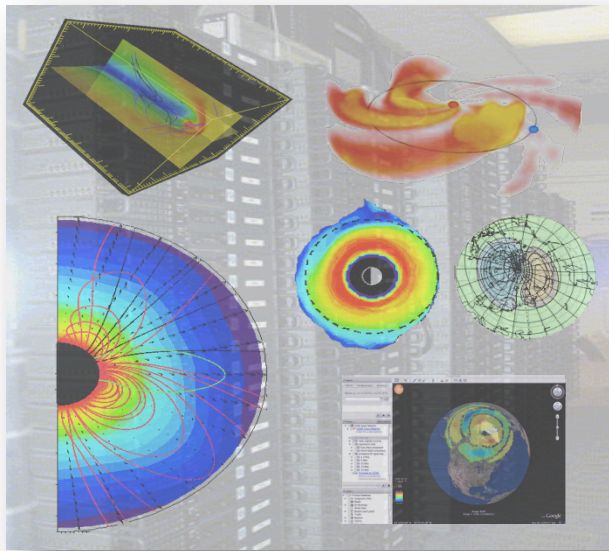
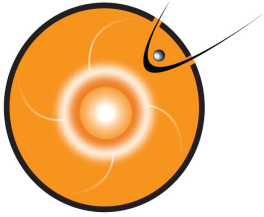


# Sensitivity analyses for evaluation of ground magnetic field predictions

*Pulkkinen, A.<sup>1,2</sup>, M. Kuznetsova<sup>2</sup>,  
and L. Rastaetter<sup>2</sup>*

<sup>1</sup> CUA Physics Department  
<sup>2</sup> NASA/GSFC CCMC





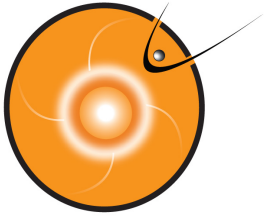
# Background

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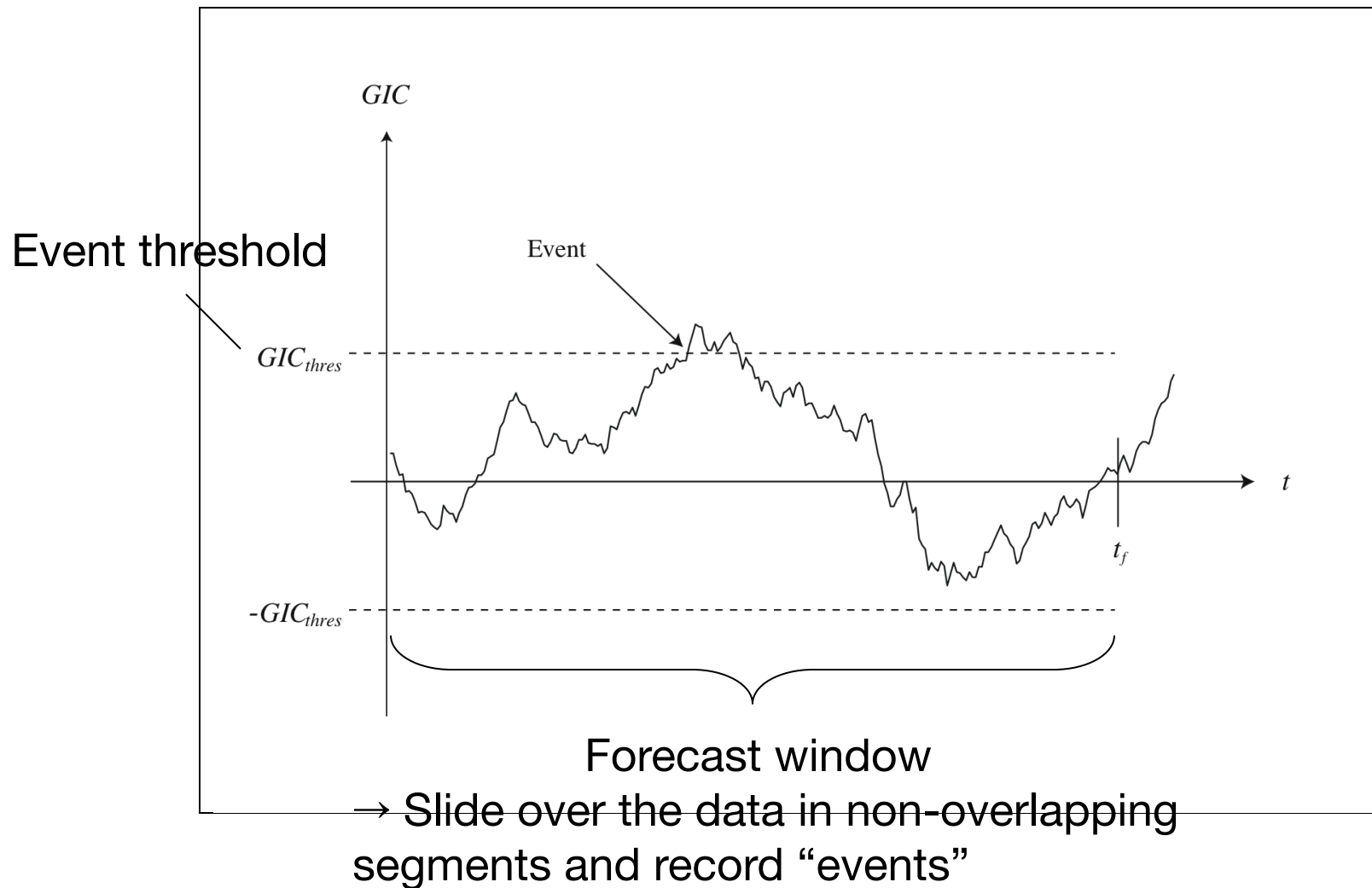
- In the Geospace Workshop, April 25, 2011 the following additional “sensitivity” analyses were requested:
  - Test the sensitivity of the threshold-based results using different forecast window lengths. Use 10-min, 20-min and 45-min windows.
  - Test the spatial scales of dB/dt by computing the field 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.

