Summary of the Fourteenth Meeting of the Working Group I for Joint Research on Dust and Sand Storms

Online Meeting, Tokyo, Japan, 28-29 September 2021

1. The 14th meeting of the Working Group I (WG I) for Joint Research on Dust and Sand Storms (DSS) under the Tripartite Environment Ministers Meeting (TEMM) was hosted by Japan virtually on 28 and 29 September 2021. The representatives of the WG members from Japan, Korea and China as well as invited representatives from Mongolia participated in this meeting (Annex1: Agenda of the Meeting and List of participants).

2. In Session One, Mr. YAMASAKI Toshiyuki, Director of Office of International Cooperation in Air and Water Quality Management, Environmental Management Bureau of Ministry of the Environment of Japan (MOEJ), delivered the opening remarks and warmly welcomed the participants. Ms. SUMIKOSHI Masae from the Overseas Environmental Cooperation Center, Japan (OECC) introduced the agenda of the Meeting which was adopted by all participants.

3. In Session Two on "Taking stock of discussions and activities" chaired by Dr. Sang Boom RYOO from National Institute of Meteorological Sciences of the Korea Meteorological Administration (NIMS/KMA), the three participants made their presentations. Dr. Liang LI from China National Environmental Monitoring Centre of Ministry of Ecology and Environment of China (CNEMC/MEE) gave a presentation entitled "Review on the 13th Meeting of Working Group (I)". In his presentation, he summarized the 13th Meeting of the WG I (13 October 2020) hosted by China.

4. Dr. Jeong Eun KIM from NIMS/KMA made a presentation on the current status of DSS data sharing. According to her report, observation data for the selected research cases have been shared among the participating countries through the Webhard. The shared data are meteorological parameters such as relative humidity and visibility, PM mass concentration, aerosol size distribution, spectral AODs, aerosol vertical profile, and satellite aerosol products. For DSS2019 cases, China shared hourly average of PM_{10} mass concentration from 10 sites, which are located on the pathway of dust storm, including Northeast or East part of China. A sharp increase of PM_{10} mass concentration was observed when DSS was detected in those sites. Korea uploaded hourly average of PM_{10} from 20 sites, RH and visibility from 6 sites, spectral AOD from 1 site, aerosol number and volume size distribution from 3 sites, and aerosol Lidar data. PM_{10} mass concentration increased up to 6 times when DSS arrived in Korea. Coarse particles were dominant when DSS was observed. Japan shared hourly average of PM_{10} mass concentration from 11 sites, SPM from 21 sites, $PM_{2.5}$ from 11 sites, Lidar from 17 sites (Mongolia and Japan), visibility and RH from 59 sites, hourly AOT from 4 sites, POPC from 1 site, and aerosol products from HIMAWARI-8 satellite. POPC showed that particles with a diameter larger than 1 micrometer increased during dust event on 2-3 May 2019. After his presentation, the four countries recalled

the discussion made last year by Korea regarding the shortage of the space of the Webhard. The suggestion to delete large data on the Webhard at the end of year to save up the repository was agreed by the four countries. China suggested that taking into account the preciousness of the data, the WG I should burn a DVD-ROM or mobile hard drive for backup to each member state before deleting it.

5. Ms. WATARAI Hiroka from OECC shared the updates of developing the TEMM DSS Online Portal (www.temm-dss.com) according to the requirements of the Mid-term Action Plan 2020-2024 (MTAP2020-2024). After expressing the gratitude to all WG I members for their cooperation, she shared that the draft contents which had been circulated among the four countries and asked the participants for their confirmation on opening the Portal to public during the outreach session on 30 September 2021 as well as their continued cooperation for updating the Portal. The four countries welcomed the progress of the work, confirmed that the contents are appropriate and agreed to publish Top page, What is TEMM DSS page, Research Articles page and Links page in the Portal with the contents as well as DSS Data Set page as "Coming soon" without contents because its content and layout style need further discussion, on 30 September 2021.

6. In Session Three on "The study on DSS monitoring modelling" chaired by Dr. Liang LI from CNEMC, the four participants made their presentations. Ms. Yilin ZHAO from CNEMC gave a presentation entitled "Evaluation of Sand and Dust Forecast Products based on NAQPMS Mode". She explained followings: Using the multi-mode prediction products of the new platform, the results of the numerical forecast model are evaluated according to a sand and dust process in November 2019, the model output products in different periods and the next three days in the same day are analyzed, and the automatic correction of the model is interpreted.

