WORLD METEOROLOGICAL ORGANIZATION

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THE THIRD JOINT MEETING OF RA II WIGOS PROJECT AND RA V TT-SU FOR RA II AND RA V NMHSS

Final Report

5 November 2021, Online Meeting

1. OPENING

The Third Joint Meeting of Regional Association II (Asia) WIGOS Project and Regional Association V (South-West Pacific) Task Team on Satellite Utilisation for RA II and RA V National Meteorological and Hydrological Services (NMHSs) was held virtually, on November 5, 2021. The list of meeting participants is provided in **Annex 1**.

1.1 Welcome address

The Chair of the opening session Dohyeong Kim (Director of Satellite Operation Division, National Meteorological Satellite Center (NMSC) of Korea Meteorological Administration (KMA), the co-coordinator of the RA II WIGOS Project) welcomed all the participants from RA II and RA V, and WMO. He expressed a special gratitude to the China Meteorological Administration (CMA) for hosting the Eleventh Asia-Oceania Meteorological Satellite Users' Conference (AOMSUC-11) as well as the RA II and RA V joint meeting.

Peng Zhang (Deputy Director-General of National Satellite Meteorological Center (NSMC)) welcomed all the participants on behalf of CMA. He noted that CMA had always been an important participant and contributor to the activities of RA II and RA V, with a special focus on strengthening the role of FENGYUN satellites as a bridge for the international cooperation in the region. The Emergency Support Mechanism of FENGYUN geostationary satellites introduced by CMA in 2018 was also highlighted as an important mechanism implemented in the region. The polar-orbiting satellite FY-3E on early morning orbit launched in July this year was also pointed out as an example of success of the international cooperation. In conclusion, Peng Zhang wished everyone a successful and very productive meeting.

1.2 Opening address

On behalf of the WMO, Heikki Pohjola (WMO Space System and Utilization Division) welcomed all the participants of the meeting. He expressed his appreciation to CMA for hosting RA II and RA V meeting back-to-back to AOMSUC-11, and thanked KMA, Japan Meteorological Agency (JMA) and the Bureau of Meteorology (BoM) for coordination of the activities in the region. He pointed out the important role of the meeting as an interface between users and satellite operators in the region as well as an efficient means for collecting user requirements for satellite data utilization and planning future work and collaboration between RA II, RA V, and WMO. The opening address was concluded with an expression of the hope for fruitful discussions and a successful meeting.

1.3 Adoption of the agenda

The agenda of the meeting (**Annex II**) was approved. All documents and presentations submitted for the meeting will be posted on the Project website at: http://www.jma.go.jp/jma/jmaeng/satellite/ra2wigosproject/ra2wigosproject-intro_en_jma.html.

2. STATUS OF PROJECT

2.1 Accomplishments, current status and work plan of the RA II Project and the RA V Task Team

Dohyeong Kim (KMA, RA II Project co-coordinator) presented the Regional Association II (Asia) WIGOS Project accomplishments, highlighted the current status and future plans. The presentation was started with a short overview of the background information for the RA II Project, which was established as a Pilot Project in 2008 for the development of support for the NMHSs in the areas of satellite data, products, and training. In 2012, considering the Project's importance in improving dialogue between satellite operators and users in the region, it was decided that the Project should have the official status and become the RA II WIGOS Project. Then the work plan was developed for 2017-2020. In the presentation, the structure and coordination of the RA II WIGOS Project were also presented (figure 1).

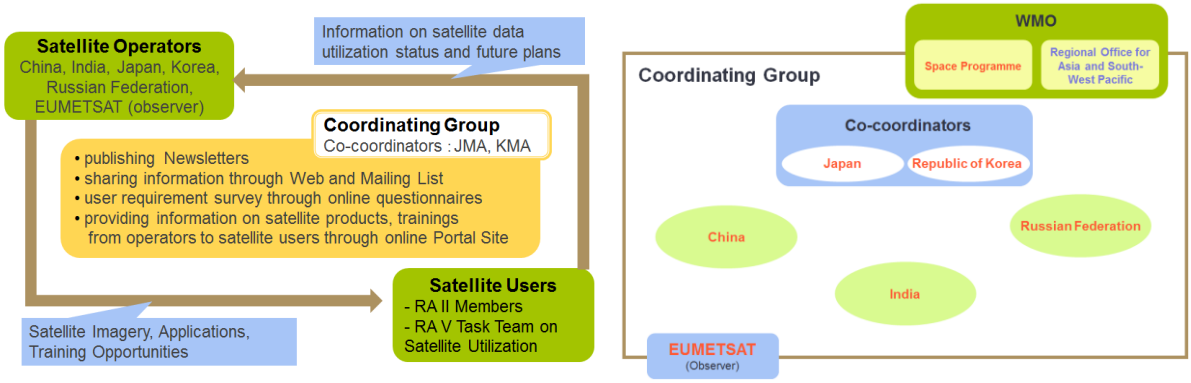

Figure 1. Structure and coordination of the RA II WIGOS Project

The following accomplishments of the Project in 2013-2020 were highlighted:

- Support for the preparation of satellite data users in relation to the new generation of geostationary meteorological satellites;
- Establishment of close coordination between the RA II WIGOS Project and the RA-V Task Team on Satellite Utilization;
- Establishment of the new webpage of the RA II WIGOS Project (hosted by JMA) http://www.jma.go.jp/jma/jma-eng/satellite/ra2wigosproject/ra2wigosproject-intro_en_jma.html;
- Convening the series of Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC);
- Conducting the trainings and questionnaires on the utilization of new generation of geostationary meteorological satellites through the AOMSUCs;
- Quarterly newsletters for RA II Members (half-yearly newsletters since 2020) – 42 newsletters have been published (since 2009).

It was also noted that the 1st Joint RA II and RA V Meeting was held in Jakarta, Indonesia (in 2018) and the 2nd Joint RA II and RA V Meeting was held in Melbourne, Australia (in 2019).

