Qualitatative Assessment of Differences in Performance between the Flow-following Isentropic Coordinate Model and the Global Spectral Model (GFS)

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Purpose of comparisons
Configuration of FIM real-time runs
Anomaly correlation scores
Tropical cyclones
Mid-latitude features

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Background

Short-term (next 18-24 months) goal for FIM:

Demonstrate ability to add diversity to the NCEP Global Ensemble Forecast System

First Step: Show at least equivalent skill with the GFS at comparable resolution

FIM configuration

Resolution

- G8 - 30km resolution (☐GFS: T384 ~ 45km)
- 50 layers (224-547K) - hybrid theta-sigma (GFS: 64)
- Ptop = 20 hPa (GFS: 0.1 hPa)

Physics

- GFS physics
- Non-radiation (currently) called every dynamics time step (45 s) (GFS: 180s)

Initial conditions

- Interpolation from GFS spectral data to FIM icosahedral hybrid vertical coordinate
- Horizontal first, then vertical

Major FIM changes

Early

- 17 April - Begin use of virtual potential temperature instead of dry potential temperature
- 3 June – Fix to land-surface specification problem

More recent

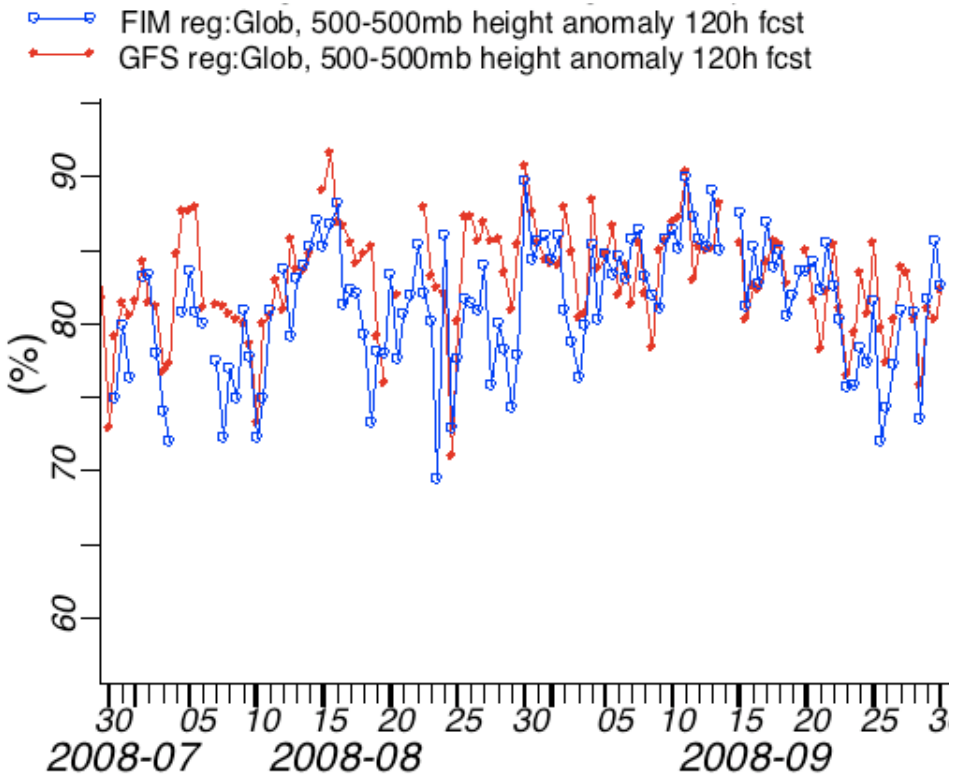
- 21 August - Solution to FIMprep problem - wrong assignment of GFS hybrid sigma-pressure levels
- 28 August - Fix to assignment of soil moisture values to both liquid water and total values.

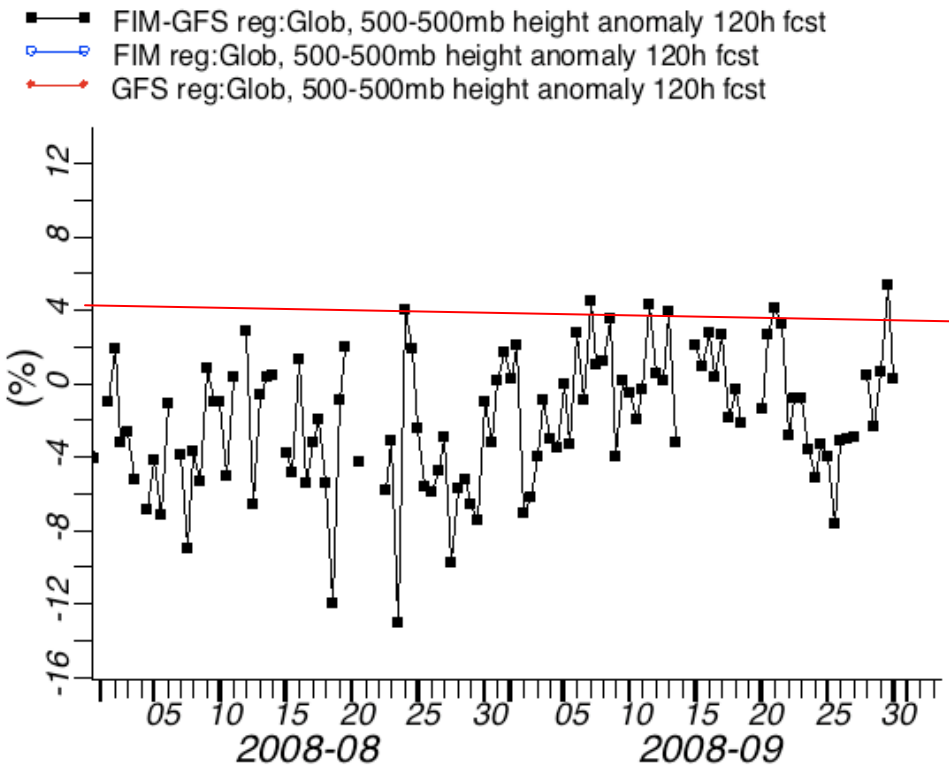
Still a problem

- In low-middle troposphere: interpolation from GFS initial conditions to FIM (vertical interpolation)

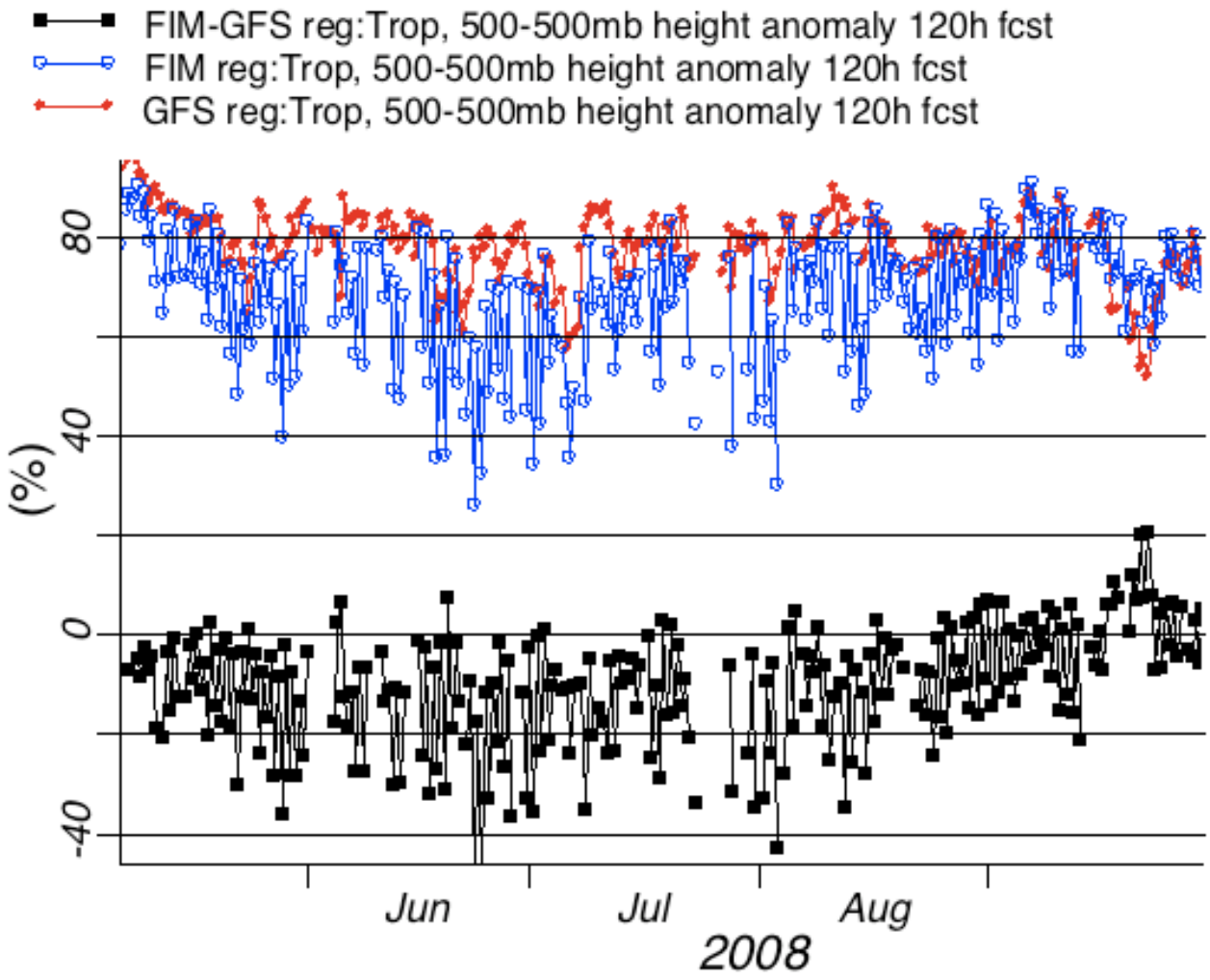
A few more 500 hPa height Anomaly-Correlation (AC) results

Whole Globe

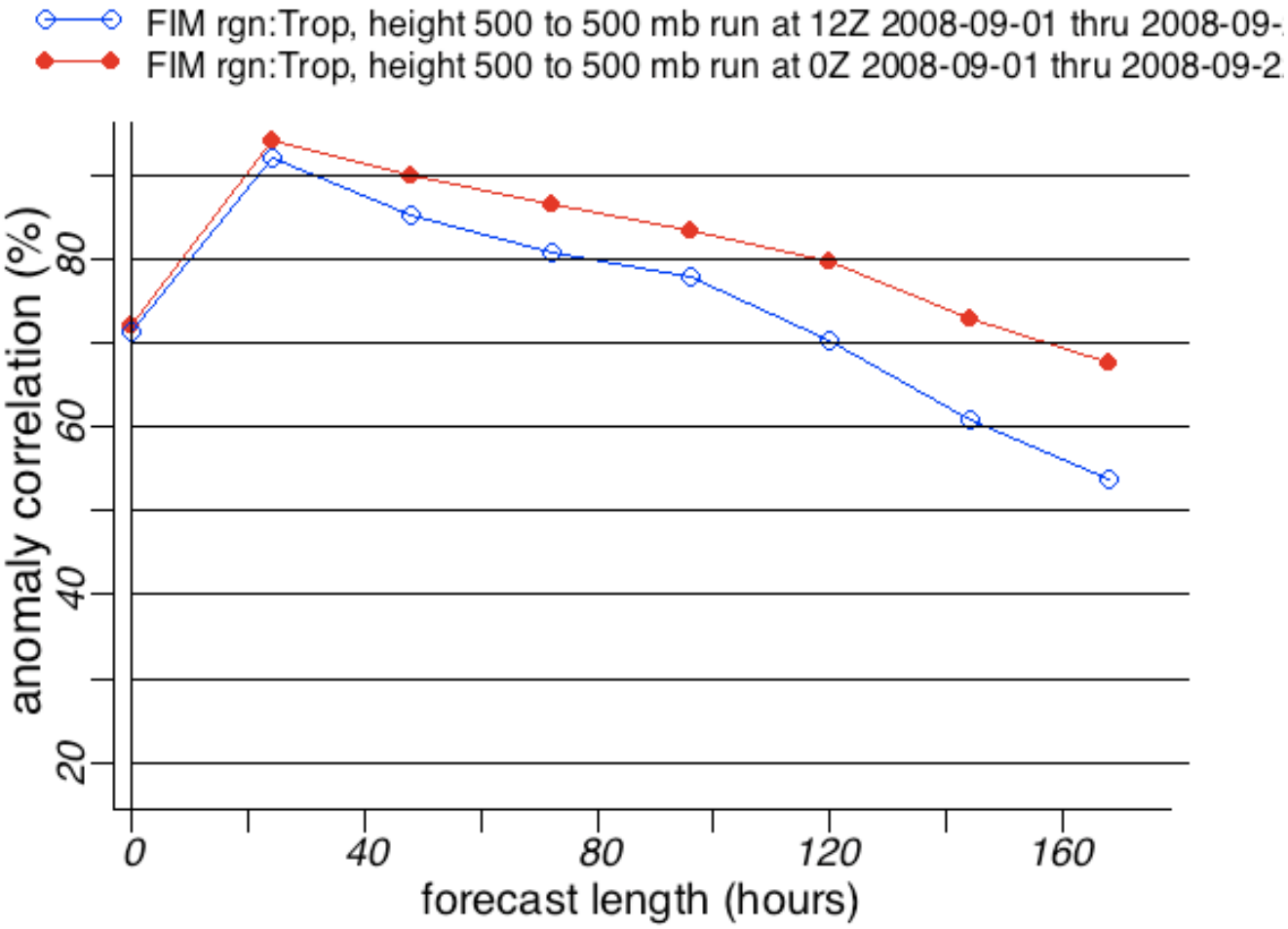




- FIM fixes in late August improved 5-day forecast skill relative to GFS in September
- Major variations in day-to-day skill between GFS and FIM



