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Combined Influences of PDO, ENSO, and QBO on Tropical Cyclone Activity in the Western North Pacific

John Ariel T. Rojas[1,2]*, Ronald C. Macatangay[3], Gerry Bagtasa[2], Mylene G. Cayetano[2], Esperanza O. Cayanan[1], and Leoncio A. Amadore[2]

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Tropical cyclone (TC) frequency, genesis location, tracks, and accumulated cyclone energy trends and variability in the Western North Pacific (WNP) were investigated during combined phases of Pacific Decadal Oscillation (PDO), El Niño-Southern Oscillation (ENSO), and Quasi-Biennial Oscillation (QBO) from 1980-2014. Total TC frequency was highest when moderate ENSO intensities were in-phase with PDO and coincided with the easterly phase of QBO (E-QBO) but normalized frequency was highest when moderate ENSO events were out of phase with PDO, with E-QBO (westerly phase of QBO or W-QBO) coinciding with La Niña (El Niño). Genesis location shift observed between the cold and warm ENSO phases was also noticed across the phase combinations of the climate modes. There were more straight-moving and recurving-south TCs in almost all phase combinations. Total accumulated cyclone energy (ACE) was highest when moderate and very strong intensities of El Niño coincided with E-QBO and W-QBO, respectively, and warm PDO while there was no clear pattern in the mean ACE across all phase combinations. Although there is significant influence exerted individually by ENSO, these results show that the different phase combinations of the three climate modes modulate environmental conditions in the WNP that lead to varying effects on TC activity. The findings of this study can be incorporated in long-term and seasonal TC forecasts to better improve disaster risk reduction management. Finally, there is a need for further investigation of interplay of the climate modes to better understand their combined influences on TC activity in the WNP.

Keywords: Tropical cyclone, PDO, ENSO, QBO, Western North Pacific

Increasing Tropical Cyclone-induced Rainfall in the Philippines

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Tropical cyclone (TC)-induced rainfall in the Philippines was investigated in this study using a blended 64-yr precipitation dataset. A total of 1673 TCs were examined using best track data from the Japan Meteorological Agency. TC rain contribution is highest in the northern Philippines, particularly along the western coast of Luzon (up to 54%), and lowest in the southern islands of Mindanao (6%). An unsupervised clustering method, k-means clustering, was used to divide the archipelago into four climate subtypes according to monthly rainfall variability. Interannual variability of total rainfall from climate clusters with high TC rain contribution is well correlated to variability of TC rain. On the other hand, the variability of low TC rain clusters is mainly influenced by El Niño–Southern Oscillation (ENSO). All over the Philippines, TC rain percentage contribution is shown to have increasing trends of 16.9%–19.3% per decade since 2000. This trend is likely due to changes in the characteristics of TC steering mechanisms and thermodynamic properties east of the Philippines in the past one-and-a-half decades.

Keywords: ENSO, k-means clustering, Tropical cyclone, TC-induced rainfall

Potential Impact of Sea Surface Temperature on Rainfall over the Western Philippines

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The study used a 5 km-resolution regional climate model, the Advanced Research Weather Research and Forecasting Model, to quantify the potential impact of sea surface temperature (SST) west of the Philippines on summer monsoon rainfall on the northwestern coast of the country. A set of control simulations (CTL) driven by ERA-Interim reanalysis data and the monthly National Oceanic and Atmospheric Administration Optimum Interpolation SST dataset was performed for the months of June to August of 1982–2012. A second set of simulations driven by climatological SST values was performed for the same period. The difference between these two simulation sets is analyzed to determine the sensitivity of rainfall to interannual variations in local SST, not remote SST, via a regional climate model. The CTL simulations represented spatial and temporal variations in rainfall well, yielding realistic climatological rainfall values with high spatial correlations with observations. The interannual correlation of monthly rainfall over the northwestern region of the Philippines was also high when compared to observations. The results showed that positive SST anomalies west of the Philippines induced positive rainfall anomalies in the northwestern Philippines via an increase in latent heat flux from the sea surface, implying that summer monsoon rainfall in the northwestern Philippines is modulated by interannual variations in SST west of the Philippines. The impact of SST on latent heat flux and rainfall were 20–40%, greatly exceeding the 7% approximation from the Clausius–Clapeyron equation, which can be explained by the enhancement of low-level winds and a weak warming of surface air temperature over the ocean.

