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

This Brief is Unclassified

Brian Strahl, JTWC
Buck Sampson, NRL-MRY
AG2 Jack Tracey, JTWC

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Motivation

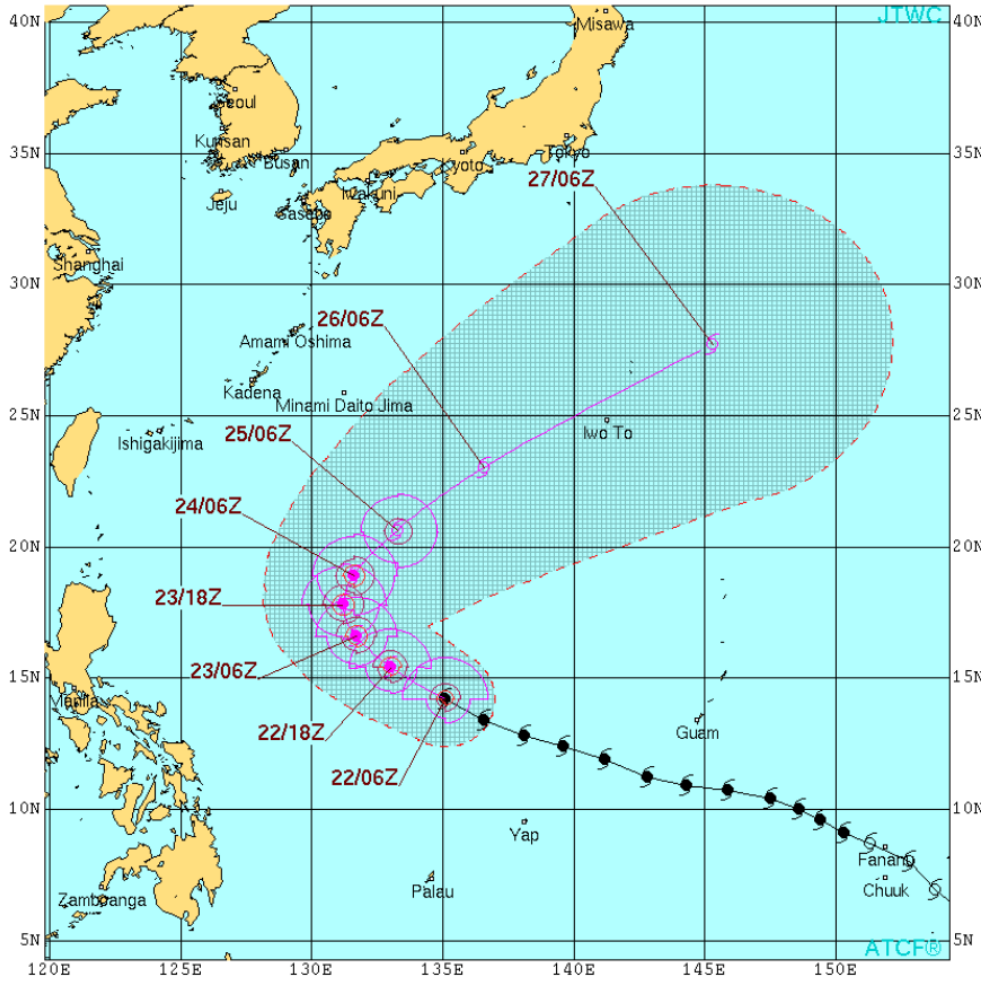
- JTWC desires a dynamic swath based on forecast confidence vice climatology
  - Swath based on wind probabilities would have actual probabilistic meaning, but requires more R&D to determine appropriate threshold value
- Typhoon duty officers (TDO) require more objective method to assess subjective forecast 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):

Tau	12	24	36	48	72	96	120
FTE (nm)	35	55	75	95	140	190	280



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:

