

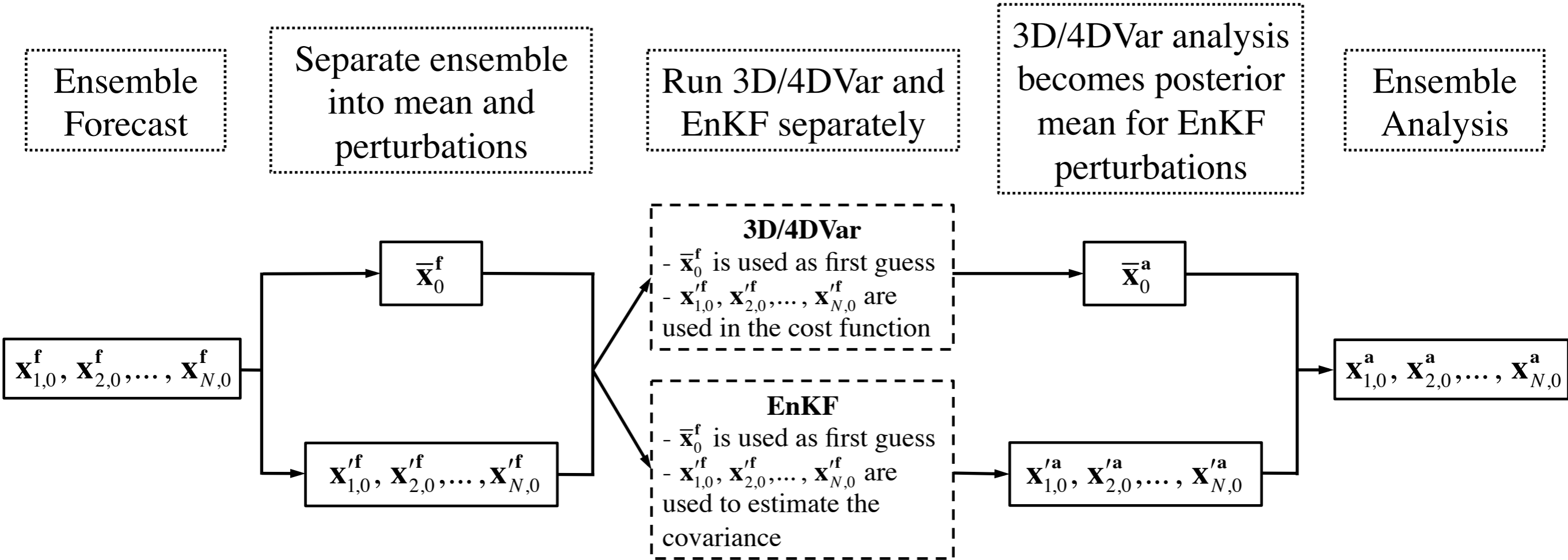
Application of a Coupled Data Assimilation System at CIMH.

Ashford D'Arcy Reyes

Caribbean Institute for Meteorology and Hydrology

**EUREC4A Symposium
Saturday 1st February 2020**

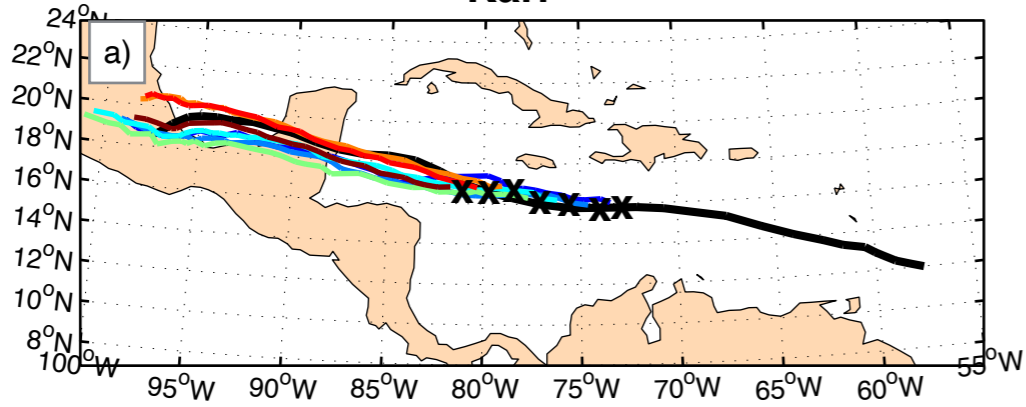
Coupled EnKF-3DVar/4DVar Data Assimilation Schematic



