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Recent improvements of the Saturnian satellites atlases: Mimas, Enceladus, and Dione

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ABSTRACT

The Cassini Imaging Science Subsystem (ISS) acquired many high-resolution images (< 1 km/pixel) of the Icy Saturnian satellites during the nominal mission of the Cassini spacecraft between 2004 and 2008. These images were used to create high-resolution mosaics of these satellites. The Cassini mission is expected to continue till 2017 and high-resolution images of the first three years of the extension were used to improve the mosaics, especially in the Northern parts which were not illuminated during the nominal mission. These improved mosaics were the baseline for new versions of the atlases of Mimas, Enceladus, and Dione described in this paper. These new atlases supersede the previous versions from 2006 (Enceladus) and 2008 (Mimas and Dione), and include the official names of additional features, proposed by the Cassini imaging team, approved by the International Astronomical Union (IAU). The new atlases are available to the public through the Imaging Team's website and the Planetary Data System (PDS).

1. Introduction

The Cassini spacecraft started its tour through the Saturnian system in July 2004. The Imaging Science Subsystem onboard the orbiter consists of a high-resolution Narrow Angle Camera (NAC) with a focal length of 2000 mm and a Wide Angle Camera (WAC) with a focal length of 200 mm (Porco et al., 2004). One of the main objectives of the Cassini mission is to investigate the icy Saturnian satellites. These satellites were imaged in many flybys during the nominal mission between 2004 and 2008. The imaging campaign continued during the first extended mission ("Equinox mission") between 2008 and 2010 and continues during the current second extended mission ("Solstice mission"). It is now possible to image also the Northern parts of the Icy satellites which were not illuminated during the nominal mission.

2. Mosaicking and cartographic work

The image data processing chain consists of the same steps as described in Roatsch et al., 2006: radiometric calibration, geometric correction, map projection, and mosaicking. Spacecraft position and camera pointing data are available in the form of SPICE kernels (http://naif.jpl.nasa.gov). While the orbit information is sufficiently accurate to be used directly for mapping purposes, the pointing information must be corrected using limb fits (semi-controlled mosaics) or by photogrammetric bundle adjustment (controlled mosaics).

The images used for the creation of the mosaics are summarized in Figs. 1–3 and Tables 1–3. The coordinate system adopted by the Cassini mission for satellite mapping is the IAU "planetographic" system, consisting of planetographic latitude and positive West longitude. The surface position of the prime meridian as defined by the IAU cartography working group (Archinal et al., 2011) is defined by the small craters Palomides at Mimas, Salih at Enceladus, and Palinurus at Dione. New values for the rotational parameter W_0 which defines the location of the prime meridian at January 1, 2000 were calculated based on the high-resolution mosaics to be consistent with this definition (Roatsch et al., 2009b) and approved by the IAU (Archinal et al., 2011). The new values are 333.46, 6.32, and 357.6 for Mimas, Enceladus, and Dione, respectively.

The Mimas atlas was produced at a scale of 1:1,000,000 and consists of 3 tiles using the subdivision of the synoptic format (Greeley and Batson, 1990) which consists of two equatorial tiles and one tile containing the two poles as shown in Fig. 4. The resolution of the atlas was improved by a factor of 5 compared to the former version (Roatsch et al., 2009a) mainly with the high-resolution images from the first targeted Mimas flyby on 13 February 2010. The polar part of the atlas is shown in Fig. 5.

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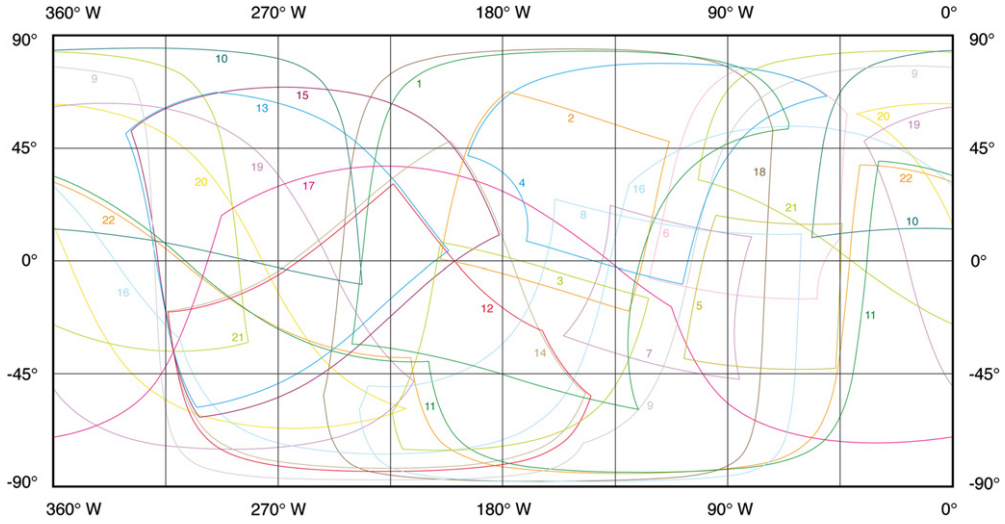

Fig. 1. Global mosaic showing the location of the Cassini ISS images of Mimas (see Table 1). Mosaic is in simple cylindrical projection with latitude = 0°, longitude = 180° in the center.

