COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./DUE DATE
NSF 18-522 **10/01/19**

☐ Special Exception to Deadline Date Policy

FOR NSF USE ONLY
NSF PROPOSAL NUMBER
2000201

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)
HRD - Hist Black Colleges and Univ, (continued)

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
10/01/2019	**1**	**11060000 HRD**	**1594**	**056282296**	**10/02/2019 2:31am S**

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)
530204707

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE
Howard University

AWARDEE ORGANIZATION CODE (IF KNOWN)
0014480000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
Howard University
2400 Sixth Street N W
Washington,DC.200599000

NAME OF PRIMARY PLACE OF PERF
Howard University

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE
Howard University
DC ,200590001 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Excellence in Research (Collab. Research): Analyzing Planetary Boundary Layer Processes from an Incipient Surface/Upper Air Mesonet Network in the Washington DC-Baltimore MD region**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **653,073**	**36** months	**05/01/20**	

THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
☐ BEGINNING INVESTIGATOR
☐ DISCLOSURE OF LOBBYING ACTIVITIES
☐ PROPRIETARY & PRIVILEGED INFORMATION
☐ HISTORIC PLACES
☐ VERTEBRATE ANIMALS IACUC App. Date _____
PHS Animal Welfare Assurance Number _____
☒ TYPE OF PROPOSAL **Research**

☐ HUMAN SUBJECTS Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☐ FUNDING OF INT'L BRANCH CAMPUS OF U.S IHE ☐ FUNDING OF FOREIGN ORG
☐ INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED
☒ COLLABORATIVE STATUS
A collaborative proposal from multiple organizations (PAPPG II.D.3.b)

PI/PD DEPARTMENT
Chemistry

PI/PD FAX NUMBER

PI/PD POSTAL ADDRESS
2400 Sixth Street N W
Washington,DC 200599000
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Email Address
PI/PD NAME **Ricardo K Sakai**	**DSc**	**2000**	**518-478-3718**	**ricardo.k.sakai@howard.edu**
CO-PI/PD **Belay B Demoz**	**DSc**	**1992**	**410-455-2715**	**bdemoz@umbc.edu**
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide (PAPPG). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

Certification Regarding Conflict of Interest

The AOR is required to complete certifications stating that the organization has implemented and is enforcing a written policy on conflicts of interest (COI), consistent with the provisions of PAPPG Chapter IX.A.; that, to the best of his/her knowledge, all financial disclosures required by the conflict of interest policy were made; and that conflicts of interest, if any, were, or prior to the organization's expenditure of any funds under the award, will be, satisfactorily managed, reduced or eliminated in accordance with the organization's conflict of interest policy. Conflicts that cannot be satisfactorily managed, reduced or eliminated and research that proceeds without the imposition of conditions or restrictions when a conflict of interest exists, must be disclosed to NSF via use of the Notifications and Requests Module in FastLane.

Drug Free Work Place Certification

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent), is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Proposal & Award Policies & Procedures Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Proposal & Award Policies & Procedures Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, 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, an officer or employee of Congress, or an employee of 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 of Lobbying Activities,'' 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.

Certification Regarding Nondiscrimination

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Proposal & Award Policies & Procedures Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:
(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:
(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR)
(This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Chapter IX.B. , the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research. The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

CERTIFICATION PAGE - CONTINUED

Certification Regarding Organizational Support

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.

Certification Regarding Federal Tax Obligations

When the proposal exceeds $5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations. By electronically signing the Certification pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:
(1) has filed all Federal tax returns required during the three years preceding this certification;
(2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
(3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

Certification Regarding Unpaid Federal Tax Liability

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

Certification Regarding Criminal Convictions

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.

Certification Dual Use Research of Concern

By electronically signing the certification pages, the Authorized Organizational Representative is certifying that the organization will be or is in compliance with all aspects of the United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Caribbean M Ross**	**Electronic Signature**	**Oct 1 2019 2:47PM**

TELEPHONE NUMBER	EMAIL ADDRESS	FAX NUMBER
202-238-2580	**c_ross@howard.edu**	**202-986-6937**

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

AGS - GEO/ATM - Physical & Dynamic Meteorology

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./DUE DATE	☐ Special Exception to Deadline Date Policy	FOR NSF USE ONLY
NSF 18-522 10/01/19		NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)		2000219
HRD - Hist Black Colleges and Univ, (continued)		

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
10/01/2019	1	11060000 HRD	1594	879941318	10/02/2019 2:31am S

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS ☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)
530204707		

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
Morgan State University	Morgan State University 1700 East Cold Spring Lane Baltimore,MD.212510002
AWARDEE ORGANIZATION CODE (IF KNOWN) 0020834000	

NAME OF PRIMARY PLACE OF PERF	ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE
Morgan State University	Morgan State University 1700 East cold Spring lane Baltomore ,MD ,212510001 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) ☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS ☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Excellence in Research: Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC - Baltimore, MD Region.**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 316,606	36 months	05/01/19	

THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR
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☐ PROPRIETARY & PRIVILEGED INFORMATION
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☐ HUMAN SUBJECTS Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☐ FUNDING OF INT'L BRANCH CAMPUS OF U.S IHE ☐ FUNDING OF FOREIGN ORG
☒ INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED
GM SF
☒ COLLABORATIVE STATUS
A collaborative proposal from multiple organizations (PAPPG II.D.3.b)

PI/PD DEPARTMENT	PI/PD POSTAL ADDRESS
Physics	1700 East Cold Spring Lane Baltimore,MD 212510002 United States
PI/PD FAX NUMBER	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Email Address
PI/PD NAME Richard Damoah	DPhil	2005	443-885-1557	richard.damoah@morgan.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

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(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 of Lobbying Activities,'' in accordance with its instructions.
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CERTIFICATION PAGE - CONTINUED

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(2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
(3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Edet E Isuk**	**Electronic Signature**	**Oct 1 2019 3:05PM**

TELEPHONE NUMBER	EMAIL ADDRESS	FAX NUMBER
443-885-3447	**Edet.Isuk@morgan.edu**	**443-885-8280**

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

AGS - GEO/ATM - Physical & Dynamic Meteorology

PROJECT SUMMARY

Overview:

Howard University, Morgan State University (MSU), and University of Maryland Baltimore County (UMBC) propose to investigate planetary boundary layer (PBL) processes in the Washington DC-Baltimore, MD, I-95 corridor. In situ surface parameters, such as turbulent fluxes at the surface layer (SL), and aerosol and thermodynamic profiles temporal evolution within the lower troposphere will be monitored. The focus of this work is to understand the influence of the urban heat island (UHI) PBL to the adjacent suburban/rural region in the Washington area. For the Baltimore area, the influence of the Chesapeake Bay Breeze will be assessed to the PBL in the city, and to a suburban area. The study will seek to assess local and non-local influences on PBL height, formation of elevated mixing layers, and air mass modification detection.

Since the past decade, mesonet networks have been implemented to improve short term weather forecast (e.g. Oklahoma and New York mesonet networks). These networks give an opportunity to improve the monitoring meteorological surface parameters, thermodynamic profiles, and PBL height (PBLH) detection. Flux data has been collected since 2005 at HUBC. The micro waver radiometer (MWR) is capable of deriving air temperature and water vapor profiles up to 10 km above the ground. Also, from the past years, there are some emphasis in utilizing the ceilometer aerosol backscatter profile to determine aerosol properties and mixing height, a proxy for the PBL height. We are currently implementing our MWR/ceilometer network. Ceilometer and MWR data have been collected at HU Beltsville Campus since 2006 and 2010, respectively, and in 2017 the UMBC system was set up. We will expand our network to include one system at HU-DC and MSU.

Intellectual Merit:

The proposed work will allow us to understand the atmospheric processes over the Washington D.C. - Baltimore area, a mix of urban, suburban, rural, and estuary coastal regions. We will focus in 2 subjects:
1. The thermodynamical and aerosol composition contrasts over these landscapes will be investigated, focusing on the effects of local and non-local effects to the PBL height for complex landscapes.
2. Also, the effects of air mass modification on the PBL that might generate elevated mixing layers, and impact of the Chesapeake Bay breeze on the network will be assessed. Detection of elevated mixing layers to determine the impact of internal boundary layer or mesoscale circulations into surface parameter. Comparisons among rural, urban, and coastal plain estuary environments will be performed.

Broader Impacts:

The studies based on this network can enhance the air quality understanding and weather forecast for the local community. The proposed analysis will increase the understanding of air mass patterns and improve numerical modelling studies for a region with complex landscape and meteorology pattern. Also, minority underrepresented students in natural sciences will be targeted to perform data analysis and participate in the observational aspects of this study.

TABLE OF CONTENTS

For font size and page formatting specifications, see PAPPG section II.B.2.

	Total No. of Pages	Page No.* (Optional)*
Cover Sheet for Proposal to the National Science Foundation		
Project Summary (not to exceed 1 page)	1	
Table of Contents	1	
Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) **(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**	11	
References Cited	4	
Biographical Sketches (Not to exceed 2 pages each)	4	
Budget (Plus up to 3 pages of budget justification)	12	
Current and Pending Support	2	
Facilities, Equipment and Other Resources	4	
Special Information/Supplementary Documents (Data Management Plan, Mentoring Plan and Other Supplementary Documents)	15	
Appendix (List below.) **(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**		
Appendix Items:		

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

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Biographical Sketches (Not to exceed 2 pages each)	2	
Budget (Plus up to 3 pages of budget justification)	6	
Current and Pending Support	1	
Facilities, Equipment and Other Resources	1	
Special Information/Supplementary Documents (Data Management Plan, Mentoring Plan and Other Supplementary Documents)	5	
Appendix (List below.) **(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**		
Appendix Items:		

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

1.0 Introduction

The planetary boundary layer (PBL) is the bottommost atmospheric layer in which is directly affected by Earth's surface. Most of the heat, moisture, aerosols, and trace gases exchange between solid Earth and atmosphere happen within the PBL. Besides the PBL thermodynamics, one key parameter is the PBL height (PBLH), principally needed for air quality analysis, models for air pollution dispersion, and quantification of pollutant budgets (McQueen et al, 2010, Cohen et al, 2014). The aerosol mixing height, estimated using ceilometer aerosol backscatter, can be used as a proxy of the PBL height (Hicks et al 2015). This and for other convection related reasons led the National Research Council of the National Academies to issue the report - "Observing Weather from the ground up: Network of networks" (NRC, 2009), where it detailed the urgent need to improve the monitoring of thermodynamic profiles, and planetary boundary layer (PBL) height from ground networks. Recently, PBL has emerged as the topic identified as "Most Important" and of strategic importance in earth science (areas of Hydrology, Weather and Air Quality, Ecosystems, and Climate) in the NASA 2017 NAS Decadal Survey for Earth Science and Applications from Space report study made by the NAS.

Following the NRC (2009) study, a workshop report of recommended a wider use of the ground based remote sensors as a means for achieving the PBL profiling goal needed by the community. The Thermodynamic Profiling Technologies workshop (Hoff et al 2011) recommended that *microwave radiometers* and *ceilometers* as a mature system ready to contribute and achieve the NRC (20029) goals. Since then several studies have shown the value of ceilometers in characterizing the aerosol backscatter in the PBL (see Hicks et al 2019 and references therein for details). In collaboration with UMBC and NOAA, we have built a limited network of ceilometer network in this area that has been used by the Maryland Department of Environment, NOAA and EPA for operational air quality work as well as planning of future operational network. Ground base microwave radiometers (MWR) have been successfully used to probe the lower troposphere (Bianco et al, 2017). These instruments can be useful to probe PBL quantities in urban settings, where there are restrictions for instrumentation boarded in an aerial platform, such as balloons and drones. Since 2006 and 2017, MWRs have been collecting data at the HU Beltsville Campus and University of Maryland Baltimore County (UMBC), respectively. This particular MWR model collects infrared radiance for 12 wavelength bands and is capable of deriving air temperature and water vapor profiles up to 10 km, where the above 5km values are primarily climatologically derived.

In this proposed activity, we layout a strong plan to integrate an existing ceilometer network and an emerging MWR network and enhance surface stations to monitor turbulent exchanges close to the surface to monitor PBL evolution and exchange of aerosol and thermodynamic parameters over the lower troposphere in the Washington DC- Baltimore City region. This proposed network will allow investigation of several atmospheric processes. We will focus our studies on contrast of the PBL properties over different air masses (continental vs. estuary coastal) and landscapes (urban vs. suburban/rural, estuary coastal) while demonstrating the value of a limited regional network to the study of PBL – its diurnal, evolution as well as seasonal variability. In particular, we focus our investigation on the thermodynamics of the PBL and aerosol loading contrasts over the varying underlying landscapes (a mix of urban, suburban, rural, and estuary coastal regions) with a priority given to local and non-local effects on the PBL height (Sakai et al, 2016). Also,

the effects of air mass modification due to mesoscale systems on the network (Bay breeze) will be assessed. Further, using the ceilometer and surface data, PM2.5 (particle matter concentrations less than 2.5 μm) will be estimated (Li et al, 2016) and comparisons among rural, urban, and coastal plain estuary environments will be performed.

A central objective of the HU Beltsville site is to serve as a co-laboratory for inter-agency and inter-university faculty and researchers. We have shared the data collected there for operational use by NWS and NOAA as well as teaching material development at HU, UMBC, and UMD. Data from the site has also been used as a guide to future network planning by EPA and NOAA on profiling systems and radio sounding training (Attkinson et al, 2018, Hicks et al., 2019). We propose to continue this tradition by providing public access to the realtime data and student training. The studies based on this network will inform regional air quality understanding and weather nowcast/forecast. For instance, data analytic products from the MWR will be generated, and they can better forecast convective systems (such as squall lines, derechos, and isolated convective storms) that might be poorly forecasted using conventional twice-daily NWS data (Cooper, 2016).

2.0 Proposed Instrumentation and network

Central to this proposal is the establishment of the instrument network and analysis and visualization of the collected data. AS such, we first briefly summarize the existing instrument types and our experience and existing partnership with the instrumentation. In the next section, we give a brief description of the instruments.

2.1 Ceilometer: An operational lidar

The Vaisala ceilometers (http://www.vaisala.com/en/products/ceilometers/Pages) is a lidar which was primarily designed to detect cloud ceiling. As with any single wavelength lidar, ceilometer main data products is the elastic backscatter return signal, and uses a diode laser to measure the backscatter profile of the atmosphere. The profile is then derived from the height normalized volume backscatter coefficient, $\beta(z)$. The returned signal is integrated over a 15 s time period with a 10 to 20 m vertical resolution and saved to create a time-history of backscatter profile and stored to a data file. For the past 10 years, HUBC have used a variety of Vaisala ceilometers, from oldest to newest models: CT12K, CT25K, CL31, and CL51 as well as ceilometers from other vendors (Lufft, Campbell). Ceilometers are already installed at HUBC, UMBC, and some stations of the Maryland Department of Environment (MDE) air quality stations.

2.2 Radiosonde Stations and Radiometrics Micro Wave Radiometer (MWR)

HUBC and UMBC already have operational radiosonde stations. Both locations are capable to launch meteorological balloons with radiosondes (Vaisala and/or IMET) that provide profiles of temperature, humidity, pressure, and wind speed and direction. Even though, it is considered an "old" technology, radiosondes are still used nowadays for remote sensing calibration/validation, such as Raman lidars (Adam et al, 2007; Venable et al, 2011) or weather satellites (Nalli et all, 2018, Nalli et all, 2018b).

The ground-based Radiometrics MWR (http://radiometrics.com/mp-series/) is a passive remote sensing instrument that has been used to monitor evolving thermodynamic conditions within the troposphere (Westwater et al., 2005). It measures downwelling atmospheric thermal

emission from water vapor, cloud liquid water, and oxygen. The MWR operates at 12 frequencies ranging from 20 to 60 GHz. Within this range atmospheric emission comes primarily from oxygen, water vapor, and liquid water. In the center of the oxygen absorption band, the atmosphere is optically thick and measured radiation comes from regions closest to the MWR. For frequencies farther away from the center, the atmosphere becomes more transparent allowing for radiation to be observed at greater distances from the MWR (Crewell et al., 2001). Every two minutes, the MWR provides a profiles of water vapor density, temperature, liquid water with a 100 to 250 m vertical resolution and reaching 10km altitude.

