COOPERATIVE INSTITUTE FOR METEOROLOGICAL SATELLITE STUDIES
Space Science and Engineering Center
University of Wisconsin—Madison
1225 West Dayton Street
Madison, Wisconsin 53706
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To: The National Oceanic and Atmospheric Administration United States Weather Research Program (USWRP)
Joint Hurricane Testbed (JHT)

From: The Cooperative Institute for Meteorological Satellite Studies (CIMSS)
Space Science and Engineering Center (SSEC)
at the University of Wisconsin-Madison
1225 West Dayton Street
Madison, Wisconsin 53706

The attached proposal is being submitted to you for your consideration by the NOAA Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin - Madison. Should you recommend funding for this proposal, we request that the funding be transferred through our current NOAA cooperative agreement, NA10NES4400013. The NOAA contact (described below) for this cooperative agreement should be contacted immediately if this proposal is accepted for funding.

Title of Proposal: Integration of an Objective, Automated TC Center-fixing Algorithm Based on Multispectral Satellite Imagery into NHC/TAFB Operations

Co-Principal Investigator(s): Anthony Wimmers, Christopher Velden

Period of Performance: 1 August 2013 – 31 July 2015

Funding Amount: $221,300

Competitive FFO #: NOAA-OAR-OWAQ-2013-2003469

DUNS#: 161202122 **EIN#:** 396006492 **Congressional District:** WI-002

University Sponsored Programs Office Contact: Nick Novak
Phone: (608) 262-3822
E-mail: preaward@rsp.wisc.edu
Fax: (608) 262-5111

To Sponsor: Should funding be awarded, we request funding be associated with Cooperative Institute Memorandum of Understanding.

NOAA Administrative Contact: Heather Hay
Phone: (301) 683-3511
E-mail: heather.hay@noaa.gov
Fax: (301) 713-1459

Integration of an Objective, Automated TC Center-fixing Algorithm Based on Multispectral Satellite Imagery into NHC/TAFB Operations

A Proposal to

The National Oceanic and Atmospheric Administration
Office of Oceanic and Atmospheric Research

For the Period
1 August 2013 – 31 July 2015

Support Requested: $221,300

Submitted by the
University of Wisconsin-Madison

On behalf of
The Cooperative Institute for Meteorological Satellite Studies (CIMSS)
Space Science and Engineering Center (SSEC)
at the University of Wisconsin-Madison
1225 West Dayton Street
Madison, Wisconsin 53706
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Email	wimmers@ssec.wisc.edu

CoPI Name	Chris Velden
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Institutional Representative: Nick Novak, Managing Officer, Research and Sponsored Programs, 21 N. Park Street, Suite 6401, Madison, WI 53715, (608) 262-3822, preaward@rsp.wisc.edu

November 2012

Abstract

Integration of an Objective, Automated TC Center-fixing Algorithm Based on Multispectral Satellite Imagery into NHC/TAFB Operations

PIs: Anthony Wimmers, Christopher Velden
Cooperative Institute for Meteorological Satellite Studies (CIMSS)
University of Wisconsin – Madison

NOAA Research Theme (research role as a Cooperative Institute): Satellite Meteorology Research and Applications

The ARCHER algorithm (Automated Rotational Center of Hurricane Eye Retrieval) has been developed at UW-CIMSS over the past several years with Naval Research Laboratory funding support and is ready for operational distribution. The availability of this fast, automated satellite image center-fixing algorithm in the NHC/TAFB work environment can expedite the process of real-time storm monitoring by objectively reconciling varied fix information (IR/visible from geostationary and microwave from low-earth satellites), and also provide fix confidence indicators. In addition, the re-centered image framework readily allows quantitative analysis of TC structural characteristics (i.e., eye diameter, spiral banding scores for intensity estimation), which are also generated by the algorithm. NHC priorities directly served with this initiative include NHC-2 (supporting model initialization), NHC-4 (enhancements to the operational environment), NHC-7 (improved track guidance) and NHC-13 (improved microwave satellite utility). The ARCHER algorithm could also be employed in post-season final Best Track decision-making.

We propose to implement and deliver an independently operating version of ARCHER on an NHC/NCO server, an AWIPS-2 plug-in for viewing and interpreting the output in the operational environment, and associated documentation. The two-year work plan involves coordinating with collaborators at NHC/TAFB and the JHT facilitators to insure that the deliveries meet their standards for ease of use and optimal integration into the NHC/TAFB operational environment.

Statement of Work

(1) Duration: 2 years

(2) Project Description:

For this project we propose to take an established satellite-based TC center-fixing algorithm at CIMSS (ARCHER: Automated Rotational Center of Hurricane Eye Retrieval; Wimmers and Velden, 2010) and adapt it to run independently in the NHC/TAFB operational environment. The NHC/TAFB would benefit from the availability of this fast, automated satellite-based algorithm by expediting the practice of real-time storm tracking and monitoring. The algorithm can objectively reconcile varied fix information (IR/visible from geostationary and microwave from low-earth satellites), provide fix confidence indicators, and could also be employed as an objective aid in post-season final Best Track decision-making. In addition, the re-centered image framework readily allows quantitative analysis of TC structural characteristics (i.e., eye diameter, spiral banding scores for intensity estimation), which also provides input to the Advanced Dvorak Technique algorithm (ADT, Olander and Velden, 2007). NHC priorities directly served with this initiative include NHC-2 (supporting model initialization), NHC-4 (enhancements to the operational environment), NHC-7 (improved track guidance) and NHC-13 (improved microwave satellite utility).

Finding the rotational center of an existing tropical cyclone (TC) is an essential step in the analysis and forecasting of the event. Studies have shown the importance of accurate initial positioning to intensity estimation methods (Olander et al., 2004; Velden et al., 2006) and operational forecasts (Franklin, personal communication, 2009). In addition, numerical model track predictions can benefit from synthetic (bogus) TC observations (Goerss, 2009) and/or initial TC motion vectors (Aberson, 2002) that rely on accurate center positioning. In the North Atlantic basin, accurate positioning from satellites is of critical importance when the TC is away from aircraft reconnaissance. The ARCHER algorithm has been developed at UW-CIMSS over the past several years to automate this process of TC center-fixing from multi-platform visible, infrared and microwave imagery. The algorithm works by finding the center-point that is the most strongly indicated by the gradients from rotational shearing and spiral banding as well as the eyewall (when it is present or in formation), as in Figure 1.

The ARCHER algorithm was originally developed and validated using only 85-91 GHZ passive microwave (PMW) imagery. This version yielded RMS position errors on the order of 17 km for overall cases with low to moderate vertical shear (9 km for Category 2-5 hurricanes), and 31 km (21 km for Category 2-5 hurricanes) for cases with high vertical shear (defined as the highest ~10% of overall cases) (Wimmers and Velden, 2010). Obviously, the algorithm performs best when there are discernible gradient signatures, and defaults to the first guess position (NHC short-term track forecast) when the signals are too weak to use with confidence. The current form of ARCHER operates on multispectral imagery that includes continuous IR/VIS, and also provides probabilistic center fix confidences that account for the strengths and weaknesses of each satellite source and the robustness of the information in each image. In addition, with research funding from the Naval Research Laboratory, we are scheduled to incorporate Near-IR (shortwave) and additional calibration for 37 GHz imagery into ARCHER by mid-2013. In cases when multispectral imagery is available at the same time for fixing, the final position represents a weighted consensus. For example, PMW center-fixes will be weighted more heavily in a

concurrent IR overcast scene. The information from recent past fixes (track, confidence, etc.) can also be employed in the analysis of new imagery to provide higher confidence fix results than would otherwise be available from the new image alone. See Figure 2 for an example. Preliminary results show that this method achieves the same robust accuracy as when applied to individual PMW images, but with the added advantage of a temporal resolution and latency that matches geostationary image availability (Wimmers and Velden, 2012).

