2011 NASA/Goddard Projects for International Student Consideration

1. **Title:** James Webb Space Telescope (JWST) Mission Systems Verification Project (ESA, CNES)

   Abstract: Support the James Webb Space Telescope (JWST) Mission Systems Verification Working Group. The specific task consists of matching up the specific tests, analyses, demonstrations and inspections called-out in Observatory-level documentation to the scheduled date for which these items are identified in the detailed Program schedule. The result is a metric of planned verification progress as a function of time. Another specific task would be a review of available test information sheets to ensure they are compatible with Expanded Verification Matrices. Additional tasks would be assigned on an "as available" and "as identified" basis.

2. **Title:** James Webb Space Telescope (JWST) Mission Assurance Modeling Project (ESA, CNES)

   Abstract: Numerical modeling is an integral part of how much of industry, and in particular NASA, deals with the challenges of understanding complex designs. There are key elements of a good model that help lead to mission success. With this in mind, Mission Assurance needs to develop a proper understanding of what constitutes a good model, as well as how our quality team can provide the most value-added support with regard to models and modeling. A checklist that would incorporate those aspects that are agreed to contribute to a high-fidelity model would therefore be of significant benefit to the Quality Professional. This checklist would be based upon our current NASA requirements for model acceptance and validation. As such, an individual with some modeling background would be beneficial in helping to lay the groundwork for the establishment of a mission assurance modeling checklist.

3. **Title:** Formation of liquid water in the shallow subsurface of Mars and prospects of Martian habitability (ESA)

   Abstract: Availability of liquid water is one of the major constraints for the potential Martian biosphere. Therefore, understanding of conditions under which liquid water would form on Mars is of critical importance to the future Martian missions. Furthermore, recent discovery of shallow ice by the Phoenix mission challenges all current theories of water cycle on Mars. According to these theories, ice should not be stable at 3-4 cm depths on Mars but it was observed there. This project will focus on the laboratory modeling of the Martian shallow permafrost layer. The intern will study formation of liquid films of water and ice stability in various soils using a Martian simulation chamber. The intern will measure conductivity and dielectric constants of ice/soil martian analog samples as a function of temperature, frequency and salt content. The intern will also use the RGA mass spectrometer to estimate the rate of ice sublimation from various soils. Depending

on progress, the intern might be asked to study stability of CO2 clathrates in the soil as well.

4. **Title:** Simulation of microbial survival and growth in the shallow subsurface of Mars (ESA)

Abstract: Recent discovery of methane in the Martian atmosphere sparked speculations that Mars might have a currently active biosphere. Yet, most experimental work on bacterial survival does not show any bacterial growth in the simulated martian surface conditions (low pressure, extreme dryness etc.). However, there were virtually no studies of the possibility for bacterial survival in the Martian subsurface where water is expected to be more stable and biota would be better protected from UV radiation. Our lab has a unique martian chamber setup which allows the study of bacterial growth in conditions similar to the Martian subsurface at 3-8 cm depths. The intern will be expected to introduce various microorganisms into various Mars analogue soils. The intern will look for biological activity by measuring changes in gas composition in the chamber above the soil sample during simulated Martian day/night conditions. After experimental runs, the intern will count survived cells in the soil using an epifluorescence microscope.

5. **Title**: Heliophysics: from our ionosphere, to the solar chromosphere, and out to the heliopause (ESA, JAXA)

Abstract: Interactions between ions and neutrals in a partially ionized plasma are important throughout Heliophysics: from our ionosphere, to the solar chromosphere, and out to the heliopause. To advance our physical understanding of magnetized systems involving a transition from a weakly ionized dense gas to a fully ionized tenuous plasma, we will investigate how ion-neutral coupling affects formation, structure, and dynamics of solar prominences, the birthplace of space weather. One of the most important objectives of solar physics research is to understand the physical processes that govern the initiation of solar eruptions (flares and coronal mass ejections). Solar prominences are an important component of this activity, and by understanding the fundamental physics behind their structure and dynamics, we will make great strides toward understanding and predicting geoeffective space weather.

The proposed project is part of an ambitious research program that addresses the formation and evolution of prominences, combining high-resolution prominence observations from ground-based facilities and NASA missions. To investigate how observed motions and spatial scales, as well as condensation lifetimes, in prominences compare with the model calculations, properties of mysterious downflows seen in *Hinode/SOT* prominences off the solar limb will be measured, including the timescales and spatial scales on which blobs and threads of cool material form, the velocities of distinct features moving vertically and horizontally, and how long the cool filaments “survive” on small spatial scales.

During the summer, the student is expected to become familiar the Solar Optical Telescope (*SOT*) (Tsuneta et al. 2007) on the Japanese *Hinode* satellite (Kosugi et al. 2007), which was launched in 2006 September. The SOT is a 0.5-m diameter Gregorian telescope free from atmospheric distortion and scattering, making possible unprecedentedly stable images of

prominence and other features. They will also be expected to become proficient at using the data from the SOT to complete the measurements described above.