Keywords: Summer monsoon, Rainfall, Sea surface temperature, Regional climate model

Multi-day Predictability of Tropical Cyclone Occurrence in the Philippines

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Tropical cyclones (TC) are among the natural hazards known to be the main causes of deaths and damaging impacts in many countries, including the Philippines. Forecasting the potential TC formation and its expected path of trajectory, multi-day in advance, could minimize TC-related impacts. This could help people seek safe shelter and complete disaster preparedness activities prior to the TC occurrence. In this study, we investigated the potential predictability of TC formation, including its possible path of trajectory, in the Philippine area of responsibility (PAR) 5–16 days ahead of its occurrence. We use the TC tracking system operationally being employed by the Central Weather Bureau (hereafter, the CWB TC Tracker). The CWB TC Tracker detects and tracks TC-like vortices (TCLV) from the 16-day, 6-hourly forecasts of the National Centers for Environmental Prediction – Global Ensemble Forecast System (NCEP – GEFS). The TCLV maps derived from the NCEP – GEFS forecasts issued at 0000 UTC comprising of 21 ensemble members are evaluated in this study. Preliminary analyses covering a 7-month period (from 1 June to 31 December 2016) of daily TCLV maps issuances were included. During the 7-month period investigated here, 14 TCs (corresponding to 67 TC days) were observed in the PAR. Comparisons made between the forecast TCLV maps and observations indicate that the CWB TC Tracker is somewhat skillful in predicting TC occurrence in the PAR. The daily forecasts issued during the 7-month period were able to capture 48.2%, 27.5%, and 12.0% of TC occurrences over the PAR for 5–8 days, 9–12 days, and 13–16 days lead times, respectively. Further analyses covering a longer time period are currently being done to obtain more robust conclusions and eventually be used for operational multi-day forecasting of TC in the Philippines.

Keywords: CWB TC Tracker, Tropical cyclone forecasting, Tropical cyclone-like vortices

Determination of Z-R Relationship for Radar-Based Quantitative Precipitation Estimation (QPE) Using *In-Situ* Measurements in Metro Manila

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Weather radar is an effective meteorological tool that gathers high spatial and temporal data through the detected backscattered energy called reflectivity factor (Z). Radar-based quantitative precipitation estimation (QPE) is a key feature of weather radars that converts reflectivity (Z) to precipitation rate (R) by means of the Z-R relationship (Z=aRb). The aptitude of radar rainfall conversion using the empirical equation varies in time and space; hence, the determination of geographically best fit Z-R relationship is important. In this study, the operational use of Marshall-Palmer (MP) Z-R equation (Z=200R1.6) in Tagaytay radar-based QPE was evaluated by using rain observation data at all-year and seasonal (i.e., JJAS, NDJF, MAM) scale with the application of wradlib python module preprocessing techniques (static clutter removal, attenuation correction) and varying grid resolution (i.e., 1x1 km, 3x3 km, 5x5 km, 7x7 km, 9x9 km). This study determined alternative radar reflectivity to rain rate equations from using the same sampling and test method of preprocessed all-year radar dataset, reckoning fifteen (15) total equations. The derived Z-R relationship assessed against Marshall-Palmer radar reflectivity to rain rate conversion skill such that the radar rainfall estimates must equal or be closest to in-situ measurements. The validation result of Marshall-Palmer Z-R relationship rainfall estimates showed below 0.42 correlation using all-year dataset in all data type inputs and grid sizes; while the noise corrected (i.e., Z_cln, Z_pia) data inputs displayed increase of QPE confidence with the highest correlation equal to 0.88 during MAM period. The seasonality of Marshall-Palmer Z-R relationship rainfall estimation skill was highly influenced by the change of raindrop size and rainfall distribution as a consequence of cloud type (i.e., cumuliform, stratiform) variation as well as the frequency of rainfall events (number of rainy days) in the study area. The larger values of a and b coefficients in derived Z-R relationships proved the direct proportionality of high reflectivity factor (Z) to bigger diameter (D) size of raindrops ($Z \alpha D$), a characteristic of tropical convective rain in greater Manila area. The verification result of the newly developed Z-R relationship surpassed the ability of MP radar-based rainfall estimates in all test groups with optimum correlation (equation) equivalent to 0.799 (Z=320R2.60), 0.986 (Z=410R4.65), and 0.986 (Z=420R4.70) in 5x5 km grid resolution using raw (Z_raw), clutter-removed (Z_cln), and attenuation-corrected (Z_pia) radar reflectivity data, respectively. Finally, the use of noise corrected radar reflectivity data and the newly derived Z-R relationship in no distinct grid size presented an advancement of radar-based quantitative precipitation estimation compared to the existing equation currently used by PAGASA.

