



# TC Dressing: Next-generation GPCE

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Buck Sampson



# Outline

- A spectrum of approaches to predict track error
  - GPCE
  - GPCE-AX
  - TC Dressing
- Small ensemble size limits the utility of TC Dressing.
- Provide skewness-like information by extending GPCE-AX with probability of left/right/fast/slow (P-LRFS).



# Goerss Prediction Consensus Error (GPCE)

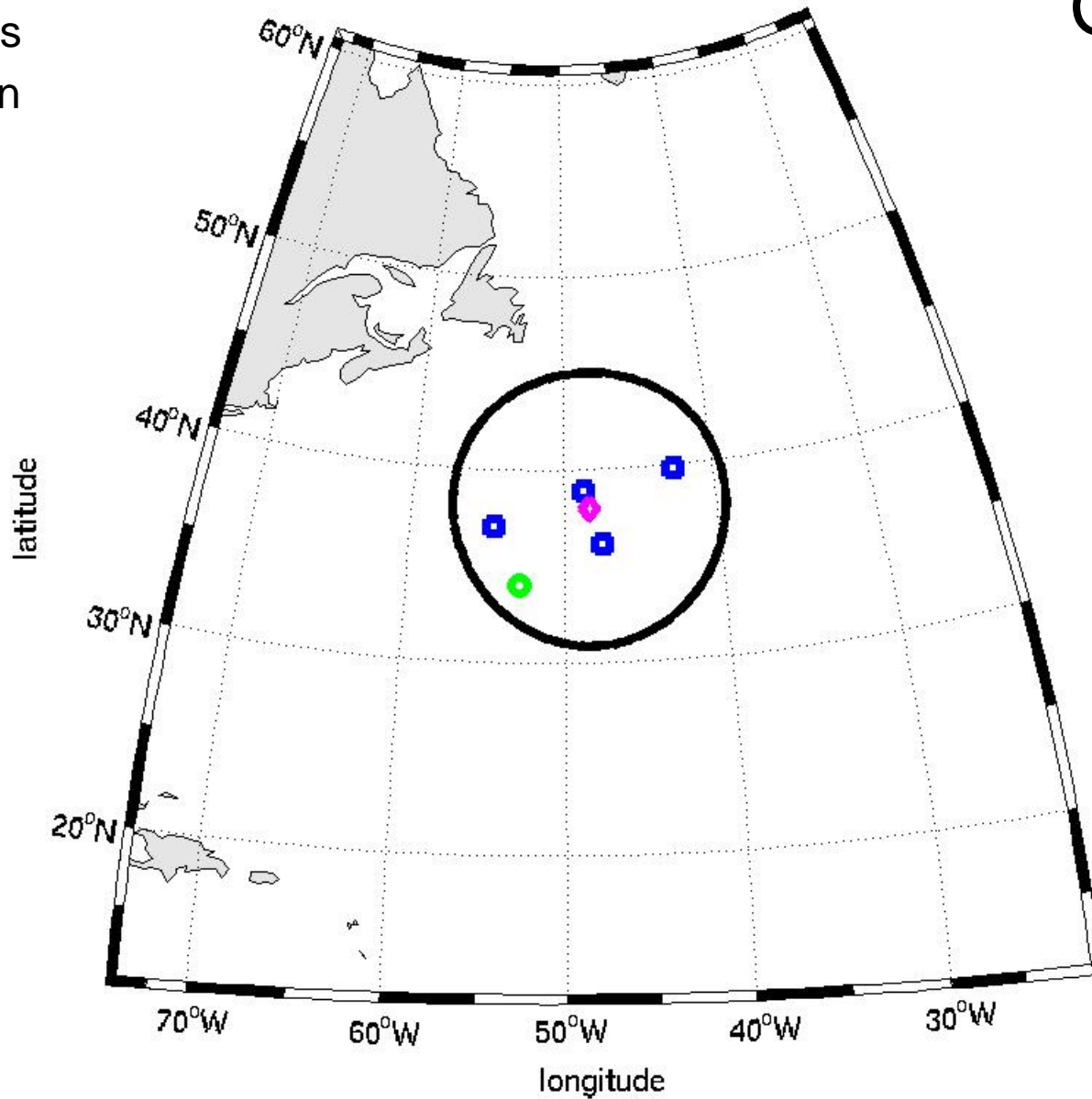
- Produces state-dependent, isotropic track error estimates.
  - Multivariate linear regression
  - Predictors include
    - Ensemble spread
    - Initial intensity
    - Predicted longitudinal displacement
- Displays 70% probability isopleth
- Reliable, and sharp relative to climatology

Tuned IGN: 13.1967, base IGN: 13.0862

120hr lead, storm 7, dtg 6091218

GPCE

- GUNA
- ◇ Consensus
- Verification





# GPCE Along/Across (GPCE-AX)

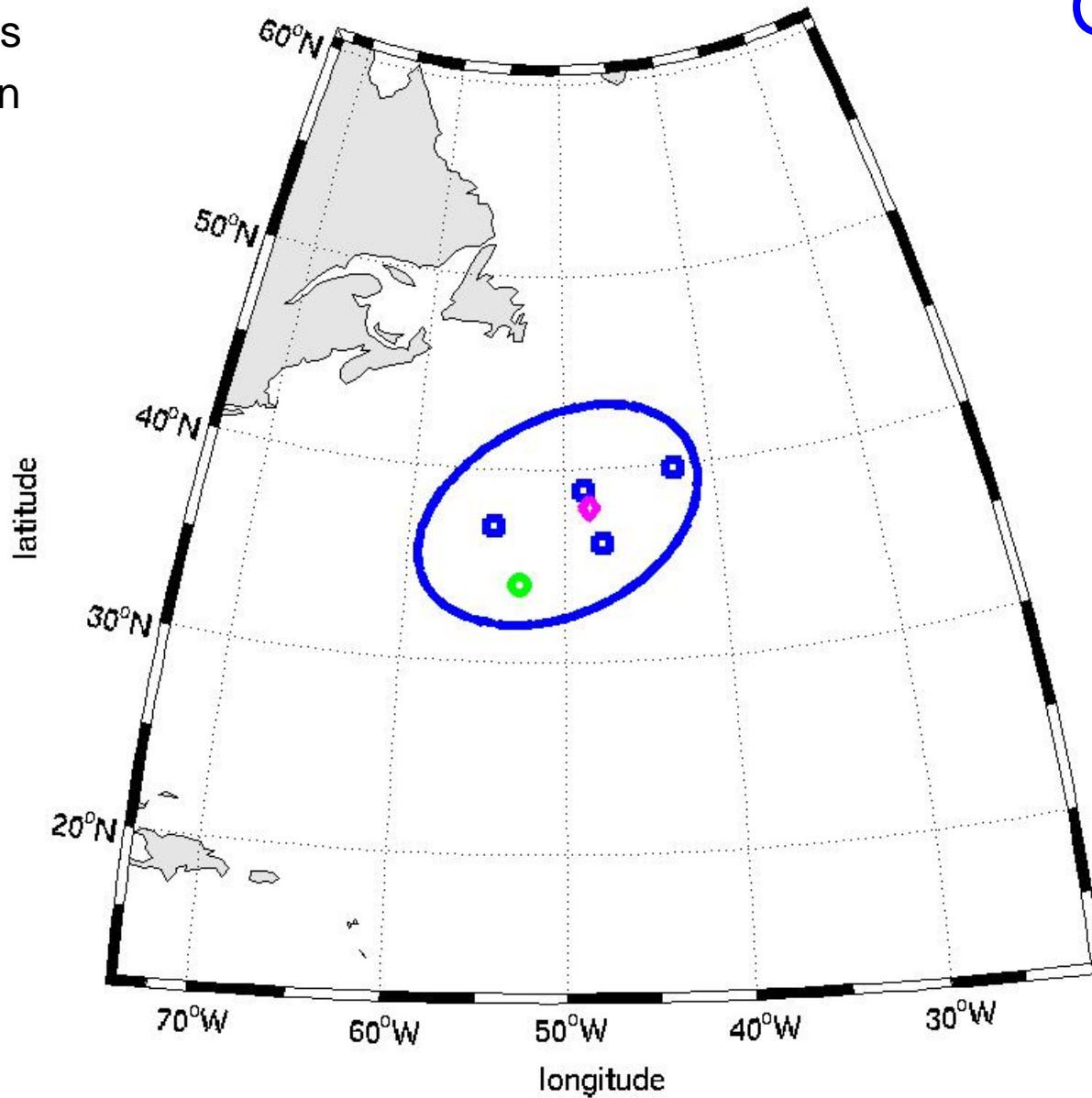
- Produces state-dependent, anisotropic track error estimates (ellipses).
  - Eigenvectors are across-track/along-track directions
  - Includes bias correction
  - Multivariate linear regression
  - Predictors include
    - Across/along ensemble spread
    - Initial intensity
    - Initial longitude
    - Predicted longitudinal displacement
- Displays 70% probability isopleth
- Reliable, and sharp relative to GPCE

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GPCE-AX

- GUNA
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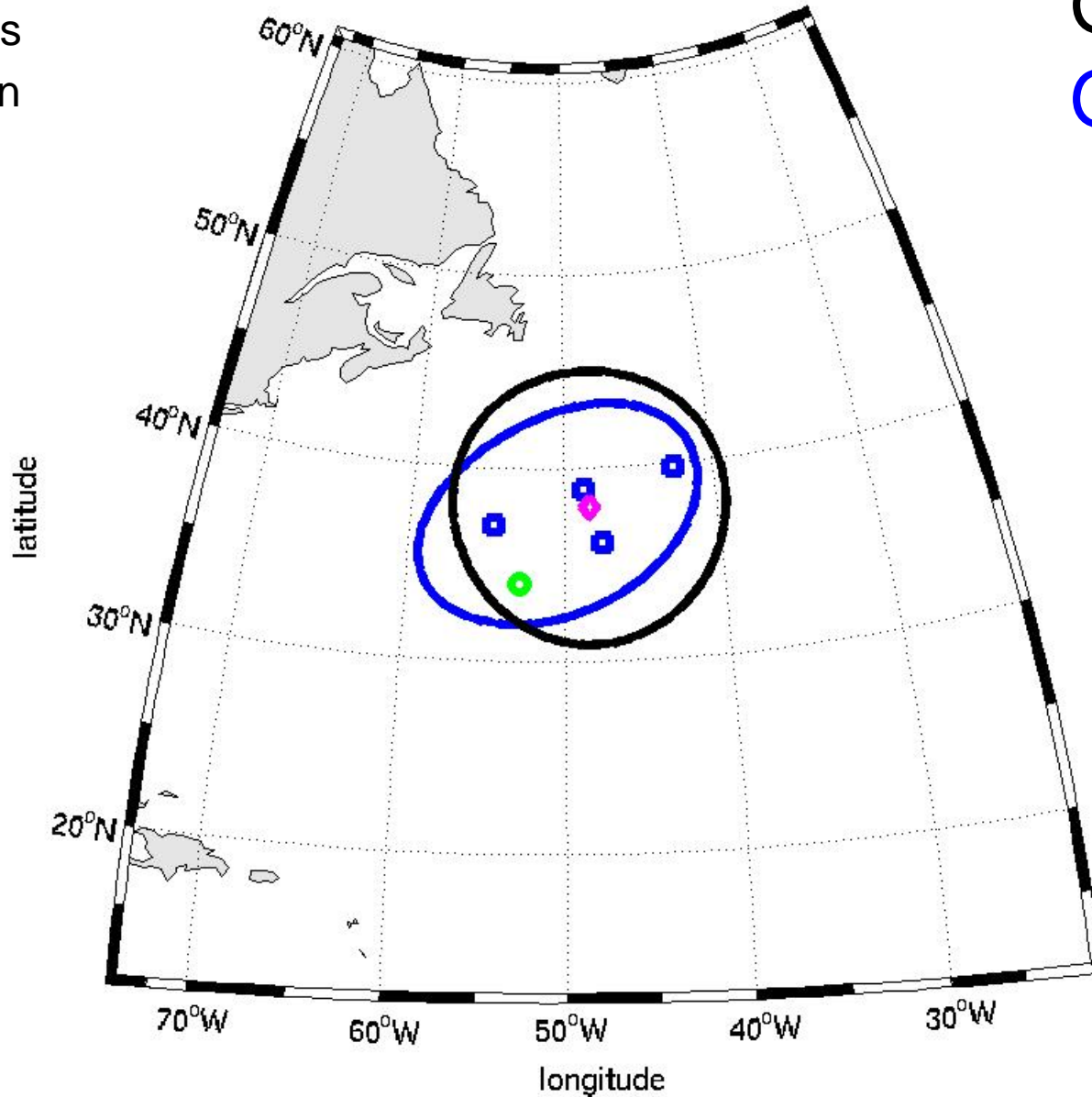