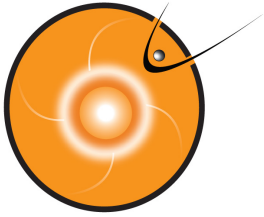
This will require additional work

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# Sensitivity on the forecast window lengths

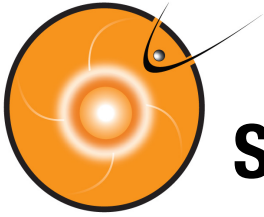




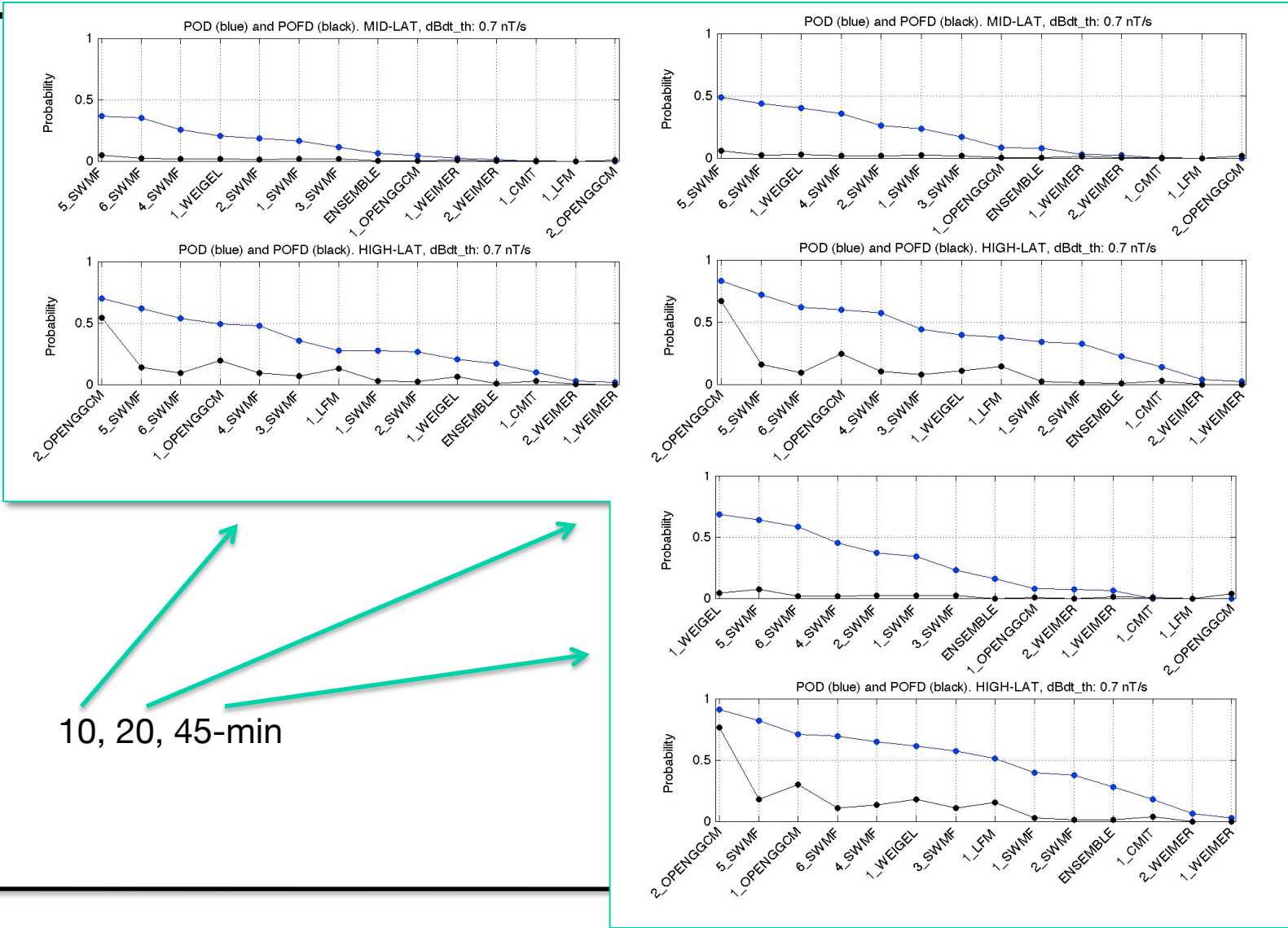
## Sensitivity on the forecast window lengths

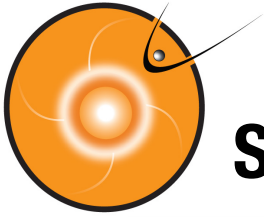
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- We generated the contingency tables for horizontal dB/dt using 10-min, 20-min and 45-min window lengths. Results integrated over all GEM events (note again that some models do not have predictions for all four events).
  - Probability of detection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

