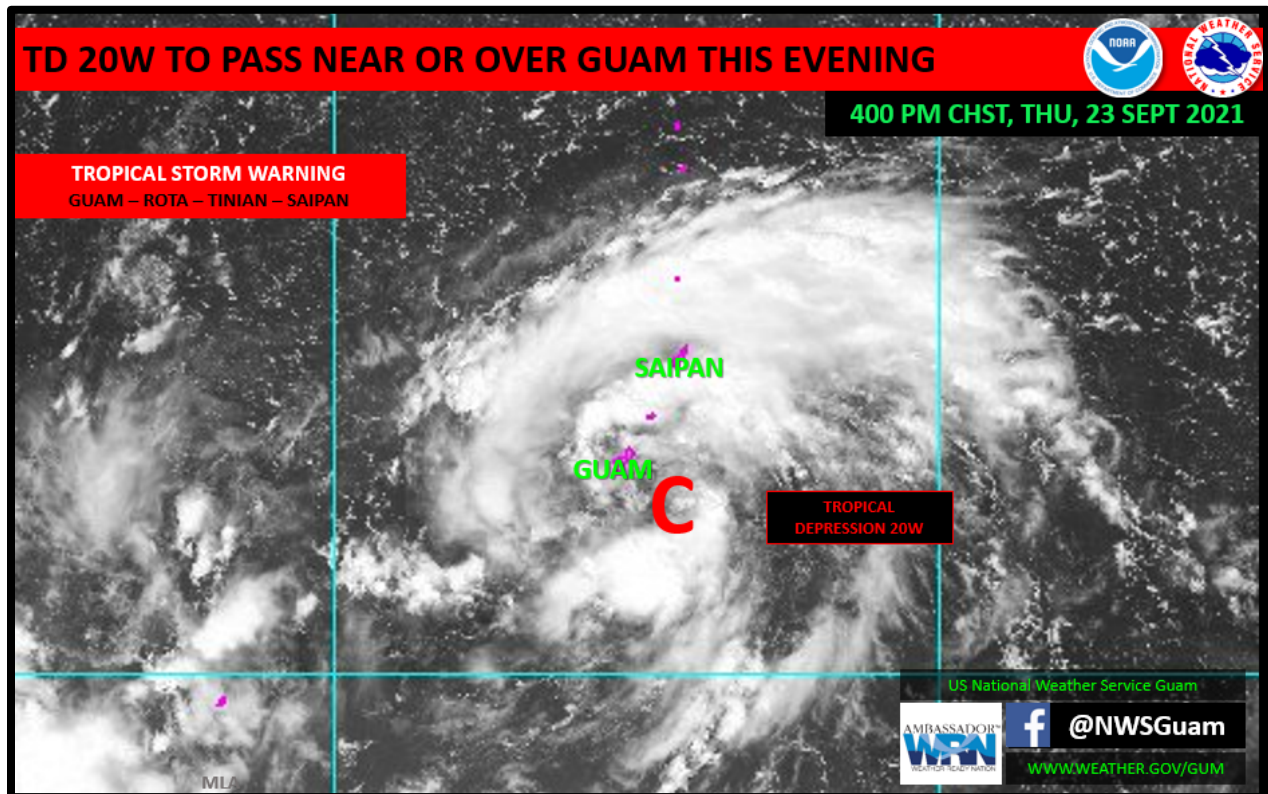


# MEMBER REPORT

## United States of America

### Pacific Region



ESCAP/WMO Typhoon Committee  
16th Integrated Workshop  
(Video Conferencing)  
2-3 December 2021

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**Cover caption:** Weather Forecast Office (WFO) Guam's Weather-Ready Nation Email Alert graphic based on the warnings issued by the Joint Typhoon Warning Center (JTWC) for Tropical Depression 20W, which later became Super Typhoon Mindulle. TD 20W was upgraded to tropical storm (Mindulle) shortly after this announcement. Rainfall of up to ten inches (254 mm) and winds in the low tropical storm-force range affected the Mariana Islands of Guam, Rota, Tinian, and Saipan. The Weather-Ready Nation Outreach program has been a successful program that involves stakeholders, including government officials, businesses, and individuals, to help pass the word for threatening weather events.

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## I. Overview of tropical cyclones which have affected/impacted Member's area since the last Committee Session

The Pacific Region of the United States of America (USA) National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) encompasses both the western North Pacific Islands in Micronesia (except Kiribati) and the Central Pacific areas. In Micronesia, the USA tropical cyclone activities involve the NWS Pacific Region and the Department of Defense Joint Typhoon Warning Center (JTWC) located at Pearl Harbor, Hawaii. The NWS Weather Forecast Office (WFO) on Guam provides weather forecasts, advisories, watches, and warnings within its Area of Responsibility (AOR). The WFO Guam AOR roughly extends from 130 Degrees East Longitude eastward to the International Date Line, covers an ocean area of more than 4 million square miles (about 10.4 million square kilometers) and includes more than 2000 Micronesian islands. This AOR includes the Commonwealth of the Northern Mariana Islands (CNMI), Republic of Palau, Federated States of Micronesia (FSM), Republic of the Marshall Islands, and the U.S. Territory of Guam. The FSM is composed of the States of Chuuk, Yap, Pohnpei, and Kosrae.

