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Design and Test of a Shock Tube Facility to Investigate Droplet Aerobreakup
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Lipid and Fatty Acid Analysis of Microalgal Biomass as Life Support Products for Space Explorations
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Design of a Planar, Cable-Stiffened and Cable-Actuated Continuum Robot for Space Applications
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Electrostatic Levitation System Development for Advanced Material Characterization in Support of For-Space and In-Space Manufacturing
LaSPACE GSRA project, presented by Neil Sand, Mechanical Engineering Master's student, University of Louisiana at Lafayette, Lafayette, LA 70504

Effects of KAGE and Salinity on Germination of Space Biology Bacillus Isolates
LaSPACE REA project, presented by Jacob Saucier, Biology Senior, Louisiana Tech University, Ruston, LA 71270

Cultivation of Chlorella vulgaris in a photobioreactor system for conversion of carbon dioxide into oxygen
EPSCoR & BoR project, presented by Sarah Simoneaux, Chemical Engineering PhD student, University of Louisiana at Lafayette, Lafayette, LA 70504

Chlorella vulgaris growth from Sodium Bicarbonate produced via Carbon Dioxide absorption using Sodium Hydroxide

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Applying Deep Learning for Prediction of Shoreline Dynamics in Coastal Louisiana

LaSPACE & La Sea Grant LaSSO project, presented by Kevin Toups, Chemical Engineering Junior, University of Louisiana at Lafayette, Lafayette, LA 70504

A distributed fuel injection approach to suppress lean blow-out and NOx emissions in an Methane-Ammonia-fueled premixed swirl combustor

EPSCoR & BoR project, presented by Varun N. Viswamithra, Mechanical Engineering PhD student, Louisiana State University A&M, Baton Rouge, LA 70803

Embedded Development for Spaceflight Radiation Detectors

LaSPACE LURA project, presented by Duncan Wilkie, Physics & Mathematics Junior, Louisiana State University A&M, Baton Rouge, LA 70803

Downscaling CMIP6 Global solutions to regional ocean carbon model: Connecting the Mississippi, Gulf of Mexico, and Global Ocean

EPSCoR & BoR project, presented by Le Zhang, Oceanography PhD student, Louisiana State University A&M, Baton Rouge, LA 70803

Remil Aguda, EPSCoR & BoR, University of Louisiana at Lafayette
"Algae Cultivation in a Space-based Biorefinery System"

Biorefinery systems involving microalgae have been demonstrated to simultaneously reclaim wastewater (through nutrient biofixation), provide food supplements (as biomass) and revitalize air (through the photosynthetic conversion of carbon dioxide to oxygen). Microalgal cultivation in human-derived waste (both gas and liquid), could encounter issues if the nutrient levels in the wastewater surpass system tolerance. Experiments on the microalgae *Chlorella vulgaris* UTEX 2714 strain showed the levels of macronutrients (C, N and P) that inhibit growth. Hence, dilution of the human-derived wastewater in a space station is recommended. An analysis of the nutritional composition of the harvested *Chlorella vulgaris* grown in synthetic media, showed that it can be a source of protein, carbohydrates, and lipids. Photobioreactor volumes were estimated based on the inhibitory levels of the C, N and P on *C. vulgaris* and baseline values of these macronutrients in urine flush water in the International Space Station for a crew of six astronauts.

Saleh Ahmed, EPSCoR & BoR, University of Louisiana at Lafayette
"Utilization of human feces and urine with concomitant production of biogas in confined environments"

Efficient and environmentally safe utilization of human waste in a confined environment possesses a certain challenge. It is particularly important for space flights and establishing of settlements on the Moon and Mars. The goal of this project was to select a stable microbial community capable of an effective digest of human wastes with concomitant production of biogas. Dog feces (in lieu of human feces) were incubated anaerobically with human artificial urine in batch reactors for up to four months. Production of molecular hydrogen, methane and carbon dioxide were monitored by gas chromatography and production of fermentation products were monitored by HPLC. The composition of the established microbial communities was determined by 16S rRNA gene analyses. It was established that butyric fermentation is the key fermentation process during incubation. Hydrogen production initially tends to increase but then its concentration substantially drops until it is consumed, and methane was not produced during most of the experiments. Addition of a Clostridium butyricum culture to the fermentation does not improve production of molecular hydrogen and/or methane. Analyses of the microbial communities in incubation vessels indicate that a substantial change in the microbial community composition takes place over the time of incubation and added clostridia successfully survived in the fecal-urine environment used for the project.

