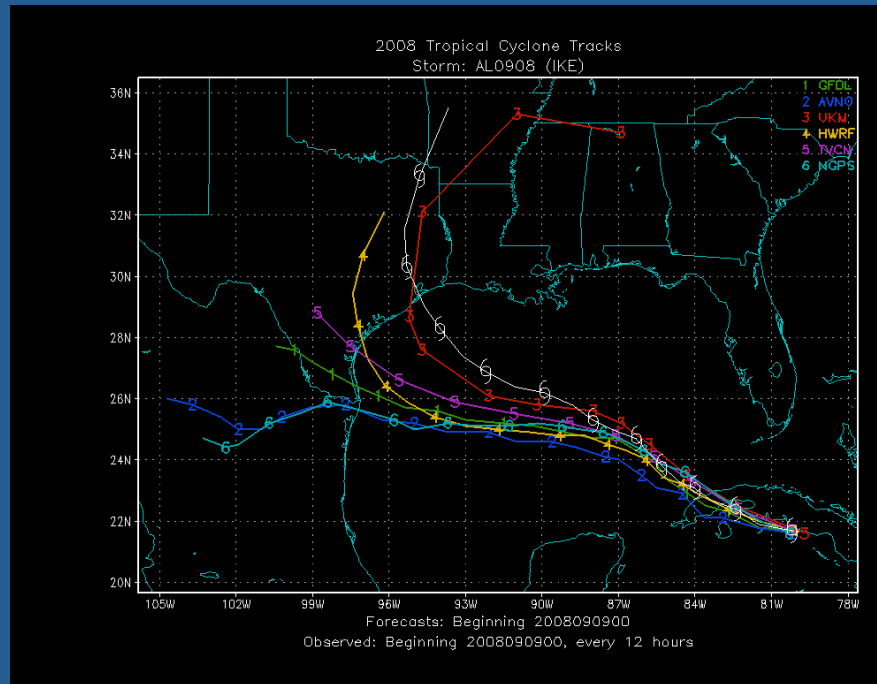


Use of the GFDL Vortex Tracker



Tim Marchok

NOAA / Geophysical Fluid Dynamics Laboratory

Hurricane WRF Tutorial
January 15, 2014

Outline

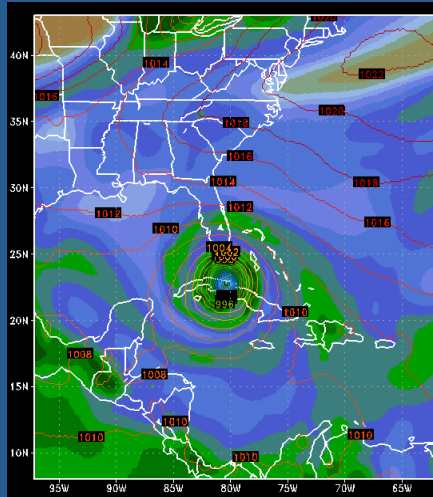
- History & description of the GFDL vortex tracker
- Inputs & Outputs
- Genesis tracking
- ATCF-plot: GrADS-based track and intensity plotting script

GFDL Vortex Tracker: History

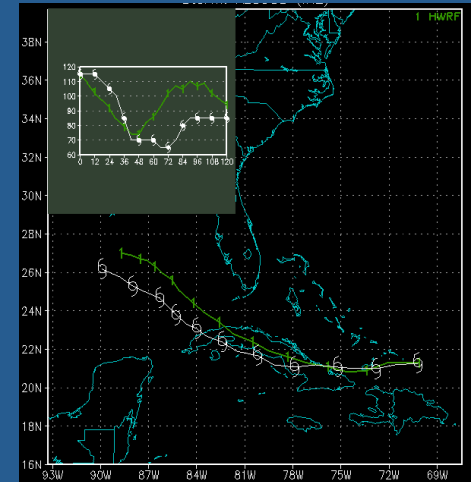
- Requirements:
 - A flexible tracking algorithm to work on a variety of models and resolutions.
 - Must run quickly
 - Must produce output in ATCF format
- Became operational at NCEP in 1998

Purpose of a vortex tracker

```
.  
.   
11000100100100101010  
00010010011110010010  
11001110001101010001  
00001010010011001011  
10101110101100011001  
10001110100100010100  
.   
.
```



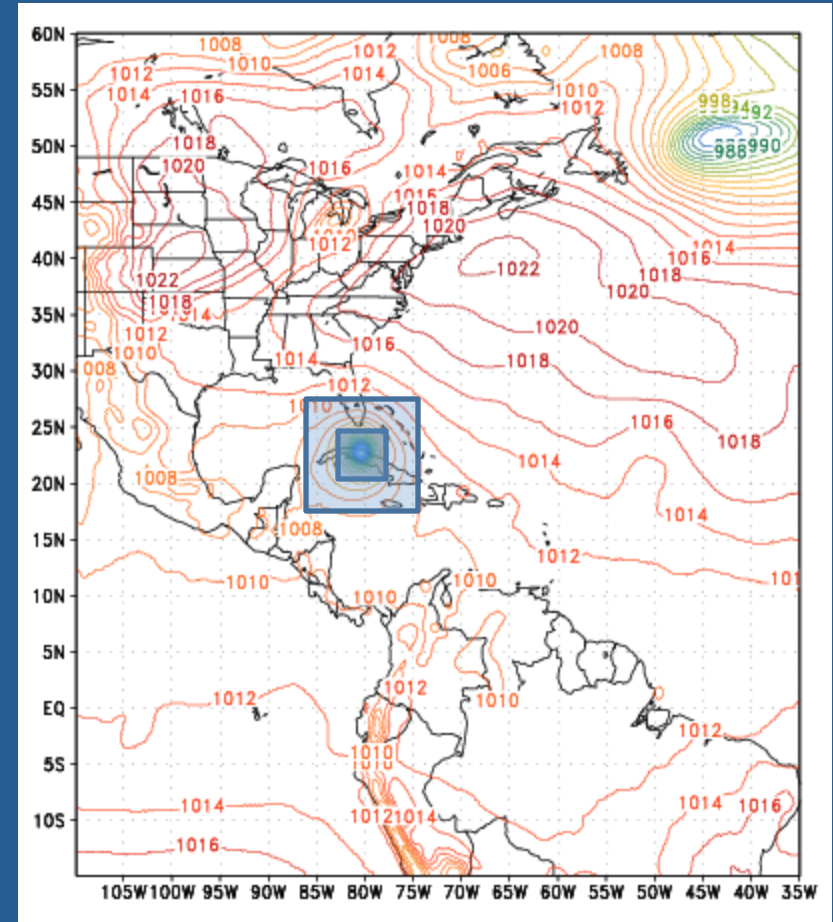
NOW
WHAT ?



- Operations: Quick reporting of track and intensity forecast data to NHC, JTWC, others.
- Research: Quick evaluation of the track & intensity skill of a forecast

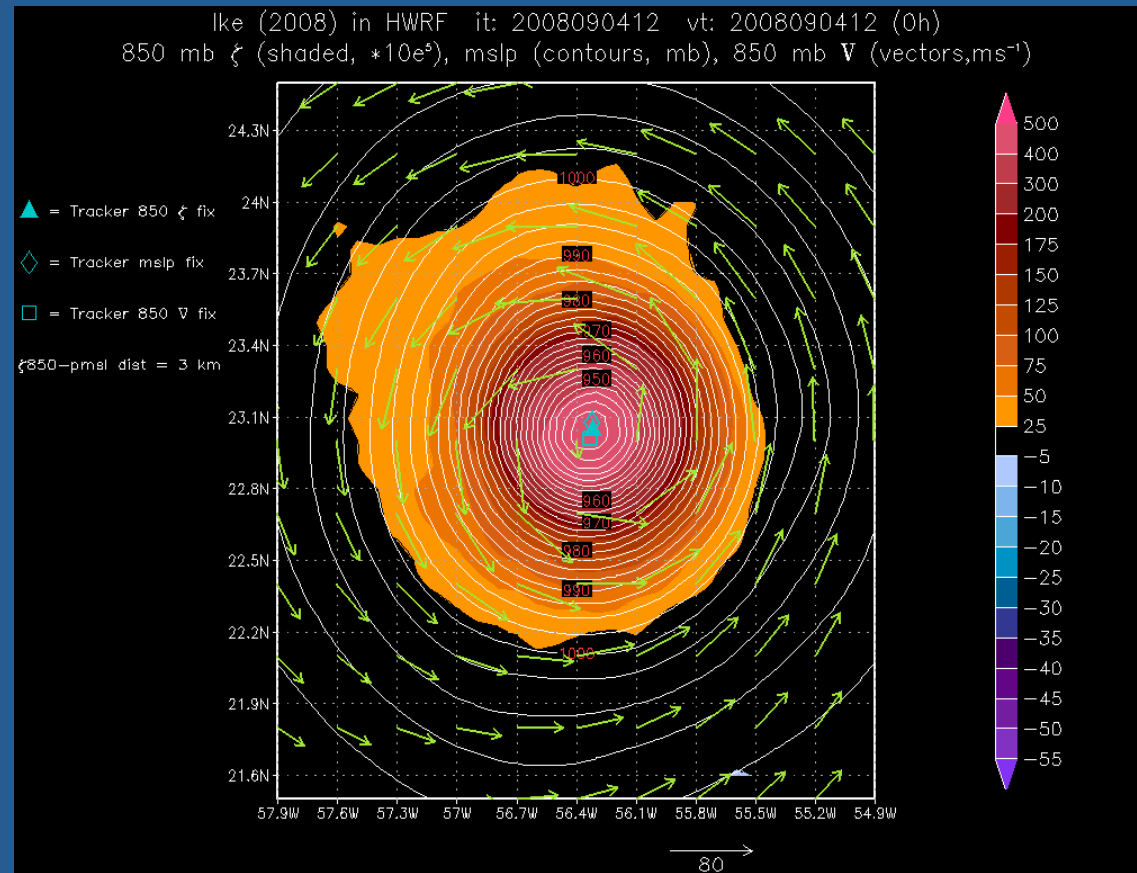
Why the need for an external tracker?

- Valuable CPU time is not wasted during model execution.
- Tracking analysis can be re-done without re-running model.
- Uniform tracking criteria can be applied to multiple models.

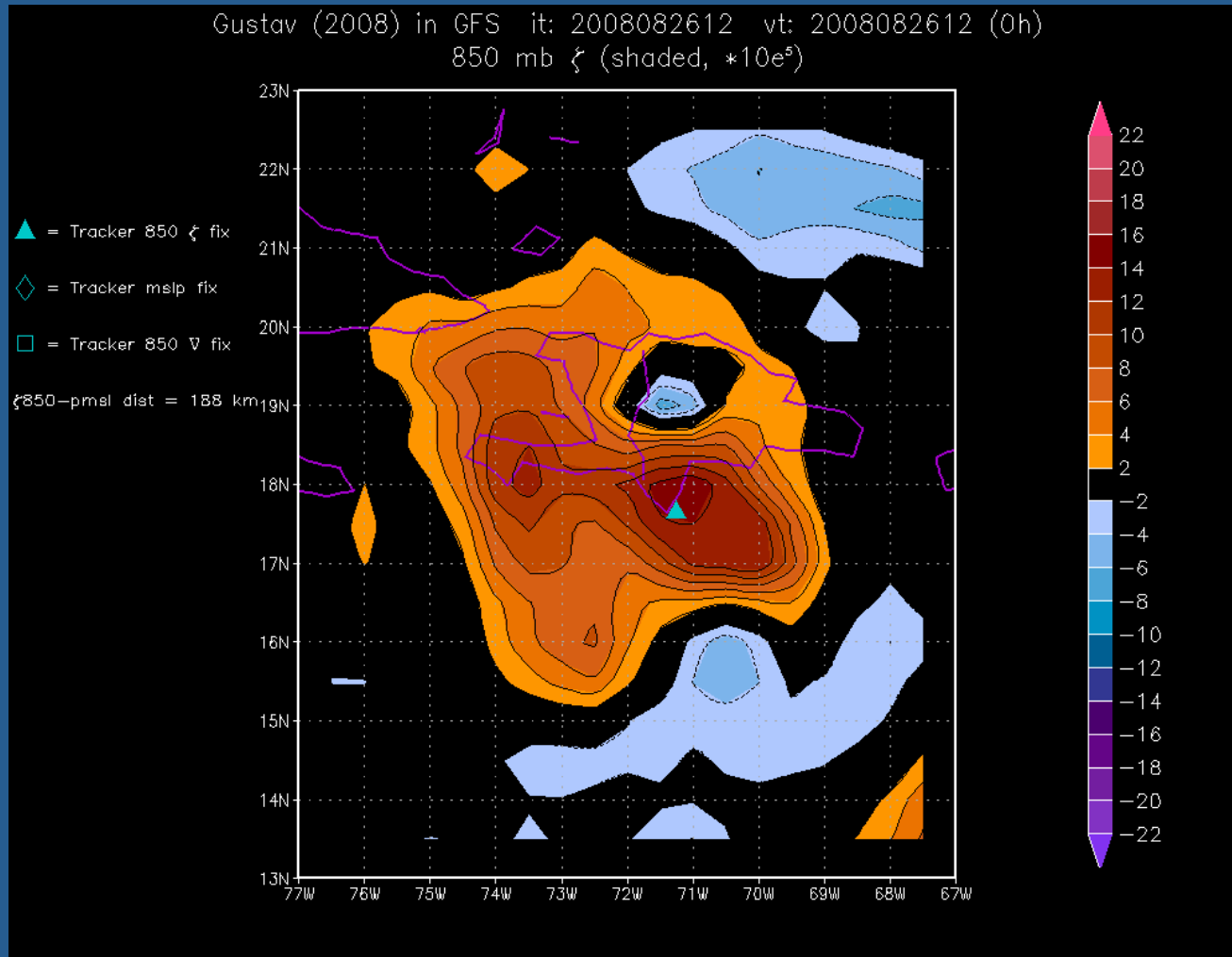


Why the need for an external tracker?

