Hurricane Maria NCST Investigation Update

NCST Advisory Committee Meeting

November 8, 2021

Joseph Main

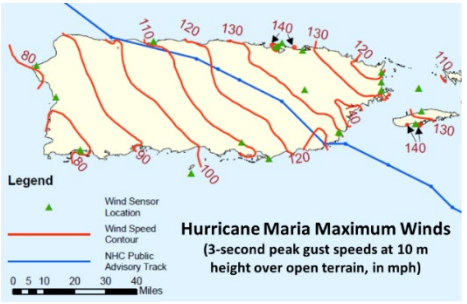
Team Lead, Hurricane Maria NCST

National Institute of Standards and Technology

NCST Investigation Projects

Hazard Characterization: Document and understand the storm's wind environment and other hazards including storm surge, rainfall, flooding, and landslides

Project Leaders: DongHun Yeo and Scott Weaver



Performance of Critical Buildings: Evaluate how critical buildings performed (specifically hospitals, schools, and shelters) – including their dependence on electricity, water, and other infrastructure

Project Leaders: Joe Main and Marc Levitan

Public Response to Emergency Communications: Document the role of emergency communications and the public's response to those communications – focusing on communications during response and recovery (during and immediately after the hurricane)

Project Leader: Jo Johnson

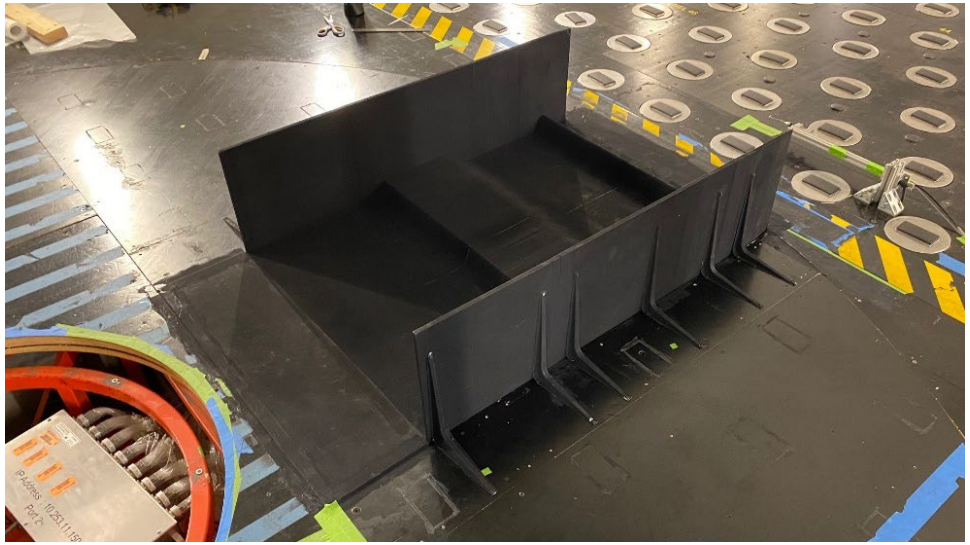
Morbidity and Mortality: Better understand how damaged buildings, and failures in supporting infrastructure, played a role in injuries and deaths associated with the hurricane

