P5.30 VIRTUAL LABORATORY FOR TRAINING IN SATELLITE METEOROLOGY

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1.0 ABSTRACT

The Co-ordination Group for Meteorological Satellites (CGMS) and the World Meteorological Organization (WMO) have established the Virtual Laboratory (VL) for Training in Satellite Meteorology. The primary goal of the VL is to promote effective use of satellite meteorology in forecast offices throughout the WMO member countries. The WMO noted the importance of the coordination and overseeing needed for the VL and approved the formation of an International Satellite Data Utilization and Training Focus Group. A major function of the focus group is to help foster the VL to support the WMO Strategy for Education and Training in Satellite Matters and realize the challenges set forth by the WMO Executive Council Panel on Education and Training.

The implementation plan for the VL calls for the following items to be addressed: 1) the resource library: its role, how it is structured, how training materials are "peer reviewed"; 2) the VISITview teletraining program: how it works, numbers of forecasters trained in USA, how it fits into the Virtual Laboratory construct; 3) expectations for the WMO Regional Meteorological Training Centers (RMTCs) that are participating in the Virtual Laboratory especially in the area of how to help focus their training, and as an input to WMO; 4) coordination of WMO satellite training activities leading to a schedule of "classes" for each year; 5) Virtual Laboratory participant roles and responsibilities; 6) archiving of training class presentations as a future training resource; 7) development of a web based training resource available for all WMO countries; and 8) how the VL should be managed.

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Several major steps were taken in 2000, 2001 and 2002 in establishing the VL. The main VL web sites are now in place and ready for use by the WMO RMTCs (see http://www.wmo.ch/hinsman/vl.htm). A regional training seminar on the "Use of Environmental Satellite Data in Meteorological Applications" was held in Nanjing, China, December 2000. The Asian Pacific Satellite Applications Training Seminar (APSATS) held in Melbourne Australia in May 2002 was conducted successfully using the VL approach. During APSATS, the VISITview software was used to conduct two presentations plus a live satellite weather briefing between the U.S. and the participants in Melbourne.

2.0 BACKGROUND

Operational meteorological satellites provide essential data for meteorological, climate, oceanographic and hydrological services to World Meteorological Organization (WMO) Members across the globe. New instruments on research satellites are providing insights into future satellite systems, such that the number and variety of new environmental applications are growing vigorously. We should expect great strides forward during the next decade with planned improvements to the space based component of the global observing system, and we must strive for full exploitation of that component. To accommodate the rapid-paced development cycle that informed users will demand, updated and improved methods must be developed for preparing products for distribution to an increasingly sophisticated and diverse user community. Maximum utilization of satellite data for environmental applications requires a strong training component at all points in the product preparation, distribution and user chain. Meeting the demands of this challenge is becoming possible because of the combined efforts of

the WMO and the world's producers of operational meteorological and R&D satellite data. This combined effort is taking shape through the Coordination Group for Meteorological Satellites (CGMS) with the formation of the Virtual Laboratory for Satellite Meteorology.

The Virtual Laboratory for Satellite Meteorology (VL) is a collaborative effort joining the major operational satellite operators across the globe with WMO "centers of excellence" in satellite meteorology. Those "centers of excellence" serve as the satellite-focused training resource for WMO Members across the globe. A schematic of the VL is shown in Figure 1a. The "centers of excellence" are five WMO Regional Meteorological Training Centers (RMTCs) and the Australian Bureau of Meteorology Training Centre (BMTC), while the four satellite operators are the USA (NESDIS), Europe (EUMETSAT), China (NSMC), and Japan (JMA). The various centers of excellence are sponsored by one of the major satellite operators (see the circles touching the boxes in figure 1a).

The Virtual Laboratory for Satellite Meteorology benefits greatly from work done by CIRA, the Cooperative Institute for Research in the Atmosphere, at Colorado State University, in the early to mid 1990's.

