

VIRTUAL LABORATORY FOR TRAINING IN SATELLITE METEOROLOGY

(Submitted by the WMO)

Summary and purpose of document

The purpose of the document is to inform CGMS of WMO activities related to the development of a Virtual Laboratory for Training in Satellite Meteorology and the co-sponsorship by China of the RMTTC Nanjing as a specialized centre of excellence in satellite meteorology.

ACTION PROPOSED:

CGMS Members to discuss the Virtual Laboratory for Training in Satellite Meteorology and the role of CGMS.

Appendix: Virtual Laboratory for Training in Satellite Meteorology

DISCUSSION

The 'Virtual Laboratory' to Improve Satellite System Utilization

1. The second session of the CBS OPAG IOS Expert Team met in Melbourne, Australia, 25-29 October 1999 and discussed the development of the "Virtual Laboratory" concept as it related to improving the utilization of satellite systems' data, products and services. As part of the discussion, the meeting reviewed the progress in the use of a "Virtual Laboratory" at the RMTCs in Barbados and Costa Rica. It was also briefed on ongoing coordination between the satellite operators including their co-sponsorship activities at regional RMTCs, e.g., EUMETSAT activities at the RMTCs in Nairobi and Niamey as well as related Computer Aided Learning (CAL) activities.
2. The second session discussed the evolution of a "Virtual Laboratory" at the RMTCs in Costa Rica and Barbados. In November 1995, Costa Rica hosted WMO's Regional Training Seminar on Satellite Meteorology for Regional Associations III and IV. At the seminar, the possibilities for a demonstration project for a "Virtual Laboratory" in RA III and RA IV (Regional Association III and Regional Association IV) were explored. In 1996, NOAA/NESDIS approved a demonstration project proposed by CIRA (Cooperative Institute for Research in the Atmosphere) for a satellite applications focused RMTTC, involving the RMTCs of Costa Rica and Barbados. Immediate actions began, with representatives from each RMTTC attending CIRA for intensive training in familiarization with the Regional and Mesoscale Satellite Display and Information System (RAMSDIS) systems, and the arrival of two configured RAMSDIS units to the RMTCs in Costa Rica and Barbados before the end of 1996.
3. Since the inception of the project, many sets of retrospective digital satellite imagery data have been provided to both RMTCs. These cover heavy rain events associated with Hurricanes Cesar and Mitch at different stages of development and other major tropical disturbances. Other case studies demonstrate cycles of convective development over land and water, strong wind events, fire detection and volcanic ash detection. The case studies have been used for training on the use of single and multi-channel imagery in detecting fire, fog, water and ice clouds; and on the use of applications such as cloud identification, image averaging and determination of cloud motion winds.
4. At the beginning of 1997, one of the systems in Costa Rica was programmed to receive near real-time GOES-8 digital imagery via Internet, using the NESDIS (National Environmental Satellite Data and Information Service) GOES-8 server. Night-time access was excellent, but daytime ingest of imagery was interrupted due to heavy Internet traffic.
5. A WMO-sponsored 2-week satellite meteorology training course was hosted by CMI (Caribbean Meteorological Institute) in Barbados, 5-16 October 1998. Computers were used for hands-on laboratories, which were designed to complement the lectures. A web-based format with RAMSDIS Java-loops was used for many of the lecture examples and lab exercises. At the end of the training, the students were given a CD containing the lecture material and the laboratory exercises used during the 2-week training.
6. With the ongoing demonstration project, there have been several internal meetings at the RMTTC in Costa Rica to respond to the establishment of the "Virtual Laboratory" and to discuss the new possibilities available for training and research. One recommendation for the "Virtual Laboratory" was that satellite imagery should be complemented with synoptic meteorological data: surface and upper air observations. Another strong recommendation was to facilitate access to satellite imagery by making it available through computers other than the ones with the RAMSDIS system. The Costa Rica Meteorological Service has a STAR IV system that received analyses and products from the Aviation Model. However, until 1998, the RMTTC could have no access to their data as their computer was not connected to the Internet. An agreement signed between the University of Costa Rica and Unidata at the beginning of 1999 has opened new possibilities for data access through the Internet to be explored by the RMTTC in the year 2000. A homepage similar to CIRA's RAMSDIS-on-line with imagery and loops over Costa Rica, Central America, the Caribbean and South America and with imagery over Barbados, was developed and set on a server at the University of Costa Rica with imagery from

different channels in loops including data from the past three days.