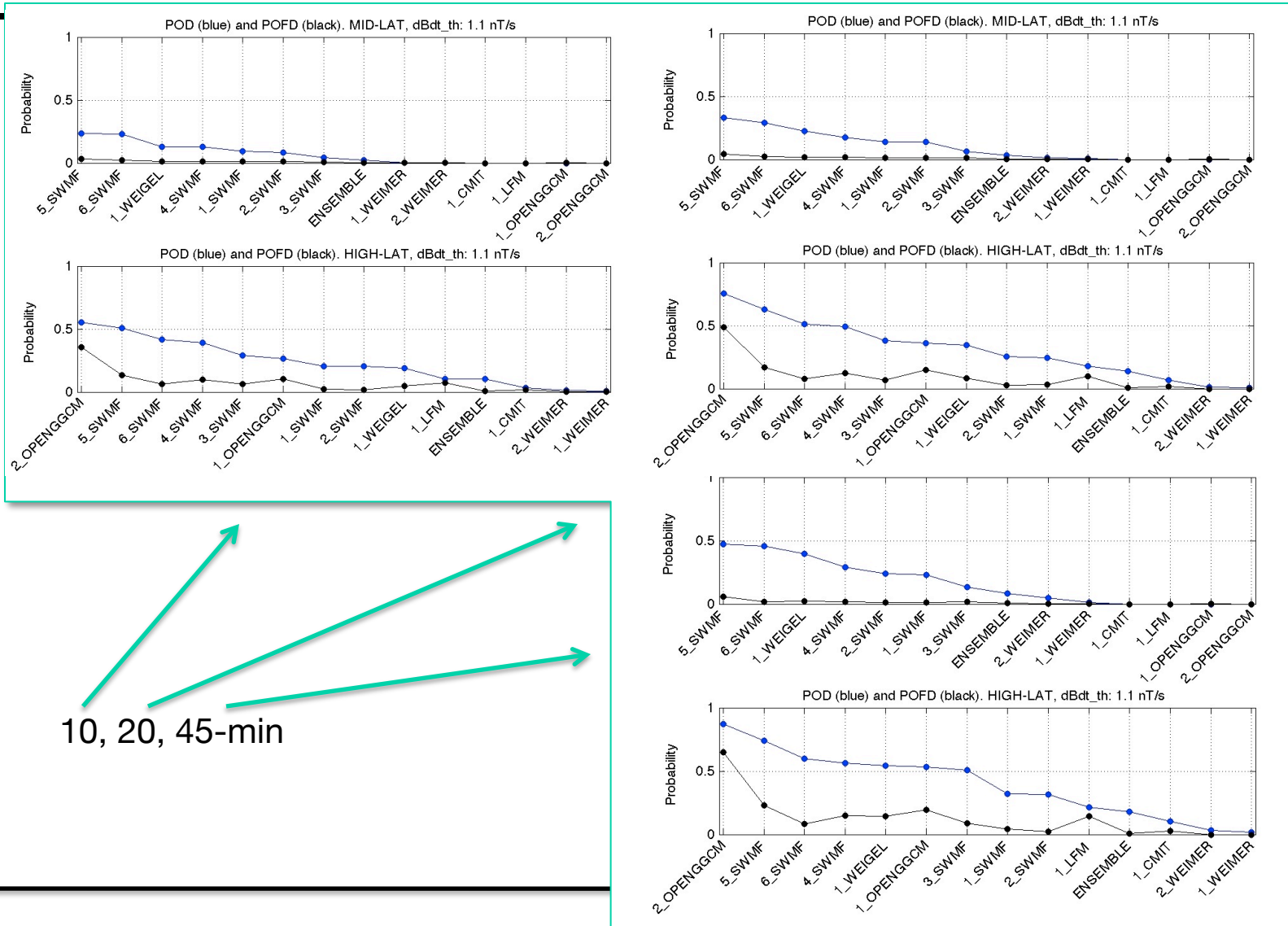


# Sensitivity on the forecast window lengths – 0.7 nT/s

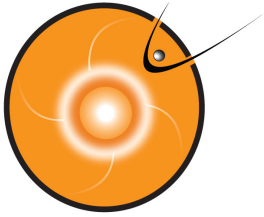




# Sensitivity on the forecast window lengths – 1.1 nT/s



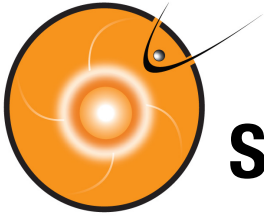
10, 20, 45-min



## Sensitivity on the forecast window lengths

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

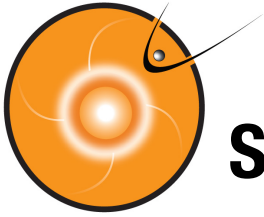


## **Sensitivity on the variations in the station location**

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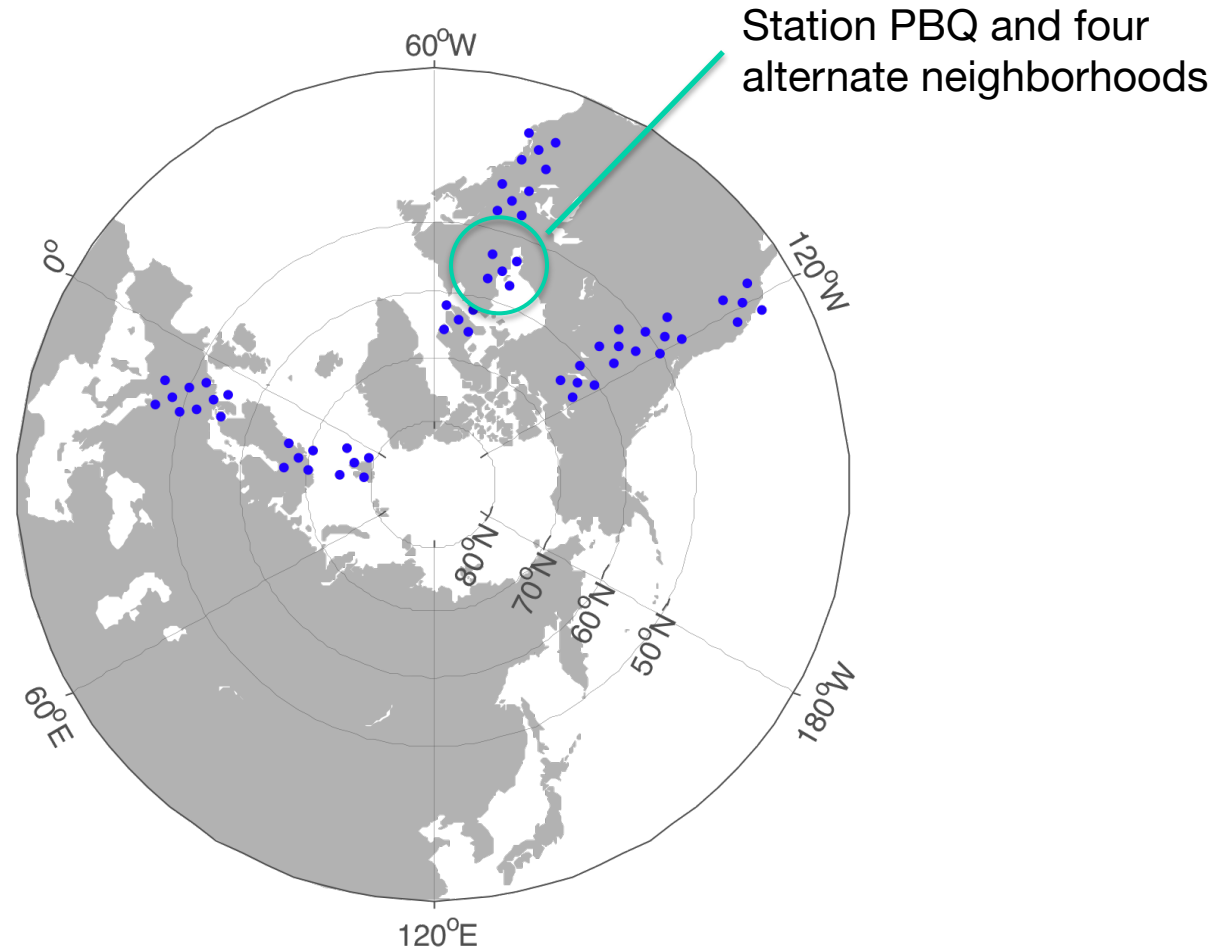
- Vary the GEM station locations by  $\pm 200$  km.
- Calculate the ground magnetic field predictions and threshold-based metrics results for alternate locations.
- GEM event no. 2 (fall AGU storm) used in the analyses.

