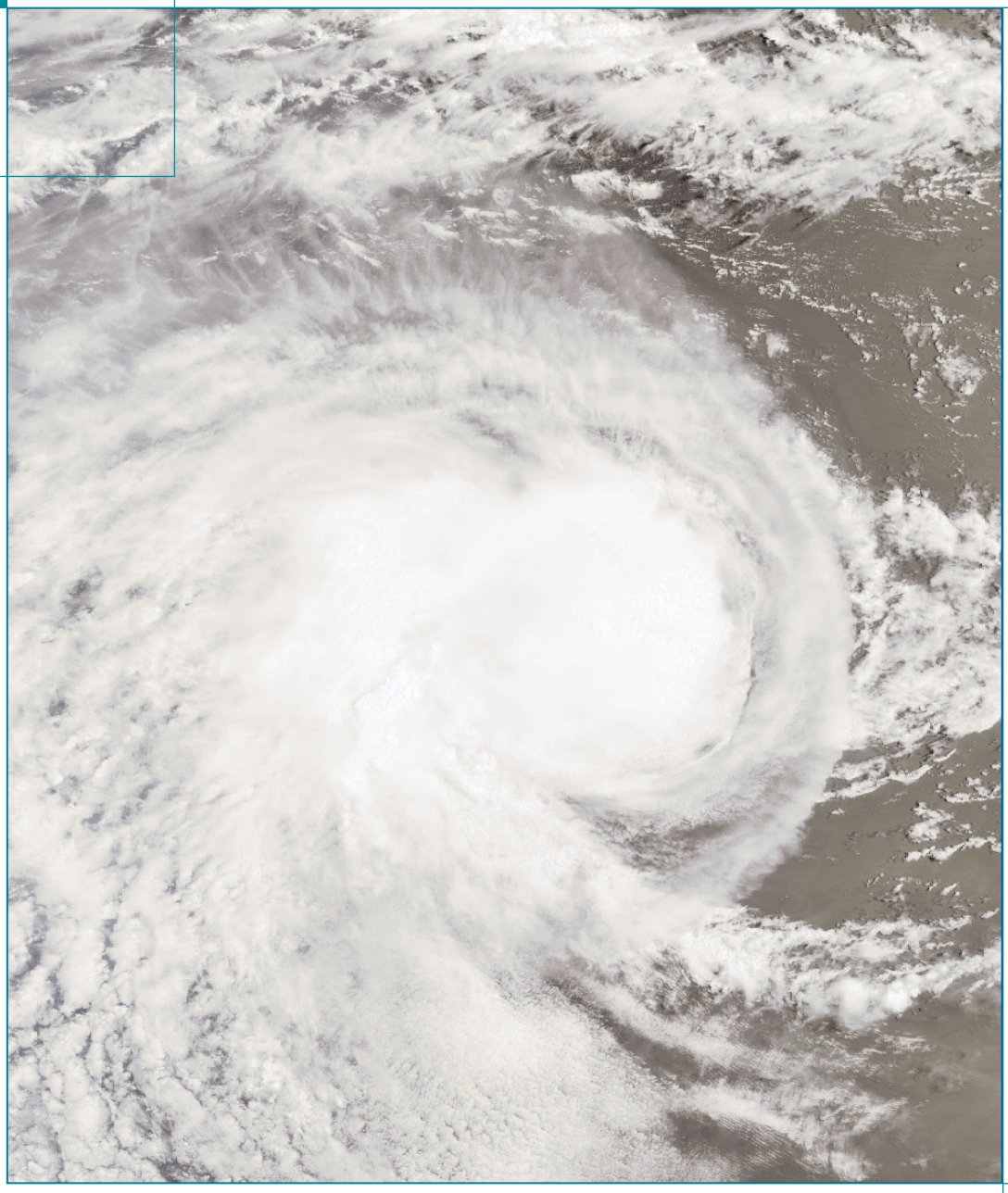
09

TWO THOUSAND NINE

2008 Tropical Cyclone Review



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Executive Summary

The 2008 Tropical Cyclone Review summarises last year's global tropical cyclone activity and the impact of the more significant cyclones after landfall. Tropical cyclone activity is reviewed by oceanic basin, covering those that developed in the North Atlantic, Northwest Pacific, Northeast Pacific, North Indian Ocean and Australia. This report includes estimates of the economic and insured losses sustained from each cyclone (where possible). Predictions of tropical cyclone activity for the 2009 season are given per oceanic basin when permitted by available data.

In the North Atlantic, 16 tropical storms formed during the 2008 season, compared to the 1950 to 2007 average of 9.7,[1] an increase of 65 percent. The season also witnessed the first tropical cyclone ever to make four landfalls in one state (i.e., Hurricane Fay, impacting Florida). Hurricane Ike was dramatically larger than the modelling firms had expected in their event sets, and the discrepancy generated vastly different loss estimates that have yet to be resolved. Early indications for 2009 suggest another above-average tropical cyclone year.

1 WSI Corporation - http://www.wsi.com/corporate/news/default.asp

2 North Atlantic Basin

The 2008 Atlantic tropical cyclone season displayed an above-average level of activity, producing a total of 16 named tropical cyclones, of which eight were hurricanes. Five became major hurricanes (i.e., Category 3 strength or higher on the Saffir-Simpson scale). The 2008 hurricane season was the fourth most severe since reliable records have been available. For the first time on record, six consecutive tropical cyclones (Dolly, Edouard, Fay, Gustav, Hanna, and Ike) made landfall on the US mainland, and a record three major hurricanes (Gustav, Ike, and Paloma) struck Cuba. It was also the first Atlantic season to have a major hurricane form in five consecutive months (July: Bertha, August: Gustav, September: Ike, October: Omar, and November: Paloma).

Summary of 2008 North Atlantic Basin Tropical Cyclones

#	Name	Dates Sustained Wind (knots)	Max	Cat (Max)	Country of Landfall and Category at Landfall	Economic Loss (US$)	Insured Loss (US$)
1	Tropical Storm Arthur	31 May-1 June	35	TS	Belize (TS)	-	-
2	Hurricane Bertha	3 Jul-20 Jul	105	3	-	-	-
3	Tropical Storm Cristobal	19 Jul-23 Jul	55	TS	-	-	-
4	Hurricane Dolly	20 Jul-24 Jul	85	2	United States (2)	-	525m
5	Tropical Storm Edouard	3 Aug-5 Aug	55	TS	United States (TS)	-	-
6	Tropical Storm Fay	15 Aug-24 Aug	55	TS	Cuba (TS) United States (TS)	-	245m
7	Hurricane Gustav	25 Aug-2 Sep	130	4	Haiti (1), Jamaica (TS), United States (2), Cuba (4)	10bn	4bn
8	Hurricane Hanna	28 Aug-7 Sep	70	1	United States (TS)	-	80m
9	Hurricane Ike	1 Sep-14 Sep	125	4	Turks & Caicos Islands (4), Cuba (3), United States (2)	30bn	20bn
10	Tropical Storm Josephine	2 Sep-5 Sep	55	TS	-	-	-
11	Hurricane Kyle	25 Sep-29 Sep	70	1	Canada (1)	-	-
12	Tropical Storm Laura	29 Sep-1 Oct	50	TS	-	-	-
13	Tropical Storm Marco	6 Oct-7 Oct	55	TS	Mexico (TS)	-	-
14	Tropical Storm Nana	12 Oct-13 Oct	35	TS	-	-	-
15	Hurricane Omar	14 Oct-18 Oct	110	3	-	-	-
16	Hurricane Paloma	6 Nov-9 Nov	125	4	Cuba (3)	-	-

Sources:
Summary of 2008 Atlantic Tropical Cyclone Activity and Verification of Author's Seasonal and Monthly Forecasts. Klotzbach, P.J. and Gray, W.M., 2008. http://hurricane.atmos.colostate.edu
Insurance Services Office, Property Claim Services. Catastrophe Bulletins and Estimates
Swiss Re http://www.swissre.com/pws/media
Munich Re NatCat Service, 2008. "The ten largest natural catastrophes in 2008" http://www.munichre.com/en/press/press_releases/2008/2008_12_29_press_release.aspx

Verification of 2008 Atlantic Basin Tropical Cyclone Forecasts

Forecasts of tropical cyclone activity by Colorado State University have been issued for more than 20 years. For the 2008 North Atlantic basin, Philip J. Klotzbach and William M. Gray released forecasts on 7 December 2007, followed by updates in April, June, and August 2008. The table below shows their initial December 2007 forecast and the August 2008 mid-season update, compared to the observed numbers of tropical cyclones that developed in 2008. Prediction accuracy improved after spring meteorological conditions were observed, and forecasts made before early May are typically less accurate.

Colorado State University Comparison of Forecast Atlantic Basin Storm Development for 2008 with Observed Development

	Total Named Storms	Hurricanes (>63 knots)	Major Hurricanes (>95 knots)
Average storm development (based on climatology data from 1950 – 2000)	9.6	5.9	2.3
2008 forecast storm development (released 7 December 2007)	13	7	3
Mid-season storm forecast (released 5 August 2008)	17	9	5
2008 observed storm development	**16**	**8**	**5**

Source: Summary of 2008 Atlantic Tropical Cyclone Activity and Verification of Author's Seasonal and Monthly Forecasts. Klotzbach, P.J. and Gray, W.M., 2008. http://hurricane.atmos.colostate.edu

Forecasts for Atlantic tropical cyclones are also provided by Tropical Storm Risk (TSR) and WSI Corporation, a global provider of weather-driven business solutions. Their forecasts are displayed in the tables below.

