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November 4, 2010

U.S. Nuclear Regulatory Commission
Rulemaking and Directives Branch
Office of Administration
11545 Rockville Pike
Rockville, MD 20852-2739

Subject: Bechtel Comments on DG-1247

Attached for your consideration are comments on Draft Regulatory Guide DG-1247, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants."

Please refer any follow-on questions related to these comments to the undersigned at (301) 228-8987 or to Dr. Y.J. Lin at (301) 228-7642.

Sincerely,

Desmond Chan, Ph.D.
Chief Nuclear/Environmental Engineer

SUNSI Review Complete

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Comments on Draft Regulatory Guide DG-1247
Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants

Currently, NRC expectation for COLA content includes the applicant's presentation of a historical maximum or the 100-year return values for hurricane velocities at the proposed site, using the more limiting value to characterize the site. Our involvement in these recent COLA preparations has resulted in our examination of a significant portion of the hurricane historical database, and we are concerned that the methodology used to develop DG-1247 has resulted in a significant departure from historical wind speed data and has significantly extended these wind speeds inland, well beyond what has been observed. The following observations are intended to present the level of conservatism that we have observed and to offer possible explanations within the methodology that could have lead to these conservatisms.

1. In the five coastal regions[1] the design-basis gust winds provided in DG-1247 are often more than 30% higher than the HURDAT wind speed values obtained from historically significant hurricanes. Table 1 summarizes the significant storms that were investigated for this study. This set was selected based on damage caused at landfall and damage during the inland progress of the storm. Storm tracks are provided in attached Figures 1a - 1m, and the proposed contours from DG-1247 are superimposed on these figures. Consideration should be given to calibration of the 10^{-7} per year gusts to historical values for land-falling wind speeds.

2. The hurricane database is much smaller than that for tornados. Because a relatively small dataset raises the potential for any extrapolation to compound the uncertainty of the result, the repeated extrapolations required to generate values for frequencies of 10^{-7} per year from a dataset with a period of record of 10^{2} years risk becoming overly conservative based on the historical record. Further, the impacts of the short period of record may be further amplified by the relative (spatial and temporal) scarcity of data points within the database.

3. Related to items 1 and 2, for land-falling hurricanes in NUREG/CR-7005 (Reference 12) unrealistic translation wind speeds might have been used. For higher probability events, this limitation is not evident (see Figures 2-24 and 2-25 of Reference 12 or Figure 6-1 of Reference 5). At low frequency (10^{-6} or 10^{-7} per year), the wind speed values appear to have unrealistic behavior. Figure 2 shows contours of maximum estimated wind speeds from land-falling Category 3/4/5 hurricanes (Reference 1); these contours exhibit sharper gradients of wind speed than the contours from DG-1247. Using HURDAT data, Table 2 presents maximum landfall 3-second gust wind speed for Category 3 and above hurricanes.

Simplified HURDAT data were examined for Category 4 and 5 storms for storm motion. Storms with more rapid forward movement tend to have direction changes to the east, accelerating forward motion immediately preceding rapid decreases in intensity. These are indicative of hurricane interaction with mid-latitude troughs and weakening. The rapid decrease in intensity of these observed storms suggests that while some storms can be observed to have this high forward speed, this subset would be weakening prior to landfall, and the subsequent loss of inflow after landfall would decrease the overall intensity faster than the DG-1247 model predicts. In general, it has been

[1] Texas, Louisiana/Mississippi, Florida, Southeastern Atlantic, and New England

concluded that hurricane wind speeds in flat terrain decrease by about 15% in the first 15 km from the coast (Reference 14).

This argument suggests that the entire range of possible hurricane translation speeds should not be used as inputs to creating the maximum wind speeds. Entrainment of dry air and loss of inflow for land-falling storms is such that strong storms cannot persist to transfer the high winds as far inland as DG-1247 suggests. These effects do not appear to be discreetly accounted for in the methodology described in NUREG/CR-7005 (Reference 12).

Additional Minor Comments

- There are 2 typographical errors on pages 28 and 30 (one each) of NUREG/CR-7005, where the unit conversion for the wind speed bin width (5 mph) is incorrectly presented. It should be 2.23 ms^{-1} (or 2.2 ms^{-1} if being generalized), not 2.5 and 4.5 ms^{-1}, respectively.

- Suggest providing state boundaries in Figures 1 through 3 of DG-1247, because storm data can be conveniently sorted by state from the NCDC NOAA storm events database. It is difficult to see state boundaries among the many county boundaries, unless some method of contrast is introduced.

Table 1. Significant US Hurricanes Landfalls.

Storm	Category at Landfall	Sustained Wind (mph)[a]	Gust Wind (mph)[b]	DG-1247 10^{-7} (10^{-6}) Speed (mph)	Difference vs Observed 10^{-7} (10^{-6})	Notes (From Ref. 9 unless otherwise noted).
New England						
Carol ('54)	2	98	119	190 (180)	+60% (+34%)	Name retired retroactively after Carol ('65). Peak measured gust of 130 mph in Block Island RI, (ref 8).
Edna ('54)	1	92	112	190 (180)	+50% (+61%)	Name retired retroactively after Edna ('68). Peak measured gust of 95 mph at Brookhaven National Lab (ref 8).
Donna ('60)*	2	104	127	190 (180)	+50% (+42%)	Sustained winds of 90 kts on Long Island, gusts of 100 kts (115 mph) or higher were reported at Montauk Long Island & Block Island RI. Sustained wind was less than Hurricane force through most of NE, except for 80 kts (92 mph) & gusts of 120 kts (138mph) at Blue Hill Observatory at Milton MA, (ref 8).
Gloria ('85)	2	104	127	180 (170)	+43% (+34%)	Islip, NY 38 ms^{-1} (85 mph) gust, Bridgeport, CT 33 ms^{-1} (74 mph) sustained (1-minute), 41 ms^{-1} (92 mph) gusts, Westerly Airport (RI) gust of 41ms^{-1} (92 mph), Blue Hill, MA 37 ms^{-1} (83 mph),and Chatham (CG), MA, 30 ms^{-1} (67 mph) with gusts of 49 ms^{-1} (109 mph)
Southeast Atlantic						
Hazel ('54)	3	127	154	220 (210)	+43% (+36%)	Gusts of 98 mph at Wilmington NC, & 106 mph gust at Myrtle Beach SC, (ref. 8).
Hugo ('89)	4	138	169	230 (220)	+37% (+30%)	SC: Charlestown City sustained at 39 ms^{-1} (87 mph) with gusts to 49 ms^{-1} (107 mph), Charlestown WSO 35 (78 mph) with gusts to 44 ms^{-1} (98 mph), Columbia AT&T gusts of 44 ms^{-1} (107 mph), Mt. Pleasant 37 ms^{-1} (83 mph) sustained wind with gusts to 43 ms^{-1} (96 mph), Ship Snowgoose on Sampit River had sustained winds of 54 ms^{-1} (121 mph) at 18.5 meter (60.7 feet), Shaw AFB had sustained winds of 30 (67 mph) and gusts to 49 ms^{-1} (107 mph). Charlotte, NC sustained winds of 31 (69 mph) and gusts to 44 ms^{-1} (98 mph).
Florida						
Donna ('60)*	4	H: 138 L: 131[6]	H: 169 L: 159[6]	260 (250)	+54% (+48%) +64% (+54%)	Revised wind speed from Reference 6. is 120 kts (138 mph) at landfall (Naples, FL), which would suggest a 3-second gust of 146 kts (169 mph). Momentary gusts of at least 155 kts (178 mph) over the FL Keys. Sustained winds of 90 kts (104 mph) & gusts from 100 kts (115 mph) to 130 kts (150 mph) (ref 8). Re-analysis suggests wind speeds should be somewhat decreased, but HURDAT has not yet been updated to reflect this (ref. 2 & 6).
Wilma ('05)	3	H: 127 L: 121[7]	H: 155 L: 147[7]	270 (250)	+75% (+61%) +84% (+41%)	2W TNT FCMP tower 77 kts (89 mph) sustained wind with gusts to 101 kts (116 mph), Belle Glade SFWMD 68 kts sustained (102 mph) sustained with gusts to 102 kts (117 mph), Cache RAWS 57 kts (66 mph)sustained with gusts to 97 kts (112 mph), Chekika RAWS 67kts (77 mph) sustained with gusts to 98 kts (113 mph), FCMP Tower 0 - 63kts (73 mph) with gusts to 82 kts (94 mph), FCMP Tower 2 – 71 kts (82 mph) sustained with gusts to 95 kts (109 mph) and KFLL 61 kts (70 mph) sustained with gusts to 86 kts (99 mph).
Andrew ('92)*	5	H: 150 L: 167[4]	H: 183 L: 204[4]	260 (250)	+42% (+37%) +27% (+23%)	NHC gust estimates were "...likely to be on the order of 160-170 kts (184-196 mph), based on typical gust factors ... " (ref. 4). Andrew was in the process of rapid intensification when it made landfall in FL. See Reference 4 for details.
Charley ('04)	4	H: 144 L: 150[7]	H: 176 L: 183[7]	260 (250)	+48% (+42%) +42% (+37%)	Peak wind gusts were observed at Charlotte County airport at 139 kts (160 mph) and Charlotte County Medical Center 150 kts (173 mph).

Table 1. Significant US Hurricanes Landfalls (cont.).

