CENTRO DE ASTROBIOLOGÍA

ASOCIADO AL NASA ASTROBIOLOGY INSTITUTE

CSIC INTA

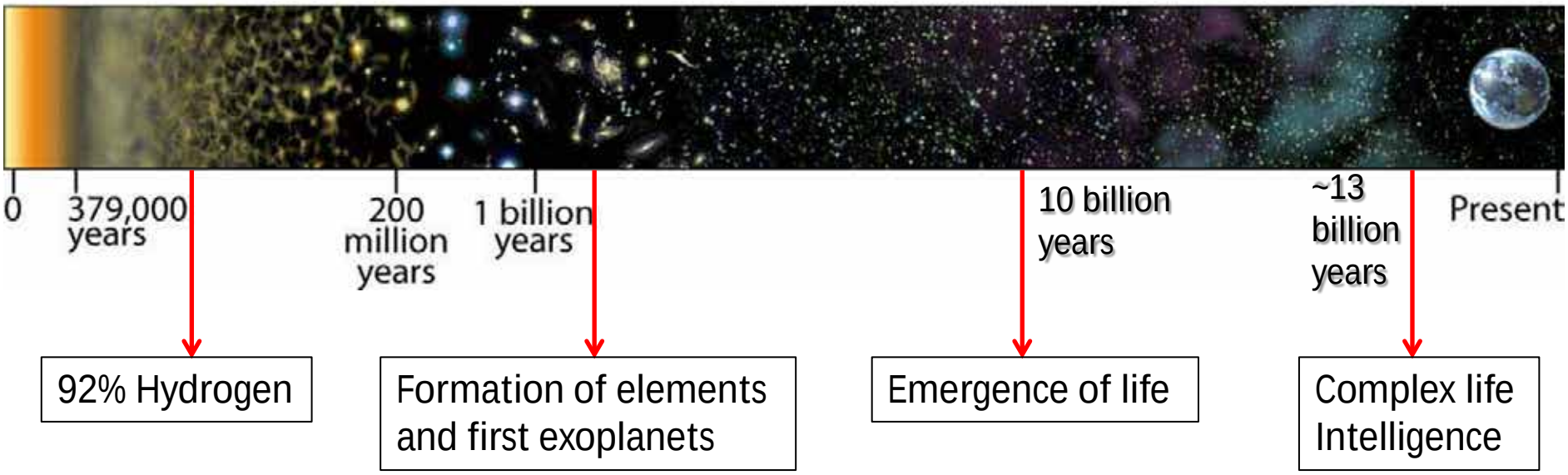
Center for Astrobiology

The origin of life and the evolution of the Universe

CAB: Center for Astrobiology

Understanding the origin and evolution of life along the history of the Universe

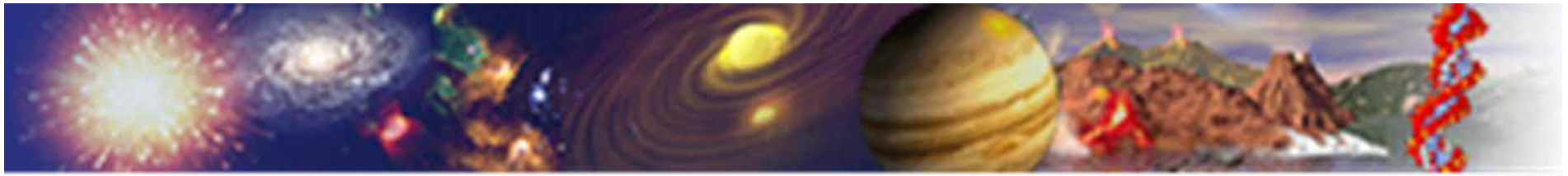
- How, where and when did life emerge?
- How did it evolve towards intelligence and consciousness?
- What is the future of life on Earth and beyond?



CAB: Center for Astrobiology

Transdisciplinary approach

- Astrophysics
- Geology/Planetology
- Biology/Biochemistry
- Planetary exploration
- Simulation chambers
- Engineering



CAB: Center for Astrobiology

- Founded in 1999 as a joint institute INTA + CSIC
  - Close collaboration with the INTA technical laboratories, specially for the development of space missions.
  - Multidisciplinary scientists formed within CSIC.

- Since 2000 associated to the NASA Astrobiology Institute

Departments and groups

- Astrophysics:
  - Formation and evolution of galaxies
  - Interstellar and circumstellar medium
  - Formation and evolution of stars, brown dwarfs and planets
  - Virtual Observatory and astronomical archives

- Planetology and habitability:
  - Planetary geology and atmospheres
  - Habitability
  - Extremophiles and extreme environments

Departments and groups

- Molecular evolution:
  - Biomolecules in planetary exploration
  - Molecular evolution and genomics
  - Prebiotic chemistry
  - Molecular mechanisms of the biological adaptation

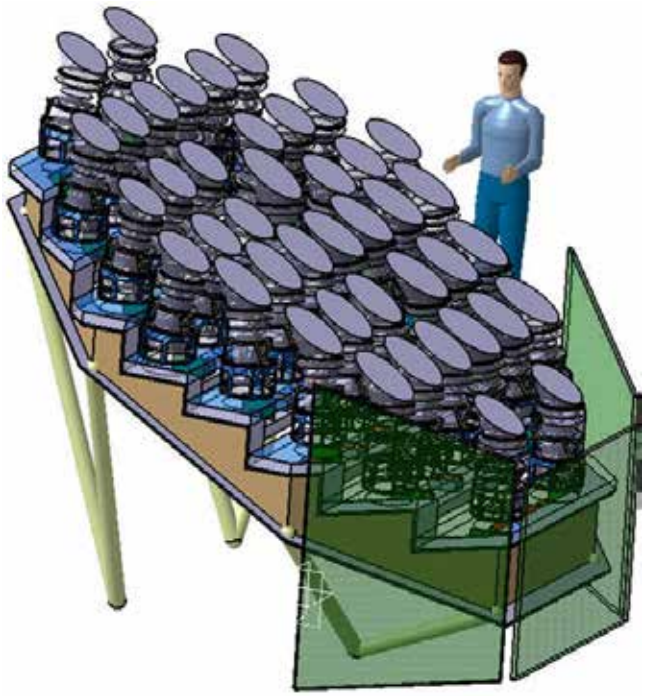
- Instrumentation:
  - Space instrumentation
  - Simulation chambers