Tau	12	24	36	48	72	96	120
GPCC (nm)	33	41	69	84	129	185	211

  - 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

GPCE < GPCC

- 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

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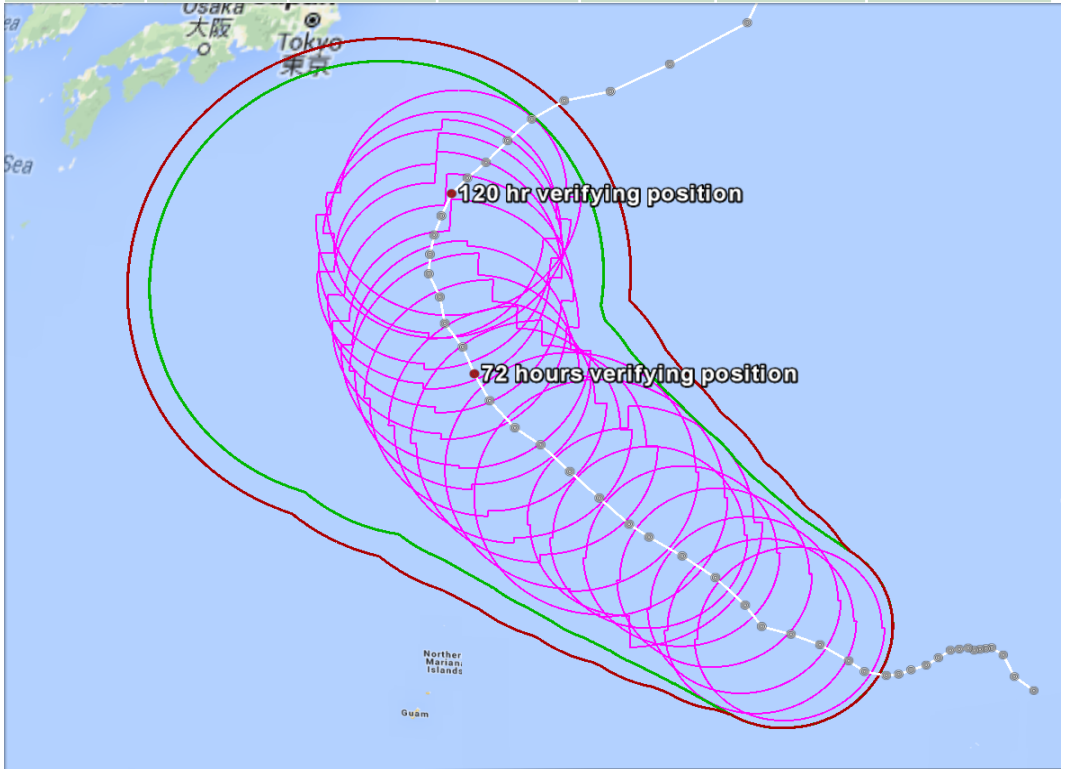
- TDO would assess high forecast track confidence in days 1-3 and days 4-5, and reduced swath size increases potential OPAREA

