DEPARTMENT OF COMMERCE
RESEARCH PERFORMANCE PROGRESS REPORT (RPPR)

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AWARD INFORMATION	
1. Federal Agency: Department of Commerce / NOAA	2. Federal Award Number: NA16OAR4320115
3. Project Title: 5-Yr Renewal - Cooperative Institute for Mesoscale Meteorological Studies (CIMMS)	
4. Award Period of Performance Start Date: 10/01/2016	5. Award Period of Performance End Date: 09/30/2021
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REPORTING INFORMATION	
Signature of Submitting Official: Tracy Reinke	
16. Submission Date and Time Stamp: 09/24/2019	17. Reporting Period End Date: 06/30/2019
18. Reporting Frequency: (●) Annual ( ) Semi-Annual ( ) Quarterly	19. Report Type: (●) Not Final ( ) Final
RECIPIENT ORGANIZATION	
20. Recipient Name: UNIVERSITY OF OKLAHOMA	
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22. Recipient DUNS: 848348348	23. Recipient EIN: 731377584

ACCOMPLISHMENTS

24. What were the major goals and objectives of this project?

CIMMS is a cooperative program between NOAA and OU providing a mechanism to link their scientific and technical resources to create a center of research excellence in weather radar, storm-scale meteorological phenomena and related subjects with the goal of researching products and procedures for creating better forecasts and warnings that save lives and protect property. CIMMS promotes cooperation and collaboration on problems of mutual interest among OU researchers and NSSL, the ROC, SPC, WDTD, NWS Norman Forecast Office, NWSTC in Kansas City, NWS in Anchorage, and ARL ATDD in Oak Ridge.

CIMMS contributes to the NOAA mission through improvement of the observation, analysis, understanding, and prediction of weather elements and systems and ranging in size from cloud nuclei to multi-state areas. Advances in observational and analytical techniques lead to improved understanding if the evolution and structure of these phenomena. Understanding provides the foundation for more accurate prediction of hazardous weather and anomalous regional climate which contributes to social and economic welfare. CIMMS promotes collaboration between OU and NOAA by providing a center where government and academic scientists work together to learn about and apply their knowledge of stormscale weather and regional-scale climate processes. CIMMS is part of the National Weather Center, a unique confederation of federal, state, and OU organizations that work together to improve understanding of the Earth's atmosphere.

CIMMS concentrates on the following: (1) weather radar research and development, (2) stormscale and mesoscale modeling research and development, (3) forecast and warning improvements research and development, (4) impacts of climate change related to extreme weather events, and (5) societal and socioeconomic impacts of high impact weather.

CIMMS is organized into teams to manage the 204 employees and large amount of work performed. This report contains information on the major activities and significant accomplishments of each team, opportunities for training and professional development provided, how research has been disseminated to communities, products generated (publications, patents, software, models, data products, etc.) and a list of agencies that have collaborated with CIMMS. We also document the impacts of our work beyond science and technology, on technology transfer and human resources, and describe our teaching and educational efforts.

Different teams have various foci. A detailed observation of the state of Earth's atmosphere is an important step in improving forecasts of weather systems. Radar provides key observations for this. Within the NSSL Radar Research and Development team, work is improving retrievals from current radars as well as determining what the next generation of radars should look like. The NSSL Warning Research and Development team is researching ways to improve warnings that are disseminated to the public. The Hazardous Weather Testbed (HWT) is important for these activities as it provides a conceptual framework and physical space to foster collaboration between research and operations to test and evaluate emerging technologies. The NSSL Forecast Research and Development team is concentrating on research and development of improved forecasting techniques. The development of probabilistic forecast techniques and the ability to warn on forecast (rather than warn on detection) are its important activities. Training activities within WDTD aim at ensuring forecasters are able to issue the best warnings possible. The SPC is tasked at improving the forecasting of the risk of severe thunderstorms and tornadoes. Training of forecasters and development of improved forecasting techniques is taking place within the Kansas City NWS Training Center team. Improving the High Resolution Rapid

