

Re-envisioning Hurricane Predictions using Ensemble Displays

Workshop on
Visualization for Decision Making Under Uncertainty
IEEE Vis 2015
October 26, 2015

Donald House and Le Liu
Clemson University

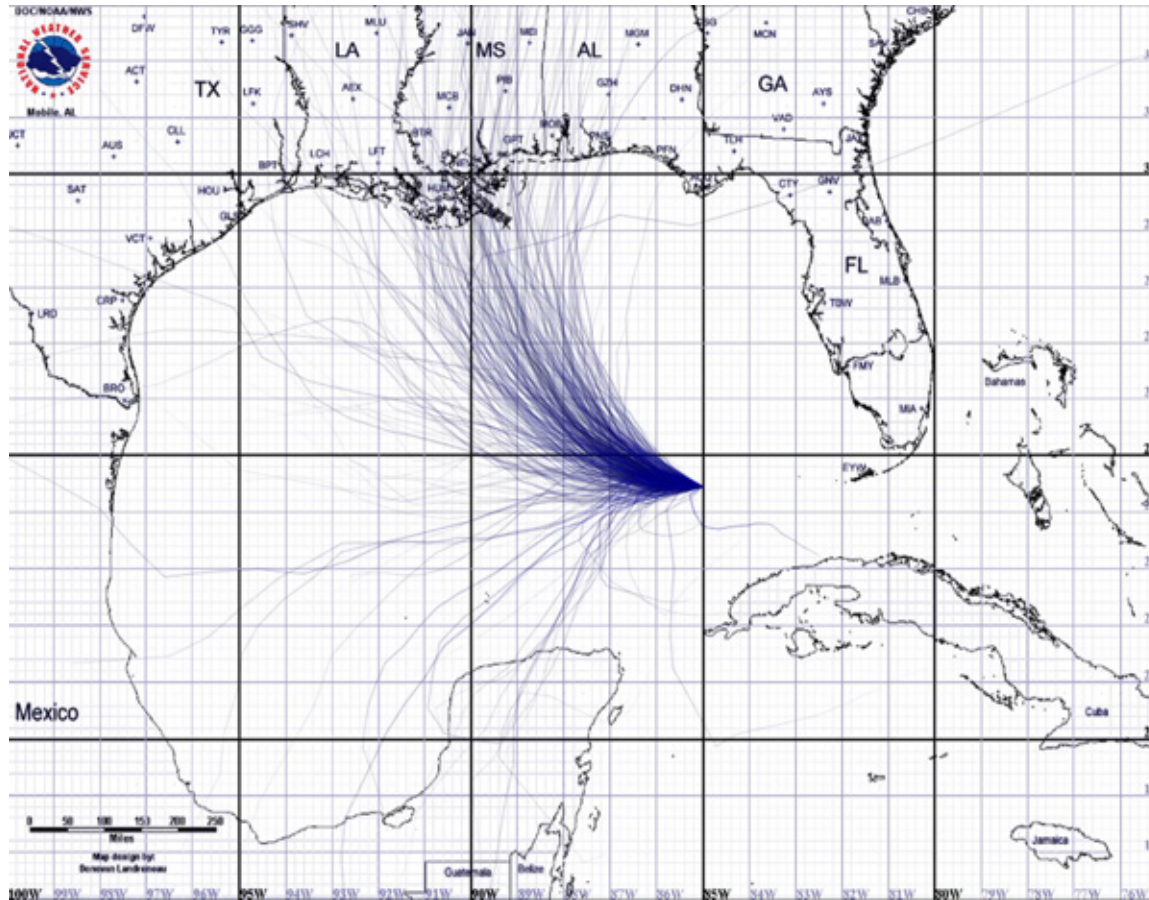
Key point of the talk:

There are cases where ensembles, representing a prediction, can intuitively convey the uncertainty without requiring an explicit summary representation.

