DTU Space
National Space Institute

VNIVERSITAT DE VALÈNCIA

BIRKELAND CENTRE FOR SPACE SCIENCE

Doc. no:	ASDC-DTU-TN-008
Rev:	2.0
Date:	2023-02-22

ASIM Science Data Centre (ASDC)
Technical Note:
MMIA Data availability: Latitude Range vs Day of Year

Prepared by:

Freddy Christiansen
ASDC Instrument Specialist

Approved, ASDC:

Carol Anne Oxborrow
ASDC Project Manager

Approved, ASIM FST:

Torsten Neubert
Chair ASIM Facility Science Team

Template no: 1

Table 0.1 Change Log

ECR/ECO	Description	Rev	Date
FC/CAO	First Issue	1.0	2021-09-23
FC	Updated with beta angles for 2021-22 and predictions for 2023.	2.0	2023-02-22

Reference Documents

The following documents contain supporting and background information to be used during the activities specified within this document.

Ref.	Doc. No.	Title	Issue
RD#1	ASIM-MA-CGS-004	ASIM DHPI-SW User Manual	6
RD#2	ASIM-DTU-MXGS-MAN-001	ASIM MXGS User Manual	2B
RD#3	ASIM-TER-MMIA-MAN-002	ASIM MMIA User Manual	2A
RD#4	ASIM-TER-SYS-MAN-025	ASIM Payload Operations and User Manual	2A
RD#5	ASIM-TER-SYS-ICD-001	ASIM Software Communication ICD	4A
RD#6	ASIM-TER-MMIA-ICD-002	ASIM MMIA Software ICD	2C
RD#7	ASIM-TER-MXGS-ICD-001	ASIM MXGS Software ICD	2E
RD#8	ASIM-ESA-HSF-RQ-002	ASIM Phase C/D System Requirements Document	2.1
RD#9	ASIM-TER-SYS-SPEC-003	ASIM Software System Specification	6
RD#10	ASIM-DTU-MXGS-TP-014	ASIM MXGS PFM Functional Test Procedures	1dB
RD#11	ASIM-UV-MXGS-DD-003	ASIM MXGS Data Acquisition Algorithm Description Document	3CdA

Abbreviations

ASDC	ASIM Science Data Centre
ASIM	Atmosphere-Space Interaction Monitor
BGO	Bismuth Germanium Oxide
B.USOC	Belgian User Science Operations Center
CCSDS	Consultative Committee on Space Data Systems
CDF	Common Data Format (NASA)
CHU	Camera Head Unit (MMIA)
Col-CC	Columbus Control Centre
CZT	Cadmium-Zinc-Telluride
DAU	Detector Assembly Module
DHPU	Data Handling and Power Unit
DK	Denmark
DMI	Danish Meteorological Institute
DPU	Data Processing Unit
DTU	Technical University of Denmark
ER	Event Report
ERM	Energy Response Matrix
ESA	European Space Agency
ESR	Experiment Science Requirements
ESTEC	European Space Technology Centre
EUMETSAT	European Meteorological Satellite Organisation
FITS	Flexible Image Transport System
FOV	Field of View
FST	Facility Science Team
GLPS	Global Lightning Protection Services
HED	High Energy Detector (MXGS)
HK	House Keeping (data)
HSO	Human Spaceflight and Operations
ISS	International Space Station
LED	Low Energy Detector (MXGS)
LEP	Lightning-induced Electron Precipitation
LIS	Lightning Imaging Sensor
MMIA	Modular Multi-spectral Imaging Array
MTG	Meteosat Third Generation
MXGS	Modular X-ray Gamma-ray Sensor
NASA	National Aeronautic and Space Administration
PMC	Polar Mesospheric Clouds
PMT	Photo-multiplier Tube
PRODEX	PROgramme de Développement d'Expériences scientifiques
REP	Relativistic Electron Precipitation
SAA	South Atlantic Anomaly
SDO	Science Data Observation
TARANIS	Tool for the Analysis of RAdiation from lightNIngs and Sprites
TBC	To be confirmed
TBD	To be determined
TC	Tele command
TEA-IS	Thunderstorm Effects on the Atmosphere-Ionosphere System
TGF	Terrestrial Gamma-ray Flash
TLE	Transient Luminous Events
UB	University of Bergen
UV	University of Valencia

ISS Orbit

The optical instruments on ASIM, the photometers and cameras of the MMIA instrument only observe during night time of the ISS orbit, with an added safety margin at twilight. The length of the night time period and the latitude range of ISS night varies with the beta angle of the ISS orbit. The beta angle is dependent of season (Day of Year) and the orientation of the ISS orbit. The ISS orbit is precessing very close to 6 times a full 360 degrees revolution in one year (with respect to the Sun).

Beta angle variation

The variation of the beta angle can be seen in Figure 1 and Figure 2, the values 2023 are predictions.

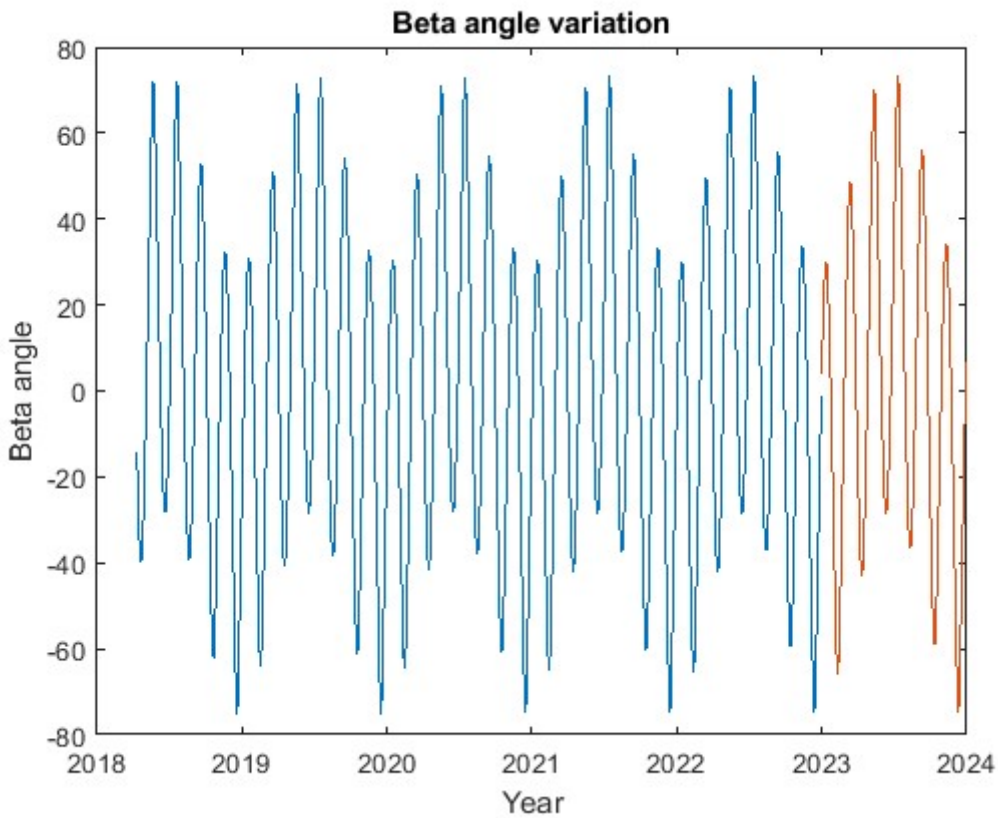

Figure 1: Beta angle (blue: actual, red: predicted). Fast variation is due to precession of ISS orbit, slow variation is seasonal.

