High-Definition Clean Energy, Climate, and Weather Forecasts for the Philippines Project

ANNUAL REPORT

July 2022 to June 2023

MANILA OBSERVATORY

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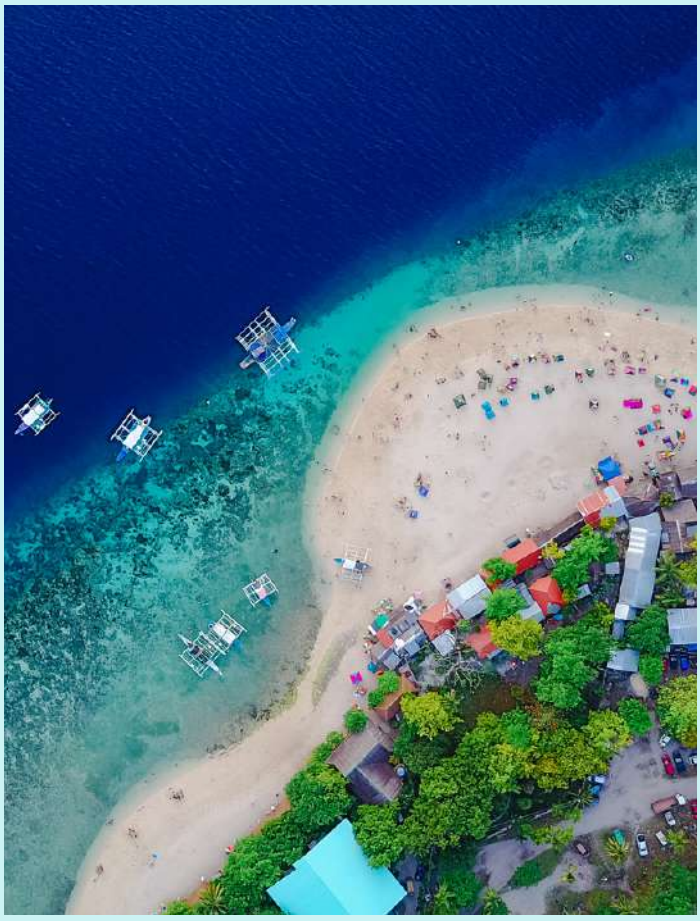
Summary

This report describes the second year of operations of the High-Definition Clean Energy, Climate, and Weather Forecasts for the Philippines Project or ECW. Year Two of this five-year project covers activities from July 2022 to June 2023.



We are happy to share what we have accomplished thus far in the three components that make up the ECW Project, which are the Observation network, Forecasting system, and Communication and Outreach.

In the Observation network, we have increased the number of automated weather stations (AWS) in our observatory network by an additional 40 stations, mostly in Mindanao and the Visayas. This year we have also forged new partnerships not just with the private sector but with local governments as well that have expressed interest in working with us on climate change.

Summary

In our Forecasting system, we continue to improve the accuracy of our clean energy, weather, and climate predictions by increasing our computing capacity, updating the land cover input in our models, validating our model estimations with actual observations, developing extreme weather/climate indices, and preparing to upgrade our local climate estimations with the latest global climate models (i.e. Coupled Model Intercomparison Project Phase 6 or CMIP6) focused on the Philippines and Southeast Asia.

In Communication and Outreach, aside from the Extreme Weather Bulletins that we regularly issue, we now have included slow onset climate events like drought, which can be challenging to detect and anticipate. A welcome development is how we have been able to leverage our efforts in this project with related work such as that in the Bangsamoro Autonomous Region in Muslim Mindanao, where we are developing proper triggers for anticipatory action in the face of imminent climate disasters. As part of our social outreach, we continue to present our learnings from this project with local and grassroots communities in various fora, interviews, podcasts, and the like. This project has also allowed us to expand the global pool of scientific knowledge on climate change through the papers we have submitted for publication this year.

Introduction

The High-Definition Clean Energy, Climate, and Weather Forecasts for the Philippines (ECW) Project aims to provide timely data, information, and analysis to support climate change adaptation and clean energy choices.

The three main elements that enable us to achieve this are: (a) an observation network, (b) a forecasting system, and (c) communication and outreach.

The observation network is composed of AWSs at select sites throughout the archipelago that monitor the 24/7 state of the atmosphere in real time. The observation system provides updates on the ground and is also the basis for validating our present and future assessments of weather and climate.

