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Chemistry and photochemistry of tropospheric aerosols: Their role in controlling the earth albedo

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Aerosol particles affect the earth's energy balance directly by absorbing and scattering radiation and indirectly by altering the reflectance and persistence of clouds. Laboratory experiments show that the absorptivity of representative aerosol organic matter is not a single-valued function of its molecular composition CxHyOz, but markedly depends on temperature and ionic strength, which is inversely dependent on relative humidity, and changes from dark to bright conditions (i.e., between night and day). Suites of representative polyfunctional CxHyOz oligomers in water develop intense visible absorptions upon addition of inert electrolytes such as ammonium bisulfate (ABS). The resulting mixtures reach mass absorption cross sections (532 nm) ~0.1 m^2/gC in a few hours, absorb up to 9 times more solar radiation than the starting material, can be half-bleached by sunlight in ~1 hour at noon and repeatedly recycled without carbon loss. Visible absorptions red-shift and evolve increasingly faster in subsequent thermal aging cycles. These transformations are deemed to underlie the daily cycles of aerosol absorption observed in the field, which introduce critical feedbacks in the Earth's radioactive balance. These phenomena and their timescales are consistent with the diel cycles of aerosol scattering and absorption observed over Mexico City at constant total carbon (15.5) gm^{-3} loadings. Aerosol absorptivity peaks early in the morning and reaches minimum values.

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Sustainable energy development

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Energy production and consumption is closely related with all global economic, social and environmental development issues. In order to sustain and in turn to ensure sustainable society development the energy sector development should be sustainable by itself. Therefore, the main goal of sustainable energy development is to ensure production and use of energy resources in ways that promote or at least are compatible with long-term human well-being and ecological balance. The competitiveness of countries is directly related to the progress achieved in implementing sustainable energy development as the energy sector has great significance for the future development of the country. The energy sector is crucial for economic growth and has a major impact on the environment. Sustainable energy development permits the decoupling of economic growth from energy consumption and the decoupling of energy consumption from atmospheric pollution. This paper compares the Baltic States within the boundaries of the most important sustainable energy development indicators: Energy efficiency, GHG emissions, the share of renewable energy in gross final energy consumption; the share of RES in transport and electricity, etc.

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Notes:

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Kaya identity for analysis of GHG emission trends in Baltic States

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The decomposition analysis of GHG emission trends will be performed to define the main drivers of GHG emission reduction in Lithuania conformed to achieve in 2020 and 2030. GHG emission reduction, RES in final energy consumption and energy intensity reduction targets were compared to year 2005 level. As all these targets are interrelated and have to be achieved together. Therefore, it is very important to track the changes of GHG emissions in EU member states by addressing the achieved progress in GHG emission reduction to the changes in energy intensity and increase in the share of renewables in final energy consumption. The Kaya identity and decomposition analysis allow the linking of changes in GHG emissions to changes in energy intensity and carbon intensity of energy. This directly reflects the increase of the share of renewables in final energy consumption. Kaya identity and decomposition analysis allow defining the impact of increase of the use of renewables and decrease in energy intensity on GHG emission reduction in EU Member States. Kaya identity is an equation relating factors that determine the level of human impact on climate, in the form of emissions of the greenhouse gas carbon dioxide. This identity states that total emission level can be expressed as the product of four inputs: human population, GDP per capita, energy intensity (per unit of GDP), carbon intensity (emissions per unit of energy consumed).

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Study on method for synthetic precipitation data for ungauged sites using quantitative precipitation model

