Sensitivity analyses for evaluation of ground magnetic field predictions

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In the Geospace Workshop, April 25, 2011 the following additional “sensitivity” analyses were requested:

- Test the sensitivity of the threshold-based results using different forecast window lengths. Use 10-min, 20-min and 45-min windows.
- Test the spatial scales of dB/dt by computing the field in a grid around selected stations for a selected event.
- Test the sensitivity of the modeled dB/dt on the temporal resolution of the used modeled data. Test computation of dB/dt with 10-s, 30-s and 60-s ionospheric outputs.

This will require additional work.
Sensitivity on the forecast window lengths

Slide over the data in non-overlapping segments and record "events"
Sensitivity on the forecast window lengths

- We generated the contingency tables for horizontal dB/dt using 10-min, 20-min and 45-min window lengths. Results integrated over all GEM events (note again that some models do not have predictions for all four events).
- Probability of detection (POD) and probability of false detection (PODF) will be reported in the following for event thresholds of 0.7 and 1.1 nT/s.
Sensitivity on the forecast window lengths – 0.7 nT/s

10, 20, 45-min
Sensitivity on the forecast window lengths – 1.1 nT/s

10, 20, 45-min
Sensitivity on the forecast window lengths

- We conclude that the results for the GEM events are not very sensitive for changes in the forecast window length between 10-45 minutes.
Sensitivity on the variations in the station location

- Vary the GEM station locations by ± 200 km.
- Calculate the ground magnetic field predictions and threshold-based metrics results for alternate locations.
- GEM event no. 2 (fall AGU storm) used in the analyses.
Sensitivity on the variations in the station location

Station PBQ and four alternate neighborhoods
Sensitivity on the variations in the station location

- 5_SWMF (paper) at PBQ and alternates.
Sensitivity on the variations in the station location

- 2_OPENGGCM (paper) at PBQ and alternates.
Sensitivity on the variations in the station location

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Sensitivity on the variations in the station location

- The modeled ground magnetic field and dB/dt magnitudes can vary notably within ± 200 km neighborhood.
- The threshold-based metrics results can vary within the ± 200 km neighborhood.
- How to choose optimally between the neighborhoods?
- Introduce alternate_6 “ensemble”, which is the maximum dB/dt (max. separately for different components) over the neighborhood.
Sensitivity on the variations in the station location

- SWMF (paper) at PBQ and alternates.
Sensitivity on the variations in the station location

- 2_OPENGGCM (paper) at PBQ and alternates.
Sensitivity on the variations in the station location

- Max. dB/dt over the neighborhood optimizes the probability of detection. Note: also the probability of false detection increases.
- Mean or median of the magnetic field over the neighborhood generates an ensemble that ranks systematically in the middle of the alternates (not shown).
Sensitivity on the temporal resolution

- We run SWMF using one of the selected SWPC validation settings for the GEM event no. 1.
- Ionospheric output saved with 10-s cadence and ground magnetic field perturbations calculated using CCMC tools.
- The ground magnetic field at GEM stations calculated also using SWMF scripts. Only ionospheric source used. Note: these are not yet systematic comparisons between CCMC and SWMF tools.
Sensitivity on the temporal resolution
Sensitivity on the temporal resolution

These are very large dB/dt
Sensitivity on the temporal resolution

Large fluctuations in 10-s temporal scales
Sensitivity on the temporal resolution

- 10-s cadence SWMF (with given setting) ionospheric currents generate large ground magnetic field fluctuations in 10-s scales that lead to very large dB/dt.
- The fluctuations are present in the magnetic field computed both with the CCMC and SWMF tools.
- Are the fluctuations physical? Further work needed before we can proceed with the temporal resolution sensitivity tests.
Summary

- Tests for the sensitivity of the threshold-based results on different forecast window lengths completed.
- Tests for the spatial scales of dB/dt carried out/completed.
- Further work required on the temporal resolution tests.