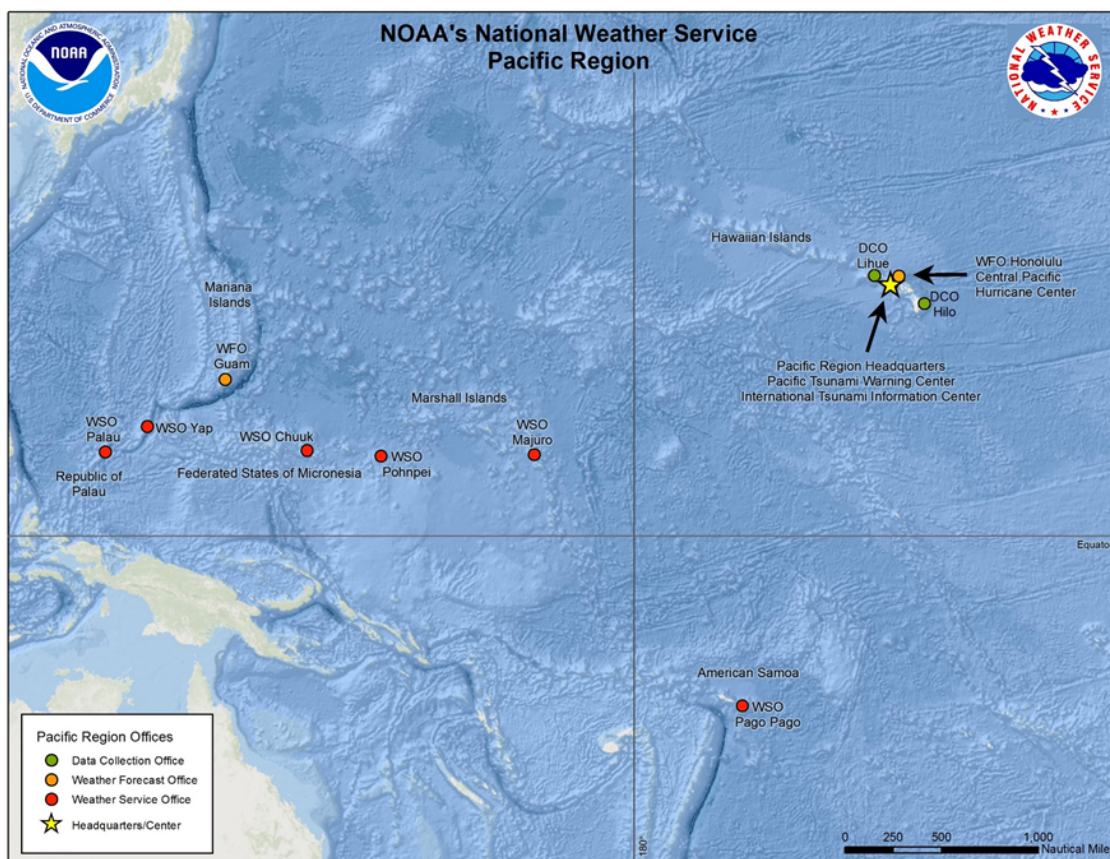


Figure 1: U.S. National Weather Service, Pacific Region

When tropical cyclones occur, WFO Guam provides the warnings for the U.S. Affiliated Islands of Micronesia. The WFO Guam uses the track, intensity and wind distribution information provided by JTWC to produce plain language and graphical forecast and warning products informing the general public and governmental agencies of impending severe weather.

The Central Pacific Hurricane Center (CPHC) is co-located with the NWS Honolulu Forecast Office. The NWS Honolulu Forecast Office activates the CPHC when tropical cyclones form in, or move into, the Central Pacific region from 140 Degrees West Longitude westward to the International Date Line. CPHC is also the World Meteorological Organization (WMO) Regional Specialized Meteorological Center (RSMC) for tropical cyclones in this region and in this capacity is known as RSMC Honolulu. The NWS Forecast Office in Honolulu's AOR covers around 5 million square miles (about 13 million square kilometers) from the Equator to 30N between 140W and 160E.

# 1. Meteorological Assessment (highlighting forecasting issues/impacts)

## *Central North Pacific (140W to 180, North of the Equator) Overview*

The 2021 tropical cyclone season featured below normal activity across the RSMC Honolulu area of responsibility (AOR). There were three tropical cyclones, which entered the central North Pacific during the period from 1 January through 15 November 2021.

The first two tropical cyclones were classified as tropical depressions: Felicia (20 July) and Jimena (6 August). These dissipated almost immediately upon crossing into the area from the eastern Pacific basin.

The final tropical cyclone in the RSMC Honolulu AOR was Tropical Storm Linda, which crossed 140 west longitude on 19 August. Linda was a unique tropical cyclone in that it maintained its 35 to 40 knot strength as it transitioned to a post tropical cyclone, as deep convection ended, but the gale force winds remained to the north of the center, even several days later as the remnant low passed through the middle of Hawaiian Islands. Deep convection did occasionally flare up far to the northeast of the low as upper-level wind shear kept the tropical cyclone from redeveloping. However, the remnant low brought impactful wind, rain, and surf to mainly the islands of Oahu and Kauai on 24 August, but moved quickly to the west, and conditions improved quickly.

In addition, CPHC began tracking invest 91C on 6 August, in the southwest portion of the AOR. This disturbance moved west-northwest across the International Date Line on 10 August, after which it eventually developed into Tropical Storm Omais in the western North Pacific.