2.3 Surface Data

Integrating surface data is key to understanding atmospheric processes in the PBL. We plan to retrofit the existing surface data stations at proposed locations (but HUBC) to be able to measure momentum, sensible, and moisture fluxes, using Eddy Covariance System (EC). The EC system consists of a 3D sonic anemometer (Campbell, CSAT) and an open path infra-red gas analyzer - IRGA (Licor, 7500a) or a coupled 3D sonic anemometer with an IRGA (Campbell Sci., IRGASON). At the HUDC site, we will also include the standard meteorological parameters (pressure, air temperature, humidity, and wind speed/direction). We have maintained this tower throughout its installation with QA/QC protocols.

2.4 Local Network – current status and future plans.

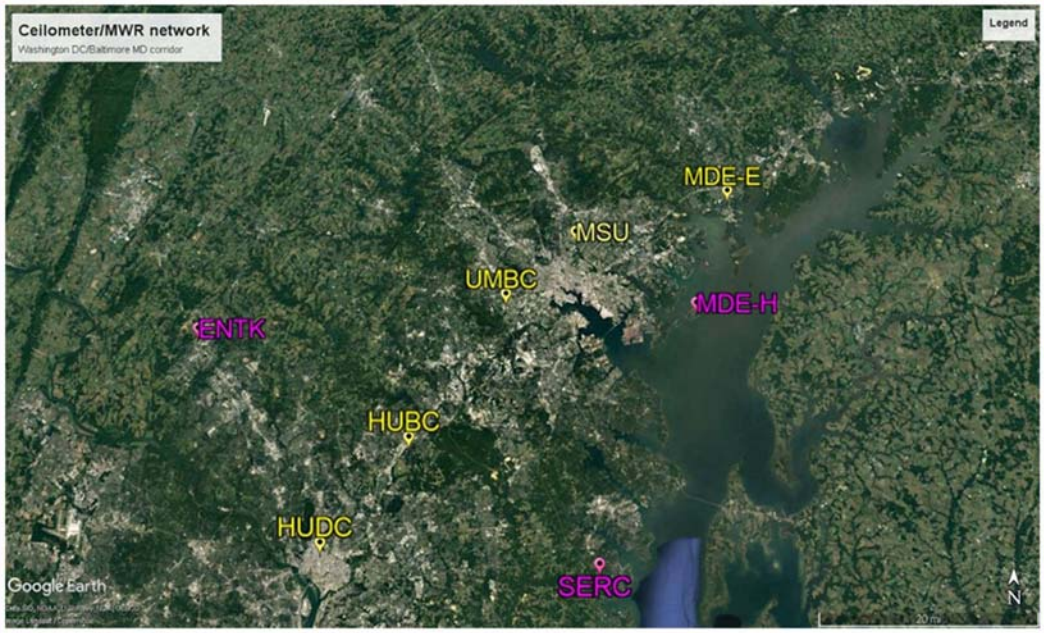

Figure 1: location of the BWTMS stations (yellow) and other study sites (magenta) in the Maryland/Washington DC region.

Figure 1 shows the current and the projected Washington-Baltimore Tropospheric Monitor System (BWTMS). Currently there are four ceilometers, and two micro wave radiometers in operation. The microwave radiometer in Germantown is operated by Environmental Networks, and its data is available (table 1). The landscape varies from forest, rural, suburban, and urban which allows to study the PBLH variation due to land use. As future plan, we will move the two MWR to study the contrasts at HUDC/HUBC or the UMBC/MSU/MDE/MDE-H area. Also, ceilometer at Edgewood can be moved to MDE-H. With this configuration, we will be able to monitor the progression most common weather patterns, from the Southeast, West, and Northwest, and the influence of the bay breeze from the Chesapeake Bay. With exception of ENWK, all instruments are maintained by HU, UMBC, and MSU teams. The Smithsonian Environmental Research Center (SERC) has a NEON tower, and it might be possibly a location for the rover system (ceilometer/MWR).

Table 1: BWTMS stations and current situation. See section 4 for more details of the current status

Station	Location	Landscape	Current Status
Howard Univ. Beltsville Campus (HUBC)	Beltsville MD	Suburban/Rural/ Urban	Luft 15K, MWR, radiosonde, and EC operational.
Univ. Maryland, Baltimore County (UMBC)	Baltimore, MD	Suburban/Coast al	Luft 15K, MWR, and radiosonde operational. EC to be installed
Howard Univ. DC Campus (HUDC)	Washington DC	Urban	CL51 operational MWR (rover) EC to be installed Radiosonde (?)
Morgan State University (MSU)	Baltimore, MD	Urban/Coastal	CL 31 to be installed EC to be installed Radiosonde to be installed MWR (rover)
Maryland Dept. of Enviroment, Edgewood station (MDE-E).	Edgewood, MD	Coastal	CL 31 operational (rover) MWR (rover)
Hart Miller Island station (MDE-H)	Chesapeake Bay	Water	Ceilometer (rover) MWR (rover) EC (rover)
ENTK	Germantown, MD	Urban/Suburban	MWR operational

3.0 Preliminary studies.

3.1 Ceilometer – PBLH and its relation to Surface Meteorological Parameters.

Determination and observation of the atmospheric planetary boundary layer (PBL) is one of the high priority requirements in pollution and storm dynamics as well as energy sectors (NRC, 2009).

Knowledge of PBL characteristics is crucial in developing an understanding of air pollution dynamics and forecasting pollution using numerical weather models. For a well-mixed layer, the backscatter aerosol profile can be used as a tracer for its mixing layer height. A number of studies show the adequacy of the use of lidars to determine the aerosol mixing height that can be used as a proxy of the PBLH (Menut et al., 1999; Steyn et al., 1999; Cohn and Angevine, 2000; Davis et al., 2000; Munkel et al., 2007; Pal et al., 2009). Lidar-derived PBL heights (PBLH) are part of NASA-NOAA high resolution model verification study (McQueen et al. 2010). Most methods assume that a clear and well-defined boundary and drop-off between in aerosol concentrations between the mixed layer and the free troposphere. The PBLH is usually defined to be the altitude where sharp transition in the backscatter occurs. This location is determined, in practice, using different mathematical methods. These methods can range from using wavelet techniques (Brooks 2003); to simple gradient of the backscatter (Munkel et al, 2007); to assuming and fitting an idealized backscatter profile (Steyn et al. 1999), or to a combination of the two methods (Hicks, 2015). Figure 2 shows a comparison of several PBLH estimate using three different lidars, and different methods at the Howard University, Beltsville Campus (HUBC). PBLH estimated from the Vaisala CL51 ceilometer used the commercial Vaisala software (BLview) with other research grade methods. One of the methods (Hicks et al, 2015) combines several of the techniques and is currently being developed to give a real-time output.

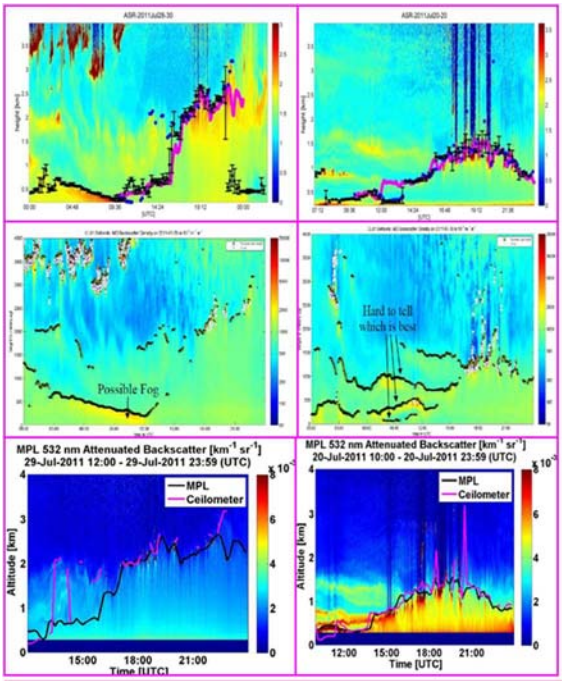

Figure 2: Lidar backscatter profile image from 29 July (left) and 20 July 2011 with derived PBL height (lines). ***Top:*** HURL Raman lidar aerosol backscatter image with PBLH from MPL (magenta), CL51 BL-View method (Blue dots), and Hicks-methods (black). ***Middle:*** Vaisala ceilometer CL51 image and BL-View PBLH. ***Bottom:*** MPL image overlaid with CL51 PBL height data (magenta) and MPL processing. See Hoff et al 2012 for details. Note: the MPL image only cover 1200-2400 UTC.

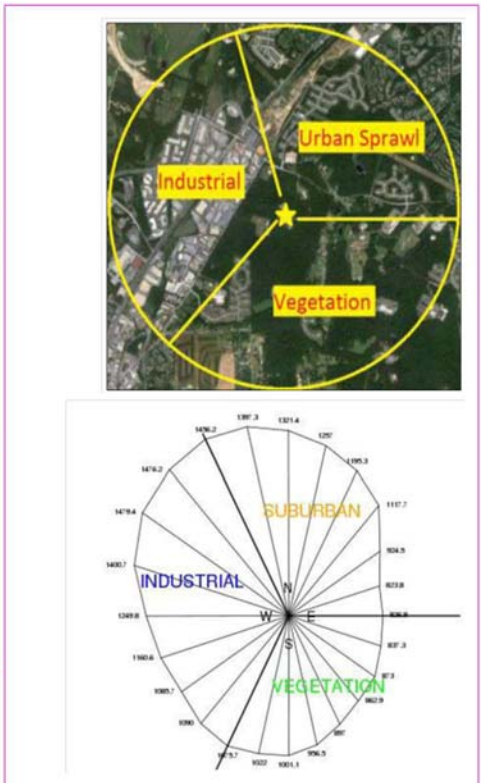

Figure 3: (top) aerial view of HUBC, with 3 major sectors identified (industrial, suburban, and vegetation). (bottom) Radial plot of the PBLH according to the meteorological wind direction at HUBC.

Even though the surroundings of HUBC have a complex landscape, it can be separated in

3 major sectors, industrial, suburban, and forest (figure 3, top). The subset of the PBLH associated with capped boundary layer clouds allow to link the underneath land/soil and foliage type to the PBLH. According to figure 2b, segregating the PBLH by meteorological wind direction (figure 3, bottom), highest PBLH values are attained when winds come from the industrial sector, and the lowest PBLH values from winds coming from the vegetated sector. Differences between the lift condensation level (LCL) and PBLH are used as the criteria to determine if those are capped boundary layer clouds. Air masses from the industrial area are warmer and drier than the ones from the vegetated sector where the partition of the available energy between sensible and latent heat leads to a colder and moister air mass. Therefore, sites such as HUBC poses a real problem to characterize the PBL, since it will depend on the wind direction

3.2 PM 2.5 estimates using Ceilometer and Surface Meteorological Parameters.

The PM2.5 is an important airborne pollutant due to the negative impact on people's health (Krewski et al, 2009, Lepeule et al., 2012). Several studies show the use of lidars to estimate PM2.5 (Munkel et al, 2007, Li et al., 2016). However, these aerosol retrievals are only valid for clear days. Li et al (2016) developed a ceilometer aerosol model to estimate PM2.5 concentrations not only for cloudless daytime periods, but also for cloudy and nocturnal periods. In this study, the empirical model is based on the regression between hourly PM2.5, meteorological parameters, and the closest to the surface backscatter coefficient measured by the ceilometer backscatter (β_1). Results show great improvement using the additional meteorological information in comparison to a single relationship between PM2.5 and β_1. Also, this study shows that depiction of the aerosol profile will remove any elevated aerosol layer to the aerosol retrieval from passive instruments, such as the sun photometers. There is a caveat though, for any individual ceilometer, a unique empirical relationship should be determined owing to the calibration used by the instrument vendor, which we plan to obtain through collaboration with the vendor and/or in house comparison with other well calibrated lidars and re-calibration. Even so, ceilometer can detect air masses changes, or detect elevated well mixed aerosol layers related to a different air mass.

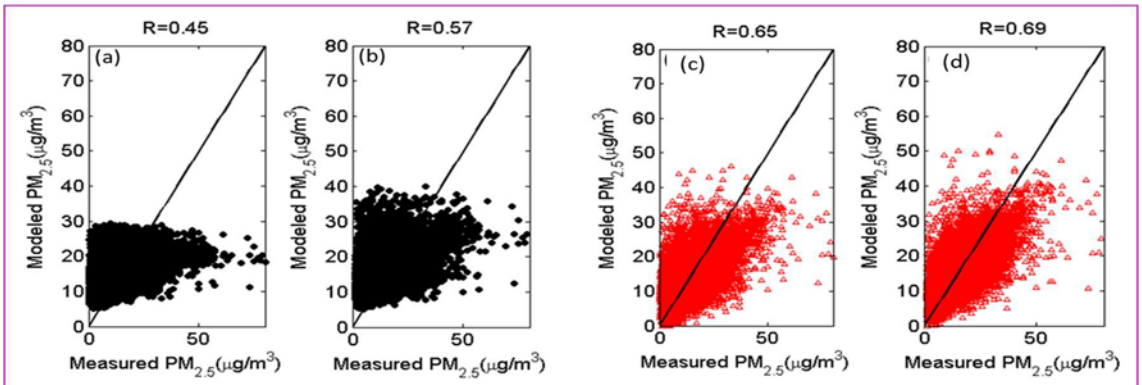

Figure 5: Comparison of measured PM2.5 and Modeled PM2.5. Meteorological variables are not taken into accounts using (a) all data available, (b) model is seasonally fitted. Meteorological parameters are considered (c) all data, (d) seasonally fitted.

3.3 Case Study of Air Mass Contrasts.

Daytime profiles from radiosonde data during OWLETS 2 field campaign (https://www-air.larc.nasa.gov/missions/owlets/index.html) show the spatial variability within the PBL in the study area. Balloon trajectories (figure 6f) show that the balloons did not travel too far from launching sites. For the land soundings (HU and UMBC), the convective boundary layer heights are about 1,200-1,500m, whereas over the Chesapeake Bay site (MDE-H) there is a stable boundary layer about 500 m high. Above 2,500m thermodynamical and wind profiles are homogenized. Close to the surface, due to a more urbanized location, UMBC humidity (figure 6a) temperature (figure 6b) profiles are warmer and drier than the HU site, presenting a stronger potential temperature gradient (super-adiabatic layer). Wind speed are higher over water than land (figure 6c) due to less friction, and the meteorological wind direction rotates clockwise, indicating that winds over the Bay and UMBC comes from southeast/south at surface, and turns to southwest at the top MDE-H SBL level. At HUBC, PBL winds are predominantly from southwest. Contrary to the thermodynamic profiles, ozone profiles show a different pattern. At HU there is high ozone concentration throughout the PBL. At surface, over UMBC and MDE-H, ozone concentration is low, increasing till about 300m and 1200m for UMBC and MDE-H respectively. At the top of the PBL, MDE-H and HU present similar ozone concentrations.

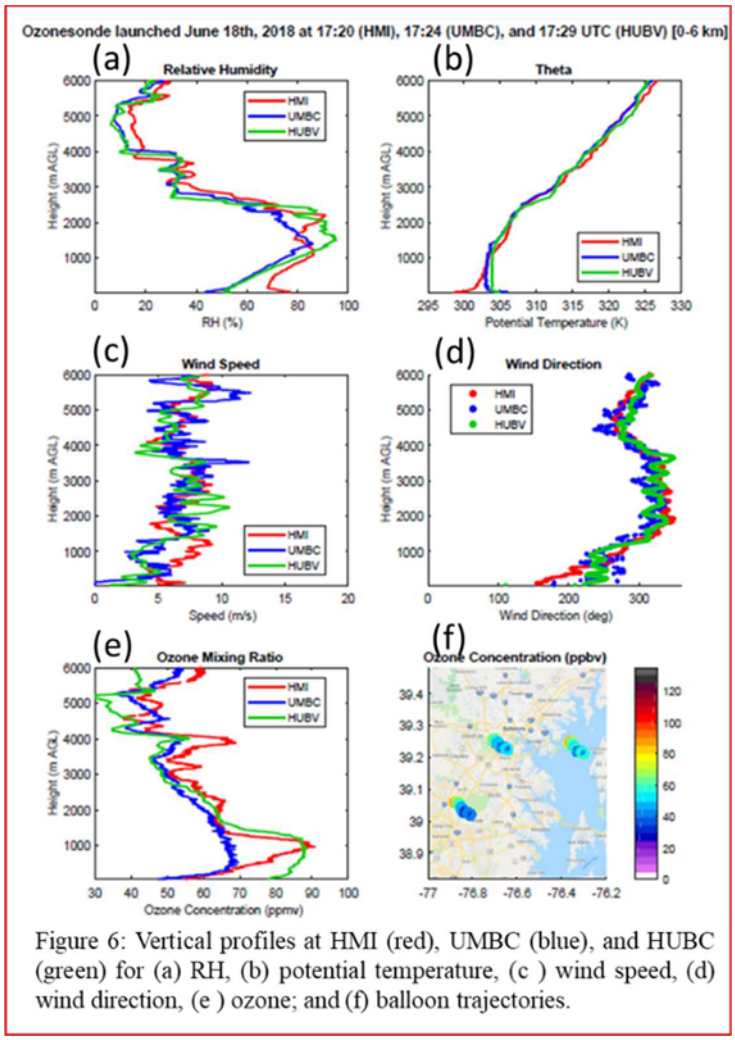

Figure 6: Vertical profiles at HMI (red), UMBC (blue), and HUBC (green) for (a) RH, (b) potential temperature, (c) wind speed, (d) wind direction, (e) ozone; and (f) balloon trajectories.