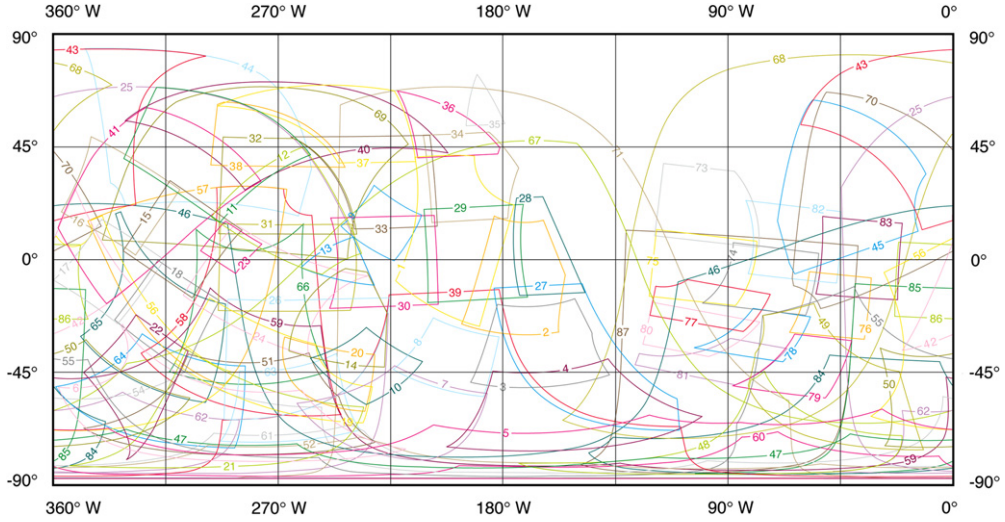

Fig. 2. Global mosaic showing the location of the Cassini ISS images of Enceladus (see Table 2). Mosaic is in simple cylindrical projection with latitude = 0°, longitude = 180° in the center.

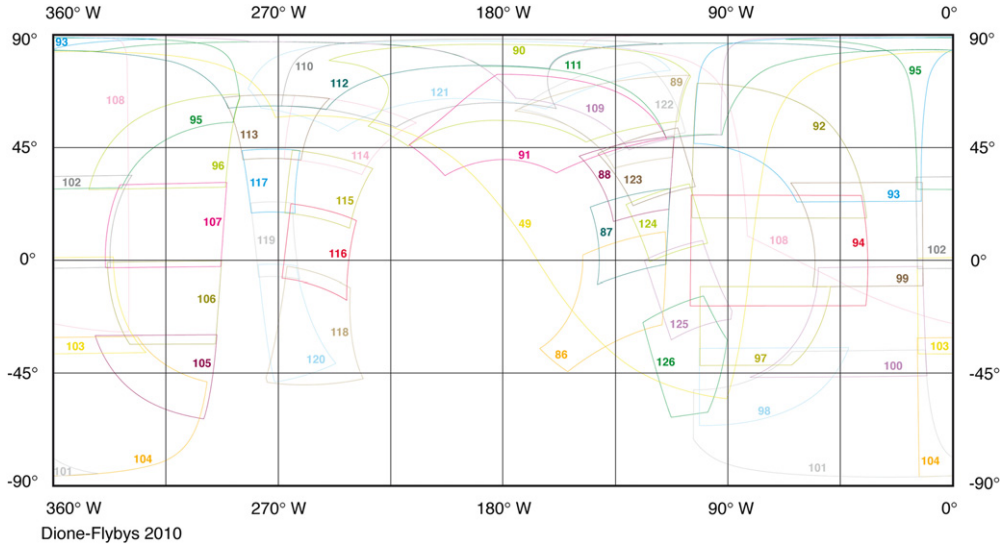

Fig. 3. Global mosaic showing the location of the Cassini ISS images of Dione taken in 2010 (see Table 3). Mosaic is in simple cylindrical projection with latitude = 0°, longitude = 180° in the center.

Table 1
Cassini images used for the Mimas mosaic. New images in the atlas have a filename starting with N16.

Image number	Image name	Resolution (km/pixel)	Center latitude (degree)	Center longitude (West/degree)
1	N1644785949	357.8	13.5	177.8
2	N1644781312	200.9	17.7	153.9
3	N1644781481	206.4	−34.2	173.8
4	N1644781164	196.3	28.7	131.8
5	N1644780833	186.1	−14.2	70.8
6	N1644780986	190.8	16.6	84.7
7	N1644780692	181.4	−12.4	115.4
8	N1644784329	298.9	−30.3	122.9
9	N1561689030	1116.5	−5.8	63.4
10	N1596533429	966.6	77.7	183
11	N1592293760	1267.3	−42	31.2
12	N1501646674	381.3	4.7	220.3
13	N1501647313	375.7	6	296.8
14	N1501646883	379.3	−26.2	203.3
15	N1501647096	377.2	31.2	255.7
16	N1558927355	1153.4	−27	100.8
17	N1542758143	884	−66	291
18	N1644787173	406.7	−7.1	160.8
19	N1492217357	566.1	14	286.4
20	N1492222810	510.4	23.6	259.6
21	N1591657420	1549	47.6	316.7
22	N1593516848	1156	−44.1	33.2
23	C4398902.geoma	8.4		

Table 2
Cassini images used for the Enceladus mosaic. New images in the atlas have a filename starting with N16.