Uncertainty cone –NHC prediction summary

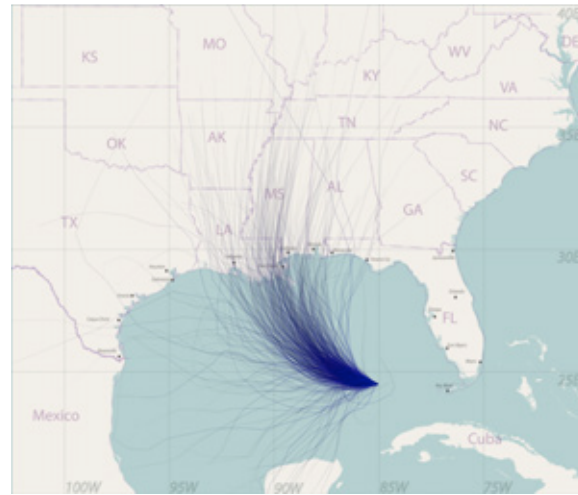
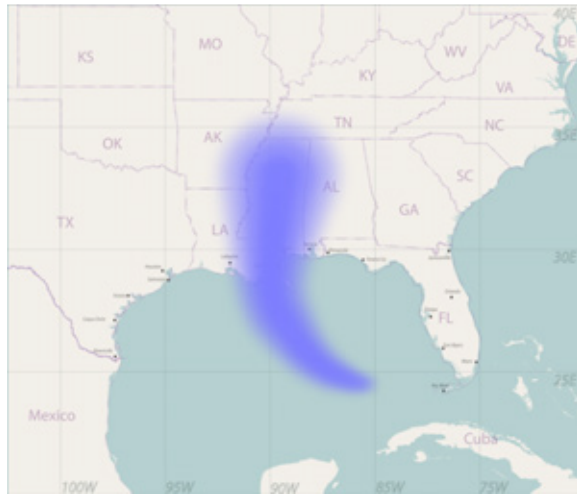
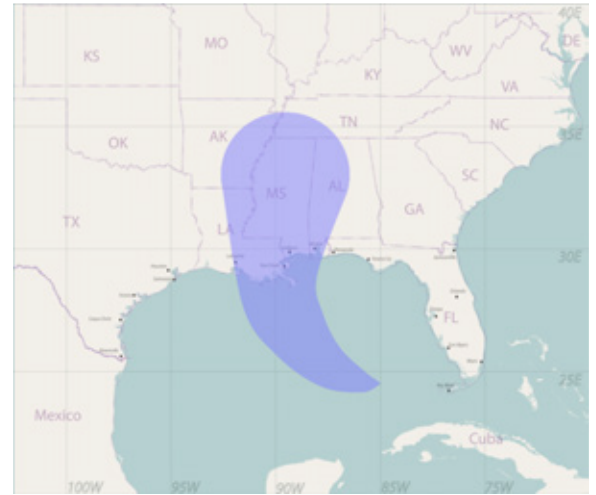
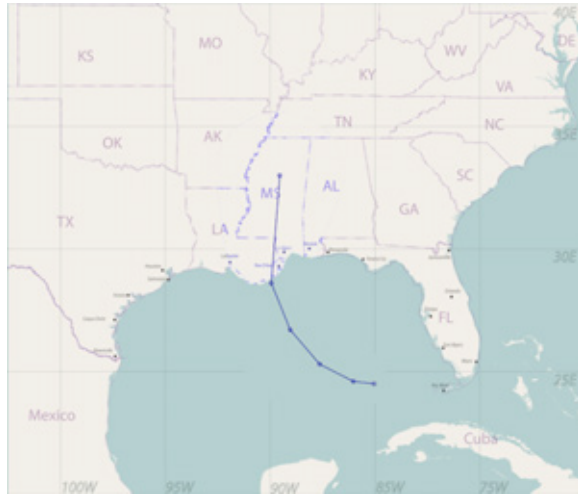
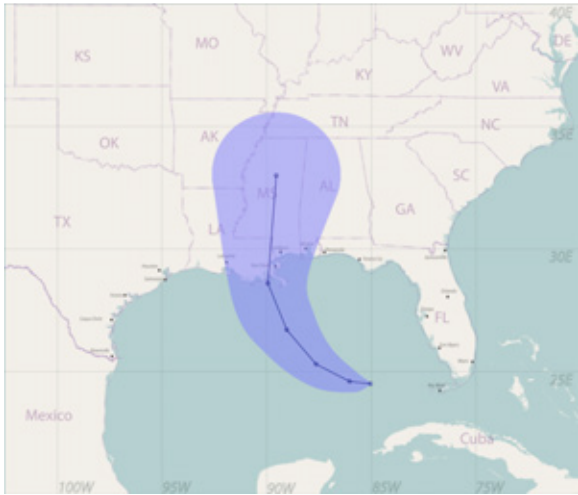


