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Educational activities with the Mars Webcam

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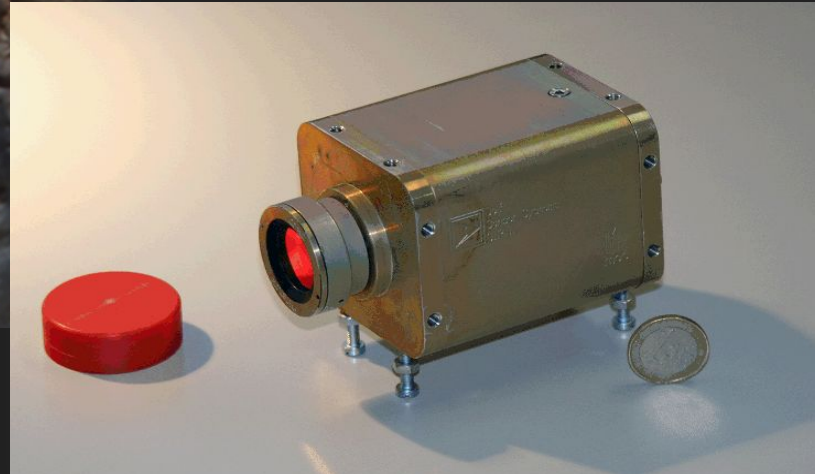
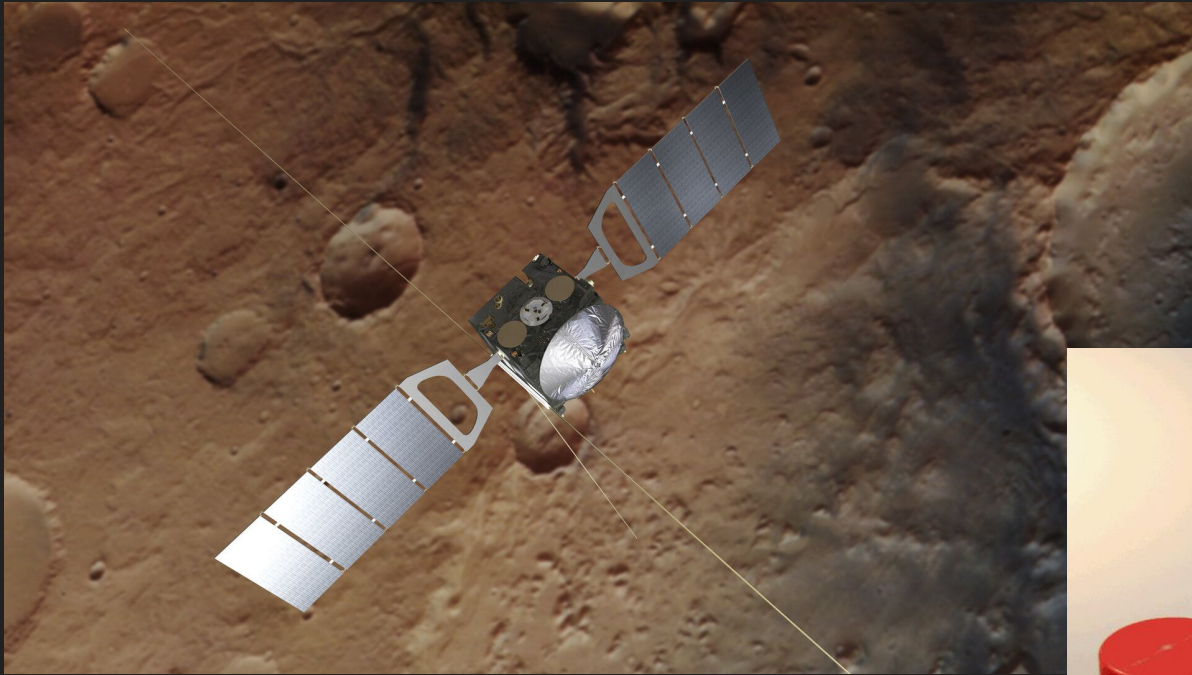


mars express

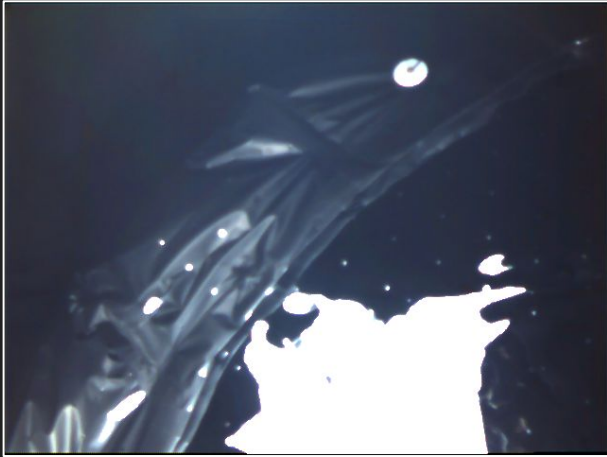
Galileo Teacher Training Program (19-23 October 2020)
Hands-On Session: Mars Express Visual Monitoring Camera

