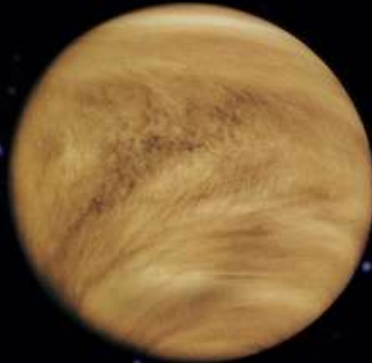


Remote sensing of the planets

A vast literature and methodology exists in modern optical and radar astronomy that parallels and often exceeds methods used in environmental remote sensing



Mars



Venus



Saturn



Jupiter



Earth



Mercury

Wavelengths and Sensors used

- Gamma Rays
- X-Rays
- Ultraviolet spectrometry
- **Visible** – Panchromatic and RGB
- **Near-IR / LiDAR** (mid-IR ?)
- **Thermal IR**
- Microwave – passive / **RADAR**

Types of Remote Sensing Missions

- Fly-bys



Mariner Missions,
Mercury and Venus



New Horizons 2006,
Jupiter and Pluto

- Orbiters



LandSat, Earth



Mars Reconnaissance Orbiter

- Landers/
Rovers



Surveyor Lunar Lander, 1966



Mars Rovers, 2003

Wide-field Infrared Survey Explorer (WISE) Nov 20, 2009



Orbit 525km

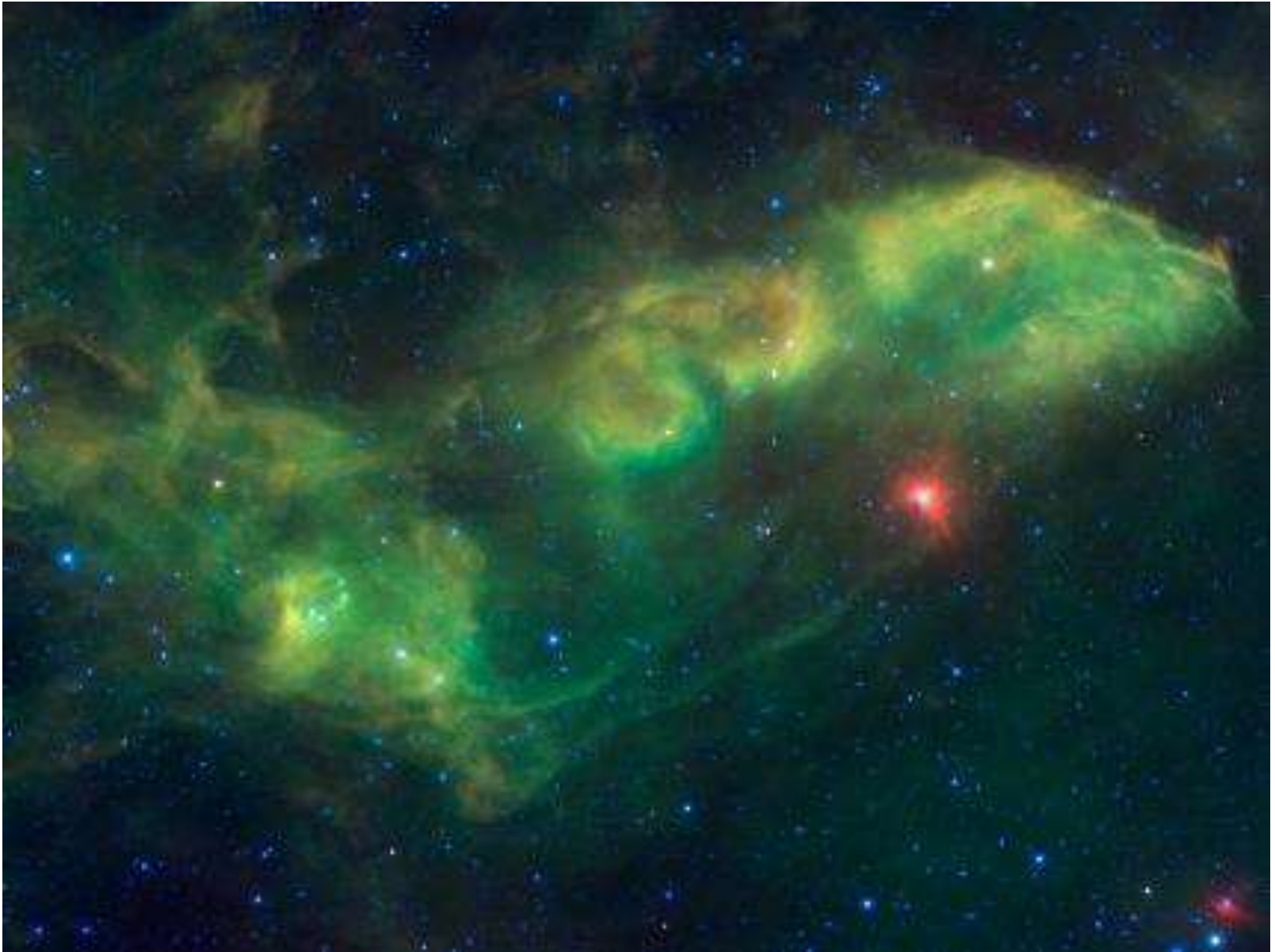
**4 thermal bands
Renamed
NEOWISE, 2013**

**Capture the entire
sky - Near Earth
Objects**

http://www.nasa.gov/mission_pages/WISE/main/index.html

Gallery:

