

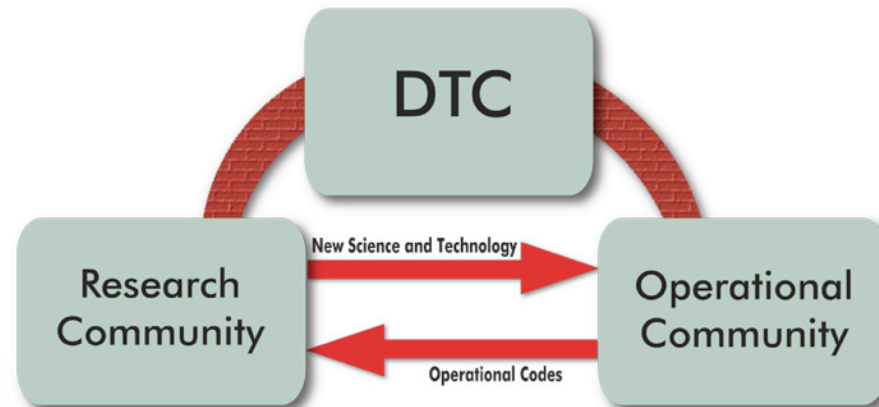
# DTC's support for NWP 02R20

Bill Kuo and Louisa Nance



# What is DTC?

- **Purpose:** Facilitate the interaction & transition of NWP technology between research & operations
  - **O2R:** Support operational NWP systems to the community
  - **R2O:** Perform T&E on promising NWP innovations for possible operational implementation
  - **Community:** Visitor Program, Workshops, Newsletter
- Jointly sponsored by NOAA, Air Force, NSF, & NCAR



# Software Systems

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Framework for bringing together operational capabilities and research innovations to accelerate the transition of new technology into operations by facilitating carefully-controlled extensive T&E

Close collaboration between DTC & developers  
is critical to the success of this work!

# Software system philosophy

- Shared resource w/ distributed development that includes capabilities of current operational systems
- On-going development maintained under mutually agreed upon software management plan
- Periodic releases made available to the community that include latest developments of new capabilities & techniques
- Centralized support (**in collaboration with developers**)
  - Software downloads
  - Documentation
  - Tutorials (online and onsite)
  - Email helpdesk

# HWRF developer support

- J. Michalakes (EMC) - WRF nest parallelization for multistorm
- X. Zhang (HRD)- End-to-end multistorm implementation
- X. Wang (OU) - Regional HWRF EnKF
- R. Fovell and P. Bu (UCLA) - WRF physics diagnostics, testing & development
- J. Otkin (CIMMS)- Synthetic satellites added to UPP
- R. Yablonsky (URI) - MPIPOM-TC diagnostics & initialization in global basins
- H.-S. Kim (EMC) and HFIP ocean team - Diagnostic codes distributed through DTC's *hwrf-contrib* repository
- G. Grell and E. Grell (ESRL) - Grell-Freitas cumulus parameterization
- S. Bao (Coastal Carolina University) – diagnostic tools for evaluating HWRF using satellite brightness temperature
- S. Subramanian (Purdue) – Addition of simulated landfall to idealized HWRF

- Repository access
- Developer website
- Training: Rocoto, code management
- Bi-weekly telecons
- Helpdesk
- **Primary goal - facilitate R2O!**

# Work towards advancing capabilities

- **WRF**
  - Hybrid vertical coordinate
  - SPP option for PBL MYNN & RUC LSM
- **HWRF**
  - Idealized capability, including land-fall
  - Physics
    - Improvements to PBL physics to complement use of RRTMG radiation
    - Scale-aware RH-based partial cloudiness scheme (ongoing improvements)
    - Alternate cloud overlap methodology for RRTMG radiation
    - Grell-Freitas cumulus parameterization
  - Multi-storm configuration
  - Ocean-coupling for all ocean basins (MPIPOM-TC), plus alternate initialization data sets & diagnostic tools
  - Unified scripting & automation
  - Hwrf-contrib repository for inter-developer exchange of codes
    - Scripts for GOES satellite verification
  - Nest parallelization modifications to improve run-time efficiency
- **UPP**
  - New microphysics-specific reflectivity output fields
  - Synthetic satellite fields
  - GRIB2 support
- **GSI/EnKF**
  - Capability to assimilate satellite aerosol optical depth & particulate matter 2.5 & 10 mm
  - CMAQ & WRF-CHEM interfaces
  - Added functions to enhance 4DVar for ARW w/ RAP/HRRR sfc DA configurations
  - Capability to use sub-hourly obs, ensemble & background (available for testing)
  - Capability to use ARW hybrid vertical coordinate
  - Unified multiple-platform build system
  - Improved diagnostic & display utilities, such as new utility function to generate ensemble initial files for regional ARW.
  - Improved forward observation operator for coastline observations
- **MET**
  - Numerous improvements

