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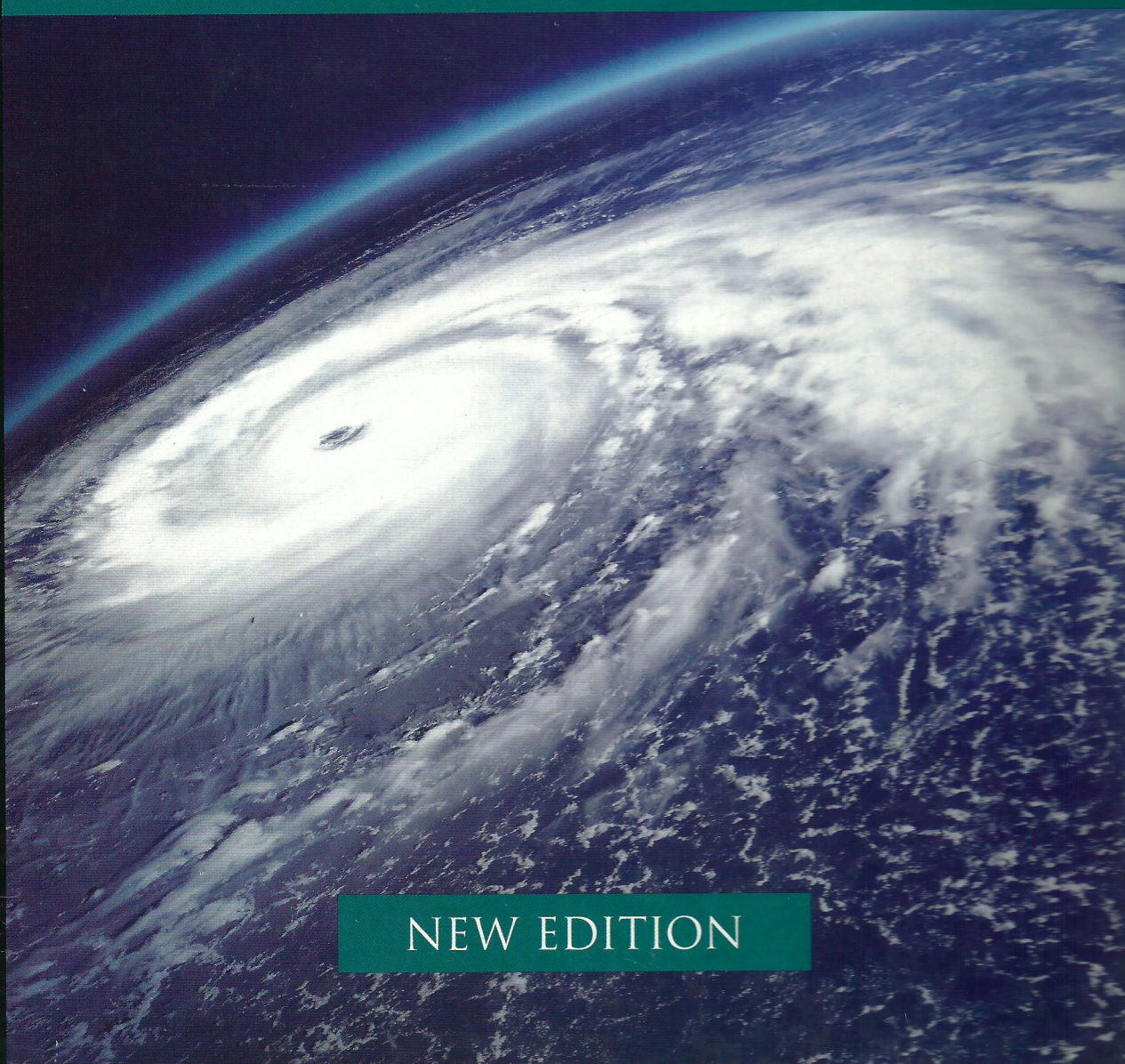
ENCYCLOPEDIA OF HURRICANES, TYPHOONS, AND CYCLONES