The forecasting system is the Manila Observatory's own dynamical weather and climate prediction method that adapts the Weather Research and Forecasting (WRF) model to the entire country at 5-km resolution. We produce five-day forecasts not only of the weather but also of those variables on which solar and wind energy systems depend.

For climate projections, we use the RegCM model to make decade-long assessments of climate change in the Philippines and Southeast Asia for the entire 21st century.

The third element, communication and outreach, conveys scientific data and analysis to all those who have a stake in climate change. Our primary portal is the MO ECW website (https://panahon.observatory.ph/ecw) which publishes the current and future conditions of weather and climate. We produce bulletins (e.g. Extreme Rainfall, Drought Watch, etc) to augment and complement the official warnings of PAGASA and other international groups. These scientific predictions are then combined with social parameters to generate disaster risk maps that can aid timely decision making and disaster response.

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Observation Network

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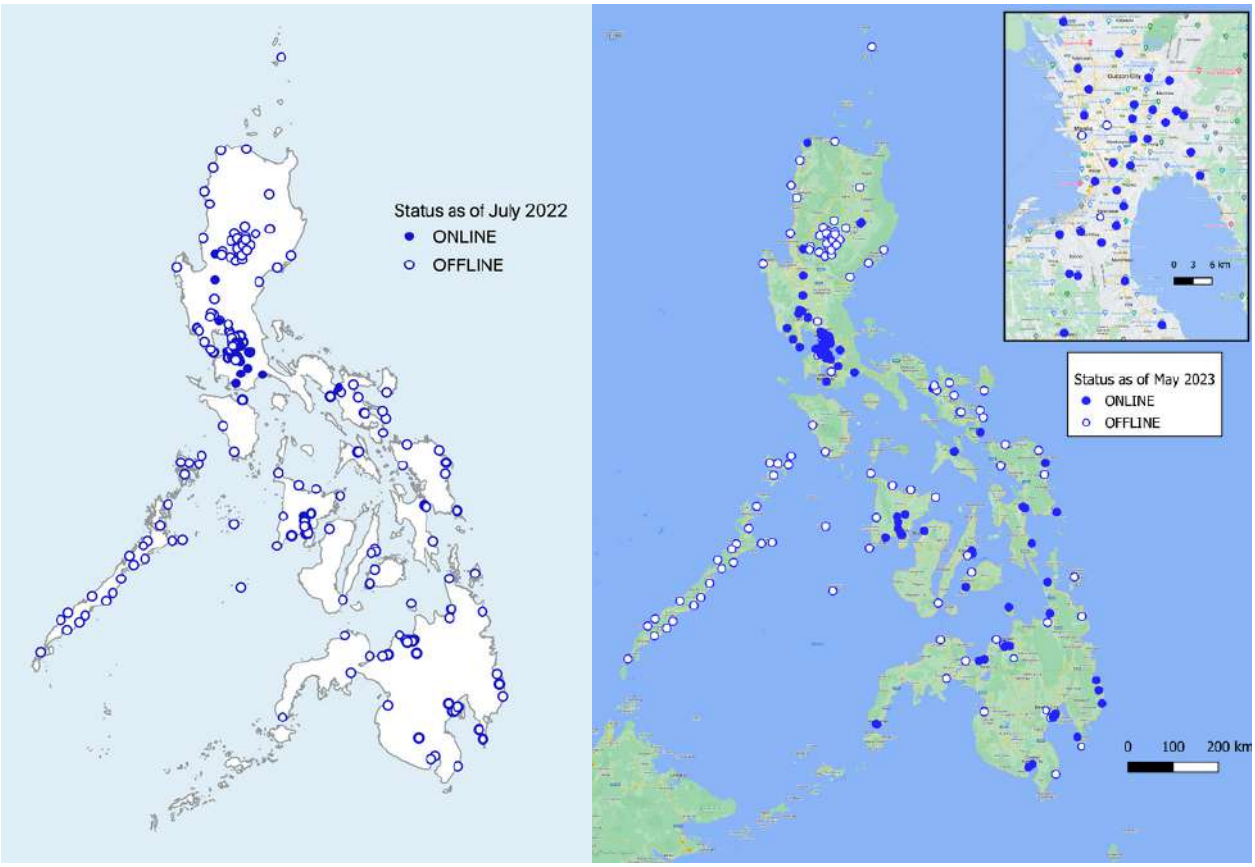
Observation Network



As of July 2022

As of May 2023

The heart of the ECW observation system is the automated weather station. These AWSs are essentially Davis (US) and Lufft (Germany) stations that measure meteorological conditions every ten minutes. The AWS data are regularly sent via SMS/internet to MO's central databases where they are stored and analyzed, subject to Quality Assurance and Quality Control protocols.

