Parallel Session A:
Advances in regional downscaling

A1: Uncertainties and added value

POSTER PRESENTATIONS

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-01

Evaluation of the Climate Forecast System version 2 over Iran

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Skillful seasonal prediction of the surface temperature and precipitation is needed to mitigate the impact of extreme climate events such as floods and droughts. Using a continuous multi-decadal simulations over the period 1981-2010, subseasonal to seasonal simulations of the Climate Forecast System version 2 (CFSv2) over Iran against the Climatic Research Unit (CRU) dataset are evaluated, focusing on forecasts of 2-m temperature and precipitation. CFSv2 shows cold biases over northern hillsides of the Alborz Mountains with the Mediterranean climate and warm biases over northern regions of the Persian Gulf and the Oman Sea with a dry climate. Magnitude of the model bias for 2-m temperature over different regions of Iran varies by season, with the least bias in temperate seasons of spring and autumn, and the largest bias in summer, and the model bias decreases as temporal averaging period increases from seasonal to annual. The forecast generally produces dry and wet biases over dry and wet regions of Iran, respectively. In general, 2-m temperature over Iran is better captured than precipitation, but the prediction skill of precipitation is generally high over western Iran. Averaged over Iran, observations indicated that 2-m temperature has been gradually increasing during the studied period, with a rate of approximately 0.5ºC per decade, and the upward trend is quite well simulated by CFSv2 (with a rate of approximately 0.6ºC per decade). Averaged over Iran, both observations and simulation results indicated that precipitation has been decreasing in spring, with averaged decreasing trends of 0.8 mm (observed) and 1.7 mm (simulated) per season each year during the period 1981-2010. Observations also indicated that the maximum increasing trend of 2-m temperature has occurred over western Iran (nearly 0.7ºC per decade), while the maximum decreasing trend of annual precipitation has occurred over western and parts of southern Iran (nearly 45 to 50 mm per decade).

Keywords: Climate Forecast System version 2 (CFSv2), Seasonal Prediction, Model bias, CRU dataset

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A1-P-02

Performance of downscaled convective and stratiform precipitation over the Philippines during the East Asian Winter Monsoon

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We investigate the disagreement in the convective and stratiform pentad precipitation between the 0.25° x 0.25° Global Precipitation Measurement (GPM) Microwave Imager (GMI) and the 0.75° x 0.75° European Centre for Medium-Range Weather Forecasting (ECMWF) Reanalysis Interim (ERA-Interim) datasets. The study focuses on the East Asian Winter Monsoon period from 2014 to 2017 over the Philippine region. The ERA-Interim reanalyses are then downscaled to match the GMI resolution using the Regional Climate Model version 4.7 (RegCM4.7) with the MIT-Emanuel and Tiedtke cumulus parametrization schemes. Rainfall over ocean is better captured using the Tiedtke scheme although rainfall over land is generally overestimated for both schemes. Wet bias of stratiform rainfall is observed over the Cordilleran mountain range especially for the Tiedtke scheme.

Keywords: Dynamical downscaling, Rainfall, Philippines, East Asian Winter Monsoon

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A1-P-03

Large-scale consistency with driving GCM and fine scale details in the present-day climate simulated by the EuroCORDEX RCM integrations

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The analysis of the consistency of RCMs with the driving boundary conditions at the larger scale, implicitly assumed to be satisfied in the "one-way" nesting approach, has been analysed for the EuroCORDEX 12km set of simulations.

The results indicate that the consistency with driving conditions is very high, and its dependence on the GCM formulation could be neglected as a first order approximations, supporting the assessments of the multi-model uncertainty based on experimental design whereby RCM and GCM are treated as independent factors (GCM/RCM matrices). Additional investigation of the factor influencing the GCM/RCM consistenct will be presented at the conference.

Keywords: Experimental design, One-way nesting, Large scale constistency

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A1-P-04

The influence of regional nuding over South America on the simulation of the Southern Hemisphere extratropical circulation

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This work presents new modeling evidence showing the added value of high-resolution information from South America (SA) in the simulation of the Southern Hemisphere extratropical circulation. LMDZ, a coarse-resolution atmospheric global general circulation model constitutes the main tool for this investigation. Parallel to the control (CTR) simulation, a two-way nesting (TWN) simulation of LMDZ is performed with an interactive coupling to the same model, but with a higher-resolution zoom over SA. The third simulation (fERAi) is a perfect boundary simulation for which re-analysis information from ERA-Interim is used to nudge LMDZ, but only over SA. Results indicate that enhanced resolution over SA improves the representation of the low-level circulation over the continent and, thus, simulates better the meridional transport of energy from the tropics into extratropics. The local improvement of the low-level circulation is followed by a better representation of the global extratropical circulation, especially in austral summer. The regional climate enhancement over SA has positive effects on simulation of the midlatitude jet position during the austral summer by significantly reducing the bias of the mean zonal kinetic energy outside the nudged zone. On the other hand, the wintertime general circulation outside the nudged-zone shows a limited bias-reduction for the regional-driven simulations, especially in the case of the TWN system. However, improvements of the TWN system compared to the control experiment are noticed in early stages of cyclone lifecycle, as it is identified in a better simulation of transient meridional transport and transient kinetic energy intensity. The findings of the present study suggest, thus, that improvements in resolution over SA effectively excite the simulation of the mean atmospheric circulation in the Southern Hemisphere.

Keywords: Two-way nesting system, Extratropical circulation, Southern hemisphere, Influence of South American regional climate

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A1-P-05

The potential added value of Regional Climate Models in South America using a multiresolution approach

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This work aims to identify those regions within the South American continent where the Regional Climate Models (RCMs) have the potential to add value compared to their coarser-resolution global forcing. For this, we distinguished the mesoscale climatic signal present in atmospheric surface fields from observed data and 6 RCM simulations belonging to the CORDEX Project. We used a spatial-scale filtering method based on the wavelet theory and kept those scales that can be explicitly simulated by the RCM and not by its driver. Once the longer wavelengths were filtered, we focused on analyzing the spatial variability of extreme rainfall and the spatiotemporal variability of maximum and minimum surface air temperature on a daily basis. The results obtained suggest essential differences in the spatial distribution of the mesoscale signal of extreme precipitation between TRMM and regional models, together with a large dispersion between models. While TRMM registers a large signal throughout the continent, the RCMs place it over regions with complex topography or areas where convective systems dominate. Surface air temperature has a large mesoscale stationary component over regions characterized by complex topography, such as the Andes Cordillera and the Brazilian Highlands, and the coasts of the continent. The transient part is much smaller than the stationary one, except over la Plata Basin where they are of the same order of magnitude. Also, the RCMs and CRU showed a large spread between them in representing this variability. The results confirm that RCMs have the potential to add value in the representation of extreme precipitation and the mean surface temperature in South America. However, this condition is not applicable throughout the whole continent but is particularly relevant in those terrestrial regions where the surface forcing is strong, such as the Andes Cordillera or the coasts of the continent.

Keywords: Added value, South America, Wavelet

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A1-P-06

Intercomparison of observed and simulated climatic trends in the CORDEX-CAM (Central America, Caribbean and Mexico) domain

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An intercomparison of three regional climate models (RCMs) was performed over the Coordinated Regional Dynamical Experiment (CORDEX) - Central America, Caribbean and Mexico (CAM) domain to determine their ability to reproduce observed temperature and precipitation trends during 1980-2010. PRECIS-HadRM3P, RCA4, and two versions of RegCM4 were forced with ERA-Interim Reanalysis. Observations from the Climate Research Unit (CRU) and ERA-Interim show a generalized warming over most of the domain. The most significant warming trend (≥ 0.33°C decade-1) is observed in the North American monsoon (NAM) region, which is moderately captured by the three RCMs, but with less intensity; each decade from 1970 to 2016 has become warmer than the previous ones, especially during the summer. Moreover, since the 1990s the 95th percentile threshold of summer temperatures in the NAM has also significantly increased. The warming trend is also observed in the 1950-2017 period and appears to be partially related to the positive phase of the Atlantic Multidecadal Oscillation (+AMO).

