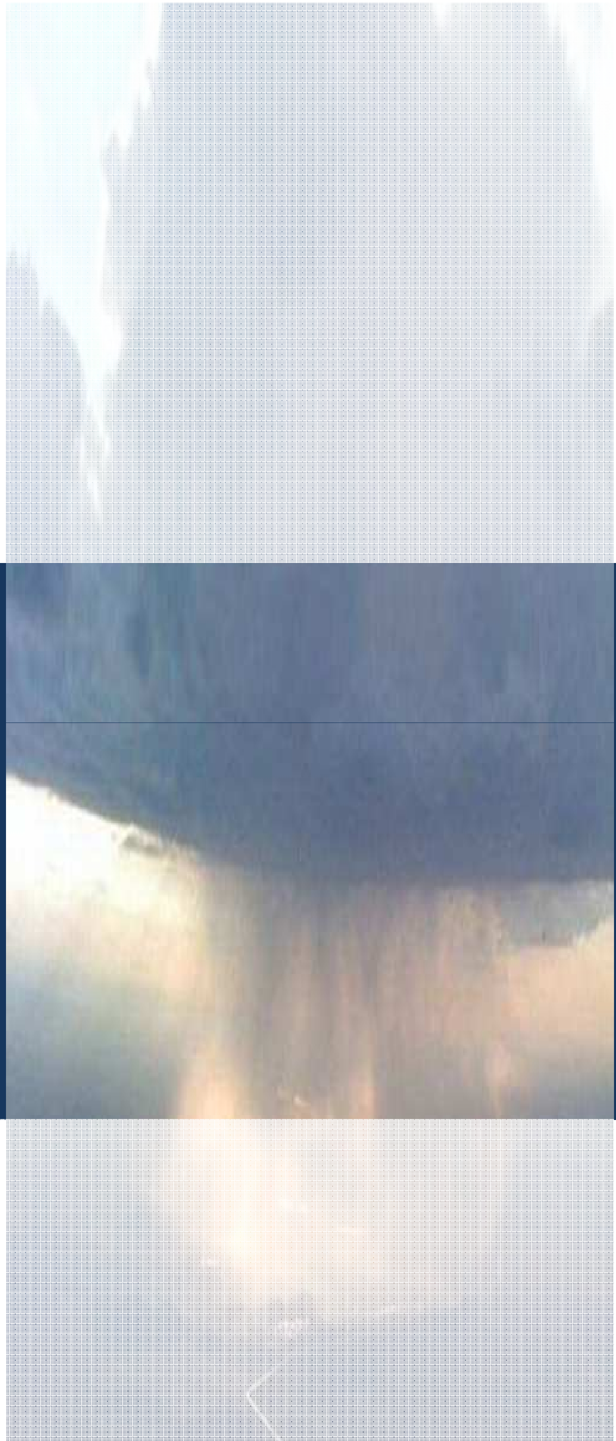
Tracking and Nowcasting of Hurricanes



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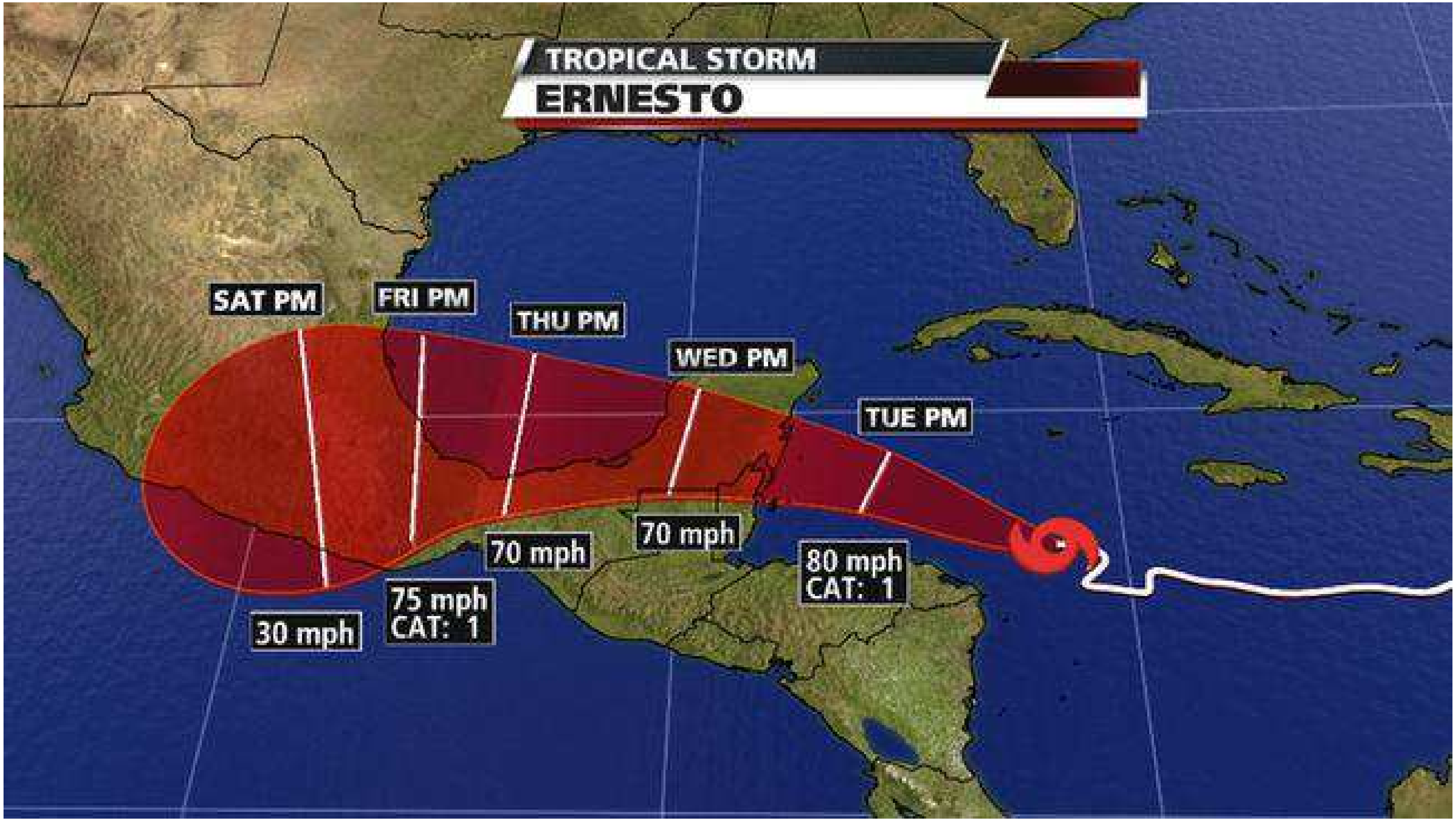
University of California, Irvine

3rd World Meteorological Organization (WMO) International Symposium on Nowcasting (WSN12)
6-10 August 2012, Rio de Janeiro, Brazil.

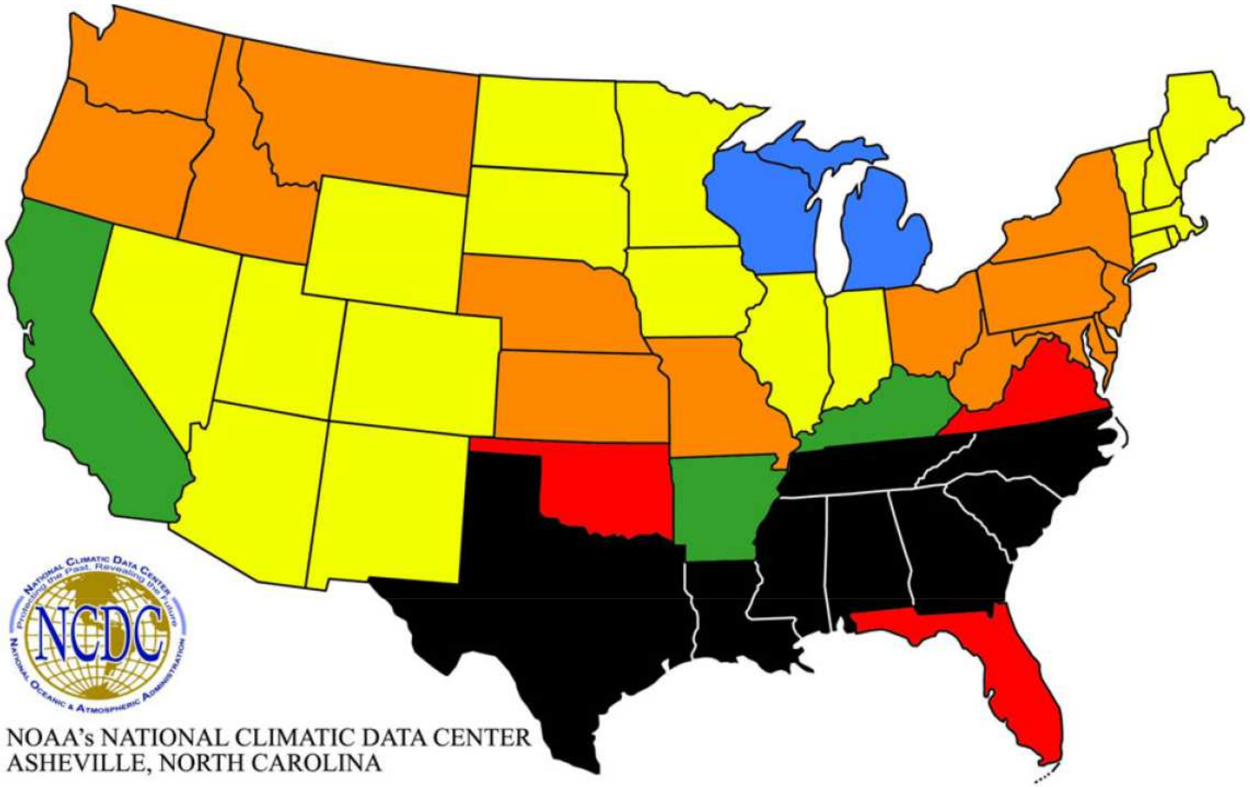
Tropical Storm Ernesto Heading for Yucatan Peninsula

