A Preliminary Evaluation of a Dynamically Sized Swath of Potential Gale Force Winds Using Goerss Predicted Consensus Errors (GPCE)

This Brief is Unclassified

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Acknowledgements

Mahalo to:

— Ann Schrader
— Mike Frost
— Ed Fukada
— John Knaff
— Jim Goerss
Motivation

- JTWC desires a dynamic swath based on forecast confidence vice climatology
  - Swath based on wind probabilities would have actual probabilistic meaning, but requires more R&D to determine appropriate threshold value
- Typhoon duty officers (TDO) require more objective method to assess subjective forecast confidence
  - Subjective forecast confidence (high/low) given in prognostic reasoning message for forecast days 1-3 and days 4-5.
- Decision makers in maritime OPS and resource protection rely heavily on the swath
  - Used in setting of Tropical Cyclone Condition of Readiness (TCCOR)
  - Ship routers & drivers know to “stay out of the cone”

Note: All best track data shown in this presentation are preliminary and subject to change
**Current Swath**

- The JTWC graphical swath denotes the area of potential gale force winds, **not** forecast track uncertainty.
- Swath radius is computed at each forecast tau by adding the maximum R34 to the 5-year mean forecast error for that tau:
  - JTWC does not forecast radii at taus 96/120, so tau 72 radius is used.
  - Radii not forecast until winds exceed 35/50/65 kt thresholds (i.e., 40/55/70).
  - Radii not forecast for sub/extra-tropical, or over land.
  - 2015 five-year running mean track errors (FTE):

<table>
<thead>
<tr>
<th>Tau</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
<th>72</th>
<th>96</th>
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<tr>
<td>FTE (nm)</td>
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<td>95</td>
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GPCE Based Swath

- ATCF v5.7 added new capability for GPCE based swath (a proxy for wind probabilities)
  - Mean spread of JTWC consensus members (CONW) is the leading predictor
  - Track GPCE is recomputed annually, based on regression of adeck/bdeck parameters
  - Data available in ATCF e-decks
- GPCE swath radius = Max R34 + FTE * (GPCE/GPCC)
  - GPCC is the climatological GPCE, also updated annually. For 2015:

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<th>Tau (h)</th>
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<td>GPCC (nm)</td>
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- GPCE < GPCC will result in reduced swath width and visa versa. GPCE==GPCC results in current climatological swath width
- GPCE swath is isometric, and radius is constrained so that swath does not shrink if later forecast tau GPCE value decreases
- Evaluation focused on 72 hour forecasts to identify high and low CONW spread cases
  - 2015 72-hour GPCE values ranged from 72 to 331
  - Results in 72- hour swath size weighting factor ranging from .39 to 2.57
WP172015 (Atsani): 081800Z
In this case, GPCE < GPCC at all taus
Low CONW member model spread
Relatively large R34 values produce large climatological swath (red)
Ratio of GPCE to GPCC reduces GPCE swath (green) at all taus
  Danger area is reduced by 197,000+ sq miles
Working best track R34 remain inside the GPCE based swath at all taus

TDO would assess high forecast track confidence in days 1-3 and days 4-5, and reduced swath size increases potential OPAREA
GPCE < GPCC

- WP162015 (Goni): 081700Z
- Similar to 17W with GPCE < GPCC at all taus due to low spread
- TDO has high confidence
- Ratio of GPCE to GPCC reduces GPCE swath (green)
  - Danger area is reduced by 165,000+ sq miles
- Working best track R34 remain inside the GPCE based swath at all taus, However...
- Preliminary review of scatterometry suggests true wind field (yellow) is much larger than analyzed and forecast
Another Example of Wind Radii Errors

- WP092015 (Chan-Hom): 070700Z
- Scat data likely led TDO to increase radii by 100% (still awaiting re-best)
- If verified, 35 kt winds exceed both swaths

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<thead>
<tr>
<th>(NM)</th>
<th>GPCE</th>
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JTWC Wind Radii

- JTWC radii (analysis and forecast) confidence is not insignificant – can be nearly the same order as the CONW spread at times
  - Verified track may deviate only slightly from forecast, but radii may be grossly under-estimated
  - Greater potential for gale force winds outside the swath when the swath size is reduced
- Room for improvement
  - Limited analysis data, which may arrive after forecast generation, with bleak future for active scatterometers
  - Known low bias of JTWC radii resulting in guidance that is low biased
  - NRL-MRY/CIRA/JTWC review found that wind radii analysis consensus comprised of model, JTWC fix, and CIRA DWR fixes performs well – will be implemented in ATCF v5.8
  - NRL-MRY delivered radii forecast consensus (RVCN) for evaluation, included in v5.8
  - Plans for re-derivation of DRCL
**GPCE > GPCC**

- **WP272015 (In-Fa): 112406Z**
- **GPCE > GPCC cases largely occur after or during re-curvature**
  - Model spread tends to increase, consistent w/ Goerss (2007a)
- Despite forecast 40 kts, t72 posit has no radii (no R34 for ET posits)
  - Results in unrealistic shrinking of swath, JTWC has to communicate risk with OTSR
  - GPCE swath reflects uncertainty and may more accurately reflect large ET wind field

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*Forecast and Working Best Track*
WP272015 (In-Fa): 112306Z
- Additional 2,000,000 sq miles
- Near stationary JSGM, large speed differences in ETT – model spread was all along-track
  - Need to evaluate use of GPCE-AX

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Other Examples

- Lack of forecast radii over land causes unrealistic shrinking of swath, despite forecast 55 kts prior to landfall.
  - GPCE swath constraint persists the size

- GPCE swath can be smaller than the climatological swath at some forecast lead times while larger at others
  - Here, GPCE becomes > GPCC at tau 120
Summary and Conclusions

- ATCF provides TDOs the option to compute and display a dynamically sized swath based on GPCE
  - Consensus spread is typically lower in straight running/westward moving TCs, resulting in a swath that may be smaller than current operational version
  - Spread is typically larger for recurving TCs, potentially leading to large swaths
    - May be more realistic given wind field expansion during extra-tropical transition
- TDOs can view GPCE and GPCC circles in ATCF to assess forecast track confidence
- Methodology can be adapted for other agency forecast track error swaths
- Evaluation is ongoing, GPCE swaths will be produced in real-time throughout 2016
  - Evaluation made possible in part by first-time NRL (contractor) efforts to best track 2014-2015 Westpac 34 knot wind radii (R34)
  - Tailoring the swath by along-track/cross-track components via GPCE-AX will be considered once that dataset is updated
  - Wind radii analysis/forecast are expected to improve in 2016 due to new aids coming in ATCF v5.8, translating into potentially improved swath accuracy
References


