Imaging Mars from Curaçao in 2018

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During the 2018 apparition we imaged Mars on the island of Curaçao (E. S.) and from the Netherlands (J. S.), using Celestron C8 and C14 Schmidt–Cassegrain telescopes, respectively. Since the altitude of Mars was the highest on Curaçao and this Caribbean island often has excellent seeing conditions, the most detailed information was collected there. Starting at the end of 2018 May, a big dust storm developed, which at the end of 2018 June covered almost the entire martian surface. In 2018 September the storm had vanished again.

Figure 1. Location of Curaçao.

Introduction

The 2018 apparition of Mars was especially interesting, because at the opposition of 2018 Jul 27 the apparent size of the disc reached a comfortable 24.3 arcseconds (″). Unfortunately, for European observers the planet stood only ~12° above the horizon. From their locations Mars could best be observed in January–February (average altitude ~18°) and November–December (average altitude ~30°). However, during those periods, the apparent size of Mars was only 6 & 10″, respectively.

For observers on the Dutch Caribbean island Curaçao, the situation was quite different. At its latitude of 12°N, Mars stood 40° higher above the horizon. In this paper we describe the fine observing conditions on Curaçao for planets in general and, in particular, the imaging of Mars during the 2018 apparition. The observations of the planet in the early and late phases are complemented with those from the Netherlands.

Equipment & protocols

E. S. started planetary imaging in 2017 July with a Celestron Maksutov 90SLT and a NexImage 5 camera. From 2018 March he used a Celestron C8 (200mm) Edge HD Schmidt–Cassegrain telescope in combination with an ASI290MC colour camera. J. S. used a Celestron C14 (356mm) telescope with a monochrome ASI290MM camera plus various filters, or an ASI290MC camera plus an Atmospheric Dispersion Corrector (Astro Systems Holland).

The cameras were equipped with Barlow lenses with magnifications from ×1.5 to ×3. For imaging of Mars, videos in SER format were collected, containing 10,000 frames. The frames were centred with the software program *PIPP*. Subsequently, the best frames were stacked with *Autostakkert 3* and subjected to sharpening using the wavelet functions of *Registax 6.1* or *Photoshop*.

Figure 2. The appearance of the daily sky over Curaçao.

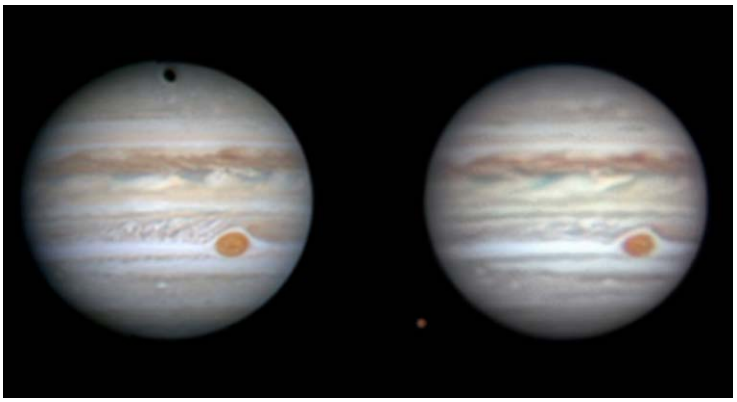

Figure 3. Comparison of the performance of a C8 telescope on Curaçao (*left*, taken 2018 Jun 26 by E. Sussenbach; *f*/30; alt. 60°) and a C14 telescope in Houten in the Netherlands (*right*, taken by J. Sussenbach on 2018 Jul 13; *f*/11; alt. 20°). North is up.

