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# ROMTEKNOLOGI

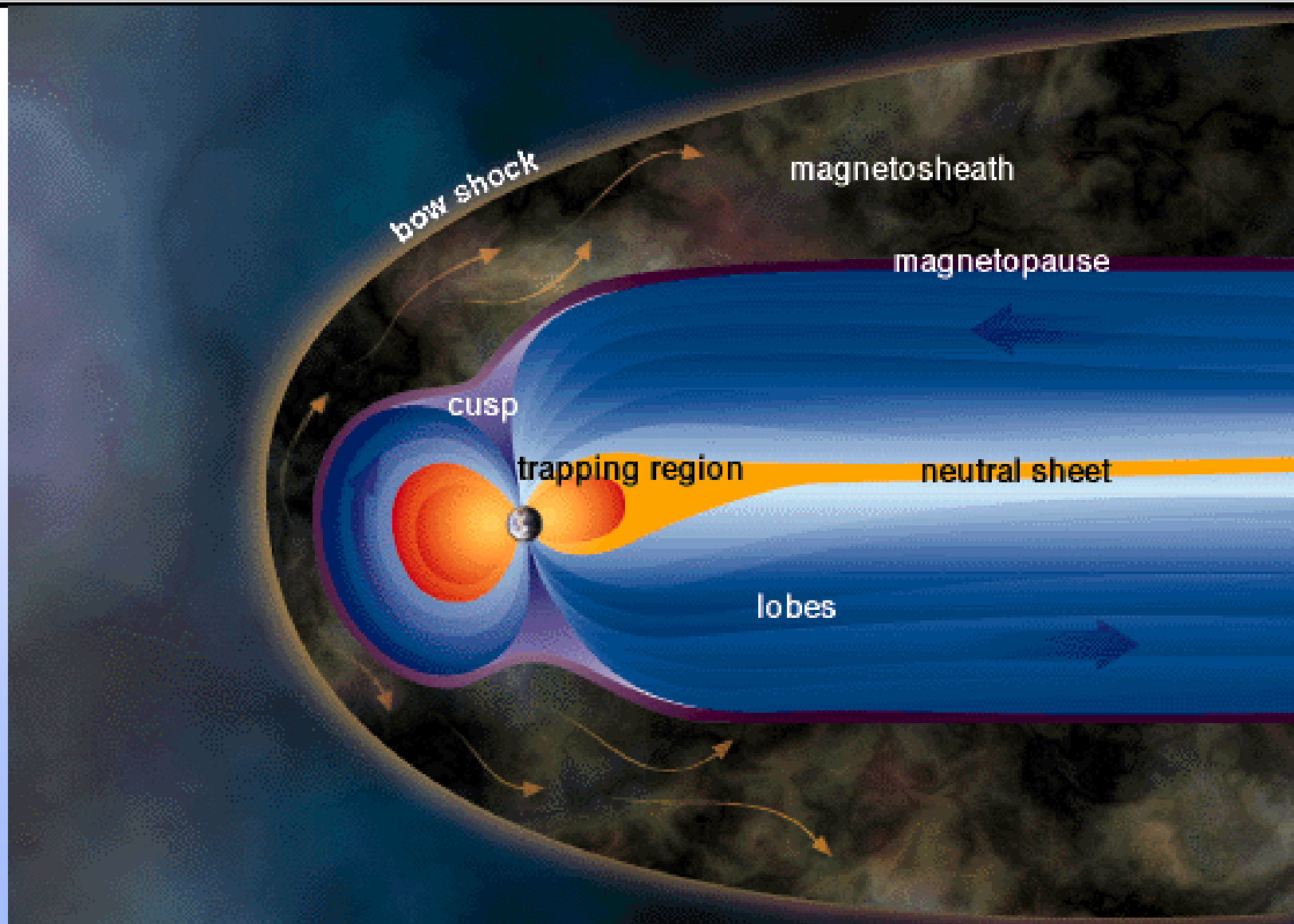
Kapittel 3

## Miljøet i rommet

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# MILJØET I ROMMET

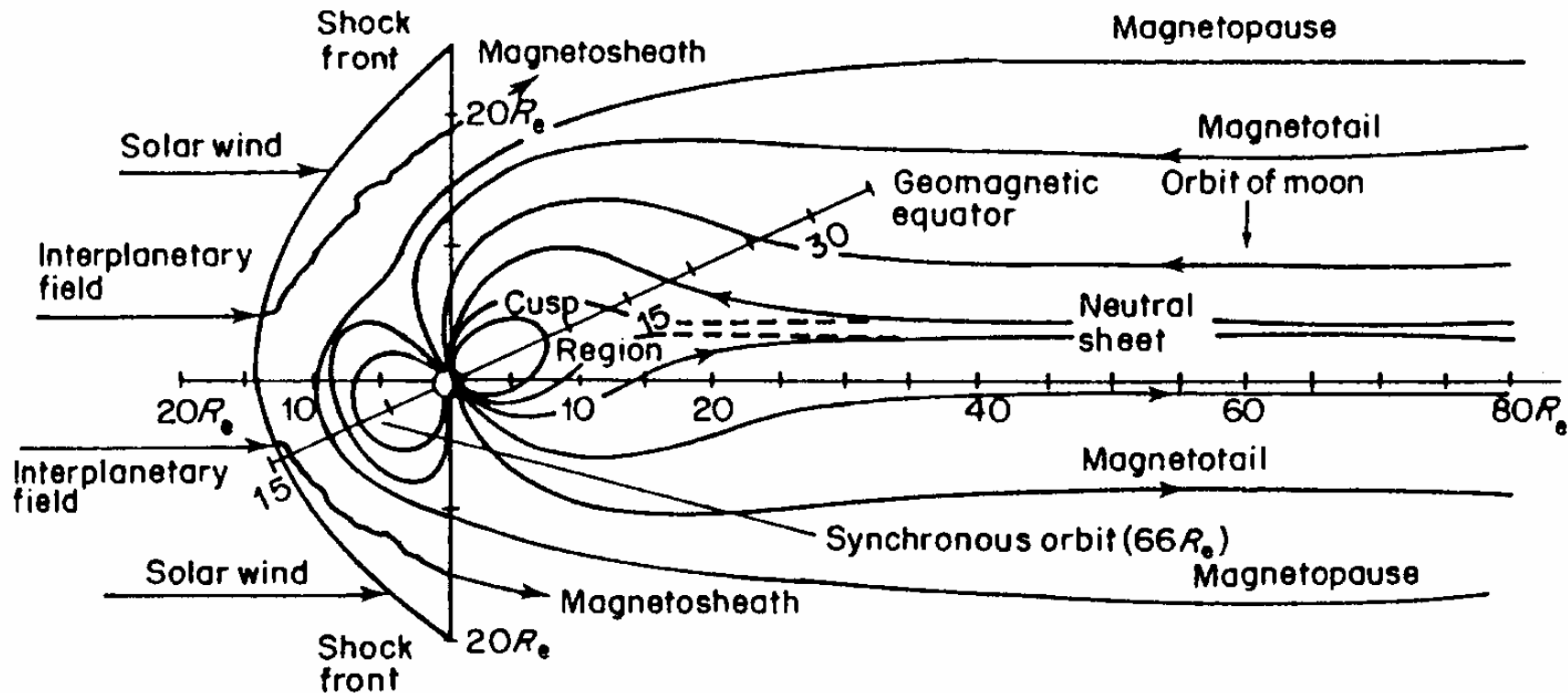


# ENVIRONMENTAL FACTORS

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- Mechanical
  - irregularities of the earth's gravitational field
  - the gravitational field of the moon and the sun
  - radiation pressure
- Thermal influence, sun, earth, cold space
- Radiation etc.
  - The earth's magnetic field
  - Vacuum
  - Radiation from the earth