Agnes Lane (Manager Satellite Earth Observations Planning and Coordination, BoM, Chair of the RA V Task Team on Satellite Utilisation) thanked Dohyeong Kim for the comprehensive

overview of joint activities of RA II WIGOS Project and RA V Task Team. She added that the key activities implemented by RA V Task Team will be mainly covered in the session focused on the training activity (by Bodo Zeschke). It has been noted that the RA V Task Team has not been active since conducting the WMO Regional Survey on the Use of Satellite Data in 2018, but it was highlighted that all the NMHSs in RA V are welcome to express their interest to join the Task Team in order to reform the Group to address key priorities in the Region.

3. USER PERSPECTIVES

3.1 User requirements for satellite data utilization

This session was chaired by Agnes Lane (Chair of the RA V Task Team on Satellite Utilisation).

3.1.1 Country Reports of RA II / RA V

The Summary of country reports submitted by the NMHSs in RA II and RA V was presented by Zoya Andreeva (WMO Space System and Utilization Division). The presentation was focused on providing the most important highlights from the reports of NMHSs, aiming at calling attention to the most critical points, spotting so called “red flags”.

It was specifically noted that country reports had always been a central part of the meetings as it provides an opportunity for NMHSs to raise awareness among the WMO and satellite operators in the region about challenges they are facing, about the requirements for satellite data and products as well as training needs; but it is also a chance for the satellite operators and WMO to become aware of those challenges and try to figure out how they can be mitigated.

The presentation was based on the information submitted by 14 NMHSs, including:

- 10 from the RA II (Hong Kong (China), Iran, Kingdom of Saudi Arabia, Maldives, Mongolia, Myanmar, Pakistan, Sri Lanka, Thailand, United Arab Emirates);
- 4 form the RA V (Federated States of Micronesia, French Polynesia, Indonesia, Malaysia).

It mainly covers: 1) utilisation of geostationary and polar-orbiting satellite data and associated challenges, 2) key examples of using this data, 3) critical technical infrastructure challenges, 4) training needs in satellite meteorology and related areas.

3.1.2 Presentation and discussion from RA II / RA V users’ representatives [NMHSs]

3.1.2.1 Regional Association II (Asia)

Hong Kong, China

Yw Chan (Hong Kong Observatory) presented a country report on behalf of the Hong Kong Observatory (HKO). HKO receives FY-4A, FY-2F, 2G, 2H satellite data using CMACast, Himawari-8 via HimawariCast and HimawariCloud, GK-2A via Internet, GOES-E & GOES-W via CMACast, Meteosat series satellites data via CMACast as well.

HKO receives the following LEO satellite data: FY-3B, 3C, 3D, EOS (Aqua & Terra), NOAA-15, 18, 19, SNPP, Metop-A, B via ground reception systems; Haiyang-2, FormoSat-7/COSMIS-2 via Internet.

The following images and products are produced based on both GEO & LEO satellite data: visible, infrared, and water vapour channels imagery; RGB products; processed imagery such as blended sandwich, HotTower, Dvorak; high pass filtered (HPF) images; vertical temperature and relative humidity profiles, tropopause folding turbulence detection products. Key applications mentioned in the report: daily weather monitoring and forecasting, nowcasting and data assimilation in NWP, informing public (via HKO website and mobile application). Several showcases were presented in the report, including: the use of deep learning model for auto-detection of atmospheric gravity waves (AGW) triggered by jet stream, convection, and topography; the use of FormoSat-7/COSMIS-2 radio occultation data for identifying volcanic plume height, stratospheric intrusion as well as warm core structure of mature tropical cyclone, Quantitative Precipitation Estimate (QPE), etc.

HKO developed different tools for forecasters to visualize and manipulate various data, including the WebGIS system, which has received a lot of positive feedback from the local forecasters.

When it comes to future plans, HKO is preparing to receive data from FY-4B, FY-3E, and GK-2B satellites and develop satellite products based on this data as well as implement a new system for archiving satellite data.

Training priority expressed by HKO: 1) enhance the usability of WebGIS systems by local forecasters; 2) compile AGW reference cases to train aviation forecasters on the characteristics of the deep learning model outputs in auto-detecting AGW; 3) use of radio occultation data in NWP; 4) applications of RGB products (for your meteorologists); 5) special training on lightning detection.

The technical infrastructure development plans: 1) cloud services for reception of satellite data; 2) reception satellite data via EUMETCast and AmericaCast, including GOES-W, GEOS-E, and MTG for generation of global mosaics with a half-hourly update.

Kotaro Bessho (JMA, RA II Project co-coordinator) noted that judging by the HKO presentation made at AOMSUC-11, HKO is using the lightning dataset from F-4A. He inquired if HKO uses the lighting data received from satellite in operational work (not only for research purposes). Mr Yw Chan confirmed that the capabilities of this data in lightning detection is still limited. HKO operationally provides public with the information about the lightning strikes based on the information from surface sensors. In comparison with this data, the number of strikes detected by FY-4A are significantly low.

Kotaro Bessho posed a question about the use of lightning datasets for predicting typhoon intensity (this study was carried out by American researchers). At this stage HKO does not have such experience, and that they mainly use the data from scatterometers and even airplanes for this purpose.

Finally, Kotaro Bessho questioned about the assimilation of lightning data from satellites. Mr Yw Chan said that he is not working in the area of NWP, so he is not in a position to share the experience in this field.

Jim Purdom (the Chair of AOMSUC ICSC) noticed that scatterometers might be not the best solution for analysing intensity of tropical cyclones and typhoons in case of a very intense storm, and microwave satellite data might be more efficient for looking at warm core anomalies (based on the temperature anomalies and its changes), especially taking into account a great number of microwave instruments currently available.

Iran

The country report from the Islamic Republic of Iran was submitted after the meeting. The key points highlighted in the report are presented below.

The Meteorological Organization of Iran receives GEO satellite data via the Internet and FTP server; the data is used to produce infrared, visible, water vapour imagery; Synergie software (France) is used for processing and visualisation of this data. The Meteorological Organization of Iran does not receive any LEO satellite data.