Saber Aradpour, EPSCoR & BoR, Louisiana State University A&M
"Modeling and Mapping Solar Radiation in Coastal Waters of Louisiana"

Solar radiation (SR) is the main deriving force of photosynthesis and atmospheric heat exchange of ocean. Through years scientists perfected ways to predict SR over oceans, but most of the proposed approaches required detailed meteorological data and, in many cases, they required cloud cover information of the study area. In this study, a novel algorithm was proposed for the estimation of SR using satellite remote sensing data. Random Forest machine learning algorithm was utilized to develop SR model. The input data included observational solar radiation of coastal weather stations along the LA shoreline, and ocean color products including: Rrs_412, Rrs_443, Rrs_469, Rrs_488, aot_869, angstrom, par, and ipar. Solar radiation model was developed using 1439 datasets extracted from both land and satellite observations. The whole dataset was divided into two datasets randomly for model training (60% of data) and testing (40% of data). The results of model evaluation for training periods revealed high RMSE and Pearson Correlation coefficient values, 0.202 and 0.796 for training, 0.201 and 0.791 for testing. Also, the developed model performance was validated using an independent set of data from the west of Gulf of Mexico with RMSE and Pearson correlation coefficient of 0.159 and 0.860 respectively. This model can be utilized for the prediction of SR along the coastal waters of United States of America and Beyond.

Augustus Bates, EPSCoR & BoR, Louisiana State University A&M
"Characterizing the Subsurface and Surface Properties of Ice-Cemented Soils on Mars"

Prior works modeled the various states and stability regimes of regolith-bound H2O-ice on Mars based on the diffusion of atmospheric water vapor into the porous regolith of Mars. Such models rely upon the orbital dynamics of Mars, especially obliquity variations, to determine periods of thermophysical stability of ice within the lower latitudes. As the obliquity of Mars changes, the stability regimes for ice change as well, which results in latitudinal transfer of ice through vapor diffusion. However, ice may remain metastable at shallow depths within lower latitudes (~55°) even during low obliquity, as verified by satellite observations. In addition to poorly constrained metastability, the quantity of ice found at lower latitudes exceeds what could have accumulated solely through available atmospheric vapor through the previous ~1.4-2.5 Ma obliquity cycle. In order to understand seasonal controls and identify key regions of regolith ice growth, future in situ missions must have established methodology to survey the martian surface and subsurface for evidence of ongoing or past ice activity. The cold, arid climate on Mars coupled with extreme aeolian weathering is an environment whose conditions are difficult to find replicated on Earth. However, prior studies have placed emphasis on the role of wind activity and sublimation rates. We present a synthesis of terrestrial data regarding sublimation rates and geomorphological features related to sublimation and how such properties would change on Mars. We summarize the results of available research related to sublimation in such environments and relate those results to the martian environment. However, such features may not be representative of what volumes of ice are present at depth. We also present results regarding the applicability of terrestrial-based rock physics models, such as modified contact theory, to explain velocities of ice-saturated regolith as well as in-situ data collected by the InSight rover.

Connor Becnel, LaSPACE REA, Louisiana State University A&M
"A fan-beam approach to temperature field measurements in rocket exhaust using laser absorption spectroscopy"

The temperature field in the supersonic exhaust plume of a rocket engine critically determines heat flux to many of the rocket motor components. This includes surrounding support systems used to test rocket motors on test stands such as the stands used at NASA Stennis. Measurement of this temperature field has been difficult using conventional techniques due to the high temperatures experienced during operation. This project outlines a tunable diode laser-based approach to obtain a 2-dimensional temperature field in the rocket exhaust plume using near infrared laser absorption spectroscopy. This approach involves generation of a fan beam using laser optics and measurement of the transmitted laser signal using multiple photodiodes. The transmitted laser signal is dependent on the water content generated from the combustion process as the water absorbs some of the incident energy from the incident beam. Reconstruction of the temperature field using Abel inversion techniques will produce the 2-dimensional temperature field of interest. Currently the system is being tested on a McKenna burner for initial testing/tuning and eventually the technique will be demonstrated on a scaled rocket motor.