Tropical Storm Risk Comparison of Forecast Atlantic Basin Storm Development for 2008 with Observed Development

	Total Named Storms	Hurricanes (>63 knots)	Major Hurricanes (>95 knots)
58-year climate norm for storm development based on data between 1950 – 2007 (± SD)†	10.3 (±4.0)	6.2 (±2.6)	2.7 (±1.9)
2008 forecast storm development, released 10 December 2007 (± FE)‡	15.4 (±4.7)	8.3 (±3.0)	3.7 (±1.8)
Mid-season storm forecast, released 5 August 2008 (±FE)	18.2 (±2.9)	9.7 (±1.7)	4.5 (±1.4)
2008 observed storm development	**16**	**8**	**5**

†: SD = Standard deviation
‡: FE = Forecast error (standard deviation of errors in replicated real time forecasts 1988 – 2007)
Source: Tropical Storm Risk - http://www.tropicalstormrisk.com/docs/TSRATLForecastDec2008.pdf
http://www.tropicalstormrisk.com/docs/TSRATLForecastAug2008.pdf

WSI Corporation Comparison of Forecast Atlantic Basin Storm Development for 2008 with Observed Development

	Total Named Storms	Hurricanes (>63 knots)	Major Hurricanes (>95 knots)
1950-2007 averages	9.7	5.9	2.3
2008 forecast storm development (released 18 December 2007)	14	7	3
Mid-season storm forecast (released 19 August 2008)	15	9	4
2008 observed storm development	**16**	**8**	**5**

Source: WSI Corporation - http://www.wsi.com/corporate/news/default.asp

Tropical Cyclones Making US Landfall in 2008

Six tropical cyclones made landfall in the United States in 2008. Edouard, Fay, and Hanna made US landfall as tropical storms, whilst Dolly, Gustav, and Ike came ashore as Category 2 hurricanes. Hurricanes Dolly and Gustav both caused considerable amounts of damage, and Hurricane Ike has been provisionally ranked as the fourth most damaging system in US history (see below). There has been considerable controversy over Ike's total insured loss. ISO PCS claims that Hurricane Ike caused an insured loss of US$10.7bn in the United States, but other industry estimates suggest the loss may be far greater. Swiss Re estimates that Hurricane Ike's total insured loss (onshore and offshore) could reach US$20bn, which would make the storm the fourth biggest insurance loss ever. Munich Re, meanwhile, said that Hurricane Ike caused an estimated economic loss of US$30bn, with insurance claims reaching US$15bn. Please note that PCS' definition of industry loss does not include categories of risks that others generally provide. In all, the 2008 Atlantic tropical cyclone season was one of the most damaging on record.

Ten Costliest Hurricanes to Make US Landfall

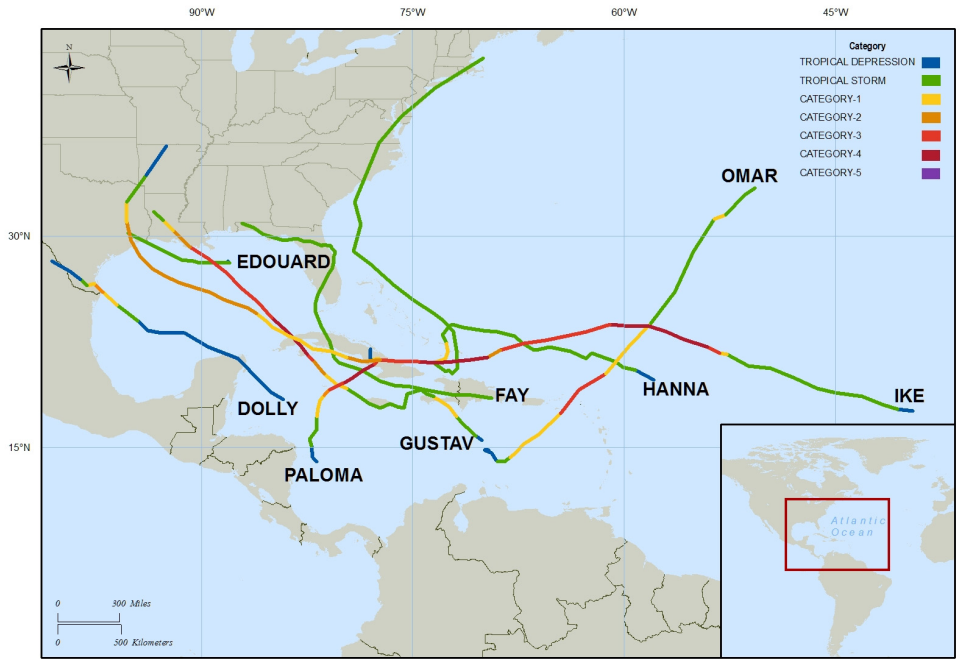
Hurricane Name/Date	Estimated Insured Loss (adjusted to approximately year 2007 US$)
Katrina/August 2005	43.6bn
Andrew/August 1992	22.9bn
Wilma/October 2005	10.9bn
Ike/September 2008	10.7bn (expressed in 2008 dollars)
Charley/August 2004	8.2bn
Ivan/September 2004	7.8bn
Hugo/September 1989	7.0bn
Rita/September 2005	6.0bn
Frances/September 2004	5.0bn
Jeanne/September 2004	4.0bn

Sources: Insurance Services Office, Property Claim Services. Catastrophe Bulletins and Estimates
Insurance Information Institute http://www.iii.org/media/facts/statsbyissue/hurricanes

Significant North Atlantic Tropical Cyclones in 2008

Of the 16 named storms in 2008, eight went on to make landfall in the United States and Caribbean and cause significant levels of damage (see image below).

Significant Tropical Cyclones of 2008 Atlantic Basin Season



Source: Guy Carpenter & Company, LLC

Hurricane Dolly (20 – 25 July 2008)

Hurricane Dolly originated from a strong tropical wave in the Western Caribbean on 20 July 2008. In the early part of its lifecycle, Dolly tracked northwest, brushing the northern tip of Mexico's Yucatan Peninsula as a tropical storm before entering the Gulf of Mexico. Dolly intensified into a Category 1 hurricane on 22 July and further intensified into a Category 2 hurricane with sustained winds of around 100 mph (160 kmph) just before making US landfall on South Padre Island, Texas (TX) on 23 July 2008. The system weakened upon landfall and was downgraded to a tropical storm early on 24 July. It dissipated as a tropical depression later the same day.

Dolly's initial landfall on the Yucatan Peninsula caused only minor damage and disruption. However, more severe damage was reported in the United States when Dolly made landfall in a sparsely populated area on South Padre Island. Here, there was major roof damage to hotels and homes and significant flooding across the area. Dolly also caused major damage in Hidalgo County, TX, where residents' homes remained underwater a week after the storm came ashore. In all, Dolly dropped around 12 inches (300 millimetres) of rain over Texas and caused a coastal storm surge of up to 6 feet (1.8 metres). Offshore damage to oil platforms in the Gulf of Mexico was minimal.

Dolly was responsible for 21 fatalities, according to reports. Latest estimates of monetary loss state that Dolly caused around US$525 million in insured onshore losses.[2]

Modelling Company Loss Estimates from Hurricane Dolly

The modelled loss estimates for Hurricane Dolly from the three major modelling companies (AIR, EQECAT, and RMS) are summarised below. Note that losses quoted for RMS and AIR represent US losses only.

AIR: Hurricane Dolly Modelled Industry Losses

Onshore – insured (US$)	Gulf of Mexico Offshore loss – insured (US$)
350 m - 700m (issued on 24 July 2008)	-

Source: AIR Worldwide http://www.air-worldwide.com/_public/index.asp

EQECAT: Hurricane Dolly Modelled Industry Losses

Onshore – insured (US$)	Gulf of Mexico Offshore loss – economic (US$)
100m - 800m (issued on 24 July 2008)	-

Source: EQECAT http://www.eqecat.com/pressReleases.html

RMS: Hurricane Dolly Modelled Industry Losses

Onshore – insured (US$)	Amount represented by offshore insured in Gulf of Mexico (US$)
350m - 700m (issued on 24 July 2008)	-

Source: AIR Worldwide http://www.air-worldwide.com/_public/index.asp

2 Insurance Services Office, Property Claim Services, Catastrophe Bulletins and Estimates

Tropical Storm Edouard (3 – 6 August 2008)

Edouard formed from an area of low pressure in the Gulf of Mexico on 3 August and intensified into a tropical storm later that day. As Edouard neared the Texas coastline, the system underwent some intensification, making landfall between High Island and Sabine Pass on 5 August with sustained wind speeds of 65 mph (100 kmph). Before Edouard made landfall, there was a state-wide emergency declaration and an evacuation order for people in flood-prone areas. However, Edouard caused minimal damage and was quickly downgraded to a tropical depression after making landfall.

Tropical Storm Fay (15 – 26 August 2008)

Fay formed from an area of low pressure in the Mona Passage on 15 August. After formation, Fay moved westwards across Hispaniola and by 18 August had curved towards the north, crossing Cuba and moving into the Florida Straits. After modest intensification, Fay made its first landfall with sustained winds of 57 mph (93 kmph) near Key West, Florida (FL) as a tropical storm late on 18 August. After crossing the Florida Keys, Fay made a second landfall early on 19 August at Cape Romano, FL, as a slightly weaker tropical storm with sustained winds of 57 mph (93 kmph). Fay moved northeastward across the Florida peninsula and by 20 August had reentered the sea, after which it tracked northward along the east coast of Florida. On 21 August, Fay veered west to make a third landfall as a tropical storm with sustained winds of 57 mph (93 kmph) near Flagler Beach, Florida. Fay then drifted slowly westward across Florida and emerged over the extreme northern portion of the Gulf of Mexico on 23 August. Fay strengthened slightly over the Gulf before making its fourth and final landfall near Carrabelle, FL as a tropical storm later on 23 August. The system was downgraded to a tropical depression as it drifted slowly westward across northern Florida early on 24 August.

