"Climate Change and Hurricanes." Presented to the Ag Leadership Conference, Baton Rouge, LA, December 13, 2012.

"Hurricanes in a Changing Climate," Presented to the LSU-Department of Civil and Environmental Engineering Seminar Series, October 31, 2012.

"Hurricanes in Mexico." Presented in a Webinar on Extremes in the Southwest U.S. and Mexico hosted by CLIMAS (NOAA's Climate Assessment for Southwest –RISA), September 6, 2012.

"Temporal and Geographical Perspectives on Atlantic Hurricanes" Presented to the LSU School for the Coast and the Environment, August 24, 2012.

"Hurricanes in a Changing Climate," Presented to the Baton Rouge Ham Radio Operators, July 30, 2012.

"Hurricanes." Presented in a Webinar on *Managing Extremes,* hosted by SCIPP, July 26, 2012.

"Drought in Louisiana." Presented in a Webinar on *Managing Drought in the Southern Plains,* hosted by SCIPP and NIDIS, February 9, 2012.

"Climate Change" Presented in a Webinar to the PINEMAP (Pine Integrated Network: Education, Mitigation, and Adaptation Project), hosted by the North Carolina State, January 20, 2012.

"Louisiana Drought" Presented in a Webinar on *Managing Drought in the Southern Plains,* hosted by SCIPP and NIDIS, December 11, 2011.

"Hurricane Impacts" **Keynote Address** presented at the National Council for Family Relations Annual Meeting, Orlando, Florida, November 17, 2011.

"Louisiana's Drought Condition" Presented to the Livingston Parish Cattlemen's Association, Albany, Louisiana, October 29, 2011.

"Hurricanes of the Gulf of Mexico," Presented to the LSU Retired Faculty Club, September 12, 2011.

"2011 Hurricane Season" Presented to the Baton Rouge Press Club, Baton Rouge, LA, June 6, 2011.

"Hurricanes and Climate Change: The Gulf Coast Experience." **Keynote Address** presented at the Groves Conference on Marriage and Family, New Orleans, Louisiana, March 15, 2011.

"Hurricanes of the Gulf of Mexico." Presented at New Orleans' Presbytere - Louisiana State Museum - as part of a speaker series entitled "Living with Hurricanes: Katrina and Beyond," February 17, 2011.

"Hurricanes in a Changing Climate." Presented to the Coastal Sustainability Studio, Louisiana State University, January 21, 2011.

"Climate Change." Presented to the Ag Leadership Conference, Baton Rouge, LA, January 4, 2011.

"2010 Hurricane Risks in Louisiana." Presented at the annual ENTERGY Hurricane Preparedness Workshop and Press Release, New Orleans, LA, June 2, 2010.

"Hurricane Issues Related to the BP Oil Spill." Presented to the Governor's Office of Homeland Security and Emergency Preparedness, May 27, 2010.

"2010 Hurricane Risks in Louisiana." Presented at the annual ENTERGY Hurricane Preparedness Meeting, Baton Rouge, LA, May 24, 2010.

"Hurricanes in a Changing Climate." Presented to the International Studies Program, Louisiana State University, Baton Rouge, LA, April 27, 2010.

"Hurricanes in a Changing Climate." Presented at the monthly meeting of Louisiana CEOs, Baton Rouge, LA, February 15, 2010.

"Hurricanes in a Changing Climate." Presented to the Department of Civil and Environmental Engineering Seminar Series, Rice University, January 29, 2010.

"Hurricane Risks in Louisiana." Presented at the Louisiana Senate - Natural Resources Committee Meeting, Baton Rouge, LA, December 17, 2009.

"NOAA-Regional Integrated Sciences and Assessment." Proposal Panel Review in Silver Spring, Maryland, December 1-2, 2009.

"Hurricanes of the Gulf of Mexico." Presented at the Louisiana Book Festival, Baton Rouge, Louisiana, October 17, 2009.

"Hurricanes in the Southeast." Presented to the Department of Earth Sciences, University of Texas-Arlington, October 1, 2009.

"Gulf Hurricanes" Presented to the Adult Class, Contemporary Christian Concerns, University Methodist Church, Baton Rouge, July 2009.

"Hurricanes in a Changing Climate." **Keynote Speaker** at the Louisiana Remote Sensing and GIS Workshop, Baton Rouge, LA, April, 2009.

"Hurricane Research at LSU." Presented at the Spring Luncheon of the LSU College of Arts and Sciences, April, 2009.

"Climate Change: Fact or Fiction" Presented to the Agricultural Leadership Program, LSU, January 6, 2009.

"Hurricanes." Presented at Nicholls State University Forum Series, October 28, 2008.

"The Global Warming Debate." Presented at the Nicholls State University Forum Series, March 13, 2008.

"Climate Data and Climate Prediction. Presented to the Louisiana Levee School at LSU, November 29, 2007.

"Hurricanes and Climate Change." Presented to the Louisiana Department of Environmental Quality, November 27, 2007.

"High Water: Wave of the Future" Served on a Panel on Louisiana Public Broadcasting's *Louisiana Public Square*, March 28, 2007.

"Global Climate Change: The Status of the Science and Implications for Coastal Louisiana." Address presented at the 3rd President's Forum on Meeting Coastal Challenges, March 23, 2007.

"Hurricanes in a Changing Climate" Presented to the Tulane University Department of Earth and Environmental Sciences Seminar, March 2, 2007.

"Living on the Edge of Climate Change" Presented to the American Society for Environmental History, Baton Rouge, LA, March 1, 2007.

"Climate Change." Presented to the Amite River Basin Commission, February 21, 2007.

"Climate Change: Fact or Fiction" Presented to the Agricultural Leadership Program, LSU, January 9, 2007.

"Climate and Hurricanes." Presented to the American Meteorological Society-Central Louisiana Chapter, December 13, 2006.

"Research and Service of the Louisiana Office of State Climatology." Presented at the National Weather Service and Texas A&M School of Government and Public Service Climate Workshop, College Station, TX, August 1, 2006.

"Hurricanes in a Changing Climate." Presented at the Climate Change Symposium, University of North Carolina-Greensboro, April 7, 2006.

"Hydroclimatology of the U.S. Gulf Coast Under Global Warming Scenarios." Presented at the Severe Storms: Impact and Disaster Response in Gulf Coast Communities

Conference, Rice University, Houston, TX, March 15, 2006.

"Hurricane Katrina in Perspective." Presented to the LSU Black Law Students Association panel called "Hurricane Katrina: What went wrong? What went right?," Baton Rouge, LA, October 27, 2005

"Meteorological Overview of Hurricane Katrina and Observations from a Chalmation." Presented at the Geography and Anthropology Society Panel Discussion entitled Hurricane Katrina: Critical Perspectives on a National Tragedy, Baton Rouge, LA, October 13, 2005.

"Louisiana's Hurricane Climatology." Presented to the Amite Rotary Club, Amite, Louisiana, April 26, 2005.

"The Vagaries of Louisiana Climate" Presented to the Canary Islanders Heritage Society of Louisiana, Baton Rouge, LA, February 12, 2005.

"Louisiana Climate and the Coastal Zone." Presented to the Iberia Parish-Natural Resources Conservation Service Annual Awards Meeting, Avery Island, LA, May 26, 2004.

"Louisiana Climate." Presented to the KLFY-TV 10 (Lafayette, LA) Hurricane Conference, Lafayette, LA, May 13, 2004.

"The Science Behind the Global Warming Debate." **Keynote Address** presented to Emissions Marketing Association, 8th Annual Spring Meeting, New Orleans, LA, May 3, 2004.

"Research Methods in Climatology." Presented to the Department of Geosciences, Mississippi State University, November, 2003.

"New England Weather, New England Climate." Presented to the American Meteorological Society-Central Louisiana Chapter, January 2003.

"Southern Regional Climate Center: An Overview of Capabilities and Activities." Presented to the Department of Atmospheric Sciences, Texas A&M University, December 2002.

"New England Weather, New England Climate." **Keynote Address** presented at the Northeast Arc-Users Convention, Bretton Woods, New Hampshire, November 2002.

"New England Drought Assessment 2002." Presented at the New England Conference of Public Utilities Commissioners, Stowe, Vermont, June 2002.

"New England Weather: If You Don't Like It, Wait a Minute." Presented at the Seacoast Science Center - Heritage Dinner Series, Rye, NH, March 2002.

"New England Weather and Climate." Presented to the Stratham Historical Society, Stratham, NH, March 2002.

"New England Weather: If You Don't Like It, Wait a Minute" Presented at the Mount Washington Hotel, Bretton Woods, NH, August 2001 and January 2002.

"Climate Change: Fact or Fiction." Presented at the Balsam's Hotel Speaker Series, Dixville Notch, NH, March, 2001.

"New England's Changing Climate." Presented at the New England Climate Change Indicators Workshop sponsored by Clean Air-Cool Planet, January 2001.

"New Hampshire Climate." Participant in the Celebrate New Hampshire Culture Festival in Hopkinton, New Hampshire, June 2000.

"Research in Hydroclimatology" Presented to the Water Systems Analysis Group of the Institute for the Study of Earth, Oceans, and Space, UNH, May 2000.

"New England Weather: If you don't like it, wait a minute". Presented to the UNH Retired Faculty Association, Durham, NH, May 2000.

"New England Weather: If you don't like it, wait a minute." Presented to the Rochester Rotary Club, Rochester, NH, March 2000.

"New England Weather and Climate." Presented at the Balsam's Hotel Speaker Series, Dixville Notch, NH, January, 2000.

"New England Weather Types: Implications for Atmospheric Chemistry." Presented to the UNH Department of Chemistry Forum Series, November 1999.

"New Hampshire Climate." Participant in the Smithsonian Institution Folklife Festival featuring New Hampshire, Romania, and South Africa, Washington, DC, June 1999.

"Extreme Events in New England's Changing Climate." Presented at the Boston Museum of Science Climate Change Lecture Series, May 1999.

"Components of New England Weather and Climate." Presented to the New England Regional Assessment on Forestry, Water Resources, and Human Health, March and April, 1999.

"A Climatology of New England." Presented to the UNH President's Breakfast for the Durham (New Hampshire) Merchants Association, Durham, NH, November 1998.

"A Climatology of New England." Presentation and Panelist for the Sigma Xi Discussion on New England Climate Change, November, 1998.

"Climate Change in New England." Presented to the University of New Hampshire - Department of Natural Resources Seminar Series, September 1998.

"New England Weather." Presented to the Durham, NH Active Retirement Association, April 14, 1998.

"A Look at New Hampshire's Weather and Climate." Presented at the Mount Washington World Record Wind Commemoration, April 11, 1998.

"Climate Variability in New Hampshire and its Effect on Groundwater." Presented to the New Hampshire Water Works Association, November 1997.

"The White House Conference on Global Warming and Climate Change." Invited Panelist at the University of New Hampshire Post Satellite Downlink Discussion, October 1997.

"Climate Change and New England Extreme Events." Presented at the New England Regional Climate Change Impacts Workshop, Durham, New Hampshire, September 1997.

"Extreme Events in a Changing Climate." Presented at the Randolph W. Chapman Colloquium, Department of Earth Sciences, University of New Hampshire, February 1996.

"Global Warming: Fact or Fiction." Presented to the Baton Rouge Chapter of the Sierra Club, May 1991.

"Potential Impacts of a Global-Warming-Induced Sea Level Rise in Louisiana." Presented to the American Meteorological Society-Central Louisiana Chapter, January 1991.

"The Nature of Heavy Rainfall in New Orleans, Louisiana." Presented to the American Meteorological Society-Central Louisiana Chapter, December 1990.

"Potential Impacts of Global Warming and Sea Level Rise in Louisiana." Presented to Governors Roemer (Louisiana) and Thompson (Illinois) at the National Governor's Association Task Force on Global Warming, New Orleans, Louisiana, March 1990.

"Potential Impacts of Global Warming on Coastal Louisiana." Presented at a Special Program Developed by the Union of Concerned Scientists in Association with the American Meteorological Society-Central Louisiana Chapter, November 1989.

Dissertations and Theses Directed

PhD Advisor

Brown, V. Department of Geography and Anthropology, LSU
Dissertation: *Hourly Precipitation Climatology of the Southeast United States*
(successfully defended in May, 2019, graduated August 2019)

Bartels, R. Department of Geography and Anthropology, LSU
Dissertation: *A Climatology of Precipitation Days Throughout the Contiguous United States*
(successfully defended in May, 2018, graduated August 2018)

Eachus, J. Department of Geography and Anthropology, LSU
Dissertation: *Weather Communication on Twitter: Identifying Popular Content and Optimal Warning Format via Case Studies and Survey Analysis*
(successfully defended in October, 2017, graduated December 2017)

Gilliland, J. Department of Geography and Anthropology, LSU
Dissertation: *Brazilian Surface and Upper-Level Wind Characteristics Based on Ground and Model Observations from 1980 to 2014*
(successfully defended March 2017, graduated August 2017)

Needham, H.F. Department of Geography and Anthropology, LSU
Dissertation: *A Data-Driven Storm Surge Analysis for the U.S. Gulf Coast*
(successfully defended in March 2014, graduated August 2014)

Powell, E. Department of Geography and Anthropology, LSU
Dissertation: *Climate Extremes in the Southeastern United States: Observed Trends, Spatial Variability, and Related Planning*
(successfully defended in December 2013, graduated May 2014)

Shao, W. Department of Geography and Anthropology, LSU
Dissertation: *Understanding Public Perceptions of Global Warming*
(successfully defended in May 2012, graduated August 2012)

Boyd, E. C.-K. Department of Geography and Anthropology, LSU
Dissertation: *Fatalities due to Hurricane Katrina's Impacts in Louisiana.*
(successfully defended in April 2011, graduated August 2011)

Noguiera, R.C. Department of Geography and Anthropology, LSU
Dissertation: *Atlantic Tropical Cyclones: Climatology and the Contribution to Monthly and Seasonal Rainfall in the Eastern United States 1960-2007.*
(successfully defended in December 2008, graduated May 2009)

Miller, S.T.M. Department of Earth Sciences, University of New Hampshire.
Dissertation: *Climatology of the New England Seabreeze* (successfully defended in September 2003, graduate December 2003).

MS Advisor

Grondin, N. Department of Geography and Anthropology, LSU
MS Thesis: *Climatology, Variability, and Return Periods of Tropical Cyclone Strikes in the Northeastern and Central Pacific Basins*

(graduated August 2019)

Thompson, D. Department of Geography and Anthropology, LSU
MS Thesis: *Construction of a Tropical Cyclone Size Dataset Using Retroactive Analysis Data with a Damage Application*
(graduated August 2018)

Gauthreaux, R. Department of Geography and Anthropology, LSU
MS Thesis: *Long-Term Dewpoint Variability in the Southeastern United States with an Emphasis on Extreme Dewpoint Climatology*
(graduated May 2018)

Collins, C. Department of Geography and Anthropology, LSU
MS Thesis: *Impacts of ENSO on Tornado Frequency, Intensity, and Geography Across the Eastern United States*
(graduated May 2017)

Billiot, A. Department of Geography and Anthropology, LSU
MS Thesis: *A Hybrid Procedure for Classifying Synoptic Weather Types for Louisiana with an Application to Precipitation Variability.*
(graduated Dec 2013)

Town, H. Department of Geography and Anthropology, LSU
Thesis: *Saving the Baton Rouge Fresh Water Aquifer From Salt Water Intrusion*
(graduated May 2013)

Beckage, S. Department of Geography and Anthropology, LSU
Thesis: *An Anlysis of Tropical Storm Surge Trends for the Atlantic Coast of the United States* (graduated August 2012).