Miranda Carnes, LaSPACE LURA, University of Louisiana at Lafayette
"Machine Learning Analysis of Gene Transcriptions of Cancer Cells in Spaceflight Microgravity"

Studying the growth of cancer cells in the microgravity environment simulates the realistic view of how the large, spherical cancer tumors grow in the human body. The effects of spaceflight on humans has been studied for in the past amid the goal of conducting deep-space human explorations.

Megan Chesal, LaSPACE GSRA, Louisiana State University A&M
"Novel Computational Phantoms for Assessing Dose Topology Following Exposure to the Space Radiation Environment"

The space radiation environment is a complex hazard for space flight endeavors and remains a health risk for astronaut crews. Simulations assessing the risk of space radiation exposure face difficulties in simulating the radiation environment and providing high resolution and accurate dose analysis. Using the space radiation emulation moderator block methodology proposed by Chancellor et al. in 2017, the space radiation spectrum was produced and used to simulate a single day exposure for male and female advanced tetrahedral mesh-type computational phantoms, where spatial dose distributions were determined. Furthermore, average absorbed dose, dose equivalent, and energy deposition for 170 pre-defined regions were calculated using high performance computing clusters and MPI protocol. Additionally, the same process and results were determined for a tetrahedral mesh-type mouse phantom using the same simulated exposure. While results for the human phantoms were within expectation, the mouse results deviated significantly, with very large dose estimates but low energy deposition. These results showcase problems of animal model extrapolation to human outcomes and indicate a potential pitfall in using dose as a common metric between large- and small-scale models.

Lisa Stephanie H. Dizon, EPSCoR & BoR, University of Louisiana at Lafayette
"Bacterial Conversion of Methane to Bioproducts: towards a Closed-loop Biomanufacturing in Space"

The International Space Station (ISS) uses an Environmental Control and Life Support System (ECLSS) as a regenerative life support system to provide clean air and water to its crew. These life support systems need to be efficient in recycling existing resources due to high resupply costs which makes it hard for the ECLSS to carry out long duration missions or deep explorations like in Mars. Currently, the Sabatier process is employed to recapture oxygen from carbon dioxide (CO2) by reacting it with hydrogen (from H2O electrolysis) over a catalyst at elevated temperature and pressures to produce water (H2O) and methane (CH4). The H2O is then subjected to electrolysis to generate O2 while, CH4 is vented to space resulting in the loss of one carbon and for hydrogen atoms for every molecule of CO2 treated. Closed loop cycles are desirable to attain sustainability in the process. Methanotrophs are gaining interests due to their ability to utilize CH4 as their sole carbon and energy source to produce a wide variety of bioproducts. Methane bioconversion has the potential for biomanufacturing bioproducts that are relevant in extended period of stay in space and could serve as a possible solution for closing the loop system to prevent material losses and reduce operational costs for launching and resupplying. Therefore, the main objective of this paper is to gather related studies that will discuss the innovative strategy for resource utilization, production and recycling via methanotrophs CH4 bioconversion into bioproducts.

Ashton Fremin, LaSPACE LURA, University of Louisiana at Lafayette
"Making NASA's Open-Innovation Data More Machine-Learning Friendly: A Case for the Mars Spacecraft MAVEN Datasets"

Impacted by recent government mandates requiring improvements to the public's ability to use federal data for artificial intelligence, NASA has been looking for ideas and demonstrations on solving several issues that have made NASA datasets hard to work with for artificial intelligence and machine learning (AI/ML). The purpose of this project is to develop and demonstrate architectures and cyber-infrastructures implementing AI/ML tools to usher the public in the access and analysis of big planetary data with the goal of improving citizen engagement in paving new paths for future discovery plans of NASA. The project focuses on the big data from the Mars spacecraft MAVEN to demonstrate a base-case design, but the overarching goal is a cyber-architecture that may be seamlessly adopted by other NASA centers for various NASA rovers and spacecraft.