There is a good agreement between observations (CRU, GPCP and CHIRPS) showing annual decreases of precipitation (less than -15% decade-1) in parts of the Southwest United States and Northwestern Mexico, including the NAM, and a positive trend (5% to 10% decade-1) in June-September in eastern Mexico, the mid-summer drought (MSD) region, and northern South America, but observed longer trends (1950-2017) in the NAM and the MSD are not statistically significant. Some of the observed regional trends of precipitation are captured by the RCMs. During 1980-2010, observations and RCMs show a good consistency in the wintertime precipitation trends in most of the domain. However, summer precipitation trends from GPCP show opposite sign to those of CRU and CHIRPS over the Mexican coasts of the Gulf of Mexico, the Yucatan Peninsula, and Cuba, possibly due to data limitations and differences in grid resolutions. Summer precipitation trends from the RCMs also show more regional differences than during winter. Our results show the importance of evaluating several observational datasets and RCMs to determine the regions and seasons that show less uncertainty.

Keywords: Trends, CORDEX-CAM, Intercomparison, Regional models

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A1-P-07

Frequency analysis of annual maximum rainfall over Thailand £under changing climate

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Regarding to climate change affected to the changes in local hydrology which caused to more frequency of flood and drought. These impacts obviously influence the frequency and severity of floods and droughts experienced in many countries around the world. In the vulnerable areas might obtains more disaster with unavoidable. Especially the flood risk areas have more chances to encounter the uncertain of heavy rainfall. Therefore, one of adaption measure should be provided the future climate information to make awareness to people to cope with the changes. This study aims to analyze the changes in frequency of annual maximum rainfall using multi bias corrected GCM under CMIP5 project. Ten sets of bias corrected GCM precipitation datasets under the Representative Concentration Pathway (RCP4.5 and RCP8.5) are used to calculate annual maximum rainfall. The Gumbel, General Extreme Values, Weibull, Log normal, Log Pearson Type III distribution are used to analyze frequency of maximum rainfall and the goodness of fit tests are evaluated the appropriate distribution of maximum rainfall. The resulting of maximum rainfall with return period can be used to identify the flood risk area under changing climate.

Keywords: climate change,frequency analysis, Gumbel, General Extreme Values, Weibull, Log normal, Log Pearson Type III

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A1-P-08

Evaluation of added value of CORDEX-SA experiments in representing Indian summer monsoon characteristics

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In recent times, there has been a growing debate on benefit of dynamical downscaling that is applying regional climate models (RCMs) over their coarser counterparts- global climate model models (GCMs). In light of this new area of research in climate modeling, the following study aims at investigating the added value (AV) of a suite of RCMs over their respective forcings that is, GCMs in simulating Indian summer monsoon (ISM) features. These RCM simulations are part of Coordinated Regional Climate Downscaling Experiment- South Asia (CORDEX-SA) initiative. To evaluate the AV, the skill of RCMs and their respective parent GCMs is compared for the present day climate (1970–2005) against observations and reanalysis datasets with respect to different ISM characteristics- the spatial pattern of mean precipitation, the evolution of vertical shear of westerlies and the onset of ISM. The RCMs show a definite improvement over their driving GCMs in representing the chief spatial features of ISM precipitation with drastic reduction in bias over some regions in India, for example the orographic precipitation along Western Ghats is well captured by RCMs. This improvement mainly comes in the form of reduction in dry biases shown by GCMs. In terms of simulation of onset timing, a few RCMs show a marked improvement, particularly, RegCM4 driven by IPSL-CM5A-LR. The general conclusion is that the present set of CORDEX-SA RCM experiments do indeed add value to their parent GCMs for a number of characteristics associated with the ISM precipitation but this value depends on the region, the driving GCM and the specific feature of ISM under study.

Keywords: CORDEX- South Asia, Added value, RCMs, GCMs, Indian summer monsoon

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A1-P-09

How European projections have changed through 20 years of multi-model ensemble projects

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For more than 20 years, coordinated efforts to apply regional climate models to downscale GCM simulations for Europe have been under way. European research projects like RACCS and MERCURE in the '90s were first. Here, the foundation for today's advanced worldwide CORDEX approach was laid out with some of the first coordinated multi-RCM simulation collections aiming to assess regional climate change for Europe in a robust way. The first public multi-model collection of climate change data was created in the PRUDENCE project (2001-2004). Additional coordinated efforts involving ever increasing numbers of GCMs and RCMs followed in ENSEMBLES (2004-2009) and currently CORDEX, specifically Euro-CORDEX, for the area covered during the prior projects. Simulations have increased their standard resolution from 50km (PRUDENCE) to about 12km (CORDEX EUR-11) and from time slice simulations (PRUDENCE) to transient experiments (ENSEMBLES and CORDEX); from one driving model and emission scenario (PRUDENCE) to several (Euro-CORDEX). This wealth of simulations have been used to assess and frame the potential impacts of future climate change in Europe providing a baseline change as defined by a multi-model mean change with associated uncertainties calculated from model spread in the ensemble.

Here we investigate how the overall picture of state-of-the-art regional climate change projections changed over this period of almost two decades. By scaling with global temperature change we identify robust results from the various emission scenarios having been used about the projected future European temperature and precipitation changes, which confirm the basic findings of PRUDENCE. The large-scale patterns of change show remarkable agreement across model resolution, ensemble strategy and emission scenario.

A comparison with observed European temperature and precipitation trends since 1950 shows good agreement with the simulations measured with root mean square distance, though precipitation only shows clear trends in limited areas.

With an EOF analysis in model/signal space of all simulations we quantify and discuss the patterns of main differences between the multi-model ensembles of these projects.

Keywords: Multi-model ensembles, European climate change

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A1-P-10

Climatology and trend of cyclones over the South Atlantic Ocean simulated by global and regional climate models

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Synoptic scale cyclones affect the weather and the climate of many regions of the globe by producing clouds, precipitation, temperature changes and intense winds. Over South Atlantic Ocean, cyclones occur throughout the year with greater frequency in austral winter. In this work, a tracking algorithm based in relative vorticity at 925 hPa is applied to identify cyclones in the present (1979-2005) and future (2020-2050, 2070-2099) climates under RCP8.5 scenario. These systems were identified in: (a) three global climate models (GCMs) of CMIP5 (HadGEM2-ES, MPI-ESM-MR and GFDL-ESM2M) and in their respective downscaling's with the regional climate model RegCM4 (RegHad, RegMPI and RegGFDL); (b) Era-Interim reanalysis. Preliminary results show that in the present climate the models represent the cyclogenetic density over southwestern South Atlantic Ocean with similar patterns observed in Era-Interim reanalysis. However, there are some differences as: GFDL-ESM2M presents a general underestimation of the cyclogenetic density; HadGEM2-ES simulates a more intense cyclogenetic core in southern Argentina. On the other hand, the RegCM4 downscaling improves some results, for example, it decreases the cyclogenetic density in southern Argentina that is simulated by HadGEM2-ES. Models tend to overestimate the trajectory density of the cyclones in the longitudinal belt of 30o-20oW and underestimate the velocity of cyclones compared to Era-Interim with GFDL-ESM2M presenting greater underestimation. In terms of trend, at the end of the century (2070-2099) the GFDL-ESM2Mand MPI-ESM-MR project a change in the meridional location of the storm tracks region compared to the present climate, while HadGEM2-ES projects a gradual increase of the cyclones in the subtropical sector of South Atlantic. Complementary analyses of the trends are being developed.

