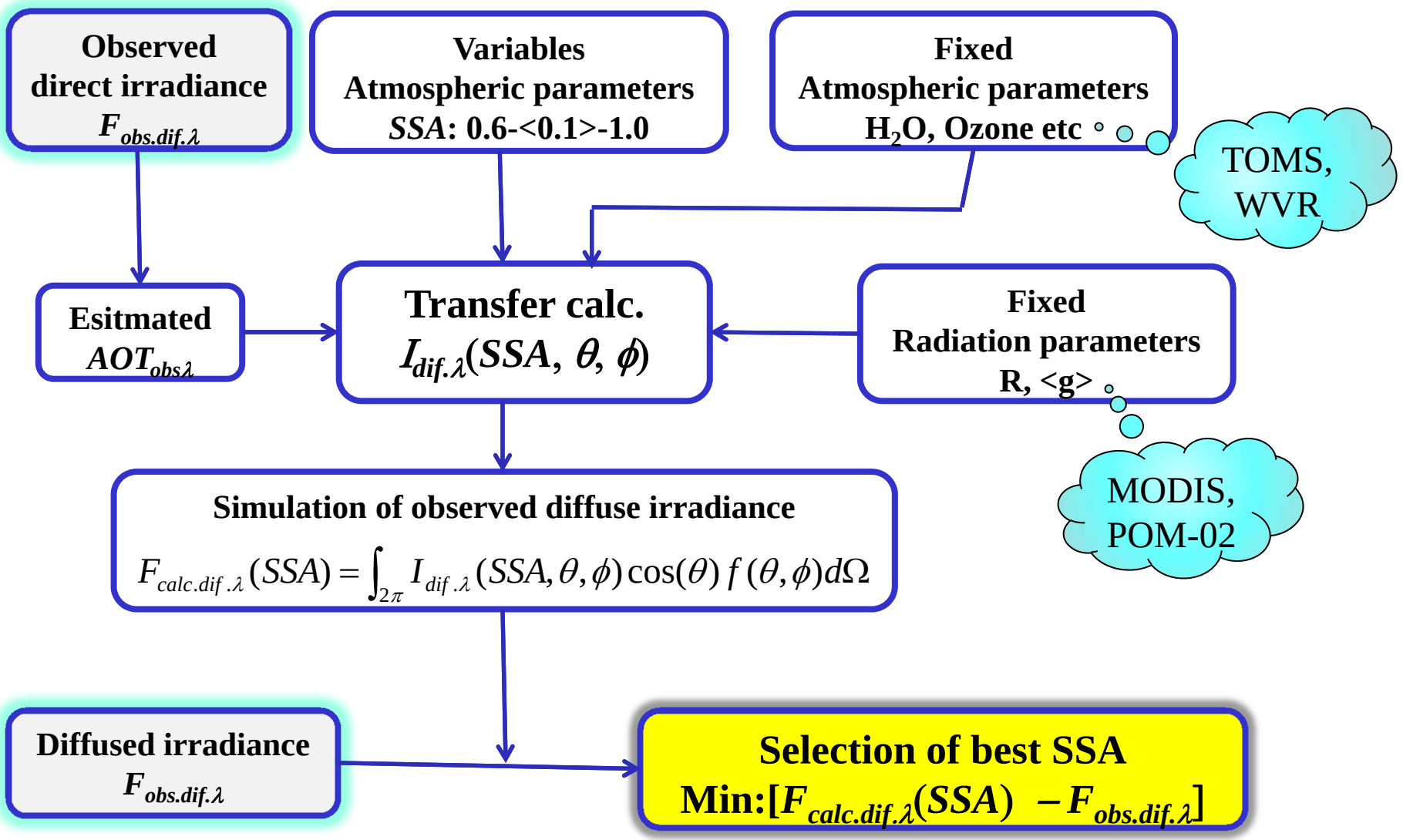
Sample pattern of γ_1

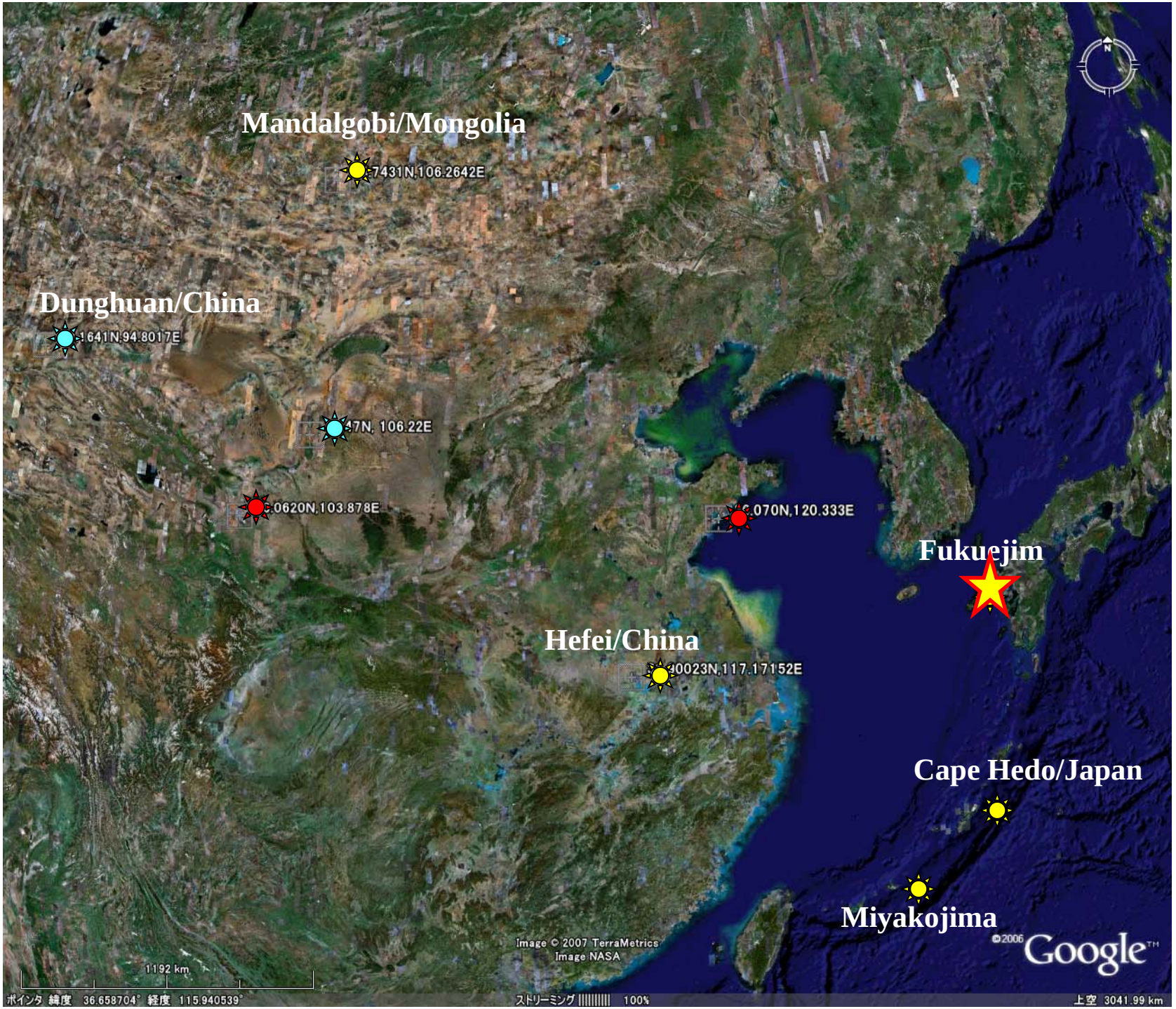
γ_1: Deviation of cosine characteristics