25. What was accomplished under these goals?

• Developed(ing) 7 new products for tech transfer that benefit impact-based decision support for transportation sector
• Demonstrated Warn-on-Forecast for extreme rainfall & flash flood in NOAA HMT
• Developed & demonstrated severe weather prediction using stand-alone-regional FV3 model in HWT
• Developed novel polarimetric radar algorithms for classifying/quantifying precipitation
• Introduced polarimetric microphysical retrievals to optimize performance of NWP models
• Advanced satellite data assimilation into high resolution NWP models to improve forecasts of high impact weather
• Provided community leadership to identify major meteorological & social/behavioral research problems to reduce impacts of tornadoes in Southeast US
• Performed satellite data assimilation in operational environment for evaluation in testbeds
• Developed capability to generate/display new products to support Satellite & Convective Applications Experiment
• Developed Probabilistic Hazard Information Prototype to support 2019 Emergency Manager Experiment
• Led & supported development, implementation, installation, integration, testing, calibration & operation of Advanced Technology Demonstrator
• Developed & transferred novel calibration & signal-processing techniques to improve data quality from research & operational weather radars
• Developed realistic simulations to evaluate radar designs in support of SENSR program
• Upgraded advanced precipitation estimation techniques using dual-polarization radar & other observations
• Developed new precipitation estimation quality control and techniques, including machine learning
• Evaluated research & testbeds regarding probabilistic hydrologic modeling output for FACETs paradigm
• Developed hydrologic forecasting systems for railroad operations & post-wildfire debris flows
• Upgraded weather training simulator at NWS offices, WDTD lab & partners
• Developed cloud-based simulation technologies
• Created materials and workshop to cultivate technical expertise to configure new Hazard Services warning generation software, deemed essential for all NWS offices
• Provided training for NWS forecasters on best practices for warning operations, radar, hardware & software
• Facilitated experiments designed to improve prediction of convective storms through HWT
• Post-processed, visualized, & verified output from convection allowing ensembles
• Demonstrated effect of precipitation sampling error on flash flood prediction, showing benefit of rapid-scan radar data
• Demonstrated operational uses of ZDR column depth in warning decision process
• Redeveloped IDSS Boot Camp into a 100% simulation/exercise-based week-long residence course
• Developed & offered first Pacific Region Effective Hurricane Course
• Continued offering NWS 101 New Hire course, a top priority of NWS Senior Leadership, & has been offered nearly every month
• Assisted with ORE titled "Evaluating Role of Mesoanalyst in Severe Weather IDSS", the 2019 Satellite Applications Workshop, &

Attach a separate document if more space is needed for #6-10, or #24-50.

ACCOMPLISHMENTS *(cont'd)*

26. What opportunities for training and professional development has the project provided?

DRARSR Team
•Published the book "Radar Polarimetry for Weather Observations" that offers a wide range of weather radar applications and can serve as a primary source of information for scientists and meteorologists using modern operational radars.

Testbed/Prototype Team
•45 forecasters (NWS, broadcast, DoD) evaluated experimental products in the HWT
•8 emergency managers participated in tabletop and functional weather exercises in the HWT

SHMET Team
•On-site and remote presentations were made on the development and use of new MRMS precipitation products to NWS forecasters

SHydro Team
•On-site and remote presentations were made on the development and use of FLASH products to NWS forecasters

WDTD Teams
•Participated in professional conferences (e.g., AMS and NWA)
•Collaborated with NWS forecasters to learn more about specific weather forecast office staff duties & tasks
•Provided access to professional journals & experts and technical documentation from partner agencies (e.g, Radar Operations Center, Raytheon)
•Participated in Hazardous Weather Testbed experiments
•Provided access to full suite of training for NWS staff
TAPT Team
•Developed online training module for understanding and interpreting probabilistic Warn-on-Forecast guidance.

