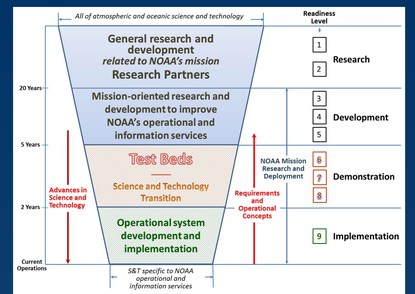
Tracking Progress on NOAA's MAPP-CTB Projects: Accelerating Transition of Research Advances into Improved Operational Capabilities

Jiayu Zhou, Climate Mission, Office of Science and Technology Integration
David DeWitt, Climate Prediction Center, National Centers for Environmental Prediction
National Weather Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce



6 System/subsystem model or prototyping demonstration in a relevant end-to-end environment
7 System prototyping demonstration in an operational environment
8 Actual system completed and mission qualified through test and demonstration in an operational environment

NOAA's operational climate monitoring and prediction products provide the public with critical information about environmental conditions for better preparedness and improved resiliency. NOAA's Modeling, Analysis, Predictions and Projections - Climate Test Bed (MAPP-CTB) projects support transition of research advances from external community to National Centers for Environmental Prediction (NCEP) to accelerate the improvement of operational climate monitoring and predictions. Three focus areas are 1) testing the performance of model components and schemes of methodologies, 2) testing experimental prediction methodologies and products, and 3) testing a multi-model subseasonal climate prediction system via model selection, system optimization and products evaluation. By tracking progresses on twenty-three MAPP-CTB projects, this presentation highlights major achievements to date and assesses the Transition Readiness Level (TRL) by measurements of benchmarks and deliverables following NOAA Administrative Order (NAO).

Performance of Model Components and Schemes of Methodologies

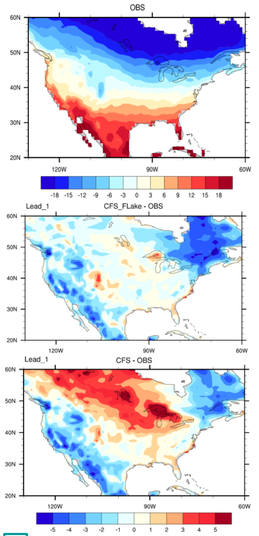
Targets:

1) Model components critical to S2S prediction, 2) Representation of predictability sources,
3) Parameterization of subgrid scale dynamic-thermodynamic processes, 4) Data assimilation

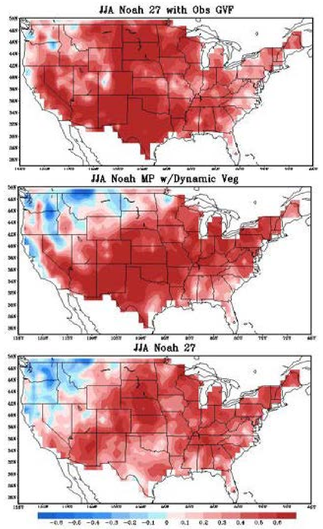
Projects Status:

Model Components and Schemes	Research Developer	Operation Beneficiary	TRL
1. Flake lake model	USU	CFS	6
2. Community Noah-MPv2 LSM	NCAR	CFS	7
3. NASA GMAO's physically-based cloud/aerosol packages	SUNY	GFS,CFS	6
4. Cloud and boundary layer processes	UW, JPL	GSF, CFS	7
5. Turbulence and cloud processes	UU	GSF, CFS	6
6. Land Information System	NASA	NLDAS	5
7. MOM6/SIS2 Hybrid-GODAS (eddy permitting)	UMD	GODAS	5
8. Coupled wave-Ocean System	GFDL	CFS, NGGPS	5
9. LETKF assimilation for sea ice analysis and forecasting	UMD	CFS, NGGPS	5

