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COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

INTER-PROGRAMME EXPERT TEAM ON SATELLITE UTILIZATION AND PRODUCTS

ITEM: INF.5.1

THIRD SESSION

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GENEVA, SWITZERLAND, 2-5 MAY 2017

Report on the 7th Asia/Oceania Meteorological Satellite Users' Conference

(Submitted by KMA)

Summary and Purpose of Document

This document reports the 7th Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC-7).

ACTION PROPOSED

The second session is invited to:

(a) take note of the information provided in this report.

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Appendices: A. AOMSUC-7 Summary

The Seventh Asia/Oceania Meteorological Satellite Users' Conference

The seventh Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC-7) was held in Songdo City, Republic of Korea from 24-27 October 2016. The conference was hosted and sponsored by the Korea Meteorological Administration (KMA), and was co-sponsored by the China Meteorological Administration (CMA), the Japan Meteorological Agency (JMA), the Australian Bureau of Meteorology (AuBoM), the Russian Federal Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET), the Agency for Meteorology, Climatology and Geophysics (BMKG), India (IMD), the World Meteorological Organization (WMO), and the Group on Earth Observations (GEO). The conference was held in conjunction with the 2nd AMS-Asia Satellite Conference and the 2nd KMA Meteorological Satellite Users' Conference. A training event was conducted prior to the conference that brought together participants from WMO Regions II and V. Over 230 scientists, users, and satellite operators representing 37 countries participated in the AOMSUC-7. The welcome speech was given by KMA administrator Yunhwa Ko. He noted that the new generation of GK-2A was expected to have 16 channel characteristics similar to HIMIWARI-8 and GOES-R and stressed the importance of this AOMSUC as an opportunity for enhancing cooperation, exchanging information, and improving satellite data utilization.

AOMSUC-7 featured high quality presentations in 10 oral sessions, a poster session, and a concluding panel to summarize the highlights; each panel expressed appreciation of the conference accomplishments and stressed the importance of the AOMSUC. The oral sessions are;

- Session 1: Current and future meteorological satellite programs
- Session 2: Expectations from the Next Generation Satellites and User's Broad Needs in Asia/Oceania
- Session 3: Preparing for the Next Generation of Meteorological Satellites
- Session 4: Program plans, data access and utilization
- Session 5: Atmospheric parameters derived from satellite observations
- Session 6: Application of satellite data to weather analysis and disaster monitoring
- Session 7: Application of Satellite Data to Data Assimilation and Numerical Weather Prediction (NWP)
- Session 8: Application of Satellite Data Calibration/ Validation and Climate/ Environmental Monitoring
- Session 9: Land surface and ocean parameters derived from satellite observations
- Session 10: Capacity building and training activities

In the poster session, over 40 posters detailed new developments in sensor calibration, cloud detection and characterization, wind retrievals, dust detection, fire monitoring, nighttime sea fog detection, convective initiation characterization, rainfall estimation, NWP improvements resulting from satellite data usage, and several other topics.

The two day training event was hosted by KMA immediately prior to the conference from 21-22 October 2016. Including lecturers, NMSC staff and attendees there were around 60 participants to the Training Event. The audience was represented by participants from 27 countries. The two days involved a blend of introductory lectures followed up by practical sessions. On the first day this included an introduction to the Community Satellite Processing Package (CSPP), and then practical exercises utilizing the latest version of the HYDRA software in order to display Himawari-8 satellite images and image (RGB) products, and to perform statistical analysis of the data. The second day included an introduction into the latest developments in the detection and monitoring of rapidly developing thunderstorms by presenters from KMA, JMA and CMA. This was followed by a practical session on satellite image analysis and the practical demonstration of the KMA NMSC Cloud Analysis System for satellite image analysis and practice.

The Russian Federation announced that they are planning to host the 8th AOMSUC on 16-21 October 2017 and invited prospective attendees to Vladivostok, and Indonesia announced its intentions to host the 9th AOMSUC in a venue to be decided in Indonesia in October of 2018.

In summary AOMSUC-7 was very successful in meeting the four goals of these conferences; (1) to promote the importance of satellite observations and highlight their utility, (2) to advance satellite remote sensing science by enabling scientist to scientist information exchanges focused on Asia/Oceania, (3) to provide a means for satellite operators to interact directly with the user community concerning current and future satellite related activities and plans, and (4) to engage young people entering into the field.

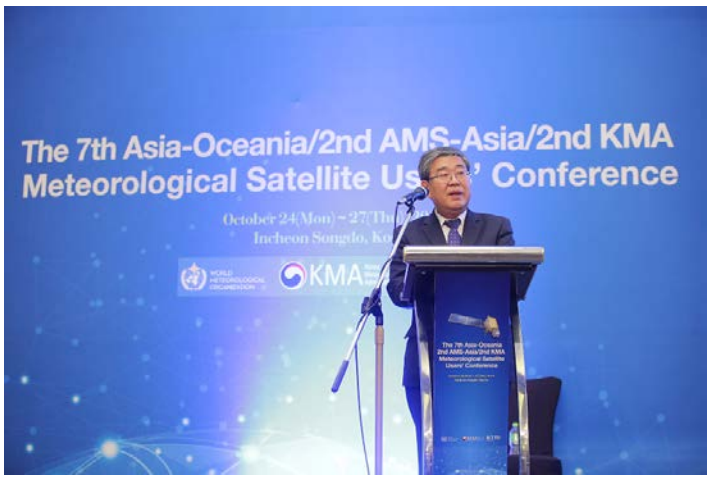
AOMSUC-7 Summary

The seventh Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC-7) was held in Songdo City, Republic of Korea from 24-27 October 2016. The conference was hosted and sponsored by Korea, and was co-sponsored by China, Japan, Australian, the Russian Federation, Indonesia, India, the World Meteorological Organization (WMO), and the Group on Earth Observations (GEO). The conference was held in conjunction with the 2nd AMS-Asia Satellite Conference and the 2nd KMA Meteorological Satellite Users' Conference. A training event was conducted prior to the conference (summarized in the conclusions) that brought together participants from WMO Regions II and V. Over 230 scientists, users, and satellite operators representing 37 countries participated in the AOMSUC-7. All attendees expressed their great appreciation of the outstanding hard work of KMA in its planning and hosting of the conference as well as the support of the co-sponsors and the work of the International Conference Steering Committee (ICSC).

Noting that the move to the next generation of geostationary and polar orbiting meteorological satellites underway and planned for the next few years were leading to a new era in the Space Based Component of the WMO Integrated Global Observing System (WIGOS), the participants welcomed the efforts being undertaken to distribute and utilize this unprecedented stream of very high resolution multispectral digital data (15 or more channels in the visible to near infrared and across the infrared portion of the spectrum); it was agreed that this early coordination in the generation of new products and services and the preparation for their utilization by the Asia/Oceania user community must be actively sustained. This data and product flow is a significant undertaking for the operational space agencies in the coming years, as is the associated user preparation and these annual conferences of the Asia/Oceania satellite community are an important part of that effort. It also points to the potential need for joint satellite applications facilities as is spelled out in the Memorandum on the AOMSUC signed at WMO EC 2016 (immediately below).

