Met-TC Discussion

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Topics

(1) Met-TCgen can not verify ensemble TC genesis probability forecasts. Need to send a request for development?
https://github.com/dtcenter/METplus/discussions/1304

(2) Met-TC can not verify the relationship of ensemble mean track/intensity error and spread. The error/spread case number needs to be matched.
https://github.com/dtcenter/METplus/discussions/1341

(1) Met-TCgen can not verify ensemble TC genesis probability forecasts. Need to send a request for development?

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Jiayi, I responded to that discussion as well as Dan Halperin, with whom the DTC has collaborated on the TC-Gen tool. MET-TC is currently set up to process a few different types of probabilities contained in the ATCF E-Deck format. In MET version 10.1.0, we're adding vx of shapefiles containing genesis probabilities percentages. Since you're not available today, I'll re-open and unlock your discussion. And will ask you to provide sample data to demonstrate exactly what you're looking for.

Usage: tc_gen
     -genesis source   ----genesis track in ATCF format
     -edeck source   ---- E-deck file
     -shape source   ---- Shapefile
     -track source   ---- Best track/CARQ
     -config file
     [-out base]
     [-log file]
     [-v level]

The -edeck source argument is the path to one or more ATCF edeck files, an ASCII file list containing them, or a top-level directory with files matching the regular expression ".dat".
The probability of genesis are read from each edeck input file and verified against at the -track data.

The -shape source argument is the path to one or more NHC genesis warning area shapefiles, an ASCII file list containing them, or a top-level directory with files matching the regular expression "gtwo_areas.*.shp". The genesis warning areas and corresponding 2, 5, and 7 day probability values area verified against the -track data.

Raw genesis data from operational GEFS forecast

GEFS TC genesis data in ATCF format, 1 ctrl + 30 members:

storms.ac00.atcf_gen.altg.2021080100

storms.ap01.atcf_gen.altg.2021080100	storms.ap11.atcf_gen.altg.2021080100	storms.ap21.atcf_gen.altg.2021080100
storms.ap02.atcf_gen.altg.2021080100	storms.ap12.atcf_gen.altg.2021080100	storms.ap22.atcf_gen.altg.2021080100
storms.ap03.atcf_gen.altg.2021080100	storms.ap13.atcf_gen.altg.2021080100	storms.ap23.atcf_gen.altg.2021080100
storms.ap04.atcf_gen.altg.2021080100	storms.ap14.atcf_gen.altg.2021080100	storms.ap24.atcf_gen.altg.2021080100
storms.ap05.atcf_gen.altg.2021080100	storms.ap15.atcf_gen.altg.2021080100	storms.ap25.atcf_gen.altg.2021080100
storms.ap06.atcf_gen.altg.2021080100	storms.ap16.atcf_gen.altg.2021080100	storms.ap26.atcf_gen.altg.2021080100
storms.ap07.atcf_gen.altg.2021080100	storms.ap17.atcf_gen.altg.2021080100	storms.ap27.atcf_gen.altg.2021080100
storms.ap08.atcf_gen.altg.2021080100	storms.ap18.atcf_gen.altg.2021080100	storms.ap28.atcf_gen.altg.2021080100
storms.ap09.atcf_gen.altg.2021080100	storms.ap19.atcf_gen.altg.2021080100	storms.ap29.atcf_gen.altg.2021080100
storms.ap10.atcf_gen.altg.2021080100	storms.ap20.atcf_gen.altg.2021080100	storms.ap30.atcf_gen.altg.2021080100

https://ftp.emc.ncep.noaa.gov/gc_wmb/jpeng/gefs.20210801/00/genesis/

How to generate E-deck files/Shapefiles (48, 120 and 168hrs genesis probability) from the GEFS 30 members' genesis data ?
The code needs to be included in Met-TC package.

Basin, CY, YYYYMMDDHH, ProbFormat, Tech, TAU, LatN/S, LonE/W, Prob, ...