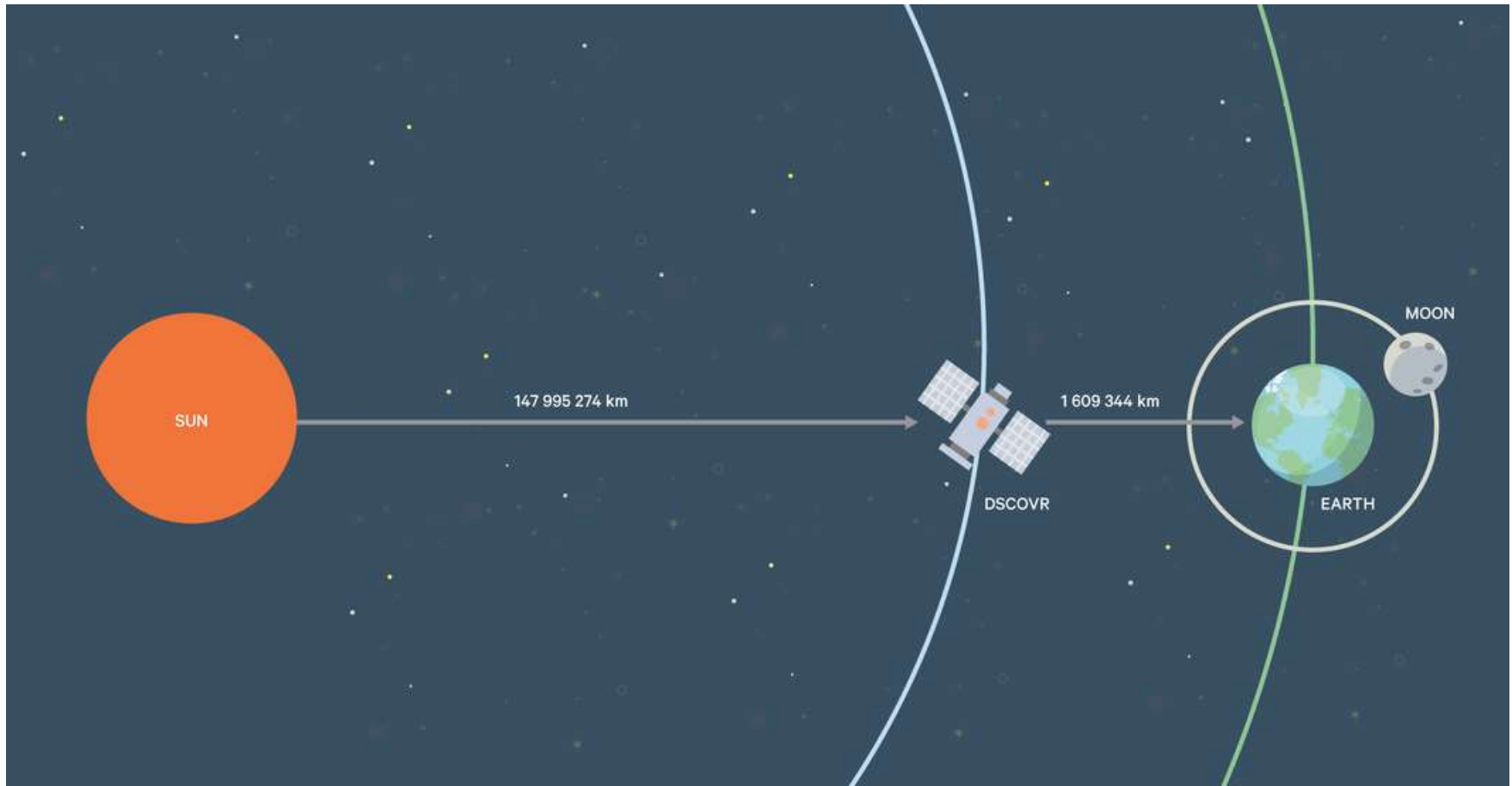
https://www.nasa.gov/mission_pages/WISE/multimedia/gallery/gallery-index.html



WISE: Jabba – bright red star, in the Scorpius constellation

DSCOV: Deep Space Climate Observatory - 2015

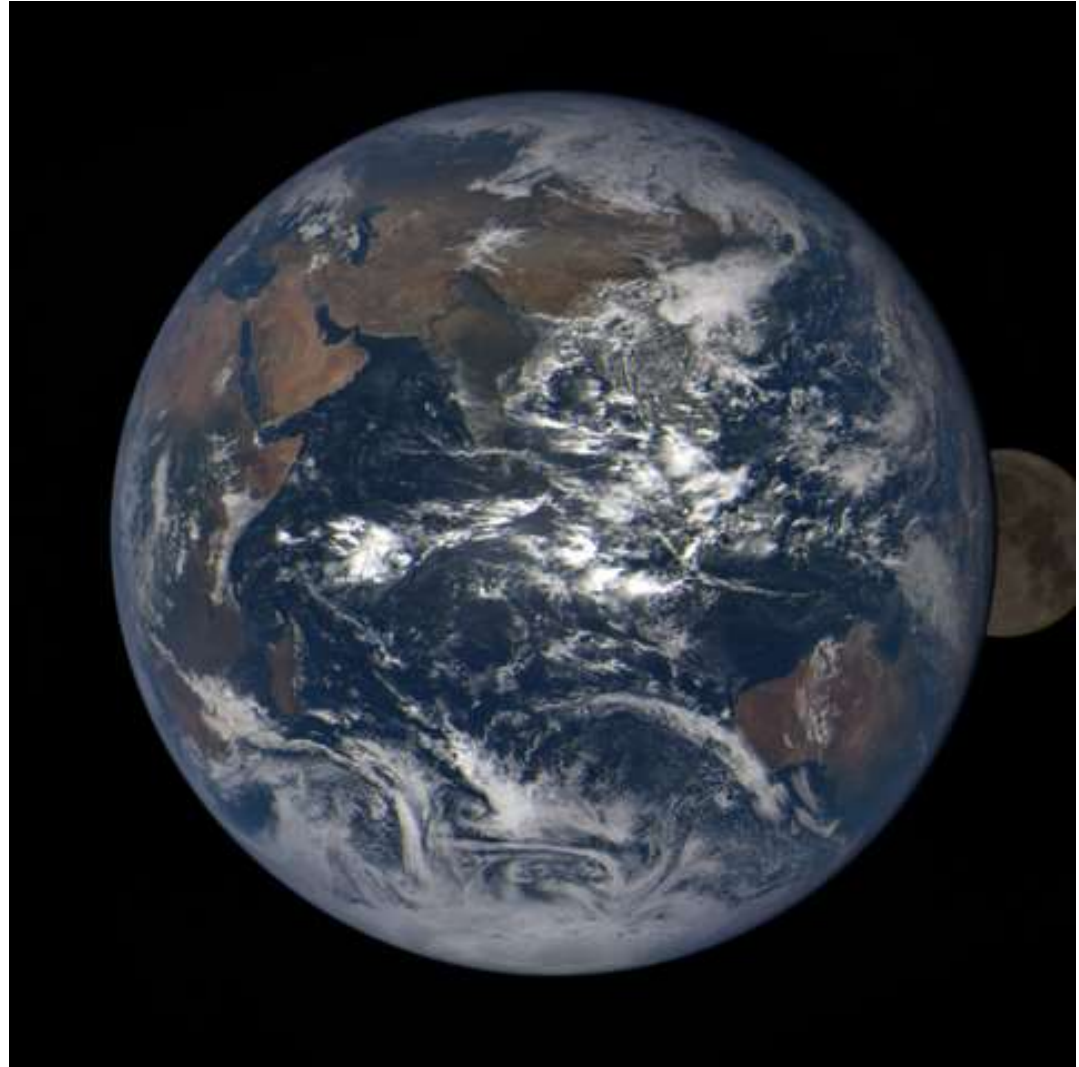
1 million miles away – ~10km resolution at the Lagrange point Sun-Earth
Heliocentric orbit



Proposed by Al Gore, 1998 to study earth and solar wind

- In addition to an imaging camera (10 bands UV-Near-IR), a radiometer would take direct measurements of how much sunlight is reflected and emitted from the whole Earth (albedo). This data could constitute a barometer for the process of global warming.

