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# A Hybrid Approach to Assessing Tropical Cyclone Wind and Pressure Fields

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# Windfield Approaches

Parametric radial wind profiles:

- fast, smooth fields, empirical adjustments

Spatial analysis of observations:

- details, few storms, not global.

Geostatistical spatial modeling:

- fast, only applied to European windstorm so far.

Numerical modeling:

- many physical processes, slow, track error.

# Hybrid Approach

Diagnoses boundary-layer flow using dry equations of motion for a specified pressure field  
(Modified Kepert and Wang 2001).

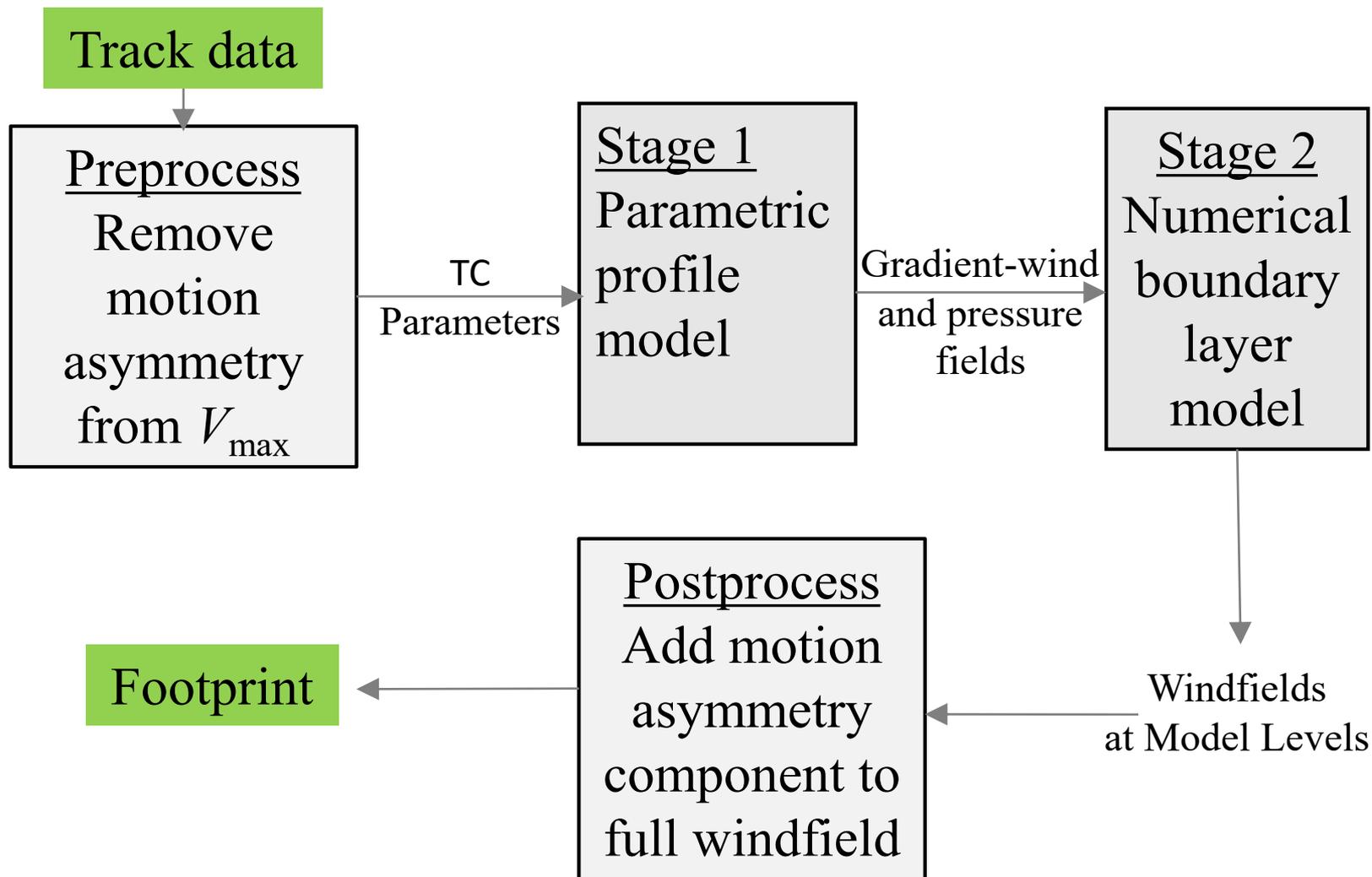
- High-order turbulence scheme, prognostic TKE, 4-sec time step
  - Top boundary 2 km, 18 vertical levels, resolution 2 km
  - Ignores strong thermal effects.
- Driven by Parametric Model (Willoughby, Holland).

Code modifications to allow storms to

- Move at varying speeds and directions
- Change intensity and size, and
- React to orography and surface roughness.

