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


Meteorological Research Institute
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)


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

- 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).

# MRI CGCM3 has also been used for climate research (e.g. CMIP5).
JMA also provides UV index and total O3 prediction results (GPV) for private weather services via the Japan Meteorological Business Support Centre (JMBSC).
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

- 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).

# MRI CGCM3 has also been used for climate research (e.g. CMIP5).
JMA has provided photochemical oxidant information for the whole of Japan by a CTM since August 2010.
1-3-2. Schematic View of CCM2

- 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.

<table>
<thead>
<tr>
<th>name</th>
<th>emission sources</th>
<th>coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDGAR v2.0 (Olivier et al.)</td>
<td>anthropogenic</td>
<td>Global</td>
</tr>
<tr>
<td>GEIA (Guenther et al. (1995))</td>
<td>natural</td>
<td>Global</td>
</tr>
<tr>
<td>REAS1.1 (Ohara et al. (2007))</td>
<td>anthropogenic</td>
<td>East Asia</td>
</tr>
</tbody>
</table>
1-3-3. Future plans

- 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.
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 need more observation data for input and validation near dust source region.
2-2-1. Regional chemistry transport model development

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.

### Category approach: List of aerosol tracers

<table>
<thead>
<tr>
<th>Category name</th>
<th>Physical components</th>
<th>Chemical compositions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATK</td>
<td>M₀, M₂</td>
<td>OA, SO₄²⁻, NH₄⁺, NO₃⁻, Cl⁻, H₂O</td>
</tr>
<tr>
<td>ACM</td>
<td>M₀, M₂, UID</td>
<td>OA, SO₄²⁻, NH₄⁺, NO₃⁻, Cl⁻, H₂O</td>
</tr>
<tr>
<td>AGR</td>
<td>M₀, M₂, UID, BC</td>
<td>OA, SO₄²⁻, NH₄⁺, NO₃⁻, Cl⁻, H₂O</td>
</tr>
<tr>
<td>COR</td>
<td>M₀, M₂, UID, BC, OA</td>
<td>DU, SS, SO₄²⁻, NH₄⁺, NO₃⁻, Cl⁻, H₂O</td>
</tr>
</tbody>
</table>

Kajino et al., ACP, 2012 in press.

Kajino, JAS, 2011

Pre-existing particles $d_a=80\text{nm}$, $N=10^3$/cm³

Kajino et al., ACP, 2012 in press.
2-3-1. Data assimilation technique development

Model estimate

Data assimilation

Correction = (b) − (a)

Sekiyama et al., SOLA (2011)

Same model (MASINGAR) & Different observation (PM$_{10}$ conc.) & Different methodology (Bayesian Synthesis)

→ The results are consistent!

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

Maki et al., SOLA (2011)
2-3-2. Data assimilation technique development

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

It is difficult to estimate dust emission flux due to errors of soil wetness.

Sekiyama et al., SOLA (2011)
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.
References


Thank you very much for your attention!