CGMS-44 WMO-WP-09
26 May 2016

Prepared by WMO
Agenda Item: I
Discussed in Plenary

The VLab Global Infrastructure for Education and Training: Activity Update

HLPP reference: 4.2

This document reports on recent activities and plans of the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab). In 2015, VLab members have offered a variety of training opportunities, with highlight to the Himawari-8 Training Campaign, the "Preparing for the Next Generation of Satellites" event, a Train the Trainer Workshop on GEONETCast Americas, and the Meteorological Science Week. These provided very good opportunities for stakeholders from all WMO Regional Associations to be informed and make effective use of data, products and tools that are or will soon be available

At its May 2016 meeting, the VLab management group took key decisions in response to the new VLab Strategy 2015-2019:
(i) Organization of a virtual roundtable on climate monitoring from space in 2016, in all WMO languages; for further scoping of training on climate datasets, access to the ECV inventory will be needed
(ii) Support user preparation in the Indian Ocean region in connection with the IODC CGMS roadmap .
(iii) Develop a process of quality control and self-assessment of the Centres of Excellence and supporting satellite operators
(iv) Organize an expert workshop on RGB composites derived from multi-spectral (including new-generation) imagers in 2017

VLab also identified the recommendations for consideration by CGMS related to (i) the availability of training resources in languages other than English, (ii) continuation of the project "Conceptual Models for the Southern Hemisphere (CM4SH)".

The VLab Trust Fund received an increased level of contributions since May 2015 compared to the previous year, from NOAA, EUMETSAT, KMA, and WMO. However, a larger number of contributing CGMS agencies is required to improve its resilience. Regular financial contributions from CGMS Members are critical to maintain technical support to the VLab.

Action/Recommendation proposed:

Action: For the scoping of training activities on climate datasets, CGMS through WGClimate to inform the VLab TSO (luveeck@gmail.com) about access to the ECV inventory once it is available.

Recommendation: CGMS members are invited to share product information, dissemination information and training resources with the CoEs in Kenya, South Africa, Russian Federation, China, and Oman, and with users, to support VLab training activities in the Indian Ocean region.

Recommendation: CGMS operators to make available training resources in all official languages as defined by the satellite operator's charter. Translation of training resources should be considered as a continuous, ongoing effort. Satellite operators without multiple official languages should consider coordinating the translation of their training resources through in-kind contributions by user institutions.

Recommendation: CGMS to join efforts with VLab to investigate ways to fund the continuation of the Project "Conceptual Models for the Southern Hemisphere" (CM4SH) and also extend the initiative to prepare case studies related to the new generation of satellites.

The VLab Global Infrastructure for Education and Training: Activity Update

1 INTRODUCTION

This document reports on the activities and plans of the WMO-CGMS Virtual Laboratory (VLab). Since CGMS-43, the VLab has:

- Taken key decisions at its May 2016 Management Group meeting in support of the VLab Strategy 2015-2019
- Organized a total of 111 training events and 37 Regional Focus Group sessions (period January to December 2015); training was offered in all WMO languagues and Portuguese
- Prepared users to the new generation of satellites, through the Himawari-8 Training Campaign, the "Preparing for the Next Generation of Satellites" online event, a Train the Trainer Workshop on GEONETCast Americas, and the Meteorological Science Week.
- Collaborated with partner programmes on development of training tools, such as with the WMO Education and Training Programme, Eumetrain, Eumetcal, COMET/MetEd, and various NMHSs
- Developed a document describing the skills required by operational meteorologists to support the WMO Competencies related to the use of satellite data (Appendix B)
- Revised the formal Expectations from VLab Centres of Excellence (CoE) and supporting Satellite Operators (http://www.wmo-sat.info/vlab/governance-documents/)

The VLab Management Group (VLMG) has met three times in virtual meetings, and on 9-13 May 2016 for its 8th face-to-face meeting. Further details to VLab achievements over the reporting period, and plans is given below.

2 MAJOR ACTIVITIES OF THE VIRTUAL LABORATORY IN 2015

The VLab Centres of Excellence (CoEs) and supporting Satellite Operators have recently reported on their training activities for the period January to December 2015. A general outline of regional training activities organized by CoEs is presented below. Full reports can be downloaded from the VLab central website at http://www.wmo-sat.info/vlab/coe-reports/

CoEs, using both online and classroom training, offered a total of 111 training events and 37 Regional Focus Group (RFG) sessions during this reporting period. Training was offered in all 6 WMO official languages plus Portuguese and had participants from all WMO Regional Associations. A full list of events organised in 2015 can be seen in Appendix A.

Regarding the total number of participants attending VLab training events, the numbers exceeded the 3500 figure. This number excludes the number of participants using the online resources that are accessible via VLab partner websites, such as the recorded lectures available from some VLab CoEs and Satellite Operator websites (e.g. Russian Federation, Brazil, Australia, EUMETSAT, JMA, and CIRA). Additionally, whilst great effort was made to report on the number of people trained in 2015, figures were not available for every event organised.

During 2015, 85 classroom courses were offered, compared to only 26 online. Nevertheless, the average number of participants in online courses is generally higher, making a

substantial contribution to the total number of people trained (1056 out of 3653 trained online – not including RFG sessions). This highlights the importance of online training activities as a way to reach larger numbers of personnel to be trained.

Three CoEs continue to offer RFG sessions on a monthly basis (RFG Americas and Caribbean, Australia and South Africa) and one additional group offers sessions on demand (Caribbean Weather discussion). Consistent participation in RFG sessions continued in 2015, reaching around 1000 participants. Besides RFG sessions have been only offered in English and Spanish, participants on these sessions are from all WMO RA.

