Parallel Session A:
Advances in regional downscaling

A3: Downscaling tools and methods

POSTER PRESENTATIONS

Parallel Session A: Advances in regional downscaling

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A3-P-01

Trends and variability of surface temperature over the Olifants River catchment

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This study examines trends in temperature using historical observation and model daily minimum and maximum temperature data over the Olifants River catchment for the period 1951–2005. An ensemble of regional climate model (RCA4) simulations, forced with CMIP5 models under the "Business as usual" climate scenario RCP 8.5 was performed for the catchment for future period of 2006-2060. All the simulations were obtained from the CORDEX Africa. Trends and the statistical significance of the annual and seasonal series were calculated using the modified Mann-Kendall test in the R package. The results indicate that the catchment has experienced increase in the frequency of warm temperature, although no significant change in the shapes of the historical and future distributions are discernible. The results further indicate that warm temperature extremes are expected to increase significantly, continuing from already significant historical trends in the mean temperature as well as extremes. Seasonally, the frequency of warming in minimum temperature is stronger in the Summer season of December, January, February (DJF) and Spring season of September, October, November (SON) compare with Winter season of June, July, August (JJA) and Autumn season of March, April, May (MAM). The results of this study provide an understanding of the characteristics of changing temperature, in the context of the present anthropogenic global warming and are relevant for decision-making process, especially for sustainability of the River catchment and its resources.

Keywords: Trends,Projections, Temperature, Rainfall

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A3-P-02

Changes in moisture dynamics as potential drivers of precipitation change in the Central African region under global warming of 1.5°C and 2°C

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Anthropogenic climate change is anticipated to influence the frequency and intensity of climate extremes in vulnerable regions. This study examines the effects of global warming levels (GWLs) of 1.5°C and 2°C on future changes of moisture fluxes to constrain modeled change in Central Africa (CA) rainfall, using an ensemble of transient projections from the regional climate model RCA4 in the framework of the coordinated regional climate downscaling experiment over Africa (CORDEX-Africa). RCA4 is nested within eight General Circulation Models (GCMs) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) under the Representative Concentration Pathways (RCPs) 4.5 and 8.5. Results indicate that regional scale responses to anthropogenic forcings vary across GWLs and seasons. Seasonal changes of precipitation and moisture divergence are correlated; more pronounced in March-May, relative to September-November; and larger for 2°C GWL relative to 1.5°C GWL. Whilst most forcings seems to show a projected decrease precipitation over major areas in MAM, there is rather a tendency to localised decreases or increases in SON. There is a substantial increase of zonal moisture divergence fluxes in upper atmospheric layers (>700) under RCP8.5 compared to RCP4.5 leading to large changes in the moisture transport. Moreover, it's found that additional warming of 0.5°C will change Central Africa hydrological cycle with modification of water availability, which means serious problems to water resource management in agriculture, hydro-power generation, breeding, sanitary and other ecosystems.

Keywords: Central Africa, RCA4, CMIP5, global warming levels, moisture flux convergence

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A3-P-03

Dynamical and statistical downscaling: intercomparison in three extreme temperature events in southern South America

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Global Climate Models are the main tools used to generate weather and climate predictions at different time scales. However, it is well recognized that these models are unable to provide information at the spatial scale required by many stakeholders. Hence, dynamical and statistical downscaling (RCM and ESD) approaches are necessary for adapting the global model predictions to smaller spatial scales, providing suitable products for a range of applications. Despite of the large number of works that applied these techniques, in South America the comparison of strengths and weaknesses of ESD and RCM has not comprehensively been performed yet, especially in the simulation of extreme events.

In this context, the aim of this work is to compare ESD and RCM in representing extreme temperature events in central-eastern Argentina. To this end, three hot summers in which record heat wave events occurred were selected: 2002-2003, 2013-2014 and 2015-2016.

For the comparison of the two downscaling methodologies, the WRF RCM was used with two different configurations, in which the soil physics were altered. Jointly three ESD models based on linear regression and analogues were considered. All models were driven by ERA Interim. Also, to train the ESD models and to evaluate the downscaling approaches, daily station data from Argentina was used. Two different bioclimatic indices based on the wet bulb temperature were also simulated and compared.

