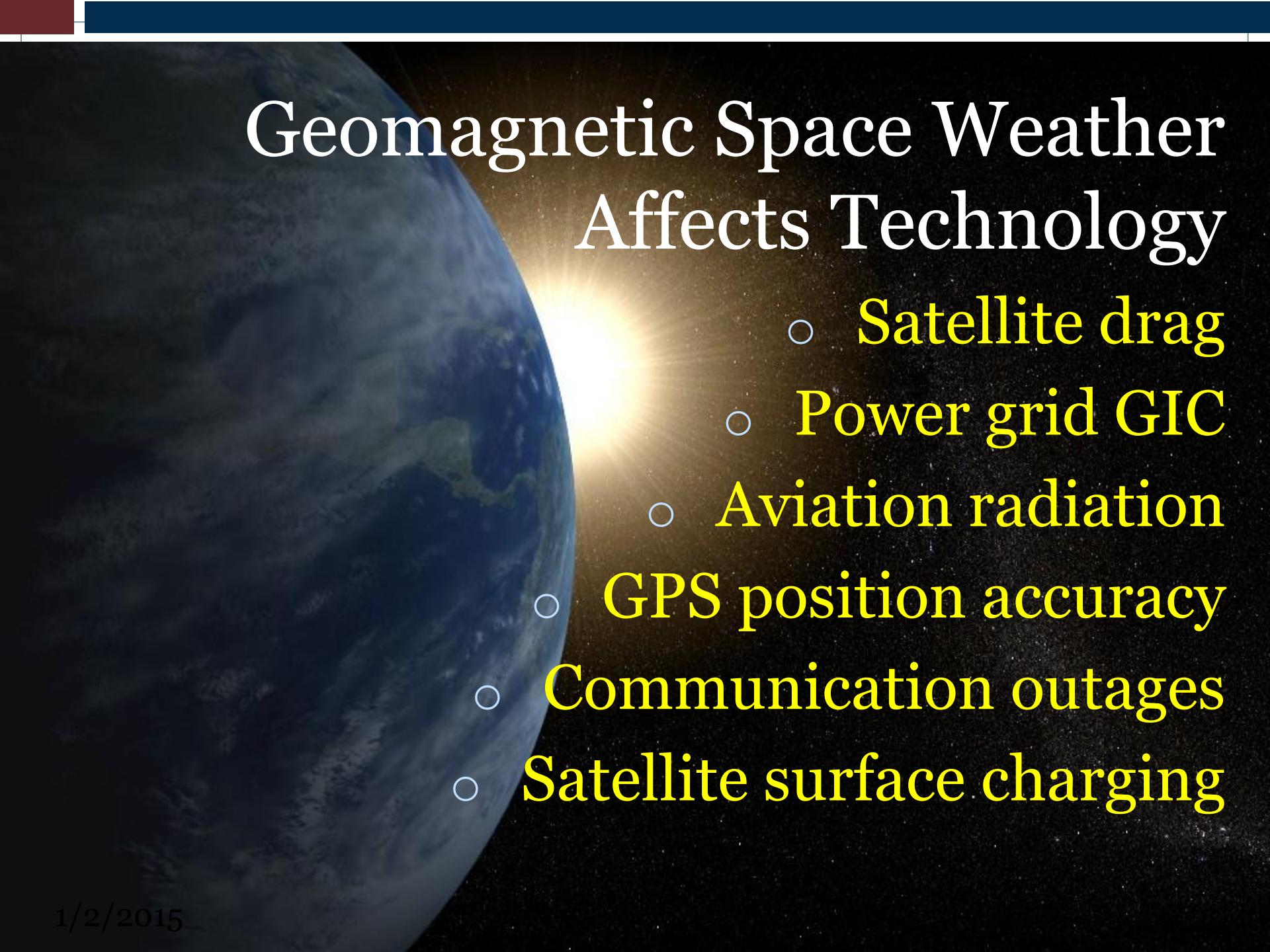
SET

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

