Parallel Session C:
Climate Change Impacts

C1: High impact regional phenomena

POSTER PRESENTATIONS

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-01

Seasonal and interannual variations of the ITCZ in the Indian Ocean

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The climate of tropical regions on the monthly and longer time scales is significantly affected by migration of the intertropical convergence zone (ITCZ), while the ITCZ position depends on the cross-equatorial atmospheric energy transport (AET) and the equatorial net energy input (NEI0). Using the ERA-Interim dataset for the period 1980-2018, the ITCZ position in the Indian Ocean and its migration on the seasonal and interannual time scales are investigated. In addition, the cross-equatorial AET and the NEI0 in the Indian Ocean are analyzed to determine position of the ITCZ based on the atmospheric energy balance. Results indicated that the annual mean position of the ITCZ in the Indian Ocean is in the Southern Hemisphere (approximately at 5.5ºS), while in some seasons, a double ITCZ forms. It is also found that during the period 1980-2018, the annual mean position of the ITCZ in the Indian Ocean is migrated toward the equator by approximately 1º. The largest meridional migration of the ITCZ in the Indian Ocean occurs with the period of 1 year, showing seasonal migration of the ITCZ associated with the monsoon circulation. Our analysis indicated that position of the maximum precipitation in the Indian Ocean is different from the energy flux equator (EFE, where the column-integrated meridional energy flux vanishes), such that the EFE is always located at north of the position of maximum precipitation. It is found that variations of the cross-equatorial AET and the ONI are not consistently correlated, while variations of the NEI0 in the Indian Ocean and the ONI are quite consistent. Variations of the cross-equatorial AET dominate interannual variations of the ITCZ position, while variations of the NEI0 dominate seasonal variations of the ITCZ position in the Indian Ocean.

Keywords: ITCZ,cross-equatorial atmospheric energy transport, equatorial net energy input, energy flux equator, Indian Ocean

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-02

Empirical Assessment of Climate Impact on the Population of the Oil palm Leaf miner

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The leaf miner (Coelaenomenodera elaeidis) is the most serious insect pest of the oil palm. It breaks out in epidemic proportions periodically, resulting in severe leaf defoliation and consequently low fresh fruit bunch (ffb) yield. This study analyses patterns in leaf miner abundance, and elucidates climatic factors influencing leaf miner abundance. The leaf miner sampling records during 2009-2010 in oil palm fields and records from previous surveys from 1976-1980 were utilized. The study analyses temperature, rainfall and relative humidity between 1961 and 2010 in the main station of the Nigerian Institute for Oil Palm Research (NIFOR). Data on temperature, rainfall and relative humidity were obtained from NIFOR meteorological unit. Decadal variation in air temperature indicated increase in air temperature between 1961-1970 and 2001-2010 while variation in rainfall and relative humidity indicated a decrease. It was also observed that there was temperature increase across seasons with highest increase in the dry season, and suitable for leaf miner control. Relationship between mean weather factors (temperature, humidity and rainfall) and leaf miner insect stages (larvae, pupae and adult) between 2009 and 2010 showed significant relationship ($P \leq 0.05$). This could be attributed to relatively higher weather values and higher leaf miner population. The need for continuous monitoring has great potential for control of insect pests in oil palm growing areas.

Keywords: Climate variability, Insect population, Climate impact

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-03

Can the CORDEX- SEA historical simulations capture the observed spatiotemporal characteristics of the drought signal over the Philippines?

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Drought has been a recurrent hazard in the Philippines. Gaining an understanding of the spatiotemporal characteristics of drought in the Philippine setting is needed to frame appropriate mitigation measures. Meteorological thresholds leading to drought conditions differ on regional scales. The Standard Precipitation Index (SPI) is used to characterize drought through frequency, duration and seasonality. This study uses five gridded reanalysis observational datasets: CHIRPS, CRU, JRA, PERSIANN and UDEL to compare with the results from CORDEX-SEA historical simulations. The CORDEX-SEA simulations were downscaled using the RegCM4 model and driven by different GCMS: CNRM, CSIRO, EC-EARTH, HADGEM2 and MPI.

SPI values are computed over 3 and 6 month timescales representing seasonal and semiannual rainfall contexts. For both SPI3 (agricultural) and SPI6 (hydrological) droughts, results show that droughts are more frequent over the largest islands (Luzon and Mindanao) with a clear west-east difference. Generally, there are more droughts in the western half of the Philippines. Furthermore, results show that Luzon experiences more distributed number of droughts over all duration lengths (2, 3, 4, 5 months or greater), compared to Mindanao. Luzon experiences more frequent 3-month droughts while Mindanao droughts are seen to be split equally, lasting from 2 to 3 months, with generally no droughts lasting 5 months or longer. In terms of seasonality, SPI3 droughts start most commonly between December and February, while SPI6 starts between February and April over all areas. By assessing the performance of CORDEX-SEA historical simulations in replicating the drought signal exhibited by observation datasets, application of the same methodology on future downscaled projections can be contextualized and assessed properly.

Keywords: Drought, Standard Precipitation Index, climate variability, CORDEX-SEA

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-04

Quantification of future climate risks and onset of extreme weather events to metropolitan cities in Asia

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More than 50% (~3.5 billion) of the global and 49.6% Asian population is living in cities becoming increasingly urbanized, and population in Asia is equivalent to 59.66% of the total world population. Current growth simulations indicated that the relative magnitude will increase to 58% by 2030, and by 2050 nearly 6.3 billion out of an estimated global population of 9.1 billion will live in urban territory. Cities consume 75% of the world's energy use and produce more than 76% of all CO2. Warming of just 1.5 degrees Celsius could bring on the most severe consequences of climate change. During 2010 to 2018 people's lives were disrupted by heat waves, floods, drought, erratic rains and sea level rise. Changes in temperature, precipitation, sea level, and coastal storms will likely increase the vulnerability of infrastructure across the Asia. Each city has its own particular reaction under the stress of extreme weather events, and weather poses one of the biggest risks to human health and economy. Cities have direct linkages with climate change, and urban centers are major drivers of global warming because they concentrate transportation, industries, households and many of the emitters of greenhouse gases. Already, a third of the urban population in developing countries in living in slum, this usually implies a lack of safe drinking water, sanitation, and highly vulnerable to natural disasters. In Asia more than 18% of urban population living in Low Elevation Coastal Zone that is less than 10 meters above sea level (Mumbai, Karachi & Jakarta). Marginalized urban residents such as labor migrants in, for instance Manila, Colombo and Dhaka are forced to live in highly exposed locations which are highly susceptible to extreme weather. Using regional research and to analyze vulnerability, impacts, and adaptation practices, this paper estimates impacts to human health, economy, coastal properties, and urban infrastructure and investigates sensitivity to varying greenhouse gas emission scenarios and climate sensitivities. The study will provide better understanding to policy makers to rethink what and where a central business district is in the 21st century to reduce our GHG emissions by 45% before 2030 and reach net zero emissions by 2075.