Tuned IGN: 13.1967, base IGN: 13.0862

120hr lead, storm 7, dtg 6091218

- GUNA
- ◇ Consensus
- Verification

GPCE  
GPCE-AX







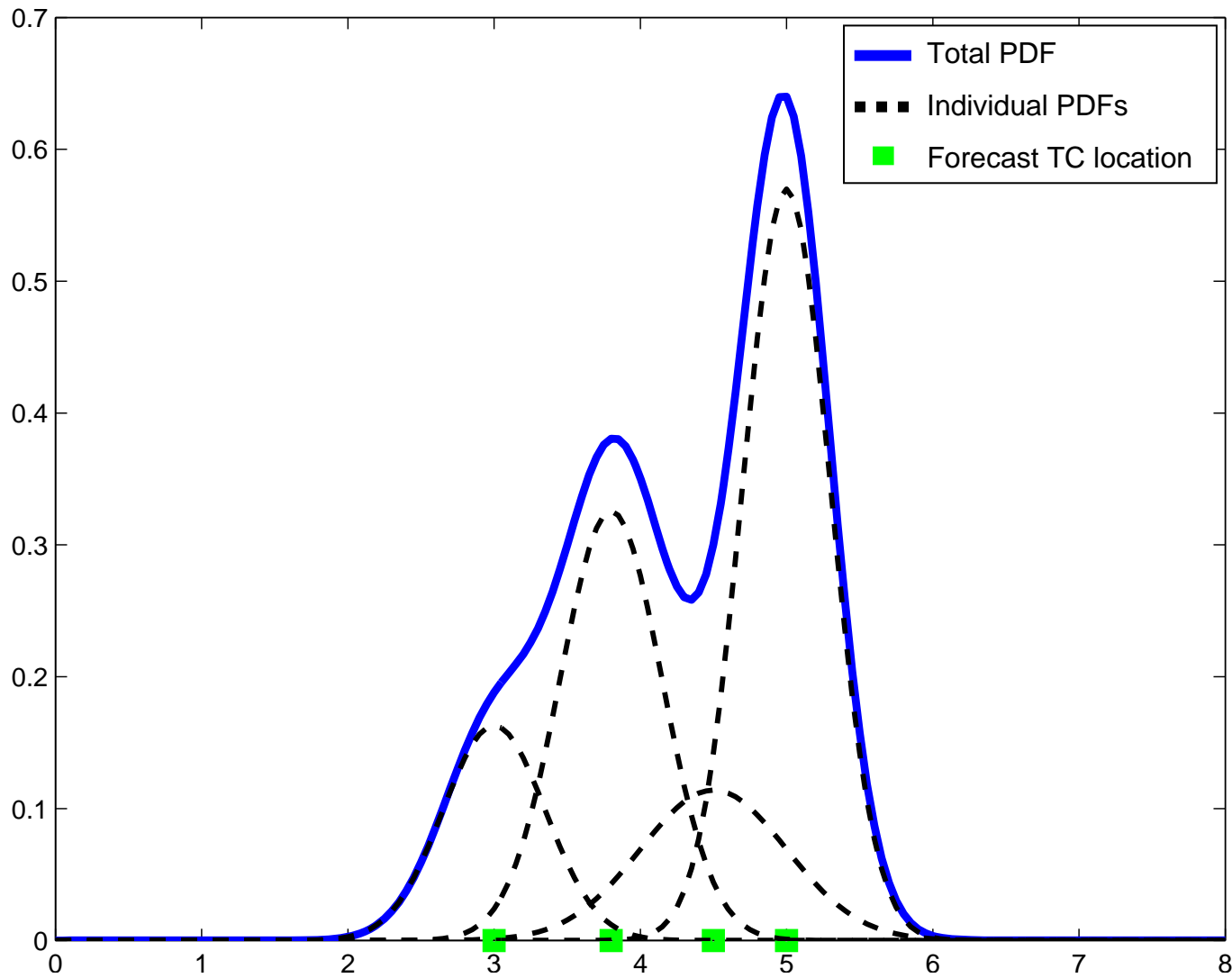
# TC Dressing

- Each TC track forecast in an ensemble is dressed with a Gaussian “kernel”.
- The sum of the ensemble of Gaussian PDFs defines the total forecast PDF.
- Gaussian parameters (weight, spread) are tuned to optimize a probabilistic cost function.
- Climatology is included as a kernel whose spread is fixed but whose weight can vary.



