SPACE WEATHER NOTE – supporting Joe Allen's power point presentation:

Definition used by the US National Space Weather Plan:
Conditions on the Sun and the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life and health.

The Sun is the main driver of space weather near Earth.

Other Sources:
Natural

- Galactic cosmic rays (energetic particles close to the speed of light; 20% reduced during solar max; the solar wind work as a shelter)
- Meteorids – originate from comets and asteroids – snowy, icy, stony or metallic compunds (μ- m).

Anthropogenic

- Gravity waves generated by explosions
- Nuclear explosion tesing in the 60´s led to aurora and radiation belt enhancements
- Electromagnetic waves : high power lines, radio and TV emitters, radars, city-light.
- Gas and debris generated by spacecraft and spacecraft launches.

Basic types/causes of satellite anomalies (cf. Joe Allen and figures next page):

(a) **Single Event Upset (SEU)** caused by direct circuit element penetration of high energy protons or heavier ions.
(b) **Deep Dielectric Charging** (bulk charging) when relativistic electrons ($\geq$ 1~2 MeV) penetrate and accumulate in dielectrics either outside the satellite (cables, thermal blankets, or power panel structure) or inside (circuit boards), and discharge with destructive effect. And
(c) **Surface Charging** when differential voltages originate on the satellite outer surface due either to its being engulfed by a cloud of thermal energy electrons (~10-15 Kev), or some change that interrupts the balance of charge maintained by photoelectron burn off (orbital eclipse or structural shadowing). These can result in either changes in reference voltages that trigger circuits (Phantom Commands), or generate destructive electrostatic discharges.
I have added less generally appreciated causes of other types of "anomalies":
(d) **Magnetopause Crossing Events** (MPE) at GEO when the geomagnetic reference field is suddenly reversed and the satellite becomes disoriented. These field changes can have a range as large as 400 nT.
(e) **Ambient Geomagnetic** (field) **Changes** at LEO due to large currents encountered by satellites transiting field-aligned current regions that connect partial ring-currents with auroral electrojets. These can confuse instruments and interfere with electromagnetic coupling between the satellite and its momentum transfer wheel.
(f) **Optical Disorientation** due to limb sensors or star trackers that lose references when energetic protons and heavier ions create sparks in the viewing circuitry that obscures the normal target. And
(g) **Power Panel Degradation** due to the destructive penetration of the panel active elements by protons of energy >= 10 MeV.

Space Environment Effects