# New areas of development

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NWP software containers

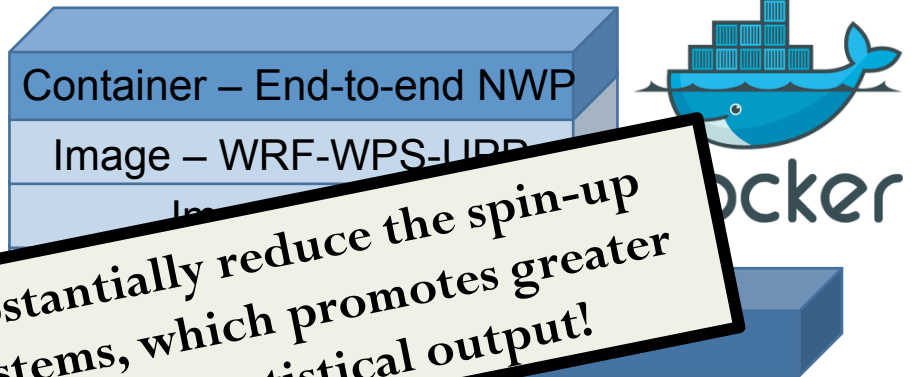
Common Community Physics Package

Physics Testbed

# Enhancing community collaborations through NWP software containers

## Why use containers in NWP?

- ✓ Containers allow for software systems to be bundled (including operating system, libraries, code, and executables) and provided directly to users
- ✓ A frequent stumbling block is the problem of running software on different operating systems!
- ✓ Advantages:
  - Highly portable
  - Use in cloud computing
  - Easily sharable with other collaborators
  - Easy to replicate procedures and results



**Ultimately, containers will substantially reduce the spin-up time for setting up software systems, which promotes greater efficiency in producing model and statistical output!**

## Who is interested in containers?

- ✓ Graduate & undergrad students
- ✓ University faculty
- ✓ Researchers
- ✓ Tutorial participants



# Enhancing community collaborations through NWP software containers

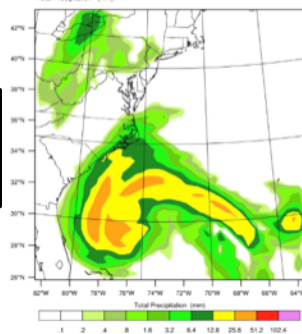
## What is in DTC containers?

- README files for building Docker images & running code components
- Run scripts for WPS, WRF, UPP & MET
- Necessary namelist & configuration files
- Case-specific data (ICs, BCs & verification data)

## Current case inventory:

- Two cases w/ full datasets
  - Hurricane Sandy (6-h forecast)
    - 40-km domain centered over East Coast
  - 29 June 2012 derecho (24-h forecast)
    - 12-km parent domain w/ 3-km nest

