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Real-time Ventilation Diagnostics for Operational Forecasts of Tropical Cyclone Intensity and Genesis

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“Real-Time Ventilation Diagnostics for Operational Forecasts of Tropical Cyclone Intensity and Genesis”

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2. ABSTRACT:

This proposal addresses the need for guidance products to improve tropical cyclone forecasts at the National Oceanic and Atmospheric Administration operational forecast centers, as announced in the 2013 Joint Hurricane Testbed (JHT) request for proposals. The proposed work is expected to lead to new and improved guidance products and forecasting techniques for tropical cyclogenesis and tropical cyclone intensity, including rapid intensification and weakening. The ventilation index, which is a theoretically based measure of the nonlinear effects of the environmental wind shear and the environmental thermodynamic state on tropical cyclones, is the foundation for the proposed products and techniques.

The ventilation index provides information in both the short and medium ranges that can objectively identify how likely a tropical disturbance is to develop. Maps of the ventilation index and time series of the ventilation index following disturbances provide categorical favorability for development. Additionally, a logistic regression model using the mean ventilation index following a disturbance provides skillful probabilities of tropical cyclogenesis over a desired forecast interval. The ventilation index will be incorporated into a more comprehensive genesis model, such as a multivariate logistic regression model, in order to further improve skill. The ventilation index will be calculated using multi-model deterministic global models and model ensembles to produce uncertainty measures of genesis in the guidance products.

The ventilation index combined with the normalized intensity, defined as the intensity divided by the potential intensity, also constrains the intensification of a tropical cyclone. Where a TC lies in the joint ventilation index and normalized intensity parameter space controls the probability distribution of the intensification over the subsequent 24 hours, and thus, provides guidance on the expected ventilation-induced intensification and probability of rapid intensification or weakening. By mapping out a trajectory of the TC in the joint ventilation index and normalized intensity parameter space with deterministic forecast data, probability distributions of intensification can be generated at longer lead times. Ensemble data will be used to assess the uncertainty of the trajectory and give more dispersive probability distributions that reflect the forecast uncertainty. The ventilation index will also be used as an input parameter in modified versions of the Statistical Hurricane Intensity Prediction Scheme (SHIPS) and the Logistic Growth Equation Model (LGEM) to assess whether the ventilation index increases the skill of these models.

3. STATEMENT OF WORK:

a) DURATION

We anticipate the duration of the project to be two years (August 1, 2013 to July 31, 2015).

b) PROJECT DESCRIPTION

Tropical cyclogenesis and tropical cyclone (TC) intensification are two challenging aspects of TC prediction. The environment plays a role in both processes. One important environmental control is vertical wind shear. Sufficiently strong vertical wind shear impedes the development of tropical disturbances in to TCs (Gray 1968; Tory et al. 2007; Nolan and Rappin 2008) and also impedes TC intensification (DeMaria 1996; Gallina and Velden 2002; Rappaport et al. 2010).

An additional environmental control is midlevel tropospheric moisture. In tropical disturbances, advection of dry air into the disturbances disrupts the formation of a deep, moist column that is postulated to be imperative for genesis (Emanuel 1989; Bister and Emanuel 1997; Nolan 2007). In TCs, dry air reduces the buoyancy of convective updrafts and encourages the formation of downdrafts, which transport low-entropy air into the boundary layer (Powell 1990).

Environmental vertical wind shear and dry air at midlevels combine to ventilate the disturbance or TC with low-entropy air, acting as a constraint on the development of the incipient vortex or the efficiency of the hurricane heat engine (Simpson and Riehl 1958; Marin et al. 2009; Rappin et al. 2010; Riemer et al. 2010; Tang and Emanuel 2010; Riemer and Montgomery 2011; Tang and Emanuel 2012a). While forecasters are aware that wind shear and dry air are inimical to TCs, there is no system in place to robustly analyze the interaction of these factors and their combined effect on both genesis and intensification.

Tang and Emanuel (2012b), hereafter TE12, addressed this problem. TE12 developed a ventilation index based on a simple analytical model of a ventilated TC. The ventilation index is defined as

$$\Lambda = \frac{u_{\mathrm{shear}}\chi_{\mathrm{m}}}{u_{\mathrm{PI}}},$$

where u_{shear} is the bulk vertical wind shear between 850 and 200 hPa, χ_{m} is the nondimensional entropy deficit, and u_{PI} is the potential intensity. The nondimensional entropy deficit is a measure of how dry and cool the environment is relative to the TC or disturbance and provides a more complete metric of the thermodynamic difference between the system and environment.

The ventilation index can be interpreted as a ratio between "anti-fuel" processes that contribute to the destruction of available potential energy of the TC or disturbance and processes that generate available potential energy, namely surface fluxes. A small ventilation index allows an incipient vortex to incubate and spin up in to a TC or for an already mature TC to intensify. On the contrary, a large ventilation index decreases the work that can be accomplished, leading to failed genesis or weakening a TC.

The ventilation index is a promising new metric to evaluate the potential for genesis and ventilation-induced intensity changes. In contrast to a purely empirical metrics, there is a body of theoretical, modeling, and observational evidence that supports the utility of the ventilation index. Second, the ventilation index is applicable for all phases of a TC, except tropical-transitioning or extratropical-transitioning storms. Third, the ventilation index can be easily calculated from a variety of gridded data, from high-resolution TC models to coarser global numerical weather prediction models. Finally, the ventilation index has the potential to have broader impacts on a number of other JHT projects. In the following two subsections, we outline a number of tools that incorporate the ventilation index to aid operational centers to better forecast the formation and intensification of TCs.

i) Tropical Cyclogenesis

This section elaborates on how the ventilation index may be used as part of a framework to address the need for "guidance for TC genesis at both the short-range (0-48 hours) and the medium-range (48-120 hours) that exhibits a high probability of detection and a low false alarm rate, and/or provides probability of genesis" (NHC-8/JTWC-3) and "diagnostic techniques to further increase the utility of global models in forecasting TC genesis" (EMC-2).