7. The data for archiving, case studies and satellite climatology combined with the ingest capabilities in Costa Rica and Barbados have demonstrated the value of digital satellite data and the success of international efforts between the USA and the RMTCs in developing joint research projects. The next step in this endeavour would be to continue to move the concept of the "Virtual Laboratory" forward. One priority was to continue interaction with Costa Rica and Barbados in achieving the direct reception of GOES imagery. The Costa Rica RMTc will continue with its efforts to improve Internet connections within the University. Other efforts included the University of Wisconsin, with particular attention to SSEC (Space Science and Engineering Center of the University of Wisconsin) and CIMSS (Cooperative Institute for Meteorological Satellite Studies), as well as CIRA and the RMTCs, focused on the direct reception of imagery through a satellite dish, with PC-based GVAR (GOES Variable (Data format)) ingest software. When coupled with the expanded McIDAS (Man-computer Interactive Data Access System) proprietary software availability, these low cost systems, which received near real-time imagery, offer tremendous resources for research in regions that have few resources otherwise. The CIRA concepts for RAMSDIS and RAMSDIS Online were the model for this training. A project was underway for distributing imagery and image products throughout the Caribbean, Central and South America via the Internet and RAMSDIS Online. In the future, when digital data will be distributed, RAMSDIS will allow advanced applications to be used in analysing satellite imagery for weather forecasting. It was hoped that the "Virtual Laboratory" would evolve to allow training that would occur over the Internet utilizing the visual capabilities of RAMSDIS Online in conjunction with developing teleconference and computed aided learning capabilities. This would alleviate travel costs associated with training.

8. The second session discussed the development and status of EUMETSAT Satellite Application Facilities (SAFs) with regard to their relationship to the "Virtual Laboratory" concept. SAFs were specialized development and processing centres which were elements of a network within the EUMETSAT Applications Ground Segment. Each SAF was focusing on a given thematic area selected after an initial call for ideas in the light of user requirements. SAFs were being developed by a consortia of organizations from EUMETSAT Member States and were based on National Meteorological Services or other agreed entities, in order to benefit from existing expertise and facilities. SAFs were responsible for research, development and operational activities, around specialized themes, that were not carried out at EUMETSAT's Central Facilities in Darmstadt, Germany. SAFs complemented the production of standard meteorological products by these Central Facilities. The resulting products, intellectual property and technical data, including algorithms and software, would be the property of EUMETSAT and would be available to all EUMETSAT Member States as an integral part to the overall EUMETSAT service.

9. The meeting noted several important conclusions with regard to SAFs. First of all, such cooperation focused a critical mass on a given topic to progress in the development of applications, in a time-frame consistent with the development of the spacecraft and its core ground segment. It efficiently used a critical resource: the development expertise. Otherwise it would not have been possible to be ready by the time of the in-orbit commissioning of the new satellites. The establishment of a consortia for the SAF development phase, under the umbrella of EUMETSAT, clearly fostered cooperation among the SAF partners, and beyond, due to the visiting scientist scheme. The development was closely monitored, along the usual project management practices, with formal reviews held at every important milestone. Since developments were undertaken by operational users, the initial iterative process to define the User Requirements was greatly enhanced and converged quickly on a list of useful and achievable products. Experience also suggested that the users involved in the development were engaged and would be eager to quickly put such products into operation. The common operational basis resulting from the SAF had a further integrating effect in that it facilitated cooperation on downstream applications beyond the SAF itself. As a conclusion, it was noted that whilst aiming at the same quality standards as the central ground segment facility, the SAF were expected to benefit from a more direct user feedback and permanent contact with user expertise, at least for those SAF which were expected to be operated in a decentralized way.

10. The second session then discussed the concept of a WMO Virtual Laboratory for Training in Satellite Meteorology. The session agreed that such a virtual laboratory should be **a global network of specialized meteorological satellite training institutions** that would utilize modern technology to provide a range of training opportunities and materials to WMO Members. The virtual laboratory framework should build upon and enhance the WMO Education and Training Strategy with regard to satellite data utilization¹. The enhancement to training would be accomplished through this global network which would use modern technologies to provide access to high quality, up-to-date training for users world-wide in the use of satellite data and products.

11. The session agreed that the accumulated expertise in satellite meteorology training and modern information technology as well as established links to the science community would make it possible to implement the virtual laboratory in a cost-effective manner. The current under-utilization of satellite data coupled with the anticipated dramatic increase in satellite capabilities and the large number of people requiring training would make implementation of the virtual laboratory imperative.