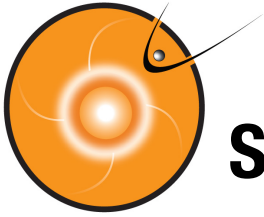




# Sensitivity on the variations in the station location

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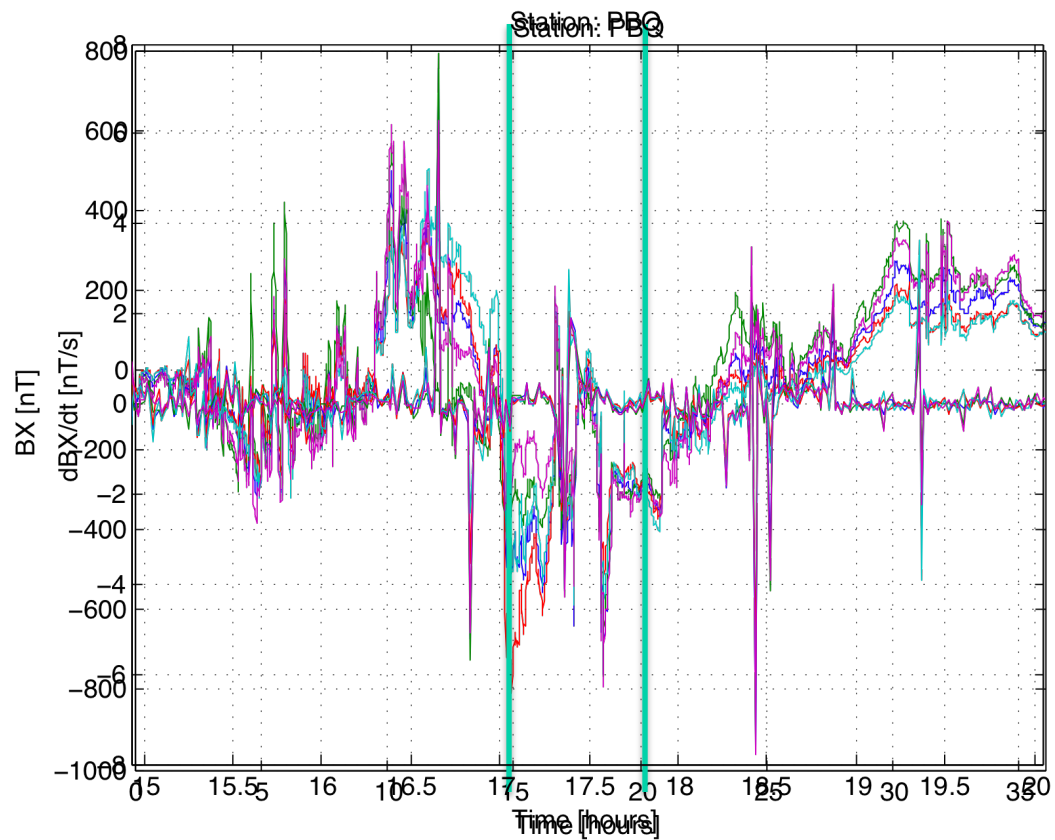


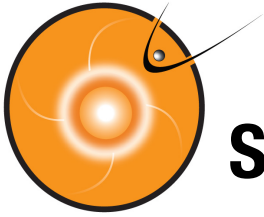


# Sensitivity on the variations in the station location

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- 5\_SWMF ([paper](#)) at PBQ and alternates.