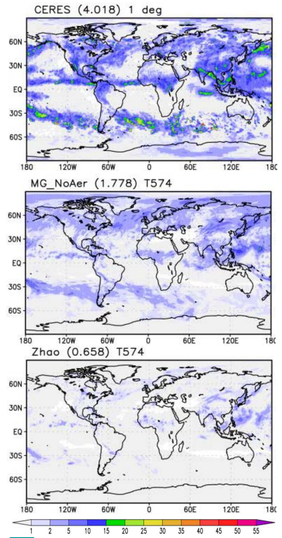
Progress Report:



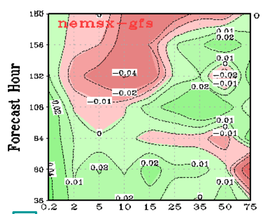
1 One-month-lead two meter height temperature ensemble forecasts over North America averaged for JFM 2014. The top panel is for observation. The lower two panels are for the differences of forecast by **CFS-Flake** (middle) and CFS (bottom) minus observation, respectively. (PI: J. Jin)



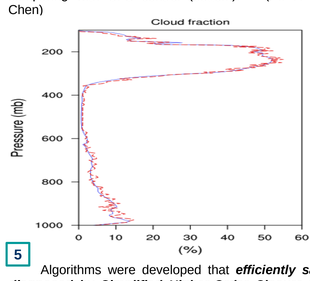
2 Anomaly correlation skill of averaged JJA 2-m temperature over CONUS from CFS experiments of using satellite-based GVF in Noah (top) and ***Noah-MP with dynamic vegetation*** (middle), comparing with CFS control (bottom). (PI: F. Chen)



3 High-level cloud optical depth from NEMS GFS runs (*CERES* estimates (top), ***MG_NoAER*** (middle), and CTRL (bottom),) averaged for Aug 10-17, 2016. (PI: S. Lu)



4 ***Modified Thompson cloud microphysics*** improves GFS precipitation skill over CONUS, as measured by the equitable threat score (ETS). The horizontal axis is precipitation in mm/day. The green regions show improvement. For almost all precipitation intensities at forecast leads up to 72 hours, the ETS is improved by about 5%. (Lead PI: C. S. Bretherton)



5 Algorithms were developed that ***efficiently sample the distribution of cloud condensate diagnosed by Simplified Higher-Order Closure*** (SHOC) for radiative transfer calculations. The algorithms have been tested against a time series of SHOC parameters fit to the simulations of tropical deep convection using high resolution (100-m horizontal grid size) and large domain (200 km by 200 km). The figure shows domain-mean profiles of cloud fraction (left panel) and cloud liquid water content (right panel) obtained directly from the simulation (blue), and as reproduced by Monte Carlo methods (red) using 250 samples. The instantaneous errors are a few percent in cloud fraction and a few mg/kg in cloud water content. (Lead PI: S.K. Krueger)

Experimental Prediction Methodologies and Products

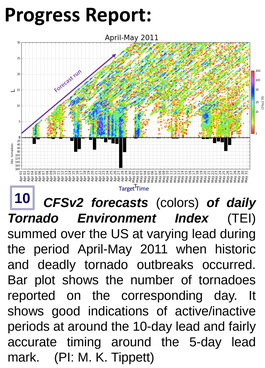
Targets:

1) Prediction of extreme events, 2) New tools and ideas, 3) Products for End-user needs

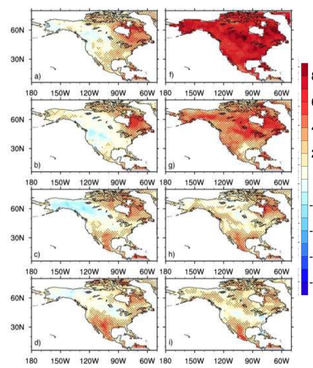
Projects Status:

Monitoring and Prediction Methodologies	Research Developer	Operation Beneficiary	TRL
10. CFS-based severe weather forecast tools	CU	CPC	7
11. Week 3 & 4 T and P forecast products	UCSD	CPC	8
12. Flash drought monitoring processes	UCLA	CPC in real-time	7
13. Subseasonal Excessive Heat Outlook System for global tropics and subtropics	UMD/ESSIC	CPC	6
14. Water sector applications of S2S climate products	NCAR	CPC	5
15. Calibration, bridging and merging (CBaM) for S2S prediction	CPC	CPC	5
16. Application of seasonal climate forecast to wildland fire management in Alaska	UAF	CPC, NWS/AR	5