4. *Proposed Work*

In this section, we present two of the main hypotheses that we plan to investigate in this proposal. We present them in a form of hypothesis and our plan of ways to address these questions.

*4.1. **Hypothesis 1:** Local and non-local contributions to PBL evolution.*

The planetary Boundary layer height is a key parameter that has been quite difficult to reproduce correctly in forecast models. One of the primary problems, among many others, in simulating PBLH has been accurate understanding of its interaction with the underlying ground characteristics. The heat and momentum exchange with from the underlying surface depend on the soil moisture as well as the air mass (weather systems) that is in dominance (Friedman and Fitzjarrald, 2001). *We hypothesis that contribution to the variability of PBLH, as measured by lidar backscatter gradient (Hicks et al, 2015, 2019, and others), depends on the variability of the underlying surface characteristics and specially the state of the "greenness" of the foliage and wind speed*.

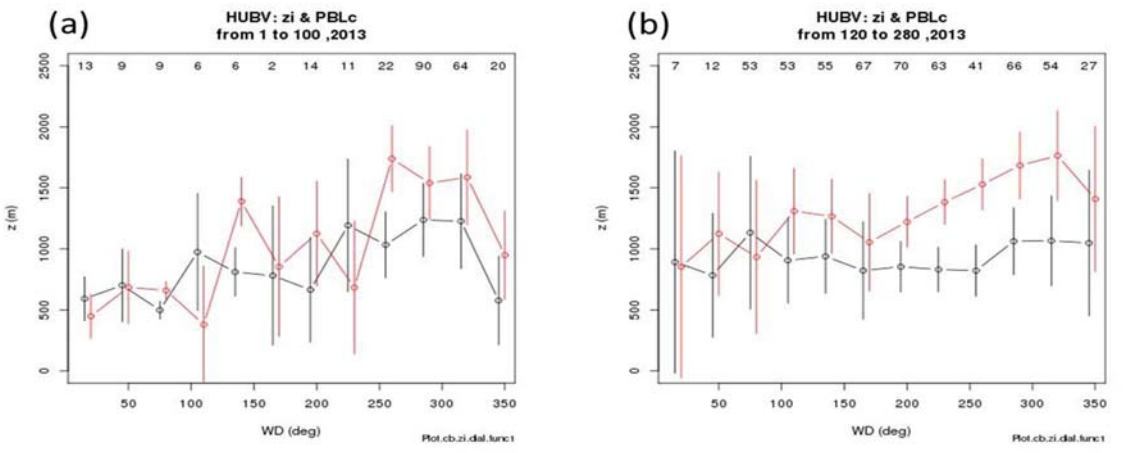

Figure 5: PBLc (red) and zi (black, see text) separated according to prevalent meteorological wind direction for day of the year (a) 1-100 (leafless period), (b) 120-280 fully canopy cover. Error bars represents the standard deviation for each wind direction, and the number at the top of the graphs are the sample size.

The rate of change of the temporal averaged potential temperature within the PBL (θ_{PBL}) in natural coordinates can be approximately given by:

$$(PBLH)\frac{\partial \theta_{PBL}}{\partial t} = \underset{(I)}{\overline{w'\theta'}_0} - \underset{(II)}{\overline{w'\theta'}_{PBL}} - \underset{(III)}{U\frac{\partial \theta_{PBL}}{\partial x}} \qquad (1)$$

where $\overline{w'\theta'}_0$ and $\overline{w'\theta'}_{PBL}$ are the potential temperature fluxes at the surface and at the top of the PBL, respectively, U is the temporal averaged the wind speed, and x is the direction of the wind direction.

Assuming no mean vertical velocity at the top of the PBL, the heat flux at the top of the PBL can be approximated to (Garrat, 1994):

$$\overline{w'\theta'}_{PBL} = -\Delta\theta_{PBL} \frac{\partial(PBLH)}{\partial t} \quad (2)$$

where $\Delta\theta_{PBL}$ is the temporal averaged potential temperature difference between the PBL and free atmosphere.

A preliminary study using ceilometer data from HU, UMBC, and NOAA is performed to develop a quasi-real time algorithm, to compare the PBLH from ceilometer network and compare it to a surface-flux based estimate. A comparison of these independent measurements reveals quite interesting results that has encouraged us to study further. At HUBC estimates of the PBLH from surface fluxes based on term I from above equation (Garratt, 1994) show a good agreement with PBLH derived from ceilometer (PBLc) during winter/leafless period (See figure 5). However, during the summer/foliated period, turbulent fluxes do not explain the higher PBL detected and when winds are from the industrialized side of the ceilometer location (225^0 to 345^0 in figure 5, see figure 3 for aerial view). We believe that this suggests that non-local effects should be considered when investigating the PBL properties temporal evolution.

Thermodynamic profile modifications from non local sources, such as warm advection or from urban regions, and/or the ocean/bay in these regions within the PBL (equation 1, term III) and the entrainment rate at the top of the PBL (equation 1, term II) can be evaluated. Local contributions to PBLH will be estimated by the EC system, PBLH by ceilometer and profiles from radiosonde and MWR. Contributions of local sources to the PBLH will be evaluated from heat fluxes estimated from EC systems. PBLH estimates will be derived from radiosonde profiles and/ or using the aerosol mixing heights from ceilometer. Flux at the top of PBL (equation 2) will be assessed from the PBLH and MWR profiles to determine the lapse rates in the free atmosphere, PBLH, and potential temperature within mixed layer in the convective boundary layer. Modelled and observed (e.g., wind profiler at HUBC) wind information will be used for horizontal advection of heat and moisture within the PBL. Unfortunately, we will not be able to direct estimate mesoscale fluxes within the PBL, and it will be done by the residual from a 1D box-model.

4.2 Hypothesis 2: Does the landscape contrast generate elevated mixing layers? Do aerosol measurements can detect such layers?

Another possibility for such high PBLH is the presence of elevated mixing heights (EML). *We hypothesized that EML (Elevated Mixed Layer) is due to internal boundary layer appearance at the transition of two different landscapes, such as urban/suburban-rural or due to a Bay breeze front.* We plan to conduct further studies on the PBLH control by the underlying landscape using a network of ceilometers from urban setting (Howard University in Washington DC, and Morgan State University, Baltimore), suburban and forested stations (HUBC). We have acquired several years of data collected at these stations and a well characterized long-term soil moisture and multi-layers instrumented tower at HUBC. This proposed work plans to conduct further studies on the PBLH and the underneath landscape, evolution of the PBLH and PBL backscatter in between weather system passages due to air mass modification (Friedman and Fitzjarrald, 2001) over different landscapes and mesoscale circulations, such as Bay breeze.

To do that, we will use the ceilometer data and MWR profiles due to their high temporal resolution, and radiosonde data. Several studies show the adequacy of utilizing ceilometers to detect changes in air masses, such as sea/bay breezes circulation (Uzan et al, 2016; Caicedo et al,

2019) and MWR (Gaffard et al, 2017). We will seek to identify elevated mixed layers, which are formed from the juxtaposition of two PBL from different air masses (Arrit et al., 1992; Freedman and Fitzjarrald, 2017), and compare with ceilometer aerosol backscatter profile. Those EML are identified by the PBL potential temperature upwind of the internal boundary layer. Also, we will seek contrasts and correlations of EML with elevated aerosol layer (Hicks et al, 2015) using aerosol backscatter, ground measurements, ground based remote sensing instruments that provides information of the total aerosol column.

4.3. Synergy among institutions, investigators and collaborators.

We plan to perform this work in collaboration with Howard University, Morgan State University (MSU), and University of Maryland Baltimore County (UMBC). The main goal is to organically build an upper air network in which the involved institutions can share quality-controlled data and produce quality scientific research work. Dr. Ricardo K. Sakai will have the overall responsibility for managing the work with science review and deliverables in coordination with Dr. Richard Damoah (MSU) and Dr. Belay Demoz (UMBC). We intend to recruit underrepresented minority graduate students to work on this project. Regular meetings are planned, and a workshop will be organized during summer. At MSU, there is an effort to develop a meteorological and upper air observatory, such as a radiosonde ground station and ceilometer. There is a long-standing relationship between HU and UMBC. Before accepting the position of director at the (JCET), Dr. Belay Demoz has been part of the HU atmospheric faculty. Dr. Demoz set up the ceilometer and MWR at HUBC and promoted the installation of the HU MWR/ceilometer system at the UMBC site. We plan to install also an EC system at UMBC.

The Maryland Department of Environment (MDE) has a long partnership with HU. The MDE air quality super-station is located at HUBC that contains not only surface meteorological and air quality measurements, but also a wind profiler. Also, since 2004, ozonesondes are launched during high ozone episodes by request of MDE. Collaborations also include of use of ceilometers at several air quality stations, such as the Edgewood station. On 2018, HU instruments were used at Hart Miller Island as a part of the NASA OWLETS 2 field campaign.

4.4. Data Management and Deliverables

a) Data management.

All data will be made public, according to our cooperative institute, NOAA NCAS-M, directives. Data from the proposed network will be stored in the local server that already automatically collects the HUBC environmental data. In this server most of the products will be generated (surface meteorological data, surface fluxes, radiosonde data, PBLH, profiles from MWR and aerosol backscatter, aerosol mixing heights).

b) Deliverables.

If this proposal is awarded, the PI, Co-PIs, students, and staff will attend AMS or AGU conferences to divulge this work.

After the project completion, we plan to publish at least 5 articles in a peer review journal with the following themes:

- PBL height comparison over different landscapes (forested, rural, urban, and coastal).
- Effects of urbanization over surroundings suburban area.
- Bay Breeze influence over the Baltimore region.
- Elevated Mixing Layers.

4.5. Schedule/Time line (starting on May 1)

Semester	Milestones
1st	- Instrumentation Acquisition - QA/QC protocols. - EC installation at HUDC, MSU, and UMBC. - Consolidate all data streams to server hosted at HUBC and MSU. - Comprehensive ceilometer inter-comparison - PBLH study at HUBC test bed. - Comprehensive MWR study at HUBC test bed. - Radiosonde training at HUBC.
2nd	- Automatization of ceilometer and EC products - HUDC/HUBC MWR installation - Data Analysis - Conference presentations (AMS and/or AGU):
3rd	- Data Analysis - Workshop at HUBC – discussion on Washington DC results. - MWR study at UMBC/MDE-H(or MDE-E) or MSU/MDE-H (or MDE-E)
4th	- Data Analysis - Paper(s) submission. - Conference presentations (AMS and/or AGU)
5rd	- Data Analysis - Summer Workshop at MSU – discussion on Baltimore MD results. - MWR return to HUBC and UMBC.
6th	- Data Analysis - Papers submission - Conference presentations (AMS and/or AGU)

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Hicks, M., Demoz, B., Vermeesch, K., and Atkinson, D., 2019. Intercomparison of Mixing Layer Heights from the National Weather Service Ceilometer Test Sites and Collocated Radiosondes. Journal of Atmospheric and Oceanic Technology, 36, 129-137.

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Nalli, N., Gambacorta, A…., Smith, J.W., 2018. Validation of Atmospheric Profile Retrievals Fromthe SNPP NOAA-Unique Combined Atmospheric Processing System. Part 2: Ozone. IEEE Transactions on Geoscience and Remote Sensing, 56, 598-607.

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Sikora, T. D., G. S. Young, and M. J. Bettwy, 2010: Analysis of the western shore Chesapeake Bay bay-breeze. Natl. Wea. Dig., 34, 55-65.

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Westwater, E. R., S. Crewell, and C. Mätzler, 2005. Surface-based Microwave and Millimeter wave Radiometric Remote Sensing of the Troposphere: a Tutorial, IEEE Geoscience and Remote Sensing Newsletter, 16-33.

NSF Biographical Sketch

Ricardo K. Sakai, PhD
Senior Scientist at Howard University, Beltsville Campus
7501 Muirkirk Rd, Beltsville MD
(310) 419 9035
ricardo.k.sakai@howard.edu

(a) Professional Preparation

Universidade de Sao Paulo	Sao Paulo, Brazil	Atmos. Science	B.S., 1998.
University at Albany, SUNY	Albany, NY	Atmos. Science	Ph.D., 2000.
University at Albany, SUNY	Albany, NY	Atmos. Science	Post-Doc, 2000-2004

(b) Appointments

Howard University – Senior Scientist	2010- present
University at Albany, SUNY – Research Scientist	2004-2010
Universidade de Sao Paulo – Data technician	1988-1992

(c) Publications

(i) Selected publications

Joel Dreessen, D. Orozco, J. Boyle, J. Szymborski, P. Lee, A. Flores, and R. K. Sakai 2019. Observed Ozone Over the Chesapeake Bay Land-Water Interface: The Hart-Miller Island Pilot Project. Journal of the Air & Waste Management Association, DOI: 10.1080/10962247.2019.1668497.

David R. Fitzjarrald , R.K. Sakai, O.L.L. Moraes, R.C. de Oliveira, O. C. Acevedo, Matthew J. Czikowsky, and Troy Beldini, 2008. Spatial and temporal rainfall variability near the Amazon-Tapajós confluence, Journal Geophyical. Research – Biogeosciences.

Ricardo K. Sakai, D.R. Fitzjarrald, O.L.L. Moraes, R.M. Staebler, O.C. Acevedo, M.J. Czikowsky, R. da Silva, E. Brait, and V. Miranda, 2003. Land-use change effects on local energy, water, and carbon balances in an Amazonian agricultural field, 2004. Global Change Biology, 10, 895-907.

Otávio C. Acevedo, OLL Moraes, R. Silva, D.R. Fitzjarrald, R.K. Sakai, R.M. Staebler, and M.J. Czikowsky, 2004. Inferring nocturnal surface fluxes from vertical profiles of scalars in an Amazon pasture. Global Change Biology, 10, 886-894.

Jeff M. Freedman, D. R. Fitzjarrald, K. E. Moore, and R. K. Sakai, 2001. Boundary layer cumulus clouds and vegetation atmosphere feedbacks. *Journal of Climate*, 14, 180-197.

Ricardo K. Sakai, D.R. Fitzjarrald, and K.E. Moore, 1997. Detecting Leaf Area and Surface Resistance during Transition Seasons. Agricultural and Forest Meteorology, 273-284.

(ii) Published publications with Howard University alumni/students.

Cassie Stearns, R.K. Sakai, E., Joseph, 2016. A Novel Method of Urban Land Type Identification Utilizing Meteorological Station Network Temperature Data, as developed for the Baltimore-Washington Region. Urban Climate, 17, 146-160.

Sium Gebremariam, B. Demoz, C. Okonkwo and R. K. Sakai, 2016. An observational and model characterization of vertical structure of wind fields over Eastern United States: A Case study of Sterling, Virginia. Advances in Meteorology. vol. 2016, Article ID 2020379, 15 pages.

Churchill Okonkwo, B. Demoz, R. K. Sakai, C. Ichoku, C. Anarado, J. Adegoke, A. Amadou, S. I. Abdullahi, N. Krakauer, 2015. "Combined effect of El Nino southern oscillation and Atlantic multidecadal oscillation on Lake Chad level variability". Cogent Geoscience.

