Speech to IEEE Student Banquet

February 28, 1997

Thank you, Mr. Chairman, for your kind introduction, and thanks to all of you for the invitation to come and enjoy this banquet with you. The circumstances remind me of the story of the Christians in ancient Rome who were thrown into the arena there. And moments later, the hungry lions were released and came charging at them. And before they could quite get at them, one of the Christians stood up, stepped forward, and said something. And the lions suddenly just laid down and refused to attack the Christians.

Well, the crowd at the Coliseum got mad. They yelled at the lions. They were throwing rocks at them and everything, but they couldn't get them to eat the Christians.

Finally, Nero called the Christian leader to his side and said, "What is it that you told the lions?"

He said, "I simply told them there would be speeches after the meal."

(Pause for laughter, if there is any.)

When I was invited to speak to you tonight, I asked myself what I might have to say, that student electrical engineers would like to hear about. As you may know, I am an experimental space physicist, and my research interests include the aurora borealis, the polar ionosphere, and "space weather". By space weather we mean changes in the electromagnetic and radiation environment in the upper reaches of the Earth's atmosphere. All of these are among the numerous effects in the upper atmosphere that are produced by energy flowing outward from the Sun. The major part of this energy is carried by electromagnetic waves, such as light, and goes to warm the Earth's surface and atmosphere, and to sustain life on the Earth. The remaining energy is carried by the solar wind, an electrically neutral plasma of electrons and nuclei of hydrogen and helium, which carries with it an embedded magnetic field. The amount of energy transported by the solar wind varies cyclically with a period of about 11 years, like the sunspot cycle, but is always small compared to the total energy output of the Sun.

There have been many attempts to discover a cause and effect relation between the solar wind and conditions on the Earth's surface, where we live. One of these is a study carried out many years ago by Dr. Balfour Currie, who founded the Institute of Space and Atmospheric Studies where I work. He was trying to identify a connection between geomagnetic storms, which are caused by enhanced particle energy output from the Sun, and periods of drought on the Prairies. From the earliest times, space scientists have kept a keen eye on the practical implications of their research. Unfortunately, Currie's study, like so many others, was inconclusive regarding the existence of a Sun-weather connection. The weather we experience at the surface is largely controlled by the electromagnetic energy from the Sun, which greatly exceeds

that portion carried by the solar wind. Any influence of the solar wind on our weather is swamped by the dominating influence of the electromagnetic energy.

However, the situation is quite different for the “weather” in space, where satellites orbit. As sunspot activity waxes and wanes throughout the 11-year cycle, the Sun’s output at wavelengths shorter than about 20 nm also varies. Light at these short wavelengths is absorbed in the upper atmosphere at heights of 100 to 200 km. The photons have enough energy to dissociate molecules and ionize atoms, and in the process heat is added to the atmosphere. As the upper atmosphere warms, it expands outward from the Earth. Satellites orbiting in this region, from low Earth orbits of 250 km up to 600 km or more, move though a denser atmosphere and experience greater drag. This slows them down, their orbits drop, and propellant must be expended to keep them at the required altitude. In the last solar cycle, which began in early 1986 and is just now coming to an end, the Sun’s activity was unusually high, and
(Examples of satellite mission truncation by accelerated orbital decay - Ted?)

(Discuss sporadic outbursts of high density/speed solar wind (CMEs), and magnetospheric effects, with recent storm as an example.)
(Discuss subsequent satellite malfunctions caused by energetic particle radiation damage - Aniks, Telstar 401.)

(Discuss impacts of geomagnetic induced currents on transformers and power grid during major geomagnetic storms.)
(Discuss need to establish means to monitor GIC and mitigate effects of geomagnetic storms - Kappenman article.)

(Transition to another environmental threat caused by changes in the atmosphere - ozone depletion in the height range from 10 to 50 km.)
(Discuss mechanisms of ozone depletion, and role of cold temperatures, chlorine compounds, entrapment in polar vortex(, and return of sunlight at polar latitudes?).)
(Discuss current ozone monitoring techniques, mostly sunlight-based, and value of ozone monitoring in darkness.)

(Digress to discuss history of Canadian space program, including U of Sask. successes in rocketry (SED, etc.) and in training space scientists (read the roster or give statistics?). Mention benefit of rocket experiments in hands-on training of students.)
(Discuss Canadian Space Agency Announcement of Opportunity for Small Payloads, and key goals of the Small Payloads Program.)

(Discuss U of Sask’s approach to preparing a proposal for the SPP: close linkage with industrial partner; wide cross-disciplinary collaboration, including participants without previous space experience; integral involvement of graduate students; proposal prepared as course-work for graduate course; submit on time and comply with requirements or fail the course.)

(Discuss idea as presented to first meetings.)