

THE AERIAL REGIONAL-SCALE ENVIRONMENTAL SURVEY (ARES) MISSION TO MARS: J.S. Levine¹ and the ARES Science and Engineering Teams. ¹NASA Langley Research Center, Hampton, VA, 23681-2199 (joel.s.levine@nasa.gov).

Summary: ARES is an exploration mission concept for an Aerial Regional-scale Environmental Survey of Mars designed to fly an instrumented platform over the surface of Mars at very low altitudes (1-3 km) for distances of hundreds to thousands of kilometers to obtain scientific data to address fundamental problems in Mars science. ARES helps to fill a gap in the scale and perspective of the Mars Exploration Program and addresses many key COMPLEX/MEPAG questions (e.g., nature and origin of crustal magnetic anomalies) not readily pursued in other parts of the exploration program. ARES supports the human exploration program through key environmental measurements and high-resolution contiguous data essential to reference mission design. Here we describe the major types of scientific goals, candidate instruments, and reference mission profiles.

Mission Summary: ARES is a proposed Mars Scout Mission designed to use an airplane platform to fly over the surface of Mars and make measurements of key science objectives. ARES extends and complements NASA's Mars Exploration Program (MEP) by returning benchmark measurements in three critical scientific themes: 1) Crustal Magnetism, 2) Near-Surface Atmospheric Chemistry and 3) Near-Surface Volatiles and Climate Change. These embody six primary science objectives:

1. High spatial resolution crustal magnetic survey and crustal magnetism source structure.
2. Evidence for near-surface volatiles.
3. Regional geological context.
4. Role of water vapor in the Mars atmospheric chemical cycle.
5. Chemical coupling between the atmosphere and surface.
6. Atmospheric chemical and isotopic composition and evolution.

ARES will provide fundamental scientific insight into the origin and evolution of magnetic fields, early planetary crustal formation processes, the role of water in the Mars atmospheric chemical cycle, Mars' volatile and climate history, and the viability of Mars as a biosphere conducive to past or present life.

ARES offers the opportunity to target and explore specific regions of highest scientific interest, returning previously unobtainable measurements from a vantage point ~1.5 km above the surface across hundreds to thousands of kilometers of diverse terrain.

ARES provides NASA with the opportunity to elicit an immediate and significant science response while inspiring the next generation of explorers through a large and complementary Education and Public Outreach (E/PO) effort.

Science Payload: A comprehensive suite of candidate science instruments provides critical, high-priority COMPLEX and MEPAG measurements:

- *Magnetometer:* Magnetic field with 2 km spatial resolution and 1 nT sensitivity.
- *Mass Spectrometer:* Atmospheric constituents measured in situ with 1 ppb sensitivity.
- *Neutron Spectrometer:* Assess distribution of near-surface water at high resolution and in geological context.
- *Ionizing Radiation Detector:* Provide measurements supporting the human exploration program.
- *Atmospheric Data System:* Regional-scale pressure, temperature, density and wind.
- *Context Camera:* Contiguous imagery of science traverse over 3 km horizontal swath.
- *Video Camera:* Video rate imagery of critical deployment events, aerial platform and science traverse.

Science Advancements: ARES science objectives, measurement requirements and data products flow directly from NASA's strategic plan for Mars Exploration, the COMPLEX and MEPAG reports. ARES' science return is derived from orders of magnitude improvement in spatial resolution and precision.

- Two orders of magnitude higher spatial resolution magnetic survey than provided by Mars Global Surveyor (MGS), with the ability to resolve the crustal magnetism source structure.
- Orders of magnitude better Neutron Spectrometer resolution and correlation with geology.
- Search for methane and other short-term species in the atmosphere of potential biological or volcanological origin [e.g., 1].
- First direct measurement of near-surface water vapor and chemically active gas concentrations.
- More than one order of magnitude higher precision isotopic ratio measurement than Viking Landers.

