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Training Development Plan
Mesoscale Convective Systems in Southeastern South America

Overview

The goal of this blended course (online course, workshop, and informal training) is to help forecasters in dealing with development of MCSs. Four countries in South America (Argentina, Paraguay, Brazil and Uruguay) are affected by these phenomena which produce dramatic impact on the population and economic activities. This course is intended to improve the forecast in the region by integrating forecasters from different countries, working together with the guidance of experts. The importance of achieving the goals of the course is highlighted in consideration of the needs presented in the project ALERTAR.

The MCS conceptual model, developed within Conceptual Models for the Southern Hemisphere (CM4SH) project, presents the features of the different types of MCSs in the region and the influence of low level jets, in a concise and practical manner, based on satellite information and model output. In this course the forecasters will take advantage of this conceptual model to evaluate the importance of each piece of combined information (NWP, satellite images, cross sections, and surface based observations) and its contribution to an early forecast. Discussions based on forecasters' skills and experience will enrich the process. The participants will be guided towards working out tools to improve the forecast. Opportunities are offered for the forecaster to incorporate the new parameters into the analysis. It is expected that a common forecasting methodology may arise from this experience and be defined for the wrap up.

This course would benefit from a blended format with considerable short time length (pre course preparation is necessary). It is recommended to have a follow-up stage during one year to keep track of MCS events and forecast performance.

Audience

- Primary audience: forecasters at airports in the region of interest and forecasters working in the operation office of the National Weather Service or Meteorological Centres of the countries involved. A regional participation is recommended, at least 2 forecasters from each country. The participants are expected to have varied backgrounds and experience.

- Secondary audiences: meteorologists interested in synoptic and mesoscale phenomena, involved in training, research or management, who would benefit from the course and also provide necessary feedback.

Learning Needs

- A training needs assessment is carried out to determine the highest priority needs regarding the forecast of hazardous weather in the region of interest. The objective of the training program is to make each forecaster competent to perform the Job Tasks at a high level, specifically to improve warnings and awareness of weather risks due to MCS. The result of the needs assessment shows the most critical performance gaps (between the required competency and the current job performance) related to skills, knowledge and attitudes that can be addressed by training.

The needs assessment process is planned taking into account: a) the target audience for needs data b) method of data gathering and c) data analysis strategies.

A study of performance evaluations, reviews and past training records is necessary to develop a training needs analysis and classify the findings by order of importance. The final report contains the results of the analysis and recommendations for developing an action plan.

- **Planning Phase**

  a) Target audience for needs assessment: forecasters from countries in the region of interest, managers, experts, customers.

  b) Method of data gathering:

  - Examine existing competency standards: organizational and international competency standards and best practices.
  - Educational curricula standards.
  - Standardized assessment structured observations.
  - surveys,

- interviews,

Relevant data is collected in the order suggested by steps 1 to 4 below. Some examples of tentative questions are presented and subject to revision. The questions may be open-ended or closed (rated from 1 to 5).

Step 1- Check the definitions of desired Job Competencies:

- Are they authentic? , High level? Clear and concise? Assessable? Sufficient?

Step 2- Compare the desired competencies to existing knowledge and skills.

- Which are the main forecasters' responsibilities in the presence of severe storm development?
- Is the accuracy and timeliness according to expectations?
- Which techniques and tools do forecasters use?
- What is the consequence of selecting certain parameters/ satellite images?
- Which is the forecaster`s experience level and type, regarding MCS?
- Which are the physical processes involved in mesoscale convective systems (according to the state of the art)?
- Are forecasters aware of the regional characteristics and climatology of MCS?
- Which are the most challenging tasks during MCs forecast?
- Which are frequent problems?
- What are the differences in how successful forecasters perform the job compared to less successful ones?

Step 3- Needs Analysis to determine the source of the gap with the information gathered. Distinguish the lack of knowledge and skills from the rest. Maybe additional interviews to managers, experts and forecasters are necessary.

- What prevents good performance on the job?
- Are procedures in place for performing the job?
- How is the job changing in ways people are not prepared?
- Which numerical models do you use for forecasting?
- Where do you get that information from?

