Characterization of the Pc5 activity at L'Aquila magnetic station in 22 years of observations.

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An important aspect of the interaction between the solar wind (SW) and the Earth's magnetosphere concerns the possible relationship between SW and magnetospheric fluctuations under different SW conditions.

Di Matteo and Villante (2017, 2018) revealed the critical role of the analytical methods and the spectral analysis techniques in the identification of fluctuations between *f*≈1-5 mHz in the SW parameters as well as in the magnetospheric field measurements at the geostationary orbit. They showed that the event identification can be deeply influenced by the signal characteristics and analytical methods and developed a new approach, based on the joint use of the Welch and the Multitaper methods, for a more robust identification of these oscillations in both regions.

In this preliminary investigation, we extended the analysis to ground measurements, analysing 22 years of geomagnetic field measurements (H and D) at low latitude (L'Aquila, Italy, λ≈36.3°, L≈1.6), examining the LT and seasonal variation of the power spectra and paying attention to the possible contamination of the Sq variation and of the spectral slope on the event identification. The power spectra have been evaluated on two hours intervals during low geomagnetic activity conditions (Dst>-50).

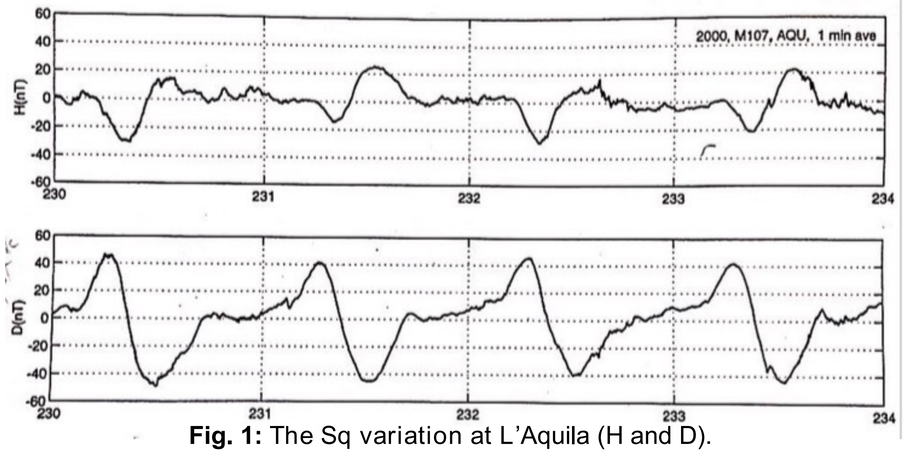

Fig. 1: The Sq variation at L'Aquila (H and D).

THE POWER SPECTRA.

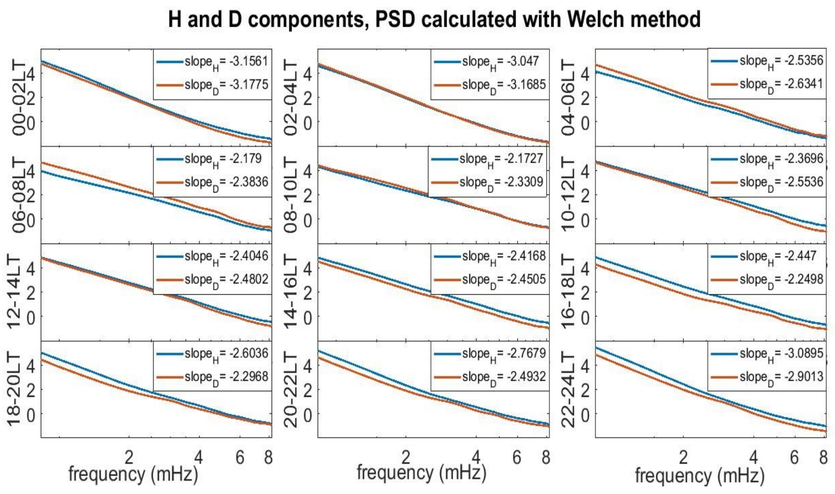

Fig. 2: The average spectra for H (blue) and D (red) as evaluated with the Welch method over 22 years. Similar results are obtained with the Multitaper.

