The opposition of Mars, 1995

Richard McKim

A report of the Mars Section (Director: R. J. McKim)

This aphelic apparition was remarkably well observed, with 122 contributors watching the planet between 1994 March and 1996 January. The greater use of CCD imaging within the Section enabled some to approach the limiting resolution of their systems. No great changes on the martian surface had taken place since 1993. The N. border of *Hellas* was unusually dark, continuing west into *Mare Serpentis–Hellespontus*. *Pandorae Fretum* remained dark, running further south than on average. *Ismenius Lacus* was diminished to the east. *Solis Lacus* remained large, but somewhat faded on its W. side. *Cerberus–Trivium Charontis* remained faint. The *Aetheria* secular darkening persisted. Dust storm activity was low, traceable only by polarimetry and in a few HST images, and mostly limited to certain desert regions already affected by seasonal white cloud. The increase in white cloud activity as the N. polar cap regressed was well observed. The surface markings were fairly well seen in blue-violet light from 1994 November till early 1995 March, except near the equator where equatorial cloud banding was pronounced. The martian 'W' cloud was also well-seen. A detailed picture of the behaviour of the N. polar region from northern winter till early summer was built up: the seasonal appearance of *Ierne, Olympia, Rima Borealis, Rima Tenuis* and *Chasma Boreale* was observed. In its early recession phase before Ls approx. 50° there were two anomalies: the cap was slightly smaller than in 1992–'93, and a dark annular rift was observed within the cap. This rift coincided in latitude with the low albedo polar dune field observed to surround the summer seasonal cap remnant: rare past sightings of the annular rift suggest that the cap thickness may be variable from year to year.

Introduction

BAA martian studies, 1992–2004

We are sorry that there has been no full Mars Section report since the one for the 1992–'93 apparition.[1] In the years following that report the Director was busy completing the Section *Memoir*[2] on the subject of historical dust storms. The latter presented the first-ever complete narrative account of dust activity on the planet. This is therefore the first in a new series of full apparition reports which will discuss BAA observations from 1995 to date. However, interim reports for the 1995 opposition,[3–4] for 1997,[5–10] 1999,[11] 2001[12–13] and 2003[14–19] have been published, and much of this information is available at the Section's website.[20]

The 1995, 1997, 1999, 2001 and 2003 apparitions each allowed observers to watch three-quarters (or more) of the successive martian years; the maximum disk diameter increased from opposition to opposition, but the altitude at opposition for UK observers was relatively unfavourable in 2003 and even more so in 2001. Nevertheless, very complete observations were made in each apparition, as Figure 1 shows. (Ls is the areocentric longitude: Ls = 0° is the start of spring in the N. hemisphere, and the autumnal equinox in the south; Ls = 90° marks the N. summer solstice, and the start of winter in the south, and so on.)

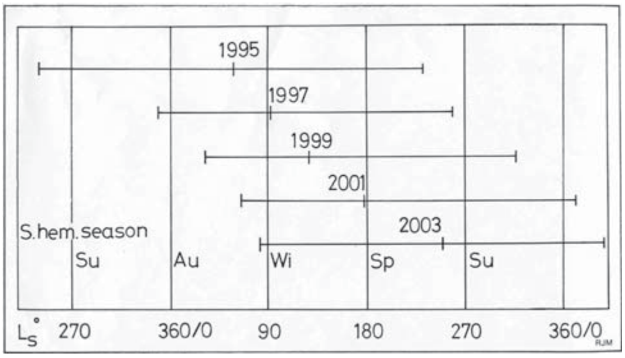


Figure 1. Coverage of martian seasons by BAA data for the oppositions of 1995 to 2003. *R. J. McKim*

Observations in 1995 and 1997 were best placed to follow the decline of the N. polar cap (NPC). In 1999 the formation of the new SPC could be witnessed. In 2001 and 2003 the decay of the SPC was well recorded. In 1995–1999 many observations showed the seasonal trend in crystal cloud activity in response to the release of volatiles by the N. polar cap. In 2001 and 2003 the Section's observations completely covered spring and summer in the S. hemisphere, the so-called 'dust storm season', and it was possible to follow in detail the evolution and decay of the great planet-encircling storm of 2001, and the regional events of 2003. In 1997 there was a large regional dust storm in the S. hemisphere,[10] and in 1999 there were several significant storms along the *Valles Marineris* witnessed both by Section members and by *Mars Global Surveyor* (*MGS*).[11] Of course, *MGS* has also recorded many small-scale events which could never have been detected from Earth.

Of the surface features, the 1990s and early 2000s saw little change. Only during and after the encircling storm of 2001 and the regional storms of 2003 were significant variations detected in the albedo markings (including *Syrtis Major, Hellespontus, Depressiones Hellesponticae, Mare Serpentis*, *Pandorae Fretum, Solis Lacus and Phasis*) in response to dust movement upon the martian surface.

The exploration of Mars from space, 1992–2004

The entire period has seen the planet under scrutiny from the Hubble Space Telescope (HST). Furthermore, beginning in 1997, a new post-*Viking* generation of Mars spacecraft[21–23] has visited the planet, as summarized below:

Name of craft	*Martian orbital insertion/ landing*	*(Agency/ Country)*
Mars Observer	(1993: contact lost at Mars)	(NASA)
Mars 96	(1996: failed to leave Earth orbit)	(Russia)
Mars Pathfinder	Landed *Sojourner*, which operated 1997 July 4–September 27 (*Chryse Planitia*, +10, 23)	(NASA)
Mars Global Surveyor ('*MGS*')	Martian orbit reached 1997 September; mapping orbit attained 1999 February; primary mission completed 2002 April; acted as relay station for next arrivals in 2003–'04	(NASA)
Mars Climate Orbiter	Burned up at Mars, 1999	(NASA)
Mars Polar Lander	Crash-landed on Mars, 1999	(NASA)
Mars Odyssey	Martian orbit reached 2001 October; planned operation till 2004	(NASA)
Mars Express	Martian orbit reached 2003 December 25; *Beagle 2* crash-landed on Mars, 2003 Dec 25 (*Isidis Planitia*, +12, 270); *Mars Express* performed mineralogical mapping and high resolution photogeology, and is to search for subsurface water; *Beagle 2* would have performed exobiological and geochemical experiments in 180-day primary mission	(ESA)
Nozomi	Reached Mars 2004; mission is to investigate interactions in martian upper atmosphere	(Japan)
Mars Exploration Rovers	Reached Mars 2004 January; mobile geological laboratories analysed rocks and soils by X-ray spectroscopy, and identified iron-bearing minerals by Mossbauer spectroscopy; *Spirit* landed in Gusev crater (–15, 176) January 4; *Opportunity* landed at *Meridiani Planum* (–2, 354), January 25; rovers to have 90-day+ operational missions	(NASA)

Further NASA missions are planned for launch windows in 2005, 2007 and 2009, etc.

Characteristics of the 1995 apparition

Mars came to its aphelic opposition on 1995 February 12, with the areocentric longitude reading 58°: mid-spring in the north. In seasonal character the apparition resembled the following oppositions covered by the BAA: 1980,[24] 1963,[25] 1948, 1931, 1916,[26] 1901,[27] etc. The following data[28] are important:

Solar conjunction	1993 Dec 27	
Winter solstice N. hemisphere/ Summer solstice S. hemisphere	1994 May 4	Ls = 270°
Spring equinox N. hemisphere/ Autumn equinox S. hemisphere	1994 Oct 9	Ls = 0°
Opposition	1995 Feb 12	Ls = 58°
Aphelion	1995 Mar 11	Ls = 70°
Summer solstice N. hemisphere/ Winter solstice S. hemisphere	1995 Apr 26	Ls = 90°
Autumn equinox N. hemisphere/ Spring equinox S. hemisphere	1995 Oct 26	Ls = 180°
Solar conjunction	1996 Mar 4	

At opposition Mars was in Leo with a healthy northern declination of +18°, and the latitude of the apparent centre of the disk was +19°. Mars was closest to Earth on February 11 when its apparent diameter was 13.9 arcseconds ("), and it was 101 million kilometers distant. The S. hemisphere was better presented for observation before early 1994 August. After that, the northward tilt increased to +22° by late December. In 1995 the tilt decreased to +17° in March, increasing to +26° by July. The S. hemisphere was more favourably displayed from late 1995 November.

Observational material

The observations covered the period 1994 March 19 [Ls = 240° (Ted Stryk)] to 1996 January 20 [Ls = 231° (Don Parker and Stryk)]. Coverage was excellent for an opposition occurring so close to aphelion: no days were missed between 1994 December 9 and 1995 May 9. Coverage in terms of original observations submitted is summarised as days observed/ days possible as follows: 1994 Mar 1/31; Apr 2/30; May 0/31; Jun 3/30; Jul 4/31; Aug 12/31; Sep 16/30; Oct 17/31, Nov 25/30; Dec 29/31; 1995 Jan 31/31; Feb 28/28; Mar 31/31;

Figure 2 *(opposite)*. CCD images of Mars by Parker. Tricolour filter work with Schott glass filters (original images: red with RG610; green with VG9 + IR rejection filter; blue with BG12 + IR rejection filter) with 410mm refl., F/43, and Spectrasource Lynxx cooled camera. The composites do not show NPC interior details, but red images do: see Figures 10 and 13.

Top row, left to right:

A. 1994 November 22d 09h 07m, CML =288°. Large early spring NPC free from winter hood.

B. 1995 February 3d 05h 35m, CML = 289°. Compare with **A**. *Aetheria* dark patch elongated SW. *Huygens* and other fine details around *Syrtis Major*.

C. 1995 February 15d 04h 38m, CML = 171°. *Propontis* on CM; orographics in afternoon; details in far north.

Second row:

D. 1995 February 17d 03h 04m, CML = 131°. Orographics; fine details such as *Gallinaria Silva* around *Solis Lacus*. Three small patches form chain in N*f*. quadrant: an unnamed 'lake', *Euxinus Lacus* and *Propontis (I)*.

E. 1995 February 17d 04h 17m, CML = 148°. Little detail in far southern *Maria Sirenum* and *Cimmerium*. *Xanthe* brilliant on *p*. limb.

F. 1995 February 20d 02h 18m, CML = 93°. W. side of *Solis Lacus* faded in centre; fine structure in *Tithonius Lacus*; irregular NPC S. edge.

Third row:

G. 1995 February 28d 02h 48m, CML = 30°. Complex details in S. *Chryse* and *Mare Acidalium–Niliacus Lacus–Nilokeras*. *Alba* bright at morning terminator.

H. 1995 March 8d 02h 38m, CML = 317°. *Protonilus* leads to diminished *Ismenius Lacus* and broad *Deuteronilus*. *Mare Serpentis* very dark and extends to dark *Pandorae Fretum* (latter further S. than normal). *Nerei D*. dark spot on *Yaonis Fretum* at W. side of *Hellas*.

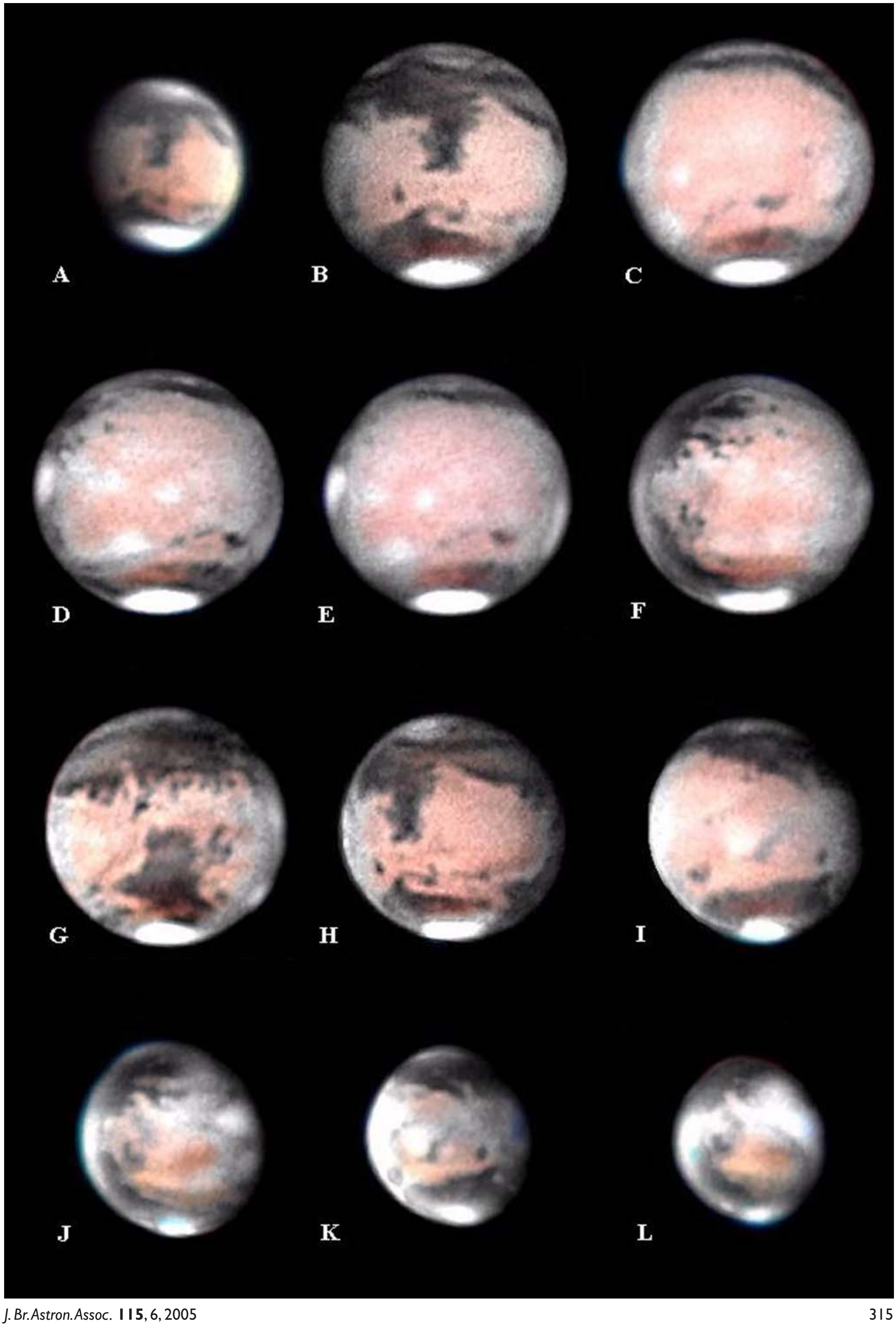
I. 1995 March 18d 02h 40m, CML = 228°. *Cerberus* comprises two tiny dots, *p*. one being *Trivium Charontis*. *Cerberus II* and *Cyclops* run N. from *Mare Cimmerium*.