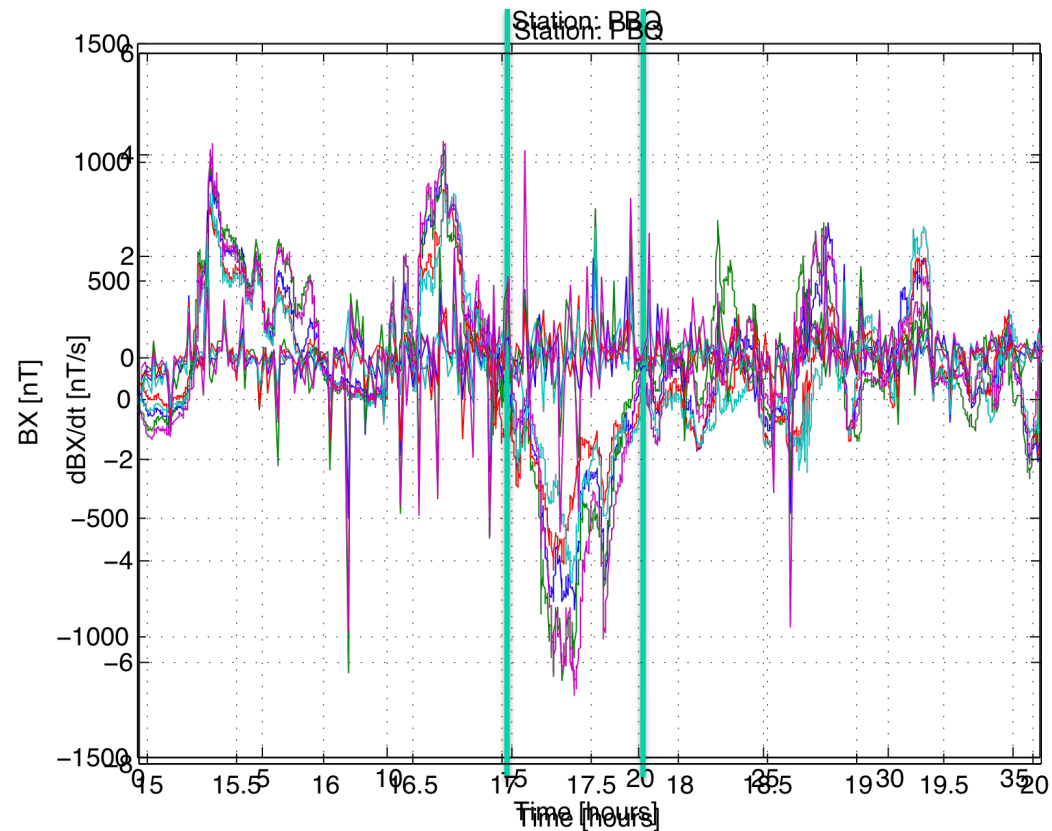


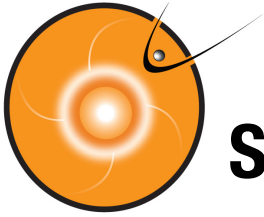


# Sensitivity on the variations in the station location

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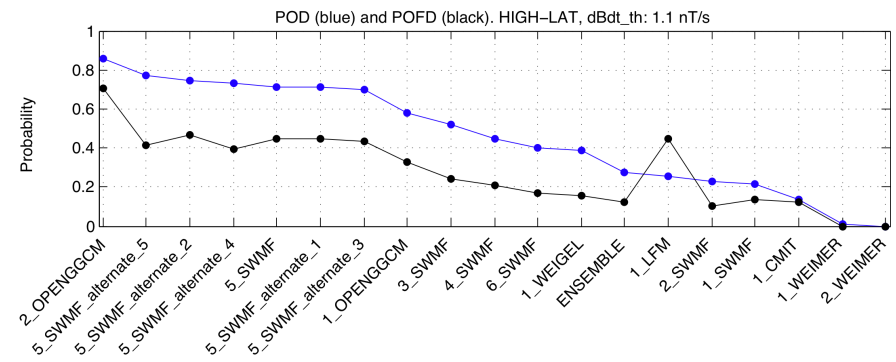
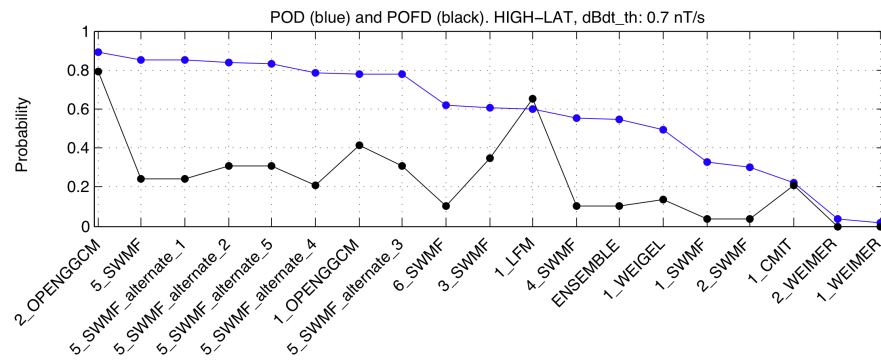
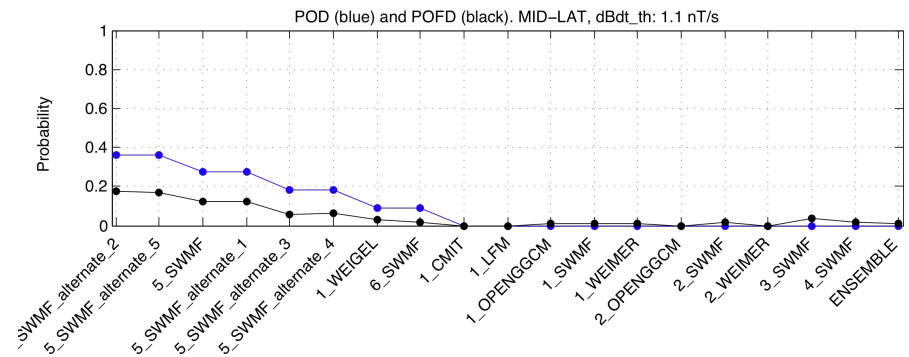
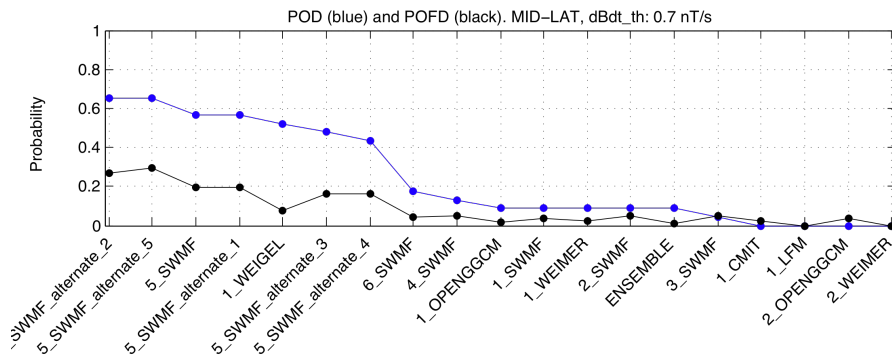
- 2\_OPENGGCM ([paper](#)) at PBQ and alternates.

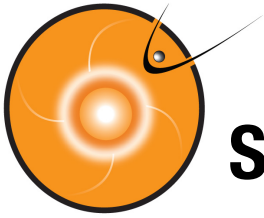




# Sensitivity on the variations in the station location

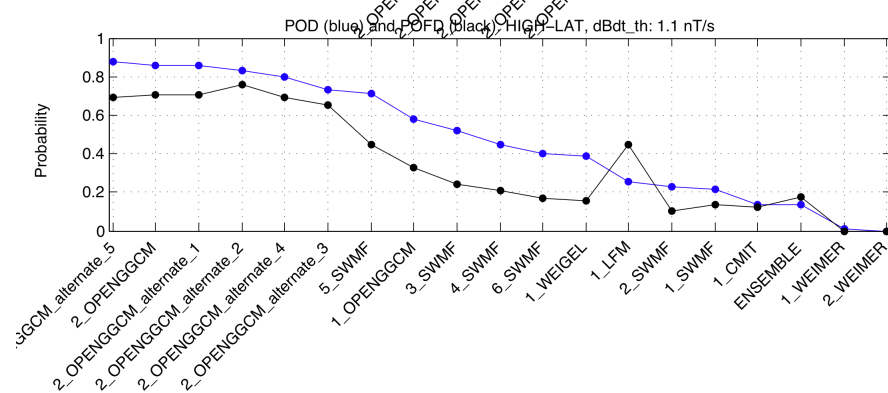
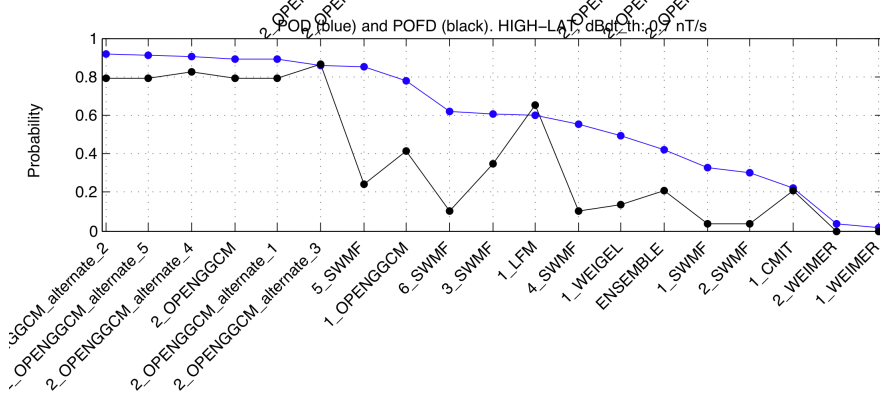
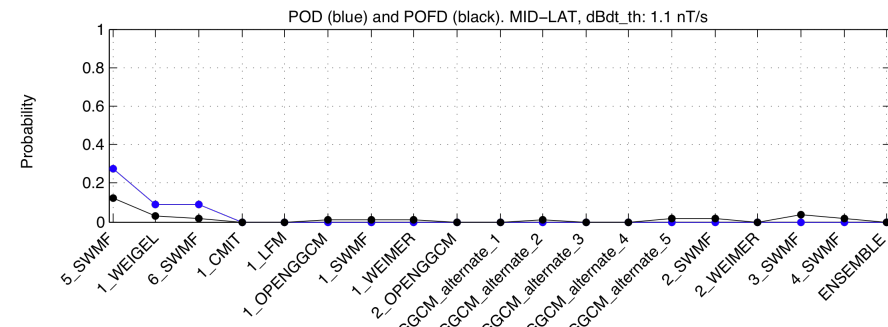
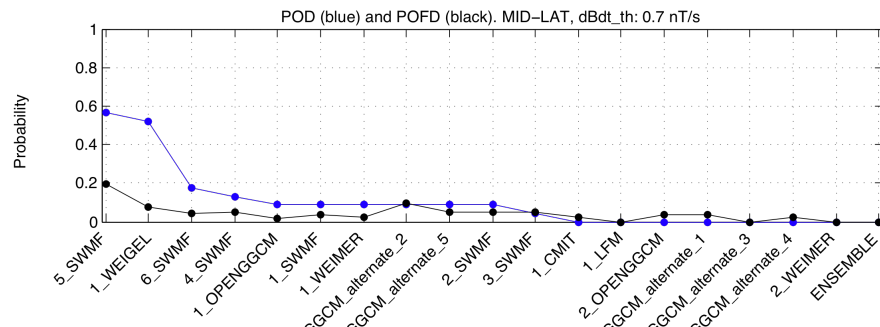
- 5\_SWMF ([paper](#)) and alternates.

