A statistical study on the timescales involved into the solar wind-magnetosphere interaction during the March 17, 2015 storm

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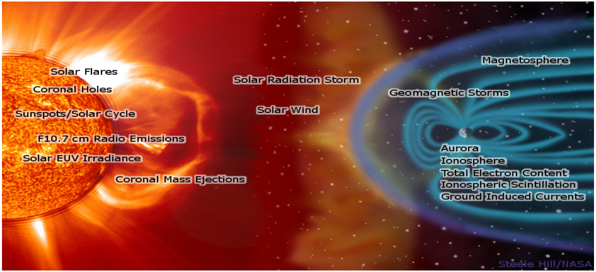
Ground and space-based instruments for future research in Solar-Terrestrial physics

L'Aquila, 6-10 June 2016

Solar-Terrestrial Interactions are related to the conditions and phenomena in space and specifically in the near-earth environment.



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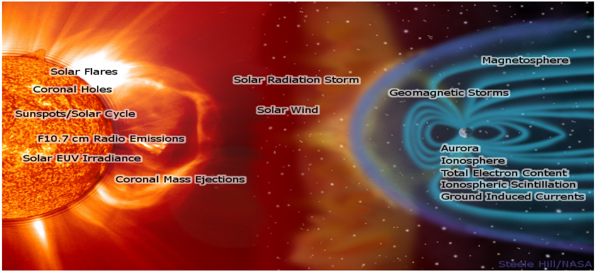

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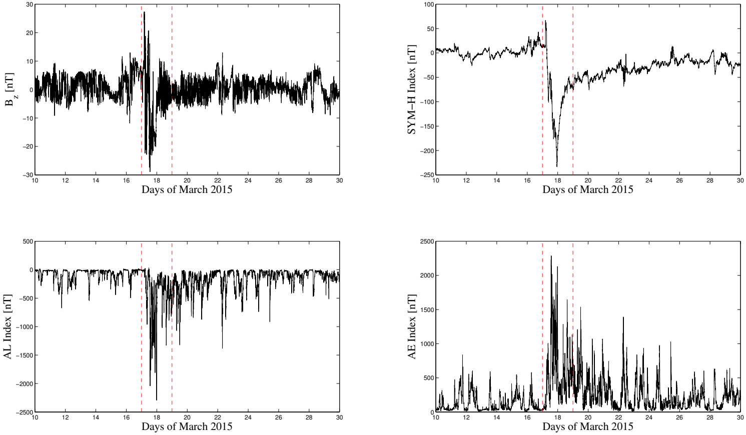
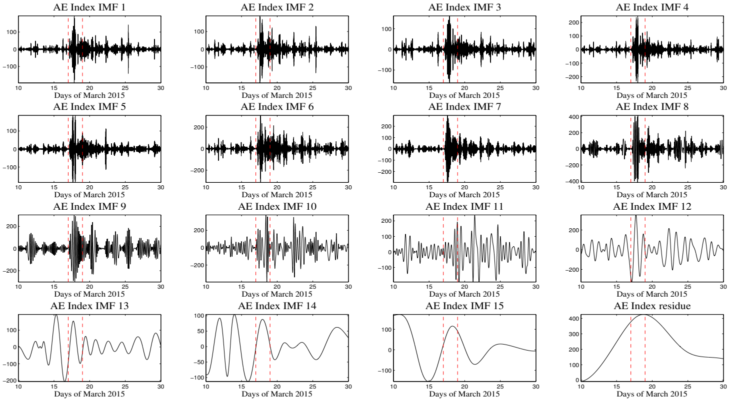
Investigation of statistical properties of time scales involved into the solar wind-magnetosphere interaction during a storm

- Investigation of the magnetospheric dynamics in response to solar wind changes during magnetic substorms and storms via a set of geomagnetic indices
- A case study: the St. Patrick's Day Geomagnetic Storm of 2015



- Extraction of the intrinsic oscillations in IMF-Bz component, AE, AL and Sym-H indices via EMD procedure

$$X(t) = \sum_{n=1}^{N} C_n(t) + r(t)$$

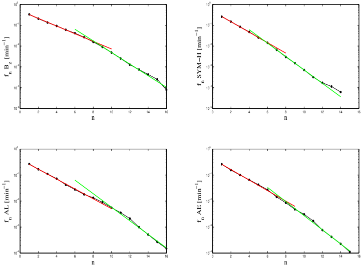


EMD

- The Empirical Mode Decomposition (EMD) method reads:

$$X(t) = \sum_{n=1}^{N} C_n(t) + r(t)$$

- $C_n(t) = A_n(t) \sin\left[\Phi_n(t)\right]$
- A mean frequency can be found $f_n = < d\Phi_n/dt >$



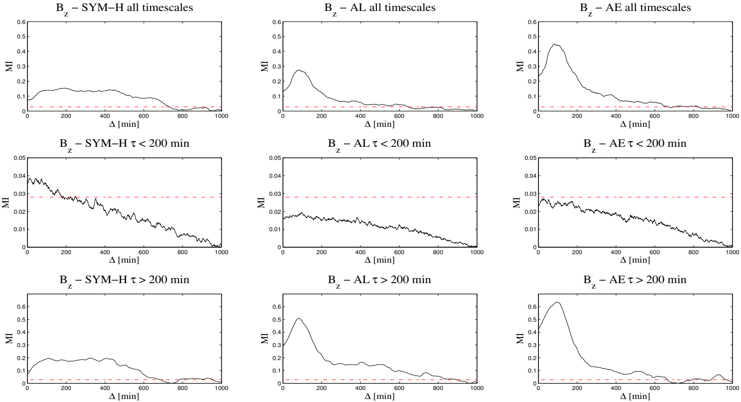
A timescale separation is found, allowing us to split each set of modes into two subsets:

1. a short-timescale reconstruction which contains modes with a characteristic timescale $\tau \lesssim 200$ min
2. a long-timescale reconstruction involving modes with $\tau > 200$ min

DMI

Considering a time delay Δ, it is possible to introduce a quantity capable of quantifying the information shared by two sequences

$$MI(\Delta) = \sum_{i,j=1}^{N} p_{ij}(X(t), Y(t+\Delta)) \log \frac{p_{ij}(X(t), Y(t+\Delta))}{p_i(X)p_j(Y)}$$



- We show the existence of a timescale separation which allows us to detect two contributions: (i) short-timescale ($\tau \lesssim 200$ min), (ii) long-timescale ($\tau > 200$ min).
- By applying the DMI we note that:
  1. the magnetospheric short-timescale reconstructions seem to be not related to that in the solar wind because the MI is under the null hypothesis threshold. This is a relevant result indicating an internal origin of timescales lower than 200 min;
  2. on the contrary, the solar wind long-timescale reconstruction plays a primary role into the generation and transmission of timescales greater than 200 min in the magnetosphere.
- Moreover, a time delay of $\sim$ 100 min is found between input and output according to the travel time of the perturbation from the ACE spacecraft position to the Magnetopause and to the internal magnetosphere.
- These results can be very useful for Space Weather prediction models of storms and substorms.