ACME Team
•Made four updates to v11 MRMS at NCO operations
•MRMS V12 was installed on NSSL's vMRMS along with a v12 product viewer
•Long term QPE webpages were created for hurricane's Florence and Michael transitioned to generic page for general use.

PAMST Team
•Through interactions with WDTD, developed training to help NWS forecasters diagnose false circulations

NWSTC Team
•Conducted Impact-Based Decision Support Services (IDSS) Training, which included IDSS Deployment-Ready Boot Camp. The

27. How were the results disseminated to communities of interest?

Transportation Team
•We were invited to give 5 webinars to various subgroups within the National Weather Service, we have in preparation or in press 4 formal journal articles. We presented 8 conference presentations and participated in one technical exchange meeting with the NWS and FAA.

SDAM Team
•Project website: https://wof.nssl.noaa.gov

Testbed/Prototype Team
•Presentations at the 2019 AMS Annual Meeting, 2019 Conference on Broadcast Meteorology, and 2018 Severe Local Storms Conference
•Tours of the HWT for visiting scientific groups

ART and RED Teams
•Presentations at local, national, and international meetings, conferences, symposia, and workshops
•Peer-reviewed, conference papers, and technical reports
SHMET Team
•Local and national workshops and presentations; on-site collaborations; web pages

SHydro Team
•Local and national workshops and presentations; on-site collaborations; web pages

WDTD Teams
•NWS forecasters reached through the Commerce Learning Center, webinars, workshops, and other forms of direct communication
•NWS partner agencies accessed comparable information to NWS forecasters through web sites and e-mail
•The general public participated in the National Weather Festival, student lab exercises (college & high school), & professional association outreach events

PAMST Team
•Introduced radar products to Emergency Managers through presentations at Oklahoma EM monthly meetings
•Taught a Life-long Learning Institute course on severe convective weather at the University of Oklahoma

NWSTC Team
•Continued to expand our base of core partner and NWS employee participation in exercises, simulations, facilitators and mentors throughout the courses. The EHM CONUS class was attended in its entirety by John Murphy, NWS Chief Operating Officer.
•Encouraged our NWS participants to reach out within their communities to participate in and help develop exercises with their

Attach a separate document if more space is needed for #6-10, or #24-50.

ACCOMPLISHMENTS *(cont'd)*

28. What do you plan to do during the next reporting period to accomplish the goals and objectives?

In the next reporting period, work will continue in the weather radar, storm-scale meteorological phenomena and related subjects with the goal of researching products and procedures for creating better forecasts and warnings. Collaboration among university researchers and NSSL, NWS ROC for the WSR-88D (NEXRAD) Program, NWS SPC, NWS WDTD, NWS Norman Forecast Office (OUN), NWSTC in Kansas City, NWS in Anchorage, and NOAA ARL ATDD in Oak Ridge will also continue.

As before, CIMMS will concentrate its resources on the following themes: weather radar research and development, stormscale and mesoscale modeling research and development, forecast and warning improvements research and development and societal and socioeconomic impacts of high impact weather. We will also document impacts of our work beyond science and technology, on technology transfer and human resources, and on teaching and education outreach.

