The opposition of Mars, 1984

Richard Me Kim

The low altitude of Mars for northern hemisphere observers during the 1984 opposition considerably reduced the number of observations made in the UK. Thanks to numerous overseas contributions, however, the apparition has been well covered.

The Martian surface showed several small changes from 1982, the most interesting being the disappearance of the *Claritas-Daedalia* feature and the return to prominence of the *Phasis* 'canal' nearby. There was a moderate level of white cloud activity and an unusually high frequency of yellow cloud throughout the period of observation. The behaviour of both polar regions was documented, including the formation of the north polar hood, and the emergence of the south polar cap from beneath the south polar hood. The report concludes with an account of a stellar occultation by Mars.

Report of the Terrestrial Planets Section *Director: R. M. Baum; Mars Coordinator: R. J. McKim*

Introduction

Mars was in opposition to the Sun on 1984 May 11, and was closest to the Earth on May 19, then lying in the constellation of Libra. The large southerly declination of the planet gave it a meridian altitude of only some 20° for the latitude of Greenwich, and there were consequently fewer UK observers than in 1982. However, the opposition disc diameter of 17.4 arcseconds was respectably large, enabling detailed observations to be made by those who were better placed geographically.

The Martian N pole was tilted towards the Sun at opposition, with the latitude of the centre of the disc as seen from Earth varying a good deal during the apparition*. The Martian Date[1] at opposition was August 18; observations ranged from spring through summer to autumn in Mars' N hemisphere. The observational aspects were closely comparable to those of the 1969 apparition[2]. Physical details of the apparition were as follows:

Latitude of centre of disc at opposition	+ 13°.8
Declination at opposition	—18°
Mars in aphelion	1983 November 29 (η = 155°)
Summer Solstice of N hemisphere / Winter Solstice of S hemisphere	1984 January 13 (η = 175)
Mars in opposition to the Sun	1984 May 11 (η =231°)
Autumnal Equinox of N hemisphere / Spring Equinox of S hemisphere	1984 July 14 (η =265°)
Mars in perihelion	1984 November 7 (η =335°)

*Selected data for the latitude of the centre of the disc: + 25°.3 in 1983 early November, falling to a minimum of +9°.6 in 1984 late March/early April, increasing to a second maximum of + 18°.8 in late June, falling to zero on October 1, and reaching -26°. 1 by 1985 late January/early February.

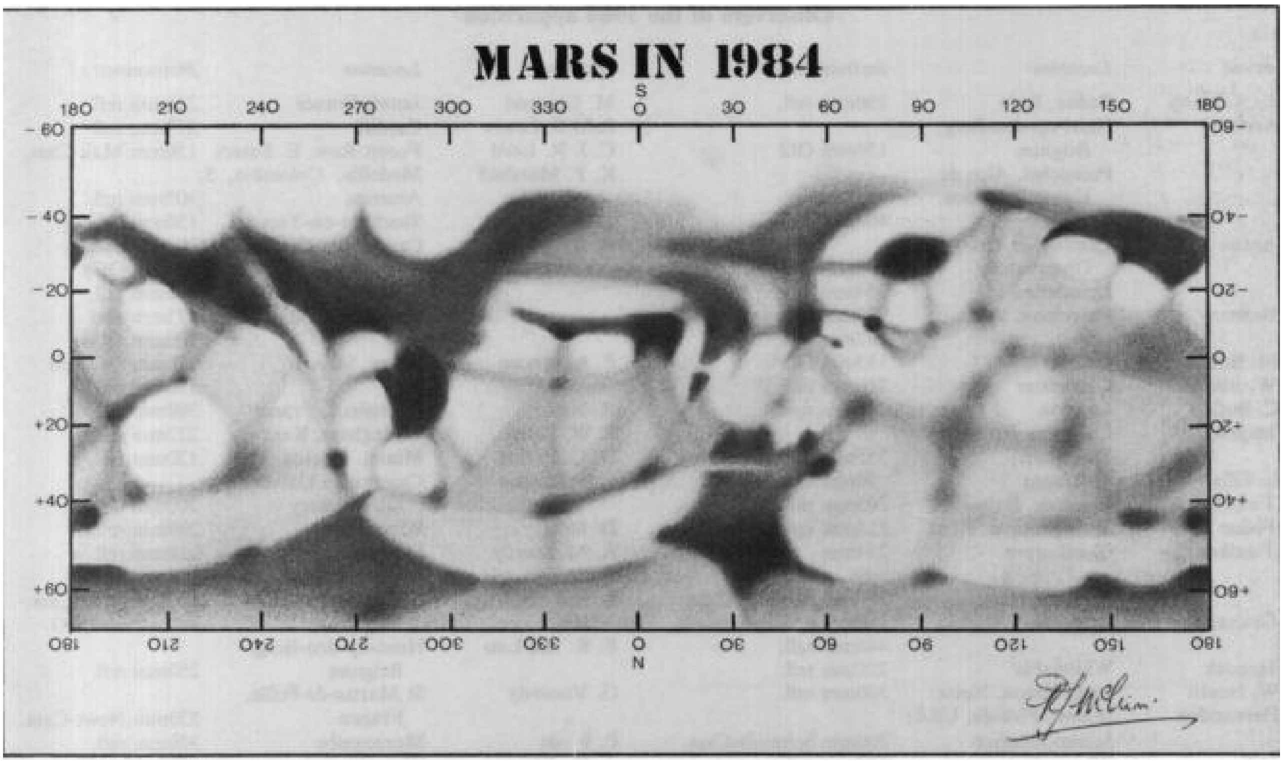


Figure 1. Albedo map of Mars in 1984, *R. J. McKim.*

Useful observations were received from 37 members of the Section; see Table 1.

A total of 733 drawings and 95 photographs was received, with the work of Butler, Foulkes, Heath, Hill, Lewis, McKim, Moore and Wilkinson accounting for most of the UK observations. From Cotonou , Prof. Jean Dragesco (President of the Commissio n des Surfaces Planétaires of the Société Astronomique de France (SAF)) obtained 74 drawings and 24 photographs between 1984 January 11 and July 6. Marshall sent in 103 drawings, and there were good series from the Belgian observers. Dr D. C . Parker, a new member from Miami, Florida, sent in 60 of his best photographs, some of which reveal more detail than many UK observers could see visually. His series covers the period April 14 to August 14, and includes some very successful colour photographs. Details of work by the Association of Lunar and Planetary Observers (ALPO) in the USA were sent by C . F. Capen* . Photographs were also obtained by Aerts and Viscardy, while Dr A. Dollfus of the Meudon Observatory kindly sent in copies of photographs obtained at the Pic du Midi Observatory, France, during April 12-14.

Although fewer *drawings* are available than in 1982, of much greater significance is the fact that our *photographic* coverage is much more complete for the present apparition.

Observations were attempted by Aerts as early as 1983 September, while the recorded useful observations cover the period 1983 October 22 (Wade, $\eta = 139°$) to 1985 March 17 (Graham, $\eta = 54°$), and are particularly complete in the period 1984 February to July inclusive. Preliminary reports of the observations have appeared in BAA publications[3], while others have reviewed the observational prospects for the apparition elsewhere[4].

The present report may be compared with the pre-

*The writer is sorry to have to record that Charles Capen died in 1986 May. His work is being continued by Dr Parker for the ALPO.

Figure 2 (opposite). Photographs of Mars in 1984 by J. Dragesco (355mm Schmidt-Cass., f/80, j-2 sec, Kodak TP2415 b/w film) and D. C. Parker (320mm refl., f/198; 2-5 sec, Kodak TP2415 b/w film, and 3-4 sec, ED-200 colour film). Photographs in white light and on TP2415 film except where stated.

(A) April 29d 05h 34m, $\omega = 9°$, *Parker;*
(B) May 23d 21h 26m, $\omega = 30°$, *Dragesco;*
(C) June 4d 04h 16m, $\omega = 32°$, *Parker* (ED-200);
(D) April 23d 05h 20m, $\omega = 59°$, *Parker* (ED-200);
(E) June 24d 19h 36m, $\omega = 76°$, *Dragesco;*
(F) May 19d 22h 29m, $\omega = 81°$, *Dragesco;*
(G) April 22d 06h 20m, $\omega = 83°$, *Parker* (ED-200);
(H) May 30d 06h 20m, $\omega = 107°$, *Parker;*
(I) July 2d 02h 23m, $\omega = 110°$, *Parker,* with W23A red filter;
(J) June 21d 20h 45m, $\omega = 120°$, *Dragesco;*
(K) May 22d 03h 01m, $\omega = 130°$, *Parker* (ED-200);
(L) May 20d 04h 21m, $\omega = 167°$, *Parker;*
(M) June 15d 20h 25m, $\omega = 170°$, *Dragesco;*

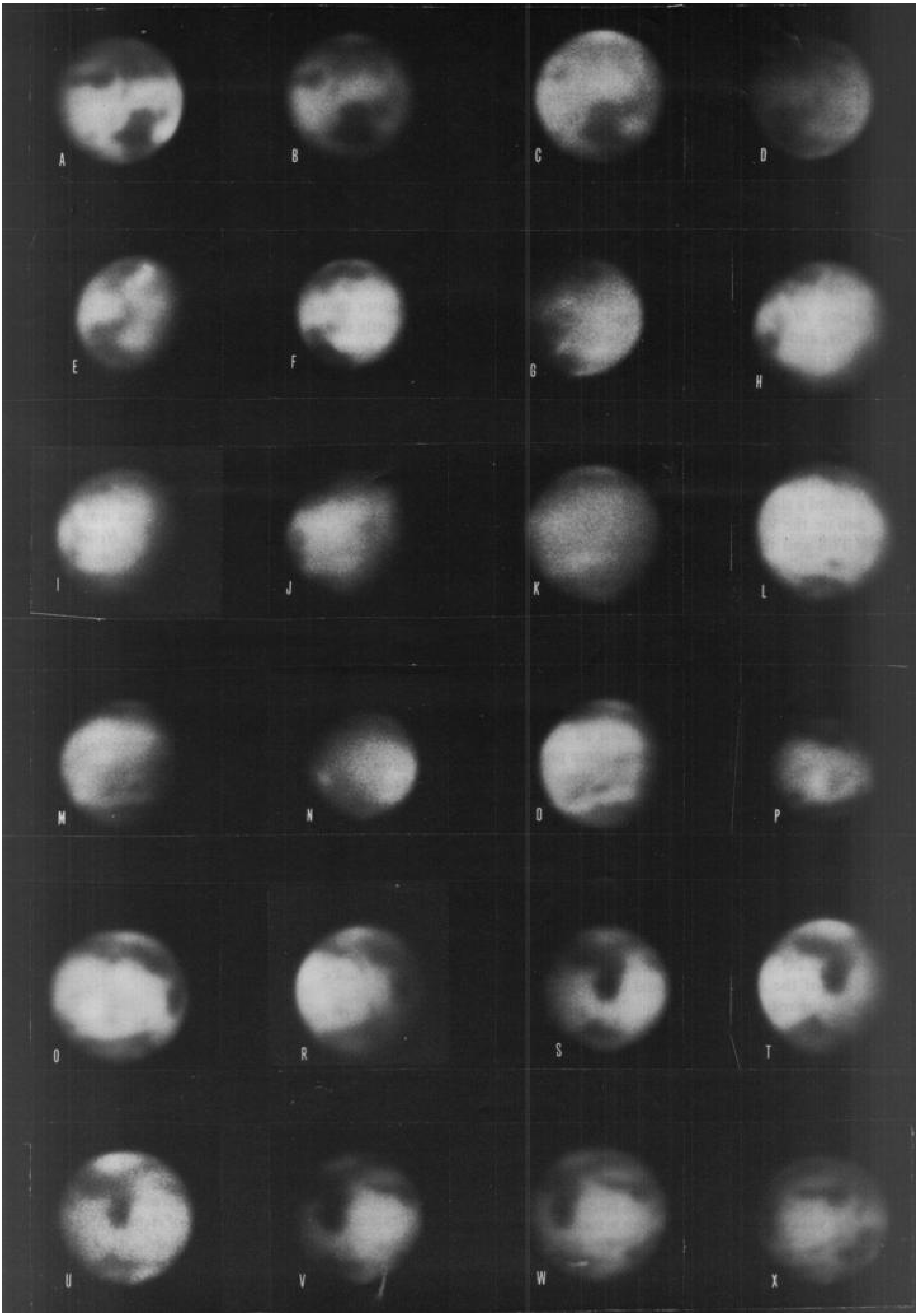
(N) April 14d 08h 05m, $\omega = 180°$, *Parker* (ED-200);
(O) June 13d 20h 39m, $\omega = 191°$, *Dragesco;*
(P) May 9d Olh 32m, $\omega = 222°$, *Dragesco;*
(Q) May 13d 05h 00m, $\omega = 238°$, *Parker;*
(R) June 18d 03h 31m, $\omega = 256°$, *Parker;*
(S) April 30d OOh 29m, $\omega = 286°$, *Dragesco;*
(T) June 13d 02h 31m, $\omega = 286°$, *Parker;*
(U) May 6d 04h 43m, $\omega = 295°$, *Parker* (ED-200);
(V) April 29d Olh 26m, $\omega = 308°$, *Dragesco;*
(W) May 5d 05h 54m, $\omega = 321°$, *Parker;*
(X) May Id 05h 00m, $\omega = 343°$, *Parker.*