TE12 conducted a statistical analysis of the ventilation following individual tropical disturbances in the 2005-2009 NHC and JTWC invest databases. In contrast to nondeveloping disturbances, developing disturbances preferentially undergo genesis when the ventilation index is anomalously low 0-60 hours before genesis. Hence, the ventilation index provides information in both the short and medium ranges that can objectively identify how likely a disturbance is to develop.

The most basic guidance products are real-time maps of the ventilation index and anomalies from gridded analyses and forecasts from a numerical weather prediction model. Figure 1 shows an example of the ventilation index and the location of disturbance al982012 from the GFS analysis on 1200 UTC 20 October 2012. The shading reflects a categorical favorability for genesis based on the statistics of TE12: cool colors reflect favorable conditions for genesis, gray colors reflect neutral conditions, and warm colors reflect unfavorable conditions for genesis. In the preceding three days before genesis, the ventilation index around al982012 remained favorable. This information would alert a forecaster that genesis was becoming increasingly likely, as the time-averaged ventilation index remained favorable for development.

In addition to analyses, the forecasted ventilation index can be plotted in the same manner using forecast fields from a numerical weather prediction model. The prior history of the ventilation index plus the forecasted ventilation index following a particular disturbance allows a forecaster to quickly assess whether a particular disturbance is forecasted to remain in favorable conditions or move into more unfavorable conditions in the future. A forecaster can also assess the forecast uncertainty by comparing the ventilation index from different deterministic models or model ensembles.

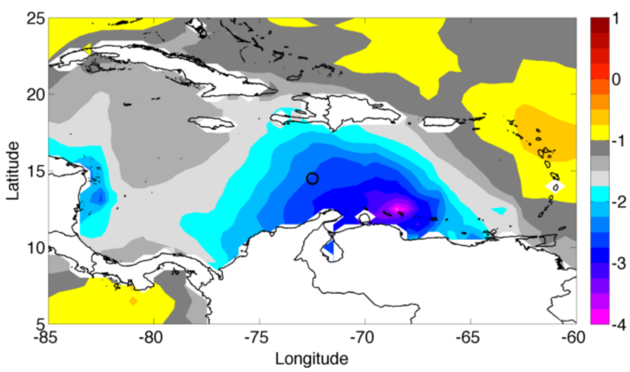

Figure 1. The logarithm of the ventilation index from the GFS analysis on 1200 UTC 20 October 2012 (shading) and the estimated position of disturbance al982012 (circle) that was upgraded to a depression on 1200 UTC 22 October 2012 and became Hurricane Sandy thereafter.

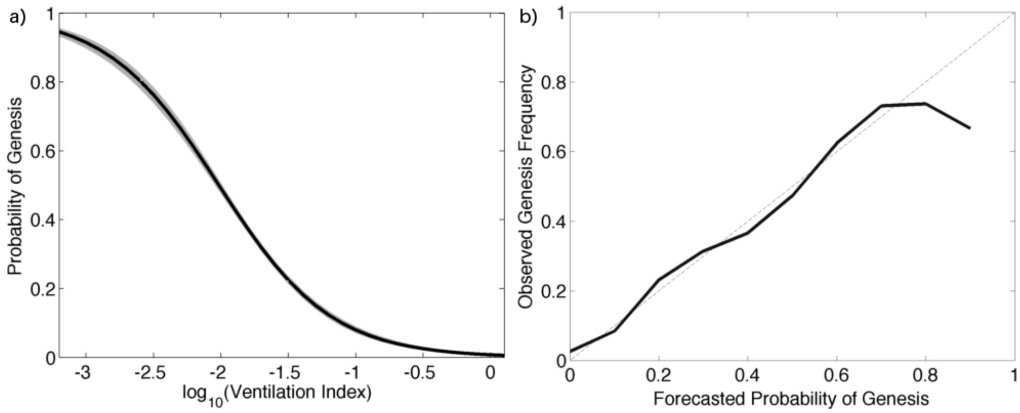

Figure 2. (a) A logistic regression genesis model for the probability of genesis within 48 hours as a function of the ventilation index. The gray shading gives the 95% confidence bound of the model. (b) The reliability (forecasted probability of genesis versus observed genesis frequency) of the model when used to hindcast the probability of genesis within 48 hours for the 2005-2009 NHC and JTWC invests. The dashed line is the one-to-one reference line of perfect reliability.

In addition to the categorical likelihood maps, we plan to implement a logistic regression model as a "guidance-on-guidance" tool that assigns a probability of genesis at specified lead times given the mean ventilation index following a disturbance. Figure 2a gives an example of the logistic regression model for the probability of genesis within 48 hours given the mean ventilation index over a 72-hour window encompassing the prior 24 hours and the 48-hour forecast window. Figure 2b shows the reliability of the model when used to hindcast the genesis of disturbances in the 2005-2009 NHC and JTWC invest databases. Except for the highest forecast probabilities, the model shows excellent reliability, as evidenced by the close proximity to the one-to-one line.

The advantage of using a logistic regression model is its flexibility. The model can be easily reformulated to any desired range of forecast lead times and only requires the ventilation index following the disturbance over the chosen averaging window. For instance, the model can be retrained to calculate the probability of genesis between 48-120 hours using the mean forecasted ventilation index between 24 and 120 hours as a predictor. Additionally, the ventilation index can be calculated from any numerical weather prediction model or ensemble in order to provide a set of multi-model/ensemble genesis probabilities to form a model consensus or to assess differences between individual models.