Besides the various regional activities that took place in the VLab CoEs, the major activities conducted by the VLab since CGMS-43 can be summarised as follows:

2.1 Train the Trainer Workshop on GEONETCast Americas

VLab has again conducted a WMO/NOAA sponsored Train the Trainer Workshop on GEONETCast Americas, on 25-26 April 2015, prior to the NOAA Satellite Conference (27 April to 01 May). The workshop highlighted resources available for GEONETCast: the system, installation guidelines, what data the system has, and software to visualize the data. There was an update on the progress of the WMO Coordination Group on Satellite Data Requirements Group for Region III/IV and how these efforts link in to preparations for GOES-R. Hands-on software activities highlighted case examples that demonstrated RGB capabilities for GOES-R using VIIRS and MODIS imagery. The VLab participants also took part in the WMO Coordination Group on Satellite Data Requirements for Region III and IV meeting at the beginning of the conference. As part of the Conference session was devoted to International training, a presentation about VLab was made by the VLab co-chair to highlight its role in International Training in satellite meteorology.

2.2 Science Week 2015

The VLab CoE in Australia hosted the “Science Week” from the 27th to the 30th July 2015. Fifteen online sessions were presented in collaboration with presenters from the Australian Bureau of Meteorology Training Centre (BMTC), the Centre for Australian Weather and Climate Research (CAWCR), Japan Meteorological Agency (JMA), Met Service New Zealand, Korea Meteorological Administration (KMA), China Meteorological Administration (CMA) and South African Weather Service (SAWS). The event featured sessions pertaining to the latest developments in meteorological science with respect to operational forecasting, including sessions about the new generation of geostationary satellites.

All sessions were recorded and are available in the website of the VLab CoE Australia at http://www.virtuallab.bom.gov.au/events/science-week-2015/science-week-2015-recordings/

2.3 Himawari-8 Training Campaign

A training campaign was organised by the CoE in Australia to help WMO Region V and stakeholders elsewhere to prepare for the effective use of Himawari-8 data. The first phase of the Campaign started in January, prior to Himawari-8 data availability, and included thirteen tutorial sessions. A second phase of the Campaign took place from June to December, with another eighteen tutorial sessions conducted. All tutorials were offered online.

A considerable amount of training resources was produced for this event and is available at http://www.virtuallab.bom.gov.au/training/hw-8-training/

2.4 Event Week – Preparing for the next generation of satellites

Another event that also addressed the importance of preparing stakeholders for the next generation of satellites was organised by the VLab in the format of an Event Week.

The Event was composed of a selection of webinars presented from 16 to 20 November by many CGMS operators: JMA, CMA, IMD, NOAA, EUMETSAT, KMA, as well as CIRA, INPE, and the COMET Program.

Ninety-five attendees from all WMO Regional Associations participated in this event. A good number of attendees participated in more than one session, showing the interest in learning about everything that is new in the next generation of satellites.

All resources presented and recorded sessions are available at http://www.wmo-sat.info/vlab/next-generation-of-satelliles/

2.5 Conceptual Models for the Southern Hemisphere Project

Conceptual Models for Southern Hemisphere (CM4SH) was a joint project between four southern hemispheric Centres of Excellence: Argentina, Australia, Brazil and South Africa. The project was co-funded by WMO and EUMETSAT. The first phase of CM4SH project was completed in March 2014 (full report available at http://www.wmo-sat.info/vlab/conceptual-models-southern-hemisphere/), and the second phase in May 2016 (full report will be submitted to WMO and EUMETSAT in June 2016).

3 Revised Expectations from VLab contributors

The two documents describing the VLab expectations from its Centres of Excellence and the supporting Satellite Operators were revised in 2015. Updates include links to important documents released by the WMO Education and Training Programme, the WMO Product Access Guide and also the new VLab Strategy for 2015-2019. The document also makes clear statements of the functions of nominated VLMG representatives and focal points of contact.

These documents were approved by VLMG and circulated within VLab members of CGMS. The revised documents are included in this report as Appendices C and D for reference, but are also available at http://www.wmo-sat.info/vlab/governance-documents/

4 VLMG-8 Meeting – May 2016

The recent face-to-face meeting of the VLab management group (VLMG) took place at the Caribbean Institute for Meteorology and Hydrology in Bridgetown, Barbados, from 9 to 13 May 2016. The meeting, which counted on full support from BRCCC Programme (Programme for building Regional Climate Capacity in the Caribbean), had a total of 30 participants. With the exception of JMA and CONAE, the meeting had representation from all VLab partners.

VLab CoEs, Satellite Operators and Partner Programmes presented their latest achievements and planned activities that, together with the discussions that took place, generated actions and recommendations.

Key decisions, in response to the VLab Strategy 2015-2019, and for consideration by CGMS are:

I) Training on climate monitoring from space

A week-long virtual climate roundtable is planned by CoE Barbados for late 2016, as an introduction to satellite-based climate monitoring and climate data records. A collaborative online training event on the climate-agriculture nexus is planned by CoE South Africa, EUMETSAT, and NASA. To assist scoping of further training activities in this area, access to the catalogue of level 2 datasets (the ECV inventory) will be needed. VLab should be informed once the inventory is completed.

Proposed Action**:** For the scoping of training activities on climate datasets, CGMS through WGClimate to inform the VLab TSO (luveeck@gmail.com) about access to the ECV inventory once it is available.

II) Supporting user preparation in the Indian Ocean region in connection with the IODC CGMS roadmap

Given the evolution of the regional geostationary satellite coverage over the Indian Ocean as described in the IODC CGMS roadmap (CGMS-43, EUMETSAT-WP-14), VLab Centres of Excellence (CoE) plan the following activities in 2016 and 2017 to support the use of the operational data and products:

- CoEs will establish user training requirements through the African and Asia-Oceanic user forums;
- The African Island states receive and have experience of the MSG and FY data already. No new additional readiness requirements are identified. The MSG-IODC data will be used in training from the Kenya and South African CoEs;
- The Russian CoE will explore the possibility of a blended course for the CIS countries. Covering the application of the FY and MSG data. Ideally this will also include INSAT and Electro-L data if relevant training resources are available;
- The Omani CoE will continue to host blended courses on MSG applications for the Middle East area, this will include the application of MSG, INSAT and FY Indian Ocean data;
- The China CoE will continue to promote the application of the FY, MSG and potentially INSAT data in their international courses which draw participants from across the region. This includes participants from countries not covered by the CoE's in Oman and Russia.