Ilerioluwa Giwa, LaSPACE REA, Louisiana State University A&M
"Planetary Construction 3D Printing Using Indigenous Materials"

Space exploration is a key aspect of human colonization of the Moon and Mars in the future. In preparation for the NASA Artemis mission and a subsequent challenging journey to Mars, temporary or permanent structures like habitats, research labs, landing pads, hangars, and shield structures are necessary for the survival of astronauts and protection of assets and equipment. Such supporting infrastructure are central to the successful coordination and completion of space exploration missions in extreme environments such as the Moon and Mars. Lack of atmosphere, microgravity, cosmic radiations, micrometeorites, dusty terrains, and significant thermal fluctuations present a high risk to unprotected humans and a variety of exploration and research equipment which are needed for comprehensive Lunar and Martian exploration. Construction 3D printing (C3DP) is large-scale additive manufacturing technique which could be used for fabricating habitats and other infrastructure needed to support these manned or unmanned missions on the celestial bodies. Extrusion-based C3DP is a robotic construction technology that holds great potential for automated planetary construction using in-situ resource utilization (ISRU) based materials. Constraints associated with the cargo payload of Space Launch Systems (SLS) limit the number of terrestrial construction materials that can be transported to the Moon and Mars. Therefore, ISRU offers a viable solution for manufacturing construction materials out of indigenous raw materials. The scarcity of readily available construction materials or the high-energy demand for processing extraterrestrial resources into needed construction materials highlight the importance of investigating the use of mission recyclables as another possible option for space construction. This paper presents a review of the performance, potentials, and challenges of ISRU based materials that can be harnessed and processed as the printing material for extrusion-based construction 3D printing. Finally, some preliminary results and experimental results are presented on the characterization of ISRU-based printing materials to assess their flowability and extrudability, printability, and buildability.

Timothy Ismael, EPSCoR & BoR, Tulane University
"Ultra-light Space Solar Cells from Two-Dimensional MoS2"

Current and future space missions require significant amounts of solar power generation with minimal weight and volume of material to launch into space. This requires the development of ultra-thin, high specific power, and flexible solar cells, or photovoltaics (PV). Two-dimensional (2D) transition metal dichalcogenide (TMDC) semiconductors show great potential for this application. TMDCs exhibit high absorption due to their strong light-matter interaction at monolayer (0.65 nm) thickness. Doping of 2D materials to create a traditional solar cell junction has been a challenge; however, a Schottky device architecture is an alternative to obtain efficient PV devices. Here, we present a Schottky PV device using large area monolayer MoS_2 synthesized by chemical vapor deposition. MoS_2 of 25% external quantum efficiency at 620 nm illumination and 3.3 cm2/(V·s) carrier mobility is used to fabricate an interlocking asymmetric contact PV device.

MoS2 PV device modelling indicates that Ti and Pt are suitable contacts for selective electron and hole transport, respectively. The model shows that a VOC of 919 mV and 41 mA/cm2 JSC should be achievable. A 25 mm2 2D PV device was fabricated, with the monolayer MoS2 film transferred on top of the metal contacts. 260 mV VOC and 19 µA/cm2 JSC was achieved under 1 sun AM1.5D illumination. A 0.0007% cell power conversion efficiency and a 2.2 kW/kg specific power show promise for the use of 2D PV for space applications and payload mass and volume reduction. Ongoing work on contact engineering, improving film quality, and device architecture optimization guided through modelling and spatial mapping of device properties will further improve the efficiency of these devices. We will also report preliminary designs and performance metrics for a solar power generation system using these cells that is attached to a 6U cubesat.

Xiaobo Lei, EPSCoR & BoR, University of Louisiana at Lafayette

"Enhanced adsorption of perfluorooctanoic acid (PFOA) onto low oxygen content ordered mesoporous carbon (OMC): Adsorption behavior and mechanisms"

The pollution of perfluorooctanoic acid (PFOA) in water bodies has been a serious threat to the environment and human health. Ordered mesoporous carbons (OMCs) with different oxygen contents were prepared and first used for adsorbing perfluorooctanoate (PFOA) from aqueous solutions. The OMC-900 with a lower oxygen content has a higher PFOA adsorption capacity than the oxygen-rich OMC-700. OMCs require a much shorter time to reach the adsorption equilibrium compared with other adsorbents reported in the literature. The mesopores play an important role in this rapid adsorption kinetics. The pseudo-second-order model better fitted the kinetic data. The multilayers adsorption was proposed for the adsorption of PFOA onto OMCs since the Freundlich isotherm model fits the experimental data well. The micelle or hemi-micelle structures may be formed during the adsorption. Various background salts showed a positive effect on PFOA adsorption due to the salting-out and divalent bridge effects. The humic acid can lead to a discernible reduction in PFOA adsorption by competing for adsorption sites on OMCs. The hydrophobic interaction and electrostatic interaction adsorption mechanisms were proposed and verified by the adsorption data. The high adsorption capacity and fast adsorption kinetics of the OMC make it a potential adsorbent for PFOA removal in engineering applications.

