Developmental Testbed Center: Facilitating R2O for Numerical Weather Prediction

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1. National Center for Atmospheric Research
2. NOAA Earth System Research Laboratory

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What is the 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
  - **Interaction between R & O**: Workshops, Visitor Program, Newsletter
- Jointly sponsored by NOAA, Air Force, NSF, & NCAR

Distributed facility:
NCAR & ESRL
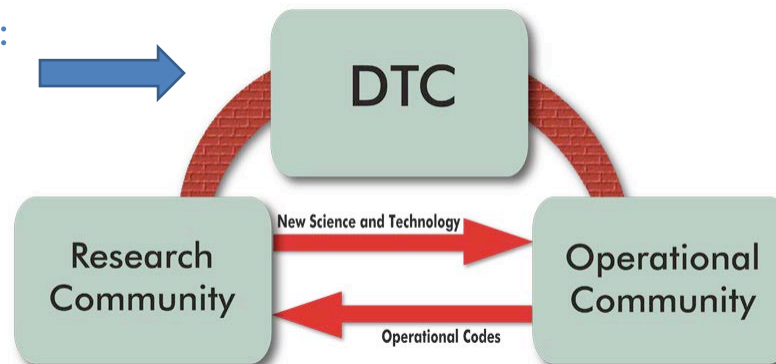
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Software Systems

➢ Include capabilities of operational system
➢ Distributed development
➢ Code management plans

Verification Tools

Past foci:
mesoscale modeling, hurricanes, data assimilation & ensembles

Testing and Evaluation

➢ Diagnostics of current operational systems
➢ Performance of new innovations

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Software Systems

➢ Include capabilities of operational system
➢ Distributed development
➢ Code management plans

Verification Tools

Future outlook:
Regional ensembles, hurricanes, data assimilation and global – with emphasis on physics
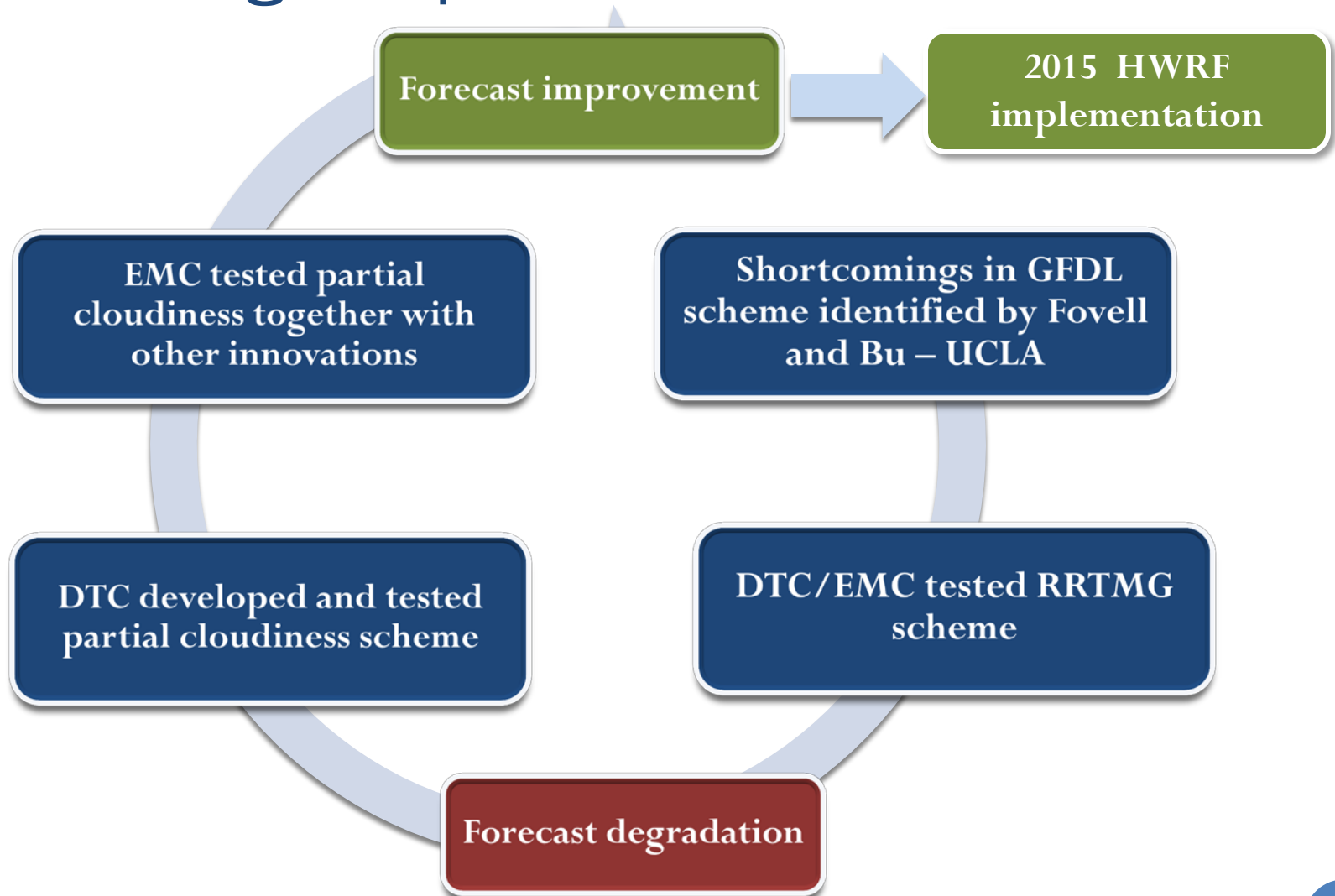
Testing and Evaluation