Fay's slow forward speed brought heavy and persistent rainfall to large parts of Florida as the storm crossed the Florida panhandle. Damage included severe flooding, power outages to many homes and businesses, and the destruction of several buildings due to tornadoes that were spawned by the storm. Recent estimates state that Fay was directly responsible for 25 fatalities and present estimates of insured loss stand at US$245m. Fay distinguished itself as the first system in US history to make four landfalls in the same state, breaking the record of three landfalls set by Hurricane Gordon in Florida in 1994.[3] [4]

3 Summary of 2008 Atlantic Tropical Cyclone Activity and Verification of Author's Seasonal and Monthly Forecasts. Klotzbach, P.J. and Gray, W.M., 2008. http://hurricane.atmos.colostate.edu

4 Insurance Services Office, Property Claim Services, Catastrophe Bulletins and Estimates

Hurricane Gustav (25 August – 4 September 2008)

Hurricane Gustav formed from an area of low pressure in the central Caribbean on 25 August and became a tropical storm later that day. Gustav tracked northwest and intensified into a hurricane early on 26 August whilst tracking towards southern Haiti. Gustav made landfall in southern Haiti as a Category 1 hurricane, weakening to a tropical storm whilst traversing the mountains to the south of the island. On entering the western Caribbean, Gustav intensified into a strong tropical storm before making landfall in southern Jamaica on 28 August. Gustav tracked west across the island, taking its path across the capital, Kingston. On leaving Jamaica, Gustav strengthened rapidly to reach hurricane status on 29 August. By 30 August, Gustav had become a major Category 4 hurricane and hit the western tip of Cuba with 150 mph (240 kmph) sustained winds later the same day. The interaction with land weakened Gustav and the storm entered the Gulf of Mexico on 31 August as a Category 3 hurricane. Conditions prevented Gustav from strengthening as it crossed the Gulf of Mexico, and the system actually weakened to a Category 2 hurricane before making landfall on the US coastline near Cocodrie, Louisiana on 1 September with sustained winds of 110 mph (175 kmph). Gustav weakened rapidly upon landfall and was downgraded to a tropical storm early on 2 September and to a tropical depression later that day.

Gustav caused considerable amounts of damage to the Caribbean islands of Haiti, Jamaica, and Cuba. In Haiti, the storm triggered flooding and landslides that destroyed houses and claimed many lives. In Jamaica, heavy rain and strong winds caused heavy damage to houses, cut power, and damaged infrastructure. Many people were forced to evacuate the capital, Kingston, due to flooding. In Cuba, there was extensive flooding and severe damage to houses and infrastructure. Hundreds of thousands of people were evacuated to safety in the province where Gustav made landfall.

In the United States, Gustav battered the Gulf Coast with torrential rain and high winds. More than a million homes lost power in Louisiana, where there was also severe damage to houses. Gustav caused widespread flooding and the destruction of around 58 percent of Louisiana's cotton harvest. New Orleans was on the boundary of hurricane-force winds and although there was some damage to infrastructure, the city's flood levees did not breach as they did after Hurricane Katrina in 2005. Offshore, oil companies in the Gulf of Mexico evacuated workers before the arrival of Gustav and nearly all offshore oil production was shut down. Gustav caused little damage to oil production facilities in the Gulf, probably owing to weakening of the system as it approached the coast.

According to recent estimates, approximately 138 fatalities have been attributed to Gustav, of which around 43 occurred in the United States. Recent onshore insured loss estimates state that around US$2.15bn can be attributed to Gustav in the United States[5]. Swiss Re, meanwhile, estimates that the total insured loss (including onshore and offshore US and Caribbean losses) from Gustav could amount to a total of US$4bn[6].

Modelling Company Loss Estimates from Hurricane Gustav

The modelled loss estimates for Hurricane Gustav from AIR, EQECAT, and RMS are summarised below.

RMS: Hurricane Dolly Modelled Industry Losses

Onshore – insured (US$)	Gulf of Mexico Offshore loss – insured (US$)
2bn - 4.5bn (issued on 1 September 2008)	-

Source: AIR Worldwide http://www.air-worldwide.com/_public/index.asp

EQECAT: Hurricane Gustav Modelled Industry Losses

Onshore – insured (US$)	Gulf of Mexico Offshore loss – economic (US$)
6bn - 10bn (issued on 1 September 2008)	-
3bn -7bn (issued on 2 September 2008)	-

Source: EQECAT http://www.eqecat.com/pressReleases.html

RMS: Hurricane Gustav Modelled Industry Losses

Onshore – insured (US$)	Amount represented by offshore insured in Gulf of Mexico (US$)
4bn - 10bn (issued on 1 September 2008)	1bn - 3bn

Source: RMS http://www.rms.com/NewsPress/PressReleases.asp

5 Insurance Services Office, Property Claim Services, Catastrophe Bulletins and Estimates
6 Swiss Re http://www.swissre.com/pws/media

Hurricane Hanna (28 August – 7 September 2008)

Hanna formed from a tropical wave on 28 August and became a tropical storm later that day whilst moving northwest across the Atlantic. The system strengthened to become a hurricane on 1 September, but weakened back to a tropical storm on 2 September whilst turning in a counterclockwise loop near the Turks and Caicos Islands. During this time, Hanna brought huge amounts of rainfall to Haiti, with floodwaters causing considerable amounts of devastation.

A ridge of high pressure building north of Hanna caused the system to track towards the northwest, and after some intensification, Hanna made landfall as a tropical storm with sustained winds of around 60 mph (95 kmph) early on 6 September near the border between North and South Carolina. With this landfall, Hanna caused power outages and isolated flooding, but little material damage. Most areas along Hanna's path through the northern Mid-Atlantic States suffered some flooding along with minor damage to homes and infrastructure.

After following a track towards the north and then northeast along the mid-Atlantic coast, Hanna completed extra-tropical transition as it moved through New England on 7 September.

Recent estimates state that Hanna was responsible for 536 deaths, of which 529 occurred on Haiti[7]. Recent insured loss estimates for the United States stand at US$80m[8].

Hurricane Ike (1 – 14 September 2008)

Ike formed from a tropical wave in the eastern tropical Atlantic on 1 September and was upgraded to a tropical storm later that day whilst travelling westward. Ike intensified rapidly on 3 September and, after classification as a hurricane later that day, the system reached Category 4 status on 4 September. Ike then tracked on a west-southwest course across the central Atlantic, hitting the Turks and Caicos Islands, Haiti, and the Dominican Republic as a Category 4 hurricane, before making landfall on Cuba's eastern province of Holguin as a Category 3 hurricane with sustained winds of up to 125 mph (205 kmph) on 8 September.

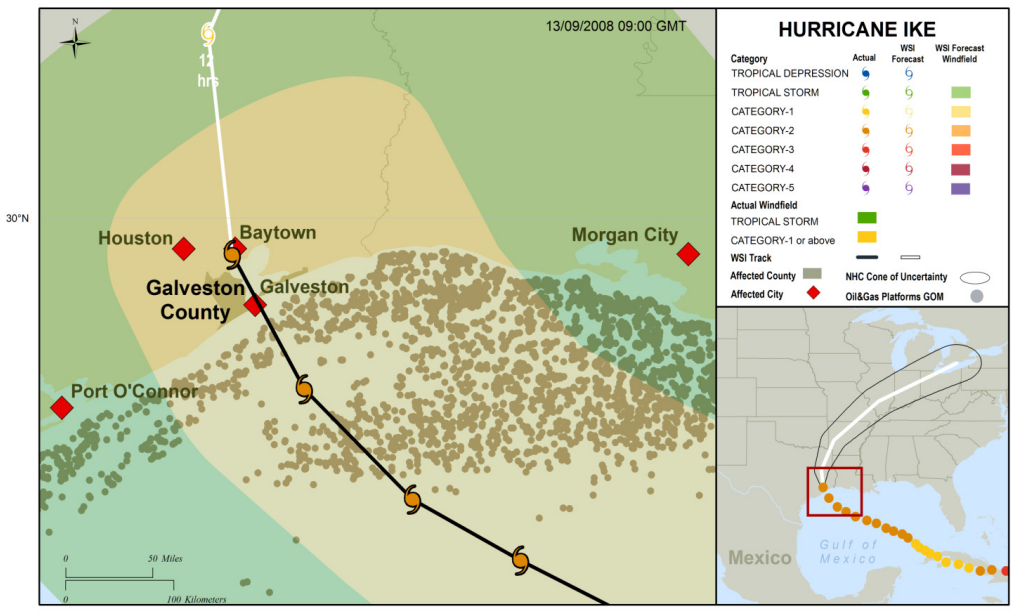
7 Summary of 2008 Atlantic Tropical Cyclone Activity and Verification of Author's Seasonal and Monthly Forecasts. Klotzbach, P.J. and Gray, W.M., 2008. http://hurricane.atmos.colostate.edu

8 Insurance Services Office, Property Claim Services, Catastrophe Bulletins and Estimates

Ike caused huge destruction during its course through the Caribbean. The low-lying Turks and Caicos Islands suffered massive storm surges that, in combination with Ike's powerful winds, destroyed or severely damaged the majority of homes across the region. Infrastructure across the islands was also damaged severely, and power to many residents was cut for weeks. In Haiti, Ike's outer rain bands caused yet more flooding, adding to the humanitarian crisis that had been left in the wake of the two preceding tropical cyclones – Gustav and Hanna. In Cuba, Ike moved across the country, battering northern and eastern regions with strong winds, torrential rain, and a storm surge of up to 50 feet (15 metres). Thousands of homes across Cuba were destroyed or damaged as were many of the island's agricultural crops. Ike hit Cuba's capital, Havana, but damage here was less extensive than in other parts of the country.

Ike weakened to a Category 1 hurricane before leaving western Cuba on 9 September. Ike then intensified in the Gulf of Mexico as it tracked northwest towards Texas, reaching Category 2 hurricane status on 10 September. At this stage, Ike was notable not for its intensity, but for its large size, and by 11 September, Ike's sustained hurricane force winds extended out to at least 100 miles (160 km) in several of its quadrants. The size of the system prevented rapid intensification across the Gulf of Mexico, and Ike finally made landfall on the US Gulf Coast near Galveston Island, TX as a high Category 2 hurricane on 13 September. Ike hit Galveston Island with winds of up to 110 mph (177 kmph) and an accompanying storm surge of around 12 feet to 15 feet (4 metres to 5 metres). On making landfall, Ike weakened rapidly and was first downgraded to a tropical storm later on 13 September and then to a tropical depression by 14 September.