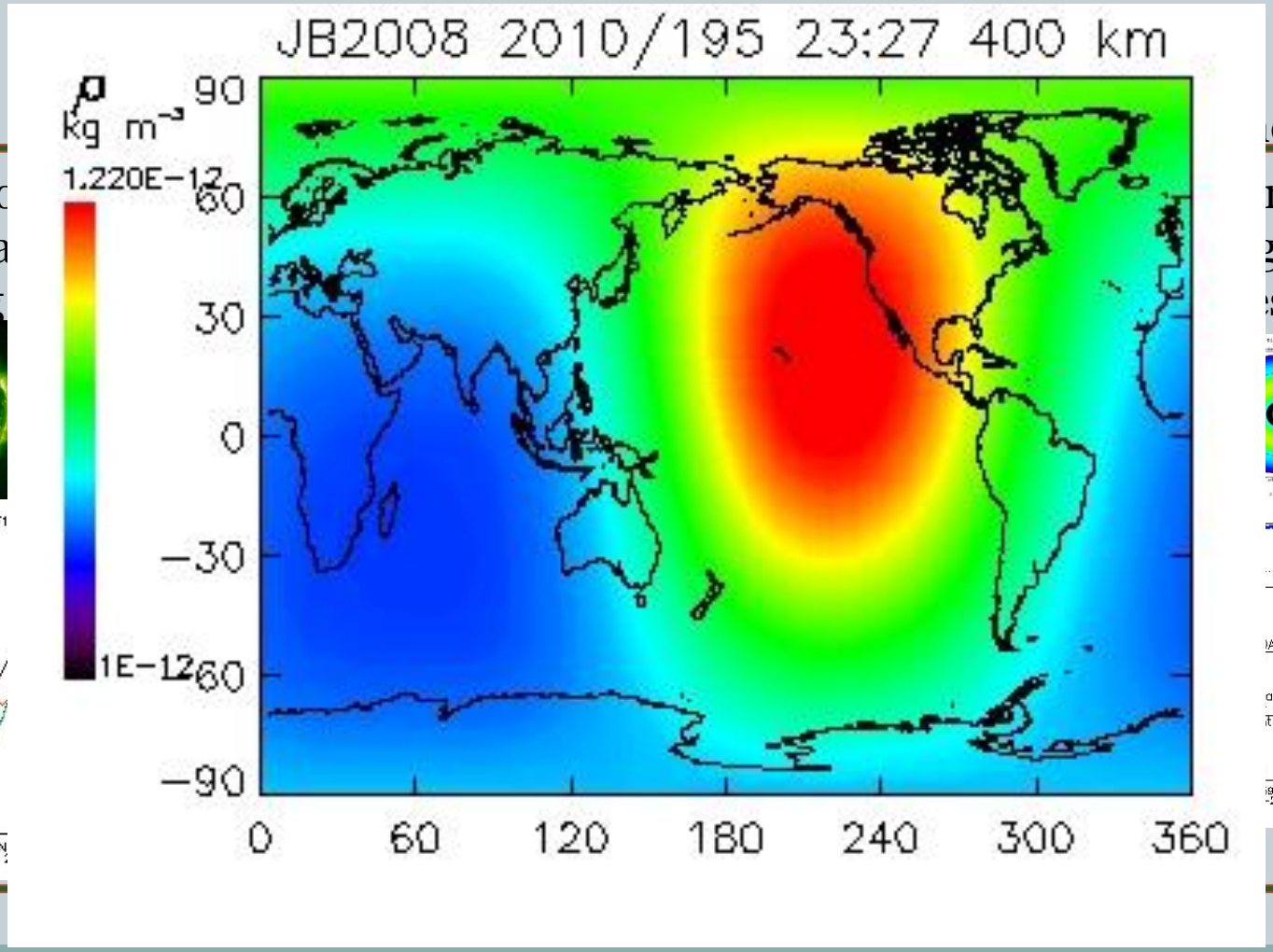
# Turning Measurements into Useful Products