Chase LeMaire, LaSPACE GSRA, Louisiana State University A&M

"Tunable Passive Shock and Vibration Isolators for Rotational Isolation"

Shock and vibration isolation are a critical need in helmets, which are widely used to protect athletes, workers, soldiers, and astronauts. Passive vibration isolation systems are a good option when mass and volume should be minimized and when the experienced loadings can be predicted. However, it is frequently challenging to find materials and structures which exhibit optimal vibration and impact isolation in a specific application. As a case study illustrating a novel design paradigm for rotational shock absorption, we present the family of optimal solutions for the physical properties of helmets for American football, describe the design and finite element analysis of a planar, passive isolator designed to reduce the rotational accelerations during helmeted head impacts, and describe the results of initial prototype testing for the planar shock absorber components. Lumped parameter Simulink models are used to simulate a variety of impacts to a helmeted head and to determine the optimal values of rotational and translational stiffness and damping between the head and helmet, which are used to drive the specification of individual shock absorbing elements. Nonlinear, hyper-elastic finite element models are used to predict the physical response of individual isolator components. Finally, a custom impact testing machine is used to validate the properties of prototype isolators. This research illustrates a new design paradigm for independent tuning of rotational energy storage and dissipation that can be translated to a variety of aerospace-related applications.

James Leung, LaSPACE GSRA, Louisiana State University A&M
"Design and Test of a Shock Tube Facility to Investigate Droplet Aerobreakup"

The interaction between a propagating shock wave with fuel droplets forms a fundamental process occurring in several propulsion applications such as high-speed flight, fuel injection, and two-phase detonations. The ensuing processes including droplet aerobreakup, ignition, and combustion, are strongly influenced by the droplet-shock wave interaction. This study documents the design, fabrication, assembly, and preliminary testing of a shock tube facility to study droplet-shock wave interaction under controlled conditions using non-intrusive diagnostic techniques. A shock tube capable of operating up to Mach 6 using Helium as the driver gas and air as the driven gas is designed and built. The various dimensions of the shock tube sections including lengths, diameters, and wall thicknesses are determined. Stress analysis using FEA is conducted to ensure a minimum factor of safety requirement. Preliminary tests of the shock tube will be conducted with water. High-speed imaging with laser illumination will be utilized to study droplet breakup phenomena as a function of shock speed and strength.

Shahrzad Massiha, LaSPACE LURA, University of Louisiana at Lafayette
"Lipids and fatty acid analysis of microalgal biomass as potential life support product for space exploration"

Microalgae grown in photobioreactors can act as life support systems for space exploration. While growing, microalgae can assist in air revitalization and wastewater treatment. Once harvested from photobioreactors, the algae can be consumed by astronauts as a source of nutrients. This study aims to measure the lipid content and identify the fatty acids in the extracted lipids of three microalgae species. The species chosen were *Chlorella vulgaris*, *Botryococcus braunii*, and *Spirulina platensis*. *C. vulgaris* and *S. platensis* were chosen because they have been tested in outer space while *B. braunii* was chosen due to its ability to accumulate a high amount of lipids compared to the other species. An accelerated solvent extraction (ASE) method using a mixture of chloroform and methanol as solvent was used to determine the lipid contents of the species. The highest percent lipid content from the ASE extracts of *C. vulgaris, B. braunii*, and *S. platensis* were 22.5, 55.2 and 13.7 %, respectively. The lipids obtained were esterified for identification of their fatty acid components through gas chromatography-mass spectrometry (GC-MS). GC-MS of the fatty acid methyl esters, derived from the lipid extracts from *C. vulgaris* and *B. braunii*, detected the presence of lauric, myristic, stearic and oleic acids. Other on-going extraction methods are the Bligh and Dyer and Folch methods, and the extracted lipids will be further esterified for fatty acid analysis by GC-MS. The results of this study suggest that the lipids from these microalgae could be used as source of healthy fats due to presence of significant proportion of unsaturated fatty acids. The high lipid content of *C. braunii* is of particular interest. However, additional evaluation of the possible harmful health effects of this species must be conducted.