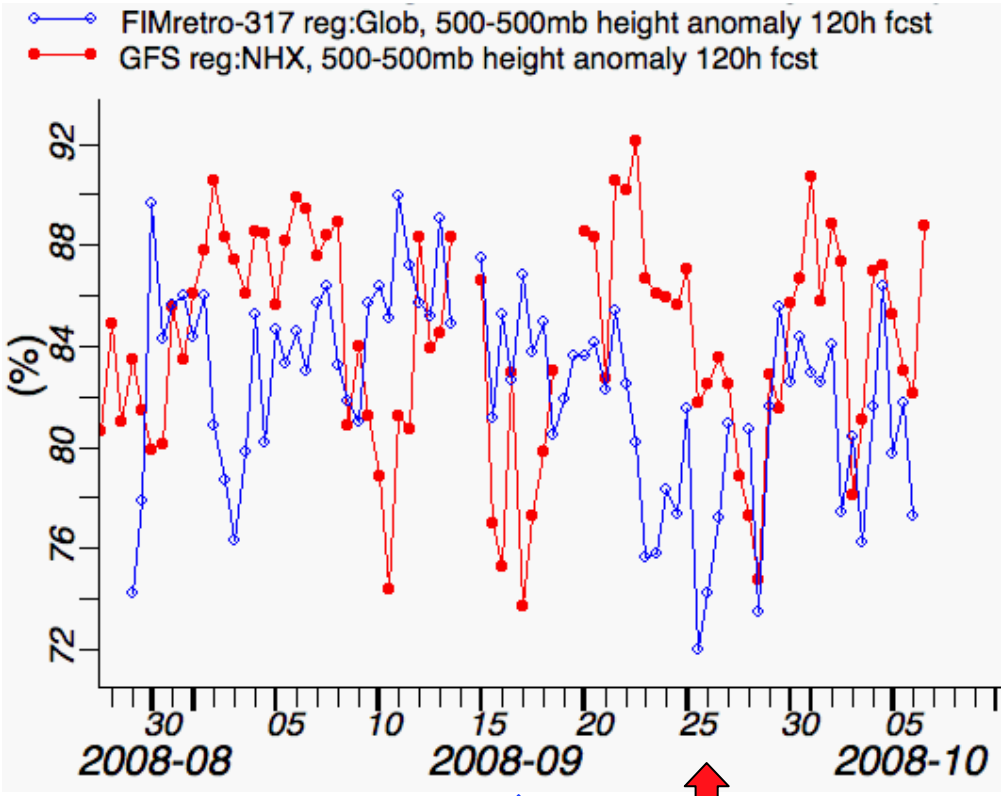
- Tropics - FIM comparable to GFS in late September but not early Sept



-Tropics (20 deg S to 20 deg N) - FIM 120h skill much poorer for 12z init than for 00z init

- FIM initial height problem also more prominent in tropics

Recent Northern Hemisphere Performance
Anomaly Correlation--500mb Height



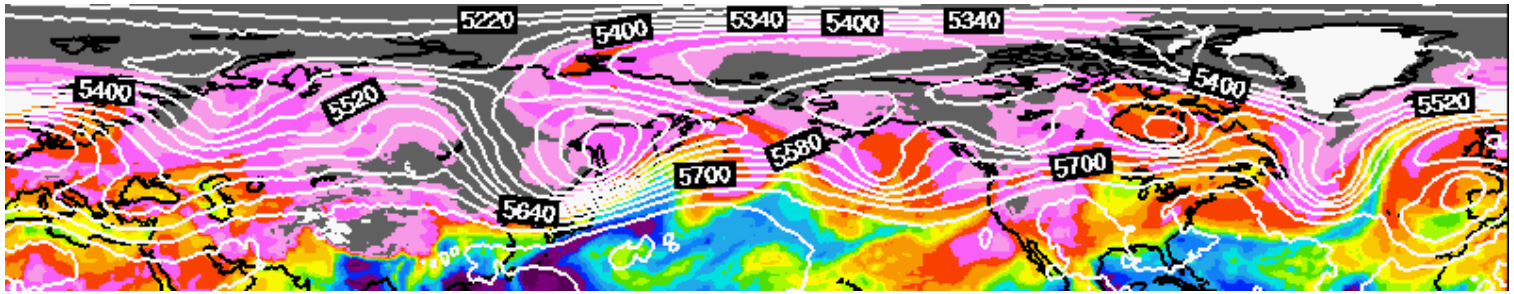
FIM better

GFS better

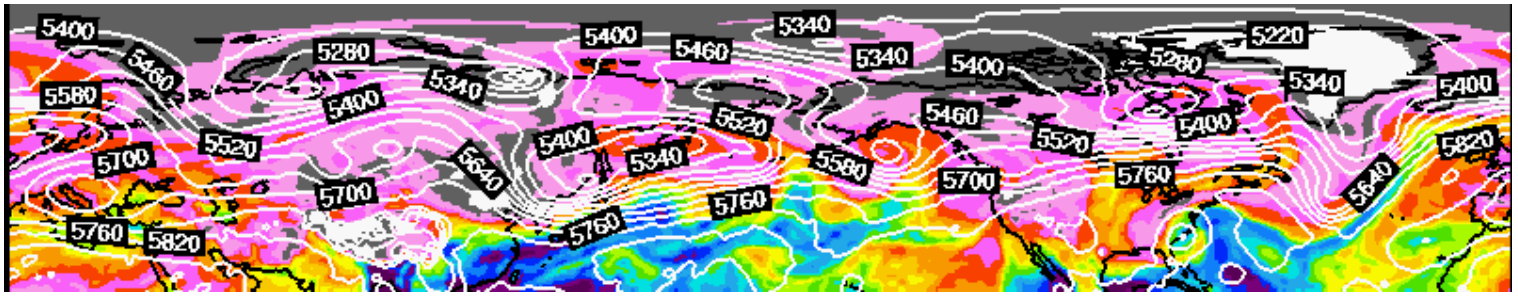
FIM-GFS Northern Hemisphere Comparisons 120h 500 hPa height, Precipitable Water Forecasts valid 00Z 26 Sep 08

AC = Anomaly Correlation

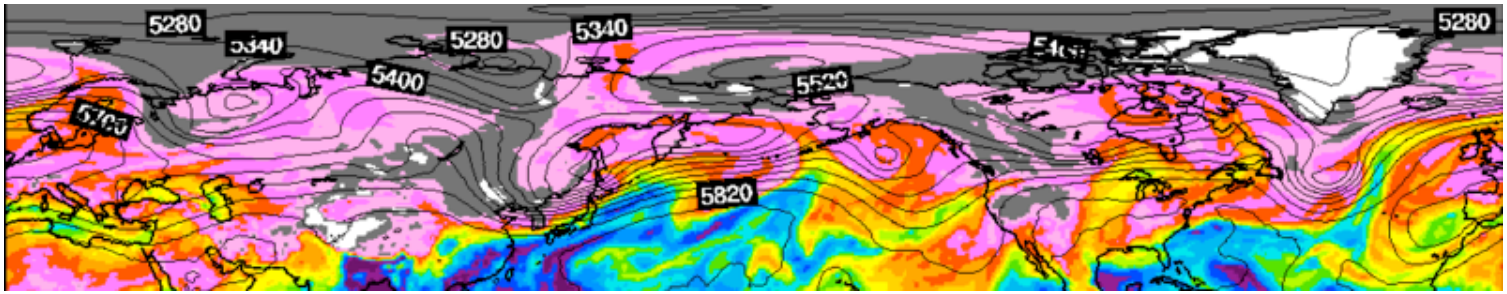
FIM
AC=.74



GFS
Analysis



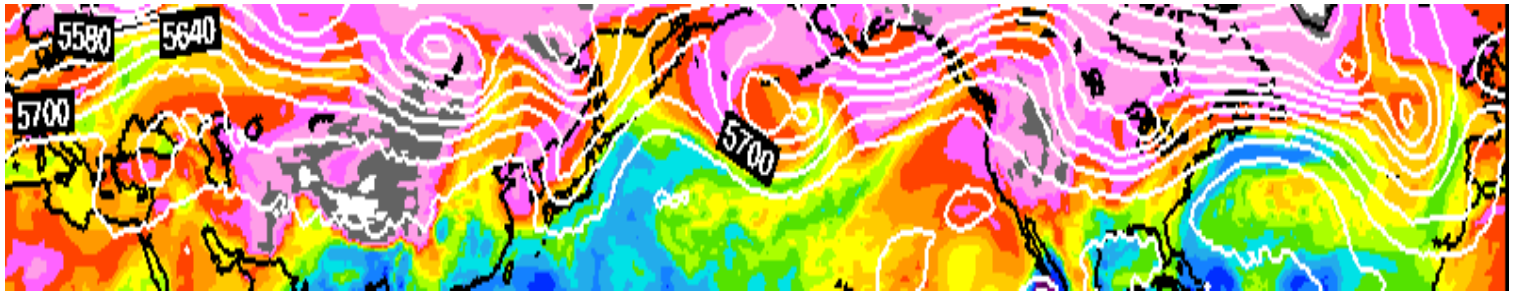
GFS
AC=.83



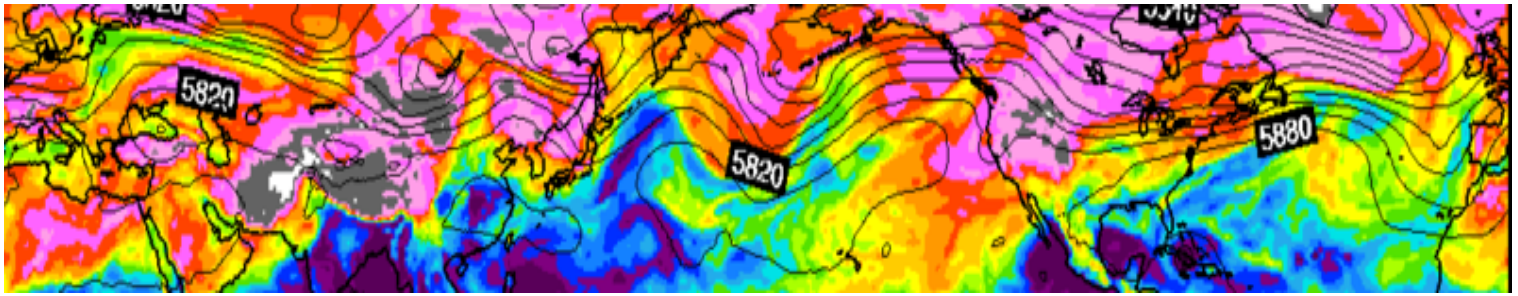
FIM-GFS Northern Hemisphere Comparisons
120h 500 hPa height, Precipitable Water
Forecasts valid 12Z 12 Sep 08