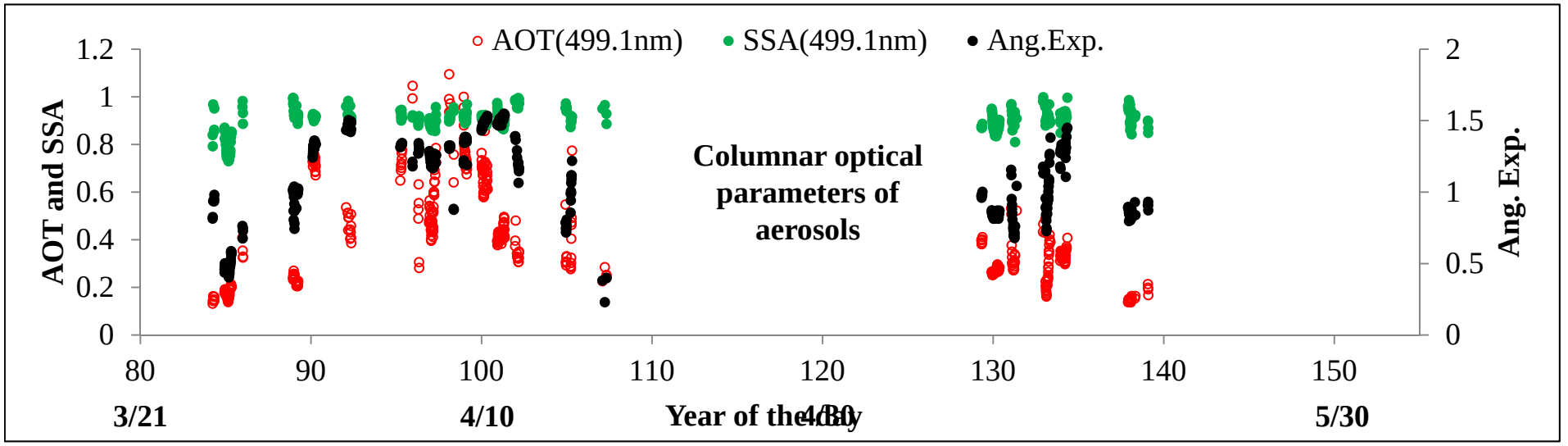
Algorithm for data analysis of MS-700

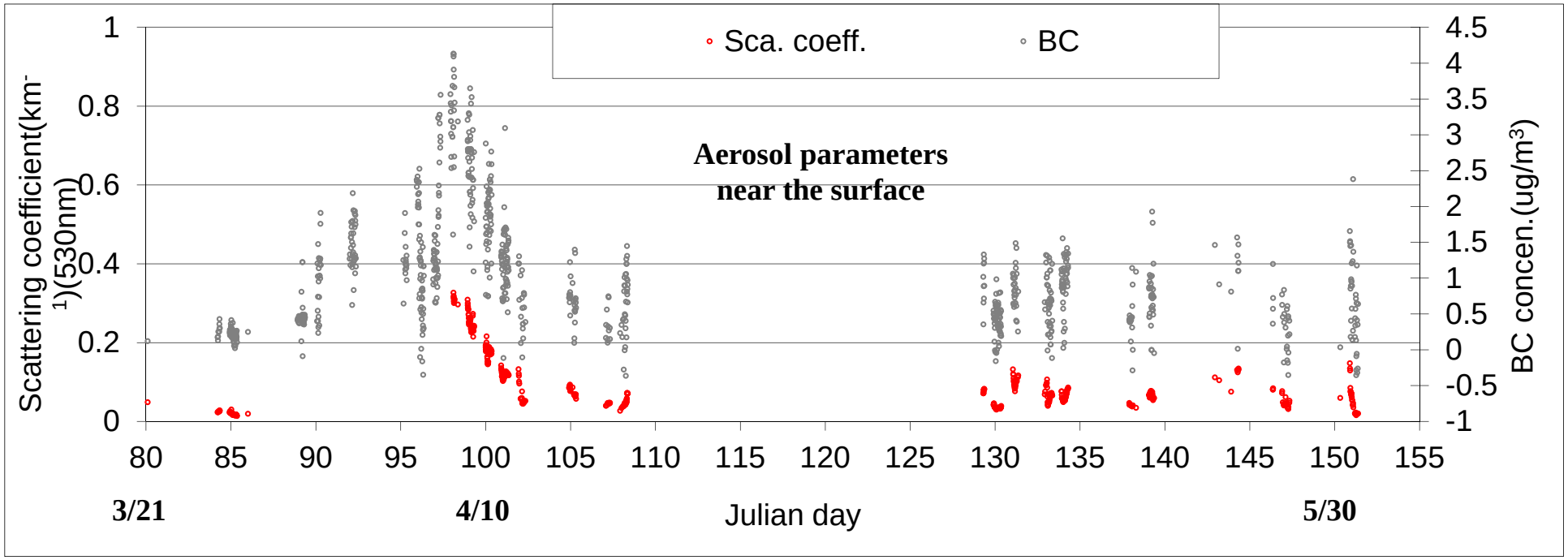


Reference: Khatri, P., T. Takamura, A. Yamazaki, and Y. Kondo (2012), *J. Atmos. and Oceanic Technol.*, Accepted.