Image number	Image name	Resolution (km/pixel)	Center latitude (degree)	Center longitude (West/degree)
1	N1500060756	147.4	−3.8	203.2
2	N1500060887	140.9	−14	177.8
3	N1500061010	134.6	−37.9	170.4
4	N1500061132	128.7	−61.9	158.7
5	N1500061253	123	−84.5	100.7
6	N1500061390	116.4	−68.3	298.8
7	N1500061512	110	−63.1	223.8
8	N1500061634	103.9	−42.2	204.3
9	N1500061771	97.3	−29.8	222.8
10	N1500061892	91.4	−45.3	237.4
11	N1487299402	177.2	45.2	296
12	N1487299578	170.2	19.3	262.2
13	N1487299765	161.9	1.4	320.7
14	N1487299918	155.7	1.5	321
15	N1487300285	140.8	5.2	313.1
16	N1487300482	133	20.8	336
17	N1487300648	126.2	−6.6	339.8
18	N1487300854	118	−22.7	317.9
19	N1487301032	111.2	−39.5	290.5
20	N1487301209	103.5	2.7	323.5
21	N1487301386	97.6	−69.6	283.2
22	N1487301590	88.7	−42.9	328.6
23	N1487302209	63.7	2.4	293.3
24	N1487300107	148.4	−12.5	285.2
25	W1487299765	615.2	1.4	320.7
26	N1489047359	187.5	−1.1	202.2
27	N1489047708	173.9	−34.7	151.7
28	N1489047867	167.2	3.4	155
29	N1489048050	159.2	−0.3	195.9
30	N1489048222	152.4	−3.4	228.3
31	N1489048394	146.1	−5.8	269.1
32	N1489048550	140.1	24.7	281
33	N1489048724	132.2	26.4	228.5
34	N1489048898	125.2	28.5	196.8
35	N1489049072	118.6	31.1	163.1
36	N1489049404	105.5	59	199
37	N1489049580	98.5	53.7	243.3
38	N1489049756	90.6	−1.8	211
39	N1489047533	180.7	−39.3	206.3
40	N1500069258	266	81.6	285.4
41	N1500069083	257.9	24.8	328.4
42	N1500068930	250	10	21.2
43	N1584039961	190.5	58.1	13.3
44	N1584039815	203.2	53.5	297.2
45	N1584040124	176.7	33.2	52.1
46	N1584051633	781.4	−22.5	10.2
47	N1597183061	81.3	−83.9	345.2
48	N1597183216	98	−73.2	86.7
49	N1597183387	116.4	−56.3	53
50	N1597183548	133	−58.7	354.1
51	N1597183748	154	−62.2	285.2
52	N1597182896	63.8	−84.4	246.8
53	N1602274088	141.7	−71	313
54	N1602274348	169.2	−72	298.8
55	N1602274610	197.4	−60.7	36.2
56	N1602274753	212.3	−43.4	344.4
57	N1602274900	228.2	−8.1	306.3
58	N1602275039	242.4	−33.6	277.7
59	N1602275201	259.3	−60.2	281.7
60	N1604167409	58.7	−82.7	87.3
61	N1604167575	76.1	−81	256.6
62	N1604167805	100.5	−72.5	337.1
63	N1604167982	119.2	−59.5	262.5
64	N1604168160	138.1	−56.7	318.6
65	N1604168315	154.7	−34.4	319.5
66	N1604168525	176.8	−30.3	285.2
67	N1500050692	662.7	−41.7	169.4
68	N1569850128	645.9	15.7	115.2
69	N1536530570	386.3	84	184.2
70	N1597179953	245.9	28	39.6
71	N1489034080	860.7	16.2	167.1
72	C4400044.geoma			
73	N1637465707	116.5	−5	32.3
74	N1637465488	106.7	−11	73.7
75	N1637465598	112.9	−4.1	120.4
76	N1637465376	101.2	−21.1	50
77	N1637464594	65.7	−21.9	95.3
78	N1637464708	70.6	−32.4	77.3
79	N1637464820	75.7	−43.9	60.5
80	N1637464490	61.1	−31.6	105.5
81	N1637464382	55.9	−43.5	90.6
82	N1637465824	122.2	4	65
83	N1637466051	132.7	−2.1	40.1
84	N1637466149	138.2	−69.3	32.6
85	N1637470054	326.1	−1.7	43.2
86	N1637465942	127.6	−10.6	11.3
87	N1637469787	313.5	−30.5	92

The resolutions of the Enceladus and Dione atlases (1:500,000 and 1:1,000,000, respectively) were not changed since the first version (Roatsch et al., 2008a, b) but many low-resolution areas were replaced by higher resolution images. The quadrangle scheme still consists of 15 tiles that conform to the quadrangle scheme proposed by Greeley and Batson (1990) for larger satellites (Figs. 6 and 7). Examples of the atlases are shown in Figs. 8 and 9.

The Cassini imaging team proposed 26 new names for geological features on Enceladus and 16 new names for features on Dione, in addition to the features named earlier in the Cassini mission by the Cassini Imaging team and long ago by the Voyager Imaging team. By international agreement, the features on Enceladus must be named after people or locations in the medieval Middle Eastern literary epic “The Thousand Nights and a Night”; the features on Dione must be named after people and locations from “The

Table 3
Cassini images used for the Dione mosaic. New images in the atlas have a filename starting with N16.

