GSL Participation in Testbeds

Arctic Testbed and Proving Ground

FY2017 AWIPS Aviation Hazards Tool Evaluation

FY2018 Evaluation of Ceiling and Visibility Guidance for Alaska

Aviation Weather Testbed

FY2017 Winter Experiment

Spring Experiment

FY2018 In cooperation with NWS Operations Proving Ground, tested aviation cloud guidance as part of the real-time TAF experiment

FY2019 AWT Summer Weather Experiment: Evaluation of the experimental **RAPv5/HRRRv4** as compared to the current operational RAPv4/HRRRv3, in addition to the use of the real-time mesoscale analysis in the forecasting process.

FY2020 GSL researchers participated in virtual AW Testbed providing ensemble guidance (**HRRRE**) such as forecasting radar echo tops

Climate Testbed

FY2017 **SubX Experiment**: FIM-HYCOM inputs to MAPP model

FY2018 **SubX Experiment**: FIM-HYCOM inputs to MAPP model

Global Model Test Bed (GMTB) (Absorbed by the DTC in May 2019)

FY2018 Release of **Common Community Physics Package (CCPP v1)** by the Global Model Test Bed

FY2019 Development of **physics suite for Global Forecast System (GFS) v16**

NOAA/NWS/EMC scientists came to DTC to collaborate on the inclusion of the **Ferrier-Aligo microphysics** parameterization in the CCPP.

Hazardous Weather Testbed (HWT)

FY2016 Spring Experiment (RAP/HRRR)

Experimental Warning Program testing Hazard Services-PHI

FY2017 Spring Experiment (RAP/HRRR, FACETs/Hazard Svcs)

Experimental Warning Program testing Hazard Services-PHI

FY2018 **Experimental Forecast Program**: Participation entire month of May 2018, with at least one ADB staff member there in person during each week of the month. The focus this year was on gauging the skill of the experimental HRRR Ensemble (HRRR-E) as compared to other experimental ensembles and especially the operational High-Resolution Ensemble Forecast (HREF) system. The experiment provided an opportunity to examine model performance for a large variety of

	severe weather scenarios across the lower 48 states.
	Experimental Warning Program: Testing of Hazard Services and PHI
FY2019	Spring Forecasting Experiment, the **Community Leveraged Unified Ensemble (CLUE)** testing and evaluation (DTC-GSD)
	Spring Forecasting Experiment with the NOAA Storm Prediction Center and NSSL: Real-time experimental tests of RAPv5/HRRRv4 including inland lake model, new data assimilation capabilities, and new storm-scale ensemble data assimilation system; Upgraded HRRR Ensemble for the Warn-on-Forecast system; a Stand-Alone-Regional FV3 Convection Allowing Model; and a new 3D Real-Time Mesoscale Analysis (3D RTMA).
	Pilot test for **FACETS** at Hazardous Weather Testbed
	The **3D RTMA** was recently evaluated by the SPC as part of the Hazardous Weather Testbed (HWT) Spring Program. Comparison against their current “sfcOA” system indicated encouraging results for both a 3-km 3D RTMA and a version coarsened to 40-km. The tests also provided some very good feedback to the developers, as some specific issues to be addressed were identified (small-scale CAPE maximum, reflectivity “ghosting”).
FY2020	Test and evaluate Hazard Services functionality involving **probabilistic hazard information (PHI) and threats in motion (TiM)**; also evaluating utility of PHI and TiM in "on-air" scenarios with broadcast meteorologists (October and February)
	Hazard Services Focal Point Workshop, Norman, OK

Hydromet Testbed (HMT)

FY2017	**Colorado-New Mexico Regional Extreme Precipitation Study**
FY2018	**Advanced Quantitative Precipitation Information (AQPI)** system experiment for San Francisco Bay Area
	Flash Flood and Intense Rainfall Experiment joint with Weather Prediction Center
FY2019	**Improved Lake-Effect Snow Forecasts** as part of WPC's Winter Weather Experiment: https://esrl.noaa.gov/gsd/learn/hotitems/2019/fvcom.html
FY2020	Participated in all-day NCEP HMT workshop in College Park, MD focused on prediction of precipitation type and snowfall from high-resolution NWP systems.