Parsa Molaei, LaSPACE REA, Louisiana State University A&M

"Design of a Planar, Cable-Stiffened and Cable-Actuated Continuum Robot for Space Applications"

We present a novel design concept for a lightweight, high payload-to-mass ratio modular robot applicable to on-orbit and planetary surface assembly, manufacturing, and maintenance of structures. The robot module is a continuum section which uses elastic deformations to move in a plane and has no traditional kinematic joints. Continuum robots are advantageous for operation in unstructured and uncertain environments because their elastic compliance to external loads protects the robot and the environment. However, current continuum robot designs generally suffer from mechanical instability and difficult control due to the presence of unwanted modes of deformation. Our novel design strategy uses cables to drive the deformation of an anisotropic beam and also to stiffen the structure against unwanted modes of deformation. Engineering prototype specifications were derived collaboratively by engineers at Louisiana State University and NASA's Langley Research Center. A theoretical, model-based analysis of the coupling between actuating cables and stiffening cables is described which reveals a strategy for the geometric design of the support structures between the robot's flexible backbone and the cables.

Neil Sand, LaSPACE GSRA, University of Louisiana at Lafayette

"Electrostatic Levitation System Development for Advanced Material Characterization in Support of For-Space and In-Space Manufacturing"

Accurate measurement of thermophysical properties is key to the study and characterization of materials. Standard materials characterization techniques may be inadequate for proper analysis of highly reactive or refractory materials, due to interactions with the crucible. As such, containerless processing is vital to ascertaining the properties of these materials. Electrostatic levitation (ESL) is a particularly valuable method for containerless materials characterization, as it allows the user to observe a wide range of thermophysical properties with a single device, minimal sample count, and no interference. As in-space manufacturing techniques for metal continue to develop, advanced materials studies are needed for process optimization. ESL offers an excellent avenue for obtaining critical property data for additively manufactured metals and alloys, such as density, viscosity and surface tension in molten metals. The Cajun Integrated Computational Materials Engineering (C-ICME) Lab at ULL has developed a machine vision-based ESL apparatus with core functionality and demonstrated levitation with both metallic and non-metallic sample compositions. This presentation describes the key components and fundamental operation of the system. The results of several sample flight tests as well as future developments are also presented.

Jacob Saucier, LaSPACE REA, Louisiana Tech University

"Effects of KAGE and Salinity on Germination of Space Biology Bacillus Isolates"

Space exploration continues to dominate as a means of understanding celestial bodies within our solar system yet presents a risk of forward contamination to other planets with terrestrial microorganisms. Planetary protection policies seek to mediate this contamination through biological control processes such as spacecraft mission assembly facility clean rooms. Bacterial spores, specifically those of Bacillus, represent a specialized, dormant cell type with robust resistance capabilities due in part to its low water content. Bacillus ssp. strains have been isolated which can overcome current clean room protocols and, potentially, survive space travel if protected against solar irradiation making them candidates for forward contamination. Spores can be reactivated with nutrients by a process called germination which includes rehydrating the spore. Water found on extraterrestrial planets will likely contain high concentrations of salt. Therefore, ten bacterial isolates with ties to space biology (Jet Propulsion Laboratory's (JPL) clean room, EXPOSE mission, and the ISS) were selected for this study. The goal of this study is two-fold: to first test the "universal" capabilities of the germinant mixture KAGE and secondly test the effects of salinity (3.6 M NaCl) on germination. Germination was measured by the loss of optical density (OD) at 580 nm. Seven of the strains germinated in the presence of KAGE. Four of these seven strains were further tested for salt tolerance and showed an ability to germinate under increased salt concentrations. This research suggests that KAGE is not a universal germinant mixture under the conditions tested. Further testing will determine salt tolerances of the remaining strains. Studying microorganisms' ability to germinate under salt stress may inform future planetary protection protocols.

