

Updates on “TC-Gen” for verifying TC genesis in the Model Evaluation Tools (METplus)

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METplus



MODEL EVALUATION TOOLS (MET)

<https://dtcenter.org/community-code/model-evaluation-tools-met>

Welcome

Welcome to the users page for the Model Evaluation Tools (MET) verification package. MET was developed by the National Center for Atmospheric Research (NCAR) Developmental Testbed Center (DTC) through the generous support of the U.S. Air Force Weather Agency (AFWA) and the National Oceanic and Atmospheric Administration (NOAA).

Description

MET is designed to be a highly-configurable, state-of-the-art suite of verification tools. It was developed using output from the Weather Research and Forecasting (WRF) modeling system but may be applied to the output of other modeling systems as well.

MET provides a variety of verification techniques, including:

- Standard verification scores comparing gridded model data to point-based observations
- Standard verification scores comparing gridded model data to gridded observations
- Spatial verification methods comparing gridded model data to gridded observations using neighborhood, object-based, and intensity-scale decomposition approaches
- Ensemble and probabilistic verification methods comparing gridded model data to point-based or gridded observations
- Aggregating the output of these verification methods through time and space



MODEL EVALUATION TOOLS (MET)

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LATEST RELEASE

MET Version 8.1.2
Released: 2019-10-31

UPCOMING EVENTS

No upcoming events

The goal of this project is to develop a new MET tool (TC-Gen) which will provide a standard framework for verifying deterministic and probabilistic TC genesis forecasts.

- Supports GFDL/Marchok tracker output (or any output following those formatting conventions).
- ATCF a- and b-decks as the verification dataset.
- TC-Gen capabilities have been developed in consultation with DTC, EMC, and NHC.

TC-Gen was first released in January 2020. Several enhancements have been implemented with the METv10.0.0-beta3 release in January 2021.



MET VERSION 9.0 BETA2

RELEASE DATE: 2020-01-03

met-9.0_beta2

MET User's Guide
9.0 BETA2

Existing Builds

The MET Version 9.0 BETA2 was released on January 3, 2020.

Release Notes

When applicable, release notes are followed by the GitHub issue number which describes the bugfix, enhancement, or new feature:

<https://github.com/NCAR/MET/issues>

- What's New:
 - Major Enhancements: python version 3, python embedding overhaul
 - New Tools: grid_diag, tc_gen, point2grid



MET 10.0.0 BETA3

RELEASE DATE: 2021-01-27

met-10.0.0-
beta3.tar.gz

User's Guide

Existing Builds and
Docker

The MET 10.0.0 beta3 was released on January 27, 2021.

TC-Gen Tool:

- Overhaul the Tropical Cyclone genesis matching logic, add the development and operational scoring algorithms, and add many config file options (#1448).
- Add config file options to filter data by initialization time (init_inc and init_exc) and hurricane basin (basin_mask) (#1626).
- Add the genesis matched pair (GENMPR) output line type (#1597).
- Add a gridded NetCDF output file with counts for genesis events and track points (#1430).

The logic was updated to include two different scoring/verification algorithms.

- “DEV” mode: Likely most relevant to model developers
 - A “hit” forecast must occur within the user-defined spatial and temporal tolerance.

- “OPS” mode: Likely relevant for NHC
 - A forecast is matched to a numbered system in the ATCF. The forecast is a “hit” if best-track genesis occurs within a user-defined time of the model initialization time.

DEV method hit example

- GFS forecast genesis at 110N, 480W; init 2019082300, valid 2019082512:

```
TG, 0001, 2019082300 F060 110N 0480W FOF, 2019082300, 03, GFS, 060, 110N, 480W,
```

- Matching entry in BEST at 2019082512 at 112N, 523W:

```
AL, 05, 2019082406, , BEST, 0, 103N, 464W, 25, 1011, TD,  
AL, 05, 2019082412, , BEST, 0, 104N, 475W, 30, 1010, TD,  
AL, 05, 2019082418, , BEST, 0, 106N, 487W, 35, 1008, TS,  
AL, 05, 2019082500, , BEST, 0, 108N, 499W, 35, 1008, TS,  
AL, 05, 2019082506, , BEST, 0, 110N, 510W, 35, 1008, TS,  
AL, 05, 2019082512, , BEST, 0, 112N, 523W, 40, 1007, TS,  
AL, 05, 2019082518, , BEST, 0, 114N, 535W, 45, 1007, TS,
```

