National Aeronautics and
Space Administration

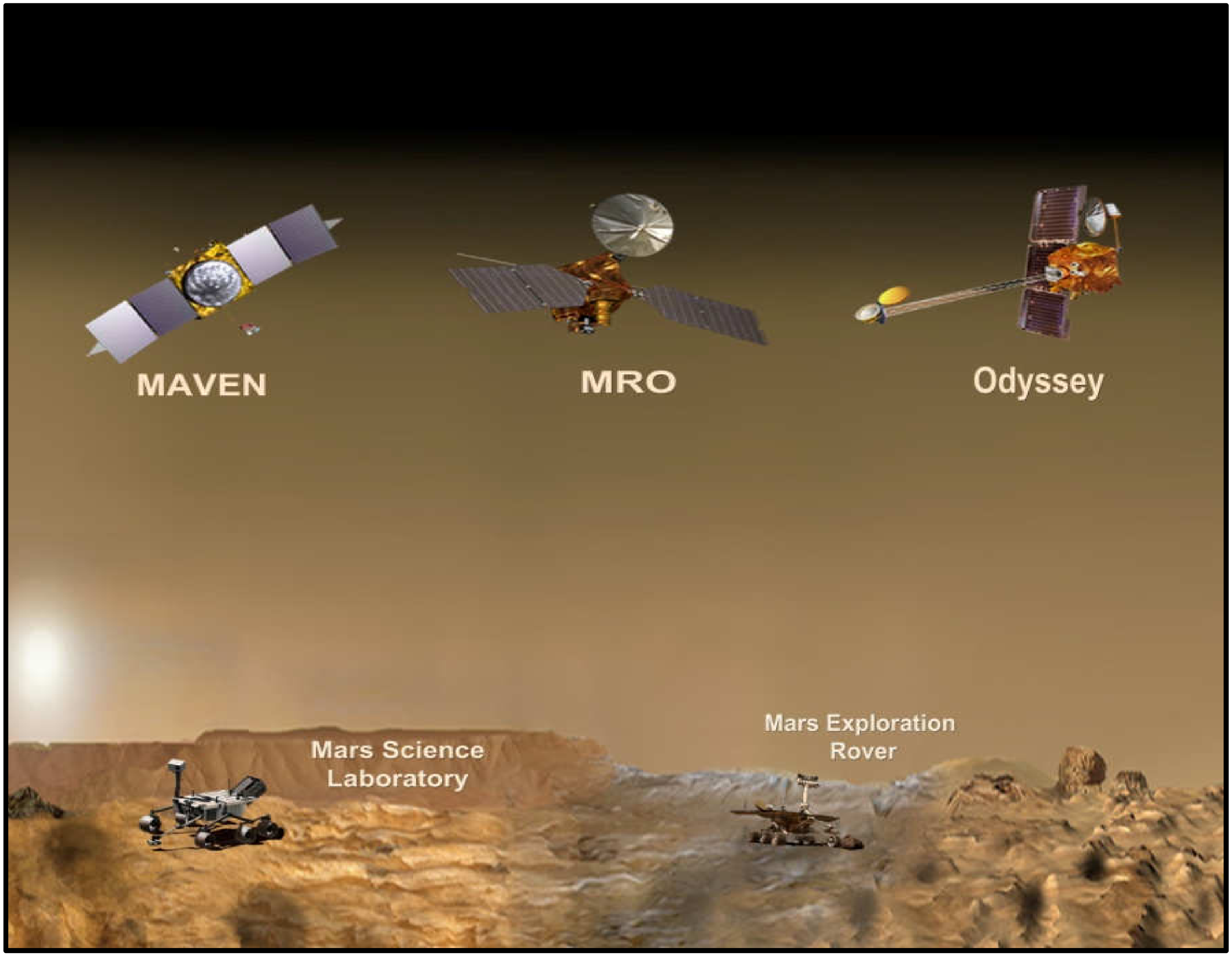
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