The training centres will work with the resources and data they have available and currently have less experiences and visibility on INSAT data. At this time, the VLab training centres do not address Elektro-L N1 data due to the ongoing anomaly; it is envisaged to consider data from Elektro-L N2 once such data are operationally available.

CGMS members are invited to share product information, dissemination information and training resources with the CoEs and users to support the training activities highlighted above.

Training will be conducted in English, Arabic and Russian. CGMS members are invited to support the translation of information materials and training resources to enable wider adoption of the products and data.

Proposed Recommendation**:** CGMS members are invited to share product information, dissemination information and training resources with the CoEs in Kenya, South Africa, Russian Federation, China, and Oman, and with users, to support VLab training activities in the Indian Ocean region.

III) Develop a process of quality control and self-assessment of the Centres of Excellence and supporting satellite operators

To continuously improve performance and services, the VLab decided to conduce a process for monitoring quality of training using self-assessments based on performance indicators developed by VLMG in 2012. This follows an Action from the WMO IPET-SUP at its February 2016 session. To ensure coherence of VLab activities with the VLab Strategy 2015-2019, a VLab Action dashboard is planned to monitor performance against key themes of the Strategy, such as user preparedness to new-generation satellites, availability of training resources, and the delivery of training.

IV) Organize an expert workshop on RGB composites derived from multi-spectral imagery in 2017

This workshop will be timely to discuss lessons learned from applying the WMO/EUMETSAT RGB standard to new-generation imagers (Himawari-8 AHI, GOES-R ABI, and the upcoming FY-4A AGRI) and implications for operational forecasting and training. It will build upon results of the 2012 Seeheim (Germany) workshop hosted by EUMETSAT.

The VLMG furthermore discussed the following items:

V) Availability of training resources in languages other than English

In many contexts, user training needs to be delivered in languages other than English. Translation of training resources into languages other than English is relatively costly. In addition, regional contextualization of training material is often required. With the goal to improve the availability of training material in languages other than English, VLMG recommended that, training resources provided by CGMS operators should be made available in all official languages as defined by the satellite operator's charter. Translation of training resources should be considered for all formal training, as a continuous, ongoing effort. Satellite operators without multiple official languages should consider coordinating the translation of their training resources through in-kind contributions by user institutions. VLMG also agreed to contribute to the effort of the WMO Global Campus initiative in order to improve collaboration designing and translating training into multiple languages.

Proposed Recommendation**:** CGMS operators to make available training resources in all official languages as defined by the satellite operator's charter. Translation of training resources should be considered as a continuous, ongoing effort. Satellite operators without multiple official languages should consider coordinating the translation of their training resources through in-kind contributions by user institutions.

VI) Follow-on to the Conceptual Models for the Southern Hemisphere (CM4SH) project

There was a unanimous agreement within VLMG that this project was very productive and that the 15 resources designed during these two years of project are of great value for training and education in satellite meteorology. In addition, the project fostered unprecedented collaboration and communication among different institutes and research group, especially in the Southern Hemisphere, which resulted in the identification of new

case studies to be prepared. Such studies would be highly valued on the training of forecasters and warning services. VLMG also acknowledged that this format of collaboration project should be considered when preparing users for the new generation of satellites.

Proposed Recommendation**:** CGMS to join efforts with VLab to investigate ways to fund the continuation of the Project "Conceptual Models for the Southern Hemisphere" (CM4SH) and also extend the initiative to prepare case studies related to the new generation of satellites.

4 VLab Trust Fund

The VLab Trust Fund has received an increased level of contributions since May 2015 compared to the previous year, from NOAA, EUMETSAT, KMA, and WMO. A joint WMO-CGMS letter inviting contributions was distributed to CGMS members on 14 December 2015 (the letter recalled the revised Expectations and needed commitments by CGMS members to the VLab, see section 3). The contract between WMO and Colorado State University/CIRA was renewed on 1 September 2015 for a 3-year period, governing the use of VLab Trust Fund resources for the VLab Technical Support Officer position.

Although the current financial status of the Fund is stable (see presentation WMO-WP-09), a larger number of contributing CGMS agencies is required to improve its resilience. Regular financial contributions from CGMS Members are critical to maintain technical support to the VLab.

5 Conclusion

VLab continues to make great strides in the forging of training in satellite meteorology. With the onset of the next generation of satellites, VLab's new strategy is designed to face and address the challenges that this presents. This will be accomplished with a strong, cohesive core, which is the VLab office members and Management Group, as well as supporting Satellite Operators and Centres of Excellence.

One issue that continues to challenge the VLab is the difficulty to aid CoEs in meeting the agreed expectations, whilst the number of personnel available in their Centres is often not adequate to meet the scope of training activities required in their respective area of responsibility.

CGMS and its membership have been a strong sponsor of VLab. It is important that this support continues so that initiatives such as the Virtual Round Table events, the Preparation for the Next Generation of Satellites and many others can be built upon as we bridge the gap between satellite data providers and users.