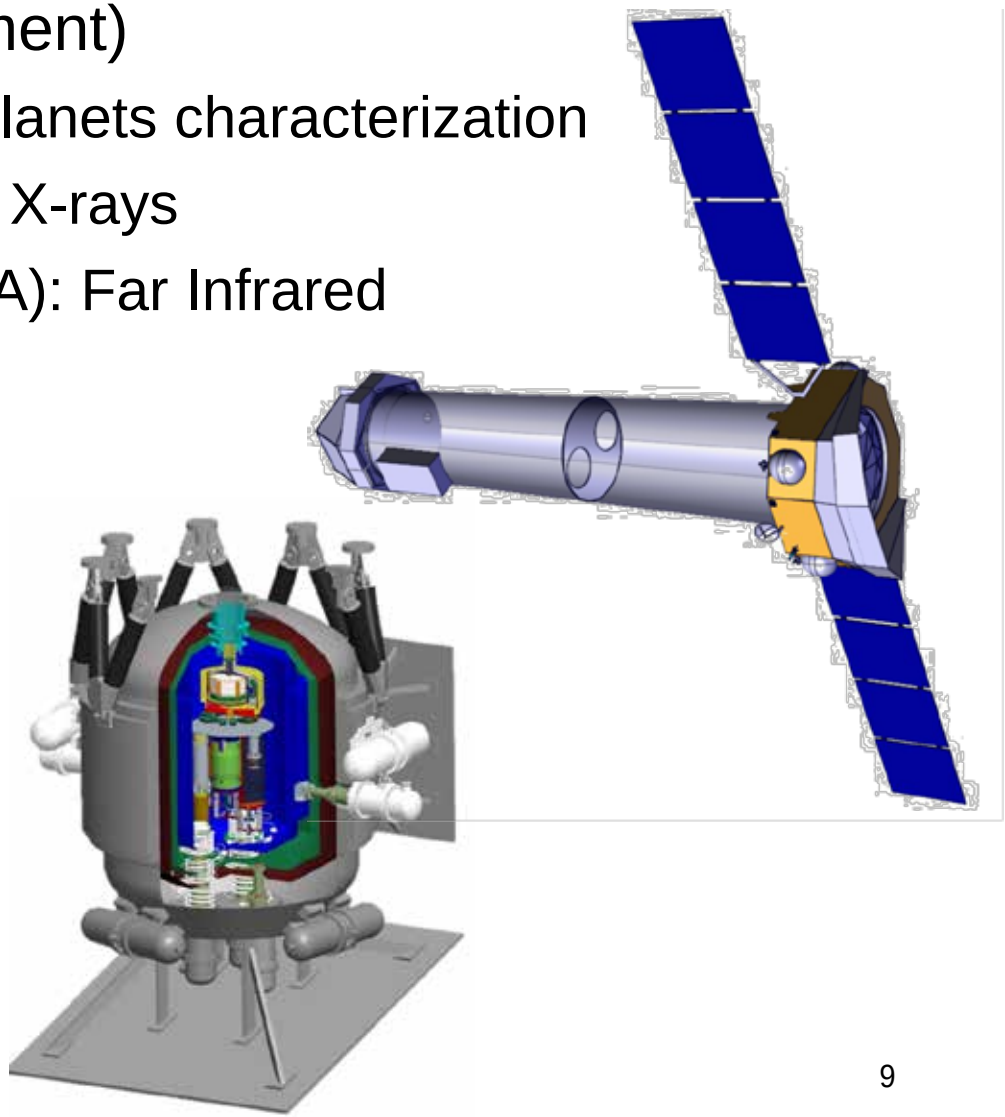
Simulation chambers

- Mars environment simulation chamber
- High pressure planetary chambers
- Planetary atmosphere and surface chamber
- Interstellar astrochemistry chamber
- Cryogenic vacuum chamber for detector testing
- Projectile impact facility

Space missions

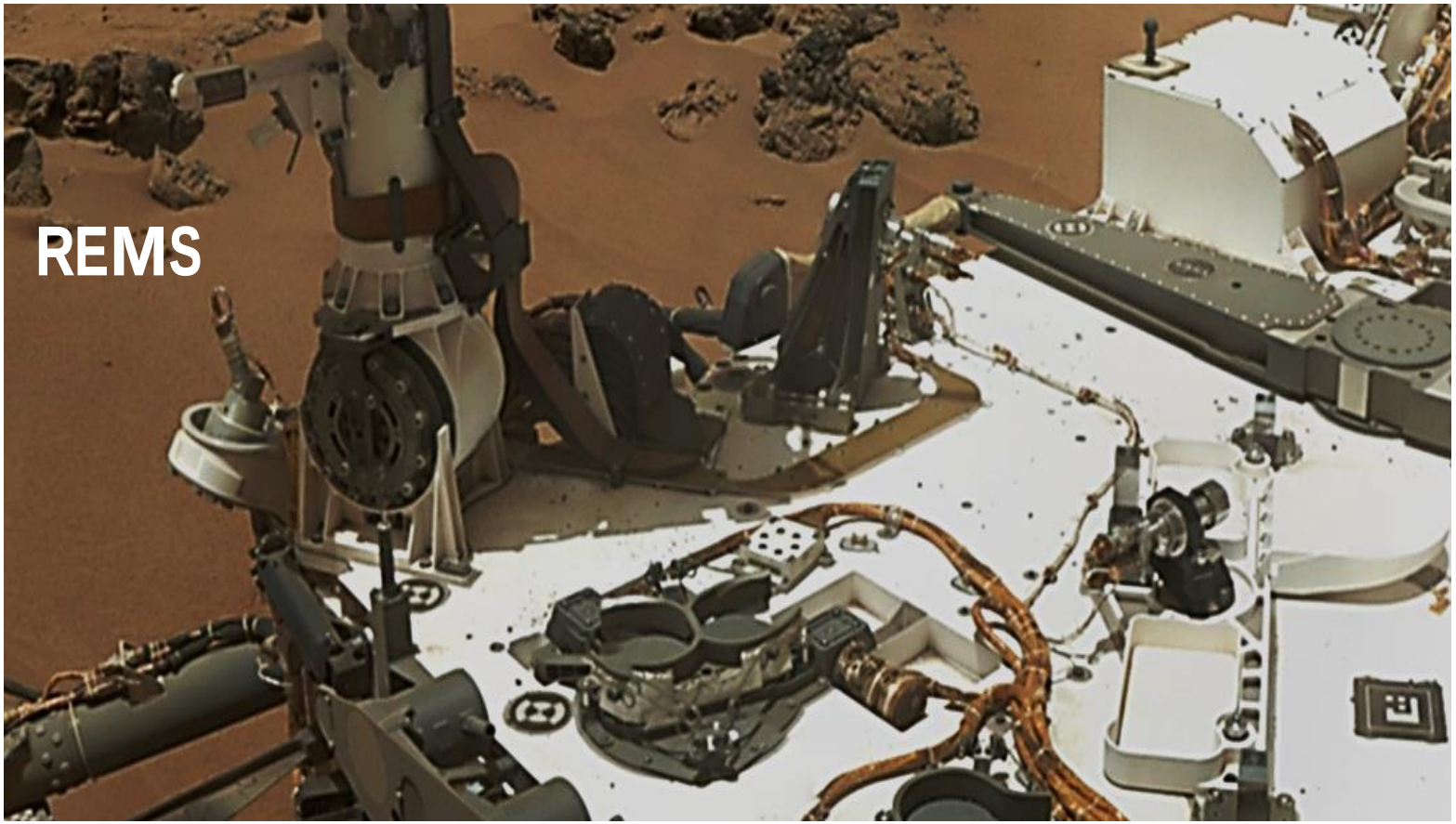
- Astrophysics (in development)
  - PLATO (M3 ESA): exoplanets characterization
  - X-IFU/Athena (L2 ESA): X-rays
  - Safari/SPICA (ESA-JAXA): Far Infrared

