Research-to-Operations Transition of Process Understanding to Operational Model Development

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August 5th, 2015

Outline

1) **NOAA Climate Test Bed (CTB) Overview**

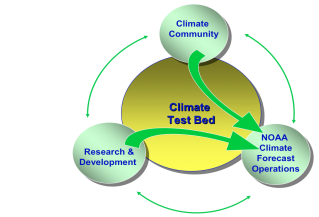
2) **CTB efforts to transition process studies to operational models**
   - **Ongoing projects**
   - **New opportunities**

NOAA Climate Test Bed (CTB) Overview

Mission: Advancing operational climate monitoring, models, and prediction capabilities

- **CTB is a joint effort of NOAA NCEP and Climate Program Office (CPO)**
  - NCEP employees
  - Grants projects funded by CPO/MAPP Program and also NWS/NGGPS fund.

- **CTB Priorities**
  1. Multi-model ensembles
  2. Climate Forecast System (CFS) improvements
  3. Climate forecast products
  4. Climate-quality reanalysis



Mission: To accelerate the transition of scientific advances from the climate research community to improved NOAA climate forecast products and services.

http://www.cpc.ncep.noaa.gov/products/ctb/

- Accelerate **research-to-operations (R2O)** transition to improve NCEP operational climate prediction
- Provide **operations-to-research (O2R)** support to the climate research community with access to operational models, forecast tools and datasets

CTB Priority: CFS Evaluation and Improvements

To accelerate evaluation of and improvements to the operational Climate Forecast System (CFS) and to enhance its use as a skillful tool in providing NCEP's climate predictions and applications

(1) Support R2O testing/demonstration grants projects

- Test and evaluate new parameterizations, schemes, model components in NCEP operational models
  - In off-line and coupled modes
- Five (5) ongoing modeling projects

(2) Engage the external community

- Organized CFSv2 Evaluation Workshop
- Led the publication of the Special CFSv2 Collection in Climate Dynamics (23 articles)
- Developed a CFSv3 Vision document
- Leading MAPP Climate Model Development Task Force with a focus on NCEP/CFSv3 development in 2014-2016

Climate Forecast System V2
Coupled A-O-L-S

Implementation Date: 30 March 2011

Atmospheric Model
GFS (2007)
T126 (~100KM) 64 levels
Deep/Shallow convection, orographic forcing, gravity drag, radiation, co2…

4-LAYER Noah **L**and Model
Vegetation, soil, frozen physics …

3-LAYER **S**ea ice Model

Ocean Model
MOMv4
fully global
1/2°x1/2° (1/4° in tropics)
40 levels (4737M)

Improving NCEP CFS through Enhancing the Representation of Soil-Hydrology-Vegetation Interactions

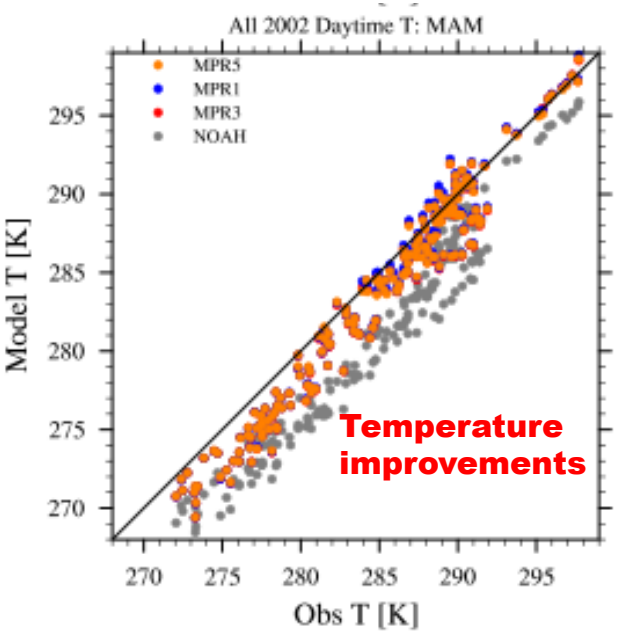
"CFS/Noah-MP development"