Satellite data is mainly used for: nowcasting for aviation; warnings of hazardous phenomena for airplanes; hazardous phenomena monitoring (turbulence, dust, convective activity, cloud type, fog).

Training needs and priority areas expressed in the report: 1) interpreting satellite images for atmospheric conditions analysis; 2) use of satellite images for daily verification of models; 3) using satellite data by general and aviation forecasters. The suggested languages for training are Persian or English.

The technical infrastructure challenges: 1) direct reception of satellite data (this option is not available for the Meteorological Organization of Iran); 2) DVB-S2 reception (frequency constraints as well as equipment purchasing constraints); 3) Internet service (internet services are not used as well); 4) PC WinSat Visualization software is used, but it cannot be upgraded.

Kingdom of Saudi Arabia

Fawzi Mohammed Zinilabidine (National Center of Meteorology) presented the country report on behalf of the National Center of Meteorology (NCM) of the Kingdom of Saudi Arabia. It was highlighted that NCM receives the MSG data in accordance with the agreement with EUMETSAT (every 15 min); the receiving system supplied by TECNAVIA is used in operational work; images available on the Internet are also in use. NCM uses the following products based on GEO satellite data: dust, air mass, jet streams and volcanic eruptions, cloud, precipitation, fog and water vapour. Key applications for GEO satellite data: general forecasts and forecasts for aviation, nowcasting and early warnings, research and climate studies.

NCM receives the data from the EUMETSAT LEO satellites using the receiving system supplied by TECNAVIA. It was reported that NCM cannot use LEO satellite data and products due to the lack of processing capabilities (e.g. for analysis of land and sea surface temperature). That is why, only images available via the Internet (e.g. Worldview portal) are used for comparison and verification purposes only.

Main challenges related to capacity building highlighted by NCM are the following: 1) limited allocation of the resources for organizing and participating in the capacity building activities; 2) disruption of the operational work when sending staff to the training due to the insufficient quantity of staff; 3) no face-to-face training due to the pandemic situation; 4) challenge for most of staff to understand English speaking experts.

Training needs and priority areas expressed by NCM: 1) processing and utilization of the data from LEO satellites and analysis of satellite data after its processing; 2) enhancement interpretation and utilization of satellite data and products; 3) efficient use of satellite data and images for nowcasting and early warning; 4) using satellite images for weather phenomena monitoring; 5) using satellite data for case studies of severe weather conditions; 6) cooperation with satellite data providers and other countries for improving the capacity for satellite data usage; 7) trainings in Arabic language.

The technical infrastructure challenges: 1) frequency interference problems at the data receiving system due to 5G application (solved by using filters); 2) outdated technology and equipment in the data receiving system; 3) low capacity of the workstations running data processing and visualization software. The needs for improvement of technical infrastructure to access and process/visualize satellite data are the following: 1) upgrade and development of existing data receiving system; 2) supply of new workstations with sufficient capability of data processing and storage; 3) update or supply of new data processing, visualization and dissemination software; 4) workstations with processing and visualization capability at the airport meteorological offices (needs to have not only satellite imagery, but also satellite-based products).

Maldives

Ali Shareef (Maldives Meteorological Service) presented the country report on behalf of the Meteorological Service of Maldives.

The unique geographical location of Maldives was highlighted in the report. Maldives is an island nation in the Indian Ocean composed of 26 ring-shaped atolls, which are made up of about 1,200 coral islands. Average height of the islands is just 1-2m above sea level.

The main challenges in delivering capacity building activities: no specialized local institution offering such programs; lack of experts specialized in the field as well as financial constraints in the local budget.

Training needs and priority areas expressed by Maldives Meteorological Service: 1) discovery, utilization, and visualization of various satellite datasets for local applications (including ocean winds, lightning data); 2) training on desktop and online applications such as SWAP, MICAPS and SMART software, training on RAPID online application, MOSDAC products; 3) nowcasting and satellite data assimilation in NWP models.

Mongolia

The representative of Mongolia was not participating in the meeting, so the country report of Mongolia was presented by the WMO. NAMEM receives the following GEO satellite data: FY (FY-2 series, FY-4A) using CMACast and Himawari-8 using both HimawariCast and HimawariCloud. NAMEM produces the following satellite images for cloud monitoring: infrared channel images (FY-2G, FY4A), water vapour channel images (FY-4A), natural colour RGB (FY-4A), and visible channel images (FY-4A). NAMEM also produces a number of satellite products based on Himawari-8 data: 24-hour microphysics RGB, airmass RGB, day convection RGB, dust RGB, infrared channel image, natural colour RGB, night microphysics RGB, visible and water vapour channels images.

NAMEM also receives the following LEO satellite data: NOAA series, Metop series, Suomi-NPP, MODIS-Terra/Aqua, as well as access Landsat, Sentinel-2, GCOM data via Internet. The following LEO satellite products are used in operational activity: snow cover, biomass (NOAA), NDVI (MODIS), dust product (NOAA, EOS), fires and fog product (EOS, SNPP), monitoring of glaciers and changes in lakes areas (based on high resolution data – Landsat, Sentinel-2), snow depth analysis (GCOM).

Myanmar

Kyaw Lwin Oo (Department of Meteorology and Hydrology) presented the country report on behalf of the Department of Meteorology and Hydrology of Myanmar.

The Department of Meteorology and Hydrology receives Himawari data via HimwariCast (receiving station was installed in 2015); CMACast was also installed in 2015, but it has not been operational since 2019, the new equipment has been received this year and it is still to be restored. At the same time,

participants were informed that LEO satellite data is not received/used by the Department of Meteorology and Hydrology.

The key application for GEO satellite data is tropical cyclone monitoring. Himwari-8 data is used jointly with ASCAT wind product visualized with the SATAID software.

The key technical infrastructure challenge highlighted by the Department of Meteorology and Hydrology is related to the needs for restoring CMACast receiving system and associated operational assistance from CMA.