Venus: /gpfs/dell2/nhc/noscrub/data/atcf-noaa/gpce/eep992021.dat
EP, 99, 2021092700, GN, OFCL, 48,   ,   , 0,   48, ESB, genFcst, , , 0, 025,
EP, 99, 2021092700, GN, OFCL, 120,   ,   , 20, 120, ESB, genFcst, , , 0, 025,
EP, 99, 2021092700, GN, OFCL, 168,   ,   , 30, 168, ESB, genFcst, , , 0, 025,
EP, 99, 2021092706, GN, OFCL, 48,   ,   , 0,   48, BJR, genFcst, , , 0, 025,
EP, 99, 2021092706, GN, OFCL, 120,   ,   , 30, 120, BJR, genFcst, , , 0, 025,
EP, 99, 2021092706, GN, OFCL, 168,   ,   , 40, 168, BJR, genFcst, , , 0, 025,
EP, 99, 2021092712, GN, OFCL, 48,   ,   , 0,   48, ASL, genFcst, , , 0, 025,
EP, 99, 2021092712, GN, OFCL, 120,   ,   , 30, 120, ASL, genFcst, , , 0, 025,
EP, 99, 2021092712, GN, OFCL, 168,   ,   , 40, 168, ASL, genFcst, , , 0, 025,
EP, 99, 2021092718, GN, OFCL, 48,   ,   , 0,   48, ASL, genFcst, , , 0, 025,
EP, 99, 2021092718, GN, OFCL, 120,   ,   , 40, 120, ASL, genFcst, , , 0, 025,
EP, 99, 2021092718, GN, OFCL, 168,   ,   , 50, 168, ASL, genFcst, , , 0, 025,

Big problem for E-deck file: missing Latitude/Longitude

For -edeck inputs:
Parse the ATCF edeck files. Ignore any lines not containing "GN" and "genFcst", which indicate a genesis probability forecast. Also, ignore any lines which do not contain a predicted genesis location (latitude and longitude) or genesis time.

https://www.nhc.noaa.gov/archive/xgtwo/atl/202108150545/gtwo_shapefiles.zip

gtwo_areas_202108150509.dbf
gtwo_areas_202108150509.shp

For warning area shapefiles specified using the -shape command line option, it processes metadata from the corresponding database files.
The database file is assumed to exist at exactly the same path as the shapefile, but with a ".dbf" suffix instead of ".shp".
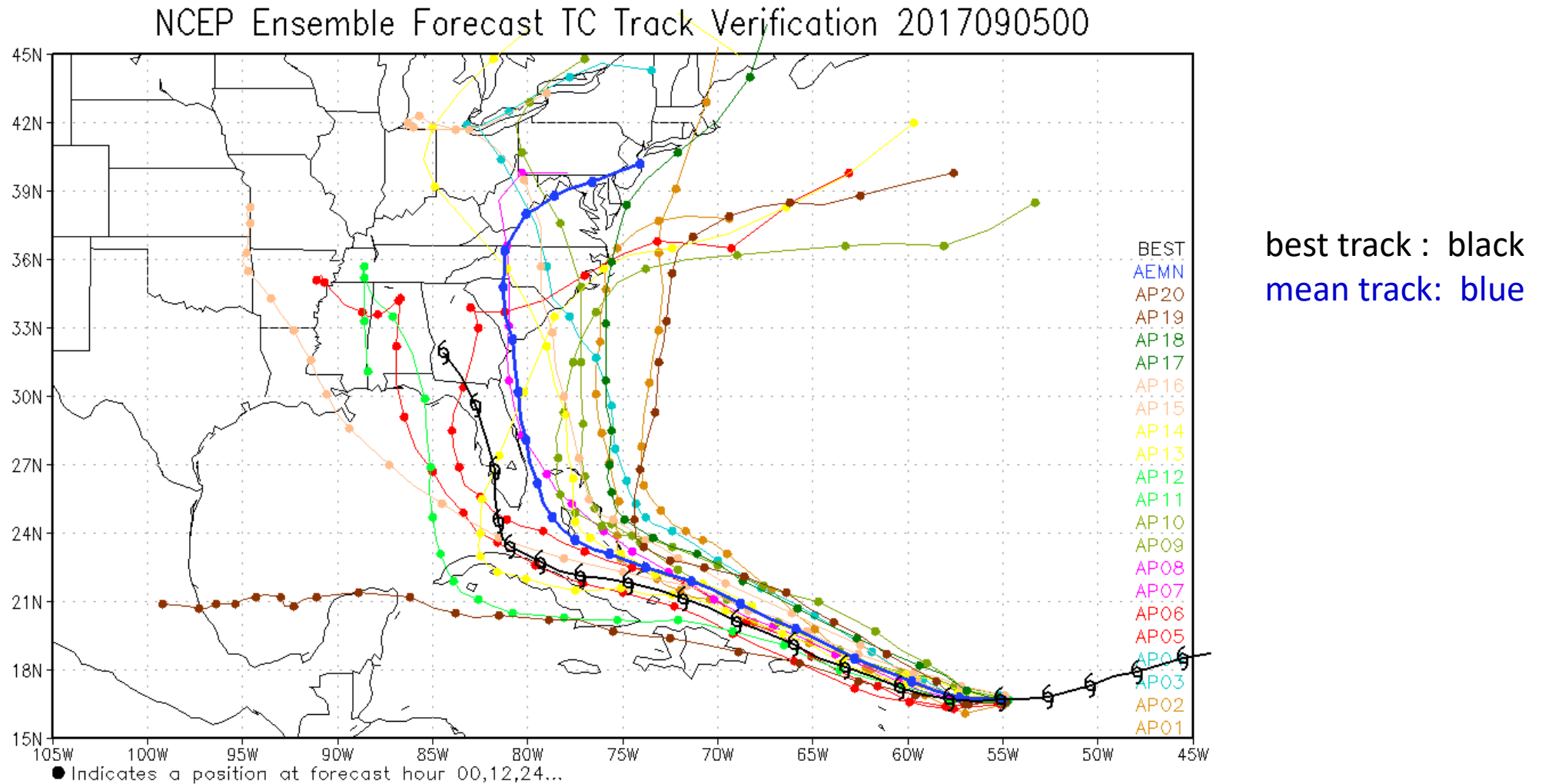Note that only shapefiles exactly following the NOAA National Hurricane Center's (NHC) "gtwo_areas_YYYYMMDDHHMM.shp" file naming and corresonding metadata conventions are supported.
For each shapefile record, the database file defines up to three corresponding probability values. The first percentage is interpreted as the probability of genesis inside the shape within 48 hours. The second and, if provided, third percentages are interpreted as the 120-hour and 168-hour probabilities, respectively. Care is taken to identify and either ignore or update duplicate shapes found in the input.