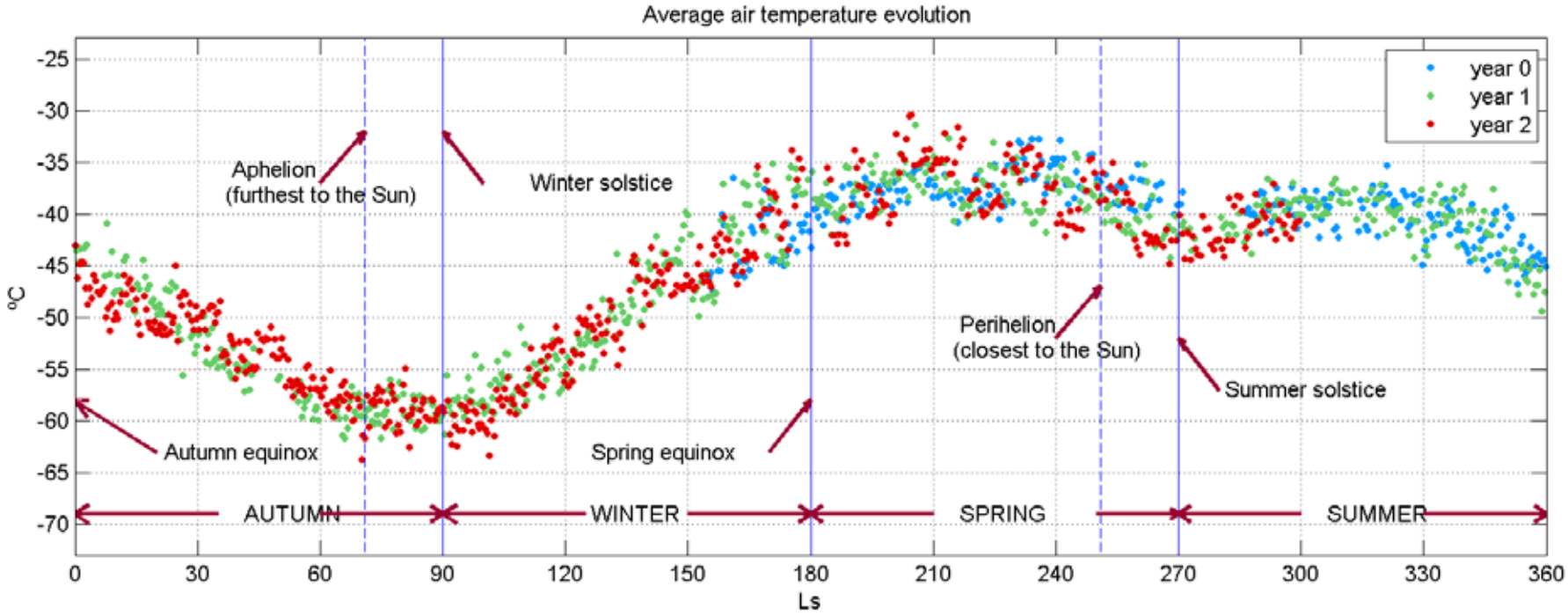


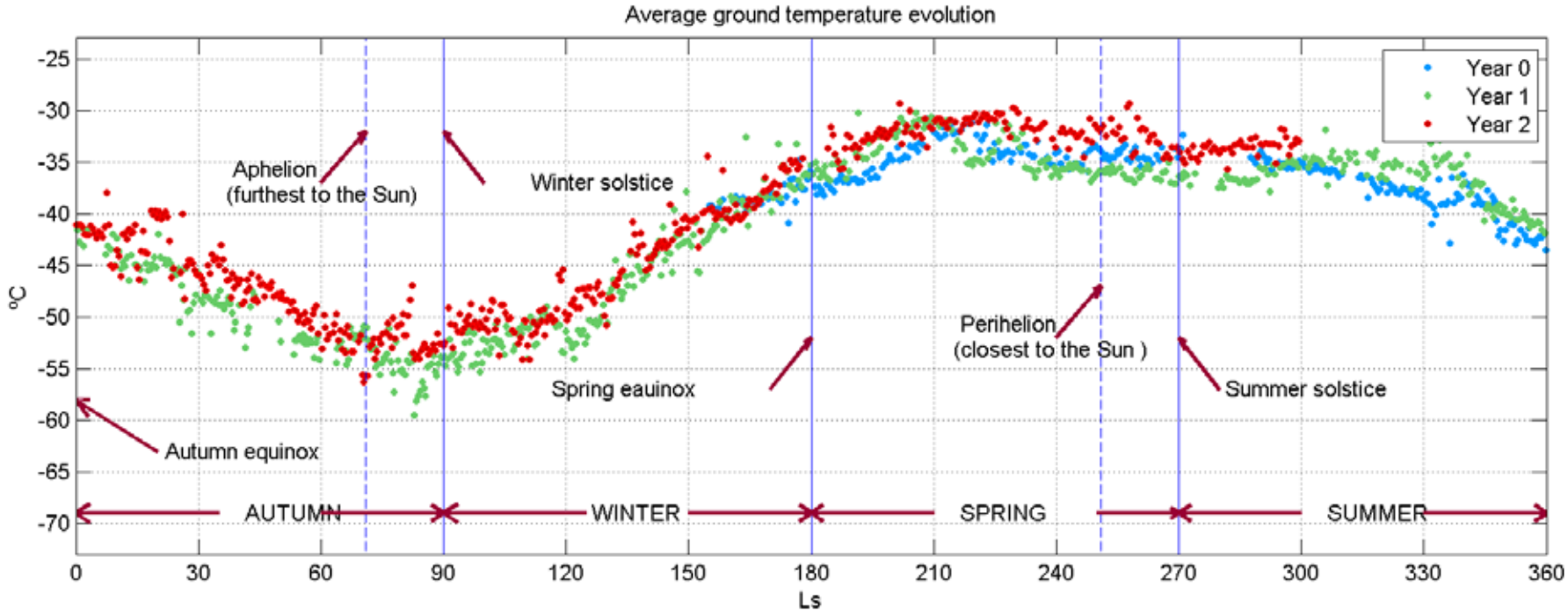


Space missions

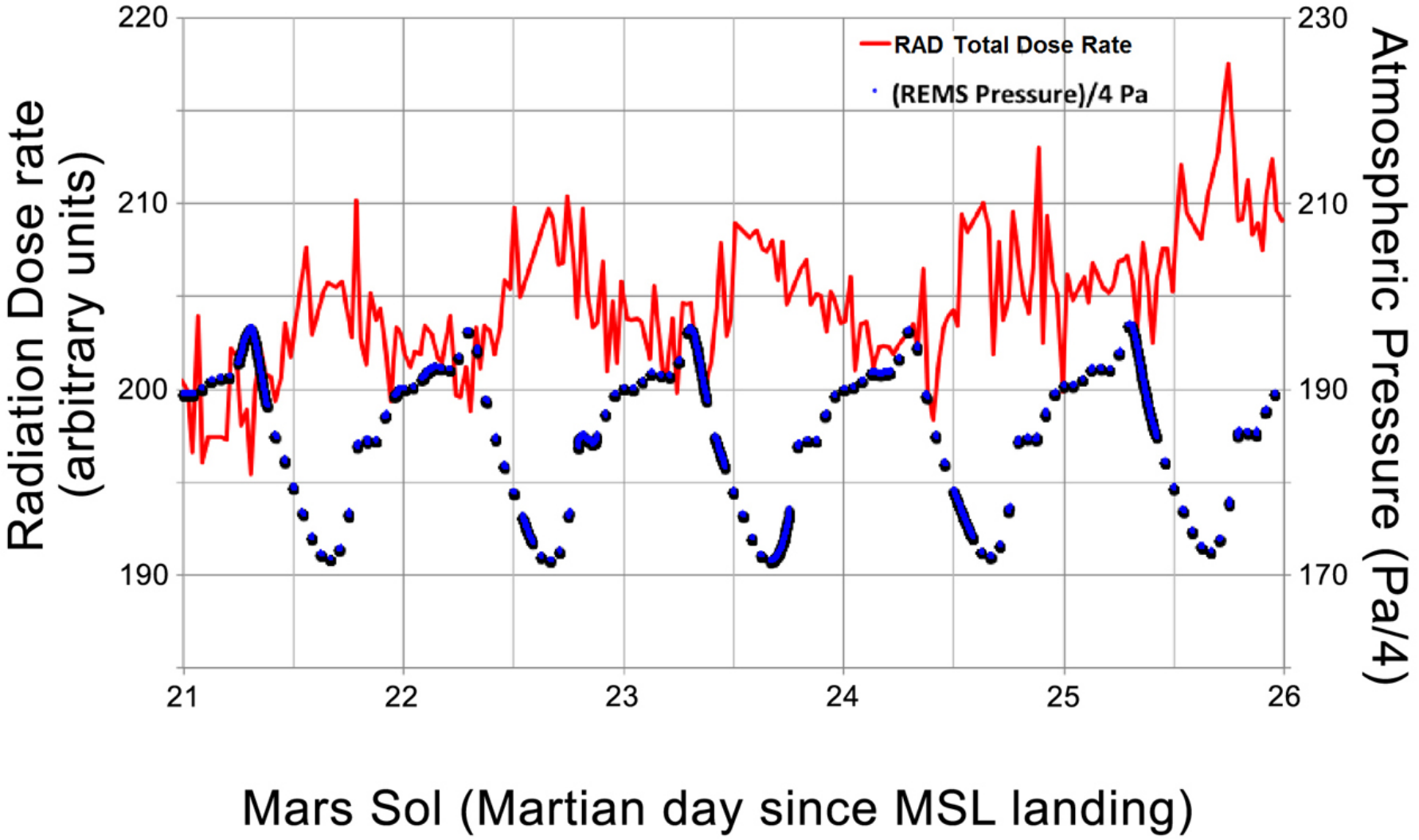
- Planetary exploration
  - REMS (NASA MSL Curiosity): *In operation since August 2012.*