Path ensemble display

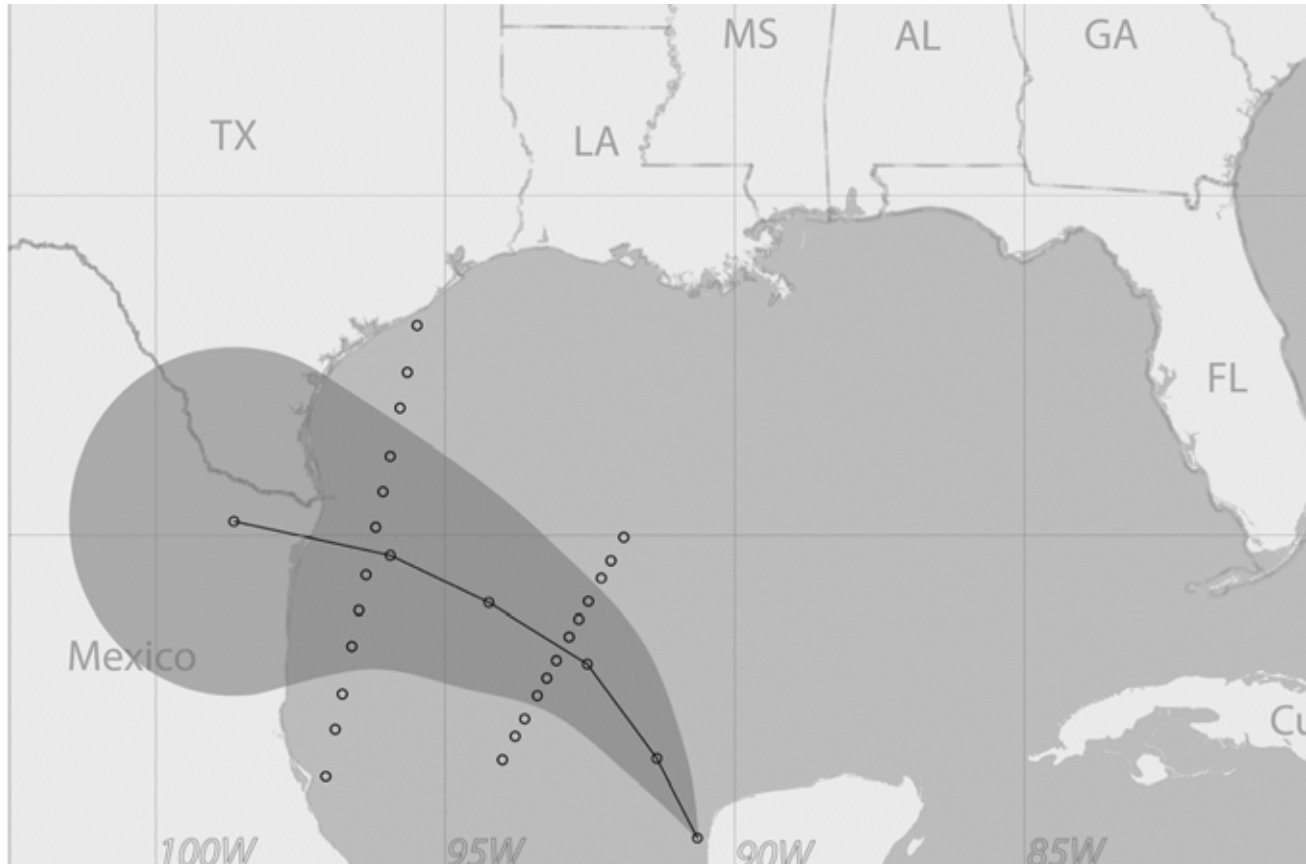


Cox, House, Lindell, *Visualizing uncertainty in predicted hurricane tracks*,
International Journal of Uncertainty Quantification, vol. 3, no. 2, pp143-156, 2013

Conditions in a recent empirical study examining damage estimation vs. display type

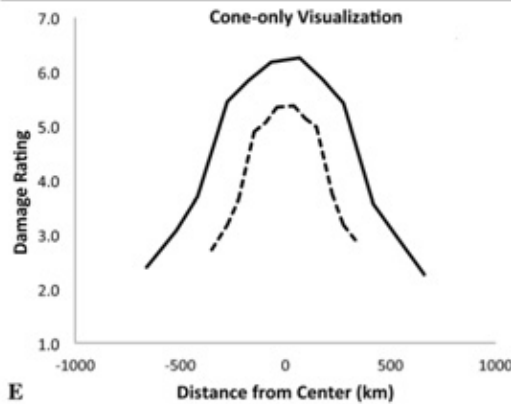
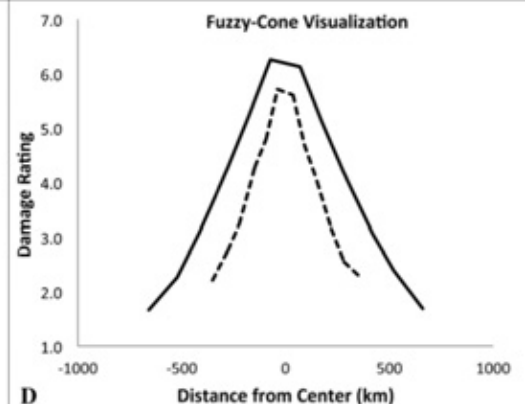
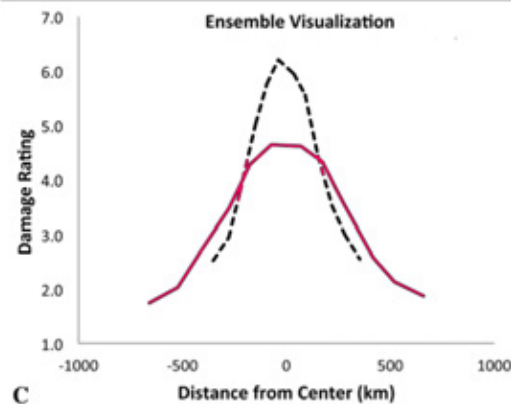
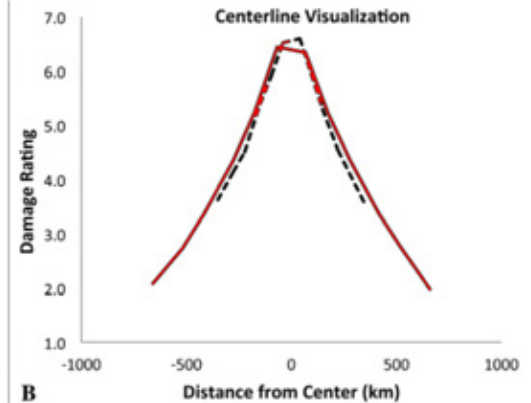
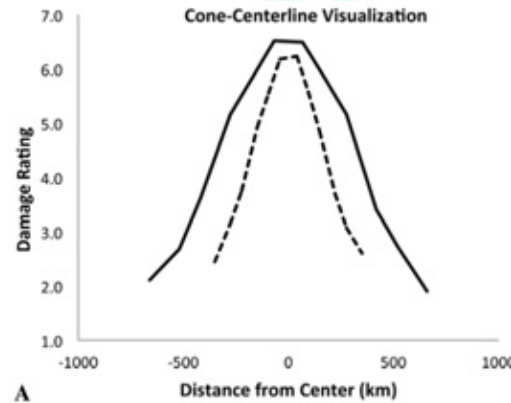


