

Chronicles of the dB/dTeam

Recommendations for next-generation ground perturbation validation

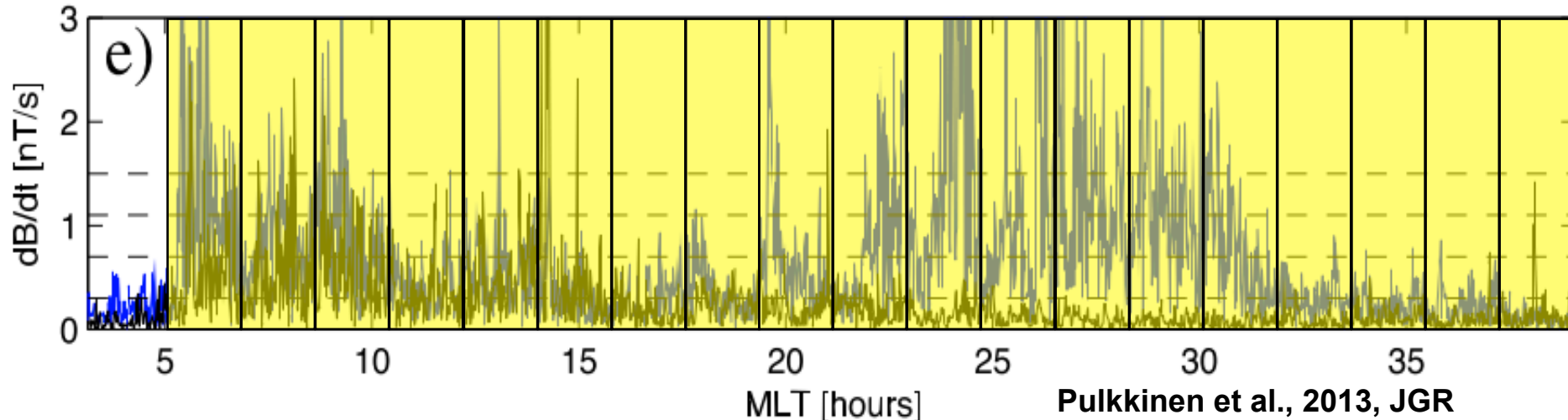
D. Welling & H. Opgenoorth, C.Ngwira, & the dB/dTeam

dB/dt Validation ca 2013

Value of interest: $dB/dt = \sqrt{(dB \downarrow x / dt)^2 + (dB \downarrow y / dt)^2}$
 Binary Event Analysis

Method:

Event no. 2, HIGH-LAT station YKC, model: 9_SWMF (black)



Forecast/Observations		Yes	No	Total
H	Yes	H	M	$H + M$
F	No	F	N	$F + N$
	Total	$H + F$	$M + N$	T

$$POD = \frac{H}{H + M}$$

$$POFD = \frac{F}{F + N}$$

$$HSS = \frac{2(HN - MF)}{(H + M)(M + N) + (H + F)(F + N)}$$

Metrics & Settings

- 20-minute time window
- 1-minute mag data
- 4 thresholds (0.3, 0.7, 1.1, 1.5 nT/s)
- 6 magnetometer stations
- 6 real-world events
- Test both mid- and high-lats