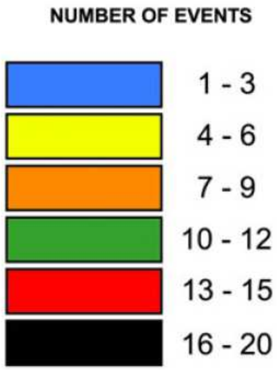
Landfall is expected as a hurricane CAT1



Source: Weather.com

U.S. Billion Dollar Weather Disasters, 1980-2005





DISASTER TYPE	NUMBER OF EVENTS	PERCENT FREQUENCY	NORMALIZED DAMAGES (Billions of Dollars)	PERCENT DAMAGE
Tropical Storms/Hurricanes	16	28.0%	102	29.2%
Non-Tropical Floods	12	21.0%	55	15.8%
Heatwaves/Droughts	10	17.0%	144	41.2%
Severe Weather	7	12.0%	13	3.7%
Fires	6	10.0%	13	3.7%
Freezes	2	3.5%	6	1.7%
Blizzards	2	3.5%	9	2.6%
Ice Storms	2	3.5%	5	1.4%
Noreaster	1	1.5%	2	0.7%
	58		349	

Source: NOAA/NCDC
(Lott and Ross, 2006)

U.S. Billion Dollar W 19

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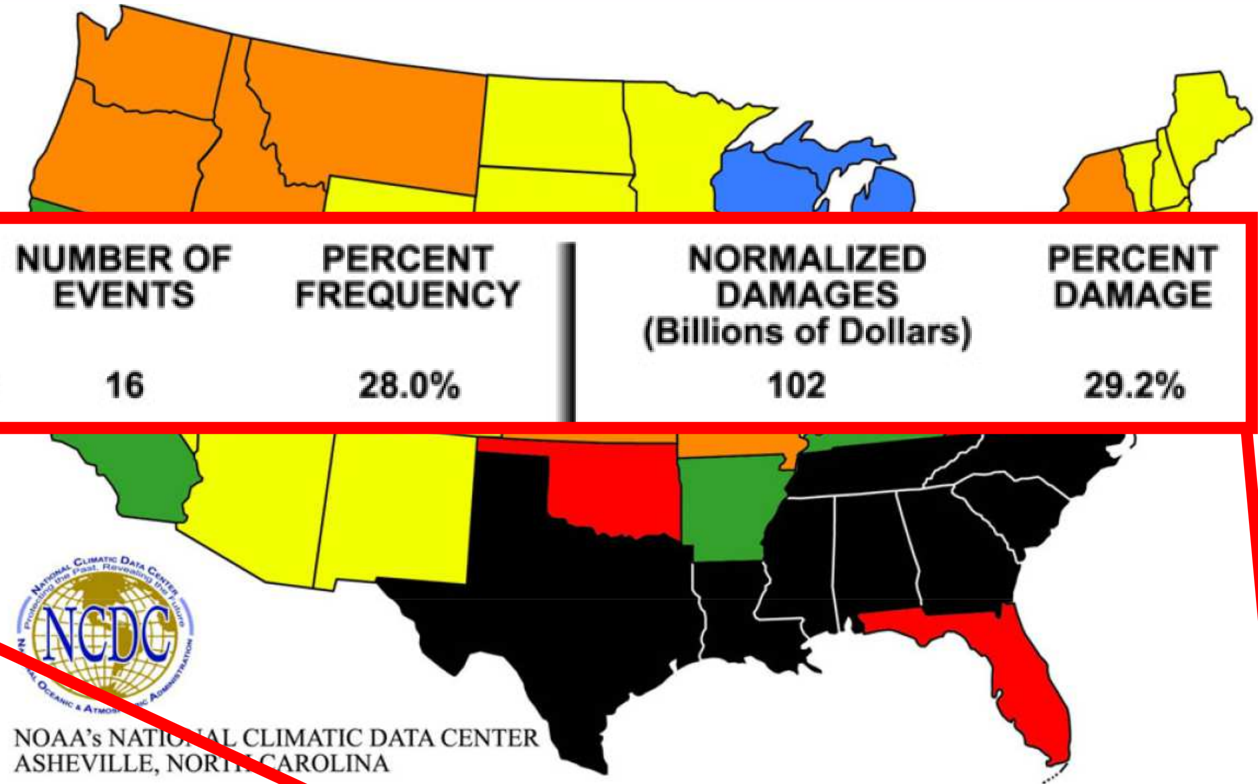

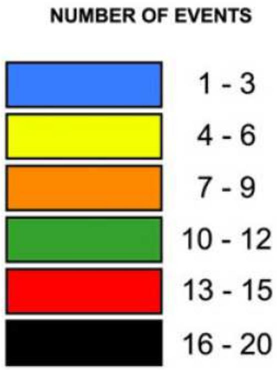

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Motivation

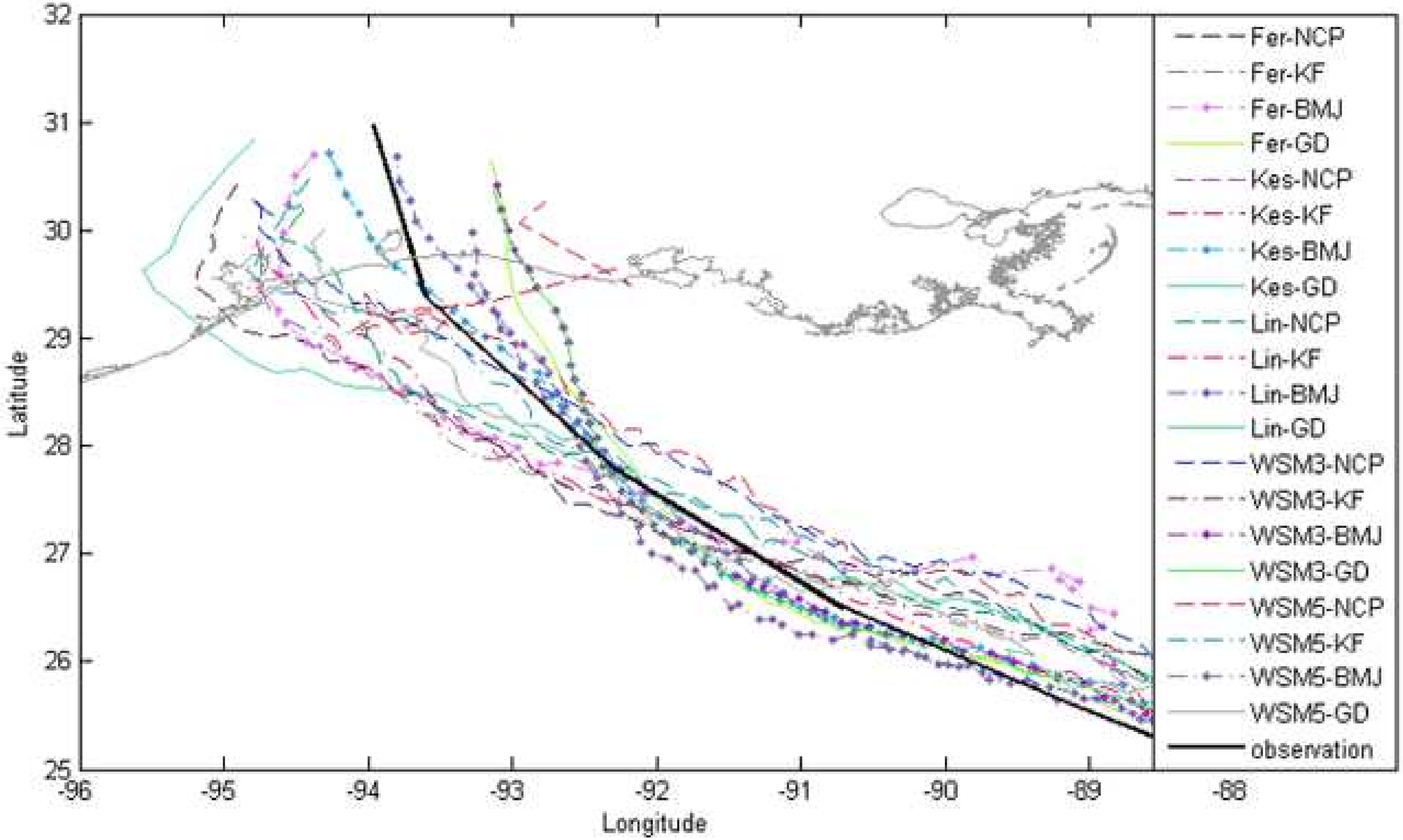
Dynamical, statistical and dynamical-statistical models used for hurricane track forecasting vary significantly in structure and level of complexity. Previous studies show that different modeling techniques have their own advantageous and disadvantageous (e.g., NHC, 2009).