The Mars Webcam

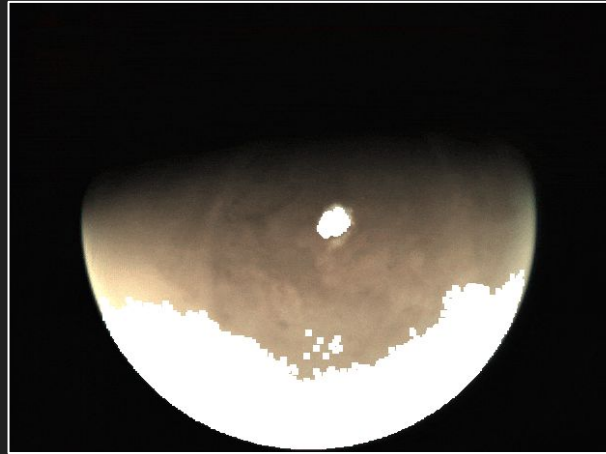
Also known as Visual Monitoring Camera (VMC)



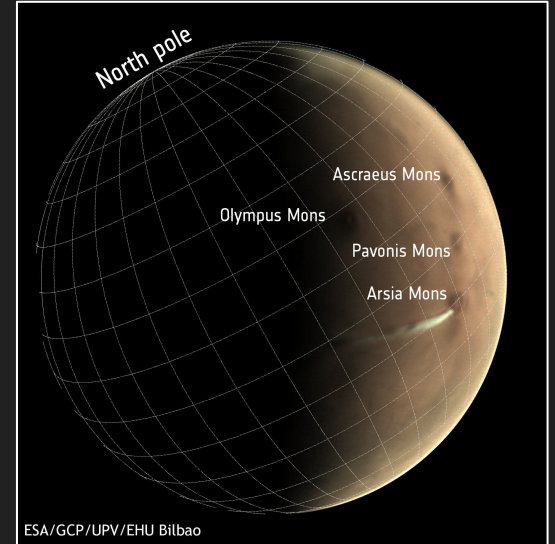
Brief history



(2003) Launched as an engineering camera intended to confirm the separation of the Beagle 2 lander.



(2007) Switch on again for outreach purposes



(2016) Acquires the status of Science instrument. Collaboration with UPV-EHU

As a Science Instrument, VMC focuses on the study of the Martian Climate.

Why is VMC special? Because of it takes full disk images.

Educational activities with VMC

My personal philosophy:

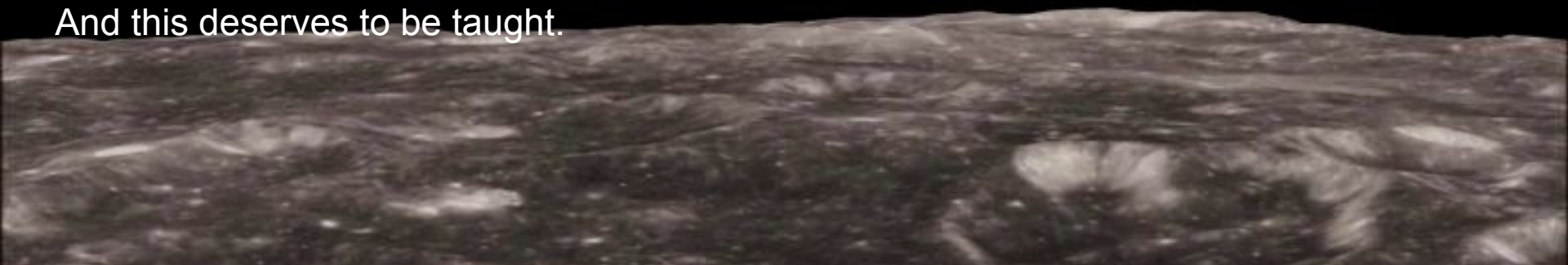
“Look at other planets to learn about what actually matters: Earth and its inhabitants”

What can we learn?

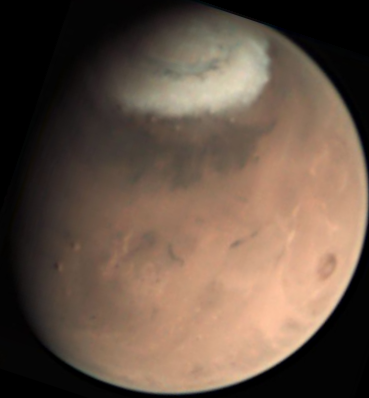


- We are alone, and on our own responsibility, on a unique planet that we must take care of.
- Life and Humans is the most special and fascinating thing we know in the Universe.

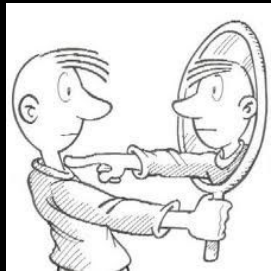
And this deserves to be taught.