12. The Virtual Laboratory for Training in Satellite Meteorology would be composed of specialized meteorological satellite training institutions and their sponsoring satellite agencies. This would initially be comprised of the training centres located in Costa Rica, Barbados, Nanjing, Nairobi, Niamey, and Melbourne and the satellite operators NESDIS, EUMETSAT, JMA and CMA (China Meteorological Administration).

13. The session established and endorsed the background, objectives, current status and guidance for a WMO Virtual Laboratory for Training in Satellite Meteorology as contained in the Appendix.

14. In view of the extensive development of the Virtual Laboratory (VL) concept that occurred at its second session, the third session of the CBS OPAG IOS Expert Team reviewed the latest status. The session agreed that the VL will strengthen training in satellite system utilization through:

- continued sponsorship of the initial six "centres of excellence" by the satellite operators;
- expansion of the training component by linking the "centres of excellence";
- user involvement;
- relevant science groups participation in a systematic manner;
- use of Internet for advancement of continuing education and training; and
- extensive use of proven and emerging instructional technologies.

15. The third session also noted the possible need for two streams of learning skills (basic and specialist) and a virtual resource library within the VL. A diagram of the VL for Satellite Meteorology as described below can be found at the end of the Appendix.

16. A VL for Basic Skills would cover the core subject material needed by personnel who would be expected to use meteorological satellite data and products as part of their normal daily activities as stated in WMO Publication No. 258. However, these forecasters would not be specialists in the field of satellite meteorology.

17. A VL for Specialist Skills would focus on personnel whose main tasks included the development, testing, implementation and maintenance of new satellite techniques, data and products. Many NHMSs would only have a small number of specialists working in this area. A VL for Specialized Skills would focus on those already in or moving into a specialist meteorological satellite role.

18. The virtual resource library links materials and information available through the "centres of

¹ "to systematically improve the use of satellite data for meteorological and hydrological applications over the next 10 years in all Member countries, with a focus on meeting the needs of the developing countries".

excellence", the satellite operators and the science working groups. The virtual resource library would provide background theory, examples of use, libraries of code, possible implementation details and a mechanism for interactions with the scientific working groups and satellite operators.

19. The session noted the importance of the coordination and the need to oversee the VL and suggested the chairman of OPAG request that CGMS, in partnership with WMO, form an "International Satellite Data Utilization and Training Working Group" (See WMO WP-20). A major function of the working group would be to help foster the VL to realize the challenges set forth by the WMO Executive Council Panel on Education and Training.

Co-sponsorship of the RMTC Nanjing in RA II and V

20. The second session of the CBS OPAG IOS Expert Team also discussed the People's Republic of China offer, made at the Thirteenth WMO Congress, that the Nanjing Institute of Meteorology (NIM) serve as a Regional Meteorological Training Centre (RMTC) in satellite meteorology. The session reviewed the capabilities at the NIM, international training courses provided by the Nanjing RMTC, existing and future facilities in the Nanjing RMTC and the plan for satellite meteorology training in the coming years.

21. The session noted that NIM was founded in 1960 and was a key university at the national level affiliated directly under China Meteorological Administration consisting of eight departments: Atmospheric Science, Environmental Science, Computer Technology and Information Engineering, Mathematics, Foreign Language and Social Science. Specialities in the atmospheric science department include synoptic and dynamical meteorology, climatology, agricultural meteorology, atmospheric physics and radar meteorology.

22. At present NIM had more than 5000 students, more than 100 professors and associate professors. Bachelor, Master and PhD degrees were being provided by NIM. Graduates from NIM working all over China in various meteorological facilities had become a major component among professional members in Chinese meteorology in both operation and research. In 1992, CMA submitted an application to the WMO to establish a regional training centre in the campus of NIM. Through the ratification of this proposal by WMO in 1993, a WMO RMTC was established aiming at the training of Class I personnel in meteorology for developing countries. The session noted NIM's intention to hold a satellite meteorology training event in 2000/2001. Finally, the meeting was informed that the RMTC in Nanjing was equipped with both polar-orbiting and geostationary satellite data receiving systems. High-resolution digital data from FY-2, GMS-5 and NOAA (National Oceanic and Atmospheric Administration) polar-orbiting was received on a regular basis. NIM also received NWP grid point value fields, surface and upper-air observational data as well as weather charts through a satellite broadcasting system from CMA's NMC. All the data could be displayed on PCs that were connected to a high speed Ethernet and thus allowed students to perform analysis exercises as part of their training syllabus.