Keywords: Climate Warming, Extreme Weather, Future Risks, Urbanization

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-05

Response of regional monsoons at various levels of radiative forcing in RegCM4-CORDEX simulations

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Using an ensemble of RegCM4 simulations over various monsoon domains, including North America, South America, Western Africa, South Asia, East Asia and Australia, we investigate changes in the regional scale monsoon dynamics in response to changes in the radiative forcing, and its impact on precipitation distribution over monsoon regions. All regional monsoon simulations are conducted at 25km horizontal grid spacing using lateral and lower boundary forcing from three CMIP5 GCMs, each covering 1970 to 2100 under two Radiative Concentration Pathways (RCP2.6 and RCP8.5) in the 21st century projections period. We make use of Lagrangian based moisture back trajectory analysis to understand the variations in moisture sourcing from contributing oceanic and terrestrial sources, dynamic and thermodynamics divers of those variations, and their impacts on the precipitation distribution at varying time-scales. Additionally, we compare results from each of the regional monsoons to understand the commonalities and dissimilarities in the regional precipitation responses, including those related with the monsoon onset, precipitation seasonality and extremes, and the timing of emergence when projected changes are permanently above the baseline variability. Use of centennial-scale, multiple RCP and multi GCM driven RegCM4 simulations provide an opportunity to understand the robustness as well as the sensitivity of projected fine-scale regional monsoon changes to various levels of radiative forcing.

Keywords: global monsoons, RegCM4

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-06

Investigation and projection of Human Thermal Comfort Stress over West Bengal, India using observations and CORDEX climate model experiments

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Numerous studies feature the extreme human bio-meteorological conditions in terms of human thermal comfort index in India for the last few decades. This research highlights the human bio-meteorological conditions and its variability in West Bengal (one of the densely populated state of India) for the last 50 years by using Universal Thermal Climate Index (UTCI). The meteorological variables from meteorological stations in West Bengal are used to calculate UTCI and the computed UTCI is also compared with the UTCI calculated from the regional climate model from the CORDEX-south Asia experiments. The results showed increasing trend of UTCI in almost all the stations of West Bengal during the study period. In addition, future human thermal comfort is projected for Kolkata and its neighbouring districts (capital city of West Bengal) under the scenarios of RCP4.5 and RCP8.5. The future projection of UTCI in Kolkata and its rural outskirts with climate change taken into account suggests that annual aggregate of heat stress days will increase significantly while the no thermal stress days or cold stress days will reduce.

Keywords: Urban Heat Island, Human Thermal Stress

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-07

Predicting Dengue cases in Kolkata, India based on variation of climate using Zero-Inflated Regression Model

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Dengue is one of the most serious vector-borne infectious diseases in Kolkata, India and its viruses and their vectors are sensitive to climate change. The widespread characteristics of dengue in Kolkata are identified with some key meteorological factors such as maximum temperature, minimum temperature, relative humidity and rainfall on the basis of statistically significant cross-correlation coefficient values. The statistical model on dengue cases was framed with the key factors for the first 120 months of the data set from 2005-2016. The remaining months were used to validate the model. Finally, climate variables from the Coordinated Regional Climate Downscaling Experiment (CORDEX) for South Asia region were input into the developed statistical model to project the occurrences of dengue infections under different climate scenarios (RCP2.6, RCP4.5, and RCP8.5). It has been estimated that from 2020-2100, dengue cases will always be higher from September to November with more cases in RCP8.5 (871 cases per year) than RCP4.5 (530 cases per year). This study further evaluates that from December to February, increases in carbon dioxide concentration under RCP8.5 leads to warmer weather conditions essential for the survival and multiplication of vectors, with more than two times the dengue cases than in RCP4.5.

Keywords: Mosquito borne disease, Dengue

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-08

Hydroclimatological variables in the South America CORDEX domain for the Amazon River Basin

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Introduction: With 7.0 x 106 km2 the Amazon River basin represents the most important hydrological region in South America. The Amazon discharges approximately 200,000 m3 s-1 becoming the main source of fresh water from the continent to the Atlantic Ocean. Methodology and data: Our aim is to study the representation of precipitation and evapotranspiration of the Regional Climate Model RCA4 v3 driven by the nine Global Climate Models available for the South America domain in CORDEX. For that purpose, we selected as comparison period the verification period of the IPCC model verification, between 1986 and 2006 at a monthly time scale. The performance of the models is compared with two datasets, the one from GPCC for monthly precipitation and the one from GLEAM for monthly evapotranspiration. Results: Accounting for the long term means of the variables in the period of analysis, models underestimate precipitation by 19% and underestimate evapotranspiration by 4%. When analyzed by wet (January) and dry (July) seasons we find that for precipitation there is underestimation during the dry season that can reach up to 70% and underestimation in the order of 60% for the wet season consistently in model CSIRO. In the case of evapotranspiration, the higher underestimations are of approximately 30% in model CSIRO. However, as for the spatial distribution of the RMSE, the northeast of the Amazon presents the highest errors for evapotranspiration and the north of the Amazon for precipitation. Finally, projections present increase in annual amplitude for both variables under the most severe climate change scenario. Conclusions: With the results so far we can conclude that CORDEX models can be used for assessment of hydroclimatological conditions of the basin taking into account that there is a general underestimation of both variables and that CSIRO is amongst the nine models the one with the lower performance in order to represent the analyzed variables.

Keywords: Amazon River Basin, SAM-CORDEX, Hydroclimatology, Water resources planning

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-09

Energy simulation of social housing in Argentina: how extremes and climate change impact on the energy demand

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Because one-third of the total energy demand in Argentina corresponds to the residential sector, there is an urgent need to define criteria and implement measures, including the labeling of energy efficiency of buildings, the rational use of energy, and the sustainable construction. Energy simulation of buildings is a working area that is at the center of the problem and an essential resource for estimating the energy consumption associated with the use of housing. This requirement is also strongly dependent on the climatic conditions of the place where the house is located and considering the comfort conditions required for each climate.

The occurrence of extreme events and changes in its characteristics (e.g., increase, intensification and/or changes in the frequency of occurrence of warm spells) will have an impact on the energy sector. To estimate it, we perform a series of experiments using a buildings' energy simulation platform (Energy Plus) to evaluate the hygrothermal behavior of social houses in Rosario City (Argentina), forced by boundary conditions from CORDEX models. Aim of this work is to (i) study the hygrothermal behavior of social houses, (ii) define design improvements and estimate changes in the average energy demand, and (iii) analyze the impact of the occurrence of extreme events and (iv) the impact of the climate change on the peaks of energy demand due to consumption from the residential sector.