Specific plans involve the following:
•Continue the development of algorithms for classifying & retrieving precipitation and cloud microphysical properties
•Continue to demonstrate uses of polarimetric radar variables & rapid-scan radar observations in prediction & warning decision process
•Continue to support the development, implementation, installation, integration, testing, calibration & operation of the Advanced Technology Demonstrator
•Continue to develop & transfer novel calibration & signal-processing techniques for research & operational weather radar
•Continue to evaluate radar designs in support of the SENSR program
•Continue to develop products for technology transfer that benefit impact-based decision support for the transportation sector
•Continue to develop capability to generate & new products to support experiments in the HWT
•Continue to improve techniques to estimate precipitation, including use of dual polarization radar & machine learning
•Continue to develop probabilistic hydrologic forecasting systems that can be used in FACETs program
•Continue to develop and improve Multi-Radar Multi-Sensor (MRMS) & single radar applications, as well as analyzing prior data for use in development of Probabilistic Hazard Information
•Continue to research on how to communicate warnings & probabilistic information to vulnerable populations, public response to such information, and evaluation of improved forecast information through the hazardous weather testbed with end-users
•Continue to develop & demonstrate products for severe weather prediction that can be tested in the HWT
•Continue to advance the state of knowledge to assimilate satellite data into numerical weather prediction models & into operational environments to improve forecasts of high impact weather through testbed experiments
•Facilitate experiments in the HWT aimed at improving prediction of convective storms, as well as visualizing & verifying output form convection allowing ensembles
•Continue to upgrade weather training simulators at NWS Offices & WDTD lab, including use of cloud-based simulation techniques
•Provide training for NWS forecasts on warning operations, radar, hardware and software

PRODUCTS

29. Publications, conference papers, and presentations

See attachment 29A for Publications
See attachment 29B for Conference Papers and Presentations

Attach a separate document if more space is needed for #6-10, or #24-50.

PRODUCTS *(cont'd)*

30. Technologies or techniques

Transportation Team
•A new composite reflectivity that includes TDWR observations
•Five new composite reflectivity products interpolated to select flight layers
•Probabilistic guidance on whether the road temperature is subfreezing across the CONUS
•A new surface hydrometeor phase algorithm
•Implementation of the NEXRAD Hydrometeor Classification Algorithm to the MRMS mosaics
•A new mosaic to provide the age of each pixel in the MRMS 3D mosaics.
•Zdr column detection algorithm within MRMS

DRARSR Team
•Refined algorithms for rainfall estimation based on specific attenuation and for microphysical retrievals in ice and snow
•Developed novel techniques for processing and displaying polarimetric radar data and their products in a height vs time format

Testbed/Prototype Team
•Investigated the use of biomimetic image processing for storm segmentation and tracking

ART and RED Teams
•Staggered Pulse-Repetition-Time (PRT) algorithm
•Hybrid-Scan-Estimator (HSE) algorithm
•SZ-2 algorithm

SHMET Team
•Precipitation techniques of dual-polarization radar and multi-sensor gap-filling capabilities
•Quality control techniques of radar observations, gauge accumulations, bright band contamination, and hardware variables

SHydro Team
•New hydrologic model output, such as probabilistic data and new high resolution output using model forecasts
•Stream gauge radars for monitoring of flash floods and high streamflows

WDTD Teams
•CIMMS-produced Severe & Winter Weather Forecast Challenges allow NWS forecasters to integrate new knowledge into practice through written forecast discussions, which are part of their daily job duties

ACME Team

31. Inventions, patent applications, and/or licenses

Limited license for Georgia Tech Research Institute for Weather Event Simulator to explore use of the simulator by the 93rd Air Ground Operations Wing of US Air Force

Attach a separate document if more space is needed for #6-10, or #24-50.

PRODUCTS *(cont'd)*

32. Other products

PDAM Team
•Software development and application of SAR FV3 model core in support of NOAA Unified Forecast System
•Collected near storm environment data during Targeted Observation by Radars and UAS of Supercells (TORUS) field campaign

DRARSR Team
•A one-dimensional spectral model of melting snow as a basis for spectral bin classifier of winter precipitation
•Specialized instrumented ground validation site for cloud microphysics studies at the Kessler Farm

Testbed/Prototype Team
•Software development to improve efficiency of WDSS-II segmotion
•Capability to distribute vMRMS products via geoserver

ART and RED Teams
•Weather radar time-series simulators (software)
•Application software for the Advanced Technology Demonstrator (software)

WDTD Teams
•Various courses for federal employees available on Commerce Learning Center: https://doc.csod.com & to the public on the WDTD web site: https://training.weather.gov/wdtd/
•Various reference materials available to NWS forecasters on NOAA Virtual Lab (VLab; https://vlab.ncep.noaa.gov)
•Delivered a formal simulation to NWS offices on a quasi-linear convective system event.

