

The Fifth Asia/Oceania Meteorological Satellite Users' Conference

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ABSTRACTS

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Keynote Speeches

The EUMETSAT Satellite Programmes and their contribution to monitoring atmosphere, climate, ocean and land

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Head of Remote Sensing and Product Division

EUMETSAT

EUMETSAT is today operating two polar orbiting and four geostationary satellites as part of its mandatory programmes and is in addition contributing to the Jason-2 programme together with NOAA, CNES and NASA. In addition to these satellites EUMETSAT is preparing to launch further satellites of its mandatory programmes in the coming years and is preparing for taking over the operation of the European Union funded Sentinel-3 programme after the launch of the first satellite in 2015. Finally it should be noted that EUMETSAT is heavily investing in the development of the next generation polar orbiting satellites under the Meteosat Third Generation programme and the EUMETSAT Polar System Second Generation Preparatory Programme. This new programmes will ensure continuity of the current observations provided by the Meteosat Second Generation and EUMETSAT Polar System programmes.

This presentation will give an overview of the current and future satellite programmes and their capability to monitor atmosphere, climate, land and ocean. Specific emphasis will be given to the contribution towards the key application areas like support to Numerical Weather Prediction, Nowcasting, Atmospheric Composition, Oceanography and Marine Meteorology.

NOAA Satellite Programs

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Current and future NOAA satellite missions are viewed in the context of how they contribute to NOAA's characterization of "Environmental Intelligence." In our rapidly changing world, connecting people with the environmental intelligence they need to prepare for today's weather and understand tomorrow's climate is incredibly important and tremendously powerful. Environmental intelligence lies at the core of what NOAA does every day. Environmental intelligence comes from data, analysis, models, predictions, and assessments.

Within the next two years, NOAA's current geostationary and polar-orbiting satellites will be replaced by the more capable GOES-R and JPSS series. Other collaborative missions such as Jason, COSMIC, and DSCOVR are underway. These missions are key contributions to the WMO space-based portion of the Global Observing System (GOS). Asian missions are also becoming ever more significant contributions to the GOS.

Key components of maximizing benefits of NOAA satellites are user preparedness activities, data stewardship, and common ground services and more robust satellite architectures.

ROSHYDROMET SPACE-BASED OBSERVATION SYSTEM: CURRENT STATUS AND DEVELOPMENT PERSPECTIVES

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The report presents an overview of Russian current and future weather and Earth observation satellite systems. According to the Russian Federal Space Program 2006-2015 the efforts are focused on the development and manufacturing the next generation of polar-orbiting (METEOR-M series) and geostationary (ELECTRO-L series) meteorological satellites. The space observation system will consist of three polar-orbiting meteorological and one oceanographic satellites, and three geostationary meteorological satellites. Currently, two spacecrafts of METEOR-M series (Meteor-M №1-2009 and Meteor-M №2-July, 2014) and one spacecraft of ELECTRO-L series (Electro-L №1-2011) are already launched. Meteor-M №1 and Electro-L №1 are now considered as experimental. Meteor-M №2 is now in commissioning phase. Along with this two series of environmental satellites is planned to be designed and launched. The first one named Kanopus-V and already launched (2012) is intended for Earth surface monitoring. The series of Resurs-P satellites is being developed to provide detailed Earth surface observations. The Resurs-P №1 satellite was successfully launched in 2013.

Basic payload of Meteor-M series satellites consists of: MSU-MR Scanning Radiometer (1 km spatial resolution, 6 channels, VIS/IR); KMSS VIS Scanning Imager (6 channels implemented by 3 cameras, 50 m and 100 m spatial resolution); Severjanin X-band Side-Looking Radar (500 m and 1000 m resolution); MTVZA-GY Imaging/Sounding Microwave Radiometer (26 channels, 10.6-183 GHz); IKFS-2 Infra-Red Fourier-transform Spectrometer (hyperspectral atmospheric sounder, spectral range 5-15 μm , spectral resolution $\sim 0.5 \text{ cm}^{-1}$ -on board Meteor-M №2 and succeeding satellites); Data collection system (DCS). Meteor-M №1 has three downlink radio lines including L-band radio link (1.7 GHz) with 665.4 Kbps data transmission rate (HRPT data transmission); VHF-band radio link (137 MHz) with 80 Kbps data transmission rate (LRPT data transmission). The direct broadcast is operational in L-band in HRPT format. The detailed format description is published at SRC Planeta and WMO websites. Future Meteor-M series of polar-orbiting satellites

and their payload, including oceanographic satellite Meteor-M №3 (scheduled for launch in 2020), and forthcoming Meteor-MP series satellites are provided.

The geostationary meteorological satellite Electro-L №1 is located at 76E. Along with standard meteorological communication package (DCS and re-transmitters) the key payload consists of MSU-GS imager that provides data in three visible and seven IR channels. The spatial resolution at sub-satellite point is 1 km for visible and 4 km for IR channels. The period between scanning sessions for all channels is 30 min and in the more frequent mode is 15 min. The meteorological data in HRIT format is distributed to some users via SRC Planeta FTP server every 3 hours (standard synoptic hours). According to the Russian Federal Space Program future Electro-L constellation should consist of three similar satellites. Electro-L №2 is scheduled to be placed at 77.8E in the end of 2014. The launch of Electro-L №3 is scheduled in 2015. The payload of Electro-L constellation is similar to Electro-L №1 spacecraft but with improved MSU-GS instrument performance.

Arctica-M project of two highly elliptical orbit satellites is outlined. It will provide observations similar to geostationary satellites but over the Arctic region. The payload of Arctica-M satellites will be similar to Electro-L series. The launch of the first Arctica satellite is scheduled for 2015.

Roshydromet ground segment consists of three SRC Planeta regional centers, responsible for receiving, processing, disseminating and archiving satellite data: European (Moscow-Obninsk-Dolgoprudny), Siberian (Novosibirsk) and Far-Eastern (Khabarovsk). These centers together give full coverage of the Russia and neighboring territories. It also includes the network of DCP, LRIT and HRIT stations. The main purpose of the segment is to provide data and products for use in operational meteorology, NWP, hydrology, agrometeorology, climate studies and environmental monitoring.

Overview of the use of satellite data in the Bureau of Meteorology

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Whilst Australia does not fly its own meteorological or environmental satellites, the country's position in the globe, and its large geographical area, mean that satellites are critical in measuring and understanding the environment. The Bureau of meteorology treats space-based observations as a core capability within its composite observing system and satellites are a key component of the Bureau's Observing System Strategy.

Satellites provide regular observations over large areas where in situ data is expensive or difficult to obtain. For Australia, with a large geographic area and relatively small population, satellite observations provide a basic level of coverage to those areas that do not have radars or other infrastructure.

This talk will cover the current use of satellites in the Bureau, some key partnerships with satellite operators and the Bureau's plans for the next 5-10 years.

Updates on Chinese Meteorological Satellite Programs

Yang Jun, Lu Feng, Hu Xiuqing, Luo Dongfeng

CMA

This PPT presentation introduces the audience of AOMSUC to the Fengyun meteorological satellite program: its past, present, and future, with emphasis on the latest progress in the operational geostationary satellite series FY-2s and polar-orbiting satellite series FY-3s. It informs the AOMSUC of the launch of FY-2G, which is scheduled in December this year, and its orbital location among other operational arrangement necessary for the data utilization of this satellite. The presentation also reports the AOMSUC the status of ground-segment for the preparation of FY-4s - the next generation of Fengyun geostationary satellites. As for the polar-orbiting satellite series, the presentation talks mainly about the FY-3 series and focuses on its operational progress and future development.

Status of Current and Future Satellite Programs of JMA

Toshiyuki Kurino

JMA

Currently, MTSAT-2 is operational in imaging over the East Asia and Western Pacific regions, and MTSAT-1R serves as its backup. The operation of MTSAT-2 has been extremely stable since its operation was started in July 2010. Utilizing the backup satellite, MTSAT-1R, JMA conducts rapid scan observations with 5-minute intervals around Japan in summer in the Northern hemisphere, to provide high-frequent cloud imagery to aviation users for their flight safety.

As follow-on satellites of the MTSAT series, JMA plans to launch Himawari-8 on 7 October 2014 and commence its operation in 2015 to replace the current satellite, MTSAT-2. JMA also plans to launch Himawari-9 in 2016 as a backup and successor satellite. Himawari-8 and -9 will have ability to observe the full disk every 10 minutes with 16 bands.

The special feature is that it has 3 visible bands corresponding to red, green and blue, with which it will be possible to produce true-color images. Himawari-8 and -9 will not carry a device for direct is semination. Instead, all imagery taken from the satellites will be distributed via the Internet. In addition, JMA will start the HimawariCast service which will disseminate a primary set of imagery via a communication satellite. It will be needed to install new equipment for receiving HimawariCast data. The detailed information on the equipment can be found at http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.htm

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Status of Current and Future Satellite Programs of KMA

Sang Jin Lyu

KMA

The COMS (Communication, Ocean, and Meteorological Satellite) MI observation data are disseminated to M/SDUS (Medium/Small Scale Data Utilization Stations) users in H/LRIT (High/Low Rate Information Transmission) formats within 15 minutes after the end of image scanning. Also, we provide high quality COMS MI level 1B data through land-based network via NMSC (National Meteorological Satellite Center) website (<http://nmisc.kma.go.kr/jsp/homepage/eng/main.do>) and FTP.

Currently, H/LRIT include the FD and ENH images and level 2 meteorological products images such as cloud detection (CT), cloud top height (CTH), cloud top temperature (CTT) and GOCI images are broadcast in only LRIT. KMA has a plan to add more contents such as sea surface temperature, fog, numerical weather prediction and typhoon information to LRIT service. The dissemination has started since April 1st, 2011

The GEO-KOMPSAT-2, COMS follow-on geostationary meteorological satellite, consists of a pair of satellites for multi-purpose. One (GEO-KOMPSAT-2A) is for meteorological mission-only. The other (GEO-KOMPSAT-2B) is for ocean and environmental missions. Ocean mission is to monitor the ocean colour using an advanced GOCI (Geostationary Ocean Colour Imager) continuously. The environmental mission is to monitor atmospheric environments globally with the first payload carried on the geostationary satellite. The GEO-KOMPSAT-2A and -2B satellites will be launched in May and December 2018, respectively.

The Advanced Meteorological Imager (AMI), the payload for meteorological mission of GEO-KOMPSAT-2A, is comparable to those of the AHI launched in October 2014 and ABI imager on board Himawari-8/9 and GOES-R. The development of AMI was kicked off in April 2013. In addition to meteorological mission, Korean Space Environment Monitor, KSEM, is the instrument for the secondary mission of GEO-KOMPSAT-2A satellite to observe the space weather. The suite of KSEM instruments consists of particle detector (PD); magnetometer (MAG); satellite charging monitor (SCM); and on-board Instrument Data Processing Unit (IDPU).

The Role of WMO in Developing a Space-Based Architecture for Climate Monitoring

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WMO Space Programme

World Meteorological Organization (WMO)

The development of an architecture for climate monitoring from space, formally initiated by the Sixteenth World Meteorological Congress (Geneva, 2011), received immediate response and strong support from Space Communities, including the Committee on Earth Observation Satellites (CEOS), the Coordination Group for Meteorological Satellites (CGMS) and some national space agencies and satellite operators. The architecture, respond to WMO sponsored climate programmes and initiatives like the Intergovernmental Panel on Climate Change (IPCC), Global Framework for Climate Services (GFCS), the World Climate Research Programme (WCRP) and the Global Climate Observing System (GCOS), , as well as broader WMO Members' and international/regional/national user community requirements on climate monitoring, calls for strengthening and enhancing international collaboration that ensures delivery of these observations over the time frames required for both: analysis of the Earth's climate system over long-term, and monitoring climate extreme events in near real time.

The architecture will build upon a constellation of research and operational satellites currently existing and planned future long-term programmes extending beyond the capabilities of one-time research missions and operational satellite systems in existence today by space agencies, supported by open data-sharing policies, contingency planning, surface observations (for validations and integration) and user interface seeking feedback, monitoring deliverables, meeting user-service needs and demonstrating the benefits.

The unique role of WMO in developing the space architecture for climate monitoring will focus on the following: 1) Requirements Anylysis and Consolidation: to set broader requirements for climate monitoring by consolidating the requirements from climate programmes and initiatives like IPCC, GFCS, GCOS and WCRP; 2)

Promotion of climate data and products policy: The Executive Council Task Team on the WMO Policy for International Exchange of Climate Data and Products (ECTT) is working to lay down general principles in order to promote data exchange and accessibility. The WMO 66th Executive Council (June 2014), adopted a resolution on “Exchange of data and products to support the implementation of the GFCS” with an annex defining climate relevant “essential data” for the purposes of implementing Resolution 40 (Cg-XII) and Resolution 25 (Cg-XIII); 3) Coordination on Space capability assessment, planning and implementation: WMO Space Programme will work together with CEOS and CGMS to define future CGMS baseline and CEOS Virtual Constellation meeting the needs of climate monitoring requirements, detailing missions and instrumentations, and coordinating the implementation. In addition, WMO will continue its leading role on (i) the Global Space-based Inter-Calibration System (GSICS) involving all the key space agencies and satellite operators; (ii) the Sustained Coordinated Processing of Environmental Satellites Data for Climate monitoring (SCOPE-CM) ; (iii) Fostering the integration of the surface with space observations by taking the advantages of the comprehensive surface observing networks from WMO Members and on going space activities. 4) Data management, access and dissemination: The role of WMO Information System (WIS) in the space architecture development is to ensure timely accessibility of observations and products in compliance with agreed interoperability standards. Metadata, catalogue interfacing, and formats should be standardized in compliance with the WIS standards for WMO Members. 5) User interface and Feedback: WMO as an organization will be a natural user interface with its Members as the key end users community for climate monitoring and services should be maintained in order to seek feedback, monitor deliverables and use the products from the architecture for climate monitoring services. The annual WMO Statements on the Status of the Global Climate, one of the operational and visible publications of WMO to Members, UN agencies and the general public, will benefit from the development of the architecture by using more timely products and information of climate monitoring from space.

Session Keynotes

SATURN: SATellite User Readiness Navigator for the next generation of geostationary satellites

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WMO

The new generation of meteorological geostationary satellites being launched by NOAA, ISRO, JMA, CMA, KMA, ROSHYDROMET and EUMETSAT before the end of this decade will provide unprecedented capabilities for the key applications of severe weather monitoring, nowcasting and short range forecasting and for a number of developing application areas, but will also present unprecedented challenges for users worldwide. The main challenge is the order-of-magnitude increase in the amount of data and products to be generated from the advanced imagers and sounders on-board the satellites. In addition, novel data types from geostationary sounders and 16-channel imagers need to be accommodated for by operators and users. These capabilities will be driving the need to develop more advanced techniques for interpretation and assimilation of the data and products generated.

It is a priority of WMO and of CGMS to support the user community in light of these challenges. Satellite data users and WMO members require timely, technical information on the new satellite generation to exploit its potential operational benefits and socio-economic value. The WMO Space Programme, with the support of the CGMS member agencies, is therefore developing the online portal SATURN (SATellite User Readiness Navigator) to provide a single point of access for all information pertinent to the global user community preparations for the new generation of satellites. The paper will present the concept behind the portal and its development and provide an online demonstration.