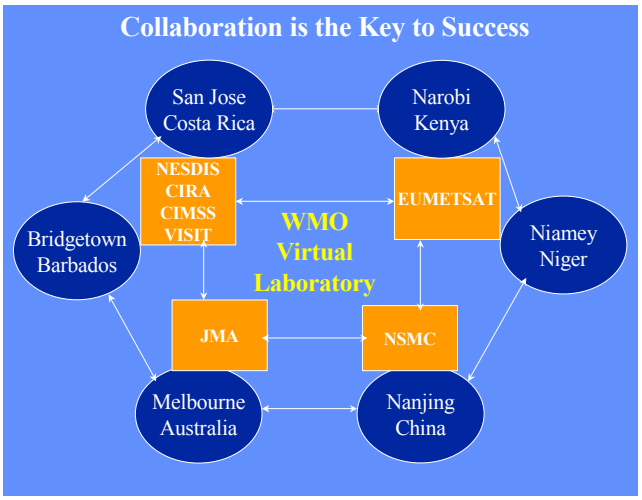

Figure 1a. Schematic illustration of Virtual Laboratory for Satellite Meteorology.

Initially the CIRA program aimed to provide online case study data for training US National Weather Service (NWS) offices staff to fully utilize GOES data, CIRA soon expanded to providing case study and near real time data to the WMO RMTCs in Barbados and Costa Rica. As with the NWS training effort, RAMSDIS software and data were provided to those RMTCs. Using common software and hardware allows work done on algorithm research at CIRA and other institutes to be used by RMTC and National Meteorological Service (NMS) staff in Barbados and Costa Rica on real-time satellite data and imagery. This cooperative arrangement has benefited the two countries and the researchers through new products, real time ground truth and increased use of existing satellite resources. For detailed discussion of the use of the RAMSDIS system and RAMSDIS Online see the report of the *Expert Team Meeting on Satellite Systems Utilization and Products, Second Session, Melbourne,* October 1999 available at http://www.wmo.ch/hinsman/Publications.html. Thus, a great deal of the functionality of what is proposed for the Virtual Laboratory for Satellite Meteorology (training in basic and advanced topics, access to software, research and access to expertise) builds upon the work done by CIRA.

Recognizing the importance for a coordinated, world-wide approach to improving satellite data utilization, the WMO's Commission on Basic Systems (CBS) Open Programme Area Group on Integrated Observing Systems (OPAG IOS) Expert Team (ET) on Satellite Systems Utilization and Products has discussed the Virtual Laboratory concept at each of its first three meetings. Initial discussions began in Locarno (Switzerland) in June 1999. The next meeting of the group, held in Melbourne, noted that satellite training institutions and their sponsoring satellite agencies must utilize modern technology to provide a range of training opportunities and materials to WMO Members. The meeting noted that a key ingredient of the Virtual Laboratory would be to build strong links with science groups. The July 2000 meeting of the ET, in Lannion (France), identified the need for two streams of learning skills (basic and specialist) and a virtual resource library within the VL. A schematic representation of the relationships between the various components of the Virtual Laboratory is shown in Figure 1b.

The concept of the VL was brought before CGMS in October 2000. CGMS and WMO agreed to establish a focus group on satellite data utilization and training within the Virtual Laboratory Framework and report back to CGMS and the WMO OPAG IOS on its findings. The meeting of the focus group occurred during mid-May, 2001, and defined the various roles and responsibilities of participants, as well as the relationships between various components of the VL, as shown in Figure 1b. A major function of the focus group is to help foster the VL to support of the WMO Strategy for Education and Training in Satellite Matters and realize the challenges set forth by the WMO Executive Council Panel on Education and Training and in support of the WMO Strategy for Education and Training in Satellite Matters.

2.0 INTRODUCTION TO VIRUAL LABORATORY

The first session of the CGMS/WMO Virtual Laboratory Focus Group to discuss coordination and oversight requirements for the Virtual Laboratory (VL) for Education and Training in Satellite Matters was held at the EUMETSAT Headquarters at Darmstadt, Germany, 16-18 May 2001. This first meeting of the focus group led to several important and far-reaching accomplishments. The focus group agreed upon: 1) a Management structure; 2) Immediate and Strategic Goals; 3) Goals relating to implementation which included Connectivity,

a Virtual Resource Library (VRL), and Utilization and evaluation of the VL; and, 4) specific action items and time tables for 0 to 1 year, and 2 to 5 years.