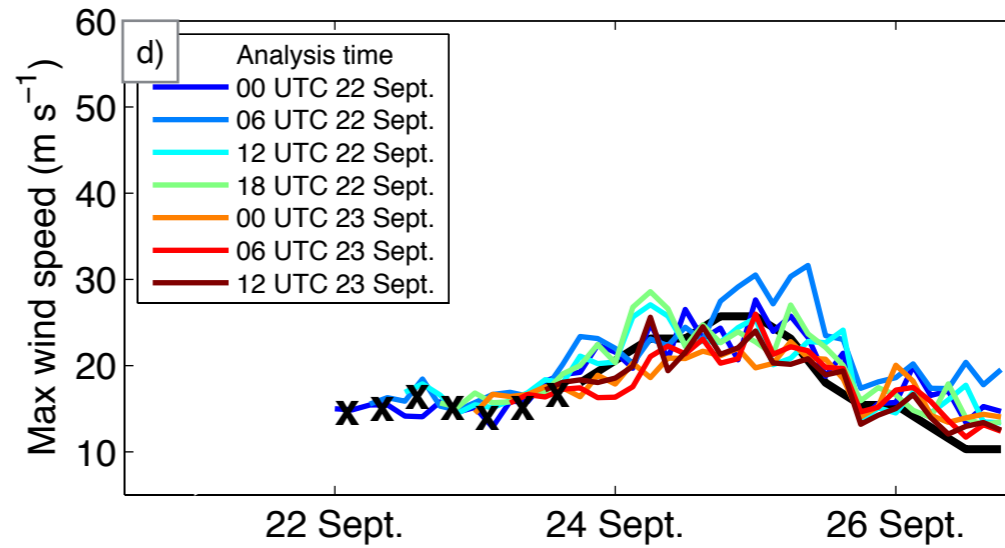
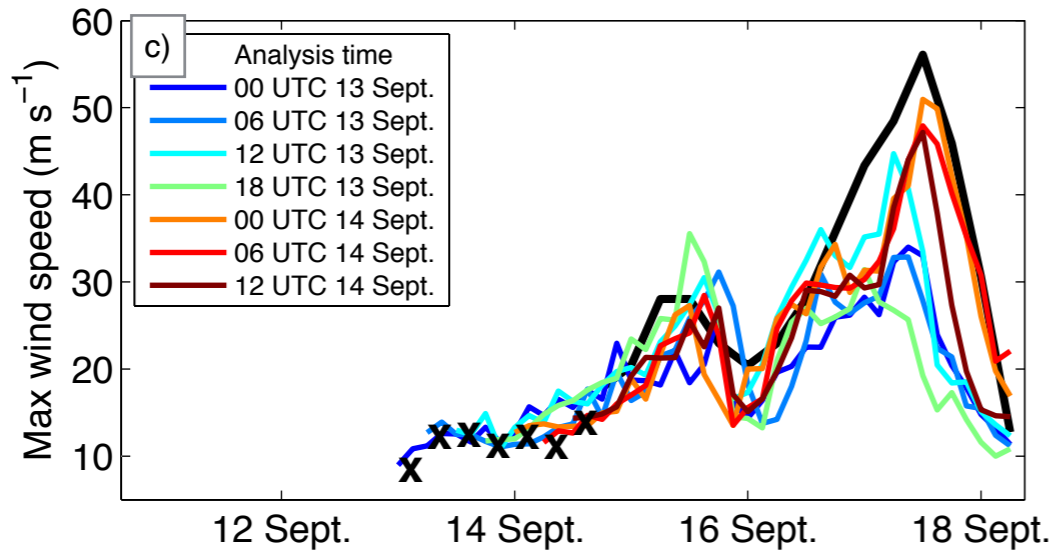
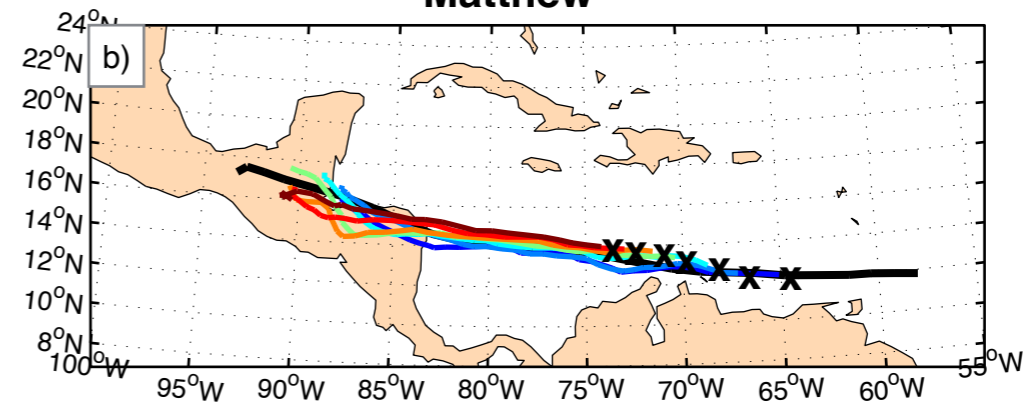
Zhang and Zhang (2012), Poterjoy and Zhang (2014)

Deterministic Track and Intensity Forecasts

Karl



Matthew

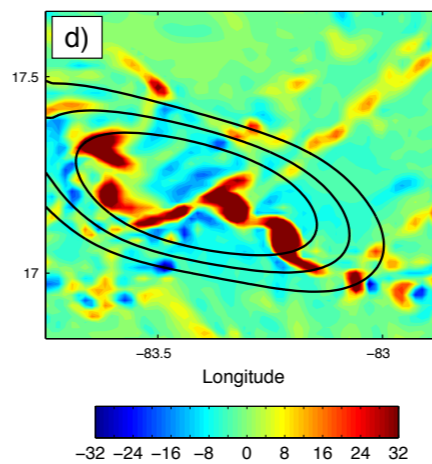
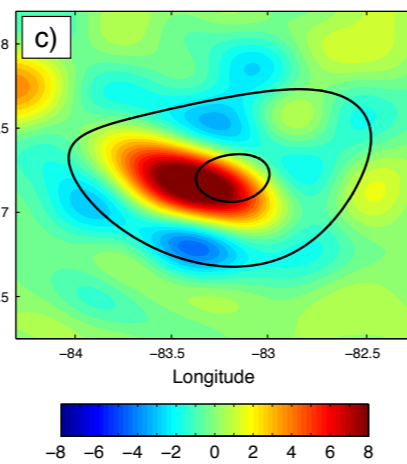
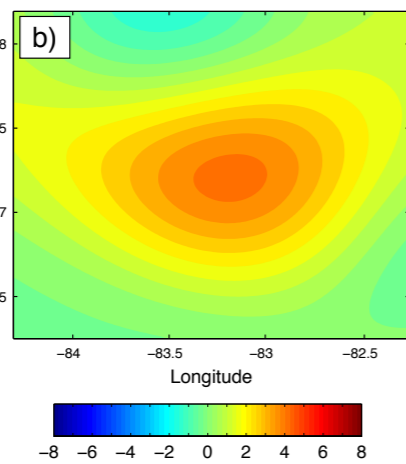
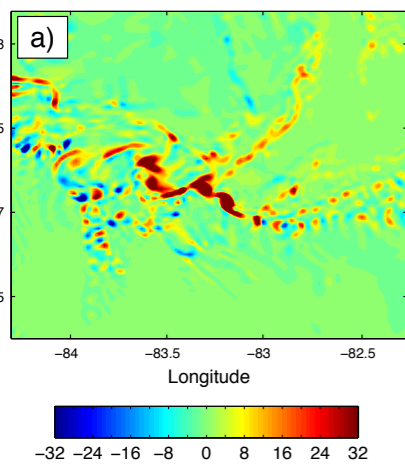