(2) Met-TC can not verify the relationship of ensemble mean track/intensity error and spread. The error/spread case number needs to be matched.

https://github.com/dtcenter/METplus/discussions/1341

NCEP Ensemble Forecast TC Track Verification 2017090500
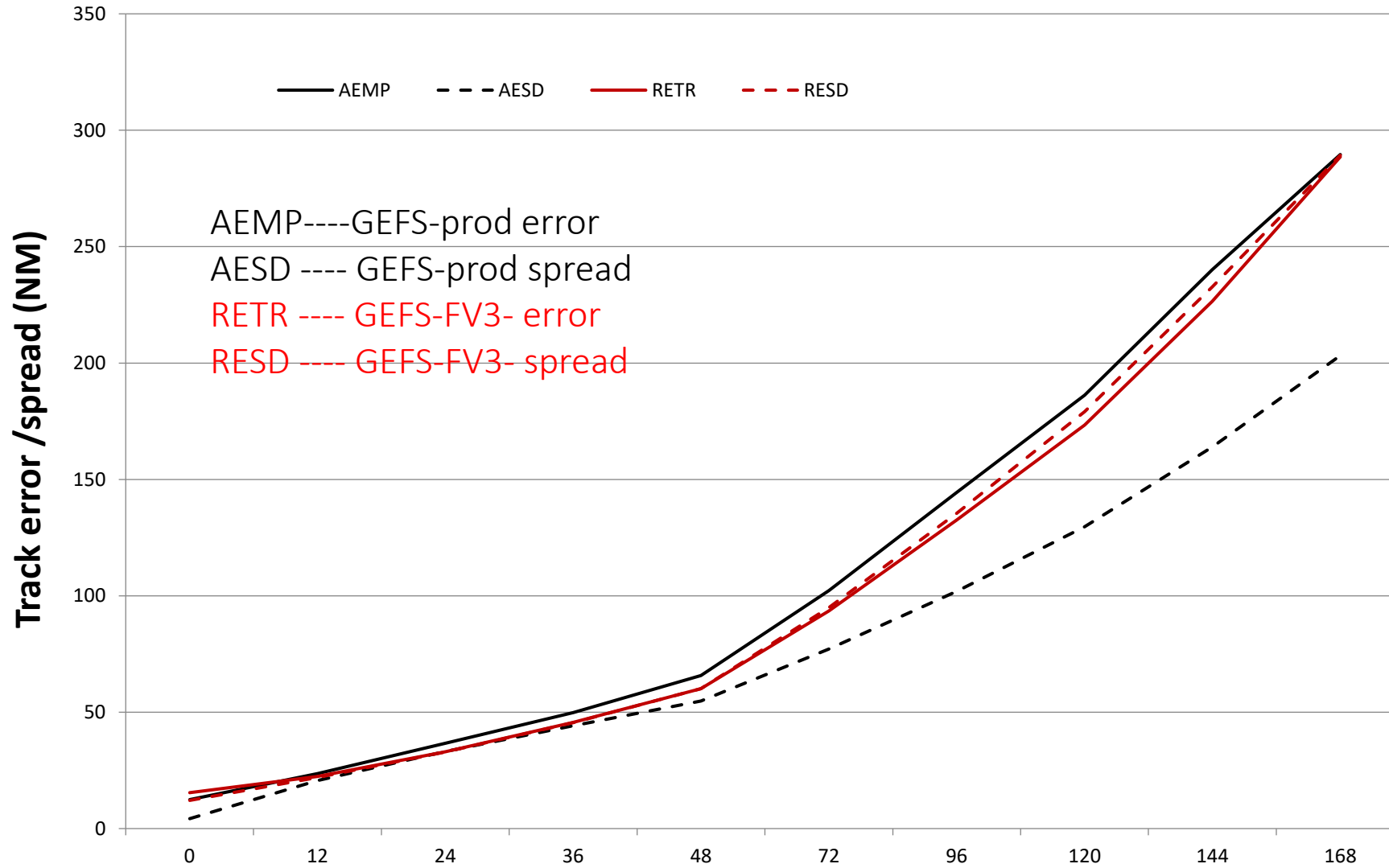
best track : black
mean track: blue

The ensemble mean track (Lat/Lon): the average of Lat/Lon of all ensemble members.
The track error: the distance between the best track and the ensemble mean track (position)
The track spread: the average distance between the ensemble mean and the member tracks (positions)

2017 June 01--Nov. 30 (00Z) TC track error/spread (AL/EP/WP)

AEMP ——— AESD - - - - RETR ——— RESD - - - -

AEMP----GEFS-prod error
AESD ---- GEFS-prod spread
RETR ---- GEFS-FV3- error
RESD ---- GEFS-FV3- spread

Track error /spread (NM)

Forecast hours

CASES   568   513   465   407   362   280   215   164   134   105

1. How does NHC generate E-Deck probability of genesis forecasts from an ensemble of genesis tracker outputs?

I suspect there is some processing logic for this that resides at NHC. Our task in METplus, to date, has been to verify this E-Deck data, not generate it. But I do understand your perspective and agree that ideally E-Deck derivation logic would be supported to the community. Don't know how this should be managed between NOAA/NHC and NOAA/EMC?

I believe that the shapefile warning areas are not automated. They are human generated. And I assume the verification of this product doesn't apply to EMC.
The E-Deck files were generated by NHC forecasters. The data is NHC's official TC genesis probability forecasts for the next 2/5/7- days. Do we still need Met-Tcgen to handle GEFS TC genesis forecast in ATCF format?

2. How can we include the ensemble spread in the output generated by TC-Pairs?

I understand the need here and do think it's reasonable to enhance TC-Pairs to compute/store the ensemble (i.e. consensus track) spread. Just need to define the details of how the spread should be computed and how it should be stored.
For example, given an ensemble of track (lat, lon) points, the consensus location is just (mean(lat), mean(lon)). Is the "spread" the standard deviation of the euclidean distance from each track location to the consensus location? Or is it the mean of those distances? Or something else?
The distance between 2-points is calculated in great-circle of the Earth, and the mean of individual distance.