Needham, H. Department of Geography and Anthropology, LSU
Thesis: *Identifying Historic Storm Surges and Calculating Storm Surge Return Periods for the Gulf of Mexico Coast* (graduated May 2010).

Roberts. M. Department of Geography and Anthropology, LSU
Thesis: *Dry Event Trends and Frequencies in the South Central United States* (graduated May 2010).

Alexa Andrews, Department of Geography and Anthropology, Louisiana State University.
Thesis Title: *Spatial and Temporal Variability of Tropical Storm and Hurricane Strikes in the Bahamas, and Greater and Lesser Antilles*
(graduated December 2007)

Michelle Russo, Department of Geography and Anthropology, Louisiana State University

Thesis: *Extreme Precipitation Events in East Baton Rouge Parish: An Areal Rainfall Frequency/Magnitude Analysis*
(graduated in August 2004)

Senior Honors Thesis Chair

Chris Dupuis, Physics Department, LSU, 2012.
Thesis: Time Dependence of Bathymetric Effects on Hurricane Storm Surge

Kim Frost, Mathematics Department, University of New Hampshire
Thesis: Recurrence Interval of the Southern NH Snowstorm of March 5-7, 2001.

PhD Committee Member, Deans Representative

M. Khan, PhD (Renewable Natural Resources, LSU 2018)
J. He, Civil and Environmental Engineering, LSU (2012)
Jennifer Banning, Human Ecology, Louisiana State University (2005)

MS Examining Committee for the following students who have graduated

A. Shefi (MS Engineering, LSU, 2020)
L. Yin (MS Geography, LSU, 2020)
J. Raihan (MS Geography, LSU, 2018)
J. Brady (MS Geography, LSU, 2017)
A.B. Ferrari (MS, Agriculture, LSU, 2017)
X. Huang (MS, Geography, LSU 2016)
D. Smith (MS, Geography, LSU 2016)
J. Punkasem (MS, Geography, LSU 2016)
P. Algu (MS, Environmental Sciences, LSU 2015)
C. Massara (MS, Engineering Science, LSU, 2012)
J. Fennel (MS, Civil and Environmental Engineering, LSU, 2009)
Sean Hribal (MS, Geography, LSU, 2009)
N. Webb (MS, Meteorology, Plymouth State University, 2009)
J. Thorp (MS, Meteorology, Plymouth State University, 2009)
P. Schmutz (MS, Geography, LSU 2007)
A. Antipova (MS, Geography, LSU, 2007)
N. Vines (MS, Geography, LSU, 2005)
B.T. Allen, (MS, Geography, LSU, 2004)
A. Babin, (MS, Coastal Studies Institute, LSU, 2004)
Z. Irons (MS, Earth Sciences, UNH, 2004)
J.A. Bradbury (MS, Earth Sciences, UNH, 2001)
E.A. Meyerson (MS, Earth Sciences, UNH, 1999)
J.F. Slater (MS, Earth Sciences, UNH, 1999)
J.M. Souney (MS, Earth Sciences, UNH, 2000)
K.B. Yalcin (MS, Earth Sciences, UNH, 2001).

PhD examining Committees for the following students who have graduated

P. Wang, PhD (Civil and Environmental Engineering, LSU 2020)

N. Chaichitehrani, PhD (Oceanography and Coastal Science, LSU 2018)
S. Joshi, PhD (Renewable Natural Resources, LSU 2017)
N. Allahdadi, PhD (Oceanography and Coastal Science, LSU 2014)
M. Bitton, PhD (Geography, LSU 2013)
A. Evans, PhD (Geography, LSU 2013)
B. Edwards, PhD (Geography, LSU, 2013)
T.A. Joyner (PhD, Geography, LSU, 2013)
T. Moore (PhD, Geography, Texas State University, 2013)
A.M. Trevino (PhD, Geography, LSU, 2012)
Y. Zhu (PhD, Geography, LSU 2007)
G.S. Bohr (PhD, Geography, LSU, 2004)
J.F. Slater (PhD, Earth Sciences, UNH 2002).
C.E. Jordan (PhD, Earth Sciences, UNH 1999)
A.B. Shrestha (PhD, Earth Sciences, UNH 1998)

Currently Serving as MS or PhD Advisor for the Following:

Brant Mitchell (PhD Candidate)
Derek Thompson (PhD Candidate)
Bethany Garfield (PhD Candidate)
Ashlee Autore (MS Candidate)
Marisa Karpinski (MS Candidate)
Cameron Goff (MS Candidate)
Jessie Parrott (MS Candidate)
Arielle Sutton (MS Candidate)

Grants Awarded

Keim, B.D. (P.I.). A Comparison of Hurricanes Harvey and Florence on Water Utilities Operations and Planning. **Funded** by the National Oceanic and Atmospheric Administration – Sectorial Applications Research Program for $107,034 from July 2019 to June 2021.

D'Elia, C. (P.I.), with K.L. DeLong, V.H. Rivera-Monroe, and B.D. Keim. A Proposal to Host the Department of Interior's South-Central Regional Climate Science Center. **Funded** by the U.S. Department of the Interior for $642,032 from September 2019 to August 2024.

Keim, B.D. (P.I.), with V. Brown and A.B. Lewis. Filling the Gaps: Climate and Weather Information for Small- and Medium Sized Water Utilities. **Funded** by the National Oceanic and Atmospheric Administration for $20,000 from November 2019-September 2020.

Keim, B.D. (P.I), A.W. Black, J.R. Edwards, and D. Sathiaraj. Southern Climate Impacts Planning Program (SCIPP) Phase III: Helping Communities Build Resilience to Weather and Climate Extremes. **Funded** by the National Oceanic and Atmospheric Administration-Coastal and Ocean Climate for $823,986 from September 2018 to August 2021.

Keim, B.D. (P.I), A.W. Black, J.R. Edwards, and M.T. Daigle. Building a More Resilient Coast: Understanding and Adapting to Extreme Events. **Funded** by the National Oceanic and Atmospheric Administration-Coastal and Ocean Climate for $400,000 from September 2018 to August 2020.

Keim, B.D. (P.I.). Climate Science Organizational Support Services for the U.S. Air Force Civil Engineering Center Energy Resilience Risk Assessment Tool. **Funded** by the National Renewable Energy Laboratory for $24,473, from May 2018 to September 2018.

Keim, B.D. (P.I.). Building Resilience to Extreme Events and Water Hazard Planning in Remote, Rural Communities. **Funded** by the National Oceanic and Atmospheric Administration-Sectoral Application Research Program for $55,907 from September 2018 to August 2019.

Edwards, J.R. (P.I), B.D. Keim, A.W. Black, and A.L. Miller, and R.R. Twilley Communicating Climate Tools to Coastal Stakeholders (CCTCS). **Funded** by Louisiana Sea Grant for $200,000 from June 2018 to May 2020.

Keim, B.D. (P.I.). Climate Science Organizational Support Services for the Strategic Petroleum Reserve Climate Change Assessment. **Funded** by the National Renewable Energy Laboratory for $24,930, from August 2016 to July 2017.

Keim, B.D. (P.I.). Louisiana State University Disaster Science and Management Program. **Funded** by the U.S. Department of Homeland Security for $263,500 from January 2016-June 2018.

Keim, B.D. (P.I.) , with K.D. Robbins, L. Romolo, and A.B.Lewis. Quantifying Future Precipitation in the South Central Region for Stakeholder Planning. **Funded** by the U.S. Department of the Interior, South-Central Climate Science Center for $120,669. September 2015-August 2017.

Keim, B.D. (P.I.), with Robbins, K.D. Southern Climate Impacts Planning Program (SCIPP) Phase II. **Funded** by the National Oceanic and Atmospheric Administration RISA Program, $1,784,099, September 2013-August 2018.

Keim, B.D. (P.I.), with Robbins, K.D. Climate Risk Mitigation Program. **Funded** by the National Oceanic and Atmospheric Administration RISA Program, $1,396,855, September 2008-August 2013.

Keim, B.D. (P.I), with L.A. Carter, and K.D. Robbins. RISA support for regional assessment services at the Southern Climate Impacts Planning Program. **Funded** by the National Oceanic and Atmospheric Administration RISA Program, $182,274, September 2010-August 2011.

D'Elia, C. (P.I.), with K.D. Robbins, B.D. Keim, V.H. Rivera-Munroy, and C.A. Wilson. A Proposal to Host the Department of Interior's South-Central Regional Climate Science Center. **Funded** by the U.S. Department of the Interior for $494,647 from October 2011-

September 2016.

Keim, B.D. (P.I) "Potential Impacts of Climate Change on the Hydroclimatology of the Northern Gulf of Mexico Coastal Zone." **Funded** by United States Geological Survey for $15,000, July 2004-December 2005.

Keim, B.D. Are there Spurious Precipitation Trends in the U.S. Climate Divisional Database? **Funded** by the LSU Faculty Research Grant Program for $9,996, July 2004-June 2005.

Talbot, R., M. Twickler, J. Koermer, B.D. Keim, C. Wake, J. Zebranski, M. Prentice, J. Dibb, R. Keller, and K. Rancourt, (Co-P.I.). "Atmospheric Investigation, Regional Modeling, Analysis and Prediction (AIRMAP): A Continuation Proposal." **Funded** by the National Oceanic and Atmospheric Administration - Office of Atmospheric Research for $2,513,000, June 2002-August 2003.

Talbot, R., M. Twickler, J. Koermer, B.D. Keim, C. Wake, J. Zebranski, M. Prentice, J. Dibb, R. Keller, and K. Rancourt, (Co-P.I.). "Atmospheric Investigation, Regional Modeling, Analysis and Prediction (AIRMAP): A Continuation Proposal." **Funded** by the National Oceanic and Atmospheric Administration - Office of Atmospheric Research for $2,000,000, September 2001-August 2002.

Talbot, R., M. Twickler, J. Koermer, B.D. Keim, C. Wake, J. Zebranski, M. Prentice, J. Dibb, R. Keller, and K. Rancourt, (Co-P.I.). "Atmospheric Investigation, Regional Modeling, Analysis and Prediction (AIRMAP)." **Funded** by the National Oceanic and Atmospheric Administration - Office of Atmospheric Research for $1,706,405, September 2000-August 2001.

Mayewski, P.A., J. Koermer, B.D. Keim, G. Zielinski, C. Wake, J. Zebranski, M. Prentice, and K. Rancourt, (Co-P.I.). "The New England Climate Initiative: A Model for Regional Scale Understanding of Climate." **Funded** by the National Oceanic and Atmospheric Administration-Office of Atmospheric Research for $2,000,000, September 1999-August 2000.

Wake, C.P., and B.D. Keim (Co-P.I.). "Development of a Multi-Parameter Ice Core Record from Eclipse Dome, St. Elias Mountains, Yukon Territory." **Funded** by the National Science Foundation for $171,854 for 2 years.

Keim, B.D. (P.I.). "Deriving Return Periods of Heavy Rainfall in Arid and Mountainous Environments: A Test Case in Western Texas." **Funded** by College of Liberal Arts Summer Research Stipends Competition for $3,000, Summer 1998.

Keim, B.D. (P.I.). "Toward a Better Understanding of the Severity of Tropical Cyclone Rainfall in the Eastern United States." **Funded** by the University of New Hampshire Discretionary Fund Competition for $6,000, May 1997-June 1998.

Keim, B.D. and J. Schoof (Co-P.I.). "Design and Acquisition of an Automated Climate Station at the University of New Hampshire." **Funded** by the University of New Hampshire - Undesignated Gifts Competition for $5,950, June 1997-May 1998.

Macdonald, N. J., and B.D. Keim (Co-P.I.). "Addendum to *Changing Weather? Facts and Fallacies about Climate Change and Weather Extremes.*" **Funded** by the Global Climate Coalition for $1,000, October-November 1997.

Keim, B.D., and G.E. Faiers (co-P.I.). "Extreme Rainfall Frequencies in the South-Central United States." **Funded** by the Southern Regional Climate Center for $2,400, June, 1996.

Muller, R.A. (P.I.), with G.E. Faiers and B.D. Keim. "Magnitude and Frequency of Excessive Rainfall Events in the South Central United States." **Funded** by the Climate Analysis Center for $203,695 from 8/1/92 - 5/30/95.

Professional Recognition

2017 LSU Senior Rainmaker Award

2016 LSU Distinguished Faculty Award

Selected as a 2009 LSU "Rainmaker" - one of LSU's top 100 research and creative faculty.

Selected as a 2008 LSU "Rainmaker" - one of LSU's top 100 research and creative faculty.

Membership in Professional Organizations

American Association of State Climatologists, 1994-present
Nominating Committee 2004-2005
Membership Committee 2008-2009

Association of American Geographers, 1987-Present
Climate and Water Resources Specialty Groups
Chair, Climate Specialty Group, 2004-2006
Secretary/Treasurer - Vice Chair: Climate Specialty Group 2002-2004
Chair, Climate Specialty Group Honors Committee 1998-2001
Climate Specialty Group Honors Committee 1995-1998

American Meteorological Society - Central Louisiana Chapter
Chair during academic year 1991-1992
Secretary-Treasurer during academic year 1990-1991

Editorial Committees

Serve on Editorial Board of the *Southeastern Geographer,* 2012 –2015.

Serve on Editorial Board of the *Geographical Review*, 2006-2014.

Served on the Scientific Advisory Committee for National Public Radio's *The Weather Notebook,* 1999-2002.

Service as Louisiana State Climatologist (2003-Current) and New Hampshire State Climatologist (1994-2002)

- Served as an expert witness in numerous trials and depositions.
- Served on 23 Boards of Consultants overseeing Probable Maximum Precipitation Studies across the United States for dam design.
- Provide approximately 50 interviews per year (2003 to Current) to *Louisiana Radio Network,* who provides news for "top and bottom of the hour" to 75 radio station affiliates across Louisiana.
- I was a contributing writer to the *St. Bernard Parish Post Newspaper* - contributing 52 articles in 2012, 52 articles in 2013, 51 articles in 2014, 51 articles in 2015, 51 articles in 2016, and 45 in 2017.
- I was a contributing writer for the *Sunday Citizen* (Dover, NH) newspaper (October 1998 – August 2002)
- I was a contributing writer to the *Portsmouth Herald* (January 1997 – September 1998).