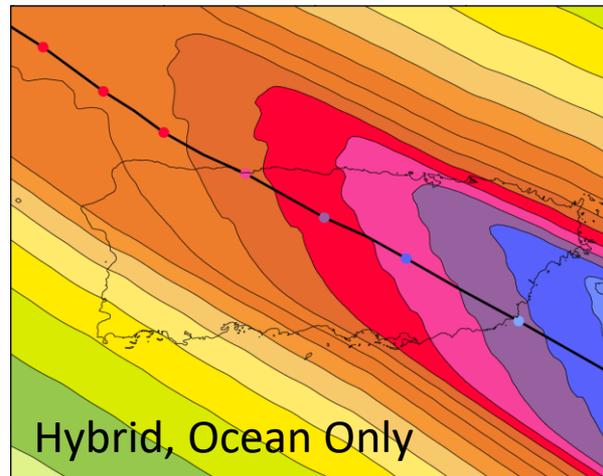
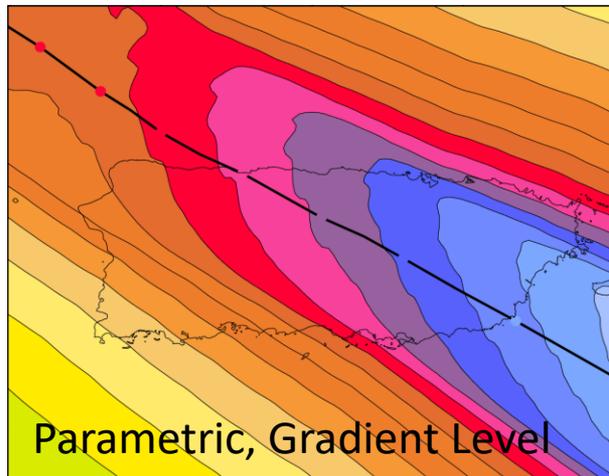
(Done et al 2019)

# Procedure

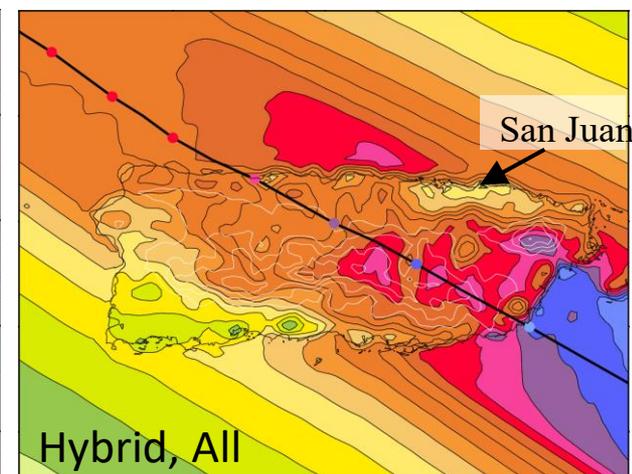
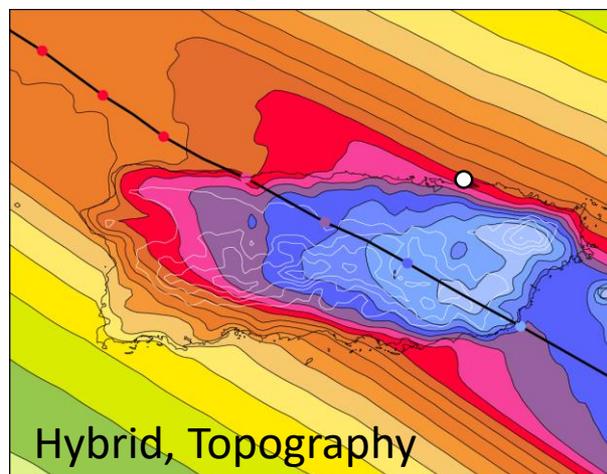
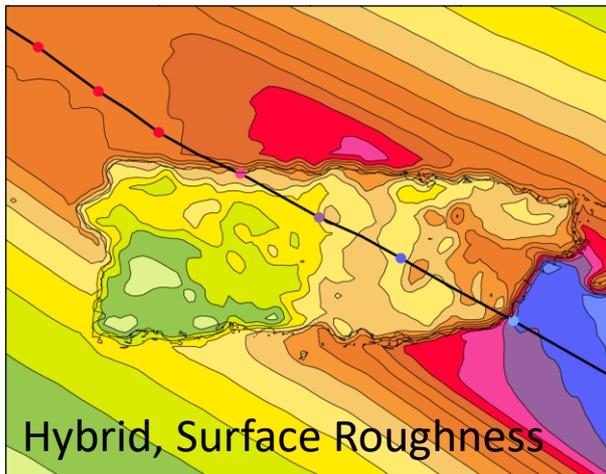
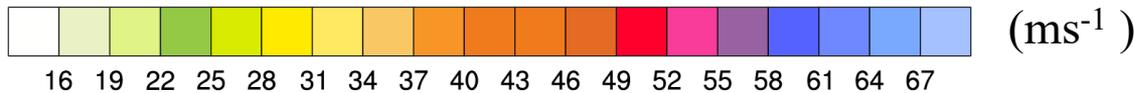


(Done et al 2019)

