Interdisciplinary Science for Eclipse 2017
Abstracts of selected proposals
(NNH16ZDA001N-ISE**)**

Below are the abstracts of proposals selected for funding for the ISE program. Principal Investigator (PI) name, institution, and proposal title are also included. 39 proposals were received in response to this opportunity. On January 27, 2017, 11 proposals were selected for funding.

Paul Bryans/University Corporation For Atmospheric Research (UCAR)
Measuring the Infrared Solar Corona During the 2017 Eclipse

This research project will measure the infrared spectrum of the solar corona using a Fourier Transform Infrared Spectrometer (FTIR). No spectral survey of the infrared corona has ever been performed, yet some of the most magnetically sensitive spectral lines are theoretically predicted in this region. All of the infrared coronal lines are forbidden lines of magnetic dipole character. We do not know how infrared emission line intensities are distributed in the corona, nor do we know wavelengths accurately enough to determine detrimental effects of telluric absorption on these particular lines. The ability to measure the magnetic field of the corona is imperative if we are to accurately diagnose the sources of space weather and, ultimately, understand the heating mechanisms of the solar corona. We intend to complete and optimize an FTIR instrument that will measure the coronal spectrum from ~2-12 microns during the 2017 eclipse. We will deploy the instrument along the path of totality in Wyoming at ~2900 masl, and measure the corona as the moon passes across the solar disk.

The principal science goals and objectives of this project are (1) to identify spectral lines ideally suited to measure coronal magnetic fields, (2) to find the range of temperatures spanned by the lines (ions from 6 to 14 times ionized), (3) to identify the typical range of features sampled by the lines (active regions, source regions of fast and slow solar wind), and (4) to determine where coronal lines lie relative to telluric absorption features.

The data to be used in this project are moderate resolution (R=10000) infrared spectra. Our effort will include calibration of the wavelength scale. We will identify the spectral features of these spectra and compare the line intensities and wavelengths with theoretical predictions. In addition, we will identify where the lines of solar origin lie in relation to the telluric absorption features. We will use complementary data from instruments aboard NASA spacecraft to provide spatial context for our results.

This research is of direct relevance to the goal of connecting the 2017 eclipse to the study of the Sun-Earth system. Measuring the IR solar corona is only possible in the event of an eclipse or with a coronagraph. The eclipse offers a unique opportunity by making the low corona (otherwise obscured by the occulting disk of a coronagraph) visible. These observations will lead to the identification of magnetically sensitive emission lines that can ultimately be used to diagnose the magnetic field of the solar corona. Measuring this magnetic field is of fundamental importance in the understanding of the Sun and how it influences the Earth.

Amir Caspi/Southwest Research Institute
Chasing the 2017 Eclipse: Interdisciplinary Airborne Science From NASA's WB-57

Total solar eclipses provide valuable opportunities for solar and planetary astrophysics. Objects normally overwhelmed by the Sun's glare become observable, allowing measurements that are otherwise impossible. Using aircraft flying along the eclipse track at high altitude, it is possible to extend the available observing time while simultaneously reducing confounding effects from Earth's atmosphere.

We propose to observe the 21 Aug 2017 eclipse with NASA's WB-57 aircraft at ~50 kft, using the existing WB-57-compatible DYNAMITE visible and near-infrared (NIR) telescopes to make rare solar and planetary observations. This stratospheric altitude eliminates obscuration by clouds and significantly reduces seeing effects by turbulence. DYNAMITE is a fully-gimbaled, stabilized platform with two 9-inch coaligned telescopes with imaging capability up to 60 Hz in both visible and NIR. Fields-of-view are ~1x1.8 deg (visible) and ~0.7x1.3 deg (NIR), with platescales of ~3"/pix. Pointing stability is <~1" RMS at 20 Hz. The instrument can accommodate narrowband filters or polarizers with only minor modification. No additional instrument development is required.