Satellite System Synergy: Maximizing the Utilization of Space-based Remote Sensing

James F.W. Purdom

ICSC

Satellites provide valuable information for weather analysis and forecasting and for climate studies. Satisfying the needs of tomorrow will require a cadre of satellites in different orbits that serve as compliments to one another to meet the temporal, spectral and spatial requirements the observational domain (requirement) demands.

Today's satellites offer a system of observations that are at various temporal, spatial and spectral resolutions. When used as a system to investigate a problem, they provide a unique capability to extract incredible amounts of information.

New remote sensing capabilities are offering higher spatial and temporal resolution and more spectral bands with higher spectral resolution and improved signal to noise. With this massive increase in data the opportunities for improvements that match the systems capabilities can be realized only with new approaches with national and international partnerships along with training for full utilization.

Planning for tomorrow's satellite systems and sensors must take into account all space observing assets, capitalizing on their strengths as part of a composite space based observing system.

Architecture for Monitoring Climate from Space

Status and Way Forward

Tillmann Mohr

EUMETSAT/WMO

The Implementation Plan (IP) of the Global Framework for Climate Services (GFCS) was finally approved by the Extraordinary Congress of WMO in October 2012. The planned Architecture for Monitoring Climate from Space (AMCS) will be a major building block of the Observation and Monitoring pillar of the GFCS. WMO Space Programme, the Committee of Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS) started in January 2011 a process to develop a strategy towards an AMCS. As a first step a logical architecture was elaborated and approved by the plenaries of CEOS and CGMS and endorsed by the Executive Council of WMO in 2012. A report was published in the same year.

The work on the physical architecture started in the middle of 2012 with the request to the space agencies to fill in an Essential Climate Variable (ECV) inventory questionnaire to get an overview on the available datasets on an ECV by ECV basis. The results were analysed in the first half of 2013 and presented to CGMS and CEOS. CGMS and CEOS decided to establish a Joint CEOS-CGMS Working Group on Climate to finalise the physical view and to develop an action plan for implementing the architecture. The WG met for the first time in March 2014. The meeting agreed on a work plan for 2014 - 2016. Further details are presented.

Utilization of Frequent Observations from the Next-generation Geostationary Meteorological Satellites for Disaster Risk Prevention

Toshiyuki Kurino

JMA

High-frequency satellite imagery is generally recognized as effective against disasters such as tropical cyclones, volcanic eruptions, and so on. For example, MTSAT-1R 10-minute rapid scans incidentally captured the Kelud Volcano eruption in Indonesia on 13 Feb 2014, and the imagery was effectively used in monitoring the eruption in Indonesia.

JMA plans to launch its next generation geostationary meteorological satellites of Himawari-8 on 7 October 2014 and commence its operation in mid-2015. Himawari-8 will provide observational 10-minute full disk scans by default. Such high-frequency full disk scanning will in the near future be a normal measure for supporting emergency situations, so that it is important to develop the usage of high-frequency data for disaster risk reduction in cooperation with Regional Specialized Meteorological Centres (RSMCs) and Volcanic Ash Advisory Centres (VAACs).

Monitoring Atmospheric Composition by GEO-KOMPSAT-1(COMS) and 2

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GEO-KOMPSAT is a geostationary program of the Korea Aerospace Research Institute(KARI)'s Korea Multi-Purpose SATellite(KOMPSAT) to observe atmosphere and ocean. GEO-KOMPSAT-1, also known as COMS(Communication, Oceanography and Meteorology Satellite) was launched in June 27, 2010, with conventional 5-channel MI(Meteorological Imager) and 8-channel GOCI(Geostationary Ocean Color Imager). GOCI is the first ocean color imager in geostationary orbit, with the spatial resolution of 500 m. These two instruments have provided information on aerosol in high temporal and spatial resolution over East Asia in terms of optical depth, size and type classification. Algorithm uses clear-sky composite to estimate surface reflectance, and takes dynamic aerosol model and nonsphericity into consideration.

GEO-KOMPSAT-2 is planned for launch in 2018 as twin satellites, 2A as weather and 2B as atmospheric environment and ocean satellite, with a 16-channel AMI(Advanced Meteorological Imager), a UV-Visible scanning spectrometer, GEMS(Geostationary Environment Spectrometer), and GOCI-2 (Geostationary Ocean Color Imager-2). GEMS measures ozone, aerosol and their precursors including NO₂, and SO₂. Synchronous measurements of atmospheric composition together with the meteorological variables and ocean color information are expected to contribute to better understanding on the distribution and transboundary transportation of air pollution, and on interactions between meteorology and air chemistry in the Asia-Pacific region. This mission provides an excellent chance to observe aerosol, ozone and their precursors with meteorological parameters. Furthermore, the constellation of the GeoKOMPSAT with the NASA Tropospheric Emissions: Monitoring of Pollutions(TEMPO) over North America and the ESA Sentinel-4 UV-Visible-NIR(UVN) spectrometer over Europe in 2017- 2020 time frame can result in great synergistic outcomes including enhancing significantly our understanding in globalization of tropospheric pollution.

An Introduction to the Global Space-Based Inter-Calibration System (GSICS): Recent Progress

Zhang Peng

Peng Zhang, Chair of GSICS Executive Panel

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Improved calibration of space-based Earth-observing instruments is a fundamental scientific need. There is an increasing demand for more accurate measurements and inter-calibration of observations from different instruments in response to data assimilation in numerical weather prediction (NWP), climate change detection, and near-real-time operational applications. To deliver the more accurate observations, it is vital that satellite instrument calibration is of the highest quality and that a capability exists to inter-calibrate the satellite sensors. This is the motivating force for the establishment of the Global Space-based Inter-Calibration System (GSICS).

GSICS is an international collaborative effort initiated in 2005 by WMO and the Coordination Group for Meteorological Satellites (CGMS). The concept and strategy for a Global Space-based Inter-Calibration System were submitted by WMO and endorsed by the CGMS at its 33rd meeting held in Tokyo, Japan, on 1-4 November 2005. Within GSICS, satellite operators and science teams collaborate to define, implement and share community-agreed best practices, standards, procedures and tools. These enable users to monitor, improve and harmonize the calibration of instruments aboard operational meteorological, climate and other environmental satellites of the Global Observing System (GOS).

In this presentation, the progress of the recent 14th and 15th Executive Panel meetings of GSICS were highlighted. The vision for GSICS in the 2020's was introduced. The challenges for GSICS were addressed. And some good examples for satellite instrument calibration benefited from GSICS were demonstrated.

SESSION 1

Facilitation of data access and utilization, user preparation

Chairs: Lars Peter Riishojgaard / Fuzhong Weng

User Requirements and Preparedness for the Next Generation of Geostationary Satellites

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The Bureau of Meteorology is a big user of geostationary satellite observations, and is greatly appreciative to Japan, China, Korea and others for access to these vital data streams. The data is used in various applications, including by forecasters for weather and warning services, and in the development of applications such as solar radiation and volcanic ash detection.

The Bureau is looking forward to the next generation of geostationary satellites which will deliver vast improvements to weather forecast quality. For example, Himawari-8 and -9 and Korea's GEO-KOMPSAT-2A will have significantly better space & time resolution, and many more channels. This improvement is so significant that it will enable new applications of satellite data, augmenting and sometimes replacing other observation systems. The impact on forecast quality is expected to be significant.

In order to optimise the benefits from Himawari, the Bureau has commenced planning for acquisition and use of this data. Work has begun on the transition of MTSAT based applications, and requirements are being collected for new advanced products, such as those for advanced warning of severe storms. In collaboration with WMO, the Bureau will be working with RA-V countries to support their smooth transition to Himawari-8/9.

Current status of Himawari-8/9 products development

Toshiyuki Kurino

JMA

The Japan Meteorological Agency (JMA) plans to launch Himawari-8 and 9 in 2014 and 2016, respectively, and start the operation of Himawari-8 in 2015. Himawari-8 and 9 carry a new imager called the Advance Himawari Imager (AHI), whose observing capability is enhanced from MTSAT-2 Imager; multi-band capacity (16 bands in visible and infrared), high spatial resolutions (0.5 – 1.0 km for visible and 1 – 2 km for infrared), fast imaging (within 10 minutes for full disk), and rapid scanning with flexible area selection and scheduling. As mentioned above, Himawari-8 and -9 will offer high observation potential, which will enable users to improve and develop a wide range of products. Using AHI data, JMA plans to improve current satellite products such as Atmospheric Motion Vector (AMV), Cloud Grid Information (CGI) and clear sky radiance. New products related to volcanic ash and dust will also be developed. For the AMV product, significant improvement of them is foreseen. Higher image resolutions and more frequent observations are expected to provide better target tracking accuracy, and the increased number of imaging bands will enhance AMV height assignment. CGI will consist of three products such as cloud mask, cloud type and cloud top height. The algorithms of them are based on those of EUMETSAT, and some parts of them will be introduced from those of NOAA/NESDIS. As new products for Himawari-8 and 9, JMA is developing two aerosol outputs relating to volcanic ash and dust. Volcanic ash directly affects airplane flight plans, and is monitored by Tokyo Volcanic Ash Advisory Center (VAAC) of JMA. From Himawari-8/9 observations, quantitative data such as ash density and height are expected. JMA is now planning to introduce NOAA/NESDIS volcanic ash algorithm. They will operate this algorithm with the data from Himawari-8/9 for Tokyo VAAC. JMA is also preparing the test-bed for the inter-comparison of volcanic ash retrieval algorithms on an operational basis in the framework of SCOPE-Nowcasting. As a first step of the test-bed, EUMETSAT algorithm for volcanic ash product, which was already introduced to JMA in collaboration with EUMETSAT, and NOAA/NESDIS algorithms as mentioned above will be compared. Dust product will be developed for the purpose of monitoring Asian dust. Two different approaches will be taken for this product. One will use visible and near-infrared data, and the other will use infrared data. Algorithm for the dust product retrieved from visible and near-infrared data has been developed based on NOAA/NESDIS aerosol algorithm.

The Space Based Component of WIGOS

Lars Peter Riishojgaard and Wenjian Zhang, WMO Secretariat

WMO WIGOS Project Manager

Steadily increasing demands within the WMO community for rapid, sustained and reliable access to various types of observational data that go beyond measurements of the classical weather variables, extending to domains like atmospheric composition, climate, oceans state and hydrology, has led to the creation of the WMO Integrated Global Observing System WIGOS. WIGOS is building on more than fifty years of success with acquiring, processing and sharing weather observations through the Global Observing System of the World Weather Watch, and will integrate observations obtained by the GOS and other WMO and WMO-sponsored systems such as GAW and the observing component of the Global Cryosphere Watch into one common framework. This integration has several dimensions. One is integration across agency boundaries, e.g. of observations acquired by National Meteorological Services with those obtained by other partners. Another is integration across disciplines, i.e. joint acquisition of observations for several application areas. And a third dimension is integration of satellite observations with conventional observations for improved forecast and warning products. Successful examples of the latter will be presented and opportunities for improved integration especially in the Asia/Oceania Region will be discussed.

Facilitating Accelerated Use of Satellite Data--The Development of Accelerator--based WRF Model

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Since 2009 a team at SSEC has devoted their ingenuity to leveraging high-performance “accelerator” technology of NVIDIA GPUs to advance their satellite data and weather forecasting applications. In 2014, the SSEC team, located at University of Wisconsin- Madison, has been selected as one of the new Intel Parallel Computing Center (IPCC) and has become a new NVIDIA CUDA Research Center (CRC) as well. In this presentation we review the successful implementation of a GPU-based high performance hyperspectral sounder radiative transfer model running on NVIDIA GPUs via CUDA (Compute Unified Device Architecture). We continue with a review of the progress made so far in the development of a Graphic Processing Unit (GPU) based high performance Weather Research Forecasting (WRF) model and demonstrate the design of a complete end-to-end GPU-CUDA WRF version, which could deliver a performance estimated to be $\gg 10X$ speedup with respect to a single, modern CPU core.

We conclude by reviewing our recent efforts in the use of Intel Many Integrated Core (MIC) Xeon Phi to advance WRF acceleration. Our initial results of a MIC Xeon implementation of WRF Thompson microphysics and TEMF planetary boundary layer scheme are outlined. We will also discuss our longer term plan to advance GPU and MIC accelerator technology for weather forecasting applications under the initiatives of IPCC and CRC.

Operational and Research Applications from the Joint Polar Satellite System

Mitchell D. Goldberg

NOAA/NESDIS/JPSS

The Joint Polar Satellite System is NOAA's new operational satellite program and includes the Suomi National Polar-orbiting Partnership (NPP) as a bridge between NOAA's operational Polar Orbiting Environmental Satellite (POES) series, which began in 1978, and the first JPSS operational satellite scheduled for launch in 2017. JPSS provides critical data for key operational and research applications, and includes:

Weather forecasting – data from the JPSS Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) are needed to forecast weather events out to 7 days. Nearly 85% of all data used in weather forecasting are from polar orbiting satellites.

Environmental monitoring – data from the JPSS Visible Infrared Imager Radiometer Suite (VIIRS) are used to monitor the environment including the health of coastal ecosystems, drought conditions, fire, smoke, dust, snow and ice, and the state of oceans, including sea surface temperature and ocean color.

Climate monitoring – data from JPSS instruments, including OMPS, CERES and TSIS will provide continuity to climate data records established using NOAA POES and NASA Earth Observing System (EOS) satellite observations. These data records provide a unified and coherent long-term observation of the environment; the records and products are critical to climate modelers, scientists, and decision makers concerned with advancing climate change understanding, prediction, mitigation and adaptation strategies, and policies.

To bridge the gap between products and applications, the JPSS Program has established a proving ground program to optimize the use of JPSS data with other data sources to improve key products and services. Examples include the use of CrIS and ATMS for improved weather forecasting, the use of VIIRS for environmental monitoring of sea ice, smoke, fire, floods, droughts, coastal water quality (e.g. harmful algal blooms), and OMPS for monitoring ozone and aerosol and sulfur dioxide.

Meteorological Applications of GNSS Ground Network in East China

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Since 2007, the integration and application of GNSS ground stations in East China are conducted by the Shanghai Center for Satellite Remote Sensing Applications. Up to now, over 220 GPS and BD ground stations have been integrated to be an operational network for meteorological applications, which are built by different departments in East China provinces. The average interval of the stations is 50-100km all over East China and 10-15km over the Yangtze River Delta region.

Based on the dataset of GNSS ground network in East China, the atmospheric parameters such as the precipitable water vapor and the ionospheric total electron content etc. are retrieved every half hour. By detecting the reflected signal from sea, the sea surface dynamic parameters such as the effective wave height and surface wind speed etc. are also retrieved. More than 20 kinds of GNSS application products have been developed.

By comparing with other source of atmospheric water vapor product retrieved from meteorological satellites data and from radiosonde data, It is concluded that the atmospheric precipitable water vapor product retrieved from GNSS ground network has advantages from the point of view of product frequency and product precision.

GNSS data and products are shared with other departments in East China by special network. These data and products have been used effectively in small and medium scale severe weather monitoring and forecasting, climate evaluation and navigation service in East China.