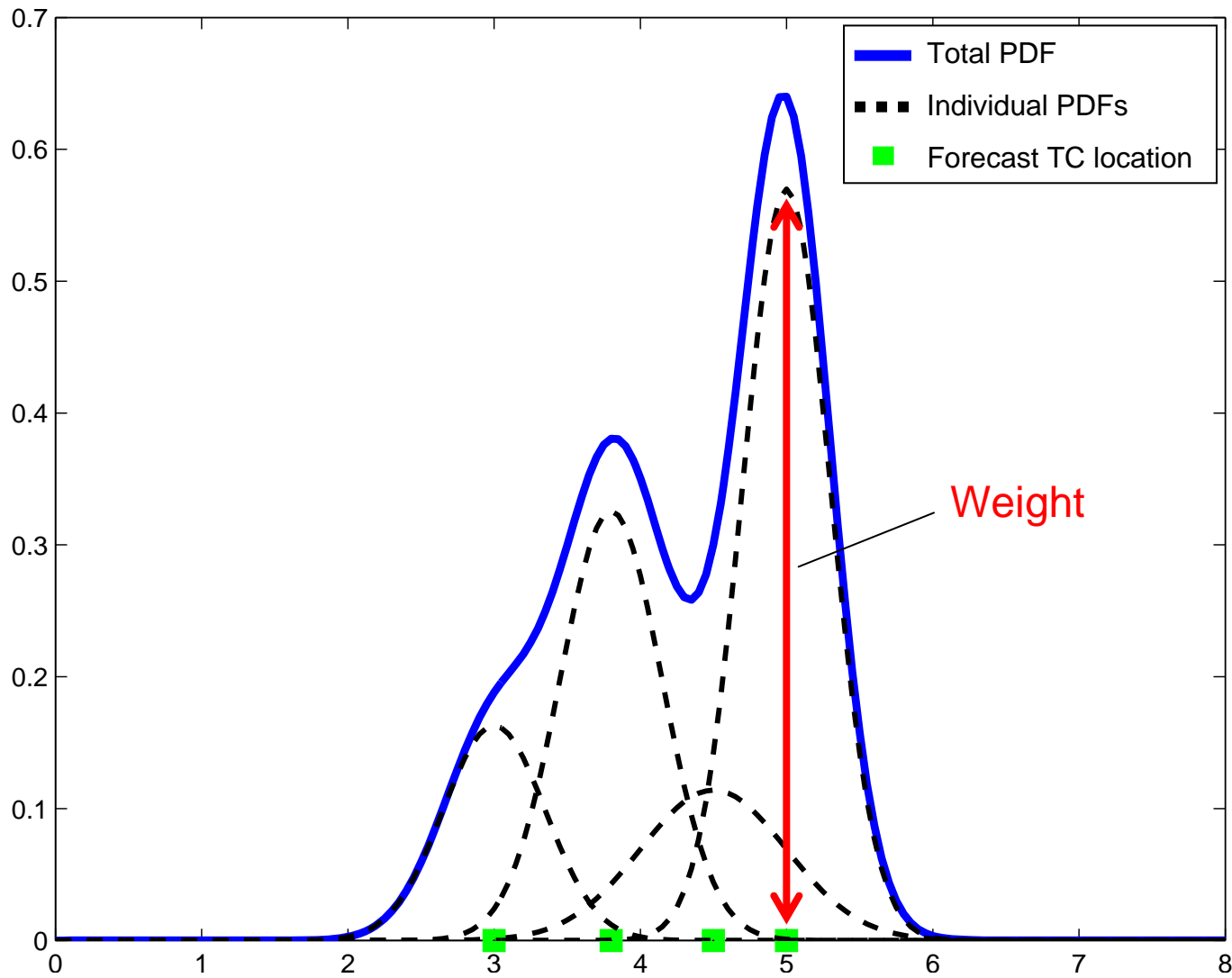


# Dressed ensemble example



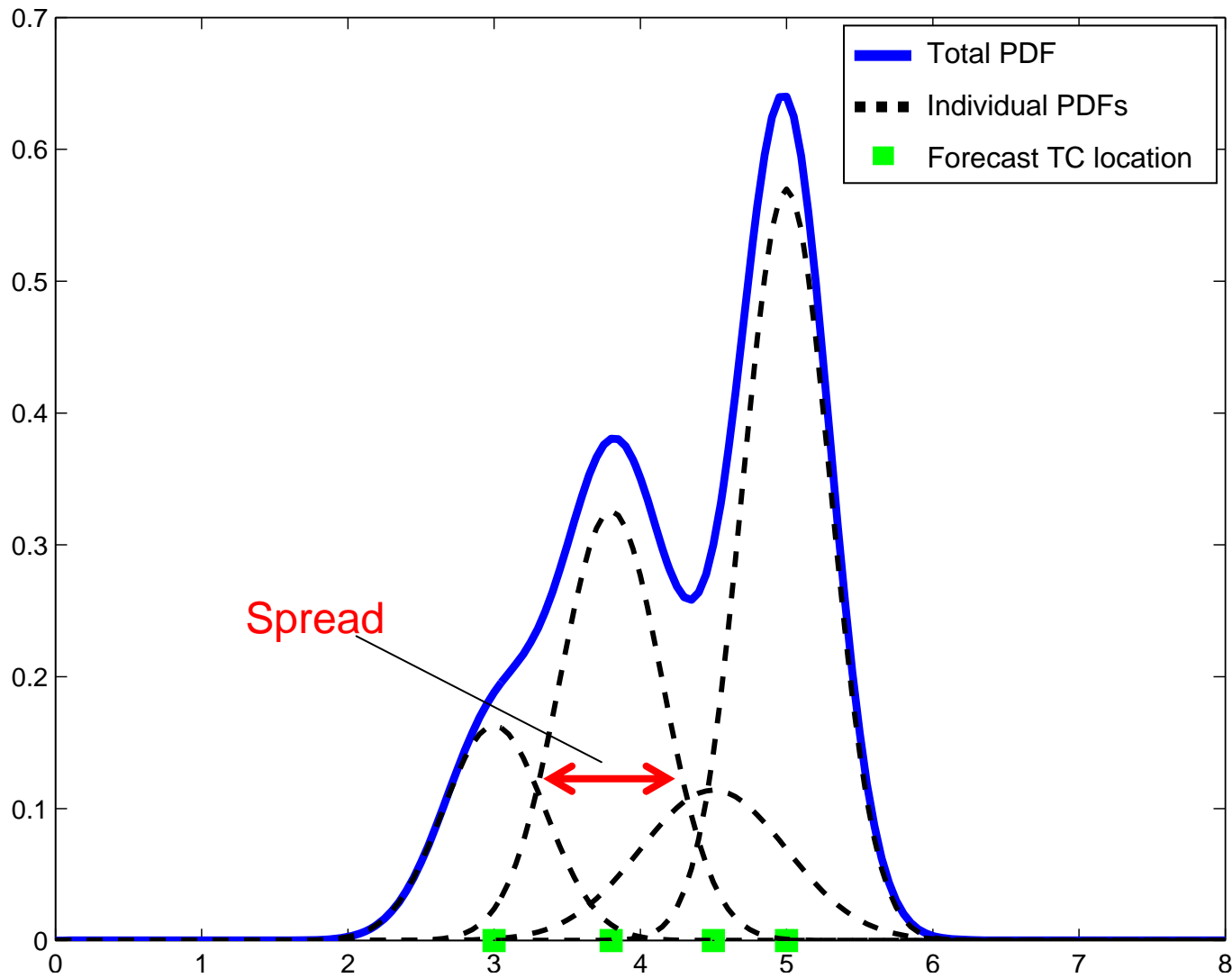


# Dressed ensemble example



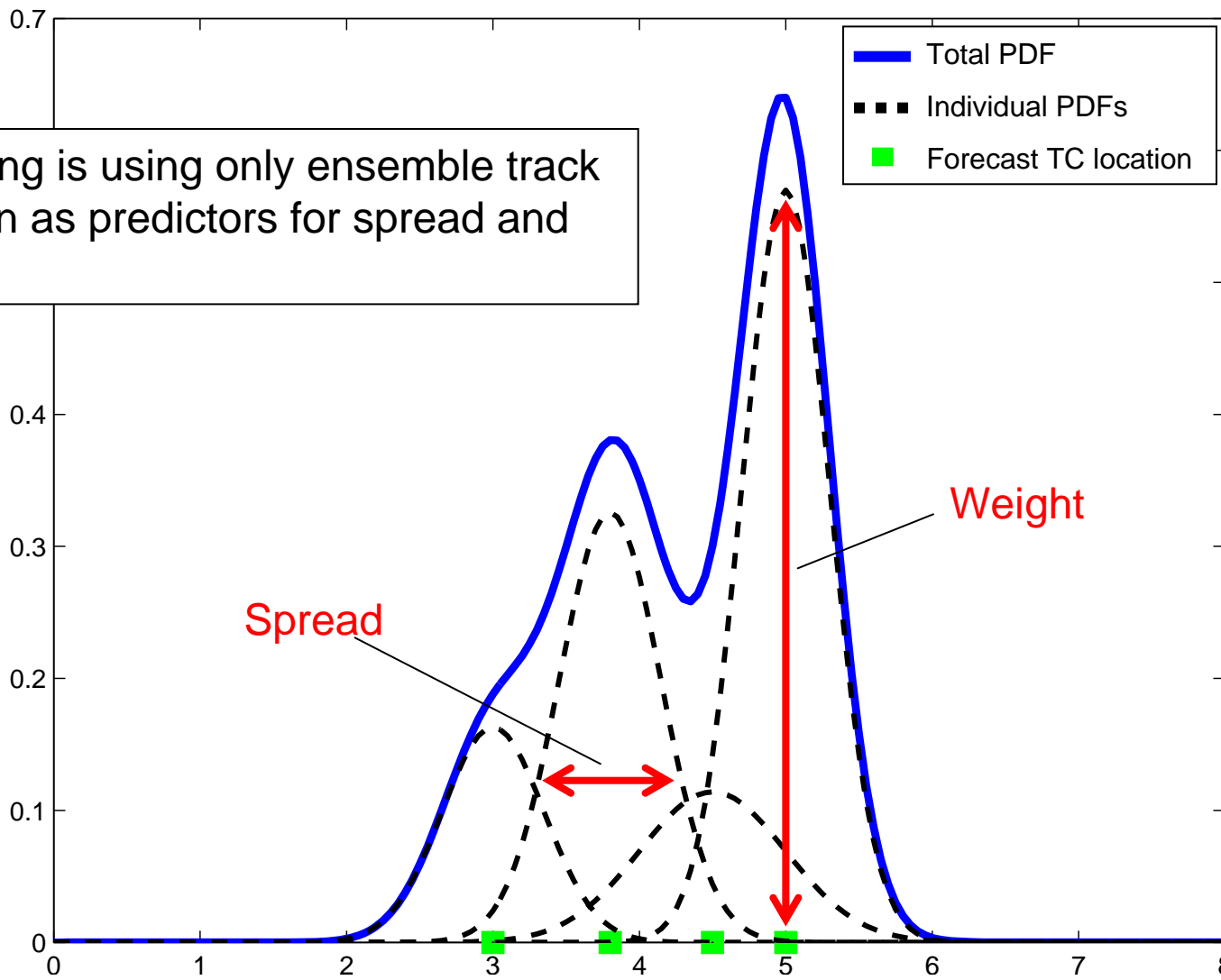


# Dressed ensemble example





# Ensemble dress example



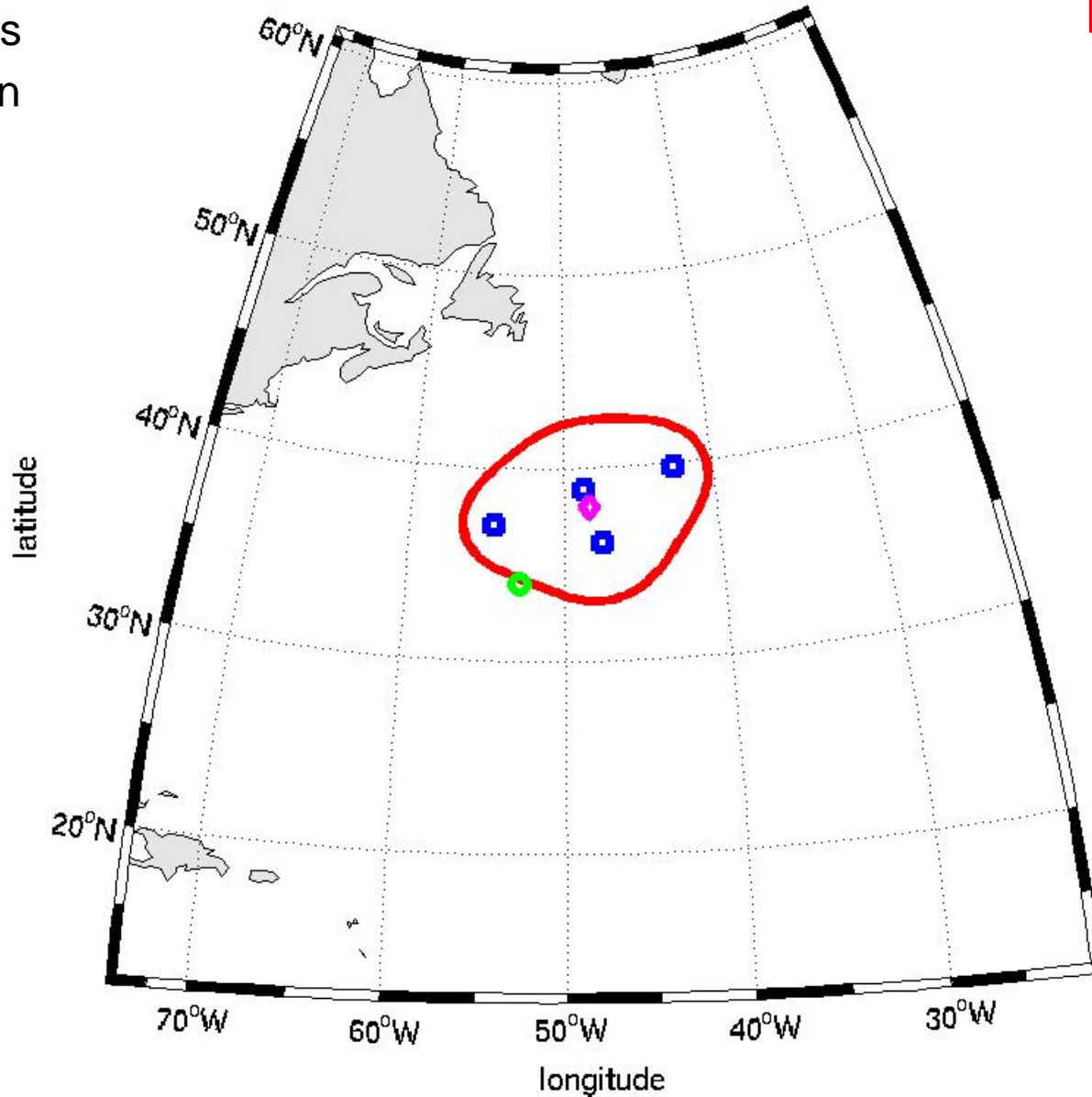
TC Dressing is using only ensemble track information as predictors for spread and weight.