TAPT Team
•Developed and maintained software and web interfaces for Warn-on-Forecast and FV3 CAM guidance
•Developed and maintained web interface for facilitation of the Spring Forecasting Experiment.

ACME Team
•Wind turbine clutter data set created & QC algorithm applied to improve QPE in those areas. Emergency Manage-centric MRMS OPV page, Gauge vs QPE comparison tool and other ROC MOU tools completed.

PAMST Team
•Created a version of the MRMS Operational Product Viewer website to provide emergency mangers easy access to useful radar products

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

33. What individuals have worked on this project?

Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) Senior Personnel
Greg McFarquhar, PhD - Principal Investigator and CIMMS Director
Randy Peppler, PhD - Co-Principal Investigator and CIMMS Associate Director
Sebastian Torres, PhD - CIMMS Assistant Director
Tracy Reinke - CIMMS Executive Director, Finance and Operations

Refer to Annual Report Demographics appendix for CI Employee Support Table

Attach a separate document if more space is needed for #6-10, or #24-50.

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS *(cont'd)*
34. Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period? Nothing to Report

35. What other organizations have been involved as partners?

Transportation Team
•Federal Aviation Administration (FAA)
•NOAA/NWS/NCEP/AWC

PDAM Team
•NOAA/OAR/ESRL/GSD
•NOAA/NWS/EMC
•OU Center for Analysis and Prediction of Storms (CAPS)

DRARSR Team
•University of Colorado, Boulder
•Stony Brook University
•Institute for Geosciences and Meteorology at the University of Bonn, Germany
•The Hebrew University of Jerusalem, Israel
•Lund University, Sweden
•Kyungpook National University, Korea

SDAM Team
•NOAA/OAR/ESRL/GSD
•NASA Langley Research Center

Testbed/Prototype Team
•University of Colorado-CIRES
•Colorado State University-CIRA
•OU CAPS
•OU School of Meteorology
•NOAA/OAR/NSSL
•NOAA/NWS/SPC
•NOAA/OAR/ESRL/GSD
•OK Dept. of Emergency Management
•NOAA/NWS/ROC
•NOAA/NWS/WDTD

Attach a separate document if more space is needed for #6-10, or #24-50.

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS *(cont'd)*

36. Have other collaborators or contacts been involved?

University of Washington
University of Colorado
Oak Ridge Associated Universities

IMPACT

37. What was the impact on the development of the principal discipline(s) of the project?

PDAM Team
•Advanced physical understanding of storm-scale processes
•Enhanced the operational data assimilation system to assimilate emerging observations for improved prediction of hazardous weather

DRARSR Team
•Utilization of advanced radar techniques for better classification and quantification of precipitation and more efficient weather warnings
•Better understanding of the microphysical processes in clouds and precipitation

SDAM Team
•Improvement of short-term (0-3 hour) probabilistic high impact weather forecasts

Testbed/Prototype Team
•The HWT enables interaction between researchers and forecasters, providing valuable feedback that can be immediately applied to the research and development process, streamlining technology transfer

ART and RED Teams
•Improvement of the quality and/or timeliness of meteorological products from research and operational weather radars.
•Demonstration of evolutionary technologies applicable to the next generation of NWS weather radars.