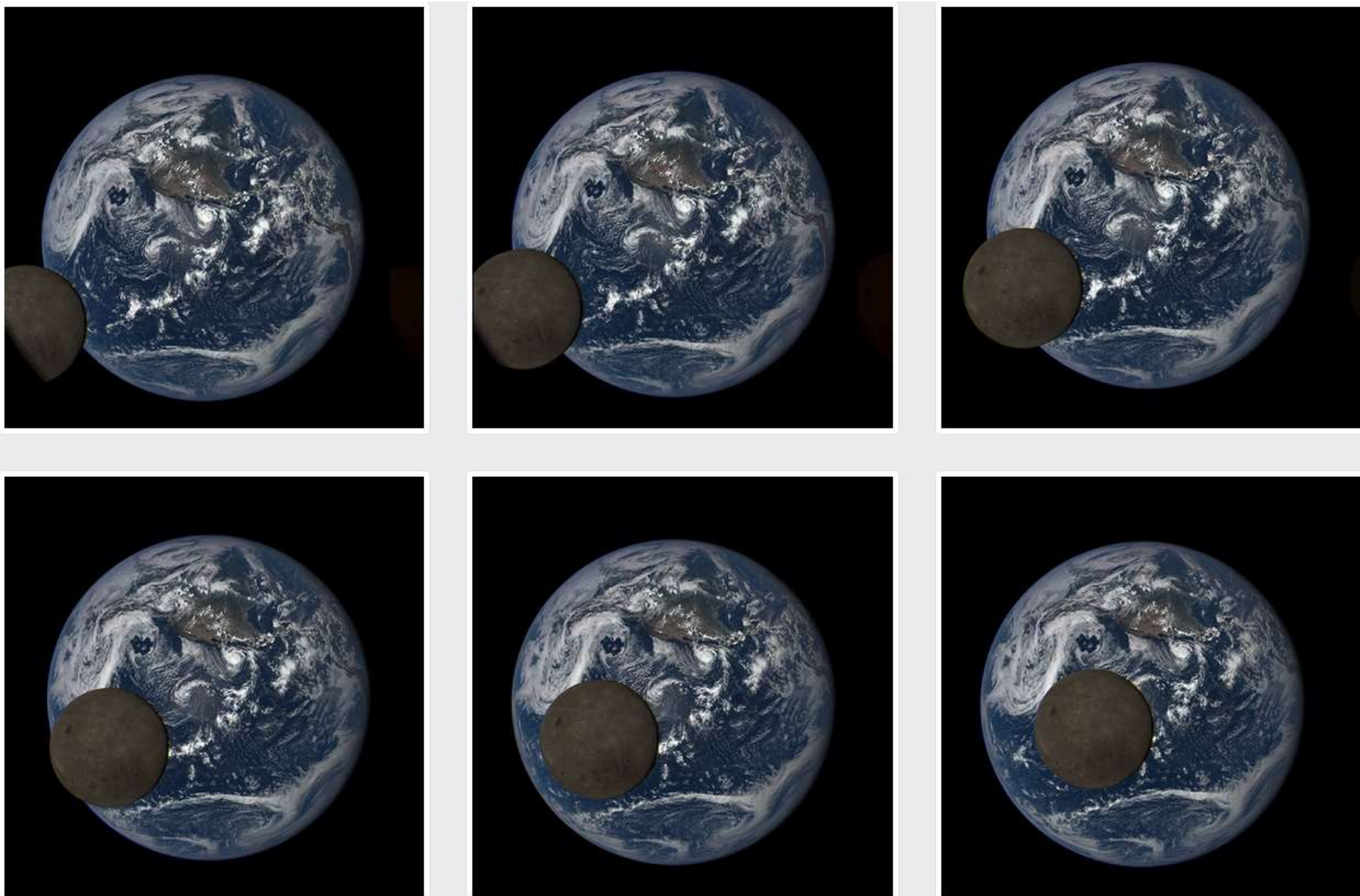
Earth Polychromatic
Imaging Camera (EPIC)

