### Undergraduate Research Semester/Exploratory Grant Application

#### Budget Worksheet

<table>
<thead>
<tr>
<th>BUDGET ITEM</th>
<th>HARBOR Funds</th>
<th>Undergrad. Research Funds</th>
<th>GRAND TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>$300 – High voltage power supply</td>
<td>$100 – filters, surface adhesive</td>
<td>$450</td>
</tr>
<tr>
<td></td>
<td>$50 - flight housing,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>$200 – Mechanics</td>
<td>$200 – electric motor</td>
<td>$1600</td>
</tr>
<tr>
<td></td>
<td>$500 – program flight cost (2 flights)</td>
<td>$500 – program flight cost (2 flights)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$200 – Electronics Control, power, and processor.</td>
<td>$200 – Electronics Control, power, and processor.</td>
<td></td>
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<tr>
<td>Mileage to gather Data (.36 per mile)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>$1050</td>
<td>$1000</td>
<td>$2050</td>
</tr>
</tbody>
</table>
Project Description

The HARBOR (High Altitude Reconnaissance Balloon for Outreach and Research) program here at Weber State University provides students and faculty an excellent opportunity for multidisciplinary research. The center of our research is an area that has yet to be explored, particulate sampling for the confirmation of microbes and the diversity and composition of non-biological particulates at very high altitudes. The goal of this project is to design sampling equipment that would function in high altitudes, minimize contamination, and allow for the confirmation of microbes through the use of a SEM (scanning electron microscope, figure 2 appendix). We believe that by utilizing the principles of charged (positive and negative) surfaces, and charged microbes/particles, we will be able to collect biological and non-biological particulate samples. If successful, this project would lead to further research in the viability, culturability, and characterization of microbes from the atmosphere. It is also probable that other non-biological particulates would be characterized through this project. This research is an area of importance due to interest in Utah air quality, particulate and chemical air pollution in Utah, climate change (seasonal or long-term), and other microbiological experiments such as determining the survival of extremophiles under conditions of flight.

The biosphere is the global sum of all ecosystems, the atmosphere, lithosphere (land), and hydrosphere (oceans, lakes, etc.) are all components of the biosphere. Generally speaking, the atmosphere is the least suitable environment for life. Many microorganisms that grow in the hydrosphere and lithosphere may become airborne. We can also say that all microbes in the atmosphere are transient. The presence of microbes in clouds and their role in ice nucleation and precipitation is well known. (Despre's, et al., 2012) Early attempts in aero-microbiology were restricted by techniques and equipment availability. The results were dismissed on the basis of contamination (Burch, 1967). Much later a group of scientists, the Indian Astrobiology research Centre (IARC), out of Hyderabad collected and cultured bacteria from the stratosphere. They found...
that these bacteria were from Earth and not evidence of *panspermia*, which is the theory that life on Earth originated from a biological (chemical or microbial) source from the exosphere (outside of Earth).

There are many environmental factors that determine the viability and prevalence of airborne microorganisms. These include air movement, temperature, pressure, ultraviolet light, solar radiation, and the presence of chemicals/particulates. There is very little known about the composition of true stratospheric microbes, spatial and temporal viability/culturability and their levels/methods of resistance to these extreme environmental factors. There are however credible studies done on the distribution of microbes in the Troposphere (sea level to 10-12 km above the Earth) from 2010, which utilized NASA DC8 flights and air filtration through 0.2-micrometer filters. (DeLeon-Rodriguez, et al., 2012)

There are many possible products of this research. First being a scholarly paper describing our findings and methodology. We also look forward to presenting our findings in the WSU Undergraduate Research Symposium, and other scientific meetings. Second, we will develop a relatively inexpensive method for particulate collection at any altitude. Third, we will assist the HARBOR program and its research goals. Fourth, and perhaps most important, any data relating to the particulate contents of the atmosphere, biological or not, are of interest particularly in how they relate to Utah air quality, pollution, climate change.

My experiences in WSU laboratory settings have prepared me for conducting this research. We are instructed to work in teams, think about the principles behind the experimentation, proper laboratory preparation, sterile techniques, developing hypotheses, and interpreting the actual data you have collected, instead of fitting it to the desired outcome. I have been at the center of this project and its progression to this point. I also receive lots of guidance from mentoring faculty; they are always willing to meet when I need to discuss the project and findings from my research.
Dependent X Independent
(student helping faculty do research) (student doing own research)

Project Methods & Timeline

It is important to note that these designs are ideas that we have developed through hours of research. The exact equipment and techniques that we will use for collecting samples and data will be experimentally determined in the laboratory then used in actual HARBOR flights.