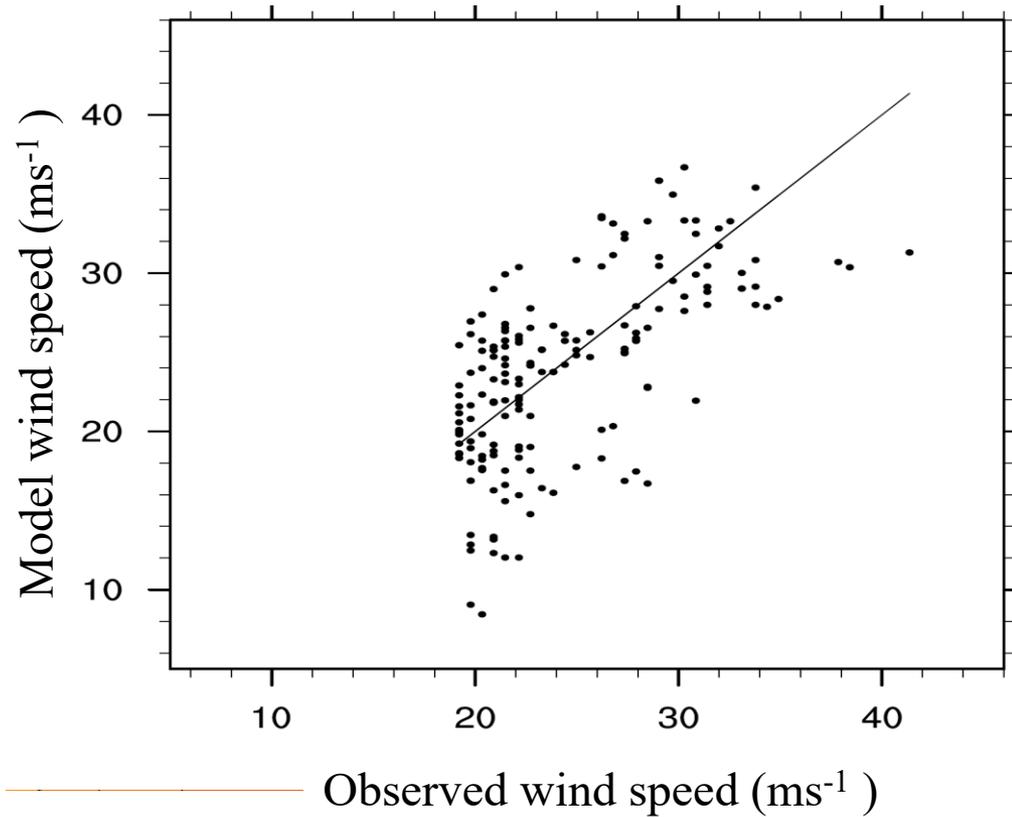
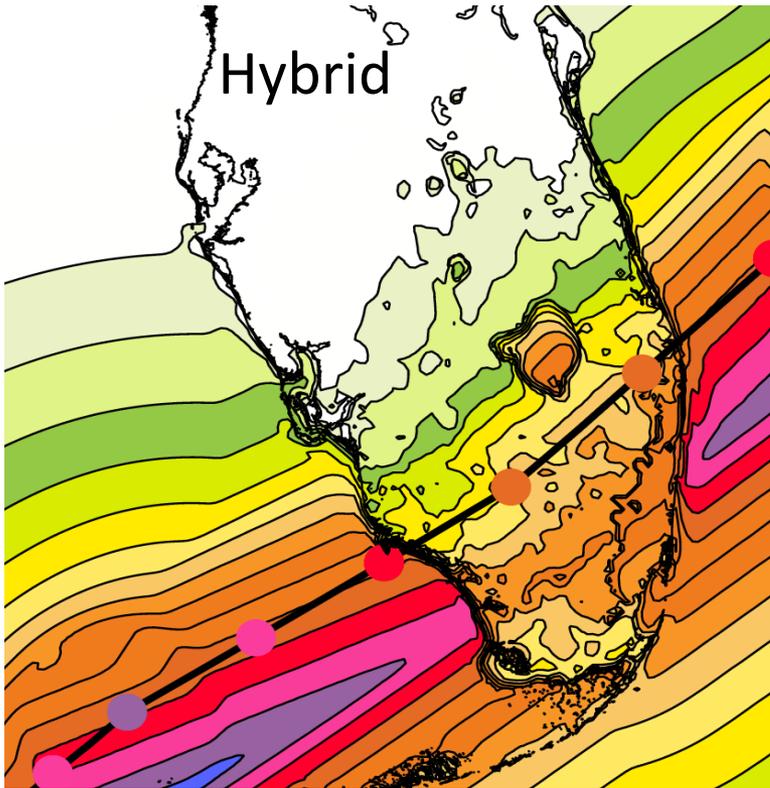
# Example for Hurricane Maria



