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P31 - THIANDOUM Adama

I am working on climate risks related to heat waves in West Africa using the Excess Heat Factor (EHF) method for analysis. The EHF method analyzes the frequency, intensity, duration, and amplitude of heat waves in a region where this approach is rarely used.

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P01

Assessing the Skill of the WRF Model for Dynamical Downscaling of Seasonal Climate Production Over Saudi Arabia

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Abstract

Understanding seasonal climate variability is crucial for sectors such as agriculture, water resource management, and disaster preparedness. This study aims to enhance climate forecasts using dynamical downscaling with the WRF model, refining the resolution of CFS data from 100 km to 30 km for the spring season (March-April-May). To ensure the reliability of forecasts, the model's skill will be assessed, particularly in simulating temperature and rainfall. Various physical parameterization schemes, including boundary layer, cumulus, and microphysics schemes, will be tested. Simulations for MAM 2024 will be conducted for each scheme, and their performance will be evaluated by comparing the results with observed data for the target period. After identifying the optimal scheme based on the MAM 2024 simulations, a hindcast for the period 2012-2023 will be generated. This hindcast will be assessed by comparing the results with observed data over the 12-year period. Finally, the WRF output will be compared with the original CFS data to evaluate the effectiveness of dynamical downscaling in improving regional climate production.

P02

Assessment of Non-Hydrostatic RegCM5 in Simulating and Predicting Heavy Sandstorms over Egypt: A Satellite-Based Validation

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Abstract

This paper investigates the impact of newly implemented physics schemes within the non-hydrostatic dynamical core of the regional climate model RegCM5 on the simulation of heavy sandstorms over Egypt.
The study focuses on a severe Saharan dust episode that occurred between 16th and 18th March 2017. RegCM5, with a 3x3 km grid resolution, incorporates updated microphysics, boundary layer, and radiation schemes to enhance the representation of key atmospheric processes.
Model simulations are validated against surface station data and compared with EUMETSAT RGB images optimized for desert dust observation, demonstrating good agreement with observations. The study analyzes the impact of the updated schemes on the simulation of dust emission, transport, and radiative effects. The model is further used to simulate the net radiative forcing (shortwave and longwave) and evaluate its impact on the region. The radiative effects of dust are discussed in relation to aerosol optical depth (AOD). The results demonstrate the improved ability of the updated RegCM5 to accurately simulate and predict heavy sandstorms over Egypt.

P03

Assessing Wind Regime Contributions to Rainfall Distribution and Aquifer Recharge in Saudi Arabia's Red Sea Hills

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This study investigates the role of seasonal wind regimes in shaping precipitation patterns and groundwater recharge dynamics in the Red Sea Hills of Saudi Arabia, a hyper-arid region facing increasing water scarcity. Using multi-source satellite observations, including GRACE (Gravity Recovery and Climate Experiment), CHIRPS, and TRMM datasets, we assess how wind-induced rainfall variability influences terrestrial water storage across recharge and discharge zones of key aquifer systems.

Results show that winter northerly and northwesterly winds, along with summer monsoonal flows from the south, are the dominant climate drivers behind regional precipitation. While southern areas receive higher annual rainfall due to monsoons, the northern and central regions show signs of increasing precipitation but declining water storage, indicating overextraction and anthropogenic stress. These findings highlight the importance of considering wind–climate interactions in water resource planning.

This research supports the development of localized water adaptation strategies under climate variability. Participation in the workshop will enhance my ability to integrate regional climate models, particularly RegCM5, and explore AI-based climate emulators to simulate hydrologic responses in arid regions. This is especially relevant for developing nations experiencing similar climate and water challenges.

P04

Extreme precipitation simulations from Convection-Permitting climate Models. An analysis based on the Metastatistical Extreme Value distribution framework

Pietro Devò[1], **Santa Andria**[1], and **Maria F. Caruso**[1]

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The emergence of convection-permitting models (CPMs) represents a significant advancement in climate simulations. By explicitly resolving convective processes, CPMs enhance spatial and temporal resolution while reducing uncertainties linked to convection parameterization. However, their high computational cost limits simulations to relatively short periods, typically around a decade, posing challenges for estimating return levels of extreme events, such as precipitation, that exceed the available record length by orders of magnitude. To address this, we leverage the Metastatistical Extreme Value (MEV) framework [1] to maximize the information extracted from limited data. Specifically, we propose a regionalized MEV approach to reduce estimation uncertainty when assessing extreme precipitation events from CPM outputs. We validate our method using long-term, high-resolution observational datasets. Finally, we derive robust spatial estimates of projected percentage changes in precipitation extremes between present and future climate scenarios. These findings offer crucial insights for guiding adaptation strategies to mitigate risks associated with changing precipitation extremes in a warming climate.

[1] M. Marani, M. Ignaccolo, Adv. Water Resour. **79**, 121–126 (2015).

P05

IMPACTS OF ANTHROPOGENIC CLIMATE CHANGE ON THE FREQUENCY AND INTENSITY OF DROUGHT IN THE SAHEL

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Anthropogenic causes of climate change are human activities that add greenhouse gases into the atmosphere. These emissions are proposed to have led to the increase of global temperature and affected rainfall patterns. The Sahel is characterized by highly variable rainfall and is particular susceptible to drought. The drought, which poses a significant threat to the region by destroying their agricultural products and livelihoods as well as associated with health challenges. While droughts are a natural occurrence in the Sahel, researches have suggested that anthropogenic induced climate change is altering the natural fluctuations in the climate systems. Long-term climate trends are important in understanding the shifts in the rainfall variability is whereas climate models are crucial for drought prediction and management. There are growing concerns on how human-induced climate change enhances the drought across the region. This research will quantify anthropogenic induced climate change impact on drought intensity and frequency over Sahel. Deep learning and machine aided analysis of observational climate data and utilizing the appropriate dynamical climate models will be employed for the data analysis and modeling. The result should address the existing gap on the dynamics of the West African Monsoon, which is the primary source of water over the region.

[1] Abdourahamane, Z. S., Garba, I., Boukary, A. G., & Mirzabaev, A. (2022). Spatiotemporal characterization of agricultural drought in the Sahel region using a composite drought index. Journal of Arid Environments, 204, 104789.

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[4] Ogunrinde, A. T., Enaboifo, M. A., Olotu, Y., Pham, Q. B., & Tayo, A. B. (2021). Characterization of drought using four drought indices under climate change in the Sahel region of Nigeria: 1981–2015. *Theoretical and Applied Climatology*, *143*, 843-860.

[5] Ogunrinde, A. T., Oguntunde, P. G., Akinwumiju, A. S., & Fasinmirin, J. T. (2021). Evaluation of the impact of climate change on the characteristics of drought in Sahel Region of Nigeria: 1971–2060. *African Geographical Review*, *40*(2), 192-210.