Total precipitation (mm)  
Hurricane Sandy forecast



## *AMS Short Course*

*6 January 2018*

*(Saturday prior to Annual Meeting)*

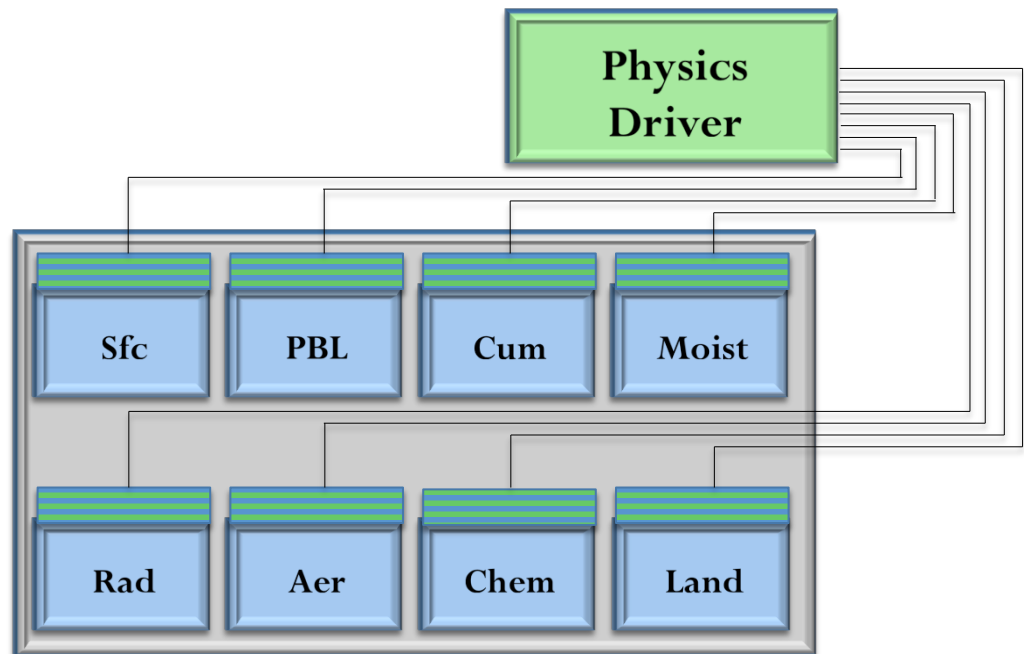
## Goals and objectives:

- ✓ Raise awareness about tools available to the community for testing & evaluating NWP, including the emerging set of software tools in Docker containers
- ✓ Provide a general overview of the NWP system components available in Docker containers (WPS/WRF, UPP, MET, METViewer)
- ✓ Conduct hands-on learning experience of running an end-to-end NWP system through specific usage examples

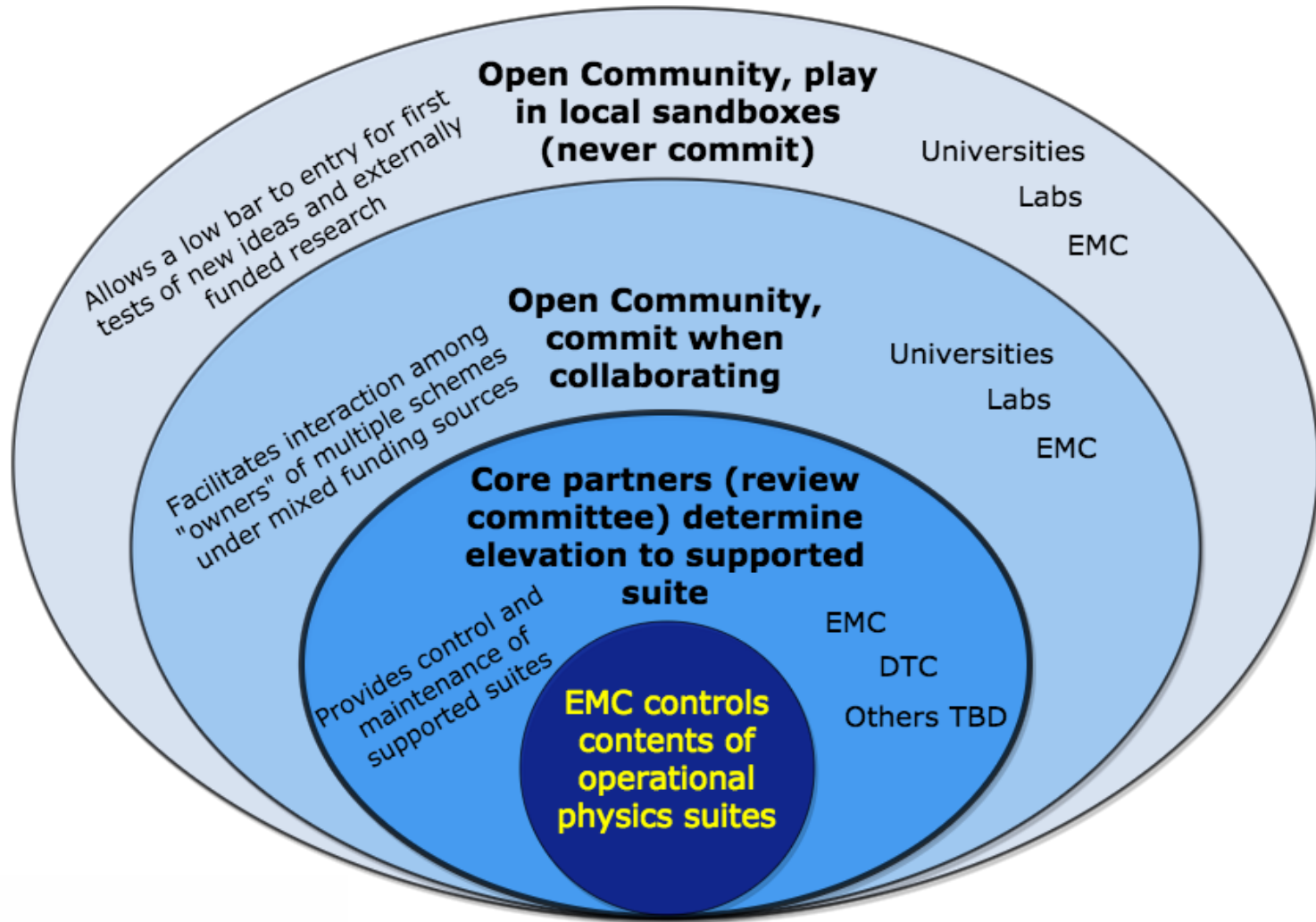
# What is the Common Community Physics Package (CCPP)?