We have been able to rehabilitate an additional 40 stations for Year 2, most of which are in Visayas and Mindanao. This brings the total to 105 operational stations in the MO AWS network.

105

Automated Weather Stations online

61%

of total number of weather stations

9

new partnerships with LGUs

Observation Network

Training sessions were conducted for various stakeholders during field site visits, including those given to Shell Terminal and Mobility Units, and colleagues from Visayas State University in Leyte.

A welcome development this year is the expansion of our partnership with local government units such as Iloilo City, the whole of Region 6, Cagayan de Oro, Tacloban, and Zamboanga. In addition, the Climate Resilient Cities Project with Catholic Relief Services has enabled us to assist the LGUs of Batangas City, Borongan City, Cotabato City, and Legazpi City in their efforts to deploy early warning systems.

Jul - Sep 2022

- NCR
- Cavite and Pampanga
- General Santos and Koronadal
- CDO
- Davao

Oct - Dec 2022

- Iloilo
- Northern Luzon
- Laguna and Batangas
- CDO and Cebu

Observation Network

Jan - Feb 2023

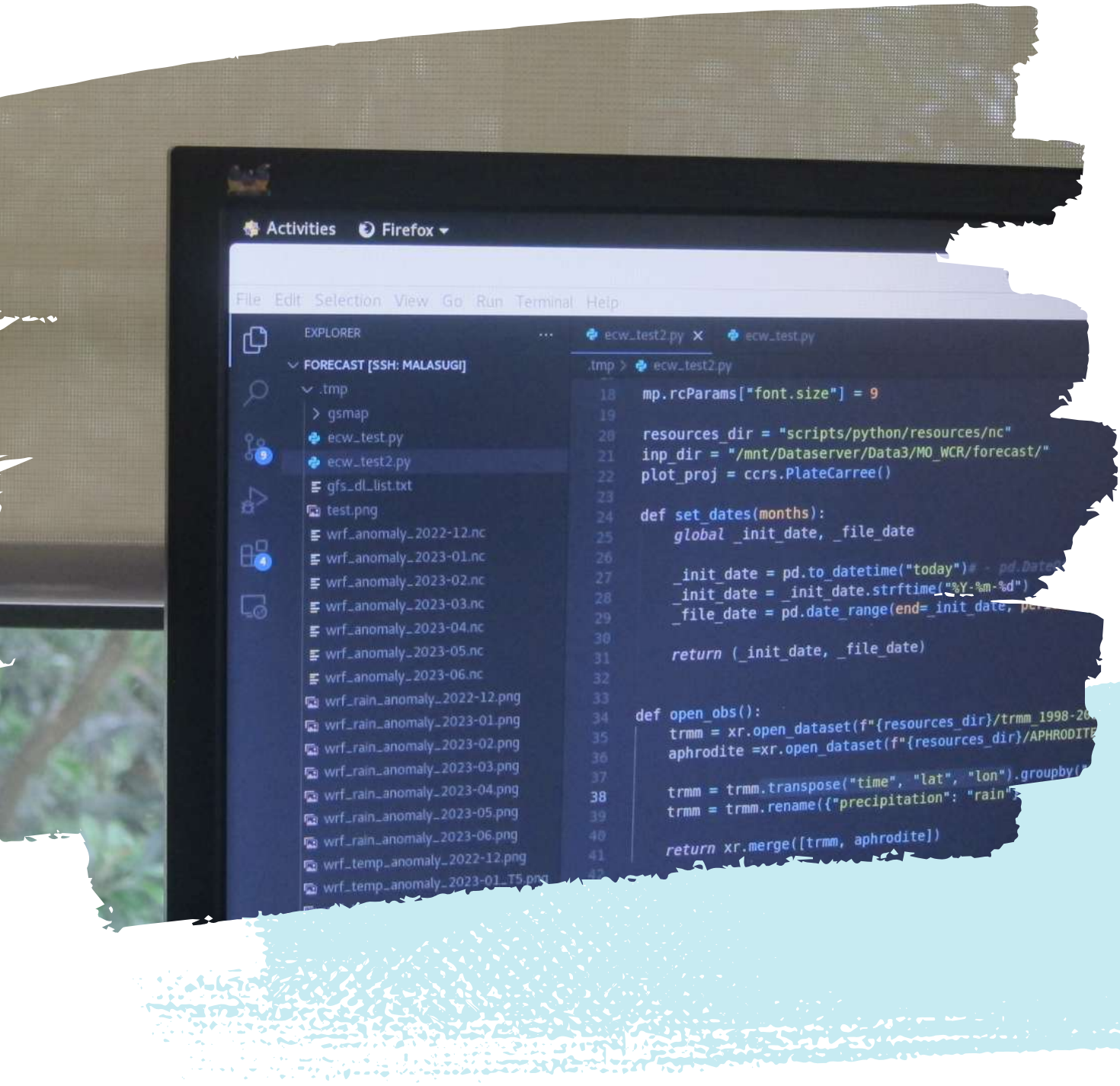
- NCR
- Baguio
- Cebu and Iloilo
- CDO and Davao
- General Santos

