From research to operational training: Conceptual Models empowering young professionals

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Abstract

Innovation is believed necessary to enable training providers to address changing demands for skills, knowledge and unarticulated needs[1] in all fields of work. While the term "innovation" seems to call for something remarkably modern and technologically advanced, one should not forget that innovations that are based on creativity and the usually understated qualities of a committed team of professionals.

The innovation in training presented here has not used the most sophisticated learning technologies available, but it is unique in the sense that it implemented clear outcomes from scientific research into operational training. It was the combination of creative ideas, timely actions and informed pedagogical choices that made it a successful initiative. This innovation is centred on the "Workbook on the application of Conceptual Models in forecasting**,**" available in Spanish under the title, "Prácticas para Pronosticadores," which became the centre-piece for various training opportunities and new projects of the WMO Regional Training Centre (RTC) and VLab Centre of Excellence (CoE) in Argentina.

Developing Conceptual Models in the Southern Hemisphere

There is a consensus about the importance and usefulness of Conceptual Models (CMs) as a diagnostic tool in weather forecasting and training, but very few conceptual models of southern hemisphere synoptic and mesoscale weather events had been developed until 2013. This fact prompted training managers in the WMO/CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab)[2] to suggest an innovative collaboration for the VLab Centres of Excellence (CoEs) situated in the southern hemisphere, following the European example of the "Manual of Synoptic Satellite Meteorology - Conceptual Models" (or CMs SatManu)[3].

Steered by the VLab and managed by EUMETSAT, the first phase of the **Conceptual Models for the Southern Hemisphere (CM4HS)** project started in 2013, involving the VLab CoEs in Argentina, Australia, Brazil and South Africa. Phase two of the project, which started in 2015, counted on additional collaborations in partnership with BMKG, Indonesia. The aim of this project was for operational forecasters to improve warnings and awareness of weather risks through the use of CMs. These CMs were specifically structured to help forecasters integrate and interpret satellite data in combination with numerical model outputs and conventional observations.

CM4SH provided solid foundations for a successful innovation in training. Project management was done online and played a crucial role in the success of this collaboration. It consisted in defining the structure, planning lessons, defining milestones, and guiding the development of local cases in local language and in English. Academic support was always

[1] https://cognitive-edge.com/blog/unarticulated-needsdirections/
[2] https://www.wmo-sat.info/vlab/
[3] http://www.eumetrain.org/satmanu/index.html

present. Communication was active, including scheduling a series of online meetings, sharing documents and exchanging emails. The interaction between collaborators was essential to support and monitor progress. Project management also included the coordination of external reviewers, technical revisions of case presentation formats, and the organisation of a final face-to-face meeting to wrap up achievements.

Major two-way benefits of CM4SH:

- Researchers faced challenges regarding application of CMs in addressing real situations. They established contact with operational forecasters and prepared cases at various levels of complexity;
- Operational forecasters could incorporate the CMs originating from research into their analyses, adding value to forecasts, and confirming that research can actively support operational work.

Among the many unexpected benefits of CM4SH, the following were identified:
Human resources:

- improved relationship between those who participated in the project: university researchers, senior students, and professionals from NMHS;
- enhanced regional and international relations between project collaborators;
- good practices and further developed organizational and communication skills.
- interaction between the different groups that participated in the project, including university researchers, senior students and professionals from NMHS, was enriching to all, improving the relationship between academia and operational professionals.
- Regional and international relations between project collaborators began.
- Good practice and further developed organizational and communication skills set a new standard

Meteorological and technical improvements:

- utilization of new technologies in meteorology and consideration of new parameters in the forecast process;
- analysis of new case studies;
- increased research efforts.

The participants of this project valued the experience provided, particularly the openness and equality promoted among experts and less experienced researchers. They also welcomed the opportunity to learn about free access to digital learning materials and tools that are considered Open Educational Resources (OER), clarifying copyright practices and reusability policies. These have been adopted and promoted by project collaborators since then.

