# Developmental Testbed Center Hurricane Research Activities

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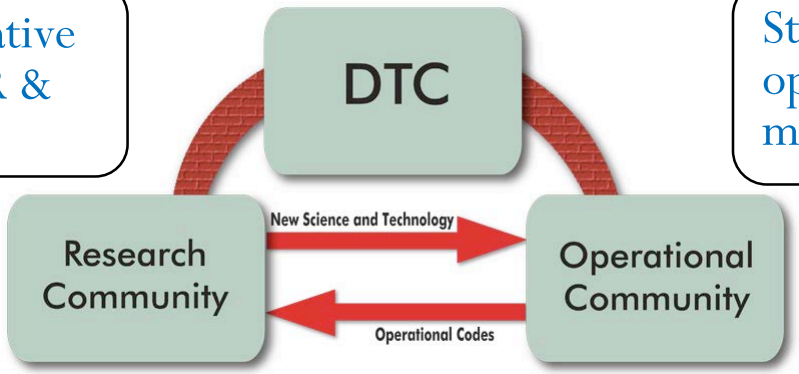
# Overview of the DTC

**DTC purpose**: Facilitate the interaction and transition of NWP technology between research & operations

The DTC is a collaborative facility between NCAR & NOAA/ESRL/GSD




Strong partnerships with operational partners & model developers is critical

**O2R**: Support operational NWP systems to the **community**

**R2O**:

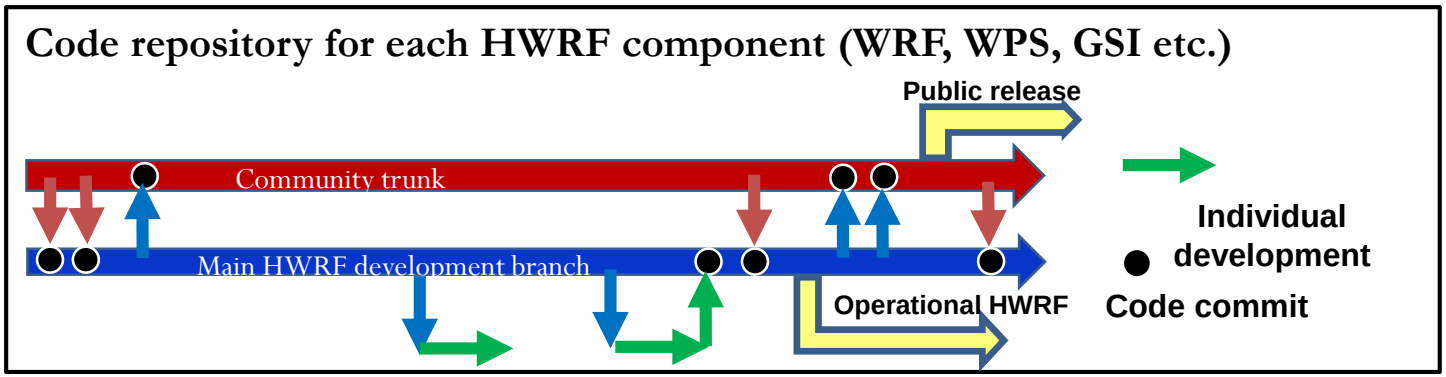
**Partner with developers** to get innovations into **centralized code**

Perform diagnostics and **T&E on promising NWP innovations** for possible operational implementation

**Interaction between R&O**: Workshops, **visitor program**, newsletter

# Code Management

- **Centralized HWRF repository**
  - SVN & Git repositories house all HWRF components
    - Transition to unified GSI (VLab Git) repository
    - Preparation for transition to unified UPP repository (VLab Git)
  - Automated build system, End-to-end python scripts, tools for automation (Rocoto workflow manager), source for components
    - Build system updates for GSI: cmake and build without GSI
  - Maintain integrity of code
    - Perform consistency checks prior to integration into trunk
    - Code merges to avoid divergence with community trunk