CCPP is a collection of **dycore-agnostic** physical parameterizations. Software can contain multiple schemes for each type (PBL, cumulus etc.) to support various applications (high-res, climate etc.) and maturity level (operational, developmental).

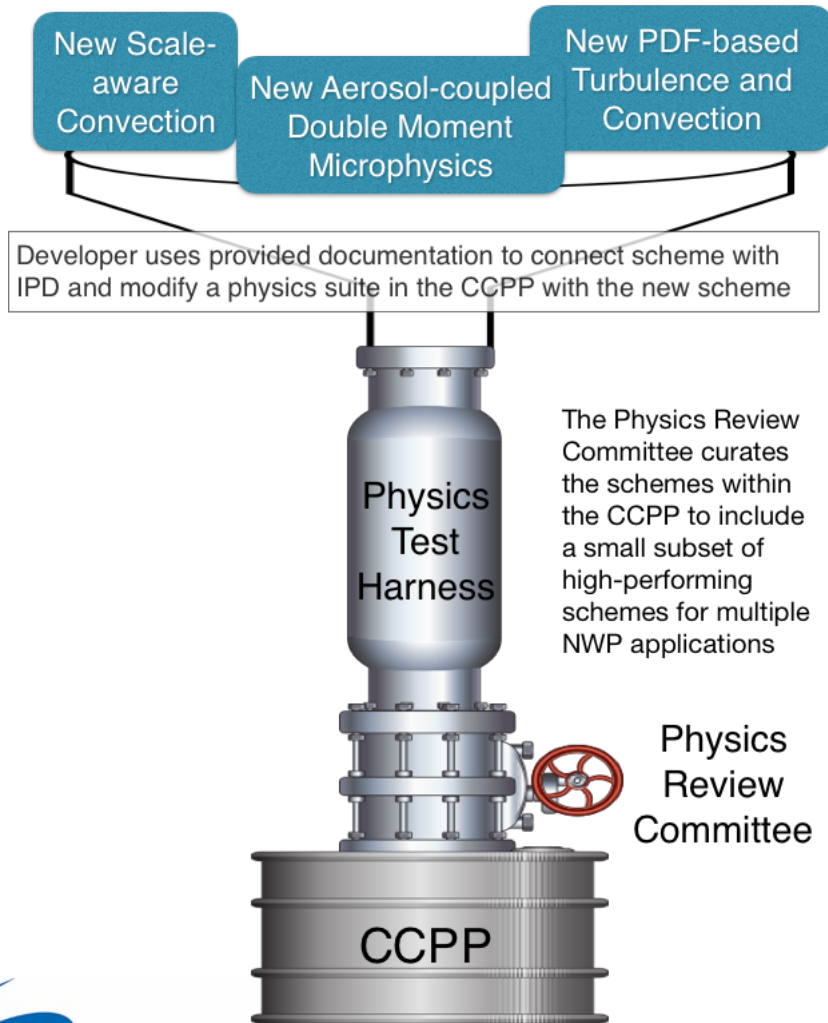
**Dycore agnostic:**  
Parameterizations  
can be used with any  
dycore