- BEST genesis at 2019082406 at 103N, 464W:

```
AL, 05, 2019082406, , BEST, 0, 103N, 464W, 25, 1011, TD,  
AL, 05, 2019082412, , BEST, 0, 104N, 475W, 30, 1010, TD,  
AL, 05, 2019082418, , BEST, 0, 106N, 487W, 35, 1008, TS,  
AL, 05, 2019082500, , BEST, 0, 108N, 499W, 35, 1008, TS,  
AL, 05, 2019082506, , BEST, 0, 110N, 510W, 35, 1008, TS,  
AL, 05, 2019082512, , BEST, 0, 112N, 523W, 40, 1007, TS,  
AL, 05, 2019082518, , BEST, 0, 114N, 535W, 45, 1007, TS,
```

GFS forecast genesis
valid time and
location within user-
defined 36 h and 500
km of BEST genesis.

OPS method hit example

- GFS forecast genesis at 110N, 480W; init 2019082300, valid 2019082512:

```
TG, 0001, 2019082300_F060_110N_0480W_FOF, 2019082300, 03, GFS, 060, 110N, 480W,
```

- Matching BEST entry in b-decks at 2019082512 at 112N, 523W:

```
AL, 05, 2019082406, , BEST, 0, 103N, 464W, 25, 1011, TD,  
AL, 05, 2019082412, , BEST, 0, 104N, 475W, 30, 1010, TD,  
AL, 05, 2019082418, , BEST, 0, 106N, 487W, 35, 1008, TS,  
AL, 05, 2019082500, , BEST, 0, 108N, 499W, 35, 1008, TS,  
AL, 05, 2019082506, , BEST, 0, 110N, 510W, 35, 1008, TS,  
AL, 05, 2019082512, , BEST, 0, 112N, 523W, 40, 1007, TS,  
AL, 05, 2019082518, , BEST, 0, 114N, 535W, 45, 1007, TS,
```

- BEST genesis at 2019082406 at 103N, 464W:

```
AL, 05, 2019082406, , BEST, 0, 103N, 464W, 25, 1011, TD,  
AL, 05, 2019082412, , BEST, 0, 104N, 475W, 30, 1010, TD,  
AL, 05, 2019082418, , BEST, 0, 106N, 487W, 35, 1008, TS,  
AL, 05, 2019082500, , BEST, 0, 108N, 499W, 35, 1008, TS,  
AL, 05, 2019082506, , BEST, 0, 110N, 510W, 35, 1008, TS,  
AL, 05, 2019082512, , BEST, 0, 112N, 523W, 40, 1007, TS,  
AL, 05, 2019082518, , BEST, 0, 114N, 535W, 45, 1007, TS,
```

GFS forecast genesis
matched to a BEST entry.
GFS forecast initialization
time is no more than
user-specified 48 h prior
to BEST genesis time.