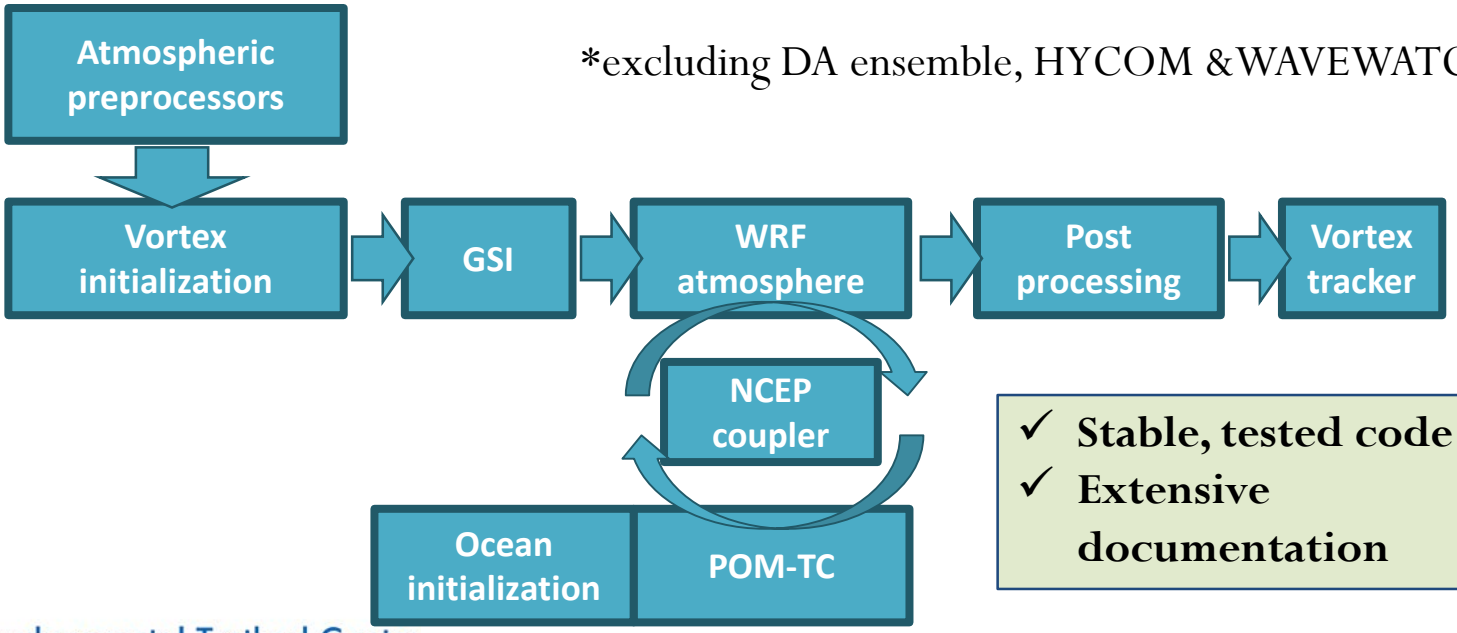


# HWRF Public Release

- **HWRF v4.0a public release**
  - Released November 2018
  - 2018 operational* + research capabilities
    - Idealized TC, alternate physics, previous operational d02/d03 grid sizes, vertical levels/model top & horizontal resolution
    - Alternate & research configurations (i.e.: DA, ocean, input datasets)

**End-to-end atmosphere-ocean coupled HWRF system fully supported**

*excluding DA ensemble, HYCOM &WAVEWATCH III




- ✓ **Stable, tested code**
- ✓ **Extensive documentation**

# GFDL Vortex Tracker Release

- **Stand alone GFDL Vortex tracker**
  - v3.9a* released April 2018
    - Includes code, sample datasets, documentation, helpdesk support
  - Tracker upgraded for use with GRIB2 and NetCDF datasets
  - Updated genesis algorithm

*consistent with HWRFv3.9a (2017 operational) version

# User Support


- Users work with stable yearly release with known capabilities
  - 1700+ registered users
  - Code downloads, datasets, extensive documentation (updated for v4.0a), online tutorial
- Helpdesk:
  - hwrf-help@ucar.edu

**www.dtcenter.org/HurrWRF/users**


- Biswas, M. K., L. Carson, K. Newman, L. Bernardet, E. Kalina, E. Grell, J. Frimel, 2017: Community HWRF Users' Guide V3.9a, *NOAA Technical Memorandum OAR GSD-51*, 160pp. http://doi.org/10.7289/V5/TM-OAR-GSD-51
- Biswas M. K., L. Bernardet, S. Abarca, I. Ginis, E. Grell, E. Kalina, Y. Kwon, B. Liu, Q. Liu, T. Marchok, A. Mehra, K. Newman, D. Sheinin, J. Sippel, S. Subramanian, V. Tallapragada, B. Thomas, M. Tong, S. Trahan, W. Wang, R. Yablonsky, X. Zhang, and Z. Zhang, 2017: Hurricane Weather Research and Forecasting (HWRF) Model: 2017 Scientific Documentation, NCAR Technical Note NCAR/TN-544+STR, doi: 10.5065/D6MK6BPR

