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FORECASTING THE IMPACT OF TROPICAL CYCLONES USING GLOBAL NUMERICAL WEATHER PREDICTION ENSEMBLE FORECASTS

A Tropical Cyclone Marcia (2015) wind and rainfall case study

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Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

RISK FRONTIERS

Wind Research Laboratory

MOTIVATION

BNHCRC PROJECT WORKFLOW

1) Use disaster scenario analysis to better understand potential landfalling tropical cyclone impacts to buildings, critical infrastructure and society.

2) Methodology:
    1. Identify historical events to be simulated over a specified region.

SCENARIO SELECTION: TROPICAL CYCLONE MARCIA (2015)

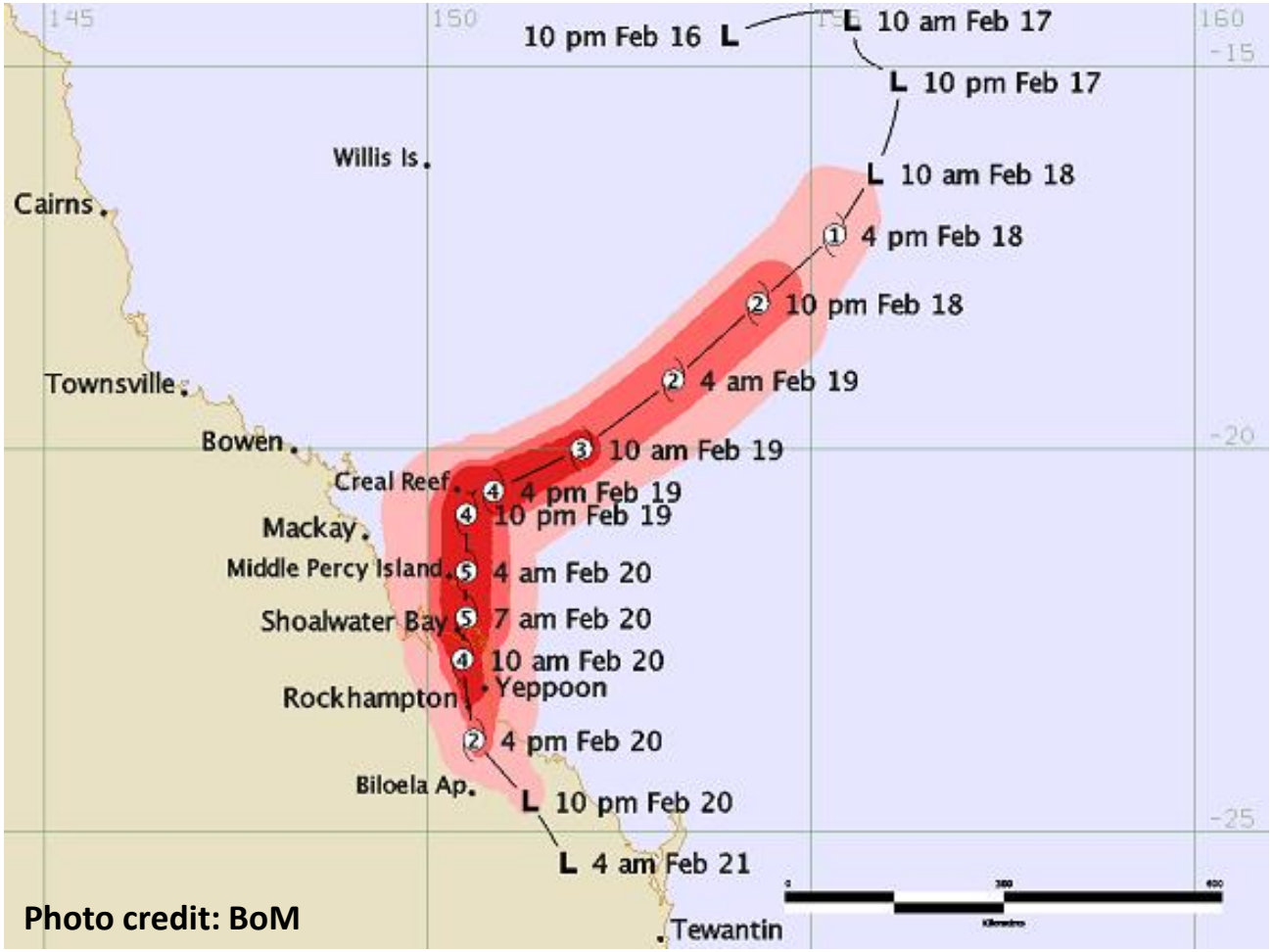

Photo credit: BoM

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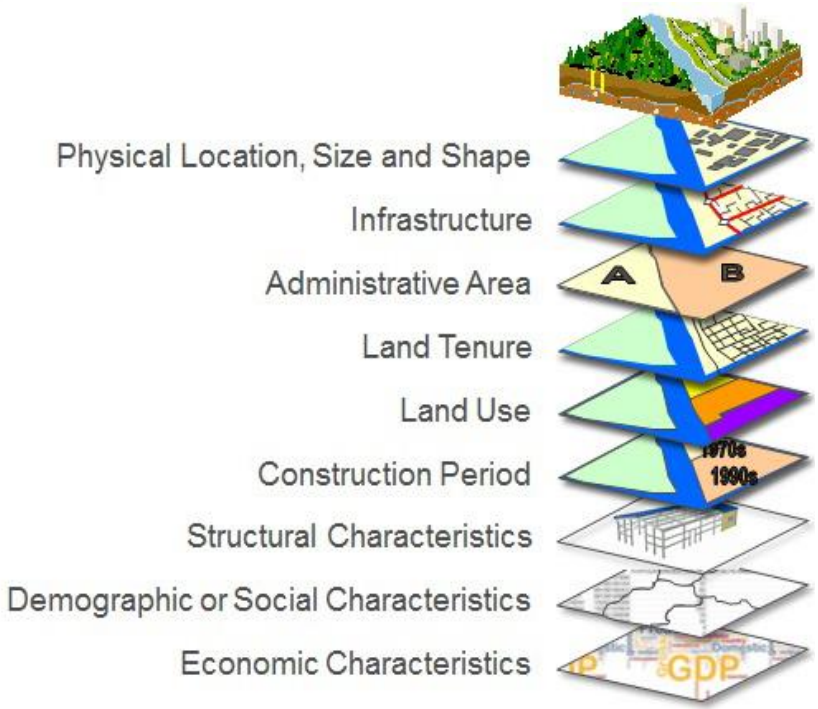
NATIONAL EXPOSURE INFORMATION SYSTEM



