


# A new type of cloud discovered from Earth in the upper Martian atmosphere



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# November 2020: A good configuration to observe Mars from the Earth.



# An observation program is initiated between amateur and professional astronomers

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# The strengths of amateurs:

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- Very well equipped
- Always observing, exchanging, enthusiastic
- Develop their own equipment
- Develop their own softwares
- Scattered all over the Earth
- Able to react on alert
- Very very very smart...

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Able to make pictures such as this one  
(Damian Peach, UK)



# November 2020: positive detection of a detached layer

- Christophe Pellier Nantes (France, +47°12 N, 1°33 W) using a 305mm (12") f/5 Newtonian telescope on an altazimuth mount, equipped with a ASI290MM monochrome CMOS camera, and a ASI224MC colour CMOS camera. Various filters (UV, B 425, B 436, broadband B mainly). The exposures ranged from 5ms (color camera) to 100ms (UV filter); only the best 5% to 25% raw frames of the whole videos were stacked to produce the final images.
- Emmanuel Beaudoin (EM) Palaiseau (France, +48.7°N, 2.23°E) using a 356mm (Celestron 14) Schmidt-Cassegrain on a AP900 mount, with a camera ASI290MM. The sampling was of 0,09'' per pixel. The exposure time was 2.5ms (red filter), 3.5ms (Green) 5.5ms (Blue). 10 to 20% raw frames were stacked to produce the final images.