# HWRF Residential Tutorial

| HWRF tutorial |
| --- |
| January 23-25, 2018 |
| College Park, MD – NCWCP |


**Lectures from HWRF developers on all aspects of the end-to-end system & hands-on practical sessions**

**13 hours of lecture material and 7 hours of practical experience**

**Past tutorial materials available on DTC webpage, including online practical exercises**

**Tutorial jointly hosted by DTC and EMC**

# Streamlining the Transition of New Developments into HWRF

- The DTC, in collaboration with EMC, provides support for HWRF developers/subject area experts
  - Access to the unified HWRF code repository w/ experimental codes
  - Support for inter-developers collaboration
  - Training, assistance with developments, specialized helpdesk
  - Oversight of code integration to avoid divergence
  - Communication through bi-weekly developer committee meetings, webpage, mailing lists
- Scripting development deemed high priority in collaboration with partners
  - Intercycle data assimilation

# Developer Support

## Sample of recent active developers

- **R. Torn & X. Zhao (U. Albany)**
  - Support for running GEFS-based HWRF ensemble on NCAR's HPC.
  - Assistance to transition developments for implementing SST uncertainty in the GEFS-initialized HWRF ensemble into the HWRF trunk.
- **A. Kren (AOML/HRD)**
  - Support for running HWRF using input data from own GFS input data
- **R. Fovell (U. Albany)**
  - Assistance to migrate MYNN and YSU PBL code into centralized repository, including consistency check
- **G. Alaka (AOML/HRD)**
  - Troubleshooting assistance for basin-scale configuration running in real-time demonstration

# DTC Visitor Program

http://www.dtcenter.org/visitors

Providing support for visitors to work w/ the DTC to test new forecasting & verification techniques, models & model components for NWP

| DTC Visitor Program – Recent hurricane-related work | | |
|---|---|---|
| Dev Niyogi & Subashini Subramanian | Purdue Univ | Developing Landfall Capability in Idealized HWRF for Assessing the Impact of Land Surface on Tropical Cyclone Evolution (2016) |
| Robert Fovell | SUNY-Albany | Impact of Planetary Boundary Layer Assumptions on HWRF Forecast Skill (2016) |
| Shaowu Bao | Coastal Carolina Univ | Evaluation of the microphysics scheme in HWRF 2016 version with remote-sensing data (2016) |
| Ting-Chi Wu | Colorado State Univ | Evaluation of the Newly Developed Observation Operators for Assimilating Satellite Cloud Precipitation Observations in GSI within HWRF system (2017) |
| Michael Iacono & John Henderson | AER | Testing Revisions to RRTMG Cloud Radiative Transfer and Performance in HWRF (2016)<br>Testing Variations of Exponential-Random Cloud Overlap with RRTMG in HWRF (2017) |
| Jun Zhang | U. Miami and HRD | Evaluating the Impact of Model Physics on HWRF Forecasts of Tropical Cyclone Rapid Intensification (2017) |

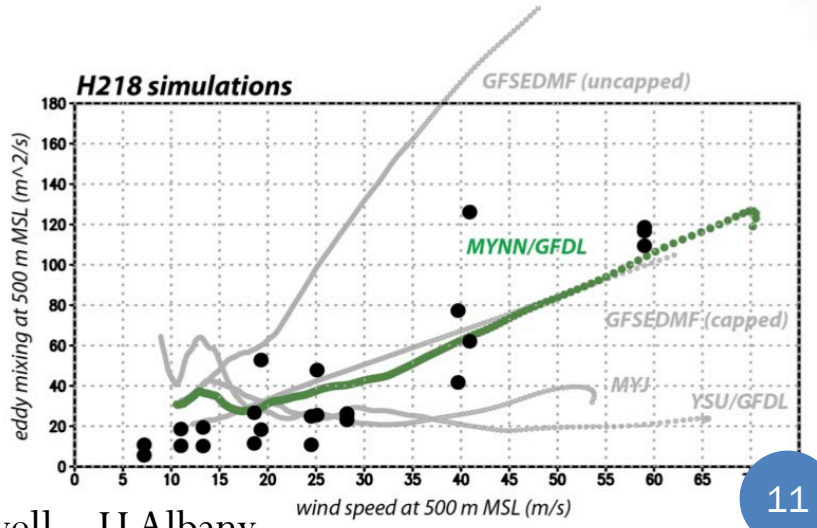
Research funded via DTC visitor program successfully contributing to HWRF development, HFIP goals