Keywords: Energy demand, residential sector, confort conditions, extreme events, Rosario City, Argentina

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-10

Multi-model projections of climate change hotspots in the Philippines

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Given the impacts of future climate change, the identification of potential climate change hotspots (i.e. areas highly responsive to changes in climate) is useful for risk assessment, in order to prepare contextualized adaptation strategies. In the Philippines, previous analyses of observation records have shown significant trends and changes in climate in particular areas. Using the multi-model, multi-scenario projections of SEACLID/CORDEX Southeast Asia, this study aims to examine how these climate change hotspots will change in the future, as well as to identify potentially new hotspots due to significant changes in magnitude and/or variability. Changes in climate means and extremes in the Philippines are analyzed for three time periods (2016–2035, 2046–2065, 2080–2099) under RCP 4.5 and RCP 8.5 scenarios, relative to the 1986–2005 baseline period. Initial results show warming that can reach 4°C on average at end of the 21st century under the RCP 8.5 scenario. Models generally agree on the direction of change in the temperature extreme indices, but also show differences in spatial extent, frequency of occurrence, and duration of warm/cold spells. Future drier conditions are also projected in most parts of the Philippines, as indicated by decreases in annual rainfall and heavy wet days, and increases (decreases) in consecutive dry (wet) days, but with more intense rainfall events. Compared to temperature, there is more variability in projected changes in precipitation extremes, in terms of direction of change and spatial distribution. For example, some models project northwest Luzon to be wetter, and Mindanao island to be drier, which would have serious impacts on these vulnerable agricultural regions.

Keywords: climate extremes, hotspots, Philippines, CORDEX Southeast Asia

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-11

Evaluation of the numerical model with CORDEX Regional Climate Models for heavy precipitation in the Meghna Basin region

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Prediction of heavy precipitation (HP) induced flood incidents is challenging when they happen on the high terrain of Meghalaya Plateau and nearby areas. Improving the simulation of the Pre-monsoon (March-May) mesoscale convective systems (MCSs) is important as such events routinely result in rainstorms, flash flood, flooding events and significant loss of lives and properties over Bangladesh, Indian eastern, northeastern region and neighborhood. The influx of moisture from the Bay of Bengal (BoB) energizes these rainstorms systems as it passes over Meghalaya and northern parts of Bangladesh and thus produces heavy convective and stratiform rain over Meghalaya and the surrounding areas. Although extreme precipitation and runoff are the root causes of the flash flood, the stretches of valley and highland plateaus of Indo-Bangla region play an important role in the weather system due to its extraordinary geography and climate. The valley and plateaus of Indo-Bangla region is the wettest place on planet earth. It is important to predict heavy precipitation precisely for assessing floods and flash flood over the region of the Meghna basin. The global precipitation products are helpful for understanding rainfall pattern over a data scare region. For the regional study, the mesoscale numerical model Advanced Research version of the Weather Research and Forecasting (WRF-ARW) is used for estimating heavy precipitation in a finer resolution for the HP event of pre-monsoon season 2004, 2010, 2016 and 2017. Sensitivity analyses of different parameterization schemes are applied in this study. The model simulated precipitation is assessed with the available rain gauge observation along with India Meteorological Department (IMD) Global Precipitation Measurement (GPM) mission merged datasets. The best and worst performing parameterizations combination schemes are identified after doing statistical analyses. In the study, the WRF model simulated precipitation are evaluated with the Coordinated Regional Climate Downscaling Experiment (CORDEX) models data for a better understanding of regional analysis. To understand the influence model grid resolution, global to regional (g2r-1:3) and global to convection-permitting (g2c-1:9) scale ratios are tested in the present study.

Keywords: Heavy precipitation, flood, Parameterization, WRF ARW, CORDEX models

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-12

EPICC – a cross-sectoral and cross-regional intercomparison of climate impacts and adaptation options

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The impacts of climate change and accordingly adaptation options vary strongly regionally and have to be assessed context-specifically. The East Africa - Peru - India Climate Capacities (EPICC) project investigates these impacts for three tropical countries - Tanzania, Peru, India - that differ strongly from each other in terms of geography as well as their vulnerability to a changing climate. In dialogue with partners from policy making, the private sector, civil society and science, EPICC has identified local demands for climate change impact assessments and for testing adaptation options.

Based on observations, global climate projections as well as high-resolution regional climate projections from CORDEX, we investigate these climate change impacts and adaption options across different sectors. Climate data from the CORDEX simulations will be bias-adjusted and statistically downscaled to the local level to allow for local analyses with particular focus on extreme events. These high-resolution climate simulations provide the basis for assessments for the agricultural as well as the hydrological sector, using a suite of statistical and process-based impact models.

Results feed into assessments of migration in the context of climate change, primarily internal migration related to changes in subsistence agriculture productivity. This project enables intercomparisons of regional studies across different sectors and different tropical locations and contexts, using the same approaches, models and statistical tools, always focusing on local user-demands.

Keywords: climate adaption, climate impacts, cross-sectorial

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-13

Extreme winter precipitation vs. model resolution across the Upper Mississippi River Valley

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As we continue to see an increase in extreme precipitation anomalies during winter months across the United States, it is important to focus on how to simulate better these events. These events can cause substantial flooding that can severely erode soil and weaken energy-transmission infrastructure. One way to better understand and simulate these extreme precipitation events is to assess how resolution in regional climate models affects processes leading to extreme precipitation. During winter months, synoptic dynamics play an important role in extreme precipitation events and should be fairly well resolved in regional climate models.

This study focuses on extreme sub-daily precipitation in the Upper Mississippi River Valley during the months of December, January, and February (DJF). We analyze extreme, 6-hourly precipitation as simulated by RegCM4 and WRF using ERA-Interim boundary conditions for the period 2002 through 2012 at grid spacings of 12, 25 and 50 km. We compare composites of simulated 6-hourly extreme events with those occurring in NOAA Stage IV quantitative precipitation for the same period. In addition, we compare composite 6-hourly fields of 2m temperature, 500hPa geopotential height, 10m wind, and 2m specific humidity for the simulated events with composites of the same fields during Stage IV events, using the North American Regional Reanalysis. We evaluate how changing resolution in the two models affects the intensity of extreme events versus Stage IV events as well as how the circulation and thermodynamics of the events changes with resolution, highlighting factors are most sensitive to resolution and their impact on replicating observed behavior.

