CCMC support of the GEM program: Status and Outlook

Dr. Elizabeth MacDonald,
e.a.macdonald@nasa.gov
NASA Goddard Code 673
April 3, 2014

GEM Focus Group Scientific Magnetic Mapping and Techniques
co-leaders: Robyn Millan, Eric Donovan, Liz MacDonald
bit.ly/gem_mapping

Aurorasaurus: www.aurorasaurus.org

CCMC support of the GEM program: blue sky ideas

Dr. Elizabeth MacDonald,
e.a.macdonald@nasa.gov
NASA Goddard
April 3, 2014

GEM Focus Group Scientific Magnetic Mapping and Techniques
co-leaders: Robyn Millan, Eric Donovan, Liz MacDonald
bit.ly/gem_mapping

Aurorasaurus: www.aurorasaurus.org

Introduction/Outline

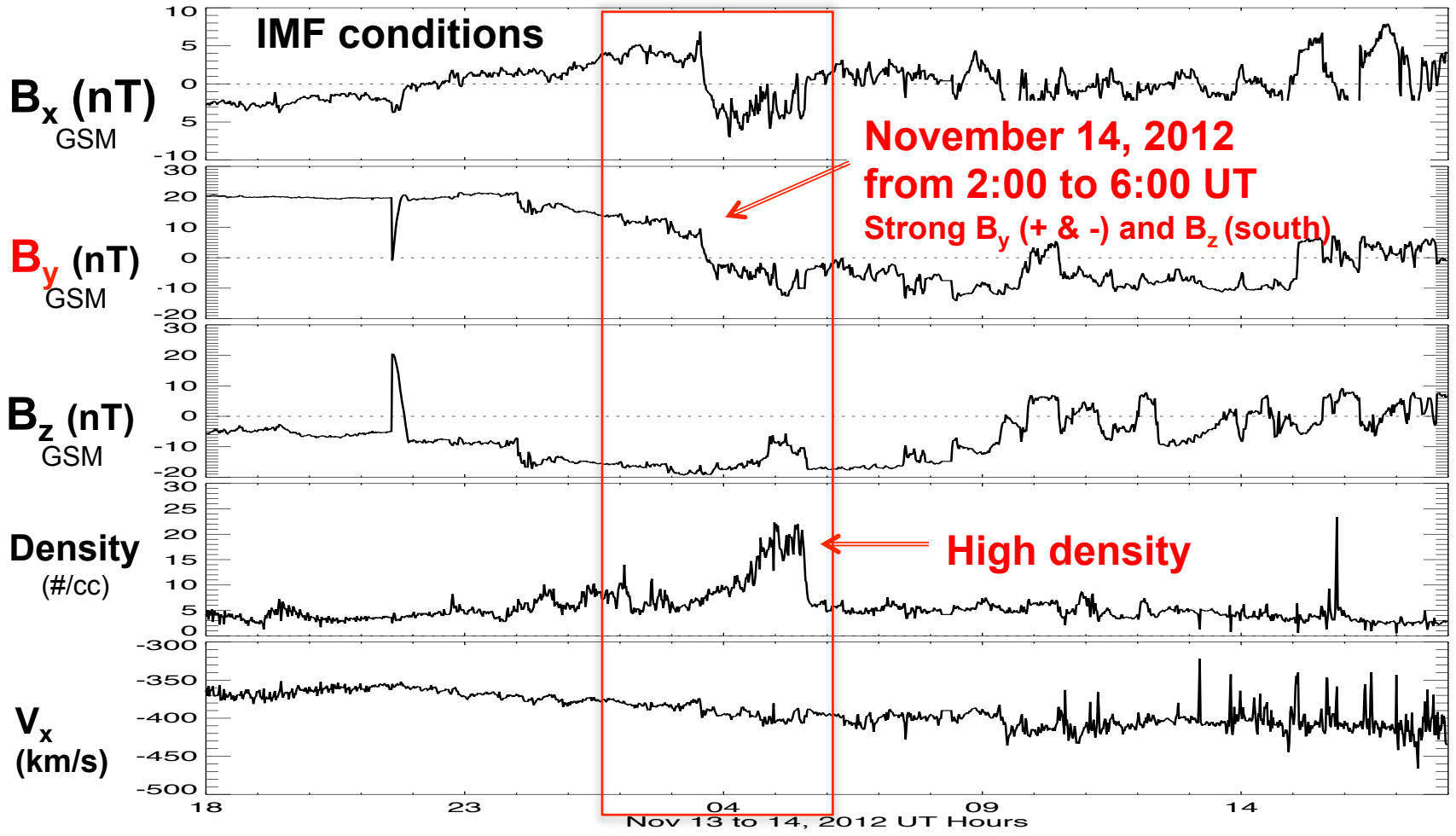
- **GEM**: past steering committee member and Focus group leader for **Scientific Magnetic Field Mapping and Techniques**
- 'Local outsider' experimentalist who likes GEM because the modelers and data analysts admit uncertainties
  - Van Allen Probes and geosynchronous plasma data and instruments
  - Aurorasaurus PI, space weather interdisciplinary
    - Goal: Improve nowcasting of auroral visibility for the public
- My personal views