This 7th AOMSUC represented an important milestone in the life of the AOMSUC. At WMO Executive Council on the 16th of June 2016 the AOMSUC was recognized on a formal international basis by the Permanent Representatives to WMO of Australia, China, India, Indonesia, Japan,

Korea, the Russian Federation and the Secretary-General of WMO; all confirmed and signed the "Memorandum on the Asia-Oceania Meteorological Satellite Users Conference (AOMSUC)". That memorandum established the conference to be held on an annual basis and set forward the goals and terms of reference for the conference. Among the many important points recognized in the memorandum is the recognition that the conferences have proven to be very effective in: (1) promoting the importance of satellite observations and highlighting their utility; (2) advancing satellite remote sensing science by enabling information exchange between scientists from the Asia Oceania region with a focus on regional issues; (3) providing a means for satellite operators and the user community to interact directly regarding current and future satellite related activities/plans and strengthening the operator response to the requirements of those users, and (4) engaging young scientists entering the field. These four areas will continue to be a focus of the AOMSUC. Below is a chronology highlighting the opening of the conference and the sessions.



The conference was opened by welcoming addresses on behalf of the International Conference Steering Committee (ICSC), the sponsor and cosponsors. Dr. James F.W. Purdom (Chair of ICSC) welcomed participants to the conference and thanked KMA for its activities in developing an exciting conference program that was a mix of oral and poster sessions. He noted that the goals of the AOMSUC were being addressed in ten comprehensive sessions that addressed current and future exploitation of the next generation polar and geostationary satellites in the Asia/Oceania area and indeed across all regions of the globe. Administrator of the Korea Meteorological Administration (KMA) Yunhwa Ko welcomed the participants. He noted that this conference was building on the past success of the last six conferences and was pleased that of the successful provision of high spatial, spectral and temporal geostationary satellites to users in the Asia/Oceania area. He further noted that the new generation of GK-2A was expected to have 16 channel characteristics similar to HIMIWARI-8 and GOES-R and stressed the importance of this AOMSUC as an opportunity for enhancing cooperation, exchanging information, and improving satellite data utilization. In their welcoming remarks, on behalf of Japan Mr. Hirosi Kunimatsu Deputy Director of the Satellite Programs Division of the Japanese Meteorology Agency (JMA), on behalf of China Deputy Director General Datong Zhao of the National Satellite Meteorological Center of the Chinese Meteorological Administration (CMA), on behalf of Australia Dr. Agnes Lane Manager of the Requirements and Analysis Division of the Australia Bureau of Meteorology (AuBOM), and on behalf of the Russian Federation Prof. Vasily Asmus Director of SRC Planeta of ROSHYHDROMET all reflected on the importance of the AOMSUC's in bringing together satellite operators and the user community. All noted the increasing efforts to engage the user community and to offer training on site and remotely in order to achieve improved satellite data utilization. In addition, Prof. Asmus announced the plans underway for the Russian Federation to host AOMSUC-8 in Vladivostok from October 16-21, 2017. On behalf of Indonesia Dr. Andi Eka Sakya Director General for the Agency for Meteorology, Climatology and Geophysics (BMKG) and President of WMO RA V expressed his enthusiasm as the newest sponsor of AOMSUC and as an original Signer of the EC Memorandum. He pointed out that the user needs for satellite data to fulfill their missions was growing and that he anticipated great results from this and future AOMSUCs; to that

end he announced that Indonesia would host AOMSUC-9 in October 2018 in a place yet to be determined. On behalf of Group on Earth Observations (GEO) Dr. Osamu Ochiai noted that AOMSUC continues as an important mechanism for enhancing scientific understanding through international cooperation and collaboration. He emphasized the importance of the AOMSUC to helping achieve GEO objectives in the region and the importance of continued GEO support for AOMSUC. On behalf of the World Meteorological Organization (WMO), Dr. Wenjian Zhang, Assistant Secretary General of WMO, lauded the vibrancy of the Asia/Oceania meteorological satellite community, complimented them for their good efforts in sharing data and information across the region, and renewed the WMO commitment to support this and future AOMSUCs. He reiterated that the increase in satellite data quality, volume, and information content presents a challenge to the community to realize the opportunity for improved weather and climate services.

Session 1, "Current and future meteorological satellite programs," was chaired by Dr. Wenjian Zhang (WMO) and Dr. Andi Eka Sakya (BMKG).

Jim Purdom introduced the new generation of satellites in GEO and LEO orbits, greatly expanding the opportunities for satellite data applications. There will be improved resolution in temporal, spatial, spectral, and radiometric (signal-to-noise ratio) domains. Rapid scanning enables for example detecting the growth rates of convective systems. Designing the new systems should be driven by expected benefits for understanding weather and climate, as well as complementarity with existing and other planned systems. He showed examples for convective storm evolution analyzed using rapid scanning, and demonstrated the value of 1-min scanning. Even at this resolution, there remain uncertainties in tracking cloud top features. Deriving cloud motion fields around the eyeball of hurricanes also calls for very rapid scanning. He showed multi-channel dust products using SEVIRI and posed the question how to maximize the exploitation of a 16-channel imager (e.g., using principal components, RGBs). The WMO/EUMETSAT standards for generating RGBs are a baseline that is currently being extended for use with 16-channel imagery.

Mitch Goldberg, JPSS Programme Scientist, described the NESDIS mission and showed the status of the NOAA GEO, polar-orbiting and other mission plans (Jason, COSMIC, DSCOVR). GOES-R AHI will provide higher resolution, with the 1-min scanning resolving many new features. The launch has been delayed to at least 16 November due to impact of hurricane Matthew on the launch site. The JPSS programme provides software to the community for direct readout applications. NESDIS undertakes a study on the future architecture of the space-based observing system, and complementing ground systems, up to 2050, consistent with the WMO 2040 Vision for WIGOS Space-based Component Systems. The NOAA Commercial Weather Data Pilot includes awarding two contracts to companies that should demonstrate the added value of their data by 2018.

Kenneth Holmlund, Chief Scientist of EUMETSAT, showed the current fleet of EUMETSAT operated satellites, and the plans for upcoming missions. He stressed the importance of user preparation to Meteosat Third Generation (MTG), building on experience gained with the use of Himawari-8 and GOES-R. Transition from 12 to 16 channel imagery, with increase spatial and temporal resolution, will be a challenge to some European and African NMHSs. There is also a NWP-IRS demonstration project to prepare for the use of the InfraRed Sounder (IRS) on MTG-S. The Indian Ocean Data Coverage service will continue with the use of Meteosat-8 at 41.5°E and SEVIRI 12-channel imager capability (e.g., to derive GEO winds). The collaboration between Europe and Asia will be critical, also in other areas. The EUMETSAT polar programme is part of the LEO constellation. When extending the lifetime of Metop-A, consideration is given to the re-entry time of the platform (and to avoid space debris in protected orbit areas). Dual-Metop configuration use of data has proven of value to atmospheric various applications, including the provision of dual-Metop winds to mitigate the known gap for Atmospheric Motions Vectors (AMV) between 55 and 70 degree north and south latitudes. The European Sentinel-3A ocean mission commissioning is underway, with the first operational data to be delivered by the end of 2016.

Jae-Gwang Won (NMSC, KMA) described the KMA challenge to produce impact-based forecasts ("the expected socio-economic impact as a result of meteorological phenomena"). A first step towards impact-based forecasts is risk-based warnings, with consideration of hazard, vulnerability, and impact. Based on data from the current geostationary COMS satellite, he showed examples for severe weather monitoring (rapidly-developing thunderstorm, fog over land and ocean). KMA expects positive impacts of Clear Sky Radiances (CSR) and AMV on their Numerical Weather Prediction (NWP) models. The plans for the next-generation GEO GK-2 mission involve two platforms (2A with a meteorological and a space weather monitor, 2B with an ocean colour and an atmospheric chemistry sensor). The imager will provide full disk scans every 10 minutes and local area scanning every 2 minutes. The ground segment of GK-2 will involve UHRIT-based direct readout. Plans for meteorological LEO satellites are underway, pending government approval, for a launch in the early 2020s. KMA are active in the WMO Global Space-based Intercalibration System (GSICS) to monitor the spectral response of the COMS imager. More efforts are required for cal/val of geophysical products, including sites and special observatories. KMA are also committed to contribute to systematic generation of ECV records, coordinated in the WMO Sustained Coordinated Processing of Environmental Data Records (SCOPE-CM) initiative.