Mar - Apr 2023

- Bulacan and Pampanga
- Northern Luzon
- Bicol and Masbate
- CDO and Bukidnon
- Cavite, Batangas, and Laguna

May - Jun 2023

- Tacloban City and Ormoc City
- Eastern Samar and Leyte
- Bacolod City
- Iloilo
- Zamboanga City



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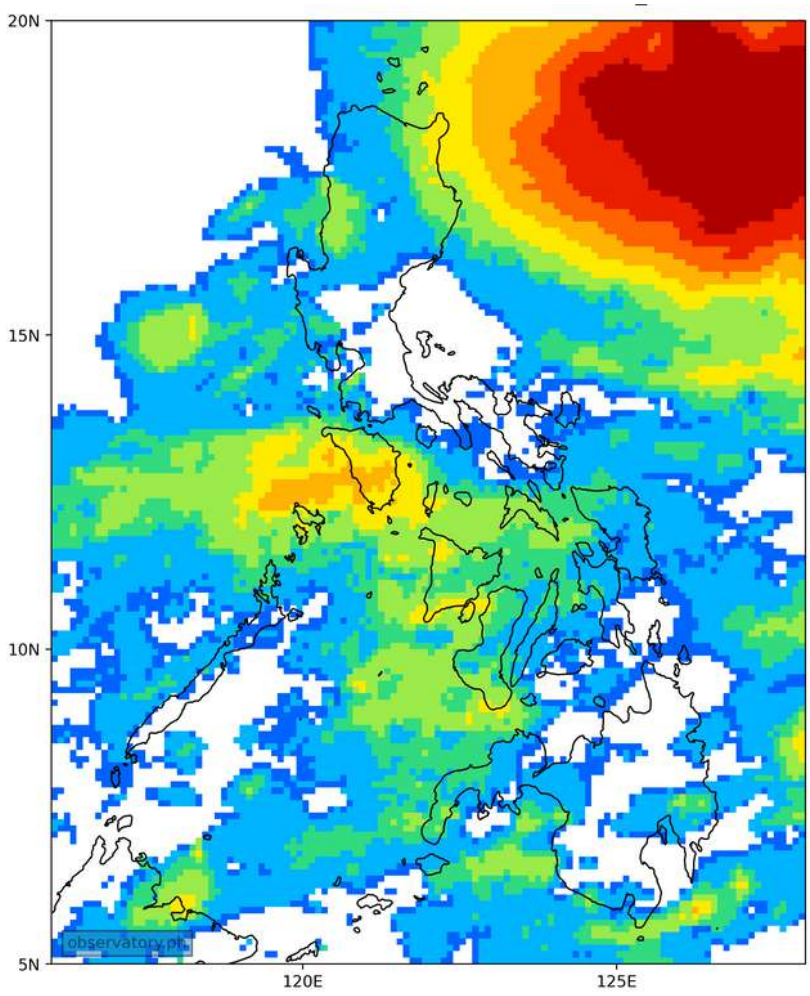
Forecasting System



Forecasting System

In Year 2, efforts to improve the forecasting system focused on (1) increased forecast frequency, (2) data assimilation, (3) updating land cover, (4) solar energy, (5) extreme weather indexing, and (6) climate projections.