APPENDIX A

Training Activities organized by VLab from January to December 2015

Name of training event	Type	Language	CoE involved	Participants Number	WMO RA
Surface Weather Observer	Blended	Spanish	Argentina	82	III
Geomagnetism and Space Climatology	Classroom	Spanish	Argentina	11	III
Radiosone Observer	Blended	Spanish	Argentina	36	III
Surface Weather Observer Self-managed	Online	Spanish	Argentina	242	III
LiDAR Data Interpretation	Classroom	Spanish	Argentina	21	III
Introduction to Environmental Remote Sensing	Classroom	Spanish	Argentina	16	III
Antartic Meteorology	Classroom	Spanish	Argentina	16	III
Volcanic Ash	Online	Spanish	Argentina	80	III and IV
METAR – SPECI	Online	Spanish	Argentina	25	III
Evaluation of Solar Radiation	Classroom	Spanish	Argentina	25	III
Magnetic mapping survey and observation	Classroom	Spanish	Argentina	6	III
Meteorologia Workshop	Classroom	Spanish	Argentina	20	III and IV
Science Week 2015	Event Week	English	Australia	252[i]	I, II, IV and V
National Himawari-8 Training Campaign Tutorial Sessions	Online	English	Australia	160[ii]	II, III, IV and V
Basic Satellite Meteorology	Classroom	English	Australia	26	V
Advanced Satellite Meteorology	Classroom	English	Australia	26	V
Introduction of regional use of the MM5 and WRF products	Online	English	Barbados	6	IV
CIMH – Continuing Professional Development Course - SIGMETs	Online	English	Barbados	7	IV
CIMH – Continuing Professional Development Course - TAF writing	Online	English	Barbados	7	IV
Preparing for the next generation of satellites	Online	English	EUMETSAT, NOAA, CMA, JMA, KMA, INPE, IMD	234	I, II, III, IV and VI
The 8th International Training Course on the Application of Meteorological Satellite Products	Classroom	Chinese	Beijing	58	II
The application of satellite image in weather forecast	Classroom	Chinese	Beijing	48	II
The Training Course on Basics of Atmospheric Sciences I	Classroom	Chinese	Beijing	40	II
The Training Course on Basics of Atmospheric Sciences II	Classroom	Chinese	Beijing	50	II
The 30th Pre-post training class for initial forecaster	Classroom	Chinese	Beijing	42	II
The 35th Pre-post training class for initial forecaster	Classroom	Chinese	Beijing	38	II
The Training Course for popularization of Meteorological knowledge	Classroom	Chinese	Beijing	34	II
Meteorological Satellite: Image, Products and Applications	Classroom	Portuguese	Brazil	34	I and III
First Training in installing and using meteorological software Gempak, IDV, and McIDAS-V	Classroom	Spanish	Costa Rica	25	III
Second Training in installing and using meteorological software Gempak, IDV, and McIDAS-V	Classroom	Spanish	Costa Rica	25	III

Name of training event	Type	Language	CoE involved	Participants Number	WMO RA
Distance Training in automation and product generation	Online	Spanish	Costa Rica	3	III
Course for the El Salvador International Airport and other personal	Online	Spanish	Costa Rica	8	III and IV
CMAO Curso de Meteorológia Aeronáutica para Observadores	Online	Spanish	Costa Rica	10	IV
Aeronautical meteorology for engineers	Classroom	Spanish	Costa Rica	6	IV
MIMOC	Classroom	English	Kenya	7	I
AMTC16	Classroom	English	Kenya	9	I
ADCON AWS-01	Classroom	English	Kenya	4	I
EISAC-XIII-E	Online	English	Kenya	22	I
EISAC-XIII-E	Classroom	English	Kenya	22	I
Instruments Maintenance and Calibration Course (IMCC)	Classroom	English	Kenya	23	I
UK Met. Office/WMO Aviation Seminar	Classroom	English	Kenya	13	I
Climatology and the use of Data base Information system	Classroom	French	Morocco	15	I
QMS for monitoring the aeronautical meteorology production	Online	French	Morocco	15	I
Meteorologiclal briefing	Online	French	Morocco	15	I
Production of a training module within asmet8 project on the “Extreme High Swell Events on the Moroccan Atlantic Coast”	Online	English and French	Morocco	iii	I
Now casting techniques	Online	French	Morocco	15	I
Management training course as part of project for establishment of Communications, Ocean & Meteorological Satellite Data Analysis System in the Philippines	Classroom	English	Republlic of Korea	8	V
Satellite data analysis course as part of project for establishment of Communications, Ocean & Meteorological Satellite Data Analysis System in the Philippines (management course)	Classroom	English	Republlic of Korea	10	V
International training course on weather forecasting for operational meteorologists	Classroom	English	Republlic of Korea	12	I and II
Understanding of Himawari-8/9 data and its effective usage	Classroom	Korean	Republlic of Korea	71	II
Understanding of Himawari-8/9 data	Online	Korean	Republlic of Korea	132	II
Training Course for Aeronautical Meteorological Observers from Macao, China	Classroom	Chinese	Nanjing	3	II
Training Course on Radar Meteorology for Developing Countries	Classroom	Chinese	Nanjing	26	II
International Training Course on Numerical Weather Prediction	Classroom	Chinese	Nanjing	11	II
Seminar on Climate Change and Climate Information Service for Developing Countries	Classroom	Chinese	Nanjing	34	II
Seminar on Management for Meteorological Officials from the Asia-Pacific Countries	Classroom	Chinese	Nanjing	28	II
International Training Course on Use of Meteorological Instruments	Classroom	English	Nanjing	11	II
Seminar on Meteorological Disaster Management and Weather Information Service for Developing Countries	Classroom	Chinese	Nanjing	27	II
International Training Course on Agrometeorology	Classroom	English	Nanjing	15	II
Applied Meteorology Course for Forecasters from Macao, China	Classroom	Chinese	Nanjing	6	II