Tuned IGN: 13.1967, base IGN: 13.0862

120hr lead, storm 7, dtg 6091218

TC Dress

- GUNA
- ◇ Consensus
- Verification

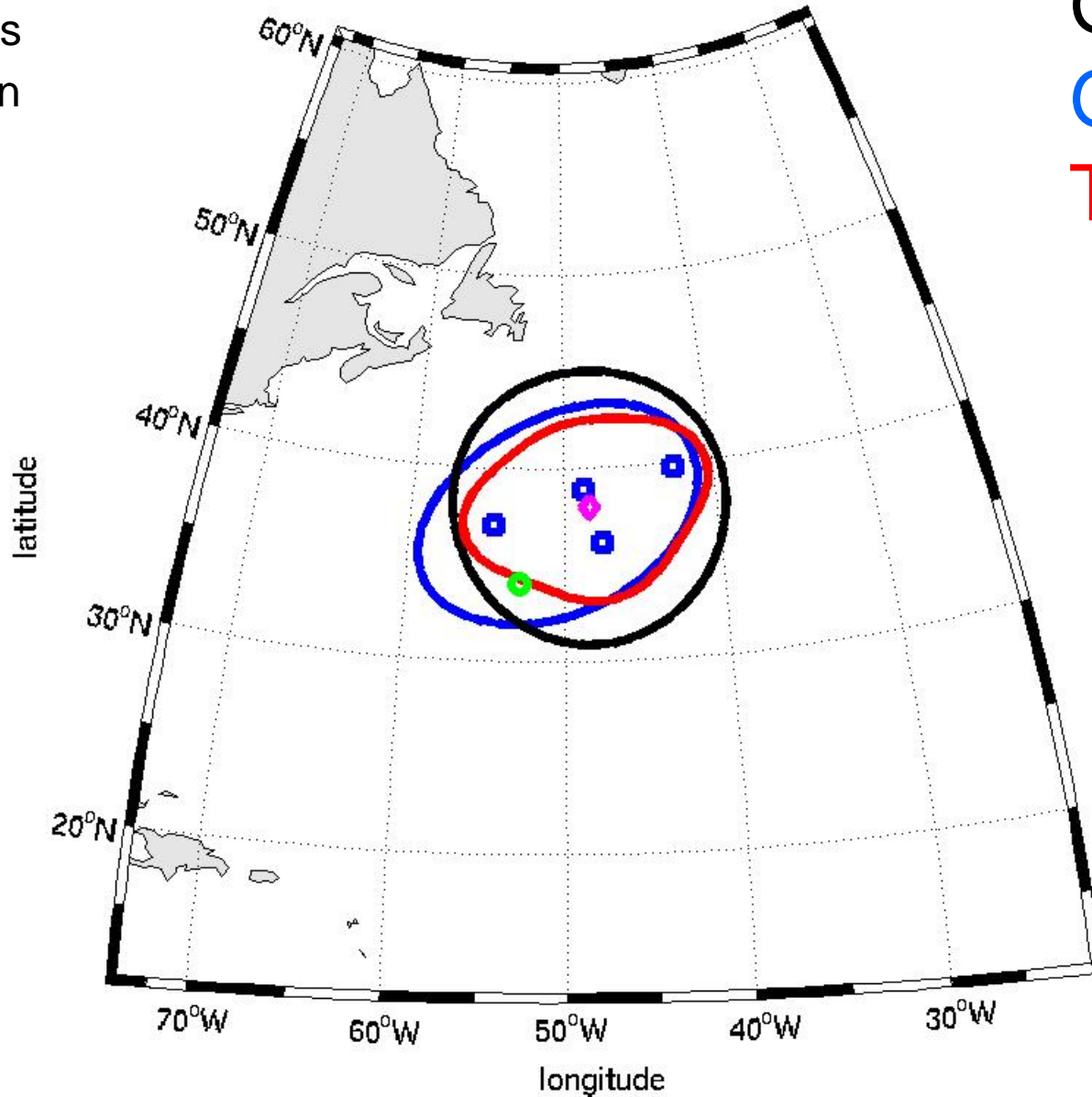


Tuned IGN: 13.1967, base IGN: 13.0862

120hr lead, storm 7, dtg 6091218

- GUNA
- ◇ Consensus
- Verification

GPCE  
GPCE-AX  
TC Dress

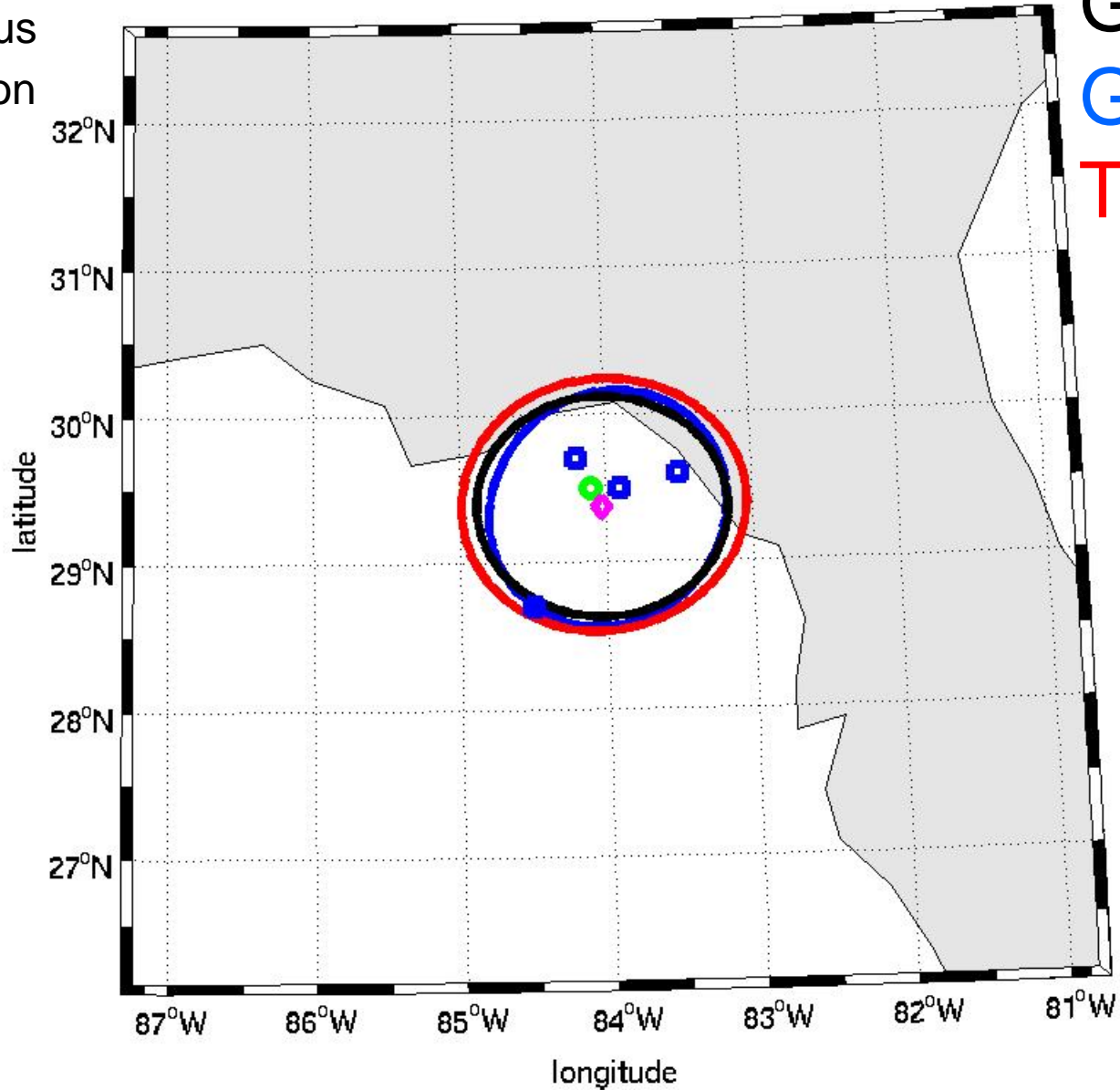


Tuned IGN: 9.1803, base IGN: 9.1329

12hr lead, storm 1, dtg 6061300

- GUNA
- ◇ Consensus
- Verification

GPCE  
GPCE-AX  
TC Dress



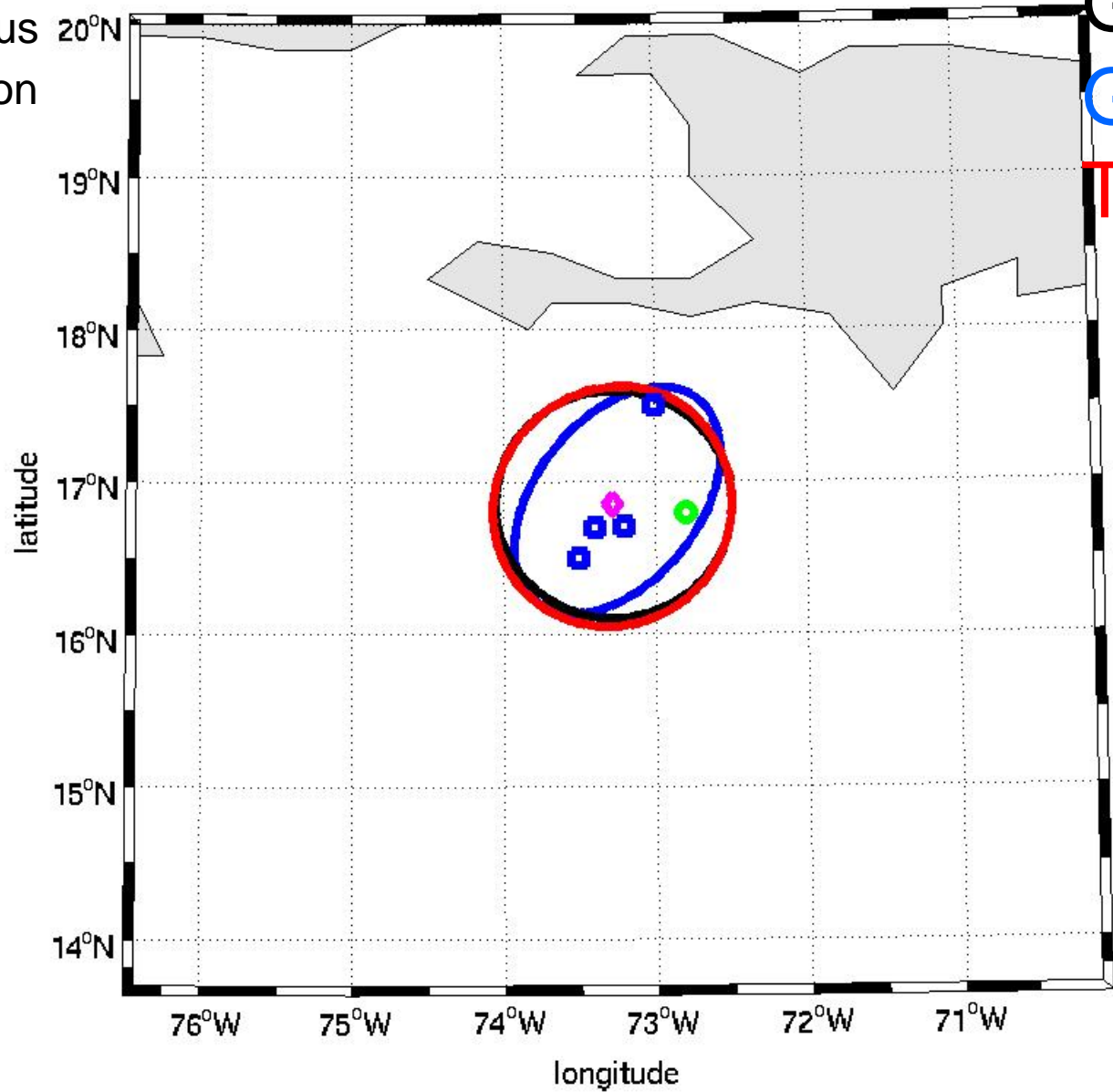


Tuned IGN: 9.1803, base IGN: 9.1329

12hr lead, storm 5, dtg 6082618

- GUNA
- ◇ Consensus
- Verification

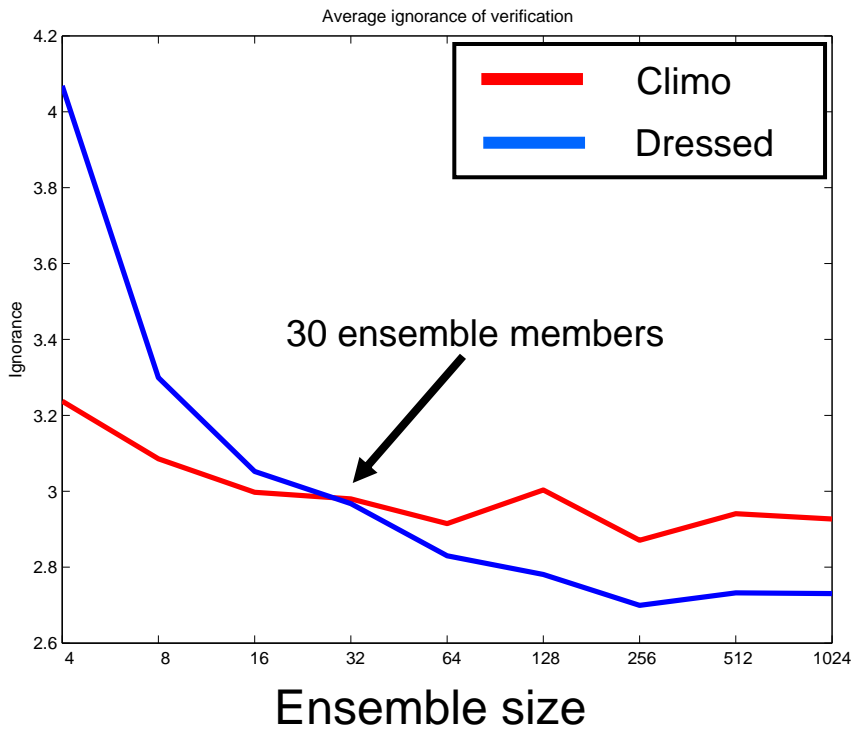
GPCE  
GPCE-AX  
TC Dress



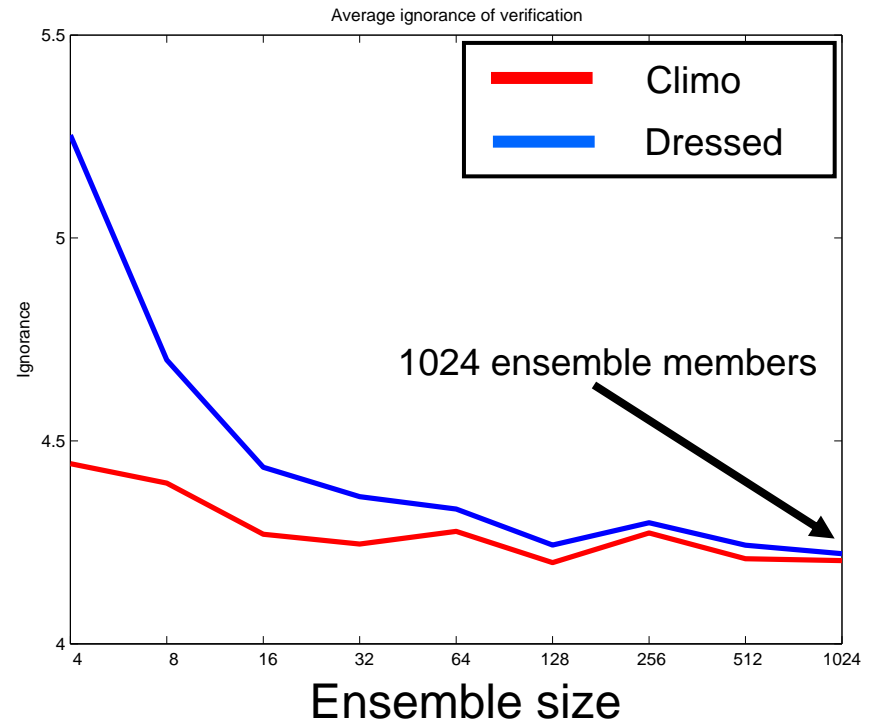


# Ensemble size for TC Dressing?

$$\textit{ignorance} = -\log(p_{\textit{verification}})$$



Variance changes by 300%



Variance changes by 10%



# Reliability and sharpness

GUNA, 2 predictors, trained using 2002-2005, tested using 2006

Lead	GPCE 70% reliability	GPCE-AX 70% reliability	Fractional difference between 70% areas	Sample size
12hr	0.80	0.77	0.31	193
24hr	0.77	0.76	0.13	173
36hr	0.81	0.73	0.19	157
48hr	0.82	0.77	0.10	136
72hr	0.82	0.80	0.11	98
96hr	0.79	0.65	0.10	68
120hr	0.84	0.70	0.12	50

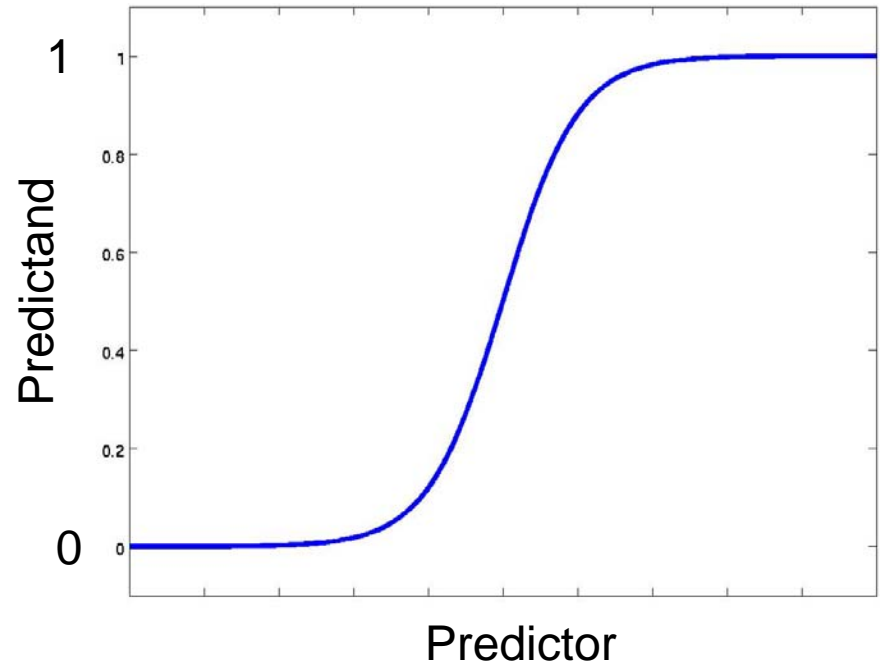


# Probability of left/right/fast/slow (P-LRFS)

- Logistic regression

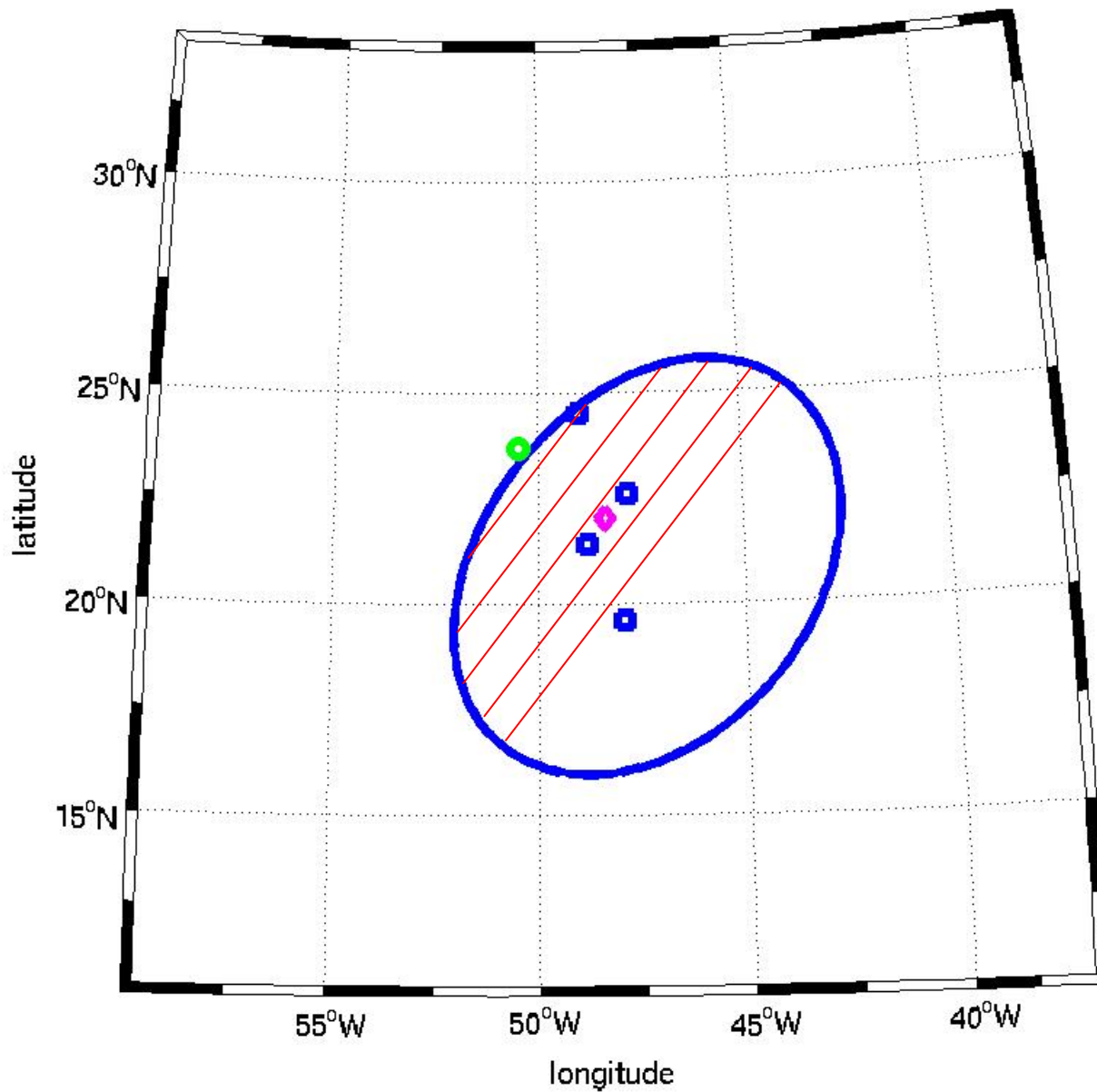
$$f(x_1, x_2, \dots, x_n) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1 + \dots + \beta_n x_n)}}$$

- Use 70% as a warning threshold.
- Simple tests indicate utility.
- Not clear how to communicate.