Micheal Hicks, R.K. Sakai, E. Joseph, 2015. The Evaluation of a New Method to Detect Mixing Layer Heights from Lidar Observations. *Journal* of Atmospheric and Oceanic Technology, 32, 2041- 2051.

Meghan K. Payne, E. Joseph, R.K. Sakai, J.D. Fuentes, W. R. Stockwell, 2015. Meteorological controls on particle growth events in Beltsville, MD, USA during July 2011. Journal of Atmospheric Chemistry, 72 23-440.

(d) Synergistic Activities

- Serve as reviewer of the following scientific journals: Agricultural and Forest Meteorology, Boundary Layer Meteorology, Journal of Applied Meteorology and Climatology, Global Change Biology, Revista Brasileira de Meteorologia, and Water Resources.
- Served as co-chair of "Poster and Paper Judging Committee" for NOAA's 9th Biennial Education and Science Forum, Washington, DC, USA, 2018
- Served as panelist at LBA-ECO Data Panel Meeting, NASA Goddard, 2011.
- Participation in NASA Earth Venture 1 (NNH09ZDA001N), Science Planning Evaluation, 2010.
- Consultant for the Fundamental Instrument Unit of the National Ecological Observatory Network (NEON), 2008.

BIOGRAPHICAL SKETCH

Name: Belay B. Demoz,
Title: Professor and Director/JCET Ph: (410) 455-2715
Institution: University of Maryland Baltimore county Fax: (410) 455-1072
Address: 1000 Hilltop circle, Baltimore, MD 21250
E-mail: bdemoz@umbc.edu

Professional Preparation

Asmara University, Eritrea,	Physics	B.S. 1984
University of Nevada, Reno	Atmospheric Physics	M.S. 1989
University of Nevada, Reno	Atmospheric Physics	Ph.D. 1992

Appointments

2014 – Present:	Professor of Physics and Director- Joint Center for Earth Systems Technology (JCET), University of Maryland Baltimore County (UMBC).
2007 - 2016:	Adjunct Professor, Atmospheric Sciences, University of Utah
2012– 2014:	Professor of Physics and Atmospheric Science, Howard University..
2008- 2012:	Associate Professor, Howard University. Appointment: Department of Physics and Astronomy as Associate Professor.
2000 – 2010:	Fellow, JCET/UMBC, Baltimore, MD
2002-2008:	Physical Scientist, NASA/GSFC
2005-2007:	Adjunct Professor**;** Howard University, Department of Physics and Astronomy
1998- 2002	Assistant Professor, JCET, Univ. of Maryland Baltimore County.
1994-1998:	Principal Scientist Hughes STX Corp.
1992-1994:	Post-Doctoral Associate, UIUC, Institute for Environmental Science.
1986- 1992:	Graduate Research Assistant, Desert Research Institute (DRI), Reno, Nevada.
1984-1986:	Lecturer-I, Asmara University. Asmara, Eritrea.

Five Products Most Closely Related to Proposed Project

1) Carroll et al (2019): An overview of low-level jet winds and corresponding mixed layer depths during PECAN. Conditionally Accepted. JGU-Atmospheres
2) Hicks, M; D. Atkinson, K. Vermeesch, B. Demoz (2018): Intercomparison of Mixing Layer Heights from the National Weather Service Ceilometer Test Sites and Collocated Radiosondes" (JTECH-D-18-0058) In Press: *Journal of Atmospheric and Oceanic Technology,*
3) Pu, Z., L. Zhang, S. Zhang, B. Gentry, D. Emmitt, **B. Demoz**, R. Atlas, 2016: The impact of Doppler wind lidar measurements on high-impact weather forecasting: Regional OSSE and data assimilation studies. Book Chapter, "Data Assimilation for Atmospheric, Oceanic and Hydrologic Applications", in "*Data Assimilation for Atmospheric, Oceanic and Hydrologic Applications, Volume III*" Contributed to Springer Book by Seon K. Park and Liang Xu (Eds.) (in press)
4) Strobach, E., Sparling, L. C., Rabenhorst, S. D., Demoz, B. B. (2018). Impact of Inland Terrain on Mid-Atlantic Offshore Wind and Implications for Wind Resource Assessment: A Case Study.J. of Applied Meteorology and Climatology, 57(3), 777-796.

5) Geerts, B., and Couthors including B. B. Demoz, (2016): The 2015 Plains Elevated Convection At Night (PECAN) field project Submitted to Bull. Amer. Meteor. Soc. Soc. 98, 767-786

Five Other Significant Products

1. Lolli, S., Di Girolamo, P., Demoz, B. B., Li, X., Welton, E. J. (2017). Rain Evaporation Rate Estimates from Dual-Wavelength Lidar Measurements and Intercomparison against a Model Analytical Solution. *Journal of Atmospheric and Oceanic Technology*, *34*(4), 829-839.
2. Strobach, E., Sparling, L. C., Rabenhorst, S. D., Demoz, B. B. (2018). Impact of Inland Terrain on Mid-Atlantic Offshore Wind and Implications for Wind Resource Assessment: A Case Study. *Journal of Applied Meteorology and Climatology*, *57*(3), 777-796. http://dx.doi.org/10.1175/jamc-d-17-0143.1.
3. Fassò, A., Ignaccolo, R., Madonna, F., and Demoz, B. B. (2014): Statistical modelling of collocation uncertainty in atmospheric thermodynamic profiles, *Atmos. Meas. Tech. Discuss*., 6, 7505-7533, DOI: 10.5194/amt-7-1803-2014.
4. Flores, A., R. Sakai, E. Joseph, N. Nalli, A. Smirnov, B. Demoz, V. Morris, D. Wolfe. On Saharan Air Layer Stability and Suppression of Convection over the Northern Atlantic: Case Study Analysis of a 2007 Dust Outflow Event. Submitted to the *Journal of Applied Meteorology and Climatology*.
5. Rabenhorst, S., D. N. Whiteman, D. Zhang, D. Demoz (2014): A Case Study of Mid-Atlantic Nocturnal Boundary-Layer Events During WAVES 2006. Part I: Observational Detection of Fine Scale Phenomena. *J. Appl. Meteor. Climatol.*, **53**, 2627–2648. doi: http://dx.doi.org/10.1175/JAMC-D-13-0350.1

Synergistic Activities (5 max)

2014 -Present	Co-Chair – GRUAN subgroup for network of climate sites and Convener and Chair – 6th GRUAN Implementation Workshop. WWW.GRUAN.org)
2013 - 2013:	Convener and Chair, 2nd to 6th Symposium on lidar Atmospheric Applications, 93rd Annual Meeting of the American Meteorological Society, 6-10 January 2013; Austin, TX.
2011:	Thermodynamic Profiling Technologies Workshop UCAR Center Green #1 Boulder, Colorado 12-14 April 2011; Chair a Session on Optical Active Profiling
2012-Present	Member: The AOPC Working Group on Atmospheric Reference Observations (WG-ARO), World Meteorological Organization, 2011-Presenter
2012-Present	Member, Aerosol Clouds and Trace gases Research InfraStructure Network (ACTRIS) Selection Committee

BIOGRAPHICAL SKETCH FOR RICHARD DAMOAH

(a) Professional Preparation

University of Cape Coast, Cape Coast, Ghana	Major: Physics	Bsc	2000
University of Bremen, Bremen, Germany	Major: Environmental Physics	MSc	2002
Technical University of Munich, Munich, Germany	Major: Atmospheric Science	Ph.D.	2005

(b) Appointments

- *March 2011-present*: Associate Research Scientist, NASA/GESTAR, Morgan State University, Baltimore, MD, US
- *January 2009-March 2011:* Research Fellow, University of Waterloo, Waterloo, Ontario, Canada.
- *February 2006–December 2008:* Post-doctoral Fellow, University of Edinburgh, Edinburgh, UK

(c) Publications (10)

Doyle, J. G., G. Lesins, C. P. Thackray, C. Perro, G. J. Nott, T. J. Duck, R. Damoah, and J. R. Drummond (2011), Water vapor intrusions into the High Arctic during winter, Geophys. Res. Lett., 38, L12806, doi:10.1029/2011GL047493.

Wenshou Tian, Martyn P. Chipperfield, David S. Stevenson, Richard Damoah, Sandip Dhomse, Anu Dudhia, Hugh Pumphrey, and Peter Bernath: The Effects ofStratosphere-Troposphere Chemistry Coupling onTropospheric Ozone, J. Geophys. Res., 115, D00M04, doi:10.1029/2009JD013515,

2010. Kuhn, T.,Damoah, R., Bacak, A., and Sloan, J. J.: Characterizing aerosol transport into the Canadian High Arctic using aerosol mass spectrometry and Lagrangian modelling, Atmos. Chem. Phys., 10, 10489-10502, 2010.

R. Damoah, N. Spichtinger, R. Servranckx, M. Fromm, E. Eloranta, I. Razenkov, P. James, M. Shulski, C. Forster, A. Stohl: A case study of pyro-convection using a transport model and remote sensing data, Atmos. Chem. Phys., 6, 173-185, 2006.

Ansmann, A., I. Mattis, D. Muller, U. Wandinger, M. Radlach, D. Althausen, and R. Damoah: Ice formation in Saharan dust over central Europe observed with temperature/humidity/aerosol Raman lidar, J. Geophys. Res., 110, D18S12, doi:10.1029/2004JD005000, 2005.

Damoah, R.; Spichtinger, N.; Forster, C.; James, P.; Mattis, I.; Wandinger, U.; Beirle, S.; Wagner, T.; Stohl, A. Around the world in 17 days - hemispheric -scale transport of forest fire smoke from Russia in May 2003, Atmos. Chem.Phys., 4, 1311-1321, 2004.

A. Stohl, O. R. Cooper, R. Damoah , F. C. Fehsenfeld, C. Forster, E.-Y. Hsie, G. Hubler, D. D. Parrish, M. Trainer; Forecasting for a Lagrangian aircraft campaign Atmos. Chem. Phys. , 4, 1113-1124, 2004.

Spichtinger, N.; Damoah, R .; Eckhardt, S.; Forster, C.; James, P.; Beirle, S.; Wagner, T.; Novelli, P. C.; Stohl, A. Boreal forest fires in 1997 and 1998: A seasonal comparison using transport model simulations and measurement data, Atmos. Chem. Phys., 4, 1857-1868, 2004.

Richard Damoah, H. B. Selkirk, M. Manyin, L. Oman, L. Ott, A. R. Douglass, S. Pawson, Evaluation of upper tropospheric moisture in GEOS5CCM MERRA reanalyses and implications for contrail formation, ACCRI Symposium Virginia Beach, USA, 27-29 November 2012 Richard

Damoah, H. B. Selkirk, Q. Liang, M. Manyin, L. Oman, L. Ott, A. R. Douglass, S. Pawson and R. Stolarski, Upper Tropospheric Ozone and Relative Humidity with respect to Ice: Seasonal Intercomparison between GEOS CCM, MOZAIC and MLS, ACCRI Symposium, Arlington, USA, 13-15 December 2011.

R. Damoah, & J. J. Sloan: Air pollution transport to the Arctic: A case study and climatology, CANDAC workshop, Halifax, Canada, 1-3 November 2010.

(d) Synergistic Activities

(i) PI, Course-Redesign ASCEND ($20,000.00): Redesign of the Meteorology course at the Physics department of Morgan State University

(ii) Co-Investigator SEAC4RS NASA ($401,800.00): Investigation the condition of the atmosphere using balloon sounding to profile the atmosphere during the SEAC4RS field campaign.

(iii) Co-Investigator ACCRI FAA ($456,883.52): Investigating the impact of aircraft emissions on the climate using climate model (GEOSCCM) and an off-line radiative transfer model (RTM).

(iv) Co-Investigator IDS NASA ($1,354,000): Investigating the impact of Biomass burning on climate in Africa using models and observations.

(e) Collaborators & Other Affiliations

Royal Meteorological Society since 2007
MOZAIC Co-investigator since 2007
EDITOR-Central European Journal of Geosciences since 2008
Canadian Meteorological and Oceanography Society since 2009
American Geophysical Union (AGU) since 2014
Editorial Board-International Journal of Environmental Monitoring and Analysis since 2014
PI-AERONENT Ghana Station since 2015
Reviewer-Journal of Geophysical Research (JGR) since 2015
Scientific Associate-Committee on Space Research (COSPAR), since 2017
Scientific Advisory Committee Member-Africa Initiatives for Planetary and Space Science 2018

Dr. Henry Selkirk GESTAR/USRA NASA Goddard Space Flight Center Maryland, US
Dr. David Stevenson, University of Edinburgh U.K
Dr. Andreas Stohl, Norwegian Institute for Air Research Norway

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Howard University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Ricardo Sakai

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Ricardo K Sakai - Dr.**	1.20	0.00	0.00	**8,464**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	1.20	0.00	0.00	**8,464**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	6.00	0.00	0.00	**15,600**	
3. (**1**) GRADUATE STUDENTS				**25,000**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**49,064**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**7,003**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**56,067**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Eddy Covariance system (3 units) **$ 40,400**					
TOTAL EQUIPMENT				**40,400**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**8,000**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**20,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**57,319**	
6. OTHER				**33,000**	
TOTAL OTHER DIRECT COSTS				**110,319**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**214,786**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
Total Facilities & Administrative Cost (Rate: 54.5000, Base: 84067)					
TOTAL INDIRECT COSTS (F&A)				**45,817**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**260,603**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**260,603**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Ricardo Sakai

ORG. REP. NAME*
Caribbean Ross

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Howard University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Ricardo Sakai

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Ricardo K Sakai - Dr.**	1.20	0.00	0.00	**8,464**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	1.20	0.00	0.00	**8,464**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	6.00	0.00	0.00	**15,600**	
3. (**1**) GRADUATE STUDENTS				**25,000**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**49,064**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**7,003**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**56,067**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**8,000**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**3,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**2,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**58,923**	
6. OTHER				**33,000**	
TOTAL OTHER DIRECT COSTS				**97,423**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**161,490**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Total Facilities & Administrative Cost (Rate: 54.5000, Base: 44567)**					
TOTAL INDIRECT COSTS (F&A)				**24,289**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**185,779**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**185,779**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Ricardo Sakai

ORG. REP. NAME*
Caribbean Ross

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Howard University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Ricardo Sakai

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Ricardo K Sakai - Dr.**	1.20	0.00	0.00	**8,464**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	1.20	0.00	0.00	**8,464**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	6.00	0.00	0.00	**15,600**	
3. (**1**) GRADUATE STUDENTS				**25,000**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**49,064**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**7,003**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**56,067**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**8,000**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**3,500**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**2,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**96,062**	
6. OTHER				**16,000**	
TOTAL OTHER DIRECT COSTS				**118,062**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**182,129**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Total Facilities & Administrative Cost (Rate: 54.5000, Base: 45067)**					
TOTAL INDIRECT COSTS (F&A)				**24,562**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**206,691**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**206,691**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Ricardo Sakai

ORG. REP. NAME*
Caribbean Ross

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Howard University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Ricardo Sakai**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Ricardo K Sakai - Dr.**	3.60	0.00	0.00	**25,392**	
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	3.60	0.00	0.00	**25,392**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**3**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	18.00	0.00	0.00	**46,800**	
3. (**3**) GRADUATE STUDENTS				**75,000**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**147,192**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**21,009**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**168,201**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ **40,400**					
TOTAL EQUIPMENT				**40,400**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**24,000**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**26,500**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**5,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**212,304**	
6. OTHER				**82,000**	
TOTAL OTHER DIRECT COSTS				**325,804**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**558,405**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**94,668**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**653,073**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**653,073**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Ricardo Sakai**

ORG. REP. NAME*: **Caribbean Ross**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

BUDGET JUSTIFICATION FOR ALL YEARS

1. **Personnel**:
    a. *Salaries*
        i. Dr. Ricardo K. Sakai will serve as PI. During the calendar year, he will dedicate 10% of his time to grant activities and overall grant management. 10% of Dr. Sakai salary is allocated to support his effort.

Total requested for salary: $25,392.00

        ii. Adrian Flores will be the data technician. Mr. Flores will assist in field work, and QA/QC. He will dedicate 50 % of his time to grant. 50% of Mr. Flores salary is allocated to support his effort.