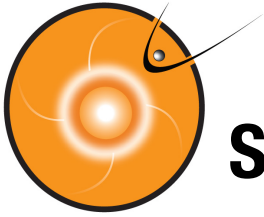




# Sensitivity on the variations in the station location

- 2\_OPENGGCM ([paper](#)) and alternates.

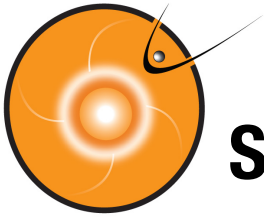




## Sensitivity on the variations in the station location

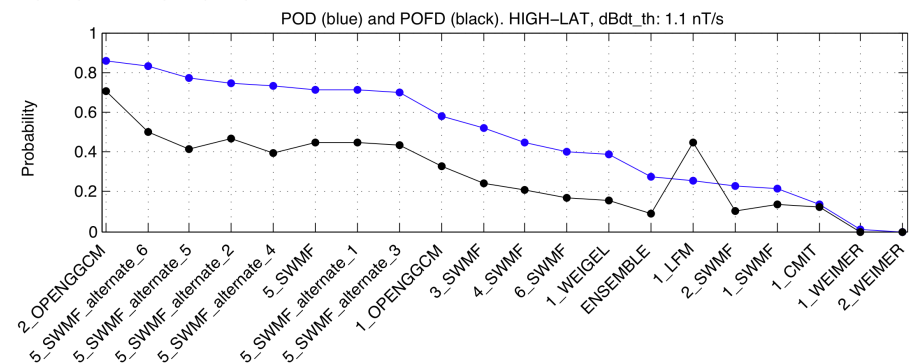
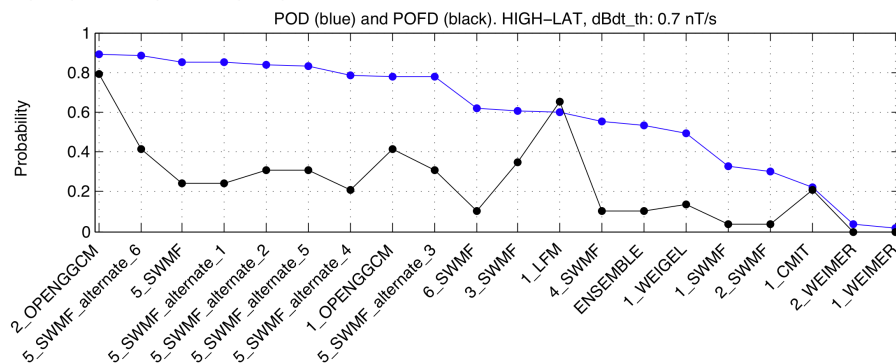
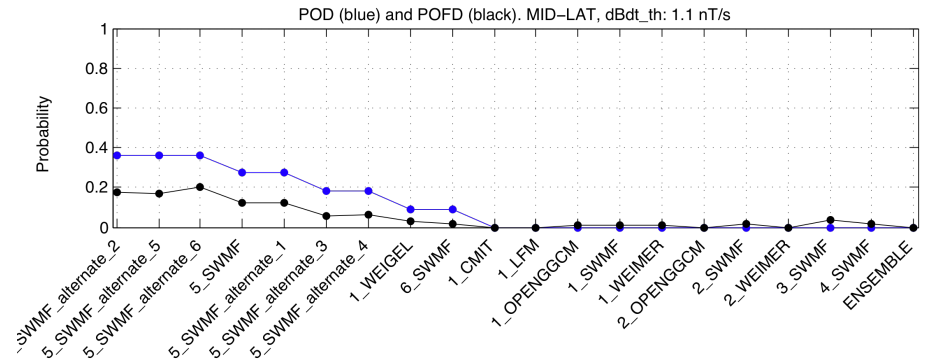
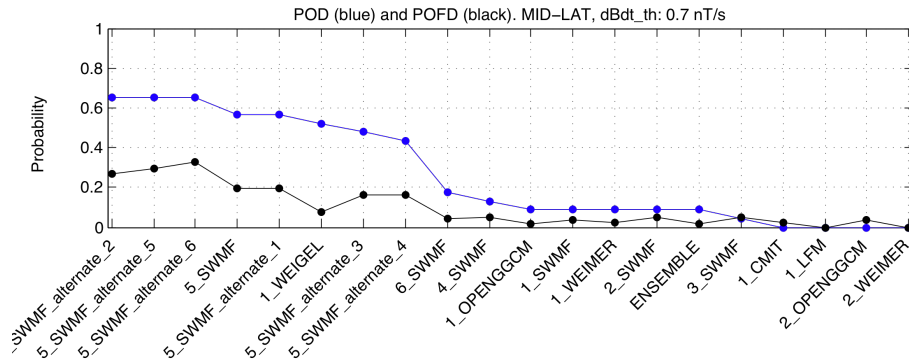
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- The modeled ground magnetic field and dB/dt magnitudes can vary notably within  $\pm 200$  km neighborhood.
  - The threshold-based metrics results can vary within the  $\pm 200$  km neighborhood.
  - How to choose optimally between the neighborhoods?
  - Introduce alteranate\_6 “ensemble”, which is the maximum dB/dt (max. separately for different components) over the neighborhood.
-



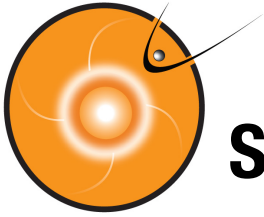
# Sensitivity on the variations in the station location

- 5\_SWMF ([paper](#)) at PBQ and alternates.