Extent of Ike's Hurriane Windfield at Landfall



Source: Guy Carpenter & Company, LLC

Ike's hurricane-force winds extended around 125 miles (200 km) from the storm's eye at landfall, and this was the biggest contributing factor to the ensuing onshore damage. Upon landfall, the accompanying storm surge swamped much of the US Gulf Coast, causing significant damage to coastal areas and inland flooding. Although Ike was not as powerful as had been feared before making landfall, its large size caused storm surge, wind damage and power outages across wide areas of Texas and Louisiana.

In Galveston, where Ike came ashore, around 75 percent of homes sustained damage from a combination of Ike's powerful winds, rain and storm surge. A month after Ike first hit, around 10,000 households in Galveston remained without power and around 400 people were still living in tent shelters.

Ike's powerful winds and flooding also cut power to more than 4 million people in the Houston area, which sustained relatively little damage in comparison to communities around Galveston Island. Three days after making landfall, around 2 million residents in the city of Houston remained without power and there was extensive damage as a result of the powerful winds to high-rise buildings in the city, many of which sustained substantial window damage. A month after Ike made landfall, 10,000 homes were estimated to have been damaged in the city of Houston. Counties in neighbouring Louisiana also suffered from storm surge related flooding. Days after landfall, heavy rain associated with the passing remnants of Ike caused extensive flooding and infrastructure damage further inland in the states of Missouri, Illinois, and Indiana. Ohio and Kentucky experienced hurricane force winds, and tornadoes damaged several buildings in Arkansas.

Before landfall, Ike's path through major oil and gas producing facilities in the Gulf of Mexico prompted the closure of 13 of Houston's 17 oil refineries (representing a fifth of US refining capacity). According to recent information from the US Minerals Management Service (MMS)[9], approximately 1,450 of the 3,800 oil and gas production platforms in the Gulf of Mexico were exposed to hurricane conditions during the passage of Ike. Of these, 54 have been confirmed as destroyed. Estimates from the MMS state that the 54 destroyed platforms produced a total of 13,300 barrels of oil per day and 90 million cubic feet of gas per day.

Numbers of Offshore Oil Producing Facilities Destroyed by Hurricane Ike (as of 06/10/08)

Number of Destroyed Platforms	Classified by Daily Oil Production Rates
49	< 1,000 barrels/ day
5	1,000 – 5,000 barrels/ day
0	> 5,000 barrels/ day

Source: US Minerals Management Service. http://www.mms.gov/ooc/press/2008/press1007c.htm

9 US Minerals Management Service. http://www.mms.gov/ooc/press/2008/press1007c.htm

Recent estimates state that Ike caused 143 deaths in the Caribbean and the United States. The storm is estimated to have caused losses of around US$4bn in Cuba.[10] Latest estimates of insured loss from ISO PCS suggest that Ike caused a total of US$10.7bn onshore damage in the United States, making Ike the fourth most destructive tropical cyclone in US history, after Hurricane Katrina in 2005, Hurricane Andrew in 1992 and Hurricane Wilma in 2005[11] [12]. Recent estimates from Swiss Re suggest that Ike could have caused a total of US$20bn in insured damage (this figure includes insured onshore and offshore losses from Ike in both the Caribbean and the United States).[13]

Modelling Company Loss Estimates from Hurricane Ike

The modelled loss estimates for Hurricane Ike from AIR, EQECAT, and RMS are summarised below.

AIR: Hurricane Ike Modelled Industry Losses

Onshore – insured (US$)	Gulf of Mexico Offshore loss – insured (US$)
8bn -12bn (issued 13 September 2008)	600mn - 1.5bn (issued 13 September 2008)
10bn - 15bn (as of December 2008)	1bn - 2bn (as of December 2008)

Source: AIR Worldwide http://www.air-worldwide.com/_public/index.asp

EQECAT: Hurricane Ike Modelled Industry Losses

Onshore – insured (US$)	Gulf of Mexico Offshore loss – economic (US$)
8bn - 18bn (issued 13 September 2008)	-
8bn - 12bn (issued 19 September 2008)	4bn - 6bn (issued 19 September 2008)

Source: EQECAT http://www.eqecat.com/pressReleases.html

RMS: Hurricane Ike Modelled US Industry Losses

Onshore & offshore – insured (US$)	Amount represented by offshore insured in Gulf of Mexico (US$)
6bn - 16bn (issued 14 September 2008)	-
7bn - 12bn (issued 17 September 2008)	-
13bn – 21bn (issued 24 October 2008)	1bn - 3bn (issued 24 October 2008)

Source: RMS http://www.rms.com/NewsPress/PressReleases.asp

10 Summary of 2008 Atlantic Tropical Cyclone Activity and Verification of Author's Seasonal and Monthly Forecasts. Klotzbach, P.J. and Gray, W.M., 2008. http://hurricane.atmos.colostate.edu
11 Insurance Services Office, Property Claim Services. Catastrophe Bulletins and Estimates
12 Insurance Information Institute http://www.iii.org/media/facts/statsbyissue/hurricanes
13 Swiss Re http://www.swissre.com/pws/media

Hurricane Omar (13 – 18 October 2008)

Hurricane Omar was formed from an area of low pressure in the eastern Caribbean on 13 October. Omar became a tropical storm on 14 October and strengthened into a hurricane later the same day whilst over the warm deep waters of the Caribbean Sea. By 16 October, Omar rapidly intensified into a major Category 3 hurricane with maximum winds speeds of 125 mph (205 kmph) whilst battering the Leeward Islands. After a period of rapid weakening, Omar was downgraded to a tropical storm on 17 October whilst accelerating to the northeast. After intensifying briefly back into a hurricane on that same day, cooler sea surface temperatures caused Omar to lose strength and the system was downgraded into a remnant low on 18 October. Omar brought severe weather to the northeastern Caribbean, where it passed as a Category 3 hurricane. Omar caused moderate damage to the Lesser Antilles and led to one indirect fatality.[14]

Hurricane Paloma (5 – 10 November 2008)

Paloma formed from an area of low pressure in the southwestern Caribbean Sea on 5 November. Paloma strengthened rapidly, becoming a tropical storm on 6 November and a hurricane early on 7 November whilst moving slowly northward. Paloma became a major hurricane later that day and battered the Cayman Islands whilst turning to the northeast. The system became a Category 4 hurricane whilst approaching Cuba, but after interaction with dry air and the landmass of Cuba, the storm weakened rapidly. Paloma became a tropical storm on 9 November and was downgraded to a tropical depression later that day.

Paloma caused considerable damage in the Cayman Islands and Cuba, where one fatality occurred.[15]

In the Cayman Islands, the smaller islands of Cayman Brac and Little Cayman bore the brunt of Paloma's hurricane-force winds and heavy rain. Most of the two island's 2,000 residents were evacuated or moved to shelters before the storm's arrival. Property damage occurred on both islands as a result of wind damage and storm surge flooding. Power supplies were cut on both Little Cayman and Grand Cayman, but no deaths were attributed to the storm on the islands.

14 Summary of 2008 Atlantic Tropical Cyclone Activity and Verification of Author's Seasonal and Monthly Forecasts. Klotzbach, P.J. and Gray, W.M., 2008. http://hurricane.atmos.colostate.edu

15 Summary of 2008 Atlantic Tropical Cyclone Activity and Verification of Author's Seasonal and Monthly Forecasts. Klotzbach, P.J. and Gray, W.M., 2008. http://hurricane.atmos.colostate.edu

In Cuba, Paloma made landfall near Santa Crux del Sur on 9 November as a Category 3 hurricane with sustained winds of around 120 mph (195 kmph). More than 500,000 people were evacuated from their homes in southern provinces of the island. In southern Cuba, thousands of homes were destroyed by the storm's powerful winds and a 10 foot (3 metre) storm surge that sent waves almost a mile (1.6 km) inland.

Atlantic Basin Tropical Cyclone Forecasts for 2009

Colorado State University

On 10 December 2008, Philip J. Klotzbach and William M. Gray at Colorado State University released their forecast for the 2009 season, making predictions for somewhat above-average activity in the North Atlantic basin (based on the average 1950 to 2000 season). The team also predicted an above-average probability that a major hurricane would make landfall on the US coastline at some point during the 2009 season.

2009 Atlantic Basin Tropical Cyclone Forecast from Colorado State University

	Total Named Storms	Hurricanes (>63 knots)	Major Hurricanes (>95 knots)
Average storm development (based on climatology data between 1950 – 2000)	9.6	5.9	2.3
Forecast number of storms for the 2009 season (as of 10/12/2008)	14	7	3
Probability of at least 1 hurricane making landfall at any point on US coastline (average for last century given in parentheses)	-	78% (68%)	63% (52 %)

Summary of 2008 Atlantic Tropical Cyclone Activity and Verification of Author's Seasonal and Monthly Forecasts. Klotzbach, P.J. and Gray, W.M., 2008. http://hurricane.atmos.colostate.edu

Tropical Storm Risk

TSR's extended range forecast for 2009 Atlantic Basin Hurricane activity was released on 5 December 2008. TSR anticipates another active Atlantic hurricane season in 2009, with Atlantic basin and US landfalling tropical cyclone activity forecast to be 35 percent above the 1950 to 2008 norm in 2009. The forecast spans the period from 1 June 2009 to 30 November 2009 and uses data through the end of November 2008. TSR's main predictors are the forecast July 2009 to September 2009 trade winds over the Caribbean and tropical North Atlantic, and the forecast August 2009 to September 2009 sea surface temperature in the tropical North Atlantic. The TSR forecast, together with predicted numbers of tropical storms and hurricanes making US landfall, are summarised in the table below.