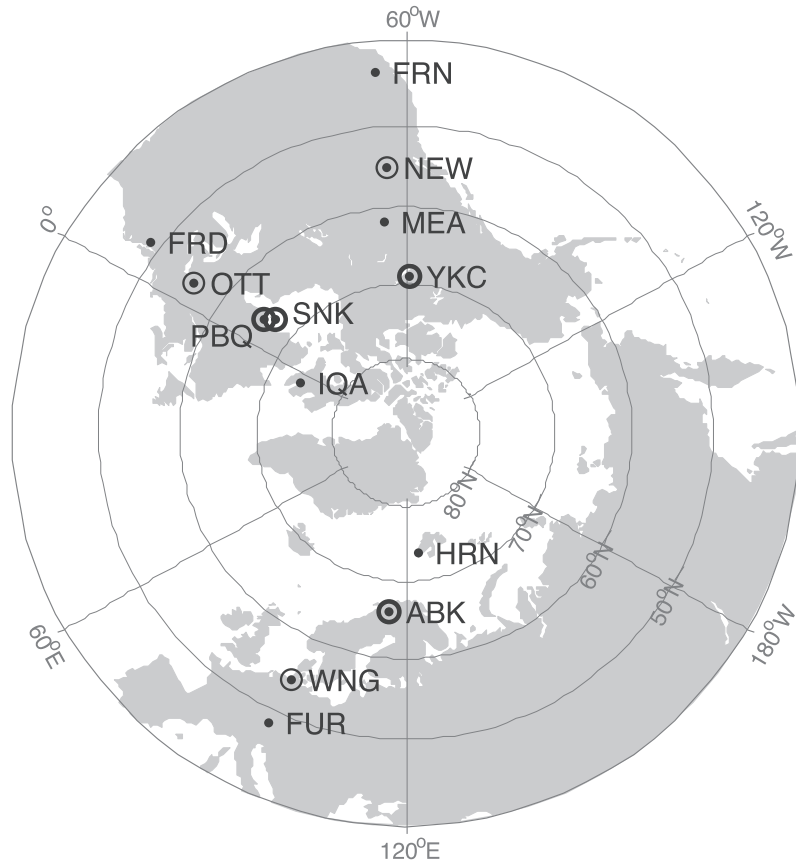
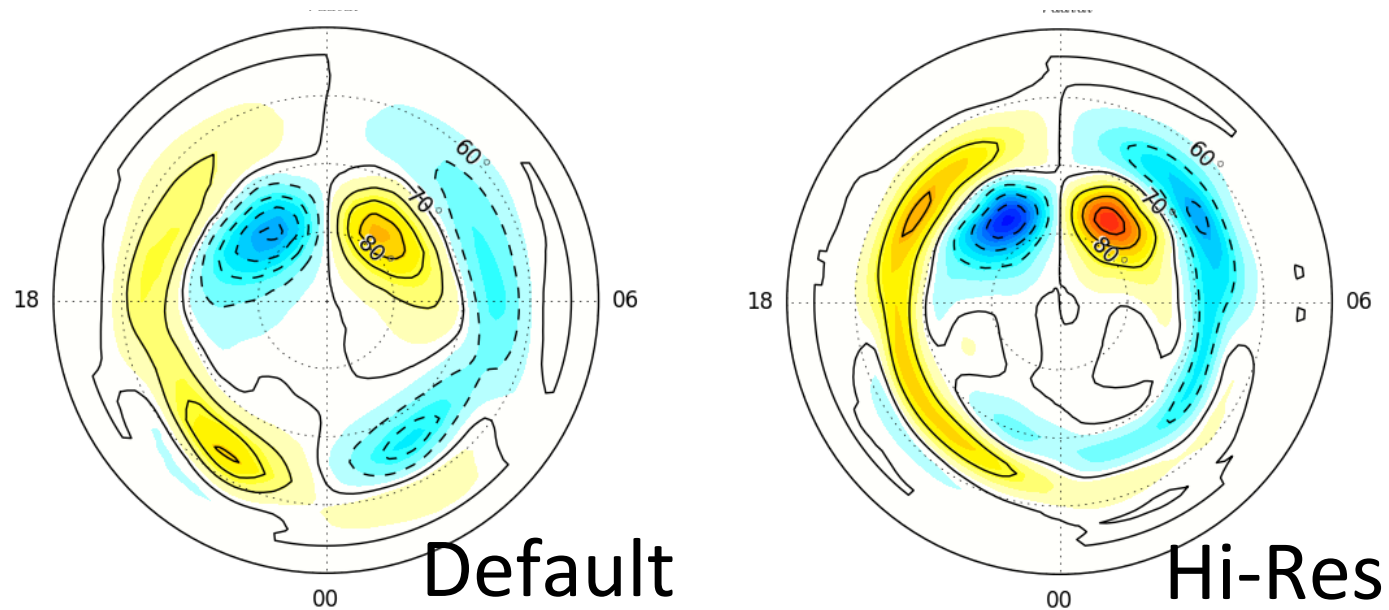