  - Particle radiation
  - Debris in space

# The Magnetosphere (II)

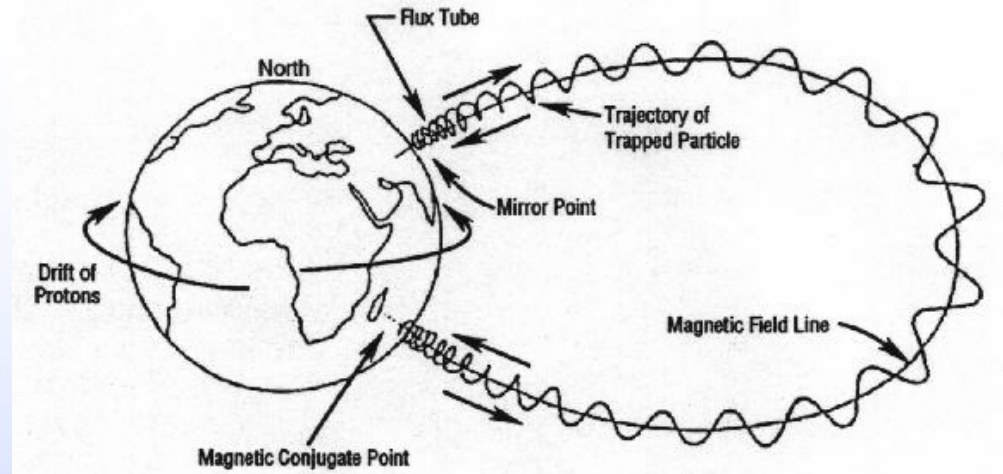


*Notes*

- $R_e$  Geocentric distance in earth radii
- Direction of magnetic flux lines

# IONIZING RADIATION

- Three types of ionizing radiation
  - trapped radiation belt particles
  - cosmic rays
  - solar flare particles
- The Earth's magnetic field traps charged particles within specific regions, the van Allen belt
  - The ionized radiation belts lowest in of the South American coast (SAA South America Anomaly)
- Damage to spacecraft, solar array, electronics

