DOWNSCALED HIGH-RESOLUTION CMIP5 PROJECTIONS FOR CLIMATE CHANGE IMPACT ASSESSMENTS

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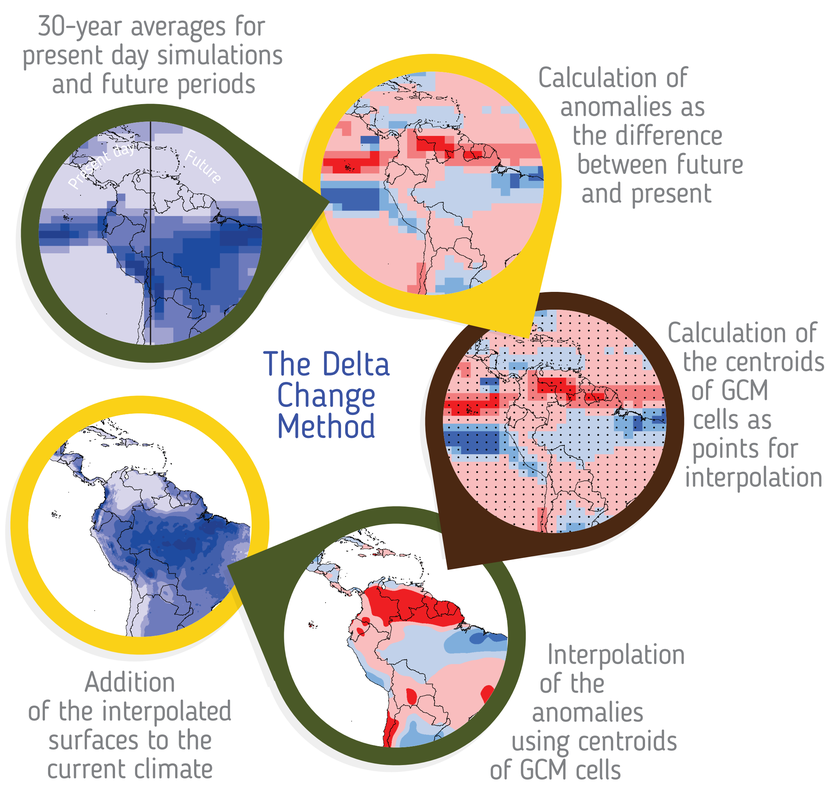
ABSTRACT

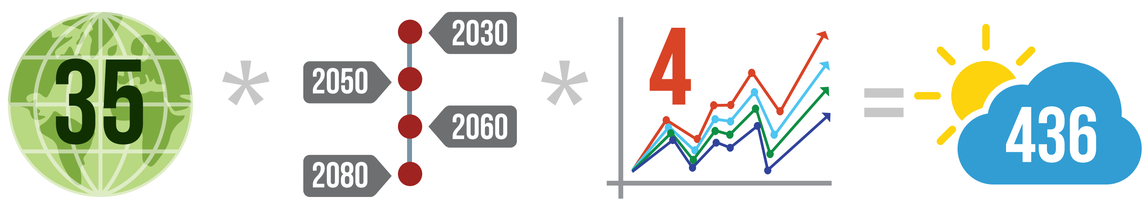
Climate scientists debate the best resolution for projecting the impacts of climate change on agriculture and biodiversity. Robust projections of climate change can only be made at coarse scales (70-400 km). But agriculture operates at a much finer scale, which requires appropriate fine-scale data of future climate. The problem is worse in the tropics where orography and climate, especially precipitation, vary across short distances. Here, we present a global database of future climates developed by applying a statistical method for climate model downscaling. The datasets can be used for crop modeling, niche modeling, and more generally, for assessing impacts of climate change on agriculture and biodiversity. The data, at 1-km resolution, include monthly maximum and minimum temperatures and monthly total precipitation. Evaluation analyses show that the downscaling method produces robust climate projections. The approach corrects much of the mean and the variance of the seasonal temperature and the seasonal rainfall bias in most of the world. The data integrate a global comprehensive downscaled set of climate change scenarios publicly available in the CCAFS-Climate portal (www.ccafs-climate.org) which has been used up to date in more than 350 studies of ecosystem and agricultural impact assessment.

METHOD

We produce a global database by downscaling of the original General Circulation Models (GCM) outputs using spatial interpolation of the anomalies or deltas. We applied the interpolated anomalies to the baseline climate of the WorldClim high resolution (30 arc-s, ~1 km) surfaces. This statistical downscaling method is called delta change or change factor.



DATA RECORDS



General Circulation Models (GCM) * 4 different 30-year running mean periods * Representative Concentration Patways (RCP) = Different global scenarios produced. (Not all GCM are available for each RCP).

Our datasets comprise the most up-to-date (i.e. IPCC AR5) and comprehensive downscaled set of climate change scenarios. The Delta Method downscaling approach was applied over 35 different GCM outputs from CMIP5, for the 4 Representative Concentration Patways (RCP) scenarios. We use 4 different 30-year running mean.