DAVID LONGSHORE



NEW EDITION

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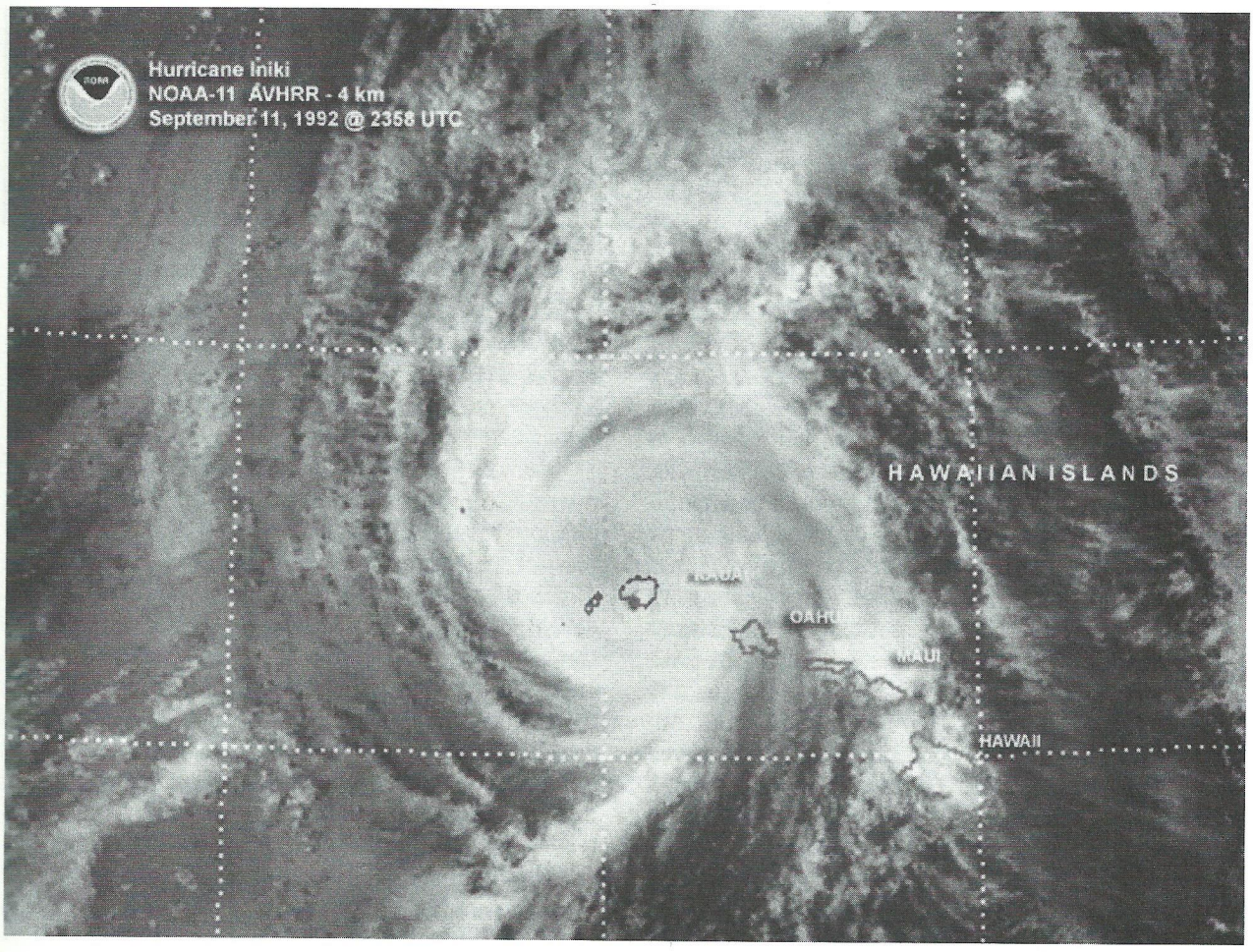
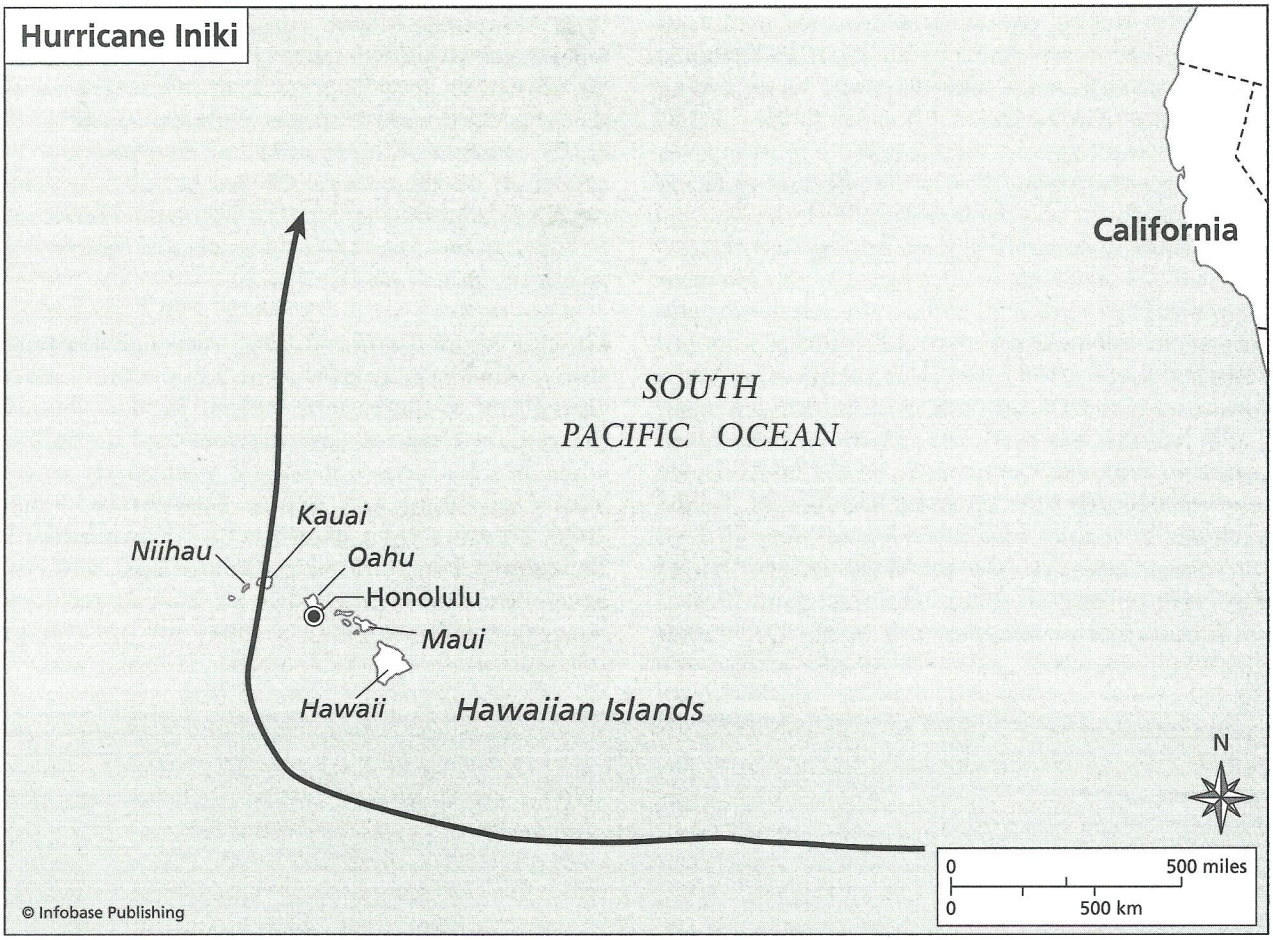
sailors aboard the cruiser were drowned. Although the hurricane was a rainmaker almost from birth, the rapidity of its passage over Bermuda, while adding the strength of its STEERING CURRENTS to the system's sustained wind speeds, denied it the opportunity to linger over the island, thereby significantly reducing drowning deaths and damage from flash floods.