Table 1. Geospace Events Studied in the Validation Activity^a

Event #	Date and Time	Min (<i>Dst</i>)
1	29 October 2003 06:00 UT–30 October 06:00 UT	–353 nT
2	14 December 2006 12:00 UT–16 December 00:00 UT	–139 nT
3	31 August 2001 00:00 UT–1 September 00:00 UT	–40 nT
4	31 August 2005 10:00 UT–1 September 12:00 UT	–131 nT
5	5 April 2010 00:00 UT–6 April 00:00 UT	–73 nT
6	5 August 2011 09:00 UT–6 Aug 09:00 UT	–113 nT

Current Metrics Are Useful!



Threshold	POD	POFD	HSS
0.3 [nT/s]	0.754 (+0.061)	0.181 (+0.011)	0.517 (+0.058)
0.7 [nT/s]	0.637 (+0.073)	0.144 (+0.032)	0.500 (+0.036)
1.1 [nT/s]	0.576 (+0.080)	0.121 (+0.028)	0.476 (+0.039)
1.5 [nT/s]	0.507 (+0.094)	0.100 (+0.027)	0.434 (+0.047)

Table 1: Performance metrics for the SWMF.

Current Metrics Are Limited!

Lack of detailed performance information

- No information about spatial dynamics except mid/high lat groups.
- No information about spatial “near misses”.
- No information about performance as a function of activity strength.
- No information about performance as a function of activity type.