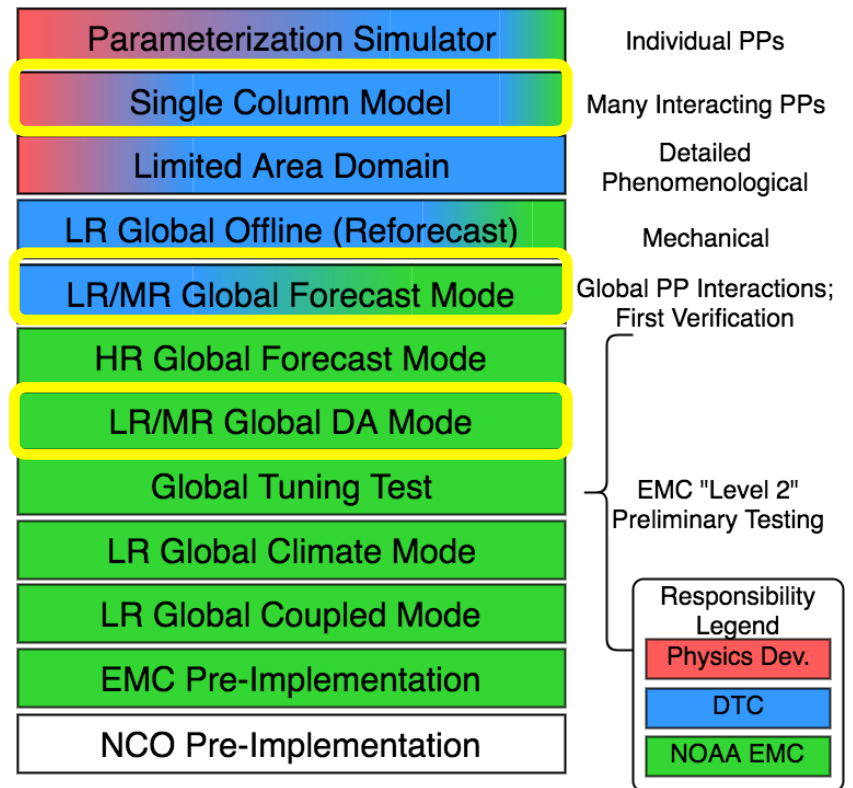
# CCPP ecosystem



# Process supported by GMTB



## GMTB/EMC Testing Hierarchy



# Community Outreach

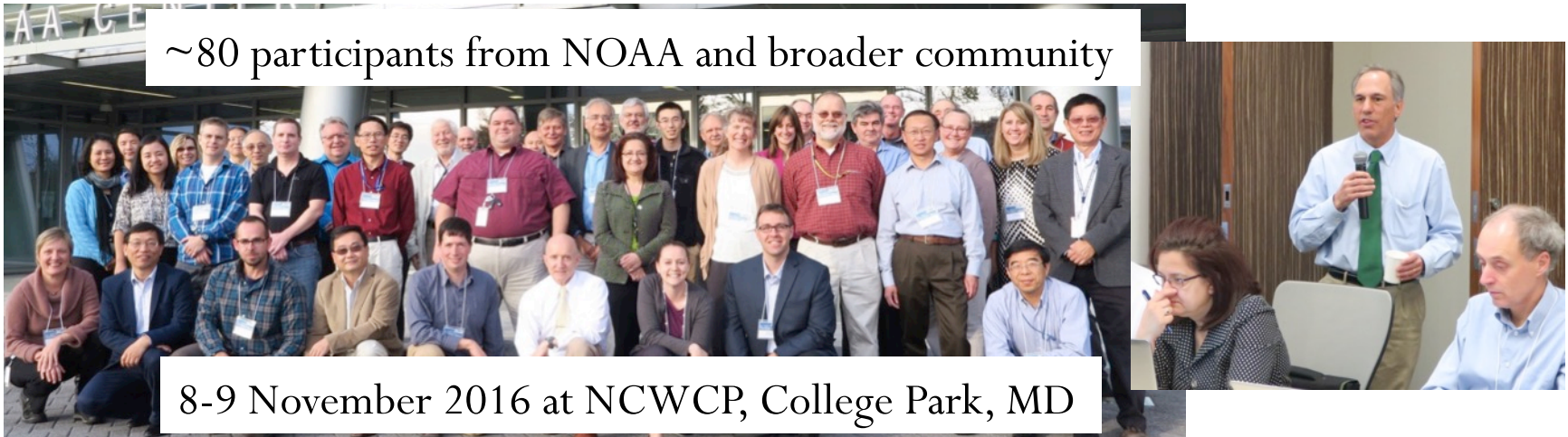
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Important mechanism for bringing together research and operations to discuss how to work together to advance NWP

# DTC-sponsored events 2014-2017

- Mesoscale Modeling
  - Annual WRF Users Workshop (June 2014-2017)
  - Parameterization of Moist Processes for Next Generation Weather Prediction Models Workshop (2015)
  - MMET instructional session at WRF Users Workshop (June 2015, June 2016)
- Hurricanes
  - Workshop on Numerical Prediction of Tropical Cyclones (May 2014)
  - HWRF instructional session at WRF Users Workshop (June 2015)
- Ensembles
  - 6<sup>th</sup> NCEP Ensemble User Workshop (March 2014)
  - 7<sup>th</sup> NCEP Ensemble User Workshop (June 2016)
- Global
  - MPAS Workshop (September 2014)
  - The Future of Statistical Post-Processing in NOAA and the Weather Enterprise (Jan 2016)
  - NGGPS Community Sea Ice Model Recommendation Workshop (Feb 2016)
  - NGGPS Physics Workshop (Nov 2016)

# NGGPS Atmospheric Physics Workshop



~80 participants from NOAA and broader community

8-9 November 2016 at NCWCP, College Park, MD

## Goal:

Refined investment strategy -

- Recommendations on highest priority physics dev
- Process for setting priorities
- Framework for community collaborate

## Basic recommendations:

- Need transparent process for making decisions
- Evaluation criteria for physics schemes should include:
  - Forecast performance
  - Potential for advancement

# DTC Visitor Program

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Framework for engaging the research community in projects directed at improving NWP, with an eye towards eventually improving operational forecasts