Educational activities with VMC



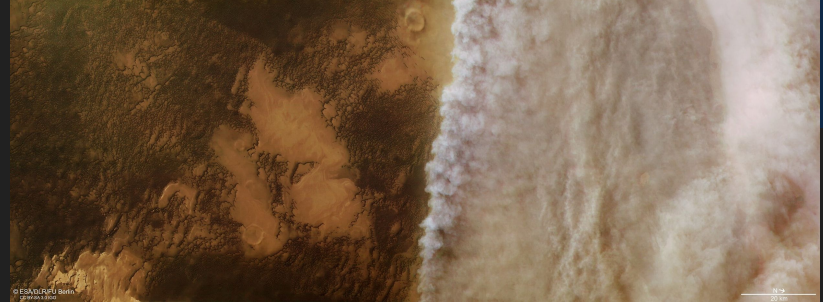
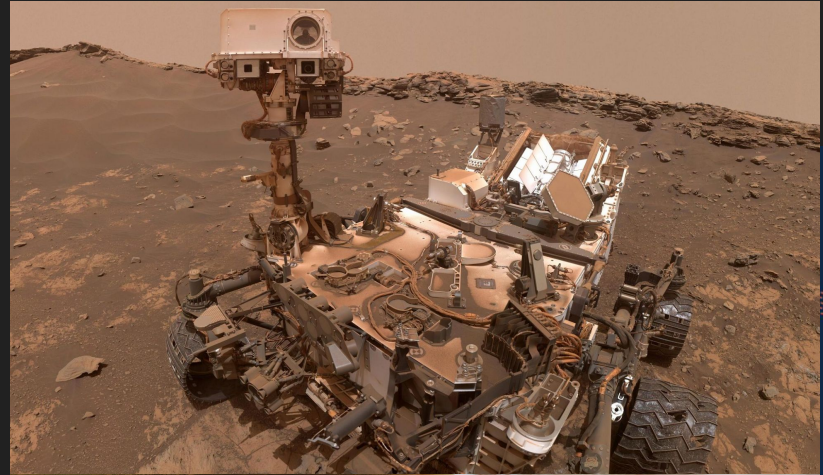
Full-disk images of Earth
<https://epic.gsfc.nasa.gov/>



The Martian Climate: **Ingredients**

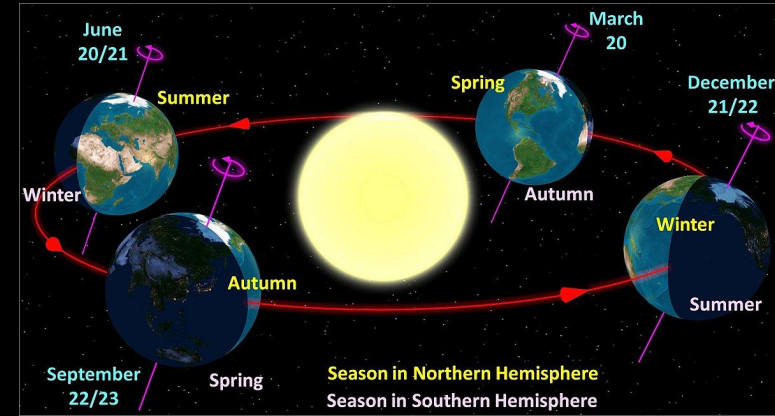


- Mars has a thin atmosphere, mostly made of CO₂
- Is there water on Mars? Yes. But not liquid water
- There are clouds. They are made of water ice, and more rarely dry ice (CO₂)
- A lot of dust!



The Martian Climate: Orbit and Rotation

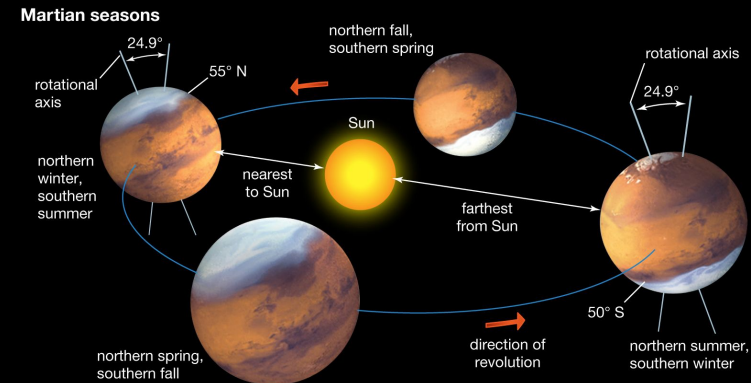
- Orbital tilt very similar to Earth -> Analogous Seasons
- More eccentric orbit -> Effects on climate!
- A Martian Year lasts ~2 Earth Years (23 months)
- A Mars “sol” lasts 24h39m (Earth day: 24h)



Concepts of the Martian Calendar

- Martian Year (MY)
- Solar Longitude (Ls): Orbital Position, 0°-360°

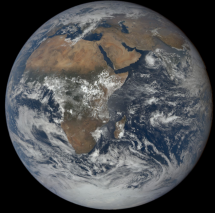
20 October 2020 on Earth = MY35, Ls 300°



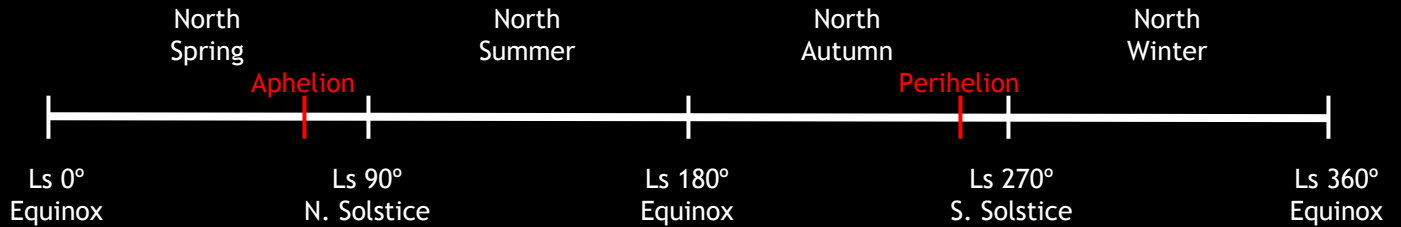
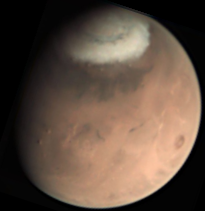
The Martian Year

