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Partnerships, Constellations and Technology Advances: Key Elements to the Science and Benefits of Earth Observations in 2040

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The recent release of the U.S. National Academy of Sciences (NAS) 2017 Decadal Survey makes recommendations for addressing the most critical Earth science and technology needs in the ensuing decade(s). This includes identifying and prioritizing a number of Earth science questions and applications that demand systematic, space-based Earth observations to support a number of societal benefits areas, ranging from water availability, sea level rise, air, water and environmental quality, weather and natural hazards prediction, biodiversity, and climate change. Within its second decadal survey, the NAS emphasizes the profound manner that Earth observations have advanced to routinely impact society, including for day-to-day personal decisions, as basic infrastructure supporting commercial and civil decision making, providing for ever-advancing environmental monitoring and prediction capabilities from local to global scales, etc. Moreover, they note that this reliance by society on Earth observations is coming with requirements for increasing temporal and spatial sampling, a richer array of observation types, and, in many cases, longer and sustained records.

Meeting these future challenges will demand more from a number of growing or new paradigms. These include a greater emphasis on partnerships, namely through: 1) more holistic approaches associated with individual mission contributions made by various space agencies, 2) more synergistic, international constellation approaches in the case of especially demanding and complex science questions and applications (e.g. storms, hazard monitoring, water availability, carbon-water-climate processes), and 3) more reliance on the commercial sector for critical and sustained contributions where feasible. To best leverage these programmatic advances, is an associated need to develop flexible, constellation-based observing architectures that will rely on a mix of state-of-the-art, stable, high accuracy platforms and sensors, and an increasing stable of constellations made up of small and cube satellites. Arriving at the optimum configurations and exploitations of these partnerships and implementation approaches will necessarily involve advanced Earth system modeling capabilities within the contexts of carrying out observing system simulation experiments (OSSEs) for mission/architecture design as well as data assimilation for product development and environmental predictions. Routine and judicious use of products from these advanced observing systems will require end-to-end application of uncertainty quantification (UQ) methods as well as a more interwoven yet nimble data architecture to meet the acquisition, processing, archiving and dissemination demands.

This presentation will focus on approaches and concepts being developed by NASA's Jet Propulsion Laboratory, in concert with the broader science, operational, commercial and applications communities, to address Earth observations in 2040. These include opportunities resulting from developments in the small satellite and cubesat market and the associated miniaturization of sensors being implemented to support constellations of satellites and instruments. Constellation and platform approaches (e.g. space "condo", disaggregated and tightly coordinated constellations) to observations, monitoring, and science, such as for clouds and precipitation observations as well as for water and carbon cycles and natural hazards will be presented. In addition, the presentation will include emphases on the strategic and critical use of OSSEs and end-to-end application of UQ principles and methods.