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A method was developed to estimate a synthetic precipitation record for ungauged sites using irregular coarse observations. The proposed synthetic precipitation data were produced with ultra-high hourly resolution on a regular 1×1 km grid. The proposed method was used to analyze selected real-time observational data collected in South Korea from 2010 to the end of 2014. The observed precipitation data were measured using the Automatic Weather System and Automated Synoptic Observing System. The principal objective of the proposed method was to estimate the additional effects of orography on precipitation introduced by ultra-high-resolution (1×1 km) topography provided by a digital elevation model. The Global Forecast System analysis of the National Centers for Environmental Prediction was used for the upper atmospheric conditions, necessary for estimating the orographic effects. Precipitation data from 48 of the more than 600 observation sites used in the study, which matched the grid points of the synthetic data, were not included in the synthetic data estimation. Instead, these data were used to evaluate the proposed method by direct comparison with the real observations at these sites. A bias score was investigated by comparison of the synthetic precipitation data with the observations. In this comparison, the number of Hit, False, Miss, and Correct results for 2010-2014 was 74738, 25778, 7544 and 367981, respectively. In the hit cases, the bias score was 1.22 and the correlation coefficient was 0.74. The means of the differences between the synthetic data and the observations were 0.3, -3.9, -14.4 and -34.9 mm h^{-1} and the root mean square errors (RMSEs) were 2.7, 8.3, 19.3, and 39.6 mm h-1 for the categories of 0.5-10.0, 10.0-30.0, 30.0-50.0 and 50.0-100.0 mm h^{-1}, respectively. In addition, in each range, the 60% difference between the synthetic precipitation data and the observation data was -1.5 to +1.5, -5.0 to +5.0, -17.0 to +17.0 and -33.0 to +33.0 mm h-1, respectively. Overall, the correlation coefficient of the synthetic precipitation data was >0.7 for 43 of the 48 test stations and the RMSE was <4 mm h^{-1} at 31 stations. The results are significant at all evaluation stations at the 0.05 significance level.

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Sea ice study and Arctic polar amplification using CMIP5 models

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Important international reports and a significant number of scientific publications have reported on the abrupt decline of the Arctic sea ice, polar amplification and its impact on the global climate system. In this work, we have evaluated the ability of Coupled Model Intercomparison Project, Phase 5 (CMIP5), specially the Brazilian Earth System Model (BESM) to represent the Arctic sea ice changes and sensitivity to the atmospheric carbon dioxide (CO_2) forcing. We have used decadal simulations (1980-2012), future scenarios with Representative Concentration Pathway (RCP) 4.5 and RCP 8.5 (2006-2100) and quadrupling of the atmospheric CO_2 concentration (2006-2300). We validated our results with satellite observations and re-analyses data set. BESM results for the Arctic sea ice seasonal cycle are consistent with CMIP5 models and observations. However, almost all models tend to overestimate sea ice extent (SIE) in March compared to observations. The correct evaluation of minimum record of sea ice, in terms of time, spatial and area remains a limitation in Coupled Global Climate Models (CGCM). Looking to spatial patterns, we found a systematic model error in September sea ice cover between the Beaufort Sea and East Siberia for most models. Future scenarios show a decrease in SIE as response to an increase in radiative forcing due to the increase of greenhouse gases concentration for all models. From the year 2045 onwards, all models show a dramatic shrinking in sea ice and consequent expansion of ice-free conditions at the end of the melting season. The projected future sea ice loss is explained by the combined effects of both: The amplified warming in northern hemisphere high latitudes and climate feedbacks. The quadrupling of CO_2 concentration numerical experiment shows the amplified warming at high latitudes as response to CO2 forcing with strongest warming in winter (DJF) and autumn (SON). The polar warming is linked with changes in SIE and Sea Ice Thickness (SIT). The albedo sea ice feedback reinforces the polar warming with marked contributions from April to August.

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Global governance through regional organizations: A policy tool for climate change

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Climate change has become a fixture in transnational proceedings as evident in Paris 2015. Nations are working together as well as they ever have on this issue to develop mitigation and adaptation measures. Although policy negotiations are occurring at the global level, primarily under the auspices of the United Nations, subnational governance entities, such as state and local governments, will be increasingly relied upon to implement strategies addressing the impacts associated with climate change. The notion that climate change is occurring globally, but manifests itself locally is a common idea. An overview of the policy process is offered with emphasis placed on state and local governments. The use of the IPCC report is essential to understanding the mitigation and adaption needs of the region. A survey of potential impacts will be discussed. This paper considers the level of scientific and policy knowledge of US leaders, such as the Delta Regional Authority (DRA). Then, using survey data and analysis, this paper will consider options available to those regional organizations developing climate change policy.

