別紙３

2016-2018

Bilateral Cooperation on PM2.5

Between Japan and the Republic of Korea

Summary for Policy Makers

November 2019

Ministry of Environment of Japan

Ministry of Environment of the Republic of Korea

TEMM21

Ⅰ. Background

Recognizing the growing public concern on fine particles and urgent call for regional clean air, the two Ministers of Environment of Republic of Korea and Japan mutually acknowledged the importance of strengthening bilateral cooperation for control and reduction of $PM_{2.5}$, during a meeting held on the occasion of the United Nation's Climate Change Conference on November 2013, in Warsaw, Poland. For further discussion, the two ministers had a meeting at the 16th Tripartite Environmental Ministers' Meeting (TEMM 16) on April 2014 in Daegu, Korea. They reached an agreement to launch a new bilateral channel for collaboration on $PM_{2.5}$ reduction and management.

To follow up, working-level administrators and scientists in the field hold a kick-off meeting on June 2015 in Incheon, Korea, to identify potential topics for collaboration in which the both countries were interested and produce detailed action plans. They agreed to share scientific knowledge and technologies for $PM_{2.5}$ forecasting and emission inventory and to exchange best policy practices in mitigating and controlling emissions with a special focus on the following five subjects.

- Evaluation of equivalence between automatic and manual standard methods on PM2.5 mass concentration monitoring
- Improvement of $PM_{2.5}$ forecasting accuracy
- Sharing of real-time monitoring data of $PM_{2.5}$
- Joint research on emission inventory and transboundary pollution of $PM_{2.5}$
- Countermeasures toward achieving environmental standards of $PM_{2.5}$

For joint research, two groups were established, one for $PM_{2.5}$ forecasting model and the other for $PM_{2.5}$ emission inventory. The two countries met biannually on a rotation basis for a host country, with the attendance of two Ministries of Environment (MOEJ, MEK), National Institute of Environmental Research of Korea (NIER), National Institute for Environmental Studies of Japan (NIES), Japan Automobile Research Institute (JARI), Asia Center for Air Pollution Research (ACAP), and Overseas Environmental Cooperation Center of Japan (OECC). In general, a meeting has 3 pillars, one for policy dialogue and the other two for joint modeling and emission inventory research.

As of Aug 2019, the two countries marked 11^{th} meeting for the channel. It has provided a great opportunity for both countries to exchange information and practical ideas on fine particles management and scientific approach. It serves as solid foundation to promote ambient air cooperation of the two countries. Tighter linkage is expected to share policies and views and explore joint actions for the regional clean air.

Ⅱ .Joint Research Summary

[Forecasting Modeling Group]

The modeling group's purpose is to obtain in-depth understanding on behavior characteristics of PM2.5 in the North East Asia by season and analyze accuracy of the air quality models used for forecasting in Japan and Korea to improve them. In this regard, the group conducted simulation with the models for the four periods of 2015 for which both sides measured PM2.5 and its major components. The accuracy of the forecasting models was assessed by comparing the modeled concentrations and actual monitoring data, and the causes of the differences between the model results and monitoring data were analyzed. Information and opinion exchanges between the two countries on the issues related to the forecasting models have contributed to improving the accuracy for the two countries' forecasting models.

More concretely, the two countries studied the following four cases:

Case 1- January 21 to February 3, 2015
Case 2- May 7 to May 21, 2015
Case 3- July 22 to August 5, 2015
Case 4- October 21 to November 4, 2015

The study results are described as following.

1. *Korea*

To simulate PM2.5 in the North East Asian region, the Korean side used the weather model "WRFv3.8.1" and air quality model "CMAQv5.0.2." The Korean side also used FNL[note1] 1°×1° data for the meteorological input data, the anthropogenic emission inventory MIX 2010 for foreign contributions, and the South Korean emission inventory CAPSS 2010 for local emissions.

For the Korean forecasting model, data from six areas were used: Baengnyeongdo, Seoul, Daejeon, Gwangju, Ulsan and Jeju, where the Intensive Monitoring Stations (IMSs) are situated, to assess the simulation results.

For the four seasonal cases, the models had significant correlations ranged from 0.61 to 0.85 on average for the intensive monitoring stations except for Daejeon of the Case 1 where they failed to simulate characteristics of PM2.5 change.