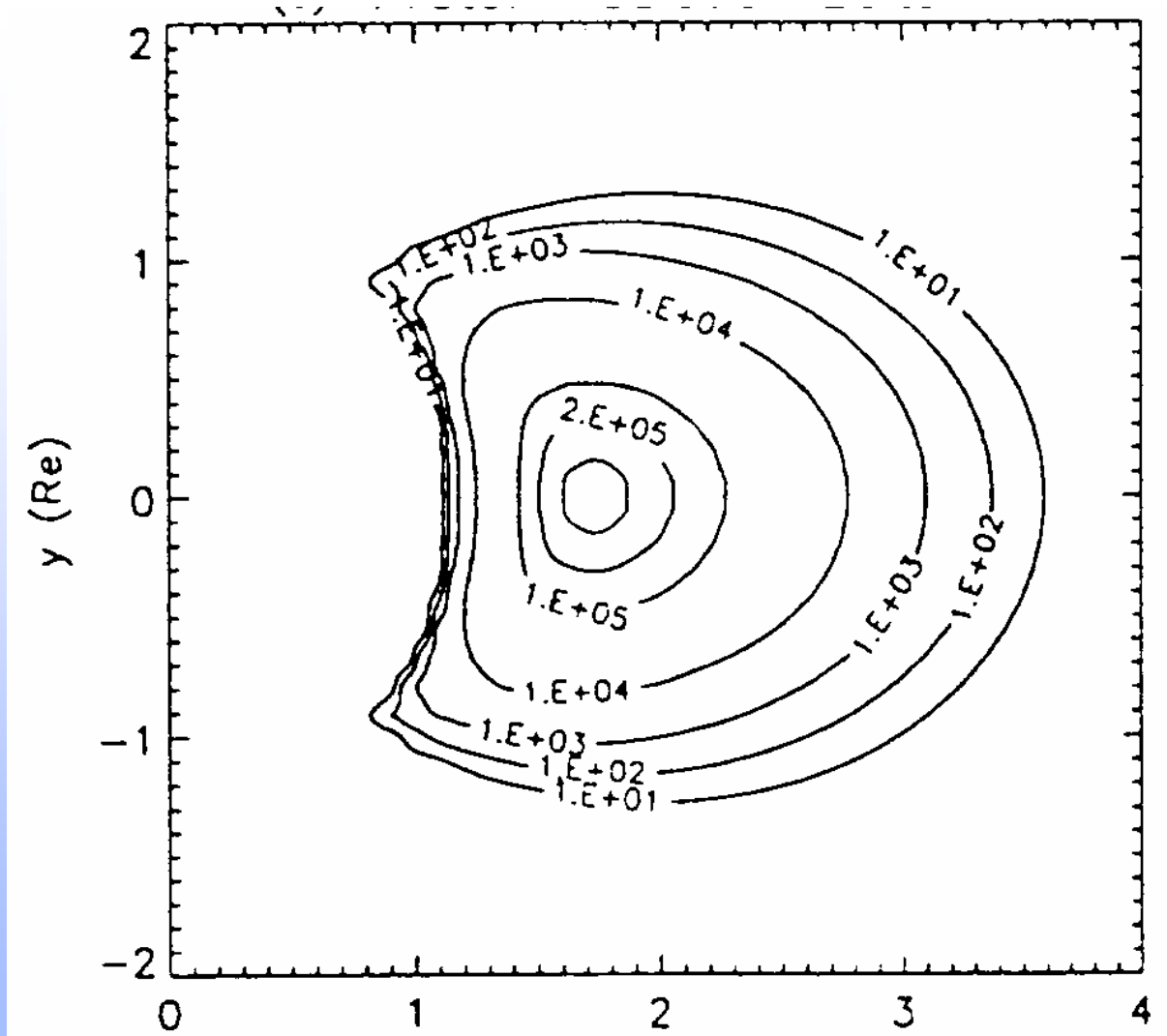


# THE IONOSPHERE, ABOVE 90 KM

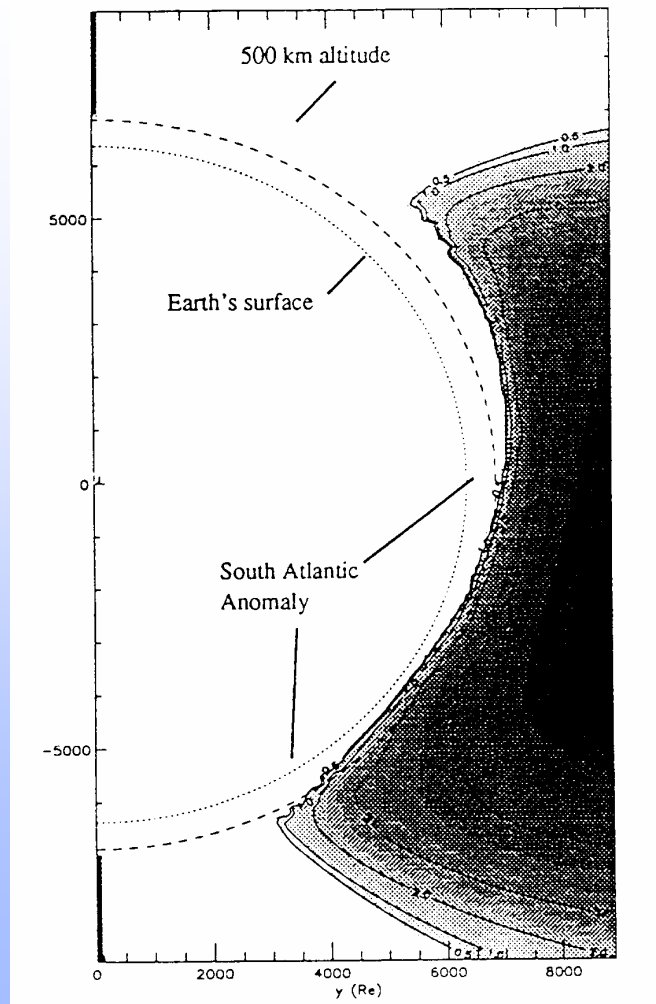
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- Ion and electron densities vary dramatically with altitude, latitude, magnetic field strength and solar activity
- Photochemical effects on the gases
  - splitting of diatomic Oxygen into atoms
  - Plasma is neutral ionized gas
- Spacecraft may develop induced charges
  - LEO spacecraft travel faster than the ions but slower than the electrons. This leads to negative charging in the thousands of volts
  - Spacecraft charging may cause arcing, ion sputtering, and other electric disturbances.