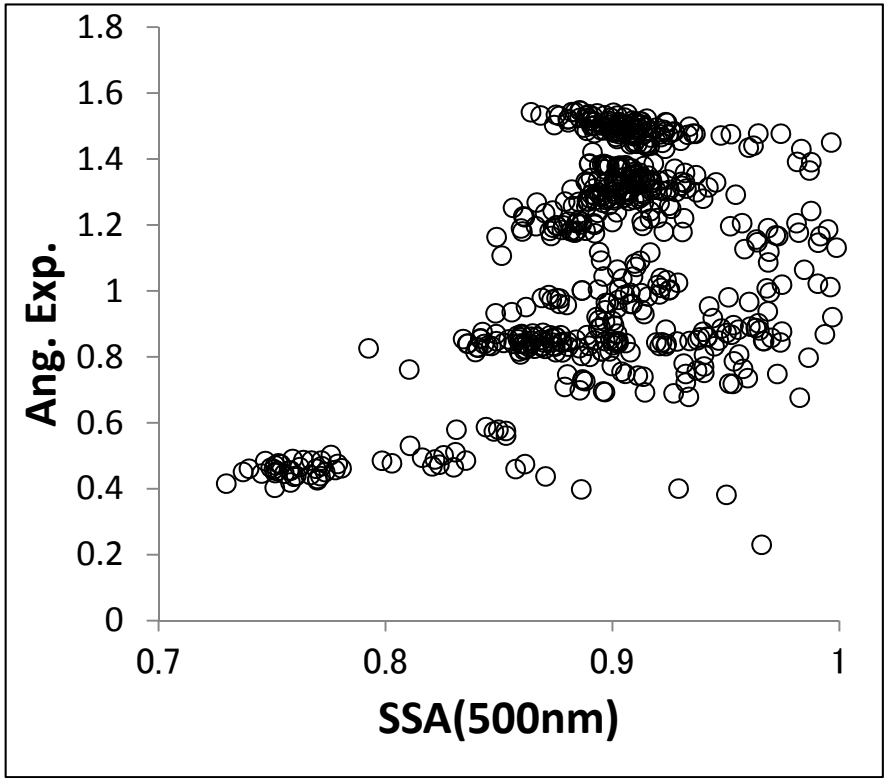

Mandalgobi/Mongolia
7431N,106.2642E
Dunghuan/China
1641N,94.8017E
7N, 106.22E
0620N,103.878E
070N,120.333E
Fukuejim
Hefei/China
0023N,117.17152E
Cape Hedo/Japan
Miyakojima
Image © 2007 TerraMetrics
Image NASA
©2006 Google
1192 km
ポインタ 緯度 36.658704° 経度 115.940539°
ストリーミング 100%
上空 3041.99 km

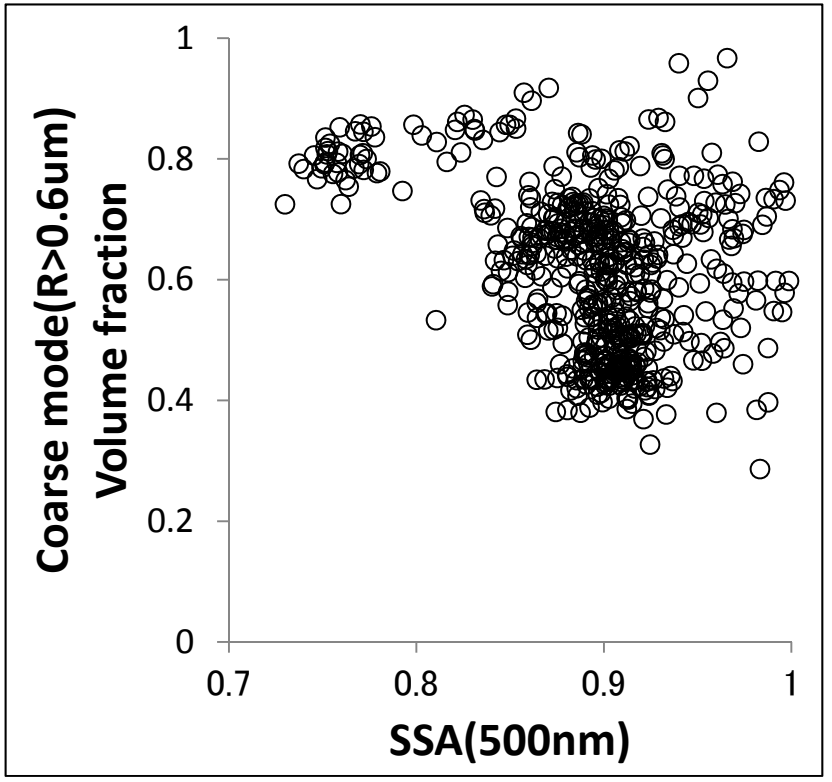
Time series of aerosol optical parameters observed at SKYNET Fukuejima Island, Japan, Mar-May, 2009





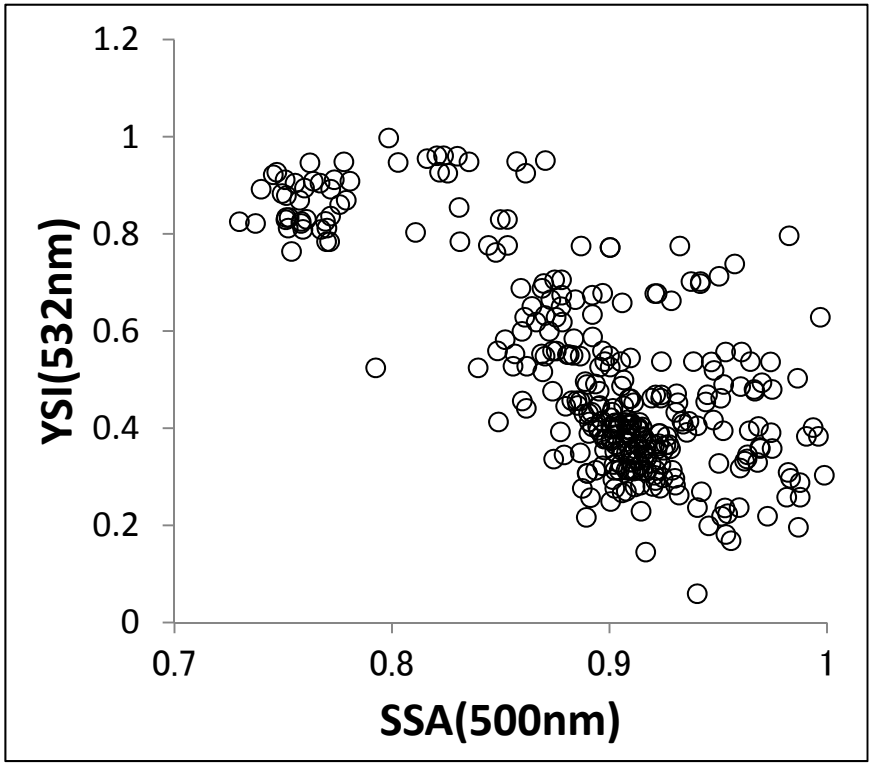
Which size rage has more absorptive aerosols ?