AC = Anomaly Correlation

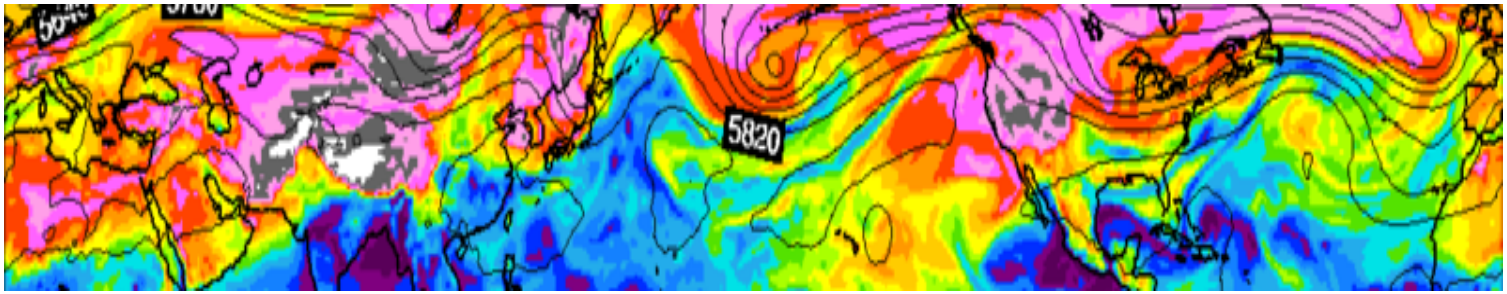
FIM
AC=.72



GFS
Analysis



GFS
AC=.81



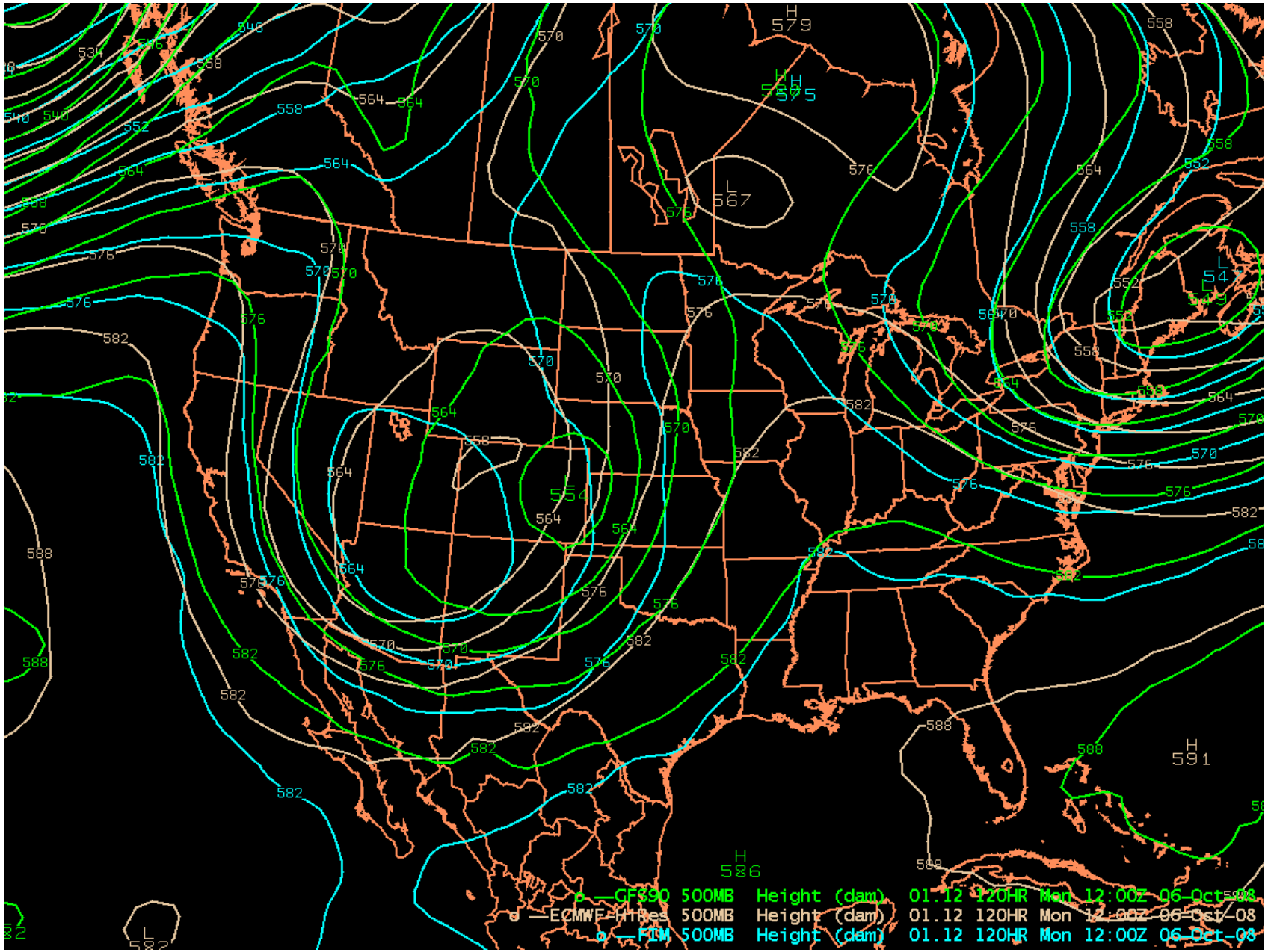
Examples of FIM's Western US Cutoff Low Performance

Forecasts verifying 1200 UTC Monday 6 October 2008
And
1200 UTC Sunday 12 October 2008

FIM often shows more of a tendency to form cutoff lows and locates them farther west than the GFS

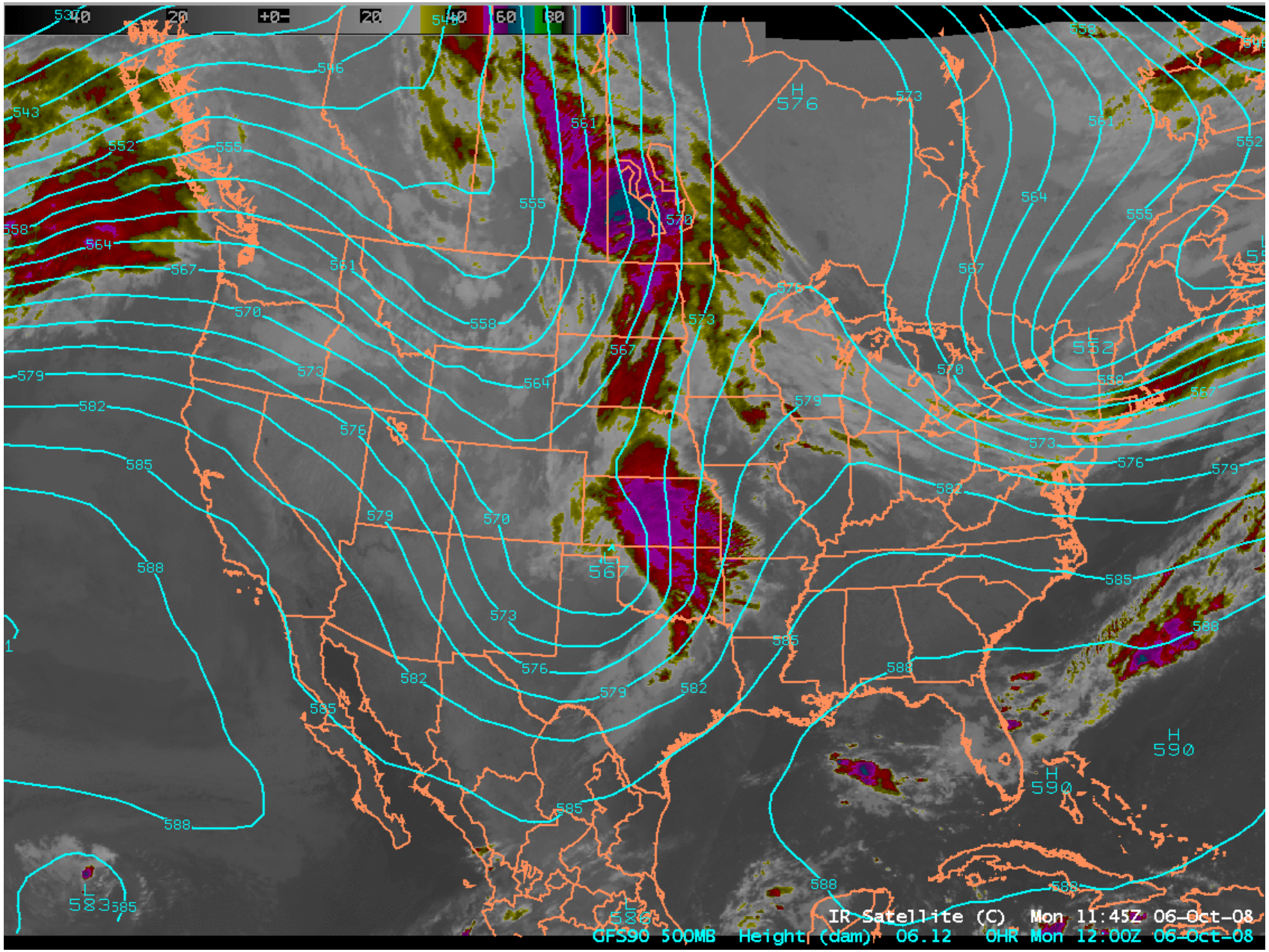
FIM is often intermediate between GFS and ECMWF (but closer to GFS)

120-h forecasts 500hPa height from FIM, ECMWF and GFS valid 1200 UTC 6 Oct 08. Verification next slide

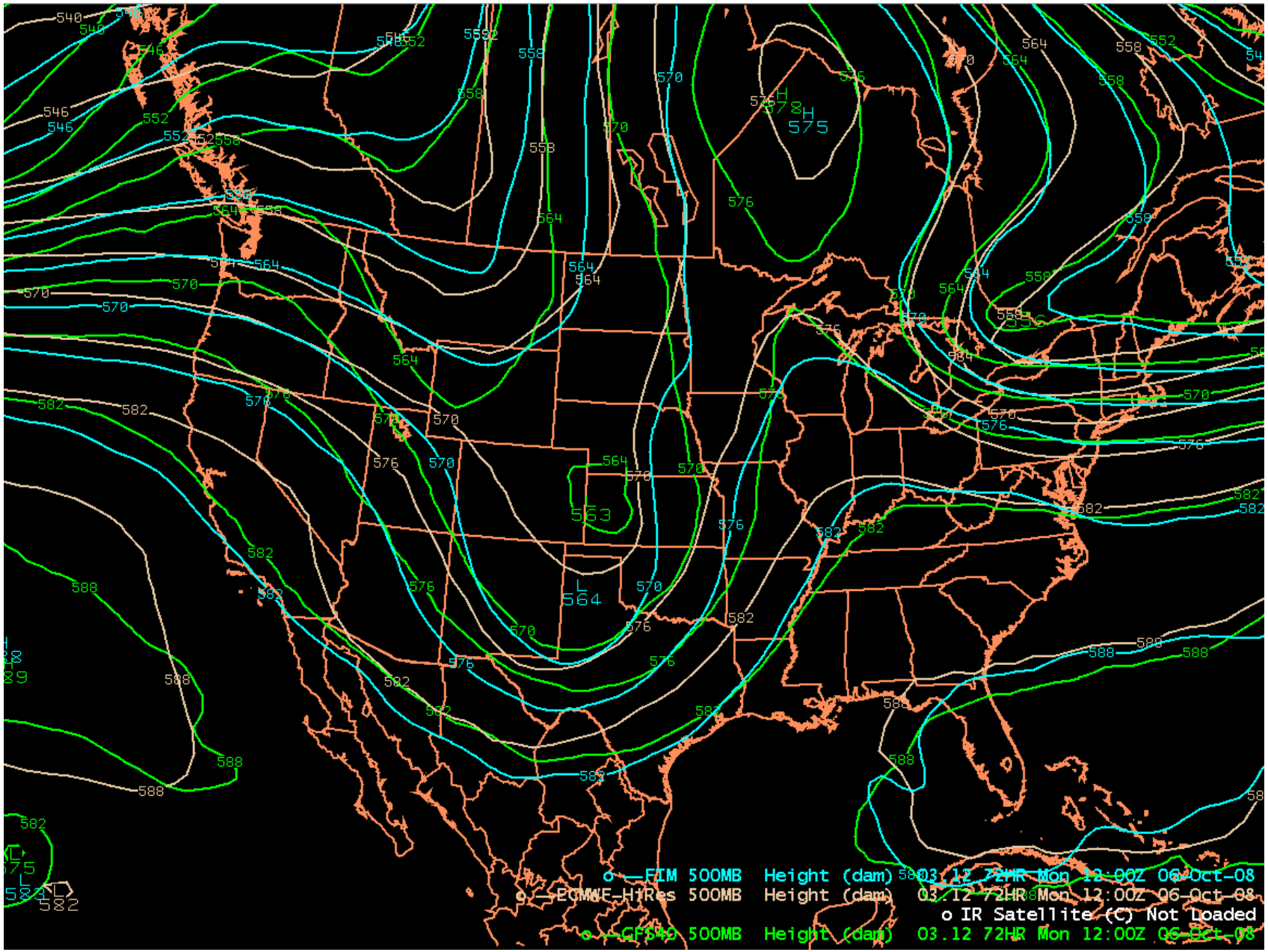


GFS analyzed 500hPa height valid Monday 1200 UTC 6 Oct 08

All forecasts too slow. GFS best on speed.

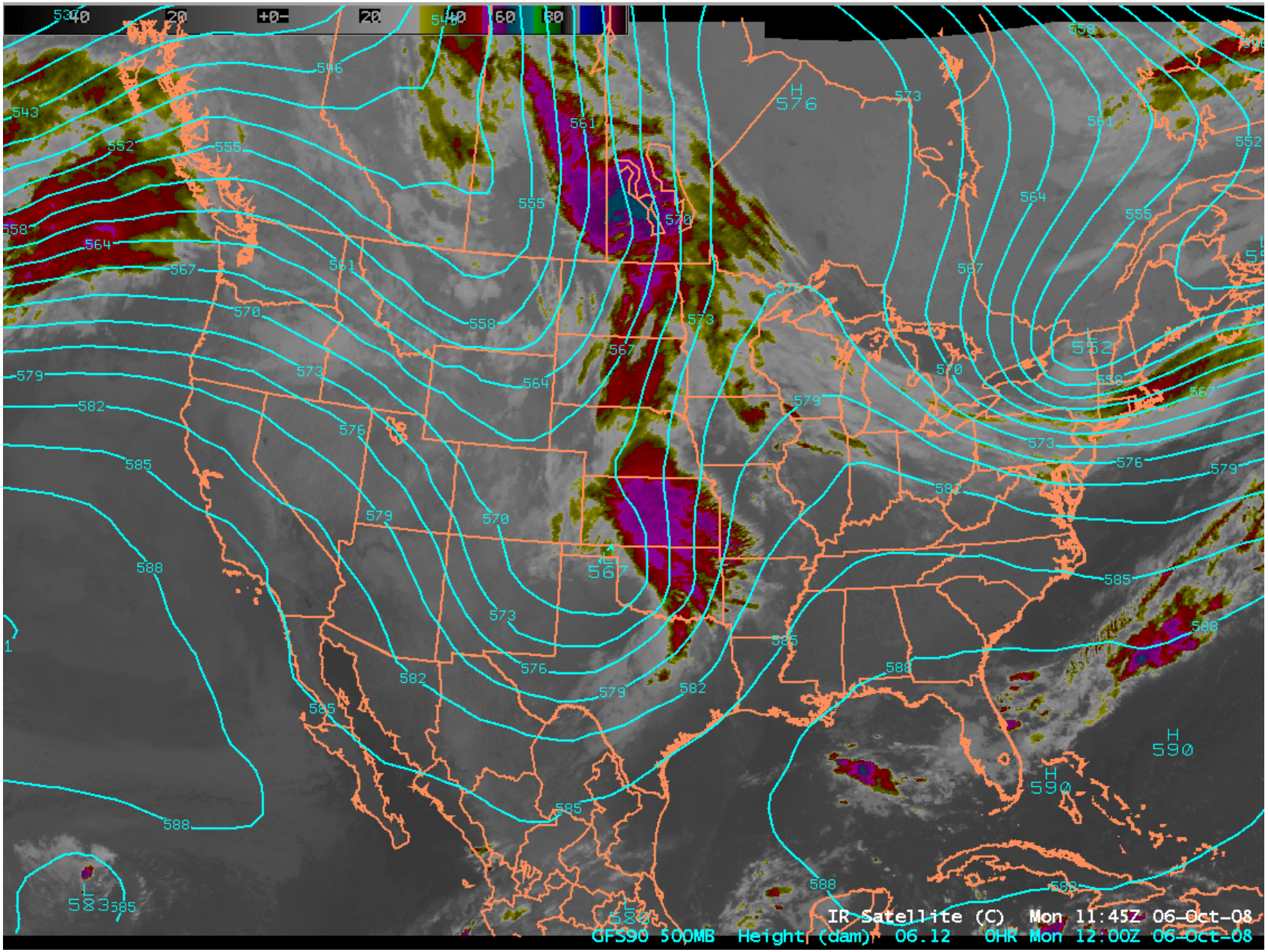


72-h forecasts 500hPa height from FIM, ECMWF and GFS valid 1200 UTC 6 Oct 08. Verification next slide

