Improvement of photochemical oxidant information by applying transport model to oxidant forecast

Isao Takano, Yuri Aikawa and Susumu Gotoh

Japan Meteorological Agency
E-mail: itakano@met.kishou.go.jp, aikawa@met.kishou.go.jp

1. Introduction

The Japan Meteorological Agency (JMA) has produced a statistical guidance of oxidant using weather and pollutant observation and issued photochemical oxidant information for prefectures in high oxidant concentration days.

To offer more detailed information in time and in space, we have developed an atmospheric transport model that takes in the forecast of the operational mesoscale NWP model (MSM) and the air pollutant observation.

The statistical verification showed that the information produced by the atmospheric transport model was more accurate than that by the statistical guidance.

2. Methodology

The JMA obtains air-pollution observation in the southern part of the Kanto region using private lines from the Tokyo metropolitan Government immediately, and those in northern part of the Kanto region through internet from the website AEROS [1] within two hours. Analysis of oxidant concentration at 03UTC is calculated as a weighted average of observation data at each horizontal grid with a spacing of 0.1 degree in lat. 35-37°N and long. 139-141°E.

High oxidant condition is produced through complex photochemical processes involving NO_2 and other gases. We approximated oxidant production during the forecast period using NO_2 concentration and model-forecast solar radiation and temperature.

Assuming that the time tendency of the NO_2 concentration is small, NO_2 concentration at 03UTC is applied to 03-08UTC. This estimated oxidant concentration is proportional to NO_2 concentration using a coefficient dependent on solar radiation and surface temperature of MSM outputs.

The atmospheric transport model (Iwasaki et al., 1998; JMA, 2002) is applied to oxidant forecast. One hundred thousand particles are released at the analysis time and the location (distributed uniformly 0-500m above ground here) and transported with a time interval of 10 minutes using the hourly outputs of MSM at 00UTC initial time. The dropped and deposition schemes are not used. The horizontal diffusion scheme depends on Gifford (1982). It adopts Gifford (1977), which treats a similar time scale, as a diffusion parameter. Some particles are emitted after 04UTC as oxidant generated from NO_2.

3. Verification Experiments and results

The performance of the statistical guidance and the atmospheric transport model are compared with cases of 9 days in August 2006 that the photochemical oxidant information was announced and the oxidant concentration reached to the level of the photochemical oxidant advisory (120ppb).

If both the analysis and the forecast include (or do not include) a high oxidant concentration grid within a first subdivision forecast district (where a prefecture is divided into several), it is assumed to be a hit, and a failure when only the forecast includes a high concentration grid, and a miss when only the analysis includes a high concentration grid.

The maps of the oxidant concentration of the analysis and the five-hour forecast at 08UTC on 4 August 2006 are shown in Fig. 1. A high concentration region of the forecast captures that of the analysis very well.

The hourly scores of the model and the guidance at 04-09UTC for 9 days in the southern part of the Kanto region is shown in Fig. 2. The hit rate of model exceeds that of the guidance throughout the forecast time. Besides, the false rate of the model is equal to and the missing rate is less than those of the guidance.

[1] Atmospheric Environmental Regional Observation System, http://soramame.taiki.go.jp

4. Conclusion

The result indicates that the transport model applied to the oxidant contributes to the improvement of the forecast. In addition, the model has good precision in each forecast district throughout the forecast time in the southern part of the Kanto region. The JMA comes to be able to announce the photochemical oxidant information supplemented with the model oxidant forecast 04-09UTC in this area after 04UTC.

On the other hand, there is some difficulty in the forecast of high oxidant concentration areas in the northern part of Kanto, which is mostly attributable to the discrepancy of the analysis time and the observation time there.

MSM plans to adopt a hybrid terrain following vertical coordinate (JMA, 2007), then the transport model will be modified to adopt the same coordinate.