Storm	Category at Landfall	Sustained Wind (mph)[a]	Gust Wind (mph)[b]	DG-1247 10^{-7} (10^{-6}) Speed (mph)	Difference vs Observed 10^{-7} (10^{-6})	Notes (From Ref. 9 unless otherwise noted).
Louisiana – Mississippi						
Katrina ('05)	3	127	155	270 (250)	+76% (+61%)	Buras ULM 2-m tower observed 73 kts (84 mph) sustained, gust to 93 kts (107 mph), Lake Pontchartrain NWS, 68 kts (78 mph)sustained with gusts to 93 kts (107 mph), New Orleans International LLWAS 85 kts (98 mph) at 120-ft, Slidell TTU had 61 kts (70 mph) sustained with gusts to 87 kts (100 mph), Stennis TTU had 59 kts (68 mph) sustained with gusts to 102 kts (117 mph).
Rita ('05)	3	115	141	230 (220)	+63% (+56%)	LA: Johnson Bayou ULM 61 kts (70 mph) sustained with gusts to 79 kts (91 mph), Lake Charles WFO 83 kts (96 mph) gusts. TX: KBPT 70 kts (81 mph) sustained wind with gusts to 91 kts (105 mph), Nederland FCMP 57 kts (66 mph) sustained with gusts to 80 kts (92 mph), Orange FCMP 65 kts (75 mph) sustained with gusts to 85 kts (98 mph), Port Arthur FCMP sustained winds at 82 kts (94 mph) with gusts to 101 kts (116 mph) and Port Arthur TTU sustained wind at 81 kts (93 mph) with gusts to 101 kts (116 mph).
Andrew ('92)*	4	H:115 L:121[4]	H:141 L:147[4]	260 (240)	+84% (+70%) +77% (+63%)	Landfall wind speed for Andrew in LA from Andrew Reanalysis (ref 4).
Betsy ('65)	4	155	189	260 (240)	+37% (+27%)	Peak measured wind of 69 mph (fastest mile or one minute) sustained wind and 112 mph gust at New Orleans WBAS station. Estimated gusts of 160 mph gusts at Grand Isle, LA and 128 mph at Morgan City LA.
Camille ('69)	5	190	232	270 (250)	+16% (+8%)	Wind speeds near coast were probably gusts to 175 kts (201 mph) based on post event damage analysis. No aircraft and limited surface data was available for the peak wind analysis when the storm made landfall (ref. 8). Columbia, MS, 120 mph fastest mile wind speed with 135 mph gust before instrument was disabled; Keesler AFB recorded 81 mph fastest mile wind with gusts to 129 mph, Bogalusa LA recorded gusts of 100 mph before anemometer failed, Boothville, LA (WBO) recorded gusts of 107 mph before power failure interrupted data collection, Lakefront Airport (LA) recorded fastest mile speed of 87 mph and 109 mph gust.
Texas						
Carla ('61)	4	144	176	220 (210)	+25% (+19%)	175 mph gust estimated at Port Lavaca, TX. Measured gust of 153 mph at Bauer Dredging Company (Port Lavaca, TX) before instrument failed. Figure 11 of MWR article (March 1962) has contour maps of max winds, see Figure 1f.
Allen ('80)	3	H: 127 L: 115[7]	H: 155 L: 141[7]	220 (210)	+43% (+35%) +56% (+49%)	Port Mansfield, TX observed 104 kt (120 mph) gust.
Alicia ('83)	2	115	141	220 (210)	+56% (+49%)	USCG cutter Buttonwood at east end of Galveston Island observed 43 ms^{-1} (96 mph) fastest mile speed with gusts of 56 ms^{-1} (125 mph). Figure 4 of MWR article contains contour maps of max winds.
Celia ('70)	3	127	155	220 (210)	+43% (+35%)	Nueces County (Corpus Christi), TX observed the following wind speeds: Lipan St CPL (Central Power and Light Company) 143 mph gust, NAS 120 mph gust, WSO 161 mph, Nueces Bay CPL 150+ mph. San Patricio, Co, TX observed the following: Gregory Reynolds Metal 128 mph fastest mile and 138 mph gust at 80 feet AGL, Odem 160 mph gust through eye, Mathis 150 mph gust.

All the Hurricanes on the list above have had their names retired.

* Signifies a storm that made list twice with two landfalls in both Florida and another location.

[a] the first number in the field represents the HURDAT best tracks data (ref.1 & 2) for a particular storm immediately before landfall. However, since the data is only recorded every 6-hours, there have been observed differences between nominal observations times and landfall. In these cases research was conducted to record any additional observations (ref. 4 & 6-10). Numerical subscripts refer to reference where value was obtained.

[b] the sustained wind (1-minute average) that has been converted to 3-second gust using the conversion of 1.22 from ASCE/SEI 7-05 Figure C6-4 (ref 5).

Table 2. Maximum Landfall 3-Second Gust Speed for Category 3 or Greater Hurricanes.

Hurricane Name	Year	Maximum Category	Max 3-Second Gust (mph)
NOT NAMED	1935	5	84
CAMILLE	1969	5	140
ANDREW	1992	5	161
NOT NAMED	1856	4	155
NOT NAMED	1886	4	120
NOT NAMED	1893	4	120
NOT NAMED	1898	4	127
NOT NAMED	1900	4	127
NOT NAMED	1915	4	105
NOT NAMED	1916	4	127
NOT NAMED	1919	4	133
NOT NAMED	1926	4	168
NOT NAMED	1928	4	196
NOT NAMED	1932	4	127
NOT NAMED	1947	4	196
HAZEL	1954	4	120
AUDREY	1957	4	84
DONNA	1960	4	161
CARLA	1961	4	140
HUGO	1989	4	168
CHARLEY	2004	4	148
NOT NAMED	1851	3	127
NOT NAMED	1852	3	127
NOT NAMED	1854	3	112
NOT NAMED	1855	3	99
NOT NAMED	1860	3	140
NOT NAMED	1869	3	112
NOT NAMED	1871	3	140
NOT NAMED	1873	3	112
NOT NAMED	1875	3	127
NOT NAMED	1877	3	127
NOT NAMED	1879	3	127
NOT NAMED	1880	3	155
NOT NAMED	1882	3	112
NOT NAMED	1885	3	127
NOT NAMED	1886	3	105
NOT NAMED	1888	3	120
NOT NAMED	1893	3	112
NOT NAMED	1894	3	120
NOT NAMED	1896	3	140
NOT NAMED	1899	3	168
NOT NAMED	1906	3	148
NOT NAMED	1909	3	148
NOT NAMED	1915	3	84

Hurricane Name	Year	Maximum Category	Max 3-Second Gust (mph)
NOT NAMED	1916	3	112
NOT NAMED	1917	3	127
NOT NAMED	1918	3	148
NOT NAMED	1921	3	112
NOT NAMED	1926	3	112
NOT NAMED	1929	3	168
NOT NAMED	1933	3	155
NOT NAMED	1934	3	99
NOT NAMED	1936	3	92
NOT NAMED	1938	3	99
NOT NAMED	1941	3	84
NOT NAMED	1942	3	120
NOT NAMED	1944	3	148
NOT NAMED	1945	3	161
NOT NAMED	1948	3	140
NOT NAMED	1949	3	183
EASY	1950	3	148
KING	1950	3	148
CAROL	1954	3	105
EDNA	1954	3	92
CONNIE	1955	3	92
GRACIE	1959	3	84
HILDA	1964	3	84
BETSY	1965	3	127
BEULAH	1967	3	196
CELIA	1970	3	99
CARMEN	1974	3	168
ELOISE	1975	3	77
FREDERIC	1979	3	133
ALLEN	1980	3	120
ALICIA	1983	3	112
ELENA	1985	3	84
GLORIA	1985	3	105
OPAL	1995	3	112
FRAN	1996	3	92
BRET	1999	3	112
IVAN	2004	3	99
JEANNE	2004	3	133
DENNIS	2005	3	140
KATRINA	2005	3	112
RITA	2005	3	92
WILMA	2005	3	155

