HOW HAVE RESULTS FROM RECENT LUNAR MISSIONS CHANGED OUR VIEW OF THE MOON?. J. B. Plescia[1], [1]The Johns Hopkins University, Applied Physics Laboratory, Laruel, MD 20723 (jeffrey.plescia@jhuapl.edu).

Introduction: While lunar exploration has been occurring for almost 50 years (beginning with the Soviet Luna 1 mission in 1959) and the surface has been explored by robots and humans and samples have been returned to the Earth, our understanding of the origin and evolution of the Moon is far from complete. Many questions remain unanswered and as existing questions are answered, new ones are posed. The recent suite of lunar robotic missions has provided significant new data and progress has been made on some questions. It is important to assess the direction future missions should take to make further progress.

Outstanding Questions of Lunar Science: Lists of the outstanding questions of lunar science have been developed by various groups. These lists include those in The New Views of the Moon [1], that prepared by the Lunar Exploration Analysis Group [2], and those outlined by in Scientific Context for Exploration of the Moon (SCIM): Final Report [3]. These lists were compiled with different philosophies and priorities, but they are largely similar.

Topics from the SCIM report include:
Bombardment history.
Interior structure and composition.
Diversity of lunar crustal rocks.
Lunar poles.
Lunar volcanism.
Impact process on planetary scales.
Regolith processes and weathering.
Atmosphere and dust environment.

Key Results from Recent Missions: Five lunar orbiter mission have been flown within the last few years including: Lunar Reconnaissance Orbiter (LRO, Chandrayaan-1, Chang'e-1, Kaguya, and SMART-1 respectively by the US, India, China, Japan, and ESA. In addition, LCROSS impacted into a permanently shadowed area near the south pole. Each mission carried a different suite of instruments and had a somewhat different set of scientific objectives.

Some of the more important results to date include: identification of water ice in north polar craters using LRO Mini RF [4]; measurement of temperatures in permanently shadowed areas from LRO Diviner and Chang'e radiometer data [5, 6]; identification of extensive adsorbed and bound H_2O and OH using M3 data from Chandrayaan [7]; recognition of significant areas of pure anorthosite and olivine from Kaguya data [8]; definition of the far-side gravity field with Kaguya [9]; a global topographic map from Kaguya, Chang'e and LRO laser altimeter data [10-12]; global elemental maps using gamma-ray and X-ray data from Chandrayaan, Chang'e and Kaguya [13-15]; and the LCROSS impact into a polar shadowed area [16].

Next Steps: Most of the outstanding lunar sciencequestions can not be addressed by a single mission or experiment; many require multiple samples from across the Moon; multiple concurrent extended observations; or numerous samples. Any lunar mission can make important relevant observations if the capabilities of the spacecraft are used appropriately. Some questions could be addressed by a single mission (e.g., presence of a core by a seismology network) whereas others require multiple independent missions and may never be fully resolved (e.g., bombardment history of the solar system by dating of impact craters).

Among the most important questions that should be addressed next include: definition of the lunar interior; calibration of the recent cratering chronology and determination of the youngest volcanic events; determination of the species, form and distribution of polar volatiles, understanding the nature of spectroscopically recognized H_2O and OH, and assessment of the lunar exosphere. These objectives can all be met with single missions (although the network mission requies multiple vehicles) and significant understanding can be achieved with in situ experiments. None of these require sample return.

References: [1] New Views of the Moon, Jolliff, B.,et al., eds., *Revs. Mineral. Geochem., 60*, 2006. [2] Lunar Exploration Analysis Group, Lunar Exploration Roadmap,. [3] The Scientific Context for Exploration of the Moon, National Academy of Sciences, 108 pp., 2007. [4] Spudis, P. et al., *Geophys. Res. Lett., 37*, L06204, doi:10.1029/ 2009GL042259, 2010. [5] Paige, D., et al., 2010, *Lunar Planet. Sci. 41st,* Abstract 2267. [6] Fa, W., and Jin, Y.-Q., 2010, *Icarus, 207*, 605-615. [7] Pieters, C., et al., 2009, *Science, 326*, 568-572. [8] Ohtake, M., et al., *Nature, 461*, 236-241. [9] Namiki, N. et al., 2009, *Science, 323*, 900-905. [10] Araki, H., et al., 2009, Science, 897-900. [11] Smith, D., et al., 2010, *Lunar Planet. Sci. 41st,* Abstract 1993. [12] Ping, J., et al., 2009, Science in China, Series G., 52, 1672-1799. [13] Huang, W., et al., *Lunar Planet. Sci. 41st*, Abstract 1265. [14] Zhu, M., et al., 2010, *Lunar Planet. Sci. 41st,* Abstract 1046. [15] Ling, Z., et al., *Lunar Planet. Sci. 41st,* Abstract 2061. [16] Colaprete, A., et al., *Lunar Planet. Sci. 41st*, Abstract 2335.