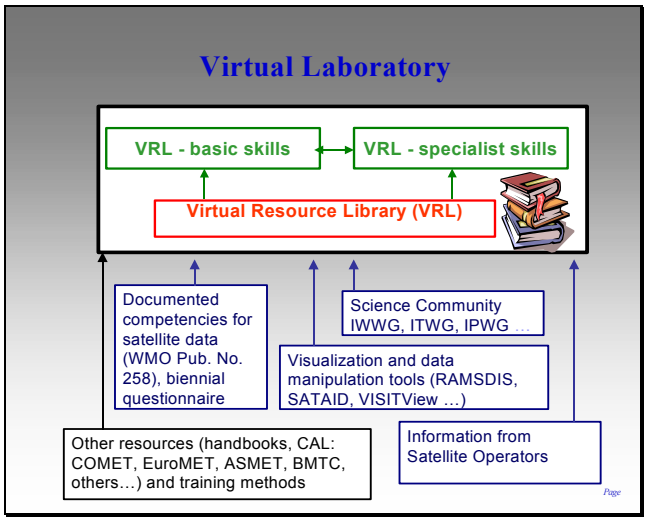

Figure 1b. Schematic of the Virtual Laboratory

2.1 Immediate and Strategic Goals

The immediate goal set by the focus group was to implement a baseline VL and to foster its logical growth. Challenges that are being met in implementing this immediate goal are set forth in the section below that addresses year one actions. Strategically, the focus group emphasized the need to provide high quality and up-to-date training resources on current and future meteorological and other environmental satellite systems, data, products and applications to improve utilization among Members; and, to enable the "centers of excellence" to facilitate and foster research and the development of socio-economic applications at the local level by the NMS through the provision of effective training and links to relevant science groups. A component of immense strategic importance to the VL is the virtual resource library, addressed in a separate section below. The virtual resource library supports all three cornerstones of the WMO strategy to improve satellite system utilization: 1) providing access to training and educational material; 2) providing software and expertise on how to the utilize data; and, 3) providing case study and near real time data. Baseline activity toward the establishment of the virtual resource library included web servers by EUMETSAT at their Darmstadt facility as an initial site for training resources and materials (September 2001) and by NESDIS at CIRA for an initial set of near real time data and products (November 2001). To facilitate this, each member of the focus group prepared an inventory of training resources and materials that are presently available for the core virtual resource library. Each satellite operator identified what data and products could be linked into the core virtual resource library. In the initial implementation, the servers will be at only selected locations, the final goal is to have servers located at all nodes.

2.2 GOALS FOR IMPLEMENTATION

2.2.1 Connectivity

The component centers of the virtual laboratory must be able to communicate with one another from their home facility. In addition, each component must have access to resources available within the virtual laboratory. To address those issues, a near term goal is to establish Internet links at the six "centers of excellence" and supporting satellite operators. The main purpose of those links is to support communications (email, voice) as well as the exchange of software and selected image data sets. Those selected image data sets include both case studies and some near real-time data sets. Data is of fundamental importance to the centers of excellence, and a preferred method for receipt of data, in the short-term, is the direct ingest of data from a ground receiving station at each site for insertion into their Virtual Laboratory servers. To enhance the exchange of training materials, including real-time lectures and classroom participation between nodes of the VL, the “centers of excellence" will consider means to increase communications capacity within 5 years.

2.2.2 Virtual Resource Library (VRL)

A strategic goal is to have servers located at all nodes of the VL. Those servers are at the heart of the Virtual Resource Library (VRL). The VRL will have two components: a core of baseline information to be exchanged (mirrored as appropriate) to all "centers of excellence", and a repository of data and specialized information for local use. Local use distribution will be the responsibility of the data provider, and could range from complete distribution to all "centers of excellence," to restricted distribution to only the local "center of excellence." Included within the baseline information at the VRL (refer to figure 1b) are a suite of standard software packages and applications for use with those software packages. Used in combination with the case study data, they provide capabilities for adapting algorithms and software to those data in a variety of standard formats. The data are linked to training sessions, and can be used independently for activities such as application development and testing. Visualization and data manipulation tools such as RAMSDIS, SATAID, VISITview, and RAMSDIS On-line are important components of the VRL core, as are learning resources and guides. A number of important issues have been addressed by the focus group: 1) establishing a list of usable training resources (includes image data sets, s/w, tools); 2) implementing a structure for the depository of training resources to allow easy access by the "centers of excellence" trainers; and, 3) populating this structure with a core set of material from

the training resources list. To assure scientific integrity, the VL is developing strong links to specialized science groups such as the International TOVS working group (ITWG), the International Precipitation Working Group, the International Wind Workshops (IWW), and the International Precipitation Working Group (IPWG)..

