




SET



Anemomilos



Operational Dst from real-time data streams and forecast algorithms

W.K. TOBISKA, D. KNIPP, D. BOUWER, R. SHELLEY, J. BAILEY, B. BURKE, P. HAGAN, D. ODSTRCIL, J. LOVE, J. GANNON, P. FRIBERG, V. ECCLES, B. SCHUNK, D. INTRILIGATOR, M. HESSE, M. KUZNETSOVA, R. MORRIS, R. QUINN, S. O'MALLEY, AND B. BOWMAN



Geomagnetic Space Weather Affects Technology

- Satellite drag
- Power grid GIC
- Aviation radiation
- GPS position accuracy
- Communication outages
- Satellite surface charging



Turning Measurements into Useful Products

- **Real-time Dst:** operational data is now being produced by several institutions
- **Forecast Dst:** operational algorithms (prime/stream A and redundant/stream B) now being tested
- **Distributed Network:** Real-time and forecast Dst is collected/produced/delivered via a distributed network to provide end-user content (a supply chain)
- **Satellite Drag End Product:** Dst is an input into JB2008 thermospheric density model used for operational satellite drag calculations



SPACE ENVIRONMENT TECHNOLOGIES

Space Research Space Operations Space Standards

OPERATIONAL DST



JB2008 2010/195 23:27 400 km

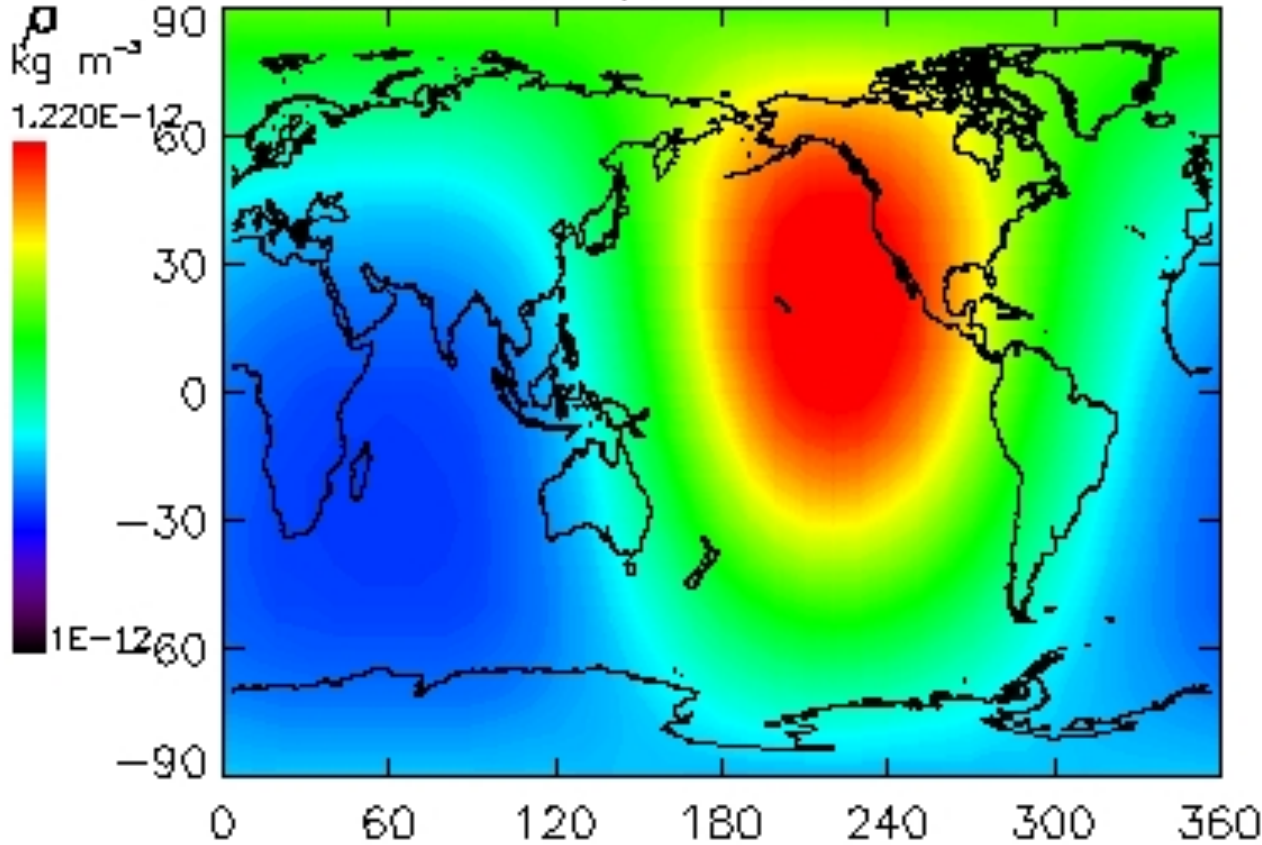
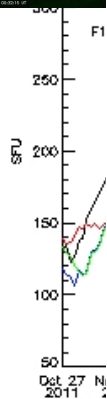
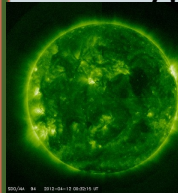
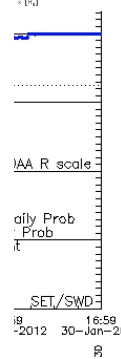
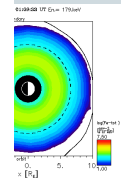