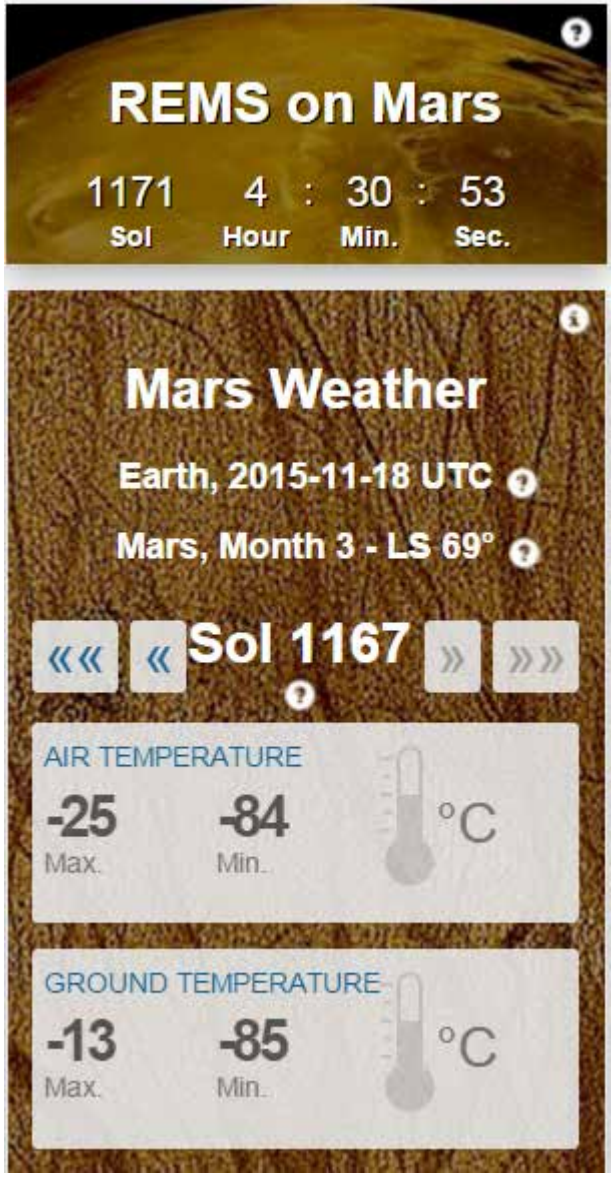

Average air temperature evolution
year 0
year 1
year 2
Aphelion
(furthest to the Sun)
Winter solstice
Perihelion
(closest to the Sun)
Summer solstice
Autumn equinox
Spring equinox
AUTUMN
WINTER
SPRING
SUMMER
°C
Ls

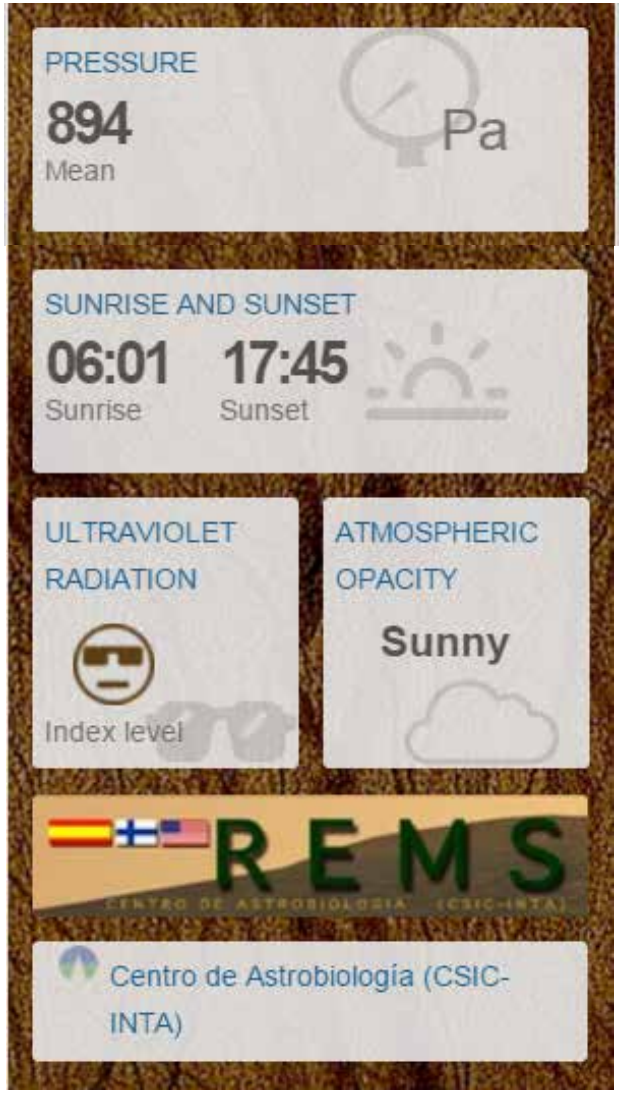

Average ground temperature evolution
Year 0
Year 1
Year 2
Aphelion
(furthest to the Sun)
Winter solstice
Perihelion
(closest to the Sun)
Summer solstice
Spring eauinox
Autumn equinox
AUTUMN
WINTER
SPRING
SUMMER
°C
Ls

Daily Variation of Radiation Dose on the Mars Surface



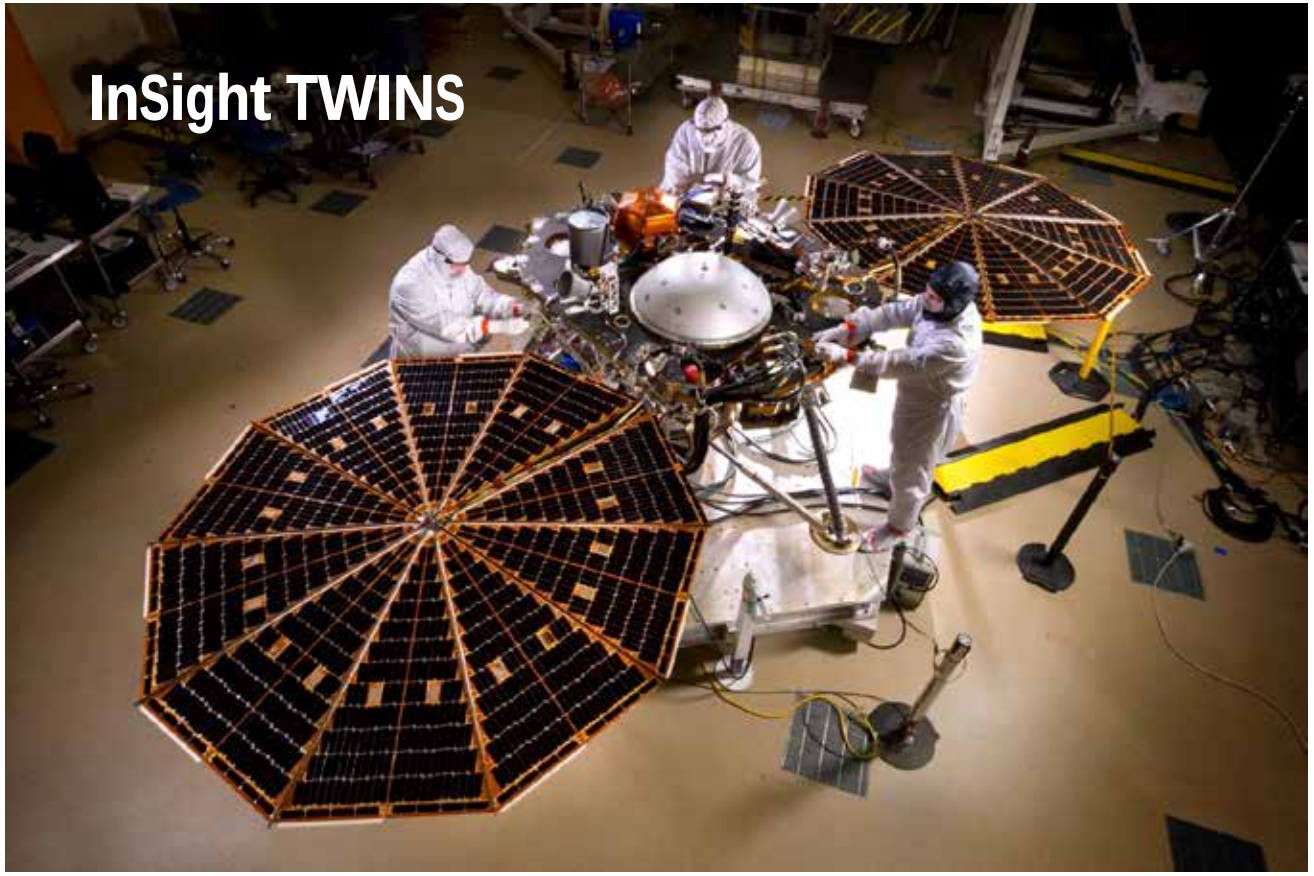
Space missions





Space missions

- Planetary exploration
  - REMS (NASA MSL Curiosity): *In operation since August 2012.*
  - TWINS (NASA InSight): *Delivered. 2018.*