The results show that both approaches are able to reproduce the persistence and spatial distributions of the extreme events as well as the seasonal characteristics of each hot summer. The spread in the simulation of the intensities of the heat waves varies depending on the particular event, the region and the simulation considered. They also showed a good performance in simulating the bioclimatic indices highlighting the importance of the generation of detailed climate information for impact assessment.

Keywords: Dynamical and Statistical Downscaling, Heat waves, Center-eastern of Argentina

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A3-P-04

Inter-comparing grid resolution impacts in WRF and RegCM4 simulations for 2004-year over South America

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To understand the impact of fine resolution in the regional climate (RCM) simulations, the climatology of two RCMs over South America (SA) CORDEX domain is investigated. The special interest is drawn into the evaluation of simulated rainfall and near-surface wind over southeastern South America (SESA) and southeastern of Brazil (SDE), which are two of the main cyclogenetic areas of SA. Therefore, for the 2004-year, the Regional Climate Model (RegCM, version 4) and the Weather Research and Forecasting model (WRF, version 3.9) were integrated using two different horizontal grid spacings and strategies. WRF simulations are two-way nested with grid spacings of 27 and 9 km and used spectral nudging to synoptic waves (2000 km). RegCM4 used 25 and 12.5 km of grid spacings without two-way nesting and forced only in the boundaries. Both simulations were nested in the CFSR reanalysis and the WRF run used SST updates from the NOAA OISST. The simulated rainfall is compared with different TRMM rainfall and 10-m height winds are compared with ERA5 reanalysis. For annual mean, the simulated spatial pattern of rainfall is similar to the observed one, but there is an underestimation of rainfall over the tropical sector of the domain. For the SESA region, both RegCM4 and WRF simulate the annual cycle of rainfall similarly to the observation. In SDE area, WRF tends to overestimate the rainfall while the opposite occurs with RegCM4. In both regions, it is noted a small impact of the grid resolution in both the phase and intensity of the simulated rainfall. For the SDE and SESA areas, the simulated 10-m height wind is more intense than the observed one, with WRF presenting smaller overestimation of wind than RegCM4. In the annual cycle of wind, it is noted also a small impact of grid resolution. An analysis of grid resolution impact in daily rainfall and wind is also presented.

Keywords: model grid resolution, South America, WRF and RegCM4

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A3-P-05

Analysis of observations-simulations-projections and scenarios production in Guinea

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Forecasting at reduced scales (downscaling) is still insufficient because of insufficient observations and duration; early warning systems are unreliable due to lack of technical means, information and consistent data. Even some climate models are difficult to validate on the African continent (IPCC, 2007). Models do not show a consistent enough trend for tropical Africa (Cook and Vizy 2006, Biasutti et al., 2008), which makes medium and long-term planning difficult. However, tropical Africa, like Guinea, is one of the areas where populations, resources and natural ecosystems are the most vulnerable to climatic hazards (Brassard et al., 2007, Tsalefac et al., 2007; 2009, Sultan 2011).

To evaluate and validate the performance of the multi-model approach used in the study area, several climate simulation data were analyzed. The results were compared with observations and analyzes for the main elements controlling climate in tropical Africa (Kamga and Buscarlet, 2006).

It is in fact a data processing of IPCC climate projections and complete the historical analyzes for the plausible scenarios for the period 2020-2050 on our study area.

In this work we used CMIP5 & CORDEX AF simulation data that we then evaluate using data from our observation stations to be able to scenarios (projection RCP)

Keywords: Cordex, RCP

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A3-P-06

Present climate and climate trends using the regional model RegCM4 over regions of complex topography of the Andes.

