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REVIEW OF PROGRAMME PLANNING AND IMPLEMENTATION

(Item 5 (a) of the provisional agenda)

Transboundary Air Pollution in North-East Asia

Note by the Secretariat

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I. BACKGROUND OVERVIEW

1. NEASPEC had carried out the "Review of existing and required capacities for addressing adverse environmental impact of transboundary air pollution in North-East Asia" in 2012. The review showed strong potential for further improvement of national and subregional capacity on air pollution issues both on technical and policy levels, and identified existing gaps and possible steps forward. The review also recommended the development of a subregional framework that promotes a holistic approach covering all components of transboundary air pollution management, to strengthen connections between science and policy, and to provide channels for open and effective exchange of knowledge and information, etc.

2. As a follow-up to the review, NEASPEC member States had a series of consultations on a new project to enhance cooperation on assessment and mitigation of transboundary air pollution in the subregion. The Expert Group Meeting (EGM) held in May 2014 came to the following conclusions:

- **Target pollutants of the subregional framework:** Particulate Matter ($PM_{2.5}$ and PM_{10}) and Ozone, and their linkages with other pollutants including Sulfur Oxide (SO_x), Nitrogen Oxide (NO_x), Black Carbon, Ammonia (NH_3) and Volatile Organic Compounds (VOCs).

- **Priorities of the framework:** (a) health impact of air pollution, (b) policy scenarios, (c) emission inventory, (d) abatement technology assessment, (e) modeling of source-receptor relationship of transboundary air pollution, policy scenarios, impact assessment, etc.

- **Focuses of the activities under the current project:** modeling of source-receptor relationship of transboundary air pollution in collaboration with the planned modeling work of the Joint Research Project on Long-range Transboundary Air Pollutants in North-East Asia (LTP) and relevant research, and by utilizing national emission inventories and monitoring data of the Acid Deposition Monitoring Network in East Asia (EANET).

- **Implementing body of the modeling:** Scientific Research Institute for Atmospheric Air Protection (SRI), the Russian Federation, in collaboration with other national institutions including the Chinese Research Academy of Environmental Sciences (CRAES) and Pusan National University (PNU), Republic of Korea, and national experts involved in LTP.

3. The recommendations of the EGM were generally supported by the SOM-19 held in September 2014 while the SOM highlighted the need to seek synergies and avoid

duplication with existing mechanisms and to focus on modeling research cooperation. The SOM also supported the proposed work of the research institutions and experts.

4. To further discuss the planned work, the Secretariat organized the Consultation Workshop on Modeling of Source-Receptor Relationship (SRR) of Transboundary Air Pollution at Pusan National University and the visit of SRI researchers to the National Institute of Environmental Research of Republic of Korea and Chinese Research Academy of Environmental Sciences during 18-21 March 2015. The workshop enabled modelers and researchers of SRI to have in-depth consultations with LTP experts at the three institutions to (a) connect the on-going works in North-East Asia with the planned work of SRI on the modeling of source-receptor relationship of transboundary air pollution, (b) share information of modeling methodologies and emission inventories in North-East Asia, and (c) develop a detailed plan of SRI's modeling including required technical support from other institutions.

5. In addition to the overall review of LTP works and the existing modeling work of SRI, the workshop discussed key technical elements of the SRR modeling including the configurations of meteorological and chemical transport model, model performance evaluation and verification, source and arrangement of input data, etc.

