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

INTER-PROGRAMME EXPERT TEAM ON SATELLITE UTILIZATION AND PRODUCTS

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VLab STATUS AND PLANS

(Submitted by VLab co-chairs)

Summary and Purpose of Document

This document reports on activities within the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) along with future plans. Since IPET-SUP-4, VLab members have offered a variety of training opportunities, with highlight to training efforts addressing the new generation of satellites, as this proved to be the major training need identified by VLab members in recent years. Furthermore, important developments have taken place, including the change in VLab co-chairmanship, the Ninth Virtual Laboratory Management Group meeting (VLMG-9) in July 2018 in Fort Collins, USA, and the elaboration of the new Five-year Strategy document for VLab activities 2020-2024.

The focus of the new VLab strategy continues to be on training on the use of satellite data and products, with this period focusing particularly on fostering the use of satellites to support impact based forecasting and impact based decision support services.

ACTION PROPOSED

The fifth session is invited to note the important achievements of the VLab, to provide comments, to consider the actions and recommendations below.

In particular, the session is invited to review the new Five-year Strategy document proposed by VLab, provide comments and endorsement.

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Appendices:
A. Five-year Strategy for the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology - 2020-2024
B. VLab Members' Statements: challenges and successes in training of forecasters, particularly for: (a) marine, (b) aviation and (c) impact based decision support services

VLab STATUS AND PLANS

1   INTRODUCTION

This document reports on the activities and plans of the WMO-CGMS Virtual Laboratory (VLab). Since IPET-SUP-4 the VLab has:

- -   Updated and published the Guidelines on Satellite Skills and Knowledge for Operational Meteorologists. The updated document is available at https://www.wmo-sat.info/vlab/satellite-skills/ ;

- -   Responded to training needs and user requirements by offering training on the new generation of satellites;

- -   Collaborated with the Global Campus initiative, ensuring information about

The VLab Management Group (VLMG) has met six times in virtual meetings, and had its 9th face-to-face meeting in Fort Collins, USA, in July 2018. Also during VLMG-9, Kathy-Ann Caesar (CoE Barbados), whose long-term contribution to VLab is highly commended by all partners, communicated the need to leave her duties in the co-chairmanship of VLab. This resulted in the nomination of Marinés Campos (CoE Argentina), who was unanimously voted (VLMG meeting September 2018) to represent the VLab CoEs in the VLab co-chairmanship. Marinés Campos has since been working together with Mark Higgins (EUMETSAT), who represents the satellite operators in the VLab network.

Further details regarding the most recent activities of VLab and a short review of major training events and plans is given below.

2   MAJOR IMPACT OF ACTIVITIES OF THE VIRTUAL LABORATORY SINCE IPET-SUP-4

Based on the various regional training activities that were delivered by the VLab Centres of Excellence and satellite operators, the following are the major impact of VLab activities, as described by VLab members:

2.1 GOES region training
- ●   26 new training resources were developed by Meted and CIRA;
- ●   The VLab Americas and Caribbean Focus Group sessions had boosted participation and interaction among meteorologists and forecasters in WMO RA III and IV (bilingual sessions). These sessions have been providing informal learning while also promoting the new data types and products from GOES and JPSS satellites;
- ●   GOES-16 and GeonetCast Workshops were carried out in various countries;
- ●   Collaborations with CoEs Costa Rica and Brazil supported linkages in data access associated with the new satellites and in support of GEO via AmeriGEOSS;
- ●   CoE Brazil developed numerous resources on Goes-16 (videos, slides, and blogs) to support the various sectors using the imagery;

- CoE Argentina collaborated with COMET to produce "GOES-16 GLM Case Exercise: Buenos Aires Tornado and Hail Event", in the context of Relampago Project. Four short online courses were delivered in WMO RA III and IV, based on Conceptual Models developed in CM4SH project (about 80 participants each) using updated GOES-16 imagery. Current examples of 3 CM were presented at RFG for America and the Caribbean.

2.2 Himawari region training

- JMA launched the Himawari Request service in January 2018 to provide National Meteorological and Hydrological Services (NMHSs) in WMO RA II and RA V with Himawari-8/9 on-demand TA-observation earth images taken every 2.5 minutes over an area of approximately 1,000 x 1,000 km within the Himawari observation domain;
- VLab CoE Australia continued organising monthly RFG meetings during 2018, with an average of at least 28 attendees, principally from WMO RAV, RAII, RAIV. This marks the 5th year of organising monthly RFG meetings in the Region. Ongoing strong attendance by JMA, KMA, BMKG Indonesia, which frequently provide presenters for the sessions, and also increased attendance by the USA. Recorded sessions are available at http://www.virtuallab.bom.gov.au/archive/regional-focus-group-recordings/ ;
- VLab CoE Republic of Korea created a central library/repository for recorded RFG sessions and other online training events. Available at http://nmsc.kma.go.kr/html/homepage/en/ver2/component/categoryBoard/searchCategory.do?board_c_cd=001 ;
- AOMSUC-9 (6-11 October 2018, hosted by BMKG, Indonesia). A pre-conference Workshop was organised and had various contributors. VLab members offered 3 training sessions: JMA: "Practical training about RGB technique by using SATAID", CoE Australia: "*Satellite Training for Trainer on RGB techniques for Meteorological Applications*", and CoE Republic of Korea: "*Introduction of User Customized Imagery Processing Tool for Geo-KOMPSAT-2A Geostationary Satellite Data*".

2.3 FY-4 region training

- CoEs Beijing and Nanjing China have produced and shared abundant resources including disaster risk reduction and emergency management. They offered online and classroom International courses. Plans for 2019 include application of FY-4 in disaster risk reduction for WMO RA II and V;

2.4 Training in the Meteosat region

- CoE Oman with support from WMO / Eumetsat hosted the course " Satellite Application Course on Tropical Cyclone" at Muscat with 18 participants from Region 2.
- CoE South Africa is working on a new resource: "Asmet Comet module" to come out soon. The CoE offered an online workshop on EUMETSAT MSG satellite for 48 trainees from WMO RAI (Africa), followed by a face to face course for 16 participants from different African countries. An EUMETSAT Climate workshop event week took

place with 20 participants. The online Weather Briefings for RAI were followed by 25 forecasters.

- CoENiger, with very limited resources has carried out 7 classroom courses for 18 participants RAI (french). An EAMAC and Eumetsat blended Satellite Application course (ESAC) is planned for a near future.
- CoE Morocco offers online and classroom training on the "Application of Satellite Imagery" in Meteorology for RAI (french)
- In conjunction with WMO teams EUMETSAT has supported training on dust, land and agricultural applications in the region.

3   COLLABORATION:

3.1 Collaboration between Centres of Excellence and Satellite Operators

The launching of a new generation of satellites is setting a growing demand on training needs for members of all WMO Regional Associations. Close collaboration between satellite operators and VLab CoEs is driving the response to address these training needs as they are identified.