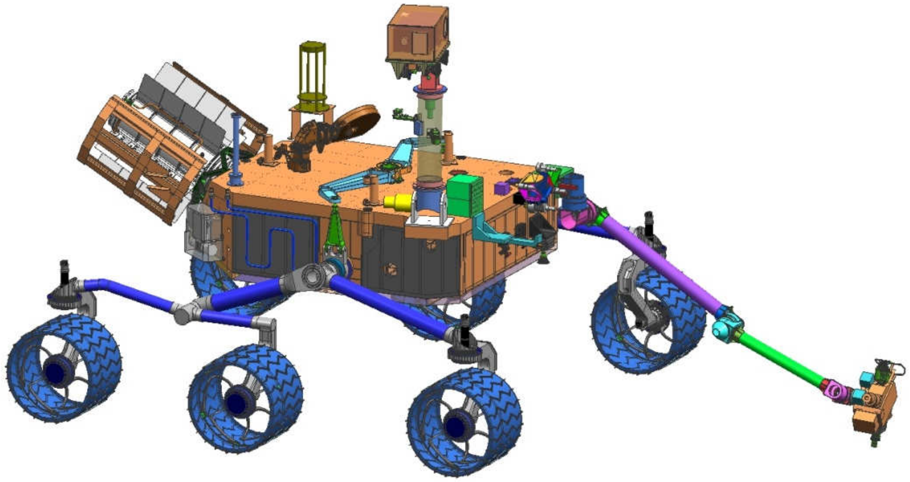
Presentation to MEPAG

F. Li

Feb 27, 2012

Mars Exploration Program





160 Days to Landing

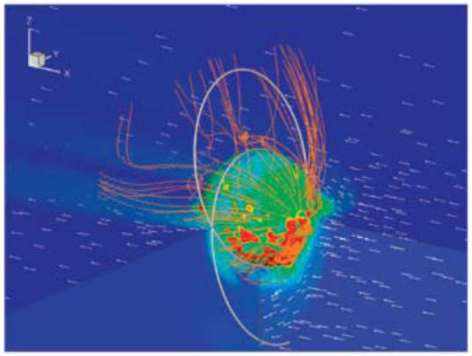
Gale Crater

August 5, 2012

10:32:13 pm (PDT)

- EDL Video

MAVEN Status and Plans



Mission Objectives

- Determine the role that loss of volatiles from the Mars atmosphere to space has played through time, exploring the histories of Mars' atmosphere and climate, liquid water, and planetary habitability
- Determine the current state of the upper atmosphere, ionosphere, and interactions with the solar wind
- Determine the current rates of escape of neutrals and ions to space and the processes controlling them
- Determine the ratios of stable isotopes that will tell Mars' history of loss through time

Mission Overview

- Obtain detailed measurements of the upper atmosphere, ionosphere, planetary corona, solar wind, solar EUV and SEPs over a 1-Earth-year period, to define the interactions between the Sun and Mars
- Operate 8 instruments for new science results:
  - Particles and Fields Package (6 instruments):
    - SWEA - Solar Wind Electron Analyzer
    - SWIA - Solar Wind Ion Analyzer
    - STATIC - Suprathermal and Thermal Ion Composition
    - SEP - Solar Energetic Particle
    - LPW - Langmuir Probe and Waves (with EUV detectors)
    - MAG - Magnetometer
  - IUVS - Imaging Ultraviolet Spectrometer
  - NGIMS - Neutral Gas and Ion Mass Spectrometer
- Fly 75°-inclination, 4.5-hour-period, 150-km-peria psis-altitude science orbit
- Perform five 5-day "deep dip" campaigns to altitudes near 125 km during the 1-year mission

Status and Plans

- Nov 2010 – Phase C/D start
- July 2011 – Mission CDR – passed
- Jan 2012 – Mission Ops/Ground System CDR – passed
- Apr-Aug 2012 – Instrument-package Pre-Environmental Reviews
- June 2012 – System Integration Review
- Aug 2012 – Start ATLO (Assembly, Test, and Launch Operations)
- Jan 2013 – Orbiter Pre-Environmental Review
- Aug 2013 – Operational Readiness Review & Pre-Ship Review

Launch

- On an Atlas V between November 18 and December 7, 2013
- Mars Orbit Insertion on September 22, 2014 (for Nov 18 launch)

