COAMPS-TC Status and Future Plans

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JTWC, NHC
COAMPS-TC System Overview

- COAMPS-TC is a specialized version of COAMPS designed to predict tropical cyclone (TC) track, intensity and structure (wind radii)
- Features: TC-following nested grid meshes (4 km on inner mesh, 40L) Specialized TC PBL physics ($C_D$ and PBL); Vortex initialization Coupled with NRL Coastal Ocean Model, NCOM
- Operational at Navy FNMOC since 2013 using NAVGEM BCs (COTC)
- “Real-time” mode at NRL since 2013 using GFS BCs (CTCX)

Vongfong (2014) Simulated Radar Reflectivity

Gaston (07L) (12Z 28 Aug 2016)
• Marked improvements in COAMPS-TC (CTCX) forecasts since 2013
• 2017 version of COAMPS-TC with 4 km horizontal resolution.
  ➢ Intensity MAE improved substantially (~10% over 2016)
  ➢ Forecasts improved for TCs with observed rapid intensification
• CTCX (GFS based) track trails HWRF by less than 25 nm in first 72h (NE bias)
• COTC (NAVGEM based) track trails NAVGEM, CTCX
• WATL: CTCX generally has 0-3 kt greater intensity errors than HWRF
• WPAC: CTCX top performer for intensity
Rapid Intensification
2017 Atlantic, Eastern, and Western Pacific

CTCX, COTC and HWRF exhibit similar skill for rapid intensification (relatively poor)
HFIP High-Resolution Ensemble

- Intensity changes (RI) may not be predictable in a deterministic sense.
- Multi-model ensembles are more capable of accounting for forecast uncertainty.
- Real-time HFIP ensemble: COAMPS-TC (4km), HWRF (3km), HMON (3km).
- COAMPS-TC & HWRF control consensus and ensemble mean outperform their single-model counterparts in deterministic validation.

**Irma (11L), 2017090800 initial time (~60 h before FL Keys landfall)**

**Multi-Model HFIP Ensemble**

**COAMPS-TC/HWRF/HMON**
Ensemble control vs Ensemble mean vs CTCX

**Track:** Ensemble mean similar or better MAE w.r.t. control for most lead times

**Intensity:** Ensemble mean has a lower MAE than CTRL and CTCX through 72h (ATL) and 120h (ATL/EPAC/WPAC)
COAMPS-TC Ensemble System
2017 Real-Time Products

Ensemble forecast products: 24 h intensity change probabilities

*Harvey (09L), 2017082406 initial time (~48 h before TX landfall)*

**COAMPS-TC**

24 h lead time window

| Δ I >= 30 kt (Rapid Intensification) |
| 10 kt <= Δ I < 30 kt (Moderate Intensification) |
| -10 kt < Δ I < 10 kt (Steady Intensity) |
| -30 kt < Δ I <= -10 kt (Moderate Weakening) |
| Δ I = -30 kt (Rapid Weakening) |

TC already dissipated or dissipates during window

**HFIP: COAMPS-TC/HWRF/HMON**

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TC already dissipated or dissipates during window

New product to display the 24h intensity change probabilities

COAMPS-TC Ensemble System
2017 Real-Time Products
10-m wind threshold exceedance probability

COAMPS-TC
- 15L2017, DTG = 2017091912, lt = 0 h, prob (%) 34-kt

COAMPS-TC / HWRF / HMON
- 15L2017, DTG = 2017091912, lt = 0 h, prob (%) 34-kt

Available for 34 kt, 50 kt, and 64 kt thresholds, with both animations as shown above and static images for 120h forecasts

https://www.nrlmry.navy.mil/coamps-web/web/ens?&spg=1
COAMPS-TC Upgrades for 2018
Physics Improvements

- **Track MAE**
  - 5% improvement in MAE averaged over all lead times

- **Intensity MAE (solid) and ME (dashed)**
  - 3% improvement in MAE averaged over all lead times

**New Physics:**
- i) improved shallow cumulus
- ii) snow-ice interaction with Fu-Liou radiation
  - Track improvement is largest in the W. Pacific basin, in part due to reduced NE bias
  - Intensity improved for initially weak TCs - intensifying weak storms more rapidly
  - RI statistics are also improved.

- Experiments underway with improved Kain-Fritsch & Tiedke schemes to address NE bias.
TCs initially of hurricane intensity often have a transient “spin-up” during the first 12 h.

Intensity summary statistics for TCs initially Cat 1 – 3 strength show much improved MAE and bias at 6 h lead time.

- Refinement of the initial intensity perturbations: Eliminates unrealistically large perturbations and unrealistically weak initial intensities.
- Perturbed $C_D$: Introduces additional spread for intense TCs to account for uncertainty in the parameterization of $C_D$.

Intensity variability due *only* to drag coefficient perturbations.
COAMPS-TC

Summary and Future Plans

COAMPS-TC Much Improved for Track & Intensity in 2016/17:

• Improved intensity (ocean coupling; new vortex initialization; new $C_D$ param)
• Multi-model high-res. ensemble (HFIP NOAA/Navy) promising
• Upgrades in 2018: Physics to address spin-up and track NE bias, Ensemble update

Key Gaps:

i. Lack of TC observations
ii. Inadequate data assimilation methods in the TC
iii. Uncertainties in physics
iv. Poor prediction of rapid intensification
v. Insufficient research and operational computing

Future Plans:

• 2018: Physics, initialization upgrades (June 1)
  Transition COAMPS-TC ensemble to ops
• 2019+
  - 4D-Var/hybrid, improved physics, waves
  - New models:
    Convection Permitting COAMPS-TC
    NEPTUNE (~2024)
• Utilize field observations: ONR TCI, HRD
Convection-permitting COAMPS-TC track takes Harvey offshore, closer to best track than nested CTCX. Axis of heaviest precipitation is near the coast instead of inland.