Keywords: Weather radar, Quantitative Precipitation Estimation (QPE), Z-R relationship, Radar noise

Relationship of Aerosol Optical Depth with the Weather Parameters over Baguio City

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Aerosol Optical Depth (AOD) at 550nm obtained from Moderate Resolution Imaging Spectroradiometer (MODIS) Aqua was used to analyze its relationship with regards to changes in temperature, pressure, relative humidity, precipitation and wind speed. Pearson correlation was used in identifying the relationship of AOD with the data provided by Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), which includes the observation for more than 14 years period (July 2002 to December 2016) over Baguio City. The result of the said test was then compared to the correlation results performed by a web interface for analysis and display, GIOVANNI or Goddard Earth Sciences Data and Information Services Center (GES DISC) Interactive Online Visualization and Analysis Infrastructure, using data obtained from MODIS Aqua, Modern-Era Retrospective analysis for Research and Applications (MERRA) and Global Land Data Assimilation System (GLDAS). Both tests have resulted to a positive moderate correlation with regards on temperature. Precipitation resulted to a positive weak correlation. However, station pressure resulted to a negative weak correlation as well as the wind speed. Relative humidity on the other hand resulted to a positive weak correlation using PAGASSA data, but a negative weak correlation on MERRA data

Keywords: Aerosol, MODIS Aqua, PAGASA, GIOVANNI

Standardization of Automatic Weather Station Sensors in PAGASA - Operational Performance and System Upgrading

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Observational data are considered vital information for any national meteorological and hydrological service of a country. These measured values are used in formulating weather, flood and climate forecasts, and in providing advisories and alerts. It is very important that any manual or Automatic Weather Station (AWS) should have accurate and timely measurement of weather variables. Homogeneity in readings and information in a time series should always be at the top agenda for meteorological observations. Performance of selected AWS shall be rated compared to previous installations before the standardization. This includes a comparison with manual observations. Selected stations with available data were provided with mean-time between failure (MTBF) and mean-time to repair (MTTR) values in order to assess initial operational performance as well as establishment of correlation between data of AWS with the manual observation values in a 1-year period.

By correlating the data of the AWS from manual observation, we can distinguish the relationship of data and the standard deviation with differences that will show deviation from the observed values. For the identification of MTTR and MTBF, we shall extract data from each AWS. We conducted initial data quality control where there are missing data or dates when it was not able to send observations. We removed duplicate data (data transmitted twice or more) and computed the MTBF and MTTR values for each AWS. Improvements and upgrading of sensors including data processing contributes to the resilience of an AWS network. Simplified methodology incorporating open-source and ready-to-use algorithms and program scripts for data collection, reception and processing greatly reduce maintenance and operational concerns both for software and hardware aspects. This study shows that the standardized AWS is a better upgrade than the previous AWS installation but still requires some improvements in other aspects as well as regular maintenance.

Keywords: Automatic weather station, data logger, meteorological sensors, remote sensing, GSM modem

Evaluation of the Relationship of Automatic Weather Station (AWS) and Synoptic Data

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Observation of meteorological parameters is an essential part in climatological, weather forecasting, and hydrometeorological studies. These data serves as the basis to determine the current condition of the atmosphere on specific time and space. However, logistics continue to limit the setting up of manned synoptic stations in the country. This poses as challenge in the collection of meteorological data. Although, with the advent of technology this limitation can be eased through the installations of Automatic Weather Stations (AWS) – unmanned stations. In this study, we explored the relationship between the available data from AWS and PAGASA's synoptic data from 2013 to 2017. Since the quality of these AWS data could be affected by different externalities, this study aims to evaluate the comparison using the monthly accumulated rainfall data across different months and over the four climate types. The point data from the synoptic stations were interpolated then converted into gridded data and was compared to the data gathered by AWS. Evaluation using Pearson's test shows an average monthly correlation of 0.2–0.6 while Climate Type 1 has the highest correlation among the four types. The result of this study provides researchers and other stakeholders on the relationship of AWS and synoptic data and how it can be utilized for various purposes.