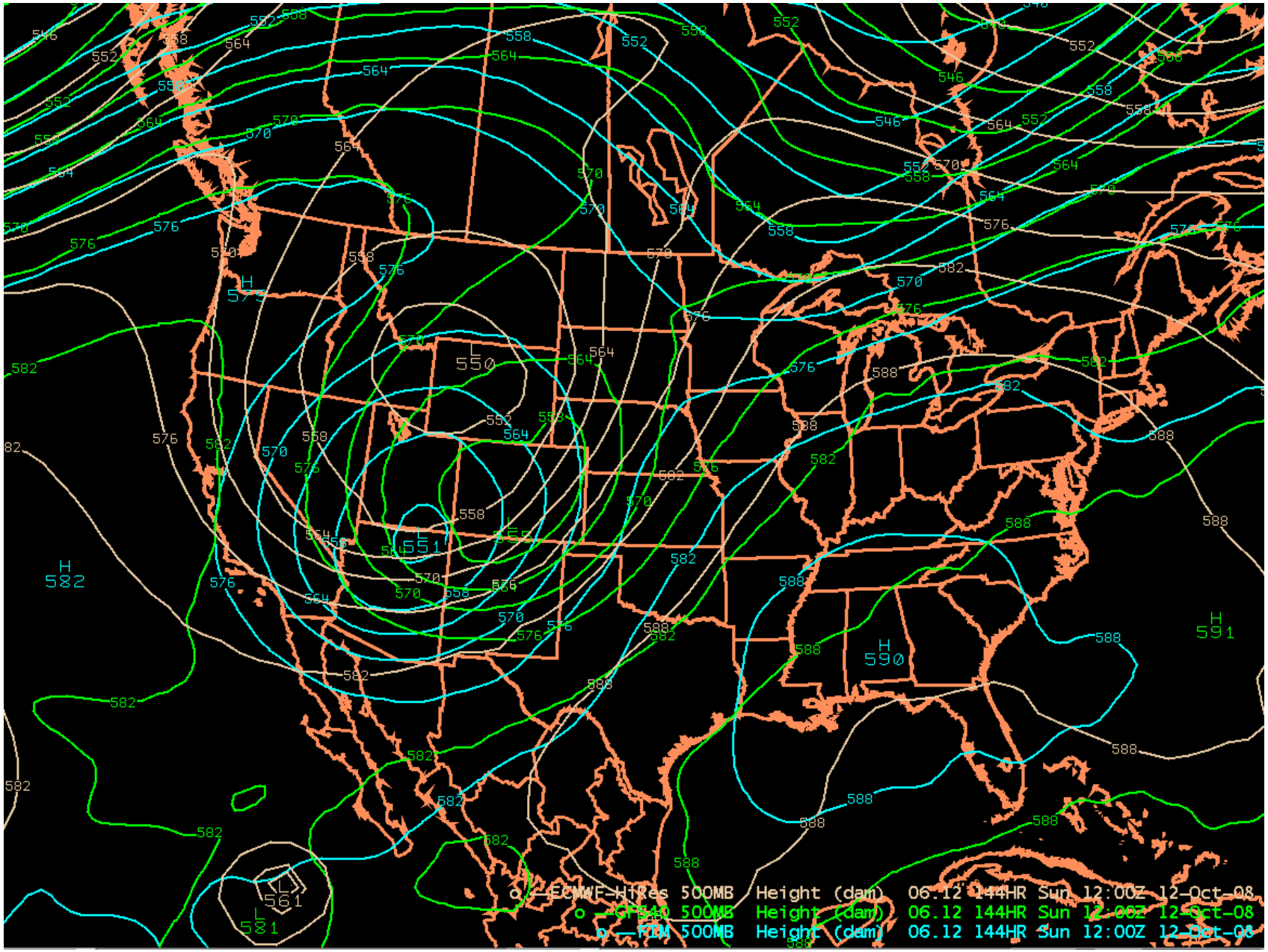


GFS analyzed 500hPa height valid Monday 1200 UTC 6 Oct 08

FIM forecast slower than GFS forecast

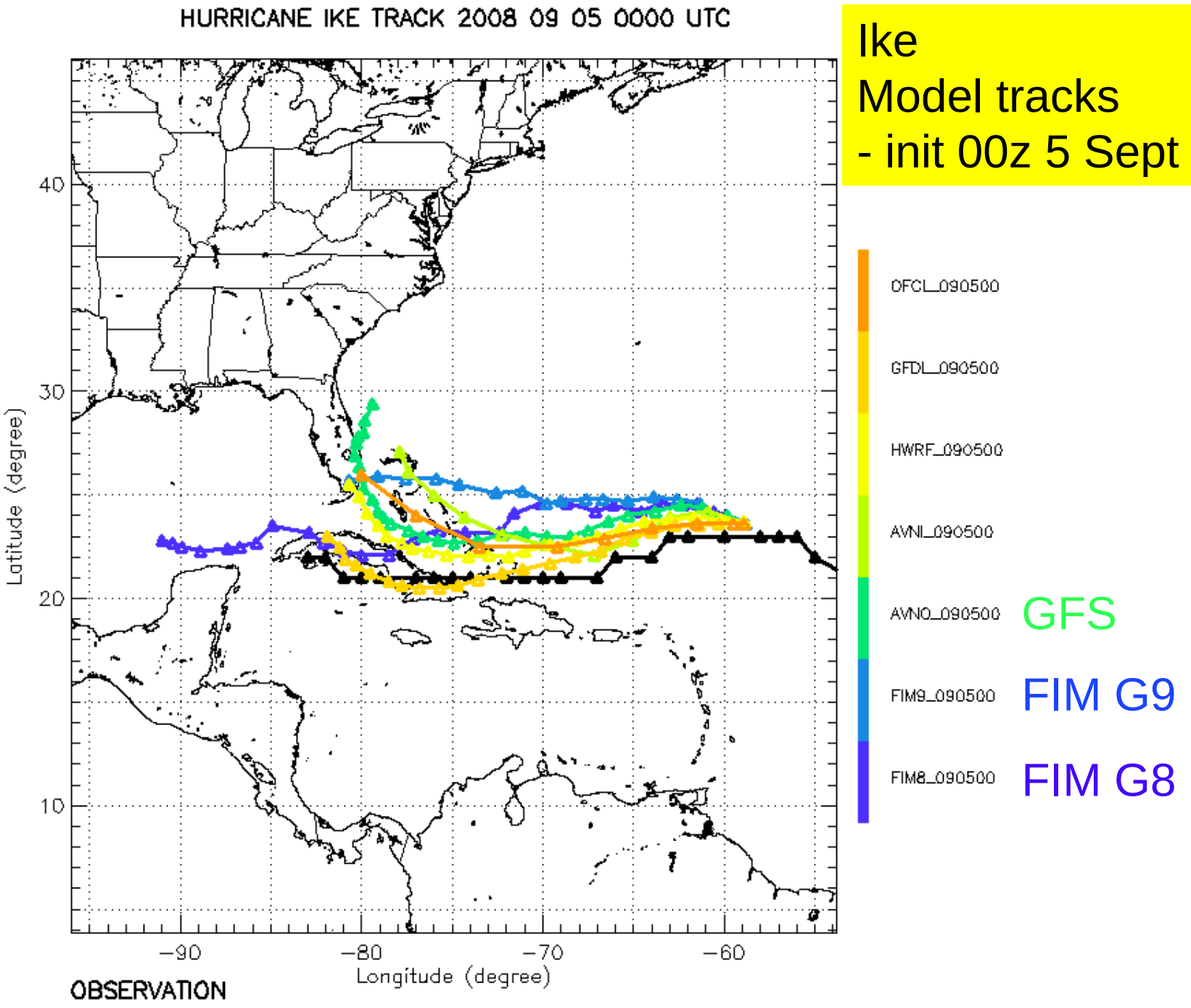


144-h forecasts 500hPa height from FIM, ECMWF and GFS valid 1200 UTC Sun 12 Oct 08. Boulder's first snow?