Multi-Scale Features of a Developing Vortex at 200 meters

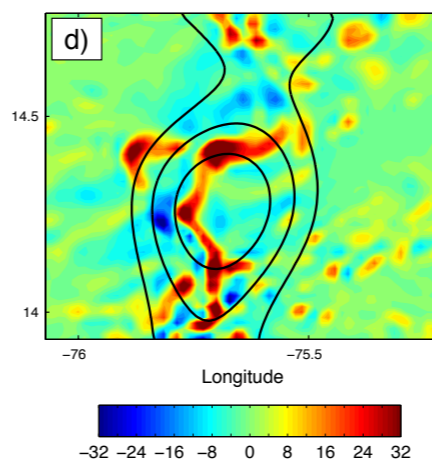
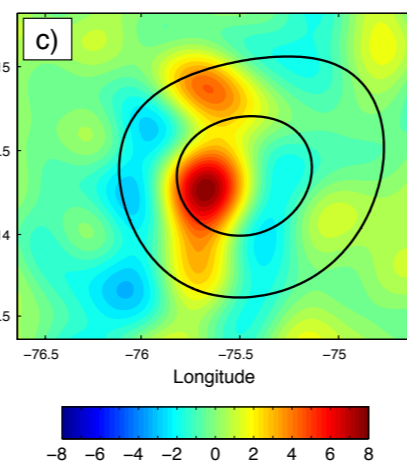
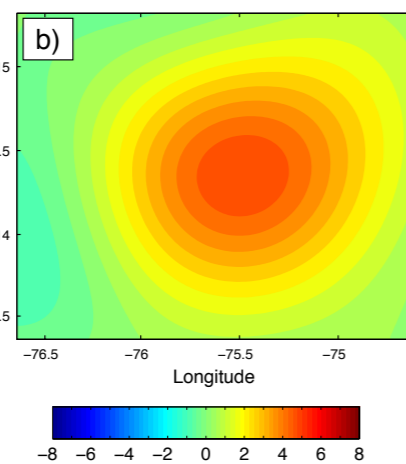
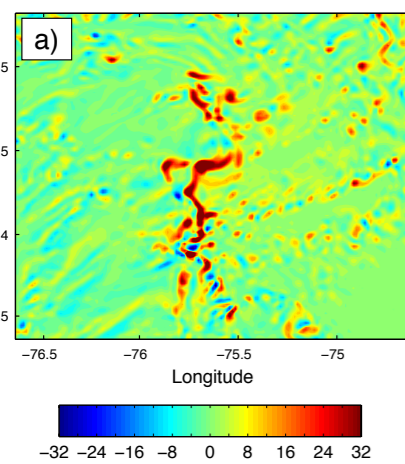
← 225 km →

Hurricane Karl

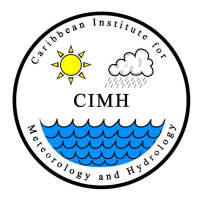
← 90 km →



TS Matthew

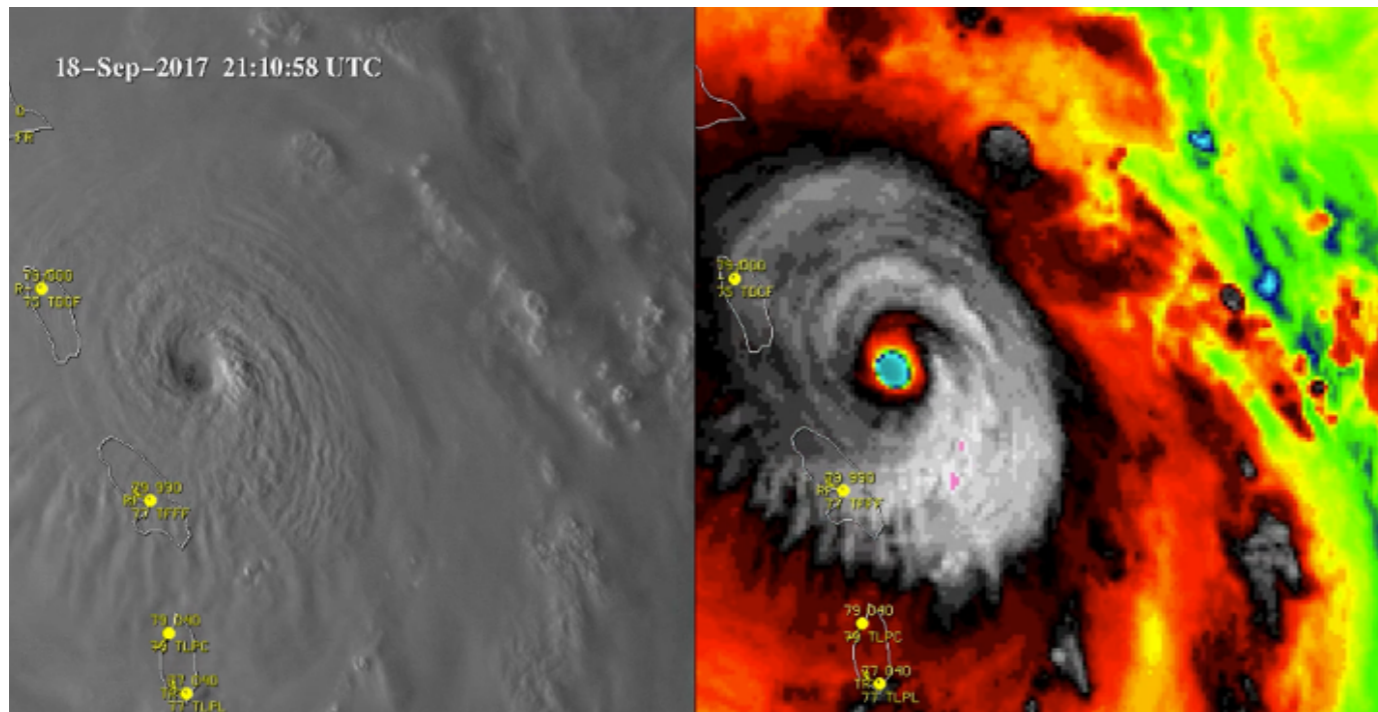


- Vorticity anomalies converge towards the center.
- Large number of CVAs within the cluster scale vorticity anomaly.
- Convective and cluster scale vortices are greater in magnitude than the system scale vortex.