Variables

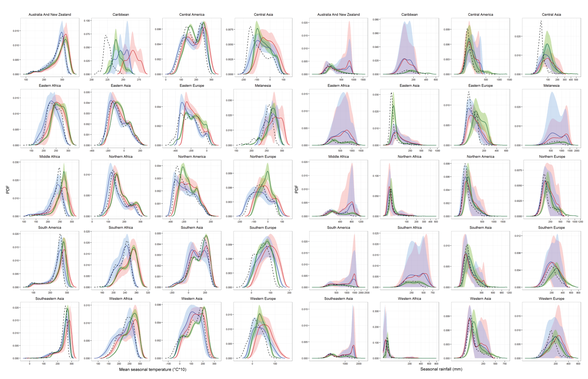
Minimum
Maximum
Mean

Temperature | Rainfall | Bioclimatic

Resolutions

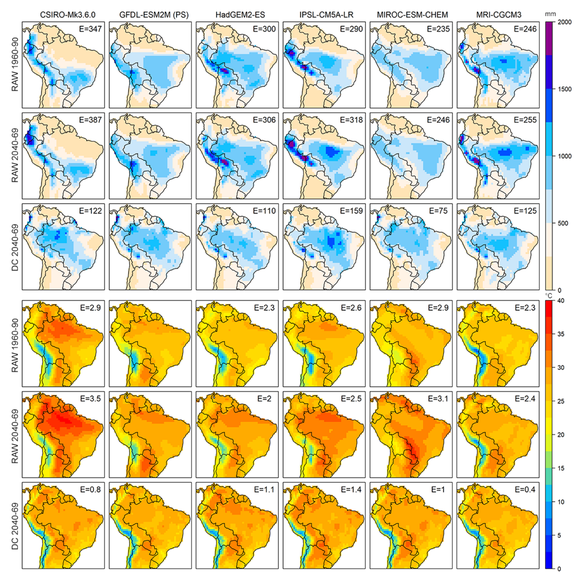
~1KM Primary resolution 30 arc-s
~5KM Aggregation 2.5 arc-m
~10KM Aggregation 5 arc-m
~20KM Aggregation 10 arc-m

VALIDATION



Probability density functions (PDF) of seasonal rainfall for December-January-February season in comparison with observations. The continuous lines belong to PDF average and the shading shows the average ± one standard deviation, for all future GCM raw (red), historical GCM raw (blue) and Downscaled GCM (green). Dotted line is average PDF for the observations (i.e. WorldClim).

The method corrects much of the mean and the variance of the seasonal temperature and the seasonal rainfall error in the majority of the world zones. In Australia, New Zealand, South America and Southeast Asia, the approach corrects both the mean, the variance and the overall PDF distribution. In the Caribbean, Melanesia, Southern Africa, the method corrects the systematic underestimation of seasonal rainfall (the 'drizzle problem' of the GCMs). In many cases, GCMs do not reproduce very low temperatures such as those in Eastern Europe, and low tropical temperatures. The approach brings the shape of the PDF of the future projections closer to that of the observed PDF, therefore likely reducing bias.



Demonstrating the method calibration methodology using a range of GCM simulations for DJF seasonal rainfall (top) and DJF mean seasonal temperature (bottom). GFDL-ESM2M is selected as the "prefect sibling" for verification against the calibrated projections using other GCM data. The RMS error for the region shown is given as the letter E.

RMSE decreases significantly applying the method compared with the uncalibrated case. For the South America region the error fluctuates between E=246-387 mm in the raw case and E=122-159 mm (i.e. roughly 50 % lower) for DJF seasonal precipitation, and between E=2-3.5 °C in the raw case and E=0.4-1.4 °C for DJF temperature.

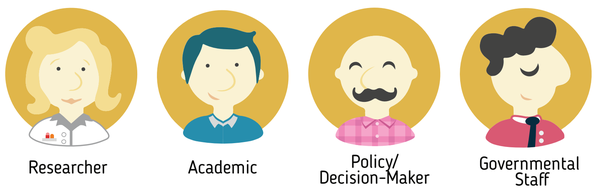
DIFFUSION AND IMPACT

The entire global high resolution data presented in this article is freely available through the CCAFS-Climate portal (www.ccafs-climate.org). Users can dynamically choose different combinations of parameters (RCP-GCM-period-variable-resolution) and download data.

The complete dataset set is ~7 TB in size

Data is stored in the AWS cloud (https://aws.amazon.com/datasets/ccafs-climate-data).

From 2014 to date, downscaled data portal has nearly 1,400 users in more than 186 countries. Users of the data include representatives from national government research institutions and the NGO sector as well as the research community.



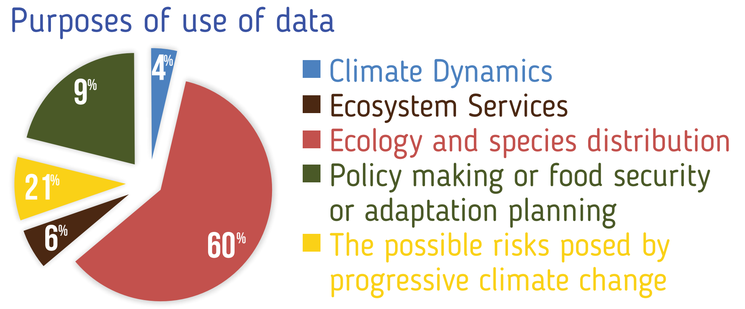
Researcher | Academic | Policy/ Decision-Maker | Governmental Staff

We have significant impact by putting climate change information into the hands of non-climate scientists and next users which represent up to 19% of all CCAFS-Climate users.

To date more than 300 journal papers, 10 book chapters, and 40 theses or reports have cited the data shown here.

Key stats

Purposes of use of data



PATRNERS

Go to CC Portal

Presented to CORDEX Central America and South America - Training Workshop on Downscaling Techniques - La Paz, Bolivia, June 25-27 2018