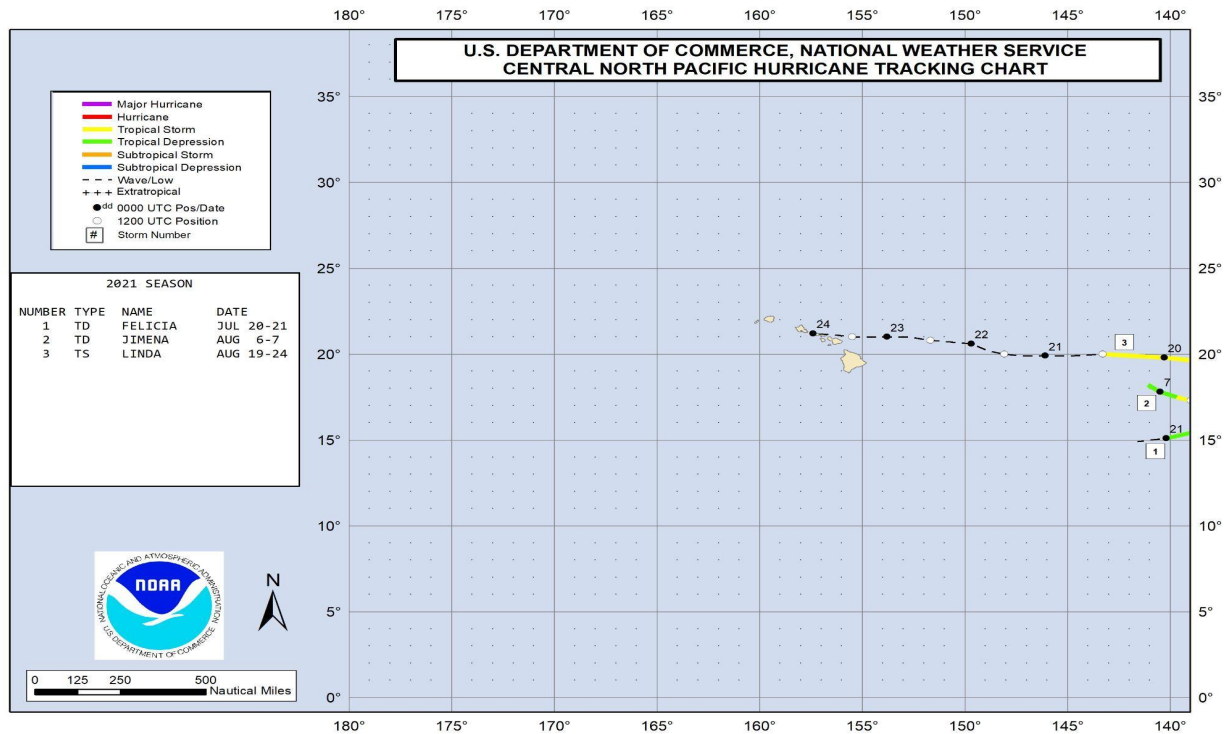


Figure 2: Central North Pacific tropical cyclone and invest tracks: 1 January 2021 to 15 November 2021

### ***Western North Pacific (130E to 180, north of the equator) Overview***

In 2021, the number of tropical cyclones was near normal within the WFO Guam AOR. However, an unusual number of tropical cyclones failed to intensify to typhoon intensity. 2021 shifted from a La Nina pattern to an ENSO-neutral in the late spring and back to a La Nina pattern in the Fall. Again, the environmental conditions remained unfavorable for strong tropical cyclone development with the general lack of low-level equatorial westerlies and an increase in upper-level westerly shear, especially north of 10N. With rainfall through October 2021 near normal, a significant amount of rainfall came from periods of strong monsoon activity, especially for the western islands, rather than from the passage of tropical cyclones.

More typical of a La Nina year, the majority of tropical cyclones that either entered or formed in the WFO Guam AOR were tropical depressions and only intensified after reaching the western or northern boundaries of the AOR. The one exception was the very unusual path of Tropical Storm Omais (16W) that formed southwest of Hawaii near 160W during a brief period of SST warming in the Central Pacific, and then temporarily making it to tropical storm intensity just north of Eniwetok in the Marshall Islands (with little reported damage), passing just south of Guam as a depression (again, with little effect) and then angling to the northwest passing through the Ryukyu Islands and just east of Cheju Island and near Busan in South Korea. During this latter period, satellite imagery indicated that it reached at least moderate tropical storm intensity. This was one of the longest tracks in the JTWC database for a tropical cyclone to cover this much distance and not reach typhoon intensity.

Since the November 2020 Member Report, there have been 21 tropical cyclones in the WFO Guam AOR, with three of these occurring in November and December 2020. Including Omais, mentioned above, there were eighteen tropical cyclones in the AOR during the first ten months of 2021. Three became major typhoons (greater than or equal to 100 knots), as well as super typhoons; however only two, Super Typhoon Surigae (02W) and Super Typhoon Chanthu (19W), had any significant impacts on member countries outside of the AOR. Surigae passed through western Yap State, just north of the Republic of Palau (ROP).



