Geophysical Research Abstracts
Vol. 17, EGU2015-1821, 2015
EGU General Assembly 2015

Missing pieces of the puzzle: understanding decadal variability of Sahel Rainfall

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The instrumental record shows that substantial decadal fluctuations affected Sahel rainfall from the West African monsoon throughout the 20th century. Climate models generally underestimate the magnitude of decadal Sahel rainfall changes compared to observations. This shows that the processes that control low-frequency Sahel rainfall change are misrepresented in most CMIP5-era climate models. Reliable climate information of future low-frequency rainfall changes thus remains elusive. Here we identify key processes that control the magnitude of the decadal rainfall recovery in the Sahel since the mid-1980s. We show its sensitivity to model resolution and physics in a suite of experiments with global HadGEM3 model configurations at resolutions between 130-25 km. The decadal rainfall trend increases with resolution and at 60-25 km falls within the observed range. Higher resolution models have stronger increases of moisture supply and of African Easterly wave activity. Easterly waves control the occurrence of strong organised rainfall events which carry most of the decadal trend. Weak rainfall events occur too frequently at all resolutions and at low resolution contribute substantially to the decadal trend. All of this behaviour is seen across CMIP5, including future scenarios. Additional simulations with a global 12km version of HadGEM3 show that treating convection explicitly dramatically improves the properties of Sahel rainfall systems. We conclude that interaction between convective scale and global scale processes is key to decadal rainfall changes in the Sahel.