Sarah Simoneaux, EPSCoR & BoR, University of Louisiana at Lafayette

"Cultivation of Chlorella vulgaris in a photobioreactor system for conversion of carbon dioxide into oxygen"

Managing waste in an efficient and beneficial manner is crucial for NASA to sustain a human population on Mars in the future. A waste management system like BIOSYS is able to convert all water-based waste streams into useful products through mostly biological processes. This system proposes the use of algae photobioreactors to convert carbon dioxide produced from an aerobic digester to oxygen and biomass. The oxygen would be recycled to the aerobic bioreactor or sent to the life support system; the biomass would be used as a source of protein or lipids. A photobioreactor system has been developed to test Chlorella vulgaris' ability to remove carbon dioxide from an air stream. Results have shown that differing operating parameters such as light/dark cycles and nutrient dosage have impacts on the algae's ability to grow and therefore remove carbon dioxide. Twenty-four hour illumination produced higher biomass quicker when compared to light/dark cycles of 12:12 and 18:6. Doubling the amount of nutrients under 12:12 illumination does not produce as much biomass as a single dose of nutrients under constant illumination. A CO2 fixation rate of 0.433 gCO2/L/day was achieved under constant illumination, 5% CO2, and 0.556 volume gas/volume media/minute.

Sarah Simoneaux, EPSCoR & BoR, University of Louisiana at Lafayette

"Chlorella vulgaris growth from Sodium Bicarbonate produced via Carbon Dioxide absorption using Sodium Hydroxide"

Chlorella vulgaris is a type of algae which can be used for many different applications, including cabin air cleaning for a NASA space camp on Mars. To determine the viability of C. vulgaris growth from inorganic carbon sources in solution rather than from gaseous carbon dioxide, a test was conducted comparing algae growth from 1.9 g/L bicarbonate solution and that from bubbling ambient air (0.07% CO2) at 1 L/min. The bicarbonate solution was prepared by bubbling CO2-rich air through a sodium hydroxide solution using a bubble column. The CO2 effluent fraction vs. time and carbon species vs. time relationships can be seen in Figures 5-7. For each situation tested, there was a signature shape of the CO2 fraction vs. time plot. The stabilization area in the middle is likely where the solution transitions from primarily CO32- to primarily HCO3-. This can be visualized in Figure 7. The algae in the bicarbonate reactor grew more quickly during days 1-7 but slowed behind the ambient air reactor during subsequent days. The bicarbonate reactor peaked during days 5-8 containing 0.6 g/L algae, while the ambient air reactor reached 0.8 g/L algae at day 11. The inorganic aqueous carbon, pH, and biomass were tracked with time for each reactor and can be seen in Figures 9-11.

Kevin Toups, LaSPACE & La Sea Grant LaSSO, University of Louisiana at Lafayette
"Applying Deep Learning for Prediction of Shoreline Dynamics in Coastal Louisiana"

The first goal is to improve National capabilities to predict climate, weather, and natural hazards, to manage resources, and to develop environmental policy. The SMD Earth Sciences Division's GPM, TRMM, and ground-based campaigns (e.g. OLYMPEX, IPHEX, IFLOODS, etc.) have been collecting satellite-based and ground-based data to improve precipitation measurements, which are key inputs to numerical weather prediction (NWP) models. Similarly, the Landsat program managed by NASA/USGS has been tasked to improve our understanding of Earth by providing essential satellite image information to help land managers and policy makers make wise decisions about our resources and our environment. The project will use Landsat data to determine shoreline dynamics, which will be used with weather data (GPM, TRMM, etc.) in the training of DL model for shoreline dynamics prediction.

The second goal is on the maintenance and restoration of healthy coastal ecosystems. Specifically, this focus area covers the development and dissemination of improved predictions of coastal processes. Specifically, the project aims to contribute to the objective of 'developing and sharing improved predictions of coastal processes (e.g. interior ponding, subsidence, sand shoreline dynamics and shore edge erosion of the marsh platform) under normal and storm conditions, factoring in projected sea-level rise scenarios and other climate change-related effects on these processes over time'. Using DL techniques to model shoreline dynamics together with weather dynamics may elucidate patterns and produce models that allow improved prediction of such complex environmental interactions. Applying DL on shoreline data has already been demonstrated in other parts of the world, but the incorporation of weather data and focus on the local regions of Coastal Louisiana will make the DL models of the project targeted to NOAA LSG research priority of healthy coastal ecosystems.