Reference Slides

Jiayi's TC genesis data format (ensemble mean position and maximum strike probability)

```
aemn.trkprob.EP91.65nm.2021080100.indiv.gene
EP, 91, 2021080100, 03, AEMN, 000, 144N, 1078W,  80
EP, 91, 2021080100, 03, AEMN, 006, 151N, 1088W,  90
EP, 91, 2021080100, 03, AEMN, 012, 158N, 1098W,  95
EP, 91, 2021080100, 03, AEMN, 018, 164N, 1109W,  95
EP, 91, 2021080100, 03, AEMN, 024, 171N, 1119W,  90
EP, 91, 2021080100, 03, AEMN, 030, 176N, 1129W,  85
EP, 91, 2021080100, 03, AEMN, 036, 180N, 1139W,  55
EP, 91, 2021080100, 03, AEMN, 042, 182N, 1151W,  65
EP, 91, 2021080100, 03, AEMN, 048, 186N, 1162W,  40
EP, 91, 2021080100, 03, AEMN, 054, 189N, 1171W,  40
EP, 91, 2021080100, 03, AEMN, 060, 195N, 1182W,  25
EP, 91, 2021080100, 03, AEMN, 066, 189N, 1188W,  15
EP, 91, 2021080100, 03, AEMN, 072, 193N, 1184W,  20
EP, 91, 2021080100, 03, AEMN, 078, 186N, 1191W,  15
EP, 91, 2021080100, 03, AEMN, 084, 183N, 1203W,  10
EP, 91, 2021080100, 03, AEMN, 090, 195N, 1220W,   5
EP, 91, 2021080100, 03, AEMN, 096, 197N, 1225W,   5
EP, 91, 2021080100, 03, AEMN, 102, 201N, 1232W,   5
EP, 91, 2021080100, 03, AEMN, 108, 205N, 1242W,   5
EP, 91, 2021080100, 03, AEMN, 114, 208N, 1251W,   5
EP, 91, 2021080100, 03, AEMN, 120, 210N, 1259W,   5
```

NHC TWO data set format

./al2012inv008.dat

al2012inv008 al042012
06190600 010 ESB
06191200 010 DPB
06191800 010 DPB
06200000 010 RJB
06200600 010 RJP
06201200 020 DPR
06201800 020 DPR
06210000 030 RJB
06210600 030 TBK
06211200 030 DPB
06211800 050 DPB
06220000 070 SRS
06220600 070 JLB
06221200 070 MJB
06221800 070 MJB
06230000 080 SRS
06230600 080 JPC
06231200 090 RJB
06231800 090 RJB