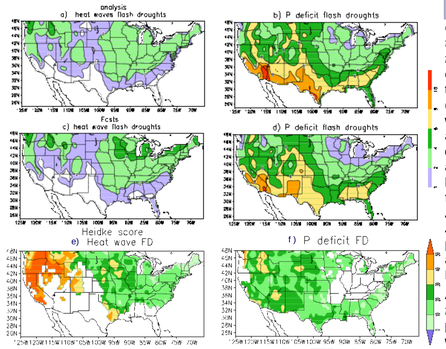
Progress Report:



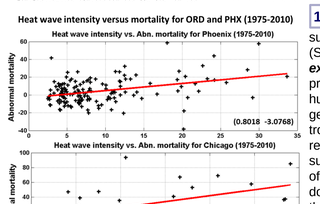
10 ***CFSv2 forecasts*** (colors) ***of daily Tornado Environment Index*** (TEI) summed over the US at varying lead during the period April-May 2011 when historic and deadly tornado outbreaks occurred. Bar plot shows the number of tornadoes reported on the corresponding day. It shows good indications of active/inactive periods at around the 10-day lead and fairly accurate timing around the 5-day lead mark. (PI: M. K. Tippett)



11 To examine the role of atmospheric initialization, two versions of initialization are compared using GFDL FLOR model. FLOR-v1 primarily captures the forcing from the ocean surface, whereas FLOR-v2 includes the additional contribution from realistic atmospheric initial conditions (AICs). The figure on left shows Heidke skill scores (HSSs) of wintertime (DJF) weekly ensemble mean T2m hindcasts of 50th percentile exceedance from FLOR-v1 (a-d) and FLOR-v2 (f-i) at lead times of 1 through 4 weeks. It reveals that the forecast skill of T2m increases dramatically for the first two weeks over the majority of North America from FLOR-v1 to FLOR-v2, and FLOR-v2 also performs noticeably better at week 3, indicating that accurate ***AICs are important for week 3-4 forecasts*** over North America.
(PI: S.-P. Xie)



12 ***The ability of the CFSv2 seasonal forecasts to capture the number of flash droughts*** has been evaluated. The figure shows the frequency of occurrence (%) of pentads under (a) heat wave flash droughts from analysis, (b) P deficit flash drought from analysis, (c) and (d) same as (a) and (b), but from CFSv2 seasonal forecasts, starting from 1 April, 1 May, 5 June and 5 July pooled together for the period from 1982-2010, (e) and (f) are corresponding Heidke skill scores.
An experimental ***real-time flash drought monitor*** is provided on the CPC website. (PI: D. Lettenmaier)



13 In order to extend existing operational subseasonal excessive heat outlook system (SEHOS) to the entire Globe, ***a new definition of excessive heat events*** (EHE) was introduced in principle of (1) describing adequately tipping points in human physiology that lead to heat disease, (2) being general enough to be applicable in both extra-tropical, subtropical and tropical areas, (3) having a relation with mortality, and (4) being predictable in subseasonal-to-seasonal lead times. The functionality of this new definition has been tested against a list of documented EHE. The figure shows scatter plots of the intensity of EHE and abnormal mortality for Phoenix-PHX (humid type) and Chicago-ORD (dry type). Red lines show the linear regression between intensity of EHE and abnormal mortality. For low EHE intensity mortality is not correlated with EHE however as the intensity of the EHE increases there is a clear increase of abnormal mortality. (PI: A. Vintzileos)

Multi-Model Subseasonal Climate Prediction System

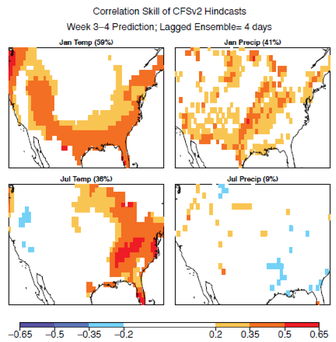
Targets:

1) Optimization of model design, 2) Robust MME forecast system

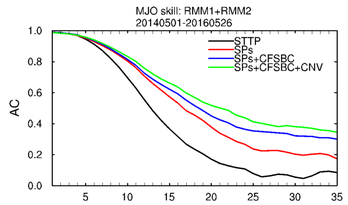
Projects Status:

Multi-Model System	Research Developer	Operation Beneficiary	TRL
17. Diagnosis of subseasonal NMME forecasts on skill, predictability, & multi-model combinations	GMU	CPC	6
18. NCEP GEFS for monthly forecasts	EMC	CPC	6
19. Operational NMME probabilistic seasonal forecast products improvement	IRI	CPC	9
20. Real-time MME subseasonal forecast system	UM-RSMAS	NMME	5
21. NASA GEOS-5 system	NASA, USRA	NMME	5
22. CCSM4 subseasonal prediction	UM-RSMAS	NMME	5
23. Navy's Earth System Model S2S prediction	NRL	NMME	5

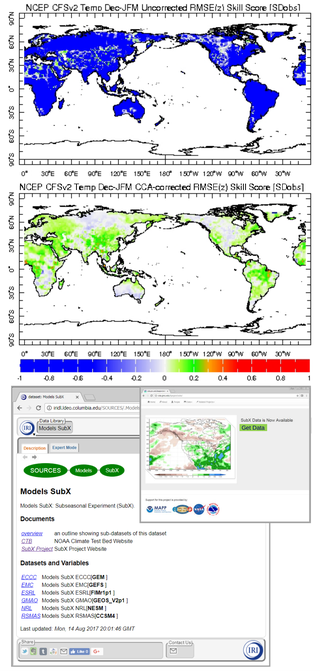
Progress Report:



17 Correlation skill of week 3-4 temperature and precipitation CFSv2 hindcasts over CONUS during January and July, 1999-2010 (12 years). The hindcasts are based on a 4-day lagged ensemble (comprising 16 members drawn from 4x daily hindcasts). Values that are statistically insignificant at the 5% level (according to the permutation test) are masked out. The percentage area with significant correlation skill (positive and negative) is indicated in the title of each panel. The results provide ***a scientific basis for predictability on the timescales of week 3-4***.
(PI: T. DelSole)



18 ***NCEP MGEFS MJO forecast skills*** in terms of bi-variant correlation of the Wheeler-Hendon RMM indices for four different experiments during the period of May 2014 to May 2016. A significant improvement in MJO forecast skill (from 12.5 days to 22 days) is carried out after applying the new stochastic physics perturbation (SPs), updated SST (CFSBC) and new convective schemes (CNV).
(PI: Y. Zhu)



19 At IRI, systematic errors in individual coupled model forecast spatial patterns were corrected, resulting in skill improvements in specific regions and seasons. Overall improvements are quite limited, however. On the other hand, improvements at a local (not pattern) level are substantial for both precipitation and temperature. The CCA was therefore found to be useful for an unintended purpose, as local corrections can be done using simpler methods than CCA. Another unexpected finding was that applying the CCA to the entire globe as a single region produced equal or better results than applying it to individual regions and merging the corrected forecasts into a global forecast. The figure shows geographic distribution of root mean squared error skill score (RMSESS) over the globe as a single region, for temperature forecasts by the NCEP-CFSv2 model for January-March made in early December. The top panel shows the original skill, and the bottom panel the skill following the CCA correction. The RMSESS is in terms of standardized anomalies with respect to the observed mean and standard deviation. (PI: A. Barnston)

20 A website has been created to provide public information about the Subseasonal Experiment (SubX) project, datasets, models, and research activities. (***http://cola.gmu.edu/kpegion/subx/***)
Each modeling group is producing re-forecasts following the SubX protocol. The re-forecasts are being made available to the research community on the IRI data server. The IRI continues to update the NMME monthly archive in the IRI Data Library in real time every month as new output files are made available by the contributing forecast centers. It also assists users of the NMME archive who send requests for help in accessing the data.
(PI: B. Kirtman)