GFDL Hurricane Model Ensemble
2011 HFIP / t-Jet Proposal

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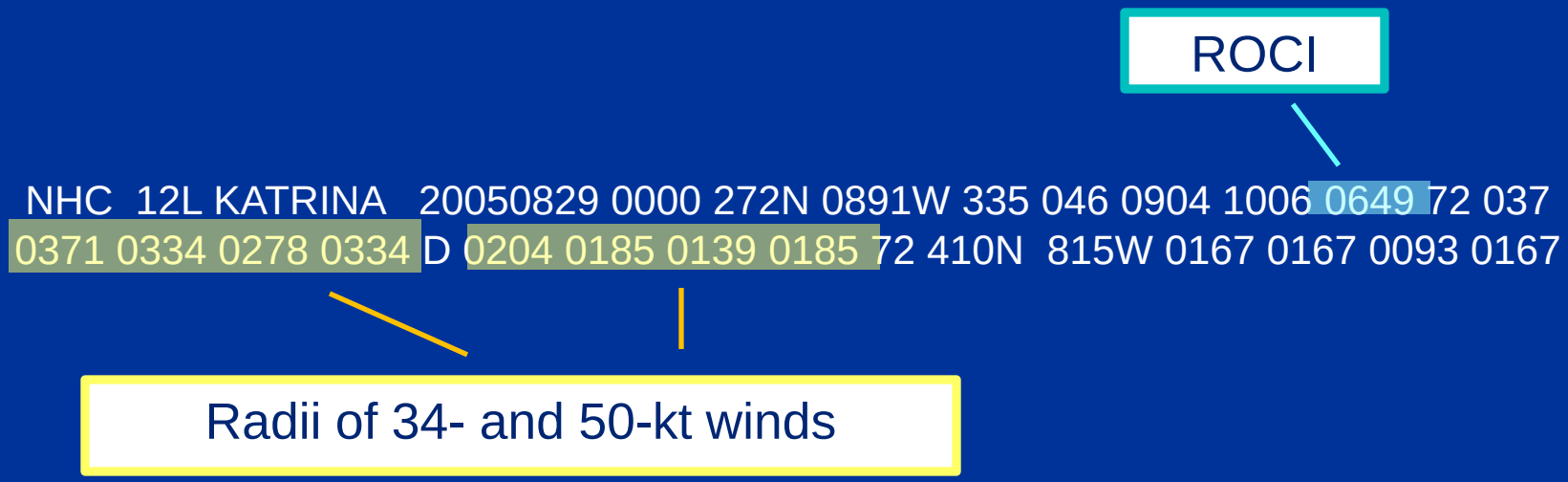
Design of the system

- Goal: Develop an ensemble of forecasts based on the operational GFDL hurricane model, with an emphasis on intensity forecasts.
- Majority of members created by modifying components of the GFDL synthetic vortex spinup
- Several members created by modifying the structure-related data from the NHC storm warning message in order to perturb the axisymmetric vortex