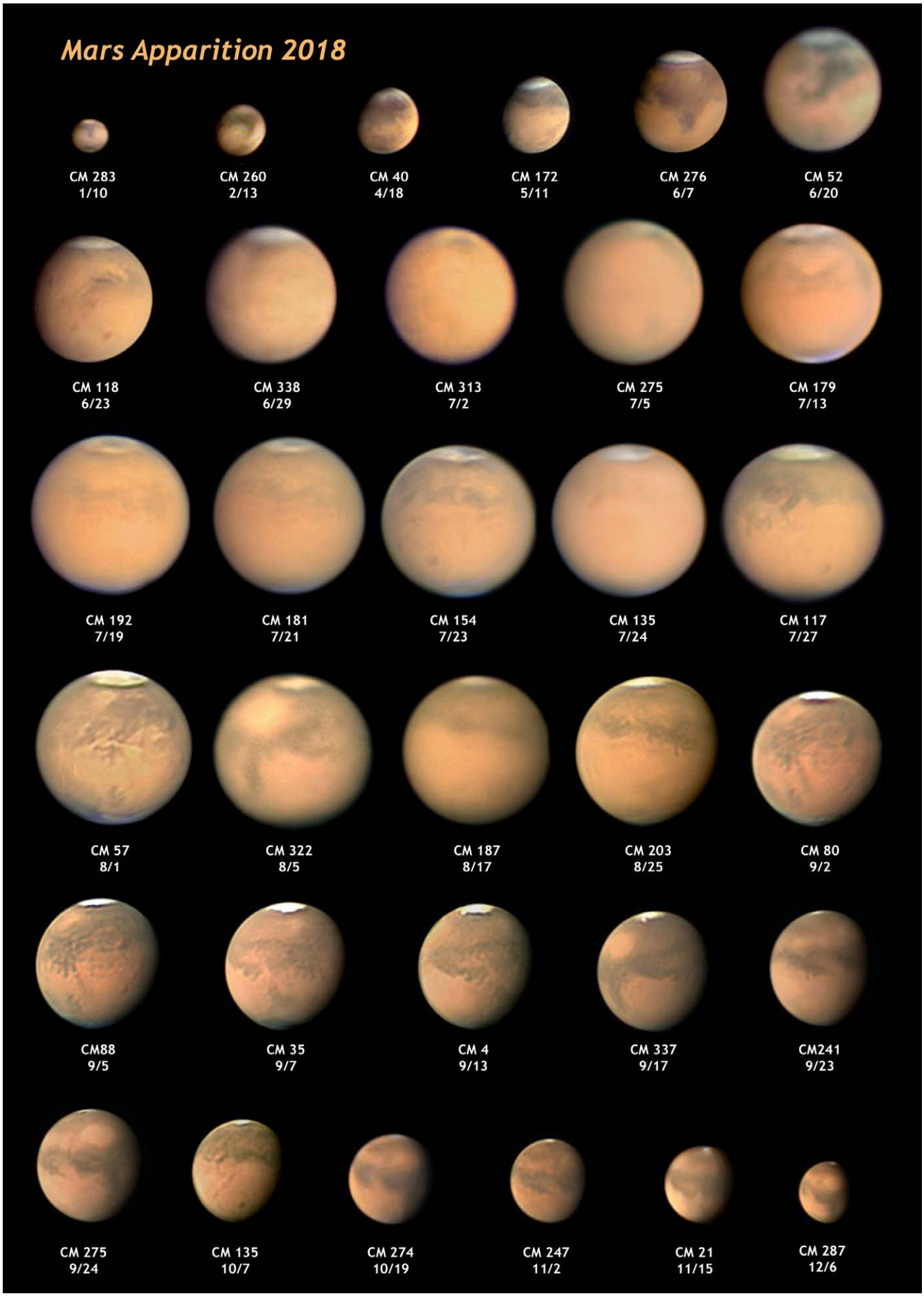

Figure 4. Compilation of Mars images obtained by Eric and John Sussenbach using C8 and C14 telescopes, respectively.

Weather conditions on Curaçao

The seeing conditions on Curaçao can in general be characterised as 'good' to 'very good'. The reason for this qualification is the location of the island (Figure 1). The surrounding sea stabilises the atmospheric temperature, which varies over the year from 29 to 32°C. The temperature at night is only a few degrees lower. Most of the year the continuous north-eastern trade winds provide a laminar airflow, which also contributes to the stability of the atmosphere and leads to excellent conditions for planetary imaging. The island does not have seasonal atmospheric changes, with the exception of the months November and December when it rains more often than usual and cloudy skies prevent imaging. Curaçao lies outside the hurricane belt, and rarely gets hit.

There is one issue the serious planetary imager must consider: on most nights, the skies are partially clouded (Figure 2). The strong trade winds let these clouds fly across the sky and their presence often interferes with the capturing of contiguous series of red, green and blue videos. Due to these clouds, an RGB series is often incomplete. For that reason, most of the time we used the ASI290MC camera.

Figure 3 illustrates the difference in imaging conditions on Curaçao (latitude 12°N) and in Houten, the Netherlands (latitude 52°N). Clearly, the C8 telescope performs much better than the C14. The C8 result was obtained with an ASI290MC camera; for the C14 image, an ASI290MM camera was used in combination with an RGB filter set.

