EPSC Abstracts
Vol. 5, EPSC2010-111, 2010
European Planetary Science Congress 2010

Europa Jupiter System Mission Jovian Tour Science

D. Senske (1), R. Pappalardo (1), L. Prockter (2), J-P. Lebreton (3), R. Greeley (4), E. Bunce (5), K. Clark (1), M. Dougherty (6), C. Erd (3), O. Grasset (7), T. Johnson (1), R. Lock (1), E. Sturm (1), T. Van Houten (1)
(1) Jet Propulsion Laboratory, California Institute of Technology, California, USA, (2) Applied Physics Laboratory, Maryland, USA, (3) RSSD, ESA/ESTEC, The Netherlands, (4) Arizona State University, Arizona, USA, (5) University of Leister, United Kingdom, (6) Imperial College, United Kingdom, (7) University of Nantes, France

Abstract

Science to be addressed by the Europa Jupiter System Mission (EJSM) would advance our understanding of potentially habitable worlds around gas giants. The tour phase of the mission would include detailed investigations of Europa and Ganymede by JEO and JGO to better understand these worlds in the context of the Jupiter system, and to understand Jovian system processes. Significant opportunities would be provided for complementary and synergistic science in the areas of magnetosphere studies, Jupiter atmosphere monitoring, satellite remote sensing, and rings and small moons studies. Unique science to be achieved by the simultaneous operation of two spacecraft in the Jupiter system includes characterization of the spatial and temporal variability of the magnetic field, atmospheric and ring studies through spacecraft-to-spacecraft radio occultations, and both satellite and Jupiter remote sensing incorporating a range of viewing geometries.

1. Introduction

The Europa Jupiter System Mission (EJSM) is a joint mission under study by NASA and ESA with the overarching theme: *The emergence of habitable worlds around gas giants* [1,2]. This mission would consist of two major flight elements, the NASA-led Jupiter Europa Orbiter (JEO) and the ESA-led Jupiter Ganymede Orbiter (JGO). Aiming for an energetically very favorable launch opportunity in 2020, the specific science to be achieved centers around three goals: (1) Explore Europa to investigate its habitability (JEO-focus); (2) Characterize Ganymede as a planetary object including its potential habitability (JGO-focus) and (3) Explore the Jupiter system as an archetype for gas giants (JEO + JGO). The last goal would be addressed primarily during the tour phase of the mission, lasting upwards of 2.5-years, whereby each spacecraft would perform multiple Galilean satellite fly-bys and make measurements of Jupiter and the Jupiter system. Over the past year, analyses have been carried out to clearly define the tour science objectives and to characterize the types of observations that might be performed.

2. Jovian Tour Observations

Prior to entering orbit at Europa (JEO) and Ganymede (JGO), both EJSM spacecraft would perform a coordinated tour of the Jupiter system with the following objectives: (1) Study the Jovian atmosphere; (2) Study the Jovian magnetosphere; (3) Study the Jovian satellite system (with focus on Io and Callisto); and (4) Study the rings and small satellites. To achieve these objectives, we have examined a variety of observations scenarios.

The EJSM Jupiter tour provides abundant opportunities to perform Jupiter system science. As a first step in generating a tour observation timeline, an assessment was made of the different types of observations that might be carried out to achieve the science. These include fields and particles/magnetometer observations; Jupiter atmosphere monitoring; Io monitoring (*e.g.* Io in Jupiter shadow; systematic plume searches as a function of longitude, etc.); spacecraft-to-spacecraft radio occultations of various targets; Galilean satellite flybys; and distant observations of the Galilean moons, small moons, and rings.

Our analysis has shown that within a practical allocation of spacecraft resources, it would be possible to accomplish significant objectives pertinent to advancing the scientific understanding of the Jupiter system. For example, fields and particles/magnetometer measurements could be carried out nearly continuously, providing unique multipoint measurements of the time-dependent three-dimensional structure of the magnetosphere. In terms of understanding the structure and dynamics of

the Jupiter atmosphere, it would be possible to perform long-duration (20+ hours) observations over regular periods throughout the tour to monitor weather and understand the behavior of individual storm systems. In a similar manner, regular monitoring of volcanic activity at Io would make it possible to assess the variability in levels of volcanic activity, characterize plume structure, and aid in determining heat flow and transport. Unique spacecraft-to-spacecraft radio occultation experiments would provide a breakthrough technique for studying Jupiter's atmosphere and tenuous rings. Two spacecraft Jupiter radio occultation experiments would for the first time permit observations at a broad range of local solar times, rather than being constrained to the terminator (Figure 1). Imaging of the Galilean satellites, with emphasis on Callisto (JGO) and Io (JEO) during multiple fly-bys would complete and augment (through different viewing geometries and capabilities) surveys begun by the Voyager and Galileo spacecraft.