Concerning forecast frequency, we are happy to report that our five-day forecasts are now updated four times a day, double the frequency of last year. This is due to increased computing capacity.

4x

update in daily forecasts

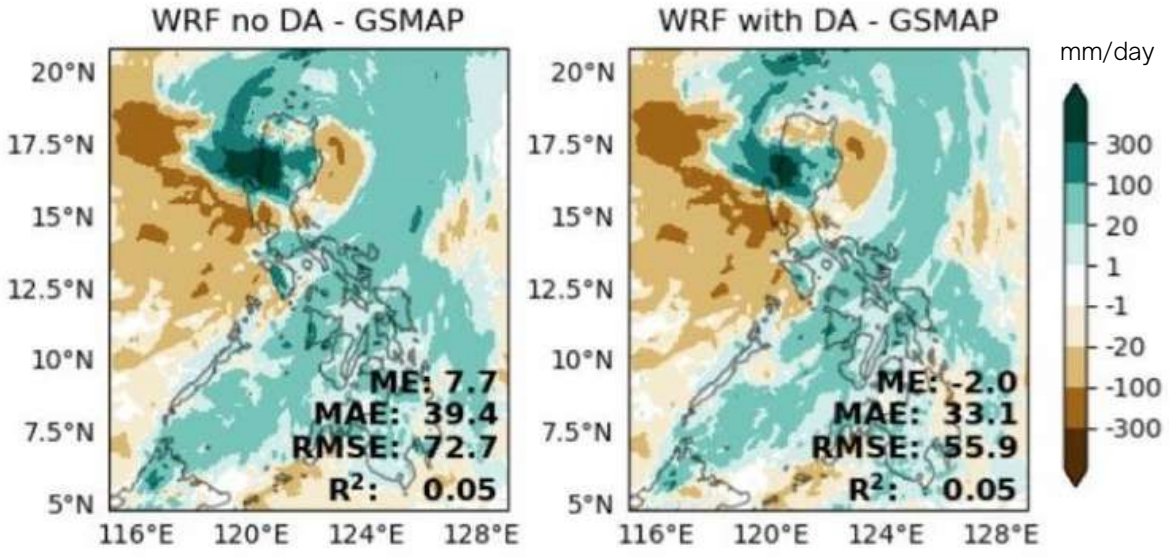
3

model ensemble members

1-hr

forecast intervals

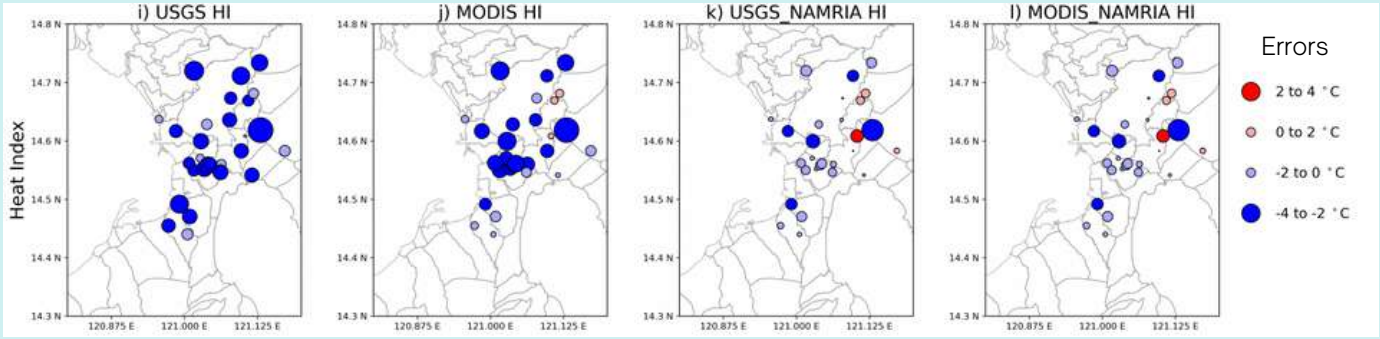
Data assimilation is about the incorporation of actual observed data from our AWS and other surface and upper air observations into our model forecasts. We have observed improved forecast accuracy in the actual case of Tropical Cyclone Florita over Northern Luzon in August 2022.