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This study used three simulations of RegCM4 forced by three different global models (GFDL, HadGEM2 and MPI) of CMIP5 (Coupled Model Intercomparison Project Phase 5) to evaluate the present climate (1981-2005) and future scenario RCP8.5 (2006-2096) over regions of complex topography like the Andes. The evaluation of the performance of the model in over Andes (CA) was made through comparisons with data from meteorological stations and interpolated data (CHIRPS) in four sub-regions, obtained by cluster analysis. In the present climate, the three RegCM4 simulations overestimate the precipitation in regions located at heights between 3000 and 4200 m. In general, in the Andes mountains, the amplitudes of annual precipitation cycles are higher in RegCM4 than in observations. It indicates that RegCM4 simulates high availability of water vapor in the atmosphere, resulting in higher precipitation rates, especially when the wet period occurs (December, January and February). In terms of circulation, in the present climate the 850 hPa winds through the Low Level Jet (JBN) indicate a strong mass convergence on the Andes favoring intense upward movements that would be contributing to the increase of precipitation in the models and a displacement towards the west compared to the reanalysis (ERA-Interim). These factors contribute to explain the overestimation of rainfall in the region in the simulations. The simulations represent the interannual variability of temperature and precipitation, but in general, an intensification of this signal is observed in comparison with the observations. Future latitudinal projections were analyzed over a 30-year period (2030-2060) and show a predominance of warming trend at all latitudes and rainfall reduction in the future, except for the simulation of RegCM4 forced by MPI. For air temperature, the probability density functions of (PDF) show a shift to the right in the future climate (2030-2060), with consequent increase of extreme events which can affect the hydrological cycle in the CA.

Keywords: Andean Region, statistical analysis , climate trends, RegCM4

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A3-P-07

The Earth System Grid Federation Data Node in India for CORDEX South Asia and CMIP6 Data Dissemination

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The climate research collaboration for understanding and predicting climate change and extreme weather events need advanced tools to archive, manage, access, analyze, visualize, and process enormous and distributed climate change projection data sets. The Earth Grid Federation (ESGF) meets this challenge by an international collaboration for the software designed and maintained by research institutions around the globe that powers most global climate change research. The ESGF was a partnership of climate modeling centers created to provide secure, web-based, distributed access to the World Climate Research Programme (WCRP) Coupled Model Intercomparison Project Phase 5 (CMIP5) climate model data that contributed to the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report (AR5).

The Centre for Climate Change Research (CCCR) established at the Indian Institute of Tropical Meteorology (IITM) under the Ministry of Earth Sciences, Government of India has joined the ESGF as a data node peered with the Swedish Meteorological and Hydrological Institute (SMHI) ESGF index node for sharing the climate model outputs generated at CCCR-IITM from the climate simulation experiments conducted for contributing to the WCRP initiative COordinated Regional climate Downscaling Experiment (CORDEX) over South Asia. This ESGF data node is also being utilized for disseminating the IITM Earth System Model (ESM) outputs generated at CCCR-IITM for contributing to the sixth phase of CMIP (CMIP6), which will serve as a basis for the forthcoming IPCC sixth assessment report (AR6). This presentation will provide an overview of the different components in the ESGF infrastructure and the software tools implemented that make the climate data easily accessible to the users for detailed analysis and application studies over the Indian region.

Keywords: CORDEX South Asia, ESGF, Data Dissemination

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A3-P-08

High-resolution temperature projections from PRECIS in different regions across China

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Average and extreme temperatures, i.e., mean temperature (Tm), maximum temperature (Tmax), minimum temperature (Tmin), diurnal temperature range (DTR), frost days (FD) and heat wave days (HD), are derived from Providing Regional Climates to Impact Studies (PRECIS) at a fine resolution (25km) across China. It is obvious that these temperatures exhibit well performance in PRECIS than its originated GCM (i.e., HadGEM2-ES), with a exception of HD. However, some biases (e.g. a bias exceed ± 3 oC for Tm/Tmax/Tmin/DTR and ± 5d for FD/HD) are still declared in some regions, western regions in especial. It is thus necessary to correct bias fro raw outputs. Mapping quantile is used to correct the bias, taking observation as reference. After that, reproduced temperatures are performed much well than raw simulation. Most regions is reported in a bias within ± 0.2 oC for Tm/Tmax/Tmin/DTR and ± 2d for FD/HD. Given the acceptance of the bias-corrected outputs, potential temperatures changes are explored. It is clear that northern and western regions are expected to experience higher warming trend of Tm/Tmax/Tmin. Though national DTR is detected in no obvious trend, it is interesting to note that DTR rises in central-southern regions, indicating a faster increment in Tmax than Tmin. Northern and western regions express a decreasing value of FD, which decrement during 2071~2100 relative to 1961~1990 under RCP8.5 is twice as much as that during 2071~2100 under RCP4.5. Central-southern regions endure an increasing HD, with an increment during 2071~2100 under RCP8.5 over 2 times than that under RCP4.5.