Tropical Cyclone Forecasts

Hurricane Ike 2008


HURRICANE IKE TRACK 2008 09 05 0000 UTC
Ike
Model tracks
- init 00z 5 Sept
OFCL_090500
GFDL_090500
HWRF_090500
AVNI_090500
AVNO_090500
GFS
FIM9_090500
FIM G9
FIM8_090500
FIM G8
Latitude (degree)
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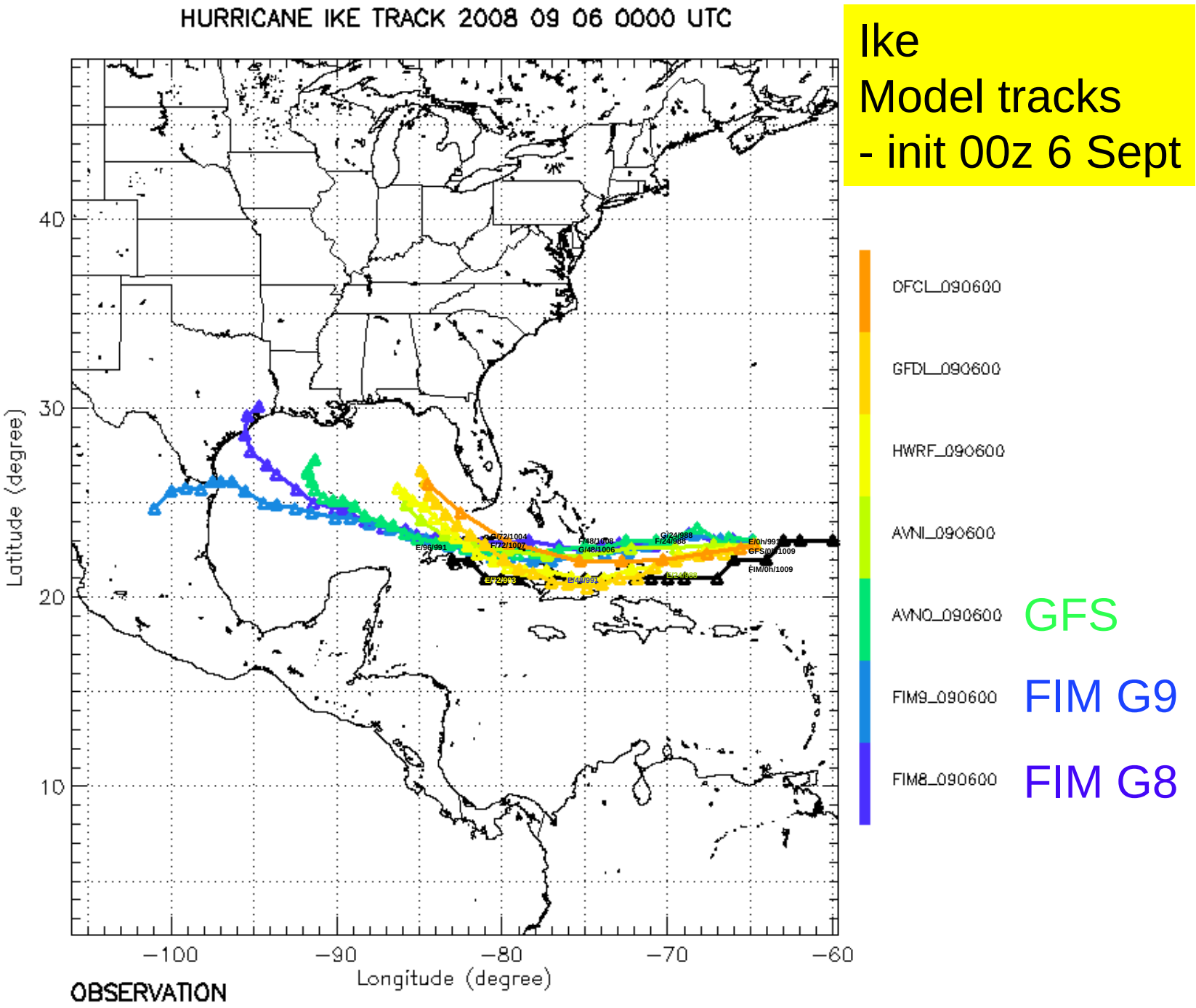
Longitude (degree)
OBSERVATION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Ike
Model tracks
- init 00z 6 Sept
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GFDL_090600
HWRF_090600
AVNI_090600
AVNO_090600
GFS
FIM9_090600
FIM G9
FIM8_090600
FIM G8
Latitude (degree)
Longitude (degree)
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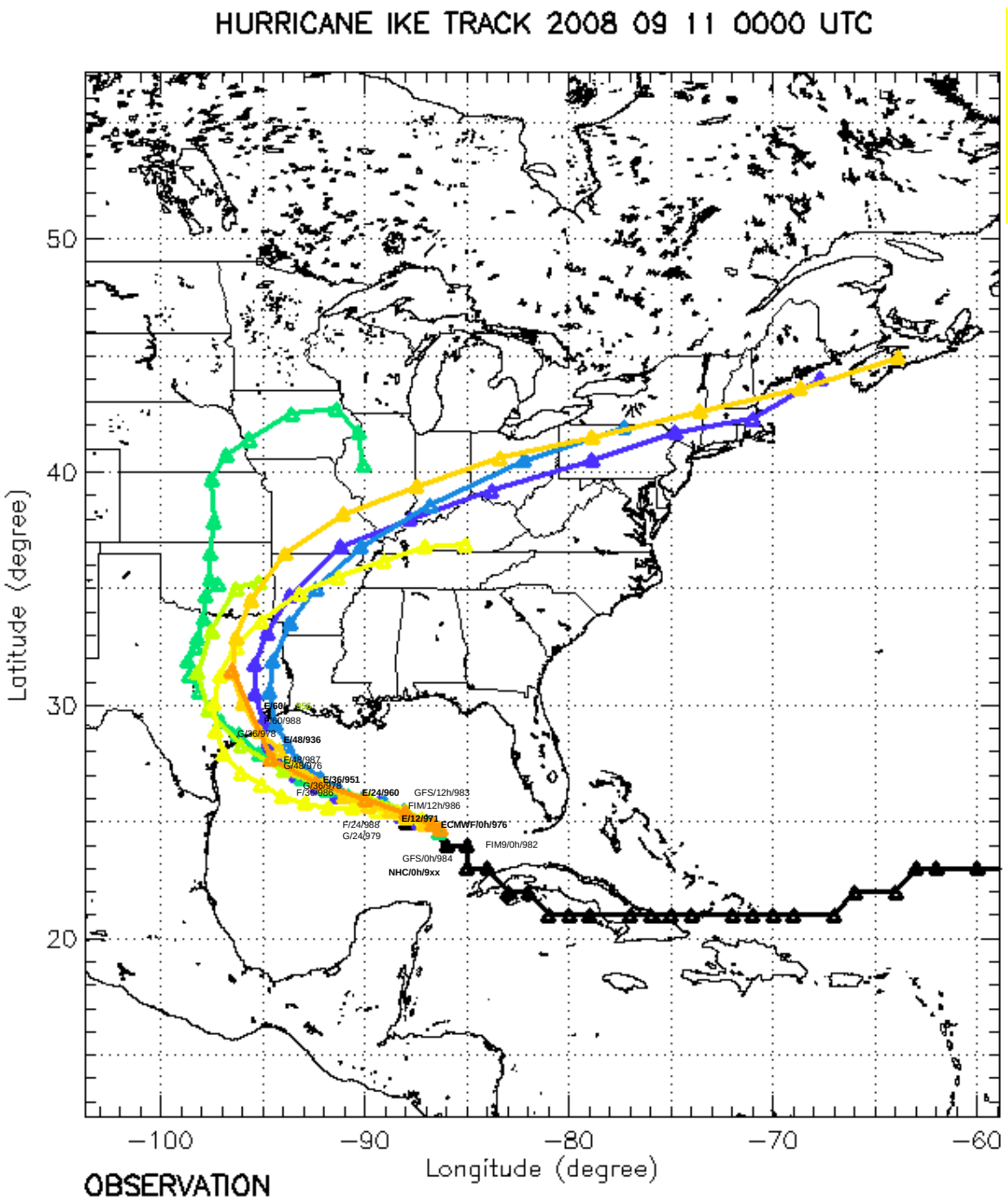
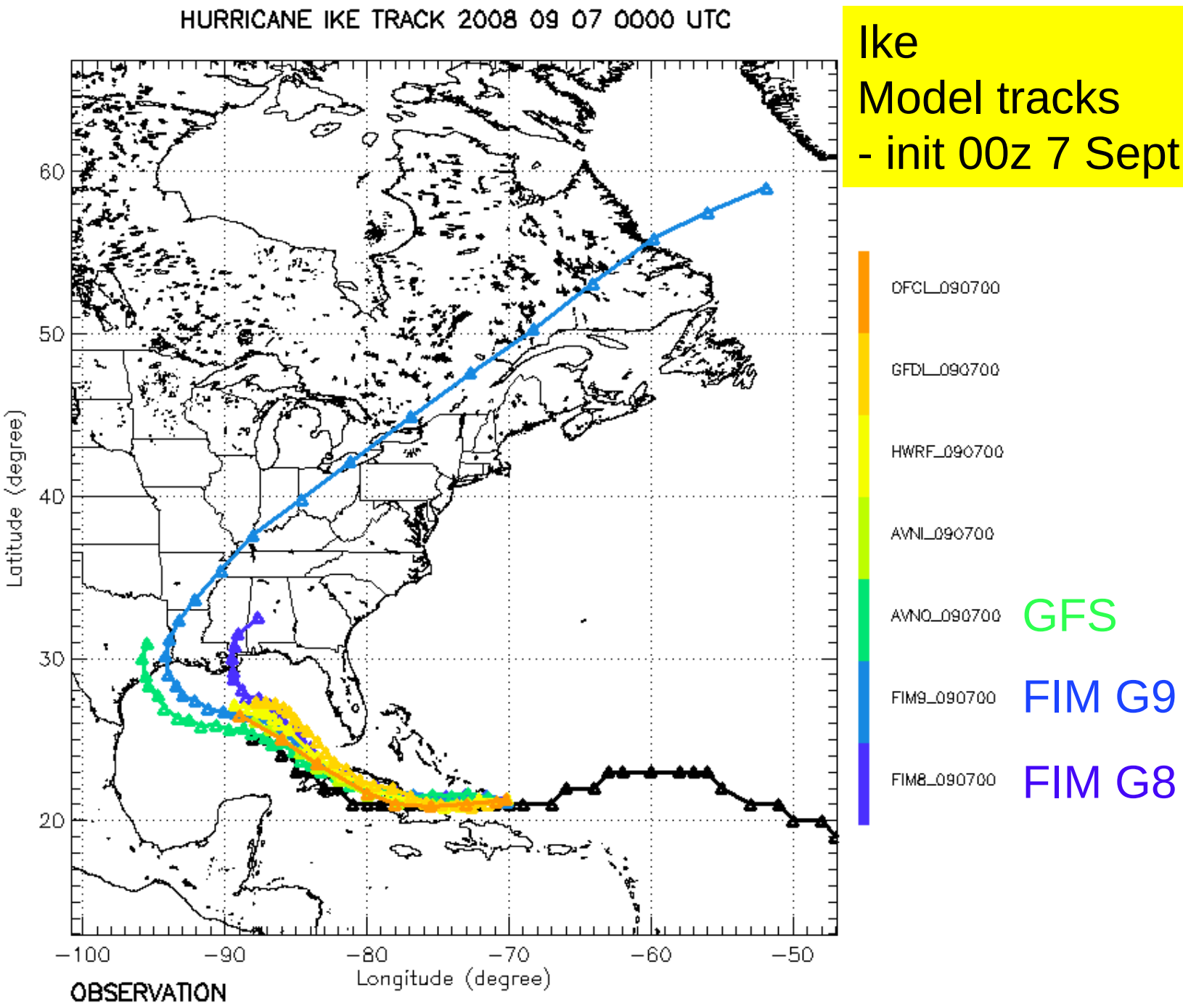
OBSERVATION



Ike
Model tracks
- init 00z 11 Sep

OFCL_091100
GFDL_091100
HWRF_091100
AVNI_091100
AVNO_091100 GFS
FIM9_091100 FIM G9
FIM8_091100 FIM G8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Ike
Model tracks
- init 00z 7 Sept
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HWRF_090700
AVNI_090700
AVNO_090700
GFS
FIM9_090700
FIM G9
FIM8_090700
FIM G8
Latitude (degree)
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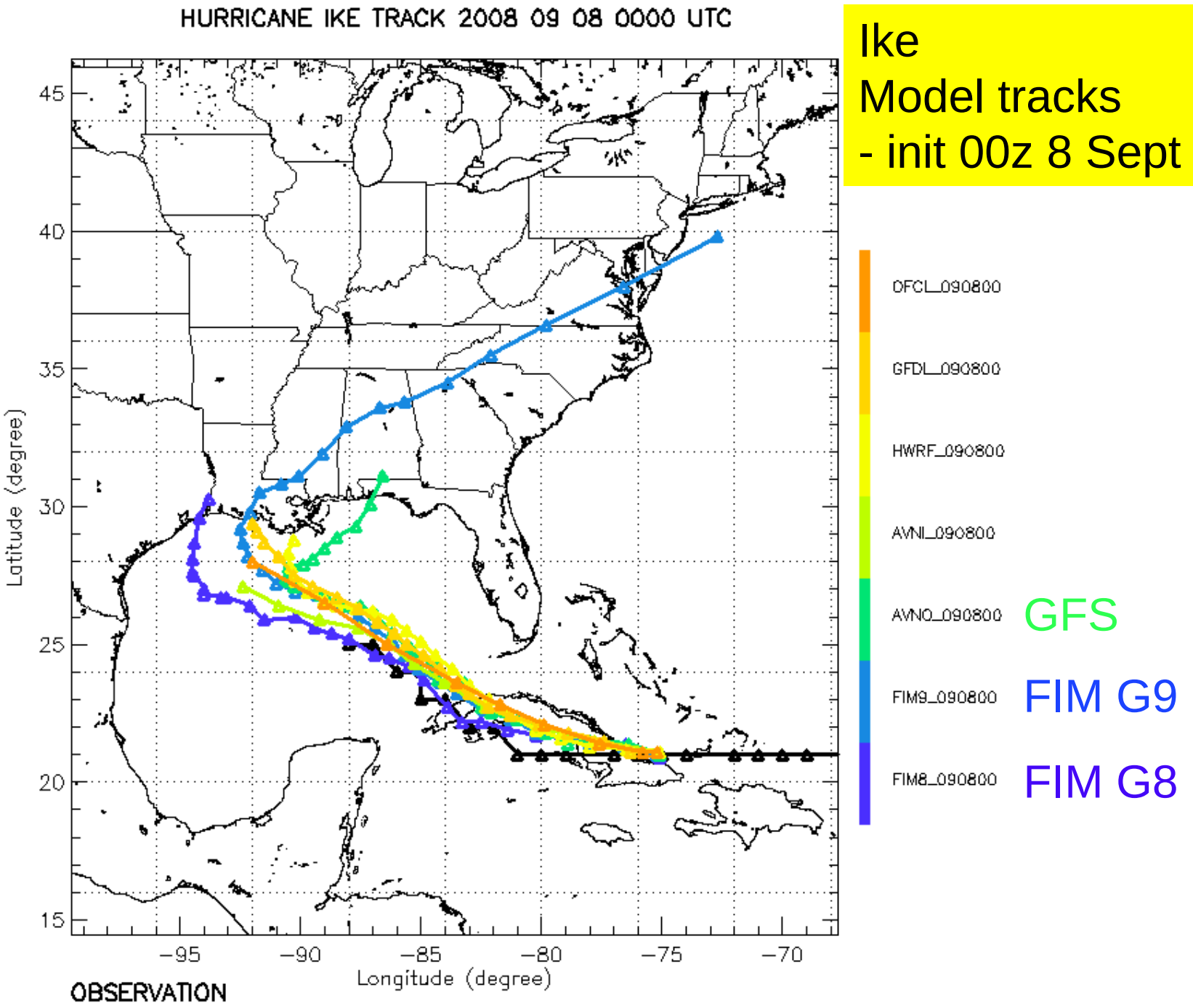
OBSERVATION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Ike
Model tracks
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HWRF_090800
AVNI_090800
AVNO_090800
GFS
FIM9_090800
FIM G9
FIM8_090800
FIM G8
Latitude (degree)
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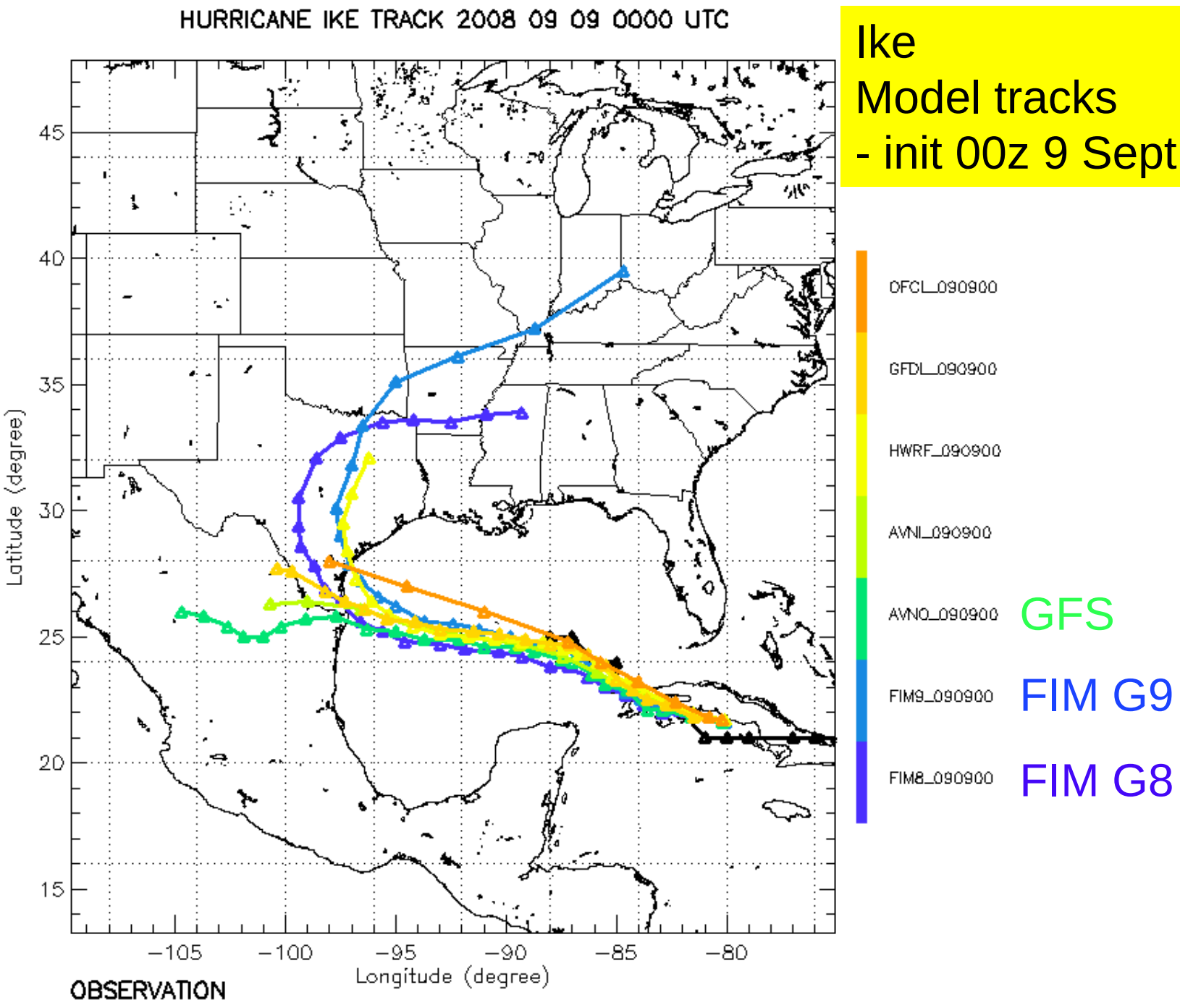
OBSERVATION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Model tracks
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AVNO_090900
GFS
FIM9_090900
FIM G9
FIM8_090900
FIM G8
Latitude (degree)
Longitude (degree)
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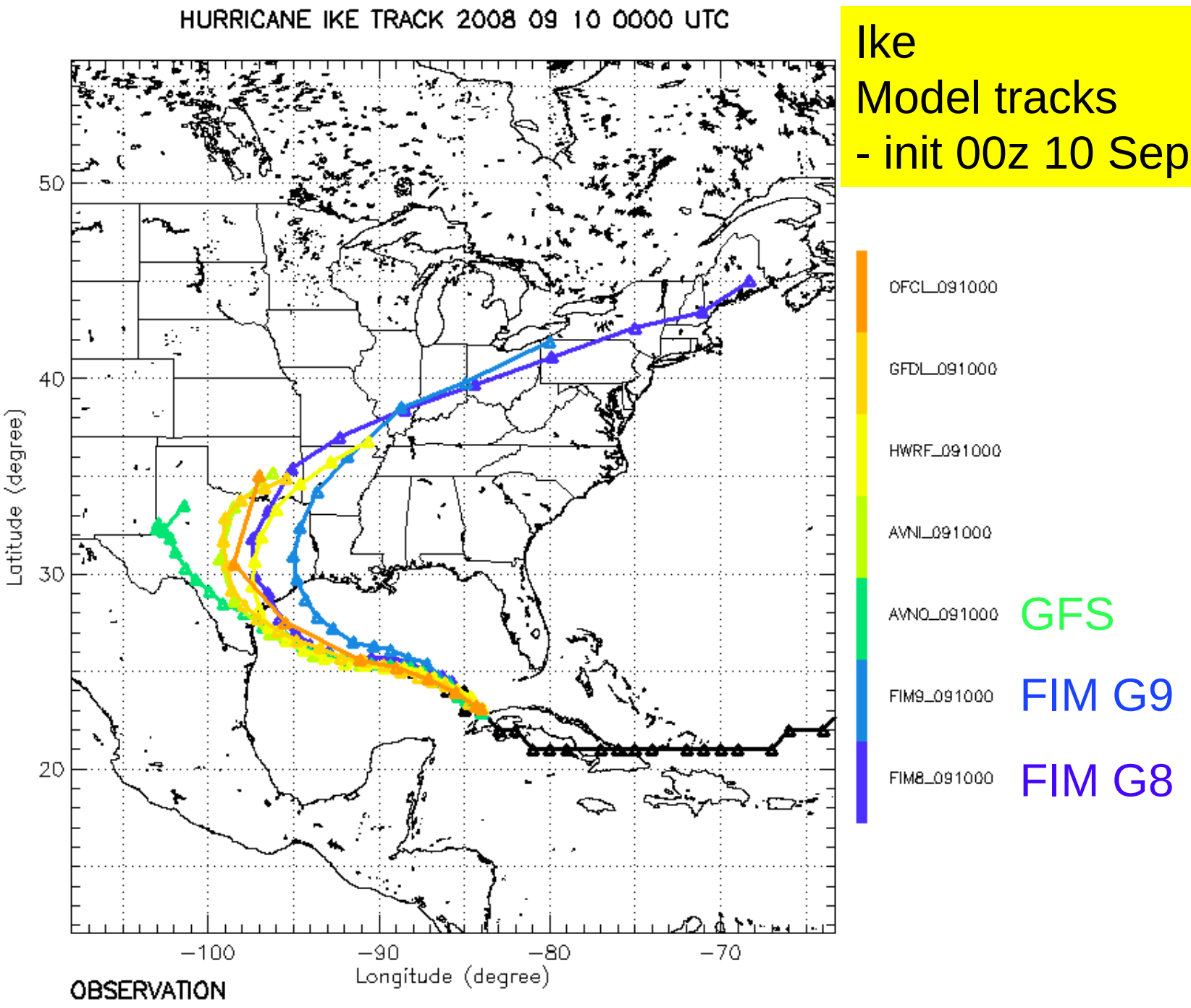
OBSERVATION