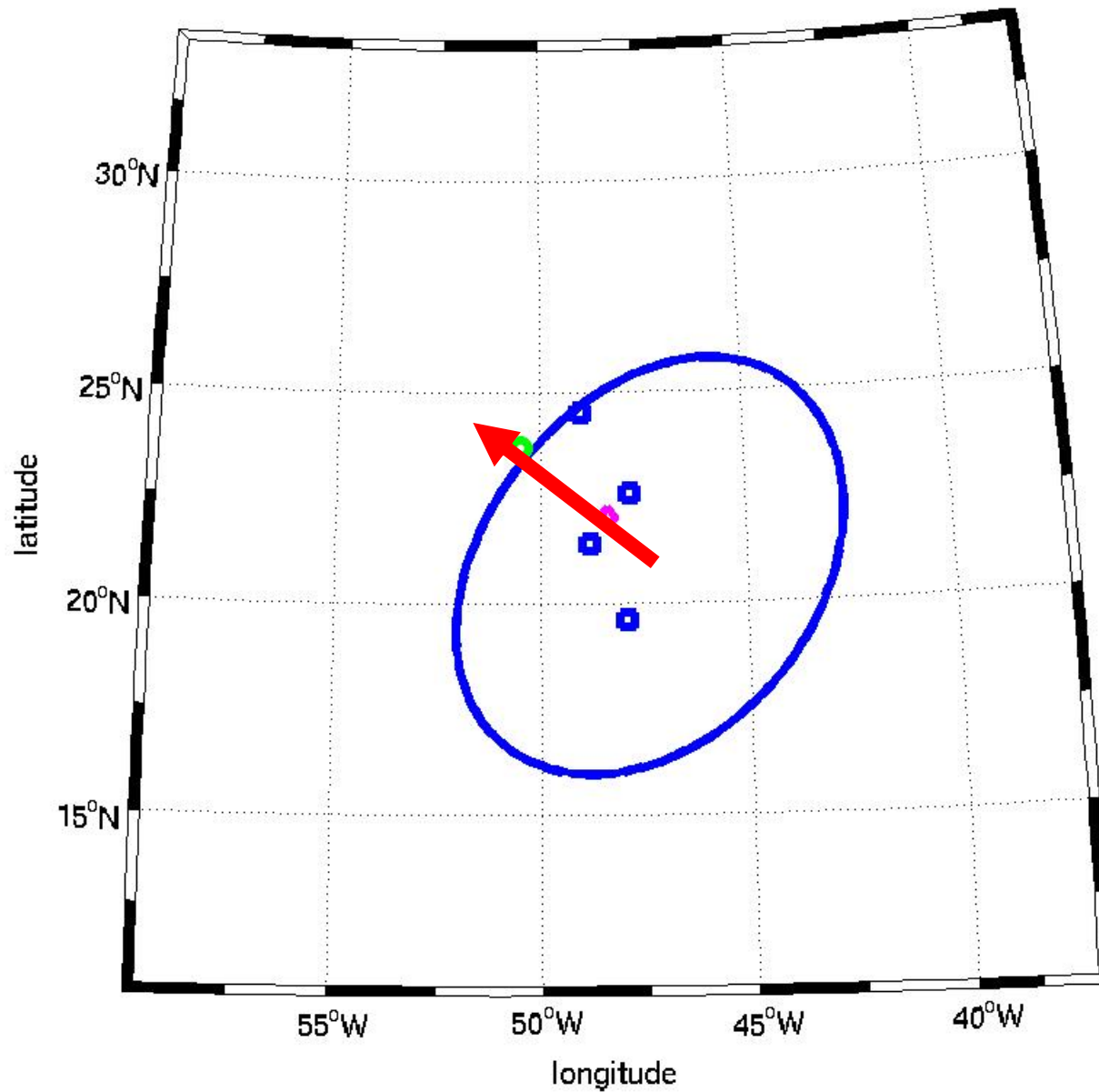
Tuned IGN: 13.1967, base IGN: 13.0862

120hr lead, storm 8, dtg 6091318



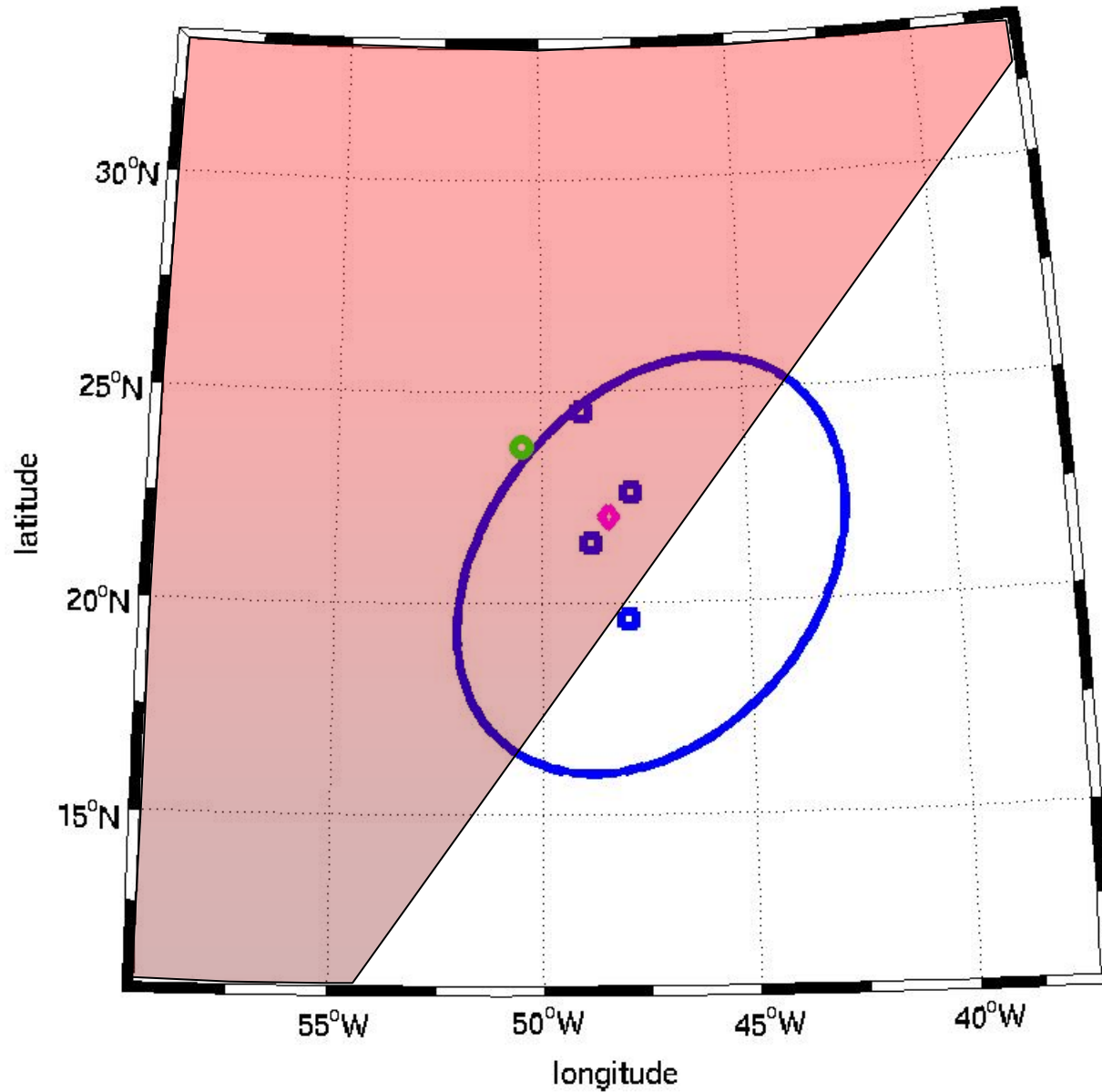
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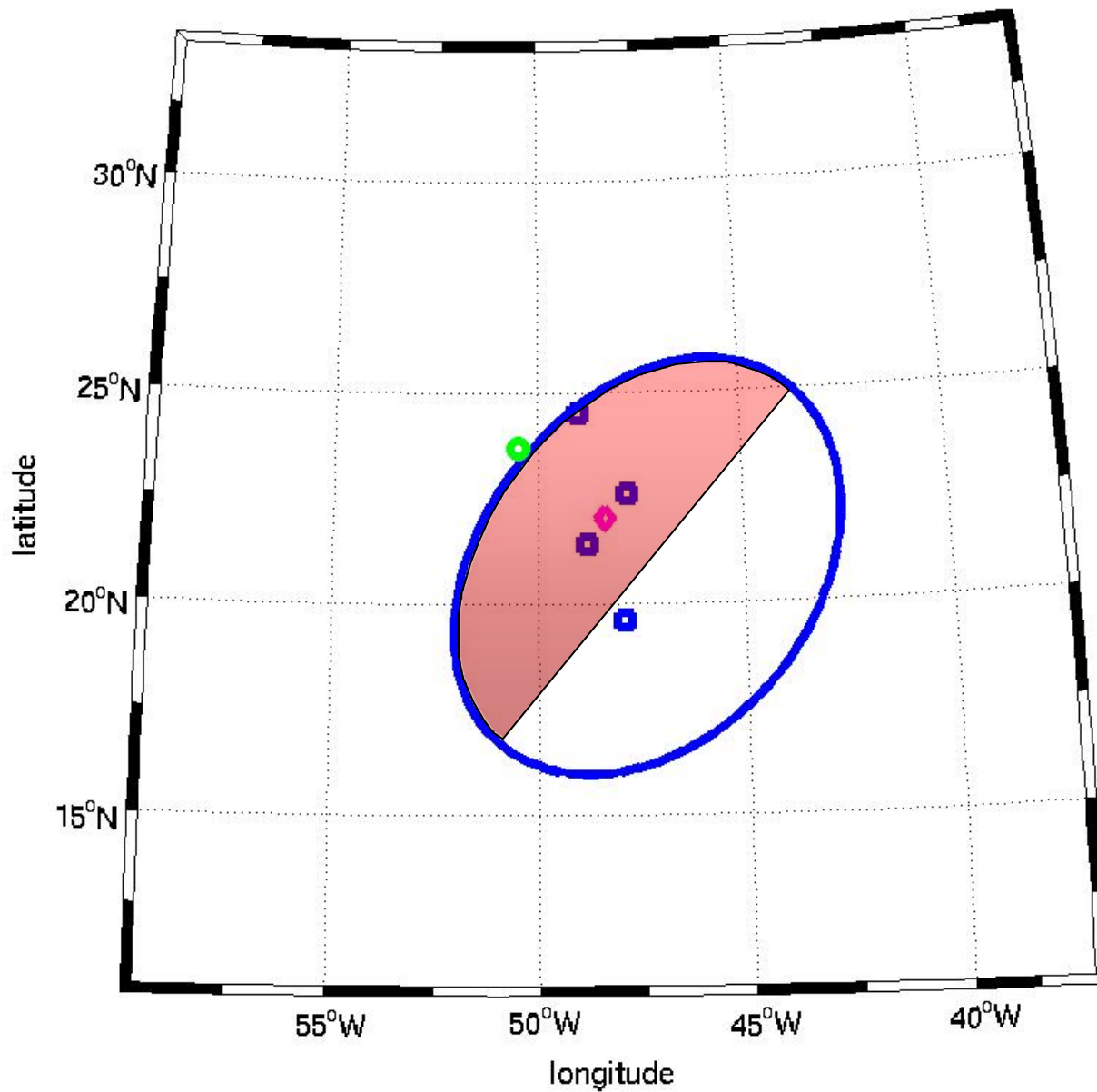
120hr lead, storm 8, dtg 6091318





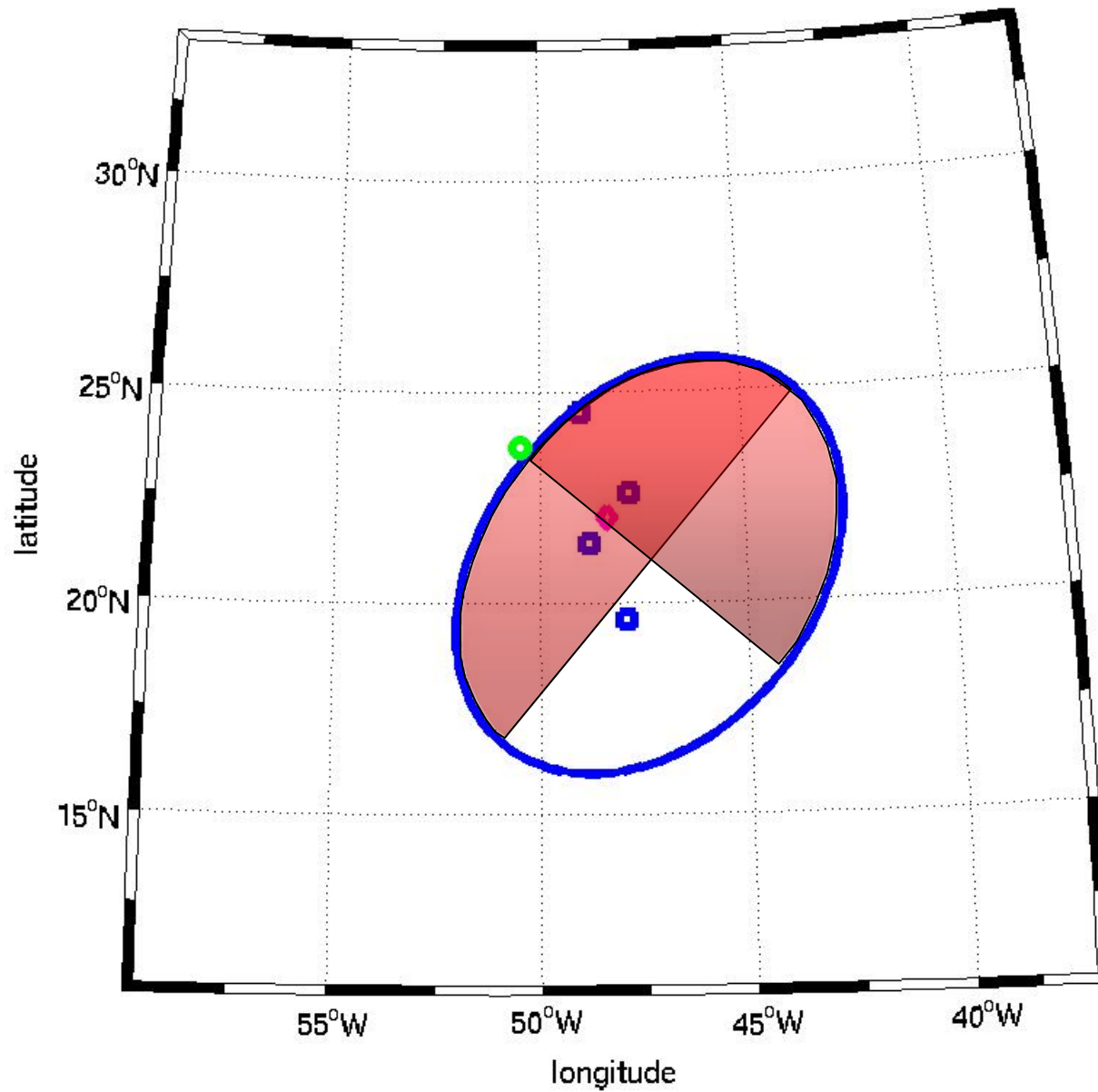
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120hr lead, storm 8, dtg 6091318



Tuned IGN: 13.1967, base IGN: 13.0862

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# Conclusions

- TC Dressing is limited by small ensemble size.
- GPCE-AX outperforms GPCE.
- P-LRFS provides value for hedging (skewness-like information).