Today

- Earth: 20 October 2020
- Mars: MY35, Ls 300°

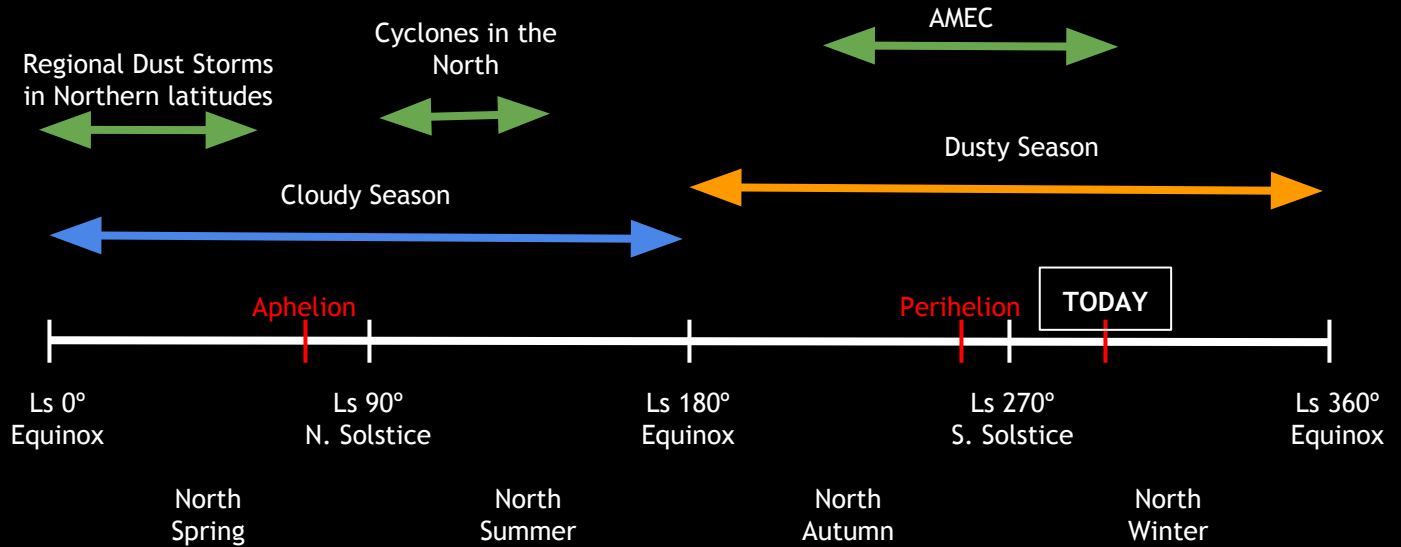


1 Earth Year = 12 Months



1 Martian Year = 23 Months

The Martian Climate through the Martian Year



Earth Time & Mars Time Conversion

Earth Date and Time

Date Year / Month / Day 2020 / 10 / 20	UTC Time (hh:mm:ss) 12 : 0 : 0
--	--------------------------------------

Some shortcuts to (re-)set Date to:

Today

Use landing dates of:

Insight Curiosity Phoenix
Opportunity Spirit Beagle 2
Pathfinder Viking Lander 2 Viking Lander 1
Mars 6 Mars 3 Mars 2

Some shortcuts to (re-)set Time to:

00:00:00
06:00:00
12:00:00
18:00:00
now (UTC)

Earth date above corresponds to Julian Date: 2459143

Convert Earth Date and time to Martian Date and Solar Longitude

Martian Year:	35	Martian Month:	10
Solar longitude Ls:	299.6	Sol number:	562

http://www-mars.lmd.jussieu.fr/mars/time/martian_time.html

Mars Year and Solar Longitude

Mars Year: 21 Solar Longitude Ls: 211

Convert Martian Date and Solar Longitude to Earth Date

Earth date above corresponds to Julian Date: 2449383.1529

Earth Year/Month/Day: 1994 / 1 / 30

http://www-mars.lmd.jussieu.fr/mars/time/mars_date_to_earth_date.html

When is my Martian Birthday?

- Convert the date I was born to Mars Time: 30 January 1994 -> MY 21, Ls 211°
- My next martian birthday: MY 36, Ls 211° -> 18 April 2022
- How “old” am I “on Mars”? I’m 14 Martian Years old! 🤪

How to get VMC Images?



<https://twitter.com/esamarswebcam>



https://www.flickr.com/photos/esa_marswebcam/



ESA Planetary Science Archive (PSA)

<https://archives.esac.esa.int>

How to use PSA



IMAGE VIEW

Show Browse Images Only

Number of selected items: 0

Sort by: **Mission** Target Product Title Processing Level **Start Time** Instrument Rating

