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INTER-PROGRAMME EXPERT TEAM ON SATELLITE UTILIZATION AND  
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## **Conceptual Models for the Southern Hemisphere (CM4SH): Results and Way Forward**

*(Submitted by VLab co-chairs and CM4SH Project Manager)*

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### **Summary and Purpose of Document**

This document reports on the achievements of the VLab project “Conceptual Models for Southern Hemisphere”, which started in 2013. Until now the project consists of two phases, during which altogether 15 Conceptual Models have been documented and described. The second phase of the project is ongoing and will end in March 2016.

The project first two phases have been funded by WMO and EUMETSAT. The project group consists of expert teams at VLab Centres of Excellence in Southern Hemisphere - Argentina, Brazil, South Africa, Australia. An expert team from BMKG Indonesia participates in the second phase of the project.

The report wishes to highlight the achievements made within the project and the importance of finding ways to continue the project in terms of values for VLab and users.

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### **ACTION PROPOSED**

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

- (a) To recommend CGMS to note the achievements of this Project and consider forms of support that could provide its continuation.
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**Appendices:** A. Final report of Phase I - Conceptual Models for the Southern Hemisphere

B. Feedback given by team members - the value of the Project

## DISCUSSION

### 1. Introduction

This document reports on the achievements of the VLab Project **Conceptual Models for the Southern Hemisphere (CM4SH)**. It explains the aims of the project, describes the achievements and value of the Project for users and for the VLab Centres of Excellence involved. A recommendation is presented with regards to the sustainability of the Project.

### 2. Project outline

Satellite imagery and products are one of the key tools weather forecasters use in monitoring and forecasting the weather. Whilst a great deal of literature and training resources exist utilizing Northern Hemisphere examples there is not the same depth and spread of material in the Southern Hemisphere.

Conceptual Models for Southern Hemisphere (CM4SH) is a project that aims to improve this situation by reviewing the current examples of dynamically and thermodynamically consistent conceptual models for the Southern Hemisphere and creating the missing models based upon templates already developed for the Northern Hemisphere around the widely used SATManu publication. When completed, the resources produced by CM4SH will be openly available to all, particularly aiding training and education in satellite meteorology in the Southern Hemisphere.

The project is co-funded by WMO and EUMETSAT. The first CM4SH project was successfully delivered from January 2013 to March 2014. The second phase of this project was launched in January 2015 and is expected to be completed by the end of March 2016.

CM4SH involves four southern hemispheric VLab Centres of Excellence (CoEs): Argentina (UBA and NMS Argentina), Australia (BMTTC), Brazil (CPTEC/INPE and LAPIS/UFAL) and South Africa (SAWS and UP). The project was reinforced in 2015, with the addition of the expert group from the Agency for Meteorology, Climatology and Geophysics, Indonesia (BMKG).

The purpose of the project is to improve warnings and awareness of weather risks through the use of conceptual models. Specific objectives include producing conceptual models based on weather events in the Southern Hemisphere, and making these available for training purposes through a comprehensive Online Catalogue.

### 3. Achievements

During phase one, eight Conceptual Models were prepared. The final report of this first phase is available as **appendix A** and the resources produced can be accessed at <https://sites.google.com/site/cmsforsh/> A brief descriptions of the CMs is given below:

#### 1. The South American Low Level Jet (SALLJ)

This CM shows a typical weather situation on the South American continent in regions of Argentina where humid, warm and unstable air masses from tropical origin in combination with a LLJ can cause CB complexes with heavy weather events. There is no direct comparable CM exists in other parts of the world. It is therefore an important and very

valuable CM for forecasters in the South American region; and it is a CM, which has the LLJ as a driving factor.

## 2. Zonda winds

This CM shows the mechanisms of Leeward side phenomena over high mountain ridges comparable with the CM Föhn on the Northern Hemisphere. It can really be an enrichment of the practical knowledge of forecasters and students and a tool for improvement of forecasting these events.

## 3. Explosive Cyclogenesis

This CM treats intensive and quick cyclogenesis over and close to the Australian continent and as such it is a very interesting supplement to the chapter of the shallow CFs. Both together describe two important synoptic scale meteorological processes for the Australian continent already in the first production step of the CM manual. But this CM raised also very important discussion about the differences of comparable weather systems on the northern hemisphere and could very clearly show different mechanisms.