Ensemble membership during 2010 season

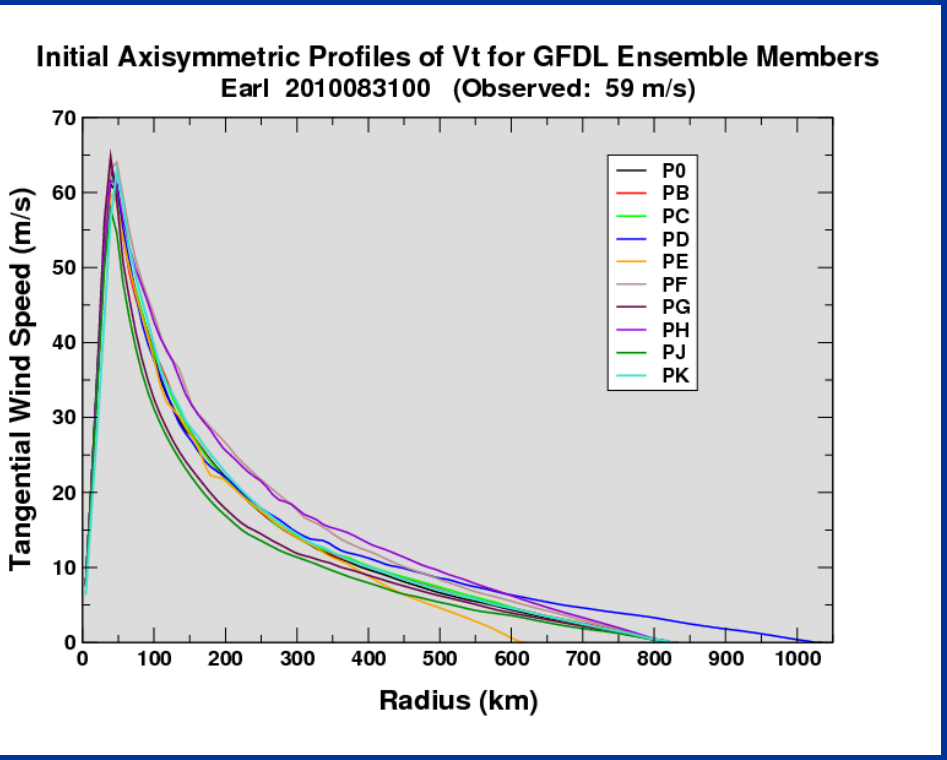
- 11-member ensemble: 10 perturbed members and a control forecast
  - GP0: Control forecast (GFD5 run on Jet)
  - GPA: Unbogussed forecast
  - GPB: Control, but with no asymmetries included
  - GPC: Control, but with the use of old environmental filter
  - GPD: Increase storm size (ROCI-based) by 25%
  - 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)

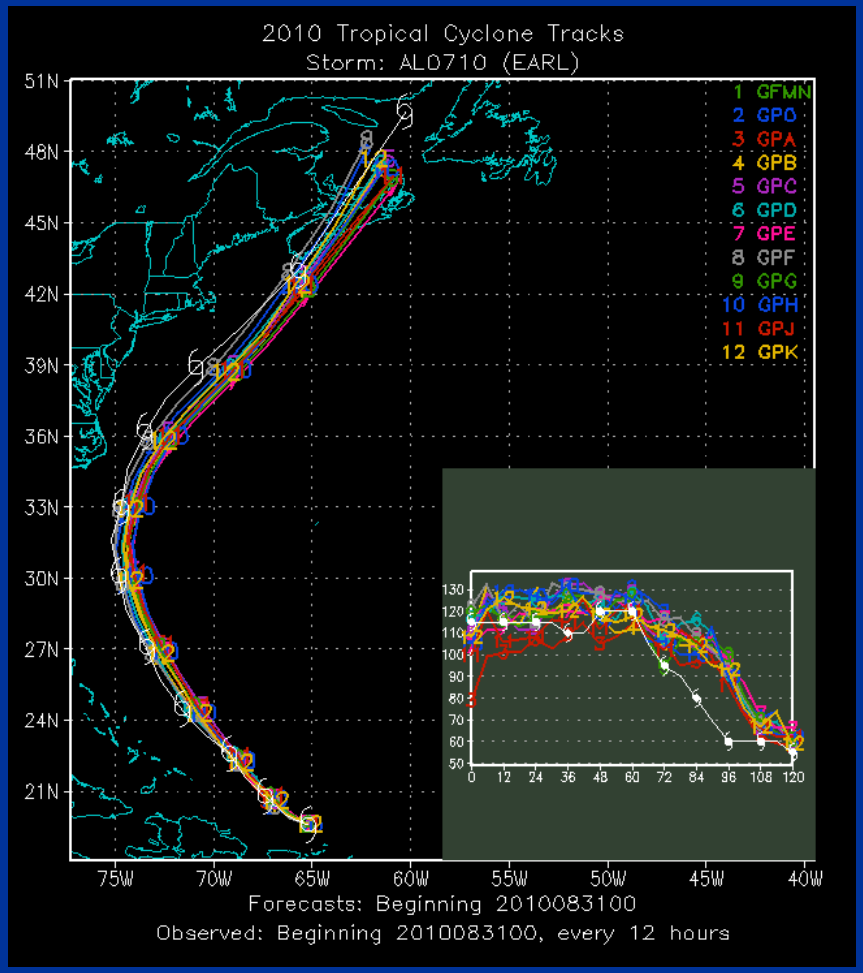
Size Members

Running the ensemble in 2010

- All 11 members were run 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 ran in under 2 hours, allowing for up to 3 storms 4x per day.