An additional goal of this project is to incorporate the ventilation index as an element in a more comprehensive genesis model that includes additional information about the environment and the disturbance itself. Previous comprehensive genesis models contain similar components as the ventilation index, but the key difference is the nonlinear nature of the ventilation index. The nonlinearity suggests an important statistical interaction that has not been previously considered. Examples of other predictors that have been shown to be skillful or are associated with tropical cyclogenesis include the Dvorak T-numbers (Cossuth et al. 2012), satellite brightness temperature (Schumacher et al. 2009), and the Okubo-Weiss parameter (Montgomery et al. 2012). In order to accomplish this goal, we plan to develop a multivariate logistic regression model formulated on a combination of the ventilation index and the above predictors. We will also work with other JHT groups that are interested in incorporating and testing the ventilation index as part of their genesis framework.

ii) Tropical Cyclone Intensity

This section elaborates on how the ventilation index may be used as a central element in a framework to address the need for "guidance for TC intensity change, especially for the onset, duration, and magnitude of rapid intensification events, as well as for over-water rapid weakening events" (NHC-1/JTWC-1).

TE12 conducted a statistical analysis of the normalized intensification of TCs as a function of the ventilation index and the normalized intensity, using the 1990-2009 NHC and JTWC best track databases. The normalized intensity is defined as the maximum sustained surface wind speed divided by the potential intensity, and the normalized intensification is the change in normalized intensity over a defined time interval. While it may seem odd to analyze the data in this manner, this normalization step is critical for extracting a ventilation signal in the observed data. The dimensional intensity change can easily be calculated by knowing the potential intensity at the endpoints of the defined time interval.

There are well-defined regions in the joint ventilation index and normalized intensity parameter space where TCs intensify and weaken in the mean, as shown in Fig. 3. Within each of these regions, there is a smaller region where there is a climatologically greater than 30% chance of observing rapidly intensifying or rapidly weakening TCs. Note that this data only includes TCs that are over water and are not subtropical or undergoing extratropical transition.

Hence, the location of a TC in the joint ventilation index and normalized intensity parameter space serves as a useful constraint on the intensification. Based on the statistics of TCs with similar ventilation indices and normalized intensities, one can generate a probability distribution of the intensification over a defined time interval, which is set at 24 hours here. A forecaster can then take the mean of this distribution as guidance for the deterministic, ventilation-induced intensity change. A hindcast of this technique for TCs from 1990-2009 yields a mean absolute error of 5.3 m s^{-1} for the north Atlantic and 5.9 m s^{-1} for the northeast Pacific, which are both close to the NHC official 24-hour forecast mean absolute errors over the past five years. Additionally, this technique can be repeated using forecast data to generate deterministic intensity forecasts at longer lead times, e.g. the forecasted ventilation index and normalized intensity at 48 hours can be used to generate an estimate of the ventilation-induced intensity change between 48 and 72 hours.

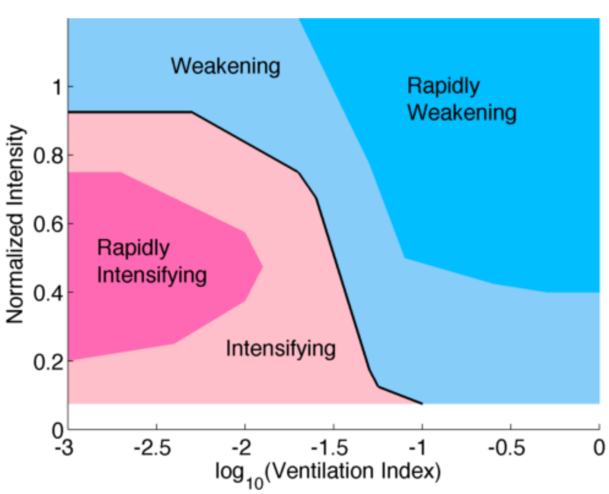

Figure 3. Phase diagram of the mean normalized intensification as a function of the logarithm of the ventilation index and the normalized intensity of a TC. Rapid intensification (weakening) is defined as at least a 15 m s^{-1} increase (decrease) in maximum surface winds of a TC over 24 hours.

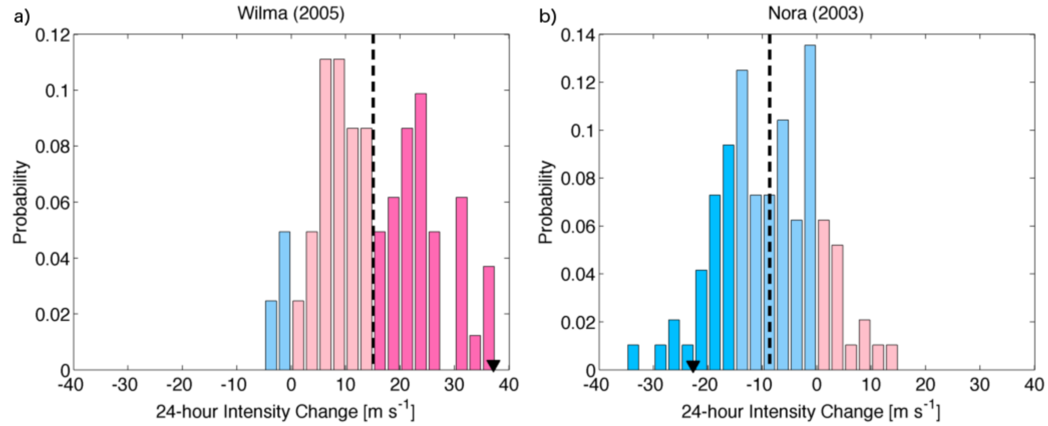

Figure 4. Probability distributions of the 24-hour intensity change for (a) Hurricane Wilma (2005) beginning on 00 UTC 18 October 2005 and (b) Hurricane Nora (2003) beginning on 00 UTC 6 October 2003 based on the analyzed ventilation index and normalized intensity of each storm. The dashed black line denotes the mean intensity change of the distribution, and the black triangle denotes the verifying 24-hour intensity change of the storm.