Total requested for salary: $46,800.00

    b. A Master student will be recruited. He/She will assist in field and data analysis leading to a peer review publication, and he will be a full-time student. Stipend and tuition is requested at $25,000 per year for 3 years/

Total requested for student stipend: $75,000.00

Total requested for personnel cost: $147,192.00

2. **Fringe Benefits**:
We note that the Howard University Provost and Dean of the Graduate School have pledged 15% recovery of the indirect cost. In addition, fringe benefits are not applied to student stipends.
    a. *Salaries*
    The HU negotiated fringe benefit rates are 29.1% on salaries.

Total requested for benefits: $21,008.00

3. **Travel:**
Funds are requested for faculty and staff to:
    a. *Domestic travel*
    Two domestic trips at $4,000/per person is allocated for each year to attend conference meetings (AGU and/or AMS).

Total requested for travel: $24,000.00

4. **Equipment:**
Funds are requested for the following purchase in year 1:
    a. 2 EC systems $20,200.00/system (Campbell Sci, IRGASON).

Total requested for equipment: $40,400.00

5. **Other Direct Costs:**

a. **Materials and Supplies**

Funds are requested for the following materials and supplies in year 1:

i. Research Supplies: Meteorological instruments, tower sections, tower hardware, environmental enclosures for the EC system, cables, UPS. The estimated cost is about $4,000.00.

ii. Repair for 1 Vaisala CL31 Ceilometer at an estimated cost of $10,000.00

iii. Computers: 2 desktop computers at an estimated cost of $2,500.00 each.

iv. Miscellaneous supplies $1,000.00

Funds requested for year 2:

v. Instrumentation repair $2,000

vi. Miscellaneous supplies $1,000

Funds requested for year 3:

vii. Instrumentation repair $2,500

Miscellaneous supply $1,000

Total requested for Material and Supplies: **$26,500.00**

b. Publication Costs/Documentation/distributions

One publication for year 2 and year 3 in peer review journals at $2,500

Total requested for Publication: **$5,000.00**

c. Subcontracts:

A sub award agreement will be established with University of Maryland Baltimore County.

Total requested for subaward: **$212,304.00**

d. Other

Tuition for the Master student ($33,000.00 for year 1 and 2, $16,000 for year 3).

Total requested for other: **$82,000.00**

Total requested for Other Direct Costs: $325,804.00

8. **Indirect Cost**:

a. Facilities and Administrative Cost

The Howard University indirect institutional cost is calculated at 51% of the Modified Total Cost (MTDC). The MTDC excludes student costs, equipment purchases and the first $25K (for year 1 only) of all subcontracts/sub awards.

Total requested for indirect cost: $94,666.00

TOTAL REQUESTED IN THIS PROPOSAL: $653,070.00

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Maryland Baltimore County

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Belay Demoz

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Belay B Demoz - Dr.**	0.48	0.00	0.00	**7,193**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.48	0.00	0.00	**7,193**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**1**) GRADUATE STUDENTS				**15,397**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**22,590**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**9,761**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**32,351**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**4,830**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**2,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,500**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**39,681**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Total Facilities & Administrative Cost (Rate: 53.0000, Base: 33281)**					
TOTAL INDIRECT COSTS (F&A)				**17,639**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**57,320**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**57,320**	
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME
Belay Demoz

ORG. REP. NAME*
Caribbean Ross

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Maryland Baltimore County

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Belay Demoz

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Belay B Demoz - Dr.**	0.48	0.00	0.00	**7,409**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.48	0.00	0.00	**7,409**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**1**) GRADUATE STUDENTS				**15,858**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**23,267**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**10,054**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**33,321**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**4,975**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**2,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,500**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**40,796**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Total Facilities & Administrative Cost (Rate: 53.0000, Base: 34204)**					
TOTAL INDIRECT COSTS (F&A)				**18,128**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**58,924**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**58,924**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Belay Demoz

ORG. REP. NAME*
Caribbean Ross

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Maryland Baltimore County

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Belay Demoz

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Belay B Demoz - Dr.**	0.48	0.00	0.00	**7,631**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.48	0.00	0.00	**7,631**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**1**) GRADUATE STUDENTS				**32,668**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**40,299**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**19,566**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**59,865**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**5,124**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**2,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,500**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**67,489**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Total Facilities & Administrative Cost (Rate: 53.0000, Base: 53910)**					
TOTAL INDIRECT COSTS (F&A)				**28,572**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**96,061**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**96,061**	
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME
Belay Demoz

ORG. REP. NAME*
Caribbean Ross

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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Maryland Baltimore County

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Belay Demoz

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Belay B Demoz - Dr.**	1.44	0.00	0.00	**22,233**	
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	1.44	0.00	0.00	**22,233**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**3**) GRADUATE STUDENTS				**63,923**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**86,156**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**39,381**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**125,537**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**14,929**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**7,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**7,500**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**147,966**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**64,339**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**212,305**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**212,305**	
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME
Belay Demoz

ORG. REP. NAME*
Caribbean Ross

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Summary of Proposal Personnel:

Belay Demoz– Co-I, University of Maryland, Baltimore County; Joint Center for Earth Systems Technology (JCET); Goddard Space Flight Center.

UMBC BUDGET JUSTIFICATION: Narrative and Details

Personnel: Co-I, Dr. Belay Demoz, will spend .04 FTE (2 weeks) in each year of the proposed project. There will be a GRA working .5 FTE (6 months) in years 1 and 2, and 1.00 FTE in year 3 of the project. FY salaries are escalated by 3% for each subsequent year for anticipated COLA and merit increases.

Fringes: Fringe benefits are estimated at 15% of salary for Dr. Demoz, Graduate student rate is estimated at 14.82%, however only actual fringe benefits are charged to the sponsor.

Student GRA Tuition: Tuition benefits are included for the graduate student as part of their GRA annual appointment. The current academic Fall 2019 in-state rate per credit hour is $640. A 3% escalation factor has been used for tuition in each subsequent year for anticipated increases in tuition costs. It is expected that the graduate students will take 10 credits in year 1 and 2, and 20 credits in year 3

Travel: Funds are requested Dr. Demoz and one other personnel to attend one AMS conference per year. Travel Costs to AGU in San Francisco are being used for estimate purposes.

UMBC Travel	# trips	# people	# days	Air tickets	Hotel	rental car/day	Per diem	Incidentals	Sub Total
Year 1									
AGU Conference or Similar	1	2	5	$600	$180	$30	$45	$540	$4,830
								Total year 1	$4,830
Year 2									
AGU Conference or Similar	1	2	5	$618	$185	$31	$46	$556	$4,975
								Total year 2	$4,975
Year 3									
AGU Conference or Similar	1	2	5	$637	$191	$32	$48	$573	$5,124
								Total year 3	$5,124
								Total	$14,929

Publications: Support is requested for one publication in each year of the proposed period. This support is required to present the results of the proposed research in peer-reviewed journal articles. Costs of $2,500 is estimated based on actual costs of recent submissions.

F&A: UMBC has a Federally Negotiated Indirect Cost Rate Agreement (NICRA) with our cognizant federal agency DHHS. The negotiated rates for off-campus research applicable to this proposal is 26%. These rates apply to total direct costs, consisting of all direct salaries and wages, applicable fringe benefits, material and supplies, service, travel and up to the first $25,000 of each subaward (regardless of the period of performance of the subawards under the award.) Modified total direct costs shall exclude tuition remission, the portion of each Subaward in excess of $25,000, equipment and participant support cost.

Budget Details

Proposal Title:	**Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC – Baltimore, MD Region.**									
Proposal:	**NSF**									
Principal Investigator:	**Richard Sakai**									
Co-Investigator(s):	**Belay Demoz (UMBC/JCET)**									
Proposal Term:	**May 1, 2020 - April 31, 2023**									
	YEAR 1			YEAR 2			YEAR 3			TOTAL
	FTE	Cal		FTE	Cal		FTE	Cal		
Salaries										
Belay Demoz	0.04	0.48	7,193	0.04	0.48	7,409	0.04	0.48	7,631	22,233
GRA	0.50	6.00	15,397	0.50	6.00	15,858	1.00	12.00	32,668	63,923
Total Salary	0.54	6.48	22,590	0.54	6.48	23,267	1.04	12.48	40,299	86,156
Fringes										
Belay Demoz	15%		1,079			1,111			1,145	3,335
GRA Health Benefits			2,282			2,350			4,842	9,474
GRA Tuition			6,400			6,592			13,580	26,572
Total Fringe Benefits			9,761			10,054			19,566	39,381
Total Salary and Fringes			**32,351**			**33,321**			**59,866**	**125,537**
Other Direct Costs										
Domestic Travel			4,830			4,975			5,124	14,929
Publicaton			2,500			2,500			2,500	7,500
Total Other Direct Costs			**7,330**			**7,475**			**7,624**	**22,429**
Total Direct Costs			39,681			40,796			67,490	147,966
MTDC			33,281			34,204			53,910	121,395
Indirect Costs	53.0%		17,639		53.0%	18,128		53%	28,572	64,339
Total UMBC Costs			**57,319**			**58,923**			**96,062**	**212,305**
TOTAL PROPOSED COSTS			**57,319**			**58,923**			**96,062**	**212,305**
DC			39,681			40,796			67,490	147,966
less tuition			-6,400			-6,592			-13,580	-26,572
less subcontract over $25k			0			0			0	0
less equipment			0			0			0	0
MTDC			33,281			34,204			53,910	121,395

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Morgan State University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Richard Damoah**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Richard Damoah - PI**	2.00	0.00	0.00	**16,771**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	2.00	0.00	0.00	**16,771**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**16,771**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**7,044**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**23,815**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Ceilometer 15K $ **30,154**					
Gas Analyzer **20,200**					
Radiosone ground Station **24,500**					
TOTAL EQUIPMENT				**74,854**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**5,000**	
2. INTERNATIONAL				**10,000**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **16,000**					
2. TRAVEL **2,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**2**) TOTAL PARTICIPANT COSTS				**18,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**25,400**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**25,400**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**157,069**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 26.0000, Base: 64215)**					
TOTAL INDIRECT COSTS (F&A)				**16,696**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**173,765**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**173,765**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Richard Damoah**

ORG. REP. NAME*: **Edet Isuk**

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

1 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Morgan State University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Richard Damoah

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Richard Damoah - PI**	2.00	0.00	0.00	**17,274**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	2.00	0.00	0.00	**17,274**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**17,274**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**7,255**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**24,529**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**5,000**	
2. INTERNATIONAL				**10,000**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **16,000**					
2. TRAVEL **2,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**2**) TOTAL PARTICIPANT COSTS				**18,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**2,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,500**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**60,029**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 26.0000, Base: 42029)**					
TOTAL INDIRECT COSTS (F&A)				**10,928**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**70,957**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**70,957**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Richard Damoah

ORG. REP. NAME*
Edet Isuk

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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Morgan State University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Richard Damoah

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Richard Damoah - PI**	2.00	0.00	0.00	**17,792**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	2.00	0.00	0.00	**17,792**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**17,792**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**7,473**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**25,265**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**5,000**	
2. INTERNATIONAL				**10,000**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **16,000**					
2. TRAVEL **2,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**2**) TOTAL PARTICIPANT COSTS				**18,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**2,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,500**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**60,765**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 26.0000, Base: 42765)**					
TOTAL INDIRECT COSTS (F&A)				**11,119**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**71,884**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**71,884**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Richard Damoah

ORG. REP. NAME*
Edet Isuk

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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Morgan State University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Richard Damoah**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Richard Damoah - PI**	6.00	0.00	0.00	**51,837**	
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	0.00	0.00	**51,837**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**51,837**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**21,772**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**73,609**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ **74,854**					
TOTAL EQUIPMENT				**74,854**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**15,000**	
2. INTERNATIONAL				**30,000**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **48,000**					
2. TRAVEL **6,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**6**) TOTAL PARTICIPANT COSTS				**54,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**25,400**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**5,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**30,400**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**277,863**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**38,743**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**316,606**	
K. FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**316,606**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Richard Damoah**

ORG. REP. NAME*: **Edet Isuk**

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Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

BUDGET JUSTIFICATION FOR ALL YEARS

A. **Senior Personnel**: $51,837
Dr. Richard Damoah will serve as PI on this project. An Associate Research Scientist affiliated to the physics department at MSU, he has been funded for several NASA investigating the impact of air pollution (aerosols) on air quality and climate. Specifically, he employed climate model simulations and remote sensing technique to quantify the impact of emissions on the climate and air quality. His expertise in air quality and climate will assist in the project objectives.

Dr. Richard Damoah will serve as PI. During the calendar year, he will dedicated 2 months of his time per year to grant activities and overall grant management. 2 months of Dr. Damoah's salary ($97,698) is allocated to support his effort. A rise of 3% per year for Dr. Damoah's salary has been calculated for the period.
Year 1 is will be $16,771, year 2 will be $17,274 and year 3 will be $17,792.

B. **Other Personnel: None**

C. **Fringe Benefits**: $21,772
MSU negotiated fringe benefit rates is 42% for 12 month faculty.
Year 1 is $7044, year 2 is $7255 and year 3 is $7473.

D. **Equipment** : $74,854
Funds are requested for the following purchase in year 1:
The PI requests 1 Lufft CHM15K Ceilometer including its viewing software from OTT Hydromet at a quote of $30,153.86, for profiling atmospheric particles.

One integrated CO2 and H2O Gas Analyzer and 3-D Sonic Anemometer will be purchase from IRGASON at estimated cost of $20,200.00 to measure fluxes.

Two Atmospheric Sounding System iMET-3050A, from iMET at $12,250.00 per system to measure upper air meteorological fields.

E. **Travel: $45,000**
Funds are requested for Travel:
Domestic travel $15,000
One domestic trip for Dr. Damoah and one participant at $2,500/per person is allocated for years 1, 2 and 3 to attend American Geophysical Union (AGU) meetings to present findings. This includes airfare, hotel and per diem.

Faculty International travel $30,000
One international trip for the PI and one participant at $5,000/per person is allocated for years 1, 2 and 3 to attend COSPAR meetings. This includes airfare, hotel and per diem.

F. **Participant Support Cost**: $54,000

The PI will support participating students including travel to attend AGU to present a poster on the findings at $18,000 per year. This includes stipends, airfare, hotel and per diem

G. **Other Direct Cost**: $25,400

Supplies/Materials:
To accomplish the work the PI requests the following materials and supplies in year 1:

Research Supplies: 15 Meteorological Radiosonde Kits at $300 each, 5 Weatherbug Display at $200 each and 10 $PM_{2.5}$ Monitor at $250 each. Total estimated cost for research supplies is $8,000.

Computers: 4 desktop computers at total estimated cost of $8,000, 3 laptop computers at total estimated cost of $ 6,000 and 1 Printer at an estimated cost of $400

Software: 4 IDL at $500 each and 1 StreamerRT license at $1000. Total software cost is $3,000

Publications: $5,000
We request the amount of $2,500 in Years 2 and 3 to publish the results of our study. Findings will be disseminated through conferences and publications in journals. The amount of $2,500 per year will cover journal page costs and production of posters for research meetings.