https://www.nrlmry.navy.mil/atcf_web/docs/database/new/edeck.txt

TC GENESIS PROBABILITY

ProbItem - time period, ie genesis during next xxx hours, 0 for genesis or dissipate event, 0 - 240 hrs, 4 char.
Initials - forecaster initials, 3 char.
GenOrDis - "invest", "genFcst", "genesis", "disFcst" or "dissipate"
DTG - Genesis or dissipated event Date-Time-Group, yyyymmddhhmm: 0000010100 through 9999123123, 12 char.
stormID - cyclone ID if the genesis developed into an invest area or cyclone ID of dissipated TC, e.g. al032014
min - minutes, associated with DTG in common fields (3rd field in record), 0 - 59 min
genesisNum - genesis number, if spawned from a genesis area (1-999)
undefined - TBD

```
AL, 91, 2021092600, GN, OFCL,  48,    ,    ,   0,   48, RJB, genFcst, , ,  0, 043,
AL, 91, 2021092600, GN, OFCL, 120,    ,    ,  20,  120, RJB, genFcst, , ,  0, 043,
AL, 91, 2021092600, GN, OFCL, 168,    ,    ,  30,  168, RJB, genFcst, , ,  0, 043,
AL, 91, 2021092606, GN, OFCL,  48,    ,    ,   0,   48, BJR, genFcst, , ,  0, 043,
AL, 91, 2021092606, GN, OFCL, 120,    ,    ,  30,  120, BJR, genFcst, , ,  0, 043,
AL, 91, 2021092606, GN, OFCL, 168,    ,    ,  40,  168, BJR, genFcst, , ,  0, 043,
AL, 91, 2021092612, GN, OFCL,  48,    ,    ,   0,   48, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092612, GN, OFCL, 120,    ,    ,  30,  120, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092612, GN, OFCL, 168,    ,    ,  40,  168, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092618, GN, OFCL,  48,    ,    ,   0,   48, ASL, genFcst, , ,  0, 043,
AL, 91, 2021092618, GN, OFCL, 120,    ,    ,  50,  120, ASL, genFcst, , ,  0, 043,
AL, 91, 2021092618, GN, OFCL, 168,    ,    ,  50,  168, ASL, genFcst, , ,  0, 043,
AL, 91, 2021092700, GN, OFCL,  48,    ,    ,  20,   48, ESB, genFcst, , ,  0, 043,
AL, 91, 2021092700, GN, OFCL, 120,    ,    ,  70,  120, ESB, genFcst, , ,  0, 043,
AL, 91, 2021092700, GN, OFCL, 168,    ,    ,  70,  168, ESB, genFcst, , ,  0, 043,
AL, 91, 2021092706, GN, OFCL,  48,    ,    ,  30,   48, BJR, genFcst, , ,  0, 043,
AL, 91, 2021092706, GN, OFCL, 120,    ,    ,  80,  120, BJR, genFcst, , ,  0, 043,
AL, 91, 2021092706, GN, OFCL, 168,    ,    ,  80,  168, BJR, genFcst, , ,  0, 043,