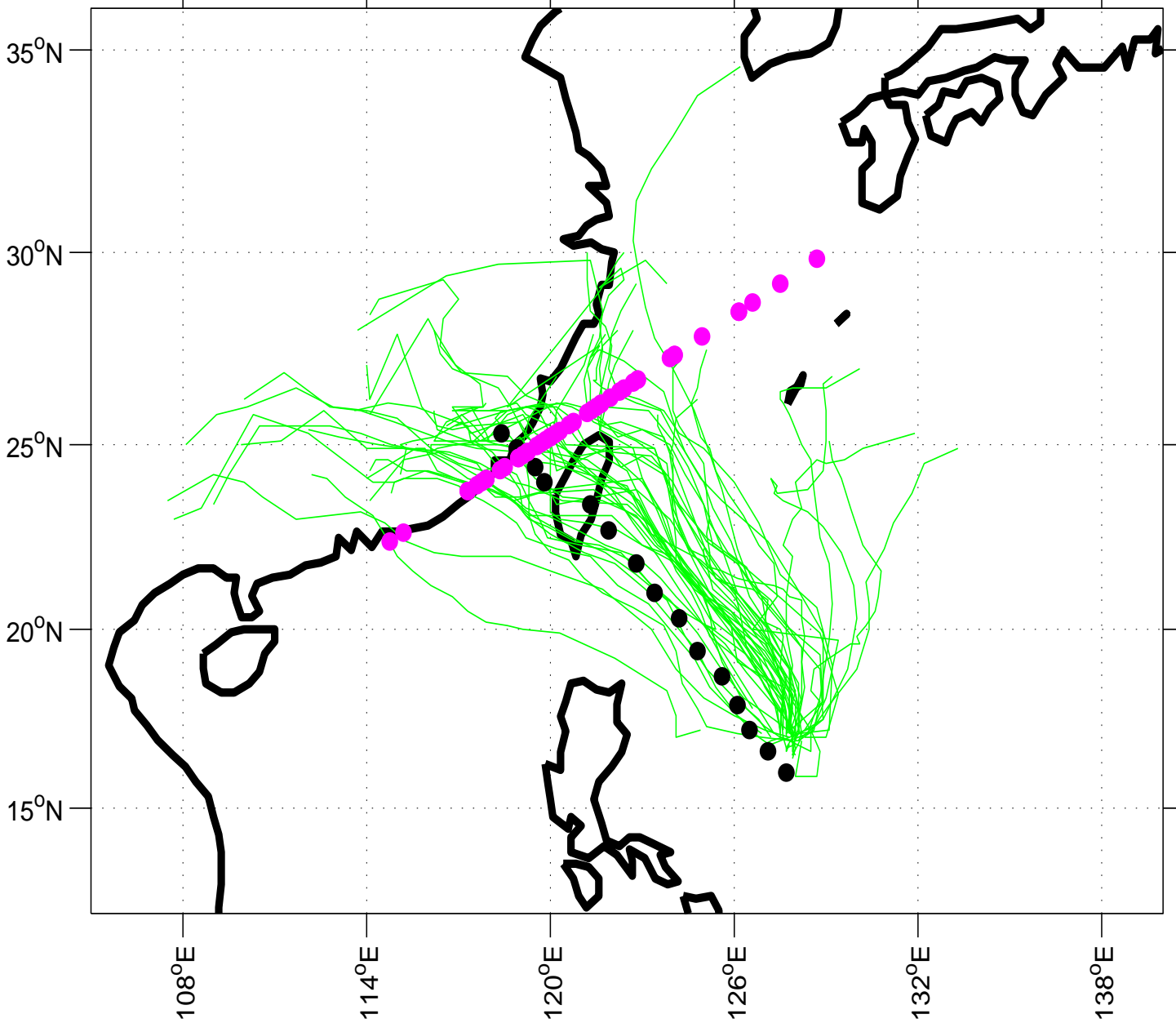


**Why** does the uncertainty look the way it does?

# Typhoon Sepat Ensemble Tracks 8.15.07.12

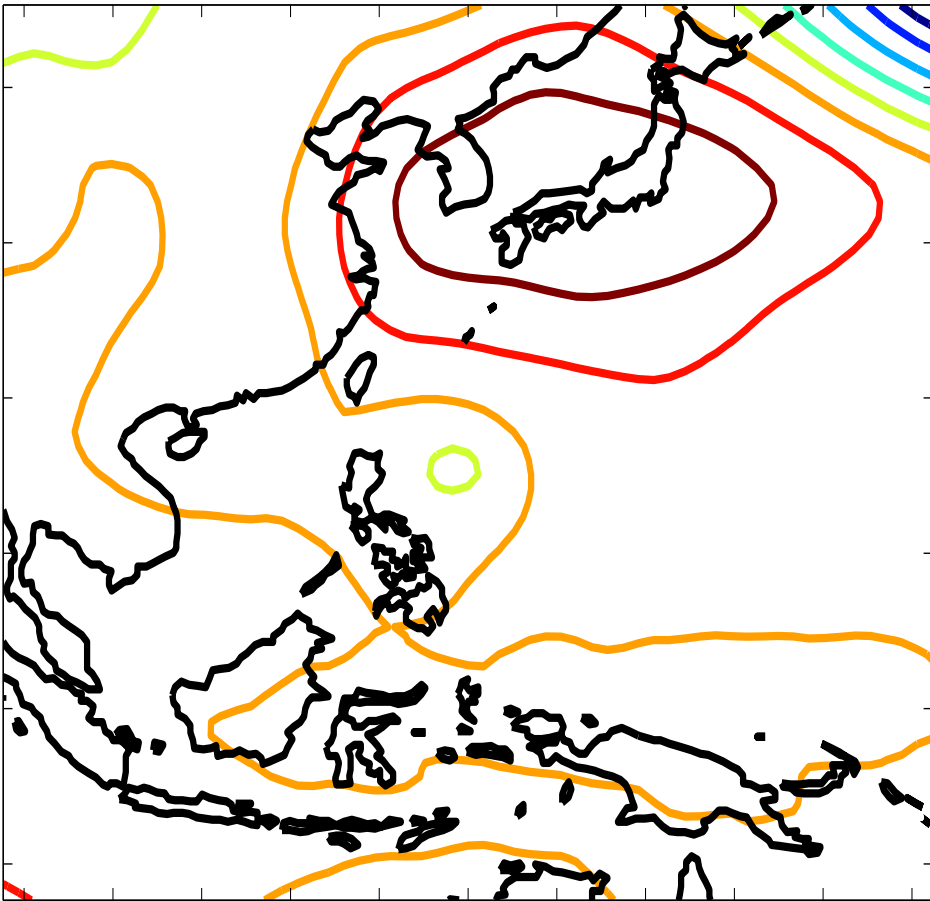
Japanese nens=50

- Ensemble track
- Landfall location
- Actual track

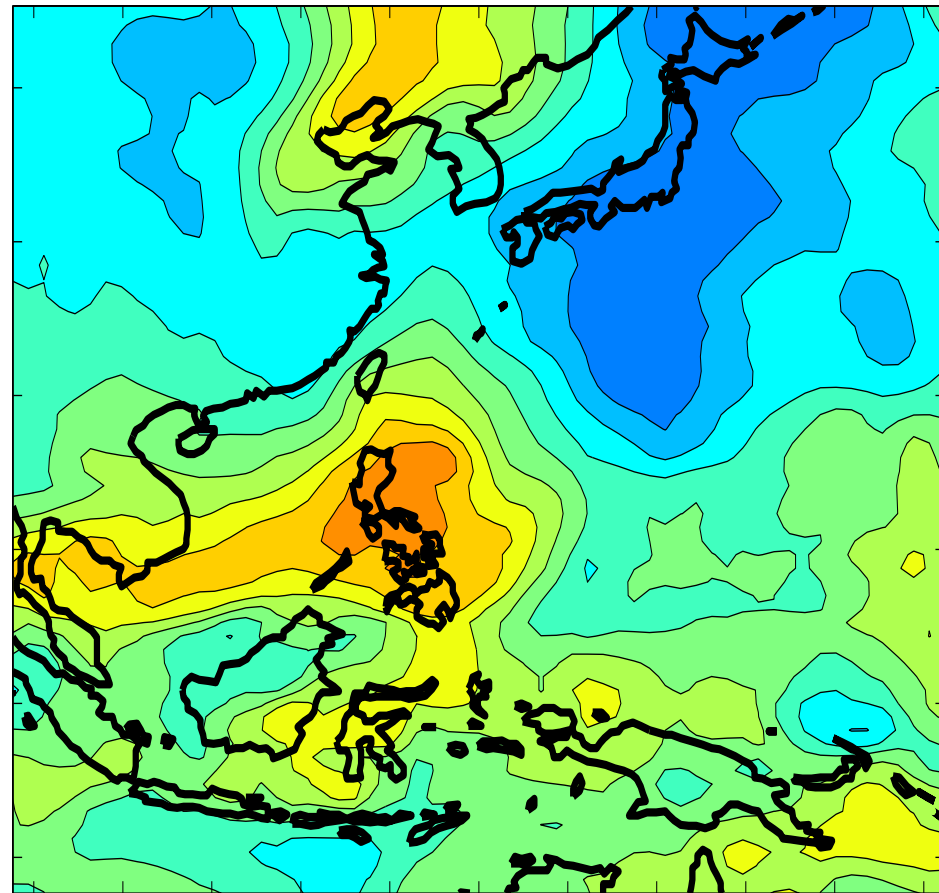


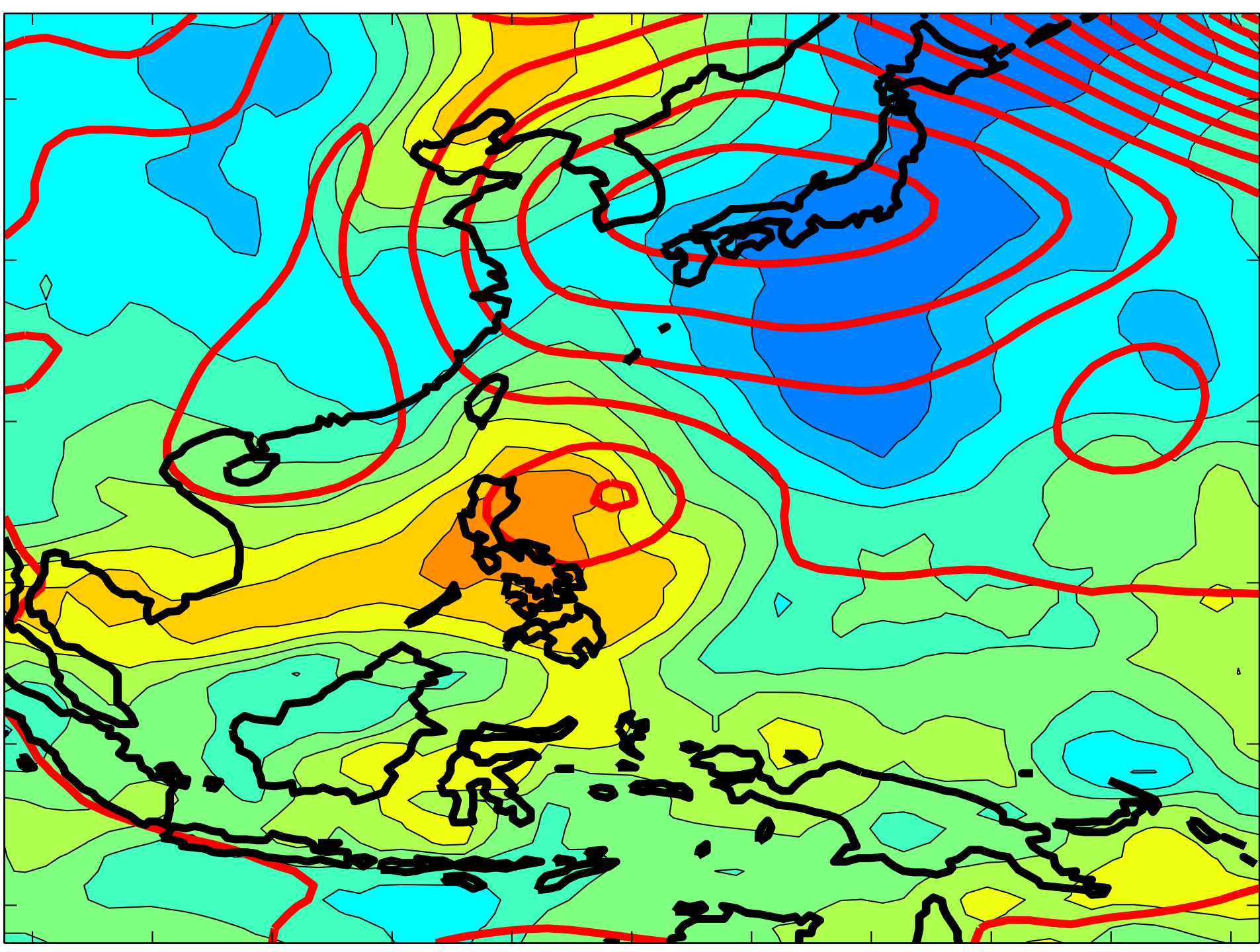


Ensemble mean 500mb at 6hrs



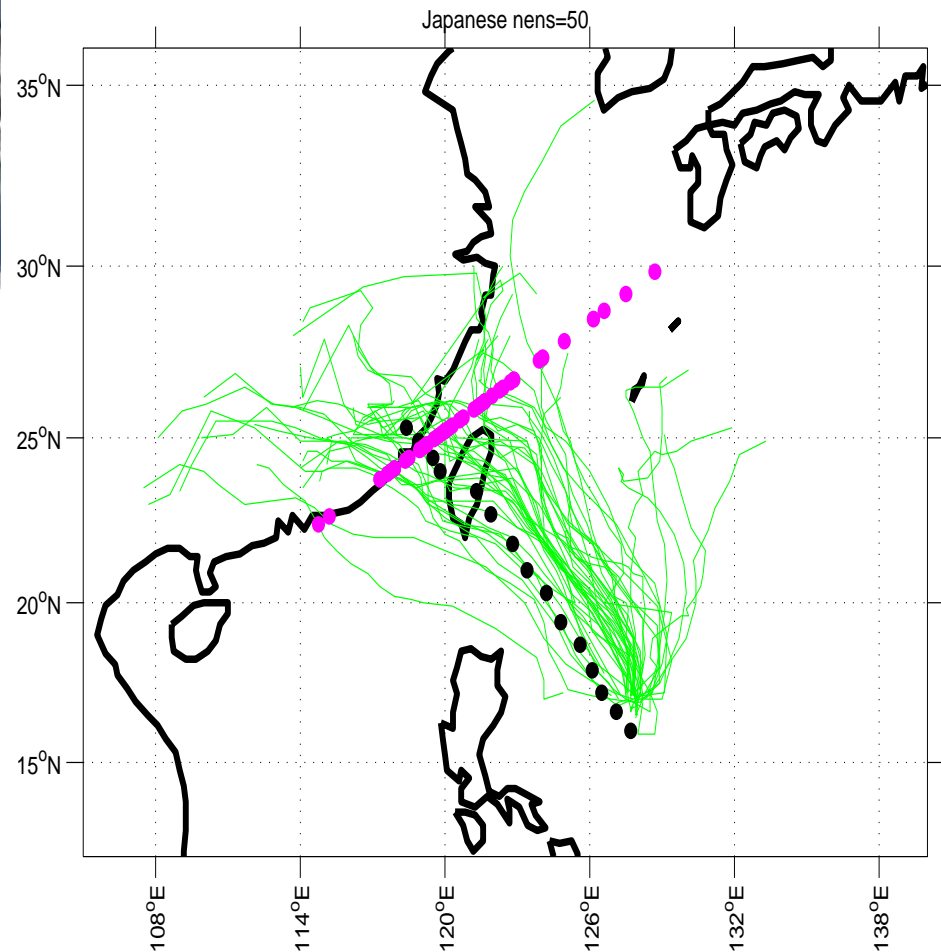
Sensitivity of latitude of landfall to 500mb heights at hour 6 of forecast







