User's Guide TO AMICAF/PAGASA CMIP3 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 projected future climate (2011-2040) based on the statistical downscaling of three global climate models (BCM2, CNCM3, and MPEH5) and two emission scenarios (A1B and A2). 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

[1] Corresponding Author: Joseph Q. Basconcillo, jbasconcillo@pagasa.dost.gov.ph
+632-434-0955, PAGASA, Diliman, Quezon City

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 3 (CMIP3) used in SD via the FAO-MOSAICC Portal (http://mosaicc.da.gov.ph): BCM2, CNCM3, and MPEH5. 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 Special Report on Emission Scenarios (SRES) from the IPCC Fourth Assessment Report (AR4) are often used to describe future world based on different driving forces: human activities, technology, policies, and greenhouse gases (GHG) emissions. In Philippine case, SRES choice should be based on its capability to sustain climate change adaptation strategies wherein both A1B (business-as-usual scenario) and A2 (differentiated world scenario) seems to be plausible.

Results are statistically downscaled seasonal projections for three variables (precipitation, Tmin and Tmax) at station level using three GCMs (2011-2040) with two scenarios (A1B, A2) and 20C3M/Historical (1971-2000). 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

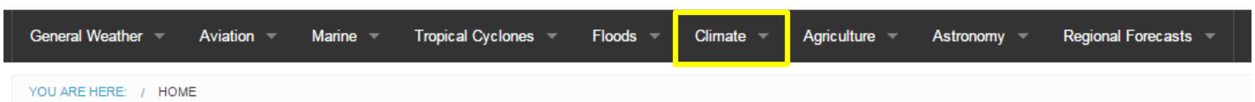
Downscaled data at station level were spatially interpolated using the AURELHY (Analyse Utilisant le RElief pour l'Hydrométéorologie) technique (Benichou and Breton, 1987) for the whole country using all stations. To compensate for the limited density of stations, this technique incorporates topography 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 DOWNLOAD AND INTERPRET CLIMATE PROJECTIONS

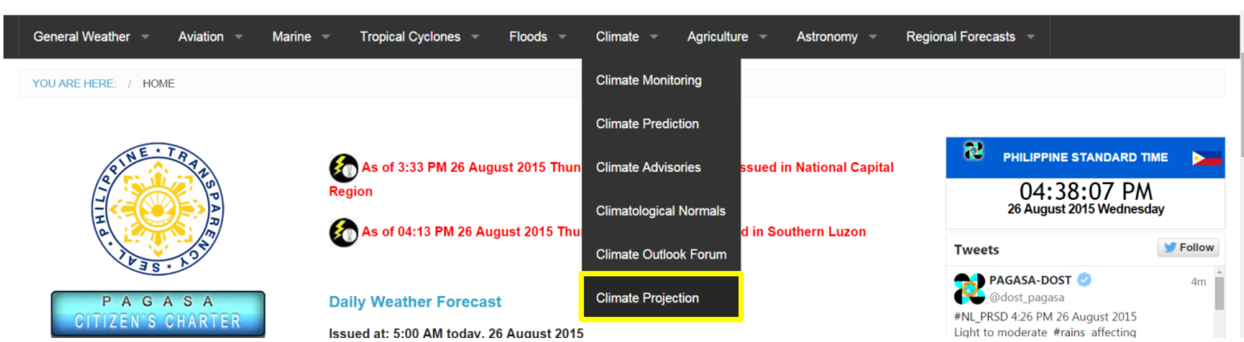
This section will provide step-by-step process on how to download and interpret climate projections:

1. Using your preferred internet browser, go to http://www.pagasa.dost.gov.ph/.

2. Click on the category **Climate**

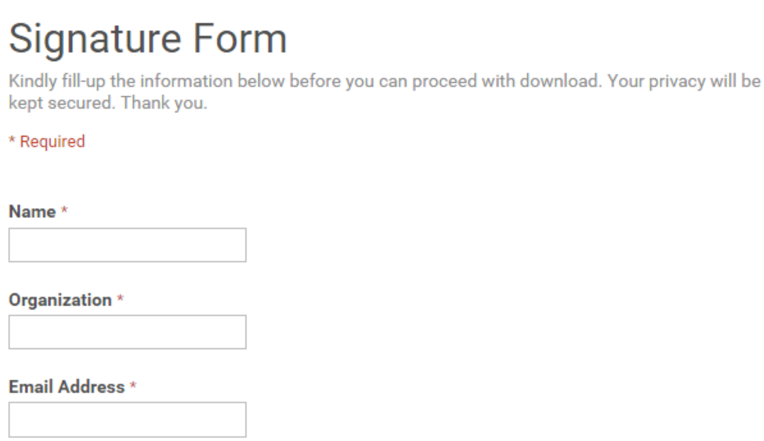


3. Click on subcategory **Climate Projection**



4. From the **Overview** page, click on download link found as shown below

5. You will be redirected to a digital signature form. Kindly fill in requested information as indicated in the form.



6. A download link will be sent to your email address where you will be redirected to the download page.

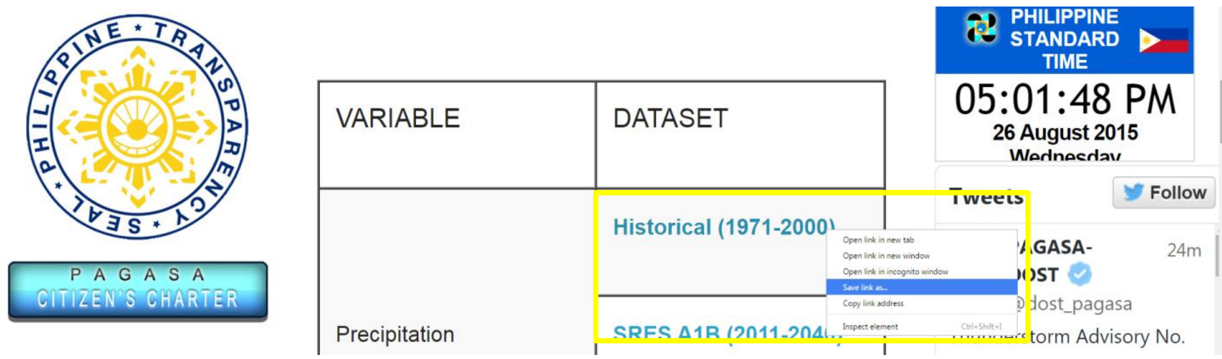
VARIABLE	DATASET
Precipitation	Historical (1971-2000)
	SRES A1B (2011-2040)
	SRES A2 (2011-2040)
Minimum Temperature	Historical (1971-2000)
	SRES A1B (2011-2040)
	SRES A2 (2011-2040)
Maximum Temperature	Historical (1971-2000)
	SRES A1B (2011-2040)
	SRES A2 (2011-2040)

Note: You need Google Earth to visualize the downloaded products

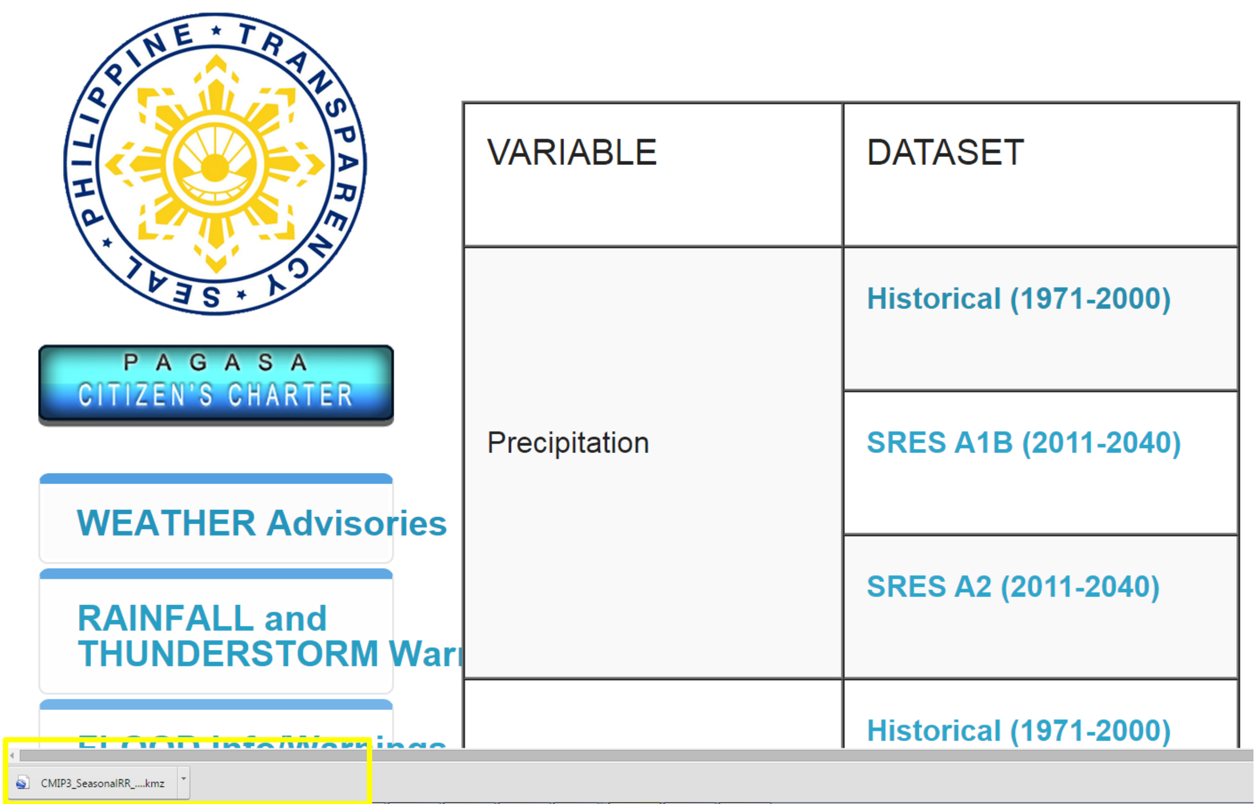
Note that you need to install Google Earth to visualize the climate projections.