Websites

- http://www.nasa.gov/maven
- http/lasp.colorado.edu/maven

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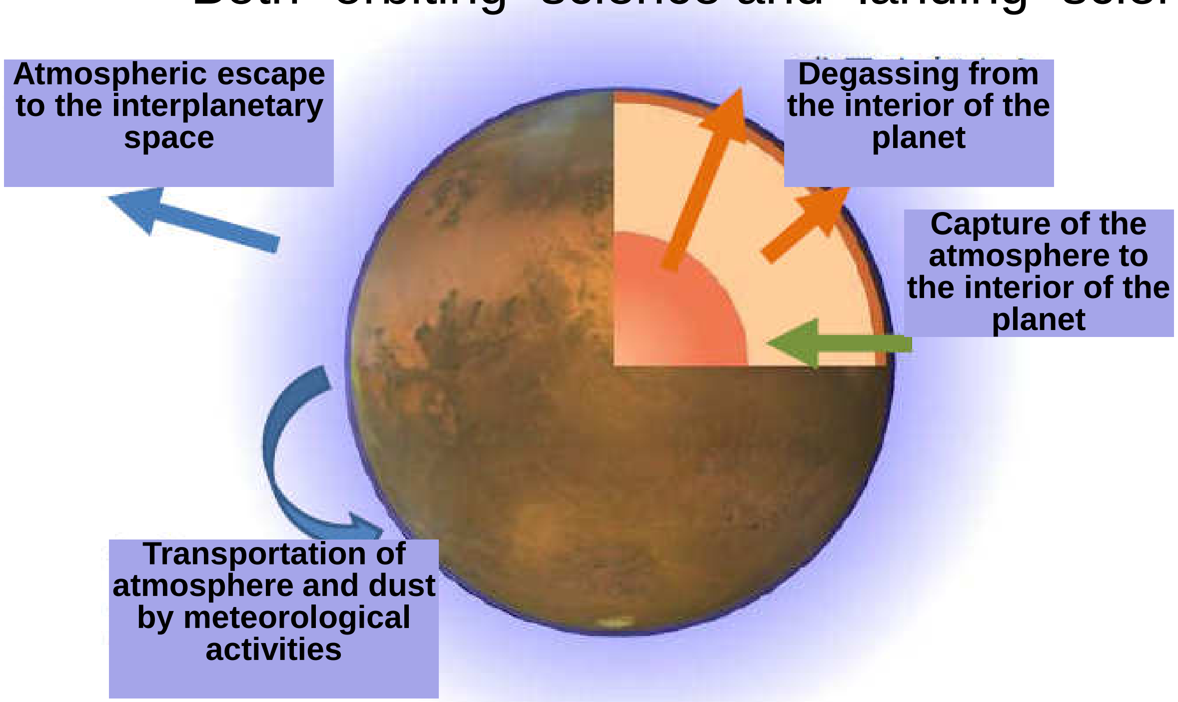
MELOS:
Japan's Mars Exploration Plan
~ Updates on MELOS1 ~

T. Satoh (JAXA)
and
MELOS Working Group

Mars
Exploration with
Lander-
Orbiter
Synergy

Science Target of MELOS

- Understanding the Martian System
  - Interior + surface + atmosphere + surrounding space
    - To understand the evolution and to answer the fundamental question “Why (and how) is Mars different from the Earth?”, missions designed to study inter-relations between these are needed.
    - Both “orbiting” science and “landing” science are important.



Keyword:
Why is Mars “red”?

Orbiter (A): Meteorology
Orbiter (B): Aeronomy
for **MELOS-1**

Lander (A): Surface
Lander (B): Biology
Lander (C): Interior
Lander (D): Sample Return
for **MELOS-1 EDL** and
for MELOS-2

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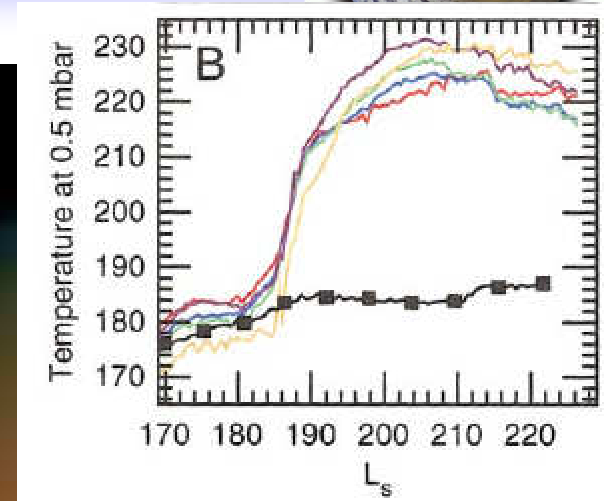
Dust Meteorology of Mars

Roles of the Martian dust:

- ➢Dust as the source of heating the atmosphere
- ➢Dust as an agent of chemistry
- ➢Dust as the surface albedo changer