SHMET Team
•Improved precipitation estimations provides a better spatial and magnitude representation of precipitation across the United States that will help from hydrologic operations to water resourcing and climatological analysis

SHydro Team
•Experimental probabilistic outputs provided a means of conveying uncertainty and magnitude of predicted flash floods, which could assist impact-based decision support

WDTD Teams
•Developed and updated approximately 80 web-based training lessons directly related to NWS operations
•Provided additional operations-based learning experience through seasonal forecast challenges, webinars, simulations, &

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IMPACT *(cont'd)*

38. What was the impact on other disciplines?

Nothing to Report

39. What was the impact on the development of human resources?

WDTD Teams
•Numerous consultations with NWS staff on creating specific training simulations and on science, technology and human issues related to operations & training
•Training simulations led to better familiarity with tools and improved forecaster confidence in certain weather scenarios
•Enabled NWS offices to satisfy internal policy mandating forecasters complete training simulations
•Troubleshoot issues for NWS staff that led to improved training outcomes
•Training simulator used by NWS to evaluate forecaster performance for promotion

Attach a separate document if more space is needed for #6-10, or #24-50.

IMPACT *(cont'd)*

40. What was the impact on teaching and educational experiences?

Transportation Team
•Mentored REU students Elizabeth Sims (2018) and Joseph Burzdak (2019)
•Funded OU Masters graduate student Nathan Lis
•Served on OU Masters graduate student committee for Daniel Tripp

PDAM Team
•Elizabeth Smith: taught OU School of Meteorology Spring 2019 METR6970-Boundary Layer, Urban Meteorology, and Land-Surface Processes Seminar; mentored a Summer 2019 REU Student on Nocturnal Low-Level Jets and Convection Initiation

DRARST Team
•Alexander Ryzhkov, Valery Melnikov, and Djordje Mirkovic mentored graduate students at the OU Schools of Meteorology and Electrical Engineering and Computer Sciences (4 students altogether)

SDAM Team
•Thomas Jones: taught OU School of Meteorology METR 6970 Convective Seminar; mentored Joel McAuliffe; mentored/committee member Sijie Pan

Testbed/Prototype Team
•Kodi Berry: mentored Hollings Scholars Caroline Kolakoski (2018) and Rebekah Cheatham (2019); mentored Joseph Trujillo and Austin MacDonald (Graduate Research Assistants)

ART and RED Teams
•Eddie Forren mentored Tom Buckman (CS graduate student)
•Sebastian Torres mentored David Schvartzman (ECE graduate student); Sebastian Torres taught a portion of the graduate-level course Weather Radar Theory and Practice at the University of Oklahoma;Sebastian Torres taught a 2-day short course on "Weather Radar Signal Processing" at the National University of Cordoba (Argentina)

WDTD Teams
•Recently hired NWS forecasters developed necessary skills for severe convection, flash flood, and winter weather operations
•All NWS meteorologists provided seasonal and system readiness training to maintain and improve operational skill set
•Taught OU meteorology and high school students about NWS operations and warning practices

TAPT Team
•Katie Wilson and Patrick Skinner: Mentored OU School of Meteorology Capstone Group

41. What was the impact on physical, institutional, and information resources that form infrastructure?

Nothing to Report

Attach a separate document if more space is needed for #6-10, or #24-50.

IMPACT *(cont'd)*

42. What was the impact on technology transfer?

DRARSR Team
•Most recent versions of the algorithms for rainfall estimation using specific attenuation and winter surface hydrometeor classification have been transferred for operational implementation by the NWS Radar Operations Center.

Testbed/Prototype Team
•The HWT accelerates the transition of new meteorological insights and technologies into advances in forecasting and warning for hazardous weather events

ART and RED Teams
•Transferred 3 new/updated signal-processing techniques to the NWS Radar Operations Center.
SHMET Team
•Work generated for the MRMS v12.0 update to the National Weather Service are currently scheduled for operational transition in Q3 of FY2020

SHydro Team
•Current operational version of FLASH received code updates in 2018 at NCEP Central Operations

WDTD Teams
•Facilitated webinars given by Hazardous Weather Testbed/Experimental Weather Program participants to share experiences with other operational forecasters
•Used results from recent scientific research and technological innovations to teach NWS forecasters storm interrogation and warning decision-making skills

TAPT Team
•Transferred a local probability matched mean post-processing technique to NOAA/EMC for operational implementation

ACME Team
•MRMS helps transition research to operations via NCO. We provide documentation, training and support so NCO can fulfill their mission by keeping MRMS up and running 24/7. Forecasters can then use this information to inform and educate the public about weather.