23. The session was unanimously of the opinion that the RMTC in Nanjing would serve as an excellent specialized centre of excellence in satellite meteorology. The available facilities and expertise coupled with the strong support by CMA would ensure that NIM would be a valuable addition to the existing specialized centres of excellence in Barbados, Costa Rica, Niamey and Nairobi.

24. The session recalled that the Japan Meteorological Agency (JMA), the Australian Bureau of Meteorology (BoM) and WMO had cosponsored the Asia Pacific Satellite Applications Training Seminar (APSATS) in November 1996 in Melbourne, Australia. At the Thirteenth WMO Congress in May 1999, JMA had also indicated a willingness to continue to support similar training seminars and actively participate in the seminar by sending lecturers as well as providing training materials. The meeting noted that APSATS had been considered a major success as a training event in that it was one of the first WMO training events to utilize the latest training technologies and methods. All training materials for APSATS had been mastered onto CD ROMs and provided to the participants in order to allow their further use. The session was pleased to note the tentative plans of the Bureau of

Meteorology to hold a second APSATS in 2001.

25. In recognizing the extent of the RA II and RA V areas, the diversity of meteorology spanning tropical to polar regimes and the large number of WMO Members, the meeting was of the firm opinion that the three centres of excellence for satellite meteorology (the RMTC Nanjing cosponsored by CMA, JMA training events in Tokyo cosponsored with WMO and APSATS at the BMTC (Bureau of Meteorology Training Centre) supported by JMA and cosponsored by WMO) would provide a well-balanced approach to meeting the training needs of WMO Members well into the 21st Century.

26. In recognizing that with the three centres of excellence for satellite meteorology in RA II and RA V, all WMO Regions were now served through close cooperation between the satellite operators and the RMTCs. Thus, the full implementation of the WMO Strategy for Education and Training in Satellite Matters had been achieved. The session suggested that the WMO Education and Training Programme review this milestone especially in light of its wider application across all WMO training needs. Finally, the session stressed the need to strengthen further the centres of excellence for satellite meteorology through exchange of teaching expertise at the various training events and through the establishment of networks allowing direct connections between the centres for exchange of information, training modules and materials as appropriate.

Virtual Laboratory for Training in Satellite Meteorology

CBS OPAG IOS

Expert Team Meeting on Satellite Systems Utilization and Products

Melbourne Australia

25 to 29 October 1999

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1. Introduction

The Virtual Laboratory for Training in Satellite Meteorology is ***a global network of specialized meteorological satellite training institutions*** that utilize modern technology to provide a range of training opportunities and materials to WMO Members. The virtual laboratory framework builds upon and enhances the WMO Education and Training Strategy with regard to satellite data utilization². The enhancement to training is accomplished through this global network which uses modern technologies to provide access to high quality, up to date, training for users world-wide in the use of satellite data and products.

The accumulated expertise in satellite meteorology training and modern information technology as well as established links to the science community make it possible to implement the virtual laboratory in a cost effective manner. The current under-utilization of satellite data coupled with the anticipated dramatic increase in satellite capabilities and the large number of people requiring training make implementation of the virtual laboratory imperative.

The Virtual Laboratory for Training in Satellite Meteorology will be composed of specialized meteorological satellite training institutions and their sponsoring satellite agencies. This will initially comprise the training centres located in Costa Rica, Barbados, Nanjing, Nairobi, Niamey, and Melbourne and the satellite operators NESDIS, EUMETSAT, JMA, CMA.

2. Background

The Commission for Basic Systems, at its Extraordinary Session in Karlsruhe, Germany in 1998 strongly endorsed a new Strategy to Improve Satellite System Utilization. The approved Strategy complemented and reinforced the WMO Strategy for Education and Training in Satellite Matters that had already been approved by the WMO Executive Council. There were three action topics for Education and Training from the CBS Extraordinary Session:

- Favour the implementation of specific satellite E&T programmes in RMTC's and organization of other relevant WMO training activities;
- Expand the US-based virtual lab model that is currently being implemented in RAs III & IV;
- Focus on better use of polar-orbiting data and products.