7. Mr. Jeong Hoon CHO from NIMS/KMA gave a presentation entitled "Recent improvements of Asian Dust Aerosol Model version 3 (ADAM3) in KMA". In his presentation, KMA operates ADAM3 to support prediction of Asian dust and haze over East Asia. Recently two major improvements have been achieved. Firstly, data assimilation system was upgraded. The data assimilation method was changed from the optimal interpolation to the three-dimensional data assimilation where background error covariance is updated by ensemble method every 6 hour. And also, observed $PM_{2.5}$ concentration data from air quality monitoring network in China and South Korea were additionally utilized in the data assimilation system. Upgrade of data assimilation system improved performance of ADAM3 during the initial 12 hours, especially over the Asian dust emission region (Gobi). The second one is applying soil moisture effect on the dust emission model of ADAM3. Followed Fécan et al. (1999), threshold wind speed increases with soil moisture. With this method, dust generation time was reduced and the emitted PM_{10} ratio was also decreased. With case experiment, it was clearly shown the new dust emission model could improve the performance of ADAM3 in South Korea as well as in Asian dust emission region.

8. Dr. YUMIMOTO Keiya from Kyushu University, Japan gave a presentation entitled "DSS monitoring and modeling with Himawari-8". He explained followings: (i) Himawari-8 (H08) can provide full-disk (from East Asia to Oceania) with high frequency; (ii) Dust RGB by H08 can detect DSS outbreaks and transport paths and provide early warnings. The location and timing of DSS outbreaks detected by H08 will lead to the understanding of the mechanism of DSS outbreak and the improvement of the dust emission process in numerical model. JMA started the dust

prediction which assimilates H08 observations. The high-frequency observation provides a more DA opportunity and a better AOD coverage compared with LEO satellite. Unification of satellite retrieval process, data assimilation and model forecasting will lead to synergistic improvement.

9. Mr. DAVAANYAM Enkhbaatar from Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE), Mongolia made a presentation entitled "Dust monitoring and dust modelling in Mongolia." In 2017, ADAM-Haze model was installed at NAMEM in Mongolia. The particle size in ADAM model is divided into three different classes for the research convenience: Size 1 (the particle diameter, D 2.23 μm), Size 2 (2.23 μm D 10 μm) and Size 3 (10 μm D 74 μm). In this research, the simulation of ADAM model 72 hours forecast on 14th march 2021 was made. According to the simulation results during the dust storm, it was found that the ratio of particles size was 6.6% of size 1, 57.8% of size 2, and 35.5% of size 3. The maximum concentration of larger particle Size 3 was of about 800 μg/m³ in 1 kilometer. Medium particle Size 2 was maximum concentration about 1000 μg/m³ in 2.4 kilometer. These results were one of the examples of Asian dusts (yellow sand) of the Gobi Desert, its size and the vertical distribution of the cases. Mr. Davaanyam also mentioned that DSS monitoring network in Mongolia was in necessity to repair equipment (most of the stations are not working) and needs to expand monitoring sites for further research.

10. In Session Four on "Report from the countries on DSS Events" chaired by Dr. Chu-Yong CHUNG from NIMS/KMA, the four presentations were delivered. First, Dr. Chu-Yong CHUNG from NIMS/KMA gave a presentation entitled "Observation and Analysis of DSS2019-2 (November 2019) Case". This study presents the observation and analysis results on DSS2019-2 (November 2019) case in NIMS/KMA. In this case, strong Asian dust outbreak was observed over inner Mongolia on 17 November 2019 in the morning and this moved and diffused along the low-pressure system and affected all over the Korean Peninsula on 18 November 2019. Based on ground PM_{10} observation, dust began to be observed at Baengnyengdo site at 5:50 KST and finished to be observed at 21:30 KST at Seogwipo site in Jeju Island on 18 November 2019 in South Korea. Total dust influence duration time in South Korea was 15 hours and 50 minutes. The highest PM_{10} concentration was 318 $\mu g/m^3$ at Ganghwa site in Incheon area around 15:00 KST on 18 November 2019. In this case, dust distributed vertically from surface to 1.5 km altitude height with uniform range corrected backscattering signal values around 0.15 A.U. when it passed over Seoul, based on the Lidar observation. Chemical component analysis showed that the contribution of soil components (Calcium ion) of PM_{10} and $PM_{2.5}$ were 7.6% and 6.6%, respectively, which were higher than those in non-dust cases (normally 3-5%). These results also denote the Asian dust influence in South Korea in this case period.