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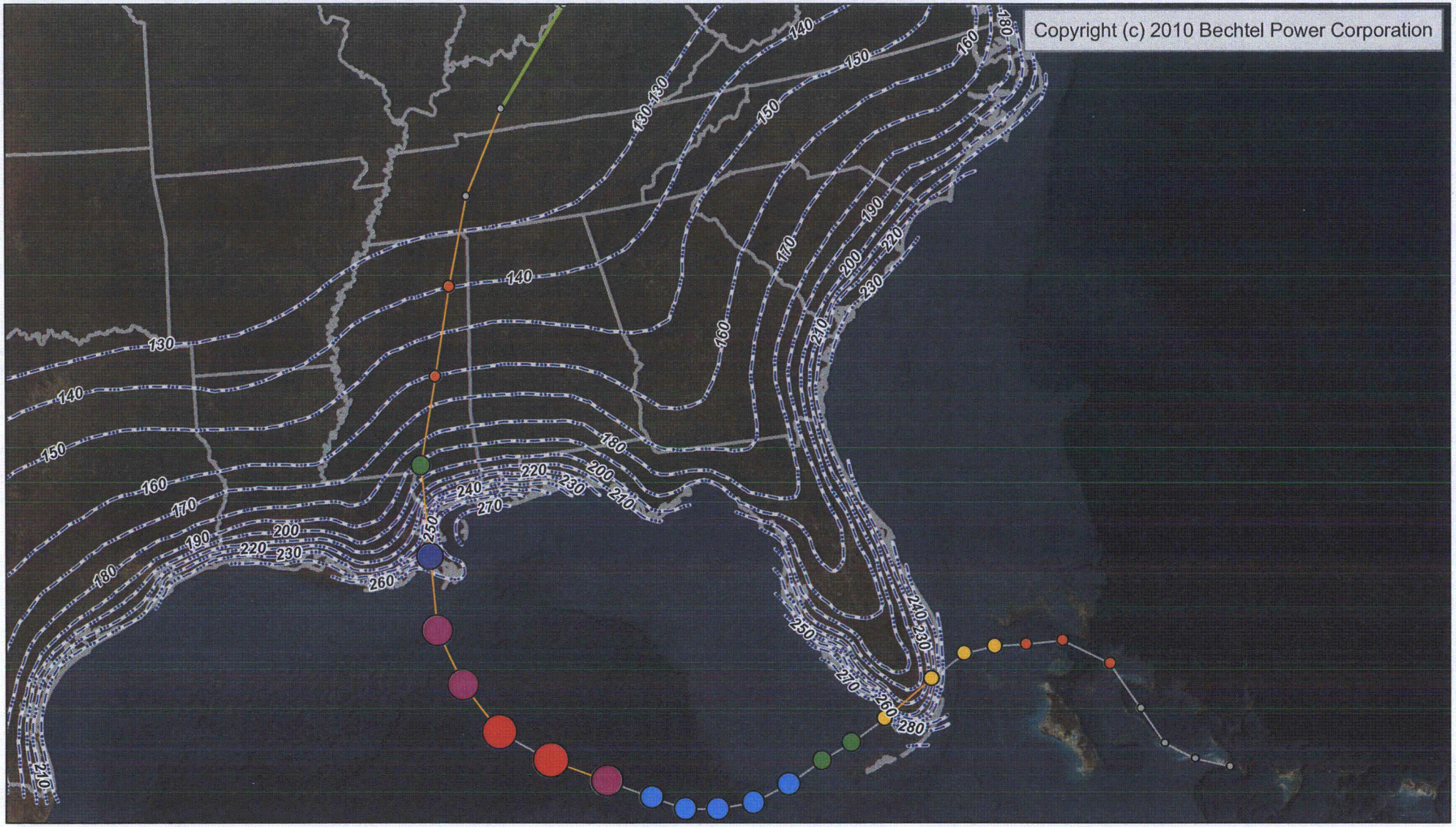

Figure 1a: Hurricane Katrina (2005)

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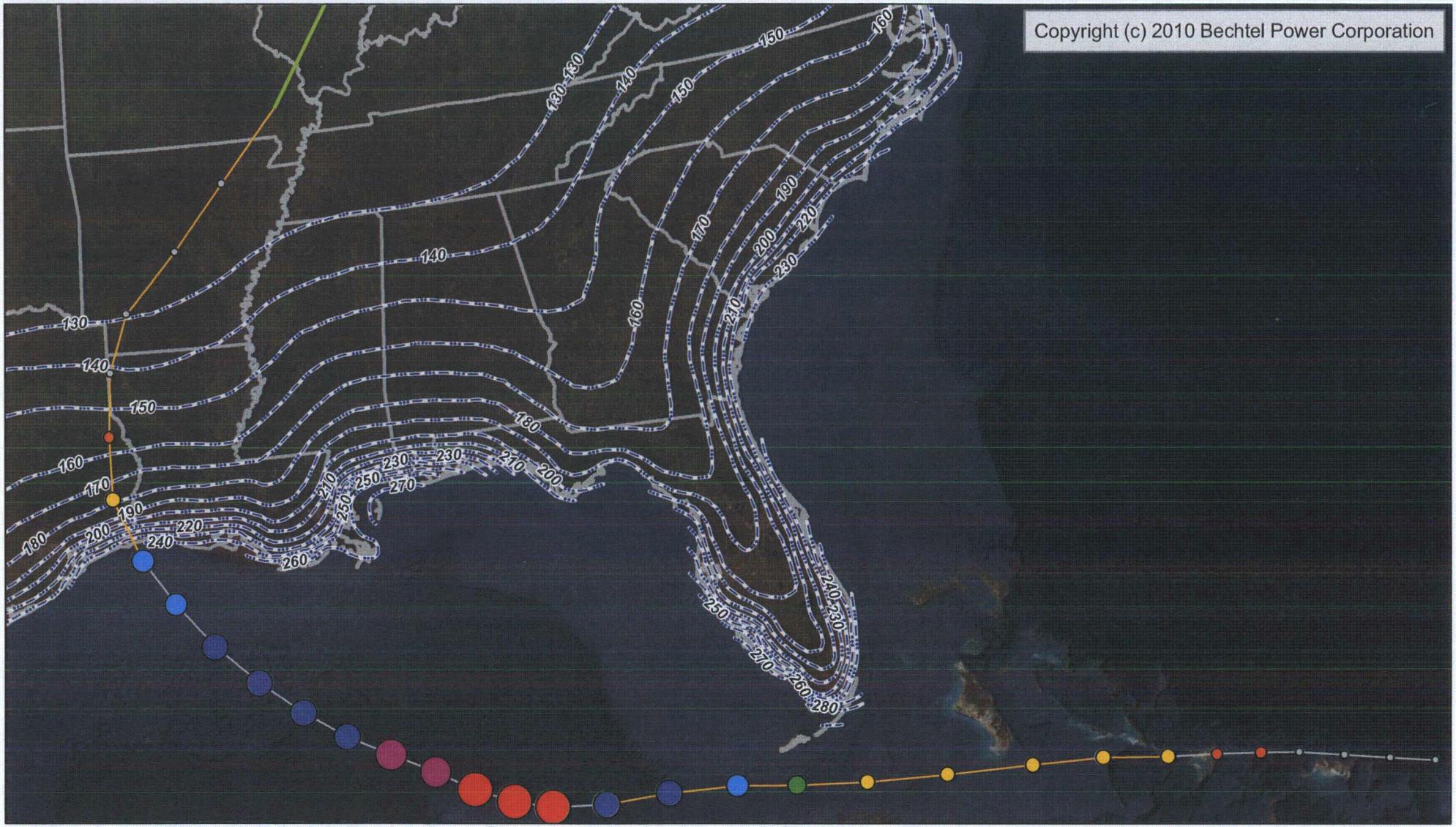

Figure 1b: Hurricane Rita (2005)

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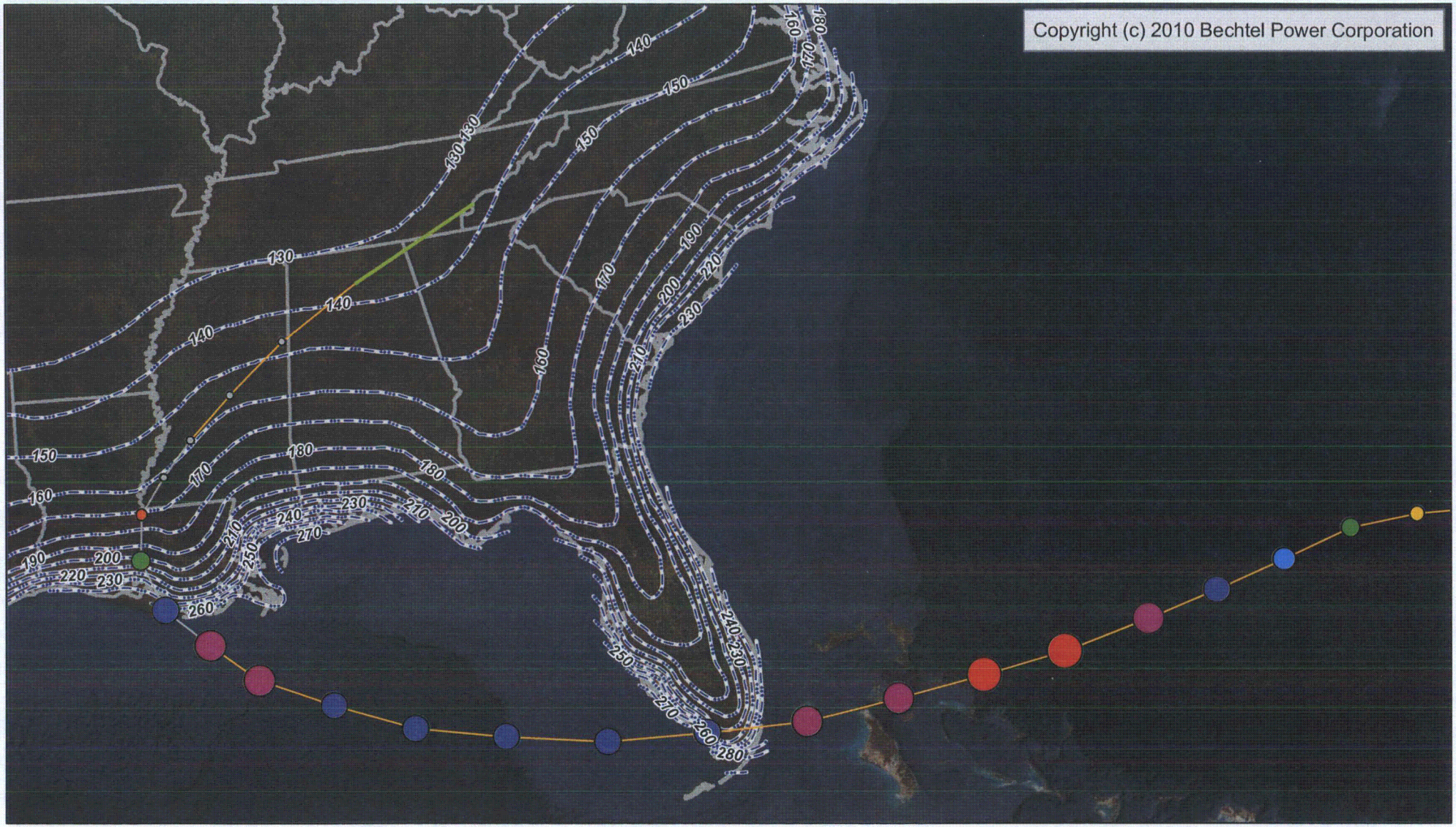