# The proton belt (the inner van Allen belt)

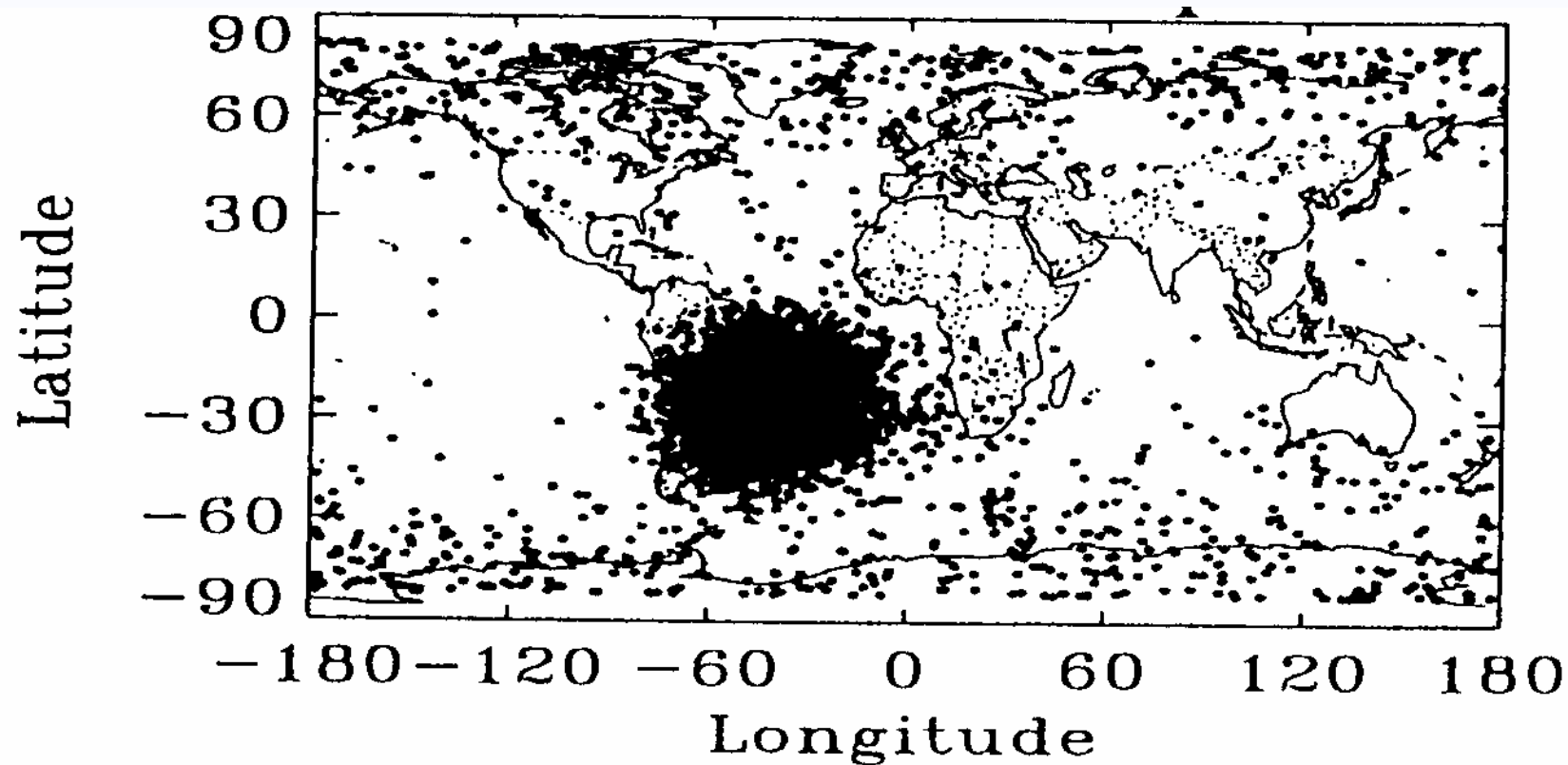


# The South American Anomaly

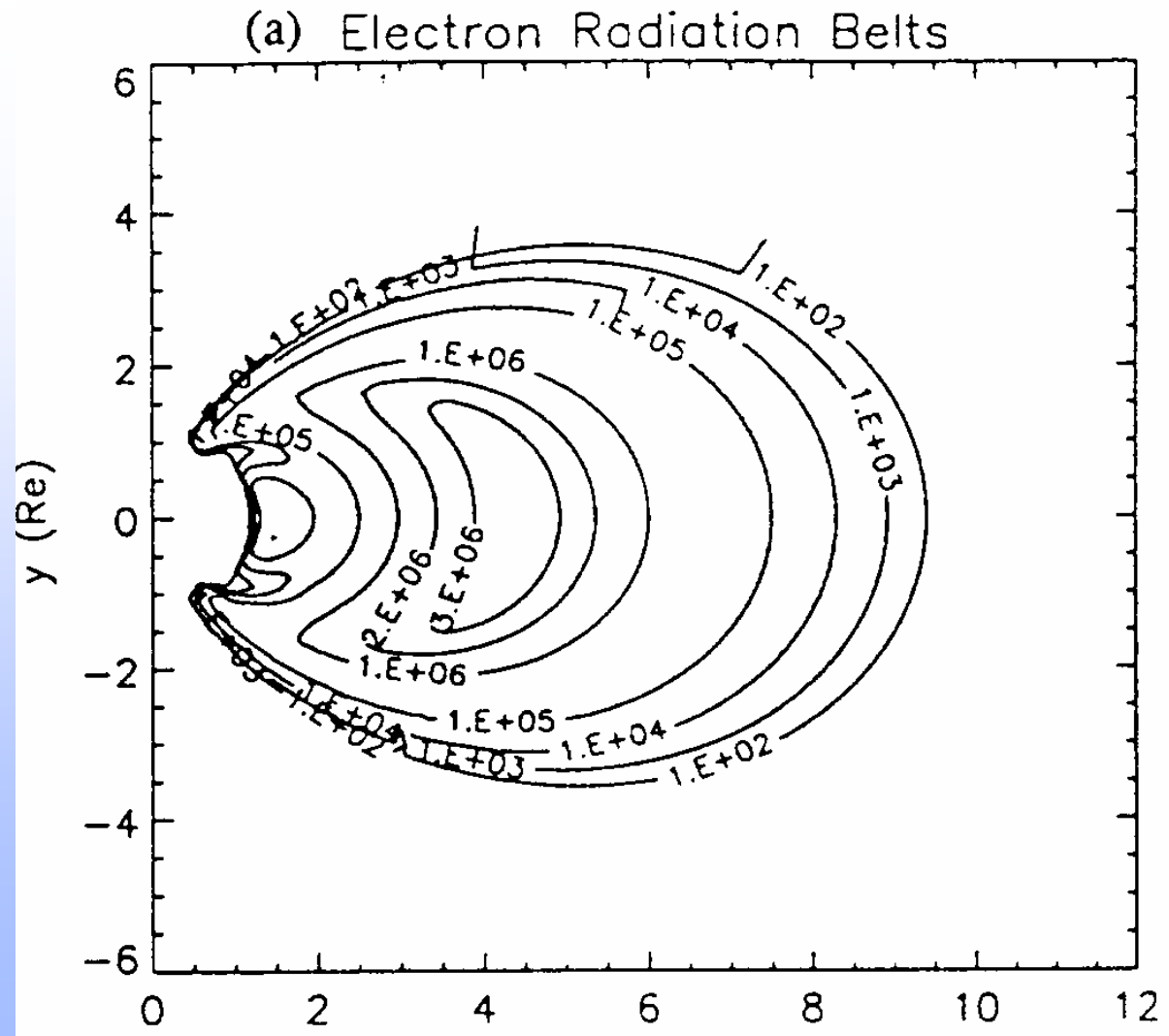