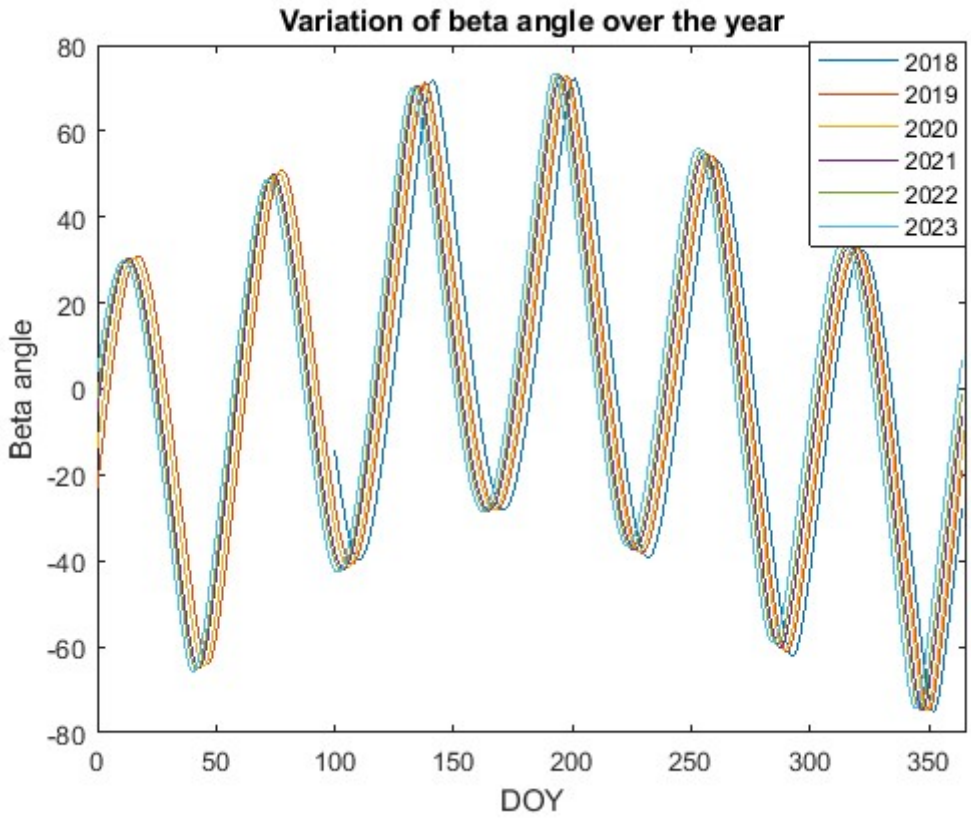

Figure 2: Beta angle vs DOY. Max beta angle is shifted back 1-2 days/year.

MMIA OBSERVATIONS: LATITUDE RANGE

In Figure 3 the maximum and minimum latitudes for MMIA instruments are plotted for each day. Notice that there are gaps in observation for periods when the ISS is not in eclipse (there are also gaps for various other reasons, such as ISS operations or maintece.

In Figure 4 the same can be seen as a function of day of year, and Figure 5 is a close up of this during the northern Summer period, and Figure 6 for the southern Summer period. Notice that there are two periods of observation gaps in the northern Summer period and only one gap during the southern Summer period due to the orientation of the ISS orbit.

In Table 1 the periods with no MMIA observations are listed (only gaps due to beta angle) with predictions up to 2021.

In Table 2 daily latitude ranges for possible MMIA observations are listed from beginning of the ASIM mission with actual values up to 2020, DOY 212 and predictions up to 2022, DOY 120.