2009 Atlantic Basin Tropical Cyclone Forecast from Tropical Storm Risk

	Total Named Storms	Hurricanes (>63 knots)	Major Hurricanes (>95 knots)
59 year Climate Norm for storm development (based on data between 1950 – 2008) (± SD)†	10.4 (±4.0)	6.2 (±2.6)	2.7 (±1.9)
Forecast number of storms for the 2009 season (as of 5 December 2008) (± FE)‡	14.8 (±4.3)	7.7 (±2.8)	3.5 (±1.8)
Forecast US Landfalling tropical storm numbers in 2009 (59 year climate norm data shown in brackets)	4.7 (3.2)	2.1 (1.5)	Numbers of major hurricanes not predicted

†: SD = Standard deviation
‡: FE = Forecast error (standard deviation of errors in replicated real time forecasts 1984 – 2008)
Source: Tropical Storm Risk - http://www.tropicalstormrisk.com/docs/TSRATLForecastDec2009.pdf

WSI Corporation

WSI Corporation also released its 2009 hurricane forecast on 24 December 2008. WSI predicts that 13 named storms, seven hurricanes, and three intense hurricanes will develop in 2009.[16] These forecast numbers are all higher than the 1950-to-2008 averages of 9.8 named storms, six hurricanes, and 2.5 intense hurricanes. WSI said the forecast for an active 2009 season are due to the expected continuation of warmer-than-normal Atlantic Ocean temperature anomalies into next summer and the likelihood of a favourable or neutral wind shear environment associated with the lack of an El Nino event.

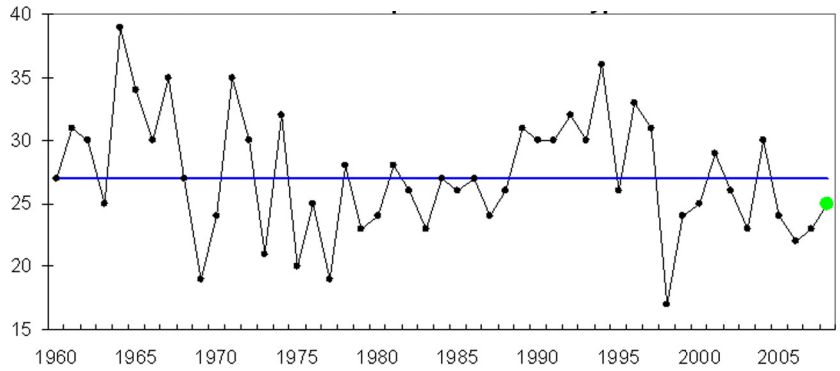
16 WSI Corporation http://www.wsi.com/corporate/news/releases/useg122408_tropcoutlook.asp

3

Northwest Pacific

The Northwest Pacific typhoon season runs throughout the entire year, but the main season tends to occur between July and November, with peak activity in late August and early September. According to the Guy Carpenter Asia Pacific Climate Impact Centre (GCACIC), the 2008 season was considered to be relatively inactive, with the total numbers of tropical storms being below average (see below image). The 2008 season saw the formation of a total of 22 named tropical storms (four more were considered as having attained tropical storm intensity by the Joint Typhoon Warning Center, but no name was given by the Tokyo Regional Specialised Meteorological Center, RSMC), of which there were 12 typhoons and five major typhoons.[17]

Annual Number of Tropical Storms and Typhoons



Source: Guy Carpenter Asia Pacific Climate Impact Centre
Note: The horizontal line indicates the climatological mean. The green circle indicates the year of 2008.

The 2008 Northwest Pacific season was unusual in that it was the first since 1984 that no tropical cyclone made landfall on the Japanese mainland.

Taiwan was hit by four typhoons during the 2008 Northwest Pacific season. Kalmaegi, Fung-Wong, Sinlaku and Jangmi affected northern and eastern parts of the island. The total economic damage to Taiwan from these four systems has been estimated to be more than US$1bn.

Typhoon Neoguri made landfall in the Guangdong Province of China in April, becoming the earliest typhoon to hit the province during the last 50 years. Typhoon Hagupit struck the same province in September, making it the first Category 4 typhoon to come ashore in Guangdong. Hagupit was the most damaging typhoon of the 2008 season, causing an estimated US$1bn in economic damage.

17 Verification of Forecasts of Tropical Cyclone Activity over the Western North Pacific in 2008, January 2009, http://www.cityu.edu.hk/gcacic/2008_verification.htm

Three typhoons struck the Philippines in 2008 – Nuri, Halong and Fengshen. Of these, Typhoon Fengshen killed more than 1,300 people, making it one of the top 10 deadliest typhoons to strike the Philippines.

Summary of 2008 Northwest Pacific Tropical Cyclones. NB only named cyclones are shown

#	Name	Dates	Max Sustained Wind (knots)	Cat (Max)	Country of Landfall and Category at Landfall	Economic Loss (US$)	Insured Loss (US$)
1	Typhoon Neoguri	14 Apr-19 Apr	95	2	China (TS)		
2	Typhoon Rammasun	07 May-12 May	135	4	-		
3	Tropical Storm Matmo	14 May-16 May	40	TS	-		
4	Typhoon Halong	15 May-20 May	70	1	Philippines (1)		
5	Typhoon Nakri	27 May-03 Jun	125	4	-		
6	Typhoon Fengshen	12 Jun-25 Jun	95	2	Philippines (2), China (TS)		
7	Typhoon Kalmaegi	14 Jul-18 Jul	90	2	Taiwan (2), China (TS)		
8	Typhoon Fung-Wong	25 Julv28 Jul	95	2	Taiwan (2), China (TS)		100 million in Taiwan (AIR) ‡
9	Tropical Storm Kammuri	04 Aug-06 Aug	50	TS	China (TS)		
10	Tropical Storm Phanfone†	10 Aug-11 Aug	50	TS	-		
11	Tropical Storm Vongfong	14 Aug-16 Aug	50	TS	-		
12	Typhoon Nuri	17 Aug-22 Aug	95	2	Philippines (2), Hong Kong (TS)		
13	Typhoon Sinlaku	08 Sep-20 Sep	125	4	Taiwan (2)		
14	Typhoon Hagupit	18 Sep-24 Sep	120	4	China (4)	1 billion	100-250 million in China (AIR) ‡
15	Typhoon Jangmi	23 Sep-30 Sep	135	4	Taiwan (4)		40-120 million in Taiwan (AIR) ‡
16	Tropical Storm Mekkhala	28 Sep-30 Sep	55	TS	Vietnam (TS)		
17	Tropical Storm Higos	29 Sep-04 Oct	45	TS	Philippines (TS)		
18	Tropical Storm Bavi	18 Oct-20 Oct	45	TS	-		
19	Tropical Storm Maysak	06 Nov-10 Nov	60	TS	-		
20	Tropical Storm Haishen	15 Nov-16 Nov	40	TS	-		
21	Tropical Storm Noul	16 Nov-17 Nov	40	TS	Vietnam (TS)		
22	Typhoon Dolphin	10 Dec-18 Dec	90	2	-		

Sources: Unisys Weather. http://www.weather.unisys.com/hurricane/w_pacific/2008/index.html
Verification of Forecasts of Tropical Cyclone Activity over the Western North Pacific in 2008. January 2009. http://www.cityu.edu.hk/gcacic/2008_verification.htm

Verification of 2008 Northwest Pacific Basin Tropical Cyclone Forecasts

Forecasts for the 2008 season were provided by the GCACIC[18] in April and June 2008 and by TSR[19] in March, May, July, and August 2008. These forecasts are summarised and verified against observed tropical cyclone development below.

2008 Northwest Pacific Basin Forecasts as issued by the GCACIC and TSR.

		Tropical Storms	Typhoons	Major Typhoons
Average Storm Development ± SD (based on climate norm data 1965 – 2007)		26.6 ± 4.4	16.8 ± 3.6	8.7 ± 3.0
Observed Storm Development in 2008 according to RSMC		22	12	5
GCACIC Forecasts	18 Apr 2008 24 Jun 2008	30 30	19 19	- -
TSR 2008 Forecast Data ± FE†	10 Mar 2008 6 May 2008 4 July 2008 5 Aug 2008	- 28.3 ± 3.7 28.3 ± 3.7 28.3 ± 3.7	- 18.2 ± 2.9 18.2 ± 2.9 18.2 ± 2.9	6.4 ± 2.9 7.7 ± 2.5 7.5 ± 2.4 7.8 ± 2.4

† FE = Forecast Error
Sources:
"Verification of Forecasts of Tropical Cyclone Activity over the Western North Pacific in 2008." January 2009. http://www.cityu.edu.hk/gcacic/2008_verification.htm
Lea, A. & Saunders, M. 2009. "Summary of 2008 NW Pacific Typhoon Season and Verification of Author's Seasonal Forecasts." http://www.tropicalstormrisk.com

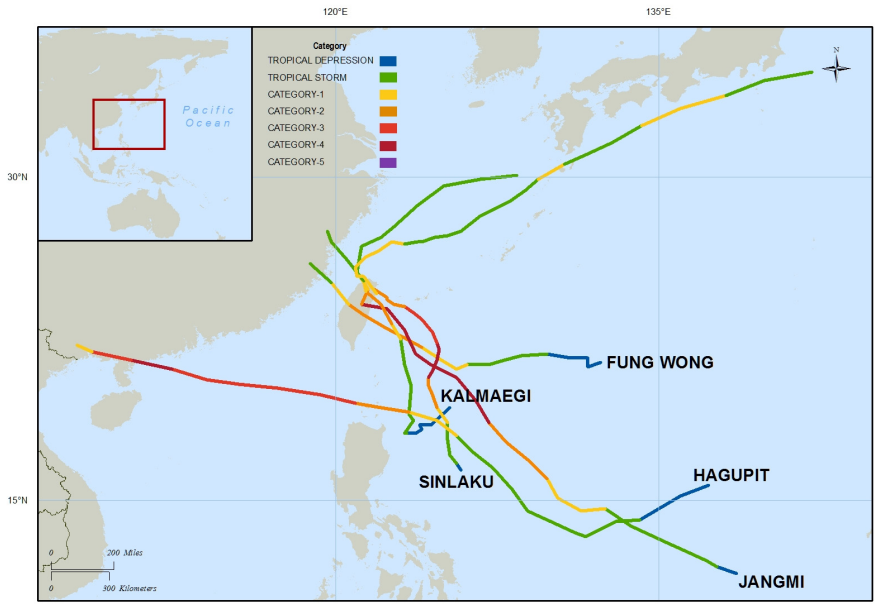
Using the RSMC as the source, the 2008 forecasts from both organisations overestimated tropical cyclone activity when compared with observed cyclone development, which was below normal for the Northwest Pacific in 2008. A discussion of the overestimation is presented in the paper, Verification of Forecasts of Tropical Cyclone Activity over the Western North Pacific in 2008, at http://www.cityu.edu.hk/gcacic/2008_verification.htm.