Our observations enable four main science goals: (1) characterizing the fine-scale structure of the solar corona out to the "mid-corona" above the conventional source surface at 2.5 Rs; (2) exploring small-scale transient motions including possible high-frequency (30-300 mHz) waves in the corona; (3) NIR observations of Mercury; and (4) a search for possible Vulcanoid asteroids. The primary goal of our campaign will be to capture these highly unique data, which will enable future in-depth studies that address the above science in detail. However, we include sufficient scope to publish a first-results paper and identify key findings.

Observations of the solar corona are generally limited by both stray-light constraints and by either telemetry constraints for spaceborne instruments or atmospheric effects for ground-based instruments. Our campaign will provide high-resolution images with none of these limitations, out to at least 6 solar radii. DYNAMITE's high cadence oversamples the frequency range of interest, permitting higher sensitivity and better atmospheric rejection than would be available with direct 1 Hz sampling. We will use advanced image processing techniques as well as Fourier and wavelet analysis to search for short-timescale dynamics and wave-related phenomena that could be related to the heating of the corona and the acceleration of outflows related to the solar wind.

A target of particular interest will be coronal fans: structures associated with bundles of elongated, open magnetic field lines visible out to several solar radii. These structures have been reported in EUV observations, but have not been well characterized in visible light. There is evidence that these structures are related to both wave-driven heating and outflows. Better characterization of these structures is one goal of our collaboration with our European partners.

For planetary science, we will observe Mercury and search for Vulcanoids. Since MESSENGER did not observe Mercury in the NIR, our DYNAMITE observations will help to constrain the rate of cooling of Mercury's nightside surface. Vulcanoids are hypothesized asteroids between the Sun and Mercury that can only be studied during eclipses or at twilight. Our observations will provide unprecedented sensitivity to these possible small bodies.

Our campaign also provides complementary data for a separately-funded program by collaborators, making eclipse observations using an airborne NIR spectrometer and slit-jaw imager, and provides data for preflight radiometric modeling and calibration of the ASPIICS coronagraph on the European formation-flying PROBA3 mission.

This work has obvious relevance to and directly addresses the NRA goals of eclipse observations, heliophysics, and interdisciplinary science (viz. planetary science).

Gregory Earle/Virginia Polytechnic Institute & State University
Empirically-Guided Solar Eclipse Modeling Study

Methodology & Models:

We propose a data analysis/modeling study of solar eclipse-related ionospheric F-region electrodynamics using the first-principles NRL SAMI3 and SAMI3/ESF models (Huba, NRL). This effort will augment a ground-based eclipse experiment already funded by the NSF.

Science Goals & Objectives:

Using the data from the ground-based resources and the in-situ observations we will seed the SAMI model and address several key science objectives:

1. Study the effects of conjugate hemisphere coupling along magnetic flux tubes during eclipses. In particular, we will model plasma flow along field lines subject to prevailing geophysical wind systems in both hemispheres, and study the effects of geomagnetic latitude and local time on eclipse-related plasma motions and electrodynamics.
2. Use SAMI to identify regions of instability and/or radio frequency scintillation effects within the eclipsed region.

These science goals will directly impact and inform the data analysis efforts from our ongoing NSF/CEDAR experimental eclipse project. In addition, we will use the model results with our ground-based data to form and test hypotheses about latitudinal and local time effects.

Data Sources:

The empirical data used in this study includes data from the CORS GPS-TEC network, the SuperDARN radars in Kansas and Oregon, and from four HF transceivers/portable ionosondes to be fielded by Virginia Tech students along the eclipse line in August 2017. The field work is funded under our NSF-CEDAR grant; we propose to augment and enhance the scientific return of this experiment using SAMI to help interpret the empirical results, and to study how eclipse effects may vary as a function of local time and geomagnetic latitude.

Our co-investigators are Drs. Douglas Drob and Joseph Huba from NRL. They will work with a Virginia Tech doctoral student to provide guidance on using the data and models for the proposed study.