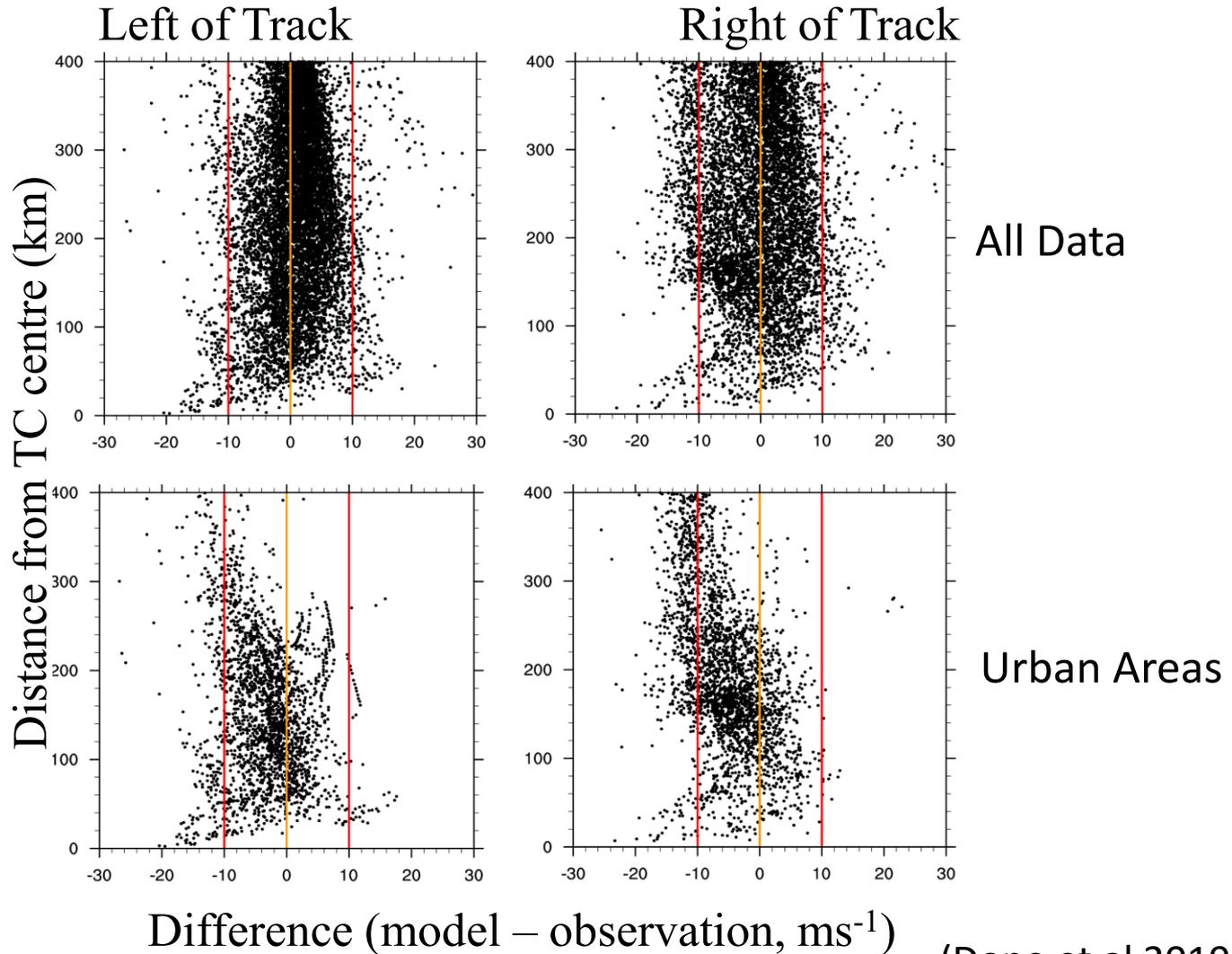
Peak wind along the track



# Hurricane Wilma