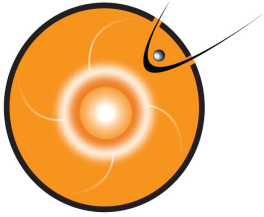




## Sensitivity on the variations in the station location

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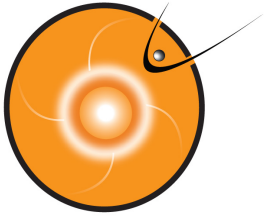
- Max. dB/dt over the neighborhood optimizes the probability of detection. Note: also the probability of false detection increases.
  - Mean or median of the magnetic field over the neighborhood generates an ensemble that ranks systematically in the middle of the alternates (not shown).
-



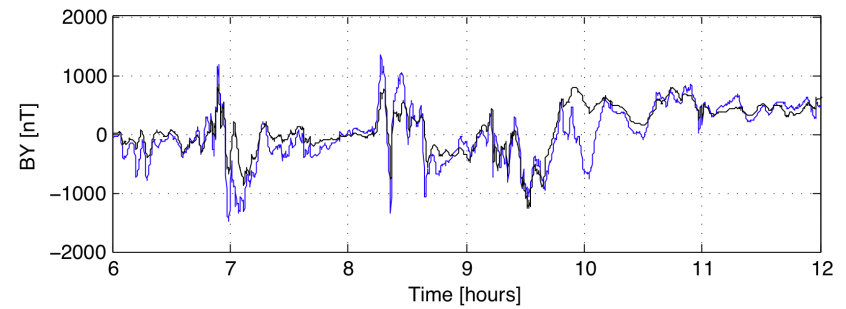
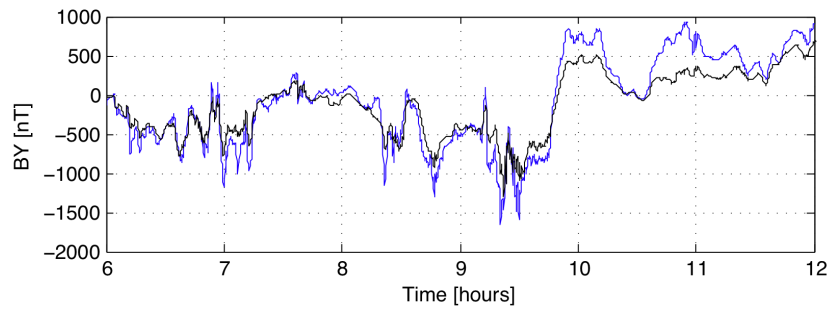
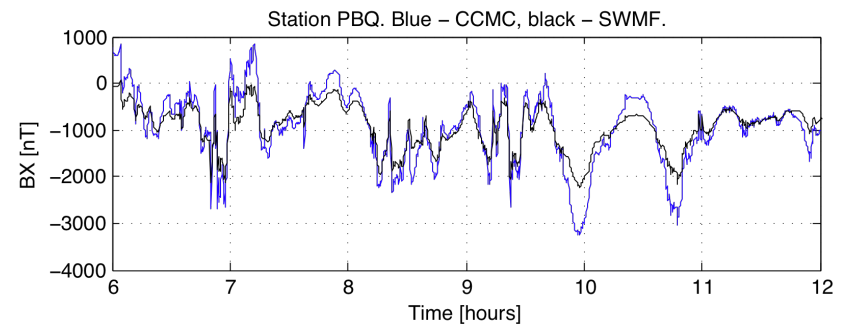
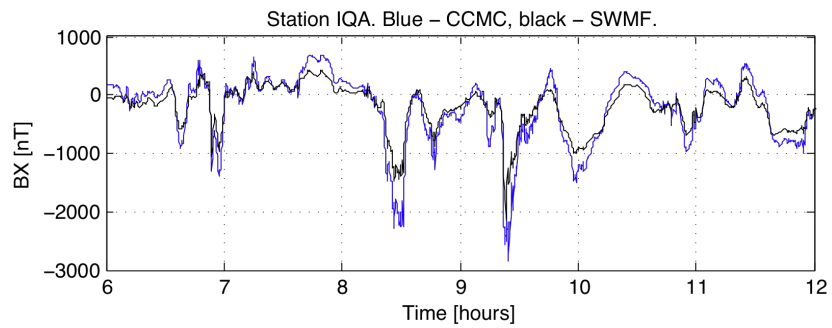
## Sensitivity on the temporal resolution

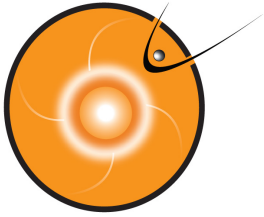
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- We run SWMF using one of the selected SWPC validation settings for the GEM event no. 1.
  - Ionospheric output saved with 10-s cadence and ground magnetic field perturbations calculated using CCMC tools.
  - The ground magnetic field at GEM stations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