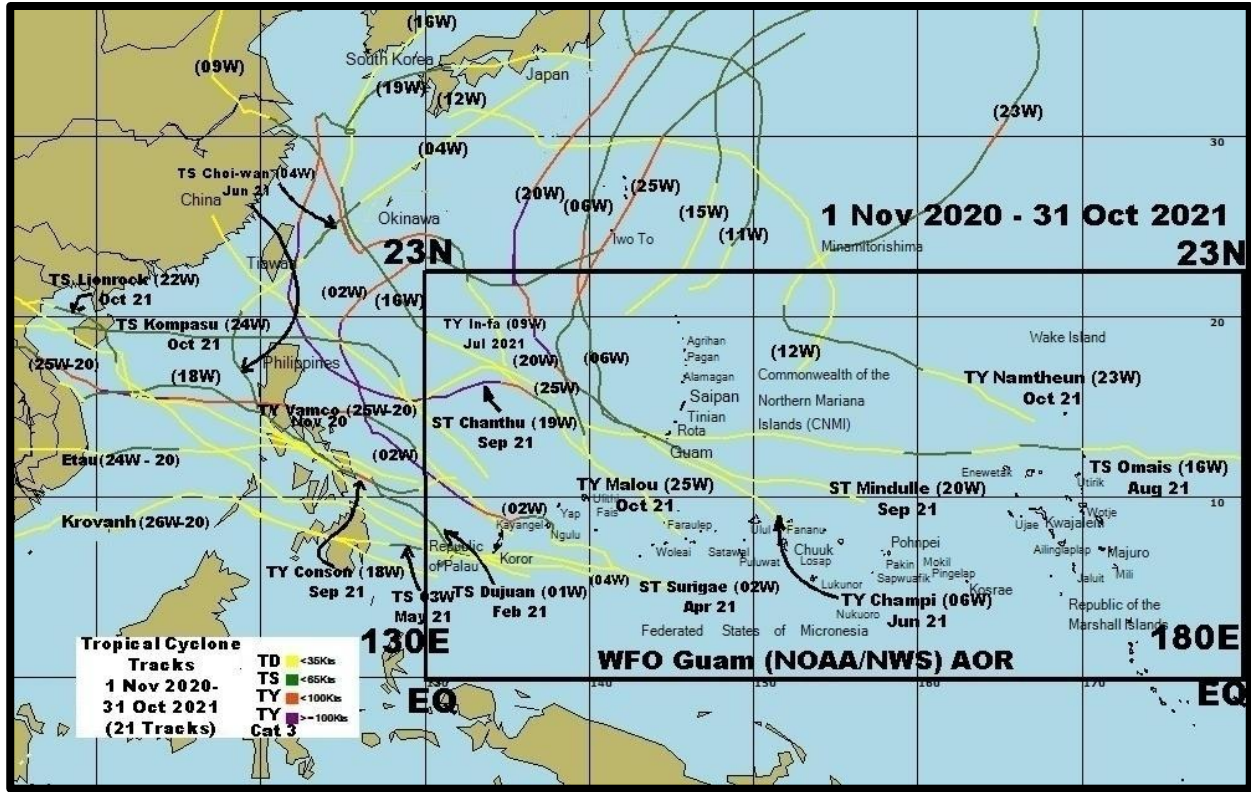


Figure 3: Western North Pacific tropical cyclones 1 November 2020 to 31 October 2021



## 2. Hydrological Assessment (highlighting water-related issues/impact)

### *Central North Pacific (140W to 180, North of the Equator) Overview*

The region experienced persistent near to below normal rainfall, which is typical for La Nina ENSO. These drier than normal conditions have largely remained in place since 2020, although some relief occurred during the spring of 2021. Many areas have seen worsening impacts including dry rangelands, wildfires, and water shortages. Severe to extreme drought remained in place across many portions of the state of Hawaii and other remote islands in the central north Pacific region in summer and fall of 2021.

### *Western North Pacific (130E to 180, north of the equator) Overview*

Several tropical systems affected the western North Pacific from 1 October 2020 to 31 October 2021. 2021 began as a La Nina, then became ENSO-neutral, then returned to a La Nina pattern. This helped to limit tropical cyclone development over the Marianas and most of Micronesia. Most of the tropical cyclones passed through the region as tropical depressions. Only a few were noteworthy.

Super Typhoon Surigae (02W) passed directly over Ngulu atoll as a tropical storm (no significant damage reported) and followed with a very moist pattern that helped produce rainfall of up to 15 inches (381 mm) on Yap Island and from 14 to 19 inches (356 to 483 mm) for some of the islands in Palau. Surigae strengthened to typhoon intensity just north of Kayangel, Palau and did quite a bit of structural and agricultural damage to the islands in Palau, especially to Kayangel. The heavy rain had considerable effect throughout Palau, producing flooding, damage to the roads, and mudslides on the higher islands.

Tropical Storm Omais (16W) formed southwest of Hawaii near 160W, briefly reaching tropical storm intensity just north of Enewetak in the Marshall Islands. This brought welcome rainfall to the island. Omais then passed just south of Guam as a depression, with little rainfall for the Marianas.

Super Typhoon Mindulle (20W) tracked primarily over the open ocean; however, it did pass through the southern Mariana Islands as a tropical storm. During this period rainfall ranged from about 5 inches (127 mm) over Saipan and Tinian and over 10 inches (254 mm) in some locations on Guam. This produced some minor flooding with only minor flood damage reported.

With rainfall below normal for the first 6 to 8 months of 2021, rainfall increased to near or a little above normal across most of Micronesia and the Marianas by the end of October. A significant amount of rainfall came from periods of strong monsoon activity, especially for the western islands, rather than the passage of tropical cyclones. This was especially true over Palau and Yap. Koror received several days of significant rainfall during the month of October, resulting in mudslides, damaged roads, and flooding. Yap saw increased rainfall as well, though not as extreme as Palau. Guam ended the month at nearly 13 inches (330 mm) above normal, setting a new record of 26.68 inches (677.7 mm) for the month of October.

### **3. Socio-Economic Assessment (highlighting socio-economic and DRR issues/impacts)**

#### ***Central North Pacific (140W to 180, North of the Equator) Overview***

Regional Specialized Meteorological Center (RSMC) Honolulu conducted dozens of tropical cyclone related outreach events, over 100 broadcast and print media interviews, and many formal emergency manager briefings. Due to the ongoing pandemic conditions before and during the season, these outreach events, interviews, and briefings were nearly all performed virtually through video conferencing.