Keywords: temperature projections, Providing Regional Climates to Impact Studies (PRECIS)

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A3-P-09

Projection of future water cycle in East China with an ensemble of climate downscaling simulations

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The ensemble approach is an essential methodology to gain confidence for future climate projection at both global and regional levels. International initiatives, such as CMIP and CORDEX, clearly showed added value of the multi-model ensemble approach. Nevertheless, MME still remains very heavy to actually conduct. Especially for the commonly-used downscaling approach that employs a regional climate model forced by high-frequency boundary conditions (usually every 6 hours) from global climate model, it is indeed very rare to see ensemble simulations in a same regional climate model forced by different global models. In this work, an alternative methodology is proposed and consists of adding a global atmospheric model between the coupled climate system model and the regional climate model. Within this methodology, only monthly-mean global sea-surface temperature and sea-ice extension are necessary and sufficient to propagate climate signal from the global model to the regional one. This hypothesis was approved to be a very reasonable one for climate downscaling purposes, as reported in Krinner et al. (2014, J of Climate) and Hernandez-Diaz et al. (2017, Climate Dynamics) for the Antarctic and Africa respectively. A similar regional downscaling study in East China is reported here with LMDZ-regional, the regional version of the climate model LMDZ. The coarse-resolution global version of LMDZ, noted as LMDZ-global plays the role of intermediate model to pass global climate information to regional scale. Within this framework, climate scenarios from about ten CMIP5 models are used to perform climate downscaling in East China. All of them cover the historical period from 1951 to 2005 and the RCP8.5 scenario from 2006 to 2100. Water cycle is the main focus of this study. Precipitation, evaporation and runoff are carefully examined, especially for the major rivers in the region, such as the Yangtze river and the Yellow river.

Keywords: climate downscaling, water cycle

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A3-P-10

Multi-scale Simulation of East Asian Climate

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Traditional global climate models (GCMs) with coarse resolution usually have deficiency in simulating realistic regional weather because of the difficulties to resolve complex orography at regional scales. Experimental global high-resolution models show some benefits but also raise much computational burden, while variable resolution (VR) models with unstructured mesh can provide comparable results and require less computational resources. In recent years, a VR dynamical core Model for Prediction Across Scales (MPAS) has been incorporated into the Community Atmosphere Model Version 5 (CAM5) and shows promising results. Here the MPAS dynamical core and CAM5 physics package are used to evaluate the effect of regional refinement over East Asia on the climate mean state, with the resolution from 30 km to 120 km. The VR simulation is evaluated against a 20 km regional climate model simulation, observations and ERA-Interim reanalysis data for surface temperature, large-scale circulation and precipitation. The analysis is performed for the whole year and summer, over the 30-year period from 1979 to 2009.

Keywords: MPAS,Variable resolution, East Asia

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A3-P-11

Meteorological drought magnitude duration, intensity and frequency in the future climate of Eastern Tigray, Northern Ethiopia