- Which variables do you analyse for MCS?
- Are they different to the ones you use for other meteorological situations?
- Which levels do you consider for development of convection?
- Do you use satellite images? Which products? Which web pages do you check?
- Do you have radar information? If so, which products do you look at?
- Do you use soundings? How often?
- What new tools and techniques are available to improve performance?
- Are forecasters prepared to use them?

Step 4- Determine priorities. Gather additional data from forecasters, managers, experts, customers.

- What problems or mistakes are reported most frequently?
- Which of the following knowledge and skills are most in need of training? (list)
- Are the new tools essential for forecasting MCS?

Recommendations

- The Learning Needs Assessment process has to be well planned beforehand, it should be agreed upon by representatives of each country. There must be a common set of questions. The option: N/A (not applicable will be used when necessary).
- An introductory document must be written to present the regional training project and needs assessment activities.
- Focus groups within each country to gather local data.
- Carry out a set of interviews to forecasters and managers by web conference or in person where possible.
- A survey will be distributed to all after the set of interviews. The same survey for all countries so it is comparable.

Performance/Learning Outcomes

The **outcomes** of this course comply with WMO Aeronautical Forecasters Competency (higher level) and WMO PWS Competency. Background knowledge and skills are implicit in these outcomes.

♦*Produce a diagnose based on the analysis and monitor* of the weather situation applying the MCS conceptual model (include: weather parameters, satellite images , radar, surface observations and evolving significant weather phenomena).

Determine relevant conclusions from the analysis of : Interaction between SALLJ and deep convection, VIS, WV and IR images, and TRRM satellite imagery, Different types of LLJ , their life cycle and variability, Bonner criterion 1 (to identify SALLJ events), Vertical structure of the SALLJ events, Meridional wind, Equivalent potential temperature, Meridional moisture transport, Convergence and vertical motions.

♦*Forecast relevant weather phenomena* and parameters: temperature and humidity, wind including temporal and spatial variability (wind-shear, directional variability and gusts), cloud (types, amounts, height of base and vertical extent), precipitation (intensity and temporal variations, onset/cessation and/or duration, amount and types), and associated visibilities.

♦*Forecast hazardous weather phenomena* consisting of organized systems of thunderstorms and associated weather events (turbulence, in-flight icing, hail, and heavy precipitation with poor visibility, electrical phenomena, down-burst/microburst or gust front, tornadic activity):

- Forecast the spatial extent, onset/cessation, duration, and intensity and temporal variations of the MCS based on the conceptual model.
- Prepare and issue the forecast of MCS and associated parameters in accordance with documented requirements, priorities and deadlines.
- Issue Warnings in a timely manner when MCSs conditions are expected to occur or when parameters are expected to reach documented threshold values, and updated or cancelled according to documented warning criteria, in accordance with ICAO Annex 3, WMO-No.49.
- Ensure that warnings of hazardous weather phenomena are consistent (spatially and temporally) across boundaries of the area of responsibility.
- Monitor forecasts/warnings issued for other regions, and liaison with adjacent regions as required.

♦*Determine the need for cancellation or amendment/update of forecasts and warnings* according to documented thresholds and regulations based on the analysis and monitoring of the weather situation (mentioned above).

♦*Communicate meteorological information to internal and external users:*

- Communicate concise and complete forecasts/warnings in a manner that can be clearly understood by the users responding to users requirements,
- Explain aeronautical meteorological data and information, deliver weather briefings and provide consultation to meet specific user needs.

Specific performance gaps to be addressed.

G*ap in forecast quality* (based on verification results)

The course addresses this gap by providing forecasters with a useful tool. It is expected that the understanding and application of MCS conceptual model will help improve forecasts, and thus provide a better service.

C*ommunication gap*

a) Communication among forecasters (within a country and with neighbouring countries) is addressed in this course by developing a common methodology and criteria incorporating new forecasting tools for the entire region.

b) Communication with clients and with the community is addressed by a deep understanding of the phenomenon and how it is detected (evidence), by a consensus on the forecast criteria, and thresholds for warnings.

c) Communication between research meteorologists and forecasters is increased by working together and learning from each other.

d) Communication between new and old forecasters improves by both acquiring new skills at the same time and being given the time to work together.