- Ike in HWRF:
A well-defined storm with center locations collocated.
- So then... why the need for anything sophisticated?

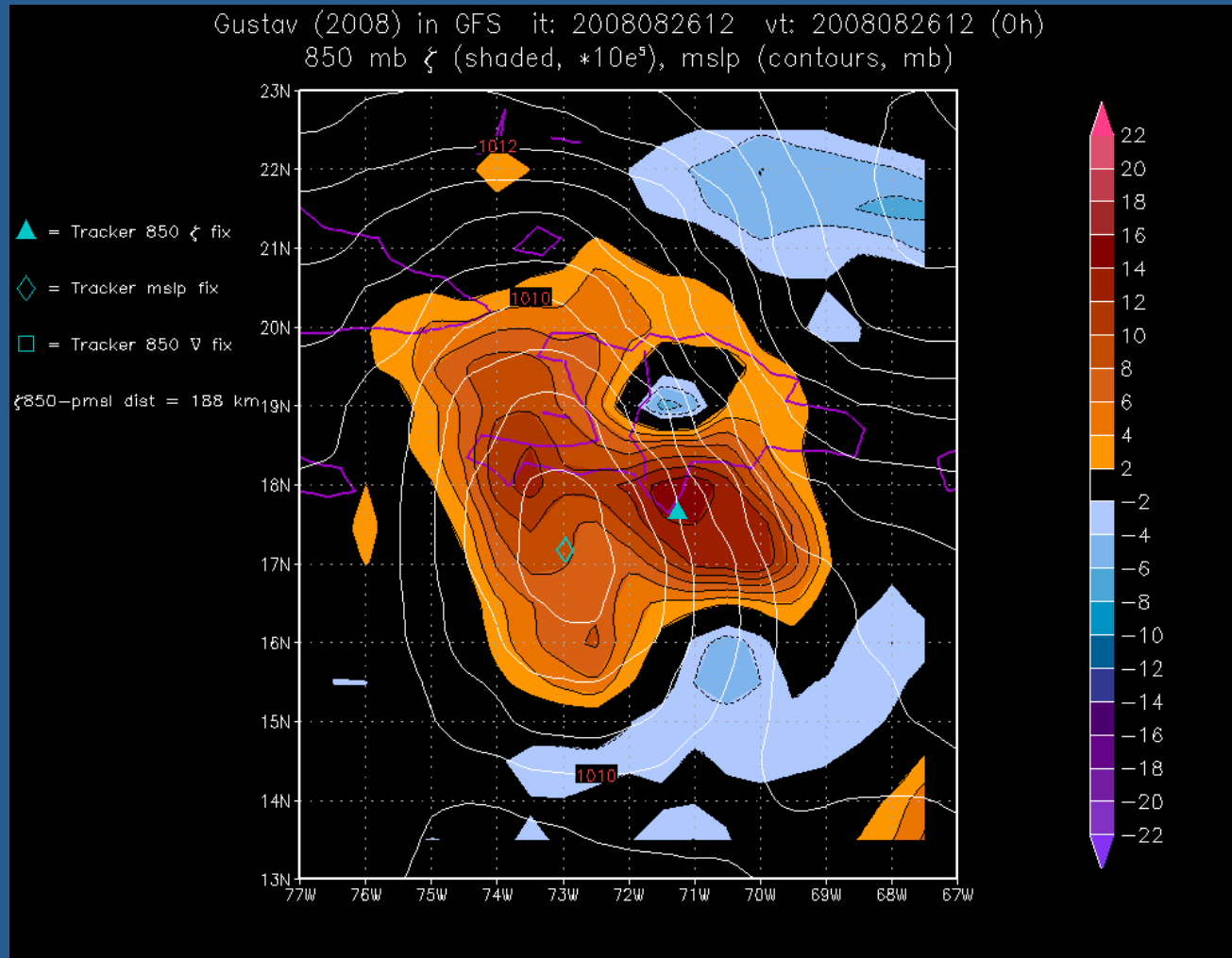


Why the need for an external tracker?



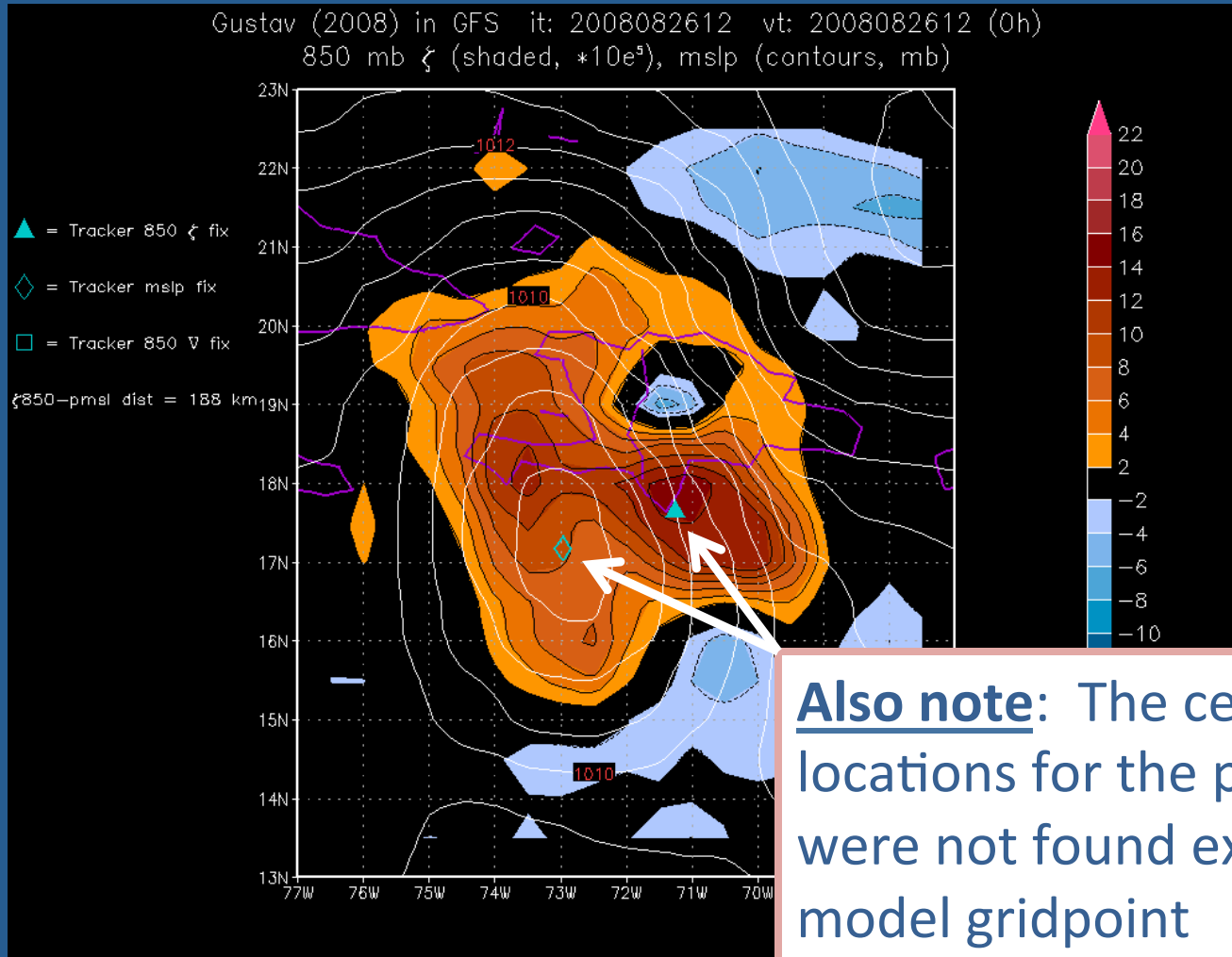
- Gustav in GFS: For an observed 80-knot hurricane, the GFS was initialized with a poorly organized vorticity center.

Why the need for an external tracker?



- Gustav in GFS: The SLP center was found 188 km from the vorticity center. What is the storm's central position?

Why the need for an external tracker?



- Gustav in GFS: The SLP center was found 188 km from the vorticity center.

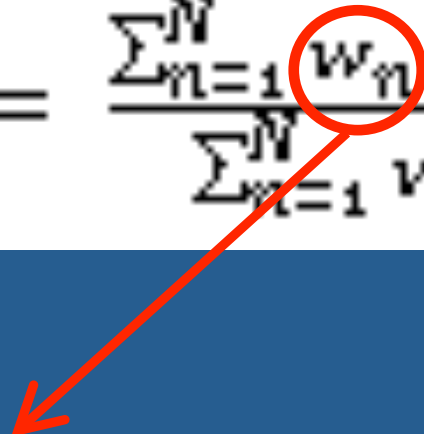
Tracker Design: Multiple Variables

- A weighted average of the positions of several low-level variables is used.
- 6 Primary parameters:
 - 850 mb vorticity
 - 700 mb vorticity
 - Surface (10 m) vorticity
 - 850 mb gp height
 - 700 mb gp height
 - Mean Sea-Level Pressure
- 3 Secondary parameters:
 - 850 mb minimum in wind speed
 - 700 mb minimum in wind speed
 - Surface (10 m) minimum in wind speed

Tracker Design: Center-fixing algorithm

- Instead of interpolation, a Barnes Analysis is performed on an array of points surrounding a guess storm location:

The Barnes function, B , provides a Gaussian-weighted average value for a variable, $F(n)$, at a given gridpoint, g .

$$B(g) = \frac{\sum_{n=1}^N w_n F(n)}{\sum_{n=1}^N w_n}$$


The weighting function, w , is dependent on the distance, d_n , of a point from the origin gridpoint, g , and the choice of the e-folding radius, r_e .

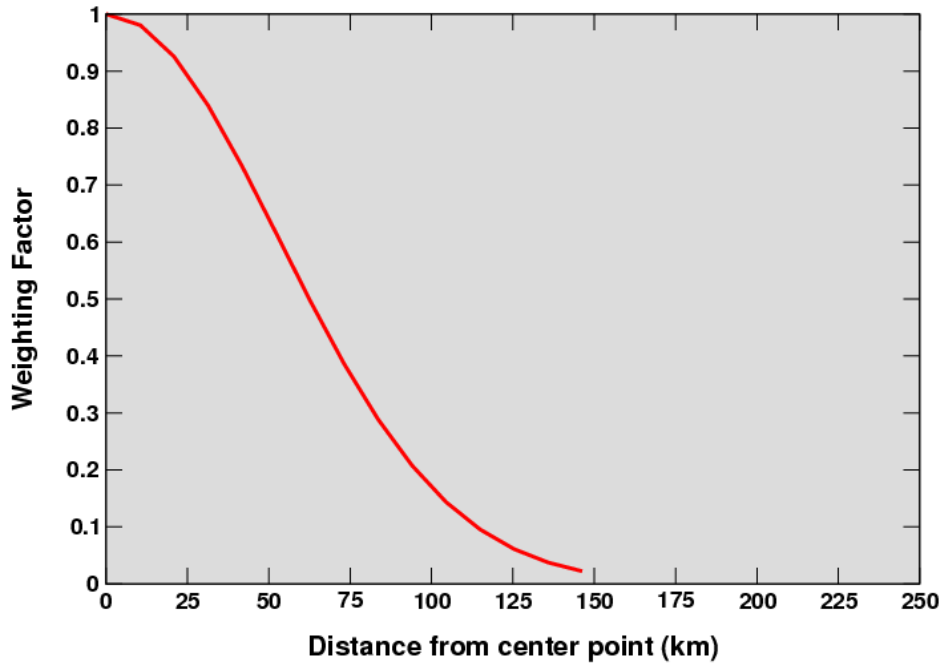
$$w = e^{-(d_n^2 / r_e^2)}$$

The center is found at the point where this Barnes function is maximized (e.g., NH vorticity) or minimized (e.g., MSLP).