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Precipitation deficit and its daily, seasonal and annual vacillations are intrinsic features of Ethiopian's climate. This study aimed at analyzing meteorological drought and its characteristics in future climate of eastern Tigray, northern Ethiopia, with the principal goals of enhancing an early warning and better drought disaster response mechanisms. To predict the climate of the study area, the delta scenarios were generated from CMIP5 GCMs and BCSD using the R-software to create 120 delta-adjusted data files (3 times scales [NT=near term (2010-2039) MT=midterm (2040-2069) and ET=end term (2070-2099)] * 2 RCPs [4.5 and 8.5] * 20 GCMs). The meteorological droughts events under future climate of the study area were analyzed using a 4- and 12-months SPI and SPEI. The two-parameter gamma (α, β) probability and log-logistic distributions (α, β and γ) were used to compute SPI and SPEI respectively. In the future, the duration and magnitude of short-term drought will increase in Fatsi but the mean intensity will drop slightly below the baseline. Wukro and Atsbi will probably experience a slightly lower mean intensity of drought relative to the baseline but an increase in duration and magnitude was noticed. Moderate drought frequency will increase in all time segments. Regardless of the predicted increase in mean annual rainfall, some years will still experience deficit that will tantamount in to drought events coupled with higher evapotranspiration. Moreover, the predicted increase in precipitation under the future climate will have uneven temporal characteristics/variability. We therefore recommended better soil and water conservation practices to minimize evapotranspiration.

Keywords: Global Circulation Model, Climate Change, Drought

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A3-P-12

Modeling the current atmospheric parameters trends for Sinai Peninsula using RegCM4.7

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Surface air temperature, sea level pressure, surface wind, surface heat fluxes, and total precipitation are considered as the most important components to describe the Sinai recent climate. The current research presents a three-step downscaling of these atmospheric parameters over Sinai from 1991—2016 using f-nest technique within RegCM4.07 model. The results indicate that the simulated surface air temperature, sea level pressure, and surface wind closely follow the observations. In addition, simulated surface heat fluxes and total precipitation have a significant correlation (over 0.8) with available reanalyze data. In general, the third step downscaling with 10 km grid resolution shows more relevant results incomparable to the first downscaling step with 30 km grid resolution. Generally, the data for Sinai, 1991–2016, display a significant positive trend for surface air temperature (0.45oC decade–1) together with significant negative trends for total precipitation (-0.028 mm day–1 decade–1), and sea level pressure (-0.32 mbar decade–1).

Keywords: Regional modeling, Air temperature, Total precipitation, fnest

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A3-P-13

How well do RCMs and ESDs reproduce the occurrence of extreme precipitation events over Southeastern South America? A case study approach

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Individual extreme precipitation events over Southeastern South America (SESA) during the spring and summer time are responsible of more than 40% of the total accumulated seasonal precipitation. These extreme events are associated with the occurrence of organized convection in the region. Given the mesoscale features involved in their development, modelling their main features and lifecycles is challenging. In this work we gather different modelling strategies, including several Empirical Statistical Downscaling (ESD) models, several CORDEX Regional Climate Models (RCMs) for the South American domain at various horizontal resolutions and several convective permitting simulations performed with the WRF model for selected case studies to assess the capability of different methodologies in capturing the spatial distribution of rainfall during the occurrence of an extreme event. The evaluation of different methodologies also allows identifying their capability in capturing (or not) the associated physical forcings triggering extreme events. Ten individual events were selected based on data from the TRMM dataset and the CPC-Unified gridded dataset for the period 1979-2015 satisfying the following criteria: daily precipitation exceeding the 95th percentile and with a coverage of more than 10% of grid points within SESA. Due to the large observational uncertainty, we also included several observational datasets to characterize the main features of the individual cases evaluated, which include station data, gridded products (CPC-Unified data) and several precipitation estimates based on satellite data (CHIRPS; MSWEP; TRMM; PERSIANN; CMOPRH). For each individual event, evaluation RCM simulations from the CORDEX database at 50 km and 25 km resolutions; 72-hours simulations performed with the WRF model driven by ERA-Interim reanalysis at roughly 20km, 12 km and 4 km, and several ESD models based on different techniques and different predictor variables were compared.