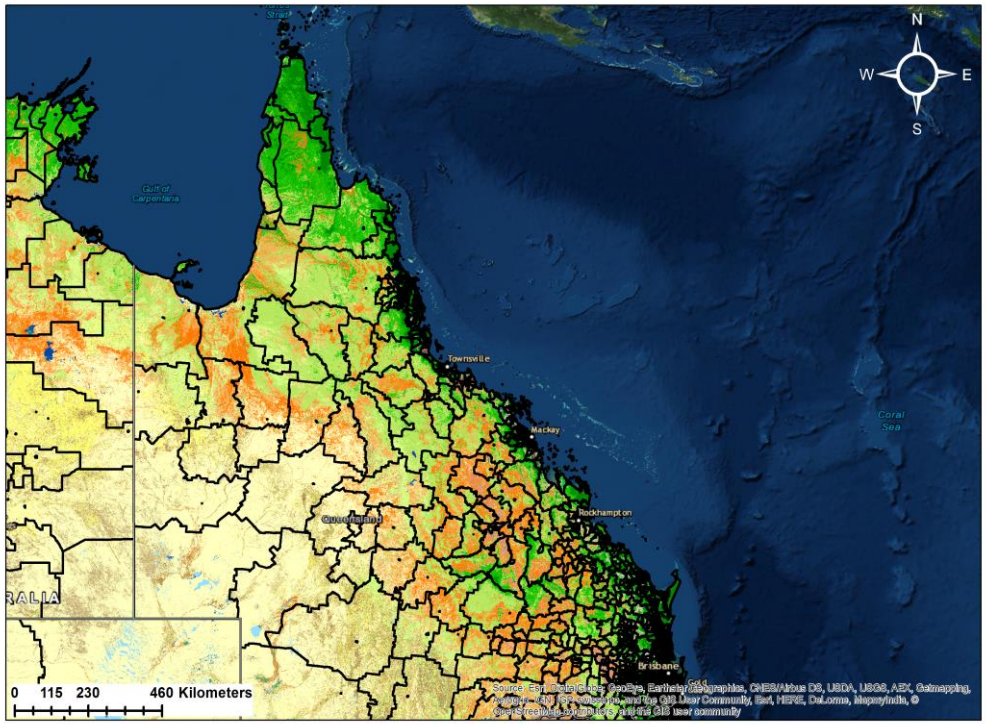


Photo credit: Geoscience Australia

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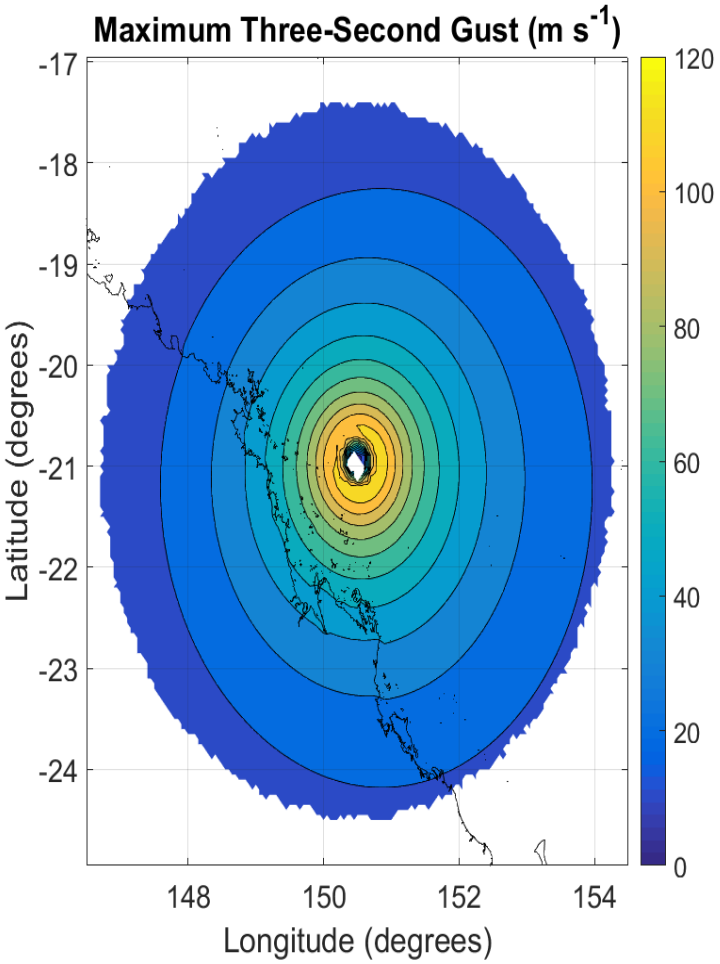
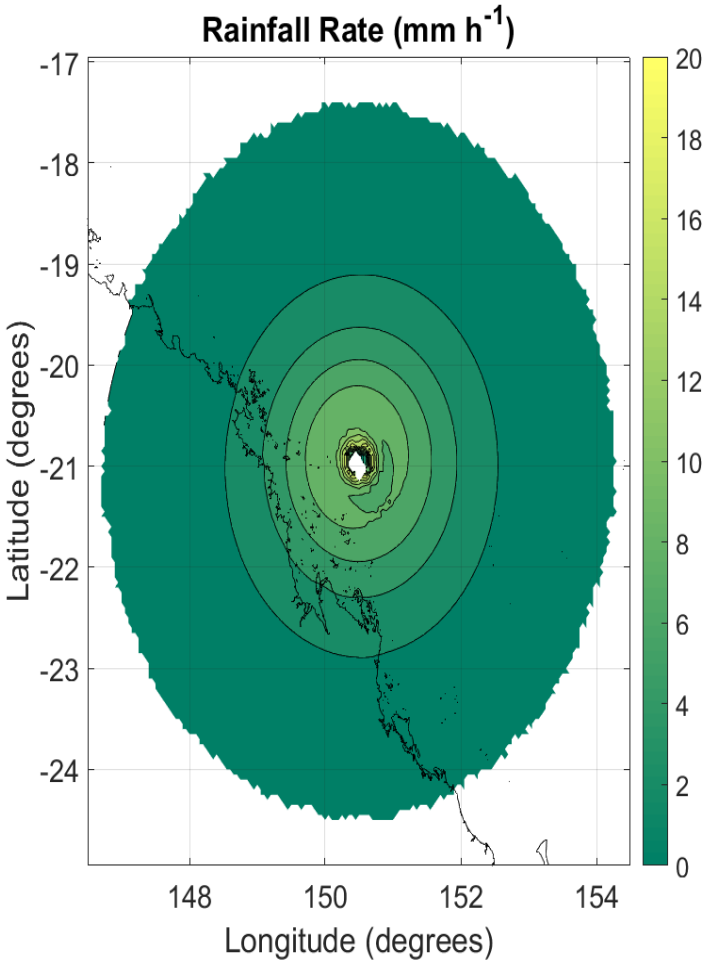
WIND AND RAINFALL HAZARD MODELLING





