CORDEX Central America and South America Training Workshop on Downscaling Techniques

25-27th June 2018, La Paz, Bolivia

Summary Report

by

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1. Background

In face of the strong need to foster coordination of downscaling initiatives for the South America and Central America and the Caribbean regions (SAM/CAM) and to pursue capacity-building activities in the region, the World Climate Research Programme (WCRP) through its major project CORDEX, in partnership with the Swedish Meteorological & Hydrological Institute (SMHI) supported the development of the CORDEX Central America and South America Training Workshop on Downscaling Techniques. The Workshop was hosted by the Laboratory for Atmospheric Physics, Universidad Mayor de San Andres. The overall goal of this activity was to support science-based sustainable regional development

and policymaking in the context of climate change in the region through a coordinated approach.

The Workshop was intended for PhD students and early career researchers in the field of climate science with background on regional climate. The main objective was to continue coordinating the CORDEX activities in the SAM/CAM regions. One of the goals was to update on available and planned empirical statistical downscaling (ESD) and regional climate models (RCM) simulations and to present an update of CORDEX-related research activities.

The 3-day Workshop held in La Paz, Bolivia, during 25-27 June 2018 was aimed to:

- To train participants on ESD methodologies and perform hands-on ESD experiments.
- To coordinate a collaborative research to explore the added value of downscaling (ESD and RCM) in a collection of regional phenomena.
- To foster the interaction/discussion between climate modelers and representatives from the user/impact community

2. Key issues

The Workshop was organized into three main building blocks: 1) Update on Regional expertise; 2) Training activities and 3) Coordinated collaborative approach. Based on these premises the Agenda was organized as follows:

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Invited speakers provided the context for main topics of regional concern. The invited presentations covered topics related to the overall WCRP activities, on-going research activities at the Laboratory for Atmospheric Physics, Universidad Mayor de San Andres, the impact of climate change on hydrology in the target region and on-going research on

regional climate science over the SAM/CAM regions. The update on regional on-going studies was also achieved through participants' poster presentations.

Several training sessions focused on ESD methodologies including hands-on experiments were developed in order to offer participants updated tools on ESD techniques. Additionally, a training activity on the use and interpretation of model outputs was also carried-on.

The coordinated collaborative approach was proposed to explore the added value of downscaling (ESD and RCM) in a collection of regional phenomena and to pursue the Interaction/discussion between climate modelers and representatives from the user/impact community.

30 participants from 11 countries within SAM/CAM attended the Workshop. Most of them were early career scientists. Additionally, 10 invited speakers participated actively on both, the scientific presentations and the training activities.

It is also worth to remark the attendance of representatives from the National Weather Service of Bolivia (SENAMHI) and from the Ministry of Environment and Water during the opening session.

3. Session summary

3.1 Invited presentations

The opening Session of the Workshop started with an overview of the general objectives and expected outcomes of the training Workshop. The CORDEX project was first introduced to the participants and an overview of CORDEX Empirical Statistical Downscaling activities was discussed. The invited presentations were envisioned to cover the most updated on-going research in the region and to identify research needs and gaps. With that in mind, invited speakers presented updates on the CORDEX activities within the SAM and CAM CORDEX domains (Silvina Solman for SAM and Roxann Stennett-Brown for CAM) and several invited presentations covered a variety of specific regional studies, including modelling challenges in Bolivia (Marcos Andrade), modelling activities in Brazil for the SAM and CAM CORDEX domains (Sin Chan Chou), modelling activities with the RegCM4 RCM within the SAM domain (Rosmeri Porfirio da Rocha), climate studies within the CORDEX framework focused on the CAM region (Ramón Fuentes-Franco) and hydroclimatological studies over Central America (Hugo Hidalgo). These presentations highlighted the need of further improvements on the quality of the downscaled data for a better representation of regional climatic features and for impact studies. The impact of climate change on water management in Bolivia was discussed by Jorge Molina. A summary of studies focused on assessing Impacts of climate change on the hydrology of Central America were also raised by Hugo Hidalgo.