Keywords: downscaling techniques, extreme precipitation events, Southeastern South America

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A3-P-14

Orographical modulation of regional fine scale precipitation change signals - European examples

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High number of regional climate model (RCM) experiments have been accomplished over different sub regions of the globe in the framework of the international initiative called the COordinated Regional Downscaling Experiment (CORDEX). Being the European branches of the CORDEX program: EURO-CORDEX and Med-CORDEX provide RCM simulations targeting Europe (for Med-CORDEX: being the Mediterranean region in focus) at grid resolutions of 0.44° (medium resolution) and of 0.11° (high resolution). Detailed investigation of ensembles of driving GCM and nested RCM simulations for the late 21st century with respect to late 20th century from the CMIP5, EURO-CORDEX, and Med-CORDEX experiments are presented at high resolution, with a special focus on the Alps and the Carpathian region. Present work gives an overview on how the fine-scale RCM downscaling can modulate the GCM produced precipitation change signal in future climate projections over the regions of interest. Our findings point to the fact that the topographically induced fine scale precipitation signal is mostly of dynamical nature in winter, while is more thermodynamic in nature during summer, thus the high-resolution representation of topography in climate models is crucial for the provision of fine scale precipitation projections in mountainous regions.

Keywords: regional climate modeling, precipitation change

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A3-P-15

Future projection of heat waves over China under global warming within the CORDEX-EA-II project

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Driven by four global climate models (GCMs) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) (i.e., CNRM-CM5, EC-EARTH, GFDL-ESM2M and MPI-ESM-LR) under the Representative Concentration Path- way 8.5 (RCP8.5) scenario, projections for future changes in heat waves over China are performed by Weather Research Forecasting (WRF) model simulations for future (FTR, 2031–2055) and present (1981–2005) periods. Six heat wave indices are applied to characterize heat waves based on their frequency, duration, magnitude, intensity, accumulated occurrence days and severity. Analyses show that notable increases in heat wave indices cover all of China. More areas will endure more frequent, longer lasting and more severe heat waves in the coming decades. The increasing tendencies of heat wave indices in the FTR period are more signi cant than those at present, indicating that heat waves will intensify more rapidly in the future. The impacts of climate changes on the accumulated properties of heat waves are more substantial than those on the individual aspects of heat waves. It is also projected that stronger heat waves with prolonged durations and more severe magnitudes will occur more often in the FTR period, whereas relatively weaker heat waves would occur less often. Hence, the occurrence of extreme heat waves shows a more remarkable increase than the occurrence of moderate heat waves. The changes in heat waves can be largely explained by the changes in the dominating high-pressure systems.

Keywords: Heat Waves, WRF,CORDEX-EA-II, Future projection

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A3-P-16

A Case Study for the Impact of Nudging Parameters in WRF over CORDEX East Asia Phase II Domain

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In the study, we investigate the sensitivity of the Weather Research and Forecast model (WRF) to the nudging parameters in simulating JJA precipitation by applying sixteen experiments over CORDEX-EA-II domain. The effects of various nudging parameters in spectral nudging (SN) and grid nudging (AN) experiments were explored, including wavenumbers, relaxation time, nudging levels and nudging variables for SN and relaxation time and nudging variables for AN.

Results showed that both the two interior nudging methodologies can improve the WRF model's ability to reproduce the JJA precipitation and large-scale fields.

1) Spectral nudging shows an advantage over grid nudging in simulating heavy rainfall and low-level circulation.
2) Nudging both kinematic and thermodynamic variables can simulate the JJA precipitation better for both SN and AN simulations.
3) The effect of spectral nudging parameters is dependent on the regions of interest in simulating JJA precipitation.
4) In SN simulations, the options of wave number display larger effects on JJA precipitation when nudging solely the kinematic variables compared to both kinematic and thermodynamic variables over wet sub-regions.
5) The application of small wavenumber can decrease the improvement from both kinematic and thermodynamic variables in simulating large-scale fields and sub-seasonal variations of precipitation.
6) Nudging coefficient has an effect on the performance obviously in grid nudging.

Generally, the experiment adopting spectral both kinematic and thermodynamic variables, 1h relaxation time and four or eight wavenumbers captures the characteristics of summer precipitation more reasonably.