# DTC Visitor Program

- Supports visitors to work w/ the DTC to test new forecasting & verification techniques, models & model components for NWP
  - PI project – up to 2 months salary & travel & per diem
  - Graduate student project - up to 1 yr temp living per diem stipend & travel expenses for student to work w/ DTC &/or one of its partners + travel & per diem for up to 2 2-wk visits to the location of the student by project PI
- Selection process
  - **Call for proposals open year-round**
    - Focus areas based on input from Task Leads
    - Task Leads encouraged to actively pursue connections with research community
  - Proposals reviewed by DTC staff and Science Advisory Board & approved by DTC Management Board
  - Select appropriate DTC staff member to serve as host for each project

# DTC Support for O2R20

- Community support for WRF (partner with NCAR/MMM), HWRF, UPP, GSI/EnKF, and MET, including:
  - Code management and documentation
  - Tutorial (in person and online)
  - Helpdesk
  - Making code available through container
- Developer support for HWRF
  - Repository access
  - Special training
- Datasets for cases important for operation
- Global Model Test Bed (GMTB) support for Community Common Physics Package – under development
- Visitor Program
- Community workshops on focused themes

# Lessons learned from O2R2O

- Effective O2R (community and developer support) is critical to engage academic community in R2O
- O2R2O needs to be a fully integrated process to be effective:
  - Integrated team including PI, DTC, and EMC, each is properly resourced
  - Project coordination from the very beginning (not a 'throw over the fence' approach)

# Thank you!



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