The probability distribution can also be used to calculate intensification or weakening probabilities for certain thresholds, particularly for rapid intensification and rapid weakening. Figure 4 shows hindcast probability distributions for Hurricane Wilma (2005) and Hurricane Nora (2003) at the beginning of their respective periods of rapid intensification and weakening. The guidance predicted a 46% chance of rapid intensification over the subsequent 24-hours for Hurricane Wilma and a 26% chance of rapid weakening over the subsequent 24-hours for Hurricane Nora. Probabilities such as these will increase the diversity of available guidance that forecasters will have available to complement other probabilistic rapid intensification models (Kaplan et al. 2010; Rozoff and Kossin 2011) and introduces a tool for forecasting the probability of over-water rapid weakening.

Using the combined analysis and model forecast data for a given TC, a forecaster can access a trajectory of a TC in the joint ventilation index and normalized intensity parameter space to compactly assess ventilation-induced intensity changes that may be expected from a given model (see Fig. 10 of TE12 for an example). This method can be repeated using a (multi-) model ensemble approach to generate confidence measures or to generate more realistic and dispersive intensity change probability distributions that incorporate initial condition and/or model physics uncertainty.

While ventilation appears to be an important predictor of intensity changes, ventilation is not the only factor controlling intensity. Hence, we propose to test versions of the SHIPS and LGEM models (DeMaria et al. 2005; DeMaria 2009) using the ventilation index as a predictor to assess whether it improves the skill of these statistical-dynamical intensity models. Although the statistical-dynamical models incorporate aspects of ventilation index into them, the nonlinear combination of the ventilation index represents a statistical interaction that adds additional information beyond that included in the vertical wind shear, the nondimensional midlevel entropy deficit, and the potential intensity alone. Furthermore, there has been uncertainty how to best incorporate environmental thermodynamic quantities, particularly metrics of the environmental moisture, into these models. The nondimensional entropy deficit represents a promising candidate, but may only be important to TC intensity when it covaries with the environmental vertical wind shear, as the ventilation index suggests.

We also plan to work with other JHT groups with mutual interest in the intensification problem. For instance, the ventilation index is a candidate predictor for other rapid intensification guidance products, for the same reason given above for the SHIPS and LGEM models, or as a diagnostic for an observational or modeling system.

c) WORK PLAN

Task 1: Implement regional ventilation maps for tropical cyclogenesis and tropical cyclone intensification guidance. We propose to produce real-time maps of the ventilation index and anomalies using GFS, NOGAPS, and/or UKMET analysis and forecast gridded data. An additional objective will be to produce mean and spread plots using ensemble data, such as the GEFS, NOGAPS ensemble system, and/or MOGREPS. These maps will provide categorical favorability for genesis and intensification.

Task 2: Implement storm-specific ventilation guidance products. We propose to create time series of the ventilation index following disturbances and TCs. For disturbances, this will serve as input to a logistic regression model to forecast the probability of genesis in the short and medium ranges. For TCs, this will be combined with normalized intensity to plot trajectories in ventilation index and normalized intensity parameter space to forecast ventilation-induced changes in intensity and the probability of (rapid) intensification or weakening in the short and medium ranges. In addition to the aforementioned deterministic and ensemble models, this task will use high-resolution data from the HWRF.

Task 3: Refine the ventilation index. We propose to test different versions of the ventilation index using averaging radii based on TC size, using reconnaissance data, and calculating the ventilation index by quadrant relative to the shear vector. We will compare the relative skill of the different versions of the ventilation index in the guidance products in task two.

Task 4: Incorporate the ventilation index into more comprehensive statistical genesis and intensity models. We propose to develop a multivariate logistic regression model incorporating a suite of variables in order to introduce a more robust statistical genesis model. We also propose to test versions of the SHIPS and LGEM using the ventilation index to assess whether it increases the skill of these statistical-dynamical intensity models.

Task 5: Work with other JHT groups with mutual interest in the genesis and intensification problems. We plan to collaborate with other PIs whose projects may benefit from using the ventilation index as a diagnostic or predictor.

For all of the tasks, the primary hardware need will be storage space for gridded data and post-processed ventilation metrics. A student will be assigned to work on task three and four and will need a computer to perform the objectives. The software to ingest, analyze, and plot the data is already available at the PI's institution.

Testing and analysis of the new guidance will be performed on archived invests and TCs from 2010-2012 NHC and JTWC best track databases and archived analysis and forecast data from the THORPEX Interactive Grand Global Ensemble or through special arrangements. Metrics for success for task one will be an analysis of variance to assess whether ventilation indices and the categorical favorability for genesis for developing and nondeveloping disturbances provide meaningful information. For tasks two through four, metrics for success will be the brier skill score and reliability diagrams for probabilistic guidance. The mean absolute error and skill relative to climatology-persistence models will be the verification metric for deterministic guidance. These metrics will be compared to other genesis and intensity models and the official forecasts in order to determine the relative skill of the new ventilation-based guidance products. The goal will be to provide new and improved genesis and intensity guidance that adds skill to the current guidance suite.

The project deliverables will be maps and time series of the ventilation index over ocean basins and for individual disturbances or TCs, a new probabilistic guidance tool for tropical cyclogenesis at the short and medium ranges based on the logistic regression model, deterministic and probabilistic ventilation-based intensity change guidance, and probabilistic ventilation-based rapid intensification and weakening guidance.