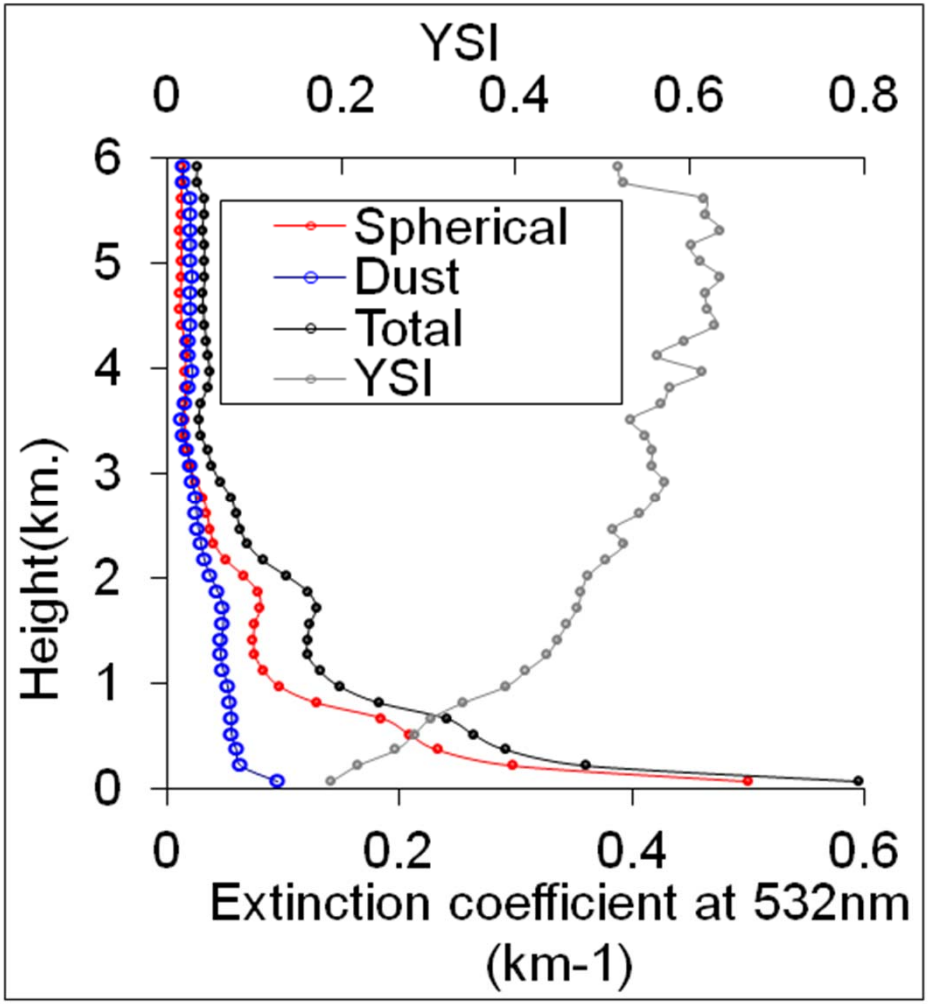




Average vertical profiles by Mie lidar with YSI index

$$YSI \equiv \frac{\sum_i \sigma_{NS}(z)\Delta z}{\sum_i \sigma_{NS}(z)\Delta z + \sum_i \sigma_{SP}(z)\Delta z}$$





Courtesy of Dr. Nobuo Sugimoto/NIES

Two typical data sets selected for anthropogenic and dust dominant aerosols

2009/03/26

Dust rich aerosols

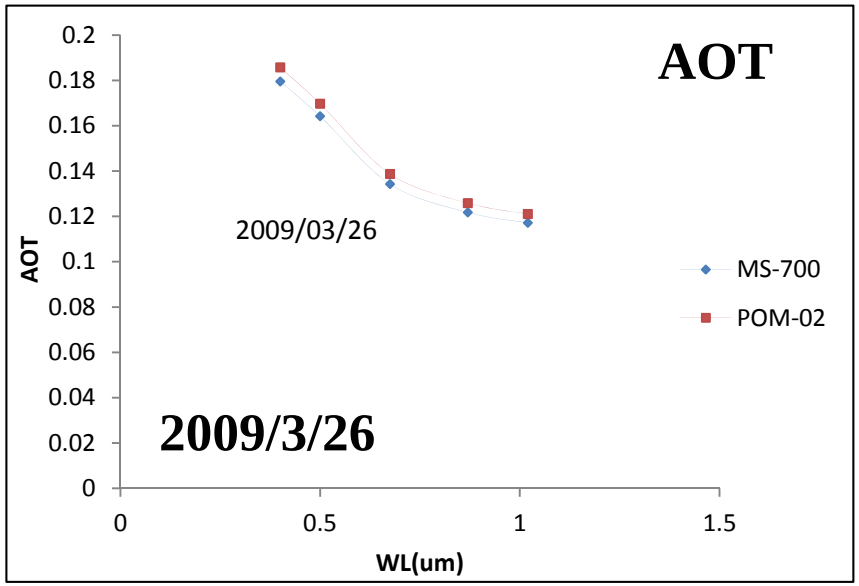
Daily mean	POM-02	MS-700
AOT(500nm)	0.169±0.015	0.164±0.0125
SSA(500nm)	0.867±0.074	0.784±0.034
Ang.Exp.	0.478±0.045	0.478±0.045
YSI(532nm)	0.87±0.06	

