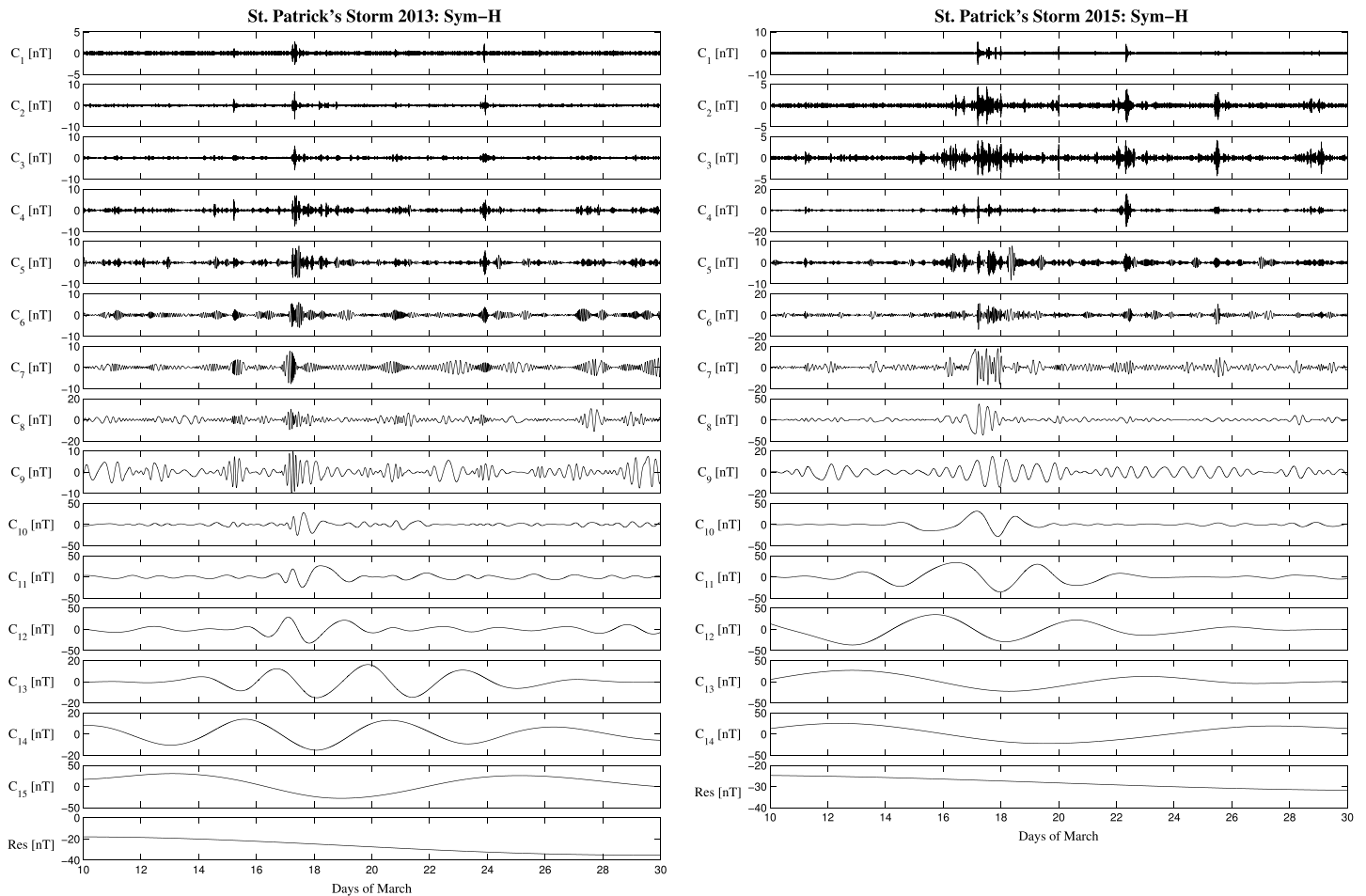




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**Figure 2.** EMD results obtained by analyzing *SYM-H* index for both Storm time periods.

This allows us to obtain the characteristic timescale oscillation of each mode as  $\tau_n = f_n^{-1}$ . Moreover, since the decomposition is local, complete, and orthogonal, the EMD can be used as a filter by reconstructing partial sums of equation (2) in a chosen frequency range [Laurenza *et al.*, 2012; Vecchio *et al.*, 2012b; Alberti *et al.*, 2014; De Michelis and Consolini, 2015].

Figure 4 shows the characteristic frequencies  $f_n$  as a function of the mode number  $n$  corresponding to the IMFs shown in Figures 2 and 3 relative to *SYM-H* (red circles) and *AE* (blue circles) indices, and to the IMFs obtained from the  $B_z$  component (black stars) measured by ACE, for both periods.

### 2.3. The Delayed Mutual Information (DMI) Approach

In the framework of information theory some different quantities can be estimated to characterize the behavior of a system  $X$  or the interference between two systems  $X$  and  $Y$ . For instance, the *Shannon information entropy*  $H(X)$  or the *mutual information*  $MI(X, Y)$  [Shannon, 1948] are useful quantities to characterize the behavior of a system  $X$  and the degree of statistical independence between two systems ( $X$  and  $Y$ ) by looking to the set of states the systems visit as they evolve in time. In detail, if we indicate as  $p(x)$  and  $p(x, y)$  the probability of finding a system in state  $x$  and the joint probability for the systems  $X$  and  $Y$ , respectively, then the Shannon information entropy  $H(X)$  and the mutual information  $MI(X, Y)$  as follows:

$$H(X) = \sum_{x \in X} p(x) \log \frac{1}{p(x)}, \quad (4)$$

$$MI(X, Y) = \sum_{x \in X} \sum_{y \in Y} p(x, y) \log \frac{p(x, y)}{p(x)p(y)} \quad (5)$$