Barnes analysis weighting

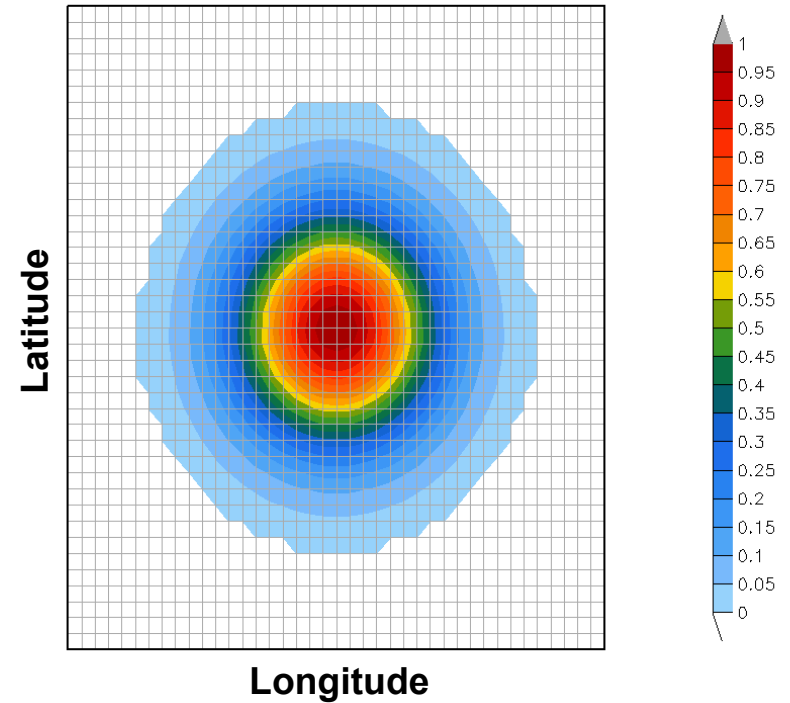
Linear Response

Barnes Analysis Weights
Using an e-folding radius of 75 km



Spatial Response

Grid spacing = 0.1°

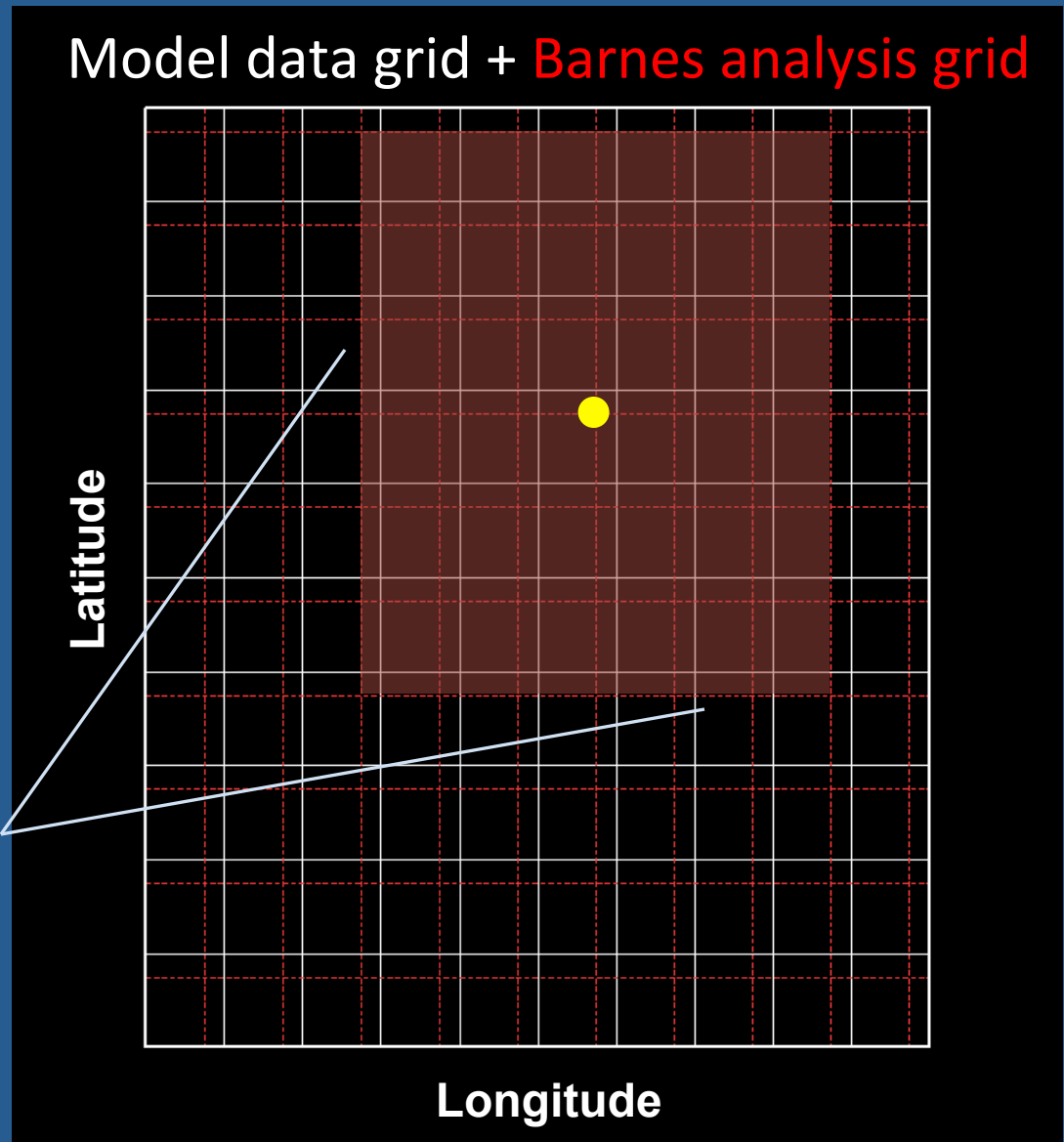


- Choosing r_e : A balance between including enough points to get a representative sample vs. too much smoothing.
- For most models, we use $r_e = 75$ km. For $dx < 0.1^\circ$, $r_e = 60$ km.

Barnes analysis: multiple search iterations

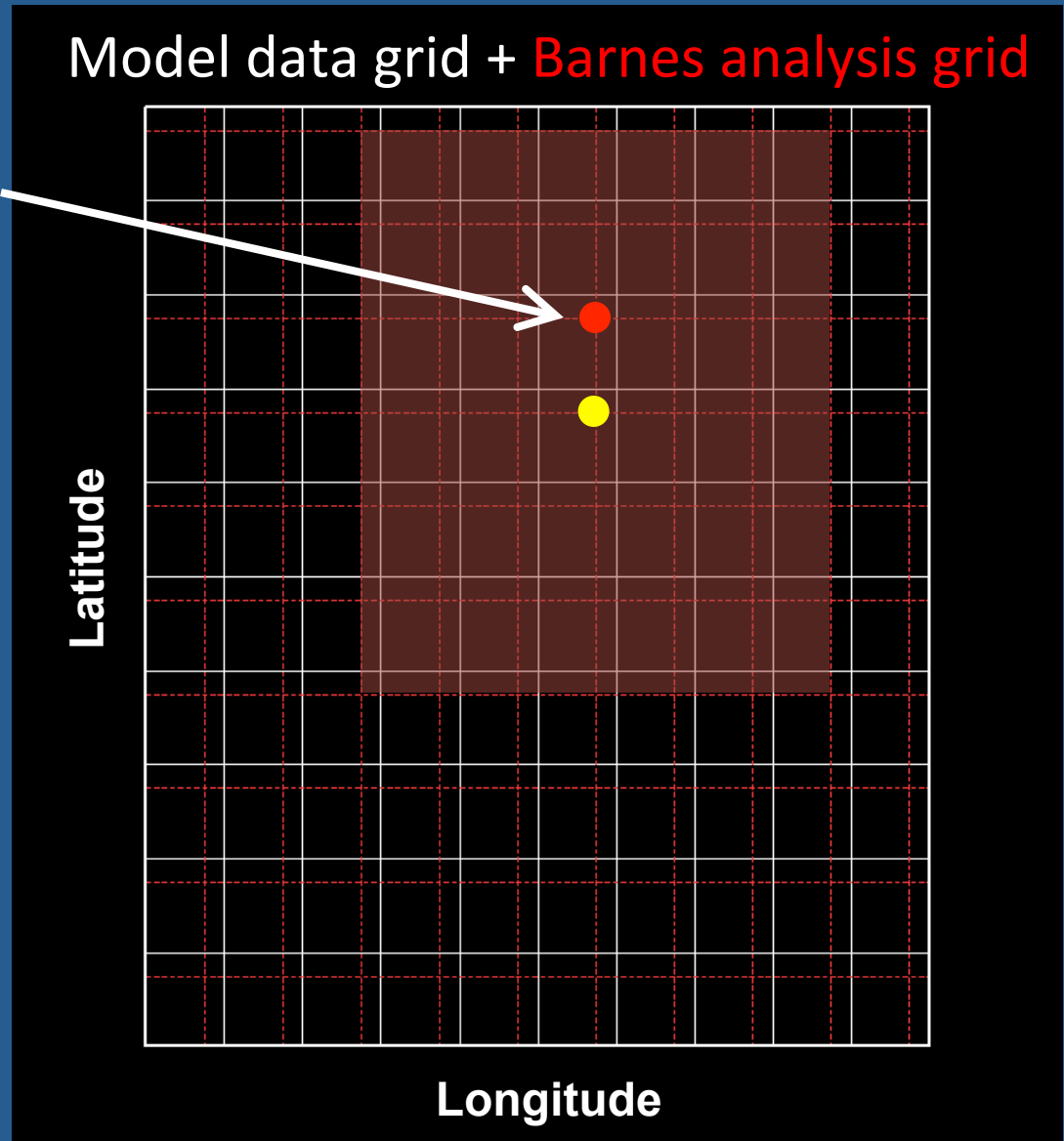
A grid of analysis points is set up, relative to the NHC observed position.

A Barnes analysis is performed for all points within a specified distance from the NHC position.



Barnes analysis: multiple search iterations

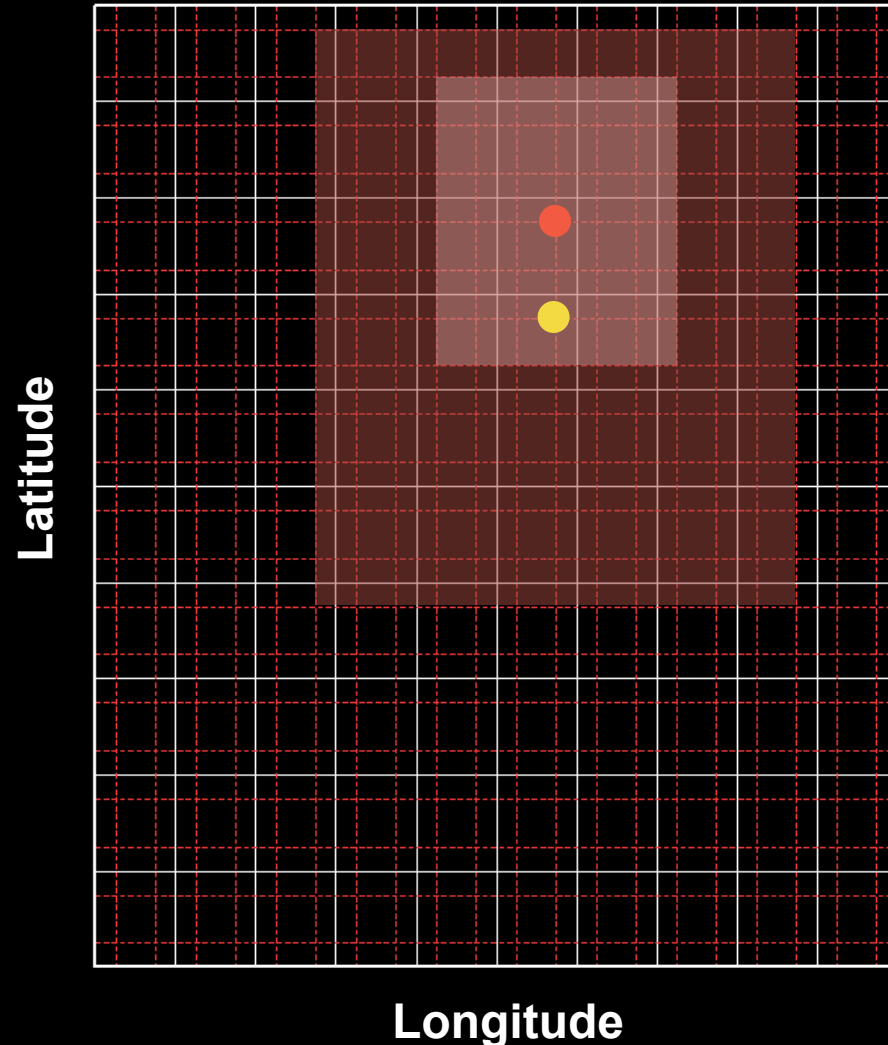
After the first iteration through all the points, suppose the Barnes analysis identifies the center as being here.