A Cloud Computing Platform for FY-4 Based on Resource Scheduling Technology

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Compared with FY-2 satellite, the IT scale of FY-4 satellite ground segment has a hundred times of growth and the business logic becomes more complex. How to structure an advanced computing platform to support FY-4 applications efficiently and reliably remains a challenge. In order to solve this issue, this paper introduces the idea of cloud computing and proposes a private cloud platform for the FengYun meteorological satellite data processing based on the resource scheduling technology. This platform consists of four layers which are application layer, job scheduling bus layer, resource scheduling layer and infrastructure layer. The infrastructure layer organizes all the medium and low level heterogeneous physical resources such as computing, networking and storage to supply high performance computing power, high-speed network and mass storage capacity. The resource scheduling layer achieves the unified pool management of heterogeneous computing resources and designs fault-tolerant mechanisms that deal with resources and application exceptions to ensure the high efficiency, flexibility and reliability of resources. The job scheduling bus layer is designed to provide a standard interface for job submission of application layer and is compatible with LSF, PBS, and other business Scheduler in the resource scheduling layer. Corresponding to a meta-Scheduler, this layer can forward jobs to their appropriate schedulers, in which fault-tolerant strategies for fault handling are also designed. The application layer is used to provide the user interface and business logic management. The proposed private cloud computing platform does not adopt the virtualization technology and it sets up resource pools with lots of medium and low level physical computers directly through the resource scheduling technology. Therefore, this architecture can improve the system performance to price ratio and enhance the expansibility of the system. The load balancing scheduling and fault tolerance mechanism designed in the platform can improve the reliability and efficiency of the system as well.

Current Status of GeoKOMPSAT-2A Ground Segment

Development and Data Service Plan

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The National Meteorological Satellite Center (NMSC)/Korea Meteorological Administration(KMA) has a plan to launch COMS follow-on, Geo-KOMPSAT-2A(GK-2A) in 2018 to ensure continuity of COMS meteorological mission.

To prepare the GK-2A operation, NMSC/KMA kicked off the project of GK-2A ground segment development in Jul. 2014, which will be carried out for five years until 2019 including in-orbit test period after GK-2A launch.

The GK-2A ground segment will be accomplished via developing core techniques and systems as follows;

- Meteorological and space weather data receiving, processing and dissemination system
- Satellite control system
- Data management and service system
- Meteorological/space weather products algorithm
- Satellite-based data application techniques
-

For GK-2A meteorological data service, the data dissemination mission via GK-2A will include all sixteen channels meteorological data in Ultra HRIT(tentatively named as UHRIT) format (X-band downlink) as well as HRIT/LRIT broadcasting(L-band downlink) corresponding to five channels of COMS. And Web-based landline data service will be also available via NMSC(<http://dcpc.nmsc.kma.go.kr>) and DCPC(<http://dcpc.nmsc.kma.go.kr>) websites. More details will be presented in the conference.

Fengyun Satellite Data Services and User Survey

Xian Di

CMA/NSMC

China has launched six geo-stationary orbit Fengyun satellites and seven polar orbit Fengyun satellites. Both volume and category of data products are rapidly rising. According to users' need for data products driven from Chinese meteorological satellites, the Fengyun satellite data sharing service has developed a multiple space-ground unified system architecture. Users can get Fengyun products via CMACast, Internet, Intranet, and many other ways. With more than 2500 users at present, CMACast is one of the most important ones to access near real-time Fengyun satellite data. As the development of internet and the establishment of two main website, website users has boomed by 20 times in recent 9 years. The volume of data served via internet has risen to 410TB for one year. To track users' need for Fengyun data products and services, NSMC has conducted surveys of more than 30,000 website users in 2011 and 2013. The 2013's survey shows a positive social economic statistics result in this article. This service system will apply new technologies, such as cloud computing and virtualization, to meet the need of more users in near future

SESSION 2

**Application of satellite data to weather analysis, numerical
weather prediction and nowcasting**

Chairs: Xu Jianmin / Jun Li

ATMS Striping Mitigation and Data Assimilation

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The Advanced Technology Microwave Sounder (ATMS) onboard Suomi NPP satellite provides NWP required key measurements of the atmospheric temperature and moisture profiles under almost all weather conditions except for heavy precipitation. However, a striping noise is visually discernable in the global O-B differences of brightness temperature fields for the ATMS temperature sounding channels, and was found to be hidden in the ATMS water vapor sounding channels (Qin et al., 2013). A total of 22 de-striping optimal filters are developed for the 22 ATMS channels. Numerical results before and after applying the optimal filters confirm the effectiveness of these new filters for striping mitigation of ATMS data. The added benefits of assimilating the ATMS radiance measurements in the Hurricane Weather Research and Forecasting (HWRF) system are also shown for the four Atlantic hurricane cases that made landfall in 2012. The importance for raising the HWRF model top to ~ 0.5 hPa and changing the cold start embedded in the HWRF system into a warm start for satellite sounding data assimilation are demonstrated. It is shown that ATMS data assimilation in HWRF results in a consistent, positive impact on the track and intensity forecasts of four landfall hurricanes.

Update on SCOPE-Nowcasting

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The goal of the WMO Sustained, Co-Ordinated Processing of Environmental Satellite Data for Nowcasting (SCOPE-Nowcasting) initiative is to demonstrate continuous and sustained provision of consistent, well-characterized satellite products for nowcasting and severe weather risk reduction.

Objectives of SCOPE-Nowcasting are:

To provide a mechanism through which satellite data can be made available simply and quickly, for nowcasting applications

To primarily serve users in the NMHSs of smaller or developing nations, where expertise and facilities for processing and utilizing satellite data may be limited or non-existent,

To assist advanced nations in data processing and application where there may be efficiencies possible through combining resources, expertise, and efforts.

SCOPE-Nowcasting has made significant progress since its inception and this talk will provide an update on the progress of SCOPE-Nowcasting and an outline of plans for the future of the initiative.

Current Status of Weather Support for Nowcasting and Very Short Range Forecast in KMA/NMSC

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KMA/NMSC has operationally been providing 16 meteorological products derived from Communication, Ocean, and Meteorological Satellite (COMS) data from April 1, 2011. These products are mainly used as one of many datasets to analyze and forecast hazardous weather, in particular, rapid growing of convective storm and typhoon tracking.

This study describes COMS-based nowcasting technique, operation system and validation results of the products. Currently, COMS nowcasting products are cloud analysis products such as CTT, CTH, CT and CP.

In particular, KMA/NMSC has introduced NWC SAF such as CRR and RDT of EUMETSAT since 2010 and given feedback on experiences using COMS data.

These are validated with data from other satellite, weather radar, rain gauge, lightning detections, and synoptic weather maps. Also this paper discusses the results of case study through comparison with ground data set.

* CTT : cloud top temperature, CTH : cloud top height, CT : cloud type
CP : cloud phase
CRR : convective rain rate, RDT : Rapid developing thunderstorm

Direct Assimilation of CrIS/ATMS Radiances in HWRF to Improve Hurricane and Typhoon Forecasts

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The Advanced Technology of Microwave Sounder (ATMS) and the Cross-track Infrared Sounder (CrIS) on board Suomi National Polar-Orbiting Partnership (SNPP) satellite provide data for profiling atmospheric temperature and moisture under all weather conditions and supporting continuing advances in data assimilation and NWP modeling. As of today, both ATMS and CrIS radiances are well calibrated and the SDR data have reached a validated level for user applications. This study will present the assimilation of ATMS and CrIS data in Hurricane Weather Research and Forecast Model (HWRF) and the impacts from uses of new satellite data on hurricane track and intensity forecasts in the Western Pacific. The NCEP's Gridpoint Statistical Interpolation (GSI) scheme was re-configured for an effective assimilation of upper-air satellite sounding channels. The quality control and bias correction schemes in GSI are improved for optimal radiance assimilation. Several experiments are conducted for comparing the impacts from the different model tops and the impacts from assimilation of satellite data. Compared to the operational HWRF, with model top of 50 hPa and 43 vertical levels, the experiment L61W has model top of 2 hPa and 61 vertical levels, respectively. Moreover, in experiment L61W, the satellite radiance is assimilated in both domain 2 (9-km resolution) and domain 3 (3-km resolution). For the three recent Western Pacific typhoon events in 2014 (Typhoon Neoguri, Rammasun and Matmo), both their track and intensity forecasts are significantly improved by using the L61W model (see Figures 1 and 2).

Applications of future geostationary advanced IR sounder moisture information for high impact weather forecasting – demonstration with regional OSSE

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Using numerical modeling, forecasters can obtain more accurate high impact weather predictions. One factor limiting forecast quality is the lack of information about the amount of water vapor in the atmosphere. Varying greatly over short distances and time periods, water vapor travels rapidly and provides energy in storm development. Atmospheric-water-vapor information is one of the key parameters needed in the regional numerical-weather-prediction (NWP) model for accurate storm forecasting. The future high spectral resolution infrared (IR) sensors from geostationary orbit (GEO) have a much greater vertical resolving power for atmospheric temperature and moisture structures than the broad band sensors such as the current Geostationary Operational Environmental Satellite (GOES) Sounders, and provide nearly time continuous three-dimensional temperature and moisture profiles that allow substantial improvements in monitoring the mesoscale environment for severe weather forecasting. These measurements would be an unprecedented source of information on the dynamic and thermodynamic atmospheric fields, an important benefit for nowcasting and NWP. In order to demonstrate the impact of GEO advanced IR sounder radiances on high impact weather forecasting, a regional Observing System Simulation Experiment (R-OSSE) frame work has been designed, the first step is to simulate both the GEO and polar (LEO) satellite based hyperspectral IR sounder radiances under both clear and cloudy sky conditions with the atmospheric state from a suitable high spatial resolution natural runs (NRs). The Atmospheric Infrared Sounder (AIRS) is chosen for GEO advanced IR sounder demonstration and validating the simulated radiances. A fast radiative transfer model (RTM) has been developed based coupled Stand-alone AIRS Radiative Transfer Algorithm (SARTA) for molecular absorption and a cloud model accounting for scattering and absorption. The simulated LEO based AIRS radiances from NRs are compared with the

collocated GOES Imager radiance measurements to examine the quality of the simulation, including channels consistency, diurnal variations, cloud coverage etc. Regional OSSEs are performed using the high resolution NRs to investigate the potential value-added impact of high temporal GEO hyperspectral IR sounder moisture information on convective storms and tropical cyclones (TCs) forecasting.

Introduction of the utilization of satellite data in NWP and climate change in NSMC

Tang Shihao

CMA/NSMC

In recent years, more and more meteorological satellites have been launched. To use these satellite data efficiently and benefit from them is very important. This presentation mainly introduces some recent progresses of the application of satellite data to NWP, climate change and weather analysis in NSMC, CMA. For NWP, NSMC has established a comprehensive calibration system and a quality monitoring system to improve Fengyun satellite data quality. Now, FY-3 satellite data have been testified applicable in NWP. NWPC/CMA and ECMWF has begun to use the data formally in their NWP models. Satellite data can also play an important role in climate change researches. NSMC is developing a land long term data record, which was called CG-LTDR, under the support of a special fund for meteorology. CG-LTDR includes six parameters, land cover, NDVI, LAI, albedo and snow cover. Its spatial resolution is 5km in global scale, and 1km in regional scale. The time span is from 1992 to 2012. Some new techniques are applied to CG-LTDR, including cloud screening method, classification method, inversion algorithms, etc. CG-LTDR shows some advantages over the current climate datasets, and it may be used as a reference data source in the climate change studies. For weather forecasting, the main problem lies in forecasters may face to a lot of data but must make decisions within a very short time. To resolve this problem, NSMC is developing a 3D digital atmosphere platform, which may liberate forecasters from massive data. Depending on the platform, forecasters needn't care which kind of data they are using. The only thing they need to do is to make decisions according to what they are seeing.

A near real time regional satellite data assimilation system for high impact weather research and application

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Although satellite data play more and more important role in numerical weather prediction (NWP), how to best represent the information from satellite observation and how to get value added information from these satellite data into regional NWP model, including both radiance and retrieved products, still need investigation. In order to enhance the application of satellite data in regional NWP for high impact weather forecasts, scientists from Cooperative Institute of Meteorological Satellite Studies (CIMSS) at University of Wisconsin-Madison have recently developed a near realtime regional Satellite Data Assimilation system for Tropical storm forecasts (SDAT). The system consists of the community Gridpoint Statistical Interpolation (GSI) assimilation system and the advanced Weather Research Forecast (WRF) model. In addition to assimilate GOES, AMSUA/AMSUB, HIRS, MHS, ATMS, AIRS and IASI radiances, the SDAT is able to assimilate satellite-derived products such as hyperspectral IR retrieved temperature and moisture profiles and total precipitable water (TPW). We are currently working on adding GOES sounder layer precipitable water (LPW) and GOES imager atmospheric motion vector (AMV) products into the system. A GOES imager simulation from the NWP model output has also been added into SDAT system. To set up the system parameters, a series of experiments have been carried out to test the impacts of different initialization schemes, different background error matrix, different NCEP global model date sets, and different WRF model horizontal resolutions. Using SDAT as a research testbed, tests have been done for different satellite data impacts study. Since the fall of 2013, the SDAT system has been running in near real time. The results from historical cases and realtime application will be demonstrated in the meeting.

Impact of varying horizontal length-scale and variance of the background error covariance matrix on typhoon forecast

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Background error covariance (**B**)-matrix is very important for variational data assimilation, which affects the analyses from assimilation system greatly. In this study, the National Meteorological Center (NMC) method was used to estimate the **B**-matrix using the forecasts from the Advanced Research WRF (WRF-ARW) regional model. The characteristics of the regional **B** were compared with global **B** estimated from Global Forecast System (GFS) model. Results indicated that its standard deviation and horizontal scale had similar patterns with global **B**, but had smaller magnitudes and more detailed features for the higher resolution of regional model. Sensitivity analyses were undertaken to examine the impact of changing horizontal length-scale and variance of the **B**-matrix on typhoon track and intensity forecast. Verification against radiosonde observations showed that the varying horizontal length-scale has a significant positive impact at the 24 h forecast of temperature, u-component of wind and specific humidity. On the other hand, changing variance of what only has a slight influence on the specific humidity forecast. Compared with the global **B**, the tuned regional **B** showed improvements on the temperature and u-wind forecast. In addition, using the tuned regional **B** also resulted in significant improvements in the typhoon track forecasts compared with un-tuned **B** and global **B**.

Characteristics of multi-channel measurements from geostationary satellite during convections over North China

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Six parameters are calculated or retrieved from geostationary satellite (FY2E) data, including 10.3~11.5 μm brightness temperature (BT_{IR1}), brightness temperature difference between 10.3~11.5 μm and 6.3~7.6 μm ($BT_{\text{IR1}}-BT_{\text{WV}}$), visible reflectance (VIS, eliminated solar zenith angle effects), cloud optical thickness (COT), 3.6~4.1 μm reflectivity (IR4Ref) and cloud water content (CWC, defined by combining VIS and IR4Ref). BT_{IR1} and $BT_{\text{IR1}}-BT_{\text{WV}}$ may depict the height of cloud top. VIS and COT are characteristics of the thickness of cloud. IR4Ref and CWC are separately used to measure the particle size of cloud top and the cloud water content. The characteristics of these six parameters in convective storms are discussed by using several convective weather cases over North China, especially the relationship with the location and the intensity of convective weather.