P06

Sensitivity analysis of dataset and cumulus convection scheme selection in temperature and precipitation simulations using RegCM over central anatolia

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Regions with semi-arid climates, such as Central Anatolia, exhibit greater susceptibility to the impacts of climate change [1]. The present study examines alterations in temperature and precipitation patterns in Aksaray, a central Anatolian city, during two time periods: 2006-2022 (historical) and 2023-2050 (near-future). The RegCM model [2] was employed under the Representative Concentration Patway 4.5 (RCP4.5) scenario, with a spatial resolution of 20 km. The simulations were performed by downscaling three global climate model (GCM) outputs; HadGEM2-ES, MPI-ESM-MR, EC-EARTH. Many aspects of the model's temperature and precipitation simulation capabilities were explored using different cumulus convection schemes (CCSs) over land and ocean: the modified-Kuo scheme, the Grell scheme [3], and the MIT-Emanuel [4] scheme. The simulated temperature and precipitation results are evaluated with the observation values. The findings demonstrate that the selection of the GCM and CCS had less effect on temperature compared to precipitation. The model exhibits better performance in simulating precipitation regimes using the MPI-ESM-MR dataset and the Kuo scheme. Better results were obtained using the EC-EARTH dataset for temperature simulation with the highest correlation coefficient of 0.92. Based on the outcomes of the simulation, it is anticipated that the mean annual temperatures within the province will undergo an increase ranging from 1 to 5^{o}C and there will be a reduction in precipitation and a rise in the occurrence and regularity of intense precipitation episodes until the year 2050.

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P07

Simulating the Urban Heat Island Augmented with a Heat Wave Episode Using RegCM4.7 in a Mega-Urban City of Karachi, Pakistan

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Karachi, a rapidly urbanizing metropolis with a population density of approximately 4,000 persons/km², faces increasing vulnerability to Urban Heat Island (UHI) effects, which can intensify heatwave impacts. This study evaluates the performance of the Regional Climate Model version 4.7 (RegCM4.7) in simulating the severe 2015 heatwave in southern Pakistan. Using dynamically downscaled ERA-Interim reanalysis at a 10 km resolution with activated urban parameterization, we assess the model's ability to reproduce key atmospheric and surface conditions during the event.

Our results indicate that RegCM4.7 effectively captures the extreme characteristics of the 2015 heatwave. Simulated surface temperature maxima exceeded 50°C for at least three consecutive days, aligning with observed heatwave severity. Additionally, the model successfully represents the extended persistence of a high-pressure ridge over Karachi and a concurrent low-pressure system over the Arabian Sea, which restricted the typical sea-breeze inflow—an essential cooling mechanism for the coastal city. The National Weather Service (NWS) heat index derived from simulations consistently exceeded 124°F, classifying the event within the "Extreme Danger" category, highlighting significant risks of heat stress and heatstroke.

These findings underscore the effectiveness of UHI-integrated RegCM4.7 in simulating extreme heatwave events. The model's capability to replicate key meteorological drivers makes it a valuable tool for future climate impact assessments and adaptation strategies aimed at mitigating urban heat risks in rapidly growing coastal cities.

P08

Extreme precipitation simulations from Convection-Permitting climate Models. n analysis based on the Metastatistical Extreme Value distribution framework

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The emergence of convection-permitting models (CPMs) represents a significant advancement in climate simulations. By explicitly resolving convective processes, CPMs enhance spatial and temporal resolution while reducing uncertainties linked to convection parameterization. However, their high computational cost limits simulations to relatively short periods, typically around a decade, posing challenges for estimating return levels of extreme events, such as precipitation, that exceed the available record length by orders of magnitude. To address this, we leverage the Metastatistical Extreme Value (MEV) framework [1] to maximize the information extracted from limited data. Specifically, we propose a regionalized MEV approach to reduce estimation uncertainty when assessing extreme precipitation events from CPM outputs. We validate our method using long-term, high-resolution observational datasets. Finally, we derive robust spatial estimates of projected percentage changes in precipitation extremes between present and future climate scenarios. These findings offer crucial insights for guiding adaptation strategies to mitigate risks associated with changing precipitation extremes in a warming climate.

[1] M. Marani, M. Ignaccolo, dv. Water Resour. **79**, 121–126 (2015).

P09

Analyzing Future Snow Changes in the Mountainous Region of Eastern Türkiye Based on Convection-Permitting Climate Simulations

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The snow cover in the Upper Euphrates Basin, the headwater of the transboundary Euphrates River located in the mountainous region of Eastern Türkiye, has changed in recent decades due to warming. Particularly, rising temperatures shift the timing of snowmelt and shorten the snow season. Since the snowmelt is crucial for water resources and energy production in the basin, changes in the snow cover pattern increase the basin's vulnerability to climate change. In this study, we performed convection-permitting climate simulations at a 3 km horizontal resolution for the 2005–2014 reference and 2041–2050, 2061–2070, and 2091-2100 future periods to reveal the changes in temperature extremes and land-atmosphere interactions due to reduced snow cover in detail over the basin. To this end, we downscaled the MPI-ESM1.2-HR simulations under the SSP3-7.0 scenario using the WRF model. Following that, we investigated the changes in snow depth and snow cover during the snow season from November to April in the Upper Euphrates Basin for the 1985–2021 period by using the Copernicus European Regional Reanalysis for Land (CERRA-Land) dataset at 5.5 km horizontal resolution. The analyses of CERRA-Land indicate that snow cover has diminished significantly in November, with levels remaining below 5% during the 2012–2021 period at grid points between 1.000 and 1.500 meters in altitude. Also, high resolution future climate simulations indicate an earlier snowmelt in spring, decreasing the snow cover by about 20%, and the surface albedo by about 10% in the same elevation range due to sudden warming in March across the study area. Moreover, trend analysis of CERRA-Land shows that the maximum snow depth during March and April decreases up to 30 cm/decade. The outcomes of this study emphasize the earlier snowmelt, the retreat of snow cover, and the shortening of the snow season in historical and future periods in the Upper Euphrates Basin.

Dynamical seasonal forecast of winter over North Africa using RegCM model

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Around three quarters of the North Africa region consist of desert that is unwelcoming to life and normal human activities, with average annual precipitation less than 50 mm, and arid climate where average precipitation is less than 150 mm per annum. The rest is of either semi-arid or Mediterranean climates. Drought materializes in a reduction of precipitation from the long-term average that extends over a given space scale for a specific period of time and results in impacts on human activities. Therefore, there is need to make more accurate seasonal forecast over North Africa for the precipitation and temperature which highly affect the drought and thus human activities.