G 20H25 UT



B 20H30 UT



G 20H34 IUT



R 20H40 UT



G 20H47 UT



G 20H51 UT



B 20H55 UT



G 21H05 UT



R 21H10 UT



G 21H15 UT



B 21H22 UT



G 21H26 UT

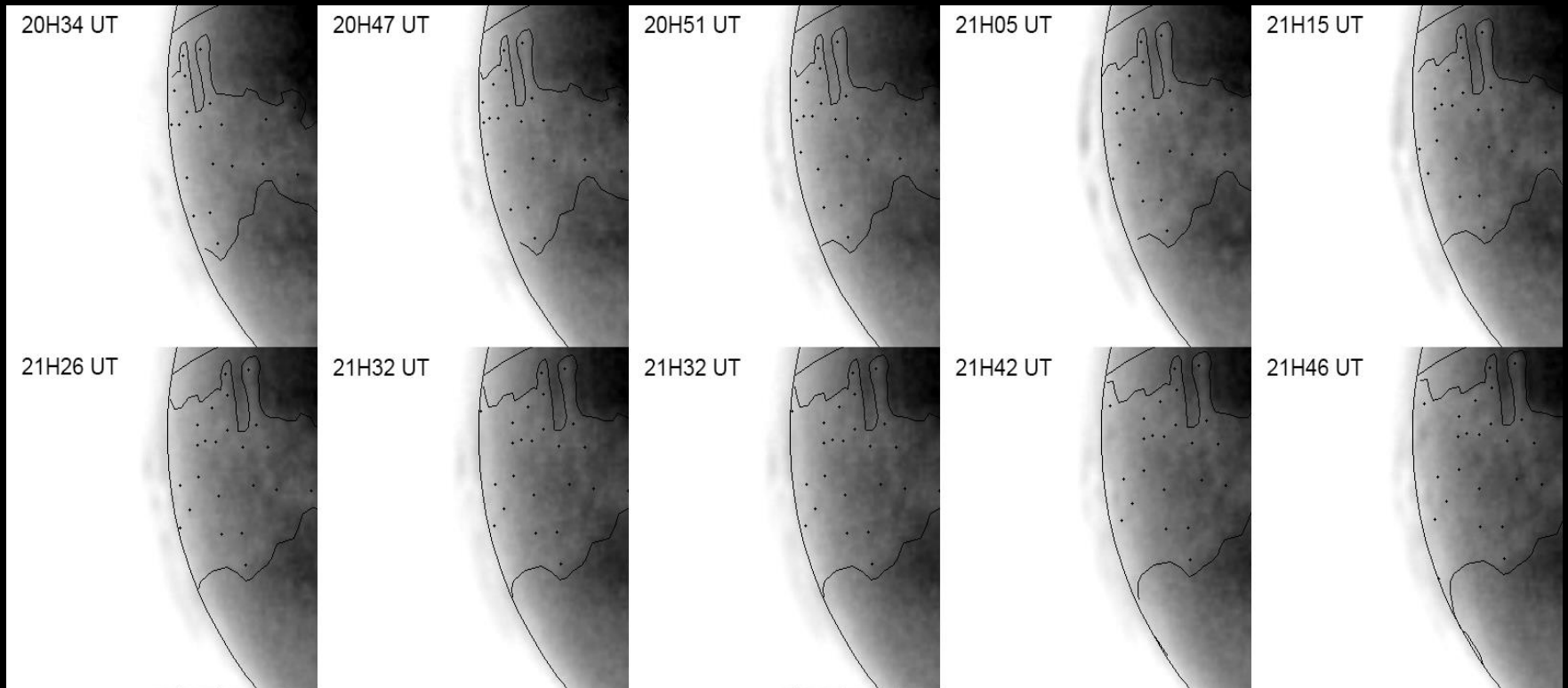


Time evolution of the detached layer from 20H25 to 21H26 UT through red (R), green (G) or blue (B) filter.

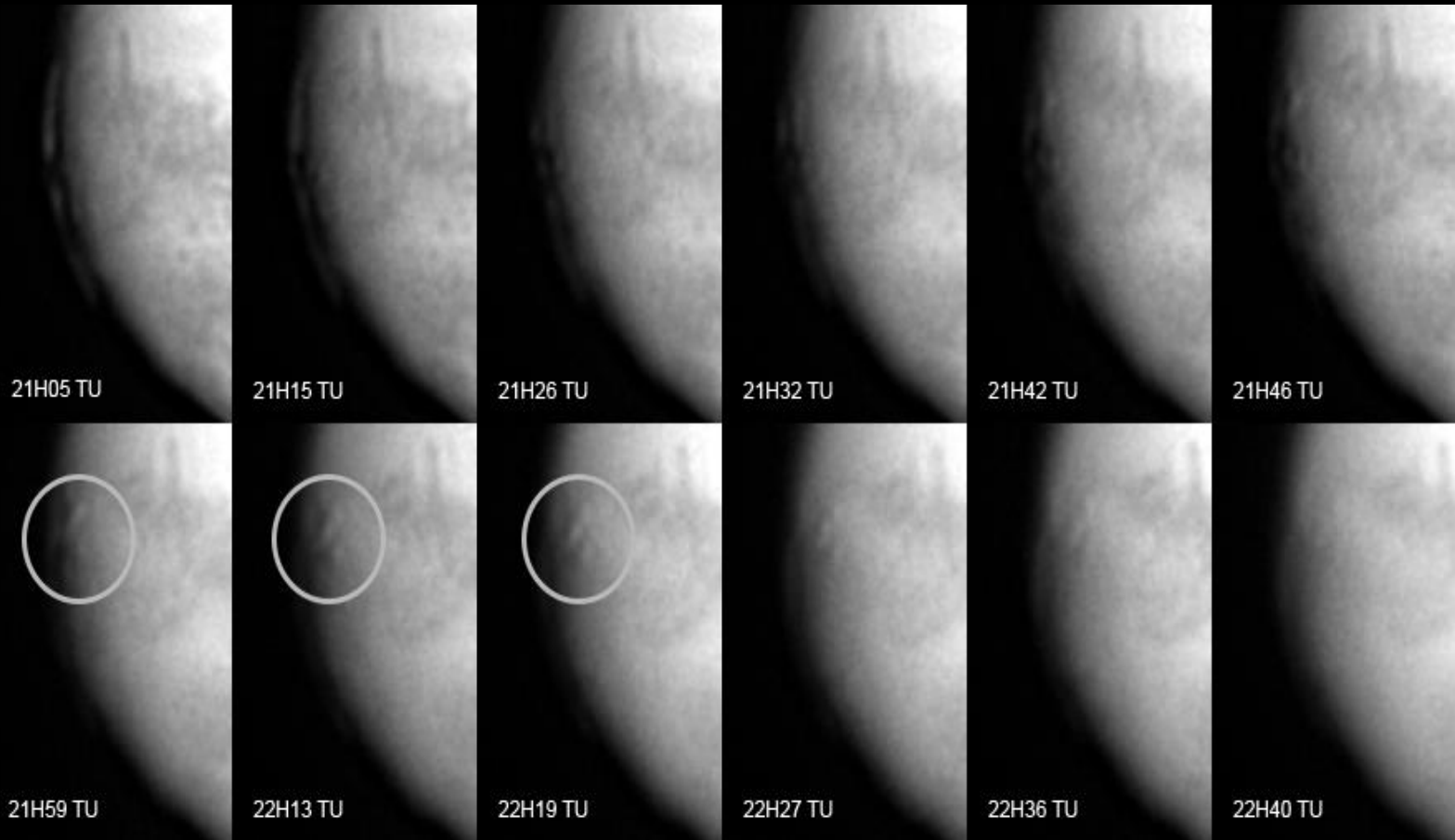
That is the first time that a large scale structure  
is observed at Mars over several hours.  
Spacecrafts cannot do that.