- **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

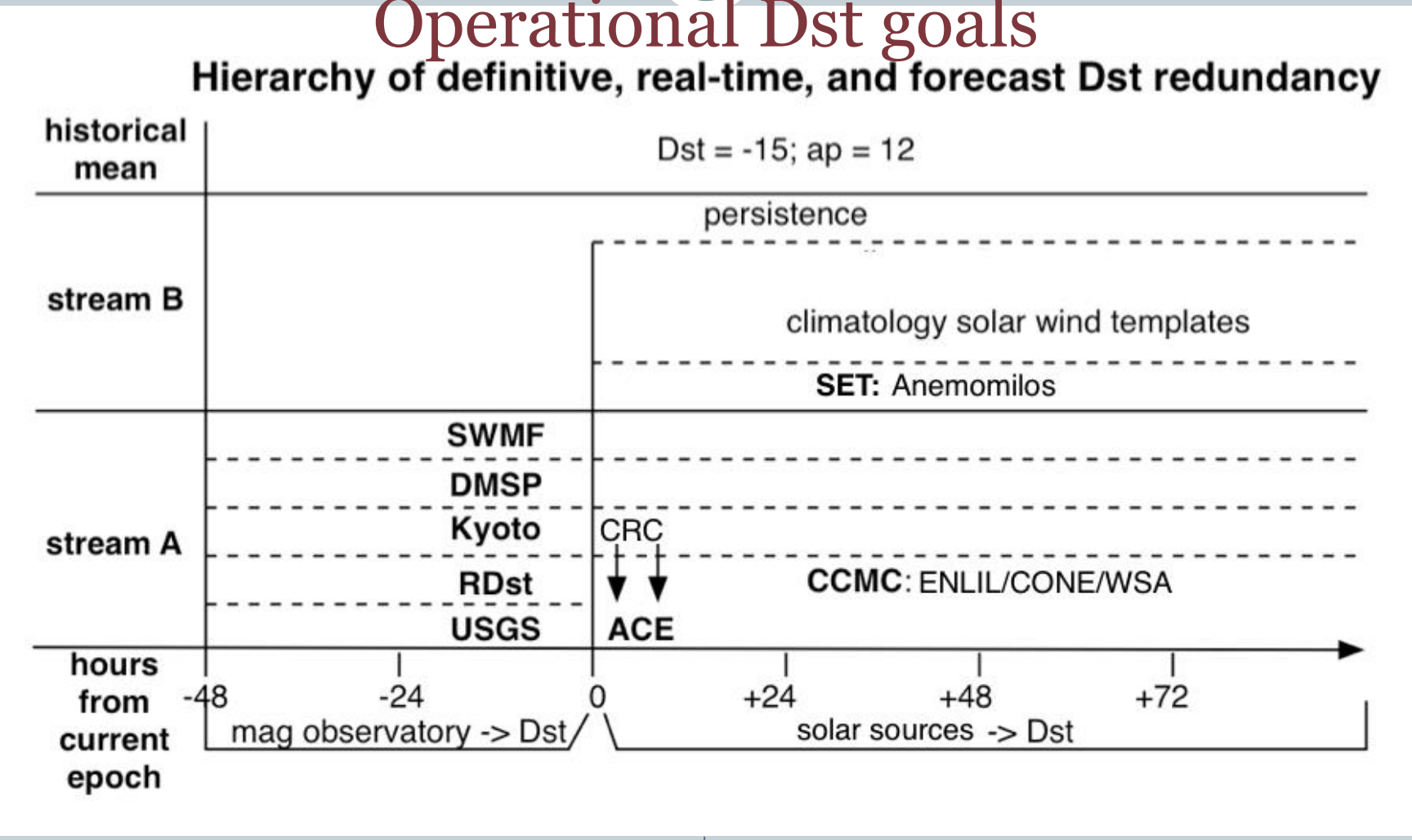
SPACE ENVIRONMENT TECHNOLOGIES

*Space Research* *Space Operations* *Space Standards*

# OPERATIONAL DST



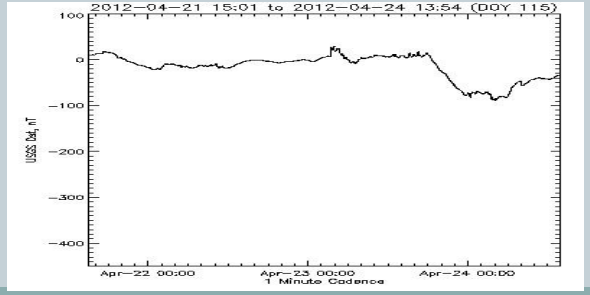
# Operational Dst goals



# Real-time operational Dst

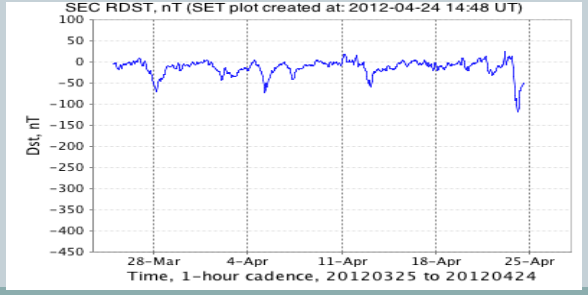
## USGS

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




## SEC

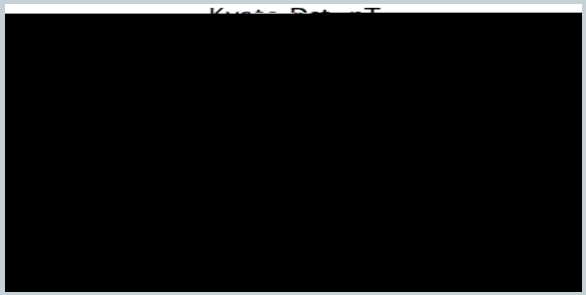
- uses up to 4 magnetic observatories (HER, SJN, HON, GUA)