Keywords: precipitation, interior nudging

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A3-P-17

Optimization of CMIP5 results based on machine learning algorithm

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Machine learning algorithms have been widely used in various subject areas including geosciences. However, there are still quite few studies on weather forecasting and climate prediction. At the same time, most GCMs underperform in some regions than the others, particularly in areas with complex underlying surface such as the Tibet Plateau. This paper uses the 'online learning' algorithm to evaluate climate model performance (2meter temperature and precipitation) in the Tibetan Plateau based on output from CMIP5. With the help of the algorithm, we could explore the ability of each model at different times and different grid points, on which optimal weight allocation scheme will be developed to reduce the error between the multi-model ensemble and the observation value as small as possible. Hopefully the algorithm will be applied for future projections in order to optimize the model ensembles.

Keywords: machine learning, GCMs, Tibetan Plateau

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A3-P-18

Assessment of the boundary layer height simulation by CAM-MPAS over East Asia

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Planetary boundary layer (PBL) plays an important role in climate and air quality simulations. Conventional global climate models (GCMs) and regional climate models (RCMs) still have some limitations in simulating multi-scale interactions between PBL and large-scale processes. Large uncertainties remain in PBL height (PBLH) simulations among different models. The development of variable resolution GCMs (VR-GCMs) models provide a great opportunity to combine the advantages of GCMs and RCMs to perform global simulation in representing the global processes with high resolution in regions of interest. In this study, radiosonde data and ERA-Interim reanalysis data are applied to evaluate PBLH simulations over China in the variable resolution CAM-MPAS compared with uniform resolution global models. The sensitivity of PBLH simulations to different model parameterizations are further explored. Our results show that, lower PBLH is simulated with grid refinement over East Asia, especially in winter. Our results also show that PBL schemes have significant impact on simulating PBLH. It is further revealed that the CAM-MPAS model is unable to reproduce the observed seasonal cycle of PBLH even with grid refinement. Reasons for model deficiency in simulating PBLH are further explored.

Keywords: Planetary boundary layer heights, CAM-MPAS

Parallel Session A: Advances in regional downscaling

A3: Downscaling tools and methods

A3-P-19

Regional climate modelling of the Central Asia: Consistencies and uncertainties of the driving GCM's bias correction

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Global climate models (GCMs), typically on horizontal scales of around 100 km, decently simulate Earth's climate system. Nevertheless, the space resolutions of GCMs are in general too coarse for regional climate studies. Regional climate models (RCMs) are therefore introduced to dynamically downscale the GCM output, producing more details of climate variables on finer scales. A GCM with biases that are negligible on planetary scales, however, can possibly lead to severe inconsistencies when employed as boundary conditions for the RCM. While diverse approaches to performing bias correction for the GCM data are proposed, the effect of these corrections on the performance of RCM still remains unclear. As a result, we aim for a thorough discussion on the consistencies and uncertainties of a GCM bias correction with a geographical focus on the Central Asia. The GCM data used in this study is the CCSM3 model data bias-corrected by the ERA-Interim reanalysis data, following Bruyère et al. (2014)'s method based on Reynolds decompositions. The RCM being selected here is the WRF model, with the CORDEX region of Central Asia set as the coarser parent domain, and a region fully covering all five countries in the Central Asia, i.e. Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, defined as the finer nest one. Through a comprehensive comparison between the numerical simulations and the observations in terms of several climate variables, e.g. temperature and precipitation, we present the strengths and weaknesses of the regional modelling of the Central Asia driven by the bias-corrected GCM data. The conclusion of our research may offer practical guidance to climate scientists in robustly determining GCM bias correction protocols for the conduction of dynamical downscalings.