These invited presentations allowed the participants having a broad overview of the most updated status of CORDEX-related research in the SAM/CAM regions.

It is remarkable that various modelling groups within the region are already working with RCM simulations at various resolutions, including very high resolution experiments for smaller domains, such as the 20 km, 8 km and 5 km resolution simulations with the ETA RCM over Central and South America and some specific areas such as the South Atlantic Convergence Zone in South America, conducted at the CPTEC/Brazil; the 25 km and 5km resolution simulations with the RegCM4 RCM over CORDEX-SAM and the Southeastern South-America region, respectively. It is also worth mentioning that some simulations using coupled RCMs (RegCM-ESM) have been performed at the SMHI, providing new tools to improve the quality of the simulations available for the SAM and CAM CORDEX domains. Finally, the updated summary of on-going activities on ESD for the South American domain and the most updated results of the Pilot Project over the La Plata Basin for providing high resolution information based on a variety of ESD techniques contributed to highlighting the relevance of incorporating various downscaling techniques for providing useful information for impact studies.

3.2 Training Sessions

Four training sessions were conducted during the workshop in order to give an introduction of the different downscaling approaches together with their advantages and disadvantages. Three sessions were related to statistical downscaling techniques and one session was dedicated to dynamical downscaling outputs, which were organized as follows:

a) A training session dedicated to the perfect prognosis approach. In this session, the analog technique was presented and used to downscale daily temperatures and precipitation in different meteorological stations over the Central America and the Caribbean and South America domains. Different validation measures were discussed. The Climate4R tool developed by the Santander Meteorology Group (https://www.meteo.unican.es/en/climate4R) was used to perform calculations. Trainer: Maria Laura Bettolli.
b) A training session dedicated to the Statistical DownScaling Model (SDSM) developed by Wilby and Dawson from Loughborough University https://sdsm.org.uk/software.html. SDSM uses a hybrid statistical downscaling approach which incorporates multiple linear regression and weather generator schemes to create the statistical models for the local variables. Participants worked with their own daily data of temperatures and precipitation from their regions of interest. Trainer: Roxann Stennett-Brown.
c) A training session dedicated to the model output statistic approach. The Regional Climate Model Evaluation System (RCMES) (https://rcmes.jpl.nasa.gov/content/statistical-downscaling) was introduced. Quantile mapping to correct simulated precipitation using TRMM observations was applied to RegCM4 simulations for the CORDEX Central America domain and RCA4 simulations for the CORDEX South America domain. Pointwise Statistical downscaling. Also, the delta method, quantile mapping and asynchronous linear regression were used to correct CMIP5 temperature and precipitation outputs for

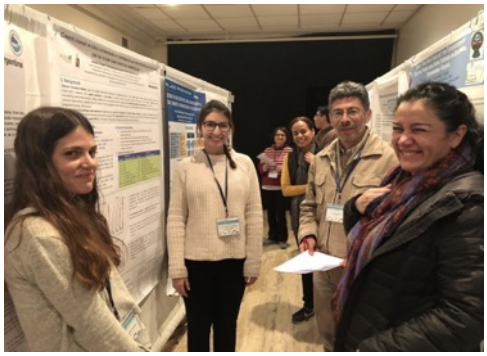
present and future climate at two points La Paz (Bolivia) and Buenos Aires (Argentina). Trainer: Kyo Lee.

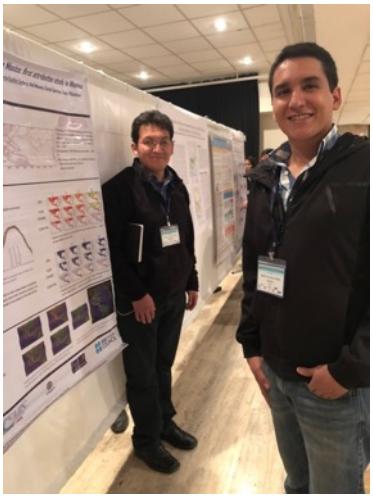
d) A training activity on how to use/interpret the GCM/RCM outputs. The training was focused on how to post-process the simulations to obtain results. It included an introduction to the basis of dynamical downscaling, a guidance of the Climate Data Operators (CDO) and GrADS tools to manipulate netCDF files including observations, GCM and RCM outputs; regridding exercises, calculation and interpretation of annual climatologies, GCM and RCM ensembles and seasonal analysis; evaluation of historical simulation and future projections. Trainers: Rosmeri P. da Rocha and Michelle Reboita.