CIMH-E4DVAR Experiment

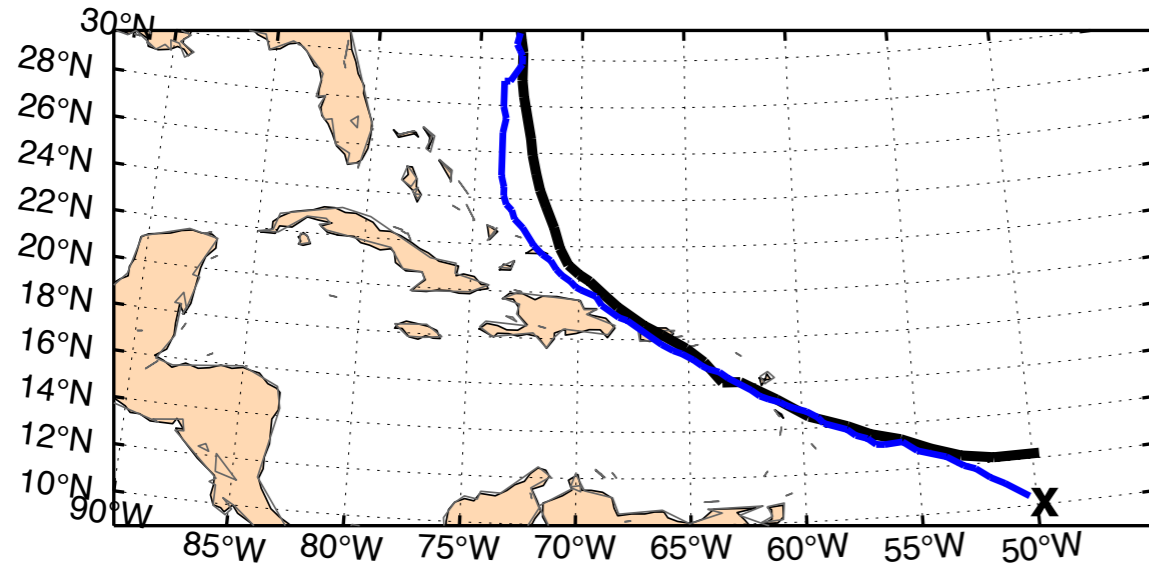
Hurricane Maria 2017



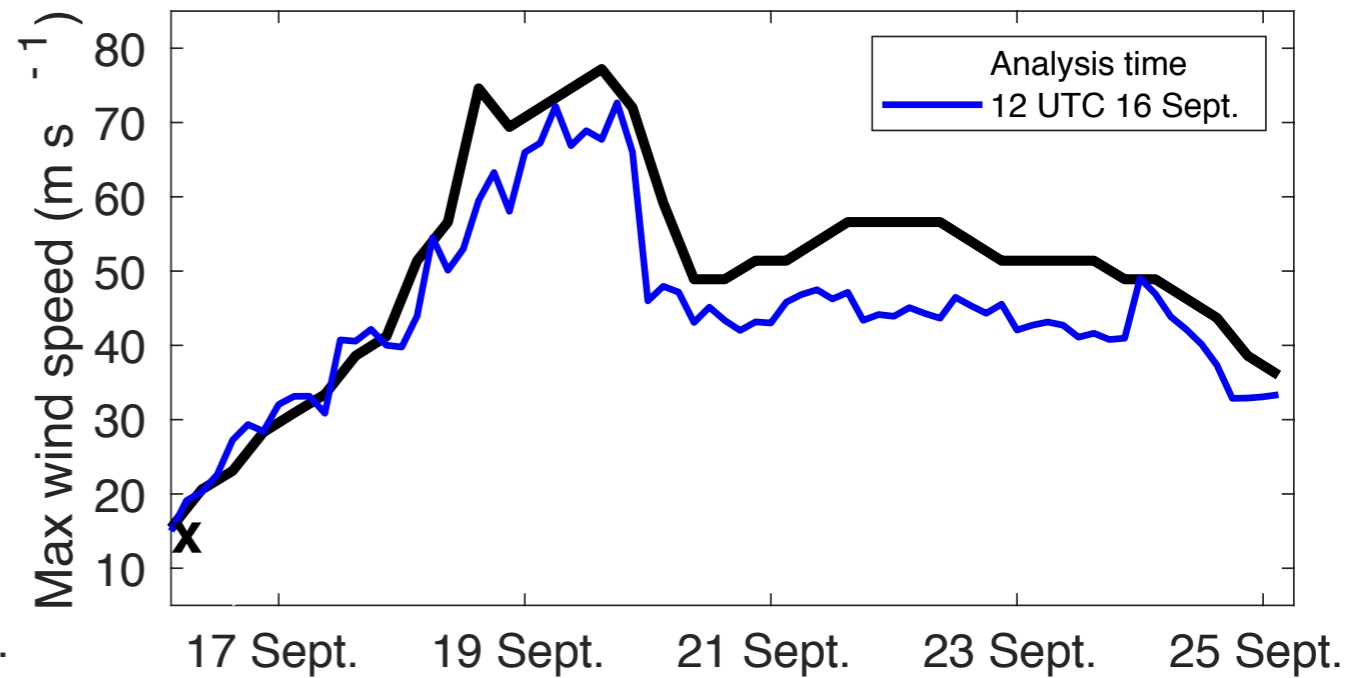
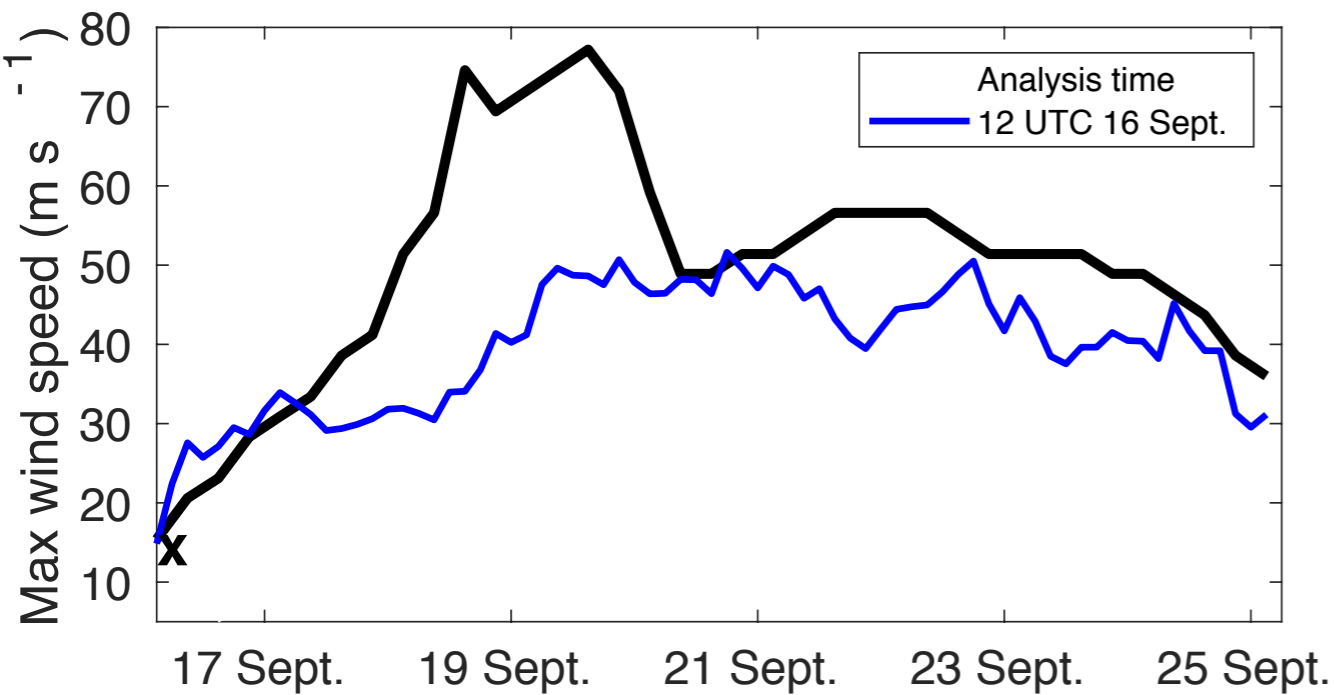