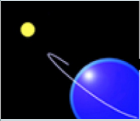
photo
corona
drag



ere

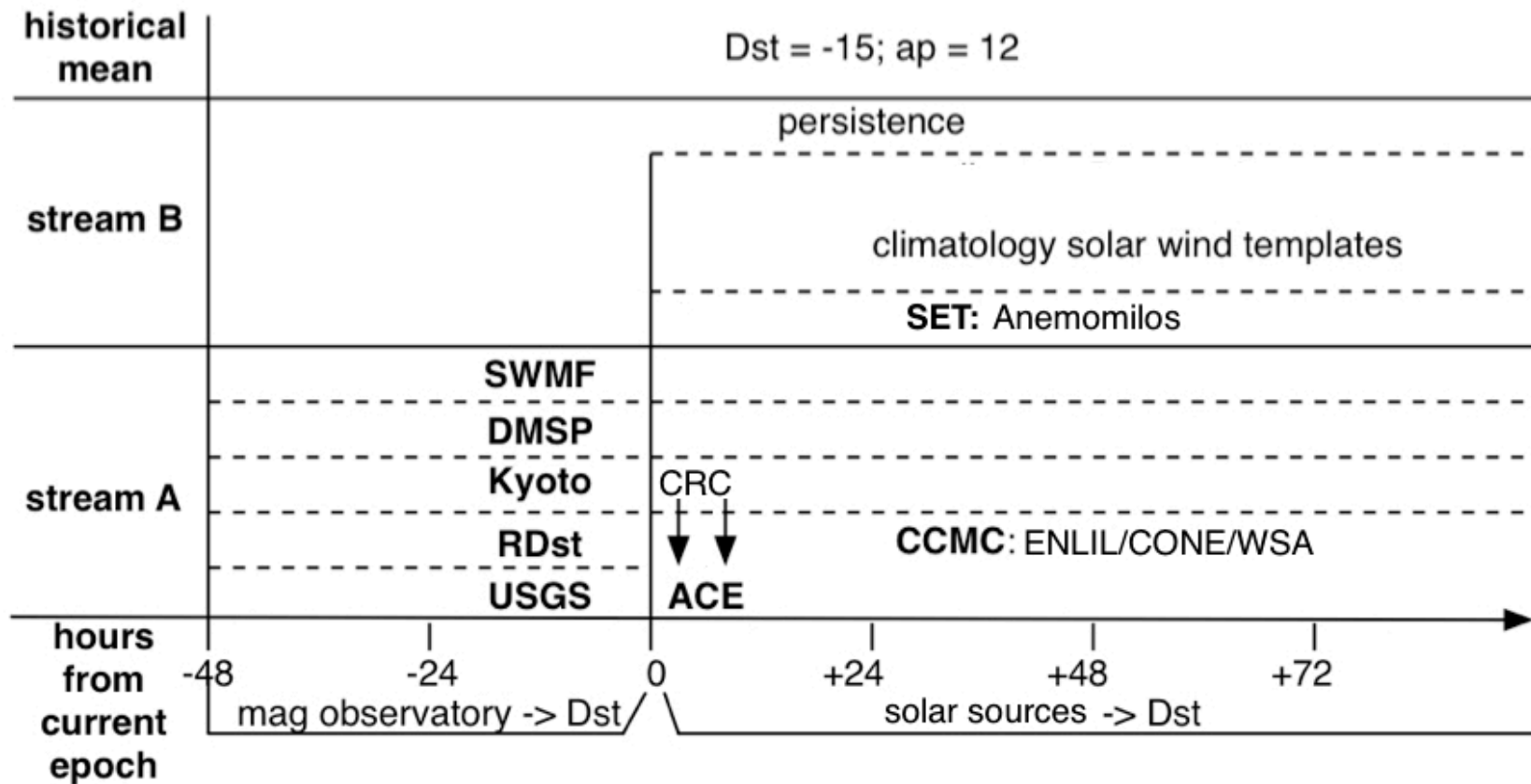
nt
S
S





Operational Dst goals

Hierarchy of definitive, real-time, and forecast Dst redundancy

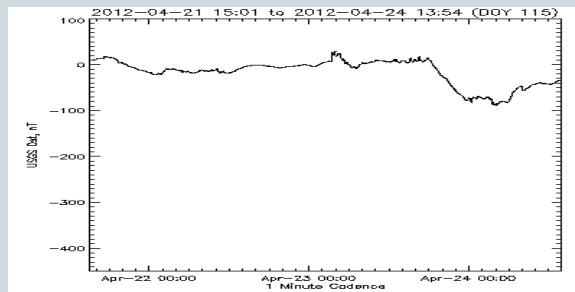




Real-time operational Dst

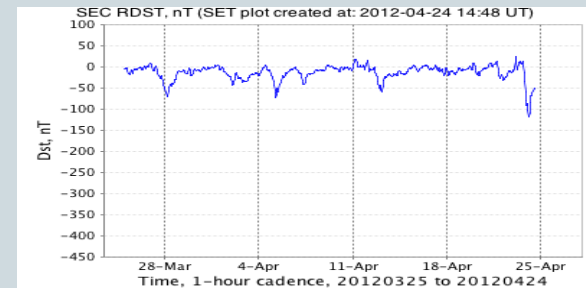
USGS

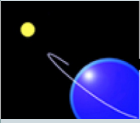
- uses up to 4 magnetic observatories (HER, SJN, HON, KAK)
- produces 1-minute Dst



