HFIP Annual Workshop

Observations & Future Directions

Modeling Issues Identified by Forecasters

Genesis

- GFS continues to be too fast/aggressive with genesis - especially in the NW Caribbean Sea, eastern Atlantic, and offshore of southern Mexico east of 100W
- ECMWF continues to miss/underplay many TC genesis events, regardless of basin
- Continued challenges with genesis timing/detection in the Gulf of Mexico and off Southeast U.S. coast (PTC1/Alex)
- Poor genesis forecasts (short lead time, low POD) continue to be a problem in the subtropics and mid-latitudes

Modeling Issues Identified by Forecasters

Intensity

- Over-aggressive forecasts in environments of low shear but suboptimal thermodynamic properties in the tropical western Pacific, from both dynamical and statistical models
- TC-resolving models (HWRF, COAMPS-TC) often seem overeager to symmetrize core convection in environments of shear and/or ambient dry air, leading to high-biased intensity forecasts
- Intensity guidance backing off in 12-24 h prior intensification prior to landfall of Ian and Ida
- Difficulty predicting intensification above 115 kt
- SHIPS model lacked skill in the east Pacific beyond 48 h

Modeling Issues Identified by Forecasters

Track

- Inconsistent track guidance for pre-genesis systems
- Leftward bias in ECMWF ensembles relative to other models and observed TC tracks was noted in several cases in the Atlantic and western Pacific
- Left-of-track bias for GFS and HWRF for Ian in the Gulf of Mexico
- Continued left-of-track bias for systems near/along the west coast of Mexico for most guidance
- Frequent track correction in the down-shear direction due to poor handling of tilted TC vortices under moderate shear, especially for TCs < 65 kt
- HWRF track skill lags GFS significantly in first 48-60 hours in the Atlantic

HAFS 2022 Challenges

- Challenging storms: Earl 06L, Fiona 07L, Ian 09L
- Cycle-to-cycle variation
- West bias of both HAFS-A and HAFS-S for Hurricane Ian
- Steep terrain induced spurious gravity wave and Model instability
- Internal tracker loses weak storms
- Bug in wind stress into ocean, fixed the issue recently

HAFS challenges:

- HAFS Physics issues/challenges: All HAFS appear to have a negative intensity bias after 48 h in WPAC, NATL, HAFS-S has weak bias after 48 h, HAFS-A seems closer to HWRF.
- HAFS impact on consensus - HAFS models provide big impact in TVCN, & HCCA tracks; HAFS produces slightly less IVCN skill in ATL, but slight positive impact in EPAC; similar RVCN skill in ATL and EPAC as IVCN
- Structure - HAFS appears to have biases in radii compared to HWRF, GFS., HAFS-S has R34 negative bias after 48 h - Is new tracker helping? Are radii defined in a similar way between model and Best Track?
- Observation impacts are mixed - DA/VI issues? Evaluation strategies?

JTWC R&D Priorities

Priority	Need
1 TC Intensity Change	***Basin-specific*** **(WESTPAC, SHEM, NIO, SIO, and SWPAC) probabilistic and deterministic** ***forecast guidance for TC intensity change*****,** ***particularly*** **the onset, duration, and magnitude of** ***rapid intensity change*** **events (including ERC, over-water weakening, etc.) at 2-3 day lead times.**
2 TC Genesis Timing and Forecast	**Guidance to** ***improve*** **the** ***forecasting of TC genesis timing*** **and the subsequent track, intensity and structure of pre-genesis tropical disturbances out to two week lead-times, that exhibits a high probability of detection and a low false alarm rate. Techniques to diagnose and predict the formation of TCs via transition of non-classical disturbances (e.g. monsoon depressions, sub-tropical, hybrids, etc).**
3 Data Exploitation	**Techniques, products, or sources that** ***improve*** **the utility and** ***exploitation of microwave satellite, ocean surface wind vectors, and radar data*** **for fixing (center, intensity, radii) TCs, or for diagnosing RI, ETT, ERC,** ***etc.*** **(*e.g.*, develop a "Dvorak-like" technique using microwave imagery). Leverage machine learning methods to maximize automation, and ensure rapid integration into visualization system.**
4 TC Structure Specification	***Basin-specific*** **(WESTPAC, SHEM, NIO, SIO, and SWPAC) probabilistic and deterministic guidance for the** ***specification*** **(analysis and forecast)** ***of key TC structure variables*****,** ***including*** **the production of 34-, 50- and 64- knot wind radii and a** ***dynamic*** **(situational) confidence-based** ***swath*** **of potential 34-kt wind impacts**
5 TC Track Improvement	**Model and DA enhancements or guidance to** ***improve TC track forecast skill and*** **the** ***conveyance of probabilistic track uncertainty*****. Includes development of guidance-on-guidance to identify and reduce forecast error outliers resulting from large speed (e.g., accelerating recurvers) and directional (e.g., loops) errors, or from specific forecast problems such as upper-level trough interaction, near/over-land, elevated terrain, and extratropical transition.**

Modeling challenges: Recommendations

- Need a clear definition of storm structure metrics (radii of 34 kt, 50 kt, & 64 kt) to use them in model diagnostics output to make sure R34 verification is using the same definitions for R34 in model and Best Track.
- Set up Tiger Team to address how to get HAFS model output into AWIPS-2. Could we use HOT and cloud-AWIPS to test different strategies that could be used to drive AWIPS 2 improvements.
- Need TC rainfall products that take into account track and structure uncertainty - Excessive rainfall outlook (ERO), probabilistic rainfall products.
- Need more interactions for the National Water Center to address TC rainfall guidance product development and evaluation.
- Need to look at physics diversity and impacts. Must be linked to DA impacts (how do physics changes affect DA performance).

Modeling challenges: Recommendations

- MAE is not sufficient to evaluate forecast guidance for track, intensity, structure, etc. Should use GROOT for all model evaluations. Need to rethink evaluation approach for extremes - RI, rain, etc.
- Need interactions between JCSDA & HFIP DA to accelerate HAFS dev.
    - **Recommend joint workshop to accelerate HAFS adoption of JEDI components (IOTA, SOCA, UFO, SABER, etc.). Could benefit from collaboration with RRFS DA team's efforts & from collaboration with JCSDA/SOCA to address wave model DA effort in JCSDA. Code Sprint?**
    - **HAFS needs a strong infusion of DA resources - both from personnel & HPC**
- Need a strategy to utilize EPIC to support HAFS through UFS Hurricane Application Team - HAFS Containers
- Need to develop NHC, WPC, and WFO messaging needs that can be addressed through our SBES projects under the supplemental

SBES Panel Issues & Discussions

- Triangulation of funded projects had 4 key takeaways related to the tropical products. How can HFIP facilitate and provide means to utilize these takeaways to test & evaluate improved products.
- Should we work from existing products? Develop new products? - **Recommend start to work with existing products if possible**
- How can we facilitate SBES and physical science collaborations -
  - **Invite SBES to participate in HFIP bi-weekly meetings;**
  - **Set up workshop to identify joint projects and collaborations;**
  - **Take advantage of HOT to test and evaluate improvements to products**
  - **Involve Super users in evaluations**
- How can we support SBES collaborations
  - **Work with PMs to add requirement to have SBES participation in proposals supported to do work supported by HFIP**