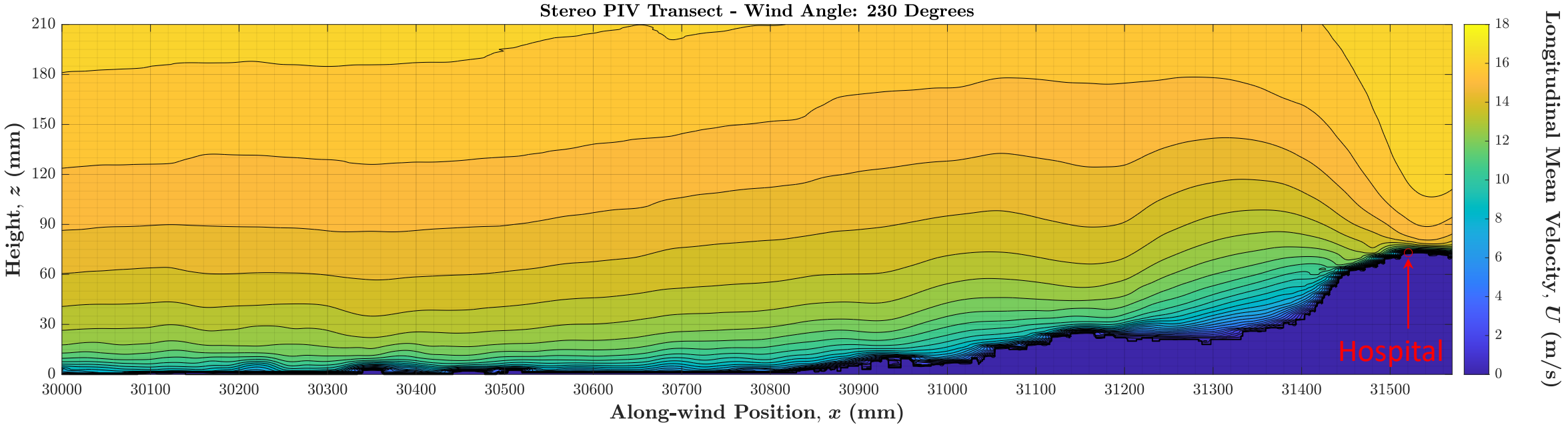
Project Leaders: Judy Mitrani-Reiser and Tom Kirsch

Project Updates: Hazard Characterization

Wind Tunnel Measurements

- Completed wind tunnel testing of generic ridge and plateau models with smooth surfaces, incorporating surface pressure measurements and Particle Image Velocimetry (PIV) flow measurements
- Data processing in progress for PIV measurements, with priority given to Mayagüez data, which provided incoming flow conditions for building testing