Mr Kyaw Lwin Oo highlighted in his presentation that the Department of Meteorology and Hydrology considers very important the participation in the training activities organized by the VLab community.

Bodo Zeschke (BoM) noted that the representatives of Myanmar attend regularly the VLab sessions, and that he considers Myanmar as one of the VLab success stories.

XIAN Di (CMA) pointed out that CMA is planning to restore the old CMACast systems for users in the region, so in case of any problems or needs related to CMACast, it was recommended to send the email directly to XIAN Di (xiandi@cma.gov.cn), and CMA will provide all the necessary support.

Pakistan

Jan Muhammad (Pakistan Meteorological Department) presented the country report on behalf of the Pakistan Meteorological Department (PMD). GEO satellite data (FY-2G) received by two satellite receiving stations in Islamabad and Karachi using the CMACast system. This data is used for the following applications: cloud cluster area, tropical storm, precipitation estimate, snow cover, sea surface temperature, outgoing longwave radiation, dust storm monitoring.

LEO satellite data (Sentinal-2, Landsat, MODIS/EOS, GSMaP) is accessed via the Internet for snow cover monitoring, soil moisture analysis, rainfall analysis, drought monitoring (Normalized Difference Vegetation Index, Temperature Vegetation Dryness Index, Land Surface Temperature), flood monitoring (flood extent).

It was pointed out that PMD is lacking the satellite based agrometeorological data to improve its services and products for the end users. The need to have more satellite ground stations was also highlighted.

PMD highlighted that there is a great need for training in handling the satellite data for the purpose of satellite meteorology and analysis. The lack of economic resources was also mentioned as the main challenge for capacity development in NMHS of Pakistan.

The priority areas for training: 1) data visualization tools; 2) data manipulation and development of specialized products; 3) multi-satellite cross validation expertise; 4) installation of satellite equipment; 5) new satellites introduced by the satellite operators.

Sri Lanka

Meril Mendis (Department of Meteorology, Shri Lanka) presented the country report on behalf of the Department of Meteorology of Shri Lanka.

Department of Meteorology receives INSAT-3D data via Internet, FY series satellites via CMACast, Himawari data is received via HimawariCast, and MSG via Internet (EUMETView portal). GEO satellite data is mainly used for monitoring of cloud properties, especially convective systems, which trigger

flood related disasters; tropical cyclone monitoring and analysis; quantitative precipitation monitoring, as well as some other products (atmospheric motion vector, sea surface temperature, convergence/divergence etc).

FY-3 satellite data is received via CMACast, a number of satellite-based products (ocean surface winds, atmospheric water vapour, precipitation measurements) are accessed via Internet.

The following priority areas for training was specified in the report: 1) ocean data analysis; 2) data assimilation in NWP model; 3) GPS radio occultation; 4) software and tools handling.

In the conclusion of the session, Agnes Lane highlighted that the beautiful thing about this community is that everyone should be able to feel that they can reach out to other meteorological services and/or satellite operators, so there are a great number of options for collaboration available for NMHSs in the region.

Thailand

The representative of Thailand was not participating in the meeting, so the country report of Thailand was presented by the WMO. The Thai Meteorological Department (TMD) is currently receiving Himawari data only using HimawariCast. But there are plans to install CMACast system soon. Besides, the data available on the Internet is also used in the operational activity. The key applications: cloud analysis, precipitation monitoring, and tropical cyclone monitoring.

TMD reported about the more in-depth analysis focused on the comparison of rainfall distribution based on satellite data and observations from Quantitative Precipitation Estimation (QPE), which showed quite a good correlation. A couple of examples of using satellite-based products (quantitative precipitation estimation form GSMaP) for flood monitoring in Thailand were also demonstrated.

The importance of training which requires collaboration with specialized agencies using internationally standardized languages was also pointed out.

United Arab Emirates

The representative of United Arab Emirates was not participating in the meeting, so the country report of United Arab Emirates was presented by the WMO. The National Centre of Meteorology (NCM) receives MSG data via EUMETCast. Visualization software supplied by TECNAVIA is used. Infrared, visible, water vapour channel images, various RGB images as well as precipitation product are utilized operationally. It was highlighted in the report that NCM does not have access to LEO satellite data.

Training needs and priority areas expressed by NCM: 1) access to satellite data and other derived products; 2) satellite imagery interpretation; 3) processing, visualization & analysis, including use of software tools; 4) preparation & effective utilization of the new generation of satellite data.

3.1.2.2 Regional Association V (South-West Pacific)

Federated States of Micronesia

Sosten Sos (Chuuk Weather Service Office, FSM) presented the country report on behalf of the Chuuk Weather Service Office of the Federated States of Micronesia. GEO satellite data is received by HimawariCast system, and it is used to produce visible, infrared, water vapour channels imagery. The key applications for GEO satellite data: monitoring of rapidly developed convective clouds as well as typhoon monitoring. It was also noted that GPS signals are used for daily tracking upper air flights.

Main challenges related to capacity building highlighted by the Chuuk Weather Service Office: 1) monitoring of rapidly developed convective clouds during typhoon seasons; 2) identification of cloud types, especially when there is a slow Internet connection while downloading satellite data; 3) interpretation of various satellite imagery such as RGB, water vapor etc.

The main technical infrastructure challenge highlighted in the report is Internet connection, which significantly limits the access to satellite data.

French Polynesia

The representative of French Polynesia was not participating in the meeting, so the country report of French Polynesia was presented by the WMO.

French Polynesia Weather Center (DIRPF) receives GEO satellite data (GOES-17, Himwari-8) in direct reception and from CMS (Météo-France Satellite Center). DIRPF also receives LEO satellite data (SNPP, NOAA-18, 19, 20, Metop-A, B, C) in direct reception and from CMS (Météo-France Satellite Center).

DIRPF uses the following products: visible, infrared, water vapour channels imagery, RGB imagery (based on both GEO and LEO satellite data) as well as cloud and lightning products (based on GOES-17 and Himwari-8).