HURRICANE IKE TRACK 2008 09 10 0000 UTC
Ike
Model tracks
- init 00z 10 Sep
OFCL_091000
GFDL_091000
HWRF_091000
AVNI_091000
AVNO_091000
GFS
FIM9_091000
FIM G9
FIM8_091000
FIM G8
Latitude (degree)
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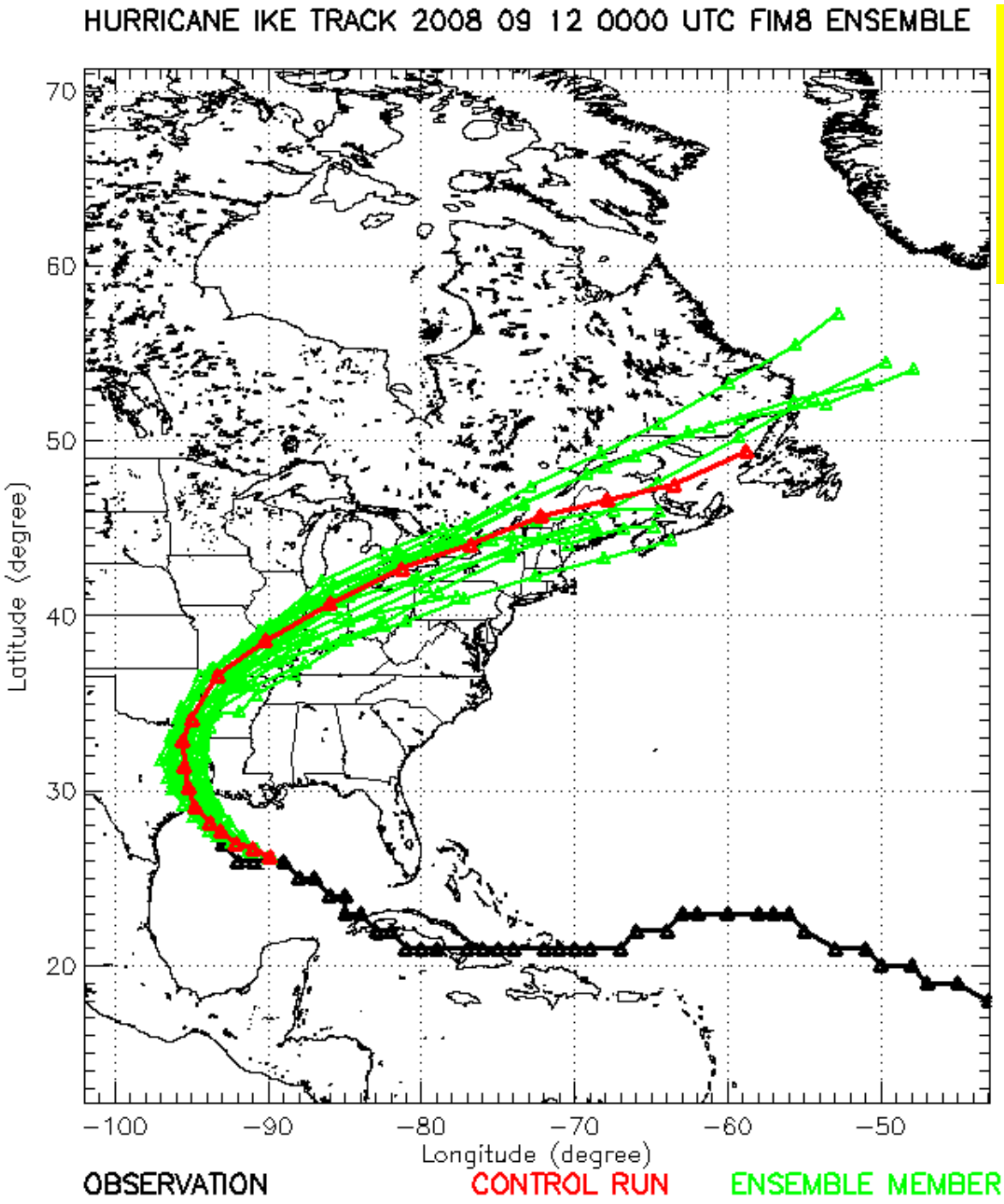
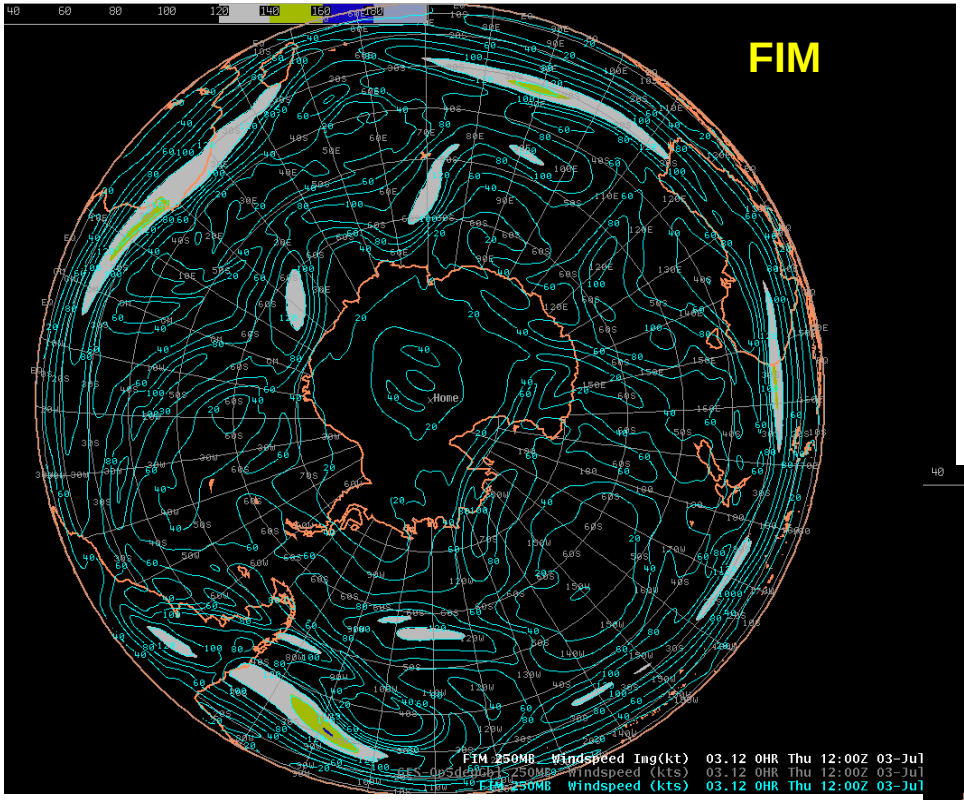
Longitude (degree)
OBSERVATION