Relevance:

Our research objectives are centered around understanding the impact of solar eclipses on the F-region of the ionosphere, and more generally on plasma dynamics spawned by eclipses. The program we propose is therefore relevant to NASA's stated objective of "understanding the sun and its interactions with the Earth, including space weather".

Philip Erickson/MIT Haystack Observatory
Solar Eclipse-Induced Changes in the Ionosphere Over the Continental US

We propose an observational study of solar eclipse produced continental US ionosphere and thermosphere perturbations during the August 21, 2017 total eclipse. Eclipse effects have been studied for more than 50 years, but modern radio sounding observational advances in sensitivity and spatial/temporal resolution can advance information on ITM system response and solar-terrestrial coupling during eclipse events.

Project objectives: We will target large scale ionospheric disturbances over the entire continental US triggered by the eclipse and spanning both totality and partial eclipse zones. The disturbances include ionospheric variations associated with photoionization rate reduction and recovery and traveling ionospheric disturbances (TIDs) associated with atmospheric gravity waves (AGWs) excited during total and partial eclipse, particularly TID/AGW generation and propagation characteristics. Understanding these signatures also requires study of thermosphere eclipse response, and we will conduct an observational program directly measuring plasma and neutral thermal state as well as neutral wind variation during rapidly evolving solar heating. In addition to classical thermodynamic processes, variations of photoelectron energetics during the eclipse have strong impacts on ionospheric plasma waves, and our studies will accordingly include observations and analysis of these impacts.

Data to be used include a dense global network of ~6000 GNSS total electron content (TEC) receivers (100 million measurements per day; seconds-minutes temporal resolution; 1x1 degree spatial grid); Incoherent scatter radar (ISR) observations of plasma parameter full altitude profiles in partial eclipse zones (Millstone Hill and Arecibo; 70+% eclipse magnitude); and NASA TIMED GUVI and SEE data for spatial variations of neutral composition and temperature as well as solar UV flux.

Analysis methodology:

1. GNSS TEC data analysis at MIT Haystack will produce (1) absolute values of continental US TEC; (2) Differential TEC for TID studies, after subtracting background TEC values (accuracy = ~0.1 TEC units). Multiple methods of background TEC subtraction will be used (e.g. average TEC from prior days), and TID propagation characteristics will be derived.
2. ISR data will be collected for 5 days (control: 2 days before/after eclipse). At Millstone Hill, the zenith and fully-steerable antennas will be used for estimates of TID propagation direction, speed, and wavelength. At Arecibo, high precision plasma density profiles from Langmuir (plasma) line data will be used to examine vertical propagation of TIDs. Both Millstone Hill and Arecibo radar data will be also used for magnetically aligned neutral wind estimates. Plasma line data will provide photoelectron impact monitors.
3. NASA mission data including TIMED/GUVI will provide spatial variations of neutral composition and temperature along eclipse affected orbits. These will be compared to ionospheric density and temperature measurements. TIMED/SEE data will correlate ionospheric variations to solar EUV changes along the solar eclipse affected satellite orbits. Multiple TIMED control day observations allow removal of background spatial variations. Changes in composition, and thermospheric wind, fusion of space-based and ground-based thermospheric and ionospheric data will examine the interplay of changing solar radiation, cooling, photochemistry and transport processes.

Relevance of the approach to program goals of connecting eclipse effects to ITM system studies: Changes in irradiation during the solar eclipse influences not only photoionization but also the generation of atmospheric and ionospheric waves. Both Heliophysics Decadal Survey goals and NASA's Strategic goals to explore the fundamental relationship between Earth's ionosphere and Sun are addressed. The research uses data from the NASA TIMED mission.