Keywords: AWS and Synoptic Data Evaluation, Meteorological Observation, Data interpolation

Poster Session

Analysis of Trends and Relationship of Sunshine Duration and Temperature in Quezon City, Philippines

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Solar radiation is the primary source of energy in the climate system from which air temperature originates. This study aims to assess the trend and correlation of sunshine duration (SD), a quantity related to solar radiation, and extreme (maximum and minimum) temperatures in Quezon City, Philippines on an annual and seasonal basis over the period of 1981-2016. The SD, maximum temperature (Tmax) and minimum temperature (Tmin) data were gathered from the Science Garden Complex Station of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). To test the homogeneity of the SD values, Kruskall-Wallis and Wald-Wolfowitz Runs Test were used. The extreme temperature data were homogenized using the software package RHtestsV4 by X. L. Wang and Y. Feng to detect possible discontinuities. The Mann-Kendall non-parametric test was applied for the trend of the climatological parameters. The correlation coefficient between SD and the extreme temperatures was obtained using the Spearman's Rank-Order Correlation Test. The results showed a statistically significant increasing trend in Tmin with a highest increase of 0.04 °C per year during the December-January-February (DJF) season. In the Tmax of the March-April-May (MAM) season, a statistically significant decreasing trend of 0.03°C per year was observed. Also found are significant decreasing trends of 0.02 hours per year in the annual SD and 0.03 hours per year in the MAM season. By analyzing the relationship of the three variables, it was revealed that a strong positive correlation exists between SD and Tmax over the MAM season, as well as a moderate negative correlation between SD and Tmin over the annual timescale.

Keywords: maximum temperature, minimum temperature, sunshine duration, Quezon City

Relationship of Particulate Matter and Meteorological Parameters in Quezon City

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The relationship between particulate matter and meteorological variables is investigated for Quezon City. Possible relationship between particulate matter and meteorological parameters can give a prediction on the future levels of air quality since meteorological parameters are routinely forecasted. Data for particulate matter, such as total suspended particulates (TSP) and particulate matter with diameter 10μm and below (PM_{10}), are obtained from the Environmental Management Bureau (EMB) of the Department of Environmental and National Resources (DENR). Meteorological data, such as relative humidity, pressure, air temperature, and rainfall, are sourced from the Science Garden Synoptic Station of PAGASA. Multiple regression analysis is performed for wet season (May to October) and dry season (November to April) for meteorological data against particulate matter from 2012 to 2017. Mean concentration for TSP and PM_{10} during the wet season is significantly lower than the dry season. During the wet season, TSP concentration has a weak significant negative correlation to relative humidity and rainfall, and a weak positive correlation to mean temperature and pressure. Also, PM_{10} concentration has a weak significant negative correlation to relative humidity and rainfall, and a weak positive correlation to pressure and mean temperature. During the dry season, TSP concentration has a moderate significant negative correlation to relative humidity and a weak positive correlation to pressure. Also, PM_{10} concentration has a weak significant negative correlation to relative humidity.

Keywords: Meteorological variables, TSP, PM_{10}, Seasonal variation

Possible Effect of Cosmic Rays on the Frequency and Intensity of Tropical Cyclones in the Philippines

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Galactic Cosmic Rays (GCR) are high-energy atomic particles released from the surface of the supernova remnant after its sudden outburst. Recent studies reveal that GCR is one of the factors that influence the intensity of cyclonic processes in the mid-latitude regions. In this regard, this research aims to determine the possible effects of GCR on tropical cyclone (TC) activity in the tropics, particularly in the Philippines. Specifically, this study investigates whether the GCR could affect the intensity and frequency of TCs that existed in the Philippine Area of Responsibility (PAR) from 1965 to 2016. Furthermore, the influence of GCR on Sea Surface Temperature (SST) over the Niño 3.4 region is also determined. Statistical analysis of the data shows that GCR and SST have a small significant correlation whereas no significant dependence was found relating the frequency and intensity of TCs in the PAR with the incoming GCR. Future studies regarding GCR with other climatological phenomenon is necessary to have a broader knowledge about the direct or indirect influences of GCR in the climate system.