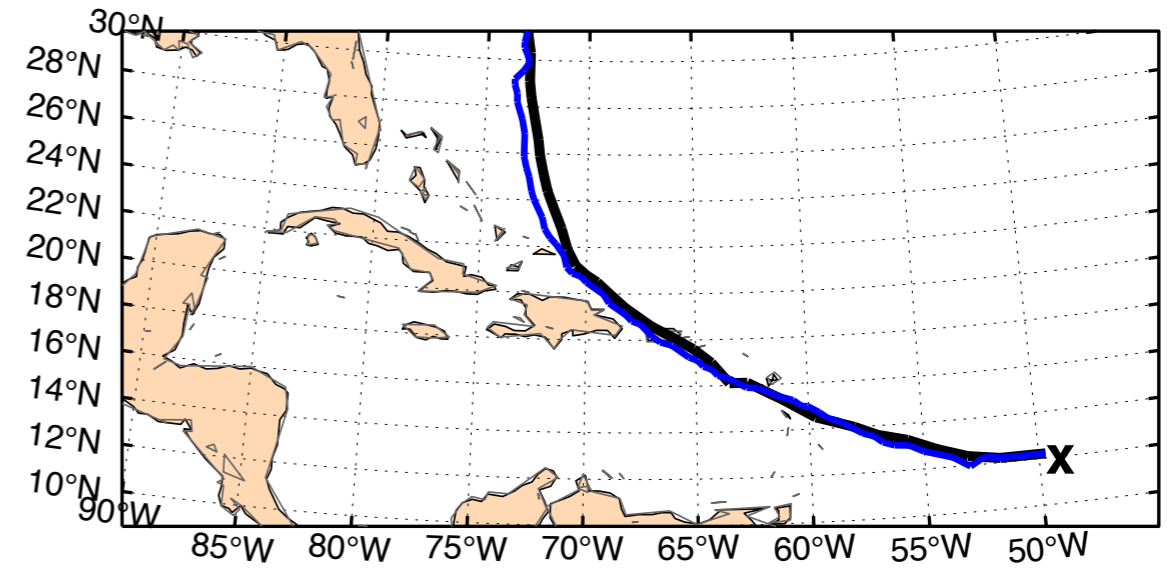
- Formed at 12.2 N, 51.7 W on September 16th at 18Z.
- Maria was a category 5 hurricane.
- Minimum central pressure of 908 hPa.
- Maximum sustained winds of 150 knots.