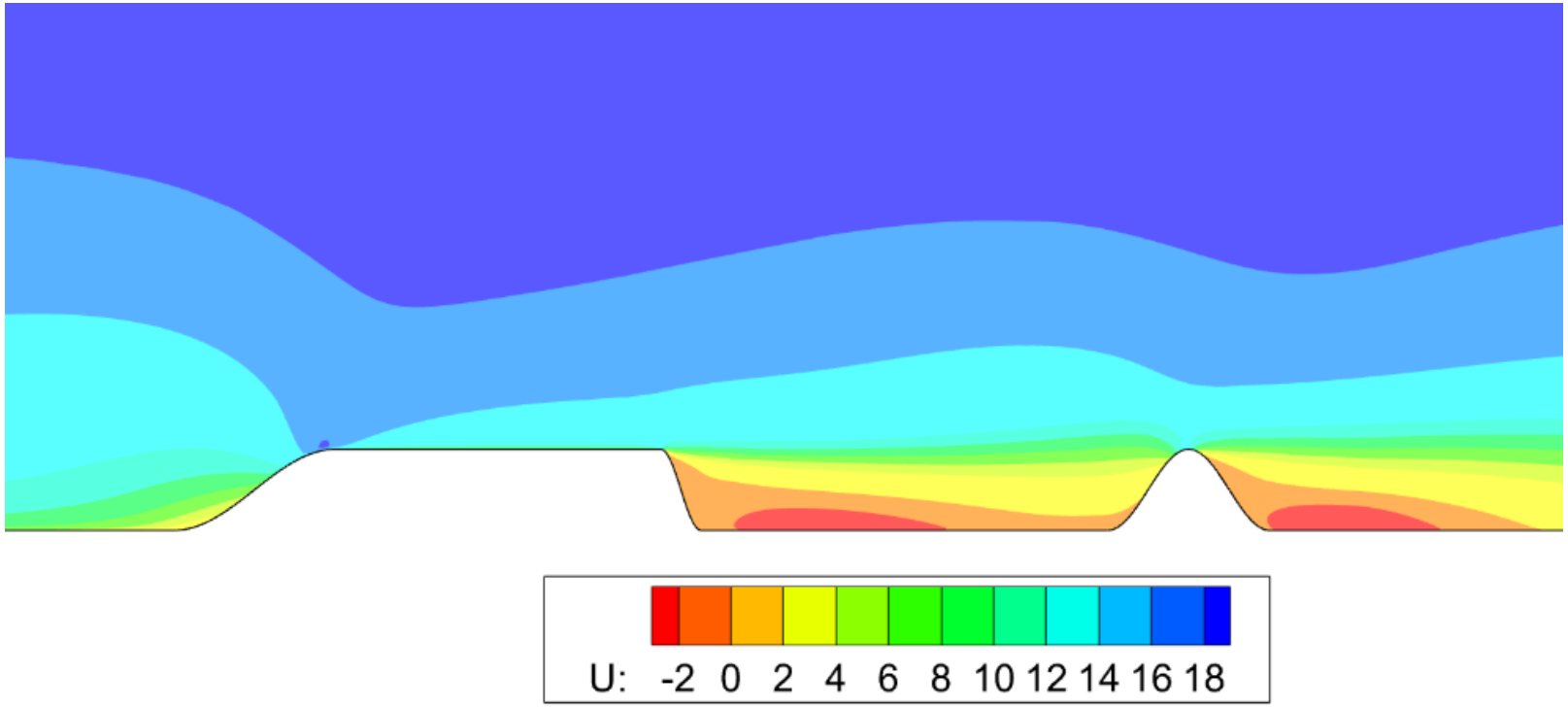




Project Updates: Hazard Characterization

Computational Fluid Dynamics (CFD) Modeling

- Completed uncertainty quantification analysis for CFD simulations of flow over generic ridge and plateau models
- Developed and implemented a canopy model to capture the effect of tree cover on flow profiles, using satellite data to obtain required model parameters with their spatial variation