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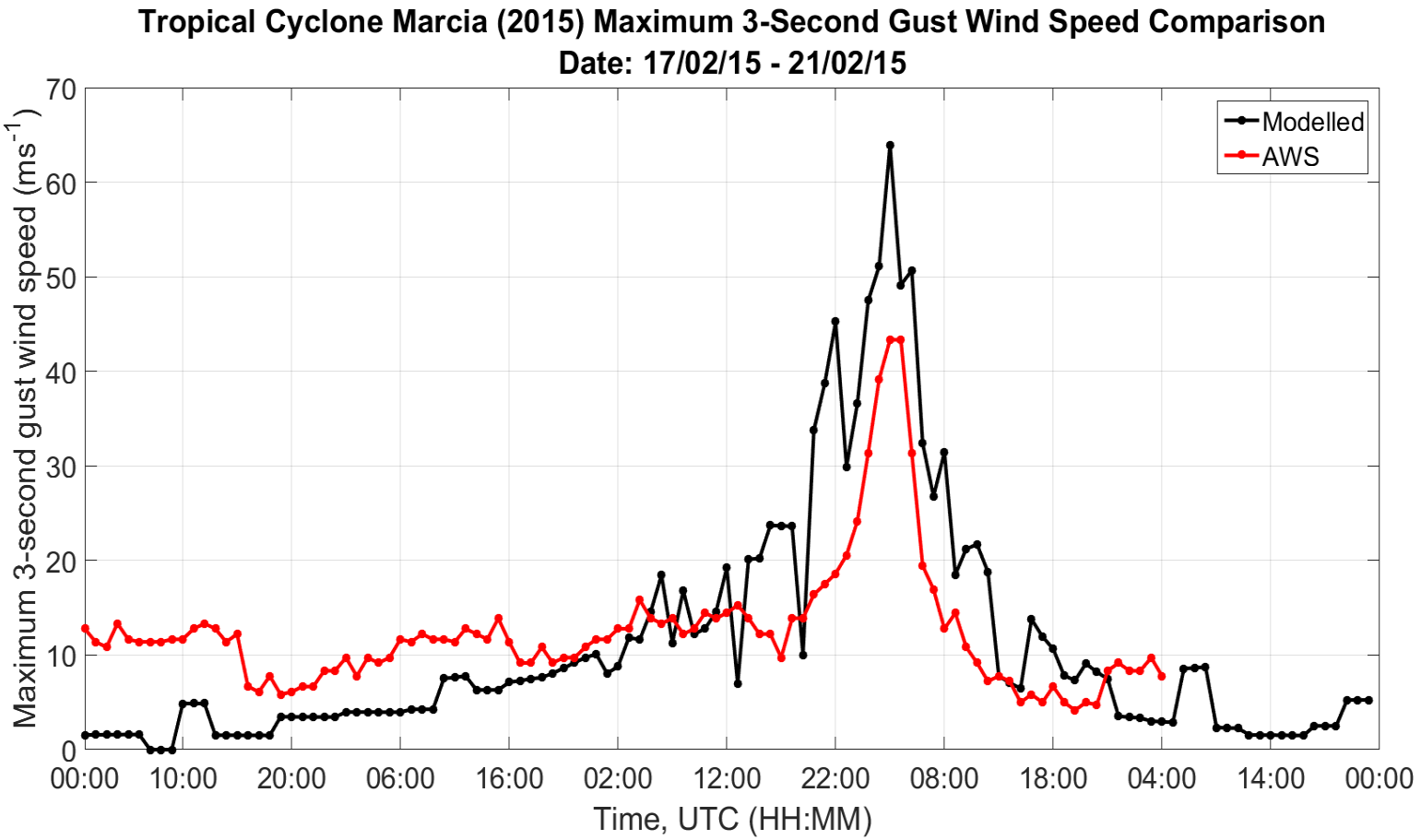

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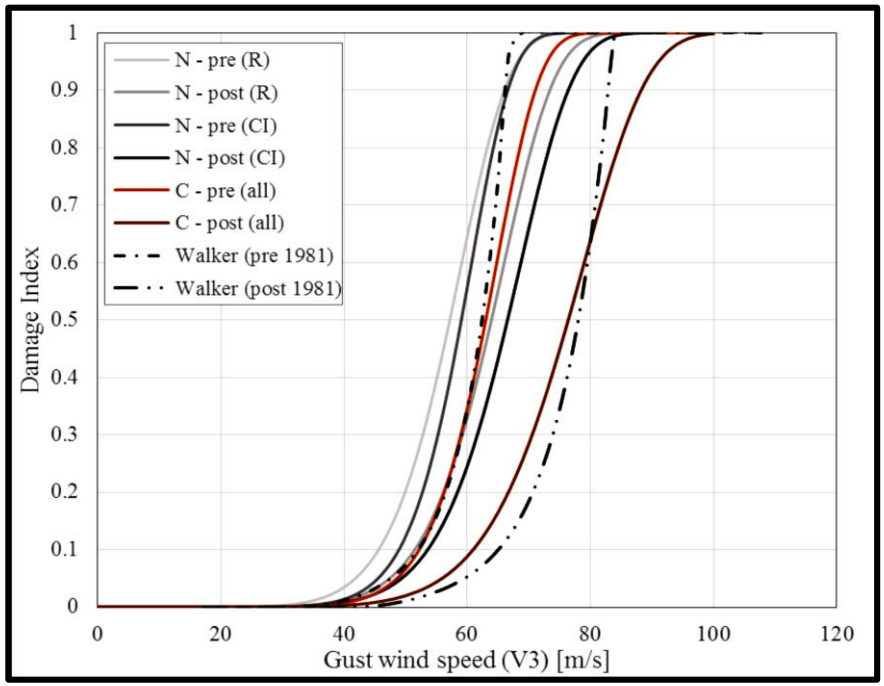
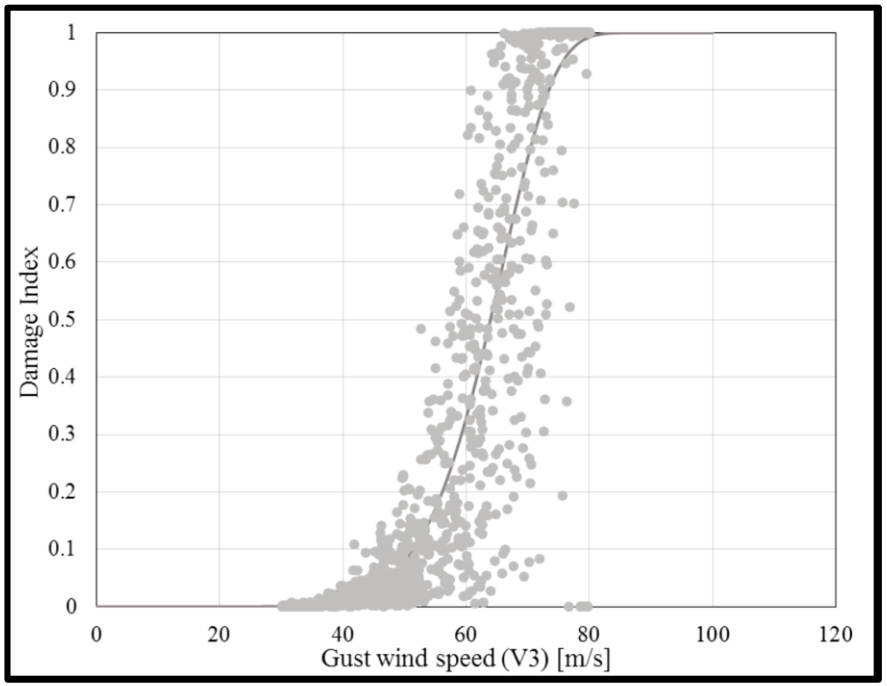
   4. Apply vulnerability models to simulate building damage.