Considering the low pressure and low temperature conditions (see figure 1, addendum 1) in the upper atmosphere, traditional sampling equipment (vacuum based pumps) will not be useful. There are special pumps in existence, which operate in these conditions, however these are very expensive. We are investigating the use of lightweight, simple, and innovative, homemade, high volume air sampling designs. These will be constructed here at WSU and will be tested in the Lab for particulate (biological and non-biological) collection capacity. These samplers will then be used for multiple HARBOR flights. Our sampling designs are centered on principles of charged surfaces over which air particulates will pass. Collection will utilize the upward movement of the HARBOR balloon through the atmosphere at approximately 20 mph.

The first design we will explore uses a series of sterile drawers (drawing 1), which, through experimentation in the lab, will open at targeted altitudes during flight. These drawers will open a chamber through which air would pass, exposing the charged media to the air and its particulate content. A way to increase airflow though the chamber would be through the use of a focuser or a funnel. As the air moves from the wide opening to the more narrow opening on the end, the velocity of the air increases, thus accelerating the flow of the air through the chamber and increasing the amount or air that is filtered. The volume of air/unit of time would be calculable through laboratory experimentation, and known physical principles of flow rates (Bernoulli principle, etc.) Multiple drawers will be included in each flight so collection can occur at multiple altitudes. A few configurations we have investigated include a stacked configuration (one on top of the other), of a
disc configuration where the drawers would sit side by side, air would flow from the outer edge of
the disc towards the center and out in a space near the center. In addition, the disk will rotate to
change the chamber being used.

The second sampling design utilizes the same basic principles, the movement of the
equipment through the air, and charged particles, varying however on the presentation of the sterile
sampling media to the outside air (drawing 2). This design will use two small electric motors, these
will synchronously turn two opposing scrolls or drums. One of these drums will deposit the
collection media, a film with a layer of the media on the surface. The collection media will be
exposed to the air, then returned to the second drum on the opposite side. Functioning like an old
role of film within a camera.

Collection Media

This is a short list of just a few of the types of media we have investigated to include in our
sample collection design. We have not done testing for functionality but we feel these will most
likely be integrated in our final equipment. We could use just one of these methods or a
combination, depending on laboratory results.

1. **Electrostatic Air Filter:** An Electrostatic air filter is used in most home air filtration
   systems. They operate based on attracting charged particles to the + and – surfaces of the
   filter. The filters are made of polyurethane and polypropylene blends. These fibers are
designed so that when air passes across them they generate a strong electrical charge.

   Different layers of the filter charge in a different way thus trapping particles of both charges

2. **Ionizing air purification:** These air purifiers utilize a method called *corona*
   discharge to create charged particles. This method creates a small but intense electrical field
   which molecules and particles would then interact with. This technique would require a high
   voltage power supply to provide the needed voltage for the creation of the electrical field. As
the particles pass through the field they would either pick up an electron or deposit one, creating a + or – charge on nearly every particle that would pass through it. Problems with this method are that larger particles that pass through this field would most likely be ionized. This would be ideal for capturing air particulates but not microbes.

Timeline

There will be two main phases to this project; the first phase will be laboratory testing of all the equipment until a final, flight ready prototype is built. The second phase will be in April 2014, when the HARBOR flight season starts. We plan to be involved with the four flights planned for the 2014 flight season. Once we have collected data and samples, we then will be able to analyze our findings, and report them in presentation form during the WSU Undergraduate Research Symposium. We also hope to right an article or scholarly paper describing methods, data, and our conclusions from it.
Budget Explanation

There are many electronic and mechanical parts that will be required for this project to reach flight ready, prototype status. A few things to consider when talking about this equipment is that each HARBOR flight has a limited weight that can be launched. The lighter the equipment the faster and higher it will be able to go. Each ounce in my project will take away from the available weight for another project, so each piece will have to be extremely light in weight and very small in size. This fact changes the cost of each piece considerably. In a conference with the HARBOR lead Dr. John Sohl, and the mentoring professor Dr. Mohammed Sondossi, we discussed what parts and expenditures will be needed for this project. We produced a list of the estimated cost for equipment.

**Electronics:**
- Control of moving parts, example - (collection drawers opening) $200
- Electric motor (to turn the disk of drawers) small, light, lots of torque. $200
- Mechanics (the pieces being moved) these pieces could be made of different types of materials including, wood, aluminum, carbon fiber, styrene (dense Styrofoam), etc. $200

Collection media
- High voltage power supply for ionizing air filter $300
- Filter materials and other media that will be tested $100
- Housing, for containing equipment and fixing to the craft $50
- Flight cost (four flights) $1000

Dr. Sohl said that the HARBOR program would be able to match what I will be able to attain through this grant plus the addition $50 dollars for an overall total of a $2050 dollar budget, asking for $1000 dollars from this research grant.
UNDERGRADUATE RESEARCH

SEMESTER/EXPLORATORY GRANT APPLICATION

Additional Questions

1. What funding have you received from OUR in the past, Where has your previous
   project been disseminated.

   None

2. Is this project part of a required course? If so, please indicate the support (monetary
   and in-kind) provided for this project by the academic department.

