MLT-dependent wave activity in the Earth's magnetosphere

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The Earth's magnetosphere is influenced by the Sun's activity and the solar wind. Large-scale structures in the solar wind, in this case interplanetary coronal mass ejections (ICME) and high-speed streams (HSS), are especially effective at creating disturbances the magnetosphere. The study of magnetospheric phenomena is important as space weather can impact a lot of infrastructure, such as satellites and electrical grids.

One relevant phenomenon to magnetospheric dynamics is ultra-low frequency (ULF) waves in the magnetic field. In this study we focus specifically on the Pc5 range waves (2-7 mHz). Waves in this frequency range are known to contribute to the acceleration of radiation belt electrons which can damage satellites in near-Earth orbits. Thus it's interesting to know where and when these waves occur. The occurrence of Pc5 waves has been observed to depend on magnetic local time (MLT). Wave activity is also known to increase during large-scale solar wind structures, and it is heavily correlated with solar wind velocity.

In my thesis I investigate how the wave activity depends on the MLT quadrant, and how it changes during ICMEs and HSSs. Two different approaches are used for this: comparison of individual events and a statistical approach for a larger amount of data. To quantify the amount of wave activity, we use a wave activity index which is calculated from ground-based SuperMAG magnetometer data from the latitudes 60-70 CGM. The index is calculated separately for the four MLT quadrants.

With these methods it's evident that the amount of Pc5 wave activity depends strongly on the quadrant, but also on various other factors. On average dawn (3-9 MLT) and midnight (21-3 MLT) are the most active ones and dusk (15-21 MLT) and noon (9-15 MLT) generally weaker. There is variation within the span of a solar cycle, with dawn being stronger than midnight at the solar maximum. Large-scale solar wind structures affect the wave activity a lot, with ICMEs having on average more activity than HSSs. The event-based analysis compares Pc5 activity in geomagnetic storms that have a similar profile of the disturbance storm time (Dst) index which is commonly used for quantifying the strength of a geomagnetic storm. It is evident that otherwise similar storms can have very varying levels of wave activity. The results don't seem to be very unexpected in comparison to previous studies on this topic.