# Time evolution of the detached layer from 20H34 to 21H46 UT through a green filter without over exposition of the Martian disk.



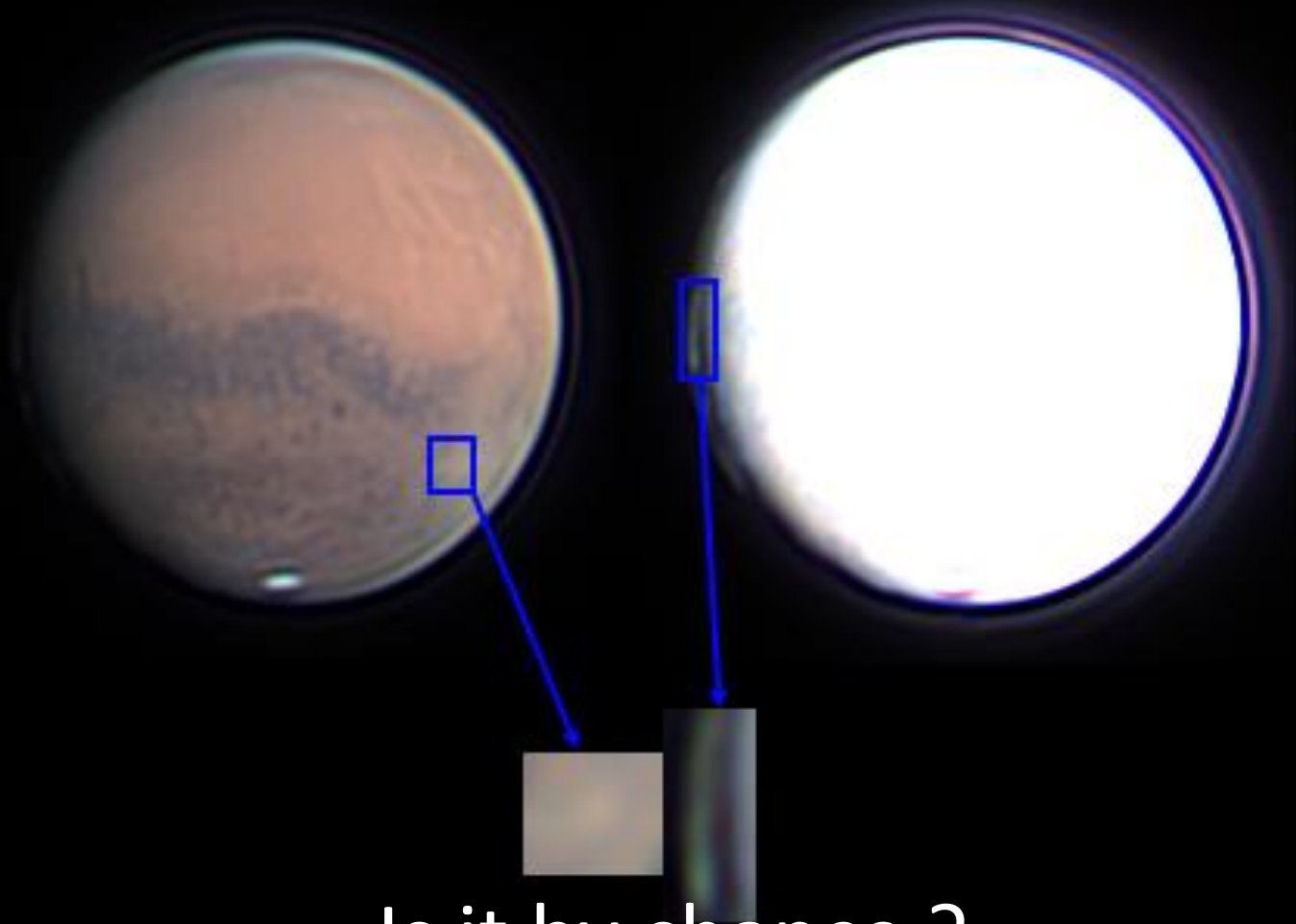
From 21H42 UT, it becomes visible in front of the disk and casts shadows.