A good example of the effectiveness of these collaborations include the **Himawari Request service,** which started in 2018 as JMA's response to a request made by VLab CoE Australia. A recorded presentation on the "High Resolution Himawari-8 Target Area Observation case study of the recent Queensland fires" is available at http://www.virtuallab.bom.gov.au/archive/regional-focus-group-recordings/

The RFG of Americas and Caribbean, organised by NOAA/CIRA is another successful example. Collaborations with CoE Argentina allowed for introduction of the RFG sessions to participants in three of their courses as well as presentations from the courses to the RFG community. Collaborations with CoEs Costa Rica and Brazil supported linkages in data access associated with the new satellites and in support of GEO via AmeriGEOSS. This also supports our sponsoring agent (CGMS) and the WMO Satellite Data Requirements.

3.3   Global Campus Initiative

VLab maintains continuous collaboration with the Global Campus Initiative. In 2018, VLab contributed to the development of the WMOLearn section of WMO E-Library. The topic "Satellite Skills and Knowledge" already contains training resources developed by VLab Members, which were added during the pilot testing phase. Since VLMG-9 meeting, VLab Members agreed to submit new training resources to the Library, contributing to the growth of shareable training resources.

VLab also takes part in the technical task team for the development and maintenance of the WMOLearn Events Calendar.

3.4   Engagement with other Training Providers

Collaboration with other training providers takes place at different levels. This includes the advertising of non-VLab training events in the online Training Calendar, indication of subject

matter experts for training collaborations, exchanges of technical expertise between training support officers and training project managers.

Training providers that have been most active in recent collaborations with VLab are NASA/ARSET, COMET, and the GEOS Working Group on Capacity Building and Data Democracy (WGCapD). Representatives of these programmes have been participating in VLMG meetings and engaging in discussions.

In addition, VLab has continuously collaborated with COSPAR on requests for the organisation of capacity building events. In 2018, a new memorandum of understanding was signed by COSPAR and WMO, to ensure the continuation of this collaboration, with possible extension of support in the domain of space weather.

4   VLMG-9

The ninth session of the Virtual Laboratory Management Group (VLMG-9) meeting was hosted by the Cooperative Institute for Research in the Atmosphere (CIRA) in Fort Collins, United States of America. The meeting was held at the premises of Colorado State University (CSU), from 16-20 July 2018.

VLab CoEs, Satellite Operators and Agencies, and Partner Programmes presented their latest achievements and planned activities which, together with the discussions that took place, generated actions and recommendations that were captured in the VLMG-9 report (available at http://www.wmo-sat.info/vlab/meeting-reports/).

The key outcomes from VLMG-9 were:

- Revisions to the new strategy that take into account the move to service driven operations, such as impact based decision support services in the NMHSs and with the new satellite and emerging and technologies on the data provider side.
- Strengthening the link between the regional data user requirements groups and the training centres to ensure that the training needs associated with new data sources and products are captured and addressed.

And of course there was discussion on sharing on how to continue to improve the quality and reach of the training, how to strengthen contribution to Global Campus and how to address outstanding training needs.

5   FIVE YEARS STRATEGY

The VLab Five-years Strategy document (2015-2019) was reviewed during the VLMG-9 meeting and a new strategy was drafted by a working group for the next period: 2020-2024. This document was circulated within the VLab Management Group (VLMG), receiving comments and suggestions that were considered in the final version.
The new document describing the VLab strategy for the period 2020-2024 was recently finalised and can be seen in **Appendix A** of this report.

The focus of the new strategy continues to be on supporting training on the use of satellite data and products as well as exploring capabilities to assist in related training areas.

VLab will strive to deliver training in line with WMO, CGMS, and GFCS strategic priorities, as well as considering the GEO societal benefit areas.

Collaboration with partner programmes will be continued and where possible, extended. VLab will also monitor the development of the WMO Global Campus initiative and explore ways to contribute and benefit from it.

The session is invited to take note of the proposed document for endorsement

6 FUTURE ACTIVITIES PLANNED

Over the next period the VLMG plans to engage with the following activities:

- The WMO Train the Trainer events and Calmet/eumetcal conference
- Adopt the "Compendium of Topics to Support Management Development in National Meteorological and Hydrological Services" to assist in working in harmony with other initiatives across the community.
- Improve speed of transfer of new technology, knowledge and skills to competency based training for operational tasks (including translations) by collaboration among CoES and funding.
- Develop satellite training support in courses and workshops developed by others concerning priority areas such as Climate Services, IDSS. Impact based forecast
- Foster Training for users of Space weather information by collaboration among CoEs and Space Weather Programme.
- Promote regional Training for Technicians and provide opportunities for special sessions , including them in meetings and conferences,
- Find more ways of involving forecasters in RFG,
- Maintain an RGBs forum of experts, trainers and forecasters
- Support the continuation of successful projects
- Involve young professionals in projects and meetings, task teams

7 CONCLUSION

From a training perspective, in the reports from CoEs for the period 2018 we find :

- more CoEs who offer training to other Regions as well as their own region, (noting that there is some struggling with language barriers and the number of participants).
- Increasing number of online offerings, and notably many more planned for 2019.
- Full agreement to sharing resources with other institutions, this Global Campus message has general acceptance among CoEs, great increase in the number of resources shared (usually not openly but through a requirement)
- Videos are have become a common format for resources nowadays. Training through briefings, focus groups and event weeks are prefered formats to train forecasters
- A great difference in the number of participants receiving training in classroom or online mode is evident in the reports: an average of around 10 to 20 trainees take part in classroom courses while around 30 to 90 trainees are covered by the online.
- Importance of keeping up with technological advance demands priority training on new generation satellites.
- Some CoEs have started focussing their courses on user's needs: disaster risk reduction, impact based forecast, fire response, nowcasting ,marine services.

Improved communication among all groups involved with satellite images avoids duplication of efforts. By integrating different areas and expertise, the applications of satellite images grow and users will benefit greatly. We face a huge responsibility towards society.

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APPENDIX A

**FIVE-YEAR STRATEGY FOR THE WMO-CGMS VIRTUAL LABORATORY
FOR EDUCATION AND TRAINING IN SATELLITE METEOROLOGY
2020-2024**

Scope and Definition

The WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) is an activity of the WMO Space Programme, based on a global network of specialized training centres, named Centres of Excellence (CoEs), that are supported by one or more CGMS satellite operators (Ref: http://vlab.wmo.int). These CoEs, often co-located with WMO Regional Training Centres (RTCs), are established in the various WMO Regions to meet user needs for increased skills and knowledge in using satellite data within their Region.

In this document when we say VLab we refer to the actions of the Centres of Excellence and the Satellite Operators.

Mission of VLab

To improve weather, water, climate and related environmental services by enabling WMO Members to utilize satellite data.