SEC

- uses up to 4 magnetic observatories (HER, SJN, HON, GUA)
- produces 1-hour Dst

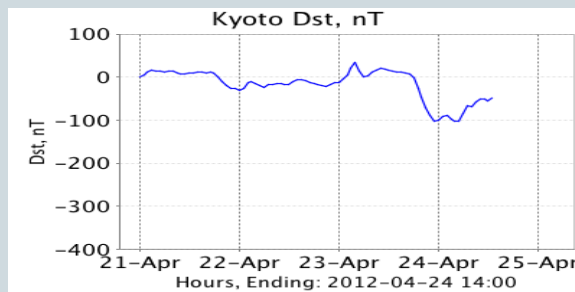




Real-time operational Dst

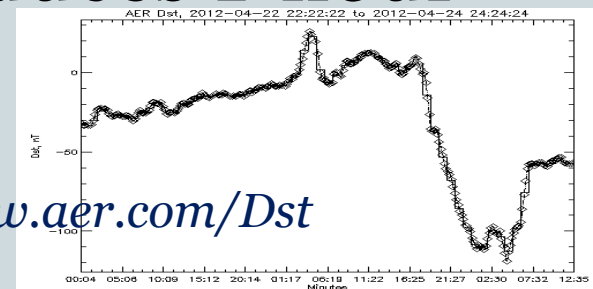
Kyoto

- uses up to 4 magnetic observatories (HER, SJN, HON, KAK)
- produces 1-hour Dst



AER & SET DMSP

- uses SSM data from 2-4 DMSP satellites
- produces 1-hour Dst



<http://www.aer.com/Dst>

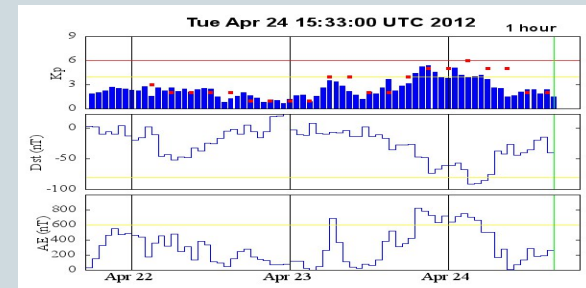
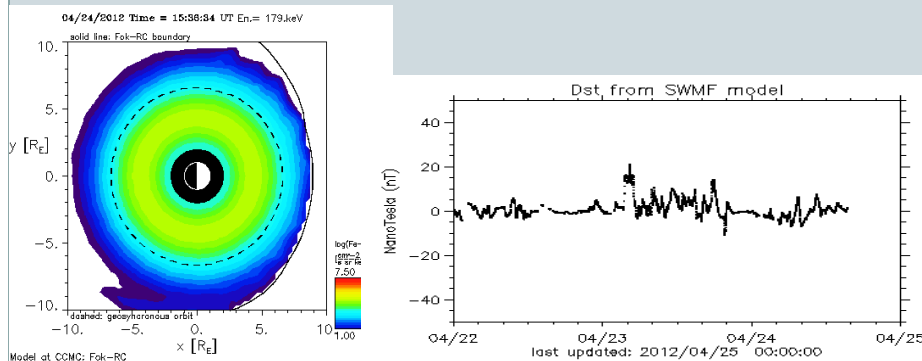
Real-time operational Dst

