Observation opportunities for Mars atmosphere with the MIRS instrument aboard the Martian Moon eXploration mission

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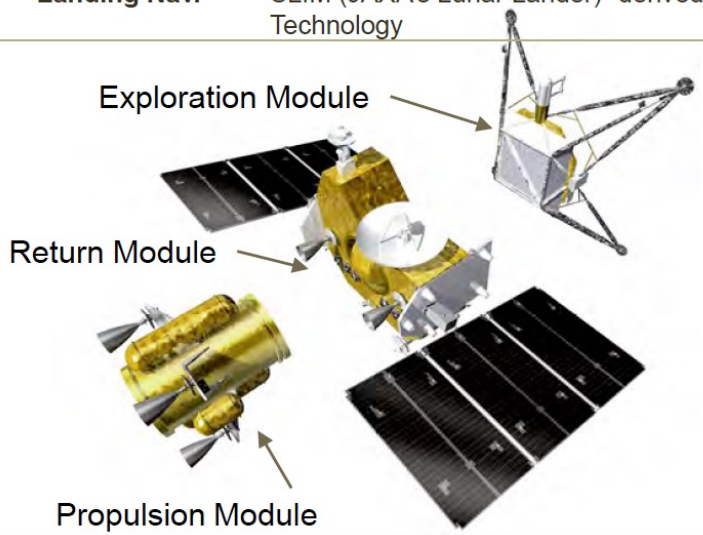
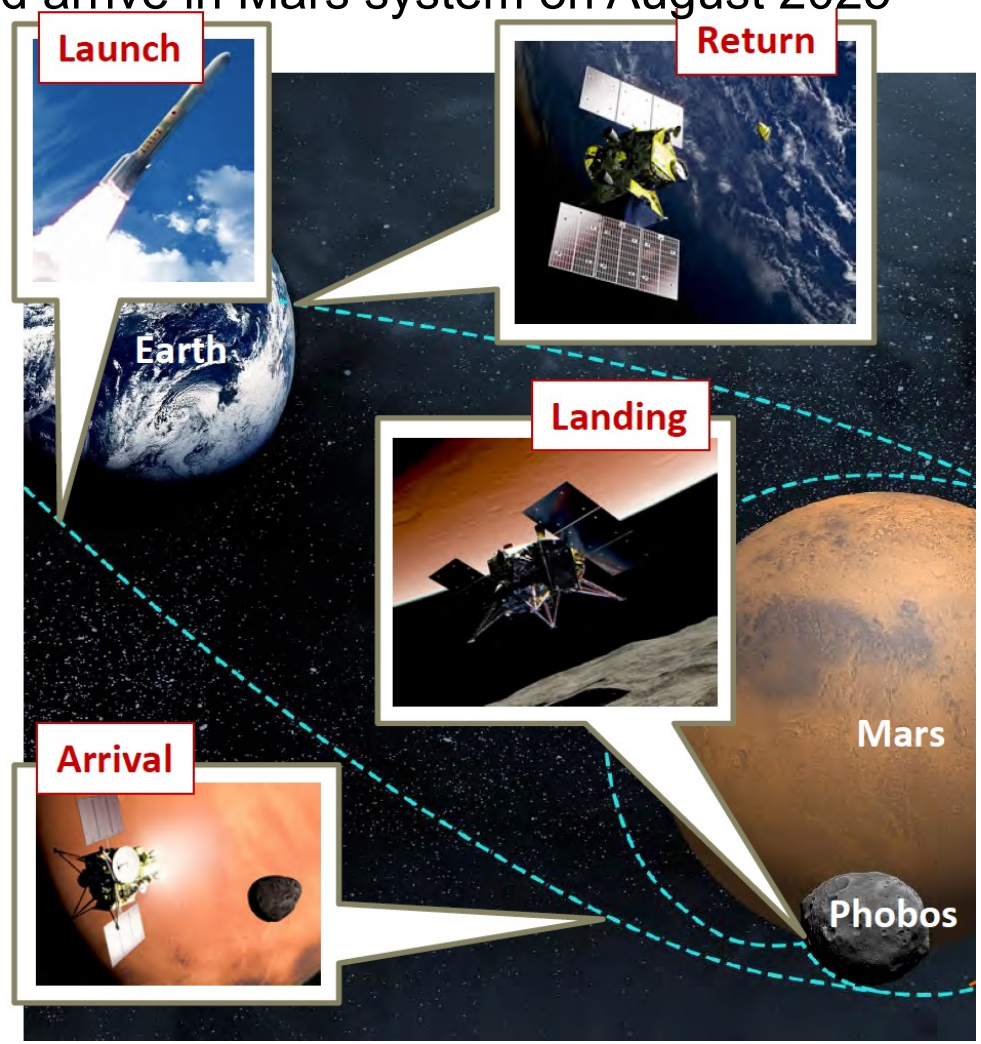
The Martian Moon eXploration mission (MMX)