H. **Total direct costs: $277,863**

Year 1: $157,069; Year 2: $60,029; Year 3: $60,765

I. **Indirect Cost: $38,743**
MSU indirect cost for off-campus is calculated at 26% of the Modified total Direct Costs. Year 1 is $16,696, year 2 is $10,928 and year 3 is $11,119

J. **TOTAL REQUESTED IN THIS PROPOSAL: $316,606**

Year 1: $173,765; Year 2: $70,957; Year 3: $71,884

Current

1. Dr. Ricardo Sakai has a position of senior research scientist at Howard University, Beltsville Campus. NOAA Center for Atmospheric Sciences pays for his base funding.
2. Principal investigator in "Impact and Ozonesonde Measurements at Howard University Beltsville Research Site for Air Quality Monitoring"
    a. Funding Source - Maryland Department of Environment
    b. Period of Performance – 6/1/2018 – 9/30/2019
    c. Level of effort – 0.05 FTE
    d. Total Award - $60K

Pending

1. This proposal – "Collaborative Research: Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC - Baltimore, MD Region."
    a. Funding Source – NSF (18-522)
    b. Period of Performance – 5/1/2020 – 4/30/2023
    c. Level of effort – 0.10 FTE
    d. Total Award - $ 653,070.00

Current & Pending Support: Belay B. Demoz						
Status	**PI**	**Effort**	**Sponsor**	**Title**	**Period**	**Amount**
Pending	Demoz	.08	NASA-	Advancing PBL Definition, Science and Application: An Integrated observation and modeling approach	10/01/19 - 10/31/20	$75K
Current	Demoz	.08	NOAA-STAR	Howard University Support of NOAA's commitment to the Global Climate Observing System (GCOS) Reference Upper Air Network (GRUAN)	02/1/12 -	$75K/yr
Current	Demoz	0.0	NASA/GSFC	Jnt Ctr Earth Sys Technology," Cooperative Agreement, Sponsored by NASA	10/1/15 - 09/30/20	$46.3M
Current	Demoz (Co-PI)	0.8	NOAA	NOAA Center for Atmospheric Science – Meteorology; A Cooperative Science Center – ***PI: V. Morris (Howard Univ)***	10/1/16- 10/1/20	$12M; UMBC: $750K
Current	Demoz (Co-PI)	0.0	NASA	NASA Early Opportunities Program for Underrepresented Minorities in Earth & Space Sciences - ***PI: P. Misra (Howard Univ.)***	08/01/16 - 07/31/19	$499,771
Current	Delgado (Co-PI)	.08	NOAA	Earth System Sciences and Remote Sensing Technologies – ESSRST ***– PI: Reza (CUNY)***	09/01/16 - 08/31/21	$12M UMBC: $501,600

Current and Pending Support

Investigator: Dr. Richard Damoah

Support: X☐ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title:
Investigate the burden of Chikungunya virus (CHIKV) and Dengue virus (DENV) transmission, infection and disease in Kenya
Source of Support: NIH
Total Award Amount: 250,000 Total Award Period Covered: 02/02/2016 – 02/01/2020
Location of Project: Goddard Space Flight Center
Person-Months Per Year Committed to the Project: Cal: 3 Acad: Sumr:

Support: X☐ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: Using Global Sub-seasonal and Seasonal Forecasts to Map Chikungunya *Risk"*.

Source of Support: NOAA
Total Award Amount: 200,000 Total Award Period Covered: 10/1/2018 – 09/30/2020
Location of Project: Goddard Space Flight Center
Person-Months Per Year Committed to the Project: Cal: 6 Acad: Sumr:

Support: X☐ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: Investigate climate/environmental conditions for the outbreak of Rift Valley Fever in South Africa

Source of Support: EcoHealth Alliance
Total Award Amount: 250,000 Total Award Period Covered: 01/21/2016 – 12/20/2019
Location of Project: Goddard Space Flight Center
Person-Months Per Year Committed to the Project: Cal: 3 Acad: Sumr:

1. **Facilities**:

1.1. Howard University Beltsville Campus (HUBC) facility

The Howard University Beltsville Campus site is located approximately 12 miles NE of downtown Washington, DC, in the State of Maryland (figure 1) on 110 acres in suburban Maryland (39.05°N, 76.88°W, 53m). Scientific interests include analysis and measurement of upper air using radiosonde, ceilometers, micro-wave radiometers, raman lidars (Alvice, Adam et al., 2007; HURL, Venable et al, 2011), wind profiler at the MDE air quality station, micrometeorology at the surface layer using a 30 m instrumented tower, air chemistry with emphasis on pollutant trace gases and aerosols, solar and terrestrial radiation studies, and rainfall. HUBC is recognized by world meteorological organization GCOS (Global Climate Observing System) Reference Upper Air Network (GRUAN) as a certified GRUAN station to launch Vaisala RS92 sondes. Beyond the research and climatic data collection, a central objective of HUBC is to train students and provide them with experience on instrumentation deployment, field experimentation, and scientific research. This site will be testbed for instrument intercomparisons and QA/QC protocols.

Routinely, about once a week or more, radiosondes (Vaisala, RS41/RS92, and IMET) are launched, and once a month a cryogenic frost-point hygrometer (EnSci, model CFH) is also launched. Thus, the MWR temperature and humidity profiles comparisons with in situ can be assessed. Also, ozonesondes (EnSci, model Z or 2Z) are launched, mainly during high ozone concentration episodes in Summer. Few ozonesonde launches are done in the winter to measure the "background ozone".

1.2. Howard University Washington, D.C., Campus (HUDC).

The HUDC station is located at the Howard University Interdisciplinary Research Building (IRB). It is a new research facility in which there is already an operational Vaisala CL31 ceilometer; we plan to install a MWR, EC system, and a meteorological station on the roof top. Also, one of the HUBC Raman lidars (HURL; Venable et al, 2011) will be relocated to this site. Data collection will be done by a PC, and data will be downloaded to the HUBC server through the internet. An EC system will also be installed. We are aware of the restrictions of launching balloons in Washington DC. However, we have been successfully launched balloons in the Washington metropolitan area and adjacent Maryland suburbs. If the Federal Aviation Administration grants the project a waiver for launching unmanned free balloons, we plan to launch IMET radiosondes within the Washington area.

1.3. Morgan State University (MSU) implementation.

On August, 2014, MSU installed a meteorological weather station at the main campus (https://owc.enterprise.earthnetworks.com/OnlineWeatherCenter.aspx?aid=5990). We plan to install a ceilometer close to this weather station. If this proposal is funded, an EC system will also be installed. An IMET ground station will be purchased, and we plan to launch radiosondes from this site. A PC desktop computer will be purchased, and it will mirror the data stored at HUBC and HUDC.

1.3. University of Maryland Baltimore County (UMBC).

HU/UMBC has a Vaisala CL31 ceilometer and a MWR installed at the top of the Physics Building, in the main campus. Several meteorological, air quality, and upper air instrumentation (lidars) were installed and maintained by UMBC. Data collection will be done by a laptop PC, and the data will be automatically downloaded to the HUBC server through the internet. UMBC also has radiosonde ground station (Vaisala and IMET), and it is able to launch radiosondes (Vaisala RS92,RS41, and IMET), and ozonesondes (EnSci, Z or 2Z0. If this proposal is funded, an EC system will also be installed.

1.4. Maryland Department of Envinroment (Edgewood – MDE-E, and Hart Miller Island – MDE-H).

A Vaisala ceilometer (CL31) is installed at MDE-E. We intend to move or install another ceilometer to the MDE-H location with an EC system. Also, MDE air quality stations record meteorological measurements (air temperature, humidity, pressure, and wind).

The Maryland Department of Environment (MDE) has a long partnership with HU. The MDE air quality super station is located at HUBC that contains not only surface meteorological and air quality measurements, but also a wind profiler. Also, since 2004, ozonesondes are launched during high ozone episodes by request of MDE. Collaborations also include of use of ceilometers at several air quality stations, such as the Edgewood station. On 2018, HU instruments were used at Hart Miller Island as a part of the NASA OWLETS 2 field campaign.

2. **Personnel**:

PIs:

Dr. Sakai has been working with HUBC instrumentation, data collection, quality assurance/quality control, and data analysis. His interests are Planetary Boundary Layer (PBL) studies on weather system, complex landscapes, air quality, and instrumentation. Dr. Sakai also mentors undergraduate and graduate students during the academic year and summer internship, and mentors MS and PhD candidates. Those initiatives have the objective to have a hands-on opportunity to do scientific research, and expose them to HUBC instrumentation. He will be responsible for the instrumentation at HUBC,and HUDC. Dr. Sakai is the resident senior scientist at HUBC. His group will be responsible for the EC system installation and QA/QC of surface flux measurements. He will lead the investigation of local and non-local contributions to the PBLH growth using ceilometers and surface measurements. He will assist Drs. Damoah and Demoz on the Chesapeake Bay Breeze influence into the PBL,

Dr. Richard Damoah (PI) is part of the Morgan State University (MSU) faculty. HU and MSU are cultivating a relationship to reach a similar level to the one with HU and UMBC. Dr. Damoah will seek a research assistant and two undergraduate students to work on this project. He will be responsible for this proposal instrumentation at the MSU site, and his efforts will concentrate on aerosol detection using ceilometer and ground measurements.

Dr. Belay Demoz (PI), director of University of Maryland Baltimore County (UMBC) Joint Center for Earth systems Technology (JCET). He has had a long collaboration with HU. Currently, he has several projects associated with HUBC, and he is interested on the data generated from the micro-wave radiometer and ceilometer network. There are already several UMBC students and post-docs, funded from other projects, working with HUBC staff and faculty. He and a master candidate will focus on PBLH detection using the ceilometer/MWR and work closely with Dr. Sakai on PBL contrasts over different landscapes. He is the point of contact (POC) for the UMBC site.

Collaborators:

Dr. Vernon Morris (Collaborator) is the program director of the Howard University Program for Atmospheric Science (HUPAS). His expertise in campaigns and long-term observations of aerosol detection is key for the success of this proposal. He will assist Dr. Damoah with the aerosol characterization. He will be responsible for this proposal instrumentation at the HUDC site.

Dr. Jeff McQueen is the NCEP (National Centers for Environmental Prediction) Air Quality Model team leader at NOAA, College Park. He provides model outputs (meteorology and trace gases) to HUBC team, and he will work with Drs. Sakai and Demoz on the PBL height performance on numerical models.

Mr. Joel Dreessen is responsible for the air quality forecast at MDE. He will assist on the MDE data set, and he is going to be the point-of-contact for MDE site locations in Edgewood and Hart Miller Island. He will also be part of understanding Bay breeze impacts into the Baltimore area.

Staff:

Mr. Adrian Flores is the data technician at HUBC. He will be responsible for the instrumentation maintenance and he will assist the QA/QC. He will also assist during installation process, and data analysis.

Morgan State University (MSU) implementation.

On August, 2014, MSU installed a meteorological weather station at the main campus (https://owc.enterprise.earthnetworks.com/OnlineWeatherCenter.aspx?aid=5990). We plan to install a ceilometer close to this weather station. If this proposal is funded, an EC system will also be installed. An IMET ground station will be purchased, and we plan to launch radiosondes from this site. A PC desktop computer will be purchased, and it will mirror the data stored at HUBC and HUDC.

Data management Plan

All data will be made public, according to our cooperative institute, NOAA Center for Atmospheric Science and Meteorology (NCAS-M), directives. Data from the proposed network will be stored in the local server that already automatically collects the HUBC environmental data. In this server most of the products will be generated.

1. Data Description and Metadata file.

Data sets will have a defined descriptive file names, formats, units of measurements, and stable formats (e.g., ascii, netcdf). For a new dataset submitted, a metadata will be generated. This metadata file consists on a relevant information, such as:

- Data description, data type. Type of data (observation, derived, model outputs).
- Origin: Instrument(s) manufacturer(s) and model(s), model name.
- Quality Assurance /Quality Control (QA/QC) descriptions for observation and derived data.
- Formulas & corrections made (Derived data) *
- Data format (avoid proprietary formats that might not be readable in the future) **
- Contact person and/or acknowledgements.
- References

(*) Source codes for derived data should be stored (e.g. fortran, matlab codes).

(**) If the data format is binary, or it has proprietary formats, programs and codes to retrieve such data have to be provided.

2. Storage and Data Divulgation

There will be dedicated computers for data storage at the Howard University D.C. campus, and mirror computers at Morgan State University, and Howard University Beltsville Campus. Any researcher associated with this project will be able to upload and access the data stored there. For external public, data will be available upon request, or some data will be publicly available online.

3. Data Sharing Policy and Disclaimer

Data from this project are freely available upon request and were furnished by our scientists who encourage their use. Please kindly inform in writing (or e-mail) the appropriate scientist(s) printed in the metadata of how you intend to use the data and of any publication plans. It is advisable to contact the investigator to assure you are downloading the latest revision of the data and to prevent potential misuse or misinterpretation of the data. Please acknowledge the data source as a citation or in the acknowledgments if no citation is available. If the Principal Investigators (PIs) feel that he/she/they should be acknowledged or offered participation as authors, they will let you know and we assume that an agreement on such matters will be reached before publishing and/or use of the data for publication. If your work directly competes with the PI's analysis they may ask that they have the opportunity to submit a manuscript before you

submit one that uses unpublished data. In addition, when publishing please acknowledge the agency that supported the research.

While substantial efforts are made to ensure the accuracy of data and documentation contained in this Data Set, complete accuracy of data and metadata cannot be guaranteed. All data and metadata are made available "as is". The Data User holds all parties involved in the production or distribution of the Data Set harmless for damages resulting from its use or interpretation.

4. Long Term Storage

The “raw” ceilometer data and the processed data are also shared with a server computer located at NOAA Sterling facility. GRUAN future plans includes in storing microwave radiometer data, making this dataset public available in its official web site

Request for Collaboration on HBCU EiR Proposal
Morris, Vernon R.
Fri 9/27/2019 8:19 AM

If the proposal submitted by Dr. Ricardo K. Sakai entitled "Collaborative Research: Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC - Baltimore, MD Region" is selected for funding by NSF, it is my intent to collaborate as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.

Sincerely,

Vernon Morris

Vernon R. Morris, Ph.D.
Director, NOAA Cooperative Science Center in Atmospheric Sciences and Meteorology
http://ncas.howard.edu
http://ncas-m.org
Director, Atmospheric Sciences Program
Professor, Chemistry and Atmospheric Sciences
1840 7th Street, NW
Howard University, Washington, DC 20001
202 865 8678; 202 865 8686 (voice)

Despite the many, common mythologies, one's success is not about social pathology, family structure, or individual exceptionalism. It is most often a product and testament to a robust and continuous support system that minimizes barriers and a constructively reinforcing learning environment, rather than a simple rewards system.

Frank N. Kandide

If A is a success in life, then A equals X plus Y plus Z. Work is X, Y is play, and Z is keeping your mouth shut.

Albert Einstein

Re: HBCU proposal
jeff.mcqueen <jeff.mcqueen@noaa.gov>
Wed 9/25/2019 1:20 PM

To whom it may concern,

If the proposal submitted by Dr. Ricardo K. Sakai entitled "Collaborative Research: Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC - Baltimore, MD Region" is selected for funding by NSF, it is my intent to collaborate as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.

Jeff McQueen

NCEP AQ model team leader

--
NCWCP Room 2095 5830 University Research Court College Park, MD 20740 Ph: 301-683-3736 Fax: 301-683-3703

Collaborative Research: Proposal
Joel Dreessen -MDE- <joel.dreessen@maryland.gov>
Wed 9/25/2019 10:56 AM

To whom it may concern:
If the proposal submitted by Dr. Ricardo K. Sakai entitled "Collaborative Research: Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC - Baltimore, MD Region" is selected for funding by NSF, it is my intent to collaborate as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.

Joel Dreessen

--
Joel Dreessen
Meteorologist
Air Monitoring Program
Maryland Department of the Environment
1800 Washington Blvd, Suite 730
Baltimore, MD 21230
Office: (410) 537-3296
Fax: (410) 537-4243
Email: joel.dreessen@maryland.gov
Publications: June 2015 Smoke & Ozone Event
Sea-level Stratospheric Intrusion Event
Hart-Miller Island Ozone Pilot Project

Co-PI: Demoz has NSF support (AGS: 1503563Amount: $82,653 Period of Support: 02/01/15-01/31/18) *"PECAN: Ground Based Lidar and Micro Wave Radiometer and Radiosonde Profiling of the Thermodynamic and Dynamic Structure of the Nocturnal Boundary"* ***Intellectual Merit:*** Our investigation will focus on nocturnal convection in conditions where the pre-convective environment includes a low-level jet (LLJ), a stable boundary layer with and transient waves. In addition to the operation of the critical ground profiling systems for the Plains Elevated Convection At Night (PECAN), we propose to (i) Characterize moisture and wind and water vapor evolution during nighttime transient waves and their role and impact in elevated convection (ii) Investigate the role of thermodynamic profiles during the onset and evolution of the NLLJ. In particular, the onset of the LLJ and associated lifting that occurs as well as the BL structure during the decay of the afternoon PBL and transition to the LLJ-dominated SBL. (iii) Enhance understanding of the evolution of thermodynamic profiles and stability during converging boundaries/fronts and their role in formation of transient waves. A limited ceilometer network will also be established motivated by the National Academies' report entitled "Observing Weather and Climate from the Ground Up: A Nationwide Network of Networks" (NRC 2009). The PI has acquired considerable experience in maintaining, deploying and analyzing data from mobile and fixed profiling equipment, radiometers, radio soundings, and lidars for a for a wide variety of projects, including several continuing low level jet projects over Maryland for air quality projects. ***Broader Impact:*** Data acquired as part of this project is being used data extensively by the community of students and scientists in all the broader PECAN goals in addition to its use in real time field conduct/planning of PECAN operations (see http://catalog.eol.ucar.edu/pecan). The lidar instrument data are unique in their detail and have been specifically requested by a large number of scientists and are distributed through the PECAN web site, PECAN data archive at NCAR, as well as at our site located at http://lidar.umbc.edu. Field data sets are being used in graduate and undergraduate education and training. Five students have participated in operation of PECAN field work (two under grad and three graduate students). PECAN data will be used in fulfillment of current and future post graduate degree and in senior projects by undergraduate students. This work funds a graduate student, Mr. Brian Carroll at UMBC who is working on evolution of LLJ in the PECAN Domain. Publications include: Geerts et al 2016: "The 2015 Plains Elevated Convection At Night (PECAN) field project" Submitted to *BAMS;* and several presentations as well as two publications near submission. Numerous presentations have been made by students and other scientist.