Indonesia

Andersen Panjaitan (BMKG, Indonesia) presented the country report on behalf of the Meteorology, Climatology, and Geophysical Agency (BMKG) of Indonesia.

It was reported that BMKG has only HimawariCast system used for receiving satellite data, CMACast system is not currently active as well as other reception stations for LEO satellite data. Apart from Himawari, some data available on the Internet is utilized.

There are the following satellite-based products used in BMKG: Himawari-8 infrared enhanced imagery and natural colour RGB, high-resolution cloud analysis information (HCAI) based on Himawari data, rapid developing cumulus area product (based on Himwari-8) as well as potential rainfall product (Himawari-8) categorized in light, moderate, and strong precipitation. Himawari-8 RGB is also used to monitor volcanic ash dispersion. BMKG has recently produced new products for forest fire monitoring ("hot" spots detection) and smoke-haze monitoring based on Himawari-8 data.

BMKG has also introduced in their country report a newly developed interactive map system, which allows users to display various satellite and weather data.

The priority areas for training: 1) using satellite data for monitoring of forest fires and transboundary haze; 2) managing archive satellite data and ways to deliver the information to users more efficiently.

Malaysia

The representative of Malaysia was not participating in the meeting, so the country report of Malaysia was presented by the WMO.

Malaysian Meteorological Department (MMD) receives Himawari-8 data via HimawariCast and HimawariCloud as well as through the JMA Data Dissemination Service (JDDS), they also use CMACast and Feng-Yun ground station as well as access GK-2A via FTP server. The key applications highlighted in the report: weather monitoring and nowcasting, monitoring of monsoon activity (heavy rain).

The main challenge related to capacity building highlighted by MMD is to train forecasters for better knowledge and skills in applying RGB products in operational weather forecasts and analysis.

The following priority areas for training was specified in the report: 1) advanced training in RGB imagery interpretation and analysis; 2) nowcasting using satellite data and products; 3) utilization of the new generation of satellite imagery and high-level product development.

The technical infrastructure challenges: 1) receiving system is down due to lightning strike; 2) Internet connection problems; 3) need for data visualization software that can generate image and product automatically for operational use.

4. TRAINING ACTIVITY

This session was chaired by Kotaro Bessho (Senior Coordinator for Satellite Systems, Satellite Program Division, JMA, and co-coordinator of the RA II WIGOS Project).

4.1 WMO-CGMS Virtual Laboratory (VLab) updates and plans

4.1.1 VLab as a Global Network of Training Providers (pre-recorded presentation)

The presentation on the WMO-CGMS Virtual Laboratory as a Global Network of Training Providers was provided by Wen Bo (VLab Co-chair, Director of the CMA Training Centre).

The WMO-CGMS Virtual Laboratory was established in 2000 as a global network of 13 specialized training centres and 8 satellite operators working together to improve the utilization of data and products from meteorological and environmental satellites.

The VLab objectives are to provide training that promotes the interdisciplinary application of satellite data; share knowledge, experience, methods, and tools related to access and usage of satellite data, especially in support of WMO Members that have limited resources.

To make the Network sustainable VLab has two Co-Chairs representing the two main stakeholders: satellite operators and training Centres of Excellence; Technical Support Office as a central point of contact for the Network that ensures communication and coordination of tasks; Trust Fund – to collect contributions to support the Network.

The importance of competency-based training was highlighted. It is necessary to consider the skills in the training development plan, identify the Skills that will be addressed, state the Skills in the course description, and add the Skills addressed in the course to the back of the certificates. It was reported that this approach helps trainers to write clearer learning objectives for courses, it also helps professionals to identify gaps in their skill sets.

It was reported that in 2020, there were 65 training events on satellite meteorology organised in total, with more than 3 600 participants from 129 countries and regions. Most of the events were offered online due to the COVID-19 pandemic situation and travel restrictions.

In the presentation, the key highlights related to VLab activities for 2022 were also pointed out: updates of the Satellite Skills documents (adding the two new skills: Skills 8. Apply satellite-based climate data records for Meteorological Services and Skills 9. Apply satellite-based products for Agricultural monitoring); updates on Expectations Documents of Satellite Operators, Centres of Excellence, WMO and CGMS; a new central VLab website.

4.1.2 Satellite Meteorology Training in WMO RAV during 2020-2021

The presentation on the satellite meteorology training in the WMO RA V in 2020-2021 (the Australian VLab Centre of Excellence experience) was presented by Bodo Zeschke (BoM Training Centre, Australian VLab Centre of Excellence).

The presentation mainly covered the following topics: 1) introducing the Australian VLab Centre of Excellence (CoE); 2) regional achievements in satellite meteorology training; 3) attendance at the Regional Focus Group meetings; 4) highlights of the monthly Regional Focus Group meetings; 5) recording of the Regional Focus Group meetings.

It was noted that the Australian VLab CoE had recently celebrated 8 years in delivering the Regional Focus Group meetings (the first one was conducted in October 2013). Up to now, 93 meetings have been arranged (the last one was organised as a part of the AOMSUC-11 training event). During these 8 years, the total number of remote participants is 2934, with the average number of participants per session is about 30. It was specifically pointed out that the number of participants for the last two years have increased significantly in comparison with the previous period.

Weather and forecast discussions, tropical and midlatitude case studies, latest development in meteorology are the main topics covered during the Monthly Regional Focus Group meetings. These meetings also covered the information about the new generation satellites introduced or planned to be launched by satellite operators, new tools to handle satellite data as well as new satellite-based products issued, highlights of the major important international events in satellite meteorology such as AOMSUC etc.

The recording of all the Regional Focus Group meetings are available online at the Australian VLab CoE website.

5. COLLABORATION AND FUTURE PROJECT WORK PLAN

This session was also chaired by Kotaro Bessho (co-coordinator of the RA II WIGOS Project).

