The Outline of Air Quality Operational and Research Activities in the Japan Meteorological Agency

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Outline

1. JMA operational Air Quality forecast activities
   1-1. Aeolian dust prediction (2004-)
   1-2. UV index prediction (2005-)
   1-3. Oxidant information (2010-)

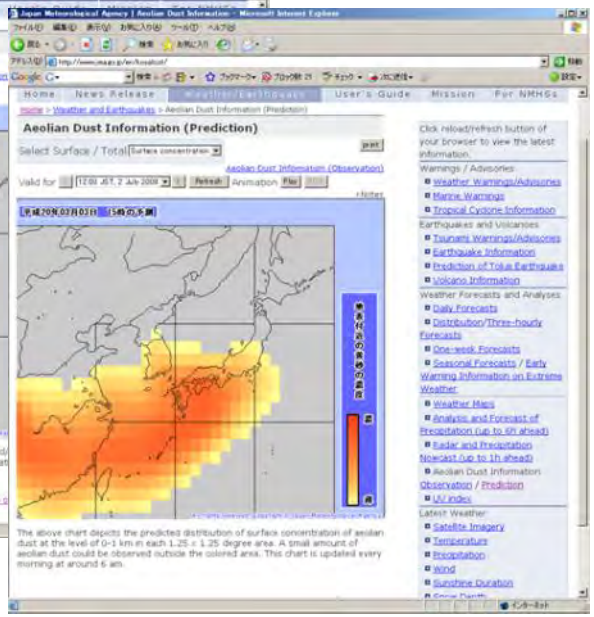
2. MRI/JMA Air Quality research activities
   2-1. Global chemistry transport model development
   2-2. Regional chemistry transport model development
   2-3. Data assimilation technique development
   2-4. Inverse model technique development

3. Summary and conclusions

1-1-1. Public information on Aeolian dust

aeolian dust observation

aeolian dust prediction

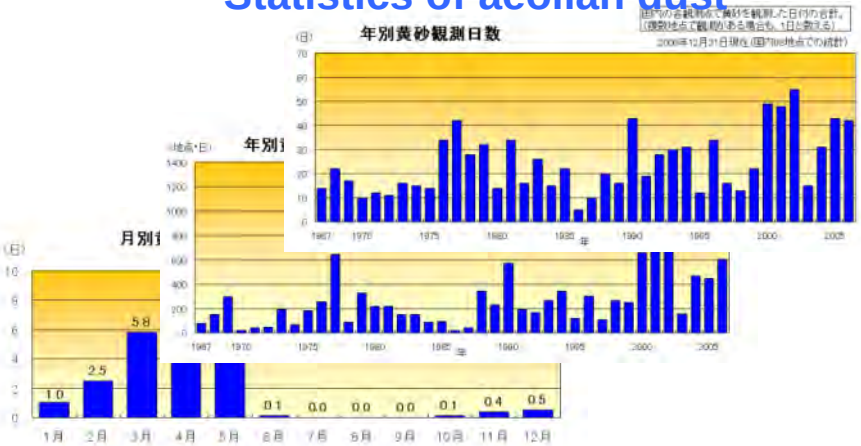


Aeolian dust warning information (In Japanese)

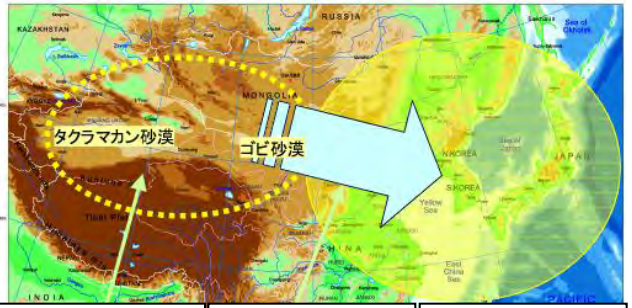
http://www.jma.go.jp/en/kosafcst/

Japanese only

Statistics of aeolian dust



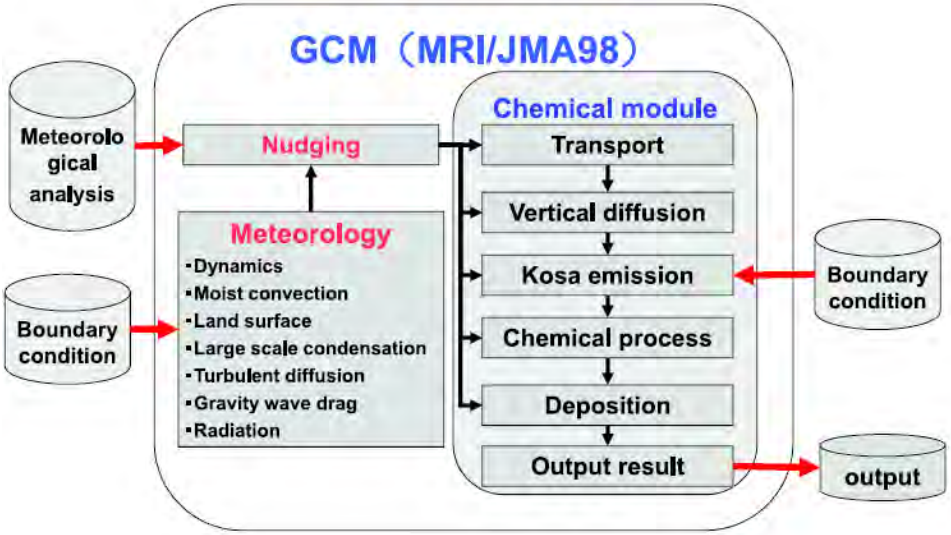
Basic knowledge about aeolian dust



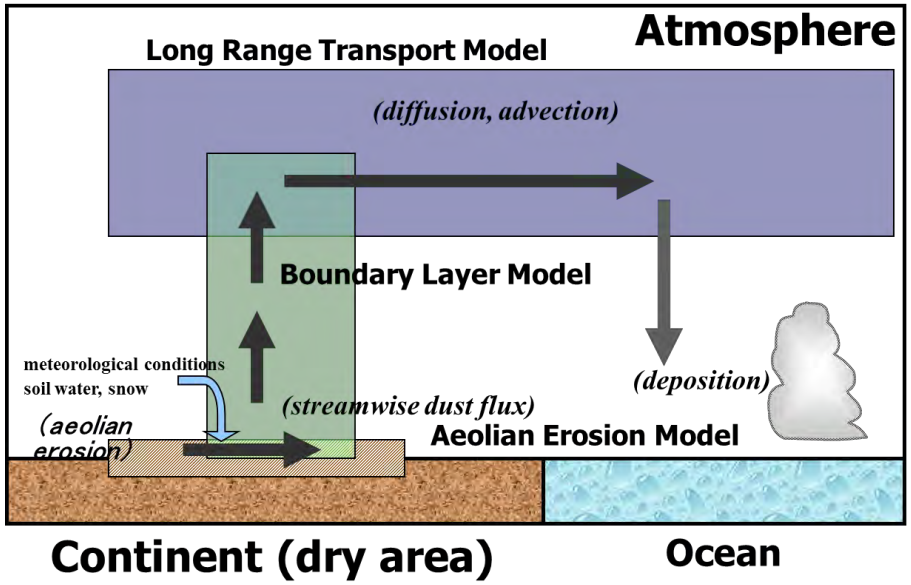
Blown up in arid area in the continent	Advected by the upper wind	Deposits in Japan

JMA also provides aeolian dust prediction results (GPV) for private weather services via the Japan Meteorological Business Support Centre (JMBSC).