Legend

HURDAT Hurricane Centers
(3 Sec Gust, MPH)

- < 50
- 50 - 74.9
- 75 - 99.9
- 100 - 124.9
- 125 - 149.9
- 150 - 174.9
- 175 - 199.9
- > 200

Translation Speed
(meters per second)

- <5
- 5 - 9.9
- 10 - 14.9
- 15 - 19.9
- > 20
- NRC DG-1247 Proposed Guidance Windspeed (MPH)

N
W E
S

0 100 200 400 600 800 Miles

Figure 1c: Hurricane Andrew (1992)

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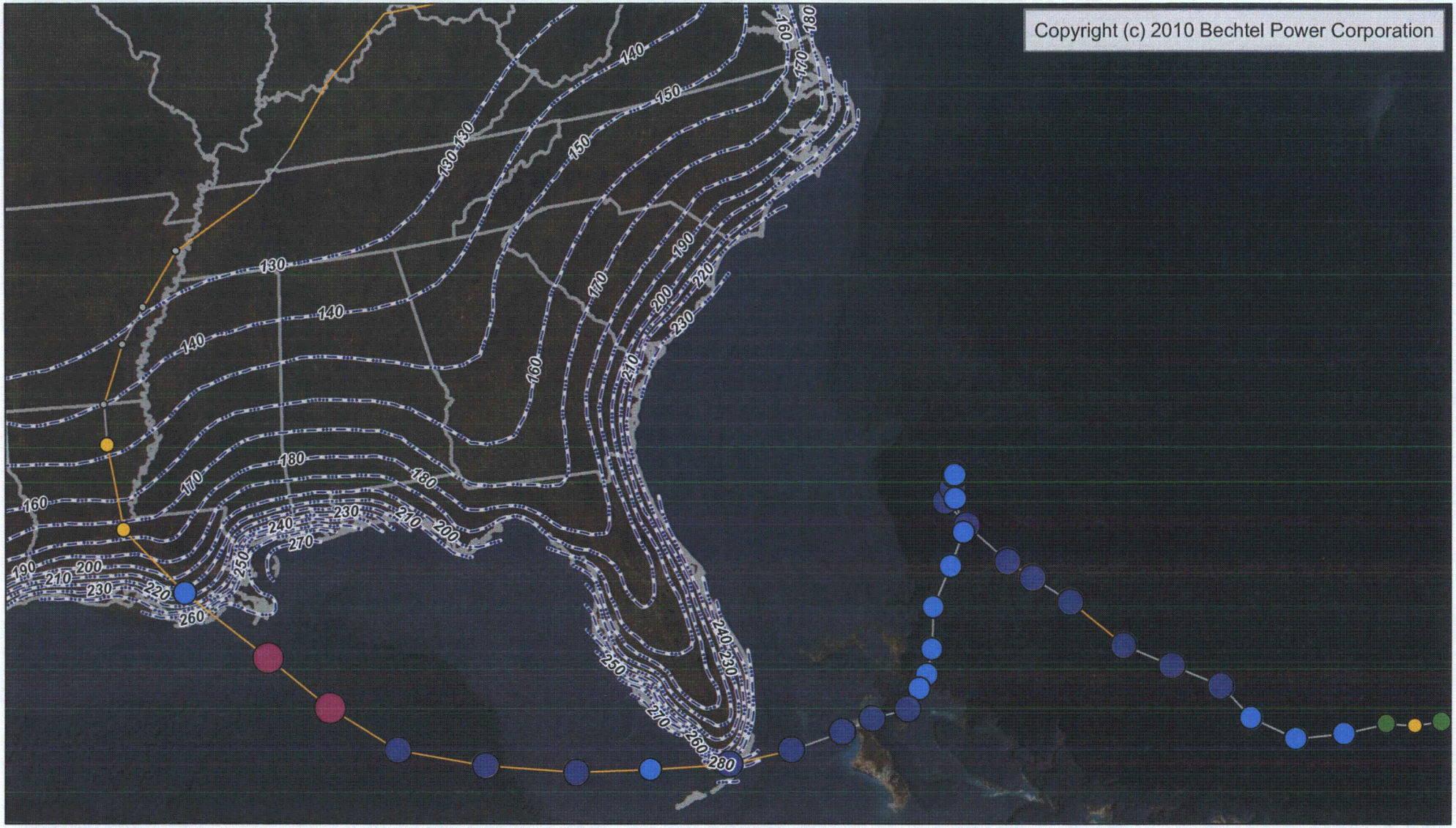

Figure 1d: Hurricane Betsy (1965)

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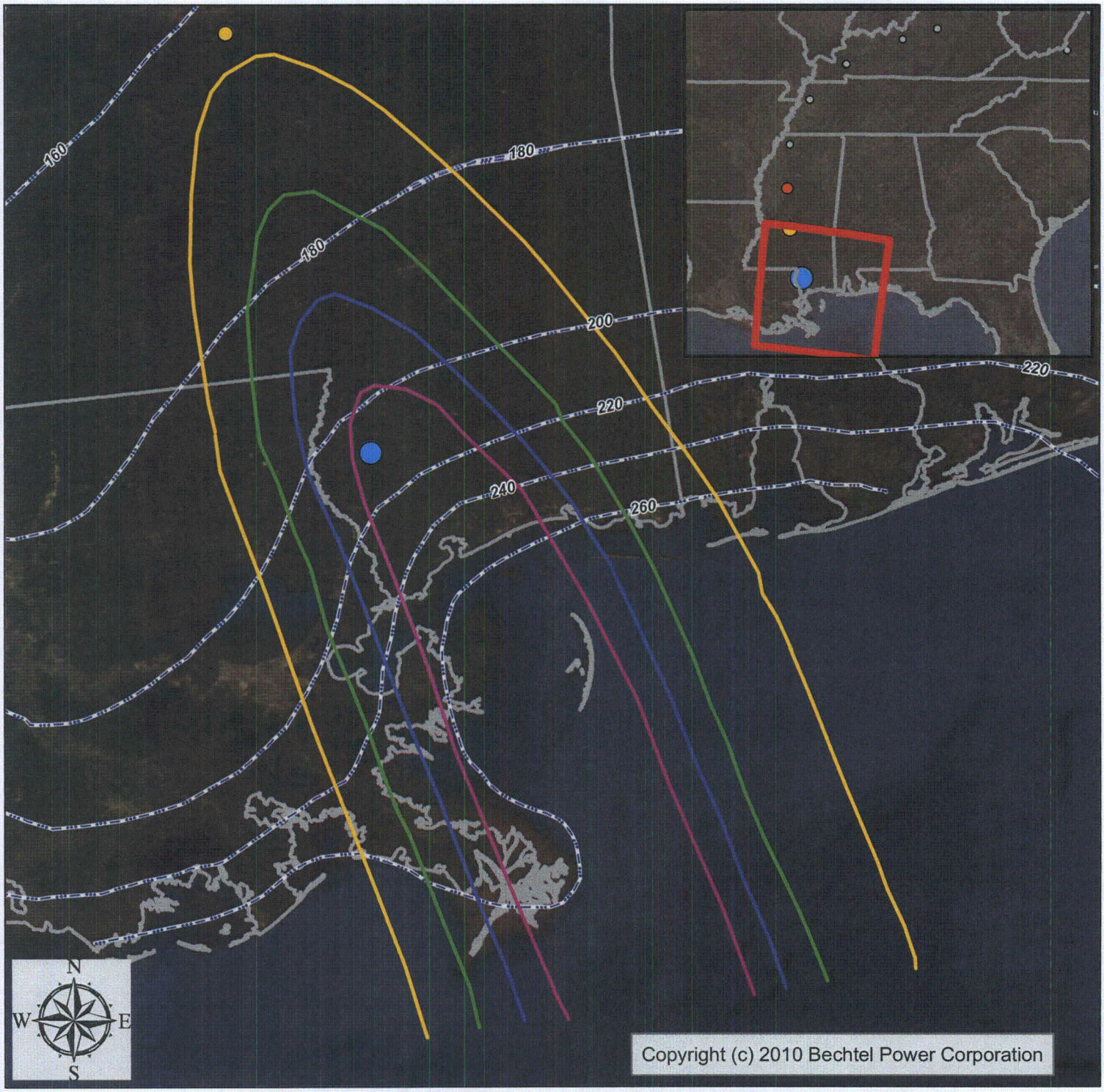

Miles

0 15 30 60 90 120 150

Legend

Estimated Windspeed
(3 Sec Gust, MPH)

- < 62
- 62 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 200
- 201 - 206
- NRC DG-1247 3 Sec Gust Windspeed (MPH)

HURDAT Hurricane Centers
(3 Sec Gust, MPH)

- < 50
- 50 - 74.9
- 75 - 99.9
- 100 - 124.9
- 125 - 149.9
- 150 - 174.9
- 175 - 199.9
- > 200

Figure 1e: Hurricane Camille (1969, colored contours from Ref. 13)