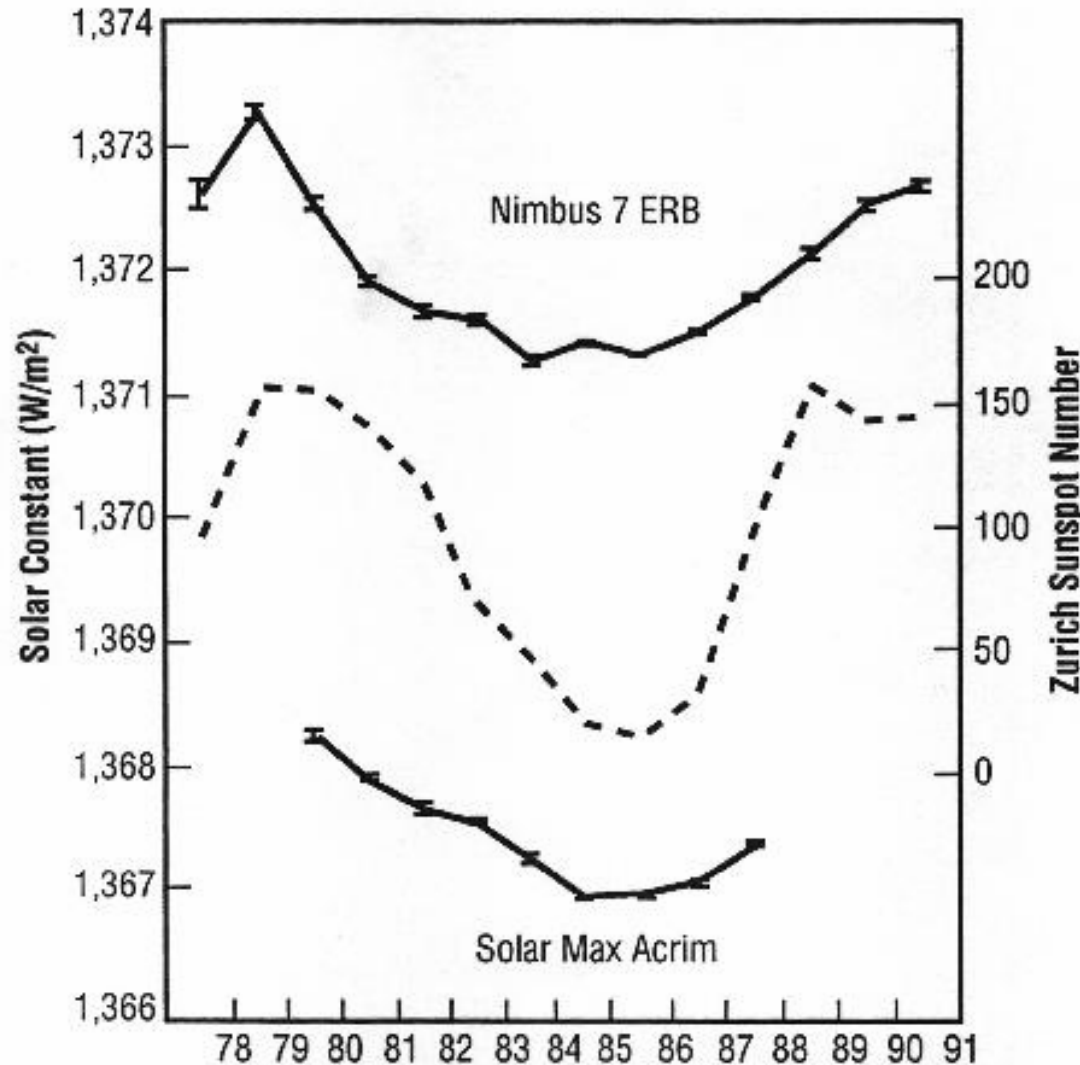
# Fault rate for the UiO satellite



# The Electron belt (the outer van Allen belt)