- produces 1-hour Dst



# Real-time operational Dst

## Kyoto

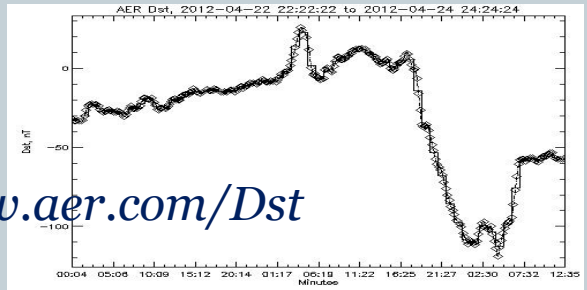
- uses up to 4 magnetic observatories (HER, SJN, HON, KAK)
- produces 1-hour Dst



## AER & SET DMSP

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

*http://www.aer.com/Dst*



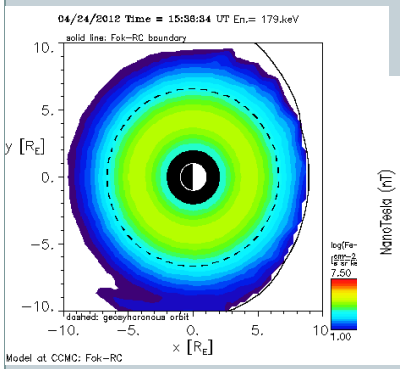
# Real-time operational Dst

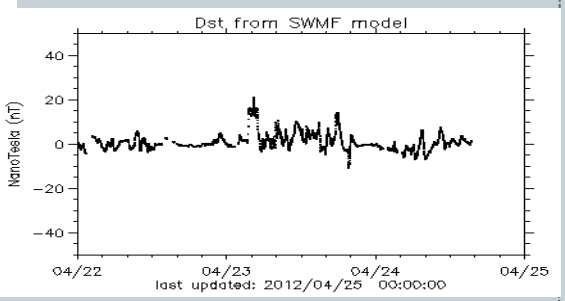
## CCMC

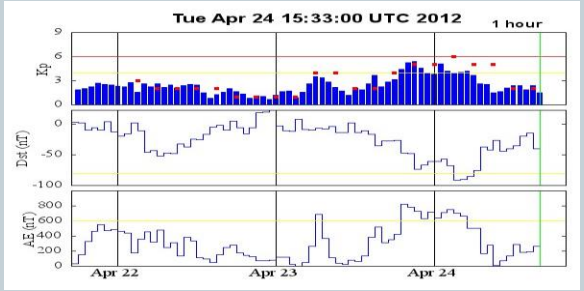
- uses SWMF and Fok Ring Current
- produces 1-minute Dst