# Typhoon Sepat Ensemble Tracks 8.15.07.12

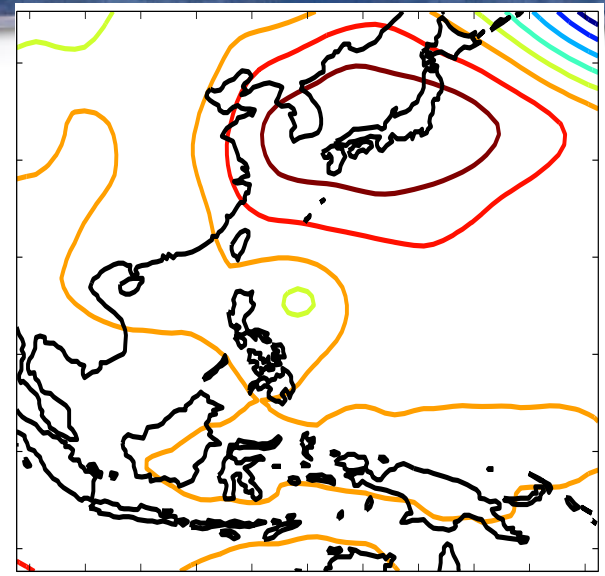


Typhoon Sepat

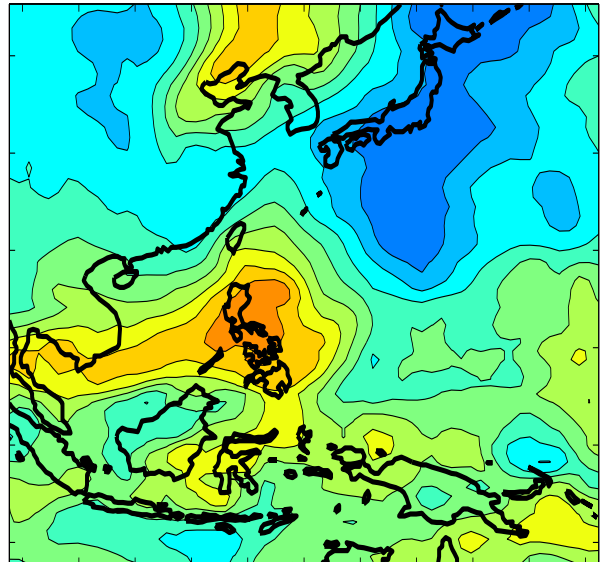
- Ensemble track
- Landfall location
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Dan Gombos, MIT