Hurricane Maria Simulation at CIMH

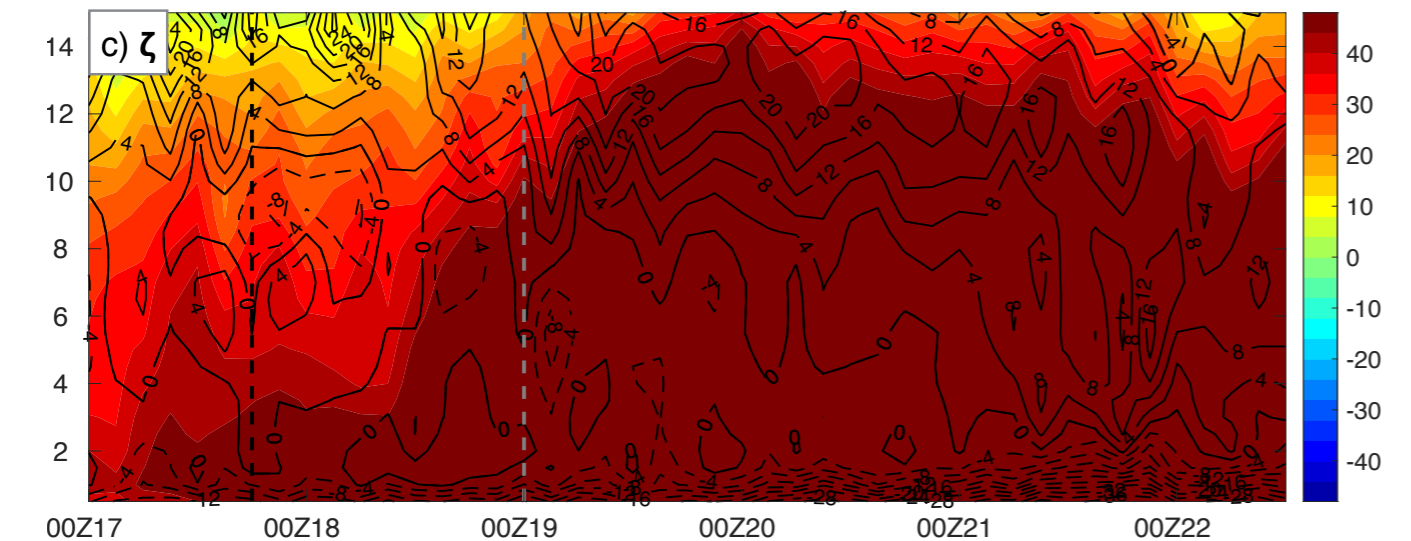
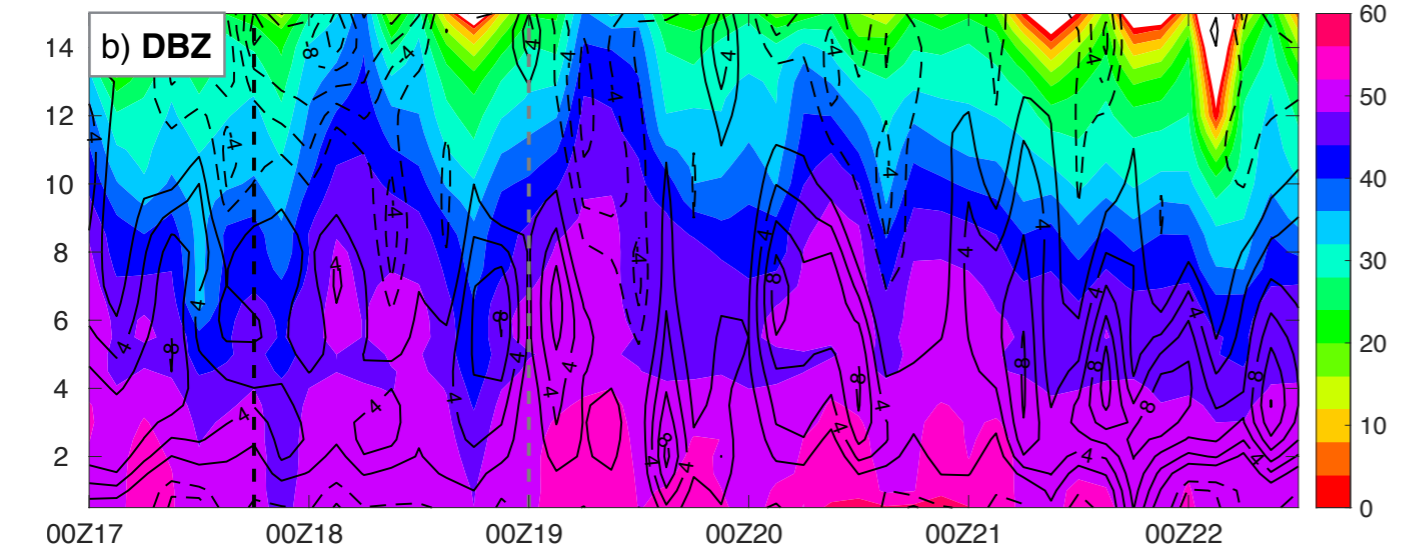
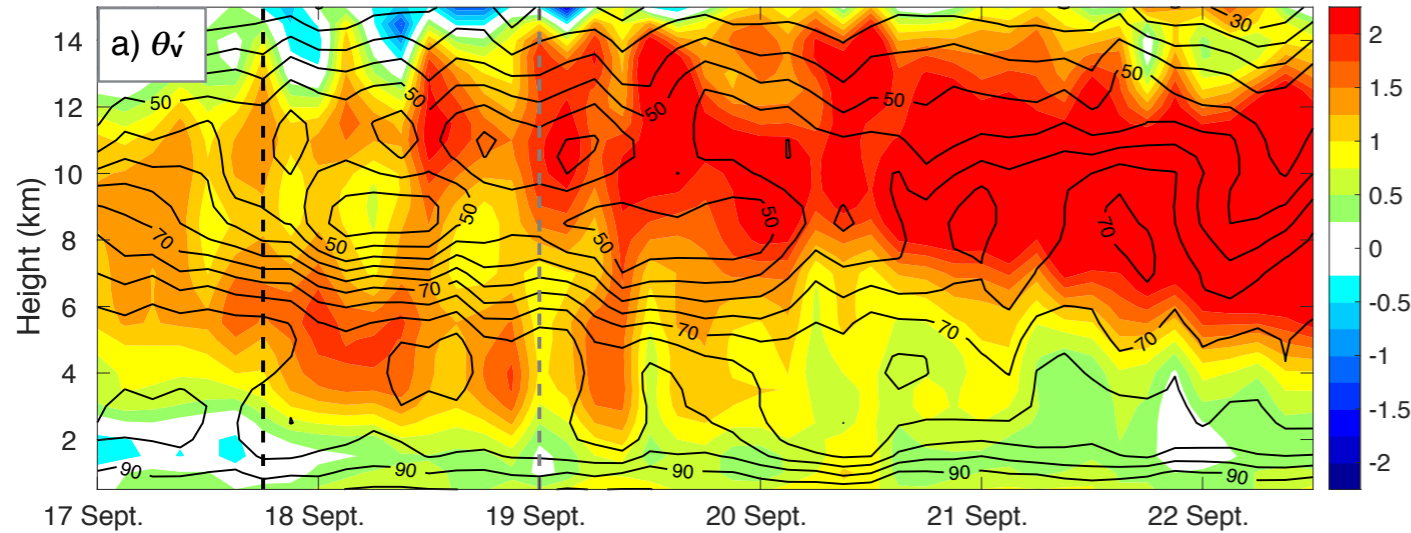
NoDA



