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# How Wiggly is the Earth's Magnetic Field?

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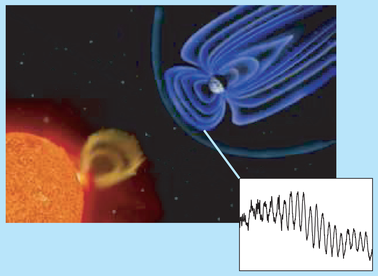
## Introduction

Pulsations, or "wiggles," in the Earth's magnetic field have been studied for a number of years using observations by both spacecraft and ground stations.

A great effort has been made to characterize the properties of these pulsations because of their relationship to the solar wind that impinges on the Earth's magnetosphere as well as the central role they play in our understanding of magnetic storms.

The following figure (courtesy of NASA) is a depiction of the magnetosphere, whose comet-like shape is a result of the interaction of the solar wind with the dipole magnetic field of the Earth. The inset is an example of a "wiggle" in the magnetic field observed by a geosynchronous satellite.



These pulsations are classified according to their periods into three categories:

| Pulsation | Period |
|---|---|
| Pc3 | 10 - 45 s |
| Pc4 | 45 - 150 s |
| Pc5 | 150 - 600 s |

***Statistical studies of these pulsations have been based on observations of individual events.***

***However, in this study, we produce global profiles of the wave power of these pulsations by filtering high-resolution spacecraft magnetic field data to the passbands that correspond to the three types of pulsation.***

***We then correlate these profiles with the level of geomagnetic activity as well as solar wind parameters.***

## Data

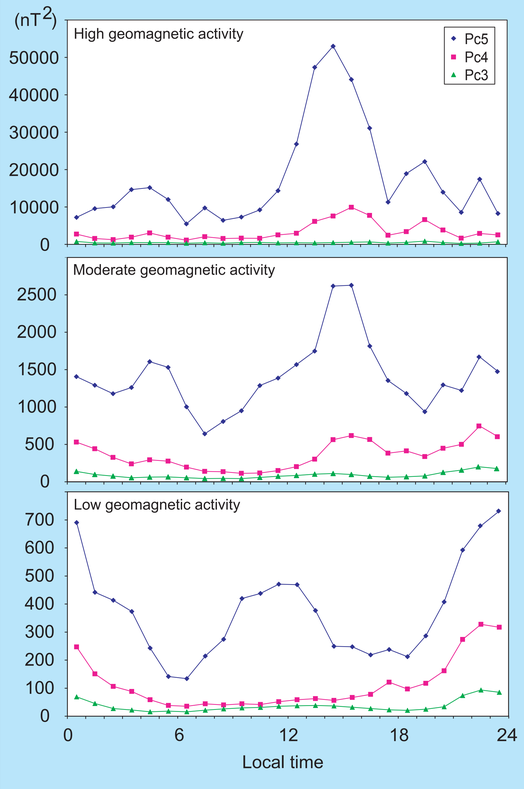
- Over 4 years of magnetic field data (1984-88) were collected from the geosynchronous GOES 5 and 7 spacecraft
- Corresponding solar wind data were obtained from the IMP 8 spacecraft

## Procedure

- Each 24-hour GOES data file was processed to eliminate unwanted noise spikes in preparation for filtering
- Using Fourier analysis, the processed files were filtered to passbands corresponding to the Pc3, 4 and 5 waves
- The hourly wave powers were calculated and correlated to geomagnetic and solar wind conditions

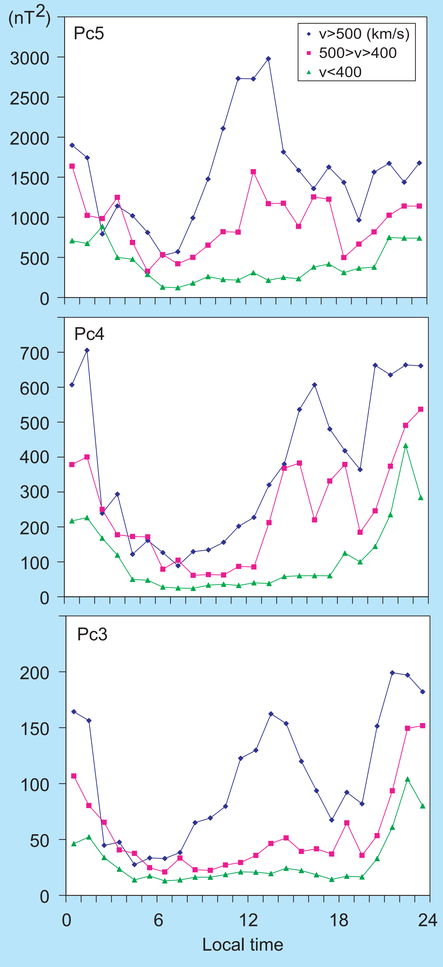
## Results and Conclusions

### 1. Wave Power vs Geomagnetic Activity



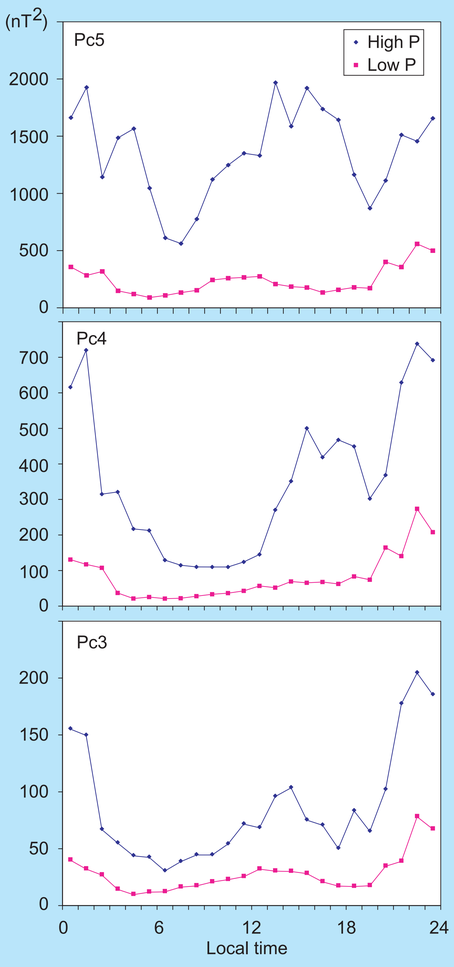

- Under all geomagnetic conditions, Pc5 wave power is dominant, while Pc3 wave power is weakest
- Pc5 wave power is particularly enhanced in the after-noon sector during periods of high geomagnetic activity (magnetic storm intervals)
- The Pc5 noontime peak during low activity may be associated with waves due to pressure pulses in the solar wind rather than Pc pulsations

### 2. Wave Power vs Solar Wind Velocity




- All three types of wave power increase with solar wind velocity, with the observed effect being strongest for Pc3 and Pc5
- Since the solar wind impinges on the magnetosphere around local noon, strong peaks are observed in that region

### 3. Wave Power vs Solar Wind Pressure




- The wave power is also observed to increase with solar wind pressure

## Future Work

We will investigate the relationship between Pc5 pulsations and "**killer electrons**" generated during certain magnetic storms. Traveling at velocities approaching the speed of light, these killer electrons create electrical discharges that "kill" satellites after penetrating the spacecraft shielding and causing electricity levels to rise. The understanding of this phenomenon has become a NASA priority.