FV3-based Applications for Hurricane and Severe Storm Prediction

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Convective-Scale Challenges

- At Δx ≤ 4 km we can *explicitly* represent deep convection (sort of).
We pass the "gray zone" and can turn off deep convection scheme—easier?
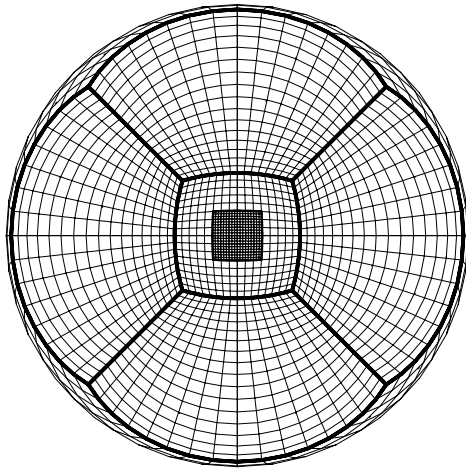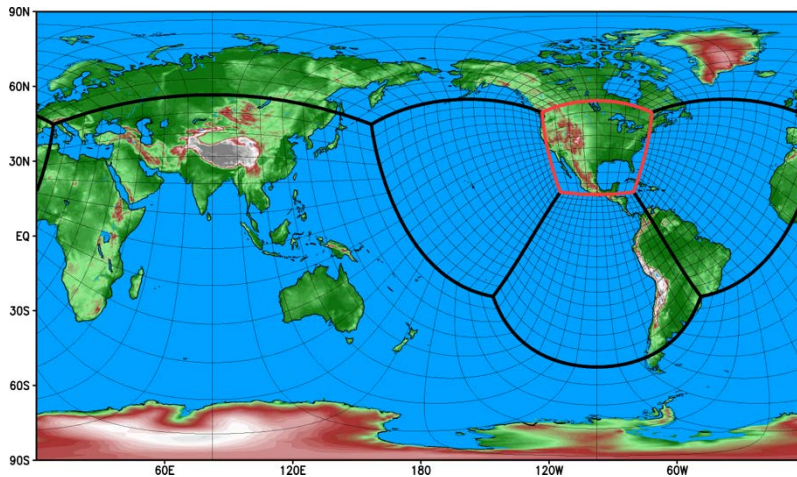
- But this resolution is too expensive for global models.
Regional models are used, but have boundary problems after a day or two—the large scale starts to suffer.
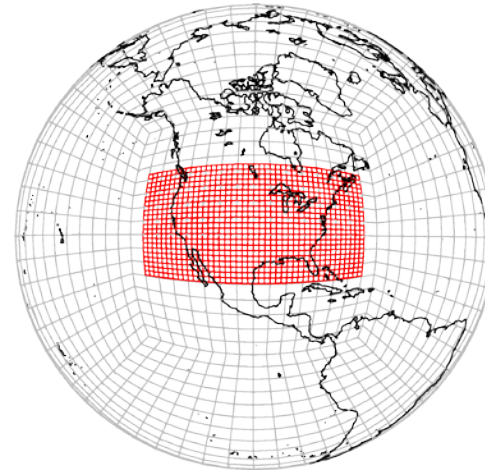
- **Solution: Local refinement of a global model!**
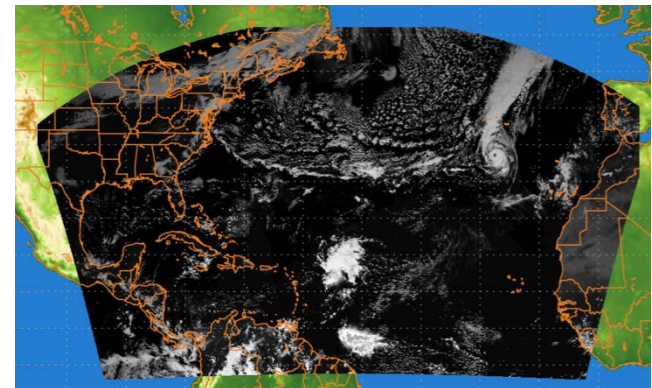
Global-to-Regional Modeling