## 4. Shallow Cold Front (Australia)

This CM presents the situation of the Australian hot continent being affected by cold fronts, which consequently manifest themselves as shallow CFs. But the hot continent is only one meteorological input for the maintenance of such systems - in fact there are three different shallow CF types influenced by additional meteorological-physical effects like orography, land-sea and day-night contrasts. The weather activity, the forecast difficulties and the threats concerning bush fires manifest the importance of this CM.

## 5. Atlantic Convergence Zone

The South Atlantic Convergence Zone (SACZ) is characterized as a persistent cloud band in northwest-southeast orientation. It connects the southern Amazon region with the western portion of the Subtropical South Atlantic. This CM is an important weather feature mainly because of the heavy precipitation caused by convection. The risk of flooding is high during such an event, which may last at least for four days with quasi-stationary behaviour during the austral summer. This CM has no comparable similarity with extra-tropical Northern Hemispheric CM's.

## 6. Mesoscale Convective Complexes

Mesoscale Convective Complexes are frequent weather phenomenon in the northern part of South America. Heavy convective rain and hail are responsible for high damages on crops and properties. This CM is comparable with the Northern Hemispheric CM Mesoscale Convective System (MCS).

## 7. Cut-Off Lows

This is a particularly important CM for South Africa since it is connected with very severe weather events. Also the comparison with Cut Off Lows in other parts of the globe is very useful. It shows the principal processes that are same in all regions, and the different variants applied to the geographical specialities of the regions.

## 8. Continental Tropical Lows

This CM comprises three sub-types and shows thoroughly some of the most important weather systems in Southern Africa in the summer season. It can widen the knowledge of forecasters and students, and be an excellent tool in the operational forecasting. This is also an important addition to SatManu where tropical/subtropical CMs are not yet presented.

The second phase of the Project is still ongoing (January 2015 - March 2016), with seven new Conceptual Models to be completed and brought into the Online Catalogue. Brief descriptions of the CMs under development in CM4SH-II can be accessed at <https://docs.google.com/presentation/d/1VcM0rQUTW4jO1Gd1ZPzdIH-zTo8Jnx2IJdhXGmewBwU/edit#slide=id.p> The new CMs are as follows:

Argentina:

1. Bolivian High and the Relationship with Deep Convection
2. Cloud patterns associated with Cold Fronts in Central Argentina

Brazil:

3. Cyclogenesis and Extra-tropical Cyclones over South-eastern South America
4. Upper Tropospheric Cyclonic Vortices in the Tropical South Atlantic
5. Tropical Cyclones on Northern Atlantic

Indonesia:

6. Northerly Cold Surge in Indonesia

South Africa:

7. South African Cold Fronts

#### **4. Value of the project for users**

Working on Conceptual Models (CMs) has value for the operational users because it enhances their understanding of the weather systems affecting particular regions.

CMs are intended for operational users (forecasters) and for trainers in operational meteorology. The starting point is satellite imagery. The features seen in the satellite imagery are explained with the help of NWP information and by explaining the Meteorological Physical background for each Conceptual Model. Key Parameters for each Conceptual Model help the user to identify the key factors they need to check when analysing the Conceptual Model. To give the user a 3-dimensional understanding of the feature, each conceptual model also describes how the weather phenomenon is seen in Vertical Cross Sections. Finally, the link to observed weather is given.

Feedback given by team members producing the conceptual models describe how the process has helped them to further develop their skills and also the way the material produced has been used. Some feedback remarks are available in **appendix B**

#### **5. Value of the project for VLab**

The Project has been instrumental in getting the VLab CoEs more efficiently organised within their regions, as they connected research groups with operational and training groups. Trainers from the VLab CoEs also had the opportunity to acquire skills in retrieving, working and visualising data, which they can now transfer to peers and students in the region.

The project has also demonstrated how the different VLab CoEs can collaborate and assist each other. The developers have learnt to work in collaboration with other VLab Centres across the hemisphere, to harmonise the material to fit with the material produced in other centres, and to facilitate a discussion about different weather systems and expand the understanding of weather systems across the southern hemisphere.

The CMs produced in the first phase of the Project are already being used as training material in courses and workshops, showing a great value for education and training in satellite meteorology in the South.