6. **Title:** Modeling and Validation of Slosh dynamics for a Spinning Spacecraft (ESA, CSA, CNES)

Abstract: As part of the internship, the student will be exposed to engineering analysis methods and practices. He/she will be provided with an advanced education of propellant slosh theory and attitude dynamics. The intern will utilize this knowledge to develop a simple equivalent mechanical slosh model. This slosh model will be implemented in Matlab/Simulink. In addition, the student will develop an attitude dynamics model of a spinning spacecraft. After combining the slosh model into the spacecraft dynamics, the intern will identify the spacecraft and slosh parameters to represent the TableSat slosh platform with a given propellant tank configuration. The results of the identification process will be verified against real data from TableSat.

7. **Title:** Spacecraft Formation Alignment Control and Estimation (ESA, CSA, CNES)

Abstract: As a member of the Attitude Control Systems Engineering Branch, the student will work on a team conducting controls and estimation research and development for formation flying missions. We are focusing on dual-spacecraft formation missions such as the New Worlds Observer (NWO) and the Milli-Arc Second Structure Imager (MASSIM). Both of these missions have very tight transverse relative position requirements, where advanced estimation and control methods may prove to be essential. The student will specifically be working on developing sensor, actuator, and algorithm models for the Formation Alignment Control and Estimation Toolbox (FACET). As a member of the FACET team, the student will work with team members on testing various control and estimation algorithms.

A presentation of the work accomplished will be given to the Attitude Control Systems Engineering Branch.

It is critical that the student has a background in computer programming. Matlab is a must and knowledge of C is desired. The student must have a background in Aerospace, Mechanical, or Electrical engineering, with a solid foundation in physics and dynamics, or a desire in such a field.

Engineering - Aerospace Eng.
Engineering - Electrical Eng.
Engineering - Mechanical Eng.

8. **Title:** Seasonal dynamics in vegetation spectral and bio-physical properties associated with climate and CO2 dynamics, at EOS/CEOS sites (ESA, CNES, CSA)

Abstract: EO-1 Hyperion imagery is effective for assessing environmental and climatic changes because of the existing coverage from various land covers around the globe and the long time scale (~ 10 years) of the observations. Radiometric calibration of remote sensing sensors is essential for quantitative & qualitative science and applications. Pseudo-invariant ground targets have been extensively used to establish the long-term radiometric calibration stability of remote sensing sensors, while core Earth observing sites have been used to monitor ecosystems properties and determine their changes. This study focuses on the analysis of EO-1 Hyperion data at the widely used Earth Observing FLUXNET vegetative sites (such as Mongu, Zambia; and Konza Prairie, USA) to assess the temporal climate, spectral and CO_2 dynamics. The results will be compared with results obtained at CEOS calibration sites (such as Railroad Valley, Frenchman Flat and Libyan Desert) as reference of the radiometric stability of the EO-1 Hyperion sensor. Since the overpass times of EO-1 at the selected LPV and cal/val sites differ, the impacts due to different view-geometries will also be considered. The long-term seasonal trends in vegetation reflectance and physiological properties will be considered in the context of climate change and vegetation productivity.

Student's Computer and/or Special Skills: ENVI and IDL, Matlab, DART; both PC and UNIX environments.

9. **Title:** <u>Assessing ecosystem bio-physical and spectral diversity by combining surface reflectance and emissivity at varying spectral and spatial scales</u> (ESA, CNES, CSA)

Abstract: With the ongoing increase in population density and the conversion of land from rural to urban settings, the urban heat island (UHI) effect has become a problem of critical importance. Land cover type and land surface temperature (LST) in urban and rural areas display significant differences, such as higher LST and lower moisture content in urban areas. Those differences tend to increase with urbanization. A way of discriminating the land cover types and monitoring the ecosystem is to combine a high spectral resolution in the range of 350-2500 nm and thermal infrared imagery. This method will be used by HyspIRI, a new satellite mission that is predicted to be a powerful instrument in generating more precise information compared to the current satellites. The functions of HyspIRI will include: mapping of cover types; identification of aquatic and terrestrial ecosystems; determination of vegetation/soil nutrient and moisture content; and assessment of the vegetation function and health. To prepare for the HyspIRI data use and to contribute toward the development of the mission's concepts, this study will assemble existing data sets covering both rural and urban environments from AVIRIS and MASTER. The goals to: 1) generate HyspIRI-like data sets; 2) characterize the ecosystems biodiversity composition and functional groups; 3) delineate urban and rural ecosystems; 4) determine the relationship between spectral and thermal properties of urban and rural ecosystems and of individual functional types within an ecosystem; 5) assess the bio-physical properties and health of the vegetation cover. Data sets for two independent locations with different regional climate, ecosystem types and functional groups will be compared. The results from the HyspIRI-like data (60 m spatial resolution) will be compared to data sets having 30 and 90 m spatial scales.

Student's Computer and/or Special Skills: ENVI and IDL, Matlab, DART; both PC and UNIX environments.