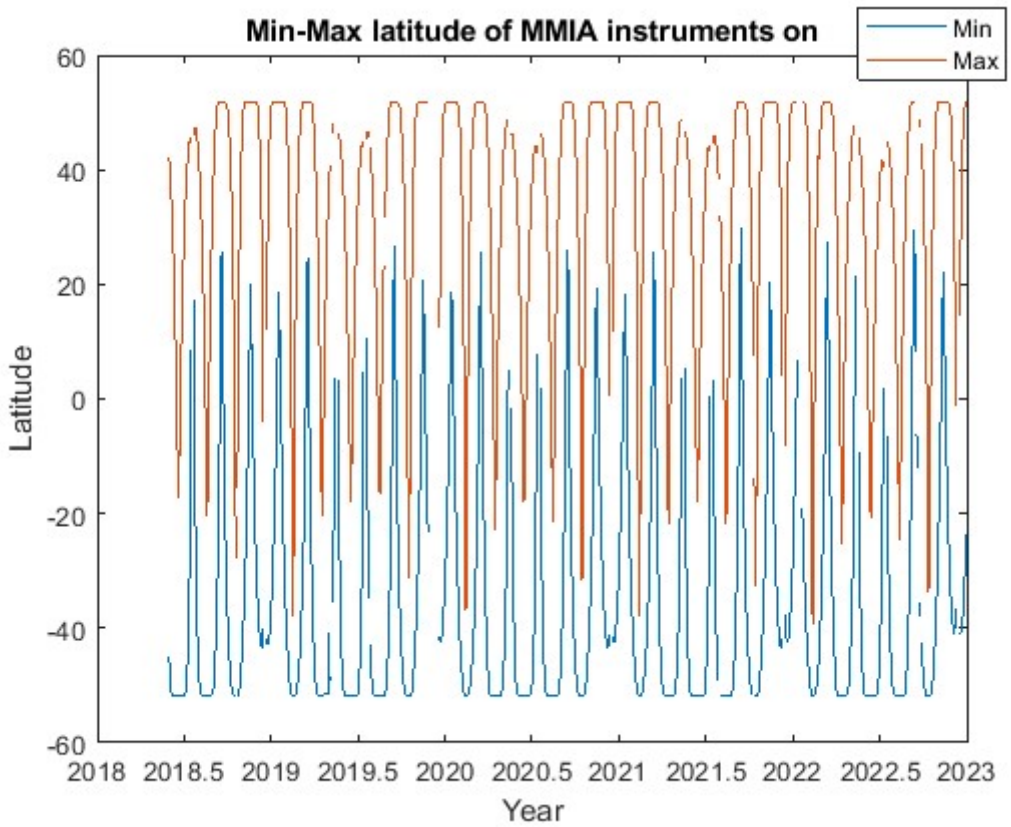

Figure 3: Daily maximum and minimum latitude of MMIA observation time

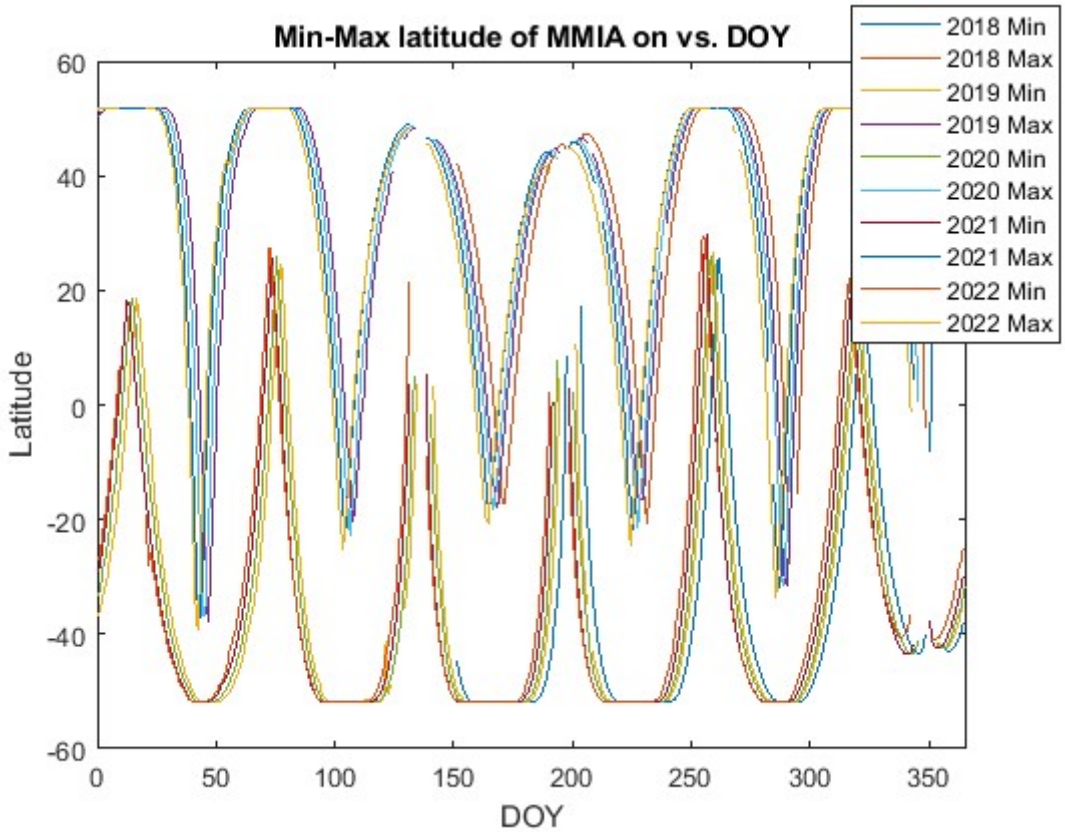

Figure 4: Daily maximum and minimum latitude of MMIA observation time vs DOY

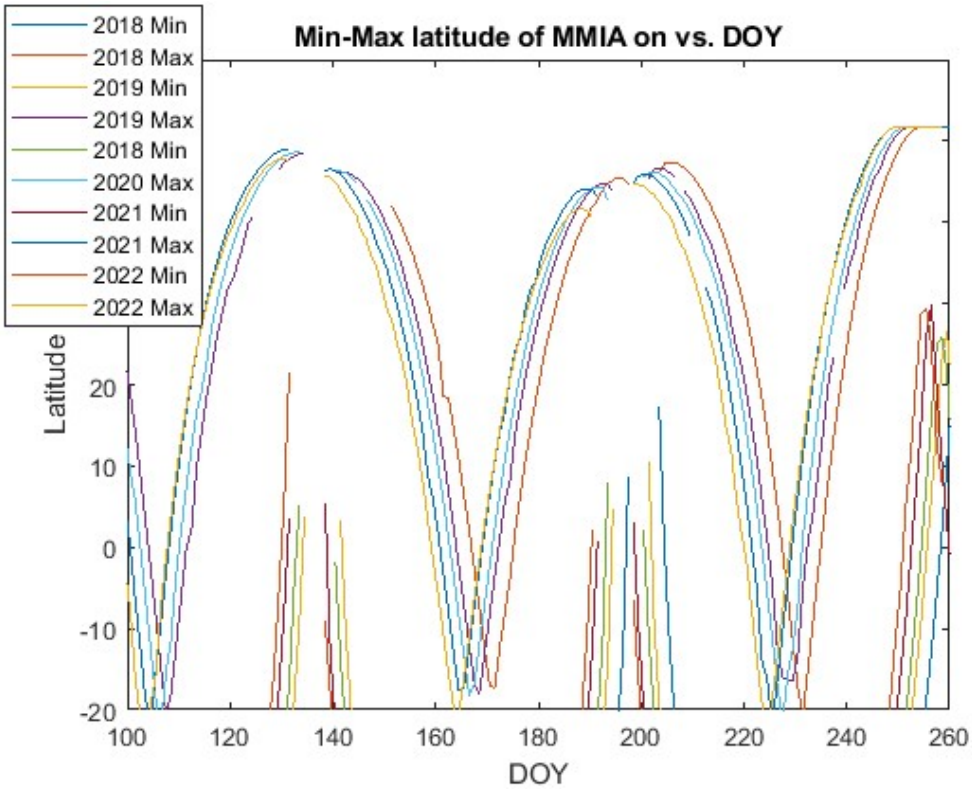

Figure 5: Daily maximum and minimum latitude of MMIA observation time during northern Summer

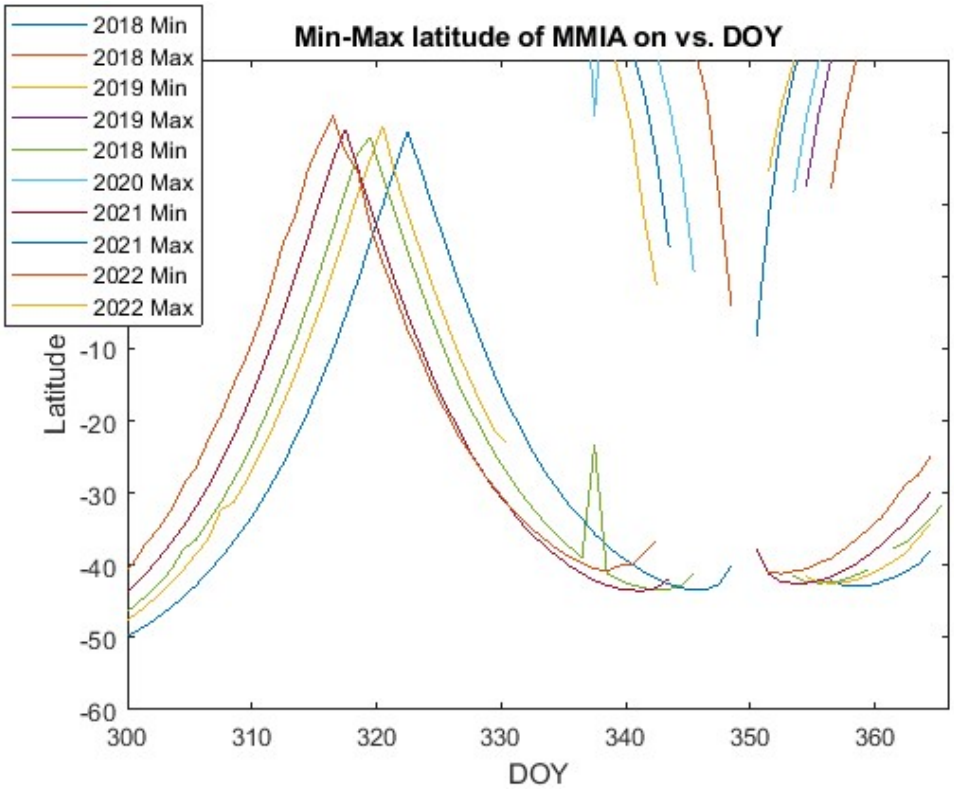

Figure 6: Daily maximum and minimum latitude of MMIA observation time during southern Summer.