E4DVar

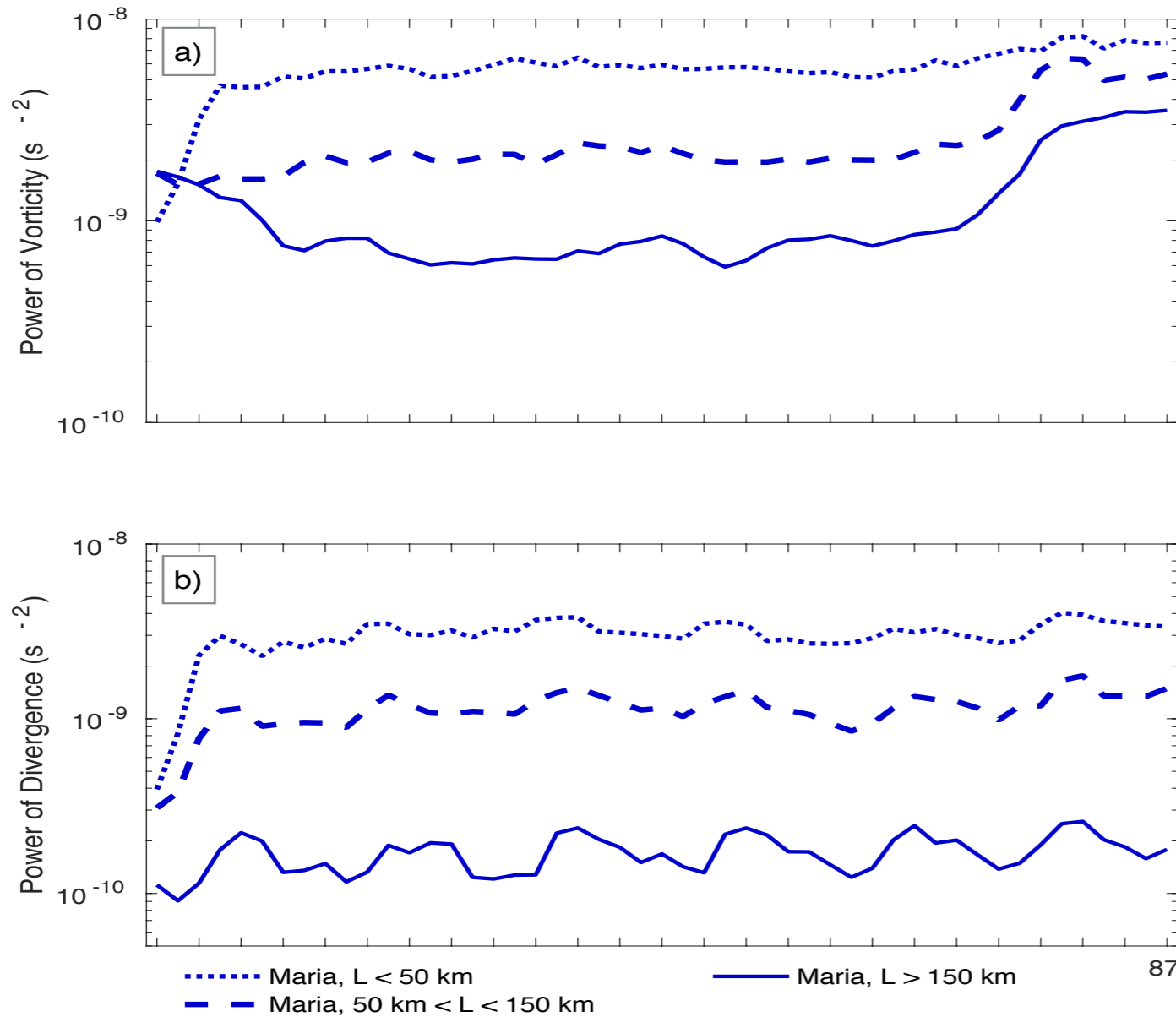


Hurricane Maria Simulation at CIMH

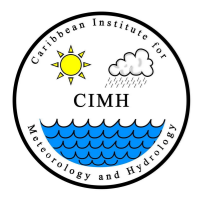


- Perturbation of Potential Temperature with RH overlay 90-km.
- Reflectivity with vertical velocity overlay 90-km.
- Relative vorticity with divergence overlay 90-km.

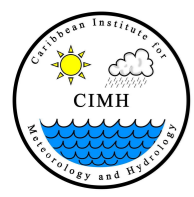
Hurricane Maria Simulation at CIMH



- Analysis are averaged over 12 hours prior to impact over Dominica.
- Less than 50-km represents cloud-scale
- 50 to 150-km represents mesoscale
- Greater than 150-km represents the system scale.
- The smaller scales make a greater contribution to the power of vorticity and divergence in a developing disturbance.