Natchimuthuk Gopalswamy/Goddard Space Flight Center
Testing a Polarization Sensor for Measuring Temperature and Flow Speed in the Solar Corona During the Total Solar Eclipse of 2017 August 21

Science goals and objectives:

The primary science goal of the proposed work is to understand the origin of solar wind near the Sun. In order to achieve this goal, we need to make accurate measurements on the temperature and flow speed of the coronal electrons close to the Sun.

The scientific objective of this proposal is to measure the intensities at the nodes and antinodes of the K-coronal spectrum without the influence of the F-corona. The intensity ratio of coronal images made at 385.0, 410.0 nm is a measure of the coronal temperature. Similarly the ratio of images taken at 398.7 and 423.3 is sensitive to the coronal flow speed. A new polarization camera will enable us measure the two ratios free from the F-corona during the upcoming total solar eclipse on 2017 August 21. This is an innovative technique because we measure two important physical parameters associated with coronal electrons as opposed to numerous other techniques that measure the same parameters associated with the heavier ions and as a result will allow us to determine whether the measurements complement each other. Use of the polarization camera makes it possible to measure both ratios within the duration of the eclipse. This was not possible in the past because tuning the polarizer wheel through three positions for each wavelength makes it impossible to complete the measurement within the duration of totality.

Data to be used in the investigation:

The data consists of a series of coronal images obtained through four narrow-band filters (centered at 385, 395, 410 and 423 nm) and in white light. The main data product is the filter ratios at two pairs of wavelengths (385, 410 nm and 395, 423 nm) at each pixel of the coronal images. We shall thus produce global maps of both the temperature and the radial flow speeds of the free coronal electrons from the coronal images obtained during the total solar eclipse.

Data analysis methodology:

The filter wavelengths are chosen such that they correspond to the nodes and antinodes of the K-coronal spectrum. The intensities at the antinodes of the spectrum at 385 and 410 nm are most sensitive to the temperature and hence the intensity ratio at these wavelengths is a measure of the coronal electron temperature. The intensities at the nodes at 398.7 and 423.3 nm are insensitive to temperature, but the nodes are red shifted when there is flow, and hence the nodal ratio is a measure of the flow speed. These ratios will be obtained from the polarized brightness, which is free from the F-corona. We shall also check the effect of polarized and total brightness in obtaining the filter ratios because we are able to get the polarized, total, and unpolarized brightness of the corona. The white-light data will be inverted to obtain the coronal electron density using standard techniques.

Relevance:

The proposed work is directly relevant to the goals of connecting the eclipse to the study of the Sun: The temperature and flow speed of coronal electrons measured from the eclipse observations provide complementary information from spectroscopic measurements that are based on coronal heavy ions.

Shadia Habbal/University of Hawaii, Honolulu
Exploring the Physics of the Coronal Plasma Through Imaging Spectroscopy During the 21 August 2017 Total Solar Eclipse

Science goals and objectives: The goals of this proposal are to capitalize on the unique properties of visible line spectroscopy to fully exploit the unique observing conditions provided by the considerable dimming of the sky brightness during the total solar eclipse of 21 August 2017, to explore the physical properties of (1) the coronal plasma, (2) the solar wind as it expands into interplanetary space, and (3) coronal mass ejections as they originate and accelerate. The objectives are to (1) design and build two new triple-channel imaging spectrographs, (2) acquire the line profile and intensity of several key coronal emission lines in the visible wavelength range, (3) operate the two spectrographs simultaneously during the eclipse to image these spectral lines over a coronal area of 5x8 square solar radii.