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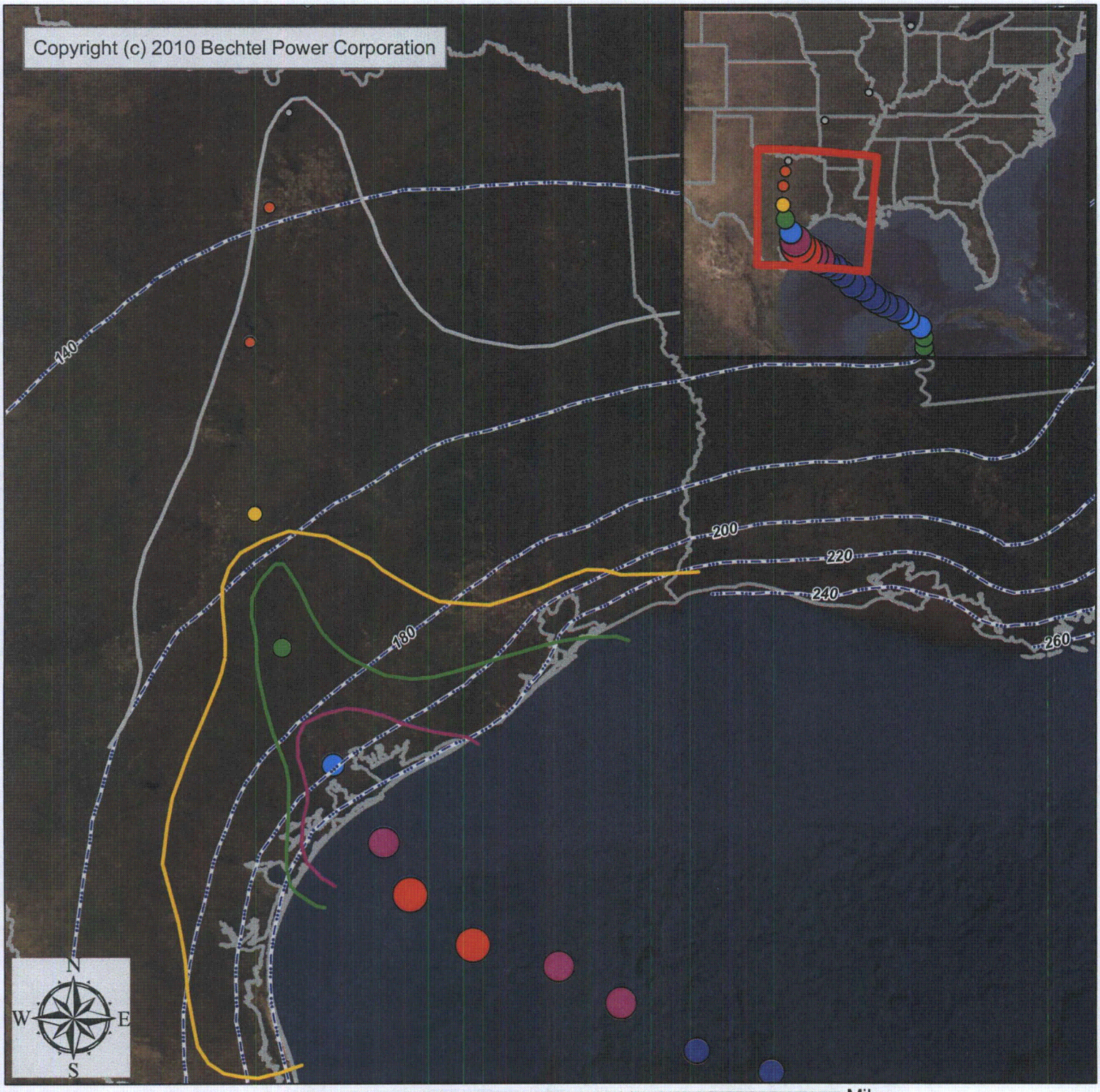

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Estimated Windspeed
(3 Sec Gust, MPH)

- < 62
- 62 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 200
- 201 - 206
- NRC DG-1247 3 Sec Gust Windspeed (MPH)

HURDAT Hurricane Centers
(3 Sec Gust, MPH)

- < 50
- 50 - 74.9
- 75 - 99.9
- 100 - 124.9
- 125 - 149.9
- 150 - 174.9
- 175 - 199.9
- > 200

Figure 1f: Hurricane Carla (1961, colored contours from Ref. 8)

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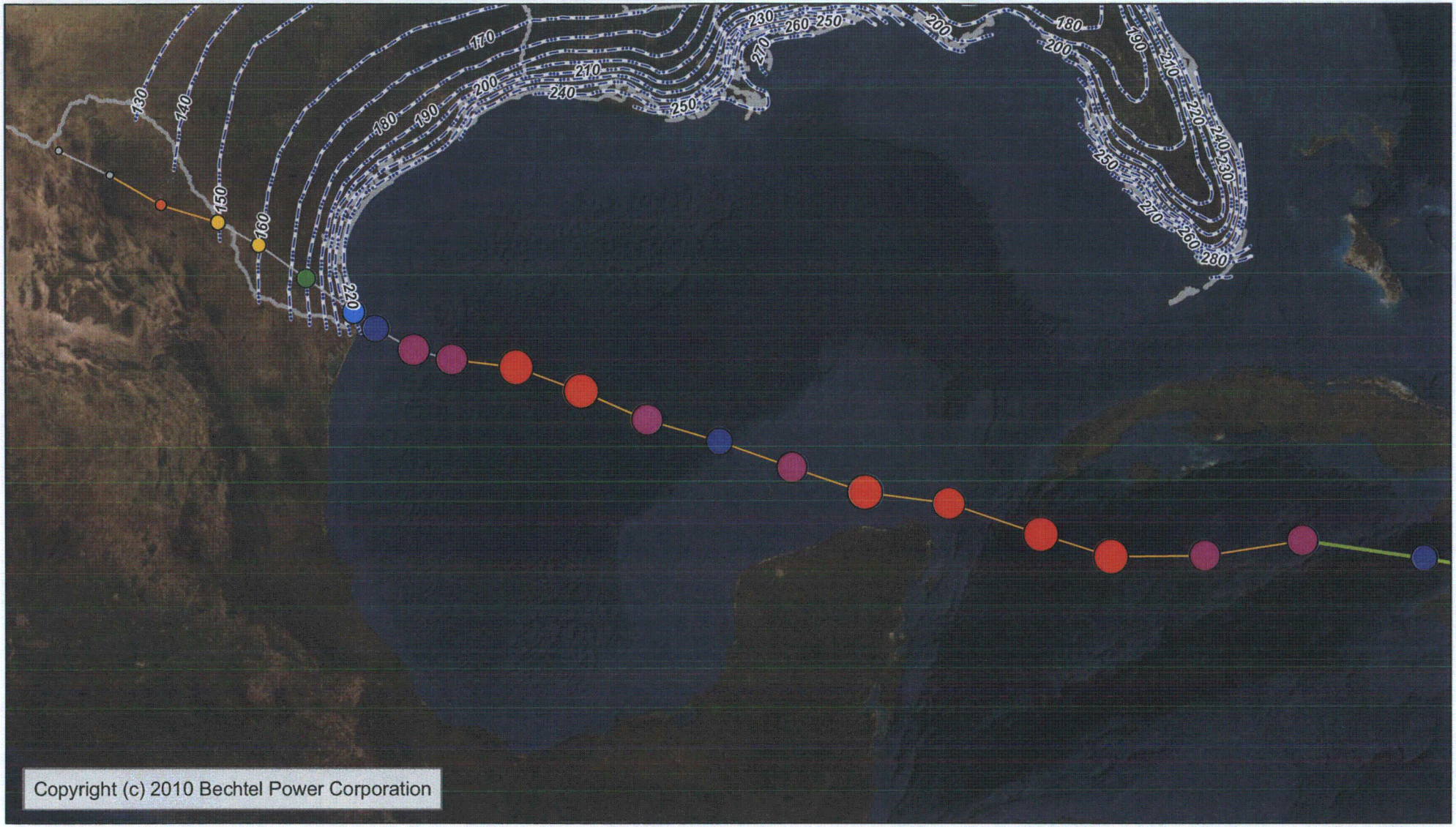

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HURDAT Hurricane Centers (3 Sec Gust, MPH)

- < 50
- 50 - 74.9
- 75 - 99.9
- 100 - 124.9
- 125 - 149.9
- 150 - 174.9
- 175 - 199.9
- > 200

Translation Speed (meters per second)

- <5
- 5 - 9.9
- 10 - 14.9
- 15 - 19.9
- > 20

NRC DG-1247 Proposed Guidance Windspeed (MPH)

N W E S

0 100 200 400 600 800 Miles

Figure 1g: Hurricane Allen (1980)

