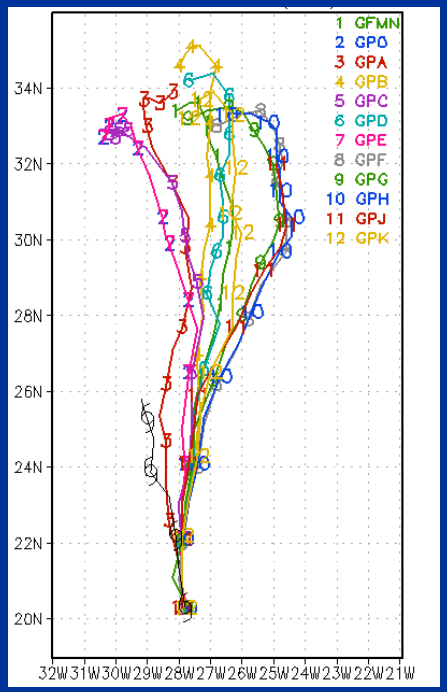
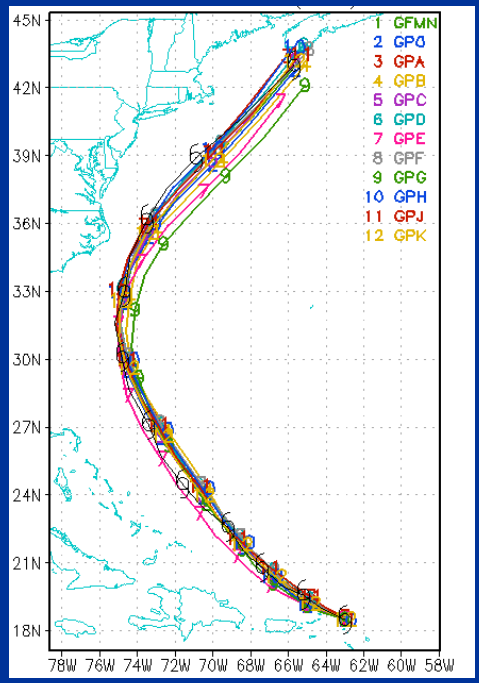
GFDL Hurricane Model Ensemble Performance during 2010 Atlantic Season



Tim Marchok
Morris Bender

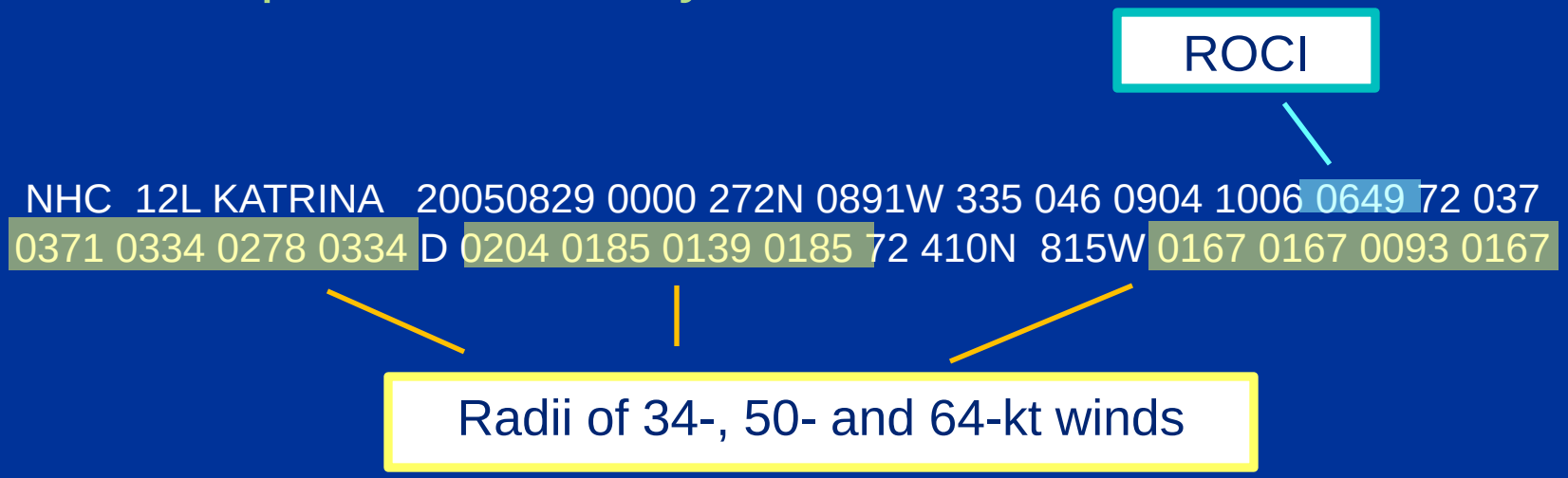
NOAA / GFDL

HFIP Team Meeting
Miami, FL
09 November 2010



Design of the system

- Focus on intensity
- Given time constraints, must be simple to implement
  - Development began in mid / late July
- Several members created by modifying the structure-related data from the NHC storm warning message in order to perturb the axisymmetric vortex



Defining the ensemble members

- 11-member ensemble: 10 perturbed members and a control forecast

  - GP0: Control forecast (GFD5 run on Jet)
  - GPA: Unbogussed forecast
  - GPB: GFD5 with no asymmetries included
  - GPC: GFD5, but with the use of old environmental filter
  - GPD: Increase storm size (ROCI-based) by 25%
  - GPE: Decrease storm size (ROCI-based) by 25%
  - GPF: Increase wind radii 25%, increase storm size 25%
  - GPG: Decrease wind radii 25%, decrease storm size 25%
  - GPH: Old filter (GPC), plus both size increases from GPF
  - GPJ: Old filter (GPC), plus both size decreases from GPG
  - GPK: Set Rmax minimum to 45 km (GFD5 control uses 25 km)

Running the ensemble

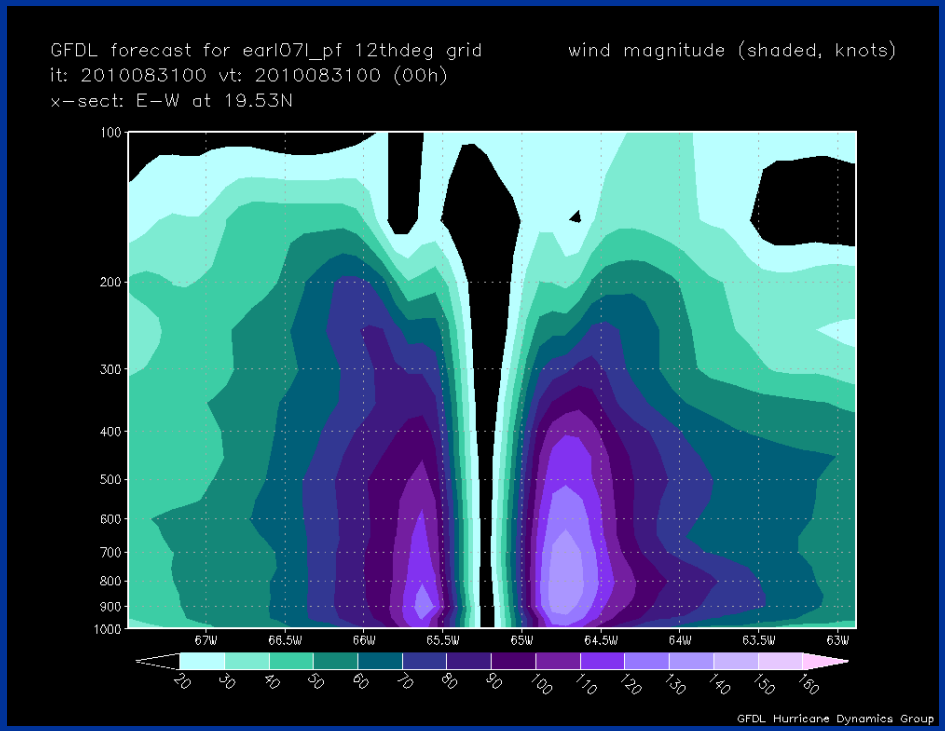
- All 11 members run on Jet at operational resolution (1/2^{o}, 1/6^{o}, 1/12^{o})
- Each member's 126-h forecast ran in 90 minutes using 31 cpus.
- Full forecast cycle in under 2 hours, allowing for up to 3 storms 4x per day.
- Automatic cycling of the system began on 21 September