However, the capability for prediction was found low for the peninsula's mid-western area under

Note[1]) NCEP FNL Operational Model Global Tropospheric Analyses

the high influence of long-range transport PM2.5 that includes Baengnyeongdo, Seoul, Daejon, Gwangju, Ulsan and Jeju as the average of the correlation factors for all the periods of the cases was 0.62, 0.65, 0.61, 0.70, 0.75, and 0.85 respectively. The air quality models had mean biases ranged from -2.6 to 0.6 on average for the intensive monitoring stations and underestimated PM2.5 compared to monitoring values. In particular for the spring and fall seasons it was analyzed that the models showed limitations as they showed lower concentrations of PM2.5 around clouds to undermine accuracy of the simulation.

The joint research shed light on the necessity to conduct an in-depth study on wet deposition and other issues.

2. *Japan*

To simulate PM2.5 in the North East Asian region, the Japanese side used the weather model “WRFv3.9.1” and air quality model "CMAQv5.1.” The Japanese side also used FNL 1°×1° data for the meteorological input data, the anthropogenic emission inventory HTAPv2.2. for foreign contributions, and the Japanese emission inventory JEI-DB and J-STREAM for local emissions.

For the Japanese forecasting model, data from four areas were used: Tokyo, Nagoya, Osaka and Fukuoka, to assess the simulation results.

As part of our effort to improve reproduction accuracy of the Japanese forecasting model, the Japanese side changed simulation configurations and updated inputs among which land use data in the WRF was most effective.

The correlation factor was 0.73 for Tokyo, 0.84 for Nagoya, 0.82 for Osaka and 0.76 for Fukuoka (total averages of all the cases from 1 to 4). Also, the mean bias was -3.1 for Tokyo, -0.6 for Nagoya, -1.4 for Osaka and -7.4 for Fukuoka (total averages of all the cases from 1 to 4). The values indicated that the model accuracy was good, nonetheless the model had a tendency to produce underestimated results for Fukuoka, the city closest to the Asian continent. Based on the joint research results, the possibility that foreign contribution was the main factor for the Japanese forecasting model to produce underestimated outcomes was indicated.

Through the above-mentioned joint research activities, both Japan and Korea have made each one’s efforts towards improving its forecasting model’s accuracy. Exchanges of information and opinions on the two countries’ forecasting issues have founded the base for the bilateral collaboration to refine the forecasting models and carry out the joint analyses of the cases of long-range transport air pollutants in the future.

[Emission Inventory Group]

Emission inventories cover a wide range of emission sources. In this regard, for the Japan-Korea bilateral cooperation, the study themes were narrowed down to the common topics that were identified mutually beneficial in elaborating emission inventories. Contrasts were made on the estimation methods and emission amounts, and experiences were shared on the concrete measures for control of emission sources.

1. *PM emissions from large combustion stationary sources*

Regarding the methods to develop emission factors, which are one of the most important elements for estimating emissions, the Japanese methods are based on surveys on the air pollutants emissions conducted by Ministry of the Environment for every 3 years. Meanwhile, the Korean methods use real-time monitoring data obtained through the continuous emissions monitoring systems that are installed in the stacks. After reviewing the conditions of the two countries for setting emission factors, difficulty was noticed in making a direct comparison between the Japanese and Korean emission factors. This is because the Japanese emission factors are developed from the gas flux after the air pollution prevention facilities, while the Korean emission factors are made from the gas before the treatment. In the future, the group will exchange knowledge to clearly understand characteristics and properties of condensable particulate matters (CPMs) which are the result of an exhaust flux from a stack when substances are contacted with air, cooled down, condensed, and changed to particles. This research will help the group to improve accuracy of the emission inventories.

2. *Evaporative VOC emissions from stationary sources accompanying industrial activities*

By comparing the emission estimation methods for evaporative VOCs, the group found difference between the two countries: Mainly in Japan, the emissions are calculated by industry associations, and the emission amounts are corrected by the MOEJ, while the Korean emission amounts are calculated according to the emission factors and activity data.

Also, the emission inventory group compared emission amounts between the two countries for each of the source categories, which are similar for both. In general the two countries showed a similar level of emissions for major industries. However, for evaporative VOC emissions from gasoline stations, the emission amounts in Korea were lower than those in Japan. This could be partly because the Korean government has implemented the policy since 2008 by introducing the vapor recovery devices at fuel stations, and expanded the targets gradually for the following years.