In recent years, ensemble (consensus) models have become more popular. Ensemble models are obtained by combining the forecasts from a number of models or multiple simulations from a model with different parameterization, initial condition, etc.

Decision makers, however, may need to know which ensemble member is more likely to be true, particularly when the ensemble is spread out over a wider area.

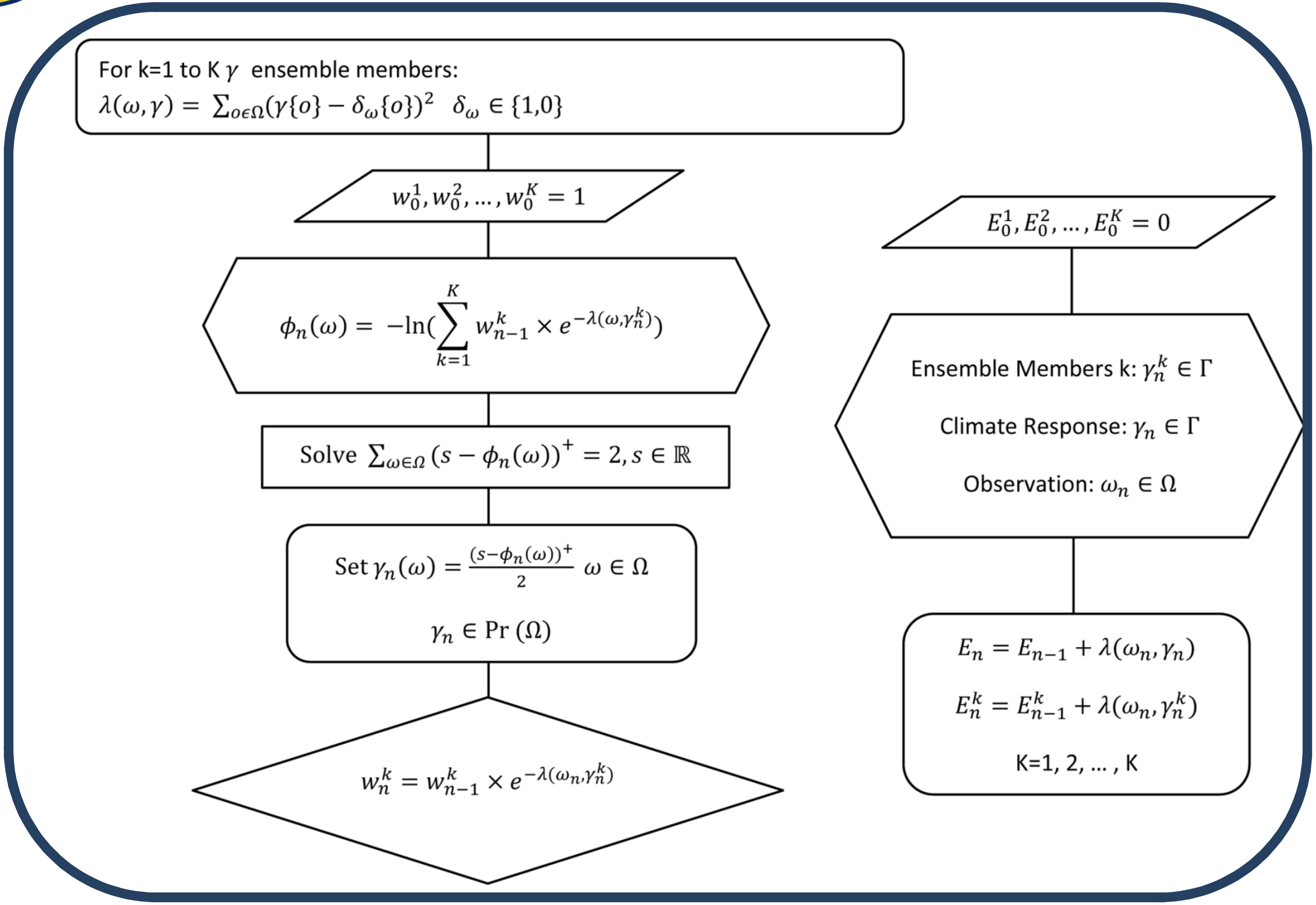
Motivation: Hurricane Rita

For example, Nasrollahi et al., 2012 showed that differences of a 20-member ensemble of Hurricane Rita at landfall were nearly 3 degrees.

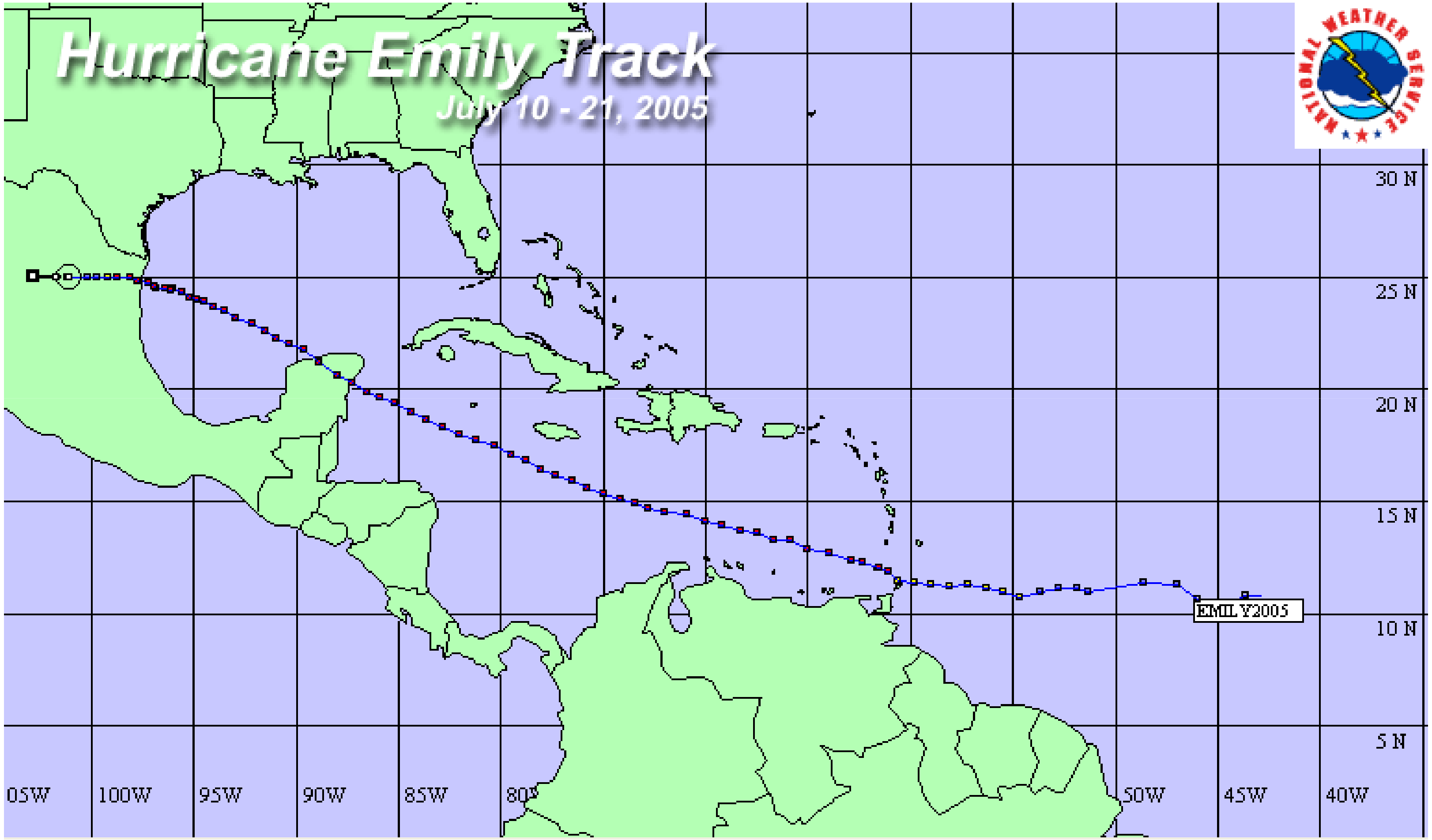


Nasrollahi N., AghaKouchak A., Li J., Gao X., Hsu K., Sorooshian S., 2012, Assessing the impacts of different WRF parameterization schemes in hurricane modeling, *Weather and Forecasting*, doi:10.1175/WAF-D-10-05000.1.