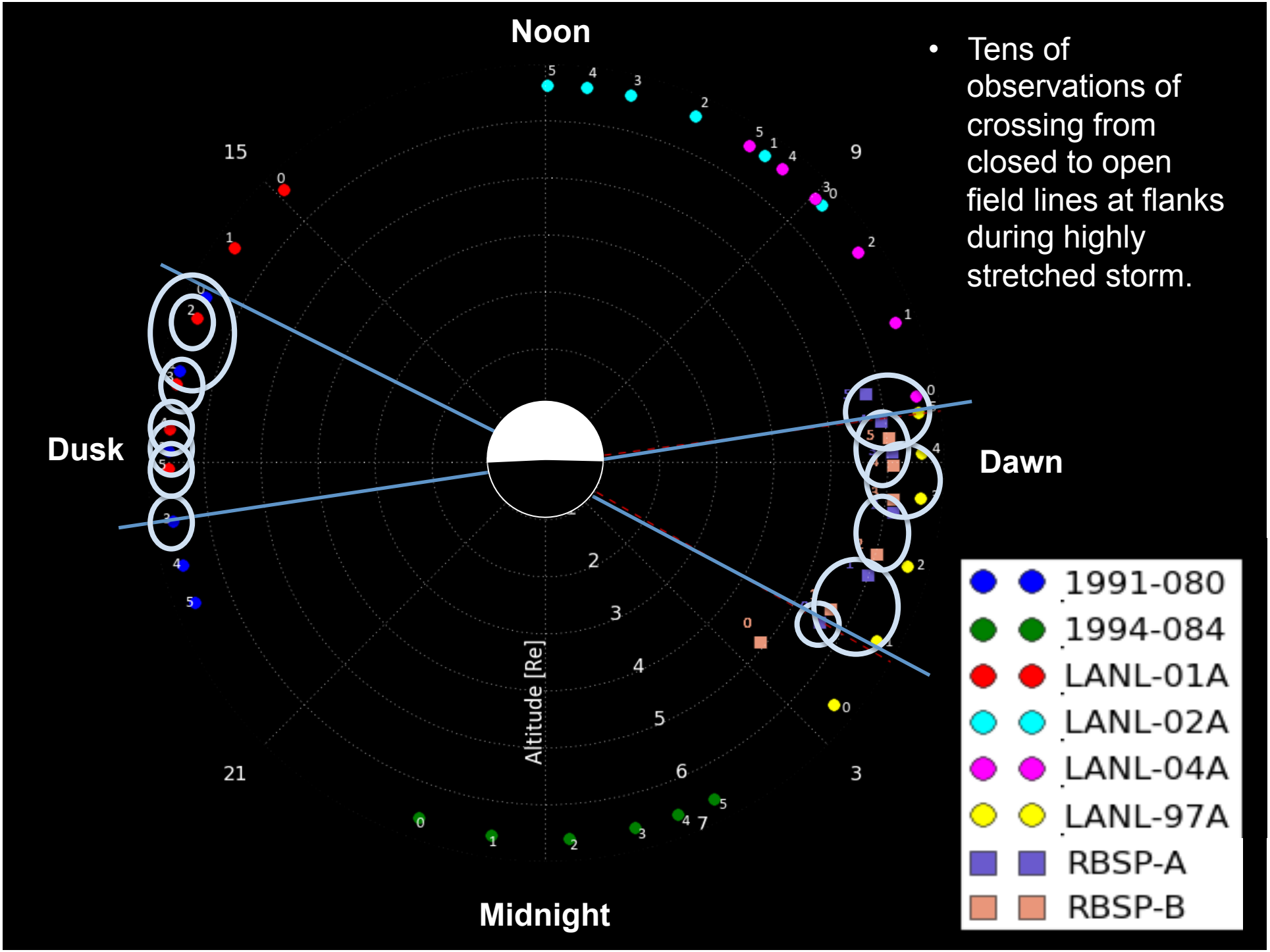
- Example 1: Data-model comparison
- Example 2: Space weather modeling simplified
  - Also data-model comparison
- Conclusion: What does GEM want?