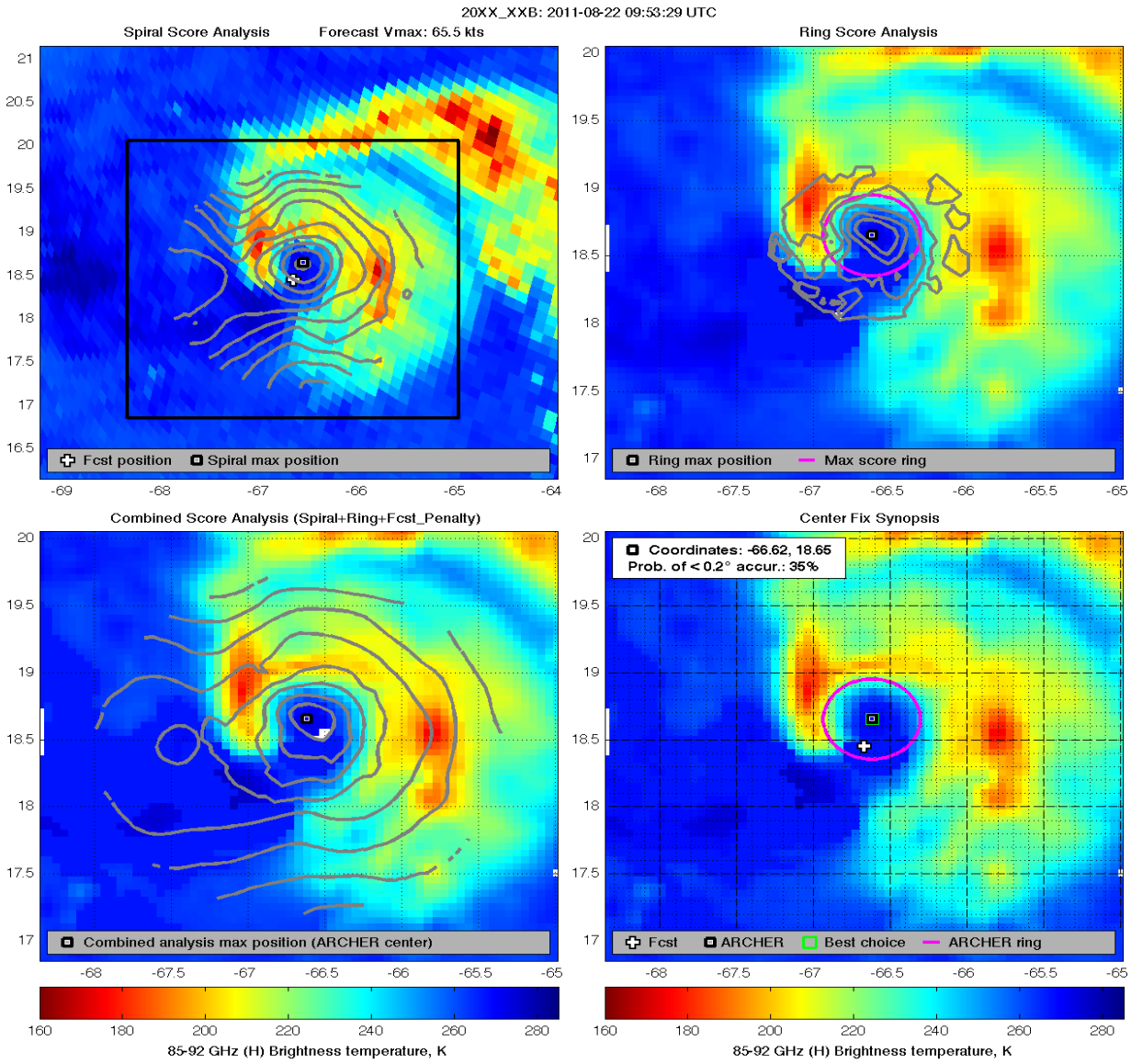

Figure 1. Example diagnostic displays for ARCHER, demonstrated on Hurricane Irene (22 Aug 2011, 0958 UTC). Upper left: Spiral score analysis (contours), indicating center of rotational shearing and banding patterns. Upper right: Ring score analysis (contours), indicating center of eyewall. Lower left: Combined score analysis (contours), which is a weighted average of the Spiral and Ring scores. Lower right: Synopsis display, for evaluating the final estimated fix position and eyewall diameter.

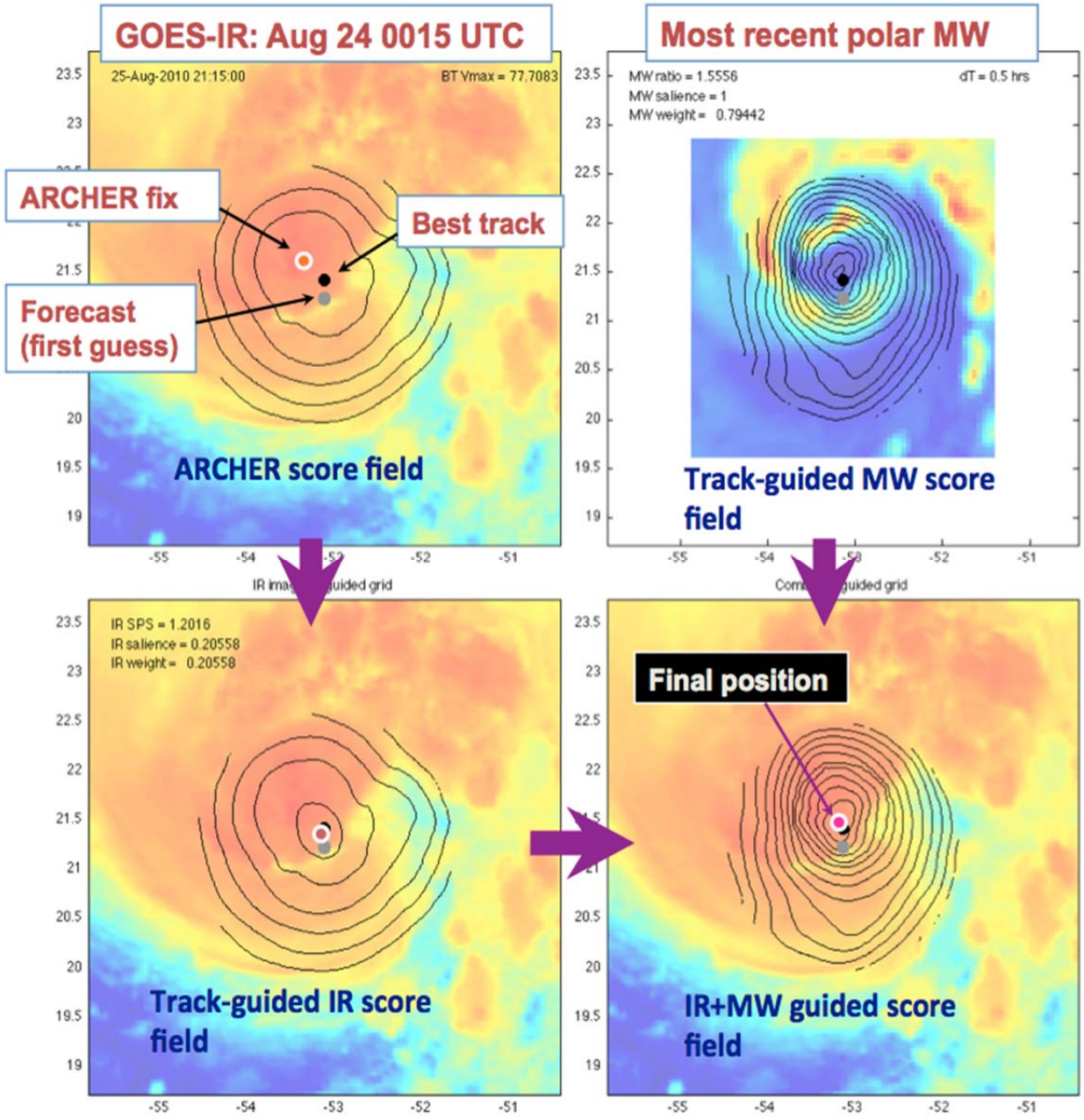

Figure 2. Example of ARCHER methodology on Hurricane Danielle (24 Aug 2010, 0015 UTC). In the upper left, ARCHER is applied to the single 10.7um infrared image (color-enhanced), yielding a low-confidence center fix 25km away from the corresponding verifying NHC best track position for that time. The first guess position is derived from a short-term NHC forecast. In the lower left, the ARCHER accuracy is improved with an additional analysis of recent center-fix history along the storm track (not shown). In the upper right, the most recent polar 85 GHz image (0.5 hr latency from the IR image) yields a high confidence center fix, but with the 0.5 hr time offset. In the lower right, the two intermediate products are combined and weighted to provide a higher confidence center-fix valid at the time of the IR image, with less than 10km position error with respect to the final post-analyzed NHC best track position.