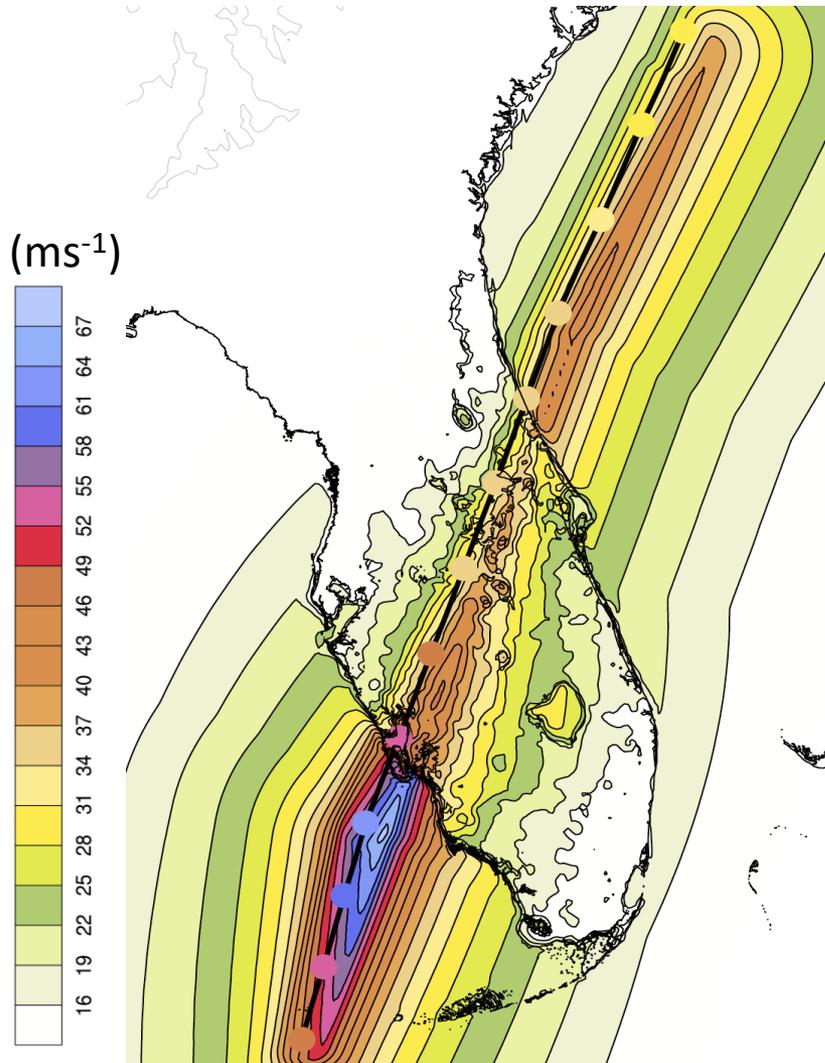


# Eight US Hurricanes

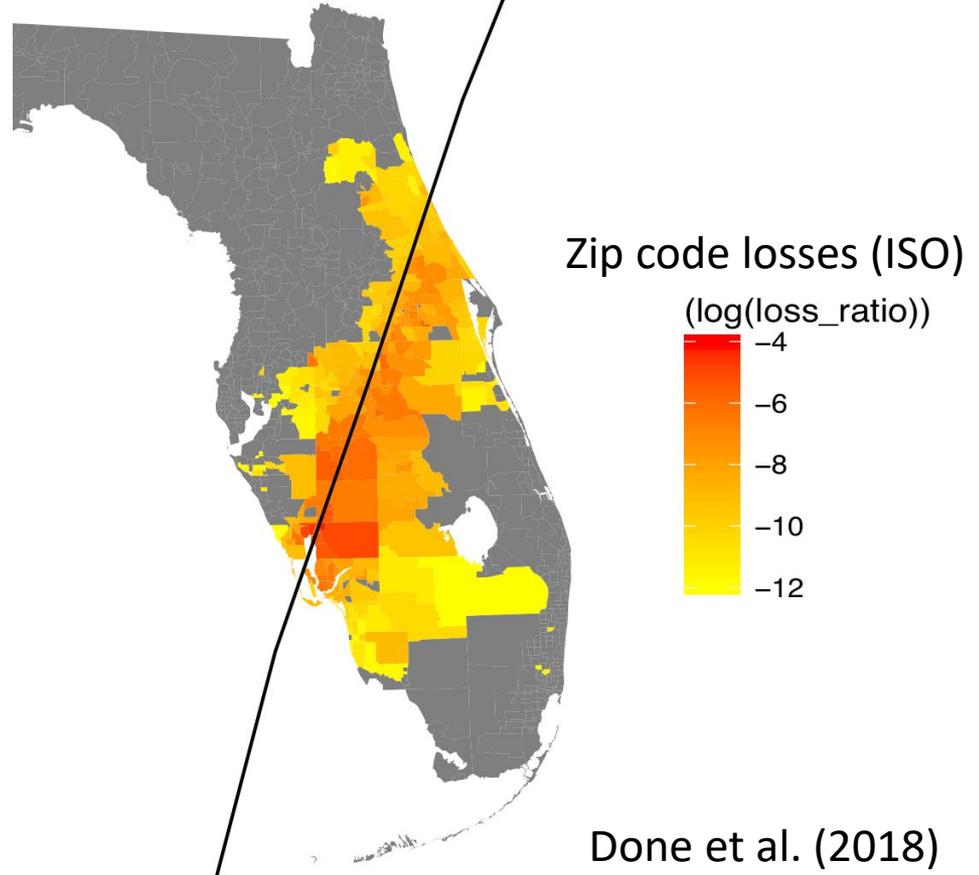


(Done et al 2019)