Cases

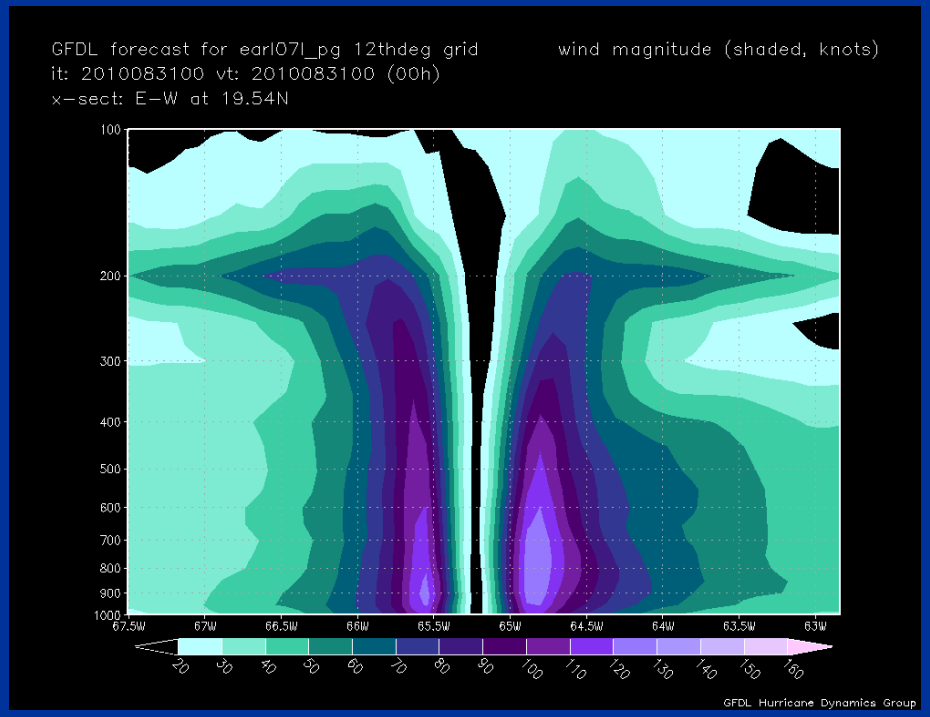
- 159 cases (1749 individual forecasts)
  - Danielle (17 cases)
  - Earl (20)
  - Igor (24)
  - Lisa (15)
  - Matthew (12)
  - Nicole (3)
  - Otto (10)
  - Paula (16)
  - Richard (20)
  - Shary (4)
  - Tomas (18)

Earl 2010083100

Wind magnitude cross-sections at initial time

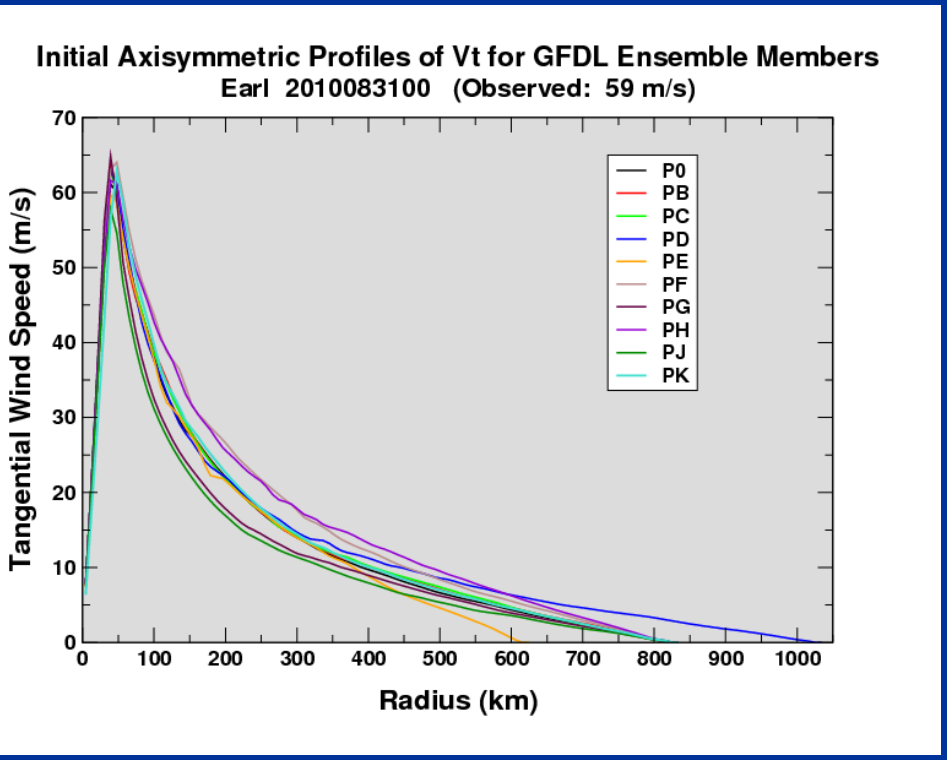


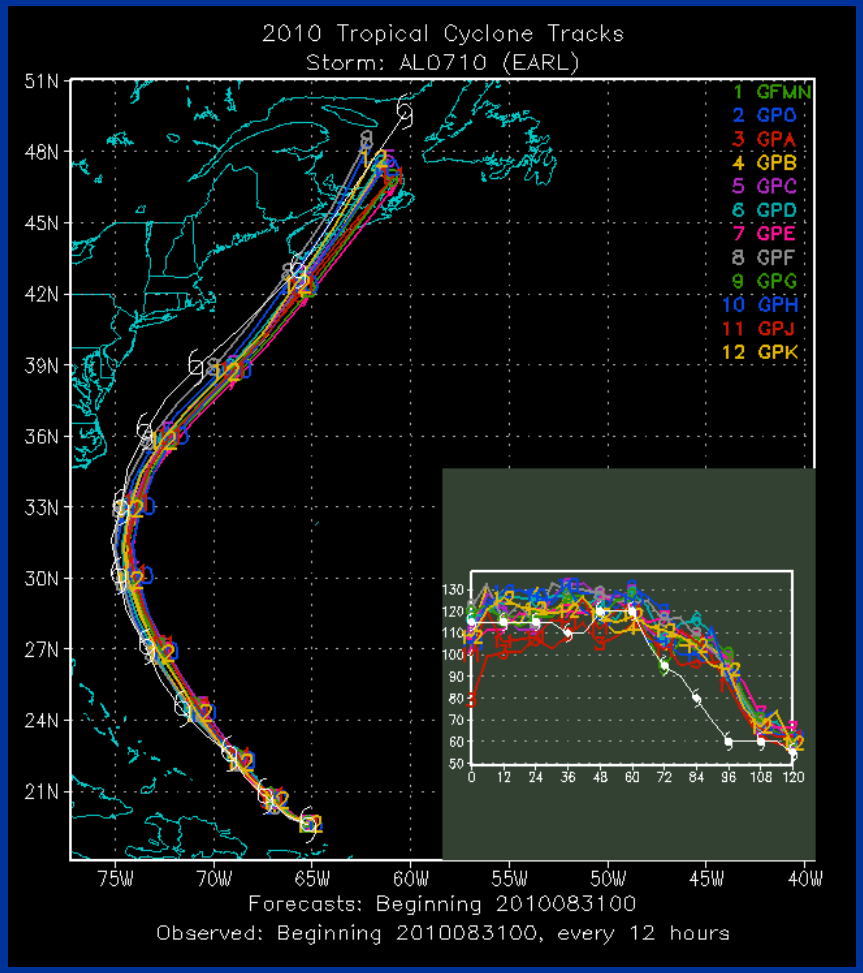
GPF: Increase all wind radii and storm size (ROCI) by 25%