The results show that the convective clouds with large VIS and COT also have coldest BT_{IR1} and $BT_{\text{IR1}}-BT_{\text{WV}}$ in some cases with weak 0~6km vertical wind shear, which means the convection nearly develop vertically. In these cases convective weather happens nearby the highest cloud tops and the thickest clouds. In other cases with strong wind shear, the location of convective weather is also close to cloud tops and thick clouds in initial stage of convection. But cloud tops move to the downwind of thick cloud gradually, because of the slantwise development of convection, and convective weather occurs between them.

The intensity of short-time rainfall is also discussed, because short-time heavy rainfall may cause great disasters in China, such as flash floods, debris flows or landslides. It is shown that the intensity of short-time rainfall has poor relationship

with BT_{IR1} , which is widely used in weather forecast operating department, but increasing while VIS and COT increase. The VIS of clouds occurring heavy rainfall ($>20\text{mm/h}$) is usually larger than 70%. The minimum $IR4_{Ref}$ of the entire cloud is used to measure the particle size of cloud top, and the heavier short-time rainfall, the smaller $IR4_{Ref}$. Meanwhile, the analysis of CWC shows that the intensity of short-time rainfall has good relationship with the cloud water content, instead of the height of cloud top.

Analysis and Explanation of Satellite Cloud Imagery of a Heavy Snowstorm in Beijing

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A heavy snowstorm is investigated by using FY-2E satellite data, observational data and microwave radiometer data, which occurred in Beijing area on November 3, 2012. The analysis shows that the deep vortex system from 500 to 850 hPa, the low level southwest jet, and the cyclone at the surface are very favorable to the occurrence of snowstorm. In this case, strong convergence and upward motion, sufficient water vapor leads to the development of convective clouds. It is very rare that thunderstorm appears in the late autumn or early winter in Beijing. The figure of TBB is maintained at 220-240k. The distribution of the cloud system had a very good correspondence with the vertical velocity field, vorticity field, divergence field, and high-level vorticity advection field. The distribution characteristics of temperature and humidity parameters, such as humidity flux, humidity flux divergence, and pseudo-equivalent potential temperature, give a clear explanation of the movement, development, and distribution characteristics of the frontal cloud bands. The difference between the cloud bottom temperature and cloud top temperature has a good corresponding relationship with the precipitation, and the peak of the temperature difference appears earlier than the high precipitation at least 2 hours. It is a good prediction index to predict the precipitation.

Key word: snowstorm, satellite imagery, TBB, cloud bottom temperature

High Impact Weather and the GOES-R Proving Ground

Steven Goodman

GOES-R Program/NOAA/NESDIS

NOAA's GOES-R series will produce a great leap forward in observing system capabilities, while at the same time providing a significant challenge to ensure that the users are ready to exploit the vast improvements in spatial, spectral and temporal resolutions. In order to ensure user readiness, forecasters and other users must have access to prototype advanced products well before launch, and have the opportunity to evaluate their usefulness and provide feedback to application developers to ensure that the end products meet their needs. Plans for the future include new and expanded relationships between the GOES-R Proving Ground and international partners to introduce more blended and fused satellite products with other forecast tools to support weather analysis, NWP, and nowcasting. This presentation will highlight demonstrations of the new and advanced applications being demonstrated with forecasters at the GOES-R Proving Ground and NOAA Testbeds.

Assimilation of Surface-sensitive Microwave Radiances over East Asia

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The assimilation of satellite microwave radiance plays an important role in the numerical weather forecast over East Asia. However, lots of surface-sensitive satellite observations are not used because of the complex surface condition over East Asia. What's more, for the Tibetan Plateau with the highest Altitude in the world, even the assimilation of those satellite data with less surface-sensitivity in general sense presents a difficult issues. To improve the assimilation of microwave sounder radiance over East Asia, a scheme of land surface emissivity is introduced. The land surface emissivity of those window channels is firstly retrieved from the satellite observation. The retrieval is then used in the assimilation of satellite data. It is not only the window channel takes the emissivity retrieval, but also the sounder channel near the window channel gets the retrieved emissivity. The emissivity of database is used in case of the retrieval is failed. In this report, we will introduce the analysis of the characteristics of retrieved emissivity, especially over Tibetan Plateau, together with the comparison with that of database.

Acknowledgements : This study was supported by funding from the International S&T Cooperation Program of China(ISTCP) under Grant no. 2011DFG23210.

SESSION 3

Application of satellite data to long term dataset for climate

analysis, reanalysis and climate process studies

Chairs: Toshiyuki Kurino / Xiaolei Zou

The Importance of Sensor Recalibration for Producing Long Term Radiance Measurements Useful for Atmospheric Trend Analyses

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The High resolution Infrared Radiation Sounder (HIRS) has been flown on sixteen satellites from TIROS-N through NOAA-19 and METOP-B forming more than a 30-year record. The Moderate resolution Imaging Spectro-radiometer has been taking measurements from the Terra (since 1999) and Aqua (since 2002) Earth Observing System platforms. Decadal trends of high, mid, and low level moisture are now being reprocessed that rely on stable sensor calibration and mitigation of sensor to sensor radiance calibration differences. Using high spectral resolution infrared data from the Infrared Atmospheric Sounding Interferometer (IASI) as a reference, NOAA-15 through NOAA-19 HIRS spectral response functions have been adjusted and Aqua and Terra MODIS calibration stability has been characterized. The associated impact on the moisture trends will be discussed.

The status of long term satellite data processing in NSMC

Liu Jian

CMA/NSMC

Since 1970's, National Satellite Meteorological Center received, processed and archived some kinds of satellite data. The archived data amount is more than 2Pb. The long term archived data provides great support for climate data processing and climate research.

Now, the start point of processing long term data set is in 1988. The processed satellite data include NOAA/ AVHRR , FY-2C/2D/2E , FY-1C/1D and GMS/ MTSAT data.

Recalibration is the base stone for long term data processing. For FengYun series satellite data, recalibration coefficients come from the GSICS results. For the other satellites, such as NOAA series satellite data, the calibration coefficients come from web page, for example ISCCP web page.

Cloud amount, land surface temperature, snow coverage, vegetation and outgoing long wave radiation are selected to build long term data set. The stable algorithm is a key point of long term data processing. Synop and similar satellite data are used to evaluate the accuracy of the processed data. The processed data has been used to analysis parameter change over the long term.

The first version of long term data finished now. The second version of long term data will begin to process according to GSICS schedule

SESSION 4

**Application of satellite data to environmental and disaster
monitoring, disaster risk reduction**

Chairs: Tillmann Mohr / Anthony Rea

The Socioeconomic Benefits of Satellite Observations for Disaster Risk Reduction

Charles Wooldridge

*National Oceanic & Atmospheric Administration (NOAA) Satellite and Information
Service (NESDIS)*

Increasingly, policy leaders and decision makers are asking meteorological satellite agencies to justify investments in Earth observing systems through the return on investment and/or the social and economic benefits derived from use of the Earth observations. Charles Wooldridge, Chair of the Coordination Group for Meteorological Satellites (CGMS) Socioeconomic Benefits Tiger Team (SETT), will provide an overview of how the SETT's activities can help agencies in the Asia Oceania region explore ways to characterize, quantitatively or qualitatively, the socioeconomic benefits of satellite observations for monitoring disasters and reducing disaster risk.

The CGMS established the SETT to develop credible methodology and common terminology for articulating the socio-economic benefit of satellite observing systems, and to explore the most effective ways to communicate this information to stakeholders.

Using volcanic ash monitoring, drought, malaria, and numerical weather prediction examples from studies presented during the first SETT Workshop in April 2014, Mr. Wooldridge will demonstrate how applying the eight key themes that emerged from the Workshop can help guide agencies planning their own socioeconomic benefit studies. The eight (8) key themes included:

- Context is essential,
- Methods are critical,
- Understanding relative impact of satellite observations is crucial,
- Quantitative and qualitative methodologies are valid approaches,
- Cost considerations should inform study parameters,
- Data availability matters,
- Interdisciplinary expertise is required, and
- Operational agencies can leverage research agency perspectives/expertise.

The China Meteorological Administration (CMA) and Japan Meteorological Administration (JMA) participate in the SETT and we welcome additional input from

the Asia Oceania region on the information that would be most useful to agencies as they develop socioeconomic benefit studies as well as best practices and case studies.

Use of satellite data in emergency situations in China

Fang Xiang

CMA/NSMC

China has many kinds of natural disasters and often suffered by them. The emergency situations often respond to the natural disasters. There are three modes in emergency response in NSMC: Passive mode, Active mode, Cooperative mode.

In the passive emergency mode, when severe hazards occurred or disastrous weather is coming, CMA start the emergency response. Users, such as: NMC or local meteorological agency, make satellite data request. Then, NSMC carry out emergency response preplan, adjust the satellite observation mode, process specific products and quickly distribute them to the users.

For Active emergency mode, Emergency response is triggered according to the monitoring result of meteorological satellite. Everyday, NSMC uses FY satellites to monitor the natural disasters in national wide. When disaster is found, NSMC report it to CMA or relative administrative departments and they will start the Emergency response depending on the disaster situation. Then NSMC, NMC/NCC etc. carry out the emergency procedure to supply the data for local users.

China also has a cooperative mechanism for using multi-source satellite data to monitor severe disasters. When major disaster occurs, NSMC can get Chinese high resolution data . CMA is the member of International Charter Space and Major disasters, so we can activate the charter and acquire more high spatial resolution data from other countries.

Although these three modes took an important part in Chinese Emergency Response, there are still some disadvantages. For national application, the product service and dissemination are not enough. For international application, It is not clear for us to acquire the users information and their requirement is difficult to be acquired.

For national issue, NSMC have a plan to enhance data transmission to fieldwork users and improve professional products. For international issue, We propose to build international disaster emergency response mechanism of meteorological satellite.

Study of the extreme rainfall events in Bangladesh using TRMM

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The extreme rainfall has significant impact on the socio-economic development of Bangladesh. In this study, TRMM 3B42 V6, V7 product and Bangladesh Meteorological Department (BMD) rain gauge three hourly data of 33 stations from 1998 to 2010 are used for the analysis of extreme rainfall events in Bangladesh. The very heavy (greater than 88 mm in 24 hour), heavy (44-88 mm in 24 hour), moderately heavy (23-43 mm in 24 hour) and moderate (11-22 mm in 24 hour) rainfall events detected by TRMM 3B42 V6 is less than that of V7 product. On the other hand, the light (2.5-10 mm in 24 hour) rainfall events detected by TRMM 3B42 V6 is more than that of V7 product. For very heavy rainfall events the correlation coefficient (CC) between BMD and TRMM V6 is 0.80 and CC between BMD and V7 is 0.84. In the case of heavy rainfall events CC between BMD and TRMM V6 is 0.76 again the CC is 0.91 in between BMD and V7. BMD data is highly correlated with TRMM V7 product than V6. It is found that the very heavy rainfall events are dominated in the coastal part of the country and the light rainfall events are dominated in the western and northern part of Bangladesh.

Key words: Rainfall, Extreme event, TRMM, Bangladesh

Mapping burned areas of China using FY-3/MERSI sensor with a multi-temporal algorithm

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Medium resolution spectral imager(MERSI) on China's second generation polar-orbit meteorological satellites FY-3, which is a MODIS-like multi-spectral and high-temporal sensor. FY-3/MERSI are capable of making continuous earth observations, and are suitable for deriving burned area over large areas. In this paper, we present an automated algorithm for the detection of burned area using FY-3/MERSI remotely sensed data. The algorithm is based on a burn-sensitive vegetation index and a measure of temporal texture. FY-3/VIRR active fire products are used to build burned and unburned pixels training sets, and FY-3/. Then dynamic thresholds are developed to derive the burned pixels by computing the posterior probabilities of burned/unburned area and the measurements of temporal texture. The algorithm was applied to three geographically and temporally diverse regions in China and Australia. By comparison with MODIS burned area products, the products of our algorithm have been validated and preliminary results are presented. Results show that the accuracy of our algorithm is acceptable.

The Estimated Rainfall with FY-2E Satellite over Thailand

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The estimated rainfall from FY-2E satellite is importance for monitoring, warning and mitigation of engineer to management. The natural disaster occurred in Thailand composed of flash floods, floods and landslide. Recently, the technological satellite was used to application for the estimated rainfall because of can measuring in the largest area. Therefore, the corrected estimation of rainfall data in the spatial area need to the natural disaster management. This paper studied the verification statistics used to in evaluating of the estimated rainfall from FY-2E satellite in infrared channel over Thailand in 2013. Comparison the satellite data from FY-2E with rainfall observed data from Thailand Meteorological Department (TMD) stations. The assessment of the accuracy FY-2E studied the estimated rainfall over all seasons, the summer (mid-February to mid-May), rainy (mid-May to mid-October) and winter (mid-October to mid February). The results of statistics verification of all seasons showed that FY-2E better performs of the relationship data; the correlation coefficient (CC) is 0.80, the mean absolute error (MAE) is 1.55 and the root mean square error (RMSE) is 2.51. The probability of detection (POD) is 0.81 and the threat score (TS) quiet high value 0.73, the false alarm ratio (FAR) is 0.06 and probability of false detection (POFD) is quiet low value 0.08. Therefore, FY2E algorithm is a good performance to estimated rainfall in the area.

Key words: FY2E Satellite, Estimation Rainfall, Rainfall

SESSION 5

**Atmospheric parameters, land surface and ocean
parameters derived from satellite observations**

Chairs: Paul Menzel / Agnes Lane

Derivation of atmospheric aerosol, cloud, and radiation budget parameters from the satellite sensors on board Himawari 8-9, GCOM-C, EarthCARE, and GOSAT2 satellites- Part 2

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There are various important future satellite projects for earth observation. I like to discuss prospects and strategies for utilizing sensors on board Himawari-8 and -9 (launch year of 2014, 2016), GCOM-C (2016), EarthCARE (2016), and GOSAT-2 (2018) satellites for retrievals of aerosol, cloud, and radiation budget parameters. Following the paper presented in the last year, this paper describes new retrieval results and plans made in the last year by JMA and research communities.

Advanced Himawari Imager (AHI) of Himawari-8 and -9 has 16 channels with 500m to 2kmFOV on geostationary orbit. Their global coverage by every 10 minutes is useful for monitoring volcanic plume, forest fire smoke and air pollution plume. JMA has a plan to develop standard products of Asian mineral dust and volcanic plumes. This year we formed two working groups, for atmosphere and earth's surface, for community support of AHI algorithm development for various geophysical parameters other than the JMA standard products. Another development of this year is a system development for remote sensing and modeling of the surface solar radiative energy flux using geostationary satellite data, that has been keenly demanded by the solar power energy generation sector.