As there is a few studies for seasonal forecasting over North Africa based on statistical methods, in the current work we used ICTP regional climate model of RegCM5 as a dynamical model in the forecasting for winter forecasting as the rainiest season in North Africa.

In this study we used RegCM5 with CFS data

1- First we run RegCM model with 20 km resolution using reforecast CFS data(hidcast) for the period (1982-2010) over Egypt, and we re-initializing RegCM every year (e.g., for winter DJF forecast therefore the run started from the 2th of November for each year of period, and November was taken as a spin up).

The previous step to form climate data based on the RegCM model to be used as reference.

2- Then the RegCM model was run using the forecast of CFS for DJF season 2023 initial and boundary conditions, We used the data of the ensemble members of CFS which produced in November 2022 and calculate anomaly by using the reference period calculated in the previous step and also with CRU data (1991-2020) as an observation to see how much the forecast deviates from the climatology from model hindcast and observation.

3- The model outputs include many parameters every 6 hours, but we just focused on temperature and precipitation as common parameters and most effect on drought.

Now we will repeat the same steps for the North Africa region.

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Projected Climate changes over the Tibetan Plateau based on a set of RegCM4 simulations

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Tibetan Plateau (TP, with the height > 3000 m) is a region with complex topographical features and a large diversity of climate both in space and time. Future climate change over TP and the surrounding areas is investigated based on the ensemble of a set of the 21st century climate change projections using a regional climate model, RegCM4. The model is driven by five different GCMs at a grid spacing of 25 km. Results show the RegCM4 greatly improves the temperature and precipitation simulations by providing finer scale spatial details of them over the region. The topographic effects are well reproduced by RegCM4 but not the GCMs. General warming and increase in precipitation are found in both GCM and RegCM4 simulation, but with substantial differences in both the spatial distribution and magnitude of the changes. For temperature, RegCM4 projected a more pronounced warming in DJF over TP compared to its surrounding areas. The increase of precipitation is more pronounced and over the basins in DJF for RegCM4. For the extreme indices of snowfall, RegCM4 generally reproduces the spatial distributions although with overestimation in the amount. General decreases in SNOWTOT and S1mm, with greater magnitude over the eastern part are projected. Both S10mm and Sx5day show decrease over the eastern part but increase over the central and western parts. Notably, S10mm shows a marked increase (more than double) with high cross-simulation agreement over the central TP. Significant increases in all four indices are found over the Tarim and Qaidam basins, and northwestern China north of the TP. The projected changes show topographic dependence over the TP in the latitudinal direction, and tend to decrease/increase in low-/high-altitude areas.

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(2) Fu Yuanhai, Gao Xuejie, Zhu Yingmo, Guo Dong, 2021: Climate change projection over the Tibetan Plateau based on a set of RCM simulations, Advances in Climate Change Research, 12(3): 313-321.

P12

Role of High Sea Surface Temperatures in Amplifying Extreme Rainfall Over the Southern Arabian Peninsula on 16th April 2024

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On April 16, 2024, the United Arab Emirates experienced an unprecedented extreme rainfall event, with Al-Ain recording 254 mm and Dubai 142 mm in a single day, driven by a Mesoscale Convective System (MCS). This extreme event resulted from the interaction of cold air from higher latitudes pushed eastward by the subtropical jetstream with warm, moist air from the Arabian Sea. A crucial factor in amplifying this event was the anomalously high sea surface temperature (SST) in the Arabian Sea, which reached 30.5°C, about 1°C above the 40-year climatological mean. This warming was linked to both El-Niño and a strong positive Indian Ocean Dipole (IOD), which contributed to increased evaporation and enhanced atmospheric moisture transport to the Arabian Peninsula. To quantify the impact of these anomalous SSTs on the intensity and distribution of rainfall, high-resolution Weather Research and Forecasting (WRF) simulations were conducted. Two experiments were designed: the first experiment was run using the real (actual) initial and boundary conditions in 2024 SSTs (CTRL), whereas the second experiment was run using 40-year (1981-2020) mean climatological SSTs (CLIMSST). Both experiments were run from 13 March to 16 April 2024.

The probability density function (PDF) analysis shows that, for higher rainfall intensities ($>$100 mm), CTRL run exhibits a longer tail, which manifest stronger downpours in CTRL run compared to the CLIMSST run. The ratio remains close to 1 for moderate rainfall, However, above 100 mm, the ratio increased by a factor of four (around 200 mm). This suggests that higher SSTs in 2024 significantly amplify extreme rainfall. A higher precipitable water content observed in the CTRL, a range (52-58 Kg/m^2) rarely seen in the CLIMSST. The precipitation percentile analysis indicates a substantial increase in rainfall intensities at higher percentiles in the real (CTRL) run. The precipitation percentile ratio between the two experiments exceeds 1.4 in the highest percentiles, indicating that extreme rainfall events are much more intense in CTRL than in CLIMSST. Moisture convergence analysis further supports these findings. The CTRL simulation exhibits stronger convergence than CLIMSST, particularly during the peak period of the event. The southern boundary contributes the most to moisture convergence in both cases, highlighting the role of moisture transport from the Arabian Sea in fueling the extreme event. As per the Clausius–Clapeyron relation, every 1°C increase in air temperature, increases the capacity of the air to hold 7% more moisture [1]. The enhanced convergence in CTRL run suggests that higher air and sea surface temperatures led to increased moisture availability, reinforcing the development of deep convection. As seen in the probability density function (PDF) analysis, this increase in moisture supply is directly linked to a higher probability of extreme rainfall events.

These findings indicate the critical role of anomalously high SSTs in intensifying extreme rainfall events, highlighting the need for improved predictive models and resilient infrastructure to mitigate the growing risks posed by climate change in the region.

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P13

CLIMATE-DRIVEN FLOOD SIMULATION FOR THE KIZILIRMAK RIVER, TÜRKIYE, USING HEC-RAS AND RCP SCENARIOS

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The Bafra Plain, located within Türkiye's ecologically and economically vital Kızılırmak Delta, faces growing flood risks due to climate change and extreme weather events. This study investigates hydrological interactions in the region by employing the HEC-RAS 2D model with historical data (1963–2005) and future climate projections (RCP 4.5 and RCP 8.5). Flood dynamics, including propagation, water depth, and velocity, are simulated to evaluate changes in flood extent and associated risks under different climate conditions. The analysis integrates high-resolution Digital Elevation Models (DEMs), land use data, and climate projections to enhance accuracy. Results indicate flood-prone areas ranging from 8.96 km² (Q25) to 12.70 km² (Q500) in past records, while future scenarios project a decrease in flood extent but persistent risks, with affected areas varying between 4.58 km² and 10.71 km² under RCP 4.5 and RCP 8.5. The findings underscore the importance of floodplain delineation in hydrological processes that shape aquatic ecosystems. This study provides valuable insights for sustainable flood risk management and ecosystem-based adaptation strategies, advancing knowledge of the water cycle in the context of climate change.