#### ***Western North Pacific (130E to 180, north of the equator) Overview***

WFO Guam conducted formal presentations for and held meetings with territorial officials (Governors, Lt. Governors), emergency managers, military decision makers, Federal Emergency Management Agency (FEMA), the U.S. National Security Council and national leaders of the Republic of Palau (ROP). The WFO has conducted more than 100 broadcast, print media interviews and has participated in a dozen outreach events (virtual). The ongoing COVID-19 pandemic continues to limit external engagements on Guam and across the WFO Guam AOR.

Typhoon Surigae was the only tropical cyclone with significant impacts to the WFO Guam AOR. Surigae passed directly over Ngulu atoll as a tropical storm (no significant damage reported) and followed with a very moist pattern that helped produce rainfall of up to fifteen inches (381 mm) on Yap Island and from fourteen to nineteen inches (356 to 483 mm) for some of the islands in the ROP. Surigae strengthened to typhoon intensity just north of Kayangel, ROP and caused widespread structural and agricultural damage to the islands in the ROP, especially to Kayangel. The heavy rain and winds had considerable effect throughout the ROP, especially to the roads, airports and seaports with damage estimated at about \$5 million. However, there were no reported injuries or deaths.

Super Typhoon Mindulle tracked primarily over the open ocean; however, it did pass through the southern Mariana Islands as a tropical storm. During this period rainfall ranged from about 5 inches (127 mm) over Saipan and Tinian and over 10 inches (254 mm) in some locations on Guam. Wind gusts were in the low tropical storm intensity with peak gusts to 46 kt (53 mph) on an exposed ridge on Saipan, to approximately 35 kt (40 mph) on Guam; however, no significant damage was reported on any of the islands.

### **4. Regional Cooperation Assessment (highlighting regional cooperation success and challenges.**

None.

## II. Summary of Progress in Priorities supporting Key Result Areas

### 1. Weather Ready Nation Ambassador Program

#### Main text:

Striving for community resilience at a national scale is a major goal for the NOAA National Weather Service. Since embarking on the Weather-Ready Nation program and expanding it to include the Ambassador Initiative in 2014, NOAA and its partners are moving to make the country weather-resilient.

As a WRN Ambassador, partners commit to working with NOAA and other Ambassadors to strengthen national resilience against extreme weather. Throughout 2021, the WRN Ambassador initiative helped and continues to help unify the efforts across government, non-profits, academia, and private industry toward making the nation more ready, responsive, and resilient against extreme environmental hazards.

WFO Guam maintains active community engagement through its WRN program, with a focus on awareness, education, and outreach. The WRN Weather Alert Email is one of the most prominent features of the program. Designed to promote instant awareness of a developing significant weather event, the email alert is sent to WRN Ambassadors under threat of a major weather event, including decision makers, media, businesses, and the public. It is written in plain language and uses infographics to share information, then directs the reader to the formal, routine WFO Guam text bulletins and forecasts.

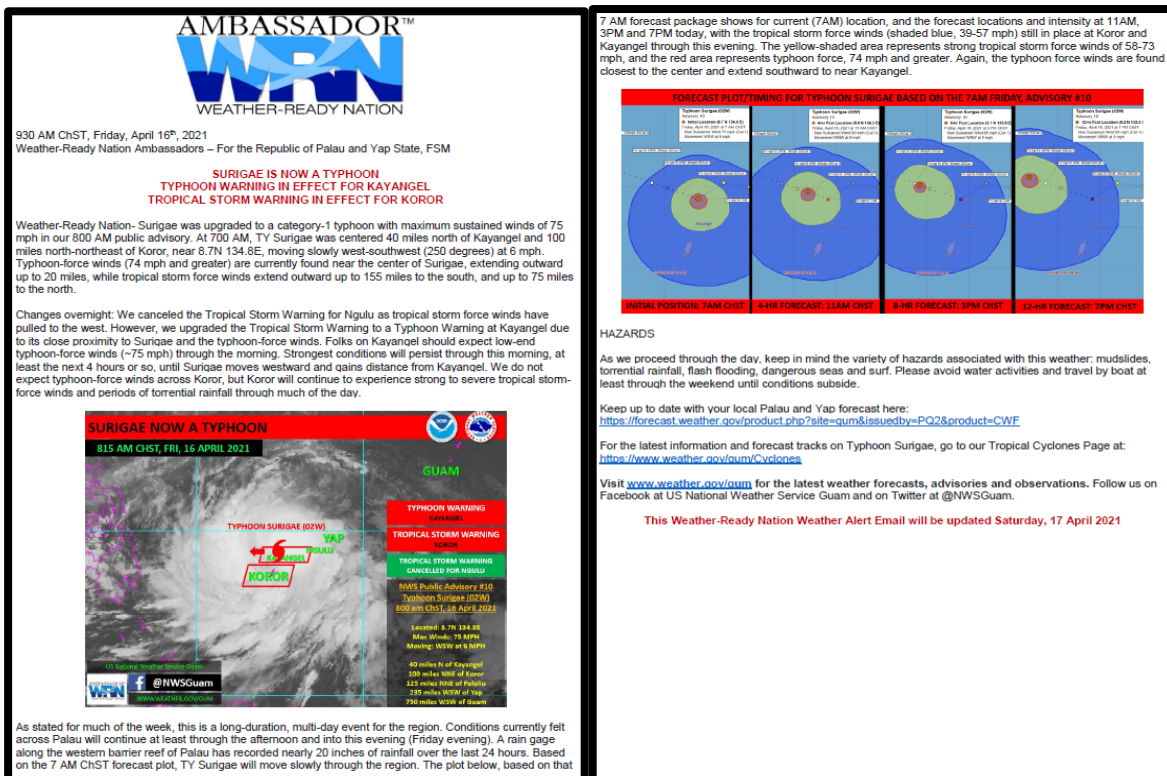


Figure 4: Email alert to WRN Ambassadors in Palau and Yap State during TY Surigae, April 2021

Numerous feedback was received from territorial and national governments in the region as well as from military partners about email alerts. Feedback was overwhelmingly positive and favorable. U.S. Ambassador Information- sharing on impacts and storm forecasts has been productive in building new partnerships and strengthening existing relationships with the U.S. State Department agencies. These email alerts have become a benchmark on these agencies’ tropical cyclone Standard Operating Procedures.