Keywords: Sea Surface Temperature, solar cycle, Philippine Climate

A Study of the Madden Julian Oscillation (MJO)
Its impact in the island of Mindanao

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The Madden-Julian-Oscillation (MJO) was studied to evaluate its impact over the island of Mindanao in terms of rainfall amount and number of rainy days. Results taken suggest strong agreement with previous research studies made by noted climate scientists. The main interest of this study is to determine the spatial and temporal rainfall pattern affecting the island during MJO occurrence and to enhance the rainfall forecasting capabilities of the Mindanao PAGASA Regional Services Division (MPRSD). Two data files were utilized, the MJO index taken from the Bureau of Meteorology (BOM) website and rainfall data were taken from PAGASA data archive from seven Mindanao Weather Stations namely Hinatuan, Davao, Zamboanga, General Santos City, Dipolog, Lumbia, and Malaybalay. Seasonality of rainfall amount and number of days with rain were analyzed to determine how the condition respond to the MJO deep convection phase and its trailing phase with suppress convection. Analyses showed that rainfall amount and number of rainy days were observed to increase over the island of Mindanao as MJO's deep convection phase cross over the maritime continent. Likewise, the trailing phase with suppress convection are found to influence dry conditions especially when episodic climate event are known to affect the climate of western pacific region where the Philippines is geographically located.

Keywords: convection phase, episodic climate event, spatial/temporal rainfall pattern, rainfall forecasting, maritime continent

Correlation Between Manual and Automated Measurements of Maximum Air Temperature Parameter

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This study uses statistical method in the data analysis using temperature parameter to serve as a basis when comparing sets of data from different methods of measurement such as manual and automated observation measurements. The data from the automatic weather system (AWS) and the synoptic meteorological observation of PAGASA Science Garden Station on maximum air temperature observations from 0000UTC to 0600UTC dated from August 1 to December 31,2017 were extracted for analysis. The mean difference and correlation coefficient of maximum air temperature of the automated and manual observation were calculated to determine the correlation relationship between sample sets. The resulting data showed that the average maximum air temperature on automated measurement is 1.3% higher than the synoptic observation which is equivalent to a mean difference of 0.4 °C. The correlation coefficient is positive (+) 0.97, which indicate strong correlation relationship between the two sets of data. Based on the result, it is acceptable to use the automated observation measurement method due to strong mutual relationship between the sets of data. Uncorrelated results will also be possible due to sample outliers or non-linear distribution of samples as common cause, else further investigation should be done to understand the cause of uncorrelation. Other weather elements (e.g. pressure, wind speed and direction, relative humidity, etc.) can be correlated using similar approach used in this study.

Keywords: automatic observation, manual observation, automatic weather system (AWS), PAGASA

Impact Assessment of Rainfall Distribution Variability and Existing Land Use on Hydrological Processes in Marikina River Basin

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Metropolitan Manila has been experiencing extreme flooding events since immemorial time until nowadays. One of the main causes of flooding in aforementioned land area is high volumetric stream discharges from Marikina River down to conjoining river system of Pasig which near to highly urbanized and populated area. The general objective of this research is to gain a good understanding of hydrological processes involving Marikina River Basin (MRB) through the analysis of rainfall distribution, streamflow and the existing land use. The research focuses on the development of hyetograph, hydrograph and the correlation of average daily rainfall and average daily water level in MRB, utilizing the available raw data of water level and rainfall. In this study, we used the Sto. Nino water level station along Upper Marikina River as reference point for water level data. For the rainfall data collection, we selected eight stations within the catchment with the time coverage starting March 2015 to May 2017. The rainfall distributions over the area were analyzed through arithmetic mean method. Two rating curve equations were used in transforming water level into streamflow values. The operating equation $Q = 32.03(h - 10.80)^2$ conform to the specific criteria for which the water level (*h) is* less than 17 meters and $Q = 17.49(h - 8.61)^2$ for equal and greater than 17 meters water level. In linear correlation analysis, the relationship of average daily rainfall and average daily water level generates a coefficient of determination (R^2) of 0.22. Overall, the results of the study indicate that the MRB is highly susceptible to extreme flood event most particularly in flood prone areas where alteration of natural land cover is evident. Rainfall distribution variability can also cause drastic changes of hydrological processes in the current time and in the future.