Instrument and data acquisition: A novel design of a dual-channel imaging spectrograph was built and operated during the 20 March 2015 eclipse. The observing sequence of this scanning spectrograph enabled the acquisition of Fe XI 789.2 and Fe XIV 530.3 nm spectral line intensities, profiles and Doppler shifts (when present) over an area of 2.5x8 square solar radii. These data led to the serendipitous detection of a CME front, with sections traveling away from the observer at speeds ranging from 100 to 1500 km/s. Furthermore, they led to the astounding discovery of emission from neutral or singly states of elements in plasmoids embedded in the CME front, characteristic of cool, prominence material ejected with the CME, retaining its original properties. To achieve the proposed objectives, we will use the unique features of the dual-channel spectrograph to build two new triple-channel spectrographs. The main features of the new design of each spectrometer are as follows: (1) an 8 solar radii long slit, (2) three wavelength bands centered on the Fe X 637.4, Fe XI 789.2, and Fe XIV 530.3 forbidden lines, and (3) each 50 nm wide band is designed to include other spectral lines characteristic of hot and cool (chromospheric) emission. By operating the two simultaneously during the eclipse, an unprecedented coronal area of 5x8 square solar radii will be scanned within the approximate 2 minutes duration of the 2017 eclipse, at any given location along the path of totality.

Data analysis methodology: These new data, including spectral line intensities, profiles, and Doppler shifts of key coronal (and chromospheric) emission lines will encompass the critical regions of coronal heating, solar wind acceleration and CME propagation. While retaining the same diagnostic potential of any EUV line from the same ion, forbidden coronal lines in the visible wavelength range can be observed at far larger heights than their EUV counterparts. This property will enable the application of emission line spectroscopy to regions seldom or never reached by previous instrumentation. Standard diagnostic techniques described in Landi et al. (2016) will be applied to these data to determine: (1) the electron temperature distribution in the corona, (2) the empirical identification of the solar wind freeze-in distance, (3) the composition of the coronal plasma, including emission characteristic of neutrals and singly ionized elements, (4) ionic temperatures of select elements, (5) the presence of wave motions through the non-thermal broadening of line profiles, and (6) the thermal structure and dynamics of CME plasmas.

Relevance: The data to be acquired with the triple-channel spectrographs will complement data from the different NASA space-based observatories operating at that time. The proposed instrument and data will directly address Objective 1.4 from the NASA Strategic Plan to "understand the Sun and its interactions with Earth and the solar system, including space weather".

Philip Judge/National Center for Atmospheric Research
Rosetta-Stone Experiments at Infrared and Visible Wavelengths During the August 21 2017 Eclipse

We propose to deploy two unique ground-based experiments with the goal of furthering our understanding of coronal magnetism and thermal structure, and to test novel instrumentation during the 21 August 2017 total solar eclipse.

First, a narrow-band imager at infrared wavelengths will provide both intensities and context images of the magnetically sensitive coronal emission lines of Fe IX 2855 nm, Mg VIII 3028 nm and Si IX 3935 nm. We will take advantage of new, inexpensive commercial filters which match well the bandpasses needed for coronal emission line work. Knowledge of the spatial brightness distribution of these lines is needed for identifying the optimal lines for coronal magnetometry.

The second novel experiment will provide instantaneous measurements of the Stokes parameters of two selected coronal lines from visible to near infrared wavelengths, at high frame rates. An innovative commercial sensor, which is coupled with an array of linear polarizers oriented at four different angles, will be augmented with a liquid crystal modulating retarder element to produce polarization measurements of coronal light. The new technology is simple and compact enough for potential deployment on future spacecraft, perhaps even cubesats, with applications for heliophysics and the astrophysics communities.

These data will be analyzed using: existing Stokes inversion methods at the High Altitude Observatory (HAO); the HAOS-DIPER atomic data and spectra tool developed by Judge; and FORWARD codes in IDL SolarSoft (Gibson 2015) to diagnose coronal magnetic fields and plasma structures. The data will also be used in conjunction with observations from EUV experiments on NASA's Hinode and SDO spacecrafts and with Mauna Loa ground-based coronal observations from CoMP and COSMO K-Cor coronagraphs. Additionally, these data will complement and be used to augment eclipse data from experiments between three NCAR laboratories and the Harvard-Smithsonian Center for Astrophysics (NCAR FTS and AIR-SPEC). We anticipate that data from this field campaign will allow us to define the magnetic and thermal structure of the corona far more precisely than done through earlier eclipses, and greatly enhance the value of other data and modeling efforts planned for this unusual natural opportunity.