Bottom row:

J. 1995 March 31d 01h 28m, CML = 92°. Compare with **F**. Increased meteorology and bright terminator clouds.

K. 1995 April 23d 02h 10m, CML = 248°. Structure in *Cerberus*.

L. 1995 May 9d 01h 33m, CML = 88°. Compare with **F** and **J**. Bright, complete ECB.


A
B
C
D
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G
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L

Table 1. Observers of the 1994–'95 apparition

Name	Location(s)	Instrument(s)
A. Ackland	Chesterfield, Derbyshire	457mm refl.
L. Aerts	Heist-op-den-Berg, Belgium	305mm refl.
T. M. Back	Seven Hills, Ohio, USA	180mm OG
D. Baruco	Siracusa, Italy	114mm refl.
G. Bates	Tamworth, Staffs.	152mm OG
S. Beaumont	Windermere, Cumbria	305mm refl.
J. D. Beish	Miami, Florida, USA	406mm refl.
N. Biver	Meudon Observatory, France	310mm OG, 600mm & 1000mm Cass.
	Versailles, Paris, France	200mm refl.
	Honolulu, Hawaii	256mm refl.
M. Bosselaers	Berchem, Belgium	250mm refl.
A. G. Bowyer	Epsom Downs, Surrey	300mm refl.
N. Bradbury*	Chesterfield, Derbyshire	457mm refl.
T. Broadbank	Poole, Dorset	203mm Schmidt–Cass.
J. N. Brown	Chesterfield, Derbyshire	254mm & 457mm refl.
P. W. Budine	Walton, New York, USA	152mm OG
D. G. Buczynski	Scotforth, Lancaster	534mm refl.
R. Buggenthien	Lübeck, Germany	152mm OG
G. L. Cameron	Des Moines, Iowa, USA	178mm refl.
G. Canonaco	Genk, Belgium	200mm OG
L. Carlino	Lockport, New York, USA	152mm OG
M. Cartisano	Pinerolo, Italy	200mm Schmidt–Cass.
T. R. Cave & V. Cave	Long Beach, California, USA	140mm OG & 320mm refl.
	Mount Wilson Observatory, California, USA	2.54m refl.+
M. Cicognani	Grisignano, Italy	102mm OG & 155mm Cass.
E. Colombo	Milan, Italy	203mm refl.
J. C. Crocker	Chicago, Illinois, USA	254mm refl.
B. M. Cudnik	Flagstaff, Arizona, USA	152mm OG
F. Daerden	Bilzen, Belgium	250mm refl.
M. Delfs	Wilhelm–Foerster Obs., Berlin, Germany	152mm & 305mm OG
P. Devadas & K. Murugesh	Madras, India	355mm refl.
D. Dierick & D. De la Marche**	Merelbeke, Belgium	130mm OG
J. Dijon**	Champagnier, France	310mm refl.
T. Dobbins**	Coshocton, Ohio, USA	250mm refl. & 200mm Mak.–Cass.
E. L. Ellis	St Albans, Herts.	90mm OG
N. Falsarella	São Paulo, Brazil	200mm refl.
G. Farroni**	St Avertin, France	410mm refl.
D. Fisher	Sittingbourne, Kent	215mm refl.
M. Foulkes	Hatfield, Herts.	254mm refl. & 203mm Schmidt–Cass.
M. Frassati	Crescentino, Italy	203mm Schmidt–Cass.
C. M. Gaskell	Lincoln, Nebraska, USA	133mm refl.
M. V. Gavin**	Worcester Park, Surrey	203mm Schmidt–Cass.
M. Giuntoli	Pistoia, Italy	80mm OG
H. Goertz	Beek, Holland	100mm OG & 200mm Schmidt–Cass.
D. L. Graham	Brompton-on-Swale, N.Yorks.	152mm OG
	Gilling West, N. Yorks.	406mm refl.
D. Gray	Spennymoor, Co. Durham	415mm Dall–Kirkham Cass.
H. Gross	Hagen Obs., Germany	250mm refl.
K. Grützmacher	Wilhelm–Foerster Obs., Berlin, Germany	152mm & 305mm OG
W. H. Haas	Las Cruces, NM, USA	203mm & 320mm refl.
A. W. Heath	Long Eaton, Notts.	300mm refl.
P. Hombach	St Augustin, Bonn, Germany	102mm OG
K. Huebner	Wilhelm–Foerster Obs., Berlin, Germany	152mm & 305mm OG
G. Jenkinson	Chesterfield, Derbyshire	457mm refl.
R. W. Johnson**	Epsom, Surrey	297mm refl.
G. F. Johnstone	Leamington Spa	254mm refl.
D. P. Joyce	Chicago, Illinois, USA	508mm refl.
J. Knott	Waterloo, Liverpool	216mm refl.
N. W. Kuleshov	Bogorodizk, Tulskaja Obl., Russia	200mm refl.
J. Lancashire	Cambridge Univ. Obs., UK	203mm & 300mm OG
D. J. Lehman	Fresno, California, USA	254mm refl.
L. T. Macdonald	Newbury, Berks.	222mm refl.
R. R. McGregor	Chesterfield, Derbyshire	457mm refl.
R. J. McKim	Oundle, Northants.	216mm & 300mm refl.
	Cambridge Univ. Obs., UK	203mm & 300mm OG
G. Marabini	Castelguelfo, Bologna, Italy	102mm OG
G. Marino & F. Salvaggio	Catania, Italy	200mm refl.
K. J. Medway	Southampton, Hants.	102mm OG
U. Meier	Magdeburg, Germany	100mm OG
F. J. Melillo*	Holtsville, New York, USA	203mm Schmidt–Cass.
C. Meredith	Prestwich, Manchester	216mm refl.
W. Meyer	Wilhelm–Foerster Obs., Berlin, Germany	152mm & 305mm OG
M. Minami	Fukui City Obs., Fukui, Japan	200mm OG
M. P. Mobberley**	Chelmsford, Essex	490mm refl.
D. Moerman	Wateringen, Holland	127mm OG
P. A. Moore	Selsey, W. Sussex	320mm & 390mm refl.
S. L. Moore	Fleet, Hants.	222mm & 356mm refl.
H. Munstermann**	Meppel, Holland	356mm Schmidt–Cass.
M. Murakami	Fujisawa, Kanagawa, Japan	150mm refl.
R. Néel	Vénissieux, France	310mm refl.
D. Niechoy	Göttingen, Germany	203mm Schmidt–Cass. & 305mm refl.
A. Nikolai	Wilhelm-Foerster Obs., Berlin, Germany	152mm & 305mm OG
D. C. Parker**	Miami, Florida, USA	410mm refl.
I. S. Phelps	Warrington, Cheshire	150mm refl.
T. C. Platt**	Binfield, Berks.	320mm refl.
I. Dal Prete	Verona, Italy	200mm refl.
C. J. Proctor	Torquay, Devon	203mm refl.
G. Quarra, A. Leo & D. Sarocchi**	Florence, Italy	300mm Cass.
P. Raphael	Wilhelm–Foerster Obs., Berlin, Germany	152mm & 305mm OG
R. L. Robinson	Morgantown, W. Virginia, USA	254mm refl.
J. H. Rogers	Linton, Cambs.	254mm refl.
M. Dal Santo	Saletto, Italy	200mm refl.
C. M. Schambeck	Nassenhausen, Germany	152mm OG
M. Schmidt**	Racine, Wisconsin, USA	356mm Schmidt–Cass.
R. W. Schmude*	Barnesville, Georgia, USA	90mm refl.
	College Station, Texas, USA	355mm Schmidt–Cass.
H. Schumacher	Hermsdorf, Berlin, Germany	127mm OG & 203mm Schmidt–Cass.
W. P. Sheehan	Hutchinson, Minnesota, USA	152mm OG
D. Shirreff	Marlborough College, Wilts.	254mm OG
E. Siegel	Malling, Denmark	203mm Schmidt–Cass.
R. D. Smith	Huntville, Arkansas, USA	200mm refl.
A. Snook	Dover, Kent	310mm refl.
I. Stellas	Athens, Greece	114mm refl. & 635mm OG ++
D. P. Stephens	Solihull	220mm refl.
D. Storey	Scotforth, Lancs.	534mm refl.
R. C. Stoyan	Nuremberg, Germany	500mm refl.
D. Strange**	Worth Matravers, Dorset	508mm refl.
E. Stryk	Bristol, Virginia, USA	254mm refl.
K. M. Sturdy	Helmsley, N. Yorks.	216mm refl.
P. Tanga	Turin, Italy	150mm refl. & 200mm Schmidt–Cass.
C. Taylor	Banbury, Oxon.	320mm refl.
G. Teichert	Hattstatt, France	279mm Schmidt–Cass.
R. Topping	Tredegar, Gwent	216mm refl.
D. M. Troiani	Schaumberg, Illinois, USA	444mm refl.
G. Vandenbulke**	Oostduinkerke, Belgium	279mm Schmidt–Cass.
J. Vantomme	Ekeren, Belgium	308mm refl.
A. Vincent*	Worthing, Sussex	203mm Schmidt–Cass.
P. Wade	Morecambe, Lancs.	203mm Schmidt–Cass.
M. Wagner	Furth, Germany	114mm refl.
J. Warell**	Uppsala, Sweden	161mm & 360mm OG
	La Palma Observatory, Canary Islands, Spain	500mm OG +++

Table 1: *continued*

Name	*Location(s)*	*Instrument(s)*
D. Weldrake	Middlesbrough, Cleveland	203mm OG
S. R. Whitby	Hopewell, Virginia, USA	152mm refl.
A. W. Wilkinson	Worcester	229mm refl.
D. Wright	Caterham, Surrey	133mm OG

* denotes the submission of photographs; **CCD images;

+ the 100-inch Hooker reflector; ++ the Newall telescope of Athens Observatory; +++ the Swedish solar vacuum telescope

Observations by ALPO members J. D. Beish, P. W. Budine, G. L. Cameron, L. M. Carlino, J. C. Crocker, B. Cudnik, N. Falsarella, D. P. Joyce, D. J. Lehman, F. J. Melillo, R. L. Robinson, M. Schmidt, R. D. Smith & S. R. Whitby were contributed by their Mars Section Coordinator Dan Troiani.

Masatsugu Minami, Mars Coordinator for the OAA Mars Section (Japan) sent observations by M. Murakami.

Paolo Tanga, UAI Mars Section (Italy) coordinator sent copies of observations by his colleagues D. Barucco, M. Cartisano, M. Cigognani, G. Marabini & I. Dal Prete.

Wolfgang Meyer contributed observations by the following VdS (Germany) members: R. Buggenthien, M. Delfs, H. Gross, K. Grützmacher, P. Hombach, K. Huebner, N. W. Kuleshov, U. Meier, A. Nikolai, P. Raphael, C. M. Schambeck, H. Schumacher, R. C. Stoyan & M. Wagner.

Observations by VvS members M. Bosselaers, G. Canonaco, D. Dierick, D. De la Marche, G. Vandenbulke, J. Vantomme, and by NVWS (Holland) members H. Goetz, H. Moerman & H. Munsterman were sent by Frank Daerden, VvS Mars Recorder, on behalf of his group and the NVWS (coordinated by Hans Goertz).

John Brown sent observations by himself and the following members of Chesterfield AS: A. Ackland, N. Bradbury, G. Jenkinson & R. R. McGregor.

Luigi Prestinenza sent the observations by G. Marino & F. Salvaggio.

Apr 30/30; May 25/31; Jun 14/30; Jul 1/31; Aug 0/31; Sep 0/30; Oct 0/31, Nov 0/30; Dec 0/31; 1996 Jan 4/31.

Overall, there were 2,140 original observations, comprising 1,640 visual drawings, 492 CCD images and eight photographs in addition to published summaries of observations by members of OAA (Japan). Observations came from 122 observers in 15 countries (Table 1).

The interval 1995–2003 has seen a change of emphasis within the amateur community concerning the nature of planetary observing. In short, most active experts in planetary photography have embraced the technique of CCD imaging. Furthermore, a new generation of observers has started to observe the planet by CCD camera without first becoming experienced in visual or photographic work. At the same time, many continue to draw the planet at the eyepiece in the traditional manner. Visual work is still of considerable importance to this Section, and observers should not feel that even comparatively low resolution drawings are of no value. Every record counts towards maintaining a 24-hour watch on the Red Planet.

Making use of Schott glass filters, which have broader bandwidths but higher percentage transmission than the equivalent Kodak Wratten ones, Dr Donald Parker was able to significantly reduce exposure times with his SpectraSource Lynxx CCD camera, working at F/43. This was the same instrumentation as in 1993, yet he was able to obtain even better results this year, despite the slightly smaller disk diameter (Figure 2). In the same field, special mention must also be made of Terry Platt's pioneering CCD work from the UK (Figure 5) and Johann Warell's sojourn with the Swedish Vacuum Telescope on La Palma. Dr Masatsugu Minami provided extensive notes of his visual observations between 1994 August and 1995 October, and details of OAA work from Japan. Nicolas Biver made excellent use of the large telescopes at Meudon, and the late Tom Cave had the luxury of a few nights at the eyepiece of the 100-inch Hooker reflector atop Mount Wilson.[4] Other very complete series of visual records were made by Glyn Bates, P. Devadas, David Graham, David Gray, Dr Patrick Moore, Mauro Dal Santo, Dr Richard Schmude, Paul Stephens, Dr Rowland Topping, Dan Troiani and the Director (Figure 6). Several organisations kindly copied some of their observers' work for our use: see Table 1. It is regretted that Isao Miyazaki had no opportunity to image the planet.

There was no spacecraft mission in 1995, following the loss of *Mars Observer* in 1993, but the Hubble Space Telescope, following its successful orbital repair and upgrade in 1993, secured diffraction-limited images of the planet. (However it would not carry out really extensive Mars imaging until1997.) These images have surely demonstrated that craters cannot be seen by ground-based observation.[4,29] Selected HST images form Figure 3.

For ground-based work, the writer wrote some general guidelines about observing Mars in 1994–'95,[30] and details were also published by Beish.[31] ALPO (USA) general reports have appeared,[32,33] along with a NPC regression analysis by Parker & Beish.[34] The proceedings of a workshop on the subject of Mars telescopic observations were edited by Bell & Moersch.[35] Warell has analysed his own CCD images from La Palma to map the NPC near opposition.[36] Stryk reported a possible dust storm as early as 1994 June,[37] upon which Haas has also commented. Schmude has published his personal observations.[38] Ebisawa has published reports of his visual and polarimetric data,[39–41] summary reports of both the 1992–'93 and 1994–'95 apparitions have been produced by Nakajima & Minami using their personal observations,[42,43] whilst Tanga has published UAI work for both years.[44,45] The OAA has continued its series of Mars *Communications*.[46] 1995 work has also been published by the Vereinigung der Sternfreunde (Germany).[47] Images taken with the 1 metre Cassegrain at Pic du Midi have been published on the internet.[48]

Also since the publication of our last major report, the late Marco Falorni analysed the 1988 SPC regression from UAI data,[49] James *et al.*, have discussed HST regression data for the SPC in 1992,[50] the ALPO have published reports for 1993[51] and 1990,[52] whilst Cantor *et al.*[53] have analysed the NPC regression data from HST images for the period 1990–'97. Iwasaki *et al.*[54,55] have depicted the NPC recession from ground-based 1994–'95 data. Klassen *et al.*[56] have performed spectral imaging of martian clouds and ices in 1995 with the NASA Infrared Telescope Facility. Bell and co-workers[57] have performed photometric analyses of HST near-IR data for 1995–'97, and compared the results with *Viking* data. This paper is of special interest for the study of long-term albedo changes. HST images were widely published in popular magazines and on the internet. The ongoing microwave observations of martian atmospheric temperature by R. T. Clancy[58–60] are of special interest in the interpretation of dust storm observations.

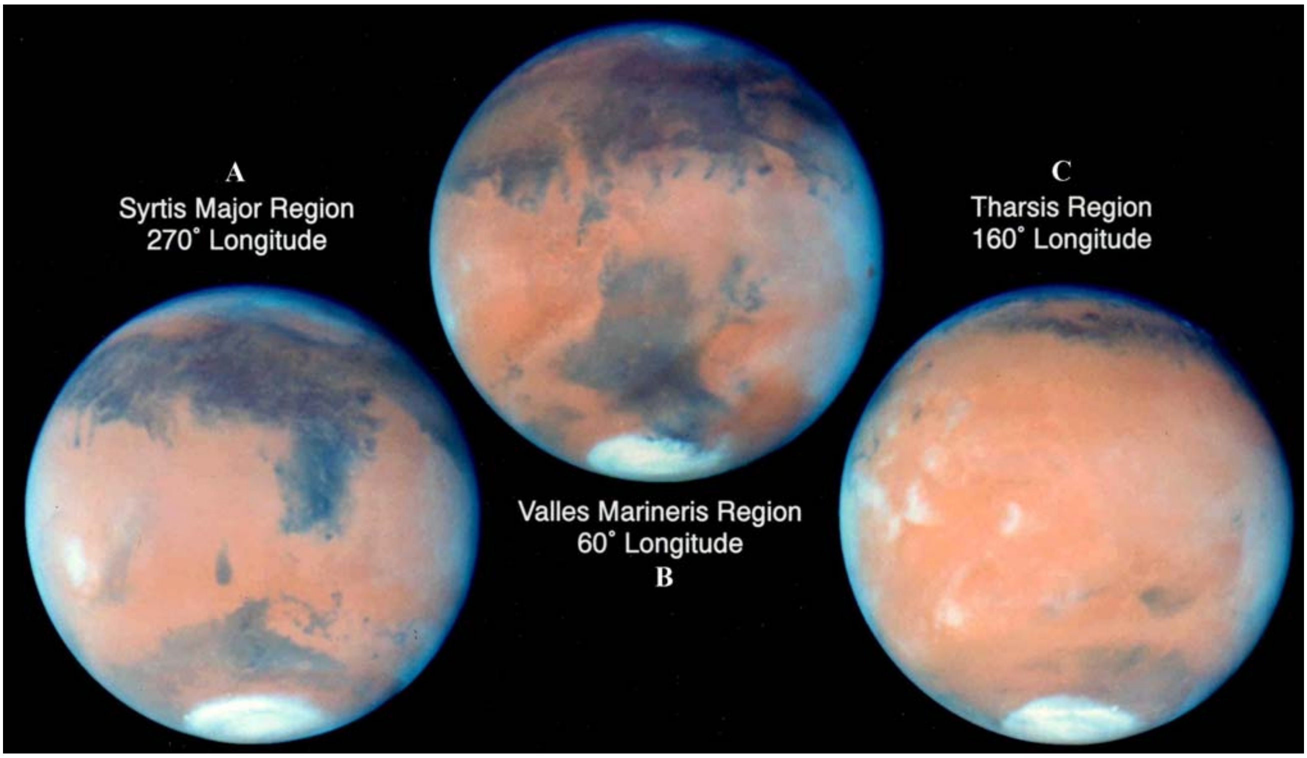


Figure 3. HST images from 1995 February 25, with wide field planetary camera 2 (P. James, S. Lee & *NASA*). Note NPC annular rift and fine cap details. *From left to right:*
A. *Syrtis Major* and *Hellas* hemisphere. The slight bluish tint of the *Syrtis* may be partly due to the thin streaks of blue-white equatorial cloud extending across it.
B. *Mare Acidalium* hemisphere. (In this and the other images, some of the dark patches correspond to parts of crater floors. But not all patches so correspond, so one cannot state that the images unambiguously reveal the existence of craters, as the writer has discussed elsewhere.[4,29]) Complex diurnal clouds are visible, within which, on the morning terminator is a small dark spot, *Ascraeus Mons* (*Lacus*). Compare Parker's colour image of February 28.
C. *Tharsis–Amazonis* hemisphere. Evening orographic clouds shown in superb detail, including a crescent-shaped one over W. *Olympus Mons*. Tiny white clouds detached from the morning terminator can be seen at high S. latitude on the original images.