AL, 91, 2021092712, GN, OFCL,  48,    ,    ,  40,   48, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092712, GN, OFCL, 120,    ,    ,  80,  120, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092712, GN, OFCL, 168,    ,    ,  80,  168, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092718, GN, OFCL,  48,    ,    ,  50,   48, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092718, GN, OFCL, 120,    ,    ,  80,  120, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092718, GN, OFCL, 168,    ,    ,  80,  168, HSM, genFcst, , ,  0, 043,
AL, 91, 2021092800, GN, OFCL,  48,    ,    ,  70,   48, SRS, genFcst, , ,  0, 043,
AL, 91, 2021092800, GN, OFCL, 120,    ,    ,  90,  120, SRS, genFcst, , ,  0, 043,
AL, 91, 2021092800, GN, OFCL, 168,    ,    ,  90,  168, SRS, genFcst, , ,  0, 043,
AL, 91, 2021092800, GN, OFCL,   0,    ,    , 100,    0,    , invest, 2021092800, al912021,  1, 043,
```

EP, 08, 2021080100, 03, AEMN, 000, 143N, 1183W, 56, 992, XX, 34, NEQ, 0000, 0000, 0000, 0000, 11,   5, 10
EP, 08, 2021080100, 03, AEMN, 006, 144N, 1191W, 49, 995, XX, 34, NEQ, 0000, 0000, 0000, 0000, 24,   4,   7
EP, 08, 2021080100, 03, AEMN, 012, 146N, 1199W, 56, 991, XX, 34, NEQ, 0000, 0000, 0000, 0000, 30,   6,   9
EP, 08, 2021080100, 03, AEMN, 018, 149N, 1207W, 54, 994, XX, 34, NEQ, 0000, 0000, 0000, 0000, 38,   5,   8
EP, 08, 2021080100, 03, AEMN, 024, 152N, 1214W, 52, 991, XX, 34, NEQ, 0000, 0000, 0000, 0000, 48,   6,   8
EP, 08, 2021080100, 03, AEMN, 030, 154N, 1221W, 52, 994, XX, 34, NEQ, 0000, 0000, 0000, 0000, 57,   5,   6
EP, 08, 2021080100, 03, AEMN, 036, 156N, 1226W, 51, 992, XX, 34, NEQ, 0000, 0000, 0000, 0000, 75,   5,   6
EP, 08, 2021080100, 03, AEMN, 042, 158N, 1230W, 52, 994, XX, 34, NEQ, 0000, 0000, 0000, 0000, 93,   5,   6
EP, 08, 2021080100, 03, AEMN, 048, 161N, 1232W, 49, 994, XX, 34, NEQ, 0000, 0000, 0000, 0000, 114,   4,   7
EP, 08, 2021080100, 03, AEMN, 054, 164N, 1234W, 48, 997, XX, 34, NEQ, 0000, 0000, 0000, 0000, 138,   4,   7
EP, 08, 2021080100, 03, AEMN, 060, 169N, 1236W, 46, 996, XX, 34, NEQ, 0000, 0000, 0000, 0000, 163,   3,   5
EP, 08, 2021080100, 03, AEMN, 066, 175N, 1241W, 44, 999, XX, 34, NEQ, 0000, 0000, 0000, 0000, 182,   3,   6
EP, 08, 2021080100, 03, AEMN, 072, 181N, 1249W, 42, 998, XX, 34, NEQ, 0000, 0000, 0000, 0000, 188,   3,   5
EP, 08, 2021080100, 03, AEMN, 078, 185N, 1258W, 39, 1002, XX, 34, NEQ, 0000, 0000, 0000, 0000, 187,   3,   8
EP, 08, 2021080100, 03, AEMN, 084, 189N, 1268W, 36, 1001, XX, 34, NEQ, 0000, 0000, 0000, 0000, 190,   4,   7
EP, 08, 2021080100, 03, AEMN, 090, 193N, 1283W, 36, 1004, XX, 34, NEQ, 0000, 0000, 0000, 0000, 181,   4,   7