Rainfall forecast errors without (left) and with (right) data assimilation (DA)

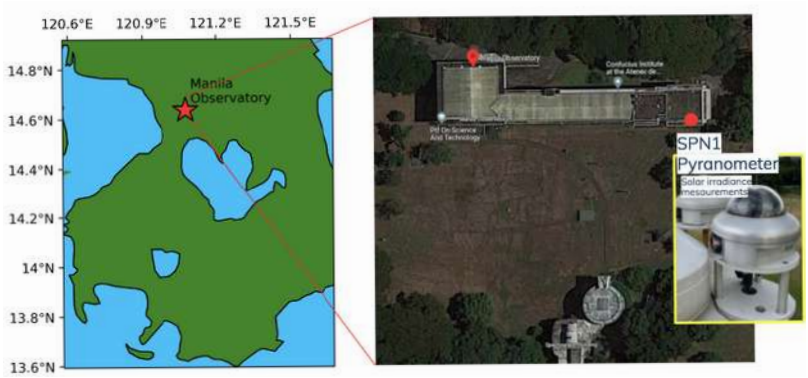
Forecasting System

Improving forecasts also depends on the crucial input of land cover. Nowhere is this more apparent than in cities. Urban surfaces tend to increase surface temperatures because of material differences in heat stored and reflected, wind circulation, and other factors. We therefore updated the land cover of the entire Philippines and saw how our forecasts improved for a pilot area like Metro Manila.



Simulations of surface temperature over Metro Manila for April 2015 were compared with MO's AWS network. **Temperature errors were reduced by 2°C** in some stations because of updated land cover.

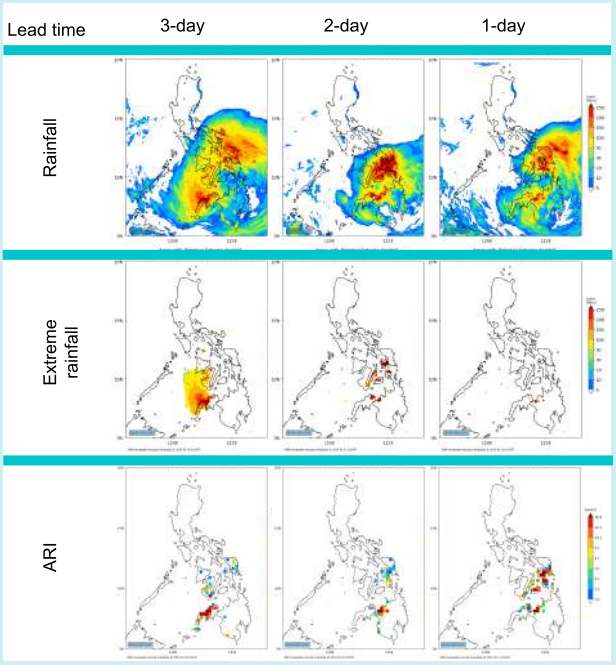
To increase our confidence in forecasting solar energy several days ahead, we looked at actual measurements of a solar parameter called Global Horizontal Irradiance or GHI at the Manila Observatory for the months of January to March and June to August in 2020. Comparison with our model results showed the ability of the model to capture observed GHI values, particularly from January to March. We also applied what is called a Kalman Filter to our forecasts and observed a substantial increase (> 50%) in the accuracy of our forecasts during cloudy and clear days.