Remote training will become an important part of the VL in the years to come. The VISITview program, in which an instructor in a remote location utilizes modern computer and communications technology to train forecasters at different locations, is an important resource within the core VRL. VISITview (http://www.ssec.wisc.edu/visitview/) is a platform-independent distance learning and collaboration software program. It allows multiple users located in different offices across a wide geographic region to simultaneously view and interact with the same series of images containing graphics and text. VISITview provides a large number of features, including annotation, color enhancements, zooming, animations, multi-panel displays, image fading, quiz questions, etc. To avoid problems with limited Internet bandwidth, the offices acquire files used for the real-time presentations in advance. The files for each training session contain all the information needed for the training. This allows each training office the opportunity to use the session to conduct on-station training. Standard voice phones are used during the session. However, for those remote offices with limited phone access, Internet voice software (such as YAHOO Messenger) can be used.

2.2.3 Utilization: User Requirements and VL assessment

Addressing user needs, and assuring that those needs are being met were important items of discussion by the focus group. To assess how well user requirements were being met, the focus group noted the important linkage between the suggested minimum competencies for utilizing satellite data and products outlined in WMO Publication 258 and the information contained in the biennial satellite data utilization questionnaire. The analysis of user responses focused on education and training, taken from the biennial questionnaire, will be carried out by the relevant "center of excellence." From their analyses, results would be reported to the VL focus group. This analysis and reporting serves a number of important purposes, such as identifying areas of common training needs and areas where development activities are required to address unmet user requirements. Establishment of a VL user tracking and feedback mechanism also was recognized as an important activity as it will assist the users and provide quantitative information to the focus group on use of the VL. Another matter discussed with respect to training was the use of real-time data. For a number of applications (such as nowcasting), training meteorological students to an operational level of expertise using near real-time data and products is a strong requirement and motivator. Near real-time data are needed to train forecasters on the effective use of new satellite reception and processing systems. This need will be one of the items addressed during the VL's evolution over the next five years.

2.2.4 Activities Conducted As VL Develops

The focus group discussed a number of generic activities that would be undertaken as the VL takes shape, as well as specific actions that must be undertaken during the next five years. The generic activities are given immediately below. These are followed by specific actions for the next five years.

- Consolidate documentation of the range of skills/competencies for operational meteorologists and specialists;
- Examine which Web-based learning, computer aided learning, CDs and hard copy learning materials are currently available for use in the virtual laboratory;
- Negotiate with copyright holders of training material rights to either link to their material and/or to acquire the rights to use their material at the designated centers of satellite training expertise;
- Work with expert training groups to design and test possible user interfaces, educational approaches for delivering the material, and examine methods for online tracking of student participation;
- Evaluate, on a trial basis, the proposed virtual laboratory material in conjunction with one of the WMO satellite training workshops for more user feedback;
- Incorporate user feedback into the educational approach and review the content of the virtual laboratory;
- Move to a wider implementation of the material;
- Undertake a periodic review of the virtual laboratory sites in conjunction with reviews of the skills and competencies of the operational meteorologists and specialists;
- Prepare sample data sets for the various data streams now being provided or planned for in the near future. The data sets would be used within the VL concept;
- Provide for continuous monitoring of user requirements for education and training as well as the effectiveness of the virtual laboratory.

The implementation schedule for the VL with corresponding action items is as follows:

First year (2001):

- During the next 6 months, all "centers of excellence" to evaluate content, and how and what can be maintained on a server at the "center";
- Train satellite operators and "centers of excellence" on the use of RAMSDIS using VISITview;
- Increase training event effectiveness through the use of VISITview;
- Add the SATAID training resource to the VRL and utilize VISITview.
- **All these actions are complete!**

Second year and beyond (2002-2005):

- Within 1½ years, all satellite operators to strive to have a server online and connected to the VL;
- Each "center of excellence" will strive to have a server online and connected to the VL;
- To establish a voice channel capability within VISITview;
- To evaluate and to improve the VRL;
- To evaluate the quality of submitted materials by the "centers of excellence", completeness , appropriate deletion dates, compatibility issues, and virus protection.
- After 5 years, conduct comprehensive review.