Varun N. Viswamithra, EPSCoR & BoR, Louisiana State University A&M
"A distributed fuel injection approach to suppress lean blow-out and NOx emissions in an Methane-Ammonia-fueled premixed swirl combustor"

Ammonia is being pursued as a fuel for power generation and as it is carbon free source. The energy content however is lower when compared to natural gas. Combustion of air- ammonia poses several challenges such as flame instabilities and flammability limits. In this study premixed swirl combustor rig operating on gaseous fuels is being used and ammonia is used as a fuel additive along with methane. Lean blow out limits and NOx emissions are studied in detail by using predetermined mixture ratios of ammonia and methane. 0-D chemkin/ cantera models are used to understand the effects of ammonia on adiabatic flame temperature and flame speed. CH* and OH* chemiluminescence study has been carried out to understand heat release patterns and reaction zones. Results obtained so far shows that NOx emissions increase for lower ammonia content (0-40% by volume) in the fuel mixtures and decreases for ammonia content above 40% (by volume). It has been observed that adiabatic flame temperature and flame speed also decreases along with increase in ammonia content in the fuel mixture. CH* chemiluminescence imaging shows that the heat release location moves down stream with increase in ammonia content.

Duncan Wilkie, LaSPACE LURA, Louisiana State University A&M
"Embedded Development for Spaceflight Radiation Detectors"

Understanding the radiation environment inside a spacecraft is essential for safe long-term human occupation of space. Currently, detectors capable of tracking the highly energetic, massive particles encountered in cosmic rays are designed for ground-based operation, and present data in ways optimized for analysis by researchers. In this poster, efforts are showcased to develop an iOS-based interface with ADVACAM's Timepix detectors that allows for easy and user-friendly presentation of key information of medical interest, without compromising the quality of data gathered. Specifically, the resolution of challenges faced in embedded development of a communications channel between the Timepix output and Apple's proprietary iAP2 protocol are detailed. The development targets Texas Instruments Tiva C microcontrollers based on the ARM Cortex M4 architecture, and implements I2C, USB, and UART communication. Also presented is work on user interface design and low-bandwidth remote data transfer over iCloud, the integration of which is a major advantage of the design.

Le Zhang, EPSCoR & BoR, Louisiana State University A&M

"Downscaling CMIP6 Global solutions to regional ocean carbon model: Connecting the Mississippi, Gulf of Mexico, and Global Ocean"

Coupled physical-biogeochemical model can greatly reduce the uncertainties in estimating the spatial and temporal patterns of ocean carbon system. Challenges of applying coupled physical-biogeochemical model in regional ocean include a reasonable prescription of carbon model boundary conditions, lack of in situ observations, as well as the oversimplification of certain processes. In this study we adapted a coupled physical-biogeochemical model (Regional Ocean Modeling System, ROMS) to the Gulf of Mexico and achieved an unprecedented high-resolution (5 km, 1/22°) 20-year hindcast covering the period of 2000-2019. Model output includes generally interested carbon system attributes, such as pCO2, pH, aragonite saturation state (Ωarag), calcite saturation state(Ωcalc), CO2 air-sea flux, carbon burial rate, etc. Unlike previous efforts which largely rely on the empirical relations between salinity, temperature, and carbonate variables, our model was driven by CMIP6-CESM2 (Community Earth System Model products) and incorporated the dynamics of organic carbon pools as well as the formation and dissolution of carbonate minerals. The model's robustness was evaluated via extensive model-data comparison against buoy, remote sensing, and ship-based measurements. Model results reveals that the Gulf of Mexico water is experiencing an ~ 0.0016 yr-1 decrease trend in pH, accompanied with a ~ 1.8 µatm yr-1 increase in sea surface pCO2. The Gulf of Mexico carbon budget is re-examined and indicates that the river-dominated northern Gulf is a strong carbon sink and open ocean being near-neutral. Sensitivity experiments were conducted to evaluate the impacts from river inputs and global ocean via boundary condition. While the coastal ocean carbon cycle is dominated by enormous carbon inputs from the Mississippi River, carbonate condition of the open ocean is largely driven by inputs from the Caribbean Sea via the Yucatan Channel.