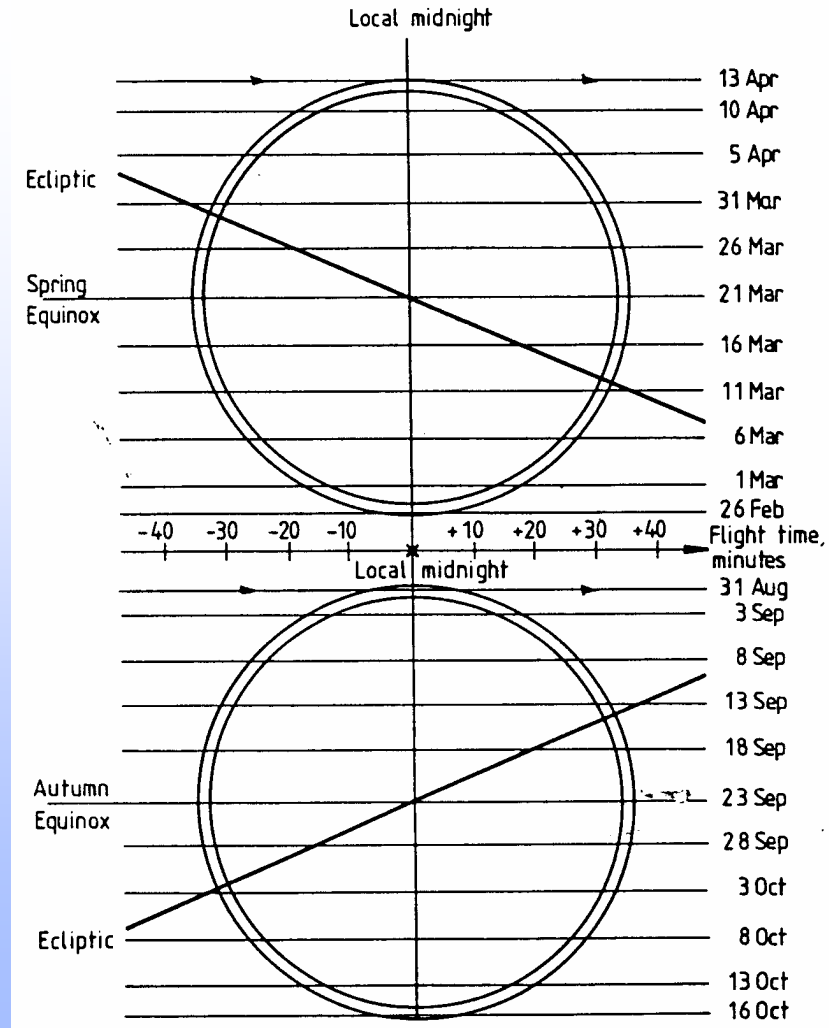


# THERMAL ENVIRONMENT

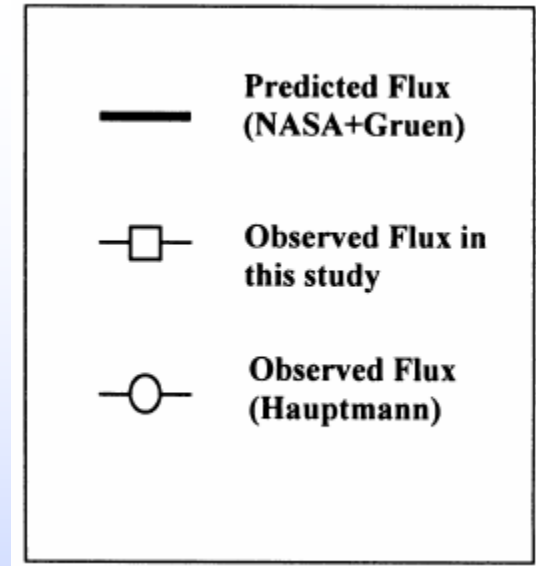
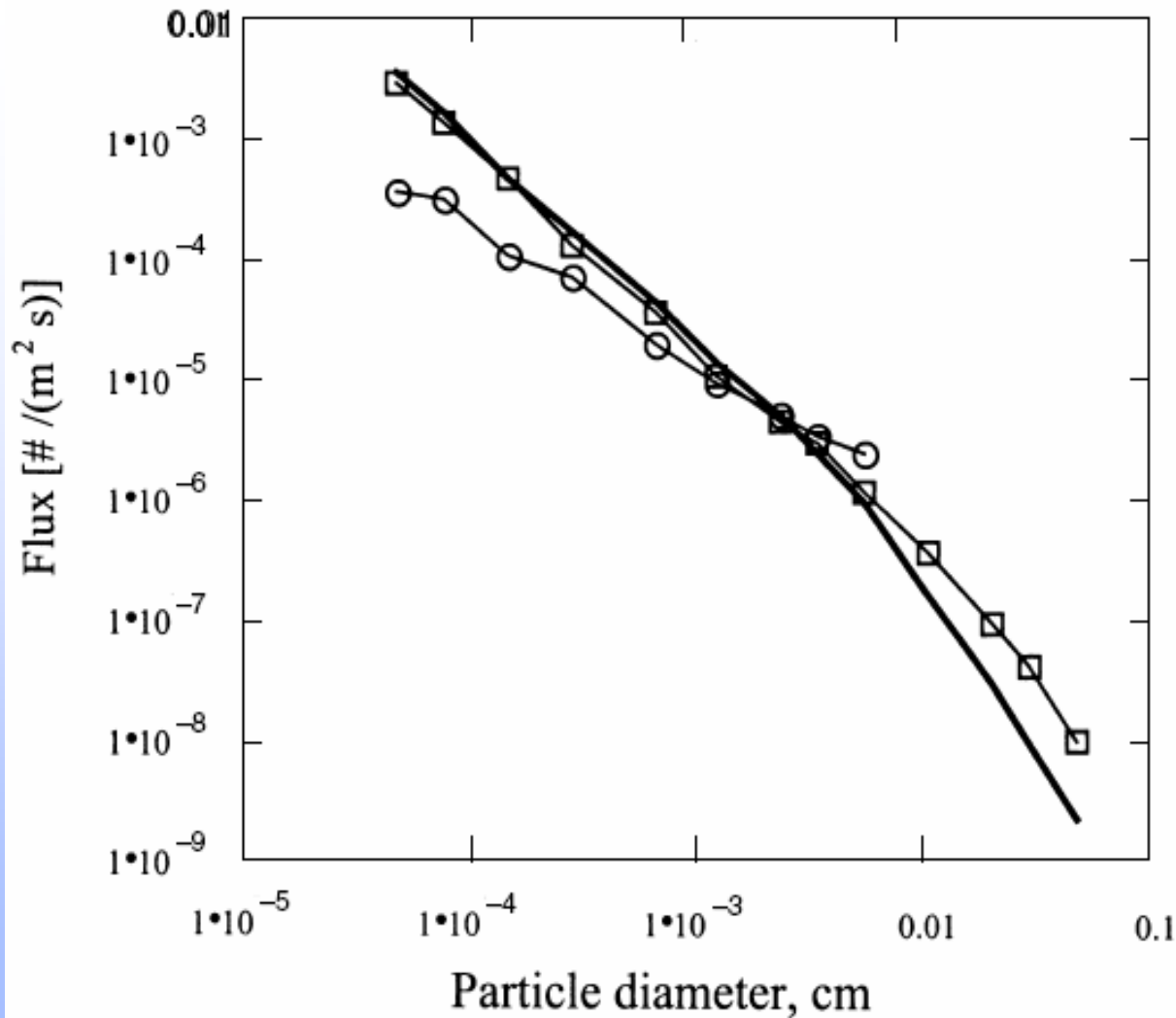