Ensemble Response Using Expert Advice (EA) Algorithm

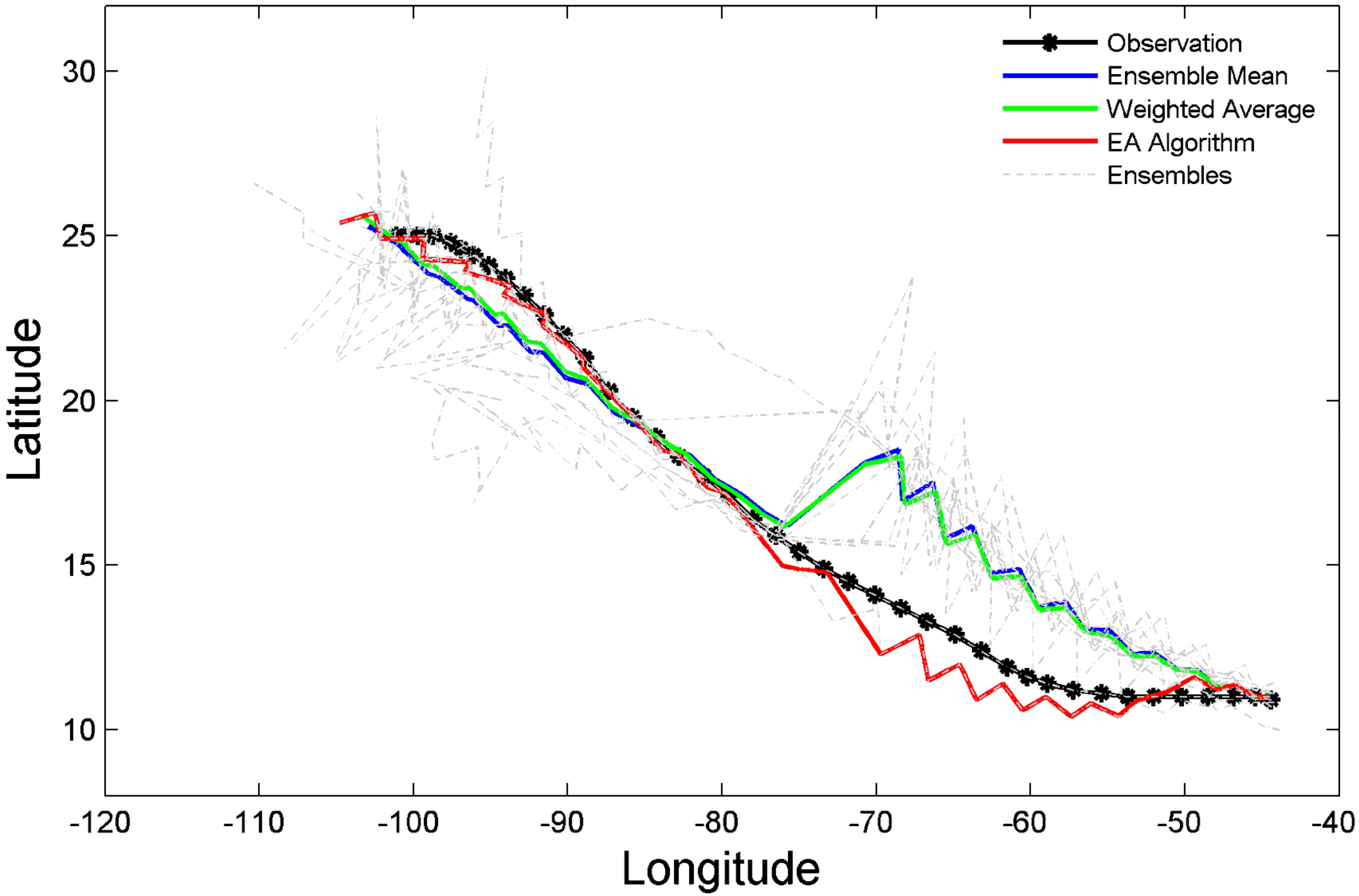


Hurricane Tracking: Emily 2005



Source: National Hurricane Center (NHC), NOAA

Hurricane Tracking: Emily 2005

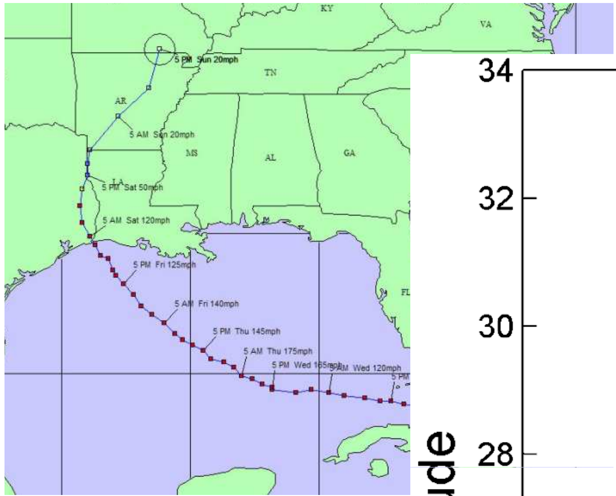


Acknowledgement: Hurricane track observations and model simulations are provided by James Francklin of the NOAA, National Hurricane Center (NHC)