GPG: Decrease all wind radii and storm size (ROCI) by 25%

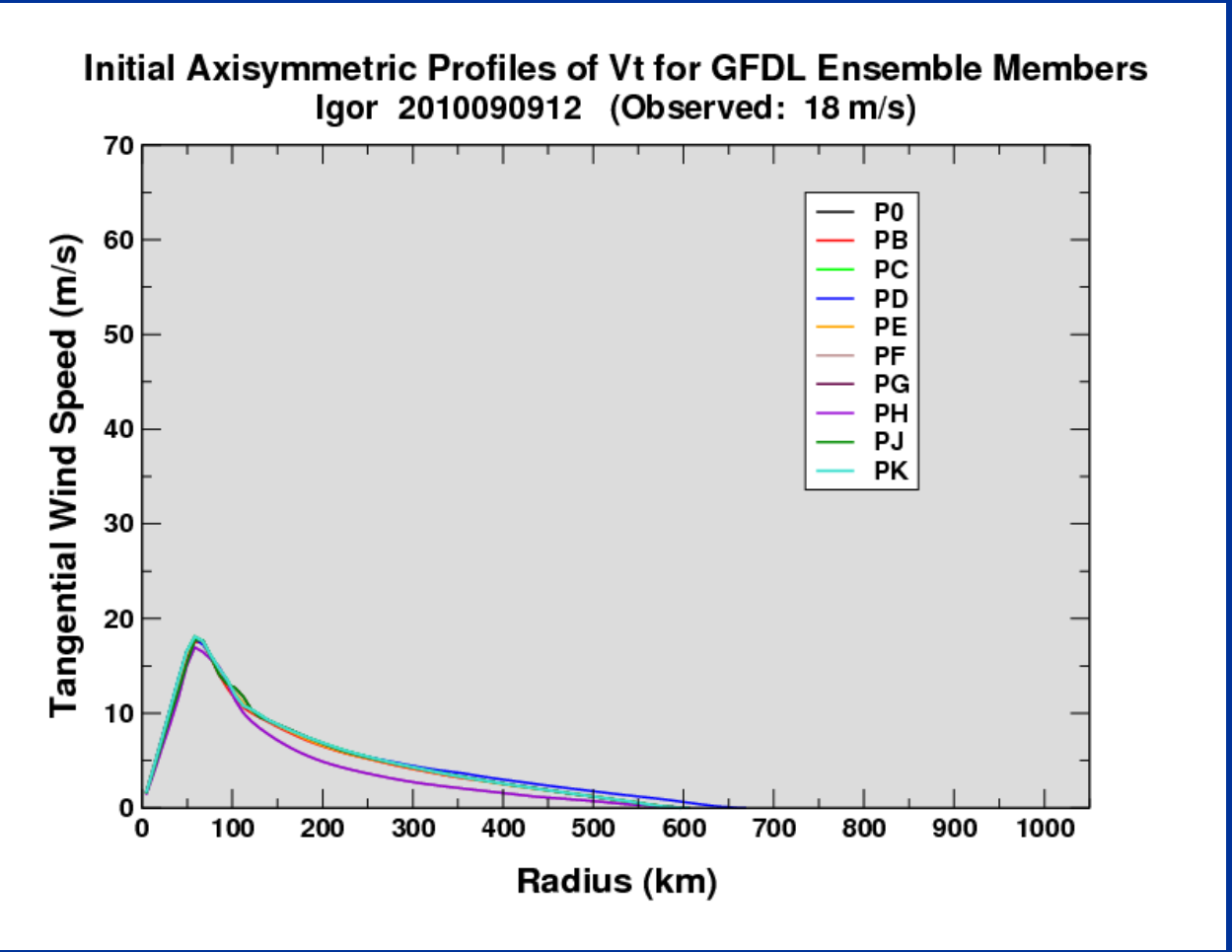
Earl 2010083100





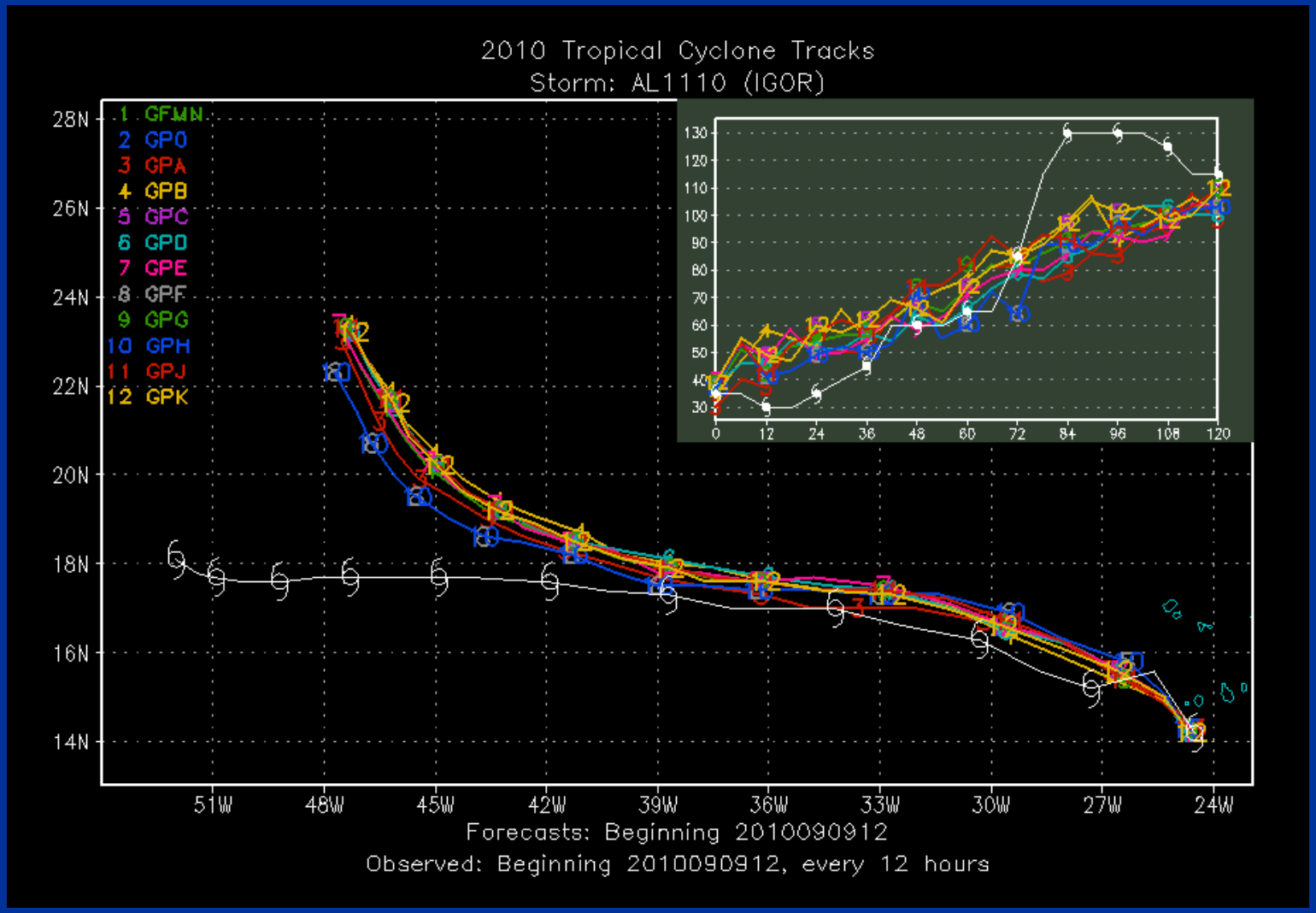
Spread evident in the V_T profiles from the vortex spinup leads to noticeable spread in the Vmax forecast, but very little spread in the tracks.

Igor 2010090912



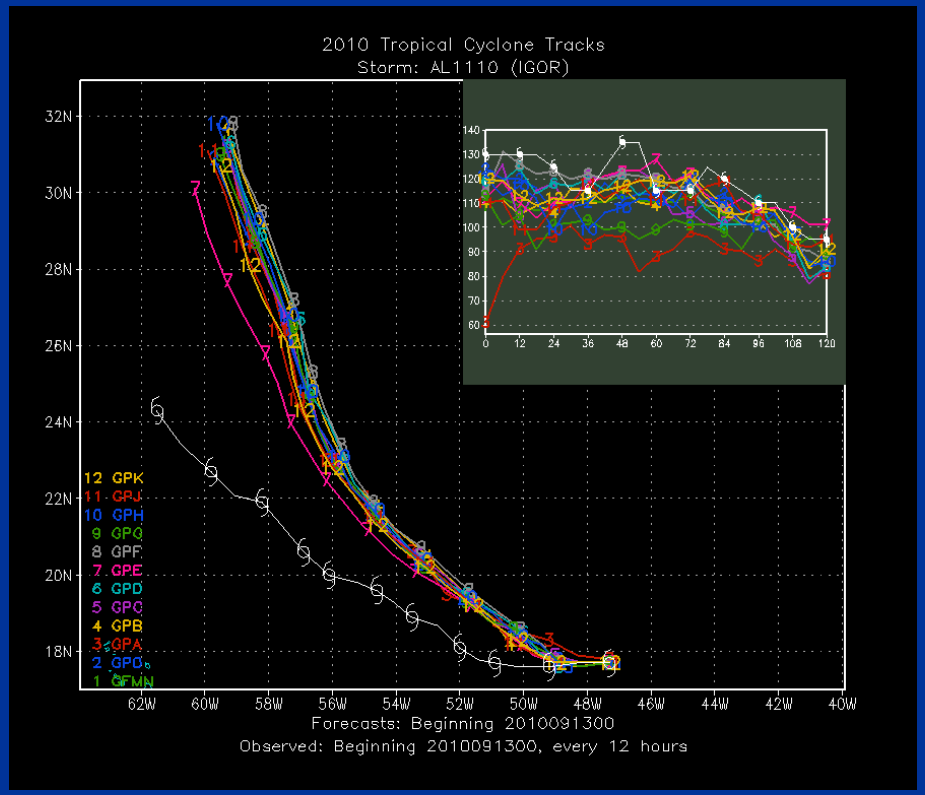
As a weak tropical storm (35 kts), there is little in the way of structure to manipulate for this case of Igor.