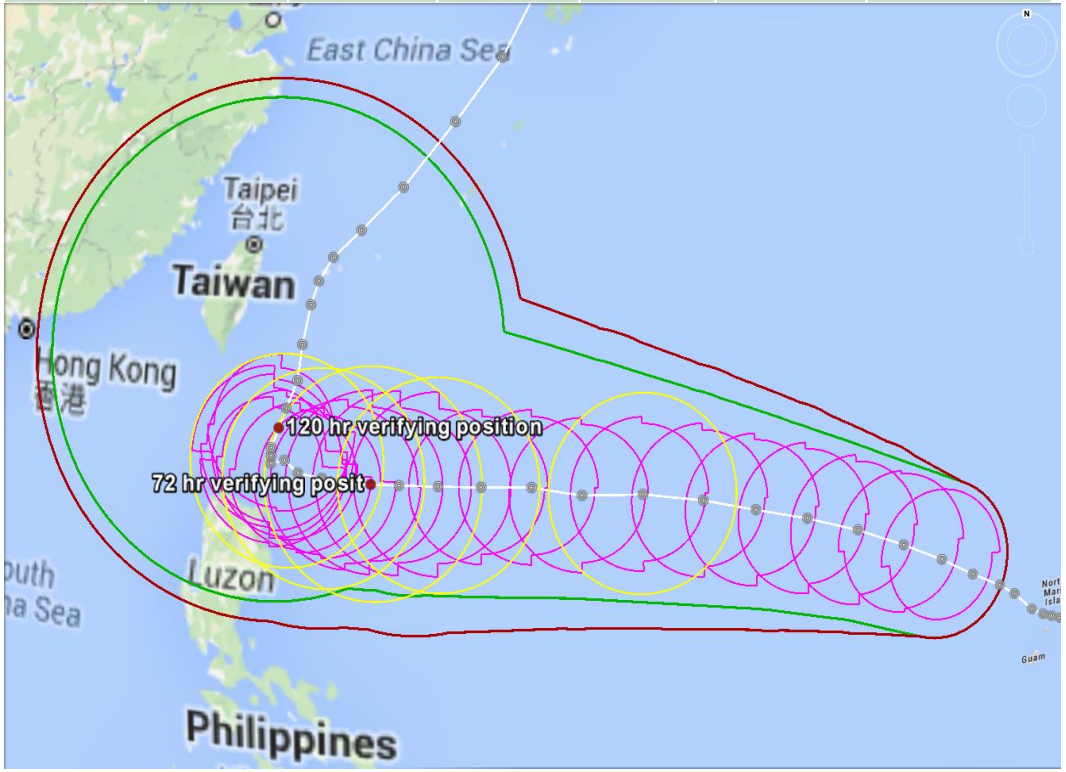
(NM)	GPCE	GPCC	FYE	R34	Swath	GPCE Swath
T12	13	33	35	175	210	189
T24	20	41	55	180	235	207
T36	32	69	75	185	260	220
T48	42	84	95	185	280	233
T72	78	129	140	180	320	265
T96	139	185	190	180	390	323
T120	176	211	280	180	460	414



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

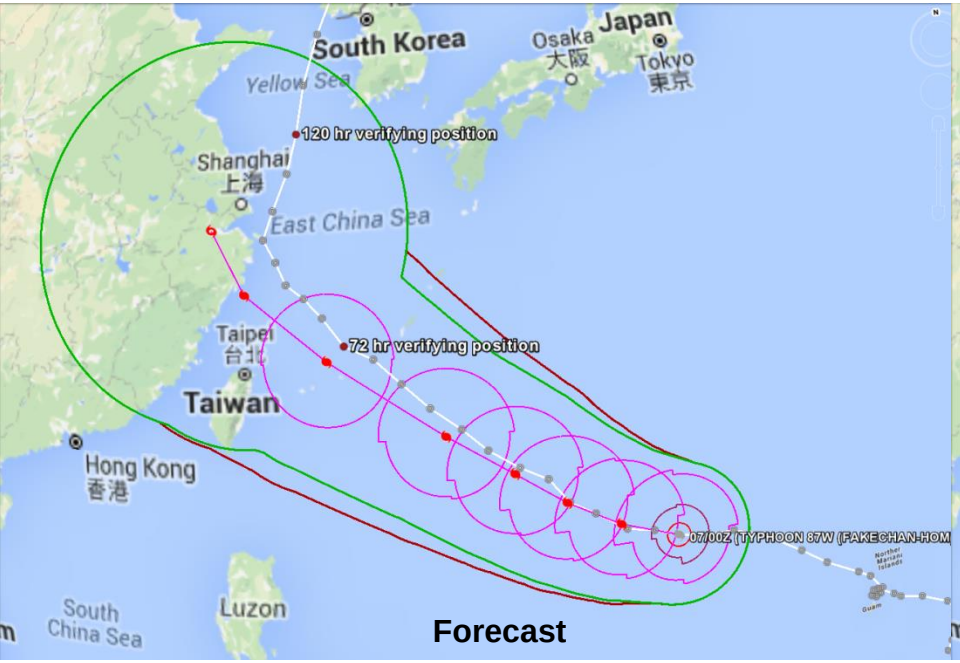
(NM)	GPCE	GPCC	FYE	R34	Swath	GPCE Swath
T12	14	33	35	115	150	130
T24	21	41	55	120	175	148
T36	33	69	75	125	200	161
T48	43	84	95	130	225	179
T72	72	129	140	135	275	213
T96	123	185	190	135	325	261
T120	188	211	280	135	415	384