Grid Stretching

Grid Nesting

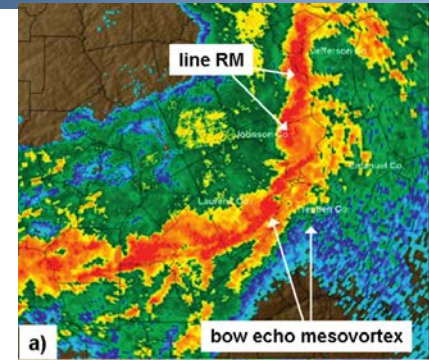
3-km CONUS Nest

3-km Hurricane Nest

Severe Storm Prediction
An extremely short introduction

- Individual storms are highly unpredictable. But models can provide useful information about **storm coverage** and **storm type**.

- We can't yet resolve tornadoes or microbursts, but we can resolve **rotating updrafts**, seen by their *helicity*

- Subjective interpretation by forecasters still important. SPC's Spring Experiment brings in forecasters and researchers worldwide to learn.
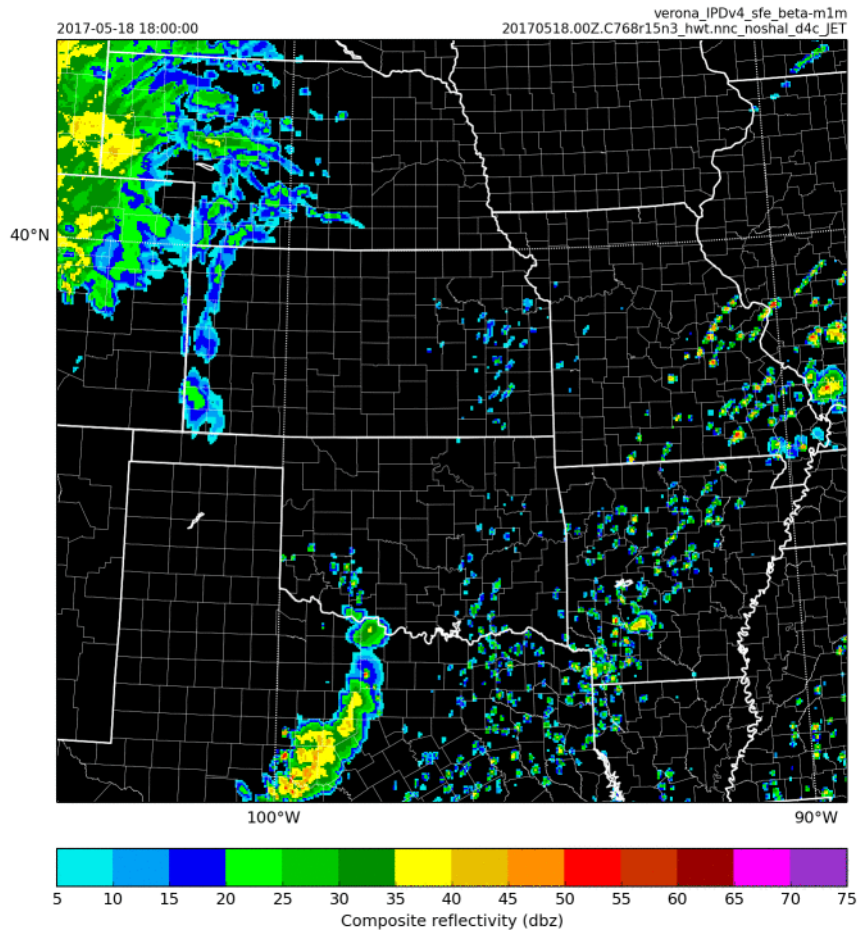