Objectives of VLab

1. To achieve better exploitation of data from the space-based component of the WMO Integrated Global Observing System (WIGOS) for services that are increasingly reliant on satellite data;
2. To globally share knowledge, experience, methods, and tools related to access and usage of satellite data, especially in support of WMO Members that have limited resources.

Strategic Drivers (the challenges outside VLab that we seek to support)

The strategic drivers of VLab have been and will continue to be:
- the improvement of the quality of services offered by WMO Members, and noting an increase in quantity;
- the growth in Earth Observing data available to support operational service delivery noting the Vision for WIGOS in 2040 (to be presented to WMO Cg-18 in June 2019);
- the diverse range of resources available for training, and the challenges users and trainers have in efficiently finding and repurposing resources;
- the introduction of new satellites, with new data types and products, new data manipulation and handling technology, as well as new dissemination systems, including cloud hosted data sources;
- the continued need to support simple and "backup" data delivery for emergency preparedness and for those members that have limited resources;

- improved scientific understanding and technological advances that can lead to improved services, and evolution in the provision of meteorological services;
- the need to address societal challenges and global development agendas such as the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction and the Paris Climate Agreement;
- responding to new and emerging service demands for Weather, Climate and Water, such as in support of marine, land, impact based decision support services (IDSS) and Global Framework for Climate Services (GFCS) applications;
- promoting and achieving the competence and quality control requirements, and professionalism within WMO Services, in particular noting the human resource management challenges facing many services;
- the growth in social/crowd created projects and increased volume of co-creation content;
- ideas for NMHS service improvement genererated within the WMO bodies.

Current status and achievements of VLab

In its 20 years of existence, the VLab has demonstrated its capability to deliver global scale events on training and education in satellite meteorology. In addition, all of the VLab activities support the objectives of the WMO Global Campus. The achievements of VLab can be segmented under the following headings:

1. Training activities
2. Collaboration and Sharing
3. Management and Oversight

During the period 2015 to 2018 (VLab Strategy 2015-2019), the main achievements of VLab within these headings were:

1. Training Activities
1. VLab hosted more than 120 Regional Focus Group discussions (RFGs) and 350 training courses, reaching 12,500 participants.
2. Supported transition to new satellite systems in all WMO regions.
3. Provided training materials created especially for identified gaps in content and data access, which included the Conceptual Models for the Southern Hemisphere (CM4SH), ASMET modules, GEONETCast Americas broadcast, and ways to display the data through SIGMACast, McIDAS-V, and python scripting.

2. Collaboration and Sharing
1. Further developed the WMO SP-12 "Guidelines on Satellite Skills and Knowledge for Operational Meteorologists".
2. Participated and contributed to WMO Global Campus activities and collaboration mechanisms.

3. Management and Oversight
1. The VLab Management Group (VLMG) met twice face-to-face, and had 15 online meetings to plan and oversee VLab activities.
2. Maintained good communication between training centres and satellite data providers around the globe, bringing research into training and operations.

3. Accelerated new product development and implementation in operations, such as the RGBs and the development of quick guides.

Strategy for the period 2020 to 2024

In this strategic period, the VLab Centres of Excellence and Satellite Operators will work towards the objectives by:
- developing and implementing training interventions, relating the intervention to the skills, competencies and qualification frameworks where they exist ;
- encouraging evaluation of the impact of the training for the use of satellite data and products and its long term benefits;
- encouraging the availability of more training material in WMO official languages other than English;
- encouraging exchange of information between researchers and operational users in developing new products from current satellite data that can lead to improved meteorological services.
- promoting the benefits of using new satellite-based products and providing technical support, where possible, to make them available to users.
- promoting good practice in training within the WMO Global Campus network and growing relationships with other training centres in allied areas such as oceans, agriculture, and forestry to explore opportunities to collaborate and share tools and knowledge for the delivery of the VLab objectives; encouraging those programmes to use the WMO competency frameworks
- engaging directly with and reporting to its co-sponsors, which currently include WMO groups IPET-SUP and CGMS;
- being active participants in WMO Global Campus and contributing to the continuous development of WMOLearn,
- increasing the coordination and collaboration between CoE's in order to maximise the efficiency of effort.
- fostering the use of the User Centred Design framework of processes to maximise the discoverability and useability of resources.
- fostering the co-creation of learning interventions utilising existing and emerging platforms, including social.
- developing or exploring guidance for impact based decision support services (IDSS) and Global Framework for Climate Services (GFCS) applications
- increasing efforts to engage with the next generation of young professionals in all fields related to the work of WMO and to create more opportunities for them to participate in and contribute to WMO activities; promoting mentoring and peer to peer learning opportunities for both students and instructors

VLab will implement these by:
- developing and delivering training in the form of distance and face-to-face events, RFG discussions, and self-study resources;
- supporting Regional and cross-Regional Satellite User Conferences .

VLab Centres of Excellence will support the satellite operators in the development of their data, products, systems and services by:
- supporting the regional satellite data requirements dialogues, and providing briefing information on the regional data access to enable NMHS managers to ensure they have the right staff to support access and application of the satellite data.
- providing feedback on the use of the available data, products, systems and services and challenges associated with full exploitation

Supporting the training centres and users by:
- providing information using the WMO Space Programme databases, including the Observing Systems Capability Analysis and Review Tool for space-based capabilities (OSCAR/Space), the WMO Product Access Guide (PAG) for satellite products and the WMO-CGMS Satellite User Readiness Navigator (SATURN).
- advertising training events in the VLab Training Events Calendar and WMOLearn Events Calendar.
- sharing training resources developed by VLab Members in the WMOLearn section of the WMO E-Library.

VLab notes that there is a growth in the level of interest in providing space weather services around the world. It is also noted that there is not yet a competency framework for space weather, reflecting the developing maturity of the international understanding of space weather services. VLab assumes that it is best to become more involved in space weather once the service levels have matured and there is a competency framework to engage with. This would require working with partners that have the appropriate skills in this area. VLab shall cooperate with other partners seeking to enhance the implementation of space weather services, such as COSPAR.

Through the experience acquired in the coordination and delivery of online training, the VLab will strive to meet the increasing demands of WMO Members in the period. These will be in line with:
- WMO Strategic Priorities;
- CGMS HIGH LEVEL PRIORITY PLAN (HLPP 2018 - 2022);
- GFCS Priority Areas;
- Group on Earth Observations (GEO) Societal Benefit Areas.