Platform design of the GOSAT-2 satellite just started. Analysis of data from the current GOSAT satellite showed that an accurate correction of the optical path length increased by aerosols is one of major problems for improving the column CO₂ loading retrieval better than 1%. We decided to redesign the Cloud and Aerosol Imager (CAI) on board the GOSAT to develop the CAI-2 of the GOSAT-2 satellite by installing two near ultra-violet bands of 340nm and 380nm and two along-track viewing angles. A new aerosol retrieval algorithm for multi-wavelength and multi-pixel use has been developed and applied to CAI data; we obtained successful retrievals of the single scattering albedo as well as optical thickness of aerosols from CAI data. This algorithm is also planned to be applied to data from future CAI-2, AHI, and the Second generation GLocal Imager (SGLI) on board the GCOM/C polar orbiter.

Recent improvements of AMVs from FY-2 satellites and historical data reprocessing

Zhang Xiaohu

CMA/NSMC

This paper briefly introduces status of AMVs operations at NSMC. There are several changes at the FY-2 operational AMVs derivation system in the last two years. (1)In image calibration, a new calibration algorithm called 'CIBEL' was realized in satellite operation system of FY-2E/FY-2D. (2)In image navigation stage, improvements or preventive measures were adopted in operation aimed at reducing the possibility of worse navigation in abnormal image cases. (3)Moreover, some improvements in AMVs' derivation algorithm are made.

This paper gives an overview to the changes of the FY-2 operational AMVs derivation algorithm in the last two years with an upcoming view in the operational configuration as a consequence of the foreseen launches of FY-2G in 2014.

GOES-R Algorithm Working Group (AWG) Level-2 Product

Validation Activities

Jaime Daniels

NOAA/NESDIS Center for Satellite Applications and Research

The GOES-R Algorithm Working Group is responsible for the development and validation of Level-2 product algorithms for the future GOES-R Advanced Baseline Imager (ABI) and Geostationary Lightning Mapper (GLM) instruments. Each of the AWG product application teams has relied on numerous GOES-R instrument proxy data for its algorithm development and validation activities during the pre-launch phase of the GOES-R program. The pre-launch validation activities are aimed at characterizing uncertainties of the Level-2 products derived from instrument proxy and/or simulated data. During the post-launch phase of the GOES-R program, the emphasis will be on characterizing the performance of the Level-2 products (derived from real on-orbit instrument data) and indentifying and making necessary product algorithm refinements. This talk will highlight the continuing Level-2 product validation activities that the AWG product application teams have been involved with and the post-launch product validation activities that it will be involved in.

On the Characteristics and Retrieval Accuracy of Atmospheric and Surface Parameters from FY-4 Ultra-Spectral Sounder under Clear Sky Condition

Wu Chunqiang , Jun Li, Hui Liu

CMA/NSMC

An ultra-spectral sounder will be onboard China's new generation geostationary meteorological satellite (FengYun-4, FY-4), which scheduled to be launched in 2016 time frame. The sounder designed to probe atmospheric temperature and humidity profiles with high temporal and spatial resolution. And it has two scanning modes, one for China area and the other for mesoscale events. In these two scanning modes, the sensor specifications differ both in signal-to-noise ratio (SNR) and spectral resolution. A nonlinear iterative physical retrieval algorithm is adopted with first guess field obtained from regression retrieval processes to extract temperature and humidity information under clear sky condition. The vertical resolution and accuracy of retrievals of mesoscale events sounding mode are introduced, as well as effects of SNR, and spectral resolution on vertical resolution and retrieval accuracy are investigated in this paper. The vertical resolution of temperature and humidity retrievals of mesoscale events sounding mode is about 3 km, and those were degraded in the China area sounding mode. The resolution of temperature is affect significantly by the SNR, while that of humidity is affected mainly by spectral resolution. Temperature soundings can be produced under clear sky condition with RMS errors on the order of, or better than, 1.3 K in 1-km-thick layers from the surface to 700 hPa, 0.8 K from 700–300 hPa, and 1.5 from 300–30 hPa, and moisture profiles can be obtained with an accuracy better than 15% absolute errors in 2-km layers from the surface to nearly 200 hPa. Compared to those of mesoscale events sounding mode, the accuracy of temperature in the China area sounding mode is degraded by about 0.5 K, and that of humidity is degraded by about 5%.

Occurrences and Properties of Marine Boundary Clouds Inferred From MODIS and CPR Measurements

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The cloud profiling radar (CPR) aboard the CloudSat satellite has been the first spaceborne millimeter radar and, is more appropriate than any other existing remote sensing platform for observing vertical structure of global clouds. Unfortunately, the CPR suffers always from the ground clutter due to its top-down perspective. The CPR's insensitivity at altitude below ~ 1 km leads to the severe underestimate of marine boundary clouds (MBC), which has significant radiative effects and is a very unique type among low-level clouds over ocean. On the other hand, Moderate Resolution Imaging Spectroradiometer (MODIS) can not accurately resolve the altitude of the cloud layer, although the retrieved cloud top temperature usually gives some hints. But when these two complementary measurements are combined, MBC can be isolated definitely. The principle is that for a given CPR pixel of about 1.4 km \times 1.7 km, MODIS indicates nearly-full cloud cover with relatively warm cloud top while CPR indicates a certain cloudless profile. Such a disagreement of cloud determination from these two instruments actually points to the clouds limited in the atmospheric boundary layer, the lowest ~ 1 km where CPR is blind. In this study, by using synchronous measurements from CPR/CloudSat and MODIS/Aqua, one-year data were analyzed to investigate the occurrences of marine boundary clouds and their common cloud properties. It was found that due to the loss of MBC, the occurrence of low-level warm clouds is largely underestimated ($\sim 40\%$) by the CPR. This result suggests that CPR still has significant biases for quantitative estimation of global low-level clouds and, that MBC constitute a major part of low-level warm clouds over ocean. For the extracted MBC, their specific macro- and micro-physical properties are revealed from the corresponding MODIS products.

Analyses on spatial and temporal characteristics of aerosol optical depth distributions over Bohai rim in China during 2013

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NASA Aqua MODIS Level2 Collection 006 data product (MYD04_3K C006), the 3km spatial resolution, was validated using the AERONET ground observation data, and as a result, it has a good accuracy to meet the requirement of studying the regional spatial and temporal characteristics of aerosol optical depth (AOD) distributions over the Bohai rim in China. Utilizing the MYD04_3K (at 550nm) data, the spatial distributions and temporal variation of AODs in this region during the year 2013 were analyzed. The results showed that the high AODs were at the North China plain, while the low AODs were at mountains and hills. The AOD values during Spring and Summer were obviously higher than that of Autumn and Winter, a trend of which was Summer(0.581±0.305)>Spring(0.454±0.333)>Autumn(0.389±0.246)>Winter(0.193±0.237). The regional AODs' temporal variation showed that the peak value(average AOD=0.740) was appeared in June, while the valley value (average AOD=0.034) was in January. The AOD spatial-and-temporal characteristics have derived from complex interactions of human activities and natural factors: the spatial distributions are mainly affected by the former, but the annual and seasonal changes are primarily drove and controlled by the latter, e.g., interannual precipitation plays a specially prominent role in processes of atmospheric aerosol deposition.

Regression modeling of finite field and anti-electromagnetic design for the ocean surface wind speed measurements of the FY-3B/C microwave imager

An Dawei

CMA/NSMC

The purpose of this study is to select a suitable sea wind retrieval method for FY-3B/C (MWRI). Based on the traditional empirical model of retrieving sea surface wind speed, and in the case of small sample size of FY-3B/C satellite load regression analysis, this paper analyzes the channel differences between the FY-3B/C satellite microwave radiation imager (MWRI) and TMI onboard the TRMM. The paper also analyzes anti-electromagnetic design and the influence of these differences on the channel in terms of receiving temperature, including channel frequency, sensitivity, scaling precision. Then, the limited range of new model coefficient regression analysis is determined (in which the channel range settings include the information and features of channel differences), the regression methods of the finite field are proposed, and the empirical model of wind speed retrieval applicable to MWRI is obtained, optimization algorithm used for typhoon, which achieves good results. Compared to the TAO buoy data, and the standard deviation is 1.2 m/s. In addition, the schematic diagram of the tropical sea surface wind speed retrieval is provided.

Application of meteorological satellite data in ecological monitoring and evaluation for Shanghai

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This paper introduces the application of meteorological satellite data in ecological monitoring and evaluation for Shanghai, emphasizing on: (1) urban heat island (UHI) monitoring and mechanism analysis in city area, (2) ecological status monitoring and assessment in Chongming Island.

Shanghai's urbanization process has been accelerating Since 1990s, population and buildings were highly gathered in urban built-up area, leading to the appearance of UHI as the most typical characteristic. Based on NOAA/AVHRR, EOS/MODIS, FY-3 etc, the monitoring of Shanghai city expansion and UHI evolution from 1990s revealed that (1) the tendency of urban sprawl and heat island expansion has spatial consistency, (2) the extent of center city's heat island expanded distinctly and the thermal environment worsened, and (3) the significant changes occurred in urban land surface environment would bring great impact to regional ecosystem. Weighting factor analysis showed that (1) the larger area proportion of the buildings, traffic and industrial ground mediums, the higher the temperature is, and (2) the improving effect of greening on heat island in urban residential district is around 0.5 to 1.2°C. the land surface temperature with resolution of 250m retrieved from FY-3/MERSI and its derivative indexes could present more elaborate thermal field patterns. The radioactive pattern of heat island in central city changes to massive pattern in outer suburb, characterized by multi-center tendency. In recently years, the strength of heat island in center city decreased and its spatial pattern became more complex. A quantitative evaluation model for urban habitat thermal environment is proposed based on FY-3 satellite and ground observations. It could derive the Geo-info-TUPU of the comfortable degree of thermal environment as well as the crisis degree of thermal disaster, revealing the eco-environmental effect of city land cover and human activities, with implications for early-warning for thermal environment disaster. Based upon the above, an integrative thermal environment disaster monitoring, evaluation and warning system was developed for operational meteorological service.

Chongming Island has been constructed as a world-class eco-island according to the national development strategy. Ecological monitoring and assessment is an important

aspect of ecological construction for Chongming Island. a remote sensing application and service system is developed for the monitoring and evaluation of Chongming ecological status. Basing on the medium resolution meteorological satellite data and the high resolution environmental satellite data, this system can realize dynamical monitoring of ecological resources (mainly wetland and forest in Chongming), assessment of non-point source pollution, and so on. In 2013, the possession rate of natural wetland in Chongming was 46.3%, and the forest coverage rate reached 22.5%. The non-point pollution assessment shows that the spatial distribution of agricultural pollution load of Chongming island is in the pattern of north high south low, west high and middle low. This pattern reflects the contribution of different planting types to the pollution load. TN pollution load was mainly from paddy field, while the contribution of the dry field increased significantly.

Key words: Meteorological satellite, Urban heat island, Ecological resource, Non-point source pollution

Estimates of the Accuracy of Radio Occultation Product from GNOS/FY3C

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A new polar meteorological satellite FY-3C, which loaded the first civil-use radio occultation sounder of China named GNOS (Global Navigation Satellite System Occultation Sounder), was launched on September 23rd, 2013. As a GNSS(Global Navigation Satellite System) receiver in LEO, GNOS records the speed and time information during the relative rise or set motion. With this active remote sounding, occultation occurs about 500 times per day between GNOS and GPS. GNOS also can be compatible with BeiDounavigation satellite system of China, making the measurements climb up to about 800 times. The advantages of radio occultation including free of calibration, high vertical resolution, high accuracy and global coverage have been demonstrated by pioneers using GPS/MET, CHAMP, COSMIC, and METOP/GRAS. Therefore, the aim of this paper is to estimate the accuracy of GNOS, by comparing refractivity profiles to co-located radiosonde soundings. Bias and standard deviation were computed in a function of altitude. The results show that the mean bias of refractivity fractional difference between GNOS and radiosonde is about 0.5% from the near surface to the altitude of 25KM, exhibiting good agreement with each other. As to standard deviation, the average value is about 2%. Specifically, the excellent sounding height from 5 to 25 kilometers demonstrates the magnitude within 1.5%. While the altitude below 5km is about 3%~5%, due to multipath propagation especially in tropical areas. On the whole, GNOS can basically meet the requirement as original designed, which indicates an important improvement for the first trial of FY-3 satellite in radio occultation sounding.

Keywords: FY-3C, GNOS Instrument, Radio Occultation, Products Precision Evaluation

Volcanic Ash Identification Using Mtsat-2 Satellite Imageries

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This study aims to design a system of identification and estimated the height of volcanic ash in Indonesia. Identification of volcanic ash performed using satellite MTSAT with Split Windows and multispectral methods Image Enhancement Techniques and estimated height and trajectory. Identification of volcanic ash and its height is very important information for flight safety.

Verify the identification of volcanic ash on the report VAAC (Volcanic Ash Advisory Centre) Darwin and the satellite Terra / Aqua MODIS (Moderate Resolution Imaging Spectroradiometer) shows that the method is capable of monitoring the volcanic ash as well. Estimate the height of the volcanic ash by wind correlation methods are also approaching the height of the dust of data obtained from observation and document SIGMET (Significant Meteorological Information).

Keywords: Identification of volcanic ash, MTSAT, volcanoes, volcanic ash height, split windows, the correlation of wind, trajectory

SESSION 6

Global Spaced-based Inter-Calibration System (GSICS)

Chairs: Zhang Peng/ Kenneth Holmlund

Characterization of ATMS on-orbit calibration accuracy for GSICS Applications

Fuzhong Weng

NOAA/NESDIS/Center for Satellite Applications and Research (STAR)

The Suomi National Polar-orbiting Partnership (NPP) satellite was launched on October 28, 2011 and carries the Advanced Technology Microwave Sounder (ATMS) on board. ATMS is a cross-track scanning instrument observing in 22 channels at frequencies ranging from 23 to 183 GHz, permitting the measurements of the atmospheric temperature and moisture under most weather conditions. In this report, the ATMS radiometric calibration algorithm is presented and its calibration accuracy is assessed through independent analyses of prelaunch thermal vacuum data and in-orbit measurements. It is found that the ATMS peak nonlinearity for all the channels are less than 0.5 K, which is well within the specification. For the characterization of the ATMS instrument sensitivity or noise equivalent differential temperatures (NEDT), both standard deviation and Allan variance of warm counts are computed and compared. It is shown that NEDT derived from the standard deviation is about three to five times larger than that from the Allan variance. In the ATMS sensor brightness temperature data record (SDR) processing algorithm, the antenna gain efficiencies of main beam, cross-polarization beam and side lobes must be derived accurately from the antenna gain distribution function. However, uncertainties remain in computing the efficiencies at ATMS high frequencies. Thus, ATMS antenna brightness temperature data records (TDR) at channels 1 to 15 are converted to SDR with the actual beam efficiencies whereas those for channels 16 to 22 are only corrected for the near-field side-lobe contributions. The biases of ATMS SDR measurements to the simulations are consistent between GPS RO, ARM site radiosonde and NWP data and are generally less than 0.5 K for those temperature sounding channels where both the forward model and input atmospheric profiles are reliable.