vs.
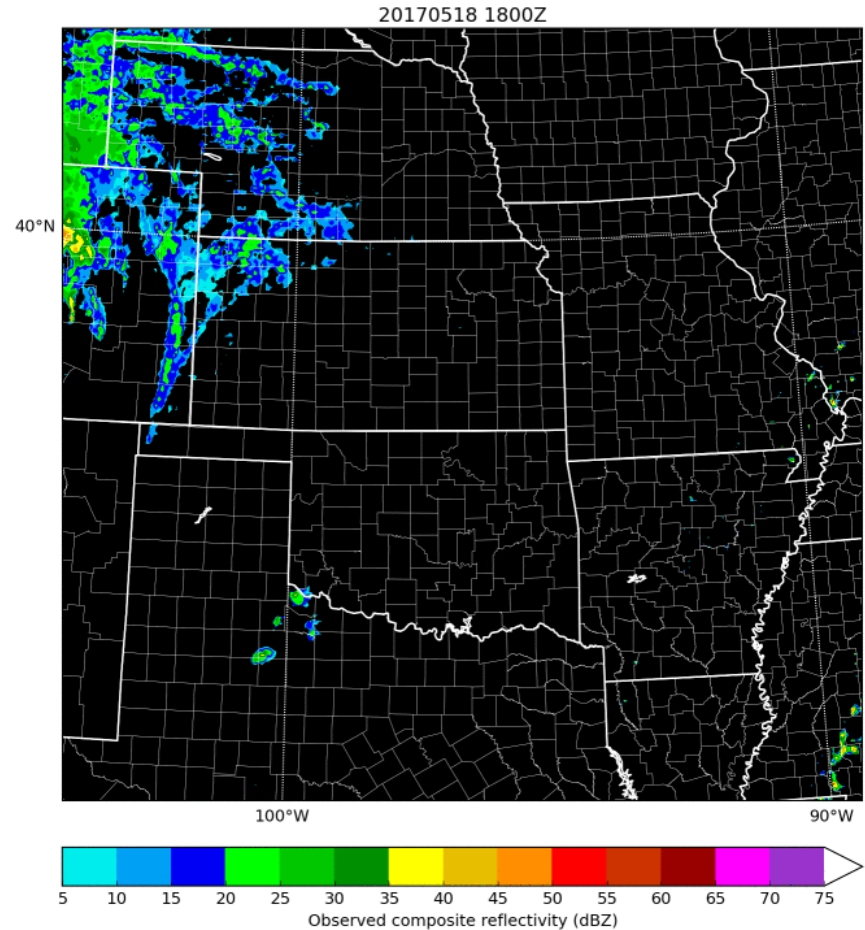
Smith et al 2012, W & F (RM = Supercell)
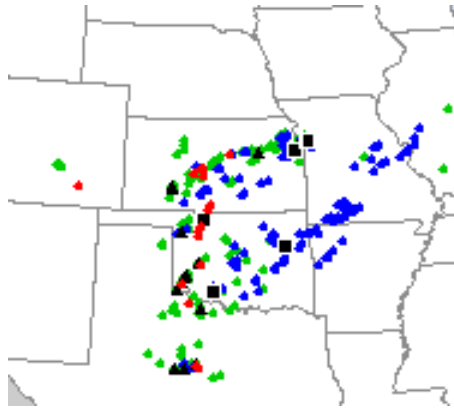
$$H = w \times \zeta$$