Surface features

Apparition map

Figure 4A is a map drawn by the Director showing the albedo features (and NPC S. edge) near opposition from the Section's CCD and visual work. Figure 4B, giving UAI results for 1988–1999, is useful for nomenclature. In the following account E. and W. are used areographically (E. = *p*., W. = *f*.), and the nomenclature is after Ebisawa.[2]

Region I: long. 250–010°

Figure 7 collects 1994–'95 drawings of this region.

Syrtis Major dominates this part of the planet. As in the 1980s and the earlier '90s it was broad, blunted to the north, and displayed several details in its interior and irregularities in its contour. Gray described it (and the other major albedo markings in *Region I*) as deep slate grey (December). To Minami it was bluish in November and bluish or green-bluish in February. The Director found both the *Syrtis* and *Iapigia* bluish-grey in February. The blue tint was particularly obvious in the morning or evening to several observers at the epoch when the '*Syrtis* blue cloud' was observable (see white cloud section). On the E. side *Osiridis Prom*. was seen as a marked inflexion, and *Moeris Lacus* was small and detached, very similar to 1993. *Nili S.* marked the NE corner, with *Nilosyrtis* faint or invisible this apparition. *Antigones F.* marked the NW corner, with *Astaboras* a short streak running to the NW. On the W. side *Nymphaeum Prom*. was seen, and further south the N. part of *Deltoton Sinus* was visible. Just south, the ring of the *Huygens* crater situated in *Iapigia*, with a dark oasis in the centre, continued to be well seen (Figure 2B, H; Figures 10 (middle), 13H).

To the W. of *Iapigia* the *Sinus Sabaeus* was very dark (and blue to Minami, McKim and others), its E. end apparently continuous with *Iapigia*. In the early 1980s,[24] when the martian date at opposition was similar to the present one, the E. end of *Sinus Sabaeus* had been faint or invisible. The N. coast of *Sinus Sabaeus* showed the usual double protrusions of *Portus Sigeus*, and *Sinus Meridiani* had its normal double aspect, with the diminutive *Fontis Valkyrii* to the N. of the W. 'fork' recorded on several CCD images (Figure 2G) and in high resolution drawings. To Minami under CML = 34° in April, *Sinus Meridiani* was the bluest marking on the disk. To the N. of *Sinus Sabaeus* there was a trace of *Euphrates, Typhon* and *Orontes*. The region of *Edom* crater was occasionally seen as a brighter spot. North of *Meridiani Sinus* the pale, diffuse *Hiddekel* (running to the W. end of *Ismenius Lacus*), *Gehon* and *Cantabras* could be detected.

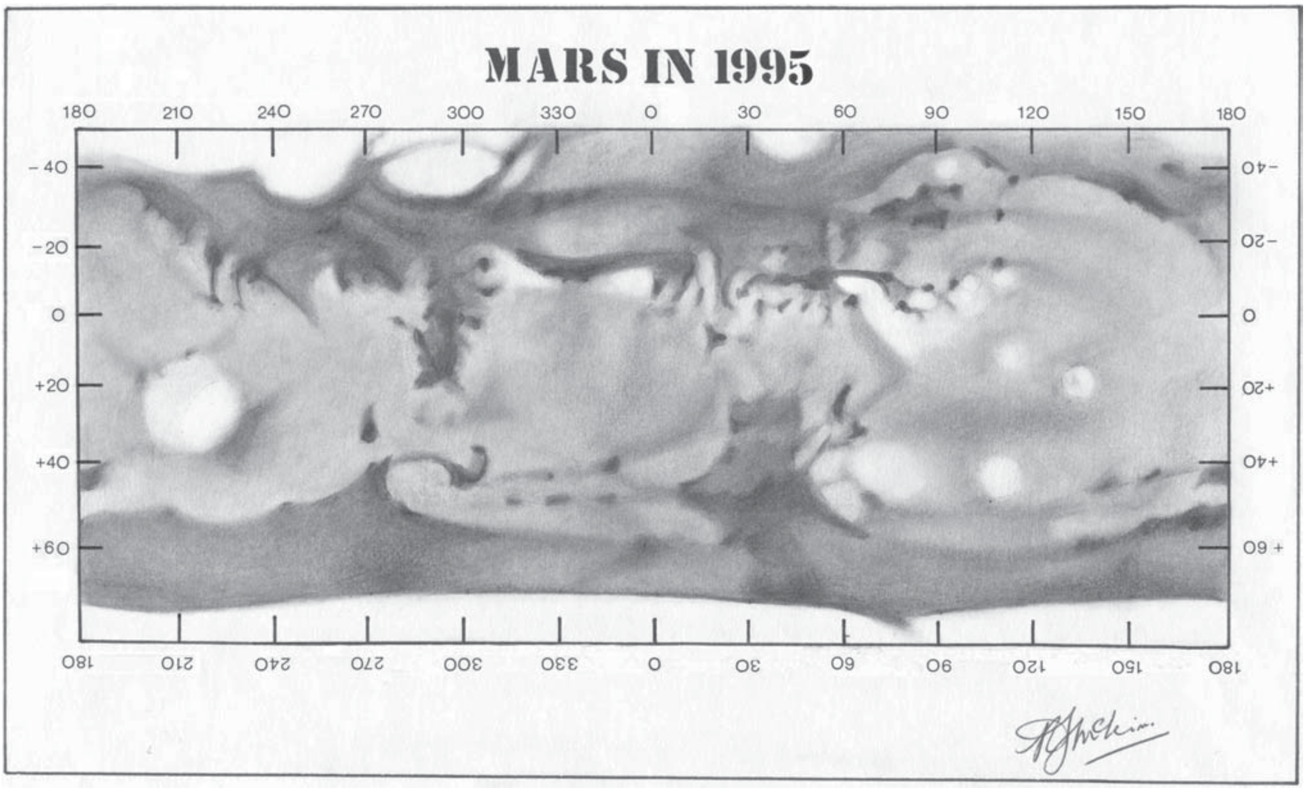


Figure 4A. Martian albedo features in 1995, drawn from images around opposition time. The S. edge of the NPC is shown for opposition. CCD images by Parker and Warell, and selected visual drawings, were used in this compilation. (HST images were *not* used, their resolution being an order of magnitude higher than BAA work.) *R. J. McKim*

These streaky features crossing *Eden* could be seen to be somewhat patchy at high resolution.

South of *Syrtis Major* the N. border of *Hellas* was marked by an unusually dark and apparently continuous boundary comprising *Mare Hadriacum*, *Mare Ionium* and *Yaonis Fretum* and continuing into *Mare Serpentis* (Figure 2B, H; Figures 6G, H, etc.). *Hellas* was bright at opposition and in other months, as described elsewhere, but cloud or frost in the basin did not prevent observers and imagers from recording *Peneus* as a rather dark E–W line. *Zea Lacus* was, however, not recorded. *Yaonis Fretum* could be traced some way south of the dark patch *Nerei D*. *Hellespontus* formed a dark band running parallel to it, but its southern part was invisible owing to the northward presentation. The terrain south of *Sinus Sabaeus* was marked by *Deucalionis Regio* and the very dark E–W oriented *Pandorae Fretum*. *Pandorae Fre-*

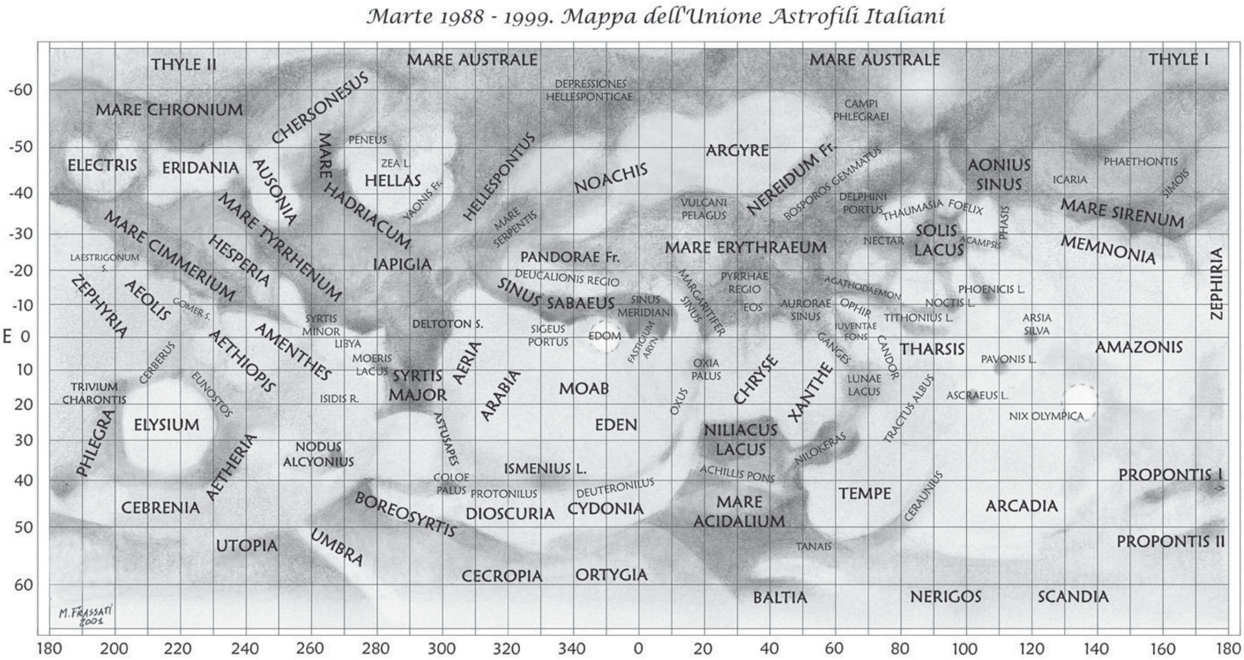


Figure 4B. General UAI albedo map 1988–1999 drawn by Mario Frassati, lettered by Paolo Tanga. (See: M. Frassati & P. Tanga, 'Marte 1988–1999: la mappa dell'Unione Astrofili Italiani', *Astronomia UAI*, No.4, 2001.)

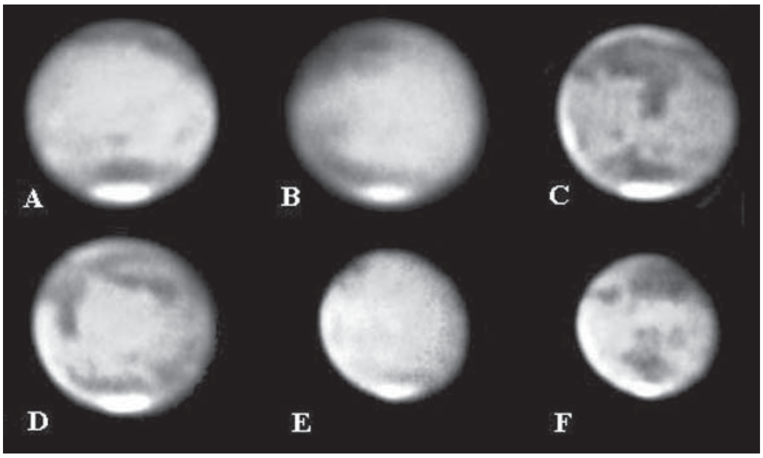


Figure 5. CCD images by Platt with 320mm refl. and Starlight Xpress camera; originals in colour.
Top row, left to right:
A. 1995 February 4d 23h 26m, CML = 182°. *Propontis* on CM; orographics on evening side.
B. 1995 February 15d 23h 47m, CML = 92°. *Solis Lacus* on CM. *Gallinaria Silva* is the small spot *f.* it. Slight whiteness in *Tempe* and *Arcadia*.
C. 1995 March 3d 22h 05m, CML = 286°. *Elysium* bright in evening. Fine desert details N. and W. of *Syrtis Major*.
Bottom row:
D. 1995 March 4d 01h 03m, CML = 330°. *Edom* lightish, small bright terminator cloud lies E. *Tempe/Mare Acidalium*. *Olympia* partly resolved on the *p.* side of NPC.
E. 1995 March 22d 22h 32m, CML = 123°. *Solis Lacus* at evening terminator. *Olympia* on *f.* side. Subtle albedo features and clouds.
F. 1995 March 29d 20h 50m, CML = 34°. Note albedo variations within *Mare Acidalium* complex.

tum merged with an even darker *Mare Serpentis* on the E. side. Comparing the 1993 and 1995 charts indicates that the course of *Pandorae Fretum*, particularly in the west, definitely lay a few degrees further to the south in 1995, with *Deucalionis Regio* therefore broader than usual. *Noachis* was featureless.

To the E. of the *Syrtis*, *Mare Tyrrhenum* was customarily prominent and showed a number of northward inflexions at its border with *Libya*, as in 1993 and earlier. Of these, the *Syrtis Minor* was again the most noticeable. *Crocea* appeared as a half tone separating *Mare Tyrrhenum* from *Iapigia* and *Syrtis Major*, and *Hesperia* was as usual seen to the east of *Mare Tyrrhenum*. *Ausonia (Australis)* formed a lighter region along the S. limb at opposition. The N. part of *Ausonia (Borealis)* was dusky as usual, and merged with *Mare Tyrrhenum* and environs.

The desert areas of *Isidis Regio*, *Neith Regio*, *Meroe*, *Aeria*, *Arabia*, *Moab* and *Eden* contained no major features of interest. Minami (January) described *Arabia* and *Eden* as reddish. The writer saw the equatorial deserts generally (including *Regions II* and *III*) as a 'brick-dust' orange tone. To the N. of *Syrtis Major* was the very dark complex of *Utopia–Casius*. Just S. of the southern tip of *Utopia–Casius*, *Nodus Alcyonius* continued in its isolated existence, appearing much the same at every apparition from 1982 onwards. As in most of these apparitions, in 1995 it was a dark triangular wedge. HST images locate its centre at +32°, 265°. To the north of the dark *Utopia* region, *Copais Palus* formed a still darker patch close to the S. edge of the N. polar cap at opposition. *Cecropia* and *Ortygia* were also very dusky. As in the 1980s and earlier 1990s, *Boreosyrtis–Coloe P.* formed a dark curving arc running west and then south from the S. tip of *Utopia–Casius*, the whole area continuing to look very different from the Ebisawa or de Mottoni maps. CCD work revealed subtle changes in the area between 1993 and 1995. *Umbra* was a light region, continuous with *Dioscuria* and *Cebrenia*. *Protonilus* was rather faint, and *Ismenius Lacus* was smaller than 1993 in the E–W sense, the E. part having faded out. This is quite unusual, for *Ismenius Lacus* is normally long and dark at aphelic oppositions. As in 1993 a small unnamed oasis lay to the E. of *Ismenius L*. *Deuteronilus* was rather broad and merged with the normal track of *Oxus II*. North of *Protonilus–Deuteronilus* there were a few unnamed 'lakes' joined by dusky streaks running in an E–W direction. *Arnon* was not recorded.

Region II: long. 010–130°

Refer especially to Figure 8.

Mare Acidalium and environs: this area was very similar in detail to 1993, with the *Niliacus Lacus* becoming relatively paler with the seasonal build-up in equatorial white cloud. *Achillis Pons* was more evident in 1995: this continues the trend evident upon our charts since 1990. *Mare Acidalium* showed much internal detail (Figure 2G; Figures 7G, 8, etc.), being darkest to the north (and especially in the NW about *Depr. Acidalia*). Minami (January) found a brown tint to *Mare Acidalium* and *Niliacus Lacus*, and Gray found them warm grey to fawn (February). Thus a 'warm' tone in the N. hemisphere broadly contrasted with the 'cold' tints to the south.

Nilokeras was dark (and double) on the east where *Achillis Fons* and *Idaeus Fons* again formed two prominent dark patches, but it was lighter to the west. In contrast to the 1980s decade, *Lunae Lacus* was unobservable as a separate feature, simply marking the union of the very pale but broad *Ganges* with the dark *Nilokeras*. To the N. of *M. Acidalium*, *Tanais* was well seen, whilst a very broad *Iaxartes* ran further to the north. *Hyperboreus Lacus* was first detected upon Parker's CCD images on February 20 (as the snow line receded), and the writer noted it for the first time visually on February 26. It appeared separated from *Mare Acidalium* by April. *Baltia*, *Nerigos* and *Mare Boreum* were all dark. The details visible just W. of *Mare Acidalium* were similar to those of 1990 and 1993, roughly corresponding to the classical *Acidalius F.* together with the N. part of the *Tempes* streak (christened by the late C. F. Capen as the halftone streak occasionally uniting *Acidalius F.* with *Achilles F.*). From *Acidalius Fons* a pale unnamed streak at around latitude +50° ran to the west nearly as far as *Euxinus Lacus* (*Region III*). This area appeared nearly the same as in 1993. *Tempe* was light, *Ceraunius* visible only weakly, and *Arcadia* light. For much of the martian day *Arcadia* often contained the bright patch *Alba* marking the location of *Alba Patera*. A broad dusky streak ran E–W from W. *Nilokeras* corresponding to the location of classical *Uranius*, *Nilus* and *Phlegethon*, ending N. of *Olympus Mons*.