## 6. Future and sustainability of the Project

As a part of the first phase of CM4SH project an inventory of CMs was created. It can be found at <https://sites.google.com/site/cmsforsh/inventory>. The inventory describes altogether 48 different large or small scale Conceptual Models. This inventory is the background database for directing the future actions on gradually completing the Online Catalogue. The decision on what CMs need to be described first depends on their relevance for understanding hazardous weather, then on geographical location and on the availability of a resource developer for the particular topic.

The sustainability of the Project depends on the continuation of funding from VLab partners. WMO and EUMETSAT have co-funded the Project for two consecutive phases. Consideration could be given to other areas of interest such as the Southern Indian Ocean, and the tropical Pacific, where CMs are yet to be established.

## 7. Conclusion

This document reports on the status of the project **Conceptual Models for the Southern Hemisphere** and presents the value of this project for VLab partners in the South.

A major challenge for VLab now is to ensure funding will be made available for the continuation of this Project, as this would certainly support the further collaborative development of the Centres of Excellence in the Southern Hemisphere.

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APPENDIX A

# **CM4SH**

## **Conceptual Models for Southern Hemisphere**

### **End Report**

**Vesa Nietosvaara and Veronika Zwatz-Meise**

#### **Introduction**

Satellite imagery and products are one of the key tools weather forecasters use in monitoring and forecasting the weather. The philosophy of using satellite material together with other meteorological material has aimed in the development of so-called “Conceptua Models”. Conceptual Model (**CM**) descriptions are material, which is widely used in weather forecasting as well as in training at universities and other meteorological training centers. Whilst there is an exhaustive amount of Conceptual Models described and presented for weather systems in Northern Hemisphere, there is not the same depth and spread of materia available for the Southern hemisphere. To balance this situation the project Conceptua Models for Southern Hemisphere (**CM4SH**) was initiated, see Appendix 1.

#### **Project Team**

Four VLab Centres of Excellence from Argentina, Australia, Brazil and South Africa took part in the project. All of them built a project team consisting of representatives from weather services and universities. The names of the team members involved in the final production of CMs can be seen here:

<https://sites.google.com/site/cmsforsh/contributors>

Project partner institutes represent very well the variable meteorological and climatological regions of Southern Hemisphere.

An European CM group, who had previous CM experience from “Satmanu” project (Manual of the Synoptic Satellite Meteorology) and EUMeTrain programme, supported the project partners, and offered training, advice and reviewing during the project.

External reviewers from NOAA and CIRA assisted in reviewing and giving feedback about the deliverables.

## Funding

The project was co-funded by WMO and EUMETSAT; WMO contributed through its the Education and Training Office EUR 20,000 towards the project and EUMETSAT EUR 10,000 plus the in-kind efforts for project oversight and management.

## Project milestones

The project was organised according to the following milestones:

Milestone	Duration
Nomination of teams and bids.	Jan 22. 2013 - Feb 01. 2013
Orientation Sessions.	Feb 13. 2013 - Mar 13. 2013
CMonSH 1st phase: literature survey and CM selection.	Feb 01. 2013 - Apr 30. 2013
Training Phase.	Mar 25. 2013 - Jun 28. 2013
Quick-look archive.	May 29. 2013 - Mar 31. 2014
Content development of Full Conceptual Models.	Oct 01. 2013 - Dec 31. 2013
Technical Presentation of Full Conceptual Models.	Jan 01. 2014 - Feb 28. 2014
Final publishing, reporting and evaluation.	Jan 31. 2014 - Mar 31. 2014

## Project phases in brief

- Orientation phase
  - This phase was necessary to come to a common understanding about the definition of CMs, the aimed use of CMs in the particular region, already existing Know How and the available technical background in the individual partner institutes.
  - Such a level of common understanding was reached with help of a questionnaire as well as presentations and information exchange in the online sessions.

The material (mostly Powerpoint presentations) as well as the summary of results of the questionnaire were collected and are available at:

<ftp://cm4sh-ext:xF28wp37@ftp.eumetsat.int/inc/TrainingMaterial/>

- Collection phase of typical CMs and existing literature
  - A literature list was the first of three defined deliverables of the project. The list is rather comprehensive especially for the CMs, which were selected for a detailed development. It can and will be supplemented for new CMs during possible consecutive phases.