18 Verification of Forecasts of Tropical Cyclone Activity over the Western North Pacific in 2008. January 2009. http://www.cityu.edu.hk/gcacic/2008_verification.htm+
19 Lea, A. & Saunders, M. 2009. Summary of 2008 NW Pacific Typhoon Season and Verification of Author's Seasonal Forecasts. http://www.tropicalstormrisk.com

Northwest Pacific Tropical Cyclones

Twelve typhoons developed in the 2008 season, of which eight made landfall at typhoon status. Of these eight landfalling typhoons, five – Kalmaegi, Fung-Wong, Sinlaku, Hagupit and Jangmi - caused significant amounts of damage.

Tracks of damaging typhoons during 2008 Northwest Pacific season



Source: Guy Carpenter & Company, LLC

Typhoon Kalmaegi (14 – 18 July 2008)

Typhoon Kalmaegi developed as a tropical depression, northeast of the Philippine Islands on 14 July , reaching tropical storm strength the next day. Kalmaegi strengthened the monsoonal rains of the Philippines as it passed, resulting in flooding that affected thousands of people. Kalmaegi became a Category 2 typhoon on 17 July, with maximum sustained wind speeds of around 104 mph (167 kmph). Later that day, Kalmaegi made landfall on northern Taiwan, just south of Ilan, as a Category 2 typhoon with sustained winds of around 100 mph (160 kmph). Kalmaegi lashed Taiwan with heavy rain, causing flash floods and landslides in southern and central areas of the island that claimed 19 lives. The typhoon led to several flight delays and cancellations, in addition to forcing the closure of schools and businesses across the island. Kalmaegi's path took it just west of the capital Taipei, subjecting the city to typhoon-force winds.

Agriculture was badly affected by Kalmaegi and Taiwan's Council of Agriculture stated that losses in the sector exceeded US$24m. The National Disaster Response Agency also stated that Kalmaegi caused around US$12.5 million in damage to water conservancy facilities, including irrigation systems and reservoirs.

After leaving Taiwan, Kalmaegi crossed the East China Sea, making a second landfall on the southeastern coast of China, in Fujian Province on 18 July as a tropical storm. Ahead of the storm's arrival, more than 360,000 people were evacuated from coastal areas of eastern China and around 61,000 fishing vessels were recalled to port.

Typhoon Fung-Wong (25 – 28 July 2008)

Typhoon Fung-Wong developed as a tropical depression in the north-western Pacific Ocean on 25 July. Fung-Wong then tracked west, strengthening to become a typhoon on 26 July, 2008, reaching peak intensity as a Category 2 typhoon with sustained winds of around 109 mph (176 kmph) the following day. Fung-Wong's outer rain bands caused intensification of monsoon rains in the northern Philippines, resulting in widespread flooding and landslides, in addition to power outages. Flooding and landslides resulted in the deaths of four people.

Fung-Wong's westerly track took it on a path towards China. The storm made its first landfall in central Taiwan in the eastern county of Hualian, early on 28 July local time as a Category 2 typhoon with sustained winds of around 100 mph (160 kmph). Fung-Wong's powerful winds and heavy rain triggered flooding and landslides across the island, and reports said that two people were killed. Hualian County, where the typhoon came ashore, received more than 36 inches (900 mm) of rain, prompting the emergency evacuation of homes. Flooding was widespread across the whole island, forcing authorities to evacuate people to higher ground in many counties. Thousands of homes lost power across the island, and all forms of transport were suspended or disrupted. Following the typhoon's landfall, the stock market in Taipei was closed for the day, along with all schools and businesses in the capital city. Agriculture on the island was affected by severe flooding, with around 3,345 hectares of crops and orchards being damaged. The Council of Agriculture said that losses to the sector could reach US$10m. Initial insured loss estimates for Taiwan released by AIR Worldwide at the time of landfall, stated that they were not likely to exceed US$100m.

After leaving Taiwan, Fung-Wong crossed the Taiwan Strait and made second landfall in China's Fujian Province as a tropical storm on 28 July. Prior to the storm's arrival, around 600,000 people were evacuated from coastal areas in both Fujian and Zhejiang Provinces.

Fung-Wong caused widespread flooding in both Fujian and Zhejiang Provinces. In the city of Wenzhou, Zhejiang, rainfall reached 13 inches (335 mm) and forced more than 150,000 people to evacuate to higher ground.

Typhoon Sinlaku (8 – 20 September 2008)

Typhoon Sinlaku developed as a tropical depression in the western Pacific Ocean, east of the northern Philippine Islands on 8 September and strengthened to a tropical storm the same day. Although the storm did not make landfall in the Philippines, the storm's outer rain bands intensified seasonal monsoon rains, causing flooding on the northern Philippine island of Luzon. On passing the Philippines, Sinlaku strengthened to become a typhoon and attained Category 4 status on 10 September, with maximum sustained winds of around 144 mph (231 kmph). Sinlaku made first landfall in Ilan County, northeastern Taiwan on 14 September as a Category 2 typhoon with sustained winds of around 107 mph (173 kmph). Heavy rain from Sinlaku triggered flash flooding and mudslides in Taiwan's mountainous northern areas, where there were at least four fatalities. Heavy rain and associated mudslides also affected central areas of the island, where a further two people were reportedly killed. Infrastructure was badly affected in northern areas of Taiwan, with mudslides blocking roads and several bridges collapsing. Flights at Taipei's Taoyuan Airport were severely disrupted and power was cut to hundreds of thousands of households. Taiwan's Council of Agriculture estimated losses to crops from the storm in the region of US$3.6m.

The east coast of mainland China was also affected by Sinlaku's outer rain bands and strong winds of around 78 mph (126 kmph) were recorded off Zhejiang Province. More than 460,000 people were evacuated from coastal areas in the provinces of Fujian and Zhejiang and thousands of fishing vessels were warned to return to land.

On leaving Taiwan, Sinlaku changed direction and tracked northeast towards Japan. The typhoon skirted Japan's southern Kyushu Island on 18 September, with sustained winds of around 86 mph (139 kmph). Sinlaku triggered flooding and mudslides in Miyazaki and Kagoshima prefectures, but there were no fatalities reported. Flights were disrupted in the southern part of Kyushu and surrounding islands and Sinlaku's strong winds also led to the closure of three of Japan's western coast oil refineries.

Typhoon Hagupit (18 – 24 September 2008)

Typhoon Hagupit developed as a tropical depression in the western Pacific Ocean on 18 September. The storm strengthened as it tracked southwest and then northwest, becoming a Category 2 typhoon on 22 September, when it was located north of the northern Philippine Island of Luzon. The typhoon's outer rain bands affected the northern Philippines and Taiwan as it moved across the Luzon Strait towards south-eastern China. After passing the Philippines as a Category 2 storm, six people were reported killed due to landslides and flooding, whilst 13 people were trapped inside a goldmine in the central Philippine mountain town of Itogon. Hagupit strengthened as it crossed the South China Sea, reaching Category 4 status with sustained maximum winds of around 138 mph (222kmph) on 23 September. Hagupit made landfall early the next day in China's Guangdong Province as a Category 4 typhoon, making it the first storm of this intensity to come shore in Guangdong.

On making landfall, Hagupit brought ferocious winds and torrential rains, which killed 10 people and inundated the coastal city of Zhanjiang in Guangdong Province. Approximately 18,500 homes were destroyed by the storm, and more than 800 were flooded. There was also substantial agricultural damage, with the destruction of banana crops. According to reports at the time, the economic loss in the Guangdong Province was around US$924m. AIR Worldwide estimated insured losses from Hagupit to onshore properties in China from wind and flooding to be between US$100m and US$250m.

Hagupit also affected Hong Kong with torrential rains and winds of up to 100 mph (162 kmph). There were several casualties resulting from the storm and severe disruption to transport infrastructure with flights cancelled or delayed. There was also flooding on the islands of Lantau and Cheung Chau.

Hagupit weakened as it moved inland towards Vietnam, although torrential rain triggered flash floods and landslides to northern regions of the country. Here, Hagupit was responsible for the destruction of thousands of hectares of crops, inundating several thousand homes and claiming the lives of around 41 people. Economic losses in Vietnam were estimated to be in the region of US$65m.[20] Sources have quoted Hagupit as being the most destructive typhoon of the 2008 season, causing economic damage that totalled around US$1bn.

Typhoon Jangmi (23 – 30 September 2008)

Typhoon Jangmi developed in the northwestern Pacific Ocean as a tropical depression on 23 September. Whilst tracking northwest, Jangmi attained typhoon status on 25 September and reached maximum strength as a strong Category 4 typhoon with sustained winds of around 155 mph (250 kmph) on 27 September, as it neared the east coast of Taiwan. Jangmi made landfall in northern Taiwan's Ilan County on 28 September as a Category 4 typhoon, with wind gusts of up to 141 mph (227 kmph). Jangmi was the most powerful typhoon to hit Taiwan during the 2008 season.