PAMST Team
•Developed training to help NWS forecasters diagnose false circulations

43. What was the impact on society beyond science and technology?

Testbed/Prototype Team
•The HWT increases the development and transition of science and technology to operations and services, and aims to increase the lead-time and accuracy for weather and water warnings and forecasts

WDTD Teams
•Demonstrated to public how NWS forecasters generate and distribute warnings they receive via television, sirens, cell phones, & other forms of technology
•Improved warning decision-making by NWS forecasters should lead to better protection of life and property throughout the U.S.

PAMST Team
•Collaboration with industry has led to revised scale for tornadic wind speed estimation and adjustments to building codes
•Collaboration with Emergency Managers leads to better emergency response after severe weather events

NWSTC Team
•Our work supports the overall mission of the NWS, and therefore society as a whole, by increasing communication and cooperation between NWS and its core partners to prepare, respond, recover, and mitigate against hazards caused or influenced by weather, water, and climate

OPG Team
•One of the goals from the evaluation mentioned earlier was to improve communication of mesoanalysis to NWS core partners
•Current CVD research is meant to help the public as much as the NWS

Severe Convection Team
•Improvements to the warning decision making process to help save lives and property
•Improved hail size estimation improves the accuracy of the estimation of economic loss

SPC Team
•Our work improves the quality of the forecasts issued by the SPC which improves public knowledge and awareness of severe convective hazards

Societal Impacts Team
•Advanced capabilities within Weather Enterprise to disseminate forecast uncertainty information
•Advanced capabilities within Weather Enterprise to disseminate more rapidly-updating warning information

Attach a separate document if more space is needed for #6-10, or #24-50.

IMPACT *(cont'd)*

44. What percentage of the award's budget was spent in foreign country(ies)?

0 , Travel expenses to attend:
European Radar Conference on Meteorology and Hydrology
China Weather Bureau meetings

Total amount is 0.003% of annual expenditure

CHANGES/PROBLEMS

45. Changes in approach and reasons for change

Nothing to Report

Attach a separate document if more space is needed for #6-10, or #24-50.

CHANGES/PROBLEMS *(cont'd)*

46. Actual or anticipated problems or delays and actions or plans to resolve them

Nothing to Report

47. Changes that had a significant impact on expenditures

Nothing to Report

Attach a separate document if more space is needed for #6-10, or #24-50.

CHANGES/PROBLEMS *(cont'd)*

48. Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Nothing to Report

49. Change of primary performance site location from that originally proposed

Nothing to Report

Attach a separate document if more space is needed for #6-10, or #24-50.

PROJECT OUTCOMES

50. What were the outcomes of the award?

See attachment Outcomes of Award

DEMOGRAPHIC INFORMATION FOR SIGNIFICANT CONTRIBUTORS (VOLUNTARY)

Gender:

◯ Male

◯ Female

◯ Do not wish to provide

Ethnicity:

◯ Hispanic or Latina/o Not

◯ Hispanic or Latina/o Do not

◯ wish to provide

Race:

◯ American Indian or Alaska Native Asian

◯ Black or African American

◯ Native Hawaiian or other Pacific Islander

◯ White

◯ Do not wish to provide

Disability Status:

◯ Yes

[ ] Deaf or serious difficulty hearing

[ ] Blind or serious difficulty seeing even when wearing glasses

[ ] Serious difficulty walking or climbing stairs

[ ] Other serious disability related to a physical, mental, or emotional condition

◯ No

◯ Do not wish to provide

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