Daetong Zhao (NSMC, CMA) presented the China National Space Infrastructure Plan, governing the planned GEO and LEO programmes. He showed details of the super-high resolution optical camera GF-4 at 50m horizontal resolution and 10s sampling frequency, and its imaging of a typhoon approaching China. Planning for launching FY-4A in December 2016 is well underway. Combination of a FY-3 satellite in early morning orbit, S-NPP and Metop provides good orbital coverage for NWP. This is foreseen to be realized with FY-3E. FY-3D features improved instruments (e.g., MERSI-II) as well as new instruments (e.g., Greenhouse Gas Absorption Spectrometer – GAS). There are thematic satellite application facilities in China. The FY-4A Lightning Mapping Imager (LMI) product will be broadcast via CMACast (note that the LMI will provide regional coverage to demonstrate the lightning detection capability, and the performance and coverage region of LMI on the following FY-4 satellites will be improved).

Hiroshi Kunimatsu (JMA) presented the status of the Himawari programme. He showed spectral response functions of the GEO imagers compared to LEO imagers and concluded that it is a good time to jointly use the two sources of data. The Himawari DCS service has been rapidly expanding to support tide gauge data transmission for tsunami warnings. The Himawari data services are based on HimawariCast and HimawariCloud (internet-based) components. The HimawariCast broadcast is available to the entire Pacific region, most useful in areas of low internet bandwidth

and available also when internet is unstable. HimawariCast reception systems have been installed in 14 countries of the region (in a WMO-JMA project) and more are planned. A resampling process has been introduced to some AHI imagery to correct for co-registration errors. Filters have been applied to reduce striping in some channels. Post-launch testing of Himawari-9 will extend into March 2017.

Vasily Asmus (ROSHYDROMET) gave an overview of the Russian plans for building up a space-based meteorological constellation, and the supporting ground systems. He expanded on the expected use of the Arktika mission to provide continuous imaging coverage of the Arctic region. He furthermore showed a range of satellite-based products generated by ROSHYDROMET for meteorological and environmental applications.

Session 2, "Expectations from the Next Generation Satellites and User's Broad Needs in Asia/Oceania," was chaired by Dr. James Purdom (ICSC Chair) and Dr. Mitch Goldberg (NOAA).

Four speakers presented requirements and needs from the user community. The session's keynote presentation by Dr. Wenjian Zhang, the WMO Assistant Secretary – General, provided an overview of the WMO Space Observation Vision in 2040. The vision responds to key drivers over the next 20 years which includes 1) evolving and emerging user requirements for increase resolution in the temporal, spatial and spectral domains; 2) the need for comprehensive data records which needs sensors which are well calibrated and traceable to SI standards; and 3) the need for mature applications in the areas of air quality, cryosphere, hydrology and space weather. Overarching priorities include 1) weather forecasting and disaster risk reduction 2) climate monitoring, assessments, attribution and mitigation, and 3) global frame work for climate services. The backbone of the observing system continues to be a geostationary constellation of advanced visible imagers, lightning mappers, and hyperspectral sounders and a 3 orbit polar orbiting constellation of advanced imager including a day night band, microwave and hyperspectral infrared sounders, as well as a constellation of new technologies including small satellites. The societal benefits were clearly demonstrated. The 2040 vision relies on enhanced international cooperation, and potentially joint planning and joint missions.

The presentation by Osamu Ochiai from the Global Earth Observations (GEO) Secretariat, gave an overview of the GEO program, which focuses on observations, applications and outreach to support eight societal benefits: 1) Water Resources Management, 2) Biodiversity and Ecosystem Sustainability, 3) Disaster Resiliency, 4) Energy and Mineral Resources Management, 5) Food Security and Sustainable Agriculture, 6) Infrastructure and Transport Management, 7) Public Health Service, and 8) Sustain Urban Development. GEO's data sharing principles are consistent with WMO and CGMS, which calls for full and open data exchange. The 9th GEOSS Asia-Pacific Symposium will be held in Tokyo, Japan, January 11-13, 2017. GEO is establishing Asia–Oceania GEOSS (AOGEOSS) to leverage existing regional efforts and establish an effective cooperative framework for Earth observation to address those challenges which pose a risk to the attainment of sustainable development in the Asia–Oceania region.

Dr. Agnes Lane's presentation on meeting user needs with new satellite products in the Bureau of Meteorology discussed the utility and expected benefits from a number of different products. The Bureau provides services in the following areas: Data Assimilation, Climate Monitoring and Services, Severe Weather Services, and Ocean and Marine Services. The presentation discussed the following products and their applications: 1) Himawari precipitation, 2) multisensor precipitation, 3) convection initiation and storm cell detection and tracking, 4) enhanced solar radiation, 5) vegetation indices and curing, 6) aerosol concentration, 7) sea surface temperatures, and 8) atmospheric motion vectors. Also presented were the satellite observations assimilated in

their regional models.

Dr. Riris Adriyanto from the Indonesia Agency for Meteorology Climatology and Geophysics (BMKG) discussed the "Challenges of Meteorological Observations Over Indonesian Maritime Continent by Using Satellite" Indonesia. Sitting between two "warm-pools", the Indian and Pacific Oceans, and its Maritime Continent (MC) plays a unique role in the weather-climate continuum of the region and the world. Its diverse surface topography and complex interactions between land-ocean-atmosphere, both local and teleconnections, often cause some impacts of hydro-meteorological disasters (flash- floods, landslides, drought and forest fires). Key satellite product needs for Indonesia include 1) Fire, Smoke/haze, and Volcanic ash detection under cloudy atmosphere for flight operation safety; 2) Predicting location of microburst from Cumulonimbus activities for aerodrome warning, 3) Estimating Clear-Air Turbulence's location à flight-route weather advisory, 4) Accurate satellite rainfall estimation for flash-flood warnings, and 5) Higher resolution SST monitoring for inner seas for understanding of air-sea interactions between inner seas and land with complex terrains. Indonesia expectations include: 1) Promote future applications of geostationary data for marine meteorology and oceanographic monitoring with emphasize to Maritime Continent region suffered from sufficient surface-based observation data. 2) Need to increase capacity building for middle and small data-users through Regional Scientific Training especially for optimizing the use of multi-channels of new generation of meteorological satellites and 3) Collaborative projects involving data providers and users to develop of Local and Regional Early Warning System for specific severe weather events based on geostationary satellite data (example : JMA – BMKG visiting scientist program to develop RDCA using Himawari-8 and local observation data).

Session 3, "Preparing for the Next Generation of Meteorological Satellites" was chaired by Dr. Allen Huang (CIMMS) and Dr. Osamu Ochiai (GEO).

Dr. Stephan Bojinski of WMO highlighted the arrival of the new meteorological satellites provided by many international meteorological and space agencies with unprecedented new and emerging capabilities with a focus on both geostationary and polar orbits weather, climate and water monitoring observing systems that affecting all regions of WMO members. In preparation and meeting the challenges of the increasing data volume and new type of data WMO Space program addresses the needs of assisting users by the development of specific guidance and best practices to both data providers and users. Especially, the development of best practices and guidance with 1) Online portal SATURN (SATellite User Readiness Navigator) as a reference user readiness project, 2) Online training material on aspects of Himawari-8 and GOES-R with the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab), 3) Online WMO Product Access Guide and 4) Observing Systems Capability Analysis and Review tool Space (OSCAR).