Barnes analysis: multiple search iterations

A second iteration through the Barnes analysis is performed after further limiting the domain and halving the grid spacing.

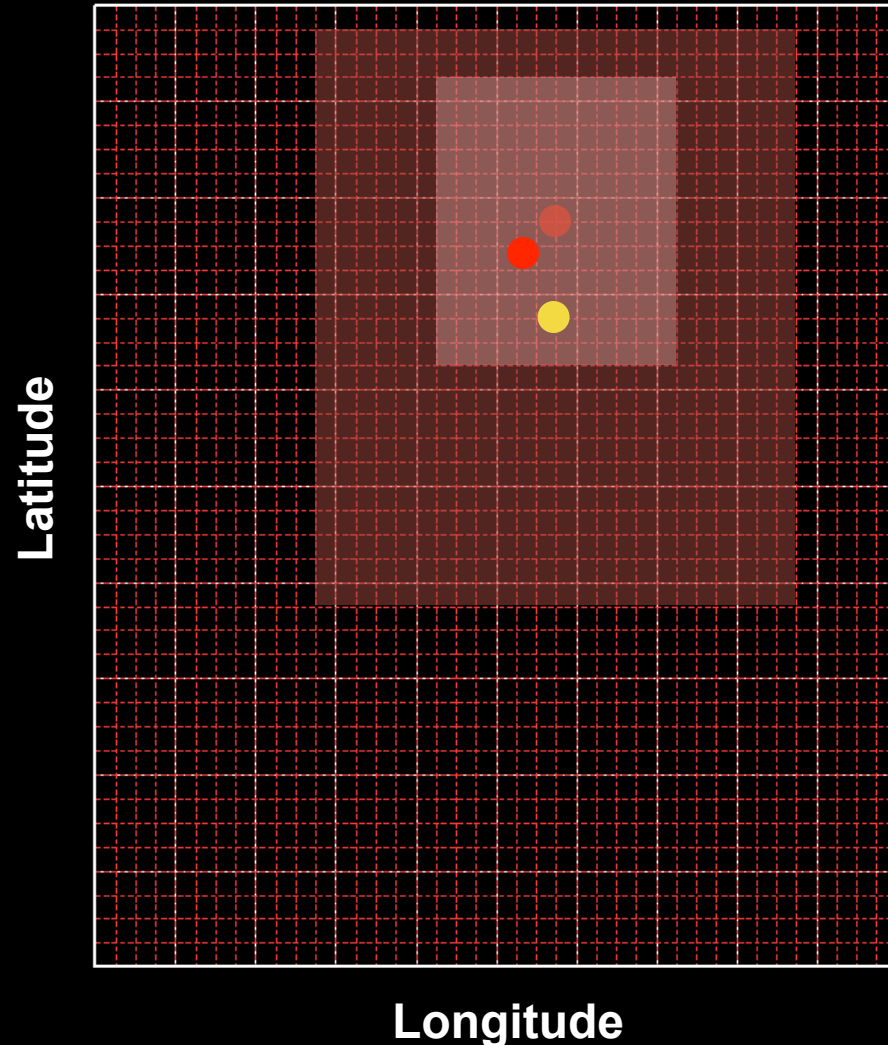
Model data grid + Barnes analysis grid



Barnes analysis: multiple search iterations

This process is repeated multiple times (up to 5), halving the grid spacing for the Barnes analysis each time, until a center position is fixed using a Barnes analysis grid spacing $< 0.1^\circ$.

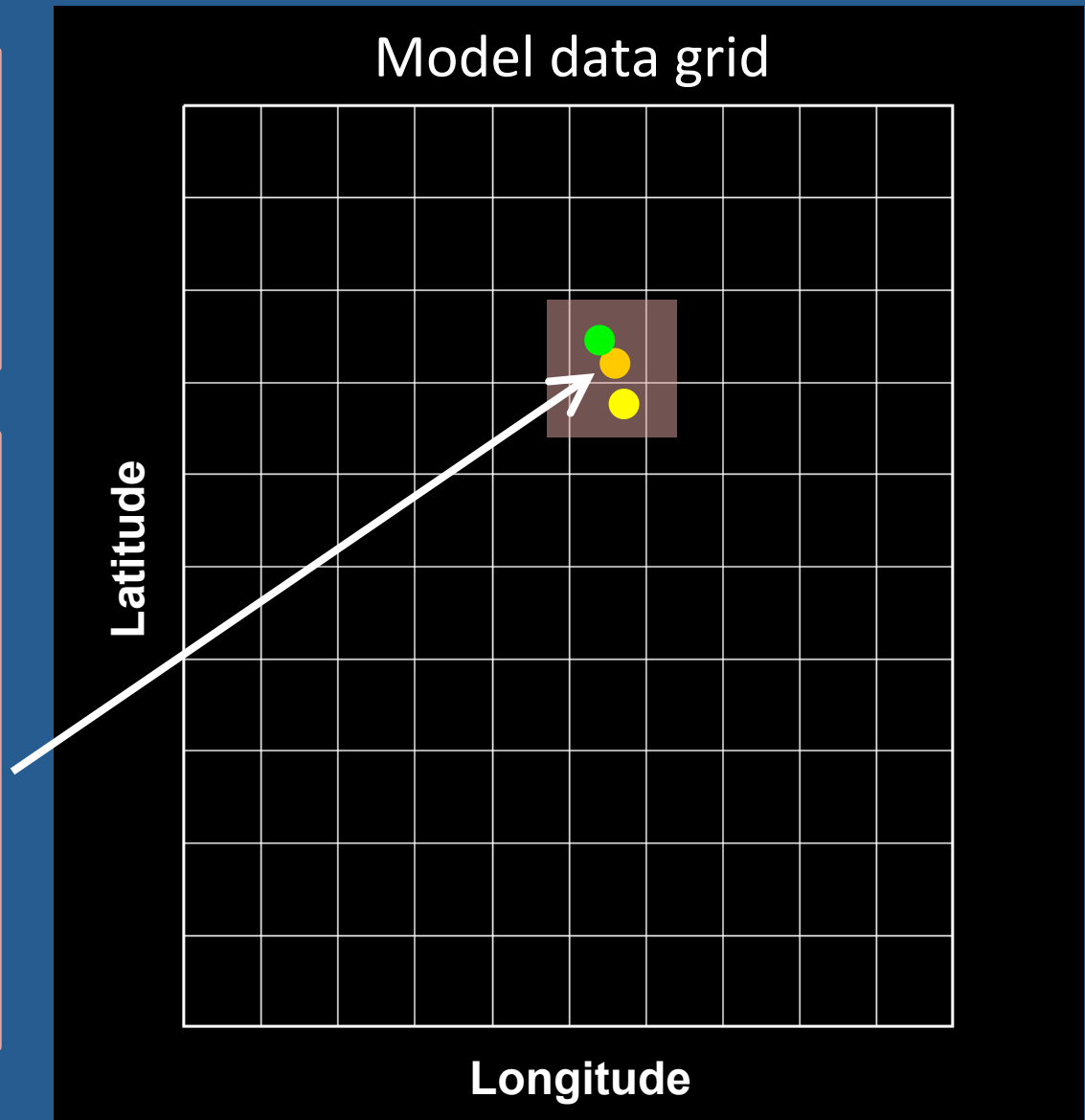
Model data grid + Barnes analysis grid



Computing the center position, Part II

The Barnes analysis is repeated for the 3 secondary, wind-based parameters.

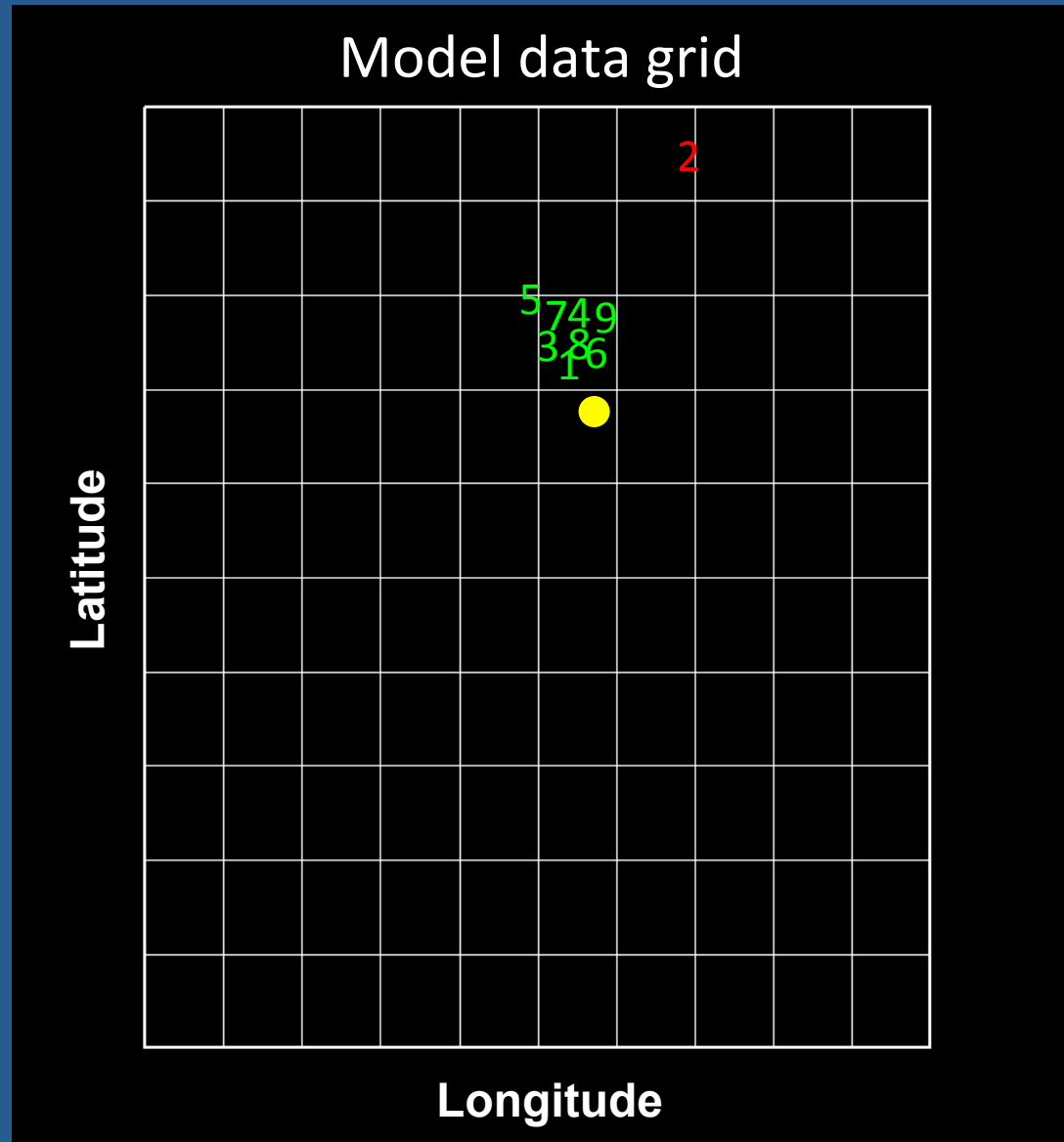
This analysis is performed over a small domain, centered on a position that is a mean of the 6 primary fixes and the guess position.



Computing the center position, Part III

Parameters fixes that are beyond a specified error distance threshold of the current guess position are **discarded**.