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A1-P-11

The Regional Climate Model evaluation system: A systematic evaluation of CORDEX simulations using Obs4MIPs

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Observation-based evaluations of global climate models (GCMs) have been a key element for identifying systematic model biases that can be targeted for model improvements and for establishing uncertainty associated with projections of global climate change. However, GCMs are limited in their ability to represent physical phenomena which occur on smaller, regional scales, including many types of extreme weather events. In order to help facilitate projections in changes of such phenomena, simulations from regional climate models (RCMs) for 14 different domains around the world are being provided by the Coordinated Regional Climate Downscaling Experiment (CORDEX; www.cordex.org). However, although CORDEX specifies standard simulation and archiving protocols, these simulations are conducted independently by individual research and modeling groups representing each of these domains often with different output requirements and data archiving and exchange capabilities. Thus, with respect to similar efforts using GCMs (e.g., the Coupled Model Intercomparison Project, CMIP), it is more difficult to achieve a standardized, systematic evaluation of the RCMs for each domain and across all the CORDEX domains. Using the Regional Climate Model Evaluation System (RCMES; rcmes.jpl.nasa.gov) developed at JPL, we are developing easy to use templates for performing systematic evaluations of CORDEX simulations. Results from the application of a number of evaluation metrics (e.g., biases, centered RMS, and pattern correlations) will be shown for a variety of physical quantities and CORDEX domains. These evaluations are performed using products from obs4MIPs, an activity initiated by DOE and NASA, and now shepherded by the World Climate Research Program's Data Advisory Council. In order to facilitate reproducibility, evaluation configurations and results for each CORDEX domain are published on our website (rcmes.jpl.nasa.gov).

Keywords: obs4mips, Model Evaluation, RCMES

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A1-P-12

Exotic Uncertainties in North America CORDEX

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A number of simulations have been produced for the North-American component of the Coordinated Regional Downscaling Experiment (NA-CORDEX). The simulations are based on a wide range of regional and global climate models (RCMs and GCMs). The RCMs include: WRF, RegCM4, RCA4, HIRHAM5, CRCM5 (with and without nudging), and the CanRCM4. The driving GCMs include: MPI-ESM-LR, MPI-ESM-MR, HadGEM2-ES, GFDLESM2M, EC-EARTH, and CanESM2. These GCMs fully span the equilibrium climate sensitivity (ECS) of the GCMs that make up the CMIP5 suite of simulations. Simulations have also been produced at both 50km and 25km and in some cases for both RCP8.5 and RCP4.5.

We present some interesting analysis results and the uncertainties they address or create. To start, the effect of spanning GCM ECS in the NA-CORDEX ensemble of projections will be illustrated and GCM sampling uncertainty will be presented. Additionally, we examine the effect of including Shared Socioeconomic Pathway (SSP)-based land-use and land-cover change (LULCC) along with the RCP-based green-house-gas-induced climate changes and the projection uncertainty overlooked by neglecting LULCC in traditional NA-CORDEX regional climate simulations. Time-permitting, a brief overview of additional results from an ongoing study on the role of extratropical cyclones in winter precipitation uncertainty over the east-south-central U.S. will also be discussed.

Keywords: North America CORDEX, Exotic uncertainties

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A1-P-13

Climate change projections in RegCM CORDEX-CORE simulations via Koeppen-Trewartha climate classification

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The analysis of climate patterns can be performed for each climatic variable separately or the data can be aggregated using e.g. a kind of climate classification. The advantage of such a method, in our case Koeppen-Trewartha classification, is putting together the most important variables, i.e. temperature and precipitation, considering not only annual means, but through monthly values the annual course as well. These classifications usually correspond to vegetation distribution in the sense that each climate type is dominated by one vegetation zone or eco-region. This way climate classifications also represent a convenient tool for the assessment and validation of climate models and for the analysis of simulated future climate changes.

The RegCM results of CORDEX-CORE experiments over nine CORDEX domains are analysed using selected CMIP5 simulations (mostly HadGEM, MPI and NorESM) driving the RegCM. Validation based on ERA-Interim driven runs compared to CRU database (E-OBS for higher resolution in Europe) shows some systematic biases in different types. Through the analysis of the control experiments together with the performance of driving GCMs we can assess the sources of the biases in present conditions as well as to see the added value, which comes mainly from the better description of topography in higher resolution and thus appearance of mountaineous tundra type, as well as bettter representation of coastal region and thus separating maritime and continental subtypes. Finally, for two scenarios RCP8.5 and RCP2.6 we show the projections of the individual types‘ area changes, individual transformations of types or their shifts in CORDEX domains (e.g. decrease of boreal and tundra type area, their shift to the higher latitudes and altitudes, increase of temperate climate, deserts, savana, more significant for RCP8.5). We compare the changes with the signal of climate change for driving GCMs to identify the added value of higher resolution RCM simulations.

Keywords: Koeppen-Trewartha climate classification, climate change projections, CORDEX-CORE experiment

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A1-P-14

Performance evaluation of all subsets from the CMIP5 multimodel ensemble used in each CORDEX region: Representation of the present climate and uncertainty range of climate change projections

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Region-specific subsets selected from the full set of CMIP5 multimodel ensemble have been used in CORDEX. Do the subsets have enough ability to represent the observed climatological state, and project a consistent tendency of the climate change with the full set? How extent do the subsets capture the uncertainty in the projections by the full set? To provide increased credibility for the scientific outcomes by answering these questions, we evaluated the performance of all subsets used in CORDEX. Regarding the climate change projection, compared with the possible subsets generated using 10,000 random samples, we investigated whether the subsets showed higher coverage of the uncertainty than the others when using the same sample size. The spreads of the biases and Taylor's skill scores obtained from the CORDEX subsets extend beyond the spread from high performed 24 models of the full set for the regional means of temperature and precipitation. Therefore, despite using models that performed acceptably, a subset exists that would have less biases than the current subsets. Compared with the random samples, CORDEX uses subsets with low coverage of the uncertainty range from the full set for the temperature change in the regions where more models are used. On the other hand, for the precipitation change the coverage is lower than that from the random samples in half of the regions. However, in the regions that used nine models or more, good coverage (>50%) is evident for the projections of both temperature and precipitation. Therefore, the subsets can a relative-widely cover the uncertainties, but it depends on the number of models used. In contrast to the subsets used in CORDEX, we also conducted the evaluation on a globally consistent model subset consisting of four models used in ISIMIP. As the result, the subset indicates difficulty in capturing uncertainties in the regional precipitation change with widely covering that in the temperature.

Keywords: Performance evaluation, Uncertainty range, Model subset

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A1-P-15

Assessment of future climate change over India and Hindu Kush Himalayan regions using CORDEX South Asia Regional Climate Model projections

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The World Climate Research Programme (WCRP) regional activity Coordinated Regional Climate Downscaling Experiment (CORDEX) provided an ensemble of high resolution (50 km) regional climate change projections for South Asia. These future projections of climate till the end of 21st century were developed by dynamical downscaling methods using regional climate models (RCMs) forced with a subset of global climate models (GCMs) that contributed to the fifth phase of the WCRP Coupled Model Intercomparison Project (CMIP5). The CORDEX initiative provided an opportunity for assessing the range of uncertainties in regional climate change within South Asia associated with varying forcing from the CMIP5 GCMs and the future greenhouse gas scenarios based on three representative concentration pathways (RCPs), and from the use of multiple RCMs. The interim report on climate change over India released by the Government of India in mid 2017 found that the CORDEX South Asia RCM ensemble based future projections were useful to better quantify the regional climate change uncertainties in the near-surface air temperature, precipitation, and in extreme events. The Hindu Kush Himalayan (HKH) Monitoring and Assessment Programme (HIMAP) report coordinated by the International Centre for Integrated Mountain Development (ICIMOD) assessed the future climate change signal in seasonal mean temperature and precipitation over the HKH region using an ensemble of CMIP5 GCMs and CORDEX South Asia RCMs. This presentation will provide an overview of the main findings in these future climate change assessments over the South Asia region.