P14

Compound Impacts of Climate Change and Land Use Dynamics on Sustainable Use of Groundwater

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Climate change and Land Use/Land Cover Change (LUCC) are key drivers of hydrological changes, significantly affecting groundwater availability. Climate change alters rainfall patterns and increases temperatures, while LUCC—driven by urbanization and agriculture—modifies land characteristics that influence groundwater recharge and storage. While the effects of these factors on surface water are well studied, their combined impact on groundwater remains less explored. This paper aims to bridge that gap by assessing how climate change and LUCC together influence groundwater resources. It highlights key challenges in evaluating these effects, including data limitations and uncertainties in modeling. To overcome these challenges, the study suggests integrating climate and land use models and improving data collection efforts. The paper emphasizes the need to consider both climate change and LUCC in groundwater management and planning. Also it emphasizes the need for further research to better understand their combined impact and support sustainable groundwater management.

P15

Extreme Weather Event Detection in High-resolution Climate Simulations

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In order to better understand atmospheric conditions during severe weather events, we will analyze decade-long simulations of high-resolution ($\lesssim$ 4 km) convection-permitting climate models (CPMs) recently performed in the framework of the CORDEX-FPS program [1]. The added value of convection being explicitly resolved in models was evaluated and confirmed in several studies so far in the context of precipitation [2, 3]. This research will, for the first time, evaluate models' ability to reproduce favorable conditions for frost and deep convection (specifically, hail and lightning) on the Croatian territory.

Since frost is not explicitly modeled in simulations, different techniques for its detection have been investigated in previous studies [4, 5]. In this research we will adopt a method from a recent study ([4]) that provided the most satisfactory results in predicting the frost development, and apply it on CPM outputs. We will evaluate this method using frost occurrence data collected from surface meteorological stations.

Convective processes are known for their complexity, and modeling products of convection such as hail and lightning is a major challenge. However, specific hail parameters can be simulated using the HAILCAST module combined with NWP models, while the use of Lightning Potential Index (LPI) showed great performance in lightning density prediction [6]. Also, numerous efforts have been made to identify weather patterns associated with hail by using proxies [7, 8, 9]. In this work, we will create a proxy and use LPI values to estimate favorable conditions for development of hail and lightning in CPM outputs. We will verify LPI results against lightning data from the Lightning Detection Network (LINET), and evaluate estimated hail events against the hail occurrences at surface meteorological stations.

Our main goal is to contribute to the understanding of how frost and convection can be detected in CPM simulations. As a final result, we aim to create a climatology of frost, hail and lightning density, leading to detailed risk maps of the mentioned extreme weather events for the present and future climate in Croatia.

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P16

Drought-induced TREE MOrtalities and REwilding in Apulia (TREEMORE)

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In the last 30 years the Mediterranean region has increasingly been subjected to prolonged droughts, a phenomenon expected to worsen due to the rising levels of anthropogenic emissions. Although the scientific community has reached an emerging consensus regarding the physical processes driving these extreme events - such as the increased frequency and duration of atmospheric blocking and the expansion of subtropical zones - the broader impacts of water shortages on vegetation and feedback mechanisms within the climate-environment system remain poorly understood. Current evidence suggests that drought may lead to widespread tree mortality, heightened wildfire risks, and a gradual transformation from Mediterranean ecosystems to vegetation types typically associated with semi-arid environments. Apulia region, in Southern Italy has been selected as the study region, as it offers a unique case study to assess the consequences of extensive olive trees die-off after the spread of the pathogen/bacteria *Xylella fastidiosa.* We will investigate the effect of die-off and of different potential replanting strategies on the regional atmosphere. The study involves three different vegetation scenarios with a total of 12 new high-resolution sensitivity experiments under low and high-emission conditions (RCP2.6 or SSP1-2.6 and RCP8.5 or SSP5 8.5). One scenario will act as a reference with the current vegetation state. A deforestation scenario, accounting for 100% desertification, will represent the worst-case scenario. A regreening scenario will represent the afforestation/rewilding with native Mediterranean vegetation over the whole region.

For this work, we will employ the regional version of the Global Environmental Multiscale Model (GEM) over the Euro-Cordex and the high-resolution Regional Climate Model (RegCM5, Giorgi et al., 2023) in convection-permitting setup, configured for the Southern Adriatic region over the domain 39.5°N - 42°N, 14.5°E - 18.5°E. The simulations will facilitate an in-depth analysis of the climatic effects of altered vegetation cover, focusing on key variables such as mean and extreme temperatures, precipitation patterns, moisture distribution, and convection. We aim at identifying climate resilient planting strategies (e.g. restoring the historical land use, olive groves, or the native mediterranean vegetation) in Apulia, as a potentially practical approach to counteract or alleviate the effects of future compound extreme events, including severe droughts and heatwaves.

P17

12th Workshop on the Theory and Use of Regional Climate Models

The impact of ocean-atmosphere coupling on heavy precipitation events over eastern Adriatic and Dinaric Alps

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The Adriatic region is one of the rainiest areas in Europe, especially along its coastal mountainous areas. This region is frequently impacted by severe weather events, including heavy rainfall and flash floods, which pose significant risks to both people and property. Air-sea interactions are particularly important in this region, especially during the autumn when heavy precipitation events (HPEs) are common and there are substantial gradients between sea surface temperature (SST) and atmospheric temperature.

Atmosphere-only regional climate models (RCMs) are forced by SST as a lower boundary condition, which comes from reanalysis or global models. These models typically have a much lower resolution than the atmosphere-only RCM. In contrast, regional atmosphere-ocean coupled models (RAOCMs) explicitly resolve air-sea interactions at high resolutions. This results in improved cyclogenesis and precipitation.

Our objective is to evaluate the impact of ocean-atmosphere coupling on heavy precipitation events that took place during the first HyMeX Special Observation Period from September 5 to November 6, 2012. We will focus on the six Intensive Observation Periods (IOPs) during which heavy rainfall affected the eastern Adriatic region. Additionally, we will assess how well the coupled simulations represent heavy and extreme precipitation at climatological scales.

We use the atmosphere-only RCMs and RAOCMs simulations from the Med-CORDEX framework for our study. We use the precipitation analysis system MESCAN-SURFEX as a reference dataset, available at 5.5 km resolution every six hours, and the rain gauge data from the local observational networks. The primary verification method for the HPEs is the quality object-based measure known as SAL, which assesses the structure (S), the amplitude (A), and the location (L) of the precipitation field. Our analysis also focuses on a range of heavy and extreme precipitation indices for the climatological scale.