- Training
  - Because CM4SH was an online-project, a detailed face-to-face CM training for all partners together was not possible. Training packages with relevant training material as well as region-specific questions were put together by the European CM group for five categories: 1) fronts, 2) jets, 3) cyclogenesis, 4) convection, 5) local phenomena. During five online sessions the project team discussed the important topics for each category using the training material. Possible modifications to or deviations from the existing standard models were discussed.
  - The results of meetings and the presentations of the partners were made available to the whole community.
  
- Collection of quick look cases
  - A quick-look archive was the second of the three defined deliverables of the project. This archive forms the nucleus of a continued wider archive of interesting cases not only for the selected CMs, but also for other interesting weather situations during possible consecutive phases.
  
- Selection and full development of
  - The following CMs were selected as important CMs and fully developed. Since this is the main final deliverable, a more detailed description is given later in chapter “Short description of the fully developed CMs”.
    - Argentina:
      - SALLJ (South American Low Level Jet)
      - Zonda and Puelche
    - Australia
      - Shallow Cold Front
      - Explosive Cyclogenesis
    - Brazil
      - SACZ (South American Convergence Zone)
      - MCC (Meso-scale Convective Complexes)
    - South Africa
      - COL (Cut off Lows)
      - Continental tropical Lows
      -
  
- Scientific Support and review phase
  - The scientific support by the European CM team took place in all phases. It culminated during the development phases of the CMs in form of “Get together meetings” during which special scientific topics as well as technical questions for the presentation of the treated CMs were discussed.
  - All three members of the European CM group reviewed all CMs and combined their comments to a review paper. The results were discussed via mail and – if necessary – in Get together meetings.

- The external reviewers from NOAA and CIRA as well as regional experts gave valuable comments during the final review phase.
- Technical finalisation
  - Technical finalisation was mainly done by the EUMETSAT team supported by comments from the European CM team

## **Deliverables**

1. An inventory of existing Literature of CMs existing in the whole SH
2. A Quick-look archive of interesting cases for CMs on the southern hemisphere
3. The two CMs selected from each partner and fully developed in a style comparable to Satmanu.

All above can be accessed through the following URL:

<http://sites.google.com/site/cmsforsh>

## **Short description of the fully developed CMs**

### SALLJ

This CM shows a typical weather situation on the South American continent in regions of Argentina where humid, warm and unstable air masses from tropical origin in combination with a LLJ can cause CB complexes with heavy weather events. There is no direct comparable CM exists in other parts of the world. It is therefore an important and very valuable CM for forecasters in the South American region; and it is a CM, which has the LLJ as a driving factor.

### Zonda and Puelche

This CM shows the mechanisms of Leeward side phenomena over high mountain ridges comparable with the CM Föhn on the Northern Hemisphere. It can really be an enrichment of the practical knowledge of forecasters and students and a tool for improvement of forecasting these events.

### Shallow Cold Front (Australia)

This CM presents the situation of the Australian hot continent being affected by cold fronts which consequently manifest themselves as shallow CFs. But the hot continent is only one meteorological input for the maintenance of such systems - in fact there are three different shallow CF types influenced by additional meteorological-physical effects like orography, land-sea and day-night contrasts. The weather activity, the forecast difficulties and the threats concerning bush fires manifest the importance of this CM.

### Explosive Cyclogenesis

This CM treats intensive and quick cyclogenesis over and close to the Australian continent and as such it is a very interesting supplement to the chapter of the shallow CFs. Both together describe two important synoptic scale meteorological processes for the Australian continent already in the first production step of the CM manual. But this CM raised also very important discussion about the differences of comparable weathers systems on the northern hemisphere and could very clearly show different mechanisms.

### SACZ

The South Atlantic Convergence Zone (SACZ) is characterized as a persistent cloud band in northwest-southeast orientation. It connects the southern Amazon region with the western portion of the Subtropical South Atlantic. This CM is an important weather feature mainly because of the heavy precipitation caused by convection. The risk of flooding is high during such an event, which may last at least for four days with quasi-stationary behaviour during the austral summer. This CM has no comparable similarity with extra-tropical Northern Hemispheric CM's.

### MCC

Mesoscale Convective Complexes are frequent weather phenomenon in the northern part of South America. Heavy convective rain and hail are responsible for high damages on crops and properties. This CM is comparable with the Northern Hemispheric CM Mesoscale Convective System (MCS).