Olympus Mons was sometimes seen as a dusky albedo feature (Figure 6B), but at opposition a bright cloud (shown as crescent-shaped in Figure 3) more usually marked its place in the martian afternoon and evening. A similar bright cloud lay over *Pavonis Lacus* (*Pavonis Mons*). *Arsia Silva* (*Arsia Mons*) also had an associated cloud, whilst Ebisawa's *Nox Lux* (in *Syria Planum*) was evident as a specific bright spot. The volcanoes could be seen as dusky spots on the morning side of the disk, whilst the HST's remarkable image of *Ascraeus Mons* surrounded by morning cloud features in Figure 3.

South of *Mare Acidalium* several albedo streaks and patches could be seen against the bright *Chryse* and *Xanthe* deserts. *Clytaemnestrae Lacus* was small and faint, lying on the *Iamuna* (which runs from *Iamunae S.* to *Engedii Fons*). *Hydraotes* (in part) was imaged, as were *Hydaspes* and *Indus*, whilst just N. of *Aurorae Sinus–Eos* could be seen the following small features, from E. to W: *Hydaspis Sinus*, *Orestes*, *Aromatum Prom.*, *Iamunae S.* and *Hydrae Palus*, *Gangis S.*, and *Baetis–Juventae Fons* (Figure 2G; Figures 5F, 8). *Margaritifer Sinus* was fairly dark and displayed internal details similar to 1990 and 1993. *Oxia Palus* was quite large, prominent, and triangular shaped. *Iani Fretum* bridged the light *Aram*, and *Brangaena* formed a third, very narrow 'prong' to *Meridiani Sinus*. *Eos* again appeared as a lighter halftone, and *Aurorae Sinus* was very dark as usual. *Pandorae Fretum* ran into the E. end of the dark *Mare Erythraeum*. Patrick Moore found *M. Erythraeum* bluish (January), and Gray (February) called it and *Aurorae Sinus* slate grey. *Argyre* (*Argyre I* on the Ebisawa chart) formed a light patch at the S. limb. *Ophir–Candor* was often a bright area, confluent with *Tharsis*, etc. In January Minami described *Chryse* as being creamish in contrast to the reddish *Eden* of *Region I*, and this was also McKim's opinion of *Chryse–Xanthe* compared with *Cydonia*, *Eden* or *Tempe* in February.

Solis Lacus and environs: *Solis Lacus*, the 'Eye of Mars', was again rather large and dark, and divided by a lighter E–W central area (Figure 2F, 8F, 13C). A few visual observers with large telescopes – including Biver and Mrs Murugesh – saw this light division. *Nectar* was dark and wide, connecting it to *Mare Eythraeum*, and with the details *Aurea Cherso*, *Nia* and *Nectaris F.* visible. The *Solis Lacus* was surrounded by the half tone of *Thaumasia* and bordered on the south by *Bosporos Gemmatus–Phrixi Regio* etc., this dark border continuing south where it was broken by *Chrysokeras*. Several darker nuclei were recorded in *Solis Lacus* which correspond to the classical *Helli D.* and *Fulgoris D.* in the southern half and to *Vestae D.* and *Phoebi D.* in the north. CCD images showed that the north component of *Solis Lacus* did not extend so far west as in 1993 or in other recent apparitions, nor was the dark patch that terminated the lighter E–W central region on the W. side in 1990 and

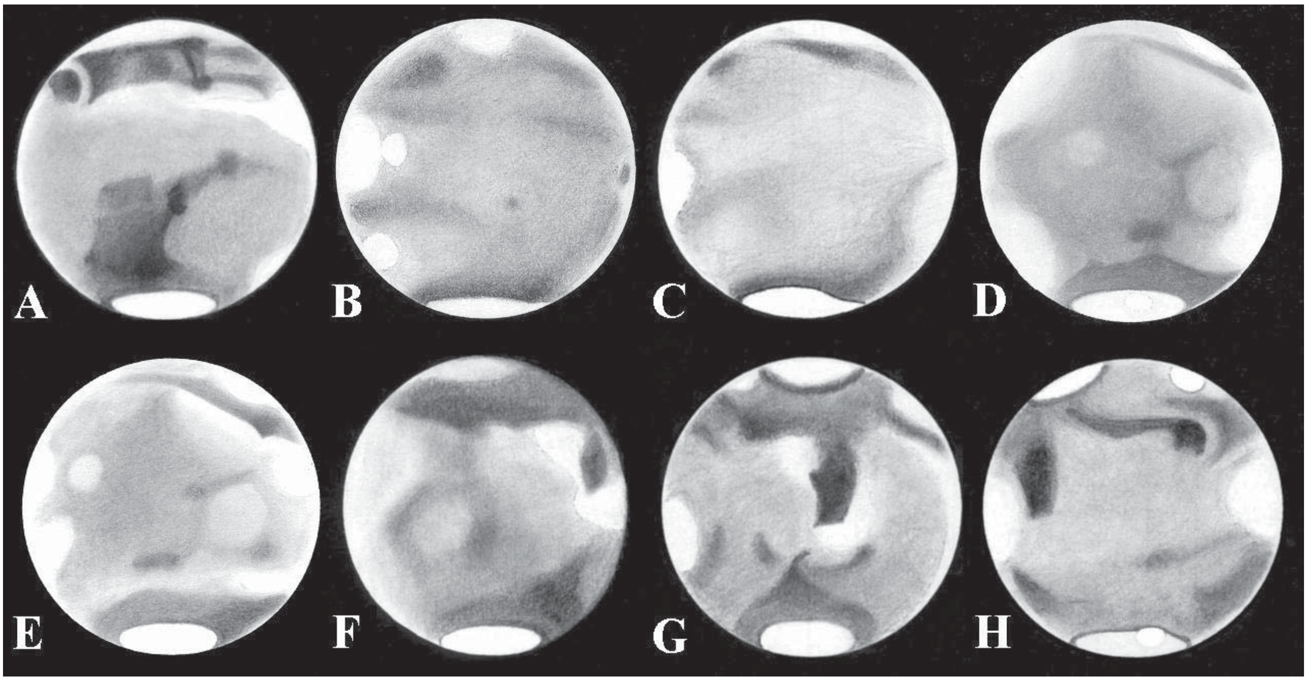


Figure 6. Drawings by the Director with 216mm refl., (**A and C–H**) and with 200mm and 300mm OGs (**B**).

Top row, left to right:

A. 1995 February 17d 22h 00m, ×232, CML = 48°. Morning cloud over *Tharsis* extends into southern *Chryse* forming partial ECB.

B. 1995 March 18d 19h 45m, ×230, ×320, CML = 118°, W15 and 44A filters. *Claritas* bright at S. limb. *Olympia* inflects NPC S. edge on *f.* side. *Olympus Mons* is an 'oasis' on the CM; *Trivium Charontis* on *f.* limb as distinct dark spot.

C. 1995 March 12d 18h 25m, ×232, CML = 152°. NPC inflexion at *Olympia* on *f.* side. *Xanthe* p.m. cloud.

D. 1995 February 4d 23h 25m, ×232, ×464, CML = 182°, W15, 44A and 58 filters. *Nix Olympica* less bright than in **E**. Morning cloud W. of *Elysium*. Bright patch on NPC.

Bottom row:

E. 1995 February 1d 22h 20m, ×232, ×260, CML = 192°, W15 and 44A filters. *Tharsis* and *Olympus Mons* orographic clouds in afternoon; a.m. cloud also visible; *Elysium* shows pale borders. *Propontis* dark near CM.

F. 1995 April 12d 20h 00m, ×232, CML = 252°. Outlines of *Elysium* dusky; morning cloud over *Isidis Regio–Libya*, etc., identifiable with '*Syrtis* blue cloud'.

G. 1995 February 26d 19h 00m, ×232, CML = 285°, W15 and 44A filters. Frost in *Ausonia–Hellas*, evening cloud over *Elysium*; morning cloud along N. *Sinus Sabaeus*. Central whiteness in *Meroe*. *Nodus Alcyonius* dark.

H. 1995 January 18d 23h 00m, ×232, ×464, CML = 325°, W15 filter. Bright patches upon *Hellas*, *Argyre*, etc. Bright area in NPC and inflexion in contour.

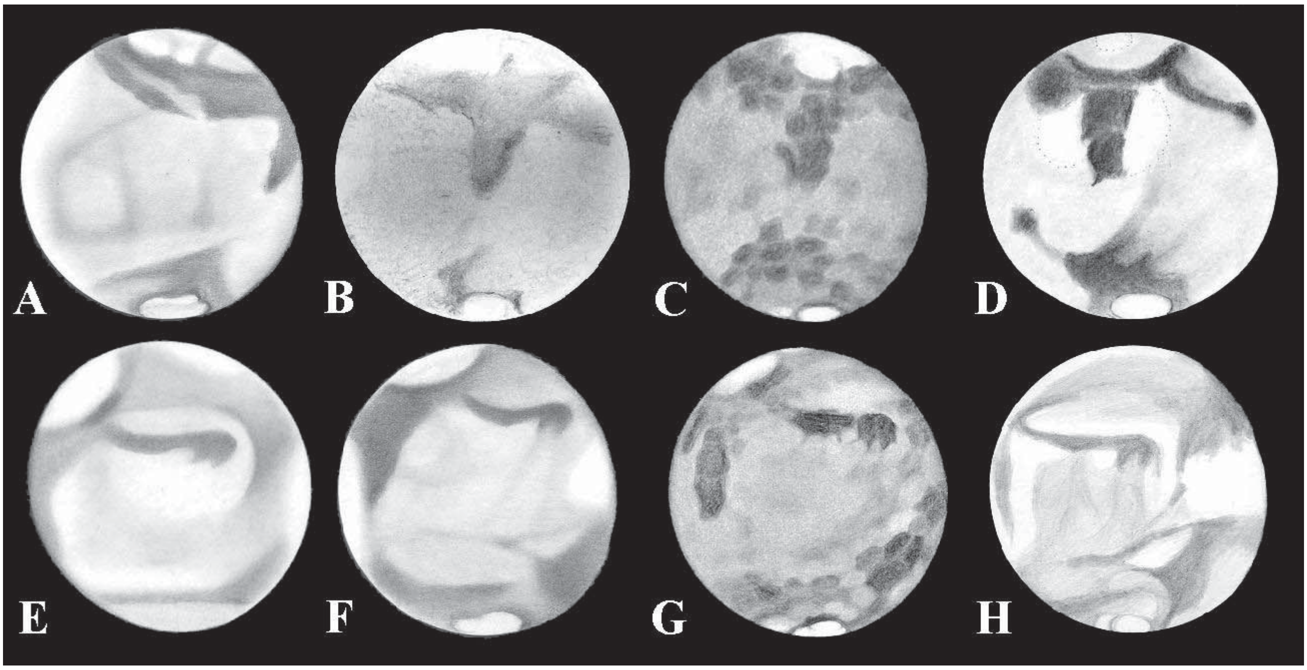


Figure 7. ***Region I*, long. 250–010°.** *Top row, left to right:*
A. 1995 April 13d 20h 40m, CML = 253°, 415mm Dall–Kirkham Cass., ×415, W15 filter, *Gray*. *Elysium* boundaries well defined. NPC shows *Olympia* and *Rima Borealis*.
B. 1995 February 25d 18h 40m, 390mm refl., ×360, CML = 289°, *P. A. Moore*. Bright *Hellas*.
C. 1995 June 19d 18h 05m, CML = 295°, 1000mm Cass. (stopped to 500mm), ×735, *Biver*. *Olympia* still visible *p*. the NPC.
D. 1995 March 4d 23h 35m, CML = 298°, 310mm refl., ×310, yellow and red filters, *Néel*. *Isidis Regio–Libya* and *Aeria* bright.
Bottom row:
E. 1994 August 29d 05h 50m, CML = 338°, 415mm Dall–Kirkham Cass., ×415, ×663, W15 filter, *Gray*. Early view showing large N. polar hood and bright *Hellas*.
F. 1995 May 13d 21h 20m, CML = 339°, 415mm Dall–Kirkham Cass., ×415, W15 filter, *Gray*. Compare with **E**. Diurnal clouds over *Chryse* and *Isidis Regio–Libya*; visibility of *Protonilus–Ismenius Lacus–Deuteronilus* and other streaky markings.
G. 1995 March 30d 18h 00m, CML = 343°, 1000mm Cass., ×735, *Biver*. Fine details on N. edge of *Sinus Sabaeus* and about *Meridiani Sinus*; structure in NPC.
H. 1995 March 22d 14h 10m, CML = 0°, 200mm OG, ×480, ×600, *Minami*. *Olympia*; light evening cloud over *Aeria* veiling *Syrtis Major*.

1993 still visible. To the Director in 1995, this change suggested the beginning of the expected fading of *Solis Lacus*, and a return to its more classical appearance: however, later events did not bear this out.

To the W. of *Solis Lacus*, the *Acampsis* streak ran to and somewhat beyond the small dark *Gallinaria Silva* as in 1993. *Phoenicus Lacus* was well marked. To the SW a pale trace of the *Phasis* 'canal' ran north from a small dark *Bathys Portus–Aonius Sinus*. To the north of the *Solis Lacus* the half tones *Geryon* and *Calydon* could be traced. The *Valles Marineris* complex was recorded in detail by Biver and Gray visually and in CCD images by Parker, Quarra *et al*. and Warell. *Agathodaemon* (*Coprates*) was dark, as were *Melas Lacus* and the smaller *Noctis Lacus*. *Tithonius Lacus* was fainter, containing an obvious *Hebes Lacus* in the north. A small dark condensation just E. of *Noctis L.* had not been mapped by the BAA in 1993; this was *Ius Lacus* (now *Ius Chasma*). It is instructive to compare the Section's albedo map here (Figure 4A) with a modern albedo-topographic chart of this area.

Region III: long. 130–250°

Section work for 1994–'95 is collected in Figure 9.

The *Mare Sirenum* continued to appear smaller than on the classical albedo charts. At the E. side it merged with the halftone of *Hyscus*, and this, coupled with the absence of *Sirenum Sinus* (the northward-pointing, classical 'Beak of the Sirens') sometimes made it hard to see precisely where it began. The W. and NW parts appeared faded, so that it continued to be thin on the W. side and not wide (Figure 2C–E; Figures 6C, 9B). *Tartarus* was noticed faintly. On the W. side *M. Sirenum* was connected with *Mare Cimmerium* through the dusky *Ariadnes D.* and *Atlantis*. *Mare Cimmerium* was dark and normal, its W. limit ending in the elongated dark point of *Tritonis Sinus*. There was a trace of *Cerberus III* crossing the dusky southern part of *Hesperia*. On its N. side, *Laestrygonum S.* and *Orestiadum D.* formed two small projections. More notable were the two dark northward projections (*Cyclopum Sinus* and *Cerberi Sinus*) associated with *Sinus Gomer*, and these have been especially noticeable since the mid-1980s. On the southern limb at opposition could be seen the bright areas *Electris* and *Eridania*. *Mare Chronium* was too far S. to be observable.