Joint Center for Satellite Data Assimilation (JCSDA)

FY2017	JEDI - Joint Effort for Data assimilation Integration
FY2018	JEDI - Joint Effort for Data assimilation Integration
FY2019	JEDI - Joint Effort for Data assimilation Integration
	JCSDA Workshop

Joint Polar Orbiting Satellite Systems (JPSS) Proving Ground

FY2016 Assimilating satellite observation data into HRRR-Smoke

FY2017 Assimilating satellite observation data into HRRR-Smoke

FY2018 Assimilating satellite observation data into RAP and HRRR-Smoke models

FY2019 Assimilating satellite observation data into RAP and HRRR-Smoke models

Weather Prediction Center (WPC)

FY2018 **WPC Summer Experiment: Flash Flood and Intense Rainfall Experiment (FFaIR),** College Park, MD: The experiment focused on new and experimental forecast products, including the HRRRv3 and prototype HRRRE. The HRRRE was evaluated against a variety of other ensemble systems in its ability to outline probabilities of flash flood producing rainfall. Other new guidance, such as the National Water Model (which is driven by HRRR precipitation forecasts for the first 18 hours), was also evaluated.

FY2019 **WPC Winter Weather Experiment** hosted the Hydrometeorological Testbed demonstration for "Improved Lake-Effect Snow Forecasts": GSL and GLERL started the project in 2017. They reached a key milestone in late February 2019 as they began to run experimental “coupled” versions of the Great Lakes Operational Forecast System (GLOFS) and the High-Resolution Rapid Refresh (HRRR) model. Then they showed the use of the Finite Volume Community Ocean Model (FVCOM) model data improves HRRR forecasts of lake-effect snow and general forecasts in all seasons over the Great Lakes region.The HRRR-FVCOM coupling is part of the next HRRRv4 model upgrade deployment in 2020. This linkage is a step towards increasing OAR coupling of earth-system components to improve operational NOAA prediction. https://esrl.noaa.gov/gsd/learn/hotitems/2019/fvcom.html

WPC Summer Experiment: **Annual Flash Flood and Intense Rainfall Experiment** (FFaIR), College Park, MD. ADB staff conduct evaluation of Experimental HRRRv4 and HRRRE. Experiment participants evaluated convection-allowing models and their performance for predicting heavy rainfall events over the continental US, with a particular focus on ensemble performance. The Experimental HRRR (prototype HRRRv4) was evaluated each day, as well as the Experimental HRRR Ensemble (HRRRE). HPC problems caused outages of model data on some days.

FY2020 4-week **Flash Flood and Intense Rainfall (FFaIR) experiment** hosted by the Weather Prediction Center Hydrometeorology Testbed.The focus of the FFaIR experiment evaluated the usefulness of operational and experimental products from high-resolution deterministic and ensemble models to increase forecast skill during the meteorological Day 1 timeframe. GSL demonstrated the High-Resolution Rapid Refresh, the High-Resolution Rapid Refresh-Ensemble, and four configurations of the FV3-Stand Alone Regional weather model (two initialized from the Global Forecast System and two initialized from the HRRR). These and other models were evaluated in a semi-operational environment.

AWIPS II Collaborative Code Development and Testing

FY2018 **Hazard Services Regional Assessment Test**, Anchorage, AK

Code development sprint for the **High Seas Formatter**, a prototype tool for National Hurricane Center forecasters to identify areas of significant weather graphically using the Graphical Forecast Editor. Code delivered to NWS Storm Prediction Center in April 2018 for AWIPS II baseline.

Real-time forecast experiment to test Terminal Aerodrome Forecast (TAF) formatter and aviation tool revisions at NWS Aviation Weather Center

Graphical Forecast Editor (GFE) with the National Hurricane Center (NHC) to develop and test new capabilities in GFE in anticipation of NHC using GFE in its operations.

Tropical Hazards AWIPS application collaboration with NWS National Hurricane Center, Miami, FL

Unified Forecast System (UFS) Workshops/Meetings

FY2019 Work toward the adoption of the **Common Community Physics Package (CCPP)** by the Environmental Modeling Center (EMC) reached a milestone with the acceptance in the EMC master codes of the CCPP-enabling changes to the UFS Atmosphere (that is, changes to the FV3, NEMS, and NEMSfv3gfs codes). CCPP is now exercised as part of the official regression tests run by EMC. As a follow up, Travelled to EMC for a Technical Visit to plan the next steps in CCPP adoption for all UFS applications.

FY2020 **UFS Workflows Workshop and CROW Review**

First UFS Workshop (held virtually). Jeff Beck is co-leading this workshop. Extensive participation by GSL researchers.

FY2021 The **1st Unified Forecast System (UFS) Training**, which was focused on the Medium-Range Weather Application, took place in early November and was attended by 35 participants from 8 time zones. The training was co-organized by GSL with lectures led by GSL team members. Recordings and slides are available here (https://dtcenter.org/events/2020/unified-forecast-system-ufs-medium-range-weather-mrw-application-users-training/agenda).

