Future ES architectures will include platforms of varying size and complexity in a number of mission trajectories and orbits. These platforms will include spacecraft, sounding rockets, balloons, and Unmanned Aerial Vehicles (UAVs). Advanced Guidance Navigation and Control (GN&C) technology is required for these platforms to address high performance and reliability requirements while simultaneously satisfying low power, mass, and volume resource constraints. A vigorous effort is needed to develop guidance, navigation and control methodologies, algorithms, and sensor–actuator technologies to enable revolutionary Earth science missions. Of particular interest are highly innovative GN&C technology proposals directed towards enabling ES investigators to exploit new vantage points, develop new sensing strategies, and implement new system-level observational concepts that promote agility, adaptability, evolvability, scalability, and affordability. Novel approaches for the autonomous control of distributed ES spacecraft and/or the management of large fleets of heterogeneous and/or homogeneous ES assets are desired. Specific areas of research include:

GN&C System Technologies

Innovative GN&C solutions for ES instrument pointing and stabilization. Advanced GN&C solutions for the Microsat attitude determination and control problem. Of special interest are low cost (at high production volumes) and highly integrated Microsat GN&C subsystems suitable for enabling both spin stabilized and three-axis stabilized Microsats. GN&C proposals that exploit and combine recent advances in miniature spacecraft subsystem architectures, spacecraft attitude determination and control theory, advanced electro-mechanical packaging, MEMS technology, ultra-low power microelectronics are encouraged. Proposals of special interest are ones that address the technologies needed to implement closed-loop spacecraft control system architectures which provide the "Drag-Free" precision orbit determination and maintenance capabilities needed for future ES Low Earth Orbit (LEO) formation-flying applications. Technology solutions are encouraged that employ Drag-Free sensors (similar to accelerometers), high specific impulse (Isp) thrusters, and low-cost processors with appropriate closed-loop filtering and control algorithms to implement a complete Drag-Free spacecraft control system module.

Vision-based GN&C system concepts, subsystems, hardware components, and supporting algorithms/flight software. Applications of interest are of high performance video image processing technology to provide alternative solutions to challenging GN&C problems such as spacecraft relative range and attitude determination while in close formation and/or during proximity operations.
Advanced GN&C solutions for balloon-borne stratospheric science payloads, including sub-arc second pointing control, sub-arcsecond attitude knowledge determination and trajectory guidance for individual balloon-borne payloads. Innovative techniques are of interest for modeling, simulating, and analyzing the inherent dynamics and control of balloon-borne payloads. Also of interest are innovative concepts, strategies, techniques, and methods for modeling, simulating, and analyzing formations, constellations, and/or networks of multiple balloon-borne stratospheric science payloads.

**GN&C Sensors and Actuators**

Advanced sensors and actuators with enhanced capabilities and performance, as well as reduced cost, mass, power, volume, and reduced complexity for all spacecraft GN&C system elements. Emphasis is placed on improved stability, accuracy, and noise performance. Nontraditional multifunctional sensor/actuator technology proposals are of particular interest.

Innovations in Global Positioning System (GPS) receiver hardware and algorithms that use GPS code and carrier signals to provide spacecraft navigation, attitude, and time. Of particular interest are GPS-based navigation techniques that may employ Wide Area Augmentation System (WAAS) corrections.

Novel approaches to autonomous sensing and navigation of multiple distributed space platforms. Of particular interest are specialized sensors and measurement systems for formation sensing and navigations functions.