Nov 14, 2012 Lobe crossings GEM Mapping Group Challenge event

E. MacDonald, P. Dixon, A. Glocer, S. Zou, and many others

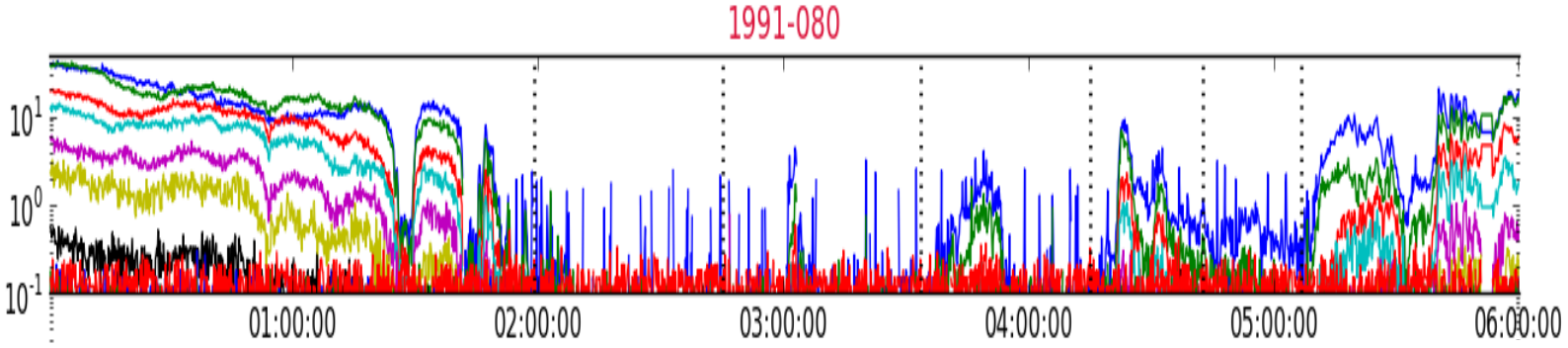
- Can this test mapping? Can this facilitate data model comparison?
- Highly stretched, main phase of storm





- Tens of observations of crossing from closed to open field lines at flanks during highly stretched storm.

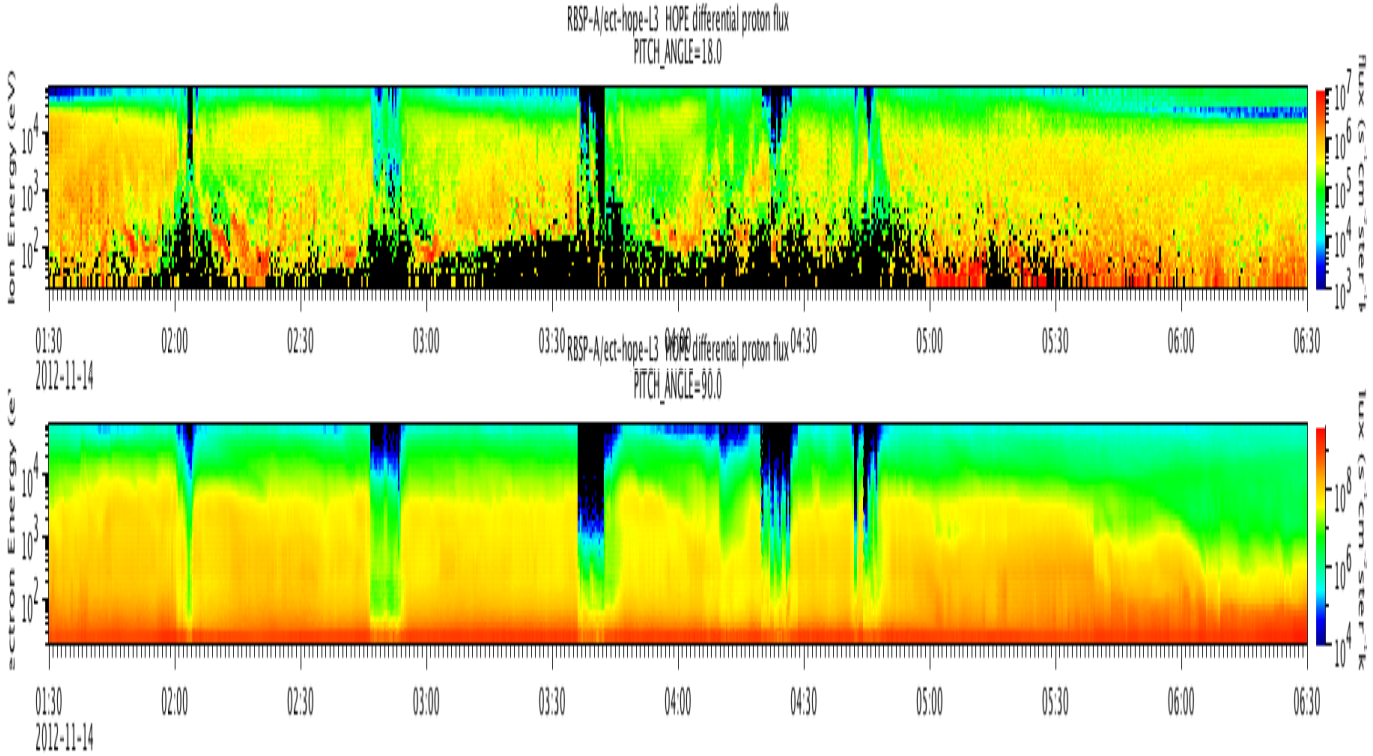
Satellite near dusk, large absences of e- and ion counts and substantial increase in B field strength