The single-image positions can also be assessed together along the storm track for an effective assessment of longer-term fix performance. As an example, Figure 3 depicts a series of center-fixes for Hurricane Julia (2010) as a weak Category 1 storm, during a stretch of time without aircraft reconnaissance. We simulate the real-time operational environment by assuming the current analysis time is when the 0615 UTC GOES image becomes available, and the first-guess position must be extrapolated from the most recent NHC forecast. The most recent microwave image is from approximately 0230 UTC. The combination of the geostationary imagery, most recent microwave image, and trend information from the recent ARCHER track leads the algorithm to select a center of rotation that follows to the south of the real-time NHC analysis and forecast track (magenta points). An overlay of the final NHC best track verifies that this result is correct. Also note that the 1515 UTC center fix provides a much less confident position (as indicated by the wider circle of confidence), and so the analyst/forecaster may consider this in the final fix decision process.

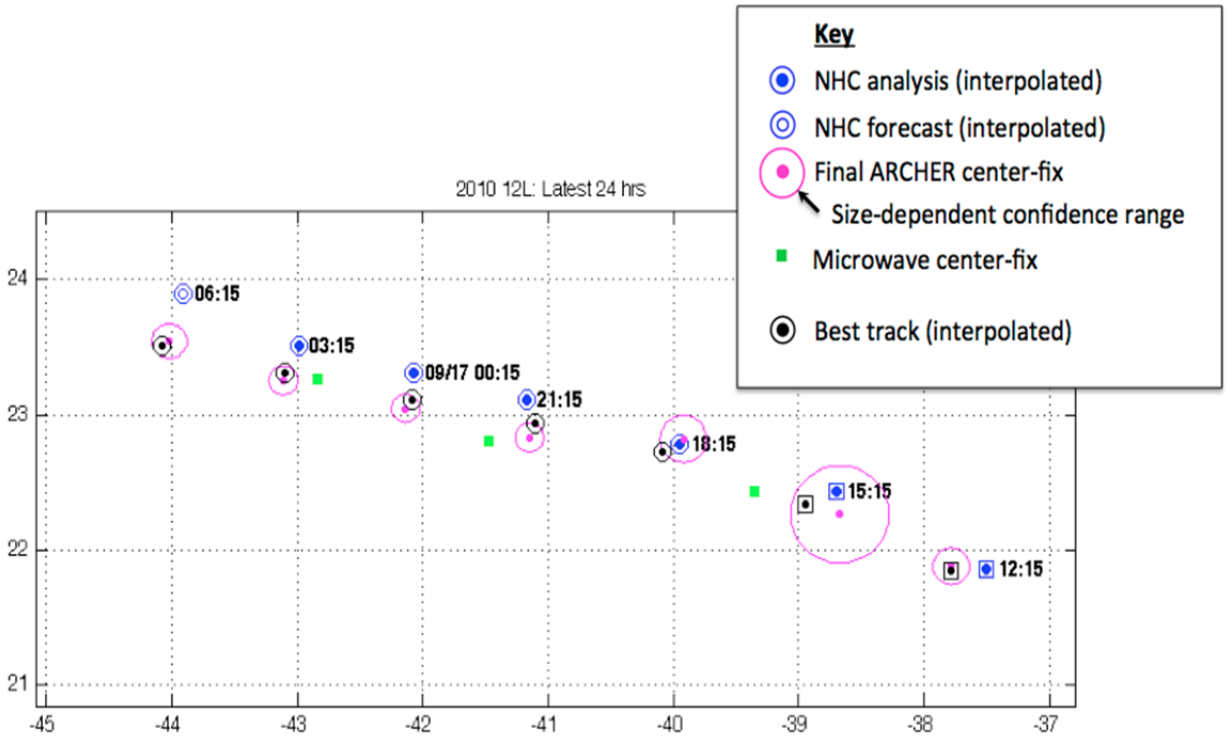

Figure 3. ARCHER simulation for an 18-hour segment (times plotted are UTC) during Hurricane Julia (2010). The current time is assumed to be 06:15 UTC. Julia was a Cat2 storm up until 15:15 UTC, then was downgraded to Cat1. NHC real-time position analyses are shown in blue, with the position at 06:15 UTC being from the most recent forecast. For readability, final ARCHER positions (magenta dots), which are influenced by concurrent IR GOES fixes and recent PMW fixes, are subsampled to every 3 hours, and PMW observation times are not labeled. The magenta circle size is inversely proportional to the amount of final ARCHER fix confidence, and is a function of the algorithm's center-fixing statistics. The verification is the final NHC Best Track (black).

To introduce ARCHER into the NHC/TAFB operational environment, we plan to adapt our demonstrational algorithm and deliver it with the following features:

- An independent software program running on either a NCEP/NCO or NHC/TAFB server that ingests all relevant satellite data, and produces/stages ARCHER output to the AWIPS-2 datastream.

- An AWIPS-2 plug-in for viewing image-specific diagnostic fields (as in Figure 1), ARCHER track output (as in Figure 3), and a pop-up chronological hypertext table linking TC statistics to graphical output.

- Comprehensive documentation for maintaining the algorithm and interpreting the output.

The option of rewriting the entire algorithm code directly into AWIPS-2 as a functional application was discussed with NCEP/NCO AWIPS-2 personnel. Given the expected added complexities and rules of the new AWIPS-2 software environment, limited NCO resources, and the fact this application is primarily site-specific (TAFB/NHC), it was recommended we take the above approach.

(3) Work Plan:

Time line

Year One:

- Modify the developmental version of ARCHER to produce and stage output for AWIPS2
- Conduct design review and begin adaption of ARCHER algorithm from Matlab to C/Fortran
- Develop prototype AWIPS2 ARCHER output viewing plug-in locally at CIMSS (CIMSS will have an AWIPS2 workstation)
- Evaluate prototype performance of ARCHER software and AWIPS2 display during 2014 TC season with JHT facilitators and NHC/TAFB personnel (assumes NHC will have its AWIPS2 workstation by then)

Year Two:

- Refine ARCHER software according to initial evaluation JHT/NHC feedback
- Refine ARCHER AWIPS2 viewing plug-in based on JHT/NHC feedback
- Implement ARCHER code on NHC or NCO server (TBD by JHT) for operational support
- Full ARCHER demonstration at TAFB/NHC (real time 2015 TC season, if possible)
- Complete ARCHER software maintenance documentation
- Complete ARCHER AWIPS2 end-user guidance documentation

Project deliverables:

Year One:

- Demonstration of real-time ARCHER products formatted for AWIPS2
- Prototype AWIPS2 ARCHER output viewer for NHC/TAFB/JHT evaluation
- Semi-annual financial and progress reports

Year Two:

- ARCHER software in C/Fortran designed to operate on a dedicated NHC or NCO server
- Final-form AWIPS2 ARCHER output viewer
- ARCHER software maintenance documentation
- ARCHER AWIPS2 end-user guidance documentation
- Semi-annual financial and progress report, and final project report

Plan to port codes to the NHC/TAFB operational environment:

A previous version of ARCHER has already been ported to C, with a few subroutines in Fortran. The latest version of ARCHER is written completely in Matlab, but the process of porting this version into C/Fortran will involve adapting and adding on to the previous code rather than a complete rewrite. This will help reduce unexpected obstacles in the porting process. The code is already capable of ingesting satellite data from the NOAAPORT datastream, so we expect few issues with this part of the delivery to a NOAA facility (NCO or NHC, TBD by JHT facilitators). As for the AWIPS2 plug-in viewer development, all required input must be able to be decoded into the AWIPS2 database. ARCHER output must be persisted in the AWIPS2 database for the display plugin. Tabular data (storm track information), hdf5 gridded data, and AWIPS2 display formats will need to be designed, approved and tested, with ultimate approval from the NCO. Access to the AWIPS2 database and hdf5 is through a Java API; thus re-coding ARCHER into C/FORTRAN will require us to learn about that interface.

Hardware and software needs:

- One local workstation at UW-CIMSS for product development and testing (provided by CIMSS at no cost)
- Updated software licenses for Matlab (local to CIMSS)
- An eventual allotment of processing capacity on an NHC or NCO server for running ARCHER, equivalent to the processing capacity of one Intel Core7 workstation
- 1 TB of storage on the NHC or NCO server

Real-time operational data needed as input:

- SSMI sensor data records from NOAAPORT (for 37, 85 GHz Tb), if DMSP F-15 continues to operate
- SSMIS sensor data records from NOAAPORT (for 37, 91 GHz Tb)

- TRMM TMI Level 1b brightness temperature files from NASA LANCE or equivalent source (for 37, 85 GHz Tb), if TRMM continues to operate
- AMSR2 Level 1b brightness temperature files from NASA LANCE or equivalent source (for 37, 85 GHz Tb, expected to come online in May 2013)
- Megha-Tropiques Level 1b brightness temperature files, if/when it becomes available
- GOES-East and West Visible, Longwave IR, and Near-IR imagery

Testing and evaluation approach:

We have budgeted travel for one PI (Wimmers) to the NHC each year to conduct an extensive review of the project progress, provide on-site training, receive feedback and discuss future directives. We have also budgeted for both PIs to travel to the Interdepartmental Hurricane Conference each year to meet with the NHC points of contact to discuss the project progress (this assumes the IHC will continue; else, an AMS conference could be substituted).