Appeared in the following Newspapers and Magazines:

National Geographic
USA Today
Boston Globe
Boston Herald
Times-Picayune
The Advocate
Seattle Times
Christian Science Monitor
Entertainment Today
U.S. News and World Report
Forbes Magazine
New York Times
Reader's Digest
Wall Street Journal
Los Angeles Times
Washington Post
Washington Times
Washington Free Beacon
New York Daily News
Ledevoir (Montreal, Canada)
Time Magazine
San Francisco Chronicle
Boston Globe
Miami Herald
The Times Picayune
The Advocate
The New Yorker
National Journal
Financial Times
The Gannet News
Seattle Post Intelligencer
Baltimore Sun

Rhythm and Blues Magazine (UK)
Johannesburg Mail and Guardian (South Africa)
Wanadoo (Jordan)
Pakistan Observer
La Nacion (Argentina)
Business Day (Thailand's only Business News in English)
Knoxville News Sentinel
Kansas City Star
Union Tribune (San Diego)
Portland Press Herald (ME)
Beaumont Enterprise (Texas)
Sun Sentinel (Ft. Lauderdale, FL)
Palm Beach Post
News Sentinel (Ft. Wayne, IN)
The News Tribune (Tacoma, WA)
Charlotte Observer
San Jose Mercury News
Worcester Telegram (MA)
Myrtle Beach Sun News (SC)
The Wichita Eagle (KS)
Tallahassee Democrat
Duluth News Tribune (MN)
Ft. Wayne News Sentinel
Ft. Wayne Journal Gazette
Monterey County Herald (CA)
Macon Telegraph (GA)
Clarion Ledger (Jackson, MS)
Wilmington Morning Star (NC)
Bloomington Pantagraph (Illinois)
Delta Farm Press
Wilkes-Barre Times-Leader
Daily Iberian
Casper Star Tribune
Health and Science News
Sierra Times
San Luis Obispo Tribune (CA)
The Advocate Magazine
The Morning Advocate
Akron Beacon Journal (OH)
Columbus Ledger-Enquirer (GA)
Grand Forks Herald (ND)
Enid News and Eagle (OK)
Bradenton Herald (FL)
The Ledger (Lakeland, FL)
Star Telegram (Dallas)
Gainesville Sun (FL)
Belleville News Democrat (FL)
Bridgewater Courier News (NJ)
Herald Today (FL)
Democrat Gazette (Little Rock, AR)
North County Times (CA)
Montgomery Advertiser
The Post and Courier (Charleston, SC)
Turkish Daily News
Tuscaloosa News
Daily Journal (MS)
Tyler Morning Telegraph (TX)
The State (SC)
Pioneer Press (MN)\
Times Daily (AL)
Town Talk Newspapers
Courier (Houma)
Sun Herald (Biloxi, MS)
Cushing Daily Citizen (OK)
Mankato Free Press
The Scotsman
Lexington Herald-Leader (KY)
Denton Record Chronicle (Denton, TX)
Hammond Daily Star
The Conservative Voice
Ft. Worth Star
Ft. Worth Weekly
News Banner (Covington, LA)
Live Science
Canton Repository (OH)
Pakistan Times
Dallas Morning News
Vancouver Sun
Daily Free Press (Boston)
The China Post
The Eagle (TX)
The Tribune (San Luis Obispo)
Press of Atlantic City
Arizona Daily Sun
Free New Mexican
Ottawa Citizen
Jefferson Journal (LA)
Greenwire Magazine
The Reflector (Mississippi State)
The Ottawa Recorder (Canada)

Jackson News Tribune
The Kindred Times
Oberlin Times
Hinesberg Journal (BC, Canada)
Brockton News (NV)
Centre Daily (PA)
The Daily Advertiser (Lafayette, LA)
Ruston Daily Leader
Mineral Wells Index (TX)
Ely Times and County (NY)
Aberdeen American News (SD)
Pontotoc Progress (MS)
Denton Record Chronicle (TX)
Mississippi Press (Pascagoula, MS)
Center Daily Times (PA)
News-Star (Monroe, LA)
The Packer (Weekly for Produce Growers)
Lufkin Daily News (TX)
Wired News
Vicksburg Post
Ledger-Enquirer
Pierceland Herald
Sky Valley Journal
Herald News Daily (the Dakotas)
Contra-Costa Times
Daily Leader (Leesville, LA)
The Assumption Pioneer
Tiger Weekly
LSU Today
The Reveille
Toronto Star (Canada)
Farm Journal
St. Bernard Parish Post (LA)
DIG Magazine
Currents Magazine
Farm News
Baton Rouge Business Report
The Nation's Health Magazine
The Lens
Arkansas Democrat Gazette
Popular Science
New Scientist Magazine

008 Magazine
Farming Magazine
Delta Farm Press
Democrat Gazette (Little Rock, AR)
Daily Iberian (New Iberia, LA)
Courier (Houma, LA)
Town Talk Newspapers (Central LA)
Union Leader (Manchester, NH)
Foster's Daily Democrat (Dover, NH)
Concord Monitor (Concord, NH)
Portsmouth Herald (Portsmouth, NH)
Yankee Magazine
Post Standard (Syracuse)
Lawrence Eagle Tribune (MA)
Keene Sentinel (Keene, NH)
The Telegraph (Nashua, NH)
The Yale Daily News
Loyola Maroon
The Courier (Littleton, NH)
Berlin Daily Sun
Berlin Reporter
Conway Daily Sun
1590 Broadcaster
Exeter Newsletter
Intertown Record
Sun Chronicle (Attleboro, MA)
New Hampshire Market Bulletin
Winter Weekly
The Daily News (Newburyport, MA)
Derry News (Derry, NH)
Laconia Citizen
Lancaster Herald (Lancaster, NH)
Sunday Valley News (White River Junction, VT)
Sun Journal-News (Norway, ME)
Rochester Times
Campus Journal
The New Hampshire
LSU Today
Baton Rouge Daily News
Southeast News
Gueydan Journal

Radio Stations and Programs:

BBC Radio (2X)
Discovery Channel-Satellite Radio

Russian National Radio
NPR
NPR – *On Point* (2X)
NPR-*The Weather Notebook* (3X)
New Hampshire Public Radio
Louisiana Public Radio
Maine Public Radio
CNN Radio
Discovery Channel Satellite Radio
ABC News Radio
CBS Radio
Portuguese National Radio (4X)
KMAR-Winnsboro (25X)
Associated Press (15X)
WJBO-Baton Rouge (42X)
Tiger Rag (4X)
Jim Engster Show (5X)
107.3 Baton Rouge (7X)
WWL-New Orleans (16X)
WRKF-Baton Rouge (5X)
The Karen Henderson Show (14X)
WWNO-New Orleans
Moon Griffen Show
Louisiana Live with Don Grady (50X)
KMOX-St. Louis
WBOK – New Orleans
KPLC - Lake Charles
The Andre Trevigne Show-WWL
WIBR-Radio News (5X)
Metro Network (21X)
WAXY-Miami
The Front Porch NH Public Radio
The Exchange NH Public Radio (8X)
All Things Considered NH Public Radio
WGIR (Manchester, NH)
WLNH (Laconia, NH)
WOKQ (Portsmouth, NH)
Topics of Interest (WJYY- Portsmouth)
Talk of the Town (WKXL - Concord)
Morning Attitude (WSMN–Nashua, NH)

Television Stations and Programs

CNN
PBS-Newshour
History Channel (2X)
National Geographic (2X)
Discovery Channel (2X)
Canadian Broadcasting Corporation (CBC) (2X)
BBC Television
BBC World News (2X)
Russian National Television
WVLA-Channel 33 (3X)
WYES-TV (New Orleans)
FOX News 8 TV – New Orleans (3X)
WBRZ-Channel 2 – Baton Rouge (10X)
Louisiana Public Broadcasting (15X)
This Week in Agriculture – Louisiana
KALB-Channel 2 (Alexandria, LA)
2une In WBRZ
WAFB-Channel 9 (2X)
KATC-TV (Lafayette)
Sunday Journal WBRZ (15X)
As I See It with Clay Young (WBTR) (5X)
WDSU News -New Orleans (2X)
WWLTV
WLOS News-Raleigh-Durham
WGNO – New Orleans
WFLA television, Tampa FL
M6 (National) Television, Paris, France
WBZ (Boston)
New England Cable News (NECN)
WMUR News Manchester, NH (33X)
Chronicle on WMUR (NH)
New Hampshire Business on WMUR (NH)
New Hampshire Outlook on NHPTV
Quest on Maine Public TV
Sinclair Broadcasting Group
CBS – 60 Minutes

Web Content

The Drudge Report
The Weather Channel
MSNBC
CNBC-Digital
ABCNews
Earth-Observatory (NASA) News
CBS News
USA Today

CNN
EurekAlert
Climate Central (3X)
A.M. Best TV
ATTN.com
EE.com
Farm News
E&E News

Documentaries

GreenWave Environmental
Pink Triangle Press - Canada
On the Brink: Solutions to Global Warming
Climatewire of E&E News
The American Sugarcane League

Other Service

Serve as Chair of the Department of Geography and Anthropology, 2020-

Served as Interim Chair, Department of Geography, University of New Hampshire, 2001

Served on the College of Humanities and Social Sciences, Promotion and Tenure Committee, Fall 2014-Spring 2017.

Served as Graduate Director for the Department of Geography and Anthropology 2011-2013.

Reviewed 29 candidates going up for promotions to Associate and Full Professor at other Institutions, including Texas A&M, Columbia University, University of Nebraska, University of Florida, University of Oklahoma, University of Tennessee, University of Georgia, University of Delaware, University of Maine, University of Nevada, Indiana University, and others.

Reviewed over 135 manuscripts for the following journals:

Annals of Association of American Geographers:
Applied Geography
ASDSO (American Society of Dam Safety Officials) Dam Safety Journal
Bulletin of the American Meteorological Society
Canadian Journal of Forest Research
Chinese Science Bulletin
CLEAN Soil, Air, Water
Climate Dynamics
Climate Research
Climatic Change
Earth Interactions
Environmental Communication
Environmental Research Letters
Environmental Science: Processes and Impacts
Geographical Bulletin
Geophysical Research Letters:

Geographical Review
Geoscience and Man
Global and Planetary Change
Hydrological Processes
Hydro Review
International Journal of Climatology:
International Journal of Environmental Health Research
International Journal of Sustainable Transportation
Journal of Climate
Journal of Arid Environments
Journal of Applied Meteorology
Journal of Applied Meteorology and Climatology
Journal of Atmospheric and Oceanic Technology
Journal of Climatology
Journal of Geography
Journal of Geophysical Research-Atmospheres
Journal of Hydrology
Journal of Hydrometeorology
Marine Geodesy:
Marine Geology:
Meteorology and Atmospheric Physics
Northeastern Geographer
Northeastern Naturalist
Physical Geography:
Professional Geographer
Scientific World Journal
Southeastern Geographer
Southwestern Geographer
The Compass
Theoretical and Applied Climatology
Transactions of the Institute of British Geographers
Weather and Climate Extremes
Weather, Climate, and Society
Water Resources Bulletin/Journal of the American Water Resources Association:
Wetlands

Also Reviewed Books and Proposals for:

United States Geological Survey
Intergovernmental Panel on Climate Change: Special Report on Regional Impacts of Climate Change
Oxford University Press
University of Mississippi Press
National Oceanic and Atmospheric Administration - Climate Transition Program
National Oceanic and Atmospheric Administration - Office of Global Programs
National Oceanic and Atmospheric Administration - Climate and Global Change Program

National Oceanic and Atmospheric Administration - Climate Change Prediction Program
National Science Foundation
Netherlands Organization for Scientific Research
U.S. Army Corps of Engineers-Cold Regions Research and Engineering Laboratory
New Hampshire Comparative Risk Project

Assessment of Sustained Winds and Wind Gusts During Hurricane Laura

Across the Greater Lake Charles Region

By

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Prepared For

Entergy Louisiana, LLC

April 2021

This report examines and estimates sustained winds, peak wind gusts, and instantaneous winds associated with Hurricane Laura with respect to damage to energy infrastructure across the Lake Charles region. Sources of information for this report include the following:

- NASA – Hurricane and Typhoon Updates for Hurricane Laura found at https://blogs.nasa.gov/hurricanes/tag/laura-2020/
- National Hurricane Center – Hurricane Advisory Archive for Hurricane Laura found at: https://www.nhc.noaa.gov/archive/2020/LAURA.shtml?
- National Weather Service Office-Lake Charles – *Hurricane Laura* found at: https://www.weather.gov/lch/2020Laura and https://www.weather.gov/media/lch/events/2020Laura/Hurricane%20Laura%20Storm%20Surge%20Marks%20(All%20-%20NAVD).pdf for storm surge verification.
- National Ocean Service - NOAA Historical Hurricane Tracks found at: https://oceanservice.noaa.gov/news/historical-hurricanes/.
- Needham, H.F., and B.D. Keim. 2012. A Storm Surge Database for the U.S. Gulf Coast. *International Journal of Climatology* 32(14):2108-2123.
- Powell, M. D., Houston, S. H., Amat, L. R., and Morisseau-Leroy, N., 1998: The HRD real-time hurricane wind analysis system. Journal of Wind Engineering and Industrial Aerodynamics 77&78:53-64.
- Hsu, S.A. 2003. Nowcasting mixing height and ventilation factor for rapid atmospheric dispersion estimates on land. *National Weather Digest* 27:75-78.
- Hsu, S.A. 2008. Estimating 3-second and maximum instantaneous gusts from 1-minute sustained wind speeds during a hurricane. *Electronic Journal of Structural Engineering*, pp 77-79.
- HWind wind speed information for Hurricane Laura from Risk Management Solutions, Inc. (RMS). (See Appendix A for disclaimer concerning this information.)

Based on these sources and my review of meteorological data, this report analyzes and estimates the maximum 1-minute sustained winds, 3-second peak wind gusts, and instantaneous wind gusts, at structures situated well above the standard 10-meter wind measuring height.

2020 Hurricane Season

The 2020 hurricane season was one for the record books. Before the season even started, it was predicted to have above average storm frequencies by both the National Oceanic and Atmospheric Administration (NOAA) and Colorado State's Tropical Meteorological Project. By the end of the season, tropical storms and hurricanes exceeded expectations with a record-breaking 30 named storms, breaking the record high of 28 named storms from the 2005 season (Figure 1). We also had 12 storms make landfall in the United States, breaking the record of 9 U.S. landfalls set in 1916. In Louisiana, we had 5 landfalling storms in 2020, breaking the State record of 4 in a single season from 2002 (Figure 1, inset). One of the 5 storms to make a landfall in Louisiana was Hurricane Laura, which is the focus of this report.

Hurricane Laura and its Place in History

Hurricane Laura began as a tropical wave over the central tropical Atlantic Ocean. It became a tropical depression on 19 August over the Atlantic and a tropical storm on 21 August as it approached the Leeward Islands. It crossed over Antigua, Barbuda, Montserrat, and St. Kitts, then skirted on the south side of Puerto Rico, Hispaniola, and Cuba on its way to the Gulf of Mexico. Once Laura entered the Gulf, it went from a tropical storm to a major hurricane in less than 24-hours – thereby meeting the definition of a hurricane with rapid intensification. It made landfall at the town of Cameron in Cameron Parish, Louisiana at 1 a.m. CDT 27 August 2020. It was at Category 4 strength with 150 mph sustained winds at landfall. This storm ties as the strongest hurricane to make landfall in Louisiana, tying with the Last Island Hurricane of 1856, which also stuck the Louisiana coast at Category 4 strength with 150 mph winds. Note that our records go back to 1851. Hurricane Laura was responsible for causing substantial wind damage, including destroying the *in situ* wind sensors at Lake Charles Regional Airport. However, the National Weather Service at Lake Charles notes that the hurricane maintained major hurricane status through Cameron, Calcasieu, and southern Beauregard Parishes, and maintained hurricane strength to just before crossing I-20 near Shreveport. Before failure, the wind sensors at the Lake Charles Airport recorded peak sustained winds of 98 mph, and a peak gust of 133 mph at 1:42 a.m. CDT. Laura also produced an estimated storm surge of 20.7 feet (NAVD88) at Rutherford Beach (Figure 2), which is the largest surge on record for Louisiana, according to the Surgedat Database (Needham and Keim 2012), and it is the fourth largest surge event on record for the Gulf of Mexico with data going back to 1880.