Seemingly committed to its northeasterly trajectory on the morning of October 23, the Havana-Bermuda Hurricane had, by late afternoon, abruptly slowed its forward speed to 22 MPH (35 km/h). Centered some 1,400 miles (2,253 km) east of Cape Hatteras, NORTH CAROLINA, and quickly diminishing in strength, the hurricane penetrated as far north as the 40th parallel before sharply altering its course *southeast* shortly after dawn on October 24. By the evening of October 27, after having described an enormous loop over the mid-Atlantic, the EYE of the Havana-Bermuda Hurricane was again located off Florida's east coast, this time nearly 2,000 miles (3,219 km) from Miami. Turning northeast, the system passed within 700 miles of Bermuda on October 28, crossed its previous track at nearly a right angle, then shot northward at speeds of almost 30 MPH (48 km/h). Situated off Newfoundland, CANADA's northeast coast on the evening of October 29, the rain-riven remains of the Havana-Bermuda Hurricane finally dissolved over the cold reaches of the NORTH ATLANTIC OCEAN on October 30.

Hawaii ***North Pacific Ocean*** Although Hawaii's 130 volcanic islands span some 1,500 stormy miles (2,414 km) of the eastern NORTH PACIFIC OCEAN, the verdant chain of coral lagoons and crystalline white beaches does not have a particularly active history of HURRICANE strikes. Between 1837 and 2006, Hawaii's eight main islands—Hawaii, Maui, Kahoolawe, Lanai, Molokai, Oahu, Kauai, and Niihau—were directly affected by at least 20 recorded hurricanes and TROPICAL STORMS for an average



As Hurricane Andrew was preparing for its devastating 1992 visit to Florida, a slightly less powerful Hurricane Iniki was landing in the Hawaiian Islands. Causing destruction across the islands with its 135 MPH winds, Iniki killed six people and ran up a tab totaling more than 1 billion dollars. ***(NOAA)***



One of the most intense hurricanes in Hawaiian history, Iniki caused widespread property losses when it blasted ashore in 1992.

of one TROPICAL CYCLONE every eight years. Of these, only six were considered major hurricanes, storms with CENTRAL BAROMETRIC PRESSURES of 28.47 inches (964 mb) and lower, and wind speeds in excess of 111 MPH (179 km/h). In 1959 and 1960, Hawaii sustained destructive strikes from two tropical storms, Dot (August 8, 1959) and Hiki (August 12–16, 1960). The first recorded tropical cyclones to strike the archipelago in consecutive years, both storms delivered staggering 52-inch (1,320-mm) rainfalls to the island of Kauai, causing serious flash floods along Waimea River banks. One person was killed during Tropical Storm Hiki, while Dot's 60-MPH (97-km/h) winds and deluging rains destroyed much of the island's rich macadamia nut harvest.

In one respect, Hawaii's dearth of hurricane activity is rather surprising. Positioned between latitudes 19 and 29 degrees North, the scythelike spread of the Hawaiian Islands shares roughly the same parallels as storm-ridden regions of the globe, including the Caribbean basin, the Arabian Sea and BAY OF BENGAL, and those western Pacific waters north of the PHILIPPINES known as TYPHOON ALLEY. Surrounded by warm, 80°F (27°C) oceans that spawn on average seven tropical cyclones per June-to-mid-November season, it would stand to reason that Hawaii would have as extensive a history of hurricane activity as FLORIDA, CUBA, or BANGLADESH.

