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The application of physics in weather and climate sciences

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According to the Assessment Report 6 of the Intergovernmental Panel on Climate Change (IPCC), climate change has changed the characteristics of weather and climate extremes, including over southern Africa. These extremes undermine the attainment of the National Development Plan, the African Union Agenda 2063 and the Sustainable Development Goals. The United Nations has pledged to work through one of its agencies, the World Meteorological Organization, to ensure that everyone on the globe has access to early warning systems by the year 2027. Early warnings can mitigate against the severity of weather and climate related disasters. Weather forecasts and climate predictions rely on the use of numerical weather and climate models. These models solve partial differential equations based on conservation of momentum, energy and mass, as well as the equation of state. Processes with a length scale much larger than the grid length are resolved explicitly by the models, while subgrid processes are parametrized. The regime where the grid length and the length scale of the targeted process are the same has been termed the greyzone. Models used for short-range forecasts generally use higher resolution than those used for climate studies. The spatial resolution used by models has increased over time due to increased availability of super-computers. This means new subgrid models need to be developed or existing ones need to be tested for high resolution or scale awareness. Model simulations continue to be associated with shortcoming, such as, missing the location of heavy rainfall events, or the intensity of events. There is an expectation that as resolution is increased, the model skill and detail will improve. The presentation will show results from sensitivity studies to resolution, cumulus schemes, cloud microphysics schemes and planetary boundary layer schemes. The use of convection scheme that are not scale aware at convective scales results in intense rainfall events being missed. Scale aware schemes are able to capture the intensity of tropical cyclones better. Rainfall simulations are more sensitive to changes in the convection schemes than they are to cloud microphysics and planetary boundary layer schemes. Subgrid models are a major source of uncertainty in climate change projections, especially of rainfall. More work is needed from across the globe, including from the African continent whose contribution to model development has remained limited, to improve models further. These developments have to be coupled with efforts to improve the observation network across the continent, that can inform better understanding of earth science processes, as well as be used as input to models.

Abstract Category

Earth Physics

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