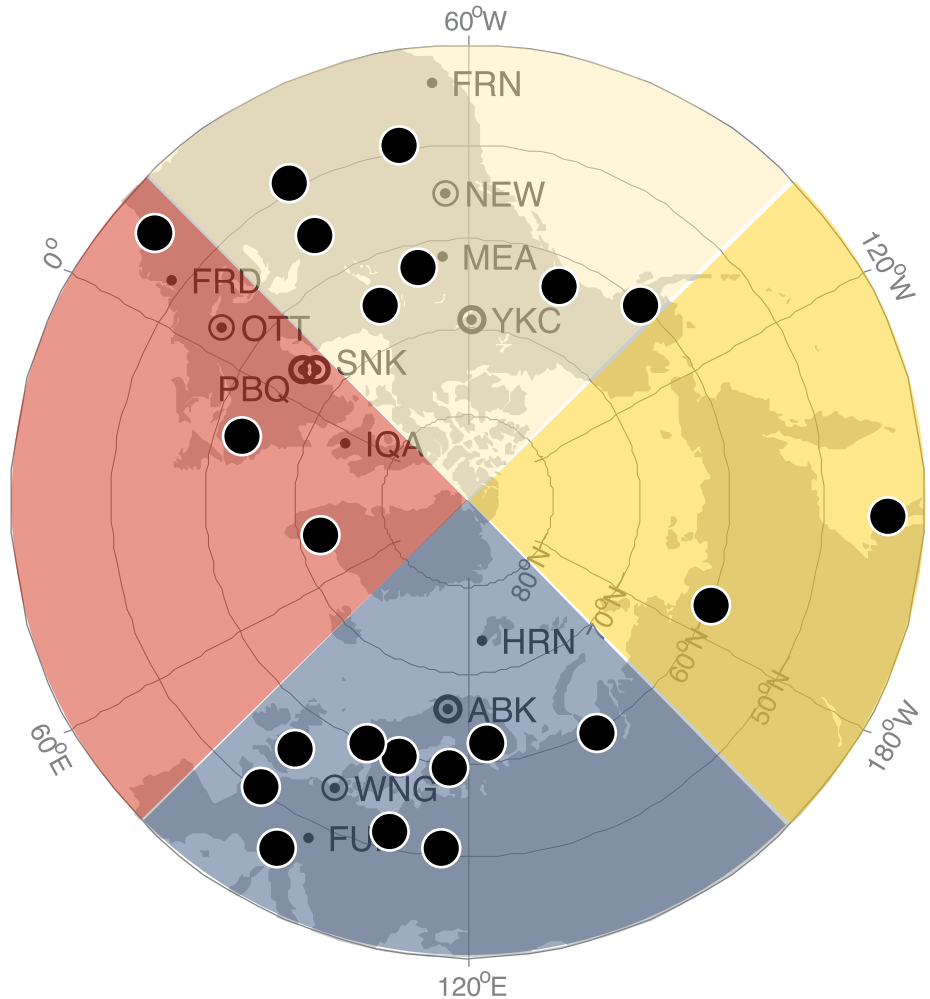
Current events favor moderate activity

- Average minimum $D_{ST} = -141\text{nT}$.
- Extreme events are a focus of the research community.

1-minute time resolution can miss/underestimate dB/dt peaks during strong driving

Our goal: *Agree on achievable next-steps for dB/dt validation.*