This work is relevant to the NASA 2017 eclipse opportunity. It will provide rare observations of IR emission lines from the ground of a quality that can only be obtained during an eclipse to help identify optimal observations for coronal magnetometry and further our understanding of coronal magnetic and thermal structure. This work will enhance our understanding of how the Sun generates space weather and test new camera technology for solar and stellar polarimetry. This new information can benefit the upcoming Solar Probe Plus mission. Our work will include significant public outreach and training of at least one university student.

Robert Marshall/University of Colorado, Boulder
Quantifying the Contributions of Ionization Sources on the Formation of the D-Region Ionosphere During the 2017 Solar Eclipse

Goals and Objectives:

This proposal aims to quantify the effects of Lyman-alpha, soft X-ray, and hard X-ray solar inputs on the production of ionization in the D-region ionosphere (below 90 km). It is well known that Lyman-alpha and hard X-rays from the sun produce ionization in the D-region and are responsible for maintaining the D-region during the daytime. Less understood is the contribution of soft X-rays (< 10 keV), due to the lack of observations of soft X-rays from space. The 2017 solar eclipse will provide a unique opportunity to study the effects of these energetic sources on D-region ionization, by removing and then re-establishing the solar sources in a short time span and over a limited spatial region. Measurements of the sources from space will be correlated with D-region measurements before and after the eclipse, while D-region measurements during the eclipse will quantify the D-region in the absence of these sources.

Data:

D-region ionization measurements will be made using VLF subionospheric remote sensing. The NML (25.2 kHz) VLF transmitter in LaMoure, North Dakota will be monitored at a VLF receiver site in Boulder, CO. This receiver will provide measurements of the VLF amplitude and phase before, during, and after the eclipse.

Lyman-alpha and EUV observations from space will be provided by the EVE instrument on SDO; SDO is extended until October 2017 at the earliest. GOES spacecraft provide hard X-ray fluxes in the energy range from 1.5 to 25 keV. Soft x-rays in the range from 0.5 to 6 keV will be provided by the MinXSS-2 spacecraft, which will be launched in January 2017. Hard X-rays up to 1 MeV or higher will be provided by the RHESSI spacecraft. Using these sources, a complete spectrum of ionizating radiation from the sun can be assembled and input into atmospheric chemistry models.

Analysis Methodology and Modeling:

Lyman-alpha, EUV, soft X-ray, and hard X-ray data will be used to form a complete picture of the spectral flux of energetic inputs to the upper atmosphere from these sources. Atmospheric chemistry modeling using the Sokankyla Ion Chemistry (SIC) model will be used to assess the effects of these sources on D-region ionization, before, during, and after the eclipse. The model will then determine the D-region electron and ion density profiles during the course of the eclipse.

The D-region ionosphere will be assessed using a second method, in particular using a propagation code to simulate the VLF transmitter signal propagating from the NML transmitter to our receiver at Boulder. The ionosphere can be specified in 2D along the path. The propagation model was developed by the PI; it is an FDTD model capable of simulating the amplitude and phase of any transmitter frequency up to hundreds of kHz propagating in the Earth-ionosphere waveguide.

The models will be run with and without an eclipsed region, to assess the difference in amplitude and phase observed with and without the contributions of solar inputs. The model results will then be compared with the observed amplitude and phase signals to assess the accuracy of the models. Differences will be studied in terms of the accuracy of the measured solar inputs.

Relevance:

The proposed work clearly connects the solar eclipse to its effects in the Earth's upper atmosphere, and in particular to the ionosphere-thermosphere-mesosphere (ITM) system. It directly pertains to the National Academy of Science 2013 Decadal Survey in Solar and Space Physics (Heliophysics) Key Science Goal 2, to "determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs."