Keywords: CORDEX South Asia, India, Hindu Kush Himalaya

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A1-P-16

Projected changes in the relationship between Precipitation, African Easterly Jet and African Easterly Waves under global Warming

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An ensemble of regional climate analysis projections is carried out with Theoretical Physics Regional Climate Model (RegCM4) over West African domain. The RegCM4 is driven by three CMIP5 Global Climate Models (GCMs) under two greenhouse gas concentration pathways such as RCP8.5 and RCP4.5 to assess regional changes in temperature, precipitation and West African Monsoon (WAM) dynamical features. In particular, we examine and inter-compare the models performance with theirs ensemble-mean in simulating the mean climatology and the response of African Easterly Jet (AEJ) and African Easterly Waves (AEWs) to increasing greenhouse gas concentrations by the end of the 21st century. The covariance analysis is used to investigate the nature of the relationship between WAM features and precipitation. Using an ensemble of regional climate models, much of model simulations project a widespread change of precipitation associated with decreased of AEJ (in term of location and intensity) and AEWs activity in the 2–10 days period and affecting their relationship. The seasonal mean precipitation events decrease in the future scenarios with largest and more extensive drying condition over the Sahel and wetter condition over the Gulf of Guinea while some models project a drier condition along the both region. This dry condition delayed the onset of the rainy season, anticipated the retreat of the rainbelt and reducing and strengthening of the Intertropical Convergence Zone (ITCZ) band. The change is consistent in all global and regional model projections, although with different spatial detail. The results suggested that changes in AEJ and AEW characteristics could play a critical role in shaping the response of WAM to elevating anthropogenic greenhouse gas (GHG) forcing.

Keywords: Monsoon precipitation, Regional climate models, Circulation dynamics

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-17

Multi-resolution investigation of long term regional/local trends in temperature and precipitation from observations and NA-CORDEX regional climate simulations

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Assessment of long-term temperature and precipitation trends is one of the most fundamental tasks for studying climate change. While the global temperature on Earth has significantly increased in the last several decades, regional trends in temperature and precipitation are not spatially uniform. Using the Global Historical Climatology Network monthly observations and regional climate models (RCMs) that participated in the North America CORDEX (NA-CORDEX) program, we investigated the spatial variability of the temperature, precipitation, and their long term trends over the contiguous United States (CONUS) using the Regional Climate Model Evaluation System (RCMES). RCMES is an open source software suite developed jointly by NASA's Jet Propulsion Laboratory and the University of California, Los Angeles. RCMES facilitates multi-model, multi-variate evaluation over any CORDEX domain using ground-based observation and NASA remote sensing datasets. The recent development of RCMES includes the hierarchical data analyzer that can show the added value of high-resolution datasets from observations and models. Our analysis of observations indicates that using temperature and precipitation observations whose spatial resolution is finer than 50 km is important in studying their temporal trends. However, NA-CORDEX RCM simulations forced by ERA-interim reanalysis data do not show expected performance in simulating the spatial structures in observed temperature and precipitation trends. Specifically, the simulated trends do not represent the fine-scale variability, which is important for supporting decisions and management plans to address the impacts of regional climate change.

Keywords: Added value of high resolution RCMs, temperature and precipitation trends, North America CORDEX

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-18

Ten years of CORDEX - a review

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The Coordinated Regional Downscaling Experiment (CORDEX) entered its tenth year in 2019 and this paper reviews the impact of CORDEX in the scientific peer-reviewed literature. We investigate the uptake of CORDEX data in peer-reviewed articles and quantify the geography of the papers (which region are the papers reporting on), in which scientific community the papers belong to (climate, health, energy, etc.), what proportion of CORDEX work is open access and report on the inclusion of CORDEX literature in the IPCC assessment cycles. A particular assessment of the climate science literature quantifies the number of studies with themes including extreme events, added value and detection-attribution. We also attempt to report on how CORDEX data is used in post-graduate studies and in government white papers or reports line National Adaptation Plans. We conclude with an assessment of how CORDEX activities align with the WCRP strategic plan and programmes within the WCRP and make some suggestions about this.

Keywords: CORDEX, Review paper

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-19

Investigating sea surface temperature representation and its potential influence in SEACLID/CORDEX-Southeast Asia regional climate simulations

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Sea Surface Temperature (SST) characteristics and its regional influence may not be well represented in climate models and these can result to biases in the downscaled climate output. Southeast Asia Regional Climate Downscaling (SEACLID)/Coordinated Regional Climate Downscaling Experiment – Southeast Asia (CORDEX-SEA) historical climate simulations showed biases in temperature and rainfall. This study examines SST representation in climate models to investigate whether this can potentially contribute to the resulting model biases. This is done by: a) describing the historical SST over Southeast Asia (SEA) from observations in terms of spatial patterns and temporal variability; b) analyzing the Coupled Model Intercomparison Project Phase 5 (CMIP5) Global Climate Model (GCM) representation of SST over SEA and its potential influence on modeled climate over the Philippines; and c) assessing the possible effect of SST representation in CMIP5 GCMs on the downscaled regional climate output. Results show that four GCMs that best represent SSTs also have good representation of GCM model climate. Particular GCMs that do not represent SST well also produce climate simulations that are far from observed data. There are also GCMs that do not show any statistical relationship between SST representation and the resulting climate simulation. Over regions of Southwest Monsoon influence including South China Sea where the SST seasonal variability is captured well, temperature, rainfall, moisture, and wind speed are also adequately represented by the models. Results suggested that negative biases in land temperature, and positive biases in precipitation and wind speed, in both global and regional climate models, are associated with negative model biases in SST. Findings give a better understanding on how SST potentially influences modeled climatology in SEA and can help improve regional climate models for better future climate projections used for adaptation and impact studies.

Keywords: regional climate modeling, climate variability, CORDEX-SEA, sea surface temperature

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-20

Assessing the value of climate information for local government officials in South Africa

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A significant amount of work has been done by national as well as international academic, research and other institutions to produce climate change information that intended to support decision making and planning. This includes the work by the Intergovernmental Panel on Climate Change at international level and the Council for Scientific and Industrial Research and the Climate Systems Analysis Group at the national level. However, it is anticipated in the traditional way of producing knowledge that when CORDEX data is generated and disseminated the targeted users will automatically start using it but this is not always the case. In an effort to understand the factors that are required to support uptake of climate change information in South Africa, this study uses two municipalities in South Africa namely Capricorn District Municipality in Limpopo and Amathole District Municipality in the Eastern Cape. The two provinces are considered to be amongst the most vulnerable to climate change in South Africa as a result of socioeconomic drivers such as poverty, dependence on primary economic sectors such as agriculture and high levels of unemployment.

Participatory methods were used to engage decision makers in the two municipalities who are involved in climate change and air quality management. The study found that knowledge about climate change risks and adaptation has improved amongst local government officials. This is a result of national efforts through programmes such as the South African Risk and Vulnerability Atlas and the Department of Environmental Affairs Local Government Climate Change Support Programme. Research and academic institutions in South Africa have been able to provide down-scaled projections that have informed the development of adaptation strategies at local level. However, there is still need for local government focused climate change products other than projections that can address the usability gaps. Other barriers to use of climate change information include issues relating to communication, accessibility, relevance and limited capacity of users to interpret information in projections and implement in different sectors. The study also found that decision making at local government is not easily influenced by the provision of information, tools and frameworks as other factors play a role and need to be acknowledged as part of that system.