P18

Enhancement of RegCM5.0 precipitation and temperature by improved bias correction methods over central Africa

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Precipitation and temperature projections from Regional Climate Models (RCMs) over Central Africa (CA) are of great importance. However, several studies have already shown that the data from RCMs cannot be directly used for climate impact studies in a local scale because of systematic biases that characterize them. Therefore RCM simulations must be preprocessed in order to make them more representative of climate at local scale. The present study focuses on improving temperature and precipitation simulations from RegCM5.0 regional climate model over CA. For this purpose, two correction methods are used: The adjusted Linear Scaling (LS) and Variance (Va) methods. Corrected and uncorrected precipitation and near surface temperature are compared with Climate Hazards group Infrared Precipitation with Stations (CHIRPS) and the fifth generation of ECMWF reanalysis data (ERA5), respectively. Comparison of the performances of both methods was made during various seasons not only over the whole CA region, but also over two sub-domains (zones 1 and 2) having different characteristics. This was done on the basis of the mean bias and Root Mean Square Error (RMSE). Results shown that the precipitation from RegCM5.0 is tainted with huge wet biases compared to CHIRPS. Overall, the analysis suggests that the Va method is the most suitable for reducing the biases of RegCM5.0 simulations, particularly for precipitation irrespectively of regions or seasons. However, it has been found that both methods fail to improve temperature biases in the Inter-Tropical Convergence Zone.

P19

Extreme summer temperatures in the Arabian Gulf favored by La Niña-like conditions

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The Arabian Gulf (AG), a shallow, subtropical, semi-enclosed sea, experiences the highest average sea surface temperatures in the global ocean during summer. While local marine organisms have adapted to these extreme conditions, interannual temperature fluctuations result in marine heatwaves that frequently trigger coral bleaching and physiological stress. However, the climatic drivers of this variability remain poorly understood. In this study, we investigate the sources and mechanisms behind extreme summer temperatures in the Gulf. Analyzing a regional eddy-resolving ocean hindcast simulation combined with ERA5 reanalysis data, we find that extreme summer surface temperatures are tightly linked to lower-than-normal pressure over the Arabian Peninsula and higher-than-normal pressure over Iran and Pakistan. These pressure anomalies are typically associated with stronger monsoon winds over the western Arabian Sea (AS) and weaker Shamal winds. Our results show that these conditions are more prevalent during La Niña years and suppressed during El Niño years. Stronger monsoon winds increase evaporation over the Arabian Sea while weaker Shamal winds enhance air moisture retention in the Gulf, trapping heat near the surface. Additionally, weakened Shamal winds—particularly in the northern Gulf—reduce evaporative cooling, further amplifying local warming. While climate change is driving a long-term rise in Arabian Gulf temperatures, interannual variability linked to ENSO and Indian monsoon intensity causes significant fluctuations, modulating temperature extremes. These findings have implications for the predictability of summer marine heatwaves and coral bleaching in the Gulf.

P20

Building Climate Resilience in Hong Kong: Integrating Sub-Daily Rainfall Projections into Engineering Design and Infrastructure Planning

K.L. Leung and W.P. Tse

Hong Kong, situated in southern China, faces increasing risks from severe convective weather extremes, as demonstrated by the record-breaking 158.1 mm/hour rainfall in 2023 [1]. While Regional Climate Models (RCMs) are widely used to project future rainfall via dynamic downscaling of Global Climate Models (GCMs), their coarse resolution (~25 km) cannot adequately capture convective-scale processes (<10 km), often underestimating short-duration, high-intensity rainfall events [2].

This study integrates convection-permitting modelling (CPM) (<4 km resolution) to improve rainfall projections of Hong Kong under various greenhouse gas emissions scenarios.

Findings will help governmental works departments refine infrastructure standards, updating design criteria for buildings, drainage, and flood control to strengthen climate resilience against extreme precipitation under warming climate.

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P21

Regional Climate Modelling as a tool for the provision of climate services in the dry Andes of Argentina.

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The Andes Mountains in western Argentina play a major role as water towers for the surrounding populations, which rely on the meltwater from glaciers and snow to support the main socioeconomic activities. In recent decades, the combination of declining trends in precipitation and human-induced warming, together with the increasing severity and frequency of extreme climate events, affected both society and ecosystems over the region, a factor that calls for stronger adaptation measures to cope with the changing climate. To better understand the future evolution of climate over the Andes, we need to account for climate models that are able to represent the complex spatial climate gradients in the region. This task can be achieved through the use of regional climate models (RCM) such as the ones belonging to the Coordinated Regional Downscaling Experiment (CORDEX). Therefore, the objective of this study is to: 1) evaluate the past performance of RCMs for the representation of temperature and precipitation over a region with complex topography spanning the latitudinal range between 21°S to 55°S in western Argentina; 2) to account for the future changes in the climate using a combination of scenarios and time horizons through the 21st century. For this, we analyzed historical simulations from 22 RCMs with spatial resolutions ranging from 0.09° to 0.44°, 21 from CORDEX and one developed by CR2 (Chile). The simulations were regridded to 0.25° and compared against CRU TS 4.07 data, using metrics such as the Taylor Skill Score and the Model Rating Index. In general, the RCMs showed an accurate representation of precipitation and temperature in the region. Nevertheless, contrary to what was found in other high-elevation areas such as the Alps [1], a higher spatial resolution does not necessarily lead to better performance in this region. We built a multi-model ensemble using the 5 best RCMs to evaluate the future evolution of regional climate. We quantified the future changes of the mean temperature and precipitation, together with 9 extreme indices, 5 derived from precipitation and 4 derived from temperature. The projected warming in the Andes is proportional to the selected scenario and temporal horizon considered, with higher warming considering the most pessimistic scenario and the far future. In particular, the warming pattern shows a dependence on elevation, a result that is in line with previous studies [2] and poses a threat to the cryosphere in the upper elevations of the Andes. Additionally, changes in mean precipitation exhibit a homogeneous pattern, but an important decline is projected in the central Andes (29°S to 37°S). In general, extreme indices based on temperature align with the projected changes in mean temperature, with an increase in warm extremes and a decrease in cold extremes. Meanwhile, precipitation extremes indices exhibit heterogeneous changes, depending on the scenario and time horizon considered, with a general decline of extreme rainfall events and an increase of dry spells at higher elevations. These future changes represent a major threat to water availability, putting both the population and ecosystems at greater risk. The results from this study will be published by the Environmental Information Center of the Undersecretariat for Environment of Argentina (https://ciam.ambiente.gob.ar/) to support decision-making related to future water availability and climate extremes over the Andes.