Table 1

Observers of the 1984 apparition

Observer	*Location*	*Instrument(s)*
G. L. Adamoli	Padua, Italy	250mm refl.
L. Aerts	Heist-op-den-Berg, Belgium	150mm OG
	Puimichel, Alps de Haute Provence, France	406mm refl.
C. Anton	Cambridge University Observatory	200mm OG
	Llandudno	254mm refl.
D. Barbany	Barcelona, Spain	80mm OG and 197mm refl.
R. M. Baum	Chester	115mm OG
K. W. Blaxall	Colchester	216mm refl.
F. C. Butler	London	221mm refl.
J. Dragesco	Cotonou, Benin, W. Africa	355mm Schmidt-Cass.
E. L. Ellis	St Albans	90mm OG
M. Falorni	Florence, Italy	205mm refl.
D. Fisher	Sittingbourne, Kent	215mm refl.
M. Foulkes	Cleethorpes	254mm and 406mm refis
	Hatfield, Herts.	203mm Schmidt-Cass.
D. Graham	Richmond, Yorks.	110mm OG and 446mm refl.
I. Hancock	Whitstable	222mm refl.
A. W. Heath	Long Eaton, Notts.	300mm refl.
C. Hernandez	Miami, Florida, USA; Jalisco, Mexico	200mm Schmidt-Cass.
H. Hill	Wigan, Lanes.	254mm refl.
A. J. Hollis	Northwich	135mm refl.

Observer	*Location*	*Instrument(s)*
M. Legrand	Janzé, France	210mm refl.
R.M.B. Lewis	Cardiff	279mm refl.
C. J. R. Lord	Forest Row, E. Sussex	150mm Mak-Cass.
K. P. Marshall	Medellin, Colombia, S. America	305mm refl.
J. McCue	Stockton-on-Tees	150mm OG
R. J. McKim	Cambridge University Observatory	200mm and 320mm OGs
	Colchester	216mm refl.
	Oundle	75mm and 100mm OGs
P. A. Moore	Selsey, Sussex	125mm OG and 390mm refl.
R. Neél	Vénissieux, France	308mm refl.
P. W. Parish	Gillingham, Kent	222mm refl.
D.C. Parker	Miami, Florida, USA	320mm refl.
J. H. Rogers	Cambridge University Observatory	200mm OG
D. Stott	Winchester	298mm refl.
K. M. Sturdy	Helmsley	216mm refl.
R. de Terwangne	Antwerp, Belgium	203mm Cass.
A. van der Jeugt	Gent and Lokeren, Belgium	150mm Mak-Cass. and 125mm OG
F. R. van Loo	Heist-op-den-Berg, Belgium	250mm refl.
G Viscardy	St Martin-de-Peille, France	520mm Newt-Cass.
P. Wade	Morecambe	308mm refl.
A. W. Wilkinson	Worcester	229mm refl.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ceding ones by the writer for 1980[5] and 1982[6], and with that for 1969 by Collinson [2]. Figures 1-9 present an albedo map and a selection of the drawings and photographs received during 1984. The nomenclature again follows that of Ebisawa's general map of Mars[7], while E and W are again used areographically (in the IAU sense).

Surface Features

Region I: ω = 250-010°

Syrtis Major was a dark, broad feature throughout 1984, and was blunt-ended to the north, not tapering. Wilkinson found it "more wedge-shaped than in 1982", and, together with Falorni, Fisher, Terwangne and van Loo occasionally saw a lighter band *(Crocea-Oenotria)* across the S half of the *Syrtis.* Lord recorded a good deal of internal detail on May 1, in excellent seeing (Figure 9g), noting the visibility of *Sinus Nili, Arena,* and other small features. Dragesco and Hill also showed a slight bulge marking *Nymphaeum Promontorium* on the W side of the *Syrtis.*

Hill and the Belgian observers generally found the apparent colour of the *Syrtis* to be bluish or grey, while Butler found it to be grey up to July 6 but with a green tint thereafter.

Nilosyrtis was well seen, especially by Dragesco, Lord and Wilkinson, while a number of observers traced the pale streaks of *Astusapes* and *Astaboras* from the tip of *Syrtis Major.* These features are also shown on some of the best photographs by Parker. *Boreosyrtis* was less dark than at opposition in 1982, although *Coloe Palus* stands out clearly in some photographs.

The area to the N of *Syrtis Major* was very much as it was in the last apparition, with *Casius* forming a darker S end of the *Utopia* shading. *Copaïs Palus* was a little darker than its surroundings (Figure 9H). *Nepenthes* was drawn faintly by Dragesco, Falorni, Lord, Wilkinson, and sometimes by others, running north from the dark bulge of *Moeris Lacus* on the E side of the *Syrtis.* As in 1982, a round, moderately dark spot was visible at the N end of *Nepenthes* at +29°N, longitude 265°*. Figures 2Q-W, 5H-J, 6D, 7C and 9F-H are all typical views of the *Syrtis Major* and its environs during the 1984 apparition.

When observed under favourable conditions, *Nodus Alcyonius* was seen to be elongated to the north, due to the darkening of the *Thoth* 'canal' connecting it to the S tip of *Casius.* This effect was noted by Adamoli, Dragesco, Falorni and McKim, and can be seen on some photographs. *Umbra* was again light, not shaded.

The *Nepenthes-Boreosyrtis* curve continued westward into a very faint *Protonilus,* a dusky *Ismenius Lacus* and a dark and broad *Deuteronilus.* Dragesco also drew *Semiramidis Lacus* and *Siloe Fons.* The 'canals' of *Gehon* and *Hiddekel* were diffuse dusky streaks and quite well seen, forming a triangle with *Deuteronilus,* according to the drawings of Dragesco and Terwangne. (Refer to Figures 2A, V-X, 4A, 5A, H-J, 6A, D, 8A and 9A.) *Typhon-Orontes, Euphrates* and *Phison* were sometimes seen as pale diffuse streaks by Dragesco and Hill.

To the south of *Syrtis Major, Iapigia* was a little lighter though of a similar colour. *Deltoton Sinus* was faintly shown by Hernandez, Lord, Terwangne and van der Jeugt. The W end of *Mare Tyrrhenum* and *Syrtis Minor* were dark, as was *Mare Hadriacum* further south. *Mare Tyrrhenum* appeared to have a grey tone, with a green or blue tint, according to Aerts, Butler, Foulkes, Hancock and Terwangne.

Hellas was always light, particularly in late March and early April. *Ausonia* was also conspicuously light to the E of *Hellas,* but *Noachis* was dull when not covered by the SPH. The *Mare Serpentis* area was dusky, and *Pandorae Fretum* was lightly shaded. *Hellespontus* was broad and quite dark, although its full southern extent could not be perceived. According to van Loo, *Hellespontus* was grey-green or blue-grey; measurements on the drawings and photographs indicate that it seemed to extend somewhat to the W of its track on Ebisawa's chart, covering a little of the SE corner of *Noachis.*

Deucalionis Regio was light, and *Sinus Sabaeus* was dark and unbroken, although its E end did not run quite up to the *Iapigia* shadings, as in 1980 and 1982. *Portus Sigeus* and *Meridiani Sinus* were darker condensations on *Sinus Sabaeus* (this feature being bluish to Hill), with the 'forked bay' clearly recognisable.

Hellespontus is well shown in Figures 2V-X, 51, J, 6D and 9 G, H, and these figures also show a number of other features described in the foregoing.

Other Region I features should receive brief mention: *Hesperia* was well seen as lighter tract, *Libya* was often bright, with the slightly dusky *Amenthes* streak nearby. *Aeria, Eden* and the other equatorial deserts were normal, and finally *Cecropia* and *Ortygia* to the north were dusky.

Region II: ω = 010-130°

Mare Acidalium closely followed its 1982 contour, according to measurements on the photographs. Its N parts (and particularly the NW corner) appeared darker according to Baum, Dragesco, Hill, Marshall, and the photographs of Dollfus, Dragesco and Parker. *Niliacus Lacus* and *Achillis Pons* were well seen, with Baum and van der Jeugt detecting the separation with small apertures. In late June and early July, Baum and Dragesco show only the E end of *Achillis Pons* Open' to the nearby deserts (Figures 4B, 5A, B). The apparent colour of *Mare Acidalium* was described by Hill as dark grey-green, and by Butler and Terwangne as grey.

Achillis Fons and more notably *Idaeus Fons* were seen

This feature is *Nodus Alcyonius,* appearing a little S and notably W of its position on Ebisawa's map. In our last report this feature was referred to as *Nubis Lacus.* According to Dr Ebisawa, the true *Nubis Lacus* was a very small faint spot visible to the S of the conspicuous *Nodus Alcyonius* during 1982[7]. Thus the true *Nubis Lacus* was not seen with any of the apertures available to BAA observers during the last apparition. Ebisawa also detected *Nodus Laocoontis* and *Thoana Palus* in 1982; the latter feature is also represented on the BAA chart for 1982.