Basic Advanced

Expand all Collapse all

- MISSIONS
- TARGETS
- INSTRUMENTS
- INSTRUMENT TYPES

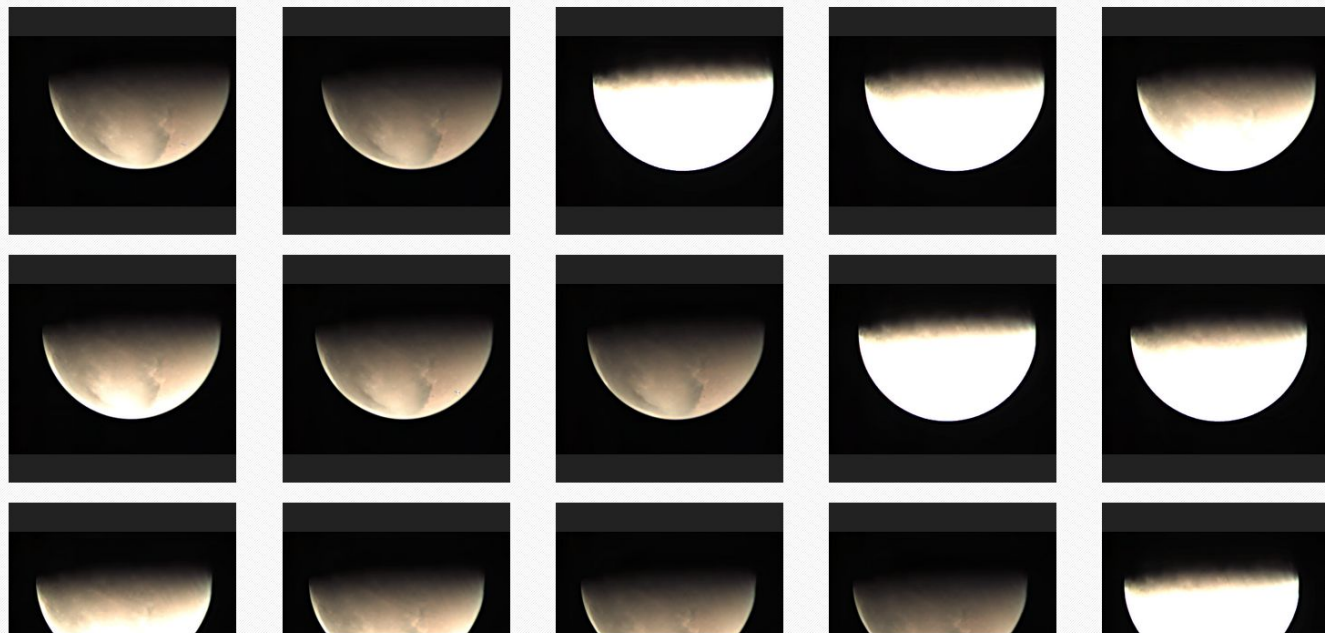
TIME

Start time

End time

- PROCESSING LEVEL
- WAVELENGTH RANGE
- PRODUCT VERSIONS

- LOCATION
- HELIOCENTRIC DISTANCE
- OBSERVATIONAL GEOMETRY
- RADIUS TO THE CENTRE
- LOCAL TIME

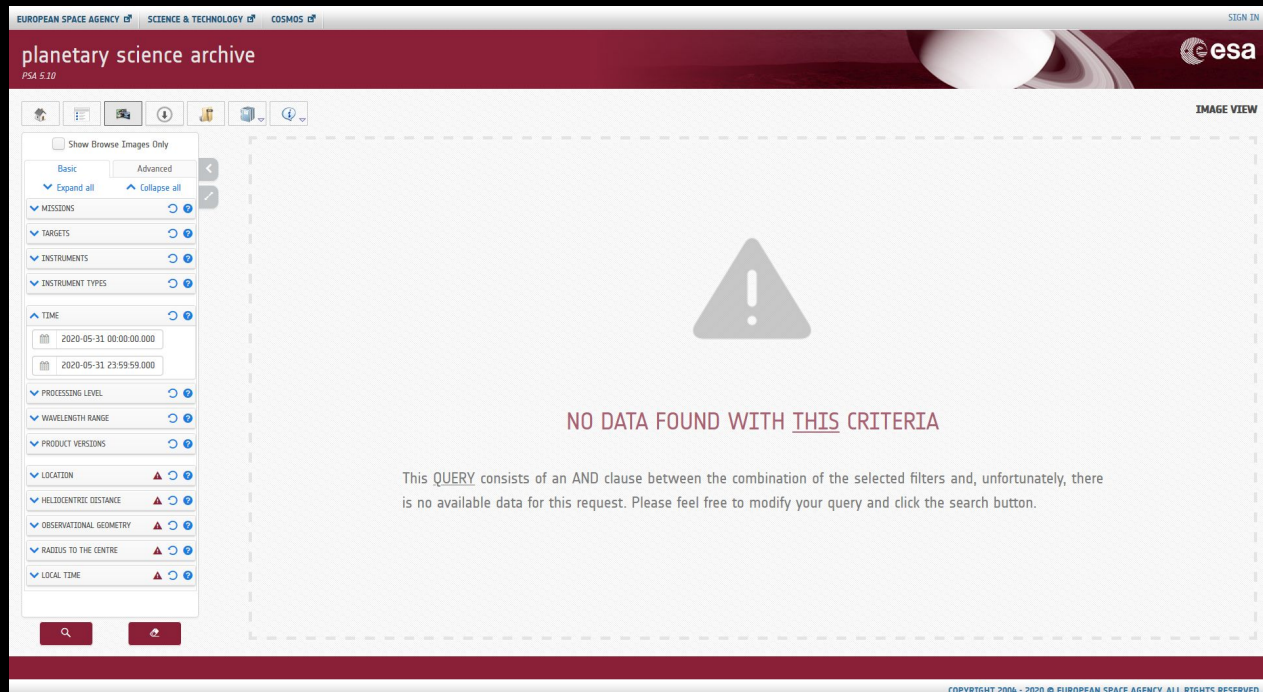


<< < Page: 1 49 > >>

Items/page: 1000 Displaying 1 - 1000 [1000 images] of 48471

How did Mars look around my last Martian Birthday?