Note that the geomagnetic spectra are much steeper than the ones estimated in the SW and at the geosynchronus orbit (≈1<α<≈2) (*Di Matteo and Villante, 2017*).

References:

- Di Matteo, S., & Villante, U. (2017). . *J. Geophys. Research: Space Physics*, 122, 4905–4920, doi:10.1002/2017JA023936.
- Di Matteo, S., & Villante, U. (2018). . *J. Geophys. Research: Space Physics*, 123. https://doi.org/10.1002.2018JA024922.

THE LT VARIATION.

The ratios between each 2-hr spectrum and the global average spectrum (24 hr) show that the power is enhanced at low frequencies in the nighttime (black and blue) and at high frequencies in the daytime (yellow and red).

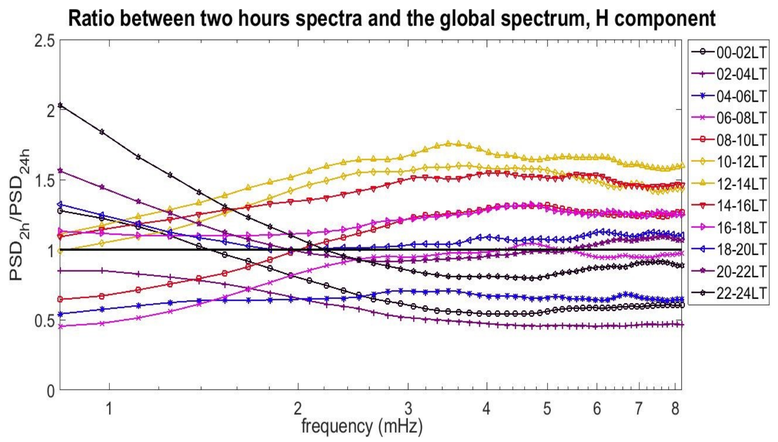

Fig. 3: The ratio between each two hour and the 24-hr spectrum.

A strong LT modulation shows much greater power in the daytime. H exceeds D after ≈09 LT, suggesting an increasing ionospheric influence on the signal characteristics in the daytime hours.

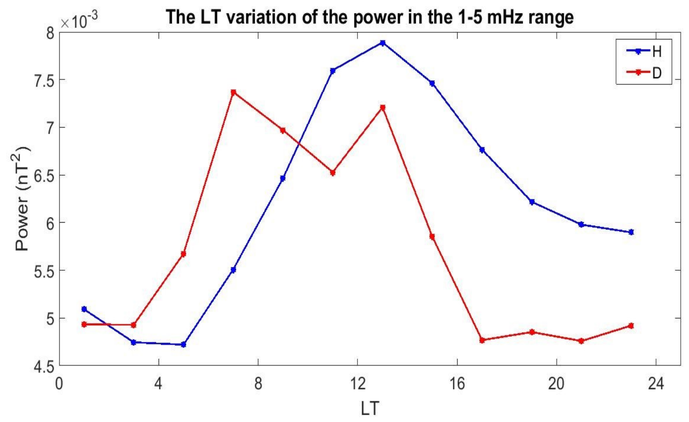

Fig. 4: The LT dependence of the power (*f*=1-5 mHz).

THE SEASONAL VARIATION.

The results obtained for different seasons (spring equinox: 6 May—5 Aug; summer solstice: 6 Aug-5 Nov; autumn equinox: 6 Nov-5 Feb; winter solstice: 6 Feb-5 May) show that the difference between the H and D slope is greater in the autumn equinox while it is steeper in the summer months; the spectra's slope is slower in the winter months.