## The detached layer:

- Extends over thousands of km from the equator to 50°S.
- Emerges from the night side and progressively dissipate in the dayside
- Its altitude is 90 (-16/+30) km over 3 hours.
- Occurs at a solar longitude of 316°.

A dust storm is visible in the south hemisphere in this RGB image (2021-11-17 21:03.3 UT). Far away from the detached layer.



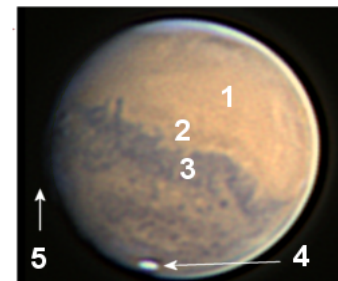
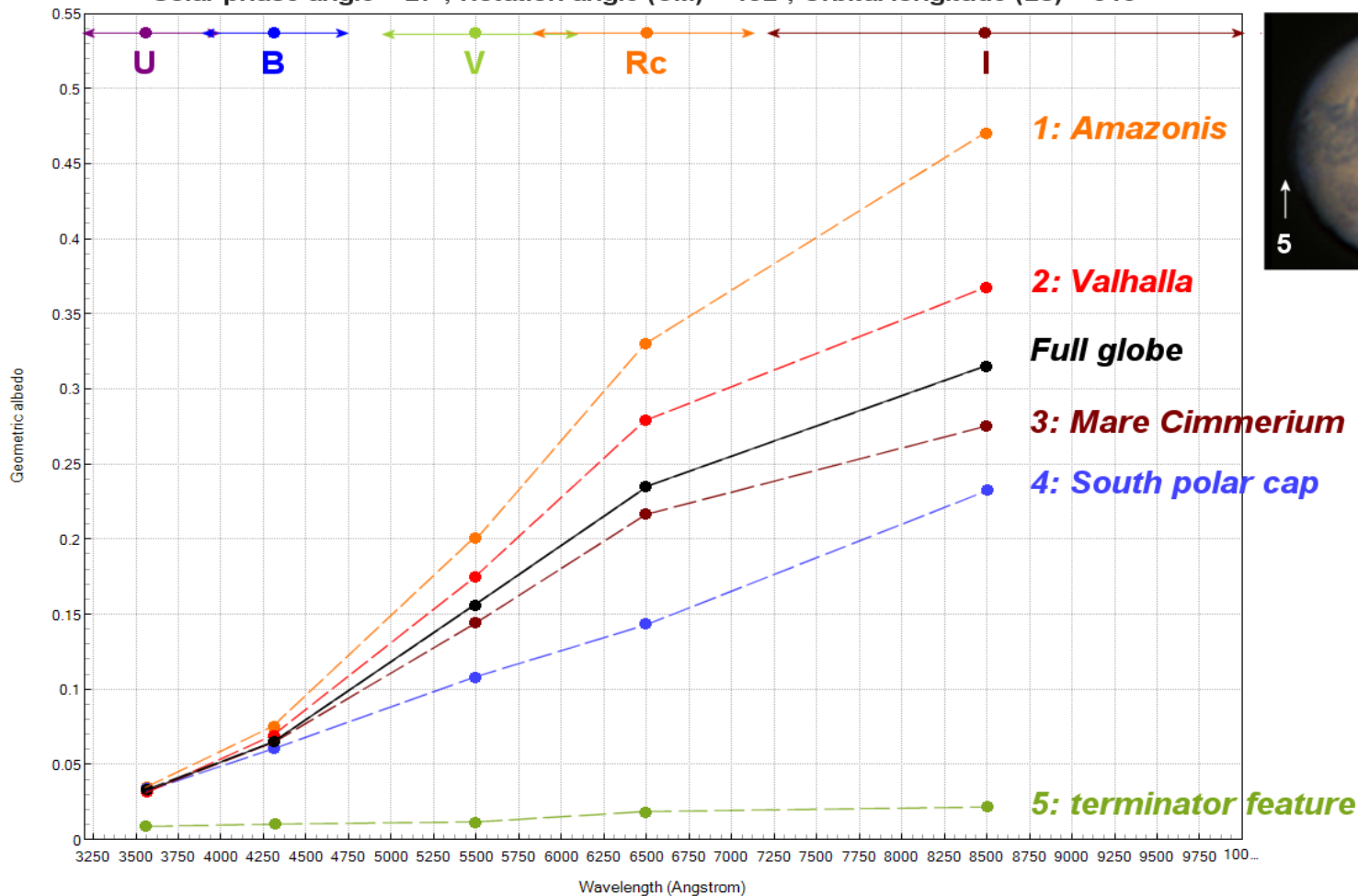
Is it by chance ?