Radar forecast: 18 May 2017

fvGFS 18–30 hour forecast
Init 7pm CDT 17 May

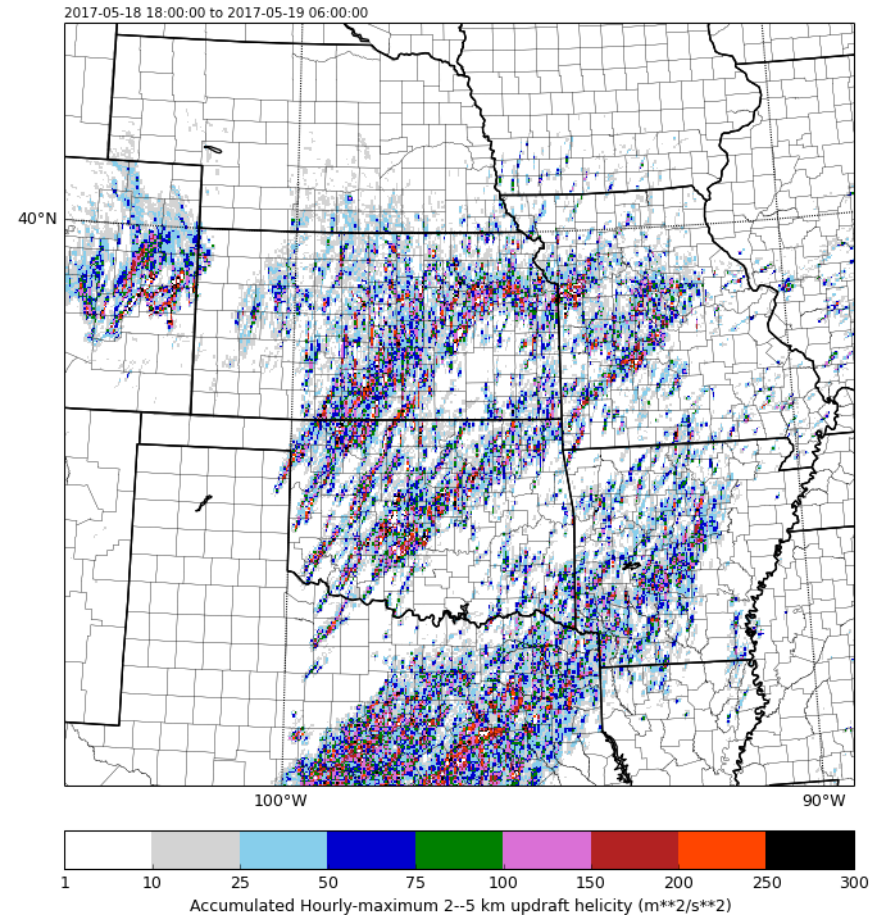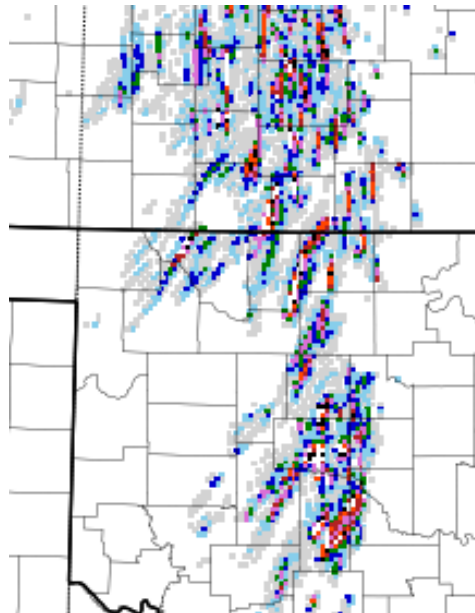Observed radar