7. There are three variables available for download: precipitation, maximum temperature and minimum temperature. Each variable comes in three climate period: historical (2011-2040) and future climate (2011-2040) under SRES A1B and SRES A2.

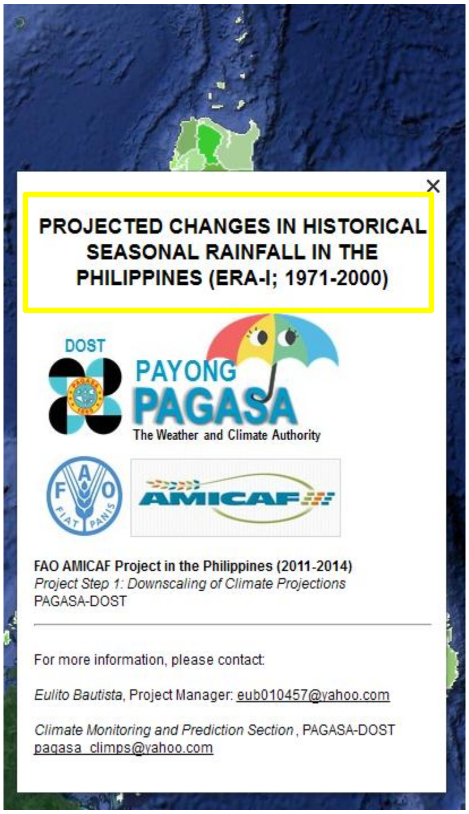
Right click and choose “Save link as” or double click to download the selected dataset.