Task to estimate oil rig damage at locations relative to centerline, at 24 and 48 hours



Conclusion:
display format
has a strong
effect on the
strategy used
for estimating
storm damage

Ruginski et al., *Non-expert interpretations of hurricane forecast uncertainty visualizations*, Spatial Cognition and Computation, to appear

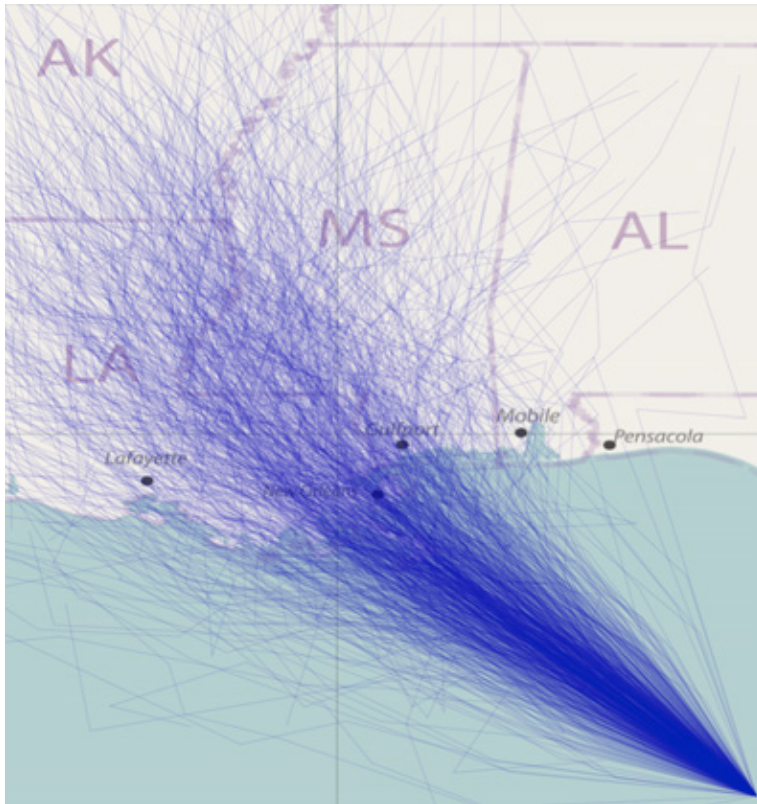


--- 24 hour timepoint
— 48 hour timepoint

FEMA is asking for better time-specific visualizations answering: “when, where, how strong”

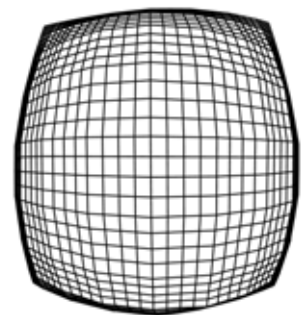
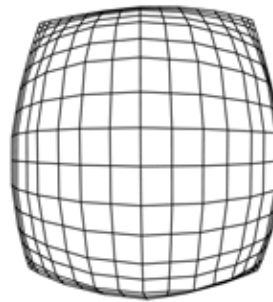
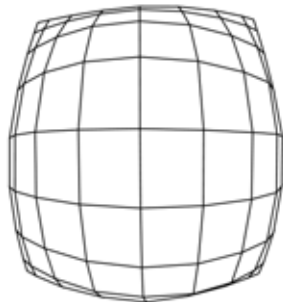
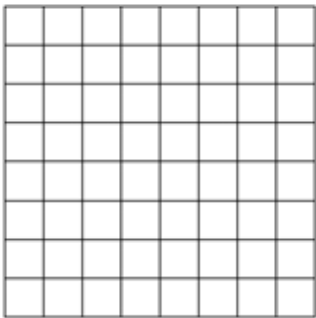
- Encouraged by good results with the ensemble path approach, we looked at time sampling
- Goal was to produce an ensemble of points
- Icons at points could answer the “when, where, how strong” question