Severe Proxies: 18 May 2017

SPC Storm Reports
Tornado
Large Hail
Severe Wind

Hourly maximum
helicity at 22Z

2017-05-18 18:00:00 to 2017-05-19 06:00:00

40°N

100°W   90°W

1   10   25   50   75   100   150   200   250   300
Accumulated Hourly-maximum 2--5 km updraft helicity (m**2/s**2)
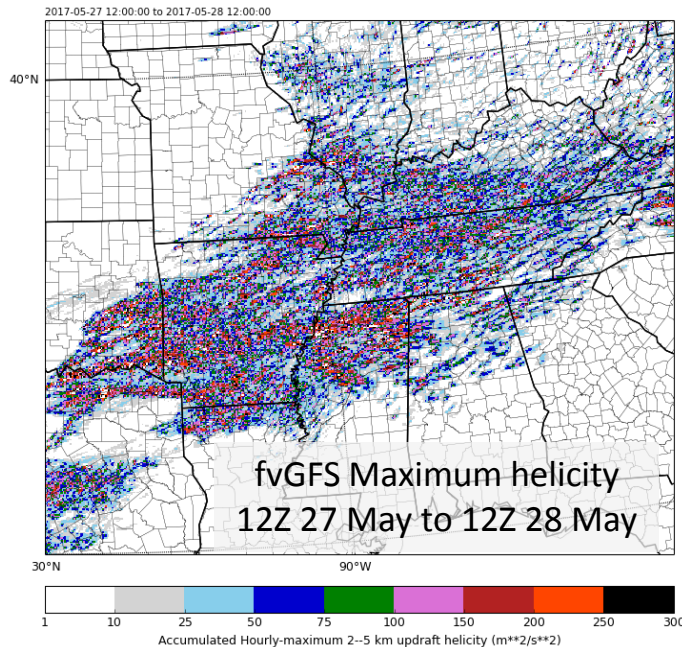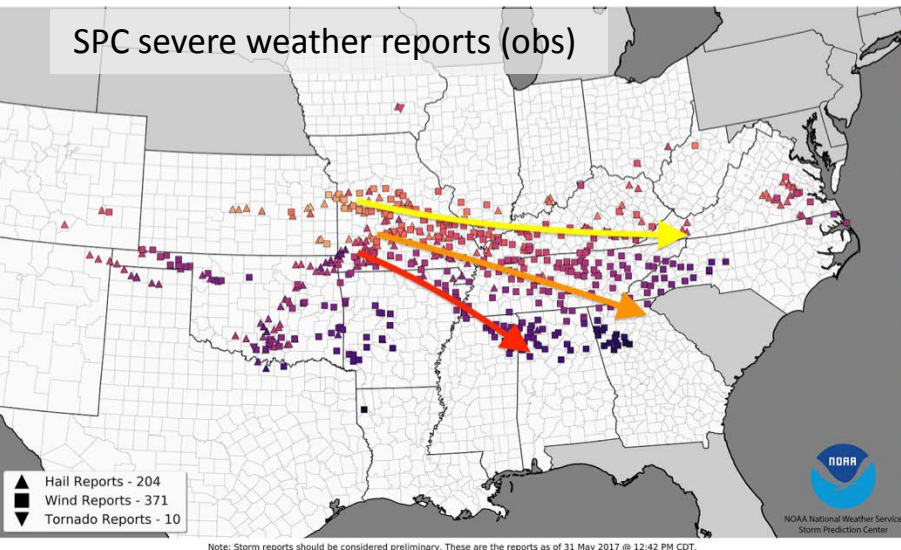
fvGFS maximum helicity
18Z–06Z (1 pm–1 am CDT)

Multi-day Derecho Prediction

fvGFS Maximum helicity
12Z 27 May to 12Z 28 May

2017-05-27 12:00:00 to 2017-05-28 12:00:00

Accumulated Hourly-maximum 2--5 km updraft helicity (m**2/s**2)

SPC severe weather reports (obs)

Hail Reports - 204
Wind Reports - 371
Tornado Reports - 10

Note: Storm reports should be considered preliminary. These are the reports as of 31 May 2017 @ 12:42 PM CDT.

2017-05-27 12:00:00
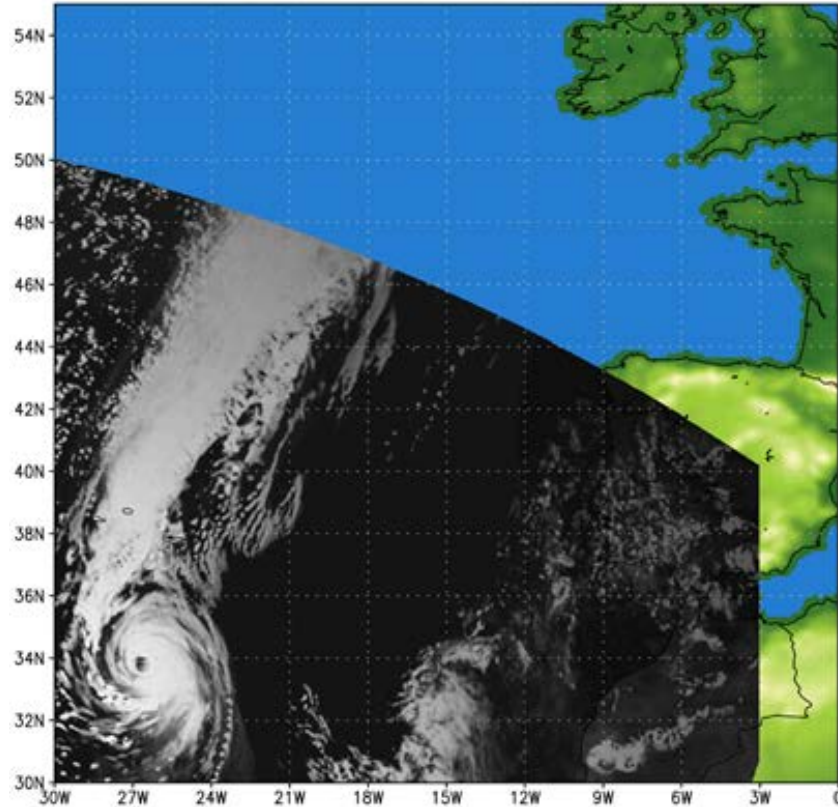
Composite reflectivity (dbz)