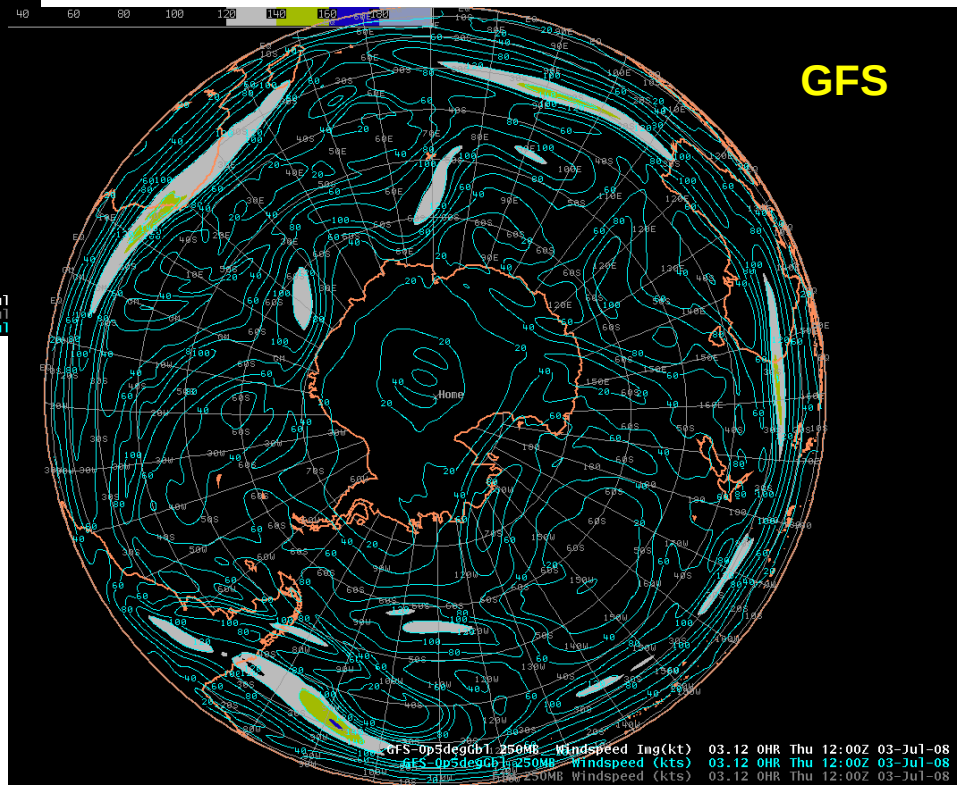
Ike fcst tracks -- FIM 20-member ensemble - G8 - init 00z 12 Sep

Jet streaks in Southern Hemisphere

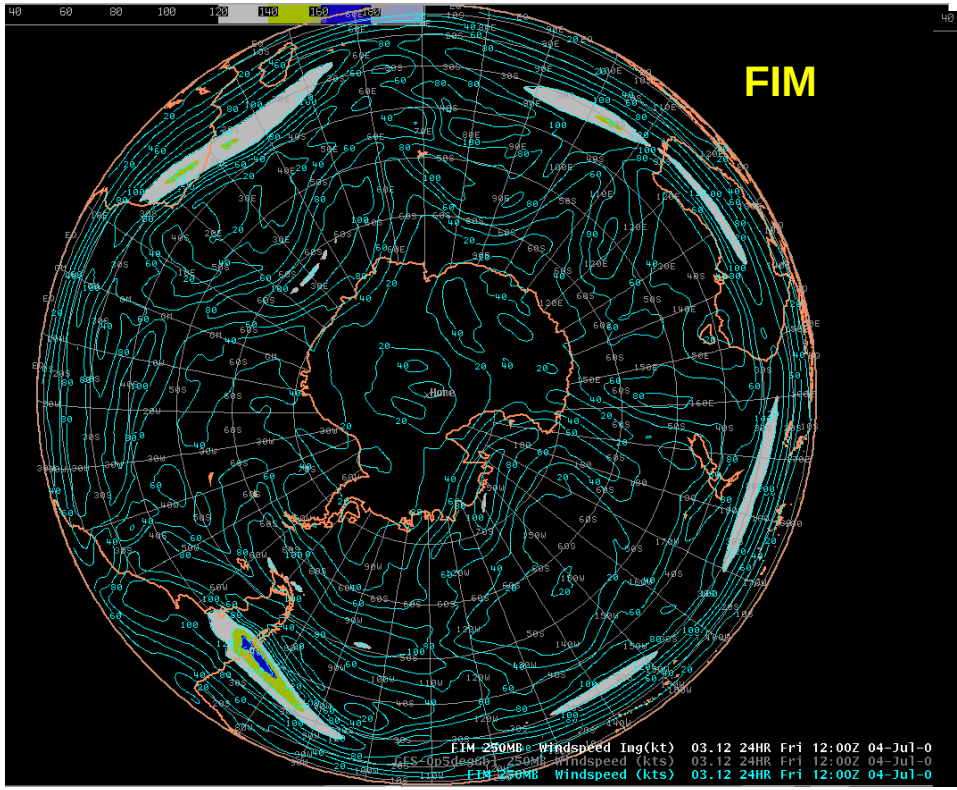
FIM and GFS 250 mb initial wind speeds in Southern Hemisphere 1200 UTC 3 July 08 (color begins at 120 knots; new color every 20 knots)

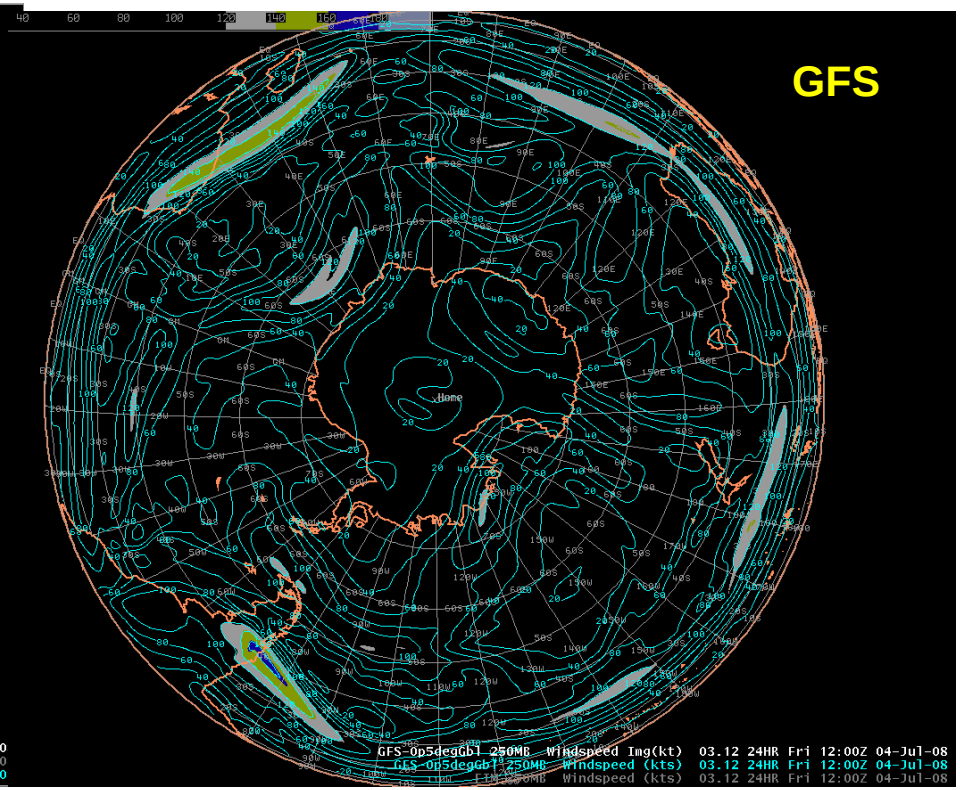


Initial fields nearly identical



Comparison of FIM and GFS 250 mb wind speed 24-h Southern Hemisphere forecasts valid 12 UTC 4 July

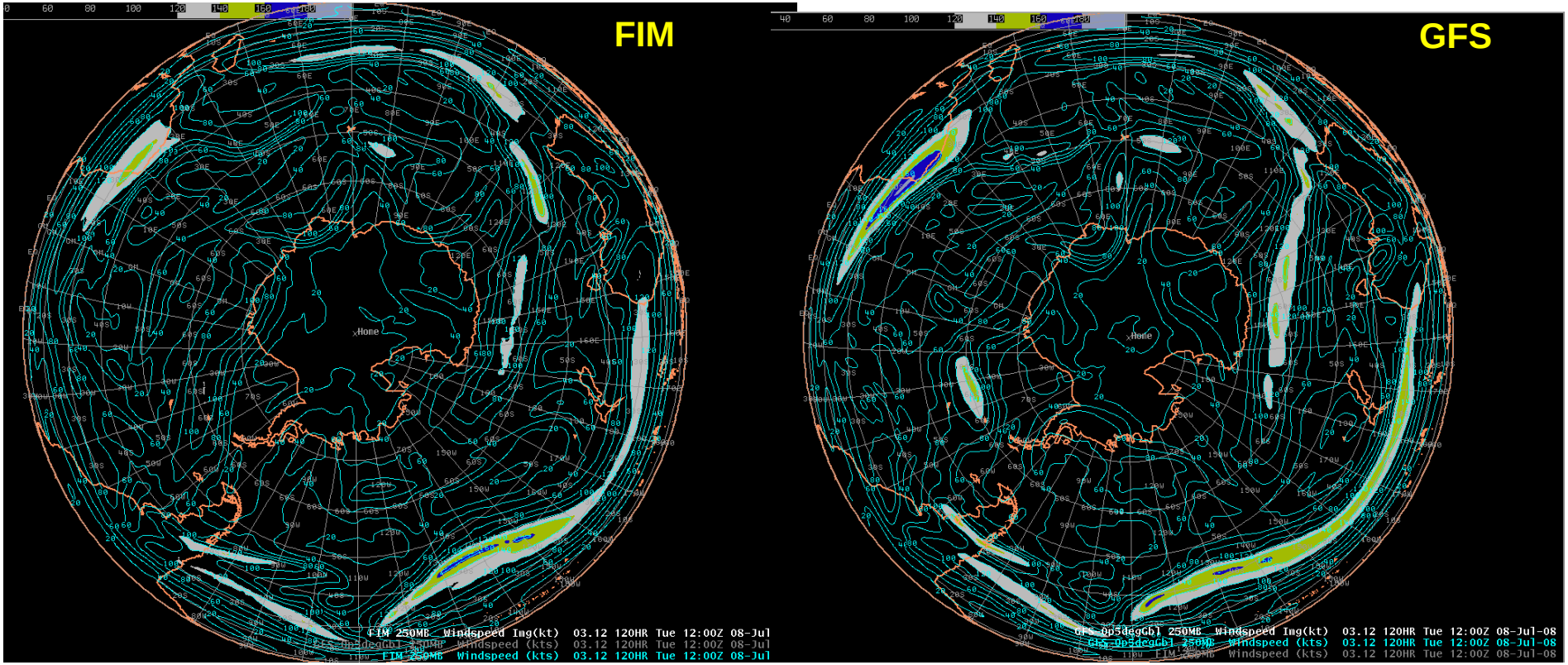




- Northern Hemisphere (>= 120 knots) at 24-h: FIM tends to slightly underpredict spee
  GFS: slight overprediction.
- Recent trend: FIM underprediction is reduced

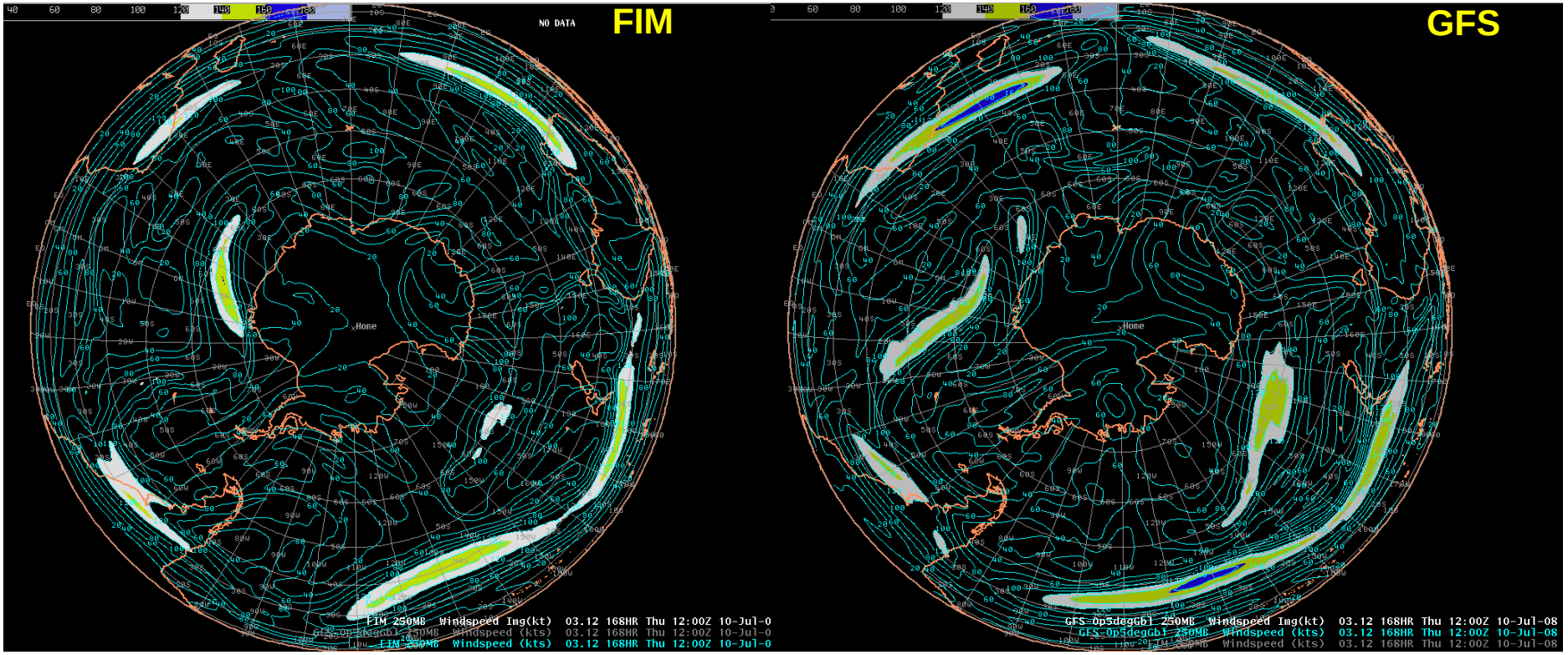
- For Southern Hemisphere, both models overpredict maxima (speeds >= 160 knots) relative to GFS analysis, more so for the GFS.

FIM and GFS 250 mb wind speed 120-h
Southern Hemisphere forecasts valid 12 UTC 8 July



By 120 h differences have grown;
GFS usually predicting stronger wind speeds

FIM and GFS 250 mb wind speed 168-h Southern Hemisphere forecasts valid 12 UTC 10 July



- Similar trend for the 168 h forecasts.
- Generally the locations of the major jets are fairly close even at 168 h.