# Albedo analysis

Geometric albedo of martian features on 2020/11/17

corrected from orbital parameters:

Solar phase angle = 27°, Rotation angle (CM) = 192°, Orbital longitude (Ls) = 316°

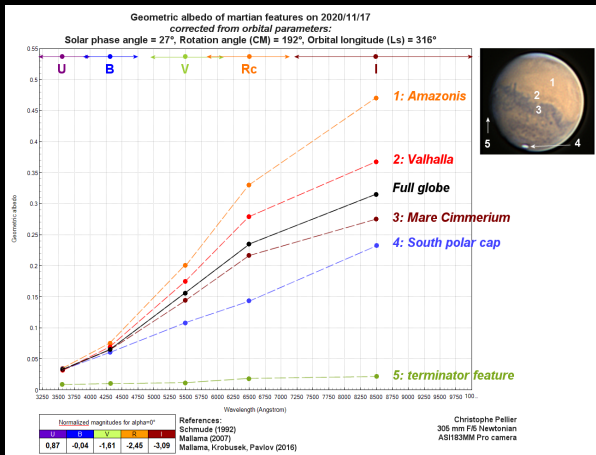


Normalized magnitudes for alpha=0°				
U	B	V	R	I
0,87	-0,04	-1,61	-2,45	-3,09

References:  
 Schumde (1992)  
 Mallama (2007)  
 Mallama, Krobusek, Pavlov (2016)