Space missions

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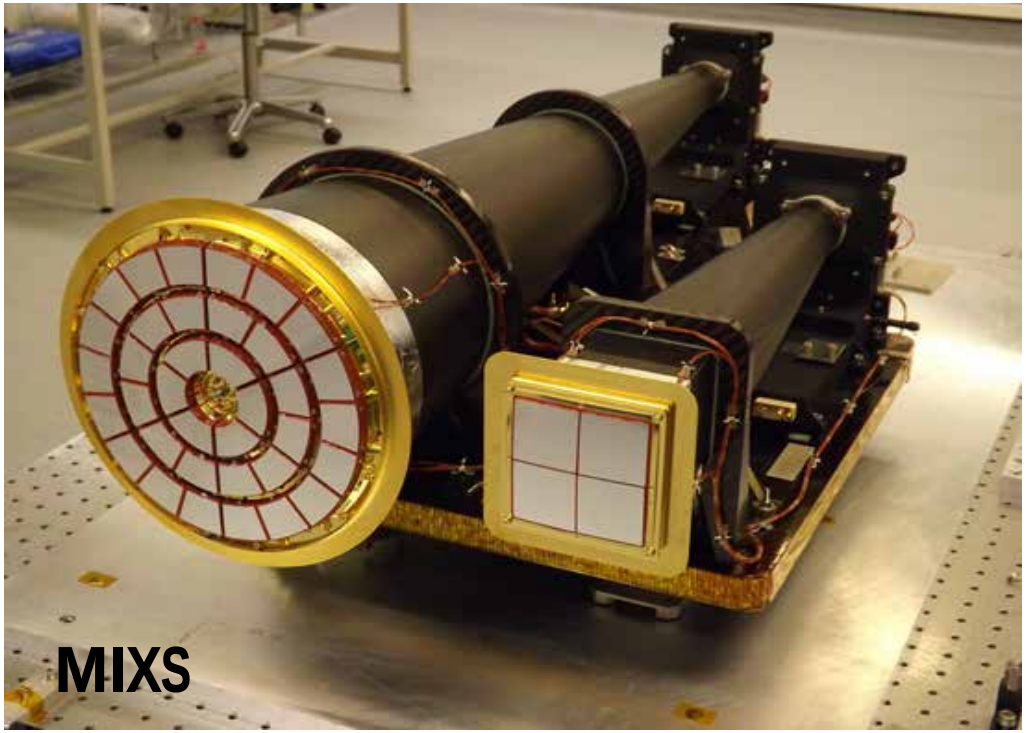
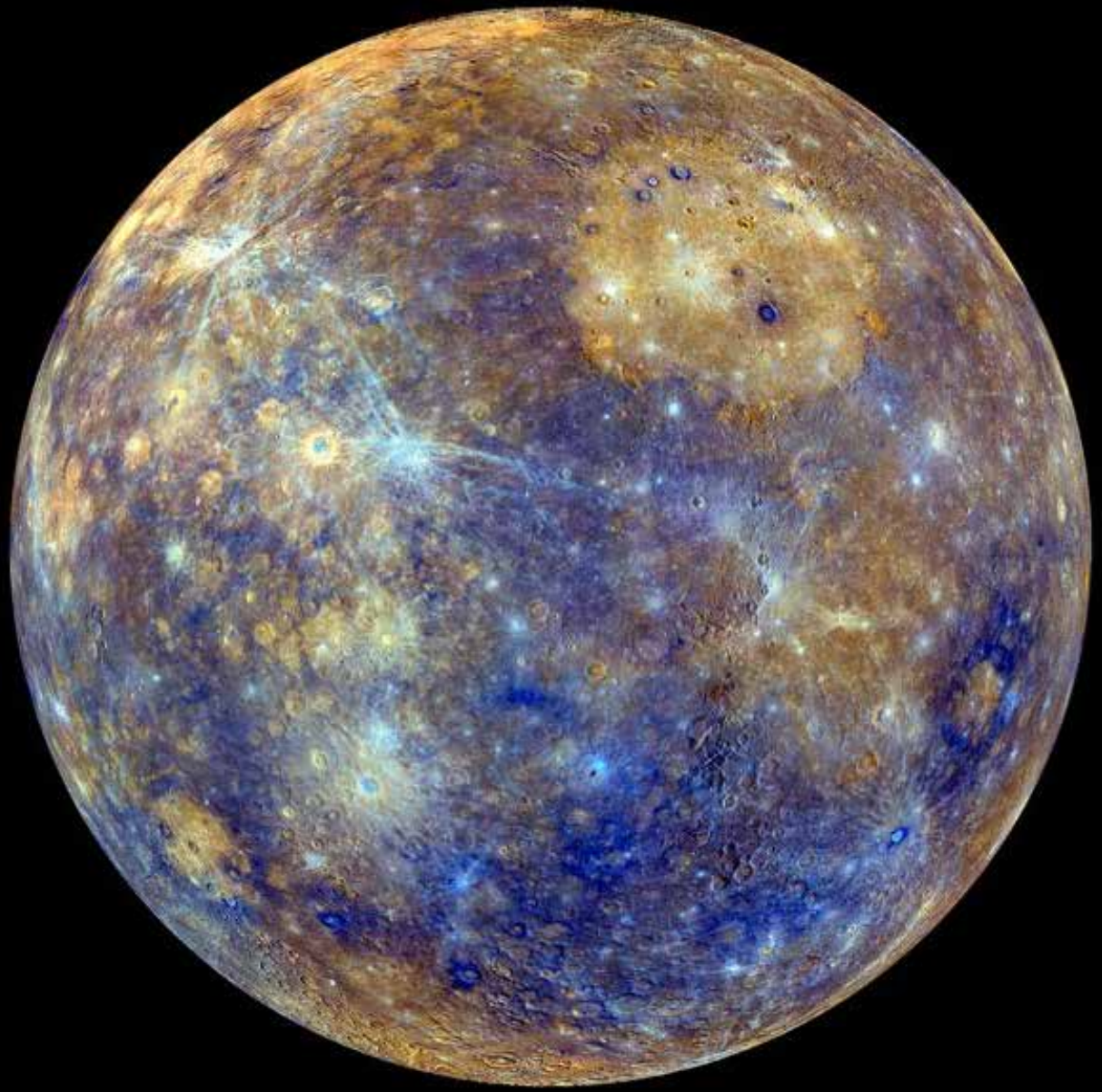
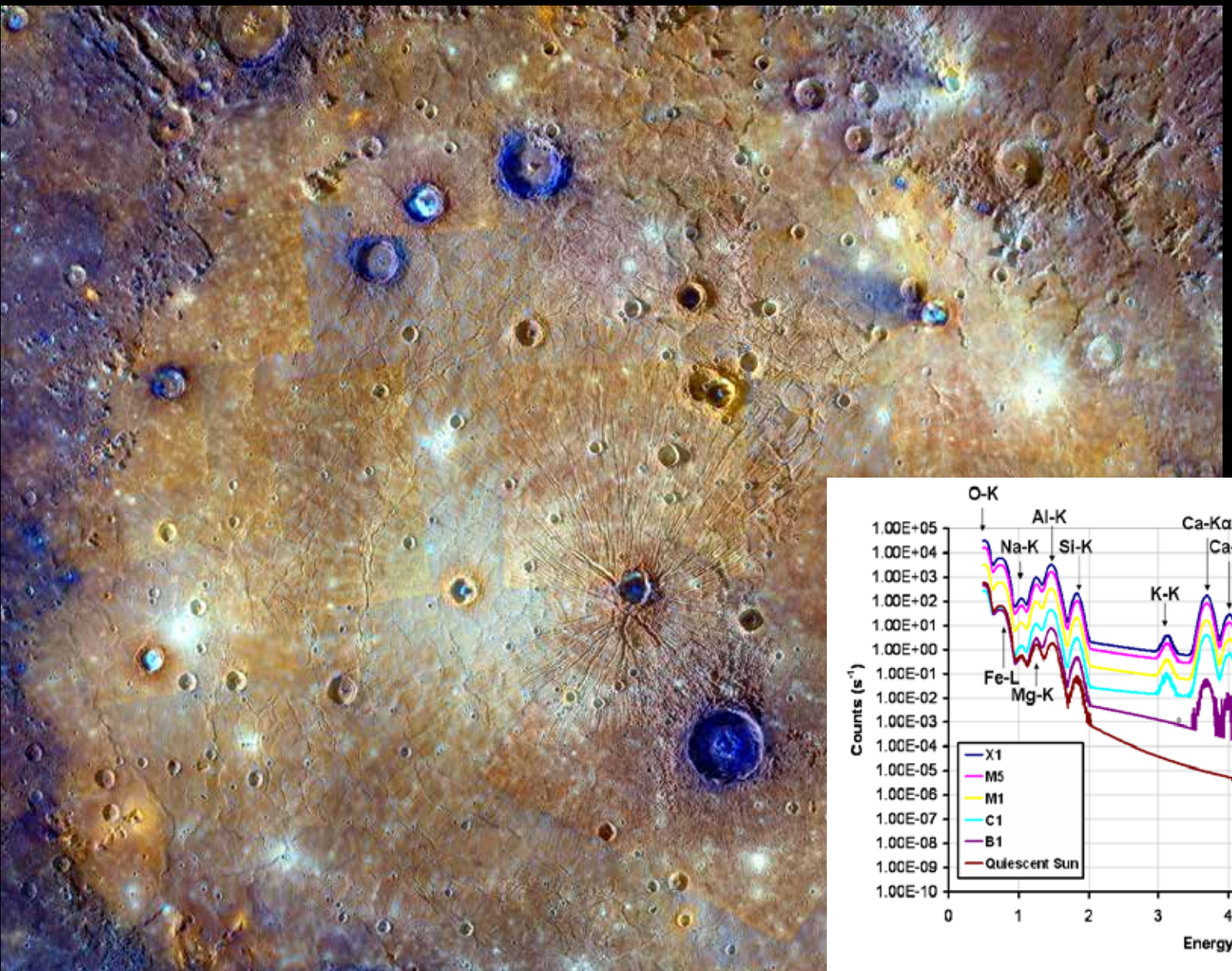
  - MIXS (ESA Bepi Colombo): *Delivered. 2018-2019.*