The ARCHER product will be tested on real-time TCs during the two years of the project, including non-Atlantic basin TCs, and can also be demonstrated on retrospective cases during the "off-season" in order to maximize the amount of NHC/TAFB/JHT interaction and feedback. In Year One, the project evaluation will focus on NHC/TAFB/JHT satisfaction with the AWIPS2 ARCHER viewing prototype. Key to the evaluation process will be comparisons between the ARCHER output produced at CIMSS and in the operational AWIPS2 environment. In Year Two, the project evaluation will focus on 1) the successful porting of the ARCHER software into the NHC or NCO operational environment, 2) complete pre-operational demonstration (hopefully in real time) of the ARCHER software and quasi-independent maintenance by NHC or NCO, 3) NHC/TAFB/JHT satisfaction with the final-form AWIPS2 ARCHER viewer, and 4) satisfaction with the ARCHER training and documentation. Naturally, communication between PIs and points of contact at NHC/JHT will continue via phone and email discussions between site visits.

Metrics for success:

- Matching performance of the CIMSS ARCHER results with that of the NHC/NCO delivery
- NHC/TAFB/JHT satisfaction with the AWIPS2 viewing environment
- Approval and affirmation from NHC/TAFB forecasters regarding ARCHER as an added value objective TC guidance aid

(4) Timeline for delivering scientific and technical documentation:

Year 2, Q1: Delivery of draft ARCHER end-user documentation, for using and interpreting ARCHER output in AWIPS2.

Year 2, Q2: Delivery of draft ARCHER software guide.

Year 2, Q3: Delivery of final ARCHER end-user documentation.

Year 2, Q4: Delivery of final ARCHER software guide.

(5) Travel Schedule:

Year 1, early Q2: Trip for PI Wimmers to NHC to discuss product design review, progress in code prototyping, and future planning.

Year 1, Q3: Trip for PIs Wimmers and Velden to IHC to discuss project progress, iterate on designs.

Year 2, early Q2: Trip for PI Wimmers to NHC to discuss forecaster feedback, finalize product form, discuss documentation, training.

Year 2, Q3: Trip for PIs Wimmers and Velden to IHC to discuss project deliveries and final adjustments. AMS conference could be substituted if IHC no longer meets in person.

(6) Estimates of JHT staff requirements:

In Year 1, we expect JHT staff requirements to be minor, since the design and prototype testing will be mainly done at CIMSS. JHT input will primarily consist of decision support and direction. The primary decision to be made is whether ARCHER will be operationally implemented and run on a local NHC server, or at NCEP/NCO; i.e. explore how and where to stand up an operational implementation and support model. This will determine operational and maintenance support issues, and where the input data queried by ARCHER will originate from.

In Year 2, the amount of JHT involvement will depend in part on the decision made above in regards to the hosting of ARCHER. Since ARCHER does not require any human intervention to operate normally, the JHT staff will be called upon to assist in the porting, interfacing and testing of the code in the local NHC server environment, if that option is chosen. The software delivery will be made with the understanding that primary responsibility for the software, including operational maintenance, will be handed over to a party at NHC or NCEP/NCO.

(d) Budget Summary (see the attached Budget Narrative document for further details)

Year 1

I. Labor	$67,293
1.5 months for C. Velden to optimize the algorithm design for the forecaster working environment	
4 months for A. Wimmers to begin adaption of the ARCHER algorithm from Matlab to a C/Fortran platform	
2.5 months for a graduate assistant (J. Gerth) to prototype the AWIPS2 plug-in.	
II. Travel	3,830
One trip for one person for two days to the NHC in Miami to coordinate algorithm design	
One trip for both PIs for 4 days to attend IHC and discuss project.	
III. Supplies	500
Software licenses, printed materials	
IV. Indirect costs	36,170
50.5% of non-capital expenses	
V. Tuition remission	2,222
Tuition costs to coincide with graduate student labor (mandatory)	

Year 2

I. Labor	68,637
1.5 months for C. Velden to lead the evaluation and revise the working algorithm	
4 months for A. Wimmers to finalize C/Fortran code and help implement ARCHER into the operational environment	
2 months for a graduate assistant (J. Gerth) to refine and troubleshoot AWIPS2 implementation.	
II. Travel	3,830
One trip for one person for two days to the NHC in Miami for intensive review of the algorithm beta version porting and testing	
One trip for both PIs for 4 days to attend IHC and discuss project	
III. Indirect costs	36,596
IV. Tuition remission (mandatory)	2,222
Total (2 Years)	$221,300

e) Non-federal applicant forms (attached)

f) Abbreviated Curriculum Vitae for Co-PIs Wimmers and Velden

Anthony Wimmers

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1225 W. Dayton St.
Madison, WI 53706

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Education

B. S. Physics, 1996, University of Dayton, Magna Cum Laude, Honors Program
M. S. Environmental Science, 2000, University of Virginia
Master's Thesis: "Remotely-sensed extratropical specific humidity in the mid- to upper-troposphere."
Ph. D. Environmental Science, 2003, University of Virginia
Dissertation: "Satellite-based location of tropopause folding signatures along air mass boundaries."

Work History

2003-2004	Postdoctoral researcher	CIMSS/SSEC
2004-2007	Assistant researcher	CIMSS/SSEC
2007-2011	Associate researcher	CIMSS/SSEC
2011-present	Researcher	CIMSS/SSEC

While at CIMSS, Dr. Wimmers has developed satellite-derived products for tropical cyclone intensity forecasting, tropical weather nowcasting, turbulence detection and air quality prediction. His studies of tropical cyclone imagery include algorithm development based on computer vision techniques, transition to operations and extensive validation using aircraft reconnaissance records.

Honors & Awards

Omicron Delta Kappa National Leadership Honor Society, 1996
Sigma Pi Sigma Senior Physics Award, University of Dayton, 1996
President's Fellowship, University of Virginia, 1997-2000
Atmospheric Sciences Graduate Student Award, University of Virginia, 1999
Best Student Poster Award, American Meteorological Society Conference, 1999
Maury Prize (Highest departmental award for graduate students), 2003
NASA Group Achievement Award for Earth Sciences Applications, 2004
Paul F. Holloway Technology Transfer Award, 2007

Relevant Publications

Wimmers, A. J. and C. S. Velden, 'MIMIC': A new approach to visualizing satellite microwave imagery of tropical cyclones, *Bulletin of the American Meteorological Society*, 88, 1187-1196, 2007.
Wimmers, A. J. and C. S. Velden, Objectively determining the rotational center of tropical cyclones in passive microwave satellite imagery, *J. Appl. Meteor.*, 49, 2013–2034, 2010.
Wimmers, A. J. and C. S. Velden, Seamless advective blending of total precipitable water retrievals from polar orbiting satellites, *J. Appl. Meteor.*, 50, 1024-1036, 2011.

Major Research and Professional Experience

Researcher for Program for Research on Oxidants: Photochemistry, Emissions and Transport (PROPHET) 2000-2001
Researcher for Tropospheric Ozone Production about the Spring Equinox (TOPSE) 2000-2003
Naval Research Advanced Satellite Applications 2003-present (Co-Investigator from 2010-present)
Researcher for NOAA Satellite-derived winds research, 2003-2004

Program Manager for Infusing Data into Environmental Applications (IDEA) sponsored by NASA, 2004-2006
Program Manager for Three-Dimensional Air Quality System (3D-AQS) to integrate satellite air quality observations and ground-based lidar into a real-time public awareness service, 2006-2007
Co-PI for NOAA GOES-R Risk Reduction, Turbulence products, 2004-2005, 2007-2012
Co-I for Graphical Turbulence Guidance project (NASA-ROSES), 2009-2011
PI for NOAA Cloud Product Updates for NCEP and NWS-Alaska, 2012-2014

Christopher Velden

Current Position: University of Wisconsin – Space Science and Engineering Center
Physical Sciences: Senior Scientist and Principal Investigator.