Image number	Image name	Resolution (km/pixel)	Center latitude (degree)	Center longitude (West/degree)
1	N1481766854	432.5	14.3	328.3
2	N1481766978	433.7	−30.8	337
3	N1481767088	433	−11.6	297.2
4	N1481767211	432.3	12.3	297.6
5	N1507733604	693.8	−0.8	159.2
6	N1507733748	687.2	56.2	192.2
7	N1507733914	676.3	0.2	196.8
8	N1507734092	665.2	−0.3	148
9	N1507734234	659.8	0.3	77.8
10	N1507734386	650	−50.9	108.5
11	N1507734588	637.8	−49.6	195.2
12	N1507739313	368	9.1	217.5
13	N1507739473	359.2	−22.2	219.9
14	N1507739633	348.8	−1.3	168.2
15	N1507739776	342.6	−60.3	184.8
16	N1507740062	324.9	−1.3	168.9
17	N1507739154	375.6	−1.2	167.5
18	N1507743058	160.2	−35.2	191.8
19	N1507742919	167.4	−20.8	187
20	N1507742601	184.7	9.1	187
21	N1507742761	175.9	−6.5	186.5
22	N1507742440	194	27.4	189.3
23	N1507740839	283.4	56.7	165.3
24	N1507740982	275.8	54.6	209.3
25	N1507742295	201.9	28.7	170.1
26	N1507738278	424.9	−0.7	165.5
27	N1507741140	266.5	41.5	134.9
28	N1507741300	256.7	14.2	145.1
29	N1507740542	298.2	−1.4	169.7
30	N1507741809	228.5	−27.5	169.2
31	N1507740222	318.1	−19.3	103.8
32	N1507741620	239.3	−28.7	144.7
33	N1507741460	247.7	−7.5	146.8
34	N1507740382	308.7	7.5	112.2
35	N1507738278	424.9	−0.7	165.5
36	N1481738546	925.5	11.2	209.4
37	N1481738450	928.2	11.1	209.1
38	N1481738371	932.1	31.2	149.8
39	N1481738274	934.7	32.7	259.3
40	N1532405126	1567.7	4.4	308.1
41	N1501604957	1722.6	−43.4	241.3
42	N1514126616	900.6	−45.1	101.1
43	N1540775893	5620.1	40.9	329.2
44	N1556123705	738.5	15.3	38.3
45	N1556123415	730.6	−1.3	91.4
46	N1556123129	724.3	−61.9	96.4
47	N1556123988	745.4	−38.5	2
48	N1496883311	1266.7	−45.6	263.2
49	W1665971522	1884.4	−1.4	83.1
50	N1569826692	272.3	−53.2	267.9
51	N1569826794	272.4	−52.2	317.3
52	N1569826902	273.9	−52.7	359.9
53	N1569827019	273.8	−24.2	345
54	N1569827127	274.8	−24	317.2
55	N1569827462	278.5	1.6	318.3
56	N1569827571	279.9	1.7	344.7
57	N1569827692	281.8	27.5	344
58	N1569827799	283.3	27.8	315.6
59	N1569827906	285.8	26.7	280.1
60	N1569828025	287.9	56.7	292.4
61	N1569828131	289.1	57.6	343.6
62	N1569828238	291.9	56.1	48.2
63	N1569828360	292.1	24.1	15.2
64	N1569828482	293.8	−2.1	12.3
65	N1569828604	296.7	−31.2	21.2
66	N1569828720	299	−11	39.1
67	N1569828843	301.3	17.5	44.2
68	N1569814652	418.9	−60.7	235.6
69	N1569814805	416.2	−52.1	316.8
70	N1569814968	409.8	−26.1	249.2
71	N1569815121	407.1	−21.3	294.5
72	N1569815285	401.8	2.5	256.4
73	N1569815436	399.3	13.4	291.2
74	N1569815593	395.4	34.7	274.7
75	N1569836937	530.3	−21.3	64.2
76	N1569837046	534.1	30.1	69.5
77	N1569837162	537.9	49.7	22
78	N1569837277	542.3	31.1	337.4
79	N1569837386	546.4	−21.6	342
80	N1569837501	550.5	−37.4	22.8
81	N1569839110	609.9	9.7	27
82	N1496883920	1253.6	−44.4	265
83	N1496883812	1256	−44.5	264.7
84	N1514090211	2605.5	−0.4	99
85	N1544893295	1794.4	36.3	134
86	N1643287262	272.9	−8.4	130.6
87	N1643287178	271.8	12.1	125.2
88	N1643287088	271.1	33.5	122.4
89	N1643286998	271.1	54.9	123
90	N1643286570	271.3	67.4	146.4
92	N1649319166	271.5	55.2	155.5
93	N1649318982	402.3	41.2	82.3
94	N1649319342	391.7	49.2	45
95	N1649317673	410.1	3.5	59.6
96	N1649317532	323.5	50.8	347.7
97	N1649316590	314.7	−0.5	12.8
98	N1649316773	268.6	−25.1	80.4
99	N1649318802	275.7	−0.5	11.9
100	N1649318622	381	9.6	32.8
101	N1649318460	371.8	−22.7	33
102	N1649317889	365.3	−66.9	61
103	N1649318068	333.5	14.3	356.4
104	N1649318247	342.8	−16.9	355.2
105	N1649317009	353.6	−56.1	338.9
106	N1649317172	287.8	−0.5	12.2
107	N1649317349	298	−16.1	311.8
108	N1652844594	307	13.3	314.2
109	N1662199400	1244.5	0	59.4
110	N1662199639	236.5	61.3	119.1
111	N1662199228	235.3	70.9	224.6
112	N1662199058	236.2	68.2	95.5
113	N1662198888	234.9	75.8	277.8
114	N1662199809	235	52.9	278.2
115	N1662199979	235.6	50.4	246.7
116	N1662200149	236.8	29.4	251.9
117	N1662198718	238.9	6.6	254.2
118	N1662200319	236.1	32	277.8
119	N1662198548	242.4	−27.9	256
120	N1662198321	238	9.5	276.6
121	N1665974110	241.9	−22.7	271.9
122	N1665974345	218.4	75.7	210.2
123	N1665974517	221.9	58.6	133.7
124	N1665974689	225.2	37.1	120.8
125	N1665974861	229.1	15.7	114.4
126	N1665975031	233.7	−8.8	107.4

Aeneid of Virgil". No new names were proposed for Mimas. The locations and dimensions of all previously known features were measured again on the basis of the Cassini data and were corrected when necessary. The nomenclature proposed by the Cassini-ISS team was approved by the IAU (http://planetarynames.wr.usgs.gov/).