In this period VLab will pay particular attention to:
- Big data: noting that there are a number of cloud based satellite access platforms, and anticipating a growth in cloud based services, including hosted processing. This shall include exploiting such platforms to support application training, and training in the use of such systems.
- Impact based forecasting and Impact based decision support services to encourage NMHS personnel to continuously work with core partners, such as emergency personnel and public safety officials, on the production and dissemination of accurate and consistent forecast information for certain weather, water, and climate events that have a high impact, noting that not all forecasting services will adopt IDSS in the short term.
- Acting as a bridge to support the application of capabilities from other centres to support the VLab objectives where the VLab members have less experience with the data or applications (for example in the application of SAR data or in hydrology and hydrological models).
- Supporting the technical staff involved in satellite data reception and processing, through training, provision of up to date information, and potentially a skills framework.

Delivery of training will rely on:
- Use of digital technology where appropriate;
- Enhanced communication capabilities for data and training material;
- Classroom (face-to-face) and distance learning delivery of training where appropriate;
- Collaboration among CoEs;

- Cooperation with other entities providing training;
- Continued support from CGMS members.

VLab has proved it can reach every WMO Region and will strive to increase its reach to all WMO Members, in line with the WMO Education and Training Programme. To ensure quality of services provided by VLab, continuous internal quality evaluations will be put in place. These include undertaking evaluations of the training impact of its activities following the best available approaches, as well as establishing procedures to ensure the meeting of the VLab expectations from both partners: the CoEs and the Satellite Operators within CGMS. Annual reviews of achievements will also be carried out to ensure focus is kept on the provision of training in the main priority areas established in this document.

The VLab is an entity sustained by contributing CoEs and Satellite Operators. Technical support function is critical for the organization of online events and VLab coordination. Currently, VLab provides a broad support to CoEs activities with its central website (http://vlab.wmo.int) serving as a platform for collaboration and networking. The work of a dedicated Technical Support Officer (TSO), who also provides pedagogical advice to the VLab community, is mission-critical in this regard. VLab will seek to provide continuous instructional and technical support of its activities through the work of the TSO. However, this requires a long-term collaborative funding effort from CGMS Satellite Providers via the designated WMO VLab Trust Fund, as per section 5.2.3 of CGMS HLPP.

It is imperative that the strong collaboration between VLab CoEs and partner Satellite Operators is kept in order to maintain the development and delivery of training, with particular emphasis on national and regional specific demands and requirements. VLab will aim to keep this strong collaboration through, but not exclusively, participation in Regional Satellite Data Requirements' Groups and Satellite User Conferences. It is the VLab belief that a strong collaboration between CoEs and partner Satellite Operators will contribute to the economic benefit of the large investments in the space based observing system.

The continuation of VLab collaboration with other training and education programmes in the subject of meteorology, including CALMet, and the WMO Training and Education Programme is essential for further success. VLab will further build on the partnership with the Committee on Space Research (COSPAR), and explore partnerships with the Working Group on Capacity Building and Data Democracy of the Committee on Earth Observation Satellites (CEOS WGCapD) and other programmes in areas of common or complementary interest.

APPENDIX B

VLAB MEMBERS' STATEMENTS: CHALLENGES AND SUCCESSES IN TRAINING OF FORECASTERS, PARTICULARLY FOR: (A) MARINE, (B) AVIATION AND (C) IMPACT BASED DECISION SUPPORT SERVICES

China Meteorological Administration – CMA, and VLab Centre of Excellence - Beijing

Achievements: Forecasters receive training on Satellite Meteorology in different levels (initial forecaster, junior and senior forecaster and chief forecaster) with different content, according to their work experience and ability. The hierarchical and targeted Satellite Meteorology On-the-job Training for forecasters has been completed, and has achieved sound effects. Challenges: Satellite meteorological knowledge and application are being updated frequently, with the continuous launch of new generation meteorological satellites and the utilization of meteorological satellite data in cooperation internationally. How to make forecasters better comprehend latest satellite meteorological knowledge and apply to operational forecast? How to better communicate and cooperate with other COEs in terms of teacher collaboration, resource sharing, and continuous update of training methods? These are the challenges for satellite meteorological training targeted to forecasters.

European Organisation for the Exploitation of Meteorological Satellites - EUMETSAT

EUMETSAT continues to plan for the new generation of European programmes MTG and EPS-SG. These will take into account learning from new satellite progra,,e user preparation activities around CGMS operators.
EUMETSAT in involved in the European Union Copernicus activities. In the last period EUMETSAT, with partnership from CAMS, hosted a massive open online course on Atmospheric Composition Monitoring - attended by over 4,00 participants. This course was a survey level course - further training initiatives are needed to assist operational, commercial and research agencies in their use of the data.

Japan Meteorological Agency - JMA

The Japan Meteorological Agency (JMA) provides training events, in cooperation with RA-V CoE. In these events, JMA experts lectured how to utilize the Himawari data and HimawariCast receiving system. In addition, JMA provides annually training sessions on improving tropical cyclone (TC) analysis and aviation weather service for forecasters. JMA dispatched experts to the Fiji Meteorological Service (FMS) to provide training on effective utilization of Himawari data with SATAID toward operational use for a week in May, 2018. Fourteen forecasters from 10 Oceania countries attended the training and eagerly engaged in repeated exercises on satellite image analysis and forecast scenario development for actual cases of TCs in Oceania region. In the next week, JMA and FMS

held a technical meeting on TC analysis using SATAID with advanced function for TC analysis (SATAID-T). FMS staff became more familiar with TC analysis using SATAID-T through lectures and exercise on using actual cases of TCs in the region.
JMA also dispatched experts to the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) in October-November, 2018 and gave technical advices both for development/operation of TC analyzing system and practical TC analysis were provided so that forecasters of BMKG could further improve operation of TC analysis by using satellite observation data.

JMA hosted the 18th ESCAP/WMO Typhoon Committee Attachment Training course at JMA headquarters in October, 2018. Three forecasters from the Typhoon Committee and two from the Panel on Tropical Cyclone attended the training. To meet the prime requirements for TC forecast competency, the training focused on TC analysis and forecasting part and public weather services. The TC analysis and forecasting part covered a range of subjects including interpreting satellite imagery and Dvorak analysis techniques using the Satellite Analysis and Viewer Program (SATAID), other analysis techniques based on microwave imagery, Doppler radar data and sea-surface AMVs, and forecasting techniques involving the use of various types of guidance and information sources. Presentations and exercises were also provided on public weather services in support of disaster risk reduction (DRR).

In June 2017, JMA started to provide the Convective Cloud Information (CCI) products on the dedicated webpages for SIGMET coordination groups. Among those products, Rapidly Developing Cumulus Area (RDCA) product can detect initiation of rapidly developing convective cloud in advance of radar observation. In 2018, JMA dispatched experts to six countries in Southeast Asia to lecture how to use CCI products for aviation weather service.