VULNERABILITY MODELLING: BUILDING DAMAGE





Mason 2015

VULNERABILITY MODELLING: POPULATION DISPLACEMENT

1) Based on HAZUS methodology and is directly associated with loss of use of residential buildings.

2) Model inputs:
   a) Regional population.
   b) Probability of occurrence of simulated damage state.
   c) Un-inhabitability function.

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   4. Apply vulnerability models to simulate building damage.
   5. Aggregate/extract information within specific regions.

ENSEMBLE PREDICTION SYSTEM FORECASTS

1) The Bureau of Meteorology (BoM) will soon begin releasing ensemble prediction system (EPS) forecasts to emergency services agencies.

2) There is a need to better understand how the uncertainty in EPS forecasts propagates through to expected impacts to the built environment and society at landfall.

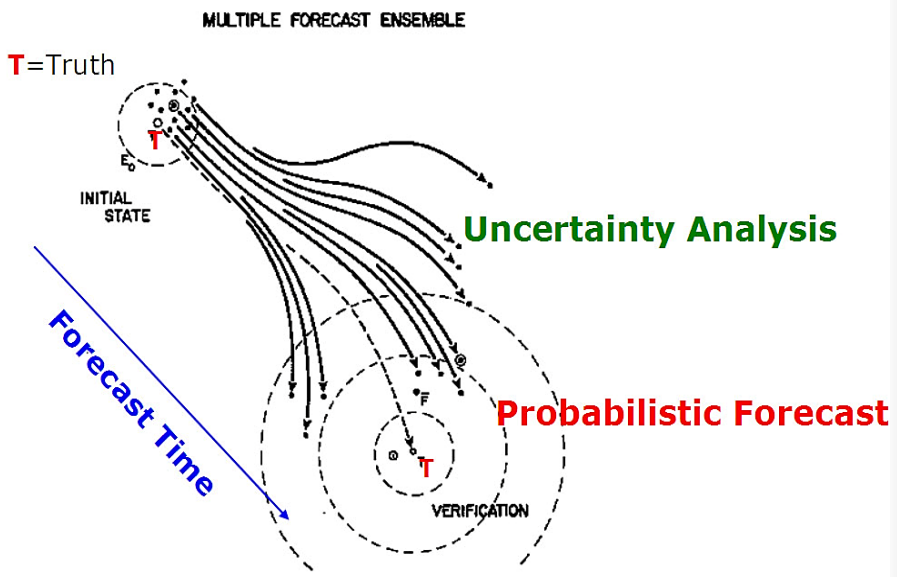
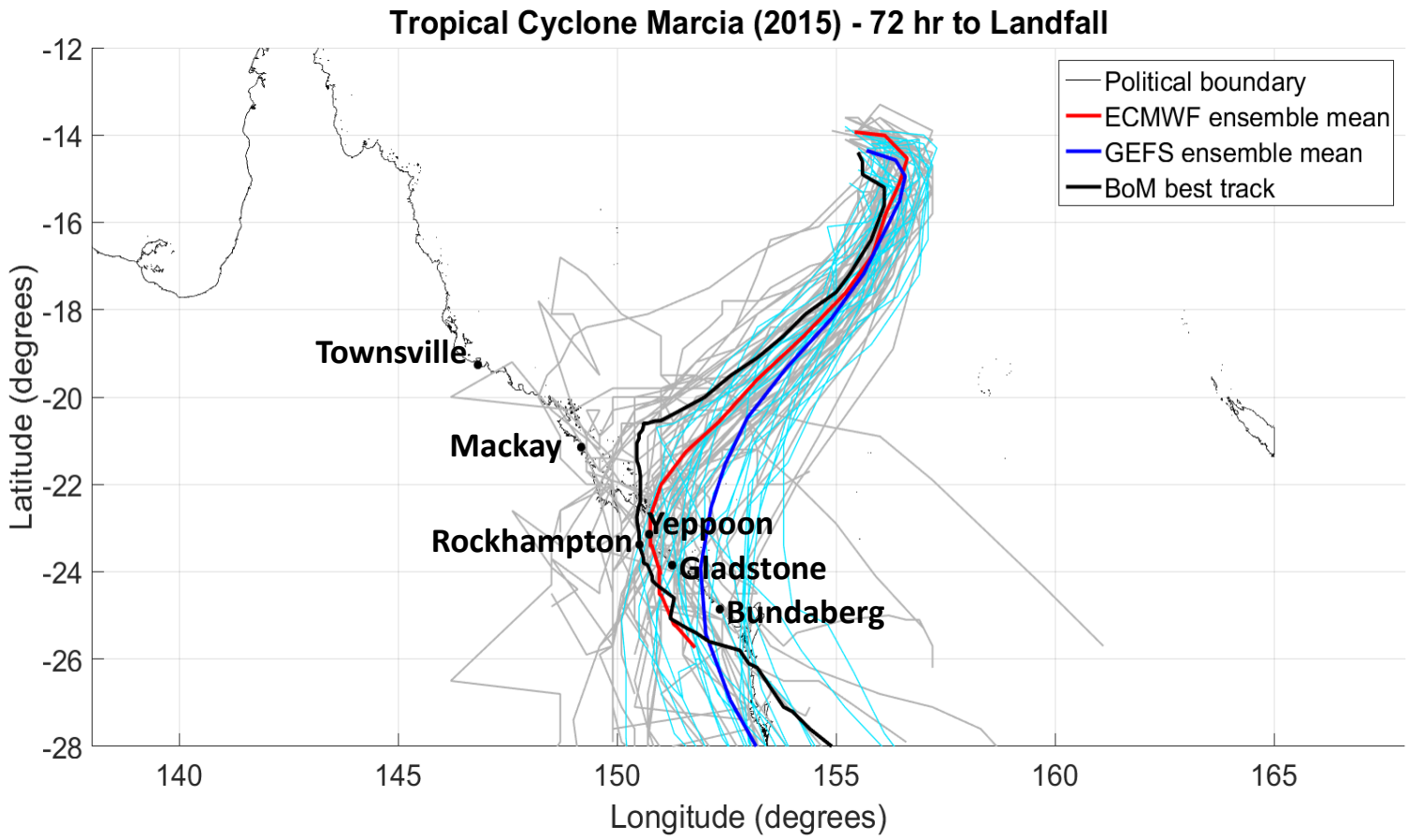