Name of training event	Type	Language	CoE involved	Participants Number	WMO RA
Seminar on Meteorological and Earthquake Forecast, Mitigation and Relief for Developing Countries	Classroom	Chinese	Nanjing	27	II
International Training Course on Instrument Maintenance and Calibration	Classroom	English	Nanjing	10	II
Seminar on Disaster Prevention Experiences and Policy for Afghanistan	Classroom	Chinese	Nanjing	29	II
International Training Workshop on Tropical Cyclone Forecasting and Warnings	Classroom	English	Nanjing	34	II
ESAC-XIIIF	Online	French	Niger	14	I
ESAC-XIIIF	Classroom	French	Niger	13	I
Satellite Meteorology course for forecasters	Classroom	French	Niger	20	I
Satellite Application course (online phase)	Online	English Arabic	Oman	20	II
Weather Briefing	Classroom	English Arabic	Oman	25	II
Satellite Application course (classroom phase)	Classroom	English Arabic	Oman	20	II
Advance Marine Meteorology	Classroom	English Arabic	Oman	10	II
Marine Metorology	Classroom	English Arabic	Oman	14	II
Marine Metorology	Classroom	English Arabic	Oman	10	II
Marine Metorology	Classroom	English Arabic	Oman	10	II
Train trainers in McIDAS-V	Classroom	English	Oman	8	II
Marine Metorology	Classroom	English Arabic	Oman	10	II
EUMETSAT MSG satellite online workshop	Online	English	South Africa	26	I
EUMETSAT MSG satellite workshop	Classroom	English	South Africa	8	I
Satellite Met for BSc Honours (UP)	Classroom	English	South Africa	12	I
Satellite application for SADC Classroom Phase	Classroom	English	EUMETSAT	17	I
Baltic+ Practical use of EUMETSAT data	Classroom	English	EUMETSAT	23	VI
Land SAF Satellite Products on Applications in Agro Meteorology	Classroom	English	EUMETSAT	44	I
Planning training sessions, what information do you need?	Online	English	EUMETSAT	52	All RAs
How do you make training sessions more active?	Online	English	EUMETSAT	53	All RAs
NOMEK 2015	Classroom	English	EUMETSAT	26	VI
International Summer School on Applications with the Newest Multi-spectral Environmental Satellites	Classroom	English	EUMETSAT	21	VI
EUMETSAT- ESSL-Testbed	Classroom	English	EUMETSAT	4	VI
Use of Gridded Satellite Data for Climate Services in Africa	Classroom	English	EUMETSAT	21	I
Satellite data application for hydrometeorology and environmental monitoring	Classroom	English	EUMETSAT	iii	VI
Eumetcal Radar Course	Classroom	English	EUMETSAT	5	VI
Advancing training and education in weather prediction	Classroom	English	EUMETSAT	iii	VI
4th SALGEE: 'MSG Land Surface Applications: Drought and Environmental Response'	Classroom	English	EUMETSAT	7	VI
Forecasting extreme hydrometeorological events	Classroom	English	EUMETSAT	iii	VI
12th Ibero-American workshop on Satellite Meteorology	Classroom	Spanish	EUMETSAT	19	III
NMS's training needs in SE Europe mtng	Classroom	English	EUMETSAT	21	VI
8th European Conference on Severe Storms (ECSS 2015)	Classroom	English	EUMETSAT	5	VI

Name of training event	Type	Language	CoE involved	Participants Number	WMO RA
Webinar on access to RapidScat data	Online	English	EUMETSAT	38	IV
Autumn School on nowcasting based on satellite data	Classroom	English	EUMETSAT	22	VI
MENA health impact of airborne dust	Classroom	English	EUMETSAT	43	I and VI
Use of rapid scan data for monitoring and nowcasting of high impact weather	Classroom	English	EUMETSAT	23	VI
Training Development Workshop for Regional Training Institutions in WMO RA VI	Classroom	English	EUMETSAT	25	VI
Event Week on Precipitation	Online	English	EUMETSAT	[iii]	VI
WMO/NOAA Train the Trainer (TtT) Workshop on Satellite Data Access, Application, and GEONETCast Americas for WMO RA III/IV members	Classroom	English and Spanish	NOAA	37	III and IV
McIDAS-V training workshop	Classroom	English and Spanish	NOAA	13	IV
Regional Technical Training Workshop on the Emergency Managers Weather Information Network (EMWIN) system (English session)	Classroom	English	NOAA	22	IV
Regional Technical Training Workshop on the Emergency Managers Weather Information Network (EMWIN) system (Spanish session)	Classroom	Spanish	NOAA	10	IV
WMO RA-I Basic Hydrologic Sciences for the African Region	Online	English	NOAA	32	I
KMA-COMET Olympic Forecaster Training Course	Classroom	English	NOAA	12	II
KMA Wx Analysis Course	Classroom	English	NOAA	12	II
'Tropical Desk' Training Workshop on forecasting techniques with emphasis on tropical cyclones and other types of severe weather in Mexico	Classroom	Spanish	NOAA	31	IV
CALMet XI	Classroom	English	NOAA	36	All RAs
Australian Regional Focus Group (12 sessions)	RFG	English	Australia	291	II, IV, V and VI
Caribbean Weather Discussion (2 sessions)	RFG	English	Barbados	13	IV
South African Regional Focus Group (8 sessions)	RFG	English	South Africa	115[iv]	I and VI
Americas and Caribbean Regional Focus Group (12 sessions)	RFG	English and Spanish	Costa Rica and Barbados[v]	379	III and IV

[i] Approximate figure calculated with basis on the average participation in the 14 online sessions.
[ii] Approximate figure calculated with basis on the average participation in the 16 online sessions.
[iii] No information available.
[iv] Approximate figure, as groups may attend using one connection.
[v] Organised by CIRA/NOAA in collaboration with VLab CoEs.

APPENDIX B

Satellite Skills and Knowledge for Operational Meteorologists

1 SUMMARY

This document describes the underpinning skills that support the WMO Competencies that relate to the use of satellite data by operational meteorologists. The skills are:

1. Identify surface features
2. Identify cloud types and their characteristics
3. Identify and interpret broadscale, synoptic and mesoscale systems
4. Identify and interpret atmospheric phenomena
5. Interpret derived fields and derived products
6. Identify and interpret oceanic features and systems

The skills definition was developed by the WMO-CGMS VLab to make it quicker and easier for training centres to develop learning objectives that relate to the WMO competencies.

1.1 Acknowledgements

These enabling skills were initiated by the WMO-CGMS VLab Management Group and developed by Ian Bell, Roger Deslandes, Bodo Zeschke from the Australian Bureau of Meteorology and Ian Mills and Mark Higgins form EUMETSAT with consultation with the WMO-CGMS Centres of Excellence and members of the CALMet community. The authors warmly thank everyone who took the time to provide feedback on the drafts.

2 BACKGROUND

The interpretation of satellite imagery is not an end in itself but is an element of the competent forecasters' toolbox.

The WMO-CGMS VLab is a global network of specialized training centres and meteorological satellite operators working together to improve the utilisation of data and products from meteorological and environmental satellite. The WMO Competencies for operational meteorologists and hydrologists and the qualifications for meteorologists and meteorological technicians is framework for the VLab training that targets operational meteorologists. The question for VLab trainers is:

What general satellite skills should we teach operational meteorologists that underpin the WMO Competencies?

The enabling skills described in this document are an answer to that question.

