User's Guide TO AMICAF/PAGASA CMIP5 Climate Change Projections[1]

Abstract. This report provides brief background on the climate projections that can be downloaded via PAGASA website. All dataset were generated and completed under a cooperation project between the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA-DOST), the Food and Agriculture Organization of the United Nations (FAO) and FAO-AMICAF Philippines. Climate projections of precipitation, maximum temperature, and minimum temperature are available in three dataset: historical climate (1971-2000) and two projected future climate (2020-2049; 2050-2079) based on the statistical downscaling of six global climate models (CanESM2, CNCM5, MPEH5, GFDL-ESM, IPSLCM5, MIROC-ESM) and two emission scenarios (RCP 4.5 and RCP 8.5). A spatial interpolation technique was utilized in interpolating downscaled seasonal climate projections at weather stations to grids, and subsequently aggregated to administrative provinces. Each dataset can be visualized using Google Earth.

Methodology

Global Climate Models (GCM) are simplified representation of the earth's climate system simulating physical processes between the ocean, lithosphere, biosphere, and different layers of the atmosphere. However, most GCMs have spatial resolution of about 200 km (~2° x 2°) and to overcome such limitation, downscaling techniques can be performed to translate coarse horizontal resolution to finer resolution while considering regional and local climate variability. Downscaled climate data have better application to climate change adaptation and policy-making strategies. There are two primary techniques in downscaling: dynamical and statistical. Dynamical downscaling (DD) attempts to reproduce physical processes considering regional and local climate variability and observations while statistical downscaling (SD) establishes an empirical relationship between local climatic condition (predictand) and large-scale atmospheric

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condition spanning across different layers of the atmosphere (predictor) to predict target variables such as precipitation and temperature.

Reanalysis dataset can be used as quasi-observations to generate climate data in lieu of actual observations. The use of quasi-observations as predictor is called downscaling in a perfect prognosis condition. Manzanas et, al., (2015) experimented on downscaling daily precipitation (through Generalized Linear Model) in the Philippines obtained from ERA-Interim (~0.78° x 0.78°) and JRA-25 (~1.125° x 1.125°) in the period 1981-2010 and concluded that ERA-Interim (1979-2010) has better performance if compared with actual observations. Both predictor dataset have been regridded using bilinear interpolation to 2.0° to overcome differences in spatial resolution. The choice of predictors in downscaling generally include atmospheric elements such as meridional/zonal wind (U/V), specific humidity (Q), temperature (T), geopotential height (Z), and sea level pressure (SLP) at different atmospheric pressure levels from surface (1000 hPa) to upper troposphere (250 hPa). In the same study, the authors identified a set of predictors for maximum/minimum temperature (U850, Q850, and T1000) and precipitation (U850, U300, Q850, and T1000) to be used for downscaling.

There are three GCMs under the Coupled Model Intercomparison Project Phase 5 (CMIP5) used in SD via the FAO-MOSAICC Portal (http://mosaicc.da.gov.ph): CanESM2, CNCM5, MPI-ESM, GFDL-ESM2M, IPSL-CM5 and MIROC-ESM. The Portal was developed for ease of climate data sharing among modelers of climate impact studies. The SD utilized historical daily data (1981-2010) at 47/33/36 PAGASA Stations (precipitation/Tmin/Tmax) employing the Generalized Linear Model (Nearest Neighbor) technique for precipitation and the Analogue technique for Tmin/Tmax (Nearest Neighbor). The former technique assumes that similar local climate patterns follow similar atmospheric conditions while the latter considers uniqueness of local climate patterns as applied to different predictors. Large-scale climate mode like El Niño Southern Oscillation (ENSO) can be captured in SD given good station records.

In climate change projections, the Representative Concentration Pathways (RCP) from the IPCC Fifth Assessment Report (AR5) are often used to describe future world based on different driving forces: human activities, technology, policies, and greenhouse gases (GHG) emissions. In Philippine case, RCP choice should be based on its capability to sustain climate change adaptation strategies wherein both RCP 4.5 (medium-range scenario) and RCP 8.5 (high-range scenario) seems to be plausible.

Results are statistically downscaled seasonal projections for three variables (precipitation, Tmin and Tmax) at station level using six GCMs with two scenarios and 20C3M/Historical (1971-2000). However, **ensemble mean** are only provided in the download links. Seasons are defined as DJF (December, January, February), MAM (March, April, May), JJA (June, July, August), and SON (September, October, November).

Spatial interpolation and scales of analyses

Downscaled data at station level were spatially interpolated using the AURELHY (Analyse Utilisant le RElief pour l'Hydrométéorologie) technique (Benichou and Breton, 1987) for the whole country using all stations. To compensate for the limited density of stations, this technique incorporates topography for spatial interpolation of downscaled variables. It combines a prediction with a multivariate regression model based on variables derived from the topography and kriging of the residuals using four main steps: 1) derivation of landscape descriptors from the topography, 2) principal component (PC) analysis of the landscape predictors, 3) linear model fit of the variable to interpolate with selected principal components and prediction on the interpolation grid, and 4) kriging of the residuals. Kriging is an interpolation technique used to predict output surface using the measured spatial correlation of known points. In addition to geographic coordinates, elevation, and distance to sea as predictors for AURELHY, 14 PCs were used for Tmin and Tmax and 40 PCs for precipitation. Interpolation was performed to obtain 10 km gridded data for the Philippines. The gridded data were further aggregated to 81 provinces. The provincial aggregation satisfies the requirements of most climate change impact study researchers, namely economists, and aids policy makers in local government units with climate change related decisions.

HOW TO INTERPRET CLIMATE PROJECTIONS

This section will provide step-by-step process on how to download and interpret climate.

1. After downloading the dataset provided in geotiff format, you will need to calculate the projected future changes.
2. To calculate the change in rainfall:

Change (%) = (FUTURE – HISTORICAL/HISTORICAL) * 100

Where
Future refers to GCM in either 2020-2049 or 2050-2079
Historical refers to GCM in 1971-2000

2. To calculate the change in temperature:

Change (°C) = (FUTURE – HISTORICAL)

Where
Future refers to GCM in either 2020-2049 or 2050-2079
Historical refers to GCM in 1971-2000

For further inquiries, kindly direct your inquiries to:

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