The entire atlases are available to the public through the Imaging Team's website (http://ciclops.org/maps). The map tiles are also archived as standard products in the Planetary Data System (PDS) (http://pds.jpl.nasa.gov/).

3. Future work

Assuming funding is approved, the Cassini spacecraft will continue its exploration of the Saturnian system through the

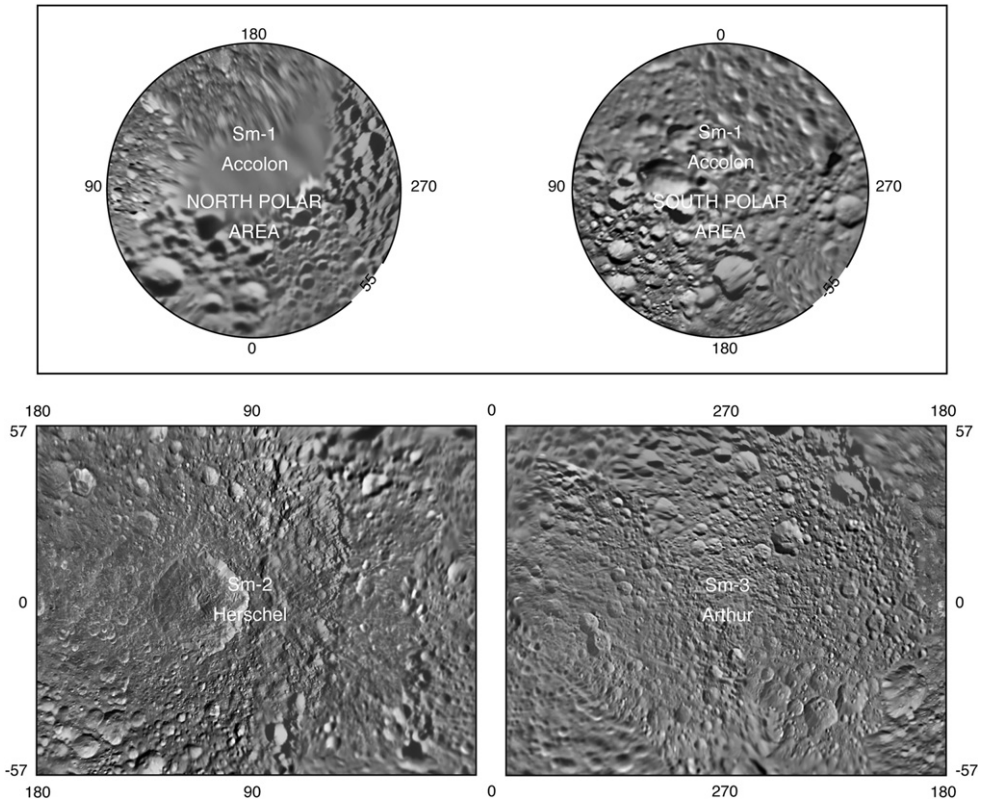

Fig. 4. Quadrangle schema of the subdivision of the synoptic format filled with Mimas mosaic.