I also include a graphic of all major hurricanes that made landfall in Cameron Parish since 1851, aside from Hurricane Laura (Figure 3), including Hurricane Rita (2005), Hurricane Audrey (1957), Unnamed Hurricane of 1918, and the Unnamed Hurricane 1886 – all of which made landfall as Category 3 hurricanes. Hurricane Rita was the most recent of these and it has a different history than Laura. It formed over the southeastern Bahamas and entered the Gulf of Mexico between Cuba and the Florida Keys. It exploded in intensity while passing over the loop current in the southeastern Gulf and reached Category 5 strength while over the Gulf with sustained winds of 180 mph. However, Rita began to weaken as it approached the Louisiana shore, and it made landfall as a Category 3 hurricane with sustained winds of 115 mph - substantially weaker than the 150 mph winds associated with Laura's landfall. Rita also made landfall in western Cameron Parish and tracked northward near the Texas-Louisiana border, which is farther west than Hurricane Laura's track, which was basically over Lake Charles. Hurricane Rita also rapidly weakened once inland, while Laura's decline in intensity was much slower. Hurricane Laura was the strongest hurricane on record to affect Southwest Louisiana.

H-Winds

To determine wind speeds at any given location, estimated values are often used, which are based upon a foundation of empirical data. This would be true in any hurricane because of the small number of available wind sensors. In addition, as already noted with Hurricane Laura

and the damage to the *in situ* wind sensors at Lake Charles Regional Airport, hurricane winds often damage the wind sensors. Hurricanes also disrupt the communication links to relay, record, and otherwise document the relevant information. As a result, a number of varying sources of wind data are required to best determine the wind fields associated with major Hurricanes like Laura. These sources should include the weather stations that survived the storm, as well as measurements made by reconnaissance aircraft commissioned by the National Hurricane Center, as well as remotely sensed data.

Historically, the Atlantic Oceanographic and Meteorological Laboratory - Hurricane Research Division (AOML-HRD), which is a branch of the NOAA, would gather all available wind information on hurricanes – including observations from Air Force and NOAA aircraft, ships, buoys, C-MAN platforms, surface airways, satellite observations, pressure-wind relationships, and available surface data – and then estimate wind fields associated with each storm. Between 1993 and 2013, the AOML-HRD produced analyses of tropical cyclone surface wind observations on an experimental basis as part of the H-Wind Project. H-Winds came in the form of 1-minute sustained wind swath footprints in 6-hour intervals and a map of maximum sustained winds for each hurricane. All data were quality controlled and processed to conform to a common framework for height, exposure, and averaging period using accepted methods from meteorology and wind engineering (Powell et al., 1998). In 2014, this technology was transferred to a private sector firm as allowed under the Technology Transfer Act of 1986 (15 US Code 3710). RMS is the firm that now maintains the H-Wind hurricane weather analytics platform.

Sustained Winds in Lake Charles Region

In connection with my work, I provided RMS certain latitude and longitude coordinates that I received from Entergy for sites on or near the Entergy transmission system. Figure 4 shows the locations, which are in both Calcasieu and Jefferson Davis Parishes. With that information, RMS overlayed its final cumulative H-Wind footprint file for Hurricane Laura and provided me with the corresponding H-Wind wind speed for each site. A large-scale map of the H-Wind maximum wind field is shown in Figure 5. With this dataset as my foundation, I provide estimates of the 10-meter, 1-minute sustained wind speeds for the series of sites of interest in Calcasieu and Jefferson Davis Parishes in Tables 1 and 2. As a check on the accuracy of the data, I compared the estimates with sustained winds measured at the National Weather Service Office (NWS)-Lake Charles located along side of the Lake Charles Regional Airport. At this location, a 1-minute maximum sustained wind of 98 mph was measured along with a 3-second peak gust of 133 mph at 1:42 a.m. CDT on the day of landfall, just before the wind equipment failed. This was very likely near the highest winds experienced at the site, but obviously it could have been somewhat higher. The Entergy locations closest to the NWS Office include sites 23, 16, 10, 17, and 3. Sustained wind estimates at these sites are, respectively, 106, 102, 102, 101, and 100 mph, which is within only a few percent of that measured at the NWS Office – 98 mph (Figure 4). **This provides some validation of the estimates, as does review of measured data from other sites assembled by the NWS-Lake Charles Office's Hurricane Laura Wind and Pressure Reports.** I proceeded to estimate sustained winds, 3-second gusts, and instantaneous gusts at elevations that corresponded with the Entergy infrastructure. The infrastructure elevations differed at each site, but were all

above the standard 10-meter elevation for wind measurements. The elevations analyzed were unique to each location. Elevations are provided in Tables 1 and 2.

Winds at Elevation

All data provided by RMS were for the standard elevation of 10 meters above the ground. Given that the infrastructure is situated at elevations greater than 10 meters, adjustments were made to the wind to account for the reduction in friction from earth's surface as altitude increases. Hsu (2003) provides the following equation for estimating winds at elevations higher than the standard 10-meter elevation:

$$U_z = U_{10}(Z/10)^P$$

where, *Uz* is the wind speed at some designated elevation *Z*, other than the standard 10-meter elevation, and *P* is an exponent that varies with stability and surface roughness. Following the guidelines of Hsu (2003), the area had neutral stability conditions during Hurricane Laura, in a rural environment.

Using Google Maps in satellite mode, I zoomed into each location using the latitude and longitude coordinates provided by Entergy. One observation was that the urban footprint of Lake Charles is relatively small, and the vast majority of the sites analyzed in this report are in rural settings, away from the core of the city. There were only a few exceptions. However, the 1-minute sustained wind information provided by RMS represent an open exposure throughout, whether in downtown Lake Charles or in a soybean field outside of the city. As such, the wind data making up the foundation of my wind estimates represent an open exposure that is appropriate for a rural setting, whether used in an urban location or not. For this reason, it is most appropriate to implement the exponent $P = 0.15$ for rural settings for estimating wind speeds at various heights in the equation above under the neutral stability conditions. Use of the urban exponent $P = 0.25$ would increase the winds at a greater rate with elevation than the rural exponent because the rough city surface would lead to even more reduced surface winds relative to winds aloft.

Therefore, using these assumptions, the peak 1-minute sustained wind speeds at various sites and elevations are shown in Tables 1 and 2. Gusts were even higher. As a general rule, 3-second peak gusts are approximately 30 percent greater than the 1-minute sustained winds. For example, at the NWS Office in Lake Charles, the 1-minute sustained wind was measured at 98 mph and the 3-second gust was 133 mph, which is within 5 percent of the 1.3 estimate. Instantaneous gusts generally are 45 percent larger than the 1-minute sustained winds (Hsu 2008). For each of the locations shown in Figure 4, there is an estimate of the standard 10-meter winds at that location, as well as an estimate of the 1-minute sustained winds at a given height of a structure, as well as the 3-second and instantaneous gusts at the same height using the guidance of Hsu (2008), which uses the coefficients of 1.3 for 3-second gusts and 1.45 for instantaneous gusts times the 1-minute sustained wind estimates (Tables 1 and 2). The wind speeds vary by location and elevation ranging from 76-132 mph for 1-minute sustained winds, from 98-171 mph for 3-second gusts, and 110-191 mph for instantaneous gusts.

Personal Experience

Hurricane Laura made landfall early in the morning on Thursday, 27 August 2020. I personally took a reconnaissance trip to the Lake Charles area with two of my graduate students on the following Sunday, 30 August 2020. We found the city to be in rough shape, with many roofs and facades removed from houses and businesses, and there were trees and downed power lines almost everywhere we turned. Not only were the lines down, but, in many cases, even the support structures were down in the middle of the roadways (See Figure 6). There was great difficulty traversing the city, and traffic was basically controlled through cooperation of those on the road, as traffic was rerouted around downed trees and power lines. The damage I witnessed was consistent with what we know about the tremendous power of Hurricane Laura and with the wind estimates set forth in Tables 1 and 2.

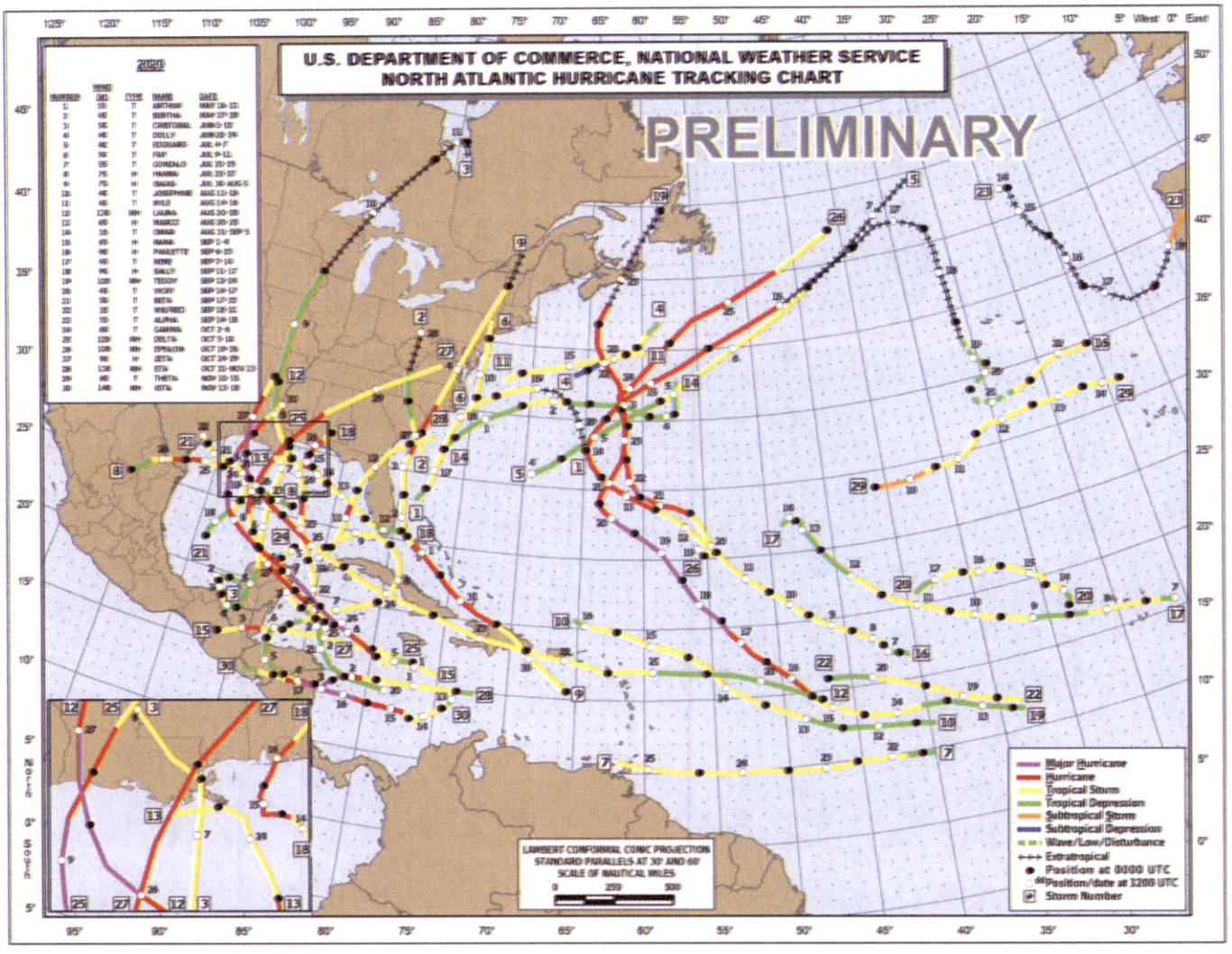

Figure 1. Storm tracks and intensities for the 2020 hurricane season, with inset map of the North-Central Gulf Coast including Louisiana. Graphic is from the National Hurricane Center and found at https://www.nhc.noaa.gov/tafb_latest/tws_atl_latest.gif.

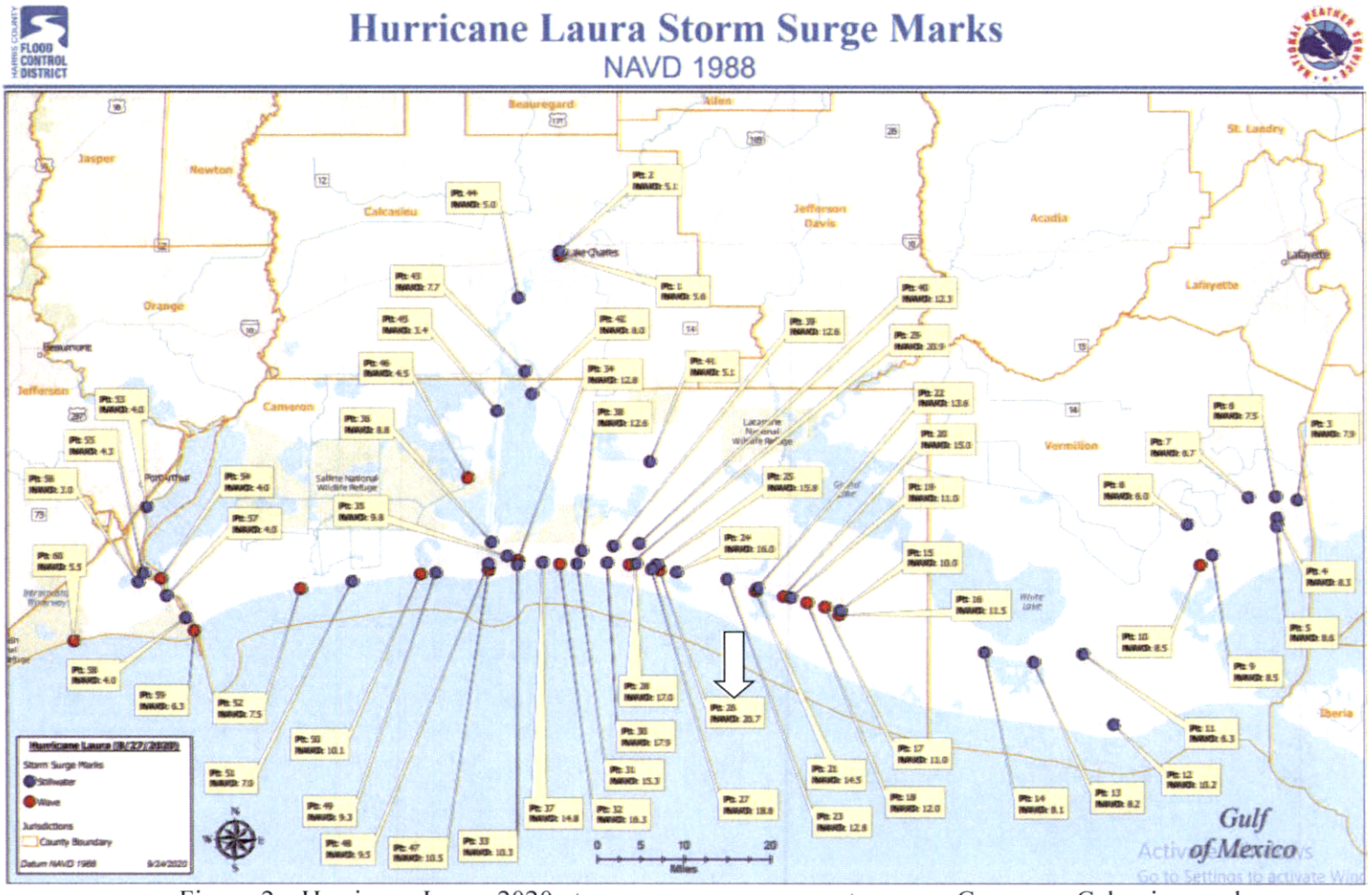

Figure 2. Hurricane Laura 2020 storm surge measurements across Cameron, Calcasieu, and Vermilion Parishes. The peak surge is highlighted with the white arrow. This graphic can be found at:
https://www.weather.gov/media/lch/events/2020Laura/Hurricane%20Laura%20Storm%20Surge%20Marks%20(All%20-%20NAVD).pdf