Keywords: Extreme precipitation, model resolution

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-14

Climate change impacts on hydrology and water resources of Upper Awash Sub-Basin, Ethiopia

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The Awash River basin is the most irrigated area in Ethiopia facing critical water resources degradation due to climate change. Climate change alters regional hydrologic conditions impacting water resource systems. Such hydrologic changes will affect almost every aspect of human well-being. Agriculture is the mainstay of Ethiopian economy. The growing population and efforts to meet the food security of the country will call for expanding irrigation on top of the rain-fed agriculture which in turn will depend on available freshwater resources. As the most irrigated basin in the country, the availability of water in the Awash River basin has declined because of the increased water abstractions for various uses. The main objective of this study is to assess the impacts of climate change on surface water availability of Upper Awash River Basin by using Soil and Water Assessment Tool (SWAT) hydrological model and Regional Climate Model (RCM). Regional climate model (ECHAM5 with A1B emission scenario) and meteorological variables at local scale were applied for three time periods (2020s, 2050s and 2080s). Bias-correction methods have been applied to individual climate variables to adjust RCM data. RCMs bias correction methods was used for scenario generation to estimate average changes in annual temperature and rainfall. The bias correction approach applied in this study gave the reasonable results. SWAT was calibrated and validated to simulate future hydrologic variables in response to changes in precipitation and temperature. The results of calibration and validation model indicated that SWAT simulated monthly flow well. This was showed by the Nash-Sutcliffe simulation efficiency (ENS) and Coefficient of determination (R2), which were 0.80 and 0.85 for the calibration and 0.78 and 0.83 for the validation, respectively. The results showed that the projected climate change scenario increase in rainfall for the time period of 2020s, whereas reduces in rainfall for the time periods of 2050s and 2080s and the projected temperatures increase for all three time periods. The SWAT model results show that the annual stream flow of Upper Awash Sub-Basin was reduced by 2.46% and 18.14% in 2050s and 2080s, respectively, while the stream flow increased in 2020s by 4.90% for A1B scenario. The simulated flow at 2050s and 2080s, with A1B scenario from RCM, showed reduction of runoff by 1.52% and 3.50%, respectively in the Sub-Basin and it was directly related to the reduction in precipitation, while the annual runoff increases in 2020s by 8%. Thus, precipitation being the main driver in the water balance computation, its variability both annually and seasonally has a direct impact on the other simulated water budget components. Model result showed that about 44.36% of annual rainfall contributes to stream flow as surface runoff. Generally, the results revealed that changes in climatic variables, such as reduction in rainfall and change in both minimum and maximum

temperature would have a significant impact on the stream flow and surface runoff, causing a possible reduction on the total water availability in the Sub-Basin. The results obtained in this study can provide useful information for future water resource planning and management in the face of climate change in the upper Awash Basin. It is concluded that future climate change by the end of the 21st century are most likely to produce significant impacts on the surface runoff and stream flow.

Keywords: A1B Emission Scenario, Climate Change, RCM, Hydrology, Water Resource

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-15

Spatiotemporal dynamics of rainfall, temperature, and vegetation greenness for Dhidhessa River Basin, Ethiopia

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Understanding the spatiotemporal dynamics between climate variables and vegetation greenness can be beneficial to design climate change adaptation strategies. However, such a study is lacking in many basins of Ethiopia. The objective of this study was to analyze the past and future temperature and rainfall trends, and determine their spatial relationship with vegetation greenness, characterized using Normalized Difference in Vegetation Index (NDVI), for the Dhidhessa River basin. Quality checked high spatial resolution satellite datasets were used for the study. Mann-Kendall test and Sen's slope method were used for the trend analysis. The spatial relationship between climate dynamics and NDVI was analyzed using Geographically Weighted Regression (GWR) technique. Past and future climate trend analysis generally showed wetting and warming for the Dhidhessa River basin where the degree of trends varies for different time and spatial scales. A seasonal shift in rainfall was also observed for the basin. These findings informed that there will be negative impact on rain-fed agriculture and water availability in the basin. NDVI trends analysis showed significant increasing trends for dry season and annual timescales and decreasing trend for the main rainy season. Spatially, a significant increase in NDVI trend was observed only for the warm moist climatic zone. The increasing NDVI trends could be due to agroforestry practices but does not necessarily indicate improved forest coverage in the basin. A declining NDVI during the main rain season indicates expansion of agricultural land by clearing forest and shrubland. The NDVI dynamics is positively correlated to rainfall (r2=0.62) and negatively correlated to minimum (r2=0.58) and maximum (r2=0.45) temperature. The study revealed strong interaction between the climate variables and vegetation for the basin that further influences the biophysical terrestrial processes like hydrologic responses of a basin. This study provides helpful information to device climate change adaptation strategies at local scales.

Keywords: Spatiotemporal climate dynamics, Vegetation greenness, Mann-Kendall test, Sen's slope method, Dhidhessa River basin

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-16

Using CORDEX data to estimate future hydro-ecological conditions in North-Western Black Sea coast

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The future hydro-ecological conditions in small watersheds of Southern Ukraine were estimated using the outcomes from the CORDEX Project – the 14 runs of 5 regional climate models (RCM). In the nearest future, 2021–2050, the rising temperature (about 0.8 °C per 30 years) and steady precipitation (~470 mm per year) during 2021-2050 in Southern Ukraine will be probably observed. Let's note that precipitation will usually decrease in Ukraine and the southern region is rather an exception to the rule. In this Figure, we can see (i) changeable increase of temperature and a sharp decrease of precipitation during the 2023-26; (ii) sharp increase of temperature following a decrease of precipitation during the 2028-31; and (iii) sharp decrease of temperature against the steady precipitation background during 2037-40. We used the standardized precipitation evapotranspiration index (SPEI) to investigate spatiotemporal droughts variability caused by climate change. The SPEI is the multi-scalar drought index and allows determining the onset, duration and severity of drought conditions on different time scales. It is common practice to assess the hydrological droughts on the time scale 13–24 months. The analysis of nearest-future SPEI time series showed that the trend to drier conditions will be expected in North-Western Black Sea coast – the next long and severe droughts can be registered about 2025 and after 2030. Moreover, we can expect in all likelihood that the period 2031-2040 will be driest, and duration of drought in that region will be a few years. We also considered a connection between time series of the SPEI on the 24-month time scale and annual runoff on a few hydrological sites in some small watersheds. The temporal features of water flow changes are in close agreement with the SPEI24 during the nearest future – all years with high water flows were registered during the wet years, i.e. the absence of atmospheric droughts.