1-1-2. Schematic View of Aeolian dust Prediction Model



Schematic view of MASINGAR



Schematic view of dust processes

JMA operates a numerical dust model for the prediction of aeolian dust.

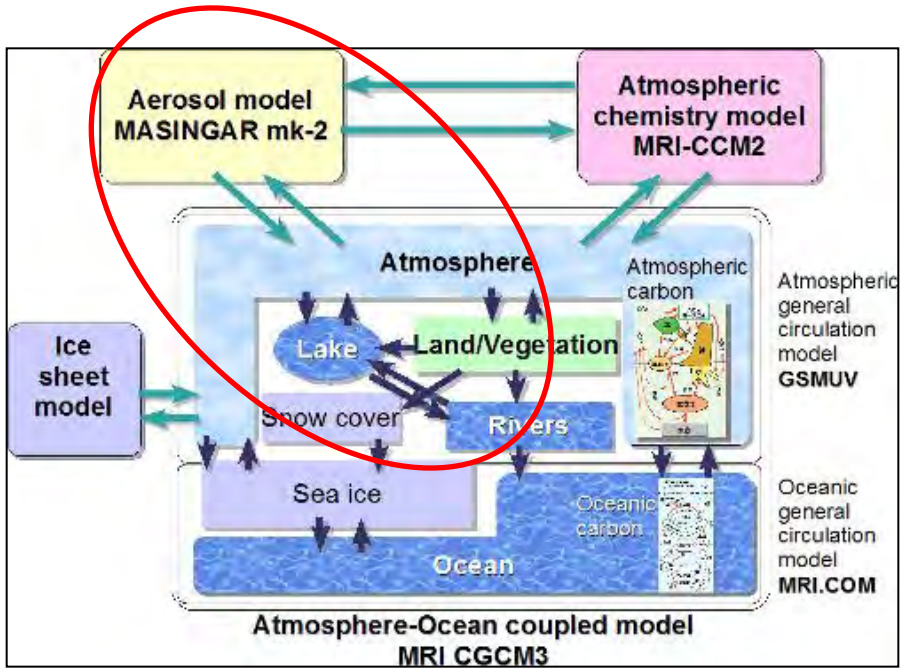
The forecast charts up to 4 days ahead with the interval of 6 hours are updated everyday.

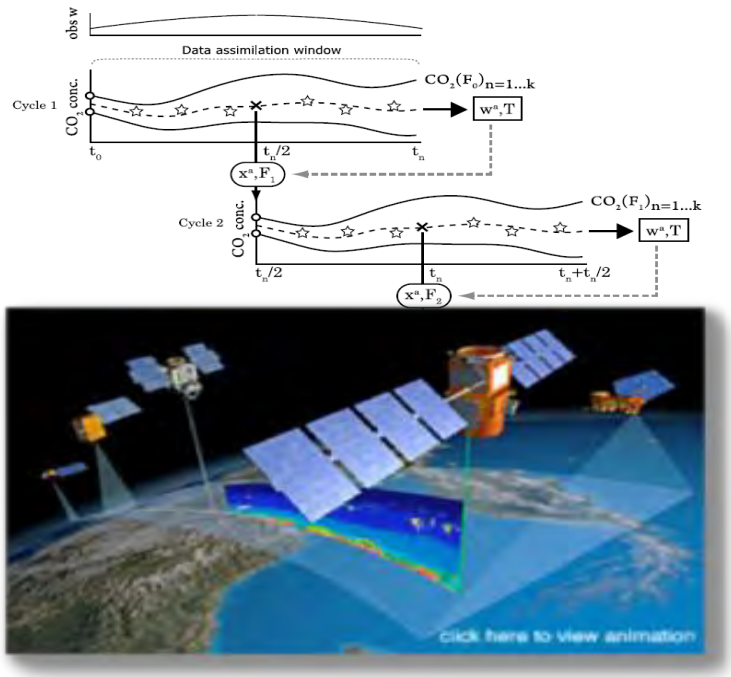
Two kinds of information are provided to the public.

1. Dust concentration from the surface to the height of 1 km
2. Total amount of dust from the surface to the top of the atmosphere

MASINGAR is developed in MRI (Tanaka et al., 2003) to study atmospheric aerosols (not limited to aeolian dust) and related trace species. MASINGAR is directly coupled with our GCM and could make use of all parameters of GCM.