The application of satellite data is most relevant to the first two of WMO Competencies for each area of Operational Meteorology and Hydrology. These require the competent meteorologists to "Analyse and monitor continually the evolving meteorological and/or hydrological situation" and "Forecast meteorological and hydrological phenomena and parameters".

As these skills are supporting the high level competencies, we have designated the satellite interpretation requirements as contributing or enabling skills rather than as competencies in their own right.

Trainers who wish their courses to be more aligned to the qualifications and competencies can use this document to more quickly develop appropriate learning objectives for the satellite related elements of their courses. Of course this document should be used in conjunction with the qualification (WMO-1083) and WMO competency definitions1.

Operational meteorologists can use the document to calibrate that the breadth and depth of the underlying knowledge and competence with respect to the application of satellite data.

Six skills are detailed in this document:

1. Identify surface features
2. Identify cloud types and their characteristics
3. Identify and interpret broadscale, synoptic and mesoscale systems
4. Identify and interpret atmospheric phenomena
5. Interpret derived fields and derived products
6. Identify and interpret oceanic features and systems

The performance and knowledge requirements that support these skills should be customised based on the particular context of the organisation, its service requirements and available satellite data. This document covers the full range of possible skills and knowledge requirements. Any individual will require only a subset of these, according to their needs.

Meteorologists in different locations or performing different job tasks will have access to different satellites with their particular characteristics and to various display and manipulation systems and tools. They will also be dealing with a variety of local meteorological systems and phenomena.

1 http://www.wmo.int/pages/prog/dra/etrp/competencies.php

The focus of this document is on meteorological forecasting. Other uses of satellite data, for example, research, oceanography, hydrology, climatology and other specialist areas, will be considered separately in other documents.

In addition to the general competencies of a meteorological forecaster, the following conditions and background skills and knowledge will apply.

General conditions

- Imagery includes single and multiple channels and combinations of channels, including RGB displays, derived quantitative products (processed satellite data blended with NWP data) and synthetic satellite imagery from numerical model predictions.
- Satellites include geosynchronous and polar orbiting satellites with passive and active sensing.
- Satellite interpretation does not happen in isolation but occurs within the context of all other observations, guidance and situational awareness
- Systems, features and phenomena of interest will be dependent on the required forecasting tasks and location.

Access, select, display and manipulation of satellite data

The forecaster will be able to:

- Access data from geostationary and polar orbiting satellites
- Select the most appropriate channels or combinations of channels for the task at hand
- Display and manipulate the imagery as individual or combined channels, singly or with animation
- Apply enhancements to imagery
- Access and display derived data

Characteristics, limitations and possible errors in the satellite data

The forecaster will take into account factors affecting data quality and characteristics, including:

- Satellite resolution (time, horizontal, vertical), channel
- Position of the satellite sub-point – resolution, parallax errors
- Time of scan for different parts of the image
- Satellite sensitivities, precision, accuracy and wavelength characteristics
- Variations due to sun angle

3 HOW TO USE THIS DOCUMENT

This document specifies the satellite interpretation skills required of a meteorological forecaster. It does not specify how satellite meteorology should be taught. This will vary according to many circumstances, including the particular job tasks required; whether it is taught as part of a short course, a full initial course or independent learning; and, whether it is a separate subject, integrated with other data sources and theory as part of a meteorological systems approach, or a combination by initially teaching background satellite theory followed by an integrated systems approach.

In any case it is recommended that the training be activities based with the following sequence used for development:

1. Set your training goals. These are the required job skills from this document (and/or higher level competencies). This is what the forecaster needs to do.
2. Identify any sub-tasks required to achieve this. If all of these sub-tasks are learned the job task will be achieved.
3. Identify learning activities for each sub-task. If the activities are well chosen, we can be confident that, when successfully completed, the learner will be able to perform the job tasks.
4. Unlike in the conventional approach, only now do we identify the knowledge and skills that are required to enable someone to perform the learning activities. Note that these are *essential* knowledge and skills only. Any extra content that is in the “nice to know” category, or that we think they might need one day, has been shown to decrease overall learning and should not be included.

4 LEARNING GUIDE

It is envisaged that a learning guide will accompany these guidelines. It will include details of techniques, channel combinations, possible learning activities, etc. These will be updated as new understanding, techniques and tools become available, whereas the skills in this document will remain more constant.

SKILL 1: IDENTIFY SURFACE FEATURES

Description

Identify geographical features, surface characteristics and conditions

Performance components

1. Identify terrain and geographical features
    - Discriminate between land and sea.
    - Distinguish mountainous from low lying regions.
    - Locate rivers and river valleys.
    - Identify lakes.
    - Differentiate natural vs human modified areas.
2. Identify surface characteristics and conditions, including dry/wet, different vegetation types and clear areas, sand and desert
    - Discriminate between areas of vegetation and areas of drought
    - Identify different types of desert surface e.g. sand, desert pavement
    - Identify areas of recent burning
    - Identify hotspots (fires, volcanic activity etc.)
    - Identify areas of recent volcanic ash cover
    - Identify areas of flooding
3. Identify snow/ice cover and analyse its extent
    - Discriminate between cloud and snow.
    - Indentify frozen rivers and lakes

Skills, techniques and knowledge requirements

- Infrared and visible channels (including high resolution visible channel)
- Appropriate RGB products (Natural Colour RGB, Day Microphysics RGB, Microphysics RGB, Snow RGB, Dust RGB)
- Appropriate Derived Products (Land SAF, Normalised Vegetation Index etc.)

SKILL 2: IDENTIFY CLOUD TYPES AND THEIR CHARACTERISTICS

Description

Identify cloud types and features including height and temperature of tops, thickness and microphysics.