3.3 Posters - Award

The poster Session was organized around 28 posters presented by the participants, covering a variety of topics. In order to allow time for in depth discussions, an important slot of time was given to poster viewing.

The poster Session was an excellent opportunity to discuss and discover the wide and diverse approach for coping with different phenomena of regional concern raised up by the participants.





Participants presenting posters were eligible to be recognized for outstanding poster awards. A distinguished review committee integrated by the invited speakers reviewed and identified outstanding posters given by early career scientists and students.

Members of the review committee have undergone a difficult task in grading the participant's posters considering 1) Scientific quality; 2) Clarity and 3) Aesthetics of the display.

Given the very high quality of the poster presentations, two categories were defined:
1) Best Poster award
2) Mention to outstanding posters

The presentations of the highest quality posters were awarded with a WCRP/CORDEX certificate and displayed in the CORDEX web site (www.cordex.org). Awards were presented during the closing session of the Workshop on the 27th of June.

The Review committee was integrated by Hugo Hidalgo (School of Physics, University of Costa Rica, Center for Geophysical Research, University of Costa Rica); Rosmeri Porfirio

da Rocha (Departamento de Ciências Atmosféricas - Universidade de São Paulo, Brazil), Marcos Andrade (Laboratorio de Física de la Atmósfera Instituto de Investigaciones Físicas Universidad Mayor de San Andrés), Jorge Molina Carpio (Institute of Hydraulics and Hydrology, Universidad Mayor de San Andrés, La Paz), Silvina Solman (CIMA/CONICET-UBA/ Department of the Atmospheric and Oceanic Sciences DCAO-UBA) and Maria Laura Bettolli (Department of the Atmospheric and Oceanic Sciences - DCAO-UBA).

The Winners of the Best Poster Awards were:

- *Yaritza Gomez* (Centre for Atmospheric Physics,Institute of Meteorology of Cuba) and
- *Alan Jesus Garcia Rosales* (Institute of Astronomy, Geophysics and Atmospheric Sciences. IAG, Brazil)

The Mention to Outstanding poster presentations were given to:

- *Daniela Osses* (Agroenergía Ingeniería Genética S.A, Chile-Facultad de Ciencias Agronómicas, Universidad de Chile, Santiago de Chile, Chile)
  and
- *Maria Mercedes Poggi* (Department of Atmospheric and Oceanic Sciences, Faculty of Exact and Natural Sciences, University of Buenos Aires; National Council of Scientific and Technical Research, Argentina)

Congratulations to the four winners!

3.4 Brainstorming activity

A brainstorming activity was developed in order to discuss and identify specific regional phenomena to explore the added-value of downscaling. The design of possible collaborative research focused on these phenomena was also a main subject of this activity. To this aim, participants, invited speakers and trainers split up then into break-out

groups according to their research interests. Groups reported back with a 5-minute presentation indicating: the research focus, objective, methods and data, expected results and timeline.

Five groups were identified addressing the following topics:

Group 1: Assessment of seasonal forecasting over South-Central America.

This group was integrated by participants from Mexico, Argentina and Brazil. The focus of this group were extreme events and their seasonal prediction. To address it a quantitative validation of CFSv2 seasonal forecast and exploration of the added value of the statistical downscaling over two specific regions (Southeastern South America and Mexico) was proposed. This evaluation comprises mean and daily statistics, including extremes (dry-wet spells, heat waves).