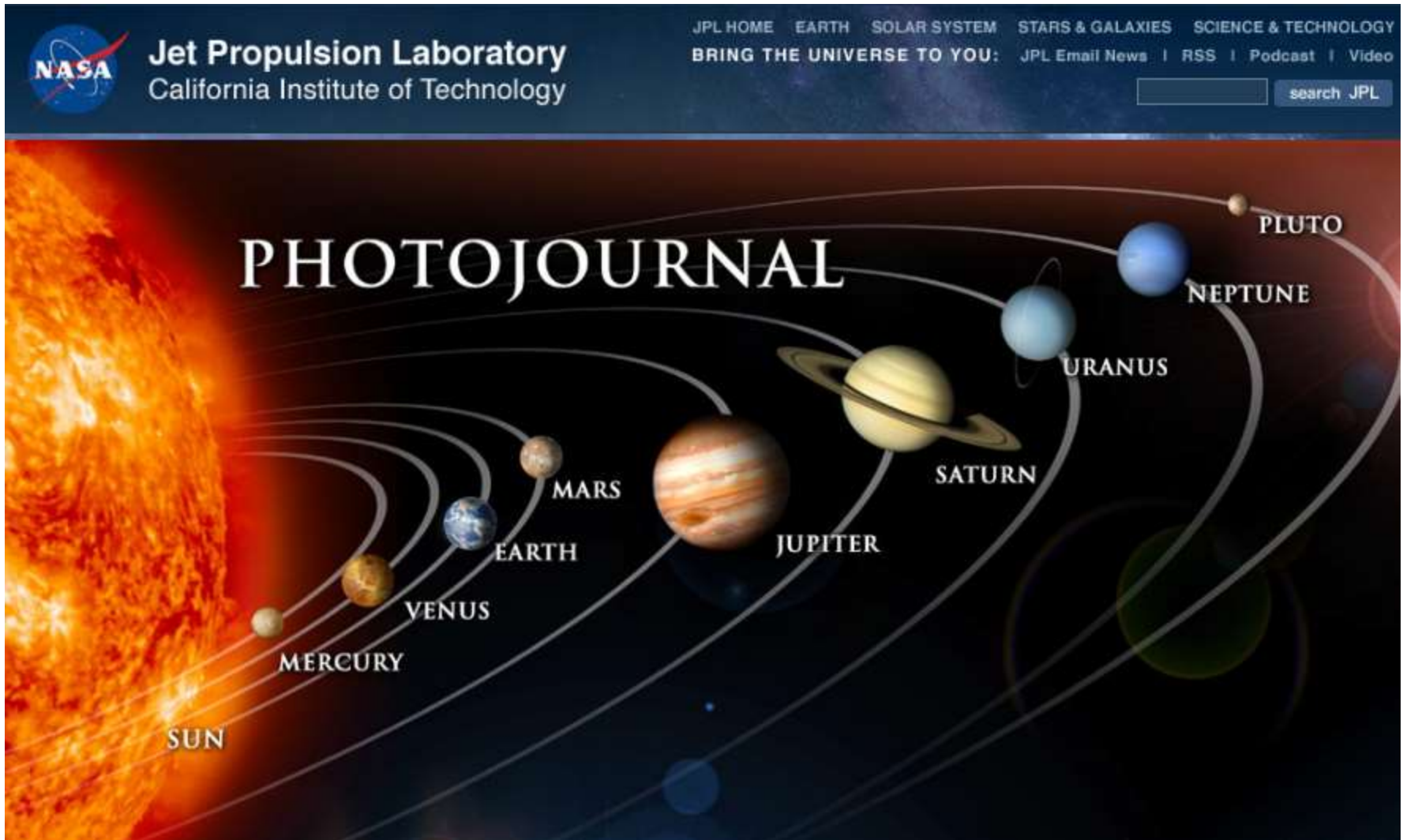


daily images from EPIC
<http://epic.gsfc.nasa.gov/>

Far side of the Moon crossing Earth from DSCOVR satellite

Earth Polychromatic Imaging Camera (EPIC); <http://epic.gsfc.nasa.gov/>



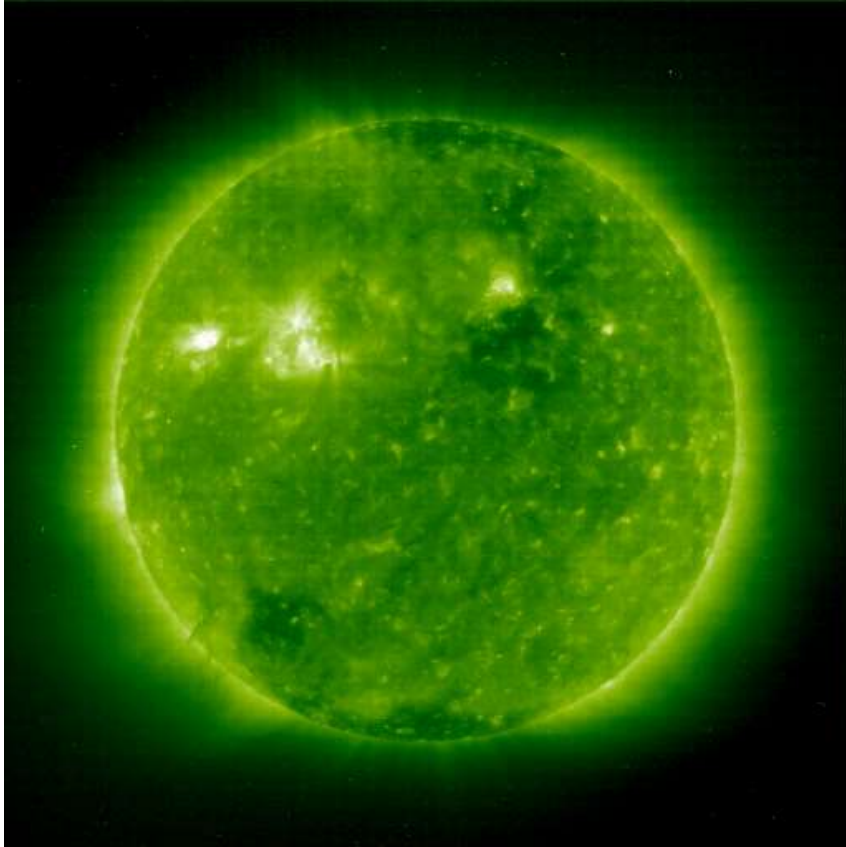


Imaging links: Sun 23, Mercury 281, Venus 149, Earth 1205 (?), Mars 6327, Jupiter 817, Saturn 2291, Uranus 55, Neptune 80, Pluto 7

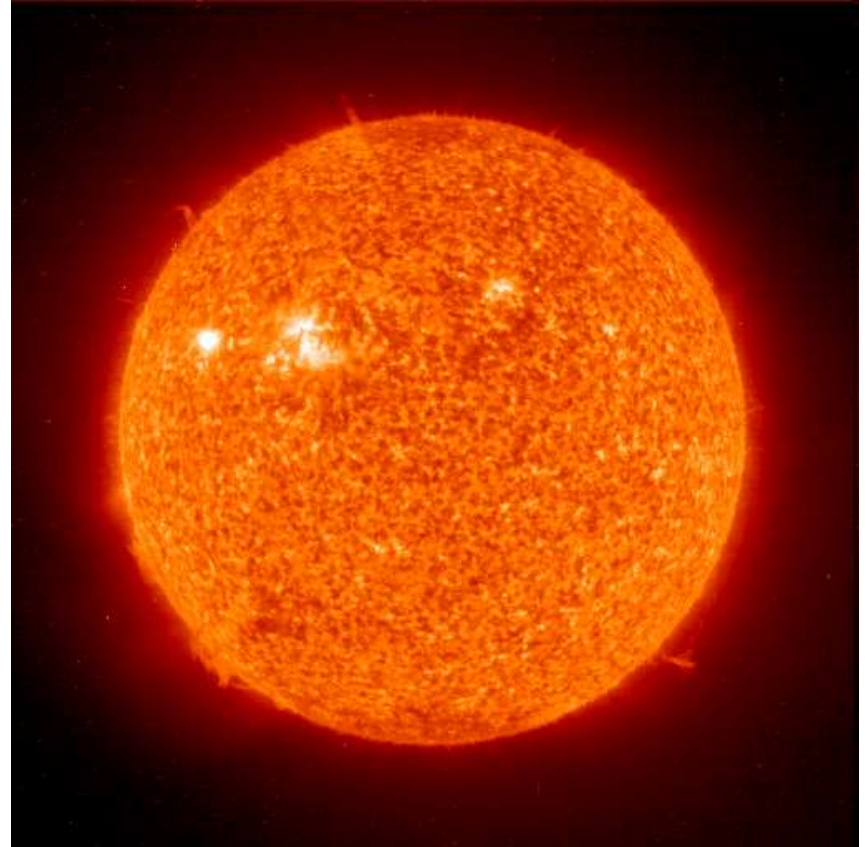
SOHO the Solar & Heliospheric Observatory

.. is a project of international collaboration between ESA and NASA to study the Sun from its core to the outer corona and the solar wind.

Nov 18, 2009: 195 nm



304 nm (also 171 and 284)