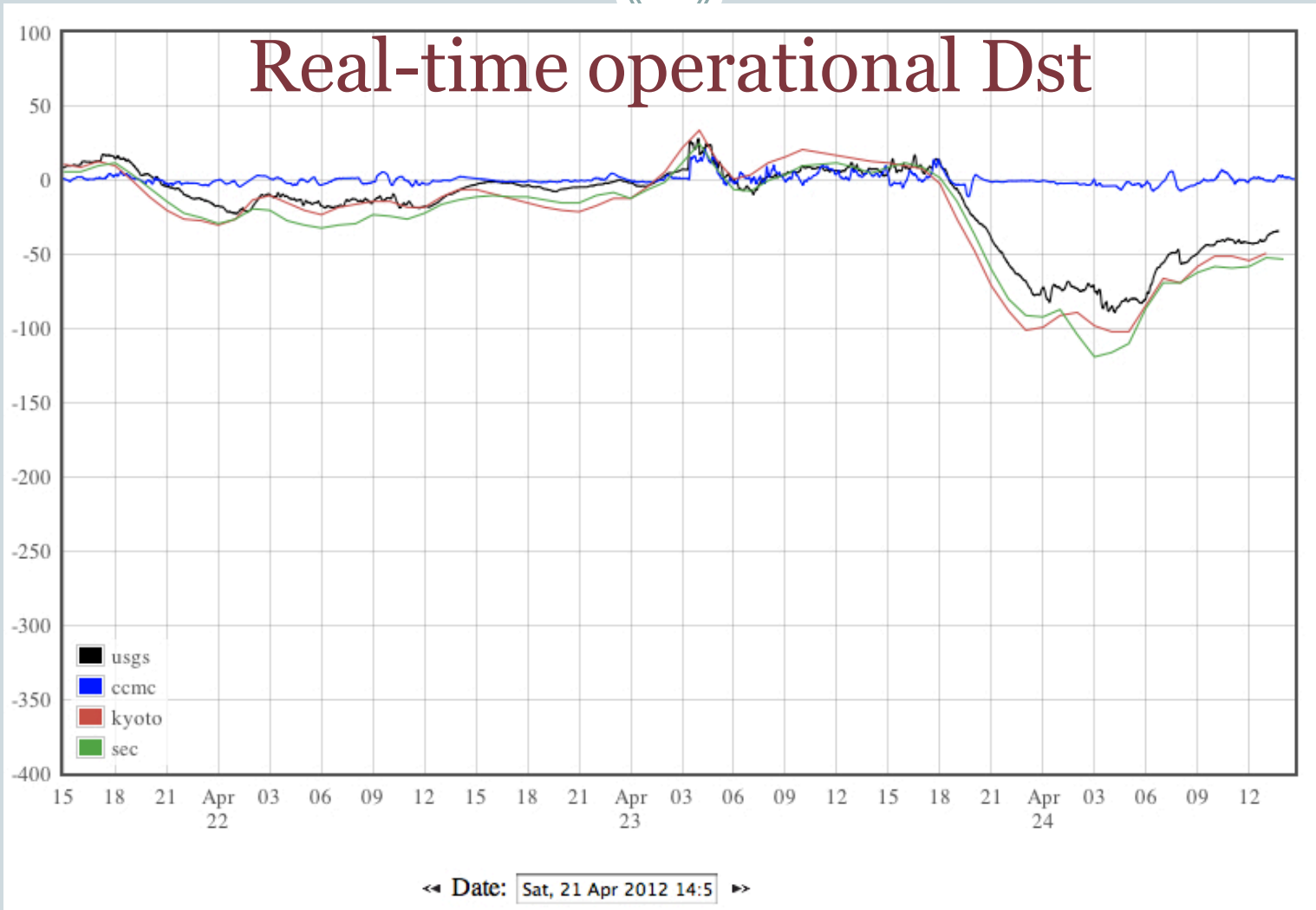
CCMC

- uses SWMF and Fok Ring Current
- produces 1-minute Dst

Other sources

- Rice, UCB, Berkeley, ...
- produce 1-hour Dst







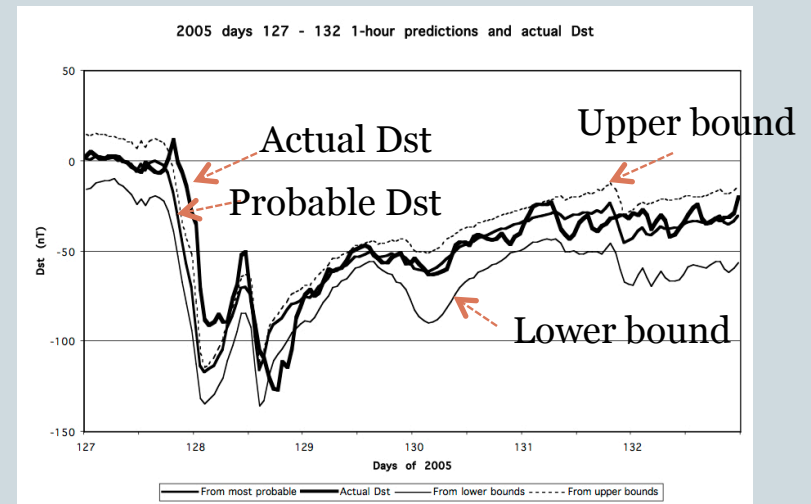
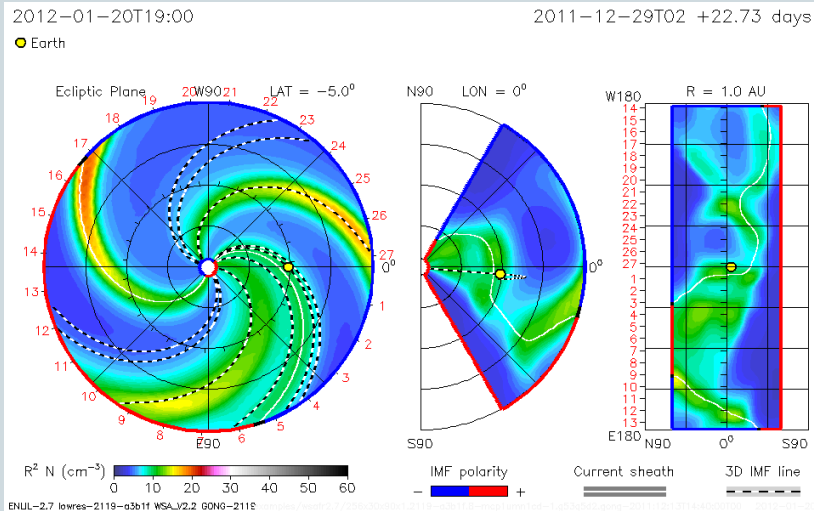
Dst operational forecasting – Stream A

ENLIL/Cone/WSA

- 72-hour forecast of hourly Dst

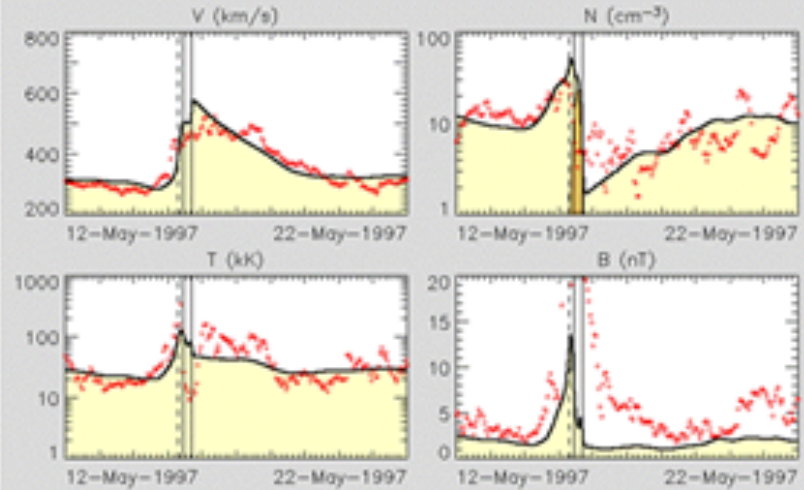
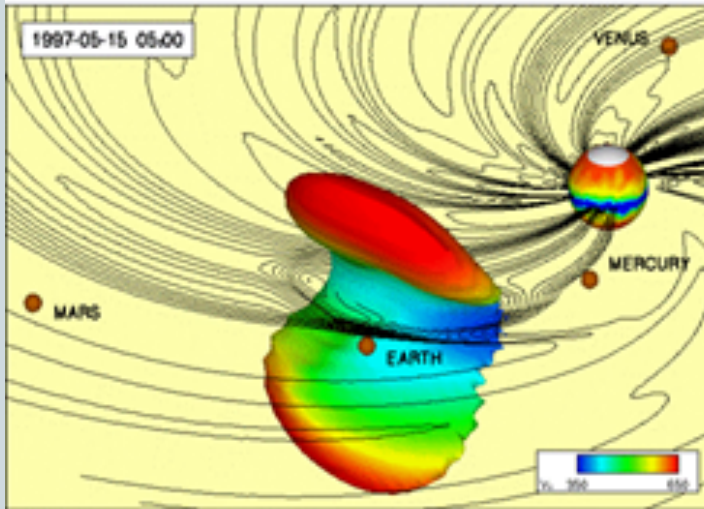
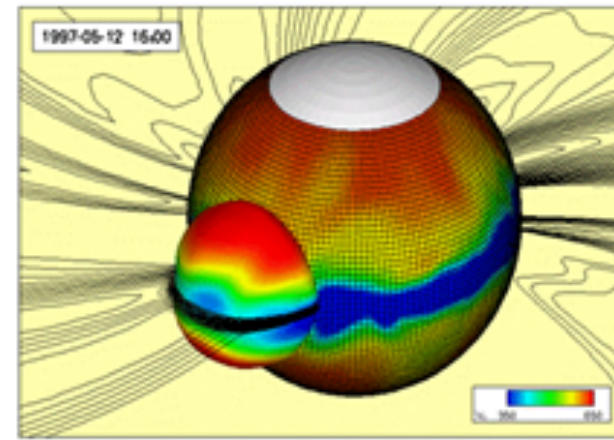
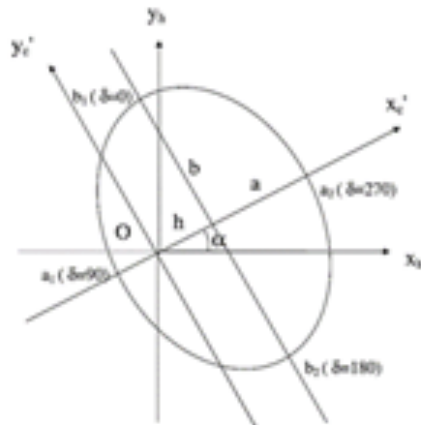
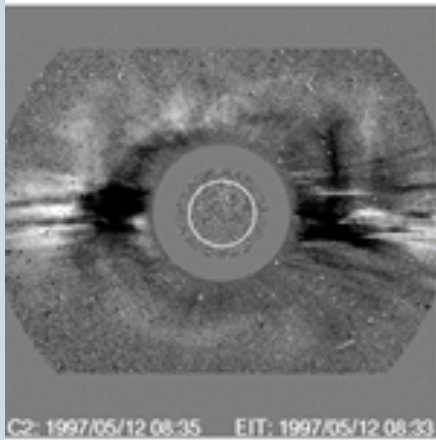
Carmel Research Center

