NC SPACE GRANT UNDERGRADUATE RESEARCH SCHOLARSHIP PROGRAM
EXEMPLARY APPLICATION EXAMPLES

Application Example #1; Awarded FY2009:

Research Project:
A particulate matter source apportionment project, focused on PM2.5, began in the summer of 2008 with formation of Appalachian Atmospheric Interdisciplinary Research (AppalAIR). The project consists of five departments working together to understand regional climate impact. In January 2009, collection of atmospheric samples has begun with daily samples being collected from the ASU campus located downtown Boone, NC. Air parcels are sampled from a 30 meter tower located at the highest point on campus, roughly 1150 meters above sea level.

The sample collection process will continue throughout the year and sample analysis should begin by the middle of February. Aerosol optical property measurements are also being taken using an aethelometer and a nephelometer to measure absorbance and scattering, respectively. Collected data will be used in conjunction with quantitative analysis of specific source tracer compounds collected on filters. Samples will be analyzed for metals using Inductively Coupled Plasma (ICP), organics using Solid Phase Micro-Extraction (SPME) and Gas Chromatography with Mass Spectrometer (GC-MS), and for inorganics using Ion Chromatography (IC). Backwards trajectories will be calculated on a day by day basis to determine the likely origin of the air parcels being sampled. Data analysis should begin by March 09 and will be a top priority throughout the summer.

Our goal is to have a reasonable source apportionment model developed by the end of July 09 and further testing and refinement of the model will continue through the end of the year. A non-negative matrix factorization method will be used to quantify the relative contribution of particulate matter originating from each source and to determine the impacts of the specific sources on aerosol optical properties. This method, developed from linear algebra and multivariate analysis, will attempt to factor the overall matrix of determined analyte concentrations into two parts. These two components will be a source contribution and a source profile matrix, with the profile being specified during the analysis. In performing the non-negative matrix factorization the development of accurate source profiles will be important in developing a realistic model and my mentor for the project, Dr. Brett Taubman, will be working closely with me in determining the correct profiles. Our goal in performing the factorization method will be to avoid an infinite number of solutions for the source contribution matrix; we hope to find one or at most two realistic contribution profiles that represent an accurate model of particulate matter for the local area.

Data for analyte analysis will only be collected in Boone but will be used in conjunction with weather event data for locations within range of the calculated backwards trajectory of the specific days air parcel. Once a source apportionment model is developed it will be compared and contrasted to other source apportionment models from around the country. The determined concentrations of analyte in air parcels will likewise be compared to aerosol properties determined from satellite imaging; due to the importance of calibrating satellite imaging techniques used to measure aerosol properties, the accurate quantification of aerosols in local air parcels is a primary goal of this project. An overall publication of results in a peer reviewed journal is planned for the first quarter of 2010 under the assumption that an accurate aerosol model can be developed by that time. At this point four student researchers will be working under Dr Brett Taubman on this project, including myself; I will be in charge of working with Dr. Taubman to develop accurate source profiles and will be performing all of the matrix factorization as data becomes available. This project will extend to my final semester at ASU, in spring 2010, and will be the subject of my senior thesis.

Relevance to NASA Mission Directorates:
The particulate matter source apportionment model developed, as well as the quantification of atmospheric particulate matter used to develop the model, will have direct significance to the NASA Science mission directorate; the specific analyses done for this project will directly relate to atmospheric composition, effects of weather events on particulate matter, better quantifying specific reactants and products of the carbon cycle, and determine the impact of specific types of particulate matter as it relates to climate variability.

Perhaps the most relevant part of our research to the NASA mission directorates is the validation of particulate matter concentrations quantified from data collected via satellite. The quantification of particulate matter has become a very important part of environmental chemistry and the study of climate change; having accurate quantification of particulate matter in the atmosphere by satellite imaging allows rapid analysis of large regions of the earth's atmosphere, which in turn helps to determine the relationship of specific species of particulate matter to clime change.

Research and Career Interests:
For my entire life I have been interested in NASA and space exploration in general and, like many children, always wanted to grow up to be an astronaut. I eventually realized that my future was not in space but in the classroom and especially in the laboratory, performing calculations and experiments. I developed a love of biochemistry and mathematics that started with my introductory biology and calculus courses; my interest in the fields of mathematics, biochemistry, math biology, and physical chemistry continues to grow each and every day. I plan on continuing on to graduate school, following graduation at ASU in 2010, and will hopefully earn a PhD in a field of chemistry.