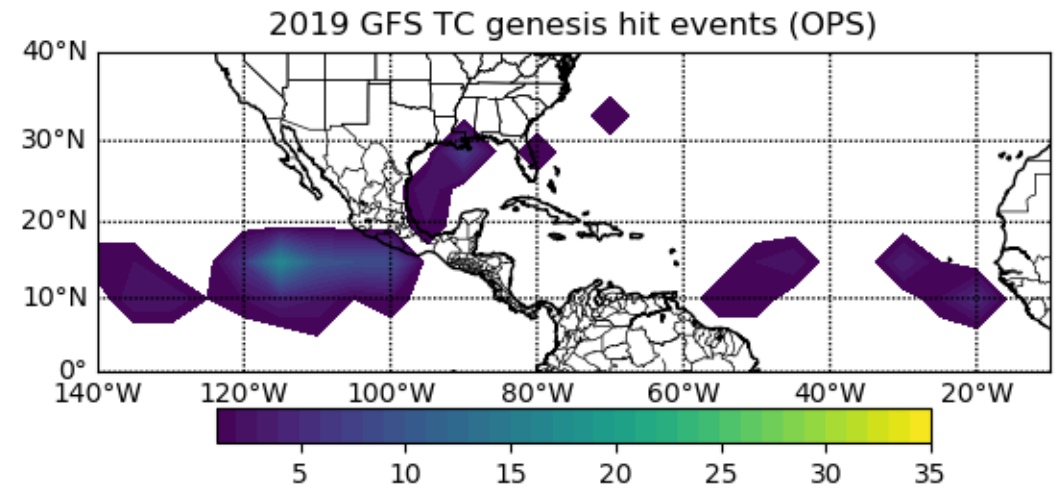
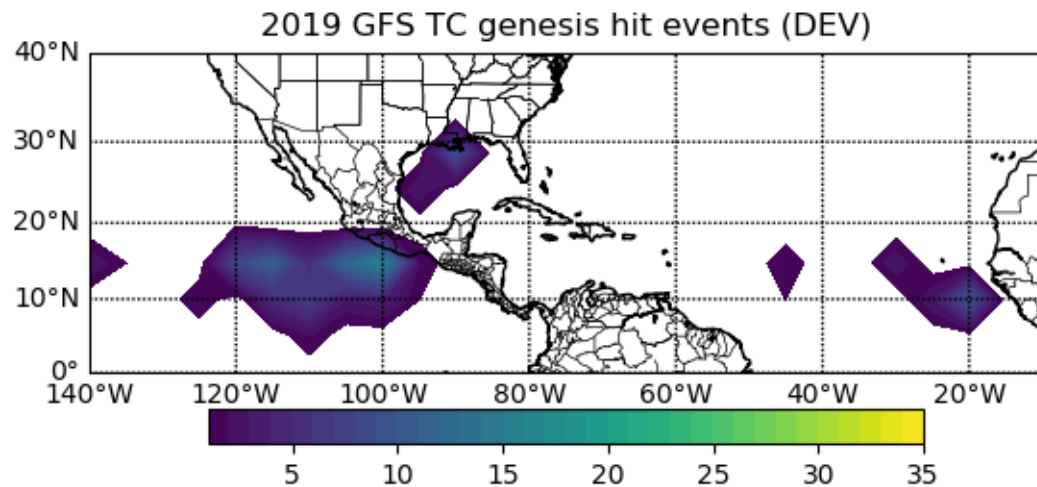
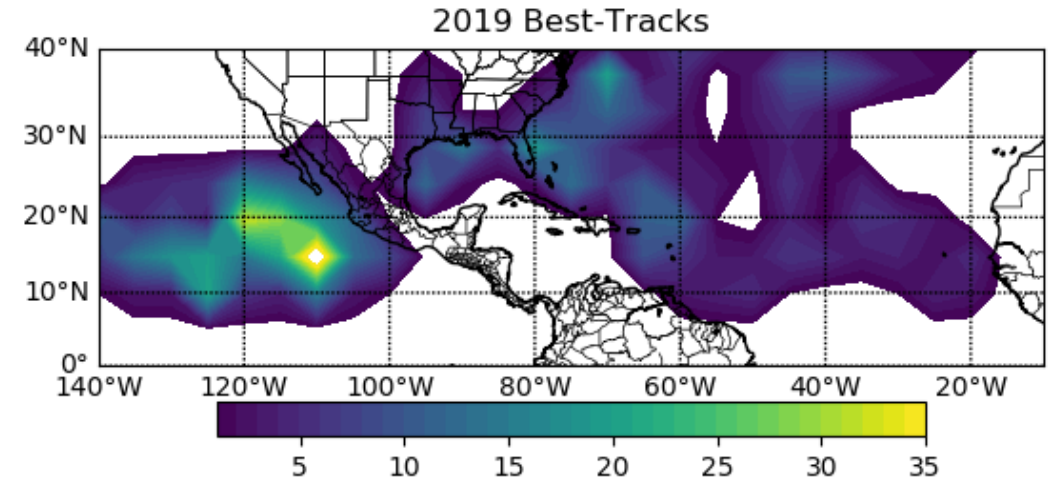
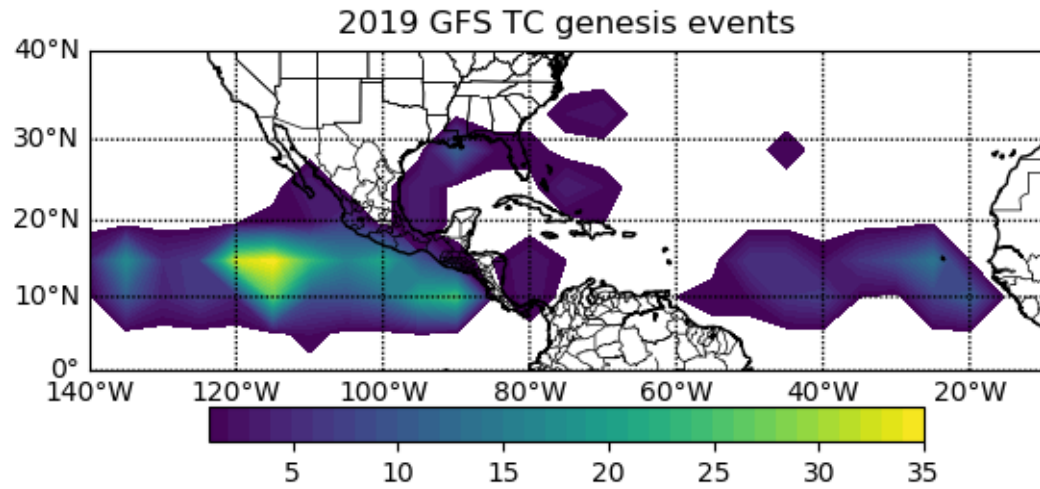
Several new config file options were added.