From ATMS TDR data, the differences between brightness temperature observations and simulated observations are calculated based on numerical weather predictions (aka O-B). For the upper ATMS temperature sounding channels, O-B exhibits a clear striping pattern (Bormann et al., 2013) in along-track direction. We propose to firstly use the principal component analysis (PCA) to isolate scan-dependent features such as the cross-track striping from the atmospheric signal, and then to use an Ensemble

Empirical Mode Decomposition (EEMD) to extract the striping noise in ATMS Earth scene brightness temperature observations for both temperature and water vapor sounding channels. It is shown that the PC coefficient of the first PC mode, which mainly describes a scan-dependent feature of cross-track radiometer measurements, captures the striping noise. The EEMD is then applied to the PC coefficient to extract the first three high-frequency intrinsic mode functions (IMFs), which are denoted as the PC1/IMF3 noise. When the PC1/IMF3 noise is removed from the data, the striping noise is imperceptible in the global distribution of O-B for ATMS temperature sounding channels 1-16. Using the same method, it is demonstrated that the striping noise is also present in ATMS water vapor sounding channels 17-22. The magnitude of the ATMS striping noise is about ± 0.3 K for the temperature sounding channels and ± 1.0 K for the moisture sounding channels. The same technique is also applied to AMSU-A, AMSU-B and MHS. The striping noise is undetectable for AMSU-A but is present in both AMSU-B and MHS data.

The cross-calibrated measurements from Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit-A (AMSU-A) on board different NOAA polar-orbiting satellites have been extensively used for detecting atmospheric temperature trend during the last several decades. Since ATMS inherited most of the sounding channels from its predecessor of AMSU, it is important to extend AMSU data records with ATMS observations. However, the ATMS field of view is different from that of AMSU. In this study, the Backus-Gilbert method is used for optimally remapping the ATMS FOVs to AMSU-A like FOVs. Differences in ATMS brightness temperatures introduced by remapping are firstly illustrated over the region of Hurricane Sandy which occurred in October 2012. Using the simultaneous nadir overpass (SNO) method, AMSU and ATMS remap observations are then collocated in space and time and the inter-sensor biases are derived for each pair of channels. It is shown that the brightness temperatures from SNPP ATMS are now well merged into the AMSU data family after remap and cross-calibration.

Inter-Comparison of Suomi NPP CrIS Radiances with AIRS and IASI toward Infrared Hyperspectral Benchmark Radiance Measurements

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The Cross-track Infrared Sounder (CrIS) on the newly-launched Suomi National Polar-orbiting Partnership (SNPP) and future Joint Polar Satellite System (JPSS) is a Fourier transform spectrometer that provides soundings of the atmosphere with 1305 spectral channels, over 3 wavelength ranges: LWIR (9.14 - 15.38 μm); MWIR (5.71 - 8.26 μm); and SWIR (3.92 - 4.64 μm). The SNPP CrIS, combined with the existed Atmospheric Infrared Sounder (AIRS) on NASA *Aqua* and Infrared Atmospheric Sounding Interferometer (IASI) on *Metop-A* and *-B*, will accumulate decades of hyperspectral spectral infrared measurements with high accuracy. These hyperspectral infrared (IR) measurements have been used as references to inter-calibrate other narrow or broad band IR instruments in the Global Space-based Inter-Calibration System (GSICS) community. Therefore, the radiometric and spectral consistency of AIRS, IASI, and CrIS is fundamental for creation of long-term infrared (IR) hyperspectral radiance benchmark datasets for both inter-calibration and climate-related studies.

In this presentation, we will 1) evaluate radiance consistency among AIRS, IASI, and CrIS, and 2) thus further demonstrate that the CrIS Sensor Data Records (SDR) can serve as a long-term reference benchmark for inter-calibration and climate-related study just like AIRS and IASI. In the first part of presentation, we will brief major post launch calibration and validation activities for SNPP CrIS performed by the NOAA STAR CrIS sensor data record (SDR) team, including the calibration parameter updates, instrument stability monitoring, and data processing quality assurance. Comprehensive assessments of the radiometric, spectral, geometric calibration of CrIS SDR will be presented. In addition, the preparation of CrIS SDR re-processing toward consistent Climate Data Records (CDRs) will be discussed. The brief of future CrIS on JPSS-1 will be also discussed. The purpose of this part is to

provide a comprehensive overview of CrIS SDR data quality to user community.

Second, the CrIS radiance measurements on Suomi National Polar-orbiting Partnership (SNPP) satellite are directly compared with the AIRS on Aqua and IASI on *Metop-A* and *-B* at the finest spectral scale through one year of simultaneous nadir overpass (SNO) observations to evaluate spectral and radiometric consistency of these four hyperspectral IR sounders. The spectra from different sounders are paired together through strict spatial collocation. The uniform scenes are selected by examining the collocated Visible Infrared Imaging Radiometer Suite (VIIRS) pixels. Their spectral differences are then calculated by converting the spectra onto common spectral grids.

Update on GSICS Inter-Calibration Product Development

Tim Hewison, Lawrence Flynn, Dave Doelling, Cheng-Zhi Zou, Manik Bali

EUMETSAT

GSICS is an international collaborative effort initiated by WMO and the CGMS to monitor, improve and harmonize the quality of observations from operational weather and environmental satellites of the Global Observing System. GSICS systematically generates inter-calibration products for Level 1 data from satellite sensors to compare, monitor and correct the calibration of *monitored instruments* to community references by generating calibration corrections with specified uncertainties through well-documented, peer-reviewed procedures based on various techniques to ensure consistent and robust results

GSICS Corrections are the key products, which allow users to convert the nominal calibration of various satellite instruments to be consistent with references. To lead the development of inter-calibration products in different spectral bands, Sub-Groups of the GSICS Research Working Group (GRWG) have been defined. The Microwave and UV will be reported separately in this workshop.

Currently GSICS Corrections are available in demonstration or pre-operational phases for the infrared channels of various geostationary imagers from EUMETSAT, NOAA and JMA. CMA, KMA and ISRO are currently developing similar products for their geostationary imagers and expect to have demonstration products available soon. So far these products use Metop-A/IASI as a reference. The GRWG is developing *Delta Corrections*, based on double-differences, to transfer between different references, and is creating a concept whereby inter-calibration results using multiple references are merged, incorporating these delta corrections. This will simplify application to users, while ensuring traceability back to the *Primary GSICS Reference* (Metop-A/IASI in this case).

Meanwhile, the VIS/NIR Sub-Group has been developing counterpart inter-calibration products for the visible channels of geostationary imagers. These are based on globally-available pseudo invariant targets to transfer calibration of a reference sensor (currently Aqua/MODIS) to geostationary instruments. The first demonstration products based on Deep Convective Clouds (DCC) are expected to become in late 2014. Later refinements may be needed to account for regional and seasonal variations in DCC characteristics, which are currently being investigated. A second algorithm, based on the Moon is also under development. The GSICS

implementation of ROLO lunar irradiance model has already applied to Meteosat and MTSAT imagers and will be made available to other agencies at a Lunar Calibration Workshop, hosted by EUMETSAT in winter 2014/15. The GRWG aim to combine these methods to cover instruments' full dynamic range before going on to apply these algorithms to inter-calibrate LEO instruments and investigate other possible inter-calibrations method for the VIS/NIR band.

CMA GSICS product development and services

Hu Xiuqing, Xu Na

CMA/NSMC

This paper describes the progress of GPRC/CMA in the past five years. CMA has established the GSICS operational system for monitoring the sensors' calibration biases of FY-2 geostationary series satellites and FY-3 polar orbiting satellites. These GSICS operation includes the FY-2C/2D/2E/2F calibration monitoring based on GEO-LEO IR inter-calibration algorithm and LEO-LEO IR inter-calibration for the three sensors (MERSI/VIRR/IRAS) of FY-3A/B/C satellites. The NPP/CrIS was first introduced as the hyper-spectral reference sensor for IR bands into the GSICS platform in this year, in addition to Metop/IASI and Aqua/AIRS. For the solar reflective bands, the calibration monitoring system based on invariant targets (desert, snow) and deep convective cloud (DCC) was established for FY-3/MERSI and FY-2. The inter-calibration based on the reference instrument MODIS and GOME-2 is being run for FY-3/MERSI, and the Spectral Band Adjustment Factor (SBAF) is tested using GOME-2 hyper-spectral observation. The Lunar calibration has just been applied for FY-3C/MERSI base on the lunar observation being taken by extending the view window while viewing the space. All of these GSICS products are released on the CMA GSICS website: [http:// gsics.nsmc.cma.gov.cn](http://gsics.nsmc.cma.gov.cn).

Report on GSICS Coordination Center Activities and Plans

Lawrence E. Flynn, Manik Bali

NOAA/NESDIS

This talk provides a status report on the GSICS Coordination Center (GCC) activities for the last year and plans for the coming year. The GCC has published the last four GSICS Quarterly with special issues on Lunar calibration and Microwave sensors, and has four planned issues for the coming year with special issues on Ultraviolet and Visible sensors. Additional information will be provided on new and planned products and product acceptance and promotion procedures, work on establishing baseline algorithms, and the latest website revisions.

POSTER

Facilitating Optimal Use of Satellite Data-The Advancement of Community Based Satellite Processing Packages

Allen Huang

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In cooperation with the NOAA Suomi NPP/JPSS and NASA EOS Terra/Aqua program, CIMSS/SSEC continues to leverage and expand International MODIS/AIRS Processing Package (IMAPP) effort, and to facilitate the use of international polar orbiter satellite data through the development of a unified Community Satellite Processing Package (CSPP) to support the Suomi NPP and JPSS, and subsequently build up over time, to support operational GOES-R, METOP series, and geostationary meteorological and environmental satellites for the global weather and environmental user community.

This paper highlights more than 13 years of success of IMAPP as a pathway to the development of a freely available software package CSPP to transform VIIRS, CrIS, and ATMS Raw Data Records (RDRs) (i.e. Level 0) to Sensor Data Records (SDRs) (i.e. Level 1), and SDRs to Environmental Data Records (EDRs) (i.e. Level 2).

Current status and future outlook of IMAPP and CSPP will be given to report on the software release so far and the ongoing prototyping and operational use of SDR and EDR of MODIS, AIRS, VIIRS, CrIS and ATMS in US National Weather Service (NWS) field offices' daily operation and many other national and international direct broadcast, operational and research users for their time critical applications and weather and environmental research.

Characterization of the Environmental Information Trend of the COMS MI

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We have investigated environmental information such as temperatures, currents, and voltages of the three modules which are sensor module, electric module and power module of the Meteorological Imager (MI) on the Communication, Ocean, and Meteorological Satellite (COMS) which is the Korean meteorological geostationary satellite to monitor its health and status. It is necessary to monitor and characterize the environmental information trend because radiometric performance of the Infrared channels' detectors may fall under the influence of some of them.

According to the trend analysis of the environmental information, there are variations of temperatures and they come under the influence of the change of the Earth's position with respect to the Sun like as seasonal effect. On the other hand, the Servo current is not connected with the celestial dynamics but influenced by observation mode. Thus, we found out the characterization of the environmental information of the COMS MI such as variation cycle with annual and diurnal period.

In this paper, we will present not only characterization of the environmental information but also influence in relation to radiometric calibration of the COMS MI.

Analysis of characteristics of satellite images on an extreme spring blizzard process on 19 April 2013

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Using the conventional data and satellite cloud images, an extreme spring blizzard process in the northwest of Shandong province on April 19, 2013 was analysed. The results show that the process is an obvious returning flow situation. The large scale circulation background of this snowfall process is that high-level moist air climb in the lower cold mass. precipitation phases are complex, from rain to sleet, finally to pure snow. In the process of phase transformation, cloud characteristics also change. With the change of the TBB, cloud height is different, precipitation phase have different. Precipitation clouds are three layers of clouds and clouds of no precipitation are two layers in this process. Cirrus spissatus is consistent with precipitation area. Temperature lapse rate is small, the 0 °C layer is low, and there is deep wet layer over the precipitation area.

Key words: Spring blizzard Satellite cloud image returning flow situation

COMS MI Image Navigation and Registration Performance

According to the Landmark Selection Scheme

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Communication, Ocean and Meteorological Satellite (COMS), the first Korean geostationary meteorological satellite, has providing high quality data since the official Meteorological Imager (MI) data release on April 1st 2011. Image Navigation and Registration (INR) of COMS MI for rectification of distorted image is processed in the ground segment, National Meteorological Satellite Center (NMSC), using a combination of landmarks, ephemerides and satellite attitude data. COMS MI level 1B INR performance is based on image geometric quality information and the residuals of landmarks including 3-sigma values. In this research, we analyzed relationships between the landmark selection scheme and the INR performance caused by diurnal variation. The characteristics of the used landmarks explain an unexpected sudden increment of east-west direction navigation residuals around 9 UTC.

Analysis of Satellite-based Soil Moistures for Application in Land Surface Data Assimilation

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KMA has been using the surface soil wetness derived from Metop-A/ASCAT for land surface data assimilation in global NWP model since June 2012. Metop-A/ASCAT soil wetness showed positive benefit on forecasts of screen temperature and humidity for the tropics, according to North America and Australia (Met-Office Forecasting R&D Technical Report No. 548, 2010). Recently, Metop-B/ASCAT with same specification of Metop-A was also launched in September 2012. Therefore we can get the additional satellite data to increase the spatial coverage of soil moisture retrievals and it is useful data for application in land surface data assimilation.

This study deals with the characteristics of Metop-A/ASCAT surface soil wetness in surface data assimilation system in operational global NWP model at KMA. For land surface data assimilation, we analyzed characteristics of Metop-B/ASCAT and other satellite-based soil moisture. The features of soil moisture according to land cover types were researched. And these satellite-based soil moisture products are compared to ground observations and model forecasts. The results will be shown in the presentation.

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The progress of meteorological satellite operational application in SMB

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Chinese FY meteorological satellite data have been widely used in synoptic analysis, numerical weather forecasting, climate and climate change evaluation, agricultural and ecological monitoring etc. The operational state of remote sensing applications in Shanghai Meteorological Bureau (SMB) was given in this paper.

In SMB, the Shanghai Center for Satellite Remote Sensing Applications take the responsibility of developing satellite remote sensing application to support weather forecasting and other business related to meteorology. The existing remote sensing data sources include satellites of FY and HY (China), NOAA and EOS (USA) and MTSAT(Japan) etc. these data are achieved by two modes: one is from the Chinese national satellite broadcasting system and the other is from local receiving systems built by SMB.

In the past years, seven operational application systems have been built for weather and environment monitoring, evaluation and analysis, such as for heavy fog, typhoon, lake alga and urban heat island etc. Based on these systems, nearly forty operational remote sensing products can be made automatically or semi-automatically, which are uploaded to the Integrated Information Website or Micaps system to serve for various users. These products are used widely in weather consultation, especially in the monitoring and early warning of strong convection, typhoon, haze and other severe weather.

Operational procedure and organization framework have been formed for remote sensing service to definite what to do ,who to do, how to and when to do in normal time, high water season and emergency state respectively. Especially stressed in the operation remote sensing service is the the interface, the post duty and the work diary. The operational remote sensing service is not only restricted for SMB, but also for other departments in East China.

In the future, we will continue to enhance the automation level and stability of satellite data receiving and processing, and to improve the product quality and service efficiency. Also, we will search for the new application potential of FY meteorological satellites.