- Error distance thresholds:
 - Initially 275 km
 - At later times, can be a function of spread in previous position fixes

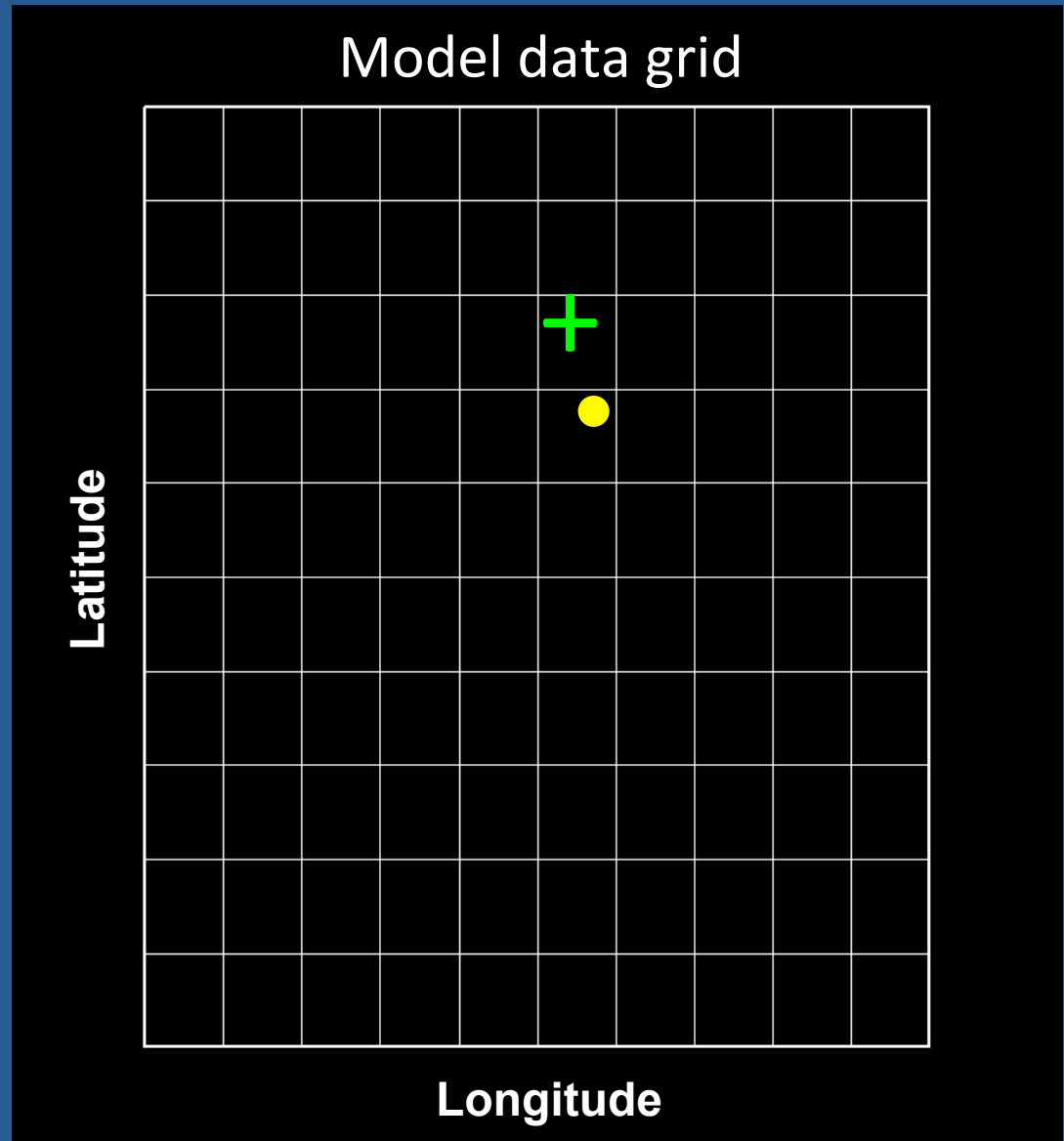


Computing the center position, Part III

The remaining parameter fixes are averaged to produce the mean position fix for each forecast

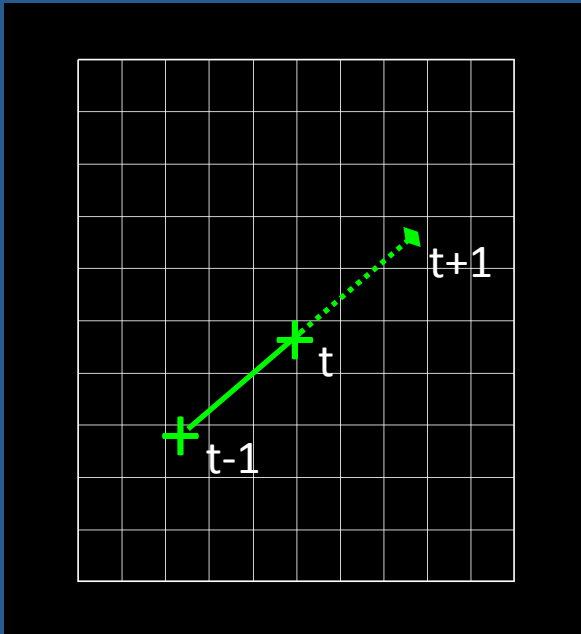
hour.

- These additional parameters are computed once the center fix is made:
 - Max surface wind
 - R_{\max}
 - Minimum MSLP
 - 34-, 50- and 64-kt wind radii

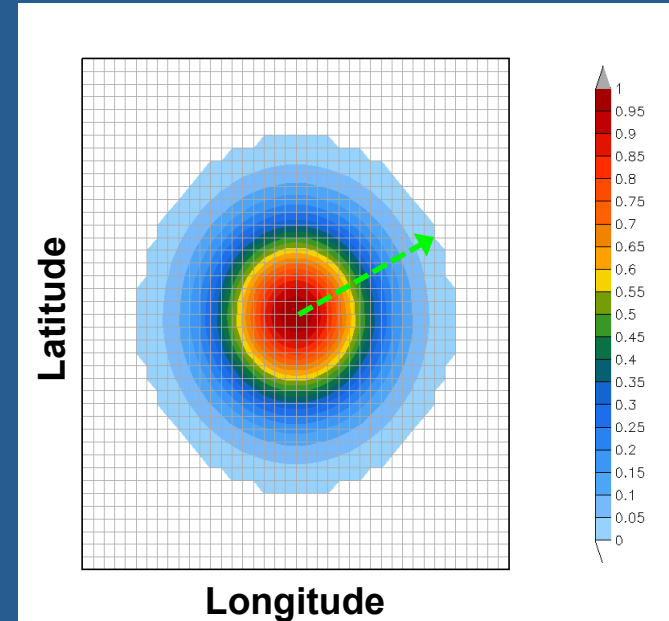


Tracking from one lead time to the next

Linear extrapolation



Barnes analysis & advection



The guess positions from these 2 methods are averaged to compute a final guess position for the search at the next lead time.

A Barnes analysis with a large r_e at 850, 700 & 500 mb is used to compute mean steering winds. A parcel is advected to a guess position at the next lead time.

“Quality Control”

A series of checks is applied to ensure that the tracker is following a storm that is the system of interest

MSLP Gradient: Gross check to ensure minimum gradient (~ 0.5 mb / 300 km) exists within 300 km of center. Set in script: “mslpthresh” variable

V_T (850 mb): Mean V_T within 225 km must be cyclonic and exceed threshold. Default (1.5 ms^{-1}) is set in script: “v850thresh” variable

$DIST_{(MSLP-Zeta_{850})}$: This distance between the MSLP and $Zeta_{850}$ parameter fixes must not exceed a distance defined in source by “max_mslp_850” (usually set to

Translational speed: Speed of storm movement must not exceed threshold, set by “maxspeed_tc” variable (usually set to 60 knots).

323 km)

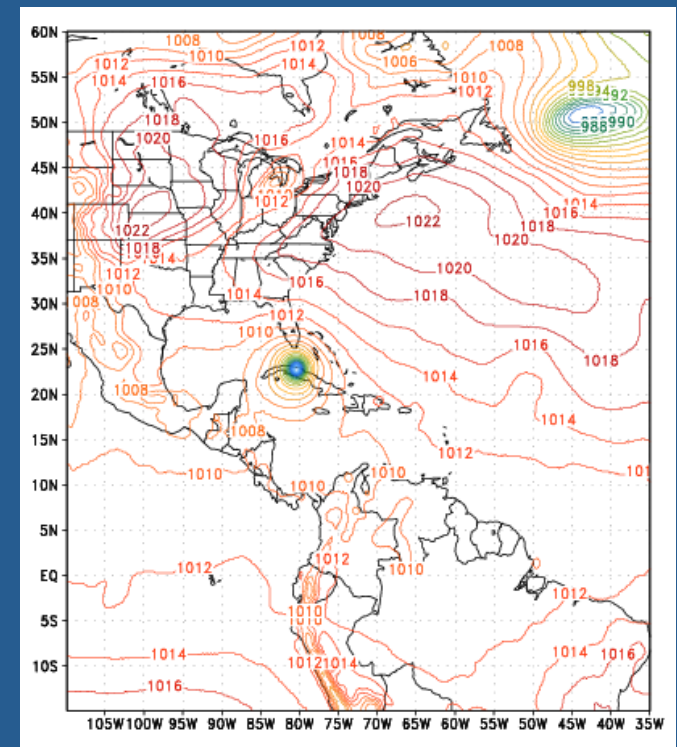
Outline

- History & description of the GFDL vortex tracker
- **Inputs & Outputs**
- Genesis tracking
- ATCF-plot: GrADS-based track and intensity plotting script

Tracker inputs: Synoptic data

- Data must be in Gridded Binary (GRIB) Version 1 format.
- Data points must increment from northwest (1,1) to southeast (imax, jmax).
- Data must be on a lat/lon grid.
- dx does not need to equal dy, but both must remain uniform over the domain.
- Data lead time intervals do not need to be evenly spaced

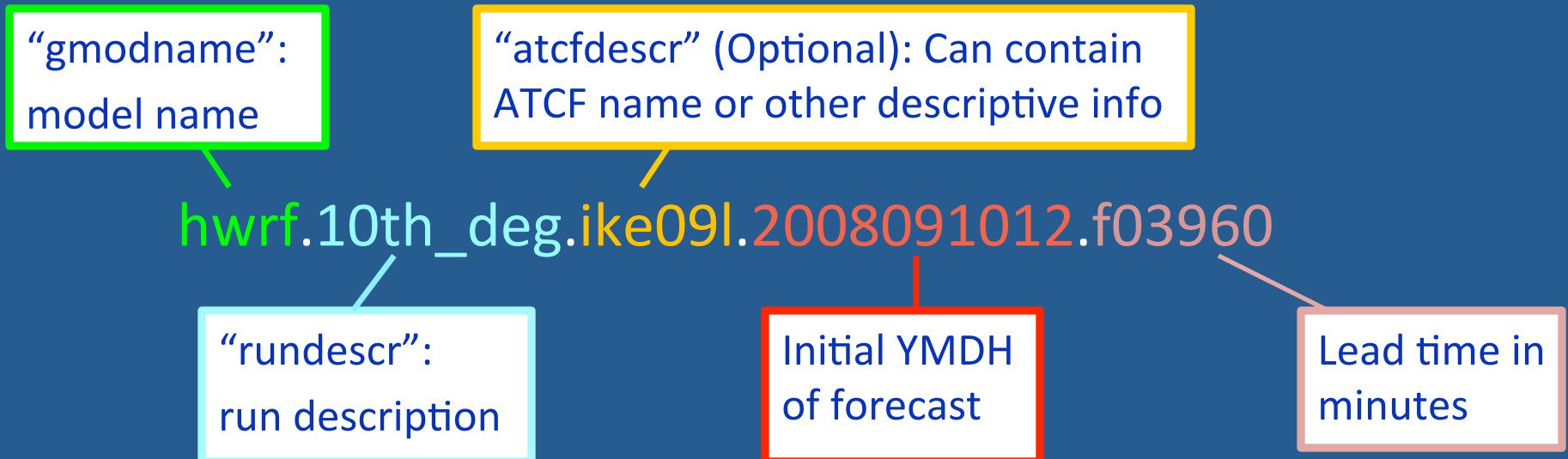
(1,1)



(imax,jmax)

Tracker inputs: GRIB files & names

- GRIB files can either contain individual files for each tau or can contain records for all taus in one big file.
- If using one big file, the file is linked from the script and the file name format is flexible.
- If using separate files for each tau, the files are opened internally, and a specific file name format must be followed. Example:



Tracker inputs: Observed TC data

- Tracker searches for a vortex initially at a location specified by NHC or JTWC on a “TC Vitals record”:

NHC 12L KATRINA 20050829 0000 272N 0891W 335 046 0904 1006 0649 72 037
0371 0334 0278 0334 D 0204 0185 0139 0185 72 410N 815W 0167 0167 0093

ATCF ID (12L = 12th storm in the Atlantic).

E = Eastern Pacific

C = Central Pacific

W = Western Pacific

Report date and time

Observed storm latitude & longitude

Observed direction of storm motion in degrees from north (335 = ~NNW), and storm translation speed (046 = 4.6 ms⁻¹)

Tracker inputs: Namelist options

```
&datein
  inp%bcc=20,inp%byy=08,
  inp%bmm=09,inp%bdd=07,
  inp%bhh=12,
  inp%model=17,
  inp%modtyp='regional',
  inp%lt_units='hours',
  inp%file_seq='onebig',
  inp%nesttyp='moveable' /
&atcfinfo
  atcfnum=83,
  atcfname='GFDL',
  atcfymdh=2008090712,
  atcffreq=600 /
&trackerinfo
  trkrinfo%westbd=105.0,
  trkrinfo%eastbd=180.0,
  trkrinfo%northbd=50.0,
  trkrinfo%southbd=1.0,
  trkrinfo%type='tracker',
  trkrinfo%mslpthresh=0.0015,
  trkrinfo%v850thresh=1.5000,
  trkrinfo%gridtype='regional',
  trkrinfo%contint=100.0,
  trkrinfo%out_vit='n' /
&phaseinfo
  phaseflag='y',
  phasescheme='both',
  wcore_depth=1.0 /
&structinfo
  structflag='n',
  ikeflag='n' /
&fnameinfo
  gmodname='gfdl',
  rundescr='6thdeg',
  atcfdescr='ike091' /
&verbose verb=3 /
```

Starting date & time

ID number for model in the executable. Leave as '17'

Indicator for GRIB data lead time units

"multi" = 1 file for each tau; "onebig" = 1 file for all taus

Obsolete, leave as '83'

ATCF model name: "HWRF", "HAHW", "TEST", etc

Starting yyyymmddhh for output ATCF record

Frequency to write out ATCF data (hours * 100)

For genesis tracking only, to limit area of search.