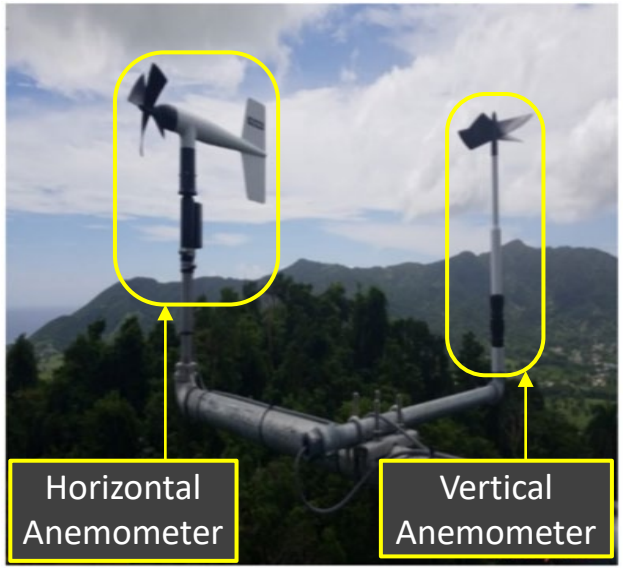


Project Updates: Hazard Characterization

Field Measurement of Winds

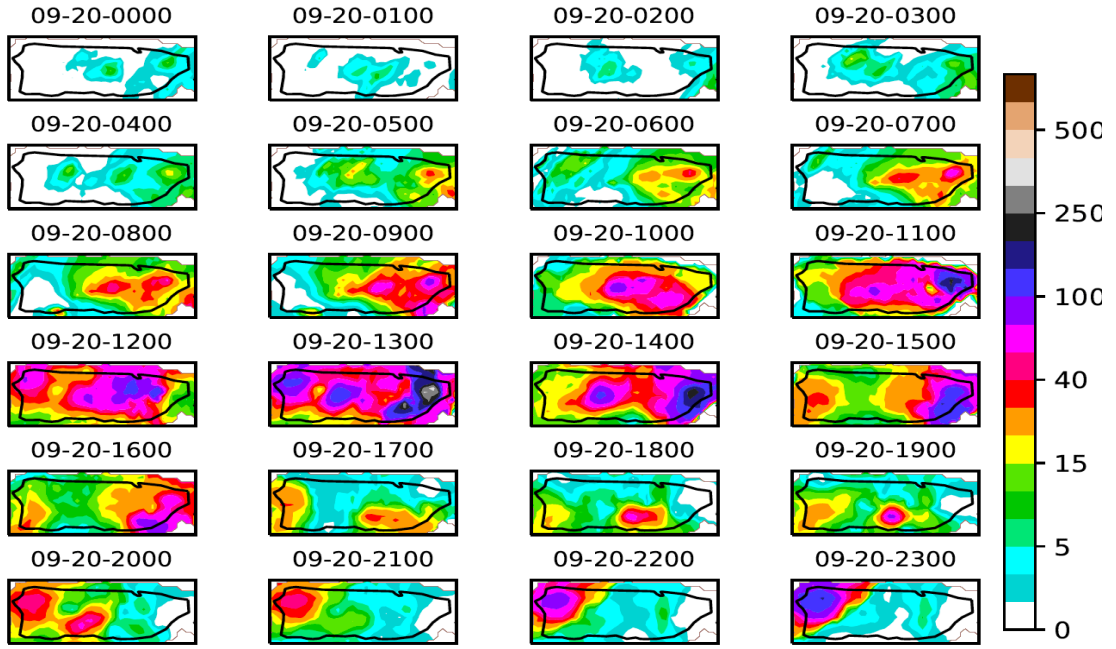
Executed contract with University of Florida and subcontractor WeatherFlow for measurements on cell towers:

- Onsite measurements of anemometer orientation to improve accuracy, quantify uncertainty in wind direction measurements
- Continuation of data collection for 2nd year (through March 2023)



Rainfall and Flooding Analysis

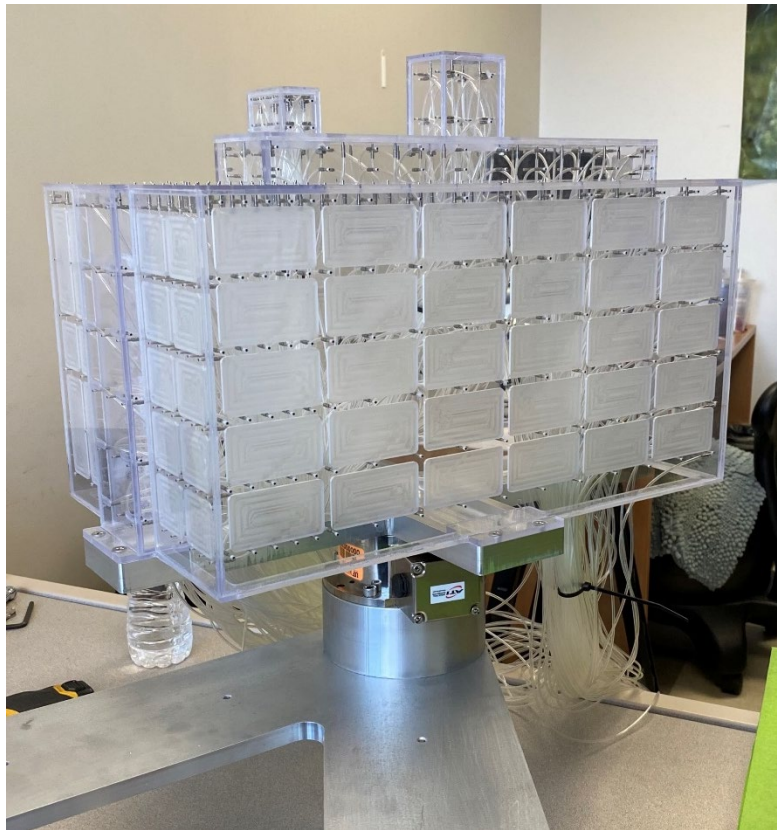
- Initiated collaboration with Bristol University and NCAR for flood modeling of Puerto Rico using rainfall observation inputs for HM based on NIST analysis
- Analyzed USGS stream gauge data