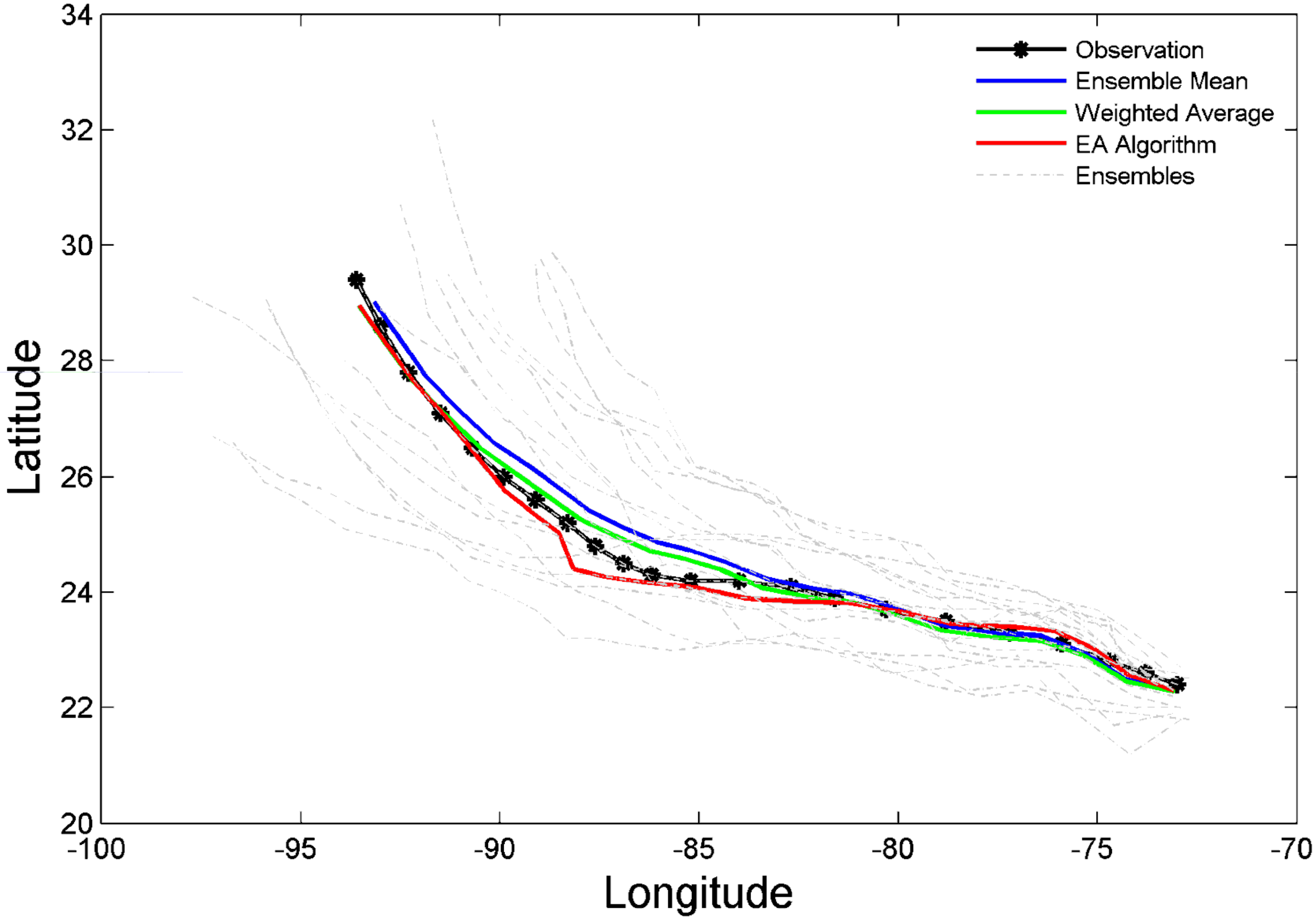
Hurricane Tracking: Rita 2005

Source: National Hurricane Center (NHC), NOAA

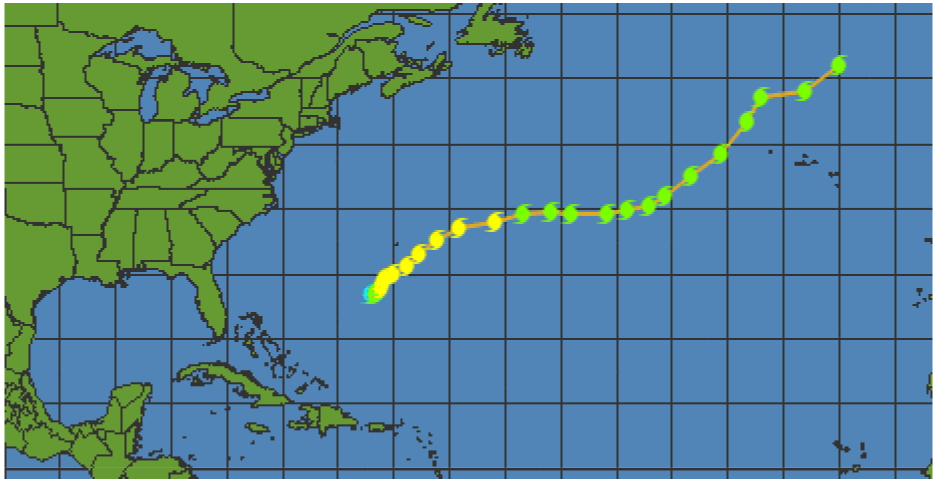
Hurricane Tracking: Rita 2005



Source: National Hurricane Cen

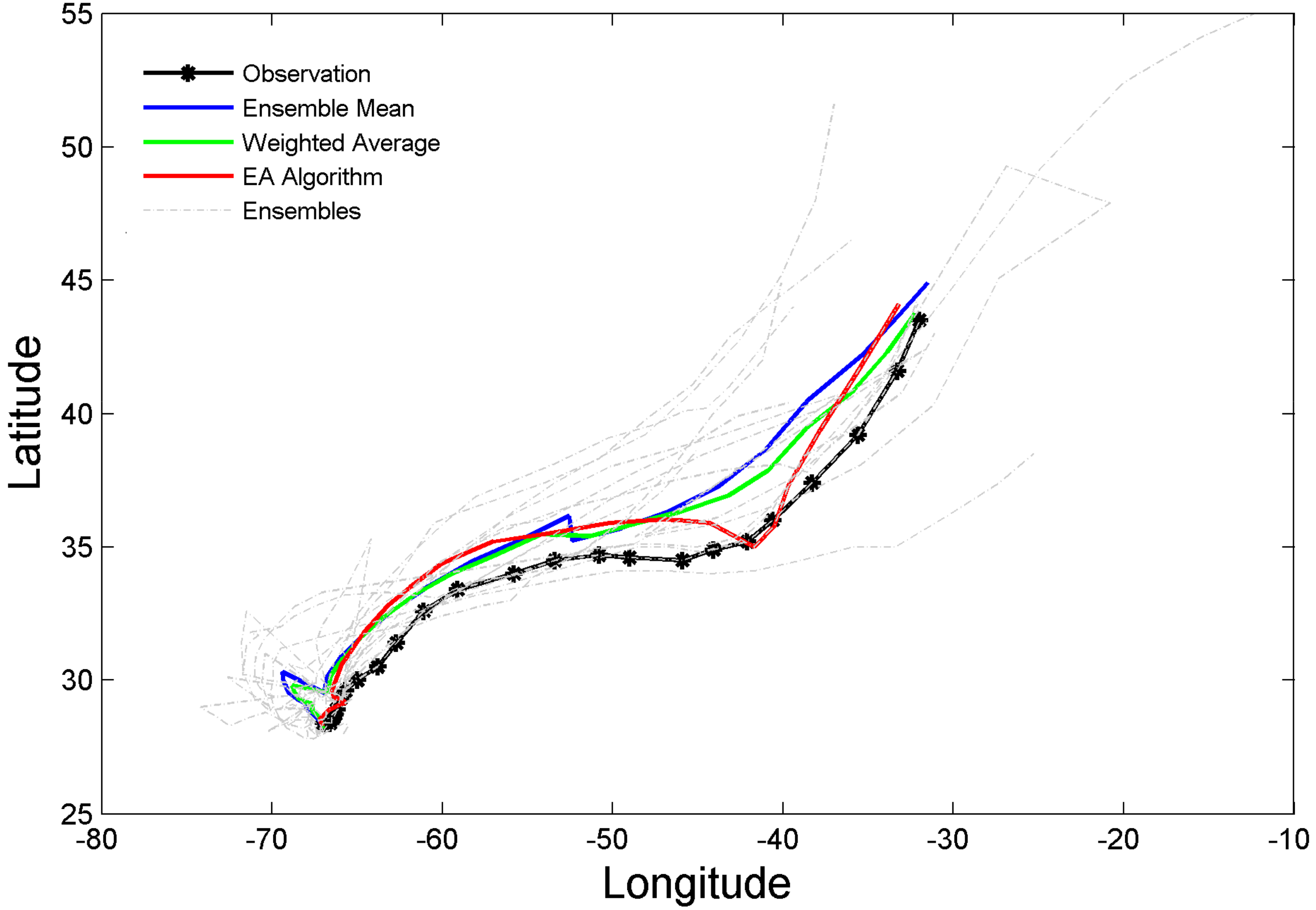