'tracker', or genesis options: 'midlat', 'tcgen'.

Thresholds for mslp gradient and V_{850}

Model grid type: 'regional' or 'global'

Intervals for closed contour checking

Cyclone phase detection schemes: "cps", "vtt", or "both"

Not yet supported. Leave values as they are....

File name info, if "multi" option chosen for inp%file_seq

Tracker inputs: List of forecast hours

- The tracker can handle lead times that are stored in the GRIB file header either in units of minutes or hours.
- Explicitly detailing the forecast hours allows for irregularly spaced intervals.
- Regardless of whether your GRIB data lead time units are in minutes or hours, you must supply a text file as input that has the lead times listed in minutes (code will convert to hours).

1	0
2	360
3	720
4	1080
5	1440
6	1800
7	2160
8	2520
9	2880
10	3240
11	3600
12	3960
13	4320
14	4680
15	5040
16	5400
17	5760
18	6120
19	6480
20	6840
21	7200
22	7560

Tracker output: Standard ATCF file

- Text format. Minimum of 1 record per lead time (↓), maximum of 3.
 - 1st record contains track & intensity info, plus radii for 34-knot winds
 - 2nd record: Same track & intensity info, plus radii for 50-knot winds, if present.
 - 3rd record: Same track & intensity info, plus radii for 64-knot winds, if present.



```
AL, 09, 2008091012, 03, HWRF, 000, 239N, 855W, 68, 969, XX, 34, NEQ, 0163, 0146, 0086, 0124, 0, 0, 064
AL, 09, 2008091012, 03, HWRF, 000, 239N, 855W, 68, 969, XX, 50, NEQ, 0090, 0088, 0063, 0070, 0, 0, 064
AL, 09, 2008091012, 03, HWRF, 000, 239N, 855W, 68, 969, XX, 64, NEQ, 0067, 0000, 0000, 0048, 0, 0, 064
AL, 09, 2008091012, 03, HWRF, 006, 240N, 861W, 95, 960, XX, 34, NEQ, 0262, 0285, 0168, 0214, 0, 0, 052
AL, 09, 2008091012, 03, HWRF, 006, 240N, 861W, 95, 960, XX, 50, NEQ, 0114, 0122, 0092, 0095, 0, 0, 052
AL, 09, 2008091012, 03, HWRF, 006, 240N, 861W, 95, 960, XX, 64, NEQ, 0084, 0087, 0049, 0073, 0, 0, 052
AL, 09, 2008091012, 03, HWRF, 012, 244N, 866W, 97, 958, XX, 34, NEQ, 0255, 0239, 0136, 0159, 0, 0, 046
AL, 09, 2008091012, 03, HWRF, 012, 244N, 866W, 97, 958, XX, 50, NEQ, 0160, 0122, 0090, 0091, 0, 0, 046
AL, 09, 2008091012, 03, HWRF, 012, 244N, 866W, 97, 958, XX, 64, NEQ, 0072, 0098, 0055, 0071, 0, 0, 046
AL, 09, 2008091012, 03, HWRF, 018, 249N, 872W, 99, 954, XX, 34, NEQ, 0263, 0245, 0182, 0241, 0, 0, 035
AL, 09, 2008091012, 03, HWRF, 018, 249N, 872W, 99, 954, XX, 50, NEQ, 0142, 0158, 0103, 0098, 0, 0, 035
AL, 09, 2008091012, 03, HWRF, 018, 249N, 872W, 99, 954, XX, 64, NEQ, 0094, 0095, 0049, 0078, 0, 0, 035
```

⋮

Tracker output: Standard ATCF file

Basin (AL, EP, WP, etc)

Storm number in basin

Forecast initial DTG

Max sfc wind (knots)

Minimum MSLP (mb)

2-char storm class

NE Quad radii (n mi)

SE Quad radii (n mi)

SW Quad radii (n mi)

NW Quad radii (n mi)

AL	09	2008091012	03	HWR	000	239N	855W	68	969	XX	34	NEQ	0163	0146	0086	0124	0	0	064
AL	09	2008091012	03	HWR	000	239N	855W	68	969	XX	50	NEQ	0090	0088	0063	0070	0	0	064
AL	09	2008091012	03	HWR	000	239N	855W	68	969	XX	64	NEQ	0067	0000	0000	0048	0	0	064
AL	09	2008091012	03	HWR	006	240N	861W	95	960	XX	34	NEQ	0262	0285	0168	0214	0	0	052
AL	09	2008091012	03	HWR	006	240N	861W	95	960	XX	50	NEQ	0114	0122	0092	0095	0	0	052
AL	09	2008091012	03	HWR	006	240N	861W	95	960	XX	64	NEQ	0084	0087	0049	0073	0	0	052
AL	09	2008091012	03	HWR	012	244N	866W	97	958	XX	34	NEQ	0255	0239	0136	0159	0	0	046
AL	09	2008091012	03	HWR	012	244N	866W	97	958	XX	50	NEQ	0160	0122	0090	0091	0	0	046
AL	09	2008091012	03	HWR	012	244N	866W	97	958	XX	64	NEQ	0072	0098	0055	0071	0	0	046
AL	09	2008091012	03	HWR	018	249N	872W	99	954	XX	34	NEQ	0263	0245	0182	0241	0	0	035
AL	09	2008091012	03	HWR	018	249N	872W	99	954	XX	50	NEQ	0142	0158	0103	0098	0	0	035
AL	09	2008091012	03	HWR	018	249N	872W	99	954	XX	64	NEQ	0094	0095	0049	0078	0	0	035

Model ID (3 or 4 char)

Lead time

Forecast latitude * 10

Forecast longitude * 10

Wind radii threshold (kts)

Begin radii in NE Quad

R_{max} (n mi)

Tracker output: Modified ATCF file

- Nearly same format as standard ATCF file, except the lead time (↓) has 2 extra places for fraction of an hour, allowing for ATCF-style output at non-hourly times.
 - Example: “04825” would be 48.25 hours, or 48 hours, 15 minutes.



```
AL, 09, 2008091012, 03, HWRF, 00000, 239N, 855W, 68, 969, XX, 34, NEQ, 0163, 0146, 0086, 0124, 0, 0, 64
AL, 09, 2008091012, 03, HWRF, 00000, 239N, 855W, 68, 969, XX, 50, NEQ, 0090, 0088, 0063, 0070, 0, 0, 64
AL, 09, 2008091012, 03, HWRF, 00000, 239N, 855W, 68, 969, XX, 64, NEQ, 0067, 0000, 0000, 0048, 0, 0, 64
AL, 09, 2008091012, 03, HWRF, 00600, 240N, 861W, 95, 960, XX, 34, NEQ, 0262, 0285, 0168, 0214, 0, 0, 52
AL, 09, 2008091012, 03, HWRF, 00600, 240N, 861W, 95, 960, XX, 50, NEQ, 0114, 0122, 0092, 0095, 0, 0, 52
AL, 09, 2008091012, 03, HWRF, 00600, 240N, 861W, 95, 960, XX, 64, NEQ, 0084, 0087, 0049, 0073, 0, 0, 52
AL, 09, 2008091012, 03, HWRF, 01200, 244N, 866W, 97, 958, XX, 34, NEQ, 0255, 0239, 0136, 0159, 0, 0, 46
AL, 09, 2008091012, 03, HWRF, 01200, 244N, 866W, 97, 958, XX, 50, NEQ, 0160, 0122, 0090, 0091, 0, 0, 46
AL, 09, 2008091012, 03, HWRF, 01200, 244N, 866W, 97, 958, XX, 64, NEQ, 0072, 0098, 0055, 0071, 0, 0, 46
AL, 09, 2008091012, 03, HWRF, 01800, 249N, 872W, 99, 954, XX, 34, NEQ, 0263, 0245, 0182, 0241, 0, 0, 35
AL, 09, 2008091012, 03, HWRF, 01800, 249N, 872W, 99, 954, XX, 50, NEQ, 0142, 0158, 0103, 0098, 0, 0, 35
AL, 09, 2008091012, 03, HWRF, 01800, 249N, 872W, 99, 954, XX, 64, NEQ, 0094, 0095, 0049, 0078, 0, 0, 35
.
.
.
```


Tracker output: Standard out

- A table is printed out that lists the tracker-derived fixes for each parameter and distance from the guess.

Maximum allowable distance that a parameter fix can be from the guess location in order to be included

```
At beg of fixcenter, stderr(ist,ifh-1) = 16.64 xavg_stderr= 11.70
At beg of fixcenter, errpgr0 = 1.2500000000000000
At beg of fixcenter, errinit = 275.00000000000000
At beg of fixcenter, errpmax = 485.00000000000000
At beg of fixcenter, ifh= 17 errmax= 275.00000000000000
```

Storm & lead time info

```
-----
Individual fixes follow..., fhr= 96:00 09L IKE
Gen ID (if available): 2008091012_F000_238N_0853W_09L
Model name = GFDT
Values of -99.99 indicate that a fix was unable to be
made for that parameter. Parameters 4 & 6 are not used.
Vorticity data values are scaled by 1e5. errdist is the
distance that the position estimate is from the guess
position for this time. MSLP value here may differ from
that in the atcfunix file since the one here is that
derived from the area-averaged barnes analysis, while
that in the atcfunix file is from a specific gridpoint.
Guess location for this time: 266.46E ( 93.54W) 37.48
```

Guess location for this lead time

Max or min barnes-averaged value found by tracker

Distance of parameter fix from guess location

parm#	parm	Max/Min	Lon_fix(E)	Lon_fix(W)	Lat_fix	Max/Min_value	calcparm	errdist(km)
1	zeta 850	Max	267.73	92.27	37.94	59.92	T	122.74
2	zeta 700	Max	267.99	92.01	38.05	43.82	T	148.76
3	vmag 850	Min	267.40	92.60	38.15	12.30	T	110.81
4	NOT USED	NOT USED	.00	.00	.00	.00	F	.00
5	vmag 700	Min	267.40	92.60	38.65	8.79	T	153.44
6	NOT USED	NOT USED	.00	.00	.00	.00	F	.00
7	gph 850	Min	267.75	92.25	37.60	1253.22	T	114.48
8	gph 700	Min	267.78	92.22	37.67	2917.31	T	118.31
9	MSLP	Min	267.72	92.28	37.53	98165.14	T	111.22
10	vmag sfc	Min	267.40	92.60	37.65	6.58	T	84.76
11	zeta sfc	Max	267.34	92.66	37.65	19.72	T	80.13

Flag to indicate if parameter fix is within errmax distance and will be included in fix average for this lead time

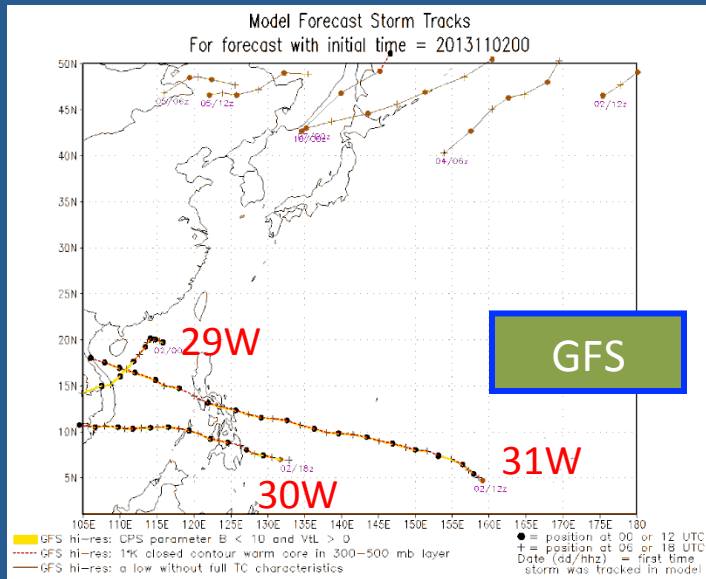
Outline

- History & description of the GFDL vortex tracker
- Inputs & Outputs
- **Genesis tracking**
- ATCF-plot: GrADS-based track and intensity plotting script

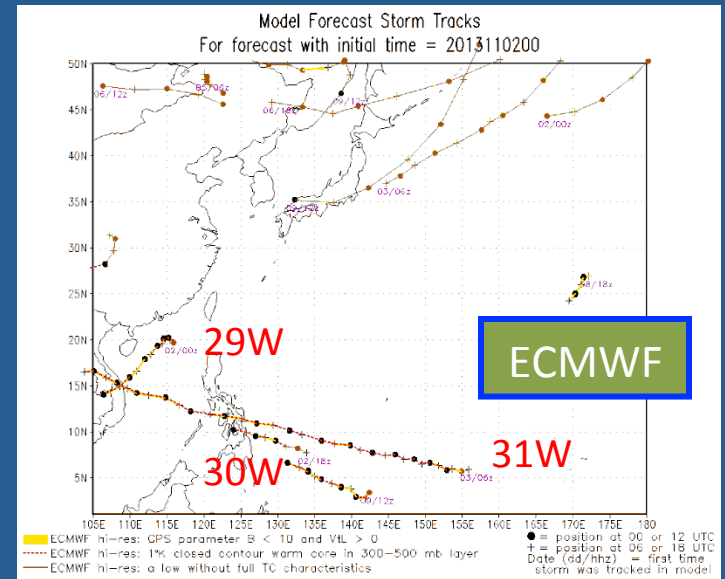
Genesis Tracking

- When run in genesis mode (`trkrinfo%type` set to either 'tcgen' or 'midlat' in input namelist), the tracker detects new storms that the model develops during a forecast and tracks them.
- Candidate lows are identified by a simple grid point analysis of lowest MSLP, and then the Barnes tracking scheme is applied to all candidate lows to more accurately fix the center.
- “tcgen” mode: All parameters used for regular TC tracking are used here.
- “midlat” mode: Only MSLP is used to track storms.