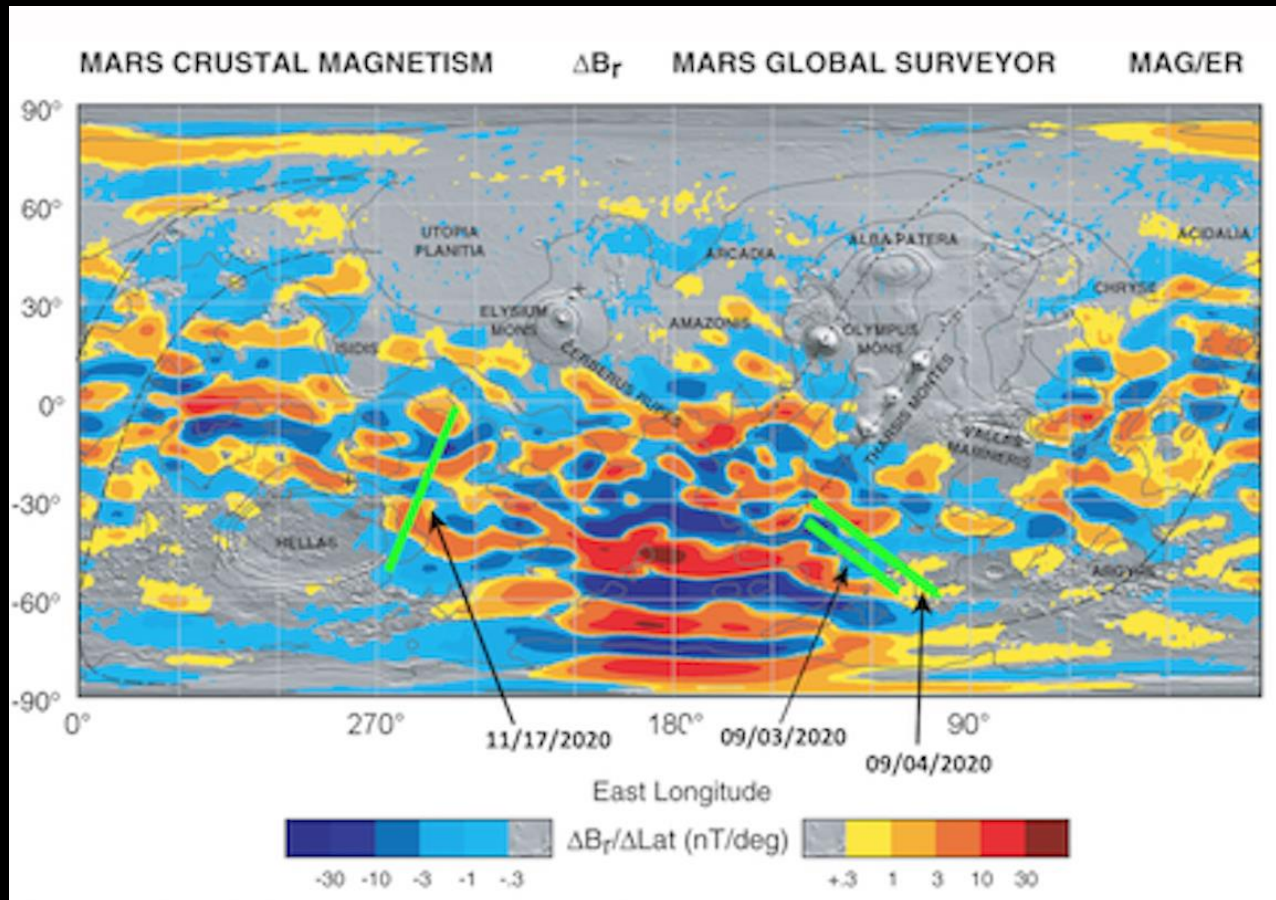
Christophe Pellier  
 305 mm F/5 Newtonian  
 ASI183MM Pro camera

The detached layer is characterised by a reflectance increase by a factor of two from blue to red. This increase is lower compared to typical Martian terrains, notably bright terrains covered by dust over which the ferric oxides result in an increase by a factor greater than 5.