Hurricane Tracking: Nate 2005

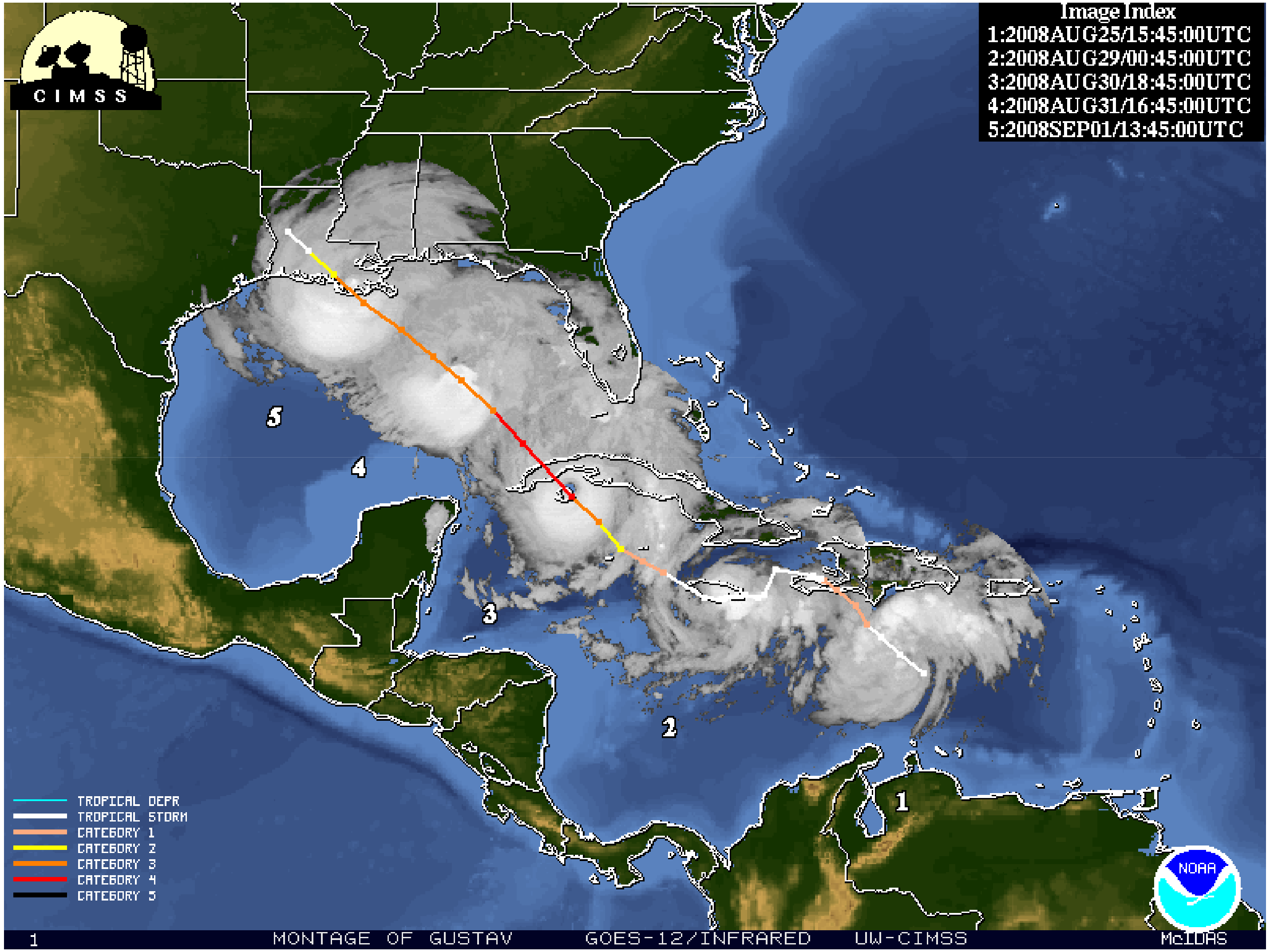


Source: Weather Underground

Hurricane Tracking: Nate 2005

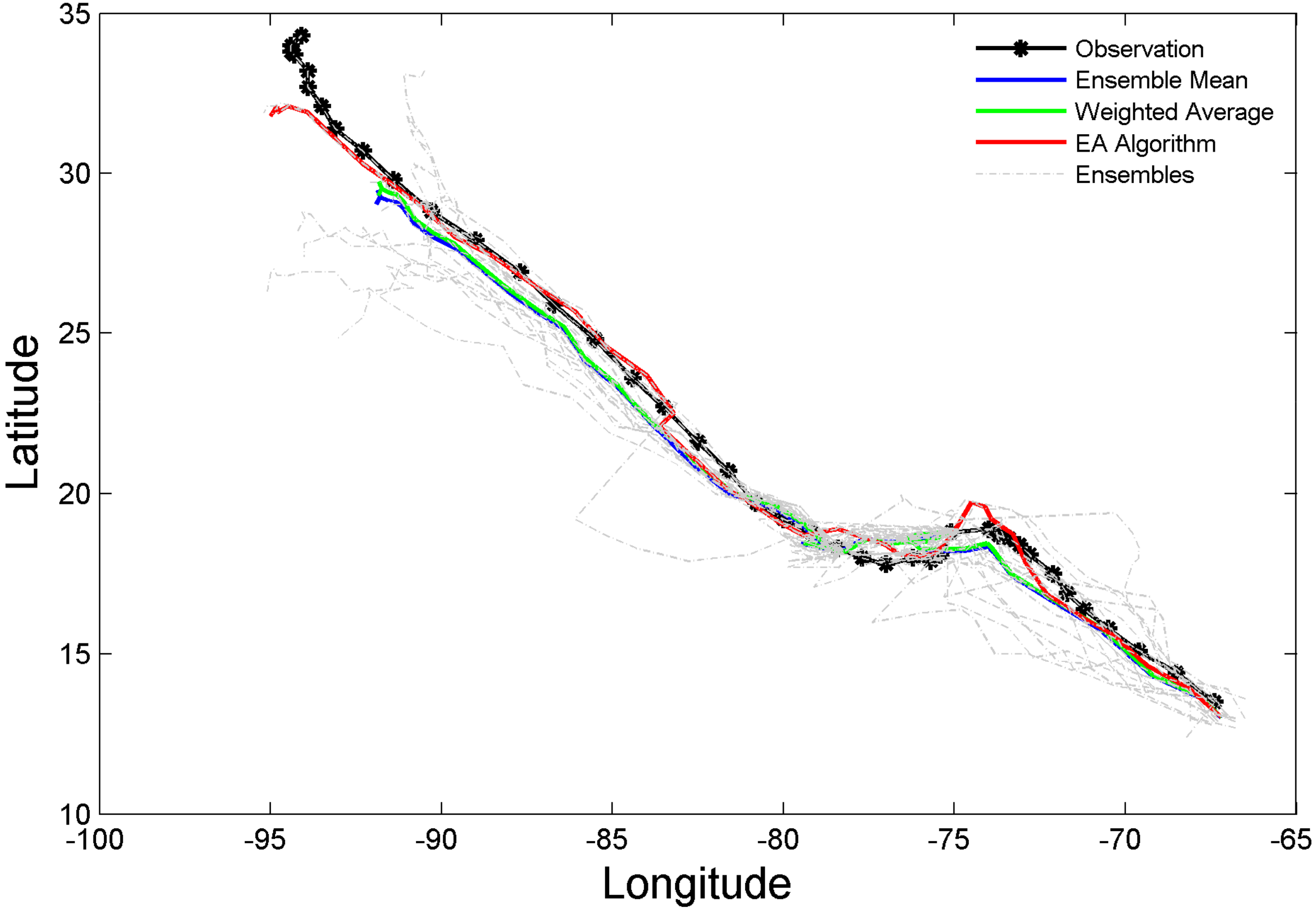


Hurricane Tracking: Gustav 2008

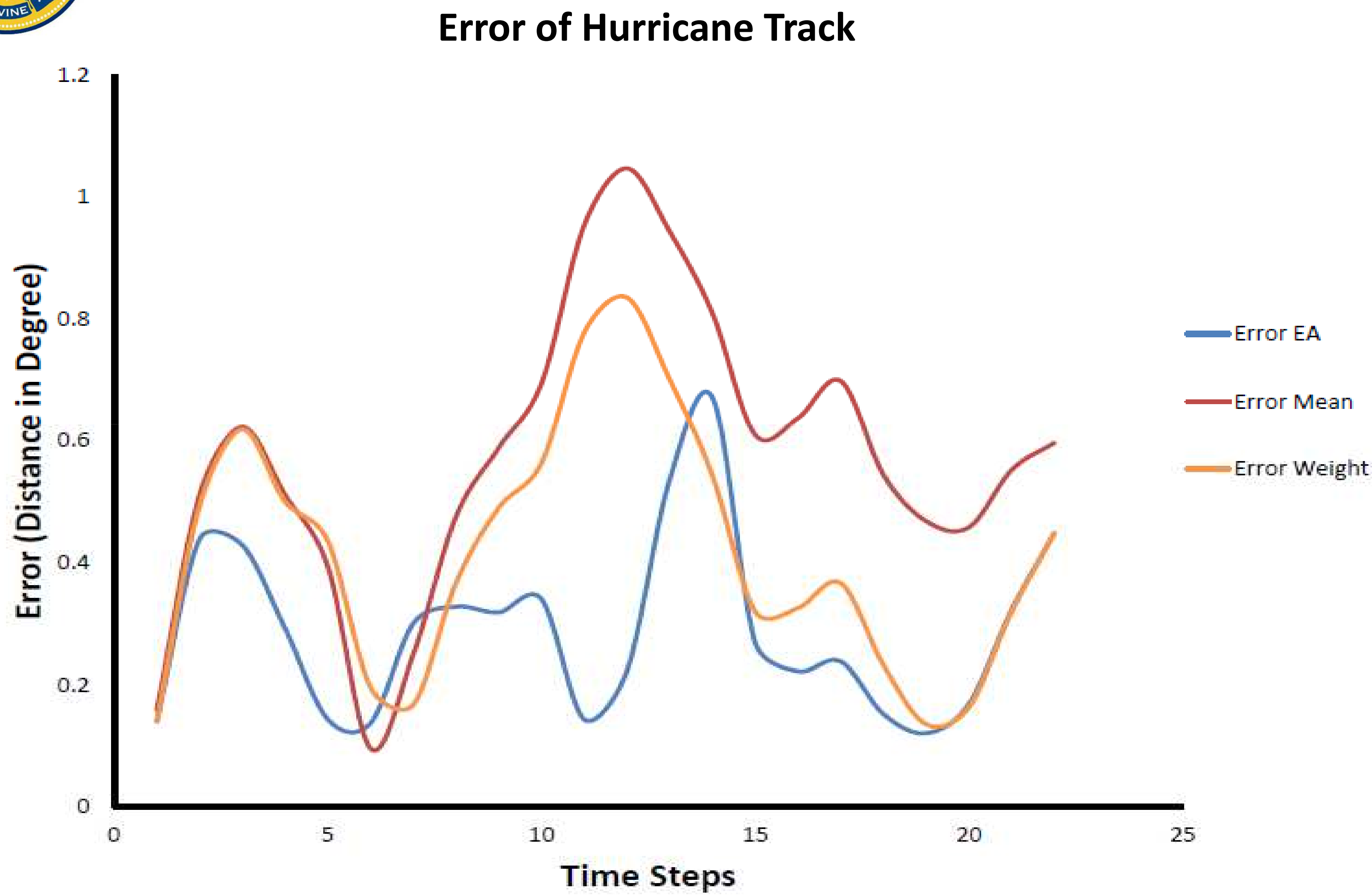


Source: NOAA