Table 1: DOY gaps in MMIA observation due to high beta angle. Numbers in red are predictions

	Gap1	Gap2	Gap3
2018		199 - 203	350 - 356
2019	136 - 141	196 - 201	349 - 354
2020	135 - 140	195 - 200	347 - 353
2021	133 - 138	193 - 198	345 - 350
2022	133 - 138	192 - 198	344 - 351
2023	131-137	190 - 196	343 - 349

Table 2: Daily latitude range for possible MMIA observations. The values from 2023. '–' means no MMIA observations are available.

DOY	2018	2019			2020			2021			2022			2023		
1	-	-37	-	50	-33	-	52	-29	-	52	-27	-	52	-23	-	52
2	-	-35	-	51	-31	-	52	-27	-	52	-25	-	52	-20	-	52
3	-	-33	-	51	-28	-	52	-24	-	52	-22	-	52	-17	-	52
4	-	-32	-	52	-27	-	52	-21	-	52	-19	-	52	-13	-	52
5	-	-30	-	52	-24	-	52	-18	-	52	-15	-	52	-9	-	52
6	-	-26	-	52	-21	-	52		-		-11	-	52	-5	-	52
7	-	-24	-	52	-16	-	52	-9	-	52	-7	-	52	-1	-	52
8	-	-21	-	52	-14	-	52	-6	-	52	-3	-	52	4	-	52
9	-	-18	-	52	-9	-	52	-1	-	52	2	-	52	9	-	52
10	-	-14	-	52	-6	-	52	3	-	52	7	-	52	13	-	52
11	-	-10	-	52	0	-	52	8	-	52		-		16	-	52
12	-	-6	-	52	5	-	52	13	-	52		-		13	-	52
13	-	-1	-	52		-		18	-	52		-		9	-	52
14	-	3	-	52	16	-	52	17	-	52		-		4	-	52
15	-	9	-	52	19	-	52	12	-	52		-		-1	-	52
16	-	13	-	52	17	-	52	7	-	52		-		-6	-	52
17	-	19	-	52	12	-	52	2	-	52		-		-10	-	52
18	-	16	-	52	7	-	52	-3	-	52		-		-14	-	52
19	-	11	-	52	2	-	52	-8	-	52		-		-18	-	52
20	-	6	-	52	-3	-	52	-12	-	52		-		-22	-	52
21	-	1	-	52		-		-16	-	52	-19	-	52	-27	-	52
22	-	-2	-	52	-12	-	52	-20	-	52	-28	-	52	-29	-	52
23	-	-7	-	52	-16	-	52	-24	-	52	-26	-	52	-31	-	52
24	-	-13	-	52	-19	-	52	-27	-	52	-29	-	52	-32	-	52
25	-	-17	-	52	-23	-	52	-30	-	52	-31	-	52	-35	-	51
26	-	-21	-	52	-26	-	52	-32	-	52	-34	-	51	-37	-	50

DOY	2018	2019			2020			2021			2022			2023		
27	-	-24	-	52	-29	-	52	-35	-	51	-36	-	51	-39	-	49
28	-	-28	-	52	-32	-	51	-37	-	51	-38	-	50	-41	-	48
29	-	-30	-	52	-34	-	51	-39	-	50	-39	-	49	-43	-	46
30	-	-33	-	52	-37	-	51	-41	-	49	-42	-	47	-44	-	44
31	-	-36	-	51	-39	-	50	-42	-	47	-43	-	45	-45	-	41
32	-	-38	-	51	-41	-	49	-44	-	45	-45	-	43	-47	-	37
33	-	-40	-	50	-43	-	47	-45	-	43	-46	-	40	-48	-	33
34	-	-41	-	48	-44	-	45	-46	-	39	-47	-	35	-49	-	27
35	-	-43	-	47	-46	-	42	-48	-	36	-48	-	30	-50	-	20
36	-	-44	-	44	-47	-	39	-49	-	31	-49	-	51	-50	-	12
37	-	-46	-	41	-48	-	35	-49	-	25	-50	-	20	-51	-	3
38	-	-47	-	38	-49	-	31	-50	-	18	-51	-	4	-52	-	-9
39	-	-48	-	34	-50	-	24	-51	-	10	-51	-	1	-52	-	-22
40	-	-49	-	29	-51	-	18	-52	-	-1	-52	-	-11	-52	-	-32
41	-	-50	-	23	-51	-	10	-52	-	-13	-52	-	-25	-52	-	-36
42	-	-51	-	16	-52	-	-1	-52	-	-26	-52	-	-37	-52	-	-35
43	-	-52	-	7	-52	-	-12	-52	-	-38	-52	-	-39	-52	-	-26
44	-	-52	-	-2	-52	-	-26	-52	-	-37	-52	-	-27	-52	-	-12
45	-	-52	-	-19	-52	-	-37	-52	-	-25	-52	-	-14	-52	-	1
46	-	-52	-	-27	-52	-	-36	-52	-	-12	-52	-	-7	-51	-	11
47	-	-52	-	-38	-52	-	-23	-52	-	-5	-52	-	8	-51	-	19
48	-	-52	-	-32	-52	-	-16	-52	-	9	-51	-	16	-51	-	26
49	-	-52	-	-19	-52	-	-1	-51	-	16	-51	-	22	-50	-	30
50	-	-52	-	-12	-52	-	9	-51	-	23	-51	-	28	-49	-	34
51	-	-52	-	3	-52	-	16	-51	-	28	-50	-	31	-49	-	37
52	-	-52	-	11	-51	-	23	-50	-	31	-49	-	36	-48	-	40
53	-	-52	-	16	-51	-	28	-49	-	36	-48	-	39	-46	-	42
54	-	-51	-	23	-50	-	32	-48	-	39	-47	-	42	-45	-	43
55	-	-51	-	29	-49	-	36	-47	-	42	-46	-	43	-43	-	44
56	-	-50	-	33	-48	-	39	-46	-	44	-43	-	42	-41	-	44
57	-	-49	-	37	-48	-	42	-45	-	46	-42	-	44	-39	-	46
58	-	-49	-	40	-46	-	44	-44	-	47	-40	-	45	-37	-	48
59	-	-48	-	42	-45	-	46	-42	-	49	-39	-	47	-35	-	49
60	-	-47	-	44	-44	-	47	-40	-	50	-36	-	48	-33	-	50
61	-	-45	-	46	-42	-	49	-38	-	51	-34	-	49	-30	-	51
62	-	-44	-	47	-40	-	49	-36	-	51	-31	-	50	-27	-	51
63	-	-41	-	48	-37	-	50	-33	-	52	-28	-	51	-23	-	52
64	-	-39	-	49	-36	-	51	-30	-	52	-25	-	52	-19	-	52
65	-	-37	-	51	-34	-	51	-27	-	52	-21	-	52	-15	-	52
66	-	-36	-	51	-30	-	52	-23	-	52	-17	-	52	-10	-	52
67	-	-33	-	52	-27	-	52	-19	-	52	-12	-	52	-4	-	52
68	-	-30	-	52	-23	-	52	-14	-	52	-7	-	52	2	-	52
69	-	-27	-	52	-19	-	52	-9	-	52	-1	-	52	8	-	52
70	-	-22	-	52	-14	-	52	-1	-	52	6	-	52	15	-	52
71	-	-18	-	52	-9	-	52	4	-	52	13	-	52	21	-	52