The proposed project timeline is as follows:

Year 1

- Aug 2013 - Coordinate with NOAA to set up gridded data streams
- Sep 2013 - Modify code to be compatible with new sources of data for tasks one and two
- Sep 2013 - Graduate student begins work on task three
- Feb 2014 - Complete validation for tasks one and two
- Mar 2014 - Report results at Interdepartmental Hurricane Conference
- May 2014 - Implement guidance that results from tasks one and two at the operational centers for real-time testing
- Jun 2014 - Evaluate the ventilation index in SHIPS and LGEM

Year 2

- Aug 2014 - Apply results of task three to new guidance models
- Sep 2014 - Graduate student begins work on task four
- Feb 2015 - Complete validation for tasks three and four
- Mar 2015 - Report results at Interdepartmental Hurricane Conference
- May 2015 - Implement guidance that results from tasks three and four at the operational centers for real-time testing
- Jul 2015 - Final evaluation of all guidance products from tasks

Real-time operational forecast data will be required to accomplish the project goals. We anticipate the need for gridded data from the GFS, NOGAPS, UKMET, and HWRF models along with the respective ensemble systems, where applicable and available. We also anticipate the need for access to the JTWC and NHC a-decks and b-decks for both invests and TCs in order to calculate the normalized intensity and to interpolate the ventilation index to the storm position.

The necessary codes will be ported to the operational centers such that the ventilation-based guidance products can be calculated in real-time and displayed in N-AWIPS (II) at the operational forecast centers. We will develop scripts that are compatible with N-AWIPS (II) by working with JHT programmers to ensure that the methodology to calculate and apply the ventilation index and ventilation-based guidance is correct and displays in an intuitive manner. We also plan to transfer scripts that generate text diagnostic files containing input and output data from the multivariate logistic regression model and modified versions of SHIPS and LGEM that forecasters can easily access on workstations.

d) TECHNICAL TIME LINE

Documentation for the ventilation index is already available in TE12, which describes the premise, methodology, and usage of the ventilation index. Additional documentation and training materials for the guidance that is outlined in the tasks above will be submitted as guidance is implemented at the operational centers for real-time testing. Specifically, documentation related to the testing and verification metrics of the ventilation-based genesis and intensity guidance will be delivered May 2014. Similar documentation related to the multivariate genesis and intensity guidance will be delivered May 2015.

The PI also plans a three-day trip to the NHC in the first year and a three-day trip to the JTWC/CPHC in the second year of the project in order to give an overview seminar of the new guidance projects and to work with individual staff and forecasters to facilitate the research to operations transfer.

e) SCHEDULE AND TRAVEL

In addition to the two trips to the operational centers, the PI plans to attend the Interdepartmental Hurricane Conference in March 2014 and 2015 to present work on the project and to interface with JHT personnel. The conference will also be an opportunity to develop collaborations with other JHT groups with overlapping interests. The PI has also planned a two-day trip each year to Fort Collins, CO to collaborate with Dr. Mark DeMaria on task four.

f) JHT STAFF AND COMPUTATIONAL REQUIREMENTS

The initial requirement will be to handle IT issues related to transfer of the necessary data from numerical weather prediction models to the PI's institutions and code to the operational centers. The PI has requested funds for 10 TB of disk space to handle the accompanying data storage requirement and funds to purchase a computer for a graduate student to work on tasks three and four. A longer-term requirement will be the assistance of JHT staff to aid in the implementation of the guidance products at the operational centers for real-time testing.

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5. DATA SHARING

The PI will operate a website, hosted by the University at Albany, containing real-time and archived ventilation figures and maps that will be accessible to the general public. Archived ventilation data for both invests and TCs will be made available for research purposes by the end of first year and will be disseminated upon e-mail request to the lead PI. The data format will be similar to the Automated Tropical Cyclone Forecast format, which contains the storm designation, date, position, and intensity, but will have an additional column for the ventilation index. Additionally, verification statistics for the ventilation-based genesis and intensity guidance will be posted online.

6. BUDGET			8/1/13 - 7/31/14	8/1/14 - 7/31/15	8/1/13 - 7/31/16
A. SALARIES AND WAGES			Year 1	Year 2	Total
1. Senior Personnel					
a. PI - Brian Tang (1 summer month)			7999	8159	16158
2. Other Personnel					
a. Research Scientist (0.5 summer month)			4524	4614	9138
b. 1 Masters student (12 calendar months)			22000	22000	44000
TOTAL Salaries and Wages			34523	34773	69296
B. FRINGE BENEFITS					
1. Senior Personnel					
a. PI 17% years 1-3			1360	1387	2747
2. Other Personnel					
a. Research Scientist 43% 43.5%			1945	2007	3952
b. Ph.D. students 16% 17.5%			3520	3850	7370
TOTAL Fringe Benefits			6825	7244	14069
TOTAL Salaries, Wages, Benefits (A-B)			41348	42017	83365
C. TRAVEL					
1. PI visit to the National Hurricane Center, Miami, FL					
Airfare from Albany, NY	560				
3 days per diem @ $218.00 ($152/$66)	654				
Parking and ground transportation	118		1332		1332
2. PI or student will attend the Interdepartmental Hurricane Conference in Miami, FL					
Airfare from Albany, NY	560				
4 days per diem @ $218.00 ($152/$66)	872				
Parking and ground transportation	118				
Conference registration	100		1650	1650	3300
3. PI visit to Colorado State, Fort Collins, CO					
Airfare from Albany, NY	580				
2 days per diem @ $140.00 ($84/$56)	280				
Parking and ground transportation	118		978	978	1956
4. PI visit to Joint Typhoon Warning Center and Central Pacific Hurricane Center in Honolulu, HI					
Airfare from Albany, NY	1194				
3 days per diem @ $234.00 ($177/$57)	702				
Parking and ground transportation	118			2014	2014
TOTAL Travel			3960	4642	8602
D. SUPPLIES	YR 1	YR 2			
3. Disk space for research data	4000	0			
4. Computer software, printer cartridges, computer supplies related to project	800	200			
TOTAL Supplies			4800	200	5000
E. OTHER					
1. Tuition for 12-month graduate student			13000	13000	26000
TOTAL DIRECT COSTS (A THROUGH E)			63108	59859	122967
INDIRECT COSTS 53% MTDC Base = Total Direct Cost minus tuition E2			50108	46859	96967
TOTAL INDIRECT COSTS			26557	24835	51392
TOTAL COSTS			**89665**	**84694**	**174359**

7. BUDGET JUSTIFICATION

Salaries and Wages: The PI is requesting 1 month of summer salary years 1-2. A 2% increase is assumed for year 2.