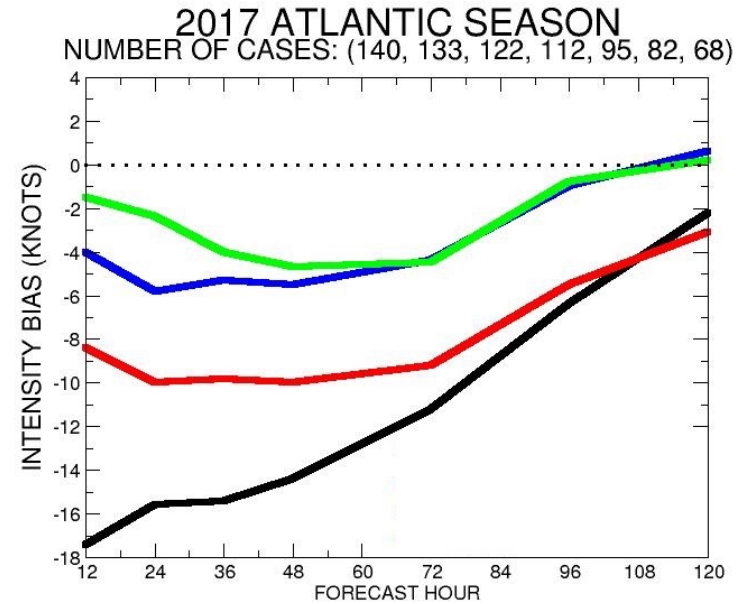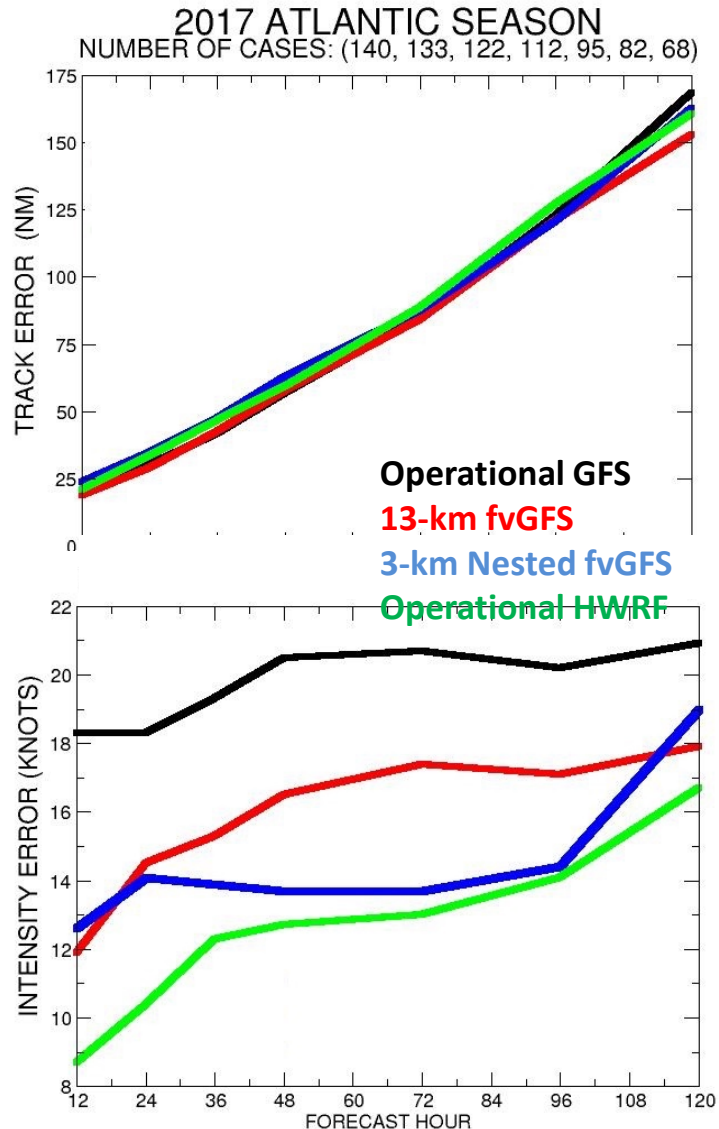**Four-day** fvGFS forecast
Forecast init 00Z 25 May 17