NOTE that sometimes VMC takes some rest, and thus there are spare days and periods without images. —————> In my case, looks like VMC hates me 😂



The screenshot shows the ESA Planetary Science Archive (PSA) search interface. The page title is "planetary science archive" with "PSA 5.10" and the ESA logo. The search filters on the left include:

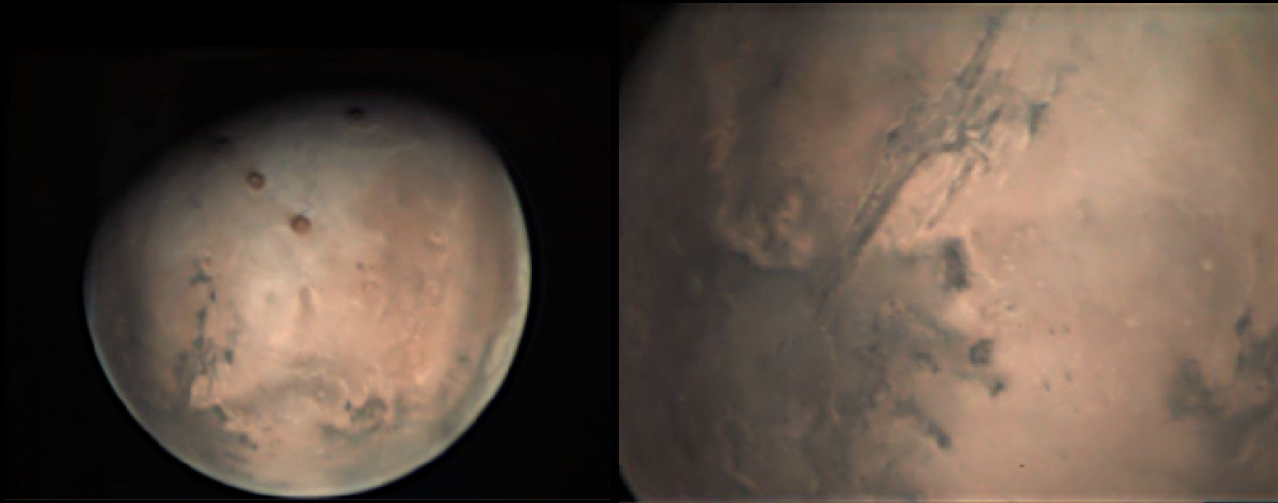
- MESSIONS
- TARGETS
- INSTRUMENTS
- INSTRUMENT TYPES
- TIME: 2020-05-31 00:00:00.000 to 2020-05-31 23:59:59.000
- PROCESSING LEVEL
- WAVELENGTH RANGE
- PRODUCT VERSIONS
- LOCATION
- HELIOCENTRIC DISTANCE
- OBSERVATIONAL GEOMETRY
- RADIUS TO THE CENTRE
- LOCAL TIME

The main content area displays a large warning icon and the message: "NO DATA FOUND WITH THIS CRITERIA". Below this, a note explains: "This QUERY consists of an AND clause between the combination of the selected filters and, unfortunately, there is no available data for this request. Please feel free to modify your query and click the search button."

At the bottom right, the copyright notice reads: "COPYRIGHT 2004 - 2020 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED."

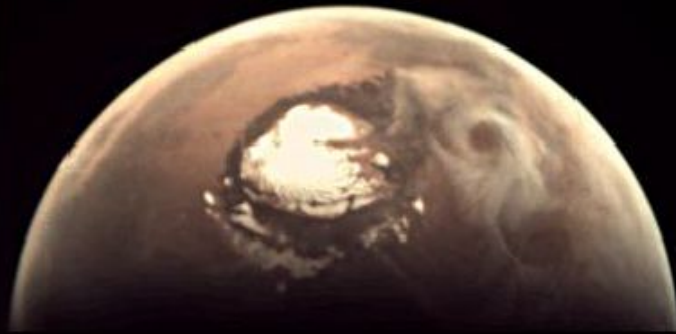
Most common features on the Martian Surface

The Valleys, Canals, Craters



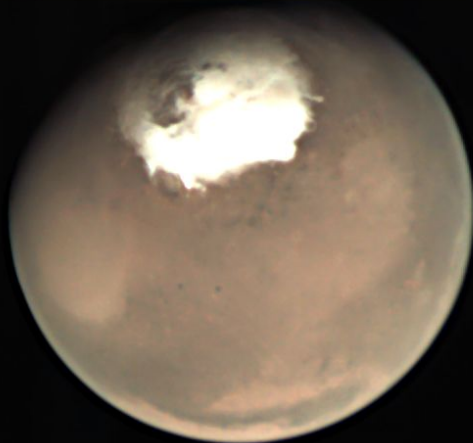
Some interesting things in the VMC archive:

- Global Dust Storm 2018
- Regional Dust Storms
- Gravity waves
- A double cyclone
- The amazing AMEC
- Polar caps

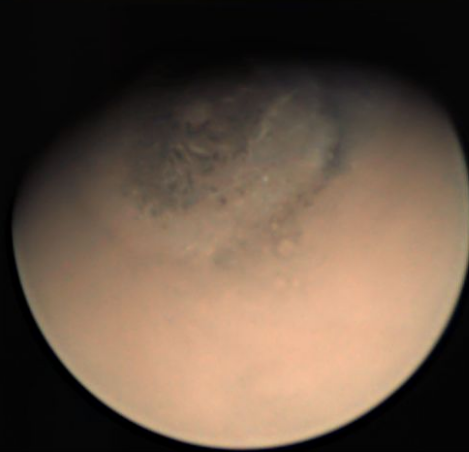


Global Dust Storm 2018

Some Martian Years, huge Dust Storms shake the whole planet. The last one took place in 2018.