Point ensemble display sampling NHC path ensemble, using NHC intensity icons

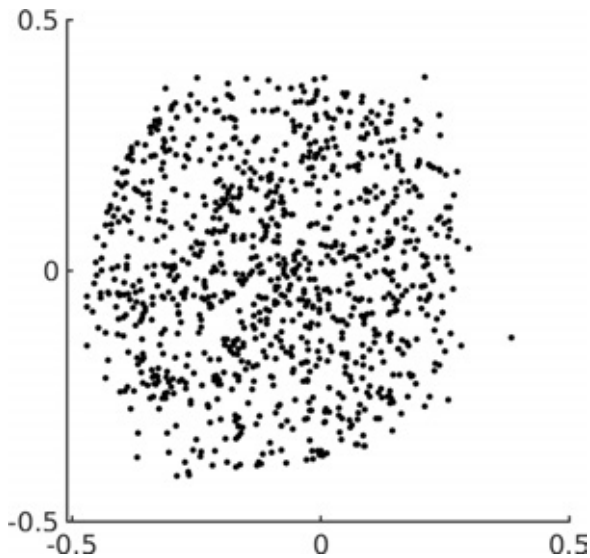


Our goal: to construct a subsampled ensemble with good spatial layout but true to the original distribution of points

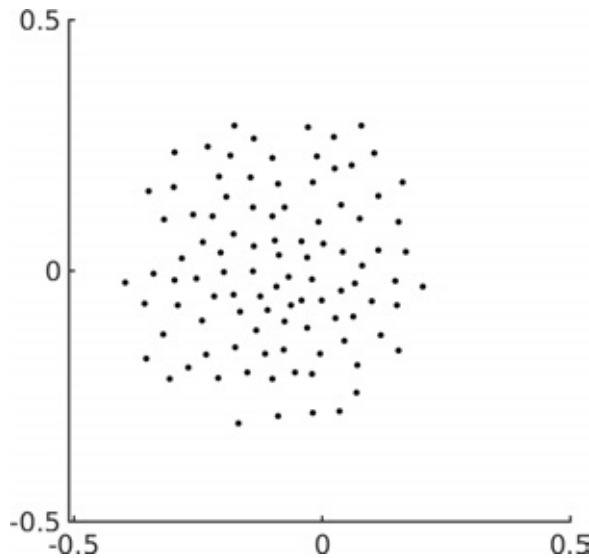
- Step 1: Construction of a space in which density is uniformly distributed (UD space)



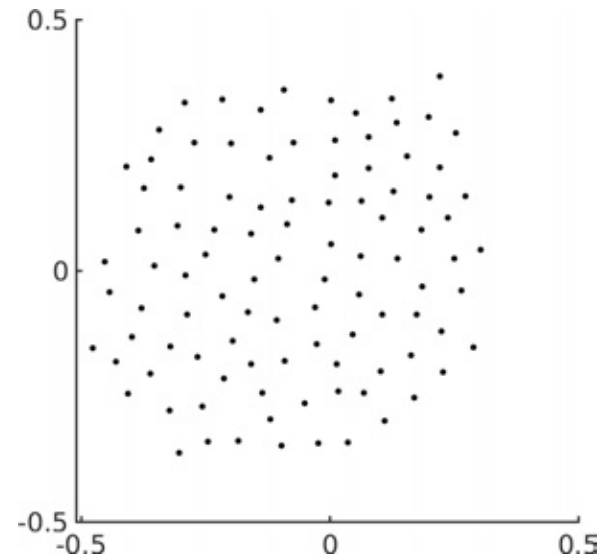
- Step 2: Project all ensemble points to UD space
- Step 3: Select a representative subset