NCAR: **Fei Chen,** Michael Barlage
UT-Austin: Zong-Liang Yang
NCEP/EMC: Michael Ek, Rongqian Yang and Jesse Meng

- **Multiple Physics (MP)** to treat key hydrology-snow-vegetation processes paradigm in a single land modeling framework:
  - Canopy turbulence (2 schemes)
  - Canopy radiation (3 schemes)
  - Canopy resistance (2 schemes)
  - Frozen ground physics (2 schemes)
  - Snow physics (2 schemes)
  - Runoff/water table (4 schemes)
- **Project Goal**: Incorporate Noah-MP into CFSv2 to enhance the representation of the soil –hydrology-vegetation interactions

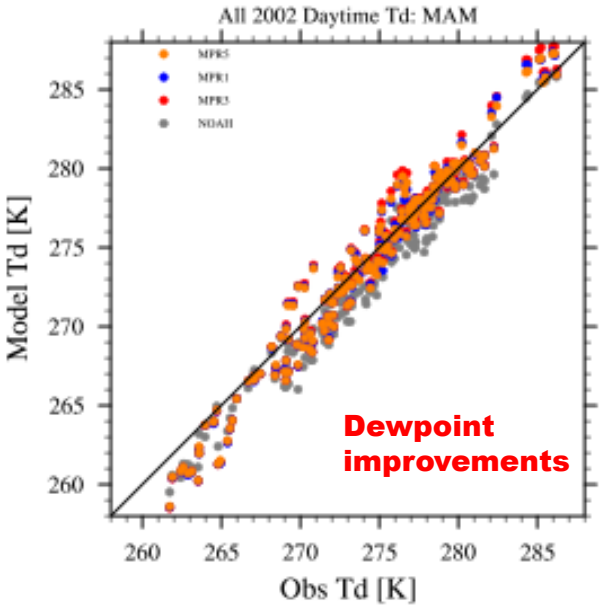
WRF Noah-MP 6-month Seasonal Simulations

- Noah-MP model significantly decreases the Noah model cold and dry bias
- Inclusion of groundwater interaction slightly improves small warm/dry bias of Noah-MP with no groundwater



Daytime temperature/dewpoint results for MAM 2002

	T bias	T RMSE	Td bias	Td RMSE
Noah	-3.0	5.0	-0.5	1.2
Noah-MP	0.5	2.2	-0.1	1.1
MP w/GW1	0.5	2.1	-0.2	1.1
MP w/GW2	0.4	2.1	-0.0	1.0



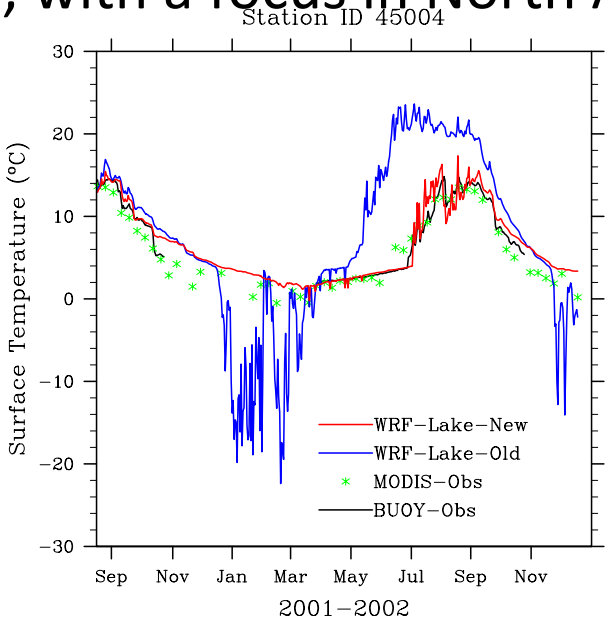
Barlage et al., 2015, *Climatic Change*.