Photo credit: Center for Hydrometeorology & Remote Sensing

TROPICAL CYCLONE MARCIA – 72 HR TO LANDFALL



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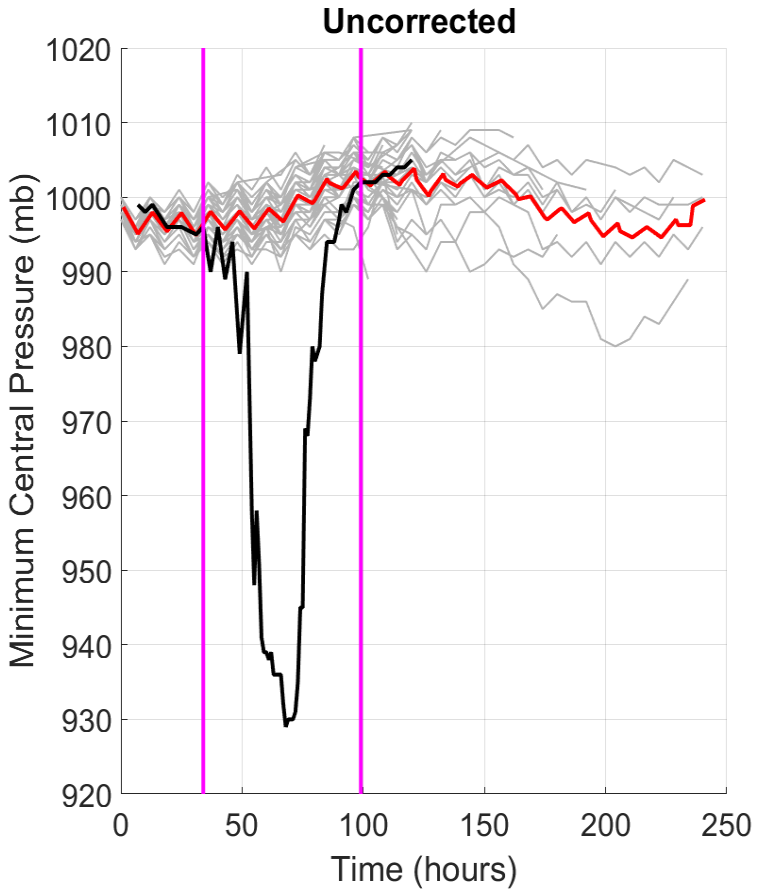
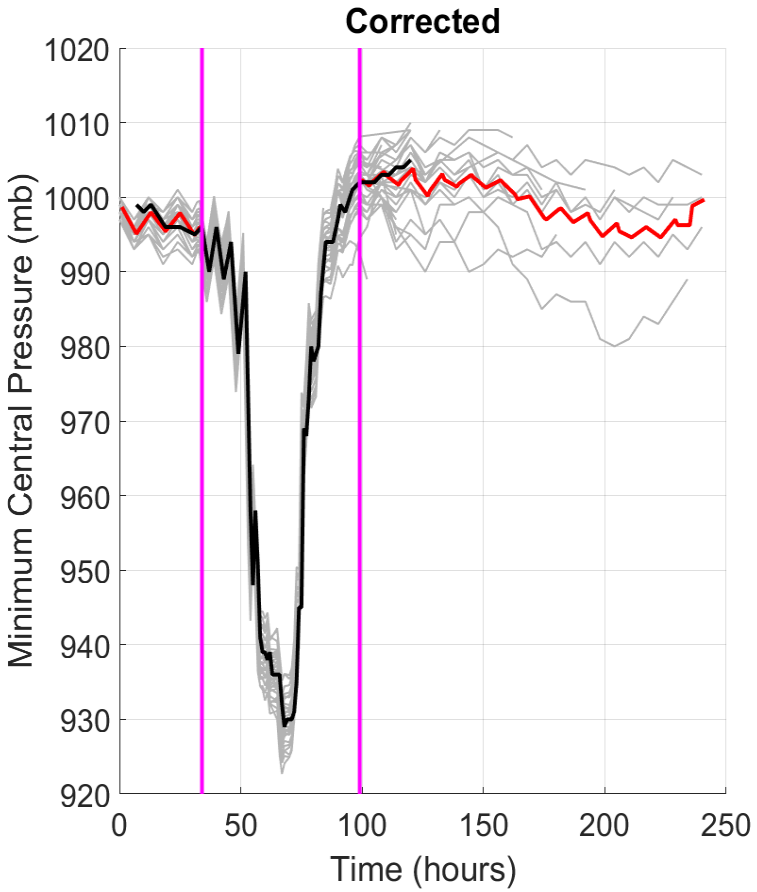
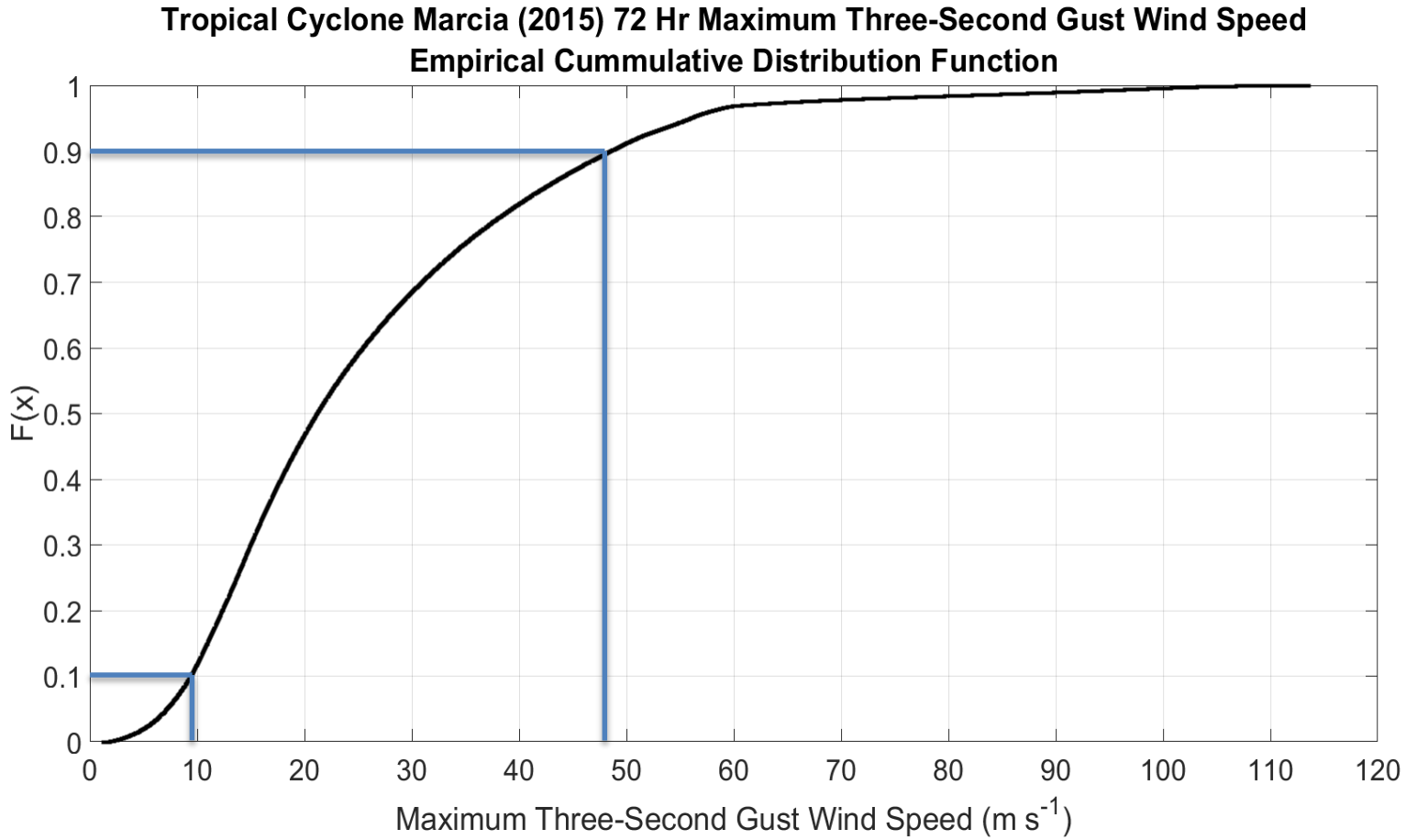
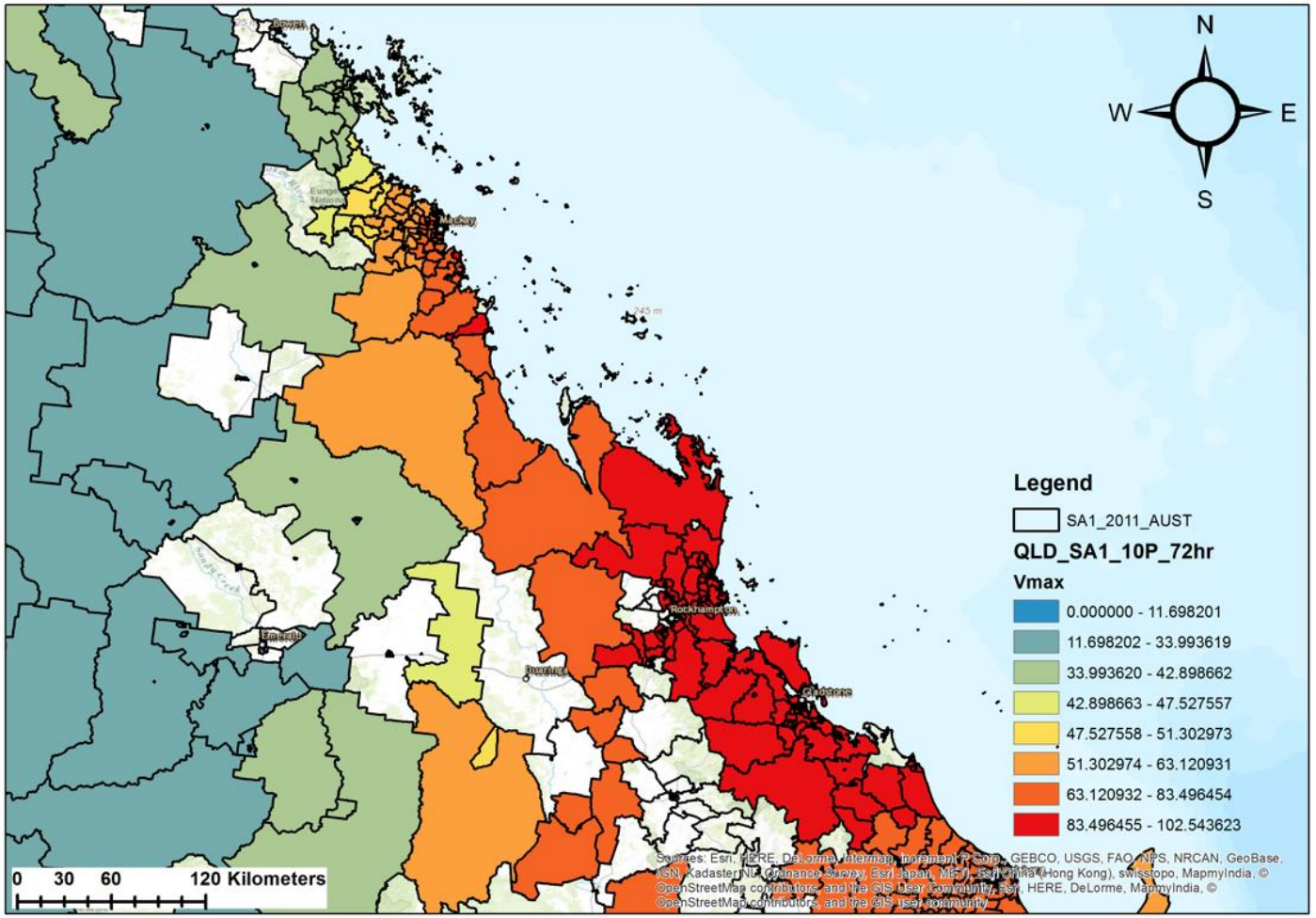