Full ensemble



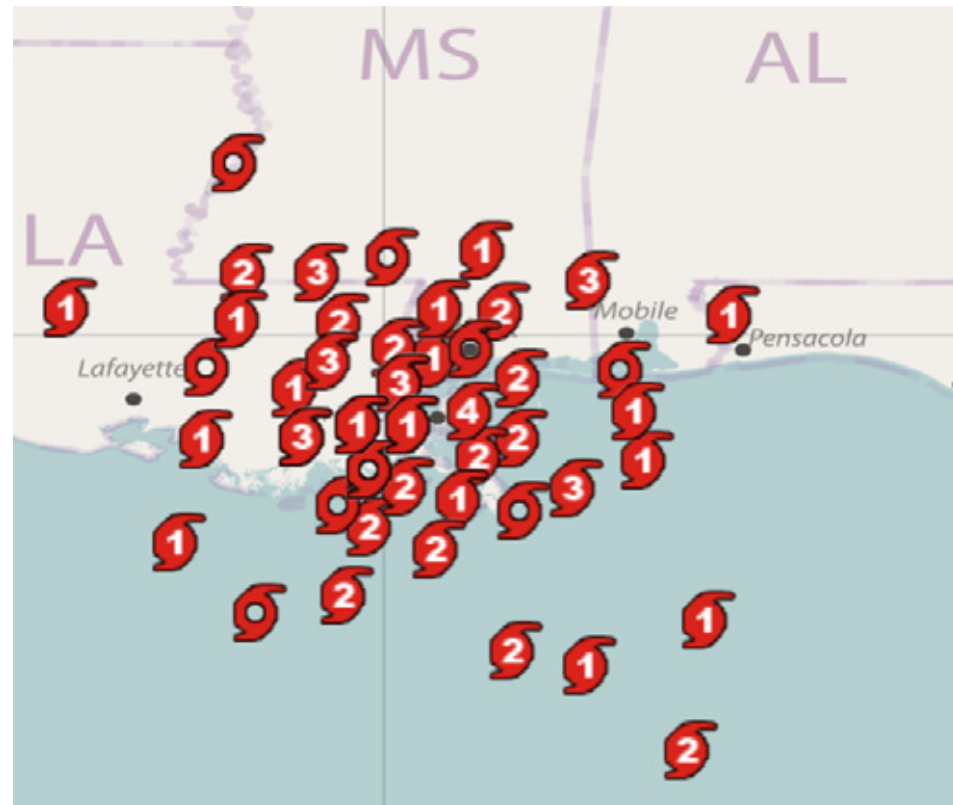
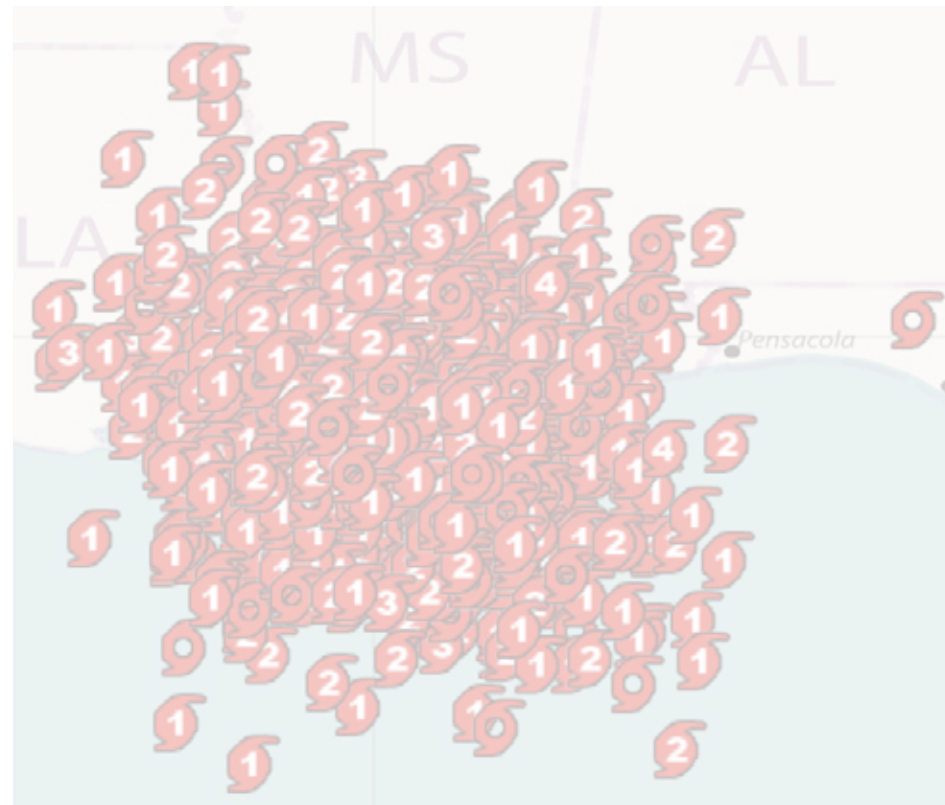
Subset selected via
Orthogonal Least
Squares (OLS)



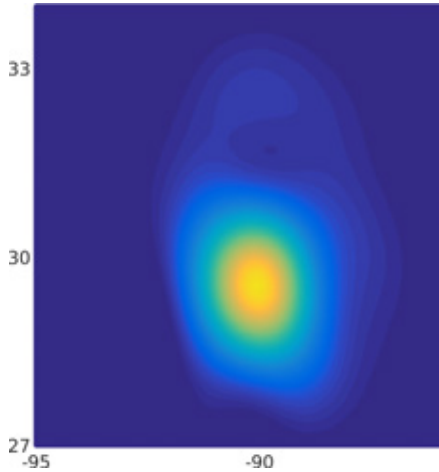
Subset selected via
Weighted Sample
Elimination (WSE)

Step 4: Project back to the original space

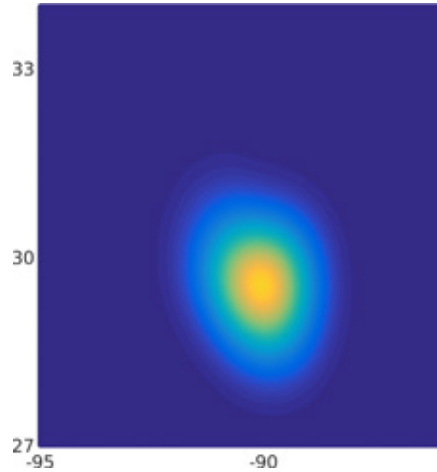
Step 5: Display using icons for intensity