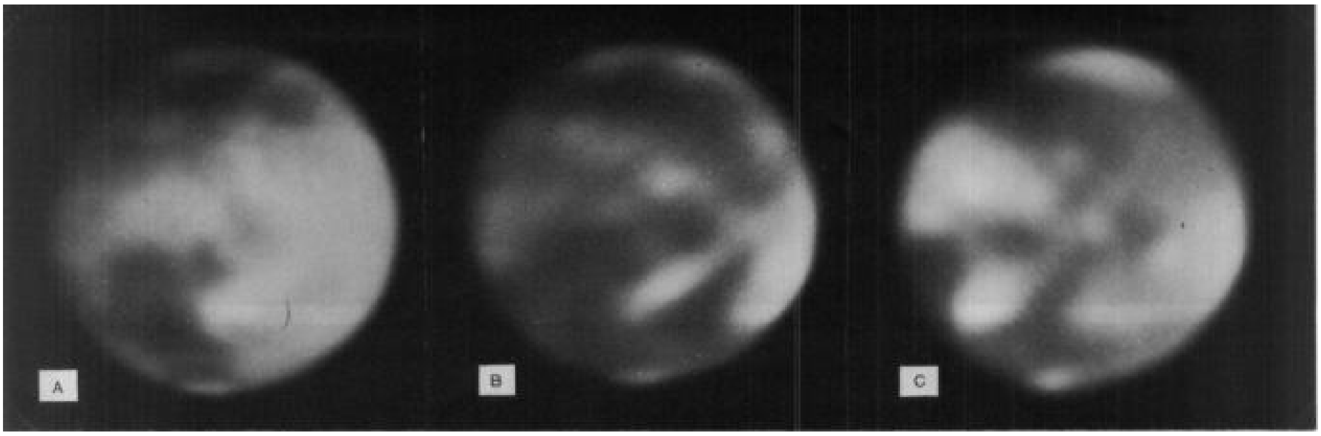

Figure 3. Photographs of Mars in 1984 by A. Dollfus and his colleagues **R.** Gouzy, J-M.Huin and J-L. Suchail at Pic du Midi Observatory, 2m reflector, f/42 - f/75, 1-16 sec, Kodak TP 2415 b/w film.

(A) April 13d 23h 42m, ω = 58°, with yellow filter;
(B) April 13d 23h 54m, ω = 60°, with strong blue filter;
(C) April 14d 02h 30m, ω = 98°, with strong blue filter.

as darker condensations on the dusky (and possibly double) streak of *Nilokeras.* Both condensations outranked the nearby, slightly larger *Lunae Lacus* in intensity in the Pic du Midi photograph of Figure 3A and in several drawings. *Nilokeras* and *Lunae Lacus* were described as grey-green by Baum. *Ganges* was dusky; some observations suggest that it had darker edges. *Juventae Fons* was small and faint, and is just visible on an original print of Figure 3A. *Indus* and *Jamuna* were detected as dusky streaks, and Parker drew attention to the visibility of *Clytaemnestrae Lucus* on his photo on June 3. *Orestes* was also detected (Hill, Parker).

Mare Erythraeum and *Margaritifer Sinus* were normal, although this area was sometimes affected by yellow haze. *Oxia Palus* was well seen and photographed, with *Eos* and *Pyrrhae Regio* as lighter areas. *Mare Erythraeum* was grey with a blue or green tint to the Belgian observers. *Argyre I* and *II* were sometimes bright on the S limb. *Mare Australe:* dusky, but mostly hidden by the S polar hazes. The details in the foregoing are illustrated by Figures 2A-F, 3A, 4B, 5A-C , 6A, B, 7A, 8A and 9A-D, H.

Baltia and *Mare Boreum* were dusky to the N of Region II, but *Iaxartes* and *Hyperboreus Lacus* were much better seen in 1982 when the N pole was tilted more towards the Earth at opposition. In the *Tharsis* region, the Martian volcanoes often appeared as dusky spots, but details were sometimes effaced by clouds. The topographic white afternoon clouds are well shown by Figures 5E and F in particular. *Ascraeus Lacus (Ascraeus Mons), Pavonis Lacus (Pavonis Mons), Olympus Mons, Arsia Silva (Arsia Mons)* were recognised features. White clouds were also associated with *Mareotis Lacus, Phoenicus Lacus (Nox Lux),* and *Nodus Gordii.* Dusky shadings interconnected details in this region. *Ceraunius* was generally faint; it was more prominent in 1980 and 1982.

Solis Lacus was larger and darker than at opposition in 1982. It is well shown in Figures 2D, F-I, 3A, 5B-E, 6B, 7A, 8B and 9B-D. Parker alone detected some internal detail in his drawing on April 22 (Figure 9D), but several observers saw faint streaks radiating outwards from *Solis Lacus,* linking it to the dark markings bordering *Thaumasia.* Thus the 'canals' *Nectar, Bathys, Geryon* and *Calydon* are indicated on some of the photos and drawings (Figures 3A, 5C , 9D).

Agathodaemon (Coprates) and *Melas Lacus* were dark, but *Noctis Lacus* and *Tithonius Lacus* less so. *Araxes* was faint, with *Aonius Sinus* appearing as a distinct dark spot *Sf Solis Lacus.*

The *Claritas-Daedalia* area showed further secular modification since 1982. The shading between *Solis Lacus* and the E end of *Mare Sirenum* which had first

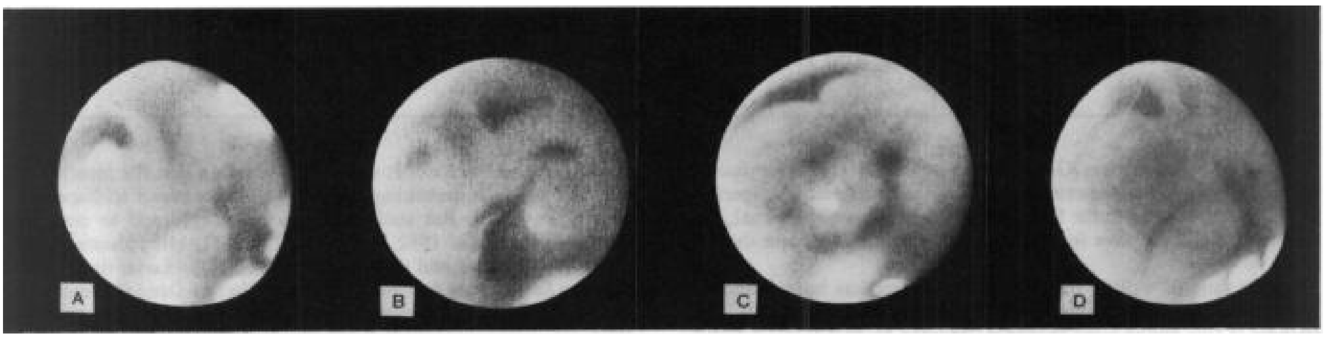

Figure 4. Drawings by R. M. Baum in 1984 with 115mm OG, x 186.

(A) July 3d 21h 20m, ω = 18°;
(B) June 30d 21h 40m, ω = 51°
(C) June 18d 21h 30m-24h 00m, ω = 159-195°;
(D) July 5d 21h 00m, ω = 354°.

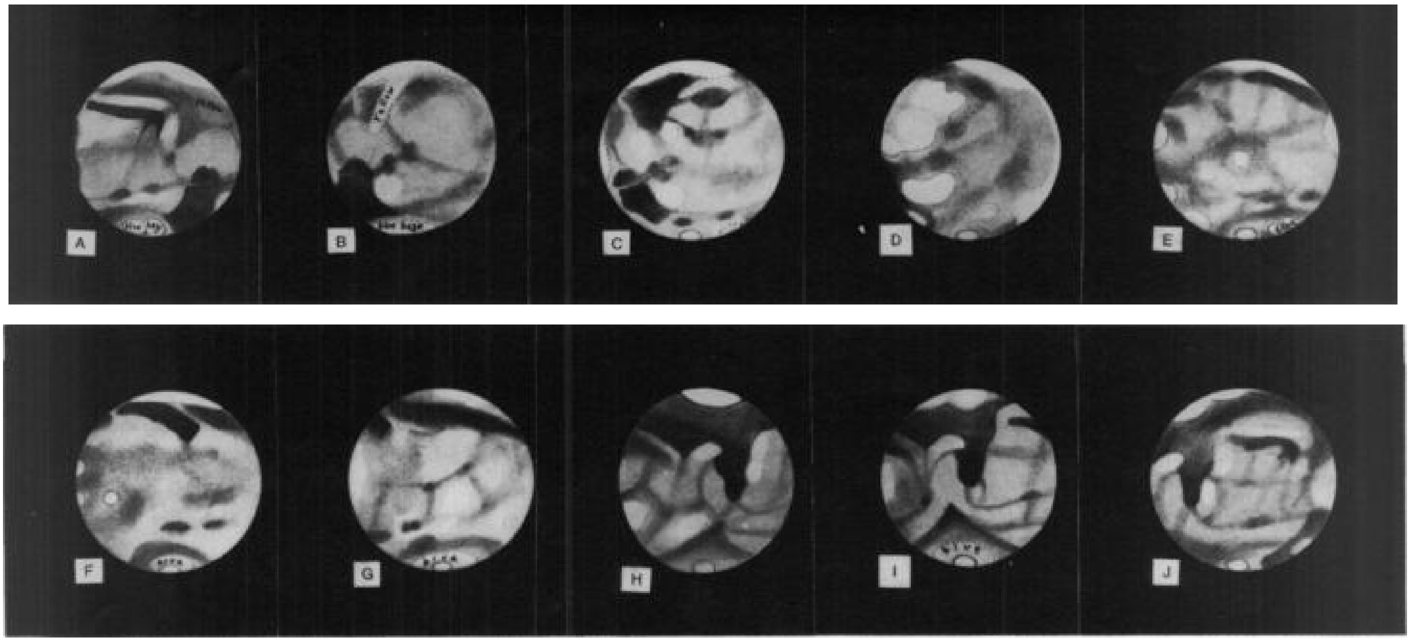

Figure **5.** Drawings by J. Dragesco in 1984 with 355mm Schmidt-Cass., x 390, x 490.

(A) July 3d 20h 15-30m, ω = 9°;
(B) June 24d 19h 20-30m, ω = 74°;
(C) May 19d 22h 10-20m, ω = 77°;
(D) April 18d 03h 55m-04h 05m, ω = 84°;
(E) May 18d 00h 25-35m, ω = 128°;
(F) May 12d 00h 00-10m, ω = 173°;
(G) May 10d 00h 15-25m, ω = 195°;
(H) March 29d 03h 30-40m, ω = 259°;
(I) June 5d 22h 35-45m, ω = 293°;
(J) April 28d 02h 10-20m, ω = 328°;

appeared in 1973 was no more, having been only a small remnant of its earlier extent during the past two oppositions. However, Parker now drew attention to the reappearance of the *Phasis* 'canal' running N-S between *Aonius Sinus* and *Phoenicus Lacus* on some of his excellent photographs taken during May and June (Figures 2H, I). The new feature is also shown on drawings by Dragesco (Figures 5C-E), Parker (Figure 9D) and Terwangne (Figure 8B) in April to June. Observations before April are not sufficiently detailed to tell whether the feature existed earlier in the apparition. The *Phasis* streak is normally invisible, or inconspicuous at best, but there have been occasions when considerable changes have taken place in this region*. *Daedalia* was slightly dusky to Parker and Terwangne.

Region III: ω = *130-250°*

The S deserts of this region were often bright, and the southern maria *Cimmerium, Tyrrhenum* and (particularly) *Sirenum* were dark and clearly visible. *Titanum Sinus* was a prominent angular feature, and *Laestrygonum Sinus* was drawn by Dragesco and Terwangne, enclosing *Symplegades Insulae* (Figures 5G, 8C). *Sinus Gomer* was a northward projection from *Mare Cimmerium,* but did not appear separated from it at this opposition. *Mare Cimmerium* was grey-green to Baum, Butler and Hill, greeny blue to Hancock, grey to Heath and grey with a blue-green tint to Terwangne.

Complex half-tones and streaks appear in a number of drawings of the equatorial desert regions, in *Amazonis, Arcadia* and *Zephyria.* Identifiable diffuse streaks included *Euminides-Orcus, Gigas* and *Tartarus,* which together enclosed a dusky shaded area. *Laestrygon* and *Erebus* were also noted.