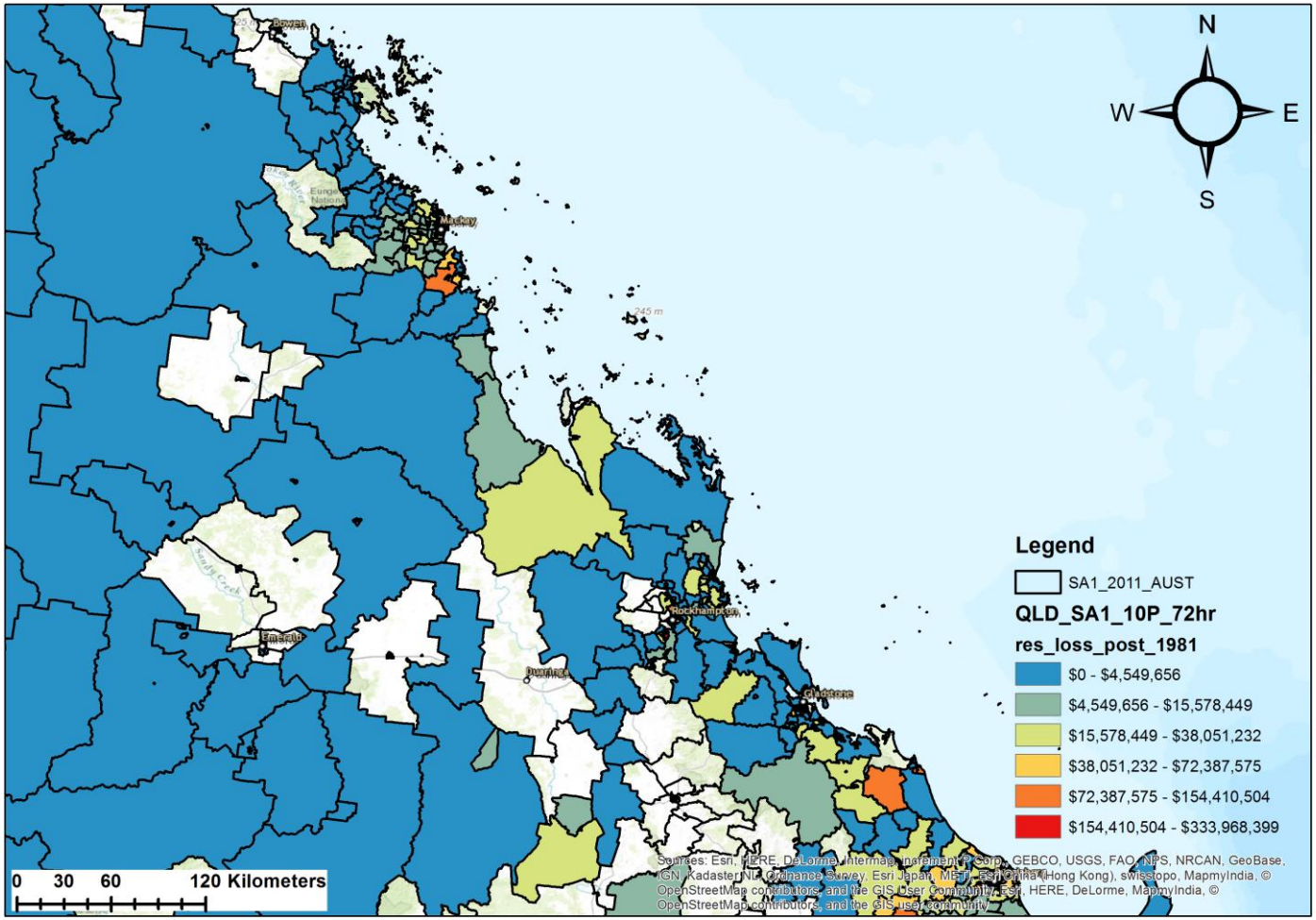
MAXIMUM THREE SECOND GUST WIND SPEED EMPIRICAL CUMULATIVE DISTRIBUTION FUNCTION – 72HR