Content Scope

- **MCS in South Eastern South America**

- *Physical background* related to the development of MCSs and Low level Jet.

Three different types of SALLJ: Chaco Jet Event (CJE), No Chaco Jet Event (NCJE), Argentinian Low Level Jet (LLJ-ARG). Seasonal and diurnal cycle of convection, Life Cycle of SALLJ, Secondary ageostrophic

circulations, Interaction between SALLJ and deep convection. Connection between SALLJ and the upper-level jet (ULJ). Three main types of MCS: Squall line, Symmetric System, MCS with embedded supercells. Significant weather events related to the occurrence of MCS in the presence of SALLJs: heavy precipitation, gusts, hail, lightning, and tornadoes.

- *Cloud structure in satellite images* that correspond to MCS. VIS, WV and IR images, and TRRM satellite imagery

- *NWP key parameters fields related to MC*S.

Bonner Criterion 1:
Wind shear 850-700 hPa, isotachs and wind vectors at 850 hPa.
Equivalent Thickness 850 -500 hPa and TFP
Moisture convergence and Thetae at 850 hPa

- *Vertical cross section fields* to determine development of MCS.

Meridional wind at 850 hPa, Equivalent potential temperature, Meridional moisture transport, Convergence and vertical motions.

- *Analysis, Diagnoses and Forecasting techniques*.

- *Warnings*: decision making related to MCSs

Learning Solutions

- **Constraint Analysis**

Criteria for choosing the level of formality

Specific learning outcomes must be achieved. The new concepts are complex and so the role of the teacher is necessary.

Formal assessment is recommended but certification is not required. The skills involved in this course should be learnt and applied as fast as possible due to the frequent occurrence and the devastating effects of MCS in the region. Forecasters are scarce, difficult to replace, so the time available for the course is restricted.

In addition to the above, the forecaster needs to be given opportunities for improvement through individualized learning solutions to put the conceptual model in practice. The participants are professionals, independent learners and responsible for their own training. They can cope with the challenge and would benefit from discussions and team work. In this informal or semiformal manner, the role of the trainer is to offer advice. Achievement should be documented (informal assessment).

Comment:

MCS in the region is important (loss of life and property). Two major projects **Alertar** and **Relámpago** are on their way and this training course could contribute to these projects.

This is regional training, so it involves the institutions of 4 countries which have different characteristics.

- The criteria to consider before choosing the **learning solution** are classified into three categories: practical, learning needs, pedagogical values.

Practical

Time and complexity have been mentioned above.

Budget: classroom meetings require a considerable budget due to travel expenses (tickets, lodging and food) of participants and instructors from different countries. Some other expenses could be taken care of locally. Instructors` costs/reimbursement must be worked out.

An online course requires budget for IT support and instructors (no travel expenses).

Budget for course development is included in instructors` fees.

Geographical distribution: forecasters from four different countries and different places within each country. Instructors from Eumetrain, Argentina and Brazil.

Training staff availability, skills and content expertise: Argentina and Brazil have experts in this topic. Eumetrain expertise and experience is necessary. Forecaster's skills would be needed for support. Although it is easier for trainers to be available for online courses than face to face, online courses usually require more time for preparation.

Student audience size: a selection of forecasters from the Forecast Office and Aeronautical Office in the region. The number should be as big as possible but the training must be manageable. For online training about 20 students per instructor but for classroom meetings the number is restricted due to travel costs.

Learning needs criteria

There is *prerequisite knowledge*. The course aims at high level forecasting. *Diversity of students*: from different countries and levels. Languages: mostly Spanish but consideration for Portuguese speakers. Some sessions could be carried out in English (translation might be required).

Frequency of application of learning: the possibility of occurrence of MCSs is several times each year. The impact may be very large.

Longevity of the instructional content: high, but could be updated with new information if needed.

Nature of the task: forecasters' competencies vary between aeronautical and central office forecasting.

It is desirable to build an ongoing community of learners among the 4 countries.

Pedagogical Values

Collaborative learning in a constructive environment is suitable to adopt the MCS conceptual model for South Eastern South America. The follow up can take place in the natural environment (on the job).