Advances in lake-effect process prediction within NOAA's Climate Forecasting System for North America

"CFS/FLake model development"

Utah State University: **Jiming Jin**,
NCEP EMC: Michael Ek and Yihua Wu

Project Goal: This project is to incorporate the numerically efficient physical based freshwater lake model FLake into NCEP's operational Climate Forecast System version 2 (CFSv2), with an objective of improving climate prediction at intraseasonal to interannual time scales, with a focus in North America.



Surface Temperature Simulations for Lake Superior

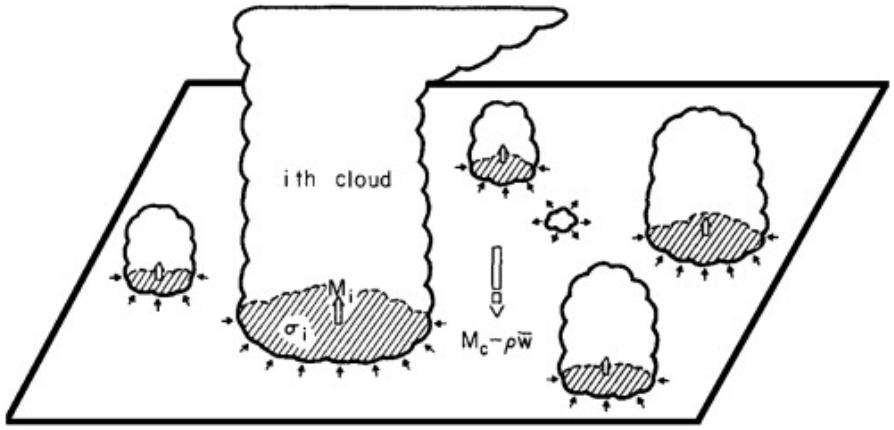
The lake temperature was significantly improved (red line) when compared to on-site buoy observations (black line), and MODIS data (green star) through modifying the eddy diffusivity in the CLM lake model, changing the surface roughness length, and using actual lake depth data.

A CPT for Improving Turbulence and Cloud Processes in the NCEP Global Models

U. of Utah: **Steven Krueger**
NCEP: Shrinivas Moorth, F. Yang
U. of Colorado: Robert Pincus
CSU: David Randall
NCAR: Peter Bogenschutz

A CPT for Improving Turbulence and Cloud Processes in the NCEP Global Models (Krueger)

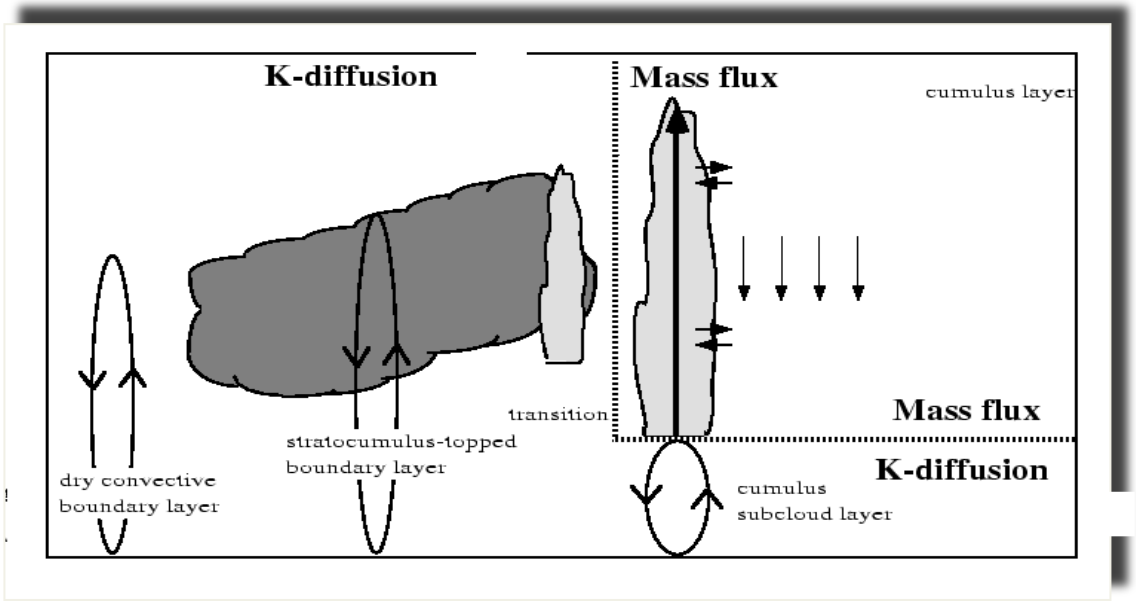
- Unify the representation of turbulence and sub-grid-scale (SGS) cloud processes.
- Unify the representation of SGS deep convective precipitation and grid-scale precipitation as the horizontal resolution decreases.
- The team has installed a modern, top-performing conventional cumulus parameterization into the GFS as a first step.