NMSC/KMA partners with ETRI, represented by Dr. Sung-Rae Chung, reported the recent activities on the Geo-KOMPSAT-2A products development. The coming 2018 GK-2A/AMI is scheduled to provide the users with vast amount of data, algorithms, products and information including 23 primary & 29 secondary products. IRT – International Review Team (steering committee on algorithm & application technique) is formed to review and guide the algorithm development work. Particularly, using AHI as proxy, an algorithm testbed is developed and along with the reference and ground truth data are collected to validate the product performance.

Dr. Kenneth Holmlund of EUMETSAT briefed the new era of geostationary satellite imaging data provide vast opportunity for deriving products beyond sole meteorological applications. Examples of non-traditional meteorological products (NMA) in area of Land (Hot-spots, LST, Snow,

Flood/Standing water, Vegetation/Drought/Evapotranspiration, Albedo, Incident Solar Radiation), Ocean (SST, Ice, Ocean Color) and atmosphere (Aerosol optical depth&type, Dust, Volcanic ash, Atmospheric composition) are highlighted. Planned NMA atmosphere, land and ocean products derived from various imaging and sounding geostationary sensors are shown. In addition, the synergistic use of LEO systems and coordination among agencies and bilateral agreement are initiated. The study under CEOS is carried out to document increasing awareness, cross-calibrating among sensors, demonstrating and encouraging the use of GEO along with LEO and developing common baseline and tools in order to further develop higher level products and applications. It was noted that "Non-Met" may be misleading and another term might be more appropriate.

Representing ETRI of S. Korea, Ms. Ji-in Kim reported the GK-2A ground segment development status. KMA GK-2k adopted the strategy of working with product development and applications techniques development teams to perform algorithm integration through modularization and standardization of individual L2 product algorithm codes to shorten the data processing time and to achieve overall reduction in design effort for the different subsystems to support the real-time and reliable on demand uses for meteorological and environmental applications. A state-of-the-art ground system under development has begun to achieve the goal of one-stop process for optimization/parallelization to benefit the users' efficient and sustainable routine operations.

Dr. Xiang Fang of CMA introduced the readiness efforts on FY-4 satellite with new and enhanced sensing capabilities. CMA's user readiness is implemented in components of 1) application platform, 2) application products, 3) data service, 4) application demonstration, and 5) user training. Efforts and progress are reported in each of these 5 areas with the user training. In particular, CMA has made FY-4 readiness progress in: 1) application software and data service system based on public cloud platform, 2) 28 baseline products production in real time, 3) conduct 30 demonstration projects and organized series of training activities for domestic and international users.

Session 4, "Program plans, data access and utilization" was chaired by Dr. Kenneth Holmlund (EUMETSAT), Dr. Jaedong Jang (KMA) and Dr. Dohyeong Kim (KMA)

Session four comprised a total of 11 presentations. The presentations included satellite programme plans from NOAA, JAXA and CMA introducing the current status of the various agency programmes and future outlook. The foreseen missions cover a wide range of systems from geostationary and polar orbits with increasing instrument capabilities in the years to come. Furthermore the presentations gave detailed information on the performance of various instruments and the capabilities of the first new generation geostationary imager onboard the Himawari-8 satellite was discussed in depth. The session also included discussions on direct readout software packages, how data is used in regional centers and the continuous expansion of connected readout stations, providing global near-real time data access from polar orbiting satellites from large portions of the globe within the WMO DBNet concept. The session was split into two parts with Dr. Kenneth Holmlund chairing the first part and Drs Dohyeong Kim and Jae-Dong Jang chairing the second part.

Dr. Mitch Goldberg presented the impact of enhanced use of JPSS data on Societal Benefits areas. Several examples of the benefits for weather forecasting were given, like hurricane monitoring or the use of microwave image compositions for global hourly merged microwave observations. The latter beings important for visualizing important moisture patterns and circulation like atmospheric rivers. Operational weather satellites have significant capabilities for deriving products that may not traditionally be seen as 'weather' products like algae bloom, vegetation health, flood mapping and ice. The impressive NOAA portfolio of products is linked directly to

NOAA's four service areas: National Weather, National Fishery, National Ocean and the Office of Oceanic and Atmospheric Research. Through a Social Benefits Application Pyramid informed decisions can be made based on robust and accurate observations. Hence, today, the use of satellite data today impacts a huge range of societal benefit areas. The presentation gave large number of examples where these benefits can be demonstrated like monitoring of coral reef bleaching leading to closure of dive sites.

Dr. Misako Kachi introduced JAXA's current and future missions and activities related to water and climate. Global precipitation observations are supported by the GPM mission, where the core observatory includes dual-microwave radar and a microwave imager provide the anchoring for global satellite microwave based precipitation observations. The Global Change Observation Mission (GCOM) is composed by two types of platforms: GCOM-W for water using a microwave imager and GCOM-C for climate flying a high resolution Second Generation Global Imager. Regarding the microwave imager AMSR-E on GCOM-W it is notable that the instrument includes frequencies around 6.9 and 7.0 GHz, which are critical for all-weather SST observations. Hence a follow-on mission to GCOM-W is under discussion, but not secured yet. It is notable that there are to date no other agency are planning future missions with instruments covering those frequencies making the JAXA efforts in that respect even more critical. Finally the activities by JAXA for developing Himawari-8 products were discussed including new products like wild fire monitoring and photovoltaic power.

The impact of Suomi-NPP reprocessing activities on weather and climate applications was presented by Dr. Fuzhong Weng. Suomi-NPP provides continuity to the NOAA satellite series and bridges towards JPSS. Significant improvements in understanding the data and how errors and noise is characterized were presented. The benefits using the Allan deviation instead of the traditional standard deviation were demonstrated using CrIS data. The Suomi-NPP reprocessing activities cover ATMS, CrIS, VIIRS and OMPS data and the use of state of the art algorithms ensure that consistent long-term data records can be created. E.g. for microwave and infrared 40 year data records are now available. The data records are used for various applications like global NWP reanalysis and tropical cyclone genesis analysis. The latest data records will soon be available from the NOAA CLASS archive.

Dr. Teruyuki Nakajima discussed the benefits of Himawari-8 and other satellites for the Earth's environmental monitoring. Carbon monitoring becomes increasingly important and this can already today be supported by missions like GOSAT. In that context the monitoring of aerosols are critical and the presentation also introduced recent improvements in aerosol retrieval using Himawari-8 data. Pollution and forest fire detection is also possible with Himawari-8 as well as ocean colour. Finally the retrieval of photovoltaic power in support of near-real time solar energy retrieval was introduced. In addition the importance of validation and analysis tools in conjunction with validation networks and simulators was noted.

Dr. Feng Lu introduced the new capabilities of the next generation Chinese geostationary satellite FY-4A and its follow-on. FY-4A is scheduled for launch in December 2016 and is seen as a research and demonstration satellite with the operational satellites following later. FY-4A will come with an exciting payload comprising of a new generation multi-spectral imager, a hyper-spectral infrared sounder (GIIRS), lightning mapping imager (LMI) and a space environment package. The GIIRS instrument will be the first hyperspectral instrument in geostationary orbit and will hence be invaluable for paving the way for other similar instruments like the MTG IRS instrument to be launched in the 2022 timeframe. The LMI instrument is the first geostationary lightning mapper over the Pacific Ocean region. Data will be made publicly available during the in-orbit checkout and calibration and validation phase The follow-on FY-4 satellites will carry improved versions of the instruments on FY-4A and new instruments like a geostationary high speed imager, with

minute scale imaging capabilities at high resolution, down to 250 m in the visible band, are also considered.