1-1-3. Future plans



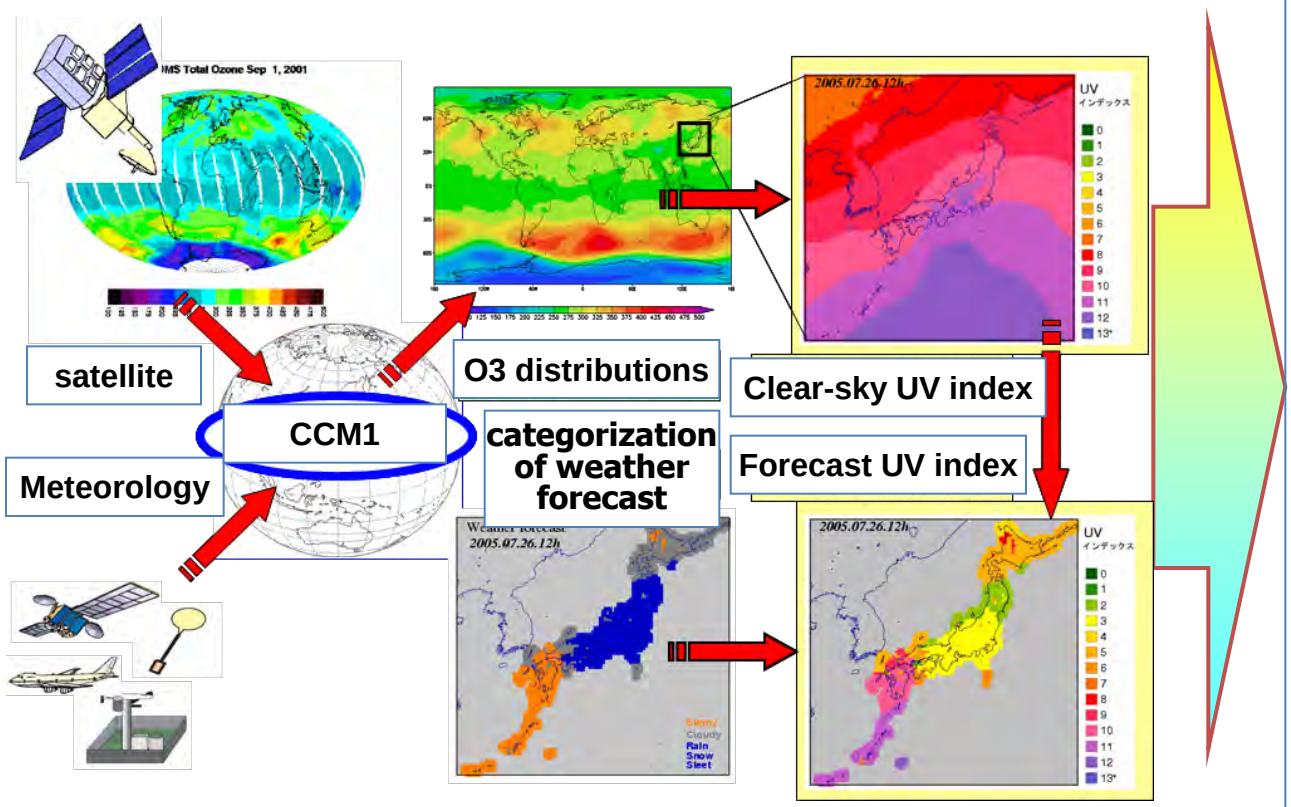


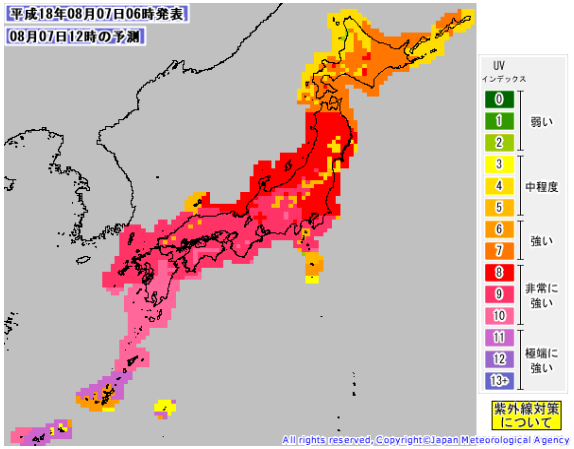
MASINGAR mk-II **Data assimilation**

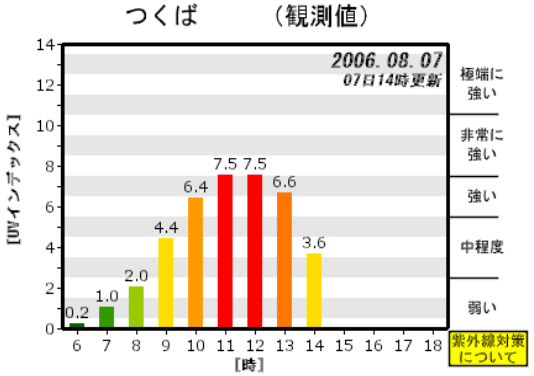
 # MRI CGCM3 has also been used for climate research (e.g. CMIP5).

- JMA has a plan to upgrade MASINGAR (MASINGAR mk-II) with higher resolution (T106; 110km → TL319; 60km) from 2014.
- JMA has a plan to introduce data assimilation system (LETKF) from 2015 (make use of EarthCARE).

1-2-1. Public information on UV index



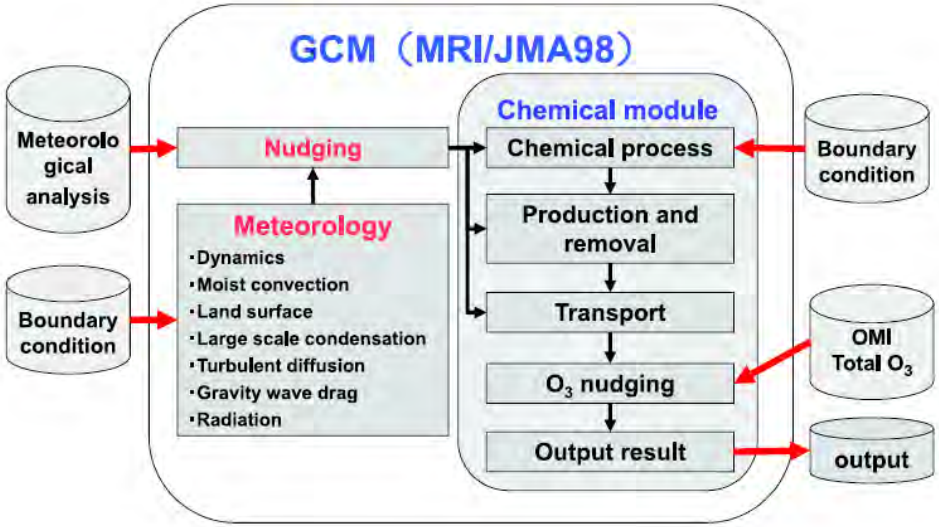




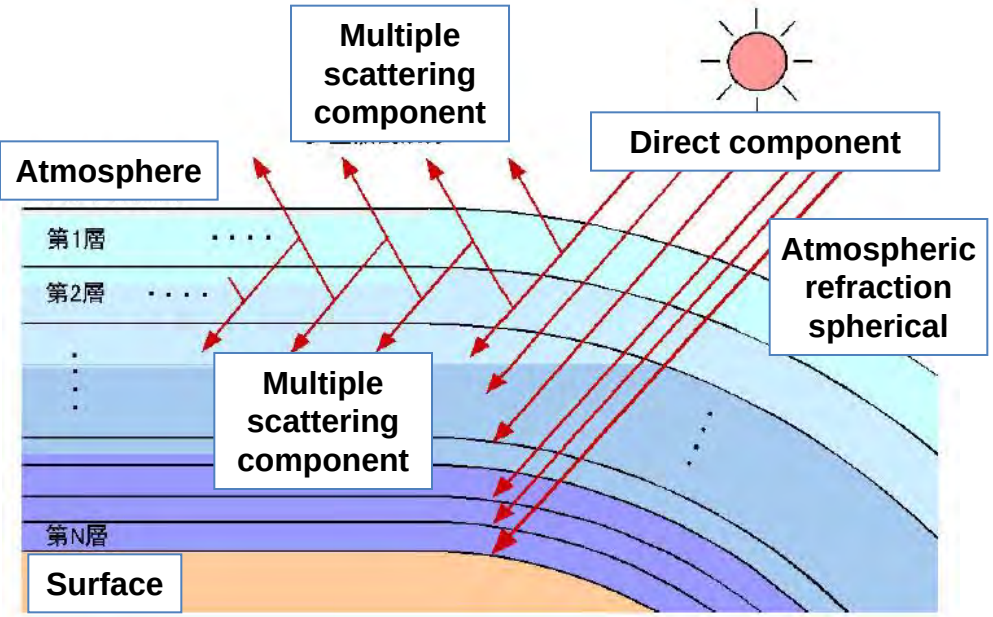
http://www.jma.go.jp/en/uv/

JMA also provides UV index and total O3 prediction results (GPV) for private weather services via the Japan Meteorological Business Support Centre (JMBSC).

1-2-2. Schematic View of CCM1 and ARTMASS



Schematic view of CCM1



Schematic view of ARTMASS

JMA operates a stratospheric chemistry transport model (CCM1, Shibata et al., 2005).