II. REVIEW OF KEY ELEMENTS AND ISSUES PERTAINING TO THE PLANNED WORK IN 2016

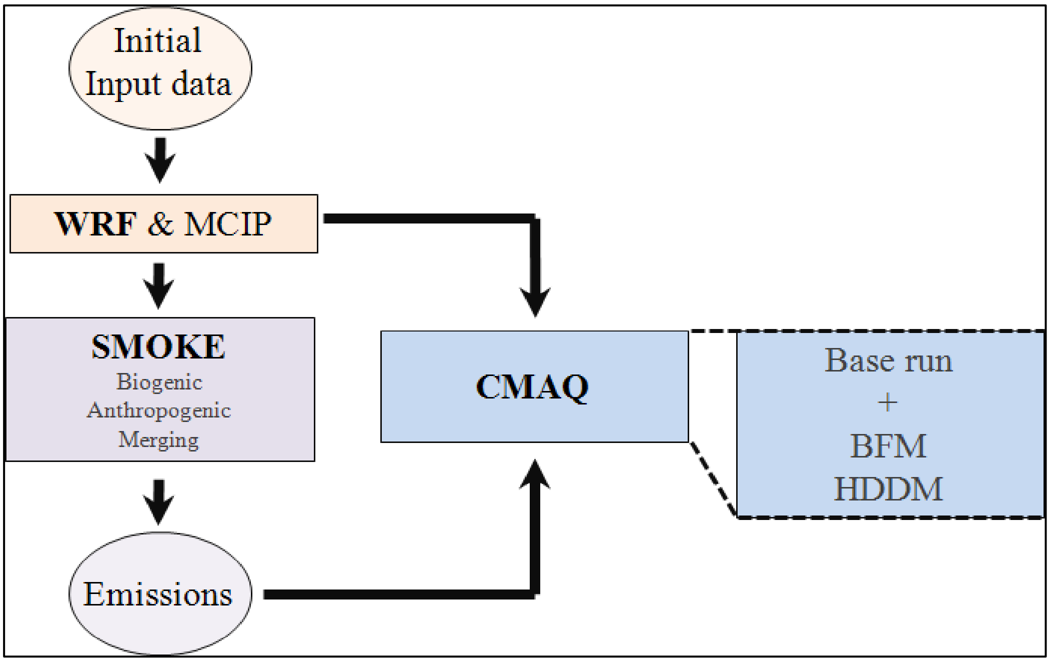
A. Modeling of Source-Receptor Relationship

6. **Configuration of chemical transport model and meteorological model for source-receptor relationship modeling:** Under the modeling work of LTP, Chinese and Korean experts have used the same chemical transport model, Community Multiscale Air Quality Model (CMAQ)[1] on NOx and SO_2, while Japanese experts have used their own model, Regional Air Quality Model (RAQM). In addition, Chinese experts have recently started using the Comprehensive Air Quality Model with extensions (CAMx) as it is also supported by the Particulate Matter Source Apportioning Technology (PSAT) that provides geographic region and source category specific PM source apportionment. Thus, there are currently three models being used by LTP experts. However, the consultation meeting in March 2015 decided to carry out the modeling work with CMAQ as SRI has

[1] CMAQ is a computational tool used for air quality management. It simultaneously models multiple air pollutants including ozone, particulate matter and a variety of air toxics to help air quality managers determine the best air quality management scenarios. The tool can provide detailed information about air pollutant concentrations in any given area for any specified emission or climate scenario (Source: US Environmental Protection Agency).

been already using it. In the case of a meteorological model that simulates and predicts the mesoscale meteorological variables, SRI uses the Fifth-Generation Penn State/NCAR Mesoscale Model (MM5) while all other countries use the Weather Research Forecast Model (WRF), designed for both atmospheric research and operational forecasting needs. As WRF was developed as a successor to MM5, the consultation workshop decided that SRI would install WRF with technical assistance from Korean LTP experts for configuration of the CMAQ and WRF. This will help SRI to carry out modeling with the latest models and enhance compatibility of modeling results with existing outcomes from LTP work.

Figure1: Modeling System using WRF and CMAQ



(Source: Cheol-hee Kim & Jong-Jae Lee, 2015, 18th LTP Expert Meeting)

Note: MCIP (Meteorology-Chemistry Interface Processor) for processing meteorological input variables; SMOKE (Sparse Matrix Kernel Emissions) for converting the resolution of the data in an emission inventory to the resolution needed by an air quality model; BFM (Brute-Force Model) and HDDM (Higher-order Decoupled Direct Method) for the calculations of Source-Receptor Relationship for selected air pollutants

7. **Input data for modeling:** A set of input data for the planned modeling work has certain requirements on accuracy, comparability (among participating countries), completeness (all sources and pollutants) and consistency (across reported years). As shown in figure 2 and reported to the SOM-19 in details, there are various regional emission inventories that are directly interlinked with national inventories. However, various discrepancies exist between the inventories in terms of target pollutants, categories, geographical coverages, time series, emission sources, etc. Furthermore, most regional inventories do not have sufficient coverage of the target domain of modeling in the Russian Federation (Siberia and Russian Far East). The global model, Emission

Database for Global Atmospheric Research (EDGAR), also lacks data for the target domain and its latest data for air pollutants is for year 2008. Thus, at a consultation between SRI researchers and LTP experts during the 18th Expert Meeting of LTP held in November 2015 in Incheon, it was agreed that the modeling would use data from the Comprehensive Regional Emissions inventory for Atmospheric Transport Experiments (CREATE) by incorporating Russia's national data to be provided by SRI. CREATE has been developed and maintained by Kunkuk University and National Institute for Environmental Research, ROK, and used by LTP modeling work as the primary input data. Thus, the NEASPEC modeling work needs to collaborate with the team of Kunkuk University to carry out the integration of national data into the regional inventory, upon the submission of Russian national data by SRI, and the preparation of CMAQ-ready file for SRI.