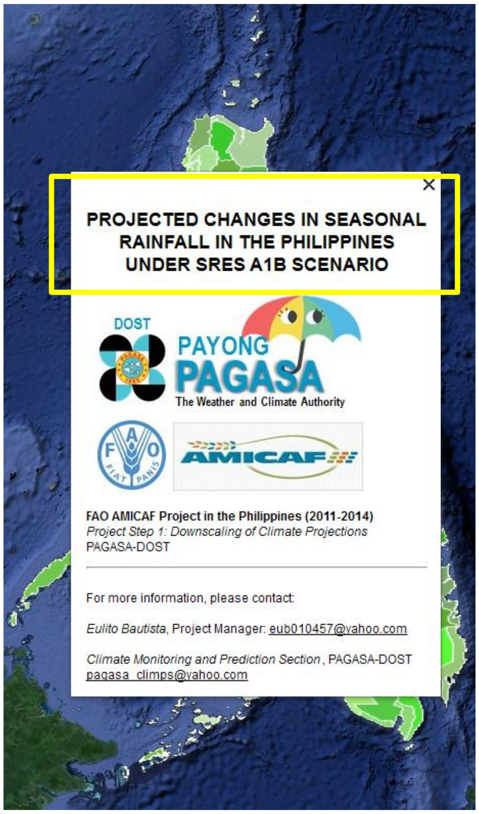


8. Open the KMZ file using Google Earth. A download link is also provided in the bottom part of download page.

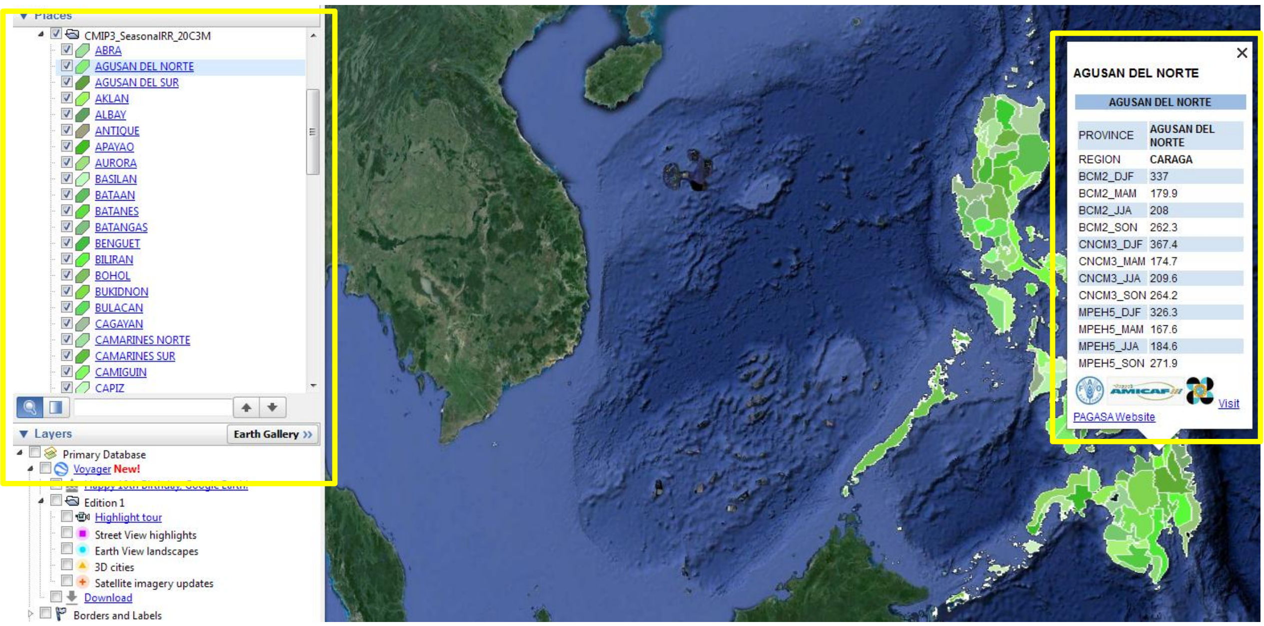


9. On Google Earth, the file will be displayed as shown below. Make sure to check the file header to assure that you are viewing the right file. Each file header found on the rightmost part of Google Earth interface will display the dataset name.





10. A list of all administrative provinces is shown in the rightmost part of the Google Earth



11. To determine the magnitude of change in seasonal precipitation in each province, multiply 100% on top of projected change to historical precipitation. Note that you can only perform this operation for a single GCM and not to another GCM.

For example, in the images below, you will find three DJF values: BCM2_DJF, CNCM3_DJF, and MPEH5_DJF. In the rightmost image is historical precipitation (mm) and in the left is projected percent change in rainfall.