Elysium was sometimes bright, especially near its E border, but was increasingly less bright in the later stages of the apparition. It was surrounded by dusky shadings on all sides. *Phlegra-Cerberus* and *Aetheria* were the darkest regions surrounding *Elysium,* while *Trivium Charontis* was sometimes seen as a small dark spot. *Cyclops* and *Cerberus II* united a diminutive *Pambotis Lacus* to *Sinus Gomer.* *Chaos* and *Hyblaeus*

*In 1877-79, Flammarion, Green, Schiaparelli and Trouvelot' found that the *Aonius Sinus* was extended northwards into a streak tapering to the N and curving to the E. This was the Schiaparellian canal, the *Phasis.* It seems to have followed a more direct N-S course during 1984.

At the time of writing (late 1986) the feature has been found to have developed further during the 1986 périhélie apparition. The changes in this region were probably triggered by dust storm activity during the latter part of the 1982 apparition, or during the early months of the present apparition. T. Osawa made several observations well after opposition in 1982. These later observations, being unconfirmed, were not described in our last report. In a letter dated 1983 May 31 he writes: "It was very interesting that the [dust] cloud over the *Daedalia* darkening and *Mare Sirenum* began to disperse in November [1982]. But such markings never returned to normal." Osawa's drawing of 1982 November 21 (CM L 110°) shows *Aonius Sinus* fairly intense and extended to the N, *Solis Lacus* dark, *Mare Sirenum* faintly seen to the W, and the *Claritas-Daedalia* feature of 1973-82 gone. Was this extension of *Aonius Sinus* a precursor of the 1984 development? Osawa observed with a 320mm reflector, power x586.

According to the ALPO the *Phasis* streak became prominent towards the end of the 1984 apparition[10].

were dusky, with the *Aetheria* secular darkening much as in 1982, though perhaps less intense. The *Aetheria* development (perhaps also a development of *Morpheos Lacus?)* was drawn clearly by Dragesco, McKim, Marshall, Neél, Parish, Rogers, Wilkinson and others, and photographed by Dragesco, Parker and Viscardy.

The E environs of *Elysium* were marked by *Phlegra, Styx, Hecates Lacus* and a large, dark, lozenge-shaped *Propontis I.* Figures 2L-Q, 4C, 5E-G, 6C, 7B, 8C and 9E-F all represent this region well. *Euxinus Lacus* seems to have darkened during the apparition, and is strikingly represented by Parker's photographs and by Dragesco's drawings and photographs; refer to Figures 2M, O and 5E-G. It appeared as a dark companion to *Propontis I. Aphnitis Fons* and *Castorius Lacus* were less marked, while *Propontis II* again formed a dark southward protrusion from *Scandia-Panchaïa.* The *Diacria-Cebrenia-Herculis Pons* region was often light and affected by cloud.

There was no sign of *Nodus Laocoontis* or *Thoana Palus* during the 1984 opposition. Sato has recently discussed the observational history of this region in the *Journal*[11].

From June onwards, the W borders of *Arcadia* and *Amazonis* were rather dusky, the shading appearing brownish to Heath, continuing up to the E border of *Elysium. Elysium* itself appeared white, yellow or orange at various times during the apparition.

To the N of Region III *Sithonius Lacus* was seen, while *Panchata* was rather dark and *Scandia* lightly shaded. To Terwangne, *Panchai'a* had a blue-green tint.

Apparition map

Visual and photographic studies in 1984 April-June were used in the compilation of the Section's chart for the apparition; see Figure 1. Ebisawa's chart[7] and our own apparition map for 1982[6] were used to lay down the outlines of the main features. In some cases, measurements made upon photographs and selected drawings were used to modify these outlines. The shading of the map was controlled with reference to the apparitional intensity estimates. As in 1982, a good deal of fine detail has been recorded on our chart.

Intensity estimates

The work of ten observers was selected for analysis. A number of other observers contributed work, but this was not systematic enough (or related to too few features) for inclusion. Table 2 summarises the 1327 useful intensity estimates received from these observers, who contributed a total of 1719 estimates.

As always, a number of observations related to features seen by too few observers or on too few occasions to be incorporated. The writer suggests that intending observers ought to: (1) cover *all* Martian longitudes, and (2) concentrate only on the main features, which they are in a position to observe clearly, rather than paying too much attention to fine details.

The intensity estimates refer to observations in white light only, on the usual scale of 0 to 10.

The Martian atmosphere

The format for this section follows that of the 1982 report[6]. Observations cover all Martian longitudes quite completely during 1984 February to July, inclusive. Observations of white clouds, yellow clouds (dust storms) and blue clearings will be discussed in turn.

A useful report on the Martian atmosphere is possible from 1983 October through to 1984 September: the following summary gives the number of days covered by the observations on a monthly basis. 1983 October, 3(observed)/31 (possible); November, 5/30; December, 9/31; 1984 January, 13/31; February, 18/29; March, 22/31; April, 29/30; May, 30/31; June, 29/30; July, 26/31; August, 15/31; September, 8/30.

White clouds

1983 October to 1984 January

Observations were incomplete in longitudinal coverage. The main observations were as follows.

On October 30, Aerts found *Hellas* whitish on the central meridian (CM), and *Aetheria-Aethiopis* was bright at the evening terminator, with *Eden-Moab* bright on the morning limb. In November, *Argyre, Electris* and *Phaethontis* were bright on the S limb, as was *Arcadia* at the evening terminator, and *Aetheria, Aethiopis, Tempe, Thaumasia* and *Zephyria* on the morning limb. In December Aerts, van der Jeugt and van Loo found *Hellas* and *Noachis* quite bright on the CM, while *Neith Regio* was bright at the evening terminator as was *Chryse* on the morning limb.

In January, *Ausonia, Eridania, Hellas* and *Phaethontis* appeared as brighter areas near the S limb, *Arcadia, Elysium* and *Tharsis* brightened at the evening terminator and *Aeria* was bright on the morning limb. On January 27 Dragesco saw a lighter patch- perhaps *Nix Olympica?*- near the CM.

1984 February

A lighter south polar hood (SPH) was sometimes detected over *Ausonia, Electris, Hellas, Noachis* and *Phaethontis.* Evening whiteness was sometimes noted over *Aeria, Aetheria, Aethiopis, Arabia, Arcadia, Azania, Chryse, Eden, Elysium, Iapigia, Isidis Regio, Meroe* and *Zephyria.* Morning haze sometimes covered *Aeria, Arabia, Cebrenia, Chryse, Cydonia, Elysium, Isidis Regio, Libya* and *Tharsis.* Bright patches near the CM were seen in *Nix Cydonia* (Dragesco, February 13) and in *Libya. Elysium* was generally dull near the CM but brighter patches were sometimes seen within its boundaries.

1984 March

As in 1980 and 1982, a good deal of white cloud activity was seen during the N hemisphere summer (Summer Solstice had been on January 13). The SPH was detected over parts of *Argyre, Ausonia, Electris, Eridania, Noachis* and *Phaethontis;* it was of variable brightness. *Hellas* was also covered by the SPH, but it brightened further still at the end of the month, becom-

Table 2
Martian intensity estimates

Feature	Adamoli	Anton	Hancock	Heath	Hollis	Lord	Marshall	McKim	Sturdy	Terwangne	Average intensity	Standard deviation	Number of estimates
Acidalium, M.	5.8	4.0	5.3	5.6		-	4.8	4.5	7.0	5.2	5.3	0.9	36
Aeolis	-	-	-	-	-	-	-	-	-	2.2	2.2	(-)	8
Aeria	1.8	2.0	-	1.5	2.0	1.6	-	2.0	-	2.3	1.9	0.3	19
Aelheria	-	-	-	-	-	-	2.5	3.0	-	2.9	2.8	0.3	13
Aethiopis	-	-	2.0	-	-	-	-	2.3	-	2.5	2.3	0.2	15
Agathodaemon	-	-	-	-	-	-	-	3.0	-	3.3	3.2	(0.2)	8
Amazonis	2.2	1.2	-	2.0	1.8	-	-	1.8	-	2.9	2.0	0.6	19
Amenthes	-	-	-	-	-	1.1	-	-	-	2.5	1.8	(0.7)	9
Aonius S.	-	-	-	-	-	-	-	-	-	3.7	3.7	(-)	5
Arabia	2.0	2.0	2.0	1.5	2.0	1.6	-	2.0	-	2.1	1.9	0.2	22
A raxes	-	-	-	-	-	-	-	-	-	3.2	3.2	(-)	5
Arcadia	2.0	1.2	-	-	1.8	-	-	1.6	-	2.5	1.8	0.5	15
Argyre (I)	1.9	-	1.5	-	-	2.5	-	2.0	-	2.4	2.1	0.4	14
Aurorae S.	5.0	4.0	5.5	5.0	-	-	-	4.0	-	3.3	4.5	0.8	13
Ausonia	0.9	-	1.3	-	-	2.5·	0.8	1.0	0.5	-	1.2	0.7	15
Baltia	-	-	3.0	-	-	-	-	-	-	3.8	3.4	(0.4)	8
Boreosyrtis	-	-	-	-	-	4.2	-	-	-	3.8	4.0	0.2	10
Boreum, M.	4.4	4.8	3.5	-	-	-	-	3.0	-	3.9	3.9	0.7	17
Candor	-	-	-	-	-	-	-	-	-	2.6	2.6	(-)	8
Casius	-	-	-	-	-	3.2	-	5.5	-	3.5	4.1	1.2	9
Cebrenia	-	-	-	-	-	-	-	2.2	-	3.4	2.8	0.6	11
Cecropia	-	-	3.3	5.0	-	4.0	-	-	5.0	3.6	4.2	0.8	14
Ceraunius	-	-	-	-	4.0	-	3.0	2.5	-	2.5	3.0	0.7	9
Cerberus	-	-	3.0	-	-	-	-	3.9	5.0	3.0	3.7	1.0	15
Chryse	2.0	1.0	2.2	-	-	-	-	0.9	-	2.5	1.7	0.7	17
Cimmerium, M.	5.8	-	5.5	4.8	4.0	4.0	3.5	5.2	7.7	4.5	5.0	1.3	27
Claritas	-	-	-	-	-	-	-	-	-	2.8	2.8	(->	4
Cyclopia	-	-	-	-	-	-	-	-	-	3.1	3.1	(-)	8
Cyclops	-	-	4.0	-	-	-	-	3.8	-	-	3.9	(0.1)	2
Cydonia	2.5	-	1.0	-	-	-	-	2.0	-	2.7	2.0	0.8	10
Deltoton S.	-	-	-	-	-	3.1	-	-	-	4.7	3.9	(0.8)	11
Deucalionis R.	-	-	-	-	-	2.7	-	-	-	2.9	2.8	(0.1)	9
Diacria	-	-	-	-	-	-	-	-	-	3.0	3.0	(-)	9
Dioscuria	2.5	-	-	-	-	-	-	2.0	-	2.9	2.5	0.4	10
Eden	2.3	2.0	2.0	-	2.0	1.4	-	2.0	-	-	2.0	0.3	13
Edom	-	-	-	-	-	1.3	-	-	-	2.2	1.8	(0.4)	9
Electris	-	-	-	0.5	-	-	-	0.7	-	-	0.6	(0.1)	4
Elysium	1.7	1.0	2.5	-	-	-	-	1.2	-	2.5	1.8	0.7	22
Eridania	1.0	-	-	0.5	-	-	-	0.5	0.5	-	0.6	0.2	5
Erythraeum, M.	-	-	4.5	5.0	-	-	3.5	4.0	-	3.6	4.1	0.7	14
Ganges	4.2	-	-	-	-	-	3.5	3.0	-	-	3.6	0.6	4
Gehon	3.5	-	3.3	-	-	-	-	3.5	-	-	3.4	0.1	5
Hadriacum, M.	-	-	-	-	-	3.5	-	-	-	4.0	3.8	(0.2)	7
Hellas	0.8	1.0	1.3	0.5	-	1.9	0.8	0.9	-	2.1	1.2	0.6	27
Hellespontus	5.2	3.5	5.0	-	-	4.2	3.0	-	6.0	3.5	4.3	1.1	15
Hesperia	-	-	3.0	3.0	-	2.5	-	-	-	3.6	3.0	0.4	10
Hyperboreus L.	-	-	-	-	-	-	4.5	5.5	-	3.5	4.5	1.0	8
Iapigia	5.4	4.2	4.5	5.5	6.0	5.1	4.0	5.8	6.0	4.4	5.1	0.7	30
lcaria	-	-	-	-	-	-	-	-	-	3.5	3.5	(-)	4
Isidis R.	1.8	-	2.3	1.5	-	1.9	-	1.7	-	2.4	1.9	0.4	22
Ismenius L.	-	-	4.0	-	-	3.0	-	-	-	3.6	3.5	0.5	8
Lemuria	-	-	-	-	-	-	-	-	-	3.1	3.1	(-)	7
Libya	2.5	-	-	1.2	1.8	1.7	-	1.0	-	2.6	1.8	0.6	18
Lunae L.	-	3.0	-	-	-	-	3.0	5.0	-	3.6	3.6	0.9	9
Margaritifer S.	3.5	-	4.6	4.3	-	-	-	4.0	-	3.6	4.0	0.5	17
Memnonia	2.5	-	-	-	-	-	-	1.8	-	2.3	2.2	0.4	12