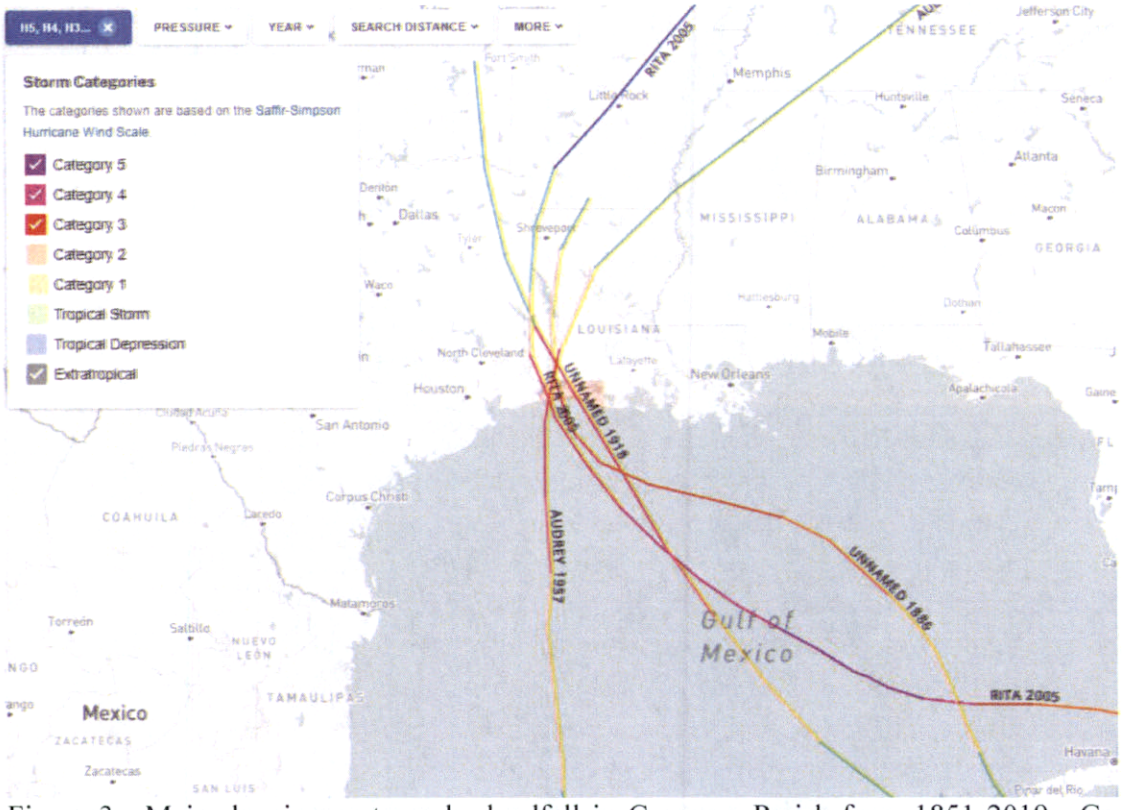

Figure 3. Major hurricanes to make landfall in Cameron Parish from 1851-2019. Graphic from the National Ocean Service website for NOAA Historical Hurricane Tracks found at: https://oceanservice.noaa.gov/news/historical-hurricanes/.

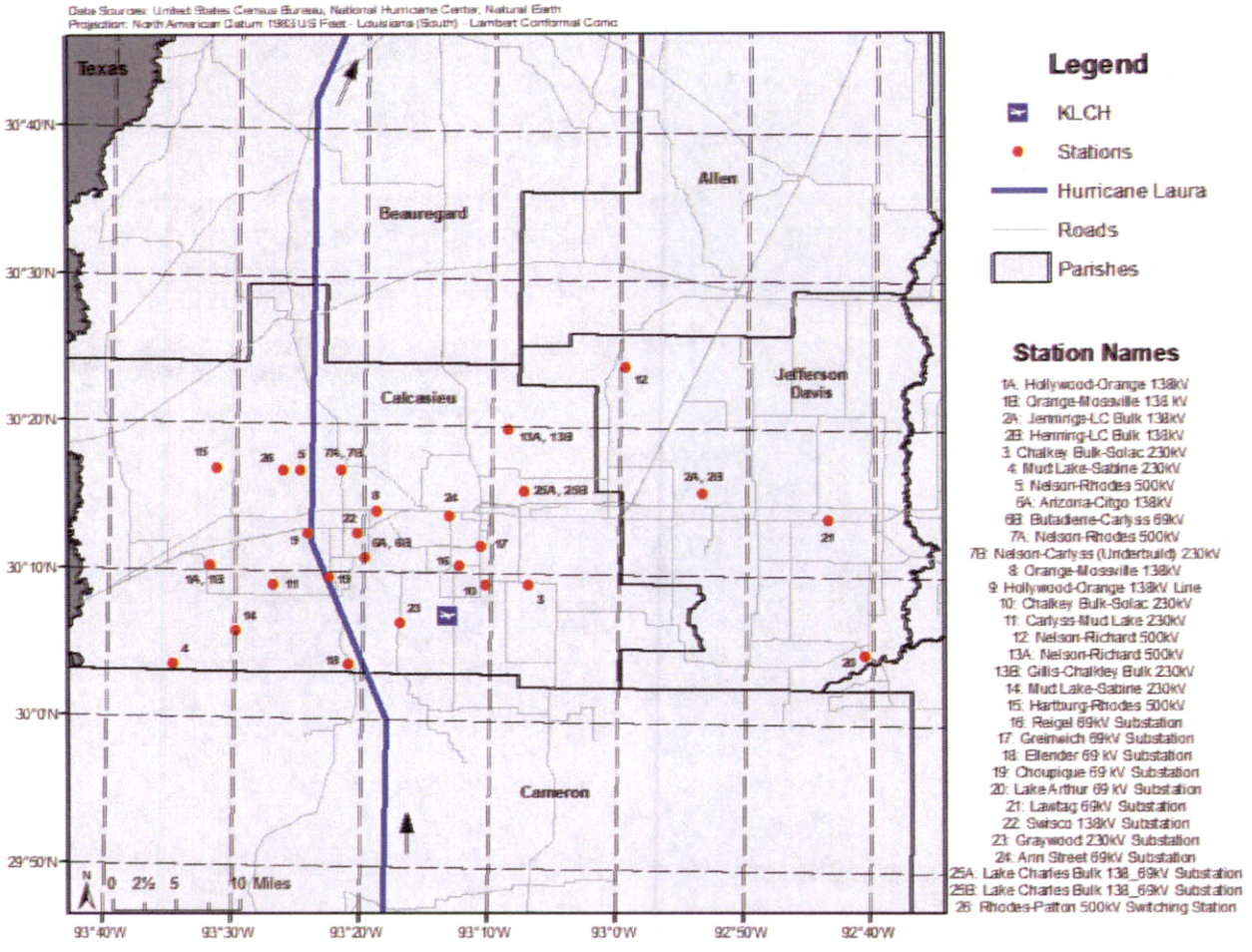

Figure 4. Locations of the Entergy infrastructure across the greater Lake Charles region in the Parishes of Calcasieu and Jefferson Davis. The blue line represents the track of Hurricane Laura 2020.

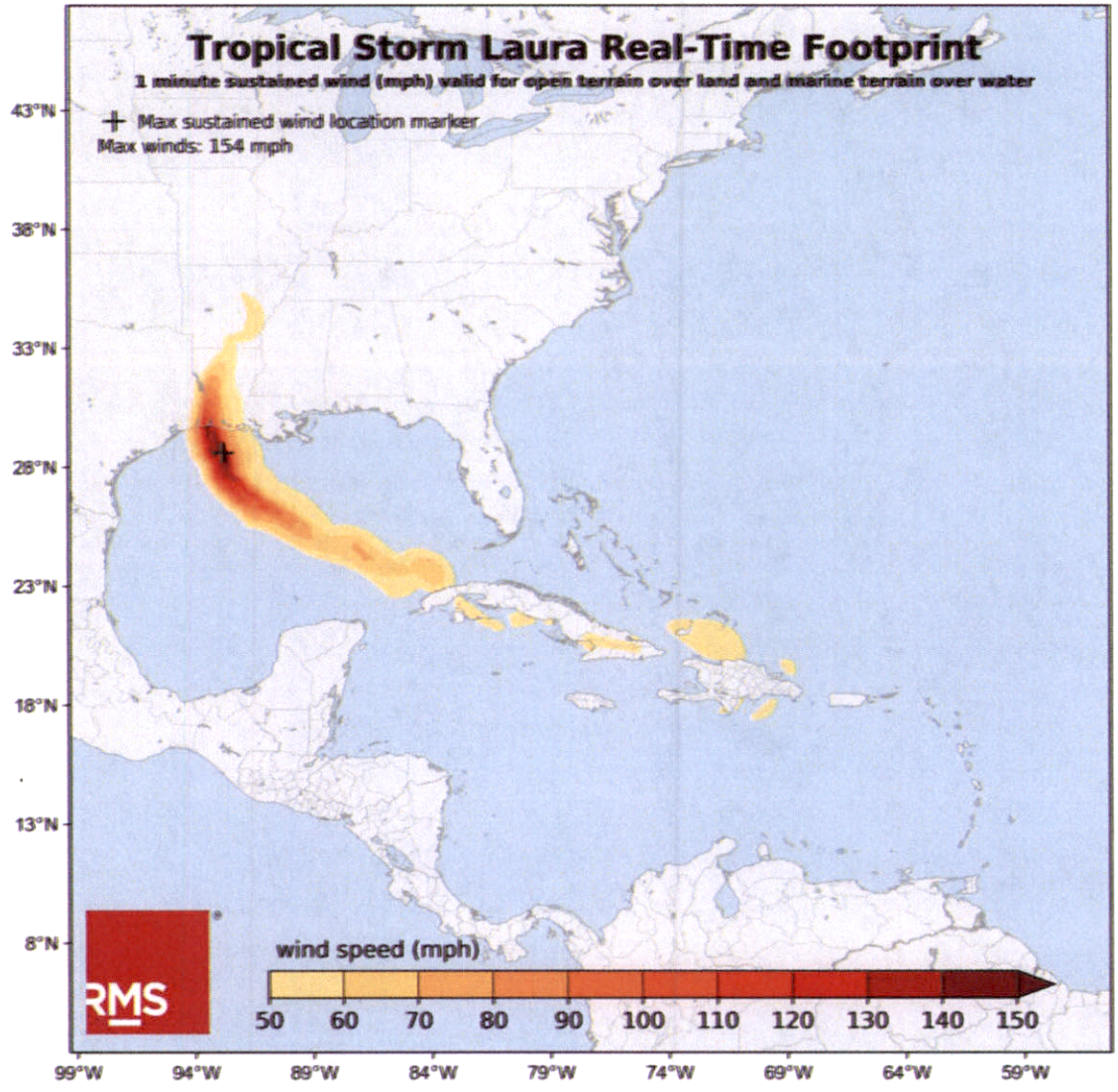

Figure 5. Maximum 1-minute sustained winds in Hurricane Laura 2020.

Figure 6. Images taken by Derek Thompson on 30 August 2020 while on reconnaissance with Barry Keim.

Table 1. Wind estimates during Hurricane Laura in 2020 at selected sites in Calcasieu and Jefferson Davis Parishes. Above Ground Height (in feet) of the utility structure, and the wind estimates are for the standard 10-meter elevation, 1-minute sustained wind estimate adjusted for elevation, with 3-second and Instantaneous Gusts at the same elevation.

Site Number	Facility	10 Meter Wind Est.	Above Ground Height	1-min Sustained Wind	3-sec Gusts	Instantaneous Gusts
1	Hollywood-Orange 138kV	108	70	121	158	176
	Orange-Mossville 138kV	108	74	122	159	177
2	Jennings-LC Bulk 138kV	81	52	86	112	125
	Henning-LC Bulk 138kV	81	52	86	112	125
3	Chalkley Bulk-Solac 230kV	100	72	112	146	162
4	Mud Lake-Sabine 230kV	107	129	132	171	191
5	Nelson-Rhodes 500kV	105	127	128	167	186
6	Arizona-Citgo 138kV	105	70	118	153	171
	Butadiene-Carlyss 69kV	105	70	118	153	171
7	Nelson-Rhodes 500kV	104	141	129	168	187
	Nelson-Carlyss 230kV Line (Underbuild)	104	89	121	157	175
8	Orange-Mossville 138kV	104	52	111	145	161
9	Hollywood-Orange 138kV Line	107	54	115	150	167
10	Chalkley Bulk-Solac 230kV	102	60	112	145	162
11	Carlyss-Mud Lake 230kV	109	73	123	160	178
12	Nelson-Richard 500kV	88	121	107	139	155
13	Nelson-Richard 500kV	98	116	118	154	172
	Gillis-Chalkley Bulk 230kV	98	60	107	139	155
14	Mud Lake-Sabine 230kV	113	68	126	163	182
15	Hartburg-Rhodes 500kV	105	132	129	168	187
16	Reigel 69kV Substation	102	68	114	148	165
17	Greinwich 69kV Substation	101	58	110	143	160
18	Ellender 69kV Substation	109	65	120	157	175
19	Choupique 69kV Substation	107	58	117	152	169
20	Lake Arthur 69kV Substation	70	56	76	98	110
21	Lawtag 69kV Substation	71	63	79	102	114
22	Swisco 138kV Substation	105	67	117	152	169
23	Graywood 230kV Substation	106	100	125	162	181
24	Ann Street 69kV Substation	101	60	110	143	160
25	Lake Charles Bulk 138_69kV Substation	99	55	107	139	155
	Lake Charles Bulk 138_69kV Substation	99	70	111	144	160
26	Rhodes-Patton 500kV	105	132	130	168	188

Table 2. Wind estimates during Hurricane Laura in 2020 at selected sites in Calcasieu and Jefferson Davis Parishes. Average Height for Line Section in feet, and the wind estimates are for the standard 10-meter elevation, 1-minute sustained wind estimate adjusted for elevation, with 3-second and Instantaneous Gusts at the same elevation.