Application of the satellite data for numerical weather prediction in KMA

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National Meteorological Satellite Center, Korea Meteorological Administration

The first geostationary meteorological satellite of Korea, Communication, Ocean and Meteorological Satellite (COMS) has been operated regularly since 1 April 2011 after launched on 26 June 2010. KMA has used atmospheric motion vector at every hour and clear sky radiance at every 3 hours from COMS for KMA global NWP model since December 2011 and June 2013, respectively. The assimilation of these products, especially, gives positive effects at the high troposphere over East Asia in KMA global model forecasts. KMA/NMSC is now developing satellite surface information such as composite sea surface temperature (SST) including COMS SST to improve surface condition of KMA NWP model. And also, KMA/NMSC, in cooperation with GNSS-related agencies in Korea, is now preparing the system of GNSS data collection and quality control in order to utilize KOMPSAT-5 satellite and ground-based GNSS data for NWP data assimilation. In this paper, we will introduce the status and plans of applications of satellite data for NWP model in KMA/NMSC.

Arctic Sea Ice Monitoring and Analyzing from Satellite Data

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Arctic sea ice is one of the most important parameters in climate change due to global warming. Arctic sea ice has declined dramatically at least the past thirty years and the lowest extent of Arctic sea has made a new record in 2012.

For monitoring of sea ice change, the National Institute of Meteorological Research (NIMR) has retrieved the sea ice extent and ice surface roughness using microwave sensor data and has implemented the real-time the “Arctic sea ice monitoring system” for the public. This system uses the Special Sensor Microwave Imager/Sounder (SSMIS) data and has produced sea ice information every week in period from 2007 to present. The ice surface roughness based on refractive index is estimated by adopting the characteristics of polarization from microwave sensor data and can be able to physically explain the sea ice change. Furthermore, current status of Arctic sea is analysed using several satellite and meteorological data.

The “Arctic sea ice monitoring system” of the NIMR and the analysis results of sea ice will be presented in the conference.

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A unique algorithm for retrieving surface wind speed and its applications to Typhoon analysis using microwave satellite observations

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Tropical cyclones (TCs), especially Typhoon, are a major natural disaster to give huge damage to Korean Peninsula from a few days to weeks. Satellite-based microwave observations are useful to estimate the surface wind speed (W_s) and TC's structure. We have developed an algorithm for retrieving W_s under rain-free and rainy conditions using passive microwave satellite observations (hereafter Hong and Seo wind algorithm). In this investigation, we use the AMSR-2 data, which is operated and well calibrated at several frequencies: 6.9, 7.3, 10.65, 18.7, 23.8, 36.5, and 89.0 GHz at the constant incidence angle of 55.0° . The rain-contaminated observations are determined using AMSR-2 rain flag data to separate inside or outside TCs. Radio Frequency Interference (RFI) is also eliminated. First, relationships between the AMSR-2 Brightness Temperature (T_B) observation and AMSR-2 T_B simulation, between AMSR-2 T_B simulation and rough sea surface reflectivities R_R are estimated for vertical (V) and horizontal (H) polarizations, in turn. For H polarization, the rough sea surface reflectivity is obtained from a radiative transfer calculation with RTTOV-9 using ECMWF surface and atmospheric profile data, and AMSR-2 sea surface temperature. The surface roughness T_B is estimated. Second, the surface roughness is estimated from rough sea surface reflectivities R_R . Finally, the W_s is calculated using a relationship between W_s and surface roughness. The current AMSR-2 W_s provided by JAXA, and W_s retrieved by Hong and Seo wind algorithm are validated with the Tropical Atmosphere Ocean (TAO) buoy observations during one month. The bias and RMSE from the Hong and Seo wind algorithm are 0.09 m/s and 1.13 m/s, while the bias and RMSE of the current AMSR-2 W_s are -0.71 m/s and 1.38 m/s, respectively. The current AMSR-2 W_s has a good agreement with the TAO buoy observation. The Hong and Seo wind algorithm exhibits the improved results statistically for the bias, RMSE, and correlations. The Hong and Seo W_s algorithm has been operationally and successfully applied for monitoring the center position and size of typhoons such as 'Neoguri' in KMA.

The Monitoring of Lake Alga Based on Meteorological Satellite Data

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During the past thirty years the inland and coastal water pollution has become an important problem due to increased agricultural and industrial activities in China. The eutrophication of lake leads to the alga forms frequently and largely. Many tests are made to monitor the development and distribution of lake alga by satellite remote sensing. The important problem for the monitoring of lake alga is how to make effective atmospheric correction.

At present, the most commonly used atmospheric correction algorithms are based on the radiative transfer models, such as MODTRAN, 6S, FLAASH and so on. However, it is difficult to acquire accurate atmospheric upwelling reflectivity. The simulation results show that the error from the atmospheric upwelling reflectivity will be magnified to the error of water-leaving reflectivity by 7-8 times, which was the main error source of atmospheric correction. In order to reduce the error of water-leaving reflectivity, a new atmospheric correction algorithm named Stable Pixel Method (SPM) was proposed. The SPM directly establishes the relationship between the apparent reflectivity of satellite image and Chl-a concentration. The Chl-a concentration retrieval tests show that, by SPM, the error of water-leaving reflectivity caused by errors of atmospheric upwelling reflectivity and remote sensing instruments, and by water waves, can be restrained greatly.

The Inland and Coastal Waters Environment Remote Sensing Monitoring and Analysis System has been developed, in which the SPM is adopted for atmospheric correction. By this remote sensing application system, the whole process of data acquisition, data pre-processing, retrieval of Chl-a concentration and output of analysis reports can be accomplished within one and a half hour. The dynamic monitoring and analysis of the algal blooms area, alga spatial distribution ranges and Chl-a concentrations are made for Taihu, Jiangsu Province in the past four years with satellite remote sensing data of EOS-MODIS, FY-3 and HJ-1A/B. The results show

that the development of lake alga was related to the meteorological conditions. High temperature and calm wind are beneficial to the breeding and spreading of the alga.

In order to improve the operational retrieval accuracy of lake alga, it is suggested to carry out In-situ measurement of Chl-a concentration in the stable region once a month and to set new bands with 250 meter spatial resolution that are sensitive to the absorption and fluorescence characteristics of Chl-a concentration in next FY meteorological satellites.

Typhoon Monitoring and Analysis based on Meteorological Satellite Data

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Most of the tropic cyclones (typhoons) are generated within the western North Pacific Ocean. To be specific, approximately 30 typhoons (38% of total global average) per year are formed in the past decades according to the Best Track records. For the lack of conventional observations over sea, satellite remote sensing is known as the most effective measurement for typhoon monitoring.

In operational work, we have got satellite data of FY series, MTSAT, NOAA and EOS-Terra/Aqua, which are received in real time. With the help of the data above and the software platforms, such as Satellite Weather Application Platform (SWAP) from NSMC, as well as FY application system of typhoon monitoring from SMB, we keep on working for typhoon monitoring and analysis, which is proved to be beneficial for the operational forecasting and scientific research.

For the complexity and particularity of the structure, intensity and moving path, forecasting results on the direction and intensity of super typhoon Muifa (2011) were far from the truth. The dark areas in water vapor images from geostationary meteorological satellite are corresponding to low water vapor content, and could be used for subtropic high pressure monitoring. The evolution of the dark boundary reflected from the continuous water vapor images denoted an earlier southern extension of the subtropic high than it from the NWP. As a result, Muifa (2011) would turn to north earlier than the forecasting.

The microwave signals can penetrate through thick clouds, so the microwave images from polar orbit meteorological satellite could reveal the low level circulation of typhoon as well as the eyewall structure. The concentric eyewall (CE) structure was observed by microwave image 3 times in the lifecycle of muifa (2011), and the CE structure evolution of each time was distinctive. As a result, the differences of the typhoon structure made the intensity forecasting more difficult. Similarly, CE structure evolutions among different CE typhoons were not the same in the microwave images. Statistical analysis indicated that the CE evolution pattern corresponded well with typhoon intensity variation. It was proved by the composite analysis that typhoons with different CE patterns were distinctive on the

configurations of the vorticity, water vapor, u-v wind, geopotential height, vertical wind shear and SST. Consequently, the internal and external factors referred above could be used as the characteristic quantities to predict the eyewall evolution pattern, and hence to forecast typhoon intensity changes.

Retrieval of Daily Actual Evapotranspiration from COMS

Products over East Asia

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Evapotranspiration (ET) including water evaporation from surfaces and vegetation transpiration is an important component of the global hydrological cycle. The National Institute of Meteorological Research at Korea Meteorological Administration (KMA/NIMR) developed an algorithm of daily ET (DET) with the Communication, Ocean and Meteorological Satellite (COMS) over East Asia region (100.00 °E ~145.00 °E, 20.00 °N~50.00 °N) since 2012. The characteristic of this algorithm based on surface energy balance equation ($R_n=LE+H+G$) is simplified aerodynamic resistance considering a variation of surface roughness length and has reflected the vegetation canopy height and surface characteristic over the East Asia region. The NIMR DET which is 1-day composite data, with spatial resolution of 1 km estimates in clear sky except urban and desert area from 1 April 2011 to present. The validation of the NIMR DET with Flux-Tower data shows 2.538 mm/day of RMSE and 1.906 mm/day of Bias.

NIMR has implemented an ET monitoring and analysing system at KMA intranet service since 2013. The ET monitoring system offers monthly mean ET and evaluating information compared with the Flux-Tower data and MODIS ET. The NIMR DET shows the seasonal variation, including the vegetation growth and decline. The detailed results will be presented at the conference.

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Diurnal variation of Inter-calibration for COMS Infrared channels

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COMS (Communication, Ocean, and Meteorological Satellite) has been monitored following Global Space-based Inter-Calibration System (GSICS) since April 2011. KMA use two well-calibrated hyper-spectral instrument on Low Earth Orbit (LEO) satellites, Atmospheric Infrared Sounder (AIRS) onboard Aqua and Infrared Atmospheric Sounding Interferometer (IASI) onboard MetOp-A, as references for inter-calibration of four infrared (IR) channels of COMS. Mean bias of brightness temperature compared to IASI appear 0.30 for IR1 (10.8 μ m), 0.23 for IR2 (12.0 μ m), -0.73 for IR3 (6.7 μ m) and 0.02 for IR4 (3.7 μ m) during the last 33 months from April 2011 to December 2013. Similarly, mean bias to AIRS are shown as 0.24 for IR1, 0.25 for IR2, -0.99 for IR3 and 1.13 for IR4.

Two LEO satellites have different equatorial crossing time each other, thus diurnal variation of inter-calibration for COMS-LEO could be examined by composing the results from two LEO satellites. In result, inter-calibration coefficients of IR1 and IR2 such as slope or bias seem to be relatively stable with respect to observation time, though negative bias for IR3 is slightly larger in the local midnight. However, especially for IR4, different features from others appear around satellite midnight time. It is thought to be a kind of midnight effect due to the extra heating of scan mirror for three-axis body-stabilized geosynchronous satellite like Geostationary Observational Environmental Satellite (GOES) imager. Otherwise, it may be impact of stray light contamination including lunar radiance.

In addition, seasonal variation of inter-calibration for COMS-LEO is also examined for 3 years accumulated observation data. Root mean square error (RMSE) of brightness temperature compared to IASI is increasing in summer season, from 1.0 to 2.0 for IR1 and IR2, from 2.0 to 3.5 for IR4, which is not apparently shown in IR3 (1.2 of RMSE). The impacts of temporal variations of inter-calibration results need to be investigated before generate the GSICS correction products for IR data.

Solar Backscatter Ultraviolet Instruments (BUV) instruments on Satellites in GEO and L1 orbits

Lawrence E. Flynn

NOAA/NESDIS

This talk describes four planned missions which will add Lagrange Point 1 (L1) and geostationary (GEO) assets to the BUV satellite instrument complement. The last three will provide opportunities to apply LEO/GEO comparison techniques as measurements from these new instruments become available. This will lead to improved intercalibration products for existing polar-orbiting BUV instruments. Even before the GEO instruments become available there will be a new BUV/Visible instrument, the Earth Polychromatic Imaging Camera (EPIC), operating from L1 opening new areas for LEO/L1 and GEO/L1 underflight comparisons. Looking back in time, the BUV experience on underflights already includes SS/LEO (Space Shuttle underflights of LEO) comparisons. The talk will conclude with an invitation for participation in the newly formed UV Subgroup of the GSICS Research Working Group on this and other projects.

In orbit determination and validation of Spectral Response Function using IASI Radiances and GSICS SNO comparisons

Manik Bali

NOAA

Measurement accuracy of a detector critically depends on the accuracy of the detector's Spectral Response Function (SRF). Any shift or leaks in the SRF can dramatically influence the measured values and induce trends and biases in its measurements, therefore it is important to know the SRF at the time of taking measurement.

In the case of instruments such as the AVHRR and the AATSR etc. that are observing Top of Atmosphere radiances from space, the SRF is determined at the time of pre-launch. Despite taking care during pre-launch testing several instruments have shown measurement biases that have been attributed to shifts, leaks or changes in the SRF created when the instrument reached orbit. Therefore it is critical to determine and validate the SRF of the detector while it is in orbit so the right SRF is applied when the instrument is taking measurements from space.

We present here a method that can determine the SRF of an instrument non-parametrically using an inverse method that uses hyperspectral data such as is available with the IASI instrument. Using simulated data we will show the sensitivity of this method towards the detection of leaks, shifts and shape changes in the SRF and the subsequent impact on calibration. We then use this method for instruments to study the SRFs of the several difference sensors and discuss the consequences of any discrepancy with their pre-launch values.

Trends in Spatial and Temporal changes of Forest Fire Frequency in China

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The study aims at identifying any spatial and temporal patterns that may govern forest fire frequency across China. The study focuses on fire incidences data obtain for the past decade from MODIS Fire Information for Resource Management System (FIRMS). The frequency of forest fires have increased in the latter part of the decade, emphasizing the need for identification of both anthropogenic and climatic factors affecting these events. Our study aims to facilitate investigations into forest fire frequency in context of climate change by understanding the temporal and spatial trends in forest fire frequency fluctuations. Data suggest that North East, South East and South West regions of China have the highest frequency of fire incidences (approximately 80% of fire incidences occur in these regions) and seem to be representative areas of China for forest fire studies. The study shows that highest frequencies of forest fire are from January to June, with North East having a delayed onset as compared to the South East and South West regions of the country. Our results indicate repetitive fluctuations in forest fire frequency from one year to the other, unique to each of the regions. The results also hint at a weak repeating inter annual cycle with years of high forest fire frequency and lower frequency grouped together and repeating one after the other.