dB/dt Validation Improvements



Expand number of magnetometers to *as many as possible* for each event.

Want to cover broader range of local times. Still discussing this point for paper.

Increase data resolution to 10s.

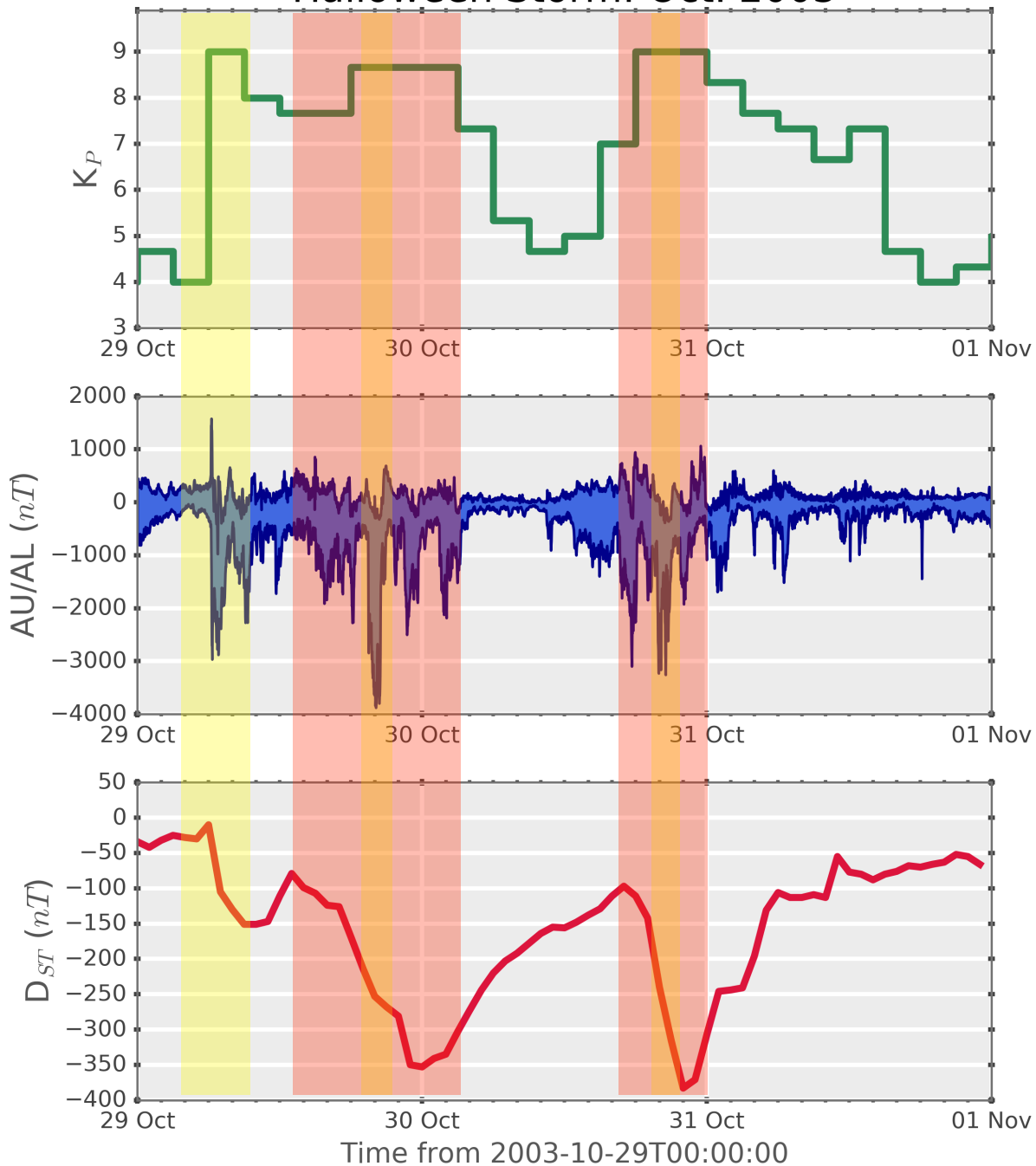
80% of SuperMAG magnetometer data sources will be retained.