➢ Diagnostics of current operational systems
➢ Performance of new innovations

Examples of how the DTC is engaging the research community

In the context of

- T&E feedback loop, including new/modified capabilities and diagnostic tools
- Providing assistance to community developers
- Workshops
- Providing framework for research community T&E
- DTC Visitor Program

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DTC's role in HWRF development: connecting the pieces

Forecast improvement → 2015 HWRF implementation

EMC tested partial cloudiness together with other innovations

Shortcomings in GFDL scheme identified by Fovell and Bu – UCLA

DTC developed and tested partial cloudiness scheme

DTC/EMC tested RRTMG scheme

Forecast degradation

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Assisting community with software system contributions

- J. Otkin's team at U. Wisconsin CIMSS (HFIP grant) added innovations to UPP – the NCEP Unified Post Processor, used by all NCEP models

- DTC's role

  - Connect U. Wisconsin team with UPP and CRTM developers at NCEP for planning

  - Assist U. Wisconsin team with incorporating developments into HWRF code repository

- Added sensors for synthetic satellite images

  - GOES-13 and GOES-15 imagers, channels 2-5

  - (MSG) SEVIRI imager , channels 5-11

  - (F13-15) SSMI, channels 1,2,4,5,6,7

  - (F16-F20) SSMIS, channels 9,12,13,15,16,17,18

- Improved computation of hydrometeor effective radii

- User configuration files simplified

Simulated TMI 37 GHz H Brightness Temperature (3 km FCST valid 2012102412)
a) Ferrier constant effr_rain
b) Ferrier variable effr_rain
c) Thompson constant effr
d) Thompson variable effr

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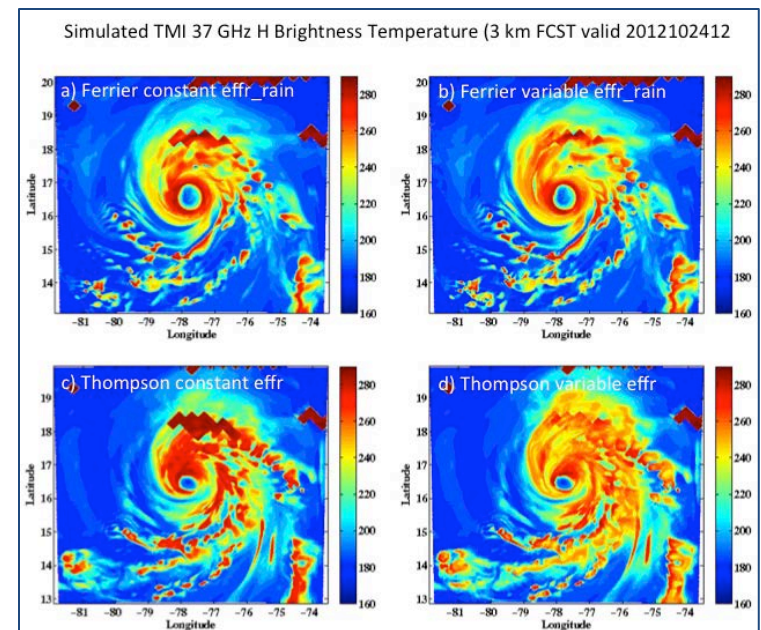
Workshop on Parameterization of Moist Processes for Next-Generation NWP Models

Goal: Inform & advise the future directions of moist process parameterization development, w/ emphasis on NWP applications for scales & resolutions ranging from synoptic-scale to convective permitting scale

Organizing committee: Jamie Wolff (DTC), Yu-Tai Hou (EMC), Jim Doyle (NRL), Robert Pincus (CIRES)