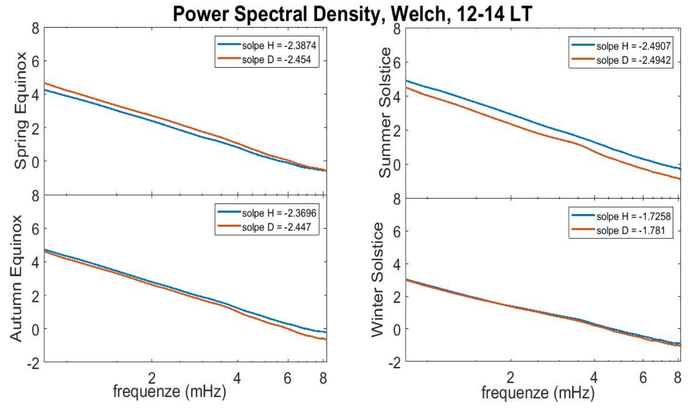

Fig. 5: The average spectra for different seasons.

The LT variations of the power for different seasons show that:

a) the power of fluctuations is strongly depressed during the winter months;

b) D exceeds H in the morning during spring and summer, confirming the ionospheric influence.

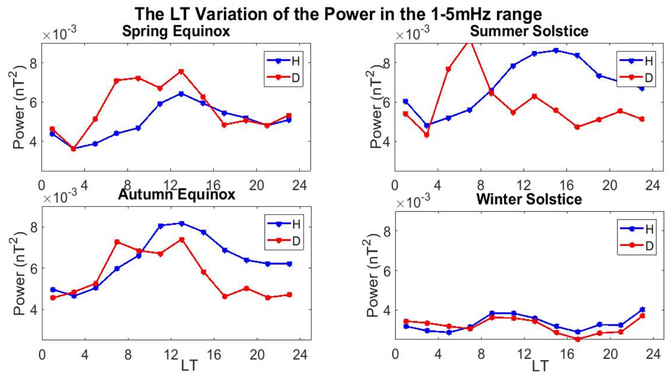

Fig. 6: The LT dependence of the power for different seasons.

THE EVENT IDENTIFICATION.

(Preliminary Notes)

To evaluate the influence of the power spectrum shape on the identification rate of events, we analysed synthetic representations of measurements combining the Sq variation with red noise representations generated using the mean spectral index (α≈2.40) in absence of fluctuations.

Remarkably, the results of Fig. 7 show that the identification of spurious events exhibit a f-dependence, with a systematic reduction of the rate of identification of real events up to ≈2 mHz, especially for the MTM methods.

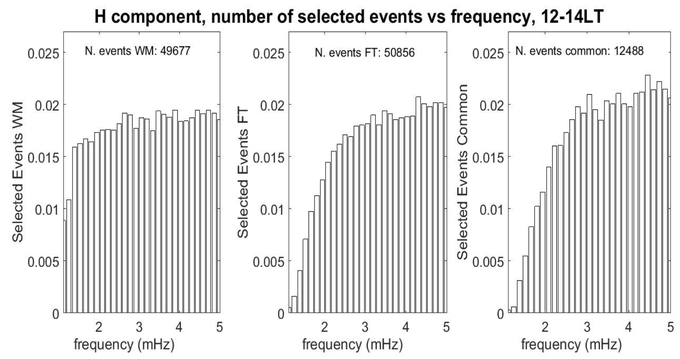

Fig. 7: Distribution of the events identified in synthetic representations (Sq + red noise) by WM, MTM, and both methods simultaneously at the 98% confidence level.

Substantially, the power spectrum slope α influences the events distribution which establishes the confidence level to distinguish real events from spurious ones in the analysis of real data.

Conclusions.

- On average, the slope of the geomagnetic spectra range between –2.1 and –3.2, steeper than the ones observed in the SW and at the geosynchronus orbit.
- In winter, the Pc5 activity is lower and the power spectra show a slower decrease with frequency.
- The LT dependence of the integrated power suggests a ionospheric influence more explicit in summer.
- The event identification, especially at lower frequencies, may dramatically depend by the analytical methods.