# R. Fovell (SUNY-Albany)

Development supported by DTC Visitor Program

- Development to enhance HWRF to run using YSU and MYNN PBL schemes with operational GFDL surface layer
  - Testing conducted (Idealized by R. Fovell, pre-implementation by EMC) to assess impact on HWRF forecasts
- Facilitated connection between research and operational partners
- DTC merged code into HWRF trunk

Capability integrated into HWRF trunk, available within HWRF v4.0a public release



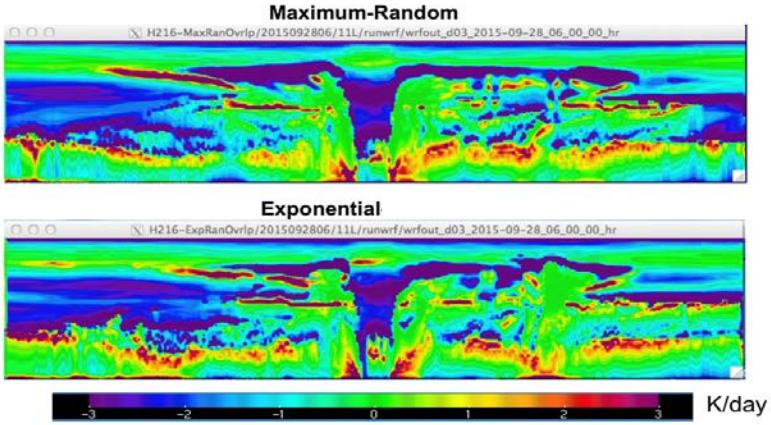

Courtesy R. Fovell – U Albany

# M. Iacono, J. Henderson (AER)

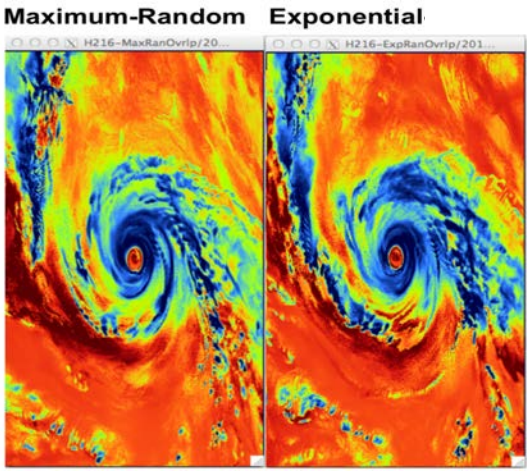
Development supported by DTC Visitor Program

- Development to add an exponential cloud overlap (EXP) assumption within RRTMG to HWRF
- Additional development to add exponential-random (ER) assumption and options for varying decorrelation length
- DTC provided development support and integrating code into trunk

**Radiative Heating Rates - LW**




**Radiative Heating Rates - SW**




Hurricane Joaquin; Courtesy Iacono & Henderson - AER

# DTC T&E: Physics Advancements

***Testing & evaluation activities with focus on impact of physics parameterization innovations***


- **Grell-Freitas cumulus**
- **RRTMG radiation**
  - Partial cloudiness modifications
  - Alternate cloud overlap assumptions

Testing during HWRF operational pre-implementation in collaboration with EMC and HRD partners