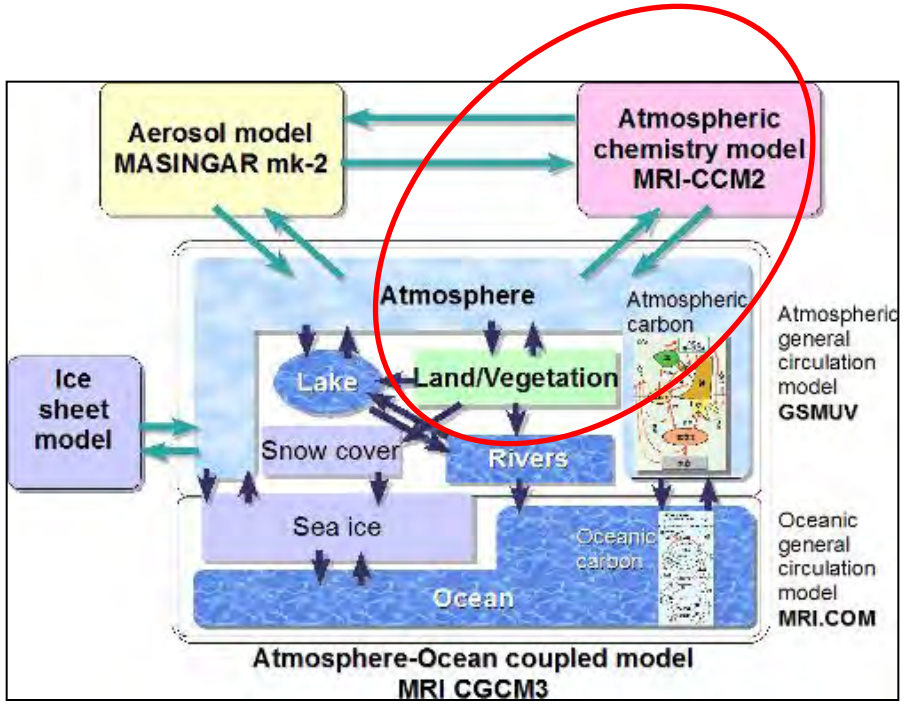
The forecast charts up to 2 days ahead with the interval of 1 hour are updated everyday.

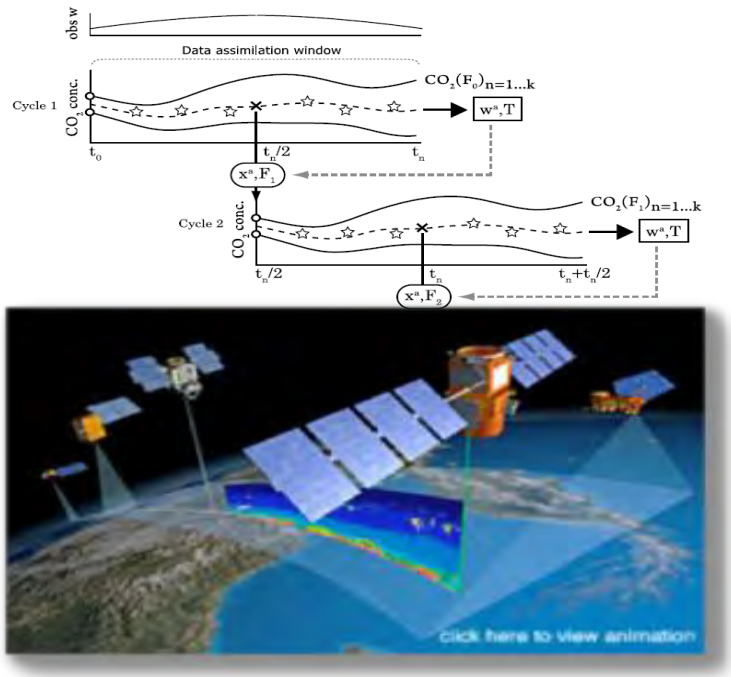
The surface UV dose are calculated under clear-sky conditions by the radiative transfer model(ARTMASS, Aoki et al., 2002).

The Clear-sky UV are corrected by climatological aerosol, distance from the sun, altitude, and climatological surface albedo.

The forecast UV index is corrected from a categorization of weather forecast.

1-2-3. Future plans





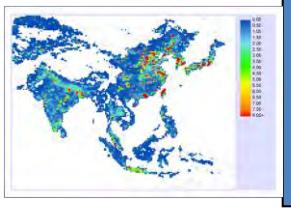
CCM2

Data assimilation

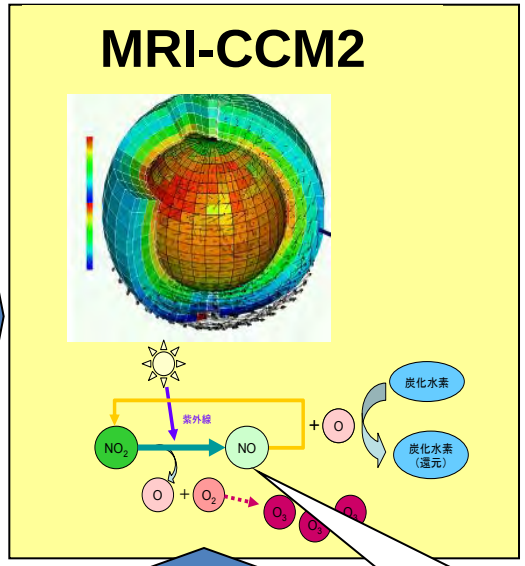
 # MRI CGCM3 has also been used for climate research (e.g. CMIP5).

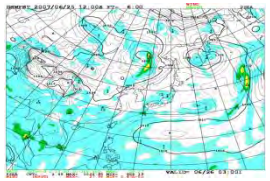
- JMA has a plan to upgrade CCM2 with higher resolution (T42; 280km → TL159; 110km) from 2014.
- JMA has a plan to introduce data assimilation system (LETKF) from 2015 (OMI, MLS).

1-2-1. Public information on oxidant



Inventory data
（statistics）

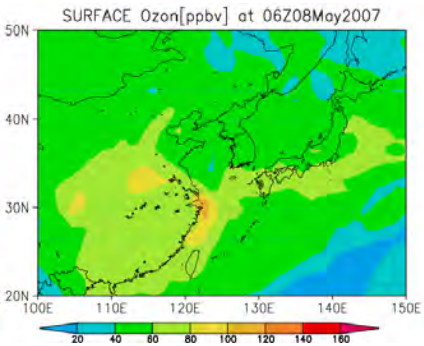




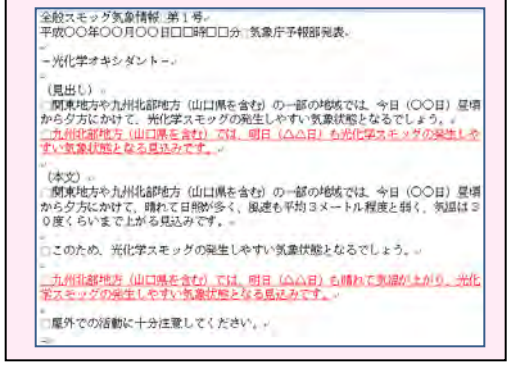
Meteorology

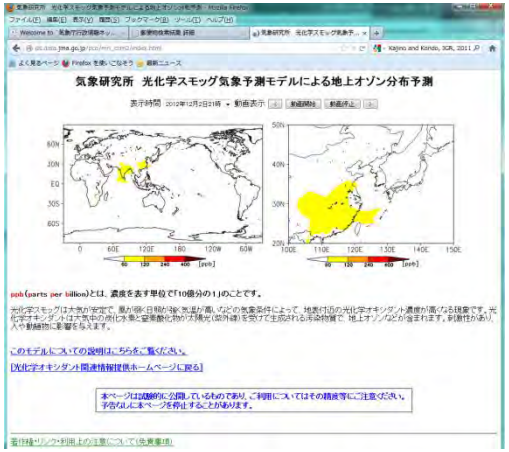
CCM2 was produced by adding detailed tropospheric chemistry to the CCM1