Keywords: Marikina River Basin; rainfall distribution; stream flow; rating curve equation; land use

Statistical Analysis of Minimum and Maximum Temperature over Clark, Pampanga

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Time series analysis can be a valuable tool to identify trends, cycles, and seasonal variances to aid in the forecasting of a future event. This study aims to analyse the trends of seasonal and annual mean daily minimum and maximum temperature of Clark, Pampanga from the year 1998-2016. Data used for this analysis were acquired from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Climate and Data Section. Minimum and maximum temperatures were homogenized using a computer-based statistical tool. Mann-Kendall test and Sen's Slope Estimator were used to determine the trend and slope magnitude. The results of the study reveal that both annual mean daily minimum and maximum temperature shows a statistically significant increasing trend. Seasonal trends for mean-daily maximum temperature are significantly increasing over time. On the other hand, the mean-daily minimum temperature shows a significant increasing trend for March-April-May (MAM) season only. Also, the slope of diurnal temperature range (DTR) is positive which means that the difference between maximum and minimum temperature increases over time. In general, both the maximum and minimum temperature of Clark have a statistically significant change annually.

Keywords: Clark Pampanga, minimum/maximum temperature, diurnal temperature range (DTR)

Trends of Tropical Cyclone Intensity and ENSO Index in the Philippines during 2000-2014

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Tropical cyclones (TCs) that enter in the Philippine Area of Responsibility (PAR) are highly influenced by the El Niño/Southern Oscillation (ENSO). In this study, the relation between the TC's intensity to ENSO index was demonstrated. Trends of each TC intensity from 2000-2014 were illustrated from the computed anomalies of its average maximum wind speed and average maximum rainfall. Using Oceanic Niño Index (ONI) as the ENSO index, correlational analyses were made in comparison with the TC intensity. It was found out that there is a direct relationship between ONI and TC average maximum wind speed. In particular, during El Niño when the sea surface temperatures (SSTs) in the central and eastern Pacific are higher than usual and with ONI's positive values from normal, the Philippines experiences relatively more intense TC winds. Conversely, when the SST departure from normal is greater than or equal to -0.5°C, the Philippines experiences relatively less intense TC winds. On the other hand, TC's average maximum rainfall and ONI revealed an inverse relationship. In the early season of ENSO's warm phase, an increase in the average maximum rainfall was observed; the late season of El Niño years yielded a decreasing trend of TC's precipitation estimates. In contrast, La Niña events have inverse effects to TC's rainfall amount. These results explain that during El Niño, there is an eastward shift of cyclogenesis due to the weakening of the Walker Circulation system over the Pacific Ocean, providing more energy for the TC development. On contrary, the decreasing TC's recorded average maximum rainfall during the late season of El Niño years proved that systems tend to recurve away toward higher latitudes as the subtropical ridge splits in two separate cells. Enhanced predictability of Philippine TC intensity can be achieved using this study. It is then recommended that the inclusion of other meteorological features and ocean-atmosphere interaction that influence in the cyclogenesis, intensity, tracks and total number of TCs entering PAR be used for future studies.

Keywords: tropical cyclone intensity, ENSO index, ONI, maximum wind speed, maximum rainfall, Philippines

Development of UV indexes for the Philippines

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Ultraviolet Radiation (UVR) emitted by the sun is ubiquitous. It has several beneficial effects for human body. Nevertheless, excessive exposure to UVR is also related to several human health problems especially for the skin and eyes. Thus, UV measurements and analyses must be performed and developed in order to have a deeper understanding and a proper action concerning the UVR.

In the Philippines, one of the pillars for the study of UVR is the Philippines Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA), which recently acquired the instrument for the measurement of Erythemally active UV irradiance (UVS-E-T) Radiometer. This radiometer has a spectral function that is close to the erythemal (sunburn) action spectrum of the human skin, which is essential for the computation of UV indices (UVI). The UVI derived from this instrument were obtained using the formula suggested by the World Health Organization (WHO).

The differences between the measurements of UV irradiance vary due to local weather events, cloud cover, altitude, latitude, elevation, season, and time of the day. This study will contribute to the issuance or implementation of the UV indexes for the country. The series of information system from this study will help educate people about the risk of exposure to the sun and other factors that are related to UV Index. This study will also serve as a baseline data for UVR for the Philippines.