Igor 2010090912

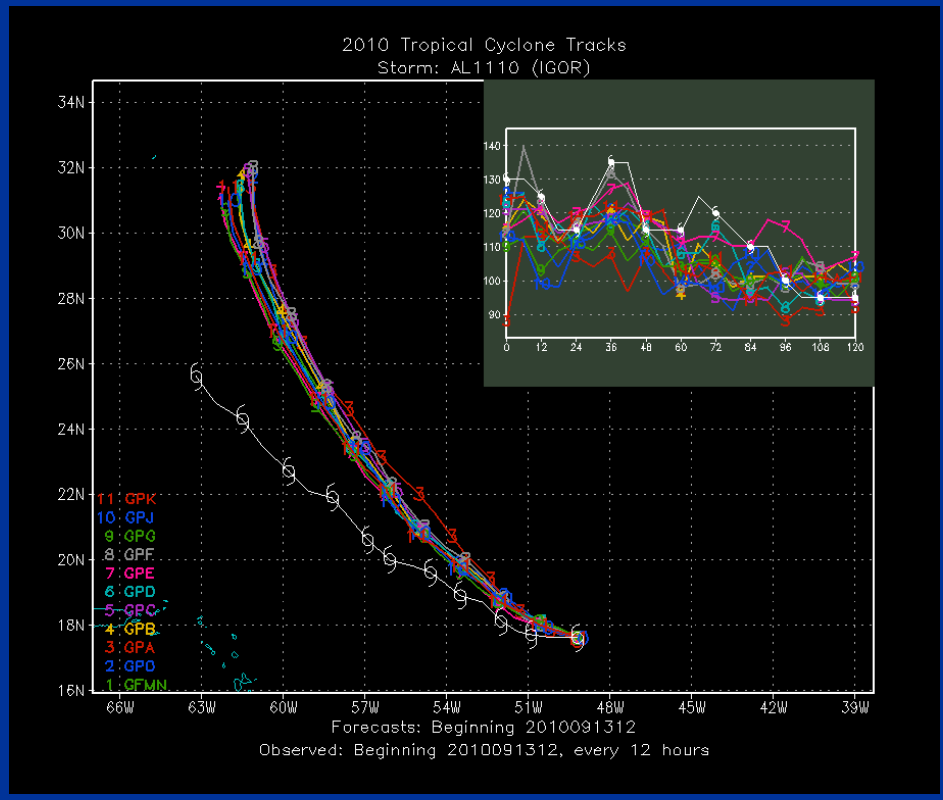


Small spread is seen throughout this case for both track and intensity

Igor



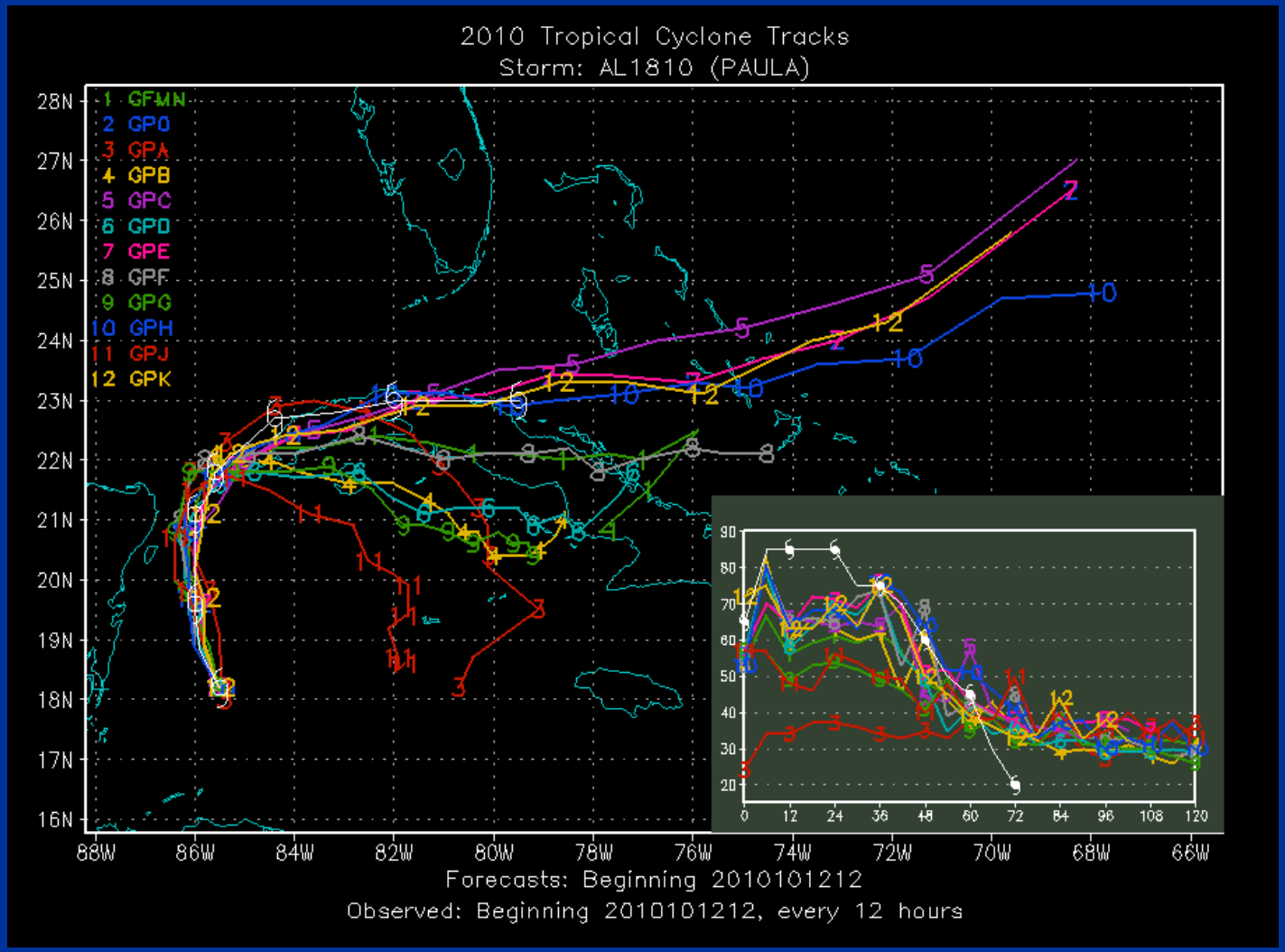
2010091300 (130 kts)



2010091312 (130 kts)