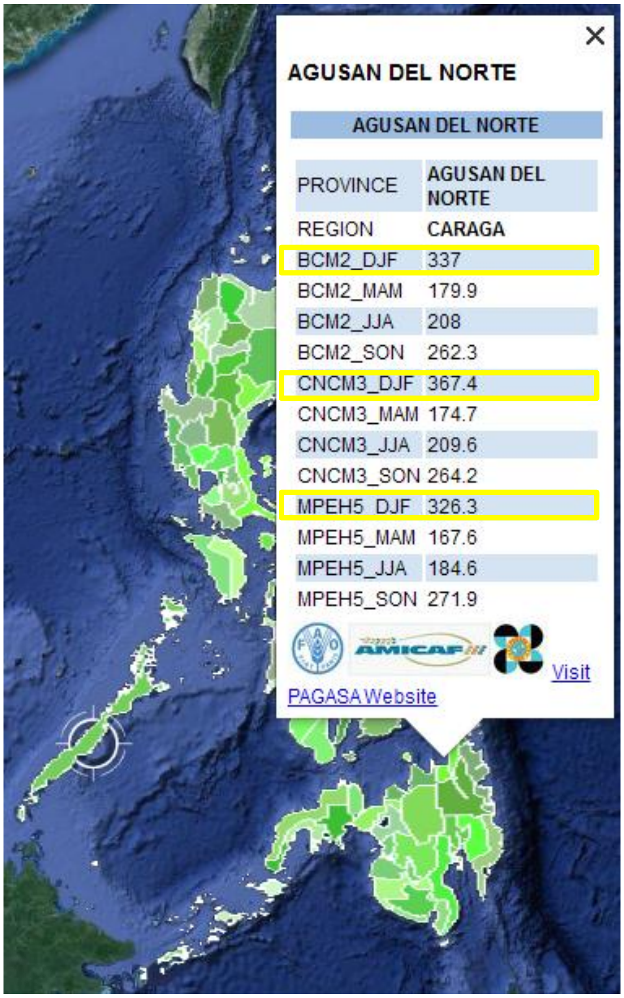
EXAMPLE:

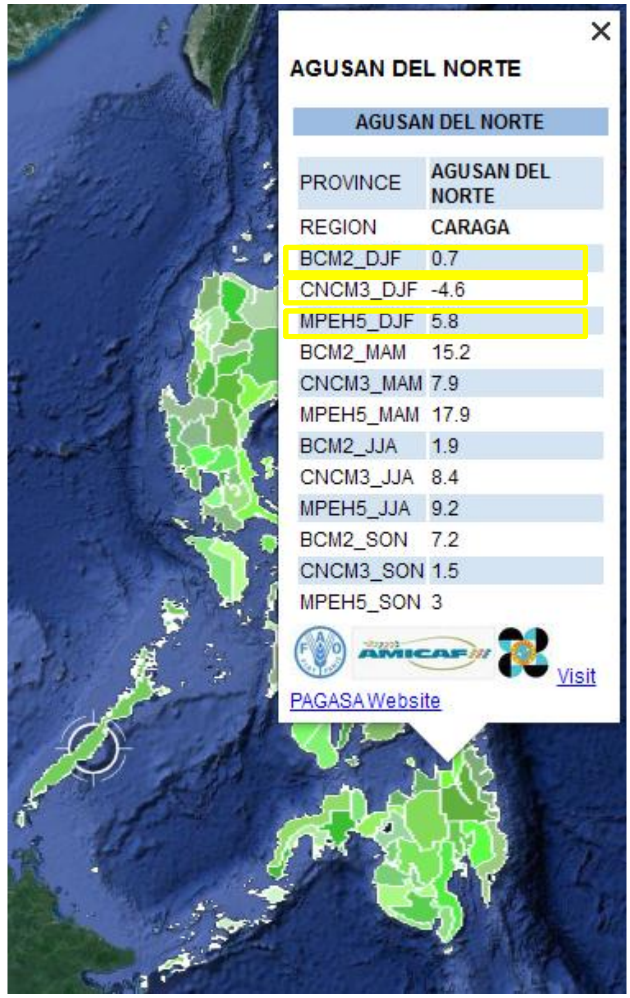
1. BCM2_DJF = 337.0 mm * 7% = 23.6 mm
   = 337.0 mm + 23.6 mm
   Future DJF = 360.6 mm

2. CNCM3_DJF = 367.4 mm * -4.6% = -16.9 mm
   = 367.4 mm - 16.9 mm
   Future DJF = 350.5 mm

3. MPEH5_DJF = 326.3 mm * 5.8% = 18.9 mm
   = 326.3 mm + 18.9 mm
   Future DJF = 345.2 mm

To determine the magnitude of change in temperature, simply add future changes to historical dataset.





Note that all GCMs under both SRES are plausible to happen in the future. This means that the choice of climate projections will depend on your objective. Based on the example on No. 11, CNCM3_DJF has the highest magnitude which could be more useful if your objective is to study higher range of future scenarios.

For further inquiries, kindly direct your inquiries to:

Climate Monitoring and Prediction Section
Climatology and Agrometeorology Division
Philippine Atmospheric, Geophysical and Astronomical Services Administration
Department of Science and Technology
Telefax: +632-434-055
Email address: pagasa_climps@yahoo.com
climps@pagasa.dost.gov.ph