RBSP-A H^+

Satellite near dawn

RBSP-A e^-



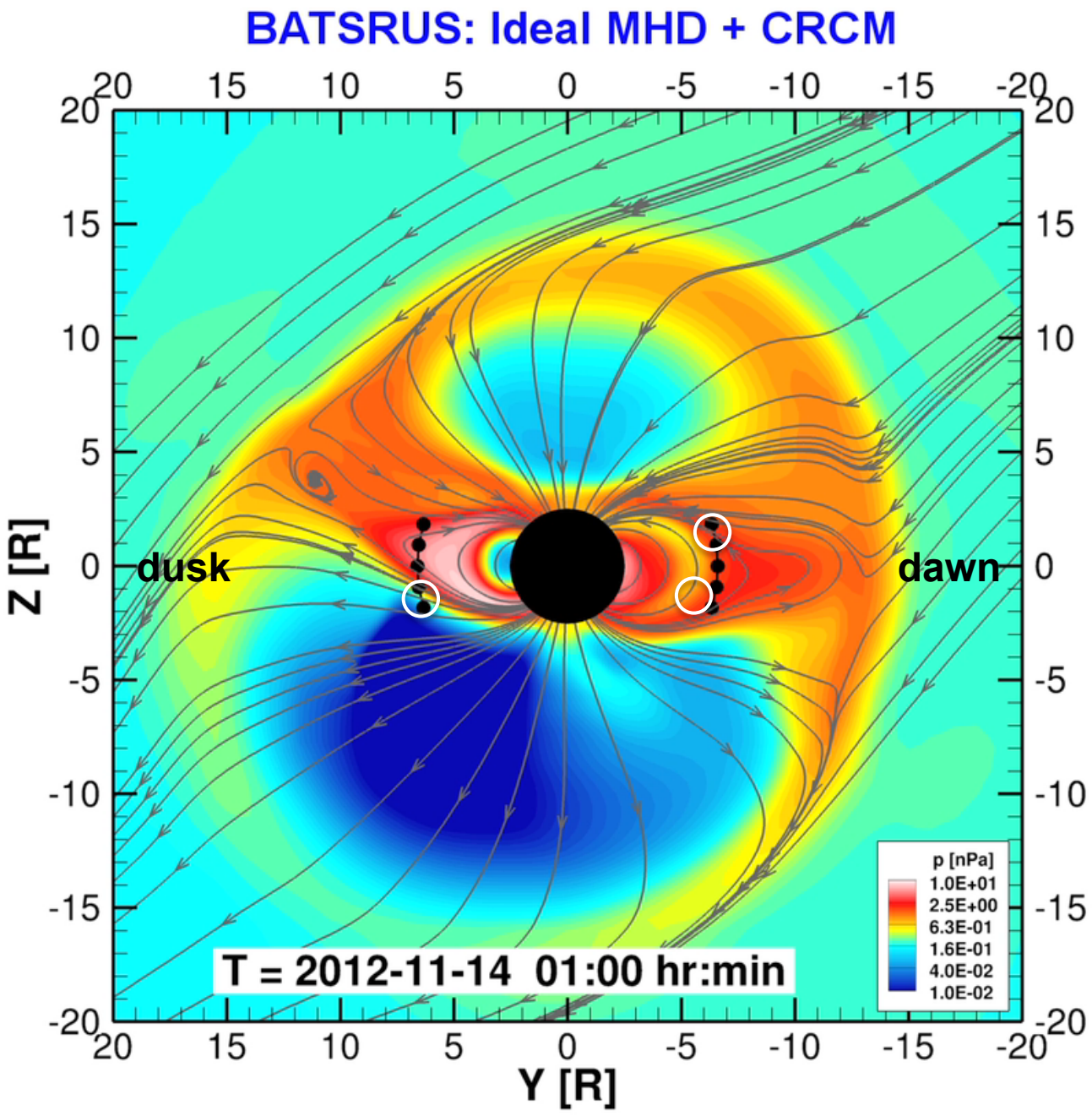
- But various satellites are at significantly different magnetic latitudes.

Y-Z GSM plane looking from down tail.

Ideal MHD + CRCM shows open field lines near satellite locations and overall (prelim.) best fit to observations compared to *Ideal MHD w/ or w/o RCM*.