DOY	2018	2019			2020			2021			2022			2023		
72	-	-13	-	52	-3	-	52	11	-	52	20	-	52	23	-	52
73	-	-7	-	52	4	-	52	19	-	52	27	-	52	17	-	52
74	-	2	-	52	11	-	52	26	-	52	24	-	52	12	-	52
75	-	6	-	52	19	-	52	20	-	52	17	-	52	4	-	52
76	-	14	-	52	26	-	52	13	-	52	9	-	52	-3	-	52
77	-	21	-	52	20	-	52	7	-	52	2	-	52	-10	-	52
78	-	25	-	52	12	-	52	1	-	52	-5	-	52	-15	-	52
79	-	17	-	52	5	-	52	-9	-	52	-11	-	52	-20	-	52
80	-	10	-	52	-2	-	52	-15	-	52	-17	-	52	-25	-	51
81	-	2	-	52	-9	-	52	-21	-	52	-21	-	52	-29	-	51
82	-	-5	-	52	-15	-	52	-25	-	52	-26	-	51	-33	-	50
83	-	-12	-	52	-21	-	52	-30	-	52	-30	-	51	-36	-	49
84	-	-18	-	52	-24	-	52	-33	-	51	-34	-	50	-39	-	48
85	-	-23	-	52	-30	-	51	-37	-	50	-37	-	48	-41	-	46
86	-	-28	-	52	-34	-	51	-40	-	49	-39	-	47	-44	-	44
87	-	-32	-	51	-37	-	50	-42	-	48	-42	-	46	-45	-	42
88	-	-36	-	51	-40	-	49	-44	-	47	-44	-	44	-47	-	40
89	-	-39	-	50	-43	-	48	-46	-	45	-46	-	42	-48	-	37
90	-	-42	-	49	-45	-	47	-48	-	43	-47	-	39	-50	-	35
91	-	-44	-	47	-47	-	45	-49	-	41	-49	-	36	-51	-	32
92	-	-46	-	46	-48	-	43	-50	-	39	-50	-	34	-51	-	28
93	-	-48	-	44	-50	-	41	-51	-	36	-51	-	31	-52	-	25
94	-	-48	-	42	-50	-	38	-52	-	33	-52	-	27	-52	-	20
95	-	-50	-	39	-51	-	36	-52	-	30	-52	-	24	-52	-	16
96	-	-51	-	37	-52	-	33	-52	-	26	-52	-	19	-52	-	11
97	-	-51	-	34	-52	-	29	-52	-	21	-52	-	14	-52	-	5
98	-	-52	-	31	-52	-	25	-52	-	17	-52	-	10	-52	-	-1
99	-	-52	-	28	-52	-	21	-52	-	12	-52	-	4	-52	-	-8
100	-	-52	-	24	-52	-	15	-52	-	6	-52	-	-2	-52	-	-16
101	-	-52	-	19	-52	-	10	-52	-	0	-52	-	-7	-52	-	-20
102	-	-52	-	15	-52	-	6	-52	-	-6	-52	-	-15	-52	-	-22
103	-	-52	-	9	-52	-	0	-52	-	-12	-52	-	-21	-52	-	-23
104	-	-52	-	4	-52	-	-6	-52	-	-18	-52	-	-25	-52	-	-20
105	-	-52	-	-2	-52	-	-12	-52	-	-22	-52	-	-20	-52	-	-13
106	-	-52	-	-8	-52	-	-19	-52	-	-16	-52	-	-16	-52	-	-5
107	-	-52	-	-15	-52	-	-23	-52	-	-10	-52	-	-7	-52	-	1
108	-	-52	-	-20	-52	-	-15	-52	-	-3	-52	-	-1	-52	-	7
109	-	-52	-	-18	-52	-	-11	-52	-	2	-52	-	4	-52	-	11
110	-	-52	-	-12	-52	-	-3	-52	-	8	-52	-	9	-52	-	16
111	-	-52	-	-6	-52	-	2	-52	-	12	-52	-	13	-52	-	20
112	-	-52	-	0	-52	-	8	-52	-	17	-52	-	18	-52	-	23
113	-	-52	-	2	-52	-	12	-52	-	21	-52	-	21	-52	-	26
114	-	-52	-	10	-52	-	17	-52	-	24	-52	-	24	-51	-	29
115	-	-52	-	14	-52	-	19	-52	-	28	-52	-	27	-51	-	32
116	-	-52	-	19	-52	-	23	-52	-	30	-51	-	30	-50	-	34

DOY	2018	2019	2020	2021	2022	2023
117	-	-52 - 22	-52 - 27	-52 - 33	-51 - 32	-49 - 36
118	-	-52 - 26	-52 - 30	-51 - 35	-50 - 35	-48 - 38
119	-	-52 - 29	-52 - 33	-51 - 37	-49 - 36	-47 - 39
120	-	-52 - 32	-51 - 35	-50 - 39	-48 - 38	-45 - 41
121	-	-52 - 33	-51 - 37	-49 - 41	-46 - 40	-43 - 42
122	-	-41 - 35	-50 - 39	-48 - 42	-43 - 41	-40 - 43
123	-	-50 - 37	-49 - 41	-46 - 43	-42 - 42	-37 - 44
124	-	-49 - 40	-48 - 42	-44 - 45	-39 - 44	-34 - 45
125	-	-49 - 41	-46 - 43	-41 - 46	-36 - 45	-30 - 46
126	-	-	-44 - 44	-39 - 46	-34 - 46	-25 - 47
127	-	-44 - 44	-42 - 45	-35 - 47	-28 - 46	-18 - 47
128	-	-	-38 - 46	-30 - 48	-23 - 47	-10 - 48
129	-	-	-35 - 47	-24 - 48	-16 - 48	1 - 48
130	-	-35 - 46	-30 - 48	-18 - 49	-6 - 48	15 - 48
131	-	-31 - 47	-24 - 48	-8 - 49	5 - 48	-
132	-2 - 45	-27 - 48	-17 - 48	4 - 49	22 - 47	-
133	-	-18 - 48	-4 - 49	-	-	-
134	-	-9 - 48	5 - 49	-	-	-
135	-	4 - 48	-	-	-	-
136	-	-	-	-	-	-
137	-	-	-	-	-	-
138	-	-	-	-	-	-16 - 46
139	-	-	-	5 - 46	-9 - 46	-24 - 45
140	-	-	-	-13 - 47	-18 - 46	-30 - 44
141	-	-	-2 - 46	-22 - 46	-25 - 45	-35 - 43
142	-	3 - 46	-14 - 46	-29 - 46	-31 - 44	-39 - 42
143	-	-10 - 46	-23 - 46	-34 - 45	-36 - 43	-42 - 41
144	-	-20 - 46	-29 - 46	-39 - 44	-39 - 42	-44 - 40
145	-	-27 - 46	-33 - 45	-42 - 43	-42 - 41	-46 - 38
146	-	-33 - 45	-	-45 - 42	-45 - 39	-48 - 37
147	-	-38 - 44	-42 - 43	-47 - 41	-47 - 38	-49 - 35
148	-	-41 - 43	-45 - 42	-48 - 39	-49 - 36	-51 - 33
149	-	-44 - 42	-47 - 41	-50 - 37	-50 - 35	-51 - 30
150	-	-47 - 41	-49 - 39	-51 - 36	-51 - 32	-52 - 28
151	-	-48 - 40	-50 - 38	-51 - 34	-51 - 29	-52 - 26
152	-45 - 42	-50 - 38	-51 - 36	-52 - 32	-52 - 28	-52 - 23
153	-47 - 41	-51 - 36	-51 - 34	-52 - 30	-52 - 25	-52 - 20
154	-49 - 39	-51 - 35	-52 - 32	-52 - 27	-52 - 23	-52 - 17
155	-50 - 38	-52 - 32	-52 - 29	-52 - 24	-52 - 20	-52 - 13
156	-51 - 36	-52 - 30	-52 - 27	-52 - 21	-52 - 15	-52 - 9
157	-51 - 34	-52 - 28	-52 - 24	-52 - 18	-52 - 12	-52 - 4
158	-52 - 32	-52 - 25	-52 - 21	-52 - 14	-52 - 8	-52 - 0
159	-52 - 30	-52 - 22	-52 - 17	-52 - 9	-52 - 3	-52 - -5
160	-52 - 27	-52 - 19	-52 - 14	-52 - 6	-52 - -2	-52 - -10
161	-52 - 25	-52 - 15	-52 - 10	-52 - 2	-52 - -6	-52 - -14