Decisions to act on adaptation are often blocked by institutional and psychological factors especially on difficult, transformational and long lifetime decisions. There is also pressure amongst individuals and groups especially when worldviews/values between the scientists and non-scientific community are different. Further to this, uptake of climate information at municipal level is also affected by the level of top down management, control risk management and local self-organised adaptation. District municipalities in South Africa are responsible for key service delivery areas such as water, sanitation, electricity, municipal health services and other district-wide functions for the municipalities in the district. Human and financial resources at these district as well as their local municipalities are often under-resourced and struggle to integrate climate change with other service delivery activities. These constraints help in understanding the instances where climate change information is available to

inform potential climate change impacts and responses but the decisions taken on what and how actions are implemented do not always match the recommendations from science (Adger et.al., 2007).

There are increasing calls for co-production and co-implementation of knowledge to enhance the value and use of scientific information including climate information. However, there is need to acknowledge that institutions such as local governments are complex systems whereby multiple actors play a key role in decision making while the institutions regulations and culture; technology; individual identity and values among other factors influence the adaptation activity space (Pelling et.al.,2014). As such, knowledge producers need to find the different entry points and packaging options for climate change information to meet the different expectations that decision makers at local government as they use information in different ways. Further to this local government officials need guidance on the use and limitations of CORDEX data in the different sectors that they operate in. To conclude, the study recommends that information needs and support for local governments need to be ongoing process as adaptation is an continuous learning process that needs regular monitoring to meet the changing needs/values.

Keywords: climate information, local government, South Africa, adaptation

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-21

Climate analog and future appearance of novel climate in Southeast Asia

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This study identified the analog locations of five big cities and the future appearance of novel climate in Southeast Asia (SEA) at the end of the 21st century under the Representative Concentration Pathways 8.5 (RCP8.5) and 4.5 (RCP4.5) scenarios. A modified version of an existing formulation to estimate climate distance is introduced, using the monthly means of temperature and precipitation from six regional climate experiments and from six global climate models (GCM). Results showed that regional downscaling allowed a more accurate representation of temperature but displayed a higher variability in rainfall over SEA compared to those of the GCMs. The ensemble mean (ENS) experiment had a relatively better performance compared to each individual experiment in representing the monthly time series of temperature and precipitation. The common tendency of climatic relocation towards warmer regions for the five big cities in SEA (Hanoi, Bangkok, Manila, Kuala Lumpur and Jakarta) was prominent with the regional ENS experiment. At the end of the 21st century, the ratio of novel climate areas over SEA, mainly located in low elevation, coastal, equatorial regions and islands, was less than 2% under RCP4.5 and increased to 24% and 21% under RCP8.5 for the ensemble regional and global experiments, respectively.

Keywords: climate analog, novel climate, regional climate model, CORDEX-SEA

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-22

On the sensitivity of seasonal and diurnal precipitation to cumulus parameterization over CORDEX-EA-II

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The ability of the Weather Research and Forecasting (WRF) model in simulating the seasonal and diurnal cycles of rainfall over the Coordinated Regional Climate Downscaling Experiment East Asia Phase II (CORDEX-EA-II) domain is validated against the Tropical Rainfall Measuring Mission (TRMM) datasets. A focus is placed on the role of convective parameterization (CP) schemes. A set of numerical experiments at a 25km resolution for 1998-2009, using six different CPs, is performed to evaluate the physic-dependency of results. All CPs simulate realistic summer mean precipitation and its northward propagation, with the best performance in the Simplified Arakawa-Schubert (SAS). The biases in the seasonal march of rainfall are related to the deficiency in simulated low-level winds and the northward propagation of the cyclonic vorticity. The simulated earlier peak time in other CPs is delayed by about 1-2 hours by the Kain-Fritsch with a modified trigger function (KFMT), although this scheme shows a disadvantage in the magnitude. The performance of different CPs in simulating diurnal rainfall cycles is dependent on regions, and none of them performs better than the others for all sub-regions. The initiation of simulated convection is weakly physic-dependent. However, the timing and magnitude of stratiform precipitation differ among the six simulations. A further analysis shows that the dry biases over the lower Yangtze River basin are a result of the weakened southwesterly water vapor transport, while the excessive afternoon rainfall in the Kain-Fritsch (KF) simulation is attributed to the largest positive perturbation in the lower level atmosphere, especially the enhanced vertical transport of humidity.

Keywords: Regional climate model, convective parameterization schemes, precipitation

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-23

The potential of CORDEX to capture long term extreme events over Guinea Coast

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We analyze the performance of a group of six regional climate models (RCMs) along with the ensemble mean of their statistics in simulating long term extreme events in daily precipitation and temperature over Guinea Coast for the period of 1961–2005. The models are run at 45km grid interval and is driven by GCM reanalysis lateral boundary conditions. A comparison made with observation data demonstrates that the model performs reasonably well in simulating the frequency of daily precipitation events as well as the precipitation intensities, with the exception of the highlands. Substantial differences are observed among the RCMs which are attributed to the wide range of estimates of high-order statistics like frequency, intensity and the convective schemes employed. This is attributed mainly to the relatively coarse representation of topography across the area of the Guinea Coast and the high variability in the precipitation pattern over the region. The model underestimates daily maximum temperature in the warmer seasons. The performance of the model improves in the simulation of daily minimum temperature. In order to apply CORDEX to the simulation of extreme events over the complex terrain for Guinea Coast, it is recommended that a higher resolution is used in order to better describe the topography of the Guinea Coast and that the daily maximum temperature bias is reduced.

Keywords: Cordex, Guinea Coast, extreme

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-24

Variability and trends of atmospheric moisture in recent West African monsoon season and the CORDEX-Africa projected 21st century scenarios

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The interannual variability and trends of atmospheric moisture flux convergence (MFC) and the flux transport and their roles in wet season rainfall variability during the West Africa monsoon have been investigated using the Climate Research Unit observational datasets and the National Center for Environmental Prediction reanalysis 2 from 1979 to 2016, and the Coordinated Regional Downscaling Experiment (CORDEX)-Africa model outputs. Particular emphasis has been placed on the three rainfall zones: the Western Sudano Sahel, the Eastern Sudano Sahel and the Guinea Coast. The MFC shows largest variability and impact on rainfall in the Western Sudano Sahel, followed by the Guinea Coast, but there is no significant impact in the Eastern Sudano Sahel. The MFC shows significant positive trends at the Sahelian locations but not at the Guinea Coast. The CORDEX-Africa models adequately simulate the climatology and spatial patterns of the mean June to September atmospheric moisture; however, differences exist in the magnitude and signs of the temporal trend. The model ensemble mean is presented, which better represents the atmospheric moisture during WAM rainfall variability. A mean bias-corrected projection of the atmospheric moisture shows a consistent enhanced variability of the Guinea Coast in the RCP 4.5 and RCP 8.5 at the end of the 21st century.

Keywords: West African monsoon, CORDEX-Africa, atmospheric moisture, rainfall, variability

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-25

How important is the climate change signature in inputs to hydrological models in 2050 and 2100?

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Developing projections of Australia-wide hydrological variables can be approached in a number of different ways. Earlier efforts (ISI-MIP: Hempel et al. 2013; Victoria: Hope et al. 2017; Potter et al. 2018) have used an ensemble of opportunity, based upon the availability of climate model simulations, downscaled data and relevant variables required to run hydrological models. In some cases relatively simple statistical shifts in the mean were applied to represent the climate change signal. However, for many variables important to hydrology (precipitation, temperature, wind and radiation), changes due to anthropogenic climate change can not be expressed as a simple shift in the mean. The tails and shape of the distribution might also be expected to change. In this work, we aim to retain as much of the information about the modelled shift in the full distribution as possible, within the constraints of providing inputs to off-line hydrological models. In this presentation we outline the change simulated by climate models relevant to key variables for hydrological projections and detail the range of bias-correction methods that can account for their inter-relationships. These results will then guide our choice of bias correction and downscaling methods to be used in the Bureau of Meteorology's hydrological projections project.