Site Number	Facility	10 Meter Wind Est.	AVG HEIGHT FOR LINE SECTION	1-min Sustained	3-sec Gusts	Instantaneous Gusts
1	Hollywood-Orange 138kV	108	57	118	153	170
	Orange-Mossville 138kV	108	57	118	153	170
2	Jennings-LC Bulk 138kV	81	57	87	114	127
	Henning-LC Bulk 138kV	81	57	87	114	127
3	Chalkley Bulk-Solac 230kV	100	68	111	144	161
4	Mud Lake-Sabine 230kV	107	129	132	171	191
5	Nelson-Rhodes 500kV	105	133	129	168	187
6	Arizona-Citgo 138kV	105	70	118	153	171
	Butadiene-Carlyss 69kV	105	57	114	149	166
7	Nelson-Rhodes 500kV	104	128	127	166	185
	Nelson-Carlyss 230kV Line (Underbuild)	104	76	118	153	171
8	Orange-Mossville 138kV	104	57	113	147	163
9	Hollywood-Orange 138kV Line	107	53	115	149	166
10	Chalkley Bulk-Solac 230kV	102	65	113	147	164
11	Carlyss-Mud Lake 230kV	109	73	123	160	178
12	Nelson-Richard 500kV	88	125	107	140	156
13	Nelson-Richard 500kV	98	119	119	154	172
	Gillis-Chalkley Bulk 230kV	98	60	107	139	155
14	Mud Lake-Sabine 230kV	113	73	127	165	184
15	Hartburg-Rhodes 500kV	105	135	129	168	188

Appendix A: Disclaimer Concerning HWind Information

This report, and the analyses, models, and predictions contained herein (collectively, "Information") are based on data provided by Keim Consulting LLC and compiled using proprietary computer risk assessment technology of Risk Management Solutions, Inc. ("RMS"). The technology and data used in providing this Information is based on the scientific data, mathematical and empirical models, and encoded experience of scientists and specialists (including without limitation, earthquake engineers, wind engineers, structural engineers, geologists, seismologists, meteorologists, geotechnical specialists and mathematicians). As with any model of physical systems, particularly those with low frequencies of occurrence and potentially high severity outcomes, the actual losses from catastrophic events may differ from the results of simulation analyses. Furthermore, the accuracy of predictions depends largely on the accuracy and quality of the data used by Keim Consulting LLC. The Information is provided under license to Keim Consulting LLC and is RMS's proprietary and confidential information and may not be shared with any third party without the prior written consent of both Keim Consulting LLC and RMS. Furthermore, this Information may only be used for the specific business purpose specified by Keim Consulting LLC and for no other purpose, and may not be used under any circumstances in the development or calibration of any product or service offering that competes with RMS.

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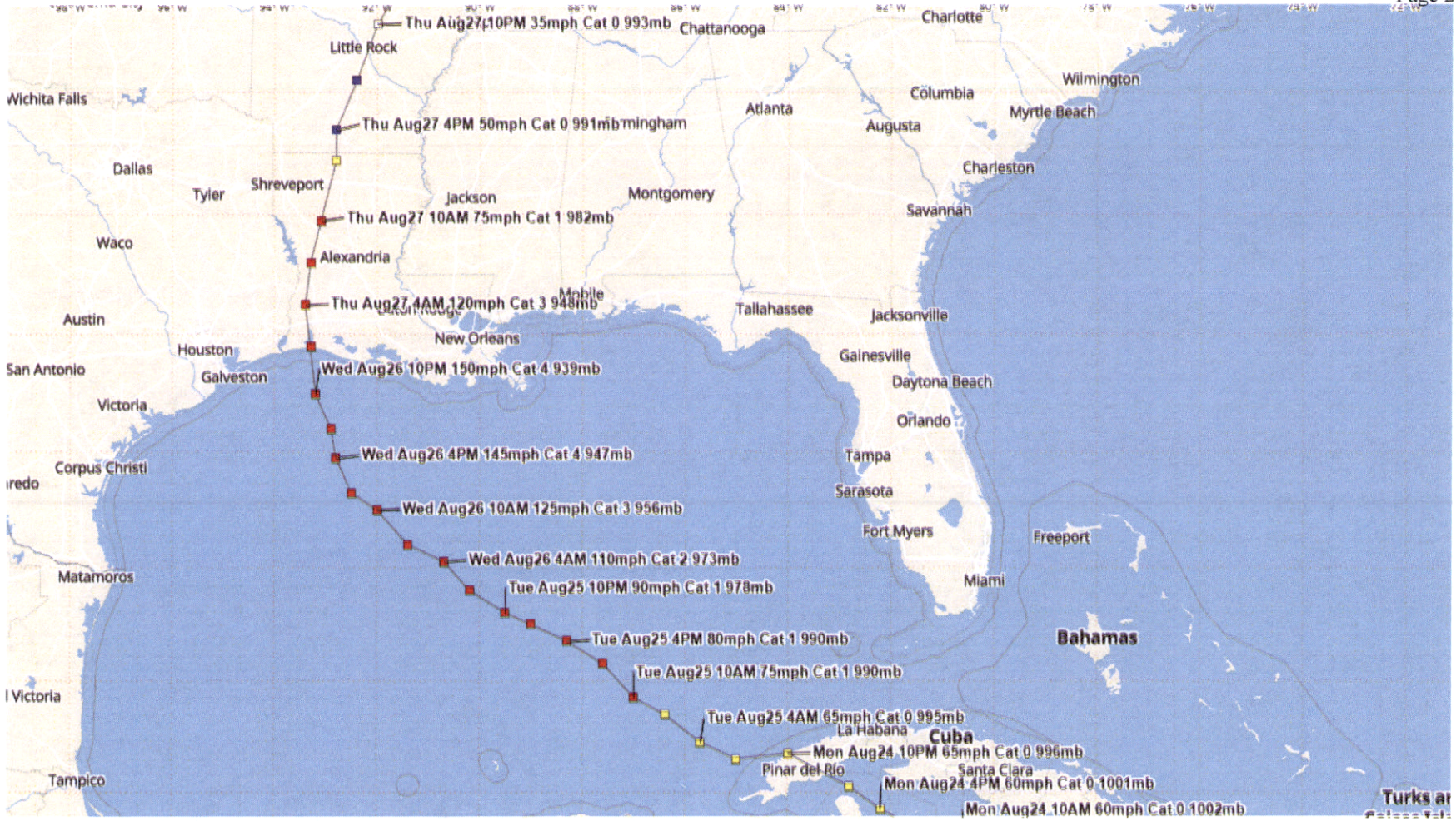
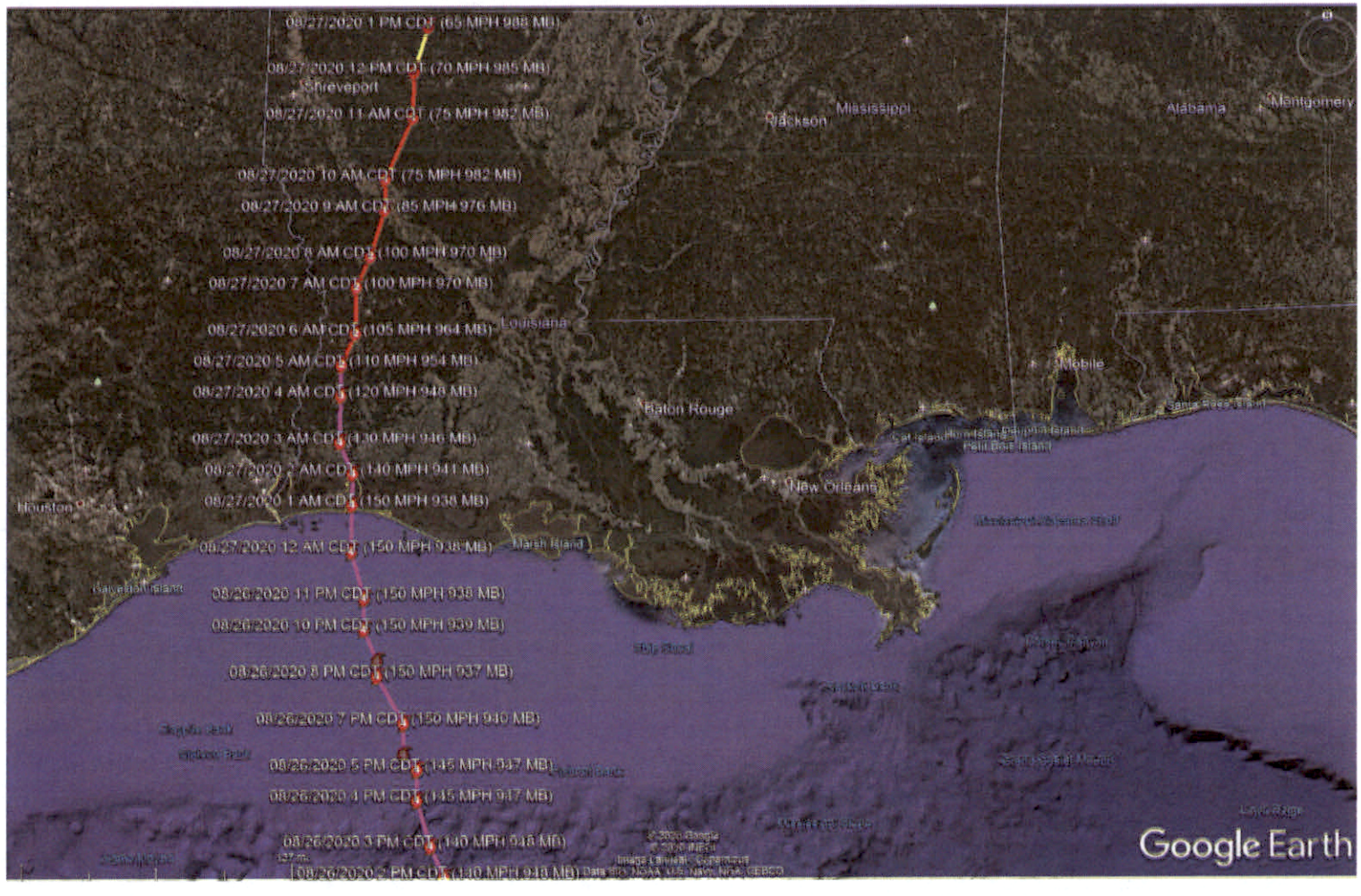
Hurricane Laura – Track, Intensity, and Radar Images at Landfall


Thu Aug27 10PM 35mph Cat 0 993mb
Chattanooga
Little Rock
Charlotte
Wilmington
Columbia
Wichita Falls
Atlanta
Myrtle Beach
Thu Aug27 4PM 50mph Cat 0 991mb
Augusta
Dallas
Charleston
Shreveport
Tyler
Jackson
Montgomery
Savannah
Thu Aug27 10AM 75mph Cat 1 982mb
Waco
Alexandria
Thu Aug27 4AM 120mph Cat 3 948mb
Mobile
Tallahassee
Jacksonville
Austin
New Orleans
Houston
Gainesville
San Antonio
Wed Aug26 10PM 150mph Cat 4 939mb
Galveston
Daytona Beach
Victoria
Orlando
Wed Aug26 4PM 145mph Cat 4 947mb
Tampa
Corpus Christi
Sarasota
Wed Aug26 10AM 125mph Cat 3 956mb
Fort Myers
Freeport
Wed Aug26 4AM 110mph Cat 2 973mb
Matamoros
Miami
Tue Aug25 10PM 90mph Cat 1 978mb
Tue Aug25 4PM 80mph Cat 1 990mb
Bahamas
Tue Aug25 10AM 75mph Cat 1 990mb
Tue Aug25 4AM 65mph Cat 0 995mb
La Habana
Cuba
Mon Aug24 10PM 65mph Cat 0 996mb
Pinar del Rio
Santa Clara
Tampico
Mon Aug24 4PM 60mph Cat 0 1001mb
Mon Aug24 10AM 60mph Cat 0 1002mb


08/27/2020 1 PM CDT (65 MPH 988 MB)
08/27/2020 12 PM CDT (70 MPH 985 MB)
Shreveport
08/27/2020 11 AM CDT (75 MPH 982 MB)
Jackson
Mississippi
Alabama
Montgomery
08/27/2020 10 AM CDT (75 MPH 982 MB)
08/27/2020 9 AM CDT (85 MPH 976 MB)
08/27/2020 8 AM CDT (100 MPH 970 MB)
08/27/2020 7 AM CDT (100 MPH 970 MB)
08/27/2020 6 AM CDT (105 MPH 964 MB)
Louisiana
08/27/2020 5 AM CDT (110 MPH 954 MB)
08/27/2020 4 AM CDT (120 MPH 948 MB)
Mobile
Baton Rouge
08/27/2020 3 AM CDT (130 MPH 946 MB)
08/27/2020 2 AM CDT (140 MPH 941 MB)
New Orleans
08/27/2020 1 AM CDT (150 MPH 938 MB)
Houston
08/27/2020 12 AM CDT (150 MPH 938 MB)
Marsh Island
08/26/2020 11 PM CDT (150 MPH 938 MB)
08/26/2020 10 PM CDT (150 MPH 939 MB)
08/26/2020 8 PM CDT (150 MPH 937 MB)
08/26/2020 7 PM CDT (150 MPH 940 MB)
08/26/2020 5 PM CDT (145 MPH 947 MB)
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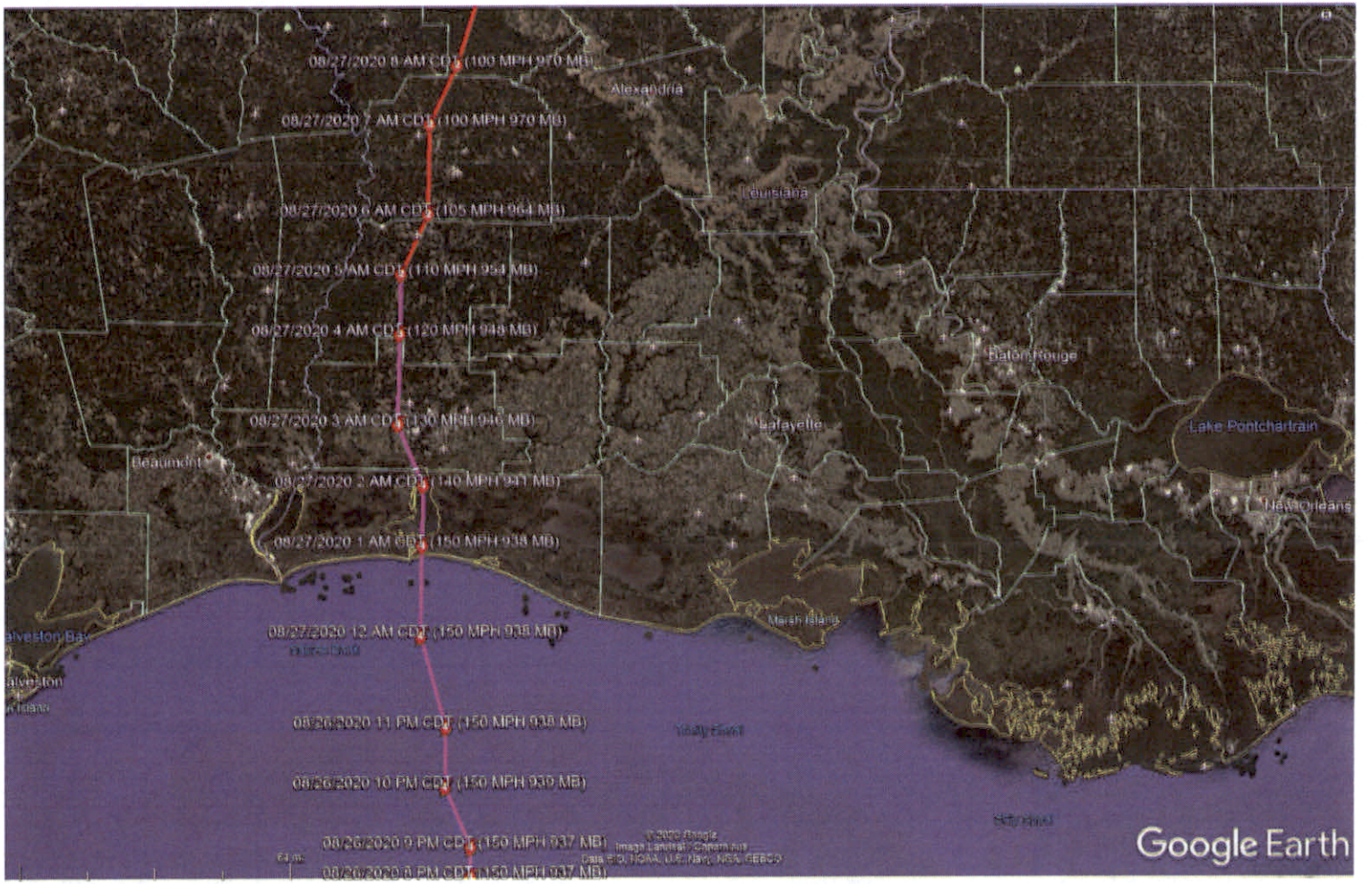
08/26/2020 3 PM CDT (140 MPH 948 MB)
Google Earth