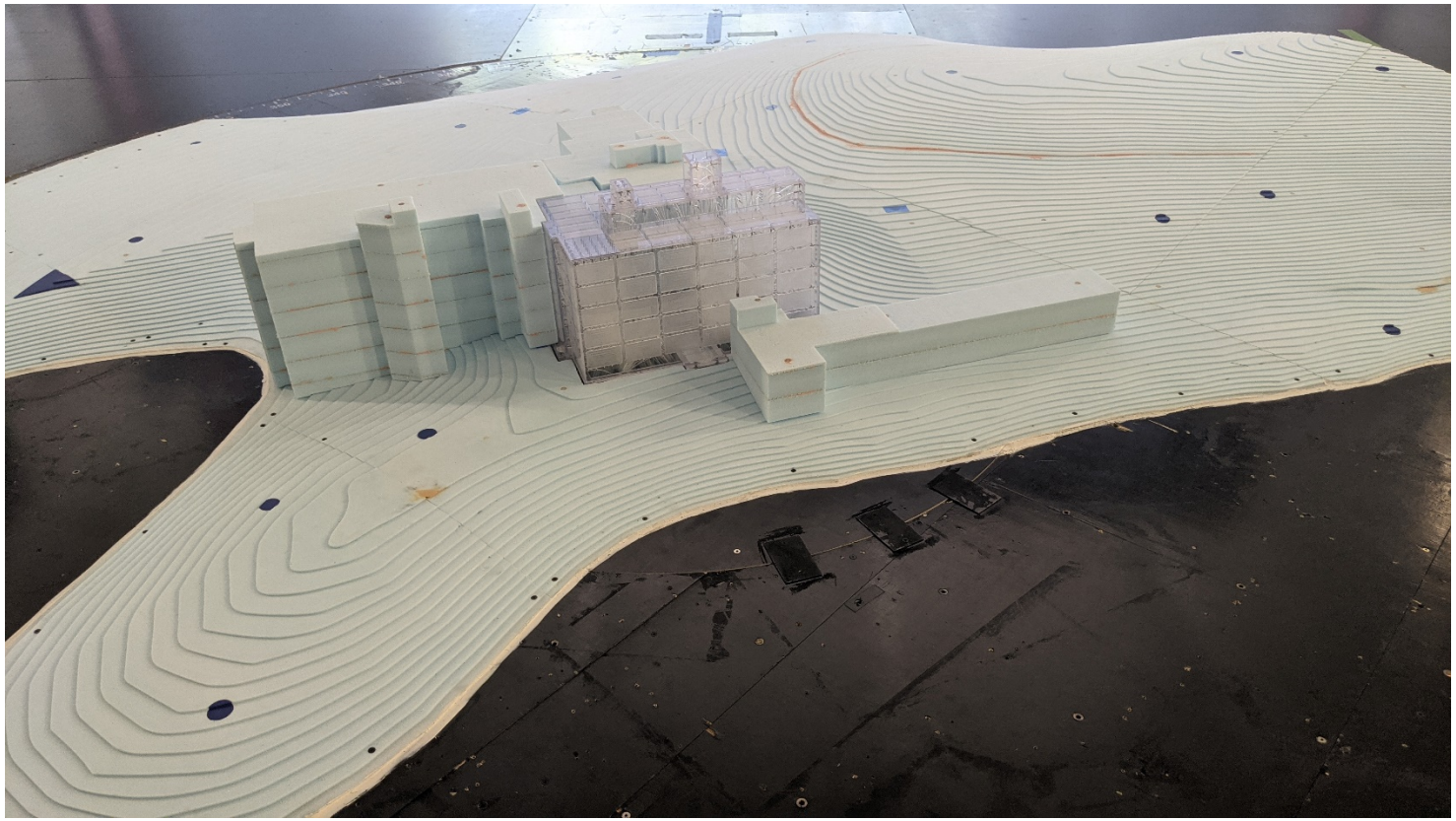


Project Updates: Critical Buildings

Wind Tunnel Measurements

- Completed design and fabrication of Hospital Bella Vista building model, incorporating tubulation for pressure tap measurements and base force balance for resultant force measurements
- Completed design and fabrication of area model and surrounding buildings