Table 2 (contd)

	Adamoli	Anton	Hancock	Heath	Hollis	Lord	Marshall	McKim	Sturdy	Terwangne	Average intensity	Standard deviation	Number of estimates
Meridiani S.	5.5	5.0	5.0	5.2	-	5.8	4.0	6.0	7.2	4.2	5.3	1.0	23
Meroe	-	-	-	0.5	-	1.9	-	1.2	-	3.1	1.7	1.1	14
Moab	-	-	-	1.5	-	1.6	-	-	-	2.1	1.7	0.3	11
Mesogaea	-	-	-	-	-	-	-	-	-	2.9	2.9	(-)	8
Moeris L.	-	-	-	-	-	3.6	-	-	-	4.2	3.9	(0.3)	9
Nectar	-	-	-	-	-	-	-	-	-	3.1	3.1	(-)	6
Neith R.	1.8	-	2.3	0.5	-	2.0	-	1.7	-	2.7	1.8	0.7	20
Nepenthes	-	-	3.5	-	-	2.7	-	-	-	3.1	3.1	0.4	11
Nereidum Fretum	-	-	-	-	-	-	-	-	-	3.5	3.5	(-)	4
Niliacus L.	5.5	-	-	-	-	-	3.5	5.0	6.0	5.0	5.0	0.9	12
Nilokeras	5.5	-	-	-	-	-	3.2	4.5	-	3.4	4.2	1.1	12
Nilosyrtis	-	-	4.0	-	-	2.8	-	-	-	3.5	3.4	0.6	12
Noachis	1.5	1.5	1.8	-	-	2.2	-	2.0	-	2.6	1.9	0.4	15
Nodus Alcyonius	3.5	-	-	-	-	2.8	-	5.0	-	3.3	3.6	0.9	14
Ogygis R.	-	-	-	-	-	-	-	-	-	3.4	3.4	(-)	6
Ophir	-	-	-	-	-	-	-	-	-	2.6	2.6	(-)	7
Ortygia	-	-	3.4	5.0	-	-	-	-	-	3.9	4.1	0.8	14
Panchaïa	5.0	-	3.0	4.0	-	-	-	4.5	6.8	4.0	4.6	1.3	19
Pandorae Fretum	-	-	-	-	-	3.5	-	-	-	3.5	3.5	(0.0)	8
Phaethontis	1.5	-	-	1.0	-	-	-	1.1	0.5	2.8	1.4	0.9	7
Phlegra	-	-	-	-	-	-	-	3.5	5.0	3.2	3.9	1.0	12
Phoenicus L.	-	-	-	-	-	-	-	-	-	2.9	2.9	(-)	7
Phrixi R.	-	-	-	-	-	-	-	-	-	3.5	3.5	(-)	6
Propontis (I)	3.5	-	4.5	3.0	4.5	-	-	4.2	6.5	3.4	4.2	1.2	14
Protêt R.	-	-	-	-	-	-	-	-	-	3.2	3.2	(-)	6
Pyrrhae R.	-	-	-	-	-	-	-	-	-	3.2	3.2	(-)	8
Sabaeus S.	4.4	4.0	5.0	4.2	4.0	5.3	3.0	4.5	7.0	4.1	4.6	1.1	32
Scandia	-	-	-	3.5	-	-	-	3.0	5.0	3.5	3.8	0.9	12
Serpentis, M.	-	-	-	-	4.0	4.8	-	-	-	4.2	4.3	0.5	9
Sinaï	-	-	-	-	-	-	-	-	-	2.4	2.4	(-)	7
Sirenum, M.	4.8	-	-	3.0	4.0	-	-	5.0	7.0	4.1	4.6	1.4	15
Sithonius L.	-	-	-	-	-	-	-	-	-	3.5	3.5	(-)	6
Solis L.	-	4.0	-	-	-	-	-	5.0	-	3.2	4.1	0.9	9
Styx	-	-	-	-	-	-	-	-	-	3.2	3.2	(-)	7
Syria	-	-	-	-	-	-	-	-	-	2.4	2.4	(-)	7
Syrtis Major	6.3	7.0	6.3	6.8	5.0	5.9	4.8	5.1	9.2	5.3	6.2	1.3	44
Syrtis Minor	-	-	-	-	6.0	4.9	-	6.0	-	-	5.6	0.6	4
Tanais	-	-	-	-	-	-	-	-	-	4.4	4.4	(-)	8
Tempe	1.5	2.0	2.4	1.5	-	-	-	1.1	-	2.4	1.8	0.5	18
Tharsis	2.2	2.0	2.5	-	-	-	-	1.7	-	2.4	2.2	0.3	14
Thaumasia	0.5	1.0	-	-	-	-	-	1.0	-	2.6	1.3	0.9	11
Thymiamata	-	-	-	-	-	1.0	-	-	-	2.7	1.8	(0.8)	8
Tithonius L.	-	-	-	-	-	-	-	4.5	-	3.4	4.0	(0.6)	11
Trinacria	-	-	-	-	-	-	-	-	-	4.3	4.3	(-)	5
Trivium Charontis	-	-	-	-	-	-	-	-	-	3.2	3.2	(-)	6
Tyrrhenum, M.	6.2	6.0	4.6	5.8	-	4.7	4.0	5.6	8.0	4.5	5.6	1.3	32
Umbra	-	-	-	-	-	3.5	-	-	-	3.4	3.4	(0.1)	10
Utopia	4.8	4.2	4.5	5.0	-	4.0	3.5	5.1	6.0	3.7	4.5	0.8	33
Xanthe	1.8	2.0	2.0	-	-	-	-	1.4	-	2.5	1.9	0.4	18
Yaonis R.	-	-	-	-	-	3.0	-	-	-	3.6	3.3	(0.3)	4
Zephyria	2.0	-	2.0	-	-	-	-	2.0	-	2.3	2.1	0.2	18
No. of useful estimates:	114	43	125	75	15	107	28	147	34	639		Total	1327
Period of observation	March 24 - June 27	December 28 - June 9	June 30 - August 19	April 23 - July 10	July 10 - July 23	April 27 - May 2	February 12 - July 18	April 4 - August 9	April 23 - June 19	April 25 - July 12			

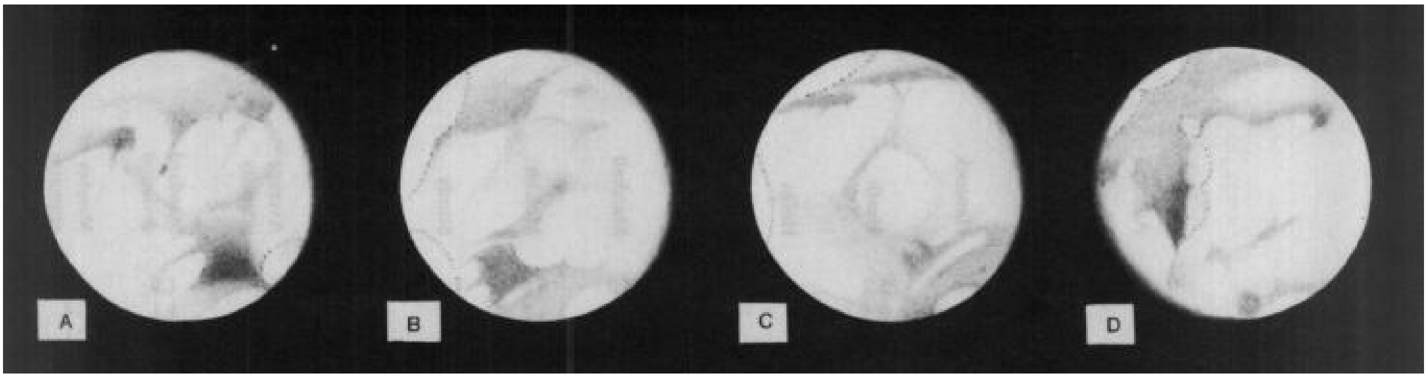

Figure 6. Drawings by H. Hill in 1984 with 254mm refl., x 286.

(A) Jul y 3d 20h 35m, ω = 17°;
(B) Jun e 28d 21h 25m, ω = 63°
(C) Jun e 14d 21h 20m, ω = 193°;
(D) April 29d 0lh 22m, ω = 308°;

ing *extremely* brilliant, with Dragesco describing it as snow-white and showing it irradiating on the evening terminator (Figures 5H, 91). Part of *Mare Australe* was also covered by the SPH.

Evening clouds were well seen over *Aeria, Arabia, Arcadia, Candor, Chryse, Eden, Elysium* (with one bright irradiating cloud noted by Falorni on March 24), *Isidis Regio, Libya, Mare Boreum, Memnonia, Mesogaea, Moab, Neith Regio, Tempe, Tharsis* and *Xanthe.* The month also saw the recovery of the topographic afternoon clouds over the *Tharsis* region by Aerts and van Loo on March 1 and Dragesco on March 3 (but note the latter's possible earlier sighting on January 27). These clouds were situated over *Alba, Ascraeus Mons, Olympus Mons* and *Pavonis Mons.*

Clouds on the following limb were noted over *Aeolis* (probably including surface frost here), *Arcadia, Aeria, Cebrenia, Chryse, Claritas, Elysium, Memnonia, Neith Regio, Tempe, Tharsis, Thaumasia* and *Xanthe.* Brighter areas near the CM were recorded in *Aeria, Aetheria, Candor, Cecropia* (probably frost, Dragesco, March 22), *Chryse, Cydonia, Dioscuria, Edom* (Marshall on March 25 and Aerts on March 22, Figure 91), *Libya, Tempe* and *Thaumasia. Elysium* was dull near the CM.

1984 April

A variable SPH again covered parts of *Argyre, Ausonia, Electris, Eridania, Hellas, Noachis* and *Phaethontis,* and reached down to the N part of *Mare Australe. Hellas* was still exceptionally brilliant early in the month, sometimes irradiating at the limb or terminator, but was less conspicuous later.

Evening clouds were seen over *Aeria, Amazonis, Arcadia, Candor, Chryse, Cydonia, Eden, Elysium, Ganges, Isidis Regio, Libya, Lunae Lacus, Memnonia, Meroe, Neith Regio, Ophir, Tempe, Thaumasia* and *Xanthe.* There were also the afternoon clouds over the volcanoes in the *Tharsis* region as in the previous month. Figure 2G shows evening clouds over *Ganges, Tempe* and *Xanthe,* while Figure 2N shows *Nix Olympica* on the evening terminator.