Keywords: Termperature, Droughts, Runoff

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-17

An analysis of the abnormal flood and its impact on environment and socio-economic conditions in Kerala

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Climate change and its impact are evident in the State of Kerala in India. In August 2018, abnormally heavy monsoon rains lead to the worst flooding in a century, killing around 500 people and thousands of livestock, displacing one million people and damaging 50000 housed, roads and other infrastructures. Estimated losses amount to more than US $3 billion. Seasonal rainfall was 42% above normal and rainfall during 1 to 19 August was 164% above normal. Around 414 mm rainfall occurred during August 15-17, which led to severe flooding. Steep slopes and destruction of wetlands added to its severity. All 39 major dams had reached their full reservoir level by the end of July, and were incapable of absorbing the torrential volumes in August. After flood, surface water bodies, especially rivers are drying up fast because of abnormal landslides and sedimentation. Around 8 to 10% of all reservoirs were already filled with sand because of deforestation and urbanization. As a result of the loss of surface soil and failure of northeast monsoon, groundwater level in the state fell by 3 metres and the state experienced serious water crisis in the beginning of 2019 itself. Destruction of check dams and erosion and deepening of rivers allow fast flow of groundwater towards the sea. Decrease in runoff now permits salinity intrusion far inland. State was not prepared to cope with the unexpected situation and flood initiated several socio-economic issues such as shortage of reliable water, hiking price of food and water, conflicts over allocation, spread of contagious diseases and large investment to rebuild infrastructure and rehabilitate the displaced population. This study analyses the hydrometeorological extremes in Kerala during 2018, trends in extremes and their impacts on different facets of life. Results show an increasing trend in extremes in near future. Guidelines for developing a better climate policy and adaptation strategy have been provided.

Keywords: Climate change, Kerala, flood, socio-economic, adapation

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-18

Numerical simulation of synoptic to quasi-biweekly disturbances involved in the summer 2003 heavy rainfall in East China

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During the Meiyu season of summer 2003, the Yangtze and Huai River Basin (YHRB) encountered anomalously heavy rainfall, and the northern YHRB (nYHRB) suffered a severe flood because of five continuous extreme rainfall events. A spectral analysis of daily rainfall data over YHRB reveals two dominant frequency modes: one peak on day 14 and the other on day 4, i.e., the quasi-biweekly and synoptic-scale mode, respectively. Results indicate that the two scales of disturbances contributed southwesterly and northeasterly anomalies, respectively, to the Meiyu frontal convergence over southern YHRB (sYHRB) at the peak wet phase. The passages of five synoptic-scale disturbances finally led to the severe flooding over the nYHRB region. In this study, a 29-day (June 15 – July 13, 2003) regional climate simulation is conducted using the Weather Research and Forecast (WRF) model. The simulation reproduces reasonably well the spatial distribution and temporal evolution of the rainfall over both regions, especially the frequent heavy rainfall events over the nYHRB regions. In addition, both the quasi-biweekly and synoptic-scale disturbances are clear in the simulation results, which well match the raw simulated rainfall peaks.

Keywords: synoptic to quasi-biweekly disturbances,heavy rainfall,numerical simulation

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-19

Features of spatiotemporal distribution and management issues of dangerous meteorological phenomena on the territory of the Republic of Armenia

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Dangerous meteorological or heliogeographysical phenomena (dangerous phenomena) are natural phenomena arising in the atmosphere and hydrosphere that are dangerous for the life, health and property of the population by their importance, intensity duration or time of occurrence, and can cause significant material damage to different branches of the economy. Dangerous meteorological phenomena are those that can or have already led to natural disasters and emergencies.

Statistics show that the number of human casualties and material losses due to hazardous meteorological phenomena is growing. In recent decades, the number of dangerous phenomena and their climatic extremes has also increased, and the zone of their impact has increased. Dangerous meteorological phenomena ca also intensify or contribute to other disasters, for example, the spread of infectious diseases, desertification, the accumulation of toxic gases in the atmosphere, the invasion of locusts, radiation accidents and so on. So their observations and studies are very important for research, weather forecasts, as well as for the correct and effective organization and development of works of a wide range of sectors of the economy. Consequently, the purpose of this work: to discuss and analyze the dynamics of changes in the hazardous meteorological phenomena of the study area, the patterns of spatial distribution to assess the vulnerability and risk of the territory of the republic in relation to hazardous dangerous phenomena.

For the solution of the tasks the theoretical basis was the relevant scientific and research works. As a source material, actual observations data of the Ministry of Emergency Situations of the Republic of Armenia “Service for Hydrometeorology and active influence on atmospheric phenomena” and the data of the RA National Statistical Service have been used. In the work methods are applied: geographic, general scientific, characteristics, statistical, analysis and correlation.

We note that more than 100 natural hazards and dangerous phenomena inherent in the territory of Armenia can be identified about 10, the most frequently recurring. These include: earthquakes, landslides, mudslides, floods, destruction, fall of stones, thunderstorms, hail, high groundwater level, forest fires and so on.

As a result of the research it was found out that in the republic there are different trends in the change of dangerous meteorological phenomena, different degrees of vulnerability to this or that dangerous phenomena. Thus, it is necessary to create a database of dangerous meteorological phenomena and make it accessible to the population, to develop and implement a local detailed study of hazardous meteorological phenomena, to hold frequent meetings with the public, to conduct a sociological survey among the general population, to develop mechanisms for effective management policies.

Keywords: dangerous meteorological phenomena,spatiotemporal distribution,change,management

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-20

Method of calculation of maximum runoff of spring flood for ungauged rivers case study the Desna river basin

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All modern methods used to calculate the runoff of rivers, both in Ukraine and abroad, are based on the assumption of the stationary nature of the formation of a long-term annual runoff. It is believed that the design value of water discharges the rare probability of exeedance, obtained by statistical processing over the past years, will remain the same in the future. But at the present stage there is already a statistical non-stationarity of hydrometeorological processes, which is confirmed by instrumentally warming of the climate.

As the calculated method used a modified version of the operator model, that allows considering "climate amendment" for the maximum snow supplies, precipitation and runoff coefficients during the flood.

The modified variant of the operator model takes into account the process of the transformation of the slope influx in to channel runoff through two transformation functions and is proposed as a calculation method for determining on the plain territory of Ukraine the maximum runoff during the spring period for ungauged rivers.

The proposed variant of determining the maximum runoff of spring flood is implemented for the rivers of the Desna basin. Consideration of possible climate change is made using the data of the regional climate model RACMO2 and scenarios RCP4.5 and RCP8.5. Analyzing the results obtained, it should be noted that the results are not significantly different, namely, in the RCP4.5 scenario, it is forecasted by the decrease of the maximum modules of spring flood resources by 2050 at the level of 5-10%, and in the more rigorous scenario (RCP8.5) - 10- 15%.

Keywords: spring flood, ungauged rivers, scenarios RCP4.5 and RCP8.5

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-21

Scientific and methodological approaches to taking into account the influence of climate change on the minimum rivers runoff

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In order to account for climate changes in calculations of maximum runoff, the author had proposed to introduce "climate corrections" to the calculated values of maximum water discharges. A similar approach can be applied to the minimum runoff of rivers. Such research was carried out on the example of the Transcarpathian rivers. If we have the predicted values of air temperature and precipitation, for example during a warm period, and the dependence of these values on the present day on the elevation (because it the mountain region), “climate corrections” can be introduced to the values of the minimum runoff in the future.