The JAXA MMX mission will aim at studying Mars satellites and return samples from Phobos to decipher the history of the Martian system. A secondary goal will be the study of the Mars atmosphere.

It will be launched in September 2024 and arrive in Mars system on August 2025

Item	Spec.
Configuration	3 modules (Propulsion/EXploaration/Return)
Launcher	H3-24L Launch Vehicle
Launch Year	FY 2024
Duration	Nominal 5 years (max. 6 years)
Weight	4,000 kg
Propellant	Prop. module : about 1,600kg Return module : about1,050kg
Delta-V	about 5 km/s (total)
RF Link (at 2.7AU)	X-band : more than 32kbps Ka-band : more than 128kbps
Power	Super high efficiency thin-film solar cells
Landing Nav.	Image-based Navigation SLIM (JAXA's Lunar Lander) -derived Technology





MIRS (MMX InfraRed imaging Spectrometer)

Among the mission instrument suite is the near-Infrared Spectrometer MIRS (MMX InfraRed Spectrometer) provided by CNES and built at LESIA-Paris Observatory in collaboration with four other French laboratories (LAB, LATMOS, LAM, IRAP-OMP)

MIRS characteristics:

(Push-broom spectrometer)

- Spectral range: 0.9 – 3.6µm
- Spectral resolution (sampled) < 20 nm
- Spectral sampling: 10 (+/-10%) nm
- IFOV: 0.35 mrad
- FOV: ±1.65°
- SNR: ≥ 100 in 2.7-3.2 µm (in less than 2 sec integration)

Objectives for Martian atmosphere

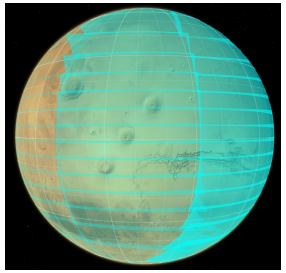
MO2.3.1 Impose constraints on dust and water transport processes in the Martian atmosphere and the processes of their exchange between the atmosphere and the surface through observations of the temporal changes in dust storms and the global distributions of water vapor and clouds.

To constrain transport processes for dust and water in the Mars atmosphere-surface system, MIRS is expected to observe characteristics of dust storms, ice clouds and water vapor columns at

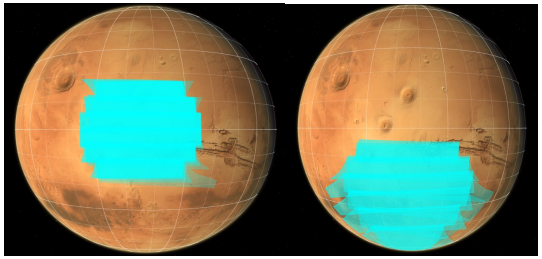
- **10 km spatial resolution**
- spectral radiometric absolute accuracy 10%
- spectral radiometric relative accuracy 1%
- **temporal resolution less than 1-hour for the mid- to low-latitude selected areas.**

These observations are expected to be performed over several successive days in different seasons.