Elysium and environs: *Elysium* was bounded by weak markings except on the NW side where the low albedo *Aetheria* development has persisted throughout the 1980s and 1990s. As in 1993 this extended somewhat in the SW direction. When *Elysium* was not covered by white cloud or frost it was almost indistinguishable from its light desert surroundings, and visual observers often then failed to recognise it in less than perfect conditions. Sometimes a small white cloud lay over *Elysium Mons* (Figure 9G). Elysium's N. and SW borders (*Chaos* and *Eunostos I*) were barely perceptible. On the E. side *Phlegra–*

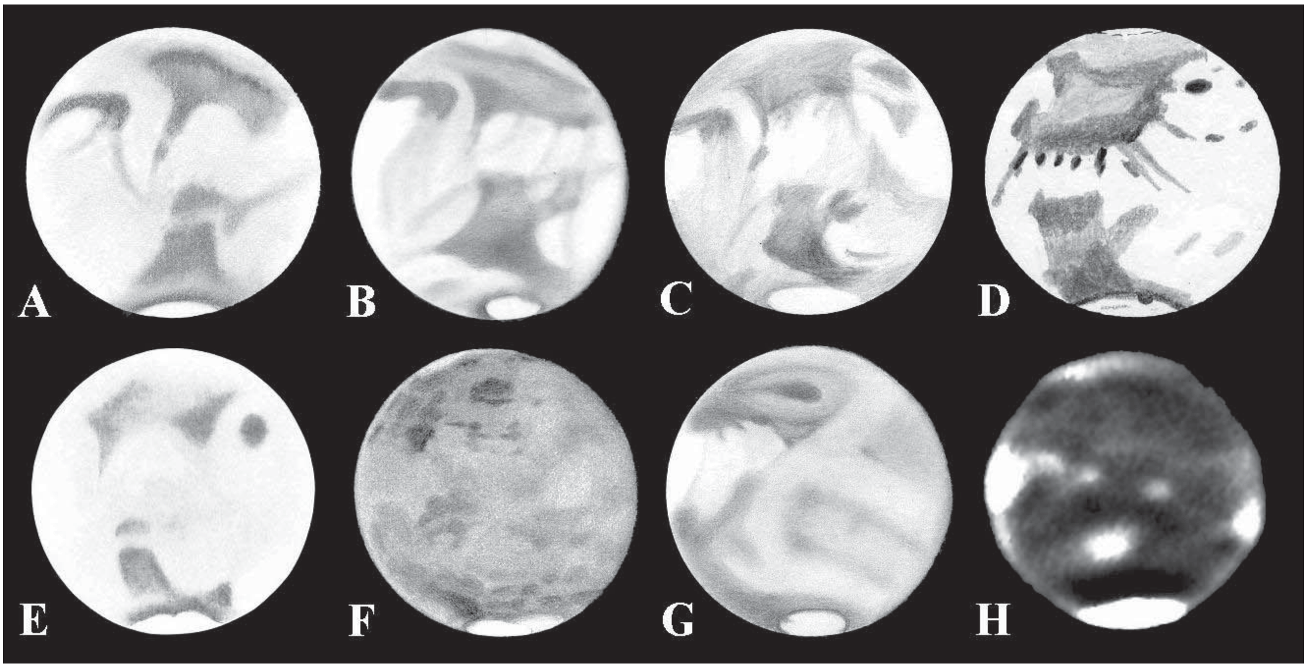


Figure 8. ***Region II*, long. 010–130°.** *Top row, left to right:*
A. 1995 February 23d 23h 00m, CML = 18°, 400mm refl. ×286, ×333, *Graham*. *Oxia Palus* well seen, also half-tone streaks *Gehon* and *Hiddekel*.
B. 1995 May 7d 20h 5m, CML = 31°, 415mm Dall–Kirkham Cass. ×415, W15, W25 filters, *Gray*. Fine structure in *Mare Acidalium–Niliacus Lacus–Nilokeras* and in many desert areas.
C. 1995 February 6d 14h 50m, CML = 39°, 200mm refl. ×430, *Minami*. Note shape of *Oxia Palus* and details in S. *Chryse–Xanthe*. *Argyre* slightly hazy at S. limb, but *Noachis* is dull.
D. 1995 February 27d 04h 19m, CML = 61°, 410mm refl. ×1050, W25 filter, *Troiani*. Fine details in S. *Chryse*; double appearance of *Ganges*; NPC *Chasma Boreale* notch and partial annular rift.
Bottom row:
E. 1995 February 17d 23h 05m, CML = 64°, 150mm OG ×286, W12 filter, *Graham*. *Chasma Boreale*; *Niliacus Lacus* detached from *Mare Acidalium*.
F. 1995 March 20d 19h 17m, CML = 93°, 1000mm Cass. ×1470, *Biver*. Fine structure in *Solis Lacus*, *Tithonius Lacus*, *Nilokeras*, etc; *Olympia* on the *f.* side NPC.
G. 1995 March 21d 20h 10m, CML = 97°, 415mm Dall–Kirkham Cass. ×262, ×415, W15 filter, *Gray*. *Chasma Boreale*; *Solis Lacus* dark; fine desert details in *Tharsis*, etc.
H. 1995 February 18d 03h 07m, CML = 123°, 410mm refl. F/43, blue light CCD image (see Figure 2 for more details), *Parker*. Orographic clouds (*e.g., Alba*) and diurnal clouds; strong Blue Clearing.

Styx were pale halftones, and *Trivium Charontis–Cerberus* were perhaps even fainter than in 1993, continuing the trend begun in the later 1980s. *Trivium Charontis* was a small pale 'oasis', from which a pale *Cerberus* extended SW as far as the tiny *Pambotis Lacus*. Between these (and closer to *Trivium Charontis*) there existed another tiny spot. Also on this side of *Elysium*, *Orcus* was a faint streak, but *Erebus* (in contrast to 1993) was not visible.

To the NE of *Elysium* the very dark and rod-like *Propontis* (*Propontis I* on the Ebisawa map) had tiny extensions at the NE and SW corners. To its north there was desert up to an ill-defined dark S. border to the uniformly shaded *Scandia–Panchaïa*, but this border was some 10° too far south to be the classical *Propontis II* (which is separated from *Propontis I* by the light half-tone *Herculis Pons*). *Castorius Lacus* was an ill-defined condensation on the S. border of *Scandia*. *Euxinus Lacus* lay to the south, smaller but better defined, and at the same latitude as *Propontis I*. An unnamed small oasis lay on its E. side. In November Minami described *Propontis I* and the dark NPC collar at that CML as brownish or reddish. *Trivium Charontis* was brownish.

To the far north of *Region III* there was little of interest. The S. edge of the NPC was marked by the nearly monotonous shading of *Scandia–Panchaïa*, which was darker in its S. parts in the longitudes of *Arcadia* and *Propontis*, and around the general region of *Arsenius Lacu*s adjacent to the NPC.

Intensity estimates

In this programme the relative intensities of the markings are estimated at the eyepiece on a scale of 0 (polar cap) to 10 (black sky), where desert areas are normally of intensity 2. Photometry of stacked but unprocessed CCD images should yield more valuable data, but as no observer has yet taken up this line of work the Director will continue to process visual estimates, but with stricter criteria than before.

White light intensity data provided by five observers met the requirements of adequate sampling and ease of interpretation (Table 2). Use of the wrong scale (or the ALPO brightness scale) caused a good deal of work to be rejected.

The martian atmosphere

White clouds

General

It was possible to follow the increase in meteorological activity concomitant with the regression of the N. polar cap. The seasonal orographic clouds were recorded from 1995 January onwards, as were the equatorial cloud bands (ECB). White patches were assumed to be white cloud except where wave-

Table 2. Martian intensity estimates

Feature	*Foulkes*	*Graham*	*Observer* *Heath*	*McKim*	*Schmude*	*Ave.*	*s.d. (±)*	*No.*
Achillis F.	–	3.3	–	–	–	3.3	–	3
Acidalium, M.	6.6	6.0	4.7	5.4	5.3	5.6	0.8	46
Aeolis	–	1.4	–	2.0	–	1.7	(0.3)	13
Aeria	–	1.5	1.0	1.9	–	1.5	0.4	12
Aetheria	–	2.1	–	2.4	–	2.2	(0.2)	14
Aethiopis	–	–	1.0	2.0	–	1.5	(0.5)	13
Amazonis	–	2.2	1.0	2.2	–	1.8	0.7	17
Amenthes	–	2.0	–	2.1	–	2.0	(0.1)	9
Arabia	–	2.2	–	1.7	–	2.0	0.2	11
Arcadia	–	2.2	1.0	2.2	–	1.8	0.6	17
Argyre	–	–	–	1.0	–	1.0	–	6
Ascraeus L.	4.8	–	–	3.8	–	4.3	(0.5)	4
Aurorae F.	–	–	–	5.5	–	5.5	–	2
Aurorae S.	7.2	5.3	5.2	6.3	–	6.0	1.0	12
Ausonia	1.7	1.2	0.5	0.4	1.0	1.0	0.5	20
Baltia	–	–	–	4.2	–	4.2	–	5
Boreosyrtis	–	–	5.3	4.5	–	4.9	(0.4)	10
Boreum, M.	5.2	5.0	5.9	3.9	4.9	5.0	0.7	23
Callirrhoes S.	–	–	–	6.5	–	6.5	–	2
Candor	–	–	–	1.0	–	1.0	–	6
Casius	–	–	4.5	5.7	–	5.1	(0.6)	10
Cebrenia	–	1.5	–	1.8	–	1.6	(0.2)	10
Cecropia	–	3.8	–	4.3	5.3	4.5	0.8	17
Cerberus (I)	–	3.0	–	3.6	–	3.3	(0.3)	8
Cerberus (II)	–	–	–	2.8	–	2.8	–	2
Chaos	–	–	–	2.8	–	2.8	–	3
Chryse	2.5	2.0	0.5	1.1	–	1.5	0.9	11
Cimmerium, M.	6.7	5.8	5.6	5.6	5.0	5.7	0.6	32
Claritas	–	–	1.0	1.2	–	1.1	(0.1)	4
Cydonia	–	–	–	2.4	–	2.4	–	8
Daedalia	–	–	–	1.9	–	1.9	–	3
Deucalionis R.	3.2	3.0	0.5	2.5	–	2.3	1.2	6
Deuteronilus	–	–	–	3.5	–	3.5	–	1
Diacria	–	–	–	2.7	–	2.7	–	3
Dioscuria	–	–	–	2.4	–	2.4	–	7
Eden	–	2.3	–	1.9	–	2.1	(0.2)	13
Edom	–	1.5	–	-	–	1.5	–	2
Electris	1.0	1.0	–	1.1	–	1.0	0.1	8
Elysium	–	1.6	1.0	1.4	–	1.3	0.3	18
Eridania	1.2	1.1	0.5	0.8	1.0	0.9	0.3	18
Erythraeum, M.	6.8	6.0	5.0	6.5	5.2	5.9	0.8	18
Eumenides-Orcus	–	–	–	3.0	–	3.0	–	1
Ganges	–	–	–	3.7	–	3.7	–	3
Gehon	–	3.0	–	-	–	3.0	–	1
Hadriacum, M.	–	–	–	5.7	–	5.7	–	5
Hellas	1.7	1.0	0.5	0.6	0.9	0.9	0.5	28
Hesperia	–	3.0	1.7	3.5	–	2.7	0.9	8
Hyblaeus	4.7	3.5	3.3	3.8	–	3.8	0.6	16
Hyperboreus L.	–	–	–	7.0	7.0	7.0	(0.0)	3
Iapigia	–	5.0	5.0	5.0	–	5.0	0.0	17
Idaeus F.	–	–	–	5.7	–	5.7	–	3
Isidis R.	–	1.9	–	1.5	–	1.7	(0.2)	14
Ismenius L.	–	–	–	3.5	–	3.5	–	2
Libya	–	1.4	1.0	1.1	–	1.2	0.2	13
Lunae L.	5.5	–	4.0	4.8	–	4.8	0.8	10
Margaritifer S.	6.0	5.5	–	5.5	5.2	5.6	0.3	12
Memnonia	–	–	–	1.6	–	1.6	–	4
Meridiani S.	6.5	6.4	5.0	5.9	–	6.0	0.7	15
Meroe	–	–	–	1.4	–	1.4	–	5
Nectar	–	–	–	5.5	–	5.5	–	2
Neith R.	–	–	–	1.6	–	1.6	–	7
Niliacus L.	6.3	5.5	–	5.4	4.4	5.4	0.8	21
Nilokeras	5.4	4.7	–	4.6	–	4.9	0.4	12
Noachis	–	1.5	0.5	1.8	0.8	1.2	0.6	8
Nodus Alcyonius	–	–	–	3.8	4.0	3.9	(0.1)	3
Olympus Mons	–	–	4.0	4.5	–	4.2	(0.2)	2
Ortygia	–	4.4	–	4.2	5.8	4.8	0.9	17
Panchaïa	5.5	4.6	5.5	4.9	5.1	5.1	0.4	31
Pandorae F.	–	5.0	–	5.0	–	5.0	(0.0)	3
Phaethontis	1.0	1.1	–	1.2	–	1.1	0.1	6
Phlegra	–	2.8	–	3.3	–	3.0	(0.2)	9
Propontis (I)	–	–	–	4.9	–	4.9	–	4
Protonilus	–	–	–	3.5	–	3.5	–	1

length-dependence suggested surface frost. It must be remembered that before opposition the actual morning terminator is never observable, nor is the evening one thereafter. The period including 1994 October to 1995 June monitored a martian disk of 6 arcseconds diameter upwards. Outside this period observations were incomplete (and so are often qualified by quoting dates of individual records in the text), and could reveal only the largest atmospheric phenomena. Lists of areas affected by white cloud follow, on a month-by-month basis. Figure 10 illustrates the wavelength-dependence of some atmospheric phenomena.

1994 July to September

July: Schmude (Jul 29) reported morning cloud over *Chryse–Xanthe* upon the tiny disk.

August: Warell (Aug 31) saw *Hellas* light in the morning. Gray (24; Figure 7E), Warell (25) and the OAA found *Hellas* light in the evening, brighter than the large N. polar hood. *Tharsis* was bright at the evening terminator. Haze covered the S. limb.

September: *Chryse–Xanthe* was light in the morning. Gray (Sep 3) found *Hellas* light when rising. Minami found *Chryse–Xanthe* light in the evening. *Hellas* was whitish on the evening side, becoming bright white by the month's end. *Hellas* was dull near the CM on Biver's drawings. Haze remained over the S. polar regions, incorporating a brighter *Argyre*.

1994 October

a.m. (morning) limb: *Elysium*, *Hellas*, *Isidis Regio* and *Libya*.

p.m. (evening) terminator: *Chryse, Hellas*, *Libya*, *Memnonia* and *Tharsis*. *Elysium* was dull.

mid-disk: Biver found *Hellas* dull and light orange on the CM (Oct 10); but Warell (6) found it very bright on the CM.

The south circumpolar limb was whitish, within which *Argyre* remained a brighter area throughout the martian day.

1994 November

a.m. limb: *Ausonia*, *Cebrenia*, *Chryse*, *Elysium* (not always), *Eridania* and *Hellas*.

p.m. terminator: *Chryse*, *Hellas*, *Memnonia*, *Tharsis* and *Xanthe*. Parker and the OAA found *Chryse* light in all visible wavelengths. Parker (Nov 2) found the bright *Xanthe* cloud apparently projecting beyond the terminator. The OAA found Hellas light through the red R60 filter, suggesting CO_2 ground frost rather than white cloud was responsible. Elysium was dull.

mid-disk: *Argyre*, *Chryse*, *Hellas* and *Xanthe*.

Table 2. *(continued)*

Feature	*Foulkes*	*Graham*	*Heath*	*McKim*	*Schmude*	*Ave.*	*s.d. (±)*	*No.*
	Observer							
Pyrrhae R.	–	4.5	–	4.5	–	4.5	(0.0)	7
Sabaeus S.	5.8	5.7	4.9	5.7	4.8	5.4	0.5	22
Scandia	–	5.2	5.5	4.1	4.5	4.8	0.5	29
Sirenum, M.	6.0	4.7	3.5	4.8	4.7	4.7	0.9	12
Solis L.	7.5	6.0	5.0	6.2	5.0	5.9	1.0	13
Syrtis Major	6.8	6.0	5.8	6.4	5.2	6.0	0.6	46
Syrtis Minor	–	–	–	7.1	–	7.1	–	4
Tanais	–	–	–	6.7	–	6.7	–	3
Tempe	–	2.2	0.5	1.8	–	1.5	0.9	14
Tharsis	2.2	2.2	–	1.5	–	2.0	0.4	20
Thaumasia	–	–	2.0	2.9	–	2.4	(0.4)	7
Thymiamata	–	–	–	1.5	–	1.5	–	2
Tithonius L.	–	–	–	3.7	–	3.7	–	3
Trivium Charontis	–	–	–	4.1	–	4.1	–	4
Tyrrhenum, M.	6.9	5.8	5.6	6.3	5.2	6.0	0.6	35
Uranius	–	3.8	–	3.8	–	3.8	(0.0)	5
Utopia	7.1	4.9	5.5	5.3	–	5.7	1.0	21
Xanthe	2.5	2.0	–	1.6	–	2.0	0.4	11
Yaonis F.	–	5.0	–	5.2	–	5.1	(0.1)	9
Zephyria	–	1.3	–	2.6	–	2.0	(0.6)	9
No. of useful estimates	91	225	113	478	102		*Total:*	1,009
Period of observation	Jan 6– Apr18	Dec 22– Apr 27	Jan 18– Apr 11	Jan 3– May 5	Dec 11– Apr 22			

1994 December

a.m. limb: *Aeria*, *Argyre*, *Ausonia*, *Cebrenia*, *Chryse*, *W. Cydonia* (Figure 10 top row), *Elysium*, *Eridania*, *Hellas*, *Isidis Regio–Libya*, *Tempe* (very bright) and *Xanthe*.

p.m. terminator: *Aeria*, *Arcadia* (Parker, Dec 1), *Chryse*, *Elysium*, *Hellas*, *Noachis*, *Tempe*, *Tharsis* and *Xanthe*. The OAA observers found *Hellas* whitish, and bright through the R60 filter, whilst Gray (22) at higher resolution found just the N. and NW parts creamy and light, with the S. part light ochre. In late December Minami (with a green filter) searched for signs of the seasonal orographic clouds, but with no success yet.

mid-disk: *Argyre*, *Ausonia*, *Chryse*, *Hellas* (especially in NW, and bluish compared with the NPC), *Tempe*, *S. Thaumasia* and *Xanthe*. On Dec 29 Minami (CML = 21°) found a brighter core in *S. Chryse* with the red R60 filter.

The S. limb generally appeared light.