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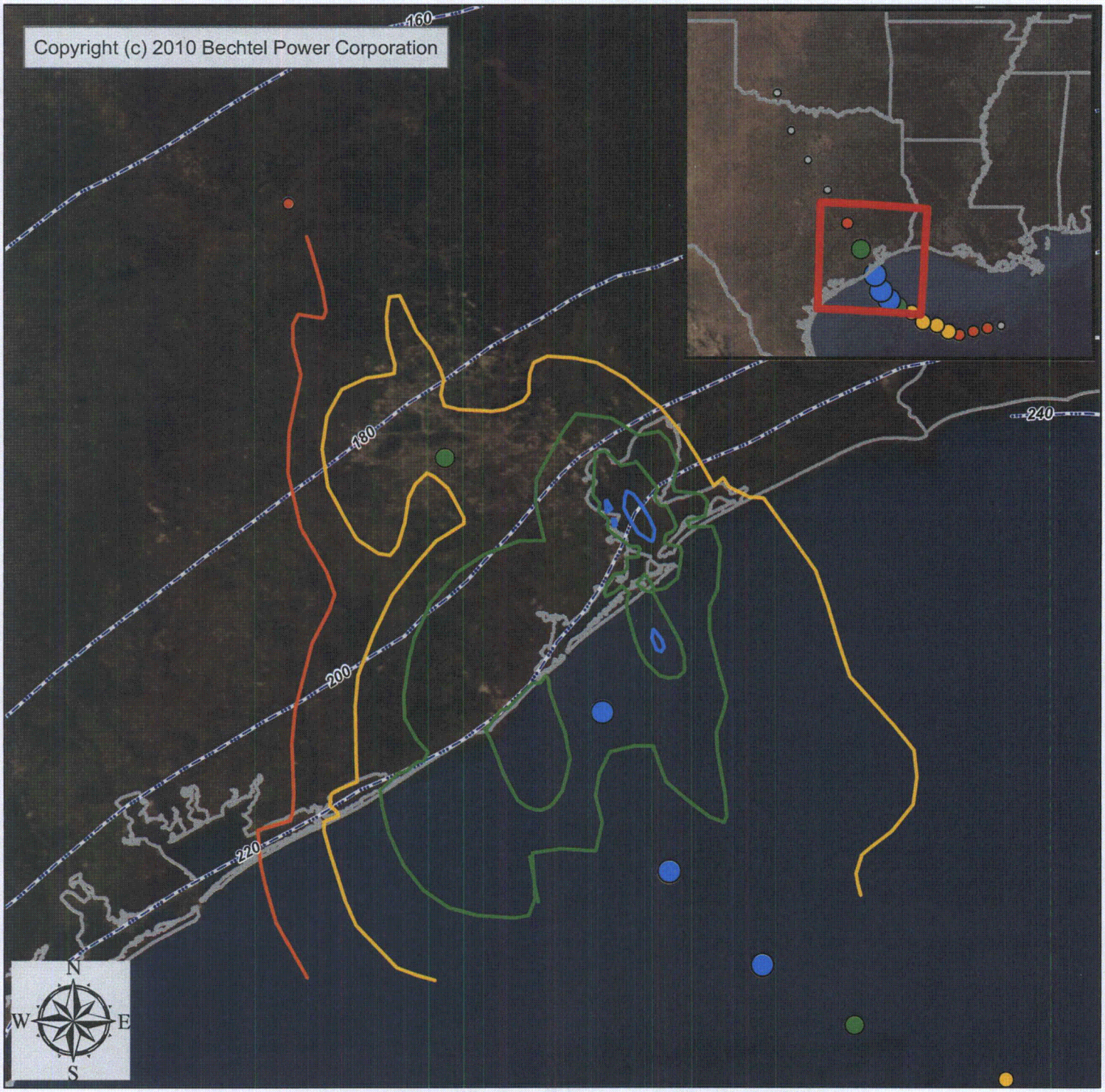

Figure 1h: Hurricane Alicia (1983, colored contours from Ref. 15)

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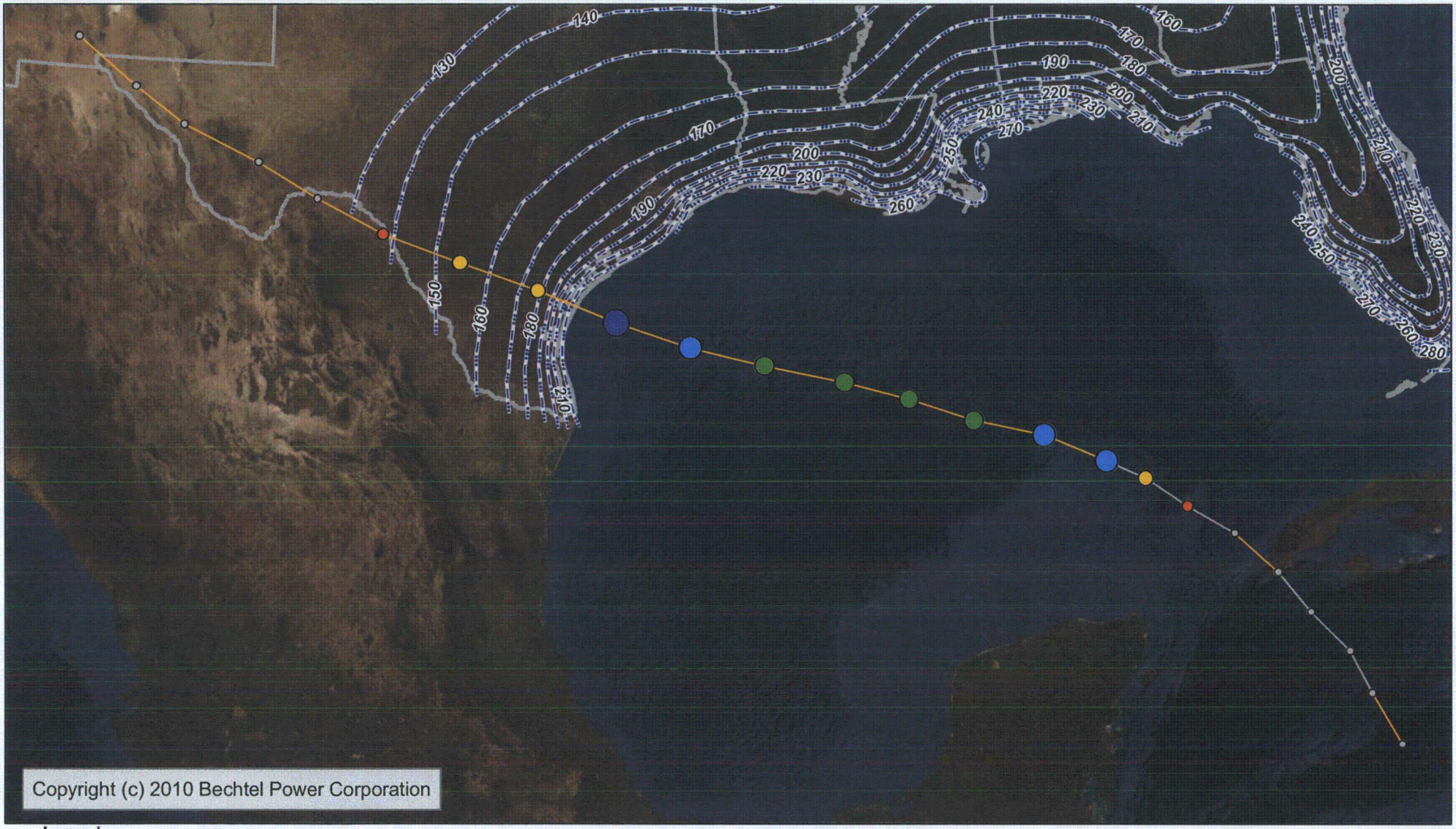

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HURDAT Hurricane Centers (3 Sec Gust, MPH)

- < 50
- 50 - 74.9
- 75 - 99.9
- 100 - 124.9
- 125 - 149.9
- 150 - 174.9
- 175 - 199.9
- > 200

Translation Speed (meters per second)

- <5
- 5 - 9.9
- 10 - 14.9
- 15 - 19.9
- > 20

NRC DG-1247 Proposed Guidance Windspeed (MPH)

N
W E
S

0 100 200 400 600 800 Miles

Figure 1i: Hurricane Celia (1980)

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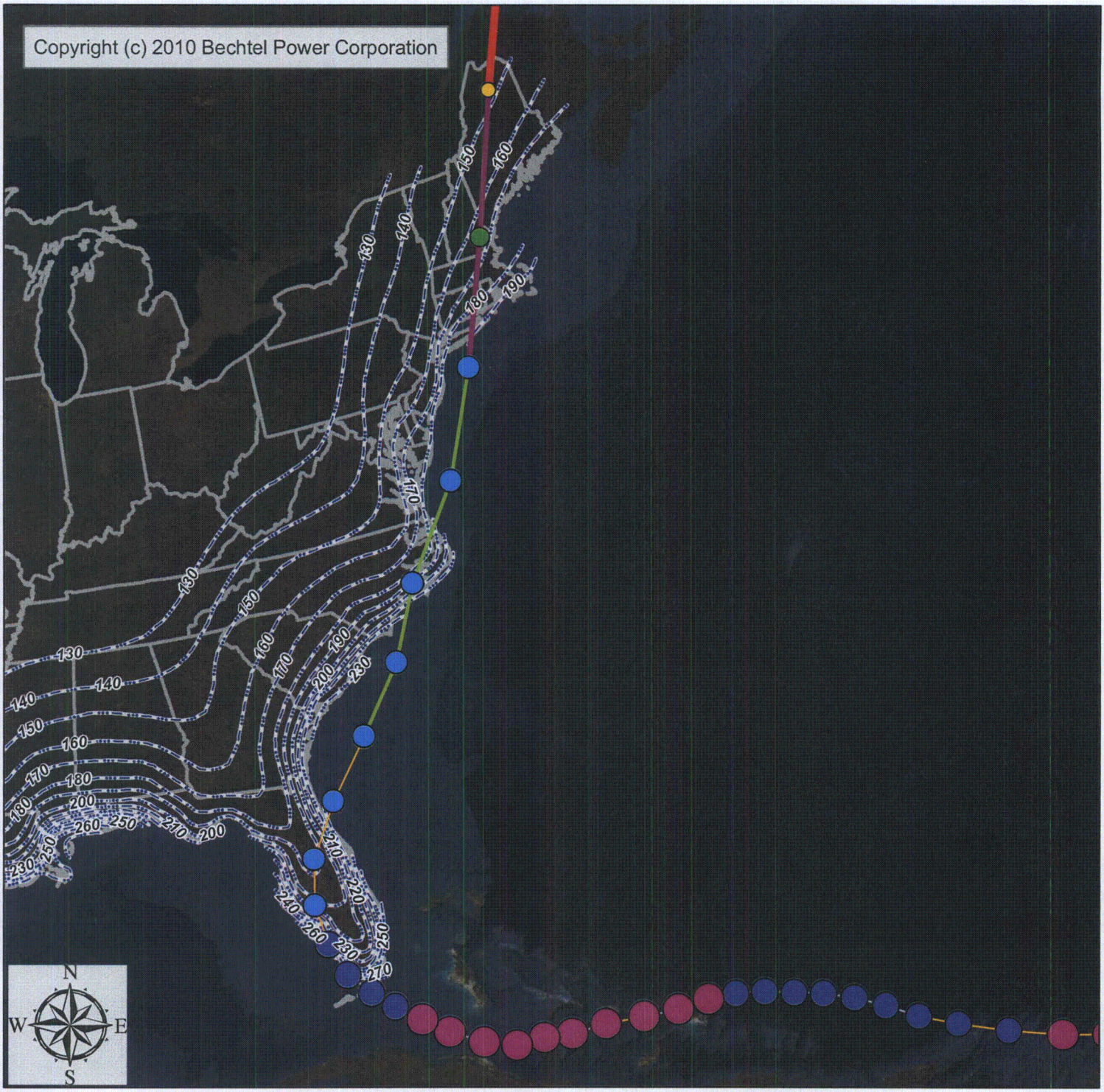