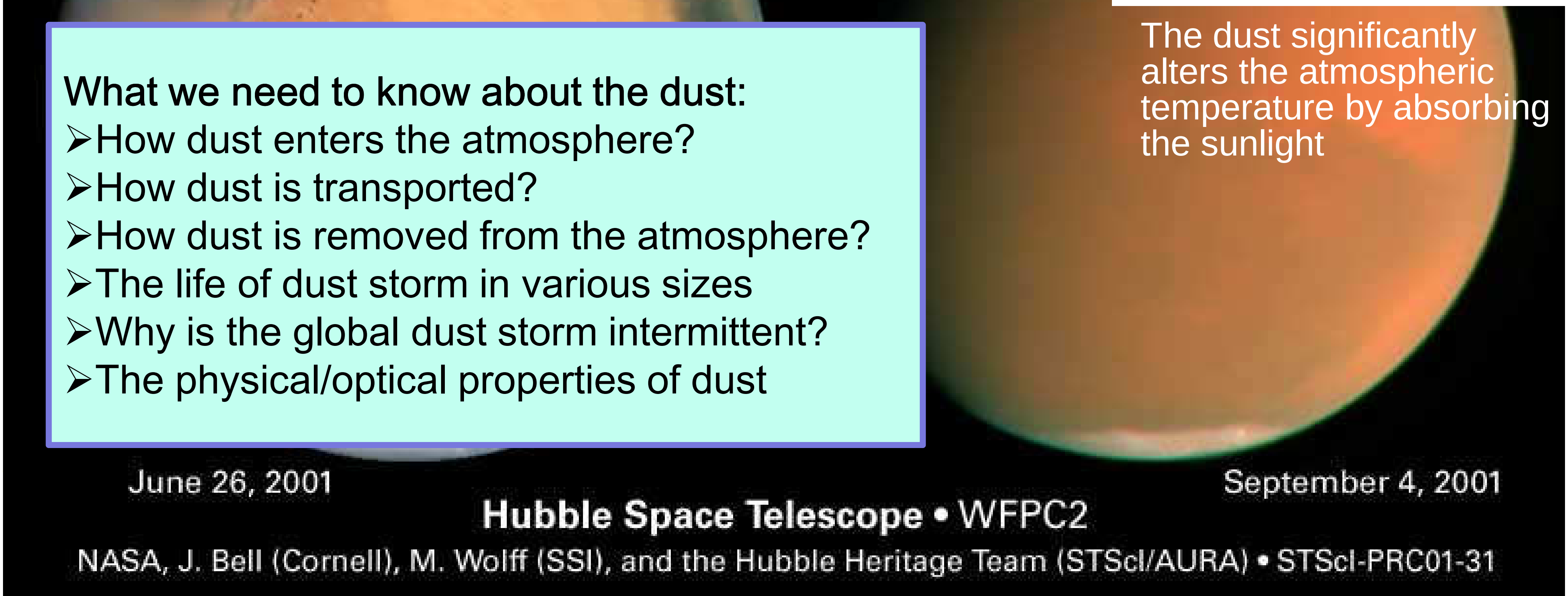
These are “what water does” on the earth!



The dust significantly alters the atmospheric temperature by absorbing the sunlight

What we need to know about the dust:

- ➢How dust enters the atmosphere?
- ➢How dust is transported?
- ➢How dust is removed from the atmosphere?
- ➢The life of dust storm in various sizes
- ➢Why is the global dust storm intermittent?
- ➢The physical/optical properties of dust



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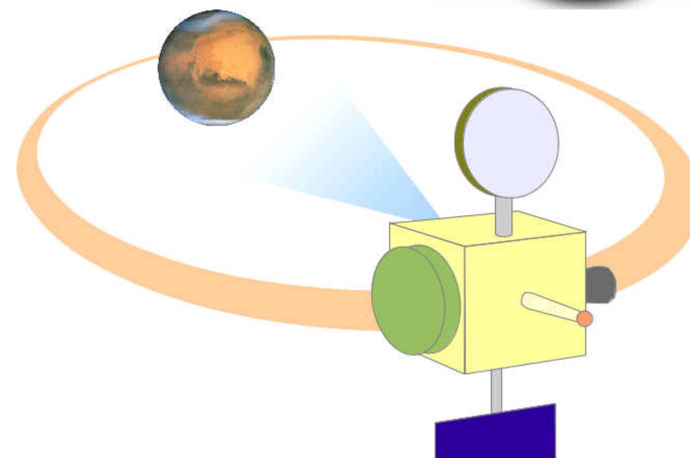
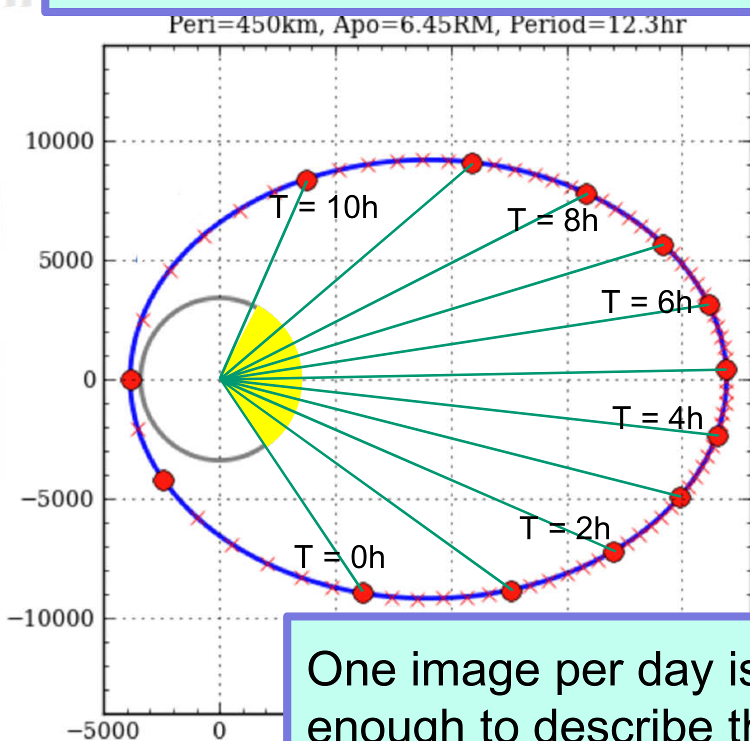
MELOS1 Utilizes a Unique Orbit

