Characterizing the Structure of Hurricane Karl (2010)

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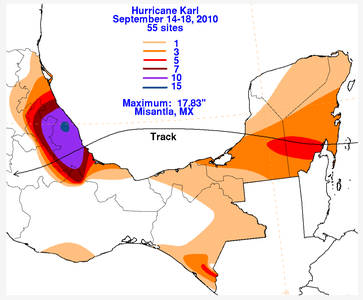
Introduction

In the literature, the orographic modification of the three-dimensional structure of tropical cyclones is understudied. In order to improve prediction of surface precipitation, the manner in which topography impacts dynamical and microphysical processes must be better understood.

Hurricane Karl's landfall in southern Mexico in 2010 provides an opportunity to study this interaction in greater detail. Before teasing out the relative contribution of the topography, this study first seeks to characterize the existing thermodynamic, microphysical and dynamical structures. This will enable further study of the role the Mexican mountains and plateau play in organizing and enhancing precipitation.

Hurricane Karl

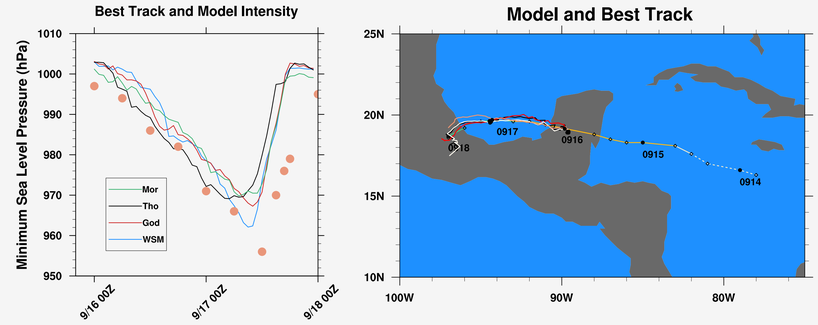
- Hurricane Karl made landfall in Mexican state of Veracruz on September 17th, 2010.
- Rainfall totals were highest near Misantla, MX (Stewart 2010).



Rainfall associated with Hurricane Karl from Stewart 2010

WRF Simulations

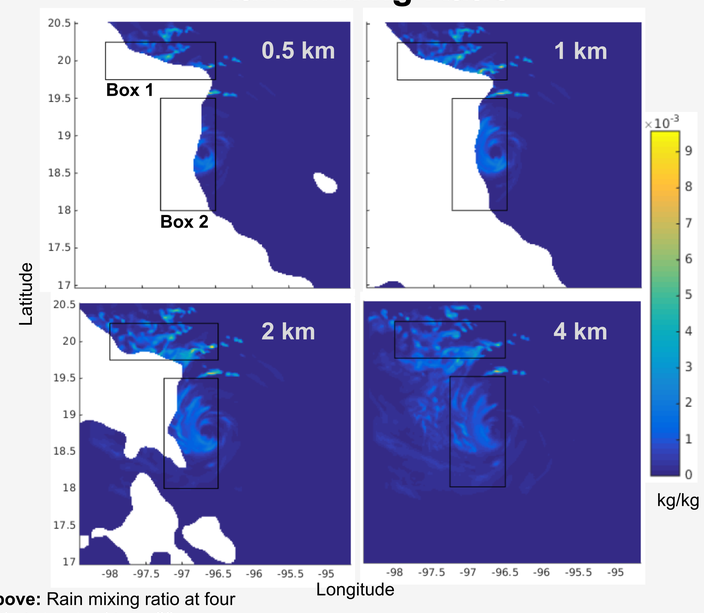
- WRF modeling study to examine structure of Karl.
- Different microphysical schemes produce similar tracks
- General intensity captured, but falls a bit short



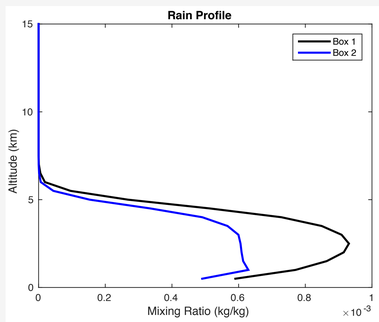
Track and Intensity of Hurricane Karl from NHC Best Track data and simulations.