5.1 Updates High-Frequency Regional Observation

5.1.1 Updates on portal including information on availability of high-frequency regional observation and so on

The presentation on the updates on portal including information on availability of high-frequency regional observation was provided by Kotaro Bessho (co-coordinator of the RA II WIGOS Project).

CMA, JMA and KMA have launched a request-based high frequency regional observation portal on RA II WIGOS Project webpage (JMA website): https://www.jma.go.jp/jma/jma-eng/satellite/ra2wigosproject/ra2wigosproject-intro_en_jma.html#request. The Portal has links to 1) CMA's Emergency Support Mechanism of FENGYUN Satellite (FY ESM); 2) JMA's HimawariRequest Service; 3) KMA's GEO-Kompsat-2A AMI Rapid Scan (ARS) Service.

There are plans to improve the usability of the RA II WIGOS Project webpage, adding the following information: 1) current and planned observation locations for each service; 2) availability of request-based high frequency observation; and 3) observation locations to be visualized on the map in real-time (if it is feasible due to security reasons – still to be confirmed).

5.1.2 Updates on HimawariRequest

The updates on HimawariRequest were also presented by Kotaro Bessho (JMA).

HimawariRequest was started in January 2018 in cooperation with BoM, Australia. Thus, HimawariRequest is an international service for NMHSs to request target area observations in Himawari-8/9 coverage area (1,000 x 1,000 km area every 2.5 minutes) to support disaster risk reduction in the Asia-Oceania region. There are currently 22 registered NMHSs, and 122 requests have been received up to now.

5.1.3 Updates on FY ESM

The updates on FY ESM were presented by XIAN Di (NSMC/CMA).

It was reported that CMA introduced the Emergency Support Mechanism of FENGYUN (FY) Satellite (FY_ESM) on April 24, 2018. This service is open to international users to make a request to address extreme events such as typhoon, heavy rain, severe convection, forest or grassland fires, and dust storm. Images and L2 products are provided through CMACast, Internet or direct broadcasting.

The following on-duty FY-2 series satellites are available: FY-2H (79°E), FY-2G (99.5°E), FY-2F (112°E). FY-2F (112°E) is used to provide the rapid scan service (every 6 min). There are six areas for the FY-4A satellite to provide the rapid scan service with the interval of about 5 min.

Currently, there are 29 NMHSs registered for FY_ESM. In 2021, 15 requests have been received up to now.

When it comes to the future plans for FY_ESM, it was highlighted that FY-4B, the second satellite of FY-4 series, was designed to be the first operational satellite of FY-4 series (launched on June 3, 2021). This satellite allows scanning the Earth with the temporal resolution of 1 min and spatial resolution of 0.25-1 km.

5.1.4 Updates of GK2A AMI rapid scan imagery (including the introduction of "KMA's new Marine Weather Satellite Broadcast Service in Asia-Pacific")

The updates on GK-2A AMI rapid scan service were presented by Sung-Rae Chung (KMA/NMSC).

It was reported that KMA started to operate GK-2A from July 25, 2019. GK-2A rapid scan service provides the information every 2 min for the target observation area of 1,000 x 1,000 km to address hazardous events such as typhoons, thunderstorms, wildfires, etc.

Since October 2021, global users over the Asia-Pacific region (RA II and RA V) can request the target area observations. Users can submit official request form defining specific measurement area via rapid scan request webpage available at KMA/NMSC (http://datasvc.nmsc.kma.go.kr/datasvc/html/special/specialReqMain.do). There are different ways to receive the requested data, including FTP service.

GK-2A data is also provided via satellite broadcasting. There are three types of this service: UHRIT broadcasting (high resolution Level 1B) reception, HRIT broadcasting reception, LRIT broadcasting reception. In order to receive the data via satellite broadcasting, users need to have their own ground receivers.

Besides, a new advanced concept for marine weather service was implemented by KMA. It is a marine weather broadcast service using GK-2A satellite. This new system uses SDUS (Small-scale Data Utilization Station), which can be easily installed and allows covering a wide area, including Australia.

A lot of marine information such as ocean colour images, weather information, and other data can be broadcasted to any ship, which has this kind of antenna.

Bodo Zeschke (BoM) questioned if it is the 24-hour advance warning that has to be given to make a request for the GK-2A AMI rapid scan service. Sung-Rae Chung (KMA/NMSC) confirmed that the 24-hour advance notice is required.

Yw Chan (HKO) posed a question if KMA plans to use the cloud service to disseminate this data. Sung-Rae Chung (KMA/NMSC) confirmed that this option is already available for users via open API service.

The question raised in the chat: is it possible to broadcast the information to a ship in the open ocean using satellite? Dohyeong Kim (KMA) confirmed that the users who have the reception system installed on the ship can have access to the broadcasted information.

5.1.5 NOAA updates: upcoming launches, GOES-West transition, and GeoXO (pre-recorded presentation)

The updates from NOAA were presented by Natalia Donoho (Senior International Relations Specialist, NOAA, Satellite and Information Service, International and Interagency Affairs Division). The presentation mainly covered the following three topics: updates on NOAA satellites, GOES-West transition plan as well as Geostationary Extended Observations (GeoXO) programme.

It was announced that GOES-T is scheduled to launch on February 16, 2022. GEOS-T/18 is the third satellite in the GOES-R series, and after the checkout period, it will become operational as GOES-W. JPSS-2 is also scheduled to launch next year (no earlier than Fall 2022).

GOES-17 was launched in March 2018, and it was declared NOAA's operational GOES-W in February 2019. It has had a tremendous benefit for severe weather forecast, specifically because of Advanced Baseline Imager (ABI), even though ABI has some issues which results in degraded imagery during four warm periods of each year (a number of mitigation techniques were implemented to address this issue).

As for the GOES-West transition plan, it will be a swap of GOES-17/18. NOAA will try to incorporate early drift of GOES-18 to the West operational longitude and GOES-18 will be drifted to 136.8°W to complete instrument activities. GOES-18 ABI data will be available to support August GOES-17 ABI warm period. After operational transition, GOES-18 will be moved to 137.2°W. GOES-17 will be then drifted to 105°W and placed in on-orbit storage. GOES-T post-launch science product validation plan was also introduced in the presentation.