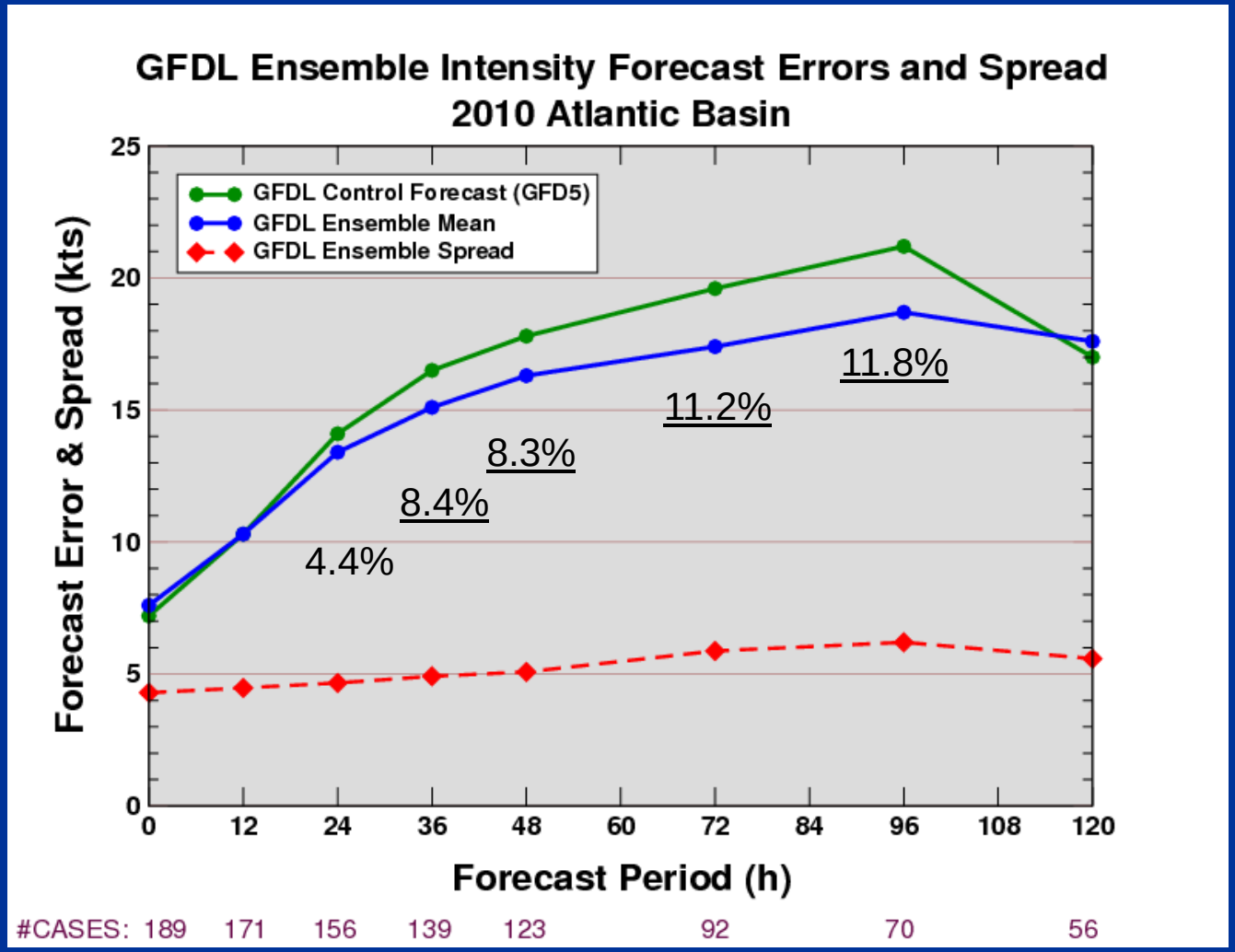
Earl 2010083100





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

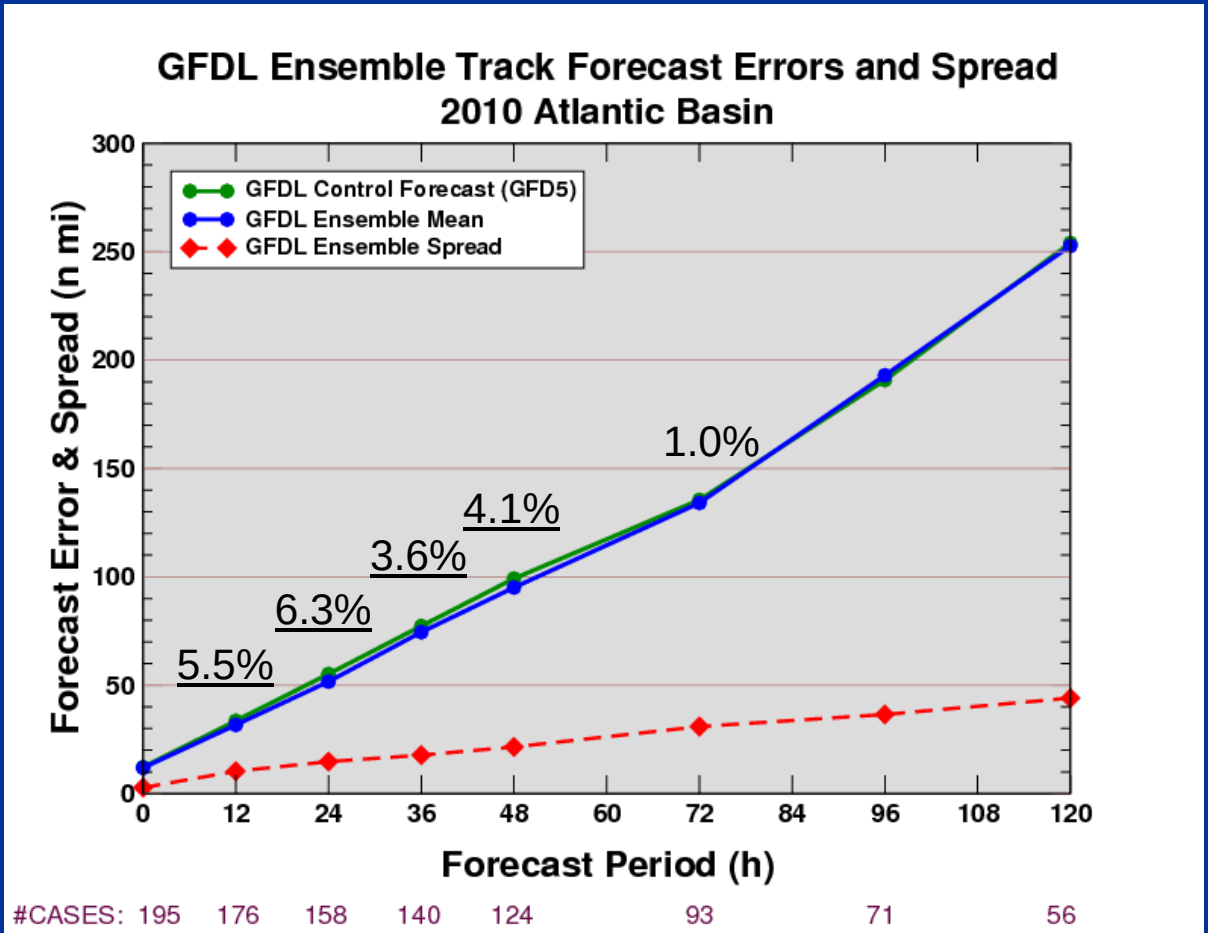
Intensity Results from 2010



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

Track Results from 2010



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

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

GFDL ensemble membership for 2011

- 16-member ensemble: 15 perturbed members + control fcst
  - 0: Control forecast (New 2011 operational GFDL)
  - A: Unbogussed forecast
  - B: Increase $Vmax_{(0)}$ +10%
  - C: Decrease $Vmax_{(0)}$ -10%
  - D: Increase 34R (+25%), 50R (+40%), ROCI (+25%)
  - E: Decrease 34R (-25%), 50R (-40%), ROCI (-25%)
  - F: Increase Rmax +25%
  - G: Decrease Rmax -25%
  - H: GFDL ensemble control from 2010 (“GFD5”)
  - J: 20% (max) modification to axisymmetric moisture perturbation
  - K: 10% (max) increase to initial mixing ratio in full field
  - L: 10% (max) decrease to initial mixing ratio in full field
  - N: Allow greater % of dissipation to go into heating
  - P: Decrease the amount of vertical momentum transport
  - Q: Reduce the penetration of downdrafts into the boundary layer