1s data is still too rare to be leveraged.

Bin by MLT (**midnight**, **dusk**, **dawn**, **noon**) and examine strongest dB/dt within a region.

Compare *any* observed peak in bin to *any* modeled peak in bin to account for near-misses.

Halloween Storm: Oct. 2003



Segregate by Activity Type

- Storm sudden commencements
- Substorms
- Ring current intensifications/
storm main phase

Future targets:

- Other pulsations
- Quiet & recovery time periods

Identifying New Events

Start Date	Duration	Notes	Score
March 13 th , 2015	~2 Days	St. Patrick's Day Storm	
Nov. 7 th , 2004	~2 Days	Super storm	
March 30 th , 2001	~1.5 Days	Super storm	
March 17 th , 2013	~1.5 Days	St. Patrick's Pocket Edition	
April 6 th , 2000	~1.5 Days	Includes extreme substorm	
July 22 nd , 2004	~7 Days	Unique triple-storm	
May 5 th , 2005	~1 Day	Strong, short storm	

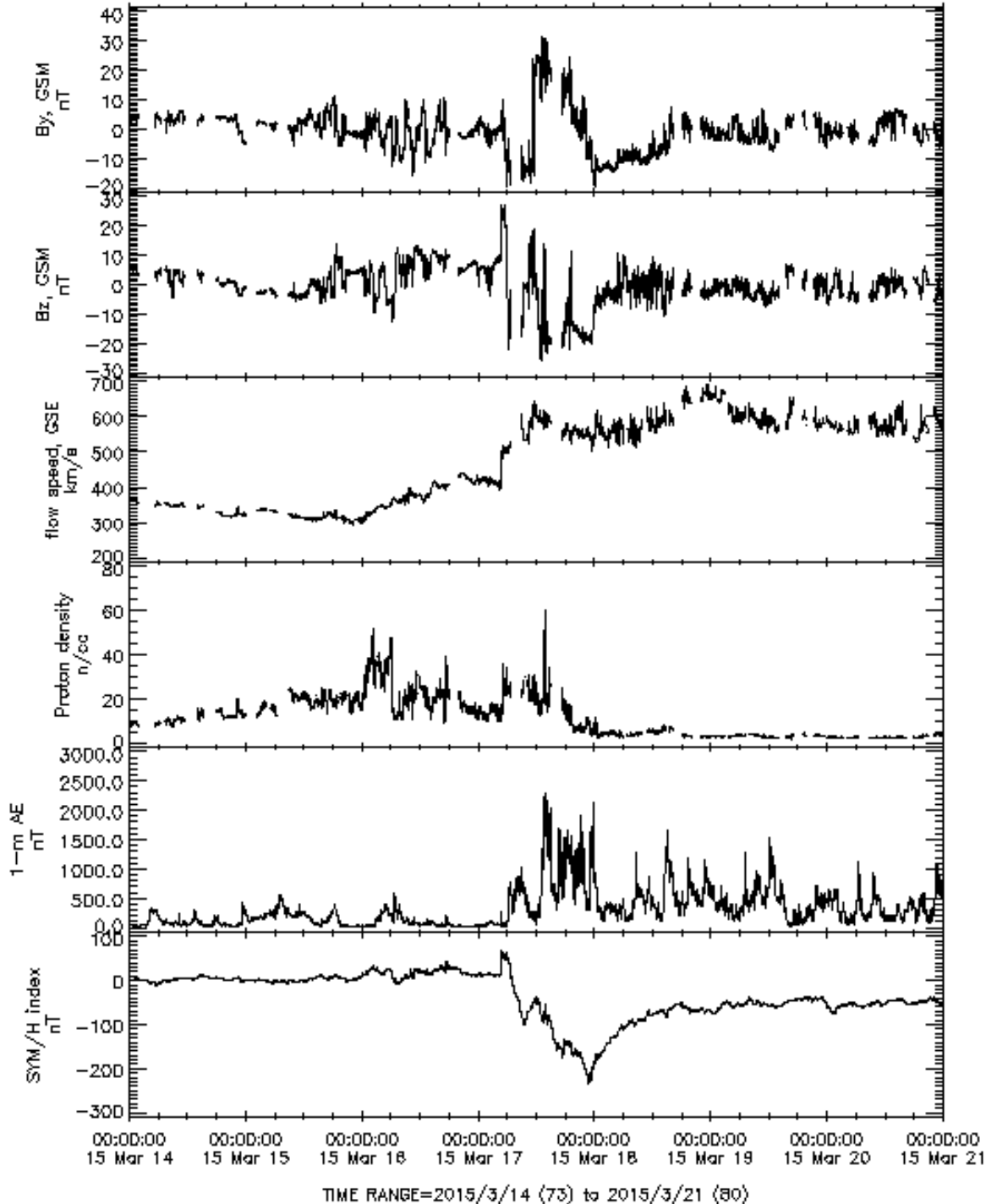
Survey sent out to dB/dTeam to decide on two of these events, provide comments.

Identifying New Events

Start Date	Duration	Notes	Score
March 13 th , 2015	~2 Days	St. Patrick's Day Storm	+12
Nov. 7 th , 2004	~2 Days	Super storm	+4
March 30 th , 2001	~1.5 Days	Super storm	+1
March 17 th , 2013	~1.5 Days	St. Patrick's Pocket Edition	+4
April 6 th , 2000	~1.5 Days	Includes extreme substorm	+6
July 22 nd , 2004	~7 Days	Unique triple-storm	+8
May 5 th , 2005	~1 Day	Strong, short storm	+4

Survey sent out to dB/dTeam to decide on two of these events, provide comments.

