Analyzing the Performance of Different Parameter Settings with the Ensemble Nowcasting of Tropical Cyclone Precipitation

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Introduction

- One of the deadliest hazards associated with landfalling tropical cyclones is flash flooding[2].
- The stagnation of progress in extending flash flood warning lead times over the past decade[1] remains a concern in the effort to protect life and property.
- To address this problem, this research tests a precipitation nowcasting scheme using MRMS precipitation data for two tropical cyclone case studies.

Methodology

- Hurricane Ian (2022) and Henri (2021) were selected as case studies.
- The Short-Term Ensemble Prediction System (STEPS) produced the nowcasts with the input MRMS data.
- A variety of case parameter value combinations produced unique performance statistics – revealing which values produce the most accurate nowcasts.

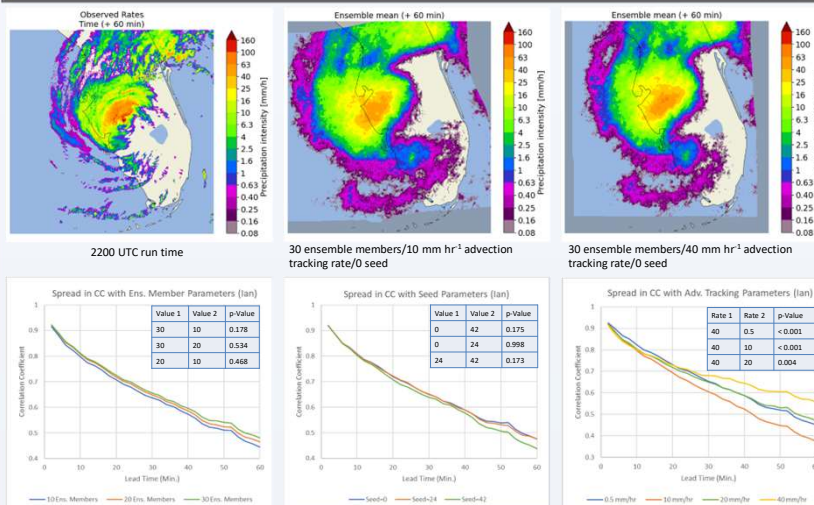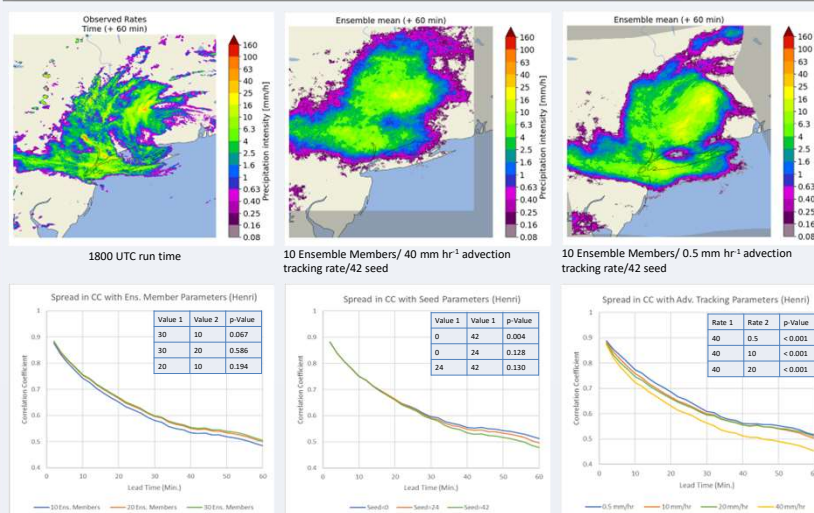| Case Parameter	Values Tested			
Advection Tracking Rate	0.5 mm hr^{-1}	10 mm hr^{-1}	20 mm hr^{-1}	40 mm hr^{-1}
Ensemble Members	10	20	30	
Seed Value	0	24	42	

Figure 1

Figure 2

Fig. 1: Track of Hurricane Ian with analyzed region (boxed).

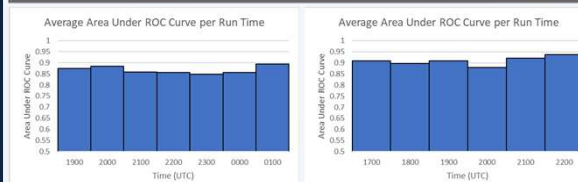Fig. 2: As in Fig. 1, but for Hurricane Henri.

Results from Ian Case Study

Observed Rates Time (+ 60 min) — 2200 UTC run time

Ensemble mean (+ 60 min) — 30 ensemble members/10 mm hr^{-1} advection tracking rate/0 seed

Ensemble mean (+ 60 min) — 30 ensemble members/40 mm hr^{-1} advection tracking rate/0 seed

Spread in CC with Ens. Member Parameters (Ian)

Value 1	Value 2	p-Value
30	10	0.178
30	20	0.534
20	10	0.468

Spread in CC with Seed Parameters (Ian)

Value 1	Value 2	p-Value
0	24	0.175
0	42	0.998
24	42	0.173

Spread in CC with Adv. Tracking Parameters (Ian)

Rate 1	Rate 2	p-Value
40	0.5	< 0.001
40	10	< 0.001
40	20	0.004

Results from Henri Case Study

Observed Rates Time (+ 60 min) — 1800 UTC run time

Ensemble mean (+ 60 min) — 10 Ensemble Members/ 40 mm hr^{-1} advection tracking rate/42 seed

Ensemble mean (+ 60 min) — 10 Ensemble Members/ 0.5 mm hr^{-1} advection tracking rate/42 seed

Spread in CC with Ens. Member Parameters (Henri)

Value 1	Value 2	p-Value
30	10	0.067
30	20	0.586
20	10	0.194

Spread in CC with Seed Parameters (Henri)

Value 1	Value 2	p-Value
0	42	0.004
0	24	0.128
24	42	0.130

Spread in CC with Adv. Tracking Parameters (Henri)

Rate 1	Rate 2	p-Value
40	0.5	< 0.001
40	10	< 0.001
40	20	< 0.001

Hourly Run-to-Run Consistency

Average Area Under ROC Curve per Run Time

- Results from Ian (left) and Henri (right) indicate a high level of consistency in nowcast performance between run times.

Main Takeaways from Case Study Results

- Changes in advection tracking thresholds produced the greatest differences in nowcast performance.
- The most ideal advection tracking threshold differed for the two case studies. This is likely due to the widely varying precipitation field characteristics between them.
- The number of ensemble members and seed value were less critical, with small spreads in performance with changes in these values.
- Overall, a high potential for usefulness in flash flood warning prediction exists with this nowcasting scheme, but more testing is required.

Future Work

- Further case and parameter testing, including resolution and velocity perturbations, have been performed since this study (Martinaitis, Wednesday at 8:45 AM).

References

[1]Martinaitis, S. M., and Coauthors, 2023: A path toward short-term probabilistic flash flood prediction. *Bull. Amer. Meteor. Soc.*, **104**, E585–E605, https://doi.org/10.1175/BAMS-D-22-0026.1.

[2]Rappaport, E. N., 2014: Fatalities in the United States from Atlantic tropical cyclones: new data and interpretation. *Bull. Amer. Meteor. Soc.*, **95**, 341–346, https://doi.org/10.1175/BAMS-D-12-00074.1.