Characteristic Structure – WSM

Rain Mixing Ratio



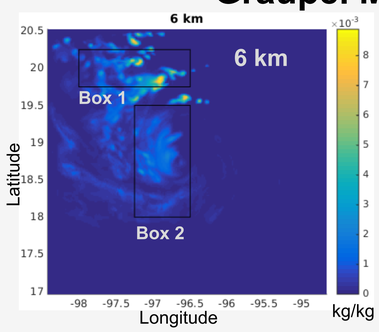
Above: Rain mixing ratio at four altitude levels at hour 63.

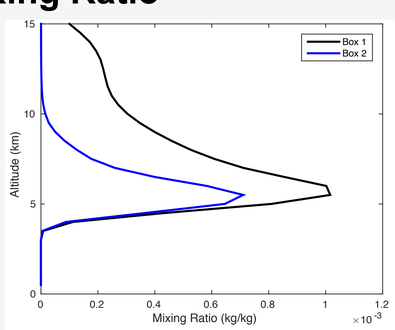


- Strong rain signature in the inner core / outer bands
- Box 1 has higher average mixing ratios through 4 km

Bottom: Rain mixing ratio profiles from data in boxes drawn above.

Graupel Mixing Ratio

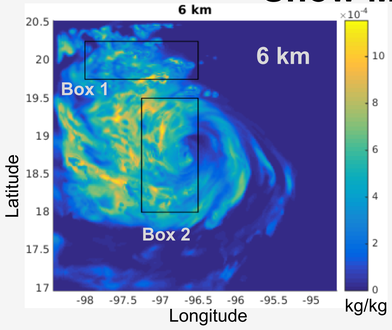


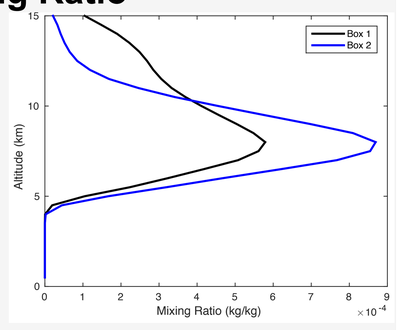


Left: Graupel at 6 km altitude at hour 63.
Right: Graupel profiles in denoted areas.

- Graupel more prevalent in Box 1

Snow Mixing Ratio

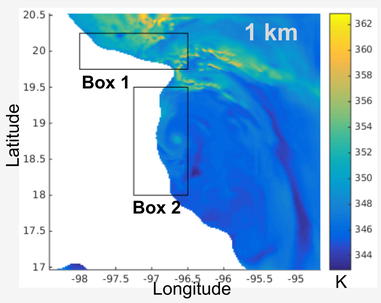


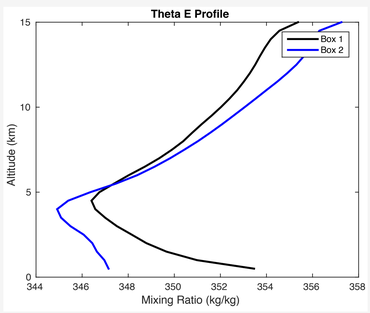


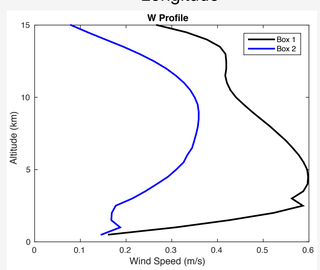
- Lighter particles like snow have a tendency to circle away from origin

Left: Snow at 6 km altitude at hour 63.
Right: Snow profiles in denoted areas.

Theta-E and W







- Stronger decrease in θ_e in Box 1
- Mean w is stronger in Box 1

Top Left: θ_e at 1 km altitude at hour 63.
Top Right: θ_e profiles from data in denoted areas.
Bottom: W profiles from data in denoted areas.

Conclusions and Future Work

- Consistent with the location of maximum surface rainfall, graupel mixing ratios are maximized along the northern edge of the terrain
- Theta-e profile indicates greater instability, supported by stronger mean ascent present in the same region
- Convection in the outer bands is strongest in the northern region, though there are several potential factors at play

- **Future Plans**
- Comparison of the simulated structures with airborne radar data from APR-2 on the NASA DC-8
- Isolate the role that orography plays in the structural patterns by modifying the terrain in WRF experiments

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