Funding is requested for .50 summer month of salary for the Department's Research Scientist in years 1-2. The University at Albany/SUNY supports his academic year salary. We get the benefit of a full-time, year-round technical systems person, who does security patches, system upgrades, hardware and software installation, and preventive maintenance on our large UNIX network for a modest expense to the grant. No money is charged us for computer time and usage. A 2% increase is assumed for year 2.

A research assistantship is requested for one M.S. level graduate student at 12-month salary in years 1-2 of $22,000. The student will be an integral part of the research to operations transfer by developing and testing modified versions of the ventilation index for use in the ventilation-based tropical cyclone guidance tools, incorporating other datasets into the ventilation index calculation, and developing and validating multivariate genesis and intensity models.

Fringe benefits for the PI are calculated at 17% years 1-2. Fringe benefits for the Research Scientist are calculated at 43% year 1 and 43.5% year 2. Fringe benefits for the graduate student are calculated at 16% year 1 and 17.5% year 2.

Travel: Support is requested in year 1 for the PI to visit the National Hurricane Center in Miami, Florida to interface with the Joint Hurricane Testbed staff to facilitate the transfer of guidance tools to the operational forecast centers, give an overview seminar to forecasters about the new ventilation-based guidance products, and solicit feedback from forecasters and the technical staff.

> *Estimated charges include:* Airfare from Albany, NY ($560), lodging and meals for 3 days per diem @ $218/day [$152/66] ($654), and parking and ground transportation ($118). Total cost is $1,332.

In years 1-2 travel is requested for the PI or student to attend the Interdepartmental Hurricane Conference in Miami, Florida in years 1-2 to present progress on the project.

> *Estimated charges include:* Airfare from Albany, NY ($560), lodging and meals for 4 days per diem @ $218/day [$152/66] ($872), parking and ground transportation ($118), and conference registration ($100). Total cost is $1,650.

Also requested in years 1-2 travel is requested for the PI to travel to Colorado State, Fort Collins, Colorado to collaborate with Dr. Mark DeMaria on applying the ventilation index to statistical-dynamical intensity models to improve their skill.

> *Estimated charges include:* Airfare from Albany, NY ($580), lodging and meals for 2 days per diem @ $140/day [$84/$56] ($280), and parking and ground transportation ($118). Total cost is $978.

Travel is requested in Year 2 for the PI to visit the Joint Typhoon Warning Center and Central Pacific Hurricane Center in Honolulu, HI to also give an overview seminar to forecasters about the new ventilation-based guidance products and to solicit feedback from forecasters and the technical staff.

> *Estimated charges include:* Airfare from Albany, NY ($1,194), lodging and meals for 3 days per diem @ $234/day [$177/$57] ($702), and parking and ground transportation ($118). Total cost is $2,014.

Total Estimated travel is $3,960 for year 1 and $4,642 year 2.

Supplies: Disk space is requested in year 1 for data related to this project only, stored on the departmental server ($4,000). Other annual supplies include computer software, printer cartridges and computer supplies needed for conducting the proposed objectives of this research project, and the preparation of publications and reports related to this project only ($800 year 1 and $200 year 2).

Other:
Tuition: Tuition for the 12-month graduate student is estimated to be $13,000 for years 1-2. Tuition is not included in the indirect cost calculations.

Indirect costs: Indirect costs at the University at Albany are charged a rate of 53% MTDC in years 1-2. Tuition is excluded from the indirect cost base. Fringe benefits and indirect costs are charged according to The Research Foundation’s negotiated indirect cost rate agreement dated 2/09/2012.

8. CURRICULUM VITA

Brian H. Tang
Assistant Professor
Dept. Atmospheric & Environmental Sci.
1400 Washington Avenue, ES 324
University at Albany, Albany, NY 12222

E-mail: btang@albany.edu
Phone: (518) 442-4572
http://www.atmos.albany.edu/facstaff/tang/

Education

Massachusetts Institute of Technology, Atmospheric Science, Ph.D., July 2010.
University of California Los Angeles, Atmospheric and Oceanic Sciences, B.S., Applied Mathematics with a specialization in Computing, B.S., June 2004.

Professional Experience

University at Albany, State University of New York, Department of Atmospheric and Environmental Sciences, Assistant Professor, September 2012 - present.
National Center for Atmospheric Research, Postdoctoral Fellow, Advanced Study Program, September 2010 - August 2012.

Honors / Awards

Joanne and Bob Simpson Postdoctoral Fellowship, National Center for Atmospheric Research, 2010.
Max A. Eaton Prize for best student paper at the AMS Tropical Meteorology and Hurricane Conference, 2008.
Graduate Student Teaching Award, Massachusetts Institute of Technology, 2007.
Top Overall Forecaster in the collegiate WxChallenge forecast competition, 2007.

Refereed Publications

Tang, B. and K. Emanuel, 2012: A ventilation index for tropical cyclones. *Bull. Amer. Meteor. Soc.*, in press.
Tang, B. and K. Emanuel, 2012: Sensitivity of tropical cyclone intensity to ventilation in an axisymmetric model. *J. Atmos. Sci.*, **69**, 2394-2413.
Evans, C. and coauthors, 2011: The PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) field campaign: Perspectives of early career scientists. *Bull. Amer. Meteor. Soc.*, **93**, 173-187.
Tang, B. and K. Emanuel, 2010: Midlevel ventilation's constraint on tropical cyclone intensity. *J. Atmos. Sci.*, **67**, 1817-1830.
Tang, B. and J. D. Neelin, 2004: ENSO influence on Atlantic hurricanes via tropospheric warming. *Geophys. Res. Lett.*, **31**, L24204, doi:10.1029/2004GL021072.