Chief Investigator for internationally-recognized UW-SSEC/CIMSS Tropical Cyclones Group and Satellite Winds Group

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E-mail: chris.velden@ssec.wisc.edu

M.S. - Dept. of Meteorology, Univ. of Wisconsin-Madison.
Topic: Tropical Cyclone Warm Core Evolution: NOAA Satellite Microwave Views. June, 1982.

B.S. - Univ. of Wisconsin-Stevens Point. Majors: Natural Sci., Geography (minor - physics). June, 1979.

Awards: Univ. Wisc. Chancellors Research Excellence Award, 2012
NOAA-CIMSS Science Collaboration Award, 2011
Elected Amer. Meteorological Society Fellow, 2008
Office of Federal Coord. for Meteorology Hagemeyer Award, 2003
Amer. Meteor. Soc. Banner Miller Award, 2001
Amer. Meteor. Soc. Special Award, 1998

Book Chapters:

C.S. Velden, J. Simpson, W. T. Liu, J. Hawkins, K. Brueske, and R. Anthes: *Chapter 11: The Burgeoning Role of Weather Satellites,* Hurricane! Coping with Disaster, American Geophysical Union Publication, Robert Simpson, Editor, 2003, 360 pp.

C.S. Velden: *Satellite Observations of Tropical Cyclones*, Global Perspectives on Tropical Cyclones: From Science to Mitigation**,** WMO New World Scientific Series on Earth System Science, C.P. Chang, Editor, 2010, 448 pp.

Major Refereed Publications (last 3 years)

Sears, J., and C. Velden, 2012: Investigating the Role of the Upper-Levels in Tropical Cyclogenesis. Submitted to *Mon. Wea. Rev*.

Monette, S., C. Velden, and K. Griffen, 2012: Examining Trends in Satellite-Detected Overshooting Tops as a Potential Predictor of Tropical Cyclone Rapid Intensification. Accepted in *J. Appl. Meteor. Clim*.

Sears, J., and C. Velden, 2012: Tropical validation of satellite atmospheric motion vectors. Accepted in *J. Appl. Meteor. Clim*.

Wu, T., S. Majumdar, C. Velden, H. Liu and J. Anderson, 2012: Influence of assimilating satellite-derived atmospheric motion vector observations on analyses and forecasts of tropical cyclone track and structure. Being submitted to *Mon. Wea. Rev*.

Berger, H., R. Langland, C. Velden and C. Reynolds, 2011: Impact of Enhanced Satellite-Derived Atmospheric Motion Vector Observations on Numerical Tropical Cyclone Track Forecasts in the Western North Pacific during TPARC/TCS-08. *J. Appl. Meteor. Clim*., Vol. 50, No. 11., 2309-2318.

Hawkins, J. and C. Velden, 2011: Supporting Meteorological Field Experiment Missions and Post-Mission Analysis with Satellite Digital Data and Products. *Bull. Amer. Meteor. Soc*., 92, 1009-1022.

Wimmers, A. and C. Velden, 2011: Seamless Advective Blending of Total Precipitable Water Retrievals from Polar Orbiting Satellites. *J. Appl. Meteor. Clim*., Vol. 50, 1024-1036.

Wimmers, A. and C. Velden, 2010: Objectively Determining the Rotational Center of Tropical Cyclones in Passive Microwave Satellite Imagery, *J. Appl. Meteor*., 49, 2013–2034, 2010

Velden, C.S and K. Bedka, 2009: Identifying the Uncertainty in Determining Satellite-Derived Atmospheric Motion Vector Height Assignments. *J. Appl. Meteor*., 48, 450-463.

Major Field and Professional Experience

Co-Chair, WMO Workshop on Tropical Cyclone Satellite Applications (2011)
Co-Chair, International Workshop on Tropical Cyclones (2010)
Co-Chair, AMS Annual Meeting (2008)
Chair, AMS Committee on Satellite Meteorology (2004-2007)
WMO/THORPEX International Science Team Working Group (2002-Present)
National Academy of Sciences NPOESS/GOES-R Study for NOAA/NASA (2007-2008)
National Academy of Sciences Decadal Study for NASA (2005-2007)
National Academy of Sciences TRMM/GPM Study for NASA/NOAA (2002-2004)
National Academy of Sciences CONNTRO Committee (2000-2003)
Bulletin of the AMS Journal Subject Editor (2002-2011)
Co-chair, WMO International Satellite Winds Working Group (1995-2008)
US Weather Research Project Science Steering Committee charter member (1996-1999)
Member AMS Committee on Satellite Meteorology (1997-2003)
Member AMS Committee on Tropical Meteorology and Cyclones (1990-1993; 2010-present)
Participant (PI or Co-I) in ~15 major atmospheric field programs since 1986
Visiting Scientist at the Australian Bureau of Meteorology (1987-1988)

g) Current and pending Federal support

Current Support - Wimmers, Anthony

Federal Award #	Agency	Project Title	Role	Project Start Date	Project End Date	Award Budget	Person Months Remaining
N00173-07-C-6004	Navy	Advanced Applications of Satellite-Based Remote Sensing	CoI	4/3/07	4/2/13	$1,128,000	0.1
NA10NES4400013	NOAA	Cloud Product Updates for NCEP and NWS-Alaska	PI	8/1/12	6/30/13	$91,429	4.3
NA10NES4400013	NOAA	Down Slope Winds	PI	7/1/12	6/30/15	$39,500	3.0

Pending Support - Wimmers, Anthony
No Proposals Pending

Current Support - Velden, Chris

Federal Award #	Agency	Project Title	Role	Project Start Date	Project End Date	Award Budget	Person Months Remaining
N00014-08-1-0251	DOD, Navy	Advanced Satellite-Derived Wind Observations, Assimilation, and Targeting Strategies during TCS-08 for Developing Improved Operational Analysis and Prediction of Western North Pacific Tropical Cyclones	PI	1/1/10	12/31/12	$332,154	0.1
NNX11AE97G	NASA	A Blended Polar Winds Product Using Atmospheric Motion Vectors from MODIS Imager and AIRS Moisture Retrieval Data	CoI	2/8/11	2/7/13	$229,125	1.8

NA10NES4400013	NOAA	CIMSS Participation in the GOES-R Algorithm Working Group (AWG) for 2012	CoI	4/1/12	3/31/13	$2,768,000	1.4
N00173-07-C-6004	DOD	Advanced Applications of Satellite-Based Remote Sensing	PI	4/3/07	4/30/13	$1,130,000	2.9
NA11OAR4310200	NOAA	Collaborative Research: Improvements to the SHIPS Rapid Intensification Index	CoI	8/1/11	7/31/13	$65,949	0.7
ATM-0850709	NSF	Characterizing Atlantic Tropical Cyclone Genesis Using Special PREDICT Measurements and Satellite Observations	PI	9/15/09	8/31/13	$375,001	0.0
N00014-10-1-0123	DOD	Achieving Superior Tropical Cyclone Intensity Forecasts by Improving the Assimilation of High-Resolution Satellite Data into Mesoscale Prediction Models	PI	10/1/09	9/30/13	$903,279	0.8
S13-0010	NASA	Utilizing NASA Reconnaissance Assets to Investigate Hurricane Upper-level Warm Core Evolution, Inner Core Pulsing, and Near-Environment Moisture Interactions	CoI	7/1/12	6/30/15	$170,489	1.7

Pending Support - Velden, Chris
No Proposals Pending

All projects for both investigators are located at UW Madison unless otherwise noted.

References

Aberson, S., 2002: Two years of operational hurricane synoptic surveillance. Wea. Fore., 17, 1101-1110.

Goerss, J., 2009: Impact of satellite observations on the tropical cyclone track forecasts of the NOGAPS. Mon. Wea. Rev., 137, 41-50.

Olander, T., C. Velden and J. Kossin, 2004: The Advanced Objective Dvorak technique (AODT): Latest upgrades and future directions. 26th AMS Hurricane and Trop. Meteor. Conf., 294-295.

Olander, T., and C.S. Velden, 2007: The Advanced Dvorak Technique (ADT) – Continued development of an objective scheme to estimate tropical cyclone intensity using geostationary infrared satellite imager. Wea. Forecasting, 22, 287-298.

Velden, C.S. et al., 2006: The Dvorak tropical cyclone intensity estimation technique: A satellite-based method that has endured for over 30 years. Bull. Amer. Meteor. Soc., 85, 353-385.