3. *Estimation of vehicle emissions and joint research on PM emissions from gasoline vehicles*

For estimation of emissions from vehicles, comparisons were made between the two countries for elements that have a great influence on vehicles' emission amounts, such as methods to develop emission factors, vehicles emission standards, and classification of vehicles. The two countries commonly defines an emission factor as an emission amount per certain distance for different driving speeds. However, the two countries have different driving cycles and other conditions to obtain the data used for developing emission factors. Meanwhile, the two countries found that both countries have a common interest in using monitoring results provided by remote sensing devices (RSD) and data on real driving emissions (RDE), in order to reflect on-road emission characteristics and improve accuracy of the emission inventories. The two countries will exchange knowledge for this research topic in the future joint research.

In addition, PM and NH3 emissions from gasoline vehicles were selected as target matters for the research. Information and opinions were exchanged on each country's status regarding development of emission factors, etc. Korea referred the PM emission data of gasoline vehicles provided by Japan when developing its national emission factors of PM.

Ⅲ.Significance and Outcomes

The Korea-Japan $PM_{2.5}$ cooperation channel achieved a remarkable progress and contributes to strengthening both countries' $PM_{2.5}$ regulations and management, accurate $PM_{2.5}$ modeling and forecasting, and better understanding of emission inventories.

Remarkably, the 4^{th} meeting produced the Memorandum of Understanding concluded for data sharing through an exclusive File Transfer Protocol (FTP). In the 5^{th} meeting the two countries agreed to publish a report on results of the 3 years 2016 to 2018 as the first phase of the channel, in order to raise awareness of the collaborative actions and summarize the joint research.

[Korea]

At a policy level, Korea reflected the lessons learnt by Japan that were shared thanks to the channel, particularly in regulating diesel vehicles and preparing early actions for high level of $PM_{2.5}$ episodes. In addition, results of the joint research bore fruits to support practical policy implementation. For example, modeling group contributed to improving forecasting accuracy by conducting a comparison research on analysis results that were generated from different models of the two countries for same episodes. In addition, Korean researchers of the emission inventory group benchmarked THC regulation standards of Japan, recognizing its high efficiency and the Korean government plans to introduce the similar tool.

[Japan]

In order to curve VOCs emissions further, the “SS Certificate System” was introduced in February 2018 in Japan, designed to promote the Stage II[note 2] by granting a certificate to the environmentally-friendly gasoline stations, as a counter measure for the fuel gas evaporation from the fuel retailers. In introducing this system, a reference was made to the example of the Korean counter measures for the fuel gas evaporation at the gasoline stations.

Furthermore, with regard to reinforcing the Japanese air quality monitoring network for PM2.5, ten sites around the country started automatic monitoring for the PM2.5 species in 2017. The example of the Korean monitoring supersites was suggestive at that time.

Moreover, the comparative studies between the Japanese and Korean simulation models have led to an improved accuracy of the Japanese air environment simulation model which reproduces the behavior of long-range transporting pollutants. Additionally, a number of insights have been obtained through the information and opinion exchanges concerning the emission inventories.

Ⅳ.Future Plan

Japan and Korea shares the atmosphere of East Asian region and thereby they make a continued effort in close collaboration toward air quality improvement.

In light of the importance for cooperation between the two countries, they reconfirmed significance of the meeting as sound foundation for the joint effort on PM2.5 management. Since launched, it has born fruitful outcomes with producing meaningful joint research outcomes and sharing best policy practices.

For the phase II (2020-2022), the two countries will take a step forward for the bilateral research and policy cooperation.

The forecasting modeling group will continue its effort for improving accuracy of the two countries' forecasting models. It is planned to analyze cases of long-range transport. This will lead to enhance understanding of behavior characteristics of PM2.5 and provide correct forecasting information on air quality to protect the people and support air pollution countermeasures of the two countries.

The emission inventory group will share the latest scientific information, technologies, and opinions on a wide range of topics including the detailed understanding on the vehicle emissions (the emissions from real driving vehicles in particular) and the VOCs emissions from point sources with

Note[2]) Measures to reduce vapor fuel gas which is emitted when vehicles are fueled (fuel station measures)

use of the latest technologies, as well as the measuring methods for condensable particles and understanding their actual emissions, to further improve the two countries' emission inventory. This will contribute to effective implementation and post-evaluation of PM2.5 policies and countermeasures.

For policy sharing, the two countries will focus on the PM2.5 management and control methods, countermeasure technologies, etc., including the responses to high concentration episodes, the application of Best Available Techniques (BATs) in the management of emissions, VOC control, etc., and will share the knowledge and experiences. This will mutually complement and solidify the two countries' national measures towards clean air and make contribution for regional air quality improvement.