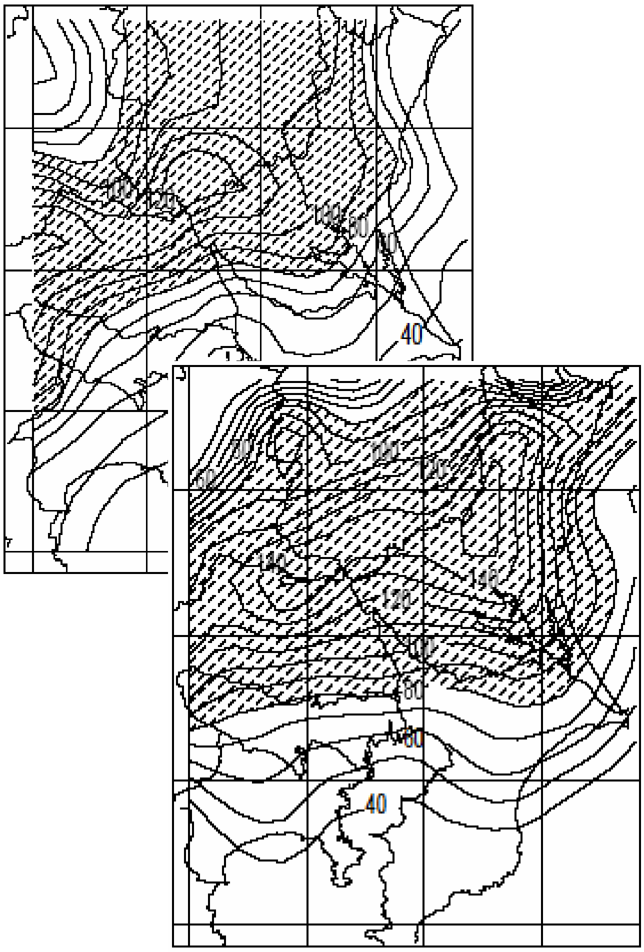

Fig. 1 The oxidant concentration of the analysis and the forecast at 08UTC Aug 4th 2006 (upper chart: analysis, lower chart: forecast). The area exceeding 80ppb is hatched.

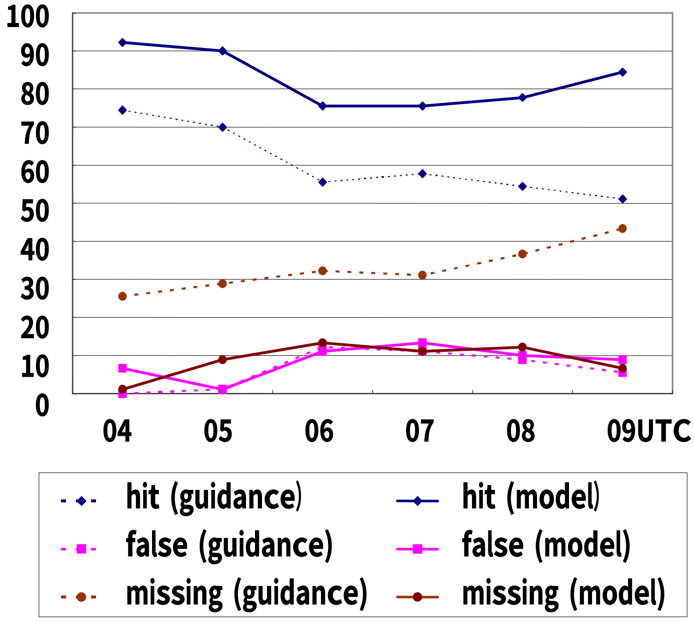

Fig. 2 The hourly scores of model and guidance between 04UTC and 09UTC for the 9 days in the southern part of Kanto.

References

Gifford, F. A., 1977: Tropospheric Relative Diffusion Observations. *J. Appl. Met.*, **16**, 311-313

Gifford, F. A., 1982: Horizontal diffusion in the atmosphere: A Lagrangian-dynamical theory. *Atmos. Environ.*, **16**, 505-512

Iwasaki, T., T. Maki, and K. Katayama, 1998: Tracer transport model at Japan Meteorological Agency and its application to the ETEX data. *JMA/NPD Tech. Rep.*, **35**,4285-4295

JMA, 2002: Outline of operational numerical weather prediction at Japan Meteorological Agency. Available from Numerical Prediction Division, JMA. 158pp

JMA, 2007: Outline of operational numerical weather prediction at Japan Meteorological Agency. Available from Numerical Prediction Division, JMA. 197pp