## Ensemble mean 500mb at 6hrs

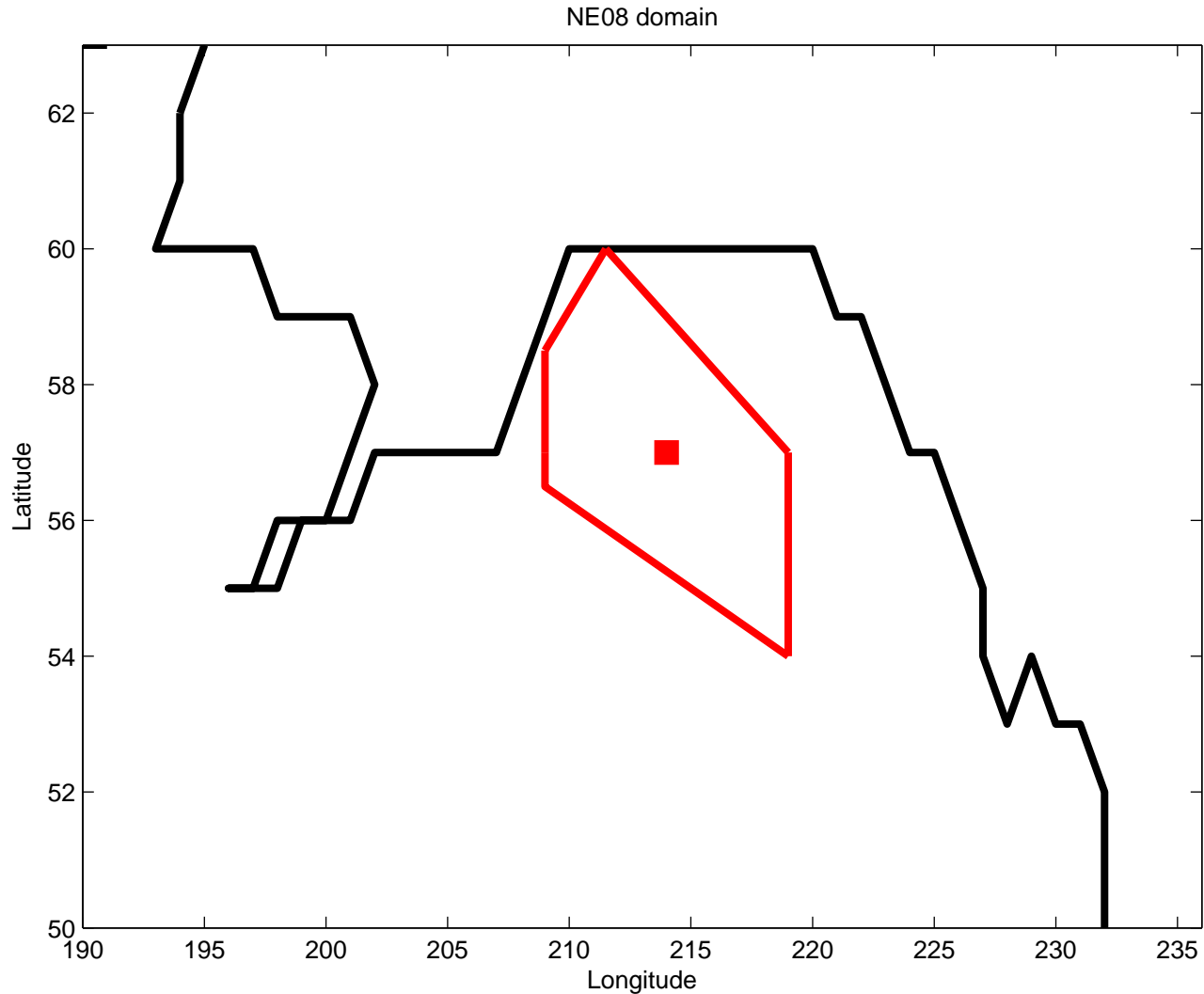


Sensitivity of latitude of landfall to 500mb heights at hour 6 of forecast

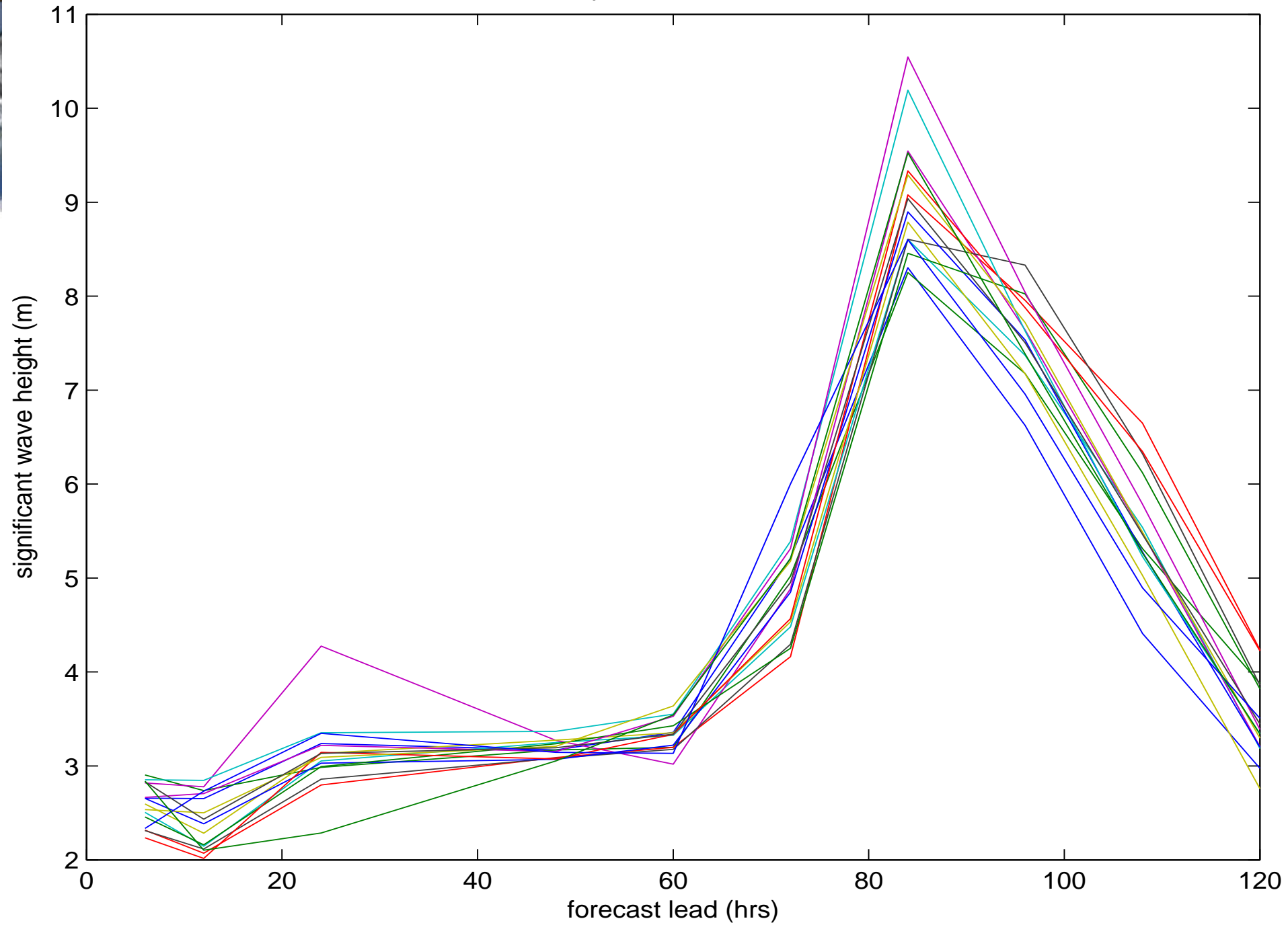




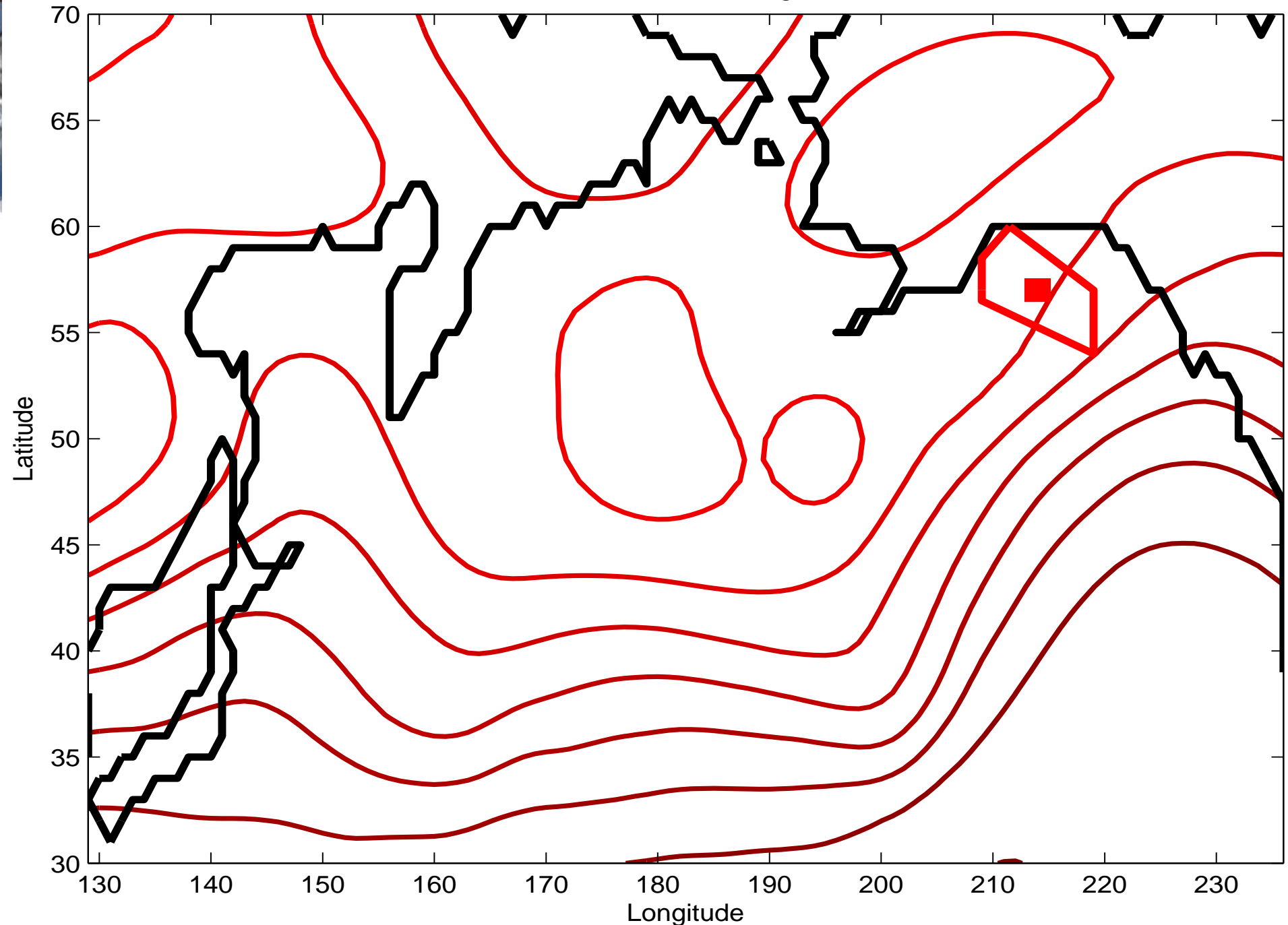
# Northern Edge 2008: High seas



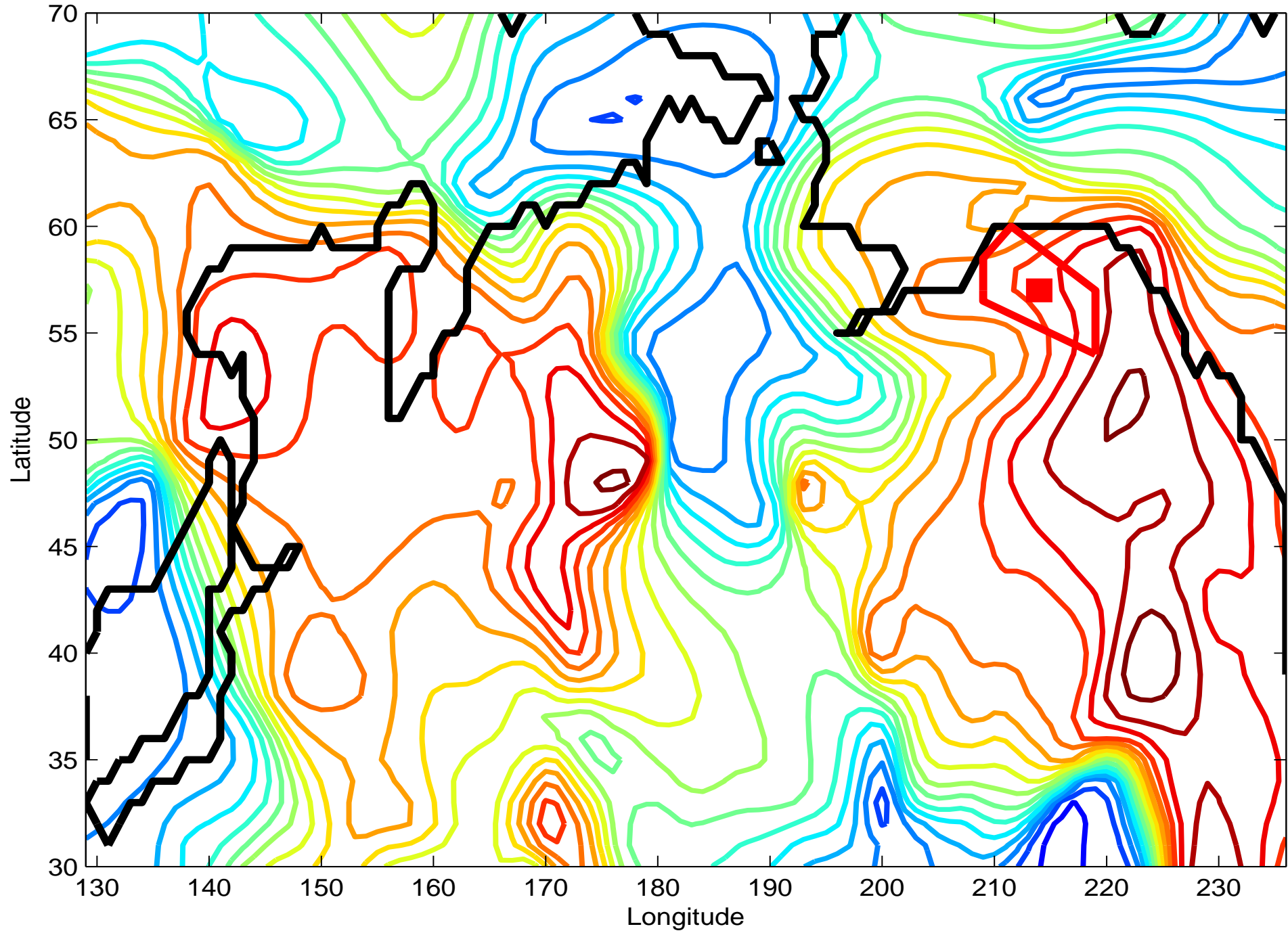
Wave plume at 214E, 57N



Ensemble mean 500mb heights at 6hrs

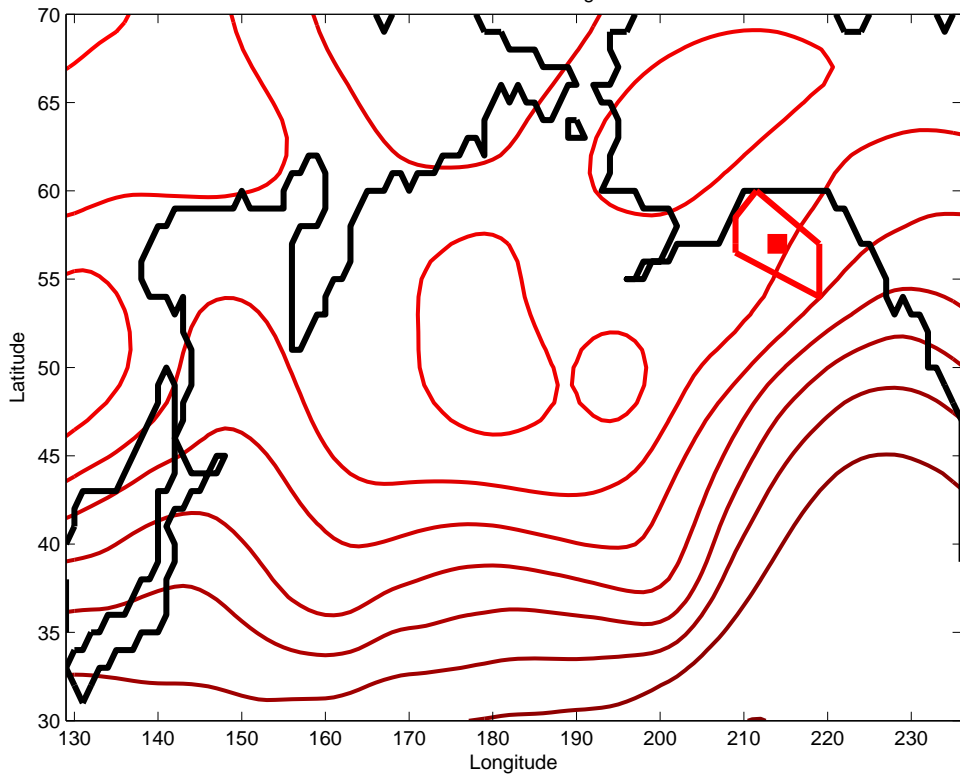


Sensitivity of 84hr waves to 6hr 500mb heights

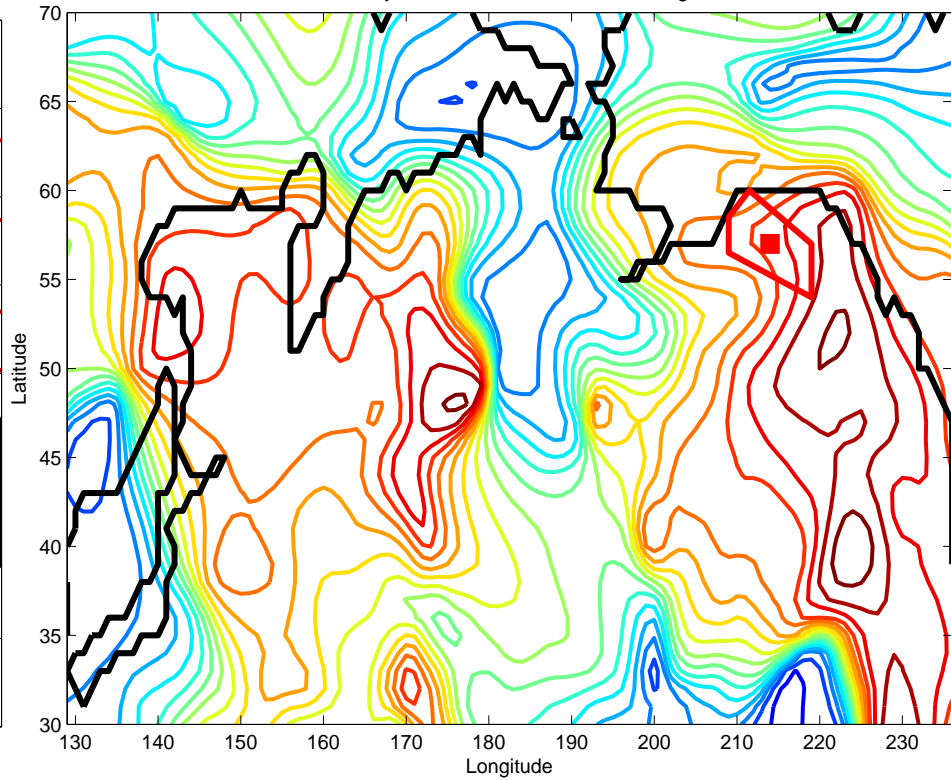




Ensemble mean 500mb heights at 6hrs

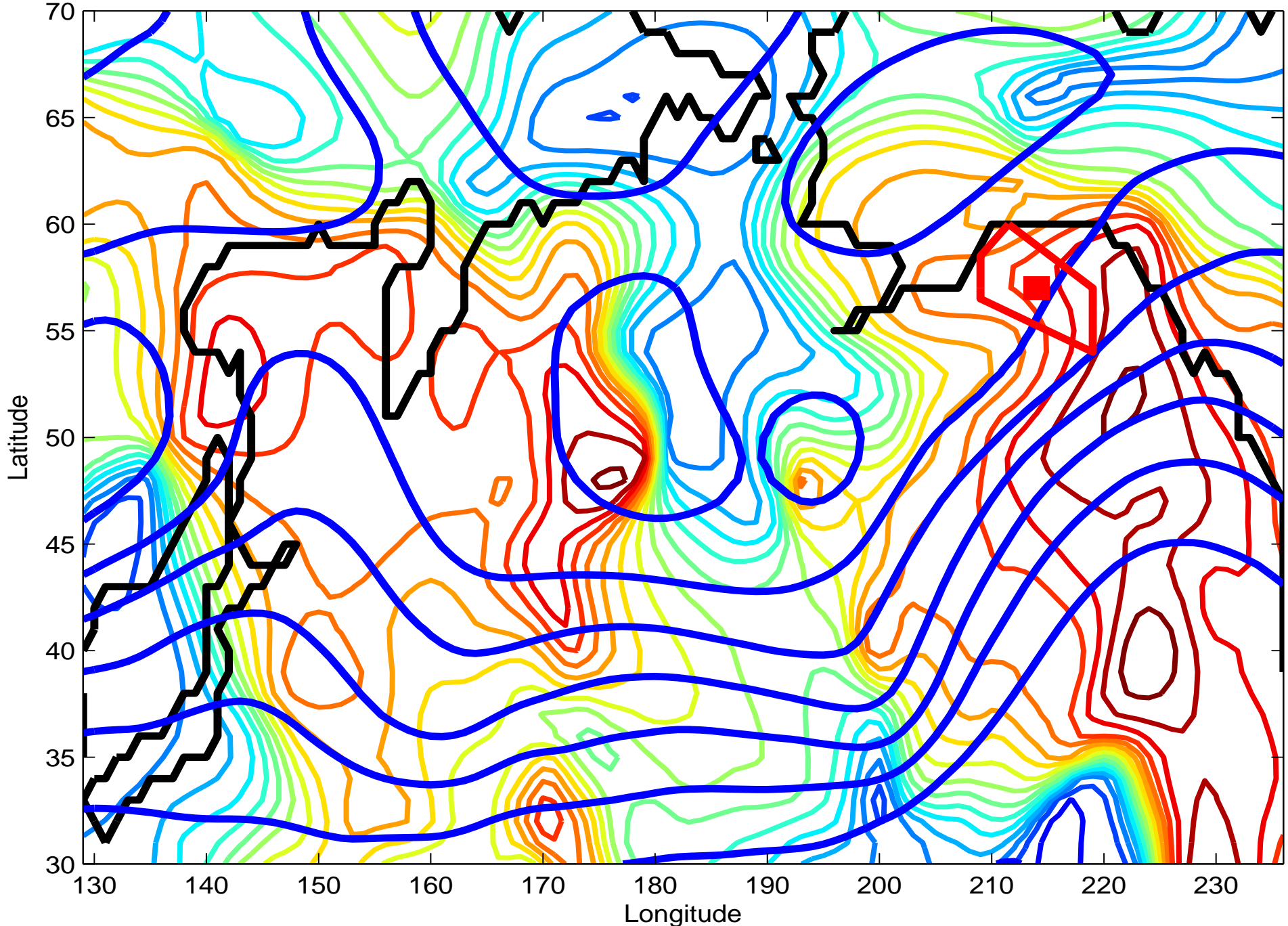


Sensitivity of 84hr waves to 6hr 500mb heights





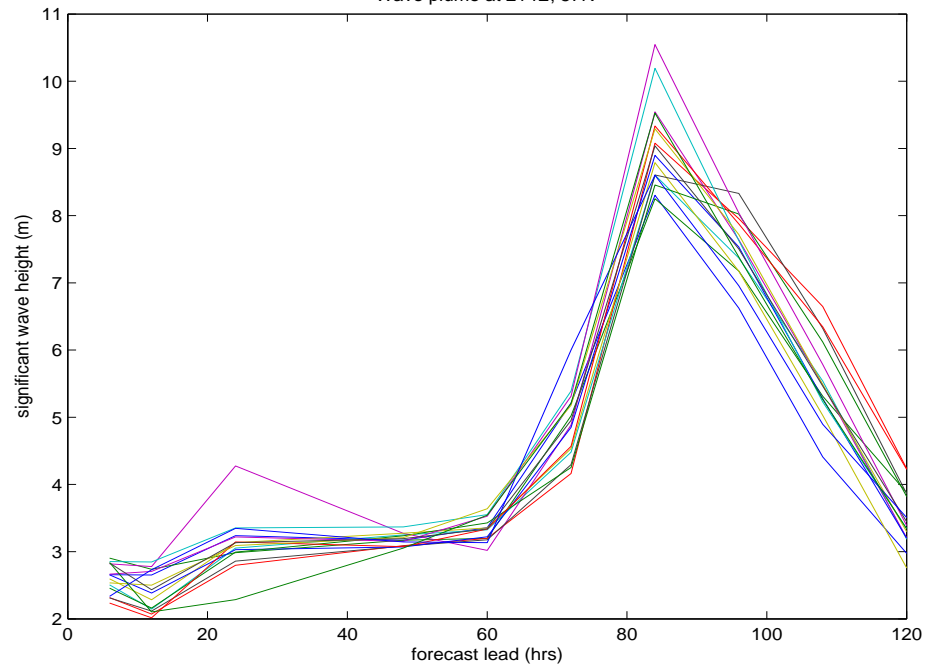
Sensitivity of 84hr waves to 6hr 500mb heights overplotted with 500mb heights







Wave plume at 214E, 57N



Sensitivity of 84hr waves to 6hr 500mb heights overplotted with 500mb heights