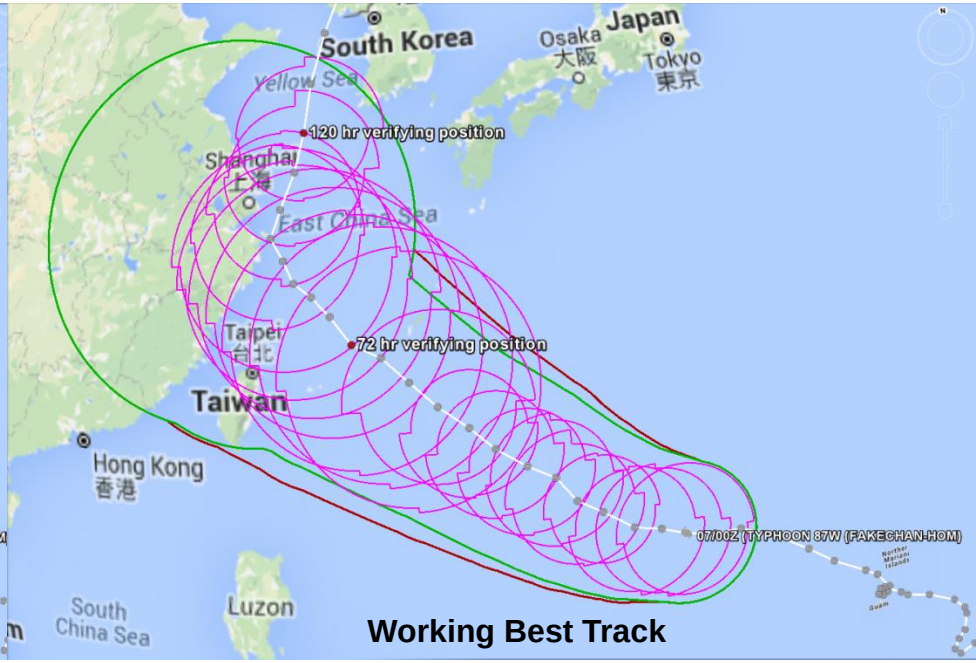
Another Example of Wind Radii Errors

- 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

(NM)	GPCE	GPCC	FYE	R34	Swath	GPCE Swath
T12	26	33	35	140	175	168
T24	37	41	55	140	195	190
T36	47	69	75	140	215	191
T48	50	84	95	140	235	197
T72	86	129	140	140	280	233
T96	178	185	190	140	330	323
T120	211	211	280	140	420	420