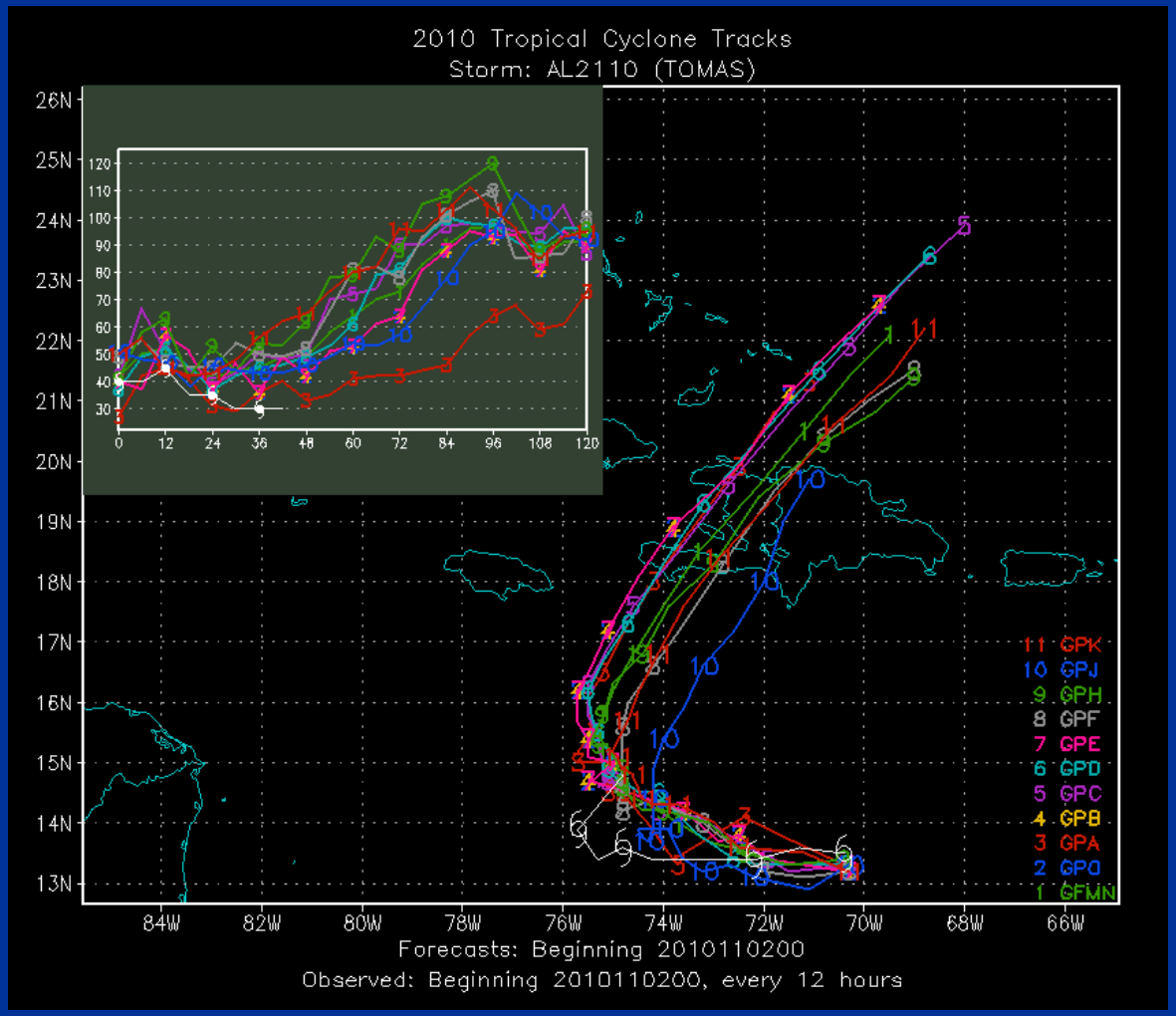
Later cases of Igor – when more intense – exhibited more spread, at least for the intensity forecasts.

Paula



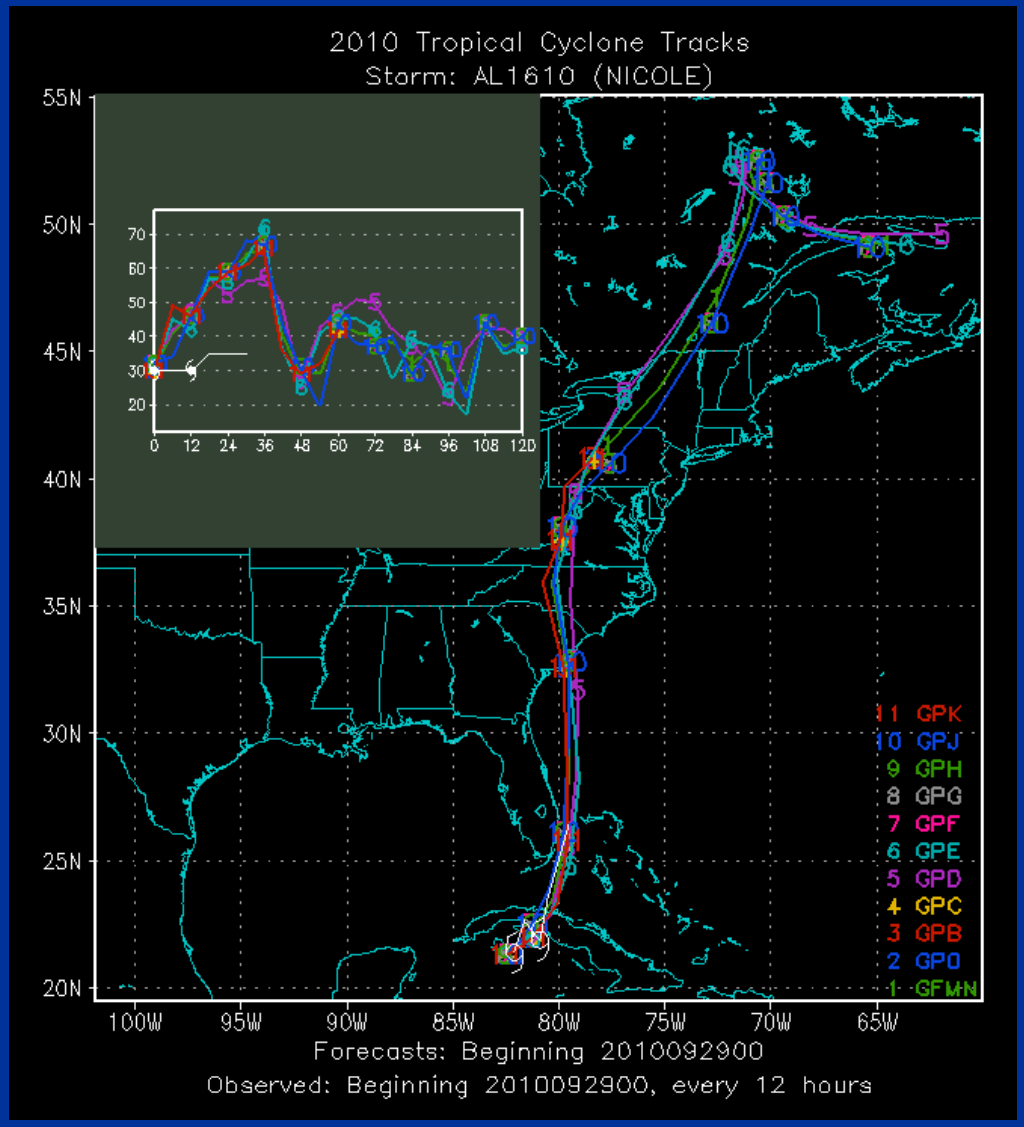
Cases of Paula exhibited some of the most spread for track forecasts