Keywords: Bias correction, Downscaling, Hydrological modelling

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-26

Inter-comparison of temperature trends in CORDEX models and CMIP5 models

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Temperature trends is an important parameter to measure the state of climate. And it provides evidence of green house gases (GHG) impact. The data used in the estimation of temperature trends include but not limited to meteorological station data, satellite observations and model data such as reanalysis products. Global climate models (GCMs) and regional climate models (RCMs) are tools used to investigating potential changes in the future climate. However, projections from RCMs and GCMs can differ, particularly in the case of rainfall. To gain more confidence in both GCMs and RCMs climate projections is important firs to analyse how trends are captured in the past climate. Yet such analysis using a suit of GCMs and RCMs hasn't been done over southern Africa. Here we compare trends in the Coordinated Regional Climate Models Experiment (CORDEX) regional climate models and the driving boundary conditions from CMIP5 to check for consistency or lack of it. Furthermore, the mechanisms driving these trends are also explored in order to provide robust message for decision making. In general the spread in temperature trends between different RCMs forced by the same GCM (boundary condition) is small compared to the spread due to the difference in GCM boundary condition. There is typically greater warming over the sub-continent than surrounding oceans, but models show substantial differences in regional detail withinthis broad pattern. The model projections analysed here indicate a strong agreement for increased (summertime) surface air temperatures over southern Africa over the century. The continental heat low was identified as the main mode of variability and influencing theses trends.

Keywords: Temperature trends, southern Africa, models

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-27

Assessment of the CORDEX-Atlas Africa simulations added value and uncertainty of the climate change signal

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Within the CORDEX-Atlas effort, RegCM4 has been used to downscale 3 GCMs (HadGEM- ES, MPI and NorESM) over the African domain for the two scenarios RCP2.6 and RCP8.5 with a resolution of 25 km. The CORDEX Africa domain has been also the central domain of the previous CORDEX Phase 1 experiment, therefore there are available many regional climate model simulations for the same scenarios at the lower resolution (50 km).

The aim of this work is to put the new CORDEX-Atlas projections in the context of the available literature.

The added value of the new high-resolution simulations is assessed for both mean climate and extreme over specific climatic regions for sub-daily to interannual time scales.

In addition, mean temperature and precipitation change, together with the change of extreme temperature and precipitation indexes are computed for the mid and far future time slices for both 25 and 50 km simulations.

Keyword: CORDEX-Africa,CORDEX-CORE

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-28

Application of the quantile maping and probability density functions approach using CORDEX data for drought and flood frequencies in Pakistan

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Abstract: Statistical Downscaling from the global to the regional scales always leave uncertainties due to the lack of fine resolution climate data incorporated at the local scale. To overcome this difficulty up to some extent, the quantile mapping (QM) approach based on observed data collected from meteorological stations were incorporated to remove the systematic biases in the regional scale simulations of the CORDEX South Asia data for maximum temperature, minimum temperature and precipitation. Due to the limited computational capacity of climate cluster, the domain size was kept to cover Pakistan area only. The output of the simulations on all the three selected parameters was modelled into probability density functions (PDFs) to indicate the anomalies of the baseline climate patterns in various statistical moments for temperature, the lowest and highest extremes while for precipitation, the driest and the wettest. The PDF-based analysis of the thermal regime identified negatively skewed patterns in projected temperatures as compared to the baseline pattern which forced shifting of percentiles and means largely towards extreme highs and relatively showing less impact on lows. However, the PDF-based analysis for precipitation produced lower kurtotic values with fatter and longer tails in the projected amounts as compared to baseline which are indicating higher frequencies of the dry and wet extremes to occur in future. Both the flood and the drought frequencies are in the matching contrast in the PDF-based output.

Keywords: CORDEX, Probability Density Functions, Statistical Downscaling, Drought and Flood ,Uncertainties

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-29

Assessment of future cyclones activity in the CORDEX Southern Hemisphere domains following a Multi-Model Ensemble approach

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This work aims at analyzing present and future cyclone activity in three CORDEX Southern Hemisphere domains (South America, Africa and Australia) using an ensemble of simulations based on the Regional Climate Model (RegCM4) system driven by global climate models (GCMs) HadGEM2-ES, MPI-ESM-MR and NOR-ESM1-M . RegCM4 has a horizontal resolution of 22 km and uses the Community Land Model (CLM4.5) as scheme for the land surface processes. The analysis includes both extratropical and subtropical cyclones which have been identified using an objective procedure based on the nearest-neighbor approach on mean sea level pressure gridded fields produced by the simulations. Historical period (1995-2014) of the simulations were validated through comparisons ERA-Interim reanalysis. RegCM4 simulates a cyclone frequency more similar to the reanalysis than GCMs ensemble. Resulting storm tracks and cyclone features for the period 2080-2099 (based on RCP8.5 scenario) in RegCM4 and GCMs have been compared with those of the historical period (1995-2014). Both GCMs and RegCM4 ensemble show in the future a decrease in the cyclone frequency over South America and Australia domains. No significant changes have been identified in the cyclone intensity over South America, while for Australia a slight decrease in the intensity of the systems has been found. Simulations for Africa are still in processing.

Keywords: cyclones, climate projections, CORDEX domains

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-30

Potential future climate regimes based on an ensemble of CORDEX-CORE simulations using REMO

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Based on the IPCC Special Report on the impacts of global warming of 1.5 degree C above pre-industrial levels, the temperature extremes on land are projected to warm more than the observed monthly global mean near-surface temperature with high confidence. The potential impacts of this significant climate change vary regionally as such that in most land regions, the current climate conditions would probably shift to a different climate regime. In this study, we are investigating how the regional climate zones of ten CORDEX regions will potentially shift in dynamically downscaled high-resolution projections forced by selected global climate models (GCMs) and two representative concentration pathway (RCP) scenarios (low- and high-end scenario). The high resolution climate change simulations from the regional climate model REMO are a part of the WCRP Initiative on CORDEX Coordinated Output for Regional Evaluation (CORDEX-CORE) Framework.

The latest version of the regional climate model REMO, which is developed and maintained at the Climate Service Center Germany (GERICS), was used to simulate the present and future climate of ten out of the fourteen CORDEX Domains: Europe, South America, Central America, North America, Africa, South Asia (formerly called West Asia), Australasia, East Asia, Central Asia, and Southeast Asia. Following the CORDEX-CORE setup, the model was run on a spatial resolution of 0.22◦ (about 25 km) with 27 hybrid vertical levels. The CORDEX-CORE simulations are composed of ERA-Interim-driven simulations for the evaluation period from 1979 to 2017, and GCM-driven simulations for the historical time period from 1950 to 2005 as well as for the two RCPs scenarios, RCP2.6 and RCP8.5, each for the time period 2006-2100 driven by three GCMs (MPI-ESM-LR, HadGEM2, and NorESM).

For the evaluation period, the mean precipitation and temperature biases were analysed using the latest CRU version TS 4.02 during the evaluation period (1981 to 2010). The climate zones were defined based on the fourteen climate types from the Koeppen-Trewartha Climate Classification. We will investigate how the fourteen climate zones are projected to vary in the futur. In addition, we will identify how the population of the regions might be exposed to the changes in the climate zones.