Wimmers, A. J. and C. S. Velden, 2010: Objectively determining the rotational center of tropical cyclones in passive microwave satellite imagery, J. Appl. Meteor., 49, 2013–2034.

Wimmers, A. J. and C. S. Velden, 2012: Advances in objective tropical cyclone center fixing using multispectral satellite imagery, AMS 31st Conference on Hurricanes and Tropical Meteorology.

Budget Narrative

Integration of an Objective, Automated TC Center-fixing Algorithm Based on Multispectral Satellite Imagery into NHC/TAFB Operations

We request a total dollar amount of $221,300 for the period 1 August 2013 to 31 July 2015 to fund the research outlined in the proposal description. Explanations of the budget information are given directly below. The costs to conduct the activities described in this proposal are summarized in the budget pages provided. Cost estimates in these budget pages are based on historical events and experience.

Personnel

The following individuals have been identified as key personnel to this proposal:
Tony Wimmers, CoPI, 1200 hours
Chris Velden, CoPI, 450 hours
Time quoted for key personnel is the total amount of anticipated effort required to complete the proposed effort over the life of the project, including during periods of no cost extension. All effort for key persons will be sponsor paid effort. Fulfillment of the effort commitment will be defined as a total for the entire project period. We cannot guarantee effort for key personnel commitments per budget period given the uncertain volatile nature of research and funding availability. Funding reductions will result in a scaled back effort; the project narrative, the budget, and key personnel obligations will all be reduced in the same manner (i.e. if the funding is cut 25%, we will cut 25% of the project narrative and 25% of the labor and cost involved) unless otherwise negotiated.

This section identifies the staff required and their time commitment (hours needed) to conduct this proposed work. Salary information is provided in the SF424A and the UW-Madison Excel budget sheets. To calculate hourly rates for salaried employees, the formula is Total Salary divided by billable hours. Hourly rates are calculated using a base of 1,350 billable hours per year for Faculty and 1,750 billable hours for Academic Staff. The base for research interns, research associates, and graduate students is 1800 billable hours. Undergraduates are paid on an hourly basis, so no computation is required. Vacation, holiday and sick leave time is not charged directly to the projects. For budgets with duration greater than one year, we use a 2% inflation factor to labor rates to account for cost of living adjustment. To achieve the goals of this proposal, we estimate an approximate total effort at CIMSS as follows:

Name	Title	Classification	Hours	% Effort
Anthony Wimmers	Co-Principal Investigator	Academic Staff	1200	34.3%
Chris Velden	Co-Principal Investigator	Academic Staff	450	12.9%
Jordan Gerth	Graduate Student	Research Assistant	300	16.7%

Participant Activity Summary

Tony Wimmers as Co-PI will oversee all project activities and reporting. He will be responsible for adapting the ARCHER algorithm to the operational environment, delivery, post-delivery modifications, assessment and documentation.
Chris Velden as Co-PI will provide guidance and assistance on the algorithm evaluation, modification and documentation.

Jordan Gerth is a student research assistant with expertise in AWIPS-2 programming and adaptations. He will prototype the AWIPS-2 plug in viewer for this project.

Fringe Benefits

Fringe rates are dependent on employee classification (which is listed under the Personnel section). Please see the below table for a detailed summary of how the fringe benefit rate is calculated at the University of Wisconsin-Madison:

Components of the 2012-2013 Fringe Benefit Rate

Benefit Category	Faculty & Academic Staff	Classified Staff	LTE	Research Associates & Grad Interns	Research, Project & Teaching Assistants Pre-Doc Fellows/Trainees	Ad Hoc Program Specialists, Undergrad Assistants and Interns	Post-Doc Fellows/Trainees	Student Hourly
Income Continuation	0.2	0.2						
Unemployment Compensation	0.1	0.2	1.9					
Worker's Compensation	0.2	0.2	0.2					
Social Security	5.6	6.0	6.2	5.3		5.8		2.1
Medicare	1.4	1.4	1.4	1.2		1.4		0.5
Health Insurance	19.5	32.9	5.0	19.0	28.0		16.2	
Life Insurance	0.1	0.1						
Retirement	15.4	15.4	3.3					
Prior Year Adjustments	4.3	5.4	2.0	1.2	2.0	1.9	1.6	(0.3)
Adjustment for Actuals	(5.8)	(5.8)			(2.0)			
Totals	41.0%	56.0%	20.0%	26.7%	28.0%	9.1%	17.8%	2.3%

Travel

Travel costs are for UW-Madison staff to attend meetings, workshops and professional conferences. The travel budgets in this proposal are based on recent history regarding the amount of travel needed to support the research project, interact with collaborators, and present results. The SSEC travel office monitors current airfares, hotel costs, car rentals, taxi fares, etc. and provides estimates for travel costs for frequent meeting sites. The UW-Madison, in accordance with Wisconsin state law, reimburses actual travel costs for hotel and meal expenses up to a certain maximum rate. All travel must be approved by the SSEC/CIMSS administration. Travel costs are reviewed by the SSEC travel office and one of the SSEC Executive Directors.

To support this research, the trips detailed below have been budgeted. We have budgeted for 1 trip per year for PI (Wimmers) to go to the National Hurricane Center to discuss product design review, progress in code porting, prototyping, and future planning in the amount of $1,010 per year. Also, we have budgeted 1 trip per year for both PIs (Wimmers and Velden) to attend the Interdepartmental Hurricane Conference to discuss project progress, iterate on designs in the amount of $2,820 per year. The total cost of travel in this budget request is $7,660.

1 Trip/ 1 person / 2 days / NHC - Miami, FL			
	fares		subtotal
Airfare	1	450	450
	# days	cost / day	
Hotel	2	160	320
Meals	2	40	80
Car Rental	2	55	110
Airport transportion - Madison	2	25	50
			1,010

1 Trip/ 2 people / 4 days / IHC-TBD			
	fares		subtotal
Airfare	2	450	900
	# days	cost / day	
Hotel	8	160	1280
Meals	8	40	320
Car Rental	4	55	220
Airport transportion - Madison	4	25	100
			2,820

Parts, Materials, Fees and Services

These items are required to support the research infrastructure of a particular project. They include items such as data storage materials, small computer peripherals, off the shelf computer software such as compilers, computer maintenance licensing agreements, conference registration and abstracts, and in-house publishing. Costs are based on current estimates and recent purchases with our contracted providers. We are requesting $500 for Supplies, Materials, Fees and Services.

Construction

This program does not expect to perform any construction or renovation.

University Indirect Cost, currently at 50.5%, is directly negotiated with the U.S. government and is charged to all budget items except capital equipment purchases over $5,000 and student tuition remission, which are free of Indirect Cost. The first $25,000 of a subcontract award is subject to university Indirect Cost, any award above $25,000 is free of Indirect Cost.

Tuition Remission is assessed by the University for graduate student employees to pay for out of state tuition costs. It is a fixed dollar amount of $8,000 per student per academic year regardless of appointment percentage and is excluded from the Indirect Cost. We propose that the graduate student for this effort will receive 2.5 months of support from this project. His remaining support will be provided by another grant.

Capital Equipment, including Purchase Quotations and Lease vs. Purchase Details

For this proposal we do not request any Capital Equipment.

Matching

We do not expect any cost matching for this proposal.

Severability

While the budgets presented herein cover the entire period of the CIMSS four and a half year Cooperative Agreement, it is recognized that each research task is comprised of many individual research projects. Proposals for these projects will be individually reviewed and funded for periods that fall within the four and a half year proposal timeframe. The budgets herein are severable. Further, because the proposal is divided into major tasks, it can be severed proportionately as needed. Since the Cooperative Agreement operates on a research collaboration basis, results of research conducted with the funds under this agreement will (to the point of being severed) be documented and submitted to NOAA/NESDIS as the University of Wisconsin CIMSS product, unless other specific arrangements are made.