- 1–5 hour forecast of Dst



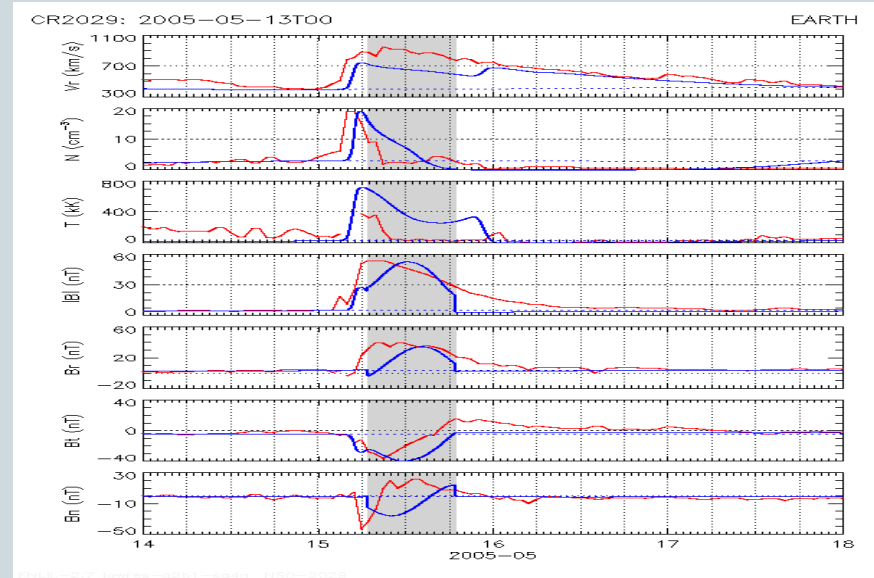
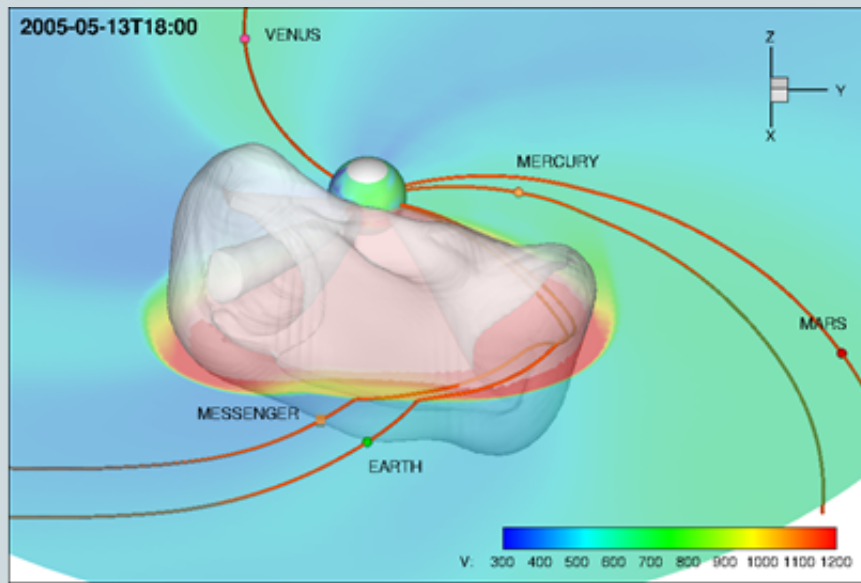


ENLIL/Cone/WSA





ENLIL/Rope/WSA

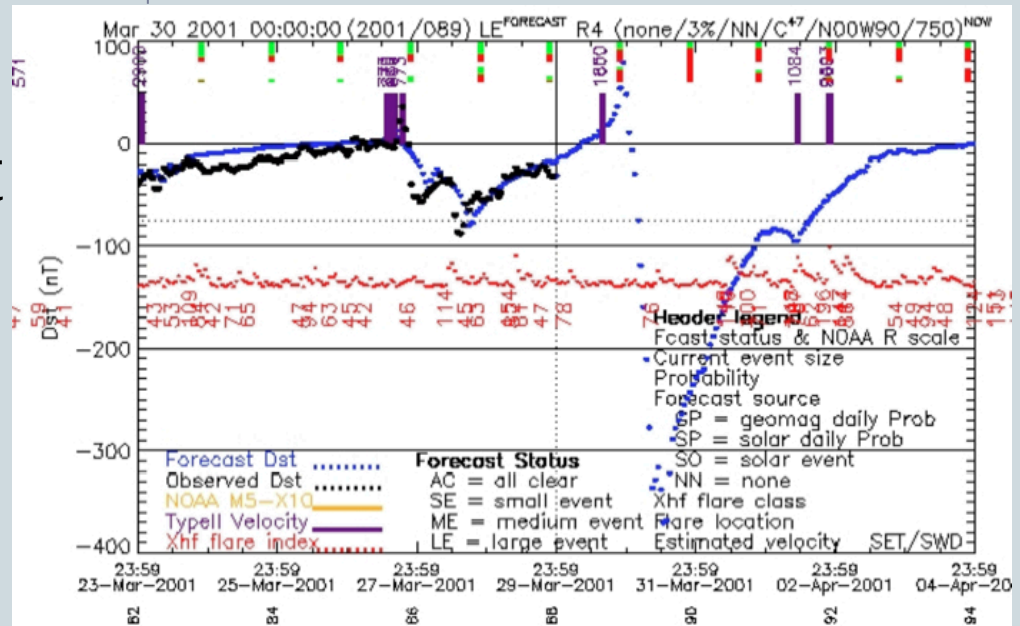


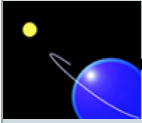


Dst operational forecasting – Stream B

Anemomilos

- 6-day forecast of hourly Dst
- data-driven deterministic algorithm
- uses 3 solar observables