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P22

Predicting Monthly Precipitation for Central Africa: Evaluation of Sub-seasonal Models and Influence of Seasonal Sources of Predictability

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Abstract

Sub-seasonal to seasonal forecasting (S2S) in Central Africa (CA) is an important issue for many socio-economic sectors. Its accuracy, strongly influenced by the geographical and seasonal context, requires rigorous evaluation of models at different scales to improve them as much as possible. Using hindcast precipitation forecasts from 13 S2S project models from September to November over 1999-2010, this study assesses their ability to forecast monthly precipitation. It also examines their ability to simulate the Indian Ocean Dipole (IOD) and the teleconnection between precipitation and sea surface temperature (SST) in the CA. The results of the analysis, based on verification measurements of deterministic forecasts, show that most of the models evaluated have a good forecasting performance over the different months, except ISAC-CNR. In addition, ECMWF, NCEP, and UKMO are more accurate than the other. Most of these models simulate the IOD well over the different months. The increase in SST anomalies in both oceans has a significant impact on precipitation and temperature. The positive correlations observed between SSTA and precipitation in CA indicate a thermal increase that leads to greater evaporation of water, thus favoring an increase in rainfall. This leads to an increase in precipitation in September and October, but a decrease in November. This variability in rainfall is particularly pronounced in Gabon, Cameroon, the Central African Republic, and the Democratic Republic of Congo. Improved S2S forecasts through more accurate models are therefore a major benefit for these regions with variable climates, facilitating informed decision-making in many sectors.

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P23

Emulator-Based Downscaling of Future Temperature by Evaluating Multiple Machine Learning Models

Abstract

This study presents the development of a hybrid, emulator-based downscaling model over Peninsular Malaysia. Future dynamic downscaled precipitation from the Coordinated Regional Climate Downscaling Experiment (CORDEX), temperature outputs from the HadGEM2-ES global climate model (GCM), and static predictors were used for the development of the models. Several ML algorithms were tested by training each on 10 representative years of CORDEX future climate projections from 2010–2099. The GCM and static data served as predictors, while the CORDEX data was the response variable. In the calibration phase, RF achieved the highest skill with an RMSE of 0.49 °C, R2 of 0.89, and KGEnp of 0.96, while Ada and ANN had larger errors and lower correlations (e.g., RMSE > 1.0 °C) and therefore, were excluded in the validation phase. In the validation phase, RF also showed the best performance among the models with overall performance of RMSE = 1.01 °C, R2 = 0.44, and KGEnp = 0.81 among the remaining four models. The final selected downscaled model based on the RF technique showed that it can replicate mean, variability, and extreme temperatures at the 95th and 99th percentile. The monthly time series showed that RF based model successfully replicated the CORDEX data with less than 0.5°C deviation. Therefore, by emulating physically based regional climate model outputs, the proposed hybrid approach retains non-stationary climate temperature relationships while significantly reducing computational overhead relative to full dynamic downscaling.

Keywords: Emulator-based downscaling, CORDEX, GCM, Machine learning, Malaysia

Climate response to stratospheric aerosol injection during the Harmattan season in West Africa

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Stratospheric Aerosol Injection (SAI), a proposed climate intervention, aims to reduce the amount of solar radiation reaching the Earth's surface by increasing the reflectivity of the atmosphere, thereby offsetting the warming effect of greenhouse gases. During the Harmattan season (December–February) in West Africa (WA), a natural meteorological phenomenon injects dust and sand particles into the atmosphere, leading to a cooling effect. In this study, we investigate the influence of SAI on West African surface temperature, dust, and other meteorological variables using the Whole Atmosphere Community Climate Model under the Shared Socioeconomic Pathway 2-4.5 scenario and the Assessing Responses and Impacts of Solar Climate Intervention on the Earth system with SAI (ARISE-SAI) dataset. Our findings indicate that SAI intervention significantly impacts the projected surface temperatures, specific humidity, and wind speed changes during the Harmattan season. Compared to a future without SAI, the intervention shows a significant net cooling effect over most parts of WA during the mid-future period (2050–2069). Also, SAI intervention significantly decreases moisture content over southern and northern WA in the near-future (2035–2054), mainly due to the net cooling effects over WA, when compared to a future without SAI. This feature is enhanced in the mid-future period. The cooling effects of SAI are likely to reduce the air's capacity to hold moisture, leading to lower specific humidity levels relative to a future without SAI. It could also have negative implications, such as increased aridity compared to a future without SAI in the northern and central regions of WA. These findings also highlight the potential for SAI to improve air quality in certain areas but also underscore the need for careful consideration of implementation strategies and possible trade-offs. The changes from SAI observed are specific to the ARISE simulation and may differ from other SAI simulations.

P25

IMPACT OF URBAN GREEN SPACE ON OUTDOOR THERMAL COMFORT AND ITS COOLING EFFECT ON SURROUNDING AREA

(A Case Study on Botanical Garden, Dhaka)

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Abstract
Rapid urbanization and climate change have made many cities vulnerable to dangerously high summer temperatures, endangering the lives of residents. When cities undergo rapid development, they alter their microclimate and ecology by replacing porous, vegetated areas with impermeable built-up surfaces. These artificial surfaces absorb and store solar radiation, leading to an increase in Land Surface Temperature (LST). Several studies have shown that urban green spaces, such as parks and botanical gardens, can mitigate the effects of urban heat islands by reducing heat accumulation in cities. This study investigates the impact of land use and land cover (LULC) changes on summertime LST, with a specific focus on the Mirpur Botanical Garden and its 800-meter buffer zone. The primary objective is to calculate the Botanical Garden's LST and examine its correlation with land use indicators, including the Normalized Difference Vegetation Index (NDVI), Normalized Difference Built-up Index (NDBI), and Normalized Difference Water Index (NDWI). The study also assesses the cooling efficiency and gradient of the garden and its surrounding areas. Landsat 8 data from the summer of 2024 was utilized to analyze LST variations. The study employed ArcGIS for spatial analysis, while Excel 2021 and SPSS were used for statistical evaluation. A questionnaire survey was conducted to measure thermal comfort and discomfort indices, and meteorological data was obtained using the Smart Sensor AR827. Findings indicate that NDVI has a negative correlation with LST, while NDBI shows a strong positive relationship. However, NDWI exhibits a weaker correlation with LST. The results also highlight that LST increases in the buffer zones, reaching its peak in the farthest buffer. Survey responses reveal that city dwellers generally find the heat uncomfortable, and residents near the outermost areas of the park report the highest levels of discomfort. The discomfort index further confirms variations in thermal comfort, with the farthest buffer zones experiencing the most extreme conditions. This study underscores the significant role of green spaces in regulating microclimatic conditions. Findings suggest that urban planners and government authorities can use this research to enhance urban parks and improve the cooling effects of green spaces. Implementing such measures can mitigate urban heat island effects and create a healthier, more comfortable urban environment during summer.