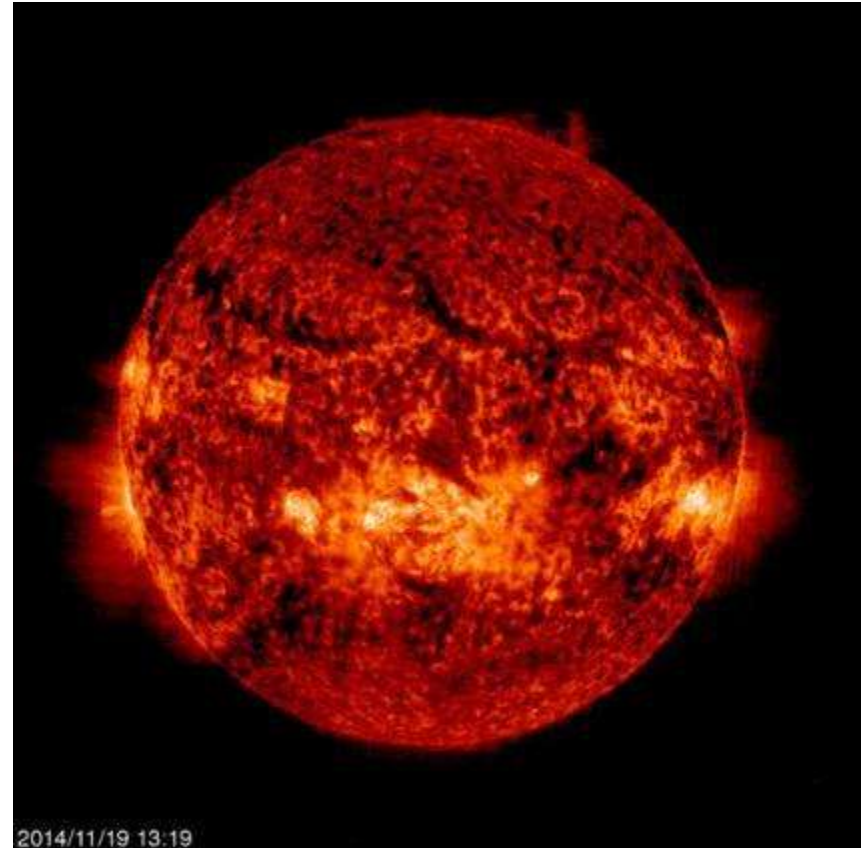
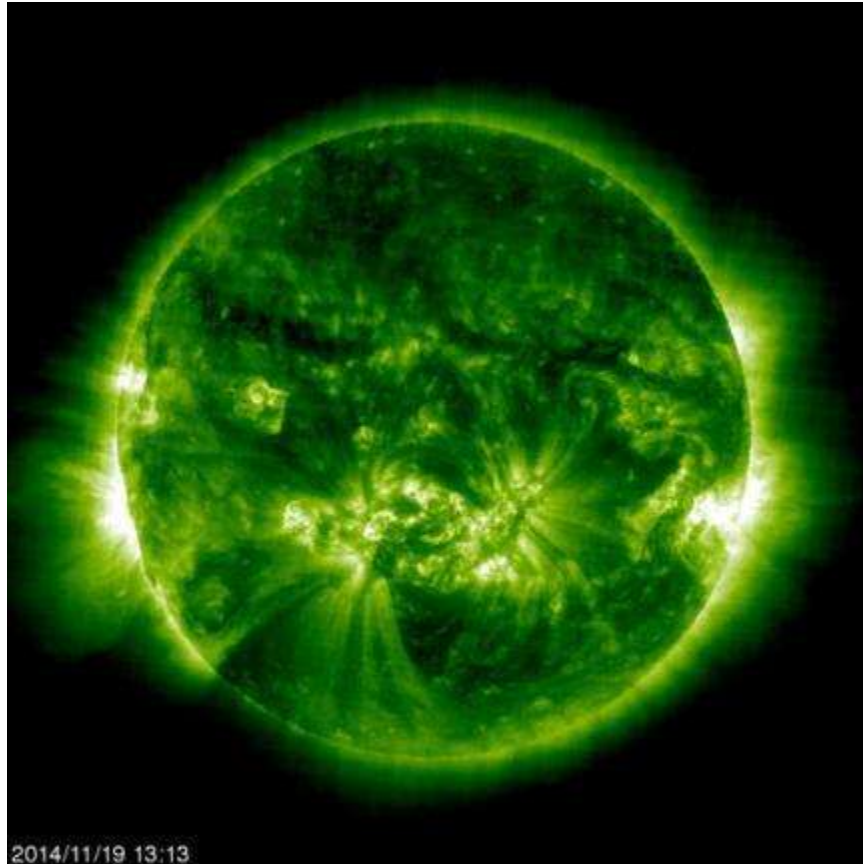


Launched 1995, cost €1 billion; Sensor: Extreme ultraviolet Imaging Telescope (EIT)

SOHO, the Solar & Heliospheric Observatory

.. is a project of international collaboration between ESA and NASA to study the Sun from its core to the outer corona and the solar wind.

"Latest images" 195nm - Nov 19, 2014: 304 nm (also 171 and 284)

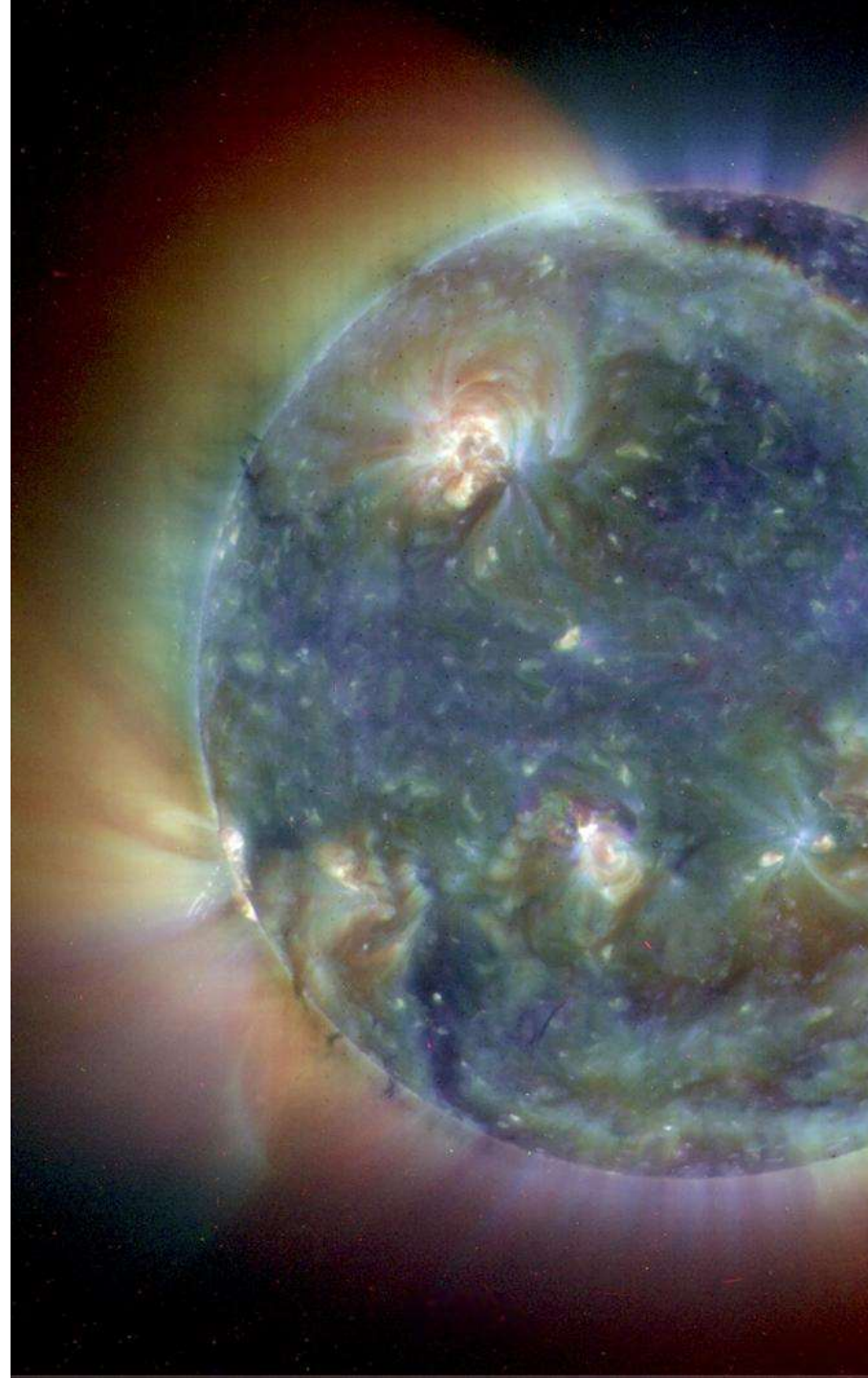


Launched 1995, cost €1 billion; Sensor: Extreme ultraviolet Imaging Telescope (EIT)

SOHO - specifically the
Large Angle and
Spectrometric Coronagraph
(LASCO)

has allowed the discovery
of comets by blocking out
the Sun's glare: ~ one-half
of all known comets