Demoz is also served as Co-PI on NSF Award#: GEO-0914597; $82,653 (03/01/10-05/31/13) "Collaborative project: Increasing Diversity in the Geosciences Through Experiential Learning" ***Intellectual Merit:*** This project evaluated a combination of approaches to recruit and retain students in geosciences. By working with students for a full calendar year it was possible to evaluate the most suitable approaches to attract minorities to pursue geosciences as their potential career. Workshops and symposia allowed investigators to assess the most effective strategies for minority students to become competent researchers and presenters of research results. The project designed a vertical and horizontal (peer-based) mentoring scheme for the students recruited at Howard University and at Penn State; worked with students on the application of the scientific method of data reductions and hands-on experiential learning; organized lectures on publication processes, paper development, scientific concept development, and data interpretation processes, role of science in society during the two summers. A networking session and a tour of research sites and visits to NASA/GSFC and other national labs in the area were organized to give students a view of what the carrier opportunities are. Throughout the academic year, regular meetings with students who decided to continue with the research activities were held. Two students decided to continue the work for required class presentation and worked with the students extensively throughout the two years. A retreat was organized to discuss with students the peer review process associated with publications in scientific journals. All students worked in a team setting. In particular, vertical and peer mentoring opportunities were used to enhance the students horizon. The students (a total of ten students, nine undergraduate and one graduate) were exposed to much wider area of research in addition to the selected task. Seven students were African American, one was Hispanic American and two were White. All students completed their bachelor's degree (Physics, Environmental policy, Meteorology) and the graduate student completed his Ph.D. ***Broader Impact:*** The new strategies served as the basis to develop broader programs to recruit and retain minorities in geosciences not only at Howard University and the Pennsylvania State University (a collaborator institute) but also elsewhere. This pilot projects outcomes are applicable to other communities such as Native American and economically disadvantaged students. The new approaches to result from this project provided the basics to develop programs to recruit K-12 students to undertake science as their major in college. Results of this work was published in Fuentes, J., V. Fuentes, D. Doughty,I. Mitrea, B. Demoz (2013) Increasing Diversity in the Geosciences Through Experiential Learning. Eos, Vol. 93, No. 51, 18 December 2012; Joseph E, K Sanchez**, D Doughty*, D Veneable, JD Fuentes, R Connell, Q Min, and B Demoz (2011). Studying Boundary Layer and Air Quality Processes in a Suburban Environment. Atmospheric Sciences Section Newsletter, American Geophysical Union, issue 5: 7-10.

Demoz served as Co-PI on the following NSF Award: GEO-0914597 Amount: $ 478,161 (06/15/10-02/26/15) *Understanding Northern Hemisphere (NH) Summer Season Tropospheric Ozone Variability across the Northern Tropical Atlantic through Focused Upstream & Downstream Campaigns* ***Intellectual Merit:*** This project seeks to understand processes associated with tropospheric ozone variability across the northern tropical Atlantic Ocean between West Africa and the Caribbean during the summer of 2010. In particular, ozonesonde measurements will be made at Sao Vicente, Cape Verde; Dakar, Senegal and Barbados. Weekly ozonesonde launches and two intensive operations periods (IOPs) are planned with IOP1 occurring in June and IOP2 occurring during August/September. The focus of IOP1 was on ozone depletion associated with the Saharan Air Layer (SAL) and the enhancement of ozone in the boundary layer in association with a soil nitrogen oxides pulse from early rain events after the dry season in sub-Saharan Africa. The focus of IOP2 was on ozone enhancement associated with lightning-produced nitrogen oxides from African Easterly Waves (AEWs) and boundary layer ozone depletion associated with surface deposition. The measurements will take advantage of additional data from three hurricane research field campaigns during August/September, and a focused aerosol, microphysics, precipitation field campaign at Barbados. Surface ozone, dust measurements and other measurements (ceilometers, lidar, surface nitrogen oxides, radar) at Cape Verde and Barbados were used and augmented the data derived from this project. Weather Research and Forecasting with Chemistry (WRF-CHEM) model forecasts for dust and AEWs will be produced on a daily basis during the campaign to help target ozonesonde launches. ***Broader Impact:*** This program will provide opportunities for professional development for up to ten underrepresented undergraduate and graduate students in the atmospheric sciences and related physical sciences. Students were divided into teams and were responsible for ozonesonde preparation, forecast discussions, and ozonesonde/radiosonde launches and participated in the daily briefings via Skype at the three locations. Students were trained in ozonesonde preparation and ozonesonde/radiosonde launch procedures. One graduate student at Howard University was supported along with a postdoctoral fellow. Research opportunities for faculty and students were created through collaboration with faculty and students with the Caribbean Institute for Hydrology and Meteorology in Barbados; Laboratory for Atmospheric- Oceanic Physics - Simeon Fongang at Cheikh Anta Diop University in Dakar, Senegal and other NASA/GSFC. This research provided an opportunity to combine atmospheric chemistry, aerosol science and tropical meteorology, exposing students to the possible synergy that exists amongst these sub-disciplines. Publications include: Jenkins, et. Al. (2013) *Atmospheric Environment.***70** 131-148.

Demoz has served as a Co-PI and collaborator in the following NSF Awards: 1238383 ($330,798; 09/15/12-08/14/16) and "TARGETED INFUSION HBCU-UP GRANT: Enhancement of the Undergraduate Physics Program in the Department of Physics and Astronomy at Howard University" and NSF Award#: 1358727 ($292,310.00: 4/1/14-3/31/17) "Research Experiences for Undergraduates (REU) Site in Physics at Howard". These awards were at Howard University and were both focused on training undergraduate student mentoring activities. Student internes were selected from across the nation through a competitive application processes and Demoz advised the students in instrument operation and data analysis at the Howard university Beltsville Campus Research site. Through the GBCU-Up grant, Demoz was instrumental in forming an atmospheric physics minor track at Howard University.

Office of Sponsored Programs
University of Maryland, Baltimore County
ECS 329
1000 Hilltop Circle, Baltimore, MD 21250
ospa@umbc.edu // p: 410.455.3140
research.umbc.edu/office-of-sponsored-programs

September 23, 2019

Ricardo Sakai, Ph.D.
Howard University
2400 6th Street NW
Washington, DC 20059

Dear Dr. Sakai,

The University of Maryland, Baltimore County (UMBC) proposes to participate in a project for which Howard University is submitting an application for funding to the National Science Foundation (NSF). The proposed subcontract is for the project entitled, "Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC, Baltimore, MD Region." This project will be under the direction of Dr. Belay Demoz in the Joint Center for Earth Systems Technology here at UMBC.

The total cost proposed is $212,305 ($147,966 for UMBC direct costs and $64,339 for UMBC facilities and administrative costs) and covers a three (3) year budget period beginning 05/01/2020 and ending 04/30/2023. Should an award be made to Howard University, UMBC is prepared to enter into a negotiated agreement for research to be performed under the award.

In a final agreement UMBC must report labor as a percent of effort as opposed to by labor hour. While estimates for labor hours can be provided, UMBC's reporting system relies on periodic reporting of percent of .

UMBC must retain rights to publish results in scholarly journals. This can be with a review period of the sponsor.

UMBC believes the project proposed herein is fundamental research and to our knowledge does not require that we seek an export licenses under EAR or ITAR. If Howard University believes UMBC's performance or deliverables of the project are subject to export regulations, UMBC requests early confirmation in writing. If export regulations will necessitate an export control plan, UMBC reserves the opportunity to re-evaluate this proposal and seek further internal and external guidance.

UMBC is a publicly controlled institution of higher education in the State of Maryland and retains more than five hundred employees. UMBC is part of the University System of Maryland, and is governed by their policies and the laws of the State of Maryland. UMBC cannot waive sovereign immunity that is granted under Maryland and federal law.

UMBC represents that it has not employed or retained a company or person (other than a full-time employee) to solicit or secure this agreement.

UMBC subscribes to a policy of equal educational and employment opportunity for people of every race, creed, ethnic origin, and sex.

If you have any question or require further information, please do not hesitate to contact me, directly at (410)-455-3255 or via email at mmielech@umbc.edu

Sincerely,

Michal Mielech, Grants and Contracts Manager
UMBC Office of Sponsored Programs

Collaborative Research:

Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC – Baltimore, MD Region.

PI: Dr. Richardo Sakai; ricardo.k.sakai@howard.edu

UMBC - SOW

Point of contact: Belay B. Demoz (UMBC-PI); bdemoz@umbc.edu
David Lucadamo (Business Manager); lucadamo@umbc.edu

Drs. Belay B Demoz and graduate student (Mr. Maurice Roots) will collaborate with Dr. Sakai of Howard University and Dr. Damaoh of Morgan State University and students in the data analysis and instrument setup at the Beltsville research site in Beltsville, Morgan State Campus in Baltimore city (both in Maryland) as well as the Howard University Campus in Washington D.C. This collaboration will include student advisement, research in radiosonde and lidar-based profiling, and other activities as needed for the execution of all the objectives of the collaborative proposal. The Howard University Beltsville Research Site (HUBRS) and UMBC have developed a strong partnership in research and education and will also use this proposal to initiate such a collaboration with Morgan State University. Dr. Demoz will assist in nurturing these collaborations and partner in graduate student mentorship at both HBCUs. Specifically,

1) ***Upper Air Network Sounding Analysis:*** Dr. Demoz and Mr. Roots will assist in analysis of the radiosonde launches and their analysis vis-à-vis the ceilometer data products (aerosol back scatter profile, Planetary Boundary Layer Height (PBLH) and Particulate Matter (PM). This work is synergistic with Dr. Demoz's work of the Global Climate Observation Sites (GCOS) Reference Upper Air Network (GRUAN) site managerial duties.

2) ***PBLH determination from the ASOS Ceilometer Network***: Dr. Demoz, in collaboration with NOAA/NWS, NOAA/NCEP, NOAA/ has been engaged primarily in a proof of concept of saving the full data profile of the NOAA/NWS Automatic Surface Observing System's (ASOS) ceilometer network (see Hicks et al, 2019, 2015). This transformational activity was initiated as a response to the NRC's recommendation as a result of the report "Observing Weather from the ground up: Network of networks". Beyond the proof of concept demonstration, work is required for helping define and design the network and possible science outcomes including helping write requirement documents, testing/design of algorithms for archiving, building demonstration modules and application of data into various scenarios (Volcanic and smoke detection, Cloud and sky coverage enhancement, model improvement, etc.). In particular, an extensive effort has been spent in retrieval of the planetary Boundary Layer Height (PBLH) from the regional lidar networks developed at UMBC and partner sites. Dr. Demoz will assist and coordinate this larger work in relation to this proposal activity. He will train the graduate student; Mr. Roots, in the principles of PBLH retrieval work. Mr. Roots will work with undergraduate interns to be recruited and trained (through other grant funding) to help carry most of the day-to-day work in this project and coordinate with Howard University and Morgan State University.

3) ***Effect of Chesapeake Bay on PBLH:*** Dr. Demoz will assist in analysis of the network ceilometer data sets and their measurements as it relates to mesoscale processes that are influenced by the Chesapeake Bay: this include bay breeze and/or any associated waves and their role in the evolution of the diurnal PBL and its height as reflected in the measured aerosols backscatter profile and associated winds. Dr. Demoz and a graduate student are working on a WRF modeling of this phenomenon and will share lessoned learned and conceptual framework for interpretation.

BIOGRAPHICAL SKETCH

Name: Belay B. Demoz,
Title: Professor and Director/JCET
Institution: University of Maryland Baltimore county
Address: 1000 Hilltop circle, Baltimore, MD 21250
E-mail: bdemoz@umbc.edu
Ph: (410) 455-2715
Fax: (410) 455-1072

Professional Preparation

Asmara University, Eritrea,	Physics	B.S. 1984
University of Nevada, Reno	Atmospheric Physics	M.S. 1989
University of Nevada, Reno	Atmospheric Physics	Ph.D. 1992

Appointments

2014 – Present:	Professor of Physics and Director- Joint Center for Earth Systems Technology (JCET), University of Maryland Baltimore County (UMBC).
2007 - 2016:	Adjunct Professor, Atmospheric Sciences, University of Utah
2012– 2014:	Professor of Physics and Atmospheric Science, Howard University..
2008- 2012:	Associate Professor, Howard University. Appointment: Department of Physics and Astronomy as Associate Professor.
2000 – 2010:	Fellow, JCET/UMBC, Baltimore, MD
2002-2008:	Physical Scientist, NASA/GSFC
2005-2007:	Adjunct Professor**;** Howard University, Department of Physics and Astronomy
1998- 2002	Assistant Professor, JCET, Univ. of Maryland Baltimore County.
1994-1998:	Principal Scientist Hughes STX Corp.
1992-1994:	Post-Doctoral Associate, UIUC, Institute for Environmental Science.
1986- 1992:	Graduate Research Assistant, Desert Research Institute (DRI), Reno, Nevada.
1984-1986:	Lecturer-I, Asmara University. Asmara, Eritrea.

Five Products Most Closely Related to Proposed Project

1) Carroll et al (2019): An overview of low-level jet winds and corresponding mixed layer depths during PECAN. Conditionally Accepted. JGU-Atmospheres
2) Hicks, M; D. Atkinson, K. Vermeesch, B. Demoz (2018): Intercomparison of Mixing Layer Heights from the National Weather Service Ceilometer Test Sites and Collocated Radiosondes" (JTECH-D-18-0058) In Press: *Journal of Atmospheric and Oceanic Technology,*
3) Pu, Z., L. Zhang, S. Zhang, B. Gentry, D. Emmitt, **B. Demoz**, R. Atlas, 2016: The impact of Doppler wind lidar measurements on high-impact weather forecasting: Regional OSSE and data assimilation studies. Book Chapter, "Data Assimilation for Atmospheric, Oceanic and Hydrologic Applications", in "*Data Assimilation for Atmospheric, Oceanic and Hydrologic Applications, Volume III*" Contributed to Springer Book by Seon K. Park and Liang Xu (Eds.) (in press)
4) Strobach, E., Sparling, L. C., Rabenhorst, S. D., Demoz, B. B. (2018). Impact of Inland Terrain on Mid-Atlantic Offshore Wind and Implications for Wind Resource Assessment: A Case Study.J. of Applied Meteorology and Climatology, 57(3), 777-796.