1995 January

a.m. limb: *Aeria, Cebrenia*, *Chryse*, W. *Cydonia*, *Diacria* (Wilkinson (Jan 3) saw an optical projection beyond the limb here), *Elysium* (with brighter core over *Elysium Mons*), *Hellas*, *Isidis Regio–Libya*, *Neith Regio*, *Ophir–Candor*, *Tempe*, *Tharsis* and *Xanthe*.

p.m. terminator: *Aeria*, *Arcadia*, *Cebrenia*, *Chryse*, *Elysium* (brighter than last month), *Eridania*, *Hellas*, *Isidis Regio–Libya* (Parker (Jan 28 onwards, in both a.m. and p.m.) further witnessed the '*Syrtis* [*Major*] blue cloud'), *Meroe*, *Neith Regio* (irradiating over terminator to Dal Santo (17)), *Tempe*, *Tharsis*, S.

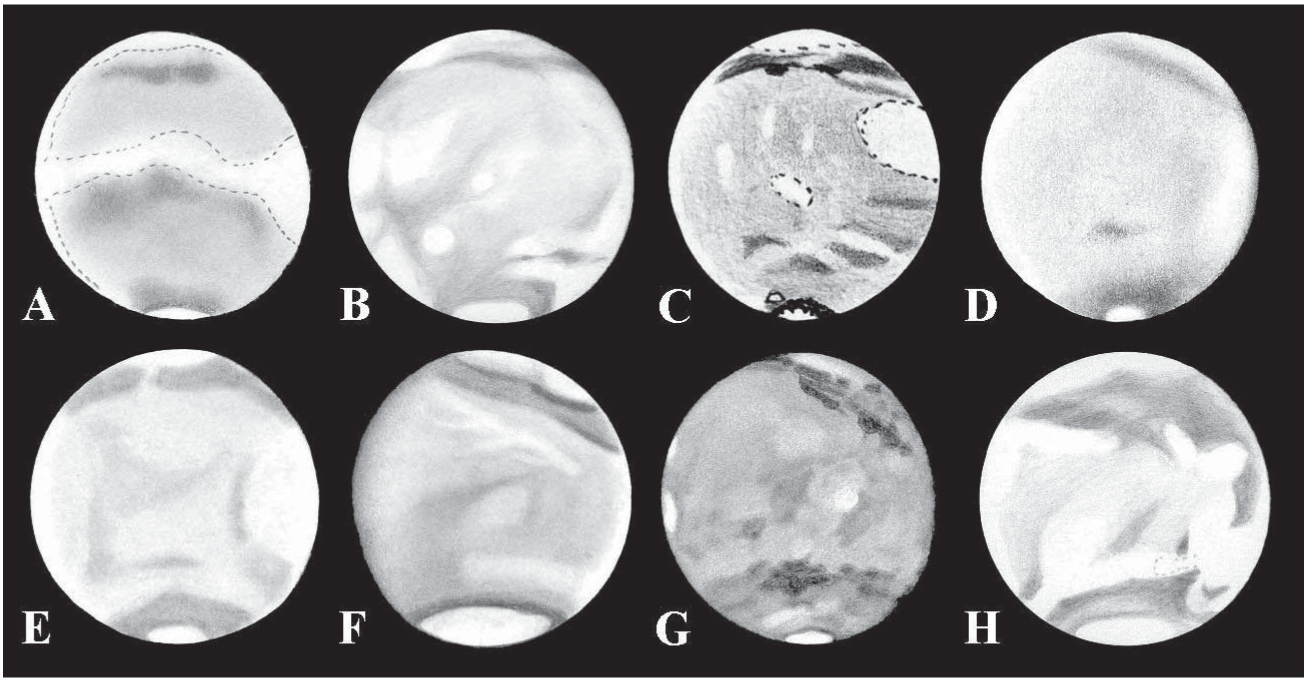


Figure 9. *Region III*, long. 130–250°. *Top row, left to right:*
A. 1995 April 27d 21h 25m, CML = 132°, 150mm OG ×333, *Graham*. ECB across the disk, uniting a.m. and p.m. clouds.
B. 1995 March 7d 14h 30m, CML = 140°, 200mm OG ×400, *Minami. Alba* whitish (especially in green light), but *Olympus Mons* diurnal cloud not yet bright. *Claritas* light at S*p*. limb. *Propontis* dark with further 'oasis' *p*. it. *Diacria–Cebrenia* light belt of cloud N. of the bright *Elysium*.
C. 1995 June 9d 03h 30m, CML = 180°, 2.54m (100-inch) refl. ×1000, ×1500, *Cave*. (Drawn at the coudé focus and later reoriented.) Serrated NPC S. edge with *Ierne* detached; small orographics; bright S. limb.
D. 1995 March 13d 21h 15m, CML = 185°, 220mm refl. ×400, *Stephens*. *Propontis* on CM; *Elysium* bright in a.m.

Bottom row:
E. 1995 March 12d 20h 55m, CML = 189°, 152mm OG ×248, *Bates*. *Elysium* is bright, with pale borders typical of recent apparitions.
F. 1994 November 28d 07h 10m, CML = 203°, 415mm Dall–Kirkham Cass. ×415, ×663, *Gray*. Early apparition view with large N. polar hood.
G. 1995 April 14d 18h 32m, CML = 212°, 1000mm Cass. ×1470, *Biver*. Cloud over *Elysium Mons*; *Nix Olympica* at *p*. limb; *Olympia*.
H. 1995 February 22d 13h 10m, CML = 235°, 200mm OG ×400, *Minami*. *Hesperia* bridged between *Maria Cimmerium* and *Tyrrhenum*. *Aetheria* dark patch extended to SW. *Cebrenia–Elysium* diurnal clouds merged on evening side.

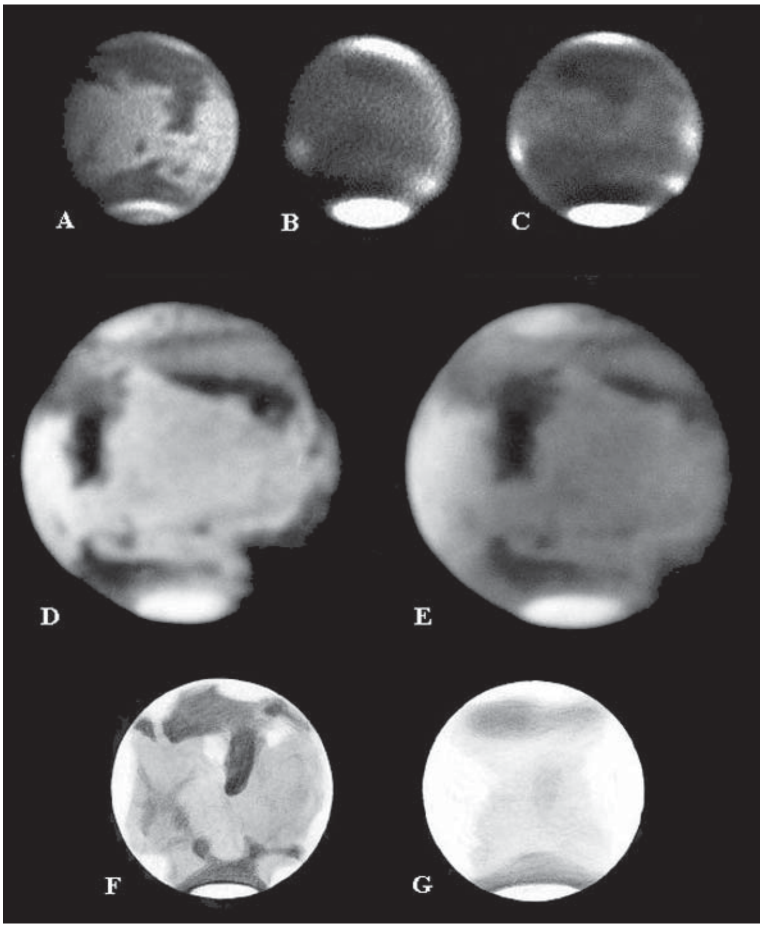


Figure 10. The wavelength-dependence of martian albedo features and clouds.
Top row:
CCD images by Parker through Schott glass filters (red with RG610, blue with BG12 + IR rejection filter), 410mm refl. F/43, and Spectrasource Lynxx cooled camera.
A. 1994 December 31d 07h 40m, CML = 263°, red filter.
B. 1994 December 31d 07h 37m, CML = 262°, blue filter. Evening cloud over *Elysium* and morning one over W. *Cydonia* best seen in blue light.
C. 1995 February 03d 05h 14m, CML = 284°, blue filter. Strong BC, but N. part Syrtis *Major* veiled by ECB (which also crosses *Aeria* and *Isidis Regio*).
Middle row:
CCD images by Warell on 1995 February 25, 500mm OG F/45, Kodak Megaplus 1.4 camera.
D. 21h 21m, CML = 328°, red (passband centred upon 650nm) filter.
E. 20h 21m CML = 314°, green (536nm) filter. Clouds and frosts enhanced in green light.
Bottom row:
Two drawings by Dal Santo on 1995 February 28, 216mm refl. ×250.
F. 19h 40m, CML = 277°, W23 and W56 filters. *Libya* and *Aeria* bright.
G. 20h 00m, CML = 282°, W47 filter. Weak Blue Clearing, but *Syrtis Major* not visible.

Thaumasia and *Xanthe*. Furthermore, from mid-month the evening orographic (topographic) clouds became visible over the martian volcanoes. Parker observed *Nix Olympica* visually from January 4 (Ls = 41°), and imaged it from Jan 10 onwards: this cloud and the others could be detected soon after local noon. Other major orographics were seen over the slopes of *Alba Patera* (in *Arcadia*) and *Ascraeus Mons*, and at *Nox Lux* (near *Phoenicus Lacus*). The *Alba* cloud was imaged by Parker from Jan 13 (Ls = 45°) onwards, and by Japanese observers from Jan 26, by which time it had become strikingly bright from around CML = 140°.

mid-disk: *Aeria*, *Arcadia*, *Ausonia*, *Cebrenia*, *Chryse*, *Elysium* (mostly dull, but sometimes imaged as fairly bright at the CM), *Eridania*, *Hellas*, *Libya*, S. *Noachis*, *Ophir–Candor*, *Tempe*, S. *Thaumasia* S. of *Solis Lacus* extending over *Phrixi Regio*, etc., to the east, and *Xanthe*.

Much of the S. limb was bright, *Argyre* especially so (*e.g.*, Figure 6H), but some areas such as *Phaethontis* were not obviously so.

There were indications of partial equatorial cloud banding this month: thus the OAA noted that evening cloud over *Chryse* crossed *Ganges* into *Tharsis*, whilst Parker (visual; Jan 11) found a partial ECB S*f*. the evening orographic clouds, which crossed *Amazonis*.

1995 February

a.m. limb: *Mare Acidalium* (weak morning mist to Minami, Feb 16), *Aeria*, *Aetheria*, *Aethiopis*, *Amenthes*, *Arcadia*, *Chryse*, NW *Cydonia*, *Edom*, *Elysium*, *Eridania*, *Isidis Regio–Libya* (including the *Syrtis* cloud), *Ophir–Candor*, *Phaethontis*, N. coast *Sinus Sabaeus* (adjoining *Edom*), (Figure 6G) *Tempe*, *Tharsis* and *Xanthe*. The *Alba* orographic was also bright from the morning side (Figure 2G).

p.m. limb: *Aeolis*, *Aeria*, *Arcadia*, *Ausonia*, *Cebrenia*, *Chryse*, *Claritas*, *Elysium* (with occasional bright core over *Elysium Mons*), *Hellas* (bright bluish-white), *Isidis Regio–Libya*, *Ophir–Candor*, *Tempe*, and *Xanthe*. *Nix Olympica* and the *Tharsis* orographics appeared from local noon onwards as in January. *Alba* especially was brilliantly white in the afternoon (Figure 8H), when it was joined to *Tempe* by a light zone. Another orographic was noted under a CML of *ca.* 170°, near *Ammonii Fons*, and the region following *Nix Olympica* whitened from local noon. These orographic clouds (Figure 2C–E, Figures 5A, 6D, E) partially coalesced in the evening to give rise to the famous ‘W’ cloud: see the HST image (Figure 3).

mid-disk: *Aeria*, *Ausonia*, S. *Chryse*, *Elysium* (from early afternoon), *Eridania*, *Hellas*, *Libya*, *Meroe*, *Noachis*, *Ophir–Candor*, *Phaethontis*, N. coast *Sinus Sabaeus* (adjoining *Edom*), and S. *Xanthe*. (The behaviour of the orographic clouds has already been noted.)

The extreme southern limb was again a continuous bluish-white strip, within which *Argyre* remained a brighter (and probably frosted) area throughout the martian day. The first confirmed observations of complete ECB were made this month, especially in the longitudes of *Chryse–Xanthe–Tharsis–Amazonis*. This effect is weakly shown in colour images from the HST, and strongly in blue filter work at all longitudes, forming a belt around the planet from latitudes approx. −10° to +30°. BAA observers recorded complete or incomplete ECB visually (Graham, McKim (Figure 6A), Niechoy, Parker, Dal Santo and Stellas making special note of it) and in CCD imaging. Orard at Pic du Midi found the ECB especially opaque from late February onwards (Ls = 62°).[48]

1995 March

a.m. terminator: *Mare Acidalium*, *Aeria*, *Aetheria*, *Ausonia*, *Cebrenia–Diacria* (a bright belt of cloud; Figure 9B), *Chryse*, W. *Cydonia*, *Elysium*, *Hellas*, *Isidis Regio–Libya* (with the *Syrtis* blue cloud seen on occasion), *Meroe*, N. border of *Sinus Sabaeus*, *Tempe* and *Xanthe*. Parker (Mar 31) imaged a large, very bright morning cloud over *Amazonis* which encompassed the location of *Olympus Mons* (Figure 2J). This cloud had been less conspicuous earlier in the month. *Nox Lux* was also bright.

p.m. limb: *Aeolis*, *Aeria*, *Arcadia*, *Ausonia*, *Cebrenia–Diacria,* *Chryse, Elysium* (with *Elysium Mons* core at times), *Eridania*, *Hellas* (as bright as NPC in green light to Minami, and so probably frosted), *Isidis Regio–Libya*, *Ophir–Candor*, *Tempe*, *Tharsis*, S. *Thaumasia*, *Xanthe* and *Zephyria*. Clouds over *Aeria*, *Isidis Regio* and *Libya* sometimes extended to veil *Syrtis Major* at the evening terminator (Figure 7H). All the orographics of February were again present, with *Alba* more compact than before (Figure 9B).

mid-disk: *Aeria* (slight), *Alba*, *Ascraeus Mons* cloud, *Ausonia*, *Cebrenia-Diacria*, *Chryse*, *Claritas* (remarkably bright to McKim (Figure 6B; Mar 18–22) and others), *Elysium* (though less bright than in a.m. and p.m.), *Eridania*, *Hellas*, *Libya* (slight), *Noachis*, *Ophir–Candor*, *Phaethontis* and *Tharsis*. In general *Cebrenia* was light throughout the martian day, forming a more general bright belt with the areas of *Diacria* (and *Herculis Pons*), but the ensemble was never exceptionally light.

There was a more or less continuous light area along the S. limb; *Argyre* remained a brighter patch within it along with the still more conspicuous *Hellas*. March was also a good month to view ECB. These were seen from *Chryse–Xanthe* via *Tharsis* to *Amazonis*. Weaker cloud also stretched from *Elysium* to *Isidis Regio–Libya*.

1995 April

a.m. terminator: *Aeria*, *Amazonis* (covering the location of *Olympus Mons*), *Argyre*, *Chryse*, *Hellas*, *Isidis Regio–Libya* (with the *Syrtis* blue cloud; Figure 2K, Figure 6F), *Meroe*, *Ophir–Candor*, N. border of *Sinus Sabaeus* (seen by Graham and McKim), *Tharsis* and *Xanthe*.

p.m. limb: *Aeolis*, *Aeria*, *Argyre*, *Ausonia*, *Chryse*, *Eden*, *Elysium*, *Hellas*, *Isidis Regio–Libya* (with the *Syrtis* blue cloud), *Noachis*, *Ophir–Candor*, *Tharsis*, *Xanthe* and *Zephyria*. The orographic clouds were well seen by Biver (1m refl.) upon the shrinking disk (Figure 9G) *Alba* was still 'moderately light' to Minami, but – perhaps because the evening terminator was no longer in view – only when near the evening limb.

mid-disk: *Aeria*, *Argyre*, *Ausonia*, *Claritas*, *Elysium* (very slight whiteness in some CCD images; Biver (Apr 14) caught small cloud in N*f*. part (Figure 9G), *Hellas* (brilliant bluish-white, having brightened by early April, rivalling the NPC), *Libya* (slight), *Noachis* and *Ophir–Candor*.

The strip of bright cloud and frost along the S. limb was less noticeable, but *Argyre* remained a specific bright area, whilst the greatly increased brilliance of *Hellas* (throughout the day and with all filters) was striking. Graham (Apr 27) saw an ECB from limb to limb under CML = 132° (Figure 9A), and Haas (Apr 7) recorded a partial ECB from E. of the CM (CML = 39°) to the morning terminator.