Dr. Paul Griffith of Harris presented the significant increase in Geostationary imaging temporal resolution of Geo-KOMPSAT-2A Advanced Meteorological Imager (AMI). AMI is same as AHI of Himawari-8 and ABI of GOES-R. The presentation highlighted the AMI timeline interleave scene collection at swath level. As results of trade off studies, the 10-minute timeline including 1 Full Disk, 5 Extended Local Area (ELA) with 2400 km by 3800 km, and 5 Local Area (LA) with 1000 km by 1000 km is now considered as baseline.

The second presentation by Dr. Paul Griffith was given on the Himwari-8 coherent noise. The cause of the coherent noise was investigated and concluded to come from the beat frequency between detector sample rate and power supply frequency with most significant impact on channel 7. One of the root causes is detector sample rate change due to its slower scan rate and data rate than ABI and AMI. Dr Griffith emphasized that the full characterization has been performed, and he further demonstrated that the coherent noise can be mitigated with ground processing algorithm of Power Supply Interference Calibration (PSIC) developed by Harris. JMA implemented PSIC for Band 7 on June 2015, and applied it for the rest of the channels on March 2016.

Mr. Liam Gumley of CIMSS of University of Wisconsin-Madison presented the Community Satellite Processing Package (CSPP) for Low Earth Orbit (LEO) Satellites: Software and Products. CSPP is a collection of freely available software systems for processing data from meteorological satellites. The primary goal of CSPP is to support users who receive satellite data via direct broadcast and create Level 1B and higher level products and images in real time. Satellites supported by CSPP LEO include Suomi NPP, Metop, NOAA-18/19, Terra, Aqua, GCOM-W, and FY-3B/C, and the supported products are Level 1, imagery, atmosphere, land and ocean. CSPP includes 12 software packages; SDR, WIIRS EDR. HSRTV, Polar2grid, Hydra, MIRS, CLAVR-x, NUCAPS, IAPP, ACSPO, Sounder Quicklook, and VIIRS Imagery EDR, and he showed individual sample.

Mr. Graeme Martin of CIMSS of University of Wisconsin-Madison presented the CSPP Geo support for direct broadcast. Like CSPP LEO, the CSPP GEO software is free to download and use. The CSPP Geo project creates and distributes software allowing direct broadcast users to create products from geostationary satellite data. CSPP GEO is currently available for the current GOES, and Himawari AHI is in beta testing and publicly available later in 2016. GOES-R will be supported after its launch and GRB stream turned on.

Mr. Mikael Rattenborg of WMO Space Programme presented DBNet – Fast processing and delivery of regionally acquired LEO satellite data. First he introduced the DBNet concept and objectives: global availability of near real-time LEO data received by a collection of Direct Broadcast stations distributed around the world, ensuring global consistency by using common software (i.e. AAPP), standardized coding and file naming, and quality monitoring. Dissemination is by the WMO Information System (primarily GTS) coordinated by WMO. DBNet is composed of regional networks and a global DBNet Coordination group. He also introduced the DBNet coverage extension with new readout stations; NWS office in Guam, Tierra del Fuego station in Argentina, Isla de Pascua station Chile, and new DBNet services e.g. IASI, CrIS.

Mr. Iurii Chetyrin of ROSHYDROMET presented Features of the Far Eastern Center of SRC «Planeta» as a regional representative of ROSHYDROMET for the remote sensing in the Asia-Pacific region. PLANETA as daily center receives more than 250 GB of satellite data from Resurs-P series, Kanopus-V, Meteor-M series, Terra/Aqua, Suomi-NPP, NOAA series, Himawari-8, Metop-B satellites. It produces more than 80 types of satellite-based products as well as cross-calibration providing data for more than 40 federal and regional users. Mr. Chetyrin finally introduced the

information system “VEGA-PRIMORIE geoinformation system “METEO-DV” that combined ground-based and satellite-based measurements.

Session 5, “Atmospheric parameters derived from satellite observations,” was chaired by Dr. Teruyuki Nakajima (JAXA) and Prof. Myoung-Hwan Ahn (Ewha Womans University).

Subjects presented are the derivation of AMV, temperature and humidity profiles, cloud, precipitation, and aerosol from geostationary and polar orbiting satellites. Compared to the traditional target tracking method, a new 4D variational method applied to satellite data including AHI data shows an improvement in the wind vector retrieval. An all-sky water vapor retrieval algorithm with satellite and NWP data is introduced with the improved 12 hours accumulative precipitation retrieval and storm forecasting. User survey told that layer PW products are needed as important as convection indices such as CAPE. A moving-window regression method for hyper spectral measurement shows improved temperature and water vapor profile retrievals, especially for the lower 1km, indicating the suitable preparation of the a-priori climate data as retrieval constraint is important. The cloud retrievals included detection, cloud parameters, cloud base height and fraction, convective initiation, and overshooting clouds. The cloud detection and screening methods based on the threshold test show progress, although more validation is required to confirm the performance of the method, such as the tendency to get more cloudiness than MODIS algorithm. The preliminary results from an optimal estimation approach for a cloud optical thickness and particle radius retrievals using 1.6 micron channel of AMI, AHI and ABI shows a possibility of an improvement over current approach. A new algorithm for CBH and cloud layer with the help of cloud liquid path shows a significant improvement over the current operational algorithm with the possibility of application for the geostationary satellite. Results from the machine learning algorithms for the detection of overshooting clouds re-confirm the importance of the training database with a varying degree of success. The algorithm to detect convective initiation based on the series of threshold tests optimized local area with Himawari-8 data shows a favorable comparison with radar observation, although it needs to reduce False Alarm Rate (FAR). Several methods for better precipitation retrieval are presented including an improved database, merging different multiple data, 1Dvar approach. A 3D cloud microphysics database used for the Bayesian algorithm constructed by numerical models and PR/DPR data shows a better performance compared to the results from passive microwave measurements. In the meantime, a variational method with the localized a priori information shows a possibility of improved retrieval with the passive microwave measurements. To extend and back-up the radar observation, a technique to merge IR, radar, and NWP outputs has been developed with a possibility of better utilization of the conventional IR technique. A comprehensive approach using multiple sources of data including surface observation, NWP, and satellite data to mitigate problems in the aerosol retrieval over coastal area shows a possibility of a continuous monitoring of dust outbreak, better quantitative retrieval of aerosol optical depth, and extension to the nighttime retrieval. These studies show that there is a large room of progress to improve retrieval algorithms for wind, temperature, water vapor, cloud, precipitation, and aerosols through utilizing multi-sensor data, simultaneous model use, and improved preparation of climate data to constrain the inversion.

Session 6, “Application of satellite data to weather analysis and disaster monitoring,” was chaired by Dr. Agnes Lane (AuBOM) and Dr. Stephan Bojinski (WMO).