For more on the National Weather Service’s Weather-Ready Nation Ambassador Program, visit <https://www.weather.gov/wrn/>

**Identified opportunities/challenges, if any, for further development or collaboration:**

NWS will continue to use the opportunity to engage in multilateral forums and engage with partners in international agreements to help infuse the global weather enterprise with our new weather and climate information, new science, and innovative technology and seek opportunities to learn best practices from other countries to improve our technology and service delivery. We will continue to expand our partnerships to help improve and sustain observing and communications networks essential for early warnings.

**Priority Areas Addressed:**

Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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## 2. Annual Tropical Cyclone Exercises

### Main text:

Annual tropical cyclone exercises were conducted by the Government of Guam, Government of the CNMI, the Republic of Palau and the State of Hawaii with participation by NWS Offices at Honolulu and Guam and the U.S. FEMA in order to maintain a level of skill and situational awareness when dealing with tropical cyclones.

WFO Guam participated in the island-wide virtual typhoon exercises for Guam and for the CNMI in June, and for Palau in October. WFO Guam provided a simulated heavy weather briefing for the exercises on Guam and the CNMI. The Republic of Palau exercise was part of a two-day workshop, set up by the International Office of Migration (IOM), the U.S. Agency for International Development (USAID), and the WFO Guam, for the national government of Palau. Day One of the workshop was a seminar delivered by WFO Guam on forecast products, tropical cyclone warnings/watches, communications, Impact-Based Decision Support Services (IDSS) and question/answer and discussion. Day Two featured four tropical cyclone scenarios to get the national agencies to respond to and list actions taken based on the scenarios.

RSMC Honolulu participated in multiple federal, state, and local annual tropical cyclone exercises in Hawaii. The United States Coast Guard District 14 held their annual HUREX hurricane exercise 24 to 28 May 2021. In addition to the scenario graphics that RSMC Honolulu usually creates, this year they also provided simulated weather briefings during each day of the week-long exercise. The RSMC also provided a briefing/scene-setter for the Honolulu Department of Emergency Management Makani Pahili 2021 Hurricane Mobilization Timeline Rehearsal of Concepts drill on 7 June and participated in a Hawaii Port Restoration tabletop exercise on 19 April with the US Army Corps of Engineers, State of Hawaii Department of Transportation, and other NOAA offices.

### Identified opportunities/challenges, if any, for further development or collaboration:

Staff turnover at partner agencies continued at elevated levels and many key decision makers are new and lack experience. Combined with limited in-person interactions due to the pandemic, exercise participation was crucial to build those skills and relationships ahead of a real disaster.

### Priority Areas Addressed:

Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings, watches, and advisories.

Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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### 3. Tropical Cyclone Workshops

#### **Main text:**

In the western North Pacific, WFO Guam conducts annual Tropical Cyclone, Disaster Preparedness and Climate Workshops for Guam and Micronesia. These workshops are tailored for each island and designed for decision makers in the local, state, and national governments and agencies.

The Workshops cover a plethora of topics such as:

- tropical cyclone behavior, structure, and hazards.
- the WFO Guam tropical cyclone program, products, and timing of products.
- tropical cyclone plotting and speed-distance-time computations.
- typhoon risk and vulnerability; a scale that relates tropical cyclone wind speed to damage and storm surge.
- tropical cyclone decision making for individual islands and states; and
- WFO Guam website products.
- General climate, climate variability, and climate change; El Niño /La Niña and their effects, impacts and status
- Other subjects such as tsunamis and volcanoes; rip currents, currents, and tides; and earthquakes upon the request of the participants.

Plans to deliver this workshop to Guam, the CNMI and islands across Micronesia in person remain on hold as the global COVID pandemic persists and restrictions remain in place. By request of the Guam Homeland Security/Office of Civil Defense, WFO Guam delivered a virtual Tropical Cyclone and Natural Hazards Seminar to both Guam and the CNMI.

#### **Identified opportunities/challenges, if any, for further development or collaboration:**

Primary means of educating decision makers of all agencies and ensuring that the information is continually updated.

#### **Priority Areas Addressed:**

Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings, watches, and advisories.

Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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#### 4. StormReady® and TsunamiReady®



##### Main Text

StormReady® is a program designed by the National Weather Service to help communities and counties implement procedures and supplemental programs to reduce the potential for disastrous, weather-related consequences. StormReady® helps communities evaluate their current levels of preparedness for and response to extreme weather-related events. These communities demonstrate a strong commitment to saving lives and protecting property when hazardous weather strikes. By participating in StormReady®, local agencies can earn recognition for their jurisdiction by meeting guidelines established by the NWS in partnership with federal, state, and local emergency management professionals. TsunamiReady® is a similar program that expands preparedness and response of coastal communities to tsunami threats. After the initial recognition, communities can reapply every 4 years.

WFO Guam is part of a small team in the NWS tasked with examining external engagements with core partners and decision makers. Revamping and modernizing the StormReady® application and program is a primary focus of the group as it looks at relationships and communications with partners.

RSMC Honolulu assisted the needs of the 17 StormReady and TsunamiReady communities across the State of Hawaii in 2021, including the recognition of three new communities. This included ensuring each community had disaster action plans in place and held outreach events to convey a preparedness message.