Hurricane Tracking: Gustav 2008



Hurricane Tracking: Rita 2005



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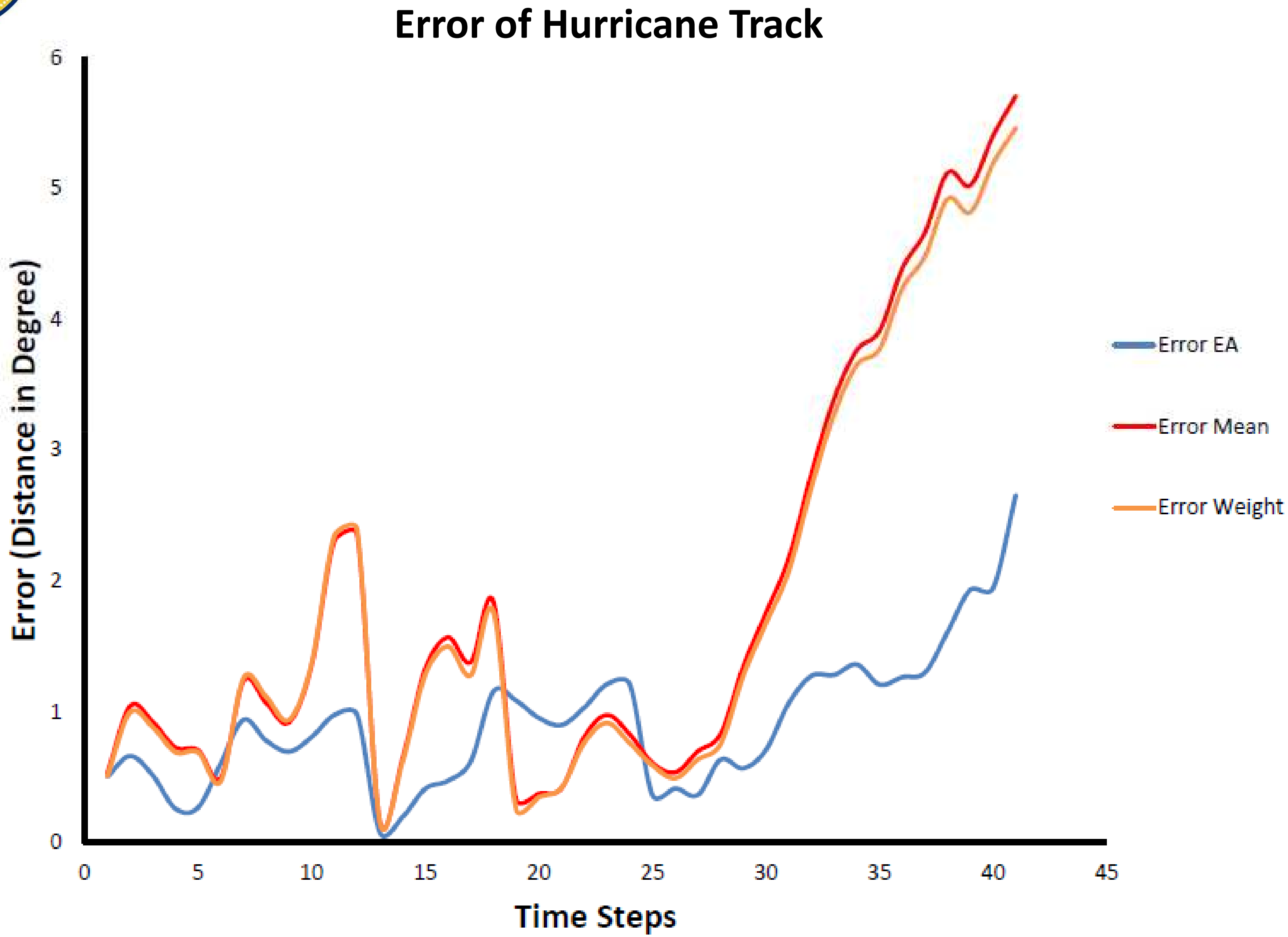
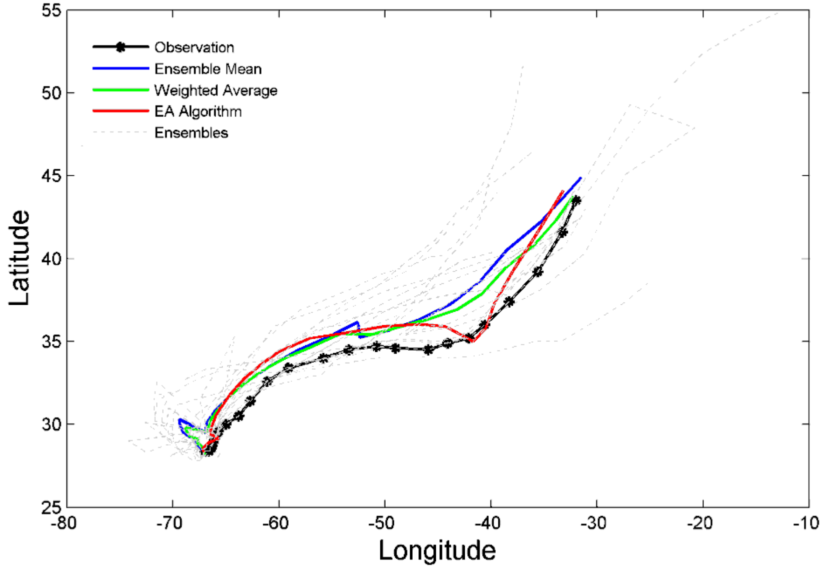
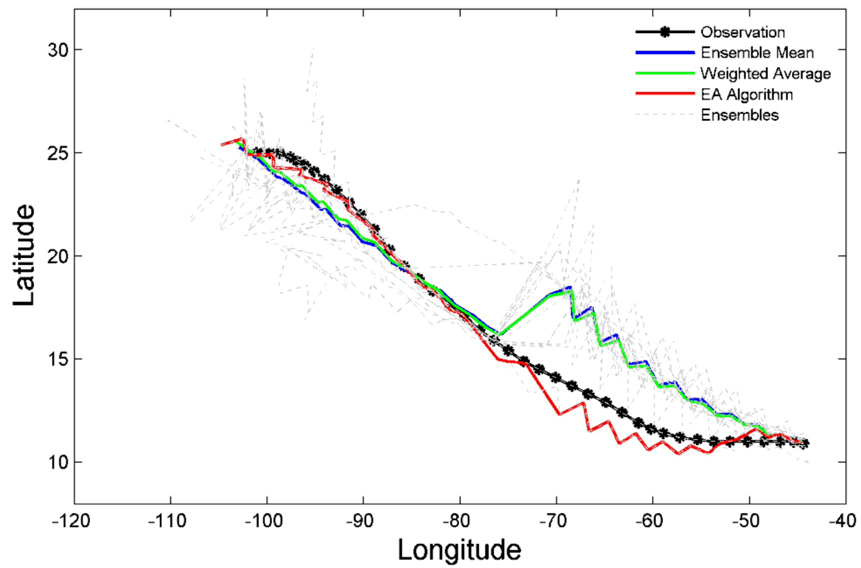
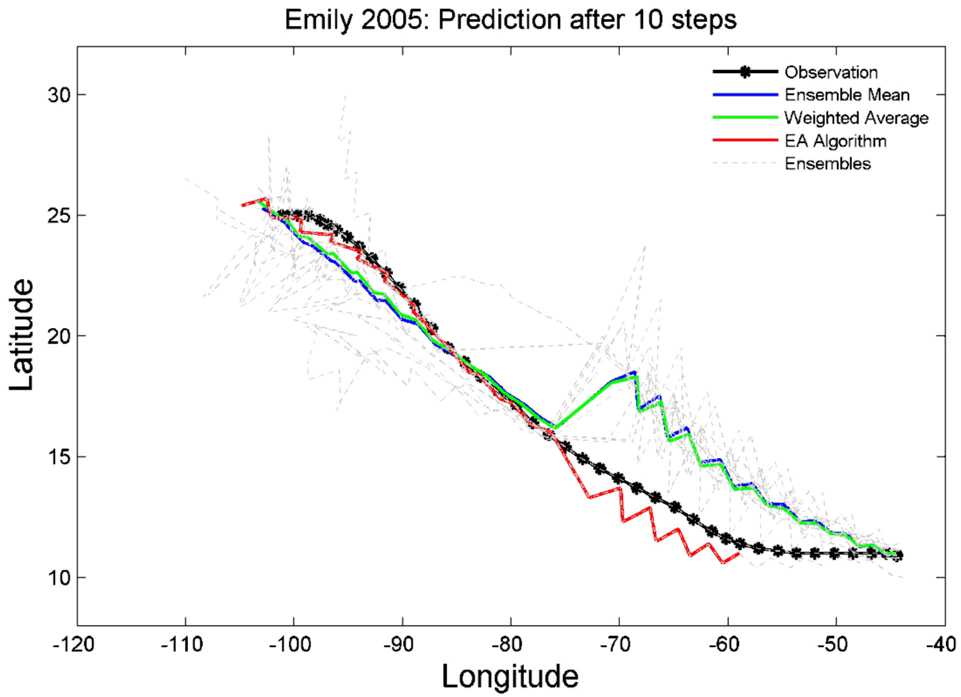