The conference heard about two different tools for visualising satellite data. Jordan J Gerth (University of Wisconsin) talked about the Satellite Information Familiarisation Tool (SIFT), which is a multiplatform system that can display, loop and manipulate new generation geostationary data,

initially from Himawari-8 but also GOES-R in the future. William Straka (SSEC/CIMSS) described McIDAS-X and –V, which are also compatible with various platforms, and can display Himawari-8 data but they also support CrIS, VIIRS, Suomi-NPP and JPSS, based on dedicated servers (ADDE). The next two presentations described the valuable applications that can be derived from AHI (Himawari), ABI (GOES) and AMI (GEO-KOMPSAT-2A), and described two techniques for extracting value and analysing the data. Curtis Seaman (CIRA) demonstrated a technique for adjusting the AHI green band to maximise the signal from vegetation and soil. Kazume Kamide (MSC/JMA) reported on a study to tune the EUMETSAT RGB recipes for Himawari, and presented the results for SO_2, cloud phase, water vapour, and fire/smoke detection. The next two presentations showed the application of satellite data for disaster monitoring. Riris Adriyanto (BMKG) described the application of Himawari-8 for detecting cumulonimbus for early warning of heavy rain, gusts and severe weather in Indonesia, and Jun Dong Park (NMSC/KMA) described the use of microwave derived sea surface winds and NWP output for typhoon analysis over the Korean peninsula.

Hiroshi Suzue (MSC JMA) discussed rapidly developing cumulus area (RDCA) detection using Himawari-8 data. He mentioned the skill of the Himawari-8 AHI compared to MTSAT-1R/2, and the observation modes and intervals. He explained the concept of RDCA detection and showed loops of the RDCA product. In a developing cumulus, the cloud top is cooling and cloud top roughness increasing. The probability of RDCA detection is a function of brightness temperatures in the used channels, and calculated using a statistical method (logistic regression). Validation of RDCA is done using lightning detection result: in one case the algorithm detects convective development earlier than ground-based radar over Japan. It is planned to extend the domain of the RDCA product using AHI full disk data, and to combine it with cloud tracking.

Sanggyun Lee (UNIST) presented on detection of deterministic and probabilistic convective initiation using H-8 AHI, weather radar, and lightning data. He noted the limitations of weather radar and NWP models in capturing CI. His work uses a machine learning approach, for which a training dataset is required, composed of radar and interest fields derived from AHI channels. Predictive capability of these fields to capture CI is validated with radar and lightning data. It was pointed out that CI is important in areas where there are no clouds (yet). The value to compare the results with PCA was suggested.

Juhyun Lee (UNIST) presented on detecting tropical cyclone centres using COMS MI sensor data. Typhoon Chaba inflicted significant damage on Korea in 2016. The Dvorak technique is used by the US National Hurricane Center, the KMA National Typhoon Center, and the Regional Typhoon Centre at JMA. The technique has limitations since it has an element of subjectivity. This study suggests improvements to the Dvorak technique. Using polar-orbiting CORIOLIS/ WINDSAT data over a research area covering Korea and adjacent maritime areas, the Circular Variance index (CV) is being investigated. A moving window method is used over the research area, to extract wind field information. Results show differences between the initial guess TC centre, and wind field CV centre. These differences are a function of the level of organization of the storm system (smaller for TCs). It is planned to analyse cloud top level convection patterns using the COMS MI sensor, with a view to detect TC centres in real time. Limitations of the MW sensor data should be considered when investigating the wind fields.

Su Jeong Lee (Ewha Women's University) discussed the possibility of using atmospheric information derived from a high performance imaging system for short-range weather forecasting. The optimal estimation method is used, based on AHI IR channels, observation error covariance, background first guess profiles (using ECMWF and UM models), and background error covariance matrices. Retrievals of humidity profiles require more iteration at cloud edges. She applied a bias correction to the imagery using GSICS corrections. Land surface emissivity is an important factor. Validation results were presented for Total Precipitable Water. It was pointed out that the

threshold value for retrievals should not be set to absolute channel BT (1K) but relative to the noise level in a channel.

Session 7, "Application of Satellite Data to Data Assimilation and Numerical Weather Prediction (NWP)," was chaired by Dr. Fuzhong Weng (NESDIS/STAR) and Dr. Datong Zhao (CMA).

Seven speakers reported on the progress of satellite radiance assimilation. The data assimilation experiments are carried out in global, regional, and convective scale models. The significant advancements have been made in assimilating geostationary satellite imager thermal-channel radiances (COM, AHI and GOES) in both research and operational forecast models. Also, significant progresses have been made on assimilation of FY-3C data in CMA and ECMWF forecast models. Specific aspects from each speaker are highlighted as follows:

"Analysis of the forecast sensitivity to observation in KMA operational global modeling system" by SeiYoung Park, Eunhee Lee, Sangwon Joo (KMA). Adjoint-based Forecast Sensitivity to Observations (FSO) method is proposed to evaluate the observation impacts on forecasts, and satellite data are shown the largest impacts in the Eastern Asia region. Channel degradation such as NOAA-18 and METOP-A AMSU-A can be detected through the FSO method.

"Impacts of AHI and AMSR2 Radiance Assimilation on Coastal Precipitation and Typhoon Forecasts" by X. Zou, J. Zhao, Z. Qin and F. Weng (US/ESSIC & NOAA/STAR). AHI radiance data are assessed and the O-B is quantified with respect to the ECMWF forecast field. The O-B statistics over oceans in general is less than 0.5-0.8K. Two forward models (CRTM and RTTOV) are used in O-B. Direct assimilation of AHI sounding channels can improve the quantitative precipitation forecast (QPF). Surface sensitive IR channels over oceans in general improve precipitation forecasts for the case in Southeast of China, and water vapor data at channels 8 and 10 can further improve the forecasts of strong precipitation, especially during the first 24 hour forecast period.

"Assimilation of Ground-based GNSS data in KMA convective scale model" by Eunhee Lee, Eun-Hee Kim, Hyun-Cheol Shin and Sangwon Joo (KMA). The quality of GNSS data is evaluated compared to sonde observation and the assimilation of ground-based GNSS data in KMA Local Data Assimilation and Prediction System (LDAPS) resulted in a positive impact on lower tropospheric humidity field in early forecast times, and significant improvements in predicting the heavy rainfall in summer over the Korea peninsula. Moreover, a new bias correction method has been investigated based on long-term monitoring of ground-based GNSS data, and preliminary results show a slightly positive impact on quantitative precipitation forecasts.

"On the assimilation of hyperspectral infrared sounder radiances in cloudy skies in numerical weather prediction models – challenges and practical approaches" by Jun Li, Pei Wang, Zhenglong Li and Mitch Goldberg (US/CIMSS, NOAA/JPSS). Several methodologies are highlighted for uses of clouds-affected radiances in NWP models. In particular, CrIS cloud-cleared radiances (CCR) data through the collocated VIIRS data are generated and assimilated in SDAT at CIMSS. The CCR data in general improves the hurricane track forecasts for Joquin and Matthew since more CrIS radiances from hurricane environments can be directly assimilated.

"Assimilation of Geostationary satellite data in the KMA Local model" by Jung-Rim Lee, Hyun-Cheol Shin, Sangwon Joo (NIMS/KMA). Clear-sky radiances and atmosphere motion wind (CSR, AMW) from geostationary satellite have been tested in the KMA local NWP system. With IR window-channel CSR, dry biases in the upper level of atmosphere in the model can be reduced in the analysis field. By adding WV CSR over low cloud, analysis fields are further improved with slower wind, moist mid-level atmosphere and the forecast error in the low atmosphere is reduced. AMW also improves the wind analysis compared to sonde and shows positive impacts on the

short-range forecast. Assimilation of both CSR and AMW can reduce the forecast errors of all variables and at all levels. Moreover, cloud information from geostationary satellite to correct low humidity will be tested and evaluated.