Bohumil Svoma/University of Missouri
Land and Atmospheric Responses to the 2017 Total Solar Eclipse

I. Science goals/objectives

The University of Missouri-Columbia and surrounding area will be in totality for approximately 2 minutes and 40 seconds during the 2017 solar eclipse, and possesses considerable human and instrumental resources for the observation and analysis of geophysical data from this event. The principal scientific goal of this proposed research is to examine the multi-scale land-atmosphere responses to the variations in solar forcing during the eclipse using earth science assets. Specific objectives are to: (1) examine field-scale changes in land-atmosphere carbon dioxide, energy and radiation exchanges, turbulence structure and canopy conductance caused by variations in solar forcing, and determine whether there are differences in responses for forest, prairie, and cropland ecosystems; and (2) examine the larger scale thermally induced changes in the wind fields and thermodynamic state of the atmosphere.

II. Data Listing

Data sources in the path of totality include:

(1) Eddy covariance systems: the Missouri Ozarks AmeriFlux site is in an oak-hickory forest, while the other three sites are situated in croplands and prairie and are part of the Central Mississippi Long Term Agroecosystem Research Network. All sites are instrumented for measuring net ecosystem exchanges of carbon dioxide, water vapor and sensible heat using the eddy covariance technique, as well as incoming and outgoing solar, longwave and photosynthetically active radiation.
(2) The University of Missouri radar will observe radial wind fields with a range that covers the entire eclipse swath.

(3) InterMET mobile rawinsonde systems will measure vertical profiles of wind, temperature, and humidity.
(4) Thirteen Missouri Mesonet stations near or in the path of totality and will monitor standard meteorological conditions every 5 seconds, including temperature, relative humidity, wind speed, wind direction, solar radiation, soil temperature, barometric pressure and precipitation.
(5) A citizen scientist network will provide air temperature measurements at high spatial resolution.

III. Data Analysis and Methods

(1) All eddy covariance data streams are sampled at 10 Hz and typically used to compute scalar fluxes and additional turbulence variables. High frequency observations throughout the eclipse day and control days (adjacent similar days) will be analyzed to determine the extent to which physiological (e.g., canopy conductance) versus atmospheric responses (e.g., stability, turbulence structure) regulate turbulent fluxes during the eclipse, and whether the ecosystem response is different for forests, prairie, and croplands.
(2) The radar operates with a gate length of 130 m and the velocity field will be processed to produce divergence and shear fields. As an X-band device, it has the sensitivity to collect Doppler velocities in 'clear air' conditions. Measurements throughout the eclipse and control days will reveal changes in the wind field induced by the eclipse.
(3) The rawinsonde thermodynamic profiles measured throughout the eclipse and control days will establish the existence (if any) of stable layers in the boundary layer that may act to decouple the boundary layer from the free atmosphere.
(4) The greater extent of the Mesonet and citizen science observations will supplement the other data sources to establish eclipse day vs control day differences in surface variables at a broader scale.

IV. Statement of Relevance:

Previous work on atmospheric responses to other eclipses suggest a significant change in sensible weather. An interdisciplinary observational campaign of this kind has not been attempted previously. Collectively, this will be the most comprehensive eddy covariance dataset ever collected during a total solar eclipse. This effort will make a powerful contribution to basic science with a limited investment.

Guoyong Wen/Morgan State University
Using the 2017 Eclipse Viewed by DSCOVR/EPIC & NISTAR From Above and Spectral Radiance and Broadband Irradiance Instruments From Below to Perform a 3-D Radiative Transfer Closure Experiment