DOY	2018			2019			2020			2021			2022			2023		
162	-52	-	19	-52	-	11	-52	-	6	-52	-	-3	-52	-	-11	-52	-	-18
163	-52	-	18	-52	-	7	-52	-	1	-52	-	-8	-52	-	-16	-52	-	-19
164	-52	-	15	-52	-	3	-52	-	-3	-52	-	-13	-52	-	-20	-52	-	-18
165	-52	-	11	-52	-	-2	-52	-	-8	-52	-	-18	-52	-	-21	-52	-	-14
166	-52	-	6	-52	-	-7	-52	-	-13	-52	-	-17	-52	-	-16	-52	-	-9
167	-52	-	2	-52	-	-12	-52	-	-18	-52	-	-13	-52	-	-11	-52	-	-3
168	-52	-	-3	-52	-	-17	-52	-	-17	-52	-	-7	-52	-	-6	-52	-	2
169	-52	-	-7	-52	-	-18	-52	-	-12	-52	-	-3	-52	-	-2	-52	-	6
170	-52	-	-12	-52	-	-13	-52	-	-7	-52	-	2	-52	-	3	-52	-	10
171	-52	-	-17	-52	-	-8	-52	-	-2	-52	-	6	-52	-	7	-52	-	14
172	-52	-	-17	-52	-	-4	-52	-	2	-52	-	11	-52	-	11	-52	-	17
173	-52	-	-12	-52	-	1	-52	-	7	-52	-	14	-52	-	15	-52	-	20
174	-52	-	-8	-52	-	6	-52	-	11	-52	-	17	-52	-	18	-52	-	23
175	-52	-	-4	-52	-	8	-52	-	15	-52	-	21	-52	-	21	-52	-	26
176	-52	-	2	-52	-	14	-52	-	18	-52	-	24	-52	-	24	-52	-	28
177	-52	-	7	-52	-	18	-52	-	22	-52	-	26	-52	-	26	-51	-	30
178	-52	-	11	-52	-	21	-52	-	24	-52	-	30	-52	-	29	-51	-	32
179	-52	-	15	-52	-	24	-52	-	27	-52	-	32	-51	-	31	-49	-	34
180	-52	-	18	-52	-	27	-52	-	30	-51	-	33	-50	-	33	-48	-	36
181	-52	-	22	-52	-	29	-52	-	32	-51	-	36	-49	-	34	-46	-	37
182	-52	-	25	-52	-	32	-51	-	34	-50	-	37	-48	-	36	-44	-	38
183	-52	-	27	-52	-	34	-51	-	36	-49	-	39	-46	-	37	-41	-	39
184	-52	-	30	-51	-	36	-50	-	37	-47	-	40	-44	-	39	-38	-	40
185	-52	-	32	-50	-	37	-49	-	39	-45	-	41	-40	-	40	-33	-	41
186	-51	-	34	-49	-	39	-47	-	40	-43	-	42	-37	-	40	-28	-	41
187	-51	-	36	-47	-	40	-45	-	41	-39	-	43	-32	-	41	-21	-	42
188	-50	-	38	-45	-	41	-42	-	42	-35	-	44	-26	-	42	-12	-	41
189	-49	-	39	-43	-	42	-39	-	43	-29	-	44	-20	-	42	0	-	41
190	-47	-	41	-39	-	43	-34	-	44	-22	-	44	-10	-	41		-	
191	-45	-	42	-35	-	44	-26	-	44	-12	-	44	2	-	40		-	
192	-42	-	43	-30	-	45	-21	-	44	1	-	43		-			-	
193	-38	-	44	-23	-	45	-12	-	44		-			-			-	
194	-34	-	45	-14	-	45	8	-	43		-			-			-	
195	-29	-	45	5	-	44		-			-			-			-	
196	-22	-	45		-			-			-			-			-	
197	-12	-	45		-			-			-			-		-4	-	45
198	9	-	45		-			-			-			-		-14	-	45
199		-			-			-		3	-	45	-7	-	45	-22	-	44
200		-			-			-		-10	-	46	-17	-	45	-29	-	44
201		-			-		2	-	46	-20	-	46	-24	-	44	-34	-	44
202		-		10	-	45	-11	-	46	-27	-	46	-30	-	44	-37	-	43
203		-		-9	-	47	-20	-	46	-32	-	46	-34	-	43	-41	-	42
204	17	-	46	-19	-	47	-25	-	46	-37	-	45	-38	-	43	-43	-	41
205	0	-	47	-26	-	46	-31	-	46	-40	-	44	-41	-	42	-45	-	40
206	-12	-	47	-32	-	46	-36	-	45	-43	-	43	-44	-	41	-47	-	38