- **init_inc**: A list of model initialization times to verify.
- **init_exc**: A list of model initialization times to exclude from verification.
- **basin_mask**: Only verify forecasts in specified basins.
- **genesis_match_radius**: The maximum distance allowed to match a forecast to an ATCF system.
- **dev_hit_radius**: The maximum distance between forecast and observed genesis location to qualify as a “hit.”
- **discard_init_post_genesis_flag**: Discard all forecasts with an initialization time after the best-track genesis time if TRUE.

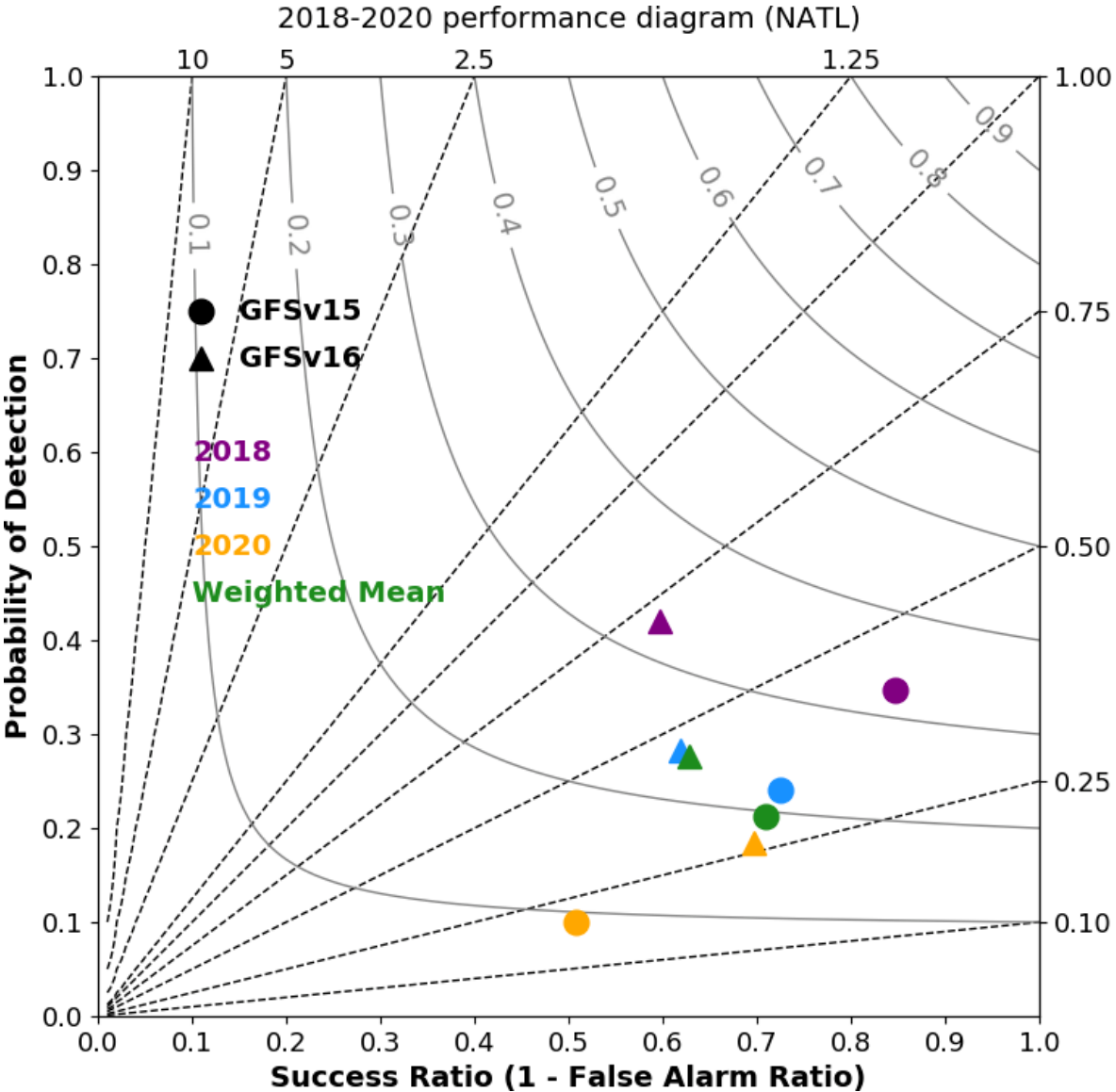
Added the genesis matched pair (GENMPR) output line type to provide information about each hit, false alarm, and miss event.