Nested-grid Hurricane Model

fvGFS Initialized 2017101212 53-Hour Forecast
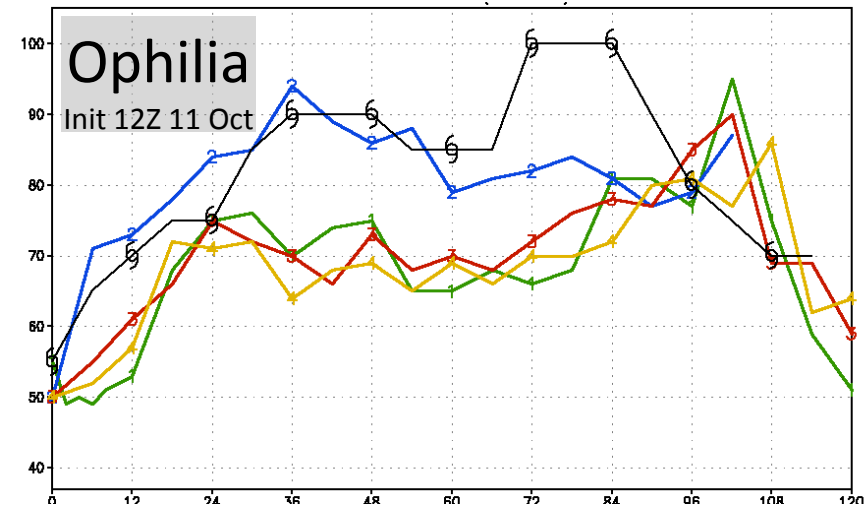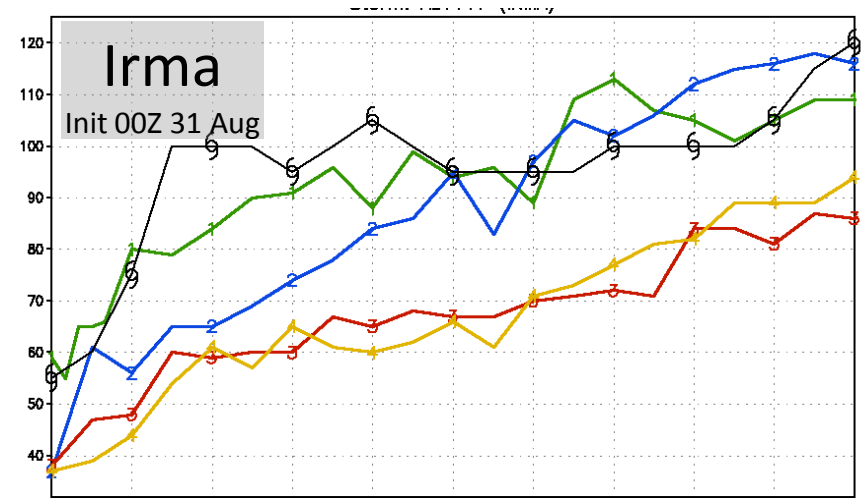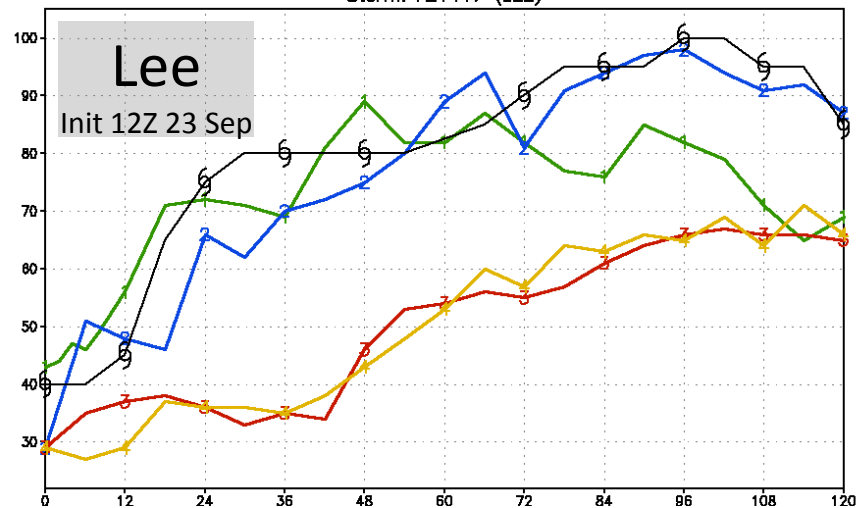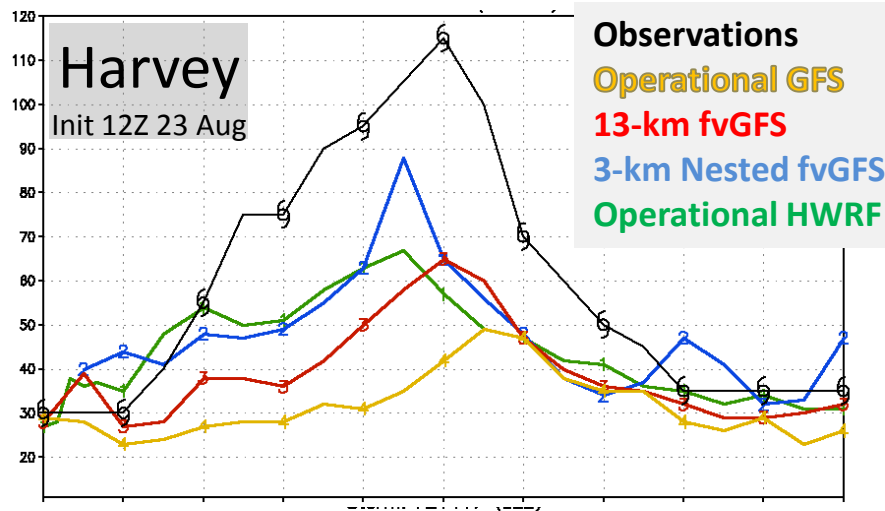Simulated Visible Satellite of Ophelia

Operational GFS
13-km fvGFS
3-km Nested fvGFS
Operational HWRF

Great intensity skill
even without many features!
- No Initialization
- No Ocean Coupling
- No Convective-scale PBL scheme

All of these features coming soon!

Individual Forecasts: Max wind vs. Obs

Observations
Operational GFS
13-km fvGFS
3-km Nested fvGFS
Operational HWRF

Harvey — Init 12Z 23 Aug

Irma — Init 00Z 31 Aug

Lee — Init 12Z 23 Sep

Ophilia — Init 12Z 11 Oct

Hours after Initialization

Towards Unification

- A good start…but much can be improved
  - ➤ Microphysics: how many species? Double-moment?
  - ➤ Improved PBL scheme
  - ➤ Deep convection—still helpful?
  - ➤ Improved vertical resolution, with **vertical nesting**
- Why stop at 5 days?
  - – S2S: explicit prediction of severe storm events and major hurricanes
  - – AM4/CM4 for convection-permitting resolutions…and beyond?