Imaging of Mars through the year

At our own locations, we both imaged the growing image of Mars during the year. From 2018 Jul 19 until Aug 1 we imaged Mars together from Curaçao. A compilation of the results obtained at the two locations is presented in Figure 4. In all images, south is up. The Mars images are presented at the same relative size and most of them were collected on Curaçao.

In the first months of the year, the disc of Mars gradually grew and the familiar darker albedo features became visible (Figure 5, 2018 Jun 7). The south polar cap was very distinct.

In May, other observers had detected dust storms in the neighbourhood of *Mare Acidalium*, moving southwards.[1] As this side of the globe was invisible from our locations, we could not capture any images of these early events. However, in the second half of June we were able to detect dust storms in the regions of *Mare Erythraeum* and *Solis Lacus* (See Figure 4; 2018 Jun 20 & 23, respectively). The development of the dust storm is nicely illustrated in Figures 5–8. Note how on 2018 Jun 23 the storm covered *Aonia Terra*, *Solis Planum* and *Terra Sirenum*. Only *Daedalia Planum* was still visible in this region. The south polar cap was big and *Olympus Mons* could be distinguished as well as the *Tharsis* volcanoes.

Towards the end of June, other regions of Mars could also be observed. Images from this period showed that regions such as *Solis Lacus*, *Mare Erythraeum* and the area around *Sinus Meridiani* were invisible in RGB images (Figure 6). Using infrared filters (*e.g.* 742nm pass) revealed more details, but still most of the surface was invisible.

On 2018 Jul 2 we imaged the region of *Syrtis Major* and dust clouds covered large areas of the surface, like *Syrtis Major* and the *Hellas* basin (Figure 7). In the RGB image, hardly any detail can be distinguished. In the 742nm image the northern tip of *Syrtis Major* could be detected.

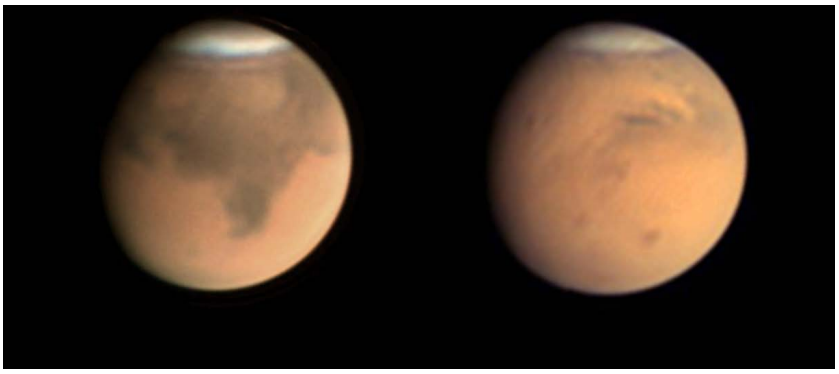

Figure 5. Mars on 2018 Jun 7 (*left*; C8, *f*/30) and 2018 Jun 23 (*right*). *E. Sussenbach*

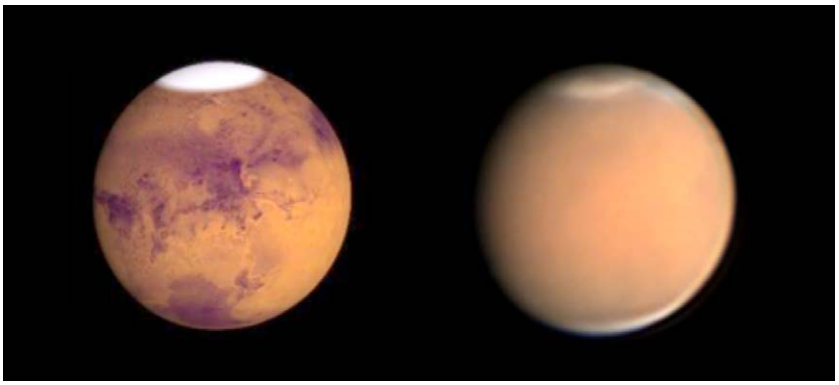

Figure 6. Mars on 2018 Jun 27. C8, *f*/30 & ASI290MC camera. *Left*: *WinJUPOS* simulation. *E. Sussenbach*