Cloud and Boundary Layer Climate Process Team (CPT) led by C. Bretherton

- "Hybrid EDMF" (Eddy-Diffusivity Mass-Flux) scheme became operational in GFS with the CPT funded during FY10-12, which improved representation of dry convective updrafts in strongly unstable boundary layers.
- The new CPT (FY14-16) is to implement a candidate EDMF parameterization for GFS and CFSv3 that includes a full representation of moist processes.

$$\overline{w'\phi'} \cong -K\frac{\partial\bar{\phi}}{\partial z} \qquad \overline{w'\phi'} \cong M(\phi_u - \bar{\phi})$$



UW: C. **Bretherton**, C. Jones, P.Blossey
NCEP: J. Han, R. Sun
GFDL: C. Golaz, M. Zhao
JPL: J. Teixeira , M. Witek

Improving cloud microphysics and their interactions with aerosols in the NCEP global models

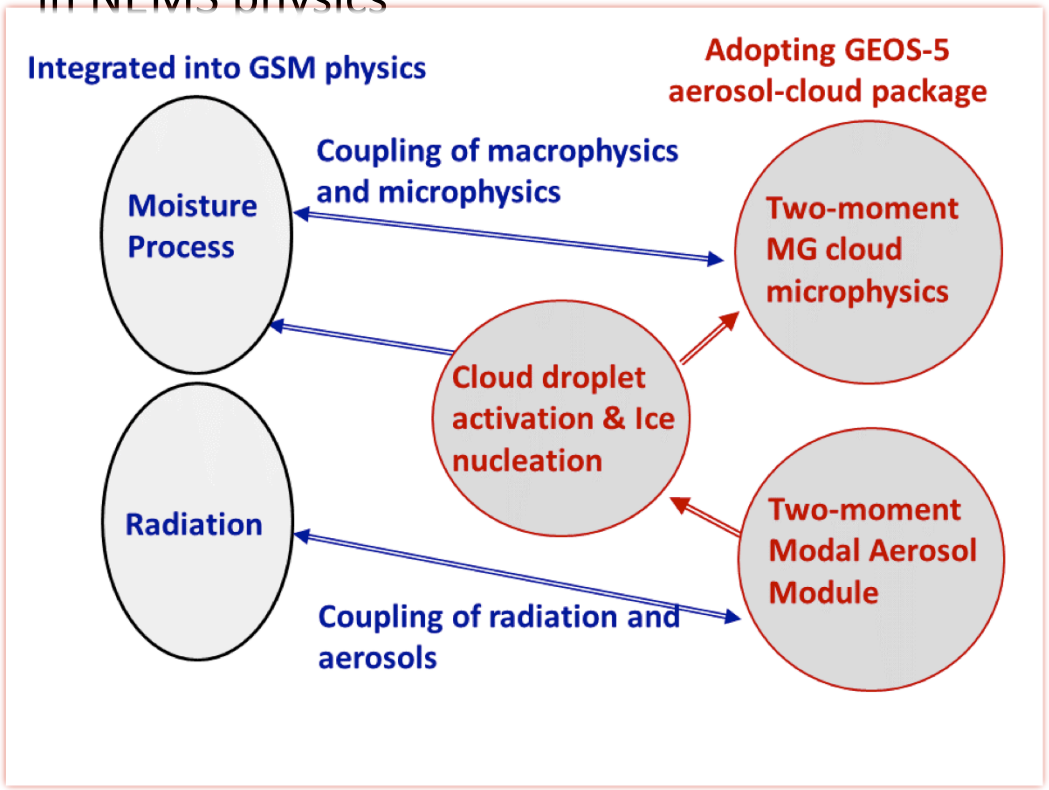
SUNYA: **Sarah Lu**, Qilong Min, Sheng-Po Chen
GSFC/GMAO: Arlindo da Silva, Anton Darmenov, Donifan Barahona
NCEP/EMC: Yu-Tai Hou, Shrinivas Moorthi, Fanglin Yang, Jun Wang