But the islands do not, again partly because of their location near the center of the North Pacific Ocean. During the months (August through November) of peak hurricane generation in the eastern North Pacific, large high-pressure ANTICYCLONES develop near latitude 30 degrees North or in those waters adjacent to the Hawaiian Islands. Because anticyclones like the BERMUDA HIGH are known to influence the tracks of respective hurricanes, the dominating presence of similar anticyclones north of Hawaii has a tendency to deflect incoming North Pacific hurricanes southwest, thus sparing the popular resort islands the fury of storms that have historically been of tremendous intensity. Born in the east over the undulating feeding grounds off northern MEXICO's northern coast, most North Pacific hurricanes follow a westward course, passing several hundred miles south of Hawaii before blowing themselves out over the central Pacific. While in some cases, such as that of 1994's Hurricane JOHN, the

Hawaiian Islands have been affected by the light rains, gusty winds, and heavy surf associated with a passing hurricane's fringe, a majority of North Pacific storms leave Hawaii's fragile ecosystem unscathed.

No climatological shield, however, is entirely consistent, and it is during those early summer and out-of-season months when the Hawaiian anticyclones are at their weakest—or absent altogether—that Hawaii has endured some of its most memorable hurricane strikes. On November 7, 1837, a fierce, late-season hurricane roared into Hilo on the island of Hawaii's southeast coast, toting 114-MPH (184-km/h) winds and an enormous STORM SURGE. Hundreds of BUILDINGS in the foundling city were destroyed, leaving an estimated 730 people either dead or missing. During the first week of April 1868, a preseason hurricane at Molokai swept away the coastal whaling villages of Keauhou and Punalu. As the hurricane's furious winds scalped a nearby mission's thatched roofs, four whaling vessels that had called at Keauhou for fresh provisions were driven aground and wrecked. Hundreds of casks of whale oil were either washed ashore intact (where they were quickly looted) or smashed against the coral entrances to the harbor. Nearly 100 people died as the hurricane's storm surge—estimated by survivors to have been some 16 feet (5 m) high—completely inundated the two communities, spreading a thick pall of whale oil and wreckage for miles across the tropical countryside.

More recently, postseason Hurricane Iwa brought 110-MPH (177-km/h) winds and torrential rains to the islands of Kauai and Oahu on November 24, 1982. Although Iwa's actual wind speeds were in the vicinity of 80 MPH (129 km/h), the hurricane's 30-MPH (48-km/h) STEERING CURRENT boosted windspeeds in the storm's DANGEROUS SEMICIRCLE to more than 100 MPH (161 km/h). One person was killed and $200 million in property damage was assessed in what was considered the most severe hurricane to have struck Hawaii in 23 years.

Nearly a decade later, on September 11, 1992, the Aloha State was visited by its first "billion-dollar" gate-crasher, Hurricane INIKI. Raging across Kavai's western slopes, Iniki's sustained 130-MPH (210-km/h) winds damaged more than 20,000 buildings and left 8,000 residents homeless. Five people on the island were killed and some $1.8 billion in damage was assessed in what was then dubbed the most severe hurricane to have struck Hawaii in the 20th century.

Hawaii is the only state in the United States to be honored with its own list of HURRICANE NAMES. Officially deemed the "Central Pacific List," its six columns of eight names apiece nonetheless feature only Hawaiian male and female first names.

On September 2, 2003, Tropical Storm Jimena sped away from Hawaii at about 18 MPH (29 km/h); at this time, the system was located about 390 miles (624 km) south-southwest of Honolulu. Sustained winds were clocked at 45 MPH (72 km/h). While the system did not directly affect the Hawaiian islands, its trajectory indicates the dangers associated with tropical cyclone activity in the central North Pacific Ocean.

In August 2003, Hurricane Jimena originated as a tropical depression on August 28, and achieved hurricane intensity during the late evening hours of August 29. Generating sustained winds of 105 MPH (169 km/h), prompting hurricane watches to be posted for the Big Island of Hawaii. If Jimena were to strike Hawaii, it would be the island's first direct strike since Hurricane Iniki devastated the idyllic chain in September 1992. Although Jimena weakened into a tropical storm as it passed south of the Big Island of Hawaii on September 1, maximum sustained winds on September 1 were measured at 39 MPH (63 km/h)—with gusts to 53 MPH (85 km/h)—at South Point. As many as 1,500 people lost electricity on the Big Island and rainfall amounts ranged from 3.74 inches (95 mm) at the Hilo airport to 6.42 inches (163 mm) in the Mountain View area.