Mission Architecture: ARES implementation includes robust technical margins and flight proven systems to achieve flexibility and success. The ARES mission delivers an airplane to Mars with a spacecraft derived from Genesis heritage, and an entry and descent system derived from Pathfinder and Mars Exploration Rover. The rocket-propelled airplane autonomously completes a pre-planned, inertially-navigated science traverse. Science and critical event data is relayed to the ARES spacecraft as it performs a Mars flyby and is returned to Earth within 18 hours of the airplane flight through the 34 m DSN subnet. All data is disseminated and archived within 6 months of receipt.

A Reference Mission:

Launch Vehicle: Delta 2925

- Launch Dry Mass: 522 kg
- Launch Wet Mass: 678 kg wet (35% margin)

Mission Design:

- Flyby spacecraft design and operations
- Direct entry trajectory
- Critical events link margin: 7 dB
- Airplane to S/C link margin: 12 dB
- S/C to Earth link margin: 3 dB

Airplane

- Mass: 66.5 kg dry (32% reserve), 125 kg wet
- Altitude: 1.5 km AGL, Ground Speed: 140 m/s
- Wing span: 6.2 m
- Maximum Duration: 101 min
- Maximum Range: 850 km
- Peak Power Margin: 53%, Cost Reserve: 49%

Airplane Robustness: ARES airplane size allows:

- Use of traditional design, test and manufacturing techniques.
- Credible aerodynamic performance and stability predictions.
- Flight-proven systems and a large payload volume margin.
- A majority of the implementation risk to be contained in a single well-defined and testable event: airplane deployment.
- Robust stability and control margins to accommodate uncertainties in the Mars environment; large margin ensures delivery of a robust, flight qualified system.

References: [1] Formisano, V., S. Atreya, T. Encrenaz, N. Ignatiev, and M. Giuranna, Detection of methane in the atmosphere of Mars, *Science*, 306 (5702), 1758-1761, 2004.

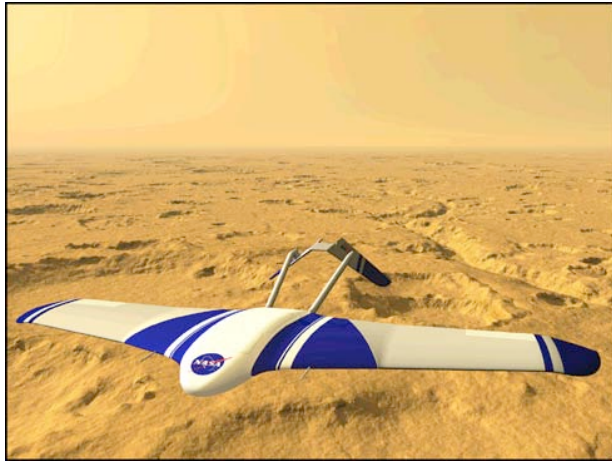


Figure 1. Artist's conception of ARES performing its survey over the surface of Mars



Figure 3. Video still from the successful deployment of a half-scale model of ARES at Mars-relevant atmospheric pressure above Oregon, USA (see <http://marsairplane.larc.nasa.gov/multimedia.html> for full sequence).

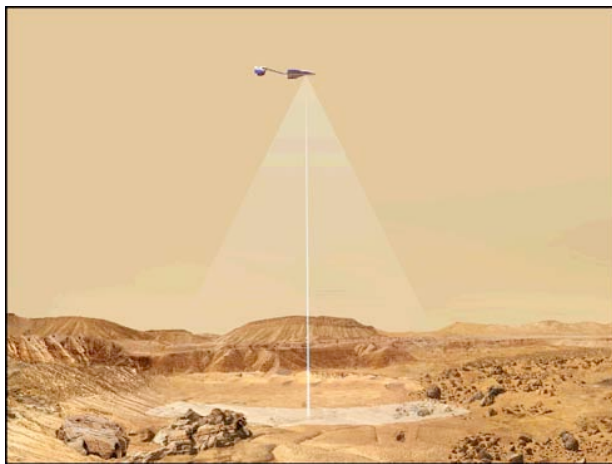


Figure 2. Artist's conception of ARES collecting data over the surface of Mars.