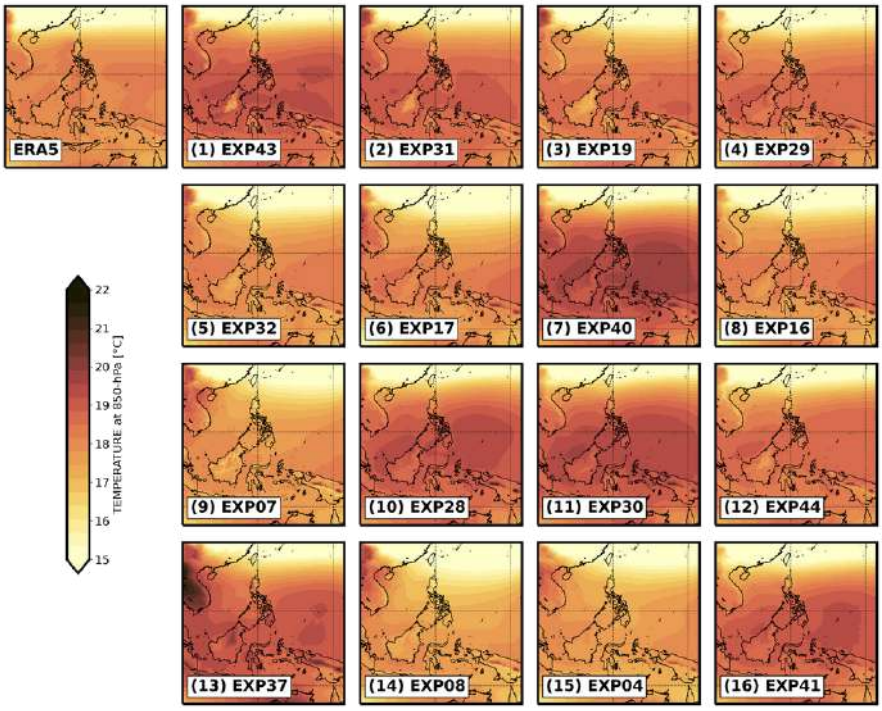
The figure on the left shows the model domain of the 1-km WRF-Solar simulations that includes the MO site (red star). Right image shows the pyranometer on the rooftop of the MO Main Building.

Forecasting System

More frequent extreme weather events are an expected outcome of climate change. For instance, the average recurrence interval or ARI is a possible measure of extreme rainfall. The use of this metric can indicate areas where extreme rainfall does not necessarily exceed the average monthly total, but is considered extreme relative to the annual maximum rainfall in the past years.



Our previous climate projections relied on emission scenarios called Representative Concentration Pathways or RCPs. This year we began running climate projections based on the more recent growth scenarios called Shared Socioeconomic Pathways or SSPs and the Coupled Model Intercomparison Projects Phase 6 or CMIP6.



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Communication and Outreach

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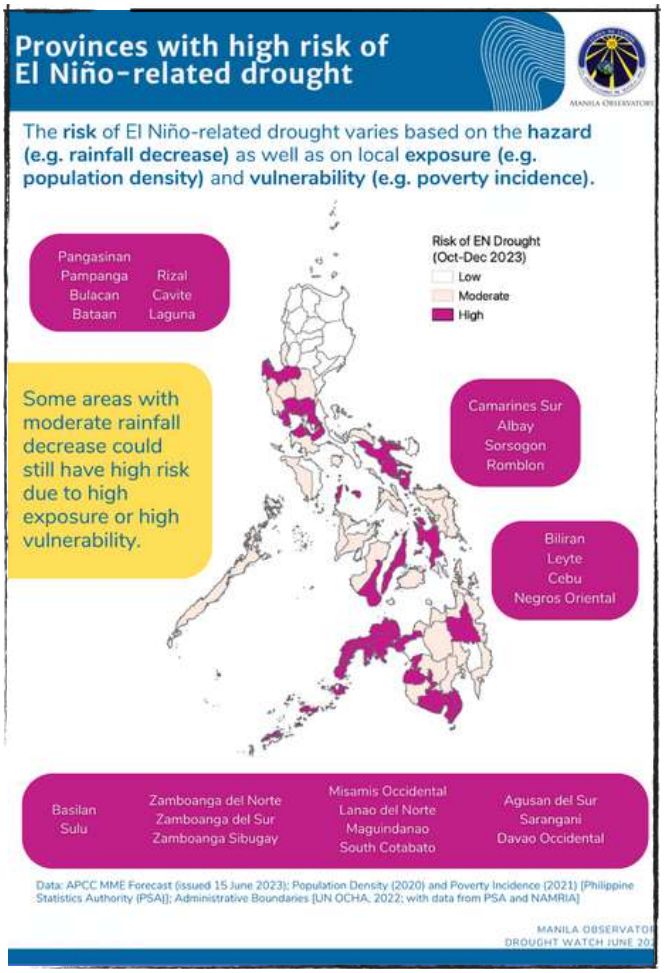
Bulletins

Conveying the results of science involved the issuance of the usual Extreme Weather Bulletins and for this year, Drought Watch Bulletins. The latter featured satellite-based information on rainfall and El Niño conditions over the Pacific, which were then analyzed to assess the potential risk of drought to the country. The evaluation of risk takes into account not only the probability of the hazard but the potential social exposure and vulnerability of assets as well.