Courtesy: Shasha Zou, UM

○ indicate sat. locations

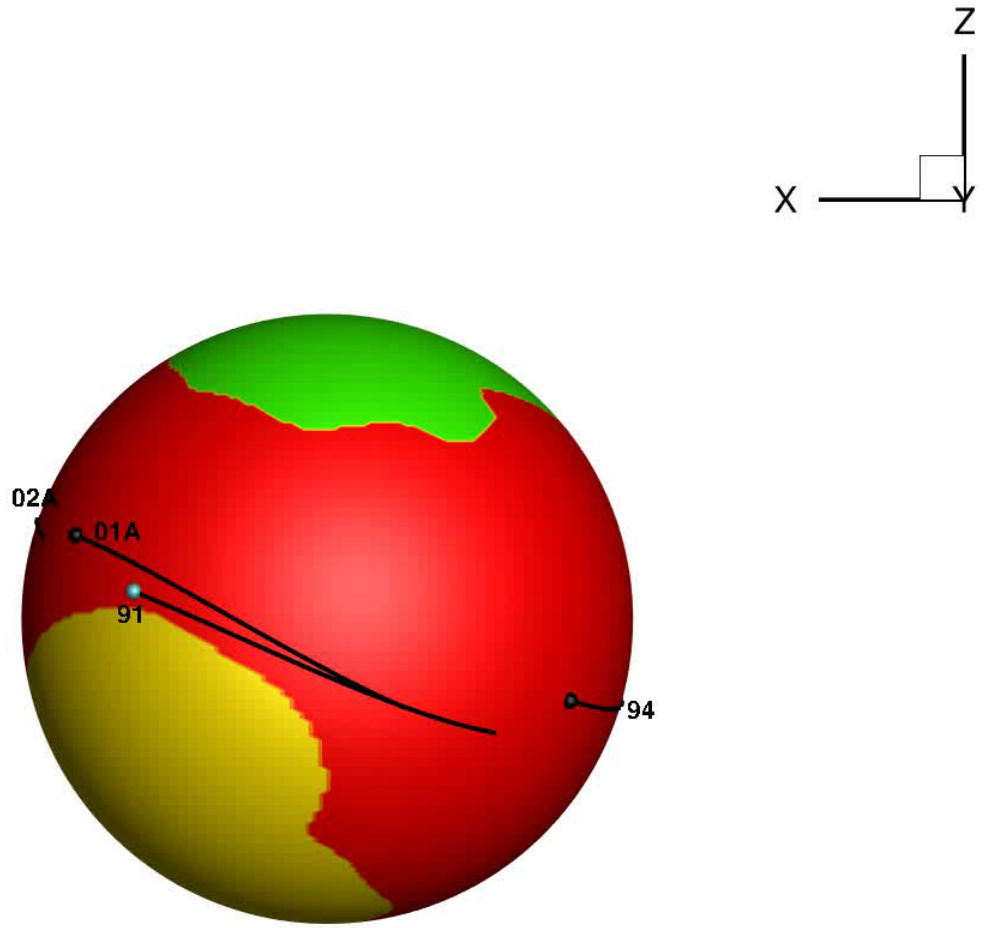


X-Z GSM plane looking at dusk, sphere is 6.6 R_e
BATSRUS+CRCM

Red = Closed field lines, Green = Open northern hemisphere, Yellow = Open southern hemisphere

LANL-GEO trajectories 1991-080 and LANL-01A shown with 'good' correlation to observed dropouts

Courtesy: Alex Glocer, GSFC



November 14, 2012. Time [hours]= 1

Two general validation problems

- How to **visualize** data-model comparisons?
  - Or model-model comparisons?
- How to **quantify** data-model comparisons?
  - Temporal/spatial differences of scale.
- Can satellites be regularly flown through events and visualized? Compare B, flux, etc.
  - Try variations, look at what's missing.
  - Love to hear thoughts on this, solving general problem could illuminate many other examples.
- **Joint GEM session** being planned between Mapping focus group and GGCM Metrics and Validation

Interdisciplinary thoughts on space weather forecasting

- Best practice: for events offer metrics and validation, comparison between models, **confidence and impact**, post-event analysis
  - e.g. Capital Weather excellent **blog** http://www.washingtonpost.com/blogs/capital-weather-gang/
- CME arrival time scoreboard is a start, go further. Offer **analysis**.
  - Public doesn't understand **uncertainties**, e.g. arrival time +/- 7 hrs
    - Better to offer a window and a forecast that slides with the window?
    - e.g. the later the CME arrives the weaker it may be
- Accountability and accuracy
  - When an event completely misses or hits unexpectedly, need to say why.
    - The core reason is because the data are so sparse and space is so large.
  - Overall **confidence** lower than potential **impact**
- Design of the tools matters to scientists and public
  - Easy to use and interpret
  - Communication to the public is another matter entirely
  - Social media as a tool