- Incoming solar radiation
  - 1.35 kW/m<sup>2</sup>
  - Depends on sun spot activities
- Reflected solar energy (albedo) less than 40 Watt/m<sup>2</sup> at GEO
- Outgoing long-wave radiation
- Apparent temp. of space 4 K

# Sun conjunction



# Partikkelflux



STUDY OF MICROMETEOROID AND ORBITAL DEBRIS EFFECTS ON THE SOLAR PANELS RETRIEVED FROM THE SPACE STATION "MIR"

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V.G. SOKOLOV<sup>2,\*</sup>,  
V.P. KONOSHENKO<sup>2</sup> and  
I.I. KOVALYOV<sup>2</sup>

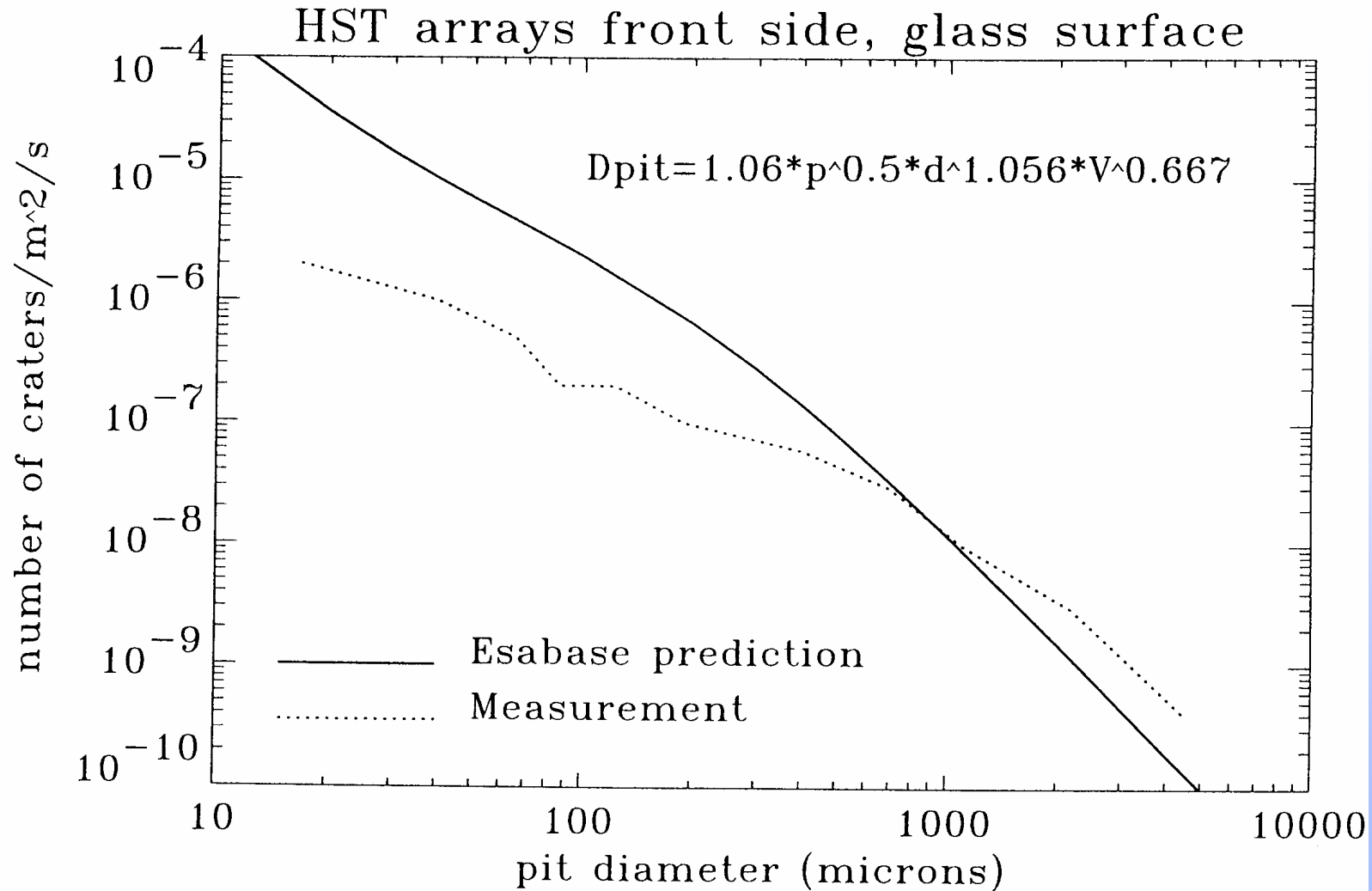
# Space debris

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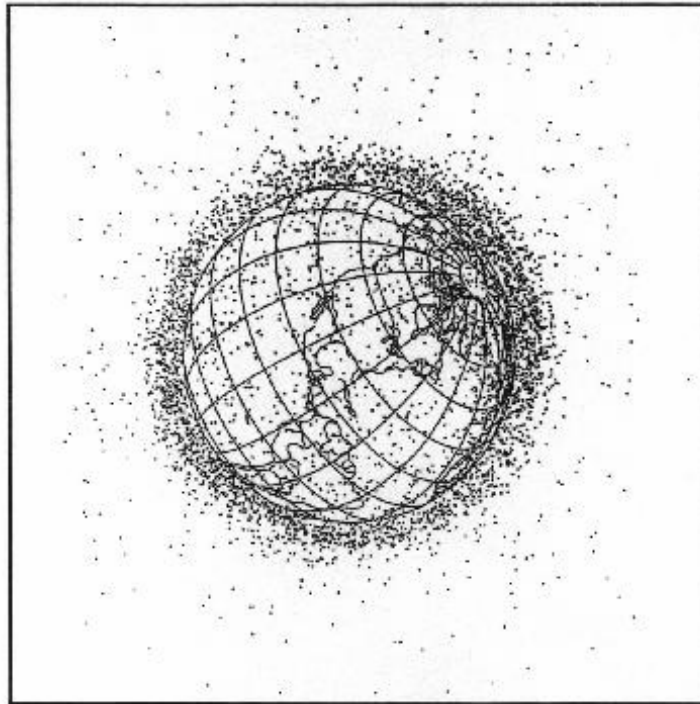
- In 39 years of space activities, some
- 3750 launches led to more than
- 23000 observable space objects (larger than 10 cm) of which currently
- 7500 are still on orbit.
