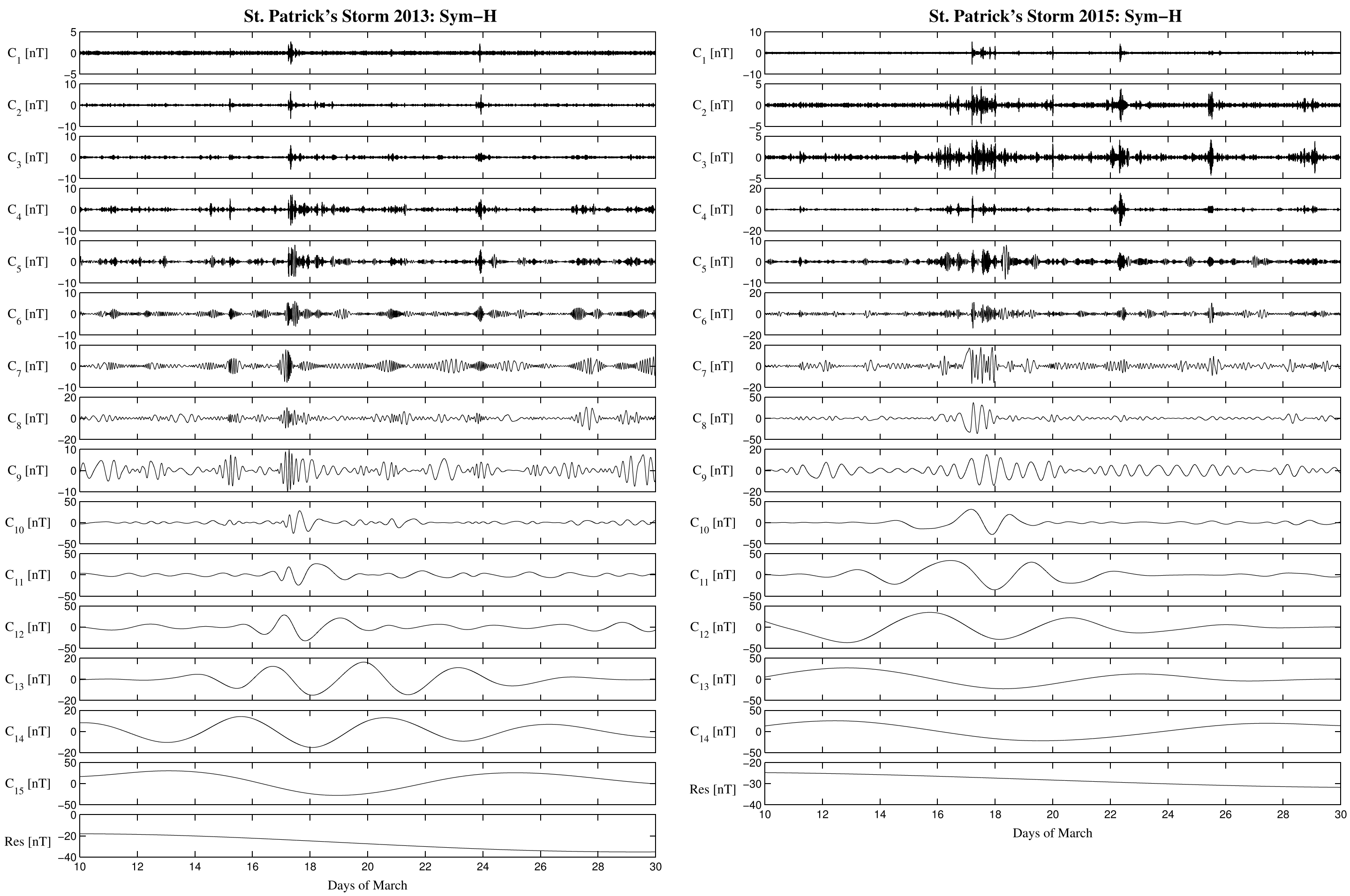

Figure 2. EMD results obtained by analyzing *SYM-H* index for both Storm time periods.

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* $\mathrm{MI}(X, Y)$ [*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 $\mathrm{MI}(X, Y)$ as follows:

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

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