Legend

0 125 250 500 750 1,000 Miles

HURDAT Hurricane Centers (3 Sec Gust, MPH)

- < 50
- 50 - 74.9
- 75 - 99.9
- 100 - 124.9
- 125 - 149.9
- 150 - 174.9
- 175 - 199.9
- > 200

Translation Speed (meters per second)

- <5
- 5 - 9.9
- 10 - 14.9
- 15 - 19.9
- > 20

NRC DG-1247 Proposed Guidance Windspeed (MPH)

Figure 1j: Hurricane Donna (1960)

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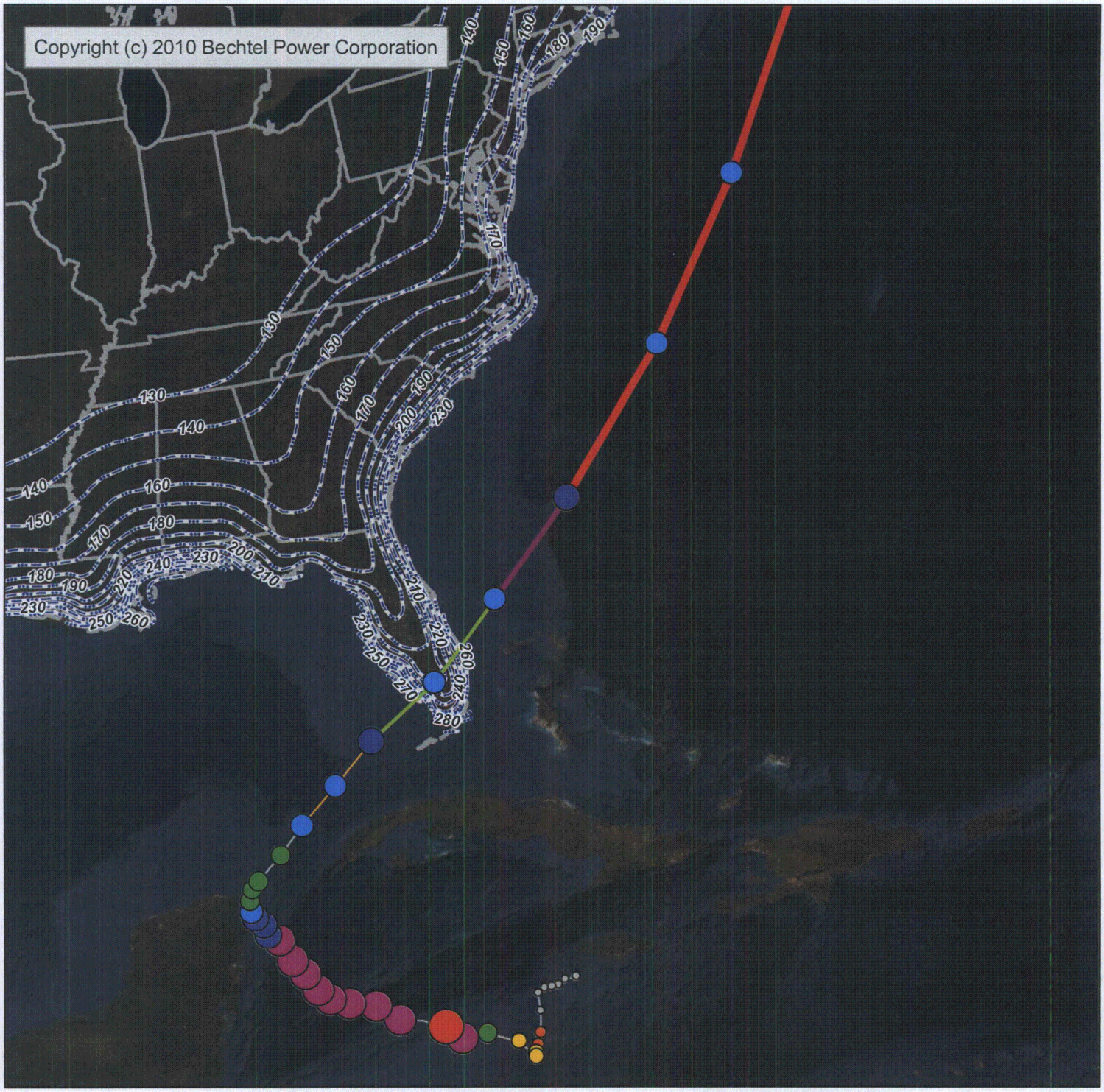

Figure 1k: Hurricane Wilma (2005)

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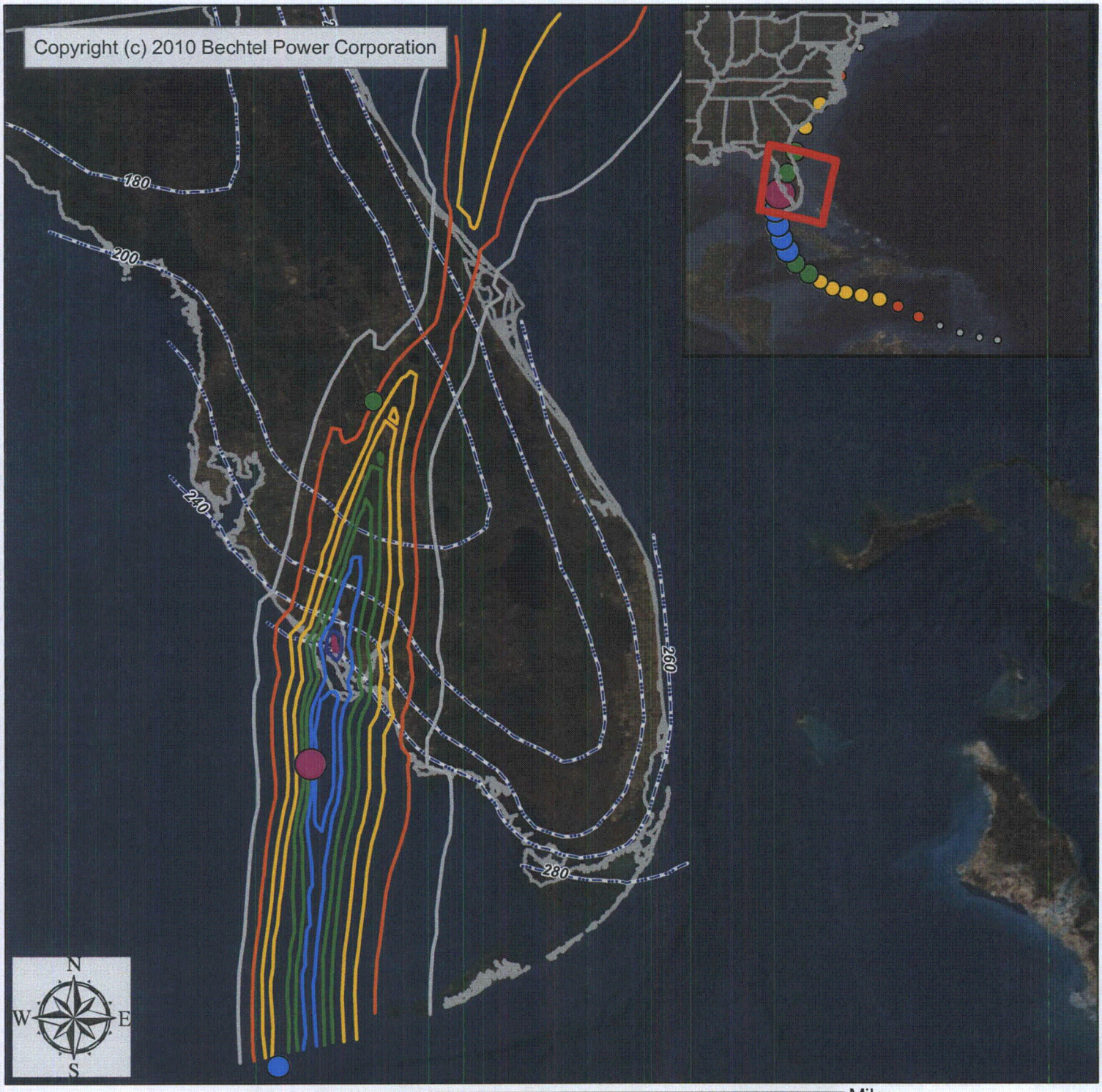