Tomas



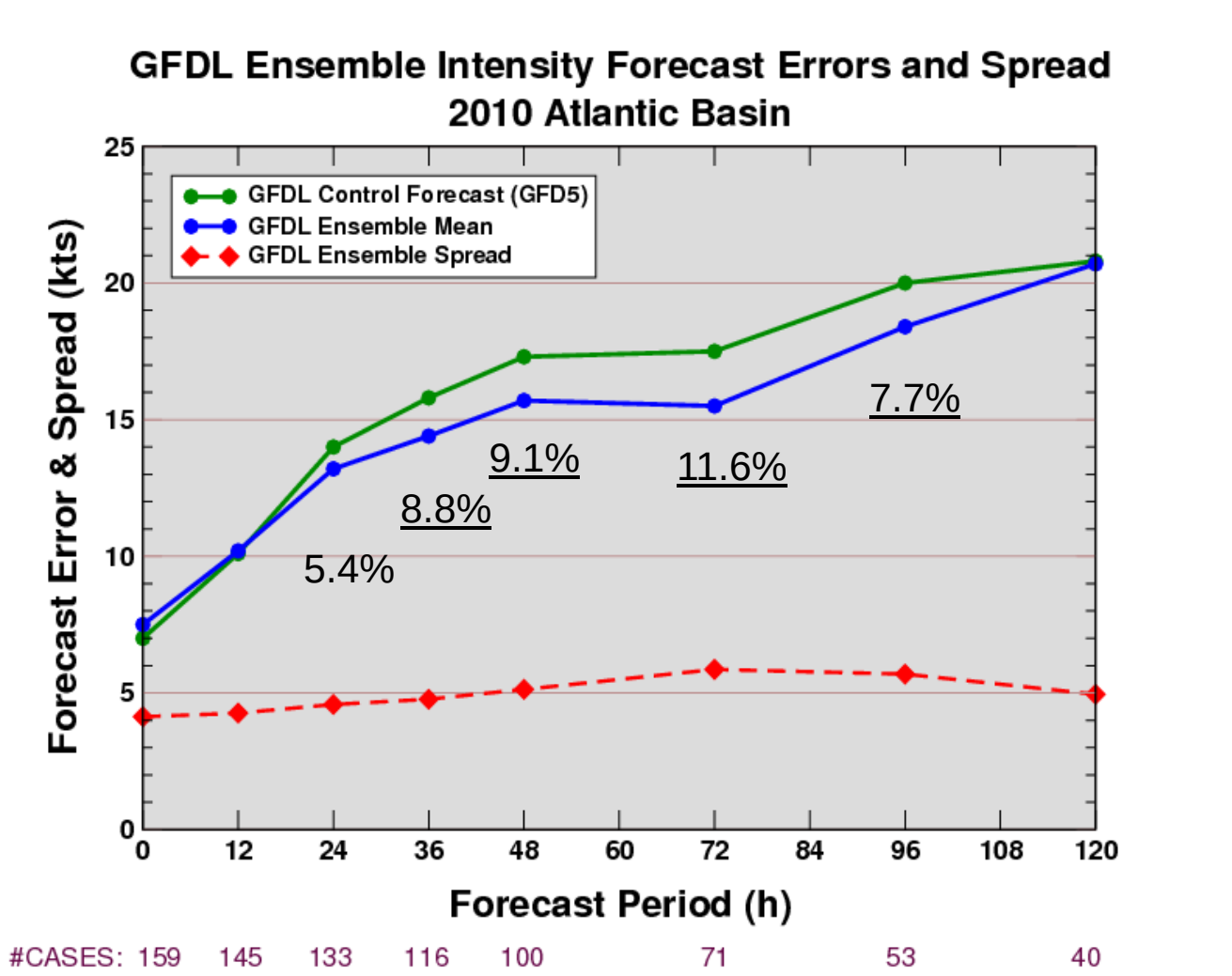
The ensemble indicated forecast uncertainty in the timing of Tomas' turn to the right.

Nicole



A problem that occasionally occurred with very weak storms is shown here for Nicole in which several identical forecasts were produced.

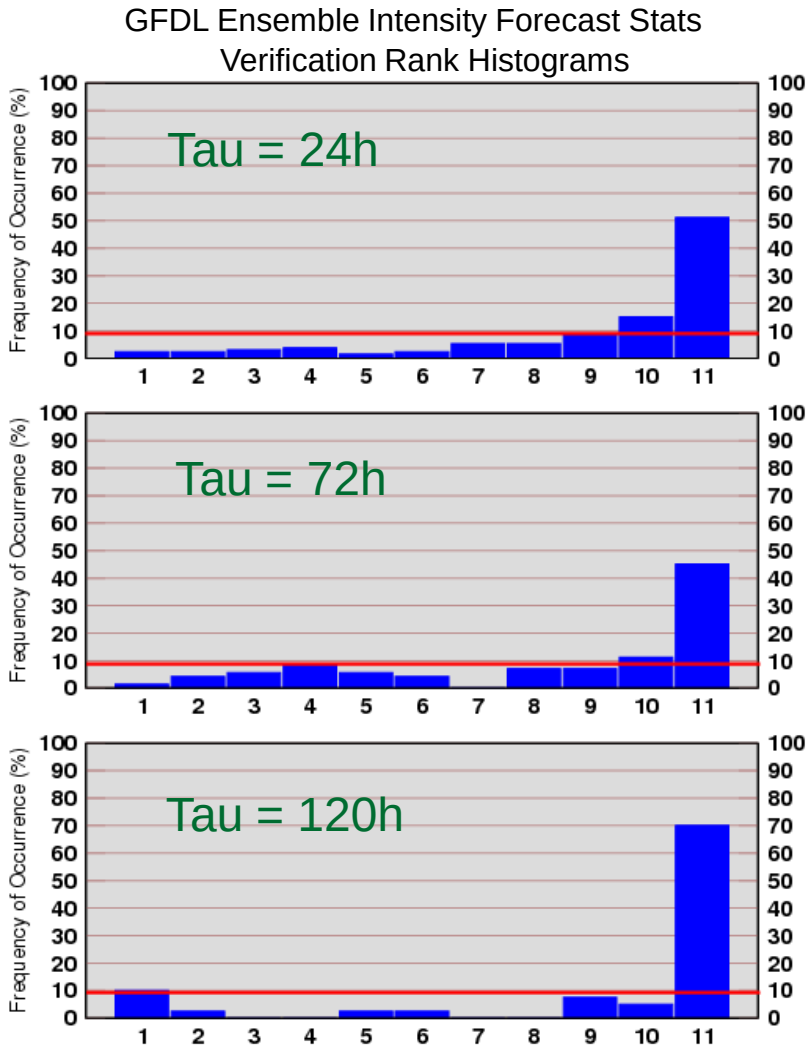
Intensity Results



Statistically significant improvements of the ensemble mean over the control are seen through the middle of the forecast period.

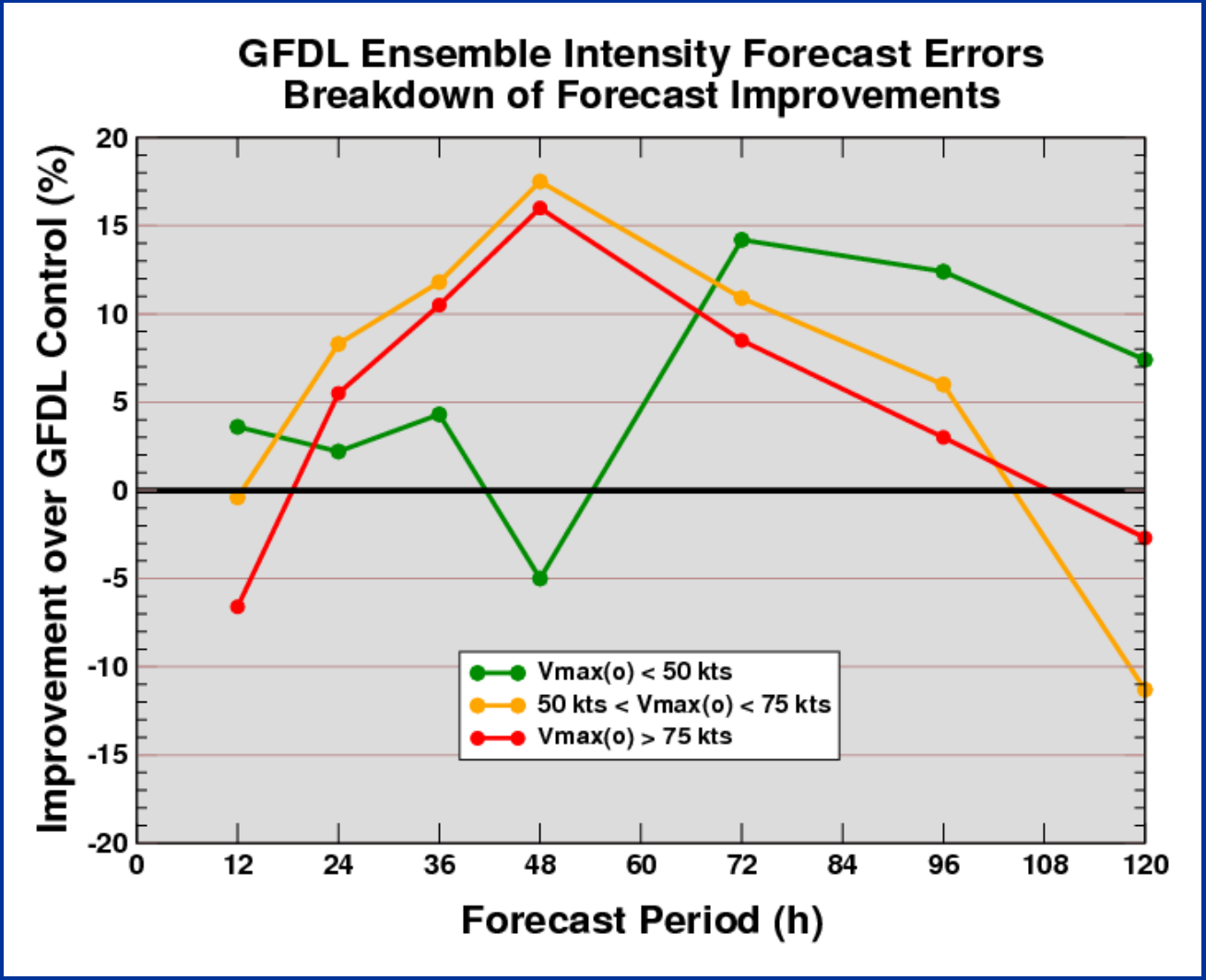
However, the spread results indicate an underdispersive ensemble

