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Operations and Services

Tropical Cyclone Weather Services Program, NWSPD 10-6

TROPICAL CYCLONE DEFINITIONS

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SUMMARY OF REVISIONS: This directive supersedes NWS Instruction 10-604 dated June 1, 2007. The following revisions were made to this manual:

Revision of the definitions of:

- Tropical Storm Watch
- Tropical Storm Warning
- Hurricane Watch
- Hurricane Warning
- Typhoon Watch

Added definition of a typhoon

Signed by David B. Caldwell May 22, 2008

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Date

Director, Office of Climate,
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DEFINITIONS

Dissipated. Used when the circulation is no longer closed.

Dissipating. Used for weakening tropical depressions which contain minimal and diminishing deep convection with no expectation for recovery.

Extratropical Cyclone. A synoptic scale low pressure system whose primary energy source is baroclinic.

Eye Wall. An organized band of cumulonimbus clouds immediately surrounding the center of the tropical cyclone.

Gale Warning. A warning of 1-minute sustained surface winds in the range 34 knots (39 mph) to 47 knots (54 mph) inclusive, either predicted or occurring not directly associated with tropical cyclones.

High Wind Warning. The high winds described here exclude those directly associated with severe local storms. A high wind warning is required when either of the following occur or are expected to occur in the near term:

- Sustained surface wind speeds (1-minute average) of 35 knots (40 mph) or greater lasting for 1 hour or longer, or
- Sustained winds or gusts of 50 knots (58 mph) or greater for any duration.

Hurricane. A tropical cyclone in which the maximum 1-minute sustained surface wind is 64 knots (74 mph) or greater.

Hurricane/Typhoon Eye. The relatively calm center of the tropical cyclone which is more than half surrounded by an eye wall.

Hurricane/Typhoon Season. The part of the year having a relatively high incidence of tropical cyclones. In the Atlantic, Caribbean, and Gulf of Mexico, and central North Pacific, the hurricane season is the period from June through November; in the eastern Pacific, May 15 through November 30. In the western North Pacific, the typhoon season is from July 1 to December 15. Tropical cyclones can occur year-round in any basin.

Hurricane/Typhoon Warning. An announcement that sustained winds of 64 knots (74 mph or 119 km/hr) or higher are expected within the specified coastal area within 24 hours. A hurricane or typhoon warning can remain in effect when dangerously high water or a combination of dangerously high water and exceptionally high waves continue even though winds may be less than hurricane or typhoon force.

Hurricane/Typhoon Watch. An announcement that sustained winds of 64 knots (74 mph or 119 km/hr) or higher are possible within the specified coastal area within 36 hours except for the western North Pacific, where typhoon conditions may occur within 48 hours.

Major Hurricane. A hurricane which reaches Category 3 (sustained winds greater than 110 mph) on the Saffir/Simpson Hurricane Scale.

Maximum Sustained Surface Wind. When applied to a particular weather system, refers to the highest one-minute average wind (at an elevation of 10 meters with an unobstructed exposure) associated with that weather system at a particular point in time.

Mean Sea Level (MSL). The arithmetic mean of hourly water elevations observed over a specific 19-year tidal epoch.

Mean Low Water (MLW). The arithmetic mean of the low water heights observed over a specific 19-year tidal epoch.

Mean Lower Low Water (MLLW). The arithmetic mean of the lower low water heights of a mixed tide observed over a specific 19-year tidal epoch. Only the lower low water of each pair of low waters, or the only low water of a tidal day is included in the mean.

National Hurricane Operations Plan (NHOP). The NHOP is issued annually by the Federal Coordinator for Meteorological Services and Supporting Research. It documents interdepartmental agreements relating to tropical cyclone observing, warning, and forecasting services. National Hurricane Center (NHC), Central Pacific Hurricane Center (CPHC), and the JTWC serve as the principal offices in coordinating the day-to-day activities of the NWS in support of the Plan in their region of responsibility.

Remnant Low. Used for systems no longer having sufficient convective organization required of a tropical cyclone (e.g., the swirls of stratocumulus in the eastern North Pacific)

Saffir/Simpson Hurricane Scale (SSHS) – (for use in Atlantic and North East Pacific basins.) A scale on a 1-5 rating based on the hurricane's present intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline, in the landfall region. Note all winds are using the U.S. 1-minute average. This scale may be used in public hurricane releases although the SSHS may not be applicable for all geographical areas.

This scale can be used in public hurricane releases and in discussions with the media to describe the hurricane's present intensity. It must be clear it is not appropriate to estimate damage or surge/coastal flood potential. In practice, sustained wind speed (the 1-minute averaged wind at the 10-meter elevation with an unobstructed exposure) is the parameter which determines the category.

ONE. Winds 74-95 mph. (64-82 kts.) No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage.