St. Patrick's Day Storm March 17, 2015

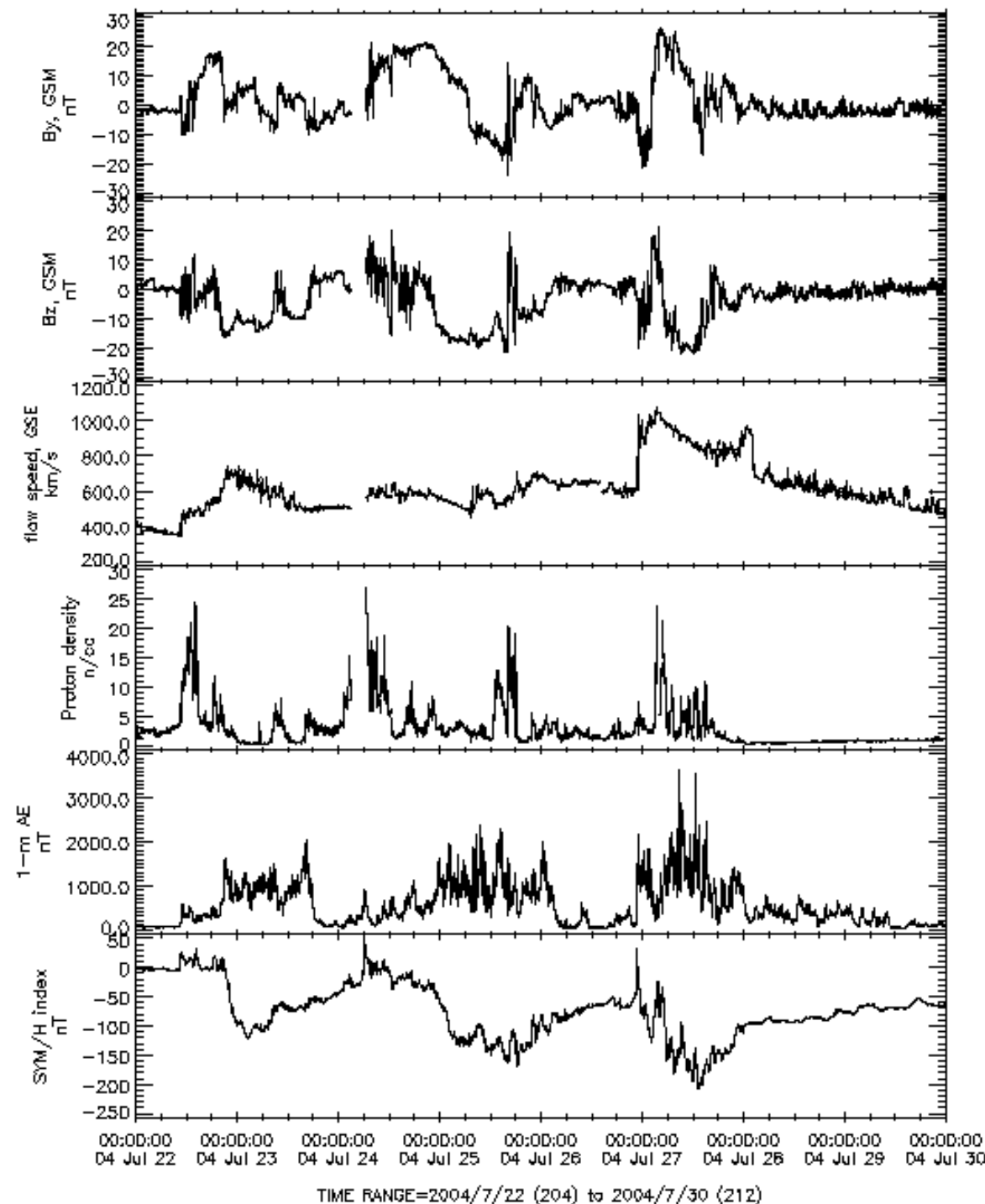


- Only event that was "easy" decision with strong consensus.
- Contemporary event with good data coverage, 1s mag data, VA Probes, etc.
- "[...] only significant storm from solar cycle 24 [...]"
- Impact over North America and Europe.

Triple Storm

July 22nd – 29th 2004

- Triple-storm event with growing intensity.
- Challenges models in unique way via prolonged simulation.
- “[...] great case for examining hysteresis-type effects [...]”
- “Large differences appear at ground magnetometers depending on longitude.”
- “It's a triple storm!”