Recommended Learning Solution:

Blended learning solution consisting of: an online course as a first phase, an informal second phase, and a classroom workshop to wrap up.

First phase: **Online course on Moodle platform**

It is a formal learning solution that must take into account practical concerns.

Time: 40 hours during 1 month- intensive online training to become familiar with the new conceptual model. Although the conceptual model has been developed, the content of the online course must be prepared and it would require 1 month.

Budget: the general planning is being carried out with the support and guidance from WMO training course. The development budget is mainly for teachers (3 trainers see below), 1 forecaster as consultant, and 1 IT person to manage Moodle platform.

Budget for the content preparation could be added to training staff budget.

Training staff:

1 Eumetrain expert, 2 local experts from CM4SH (from Argentina and Brazil), 1 forecaster for consultation (could rotate from the different countries), 1 IT person to manage Moodle platform.

If the number of participants of the online course is increased, more trainers will be needed.

Training staff availability for the online course is easier to get than for a face to face course. The skills of the training staff are guaranteed.

Student Audience Size: 30 forecasters is the approximate number that can be managed, the distribution should be proportionate to the forecasting responsibilities of each country.

Regarding Learning Needs, a specific pre-course could be prepared for the ones that need it.

Because of the importance of the goals of this course, the students need to be given the 40 hours dedication. Assessment is necessary. The learning outcomes of the first stage must be met to continue with the second phase of the project.

This course is based on collaborative learning; in this way, it will be consistent with constructivist and learner centred principles.

Second Phase: **Informal solution**

All forecasters that have passed the first phase will continue with this second step. The forecasters will integrate knowledge and skills on the job and discuss with colleagues and trainers. Individual doubts will be taken care of in this way. This is time for the forecaster to work independently, adjust to the practice of the organization and get ready for the third phase. A report on how the application worked will be sent to the training team

This phase will be alotted 1 month. Budget is provided for trainer`s guidance and consultation. Moodle platform is available.

Third Phase: **Workshop**

The importance of this phase must be highlighted. The forecasters and managers must be confident on the operational application of the CM. Coordinated forecasting of these events will be a major breakthrough. There is successful experience in carrying out workshops in Argentina. Ideally 30 participants may attend.

That involves budget for travelling expenses for participants and trainers (same 3 trainers as on the online course).

The workshop is planned at the end of the project to make the most out of it and it is reduced to 3 days to lower expenses and to concentrate the effort. The detailed organization of the workshop requires another document.

Ongoing support for 1 year is recommended and would take into account results and opinions (feedback) from the online course and workshop.

Evaluation of the learning process will be carried out for each phase and as a whole.

Learning Assessment

- *Initial Assessment*.

Due to the variety of forecasting methods used by the participants, it is necessary to have an initial assessment for the participants to analyse their own practice regarding MCSs; and for the instructors to have a baseline.

1st part online course

- *Formative Assessment.*

Quiz (Multiple choice and feedback), to show the application of each part of the conceptual model in the analysis and forecast.

- *Summative Assessment*.

At the end of the online course the participant will solve a simulation assessment (on **SIM**): forecasting MCS (two case studies).

Informal learning

- *Formative assessment.*

Short Essay questions (2) on forecasting issues should be worked out during the month of independent learning. The forecaster will be given a detailed rubric stating the expectations for the assignment and standards for a quality performance. The aim is to check consolidation of MCSs forecast method. (spatial extent, onset/cessation, duration, and intensity and temporal variations MCSs and associated hazardous weather).

Workshop

- *Wrap up oral presentation:* each participant will draw their own conclusions of challenges and benefits of this method of coordinated forecast of MCS in the region.
- *Integrated Regional Assessment (group work):* a Simulation to put into practice a common forecast method. Issue Warnings across boundaries; determine the need for cancellation or amendment/update of forecasts and warnings. Communicate and explain meteorological information to forecasters in different organizations (of the 4 countries involved) and users.

Ongoing support for 1 year

Build a Portfolio of interesting cases to check the application of the conceptual model in the region. Forecast communication and verification.