Transition to the GeoXO (Geostationary Extended Observations) is expected in 2032. The user engagement workshop was organized last year to understand user needs in order to define a new system. GeoXO is the NOAA's 6th generation GEO satellites, providing observational continuity following the GOES-R series. It will be a series of six satellites, operated in a constellation of three: GEO-West, GEO-Central, and GEO-East (NOAA-NASA partnership).

GeoXO is planned to have the following payload:

- Imager (GXI), which will provide similar coverage as GOES-R, but with additional channels and some having higher spatial resolution;
- Lightning Mapper (LMX), which will be evolving to provide more coverage out into Alaska and the Pacific Ocean with a higher spatial resolution;

- Hyperspectral IR sounder (GXS), which will be located over the central USA. This sounder will make Full Disk observations including the Eastern Pacific and with a quicker cadence than offered by LEO IR sounders;
- Hyperspectral Ocean Colour sensor (OCX) will scan key coastal zones of the USA Pacific Coasts including Hawaii multiple times in a day;
- The proposed Day-Night-Band will provide unique nighttime visible data over at least the Eastern Pacific.

After the presentation, Allen Huang (NOAA) highlighted that NOAA continues to provide a support to users around the globe to process and visualize LEO satellite data, there are dedicated tools for automated processing LEO satellite data and L2 products, all these tools are freely available online, and NOAA is ready to provide support to users to install all these tools.

5.2 Work plan 2021-2022

Dohyeong Kim (KMA, RA II Project Co-coordinator) presented the work plan for the RA II WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training for 2021-2021.

The following key activities for the next two years were highlighted:

1) The 12th Asia/Oceania Meteorological Satellite Users' Conference and user-focused training event will be held in Japan 2022 (hosted by JMA);
2) To define/provide the training requirement from country report for the user-focused training event in conjunction with AOMSUC-12;
3) The 4th joint coordination group meeting of the RA II WIGOS Project and RA V TT-SU;
4) To continue the issuance of quarterly/half-yearly newsletters.

6. SUMMARY OF THE MEETING

This session was chaired by Dohyeong Kim (co-coordinator of the RA II WIGOS Project).

The summary of the meeting highlighted in the presentation: 1) Presentation and discussion on country reports among user representatives [NMHSs]; 2) WMO-CGMS Virtual Laboratory (VLab) updates and plans [WMO]; 3) Report on WMO VLab RA II / RA V training event during AOMSUC-11 [CMA]; 4) Updates high-frequency regional observation [CMA, KMA, JMA]; 5) Introduction of KMA's new Marine Weather Satellite Broadcast Service in RA II / RA V regions [KMA]; 6) Updates on the next generation of geostationary satellites [NOAA].

Action items resulted from the meeting:

- Co-coordinators of the RA II WIGOS project and the Chair of the RA V Task Team on Satellite Utilization will provide the WMO and host country of AOMSUC-12 and training event (JMA, 2022) with the requirements from trainees which can be reflected in the next conference (WMO, JMA, KMA and BoM);
- Co-coordinators would investigate the feasibility using the multi-geo-satellites (e.g. FY-4A, GEO-KOMPSAT-2A and Himawari-8) to increase the utilization of next generated imagers over Asia-Oceania region (CMA, KMA, JMA, BoM);
- Co-coordinators of the RA II WIGOS Project and the Chair of the RA V Task Team on Satellite Utilization will update the requirements and template based on the discussion among the user representatives (KMA, JMA, BoM, WMO);

- CMA, KMA and JMA are considering to add the new information on the Portal. Current and planned observation locations for each service, and availability of request-based high frequency observation. In addition, if possible, the observation locations to be visualized on map in real-time (CMA, KMA and JMA);
- KMA to encourage the registration for the GK-2A AMI Rapid Scan (ARS) service distributing the registration form and the usage information to RA II and RA V NMHSs (KMA).

7. CLOSING

The closing session was also chaired by Dohyeong Kim (co-coordinator of the RA II WIGOS Project). In conclusion, Dohyeong Kim expressed his gratitude to CMA for hosting the meeting and thanked all the participants of the meeting.

Kotaro Bessho (JMA) has also thanked CMA for hosting the meeting, WMO, BoM, and KMA for their support as well as all the participants of the meeting.

Allen Huang (NOAA) noted that this meeting is very beneficial as it provides the opportunity for NMHSs to share the challenges and needs through the country reports. He also added that as community members we are listening to these challenges, and we are going to respond and provide the solutions together.

Ken Holmlund (Head of the WMO Space System and Utilization Division) started his closure remark with the note that he is really pleased to see how the use of satellite data is increasing and improving in terms of quality and quantity as well as better utilization not only of imagery, but also satellite data and products, including higher level products (e.g. wind products from LEO satellites). He also added that he is pleased to see the progress on data access, web-portals, user request services. However, he highlighted that a very strong note was taken in terms of concerns and issues highlighted by the NMHSs. That is one of the most important aspect of this meeting that users have voice to raise their concerns and issues. He stressed that he would like to reaffirm the WMO commitments towards the regional activities and ensure that in the future the users in the region will have access to the satellite data and products they need. He concluded his speech with expressing thanks to all participants and presenters of the meeting, adding that the participation from the region is of key essence. He also thanked CMA for hosting the meeting, KMA, JMA, and BoM for chairing the meeting. He highlighted that as outcomes of the meeting we have a lot of take-away messages which we will need to think about in detail.

In conclusion, it should be noted that the Third Meeting of RA II WIGOS Project and RA V TT-SU for RA II and RA V NMHSs allowed to identify that there is a gap in using LEO satellite data by NMHSs in the region. Significant number of countries do not use any LEO data (or have access to this data only via Internet) due to the lack of receiving systems, processing and visualization software available as well as the lack of expertise in analyzing this data. Thus, this issue should be addressed in the first place by satellite operators in the region and WMO in order to ensure that NMHSs have access to LEO satellite data via retransmission services and/or other means.