# Example: Understanding Losses

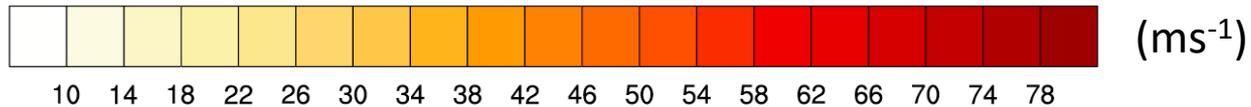
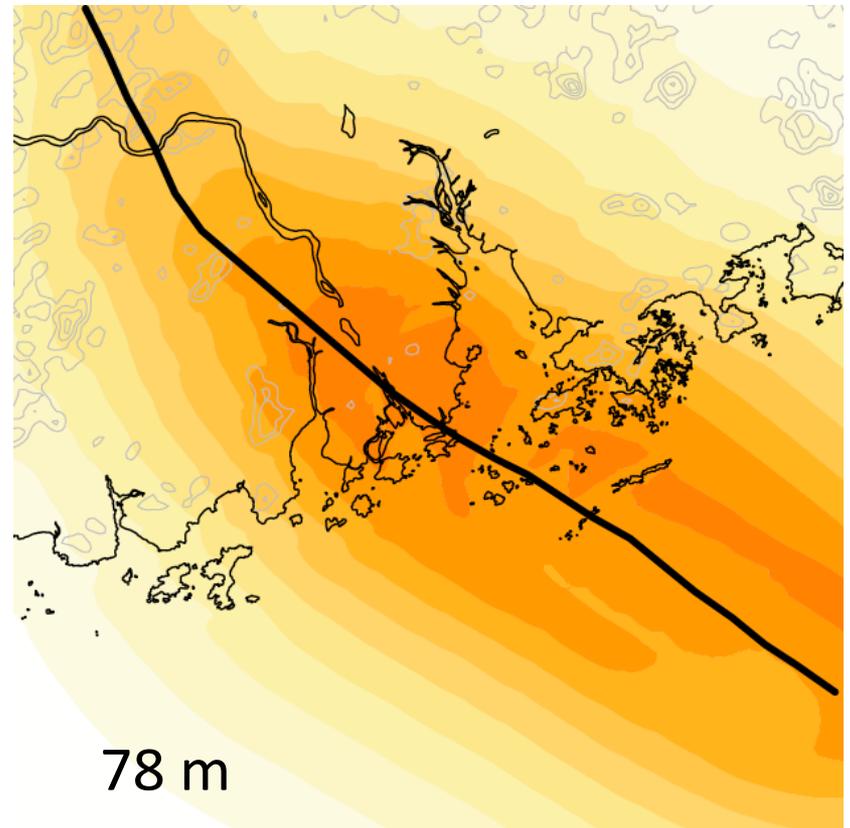
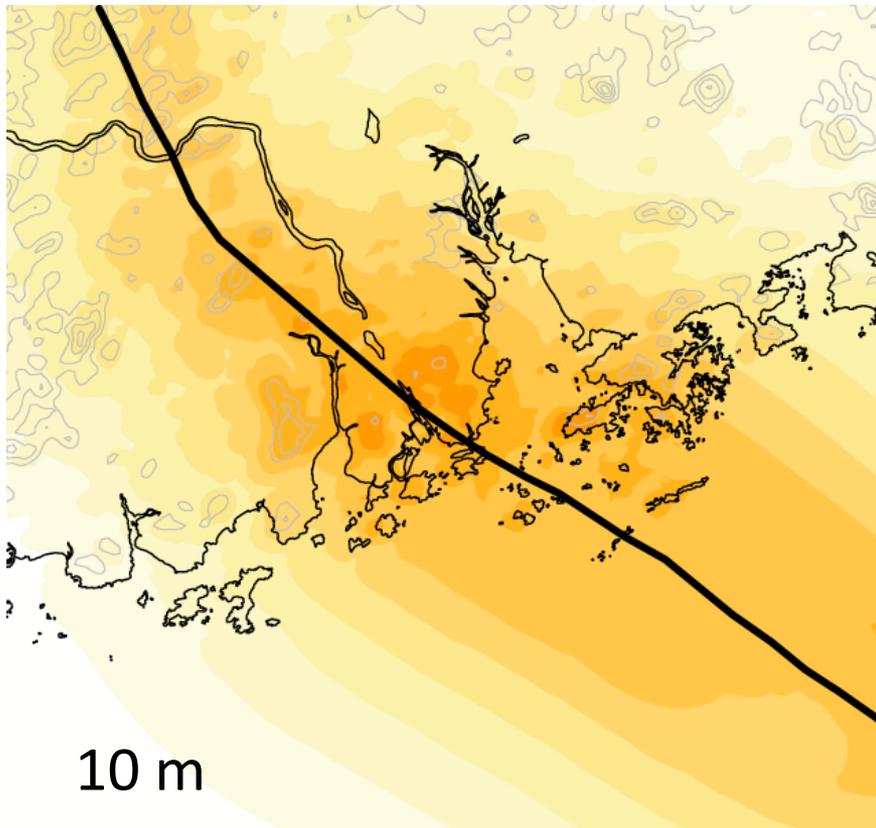


Hurricane Charley (2004)