##### Identified opportunities/challenges, if any, for further development or collaboration:

As of 1 November 2021, there were 3,093 StormReady® and/or TsunamiReady® communities in the United States. All of the locations in the Pacific Region, including WFO Guam and RSMC Honolulu AOR are both StormReady® and TsunamiReady®.

##### Priority Areas Addressed:

Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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## 5. Outreach and Education Activities

**Main text:** Numerous outreach and education activities conducted in 2021 include:

*Expanded Pacific Hydrology Discussions.* Both WFO Guam and RSMC Honolulu provide input into the Climate Prediction Center's Monthly *ENSO Diagnostics Discussion* and employ the use of more comprehensive and targeted products--the *Hydrologic Outlook* product for extreme rainfall events and the *Drought Information Statement* for drought events.

*RSMC Press Conference.* RSMC Honolulu hosted a press conference with high-ranking government officials to announce the 2021 Central Pacific Hurricane Season Outlook on 19 May.

*RSMC Honolulu media interfaces.* RSMC Honolulu conducted several media interviews in preparation for hurricane season as well as event-specific interviews and briefings as tropical cyclones remnants impacted the Hawaiian Islands.

*World Meteorological Day.* WFO Guam celebrated this day, 23 March, to commemorate the creation of the World Meteorological Organization. WFO Guam marked the occasion by participating in a Proclamation Signing with the Governor of Guam and officials from the Guam Homeland Security/Office of Civil Defense (GHS/OCD), and from the Commonwealth of the Northern Mariana Islands Homeland Security and Emergency Management (CNMI HSEM). Virtual and onsite guests included staff from the Weather Service Offices in Palau, the Federated States of Micronesia (FSM) and the Marshall Islands, as well as the U.S. Ambassador to the FSM.

*Regional Climate Conference.* WFO Guam sought to establish a virtual forum to bring weather officials, emergency managers and decision makers together from across the region into one setting to discuss weather, climate and research all geared on the western North Pacific. Due to the ongoing COVID-19 pandemic, WFO Guam staff remain unable to travel to the islands within its AOR. This conference set out to bring people together and meet virtually, until travel is possible again. WFO Guam also presented its first coordinated tropical cyclone seasonal outlook for U.S. Affiliated Pacific Islands; a joint effort between WFO Guam, NWS Pacific Region, the University of Guam, and the Climate Prediction Center.

*Weather spotter training.* Having not been able to hold an in-person Skywarn storm spotter training courses due to the pandemic, RSMC Honolulu hosted a virtual spotter-training course on 20 May, which had 133 attendees.

*National Disaster Preparedness Month.* September 2021 was declared National Preparedness Month in the USA. On Guam, staff from the WFO Guam participated in several virtual school visits, touring the operations facility, and discussing weather hazards and preparedness.

*University Course Enhancement.* WFO Guam hosted University of Guam Physical Geography classes via Zoom to provide facility tours and seminars on tropical cyclones, ENSO, and

Climate Change. This provided education to nearly 100 students majoring in such topics as nursing, education, criminal justice, and biological sciences. RSMC Honolulu hosts twice weekly weather discussions involving students and professors at the University of Hawaii (UH) Department of Meteorology, which engages the students in operational weather application focusing on societal impacts. At least two forecast personnel and management have been invited as guest instructors at university classes at UH and Leeward Community College.

**Identified opportunities/challenges, if any, for further development or collaboration:**

Outreach events are fundamental in training the general population in disaster preparedness that eventually leads to a more resilient population.

**Priority Areas Addressed:**

Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

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## 6. Pacific International Training Desk

### Main text:

The Pacific International Training Desk (PITD) was established on the campus of the University of Hawaii at Manoa in 2001 by the US NOAA/NWS at the WFO Honolulu. It is one of NOAA's contributions to the WMO Voluntary Cooperation Program (VCP). The Pacific Desk began by offering two-month training internships to visiting students from the Regional Association V (RA V) of the WMO in March 2001 and later expanded the training opportunity briefly to developing countries from WMO RA II nations in east and Southeast Asia, who were also members of the ESCAP/WMO Typhoon Committee. Up until 2016, all the PITD training were conducted at the RSMC Honolulu. In 2016, the PITD training reached out to include the Weather Service Offices in Micronesia and was conducted at the WFO Guam. In 2021, the Honolulu training continued in a virtual capacity due to the ongoing global pandemic. This year there was one virtual cadre, which had 13 students from various island nations. In addition, the PITD hosted six open webinars on diverse topics, with attendees from the Pacific Island Nations.

Webinar topics included:

- Inundation Forecasts for Low-Lying Pacific Islands
- Marine Forecasting: Wave Modeling
- Communicating the Weather: Weather Ready Nation, social media, and Disaster
- Aviation Weather: A pilot's perspective
- Aviation Weather: An aviation focal point's perspective
- Impacts of climate variability and change on productive Pacific fisheries

### Identified opportunities/challenges, if any, for further development or collaboration:

The open webinars allow students from the Micronesia Weather Service Offices and from other Pacific Island Nations Meteorological Services to continue their development in the field of Meteorology, Hydrology and Disaster Preparedness. It also offers an insight into other Pacific Island nations' Meteorological services and their operations.

### Priority Areas Addressed:

Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings.

Enhance Typhoon Committee's Regional and International collaboration mechanism.

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## 7. Resource Mobilization during Extreme Events

### Main text:

RSMC Honolulu conducted several Emergency Management Briefings during the 2021 hurricane season through video conferencing. These briefings included personnel at Emergency Operations Centers from the State level to the local level with the State Governor and County Mayors participating at times.