An “equatorial plane” orbiter:

- Pericenter = 3,847 km (450 km altitude)
- Apocenter = 21,912 km (6.45 R_M)
- Orbital period = 12.33 hours (1/2 sol)
- Inclination = 10º
- Rotation of the orbital axis = 0.5227º/day

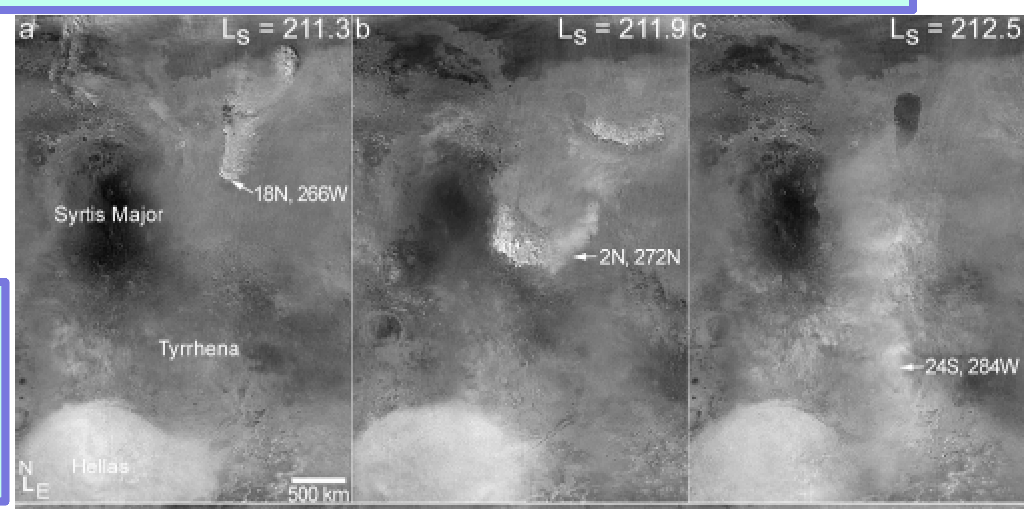
-> the apocenter’s local time can be fixed





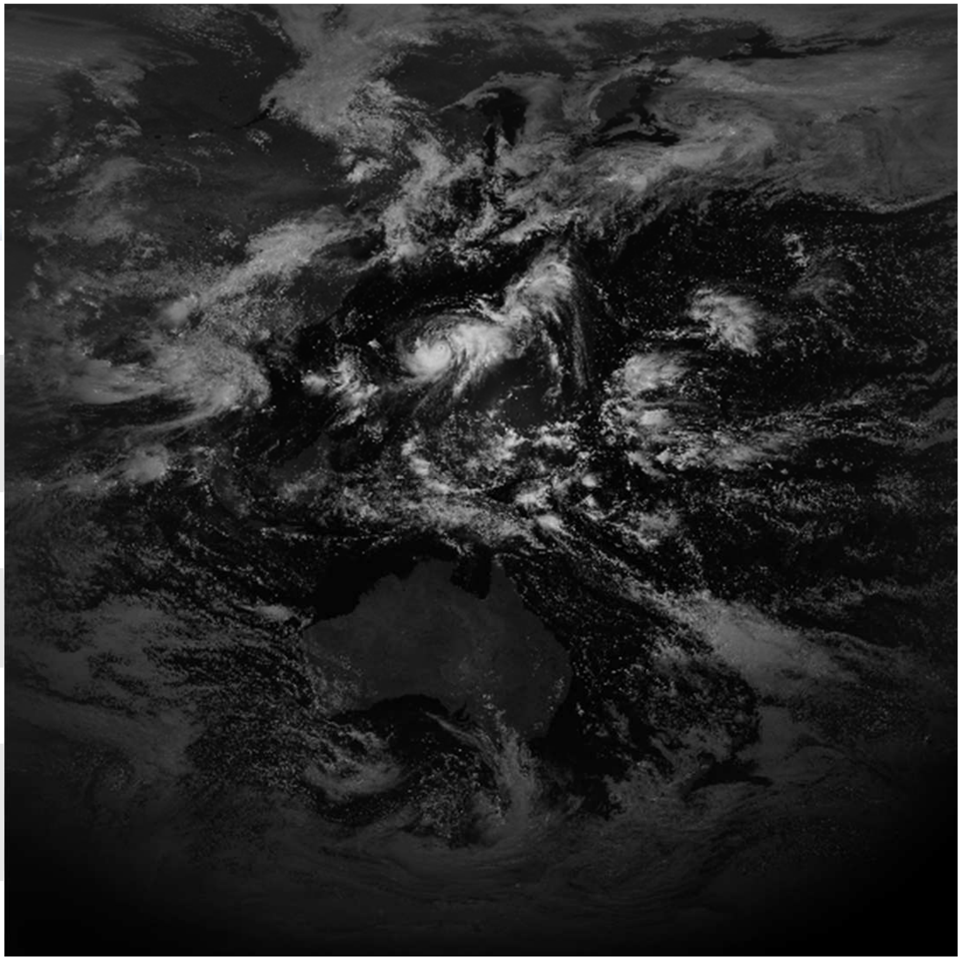
Heritage of “Akatsuki” Venus Climate Orbiter:

- Geostational meteorological satellite like orbit & on-board instruments
- Continuous monitoring of global activities

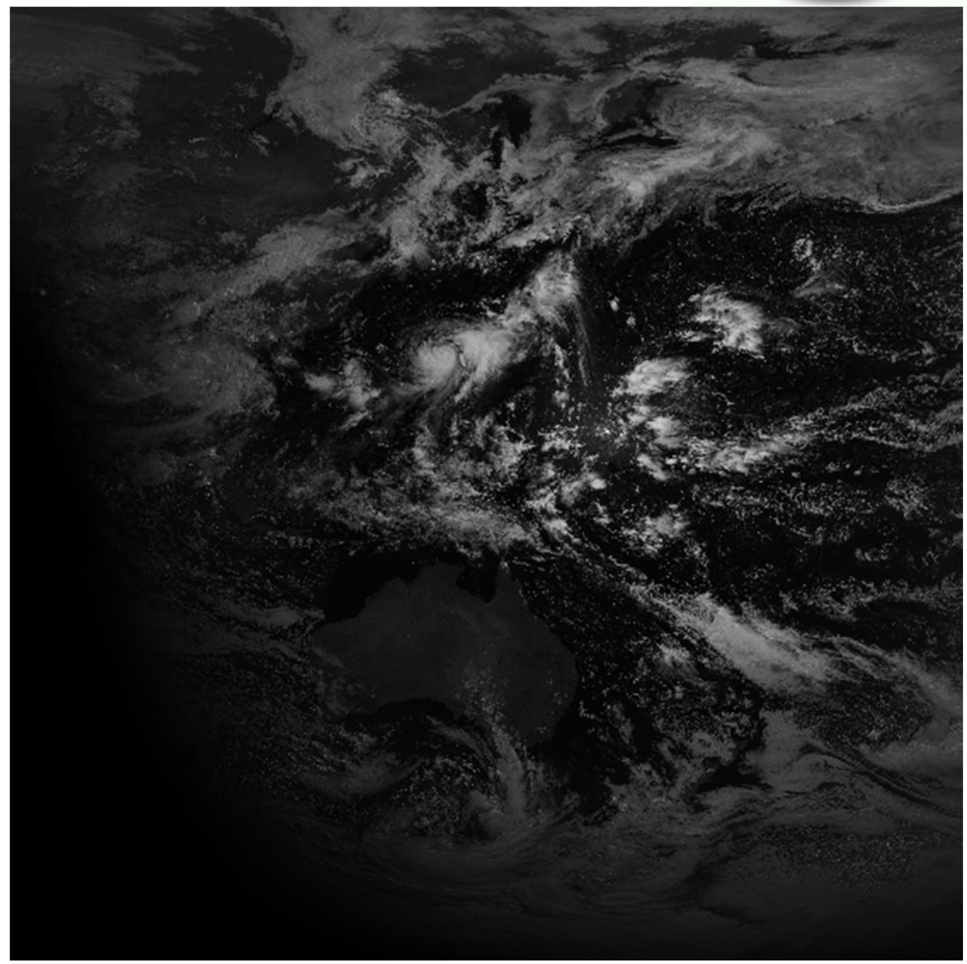


One image per day is not enough to describe the life of a dust storm.

Continuous Monitoring is Essential



This demonstrates what we can see if **only one image per day** is available.



This demonstrates what we can see if **one image every 2 hours** is available.