Intensity Results



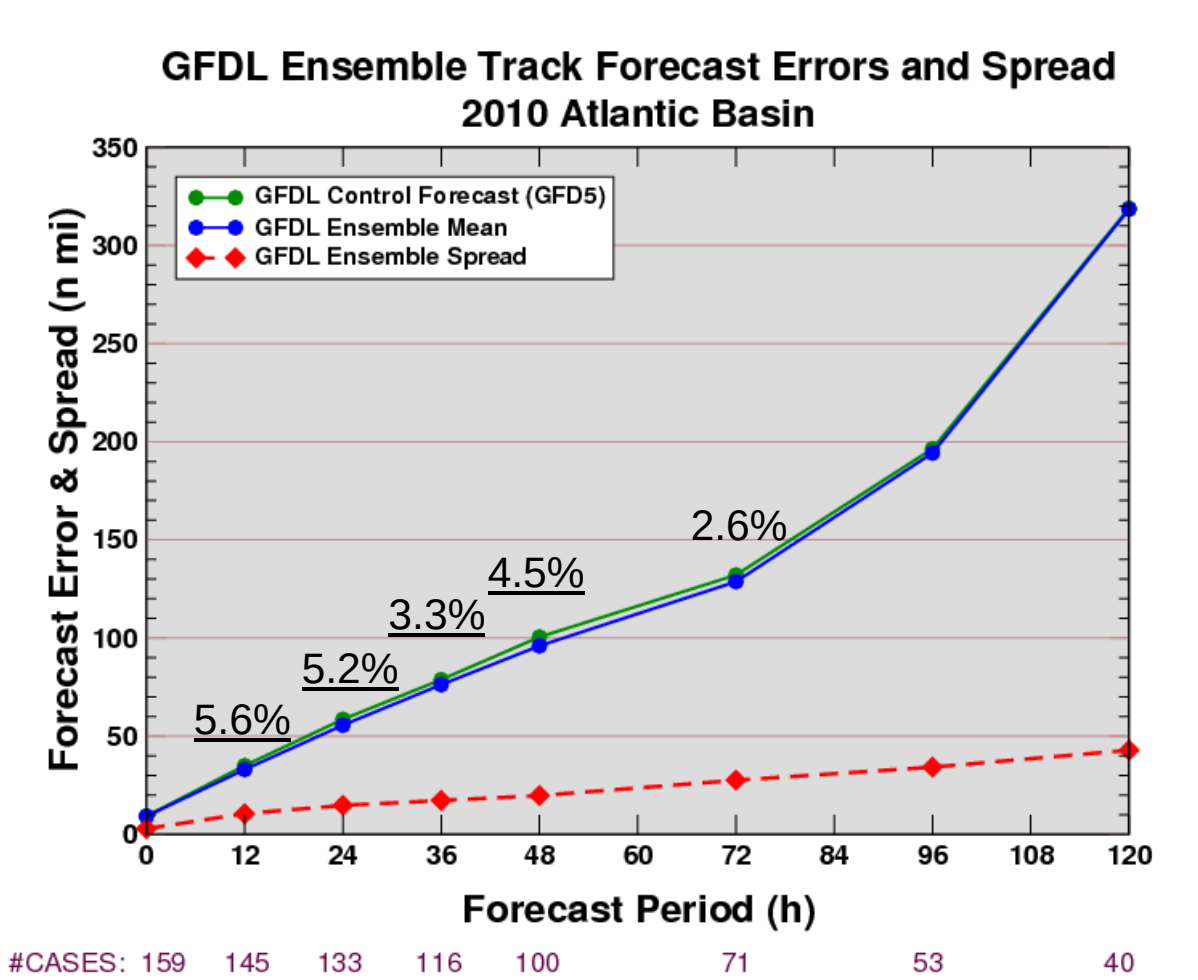
The verification rank histograms also indicate an underdispersive ensemble, although the best distribution is at 72h.

Intensity Results



Forecasts for weak storms see very little improvement from the GFDL ensemble mean until 3 days, while stronger storms see improvements at earlier lead times.

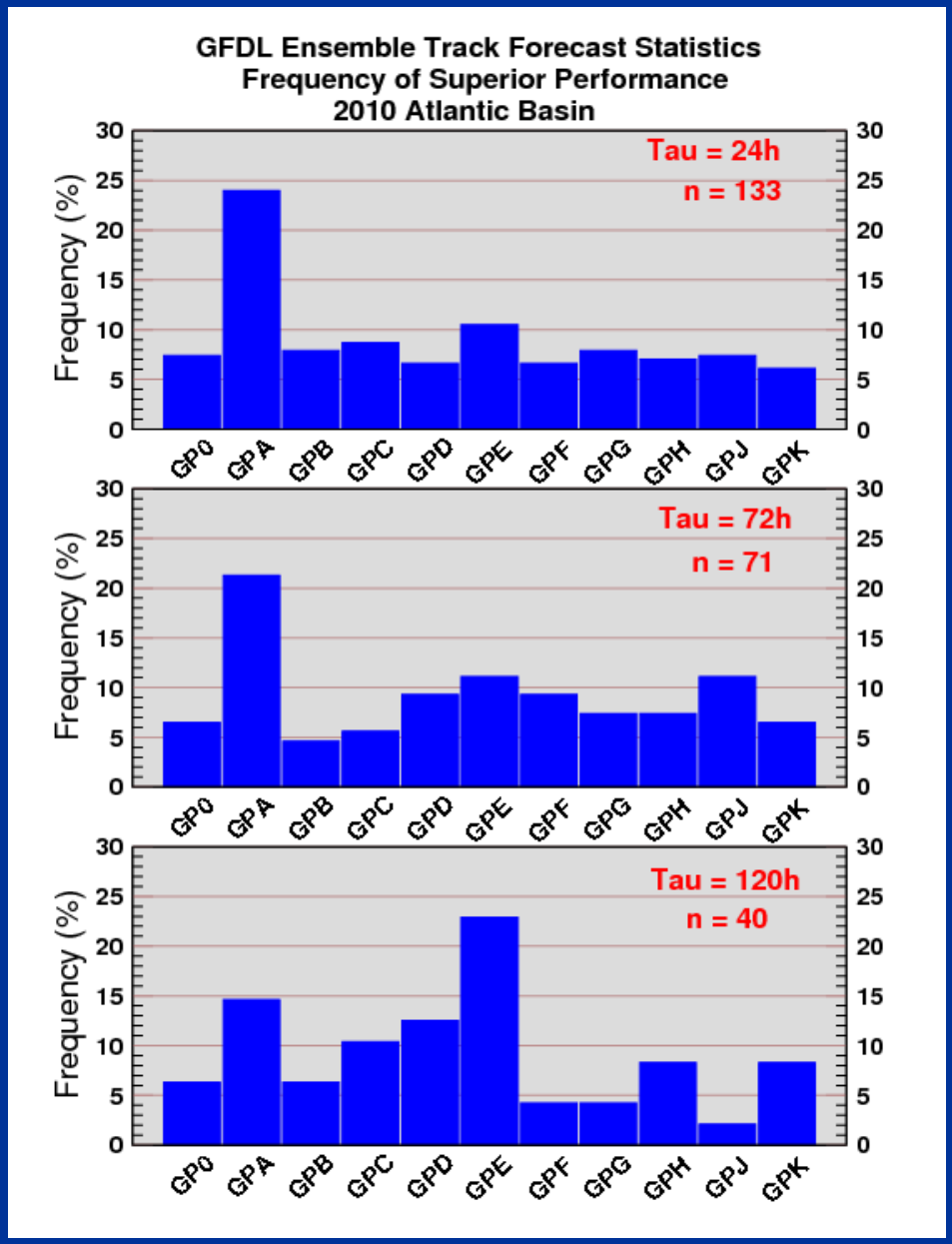
Track Results



Improvements for track are smaller than for intensity, but still significant from 12-48h .