Keywords: future climate regimes, CORDEX CORE, Koeppen-Trewarth Climate Classification

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-31

Modelling potential impacts of future climate on barley (Hordeum vulgare L.) productivity in eastern Tigray, northern Ethiopia

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Crop growth and productivity is principally a function of temperature if water is available to the ideal satisfaction. The objective of this research was to analyze the future climate of the study area and simulate the potential impacts of climate change on barley (Hordeum vulgare L.) productivity. The climate prediction was made from NT up to the end of the century (NT=near term (2010-2039) MT=midterm (2040-2069) and ET=end term (2070-2099)) using two Representative concentration pathways (RCP: RCP 4.5 and RCP 8.5) and 20 Global Circulation Models (GCM's). To capture the uncertainties in prediction associated with inter-model differences and model parameter assumptions, only under and over predicting GCMs were selected and used. Barley productivity under future climate was simulated using APSIM after thorough calibration using five years' (2013-2017) phenology data. The performance of APSIM was assessed using Relative Root Mean Square Error (RRMSE) and coefficient of determination (R2). The downscaled climate of the study area revealed that precipitation is likely to increase in a range of 20.9% to 30.3% in Atsbi Wenberta and 26.1% to 27.0% in Kilte Awulaelo (the range being the uncertainty). As well, the future temperature is predicted to increase and change in minimum temperature exceeded that of maximum temperature in ET. An output from calibrated and evaluated APSIM model showed a general grain yield decline relative to the baseline, especially during ET RCP 8.5. Relatively lower percentage yield losses resulted from early sowing (05 June) of barley cultivars as opposed to normal and late sowing (23 June and 05 July respectively). Extreme temperatures under future climate is expected to decrease yield as higher temperature is likely to increase evapotranspiration, shorten pollination and grain filling period. We therefore recommend better soil and water conservation practices to minimize evapotranspiration, early sowing and breeding for improved barley cultivars with combined traits such as heat-stress tolerance, early heading and longer grain filling period.

Keywords: Global Circulation Model, Climate Change

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-32

Uncertainty in climate change projections over India using two dynamical downscaling techniques

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Uncertainty in future climate projections at regional and sub-regional scales is an issue of concern for the research and policymaker communities. Over regional scales, dynamic downscaling is still a preferred approach to produce useful information. The use of RCMs and high-resolution AGCMs are two approaches that are popular. In this study, we investigate the impact of various dynamical downscaling methodologies (using a RCM and AGCM) on the mean change and associated uncertainty over India. We use 9 selected CMIP5 AOGCMs downscaled (to 0.5°x0.5° resolution) using the Regional Climate Model (RCM) for the South Asia domain using the Rossby Center regional Atmospheric version (RCA4) by the Swedish Meteorological and Hydrological Institute (SMHI) as a part of CORDEX. We also downscaled the same 9 AOGCMs using NCAR's Community Atmosphere Model (CAM5.3 – the atmospheric component of CESM1.2.2, at 0.9°x1.25° resolution). We compare the downscaled outputs from RCP4.5 and RCP8.5 scenarios against relevant CMIP5 model output over the homogenous climatic zones of India. Spatial and seasonal features of present-day climate over Indian region are reasonably well simulated by both the RCM and AGCM with the signature of downscaling models evident in the biases. We analysed the impact of two dynamical downscaling on mean change and associated uncertainty over the regional and sub-regional scale and also investigated how the uncertainty is fundamentally different from AOGCMs.

Keywords: Dynamical Downscaling,Regional Climate Change, Uncertainty, Regional Climate Model, AOGCMs

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-33

Validation for the tropical belt version of WRF: Sensitivity tests on radiation and cumulus convection parameterizations

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Version 3.9 of WRF-ARW is run with a tropical belt configuration for a period from 2012 to 2016 in this study. The domain covers the entire tropics between and with a spatial resolution of about 45 km. In order to verify two radiation schemes and four cumulus convection schemes, eight experiments are performed with different combinations of physics parameterization schemes. By analyzing the basic features of 2m temperature, precipitation and zonal wind at 10m, and the diurnal cycle of precipitation in boreal summer, the following main conclusions are drawn :

(1) Eight experiments present reasonable spatial patterns of surface air temperature and precipitation in boreal summer, with the spatial correlation coefficient (COR) between simulated and observed temperature exceeding 0.95, and that between simulated and observed precipitation ranges from 0.65 to 0.82.

(2) The four experiments with the RRTMG radiation scheme show a better performance than the other four experiments with the CAM radiation scheme. In the four experiments with the RRTMG radiation scheme, the COR between simulated and observed surface air temperature is about 0.98, and that between simulated and observed precipitation ranges from 0.76 to 0.82.

(3) Comparatively, the two experiments using the new Tiedtke cumulus parameterization scheme can simulate better diurnal variation of precipitation in boreal summer than the other six experiments. In particular, for the diurnal cycle of precipitation over land and ocean, the experiment using the RRTMG radiation scheme and the new Tiedtke cumulus convection scheme shows that the peaks of precipitation rate appear at 0400 LST and 1600 LST, in agreement with observation.

Keywords: Parameterization Scheme,Diurnal cycle of precipitation

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-34

CORDEX multi-RCM hindcast over Central Africa: Evaluation within observational uncertainty

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This work investigates the performance of ten RCMs hindcasts from CORDEX over Central Africa during the period 1998-2008, with focus on monthly rainfall and surface temperature. Downscaled simulations are nested within the ECMWF Interim Re-Analysis (ERA-Interim) over the period 1998–2008 and over a common area at 0.44◦(~50km) of resolution. Many observational datasets are used to assess model performances over four subregions. Throughout the work a measurement of observational uncertainty is made and we discuss whether or not the models are truly within or outside the range of observational uncertainty. We also discuss the added value of the RCMs over ERA-Interim, the uncertainty in ensemble mean of RCMs and how treating all simulations equally matters or not. Results indicate that in general, RCMs relatively simulate well rainfall and temperature basic features over the four subregions, though important biases exist and vary for models and seasons. Wet biases are quasi-systematic features in the northern and southern part of the domain, and in regions with higher topography. Dry biases are common features for few RCMs over the Congo basin. From one season to another, most of the RCMs and sometime along with their average fail to simulate rainfall and temperature by underestimating or overestimating the range of observational uncertainty. However, RCMs show a good spread of grid points where added value is found, except UC-WRF and UCT-PRECIS. This could explain why whatever the time scale of variability (seasonal, annual and interannual), UC-WRF is generally found to be one of the worst among RCMs. We can not really say the multimodel generally outperform individual model, but it is found within observational uncertainty when most models are also found inside. This highlight the fact that the ensemble mean, built from the equal treatment of RCMs is not really different from most of the RCMs and put question on the way it was built.

Keywords: Central Africa, CORDEX-RCMs, Observational uncertainty, Multi-model average, Added value

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-35

Uncertainties in detecting tropical cyclones in Regional Climate Model simulations over the CORDEX-Southeast Asia domain

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The possible sources of uncertainties in simulating the historical tropical cyclone (TC) climatology such as the model-dependent threshold values per criteria, the detection method algorithm, and the domain size are examined and compared using the three downscaled simulations of Southeast Asia Regional Climate Downscaling / Coordinated Regional Climate Downscaling Experiment – Southeast Asia (SEACLID/CORDEX-SEA) and the two downscaled datasets of Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). The study analyzes the characteristics of TC climatology in terms of pattern, intensity, frequency, and lifetime. Sensitivity tests for the detection method criteria threshold values were conducted to determine the optimum threshold configuration for each CORDEX-SEA simulation and PAGASA simulation. Model simulations underestimated the total number of TCs and the average TC days for the 1986 to 2005 period compared with the best tract dataset of Joint Typhoon Warning Center (JTWC). The detection method of Phan et al. (2015) and Hodges (1994) displayed differences in the TC count and detected maximum wind speed. However, both detection methods showed a northwestward shift of TC track density in the region. Model simulations are also affected by domain size and location of the lateral boundaries that contributes to uncertainty in simulating TC climatology.