Budget Details

	Year 1						
	08/01/2013 - 07/31/2014						
I.	Labor and Fringe Benefits	Hours	Rate	Salary	Fringe	Cost	Totals
	PI - Wimmers	600	40.07	$ 24,043	$ 9,858	$ 33,901	
	Senior Scientist - C.Velden	225	77.82	$ 17,510	$ 7,179	24,689	
	Graduate Student	300	22.66	$ 6,799	$ 1,904	8,703	
	Subtotal						$67,293
II.	Materials and Supplies						500
III.	Travel						
	1 Trip/ 1 person / 2 days / NHC - Miami, FL					1,010	
	1 Trip/ 2 people / 4 days / IHC-TBD					2,820	
							3,830
IV.	Publication 15 pages @140/page						0
V.	University Indirect Cost at 50.5%						36,170
VI.	Tuition Remission						2,222
	TOTAL						$110,015

Summary of Budget by CIMSS Research Theme	
Theme 1. Satellite Meteorology Research and Applications	110,015
Theme 2. Satellite Sensors and Techniques	0
Theme 3. Environmental Models and Data Assimilation	0
Theme 4. Education and Outreach	0
Total	**110,015**

	Year 2						
	08/01/2014 - 07/31/2015						
I.	Labor and Fringe Benefits	Hours	Rate	Salary	Fringe	Cost	Totals
	PI - Wimmers	600	40.87	$ 24,523	$ 10,054	$ 34,577	
	Senior Scientist - C.Velden	225	79.38	$ 17,860	$ 7,323	25,183	
	Graduate Student	300	23.12	$ 6,935	$ 1,942	8,877	
	Subtotal						$68,637
II.	Materials and Supplies						0
III.	Travel						
	1 Trip/ 1 person / 2 days / NHC - Miami, FL					1,010	
	1 Trip/ 2 people / 4 days / IHC-TBD					2,820	
							3,830
IV.	Publication 15 pages @140/page						0
V.	University Indirect Cost at 50.5%						36,596
VI.	Tuition Remission						2,222
	TOTAL						$111,285

Summary of Budget by CIMSS Research Theme	
Theme 1. Satellite Meteorology Research and Applications	111,285
Theme 2. Satellite Sensors and Techniques	0
Theme 3. Environmental Models and Data Assimilation	0
Theme 4. Education and Outreach	0
Total	**111,285**

		Summary					
		08/01/2013 - 07/31/2015					
I.	Labor and Fringe Benefits		Hours	Salary	Fringe	Cost	Totals
		PI - Wimmers	1200	$ 48,566	$ 19,912	$ 68,478	
		Senior Scientist - C.Velden	450	$ 35,370	$ 14,502	$ 49,872	
		Graduate Student	600	$ 13,734	$ 3,846	$ 17,580	
		Subtotal					$135,930
II.	Materials and Supplies						500
III.	Travel						
	2 Trips / 1 person / 2 days each / NHC - Miami, FL					2,020	
	2 Trips / 2 people / 4 days each / IHC - TBD					5,640	
							7,660
IV.	Publication 15 pages @140/page						0
V.	University Indirect Cost at 50.5%						72,766
VI.	Tuition Remission						4,444
		TOTAL					$221,300
		Summary of Budget by CIMSS Research Theme					
		Theme 1. Satellite Meteorology Research and Applications					221,300
		Theme 2. Satellite Sensors and Techniques					0
		Theme 3. Environmental Models and Data Assimilation					0
		Theme 4. Education and Outreach					0
		Total					**221,300**

COLLEGES AND UNIVERSITIES RATE AGREEMENT

EIN: 1396006492A1

ORGANIZATION:
University of Wisconsin - Madison and Extension
21 North Park Street Suite 6401
Madison, WI 53715

DATE:06/15/2012

FILING REF.: The preceding agreement was dated 04/06/2011

The rates approved in this agreement are for use on grants, contracts and other agreements with the Federal Government, subject to the conditions in Section III.

SECTION I: INDIRECT COST RATES

RATE TYPES: FIXED FINAL PROV. (PROVISIONAL) PRED. (PREDETERMINED)

	EFFECTIVE PERIOD				
TYPE	FROM	TO	RATE(%)	LOCATION	APPLICABLE TO
PRED.	07/01/2010	06/30/2011	49.50	On Campus	Organized Research
PRED.	07/01/2011	06/30/2013	50.50	On Campus	Organized Research
PRED.	07/01/2010	06/30/2013	50.00	On Campus	Instruction
PRED.	07/01/2010	06/30/2013	36.00	On Campus	Public Service
PRED.	07/01/2010	06/30/2013	32.00	On Campus	Ext. Public Service
PRED.	07/01/2010	06/30/2013	34.50	On Campus	Primate Ctr Rate (A)
PRED.	07/01/2010	06/30/2013	14.00	On Campus	Primate Ctr Rate (B)
PRED.	07/01/2010	06/30/2013	26.00	Off Campus	AllPrograms

TYPE	FROM	TO	RATE(%)	LOCATION	APPLICABLE TO
PROV.	07/01/2013	Until Amended			"Use same rates and conditions as cited for fiscal year ended 06/30/13"

*BASE

Modified total direct costs, consissting of all salaries and wages, fringe benefits, materials, supplies, services, travel and subgrants and subcontracts up to the first $25,000 or each subgrant or subcontract(regardless of the period covered by the subgrant or subcontract). Modified total direct costs shall exclude equipment, capital expenditures, charges for patient care, tuition remission, rental costs of off-site facilites, scholarships, and fellowships as well as the portion of each subgrant and subcontract in excess of $25,000.

(A) All Primate Center.

(B) Non P.51 Core grants only.

ORGANIZATION: University of Wisconsin - Madison and Extension
AGREEMENT DATE: 06/15/2012

SECTION I: FRINGE BENEFIT RATES**

TYPE	FROM	TO	RATE(%)	LOCATION	APPLICABLE TO
FIXED	7/1/2011	6/30/2012	44.00	All	(1)
FIXED	7/1/2011	6/30/2012	58.00	All	(2)
FIXED	7/1/2011	6/30/2012	25.40	All	(3)
FIXED	7/1/2011	6/30/2012	27.30	All	(4)
FIXED	7/1/2011	6/30/2012	17.80	All	(5)
FIXED	7/1/2011	6/30/2012	18.00	All	(6)
FIXED	7/1/2011	6/30/2012	6.00	All	(7)
FIXED	7/1/2011	6/30/2012	3.50	All	(8)
FIXED	7/1/2012	6/30/2013	41.00	All	(1)
FIXED	7/1/2012	6/30/2013	56.00	All	(2)
FIXED	7/1/2012	6/30/2013	26.70	All	(3)
FIXED	7/1/2012	6/30/2013	28.00	All	(4)
FIXED	7/1/2012	6/30/2013	17.80	All	(5)
FIXED	7/1/2012	6/30/2013	20.00	All	(6)
FIXED	7/1/2012	6/30/2013	9.10	All	(7)
FIXED	7/1/2012	6/30/2013	2.30	All	(8)

PROV.	7/1/2013	Until amended	"Use same rates and conditions as cited for FYE 6/30/13."

** DESCRIPTION OF FRINGE BENEFITS RATE BASE:

Salaries and wages of faculty and staff including vacation, hoiday abd sick leave pay and other paid absences of only the faculty and staff. Rate does not apply to student employees, research or teaching assistants.

(1) Regular Faculty and Academic Staff
(2) Regular Classified
(3) Research Associates and Grad Interns
(4) Research Assistants, Project Assistants, Teaching Assistants, Pre-Doc Fellows and/or Trainees
(5) Post-Doc Fellows and/or Trainees
(6) Limited Term Employees (LTE's)
(7) Ad Hoc Program Specialists, Undergraduate Assistants and Undergraduate Interns
(8) Student Hourly Employees

Fringe Benefit rates are combined rates for Madison and Milwaukee Campuses and are applied to both the campuses. These Fringe Benefit rates are also included on the University of Wisconsin, Milwaukee rate agreement.

ORGANIZATION: University of Wisconsin - Madison and Extension

AGREEMENT DATE: 06/15/2012

SECTION II: SPECIAL REMARKS

TREATMENT OF FRINGE BENEFITS:

The fringe benefits are charged using the rate(s) listed in the Fringe Benefits Section of this Agreement. The fringe benefits included in the rate(s) are listed below.

TREATMENT OF PAID ABSENCES

Vacation, holiday, sick leave pay and other paid absences are included in salaries and wages and are claimed on grants, contracts and other agreements as part of the normal cost for salaries and wages. Separate claims are not made for the cost of these paid absences.

OFF-CAMPUS DEFINITION: For all activities performed in facilities not owned by the institution and to which rent is directly allocated to the project(s) the off-campus rate will apply. Grants or contracts will not be subject to more than one F&A cost rate. If more than 50% of a project is performed off-campus, the off-campus rate will apply to the entire project.

Equipment Definition -
Equipment means an article of nonexpendable, tangible personal property having a useful life of more than one year and an acquisition cost of $5,000 or more per unit.