27-29 January 2015 @ NCWCP, College Park, MD

80+ scientists from leading centers around the world

In-depth discussions on state-of-the-science and current operational status at NCEP for microphysics, sub-grid scale clouds and turbulence, and deep convection
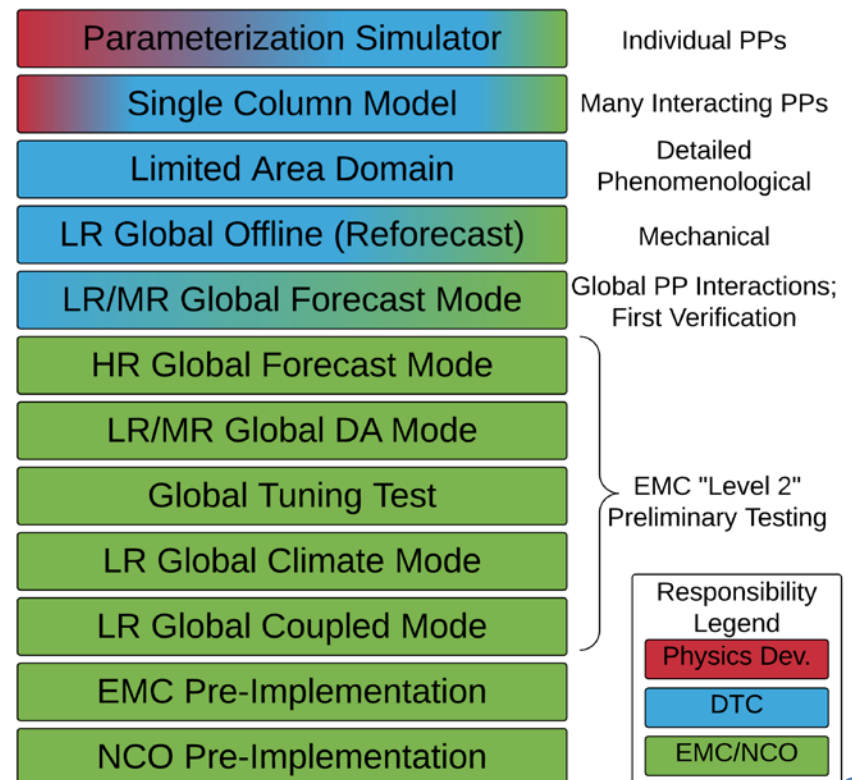
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8

Testing Frameworks

Mesoscale Model Evaluation Testbed (MMET)

- Database containing data sets for performing T&E for key events that demonstrate weaknesses in current operational models
  - Model input and output
  - Observation datasets
  - Verification statistics for operational baselines
- Potential future outlook –
  - Stronger connections with EMC's Model Evaluation Group
  - More extensive information about model issues and avenues of investigation

Physics Testbed

GMTB/EMC Testing Hierarchy

Stage	Description
Parameterization Simulator	Individual PPs
Single Column Model	Many Interacting PPs
Limited Area Domain	Detailed Phenomenological
LR Global Offline (Reforecast)	Mechanical
LR/MR Global Forecast Mode	Global PP Interactions; First Verification
HR Global Forecast Mode	
LR/MR Global DA Mode	
Global Tuning Test	EMC "Level 2" Preliminary Testing
LR Global Climate Mode	
LR Global Coupled Mode	
EMC Pre-Implementation	
NCO Pre-Implementation	

Responsibility Legend

Physics Dev.	
DTC	
EMC/NCO	

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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 year temporary 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-week visits to the location of the student by project PI
- Looking for **subject-matter-experts** to collaborate with DTC on T&E activities
- Also welcome proposals employing MMET cases to investigate avenues for addressing known weaknesses of operational systems
- Currently accepting proposals – funding is available!

http://www.dtcenter.org/visitors/

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Current DTC Visitor Project

D. Niyogi	Purdue	Improving WRF Weather Forecast through Enhanced Representation of Cropland-Atmosphere Interactions
J. Bedard	U of Quebec - Montreal	Implementation and validation of a geo-statistical observation operator for the assimilation of near-surface winds in GSI
T. Galarneau	NCAR	Diagnosing Tropical Cyclone Motion Forecast Errors in the 2014 HWRF Retrospective Test (H214)
M. Iacono	AER	Testing Revisions to RRTMG Cloud Radiative Transfer and Performance in HWRF
P. Roebber	U of Wisconsin-Milwaukee	Demonstration Project: Development of a Large Member Ensemble Forecast System for Heavy Rainfall using Evolutionary Programming
J. Otkin	U of Wisconsin-Madison	Object based verification for the HRRR model using simulated and observed OES infrared brightness temperatures
G. Mulledore	U of North Dakota	Mesoscale Model Intercomparison at Convection-Allowing Resolution using MODE

Graduate student project

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Mesoscale Modeling

Data Assimilation

Hurricanes

Ensembles

Verification

Graduate student project

DTC T&E activities

Current

- Mesoscale modeling
  - MMET
  - HRRR enhancements T&E
- Data Assimilation
  - Regional ensemble-based and hybrid T&E (RAP-based)
- Hurricanes
  - HWRF physics advancement
- Ensembles
  - Testing of stochastic physics for use in NARRE (ARW-based)
- Global
  - GFS physics diagnostics

Potential future activities

- Regional ensembles
  - MMET
  - Storm-scale ensemble evaluations in collaboration with HWT
  - Addressing model uncertainty through stochastic parameter perturbations within the HRRR ensemble
  - T&E of smoothed terrain-following coordinate in WRF
- Data assimilation
  - High resolution (3 km) EnVar
- Hurricanes
  - HWRF physics advancement

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