“The status of FY-3C in NWP and the preparation of FY-3D and FY-4A for NWP” by Qifeng Lu (CMA). Since 2009, four FY-3 instruments, MWTS-1, MWHS-1, IRAS (with clear sky route) and MWRI (with all-sky route) have been implemented in ECMWF global forecast models. Since 2008 FY-3 MWTS-1 has been implemented in CMA GRAPES. After 3-year monitoring of the MWHS-1 data quality, the FY-3B MWHS-1 is operationally assimilated, starting September 2014. Unfortunately, MWTS failed before employed into the operational assimilation systems. FY-4A will be launched in the end of 2016 and FY-3D in the second quarter of 2017, and the proxy data for these upcoming new data are developed for monitoring the instrumental parameters and characterizing the instrumental biases.

“Application of VarBC for satellite data assimilation and its impact on the UM forecasts” by Hyojin Han, Yoonjae Kim, and Tae-Kyo Jang (NIM/KMA). KMA is testing the Variational bias correction (VarBC) system and plans to use it operationally in the coming year. In order to understand the impact of VarBC, an experiment with/without VarBC has been conducted covering 2015-2016 winter season. VarBC shows generally positive impacts in terms of geopotential height, temperature, and winds. The positive effect on forecast accuracy is more significant in the Southern Hemisphere. An additional experiment for a summer season of 2016 is planned to test seasonal variation of the impact of VarBC.

Session 8, “Application of Satellite Data Calibration/ Validation and Climate/ Environmental Monitoring,” was chaired Dr. B.J. Song (Seoul National University) and Mr. Hirosi Kunimatsu (JMA).

Five papers on the quality control and accuracy tests of the L2 satellite products in NOAA and KMA, progress on the development of KMA’s GK2 AMI on-board radiometric calibration system, and use of CrIS double CO2 band for the quality control related to optically thin clouds were presented. Detailed summary of each paper is as follows:

A New Quality Control Methodology for Detecting Optically Thin Clouds from CrIS Double CO2 Band by Lin Lin, Fuzhong Weng, and Xiaolei Zou at NOAA/STAR. This paper presented a new method of detecting optically thin clouds, which normally show a small IR contrast against the background, using shortwave and longwave CO2 bands. The method was devised to predict shortwave channel from longwave channel under the clear-sky condition. Then, the cloud emission and scattering index (CESI) was introduced, as the shortwave channel difference between predicted and observed brightness temperatures. It was demonstrated that the method helps to identify the thin cloud contaminated CrIS scene, and thus is useful for the NWP.

Validation of the GOES-R Rainfall Rate Algorithm Using GPM DPR by Yaping Li, Robert J. Kuligowski, and Yan Hao at NOAA/STAR. Expecting the GOES-R to be launched soon and its derived rainfall products, the paper counted Himawari-8 AHI as a proxy to obtain GOES-R ABI like rain products. Obtained rainfall data were compared against GPM DPR data. Learned lessons will be valuably used for validating rain products once the rainfall data are produced after the GOES-R launch.

Advances in Expanding NOAA Integrated Calibration/Validation System (ICVS) to Support Satellite Application Monitoring by Ninghai Sun and Fuzhong Weng at NOAA/STAR. This paper introduces the recent efforts of the development of Integrated Calibration/Validation System (ICVS) at NOAA/STAR to better support NOAA operational environmental satellite calibration/validation and instrument maintenance activities. All ICVS generated datasets are open to the public users

so that users can have a better idea of what level of accuracies they handle.

Reprocessing and Evaluation of COMS products for leveraging Essential Climate Variables by Mo Rang Huh et al. at the Pukyong National University, Korea. The accuracies of COMS Essential Climate Variables were evaluated for the climate change monitoring and possible use for climate model validation. In the paper Sea Surface Temperature, Outgoing Longwave Radiation, and Insolation were counted as strategic variables and were evaluated using in-situ measurements or reference products. It is interesting to note that the COMS SST product shows warm biases over the open ocean, but reasons are not clear.

Improvements of GK2A AMI data calibrations compared to that of COMS MI by Kyoungwook Jin (KARI). Current efforts and progress of the onboard calibration system development for Korea GK2A AMI were presented. Solar diffuser and IR blackbody calibration concepts were introduced and progress was reported.

Session 9, "Land surface and ocean parameters derived from satellite observations," was chaired by Dr. James Purdom (Chair ICSC) and Dr. Xuebao Wu (CMA).

Christopher Griffin, AuBOM, gave the opening presentation of session 9 which had 4 presentations. In his presentation on Cross platform comparisons and validation using Himawari-8 derived surface products he discussed Himawari-8 derived surface temperature products and validation and tuning efforts using Low Earth Orbiting Satellites and in-situ measurements.

"Satellite based Evapotranspiration estimation in the Mongolian steppe area" was given by Sanjaa Tuya, of the Mongolian University of Science and Technology. The study used MODIS and weather station data to investigate seasonal changes of evapotranspiration in years 2008-2013. For the study they developed an approach based on an extension of the Bowen ratio model within the context of remotely sensed surface temperature and vegetation index. The remote sensing ET estimates were imported into geographic information systems (GIS) for further spatial analysis and mapping, in combination with land use and other ancillary data. It is expected that this technique and the resulting ET maps will assist in monitoring the effects of ground water management on the water uses and the health of terrestrial groundwater ecosystems.

Seonyoung Park, UNIST, presented "Downscaling soil moisture in East Asia through fusion of multi sensors using machine learning approaches". Many satellite instruments such as Advanced Microwave Scanning Radiometer 2 (AMSR2), Advanced Scatterometer (ASCAT), Soil Moisture Active Passive (SMAP) and Soil Moisture and Ocean Salinity (SMOS) have provided soil moisture products. However, the spatial resolution of those sensors is tens of kilometers making it difficult to identify the spatial distribution of soil moisture at local and regional scale. In this presentation it was shown how downscaling soil moisture (to 1 km) was conducted through fusion of multi sensor products and FAO soil type data in East Asia. Downscaled soil moisture was well matched with in situ soil moisture data.

Lee, Sang-Moo Lee of Seoul National University presented "Arctic sea ice emissivities retrieved from AMSR measurements and its application to differentiating between seasonal and perennial sea ice". The study's purpose was to retrieve sea ice emissivity at AMSR-E (Advanced Microwave Scanning Radiometer –EOS) frequencies. The results show that the retrieved values are stable and reasonable. Also they developed a new index of ice age, which can classify first- and multiyear sea ice, using the obtained emissivities. The new index is well matched with the NSIDC ice age data and seems to be better than other satellite-based products.

Session 10, "Capacity building and training activities," was chaired by Dr. James Purdom (Chair ICSC) and Prof. Vasily Asmus (SRC Planeta ROSHYDROMET).

The first presentation by Mary Ann Kutny and Charles Wooldridge of NOAA/NESDIS and CGMS/SETT was "Understanding and Assessing the Value of Improved Satellite Data for the Users of Operational Sea Ice Products and Information". The second presentation by Kathleen Strabala, Liam Gumley, Allen Huang, W. Paul Menzel, Tom Rink, Jessica Braun of the Space Science and Engineering Center (SSEC), University of Wisconsin-Madison was titled "Polar Orbiter Meteorological Satellite Training Workshops– From Theory to Application". The third presentation by Bodo Zeschke, AuBOM, evaluated the "Himawari-8 training conducted by the Australian VLab Centre of Excellence over the past three years".