After the successful completion of this project it was perceived that although the CMs represented a valuable resource, they had not been as readily utilized by operational forecasters as intended, indicating a further step was needed to reach the goals: turning the CMs into interactive training resources to be utilized by the growing number of forecasters in the South American region.

Workbook on the Application of Conceptual Models in forecasting

The VLab CoE in Argentina identified that forecasters required updated training on local weather events and their impact, delivered in Spanish, to be widely accessible in their region. The CMs developed in the CM4SH project could be used to this end, but the training resources needed to contain activities that required "*getting into the forecasters own shoes,*" focusing on the challenges that require solving problems, making decisions about what steps are both important and urgent. Competency-based training has proved most useful for operational forecasters, and includes challenging learners to solve real problems they face at work.

Following WMO Education and Training Programme (WMO-ETR) recommendations on the use of active learning approaches that are engaging and immersive, a Workbook for forecasters was designed by the VLab CoE in Argentina, based on the four CMs they developed in CM4SH, and making use of *simulations* to resemble job conditions. Simulations can be powerful learning activities, improving forecasters performance as a result of requiring them to think deeply and to take timely actions. Because simulations offer a chance to attempt solving problems and checking the results of their actions, these quickly became very popular among forecasters in Argentina.

The Workbook was created by a task team formed by two aeronautical forecasters under the supervision of an experienced researcher from University of Buenos Aires (UBA) and a distance learning advisor. A group of reviewers, including meteorologists from academia and forecasters from operational settings, was consulted to identify areas that could be improved. An evaluation form was also added to the Workbook, allowing users to provide feedback after using the material.

The content of the Workbook is focussed on the application of CMs and the effective use of satellite images combined with other data to improve forecasting. It contains a variety of activities (Figure 1) intended to engage the learners on working past the initial set of ideas and into more advanced thinking to consider new ways to approach problems.

