Evaluation of IGRF 11 SV Candidate Models (W. Kuang and Z. Wei)

There are 8 SV candidate models (labeled alphabetically from A to H) evaluated by our group. The detailed descriptions of each model are provided in the dedicated website.

In our evaluation process, we focus on the following properties (1) the mean M_n and the standard deviation σ_n of the energy R_n for each degree n, and the distribution of the individual models referenced to M_n and σ_n; (2) the mean and the standard deviation of each SV coefficient ($\dot{g}_n^m$, $\dot{h}_n^m$) of degree n and order m.

For the first part of evaluation, the energy R_n for each degree n is defined as

$$R_n = (n+1)\sum_{m=0}^{n}\left(\dot{g}_n^{m2} + \dot{h}_n^{m2}\right) \tag{1}$$

The mean M_n and the standard deviation σ_n for all 8 candidate models are defined as

$$M_n = \frac{1}{8}\sum_{i=1}^{8} R_n^{(i)},$$

$$\sigma_n = \left[\frac{1}{7}\sum_{i=1}^{8}\left(R_n^{(i)} - M_n\right)^2\right]^{1/2}. \tag{2}$$

The results are plotted in Figure 1. From the figure we observe that there are two different sets, (A, B, F, G) and (C, D, E, H): one is mostly above the mean and the other is mostly below the mean. However, we also examine the distribution the distribution of the scaled energy spectrum R_n/M_n, as shown in Figure 2. In this figure, the relative differences
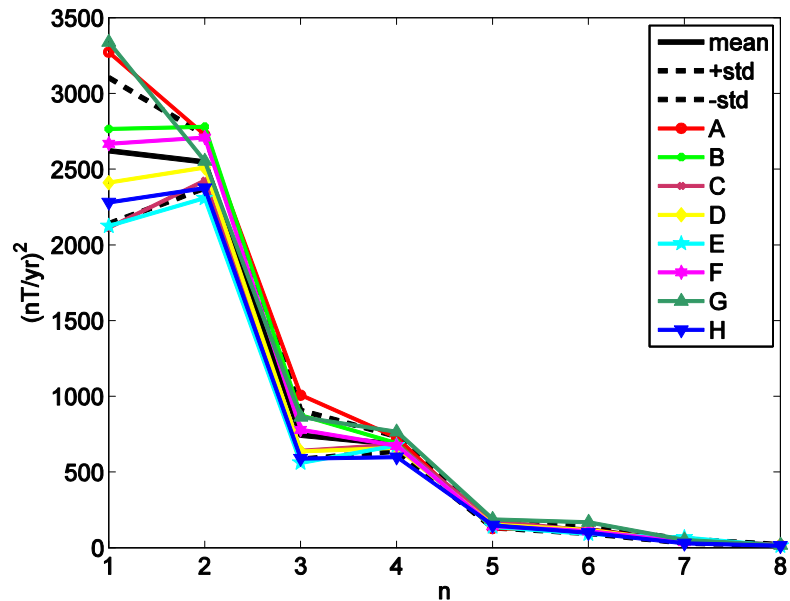

Figure 1. The energy spectrum R_n for all SV candidate models.

among the models increase with the degree n. In particular, the largest relative differences occur for the degrees n = 3, 6, 7.

The results on the individual coefficients are different, as shown in Figure 3, where the distributions of the coefficients ($\dot{g}_n^m$, $\dot{h}_n^m$) scaled by their means are displayed. From this plot, except the candidate model E (light blue) and G (dark green), the coefficients from the other candidate models are very close to each other.

Figure 2. Similar to Figure 1, but it is the scaled energy spectrum R_n/M_n for all SV candidate models. The scaled results are reset in the plot such that 0 implies the mean value. The two dotted lines are the scaled standard deviation $\pm\sigma_n/ M_n$.

Our results suggest that to reduce the relative differences among the individual coefficients, and among the energy distribution, candidate models E and G may be weighted differently from the rest of the candidate models.
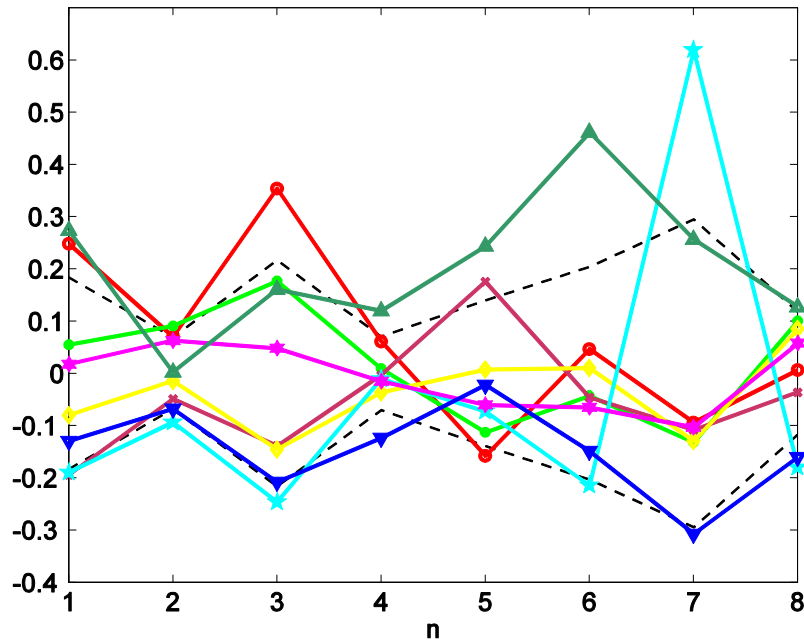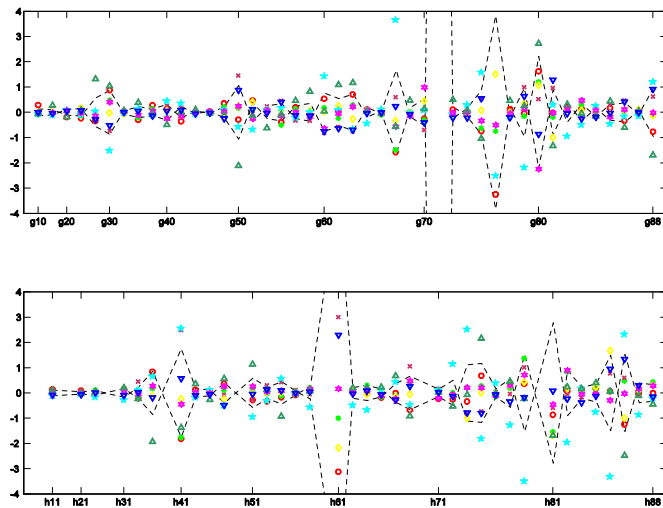

Figure 3. Distributions of the spectral coefficients $\dot{g}_n^m$ (top) and $\dot{h}_n^m$ (bottom) scaled by their means. Again, the dashed lines are the scaled standard deviation for each degree n and order m.