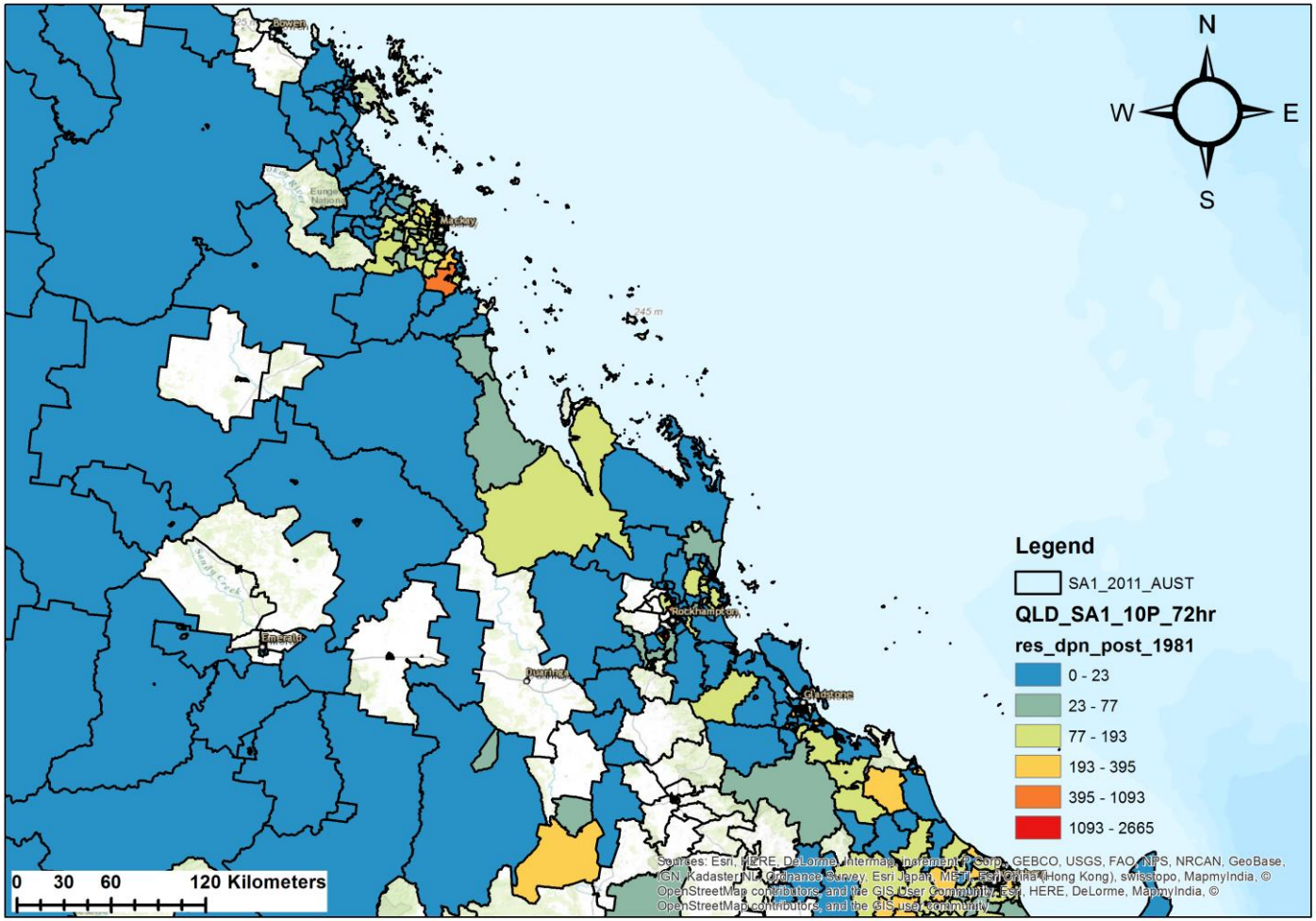
MAXIMUM THREE-SECOND GUST WIND SPEED – 72 HR TO LANDFALL



RESIDENTIAL BUILDING DAMAGE – 72 HR TO LANDFALL



DISPLACED POPULATION – 72 HR FROM LANDFALL



SUMMARY AND CONCLUSIONS

1) The wind hazard model tends to over predict the observed maximum three-second gust wind speed.

2) The rainfall hazard model underestimates inner core rainfall and cannot model rainband rainfall.

3) Global ensemble prediction system intensity forecasts are poor indicators of future storm intensity and expected impacts to buildings and society.

4) Calibrated ensemble forecasts can provide emergency managers with a range of possible scenarios to make more informed decisions depending on one's risk appetite.

FUTURE WORK

1) Develop an optimization tool to calibrate hazard models.

2) Account for the influence of terrain and topography on wind and rainfall simulations relative to the exposure information.

3) Add storm surge hazard and flood vulnerability models.

4) Simulate wind and flood impacts to Queensland power distribution stations.

http://spectrum.ieee.org/energy/the-smarter-grid/one-year-later-superstorm-sandy-underscores-need-for-a-resilient-grid

CONTACT INFORMATION

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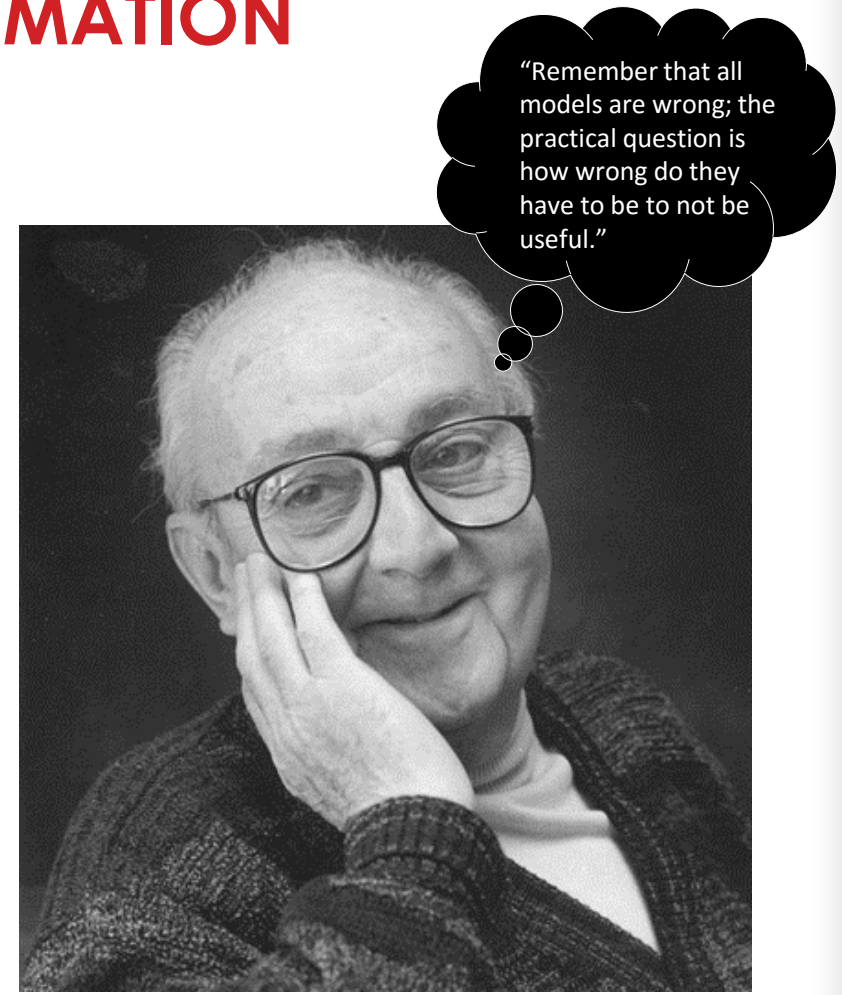

Photo credit: http://bulletin.imstat.org/2013/07/obituary-george-e-p-box-1919%E2%80%932013/

Wind Research Laboratory

OPTIMIZATION