✓ Partial cloudiness modifications implemented in **2016 & 2017 HWRF**

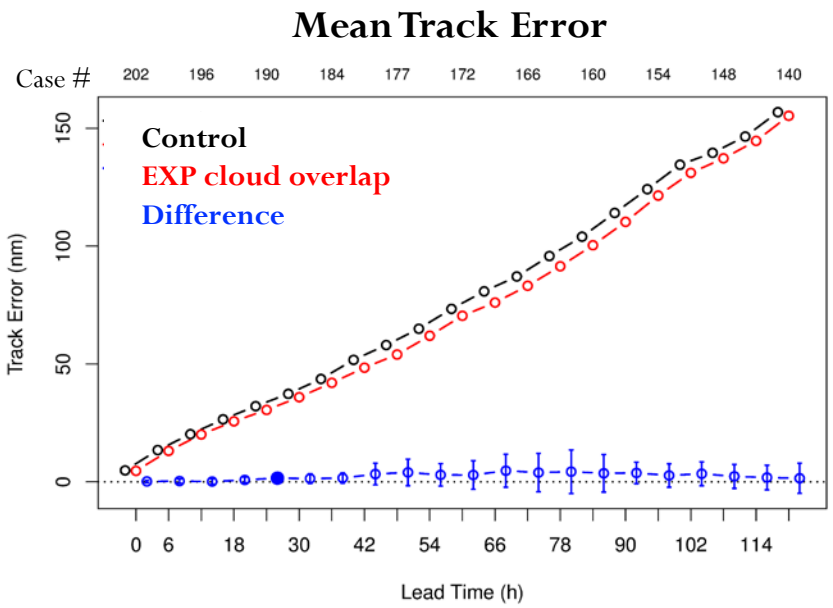
**R2O**

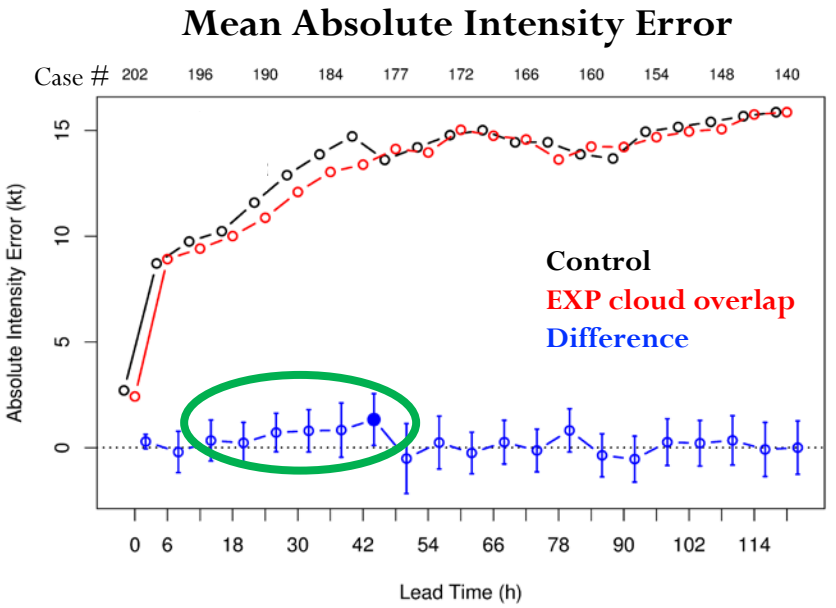
✓ EXP cloud overlap assumption implemented for **2018 HWRF**