With purpose to obtain the calculating equations of relation between the minimum runoff and the predicted values of temperature and precipitation, on the one hand, and local factors runoff on the other, the method of multiple linear regressions is applied. As predictors, all available factors were used, namely: average annual air temperature, rainfall for cold and warm periods of the year, latitudinal coordinates, catchment area, forest area, length, and slope of rivers. The average height of the catchment was not used in the calculations, because its influence is represented by the calculated values of temperature and precipitation. The most optimal equations were further used to determine the predicted values of the minimum runoff under different scenarios.

Another possible option considering the impact of climatic changes on minimal rivers runoff is its interconnection with the drought index, for example, SPEI. The time series of the SPEI index on different scales for the steppe zone of Ukraine, in particular for the basin of the Southern Bug River, were analyzed for the period 1950-2010. Estimation of the statistical connection between SPEI at different time scales and different phases of the river flow of the Southern Bug River during the period 1950- 2010 showed that the obtained dependencies are significant, which opens up the possibility of using the index of drought in the modelling of hydrological processes in the steppe zone of Ukraine.

Keywords: minimal runoff, climate change, drought index

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-22

Capturing Co-Behavior Modes in CORDEX regional climate models over Southern Africa

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We examine how co-behavior of climate processes is represented in CORDEX regional climate models. Co-behavior does play a crucial role in how the regional climate of southern Africa is influenced as established in our earlier research. Self-Organizing Map (SOM) technique is used to classify circulation patterns over the region. In order to identify strongly associated patterns across the data to explore how identified synoptic types relate to the co-behavior of three important large-scale drivers; El Niño Southern Oscillation (ENSO), Antarctic Oscillation (AAO) and Inter-Tropical Convergence Zone (ITCZ), a varimax rotated Principal Component Analysis (PCA) is employed and the statistical significance of these patterns are determined by bootstrapping. The nature of co-behavior in CORDEX models in relation to already identified co-behavior modes from observation dataset is assessed. We then explore regional precipitation and surface temperature response to these modes of co-behavior to improve regional climate understanding.

Keywords: regional climate models, large-scale processes, co-behavior

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-23

Rainfall and temperature scenarios over Bangladesh based on RCP scenarios using RegCM

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Rainfall and surface temperature are the most important climatic variables in the context of climate change. Thus, these variables simulated from ICTP RegCM models have been compared against observed (raingauge) data and projected for the middle of twenty first century under the Representative Concentration Pathway (RCP) 4.5 emission scenario. Through calibration and validation of RegCM was adapted for Bangladesh for generating rainfall and temperature scenarios. The model generated rainfall was calibrated with ground based observed data in Bangladesh during the period of 1981-2000. Better performance of RegCM obtained through validation process increased confidence in utilizing it in the future rainfall and temperature projection for Bangladesh. Rainfall, maximum and minimum surface air temperature projection for Bangladesh Is experimentally obtained for the period of 2041-2060. This work finds that the RegCM simulated Rainfall and temperature are not directly useful in application purpose. However, after validation and calibration, acceptable performance is obtained in estimating annual rainfall and maximum and minimum surface air temperature in Bangladesh. Change of rainfall is projected about -1.2 percent in pre-monsoon (MAM), -1.4 percent in monsoon season (JJAS), 1.90 percent in post-monsoon Season (ON) and 0.46 percent in winter season (DJF) during the period of 2041-2060. Similarly, change of maximum and minimum surface air temperature is projected about 1.4 and 1.5 degrees Celsius for the same period.

Keywords: Rainfall forecast, temperature forecast, climate change, calibration, validation

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-24

Impact of regional climate model projected changes on maize yield over Southern India

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Maize is one of the major cereals grown in southern state of Tamil Nadu, India and produces about 1.2 million tones which contribute 14 percent to total cereal production in Tamil Nadu. There was an increasing demand for maize grains for poultry feed and also for human consumption due to structural changes of consumption pattern. In Tamil Nadu, about 43 precent of cropping area under rain fed and nearly 40 percent of maize production comes from rainfed regions. Presently, global warming has become a great challenge for the agrarian economy of India. Among various factors, maize yield depends on the vagaries associated with rainfall and surface temperature. These two primary climate variables are expected to change in a warmer climate. To understand the projected monsoon changes impact on maize production is carried out by performing high-resolution regional model climate simulations (IPRC_RegCM) with multiple lateral forcing, and the climate variables from regional model serve as input into economic model. To predict the impact of climate change on maize yield in the future, we used the coefficients of Indian Meteorological Department (IMD) data and European Reanalysis Interim (Era-Interim) data as baseline and predicted the current yield. The projections taken from CCSM4 (Community Climate System Model) forced high-resolution regional model climate simulations and computed the climate change impacts on maize yield. This paper predicts the maize yield for the RCP6.0 scenario under the CCSM4 model by employing the panel data regression model. The model estimates the impact of maize yield is projected to decrease by 11 and 23 percent for the IMD and Era-Interim reanalysis data respectively during end of the 21st century. However, we have compared the IMD maize yield projections with ERA-Interim reanalyses outputs which is also a proxy for observations, both the models projects in similar trend gives more confidence and precise estimate on our projections.

Keywords: Climate change impact, Maize yield, Southern India

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-25

Understanding precipitation extremes over CORDEX South Asia: A regional earth system model assessment

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The impact of climate change will be mainly felt through changes in the intensity and frequency of extreme events rather than changes in mean climate. It is expected that precipitation extremes will enhance over tropics in the 21st century. Within the CORDEX South Asia framework, a high-resolution Regional Earth System Model is used to understand the precipitation extremes over south Asia focusing on different homogeneous regions, as well as the future return period frequency and intensity of extreme events will be presented with uncertainty assessment.

We use a high-resolution regional coupled model setup, which will comprise of the Max Planck Institute Ocean Model, including sea ice, and the Hamburg Ocean Carbon Cycle model (MPIOM/HAMOCC) is coupled via OASIS coupler to the Regional atmosphere Model (REMO), and the Hydrological Discharge model (HD). This system has the distinctive feature that its global ocean module provides the possibility to reduce the grid size in the region of interest to provide high resolution there and not to set the lateral boundary conditions in the ocean.

Historical and climate change simulations were performed to understand and analyze various aspects of extreme event conditions in India along with the study of Indian Ocean biogeochemistry, including phytoplankton blooms, (focusing on the Bay of Bengal) and, particularly, climate change influence on sea surface temperature (SST) which strongly effects Indian monsoons and corresponding extreme events.