Training Evaluation

- Since this is a pilot project, it is important to evaluate the effectiveness of this training and get feedback for improvement on the basis of this evaluation. The following methods will be used for each of Kirkpatrick's levels of evaluation. Corresponding qualitative and quantitative information will be required.

Level 1: Reaction- (participants' satisfaction) for each part of the project- online, informal learning, workshop, ongoing.

Method: Quiz (with statistical analysis) containing questions on: a) learning methods and material specially for online course and workshop: was the content relevant, were the activities engaging and formats suitable, assessment related to given material, were the learning outcomes satisfied, specifically the use of SIM, time available, use of forums, peer exchange, b) trainers support and interventions on all 3 parts and later ongoing support , c) Facilities (Moodle or workshop) and domestic arrangements (for workshop) d) administrative arrangements (for all phases)-

Level 2: Learning- (knowledge, skills and attitudes)

Method: analyse Assessment Quizzes, SIM assessment, Essay questions- Forecast verification (during annual ongoing phase).

Level 3: Behaviour- (application of learning, considering each forecaster and the coordination of the team of forecasting offices in the region)

Method: carry out Interviews (focus groups, managers). Documented Observation of behaviour on the job during 1 year (ongoing phase). Analyse the Portfolio (built during 1 year).

Level 4: Results- (attributed to the learning project)

Method: Quiz to stakeholders (community, authorities, others). Interview to managers of forecast offices. Documented facts or evidence of benefits of early warnings and avoiding false alarms. Look for signs of recognition of value.

Learning Activities

The goal is to challenge forecasters to think more deeply about MCS development and to ensure they can apply what they have learnt.

The **active learning strategies** chosen are:

- Discussion strategies,
- Inquiry strategies,
- Case-based strategies

These strategies demand the forecasters to carry out analytical thinking, decision-making, creative thinking, problem solving, evaluation, or to complete practical tasks that require some combination of them.

The main active learning tactics for each phase of the training are presented here:

Discussion Strategies

a) Learner-centred discussions

For *Online phase, Independent phase, Workshop phase*

b) Small group discussion: Discuss the same topic and compare outcomes or discuss a different topic and then share results with the large group. It is convenient at first to have them grouped by country.

The following strategies apply for *Online phase, Independent phase and Workshop phase:*

Inquiry Strategies

a) Practice exercises.

For *Online phase*

b) Questions and Issues.

For *Online phase, Independent phase, Workshop phase.*

c) Problem-driven.

The following strategies apply for *Online phase*

Case-based Strategies

a) Simulation. It consists of 3 parts: a) briefing b) activity, c) debriefing

The following strategies apply for O*nline –phase and Workshop phase*

Note: Simulators also provide consistent and more objective methods of practical assessment which will be used in the *Online phase* and *Workshop phase* as well as.

b) Case studies: provide an opportunity for forecasters to go through a weather event and also learn the underlying knowledge and skills required to make the forecast decisions.

Reference: Comet Case Study Development Guide and Case-based Modules, Eumetrain Case Studies

The following strategies apply for *Online phase:*

Collaborative Decision Making

For Workshop phase

- *Roles of trainers and learners during the training*

Role of the trainer: Limit lecture or explanations to short, but critical points. In Discussions and Collaborative Decision Making, the trainer provides guidance, but without a rigid structure, allowing for creative freedom and evolving team dynamics. The trainer uses a series of questions to guide learning, and offers input only when no student can answer, or when it can expand the discussion.

Simulations and Case studies require a lot of preparation, planning and implementation therefore, the trainer must communicate with content developers and IT person. Online training requires a lot of dedication from the trainer to maintain the forum active and offer support to the participants.

Role of learner:

Participate actively, communicate with peers and tutors, provide input from personal experience in forecasting, have an open mind to incorporate new skills and knowledge and apply them, make a positive contribution in teamwork, responsible in his work and attitudes, make decisions based on sound analysis.

The learner must comply with all the activities proposed.

Resources

Human Resources: The amount of participation of each person is dependent on demands of each phase of the training process

Project manager and Project lead TBD:

the *Project Manager* should have experience, could be external or internal,

the P*roject Lead* should be involved full time, internal.