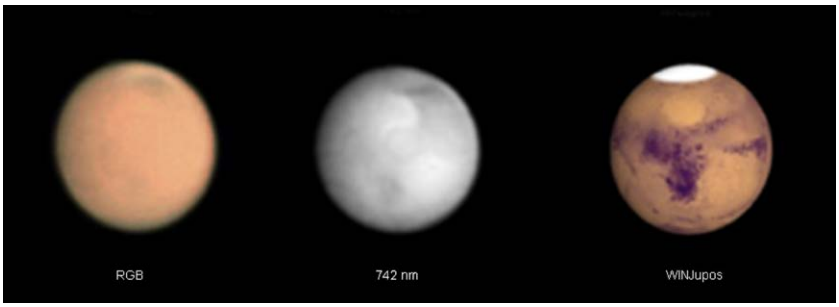

Figure 7. Mars on 2018 Jul 2; C14; *f*/11. *Left*: RGB (ASI290MC camera). *Middle*: 742nm (ASI290MM camera). *Right*: *WinJUPOS* simulation. *J. Sussenbach*

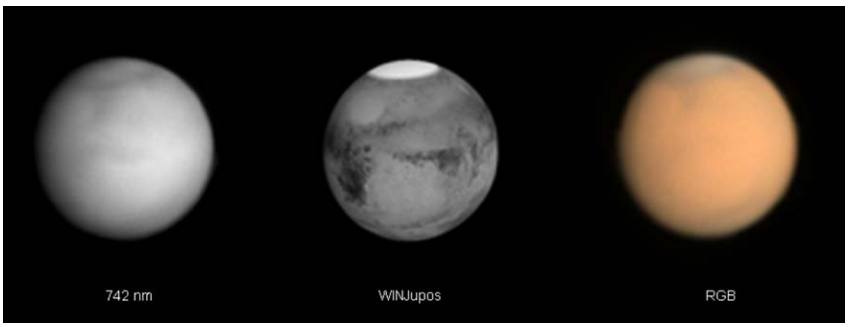

Figure 8. Mars on 2018 Jun 30. C14; *f*/11. *J. Sussenbach*

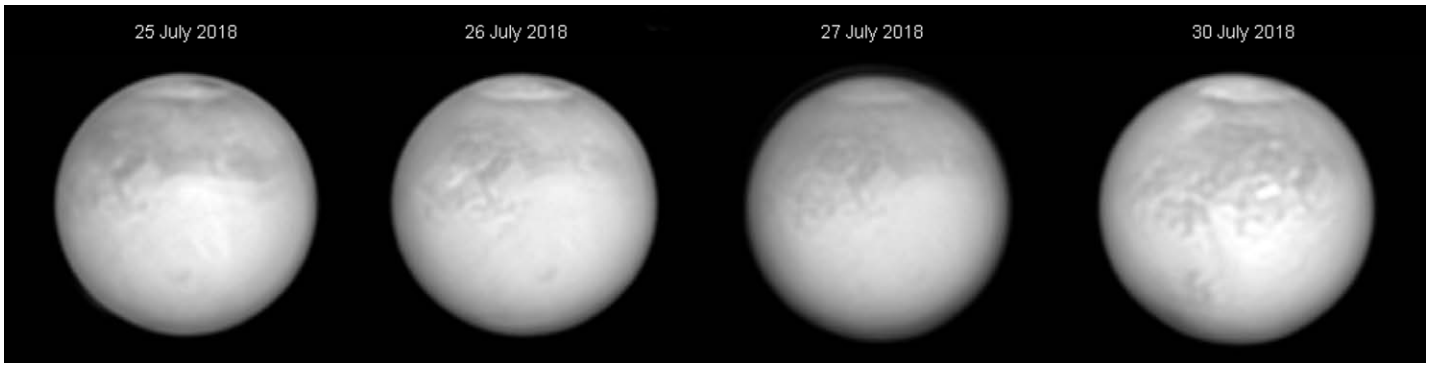

Figure 9. Short-lived storms on Mars. C8, *f*/30, ASI290MC camera and IR filter. *E. & J. Sussenbach*

Figure 8, taken on 2018 Jun 30, reveals almost no details. The dust storm covered almost the entire globe and the dust seemed to have reached the southern ice cap, which was yellowish instead of grey-white.