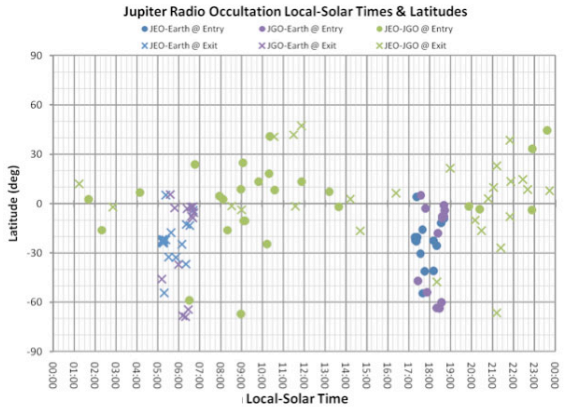

Figure 1. Two spacecraft radio occultations greatly increases the latitudinal coverage of Jupiter.

The ultimate tours that JEO and JGO would fly have not yet been defined, but sample tours have been prepared. Figure 2 provides an example of surface coverage that could be achieved by visible imaging from a single spacecraft (JGO) compared to combined JGO+JEO imaging coverage. Through careful selection of a tour, it would be possible to optimize surface coverage, as traded against other science objectives. Multiple fly-bys of a given target would allow access to a wide variety of terrains for compositional and three-dimensional morphological studies, crater statistical analyses, sub-surface profiling, and geophysical characterization of the interior structure including subsurface oceans.

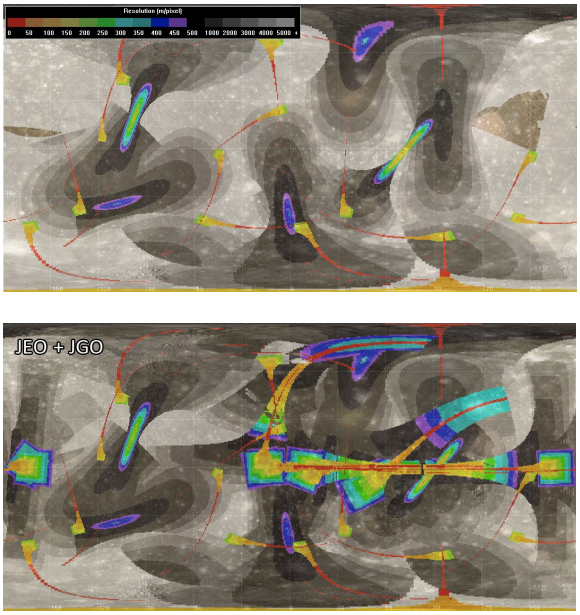

Figure 2: Observation scenario for visible remote sensing of Callisto. (Top) JGO ground tracks and image resolution for notional wide and narrow angle cameras (colored footprints indicate resolutions better than 500 m/pixel). (Bottom) Potential for combined JGO and JEO coverage. Data from both flight elements would allow global coverage of over 50% of the surface at better than 1.0 km/pixel.

3. Conclusions

Operation of two spacecraft in the Jupiter system would provide unique opportunities to address high-priority science outlined by the NASA Decadal Survey and the ESA Cosmic Vision for outer planets exploration. Science achieved during the tour phase of EJSM would provide context and a comparative planetological basis for the investigations that would take place when JEO and JGO are in orbit around Europa and Ganymede, respectively. Taken in its entirety, the EJSM mission concept provides a powerful approach to understanding the emergence of habitable worlds around gas giants.

References

[1] Jupiter Europa Orbiter, JPL Document, D-48297, 2008.
[2] Europa Jupiter System Mission, Joint Summary Report, JPL Document, D-48440, 2008.