Dust is ruled out

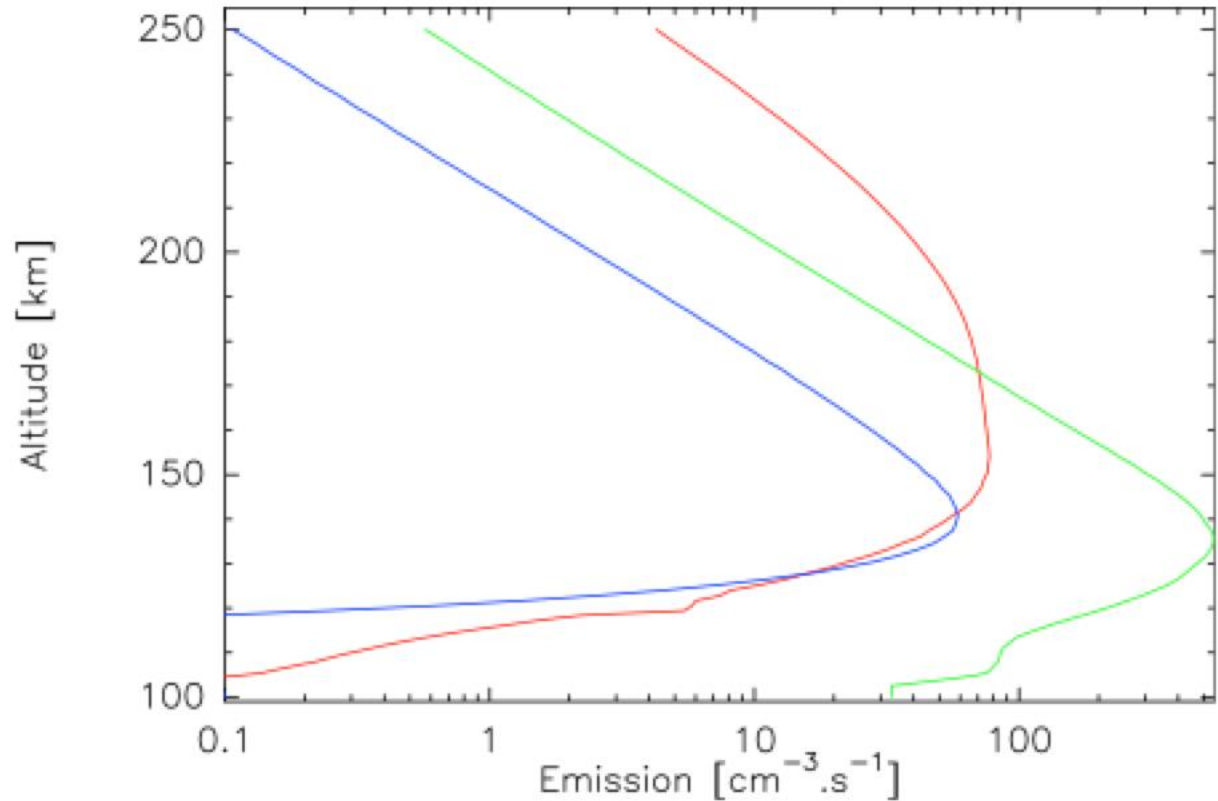
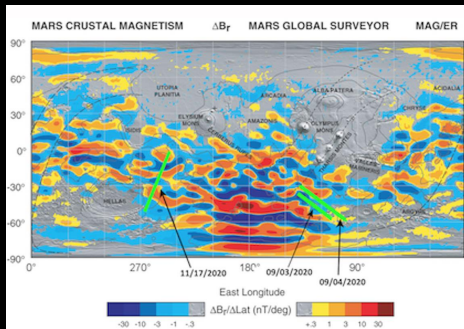
This observations occur on the west side of the main magnetic anomaly. A former one (not shown here) in September occurred on the East side. The only comparable published observation (Sanchez-Lavega et al., Nature 2015) occurred above this main magnetic anomaly



Is it by chance ?