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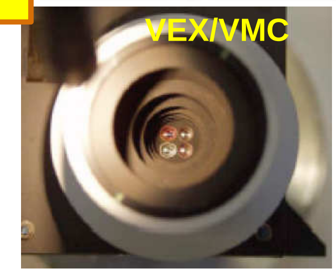
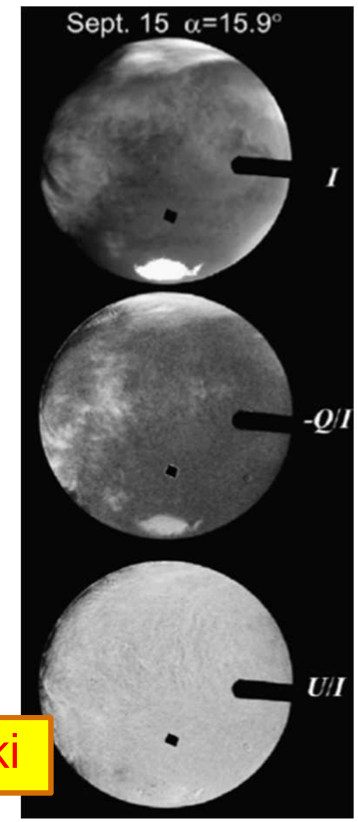
Currently-Proposed Orbiter Instruments

Mars Exploration with Lander-Orbiter Synergy

- **Simultaneous Imaging Polarimeter (SIMPLER)** Akatsuki
  - A multi-eye camera in visible wavelength that takes polarization images ($I \pm Q$, $I \pm U$) simultaneously, eliminating co-registration problems of sequential imaging.
  - The polarization phase curves for individual features can be drawn every orbit, identify the dust and the water (ice) cloud.



- **Narrow-Angle Camera (NAC)** NEW
  - A telescope camera that achieves 150 m/pixel resolution at sub-spacecraft point from the apocenter (5.45 R_M altitude).
- **Long-Wavelength Infrared Camera (LIR)** Akatsuki
  - The 10-μm thermal infrared imager to measure the suspended dust and the thermal inertia of the ground.
  - The limb images provide the vertical profiles of dust and its variability.

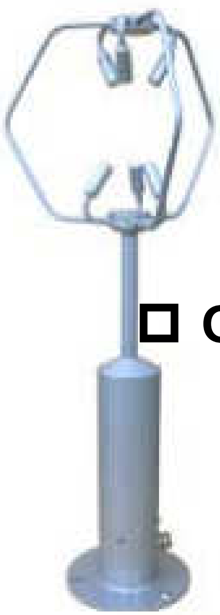


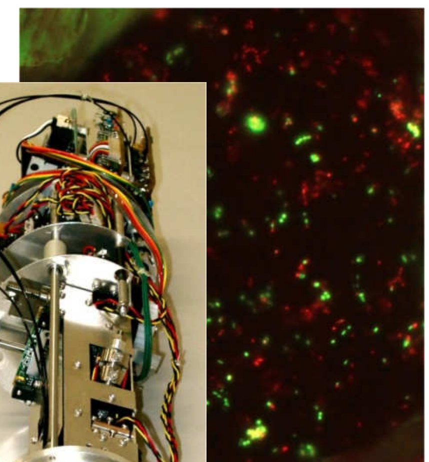
- **Sub-mm Sounder (FIRE)** NEW
  - A passive sounder that measures atmospheric temperature, wind velocity, abundances of trace gas species, etc.
- **Ultra-Stable Oscillator (USO) for Radio Science** Akatsuki
  - The same as that on board “Akatsuki” Venus Climate Orbiter.

EDL and Meteorology on the Ground

- MELOS1 EDL experiment
  - A **400-kg class EDL module** to experiment functions necessary for upcoming lander missions (MELOS2, etc.).
  - A **meteorological station** will collaborates with the orbiter
    - Temperature & pressure sensors (for the earth's stratospheric probes)
    - Near-surface wind velocity (turbulence) measurements with a supersonic sensors (optimized for the Martian atmospheric conditions)
    - A microscope to image the dust particles (their shapes and sizes)
    - A LIDAR to monitor the suspended dust above the lander
  - **Other "proposed" experiments**
    - "Search for Life" astro-biological experiment with a microscope and fluorescent technique
    - Study of internal structure with a ultra wide-range seismometer
    - Study of surface geology with a "miniature" LIBS (if the main part of EDL is a rover)

With a H-IIA 202 launch vehicle:
- ➢1.15 t to the mission orbit
- ➢500 kg orbiter (almost dry)
- ➢400 kg EDL (wet)
- ➢200 kg margin for flexibility





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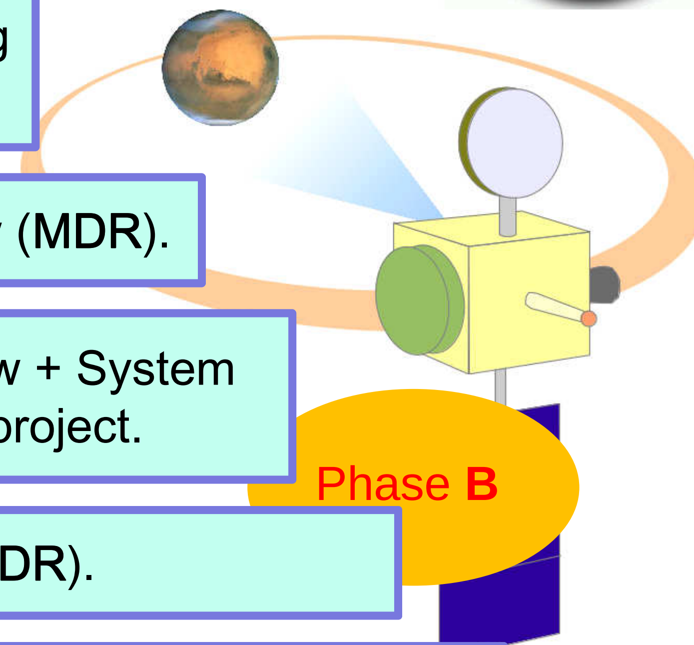
MELOS1 Schedule



