Recent Experiences with Operational Initialization, Prediction and Verification of ACCESS-TC

Noel E. Davidson, Yi Xiao, Zifeng Yu, Ying Jun Chen, Yimin Ma, Beth Ebert, Hui Yu, Xudong Sun, Difei Deng, Xun Li

1. Higher resolution to define the RMW and more accurate initialization of inner-core structures for intense storms. (Rainfall, RI related to environmental wind/shear and inner-core structure)
2. Extend verification to include rainfall, R34, RMW.
3. More attention to Forecast Busts?
4. More attention to initializing the rain field: difficult problem? (Or should it be just a by-product of the initialization?)
5. Need for ensemble prediction for TC structure, rapid intensification and rainfall (HIW)?
The ACCESS Tropical domain with three illustrative ACCESS-TC domains
ACCESS-TC System Specification

• 33.0°x33.0°, relocatable anywhere within 3° of the ACCESS Tropical domain,
• Minimum 3° from ACCESS-TC boundary for initial vortex location
• UM horizontal resolution 12km; Vertical resolution 70 levels up to 80km.
• 4DVAR Analysis horizontal resolution 36km
• Observational data used: same as ACCESS-G. Plus Synthetic MSLP Observations from an idealized vortex.
• Initialization: 5 cycles of 4DVAR over 24-hours
• Daily global 0.25° SST from the Global Ocean Analysis System.
• Nesting inside ACCESS-G (25km global model)
4DVAR:

(a) Defines the horizontal structure of the inner-core at the observed location, \( (CP, VMAX, RMW, R34) \), as best it can!

(b) Builds the vertical structure of the circulation from MSLP obs

(c) Builds the TC boundary layer

(d) Constructs the secondary circulation

(e) Creates a TC circulation at the observed location, with correct (?) structure and intensity

(f) Creates a structure which is responsive to environmental wind shear without imposing constraints on the vertical-stacking or tilt of the circulation. (important for vortex dynamics and cloud asymmetries)
Track Verification of Operational ACCESS-TC: Courtesy of Shanghai Typhoon Institute (Guomin Chen et al., STI)

Quite competitive with, but still lag the skill of forecasts from EC, GFS, UKMO.

Note Outliers <<
Comparative Intensity Verification of Operational ACCESS-TC: Courtesy of Shanghai Typhoon Institute (Guomin Chen et al., STI)

Mean NWP Absolute Intensity Error in 2012

Mean NWP Absolute Intensity Error in 2013

Reference data: as those in track
Forecast Busts:
Systematic Error
Separation of low- and mid-level circulations
Environment?
Vortex Resiliency?
Moist Processes?
Tracker?
Other ....?
FI: Analysis of FBs?
Track Forecasts from available operational systems for Heidi and Iggy (A-TC, EC, UK, JMA, GFS, NGP, GFDN,...... Courtesy J. Courtney, WA TCWC

Heidi: Forecast track outside the envelope of model forecasts
Iggy: Very large spread in model track forecasts

Track forecasting is not a solved problem.
1. Should we devote more attention to Forecast Busts?
### MADs for R34 and RMW: EXBT data sets and ACCESS-TC Vortex Specification from CP and Objective ROCI

Limitations of EXBT: Subjective, difficult, independent, no dynamical constraints

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Conventional rainfall verification for China TC Landfalls
Benchmark Verification: 26 Storms, ~ 100 forecasts
Contiguous Rain Area Verification (Ebert and McBride): New verification results after shift

Error Decomposition, Origin of Errors:
Pattern Displacement Volume Rotation

2. Should we pay more attention to initializing the rain field: difficult problem? Or should it just be a by-product of the initialization?
I: Cloud Bands and Convective Asymmetries

85GHz Imagery (left panels) and ACCESS-TC 500 hPa vertical motion field at $t = 6$ (initialized with 4DVAR) and $t = 55$ hours for Yasi from base time 00Z, 20110131

- Note regions of observed active inner rainbands and eyewall convection, and corresponding forecast regions of strong and weak ascent.
- Based on use of synthetic MSLP obs and 4DVAR, structures are consistent from even the early hours of the forecast.
- Rainfall in TCs (Ying Jun Chen)
Analysis of an ensemble of high-resolution WRF forecasts for the Rapid Intensification of Typhoon Rammasun (2014):
Xun Li, Noel Davidson, Yihong Duan, Zhian Sun and QinBo Cai

Black circle for observed
Red for RI one (member No.9, EN09), blue for SI or weaker one (member No.12, EN12), gray for other members

3. Need for high-resolution ensemble prediction for RI and Extreme Rainfall?
How does environmental shear affect vortex structure and intensification?
At hourly intervals during simulated RI, (a) rain water, (b) 850 hPa and 500 hPa circulation centres (black and blue dots), and (c) radius of maximum wind at 850 hPa and 500 hPa (black, blue circles).

Shear provides favourable down-shear, down-shear-left regions of convective asymmetries. Shear and inner-structure can sometimes create a situation of synchronization between low- and mid- level circulations.

4. Need for accurate initialization of inner-core structure: difficult problem?
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### CRA Verification Lua, Rusty, Christine (72hr rain accum)

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**Systematic Error:** Excessive inner-core rainfall.

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