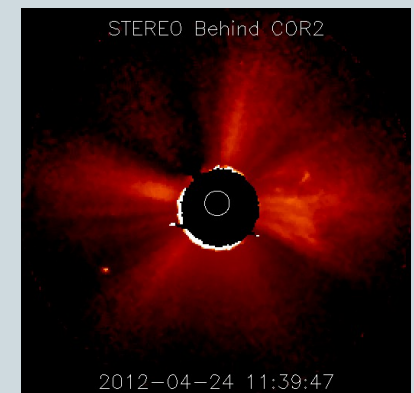
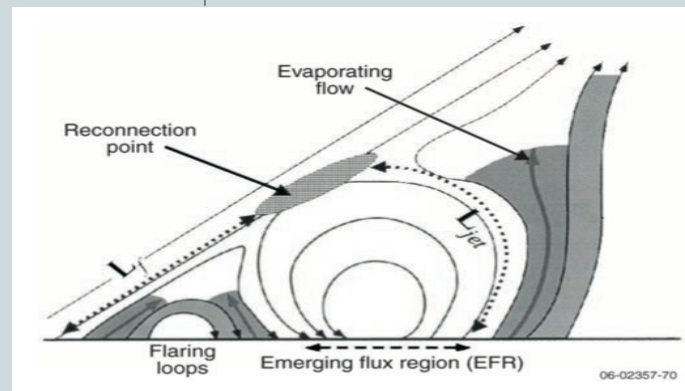
Anemomilos

Background

- ejecta (particles) continually shed from flares
- larger ones are CMEs
- evidence in coronagraph images

3 observables

- ejecta **quantity**
- flare **location**
- ejecta **velocity**

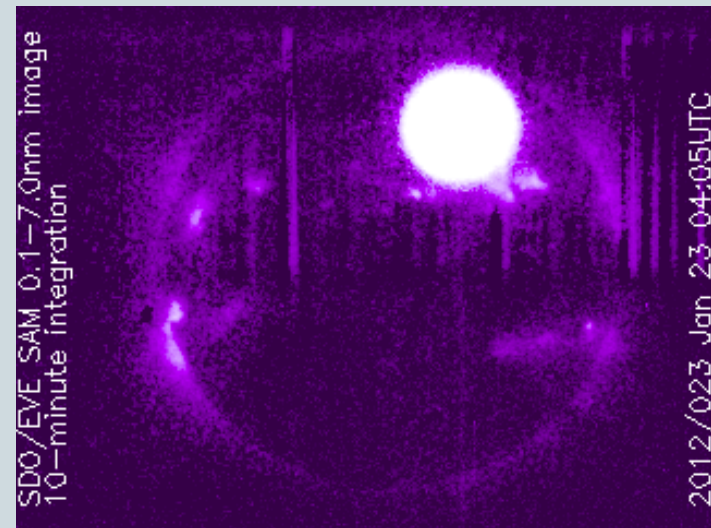
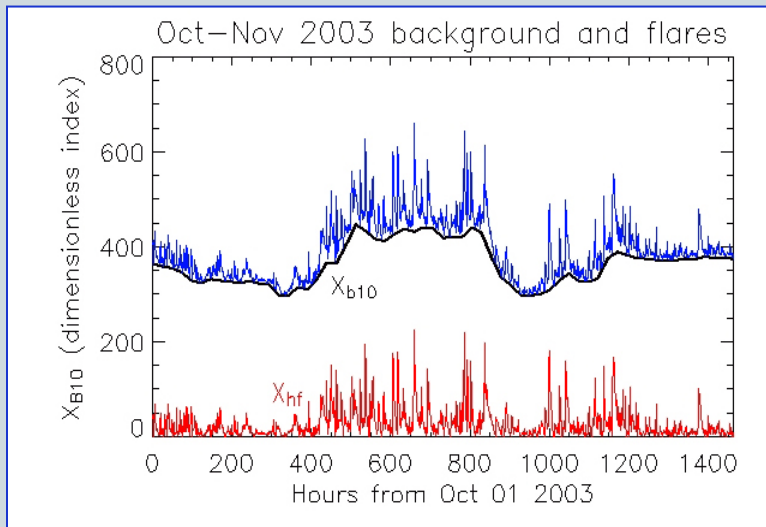


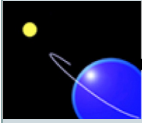


Anemomilos

Quantity of ejecta
○ individual flare
magnitude X_{hf}
proxy

Location of ejecta
○ individual flare
brightness
centroid from SAM





Anemomilos

Velocity of ejecta

- post-analysis
- time-of-flight
- analysis in 2001 & 2005
- NO DIRECT OBSERVABLES TODAY

Proxies for velocity?