Morning clouds were seen over *Aeria, Aethiopis, Arabia, Chryse, Claritas, Eden, Edom, Elysium* (though not very bright), the W end of *Deucalionis Regio, Libya, Mare Acidalium, Margaritifer Sinus, Moab, Tempe, Tharsis* and *Xanthe.* Brighter areas near the CM were seen in *Aeria, Arcadia, Candor, Deltoton Sinus* (Hill, April 29, Figure 6D, for example), *Deucalionis Regio* (a small white patch seen by Marshall on April 1), *Edom* (Figure 9J) , parts of *Elysium, Libya, Meroe, Ophir, Tempe* and *Thaumasia.* The *Tharsis* region clouds were also sometimes seen near local noon: *Alba, Nox Lux* and a cloud near *Mareotis Lacus* (Parker, April 22, Figures 2G and 9D). *Nix Olympica* was less bright at local noon.

On April 14 Falorni recorded a light band across the whole equatorial region, from limb to limb (CML 26°), but cloud banding was not otherwise noticed during the apparition.

1984 May

Hellas remained bright, but it was less conspicuous than in late March/early April. An extensive SPH remained, and its subsequent behaviour is described in the section of the report dealing with the SPC.

Evening clouds were seen over the *Tharsis* volcanoes (Figures 2L, 5E-F), which sometimes coalesced at the evening limb. These clouds were generally smaller than they had been earlier in the apparition, and were less bright. Other areas brightening in the evening were: *Aethiopis, Amazonis* (irradiating at the limb to Hill on some occasions), *Arcadia, Eden, Isidis Regio, Libya, Mare Boreum, Neith Regio, Ophir, Tempe, Tharsis, Xanthe* and *Zephyria. Elysium* was normally bright at the limb and terminator, sometimes bright on mid-disc, but more often dull near midday.

Morning clouds were noted over *Aeria, Chryse, Isidis Regio, Lemuria, Libya, Margaritifer Sinus, Meroe, Neith Regio, Scandia, Tempe, Zephyria.* Clouds seen near the CM were located in *Aeria, Aetheria, Aethiopis, Arcadia, Candor, Cebrenia, Herculis Pons, Ophir,* around *Propontis I* (Dragesco, May 10, Figure 5G), *Tempe* and *Thaumasia.* The *Tharsis* region clouds were sometimes faintly seen near local noon.

In general, the white cloud activity was less notable during May, and this is probably related to the yellow cloud activity then being observed (see next section).

1984 June

The following regions were observed to brighten on the evening limb: *Aeolis, Amazonis, Arcadia, Chryse, Cydo-*

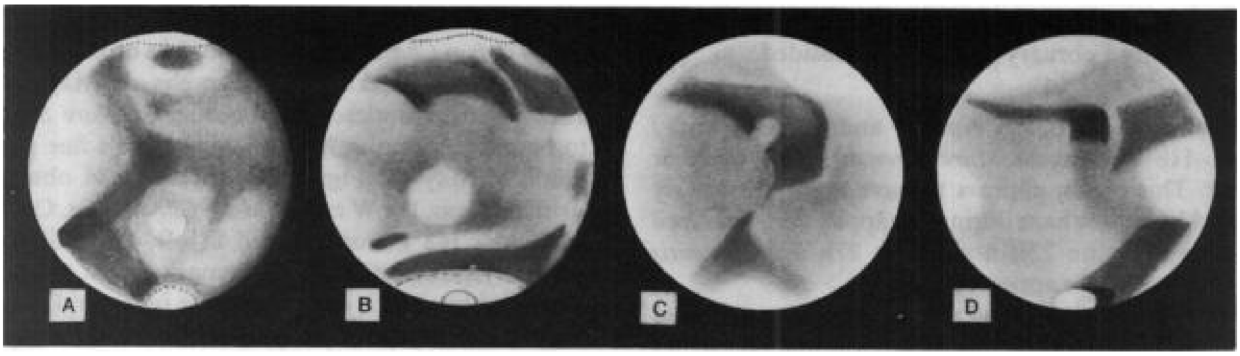

Figure 7. Drawings by R. J. McKim in 1984.

(A) June 26d 20h 40m, ω = 73°, 200mm OG, χ 170, x 240;
(B) June 9d 20h 20m, ω = 223°, 200mm OG, χ 170, x 240;
(C) April 27d 22h 25m, ω = 274°, 216mm refl., x 232;
(D) April 19d 22h 55m, ω = 353°, 216mm refl., x 232.

nia, Eden, Elysium, Isidis Regio, Mare Boreum, Memnonia, Neith Regio, Nix Olympica (Figure 2M; now less prominent), *Scandia, Tempe, Tharsis, Thaumasia, Xanthe* and *Zephyria. Elysium* was bright on the preceding limb in early June but was otherwise dull most of the time, when on mid-disc or near the morning terminator. Apart from *Nix Olympica,* the other *Tharsis* region topographic clouds were not seen.

Bright areas on the morning terminator were: *Aeria, Aethiopis, Arabia, Cebrenia, Iapigia* (Figure 7B), *Libya, Meroe, Neith Regio, Tempe* and *Thaumasia.* Brighter areas near the CM were: *Arcadia, Cebrenia* (Figures 6C, 7B), *Diacria, Herculis Pons, Libya, Nix Olympica* (Figure 4C), *Tempe* (Figures 5B, 7A) and *Zephyria.*

1984 July

Bright areas were seen as follows; *ρ* limb: *Aetheria, Cebrenia, Deucalionis Regio, Eden, Elysium* (otherwise dull), *Isidis Regio, Libya, Neith Regio, Xanthe, Zephyria; f* terminator: *Baltia, Libya, Tempe* and *Xanthe.* The observations were complete in coverage of all longitudes, but fewer in number.

1984 August onwards

The now incomplete observations for August indicate that bright areas at the *ρ* limb were seen over *Aethiopis, Amazonis, Eden* and *Xanthe. Xanthe* was also brighter at the *f* terminator. *Hellas,* which remained quite bright at the S limb during June and July was no longer bright in August. In September, *Amazonis* was brighter at the evening limb. A discussion of the scattered later observations would not be useful.

Yellow Clouds

1983 October to 1984 February

As is quite well known, dust storms on Mars during its N hemisphere summer are unusual, though not unprecedented. In 1982 and again throughout 1983-84 yellow clouds were seen at this time of the Martian year. The ALPO observed a number of important dust storms during the first half of the 1983-84 apparition. According to Beish *et al.*[12], several local storms developed and spread through the equatorial regions between October 30 and January 18, while a major (though not global) storm was followed from January 29 to mid-February. The yellow clouds observed between October and January remained largely over the desert areas, but during the January-February activity there were major obscurations of the albedo features from longitude ~ 10° westward through to ~270°. Most unfortunately, BAA observations for the same period are fewer in number and refer largely to regions of Mars unaffected by dust storms (ALPO observations were from the USA, the BAA ones largely from the UK and Europe; thus longitudes visible on a given date to a UK observer would not be visible from the USA, and *vice versa).* However, there are some significant observations to be put on record:

December 3, Hernandez (CM L 44°): W part of *Mare Acidalium* and parts of *Mare Erythraeum* and *Nilokeras* obscured.

December 2-6, Aerts, Neél, van der Jeugt and Wade (CML 284-347°): drawings suggest *Syrtis Major* partially veiled.

February 7, Hernandez (CM L 163°): E part of *Mare Sirenum* apparently veiled.

February 10, Moore (CM L 355°): *Sinus Sabaeus* and *Sinus Meridiani* well seen, but *Margaritifer Sinus* and *Mare Erythraeum* not drawn.

February 13, van Loo (CML 2°): yellowish clouds over *Chryse* on morning limb.

February 15, 17, Dragesco (CM L 306-325°): yellow clouds covering *Margaritifer Sinus* (both dates) and *Meridiani Sinus* (February 17) on morning limb.

February 26, 28, Dragesco (CM L 196-220°): yellow clouds covering *Mare Tyrrhenum* W of CM.

Due to the small disc size for these observations (made several months before the date of opposition), it is hardly surprising that more observations were not obtained.

1984 March

During March 4-11, Dragesco shows *Mare Sirenum* to be faint or only partially visible, indicating yellow haze obscuration. The *Solis Lacus* region was clearly defined on March 14, according to Dragesco. A possible yellow cloud over *Tharsis* on the morning limb was seen by Aerts on March 20, while van Loo observed a yellowish-white cloud over *Chryse,* again on the morning limb, during March 21-22. Otherwise, it appeared that the more widespread dust storm activity noted by ALPO during February had largely subsided.

1984 April

Adamoli and Aerts, on April 7 and 11 respectively (CML 118-126°) show *Mare Sirenum* to be weak or absent. This region appears to have been particularly affected by yellow haze during the apparition. On April 14 Parker (Figure 2N) noted that *Trivium Charontis* and *Mare Sirenum* appeared weak.

Meanwhile, yellow cloud activity was being recorded elsewhere. The photographs by Dollfus and colleagues with the 2m reflector at Pic du Midi Observatory show *Solis Lacus* and *Mare Erythraeum* dark and well-defined during April 12-14. However, on the yellow light photo of April 13 (Figure 3A) *Aurorae Sinus* is very faint, as is *Tithonius Lacus,* and there is a bright area covering *Pyrrhae Regio.* This would appear to represent an expanding yellow cloud system, because a few days later the activity seems to have developed considerably. On April 16, Lewis saw a yellow cloud in *Tempe,* while Dragesco (CML 102°) saw the same cloud and other yellow ones over *Ophir, Candor* (reaching to the evening terminator), covering *Tithonius Lacus* completely. A smaller yellow cloud was situated over *Nox Lux. Solis Lacus* was dark and remained unaffected.

The next day, Dragesco shows the large cloud covering *Aurorae Sinus* on the evening terminator, as well as most of *Tithonius Lacus.* The *Tempe* cloud, still visible, was bright in white, orange and red light to van Loo. On April 18 Dragesco (Figure 5D) shows *Xanthe* also covered by yellow cloud. Further to the W, *Sirenum Sinus* was missing on a good photograph by Parker on April 19 and was again weak on April 21. On April 20, Dragesco shows *Aurorae Sinus* dark and unobscured, but a yellow cloud on the evening terminator obscured *Chryse, Margaritifer Sinus* and the visible part (W end) of *Sinus Sabaeus* (CML 64°), as well as the E end of *Niliacus Lacus.* Other smaller clouds (white?) were seen in *Ophir-Candor* and *Tempe.*

The storm seems to have declined somewhat after April 18. On April 21-26 Parker photographed some small *white* clouds in the area, but the yellow cloud activity seemed to have largely ceased. Observing visually on April 22, Parker (Figure 9D) found residual yellow cloud limited to *Tharsis. Solis Lacus* remained unaffected (see Figures 2D, G). Sturdy found a yellowish tint in *Chryse* on the *f* limb on April 23 and 28, which was also seen by van Loo on April 25.