Aurorasaurus.org: Citizen Scientists Experiencing Extremes of Space Weather

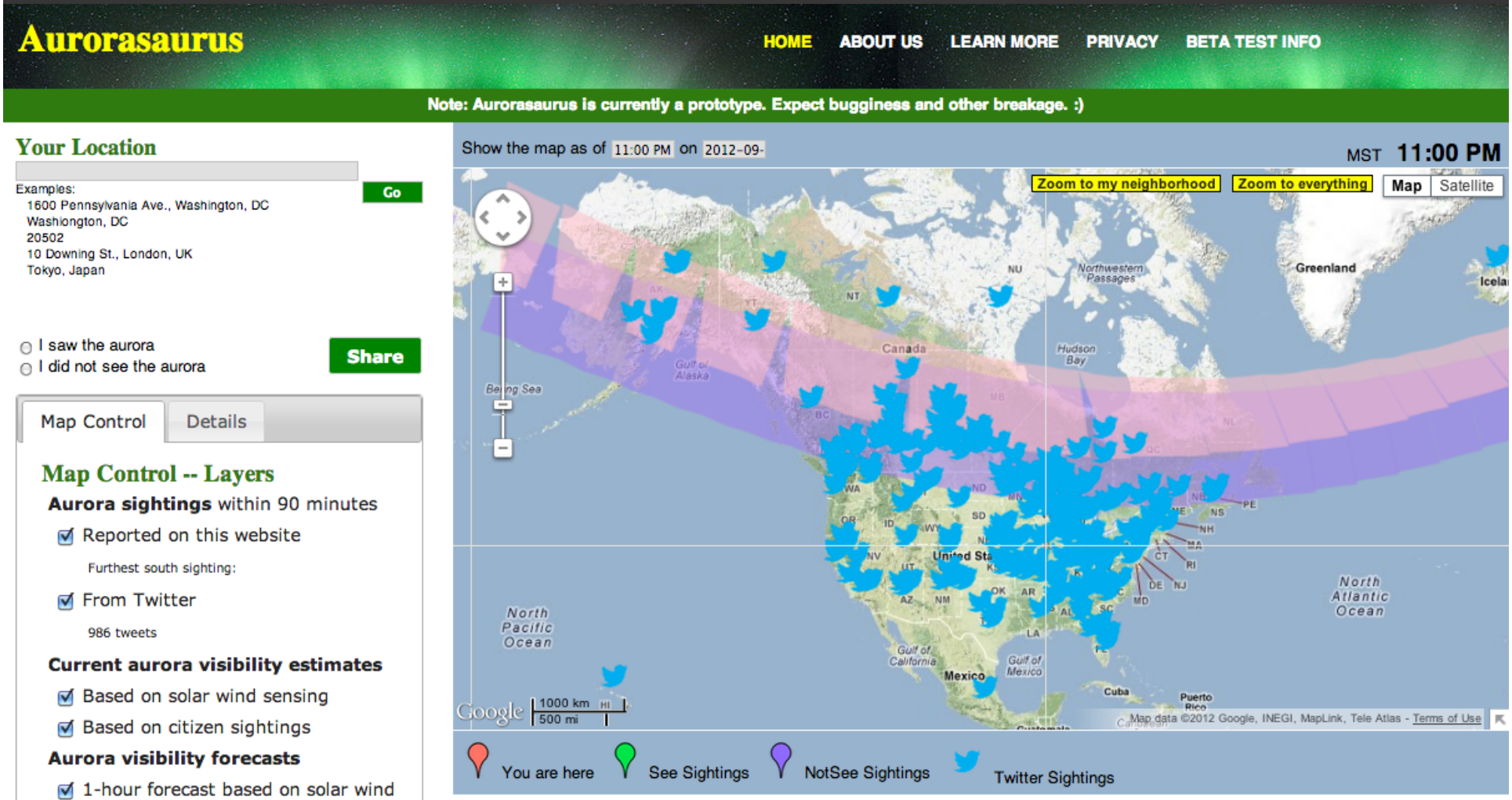
E. MacDonald, NASA GSFC; M. Hall, Science Education Solutions; A. Tapia, IST, Penn. State University; M. Heavner, New Mexico Consortium

INSPIRE = Integrated NSF Support Promoting Interdisciplinary Research and Education to support bold interdisciplinary projects in all NSF-supported areas of science, engineering, and education research