Mars
Lander
Orbiter
Synergy

2012: Finalize the orbiter and EDL configurations, including the scientific experiments (instruments), by the summer.

Phase **A**

2013 spring: Go through the Mission Definition Review (**MDR**).

2014: Go through the System Requirement Review + System Definition Review and get approved as an official project.

Phase **B**

2016 summer: Preliminary Design Review (**PDR**).

Phase **C**

2018 spring: Critical Design Review (**CDR**).

Phase **D**

2020 spring: Flight operations at the launch site starts.

Phase **E**

2020: Launch in July and arrival at Mars in early 2021.
Nominal mission = 1 Martian year in the orbit
Possible extensions

International Collaboration of MELOS1

Mars Exploration with Lander-Orbiter Synergy

- We welcome your inputs
  - We still have many TBDs in MELOS1 plan. Suggestions and comments are welcome. “Simultaneous” observations with other missions would motivate us likely to choose a certain answer for a TBD.
- We welcome collaborators
  - Some of currently-proposed instruments will benefit from having collaborators with expertise through previous experience (development & operation of instrument; modeling and data analysis).
- We welcome instruments
  - Since MELOS1 provides opportunity of science with its unique orbit, contributed instruments are welcome if they benefit from this orbit.
- We provide what we can do
  - The communication relay for the landers/rovers will be provided (although the spacecraft altitude is much higher than other missions).
- We need your support
  - It is likely that the EDL will need somebody’s support during its critical operation. MOI of MELOS1 will also need support of multiple ground stations.

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Mars
Exploration with
Lander-
Orbiter
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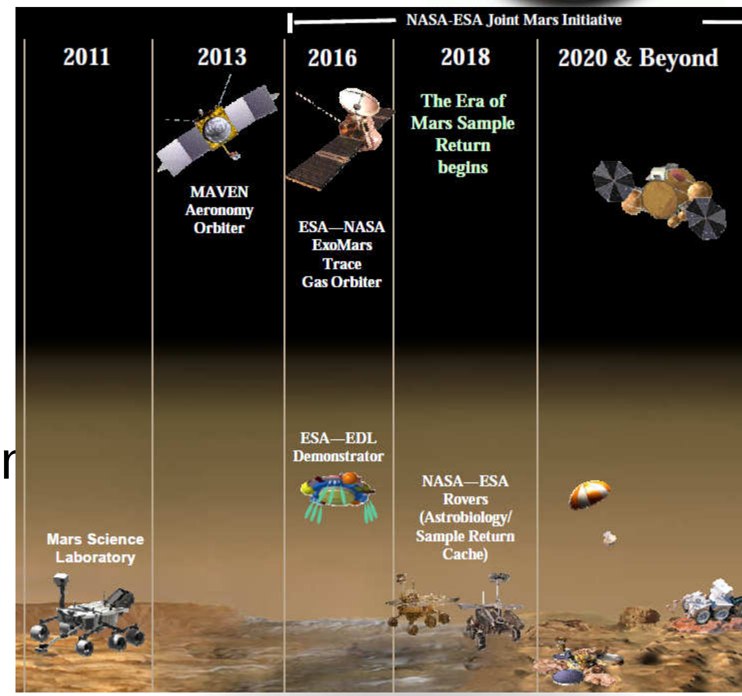
International Challenges to Mars

Mars Exploration with Lander Orbiter Synergy

- Launches in all possible windows
  - Sample return in late 2020's
    - NASA+ESA2016, 18
    - 2011: Curiosity (MSL) (USA)
    - 2013: MAVEN (USA)
    - 2011: Phobos-Grunt (Russia) + YH-1 (Chir
    - Indian Mars mission (2018?)



- Japan: NOZOMI (launch in 1998)
  - Failure before arrival at Mars
    - Then, we had HAYABUSA, KAGUYA, and AKATSUKI
    - 2014: BepiColombo Mercury mission with ESA
    - SPRINT-A/EXCEED (Earth-orbiting EUV telescope)
    - Plans of lunar, asteroidal, planetary missions
    - We challenge Mars, the planet like the Earth, with MELOS!