After making landfall, Jangmi quickly weakened as it moved across the north-eastern portion of Taiwan, exiting the island as a Category 1 typhoon which rapidly became a tropical storm. During its passage across Taiwan, Jangmi caused torrential rain and powerful winds that led to flooding and widespread power cuts to thousands of households. Two fatalities were reported and approximately 60 people were injured.

Jangmi caused severe economic disruption across the island, with the closure of major airports, offices and financial markets. Substantial agricultural losses of around US$553,000 were also reported by the Council of Agriculture, with losses to fruit crops contributing to most of the damage. At the time, AIR Worldwide estimated insured losses from Jangmi to onshore properties in Taiwan to range from US$40m to US$120m.

20 NOAA: Global Hazards and Significant Events. September 2008
http://www.ncdc.noaa.gov/oa/climate/research/2008/sep/hazards.html#tropical

In China, the threat from Jangmi prompted the evacuations of 460,000 people from eastern regions and the suspension of shipping across the Taiwan Strait. China did not suffer major damage or disruption from Jangmi because, as after it entered the Taiwan Strait, Jangmi skirted China as a tropical storm on its path towards Japan, before becoming extratropical on 30 September.

Northwest Pacific Basin Tropical Cyclone Forecasts for 2009

Forecasts for the 2009 Northwest Pacific season will be issued by the GCACIC in April and June. Forecasts from the GCACIC are statistical predictions, with predictors drawn from a large group of indices that represent atmospheric and oceanographic conditions in the previous year up to spring of the current year. Most prominent indicators include the proxies for the El Nino/Southern Oscillation (ENSO), the extent of the subtropical ridge and the intensity of the India-Burma trough. [21]

21 Verification of Forecasts of Tropical Cyclone Activity over the Western North Pacific in 2008. Issued 16/01/2009. http://www.cityu.edu.hk/gcacic/2008_verification.htm

4 Northeast Pacific

The Northeast Pacific tropical cyclone season runs from 15 May to 30 November. In 2008, 16 tropical cyclones developed, seven of which became hurricanes. Two became major hurricanes, though only one, Hurricane Norbert, made landfall in Mexico.

Summary of 2008 Northeast Pacific Tropical Cyclones. NB only named cyclones are shown.

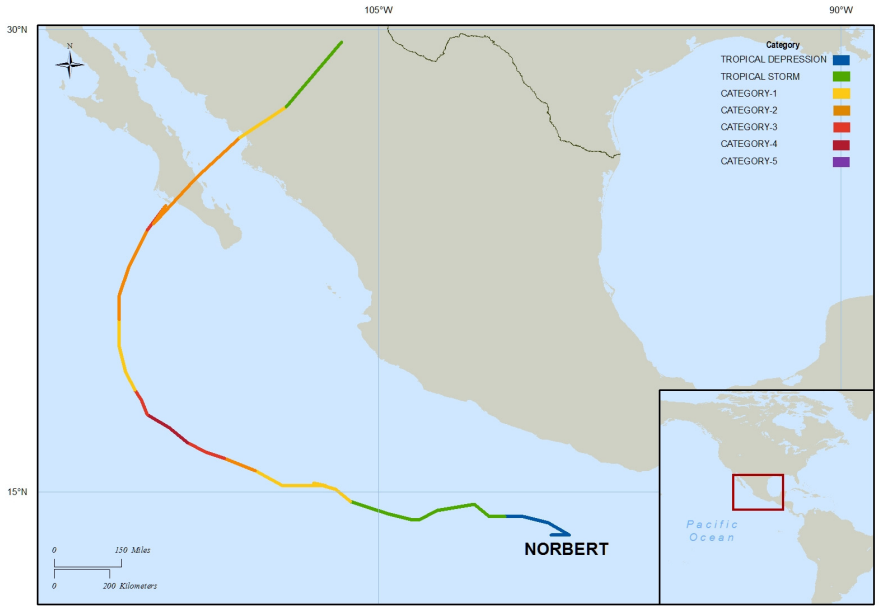
#	Name	Dates	Max Sustained Wind (knots)	Cat (Max)	Category at Landfall and Country of Landfall
1	Tropical Storm Alma	29 May – 30 May	55	TS	Nicaragua (TS)
2	Hurricane Boris	27 Jun – 04 Jul	65	1	
3	Tropical Storm Cristina	27 Jun – 01 Jul	45	TS	
4	Tropical Storm Douglas	02 Jul – 04 Jul	35	TS	
5	Hurricane Elida	12 Jul – 19 Jul	90	2	
6	Hurricane Fausto	16 Jul – 22 Jul	85	2	
7	Hurricane Genevieve	21 Jul – 27 Jul	65	1	
8	Hurricane Hernan	06 Aug – 13 Aug	105	3	
9	Tropical Storm Iselle	13 Aug – 17 Aug	45	TS	
10	Tropical Storm Julio	23 Aug – 26 Aug	45	TS	Mexico (TS)
11	Tropical Storm Karina	02 Sep – 03 Sep	35	TS	
12	Tropical Storm Lowell	07 Sep – 12 Sep	50	TS	Mexico (TD)
13	Hurricane Marie	01 Oct – 06 Oct	70	1	
14	Hurricane Norbert	04 Oct – 12 Oct	115	4	Mexico (2)
15	Tropical Storm Odile	08 Oct – 12 Oct	55	TS	
16	Tropical Storm Polo	02 Nov – 05 Nov	35	TS	

National Hurricane Center http://www.nhc.noaa.gov/archive/2008/index.shtml

Significant Northeast Pacific Tropical Cyclones in 2008

Hurricane Norbert (4 – 12 October 2008)

Storm Track of Hurricane Norbert



Source: Guy Carpenter & Company, LLC

Hurricane Norbert originated from a large area of low pressure that developed south of the Gulf of Tehuantepee on 28 September. The system became a tropical depression on 4 October, whilst centred south-southeast of Acapulco in Mexico.

Whilst moving slowly westward, the depression became a tropical storm on 5 October and continued slow intensification to become a hurricane two days later, whilst located south-southwest of Manzanillo in Mexico. Norbert then began a period of rapid strengthening whilst moving west-northwest and became a Category 4 hurricane on 8 October, whilst centred around 449 miles (722 km) south of Cabo San Lucas in Mexico.

By the next day, Norbert had weakened significantly to a Category 1 hurricane with sustained winds of around 81 mph (130 kmph). On 10 October, Norbert turned northward and then north-northeastward as wind speeds strengthened to around 115 mph (185 kmph), before making landfall near Puerto Chale, just southeast of Bahia Magdelena, on the Mexican peninsula of Baja California on 11 October. Norbert came ashore as a Category 2 hurricane with sustained winds of around 104 mph (167 kmph), making it the strongest hurricane on record to strike the western Baja California coast. [22]

22 National Hurricane Center: Tropical Cyclone Report, Hurricane Norbert (EP152008) 4-12 October 2008. Franklin, J.L., 2009 http://www.nhc.noaa.gov/pdf/TCR-EP152008_Norbert.pdf

Norbert made its first landfall along a sparsely populated stretch of coastline about 145 miles (235 km) northwest of the resort of Cabo San Lucas. According to officials in the fishing town of Puerto San Carlos, around 40 miles (65 km) from the landfall point, homes were flooded after heavy rainfall and a possible storm surge, forcing hundreds of residents to evacuate. Tree and roof damage was reported in the landfall area, with around 40 percent of homes totally or partially damaged on the islands of Margarita and Magdalena. Thousands of homes lost power in La Paz and Ciudad Constitucion. Reports said that around 3,000 people were evacuated prior to Norbert's landfall.

Norbert weakened to a Category 1 hurricane as it moved northeast over the Baja California Peninsula and entered the Gulf of California. Norbert made its final landfall on 12 October north-northeast of Los Mochis on mainland Mexico as a Category 1 hurricane with sustained winds of around 86 mph (139 kmph). Some crop damage was reported around the landfall area and at least three people were killed. No major property damage was reported. Norbert subsequently weakened whilst moving north-eastward and by the evening of 12 October, the storm had dissipated over the mountains of north-eastern Mexico.

5

North Indian Ocean

Four named tropical cyclones developed in the North Indian Ocean basin in 2008. Of these, Cyclone Nargis became a Category 4 storm and caused major damage and loss of life when it made landfall in Myanmar.

Summary of 2008 North Indian Ocean Tropical Cyclones. NB only named cyclones are shown

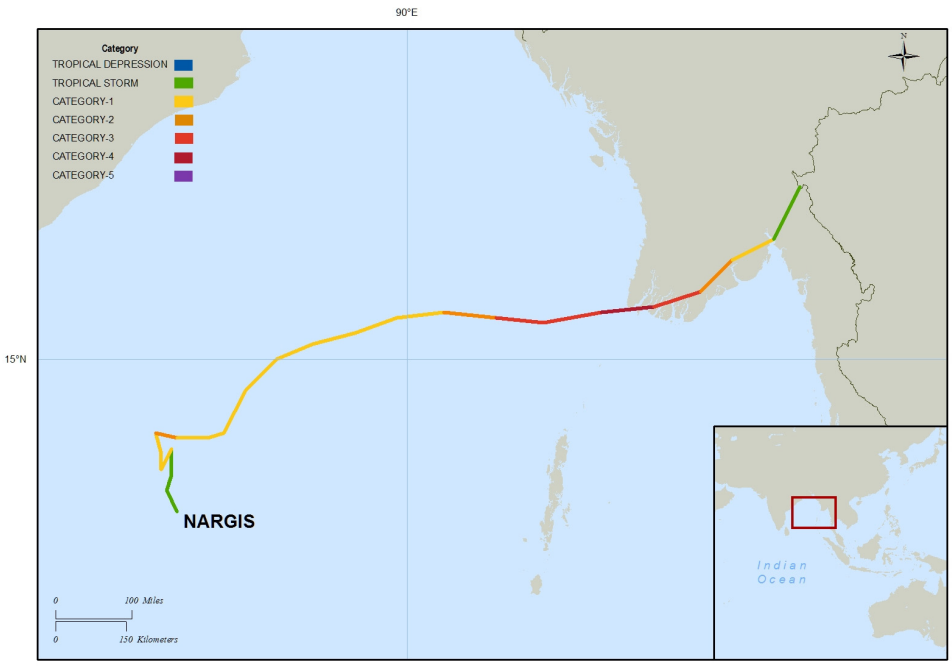
#	Name	Dates	Max Sustained Wind (knots)	Cat (Max)	Category at Landfall and Country of Landfall
1	Cyclone Nargis	27 Apr – 03 May	115	4	Myanmar (4)
2	Tropical Storm Rashmi	26 Oct – 27 Oct	45	TS	Bangladesh (TS)
3	Tropical Storm Khai-Muk	14 Nov – 16 Nov	45	TS	India (TS)
4	Tropical Storm Nisha	25 Nov – 27 Nov	55	TS	Sri Lanka (TS)

Source: Unisys Weather. http://www.weather.unisys.com/hurricane/n_indian/2008/index.html

Significant North Indian Tropical Cyclones in 2008

Cyclone Nargis (27 April – 3 May 2008)

Storm Track of Cyclone Nargis



Source: Guy Carpenter & Company, LLC

Cyclone Nargis developed in the Bay of Bengal on 27 April. Favourable atmospheric and oceanic conditions led to rapid intensification of the storm, which became a Category 4 cyclone on 2 May 2008 with maximum sustained winds of 135 mph (215 kmph).