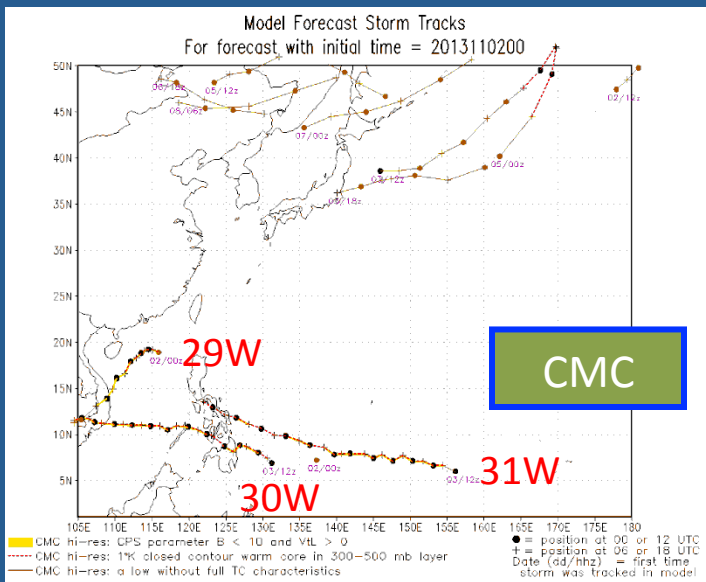
Genesis Tracking Example: 2013110200



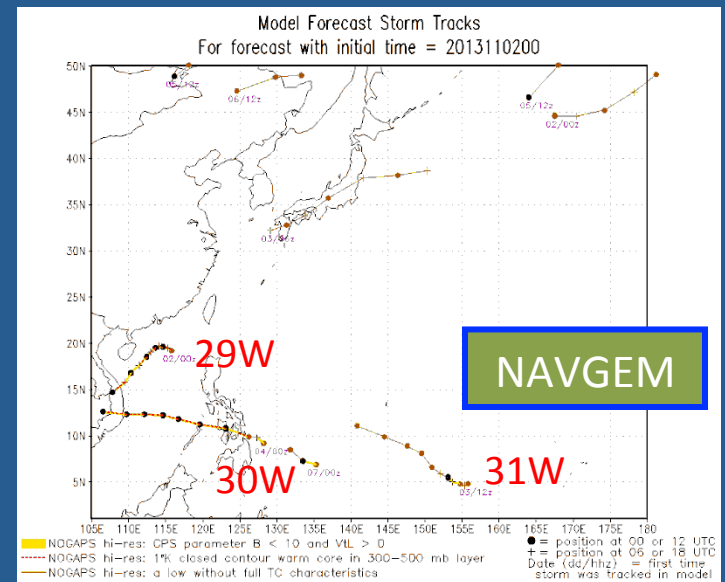
- Haiyan (31W) genesis and track well forecast by GFS, ECMWF & CMC. NAVGEM struggled to develop Haiyan.



- TD 30 (30W) genesis well forecast by all 4 models.



- Genesis runs also track existing cyclones -- TY Krosa (29W)



- Numerous mid-latitude cyclones also detected.

Genesis Tracking: New & Modified Criteria

- Criteria for detection and continuity of tracking are based on cyclone structure in general, not necessarily tropical cyclone structure.
- Closed contour in the MSLP field – Must be met in at least 50% of lead times in a 24-h period.
- 850 mb mean wind circulation – Must meet threshold in at least 75% of lead times in a 24-h period.
- Thermal structure diagnostics are computed and provided as extra data, but do not feed back into the tracking algorithm and will not cut off tracking.

Genesis Tracking: Thermal Structure Diagnostics

- Simple 300-500 mb warm core check, based on Vitart(1997): Warm anomaly must have closed contour (value of contour defined in namelist).
- Cyclone Phase Space (Hart, 2003):
 - “Parameter B”: Storm-motion-relative 900-600 mb thickness asymmetry.
 - V_T^L : Lower-tropospheric (900-600 mb) thermal wind
 - V_T^U : Upper-tropospheric (900-600 mb) thermal wind
 - V_T^L and V_T^U are both evaluated via hypsometric relationship using GP Height fields.

Genesis Tracking: Modified ATCF file

A critical element is the naming of new model storms with a unique ID composed of strings with the date, lead time, and lat & lon where the storm was first identified.

"TG", "ML" or Basin ID
 Storm number in fcst
 Unique character ID labeling storm.

```
TG, 0005, 2013110200_F012_047N_1591E_FOF, 2013110200, 03, GFS0, 012, 47N, 1591E, 15, 1008, XX,
TG, 0005, 2013110200_F012_047N_1591E_FOF, 2013110200, 03, GFS0, 018, 50N, 1586E, 20, 1006, XX,
TG, 0005, 2013110200_F012_047N_1591E_FOF, 2013110200, 03, GFS0, 024, 54N, 1579E, 23, 1007, XX,
TG, 0005, 2013110200_F012_047N_1591E_FOF, 2013110200, 03, GFS0, 030, 58N, 1572E, 23, 1005, XX,
```

- cont'd -

```
34, NEQ, 0000, 0000, 0000, 0000, 1009, 188, 139, -999, -9999, -9999, N, 272, 35, 92, 101, 149, 210
34, NEQ, 0000, 0000, 0000, 0000, 1007, 182, 155, 6, -202, 140, Y, 288, 31, 93, 110, 146, 207
34, NEQ, 0000, 0000, 0000, 0000, 1008, 114, 159, 12, -134, 137, Y, 294, 44, 109, 124, 153, 201
34, NEQ, 0000, 0000, 0000, 0000, 1006, 113, 160, -12, 75, 132, Y, 297, 39, 117, 133, 135, 175
```

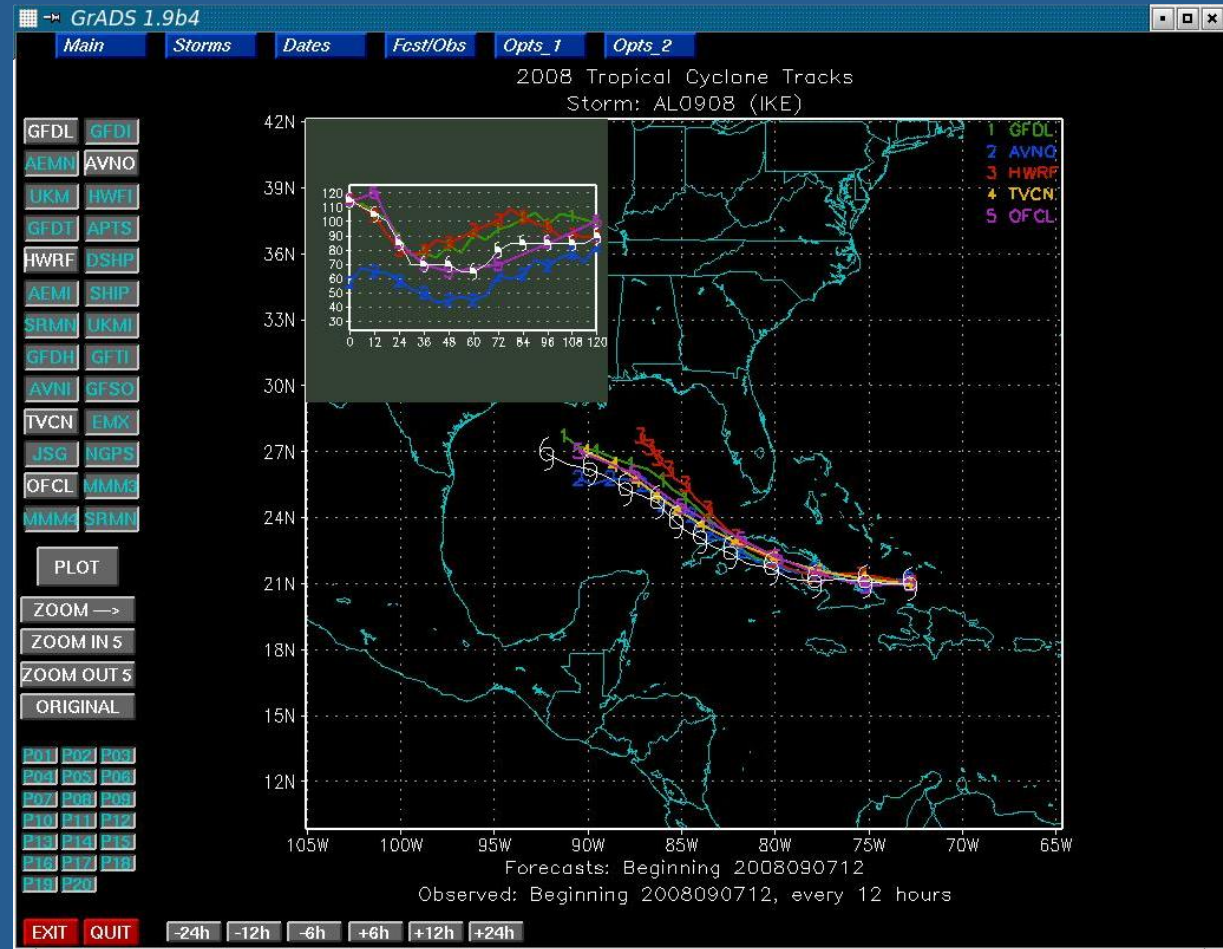
Parameter B (x10)
 V_T (x10)
 $V_u T$ (x10)
 Warm core (Vitart) flag
 Storm motion direction
 Storm speed (m/s * 10)
 Mean and grid point values of 850 and 700 mb Zeta

Outline

- History & description of the GFDL vortex tracker
- Inputs & Outputs
- Genesis tracking
- ATCF-plot: GrADS-based track and intensity plotting script

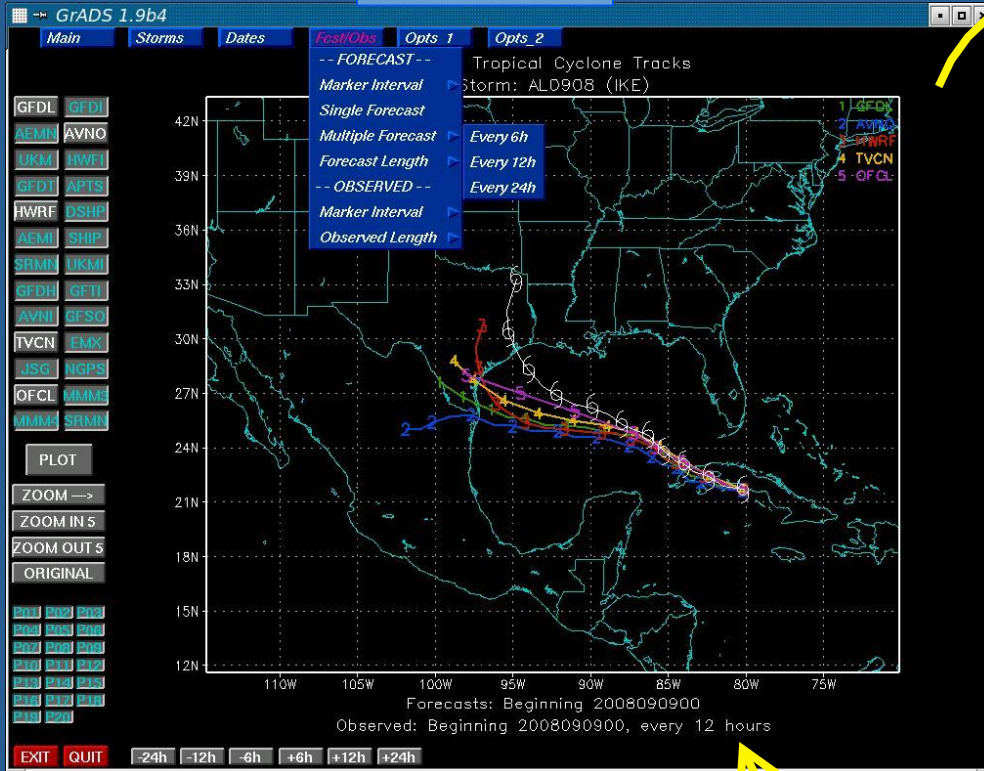
ATCF_plot: GrADS-based plotting tool

- Interactive GrADS tool for plotting both track and intensity.