Figure 2: Overview of Emission Inventories

GLOBAL INVENTORY

- EDGAR (Emission Database for Global Atmospheric Research) – HTAP (Hemispheric Transport of Air Pollution) Emission Inventory: REAS, GAINS, EMEP, UNFCCC

REGIONAL INVENTORY in East Asia

- Greenhouse Gas-Air Pollution Interactions and Synergies (GAINS) Asia
- MIX Inventory: MEIC, JEI-DB, CAPSS and REAS
- Regional Emission Inventory in Asia (REAS)
- Comprehensive Regional Emissions inventory for Atmospheric Transport Experiments (CREATE)
- Intercontinental Chemical Transport Experiment-Phase B (INTEX-B)

NATIONAL INVENTORY

- China Multi-resolution Emission Inventory (MEIC)
- Japan Auto-Oil Program Emission Inventory-Data Base (JEI-DB)
- ROK Clean Air Policy Support System (CAPSS)
- Annual overview of air emissions from major settlements and federal subject of the Russian Federation (by SRI Atmosphere)
- Annual compilation of air pollutants (by Mongolia National Agency for Meteorology and Environmental Monitoring)

8. **Progress in modeling:** Under the Letter of Agreement with the Secretariat, SRI has installed a new server for conducting modeling and software, collected and processed emission data from the target domain, and conducted MM5 calculation of meteorological fields as a test-run. The result of the test-run was presented to the 18th Expert Meeting of LTP for informing the LTP experts of ongoing NEASPEC work and seeking their technical

advice. From early 2016, SRI is expected to move onto the main stage of the work such as installing WRF, preparing national data set for integration with CREATE, running CMAQ, presenting the results for evaluation and verification by LTP experts and preparing the final report. At the Expert Meeting, SRI, LTP and NEASPEC Secretariat also discussed the plan for holding a review meeting to discuss the outcomes and implications of the modeling as well as options for a new subregional framework. The tentative plan is to hold the meeting in conjunction with the 19th LTP Meeting during the 17th IUAPPA[2] World Clean Air Congress and 9th Better Air Quality Conference to be held in Busan, ROK, from 28 August to 2 September 2016.

B. Development of the Concept for a New Subregional Framework

9. **Science-policy linkage:** As one of two project outputs, the Secretariat and SRI in 2016 will develop the concept of a subregional framework on the assessment and mitigation of transboundary air pollution. According to the project plan, the concept is supposed to present options for science-policy linkage. In this connection, a key reference for the concept will be the Convention on Long-range Transboundary Air Pollution (CLRTAP) in terms of substantive programmes on the linkage. The current Long-term Strategy of the Convention and Action Plan for Its Implementation identified a number of achievements including leading the way in delivering a single international agreement dealing with multiple pollutants with multiple effects, and bringing scientists and policymakers together that created a powerful collective driving force to improve the environment and human health. Thus, it notes one of the Convention's great strengths being its scientific basis and the unique way in which science informs policy development. This has supported Parties to produce sufficient insight into the facts and problems for taking policy actions. Thus, the Strategy highlights the positive roles of the Convention's work which has been carried out in a flexible, consensual process, and less rigid than in many multilateral environmental agreements, particularly in the way the science and policy work interact. The Strategy also suggests strengthening the linkage and the need for developing user-friendly effect indicators and cost-benefit assessments for better communication with policy-makers as well as the general public.

10. In this connection, the activity components[3] of CLRTAP for science and policy are as follow: **Science**- providing relevant data to analyze air pollutant concentrations and depositions and their adverse effects; carrying out atmospheric and effects modeling activities to generalize and quantify the relations between emissions and effects; analyzing dose response and critical loads to provide information on damages by air pollution; developing emission inventories to improve their quality, transparency, consistency and

[2] International Union of Air Pollution Prevention and Environmental Protection Associations

[3] 2016-2017 workplan for the implementation of the Convention, CLRTAP Secretariat

completeness; carrying out integrated assessment, a science-based evaluation and assessment of policy effectiveness to analyze scenarios on cost-effective reduction of damages by air pollution; and developing science-policy recommendations in the form of assessment and synthesis reports; **Policy** - addressing linkages with climate change, biodiversity and other cross-sectoral considerations, notably the linkages between nitrogen and human diet, water, ecosystems and biodiversity; exchanging information and good practices on policies, legislation and measures, as well as technology; and developing and disseminating guidance documents and materials to increase the knowledge and awareness of best available techniques (BAT), as well as the exploration of new approaches and abatement measures.