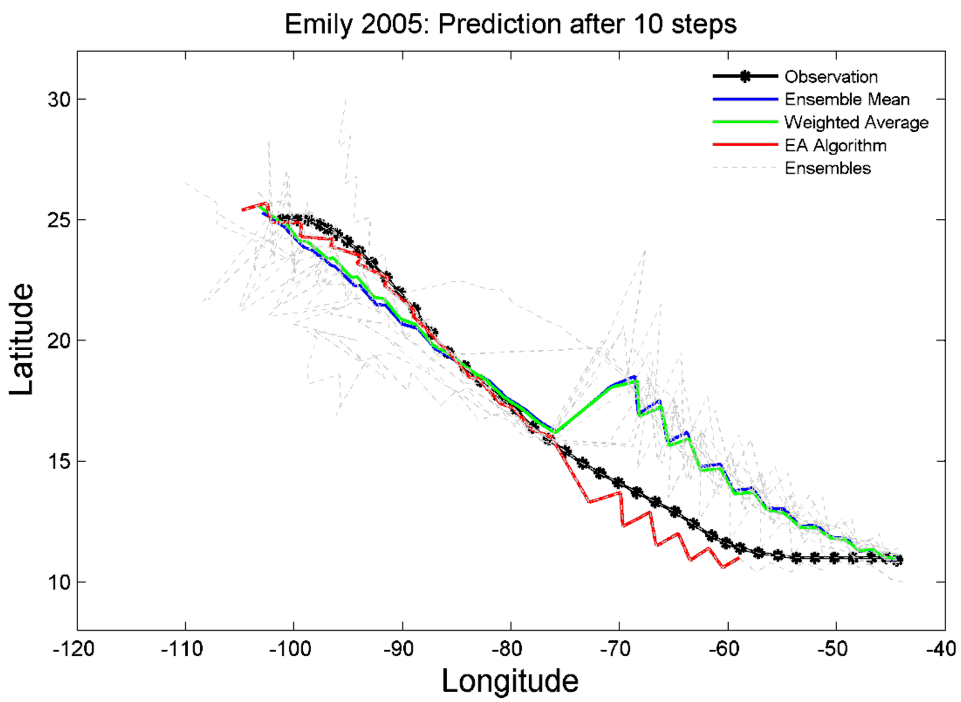


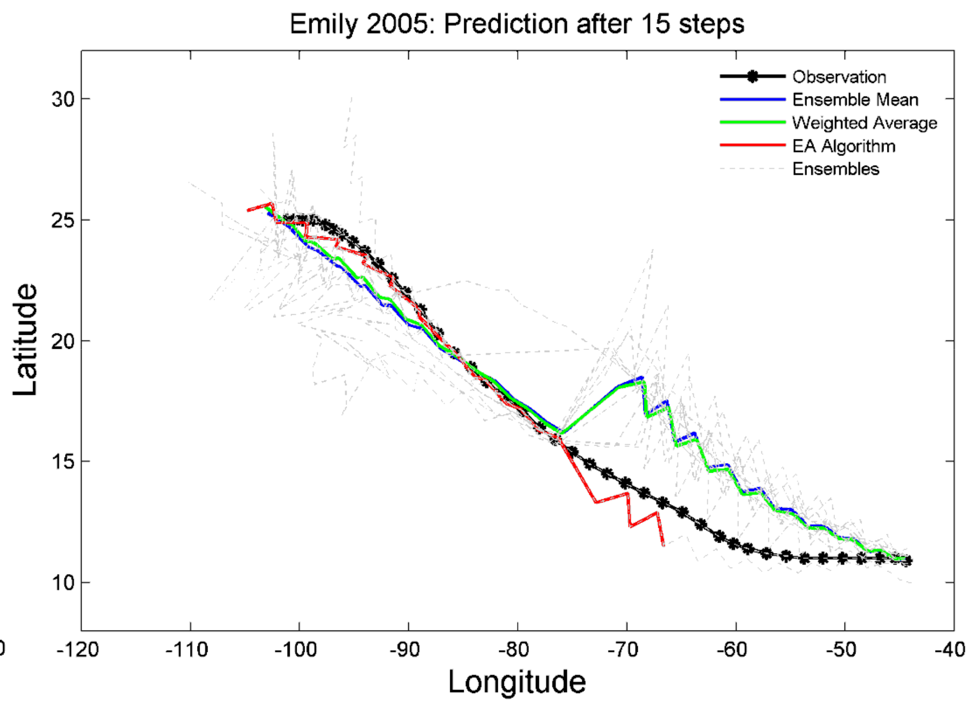
Predictability of EA Algorithm and Nowcasting

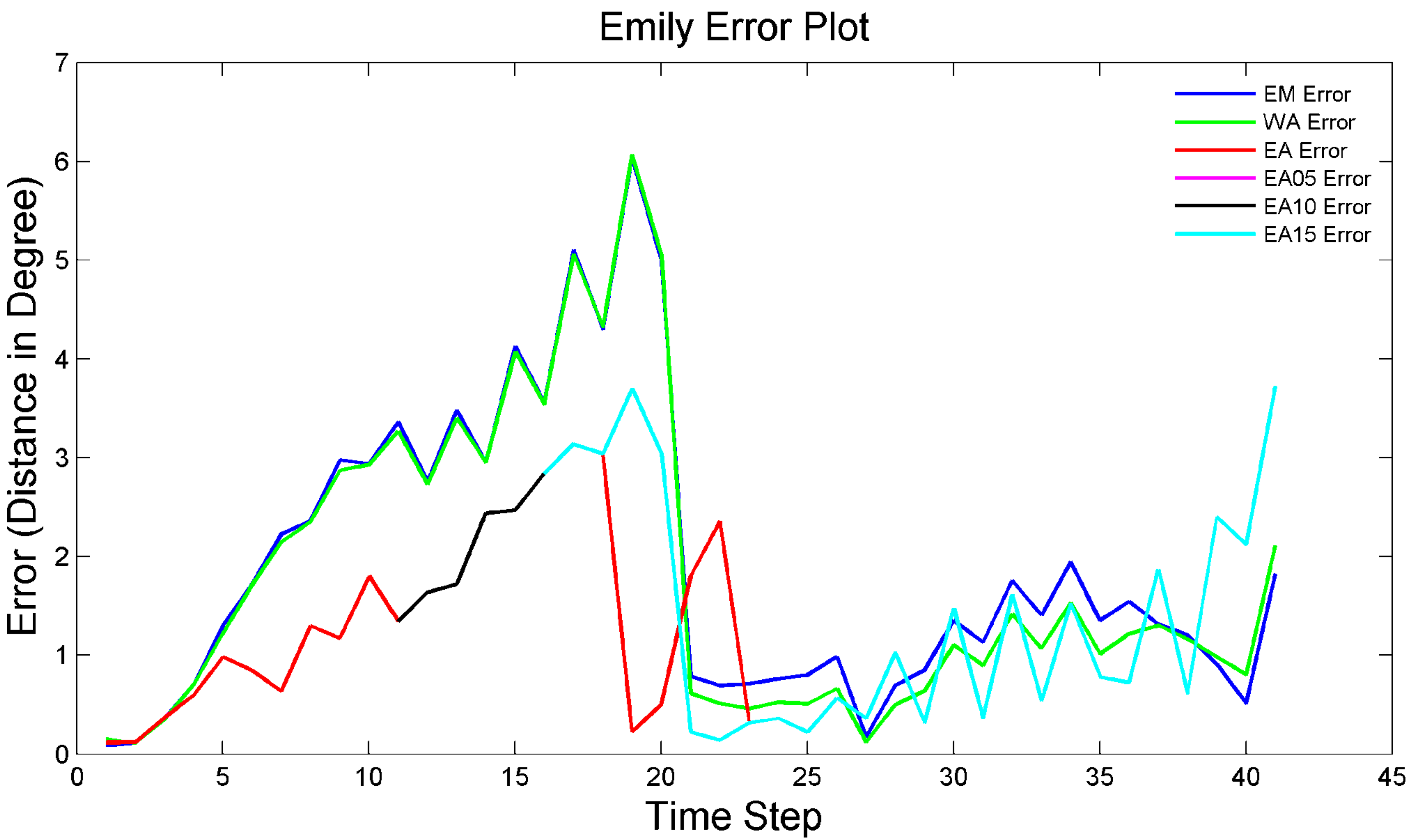
Predictability and Nowcasting



Predictability and Nowcasting






Emily Error Plot
Error (Distance in Degree)
Time Step
EM Error
WA Error
EA Error
EA05 Error
EA10 Error
EA15 Error
0
1
2
3
4
5
6
7
0
5
10
15
20
25
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35
40
45

Mean error of hurricane tracking using ensemble weighted average (WA) and expert advice (EA) algorithm methods in degree distance from observations

	WA 5	WA 10	EA 5	EA 10
Hurricane Rita	0.61			
Hurricane Gustav	1.97			

Mean error of hurricane tracking using ensemble weighted average (WA) and expert advice (EA) algorithm methods in degree distance from observations

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Hurricane Rita	0.61	0.50	**0.50**	**0.50**
Hurricane Gustav	1.97	2.07	**1.04**	**1.58**

Summary and Conclusions

A data fusion technique (Expert Advice Algorithm) is used to derive the response of ensemble hurricane simulations.

The results showed that merging simulations using the EA algorithm leads to less error compared to ensemble mean and weighted average in hurricane track analysis.

Overall, the EA algorithm was superior to the arithmetic mean and weighted average of ensemble simulations. This indicates that the EA algorithm can be used in real-time for nowcasting of hurricane tracks as simulations become available.

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