Synergistic Activities

Chair, Max Eaton Award Committee, 30th AMS Conference on Hurricanes and Tropical Meteorology, 2012.
Science Mentor, Significant Opportunities in Atmospheric Research and Science, National Center for Atmospheric Research, 2011.
Forecaster, PRE-Depression Investigation of Cloud-systems in the Tropics, 2010.
LIDAR Operator, THORPEX Pacific Asian Regional Campaign - Tropical Cyclone Structure, 2008.

8a. ABBREVIATED CURRICULUM VITA for Mark DeMaria

<u>Education</u>
Ph.D., Atmospheric Science, Colorado State University, 1983
M.S., Atmospheric Science, Colorado State University, 1979
B.S., Meteorology, Florida State University, 1977

<u>Experience</u>

1998-Present	Chief, Regional and Mesoscale Meteorology Branch, NESDIS/StAR
1995-1998	Chief, Technical Support Branch, National Hurricane Center
1987-1995	Research Meteorologist, Hurricane Research Division, NOAA/AOML
1985-1987	Assistant Professor, Dept. of Marine, Earth and Atmospheric Science, NCSU
1984-1985	Post Doctoral Fellow, Advanced Study Program, NCAR

<u>Committees and Professional Societies</u>
Member, American Geophysical Union, 2006-present
Member, American Meteorological Society, 1987-present
OFCM working group on tropical cyclone research, 2009-present
NOAA Hurricane Forecast Improvement Project Science Team Lead 2007-present
NOAA Hurricane Research Joint Action Group 2005-2007
NOAA GOES-R Risk Reduction Program Committee, Joint Chair, 2006-present.
NOAA Cooperative Institute oversight committee, 2005
NOAA internal Hurricane Intensity Research Working Group, 2005
Program manager, GOES Improved Measurement Product Assurance Plan, 2002-present
U.S. Weather Research Program Science Steering Committee, 1999-2003
Weather Research and Forecasting (WRF) Model Oversight Committee, 2000-2003
Associate Editor, Monthly Weather Review, 2002 and 2004-2006
Associate Editor, Weather and Forecasting, 2009-present.
Adjunct Faculty Member, Dept. of Atmospheric Science, CSU, 1999-present

<u>Honors and Awards</u>
2012: Colorado Governor's Award for high impact research
2012: AMS Banner I. Miller Award for best published paper on hurricane forecasting
2011: NOAA Bronze Medal for hurricane intensity model improvements
2010: NOAA Bronze Medal for new operational hurricane wind probability model
2009: OFCM Richard H. Hagemeyer Award for contributions to the U.S. Hurricane Program
2008: NOAA Bronze Medal for a new operational tropical cyclone formation probability product
2005: DOC Silver medal for improving tropical cyclone intensity forecasting using satellite data
2002: NOAA Bronze Medal for Hurricane Mitch Reconstruction Project
2002: AMS Banner I. Miller Award for best published paper on hurricane forecasting
1997: NOAA Bronze Medal for new inland wind model
1996: NWS Modernization Award for the development of N-AWIPS applications
1992: Dept. of Commerce Gold Medal (Group Award) for performance during Andrew
1989: AMS Banner I. Miller Award for best published paper on hurricane forecasting
1987: AMS Banner I. Miller Award for best published paper on hurricane forecasting
1981: AMS Max A. Eaton Prize for best student paper

Formal Publications (last 3 years)

Knaff., J.A., **M. DeMaria**, C.R. Sampson, J.E. Peak, J. Cummings, W.H. Schubert, 2012: Upper oceanic energy response to tropical cyclone passage. *J. Climate*, in press.

Li, X. J.A. Zhang, X. Yang, G. Pichel, **M. DeMaria**, D. Long, and Z. Li., 2012: Tropical cyclone morphology from spaceborne synthetic aperture radar. *Bull. Amer. Meteor. Soc*., in press.

Sampson, C.R., A.B. Schumacher, J.A. Knaff, **M. DeMaria**, E.M. Fukada, C.A. Sisko, D.P. Roberts, K.A. Winters, and H. M. Wilson, 2012: Objective guidance for use in setting tropical cyclone conditions of readiness. *Wea. Forecasting*, **27**, 1052-1060.

DeMaria, M., R.T. DeMaria, J.A. Knaff and D. Molenar, 2012: Tropical cyclone lighting and rapid intensity change. *Mon. Wea. Rev*., **140**, 1828-1842.

Goodman, S.J., J. Gurka, **M. DeMaria**, T. Schmit, A. Mostek, G. Jedlovec, C. Siewert, W. Feltz, J. Gerth, R. Brummer, S. Miller, B. Reed, R.R. Reynolds, 2012: The GOES-R Proving Ground: Accelerating user readiness for the next generation geostationary environmental satellite system. *Bull. Amer. Meteor. Soc.,* **93**, 1029-1040.

Hamill, T.M., M.J. Brennan, B. Brown, **M. DeMaria**, E.N. Rappaport and Z. Toth, 2012: NOAA's future ensemble-based hurricane forecast products. *Bull. Amer. Meteor. Soc.,***93**, 209-220 .

Tsai, Hsiao-Chung, Kuo-Chen Lu, Nai-Ning Hsu, Aimei Chia, **Mark DeMaria**, 2011: An Application of the Monte Carlo Method: Tropical Cyclone Strike Probabilities. *Atmospheric Sciences*, **39**:3, 269-288.