DOY	2018			2019			2020			2021			2022			2023		
207	-21	-	47	-35	-	46	-39	-	44	-46	-	42	-46	-	39	-48	-	37
208	-28	-	47		-		-44	-	43	-47	-	41	-47	-	37	-50	-	35
209	-33	-	47	-43	-	44	-46	-	43	-49	-	40	-49	-	37	-51	-	33
210	-37	-	46	-45	-	43	-48	-	41	-49	-	38	-50	-	34	-51	-	31
211	-41	-	45	-46	-	42	-49	-	40		-		-51	-	33	-52	-	29
212	-43	-	44	-48	-	40	-50	-	38		-		-51	-	30	-52	-	26
213	-45	-	43	-50	-	39	-51	-	36	-52	-	32	-52	-	28	-52	-	23
214	-47	-	42	-51	-	37	-51	-	35	-52	-	30	-52	-	26	-52	-	20
215	-49	-	41	-51	-	35	-52	-	33	-52	-	28	-52	-	23	-52	-	17
216	-50	-	39	-52	-	33	-52	-	30	-52	-	25	-52	-	19	-52	-	12
217	-51	-	37	-52	-	31	-52	-	28	-52	-	22	-52	-	15	-52	-	8
218	-51	-	35	-52	-	28	-52	-	25	-52	-	18	-52	-	12	-52	-	4
219	-52	-	33	-52	-	25	-52	-	22	-52	-	14	-52	-	6	-52	-	-1
220	-52	-	31	-52	-	22	-52	-	18	-52	-	10	-52	-	2	-52	-	-6
221	-52	-	28	-52	-	19	-52	-	14	-52	-	5	-52	-	-2	-52	-	-10
222	-52	-	25	-52	-	15	-52	-	10	-52	-	0	-52	-	-8	-52	-	-16
223	-52	-	22	-52	-	11	-52	-	5	-52	-	-5	-52	-	-14	-52	-	-20
224	-52	-	18	-52	-	6	-52	-	0	-52	-	-14	-52	-	-19	-52	-	-20
225	-52	-	14	-52	-	1	-52	-	-6	-52	-	-16	-52	-	-25	-52	-	-14
226	-52	-	10	-52	-	-5	-52	-	-11	-52	-	-22	-52	-	-19	-52	-	-8
227	-52	-	5	-52	-	-12	-52	-	-17	-52	-	-16	-52	-	-13	-52	-	-2
228	-52	-	0	-52	-	-16	-52	-	-21	-52	-	-10	-52	-	-8	-52	-	3
229	-52	-	-6	-52	-	-16	-52	-	-16	-52	-	-5	-52	-	-2	-52	-	8
230	-52	-	-12	-52	-	-16	-52	-	-12	-52	-	1	-52	-	3	-52	-	13
231	-52	-	-17	-52	-	-13	-52	-	-7	-52	-	6	-52	-	8	-52	-	17
232	-52	-	-21	-52	-	-5	-52	-	1	-52	-	12	-52	-	13	-52	-	21
233	-52	-	-15	-52	-	1	-52	-	7	-52	-	16	-52	-	17	-52	-	24
234	-52	-	-9	-52	-	4	-52	-	12	-52	-	21	-52	-	22	-51	-	28
235	-52	-	-3	-52	-	10	-52	-	17	-52	-	25	-52	-	23	-51	-	31
236	-52	-	3	-52	-	15	-52	-	21	-52	-	28	-51	-	28	-50	-	34
237	-52	-	9	-52	-	21	-52	-	25	-52	-	31	-51	-	31	-49	-	37
238	-52	-	14	-52	-	23	-52	-	29	-51	-	34	-50	-	34	-48	-	39
239	-52	-	19		-		-52	-	32	-51	-	37	-49	-	37	-46	-	41
240	-52	-	23	-52	-	32	-51	-	35	-50	-	39	-48	-	39	-44	-	43
241	-52	-	27	-51	-	35	-51	-	38	-49	-	42	-46	-	41	-42	-	44
242	-52	-	30	-51	-	36	-50	-	40	-48	-	43	-44	-	43	-39	-	46
243	-52	-	33	-50	-	40	-49	-	42	-46	-	45	-43	-	44	-36	-	48
244	-51	-	36	-49	-	42	-47	-	44	-44	-	47	-38	-	46	-32	-	49
245	-50	-	39	-47	-	44	-45	-	46	-41	-	48	-36	-	48	-28	-	50
246	-49	-	41	-46	-	46	-43	-	47	-38	-	49	-32	-	49	-24	-	51
247	-48	-	43	-44	-	47	-41	-	48	-35	-	50	-29	-	50	-18	-	51
248	-46	-	45	-40	-	48	-38	-	50	-31	-	51	-23	-	51	-12	-	52
249	-45	-	47	-38	-	50	-34	-	51	-27	-	52	-19	-	52	-4	-	52
250	-42	-	48	-35	-	51	-31	-	51	-21	-	52	-11	-	52	5	-	52
251	-39	-	49	-31	-	51	-26	-	52	-15	-	52	-5	-	52	14	-	52

DOY	2018			2019			2020			2021			2022			2023		
252	-37	-	50	-26	-	52	-21	-	52	-9	-	52	5	-	52	25	-	52
253	-33	-	51	-21	-	52	-14	-	52	-1	-	52	12	-	52	26	-	52
254	-29	-	52	-15	-	52	-8	-	52	7	-	52	21	-	52	28	-	52
255	-24	-	52	-9	-	52	0	-	52	16	-	52	29	-	52	27	-	52
256	-19	-	52	-1	-	52	8	-	52	26	-	52	29	-	52	21	-	52
257	-13	-	52	7	-	52	16	-	52	30	-	52	25	-	52	11	-	52
258	-6	-	52	15	-	52	25	-	52	19	-	52	13	-	52	3	-	52
259	2	-	52	23	-	52	26	-	52	11	-	52	8	-	52	-4	-	52
260	10	-	52	27	-	52	22	-	52	3	-	52		-		-10	-	52
261	20	-	52	19	-	52	10	-	52	-4	-	52	-6	-	52	-16	-	52
262	26	-	52	10	-	52	2	-	52	-11	-	52	-12	-	52	-21	-	51
263	22	-	52	3	-	52	-5	-	52	-17	-	52		-		-25	-	51
264	18	-	52	-5	-	52	-12	-	52	-22	-	52	-23	-	51	-29	-	50
265	6	-	52	-11	-	52	-17	-	52	-26	-	52		-		-32	-	50
266	-1	-	52	-17	-	52	-21	-	52	-30	-	52	-30	-	50	-35	-	49
267	-8	-	52	-21	-	52	-24	-	52	-33	-	51		-		-38	-	48
268	-13	-	52	-24	-	52	-30	-	52	-36	-	51	-36	-	49	-40	-	46
269	-18	-	52	-29	-	52	-33	-	51	-39	-	50	-38	-	47	-42	-	45
270	-23	-	52	-33	-	51	-36	-	51	-41	-	49		-		-44	-	43
271	-27	-	52	-36	-	51	-39	-	50	-43	-	48	-43	-	44	-46	-	42
272	-31	-	52	-38	-	50	-41	-	49	-44	-	47	-44	-	43	-47	-	40
273	-34	-	51	-41	-	49	-43	-	48	-45	-	45	-46	-	42	-48	-	37
274	-37	-	51	-42	-	48	-45	-	47	-47	-	43	-47	-	39	-49	-	34
275	-39	-	50	-44	-	47	-46	-	45	-48	-	42	-48	-	36	-50	-	31
276	-41	-	49	-46	-	46	-47	-	44	-49	-	39	-49	-	33	-51	-	27
277	-43	-	48	-47	-	44	-48	-	42	-50	-	37	-50	-	30	-51	-	22
278	-45	-	47	-48	-	42	-49	-	39	-51	-	32	-51	-	26	-52	-	18
279	-46	-	45	-49	-	40	-50	-	35	-51	-	30	-51	-	21	-52	-	12
280	-47	-	43	-50	-	37	-51	-	33	-52	-	25	-52	-	16	-52	-	5
281	-48	-	41	-51	-	34	-51	-	27	-52	-	20	-52	-	11	-52	-	-3
282	-49	-	39	-51	-	30	-52	-	25	-52	-	15	-52	-	4	-52	-	-11
283	-50	-	36	-51	-	26	-52	-	20	-52	-	7	-52	-	-6	-52	-	-21
284	-51	-	32	-52	-	21	-52	-	14		-		-52	-	-15	-52	-	-27
285	-51	-	28	-52	-	15	-52	-	7	-52	-	-14	-52	-	-23	-52	-	-30
286	-52	-	23	-52	-	8	-52	-	-2	-52	-	-20	-52	-	-34	-52	-	-22
287	-52	-	18	-52	-	-1	-52	-	-11	-52	-	-33	-52	-	-31	-52	-	-13
288	-52	-	11	-52	-	-10	-52	-	-21	-52	-	-31	-52	-	-21	-52	-	-3
289	-52	-	3	-52	-	-26	-52	-	-32	-52	-	-21	-52	-	-12	-51	-	7
290	-52	-	-6	-52	-	-31	-52	-	-30	-52	-	-11	-52	-	-2	-51	-	14
291	-52	-	-17	-52	-	-31	-52	-	-20	-52	-	-1	-52	-	7	-51	-	21
292	-52	-	-28	-52	-	-21	-52	-	-9	-52	-	5	-51	-	14	-50	-	26
293		-		-52	-	-10	-52	-	1	-51	-	16	-51	-	21	-49	-	31
294		-		-52	-	-1	-52	-	9	-51	-	23	-50	-	26	-48	-	35
295	-52	-	-16	-52	-	9	-52	-	17	-51	-	28	-49	-	31	-46	-	38
296	-52	-	-4	-51	-	17	-51	-	24	-50	-	33	-48	-	35	-45	-	41