   This project is not part of a required course

3. What additional sources of funding have been solicited? Is your department
   willing/able to fund any equipment they will be retaining?

   The HARBOR program through Dr. John Sohl, who is the lead for this program has said that
   HARBOR will match what I attain through this grant plus $50 dollars for flight housing cost.

4. Where do you plan to disseminate the results of this project

   We plan to present our results at the WSU Undergraduate Research Symposium and other
   scientific meetings, along with writing a scholarly paper to be published in a scientific
   journal or on the Internet.

5. If you are requesting a stipend, please list all significant time commitments (5+ hours
   per week) that you expect to maintain over the duration of your project including, for
   example, class and work schedules.

   I am not requesting a stipend
UNDERGRADUATE RESEARCH SEMESTER/EXPLORATORY GRANT APPLICATION
FACULTY MENTOR RECOMMENDATION FORM

Student Name (last, first): Gann Jess

Project Title: Microorganisms and other Particulate Sampling in Earth's Atmosphere

Mentor Directions: After carefully reviewing the proposal and assessing both the viability of this project and the qualifications of the student requesting funding, answer the questions found below. Please expand the sections as necessary (do not attach separate letter). If the project involves the use of human subjects or protected animals, be sure the student secures IRB or ACUC approval. If the project receives funding, it is your responsibility to work closely with the student, monitor the ongoing progress of the project and budget, and evaluate the project’s results. Failure to do so will jeopardize funding for this project and any future projects.

1. How long and in what capacity have you known this student?
   - 1 year as research mentor

2. Briefly describe the proposed project. Is this part of a larger research project? Is this part of a course? If so, how is the project apart from the nature and scope of activities normally taken for the course (Please attach a copy of your course syllabus)?

   There are very few, if any, credible data is available describing presence and viability of microorganisms in upper atmosphere (above Troposphere). Our collaboration with HARBOR and Dr. John Sohl provide a rare opportunity to conduct undergraduate research of this caliber. This project is not part of the course or associated lab work. It is purely a multidisciplinary research project involving students from COS.

3. Give an assessment of the project's significance to the student's discipline and of the project's educational and/or professional benefit to the student.

   Considering the nature and uniqueness of this project, if successful, the significance of the finding will be unprecedented as student project. It will bring recognition to Jess's undergraduate education and WSU. This project will propel Jess in a direction of seeking unique challenges in his education and life.

4. Comment on the qualifications of the student to successfully complete this project, both in terms of the project's scope and its time frame.

   Jess has been talking to me about this project for two semesters. He has been in constant contact with me and Dr. Sohl to design and refine the experimental approach to this challenge. Jess has had Microbiology, Chemistry, and Physics courses to give him depth of understanding required for an undergraduate student to be involved. We are by the nature of the project restricted to HARBOR flight schedule in coming spring and summer. The time between now and then will be used to construct and test some of the proposed sampling devices in the laboratory.

5. Comment on the justification and appropriateness of the project budget, including the necessity of a stipend (if requesting one).

   Project budget requested from OUR is absolutely necessary and will be matched by HARBOR + $50 to show the seriousness of the effort in this project.

6. Describe your role in the project.
My contribution as a mentor is to make sure our efforts have solid scientific foundation both in theory and design. Dr. Sohl participation will be another level of quality control in all aspects.

7. Include anything else that you think will be helpful to the committee in evaluating this application. If committee has any reservation on any aspects of the project, a direct contact with me or Dr. Sohl should be considered.

This project ____ DOES ____ DOES NOT require review by the WSU Institutional Review Board for Human Subjects or the WSU Animal Care and Use Committee.

\[Signature\]  \hspace{2cm} \text{Feb 3, 2014}

Project Mentor Signature  \hspace{2cm} Date

\[2506\]  \hspace{2cm} 6884

Campus Mail Code  \hspace{2cm} Phone Extension
WORKS CITED


Figure 1. This graph shows a basic outline of the temperature and pressure conditions as you rise in elevation. The hPa unit is for pressure and stands for hectopascal, the K unit is for temperature and stands for Kelvin. For reference, room temperature in Kelvin is about 290 Kelvin. Pressure at sea level is about 1013 hPa.

Figure 2. This is a picture from a scanning electron microscope found on en.wikipedia.org/wiki/Scanning_electron_microscope