- Only 6% of the catalogued orbit population are operational spacecraft, while
- 50% can be attributed to decommissioned satellites, spent upper stages, and mission related objects (launch adapters, lens covers, etc.).
- The remainder of 44% is originating from 129 on-orbit fragmentations which have been recorded since 1961.
- These events, all but 1 or 2 of them explosions of spacecraft and upper stages, are assumed to have generated a population of
- objects larger than 1 cm on the order of 70000 to 120000.
- Only near sizes of 0.1 mm the sporadic flux from meteoroids prevails over man-made debris.

Source: ESA

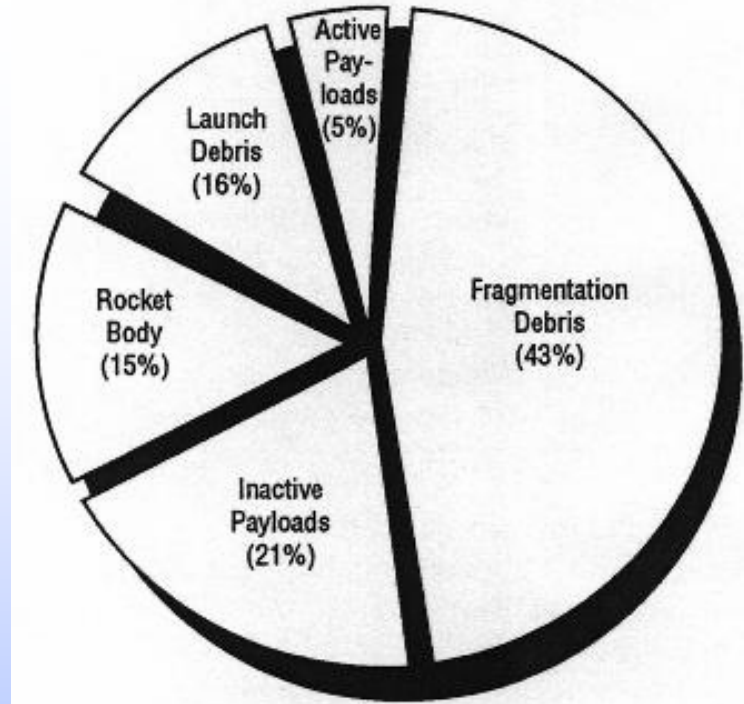
# Craters on the Hubble Space Telescope



# DEBRIS



A snap-shot of tracked objects in space



Types of objects tracked.

## Hypervelocity impact

A 90 gram particle will impact 1 MJ of energy to the spacecraft.