1984 May

On May 8 Terwangne (CML 165°) and Dragesco on May 9 (CML 219°) remarked upon the general low degree of contrast of the markings in the desert areas. Dragesco considered a dust storm was in progress, because the disc had a strong yellow-gold colour. The borders of *Elysium* (especially *Cerberus* and *Trivium Charontis)* also appeared faint to Hill at this time. On May 11 McKim found all details very difficult (CML 158°) with a 100mm OG. On the morning of May 12 Lewis (Figure 9E) shows the W end of *Mare Sirenum* to be faint. This feature was dark to Dragesco on the evening of May 12, but was faint to Wilkinson the next day. *Trivium Charontis* and the borders of *Elysium* were very faint on Parker's photographs of May 13-16; Parker further noticed the N border of *Mare Sirenum* to be missing during May 16-24. Parker's fine photograph of May 13 (Figure 2Q) shows cloud obscuring *Tritonis Sinus,* the W end of *Mare Cimmerium.* On May 14 (CML 168°) Sturdy noted a loss of detail and a general yellowish tint. Butler remarked that the desert areas had lost much of their redness on several dates in May, while Moore on May 17 (CML 105°), observing under good conditions wrote: "A very washed-out Mars, more orange of late and less red." The *Solis Lacus* region seems to have remained unaffected by yellow cloud throughout this phase of activity.

On May 22, van Loo found a yellow-white morning cloud in *Tempe,* and on May 23 Dragesco found yellow haze affecting the *Margaritifer Sinus - Mare Erythraeum - Aurorae Sinus* region although these details were still distinct. On May 24, Lewis found *Mare Erythraeum* dark, but *Margaritifer Sinus* was pale near the evening limb. *Margaritifer Sinus* appeared dark once more by May 29, but was to be obscured again in June.

1984 June

Parker's photographs of June 3 and 4 (Figure 2C) show that yellow haze was again reducing the intensity of *Margaritifer Sinus* and *Mare Erythraeum.* On June 9 McKim found that the equatorial deserts lacked contrast (Figure 7B), although features to the S and N (for example, *Propontis I)* were normal. This effect was probably exaggerated by the low incidence of white cloud over *Elysium* at the time. On the morning terminator a bright cloud over *Libya* covered part of *Iapigia* and S *Syrtis Major,* the latter feature being rather faint until it was nearer the CM. Butler saw the same cloud and described its colour as yellow-white. On June 10, Dragesco (CML 226°) noted low contrast in the equatorial desert regions. On June 14 and 15 he recorded a yellowish tint in the *Amazonis* region.

The *Mare Sirenum* region seems to have remained unaffected by yellow cloud during June. Parker's photographs of June 20-22 seem to show the surroundings of *Elysium* to be more conspicuous, having presumably returned to their usual intensity.

Perhaps the most significant observations for the month were made on June 24, when Butler (Figure 9C) and Dragesco (Figure 5B) both independently noticed a conspicuous new dust storm *beginning* to the E of *Solis Lacus.* Butler wrote of his observation: "The most interesting feature was the comet-shaped area in the southern part of the disc. It was well-defined and slightly yellowish-white. Tending towards being bright, but not really bright." Dragesco described the cloud as being yellow in colour, and obtained a confirmatory photograph (Figure 2E). Neél also shows the bright comet-shaped object in an imperfect view on the same date.

After these discovery observations the boundary of the yellow cloud became indistinct, but the subsequent

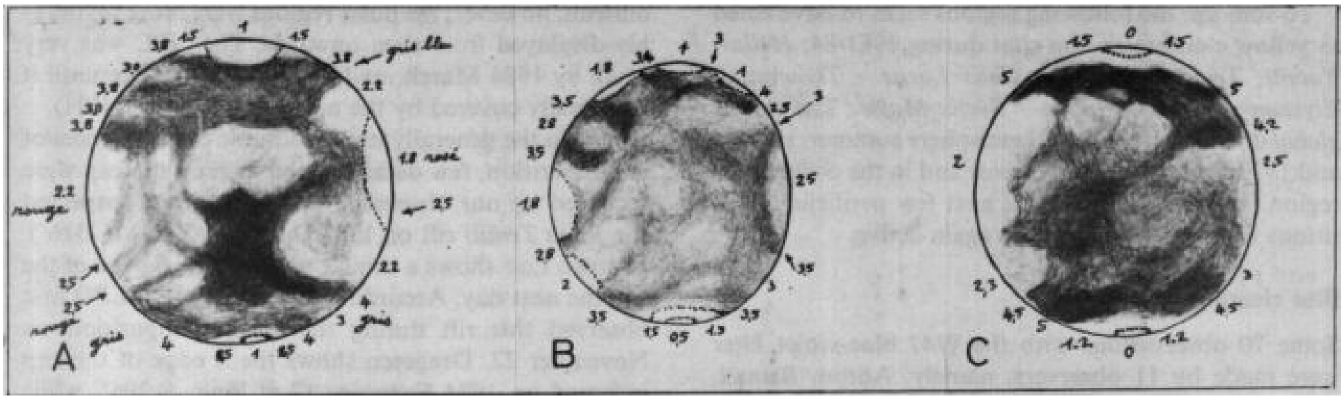

Figure **8.** Drawings by R. de Terwangne in 1984 with 203mm Cass., χ252, χ298.

(A) May 22d 21h 18m, ω = 37°; (B) June 21d 20h 35m, ω = 118°; (C) June 12d 21h 00m, ω = 206°.

drawings of Aerts, Baum, Butler, Dragesco, Falorni, Neél and Terwangne agree in showing the regions *Mare Erythraeum* and *Margaritifer Sinus* to again be very obscure or faint during June 26-30, implying an easterly motion of the storm. The dust storm does not appear to have spread into the N hemisphere. Thus *Ganges, Lunae Lacus, Nilokeras* and *Mare Acidalium* were well seen by McKim on June 26 (Figure 7A). Neither does the storm appear to have affected *Solis Lacus.* On June 25, Butler wrote that the markings in the S part of the disc were difficult, under CML 80°. *Mare Erythraeum* was partly invisible to Aerts on June 26, and very pale to Terwangne the next day. On June 28 Hill shows this area partially covered by limb haze, but all other features were well seen; *Aurorae Sinus* was dark (Figure 6B). On June 29 Dragesco found yellow haze over *Mare Erythraeum,* but *Margaritifer Sinus* and *Aurorae Sinus* were normal. Dragesco obtained a photograph at the same time which shows *Mare Erythraeum* to be almost invisible. Neél found the whole region very faint in poor seeing. Similar views were recorded on June 30. Yellow cloud activity continued into July.

1984 July

Photographs by Parker show that the N hemisphere features, together with *Aurorae Sinus* and *Solis Lacus* to the S, remained unaffected by yellow haze during July 2-6. To the E, the *Mare Erythraeum* area remained dust-covered during July 1-3 according to the work of Butler, Dragesco and others. On July 3 Baum (Figure 4A), Dragesco (Figure 5A), Hill (Figure 6A) and others show *Margaritifer Sinus* to be normal, while Dragesco also shows yellow haze covering *Mare Erythraeum* and *Pyrrhae Regio.* Further observations of this region from the longitude of the UK could not be obtained during this month.

Few other indications of yellow cloud obscuration during July were obtained. McKim, observing on July 17 and 18 (CML *circa* 240°) found *Mare Cimmerium* dark, but *Mare Tyrrhenum* was somewhat fainter than usual.

1984 August onwards

Observations were now becoming more incomplete. As the apparent disc diameter decreased, observations showed the surface features to be about as well defined as one would expect on the diminutive disc and with the apertures employed. Sporadic drawings as late as 1985 February show some features quite well-defined. For example, the *Syrtis Major* region was quite well seen by Aerts and Graham on 1985 February 17. There is no evidence that a *major* dust storm had begun by the time Graham made the last drawings for the apparition on 1985 March 17.

Discussion

The 1984 apparition was notable for the number of *local* dust storms observed during the N hemisphere summer, with the pre-opposition work by the ALPO being especially remarkable. The foregoing report documents a number of BAA observations, showing the elusive nature of these phenomena. On only one occasion was the *beginning* of a storm accurately located: this was on June 24 in the E part of *Thaumasia.* The affected areas of the planet are listed in the monthly account.

Our 1982 report[6] reveals that a number of dust storms were also observed during that apparition, but on the whole it would appear that the Martian atmosphere was more dust-laden during the present one. Since the publication of the 1982 report the writer has discovered that Dr S. Ebisawa (Planetary Research Observatory, Tokyo) observed a bar-like yellow cloud over *Tempe-Arcadia* on 1982 April 13. The exact date of appearance was not determined, but it was preceded by a darkening of the southern boundary of *Tempe* and *Arcadia (Nilus-Uranius-Phlegethon)* which was first noticed on April 8. This cloud moved S and occupied the *Tharsis - Solis Lacus - Thaumasia* regions within several days[13,14]. This region was seen to be affected by yellow cloud by BAA observers, but we had no observations for these longitudes on these dates.

The ALPO have also published details of their records of two yellow cloud systems in more detail: the dust storms which started in *Hellas* on 1981 November 20 (see also our last report[6]), and those in *Solis Lacus-Daedalia-Memnonia* during 1982 May 12-16[15]. The latter storm was probably related to activity detected by the Section in neighbouring areas at the same time. Our colleague Dragesco has also published an account of SAF work during 1982 in recent months[16].

To sum up, the following regions seem to have acted as yellow cloud initiation sites during 1981-84: *Hellas-Yaonis, Tempe - Arcadia, Solis Lacus - Thaumasia, Elysium-Aeolis* and *Libya - Syrtis Major.* The classic *global* dust storms in the S hemisphere summer, in 1971 and 1973 began in *Hellas-Yaonis* and in the *Solis Lacus* region. We must wait for the next few perihelic oppositions to see if these sites are again active.

Blue clearings

Some 70 observations with the W47 blue-violet filter were made by 11 observers, namely: Anton, Blaxall, Dragesco, Falorni, Hancock, Heath, Hernandez, McKim, Marshall, Neél and Terwangne. Marshall made the longest series of blue clearing (BC) observations, from February to November. He found some evidence of the BC effect throughout the apparition. BCs were seen at some stage at all longitudes, though they were certainly not evident at all times. Our 1984 work confirms that the BC effect varies in intensity from day to day, for any given longitude.

Some examples will be given to illustrate this phenomenon. Photographs taken during 1984 April 12-14 through a "strong blue filter" at Pic du Midi (Figure 3B-C) reveal partial clearings and many white clouds. On April 27 Anton and Blaxall did not detect a BC in the *Syrtis Major* region, but Heath and McKim both saw a slight clearing on the same night, demonstrating the threshold nature of such observations. On April 30 Dragesco commented on the BC seen at the same longitude. The daily variability of the effect is shown by Marshall's results for May 5-8. A BC in the *Syrtis Major* region was clearly seen on May 5 and 8, but was not evident on May 6.

To summarise, the frequency of the BC effect seems to have been much the same as in 1982, in so far as one can be certain about this enigmatic phenomenon.

North Polar Region

As in the apparitions of 1980 and 1982, observations were made of the seasonal shrinkage of the north polar cap (NPC). The number of really good drawings available for measurement of the NPC regression was, however, much smaller than in the two preceding apparitions, and it was therefore decided not to try to compile a regression curve from the data to hand. Neither do the observations warrant a polar projection map. (Note that during 1980 and 1982 the NPR was more favourably presented for a given heliocentric longitude). However, a detailed qualitative description is feasible.

The first observations in 1983 October show a fairly large, bright cap with a darker border, which diminished in size with time. By 1984 early February, the dark cap border had become inconspicuous at most longitudes. The tilt of the Martian N pole towards Earth fell to a minimum of +9°.6 in late March, making observations of the small summer cap more difficult; however, the polar regions were more favourably displayed from then onwards. The NPC was very small by 1984 March, undergoing little change until it was finally covered by the north polar hood (NPH).

Due to the generally less favourable circumstances of the apparition, few details in and around the cap were recorded by our observers. However, Aerts suspected the *Rima Tenuis* rift on 1983 December 2 (CML 316°), and van Loo shows a similar notch in the S edge of the cap the next day. According to Capen[10] the ALPO first observed this rift during the current apparition on November 22. Dragesco shows the S edge of the cap indented on 1984 February 17 at long. ~306°, while Parker considered that two of his best photographs also revealed *Rima Tenuis* (May 5, CML 312°; May 20, CML 155°). S. J. O.'Meara (Harvard) also reported this rift on May 3[19].