Korean Meteorological Administration – KMA, and VLab Centre of Excellence – Republic of Korea

The education and trainings by the CoE-Korea are mainly focused on the support of weather forecasting. Every year, 2~3 different satellite courses are given to more than 100 KMA forecasters. The course is composed of lecture, exercise and practice and the contents are determined according to their levels. These courses cover the interpretation of single imagery, understanding of synoptic and mesoscale phenomena using the satellite images and various products and the utilization of new geostationary satellite such as Himarwari-8 and Geo-Kompsat 2A.
To support the Marine and Aviation, satellite products and phenomena such as sea fog, sea surface temperature, sea surface winds, turbulence, jet stream, local storm etc, which are not detected by surface observation, are usually educated to the person in charge of marine and aviation works. However, satellite products such as sea fog or turbulence have still some limitation due to difficult validation.

National Oceanic and Atmospheric Administration - NOAA

Successes in the usage of satellite imagery in training of forecasters for marine, aviation, and impact based decision support services:

Both national and international users recognize the increased spatial, spectral, and temporal resolution of the GOES ABI data. In the US, for example in high impact based decision support areas of forest fires, severe weather (including tornadoes), tropical applications, and even blowing snow, the high spatial and temporal resolution has allowed to distinguish finer surface and cloud features. This results in being able to fine tune the focus on the impacted areas, and then tailor the watch and warning messages, particularly as the event is unfolding. In general, the increased spectral resolution of the GOES and Low Earth Orbiting imager data is allowing the forecaster to better distinguish between ice and water cloud, land characteristics, and distinction of snow from cloud.

Challenges:
The forecaster adoption of the use of increased spatial and temporal resolution is immediate. The learning and adoption curve on higher spectral resolution, which includes the usage of more channels and simple and complex image combinations (eg. red/green/blue), is steeper. Feedback from various Science and Operations Officers in the NWS forecast offices indicate that approximately 1/3 of the forecasters readily adopt and use the new satellite imagery and products, 1/3 of the forecasters do not show a strong interest in using satellite imagery as a major component of their forecast process, and the final third fall somewhere in-between. This is not surprising and would follow a learning trend in the general education classroom. The challenge is to continue to identify learning strategies to encourage more forecasters to become more comfortable with using the enhanced satellite products.

VLab Centre of Excellence – Argentina

1) Challenge: improve forecasting by taking advantage of all the possibilities given by satellite images for different users. Big number of forecasters in RIII to be trained, with different levels of background knowledge and skills
Success: a collaboration pilot project (RIII) has started early this year, involving Iberoamerican RTCs, to face the challenges of training in priority areas. 4 course packages have been planned for 2019/20. The use of satellite images is a key component in all of them.
1. New forecasting technology and communication techniques.
2. Strengthening the capacity of NMHSs in marine meteorology service deliver.
3. Climate services applied to agriculture.
4. Integrated management of hydrometeorological extreme events.
2) Challenge: train all forecasters at SMN in the application of new generation satellites GOES R.
Success: a lot was achieved thanks to resources provided by COMET´s modules (at first in english), then «GOES-R Series Multilingual Training Resources» Contributors: COMET, RAMMB/CIRA, CIMSS, and SPoRT. Also as a bases to develop our own online training .

· SMN Online Course: 3 online modules (available in WMOLearn). This was an essential prerequisite for the face to face training organized by NOAA.

· Workshop GOES R (2017) Face to face training organized by NOAA for Argentine forecasters. Video recording and resources shared in WMOLearn) in 2018.Workshop GOES 16

3) Challenge: Forecasters to participate in regional discussions of monthly events.

Success: increased regional participation in RFG for the America´s and the Caribbean. Special presentations from CoE SMN of RIII case studies (with Slider) in 3 different sessions during 2018 (recordings available) . Attendance of participants from Conceptual Models regional online courses.

 4) Challenge : Application of Conceptual Models in forecasting-(integrating satellite image interpretation, model output and other data**)**

Success: CoE- SMN prepared 4 short online courses for the application of CM in forecasting. Based on CM4SH project https://sites.google.com/site/cmsforsh/ (VLab, Eumetsat) and Workbook project (WMO) including activities with SIMULATIONS .

 5) Challenge: aeronautical observers need basic interpretation of satellite images

Success: a regional online course was developed and carried out.

 6) Challenge: availability of short effective satellite training resources in spanish

Success: 4 Eumetsat´s videos on RGB are being translated (subtitles) . 2 are already available on RTC SMN website for regional use.

 7) Challenge : Building Marine Meteorology Forecasting Service at SMN.

Success: Eumetsat´s support in training has been crucial to building capacity of our marine meteorology staff. During 2017/8, 2 forecasters have participated in successive blended courses (Copernicus), taking advantage of both the online and face to face phases.

8) Challenge: training on use of GLM

Success

· SMN and UBA involvement in **Relampago** project.

a catalogue was prepared: http://catalog.eol.ucar.edu/relampago/   Section for satellite images: http://catalog.eol.ucar.edu/relampago/satellite updated daily, sent by FTP to Relámpago catalogue (intensive observation period)

SMN products: GLM 24H; GLM Group Centroid Density (GCD); RGB AIRMASS; RGB ASH; RGB CLOUD; RGB DAYCONV; RGB NATCOL; RGB NGTMICRO; RGB REALCOL

· Collaboration of CoE SMN in the development of Comet´s module «GOES-16 GLM Case Exercise: Buenos Aires Tornado and Hail Event»

 9) **Challenge** Introduce aeronautical forecasters into importance of Space weather

A short online course introducing Space Weather to forecasters was delivered by CoE Argentina (SMN and UBA) to 96 participants of RIII and RIV (spanish speaking). It is necessary to continue with this training to comply with new regulations.

 ## VLab Centre of Excellence – Australia

Specifically training of Forecasters has a strong emphasis on Satellite Meteorology. It is targeted towards:

1. Students undertaking the BIP-M / Graduate Diploma of Meteorology course. Following BIP-M training, the Graduate Meteorologists are then posted to a forecast centre and undertake a period of on-the-job training (OJT) relevant to the responsibilities of that office. Currently I teach the Radiation, Advanced Satellite Meteorology, Basic Satellite Meteorology (shared with another teacher) and Tropical Meteorology subjects.
2. Ongoing support of operational meteorologists within the Bureau. These staff are responsible for public weather, aviation, marine services and impact based decision support.
3. Overseas training to International operational forecasters.

Training in relation to points 2 and 3 above includes the coordination and contribution to monthly Australian VLab Centre of Excellence Regional Focus Group meetings, direct consultation with Bureau forecasters and the teaching to operational forecasters during Australian training events and during overseas missions.