Mary Ann Kutny addressed the importance of attributing socioeconomic benefits of the data collected by meteorological satellites – the value derived from the practical application the data and data products - is increasingly important to the Coordination Group for Meteorological Satellites (CGMS) members as they seek to defend public investments in existing and planned meteorological satellite programs. As a current priority, the CGMS Socioeconomic Benefits Tiger Team (SETT) initiated a pilot socioeconomic benefit study: Understanding and Assessing the Value of Improved Satellite Data for the Users of Operational Sea Ice Products and Information. The Tiger team has participants from NOAA, NASA, CMA, JMA, JAXA, EUMETSAT and WMO, and others. The purpose of this presentation was to acquaint the audience with how the SETT community of practice is working to improve the capacity of its members to undertakes Socioeconomic Benefit (SEB) analyses, and to report progress on the conduct of the pilot study including the methodologies for measuring the impact of Earth observations on sea ice products and services and their value to users, as determined at the Fourth SETT Workshop held in Beijing, China, in September 2016.

Kathleen Strabala Space Science and Engineering Center (SSEC), University of Wisconsin-Madison presented results for training workshops on "Polar Orbiter Meteorological Satellite Training Workshops – From Theory to Application." These workshops by UW Madison scientists promote the use of directly downlinked satellite data for the enhancement of environmental forecasting and decision making, and to foster the next generation of remote sensing scientists. The courses focus on the use of locally acquired directly downlinked data and products from organizations who manage X- and L- Band antennas around the world. The 3-5 day courses include morning overviews of the satellite instruments and products, allowing the students to become familiar with the data and theory behind the standard land, ocean and atmosphere science products that can be created using free NASA and NOAA software, and the strengths and weaknesses of each one. The NASA International MODIS/AIRS Processing Package (IMAPP) and the NOAA Community Satellite Processing Package (CSPP) are a set of software that support the creation of calibrated and navigated data, as well and science products and images from polar orbiter satellite data. The software is designed to be easy to install and use, and source code is available for most products. Each course day afternoon consists of hands on lab exercises using the free software tool where students explore local data sets and applications of interest utilizing information described in the morning sessions. The final day of the workshop consists of student presentations describing a local investigation on a topic of their choice. To date, 12 workshops have been taught on 6 continents including students from more than 60 countries, working in coordination with IEEE Geosciences and Remote Sensing Symposium (IGARSS), Global Earth Observation System of Systems (GEOSS), and the World Meteorological Organization (WMO). All course lectures, labs, datasets and software utilized during the course are freely distributed through the polar orbiter workshop website: http://cimss.ssec.wisc.edu/dbs/.

Bodo Zeschke's presentation evaluated the Himawari-8 training conducted by the Australian VLab Centre of Excellence over the past three years. This included assessment of direct and indirect evidence pertaining to the effectiveness of the training. Direct evidence consists of the results of assessment and examination, examining the stakeholders at work and when presenting online sessions. Direct evidence also includes inspection of online resources created by stakeholders. Indirect evidence includes discussions with Satellite Champions, Regional Focus Group and National Himawari-8 Training Campaign questions and answer sessions as well as the written response to surveys. The evidence was further grouped into three criteria: 1) a demonstrated improvement in the basic understanding of the new Himawari-8 data and data products by stakeholders; 2) the effective operational use of the Himawari-8 data and data products by stakeholders; and, 3) the development of these data and data products, including the development of new products.

In the poster session, over 40 posters detailed new developments in sensor calibration, cloud detection and characterization, wind retrievals, dust detection, fire monitoring, nighttime sea fog detection, convective initiation characterization, rainfall estimation, NWP improvements resulting from satellite data usage, and several other topics. The session produced spirited discussion, initiated new collaborations, and provided further opportunity for useful information exchange.

AOMSUC-7 featured high quality presentations in 10 oral sessions, a poster session, and a concluding panel to summarize the highlights. Each of the co-sponsors expressed appreciation of the conference accomplishments and stressed the importance of the AOMSUC. The Russian Federation announced that they are planning to host the 8th AOMSUC on 16-21 October 2017 and invited prospective attendees to Vladivostok (the attendees were advised to apply for visas about 2 months prior to the conference), and Indonesia announced its intentions to host the 9th AOMSUC in a venue to be decided in Indonesia in October of 2018. Dr. James Purdom, Chair of the ICSC, summarized the Memorandum on the AOMSUC that was signed at WMO EC to continue the AOMSUCs, the mechanisms for continuation, and terms of reference of the hosting institute, co-sponsors, the ICSC and a AOMSUC supporting secretariat.

As noted earlier in this summary, in conjunction with AOMSUC-7, a two day training event was hosted by KMA immediately prior to the conference, titled “Capacity Building for Next Generation Meteorological Satellites” at the NMSC in Jincheon from 21-22 October 2016. Including lecturers and NMSC staff and attendees there were around 60 participants to the Training Event. The audience was represented by participants from 27 countries such as Japan, Australia, the United States, China, Indonesia, New Zealand, Micronesia, Papua New Guinea, Solomon Islands, Tuvalu, Nepal, Bhutan, Bangladesh, Malaysia, Myanmar, the Philippines, Vietnam, Hong Kong, Laos, Thailand, the Maldives, Sri Lanka, Timor Leste, Oman, Pakistan, Kyrgyz, Uzbekistan. The two days involved a blend of introductory lectures followed up by practical sessions. On the first day this included an introduction to the Community Satellite Processing Package (CSPP) as applied to LEO and GEO satellites by presenters from the United States. This was followed by practical exercises utilizing the latest version of the HYDRA software in order to display Himawari-8 satellite images and image (RGB) products and to perform statistical analysis of the data. The morning of the second day included an introduction into the latest developments in the detection and monitoring of rapidly developing thunderstorms by presenters from KMA, JMA and CMA. This was followed by a practical session conducted by the representative from the Australian Bureau of Meteorology. The afternoon session was presented and coordinated by KMA staff and involved the practical demonstration of the KMA NMSC Cloud Analysis System for satellite image analysis and practice. Feedback from attendees indicated that the activities were of very high quality and were very relevant to their training requirements. The many hands-on activities were appreciated and the good coordination of the staff supervising the training was noted.

The annual AOMSUC continues to be an excellent forum for members within the Asia/Oceania community to meet and enhance their joint efforts in the utilization of satellite data and products for improved weather and climate services. The current activities and plans presented by the satellite operators in Asia/Oceania continue to be most impressive featuring cutting edge geostationary satellite imagers from JMA, KMA, and CMA that will be capable of multispectral measurements at high temporal and spatial resolution with rapid scan as a routine part of their

operation. In addition, CMA is introducing the first hyperspectral infrared geostationary satellite sounder. In the polar orbiting area, exciting times are ahead of us with the USA, EUMETSAT and China all flying next generation sensors. Significant is that CMA is planning for FY-3E to fly in an early morning orbit, thus fulfilling a major recommendation within the Vision for the WIGOS. The operational and research satellite communities and users within Asia/Oceania are continuing their close cooperation with great benefit of all.

In summary AOMSUC-7 was very successful in meeting the four goals of these conferences; (1) to promote the importance of satellite observations and highlight their utility, (2) to advance satellite remote sensing science by enabling scientist to scientist information exchanges focused on Asia/Oceania, (3) to provide a means for satellite operators to interact directly with the user community concerning current and future satellite related activities and plans, and (4) to engage young people entering into the field. In his closing summary Dr. Purdom noted the exceptionally fine job done by KMA in preparing for and putting together AOMSUC-7. The venue was superb and the hospitality with an ice breaker, welcoming reception, lunches and coffee breaks was greatly appreciated by all. The conference was closed by Dr. Hoon Park, Director General of KMA's National Meteorological Satellite Center. In his closing he thanked the ICSC for its work in helping prepare for the conference and the participants for helping make AOMSUC-7 a great success. He remarked on how the AOMSUC venue was important for both satellite operators and the Asia/Oceania community. He wished everyone a safe trip home.