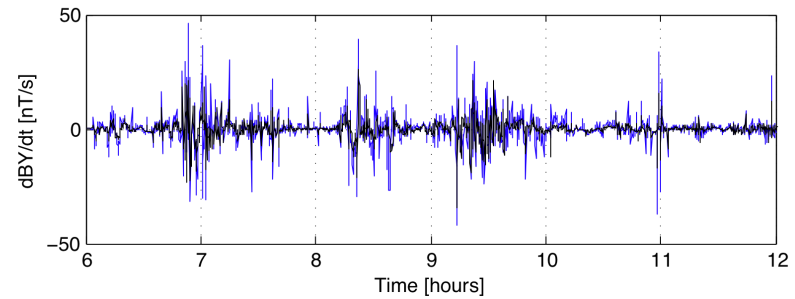
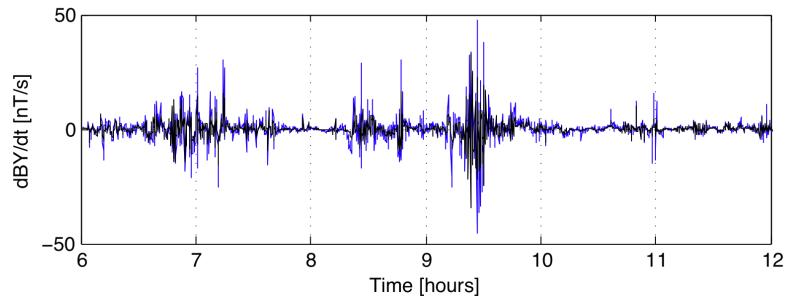
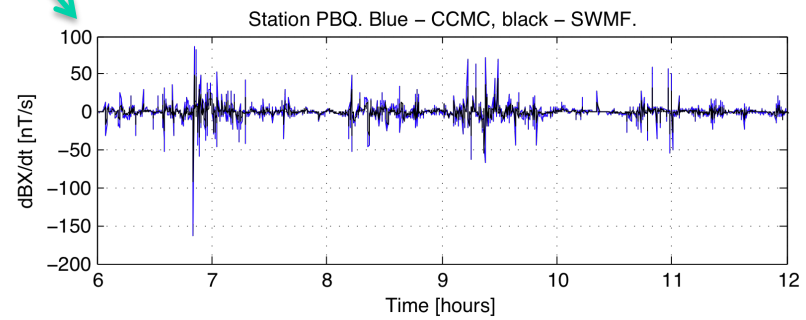
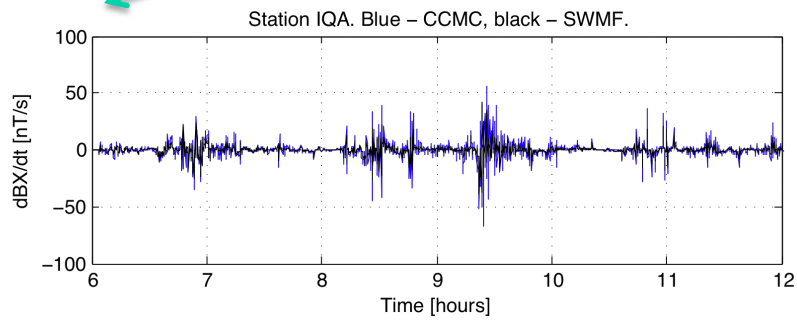
# Sensitivity on the temporal resolution

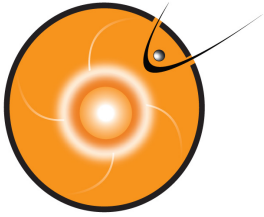




# Sensitivity on the temporal resolution

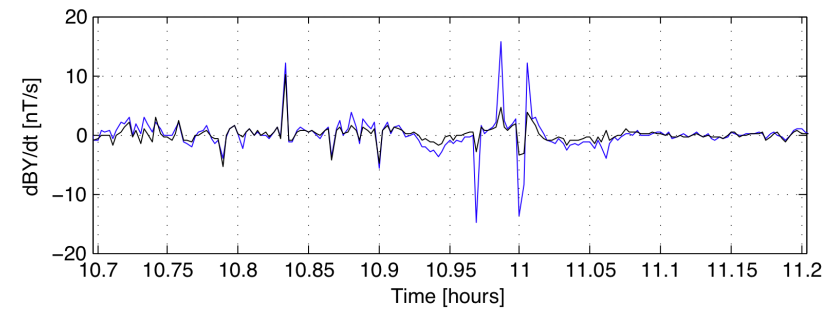
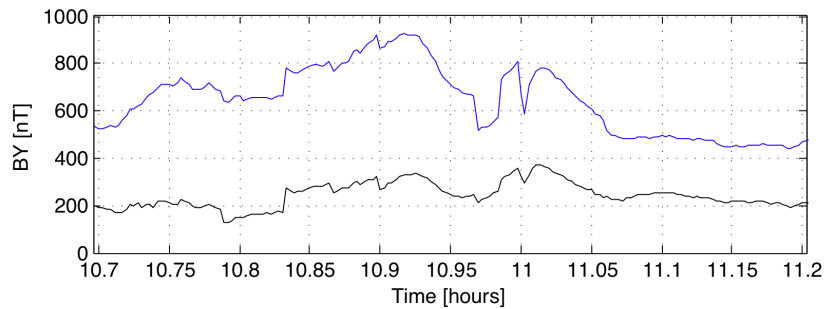
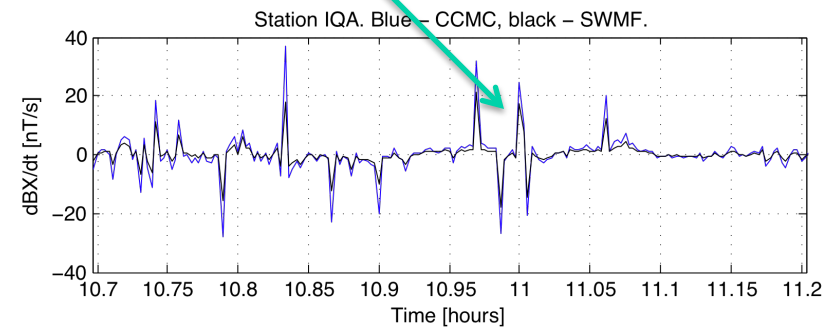
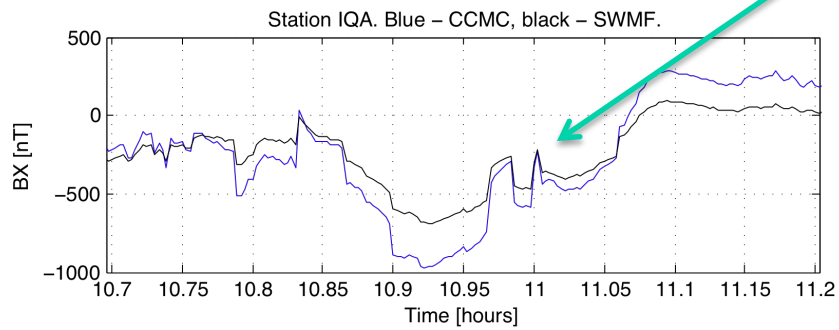
These are very large dB/dt

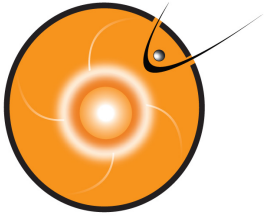




# Sensitivity on the temporal resolution

Large fluctuations in 10-s temporal scales

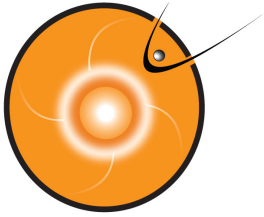




## Sensitivity on the temporal resolution

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- 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

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- 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.
-