STORM_ID	AGEN_INIT	AGEN_FHR	AGEN_LAT	AGEN_LON	AGEN_DLAND	BGEN_LAT	BGEN_LON	BGEN_DLAND	GEN_DIST	GEN_TDIFF	INIT_TDIFF	DEV_CAT
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	20190707_180000	108	29	-87	87.07259	27.8	-87.6	118.85302	145.93231	300000	780000	FY0N
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	20190708_060000	84	27.5	-90	96.14523	27.8	-87.6	118.85302	238.9967	180000	660000	FY0Y
AL022019	20190708_120000	78	27.5	-90.5	97.29927	27.8	-87.6	118.85302	287.89587	180000	600000	FY0Y
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	20190709_000000	60	27.5	-89	97.29927	27.8	-87.6	118.85302	142.03043	120000	480000	FY0Y
AL022019	NA	NA	NA	NA	NA	27.8	-87.6	118.85302	NA	NA	NA	FNOY
AL022019	20190709_120000	42	27	-89	126.99725	27.8	-87.6	118.85302	164.54377	060000	360000	FY0Y
AL022019	20190709_180000	42	27.5	-88.5	104.89008	27.8	-87.6	118.85302	94.8213	120000	300000	FY0Y
AL022019	20190710_000000	36	28.5	-89	39.30394	27.8	-87.6	118.85302	157.9677	120000	240000	FY0Y
AL022019	20190710_060000	36	28	-90	66.21009	27.8	-87.6	118.85302	237.15629	180000	180000	FY0Y
AL022019	20190710_120000	24	28	-89	67.86737	27.8	-87.6	118.85302	139.5195	120000	120000	FY0Y
AL022019	20190710_180000	24	27.5	-89	97.29927	27.8	-87.6	118.85302	142.03043	180000	060000	FY0Y
AL032019	NA	NA	NA	NA	NA	24.6	-77.4	152.28757	NA	NA	NA	FNOY
AL032019	NA	NA	NA	NA	NA	24.6	-77.4	152.28757	NA	NA	NA	FNOY
AL032019	NA	NA	NA	NA	NA	24.6	-77.4	152.28757	NA	NA	NA	FNOY

Added gridded netCDF output file with counts for genesis and ATCF points/tracks.