In addition to the three basic requirements the Expert Team meeting in Locarno recommended the following:

- Incorporate the focus of the use of polar orbiting data and products into generally better use of all multi spectral meteorological satellite data and products;
- Continue making the best use of computing, communication and educational advances to provide appropriate training to all WMO members whilst recognizing their differing abilities to rapidly incorporate such advances into their infrastructure;
- Train people in how to effectively use satellite data in a real time environment;
- Maximize the use of available training resources (thus leading to a better cost benefit ratio for the training dollar) by using modern communications to deliver more training to more people in their workplace. The ongoing digital exchanges between participants and trainers about real time events is what makes the Virtual Laboratory for Training in Satellite Meteorology very different to the current training methodology and promises to have a large positive impact on the success of this strategy.

² "to systematically improve the use of satellite data for meteorological and hydrological applications over the next 10 years in all Member countries, with a focus on meeting the needs of the developing countries".

3. Objectives

It will be recalled that the primary requirement of the virtual laboratory in satellite meteorology is to improve satellite system utilization; this will be realised by reaching the objectives stated below. Key outcomes of the virtual laboratory are to link, provide and ensure that WMO Members have access to satellite training to maximize the utilization of satellite data. The perspectives below are not mutually exclusive.

WMO perspective

- To reach as many people cost effectively as possible with relevant and up to date material;
- To provide real time and relevant examples / descriptions of the use of satellite data and products for problems faced by operational forecasters;
- To encourage the use of common nomenclature and methodologies for using and interpreting satellite data;
- To share the development of resources across a range of developers rather than each centre repeating development already undertaken at another centre. Some customizing and local adaptation will still be required but the effort will be significantly less than repeating the whole syllabus;
- To minimise the knowledge gap between developed and developing countries whilst generally improving the world wide use of satellite data;
- To provide high quality and up to date training on current meteorological systems, data, products and applications to all operational staff;
- To build links between science groups and users;
- To build online real time links between forecasters and trainers;
- To provide periodic online links between forecasters, trainers and scientists through organized training / discussion forums on topics such as the interpretation and use of new data streams as new satellites go operational;
- To ensure diversity in the types and styles of training materials and sessions to meet the diverse cultures, languages and learning styles of the meteorological community;
- To enable RMTCs to facilitate and foster research at a local level by the NMHS through provision of long term data series, appropriate tools and expertise.

Training Providers perspective

- To encourage a scientifically based use of satellite data by forecasters;
- To keep the trainers up to date between formal training programs and to complement formal training programs for trainers and other staff;
- To develop a network of mentors for trainers and forecasters;
- To provide a range of training opportunities and material to best meet the needs and learning styles of individual forecasters and the limited training budgets of NMHS and WMO;
- To improve the quality and quantity of up to date satellite training material available to all forecasters;
- To ensure the guidelines of satellite based curricula in WMO Publication No. 258 are met;
- To provide a structure that allows self-development of NMHS personnel in their use of satellite data and products;
- To promote the exchange of teaching staff between training institutions as a means of fostering the sharing of resources, material and experience between centres;
- To provide a variety of entry points into the Virtual Laboratory for Training in Satellite Meteorology that cater to different user knowledge levels;
- To allow easy adaptation of training material from one location to another while acknowledging the original source and copyright of the material;
- To allow students to access training material in a variety of ways.
- Traditional classroom training
- Online access to information and experts

- Offline, onsite training such as Computer Aided Learning

User perspective

- To have access to up to date training on operational and expected satellite systems, applications, products and data;
- To be responsive to local user needs;
- To be flexible to the students level of expertise ;
- To be fast, reliable and easy to use;
- To allow for interaction with other students and/or trainers and experts;
- To alert users about new or revised material;
- To assist the user in solving problems encountered in their day to day forecasting.

4. Status

4.1 Current training systems and methodologies

There are currently a wide range of training systems and methodologies. The Virtual Laboratory for Training in Satellite Meteorology is aimed at building upon the successes of the current distant learning methodologies of online, stand-alone computer aided learning and hardcopy material. It is also aimed at complementing and extending the value of face to face training events that utilize computers by allowing access to a wider range of material and experts.

Current resources being used in the field of meteorological satellite training include:

- excellent literature
- training workshops at specialized centres in conjunction with WMO
- real-time imagery and products with tutorial information on the Internet
- Computer Aided Learning modules
- CD-ROMS with tutorials, data and case studies
- Web based tutorials

4.2 Outcomes of current approach

The WMO training strategy focusing on "train the trainer" has led to an increase in the number of people trained by recognized satellite training institutions. Whilst the "train the trainer" approach led to an improvement in satellite data utilization, the anticipated dramatic increase in satellite capabilities and the large number of people requiring training cannot be cost effectively accommodated solely by the current approach. Furthermore, the response to the recent questionnaire on the Utilization of Satellite Data indicates the need for expanded effort to train operational forecasters.