Mercury as seen by Messenger



MIXS will obtain 2D maps of chemical composition of the Surface, disentangling craters from plains.



Space missions

- Planetary exploration
  - REMS (NASA MSL Curiosity): *In operation since August 2012.*
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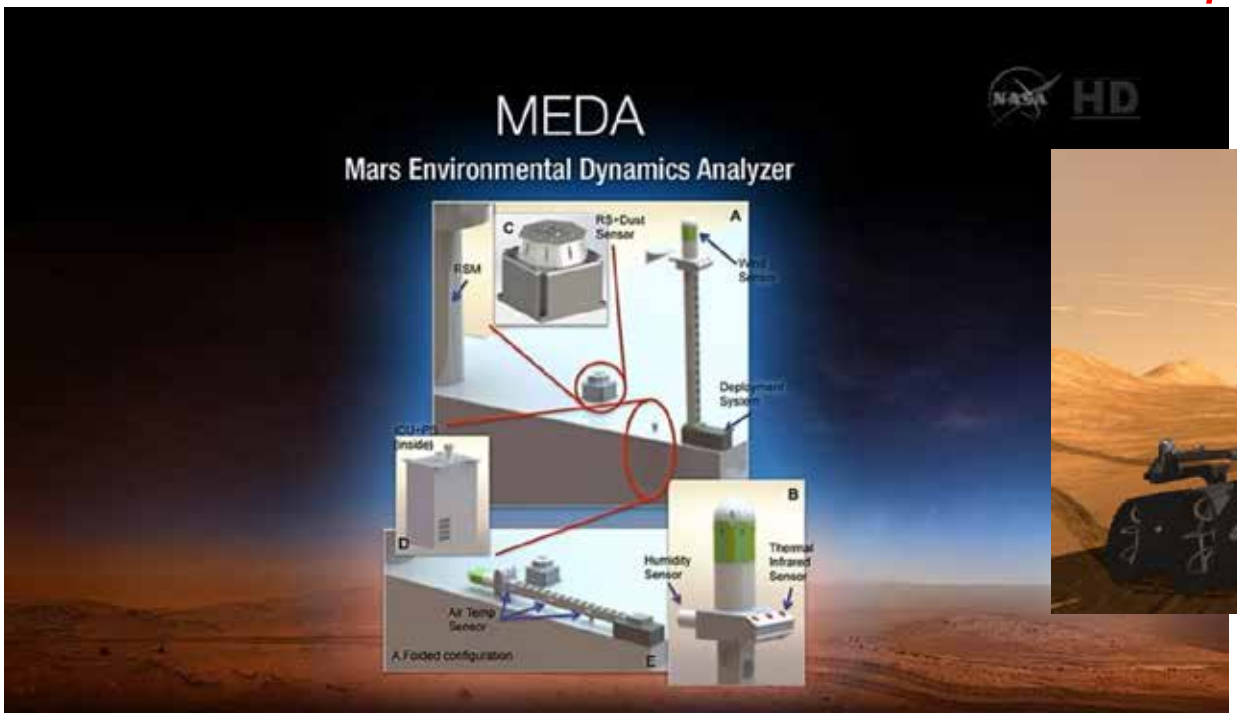
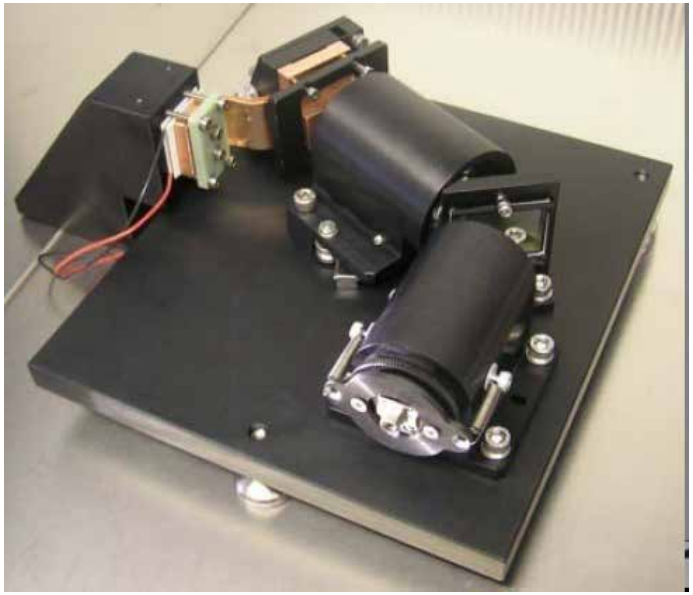
  - MIXS (ESA Bepi Colombo): *Delivered. 2018-2019.*
  - MEDA at NASA's Mars2020. *In development. 2020.*