During the last week of September 2005, the tropical depression remnants of eastern North Pacific Ocean Hurricane Kenneth (at one time a Category 4 tropical cyclone) delivered torrential rains to Oahu and Kauai islands, causing flash floods and streams to top their banks.

On August 14, 2007, a weakening Hurricane Flossie brought sustained winds of 45 MPH (72 km/h) and heavy surf conditions to the big island of Hawaii. At one time a Category 4 hurricane with a lowest observed central pressure of 27.95 inches (946 mb), Flossie's approach prompted the hoisting of hurricane watches and tropical storm warnings across the southern shores of the island chain, as well as the closing of the port of Hilo. Pushed southward by a high-pressure ridge to the north, Flossie moved past the big island and steadily weakened, finally becoming a tropical depression during the late evening hours of August 15. No deaths, injuries, or property damage were recorded.

Hazel, Hurricane ***Northeastern Caribbean–United States–Canada, October 5–16, 1954*** One of the most eccentric—yet destructive—Category 4 hurricanes on record, Hazel spent nearly two weeks weaving an erratic path of devastation through the island of HISPANIOLA, the southern BAHAMAS, the eastern seaboard of the United States, and portions of southern CANADA between October 5 and 16, 1954. In western Haiti, where Hazel came ashore as a TROPICAL STORM on October 12, fearsome 100-MPH (161-km/h) gusts killed at least 98 people and

In the Haitian port towns of Jacmel and Bathet, Inez's sweeping gusts snapped palm trees, tore storm shutters from windows, turned front porches into flying carpets, and sent undulating waves crashing against towering headlands. Torrential 12-inch (305-mm) downpours quickly converted southern Haiti's mountain gorges into a watery web of deadly rivers, floods, and landslides that soon added tons of mud and wreckage to the frothing torrents below. Strewn with hundreds—possibly even thousands—of human and ANIMAL corpses, these impromptu rivers eventually emptied into the CARIBBEAN SEA, littering miles of Haiti's coastline with their gruesome cargo. All told, some 1,379 people perished during Inez's northwesterly passage over Hispaniola, 200 in the Dominican Republic and the remainder in Haiti. Another 2,200 were injured in both nations, many of them seriously.

Considerably weakened by its assault on Hispaniola, Inez slowly spiraled northwest, delivering 81-MPH (130-km/h) winds and sporadic rain showers to Cuba's eastern Oriente Province on the morning of September 30, 1966. Although several buildings and a water tank near the Guantánamo naval base were damaged, Inez's initial landfall in Cuba claimed no lives. Widespread destruction of that season's sugarcane harvest was reported, however. Struggling inland, Inez spent the next two days executing a clockwise loop-the-loop course change over the island. At one point exiting southern Cuba altogether near the city of Cienfuegos, Inez finally came full circle on October 2, at a spot that put its Category 1 EYEWALL south of Miami, Florida. Maximum winds of 79 MPH (127 km/h), violent rain squalls, and at least one confirmed TORNADO buffeted the BAHAMAS as Inez, stalled for most of October 2 by an encroaching high-pressure AIR MASS, sought a STEERING CURRENT to carry it on its way.

After killing one person in the northern Bahamas on the morning of October 3, Inez began to drift languidly west. Quickly reintensifying as it bore down on the delicate coral chain of the Florida Keys, Inez crossed into the GULF OF MEXICO later the same day as a Category 3 hurricane of extreme intensity. Still under the influence of the high-pressure ridge, Inez battered Key West and the Dry Tortugas with 125-MPH (201-km/h) winds, flooding PRECIPITATION counts, and crushing 12-foot (4-m) seas. Five Floridians perished, one of them a teenage surfer.