Primarily supported by NOAA OAR

# RRTMG: Exponential Cloud Overlap

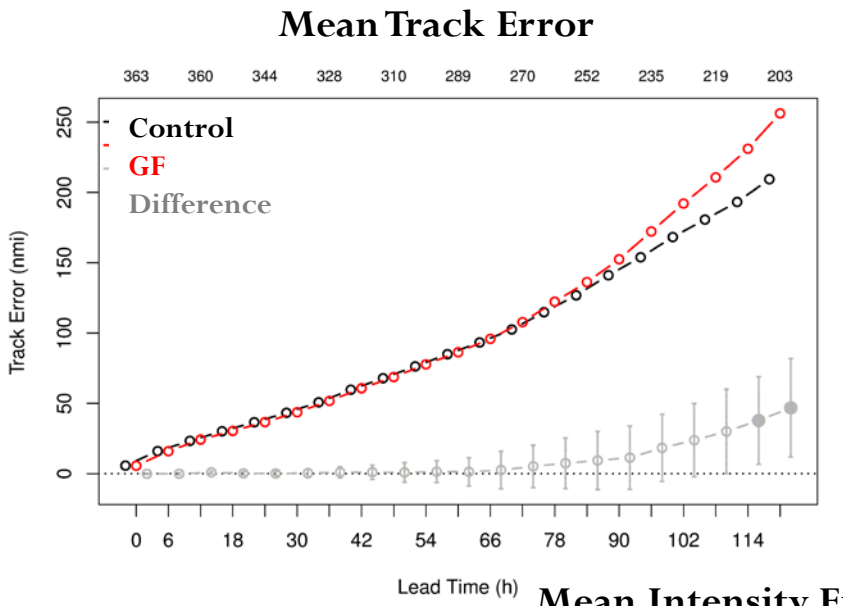


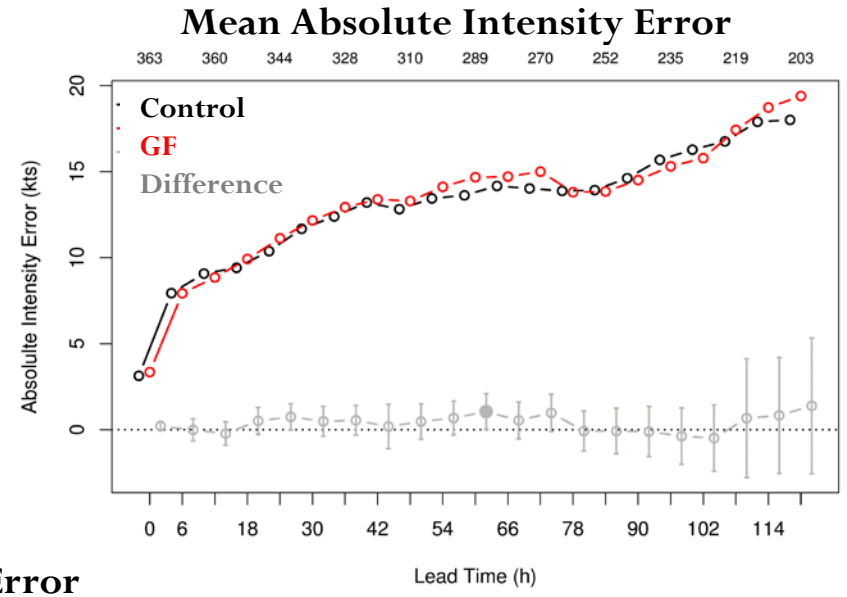




- Examined effect of replacing the default maximum-random (MR) with an exponential cloud overlap (EXP) assumption
  - Improved hurricane track and intensity forecast – intensity out to 2 days
- Follow-up project implementing exponential-random (ER) cloud overlap underway

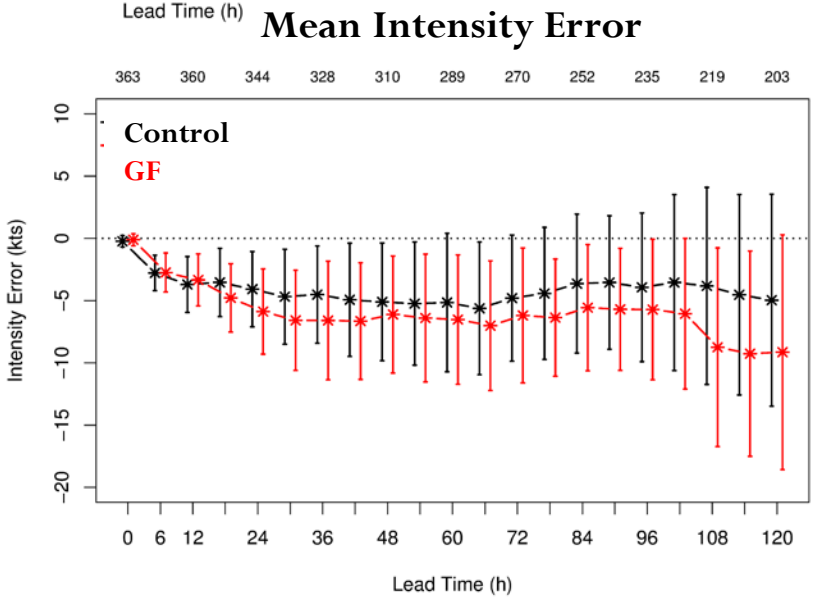
Accepted for 2018 operational HWRF

# Grell-Freitas cumulus




Storms:
Fred, Fiona, Hermine, Harvey, Irma, Kate, Jose, Nicole, Maria, Nate, Ophelia




**Degradation in track forecasts** for GF configuration at longest lead times

**Neutral intensity errors** differences between the GF and SASAS

**Negative intensity bias** present in both configurations

# Future plans

- Ongoing code management and maintenance of unified code
- Continued user & developer support
  - Support for public release and active HWRF developers (HFIP PIs)
  - Continued partnerships with DTC Visitor Program PIs
- R2O potential through T&E (physics advancement)
  - Mellor-Yamada Nakanishi Niino (MYNN) PBL scheme
  - Grell-Freitas cumulus scheme: tuning and/or with MYNN
  - Exponential-random cloud overlap for RRTMG
- Looking ahead to HAFS