Summary

- FIM is robust, and produces credible forecasts relative to other global weather forecast models.

- FIM is able to produce reasonable dynamical structures, given its resolution
  - Great Plains low-level jet
  - Terrain-modulated flows
  - Tropical Cyclones
  - Cutoff lows aloft; upper-level jet streaks

    …

- FIM more often than not forecasts slightly slower eastward progression of subtropical upper-air features than does the GFS.

Summary

- FIM more likely to spin up tropical cyclones during the forecast than GFS

  (A separate issue: GFS initialization often appears to be inadequate)

- Higher resolution (G9 ~ 15km diameter polygons) gives stronger tropical cyclones and slightly better track forecasts than G8

- GFS gives overall better (more reliable) track forecasts

  (small sample)

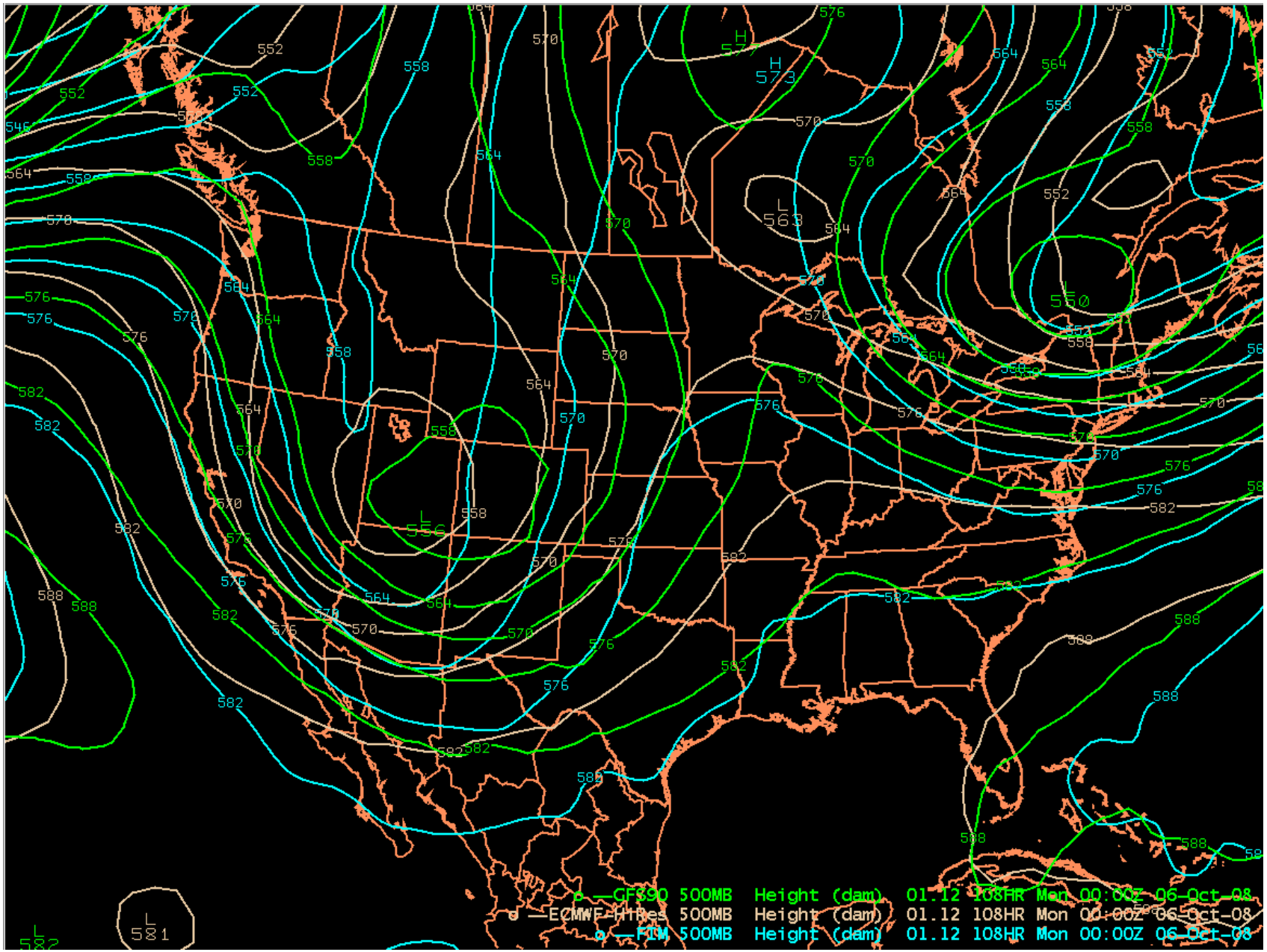
- Slight tendency toward global drying (precipitable water vapor) apparent in some forecasts (much more apparent during September 08 than during summer).

Summary and Future Work

- Performance of hybrid theta-sigma *versus* pure sigma vertical coordinate

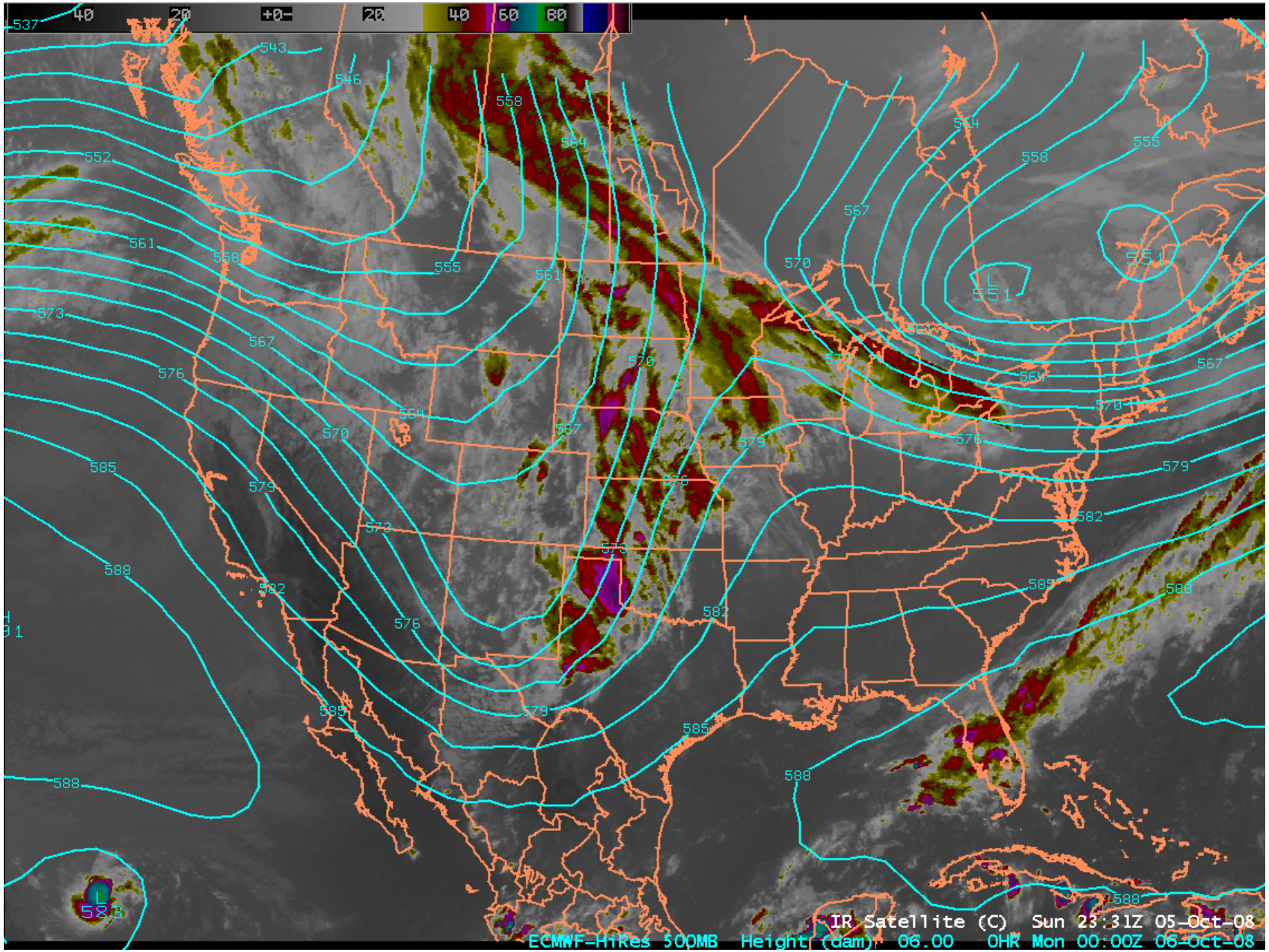
  Work underway--Stan's talk yesterday
- Upper-troposphere/Lower Stratosphere features (upper fronts, PV structures, etc.)
- Extratropical latent-heat driven phenomena (Mesoscale Convective Systems, oceanic cyclogenesis)
- Tropical cyclones
  - Genesis and track compared to GFS? Work underway, but more storms needed
- Forecast drift: what are systematic biases; do extremes of MSLP, max winds in subtropical and polar jets, precipitation, tend to increase or decrease during forecast? Specific issue: Why the decrease in precipitable water and precipitation during FIM forecasts? Is this also happening in GFS?
- Need access to native-grid GFS forecasts, and need also to generate more complete set of diagnostics, for more rigorous comparisons

Model comparison for last weekend's system. 108-h forecasts from the 12z/1 Oct runs.

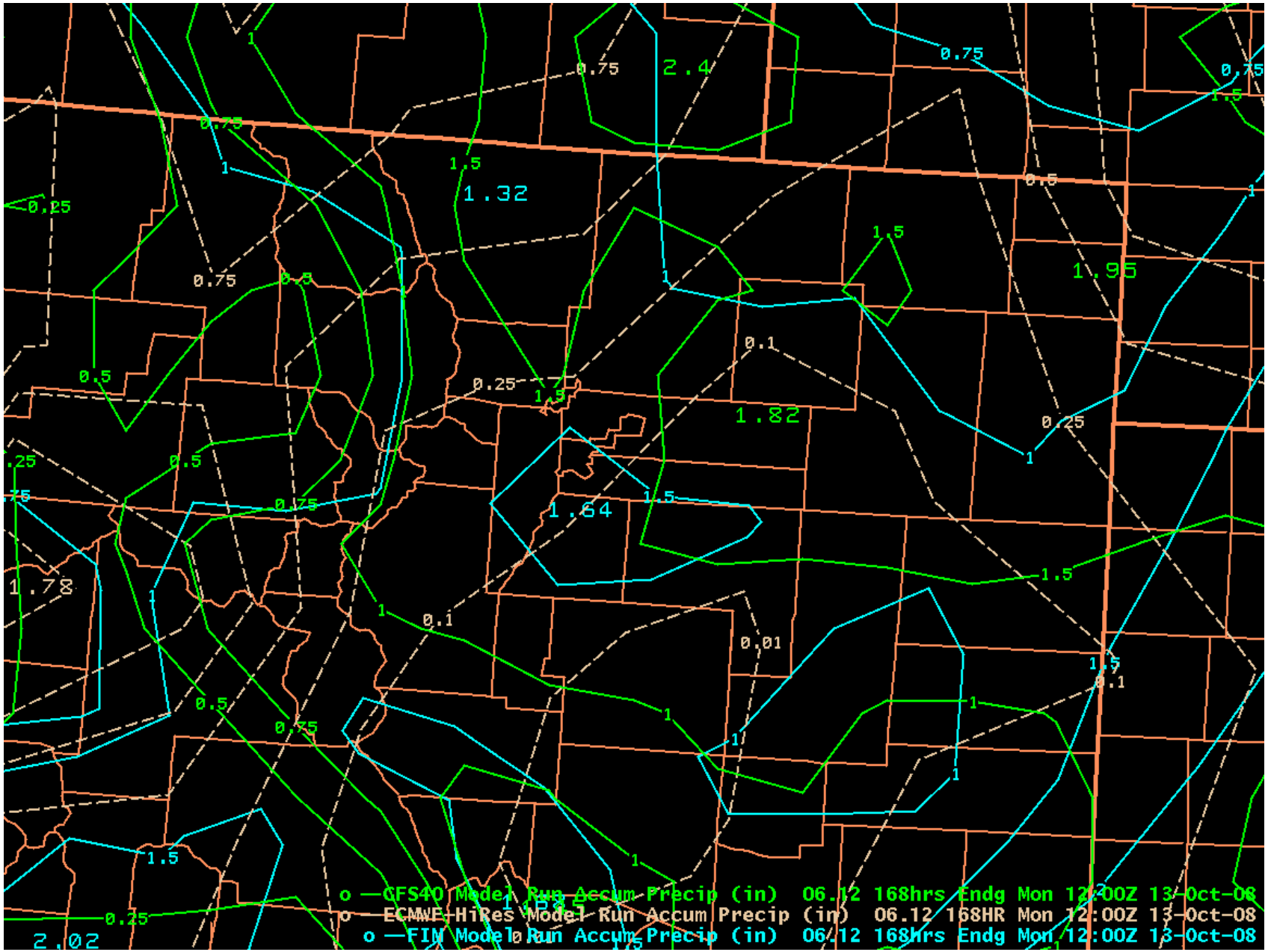


Model comparison for last weekend's system. Verification valid 00z/6 October.

All forecasts were too deep and not progressive enough.



Model comparison for next weekend's system (the first snow???). 12z/Mon/6 Oct runs. 168-h forecasts of run total precip show big differences for CO between EC and GFS/FIM



Will it snow in Boulder this weekend?