Churning to the west-northwest at the pedestrian speed of 6 MPH (10 km/h), it would take Hurricane Inez another eight days to reach Mexico's east coast. There, on the afternoon of October 11, 1966, the 110-MPH (177-km/h) eyewall winds of Inez lurched ashore approximately north of the port city of Tampico. Hurricane-force winds and pounding rains uprooted trees and inundated swamps but caused no fatalities. By the afternoon of October 12, as the last of Inez's core thunderstorms dissipated over central Mexico, the storm was gone forever. Lasting a total of 18 days, claiming nearly 2,000 lives, and inflicting tens of millions of dollars in property losses, Inez proved itself to have been among the most notable of contemporary hurricanes. The name *Inez* has since been retired from the cyclical list of HURRICANE NAMES.

Iniki, Hurricane *Hawaii, September 6–11,1992*
The first "billion-dollar" HURRICANE in Hawaiian history, Iniki lashed the northwestern islands of Niihau, Kauai, and Oahu with sustained 130-MPH (209-km/h) winds, 3–6-inch (76–152 mm) rainfall counts, and 30-foot (10 m) seas on September 11, 1992. Boasting a CENTRAL BAROMETRIC PRESSURE of 27.91 inches (945 mb) at landfall on Kauai, Iniki was the first Category 3 hurricane to strike the archipelago since November 1982, when Hurricane Iwa's 111-MPH (179-km/h) winds destroyed some 2,325 BUILDINGS on Kauai and Oahu, killing one person. A more intense storm than Iwa, Iniki leveled more than 10,000 buildings on Kauai and severely damaged several high-rise hotels in neighboring Oahu. While only five fatalities were reported, Iniki's $1.8 billion price tag immediately deemed the storm the most destructive Hawaiian hurricane of the 20th century

The only TROPICAL CYCLONE of the 1992 Hawaiian HURRICANE SEASON, Iniki developed over the shimmering waters of the eastern NORTH PACIFIC OCEAN, south-southeast of the big island of HAWAII, on the evening of September 6. Steadily curling northwest at nearly 15 MPH (24 km/h), the young TROPICAL DEPRESSION gradually sapped the ocean of its heat and moisture, graving into a weak TROPICAL STORM on the afternoon of September 8 and a minimal Category 1 hurricane, with a central barometric pressure of 28.96 inches (980 mb), by midday on September 9. Maximum sustained winds in Iniki's EYEWALL now measured 82 MPH (132 km/h), while heavy rains pelted the swirling maelstrom below.

In HAWAII, where painful memories of hurricanes Iwa and Dot (1959) made subsequent central Pacific storms a matter of significant concern, forecasters promptly set to work tracking Iniki's progress toward the islands. Even though Iniki was still several hundred miles from Hawaii, comprehensive computer ANALOGS based on climatological data and the documented behavior of earlier hurricanes indicated that the tropical cyclone had every opportunity not only to reach the state but also to grow into a major storm

along the way. TEMPERATURE readings taken from the central Pacific revealed that the large pools of cool water that normally surround the Hawaiian Islands were mostly absent that season, removing one of the two natural buffers that tend to moderate Hawaii's hurricane activity. The other buffer, the high-pressure ANTICYCLONE that forms just north of the islands each summer, was similarly weak, thereby allowing a hurricane of considerable size and intensity to recurve northwest instead of maintaining the trade winds' passage due west.