### COL (Cut Off Low)

This is a particularly important CM for South Africa since it is connected with very severe weather events. Also the comparison with Cut Off Lows in other parts of the globe is very useful. It shows the principal processes that are same in all regions, and the different variants applied to the geographical specialities of the regions.

### Continental Tropical Lows

This CM comprises three sub-types and shows thoroughly some of the most important weather systems in Southern Africa in the summer season. It can widen the knowledge of forecasters and students, and be an excellent tool in the operational forecasting. This is also an important addition to SatManu where tropical/subtropical CMs are not yet presented.

## **Communication**

This project was designed as an online project – consequently the communication techniques were essential. Also the different time zones had to be taken into account.

Besides the typical electronic communication ways like mails, a project platform within "Active Collab" was used. Information about phases and milestones, announcements of online meetings and recorded sessions as well as some discussions were done via this platform.

For the online meetings a Saba Centra communication Software was used, and despite some common small technical problems it worked very well. There were 9 meetings for all participants:

- Kick off on 22 January 2013
- Orientation meeting on 13 March 2013
- Five “training meetings” between 9 April – 25 June 2013
- Review meeting on 2 December 2013
- Final meeting on 27 March 2014

All the meetings were recorded and the playback files can be found at

<ftp://cm4sh-ext:xF28wp37@ftp.eumetsat.int/out/sabameeting-recordings/>

During the CM development Phase “Get together Meetings” among the European CM team, the management and each partner separately concentrated on the topics of the specific CMs. These meeting were very effective.

In addition to the online communication methods, the project team also needed to choose presentations software, which could be used by all partners and allow a comparability of the deliverables. This was done mainly by the management team in EUMETSAT. A simple Power Point template was developed for the Quick look archive and – even more important – the Software Google Site/Drive was introduced for a final collection and presentation of all CMs.

As described in this chapter, communication among the widely distributed partners living in very different time zones worked very well. But as a very positive side effect of the project, communication among the different institutes within one country as well as within neighbouring countries was developed and/or increased.

## **Summary and Outlook**

The choice of these CMs seems to present a selection of very relevant and important weather systems in the different regions of the Southern Hemisphere. They can be used by forecasters for widening their knowledge but also directly for their forecasts. As a second application area, the whole material is an important package for training within the CoEs on the Southern Hemisphere, and not only there: it makes a lot of sense to combine and link the current SatManu with the CM4SH to get a global view.

All partners wish to continue CM4SH and some ideas already exist for this phase:

- Continue with the tropical CMs especially for Brazil
- Continue with important synoptic scale CMs especially for South Africa
- Developing CMs for Indo-Australian Region in respect to Island weather
- Develop so-called “Short versions” comparable to SatManu, but going also beyond this way of presentation and develop more graphical schematics for quick forecaster

## Appendix 1.

# Memorandum

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To :

From : USD/VN

Copy :

Ref. : EUM/USD/MEM/12/683665, v1 Draft

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Date : 18 December 2012

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Subject : **Project outline on Conceptual Models of Southern Hemisphere**

### ***Introduction***

The request for this project has come from the Management Group of the WMO / CGMS Virtual Laboratory for Satellite Meteorology and it has been endorsed by the CGMS at its recent meeting in Switzerland (Nov 2012), see below.

CGMS/VLab co-chairs	VI.1	40.9	CGMS to investigate the possibility to provide funding to the VLab CoEs in Argentina, Australia, Brazil and South Africa, to establish a project for generation of conceptual models for the Southern Hemisphere.	CGMS-41	OPEN
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Satellite imagery and products are one of the key tools weather forecasters use in monitoring and forecasting the weather. Whilst a great deal of literature and training resources exist utilizing Northern Hemisphere examples there is not the same depth and spread of material in the southern hemisphere. This project aims to improve this situation by reviewing the current examples of dynamically and thermodynamically consistent conceptual models for the Southern Hemisphere and creating the missing models based upon templates already developed for the Northern Hemisphere around the widely used SATManu publication.

When completed the material will be used by the Centres of Excellence in the Southern Hemisphere who will also participate in the development of the material.

