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CORRECTION

# Correction to: End-of-life geostationary satellite removal using realistic flat solar sails

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Due to an unfortunate oversight the Eq. (8), Tables 2 and 4 has been given erroneously. It should read (Tables 2 and 4)

$$\underbrace{\frac{d}{dt}\begin{pmatrix} a \\ e \\ i \\ \omega \\ \Omega \\ \theta \end{pmatrix}}_{\dot{x}} = \underbrace{\begin{pmatrix} \frac{2a^2}{\sqrt{\mu a(1-e^2)}} e\sin(\theta) & \frac{2a^2}{\sqrt{\mu a(1-e^2)}}(1+e\cos(\theta)) & 0 \\ \sqrt{\frac{a(1-e^2)}{\mu}}\sin(\theta) & \sqrt{\frac{a(1-e^2)}{\mu}}\frac{2\cos(\theta)+e(1+\cos^2(\theta))}{1+e\cos(\theta)} & 0 \\ 0 & 0 & \sqrt{\frac{a(1-e^2)}{\mu}}\frac{\cos(\omega+\theta)}{1+e\cos(\theta)} \\ -\sqrt{\frac{a(1-e^2)}{\mu}}\frac{\cos(\theta)}{e} & \sqrt{\frac{a(1-e^2)}{\mu}}\frac{(2+e\cos(\theta))\sin(\theta)}{e(1+e\cos(\theta))} & -\sqrt{\frac{a(1-e^2)}{\mu}}\frac{\sin(\omega+\theta)}{\tan(i)(1+e\cos(\theta))} \\ 0 & 0 & \sqrt{\frac{a(1-e^2)}{\mu}}\frac{\sin(\omega+\theta)}{\sin(i)(1+e\cos(\theta))} \\ \sqrt{\frac{a(1-e^2)}{\mu}}\frac{\cos(\theta)}{e} & -\sqrt{\frac{a(1-e^2)}{\mu}}\frac{(2+e\cos(\theta))\sin(\theta)}{e(1+e\cos(\theta))} & 0 \end{pmatrix}}_{\text{denote as } \mathbf{P}(\mathbf{x})} \begin{pmatrix} f_r \\ f_\theta \\ f_z \end{pmatrix} + \underbrace{\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \sqrt{\frac{\mu}{a^3}}\frac{(1+e\cos(\theta))^2}{\sqrt{(1-e^2)^3}} \end{pmatrix}}_{\text{denote as } \mathbf{b}(\mathbf{x})} \tag{8}$$

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**Table 2** The GEO graveyard region

| Property | Requirement |
|---|---|
| Perigee altitude | A minimum increase of 235 km + $(100 \cdot \mathrm{C_R} \cdot A/m)$ |
| | 235 km : the sum of the upper altitude of the GEO protected region (200 km) and the maximum descent due to luni-solar and geo-potential perturbations (35 km) |
| | $\mathrm{C_R}$ : the solar radiation pressure (SRP) coefficient |
| | $A/m$ : the area to dry mass ratio |
| Eccentricity | [0, 0.003] |

**Table 4** Comparisons between the ideal solar sails and the realistic flat solar sails

| Solar sail thrust model | |
|---|---|
| Ideal sail | $\boldsymbol{f}_{\text{ideal}} = \left[2P_\odot \cdot (A/m) \cdot \cos^2\alpha\right]\boldsymbol{n}$ |
| Realistic flat Sail | $\boldsymbol{f}_{\text{real}} = \boldsymbol{f}_n + \boldsymbol{f}_t$ |
| | $\boldsymbol{f}_n = \left(P_\odot \frac{A}{m}\left[(1+\tilde{r}s)\cos^2\alpha + B_f(1-s)\tilde{r}\cos\alpha + (1-\tilde{r})\ \frac{\xi_f B_f - \xi_b B_b}{\xi_f + \xi_b}\cos\alpha\right]\right)\boldsymbol{n}$ |
| | $\boldsymbol{f}_t = \left(P_\odot \frac{A}{m}(1-\tilde{r}s)\cos\alpha\sin\alpha\right)\boldsymbol{t}$ |
| **Control angle constraints** | |
| Ideal sail | $\alpha \in [0°, 90°], \delta \in [0°, 360°]$ |
| Realistic flat sail | $\alpha \in [0°, 85°], \delta \in [0°, 360°]$ |
| **System dynamics** | |
| Ideal sail | $\dot{\boldsymbol{x}}(t) = \boldsymbol{P}(\boldsymbol{x}) \cdot \boldsymbol{C}_{OP}\boldsymbol{C}_{PG}\boldsymbol{C}_{GS} \cdot \boldsymbol{f}_{\text{ideal}} + \boldsymbol{b}(\boldsymbol{x})$ |
| Realistic flat sail | $\dot{\boldsymbol{x}}(t) = \boldsymbol{P}(\boldsymbol{x}) \cdot \boldsymbol{C}_{OP}\boldsymbol{C}_{PG}\boldsymbol{C}_{GS} \cdot (\boldsymbol{f}_n + \boldsymbol{f}_t) + \boldsymbol{b}(\boldsymbol{x})$ |

The original article has been corrected.