Successes

1. As pertaining to the training of students studying for the BMTC Graduate Diploma of Meteorology course / BIP-M.

a.   In the teaching of the satellite meteorology subjects the students gained familiarity in the effective use of the new satellite data, including RGB products. This included a practical exposure to realistic and current case studies. As I collaborate with operational forecasters on a daily basis at BOM Head Office the case studies used for the training are relevant, up to date and have a strong focus on operational applications. After graduation the students become ambassadors in publicising these new satellite products in the forecast offices where they are posted.

b.   Students assist in the development of new satellite products and teaching methods during the teaching of the satellite meteorology subjects. For example:

i.   During 2016 the students examined and evaluated the GEOCAT Fog / Low Cloud algorithm and compared this to Himawari-8 satellite data, including the Night Microphysics RGB. This comparison was facilitated through analysis of a number of Australian case studies obtained in consultation with operational forecasters. I presented the results to our satellite product development team at BOM Head Office and to our BOM Satellite Champions. This work contributed to the implementation of this product into the forecasting routine.

ii.   During 2017 students tested and presented feedback pertaining to an End-to-End forecaster friendly case study that could be adapted to a forecast simulator.

iii.   During 2018 students used their smartphones to interact with the teaching using Socrative and provided valuable feedback that helped me to fine-tune this method of teaching.

iv.   During 2019 we plan to ask the students to evaluate the advantages in using 3D stereo satellite imagery using case studies from the USA in preparation for GEO-KOMPSAT-2A data becoming available from mid-year.

c.   Socrative was shown to be an effective interactive tool encouraging student engagement within the classroom and across cultures. I have used this during the Radiation, Advanced Satellite Meteorology and Tropical Meteorology subjects. A summary report "The use of Socrative cloud based learner response system during BMTC teaching to Australian and overseas learners; November 2017 to June 2018" was forwarded to VLab contacts on the 25th September 2018.

d.   Students participate in some Australian VLab Centre of Excellence Regional Focus Group meetings.

e.   The material prepared for the VLab Regional Focus Group meetings was incorporated in the BIP-M satellite meteorology subject content.

1. Where possible competency based trainers are utilised in the Grad Dip/BIP-M program, particularly for areas such as Aviation Forecasting; Marine Forecasting & Tsunami, Oceanography and Graphical Forecast Editor (the Bureau's grid editor for public weather services). This ensures that material is current and operationally relevant.

2. Ongoing support of operational meteorologists within the Bureau.

a.   The regular communication with Bureau Satellite Champions.

b.   Introducing latest developments in satellite products (including RGB products) via case studies to operational forecasters, including Bureau Satellite Champions. Forecasters often alert me of interesting weather events. I collect and assemble the relevant resources to develop case studies that are disseminated to the forecasters and Bureau subject experts. After discussion and feedback I present this material and the feedback at Regional Focus Group meetings.

c.   Collaboration with Victorian Operational Forecasters in testing the effectiveness of web-based satellite data visualisation software as a backup to our dedicated Visual Weather software.

d.   During early 2015 the Bureau organised the National Himawari-8 Training Campaign in order to prepare staff for the operational availability of the Himawari-8 data from mid-2015. This included fortnightly online tutorial sessions culminating in a 20 question online quiz. The quiz was successfully completed by over 100 Bureau Operational Forecasters.

e.   Both BOM and overseas meteorologists will attend and sometimes contribute to Australian VLab Centre of Excellence Regional Focus Group meetings. We have conducted over 5 years of Regional Focus Group meetings. There are an average of 30+ attendees per monthly session. To date 39 guest presenters have contributed to the meetings.

1. BMTC contains a group of trainers who individually are responsible for a target service area (eg; Aviation (x2), Marine/Tsunami Services, Severe Thunderstorms, Fire Weather, Radar, Tropical Cyclones). These staff are responsible for ongoing competency-based training and assessment within these areas. Refresher training and assessment results allow operational managers greater awareness of staff capabilities.

3. Overseas training to international operational forecasters

a.   Socrative was used as an effective interactive tool during my international training missions to Korea and Indonesia. This worked well within the classroom and across cultures.

b.   The presence of an effective translator at the Korean forecaster training of 2018 made the teaching a lot more effective. It also gave me valuable experience in collaboration with the translator in order to deliver effective training. Post training survey results indicate that above 95.2% of the Korean Forecasters were satisfied with the training.

c.   The adaptation of VLab case studies and other VLab content into training resources for overseas missions. For example, for the Korean training I resourced a number of Korean case studies that had been presented during previous VLab Regional Focus Group meetings.

1.   Each year BMTC welcomes international students onto our ab-initio course the Grad Dip Met. These students are checked by both BMTC and their agency for suitability (academic and work-readiness). Students generally come from Region V.

Challenges

1.   As pertaining to the training of students studying for the BMTC Graduate Diploma of Meteorology course / BIP-M.

a.   Increased IT security within BOM has led to difficulties with utilising some software including GoToWebinar. We use GoToWebinar to host our Australian VLab Centre of Excellence Regional Focus Group meetings. It also poses limitations in our adaptation of useful satellite viewing applications developed by overseas organisations, eg. the SSEC Satellite Information Familiarisation Tool (SIFT)

b.   The slow speed of rendering the high-resolution Himawari-8 data within the Visual Weather visualisation software has limited the use of this software in the classroom. Fortunately the web-based viewers have been effectively used for BMTC teaching.

c.   Some coloured (RGB) products, eg. the Night Microphysics RGB cannot be viewed properly by staff with colour vision impairment.

d.   Issues in engaging students to participate during lectures. This may be due to cultural factors as we have a number of overseas students attending our course. The BMTC teachers are regularly collaborating during monthly MIT meetings in order to build our common experience in overcoming this limitation.

1.   2019 will see substantial service redevelopment for BOM, which will require more operational meteorologists to be trained in new areas. This may have a flow-on effect to our Grad Dip Met course as operational staff wishing to help on Grad Dip Met course may not be able to be released from operations, potentially affecting dot point 'successes 1f'.

2.   Ongoing support of operational meteorologists within the Bureau.

a.   A Geographically diverse workforce, coupled with key audience primarily consisting of shift workers. Shift workers often have problems attending Regional Focus Group meetings.

b.   Increased IT security within BOM has led to difficulties with utilising some software including GoToWebinar. It also poses limitations in our adaptation of useful satellite viewing applications developed by overseas organisations, eg. the SSEC Satellite Information Familiarisation Tool (SIFT)

c.   The slow speed of rendering the high-resolution Himawari-8 data within the Visual Weather visualisation software.

d.   Some coloured (RGB) products, eg. the Night Microphysics RGB cannot be viewed properly by staff with colour vision impairment.

e.   We are no longer conducting annual Advanced Forecaster Courses due to budgetary constraints and also a reassessment of the effectiveness of this training.

    1.   Bureau operational staffing numbers are tight. It is difficult for operational managers to have staff off shift for refresher training, particularly from around Oct-April. This puts extra pressure on BMTC staff as the bulk of training then needs to occur from May-Sep, which has flow-on implications impacts which effect leave, ability to gain exposure in other areas etc.