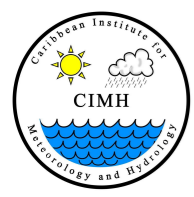


EUREC4A Experiments



Data Assimilation System

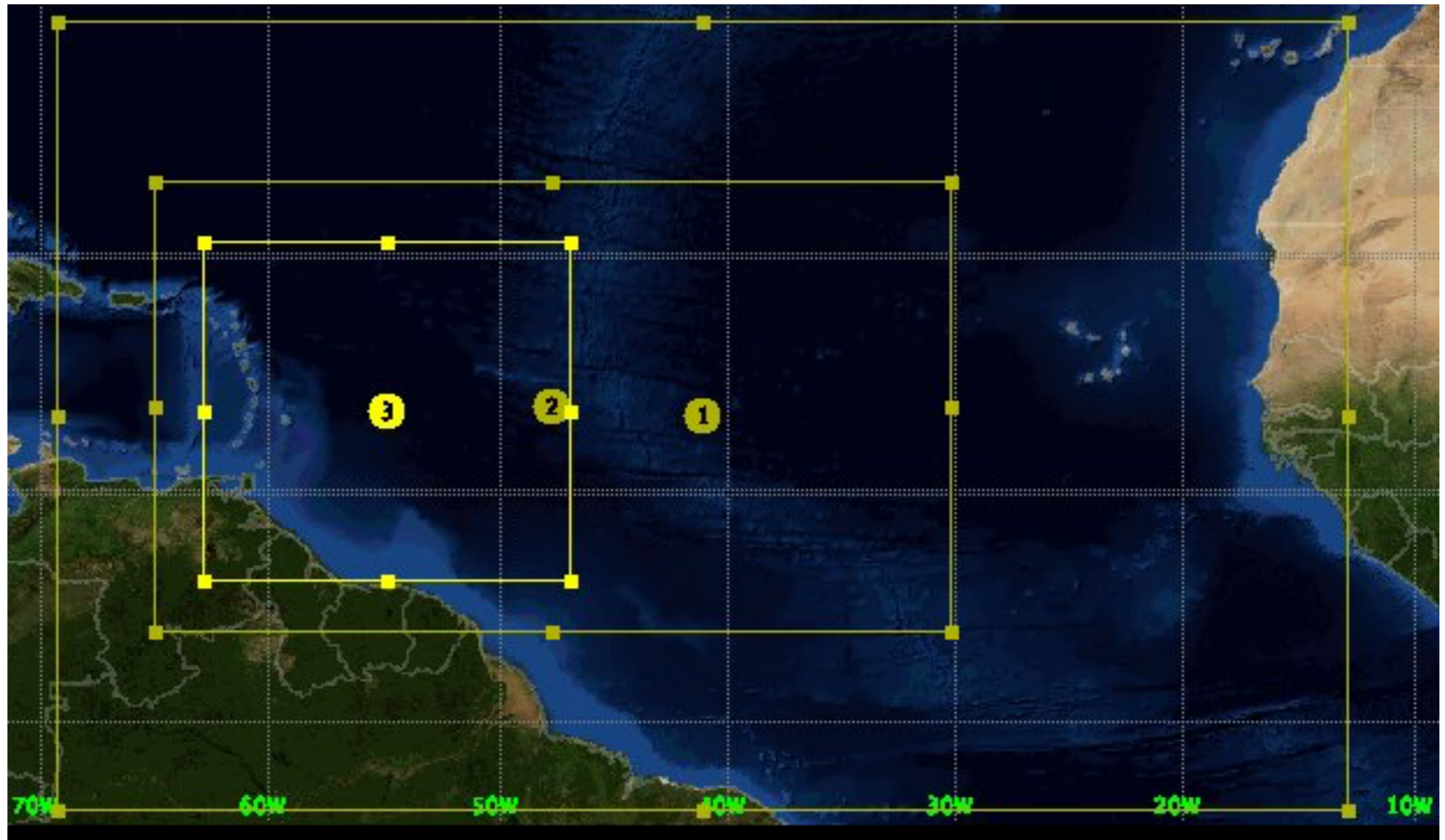
- 60 ensemble members
- Localization of 90 km in the horizontal & 15 levels in the vertical
- Relaxation coefficient of 0.8
- Two way coupling between EnKF and 3DVar
 - ▶ 3DVar uses ensemble mean first guess and ensemble perturbations
 - ▶ EnKF update the ensemble members
 - ▶ Hybrid 3DVar analysis replaces the EnKF analysis
- 80% of the increment comes from the ensemble perturbations during the hybrid minimization.

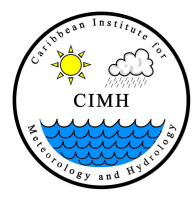


Model Setup

- Three domains with two-way nesting at 12-km, 4-km and 1.33-km grid spacing.
- 35 vertical levels together with a model top of 50 hPa.
- Explicit cumulus parameterization.
- Assimilation performed on 12-km domain.

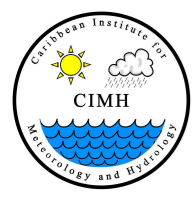
EUREC4A-CIMH Domain





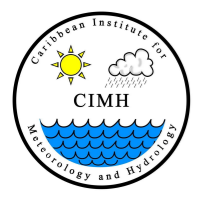
Experimental Design

- Experiments were initialized from GFS/GDAS analysis and cycled every 6 hours.
 - ▶ Assimilate satellite observations and routine ground base observations.
 - ▶ Dropsondes and Rawinsonde ship observations. (Radar observations assimilation will be added in the future)
 - ▶ Validate simulations against some Rawinsonde observations from ships



Expected Outcomes

- Improve model simulations at CIMH and by extent the region.
 - Lead to improve predictability of severe weather.
- Improve our understanding of cumulus convection and how it drives the climate system of the region.

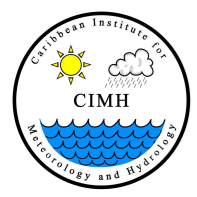


Acknowledgements

- Computational resources was provided by the Caribbean Centre for Climate and Environmental Simulations managed by the CIMH.
- Like to acknowledge the late Professor Fuqing Zhang and his entire research team for allowing me the opportunity to learn and use the PSU-EnKF code

<http://nmm.cimh.edu.bb/>

<http://www.cimh.edu.bb/>



Questions and Comments