It became increasingly apparent that I could continue on to graduate school in mathematics or chemistry, but not both. The compromise I decided on was to enter in to either a study of computational chemistry, utilizing the massive amount of computing power we now have in our modern age, or theoretical chemistry, in which my interest in understanding the underlying mathematical principles of physics could be explored. I have yet to take a chemical engineering course but do expect to explore that option in the near future as well. I have yet to decide if my final career will be in industry or academia, but I know that I will apply myself to the best of my ability to make this world a safer and more productive home for all of us. After all, nothing is more strange or amazing to me than the world we wake up in every day.

The interconnectedness of components of our biosphere, from the depths of the ocean to high in the atmosphere, will always intrigue me and tempt me to elucidate some kind of deeper pattern. I can only say, at this point, that I will be working to develop this understanding through mathematics, modeling, and careful experimentation. I also look forward to the day when I can work in tandem with other researchers to collaborate on larger projects with potential for even deeper elucidation of complex mathematical behavior. My career in mathematical modeling truly begins with the particulate matter source apportionment project directed by Dr. Brett Taubman, for which I am applying for this grant.

Application Example #2; awarded FY2009:

The goal of the project is to study the formation of immune complexes in vitro and to test the ability to speed up the reaction rate. We have observed the reaction between human Immuno Globulin G (IgG) and Goat derived Anti-Immuno Globulin G (A-IgG) in a Sodium Phosphate Buffer during a flight with Zero G and NASA. This flight allowed us the ability to view the rates of binding between IgG and A-IgG. The buffer solution contained polyethylene glycol (PEG) which served as a catalyst to breakdown the structure of the water molecules and increase the rate of reaction. The rates of binding between A-IgG and IgG are thought to be slowed during microgravity and thus immunity is lowered in individuals who are exposed to microgravity for any extended period of time.

Our goal in this project is to create a situation that is more like the actual reaction as it takes place in vivo and devising a solution to the decreased binding rate of the immune complex. It is my belief that using another subclass of IgG in combination with our current IgG will speed up the binding rates and make the research more biologically relevant. To measure the rate at which the complexes form after IgG and A-IgG solutions are combined, we will use an Ocean Optics CHEMUSB4-UV-VIS consisting of a USB4000 Spectrometer with a combination deuterium tungsten halogen light source and 1-cm cuvette holder interfaced with a PASCO Xplorer GLX Datalogger. This set up will be used to record the absorption measurements during the approximately 20-25 second periods of 0-g like our previous experiments.

Dr.s Timothy Ritter, Siva Mandjini and I will work from May 4th, 2009 through August 1st, 2009 on this project. Dr. Siva Mandjini is a biochemist and has the knowledge and background of looking at proteins and reaction rates in humans. He will be a great asset to the research in determining a way to speed up the binding rates. Dr. Timothy Ritter is the primary professor involved in the research and will work closely to ensure the project is staying on task, provide a safe working environment and be available for any questions or concerns that may arise while the research in being performed.

Relevance to NASA Mission Directorates:
The health and well being of Astronauts is paramount to the Space Operations Mission Directorate. Space flight bombards Astronauts with a plethora of environmental conditions that are detrimental to their health and welfare. If Astronauts could be armed with a stronger immune system their bodies could respond better to the threats of stress, sleep cycle disturbance, space radiation, and microgravity. Our research will assist in maintaining and bettering the Astronauts health while in space and upon return to Earth. If Astronauts are healthier while in space they will be able to focus on their mission more and less on potential health risks. Also, if Astronauts are sick they risk their lives as well as the safety of the equipment they operate. Overall, the safety and continuation of space travel hinges very closely upon the physiological condition of the Astronauts. This is why the goal of our research is to work closely with immune system function to ensure optimal operational risk management.

Research and Career Interests:
I developed an interest in the field of Aerospace medicine from my experience with the Weightless Lumbee Research program that was conducted through my undergraduate studies at University of North Carolina-Pembroke. As a team member of the Weightless Lumbee Research Program, myself and several other students tested antigen/antibody binding rates in and induced microgravity environment. This allowed the proper conditions in which we could observe the effects of gravity on the binding rates while at a parabolic flight attitude aboard the NASA Zero G aircraft located in Houston Texas. We flew several parabolic flight attitudes experiencing zero gravity environment and

the experienced firsthand the effects of an abnormal environment. During this two week stay at Houston, Texas I had the opportunity to meet and discuss the career field of aerospace medicine first hand with flight surgeons and NASA staff. Our research team also had the opportunity to experience the pressure chamber where we experienced the effects of hypoxia. Additionally, we toured the NASA astronaut training facilities were realized what an impact that aerospace medicine plays in the NASA program. Flight surgeons are in a unique field of medicine in that it deals primarily with normal physiology in an abnormal environment whereas traditional medicine focuses on abnormal physiology in a normal environment. My involvement with the Weightless Lumbee research program was very beneficial in that I now have a specific focus on what field of medicine I would like to focus on in the future.