Oxidant prediction



Oxidant information
(Japanese)

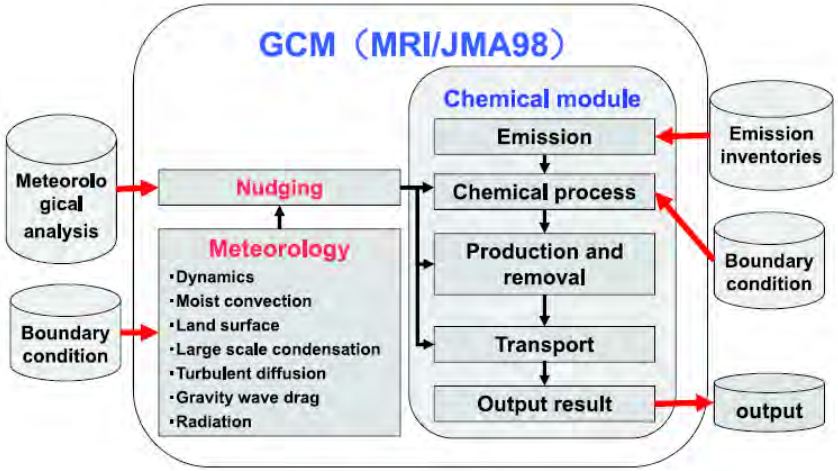




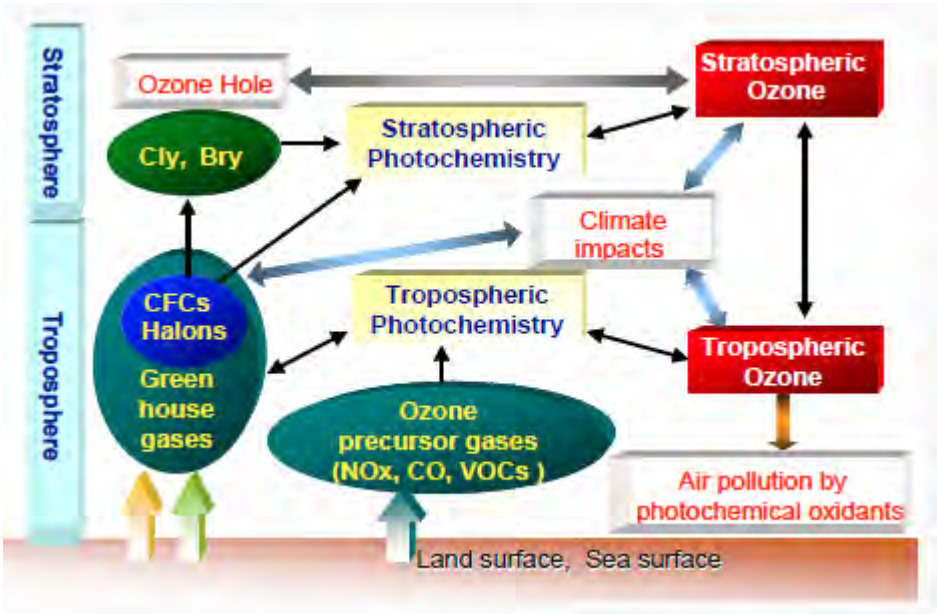
http://ds.data.jma.go.jp/pco/mri_ccm2/index.html

JMA has provided photochemical oxidant information for the whole of Japan by a CTM since August 2010.

1-3-2. Schematic View of CCM2



Schematic view of CCM2



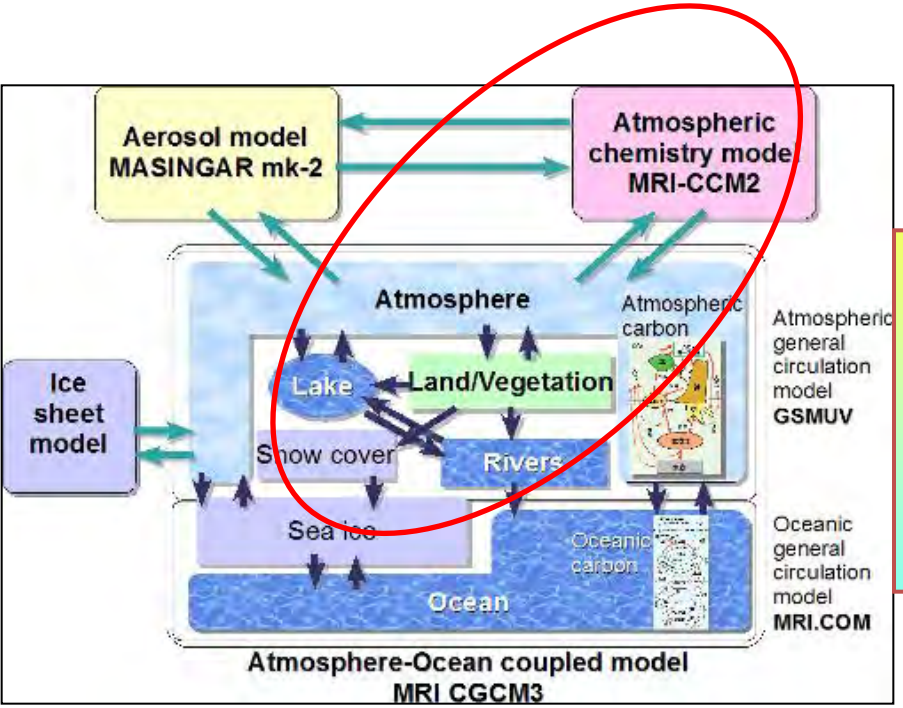
Schematic view of chemical processes

- JMA operates a chemistry transport model (CCM2, Deushi et al., 2011).
- The forecast charts up to 2 days ahead with the interval of 1 hour are updated everyday with T106L30.
- CCM2 was produced by adding detailed tropospheric chemistry to the CCM1 in order to treat ozone chemistry in both the troposphere and the stratosphere seamlessly.
- The chemistry module includes 90 chemical species (64 for the long-lived species and 26 for the short-lived species) with 172 gas-phase reactions, 59 photolysis reactions and 16 heterogeneous reactions.