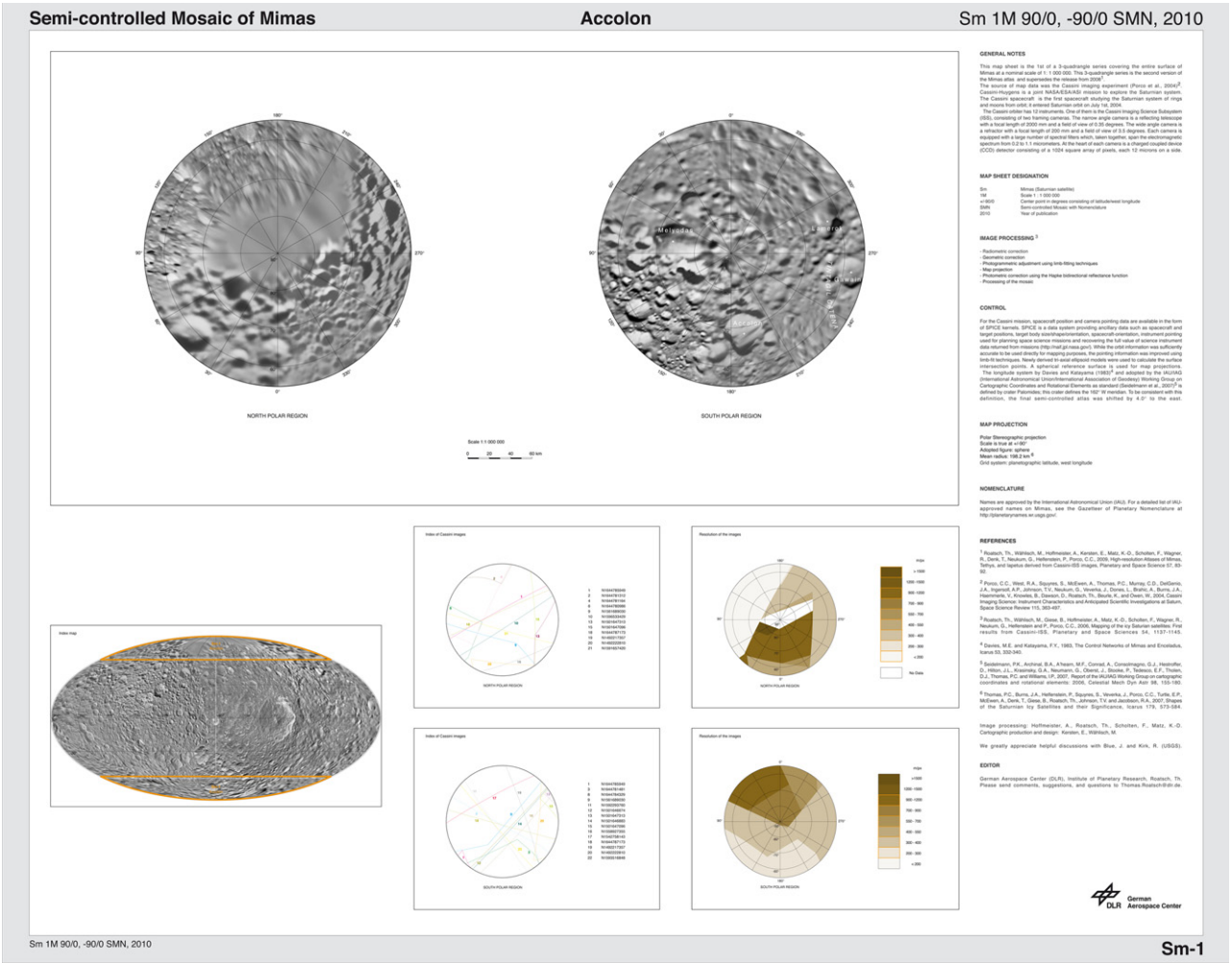

Fig. 5. Mimas map sheet 01: Accolon.

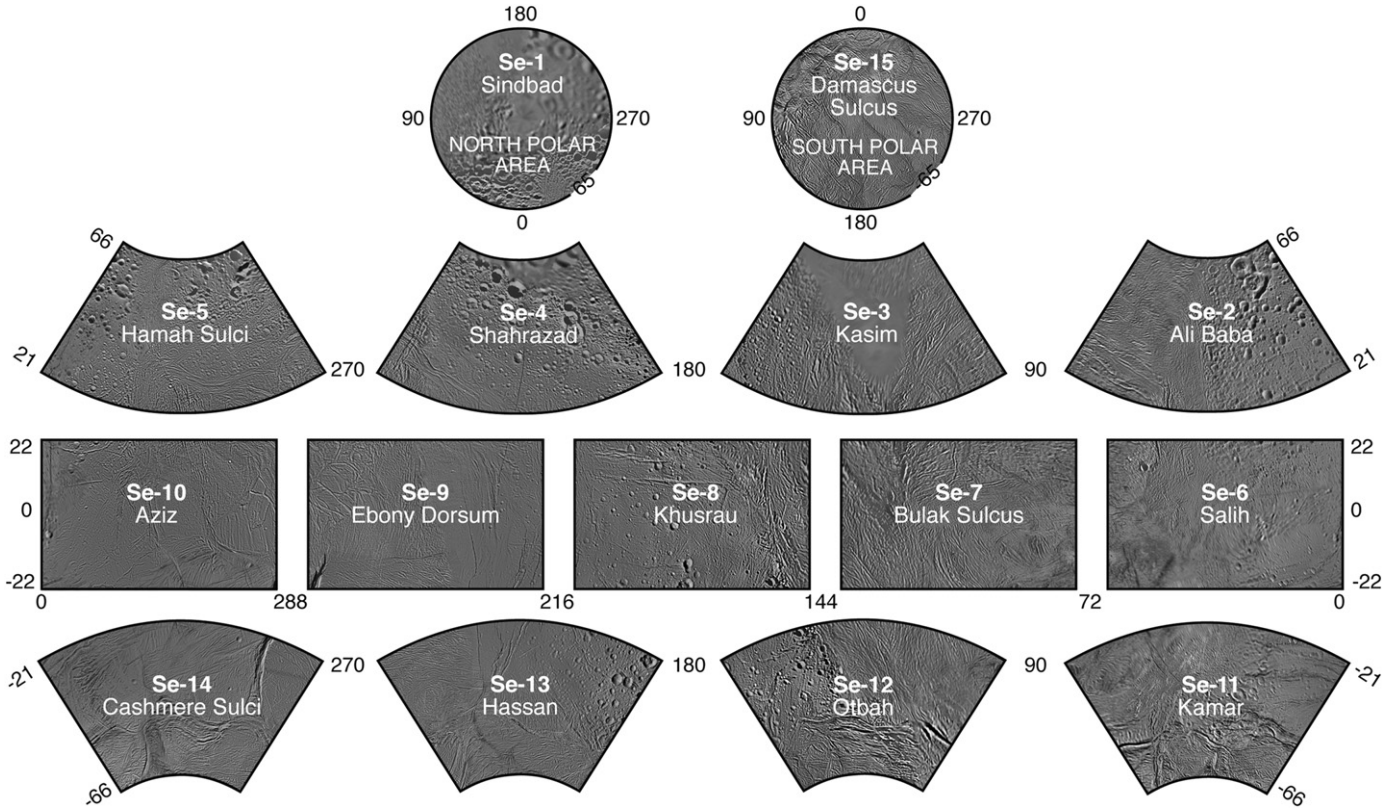

Fig. 6. Quadrangle schema filled with Enceladus mosaic.