Cyclone Nargis made landfall on 2 May in the Irrawaddy delta region in Myanmar as a Category 4 storm with maximum sustained winds of around 132 mph (213 kmph). After landfall, Nargis gradually weakened as it moved inland and tracked directly over Yangon, the largest city in Myanmar, as a Category 1 storm with sustained winds of around 80 mph (130 kmph). After passing over Yangon, the storm continued to weaken and became a tropical storm as it crossed the mountainous region to the east of the country.

Severe and widespread flooding occurred in areas around the landfall location, which was triggered as a result of torrential rainfall and an accompanying storm surge that affected the low-lying Irrawaddy delta region. The cities of Irrawaddy, Pegu and Yangon were all impacted as Nargis crossed Myanmar, with the city of Yangon (population of around 6 million) sustaining particularly severe damage. In addition to widespread destruction of buildings and infrastructure, there were tens of thousands of fatalities, making Nargis one of the worst humanitarian catastrophes of 2008.

According to recent reports, Cyclone Nargis is estimated to have claimed more that 135,000 lives in Myanmar, with 85,000 deaths officially confirmed and 54,000 people still missing.[23] The storm surge associated with Nargis travelled as far as 25 miles (40 km) inland. The country was inundated with water around 11 feet (3.5 metres) deep and more than a million people were made homeless. Reports said hundreds of thousands of buildings were destroyed by the storm and the government of Myanmar has estimated the economic damage at about US$11bn.

Although Nargis was a huge humanitarian disaster, losses to the insurance industry were minimal due to very low insurance penetration in Myanmar.

23 Munich Re Press Release, 29 December 2008.
http://www.munichre.com/en/press/press_releases/2008/2008_12_29_press_release.aspx

6

Australian Basin

The Australian tropical cyclone season runs from 1 November to 30 April, with a peak in February and March. The 2007/2008 season showed moderately above-average activity, with a total of 12 tropical cyclones, of which five reached severe tropical cyclone strength (equivalent of US hurricane strength).

Two tropical storms made landfall on the Australian coastline during the 2007/2008 season (Helen and Nicholas). This is the lowest number of landfalling tropical storms since 2001. No severe tropical cyclones made landfall along the Australian coastline in 2007 or 2008.

Summary of 2007/2008 Australian Tropical Cyclones. NB only named cyclones are shown.

#	Name	Dates	Max Sustained Wind (knots)	Cat (Max)	Category at Australian Landfall
1	Cyclone Guba	13 Nov – 19 Nov	75	1	-
2	Tropical Storm Melanie	28 Dec – 31 Dec	60	TS	-
3	Tropical Storm Helen	3 Jan – 5 Jan	45	TS	TS
4	Cyclone Funa	16 Jan – 20 Jan	105	3	-
5	Cyclone Nicholas	12 Feb – 20 Feb	80	1	TS
6	Cyclone Ophelia	1 Mar – 6 Mar	65	1	-
7	Cyclone Pancho	24 Mar – 29 Mar	95	2	-
8	Tropical Storm Rosie	21 Apr – 24 Apr	45	TS	-

Sources:
Unisys Weather: http://www.weather.unisys.com/hurricane/s_pacific/2007/index.html
Unisys Weather: http://www.weather.unisys.com/hurricane/s_pacific/2008/index.html
Unisys Weather: http://www.weather.unisys.com/hurricane/s_indian/2008/index.html
Tropical Storm Risk:http://www.tropicalstormrisk.com/

Of the two tropical cyclones that made landfall on the Australian mainland, none caused major damage or disruption.

Australian Region Tropical Cyclone Forecasts for 2008/2009

TSR's final monthly tropical cyclone forecast for the Australian region in 2008/09 was issued on 4 December 2008.[24] This forecast spans the Australian season from 1 November 2008 to 30 April 2009 and is based on data available through to the end of November 2008. TSR expects tropcial cyclone activity and landfalling numbers to be above-average during 2008/2009.

Forecast numbers for storm development and landfalling numbers in the Australian region during the 2008/2009 season are shown in the table below.

Australian Region Tropical Cyclone Forecast for 2008/2009 and Predicted Lanfalling Numbers

	Tropical Storms	Severe Tropical Cyclones
31-year Climate Norm Data ± SD (data from 1975/6 – 2007/8)	10.6 ± 3.5	5.7 ± 2.3
TSR Forecast ± FE† (2008/9)	**12.2 ± 2.9**	**6.5 ± 2.1**
Average landfalling numbers ± SD (data from 1975/6 – 2007/8)	4.5 ± 2.1	-
TSR Forecast 2008/9 TC Landfalling numbers ± FE	**5.2 ± 2.0**	**-**

†: FE = Forecast Error
Source: Saunders, M. & Lea, A., 2008. December Forecast Update for Australian-Region Tropical Storm Activity in 2009/9. http://www.tropicalstormrisk.com/

Separately, Australia's Bureau of Meteorology (BoM) released a Tropical Cyclone Seasonal Outlook for the states of Queensland and the Northern Territory in October 2008. The BoM said it expects slightly above average activity for both states in the 2008/2009 season. [25]

Australian Region Tropical Cyclone Forecasts for 2009/2010

For the 2009/2010 tropical cyclone season, the Guy Carpenter Asia Pacific Climate Impact Centre (GCACIC) is planning to develop tropical cyclone development forecasts for the Southern Hemisphere basins, including the South Indian Ocean, the Southwest Pacific and the Australian region. These forecasts will be available at http://www.cityu.edu.hk/gcacic/.

24 Saunders, M. & Lea, A., 2008. December Forecast Update for Australian Region Tropical Storm Activity in 2009/9. http://www.tropicalstormrisk.com/
25 http://www.bom.gov.au/announcements/media_releases/qld/20081020.shtml
http://www.bom.gov.au/announcements/media_releases/nt/20081020.shtml

Glossary of Terms

Hurricane/Typhoon – An intense tropical weather system of strong thunderstorms with a well-defined surface circulation (one-minute sustained windspeed greater than 63 knots (73 mph). The term hurricane is used for Northern Hemisphere cyclones east of the International Dateline to the Greenwich Meridian. The term typhoon is used for Pacific cyclones north of the Equator west of the International Dateline. [26]

Hurricane Season – The portion of the year having a relatively high incidence of hurricanes. The hurricane season in the Atlantic, Caribbean, and Gulf of Mexico runs from 1 June to 30 November. The hurricane season in the Northeast Pacific basin runs from 15 May to 30 November. [27]

Major or Intense Hurricane/Typhoon – Hurricanes or typhoons with one-minute sustained windspeeds greater than 95 knots or 110 mph.

Saffir-Simpson Scale – A measurement scale ranging from Category 1 to Category 5 of hurricane/typhoon wind and ocean surge intensity; Category 1 is a weak hurricane/typhoon, whereas Category 5 is the most intense. Category 3 to Category 5 magnitudes indicate a major or intense hurricane/typhoon.

Summary of 2007/2008 Australian Tropical Cyclones. NB only named cyclones are shown.

Category	Central Pressure (mb)	Windspeed (knots)	Windspeed (mph)	Storm Surge (ft)	Damage
Tropical depression	-	<33	<38	-	-
Tropical storm	-	>33	>38	-	-
Category 1	>980	64-82	74-95	4-5	Minimal
Category 2	980-965	83-95	96-110	6-8	Moderate
Category 3	964-945	96-113	111-130	9-12	Extensive
Category 4	944-920	114-135	131-155	13-18	Extreme
Category 5	<920	>135	>155	>18	Catastrophe

Source: NOAA-NCEP

26 NOAA
27 NOAA-NCEP

Tropical Depression – An organised system of clouds and thunderstorms with a defined surface circulation (wind speeds less than38 mph but generally greater than 20 mph to 25 mph).

Tropical Cyclone – A non-frontal, warm-core, low-pressure system of synoptic scale, developing over tropical or subtropical waters and having a definite organised circulation. Rotates anti-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Includes hurricanes, typhoons, tropical storms and other weaker rotating vortices.

Tropical Storm – An organised system of strong thunderstorms with a defined surface circulation (one-minute sustained wind speeds greater than 33 knots (38 mph)).

Throughout 2008, Guy Carpenter's Instrat® unit published some 70 reports on global tropical cyclones and their associated losses. Instrat's CAT-i reports were circulated to more than 2,500 subscribers.

For further details, please contact CAT.i@guycarp.com, or go to our Cat Central website at http://www.guycarp.com/portal/extranet/insights/catcentral.html.

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Guy Carpenter Briefing