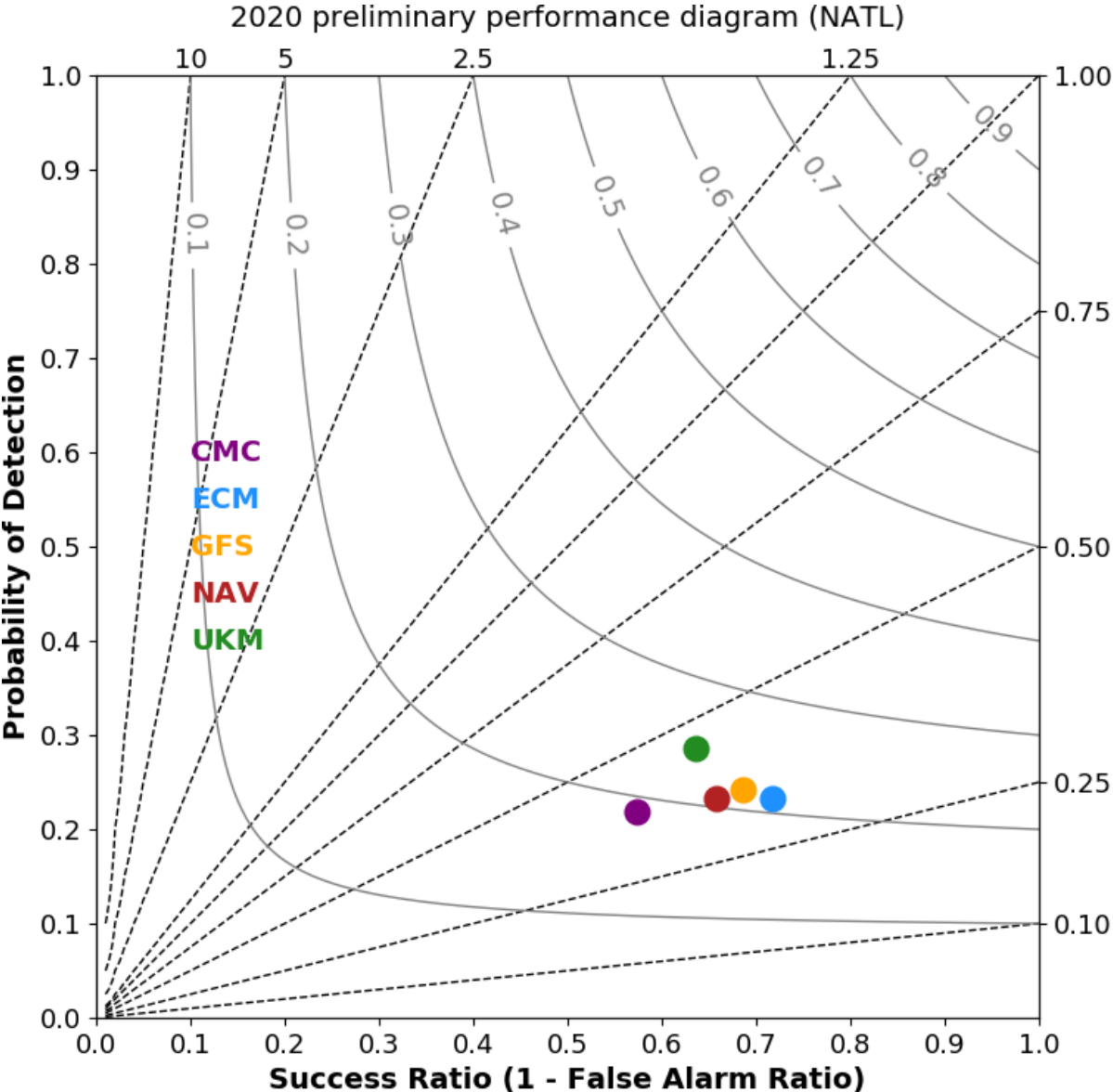


Application: Evaluation of model upgrades.



- Forecast verification by year for each model configuration.
 - x-axis: success ratio
 - y-axis: probability of detection
 - Dashed lines: frequency bias
 - Curved lines: critical success index
- All values would equal 1 for a perfect performing model.
- Compared to GFSv15, GFSv16 exhibits on average:
 - Larger probability of detection
 - Smaller success ratio
 - Larger critical success index
- Overall, GFSv16 is more cyclogenetic than GFSv15.

Application: Comparing TC genesis verification statistics among multiple models.



- Includes genesis forecasts from F006 through F120
- Forecasts can verify any time within 120 h of model initial time to be considered a “hit”
- Includes forecasts through 10/26/20
 - Arthur through Zeta
 - STS Alpha excluded
- All values would equal 1 for a perfect performing model
 - x-axis: success ratio
 - y-axis: probability of detection
 - Dashed lines: frequency bias
 - Curved lines: critical success index

Plans for 2021

- Implement the capability for verifying probabilistic TC genesis forecasts.
- Update documentation on TC-Gen in the MET User's Guide.
- Update TC-Gen use case in the MET Online Tutorial.
- Support testbed partners as they begin using TC-Gen.