Encompassing geospace, human-centered computing, and informal science education

AURORASAURUS: FIRST SOLAR MAXIMUM WITH SOCIAL MEDIA

REAL-TIME CROWDSOURCING CITIZEN SCIENCE PLATFORM



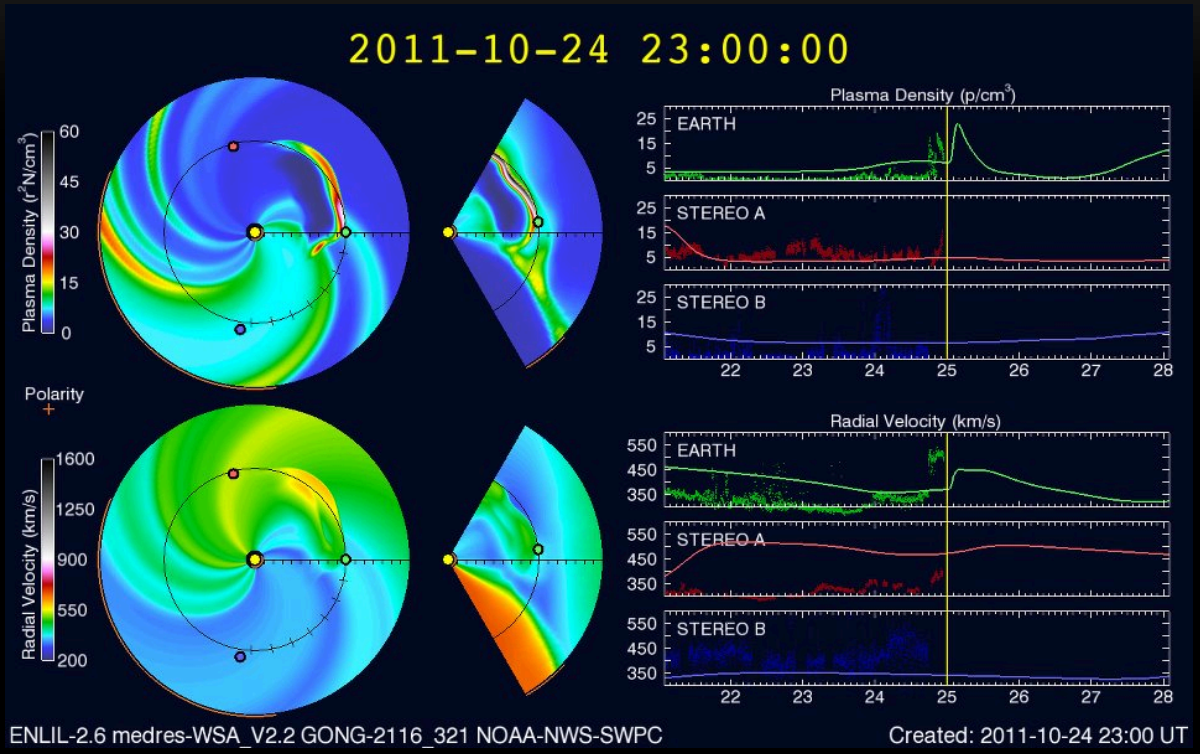
9/30/12

Please e-mail us at aurorasaurus@lanl.gov • Version 4

Aurorasaurus

- What is it?
- Why does it matter here?
- Trying to **educate and interact** with the public, trying to **develop and validate new data source**
- Trying new ideas
  - Solar wind power metric, easier to understand than Bz & v
  - **Confidence** matters. Can watch the Sun emit way more precisely than we can forecast effects. We tell people can't really predict a storm until it hits.
  - Need more operational models of **IMF magnetic field**, strength, and orientation.
  - Terminology matters. Very challenging **jargon**.