Knaff, J. A., **M. DeMaria**, D. A. Molenar, C. R. Sampson, M. G. Seybold, 2011: An automated, objective, multiple-satellite-platform tropical cyclone surface wind analysis. *J. Appl. Meteor. Climatol*., **50**, 2149–2166. (Oct)

Sampson, C.R., J. Kaplan, J.A. Knaff, **M. DeMaria** and C.A. Sisko, 2011: A deterministic rapid intensification aid. *Wea. Forecasting*, **26**, 579-585.

Rappaport, E.N., J.L. Franklin, A.B Schumacher, **M. DeMaria**, L.K. Shay, and E.J. Gibney, 2010: Tropical cyclone intensity change before U.S. Gulf coast landfall. *W. Forecasting*, **5**, 1380-1396.

Grasso, L.D., M. Sengupta, and **M. DeMaria**, 2010: Comparison between observed and synthetic 6.5 and 10.7 μm GOES-12 imagery of thunderstorms that occurred on 8 May 2003. *Int. Journal of Remote Sensing*, **31**:3, 647-663.

Kaplan, J., **M. DeMaria**, and J.A. Knaff, 2010: A revised tropical cyclone rapid intensification index for the Atlantic and east Pacific basins. *Wea. Forecasting*, **25**, 220-241.

9. CURRENT AND PENDING

Brian Tang

A. Currently funded – none

B. Pending

1) Project/Proposal Title: Collaborative Research with the National Weather Service on the Occurrence and Prediction of High-Impact Precipitation Events in the Northeastern United
Source of Support: NOAA/NWS/CSTAR
Total Award Amount: $375,000
Total Award Period Covered: 5/1/2013 – 4/30/2016
Person-Months Per Year Committed to the Project: .50 / .50 / .50

2) Project/Proposal Title: Real-time Ventilation Diagnostics for Operational Forecasts of Tropical Cyclone Intensity and Genesis - *this proposal*
Source of Support: NOAA-JHT
Total Award Amount: $174,359
Total Award Period Covered: 8/1/2013 – 7/31/2015
Person-Months Per Year Committed to the Project: 1 / 1 / 1

9a. CURRENT AND PENDING

Mark DeMaria is 100% base funded by NOAA/NESDIS and has no current or pending external support.

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 Research Foundation of SUNY

* b. Employer/Taxpayer Identification Number (EIN/TIN): 14-1368361

* c. Organizational DUNS: 1526528220000

d. Address:

* Street1: Office for Sponsored Programs, MSC 312

Street2: 1400 Washington Avenue

* City: Albany

County/Parish:

* State: NY: New York

Province:

* Country: USA: UNITED STATES

* Zip / Postal Code: 122220001

e. Organizational Unit:

Department Name: Atmospheric & Environmental Sc

Division Name: College of Arts and Sciences

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

Prefix:

* First Name: Margaret

Middle Name:

* Last Name: OBrien

Suffix:

Title: Assistant Director

Organizational Affiliation:

The Research Foundation of SUNY

* Telephone Number: 518-437-4566

Fax Number: 518-437-4560

* Email: MOBrien@albany.edu

Application for Federal Assistance SF-424

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

M: Nonprofit with 501C3 IRS Status (Other than 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:**

Real-time Ventilation Diagnostics for Operational Forecasts of Tropical Cyclone Intensity and Genesis

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: 21

b. Program/Project: 21

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	174,359.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	174,359.00

*** 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: Margaret

Middle Name:

* Last Name: OBrien

Suffix:

* Title: Assistant Director

* Telephone Number: 518-437-4566

Fax Number: 518-437-4560

* Email: MOBrien@albany.edu

* Signature of Authorized Representative: Margaret OBrien

* 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: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
1. FY 2013 Joint Hurricane Testbed	11.459	$	$	$ 89,665.00	$	$ 89,665.00
2.						
3.						
4.						
5. Totals		$	$	$ 89,665.00	$	$ 89,665.00

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SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY				Total
	(1) FY 2013 Joint Hurricane Testbed	(2) N/A	(3)	(4)	(5)
a. Personnel	$ 34,523.00	$ 34,773.00	$	$	$ 69,296.00
b. Fringe Benefits	6,825.00	7,244.00			14,069.00
c. Travel	3,960.00	4,642.00			8,602.00
d. Equipment					
e. Supplies	4,800.00	200.00			5,000.00
f. Contractual					
g. Construction					
h. Other	13,000.00	13,000.00			26,000.00
i. Total Direct Charges (sum of 6a-6h)	63,108.00	59,859.00			$ 122,967.00
j. Indirect Charges	26,557.00	24,835.00			$ 51,392.00
k. TOTALS (sum of 6i and 6j)	$ 89,665.00	$ 84,694.00	$	$	$ 174,359.00
7. Program Income	$ 0.00	$ 0.00	$	$	$

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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	$ 89,664.00	$ 22,416.00	$ 22,416.00	$ 22,416.00	$ 22,416.00
14. Non-Federal	$				
15. TOTAL (sum of lines 13 and 14)	$ 89,664.00	$ 22,416.00	$ 22,416.00	$ 22,416.00	$ 22,416.00

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. FY 2013 Joint Hurricane Testbed	$ 84,694.00	$	$	$
17.				
18.				
19.				
20. TOTAL (sum of lines 16 - 19)	$ 84,694.00	$	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges: $122,967

22. Indirect Charges: $51,392

23. Remarks:

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

ASSURANCES - NON-CONSTRUCTION PROGRAMS

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0040), Washington, DC 20503.

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
Margaret OBrien	Assistant Director
* APPLICANT ORGANIZATION	* DATE SUBMITTED
The Research Foundation of SUNY	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 Research Foundation of SUNY

* AWARD NUMBER:

* PROJECT NAME: Real-time Ventilation Diagnostics for Operational Forecasts

Prefix:

* First Name: Margaret

Middle Name:

* Last Name: OBrien

Suffix:

* Title: Assistant Director

* SIGNATURE: Margaret OBrien

* DATE: 12/05/2012