ANNEX I: Meeting Agenda

Agenda

The Third Joint Meeting of RA II WIGOS Project and RA V TT-SU for RA II and RA V NMHSs

Beijing, China (On-Line Meeting)

5 November 2021

[04:00 UTC ~ 07:00 UTC (3 hours)]

UTC					
4:00	**1**	**OPENING [Chair: KMA]**			**0:10**
4:00	1.1	Welcome address	ZHANG Peng	CMA	0:04
4:04	1.2	Opening address	Heikki Pohjola	WMO	0:04
4:08	1.3	Adoption of the agenda	Dohyeong Kim	KMA	0:02
4:10	**2**	**STATUS OF PROJECT [Chair: KMA]**			**0:10**
4:10	2.1	Accomplishments, current status and work plan of the RA II Project and the RA V Task Team	Dohyeong Kim Agnes Lane	KMA, JMA and BoM	0:10
4:20	**3**	**USER PERSPECTIVES [Chair: BoM]**			**1:30**
	3.1	User requirements for satellite data utilization			
4:20	3.1.1	Country Reports of RA II / RA V	Zoya Andreeva	WMO	0:10
4:30	3.1.2	Presentation and discussion from RA II / RA V users' representatives [NMHSs]		RA II/RA V countries	1:20
5:50	**4**	**TRAINING ACTIVITY [Chair: JMA]**			
	4.1	WMO-CGMS Virtual Laboratory (VLab) updates and plans			**0:30**
5:50	4.1.1	VLab as a Global Network of Training Providers (pre-recorded presentation)	Wen Bo	Co-Chair of WMO-CGMS VLab, CMATC	0:15
6:00	4.1.2	Satellite Meteorology Training in WMO RAV during 2020/21	Bodo Zeschke	BoM	0:15
6:10	**5**	**COLLABORATION AND FUTURE PROJECT WORK PLAN [Chair: JMA]**			**0:30**
	5.1	Updates High-Frequency Regional Observation			
6:10	5.1.1	Updates on portal including information on availability of high-frequency regional observation and so on	Kotaro Bessho	JMA	0:10
6:10	5.1.2	Updates on HimawariRequest	Kotaro Bessho	JMA	0:05
6:25	5.1.3	Updates on FY ESM	XIAN Di	CMA	0:05
6:30	5.1.4	Updates of GK2A AMI rapid scan imagery (including the introduction of "KMA's new Marine Weather Satellite Broadcast Service in Asia-Pacific")	Sung-Rae Chung	KMA	0:10

6:40	5.1.5	NOAA updates: upcoming launches, GOES-West transition, and GeoXO (pre-recorded presentation)	Natalia Donoho	NOAA	0:10
6:50	5.2	Work plan 2021-2022	Dohyeong Kim	KMA, JMA, BoM	**0:05**
6:55	**6**	**SUMMARY OF THE MEETING [Chair: KMA]**	Dohyeong Kim		**0:05**
7:00	**7**	**CLOSING [Chair: KMA]**			

ANNEX II: List of Participants

Name	Country / Affiliation
Jim Purdom	AOMSUC ICSC
Edison	BMKG/Indonesia
Dr Endarwin	BMKG/Indonesia
Andersen Panjaitan	BMKG/Indonesia
Edward	BMKG/Indonesia
Heri Ismanto	BMKG/Indonesia
RAHMAT N.R	BMKG/Indonesia
Fani Setyawan	BMKG/Indonesia
Agnes Lane	BoM
Bodo Zeschke	BoM
Mikael Rattenborg	CGMS Secretariat
Allen Huang	CIMSS
LIU Chang	CMA
Peng Zhang	CMA
Xian Di	CMA
Sosten Sos	Federated States of Micronesia
Chi Kuen SO	Hong Kong, China
SO CHI KUEN, BILLY	Hong Kong, China
YW Chan	Hong Kong, China
Rashidzad	IRAN
Mostafa Izadfar	IRIMO
Kotaro Bessho	JMA
Takuya SAKASHITA	JMA
小出 寛	JMA
Gulaiym Dauletkan	Kazakhstan
Dohyeong Kim	KMA
Jinho SHIN	KMA
Tae-Hyeong OH	KMA
Ali SHAREEF	Maldives
Thahumeena Abdulkareem	Maldives
Kyaw Lwin Oo	Myanmar
Pa Pa Swe	Myanmar
Murray Douglas	New Zealand
Obaidan	Omar
MUHAMMAD IRFAN VIRK	Pakistan
Jan Muhammad	Pakistan
Ella Marie Soriano	Philippine/PAGASA
Irwin Aguilar	Philippine/PAGASA
menandro mendoza	Philippine/PAGASA
Rolymer Canillo	Philippine/PAGASA
JMA SATO	RAII-WG-Infrastructure
Olga Nechepurenko	Russian University
Fawzi Zinalabidine	Saudi Arabia/NCM

Name	Country / Affiliation
Hamza Abdulaziz Halwani	Saudi Arabia/NCM
Abeer Asiri	Saudi Arabia/NCM
M.M.P. Mendis	Sri Lanka
Ercan Buyukbas	Turkey
Abdulla Al Shamsi	United Arab Emirates
Majed Alshkeili	United Arab Emirates
Hồng Phúc	Vietnam
Do Huy Duong	Vietnam
Nguyen Quang Vinh	Vietnam
Mai Khanh Hung	Vietnam
Heikki Pohjola	WMO
Kenneth Holmlund	WMO
Yong Qing Chen	WMO
Zoya Andreeva	WMO
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Bayasgalan Gerelchuluun	
Dharar Ahmed Aladeemi	
Ebrahim Abdulghni Qerba	
EMMS	
Faiz Rashid	
Ferdinand Barcenas	
hanillah	
Hesam sajdeh	
Mahani Abllah	
Mohammed AL-lesani	
Mukhatar ALGhayyag	
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