Keywords: Urban Heat Island, Discomfort Index, Thermal Comfort, Park Cooling Intensity, Park Cooling Efficiency, Park Cooling Gradient.

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P26

Parametric sensitivity of E3SM in the presence of aleatoric, observational, and structural uncertainty

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The atmospheric component of the Energy Exascale Earth System Model (E3SM) contains numerous new characteristics in the physics parameterizations. It becomes quite difficult to comprehend the behaviors of the models and to tune the parameters due to the complicated nonlinear interactions among the additional elements. To better understand the model behaviors and physics, we plan to conduct 263 short simulations (3 years) in which 45 parameters carefully selected from parameterizations associated with cloud processes, convection-precipitation, and aerosols were perturbed simultaneously using the Latin hypercube sampling method. As Climate models are too expensive to undergo iterative optimization procedures, a machine learning emulator is used that can map model parameters to the subset of model output. In this study we use our 263 ensemble members to train and test the Gaussian Processes, Random forests, Convolutional Neural Net (CNN) emulator. This computationally efficient emulator is then used to obtain an estimate of the optimal value of the parameters that best matches observations when comparing a subset of model output.

P27

RegCM5 high-resolution present climate simulation over South America: validation and Köppen-Geiger climate classification

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This study presents a preliminary evaluation of the climate simulation being conducted with the regional model RegCM5 [1] over South America, within the framework of the CORDEX-CMIP6 initiative led by the International Centre for Theoretical Physics (ICTP, Trieste, Italy). The simulation is performed using the new non-hydrostatic dynamical core of RegCM5 driven by ERA5 [2] reanalysis data, with a horizontal resolution of ~12 km covering the entire South American continent from 1980 to 2004. The model's physical configuration includes the explicit moisture scheme based on the approach of Nogherotto/Tompkins, which improves the physical representation of clouds, particularly mixed-phase clouds, and the deep convection scheme of Tiedtke, activated over both land and ocean, which represents deep and shallow convective processes and incorporates entrainment and detrainment mechanisms. The results are analyzed in terms of seasonal patterns, spatial distribution, and systematic biases. Additionally, the Köppen-Geiger climate classification [3] is applied to both the simulated and observed (ERA5) datasets, enabling a comparison of climate regimes and the identification of discrepancies in the distribution of simulated climate types. This integrated approach provides a comprehensive assessment of the RegCM5's skill in representing the present-day climate over South America and establishes a methodological basis for applying the Köppen-Geiger classification to future climate change scenarios. Climate projections through the end of the 21st century are planned for the next phase of the project, at which point the same methodology will be applied to assess whether the projected changes are robust enough to lead to modifications in climate types, particularly in Southeastern Brazil, with potential implications for biodiversity, agriculture, and water resources.

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P28

Km-Scale Simulations of Stronger SST Forcing Based on CMIP6 Projections Enhanced Black Sea Storm to Tropical Like Storm

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The Black Sea is a semi-enclosed basin with steep and unique topographic features in its surrounding area. During the summer season, excessive heat gain leads to an increase in the Black Sea's sea surface temperature (SST), and this accumulated heat is transferred to the following season. In September, based on ECMWF Reanalysis 5th Generation (ERA5) data, SST over the Black Sea has increased at a rate of 1.3°C per decade. This anomalous SST rise in September enhances the likelihood of extreme weather events in the region. In September 2005, an upper-level trough system moved over the western Black Sea and eventually evolved into a cut-off low. During this period, SST in the western Black Sea ranged between 20°C and 24°C, creating favorable conditions for air-sea heat flux changes. As the cut-off low remained over the western Black Sea from September 25 to September 29, a depression formed and eventually made landfall in Istanbul. The SST+1, SST+2, and SST+3 simulations over the Black Sea corresponded to the ensemble mean SST of 25 Earth System Models (ESMs) forced SSP585 scenario for the periods of 2040–2050, 2060–2070, and 2070–2080, respectively, are applied for the september 2005 case . This study aims to quantify the effects of future SST conditions for the 2005 storm by forcing an increasing SST trend. We conducted 16 numerical experiments using the Weather Research and Forecasting (WRF) Model with the simple Ocean Mixed Layer (OML) model. The WRF model was forced with the high-resolution (5.5 km) regional reanalysis dataset Copernicus European Regional Reanalysis (CERRA), with SST forcing from ERA5 data and an initial mixed layer depth (MLD) obtained from Copernicus Marine Service (CMEMS) dataset. We used a 1.5 km horizontal resolution with 60 vertical levels and applied two different surface roughness parameterizations both with and without the ocean model for the SST control and SST future scenarios. In the control simulations, the minimum sea level pressure (SLP) dropped to 1000 hPa with the ocean model and to 1002 hPa without it. In the SST+3 scenario, the SLP varied between 986 hPa and 994 hPa, primarily due to better representation of the heat fluxes between air and sea which is simulated by slab ocean model. Simulations that included the ocean model resulted in higher minimum SLP values, as the ocean model induced sea surface cooling, limiting the cyclone's intensification. In contrast, simulations without the ocean model maintained higher sea surface temperatures, leading to deeper cyclonic development. Furthermore, in the SST+3 scenario, the maximum wind speed of storm intensifies to CAT-2 hurricane level, reaching a peak of 151 km/h. Maximum enthalpy flux also increased by 142%, from 616 W/m² to 1494 W/m². The landfall location of the cyclone shifted in each experiment but the most shift is seen in SST+3 scenario. Likewise, duration of cyclone over the sea increases and the spatial extent of precipitation increased in the SST+3 scenarios. Overall, this study suggests that enhanced SST forcing in future may develop tropical-like cyclones in favorable synoptic conditions over the Black Sea.

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Impacts of Climate Change in the São Paulo Metropolitan Region: Climate Projections with Convection-Permitting Models

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The São Paulo Metropolitan Region (RMSP), the largest metropolis in Latin America, has undergone rapid urbanization, significantly altering its energy and radiation balance[2]. This has intensified the urban heat island effect, contributing to higher temperatures and severe storms, particularly through interactions with the sea breeze. With global temperatures rising, understanding climate impacts on urban centers like RMSP is crucial, especially regarding extreme rainfall and temperature events.