3.0 Activities Conducted via the VL

Since the initial meeting of the WMO VL Focus Group, we can report on two very successful training activities. A regional training seminar on the "Use of Environmental Satellite Data in Meteorological Applications" was held at the RMTC in Nanjing, China, December 2000. The following was accomplished at the workshop:

- People's Republic of China (NSMC) cosponsoring the RMTC in Nanjing
- First training event held in Nanjing as "specialized Centre of Excellence"
- Focus was on "Train the trainers"
- First event held within the concept of the Virtual Laboratory for Education and Training in Satellite Meteorology
- Internet utilized to obtain near-real-time satellite data and lessons on Internet covering such topics as html development and web pages
- Internet access in the RMTC was an Internet back-bone providing up to 100 Mbytes per second access to other web sites
- Network of over twenty computers with on-line Internet capabilities to allow each participant to view the presentations
- Linking of the "six centres of excellence" into a network enabled the real-time testing of new technology
- NOAA/NESDIS demonstrated the VISITview software whereby training could occur simultaneously between a student in Nanjing and professors in Melbourne, Australia, Colorado and the University of Wisconsin
- VISITview tool available for free download at http://www.ssec.wisc.edu/visitview
- During VISITview session - nine connections all making comments and contributing to a student/professor dialogue

Figure 2. Students from the Nanjing, China WMO Workshop held in December 2002.

The Asian Pacific Satellite Applications Training Seminar (APSATS) held at the RMTC in Melbourne in May 2002 was conducted successfully using the VL approach. During the APSATS, the following accomplishments were attained:

- Important to APSATS 2002 - WMO EC decision to expand the space-based component of the GOS to include appropriate R&D satellite missions
- NASA and ESA both have made firm commitments for the participation of their satellite missions (i.e. Aqua, Terra, NPP, GPM, ENVISAT, etc.)
- ESA provided materials relevant to ENVISAT
- NASA provided a guest lecturer, Dr. William Ridgway, to demonstrate the capabilities of MODIS
- Dr Ray Zehr (NOAA/NESDS/CIRA) provided two 90 minute lectures using VISITview from the USA (and in the process claimed the record for the most students in a single VISITview training session)
- Dr Roger Weldon (NOAA/NESDIS) used VISITview to answer questions from the USA about his material that was delivered to the workshop by Dr Ian Bell (BMTC).
- VISITview was also used for a live global image discussion between staff at CIRA, COMET, University of Wisconsin and the APSATS 2002 course using imagery from all of the geostationary meteorological satellites

Figure 3. Participants at the APSATS 2002 workshop in Melbourne, Australia.

1) Entry point to the WMO virtual laboratory web page:
http://www.wmo.ch/hinsman/vl.htm

2) Entry point to the CIRA virtual laboratory web page:
http://www.cira.colostate.edu/ramm/wmovl/main.html

3) Information on RAMSDIS:
http://www.cira.colostate.edu/RAMM/trngtbl.htm

4) VISITview tool is available for free download at:
http://www.ssec.wisc.edu/visitview

5) Lectures and selected materials for APSATS 2002:
http://www.virtuallab.bom.gov.au/apsats2002/index.htm

4.0 SUMMARY

The Co-ordination Group for Meteorological Satellites (CGMS) and the World Meteorological Organization (WMO) have established the Virtual Laboratory (VL) for Training in Satellite Meteorology. The primary goal of the VL is to promote effective use of satellite meteorology in forecast offices throughout the WMO member countries. WMO and CGMS established a Focus Group to ensure that the VL was defined, managed, established and used to support the RMTC/BMTC workshops. The goals and the initial actions set by the Focus Group for the VL have been met. Two very successful workshops were conducted in the past two years: at Nanjing, China in December 2000 and the APSATS in Melbourne, Australia in May 2002. The two workshops clearly showed that the goals of the WMO VL can be met. Several milestones were achieved at these workshops, not the least of which was the connecting of instructors at various locations around the world with the participants at the workshops in real-time. Additional WMO workshops are planned in the future and they will continue to expand on the VL approach.

And due in part to all the activities associated with establishing the VL and conducting these workshops, it is important to note the WMO EC decision to expand the space-based component of the Global Observing System (GOS) to include appropriate R&D satellite missions.

4.0 ACKNOWLEDGEMENTS

We thank the members of the WMO Virtual Laboratory Focus Group for their assistance in preparing this article and the plans for the Virtual Laboratory for Satellite Meteorology.

5.0 Internet Reference Links