TWO. Winds 96-110 mph. (83-95 kts.) Some roofing material, door, and window

damage of buildings. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected anchorages break moorings.

- THREE. Winds 111-130 mph. (96-113 kts.) Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well inland.
- FOUR. Winds 131-155 mph. (114-135 kts.) More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.
- FIVE. Winds greater than 155 mph. (greater than 135 kts.) Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.

Note: A “major” hurricane is one classified as a Category 3 or higher.

Modified Saffir/Simpson Hurricane Scale (SSHS) for the Western North Pacific.

For Tropical Depression and Tropical Storm:

Maximum sustained Wind (MSW): 30-49 mph (26-43 kt) and peak gusts 40-64 mph (33-56 kt)

Typical Damage - Damage done to only the flimsiest lean-to type structures. Unsecured light signs blown down. Minor damage to banana trees and near-coastal agriculture, primarily from salt spray. Some small dead limbs, ripe coconuts, and dead palm fronds blown down from trees. Some fragile and tender green leaves blown from trees such as papaya and fleshy broad leaf plants.

Coastal Inundation and Wave Action - On windward coasts, sea level rise of less than 2 feet (0.7 m) above normal in open bays and inlets due to storm surge and wind driven waves; breaking waves inside bays can reach 2-3 feet (0.7 - 1.0 m); less than 1 ft (0.3 m) over reefs. Rough surf at reef margin with moderately strong along-shore currents (rip currents) inside reefs.

MSW: 50 - 73 mph (44-63 kt) and peak gusts 65-94 mph (57-81 kt)

Typical Damage - Minor damage to buildings of light material; major damage to huts made of thatch or loosely attached corrugated sheet metal or plywood. Unattached corrugated sheet metal and plywood may become airborne. Wooden

signs not supported with guy wires are blown down. Moderate damage to banana trees, papaya trees, and most fleshy crops. Large dead limbs, ripe coconuts, many dead palm fronds, some green leaves, and small branches are blown from trees.

Coastal Inundation and Wave Action - On windward coasts, sea level rise of 2-4 ft (0.7-1.2 m) above normal in open bays and inlets due to storm surge and wind-driven waves; breaking waves inside bays can reach 4-6 ft (1.2-1.8 m); 1-2 ft (0.3-0.7 m) over reefs. Very rough surf at reef margin with strong along-shore currents (rip currents) inside reefs.

For Typhoon:

MSW: 74-95 mph (64-82 kt) and peak gusts 95-120 mph (82-105 kt)

Typical Damage - Corrugated metal and plywood stripped from poorly constructed or termite-infested structures and may become airborne. A few wooden, non-reinforced power poles tilted, and some rotten power poles broken and their attached lines down. Some damage to poorly constructed, loosely attached signs. Major damage to banana trees, papaya trees, and fleshy crops. Some young trees downed when the ground is saturated. Some palm fronds crimped and bent back through the crown of coconut palms; a few palm fronds torn from the crowns of most types of palm trees; many ripe coconuts blown from coconut palms. Less than 10 percent defoliation of shrubbery and trees; up to 10 percent defoliation of tangantangan. Some small tree limbs downed, especially from large bushy and frail trees such as mango, African tulip, poinciana, etc. Overall damage can be classified as minimal.

Coastal Inundation and Wave Action - On windward coasts, sea level rise of 4-6 ft (1.2-1.8 m) above normal in open bays and inlets due to storm surge and wind-driven waves; breaking waves inside bays can reach 5-7 ft (1.5-2.1 m) above normal; 2-3 ft (0.6-1.0 m) additional water across reef. Wind-driven waves may inundate low-lying coastal roads where reefs are narrow. Minor pier damage. Some small craft in exposed anchorages break moorings.

MSW: 96-110 mph (83-95 kt) and peak gusts 121-139 mph (106-121 kt)

Typical Damage - Several rotten wooden power poles snapped and many non-reinforced wooden power poles tilted. Some secondary power lines downed. Damage to wooden and tin roofs, and doors and windows of termite-infested or rotted wooden structures, but no major damage to well-constructed wooden, sheet metal, or concrete buildings. Considerable damage to structures made of light materials. Major damage to poorly constructed, attached signs. Exposed banana trees and papaya trees totally destroyed; 10-20 percent defoliation of trees and shrubbery; up to 30 percent defoliation of tangantangan. Light damage to sugar cane and bamboo. Many palm fronds crimped and bent through the crown of coconut palms and several green fronds ripped from palm trees. Some green

coconuts blown from trees. Some trees blown down, especially shallow rooted ones such as small acacia, mango and breadfruit when the ground becomes saturated. Overall damage can be classified as moderate.