Monitoring mode for complete coverage (alt. = 6000km→pixel footprint ~2.1 km). MIRS will cover the global day light Mars hemisphere, in a few days



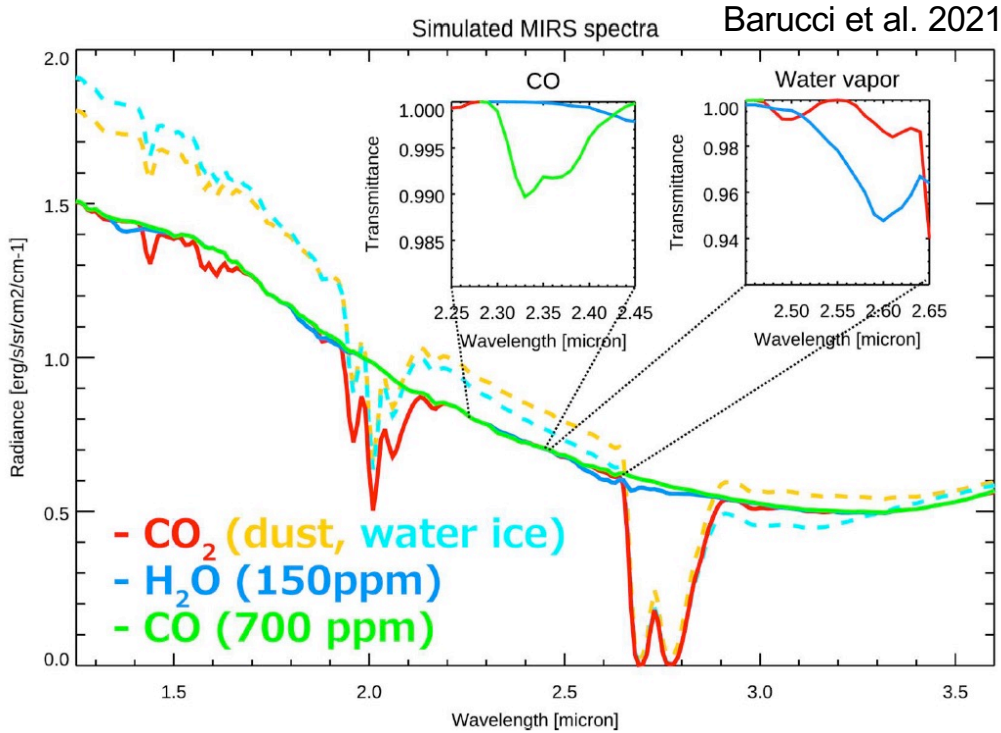
Mars Tracking strategy allows to observe several times a zone of interest



Expected Mars observations by MIRS

Target	Parameters	Spectral range
Ice cloud formation and evolution	Water ice clouds	1.5, 2 and 3 µm bands
Dust clouds/storms formation and evolution	Dust	CO_2 2.7 µm bands or 0.9-3.6 µm
Water cycle	H_2O	2.6 µm band
Atmospheric composition and dynamics	Surface pressure	CO_2 2.0 µm band
	CO	2.3 µm band
Limb observations for middle atmosphere	O_2 day-glow (water index)	1.27 µm band

Barucci et al. 2021



Expected features of the Mars atmosphere observed by MIRS. A typical condition of Mars atmosphere is assumed. The surface albedo of Mars is assumed to be 0.15 (uniform). For gases, CO_2, CO, and water vapor are calculated separately (red, orange, and blue curves, respectively).

Conclusion and references

In summary, MIRS observations, together with the other instruments MSA, OROCHI and TENGOO, will help better understand the interdependencies of species and their roles in the Martian water, CO_2 and dust cycles, thanks to long term monitoring of these key constituents of Mars atmosphere.

Acknowledgements

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