Project Updates: Critical Buildings

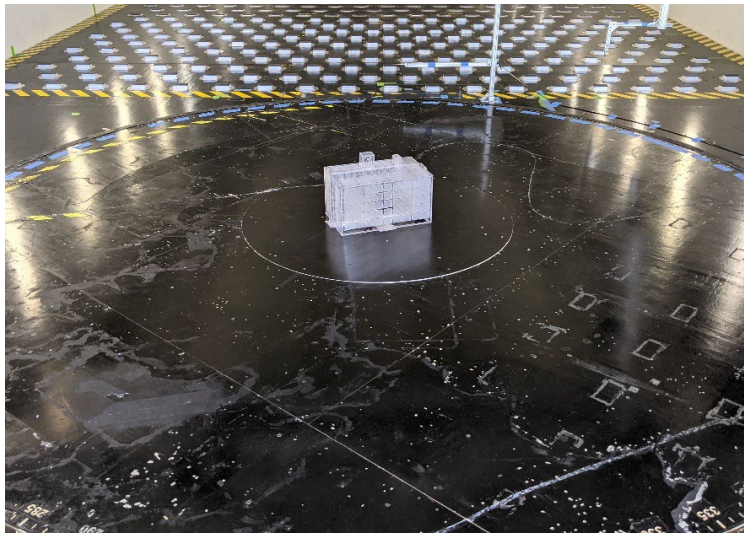
Wind Tunnel Measurements

- Successfully achieved target inflow profiles at 1:100 scale based on PIV measurements from 1:3100 scale topographic model, using machine-learning to iteratively adjust wind tunnel control parameters

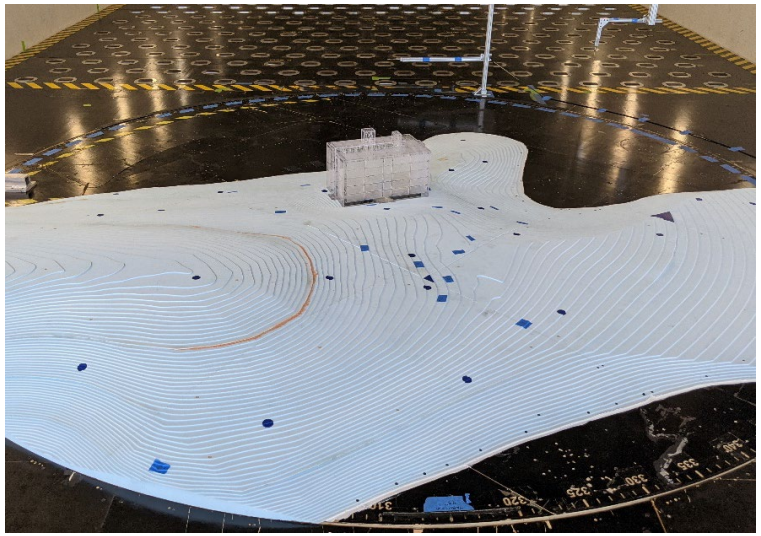
Project Updates: Critical Buildings

Wind Tunnel Measurements

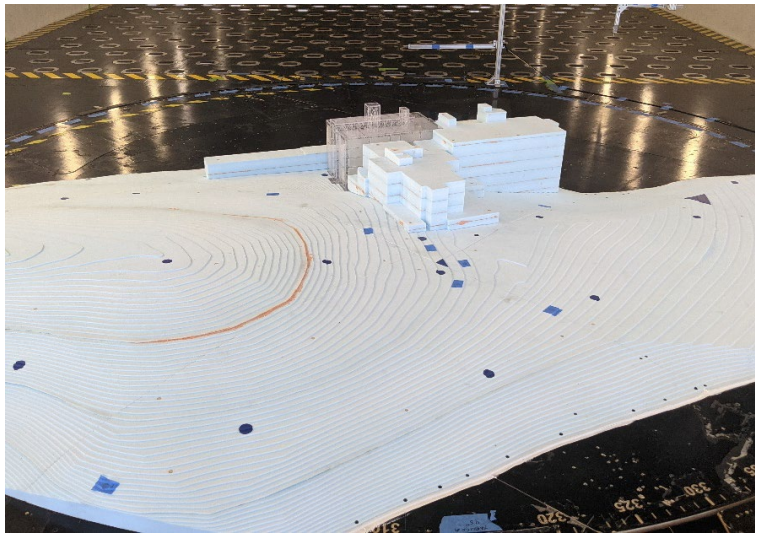
- Performed testing over 180° range of wind angles in 10° increments, for cases with and without the area model and surrounding buildings