Group 2: Investigating extremes: droughts and rainfall using biased corrected high resolution datasets in SAM and CAM

This group was integrated by participants from Brazil, Jamaica, Colombia, Guatemala and Cuba. The focus of this group was extreme rainfall and drought over tropical latitudes. The objective was to evaluate RCMs and a statistical downscaling method to reproduce extremes in the present day and future projections for tropical latitudes (SAM and CAM). The evaluation includes the quantification of the magnitude and frequency of the extremes (continuous Dry Days (CDD) and number of hot days) and the evaluation of the spread of the GCMs and of the biased corrected RCMs and statistical downscaled outputs.

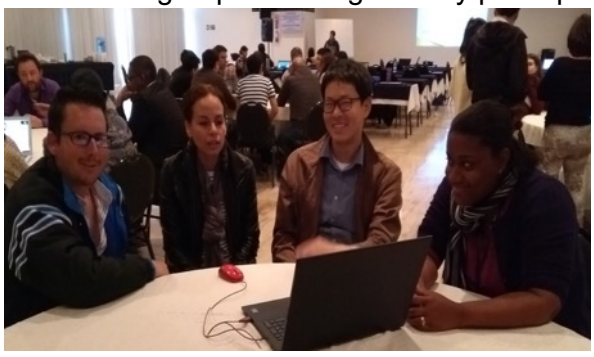
Group 3: Low level jets-Caribbean.

This group was integrated by participants from Colombia and Costa Rica. The feature of interest for this group were the low level jets. The modeling of low level jets in the Intra-Americas and the Caribbean and its relationship with precipitation will be evaluated together with the relation with the ENSO events.

Group 4: Representation of daily precipitation over the Andes

This group was integrated by participants from Chile, Peru and Ecuador. The focus of interest was the daily rainfall information over the Central Andes of South America. The generation of a database of station and satellite data for the region was the main interest. The simulation of the space-time variability over the region using RCMs and ESD methods was also proposed.

Group 5: Tropical Cyclones Activity in Atlantic and East-Pacific Basins.



This group was integrated by participants from Cuba, Jamaica, Mexico and the United States. The phenomena of interest were the tropical cyclones. The objective was to estimate the changes in cyclonic activity in the Atlantic and Pacific-East Basins based on the trajectories of historical tropical cyclones and predicted in global or regional climate models using he Tropical Cyclone Risk Model (TCRM) statistical model.

4. Outcomes

The three-day Workshop successfully provided a diversity of ESD techniques and analysis tools to the participants to cope with managing climate data for developing downscaled scenarios of climate change within the region. It has also provided the room for developing collaborative research focused on key regional phenomena identified by participants in

terms of physical and societal relevance. Through this activity participants gained a deeper understanding of downscaling approaches and they also developed skills in identifying common interests, needs for climate data and model projections and initiating the development of regional networks.

Additionally one of the foremost goals of the Training Workshop was to increase the CORDEX-SAM/CAM community and to promote developing collaborative research contributing to the CORDEX scientific challenges.

Key outcomes:

- Capacity building on ESD to improve technical capabilities of researchers within the SAM/CAM regions
- Collaborative coordinated research agenda on the added value of downscaling for regional phenomena over SAM and CAM
- Knowledge exchange, networking modelling and user/impact community
- Increased networking and dialogue amongst scientists within the regional community

The Workshop held in La Paz triggered the interest of representatives from the Ministry of Environment and Water of Bolivia. Eng. Oscar Meave, Head of the Special Studies Unit, Eng. Diego Inturias, representative of the General Planning Department and the Legal Advisor of the Ministry celebrated a meeting after the end of the Workshop with the Workshop co-chairs, Dr. Maria Laura Bettolli and Dr. Silvina Solman and the local organizer, Dr. Marcos Andrade, to discuss potential actions to help policymakers to cope with managing future water stress in the region.

CORDEX was introduced to the referred stakeholders who demonstrated a great interest on CORDEX products and manifested their willingness to further interact with the CORDEX community to foster capacity building activities in Bolivia.

5. Future

Future actions include the exploration of possible future activities, such as meetings, training activities and webinars, and potential funding to continue enlarging the SAM/CAM community and to start developing collaborative studies for both future research and capacity building efforts.

Acknowledgements

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