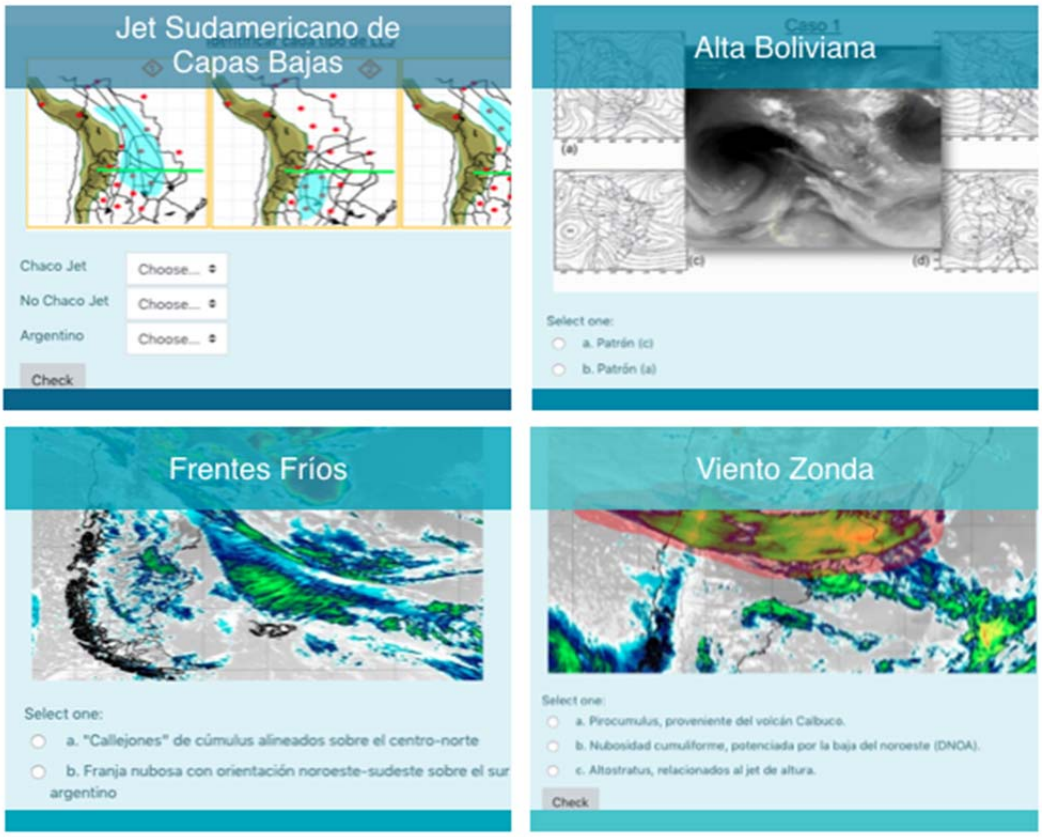

Figure 1. Examples of activities in the Workbook.

This Workbook is an open education resource, carrying the Creative Commons Atribución 2.5 Argentina (CC BY 2.5 AR)[4]. It was conceived to be shared within the WMO Global Campus community, so that others can reuse and adapt it to their own needs. We believe that the exchange of experiences and knowledge drives positive change, and we want to be part of this change. The Workbook is available to forecasters, university students and teachers at the WMOLearn website[5] (see: Collaborative Projects > Completed Projects), the WMO Global Campus E-Library[6], or directly at the SMN Moodle site at https://crf.smn.gob.ar/course/view.php?id=16

The evaluation of the Workbook has been very positive. We received excellent reviews from aeronautical forecasters, public weather Forecasters, and students and lecturers from several universities across Latin America. We also received recognition from heads at the National Meteorological Service of Argentina. It soon became evident that it would be valuable to more actively promote the availability of this OER among operational forecasters in WMO Regional Associations III (RA-III, South America) and IV (North America, Central America and the Caribbean), particularly, but not only, to the Spanish speaking countries. The actions taken to this end created far more training opportunities than we first envisaged (Figure 2). The following are the results of our efforts to apply and promote further use, adaptation and reuse of the Workbook.

[4] https://creativecommons.org/licenses/by/2.5/ar/
[5] https://public.wmo.int/en/resources/training/wmolearn#
[6] https://library.wmo.int

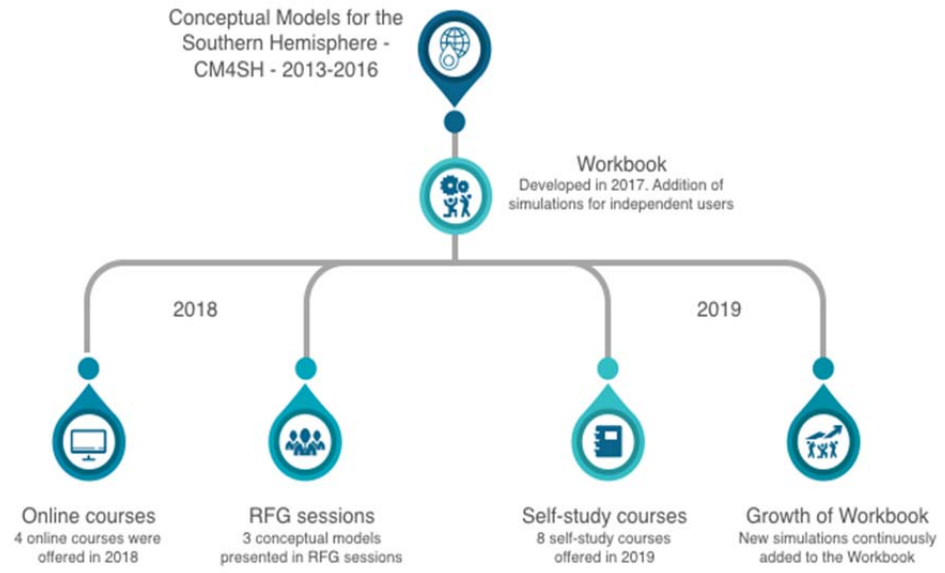

Figure 2. Sequence of training projects (RFG = Regional Focus Group, see below)