Monthly bulletins are regularly disseminated via e-mail, website, social media, lectures, dialogue and fora. These are regularly uploaded to:

Panahon website (http://panahon.observatory.ph/reports)
Facebook (http://www.facebook.com/manilaobservatory)



Publications

We were able to publish one research paper this year on tropical cyclones:

> Petilla CER, Tonga LPS, Olaguera LMP, Matsumoto J, 2023. Changes in intensity and tracks of tropical cyclones crossing the central and southern Philippines from 1979 to 2020: an observational study. *Progress in Earth and Planetary Science*, 10:32, https://doi.org/10.1186/s40645-023-00563-1.

The following are either still in preparation or have already been submitted and under international peer review:

- Henson K, Olaguera LMP, Cruz F, Villarin JRT. The sensitivity of extreme rainfall simulations to WRF parameters during two intense southwest monsoon events in the Philippines (in preparation).
- Llorin AGA, Olaguera LMP, Cruz FT, Villarin JRT. Improved WRF simulation of surface temperature and urban heat island intensity over Metro Manila, Philippines, Atmospheric Research (under review).
- Llorin AG, Olaguera LMP, Magnaye AMT, Cruz F, Dado JMB, Gozo EC, Topacio XGVM, Uy SN, Simpas JBB, Villarin JRT. Quantifying the influence of updated land use/land cover in simulating urban climate: A case study of Metro Manila, Philippines. Theoretical and Applied Climatology (under review).
- Olaguera LMP, Llorin AGA, Magnaye AM, Cruz FA, Villarin JRT, Topacio XGVM. Observed characteristics and seasonality of the diurnal patterns of precipitation over Metro Manila, Philippines. Theoretical and Applied Climatology (under review).
- Olaguera, LMP, Magnaye AMT, Visaga SMA, Cruz FT, Villarin JRT, Matsumoto J. Influence of synoptic disturbances on the diurnal cycle of precipitation over the Philippines (in preparation).
- Petilla CER, Olaguera LMP, Cruz FA, Maquiling JT, Villarin JRT. The impact of varying SSTs on the track and intensity of Tropical Storm WASHI (2011). Meteorology and Atmospheric Physics (under review).
- Visaga SM, Pascua PJ, Tonga LP, Olaguera LM, Cruz FA, Alvarenga R, Bucholtz A, Magnaye AM, Simpas JB, Reid E, Uy SN, Villarin JR. Application of Kalman Filter for post-processing WRF-Solar forecasts over Metro Manila, Philippines (in preparation).

Outreach

Manila Observatory's efforts to interface science with social concerns include sessions we continue to have with various stakeholders such as:

- Talk on High-Definition Clean Energy, Climate, and Weather Forecasts for the Philippines in the Annual General Meeting of the Private Sector Alliance for Disaster Resilient Societies (ARISE) in October 2022

- Podcast Interview in October 2022 with ARISE Philippines on the occasion of International Disaster Risk Reduction Day

- Lectures for LGUs on Anticipating the Impacts of El Niño: Supporting Preparedness of BARMM Communities (organized by SUPREME BARMM Consortium, 3 May 2023)

- Online and onsite fora:

    Farmers - El Niñong Pinalubha ng Nagbabagong Klima: Epekto at Dapat Ihanda ng Magsasaka, organized by MASIPAG, 13 May 2023

    National Government Agency - Underscoring Space-based Actions for Drought or USAD, organized by Philippine Space Agency, 17-18 May 2023

    Public - Panganib ng El Niño (Dapat all Equal, Oxfam Pilipinas program via Radyo Veritas, 24 May 2023)

    NGOs - Alerto sa El Niño (Online forum organized by Oxfam Pilipinas, 20 June 2023

Images courtesy of Erielle Esturas/Oxfam Pilipinas

Partners

We acknowledge with gratitude the generous benefaction of our partners. Without their support, the work of climate science in the Philippines and Southeast Asia would remain rudimentary and all the more impoverished. We can ill afford climate action to be blind, that is, uninformed by science. Marami pong salamat!

Project Team

Maintaining a nationwide network of stations, running high-resolution forecasts 24/7, generating decade-long climate projections for the 21st century, and analyzing climate risk are not for the faint of heart (and mind).

In truth, we are not that many. And so we try to multiply ourselves by counting on partnerships we make with other allied groups on the ground.

We are truly thankful to our team members for their scientific competence. Most of all, we are grateful for their depth of character and commitment to be at the service of the more vulnerable in our midst.

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