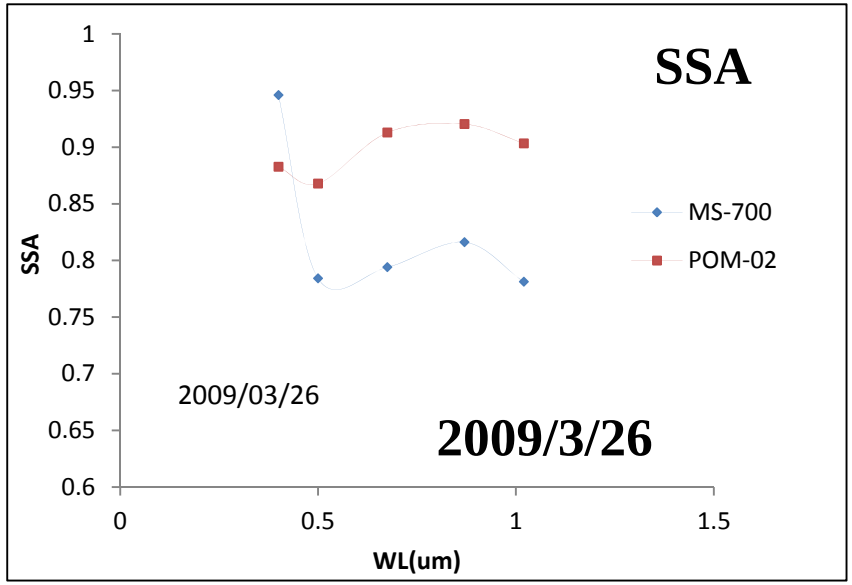
2009/04/11

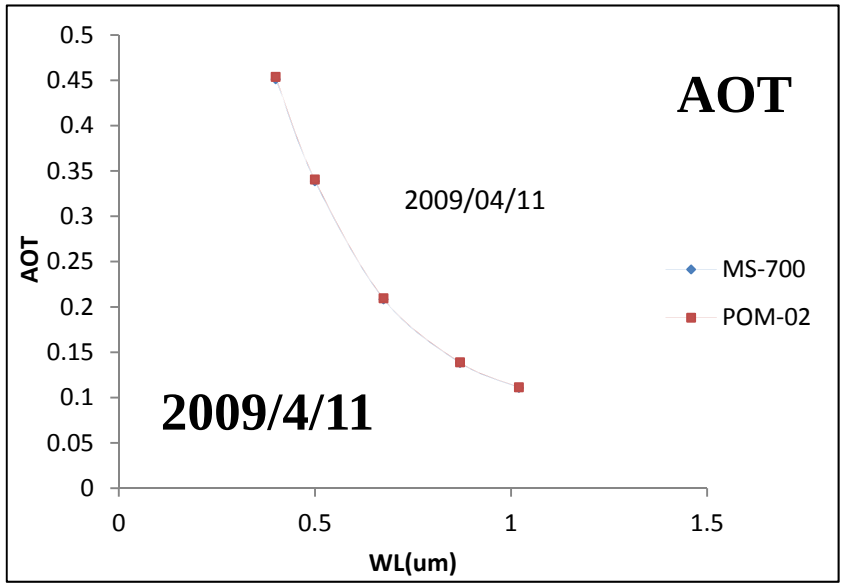
Anthropogenic type aerosols

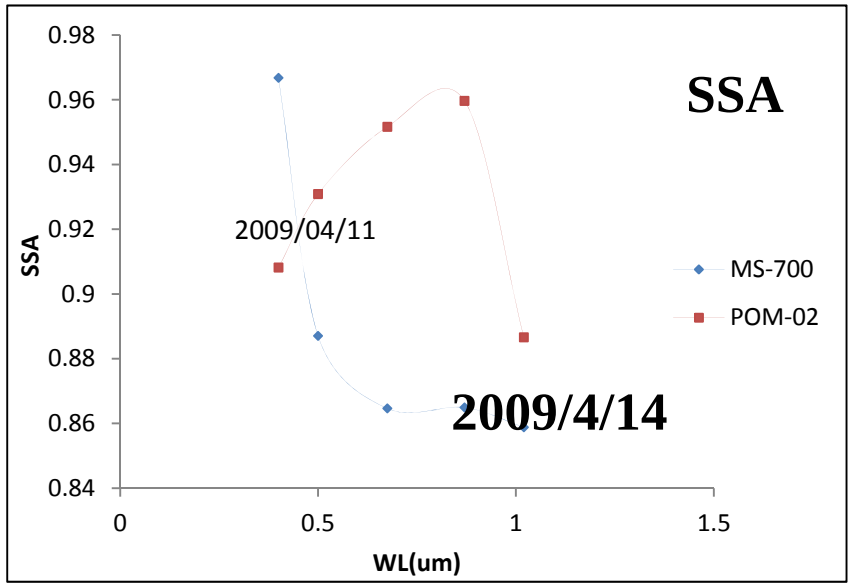
Daily mean	POM-02	MS-700
AOT(500nm)	0.3405±0.02	0.34±0.02
SSA(500nm)	0.93±0.01	0.887±0.01
Ang.Exp.	1.53±0.01	1.53±0.01
YSI(532nm)	0.257±0.029	

Comparison of AOT & SSA between these two days.