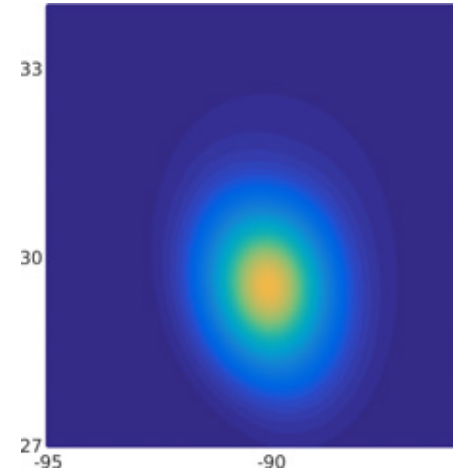
Evaluation by interpolation of simplicial depth



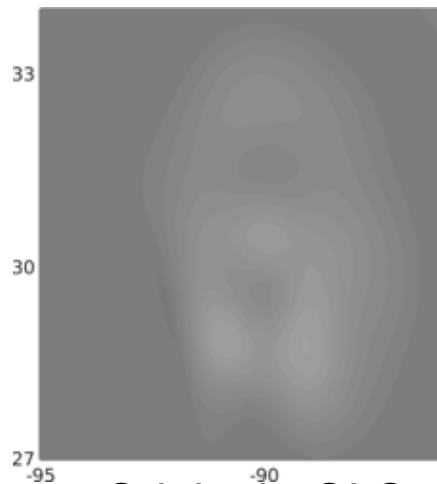
Original ensemble



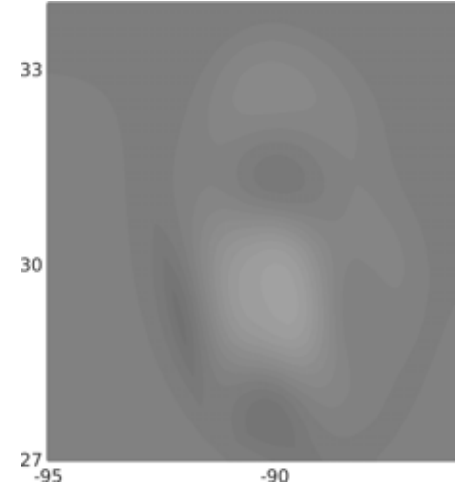
OLS



WSE

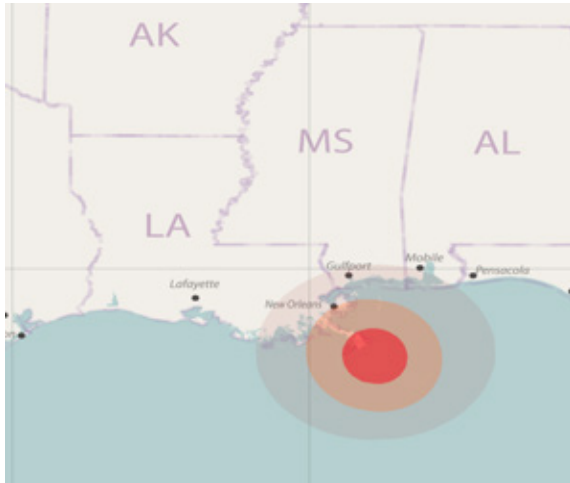


Original - OLS

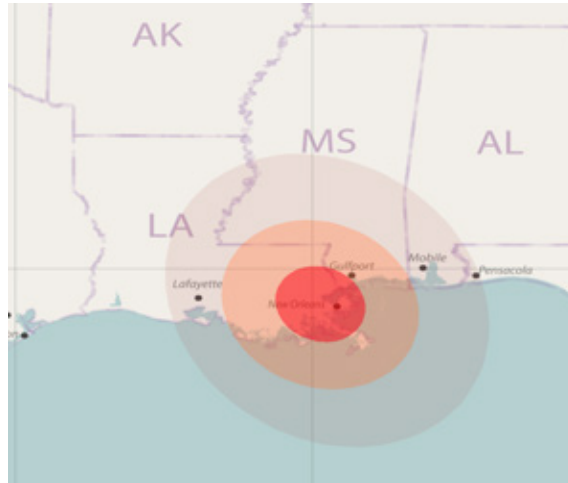


Original - WSE

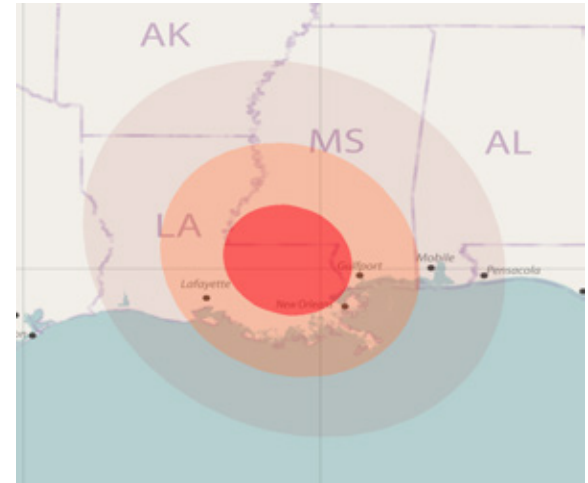
Summary display over time by (OLS)