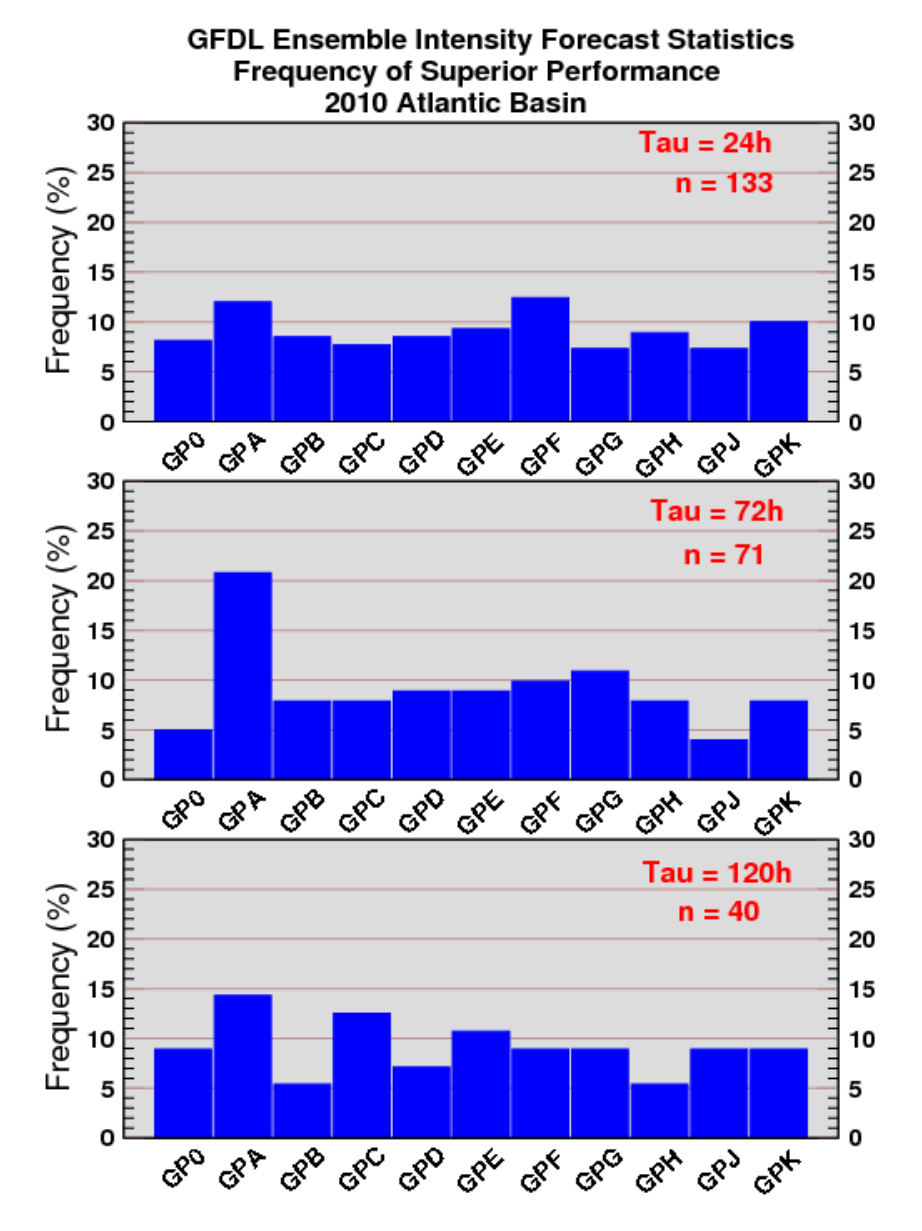
However, the spread in the track forecasts is extremely low.

Frequency of Superior Performance: Track



A surprising result was how well the unbogussed forecast performed

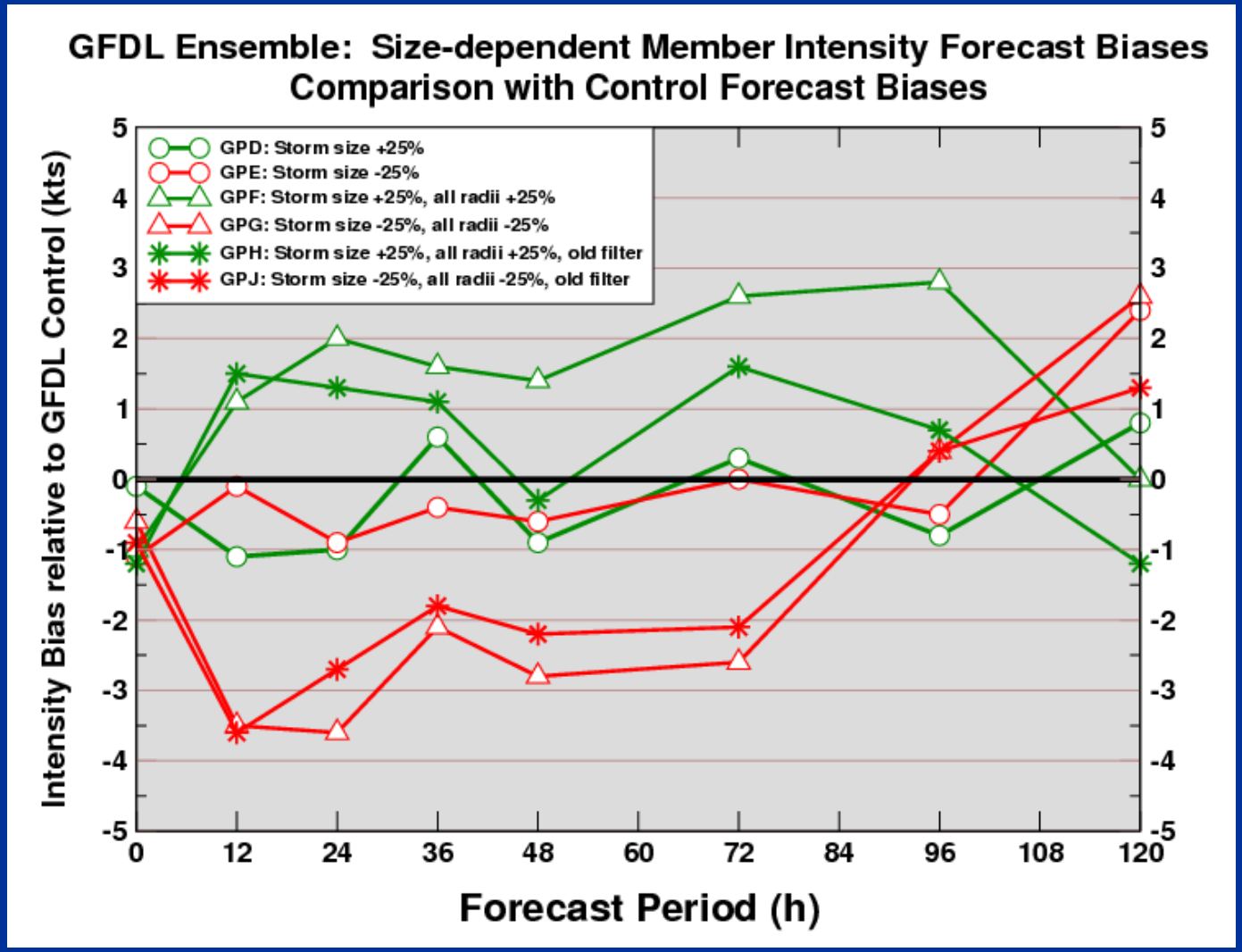
Frequency of Superior Performance: Intensity



The unbogussed forecast also performed well for intensity at later lead times, after shedding its negative bias from early lead times.

Overall, FSP for intensity is spread fairly evenly across the ensemble members.

Comparison of Forecast Intensity Biases



Modifying the wind radii has more of an impact on intensity bias than just modifying storm size alone.

Future Plans

- Complete runs for missed 2010 storms
- Consider alternate methods of perturbing member forecasts for use in FY11:
  - Use of alternate / modified physics packages
  - Use of fields from global ensemble forecasts
  - Use stronger forcing to modify the initial vortex structure
  - Others…?

Conclusions

- Modest improvements seen for intensity forecasts, somewhat less for track.
- Modifying the vortex structure shows promise for perturbing forecasts (although not as well for weak storms, given the perturbation method we used).
- The ensemble shows low dispersion for intensity and especially track, and it would benefit from increased spread.
- Modifying the wind radii has more of an impact on intensity bias than just modifying ROCI-based storm size alone.
- The unbogussed forecast performed surprisingly well for track, and even for intensity at later lead times.