ISS duty cycle 2005 - 2007 from real ISS trajectory

We estimate a ISS duty cycle for UV background less than 1500 ph/(m^2 ns sr) from real ISS trajectory and moon light evaluation.

Estimation can be described in the following points:

1. We use ISS real trajectory data (one minute time positions-resolution) from 2005 till 2010 years [1].

2. For all ISS positions we eavaluate sun zenith angle (S_{ZA}), moon zenith angle (M_{ZA}) and moon phase (M_p) for time from 2005 till 2007 (same period as Tatiana observations was).

3. For every position, M_{ZA} and M_p UV light intensity I_{UV} in ph/(m^2 ns sr) was evaluated from next equation[2][3]:

$$I_{UV} = 16000 * \cos(M_{ZA}) * 10^{-0.4*(0.16 M_p + 5.5*1e\text{-}6*M_p^4)} \quad (1)$$

Note: equation (1) gives negative values for $M_{ZA}>90^o$ - it simply means that moon is under horizon, so no moon light is present

4. From all data we evaluate a duty cycle for different sun zenith angles tresholds:

Columns: Sun zenith angle bigger than [deg], duty cycle [%]

S_{ZA} treshold [deg.]	Duty cycle [%]
90	31.2712
91	30.7674
92	30.2658
93	29.7663
94	29.2756
95	28.7827
96	28.2934
97	27.8049
98	27.3158
99	26.8283
100	26.3317
101	25.8452
102	25.3461
103	24.8433
104	24.3137
105	23.7518
106	23.1724
107	22.5994

S_{ZA} treshold [deg.]	Duty cycle [%]
131	10.4016
132	9.9813
133	9.5706
134	9.1542
135	8.7378
136	8.3462
137	7.9544
138	7.5829
139	7.2075
140	6.8476
141	6.4949
142	6.1453
143	5.8096
144	5.4817
145	5.1692
146	4.8620
147	4.5451
148	4.2396

108	22.0198
109	21.4447
110	20.8674
111	20.2907
112	19.7127
113	19.1333
114	18.5709
115	18.0170
116	17.4682
117	16.9216
118	16.3977
119	15.8720
120	15.3608
121	14.8700
122	14.3917
123	13.9231
124	13.4657
125	13.0105
126	12.5648
127	12.1099
128	11.6789
129	11.2452
130	10.8270

149	3.9317
150	3.6299
151	3.3272
152	3.0375
153	2.7868
154	2.5635
155	2.3600
156	2.1667
157	1.9819
158	1.8106
159	1.6473
160	1.4907
161	1.3449
162	1.2047
163	1.0748
164	0.9491
165	0.8325
166	0.7245
167	0.6219
168	0.5306
169	0.4441
170	0.3659

Citations

1. http://sscweb.gsfc.nasa.gov/cgi-bin/sscweb/Locator.cgi
2. Montanet: EUSO-SIM-REP-009-1.2 (2004);
3. Krisiunas & Schaefer, Astrom. Soc. of the Pactifc, 103, (1993) 1033. Krisciunas

Appendix

Equation (1) gives maximum values of moon light contribution is 16 000 ph/(m^2 ns sr) for $M_{ZA}=0^o$ and full moon.

$$I_{UV}=16000*\cos\left(M_{ZA}\right)*10^{-0.4*\left(0.16M_p+5.5*1e\text{-}6*M_p^4\right)} \quad (1)$$

Let us note that is possible find a simmilar formulas for moon UV light intensity I_{UV}. Those formulas has same or very simillar shape and amplitude (coefficient set a maximum value of I_{UV}). For example in [2]

$$I_{UV}=15500*\cos\left(M_{ZA}\right)*10^{-0.4*\left(1.5|\alpha|+4.3*1e\text{-}2*\alpha^4\right)} \quad (2)$$

Where α is moon phase angle expressed in radians (α=0 is full moon).

