Delta-B North fit with Spherical Cap Harmonic Analysis (SCHA):

\[ \psi(\theta, \varphi) = \sum_{k=0}^{15} \sum_{m=0}^{3<k} P_{n_k(m)}^m (\cos \theta)(g_k^m \cos m\varphi + h_k^m \sin m\varphi) \]

New model fit from all data:

\[ g_k^m = c_0 + c_1 B_T + c_2 V_{SW} + c_3 \sin(t) + c_4 P_{SW} + 
   c_5 B_T \cos(\varphi) + c_6 V_{SW} \cos(\varphi) + c_7 \sin(t) \cos(\varphi) + c_8 P_{SW} \cos(\varphi) + c_9 B_T \cos(2\varphi) + 
   c_{10} B_T \sin(\varphi) + c_{11} V_{SW} \sin(\varphi) + c_{12} \sin(t) \sin(\varphi) + c_{13} P_{SW} \sin(\varphi) + c_{14} B_T \sin(2\varphi) \]

Test data from 104 magnetometer stations at over 150 times (5-min. ave.) with similar IMF conditions (from four-year interval).
Site locations for 1999 example. Additional site P03 only 3.5° East from A84 at nearly same latitude.

Site locations for 2001 examples
Different measurements, but very small separation distance
Corrected Geomagnetic North (X)  
Corrected Geomagnetic East (Y)  
Corrected Geomagnetic Vertical (Z)
Chaotic, turbulent auroral currents cause significant, higher frequency variations that will be impossible to precisely predict.

Any predictions that have right spectral characteristics likely will not exactly match the phase, resulting in an even worse prediction efficiency.

One way to evaluate predictions is to see how well they match the overall, global pattern of magnetic variations, rather than just a few selected sites.

Suggestion: use an AMIE-like fit of ground magnetometers to derive maps of magnetic perturbations. Compare with model prediction maps.