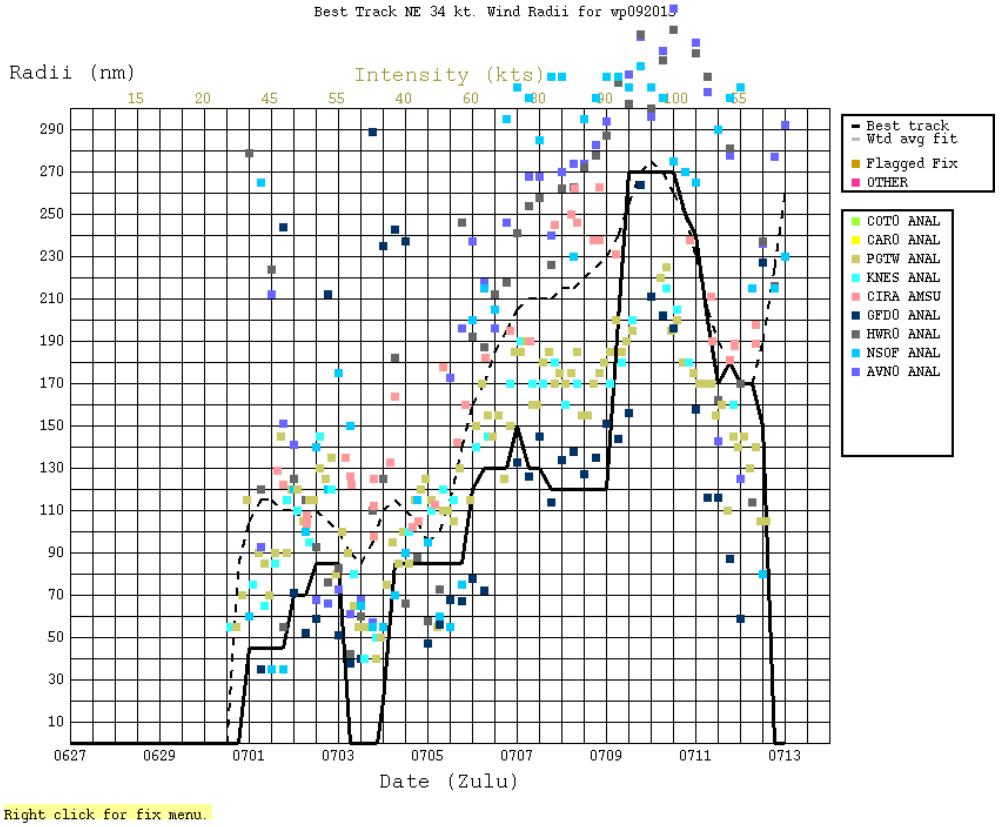
Forecast



Working Best Track

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

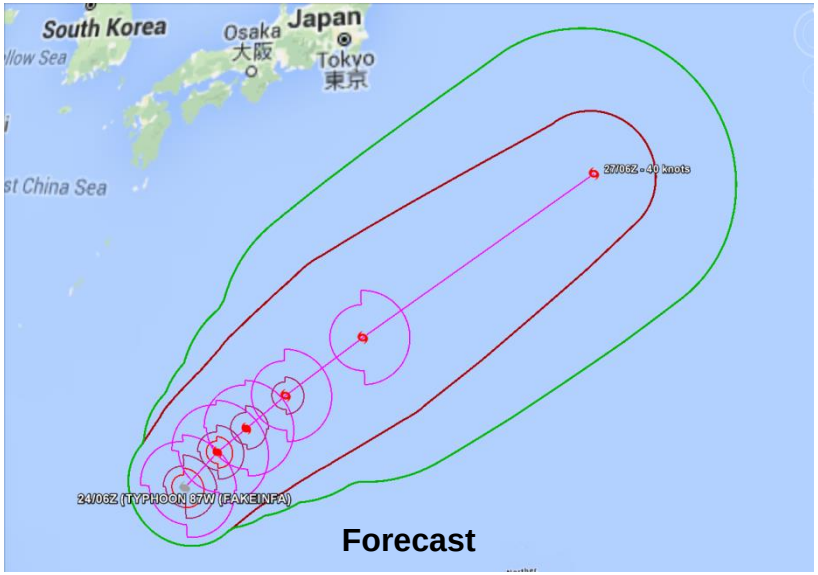


GPCE > GPCC

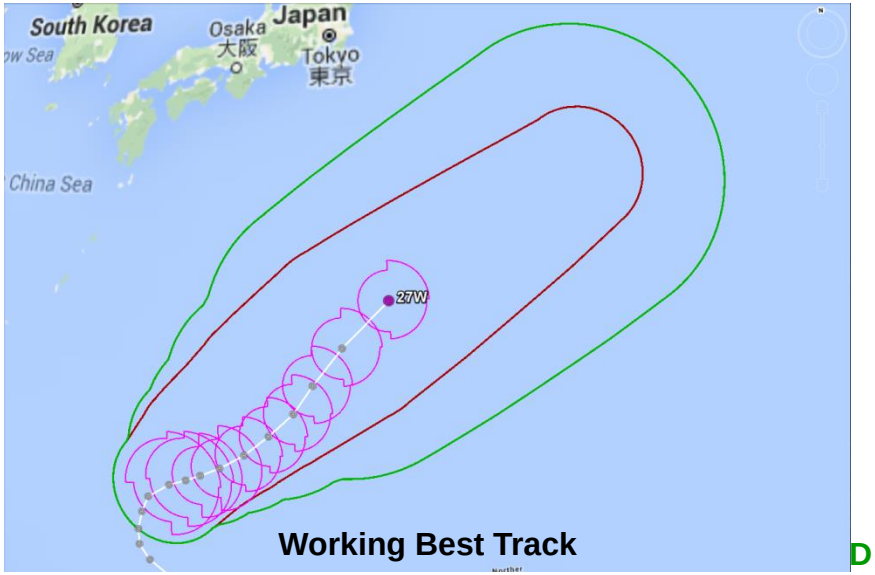
- WP272015 (In-Fa): 112406Z
- GPCE > GPCC cases largely occur after or during re-curvature
  - Model spread tends to increase, consistent w/ Goerss (2007a)

(NM)	GPCE	GPCC	FYE	R34	Swath	GPCE Swath
T12	54	33	35	115	150	172
T24	85	41	55	105	160	219
T36	125	69	75	100	175	236
T48	187	84	95	100	195	311
T72	306	129	140	0	140	332