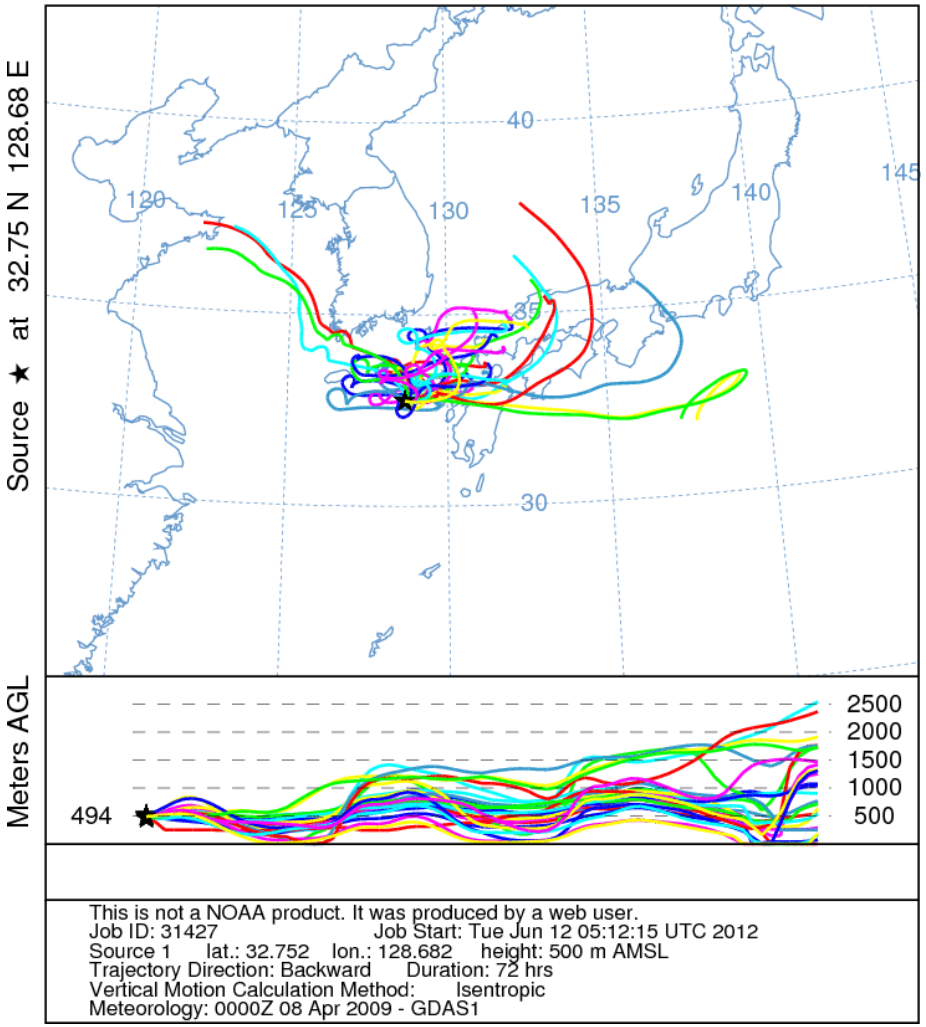






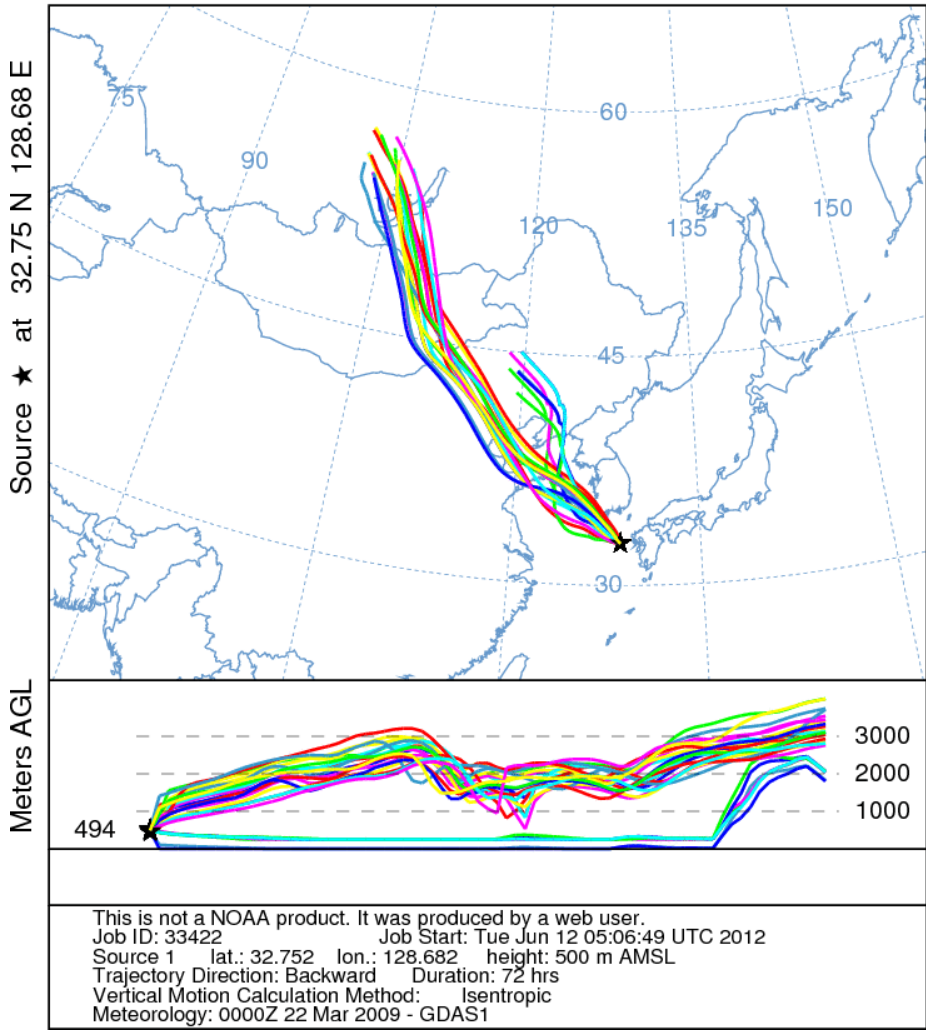


NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 11 Apr 09
GDAS Meteorological Data



This is not a NOAA product. It was produced by a web user.
Job ID: 31427 Job Start: Tue Jun 12 05:12:15 UTC 2012
Source 1 lat.: 32.752 lon.: 128.682 height: 500 m AMSL
Trajectory Direction: Backward Duration: 72 hrs
Vertical Motion Calculation Method: Isentropic
Meteorology: 0000Z 08 Apr 2009 - GDAS1

NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 26 Mar 09
GDAS Meteorological Data



This is not a NOAA product. It was produced by a web user.
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Source 1 lat.: 32.752 lon.: 128.682 height: 500 m AMSL
Trajectory Direction: Backward Duration: 72 hrs
Vertical Motion Calculation Method: Isentropic
Meteorology: 0000Z 22 Mar 2009 - GDAS1