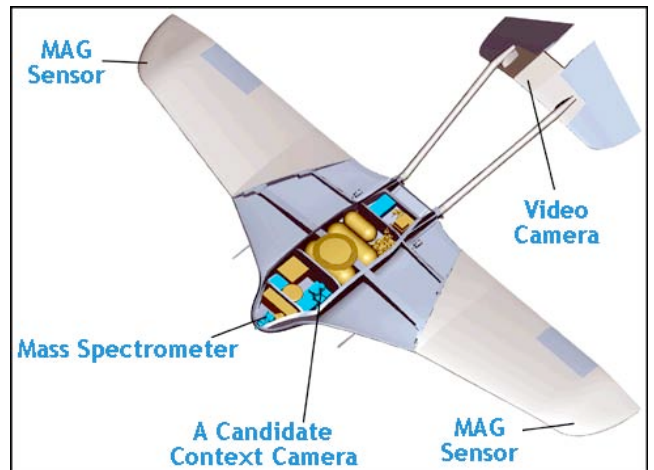


Figure 4. Scientific payload onboard ARES.

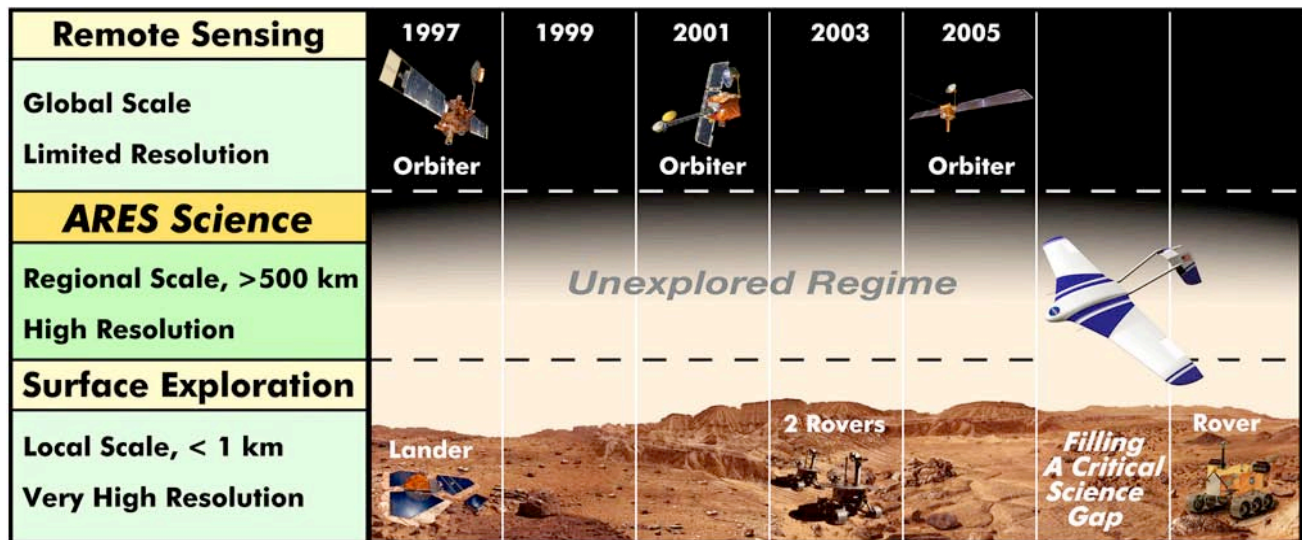


Figure 5. ARES bridges critical scale and resolution measurement gaps in the core MEP.