This study uses RegCM5[1,4] to analyze how land use changes influence climate extremes under present and future scenarios. Simulations will be conducted at two resolutions: 20 km for South America and 4 km for Southeast Brazil, with the latter using convection-permitting configurations. Three time periods will be assessed: present (1990-2014), near future (2040-2060), and distant future (2080-2100), based on the SSP-3.7.0 scenario with EC-Earth as the driving GCM.

Simulations will be performed with and without the CLM4.5[5] urbanization mode for comparison. Extreme events will be identified using percentile thresholds and validated against reanalysis and meteorological data. The Self-Organizing Maps (SOM)[3] AI technique will be used to evaluate atmospheric patterns linked to extreme events. This approach aims to improve understanding of urbanization's role in climate extremes, supporting future resilience strategies.

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Projections over Mid-high Latitudes Northern Asia Using an Ensemble of Regional Climate Model (RegCM5) Simulations

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Future climate change experiments over mid-high latitudes Northern Asia (NAS) are conducted by a series of a regional climate model, RegCM5. In the experiments, RegCM5 is driven by three CMIP6 models of EC-Earth3-Veg, MPI-ESM1-2-HR, and NorESM2-MM, at a grid spacing of 25 km. Two time slices, 1995 to 2014 for the present day climate, and 2080 to 2099 for the future under the emission pathway of SSP2-4.5, are conducted. The analysis is focused on mean temperature and precipitation in the cold season December-January-February (DJF) and warm season of June-July-August (JJA). Results show the GCMs and nested RegCM5 reproduce the present day climate well while RegCM5 provides with more spatial details. The models show a consistent warm bias over northeastern part of the domain in DJF. Cold bias in JJA in the northeastern and warm bias in the southwestern part of the region, more pronounced in RegCM5, are found. The models exhibit a general wet bias during both DJF and JJA, also greater in RegCM5. Significant warming is projected in the future. The warming is more pronounced in DJF compared to JJA. RegCM5 shows broad consistencies in the general pattern of the warming with the GCMs but with more spatial details and greater magnitudes. Precipitation changes show large differences between RegCM5 and GCMs. In DJF, while the GCMs show a dominant and consistent increase, RegCM5 projects extended areas of decrease. A regional mean decrease of precipitation in JJA is found in RegCM5, while the GCMs show a slight increase.

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PROJECTED HEAT WAVES CHARACTERISTICS IN WEST AFRICA

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Abstract

This study aims to deepen the understanding of heat waves characteristics in West Africa through an analysis based on the Excess Heat Factor (EHF) method. We have used temperature minimal and maximal from Princeton observation datasets (1981–2010), complemented by temperature projections for 2041–2100 under four future warming scenarios (SSP126, SSP245, SSP370, SSP585) from CMIP6 models [1]. The EHF method analyzes the frequency, intensity, duration, and amplitude of heat waves in a region where this approach is rarely used [2]. The results show a significant increase in the frequency, intensity, and duration of heat waves, especially in the Sahel. Future heat waves will be more intense and longer-lasting, with stronger temperature fluctuations, impacting human health and ecosystems. Coastal areas will experience moderate changes, while inland regions, such as the Sahel, will be the most affected [2]. Projections suggest continued intensification of heat waves throughout the 21st century, with the most pronounced changes under high-emission scenarios (SSP3-7.0 and SSP5-8.5) [2]. These findings highlight the urgent need for adaptation strategies and policy interventions to mitigate the increasing risks posed by heat waves to vulnerable populations.

Keywords: Heat waves, EHF (Excess Heat Factor), Scenarios, Adaptation, climate change, Risks, Climate trends

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Potential impacts of 1.5ºC and 2ºC global warming levels on large-scale environmental fields associated with tropical cyclone formations in SEA

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The potential impacts of the 1.5ºC and 2ºC global warming levels (GWLs) on the large-scale environmental fields associated with tropical cyclone (LSEF-TC) formation is assessed over Southeast Asia using an ensemble of downscaled CMIP6 GCM projections produced under the Southeast Asia Regional Climate Downscaling / Coordinated Regional Climate Downscaling Experiment – Southeast Asia (SEACLID/CORDEX-SEA) framework. The GWL periods are determined from the corresponding driving GCM by getting the first centered year when anomaly relative to the pre-industrial (1850-1900) mean exceeded the GWL threshold. The CMIP6 GCMs were downscaled using RegCM4-NH [1] with the optimal model configuration discussed in Ngo-Duc et al. (2024) and Tibay et al. (submitted) [2,3]. In this study, the baseline period (1996-2014) is first evaluated against ERA5 to determine the empirical accuracy of each ensemble member in simulating the LSEF-TC at present conditions. Then, the ensemble of the downscaled projected annual and seasonal changes in the LSEF-TC at the 1.5ºC and 2ºC GWL are analyzed relative to 1996-2014, as well as the the differences between the 1.5ºC and 2ºC GWLs. The preliminary results show that sea surface temperatures increase by more than 0.5°C under the 1.5°C GWL and more than 1°C under the 2°C GWL throughout the whole region, hence the mean TC intensity in Southeast Asia is expected to be higher in a globally warmer future.

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Kilometer-Scale Regional Modeling for Bulgaria Using the EuroHPC JU Discoverer PetaSC Supercomputer

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Climate change is a pressing global issue that significantly impacts regional climates and ecosystems. While regional climate models provide valuable insights, there is a growing need for high-resolution simulations to better assess local impacts. This study addresses this need by performing a 3-km convection-permitting (CP) scenario simulation for Bulgaria. The main goal is to analyze various precipitation indices and their projected changes under the Representative Concentration Pathway 8.5 (RCP8.5) scenario, comparing the results with high-resolution observational data.

To achieve this, data from the Coupled Model Intercomparison Project 5 (CMIP5) Global Climate Model (GCM) were downscaled for historical (1995–2005) and future (2040-2050, 2089–2099) periods using a regional climate model (RCM) with 15 km grid spacing and parameterized convection. These outputs then served as initial and boundary conditions for kilometer-scale simulations.

The findings reveal that the kilometer-scale simulations outperform the coarser models in several aspects: they better capture wet-hour intensity across all seasons, wet-hour frequency in spring, fall, and winter, and extreme precipitation events (specifically the 99.9th percentile, p99.9) during winter and fall. Additionally, the high-resolution simulations refine the projected distribution of precipitation and alter the patterns of precipitation frequency, intensity, and heavy precipitation changes in certain regions.

The results indicate a projected increase in wet-hour intensity across all seasons (13.86% in spring, MAM; 17.48% in summer, JJA; 1.97% in fall, SON; and 17.43% in winter, DJF) and in heavy precipitation during spring (13.14%) and winter (31.19%) in the kilometer-scale simulations by the end of the century. These improvements highlight the value of high-resolution modeling for more accurate climate impact assessments.

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