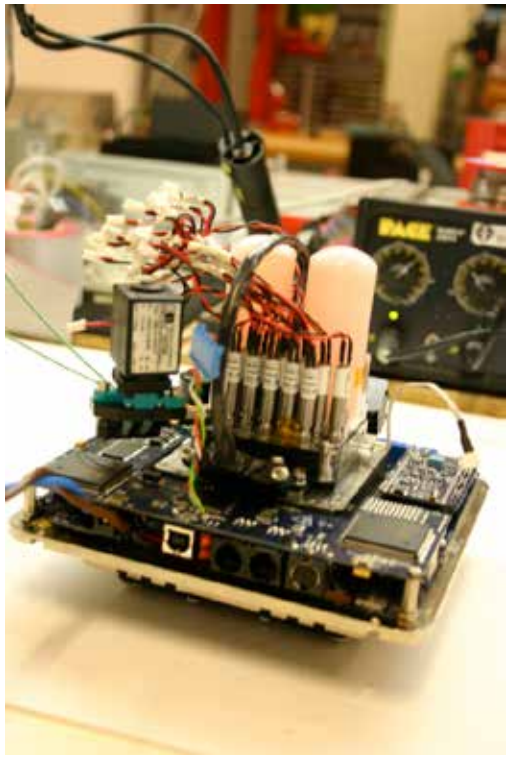
Space missions

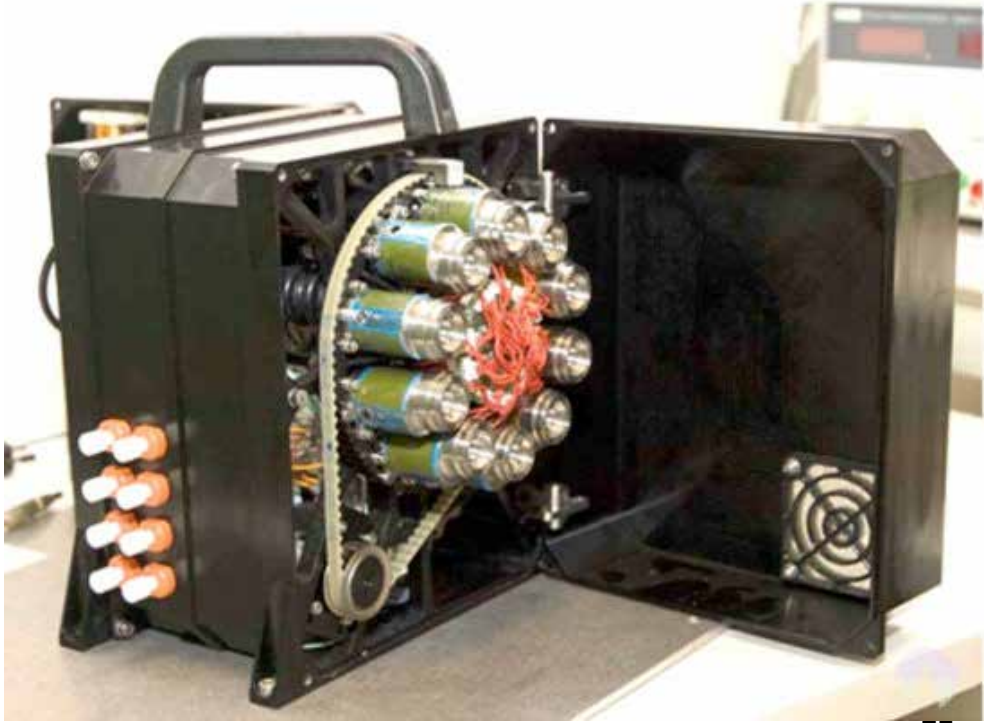
- Planetary exploration
  - REMS (NASA MSL Curiosity): *In operation since August 2012.*
  - TWINS (NASA InSight): *Delivered. 2016.*
  - MIXS (ESA Bepi Colombo): *Delivered. 2017.*
  - MEDA at NASA's Mars2020. *In development. 2020.*
  - Raman RLS at ESA's EXOMARS*. In development. 2020.*



Space missions

- SOLID: Signs Of LIfe Detector. Based on a biochip microarray sensitive to 300 complex biomolecules.
  - *In development for a launch in ~mid 2020's.*



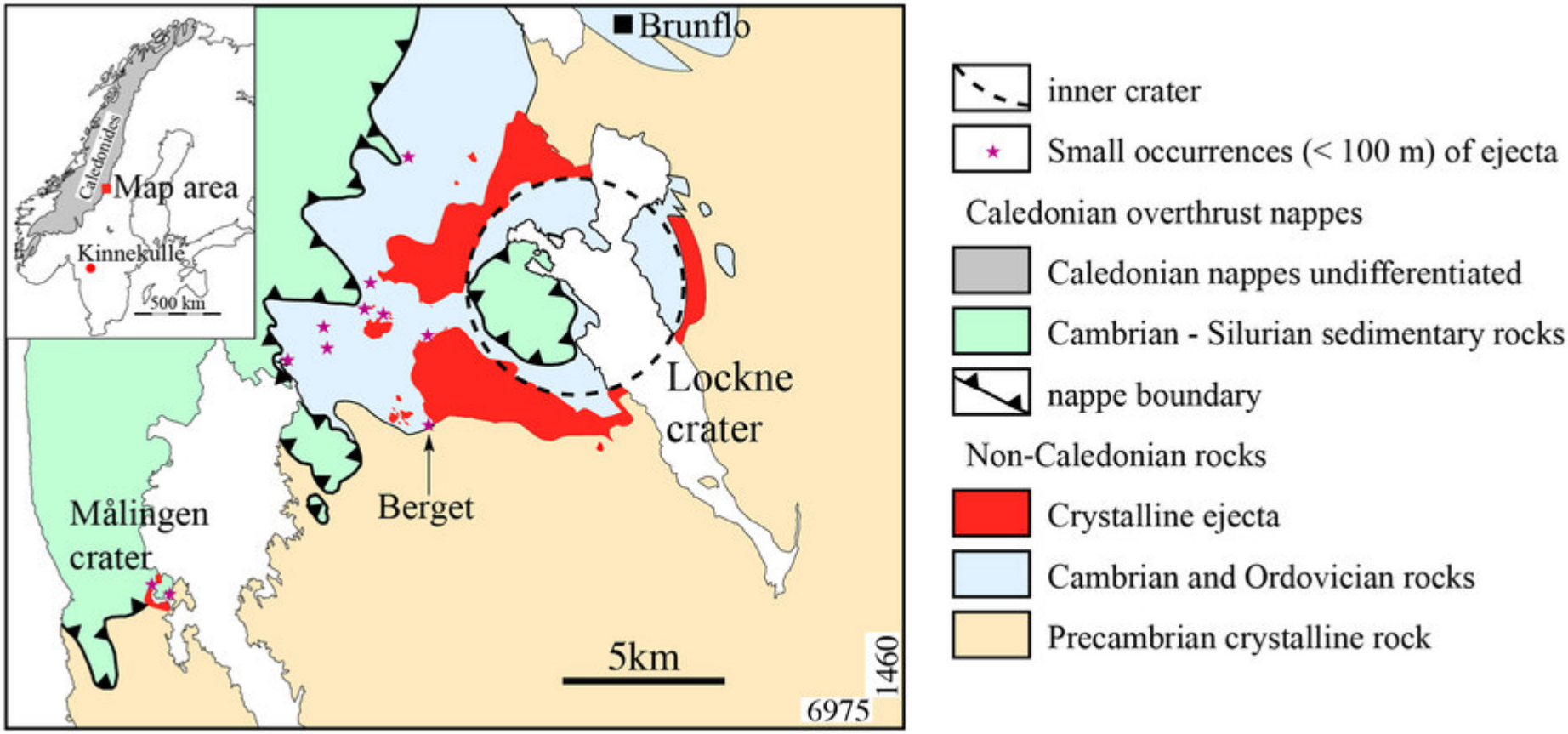


Space missions

- Some preparatory work on Earth….

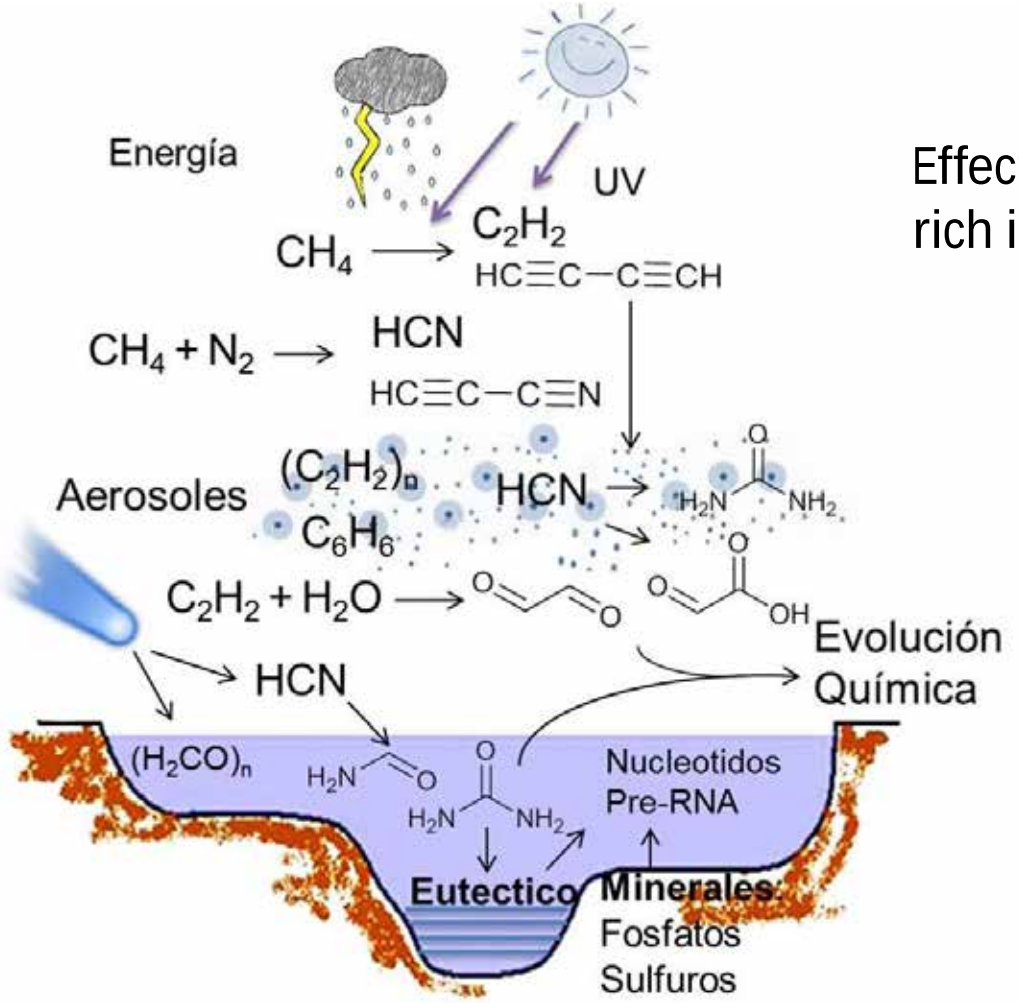
Recent results

Identification of an impact crater by a binary asteroid (-470 Myr)