Keywords: Ultraviolet Radiation, Erythemally, Radiometer, Spectrum, UV Index

Cloud Seeding Operations in Negros 2016

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The Philippines experienced dry spell in 2015- 2016 due to the strong El Niño Southern Oscillation (ENSO), which brought adverse effect to some agricultural areas. One of the most affected area is the sugar plantation in Negros- a province wherein it composed of 55-60% total sugarcane plantation in the country. Cloud seeding operations was performed to mitigate the dry spell and save the crops from the threat of the phenomenon. The cloud seeding team performed a total of 39 hours and 38 minutes with 28 sorties and dispensed 420 sacks or 10,500 kilos of Sodium Chloride (salt). The objective of this study (1) to examine the presence of El Niño within the period of the sugar cane growth (2) to investigate the cloud seeding operations being conducted whether it produce precipitation for the duration of the operations through amount of rainfall recorded within the duration of the operation (3) to show the relation of successful cloud seeding operations to sugar cane productivity for the duration of sugar cane growth with the presence of El Niño. Although with regards to the direct impact of the operations to sugarcane plantation, no further studies conducted but the Sugar Regulatory Administration reported that raw sugar production increased to 2,500,509 Metric Tons from 2016-2017, after the two consecutive years (2014-2016) of decreased production and consequently exhibited a notable 10.4% compared to the previous years. Related studies emphasized that cloud seeding program returned value many time its cost.

Keywords: Philippine Air Force, Negros, Cloud seeding, Rainfall, Dry Spell, El Niño Southern Oscillation

Meteorological Parameters that Causes Diurnal Temperature Range (DTR) Variability around Metro Manila

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The Diurnal Temperature Range (DTR), is usually influenced by different meteorological parameters like the total cloud cover (TCC), precipitation rate, and relative humidity. This study shows that even the slightest change of these meteorological parameters can yield to a significant change in the DTR of an area. Using the historical data of TCC, precipitation rate, and relative humidity from 1997 to 2013 at three Automatic Weather Stations (AWS) in Metro Manila (Port Area, Ninoy Aquino International Airport, and Science Garden), which were taken from the Climate and Agromet Data Section (CADS) of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the authors investigated the effects of these meteorological parameters to the DTR in Metro Manila. Some of the trend that was produced using the Mann-Kendall test has p-value of less than 0.05 but some also has p-value higher than 5%. Due to the testing of the homogeneity of the data, it was reduced to six years which may have led the p-values to shoot up. The authors still tried to conduct the correlation test even if the p-value results are insignificant. The results that were produced from the test supports that the three meteorological parameters directly affect the variability of the DTR. The DTR and the TCC values correlation are inversely proportional. As the TCC increases, the DTR, on the other hand, decreases because of its negative correlation. The DTR relationship with the precipitation and the relative humidity is also having a negative correlation in majority of the cases.

Keywords: Automatic Weather Stations (AWS), Diurnal Temperature Range (DTR), Total Cloud Cover (TCC),

Calibration of Radar Rain Rate with Respect to Ground Truth Measurements

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Ground-based operational S-band radar measurements are widely used for quantitative precipitation estimation (QPE). However, there are factors that could affect the accuracy of rainfall radar estimates. They introduce errors, thereby decreasing the reliability of radar estimates for applications that require QPE. This paper uses a linear relationship of radar reflectivity and rainfall rate in order to correct the rainfall radar estimates. The radar is calibrated utilizing data from rain gauges. The reflectivity data from the S-Band Doppler Weather Radar facility in Subic, Zambales for November 05 and 09, 2017 together with the daily rainfall depths at 13 rainfall stations located within a 150 km radius were investigated. The rain gauge data were used to represent the ground truth situation and the estimated radar-point hourly mean rain rates obtained from the radar images were compared with the hourly rain rates. A best fitting line is used to find an adjustment factor. The effectiveness of the methodology is verified by comparing pairs of rainfall time series that are observed simultaneously by collocated rain gauges and radar. It can be concluded that the calibration can reduce errors and produce acceptable value of rainfall estimate.