11. Ms. Xian ZHANG from CNEMC/MEE made a presentation entitled "Case Study of Higher Sulfate than Nitrate in $PM_{2.5}$ During Dust and Sand Storm Events in Beijing". She introduced the variations of SO_2, NO_2, $PM_{2.5}/PM_{10}$, water-soluble ions, heavy metals in $PM_{2.5}$ during a dust and sand storm event in Beijing. This research found that although water-soluble ions in $PM_{2.5}$ in China were driven by NO_3^- rather than SO_4^{2-} under the control measures of SO_2 emission reduction, the SO_4^{2-} concentration was still higher than that of NO_3^- in $PM_{2.5}$ during DSS in Beijing.

12. Dr. NISHIKAWA Masataka from National Institute for Environmental Studies (NIES), Japan made a presentation entitled "Chemical characteristics of aerosol samples during the Asian dust phenomenon (1-2 May 2019) in Japan". He showed the annual number of DSS events (Asian dust event) observed in 2019. During DSS2019-1 period, the Asian dust observed only on 2 May 2019 in limited Kyushu area including Fukue Island located in the East China Sea, while any Asian dust events during DSS2019-2 period were not observed in Japan. Automated time series monitoring for PM_{10}, $PM_{2.5}$ and chemical components of aerosols in the coarse range and fine range were performed at Fukue station. The time series changes elemental component concentration of the group of Al, Fe, Ca, K, Ti and Mn are similar, whereas that of the other group of Zn, Pb, S, SO_4 and NO_3 showed different behavior. From analyses for X/Al concentration ratios, the former group can be concluded as the crustal elements originated from Gobi Desert, and be considered that the latter group existed as contamination substances mixed with naked Asian dust particles in the air-parcel.

13. The period of DSS observation data to be studied by the joint research was discussed in this section led by Dr. Chu-Yong CHUNG from NIMS/KMA. In his presentation, Korea suggested two mixed dust cases among 7 dust cases occurred in South Korea for DSS2020 case study. The first one is 18-24 February case, which occurred in winter season and was the dust case mixed with haze phenomenon. On 20 February, a strong low-pressure system occurred in the east of Mongolia, and moved to the northeastern part of China on 22 February and to Hokkaido of Japan on 23 February. At this time, Asian dust occurred at the rear of this low-pressure system and moved together. Another interesting thing is that haze occurred widely in East Asian region due to the influence of wide high-pressure system, before the low-pressure system arrived. The second one is the autumn case from 20 October to 4 November. During this period, the strong low-pressure system occurred in the east Mongolia on 20 and 30 October, and passed through a similar route to the first case. Around 20 and 31 October, very high PM_{10} concentration greater than 2,000 $\mu g/m^3$ was observed in CMA. After that, on 22 October and 1 and 2 November, dust PM_{10} were captured in South Korea. Haze phenomenon has already lasted for about 2-3 days in this case. Thus, these two cases are considered to be good cases where unusually occurred in winter or in autumn, and dust and haze can be studied at the same time. After the presentation, the participants shared the view that the DSS's transport was slow in some cases in 2020 and agreed on four periods for data sharing of this WG I: 18-24 February 2020 [DSS2020-01], 20-25 October 2020 [DSS2020-02], 29 October to 3 November 2020 [DSS200-03] and 5-9 November 2020 [DSS2020-04].

14. In Session Five on "Discussions about concrete actions and milestones for the Mid-Term Action Plan (MTAP), as continued from the 13th DSS WG I Meeting: Activities 1 to 3" chaired by Dr. Liang LI from CNEMC/MEE, the four presentations were made. Dr. Chu-Yong CHUNG from NIMS/KMA introduced "GeoKOMPSAT-2A data status for the DSS research". In his presentation, updated information on the current status of GeoKOMPSAT-2A/B were provided. GeoKOMPSAT-2A images and products were operationally serviced on NMSC webpage. NMSC tried to refine the aerosol detection algorithm to compensate for some weakness, such as spatial and temporal discontinuity on the aerosol detection results. The observation data of GEMS and GOCI-II on GeoKOMPSAT-2B is available recently on each satellite center website. However, these are under commissioning phase and DSS WG1 needs more time to utilize these data .