1995 May

a.m. terminator: *Amazonis*, *Chryse* (extending over *Niliacus Lacus* sometimes), *Hellas*, *Isidis Regio–Libya* (with the *Syrtis* blue cloud seen visually by Parker up to and including May 30)), *Ophir–Candor*; *Tempe* (sometimes), *Tharsis* and S. *Xanthe*. *Amazonis*, encompassing the *Olympus Mons* site, was very white. Part of the bright *Tharsis* cloud appeared to project beyond the terminator to Taylor (May 8).

p.m. limb: *Aeria*, *Argyre*, *Cebrenia*, *Eden*, *Elysium* (slightly white), *Hellas*, *Isidis Regio–Libya*, *Noachis, Ortygia*, *Tharsis* (large and very white; resolution probably too low for sighting individual orographics), *Xanthe* and *Zephyria*.

mid-disk: *Argyre*, *Ausonia*, *Chryse*, *Elysium* sometimes whitish but normally dull, *Eridania*, *Hellas* (large and bright bluish-white like April), *Ophir–Candor*, *Tharsis* and *Xanthe*.

The ECB effect was strong at CML approx. 90° (Figure 2L). Parker (May 30; visual, blue light) further noted an ECB from *Elysium* to *Isidis Regio–Libya*.

1995 June

a.m. terminator: *Amazonis*, *Chryse*, *Elysium* (slightly light on am side; Figure 9C), *Memnonia* and *Tharsis*. Parker (June 14) reported a terminator projection over *Memnonia*, the whole surrounding area brightened by bright cloud.

p.m. limb: *Chryse*, *Hellas*, *Ophir–Candor, Tharsis* and *Xanthe*. *Chryse* and *Xanthe* appeared bright through all filters to Parker. The orographics located at *Alba*, *Nix Olympica* and *Nox Lux* were still individually visible.

mid-disk: *Aeria*, *Claritas*, *Eridania*, *Hellas* (large and still brilliant; Figure 7C) and *Tharsis*.

The ECB effect could still be traced. Parker again found it strong at CML approx. 90°.

1995 July onwards

July: Observations were no longer complete, but we can say that *Hellas* was brilliantly white throughout the martian day, the S. limb generally was light, and *Alba* was bright at the evening limb.

August: the OAA observers found *Hellas* light but less bright than previously.

Blue Clearings

For general comments upon this phenomenon, see the last Section Report.[1] This apparition we shall be excluding data for D ≤ 6". Systematic work using the standard Wratten 47 (or equivalent) filter is listed below. See also Figure 10.

Heath, visual:	Jan 26–Mar 12
McKim, visual:	Jan 3–Apr 18
Parker, CCD:	Oct 7–Apr 18
Parker, visual:	Oct 7–Jan 12; Apr 15–Jun 14
Dal Santo, visual:	Jan 8–Feb 28
Siegel, visual:	Jan 16–Mar 21
Troiani, visual:	Nov 24–Apr 3
Warell, CCD:	Feb 21–25

Heath: BC order 2 was detected on Jan 26, 30 (less complete in the south), Feb 17, 21 and Mar 3.

McKim: A degree of BC was sometimes seen between Jan 19 and Mar 3, normally not exceeding order 1, but a strong BC in both hemispheres was seen only on Feb 17, 26 (but with *Syrtis Major* hard to see near the CM) and Mar 3.

Parker, CCD: A weak BC (order 1) was limited to the N. hemisphere, Oct–Nov. In Dec-Jan a weak BC (order 1) was shown from N. to S. (Figure 10A, B), but always excluding *Syrtis Major*. All the Feb images (*e.g.*, Figures 8H, 10C) show the albedo features clearly at all longitudes. However, the N. tip of *Syrtis Major* was veiled by white cloud (ECB) which also crossed *Aeria* and *Isidis Regio*. Post-Feb images reveal only a weak BC.

Parker, visual: Before opposition a moderate to strong BC in both hemispheres was noticed only on Nov 10, Dec 16, 20, Jan 4 and 10. Otherwise the BC was weak or absent. No strong BC was seen in Apr–Jun.

Dal Santo: strong BC in the north and south (order 2) seen Feb 19–28 (Figures 10F, G).

Siegel: weak BC Jan 16 and Mar 21; strong general BC seen Feb 8.

Troiani: some degree of BC found Feb 12–Apr 3, but moderate to strong BC on Feb 27 only.

Warell (largest aperture and highest resolution): Images from Feb 21–25 all show a moderate to strong BC in the N. and S., but the N. part of *Syrtis Major* and the S. part of *Mare Acidalium* were effaced by equatorial cloud.

In conclusion, a moderate to strong BC could always be seen in the month of opposition, and was sometimes visible between 1994 Nov 10 and 1995 Mar 3. The latter period is asymmetric with respect to the opposition date (Feb 12), as in 1992–'93. Albedo features near the equator were never well seen in blue-violet light due to veiling by ECB.

Yellow clouds (dust storms)

Pre-opposition events

Between Ls = 200 and 260° (1994 mid-January to mid-April), R. T. Clancy[58] reported an enhancement in global atmospheric temperature from his measurements of millimetre wavelength carbon monoxide absorption. This work was done prior to the start of most BAA observations, using the Kitt Peak NRAO 12-metre telescope. Although the enhancement was certainly attributable to atmospheric dust, Clancy wrote to the Director:[59] 'In general I think Mars' atmospheric temperatures are forced strongly at times by dust-raising that is regional to 'sub-regional' on Mars and so does not stand out in imaging observations.' The writer agrees with this hypothesis, as data from later oppositions confirm. So, widespread dispersal of dust from a small event can affect atmospheric temperature (by markedly raising its heat capacity) and yet have little effect upon surface feature contrast.

Low-resolution and incomplete BAA data in the martian S. summer did not reveal any signs of dust. Stryk[37] on 1994 June 5 (Ls = 290°, D = 4.4"), showed the region west of *Argyre* to be bright in red light on the evening terminator, but Haas[37] considered the evidence for atmospheric dust to be inconclusive. In any case there was no large, visually apparent dust storm prior to opposition after BAA coverage had become adequate (1994 August onwards).

To Ebisawa (490mm Cass., Tokyo, Japan) in mid-1995 January, from about Ls = 45° (N. mid-spring), *Cebrenia–Elysium–Aethiopis* began to be affected by suspended dust. 'These yellow clouds were bright in all visible wavelength[s]' wrote Ebisawa,[39] who further noted that prominent diurnal cloud activity was also associated with these regions.

Then from 1995 January 26 (Ls = 51°), Ebisawa's polarimetry revealed dust over *Tempe–Arcadia* and *Chryse–Xanthe–Tharsis*. To Ebisawa these areas exhibited a more noticeable yellow tint at the a.m. or p.m. limb (higher optical thickness). No veiling was detectable visually with the regions on mid-disk, and no expansion was noticed. The *Arcadia* cloud (imaged in white, green and blue light) was clearly the ordinary *Alba Patera* orographic cloud. Indeed, the Japanese members of the OAA, observing the *Alba* cloud for the first time simultaneously with Ebisawa, simply described it as brilliant white.[46] However, Minami on January 31 found a dark band at the S. edge of the *Alba* cloud, which might suggest surface dust removal.

In seasonal date this occurrence coincides closely with the outbreak of a bright bar-like cloud over *Tempe–Alba* and environs in 1963 February at Ls = 57°. In the latter case, it was demonstrated by Ebisawa, and also by Dollfus and Focas, that dust was mixed with the diurnal white crystal cloud, and furthermore there was a darkening of the surface at the edge of the cloud due to removal of brighter deposits.[2] The phase angle was small at the time, as it would again be in 1995, but still adequate to discriminate polarimetrically between dust and crystal cloud.

A number of observers found that S. *Chryse–Xanthe* looked creamy, not white, and Parker's images show it bright in red as well as in blue. Minami has pointed out that a cream tint can arise through the partial transparency of a whitish veil with some ground colour showing through.

For each of these 1995 events, Ebisawa[40] continued to register the presence of suspended dust until at least 1995 March (Ls = 73°). We conclude that a little suspended dust was indeed mixed with the seasonally normal orographic or diurnal clouds over the locations reported, but hesitate to catalogue any *specific* dust storm event: although the events followed polarimetrically resemble phenomena reported over *Chryse–Xanthe*, etc., during the last opposition,[1] in that case bright initial *dust* clouds had also been clearly observed.

Post-opposition events

According to Wolff *et al.*,[61] HST images revealed three small dust storms (which ground-based observers could hardly hope to resolve). Two events occurred at the edge of the NPC, on 1995 April 8 (Ls = 82°) and August 21 (Ls = 145°). The first cloud, which obscured *Olympia*, occupied latitudes +55 to +90° and longitudes 180–240°. The second, invisible on an earlier image of August 2, and occupying latitudes +60 to +90° and longitudes 240–270°, partly obscured and dimmed the central summer cap remnant. Low resolution BAA data for April 8 fail to resolve the first event. Furthermore on August 21 (but not on August 2) a small yellow cloud was seen 'overlying the frosted northern edge of *Hellas*', lat. –30 to –45°, long. 270–310°. On August 21 a trace of dust also appeared over eastern *Isidis Regio*. In each case the events were caught by chance upon isolated HST images and their timecourse was not followed. Wolff *et al.*[61] reasonably concluded that this dust activity could be correlated with the 15K rise in the lower atmospheric temperature of Mars deduced from Clancy's millimetre wavelength CO observations.

No great storm could have been overlooked in the ground-based data up to 1995 October 3, at Ls = 167°, though the absence of such is unsurprising historically.[2] There follows a gap in the data. Reporting further temperature data, Clancy[60] in 1995 December announced the presence of widespread enhanced atmospheric dust, all around the planet. Despite the small solar elongation and tiny disk (D≈4"), ground-based observations were attempted in 1996 January. Stryk's drawings[62] and Parker's images and drawings reveal the expected gross markings under Ls = 224–231° and CML = 15–165°. Clancy, in a communication to the writer[59] noted that in late 1995 the temperature anomaly had extended from Ls = 205–225°. Thus, the ground-based attempts to verify dust activity came slightly too late, and in any case it may not have been detectable by imaging. Historically, any regional event during Ls = 205–225° is perfectly plausible.

By the time the planet could be observed again *after* solar conjunction, in 1996 August, no large-scale albedo changes had occurred, negating the possibility of any great encircling storm.[63]

North polar region

NPH to NPC transition

Schmude saw a N. polar hood as early as 1994 July 18, although the tilt was unfavourable. Ebisawa (July 20 onwards) found the NPH bluish. The NPH brightened and contracted between August and September, and in the latter month Minami found that the NPH veered southward on the morning side at the longitude of *Mare Acidalium*.

In late October the transition to the ground cap was witnessed. Minami carefully compared the 1994 NPH with 1992: 'The NPH at the morning side associated with *Mare Acidalium* on [1994] October 25 (Ls = 8°, CML = 323–353°) looked much weaker than ... on 1992 December 20 (Ls = 14°, CML = 328°) ... and the observations from [1994] November 8 (Ls = 14°) onwards ... showed quite different aspects to those observed in 1992 late November (Ls = 1–6°).'[46] Furthermore, the dark polar collar was well seen at all CML at an *earlier* seasonal date in 1994 than in 1992. Minami concluded that the NPH was dispersing at Ls = 10°.

Parker's red images and visual impressions of October 7 (CML = 7–26°, Ls = 359°) implied the presence of a ground cap, but the NPH was still large in blue light. The HST red images at the longitude of *Syrtis Major* reveal a hood on September 19 and a ground cap on October 20. Ebisawa[39,40] first noted the NPC visually at Ls = 358°, observed the change in polarisation indicative of a ground cap at Ls = 9°, and inferred that traces of hood persisted as late as Ls ≈ 20°.

Polar collar

Minami saw a dark band around the N. polar region on October 24 and later. The NPC collar then was very dark indeed, the extreme N. edge exceptionally so. The NPC dark fringe had become less dark by early 1995 March, but as N. summer progressed the low albedo polar dune fields were uncovered, and fringed the cap. On June 9 Cave using the Mt.Wilson 100-inch reflector drew the NPC summer remnant with a ragged edge (Figure 9C); Schmude on June 14 had a similar view.

Recession analysis

The very large amount of data available made it possible to study the regression of the cap in several ways. First, the latitude of the edge of the cap on the CM was carefully measured on 697 drawings (1994 August to 1995 June) by 67 visual observers. (As usual, measurements were limited to drawings in white light or through red, orange or yellow filters in order to exclude polar hazes, and some observers with a large p.e. were excluded). The data were binned in 5-degree intervals in Ls, and are given in Figure 11 and Table 3 whenever the sample (N) contained 4 or more datapoints. The same measurement procedure was adopted for CCD images. Colour composites, incorporating the blue filter images, tend to exaggerate the size of the cap, so where possible red light images were used exclusively. Images by Parker, together with some by Dobbins, Platt, Quarra *et al*., and Warell were suitable for measurement. These results are plotted in Figure 11 (for bins where N≥3). In addition to these data, Parker (together with Beish) submitted red-filter micrometer measures of the E–W cap diameter, and latitudes deduced from these data (N≥3) are also plotted.

Figure 11 shows a very good accord between the visual and CCD data (and with the rarer micrometrical data). The original CCD data inevitably show less scatter than the visual work, but with fewer data points available they do not necessarily sample all CM longitudes (for the asymmetric cap) in each 5-degree interval. There is a small systematic difference when the best-sampled means are compared: the CCD

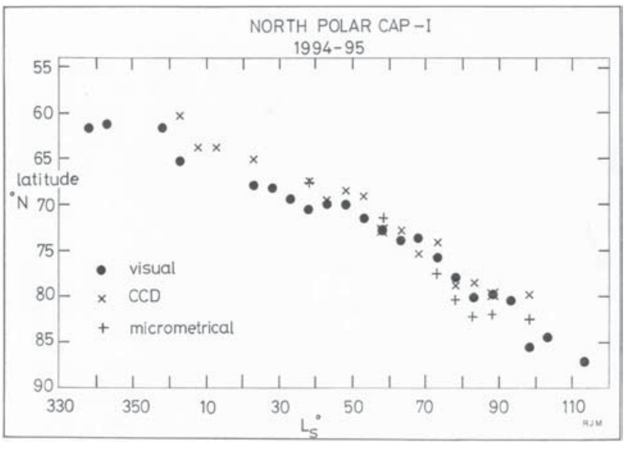


Figure 11. Recession curve for the NPC– I: BAA 1994–'95 visual, CCD and micrometrical data compared. Data averaged in 5° intervals in Ls. *R. J. McKim*

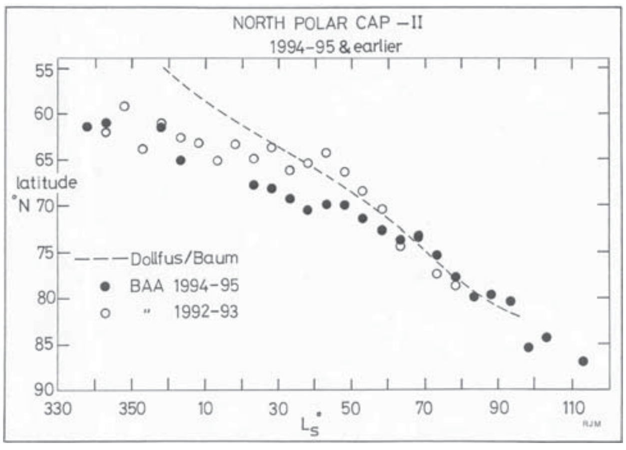


Figure 12. Recession curve for the NPC– II: BAA 1994–'95 visual data from Figure 11 compared with the historical mean curve of A. Dollfus and W. A. Baum, and with BAA 1992–'93 data. *R. J. McKim*

Table 3. NPC latitude measurements 1994–'95

Mean L_S (°)	visual drawings: Latitude of S. edge of cap (°)	visual drawings: No. of measures	CCD images: Latitude of S. edge of cap (°)	CCD images: No. of measures	micrometrical measures: Latitude of S. edge of cap (°)	micrometrical measures: No. of measures
338	61.5	8	–	–	–	–
343	61.0	5	–	–	–	–
348	–	–	–	–	–	–
353	–	–	–	–	–	–
358	61.5	6	–	–	–	–
003	65.2	4	60.2	9	–	–
008	–	–	63.7	3	–	–
013	–	–	63.7	3	–	–
018	–	–	–	–	–	–
023	67.9	8	65.0	6	–	–
028	68.2	6	–	–	–	–
033	69.4	25	–	–	–	–
038	70.5	15	67.3	21	67.5	3
043	69.9	34	69.4	7	–	–
048	70.0	41	68.3	3	–	–
053	71.5	78	69.0	9	–	–
058	72.8	56	72.7	9	71.4	6
063	73.9	93	72.7	33	–	–
068	73.5	100	75.2	6	–	–
073	75.6	57	73.9	8	77.4	5
078	77.9	44	78.7	7	80.2	3
083	80.0	51	78.4	7	82.2	5
088	79.7	16	79.7	7	81.9	3
093	80.4	22	–	–	–	–
098	85.6	5	79.6	7	82.4	3
103	84.4	5	–	–	–	–
108	–	–	–	–	–	–
113	87.0	4	–	–	–	–
Totals	*used*	683		145		28
	available	697		153		37

images are 1° or more larger than the visual data.