WFO Guam provided numerous virtual decision support services by way of Heavy Weather Briefs to the GHS/OCD, CNMI HSEM, and to the governors of both Guam and the CNMI prior to and during the passage of multiple tropical cyclones in 2021. Normally provided onsite, these briefs were delivered virtually due to the ongoing COVID-19 pandemic. WFO Guam's Warning Coordination Meteorologist consulted with both agency's Joint Information Centers to provide explanation and clarity in government press releases. These particular heavy weather briefings are primarily catered for the island leadership and military decision makers on potential tropical cyclone threats. WFO Guam also provided similar support to the U.S. Embassy in the Republic of Palau and the Weather Service Office in Koror, during the passage of Typhoon Surigae.

### Identified opportunities/challenges, if any, for further development or collaboration:

Impact-based decision support services are made available to local decision makers especially in locations that lack meteorological support and knowledge. Social media platforms have made these interagency interactions possible and allowed the sharing of information. NWS continues to look for ways to optimize our use of these tools.

### Priority Areas Addressed:

Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings.

Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.

Enhance Typhoon Committee's Regional and International collaboration mechanism.

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## 8. Improved Typhoon-related Disaster Risk Management in Various Sectors

### **Main text:**

*Tropical Weather Outlook graphic.* During the tropical cyclone season, RSMC Honolulu prepares and transmits both a text and a graphical *Tropical Weather Outlook* that illustrates the probability of tropical cyclone development in the next 48 hours and 5 days, respectively.

*Time of Arrival graphics.* When there is an active tropical cyclone in the AOR, RSMC Honolulu issues graphical products for both "Most Likely Time of Arrival" and "Earliest Reasonable Time of Arrival" to assist government officials and the public in their critical decision-making process as they prepare for potential weather impacts. A time of departure graphic is also being developed for experimental use in future seasons.

*IDSS Impact Measurements Initiative Team.* The WFO Guam Warning Coordination Meteorologist served as the Pacific Region representative on this team in the National Weather Service. The team was tasked with developing and evaluating a set of internal and external performance measures to assess NWS Impact-Based Decision Support Services (IDSS). Team goals were to determine the agency's readiness and capability of delivering IDSS and how our agency was doing at delivering IDSS. The team utilized two surveys to meet these goals: an event-based survey to be distributed to core partners/agencies immediately following an event requiring decision support services, and an annual review survey, to consider decision support services offered by the WFO throughout the year.

*Hawaii Emergency Preparedness Executive Consortium (HEPEC).* RSMC Honolulu is a member of the Hawaii Emergency Preparedness Executive Consortium (HEPEC). HEPEC is comprised of emergency managers and disaster mitigation personnel from local, state, and federal agencies. HEPEC meets quarterly to provide updates on current and outstanding threats, both natural and manmade, to the State of Hawaii. RSMC Honolulu Personnel provided several hurricane presentations to this group during the Feb 2021 and August 2021 meetings. A hurricane season wrap presentation was expected to be given at the November 2021 meeting.

*Software improvements for Emergency Managers.* Hurrevac or HVX (an online application for emergency managers to gather critical hurricane forecast information) improvements were implemented in 2021, including additional information from storm surge modeling in Hawaii.

### **Priority Areas Addressed:**

Enhance capacity to generate and provide accurate, timely and understandable information using multi-hazard impact-based forecasts and risk-based warnings.

Strengthen typhoon-related disaster risk reduction activities in various sectors, including increased community-based resiliency with better response, communication, and information sharing capability.



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## 9. Technological Improvements

### Main text:

GOES-17 and Himawari-8 Geostationary Satellite. RSMC Honolulu and WFO Guam have been utilizing imagery from JMA's Himawari-8 Advanced Himawari Imager (AHI) and high temporal resolution target area requests in operational forecasting. RSMC Honolulu is utilizing imagery from NOAA NESDIS's GOES-17 Advanced Baseline Imager (ABI) including high temporal resolution mesoscale sectors. In addition, forecasters have access to data from many polar orbiting satellites. Both the Suomi NPP (SNPP) and the Joint Polar Satellite System (JPSS-1) are onboarded with the Visible Infrared Imaging Radiometer Suite (VIIRS) which utilizes moonlight reflection to produce nighttime imagery similar to daytime visible imagery. This has been critical to locating tropical cyclone centers, particularly at night. Microwave information from sensors like AMSR2 (Advanced Microwave Scanning Radiometer-2) onboard JAXA's GCOM is also critical for assessing tropical cyclone structure such as the eyewall and rain bands.

*Continued evaluation and application of ocean surface wind vector scatterometer instruments (ASCAT A, B and C, CFOSAT, HY-2B and 2C scat) and high-resolution SAR data.* CFOSAT and HY-2B/2C scat data plus the two remaining ASCAT instruments (ASCAT A activity ended on November 15, 2021) are made available in near real-time to the operational forecasters by the European Space Agency (ESA), NOAA/NESDIS and the US Naval Research Laboratory (NRL). During the past two years, newly available high-resolution Synthetic Aperture Radar (SAR) data (C-band) have become available in near real time from the Sentinel-1 and Radarsat satellites. The SAR data plus data from two failed land moisture experiments, SMAP (Soil Moisture Active Passive) and SMOS (Soil Moisture and Ocean Salinity) (both L-band), both of which incredibly have a remaining working sensor that has the ability of measuring winds in excess of 50 m/s (~100 kt) over the ocean surface, are being used to capture the most intense winds near the center of the tropical cyclone. These winds are normally above the ability of the scatterometer sensors to easily capture and are helping to verify intense tropical cyclones that are only previously estimated through the Dvorak intensity technique and where aircraft reconnaissance is not available.

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