Keywords: Radar, Quantitative Precipitation Estimation (QPE), S-Band Doppler Weather Radar

Society Profile

The Philippine Meteorological Society (PMS) is a non-stock, non-profit governmental organization dedicated to the advancement of the atmospheric sciences and related disciplines in the Philippines.

Objectives of the Society

- Formulates, implements and coordinates projects to strengthen education, research and development in the atmospheric and related sciences;
- Establishes linkages with universities/colleges, operational forecast centers/offices, meteorological societies, non-government organizations and the private sector;
- Conducts research and extension services in various sectors impacted by climate change;
- Conducts training, seminars, workshops, symposia, etc. on atmospheric science and related disciplines;
- Publishes and distributes results of research and other scientific information on atmospheric and other related fields;
- Promotes meteorology, hydrology, climatology, agrometeorology, and astronomy as a profession; and
- Administers gifts, grants and donations of cash, property and services that will redound to the benefit of the society.

Society's mission

- To develop and disseminate knowledge of meteorology and related hydrologic sciences (hereinafter referred to as "Meteorology")
- To promote and advance the professional application of Meteorology
- To encourage collaboration amongst Members of the Society, individuals, bodies both corporate and non-corporate who may share the Society's interest in Meteorology
- To promote among the public an understanding of weather and an appreciation of the value of Meteorology and its applications

Society's Structure

The Society's affairs are run by an elected Board of Trustees, within the constraints of the By-laws of the Society. The Society is served by Executive officers composed of a President, a Vice-President, Secretaries, a Treasurer, an Auditor and a Business Manager duly appointed by the Board of Trustees. In addition, the Board of Trustees appointed members to serve certain committees such as the Membership and Awards Committee.

Services Offered by the Society

- Consultancy (weather, climate, hydrology, air pollution and water quality assessment)
- Client-customized weather forecasts and extended outlooks
- Wind and wave forecast
- Capacity building in the mitigation of impacts of extreme weather and climate
- Conducts lectures, seminars and conference on current environmental issues

Past Activities of the Society

In order to meet its responsibilities and challenges, the PMS has sponsored a number of symposia both local and international.

- 12th National Meteorological Hydrological Convention – March 2, 2017
- 11th National Meteorological Hydrological Convention – February 17-18, 2016
- Theme: "The Role of Meteorology in Disaster Prevention and Mitigation"
- 10th National Meteorological Hydrological Convention – November 19-20, 2014
  Theme: "Extreme Weather and Climate: Impacts and Preparedness"
- 9th National Meteorological Hydrological Convention – February 20-21, 2014
  Theme: "State-of-the-Art Technologies in response to Extreme Weather Climate Events"
- 8th National Meteorological Hydrological Convention – February 21-22, 2013
  Theme: "Today's Meteorologists: Scaling up Effective Early Warning Services (EWS)".
- 7th National Meteorological Hydrological Convention – November 17-18, 2011
  Theme: **"Dots, Isobars and Meteograms: Understanding the Science of Meteorology"**
- 6th National Meteorological Hydrological Convention - November 18-19, 2010
  Theme: "Adaptation Strategies: Building Blocks for a Climate Change Resilient Phil."
- 5th National Meteorological Hydrological Convention – November 19-20, 2009
  Theme: "Understanding the Climate change Issues: A Key to a better planning and investment." Makati Convention Hall
- 4th National Meteorological Hydrological Convention – November 27-28, 2008
  Theme: "Connection and Fusion: Coping with Winds of Change."
- Co-Organized the Symposium titled "Rediscovering Philippine Setting: Meteorology and Mineralization and Tectonics" – October 2-4, 2008
- 3rd National Meteorological Hydrological Convention – March 26-27, 2008
  Theme: "Climate Change: Local, Regional and Global Initiatives"
- 2nd National Meteorological Hydrological Convention – November 27-28, 2006
  Theme:"Weather Climate and Water Implication to Sustainable Development."
- 1st National Meteorological Hydrological Convention – December 12-13, 2005
  Theme: "Towards Understanding Weather, Climate and Consequences to Hydrology for Socio-Economic Development".
- PMS-ADPC National Workshop (May 15, 2003)
- Symposia on Tropical Cyclones in the South China Sea and Western North Pacific Ocean
- Extreme Climate Events (ECE)
- National Symposium on the Application of Weather and Climate information

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