In Figure 12, the historical average curve determined by Dollfus (and extended by W. A. Baum)[64] has also been plotted, together with BAA visual results from 1994–'95 and 1992–'93.[1] The new cap at the N. spring equinox (Ls = 0°) was similar in size to that of 1992–'93, but from then until around Ls = 66–70° it was somewhat smaller than normal. Up until Ls ≈ 50° the recession was very slow, afterwards accelerating. The mean recession rate subsequent to Ls ≈ 50° was faster during 1992–'93 than in 1994–'95. After Ls ≈ 60° the 1995 data follow the earlier years closely. Studies of the NPC regression during 1990–'97 from HST data were made by Cantor *et al.*,[53] although the usefulness of HST latitude data are much reduced both by their scarcity and by their bias towards the longitudes of *Syrtis Major*. Cantor *et al*. nonetheless concluded that interannual differences could be established before Ls = 0°, and moreover (in accordance with our work) that the 1992–'93 recession was a little faster than in the two following apparitions.

The ALPO[34] also published data for 1994–'95, and noted that the NPC was significantly smaller than during the epoch of the 1980s. Iwasaki *et al*.[54] also measured ground-based CCD images for 1994–'95, finding a faster shrinkage after Ls ≈ 50°, and that part of the recession curve was significantly below that observed by them for 1979–'80.

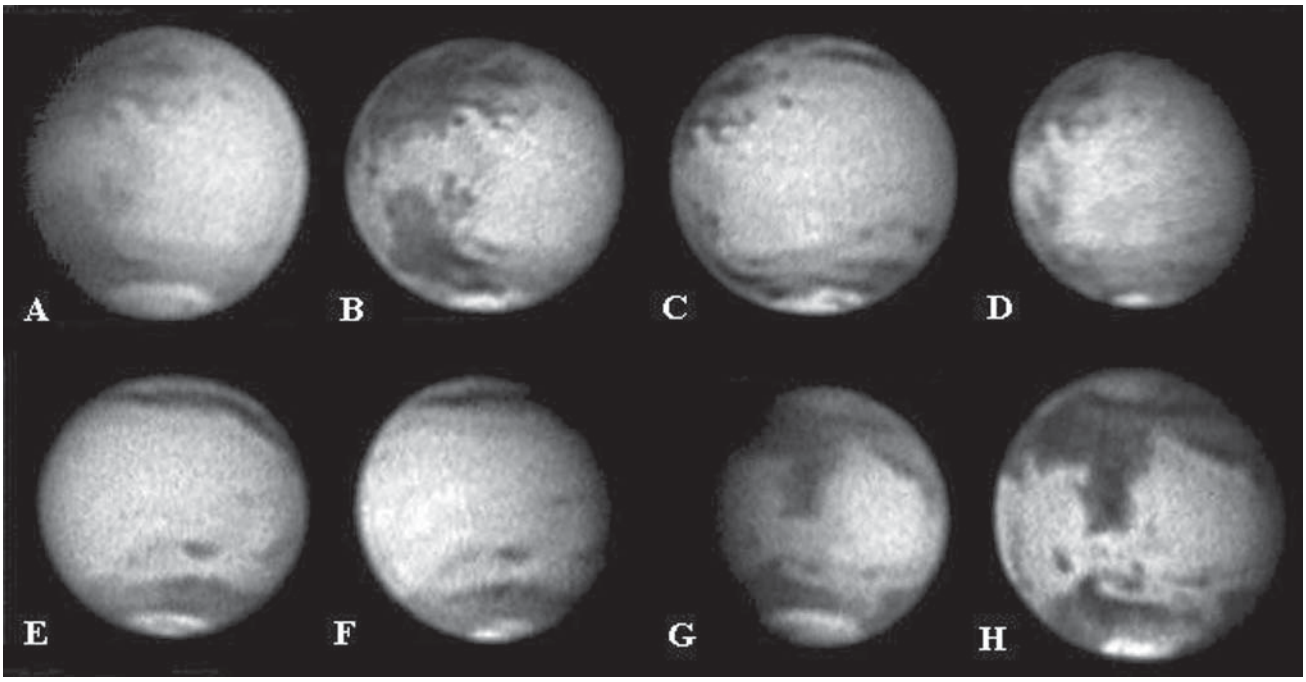
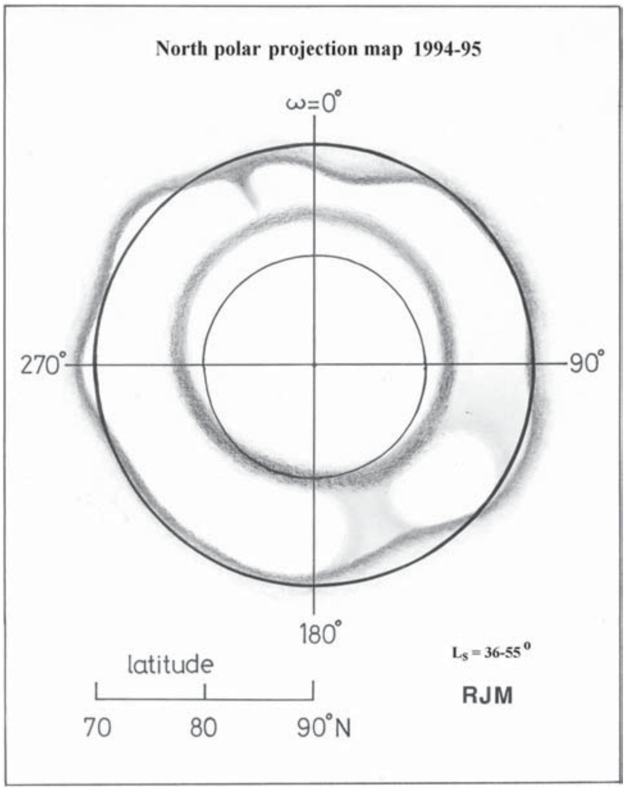


Figure 13. Some features of the NPC recession, from pairs of red light CCD images by Parker taken at similar CML. (See Figure 10 for technical details.)

Top row, left to right:
A. 1995 Jan 17d 05h 28m, CML = 77°. Annular rift.
B. 1995 Feb 25d 04h 00m, CML = 74°. Ragged cap edge at CM; *Ierne* following. Compare **A**.
C. 1995 Feb 18d 02h 46m, CML = 118°. *Ierne* and *Olympia* detached.
D. 1995 Mar 31d 02h 49m, CML = 112°. *Ierne* no longer visible. Compare **C**.

Bottom row:
E. 1995 Feb 13d 03h 10m, CML = 167°. Annular rift.
F. 1995 Mar 23d 01h 56m, CML = 172°. *Olympia* on *f.* side. Compare **E**.
G. 1994 Dec 27d 07h 25m, CML = 296°. Annular rift.
H. 1995 Mar 8d 01h 44m, CML = 304°. *Olympia* on *p.* side. Compare **G**.



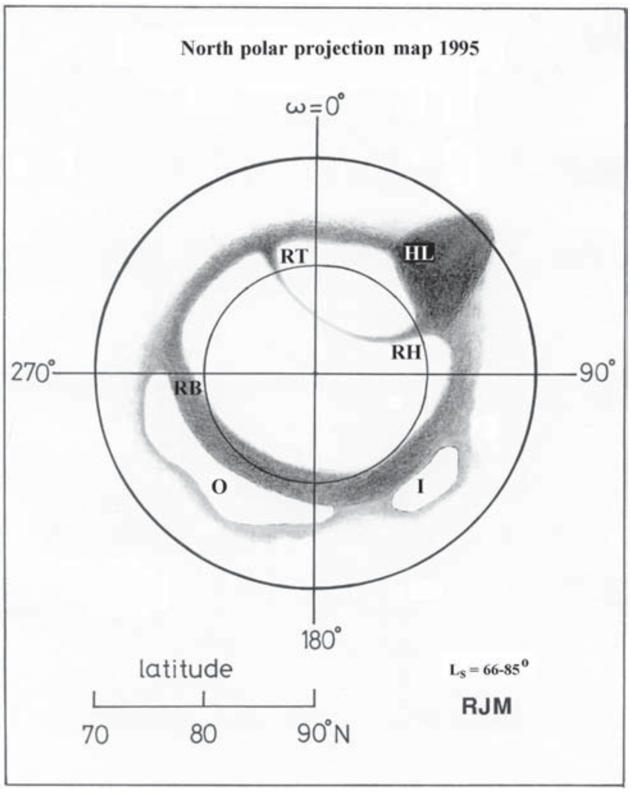


Figure 14. Stereographic polar projection maps for the NPC for the mean seasonal dates *(left)* Ls = 45° and *(right)* Ls = 75°. **RB** = *Rima Borealis*, **RT** = *Rima Tenuis*, **RH** = *Rima Hyperborea (Chasma Boreale)*, **HL** = *Hyperboreus Lacus*, **I** = *Ierne*, **O** = *Olympia*. *R. J. McKim*

BAA data show a slight arrest in the recession curve around Ls ≈ 60°, close to aphelion (Ls = 70°). Orard[48] made a similar comment, but there was no repeat of the more pronounced 'aphelic chill' witnessed by both the ALPO and BAA in 1980.[24]

The summer NPC remnant continued to be visible at least throughout 1995 August. Later amateur observations were neither able to resolve it satisfactorily, nor to watch its final transition to NPH. HST images show that the cap remnant still existed in October. However some data do show haze around the early summer cap: Warell on May 4 (Ls = 93°) found a bright annulus surrounding the remnant. On May 30 Parker noted visually that the small NPC was surrounded by an almost equally bright region, with the peripheral region of NPH larger through the W47 filter. Again on July 3 Parker saw the same effect.

Cap fragmentation

The red light CCD images in Figure 13 and the charts of Figure 14 are relevant here. Fragmentation of the NPC historically produces 'remnant' ices at approx. latitude +80°, in *Ierne* (long.≈140°), *Olympia* (long. ≈200°) and N. *Cecropia* (long. ≈ 300°). These are marked on de Mottoni's IAU (1957) general map.[2] The summer cap remnant is bordered by a low albedo 'collar' (consisting of dune fields between latitudes *ca*. +75 to +82°[65]).

A special feature of the apparition was the early appearance of a dark, annular rift within the early spring NPC. From 1994 mid-December till 1995 mid-February Parker's camera could resolve a near-complete annular rift in red light, and a few observers confirmed it visually. (The HST red image of 1994 October 20 shows a darkened northern cap but no rift; by November 18 the annular rift had formed.) The cap was brighter south of the rift, especially around the longitudes where *Olympia* would later separate. The rift was 2–3° wide, being widest and closest to the pole at the longitude of *Olympia*. In 1995 February, Warell partly mapped the rift,[36] and it appeared in images from Pic du Midi.[48]

Although CCD technology made the NPC annular rift easier to record, this was not its first sighting. At the same season in 1918, Maggini[66] charted a partial annular rift (long. ≈120–240°), though the BAA and Fournier[66] did not. Slipher, in unpublished observations from 1931 (Ls = 37–55°) recorded an annular rift around all or most of the NPC with the 60cm Clark refractor at Flagstaff.[67] In 1992–'93 there were indications of such a rift from BAA data, especially in red images by Parker (*ca.* 1992 November to 1993 January, received after publication of the Section Report[1]) but the northward tilt was considerably smaller at the critical phase. A 1996–'97 HST polar projection map[53] for Ls = 58–60° shows the same roughly circular dusky annulus within the cap, though less prominently. This and the feature observed in 1994–'95 correspond in latitude with part of the dark polar dune field which surrounds the NPC summer remnant. During most aphelic oppositions this annular rift does *not* develop during N. spring: high resolution mapping by Dollfus at Pic du Midi during 1946–'52[68] and 1982 did not reveal it. Normally, only certain sections of the annulus appear, corresponding to classical rifts such as *Rima Borealis* (see below). Its rare complete appearances suggest that the thickness of the surface deposit – at least at the inner boundary of the seasonal cap – is variable from year to year.

Parker on January 4 found an inflexion in the NPC edge under CML = 204°, where one end of *Rima Borealis* commences, and on February 17 (Ls = 60°, CML = 131°) his camera caught *Olympia* detached on the a.m. side along with *Rima Borealis*. Thus by mid-February the outer part of the cap was fragmenting into its separate parts. Some regions evaporated more rapidly to reveal the classical outliers as other portions exterior to the annular rift completely disappeared. On February 25 the HST images (Figure 3) revealed the situation to be complex, with several areas of different brightness: furthermore, the *f.* end of *Olympia* was clearly not yet detached. On February 4 (Figure 6D) and March 12 McKim saw a bright spot at the *f.* end of *Olympia*. He saw the cap elongated in the direction of *Olympia* from March 3 (Figures 6B, C). *Olympia* was first seen completely detached on the *f.* side by Parker's camera on March 8 (Ls = 70°, Figure 13H, Figure 14).

Later *Olympia* was observed frequently by Section members (Figures 7A, G and H, 8F, 9G, 13C, D and F) up to at least June 19 (Biver, 1000mm Cass., ×735, D = 6".0, Ls = 114°, Figure 7C). The final HST images at Ls = 144° still show it. Dollfus[64] has written that *Olympia* can be seen between Ls = 65 and 150°. *Olympia* has been recorded in many past BAA Mars reports, but these have rarely established its extreme visibility limits. This time we have nicely affirmed the lower limit.

On February 17 Parker also imaged *Ierne* detached (Figure 13B, C), and Ebisawa's drawing of April 5 (Ls = 81°) still suggests it. Cave on June 9 (Figure 9C) observed it, as did Schmude on June 16, and the HST followed it still later. The cap contour in the longitude of *Hyperboreus Lacus* was very serrated then, the outer cap annulus being locally reduced in width and fragmented. Graham on February 17 (Figure 8E) was one of the first observers to note *Chasma Boreale* (classical *Rima Hyperborea*) indenting the cap north of *Hyperboreus Lacus*. *Chasma Boreale* (Figures 8D–G) developed with time, veering to the east inside the cap, and was observed as late as May by the Section.

From 1995 January onwards several observers recorded a notch or inflexion in the cap edge between CML = 330–340°. These included Patrick Moore (January 21–27, 390mm refl., ×300–400),[69] Troiani (January 26–29) and the writer [January 18 (Figure 6H) and February 26]. Warell imaged a rift there in February, by which time it ran N. of the annular rift, and Biver caught it visually on February 26. In its lower latitudes this rift is (strictly speaking) Lowell's *Kison*, but more generally it is called *Rima Tenuis*. Warell imaged a light spot at the cap edge *p.* the rift, and Biver and McKim found the cap *f.* the rift to be less bright. There were no observations to suggest that the fissure cut right across the cap to the opposite side. Neither in 1980,[24] 1982[70] nor 1984[71] was there any definite evidence of such behaviour from the BAA records. Some ALPO observers considered that *Rima Tenuis* truly bisected the cap in 1994–'95 (as well as in the 1980s), but tonal differences on the polar snows coupled with the eye's tendency to complete an incomplete line can spuriously prolong such a difficult and delicate feature.

After February the NPC at the above longitudes (in N. *Cecropia*) exterior to the annular rift evaporated. From March to May *Rima Tenuis* was still observable, and Biver [March 29–April 2, 1000cm refl., ×735–1470 (Figure 7G)] at high resolution could see that it actually curved west to apparently join up with the arc of *Chasma Boreale*, just as Antoniadi (in 1933)[72] and Dollfus had viewed it. This aspect was further confirmed by HST data. Although red images by Parker in early N. summer (May 19, 23) show *Rima Tenuis* entering the cap near long. 330°, its precise northward track could not be discerned from them.

Charts of the cap

Visual latitude data from1994 December 24 to 1995 February 6 (Ls = 36–55°, 168 measures), from 1995 March 2 to April 15 (Ls = 66–85°, 252 measures) were binned in intervals of 20° in CML and the results plotted in the stereographic polar maps shown in Figure 14. Measures upon images with overlay grids supplemented these data. The charts may be compared with BAA data for 1980,[24] 1982[70] and 1993,[1] and with the classical work of Antoniadi,[72] Dollfus[68] and others.

South polar region

Stryk's early drawings of 1994 April 17 and 19 (D= 4.2", Ls = 260°) show a small, bright SPC. Neither Parker's red light CCD image of 1994 June 5 (D= 4.4", Ls = 290°), nor Stryk's June 4–7 sketches could resolve the very small cap to be expected at that later season.

During the main part of the apparition it was only possible to trace the SPR in the form of white haze (or hood) over the southern limb. (See the 'white cloud' section.) By 1995 October 26, Ls reached 180°, approximately the epoch when the SPC would again be expected to become visible from beneath the polar hood. No BAA observations were made at that critical time, but later data from 1995 December–1996 January show a bright SPC.

Errata in 1993 report[1]

In Figure 10, a datapoint at Ls = 3° was accidentally omitted, but it is plotted in Figure 12 in the present paper.

The following printer's errors appeared:

On page 117, under 'physical data', the year of opposition should have read *1993*, not *1992*. On page 133, Figure 11 has been badly reproduced, and several of the other figures have been made too dark. In Figure 9A, for *1993* read *1992*.

Address: Cherry Tree Cottage, 16 Upper Main Street, Upper Benefield, Peterborough PE8 5AN [Rmckim5374@aol.com]

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