- 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



Forecast

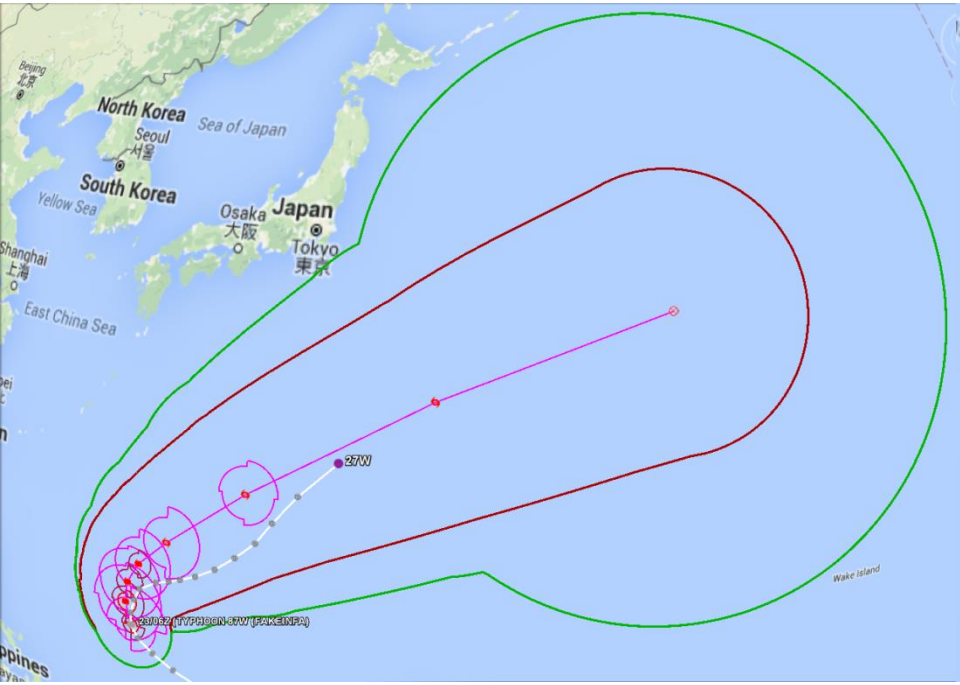


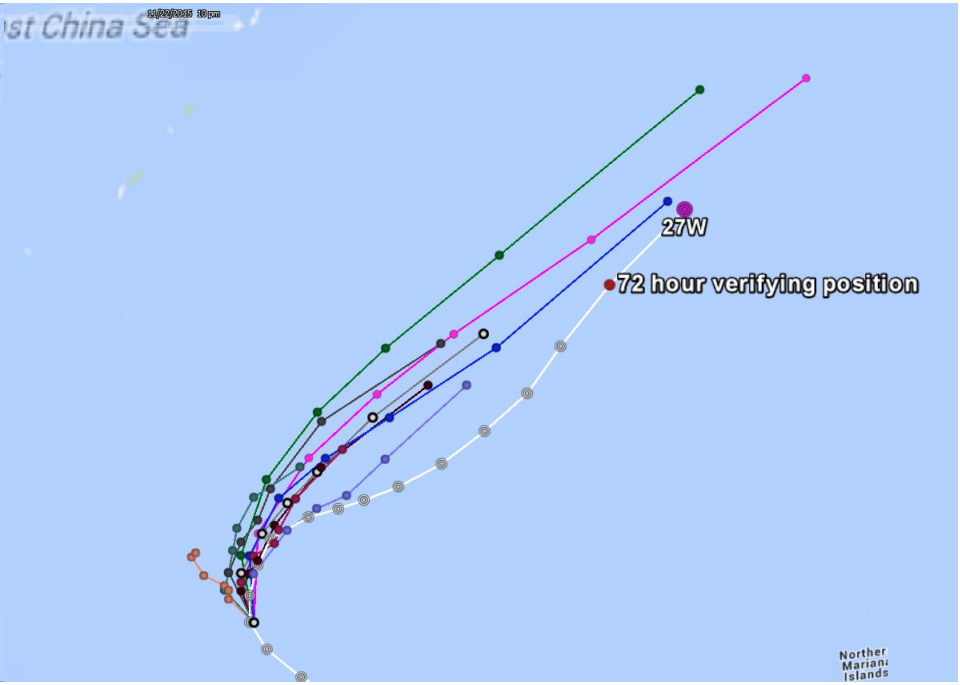
Working Best Track

GPCE >> GPCC

- 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

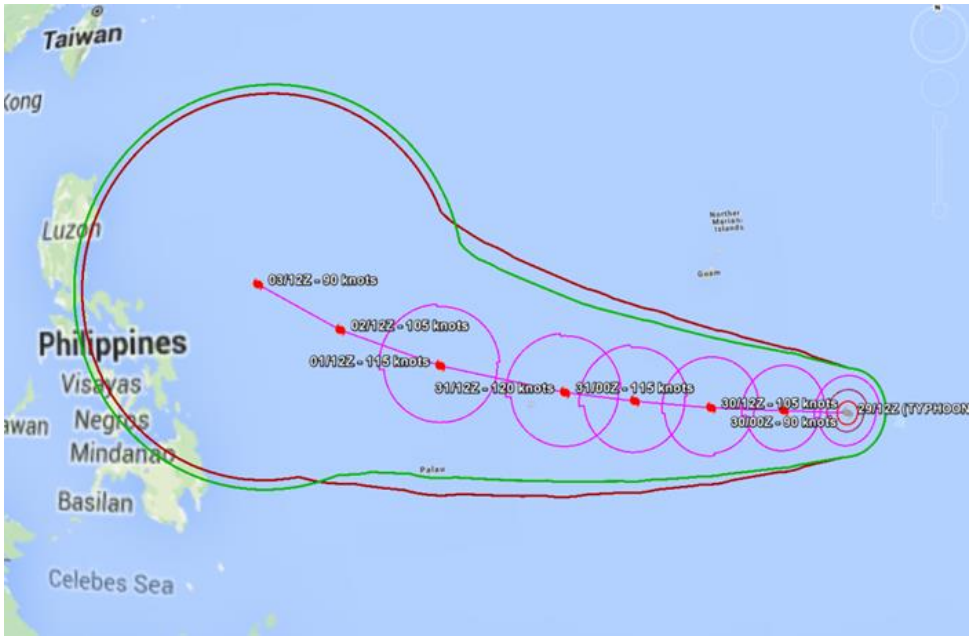
(NM)	GPCE	GPCC	FYE	R34	Swath	GPCE Swath
T12	40	33	35	115	150	157
T24	68	41	55	105	160	196
T36	99	69	75	100	175	208
T48	134	84	95	100	195	252
T72	221	129	140	90	230	330
T96	348	185	190	90	280	447
T120	548	211	280	90	370	817





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

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