Performance components

1. Identify stratiform, cumuliform and cirriform cloud regions and individual cloud types and their characteristics (thick, thin, multi-layered, developing, decaying) based on texture, brightness, brightness temperature and synoptic and mesoscale context.
2. Identify Cumulonimbus clouds, their intensity and their stage of development.
3. Identify fogs and discriminate between fog and low cloud
4. Identify contrails and ship trails
5. Deduce cloud top heights based on brightness temperatures, surface observations and sounding data (observed, satellite derived and numerical models)
6. Identify clouds made of water droplets, ice particles or a mixture
7. Discriminate between clouds with small or large cloud particles

Skills, techniques and knowledge requirements

- Cloud types and characteristics
- Brightness temperatures, contamination from higher levels
- Use Fog and Night Microphysics RGB products, shadows on visible imagery and animation to identify valley fogs as well as meteorological situational awareness and surface and aircraft observations.
- Use appropriate RGB products and/or microphysical parameters to identify clouds composed of different phases and clouds with small or large cloud particles

SKILL 3: IDENTIFY AND INTERPRET BROADSCALE, SYNOPTIC AND MESOSCALE SYSTEMS

Description

Identify and interpret broadscale, synoptic and mesoscale atmospheric systems, their characteristics, strength and stage of evolution and deduce atmospheric dynamical and thermodynamical properties

Performance components

For each system, select and apply conceptual models to locate and identify the system, its orientation, strength and stage of evolution, including precursor signatures, taking into account departures from climatological or idealised models. (Categories are not exclusive and some features relate to more than one category.)

Note that a full analysis or prediction involves all available data and guidance and is a higher order competency. Thus, the satellite interpretation task is not an end in itself but, in conjunction with other data, contributes to this higher level task.

1. **Broadscale systems and features:**
    - Intertropical convergence zones, monsoon and trade wind regimes
    - Westerly regimes with embedded cyclones and anticyclones
    - Polar easterlies and systems
    - Broadscale waves
    - Zonal, meridional flows, mobile and blocking systems
    - Upper and low level circulations
2. **Synoptic scale systems and features:**
    - Anticyclones
    - Cyclones (including rapid cyclogenesis), tropical cyclones,depressions, extratropical and polar lows, at upper and lower levels
    - Jet streams, convergence and frontal zones, conveyor belts
    - Troughs, ridges and cols, deformation axes, waves

- Cloud regions – stratiform, stratocumulus, cumulus (cold outbreaks, trade cumulus), cloud bands and cloud shields
- Cold pools and thermal shear

3. **Mesoscale scale systems and features:**

- Local thermal and topographic circulations including land and sea breezes, katabatic and anabatic winds, foehn winds, mountain waves, island and peninsula effects (including Karman Vortices and v-shaped wave clouds), heat lows and troughs
- Convective cells and cloud systems (including pulse convection, multicells, supercells, squall lines, mesoscale convective complexes and systems) and associated mesoscale features including outflow boundaries and stormtop features.
- Mesoscale boundaries and interactions, dry lines
- Low level jets
- Gravity waves

Skills, techniques and knowledge requirements

- Detailed conceptual models of each atmospheric system.
- Dvorak tropical cyclone enhancement and techniques for tropical cyclone intensity.
- RGB products (Airmass RGB, Microphysics RGB etc.)
- Infrared, water vapour and visible (including high resolution visible channel)

SKILL 4: IDENTIFY AND INTERPRET ATMOSPHERIC PHENOMENA

Description

Identify and interpret atmospheric phenomena

Performance components

For each phenomenon, locate and identify it and determine its strength, characteristics and, when appropriate, stage of evolution.

Note that a full analysis or prediction involves all available data and guidance and is a higher order competency. Thus, the satellite interpretation task is not an end in itself but, in conjunction with other data, contributes to this higher level task.

Phenomena include:

- Dust and sand storms and plumes and areas of raised dust
- Fires and smoke
- Precipitation types and amounts
- Volcanic ash particulates and chemical emissions
- Aerosol and particulate pollution
- Features indicating regions of clear air turbulence

Skills, techniques and knowledge requirements

Dust, and sand storms

- Conditions - detect dust over land and water, night and day
- Discriminate between dust, cloud, smoke and desert surfaces.
- Use Dust RGB products

Fires and smoke

- Discriminate between natural and industrial hotspots

Pollution

- Pollutants include SO_2, NO_2, etc.
- Discriminate between natural and anthropogenic pollution

Volcanic ash

Identify and analyse In particular:

- Volcanic emissions including ash, SO_2
- Determine the areal extent of the ash cloud, its height and its temporal evolution.
- Use Volcanic Ash RGB

Precipitation

- Precipitation type (convective, stratiform, deep versus shallow precipitation) using appropriate satellite channels including microwave channel data

Other aerosols

- Use the (EUMETSAT) Airmass RGB to identify ozone rich regions in the middle and upper atmosphere

CAT

- Identify CAT signatures using water vapour channels, synthetic satellite imagery

SKILL 5: INTERPRET DERIVED FIELDS AND DERIVED PRODUCTS

Description

Interpret fields and parameters

Performance components

Interpret fields and parameters in order to integrate them with other data, observations and guidance as input to analysis and diagnosis.

1. Derived fields include:

- Surface temperatures
- Vertical temperature and moisture profiles
- Atmospheric winds
- Cloud type, cloud top temperature
- Total and liquid precipitable water.
- Vegetation and fire danger indices

Skills, techniques and knowledge requirements

- Strengths and weaknesses of satellite derived products/fields
- Image interpretation - both single channel, RGB products and derived products
- Be able to effectively use satellite data in combination with derived products

SKILL 6: IDENTIFY AND INTERPRET OCEANIC FEATURES AND SYSTEMS

Description

Identify and interpret oceanic features and systems relevant to meteorological forecasting. (Note that oceanographers would require more skills, not covered here.)

Performance components

1. Interpret sea surface temperature fields and their characteristic broadscale, synoptic and mesoscale patterns.
2. Interpret near surface wind data.
3. Identify and interpret sea state data and relate this to wave height and swell.
4. Identify and interpret oil slicks and their evolution
5. Identify areas of sun glint
6. Identify and interpret sea-ice, its extent, movement and characteristics (young and old sea ice, sea ice undergoing ablation and containing melt ponds).
7. Identify and interpret ocean currents and eddies and regions of ocean upwelling

Skills, techniques and knowledge requirements

- Understand how infrared imagery is used to determine sea surface temperatures, including limitations such as cloud cover, skin temperature vs deeper temperatures.
- Understand how microwave data is used to measure sea surface wind, and be able to identify limitations in the data including wind direction ambiguities, wind speed inaccuracies, rain effects
- Understand how active microwave sensors and synthetic aperture radar are used to measure sea state, including limitations in the method. Know how to identify regions of error.
- Understand how microwave sensors, synthetic aperture radar and multispectral radiometers are used to measure sea ice. Know how to effectively use imagery produced using the MODIS Sea Ice algorithm to detect and monitor sea ice.
- Discriminate between areas of sun glint and discriminate from high cloud
- Discriminate between sea ice and cloud.