On the morning of September 10, as Iniki wobbled northwest, lashing the sea with 100-MPH (161-km/h) winds and moderate rains, Hawaiians commenced the long, expensive task of preparing for a major hurricane strike. Although weather analysts were still not certain exactly where Iniki's EYE would come ashore, all coastal resorts on Oahu and Kauai were nonetheless evacuated early, costing hotel, restaurant, and store operators millions of dollars in lost revenue. While a fleet of buses and cars shuttled thousands of vacationers to cramped storm shelters further inland, hotel work crews began to drain swimming pools, to stow away beach umbrellas and deck chairs, and to board up panoramic plate-glass windows. Rows of shuttered storefronts turned Honolulu's streets into empty canyons, veritable echo chambers for the rising northeast winds. In Pearl Harbor, two nuclear-powered aircraft carriers, along with ten other vessels belonging to the United States Navy, wisely recalled their liberty details, piped their personnel to General Quarters, and then steamed to sea. Unable to remain in port for fear that Iniki's 25-foot (8-m) waves would drive the ships against their piers, the hastily collected squadron escaped west-southwest, spending the storm's duration safely wallowing in the 37-foot (9 m) swells kicked up by Iniki's distant northwest passage.

With a central barometric pressure of 27.91 inches (945 mb) at landfall, Hurricane Iniki roared into the island of Kauai, north of the town of Kapaa, on the afternoon of September 11, 1992. As 145-MPH (233-km/h) gusts shivered the 5,000-foot (1,600-m) slopes of Mount Kawaikini, Iniki's 4–6-inch (102–152-mm) rains pelted roofs, carports, billboards, and palm groves, making an incongruous concert of the bangs, booms, rattles, and scrapes that now and again could be heard over the wind's dull scream. Those principal settlements located on the mountain's windward side Lihue, Koloa, and Princeville—bore the brunt of Iniki's southeasterly approach. Thousands of dwellings, from multimillion-dollar beachfront mansions to humble bungalows tucked into the forests of Kawaikini, were progressively pried apart by the hurricane's sustained 130-MPH (210-km/h) winds. More than 8,000 people, their houses in ruins, were forced out into the storm, compelled to find refuge in cars, local police and fire stations, schools, factories, and churches. When Iniki stripped the roof from a school near Haena Point, dozens of evacuees found themselves displaced once more. Huddled on a bus, some debated how much longer the vehicle would remain upright in the buffeting winds. Because driving it to another shelter was out of the question, they decided to arrange themselves so as to balance the swaying bus against the wind and wait out the storm. They survived.

Five other Hawaiians did not, however, making Iniki the deadliest hurricane to have pounded the islands since a preseason tropical cyclone on April 2, 1868, killed nearly 100 people on Molokai. In a year that had already seen Hurricane ANDREW rampage through south FLORIDA and LOUISIANA to the record-breaking tune of $20 billion, and Typhoon Omar (August 28) destroy almost every building on the U.S., held island of Guam, Iniki's $1.8 billion in property and agricultural losses could only seem a fitting, if relatively modest, finale to such a costly storm season. Quickly responding to the tragedy, President George Bush declared Oahu, Kauai, and Niihau disaster areas on September 12; Congress drafted a record $11.1 billion relief bill for survivors of the three storms. Criticized for adding to the federal deficit, the bill was eventually signed into law on September 23, the day the World Meteorological Organization announced that the name Iniki was being retired from the alternating list of central Pacific HURRICANE NAMES.

intertropical convergence zone Sometimes referred to as the equatorial TROUGH, the intertropical convergence zone (ITCZ) is the zone where Earth's two atmospheric hemispheres (north and south) come together. Better known in layman's parlance as the doldrums, the ITCZ is also where the Northern Hemisphere's easterly trade winds meet the Southern Hemisphere's easterly trade winds, thus providing a circulatory environment favorable for TROPICAL CYCLONE generation. The trade winds themselves are a result of the clockwise-spinning, high-pressure ANTICYCLONES that dominate circulation patterns over the Atlantic, Pacific, and Indian oceans.

Satellite photographs taken of Earth clearly indicate the climatological dimensions of the ITCZ, show it to contain a fairly regular progression of cumulus and CUMULONIMBUS cloud clusters moving from east to west over Central America and across the NORTH PACIFIC OCEAN to the BAY OF BENGAL and North Africa. Determined in part by the size and position of the winter and summer anticyclones, the parameters of the ITCZ will often migrate, shifting from north to south and back again within the