Estimating the Long-term Hydrological Budget over Heterogeneous Surfaces

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Abstract: Estimates of the hydrological budget in the Walnut River Watershed (about 5,000 square kilometers) of southern Kansas were made with a parameterized subgrid-scale surface (PASS) model for the period 1996–2002. With its subgrid-scale distribution scheme, the PASS model couples surface meteorological observations with satellite remote sensing data to update root-zone available moisture and to simulate surface evapotranspiration rates at high resolution over extended areas. The PASS model is observationally driven, making use of extensive parameterizations of surface properties and processes. Heterogeneities in surface conditions are spatially resolved to an extent determined primarily by the satellite data pixel size. The purpose of modeling the spatial and interannual variability of water budget components at the regional scale is to evaluate the PASS model's ability to bridge a large grid cell of a climate model with its subgrid-scale variation. Modeled results indicate that annual total evapotranspiration at the WRW is about 66–88% of annual precipitation — reasonable values for southeastern Kansas — and that it varies spatially and temporally. Seasonal distribution of precipitation plays an important role in evapotranspiration estimates. Comparison of modeled runoff with stream gauge measurements demonstrated close agreement and verified the accuracy of modeled evapotranspiration at the regional scale. *In situ* measurements of energy fluxes compare favorably with the modeled values for corresponding grid cells, and measured surface soil moisture corresponds with modeled root-zone available moisture in terms of temporal variability despite very heterogeneous surface conditions. With its ability to couple remote sensing data with surface meteorology data and its computational efficiency, PASS is easily used for modeling surface hydrological components over an extended region and in real time. Thus, it can fill a gap in evaluations of climate model output using limited field observations.

NOAA Climate Data Record Program: Development, Production, and Service

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Climate Data Records (CDR) reveal Earth's short- and longer-term environmental changes and variations, allowing scientists and decision makers across society to better understand the climate system; assess the state of the climate on regional, national, and global scales; project future climate states; inform economic decisions impacted by future weather and climate. NOAA's Climate Data Record Program (CDRP) at the National Climatic Data Center (NCDC) is leading NOAA's generation of operational climate records for the atmosphere, oceans, and land.

NOAA CDRs are produced by merging data from surface, atmosphere, and space-based systems across decades. NOAA's CDRP is initially focusing on data from satellites. By applying knowledge gathered over time about instruments' performance and sensor characteristics, the data are reprocessed to create consistent long-term records, allowing insight into changes in the Earth's environmental parameters, such as: atmospheric and sea surface temperatures, snow and ice conditions, precipitation and clouds, etc. In this presentation, we will share our experience on the CDR development and production, introduce our CDR products, provide application examples of the CDRs, and collect feedback from the audiences/users in the meeting.

An algorithm for correcting the solar irradiance of FY-3C/TOU

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The total ozone unit(TOU) of the FY-3C polar orbiting satellite is designed for observing daily global coverage of the Earth's total ozone, and its global total ozone products can provide important parameters for atmospheric chemistry, environmental monitoring and global climate change researches. After FY-3C being launched in Sep 2013, the Solar irradiance (after BRDF correction) of FY-3C/TOU has a large deviation when compared with that of FY-3B/TOU. By analyzing the observed irradiance (before BRDF correction) among the three instruments, we find that the variation rules between the observed irradiance and wavelength is consistent for FY-3C/TOU and FY-3B/TOU, although the actual irradiance (after BRDF correction) of FY-3C/TOU is very different from that of FY-3B. By further analysis of the irradiance dates, the geometric parameters between sun-satellite vector and instrument coordinate system is thought to be inappropriate. To revise the geometric parameters, we design an algorithm for estimating the installation matrix of FY-3C/TOU between instrument coordinate system and spacecraft coordinate system. The results were validated by comparison with simultaneous field observation data.

Oceanic Wind Speed Retrieval and Validation using FY-3B/C

Microwave Imager observations

Dou Fangli

CMA/NSMC

Ocean surface wind is one of the primary parameters of global and local climate, which plays an irreplaceable role in the study of ocean thermohaline circulation, marine environmental dynamics, tropical cyclones, air-sea interaction and climate prediction. The microwave radiation brightness temperatures (T_B 's) of calm sea surface are related to SST, salinity and electromagnetic parameters, whereas the T_B 's of actual sea are also affected by the roughness associated with the ocean surface wind vectors and the foam. Based on the unique relationship of ocean surface wind speeds and the T_B 's received by the radiometer, wind speeds can be precisely retrieved.

An algorithm of retrieving oceanic wind speed from FY-3B/C microwave imaging instrument (MWRI) observations was developed, based on the JCSDA Community Radiative Transfer Model CRTM and the ECMWF sampled databases of 60-level atmosphere profiles. An in-situ dataset containing 7471 MWRI overpasses of buoys was used to calibrate the algorithm precisely. For furthermore validation, we used the WindSat wind speed product. The rms retrieved accuracies for FY-3B and FY-3C are 1.2419m/s and 1.2441m/s.

In addition, the retrieved error caused by the relative wind direction was analyzed. An $AT_{BV} - T_{BH}$ look-up-table was made to correct the relative wind direction error. After the error correction, the relationship between the retrieved error and the relative wind direction is significantly weakened, and the rms accuracy is reduced to 0.9775 m/s.

Calibration and Validation of ERM Observations from FY-3C

Satellite

Qiu Hong

CMA/NSMC

The Earth Radiation Measurement (ERM) on FY-3C is the third Earth Radiation Budget (ERB) instrument on board FY-3 series of satellites. FY-3C was launched on September 23th, 2013 and ERM began its measurements on September 30th. The instrument observes the Earth atmosphere within a narrow scanning field of view (NFOV) and a wide non-scanning field of view (WFOV). For each field of view, the measurements are made from two broadband channels: a total waveband channel covering 0.2–50 μm and a ShortWave (SW) band covering 0.2 - 4.3 μm . During the 6 months after the satellite was launched, the evaluation and validation to ERM observation were made. The unfiltered radiance for LongWave (LW) and SW broadband produced by ERM were compared to the data from NPP/CERES FM5. The ERM LW and SW data showed a good correlation with CERES data, the bias between CERES and ERM is about -1.34 and -0.83 $\text{w/m}^2\text{sr}$ for daytime and nighttime. For SW, the bias is about -5.78 $\text{w/m}^2\text{sr}$. With the ERM on-orbit calibration data, the stability of the radiometric response at two channels was analyzed and it is shown that the gains at both total channels are stable with variations no more than 1.5% in first 6 months. The SW channels have larger changes in gain and exceed 3%, which is similar to ERM on FY-3B. This drift is caused by the detector degradation.

Total Solar Irradiance observations from FY-3C Solar Irradiance Monitor-II

Qi Jin

CMA/NSMC

Solar Irradiance Monitors (SIMs) are designed to measure Total Solar Irradiance (TSI) at the top of atmosphere (TOA) over 0.2~50 μm wave band on the second generation of Chinese polar orbit meteorological satellite series, FengYun(FY)-3 series. A newly improved Solar Irradiance Monitor (SIM-II) is onboard FY-3C which is successfully launched on Sep. 23, 2013. It has a sun tracing system and precise temperature control system compared with those SIMs from FY-3A/B. FY-3C/SIM-II is composed of two identical absolute radiometers which has a dual-cavity inter-compensating design. One observes operationally and the other one works one day a month to provide comparing observations.

For the evaluation before launch, a field experiment was designed to compare the synchronous observations from SIM-II and those from two similar TSI instruments, SIAR-1A and SIAR-2C which were calibrated with the WRR standard during the 11th International Pyrheliometer Comparison (IPC-XI) at the World Radiation Centre in Davos, Switzerland in 2010. The field experiment was held from March 27 to April 5, 2013 in Yunnan province, China. The WRR standard was transferred to FY-3C/SIM-II by the comparison. WRR factors are 1.005927 ± 0.000785 (1σ) and 1.000448 ± 0.000769 (1σ) for the two radiometers of SIM-II.

On-orbit, the aging problem is taking care by duty work of two absolute radiometers. The inter-comparison between FY-3C /SIM-II and SORCE/TIM shows good consistency. The bias is about $4.72 \pm 0.1 \text{ W/m}^2$. The system bias is caused by different calibration method. TIM is traceable to NIST by Total Solar Irradiance Radiometer Facility (TRF) under vacuum, while SIM-II is traceable to WRR using sun as source in air. The new SIM-II results could have a good response to solar activity and provide TSI data for climate application.

Monte Carlo Radiative Transfer Modeling of Optical Lightning Signals Observed by satellite

Hu Liqin

CMA/NSMC

For the next generation of Chinese geostationary meteorological satellites (FY-4) an optical lightning mapping sensor is planned to observe lightning and storms on a real-time, continual basis. FY-4 lightning measurements will detect both intracloud and cloud-to-ground lightning discharges by its optical radiation at 777.4nm with a CCD-matrix. The signals present the radiation which was transferred from the lightning source up to the cloud top. In conjunction with the simplified lightning source and cloud models, a Monte Carlo approach is applied for simulating the transfer of lightning produced photons in thunderclouds, and the outputs are designed to address the lightning radiation signatures which will be obtained by FY-4 lightning mapping sensor. The current study focuses on the quantitative relationships between the observed lightning radiance and several key observation geometry parameters. Results show that: Lightning radiative transfer simulation based on Monte Carlo method would theoretically reveal links between satellite optical-band lightning radiation observation and the most important parameters. This gives the possibility to demonstrate the impact of the various properties of clouds and lightning source on the cloud top radiation distribution which can be observed by satellite based lightning sensor.

Mapping forest biomass of China using GLAS and ancillary data.

Li Guicai

CMA/NSMC

In this paper, we present a study of mapping forest biomass of China using GLAS data and ancillary data. First, the waveform length (w , defined as the distance between the first and the last Gaussian peak) for each GLAS data was calculated, and converted into average forest height with an empirical linear model which is built based on 50 field measurements at GLAS footprints. Then, extrapolation of discrete GLAS forest height by combining remote sensing and climatic data was implemented to derive a spatially continuous forest height map. Finally, an empirical model between average forest height and aboveground biomass was developed, by which the forest height map was transformed into a forest biomass map. The total forest aboveground biomass is estimated to be 9.5 Pg, similar to other researches, but our biomass map provides detailed spatial pattern information.

Impacts of aerosol and albedo on CO₂ retrieval using the near infrared CO₂ bands

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The global carbon dioxide observation satellite (TanSat) mission of China is introduced. Two instruments carried by TanSat including carbon dioxide (CO₂) spectrometer with high spectral resolution, termed the TanSat CO₂ Spectrometer (TSCS), and the Cloud and Aerosol Polarize Instrument (CAPI) will make global measurements of atmospheric CO₂ with the high precision of 1% and resolution of 1 km approximately. In this paper, we aim at quantifying the error associated with aerosol and albedo over China utilizing the new designed parameters of TanSat. Firstly, the latest specifications of TSCS are analyzed through the observing simulations as well as the retrieval experiments over some areas in China, where space-based measurements of CO₂ confront the huge challenge induced by atmospheric aerosols which optical depth can ascend up to more than 1 at wavelengths of 550 nm at certain atmospheric conditions. MODIS aerosol and albedo products are used in the synthetic measurements. The impacts of both aerosol scattering and surface albedo on CO₂ retrieval accuracy are investigated by applying different retrieval implementation. The errors are estimated for nadir observation over land with typical solar zenith angle 30° and 60°. Comparisons amongst the three approaches suggest that correctly treatment of aerosol scattering is necessary to account for the impacts of multiple scattering in order to meet the requirement of TanSat mission. The development of retrieval algorithm will be continued to the launch of TanSat in late 2015.

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**Estimate the pre-launch calibration results of fy3c/mersi using
gome-2 data**

Wu Ronghua

CMA/NSMC

Validation of Aerosol Optical Depth affected by dust storm from products of MTSAT , FY-4 algorithm and FY-3/MERSI

Li Xiaojing

CMA/NSMC

Dust storm is a main natural calamity at east-Asia. Aerosol Optical Depth (AOD) products from the geostationary and polar orbit meteorological satellites are used to monitor the dust storm transmission in China and Japan.

Aerosol Optical Depth products obtained by visible and near infrared spectral observations are mainly used to quantitatively monitor the floating dust affected by dust storm. The product quality is the focus of concern. Validation of three AOD products from MTSAT, FY-4(using AQUA/MODIS as proxy data), FY-3/MERSI are carried out during several dust storm processes from 2009 to 2011 in which dust transferred from breakout source region , such as desert in northwest of China, to remote place, such as east China ,south China or Japan . The AOD from AERONET are used to validate the satellite AOD.

IMPROVEMENT OF AEROSOL OPTICAL PROPERTIES SIMULATION OVER EASTERN ASIA WITH MODIS AOD_s ASSIMILATION

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A new global aerosol assimilation system adopting a more complex icosahedral grid configuration is developed. Sensitivity tests for the assimilation system are performed utilizing satellite retrieved aerosol optical depth (AOD) from the Moderate Resolution Imaging Spectroradiometer (MODIS), and the results over Eastern Asia are analyzed here. The assimilated results are validated through independent AERONET/SKYNET observations. Our results reveal that the ensemble and local patch sizes have little influences on the assimilation performance, whereas the ensemble perturbation method has the largest effect. Assimilation leads to significantly positive effect on the simulated AOD field, improving agreement with all of the 12 AERONET sites over the Eastern Asia based on both the correlation coefficient and the root mean square difference (assimilation efficiency). Meanwhile, better agreement of the Ångström Exponent (AE) field is achieved for 8 of the 12 sites due to the assimilation of AOD only.

**Direct broadcast receiving system for real time application of
weather satellite data**

Li Zhengjun

CAS/IAP

Estimating ice water path in tropical cyclones with multispectral microwave data from the FY-3B satellite

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Abstract -- Ice water path is an important parameter to characterize tropical cyclones. The FY-3B satellite, with multiple passive microwave sensors onboard, offers a unique opportunity to monitor the variation of cloud ice water path during the evolution of tropical cyclones. In this study, by using the combined simultaneous measurements of the MicroWave atmospheric Humidity Sounder and MicroWave Radiometer Imager on FY-3B satellite, an improved ice water path algorithm for tropical clouds was developed. The new algorithm seeks to better estimate ice-free background brightness temperature at 150 GHz using simultaneous observations at low microwave frequencies. This approach improves ice water path retrieval accuracy especially for high ice water path clouds that often associated with tropical cyclones. The current algorithm was applied to FY-3B observations of two typhoons with different strength, and the characteristics of ice water path variation at the storms' different evolution stages were investigated. The results showed that ice water path tends to vary ahead of the storm intensification or decay, suggesting that ice water path can be potentially used to predict the change of storm intensity.

Index Terms -- ice water path, passive microwave, tropical cyclone, FY-3B, MWHS, MWRI

Method based on Remote Sensing Monitoring of Vegetation Coverage in Time and Space Changes Research – Taking Boulder tara as an example

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Abstract: the current domestic research on vegetation coverage more than using already processed good image abroad, such as the MODIS global vegetation coverage of the image, no matter from the source image or technical methods rely on foreign countries. Based on the domestic satellite images and embark on vegetation coverage products from the original image, the boulder tara Mongolian autonomous prefecture of space-time change monitoring vegetation coverage. Study found that: (1) during the period of 2010 to 2012, the tendency of changes in vegetation coverage on the whole, fluctuated, 12 - to 13-year period presents the downward trend in whole; (2) before the late period of the vegetation growth, vegetation coverage change is bigger, growth medium vegetation coverage change little; (3) under the regional vegetation coverage change human disturbance is greater than the natural areas; (4) the superior natural conditions in areas where the local vegetation coverage change is greater than the natural conditions

keywords: vegetation index; Vegetation coverage; Time changes; Spatial variation