APPENDIX C

EXPECTATIONS FROM THE CENTRES OF EXCELLENCE[2]

1. Nominate a person to be part of the VLab Management Group (VLMG). This person should have some authority to make decisions regarding the use of the VLab within the Centre of Excellence (CoE). VLMG members should participate in the VLMG online meetings and the biannual face-to-face VLMG;
2. Nominate a focal **point of contact** for Virtual Laboratory (VLab) business. The **point of contact** will be included in all VLab communications and will be responsible for delivering the messages to their regional community. The **point of contact** may be the same person nominated as VLMG member (if appropriate);
3. Organise national and international training events that conform with the Guidelines For Trainers In Meteorological, Hydrological And Climate Services document published by WMO (WMO, 2013[3]);
4. Organise regular weather briefings and satellite related discussions (and also possibly discussions covering other GEO and GFCS topics) in the form of "Regional Focus Groups";
5. Perform a regional training needs assessment every year (couple of years) in order to identify and prioritise the organisation of VLab training events;
6. Develop and maintain proficiency in providing online training using the learning technologies available;
7. Support the personnel involved in the organising and delivering of VLab training events to develop and acquire competencies mentioned in the Competency Requirements for Education and Training Providers for Meteorological, Hydrological, and Climate Services (WMO, 2013[4]);
8. Ensure that all training events organised within the VLab Network are advertised and reported in the VLab Online Calendar of events[5];
9. Maintain regular contact with the regional community, sponsoring satellite operator and VLMG;
10. Provide the Co-chairs (or designated people) an annual report of activities following the template and guidelines provided;
11. Ensure that activities adhere to the VLab Strategy 2015-2019 (VLab, 2015[6]).

[2] This document was primarily based on the Annex VII of the CGMS VL FG 2nd Session Report (Barbados/2003). Updates were made and approved by VLMG members in 2015, as part of Action VLMG7.12.
[3] WMO (2013) Guidelines For Trainers In Meteorological, Hydrological And Climate Services [Online] Available in English at http://www.wmo.int/pages/prog/dra/documents/wmo_1114_en.pdf
[4] WMO (2013) Competency Requirements for Education and Training Providers for Meteorological, Hydrological, and Climate Services [Online] Available in English at http://www.wmo.int/pages/prog/dra/etrp/documents/CompetencyRequirements_en.pdf
[5] VLab Online Calendar of events. Available at http://www.wmo-sat.info/vlab/calendar-of-events/
[6] VLab (2015) Five-Year Strategy For The WMO-CGMS Virtual Laboratory for Education And Training in Satellite Meteorology 2015-2019 [Online] Available at http://www.wmo-sat.info/vlab/wp-content/uploads/2015/07/VLabStrategy_2015-2019.pdf

APPENDIX D

EXPECTATIONS FROM THE SATELLITE OPERATORS[7]

1. Nominate a person to be part of the VLab Management Group (VLMG). This person should have some authority to make decisions regarding the collaboration with the VLab and the sponsored Centre of Excellence (CoE). VLMG members should participate in the VLMG online meetings and the biannual face-to-face VLMG;
2. Nominate a focal **point of contact** for Virtual Laboratory (VLab) business. The **point of contact** will be included in all VLab communications and will be responsible for delivering the messages to their regional community. The **point of contact** may be the same person nominated as VLMG member (if appropriate);
3. Create and maintain a page in their main websites, dedicated to explain their involvement and support to the VLab, and include the VLab logo. The inclusion of links to the VLab Online Calendar of Events[8] and the WMO Product Access Guide[9] are also recommended;
4. Make near real-time data, products and/or selected case study data available for education and training purposes to CoEs. Data formats should follow WMO recommendations and be suitable for use in software environments such as VisitView, McIdas-V, SATREP and Ramsdis;
5. Assist CoE(s) with regular weather discussions (and also possibly discussions covering other GEO and GFCS topics) in the Regional Focus Groups;
6. Maintain regular contact with the CoE(s) that the satellite operator is sponsoring, focusing in particular, but not solely, on communications and data access issues. As appropriate, provide an alerting role for the CoE(s) on new training resources and material generated within or for the satellite operator;
7. Maintain regular contact with the other VLab satellite operators on data access and format issues and other matters as appropriate;
8. Maintain regular contact with members of the VLab Management Group (VLMG), participating in the VLMG online meetings and the biannual face-to-face VLMG meetings;
9. Provide the Co-chairs (or designated people) an annual report of activities following the template and guidelines provided;
10. Assist the CoE(s) to overcome resource constraints on VLab related matters through advice, championing with other funding bodies and direct assistance as appropriate;
11. Contribute to the funding of the Technical Support Officer (TSO) of the VLab, to assure the smooth and coordinated continuous running of the VLab activities;
12. Ensure that activities adhere to the VLab Strategy 2015-2019 (VLab, 2015[10]).

[7] This document was primarily based on the Annex VII of the CGMS VL FG 2nd Session Report (Barbados/2003). Updates were made and approved by VLMG members in 2015, as part of Action VLMG7.12.
[8] VLab Online Calendar of events. Available at http://www.wmo-sat.info/vlab/calendar-of-events/
[9] WMO Product Access Guide. Available at https://www.wmo-sat.info/product-access-guide/
[10] VLab (2015) Five-Year Strategy For The WMO-CGMS Virtual Laboratory for Education And Training in Satellite Meteorology 2015-2019 [Online] Available at http://www.wmo-sat.info/vlab/wp-content/uploads/2015/07/VLabStrategy_2015-2019.pdf