Legend

Estimated Windspeed
(3 Sec Gust, MPH)

- < 62
- 62 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 200
- 201 - 206
- NRC DG-1247 3 Sec Gust Windspeed (MPH)

HURDAT Hurricane Centers
(3 Sec Gust, MPH)

- < 50
- 50 - 74.9
- 75 - 99.9
- 100 - 124.9
- 125 - 149.9
- 150 - 174.9
- 175 - 199.9
- > 200

Figure 1l: Hurricane Charley (2004, colored contours from Ref. 15)

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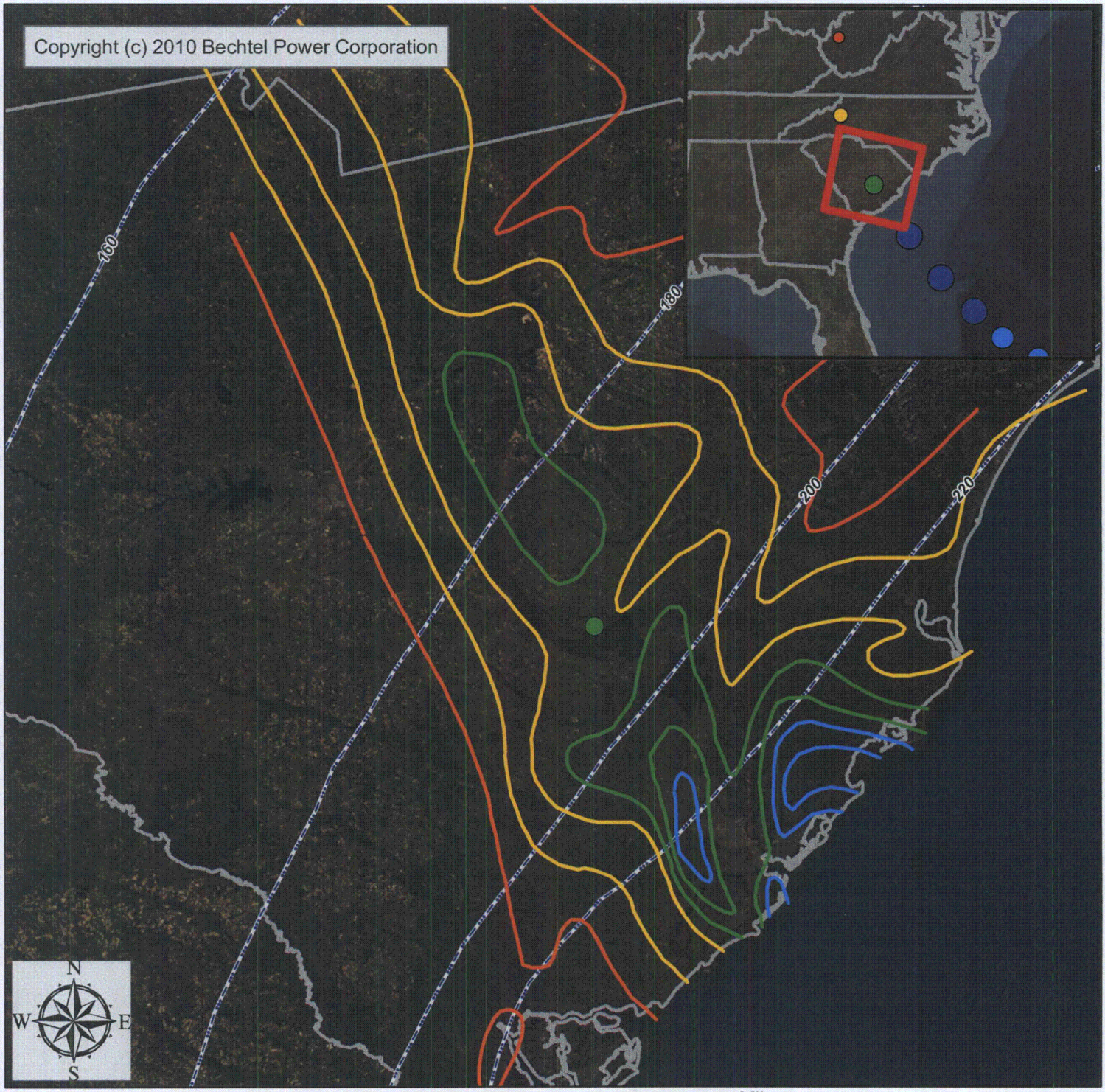

Miles

0 10 20 40 60 80

Legend

Estimated Windspeed
(3 Sec Gust, MPH)

- < 62
- 62 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 200
- 201 - 206
- NRC DG-1247 3 Sec Gust Windspeed (MPH)

HURDAT Hurricane Centers
(3 Sec Gust, MPH)

- < 50
- 50 - 74.9
- 75 - 99.9
- 100 - 124.9
- 125 - 149.9
- 150 - 174.9
- 175 - 199.9
- > 200

Figure 1m: Hurricane Hugo (1989, colored contours obtained from Ref. 16)

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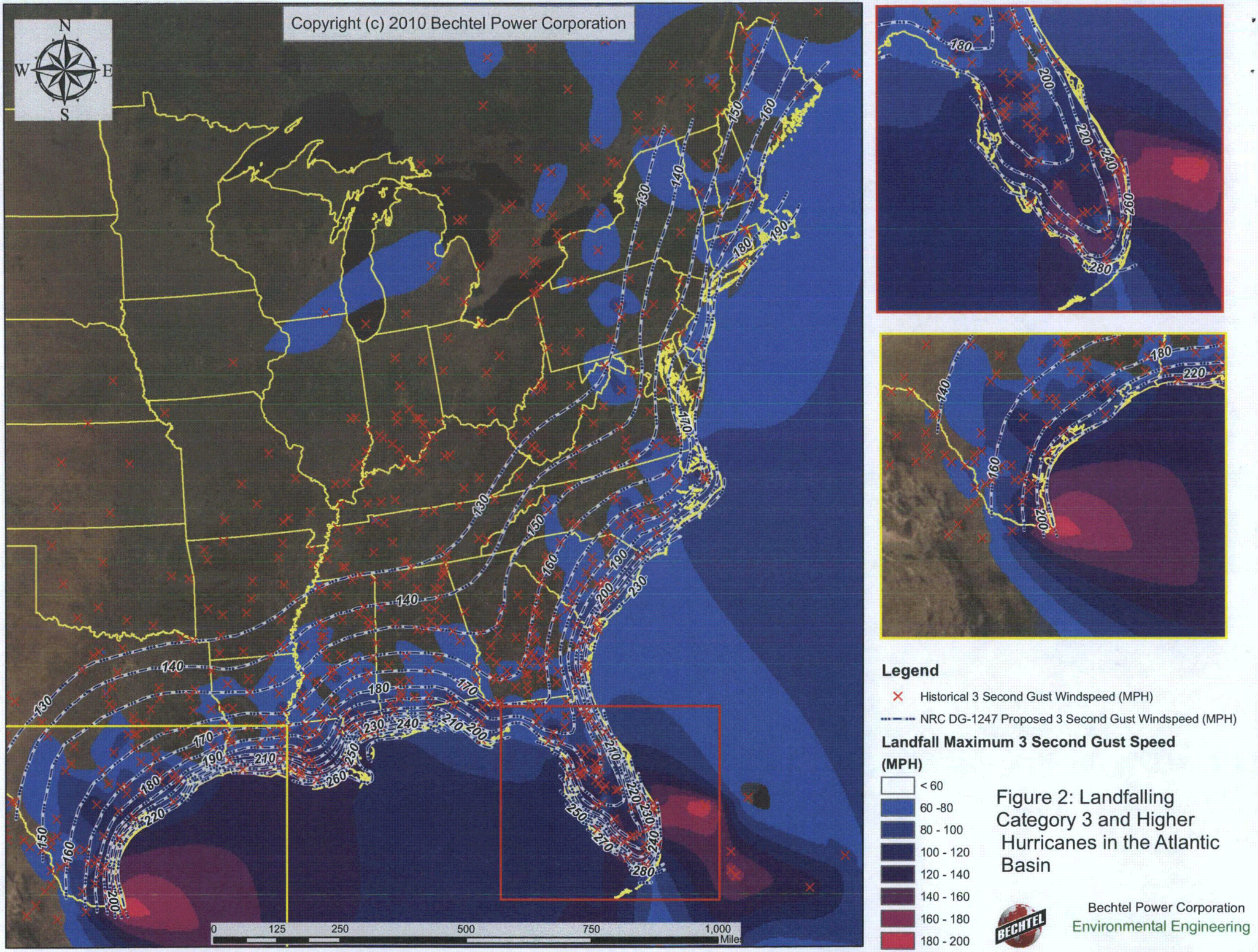

Figure 2: Landfalling Category 3 and Higher Hurricanes in the Atlantic Basin