08/27/2020 8 AM CDT (100 MPH 970 MB)
08/27/2020 7 AM CDT (100 MPH 970 MB)
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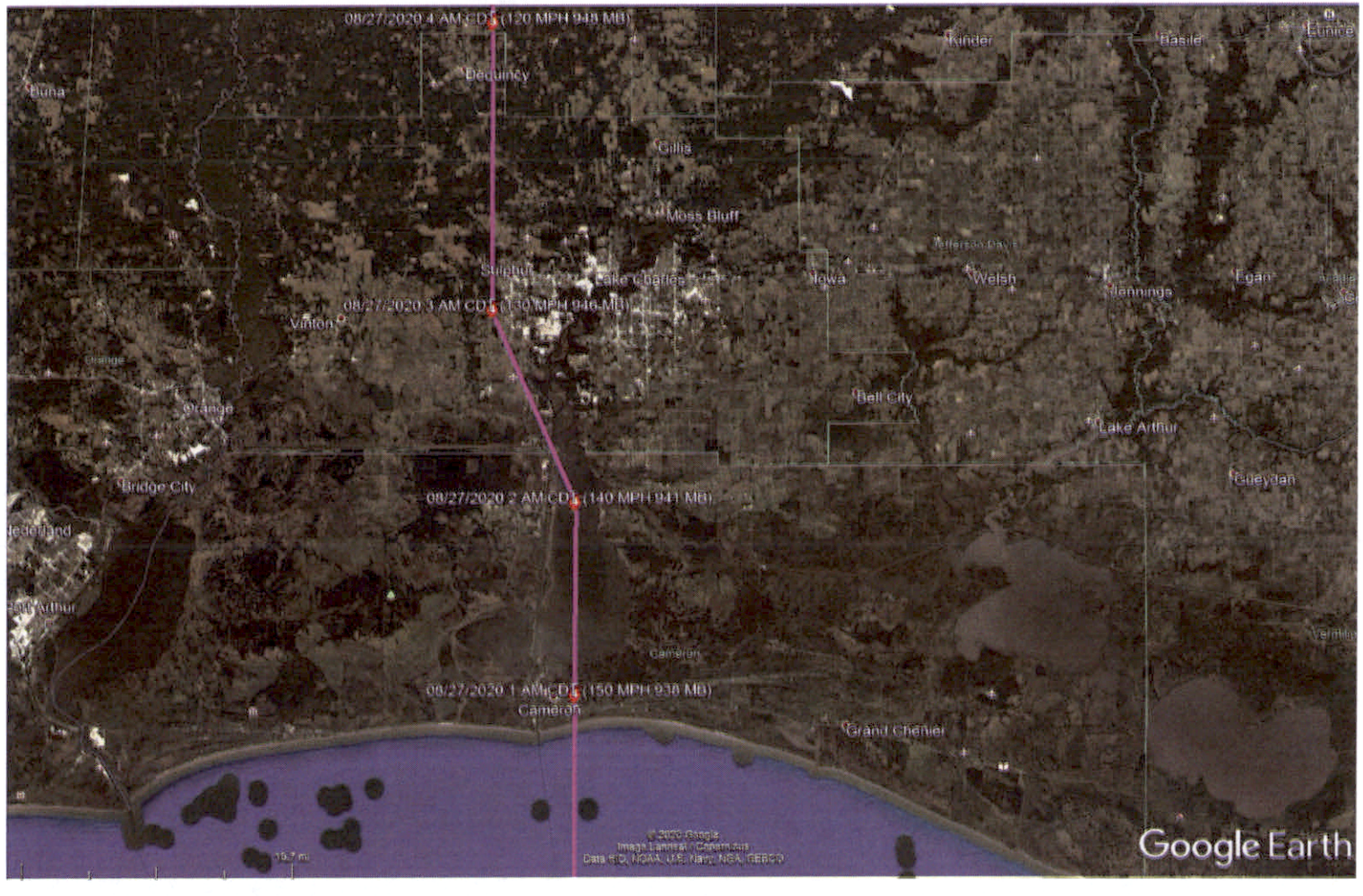
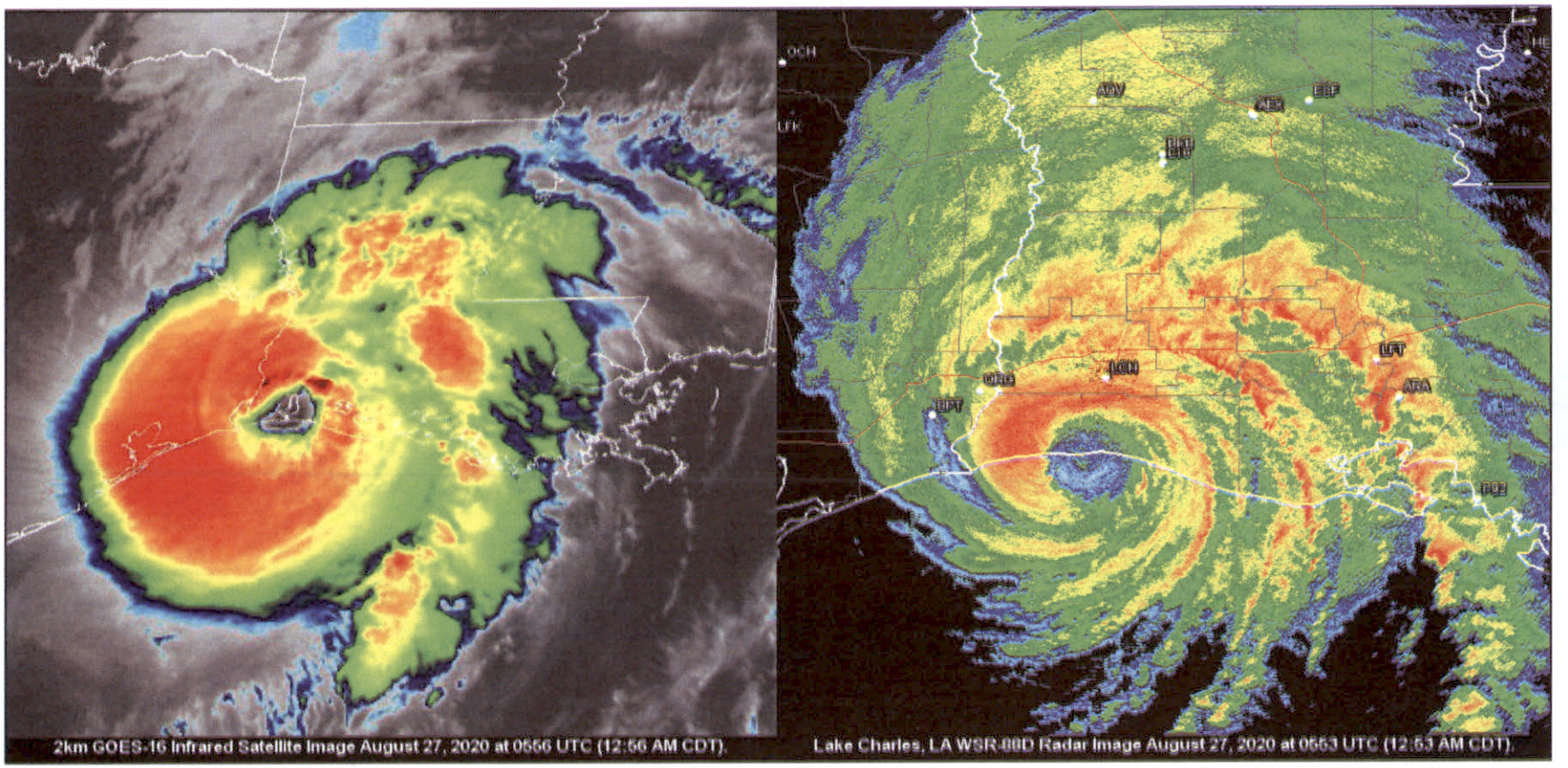
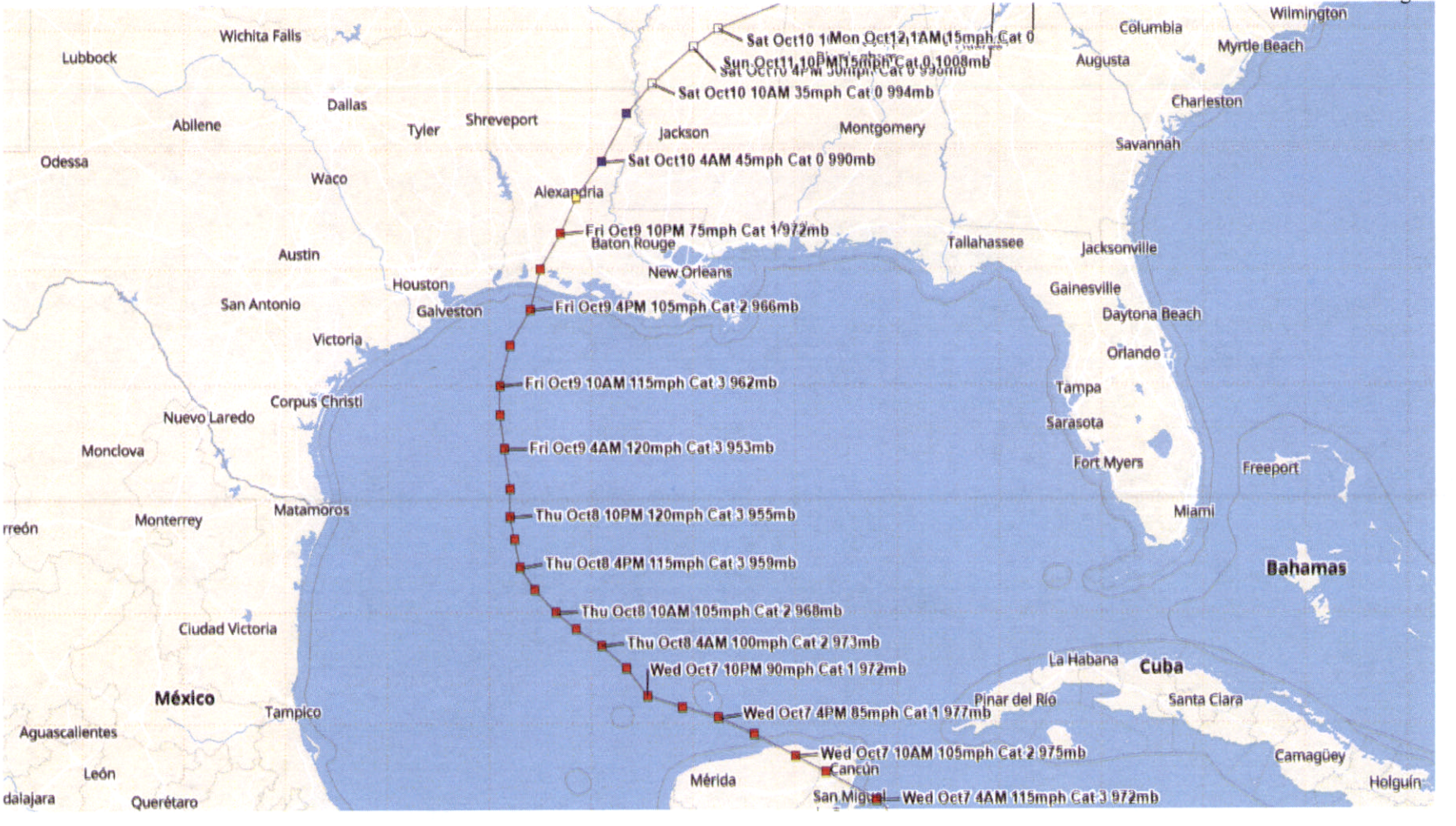
08/27/2020 4 AM CDT (120 MPH 948 MB)
08/27/2020 3 AM CDT (130 MPH 946 MB)
08/27/2020 2 AM CDT (140 MPH 941 MB)
08/27/2020 1 AM CDT (150 MPH 938 MB)
08/27/2020 12 AM CDT (150 MPH 938 MB)
08/26/2020 11 PM CDT (150 MPH 938 MB)
08/26/2020 10 PM CDT (150 MPH 939 MB)
08/26/2020 9 PM CDT (150 MPH 937 MB)
08/26/2020 8 PM CDT (150 MPH 937 MB)
Alexandria
Louisiana
Baton Rouge
Lafayette
Lake Pontchartrain
Beaumont
New Orleans
Marsh Islands
Google Earth

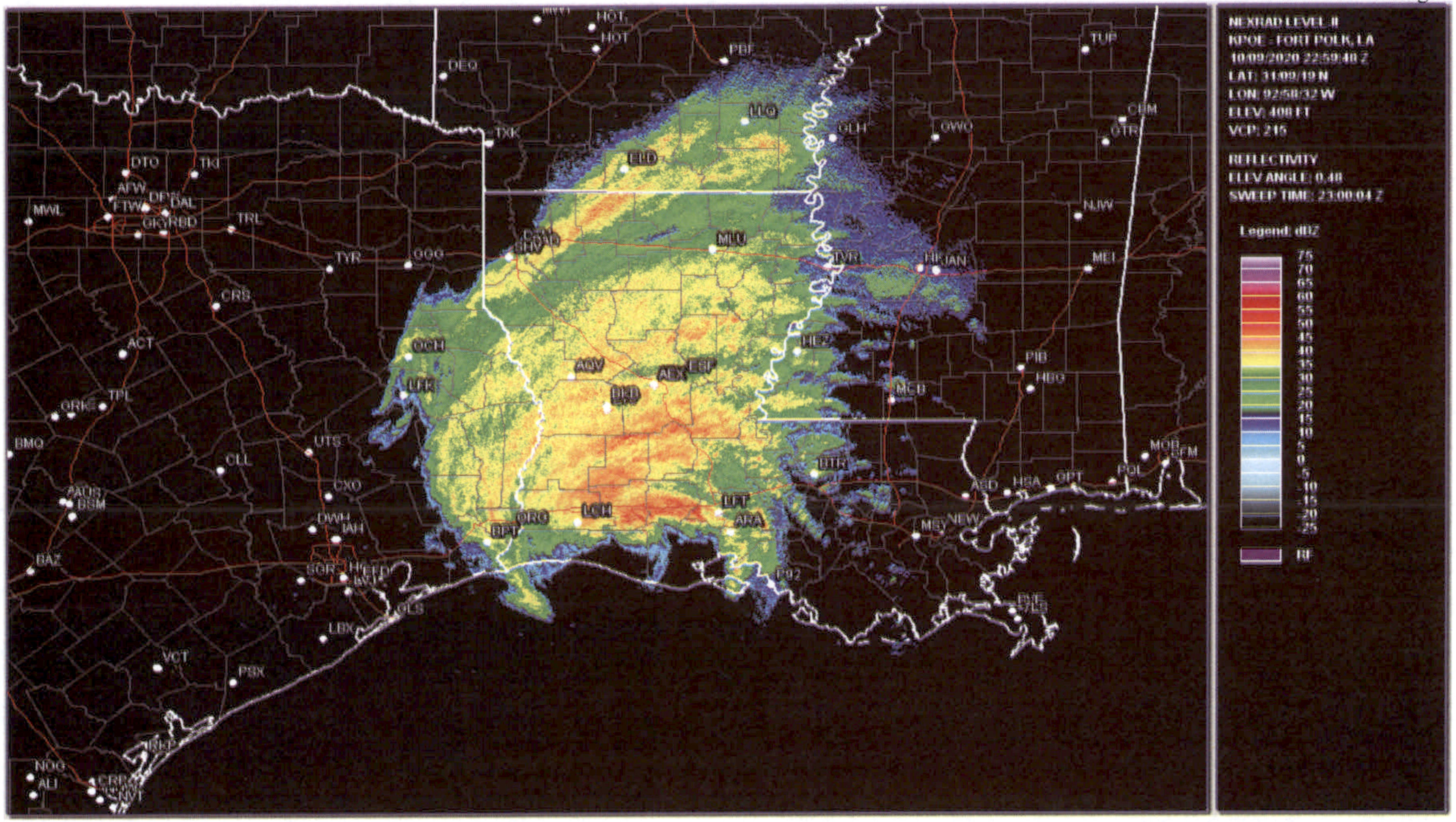

08/27/2020 4 AM CDT (120 MPH 948 MB)
Dequincy
Buna
Kinder
Basile
Eunice
Gillis
Moss Bluff
Sulphur
Lake Charles
Iowa
Welsh
Jennings
Egan
08/27/2020 3 AM CDT (140 MPH 946 MB)
Vinton
Orange
Bell City
Lake Arthur
Bridge City
Gueydan
08/27/2020 2 AM CDT (140 MPH 941 MB)
Cameron
08/27/2020 1 AM CDT (150 MPH 938 MB)
Cameron
Grand Chenier
Google Earth