15. Dr. SUGIMOTO Nobuo from NIES made a presentation entitled "Evolving DSS Observation and Data Continuity". In his presentation, he described the evolution of the lidars in the Asian dust and aerosol lidar observation network (AD-Net) and consistency of data from different types of lidar. To better characterize aerosols, advanced lidars that can measure multiple parameters and the analysis method that can separate aerosol types have been developed. This method is also useful to ensure consistency of data from different types of lidar by establishing reasonable aerosol optical models. He also presented about the possible use of commercial ceilometers. Based on the presentations by Dr. CHUNG and Dr. SUGIMOTO, the participants agreed to enrich data sharing. The participants welcomed Mongolia to share its available data.

16. Ms. WATARAI Hiroka from OECC asked the participants to confirm the list of data set to be uploaded to the DSS Data Set, and proposed a data policy to be applied to the Portal, using the discussion material. She explained that the list for confirmation had been prepared based on the responses form the four countries to the questionnaire survey conducted in February 2021, and this Session was expected to officially agreed on the data set to upload. In the questionnaire, countries have selected the content and data types that can be uploaded in their own countries according to their own circumstances. However, a concern was expressed from China regarding the number of the countries which contribute to the DSS Data Set page, and they requested to have an internal discussion with their respective management departments if they could add data to the Data Set page to solve the concern. The participants understood such concern and request, and agreed to wait their internal discussion results about additional inputs to the data list, and continue the discussion via e-mail communication for confirmation. Suggestions were made to enrich the contents of the Portal like more storytelling type by adding some factual explanations, pictures and graphics to the current contents, after its launch. Japan welcomed the suggestions and asked the participants' cooperation to materialize them.

17. Regarding the data policy, the participants agreed that the following statements shall be described in the Portal.
    - For "DSS Data Set" page: "This page provides various set of DSS related data shared by the contributors to the Portal. Those who use this data set need to be compliant with the data policy given by the relevant data contributors. If such data policy is not available, the users need to be compliant with the general data policy of the relevant government to which the contributor belongs."
    - For documents in "Research Articles" page (articles and summaries produced by the WG I): "The articles produced by the WG I and the meeting summaries are public domain, unless explicitly indicated otherwise. Those who use/cite these documents need to indicate explicitly their source - "the Working Group I for Joint Research on Dust and Sand Storms of the TEMM DSS Meeting (www.temm-dss.com)."

    Related to the Portal, an idea was suggested that the Portal Data Set could provide a space for sharing the research data dedicated only for WG members, which are currently stored at the Webhard. The participants agreed to continue exchanging views on this idea through e-mail communication.

18. Ms. WATARAI Hiroka from OECC proposed to develop the detailed milestones as a the

Thirteenth WG I Meeting discussion, in order to implementing the MTAP for the WG I, under common understanding/timelines. She presented a table filled with the possible milestones until 2024 (Annex2), and proposed that this table could be amended every year according to each country's situation and progress. She encouraged the participants to add any potential activities to the proposed milestones. The four countries discussed the milestones and welcomed the proposal in general. The four countries share the views that each activity and their milestones shall be further considered.

19. In Session Six on "Summary" chaired by Ms. HAYASHI Yayoi from OECC, the four countries made initial discussions at the Session. This Summary was finalized through post-meeting communications. Korea, the host country of the next 15th WG I Meeting, suggested that the Meeting would be held in Autumn 2022 in Jeju Island, Korea, if COVID-19 situation allows. Detailed date, venue, timeline for preparing agenda and meeting materials would be informed by Korea more than three months ahead of the Meeting. In Closing, each country representative gave their brief summary. Among others, Mr. YAMASAKI Toshiyuki, from MOEJ, as the host country of the 14th Meeting, made an acknowledgement for the efforts and contributions made by all participants, and sought their cooperation to the TEMM DSS WG I Extended Workshop to be held online on 30 September 2021. Appreciations was expressed to Dr. Sang Boom RYOO for his longtime and outstanding contributions to the WG I, noting that this Meeting became his last participation due to his retirement from NIMS/KMA.