 3.   Overseas training to international operational forecasters

a.   Some coloured (RGB) products are difficult for forecasters having colour vision impairment to use.

b.   Language difficulty, especially if forecasters cannot speak English or if English is not the first language

    1.   As mentioned we regularly host international students on course. Some are sponsored by through agency, others need to source funding, particularly those from Pacific nations. Course cost and Melbourne living costs can make this prohibitive.

VLab Centre of Excellence - Barbados

The Caribbean Institute for Meteorology and Hydrology (CIMH) (formerly The Caribbean Meteorological Institute, CMI) is a training and research organisation established in 1967. Training in meteorology and hydrology is the primary role of the CIMH and as such is a designated World Meteorological Organization (WMO) Regional Training Centre (RTC). In 2003 the Institute was also designated a WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) Centre of Excellence in Satellite Meteorology.

CIMH conducts training at all levels of WMO Aeronautical meteorology, from weather observers to forecasters. There are two paths for Aeronautical meteorological forecaster (AMF) training. The primary path is through the Senior Level Meteorological Technicians' (SLMT) Course, which is a forecasters' course based on the WMO Basic Instructional Package for Meteorologists (BIP-M). The duration is 18 months and includes first-year university level mathematics (including calculus and differential equations and physics, meteorological theory, practical work and simulations.   The second path is the training of degree meteorologists who can enroll in the Operational Aeronautical Forecasters' course (OAFC) which covers practical, competency-based training and simulations. The current focus is on aviation forecasting and this course is an attractive option given that it is less expensive than the university program, but both have proven to be very successful.

There is also the Aeronautical Continuing Professional Development (AeroCPD) course for operational forecasters. The goal of the course is to make available to regional forecasters an enhanced course designed to fulfil training needs for as many of the WMO AMF Competencies as possible. The course provides support to regional meteorological services in identifying and addressing training gaps within their workforce and allows in the introduction of training in new technologies. (Centre of Excellence) CoE Barbados in collaboration with US National Weather Service International Desk and the Cooperative Institute for Research in the Atmosphere (CIRA) initiated the VLab RAIV Regional Focus group (RFG) which is an online discussion forum on satellite meteorology. This forum has proven over the years to be an effective forum for continuing professional development training in satellite meteorology.

Additionally, CoE Barbados has been actively involved with Impact based forecasting and has developed training through various forums. CIMH have partnered with UCAR, the Barbados Meteorological Service and the Barbados Disaster Emergency Management (DEM) Agency to launch a Weather and Climate Ready Nation Project in the Barbados. The Weather and Climate Ready Nations (WCRN) projects are centred around a bottom up approach toward implementing impact-based forecasts and warning services in small island developing states and developing countries. The aim of the WCRN projects is to increase the resiliency of the population during major weather impacts. Training in Impact based forecasting is being integrated into all the forecasting courses and CIMH, by extension, will be leading the WCRN project throughout other Caribbean territories.

CIMH is looking to establish training in Marine forecasting. Recognising that there exists gaps in knowledge and knowhow related to marine forecasting and the increasing value of marine forecasts to livelihoods, reduction in loss of life and overall economic activity of many states in the Caribbean, CIMH teamed with the Caribbean Disaster and Emergency Management Agency (CDEMA) and the United Kingdom Meteorological Office (UK Met Office) to deliver an introductory one week marine forecasting course to the region, in 2010. CIMH has since developed and implemented the WaveWatch-3 marine wave modelling software over a large area covering the Caribbean Sea and adjacent oceans. In 2018, CIMH has started the search for consultancy services to both evaluate CIMH's capacity to deliver training in marine meteorology as well as provide training and advise towards the establishment of the course.

The greatest challenge faced in training is the lack of access to raw satellite data. This is being addressed with the aid of the USA NOAA with access to the GEONETCast (GNC) Americas Receiver System. The GEONETCast (GNC) is a risk-reducing backup for global data access in case of failure of any one satellite system. The onset of GOES-R (now GOES -16) data allows for a great deal of High Resolution (HR) satellite data to become available and traditional reliance on the internet will be greatly reduced. GOES –16 receiving systems are expensive ranging from $250,000 to $400,000. In reality the volume of data proposed for future dissemination may be more than any system can handle (bandwidth, frequency, antenna size, cost etc.), however with recent actions by NOAA to make more satellite data available, the GNC is an excellent option for Small Island States. The CIMH GNC unit is expected to be operational within the next month.

VLab Centre of Excellence - Brazil

The VLab CoE-Brazil, hosted by the National Institute for Space Research (INPE) at the Center for Weather Forecast and Climate Studies (CPTEC), has provided training on satellite meteorology for national and regional services, as well as other countries part of Region III (South America), since 2007. Throughout these years we have provided trainings for various weather forecast related areas including marine, aviation and hazard support services. In the past few years, however, our focus has been more on: (i) the use of next generation satellite imagery and products for weather services; (ii) satellite and forecast systems for fire weather; and (iii) nowcasting tools for regional and local weather and warning services. In respect to this last topic the targeted public has been mostly weather forecasters that work closely or within the civil defence and are developing impact based forecasts and warning systems to reach out more efficiently stakeholders and the general

public. As VLab our trainings are focused on the use of satellite imagery and products together with NWP outputs and terrestrial radar data, using software tools and apps developed by our institution to improve short-range forecasts (e.g., SOS-Chuva). There are successful examples of these trainings with good participation, development of practical exercises and implementation and application of the tools and resources at the regional services. In 2018 we had 3 successful training events with such positive outcomes, one held at INPE/CPTEC, a second at Uruguay (requested by the National Meteorological Service after the previous event at INPE), and a third one during the "Relampago Project" at the borders of Brazil, Argentina and Paraguay.

We feel now the need to bridge our training with complementary resources that may be developed by and/or in collaboration with institutions and expertise that are working on impact assessments of weather hazards at national, regional and local levels. This way we could have a second phase of the training incorporating concepts of meteorological hazard events, exposure, vulnerability and Risk, and how to apply spatio-temporal varying meteorological thresholds to develop warning tables that are easily understood and rapidly disseminated to the support services and society. We know some institutions are developing their own warning tables but there is a need to provide a better synergy and communication between weather and support services, as well as some sort of basic standardization so that, even with some regional and local particularities, such impact based forecasts and warning systems may be well understood across all nation, and even internationally. How to incorporate information from various sources within such impact-based warning systems, and not only for instance precipitation and wind intensity thresholds from NWP, but also indices developed by nowcasting systems that incorporate satellite and radar data is also something to be developed and passed on our future trainings. Our main challenge now is to get more engaged with institutions and experts in these fields and develop joint efforts for collaborative resources and trainings.

VLab Centre of Excellence – Costa Rica

Challenges:

1. Economic resources inside the UCR.

The University of Costa Rica (host of the RTC and VLab) is a public institution that relies on public funds for its operations. Since last year, a number of political and economic actions have reduced the amount of resources given to the University. In consequence, the Department of Atmospheric, Oceanic and Planetary Physics and the Center for Geophysical Research have received less resources for its operation.