Online courses using the Workbook as the main training resource

In 2018 the Workbook became the core learning resources for four short courses delivered online in Spanish, for participants from WMO RAs III and IV. These courses engaged forecasters in competency training focused on high impact weather. The Workbook provided training activities to address all learning outcomes set for the courses. Because these courses were facilitated by trainers, this was a great opportunity to expose the Workbook to their scrutiny. They naturally became very involved and enriched the course by including additional resources, updated examples based on the new generation of satellites (GOES 16), and by developing summative assessments. The courses attracted numerous Spanish-speaking forecasters in the regions, creating a sense of belonging. Open discussions were stirred up in the Forums as forecasters and trainers shared valuable experiences from their shifts. These courses generated growing regional attention on the Workbook.

Participation in Regional Focus Group sessions

In 2018, trainers of the online course mentioned above were encouraged to make a presentation of a current weather situation representing the CMs they were teaching. The presentations were made in the sessions of the VLab Regional Focus Group (RFG) of the Americas and Caribbean[7] (Figure 3). This RFG meets online on a monthly basis to view and discuss satellite imagery and share information on global, regional and local weather events. The sessions are bilingual (Spanish and English) and conducted by experienced facilitators, who move fluently from one language to another, in a very natural way. These facilitators are also experts in the use of satellite images in operational meteorology from the Cooperative Institute for Research in the Atmosphere (CIRA) and National Oceanic and Atmospheric Administration (NOAA) and make these sessions a great opportunity to expose users to new generation of satellite data.

[7] http://rammb.cira.colostate.edu/training/rmtc/focusgroup.asp

The collaboration between trainers of the CM courses and RFG facilitators resulted in mutual benefits: trainers were supported on the organisation of material to present, selection of current weather situations to show the application of the conceptual models, and use of

visualisation tools such as slider (a tool for comparing two satellite products over the same geographic area to reveal features otherwise difficult to see). The RFG facilitators had additional presenters contributing to the sessions as well, which broadened the available expertise. There was also the added bonus that continues to benefit all participants of this VLab RFG—the inclusion of new participants who were exposed to this learning opportunity and motivated to keep attending the monthly sessions as part of their continuing professional development.

All sessions of the RFG of the Americas and Caribbean are recorded and made available in the RFG website shortly after the events.

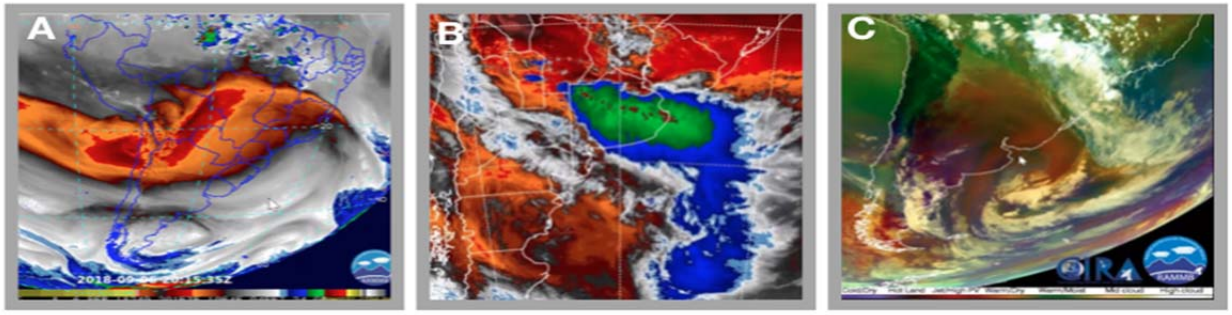

Figure 3. Presentations in RFG sessions: A) Zonda case (September 2018), B) Low-level Jet (October 2018), and C) Cold fronts (November 2018).