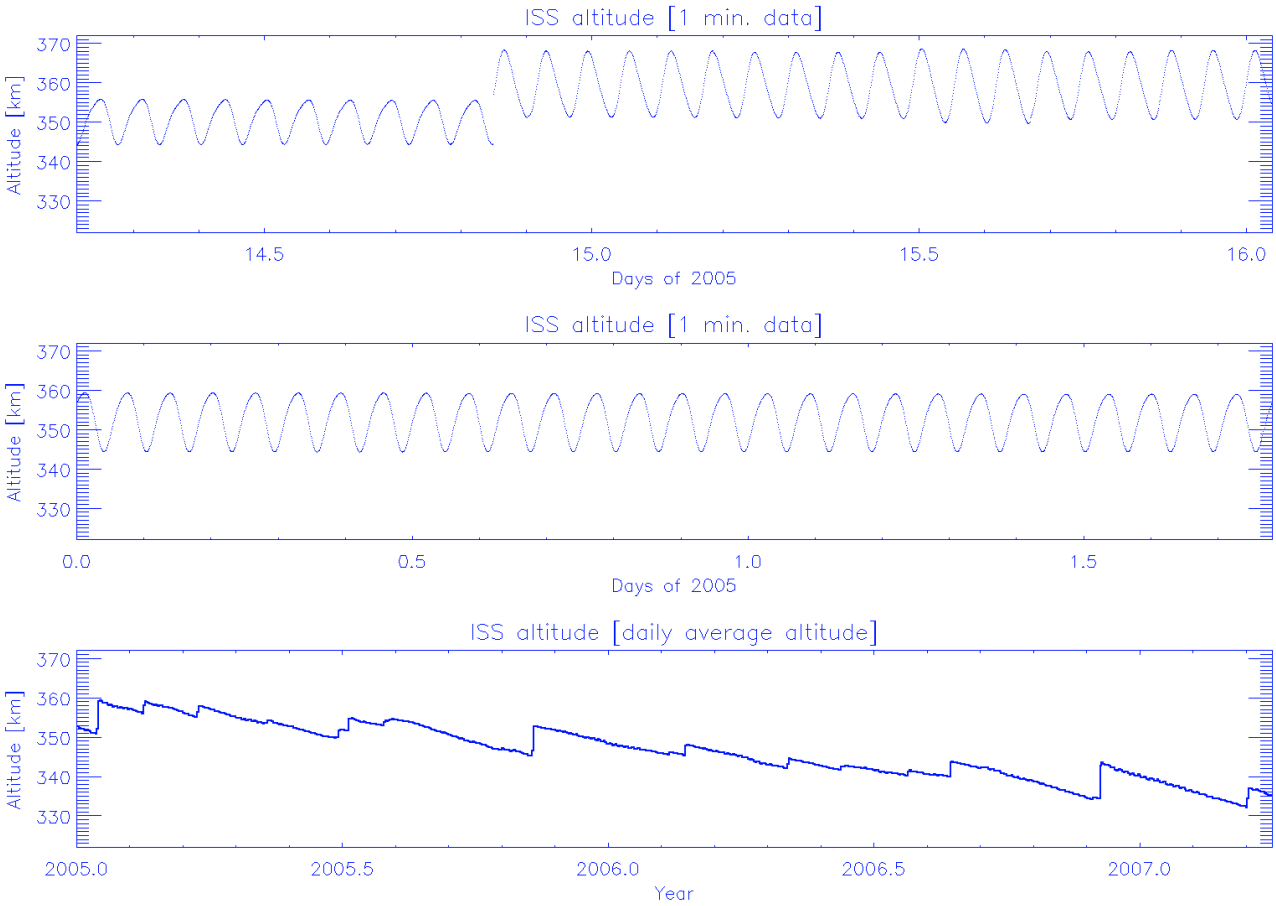

Figure. ISS altitude. Re-boost of station to higher altitudes and influence ot atmosheric drag to ISS trajectory are clearly seen.