aemn.t00z.cyclone.trackstd --track-spread, STD-slp, STD-Vmax

```
EP08  2021080100  fhour=   0   SPREAD:    11.00    nmem= 20  ifh=  1
EP08  2021080100  fhour=   6   SPREAD:    24.45    nmem= 20  ifh=  2
EP08  2021080100  fhour=  12   SPREAD:    30.19    nmem= 20  ifh=  3
EP08  2021080100  fhour=  18   SPREAD:    37.61    nmem= 20  ifh=  4
EP08  2021080100  fhour=  24   SPREAD:    47.66    nmem= 20  ifh=  5
EP08  2021080100  fhour=  30   SPREAD:    57.23    nmem= 20  ifh=  6
EP08  2021080100  fhour=  36   SPREAD:    74.75    nmem= 20  ifh=  7
EP08  2021080100  fhour=  42   SPREAD:    93.24    nmem= 20  ifh=  8
EP08  2021080100  fhour=  48   SPREAD:   114.37    nmem= 20  ifh=  9
EP08  2021080100  fhour=  54   SPREAD:   137.61    nmem= 20  ifh= 10
EP08  2021080100  fhour=  60   SPREAD:   162.81    nmem= 20  ifh= 11
EP08  2021080100  fhour=  66   SPREAD:   181.92    nmem= 20  ifh= 12
EP08  2021080100  fhour=  72   SPREAD:   187.51    nmem= 20  ifh= 13
EP08  2021080100  fhour=  78   SPREAD:   186.82    nmem= 20  ifh= 14
EP08  2021080100  fhour=  84   SPREAD:   189.72    nmem= 20  ifh= 15
EP08  2021080100  fhour=  90   SPREAD:   181.37    nmem= 19  ifh= 16
EP08  2021080100  fhour=  96   SPREAD:   175.34    nmem= 19  ifh= 17
EP08  2021080100  fhour= 102   SPREAD:   182.76    nmem= 19  ifh= 18
EP08  2021080100  fhour= 108   SPREAD:   192.20    nmem= 19  ifh= 19
EP08  2021080100  fhour= 114   SPREAD:   199.50    nmem= 19  ifh= 20
EP08  2021080100  fhour= 120   SPREAD:   210.73    nmem= 19  ifh= 21
```

TC genesis methodology

Based on Tim Marchok's latest version of the genesis tracker, we add the following steps to search for and identify TC genesis:

1) Calculate 300-500hPa temperature anomaly;
2) Calculate 200-850hPa zonal wind shear;
3) Calculate 500hPa mean relative humidity;
4) The AL90-99, EP90-99 and WP90-99 are invest storms named by NHC or JTWC. In case of potential TC genesis not identified by NHC or JTWC, we create storms of interest based on GFS-v16 operational deterministic forecasts, named as HC01, HC02, etc.

Searching for TC genesis is done in two steps:

1) In the genesis code, we track every vortex by checking:
  - 850hPa/700hPa/surface relative vorticity maximum centers
  - 850hPa/700hPa geopotential height minimum centers
  - Sea level pressure (MSLET) minimum center
  - 850hPa/700hPa/surface wind speed minimum centers
  - Check for SLP gradient ≥ 0.0015mb/km, 850hPa wind speed ≥ 1.5m/s, and a closed SLP contour

2) Afterward, the list of vortices is filtered by the following criteria:
  - Surface maximum wind speed ≥ 10kt (25kt for GFS)
  - 850hPa maximum vorticity ≥ 10**(-4) 1/s
  - 300-500hPa temperature anomaly ≥ 0.5C