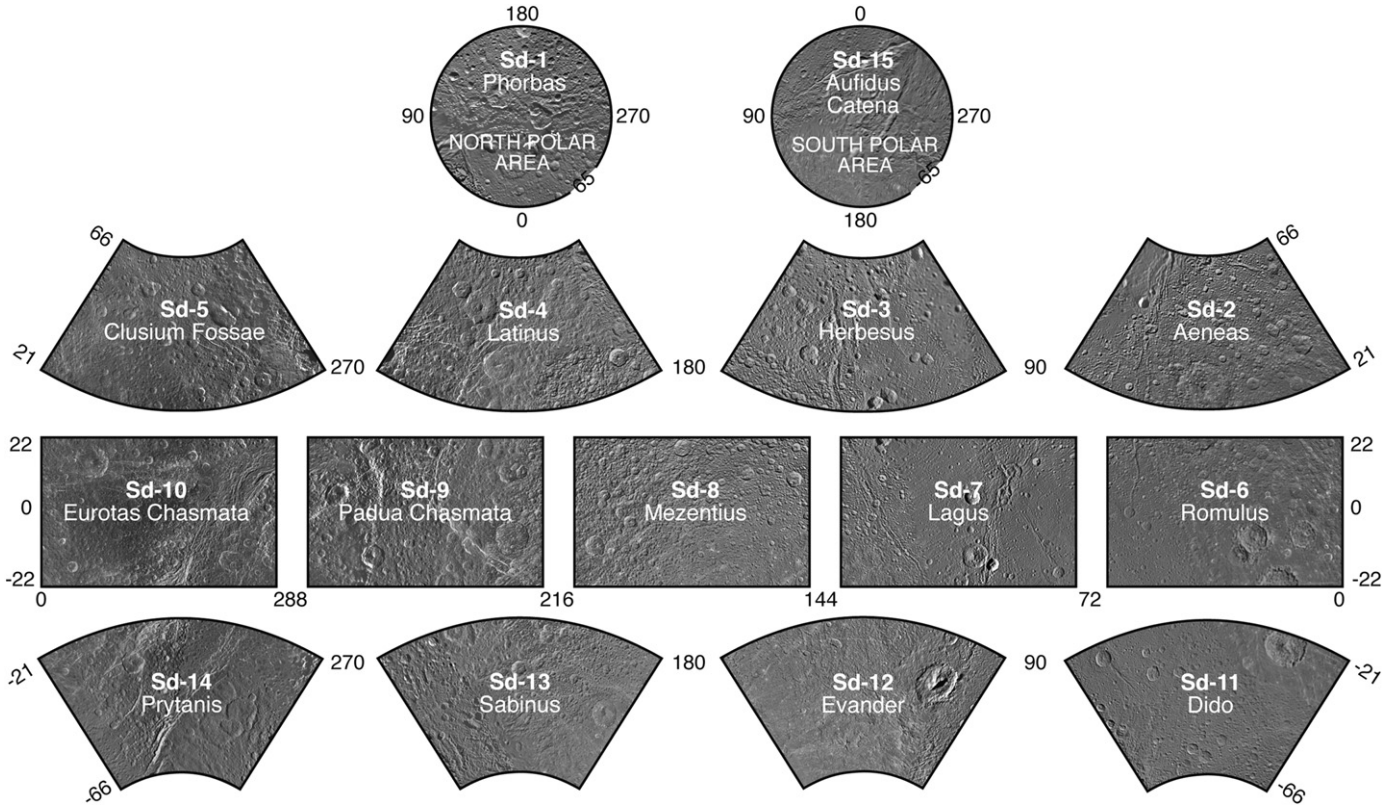

Fig. 7. Quadrangle schema filled with Dione mosaic.

middle of 2017. Several additional close satellite flybys are scheduled for this time frame. These upcoming flybys will help to replace the low-resolution parts of these atlases with higher resolution images. The northern polar regions will be illuminated during the extended mission providing an opportunity to obtain high-resolution Cassini coverage of high northern latitudes.