**Color Composite
of Solar Features**



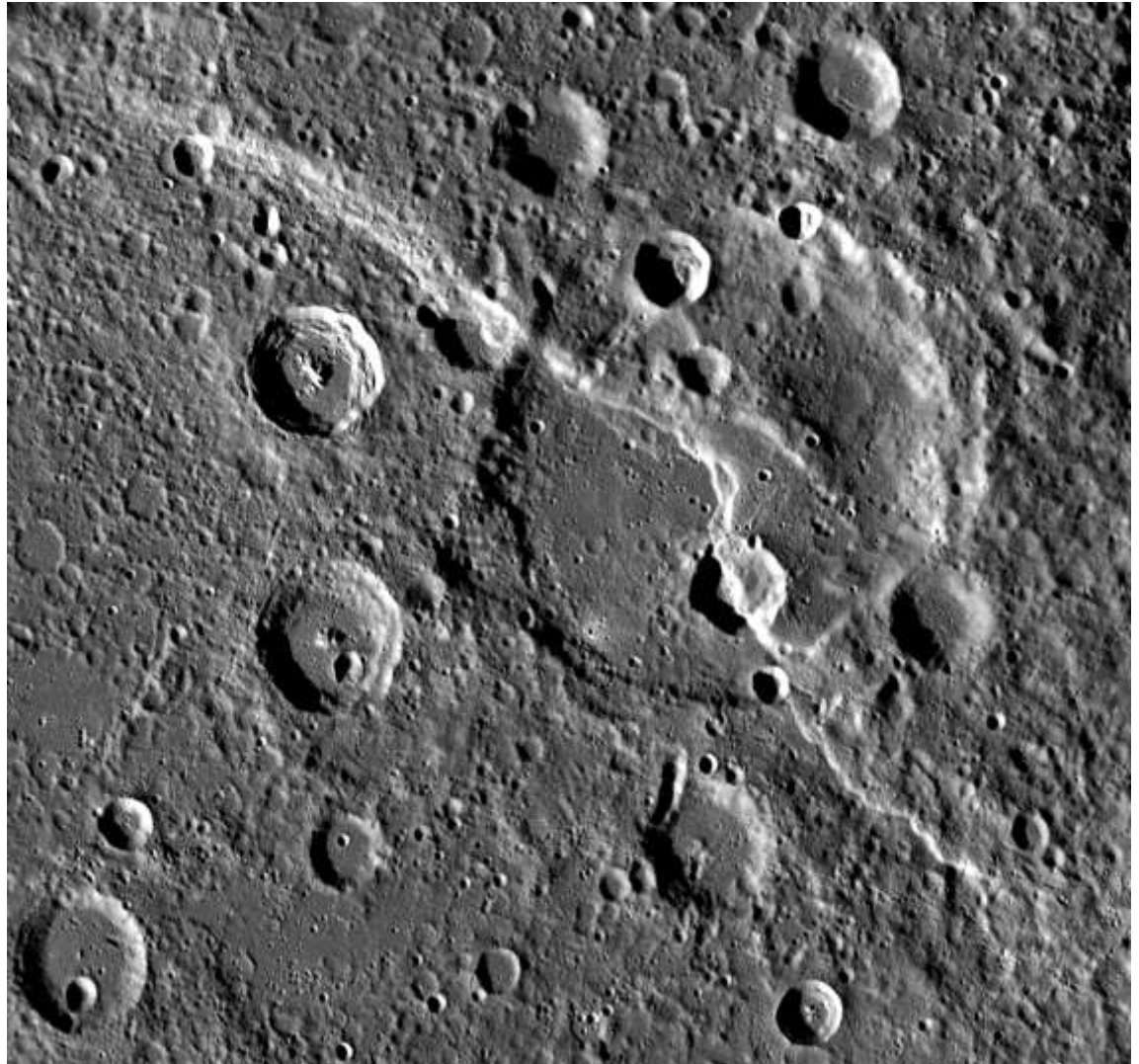
Mercury – Messenger, 2011-15- Mercury Dual Imaging System (MDIS)

The camera system provided a complete map of the surface of Mercury at a resolution of 250 meters/pixel, and images of regions of geologic interest at 20–50 meters/pixel

The most heavily cratered planet – no atmosphere, too close to the Sun

Carnegie Rupes
image mosaic.
The giant lobate
scarp (2km high)
cuts through
Duccio crater.