Trainers for the three phases TBD*:* a minimum of 3 meteorologists (from Argentina, Brazil, Eumetrain)
2 more Trainers for online and workshop phases

Content experts: 2 meteorologists involved in CM4SH (1 from Argentina and 1 from Brazil)
3 trainers and 1 professional from training department SMN.
2 reviewers (reviewers of CM4SH).

***Training support*:** 1 professional from training department for pedagogical support, internal
1 IT professional (for Moodle platform and tech support), internal
1 forecaster for proof test and consultation (experience in nowcasting), internal

Audience Size: 30 forecasters from 4 different countries.

1*. Online phase* (as mentioned above)
Training staff: 3 experts from CM4SH (Brazil, Argentina, Eumetrain)
2 additional trainers

2*. Independent phase*
Training staff: 3 experts from CM4SH (Argentina, Brazil, Eumetrain)

3*. Face to face Workshop*
Training staff: 3 experts from CM4SH (Argentina, Brazil, Eumetrain)
2 additional trainers

Note: organization of workshop according to WMO Guide (personnel for planning and delivering the workshop).

Ongoing support for 1 year: Project manager and Project lead together and 3 experts from CM4SH and support from training department (IT and pedagogical)

Content Resources activities, case studies, data

Short readings or presentations:

Pre course:

Material for background knowledge revision of basic synoptic and mesoscale processes.

Prepare a module based on: Comet/ Eumetrain/ lessons from University of Buenos Aires/ material from CPTEC and NWS of Brazil and Argentina

Glossary

Forecast process as in Comet´s Guide page 13,

Online phase:

CM4SH site link (bilingual) MCSs and LLJ

Topic for discussion (based on the conceptual model)

Questions and issues (based on the conceptual model)

Practice exercises based on MCSs and LLJ quick looks

Problem driven activities

Develop a Case study based on Comet Guide and CAeM site http://www.caem.wmo.int/moodle

Develop Simulation

Quizzes

Independent phase

Develop material for practice and revision. Suitable for discussion, questions and issues based on the feedback from online phase. Special event on convection or severe weather if suitable from http://training.eumetsat.int/

Workshop phase

Develop material for discussion, questions and issues, simulation.

Follow up phase

Regional Focus Group (RFG): online sessions organised by Argentine COE (Centre of Excellence, participants get together on a regular basis to discuss with a trainer "practice-based culture, strengthening regional collaboration amongst professionals."

- *Known gaps in required content resources*

Application of the conceptual model will depend on the availability and quality of satellite images and model output, observed data. Forecasters use different sources of information and different types of visualisation.

It is necessary to expand Data base of MCSs.

The content for practice exercises, case study and simulation will have to be developed.

Learning Resources and Tools

- *Technologies that will be used to support training development and delivery, including instructional technologies and operational equipment.*

A brief checklist to be developed with IT support.

- Computers with permission to view all that is necessary.
- Moodle platform taking advantage of all its possibilities for activities, permanent support (during course and follow up phase)
- Web conferencing system for webinars (Saba meeting or Webex)
- Case study requirements as described in Comet's Guide: online case study without data viewer, programme the case and add metadata information for search engines. Embed graphics and animations (search in Comet´s Met Ed website for examples). Audio narrations and interviews with forecasters, pilots and other forecast users. Videos. Hotspot or drawing interaction, clickable.
- Simulator (specified in annex by IT support)
- Suitable internet capacity, Wi-Fi for workshop.
- Post event surveys and evaluation (Surveymonkey)
- Advertising communication channels.
- Screen and projector for face to face presentations.

Milestones and Schedule

Relative timeline

Project Plan completed		1 month
Learning needs assessed		1 month (for basic information, to be continued)
Learning outcomes reviewed and approved		2 weeks (possible amendments)
Scheduling all resources (human, technical, facility)		2 month
Content outline developed		3 weeks
Learning resources developed or adapted		4 months
Training delivered (begin date/end date TBD)		
Pre course:	August	1 month
Online phase:	September	1 month intensive
Independent phase:	October	1 month
Workshop:	November	3 days
Follow up phase:	Dec to Nov	1 year
Training evaluation complete	end of November	2 weeks