Key to this proposal are the eclipse data observed by the DSCOVR/EPIC and NISTAR instruments at the Lagrange-1 point at approximately 10:45 local time (17:45 GMT) on August 21, 2017 near Casper, Wyoming (42.88° N, 106.3° W). Based on a previous eclipse observation, the eclipse "circle" including totality and the umbra is about 20o in diameter or 2000 km. We are proposing to locate 3 ground-based Pandora spectrometer systems (300 nm to 800 nm) in the line of totality starting north of Boise Idaho (42.9° N, 106.3° W), one near Casper Wyoming (42.88N, 106.3W), and one north of Kansas City, MO (39.7° N, 94.6° W) accompanied by pyranometers to measure spectral radiance and the total irradiance associated with the eclipse as seen from above by EPIC and NISTAR, respectively. We propose to make 1-D and 3-D radiative transfer calculations with the atmospheric structure observed by EPIC and retrieved by MODIS to match the measurements made from space and ground, thus validating the ability of the radiative transfer models to capture this special event. The combined spatially resolved EPIC data, ground-based measurements, and the validated radiative transfer model will be used to interpret the eclipse perturbation in the total earth NISTAR irradiance data. The ultimate object of this project is to extend the utility of NISTAR data for use in the Earth radiative balance studies.

Padma Yanamandra-Fisher/Space Science Institute
Citizen Science Approach to Measuring the Polarization of Solar Corona During Eclipse 2017

Goals: We propose study the solar inner corona during the total eclipse of 2017 with polarimetric imaging. Our objectives are to leverage our partnerships with Citizen CATE (PI: M. Penn; Coll: P. Yanamandra-Fisher) and NCIL/NASA@My_Library* (PI: P. Dusenbery) to observe and characterize the polarimetric nature of the inner solar corona during the total solar eclipse in August 2017, and utilize the approach of citizen science and social media for image analysis to determine the observed polarization of the corona.

Methodology: Research Science: We propose to have at least two independent locations with telescopes similar to the telescopes used in Citizen CATE project amended with polarimeters and appropriate filters to map the polarization of the inner solar corona. One location will be Tetonia, Idaho; the second location will be selected based on co-location with one of Citizen CATE sites. The process by which the inner corona is heated is still not confirmed. Mapping of the polarimetric signature of coronal features provides a measure of electron density critical to modelling coronal waves, which are possible source of coronal heating. The two independent observational locations will allow for cross-calibration, insure against weather and potential time-dependent variations in the polarization of the corona. If funded, we will also partner with other teams involved in the study of coronal polarization to increase the number of independent sites and measurements. These approaches will allow for comparison of polarization with images of the solar corona; and temporal changes, if any, in the corona.

Citizen Science: We will include students (with educators) and amateur solar astronomers to transform the project from mere observations to a citizen science project to track the changes in solar coronal polarization at different locations., including expeditions to the locations identified. We will dovetail our citizen science approach to promote multidimensional crowdsourcing of the observations and encourage the active learning process via the NCIL/NASA@My_Library project, which will be participating at three locations: Oregon, Wyoming and Kansas, along the path of totality. We propose to enhance the experience with utilization of the resources provided by Through the Eyes of NASA (Coll. L. Mayo). Finally, we will integrate various social media to enhance the participation of citizen scientists (such as Facebook, vimeo, pinterest, Flckr), based on our expertise and experience with previous comet observing campaigns (Consultant T. Greiner). Specifically, we will partner with Globe at Night to measure the darkness of the eclipse sky and compare with the night sky observations in its database (Co-I. C. Walker). We will provide the products to NASA SMD to share with educators, students and other informal audiences.

Relevance: The proposed investigation is relevant to the NSPIRES-ISE program as it leverages existing projects and networks to extend/add an extra dimension to the citizen science of the total solar eclipse of 2017. The proposal includes both collection of data and application of these data to utilize the solar eclipse for the study of the Sun, as solicited.

* The National Center for Interactive Learning (NCIL) at the Space Science Institute has received funding from NASA for its NASA@ My Library (NaML)project. NaML is part of the STAR Library Education Network (STAR_Net) program (www.starnetlibraries.org). Over 1,100 public libraries have registered to host eclipse events on 8/21/2017.