2km GOES-16 Infrared Satellite Image August 27, 2020 at 0556 UTC (12:56 AM CDT).
Lake Charles, LA WSR-88D Radar Image August 27, 2020 at 0553 UTC (12:53 AM CDT).
OCH
ADV
LCH
LFT
ARA
BPT

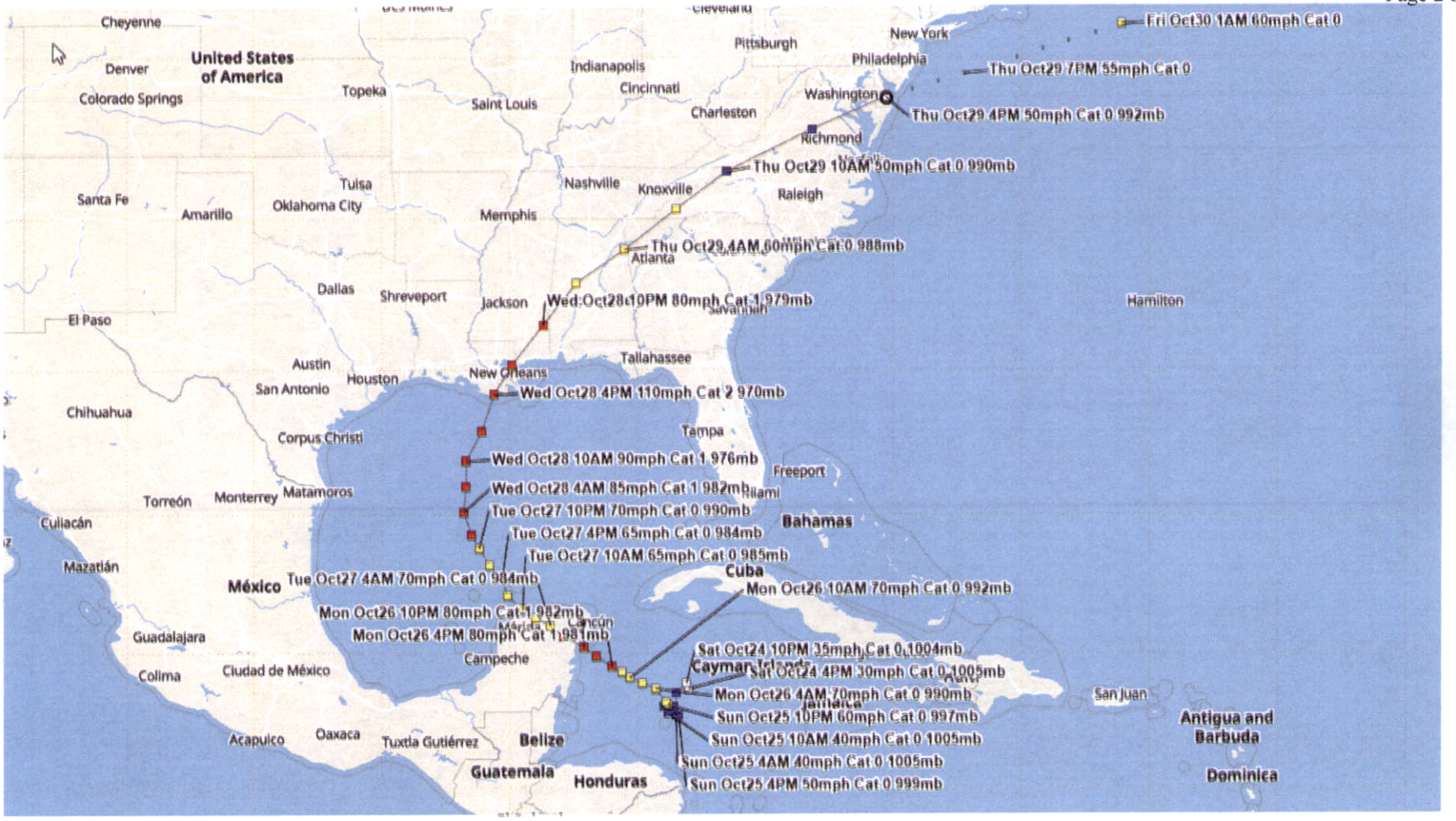
Hurricane Delta – Track, Intensity, and Radar Image at Landfall

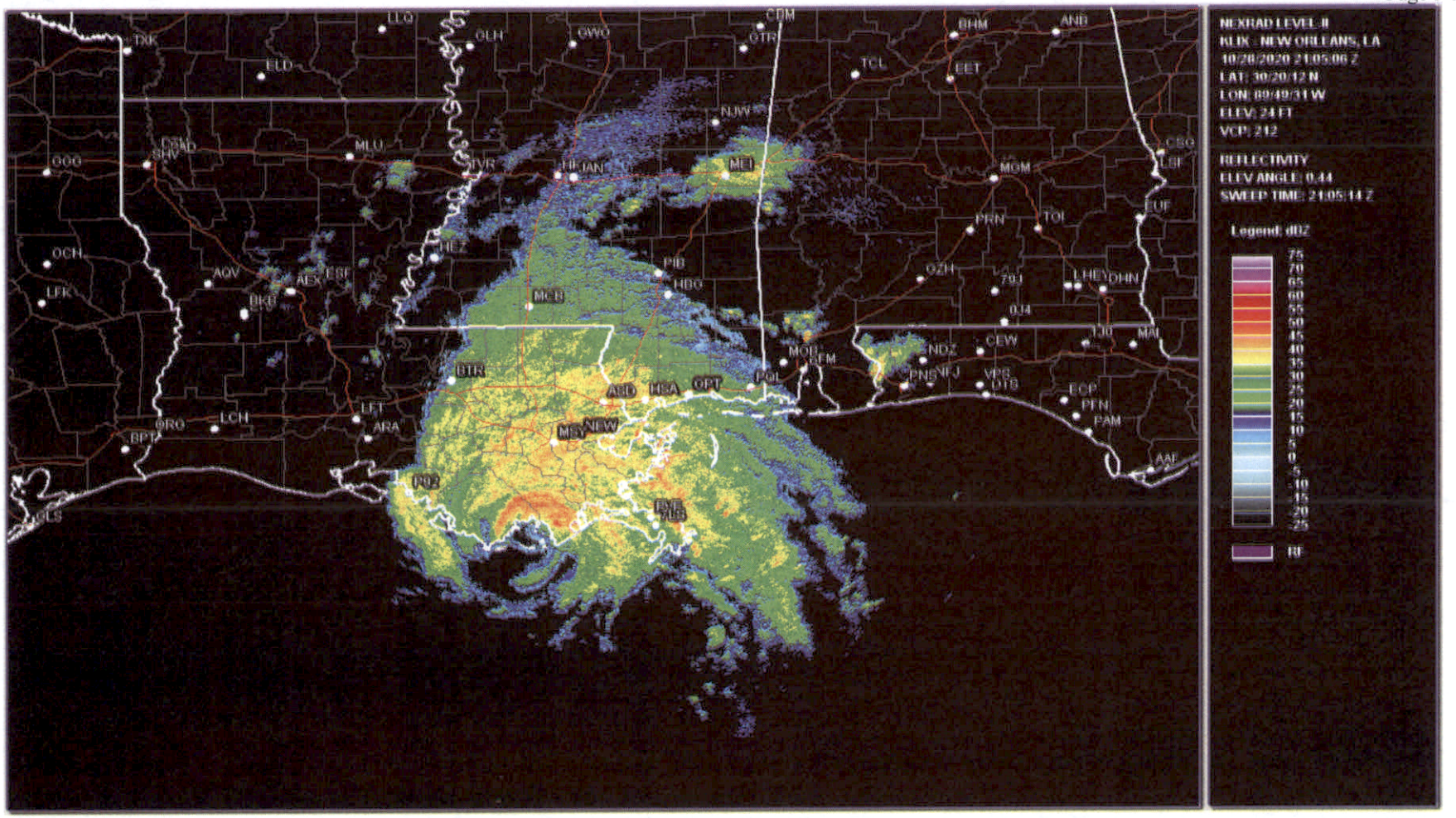

Wichita Falls
Lubbock
Dallas
Abilene
Tyler
Shreveport
Odessa
Waco
Jackson
Montgomery
Alexandria
Austin
Baton Rouge
Houston
New Orleans
San Antonio
Galveston
Victoria
Corpus Christi
Nuevo Laredo
Monclova
Matamoros
Monterrey
rreón
Ciudad Victoria
México
Tampico
Aguascalientes
León
dalajara
Querétaro
Mérida
Cancún
San Miguel
Columbia
Augusta
Wilmington
Myrtle Beach
Charleston
Savannah
Tallahassee
Jacksonville
Gainesville
Daytona Beach
Orlando
Tampa
Sarasota
Fort Myers
Freeport
Miami
Bahamas
La Habana
Cuba
Pinar del Río
Santa Clara
Camagüey
Holguín
Sat Oct10 1
Mon Oct12 1AM 15mph Cat 0
Sun Oct11 10PM 15mph Cat 0 1008mb
Sat Oct10 10AM 35mph Cat 0 994mb
Sat Oct10 4AM 45mph Cat 0 990mb
Fri Oct9 10PM 75mph Cat 1 972mb
Fri Oct9 4PM 105mph Cat 2 966mb
Fri Oct9 10AM 115mph Cat 3 962mb
Fri Oct9 4AM 120mph Cat 3 953mb
Thu Oct8 10PM 120mph Cat 3 955mb
Thu Oct8 4PM 115mph Cat 3 959mb
Thu Oct8 10AM 105mph Cat 2 968mb
Thu Oct8 4AM 100mph Cat 2 973mb
Wed Oct7 10PM 90mph Cat 1 972mb
Wed Oct7 4PM 85mph Cat 1 977mb
Wed Oct7 10AM 105mph Cat 2 975mb
Wed Oct7 4AM 115mph Cat 3 972mb


10/09/2020 10 PM CDT (75 MPH 972 MB)
Opelousas
Eunice
10/09/2020 9 PM CDT (80 MPH 971 MB)
Sulphur
Lake Charles
Crowley
Lafayette
10/09/2020 8 PM CDT (85 MPH 971 MB)
Orange
10/09/2020 7 PM CDT (90 MPH 971 MB)
New Iberia
Abbeville
Jeanerette
10/09/2020 6 PM CDT (100 MPH 970 MB)
Morgan
Marsh Island
10/09/2020 5 PM CDT (100 MPH 968 MB)
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2020 Google
Image Landsat / Copernicus
10/09/2020 4 PM CDT (105 MPH 966 MB)
Google Earth


NEXRAD LEVEL II
KPOE - FORT POLK, LA
10/09/2020 22:59:48 Z
LAT: 31/09/19 N
LON: 92/58/32 W
ELEV: 408 FT
VCP: 215
REFLECTIVITY
ELEV ANGLE: 0.48
SWEEP TIME: 23:00:04 Z
Legend: dBZ
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
RF

Hurricane Zeta – Track, Intensity, and Radar Image at Landfall


Cheyenne
United States of America
Denver
Colorado Springs
Topeka
Saint Louis
Indianapolis
Cincinnati
Pittsburgh
New York
Philadelphia
Washington
Charleston
Richmond
Fri Oct30 1AM 60mph Cat 0
Thu Oct29 7PM 55mph Cat 0
Thu Oct29 4PM 50mph Cat 0 992mb
Thu Oct29 10AM 50mph Cat 0 990mb
Tulsa
Nashville
Knoxville
Raleigh
Santa Fe
Amarillo
Oklahoma City
Memphis
Thu Oct29 4AM 60mph Cat 0 988mb
Atlanta
Dallas
Shreveport
Jackson
Wed Oct28 10PM 80mph Cat 1 979mb
Hamilton
El Paso
Austin
Houston
New Orleans
Tallahassee
San Antonio
Wed Oct28 4PM 110mph Cat 2 970mb
Chihuahua
Corpus Christi
Tampa
Wed Oct28 10AM 90mph Cat 1 976mb
Freeport
Wed Oct28 4AM 85mph Cat 1 982mb
Torreón
Monterrey
Matamoros
Miami
Tue Oct27 10PM 70mph Cat 0 990mb
Culiacán
Bahamas
Tue Oct27 4PM 65mph Cat 0 984mb
Tue Oct27 10AM 65mph Cat 0 985mb
Mazatlán
Cuba
México
Tue Oct27 4AM 70mph Cat 0 984mb
Mon Oct26 10AM 70mph Cat 0 992mb
Mon Oct26 10PM 80mph Cat 1 982mb
Cancún
Mon Oct26 4PM 80mph Cat 1 981mb
Guadalajara
Campeche
Sat Oct24 10PM 35mph Cat 0 1004mb
Cayman Islands
Sat Oct24 4PM 30mph Cat 0 1005mb
Colima
Ciudad de México
Mon Oct26 4AM 70mph Cat 0 990mb
San Juan
Jamaica
Sun Oct25 10PM 60mph Cat 0 997mb
Antigua and Barbuda
Acapulco
Oaxaca
Tuxtla Gutiérrez
Belize
Sun Oct25 10AM 40mph Cat 0 1005mb
Sun Oct25 4AM 40mph Cat 0 1005mb
Guatemala
Honduras
Sun Oct25 4PM 50mph Cat 0 999mb
Dominica



NEXRAD LEVEL II
KLIX : NEW ORLEANS, LA
10/28/2020 21:05:06 Z
LAT: 30/20/12 N
LON: 89/49/31 W
ELEV: 24 FT
VCP: 212
REFLECTIVITY
ELEV ANGLE: 0.44
SWEEP TIME: 21:05:14 Z