EGU22-2988
https://doi.org/10.5194/egusphere-egu22-2988
EGU General Assembly 2022

Correcting biases in climate simulations using unsupervised image-to-image-translation networks

James Fulton[1] and Ben Clarke[2]
[1]University of Edinburgh, School of GeoSciences, United Kingdom of Great Britain – England, Scotland, Wales (james.fulton@ed.ac.uk)
[2]University of Oxford, School of Geography and the Environment, United Kingdom

Global circulation models (GCMs) form the basis of a vast portion of earth system research and inform our climate policy. However, our climate system is complex and connected across scales. To simulate it, we must use parameterisations. These parameterisations, which are present in all models, can have a detectable influence on the GCM outputs.

GCMs are improving, but we need to use their current output to optimally estimate the risks of extreme weather. Therefore, we must debias GCM outputs with respect to observations. Current debiasing methods cannot correct both spatial correlations and cross-variable correlations. This limitation means current methods can produce physically implausible weather events - even when the single-location, single-variable distributions match the observations. This limitation is very important for extreme event research. Compound events like heat and drought, which drastically increase wildfire risk, and spatially co-occurring events like multiple bread-basket failures, are not well corrected by these current methods.

We propose using unsupervised image-to-image translations networks to perform bias correction of GCMs. These neural network architectures are used to translate (perform bias correction) between different image domains. For example, they have been used to translate computer-generated city scenes into real-world photos, which requires spatial and cross-variable correlations to be translated. Crucially, these networks learn to translate between image domains without requiring corresponding pairs of images. Such pairs cannot be generated between climate simulations and observations due to the inherent chaos of weather.

In this work, we use these networks to bias correct historical recreation simulations from the HadGEM3-A-N216 atmosphere-only GCM with respect to the ERA5 reanalysis dataset. This GCM has a known bias in simulating the South Asian monsoon, and so we focus on this region. We show the ability of neural networks to correct this bias, and show how combining the neural network with classical techniques produces a better bias correction than either method alone.