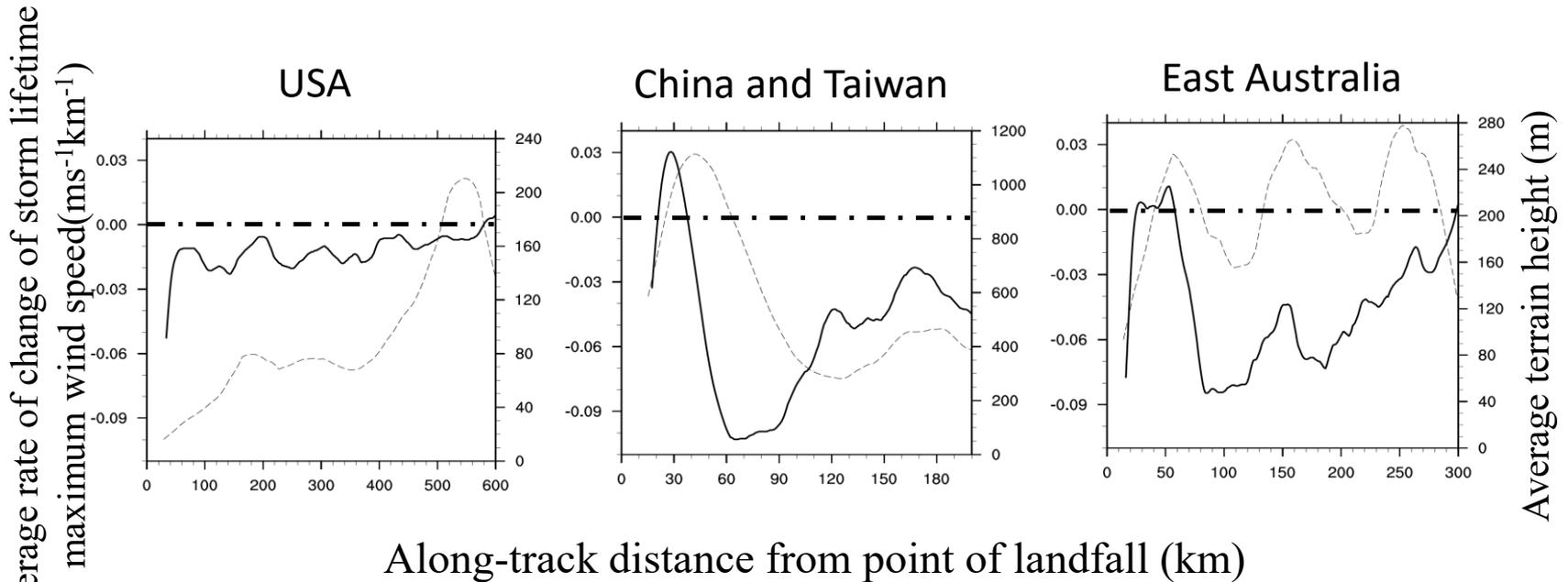


# Example: Unique View of Risk

## Typhoon Ellen (1983)



# Example: Wind Decay Rate



- - - - zero line
- wind gradient
- ..... terrain height

(Done et al 2019)

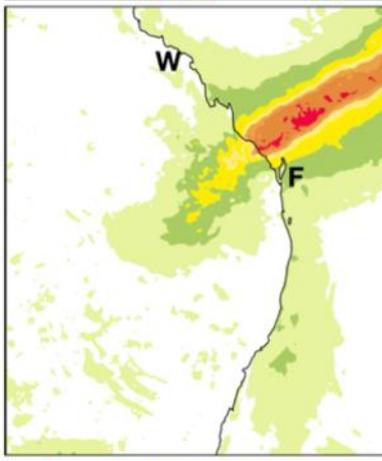
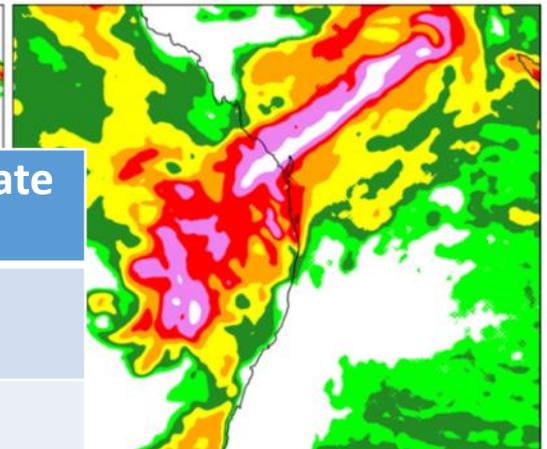
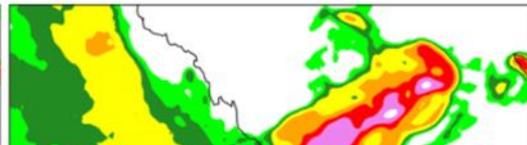
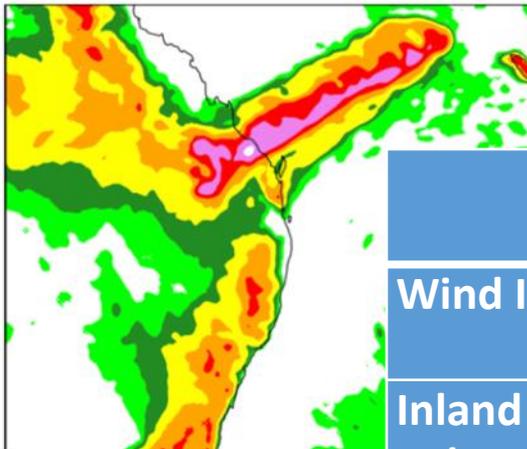
# Next: Hybrid WRF Model

Preindustrial

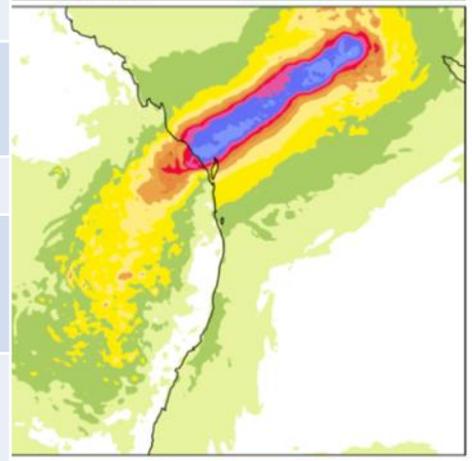
Current Climate

2100 RCP8.5

Total  
Rain

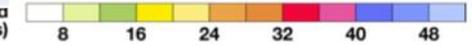


	Future Climate
Wind Intensity	+25%
Inland area > 17 m/s wind	+ 500%
Total precipitation	+120%
Max rain rate	+120%
Inland area > 50 mm precipitation	+320%
Total inland precipitation	+270%



Precipitation (mm)

maximum wind speed (m/s)