DTC UFS Evaluation Metrics Workshop (Feb 22-24, 2021) - The workshop was designed to collect feedback from the wider community on what geophysical variables and metrics for those fields needed for a model improvement to proceed through various gates along the research-to-operations pathways. GSD had a member on the organizing committee.

DTC Management Board meeting which took place over three days. The Board reached a decision about the work to be conducted by DTC using GSL base funds starting in May 2021, which include participation in the international Model Uncertainty Model Intercomparison Project, testing of ensemble configurations to inform the Rapid Refresh Forecast System (RRFS) and activities toward physics unification across the various UFS applications.

GSL-NCAR meetings to discuss code standards and management to unify the MYNN planetary boundary layer parameterization onto a single CCPP-compliant code that can be used by the UFS and the NCAR models (WRF, MPAS, and CAM/CESM), cementing a collaboration under the NOAA-NCAR Memorandum of Agreement.

NCAR Atmospheric Chemistry Observations and Modeling Division to discuss collaboration in the development and sharing of codes for atmospheric chemistry using the Common Community Physics Package (CCPP).

METplus Workshop and Tutorial at the annual DTC Management Board meeting.

GSL participation in collaborative engagement at **NOAA testbeds** is a critical part of the development process for Rapid Refresh Forecast System (RRFS). Cloud resources will be used to execute RRFS prototype components for testbed evaluation.

Other Collaborative Experiments

FY2016 **Wind Forecast Improvement Project 2 (WFIP2)**: Observations collected by CSD and PSD allowed a NOAA modeling team, including GSD, to improve wind forecasts by 15-25 percent (depending on weather conditions) in the RAP and HRRR models, and a 0.75km nest within the HRRR..

FY2017 **Land-Atmosphere Feedback Experiment (LAFE)**, DOE/ARM, Dave Turner, co-investigator

Quantifying Weather Impacts Pilot Project (QWIPP), U.S. Trade and Development Agency project demonstrating a solution concept for the East China (EC) Air Traffic Management Bureau (ATMB). GSL conducted verification of QWIPP framework against actual traffic flows.

FY2019 **VORTEX-SE**: Participated in intensive observing periods (IOPs) collecting obs from additional radiosondes, remote sensing instruments, and "StickNet" surface obs in the southeastern US. The focus was on examining impacts of data assimilation of these additional observations on forecasts of severe convective storms in the southeastern US.

In-Cloud Icing and Large drop Experiment (ICICLE) held by the FAA - GSD modelers created a 1 km HRRR nest over the Great Lakes region this winter to support ICICLE project from Jan-March 2019. GSD's numerical modeling tasks focus on identifying the advantages and disadvantages of 1-km grid spacing versus the current 3-km grid, how to optimize the physics in the HRRR model to run at 1-km, testing methods to improve forecasts of cloud development, icing conditions, and the location and type of precipitation at the surface.This work supports the FAA with national-scale products that diagnose and forecast aircraft icing at the surface in the terminal areas and aloft en-route to reduce the rate of aircraft icing-related accidents and fatalities.

GSL participated in the **FAA Program Management Review (PMR) of Aviation Weather Research Program**.

GSL assisted in setting up and monitoring the HFIP real time reservation to run the **no-vortex-initialization configuration of HWRF** (HNVI). Results can be seen on the HFIP website at http://www.hfip.org/data/index.cgi?dsKey=hwrf.

FY2020

Boulder WFO's Winter Weather Workshop with presentations on GSD's Denver International Airport snow removal operations project.

Participated in the **FAA Icing Weather Tools** meeting at NCAR-CG. Icing remains a primary weather hazard for aviation, including airframe buildup of ice due to flight through clouds containing supercooled liquid water as well as engine flameout on commercial aircraft encountering high ice concentrations in convection at high altitudes. The RAP and HRRR provide critical inputs into forecast icing products, and new versions of these products (primarily developed at NCAR-RAL) are evaluated by EDS.

Graphical Forecast Editor (GFE) with the National Hurricane Center to develop and test new capabilities in GFE in anticipation of NHC using GFE in its operations.

Advanced Quantitative Precipitation Information (AQPI) system for San Francisco Bay Area-- GSL led a Users Group meeting to discuss current system capabilities and inform the regional water agencies of collaboration,efforts over the summer to ensure that AQPI data and graphics will meet their needs and that they are prepared to use the AQPI system for operational decision support during the next rain season. AQPI team held additional user group meetings to discuss current system capabilities, standardize data interfaces, share lessons learned, best practices, etc. The San Francisco Public Utilities Commission (SFPUC) used the AQPI web interface to configure data delivery for points and areas of interest for use by PUC and Wastewater for operations.