Keywords: CORDEX, tropical cyclones, regional climate modeling, uncertainty

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-36

Harnessing the economic benefits under uncertainty: Evidence from the Teesta river basin of Bangladesh

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Climate change will increase the frequency and intensity of extreme events such as floods, riverbank erosion, and drought in both near-term and long-term which may lead further uncertain future to the poor and marginal people in the Teesta basin of Bangladesh. The farmers practicing adaptations in Teesta basin experience reduced loss and damage involves different costs and benefits. This study aimed at assessing the most promising adaptation practices, their economic cost and return, and social welfare through the cost-benefit analysis approach. The study revealed few adaptation practices with high costs but generating low benefits to the farmers and vice versa. The study found among the adaptations, shallow tube-well (STW) based irrigation practice in both sandy and loamy soil has the highest marginal adaptation cost (MAC) but the lowest benefit-cost ratio (BCR). Deep tube-well (DTW) based irrigation practice generates superior benefit to the farmers compared to the STW based farming due to the initial establishment by the government which cost a large amount. Maize farming as alternate cropping generates nearly five times higher economic benefits than the costs which can be acknowledged as a most profitable and resilient adaptation option in the Teesta basin. Though MAC is the least for the short-duration variety (SDV) rice among the promising adaptations, it's economic profitability is 36% lower than that of the maize cultivation. However, having lower BCR the SDV rice produces US$51 higher social welfare than the maize cultivation which may enhance the SDV rice over the maize cultivation. Strategic adaptation planning and subsidized resilience building may encourage the farmers to take up adaptation options which may reduce climate-induced loss and damages of the farmers and build socio-economic resilience in the Teesta basin and other similar areas of South Asia.

Keywords: Climate vulnerability, Adaptation benefit, Teesta river basin, Socio-economic resilience

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-37

High resolution simulations and projections over most of North America: achievements and on-going work

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In this presentation, we will talk about our achievements using dynamic downscaling (using WRF)over most of North America (7200km x 6192km) at a spatial resolution of 12km; we will also talk about our on-going work over a slightly larger domain than CORDEX-NA at a spatial resolution of 4km. For the 12km WRF, we developed six ensemble members, with one 30yr of WRF simulations driven by NCEP-R2, and five ensemble members of simulation and projection using three different Coupled Model Intercomparison Project Phase 5 Earth system models (ESMs): GFDL-ESM 2G, HadGEM2-ES, and CCSM4 to represent the range of the sensitivities of all ESM responses to doubled CO2. Our ensemble is made up of one simulation that uses HadGEM2-ES boundary conditions; two simulations that use GFDL-ESM 2G as boundary conditions—one with spectral nudging and one without; and two simulations that use CCSM4 as boundary conditions—one with bias correction and one without. For most of the ensemble simulations we ran each of the lateral boundary conditions with two scenarios, each for two future time periods: (1) historical simulations (1995–2005), (2) RCP 4.5 (2045–2054), (3) RCP 4.5 (2085–2094), (4) RCP 8.5 (2045–2054), and (5) RCP 8.5 (2085–2095). The model output have been extensively evaluated and studied, especially for temperature and precipitation and their extreme features. The output were also applied by statisticians, infrastructure engineers, hydrologist, crop modelers, and biologist to study the spatio-temporal features of the climate change effect on infrastructure, water cycle, crop yields, and even insect pathogen! We have published a dozen of journal articles directly out of this project. There are also scientific reports, and PhD thesis that have used this model output. Some results will be highlighted in this presentation.

One of the most recent successful applications of this project is to provide future extreme climate information (e.g inland and coastal flooding as well as strong winds) to AT&T's network infrastructure over southeastern US. A white paper is published by AT&T and dozens of new articles are written to report this application. Key outcomes from this project will be presented.

With the needs of high resolution data growing, and the fact we found from our previous study, a convective-permitting spatial resolution (less than 4km grid spacing) can significantly improve model performance, especially for extreme features. We are currently testing the feasibility and scale up capability of a 4km simulation over most of North America (similar domain as CORDEX-NA, but covers entire Alaska and Puerto Rico). There are 140 millions of grid cells (horizontally and vertically) for the domain. This project will conduct similar time periods considering different emission scenarios using GCMs as we did for the 12km. Once this dataset is generated, there will be immediate benefits for many other research topics. For example, high resolution wind data will serve better for fire risk study, coastal flooding study; high resolution precipitation will provide much better dataset for hydrological modeling (such as WRF-Hydro®); finer resolution will capture the details of complex topography and generate better precipitation over western US (such as snow over Sierra Nevada). We will present the challenge of this on-going work and the added value we found through several previous studies.

Keywords: High resolution simulations,convective-permitting

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-38

Identifying added value of RCMs for simulated precipitation in Africa

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We investigate impacts of horizontal resolution and model formulation on the climatology of simulated precipitation over Africa by conducting a number of sensitivity experiments at different horizontal resolutions by different RCMs. First we downscale the ERA-Interim reanalysis (about 80 km resolution) by two RCMs (SMHI-RCA4 and HCLIM-ALADIN) over Africa at about 25, 50, 100 and 200 km resolution for the historical period (1981-2010) for the evaluation of model performance and identify possible added value compared to the reanalysis Second, to attribute changes by RCMs on climate change signals, we downscale two global models from 1950 to 2100 (EC-EARTH and MIROC5 under the RCP8.5 scenario) by two versions of SMHI-RCA4 over Africa at the standard CORDEX 0.44° (50 km) resolution and at the spatial resolution of the driving GCMs (about 1.1º for EC-EARTH and 1.4º for MIROC5). Focusing on precipitation we find that added value of increasing resolution can be found with regards to the forcing reanalysis and GCMs, but varies depending on region and season. We also note that some of the identified added value are common to the RCMs regardless of which GCM that is downscaled. This study may give useful implication to the utility of RCMs, especially when it comes to the theme of climate services.

Keywords: Added value, Africa, RCA4, HCLIM, precipitation

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-39

Evaluation of multi-RCM high-resolution hindcast over the CORDEX East Asia Phase II region

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Based on the Coordinated Regional Downscaling Experiment-East Asia second phase (CORDEX-EA-II) with higher resolution, model results driven by ERA-Interim reanalysis using WRF, RegCM4 and CCLM are evaluated against the observational datasets including CN05.1, CRU and GPCP during the period of 1989-2009. The results show that the RCMs have the capability to simulate the annual and seasonal mean surface air temperature and precipitation, however, some biases are produced. The biases are highly dependent on the geophysical locations and the RCMs applied, and CCLM agrees better with the observed precipitation over ocean. CCLM also outperforms the other two RCMs in simulating the interannual variations of temperature and precipitation in most sub-regions, which can be attributed to its better presentation of the interannual variation of large scale circulation. Generally, all the three RCMs can well reproduce the seasonal cycles of the surface air temperature in most sub-regions, however, only in the northern regions of China can the RCMs well reproduce the seasonal cycles of precipitation.

Key words: CORDEX; Regional climate model; East Asia

Under the same framework, we are going to investigate and evaluate the RCMs' performances in simulating extreme temperature over CORDEX-EA-II region in the period after the submission of abstract. We focus on the climate extreme indices developed by ETCCDI and the relevant model performances to detect what reasons cause the biases and uncertainties in the simulations. So we may add these part of study into my oral presentation if this abstract will be accepted as we hope. On the basis of these procedures, we can better understand the underlying physical mechanisms in the regional dynamical downscaling modelling.

Keywords: CORDEX-EA-II,Regional Climate Model