First known Terrestrial Impact of a Binary Asteroid from a Main Belt Breakup Event
Jens Ormö, Erik Sturkell, Carl Alwmark & Jay Melosh. Scientific Reports. 2014

Recent results

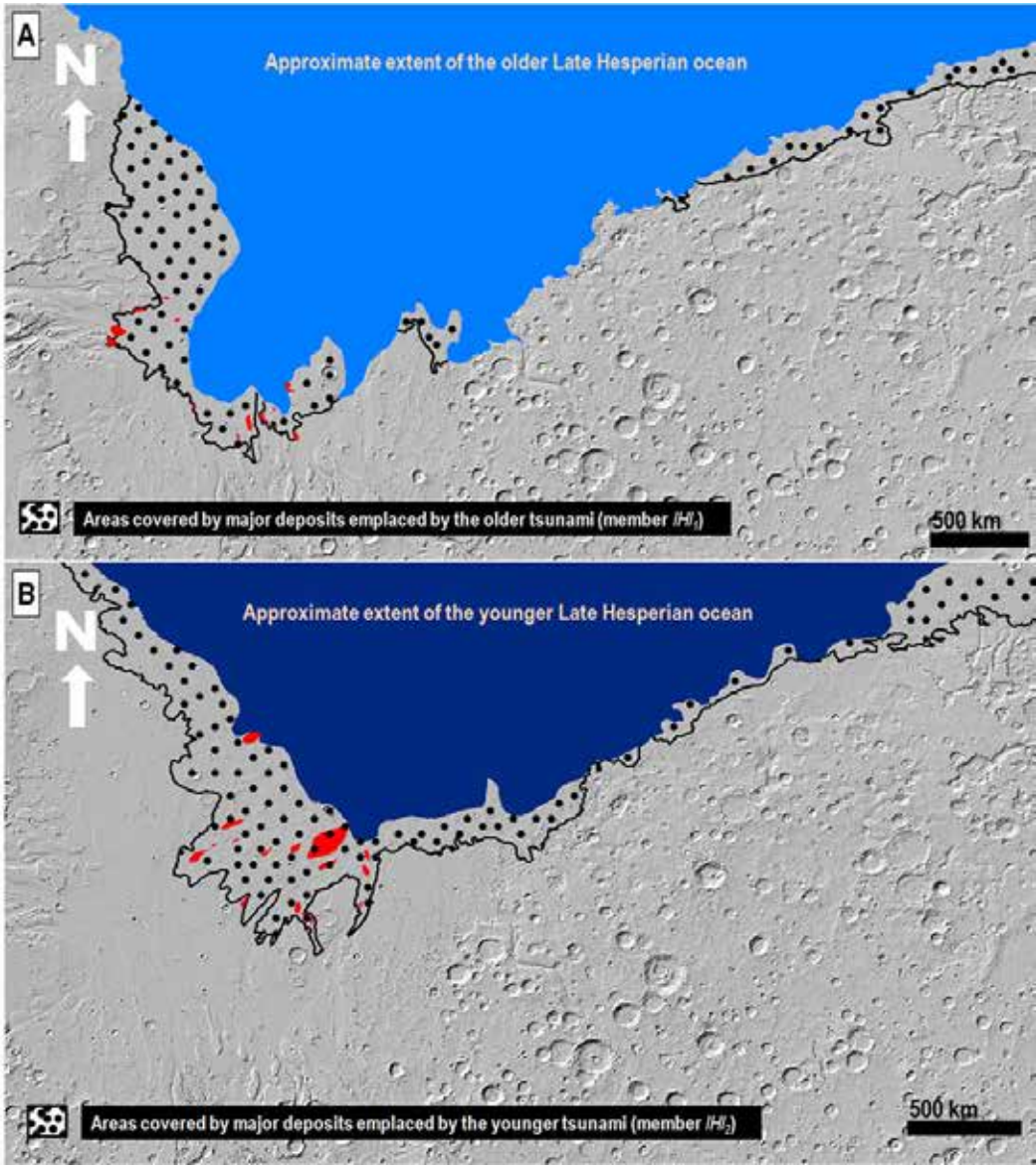


Effects of a primordial atmosphere rich in Methane (-4.500 Myr)

La composición química de la atmósfera primitiva del planeta Tierra.
Jorge Pla-García y César Menor-Salván. Anales de Química. 2017

Recent results

First identification of tsunamis in Mars



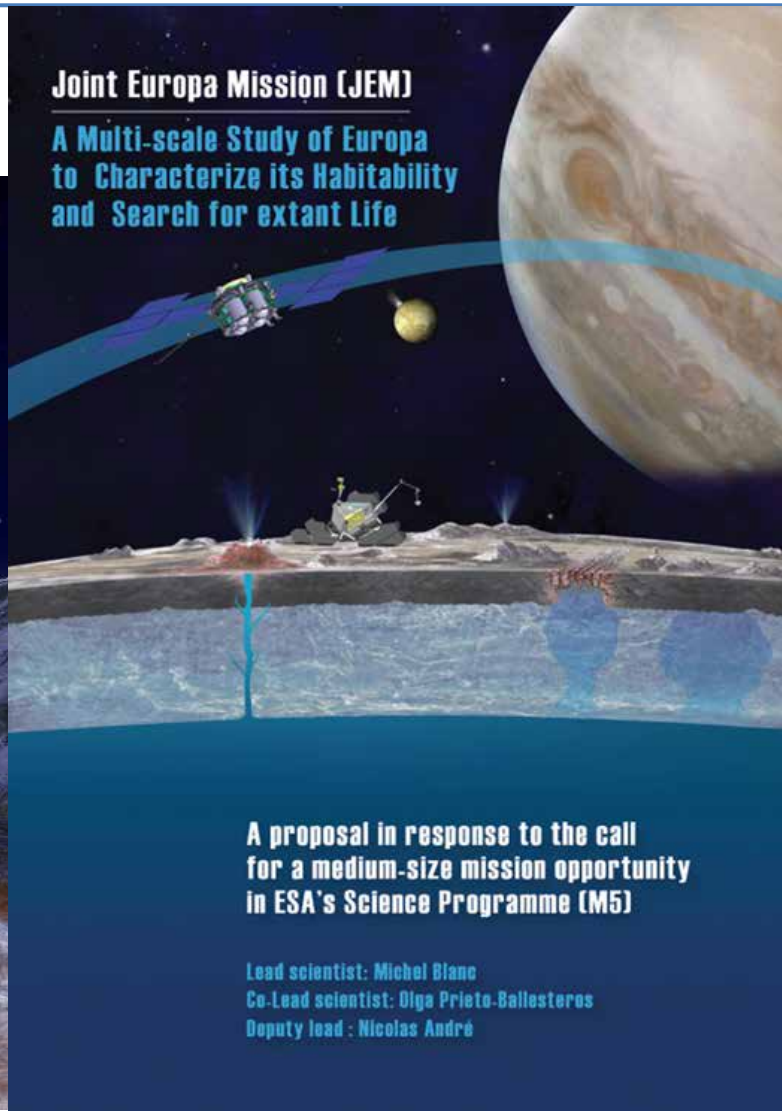
Tsunami waves extensively resurfaced the shorelines of an early Martian ocean.
J. Alexis, P. Rodriguez, Alberto G. Fairén, et al.
Scientific Reports. 2016

Field campaigns

- Identification of extreme terrestrial analogues sites:
  - Danakil (Etiopia)
  - Rio Tinto
  - Atacama
  - …

Next steps

NASA Europa Lander Mission



Some numbers

- Staff: 160 scientists and engineers
- Around 200 refereed publications per year
- R&D grants (EU, Spanish funding agencies): 3-5 M€/yr
- Main building at INTA in Torrejón de Ardoz
- Second building within the European Space Astronomy Centre of ESA (ESAC) in Villafranca.