Keywords: Regional Modeling, South Asia, Climate change, Extreme events

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-26

Modern spatiotemporal distribution of squalls on the territory of Ukraine

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According to last studies in Ukraine, since the 1990s there is a general increase in number and intensity of weather phenomena associated with the convection development. Squall is a strong wind characterized by a sudden onset, duration of the order of minutes and accompanied by changes in its direction. The Ukrainian meteo service use the next criteria of a squall: first hazard level with a wind speed of 15-24 m/s; a strong squall with a wind speed of 25-34 m/s; and an extreme squall with a wind speed more than 35 m/s.

In this study, the spatiotemporal distribution of squalls over the territory of Ukraine during warm period of 2013-2018 was analyzed. The observations data at the meteorological stations in all regions of Ukraine were used. During the study period 384 cases of squalls of varying intensity were recorded. Squalls of the first hazard level are prevailed (91%). Strong squalls were observed in 15 cases and only one squall reached an extreme criterion. This squall with a wind speed of 40 m/s was recorded in Henichesk on 29 June 2013. Most of strong squalls occurred in air masses under conditions of thermal convection, and an extreme squall formed on the cold front. In the annual distribution, the maximum of 133 cases of squalls were observed in 2013. In the other years, the total number of squalls varied between 30-70 cases per year. The maximum frequency of squalls is in the summer months. The earliest and latest squalls were recorded in 2017 on April 3 and on October 29, respectively. The largest number of squalls was observed in the southern regions (24% of all cases), most of them (18%) were in the Odessa region. The least frequency of squalls is in the western part of Ukraine. Comparison of the frequency of squalls in Ukraine with the base period 1961-1990 showed that in the western part of the country the number of squall cases decreased. In the other regions, the number of squalls has increased significantly, and in the Odessa region almost doubled.

Keywords: squall, wind speed, convection phenomenon

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-27

Features of the regional atmospheric circulation, leading to formation of dry winds in Ukraine

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Withdrawal

Dry and hot wind named as “sukhovey” is a widespread high impact phenomenon, which reduces the crop yields in Ukraine. According to criteria of the Ukrainian meteoservice dry wind is fix, if at least in one term of observation values of three meteorological parameters simultaneously amounts: air temperature 25°C and higher, wind speed at 10 m height is 5 m/s and more, and the relative air humidity is 30% or lower.

The aim of the study is to determine the synoptic conditions that led to formation of dry winds in Ukraine during the period 1995-2015.

According to observations from 24 stations of Ukraine for in all agroclimatic zones maximum frequency of dry winds observed in August: from 129 days in Steppe to 21 days in Mixed Forests. Analysis of high-level pressure fields shown that during dry wind period over Europe a meridional atmospheric circulation is establish. The upper-level trough is under Western Europe and upper-level ridge prevailed under Eastern Europe.

Analysis of HYSPLIT backward trajectories shown that at the SLP air flows from the north-east, west and east have the equal frequencies (19-20%). In 16% cases relatively short trajectories formed directly over Ukraine. At the level of 1500 m flows from the west have most frequency (30% cases). The flows from north-west, north and east directions are observed in half of all cases. At the level of 3000 m air particles trajectories from the west prevailed (45% cases). Along moving trajectories the air temperature was increased at all observed levels. The largest heating was 17-23°C per 120 hours at the level of 1500 m. At the same time, downward air moving from the upper levels was observed, which led to adiabatic heating of the air mass. The assessment of lapse rate showed that, on average, it was 0.98°C/100 m in the layer of 0-1500 m and 0.68°C/100 m in the layer of 1500-3000 m. So, during the dry wind formation the lapse rates close to dry adiabatic value in the lower troposphere that leads to maximum heating and drying.

Keywords: dry wind, backward trajectory, adiabatic heating

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-28

Synoptic conditions and frequency of heavy rainfalls in Belarus

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In recent decades in Belarus the question of the impact of weather conditions on the development of economic sectors and life of the population has become acute. The maximum damage to the country's economy is caused annually by very intense heavy rainfalls (67 %).

In this study it was analyzed the synoptic conditions and frequency of heavy rainfalls in Belarus during the period of 1995-2018. All cases of heavy rainfalls were divided into 3 groups: 1)very heavy showers (the amount of precipitation not less than 30 mm for a period of not more than 1h) – 26 cases; 2)very heavy rains (not less than 50 mm for a period of not more than 12h) – 309 cases and 3)prolonged very heavy rains (not less than 100 mm for a period of 12-48 h) – 22 cases.

It was found that heavy rainfalls of all types were observed in the warm period of the year – from May to early October. The maximum number of cases occurred in the summer months – June-August (315 cases), with the largest number in July – 182 cases.

The average number of heavy rainfalls during the warm period of the year ranged mainly from 3 to 9 cases, with a maximum of 12 cases in 2006. In some years (2008, 2012, 2014-2015) their number didn't exceed 1-2.

Trend lines showed that the frequency of intense rainfalls in the warm period decreased, but it was a positive dynamics in July during the studied period.

The active cyclonic circulation or low-gradient unstable fields caused intensive precipitation in Belarus. At night, they were mainly associated with the influence of the warm fronts near the center of surface cyclones, and in the daytime the intensity of precipitation was determined by the cold fronts with waves and severe convection.

The backward trajectories (120 h) were calculated using the HYSPLIT model. It was found that there are two main sources of air masses bringing abundant rainfalls in Belarus: the Mediterranean and the Black Sea. In rear cases the humid air masses are transported from the Atlantic region.

Keywords: rainfalls in Belarus, synoptic conditions, backward trajectories, humid air masses

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-29

Intensification of heavy precipitation events in continental-scale climate-change simulations with kilometer-scale resolution

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Climate models and observations show that heavy precipitation is intensifying with a warmer climate, and these changes are very often put in the context of theoretical expectations from Clausius-Clapeyron relation with regard to the (near-) surface temperature. However, the intensification of heavy precipitation is very sensitive to the investigated region and model, and to the analysis method, and thus often shows departures from Clausius-Clapeyron rate.

Here we employ a high-resolution model at convection resolving resolution of 2.2 km over a pan-European domain, and analyze scaling of heavy precipitation in response to warming over different regions. The increase of heavy precipitation with near-surface temperature in most of the regions is around Clausius-Clapeyron rate, except for the British Isles where it exceeds this rate for heavy daily and hourly precipitation. We show that the lower troposphere, which contains the most of moisture, warms faster than the surface, especially over oceans. Thus it can contain more moisture than expected from the increase in surface temperature, and leads to above Clausius-Clapeyron increase in heavy precipitation. These results indicate that the changes in the surface precipitation are largely controlled by the changes in the temperature of the lower-troposphere, and not by changes in the (near-) surface temperature.