<https://photojournal.jpl.nasa.gov/catalog/PIA19279>



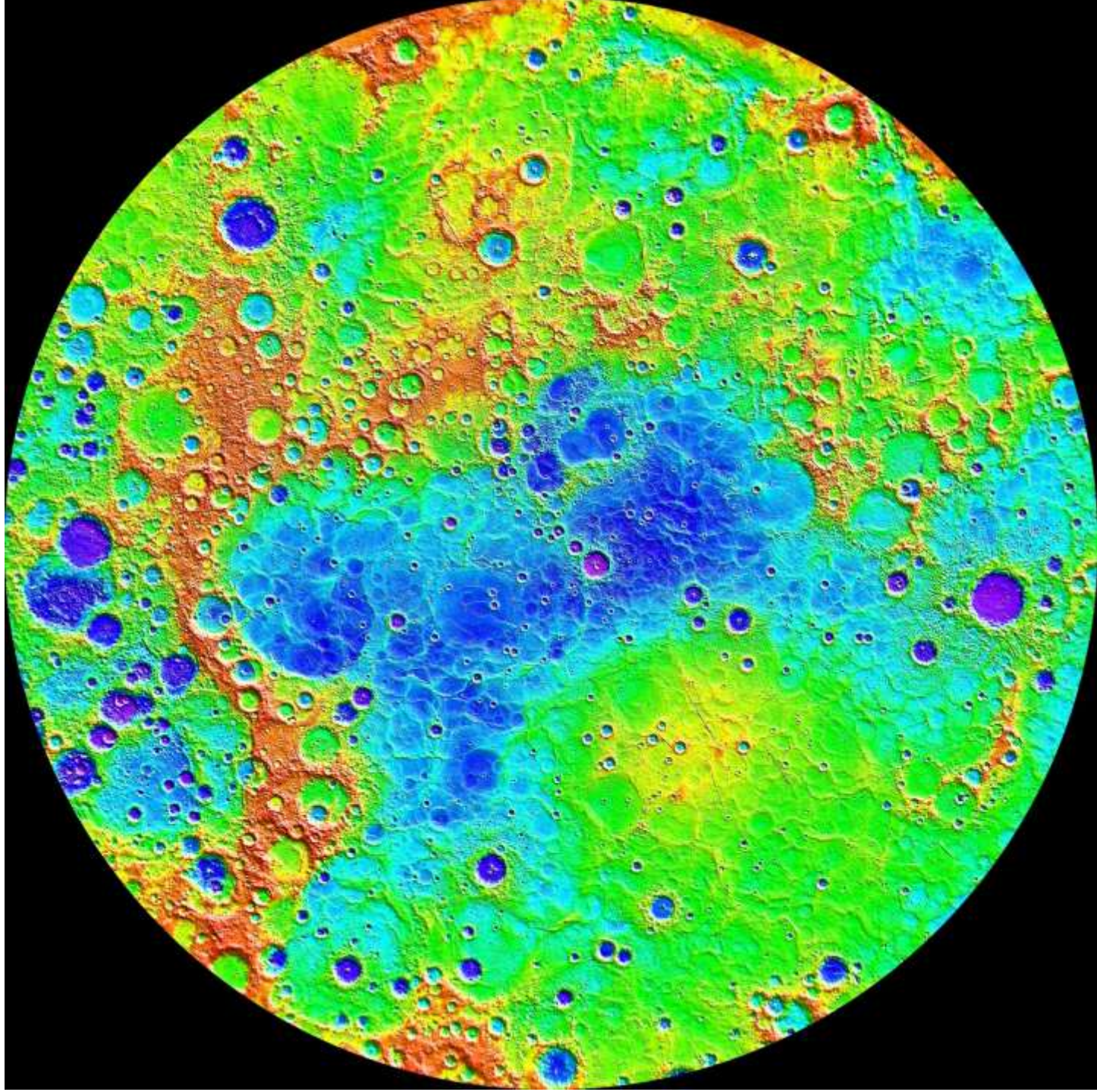
**Mercury
Laser
Altimeter
(MLA)**

**One of 7
instruments
onboard**

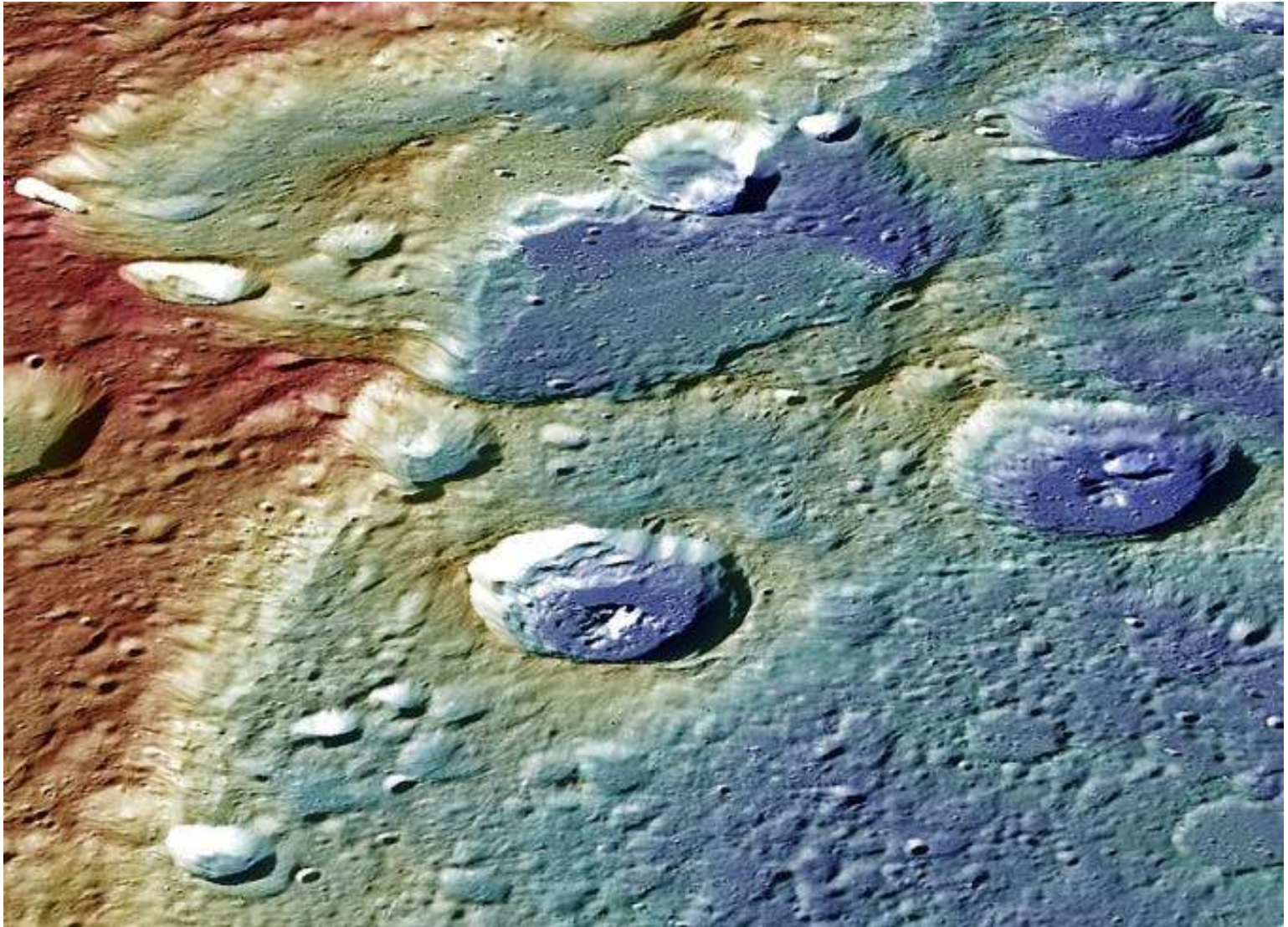
**1064nm =
near-IR**

**~1 metre
ground
resolution ?**

Data download:
[https://pds-
imaging.jpl.nasa.gov/
volumes/mess.html](https://pds-imaging.jpl.nasa.gov/volumes/mess.html)



The terrain (variations in topography) as measured by the MLA instrument and surface mapped by the MDIS instrument.