Case 1: Isolated Building



Case 2: Building + Local Topography



Case 3: Building + Local Topography + Surrounding Buildings

Facility Evaluations

- Completed Phase 1 evaluations of the 5 selected hospitals, including quality control review and updates to data collection forms in preparation for upcoming interviews
- Completed development of sample selection methodology for shelter facilities and initiated Phase 1 evaluation of first selected shelter

Project Updates: Emergency Communications

Information Provider Interviews (*n* = 35)

- Interviews completed, transcribed, and translated; data analysis in progress

Emergency Messages

- Qualitative Content Analysis of emergency messages in progress

Household Survey (*n* = 1500) and Household Interview (*n* = 100)

- Paperwork Reduction Act approval granted by OMB for Household Interview Instrument (June 2021) and Household Survey Instrument (April 2021)
- Soft launch of Household Survey completed (July 2021): a subset of the study area clusters were given information about the survey and directed to web or phone
- Following soft launch of the Household Survey, additional training completed for Albizu University subcontractors, to include option of in-person survey responses (following strict COVID protocols) in addition to web and phone
- Data collection efforts in progress for the household survey and the household interview

Project Updates: Morbidity and Mortality

Verbal Autopsy

- Pilot conducted (March – June 2021): 50 people interviewed by 15 interviewers; each lasted about 1 hour
- Post-pilot revisions completed; PRA package approved by OMB (September 2021)
- Recruitment of respondents now underway; new data collectors brought onto the team

Cause-Specific Excess Mortality Analysis

- Completed new draft of cause-specific excess mortality analysis for landfall +14 days and 6 months, with groupings of death categories using International Classification of Diseases (ICD), including population displacement and census scenarios
- Finalized geocoding of places of residence and death from the death certificate data; created layers of information for geospatial analysis from the cause-specific analysis results

NWIRP Research Projects

Recovery of Business and Supply Chains: Study the recovery of small- and medium-sized businesses – in the manufacturing, retail, and service sectors – to improve understanding of business continuity resilience planning and supply chain continuity

Project Leader: Jenn Helgeson

Recovery of Social Functions: Examine the recovery trajectories of sampled schools and hospitals to identify the underlying characteristics and conditions associated with recovery of critical social functions from Hurricane Maria

Project Leader: Maria Dillard

Impacts to and Recovery of Infrastructure Systems: Evaluate the dependencies of building function on infrastructure (power, water, and transportation), including cascading loss of function and sequencing of recovery activities and the causes of the loss of functionality and extended-duration outage of the wireless communication system

Project Leader: Ken Harrison

NWIRP Project Updates

School and Hospital Recovery Surveys and ***Manufacturing and Retail/Service Business Continuity Surveys and Interviews***:

- Pilot testing completed and data delivered to NIST
- Analysis of pilot data completed, including cross-project coordination on survey questions related to building damage, which will inform NCST project on Performance of Critical Buildings
- Finalized post-pilot changes to survey instruments and methods
- Paperwork Reduction Act approval granted by OMB for all final instruments
- IRB amendment approved for final instruments and methods

New work initiated on remote sensing of vegetation for ***Recovery of Infrastructure Project***, providing opportunities for collaboration with NCST project on Hazard Characterization

Program-Level Coordination

- Statisticians in NIST Information Technology Laboratory engaged to support data analysis across the program
- Coordination across projects to develop report organization and outlines:
  - NCSTAR 4: Main Summary Report with Findings and Recommendations
  - NCSTAR 4-1: Hazard Characterization
  - NCSTAR 4-2: Performance of Critical Buildings
  - NCSTAR 4-3: Public Response to Emergency Communications
  - NCSTAR 4-4: Morbidity and Mortality
  - *Plus supporting sub-reports and appendices*
- Preliminary drafts completed for multiple report sections

NCST Technical Investigation of Hurricane Maria (Puerto Rico)

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Questions?

Please 'raise your hand' using the Blue Jeans Participant window and unmute your audio and video