Volume Size Distribution by POM-02 in two typical cases

Case 1:Anthropogenic aerosol dominant

Observation: 2009/04/11

Ang.Exp.= 1.43±0.09

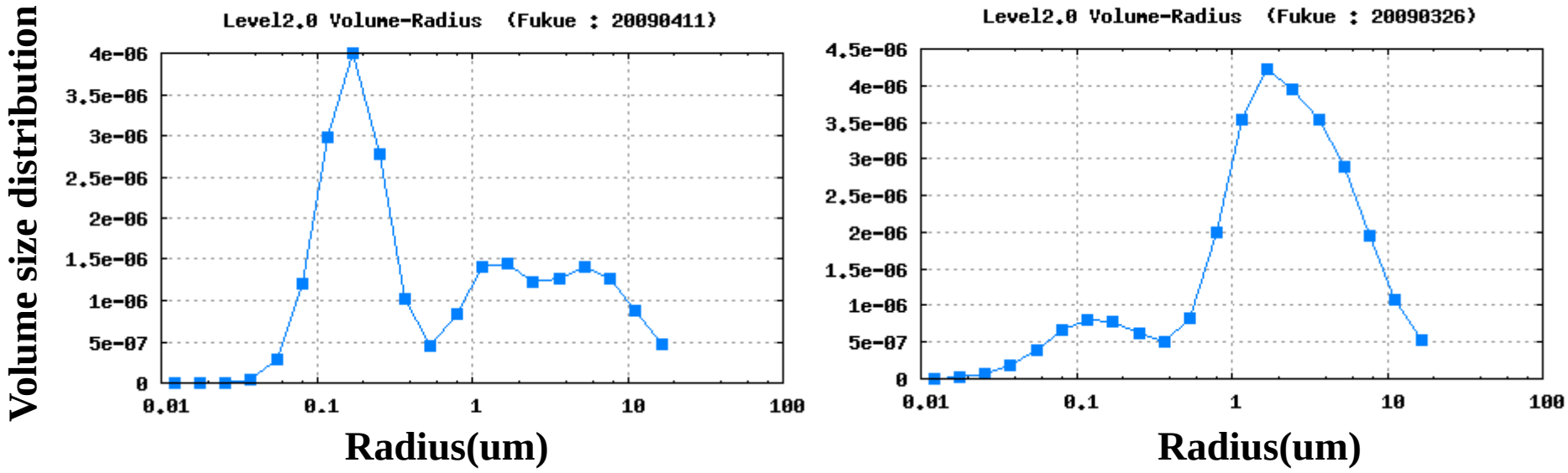
YSI(532nm)= 0.39±0.05

Case 2:Dust aerosol dominant

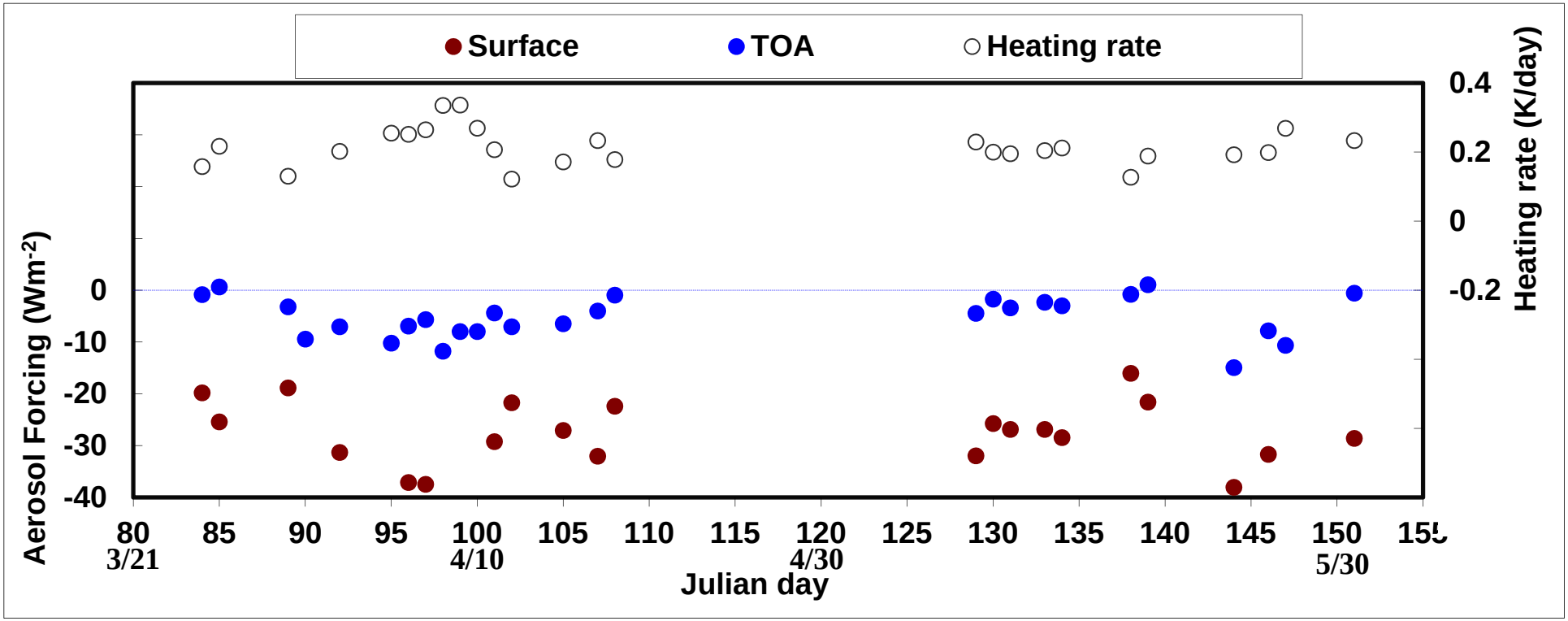
Observation: 2009/03/26

Ang.Exp.= 0.68±0.10

YSI(532nm)= 0.67±0.18



Radiative effect to the solar radiation



	AOT(500nm)	SSA(500nm)	ARF(Wm^{-2})	AFE(Wm^{-2})	HR(K/day)
TOA	---	---	-5.3 ± 4.1	-11.6 ± 6.9	---
ATM	0.38 ± 0.18	0.83 ± 0.06	26.0 ± 6.5	77.9 ± 27.8	0.22 ± 0.05
SFC	---	---	-31.3 ± 9.2	-89.5 ± 21.3	---

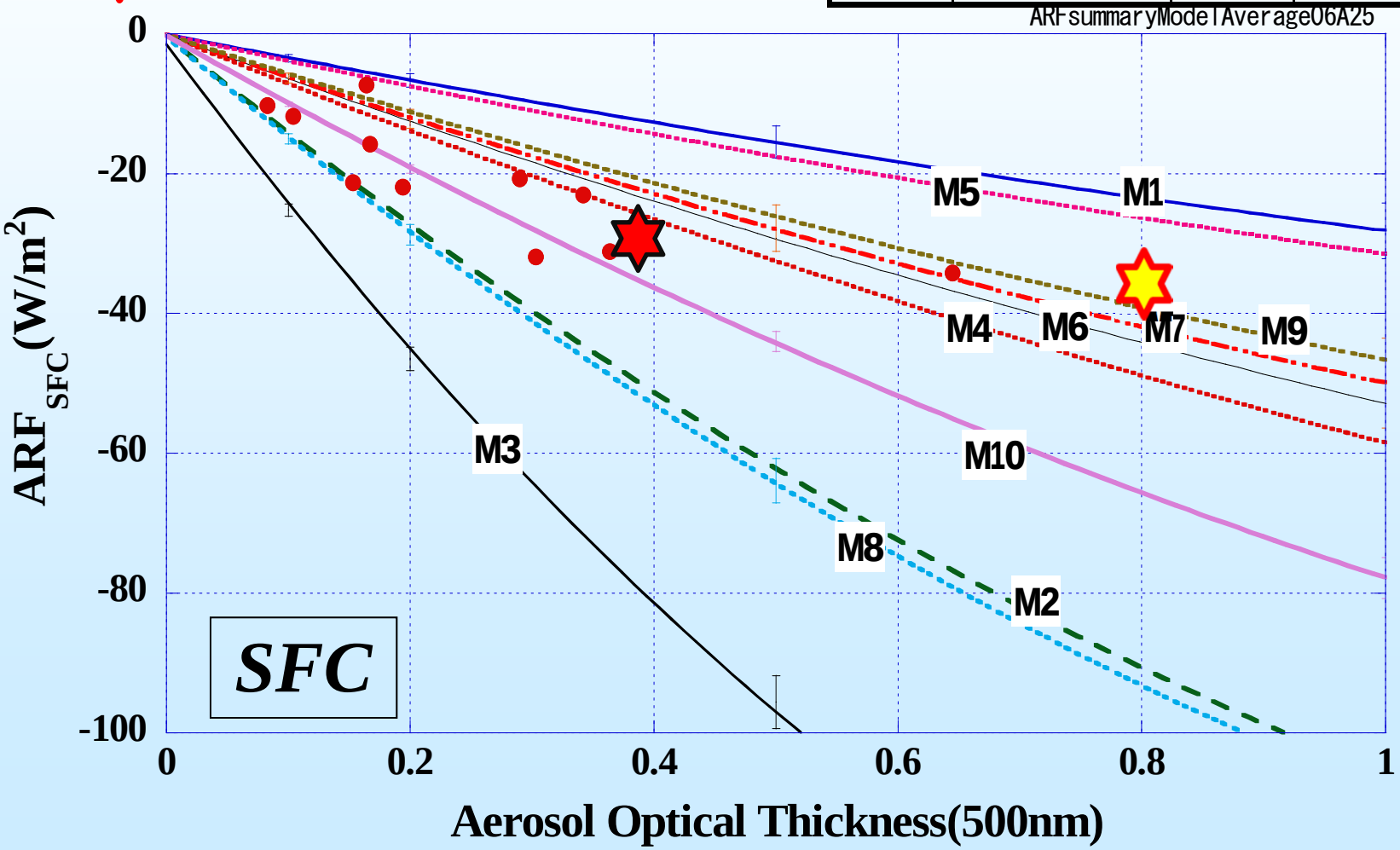
Comparison of Aerosol Radiative Forcing with aerosol models