Taiwan Central Weather Bureau Mid-Term Review (virtual)

OAR Cloud Computing Workshop led by GSL

FAA Program Management Review of Aviation Weather Research Program

SOS Users Collaborative Network Workshops (Led by GSL)

FY2017 Detroit Zoo, Royal Oak, MI

FY2019 Science City at Union Station, Kansas City, MO

FY2021 Virtual Workshop for SOS Users Collaborative Network: https://www.noaa.gov/office-education/sosnetwork/workshops/2020

Weather Information Systems Evolution Tests

Software: Hazard Services, EDAS, Aviation, FACETS, etc	Test Type (e.g. FAT, SFAT, OPG, Beta, yearly)	Dates	Location (e.g. Norman, Anchorage, Kansas City, Boulder)	Official Test Bed Name (if exists) (e.g. HWT)
Broadcasters	required by grant	3-21 June, 2019	Norman	HWT
Forecasting A Continuum of Environmental Threats (FACETS)	yearly week 1	20-24 Mar, 2017	Norman	HWT
FACETS	yearly week 2	3-7 Apr, 2017	Norman	HWT
FACETS	yearly week 3	17-21 Apr 2017	Norman	HWT
FACETS	yearly shakedown	19-21 Feb 2018	Norman	HWT
FACETS	yearly week 1	12-19 Mar 2018	Norman	HWT
FACETS	yearly weeks 2, 3	2-13 Apr 2018	Norman	HWT
FACETS	yearly shakedown	16-20 Sept, 2019	Norman	HWT
FACETS	yearly week 1	7-11 Oct, 2019	Norman	HWT
FACETS	yearly weeks 2, 3	21 Oct - 1 Nov, 2019	Norman	HWT
FACETS Probabilistic Hazards Information (PHI)	shakedown	27-31 Jan, 2020	Norman	HWT
FACETS Probabilistic Hazards Information (PHI)	week 1	10-14 Feb, 2020	Norman	HWT
FACETS Probabilistic Hazards Information (PHI)	week 2	24-28 Feb, 2020	Norman	HWT
FACETS - PHI-Taller Threats in Motion (TiM)	finish no-cost extension	July/August 2021	Virtual	HWT
Hazard Services-Initial Operating Capability (HS-IOC) Hydrology (Hydro)	Regional Assessment Test (RAT) week 1	19-23 March 2018	Salt Lake City	
HS-IOC (Hydro)	RAT week 2	26-30 March 2018	Salt Lake City	
HS-IOC (Hydro)	RAT	21-24 May 2018	Anchorage	

HS-IOC (Hydro)	RR	6-10 May 2019	Boulder	Boulder Forecasting Testing Applications Facility
HS-IOC (Hydro)	Beta	18 April 2019	WFO Omaha	
Hazard Services-Post Initial Operating Capability (HS-Post IOC) (Winter Weather)	Functional Assessment Test (FAT)	30 Nov - 2 Dec 2017	Boulder	Boulder Forecasting Testing Applications Facility
HS-Post IOC (Winter Weather, Marine)	FAT	18-20 June, 2018	Boulder	Boulder Forecasting Testing Applications Facility
HS-Post IOC (Winter Weather, Marine)	FAT	23-25 Oct 2018	Boulder	Boulder Forecasting Testing Applications Facility
HS-Post IOC (Winter Weather, Marine, Hydro HazSimp, Non-precipitation weather)	System Functional Assessment Test (SFAT) and Functional Forecaster Assessment (FFAT) Test	23-25 July, 2019	Boulder	Boulder Forecasting Testing Applications Facility
HS-Post IOC (Hydro HazSimp, Winter Weather, Non-precip weather, Marine, Severe Thunderstorm and Tornado)	SFAT & FFAT	22-24 October 2019	Boulder	Boulder Forecasting Testing Applications Facility
HS-Post IOC (Hydro HazSimp, Winter Weather, Non-precip weather, Marine, Severe Thunderstorm and Tornado)	SFAT & FFAT	11-13 February 2020	Boulder	Boulder Forecasting Testing Applications Facility
HS-Post IOC (Hydro HazSimp, Winter Weather, Non-precip weather, Marine, Severe Thunderstorm and	FFAT	16-18 June 2020	Virtual	Boulder Forecasting Testing Applications

Tornado, Misc WarnGen Workflows)				Facility
HS-POS IOC (Non-precipitation weather, Marine)	FFAT	27-29 October 2020	Virtual	Boulder Forecasting Testing Applications Facility
HS-POS IOC (Non-precipitation weather, Marine)	FFAT	23-25 February 2021	Virtual	Boulder Forecasting Testing Applications Facility
HS-POS IOC (Convective hazards)	FFAT	Scheduled for late June 2021	Virtual	Boulder Forecasting Testing Applications Facility