12 hours



24 hours



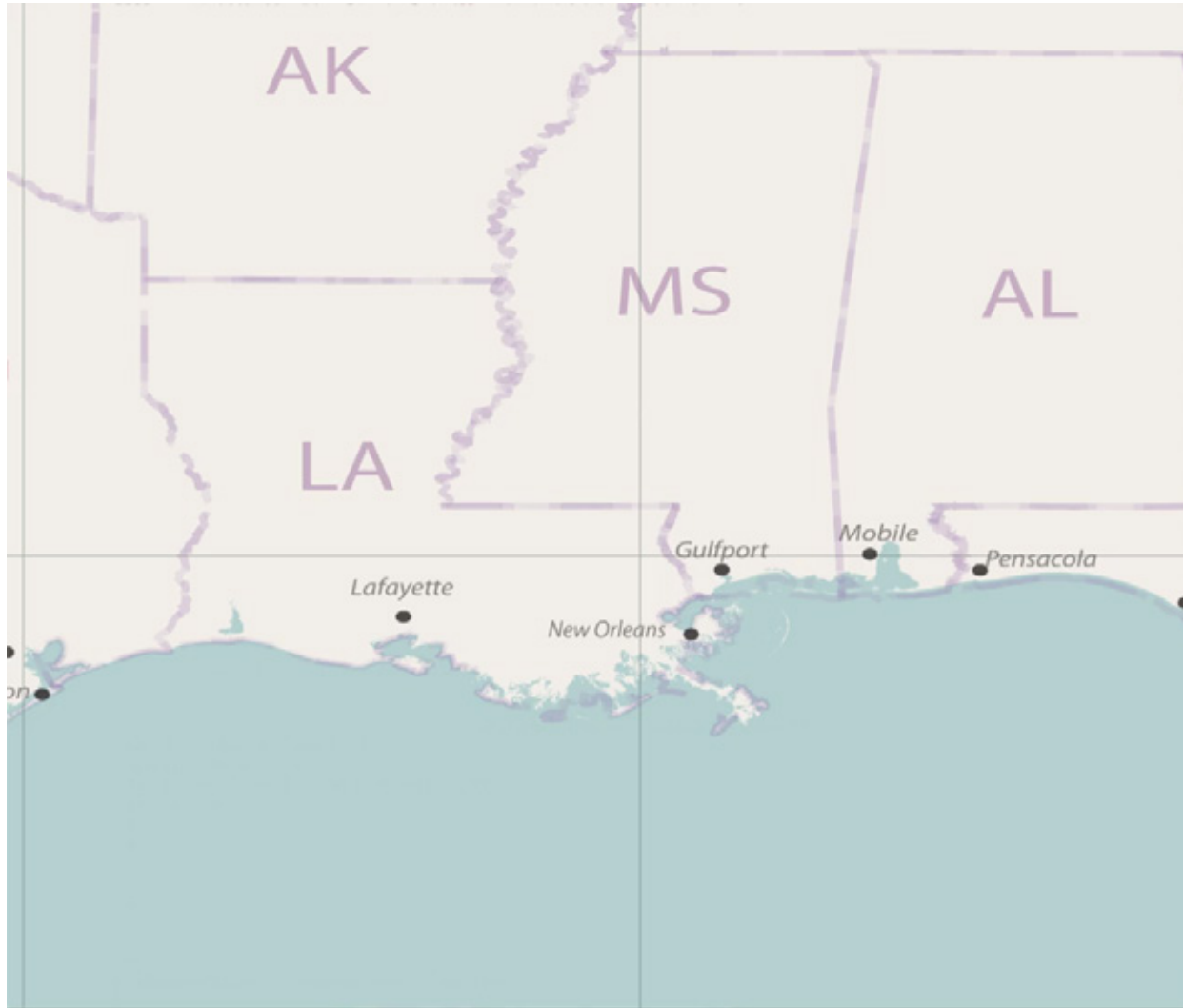
36 hours

Design similar to Liu et al., *Visualizing time-specific hurricane predictions, with uncertainty, from storm path ensembles*, EuroVis 2015

Ensemble display over time with icons



Ensemble display over time with storm size



Conclusion

- Directly showing a prediction ensemble can be an effective way of presenting uncertainty.
- This can be made to work for both prediction paths and points.
- Using points fixes time and allows superposition of additional characteristics.
- Empirical study planned to determine efficacy.
- We are exploring application of our sampling method to path displays.

Thank you to collaborators:

Sarah Creen-Regehr, Mary Hegarty,
Mike Kirby, Mike Lindell, Mahsa Mirzagar,
Bill Thompson, Ross Whitaker

And our sponsor:

NSF IIS-1212501 & 1212806