Coastal Inundation and Wave Action - On windward coasts, sea level rise of 6-8 ft (1.8-2.4 m) above normal in open bays and inlets due to storm surge and wind-driven waves; breaking waves inside bays can reach 7-9 ft (2.1-2.7 m) above normal; water is about 3-5 ft (1.0-1.5 m) above normal across reef flats. Wind-driven waves will inundate low-lying coastal roads below 4 ft (1.2 m) on windward locations where reefs are narrow. Some erosion of beach areas, some moderate pier damage, and some large boats torn from moorings.

MSW: 111-130 mph (96-113 kt) and peak gusts 140-165 mph (122-144 kt)

Typical damage - A few non-reinforced hollow-spun concrete power poles broken or tilted and many non reinforced wooden power poles broken or blown down; many secondary power lines downed. Practically all poorly constructed signs blown down and some stand-alone steel-framed signs bent over. Some roof, window, and door damage to well-built, wooden and metal residences and utility buildings. Extensive damage to wooden structures weakened by termite infestation, wet-and-dry wood rot, and corroded roof straps (hurricane clips). Non-reinforced cinder block walls blown down. Many mobile homes and buildings made of light materials destroyed. Some glass failure due to flying debris, but only minimal glass failure due to pressure forces associated with extreme gusts. Some unsecured construction cranes blown down. Air is full of light projectiles and debris. Major damage to shrubbery and trees; up to 50 percent of palm fronds bent or blown off; numerous ripe and many green coconuts blown off coconut palms; crowns blown off of a few palm trees. Moderate damage to sugar cane and bamboo. Some large trees (palm trees), blown down when the ground becomes saturated; 30-50 percent defoliation of most trees and shrubs; up to 70 percent defoliation of tangantangan. Some very exposed panax, tangantangan, and oleander bent over. Overall damage can be classified as extensive.

Coastal Inundation and Wave Action - On windward coasts, sea level rise of 8-12 ft (2.4-3.7 m) above normal in open bays and inlets due to storm surge and wind-driven waves; breaking waves inside bays can reach 11-14 ft (3.3-4.2 m) above normal; water is about 5-8 ft (1.5-2.4 m) above normal across reef flats. Wind-driven waves will inundate low-lying coastal roads below 7 ft (2.1 m) of elevation on windward locations where reefs are narrow. Considerable beach erosion. Many large boats and some large ships torn from moorings.

MSW: 131-155 mph (114-135 kt) and peak gusts 166-197 mph (145-171 kt)

Typical Damage - Some reinforced hollow-spun concrete and many reinforced wooden power poles blown down; numerous secondary and a few primary power

lines downed. Extensive damage to non-concrete roofs; complete failure of many roof structures, window frames and doors, especially unprotected, non-reinforced ones; many well-built wooden and metal structures severely damaged or destroyed. Considerable glass failures due to flying debris and explosive pressure forces created by extreme wind gusts. Weakly reinforced cinder block walls blown down. Complete disintegration of mobile homes and other structures of lighter materials.

Most small and medium-sized steel-framed signs bent over or blown down. Some secured construction cranes and gantry cranes blown down. Some fuel storage tanks may rupture. Air is full of large projectiles and debris. Shrubs and trees 50-90 percent defoliated; up to 100 percent of tangantangan defoliated. Up to 75 percent of palm fronds bent, twisted, or blown off; many crowns stripped from palm trees. Numerous green and virtually all ripe coconuts blown from trees. Severe damage to sugar cane and bamboo. Many large trees blown down (palms, breadfruit, monkeypod, mango, acacia, and Australian pine.) Considerable bark and some pulp removed from trees; most standing trees are void of all but the largest branches (severely pruned), with remaining branches stubby in appearance; numerous trunks and branches are sandblasted. Patches of panax, tangantangan, and oleander bent over or flattened. Overall damage can be classified as extreme.

Coastal Inundation and Wave Action - On windward coasts, sea level rise of 12-18 ft (3.7-5.5 m) above normal in open bays and inlets due to storm surge and wind-driven waves; breaking waves inside bays can reach 15-24 ft (4.5-7.3 m) above normal; water is about 8-12 ft (2.4-3.7 m) above normal across reef flats. Wind-driven waves will inundate coastal areas below 12 ft (3.7 m) elevation. Large boulders carried inland with waves. Severe beach erosion. Severe damage to port facilities including some loading derricks and gantry cranes. Most ships torn from moorings.