# A new modeling effort confirms that the colour ratio for aurora is not that observed



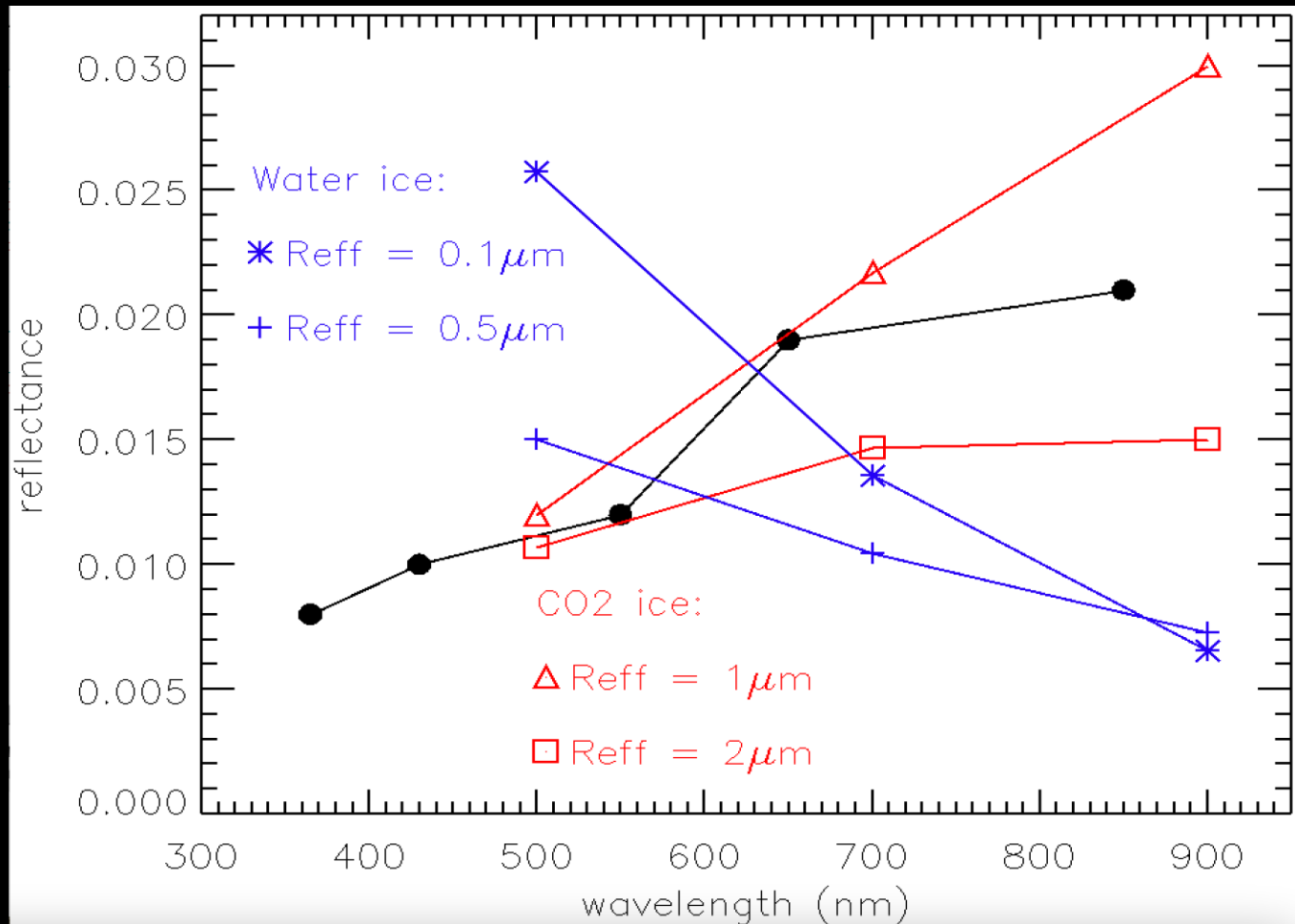


# Spectrum of typical "90 km altitude" ice clouds:

CO<sub>2</sub> (1 - 2  $\mu\text{m}$  particle size)

H<sub>2</sub>O (0.1 - 0.5 particle size)

(differences are primarily due to size and not to composition)



The detached layer is either :

1) A large-grained water ice cloud system.

Pros:

- Water ice clouds, notably at high altitude reaching 90-100 km, have been observed during this season (dust storm season)
- Large-grained water ice cloud of this size are known to go higher during major storm event and such an event is observed at the same time as the cloud

Cons:

- Water ice clouds with 1-2  $\mu\text{m}$  particle size have been reported up to 60 km so far even during global dust storm.
- Typical water ice clouds at 90 km are significantly smaller-grained (0.1 - 0.5)

The cloud is either :

2) a large-grained CO<sub>2</sub> cloud system:

Pros:

- CO<sub>2</sub> particle size is typical for this altitude range

Cons:

- Previous report of CO<sub>2</sub> clouds at this Ls are extremely sparse while our cloud is huge and last over several hours.
- Previous report of CO<sub>2</sub> clouds have smaller extent.

## Conclusion:

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We could observe **during several hours, from the Earth**, a detached layer at Mars which does not correspond to the already identified structures:

- It occurs between 74 and 119 km height, with a **mean at 90 km**.
- It is unique also by its size – **several thousands of kilometers** –
- It **lasts several hours**, with a longitudinal extension of more than 30°
- It occurs in the **southern hemisphere's mid-summer**

It could be made thanks to the **collaboration between 10 amateur astronomers and several professional astronomers**

It is an **atypical CO<sub>2</sub> cloud system** in the upper Martian atmosphere.  
It offers a good potential to learn more about Martian clouds.

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# Submission to A&A planned soon