2. Facilities for Satellite Meteorology and Distance Learning.

During the past three years we have requested new facilities in order to improve the computer labs designated to Satellite Meteorology. Some steps were given in that direction, and even blueprints of the building were created by the Planning Department at the University. Since last year these efforts have been stalled as limited funds are available for those purposes at the moment.

Successes:

1. Renovated distance learning Master program in Operational Meteorology.

The Master in Operation Meteorology program has changed in several ways since the previous generation. Instead of trimesters we are going to full semesters which will allow us more time to better train our students in specific topics of interest. The courses have been modified according to the needs of stakeholders. Efforts to ensure scholarships for most of our students are still carried out before the enrollment. A new generation will be open this year as most of the previous generation is close to graduation including students from Mexico (3), El Salvador (3) and Costa Rica (4).

2. Training on Satellite Imagery from ABI and GLM products for SENAMHI, Perú.

The Peruvian Met Service recently acquired a GRB for GOES 16 but the training activities regarding the satellite and its products is still pending. Due to previous collaborations with SENAMHI, the RTC at UCR was contacted in order to get training for ABI and GLM products. One of the reasons they contacted our RTC is because there is a need to use the products in research and UCR has a large tradition of research in meteorology as well as trained personnel in related areas. The training will be carried out from 25th of February to the May 1st, 2019. The number of trainees is 10 and the trainer is Dr. Marcial Garbanzo-Salas.

VLab Centre of Excellence – Morocco

CoE of Casablanca and EUMETSAT are working together to develop training activities in French on the use of EUMETSAT satellite products for the benefit of RA I. The covered topics are mainly: atmosphere/aviation and marine.

Before and during training events, some challenges are met. For instance, in 2018 a challenge was to prepare training materials in French that were not previously available. To begin with, efforts have been provided by CoE of Casablanca to translate some available resources from English to French.

Another challenge is that participants to the courses, who are mainly forecasters, belong to different regions of Africa. Some weather phenomena like convection or fog that occur in the Maghreb are different from those in the tropics, which are themselves different in West of Africa. Instructors must have sufficient scientific knowledge of meteorology and interpretation of satellite products throughout the African continent and not only in the region to which they belong. Hence, trainers from the four CoEs in Africa should exchange their experience and knowledge, without forgetting training them regularly.

Another challenge is to succeed a training course for a large number of participants. For instance, the online course which was organized by EUMETSAT and CoE of Casablanca in October 2018 had 48 participants from 22 countries. The classroom phase held in December 2018 had 16 participants from 10 countries. Having a sufficient number of qualified instructors is a real challenge. Furthermore, having a heterogeneous group of participants with very different levels of knowledge may happen especially in online events. This could be solved in the near future by applying more strict selection criteria.

CoE of Casablanca continues to collaborate closely with EUMETSAT to deliver courses in thematic areas that are very interesting for Africa like aviation, marine and hydrology. The past training events were successful. Assessment questionnaires carried out by the

participants at the end of each course is overall very positive. Thanks to these training events, links are established between forecasters themselves and between forecasters and instructors from different African countries. This can only be beneficial for better use of satellite products in weather forecasting in Africa

VLab Centre of Excellence - Niger

EAMAC as WMO RTC and a VLab CoE provides both ab-initio and continuous training for meteorological students and personnel (Meteorologists and Meteorological Observers) for French speaking countries of RA-I in general and for ASECANA Member States in particular. All delivered ab-initio training programs comprise a compulsory satellite meteorology course while the school also offers many face-to-face continuous training courses for Forecasters, Aeronautical Meteorological Observers, and Synoptic Observers. These courses include Satellite Meteorology, NWP, Forecasting and Regional Weather Watch, Aerodrome Weather Watch, Observations, Tropical Meteorology, etc. A yearly blended satellite application course is also organized in collaboration with EUMETSAT and self-paced online training modules on satellite products are developed with the assistance of EUMETSAT in the framework of the ASMET program. The most recent module that is under development on the use of satellite data to validate NWP models is being developed in response to the recommendations the EUMETSAT User Forum in Africa.

It should be noted that during the year 2018 a total number of 125 meteorological staff attended continuous training courses among which 69 Forecasters, 38 Aeronautical Meteorological Observers, and 18 Synoptic Observers.

The main challenges encountered in our various training are:

a) Shortage of trainers that does not allow to work to full capacity particularly in terms of continuous training. Most trainers have retired in recent years, and have only been replaced recently and most new trainers are still undergoing the coaching and confirmation process and therefore are yet to become full trainers.

b) Unstable internet connection and lack of adequate equipment in the VLAB that limits our capacity to organize and/or participate in online training activities.

VLab Centre of Excellence – Russian Federation

The Advanced Training Institute of Roshydromet (ATI), the main institution behind VLab CoE in Russia, conducts advanced and full-time refresher courses for training of forecasters, including aviation forecasters.

There are 8 full-time courses, including nowcasting for open-air sport events, short-medium-long-term forecasting methods, agro-forecasts, severe weather forecasting. There are also 15 online courses offered monthly, including 1 course in English.

In 2018, a face-to-face course was held to assess the competence of aviation personnel for internal experts, and the same is planned for 2019. We also offer a new face-to-face course for training air traffic control officers in meteorology.

Additionally, 3 members of ATI staff participated in a simulator building workshop in Helsinki (December 2018), organized by EUMETCAL/EUMETSAT. This experience will be used in

educational practice, in particular during the initial internships of weather forecasters with no work experience.

VLab partner - COMET

To support NOAA's new-generation operational satellites, COMET has been adding GOES-R and JPSS imagery and products to existing distance learning materials related to aviation and marine forecasting. Training on environmental satellite applications extends to EUMETSAT satellite systems and other international projects. Challenges include the wealth of data and expanding number of products available, which set up needs for timely training deliveries. To provide context for improving learning retention, COMET's distance learning materials focus on scenario-based approaches to showcase the advantages of the new satellite systems for forecasting and other environmental applications.

COMET has a wide variety of marine-related training. Most recently, efforts have focused on storm surge. To overcome the challenge of reaching international audiences, many of these lessons have been translated into Spanish and French.

Impact-based decision support services (IDSS) is an area of increasing interest and has been the focus of training efforts on a variety of topics including fire weather and tropical forecasting. Instructional designers at COMET have developed simulations that allow forecasters to explore the effectiveness of messaging their stakeholders through their reactions in the simulation. This type of training provides the opportunity to make and learn from mistakes as part of the experience. Internationally, COMET is working with the Barbados Meteorological Service to integrate Impact-based Forecasting in their country. In support of these efforts, a video demonstrating the use of multi-hazard, impacts-based forecast and warning services is now available on MetEd and on COMET's youtube channel.

For more information about available training, visit meted.ucar.edu.