- **Objective**: Improve the representation of aerosol processes, cloud microphysics, and aerosol-cloud-radiation interaction in NCEP global models

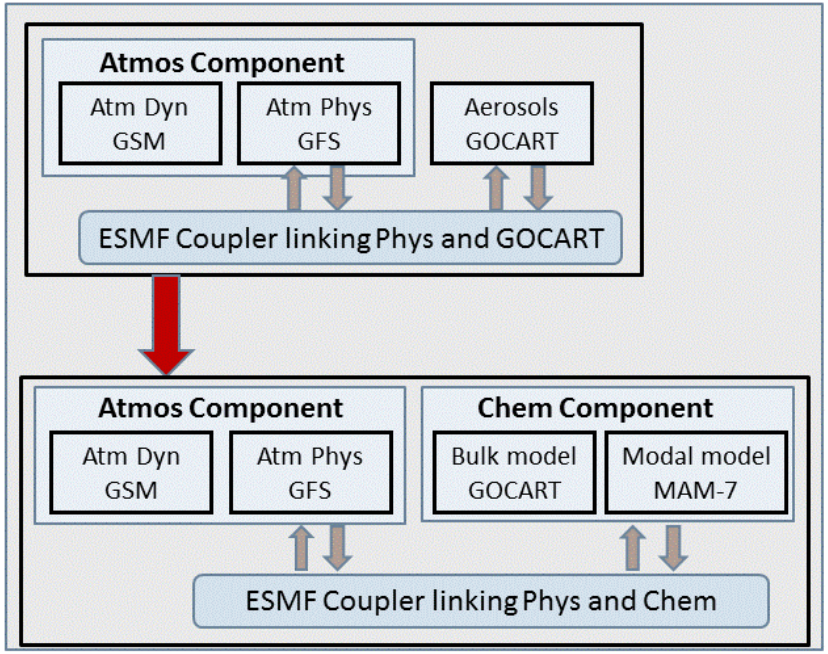
- SUNYA-NCEP-GSFC collaborative efforts to upgrade NEMS (NOAA Environmental Modeling System) physics suite by adapting GSFC's physically-based aerosol and cloud microphysics package (which in turn is based on NCAR CAM5)

Improving cloud microphysics and their interactions with aerosols in the NCEP global models

Primary outcome: NEMS physics suite improvement Adapting physically-based aerosol and cloud microphysics package to improve aerosol-cloud-radiation interaction in NEMS physics



Secondary outcome: infrastructure upgrade Introducing a generic chemistry component (containing GOCART and MAM) which can be easily extended to include GEOS-5 tropospheric and stratospheric chemistry



Modeling Priorities in MAPP- CTB FY16 Call for Proposals

Test the performance of modeling components, schemes or methodologies developed in the broader community when included experimentally in operational monitoring and dynamical prediction systems.

Focal areas:

a) **data assimilation** for Earth system components, including atmosphere, ocean, land, ice, waves and aerosols to improve monitoring and prediction capabilities,

b) improvements in the **representation and prediction of sea ice** conditions.

Summary

- **NOAA Climate Test Bed (CTB) is a mechanism to transition understanding of physical process modeling studies to NCEP operational models.**

- **Currently CTB has 5 ongoing modeling projects and will support more in FY16**

- **Key requirements for successful R2O transition:**
  - NCEP collaborators
  - Relevance to NCEP mission/priorities
  - Clear transition plan consistent with NCEP operational plan
  - NCEP O2R support to external PIs with access to operational models