Keywords: heavy precipitation, convection resolving scale

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-30

Can reanalysis products with only surface variables assimilated capture MJO characteristics?

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The Madden-Julian Oscillation (MJO), as a dominant mode of tropical intraseasonal oscillation, plays an important role in the variability of global weather and climate. However, current state-of-art atmospheric circulation models have difficulty in reproducing observed MJO characteristics when forced by observed daily sea surface temperature alone. An important practical question is how much data a model needs in assimilation in order to reproduce real MJO events? By analyzing ERA-20C and NOAA-20CR reanalysis data, the authors tried to figure out whether a model could reproduce observed MJO events by assimilating the observed surface signal alone.

The phase propagation and vertical structure associated with MJO were compared between the reanalysis data and observations during 1979-2010. A total skill score considering both temporal correlation and spatial standard deviation were defined. The result showed that both ERA-20C and NOAA-20CR could reproduce the observed MJO characteristics very well, with the former superior to the latter, regardless of MJO intensity. Thus, a minimum requirement for an operational atmospheric model for MJO prediction is the assimilation of the observed surface signals.

Keywords: MJO, Reanalysis data, data assimilation

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-31

Evaluation of the effects of a multiphysics ensemble on the simulation of an extremely hot summer in 2003 over the CORDEX-EA-II Region

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The performance of multi-physics ensemble of WRF model is assessed and evaluated for the JJA extreme precipitation and temperature in 2003 over the CORDEX-EA-II domain. While relatively larger biases of model precipitation and temperature are evident over the sub-regions where the effects of mesoscale processes are important, the combinations of WRF physical schemes also show dependency on geographic location and climate regimes. Comparably, the cumulus and microphysical schemes have substantial influences on the simulation of precipitation, and the land surface models and cumulus schemes play crucial roles in the surface temperature. The combination of Noah for the land surface process, Lin for the microphysics, G3D for the cumulus parameterization and CAM for the radiation scheme can provide the most reliable reproduction of both precipitation and temperature extremes over China. The wind fields at low-to-middle atmospheric levels, which is closely connected to model's ability to reproduce regional extremes, are sensitive to the model treatment of land surface and cumulus convective process, and the impact of the land-atmospheric interaction on regional extremes can be greatly modulated by convective activity. In conclusion, the model simulated temperature and precipitation extremes are sensitivities to the model physical processes, displayed as relatively large ensemble spread.

Keywords: regional extremes, WRF model, multi-physics ensemble analysis

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-32

The sensitivity to initial soil moisture for three severe cases of heat waves over Eastern China

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Using Weather Research and Forecasting model (WRF) simulations with different initial soil moisture (ISM) conditions, we investigate the sensitivity to ISM for the three severe heat wave events that dominated eastern China in 2003, 2007, and 2013. The control simulations are able to reproduce the spatial distributions and the daily evolutions for each of the three heat waves but apparently underestimate their amplitudes, intensities, and spatial extensions. The decreased ISM could cause an enhancement on heat waves with increased amplitudes, extents and intensities, while it has insignificant influence on the spatial distributions and temporal variations. The responses of heat waves are generally decreasing with the increasing ISM, controlled by different regimes in the surface soil moisture-temperature relationship. Through enhanced sensible flux as well as reduced latent cooling, the initial soil dryness locally strengthens the surface warming and the further drying of the soil. The three heat waves were all dominated by high-pressure systems in the mid-troposphere. The reduced ISM forces positive anomalies of geopotential height at mid-troposphere and negative anomalies at lower levels, leading to an enhanced thickness of the atmosphere. Such a thickened atmosphere can strengthen the anomalous high-pressure systems, favoring the maintenance of severe heat waves. This acts as a positive feedback between atmospheric circulation, surface warming, and soil dryness.

Keywords: initial soil moisture, heat waves, WRF, soil moisture-temperature relationship

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-33

Quantifying anthropogenic contribution to the 2017 earliest summer onset in Korea using large-ensemble RCM simulations

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During May 2017, South Korea experienced the hottest recorded temperature since 1973 which was the culmination of four consecutive years of record-breaking May temperature. The wamer May temperature were observed across South Korea, with the station mean being 1.5°C wamer than climatology (1987-2010). The hottest May coincides with the earliest summer onset about 8 day earlier than climatology, exerting huge societal impacts for health, economy, and leisure activities. To examine the human contribution to the 2017 extreme May temperature and the earliest summer onset, this study assesses extreme events under real world and counterfactual world conditions using high-resolution (50 km) large-ensemble (>1000 members) regional climate model (RCM, weather@home) over CORDEX-East Asia Phase I domain. Results are compared with those from atmospheric global climate model (GCM, CAM5.1) simulations and CMIP5 coupled GCMs with a coarse resolution. The anthropogenic contribution is quantified by using risk ratio (RR) which indicates a change in extreme event probability due to human activities. Both large-ensemble RCM and GCM simulations show that the probability of occurrence of the extreme events like the 2017 May case increases by two-three times when including anthropogenic forcing (mainly due to greenhouse gas increases). Futher analysis of differences in the attibution results among different boundary SSTs (or GCMs) suggests that the inter-model difference is closely related to the model's response to the aerosol forcing, supporting previous findings. Our multi-model assessment based on RCM and GCM simulations provides a convincing evidence that human influence has contributed to the stronger and earlier spring heat wave in Korea by better considering inter-model uncertainties.

Keywords: RCM, Summer onset, anthropogenic contribution

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-34

Response of tropical terrestrial gross primary production to the super El Niño event in 2015

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The Gross Primary Production (GPP) in tropical terrestrial ecosystems plays a critical role in the global carbon cycle and climate change. The strong 2015–2016 El Niño event offers a unique opportunity to investigate how GPP in the tropical terrestrial ecosystems responds to climatic forcing. This study uses two GPP products and concurrent climate data to investigate the GPP anomalies and their underlying causes. We find that both GPP products show an enhanced GPP in 2015 for the tropical terrestrial ecosystem as a whole relative to the multi-year mean of 2001–2015, and this enhancement is the net result of GPP increase in tropical forests and decrease in non-forests. We show that the increased GPP in tropical forests during the El Nino event is consistent with increased photosynthesis active radiation as a result of a reduction in clouds, while the decreased GPP in non-forests is consistent with increased water stress as a result of a reduction of precipitation and an increase of temperature. These results reveal the strong coupling of ecosystem and climate that is different in forest and non-forest ecosystems, and provide a test case for carbon cycle parameterization and carbon-climate feedback simulation in models.

Keywords: gross primary production, El Niño-Southern Oscillation, tropical terrestrial ecosystems, light use efficiency, extreme events