2016-09-28 23:29:23



2018-07-11 00:35:10

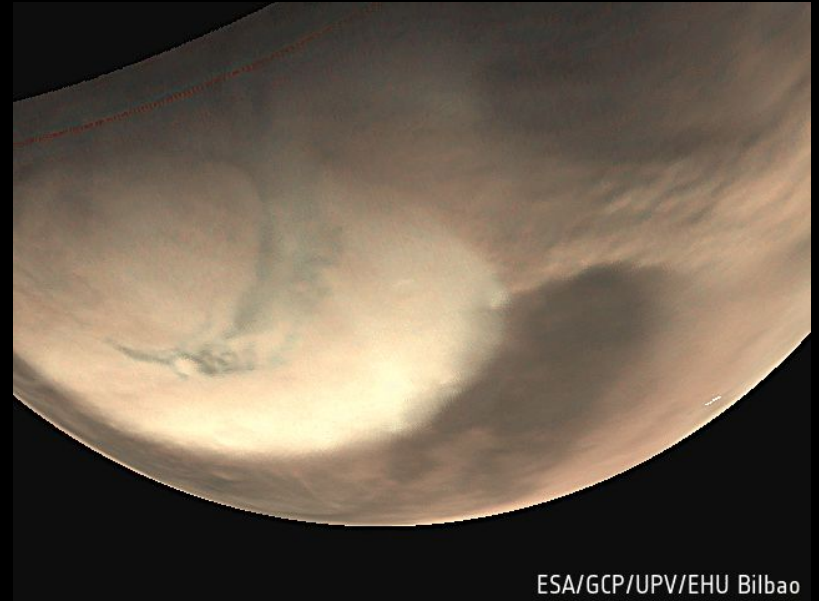
Practice: The 2018 Global Dust Storm

- Dates: June-August 2018 (MY 34, Ls 185°-240°)
- Idea: compare images from this season to images from other seasons. It is dusty!
- The Opportunity rover, which had been roving Mars for 15 years, died due to this event.

Regional Dust Storms

Regional dust storms are common. The best example captured by VMC was on May 29, 2019

https://www.esa.int/Science_Exploration/Space_Science/Mars_Express/Dust_storms_swirl_at_the_north_pole_of_Mars



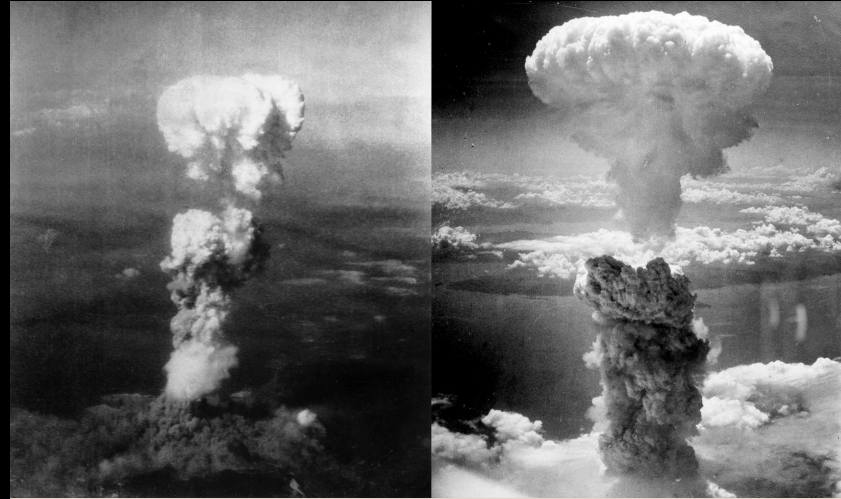
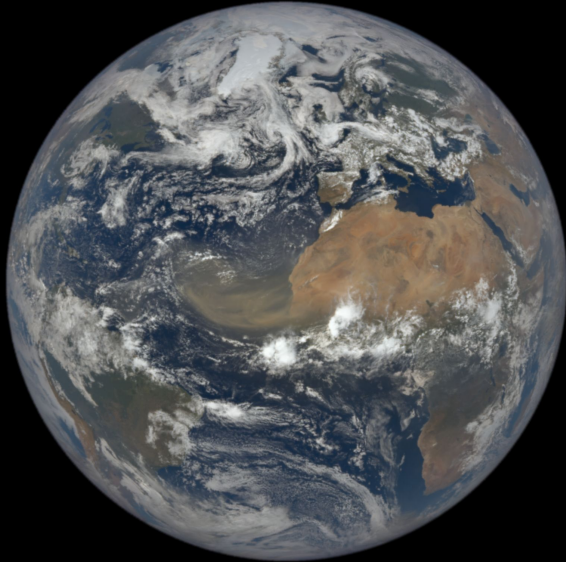
Animation showing the dust storm

Practice: A regional dust storm.

- Dates: 29 May 2019 (MY 35, Ls 31°)

What can humans learn from Mars Dust Storms?

