The LWS program has built a solid foundation on strategic capabilities, focused science topics (FSTs) and other investigations. We are now prioritizing opportunities to leverage suitable developments for the physics-based understanding leading to predictive developments in key areas of LWS science. FSTs, Strategic Capabilities (SCs) and the elements of LWS focus on separate long-term targeted areas of System Science, termed “Strategic Science Areas” (SSAs), requiring cross-disciplinary collaboration, for developing the understanding most critical to predictive development:

Physics-based Understanding to Enable Forecasting of:

SSA-0, Solar electromagnetic, energetic particle, and plasma outputs driving the solar system environment and inputs to Earth’s Atmosphere: The 2015 LWS SC formulated this new strategic science area to develop physics-based understanding enabling forecast capabilities of the variability of solar magnetism, with a particular focus on better understanding of the processes that drive the formation, interaction, and emergence of magnetic flux systems in the solar interior on time scales from days to decades. Further, this SSA should advance understanding of the impacts of such flux systems for the space environment and the responses of Earth’s atmosphere;

SSA-1, Geomagnetic Variability: The goal is to develop the physics-based understanding to enable 1–3 day (long lead-time) and 15–30 minute (short lead-time) forecasting, including predictability of pending severe geomagnetic disturbances;

SSA-2, Satellite Drag: The goal is to develop scientific capabilities that enable specification of the global neutral density in the thermosphere and its variations over time. This development will lead to the ability to predict the densities that satellites in low-Earth orbit will encounter with a lead-time of at least one hour as well as longer-term predictions out to at least three days and preferably to seven days or longer. There should be quantifiable levels of uncertainty that are specified for different data conditions and levels of redundancy in data/models;

SSA-3, Solar Energetic Particles: The goal is develop scientific understanding that enable probabilistic prediction of the spectral intensity of SEP events, and increased time periods for all-clear forecasts with higher confidence level;

SSA-4, Total Electron Content (TEC): The goal is to derive a model, or coupled set of models, that enable specification of the global ion density in the topside ionosphere and plasmasphere and its variations over time under varying geomagnetic conditions. The model or coupled models should develop the capability to predict the TEC observations globally, with a lead time of at least one hour (based on availability of real-time solar wind/IMF measurements), as well as longer-term predictions for up to three days based on solar wind forecasts;

SSA-5, Ionospheric Scintillation: The goal is to develop the scientific understanding necessary to predict scintillation occurrence utilizing limited sources of available data and ascertain how radio signals are degraded by ionospheric irregularities. Achieving this will require elucidation of the complete set of physical mechanisms responsible for producing ionospheric irregularities, the most important sources of free energy, and the causal chains that both generate and suppress irregularities leading to scintillations;

SSA-6, Radiation Environment: The goal is to develop a physics-based understanding of the atmospheric radiation environment from galactic cosmic rays (GCR) and solar energetic particle (SEP) sources, and the variabilities associated with cutoff rigidity, atmosphere density, and gamma-ray/X-ray inputs. Other success measures will include the development and application of new observational methods, both in situ and remote, that lead to new data sets for assimilation into models on global and regional scales, and new in sights into the spatial/temporal scales of radiation storm variations that are affected by space weather.