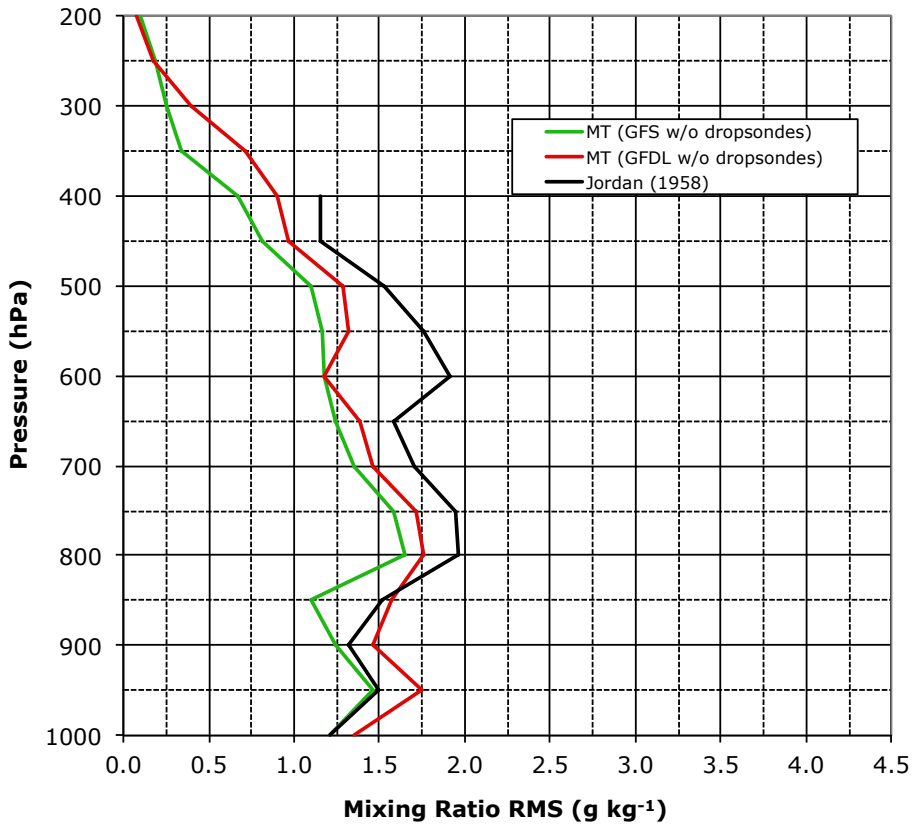
Size Members

Moisture Pert. Members

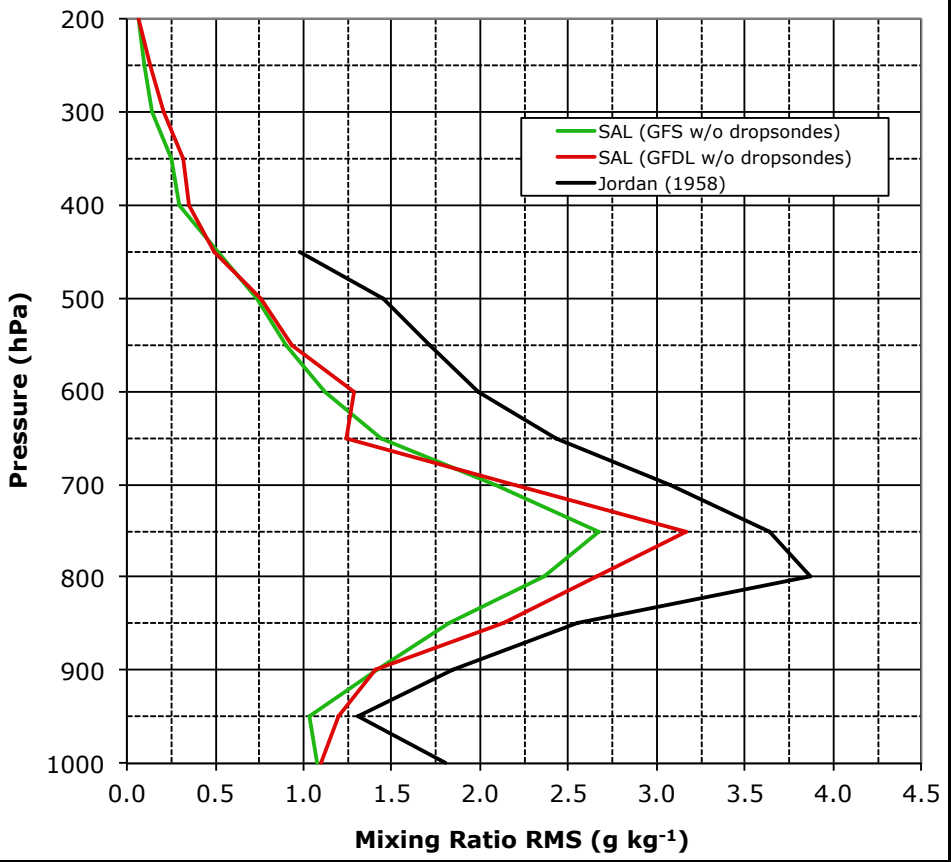
Convective Param Members

Moisture modification

Moist Tropical RMS MR differences



SAL RMS MR differences



(Source: Jason Dunion)

- G-IV drops reveal difficulty with moisture initialization in models (Dunion)
- Kimball (2006) found large sensitivity to different initial moisture profiles

System Design

System component	Jet Cores utilized	Jet Runtime (mins)
Lateral B.C.'s	<run at NCEP>	n/a
Ocean Spinup	<run at NCEP>	n/a
Vortex spinup & other prep	2/member	6
Forecast	31/member	105-110
Post	1/member	30-32*

- Total Nodes/Cores per storm: 17 / 612
- Post time can be cut to ~2 min if job script is parallelized as at NCEP
- If total runtime can be reduced to <2h, then up to 3 storms can be run in each 6h window

GFDL Ensemble Products

- ATCF output
  - Each member
  - Ensemble mean
  - Transfer to NCEP IBM for NHC ingest?
- Track & Intensity Plots
- GRIB output
  - Same files as in NCEP operations (1^o full domain, $1/6^o$ full domain, $1/12^o$ inner nest)
- Tentative tracker-derived products
  - Probabilistic surface wind structure guidance
  - Probabilistic cyclone phase guidance

GFDL Ensemble: Timing issues for Operations

- t-Jet GFDL ensemble is triggered from operational GFDL model run at NCEP.
- Tight schedule for use in 6-h interpolated guidance
- For Storm #1, forecasts will finish close to T+6.5h
- For Storms #2 (and #3), forecasts will run after Storm #1 and will be used as 12-h interpolated guidance.

Questions?