Keywords: Regional climate modelling, GCM bias correction, Central Asia

Parallel Session A: Advances in regional downscaling

A3: Downscaling tools and methods

A3-P-20

Statistical significance tests for the difference of performance between two climate models

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With the increasing emergence of climate models, it becomes more and more important to evaluate and compare the performance of different climate models objectively, quantitatively and comprehensively is more and more important. Although a number of methods are proposed to evaluate different aspects of model performance for both scalar and vector fields, these methods do not consider the difference of performance between two models. Thus, significance test is necessary when you want to know whether the difference of model performance between different models, or the difference before and after the improvement of the model is significance, significance test for the difference of performance is necessary. To the end, we proposes statistical significance test for the difference of performance between two climate models. Statistical significance test includes the test on correlation coefficient, standard deviation, root-mean-square difference and absolute mean difference. Statistical significance test can quantify to what extent one climate model differs from the other model in different aspects. The significance test is based on bootstrap and has no restriction on the distribution of tested data. In addition, the significance test can be used for both scalar fields and vector fields. The significance test would provide new perspective to the evaluation of model performance, and useful information for model developers.

Keywords: model performance, significance test

Parallel Session A: Advances in regional downscaling

A3: Downscaling tools and methods

A3-P-21

Projected mean and extreme temperature and precipitation over Central Asia results from dynamical downscaling and CCSM4

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Limited by availability of high resolution and quality climate data, the climate change and its ecosystem responses and feedback over Central Asia has not been thorough comprehension. In this study, the optimized WRF is used to downscale the ERA-Interim reanalysis data and CCSM4 outputs, producing a new regional dataset of 30 × 30 km spatial resolution covering 1986–2100. The results show that Noah-MP Parameterization is more suitable for WRF to conduct the dynamic downscaling over CA that Noah, and there is significant improvement for the mean and extreme climate simulation in dynamic downscaling compared to CCSM4 model. The projections by dynamic downscaling and CCSM4 model are very similar to each other, especially for temperature and temperature related extremes. Related to 1986-2005, a significant rise trend shown by the annual and seasonal temperature during 1971-2100 with about 2℃ and 5℃ increasing under RCP4.5 and 8.5 scenario respectively. The maximum value of daily maximum temperature, the minimum value of daily minimum temperature and annual total number of days with minimum temperature greater than 25◦C will also increase significantly, the annual total number of days with minimum temperature less than 0◦C will decrease significantly with more GHGs emissions and more significant trend. Therefore, reducing greenhouse gas emission should be a priority to mitigate warming over CA. Significant differences and different change trends are shown in the projection of precipitation and precipitation related extremes over CA by dynamic downscaling and CCSM4 model, and the impact of GHGs emissions is not obvious. The simulations for global and regional precipitation by earth system model and regional model are not reliability, resulting in large deviation of the dynamic downscaling results. In the future, the simulation of global and regional precipitation by the earth system model and regional model needs to be improved to further improve the reliability of the predicted results of climate change.

Keywords: Central Asia, Dynamic Downscaling

Parallel Session A: Advances in regional downscaling

A3: Downscaling tools and methods

A3-P-22

Projected temperature and precipitation changes on the Tibetan Plateau: Results from dynamical downscaling and CCSM4

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The regional climate of the Tibetan Plateau (TP) was simulated by dynamically downscaling reanalysis data and the Community Climate System Model version 4 (CCSM4) and comparing trends of temperature and precipitation with gridded observations. Then, future CCSM4 projections under high and low emission scenarios were downscaled and compared with CCSM4 projections. Observations showed a marked upward trend in temperature and precipitation since 1979. The spatiotemporal distribution of temperature and precipitation in the TP were well represented by the reanalysis data. Downscaled simulations of ERA-Interim and CCSM4 were able to reproduce the spatial distribution of temperature in the TP; however, a cold bias was apparent in the central and western regions. Compared to precipitation observations, the downscaled CCSM4 simulation showed markedly different precipitation trends. Future climate projections indicated that temperatures will increase markedly in the TP, especially under the high emission RCP8.5 scenario. Under RCP4.5, both CCSM4 and the downscaled simulation projected a 1.5 °C increase in annual temperatures during 2006–2050, while under RCP8.5, the downscaled simulation projected an increase greater than 2.5 °C, and CCSM4 projected an increase of 2.0 °C. Emission scenarios had no apparent impact on projections of future precipitation. Therefore, to mitigate warming over the TP, reducing greenhouse gas emission should be a priority.

Keywords: Tibetan Plateau, Dynamic downscaling,CCSM4