<https://photojournal.jpl.nasa.gov/catalog/PIA19422>

Venus

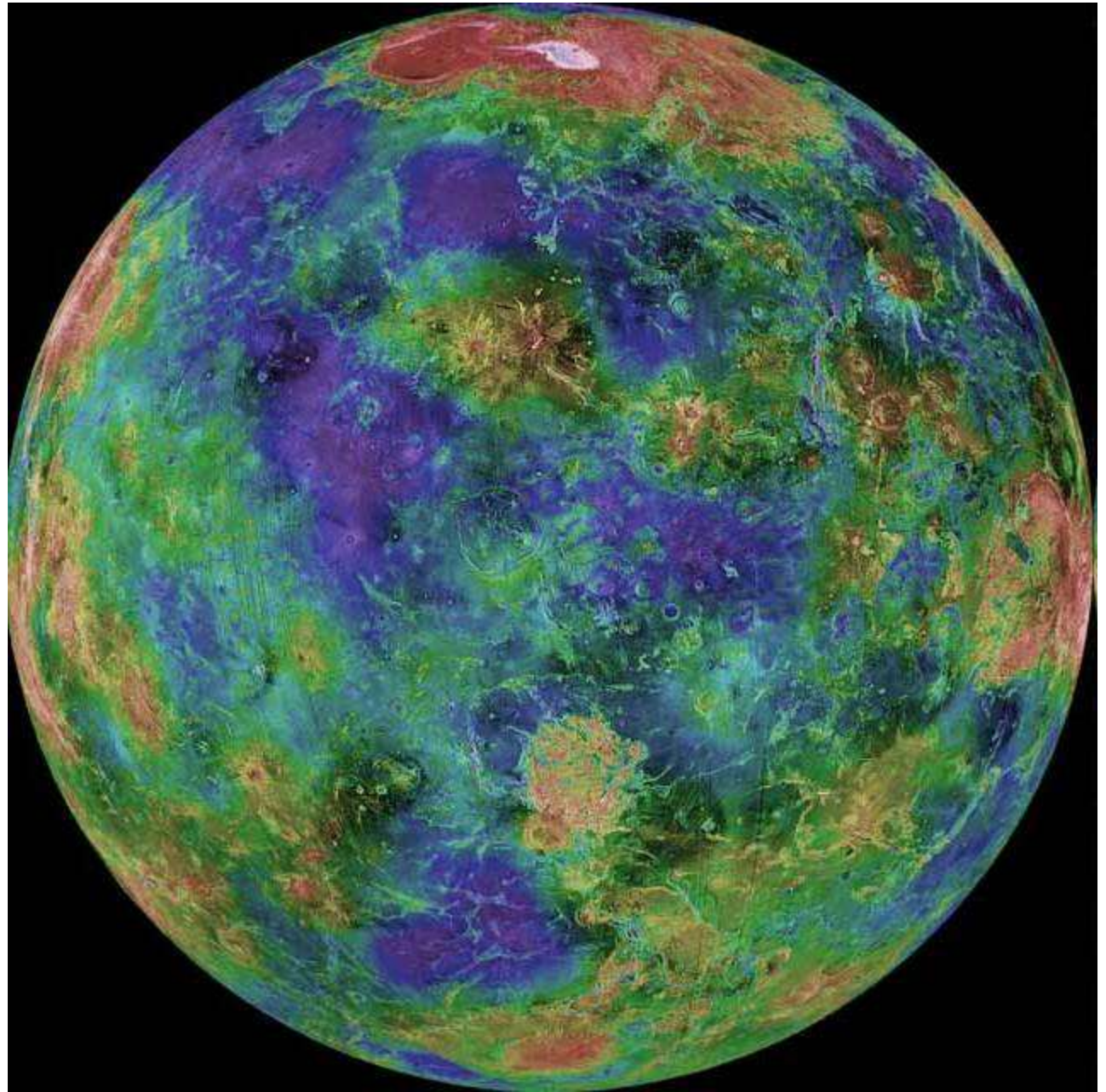
From Magellan
1990-94

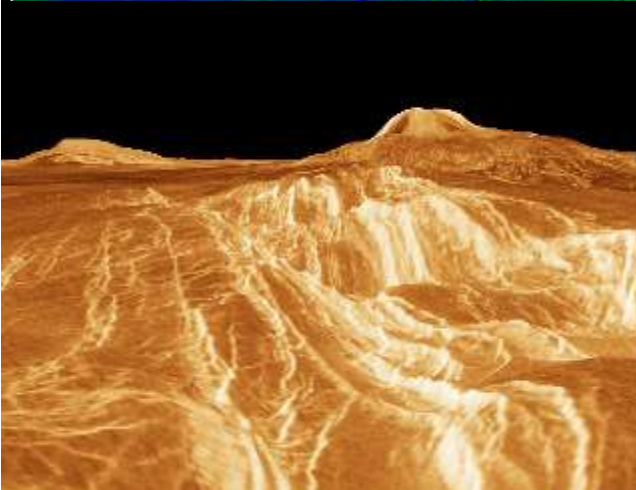
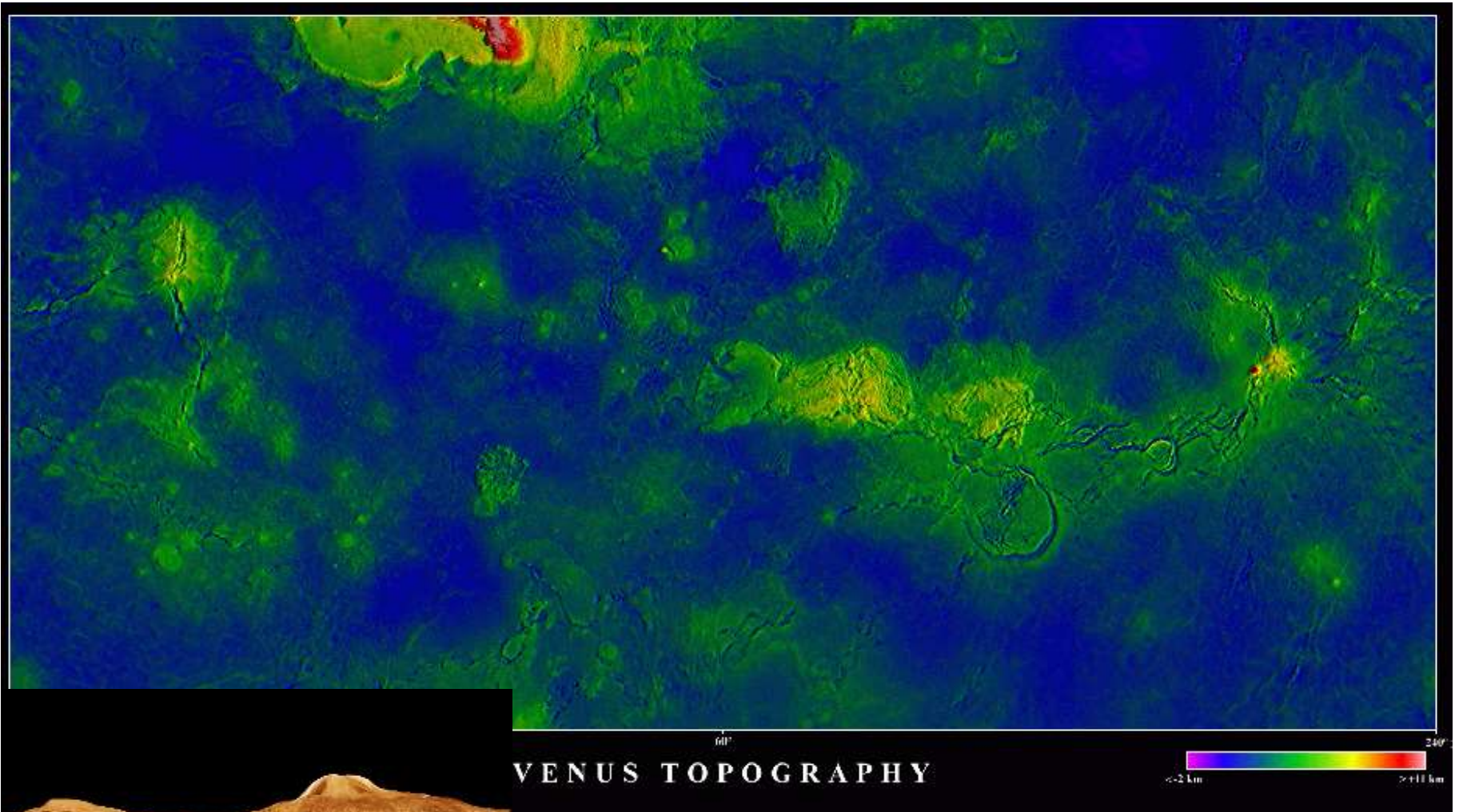
-first imaging
device launched
from Space
Shuttle (1989)

Planet is Cloud
covered

Radar 100m

Composite
colours based
on elevations





<https://svs.gsfc.nasa.gov/3728>

<https://www.youtube.com/watch?v=yUrlzPRI4GE>