Model	Characteristics	Model	Characteristics
M1	Water	M6	rural
M2	dust-like	M7	sea spray
M3	soot	M8	urban
M4	volcanic ash	M9	troposphere
M5	75%H2SO4	M10	yellow sand

Present result at Fukue-jima(Spring, 2009)

Takamura et al results at Cheju(Mar. 2005)

Wang et al results at Hefei(Mar-Spr. 07-10)



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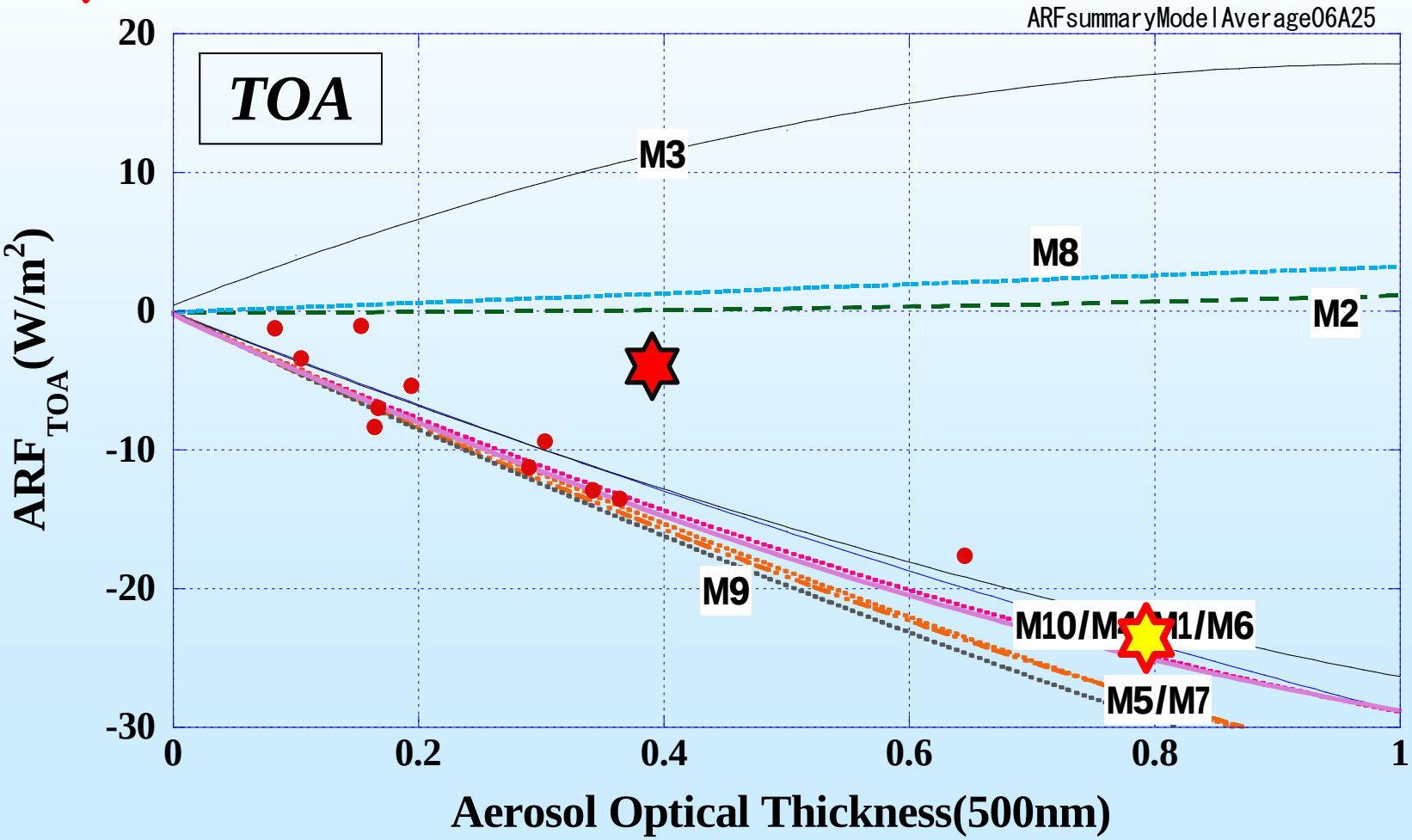

Summary in the MS-700 analysis

(1) The SSA during the spring season 2009 are estimated by a newly installed spectro-pyranometer with a shadow-band system.

(2) The average trend of SSA is found, the atmosphere with high density aerosols shows bigger SSA, i.e., light absorptive aerosols. On the other hand, in the relatively lower AOT, the SSA shows smaller values.

(3) Due to analysis of YSI index by the Mie lidar, the coarse mode includes non-spherical and absorptive particles.

(4) The radiative effects of aerosols are estimated through the observation and analysis.