MSW: 156-194 mph (136-170 kt) and peak gusts 198-246 mph (172-216 kt)

Typical Damage - Severe damage to some solid concrete power poles, to numerous reinforced hollow-spun concrete power poles, to many steel towers, and to virtually all wooden poles; all secondary power lines and most primary power lines downed. Total failure of non-concrete reinforced roofs. Extensive or total destruction to non-concrete residences and industrial buildings. Some structural damage to concrete structures, especially from large debris, such as cars, large appliances, etc. Extensive glass failure due to impact of flying debris and explosive pressure forces during extreme gusts. Many well-constructed storm shutters ripped from structures. Some fuel storage tanks rupture. Nearly all construction cranes blown down. Air full of very large and heavy projectiles and debris. Shrubs and trees up to 100 percent defoliated; numerous large trees blown down. Up to 100 percent of palm fronds bent, twisted, or blown off; numerous crowns blown from palm trees; virtually all coconuts blown from trees. Most

bark and considerable pulp removed from trees. Most standing trees are void of all but the largest branches, which are very stubby in appearance and severely sandblasted. Overall damage can be classified as catastrophic.

Coastal Inundation and Wave Action - On windward coasts, sea level rise of 18 to 30 + ft (5.5 - 9.2 + m) above normal in open bays and inlets due to storm surge and wind-driven waves; breaking waves inside bays can be >30 ft (9.2 m) above normal; water is about 12-20 + ft (3.7-6.1 + m) above normal across reef flats. Serious inundation likely for windward coastal areas below 18 ft (5.5 m) elevation. Very large boulders carried inland with waves. Extensive beach erosion. Extensive damage to port facilities including most loading derricks and gantry cranes. Virtually all ships, regardless of size, torn from moorings.

Short Term Forecast (NOW). Issued by WFOs at frequent intervals, these products give the short-term status of events and short-term forecasts. When issued every hour or so during active weather, they are effective in conveying timely and sometimes vital information about a potential or existing hazard.

Storm Surge. An abnormal rise in sea level accompanying a tropical cyclone or other intense storm and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the storm. Storm surge is usually estimated by subtracting the normal or astronomical tide from the observed storm tide.

Storm Tide. The actual sea level resulting from the astronomical tide combined with the storm surge.

Storm Warning. A warning of 1-minute sustained surface winds of 48 knots (55 mph) or greater, either predicted or occurring, not directly associated with tropical cyclones.

Subtropical Cyclone. A non-frontal low pressure system that has characteristics of both tropical and extratropical cyclones. This system is typically an upper-level cold low with circulation extending to the surface layer and maximum sustained winds generally occurring at a radius of about 100 miles or more from the center. In comparison to tropical cyclones, such systems have a relatively broad zone of maximum winds that is located farther from the center, and typically have a less symmetric wind field and distribution of convection.

Subtropical Depression. A subtropical cyclone in which the maximum 1-minute sustained surface wind is 33 knots (38 mph) or less.

Subtropical Storm. A subtropical cyclone in which the maximum 1-minute sustained surface wind is 34 knots (39 mph) or more.

Super Typhoon. Typhoon having maximum sustained winds of 130 knots (150 mph) or greater.

Tropical Cyclone. A warm-core, non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters with organized deep convection and a closed surface wind circulation about a well-defined center.

Tropical Depression. A tropical cyclone in which the maximum 1-minute sustained surface wind is 33 knots (38 mph) or less.

Tropical Disturbance. A discrete tropical weather system of apparently organized convection--generally 100 to 300 mi in diameter--originating in the tropics or subtropics, having a nonfrontal migratory character and maintaining its identity for 24 hours or more. It may or may not be associated with a detectable perturbation of the wind field.

Tropical Storm. A tropical cyclone in which the maximum 1-minute sustained surface wind ranges from 34 to 63 knots (39 to 73 mph) inclusive.

Tropical Storm Warning. An announcement that sustained winds of 34 to 63 knots (39 to 73 mph or 63 to 118 km/hr) are expected within the specified coastal area within 24 hours.

Tropical Storm Watch. An announcement that sustained winds of 34 to 63 knots (39 to 73 mph or 63 to 118 km/hr) are possible within the specified coastal area within 36 hours except for the western North Pacific, where tropical storm conditions may occur within 48 hours.

Tropical Storm/Hurricane Wind Watch or Warning. Issued when a tropical cyclone is expected to remain at tropical storm or hurricane intensity inland.

Tropical Wave (formerly known as inverted trough). A trough or cyclonic curvature maximum in the trade wind easterlies. The wave may reach maximum amplitude in the lower middle troposphere or may be the reflection of an upper tropospheric cold low or an equatorward extension of a mid-latitude trough.

Typhoon. A tropical cyclone in which the maximum 1-minute sustained surface wind is 64 knots (74 mph) or greater which forms in the northwestern Pacific Ocean.

Wind Radii. Found in the forecast advisory/products, wind radii is the largest radii of that wind speed found in that quadrant. Quadrants are defined as NE (0-90), SE (90-180), SW (180-270), and NW (270-0). As an example, given maximum 34 knot radii to 150 nm at 0 degrees, 90 at 120 degrees, and 40 nm at 260 degrees, the following line would be carried in the forecast/advisory: 150NE 90SE 40SW 150NW.