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On the correlation structure between surface soil moisture and vegetation water content with global carbon fluxes

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Statement of the Problem: The anticipated increase in the frequency and severity of droughts across the globe will intensify water stress on terrestrial ecosystems and hence on food security. Regional land surface and global climate models largely rely on satellite remotely sensed surface soil moisture (typically the top 5 cm of the soil) to predict vegetation response (carbon uptake) to water stress or otherwise to characterize land surface fluxes. Ideally, however, the deeper soil layer root-zone moisture reflected by nighttime vegetation water content is the correct measure of such feedbacks. Differences in rooting depth and vegetation plant functional types (crops, forests, grasslands, etc.) also play an important role in dictating where and when the fluctuations in vegetation water content can be more predictive of carbon fluxes than the surface soil moisture.

Methodology & Theoretical Orientation: In this study, we compile global data sets of surface soil moisture, vegetation water content and global carbon fluxes from satellite remote sensing (NOAA's AVHRR) spanning the years 2002 to 2010. The data is at high temporal (daily) and spatial ($0.25^{o}\times0.25^{o}$) resolution allowing the analysis to extend to multiple time scales. The correlation structure between surface soil moisture and/or vegetation water content with global carbon uptake is analyzed across all climatic regimes and plant functional types across the globe. The statistics of mutual information content across several plant physiologic response mechanisms, commonly referred to as isohydric vs. anisohydric response is also examined.

Findings: The preliminary results indicate that the tropics (e.g., Amazonia), dominated by isohydric shallow root plants, tend to exhibit weaker dependence on water content than higher latitudes with generally vegetation water content having stronger correlation with carbon fluxes. Isohydric plant species show less dependence on shallow soil moisture, while fluctuations in daytime vs. nighttime vegetation water content have strong correlation with anisohydric species' response.

Conclusion: This study improves the predictability of global carbon fluxes and proposes the incorporation of vegetation water content as a reliable surrogate of shallow soil moisture in global models.

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The bumpy ride of the EU emission trading scheme: An analysis of regulatory and governance challenges

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For more than a decade, the European Union Emission Trading Scheme (EU ETS) enjoys the fame for being the world's largest ETS. Nonetheless, the reality behind this fame is that the scheme has not been optimally designed to achieve its key objective of mitigating greenhouse gas emissions. Due to its unsatisfactory performance, many researchers have examined the regulatory challenges in the EU ETS using economic lens. Their works are valuable but less pragmatic for policymakers. This article aims to supplement the existing economic literature on the EU ETS by offering useful insights using legal lens. Specifically, it will analyze the influence of governance factors on the design features of the EU ETS. The regulatory problems of the EU ETS from Phase I to Phase III are explained using a three-level governance model. The main arguments are that the regulatory problems of the earlier phases were due to the discretions given to the member states. On the other hand, the sub-optimal reforms in current phase are largely the responsibility of the EU legislative institutions; the European Commission, the European Parliament and the Council of Ministers. As for Phase IV, this article highlights the importance of citizens in shaping the future reforms of the EU ETS. The findings of this article provide relevant inputs for policymakers in the EU and other jurisdictions.

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Contribution of multiple climatic variables and human activities to stream flow changes across China

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Statement of the Problem: Changing properties of hydrological processes and related causes are warmly discussed in recent years, and particularly with increasing impacts of intensifying human activities on hydrological processes. There are some scientific issues to be addressed like: More researches addressed impacts of climate changes but not human activities. In this study, we concentrated more on human activities such as land use and land cover changes, GDP, water reservoir and so on. Penmann-Monteith model was used in modeling impacts of climate changes on hydrological variations. New findings were obtained for 2001-2014 and this time interval was usually ignored by previous researches due to shortage of data.

Methodology & Theoretical Orientation: Penmann-Monteith model was introduced in modeling impacts of climate changes on hydrological variations. Trends and change points were detected by more than one method to avoid possible uncertainty as a result of single method only.

Findings: Hydrological variations are subject to higher sensitivity to climate changes and human activities in northern China than in southern China. More regions with climate changes as dominate factors behind hydrological changes come to be those with human activities as dominant factors. Major factors behind hydrological changes across entire China were differentiated.

Conclusion & Significance: Elasticity coefficients of climate change and human activities to stream flow changes in river basins of northern China are significantly larger than those in southern China. This implies higher sensitivity of stream flow changes in northern China than that in southern China. More importance should be attached to water resource managements in northern China. Comparison indicates that fractional contributions of climate change and human activities differentiated by the Budyko based model and hydrological models are similar in terms of magnitude with slight difference. The differences lie in the selection of different evapotranspiration models and time intervals considered in different studies.