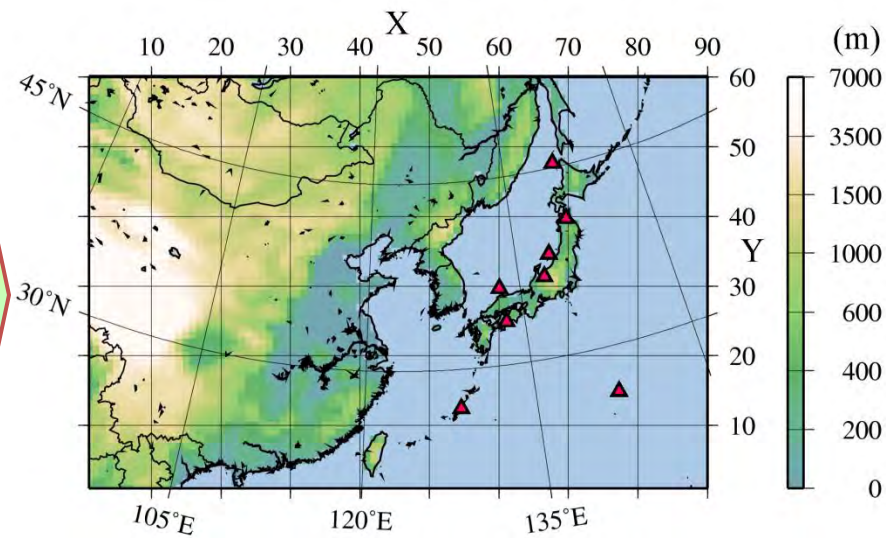
name	emission sources	coverage
EDGAR v2.0 (Olivier et al.)	anthropogenic	Global
GEIA (Guenther et al. (1995))	natural	Global
REAS1.1 (Ohara et al. (2007))	anthropogenic	East Asia

The emission inventories of trace gases

1-3-3. Future plans



CCM2



NHM-Chem

- JMA has a plan to upgrade CCM2 with higher resolution (T106; 110km → TL319; 60km) from 2014.
- JMA has a plan to introduce Regional Chemistry Transport model (NHM-Chem, Kajino et al., 2012) from 2014.

2-1-1. Global chemistry transport model development

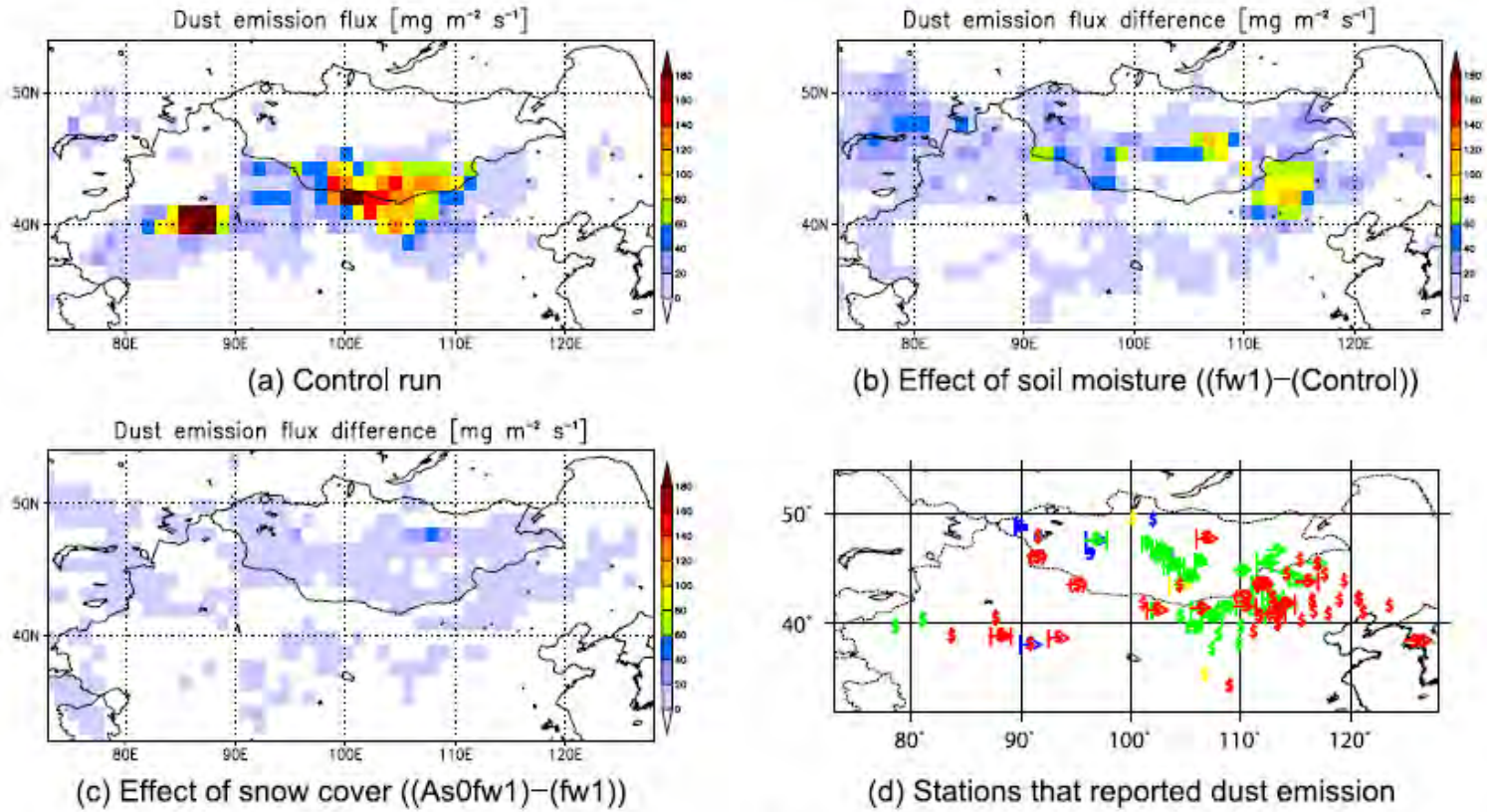


Fig. 2. Simulated dust emission distribution over East Asia from 28 to 31 March 2007. (a) Control run (b) Difference between fw1 and the control run. (c) Difference between the As0fw1 run and the fw1 run. (d) Synoptic observation of the dust emission events (weather report with 7–9 and 30–35) from 28 to 31 March 2007 (Yellow, blue, green and red symbols correspond to the stations that reported dust events on 28, 29, 30, and 31 March 2007, respectively).

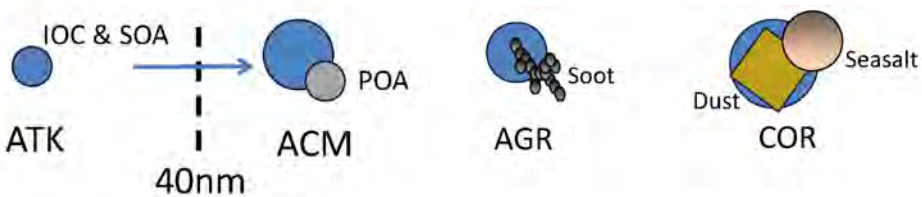
The result suggests that the underestimation of the dust event is due to excessive soil moisture, which suppresses the dust emission(Tanaka et al., SOLA, 2011).

We needs more observation data for input and validation near dust source region.