- The research on the nuclear winter was boosted by them.
 - <https://www.smithsonianmag.com/science-nature/when-carl-sagan-warned-world-about-nuclear-winter-180967198/>
- Dust Storms are an actual threat on Earth, boosted by desertification and climate change.
 - <https://www.unenvironment.org/news-and-stories/story/unep-helps-launch-new-global-coalition-combat-sand-and-dust-storms>
 - <https://climatenewsnetwork.net/sand-and-dust-storms-pose-global-threat/>



Gravity Waves (not the same thing as gravitational waves!)

Gravity waves are a common phenomenon in any fluid (liquids and gases). We can generate gravity waves by simply moving a finger in a glass of water. On atmospheres, gravity waves can produce clouds that exhibit periodic structures.



2018-06-17 13:54:33

2018-12-05 23:03:32

Practice: Gravity waves

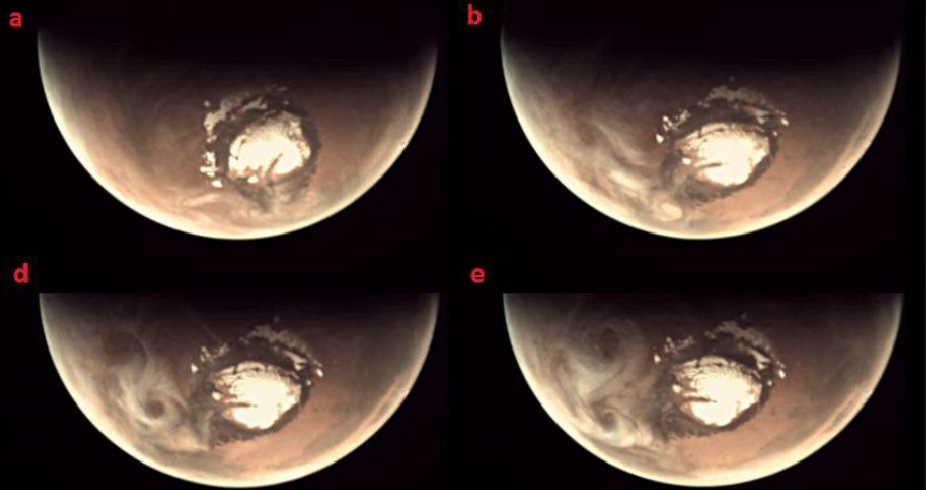
- They appear from time to time in VMC images (but not very often). See dates above.
- It can be used as example of waves, and to attract attention to gravity wave related clouds on earth.

A double cyclone on Mars

A beautiful cyclone takes place every martian year on the northern latitudes. VMC imaged it clearly in 2012.



Imaged by Hubble Space
Telescope



Imaged by VMC in 2012

Practice: A double cyclone

- Imaged clearly by VMC on June and July 2012. (MY 31, Ls 120°-140°)
- How big is it? (Image resolution in PSA labels, SalsaJ).
- Cyclones are present also on Earth, also in particular regions and seasons.

The Amazing AMEC

The AMEC is the Arsia Mons Elongated Cloud. A very special cloud that we discovered using VMC. It is an orographic cloud that appears in the slope of the Arsia Mons volcano (but it is a water ice cloud, not linked to volcanic activity!)



https://www.esa.int/ESA_Multimedia/Images/2020/07/Return_of_the_extremely_elongated_cloud_on_Mars

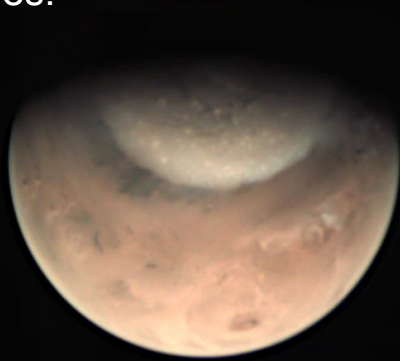


Practice: The amazing AMEC

- Best dates: October 2018, July 17 and 19 2020. Ls $\sim 240^{\circ}$ - 300° .
- How long is it? Compare to the distance between volcanoes (<https://trek.nasa.gov/mars/>, SalsaJ)
- Orographic clouds are present also on Earth, not all of them are this impressive.

The Martian Polar Caps

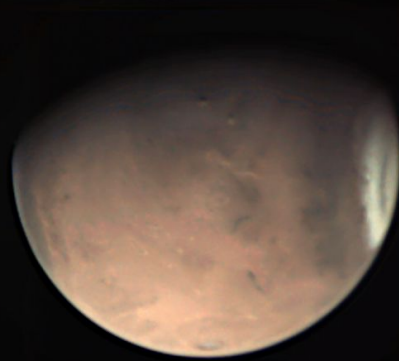
Mars exhibits Polar Caps in the North and South Poles. They are made of frozen water and CO_2 . These polar caps evolve in size through the Martian Year, and this can be appreciated in VMC images.



2019/3/27, Ls 2°



2019/6/15, Ls 40°



2019/7/20, Ls 55°



Practice: The Martian Polar Caps

- Choose different dates. This is critical. I recommend choosing similar images. It is easier on the North Polar Cap, which melts during its spring (Ls 0°-90°).
- Due to our orbit, some martian years we cannot image the melting cap.

Escape from Earth To Mars?

- Mars is not a comfortable place. Even in the worst scenario, it will be easier to make habitable spaces on Earth than on Mars.
- Let's leave Earth for **exploration and common growth**, not for surviving or private interests!
- We need **slow reflection**, and big picture, realistic, long term thinking: **we need much more than STEM** to drive our future as humanity. **Science and Technology is not enough** to understand our reality and solve our problems.



Don't Occupy Mars, Make Earth Great Again

Don't





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Thank you!

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mars express

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