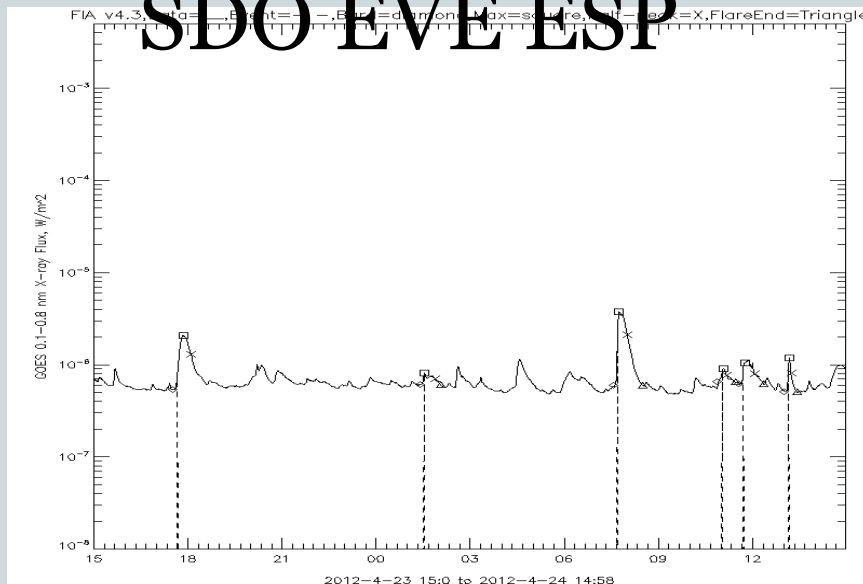
- Re-analysis of ongoing events in real-time
- rate change of brightness of flares during the rise to peak



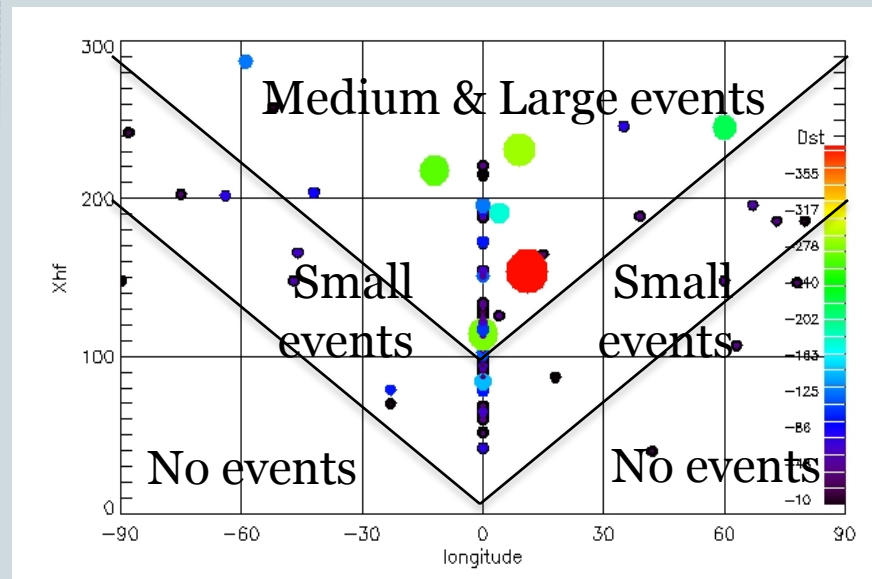
Anemomilos

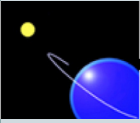
Rate change of flare
brightness proxy

- GOES XRS &
SDO EVE ESP



Relationship between
Dst event size, Xhf,
and disk longitude





SPACE ENVIRONMENT TECHNOLOGIES

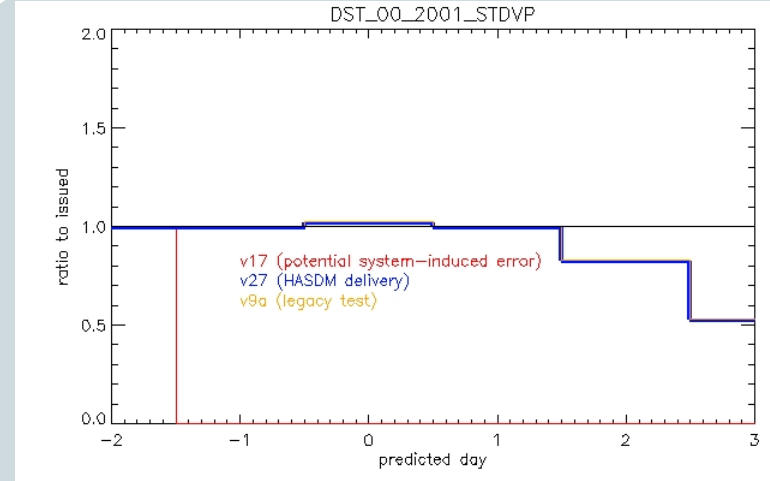
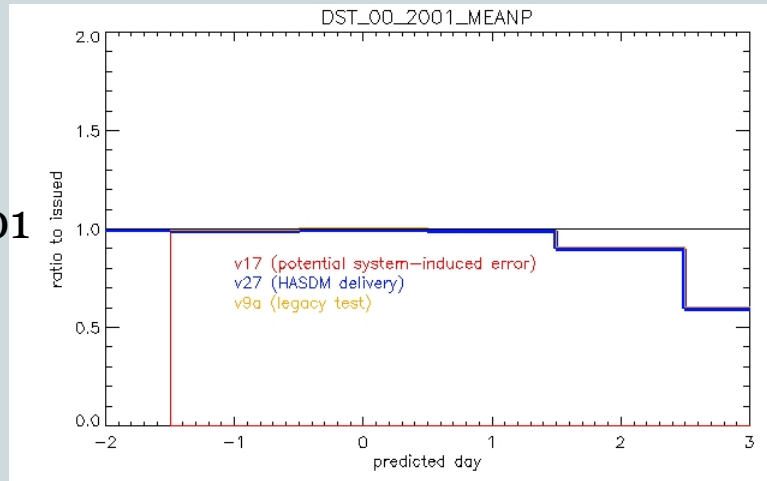
Space Research Space Operations Space Standards