DOY	2018			2019			2020			2021			2022			2023		
297	-52	-	7	-51	-	24	-50	-	29	-49	-	37	-46	-	38	-43	-	44
298	-52	-	15	-50	-	29	-49	-	34	-47	-	40	-44	-	41	-41	-	46
299	-51	-	22	-49	-	34	-48	-	38	-46	-	43	-43	-	44	-39	-	47
300	-50	-	28	-48	-	38	-47	-	41	-45	-	45	-41	-	46	-37	-	49
301	-49	-	33	-47	-	41	-46	-	44	-43	-	47	-40	-	47	-35	-	50
302	-48	-	37	-46	-	44	-44	-	46	-41	-	49	-37	-	49	-32	-	51
303	-47	-	41	-44	-	46	-43	-	48	-39	-	50	-35	-	50	-29	-	52
304	-46	-	43	-42	-	48	-41	-	49	-37	-	51	-32	-	51	-26	-	52
305	-44	-	46	-41	-	49	-38	-	50	-35	-	51	-29	-	52	-23	-	52
306	-43	-	48	-38	-	50	-36	-	51	-32	-	52	-27	-	52	-19	-	52
307	-41	-	49	-36	-	51	-34	-	52	-29	-	52	-23	-	52	-15	-	52
308	-39	-	50	-32	-	52	-31	-	52	-26	-	52	-19	-	52	-11	-	52
309	-37	-	51	-31	-	52	-28	-	52	-22	-	52	-15	-	52	-6	-	52
310	-35	-	52	-28	-	52	-25	-	52	-18	-	52	-11	-	52	-1	-	52
311	-32	-	52	-25	-	52	-21	-	52	-14	-	52	-7	-	52	4	-	52
312	-29	-	52	-22	-	52	-18	-	52	-10	-	52	-2	-	52	10	-	52
313	-26	-	52	-18	-	52	-13	-	52	-5	-	52	5	-	52	17	-	52
314	-22	-	52	-14	-	52	-9	-	52	0	-	52	9	-	52	18	-	52
315	-19	-	52	-9	-	52	-4	-	52	5	-	52	15	-	52	19	-	52
316	-15	-	52	-4	-	52	1	-	52	11	-	52	19	-	52	20	-	52
317	-10	-	52	1	-	52	6	-	52	16	-	52	22	-	52	16	-	52
318	-5	-	52	6	-	52	12	-	52	20	-	52	17	-	52	10	-	52
319	-1	-	52	11	-	52	17	-	52	15	-	52	15	-	52	4	-	52
320	5	-	52	16	-	52	19	-	52	9	-	52	7	-	52	-1	-	52
321	10	-	52	21	-	52	14	-	52	5	-	52	2	-	52	-7	-	52
322	15	-	52	14	-	52	9	-	52	-1	-	52	-3	-	52	-11	-	52
323	20	-	52	9	-	52	3	-	52	-5	-	52	-7	-	52	-14	-	52
324	15	-	52	4	-	52	-1	-	52	-10	-	52	-11	-	52	-18	-	52
325	10	-	52	-1	-	52	-6	-	52	-14	-	52	-15	-	52	-21	-	52
326	5	-	52	-6	-	52	-10	-	52	-18	-	52	-19	-	52	-24	-	52
327	0	-	52	-10	-	52	-15	-	52	-21	-	52	-22	-	52	-27	-	52
328	-5	-	52	-14	-	52	-18	-	52	-24	-	52	-24	-	52	-29	-	51
329	-9	-	52	-18	-	52	-21	-	52	-27	-	52	-27	-	52	-31	-	51
330	-14	-	52	-21	-	52	-25	-	52	-30	-	52	-29	-	51	-33	-	50
331	-18	-	52	-23	-	52	-27	-	52	-32	-	52	-31	-	51	-35	-	49
332	-21	-	52		-		-30	-	52	-34	-	51	-33	-	50	-36	-	48
333	-24	-	52		-		-32	-	52	-36	-	51	-35	-	49	-38	-	46
334	-27	-	52		-		-34	-	51	-37	-	50	-36	-	48	-39	-	44
335	-29	-	52		-		-36	-	51	-39	-	49	-38	-	46	-40	-	41
336	-32	-	52		-		-37	-	50	-40	-	48	-39	-	44	-40	-	38
337	-34	-	52		-		-39	-	49	-41	-	46	-40	-	41	-41	-	33
338	-36	-	51		-		-23	-	22	-42	-	44	-40	-	37	-40	-	28
339	-37	-	50		-		-41	-	46	-43	-	40	-41	-	34	-40	-	20
340	-39	-	49		-		-42	-	43	-43	-	37	-40	-	28	-39	-	11
341	-40	-	48		-		-43	-	40	-43	-	32	-40	-	20	-37	-	-1

DOY	2018			2019			2020			2021			2022			2023		
342	-41	-	44		-		-43	-	36	-43	-	25	-38	-	8	-34	-	-13
343	-42	-	44		-		-43	-	31	-43	-	16	-36	-	-1		-	
344	-43	-	40		-		-43	-	24	-42	-	4		-			-	
345	-43	-	37		-		-43	-	15		-			-			-	
346	-43	-	32		-		-41	-	1		-			-			-	
347	-43	-	25		-			-			-			-			-	
348	-43	-	11		-			-			-			-			-	
349	-40	-	-4		-			-			-			-			-	
350		-			-			-			-			-		-41	-	14
351		-			-			-		-38	-	-8		-		-41	-	23
352		-			-			-		-41	-	9	-41	-	15	-41	-	30
353		-			-			-		-42	-	20	-41	-	24	-40	-	36
354		-			-		-41	-	12	-42	-	28	-41	-	30	-40	-	40
355		-		-42	-	12	-42	-	22	-42	-	34	-41	-	37	-39	-	44
356		-		-42	-	22	-42	-	30	-42	-	39	-40	-	41	-38	-	46
357	-42	-	12	-42	-	30	-42	-	35	-42	-	42	-39	-	43	-37	-	48
358	-43	-	22	-42	-	36	-42	-	39	-41	-	45	-38	-	46	-35	-	49
359	-43	-	30	-42	-	40	-41	-	43	-40	-	47	-36	-	48	-33	-	50
360	-43	-	36	-41	-	43	-41	-	45	-39	-	49	-35	-	49	-31	-	51
361	-42	-	40	-40	-	46		-		-37	-	50	-33	-	50	-29	-	51
362	-42	-	43	-39	-	48	-38	-	49	-36	-	51	-31	-	51	-27	-	52
363	-41	-	46	-38	-	49	-37	-	50	-34	-	51	-29	-	51	-25	-	52
364	-40	-	46	-36	-	50	-35	-	51	-32	-	52	-27	-	52	-23	-	51
365	-38	-	49	-34	-	51	-33	-	52	-30	-	52	-25	-	52	-17	-	51
366		-			-		-31	-	52		-			-			-	