CHAPTER 12 RADIATION PRESSURE REFLECTANCE MODEL

For a near-Earth satellite the solar radiation pressure acceleration, $\ddot{\vec{r}}$ is given by:

$$\ddot{\vec{r}} = \kappa \left[\frac{A}{R}\right]^2 C_R \frac{a}{m} \frac{\vec{R}}{R},$$

where

κ = 4.560 $\times 10^{-6}$ newtons/m^2 (1367 watts/m^2),

A = astronomical unit in meters,

R = heliocentric radius vector to the satellite,

a = cross-sectional area (m^2) of the satellite perpendicular to $\vec{R}$,

m = satellite mass,

C_R = reflectivity coefficient, usually an adjusted parameter.

The radiation pressure due to backscatter from the Earth is ignored. The model for the Earth's and Moon's shadows should include the umbra and the penumbra (Haley, 1973).

Earth Radius	6 402 km
Moon Radius	1 738 km
Solar Radius	696 000 km

Global Positioning System

For GPS satellites, the solar radiation pressure models T10 (for Block I) and T20 (for Block II) of Fliegel, *et al.* (1992) are recommended. These models include thermal reradiation.

The T10 and T20 models provide variations in the X and Z components of the total nominal solar pressure force as a function of the angle B between the Sun and the +Z axis of the satellite.

The model formulae for T10 are:

$$X = -4.55 \sin B + 0.08 \sin (2B + 0.9) - 0.06 \cos (4B + 0.08) + 0.08,$$

$$Z = -4.54 \cos B + 0.20 \sin (2B - 0.3) - 0.03 \sin 4B.$$

The model formulae for T20 are:

$$X = -8.96 \sin B + 0.16 \sin 3B + 0.10 \sin 5B - 0.07 \sin 7B,$$

$$Z = -8.43 \cos B.$$

In both cases the units are 10^{-5} N.

References

Fliegel, H. F., Gallini, T. E., and Swift, E., 1992, "Global Positioning System Radiation Force Models for Geodetic Applications," *J. Geophys. Res.*, **97**, No. B1, pp. 559-568.

Haley, D., 1973, *Solar Radiation Pressure Calculations in the Geodyn Program*, EG&G Report 008-73, Prepared for NASA Goddard Space Flight Center.