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When does climate shift emerge in the future beyond the historical variability of precipitation?

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The climate model MRI-CGCM3 has relatively high horizontal resolution atmosphere among the coupled models which participated in the phases 5 of the Coupled Model Intercomparison Project (CMIP5). We used precipitation of pre-industrial control simulation for 100 years, historical experiment from 1850 to 2005 for 156 years and future Representative Concentration Pathways (RCP) 8.5 scenario experiment from 2006 to 2100 for 96 years simulated by the MRI-CGCM3. We defined 'tipping year' after year 2006 as the time of year when the projected 10-year mean climate of at each grid point moves to a state continuously outside the range of historical variability before year 2006. Tipping years of annual precipitation are earlier in high latitudes and central tropical Pacific where the increase of precipitation in the end of 21st century is large. In contrast, tipping year does not exist over subtropical high regions where precipitation decreases in the end of 21st century. Tipping year of intense precipitation exist globally including subtropical high regions. Over the Arabian Peninsula, tipping years of precipitation appears after 2050's. Information on the reliability of future projections is usually evaluated by ensemble simulations. However, future projection by the MRI-CGCM3 was restricted to only one realization due to the limitation of computer resources. Instead of real ensemble simulations, we created the set of virtual future projections based on the Monte Carlo method considering the natural variability of model atmosphere in the pre-industrial control simulation and future simulation. Here we proposed two kinds of measures for reliability in future projection; the standard deviation of precipitation and the probability of emergence of tipping year.

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Role of technical innovation to combat environmental challenges with pace of economic growth in UAE

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Statement of the Problem: With the rapid pace of economic development there are ongoing challenges regarding environmental pollution, urbanization process and energy security. These issues shed light that how to achieve the sustainable economic growth in the long run with renewable energy application. The economy of the United Arab Emirates (UAE) has prospered and its nominal gross domestic product (GDP) has grown 27 times since 1975, becoming the second largest economy in the Arab world after Saudi Arabia. The high pace of growth over the past years has been largely supported by the revenues from oil and gas, which the country has systematically reinvested in economic diversification in preparation for the approaching post-oil era. UAE has high economic development but the country has faced serious environmental challenges arisen from the high of growth in population, energy and water demand and urban areas. The purpose of this study is to examine the role of technical innovation in order to have effective planning to combat future environmental challenges.

Methodology & Theoretical Orientation: Current study utilized a time series ARDL Model to analyze the co-integration, long and short run relationship among economic growth, energy consumption, CO_2 emissions, urban sprawl and technical innovation. We have used IPAT model to highlight the theoretical background to develop the econometric model.

Findings: The overall results predicted that there is close relationship between CO_2 emissions and its determinants as GDP, population and energy consumption. There is expected to be bidirectional causality between GDP and energy consumption in UAE economy.

Conclusion & Significance: Overall the result led to important policy implications for UAE, firstly; emanating from various climate change challenges it is strong belief that building a human capital is far more critical than urban development, the UAE is keen on creating a wealth of human resources capable of meeting the country's aspirations of development across various sectors. The UAE distinctly demonstrates its ability to attract and retain top talent by becoming a primary destination for educated Arab youth seeking a better professional and personal life, besides ranking first worldwide in attracting global talent. The allocation of resources in R&D can push the economy towards green economy. Moreover, the effective policies can support UAE in achieving vision 2021 while becoming a global hub and a successful model of sustainable development.

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Economic consequences of floods in Atlantic Canada

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Statement of the Problem: Historically Atlantic Canada has been vulnerable to flooding. Destructive consequences of these events have been seen in the past and are expected to occur more frequently in the future due to changing climate. The goal of this study was to establish a relationship between economic loss from floods in Atlantic Canada and socio-economic characteristics including climate variables.

Methodology & Theoretical Orientation: Evaluation of the above mentioned relationship was done on the basis of statistical analysis based on data collected from Canadian Disaster Database, databases of the Environmental Departments and Local Governments in Atlantic Canada.

Findings: The study found the most important factors of flooding that affect economic loss and showed significance of increasing air temperature as the most important climate variable.

Conclusion & Significance: The designed statistical model will helps us define and design the required investment into future mitigation measures to reduce economic damage from floods in Atlantic Canada.

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