#1 HOW CAN I SEE THE NORTHERN LIGHTS? POSES COMMUNICATION CHALLENGES

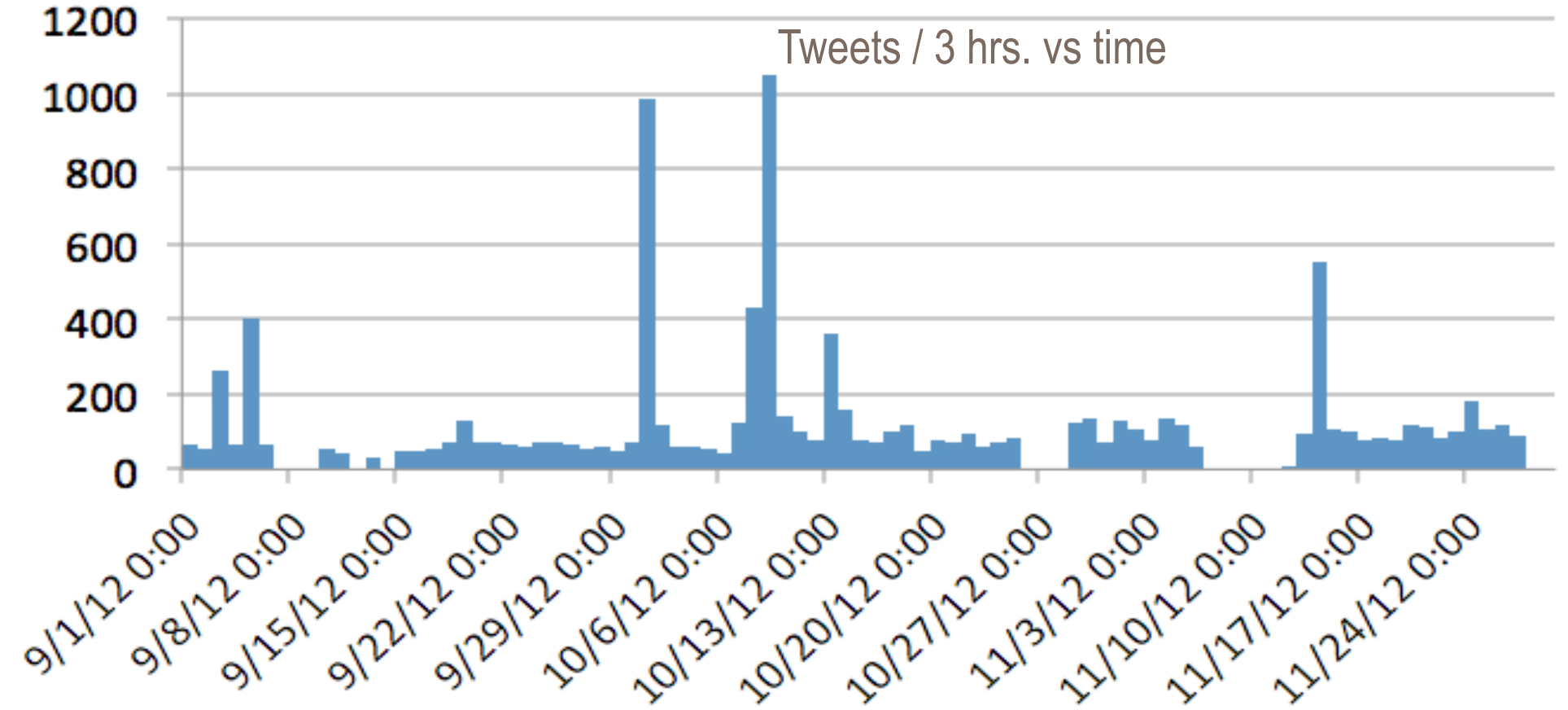


10/24/11

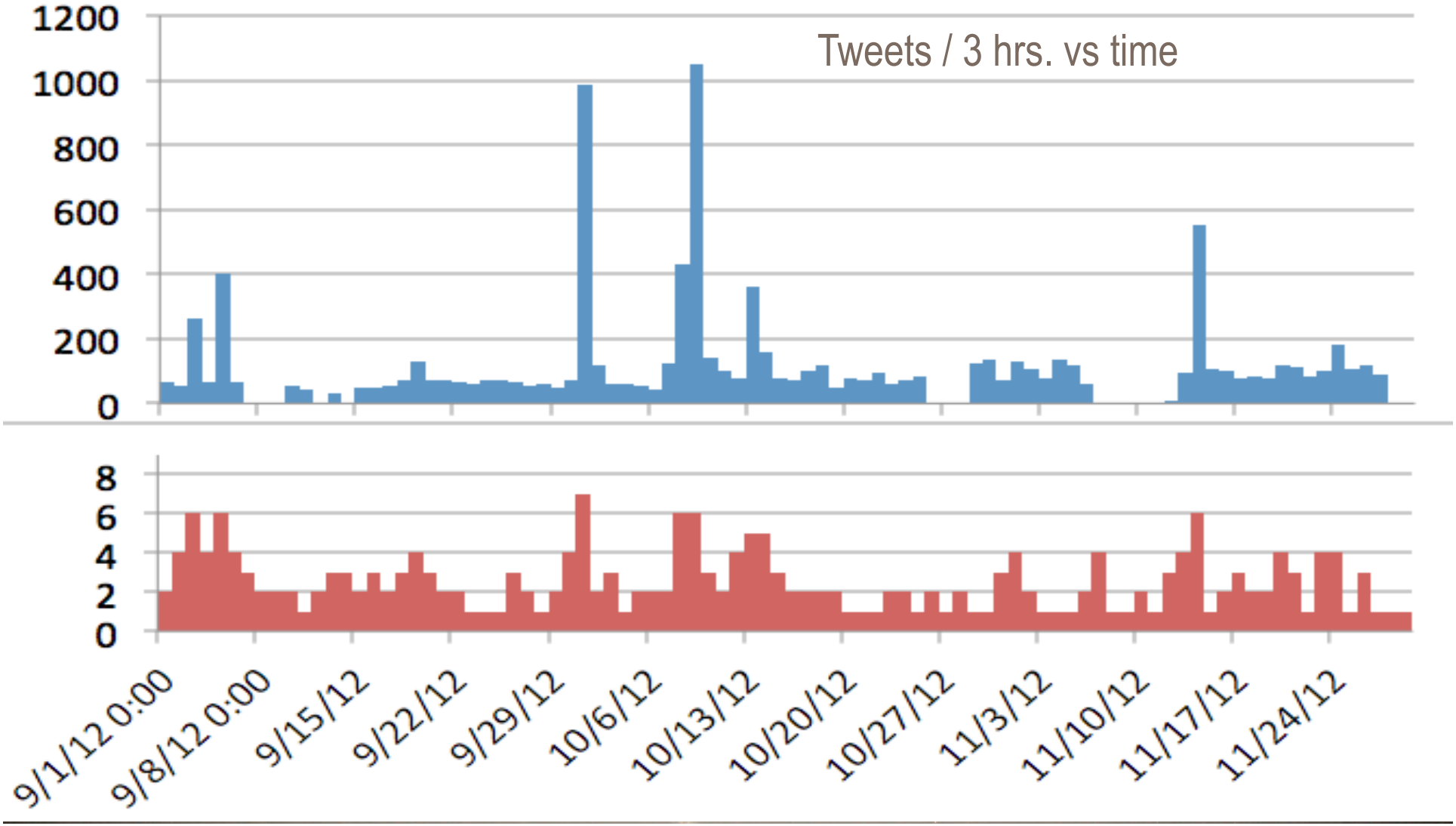
NOAA NWS Space Weather Prediction Center

The Coronal Mass Ejection observed Saturday morning arrived earlier today (Monday EDT and GMT), about 8 hours earlier than model guidance suggested. Significant space weather is not expected. Early phases of the event have reached the G1 level (http://go.usa.gov/9oi), but that should be close to the peak seen in this event. At the G1 level, weak power grid fluctuations and minor impacts on satellite operations are possible. Any power grid fluctuations are handled by the power companies and will not be visible to end customers. As for Aurora, keep an eye on the SWPC test forecast product called Ovation (http://go.usa.gov/XrR), but in general, you need to be far north in a place where you are used to seeing the aurora to have a chance of seeing anything at these levels. As always, keep your browser tuned to www.spaceweather.gov

But will it work?
Sifting through 340M tweets per day



Real-time tweets correlate with the real-time Kp index of activity (>4)



Coming soon: App and Enhanced Website

- Nowcast of aurora oval including verified human REAL-TIME observations
- Community can log in AND be notified
- Upvote tweets to validate
- Low jargon, fun, educational, engaging citizen science experience
- Postdoc and outreach positions available

Join us!

www.aurorasaurus.org

www.facebook.com/aurorasaurus.org

Photo credit: Astronomy North, Yellowknife, NWT, Canada

Conclusion

- What do we want?
- Better tools to evaluate data model comparison (starting)
  - Useful for events, ion composition, substorm studies
- Accurate predictions of IMF B strength and orientation (currently prioritized)
- Real-time use of big data (starting)
- Validated auroral oval (currently underway with CCMC)
- Open dialogue around data model comparison
  - Uncertainties and confidence