Olympia, a bright peripheral area seen by the BAA in 1980 and 1982, was not seen by our members in 1984. However, it was observed by the ALPO in addition to other peripheral detached parts of the cap, giving the summer NPC area a very similar appearance to its configuration in 1982[18]. *Hyperboreus Lacus* was reported by Anton, Dragesco, McKim, Marshall and Terwangne, and is shown on the photographs of Dollfus *et al.,* Dragesco and Parker as a dark spot bordering the NPC. It was observed between February and July, but never so clearly as in 1982; refer to Figures 3A, 5C, 7A, D and 9D in particular. In excellent seeing on April 22 (and shortly before making the drawing of Figure 9D) Parker noted that: "NPC was split by dark bar extending north from *Baltia".* This was probably the *Rima Hyperborea,* which is shown on our 1982 chart of the NPC[6].

Observations of haze surrounding the NPC (and sometimes obscuring it) were frequent, from 1984 March onwards. On March 9 Aerts found the NPC enlarged by the presence of peripheral hazes in blue light. On March 21-22 van Loo drew whitish haze surrounding the NPC, while Dragesco on March 22 (CML 334°) saw this to be a boomerang-shaped patch of frost or haze over *Cecropia,* near the CM. Sturdy and van Loo also saw polar haze on April 24-26 (CML ~345°), and Terwangne often shows this haze on his drawings from April 25. Dragesco observed a "light blue-white zone" around the NPC on April 30 (CML 282°). The bluish-white colour of these N polar hazes was confirmed by Butler. Similar observations of a cap surrounded by haze (but still distinguishable from it) were made by Marshall on May 5, 6 and 8, and by Dragesco on May 10-12 and 29. At other times the NP area appeared to be haze-free.

By early June the haze surrounding the NPC had become permanent, and the cap itself became more difficult to see. During May and June Parker photographed, and Butler, Dragesco, Falorni, Marshall and Terwangne drew isolated haze patches near the cap (Figures 2U, 5C, E). For example, on May 1 Butler drew two small bright patches in the NP region; these patches corresponded to the NPC and an area of haze rather than the NPC split in two by a rift. On June 3-6

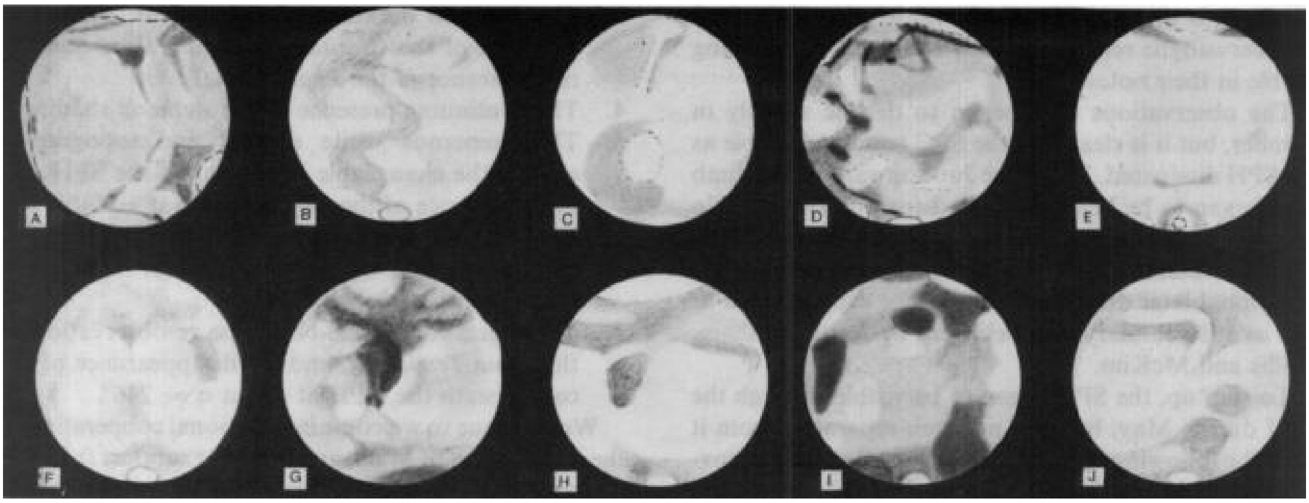

Figure 9. Drawings by various observers during 1984.

(A) June 4d 02h 10m, ω = 2°, 300mm refl., x 400, *K. P. Marshall;*
(B) May 19d 22h 15m, ω = 78°, 229mm refl., x 300, *A. W. Wilkinson;*
(C) June 24d 20h 00m, ω = 82°, 221mm refl., x 216, *F. C. Butler;*
(D) April 22d 06h 55m-07h 35m, ω = 91-100°, 320mm refl., x 590, with W12, 15 and 23A filters, *D. C. Parker;*
(E) May 12d OOh 10m, ω = 176°, 279mm refl., x 279, *R. M. B. Lewis;*
(F) June 8d 22h 20m, ω = 261°, 229mm refl., x 300, *A.W. Wilkinson;*
(G) May Id 02h 00m-03h 00m, ω = 300-314°, 150mm Mak-Cass., x 300, x 375, *C. J. R. Lord;*
(H) April 23d 22h 30m, ω - 310°, 205mm refl., x 240, *M. Falorni;*
(I) March 22d 04h 15m, ω = 334°, 150mm OG, x 320, *L. Aerts;*
(J) April 22d OOh 15m, ω = 354°, 205mm refl., x 240, *M,. Falorni.*

Dragesco found the NPC increasingly difficult to see through the bluish NP haze. McKim found the NPC to be a small, bright spot amidst a diffuse, less bright NPH on June 9; after this date (η = 246°) the NPH covered the true cap.

Figures 5F, G, I and 7B show the NPC surrounded by the NPH, and Figures 4A, B, D, 5A, B, 7A are typical representations of the region after the cap had been covered by the NPH. The NPH often appeared to consist of two or more lobes after June 29 according to Baum (Figure 4D), Butler, Dragesco (Figure 5A), Hollis, McKim and Terwangne. It is possible that the NPH did not cover the NPC at *all* longitudes immediately after June 9, because some observers continued to draw a tiny cap occasionally after this date, but from early July the NPC was not seen again. In 1982[6], final coverage of the cap by the NPH occurred a little earlier, at η = 237°.

It is interesting to speculate as to whether the yellow cloud activity described earlier in this report was responsible for the changeable aspect of the NPH (and SPH?). There is some evidence to suggest that the NPH was less evident when considerable yellow cloud activity was taking place. The ALPO[12] found the 1984 dust storms affected the NPC regression and the visibility of the SPH.

South Polar Region

The SPC was hidden by a large, variable SPH for most of the apparition. The true cap was not seen until after opposition. The character of the variable bright areas constituting the SPH has already been discussed in the white clouds section of this report. Thus, in 1984 May, when the first glimpses were had of a SPC appearing within the overlying SPH, the hood was seen to cover the S desert areas of *Ausonia, Argyre, Electris, Eridania, Hellas, Noachis, Phaethontis,* and part of *Mare Australe.*

During May, a few observers noticed brighter patches within the SPH, probably representing parts of the polar cap. This effect was seen by Terwangne on May 18 (CML 72°) and May 22 (CML 37°, Figure 8A). However, the SP snows were estimated at only intensity 1.0 on these occasions. The bright SPH had a blue tint to Dragesco on May 12 (CML 137°), and was mistaken for the true cap by several observers.

In the opinion of the writer, the cap began to appear separate from the SPH during early June, although the observations do not permit a more precise date to be given. Probably the first definite observations of this nature were those by McKim and Terwangne on June 9. On this date McKim (CM L 223°) found a bright SPH (intensity 1.0) covering *Electris-Eridania-Ausonia,* but within this region was a very bright area along the S limb (intensity 0.0), probably representing the SPC; see Figure 7B. Terwangne made a very similar observation on the same date, which is largely confirmed by a drawing by Néel.

On June 12 Néel and Terwangne (CML 206°, Figure 8C) both considered the SPC to be visible, and similar sightings were made by Terwangne on various dates and McKim on June 26 (CML 73°, Figure 7A). Baum found the brightness along the S limb to be blue-white throughout June. The photographs of Dragesco and Parker show the bright S limb of Mars throughout June, sometimes showing especially bright patches. The observations indicate however that the SPC was not free from polar haze at all longitudes or at all times. Observations into early July showed some evidence of the SPC being visible in S *Argyre* and S *Hellas* in addition to the areas listed above. McKim, Marshall and Terwangne refer specifically to the polar *cap* being visible in their notes.

The observations now began to decline sharply in number, but it is clear that the SPC remained visible as the SPH dissipated. From late June onwards, the S limb area began to be better presented for observation. No quantitative measurements of the regression of the SPC could be obtained, although its decrease in size from the occasional later drawings is clear. The cap was seen as late as 1985 January and February by Aerts, Graham, Hollis and McKim.

To sum up, the SPC began to be visible through the SPH during May, but was not seen separately from it until the following month. Taking June 9 as the approximate date for the first sighting of the SPC, we can say that the cap was visible from $\eta \sim 246°$ onwards. Martin and James[17] found that the SPC was visible on International Planetary Patrol photographs in red light at $\eta = 237°$, though at that time it was not entirely free from haze, according to photographs in blue-green and violet light. These authors also note that Viking data show the SPC to be covered by the SPH up to $\eta = 232°$ in past years. Antoniadi[9] found the SPC visible from about $\eta = 240°$.

Occultation of a star by Mars

On 1985 March 17 Mars occulted the star AGK3 +12° 0218 ($6^m.2$), according to the *Handbook*[20] and Jean Meeus[21]. Observations of this event were made by Graham, and described by the writer at a meeting of the Association[22]. Extracts from Graham's notes follow.

"The planet was found using setting circles, by offsetting the required amount from Venus. At 18h 25m the star could be seen to the east of Mars. . . . . .cloud was dimming the planet and at times I lost it altogether. At 18h 34m when I could see Mars properly again I could no longer see the star, but at 18h 35m I noticed that it had reappeared at the western limb. To conclude, although the exact disappearance was missed, the reappearance was seen. Predicted disappearance was at 18h 32m with reappearance at 18h 35m."

No other observers were able to observe this difficult twilight event; this is unfortunate, for accurate timings of such phenomena can still yield useful positional data. The last really valuable stellar occultation timings obtained by the Section were those for the occultation of Epsilon Geminorum by Mars in 1976[23].

Conclusions

The main features of the 1984 apparition were as follows:

1. The continuing faintness of *Nepenthes, Deltoton Sinus* and the E end of *Sinus Sabaeus.*
2. The prominence of *Nodus Alcyonius, Hellespontus, Propontis I* and *Euxinus Lacus.*
3. The size and darkness of *Solis Lacus,* the disappearance of the *Claritas-Daedalia* feature and the reappearance of the *Phasis* 'canal'.
4. The continuing presence of the *Aetheria* shading.
5. The numerous white diurnal and topographic clouds, the changeable behaviour of the SPH and the emergence of the SPC at about $\eta = 246°$.
6. The rather high level of yellow cloud activity throughout the apparition, though this never amounted to a global storm.
7. The regression of the NPC, the re-observation of the *Rima Tenuis* rift, and the disappearance of the cap beneath the NPH at about $\eta = 246°$.

We continue to welcome international cooperation in the observation of Mars, and hope for support from the Association's New South Wales Branch during the next apparition (1986), when Mars will have an even lower altitude for observers in the UK.

Acknowledgements

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