5) Geerts, B., and Couthors including B. B. Demoz, (2016): The 2015 Plains Elevated Convection At Night (PECAN) field project Submitted to Bull. Amer. Meteor. Soc. Soc. 98, 767-786

Five Other Significant Products

1. Lolli, S., Di Girolamo, P., Demoz, B. B., Li, X., Welton, E. J. (2017). Rain Evaporation Rate Estimates from Dual-Wavelength Lidar Measurements and Intercomparison against a Model Analytical Solution. *Journal of Atmospheric and Oceanic Technology, 34*(4), 829-839.
2. Strobach, E., Sparling, L. C., Rabenhorst, S. D., Demoz, B. B. (2018). Impact of Inland Terrain on Mid-Atlantic Offshore Wind and Implications for Wind Resource Assessment: A Case Study. *Journal of Applied Meteorology and Climatology, 57*(3), 777-796. http://dx.doi.org/10.1175/jamc-d-17-0143.1.
3. Fassò, A., Ignaccolo, R., Madonna, F., and Demoz, B. B. (2014): Statistical modelling of collocation uncertainty in atmospheric thermodynamic profiles*, Atmos. Meas. Tech. Discuss*., 6, 7505-7533, DOI: 10.5194/amt-7-1803-2014.
4. Flores, A., R. Sakai, E. Joseph, N. Nalli, A. Smirnov, B. Demoz, V. Morris, D. Wolfe. On Saharan Air Layer Stability and Suppression of Convection over the Northern Atlantic: Case Study Analysis of a 2007 Dust Outflow Event. Submitted to the *Journal of Applied Meteorology and Climatology*.
5. Rabenhorst, S., D. N. Whiteman, D. Zhang, D. Demoz (2014): A Case Study of Mid-Atlantic Nocturnal Boundary-Layer Events During WAVES 2006. Part I: Observational Detection of Fine Scale Phenomena. *J. Appl. Meteor. Climatol.*, **53**, 2627–2648. doi: http://dx.doi.org/10.1175/JAMC-D-13-0350.1

Synergistic Activities (5 max)

2014 -Present	Co-Chair – GRUAN subgroup for network of climate sites and Convener and Chair – 6th GRUAN Implementation Workshop. WWW.GRUAN.org)
2013 - 2013:	Convener and Chair, 2nd to 6th Symposium on lidar Atmospheric Applications, 93rd Annual Meeting of the American Meteorological Society, 6-10 January 2013; Austin, TX.
2011:	Thermodynamic Profiling Technologies Workshop UCAR Center Green #1 Boulder, Colorado 12-14 April 2011; Chair a Session on Optical Active Profiling
2012-Present	Member: The AOPC Working Group on Atmospheric Reference Observations (WG-ARO), World Meteorological Organization, 2011-Presenter
2012-Present	Member, Aerosol Clouds and Trace gases Research InfraStructure Network (ACTRIS) Selection Committee

Current & Pending Support: Belay B. Demoz						
Status	**PI**	**Effort**	**Sponsor**	**Title**	**Period**	**Amount**
Current	Delgado (Co-PI)	.08	NOAA	Earth System Sciences and Remote Sensing Technologies – ESSRST ***– PI: Reza (CUNY)***	09/01/16 - 08/31/21	$12M UMBC: $501,600
Current	Demoz	.08	NOAA-STAR	Howard University Support of NOAA's commitment to the Global Climate Observing System (GCOS) Reference Upper Air Network (GRUAN)	02/1/12 -	$75K/yr
Current	Demoz	0.0	NASA/GSFC	Jnt Ctr Earth Sys Technology," Cooperative Agreement, Sponsored by NASA	10/1/15 - 09/30/20	$46.3M
Current	Demoz (Co-PI)	0.8	NOAA	NOAA Center for Atmospheric Science – Meteorology; A Cooperative Science Center – ***PI: V. Morris (Howard Univ)***	10/1/16- 10/1/20	$12M; UMBC: $750K
Current	Demoz (Co-PI)	0.0	NASA	NASA Early Opportunities Program for Underrepresented Minorities in Earth & Space Sciences - ***PI: P. Misra (Howard Univ.)***	08/01/16 - 07/31/19	$499,771
Pending	Demoz	.08	NASA-	Advancing PBL Definition, Science and Application: An Integrated observation and modeling approach	10/01/19 - 10/31/20	$75K
Pending	Sakai (Co-I)	.04	NSF	*Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC – Baltimore, MD Region.*	05/01/20 - 04/30/23	UMBC: $212,305

Summary of Proposal Personnel:

Belay Demoz– Co-I, University of Maryland, Baltimore County; Joint Center for Earth Systems Technology (JCET); Goddard Space Flight Center.

UMBC BUDGET JUSTIFICATION: Narrative and Details

Personnel: Co-I, Dr. Belay Demoz, will spend .04 FTE (2 weeks) in each year of the proposed project. There will be a GRA working .5 FTE (6 months) in years 1 and 2, and 1.00 FTE in year 3 of the project. FY salaries are escalated by 3% for each subsequent year for anticipated COLA and merit increases.

Fringes: Fringe benefits are estimated at 15% of salary for Dr. Demoz, Graduate student rate is estimated at 14.82%, however only actual fringe benefits are charged to the sponsor.

Student GRA Tuition: Tuition benefits are included for the graduate student as part of their GRA annual appointment. The current academic Fall 2019 in-state rate per credit hour is $640. A 3% escalation factor has been used for tuition in each subsequent year for anticipated increases in tuition costs. It is expected that the graduate students will take 10 credits in year 1 and 2, and 20 credits in year 3

Travel: Funds are requested Dr. Demoz and one other personnel to attend one AMS conference per year. Travel Costs to AGU in San Francisco are being used for estimate purposes.

UMBC Travel	# trips	# people	# days	Air tickets	Hotel	rental car/day	Per diem	Incidentals	Sub Total
Year 1									
AGU Conference or Similar	1	2	5	$600	$180	$30	$45	$540	$4,830
								Total year 1	$4,830
Year 2									
AGU Conference or Similar	1	2	5	$618	$185	$31	$46	$556	$4,975
								Total year 2	$4,975
Year 3									
AGU Conference or Similar	1	2	5	$637	$191	$32	$48	$573	$5,124
								Total year 3	$5,124
								Total	$14,929

Publications: Support is requested for one publication in each year of the proposed period. This support is required to present the results of the proposed research in peer-reviewed journal articles. Costs of $2,500 is estimated based on actual costs of recent submissions.

F&A: UMBC has a Federally Negotiated Indirect Cost Rate Agreement (NICRA) with our cognizant federal agency DHHS. The negotiated rates for on-campus research applicable to this proposal is 53%. These rates apply to total direct costs, consisting of all direct salaries and wages, applicable fringe benefits, material and supplies, service, travel and up to the first $25,000 of each subaward (regardless of the period of performance of the subawards under the award.) Modified total direct costs shall exclude tuition remission, the portion of each Subaward in excess of $25,000, equipment and participant support cost.

Budget Details

Proposal Title:	**Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC – Baltimore, MD Region.**									
Proposal:	**NSF**									
Principal Investigator:	**Richard Sakai**									
Co-Investigator(s):	**Belay Demoz (UMBC/JCET)**									
Proposal Term:	**May 1, 2020 - April 31, 2023**									
	YEAR 1			YEAR 2			YEAR 3			TOTAL
	FTE	Cal		FTE	Cal		FTE	Cal		
Salaries										
Belay Demoz	0.04	0.48	7,193	0.04	0.48	7,409	0.04	0.48	7,631	22,233
GRA	0.50	6.00	15,397	0.50	6.00	15,858	1.00	12.00	32,668	63,923
Total Salary	0.54	6.48	22,590	0.54	6.48	23,267	1.04	12.48	40,299	86,156
Fringes										
Belay Demoz	15%		1,079			1,111			1,145	3,335
GRA Health Benefits			2,282			2,350			4,842	9,474
GRA Tuition			6,400			6,592			13,580	26,572
Total Fringe Benefits			9,761			10,054			19,566	39,381
Total Salary and Fringes			**32,351**			**33,321**			**59,866**	**125,537**
Other Direct Costs										
Domestic Travel			4,830			4,975			5,124	14,929
Publicaton			2,500			2,500			2,500	7,500
Total Other Direct Costs			**7,330**			**7,475**			**7,624**	**22,429**
Total Direct Costs			39,681			40,796			67,490	147,966
MTDC			33,281			34,204			53,910	121,395
Indirect Costs	53.0%		17,639		53.0%	18,128		53%	28,572	64,339
Total UMBC Costs			**57,319**			**58,923**			**96,062**	**212,305**
TOTAL PROPOSED COSTS			**57,319**			**58,923**			**96,062**	**212,305**
DC			39,681			40,796			67,490	147,966
less tuition			-6,400			-6,592			-13,580	-26,572
less subcontract over $25k			0			0			0	0
less equipment			0			0			0	0
MTDC			33,281			34,204			53,910	121,395

1867
HOWARD
UNIVERSITY
Graduate School
Atmospheric Sciences

October 1, 2019

Review Panel, Excellence in Research
The National Science Foundation
Directorate for Geosciences
2415 Eisenhower Avenue
Alexandria, VA 22314

Dear Panel Members,

On behalf of the Atmospheric Sciences Program at Howard University, I am pleased to provide this letterof institutional support for Dr. Sakai's application to the National Science Foundation's Historically Black Colleges and Universities Undergraduate Program entitled ""'Collaborative Research: Analyzing Data from an Incipient Upper-Air Mesonet to Monitor Planetary Boundary Layer and Aerosols Processes in the Washington, DC - Baltimore, MD Region". As the Program Director, I am responsible for coordinating research activities in atmospheric sciences in the primary facilities in the Interdisciplinary Research Building's Atmospheric and Environmental Sciences laboratories as well as those at the North Campus at Beltsville (HUBC) where the Beltsville Center for Climate System Observations (BCCSO) is located. Dr. Sakai, is the submitting principal investigator, has proposed an innovative and comprehensive research plan that is very well aligned with and will contribute to enhancing the initiatives and programs at Howard University to support our undergraduate STEM education and research excellence. This work
promotes a collaboration among three minority serving institutions (Howard University, Morgan State University, and University of Maryland, Baltimore County). The scientific objective is to amplify our understanding of the PBL processes and aerosol characterization over a rural/ suburban-urban-coastal landscape. For instance, the impact of the Chesapeake Bay breeze or Washington DC urban heat island effects on the downwind regions, and air mass modification impact on air quality and thermodynamic parameters due to synoptic and mesoscale systems.

The proposal will allow for two undergraduate students to be trained to analyze data and to work with instrumentation. The studies based on this network can enhance the air quality understanding and weather forecast for the local community. For instance, it can increase our understanding of air quality patterns, and improve numerical modeling studies for a region with complex landscape and meteorology pattern. The Program of Atmospheric Science is fully committed to providing Dr. Sakai with the research support that he needs to implement the project. If you should need additional information, please do not hesitate to contact me.

Sincerely,

Vernon R. Morris, Ph.D.
Director, Atmospheric Sciences

4th and College Streets, NW, Washington, DC 20059
Telephone 202 865 8678 https://gs.howard.edu/graduate-programs/atmospheric-science

MORGAN STATE UNIVERSITY
GROWING THE FUTURE • LEADING THE WORLD

Division of Research and Economic Development

September 26, 2019

Ricardo Sakai
Howard University

Re: Letter of Support

Dear Dr. Ricardo Sakai,

This is to confirm that Dr. Richard Damoah would serve as the Morgan State University (MSU) Co-PI on your project *Analyzing the Planetary Boundary Layer Processes from an Incipient Mesonet Network to Monitor Heat, Moisture, and Aerosols Exchange in the Washington, DC- Baltimore, MD Region*.

He will provide weather analysis from MSU's weather station as well as aerosol analysis derived from ceilometer and other platforms such as satellite and model simulations.

If you have any questions, please do not hesitate to call me at 443.885.3798 (direct-line).

Timothy A. Akers, M.S., Ph.D.
Assistant Vice President for Research Innovation and Advocacy
Professor of Public Health

Pricing Estimate

To get exact pricing, please request an official quote

The following is a preliminary pricing estimate* for the products you selected. If you need exact pricing, request an official quote (see right). Any questions that were submitted with your request have been forwarded to an expert (typical response time is one business day).

Ricardo K. Sakai
Howard Univ.
Beltsville, Maryland 20705
United States
3014199030
ricardo.k.sakai@howard.edu

September 19, 2019
Estimate #139174

	Item	Item Price	Quantity	Item Total
	**IRGASON-NM-BB-NC** Integrated CO2 and H2O Open-Path Gas Analyzer and 3-D Sonic Anemometer *Selected Options:* CR6 Options: -NM No CR6 Mounting Pressure Sensor Options: -BB Basic Barometer Carrying Case Option: -NC No Carrying Case	$20,200.00	1	$20,200.00
			Total:	**$20,200.00**

***Note:** Prices displayed are our list prices (ex works Logan, UT, USA) and do not reflect potential organizational discounts, sales taxes, shipping costs, or any other applicable pricing modifications that may be applied at the time of order. Our prices vary from country to country as a result of distribution agreements, tariffs, included services, and other factors.

What's Next?

- Submit an order
- Request an official quote
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- Learn about Campbell quality

More Options

- Save estimate as PDF
- Register for an account
- View your product list

2000219

22400 Davis Dr.
Ste. #100
Sterling, VA 20164
USA

Quote Number	19-012949
Created Date	9/25/2019
Expiration Date	12/31/2019

Prepared By	Victor Cassella
Phone	631.245.5516
Email	victor.cassella@otthydromet.com

Contact Name	Richard Damoah
Phone	2027016606
Email	richard.damoah@morgan.edu

Bill To Name	MORGAN STATE UNIVERSITY
Bill To	TRANSP. & URB. INFRAST. STUD. DEPT. 1700 E. COLD SPRING LN. Baltimore, Maryland United States

Ship To Name	MORGAN STATE UNIVERSITY
Ship To	Maryland United States

Product Code	Product	Product Description	Expanded Description	Quantity	Sales Price	Total Price
8350.10	Ceilometer CHM 15k, US-Version	USA Version The CHM 15k series is prepared to work throughout the year and in any climate. Due to their double case structure combined with a window blower and an automatic heating system, the ceilometers are not interfered with fogging, precipitation, freezing or overheating. Comes with Calibration sheet, Manual, 2 keys, 3-Wire RS485 (10m) cable, 3-Wire Power (10m) Cable, and RJ45 Ethernet (10m) Cable -longer cables can be provided if needed and 3m for ground cable.	5% University Discount	1.00	USD 28,828.80	USD 27,387.36
8350.SW	CHM-Viewer Software for one user	The CHM Data Viewer is a special visualization software with an easy to use interface. The software allows a representation of the data, which are measured with the Ceilometer CHM 15k. The data is previously stored as raw data in NetCDF format and can be visualized and saved as an image file with the Data Viewer.	Software 25% Discount	1.00	USD 2,422.00	USD 1,816.50

Total Price	USD 29,203.86
Shipping and Handling	USD 950.00

Terms & Conditions

- Credit card payments will incur a 3% surcharge
- Shipment will be invoiced for Ground shipping unless otherwise requested
- Product(s) shall be delivered *Ex Works* (*Incoterms* 2000)

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All purchases of OTT Hydromet Brand products and/or services are expressly and without limitation subject to OTT Hydromet USA's Terms and Conditions of Sale ("OTT TCS"), incorporated herein by reference and published on OTT Hydromet USA website at http://www.sutron.com/terms-of-sale **. OTT TCS are incorporated by reference into each of OTT Hydromets USA's offers or quotations, order acknowledgments, and invoice and shipping documents. The first of the following acts shall constitute an acceptance of OTT Hydromet USA's offer and not a counteroffer and shall create a contract of sale ("Contract") in accordance with the OTT TCS, subject to OTT's final credit approval: (i) Buyer's issuance of a purchase order document against OTT's offer or quotation; (ii) OTT's acknowledgement of Buyer's order; or (iii) commencement of any performance by Lufft in response to Buyer's order. Provisions contained in Buyer's purchase documents that materially alter, add to or subtract from the provisions of the OTT TCS shall be null and void and not considered part of the Contract**

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9/7/2018 08:57 AM

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Grand Rapids, Mi 49512
616-971-1005

ORDER #
3622

CUSTOMER

Morgan State University - Contact : Anthony Kinyua

BILL TO

Morgan State University
1700 East Cold Spring Lane
Baltimore MD 21251

Phone:
(443) 885-1557

SHIP TO

Morgan State University
Diane Hughes Portage Campus Rm 108
1700 East Cold Spring Lane
Baltimore MD 21251

ORDER DATE	SALESPERSON	CUST PO	FOB	SHIP VIA
	Fred Clowney	Quote	Prepay And Add	Fedex Ground

LINE	PART # / CUSTOMER PN	DESCRIPTION	UNIT PRICE	QUANTITY	EXT.PRICE / DUE DATE
1	imet-3050a	COMPLETE SYSTEM MODEL iMET-3050A w/MIL-CONN	$12000.00	1.0000	$12,000.00
	Includes 25% discount for iMet-3150 customers				
2	IMET-4	iMET-4, RADIOSONDE, 403MHz	$200.00	1.0000	$200.00
3	shipping	SHIPPING CHARGES, Ground	$40.00	1.0000	$40.00

Total: $12,240.00

Notes :

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