ATCF_plot: How it works

atcfplot.gs



User-input selections for models, storm, date, etc, are passed to unix scripts.

Unix scripts

The unix scripts pull only the requested ATCF records from the ATCF file for the user-selected storm...

```
.  
. .  
aal072008.dat  
aal082008.dat  
aal092008.dat  
aal102008.dat  
. .  
. .  
aal172008.dat
```

The ATCF records from those flist and vlist text files are read by atcfplot.gs, and the track and intensity plots are created.

flist
vlist

...and dumps those ATCF records into text files.

ATCF_plot: Script setup

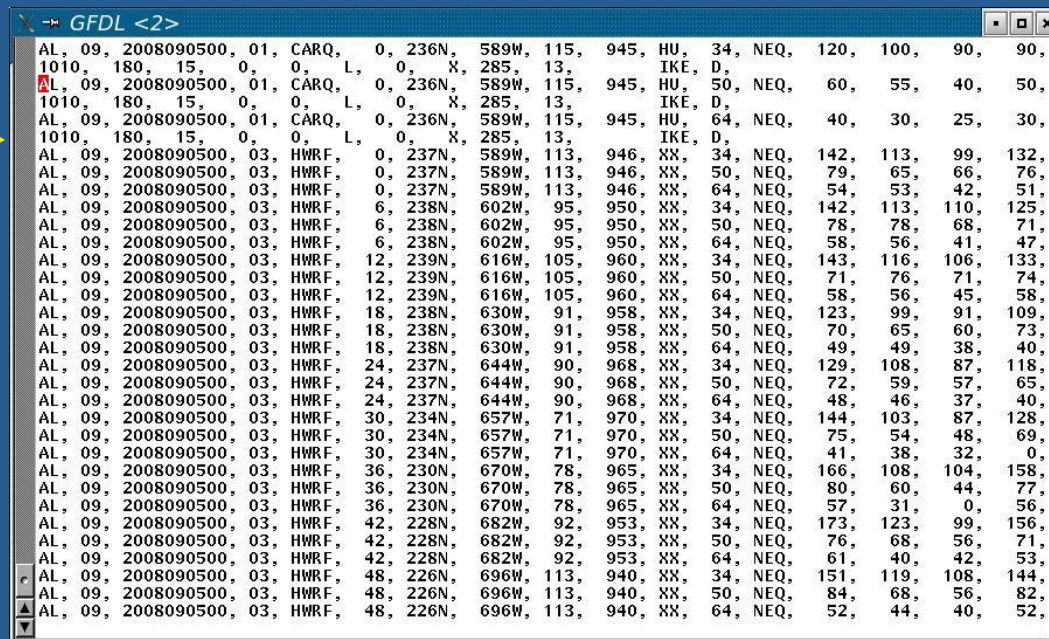
- Edit path names to replace \$USER with your username in your version of atcfplot.gs:

```
_rundir="/wrfclass/users/$USER/HWRF/src/gfdl-vortextracker/trk_plot/plottrak/"  
_netdir="/wrfclass/users/$USER/HWRF/src/gfdl-vortextracker/trk_plot/plottrak/  
tracks/"
```

- For all atcfplot unix scripts here at the tutorial, all paths are defined using environmental variables \$HOME and \$USER. Back at home, be sure to change the path names accordingly.

ATCF_plot: Input data

- atcf_plot reads in standard ATCF format records, but it needs the operational ATCF files, since it keys off of the observational “CARQ” records and uses that data to plot the observed track and intensity (note: Real-time data used, not Best Track).
- Be sure to insert your ATCF records in the ATCF file specifically named a\${basin}\${storm_ID}\${YYYY}.dat after the CARQ records for the correct DTG:



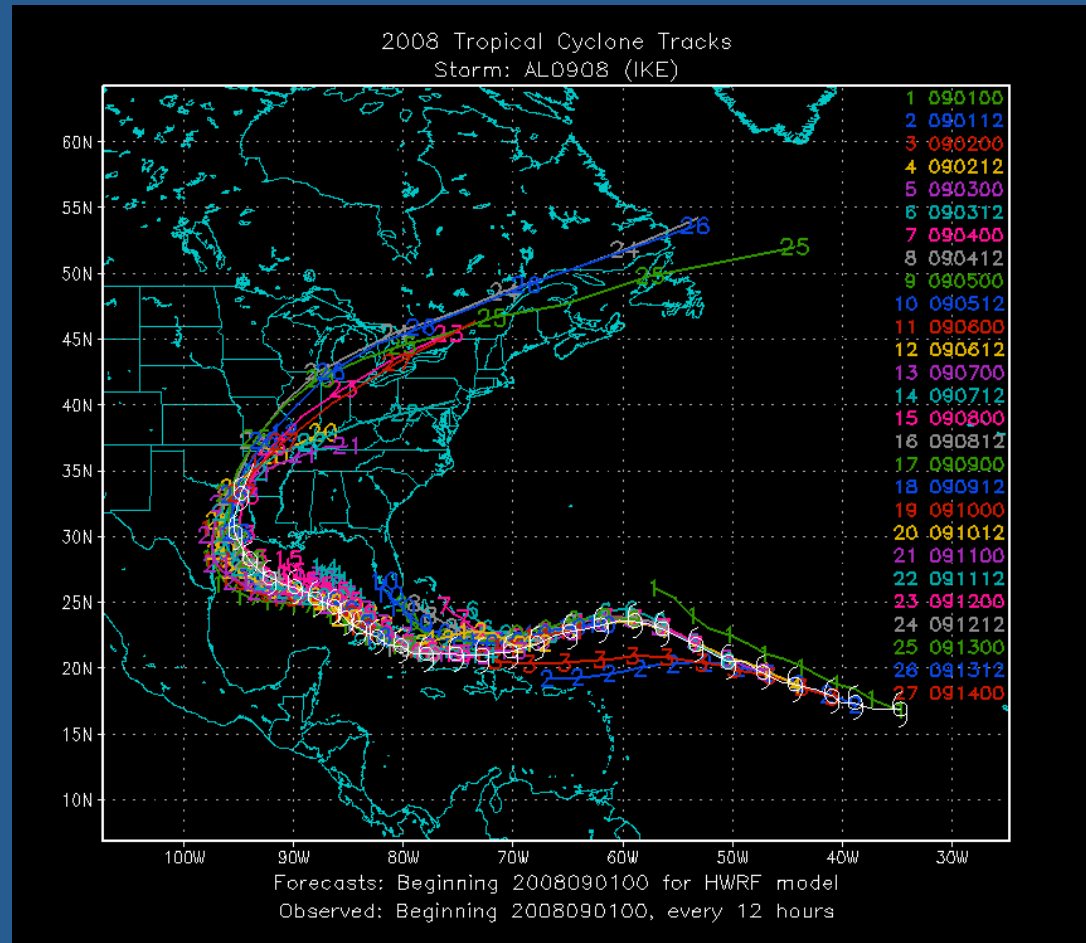
```
AL, 09, 2008090500, 01, CARQ, 0, 236N, 589W, 115, 945, HU, 34, NEQ, 120, 100, 90, 90,
1010, 180, 15, 0, 0, L, 0, X, 285, 13, 0, 0, 0, 0,
AL, 09, 2008090500, 01, CARQ, 0, 236N, 589W, 115, 945, HU, 50, NEQ, 60, 55, 40, 50,
1010, 180, 15, 0, 0, L, 0, X, 285, 13, 0, 0, 0, 0,
AL, 09, 2008090500, 01, CARQ, 0, 236N, 589W, 115, 945, HU, 64, NEQ, 40, 30, 25, 30,
1010, 180, 15, 0, 0, L, 0, X, 285, 13, 0, 0, 0, 0,
AL, 09, 2008090500, 03, HWRP, 0, 237N, 589W, 113, 946, XX, 34, NEQ, 142, 113, 99, 132,
AL, 09, 2008090500, 03, HWRP, 0, 237N, 589W, 113, 946, XX, 50, NEQ, 79, 65, 66, 76,
AL, 09, 2008090500, 03, HWRP, 0, 237N, 589W, 113, 946, XX, 64, NEQ, 54, 53, 42, 51,
AL, 09, 2008090500, 03, HWRP, 6, 238N, 602W, 95, 950, XX, 34, NEQ, 142, 113, 110, 125,
AL, 09, 2008090500, 03, HWRP, 6, 238N, 602W, 95, 950, XX, 50, NEQ, 78, 78, 68, 71,
AL, 09, 2008090500, 03, HWRP, 6, 238N, 602W, 95, 950, XX, 64, NEQ, 58, 56, 41, 47,
AL, 09, 2008090500, 03, HWRP, 12, 239N, 616W, 105, 960, XX, 34, NEQ, 143, 116, 106, 133,
AL, 09, 2008090500, 03, HWRP, 12, 239N, 616W, 105, 960, XX, 50, NEQ, 71, 76, 71, 74,
AL, 09, 2008090500, 03, HWRP, 12, 239N, 616W, 105, 960, XX, 64, NEQ, 58, 56, 45, 58,
AL, 09, 2008090500, 03, HWRP, 18, 238N, 630W, 91, 958, XX, 34, NEQ, 123, 99, 91, 109,
AL, 09, 2008090500, 03, HWRP, 18, 238N, 630W, 91, 958, XX, 50, NEQ, 70, 65, 60, 73,
AL, 09, 2008090500, 03, HWRP, 18, 238N, 630W, 91, 958, XX, 64, NEQ, 49, 49, 38, 40,
AL, 09, 2008090500, 03, HWRP, 24, 237N, 644W, 90, 968, XX, 34, NEQ, 129, 108, 87, 118,
AL, 09, 2008090500, 03, HWRP, 24, 237N, 644W, 90, 968, XX, 50, NEQ, 72, 59, 57, 65,
AL, 09, 2008090500, 03, HWRP, 24, 237N, 644W, 90, 968, XX, 64, NEQ, 48, 46, 37, 40,
AL, 09, 2008090500, 03, HWRP, 30, 234N, 657W, 71, 970, XX, 34, NEQ, 144, 103, 87, 128,
AL, 09, 2008090500, 03, HWRP, 30, 234N, 657W, 71, 970, XX, 50, NEQ, 75, 54, 48, 69,
AL, 09, 2008090500, 03, HWRP, 30, 234N, 657W, 71, 970, XX, 64, NEQ, 41, 38, 32, 0,
AL, 09, 2008090500, 03, HWRP, 36, 230N, 670W, 78, 965, XX, 34, NEQ, 166, 108, 104, 158,
AL, 09, 2008090500, 03, HWRP, 36, 230N, 670W, 78, 965, XX, 50, NEQ, 80, 60, 44, 77,
AL, 09, 2008090500, 03, HWRP, 36, 230N, 670W, 78, 965, XX, 64, NEQ, 57, 31, 0, 56,
AL, 09, 2008090500, 03, HWRP, 42, 228N, 682W, 92, 953, XX, 34, NEQ, 173, 123, 99, 156,
AL, 09, 2008090500, 03, HWRP, 42, 228N, 682W, 92, 953, XX, 50, NEQ, 76, 68, 56, 71,
AL, 09, 2008090500, 03, HWRP, 42, 228N, 682W, 92, 953, XX, 64, NEQ, 61, 40, 42, 53,
AL, 09, 2008090500, 03, HWRP, 48, 226N, 696W, 113, 940, XX, 34, NEQ, 151, 119, 108, 144,
AL, 09, 2008090500, 03, HWRP, 48, 226N, 696W, 113, 940, XX, 50, NEQ, 84, 68, 56, 82,
AL, 09, 2008090500, 03, HWRP, 48, 226N, 696W, 113, 940, XX, 64, NEQ, 52, 44, 40, 52,
```

ATCF_plot: Input data

- `atcf_plot` opens up a GrADS ctl file (`plottrak.ctl`) that points to a meaningless data set with a global domain. By opening this ctl file and plotting a variable, GrADS now has global dimensions over which we can plot tracks for TCs anywhere on the globe.
- Be sure to also have the `plottrak.grib` file, then from your unix prompt run the command “`gribmap -v -i plottrak.ctl`”. In the output, you should see one line that says “MATCH”.
- To run, enter this command from your unix prompt:
`atcfplot.sh YYYY basin`
where basin = al, ep, wp, etc....

ATCF_plot: Some features

- Plot tracks alone, intensity alone, or tracks with an intensity inset window.
- Plot tracks that span from the current DTG through the end of the storm's lifecycle
- The ability to click & drag to zoom in on a particular track segment.



Questions?



Delaware River flooding River Road in Washington Crossing, Pennsylvania, after Hurricane Ivan. September, 2004.