OPERATIONAL DST

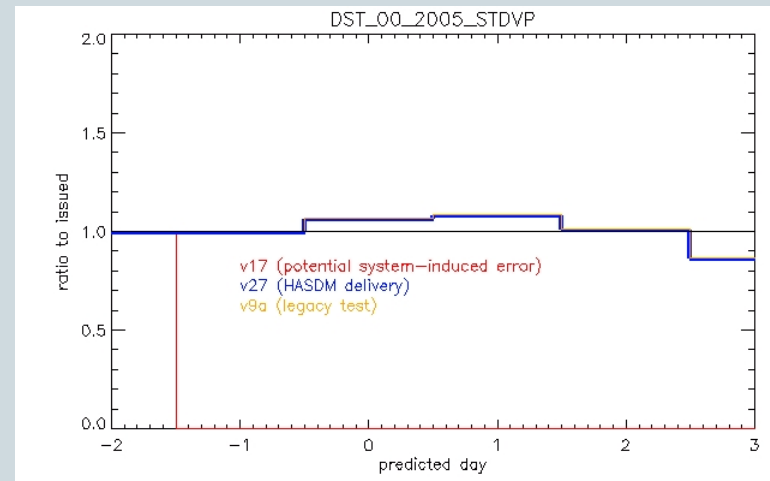
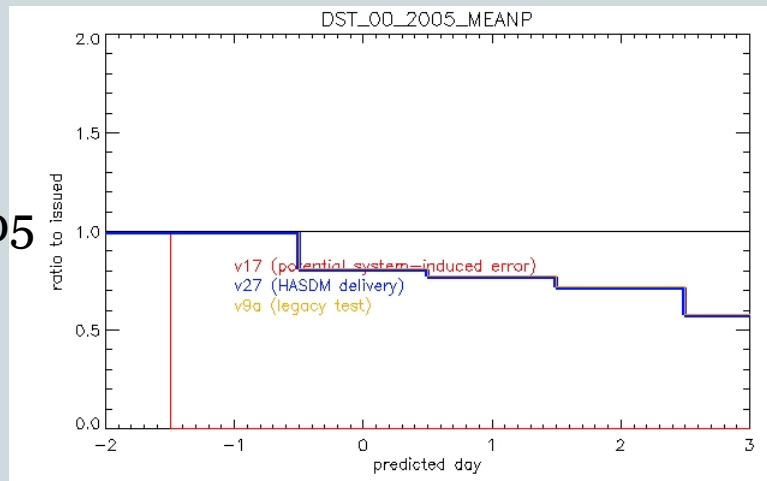
Mean value ratio of forecast to issued

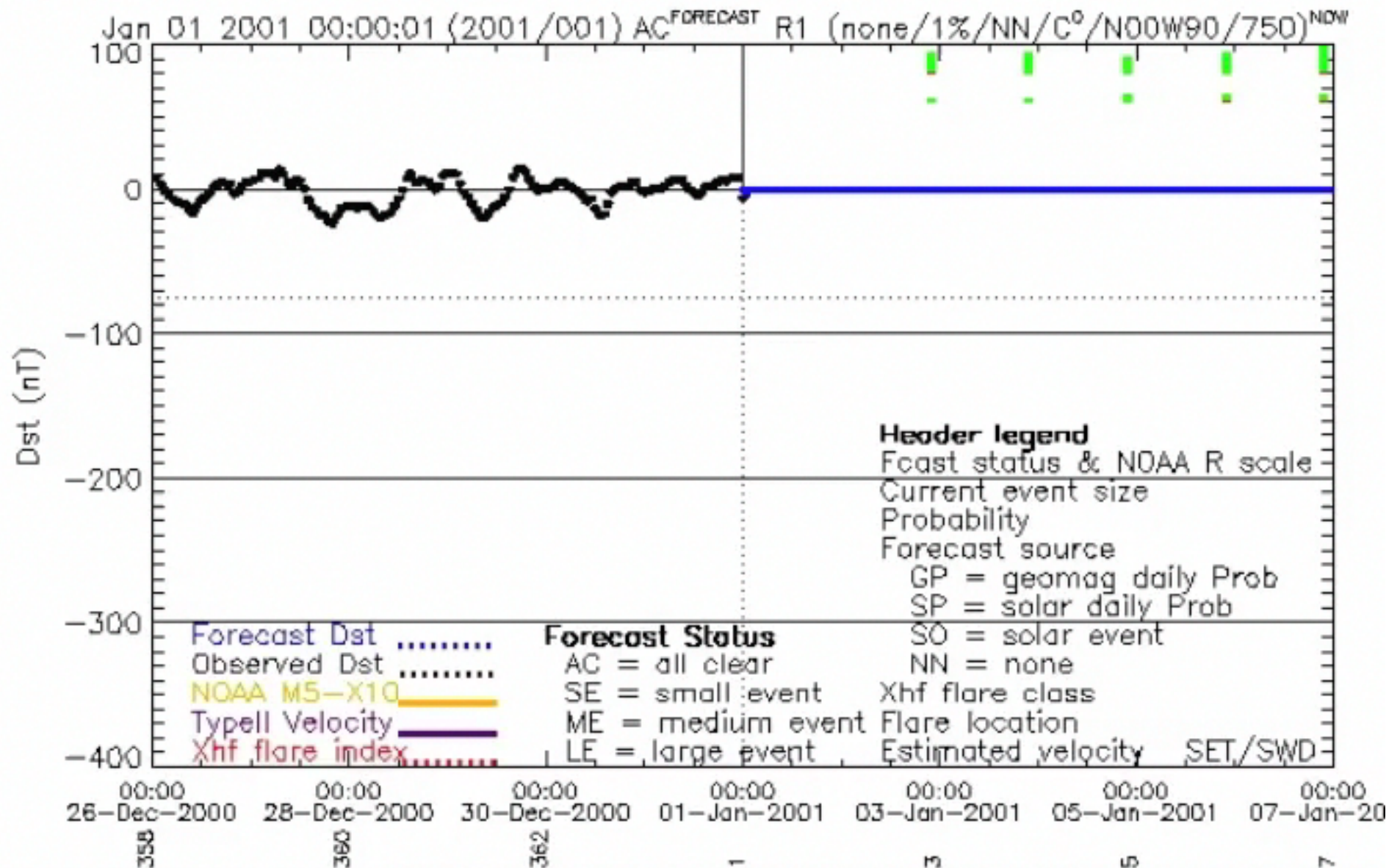
1- σ ratio of forecast to issued

2001



2005





<http://www.youtube.com/watch?v=uz2qe6Mlkwo>