Self-study courses based on the Workbook

Due to budget restrictions and the desire to offer this learning opportunity to a larger number of participants, it was decided to turn the four online courses described above into self-study courses. While the self-study courses were not facilitated by trainers, they still preserved the opportunities for practice, as the simulations were kept as main course activities.

Another important decision to take when moving the online courses to a self-study format was related to assessment. It was noted that course participants highly valued the possibility of being assessed and receiving a certificate as evidence of their achievements. Not only course participants appreciated this, but also their managers, because this assisted them keeping track of training needs and skills development of their staff.

As a result of all these considerations, eight self-study courses were delivered in 2019. Because each of the four courses could be completed easily within one week of self-study, participants were offered one month to complete the set of four courses. This provided flexibility, allowing the participants to study at the time it was most convenient for them and take more time to try all course activities. At the end of the month-long timeframe, those who completed all the activities were offered the possibility to take the assessment. They had 2 options of assessment dates to choose from. Assessments took place online,

and they were also conducted in the format of a simulation (with 1.5 hours limit to be completed).

The continuous growth of the Workbook

The original Workbook adapted for self-study in 2019 has been continuously modified since then. This is because every time the self-study courses are offered, the new cases that were used for the assessments are subsequently added to the course material in the format of new activities (simulations). This means the self-study course material is continuously increasing the number of activities available for users to practice their skills.

While this strategy was mainly intended to be a way to keep the self-study courses updated and relevant, the process of regularly and intentionally looking for interesting new cases with which to create assessments generated an additional benefit—weather events of various intensity and impacts are now not only noticed by forecasters, but also recorded in great detail, adding greatly to corporate knowledge.

Another benefit is that operational personnel have grown their expertise by having been involved in the development of the simulations to be used as part of the self-study course assessments. For example, in 2019 two young aeronautical forecasters were taking turns designing the new assessments. This provides the opportunity for development of their own skills, while also creating greater exposure in operational offices of the value of using conceptual models and simulations in training and continuing professional development.

Some final words

The benefits reached after this chain of efforts were far greater than expected. Young professionals had the opportunity to be involved in a variety of tasks related to training. Some worked on scientific transfer of research to operations when developing the CMs, others developed activities and simulations for the workbook, while another group of young professionals became trainers in the online courses, and many actively participated in the courses as learners and in the RFG discussions as colleagues. In addition, more 648 were trained in the courses that were offered since 2018.

In our experience, innovation in training proved to be challenging and demanding, and therefore engaging to researchers and operational meteorologists alike. There were many unexpected obstacles that had to be dealt with for the continuation of the project. We learned that successful innovations can reinforce and encourage positive behaviours, such as collaboration between professionals from various organizations--local, regional, and global. Coordination was key in order to align all the diverse elements that were part of this training innovation, and once the mind-set of the team was set on making a difference to drive positive change, ideas connected and accumulated. Collaboration made space for creativity and generated new ideas for future projects. Working as part of a team, managing difficult situations, coordination, organisation and collaboration are but a few of the transferable skills acquired and practiced by all the professionals involved in this innovation.

We often hear that "*variety is the spice of life"*, and that this is also true for sparking creativity. New experiences, knowledge and skills also enable the brain to form a much larger combination of connections, resulting in more original ideas. So we can envision how this sequence of positive learning experiences will trigger other useful learning projects. It takes just a few innovators who *care* to get it started, and a very dedicated and enthusiastic team to coordinate the efforts to make it happen (see Figure 4).

Figure 4. The workbook team (from left to right) Henrique Repinaldo, Denise Auzmendia, Bárbara Lapido, Luciano Chiappari, Pablo Talarico, Rodrigo Cortes

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