RMTCs, NMHSs and the university community are using improved personal computer capabilities, CD-ROMs and the Internet to gain access to material from other institutions, and to provide access by students from remote locations. Improved computing hardware and software are enabling educators and scientists in developed and developing countries to jointly contribute to the training material available on the Internet. In response to this evolving environment the virtual laboratory for satellite meteorology has become a viable cost-effective concept.

The Virtual Laboratory for Training in Satellite Meteorology will meet the requirements laid down by CBS (Section 2 this paper) and the Expert Team through:

- Enhancing the ability of the forecasters of the NMHS to utilize satellite data;
- Providing a mechanism for sharing data, training materials and experience between training institutions;
- Building upon the pre-existing material and expertise already available;

- Allowing the adaptation of training material but acknowledge the originator and their copyright;
- Providing a basis for an agreed syllabus and definition of competencies in satellite meteorology;
- Encouraging the production of material that can be readily adapted for use in both hemispheres and from the tropics to the poles;
- Providing a mechanism to keep trainers up to date;
- Minimizing the current duplication of effort in producing training material;
- Encouraging real time interaction between forecasters in different offices and trainers on real-time weather events;
- Providing a mechanism to measure the number of people being trained.

5. What will guide the development of the Virtual Laboratory for Training in Satellite Meteorology for satellite meteorological training?

The virtual laboratory for satellite meteorology is developing in a dynamic environment. Among the factors that will influence development are:

- 5.1 Technology and educational trends
- 5.2 Involvement of the scientific community
- 5.3 Commonality of teaching tools
- 5.4 Determination of curricula and competencies
- 5.5 Foundation (Basic theory) courses - (supervised) off-line learning
- 5.6 Near Real-Time training - on-line learning
- 5.7 Rolling evaluation of training material and courses
- 5.8 Data formats and systems

6. The next step

- Create an implementation and coordination team to address the development of the Virtual Laboratory for Training in Satellite Meteorology.

LIST OF ACRONYMS

APSATS	Asia-Pacific Satellite Applications Training Seminar
APT	Automatic Picture Transmission
AWG	Advisory Working Group (of the CBS)
BoM	Bureau of Meteorology (Australia)
BMTC	Bureau of Meteorology Training Centre (Australia)
CBS	Commission for Basic Systems
CGMS	Coordination Group for Meteorological Satellites
CIMSS	Cooperative Institute for Meteorological Satellite Studies
CIRA	Cooperative Institute for Research in the Atmosphere
CMA	China Meteorological Administration
CMI	Caribbean Meteorological Institute
CMS	Centre de Météorologie Spatiale
CAL	Computer Aided Learning
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GPCP	Global Precipitation Climatology Project
GVAR	GOES Variable (Data format)
HRIT	High Rate Information Transmission
HRPT	High Resolution Picture Transmission
IAMAP	International Association of Meteorology and Atmospheric Physics
IRC	International Radiation Commission
ITSC(s)	International TOVS Study Conference(s)
ITWG	International TOVS Working Group
IWW	International Wind Workshop
JMA	Japan Meteorological Agency
LRIT	Low Rate Information Transmission
McIDAS	Man-computer Interactive Data Access System
MSC	Meteorological Satellite Center (Japan)
MTSAT	Multi-purpose Transport Satellite (Japan)
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite Data and Information Service (of NOAA)
NMHS(s)	National Meteorological and Hydrological Service(s)
NMS(s)	National Meteorological Service(s)
NIM	Nanjing Institute of Meteorology
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
OPAG IOS	Open Programme Area Group on Integrated Observing Systems
OPAG ISS	Open Programme Area Group on Information Systems and Services
RA(s)	Regional Association(s)
RAMSDIS	Regional and Mesoscale Satellite Display and Information System
RMTC(s)	Regional Meteorological Training Centre(s)
SAF	Satellite Application Facility
SSEC	Space Science and Engineering Center (University of Wisconsin)
TOVS	TIROS Operational Vertical Sounder
WCRP	World Climate Research Programme
WEFAX	Weather Facsimile
WMO	World Meteorological Organization

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