11. **Policy scenario:** With regard to science-policy linkage, the EGM in 2014 identified the study of policy scenario as a priority area of the new subregional framework. In order to link scientific results to policies, CLRTAP adopts the integrated assessment modeling which presents various scenarios of cost-effective emission reductions. Integrated assessment modeling covers: (a) abatement options for reducing multiple air pollutants and greenhouse gases, and structural measures in energy, transport and agriculture as well as their costs, (b) projections of emissions, (c) assessments of the atmospheric transport of substances, and (d) analysis and quantification of the environmental and health effects and benefits of emission reductions. The integrated assessment modeling has been supported by the Greenhouse Gas - Air pollution Interactions and Synergies (GAINS) model developed by the International Institute for Applied Systems Analysis (IIASA). GAINS model presents economic activity pathways, emission control strategies, emissions scenarios, emission control costs and impacts. Outcomes of integrated assessment for policy scenarios are of high relevance to most NEASPEC member States as they require analytical tools for identifying such pathways and strategies as well as co-benefits strategies for simultaneously reducing both air pollutants and greenhouse gases.

12. The scientific community has conducted various studies on policy scenarios in North-East Asia. One study[4] has looked into the recent emission trends of SO_2, NOx, PM, and non-methane volatile organic compounds (NMVOC)[5] in North-East Asia, and projected their future emissions up to 2030 with six emission scenarios based on end-of-pipe control strategies and energy saving policies. The study concluded that the combination of successful implementation of the control policies set in China's 12th Five-

[4] Wang S. X. Wang, B. Zhao , S. Y. Cai , Z. Klimont , C. P. Nielsen , T. Morikawa , J. H. Woo, Y. Kim , X. Fu , J. Y. Xu , J. M. Hao, and K. B. He, 2014. Emission trends and mitigation options for air pollutants in East Asia, Atmos. Chem. Phys., 14, 6571–6603

[5] Non-methane volatile organic compounds (NMVOCs) are a large variety of chemically different compounds, such as benzene, ethanol, formaldehyde, cyclohexane, acetone, etc. NMVOCs are emitted into the atmosphere from a large number of sources including combustion activities, solvent use and production processes. NMVOCs contribute to the formation of ground level (tropospheric) ozone, which is also a major concern in North-East Asian cities.

Year Plan, the recently released emission standards for various industrial sources, and the progressively strengthened control measures after 2015, together could reduce China's emissions of NOx, SO_2, and $PM_{2.5}$ emissions by 16–26% lower than the 2010 levels by 2020. Secondly, the contributions of advanced energy-saving measures to reduce SO_2 and $PM_{2.5}$ emissions will exceed those of progressive end-of-pipe control measures by 2030. Thirdly, the simultaneous enforcement of energy-saving measures and progressive end-of-pipe control measures (mainly assuming enforcement of European standards) could reduce 38% of the total NMVOC emissions from the levels of baseline projection.

13. With regard to the reduction of tropospheric ozone (O_3), a key target pollutant for the subregional framework, a study[6] using WRF-CMAQ, GAINS model and others shows the benefit and cost-effectiveness of the simultaneous reduction of a number of ozone precursor species including NOx/NMVOC and CH_4, which also has co-benefits of reducing globally averaged net radiative forcing.

14. Such policy scenarios could be very useful references for assessing the maximum potentials in the reduction of air pollution and identifying the most feasible solutions. However, it is also necessary to expand the scope of such studies from modeling of mitigation scenarios to the assessment of emission control costs, abatement technologies, specific sectoral policies and measures, international scientific and policy cooperation, etc. This work requires multi-disciplinary approach with the involvement of scientists and experts from diverse fields including atmospheric science, engineering and economics. Thus, the work on the development of the concept for a new subregional framework will involve a thorough review of all relevant international programmes, existing scientific study and policy cooperation in North-East Asia.

III. ISSUES FOR CONSIDERATION

15. The Meeting may wish to request member States to provide any guidance on the planned work and intended technical support to the project.

16. The Meeting may wish to request member States to provide their views on the direction and contents of the concept of a new subregional framework.

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[6] Hajime Akimoto, Jun'ichi Kurokawa, Kengo Sudo, Tatsuya Nagashima, Toshihiko Takemura, Zbigniew Klimont, Markus Amann, Katsunori Suzuki, 2015. SLCP co-control approach in East Asia: Tropospheric ozone reduction strategy by simultaneous reduction of NOx/NMVOC and methane, Atmospheric Environment, 122, 588–595