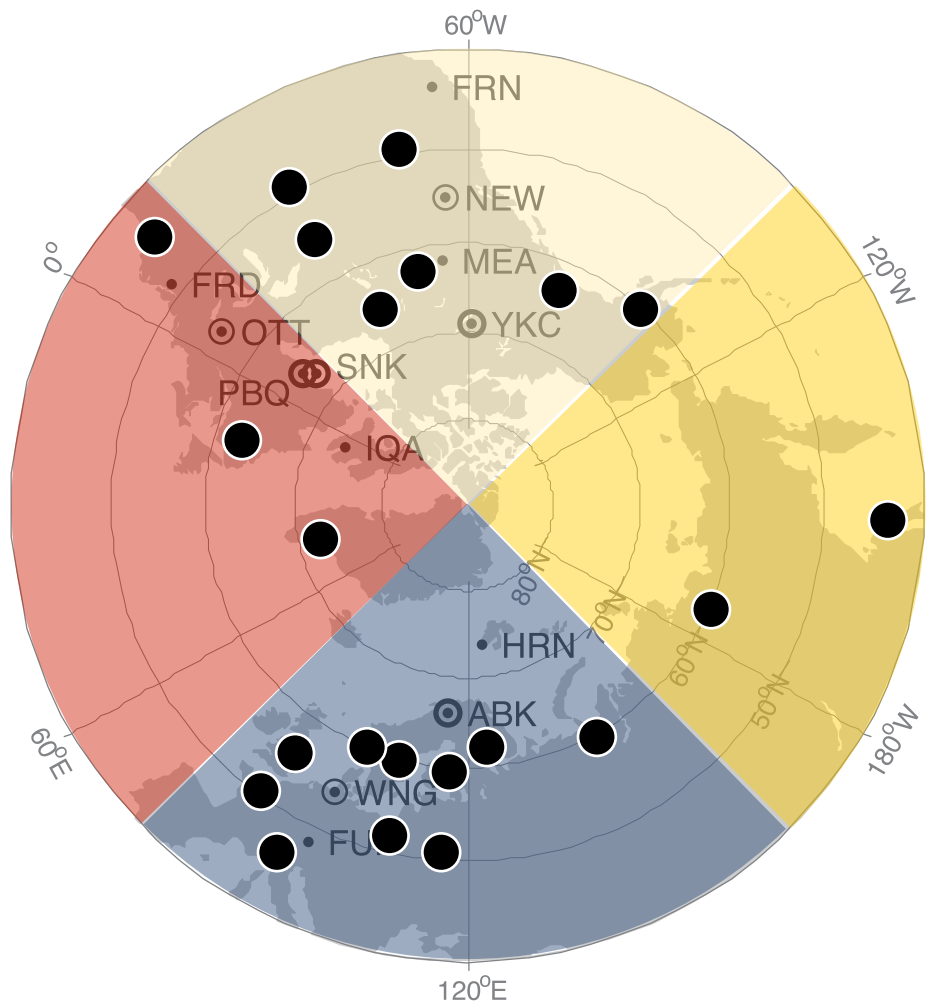


Closing Thoughts on Validation

- These recommendations represent the *immediate* next steps for enhancing the current SWPC/CCMC validation suite.
- Summary manuscript is under preparation for SWE special collection.
- Validation is a function of *user needs*.
 - Main user is SWPC; interest is mostly in dB/dt .
 - As E_{geo} becomes focus, ΔB will become more important.
- Transition from dB/dt to ΔB will require big effort!
 - Binary event study will no longer be relevant methodology.
 - Fundamental reconsideration of metrics & validation.
- Creating validation suites is a *process*, not an end goal.
 - Still open questions to be addressed, including definition of dB/dt

dB/dt Validation Improvements

CCMC dB/dt validation team recommendations for dB/dt:



- Expand number of magnetometers to *as many as possible* for each event.
- Increase data resolution to 10s.
- Bin by MLT (e.g., **midnight**, **dusk**, **dawn**, noon) and examine strongest dB/dt within a region.
- Bin by activity type (substorm, storm sudden commencement, main phase)
- Expand event list with two new events.

Find more information and get involved at ccmc.gsfc.nasa.gov/assessment/topics/geospace-dbdtd.php