## ***PROJECT OUTLINE***

The project will consist of several phases:

Phase 1 – Documentation and review of existing Southern Hemisphere conceptual models against typical southern hemisphere weather systems

Phase 2 – Development of missing conceptual models utilizing the SATManu templates and material.

Phase 3 – Testing of new and revised material by the Southern Hemisphere CoEs

Phase 4 – Initial publication of the material

## ***PROJECT ORGANISATION AND DURATION***

EUMETSAT has offered to act as overall project coordinator and manager and will contract a lead technical expert to support the work of the Centres of Excellence. Centres of Excellence will be able to bid for small amounts of funds to develop / adapt conceptual models and refine existing ones to the standard and layout of the SATManu examples for the Northern Hemisphere. Opportunities will be taken of conferences and workshops such as the CALMET workshop in August 2013 to showcase the work and bring the relevant experts together for discussions.

Project will begin 1 January. Phase 2 should be 90% complete by the end of calendar 2013 with the publication of the material during calendar 2014, date depending upon feedback from the CoEs in phase 3.

## ***DELIVERABLES***

An inventory of existing literature about Conceptual Models in the whole Southern Hemisphere.

Training of the methods in developing and applying Conceptual Models.

Descriptions or Examples of selected Southern Hemispheric Conceptual Models, preferably of Conceptual Models connected with hazardous weather.

## ***FUNDING***

WMO, through the Education and Training Office, has agreed to provide Euros 20,000 towards the project with EUMETSAT offering a further Euro 10,000 plus the in-kind efforts for project oversight and management.

## ***EUMETSAT's responsibilities***

EUMETSAT shall:

- a) Coordinate and manage the inventory of existing research and literature about conceptual models in the whole southern hemisphere;
- b) In partnership with southern hemisphere VLab Centres of Excellence, develop and describe conceptual models (or create case studies) in the southern hemisphere, using the SATManu templates and material;
- c) Assist in the testing of revised and new material by the southern hemisphere VLab Centres of Excellence;

- d) Publish the conceptual models via digital media;
- e) Provide a technical expert to lead the work and coordinate the input from the VLab Centres of Excellence;
- f) Submit six-monthly progress reports to the WMO Education and Training Office and the WMO Space Programme Officer.

***WMO's responsibilities***

WMO shall make available to EUMETSAT a maximum amount of EUR 20,000.00 (twenty thousand Euros) in 2013 as financial contribution to the implementation of the activities listed under paragraphs 1 (b), (c) and (d) above.

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## APPENDIX B

### FEEDBACK WRITTEN BY TEAM MEMBERS REGARDING THE VALUE OF THE PROJECT

#### Developers' Team - VLab CoE South Africa

*"My research students use it as a resource for their projects."*

*"We have a working partnership with the UK Met office training team and they have been using the CM's to get a better understanding of the South African weather systems. They are very keen for the cold front module to be finished."*

*"The CM's will be listed as "recommended reading" for the forecasting students at SAWS this year."*

*"As we are hosting more and more commercial training courses for other SADC countries, these CM's can now form part of the online phase of learning that must be completed before people arrive from training in SA."*

#### Developers' Team - BMKG

*"Previously, It was so hard to understand the meteorological information, especially for visual people like me. I didn't have any people to discuss with. Now, when I start to use ITACs, GraDS, process NWP, Vertical Cross Sections, analyse the satellite image, process the schematics...everything is like eye-opener for me. I will have colleagues to discuss everything with. I expand my options and confidence. "*

*"Developing the Conceptual Model has been an eye-opening experience for me, in a way that the work itself has accelerated my knowledge and understanding on atmospheric phenomena - as seen from space through satellite images or as observed from synoptic data and model output as well (being able to relate what is seen from the space and what is observed)."*

*"The ability to imagine what is going on in the atmosphere after learning to produce schematics has been the WOW factor to me so far."*

*"As an addition, being as challenging as it is, the idea of sharing our findings during the research work to forecasters in our NMHS would be a significant contribution to help them produce better analysis and forecast on Northerly Cold Surge and its impact to our region."*

*"Overall, developing CM has boosted my confidence as a researcher in talking about weather phenomena so much more than before."*

*"Strengthen my knowledge and skills especially in processing and analysis data using GRAdS."*

*"Strengthen my knowledge and skills especially in satellite image interpretation."*