Peak  
Wind

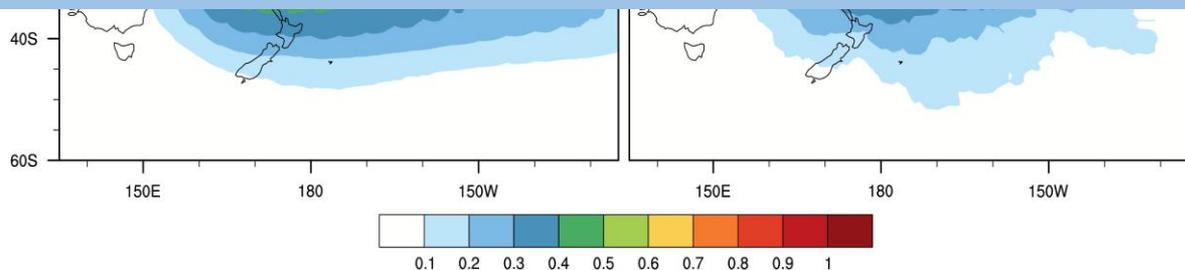
(Bruyere et al 2019)

# Next: Hybrid Assessment of Climate Change

- Set of NCAR simulations to support research into near-term Earth System prediction
- 40 member ensemble of decadal simulations starting every year from 1954-2017
- Contains 25,600 years of global model simulations

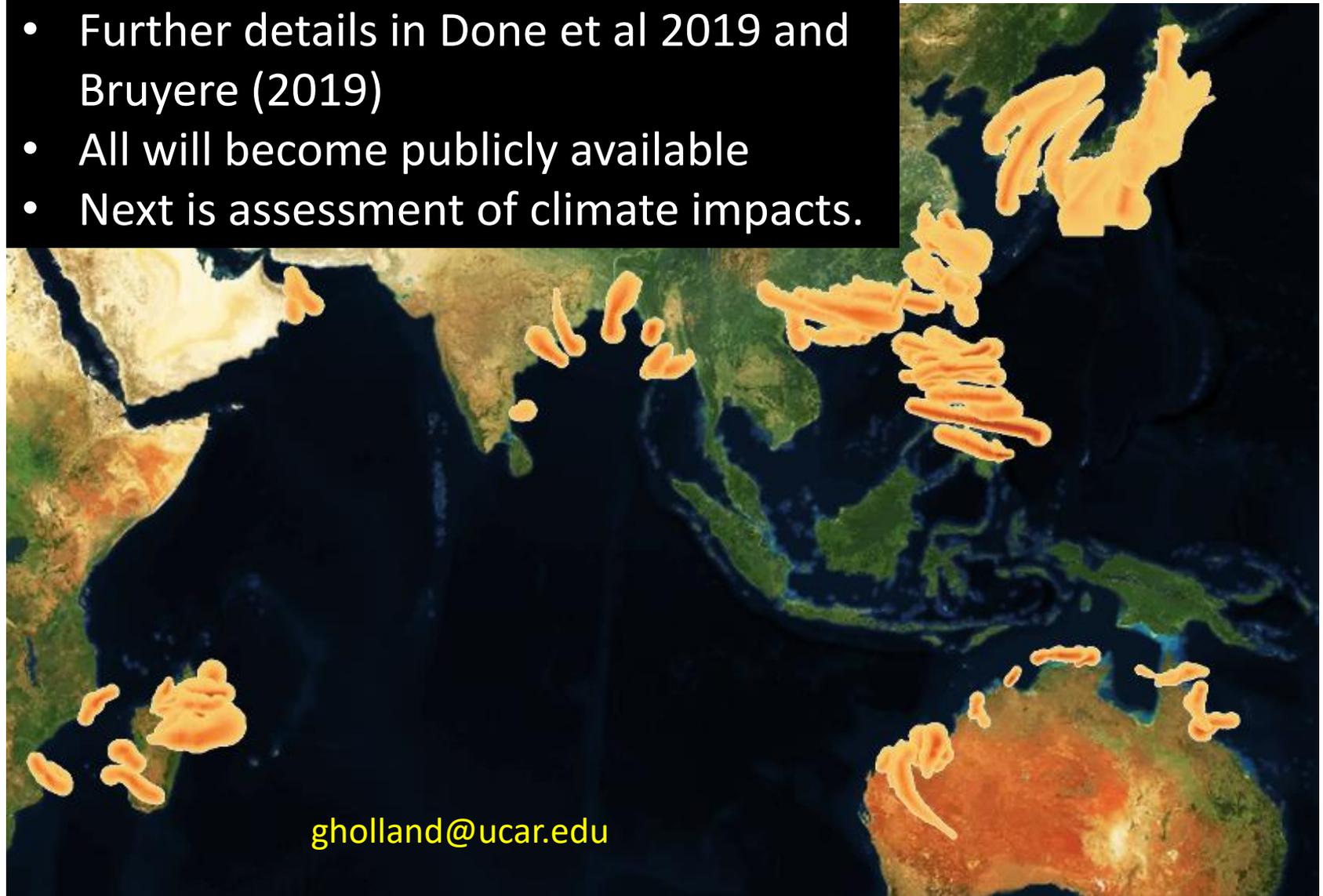
## Assessing Climate Change impacts on Tropical Cyclones

- *Changes in cyclone environments*
- *Frequency, Intensity, Translation Speed, Latitude of Maximum Intensity, Precipitation*



# Hybrid Footprinting

- Further details in Done et al 2019 and Bruyere (2019)
- All will become publicly available
- Next is assessment of climate impacts.



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