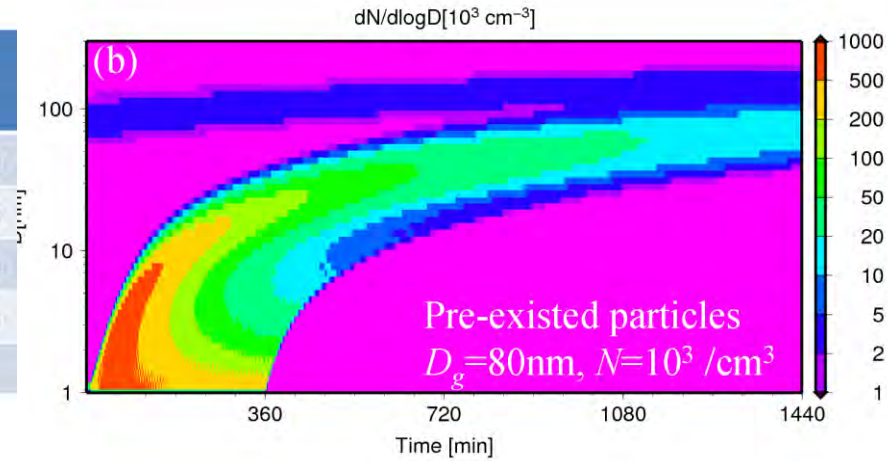
2-2-1. Regional chemistry transport model development

Category approach: List of aerosol tracers

	Category name	Physical components		Chemical compositions									
1	ATK	M_0	M_2	-	-	OA	-	-	SO_4^{2-}	NH_4^+	NO_3^-	Cl^-	H_2O
2	ACM	M_0	M_2	UID	-	OA	-	-	SO_4^{2-}	NH_4^+	NO_3^-	Cl^-	H_2O
3	AGR	M_0	M_2	UID	BC	OA	-	-	SO_4^{2-}	NH_4^+	NO_3^-	Cl^-	H_2O
4	COR	M_0	M_2	UID	BC	OA	DU	SS	SO_4^{2-}	NH_4^+	NO_3^-	Cl^-	H_2O
		M_0^{AGR}											



Kajino et al., ACP, 2012 in press.

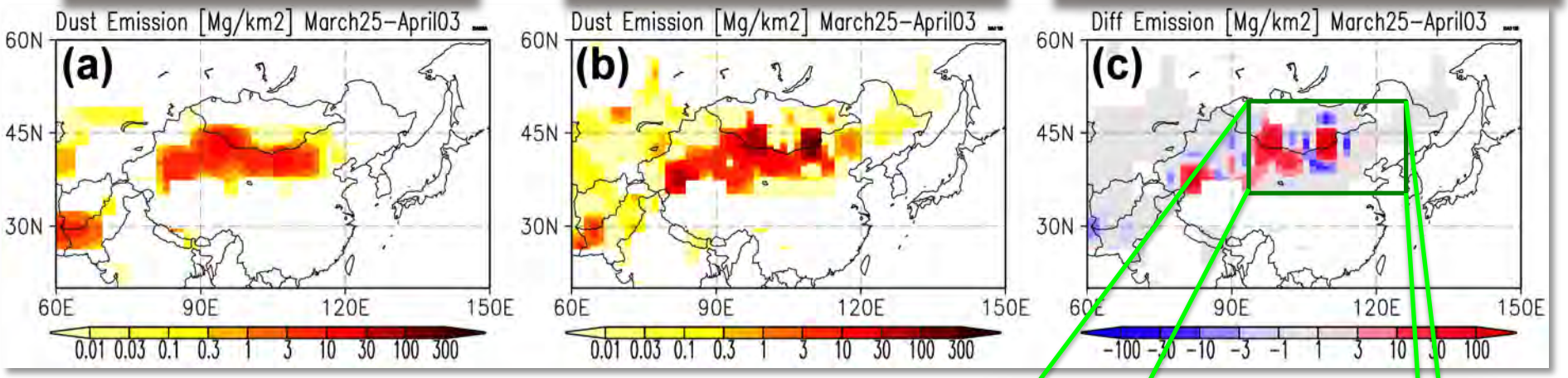


Kajino, *JAS*, 2011

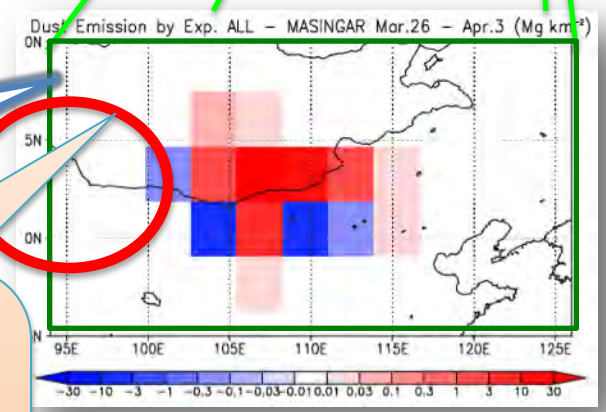
The model implements a new aerosol dynamics module (Modal Aerosol Dynamics model for multiple Modes and fractal Shapes (MADMS)), which for the first time enables simulation of intermodal Brownian coagulation between two modes with very different size distributions using the modal moment approach.

2-3-1. Data assimilation technique development

Model estimate | **Data assimilation** | **correction＝(b)－(a)**



Sekiyama et al., *SOLA* (2011)