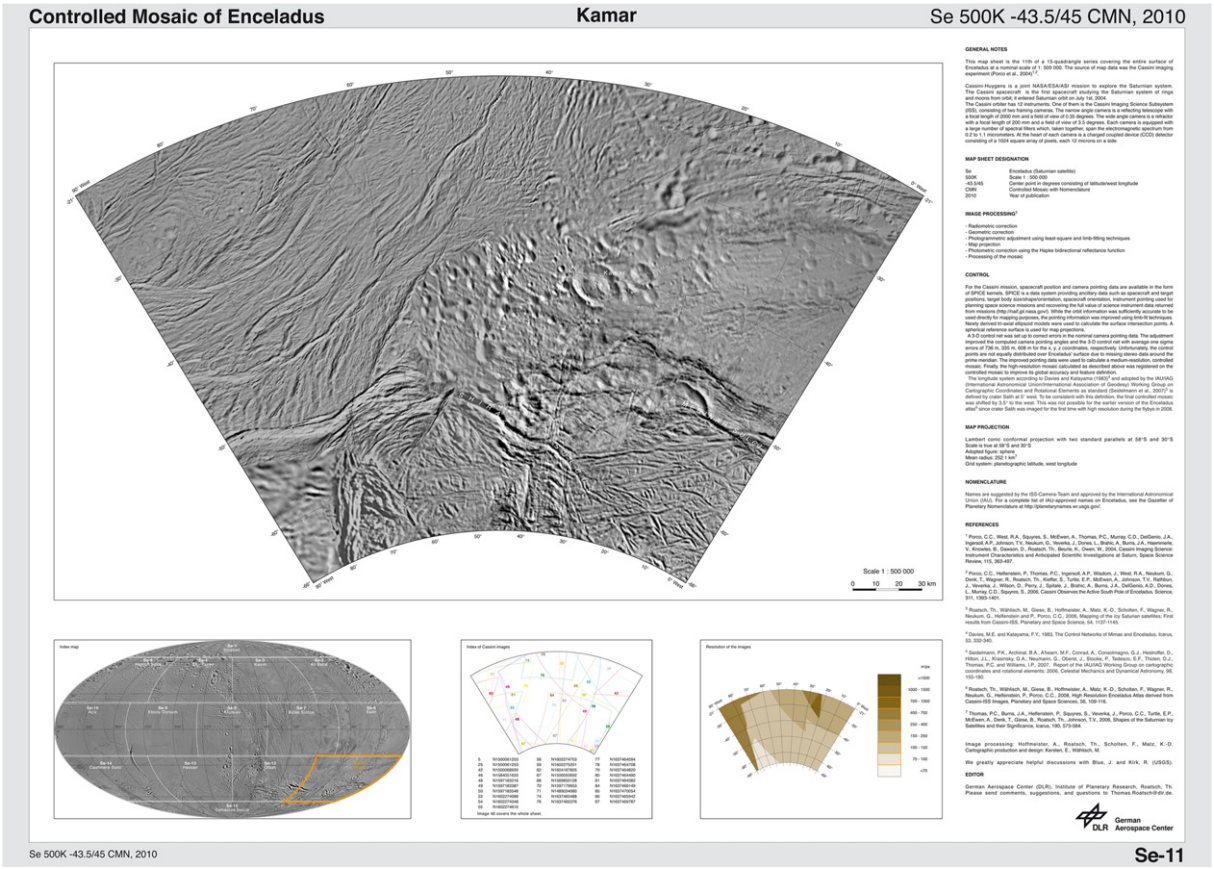

Fig. 8. Enceladus map sheet 11: Kamer.

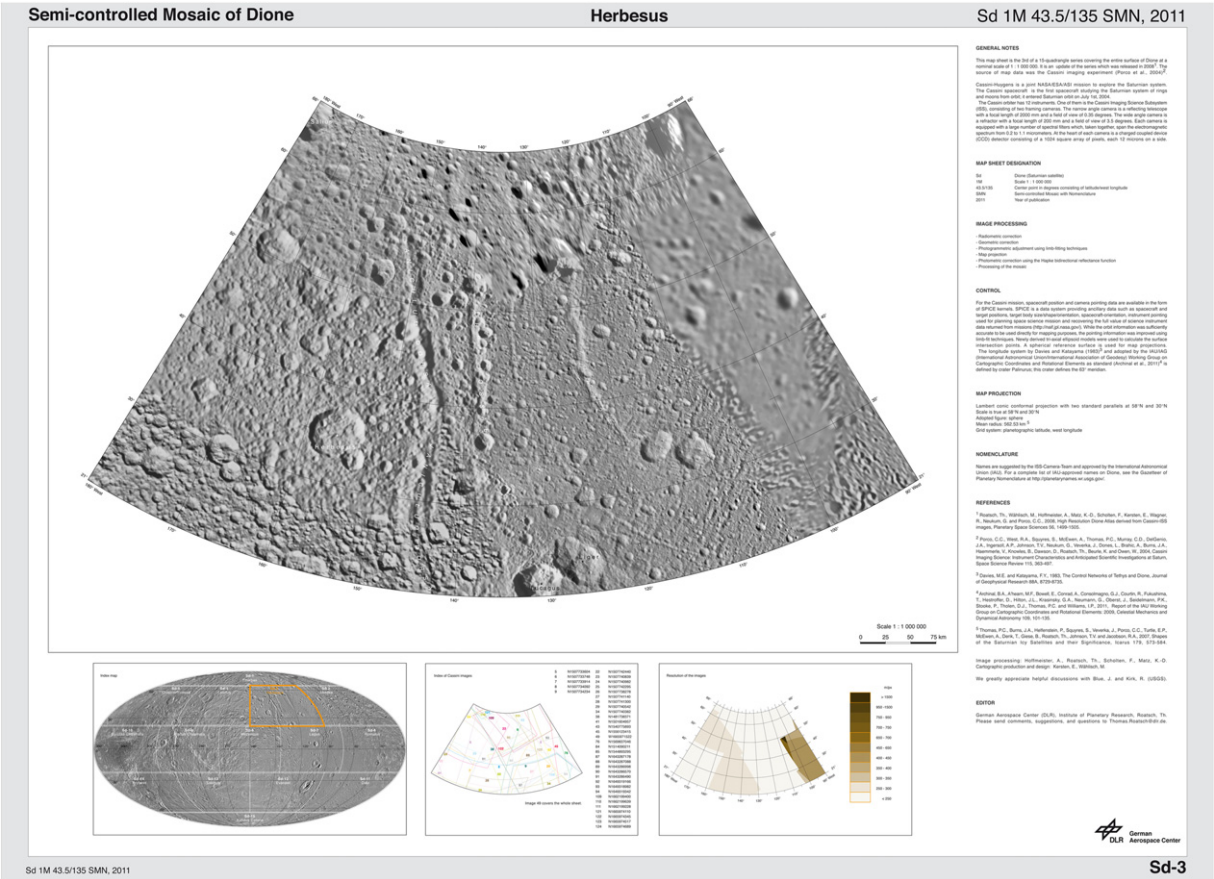

Fig. 9. Dione map sheet 03: Herbesus.

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