FRINGE BENEFITS:

FICA
Retirement
Disability Insurance
Worker's Compensation
Life Insurance
Unemployment Insurance
Health Insurance
Severance Allowance
ERA Administration
Income Continuation Insurance

ORGANIZATION: University of Wisconsin - Madison and Extension

AGREEMENT DATE: 06/15/2012

SECTION III: GENERAL

A. LIMITATIONS:

The rates in this Agreement are subject to any statutory or administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the organization were included in its facilities and administrative cost pools as finally accepted: such costs are legal obligations of the organization and are allowable under the governing cost principles; (2) The same costs that have been treated as facilities and administrative costs are not claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the organization which was used to establish the rates is not later found to be materially incomplete or inaccurate by the Federal Government. In such situations the rate(s) would be subject to renegotiation at the discretion of the Federal Government.

B. ACCOUNTING CHANGES:

This Agreement is based on the accounting system purported by the organization to be in effect during the Agreement period. Changes to the method of accounting for costs which affect the amount of reimbursement resulting from the use of this Agreement require prior approval of the authorized representative of the cognizant agency. Such changes include, but are not limited to, changes in the charging of a particular type of cost from facilities and administrative to direct. Failure to obtain approval may result in cost disallowances.

C. FIXED RATES:

If a fixed rate is in this Agreement, it is based on an estimate of the costs for the period covered by the rate. When the actual costs for this period are determined, an adjustment will be made to a rate of a future year(s) to compensate for the difference between the costs used to establish the fixed rate and actual costs.

D. USE BY OTHER FEDERAL AGENCIES:

The rates in this Agreement were approved in accordance with the authority in Office of Management and Budget Circular A-21 Circular, and should be applied to grants, contracts and other agreements covered by this Circular, subject to any limitations in A above. The organization may provide copies of the Agreement to other Federal Agencies to give them early notification of the Agreement.

E. OTHER:

If any Federal contract, grant or other agreement is reimbursing facilities and administrative costs by a means other than the approved rate(s) in this Agreement, the organization should (1) credit such costs to the affected programs, and (2) apply the approved rate(s) to the appropriate base to identify the proper amount of facilities and administrative costs allocable to these programs.

BY THE INSTITUTION:

University of Wisconsin - Madison and Extension

(INSTITUTION)

(SIGNATURE)

(NAME)

Assoc. Vice Chancellor

(TITLE)

6-26-12

(DATE)

ON BEHALF OF THE FEDERAL GOVERNMENT:

DEPARTMENT OF HEALTH AND HUMAN SERVICES

(AGENCY)

(SIGNATURE)

Arif Karim

(NAME)

Director, Central States Field Office

(TITLE)

6/15/2012

(DATE) 5121

HHS REPRESENTATIVE: Shon Turner

Telephone: (214) 767-3261

OMB Number: 4040-0004
Expiration Date: 03/31/2012

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received: 12/05/2012

4. Applicant Identifier:

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: The Board of Regents of the University of Wisconsin System

* b. Employer/Taxpayer Identification Number (EIN/TIN): 396006492

* c. Organizational DUNS: 1612021220000

d. Address:

* Street1: 21 N Park St Ste 6401

Street2:

* City: Madison

County/Parish:

* State: WI: Wisconsin

Province:

* Country: USA: UNITED STATES

* Zip / Postal Code: 53715-1218

e. Organizational Unit:

Department Name:

Division Name:

f. Name and contact information of person to be contacted on matters involving this application:

Prefix:

* First Name: Brenda

Middle Name:

* Last Name: Egan

Suffix:

Title:

Organizational Affiliation:

* Telephone Number: 608-262-3822

Fax Number:

* Email: baegam@rsp.wisc.edu

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

H: Public/State Controlled Institution of Higher Education

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Department of Commerce

11. Catalog of Federal Domestic Assistance Number:

11.459

CFDA Title:

Weather and Air Quality Research

*** 12. Funding Opportunity Number:**

NOAA-OAR-OWAQ-2013-2003469

* Title:

FY 2013 Joint Hurricane Testbed

13. Competition Identification Number:

2297052

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

Integration of an Objective, Automated TC Center-fixing Algorithm Based on Multispectral Satellite Imagery into NHC/TAFB Operations

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: WI-002 b. Program/Project: WI-002

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 08/01/2013 * b. End Date: 07/31/2015

18. Estimated Funding ($):

* a. Federal	221,300.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	221,300.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: * First Name: Nick

Middle Name:

* Last Name: Novak

Suffix:

* Title: Managing Officer

* Telephone Number: 608-262-3822 Fax Number:

* Email: preaward@rsp.wisc.edu

* Signature of Authorized Representative: Brenda Egan * Date Signed: 12/05/2012

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 06/30/2014

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Weather and Air Quality Research - Year 1	11.459	$	$	$ 110,015.00	$	$ 110,015.00
2. Weather and Air Quality Research - Year 2	11.459			111,285.00		111,285.00
3.						
4.						
5. Totals		$	$	$ 221,300.00	$	$ 221,300.00

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SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1) Weather and Air Quality Research - Year 1	(2) Weather and Air Quality Research - Year 2	(3)	(4)	Total (5)
a. Personnel	$ 48,352.00	$ 49,318.00	$	$	$ 97,670.00
b. Fringe Benefits	18,941.00	19,319.00			38,260.00
c. Travel	3,830.00	3,830.00			7,660.00
d. Equipment	0.00	0.00			
e. Supplies	500.00	0.00			500.00
f. Contractual	0.00	0.00			
g. Construction	0.00	0.00			
h. Other	2,222.00	2,222.00			4,444.00
i. Total Direct Charges (sum of 6a-6h)	73,845.00	74,689.00			$ 148,534.00
j. Indirect Charges	36,170.00	36,596.00			$ 72,766.00
k. TOTALS (sum of 6i and 6j)	$ 110,015.00	$ 111,285.00	$	$	$ 221,300.00
7. Program Income	$	$	$	$	$

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SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8.	$	$	$	$
9.				
10.				
11.				
12. TOTAL (sum of lines 8-11)	$	$	$	$

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$	$	$	$	$
14. Non-Federal	$				
15. TOTAL (sum of lines 13 and 14)	$	$	$	$	$

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS) (b)First	(c) Second	(d) Third	(e) Fourth
16. 11.459 - Weather and Air Quality Research - 1st Quarter	$ 27,821.25	$	$	$
17. 11.459 - Weather and Air Quality Research - 2nd Quarter	27,821.25			
18. 11.459 - Weather and Air Quality Research - 3rd Quarter	27,821.25			
19. 11.459 - Weather and Air Quality Research - 4th Quarter	27,821.25			
20. TOTAL (sum of lines 16 - 19)	$ 111,285.00	$	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges: 148,534

22. Indirect Charges: 72,766

23. Remarks:

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OMB Number: 4040-0007
Expiration Date: 06/30/2014

ASSURANCES - NON-CONSTRUCTION PROGRAMS

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C.§§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U. S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee- 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

19. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

* SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	* TITLE
Brenda Egan	Managing Officer
* APPLICANT ORGANIZATION	* DATE SUBMITTED
The Board of Regents of the University of Wisconsin System	12/05/2012

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FORM **CD-511**
(REV 1-05)

U.S. DEPARTMENT OF COMMERCE

CERTIFICATION REGARDING LOBBYING

Applicants should also review the instructions for certification included in the regulations before completing this form. Signature on this form provides for compliance with certification requirements under 15 CFR Part 28, 'New Restrictions on Lobbying.' The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of Commerce determines to award the covered transaction, grant, or cooperative agreement.

LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 15 CFR Part 28, for persons entering into a grant, cooperative agreement or contract over $100,000 or a loan or loan guarantee over $150,000 as defined at 15 CFR Part 28, Sections 28.105 and 28.110, the applicant certifies that to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying.' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

Statement for Loan Guarantees and Loan Insurance

The undersigned states, to the best of his or her knowledge and belief, that:

In any funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this commitment providing for the United States to insure or guarantee a loan, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying,' in accordance with its instructions.

Submission of this statement is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required statement shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above applicable certification.

* NAME OF APPLICANT

The Board of Regents of the University of Wisconsin System

* AWARD NUMBER

Not Assigned

* PROJECT NAME

Integration of an Objective, Automated TC Center-fixing Algo

Prefix:

* First Name: Nick

Middle Name:

* Last Name: Novak

Suffix:

* Title: Managing Officer

* SIGNATURE: Brenda Egan

* DATE: 12/05/2012