On the day of the opposition, 2018 Jul 27, we made an image clearly demonstrating the potential of a C8 under ideal conditions (Figure 4). Figure 9 reveals some short-lived dust storms in the region of *Ganges Chasma* in the period 2018 Jul 25–30. On Jul 26 a small dust storm was seen, which was not detectable on Jul 27. A new storm close to the previous one was found on 2018 Jul 30.

At the end of July, the global storm was gradually settling with some interesting side effects illustrated in Figure 10, which shows Mars on 2018 Aug 1. Note how the settling dust exposes quite well the contours of *Valles Marineris*. It was interesting to follow the shrinking southern polar cap in the course of the year. In Figure 10 the region of *Novus Mons* first appeared as a bright area. On 2018 Sep 17 the region was partly detached from the major body of the polar cap (Figure 11).

Discussion

In this paper we have illustrated that the island of Curaçao is an excellent place for planetary imaging. The presence of the Caribbean Sea in combination with the steady north-eastern trade winds has a very favorable effect on the stability of the local atmosphere. Most of the year, with the exception of the months November and December, the seeing conditions are very good and stable; the transparency is also very good most of the time. On the other hand, the omnipresence of wind requires a sturdy mount and sometimes good wind shields.

The better performance of a 200mm C8 telescope on Curaçao over a 360mm C14 telescope at higher latitudes is impressive. Angular size measurement of the martian surface revealed details of 0.3″, which is even smaller than the theoretical angular resolution of a 200mm instrument (Dawes limit 0.58″).

In this paper we have focused on the 2018 Mars apparition. Mars reached its maximum size on Jul 31, *viz*. 24.3″. Whereas till May the resolution increased gradually, in the course of June a massive dust storm developed, eventually covering almost the entire globe. Details were least detectable in RGB images. In the IR (742nm), surface details were slightly more discernable. The situation reminded us of the 2001 global dust storm that interfered during the opposition and lasted many weeks.[2,3]

We also detected some smaller and short-lived local dust storms in *Mare Erythraeum* (Figure 9). At the end of July the dust was settling again, but at opposition a major part of the planet's surface was still not fully visible.

An interesting phenomenon was that on Aug 1, *Valles Marineris* was detectable as a yellowish streak of dust (Figure 10). At the end of September, the Martian surface revealed itself as usual.

During the year, the southern polar cap was disappearing gradually. In July the global dust storm also affected the brightness of the polar cap. Interestingly, in August and September the region of *Novus Mons* first appeared within the cap as a bright area and later became a detached outlier (Figure 11).

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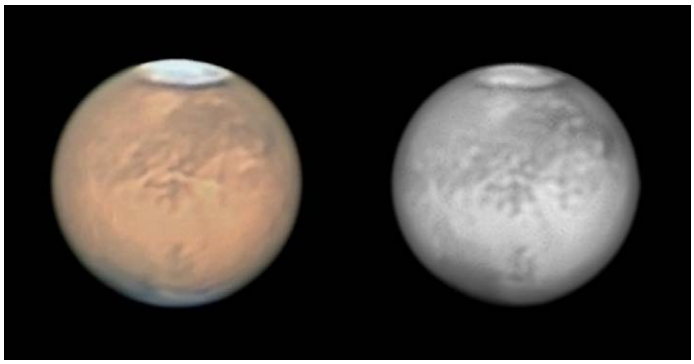

Figure 10. Mars on 2018 Aug 1, in RGB (*left*) and 742nm (*right*). Note *Valles Marineris*. C8; *f*/30. *E. Sussenbach*

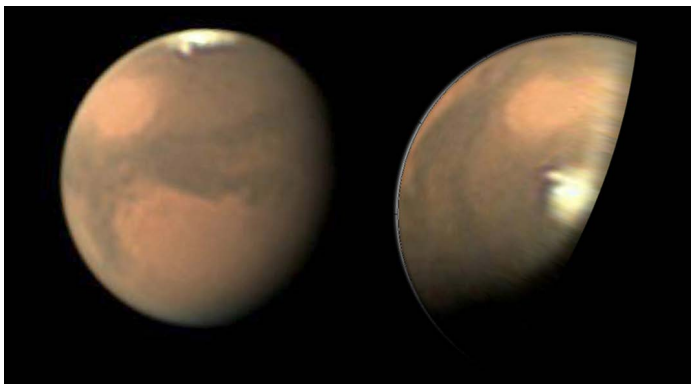

Figure 11. Mars on 2018 Sep 17. C8; *f*/30. *E. Sussenbach*