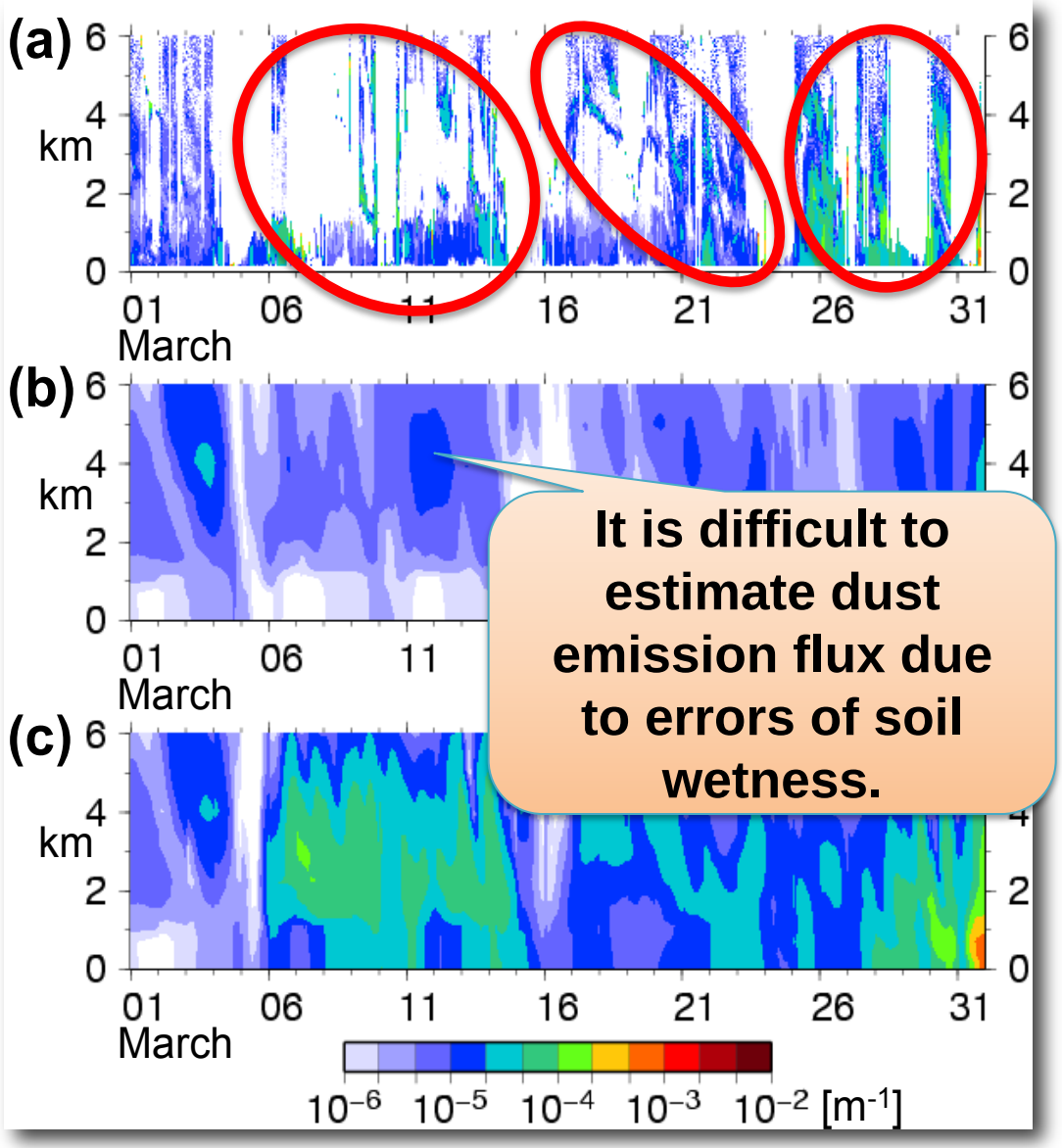


Maki et al., *SOLA* (2011)

Same model (MASINGAR) ＆Different observation (PM_{10}conc.) ＆Different methodology (Baysian Synthesis)
→The results are consistent!

It is difficult to estimate due to the insufficient observation coverage (mainly in Japan and Korea)

2-3-2. Data assimilation technique development



Sekiyama et al., *SOLA* (2011)

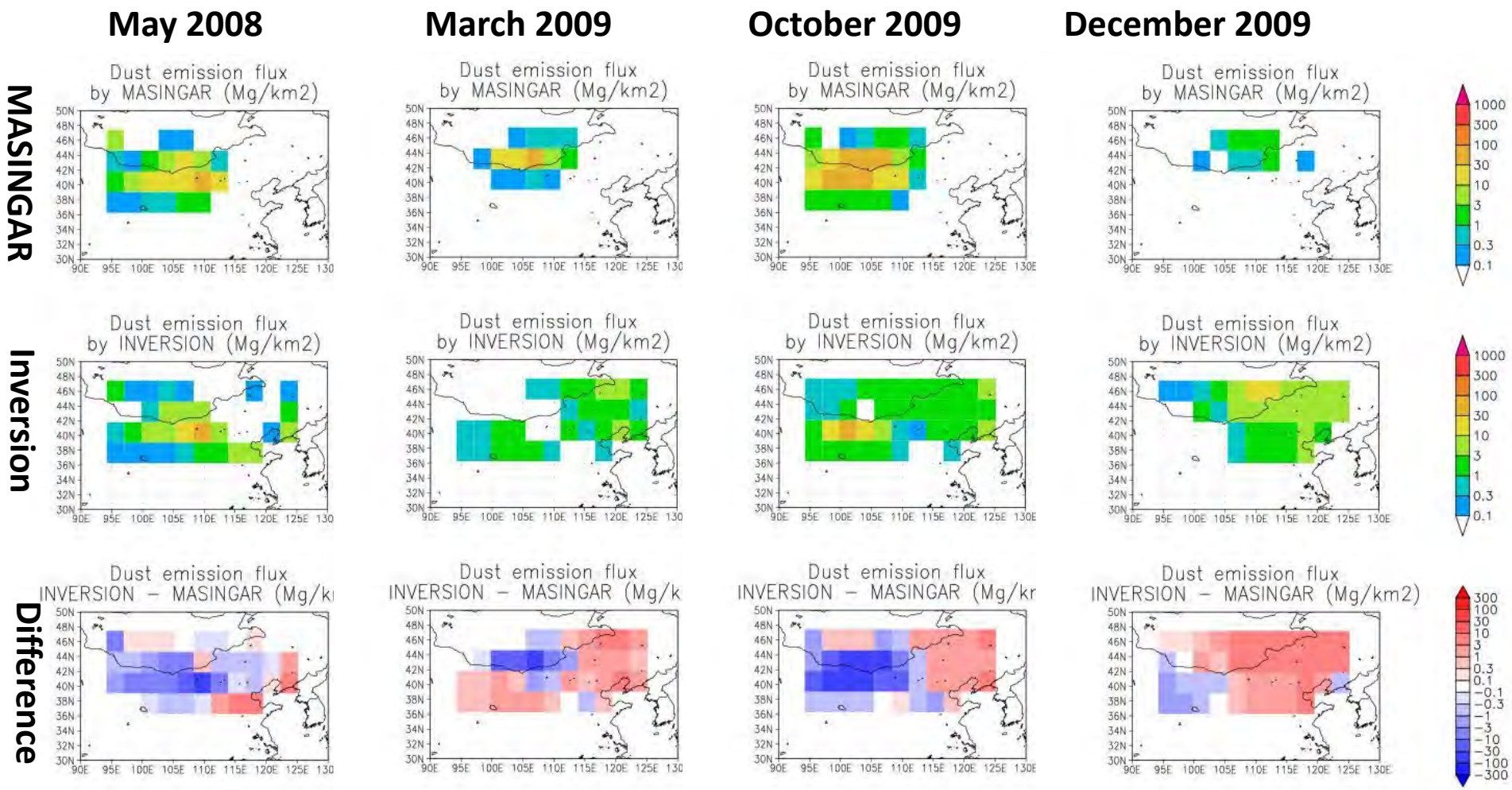
Modify dust emission flux by data assimilation

(a) dust extinction by NIES Lidar（Nagasaki）[532nm] ← independent observation

(b) Dust extinction by MASINGAR run (w/o assimilation)

(c) Dust extinction by modified dust emission using assimilation

2-4-1. Inverse model technique development



Inverse model could increase dust emission at N.E. China in all cases. Dust emission amount by MASINGAR tends to larger except Dec. 2009 case.

Summary

- JMA operates global chemistry transport models developed in MRI. The prediction information is provided via website.

- These models are coupled directly with GCM and could treat all processes of GCM. The GCM are nudged towards JMA operational analysis and forecast.

- We have a plan to upgrade our global models and introduce regional chemistry transport models in 2 - 3 years.

- We also have a plan to introduce LETKF data assimilation system to the aerosol and the stratospheric ozone prediction systems in 2 – 4 years.

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Thank you very much for your attention!