## Other sources

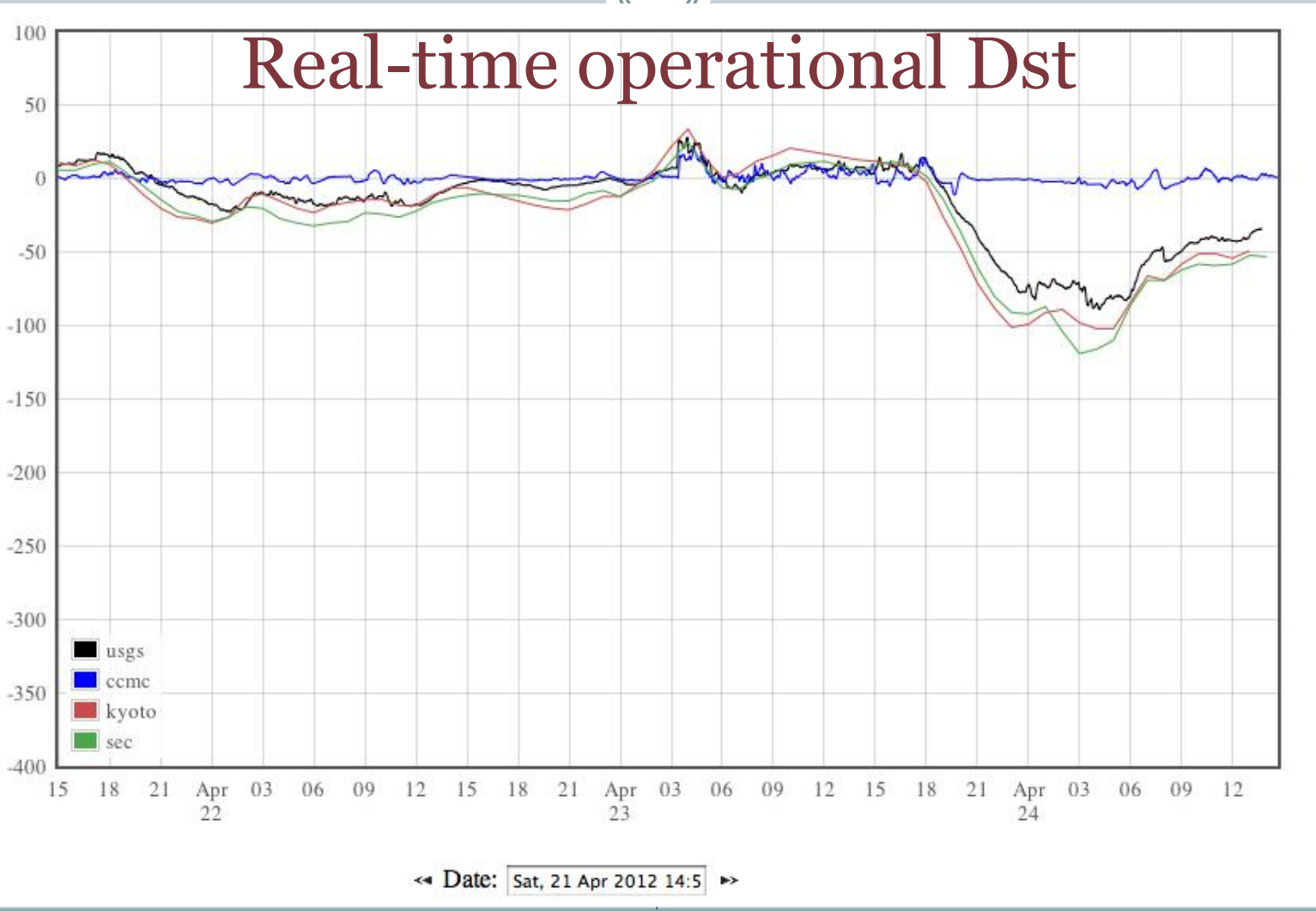
- Rice, UCB, Berkeley, …
- produce 1-hour Dst



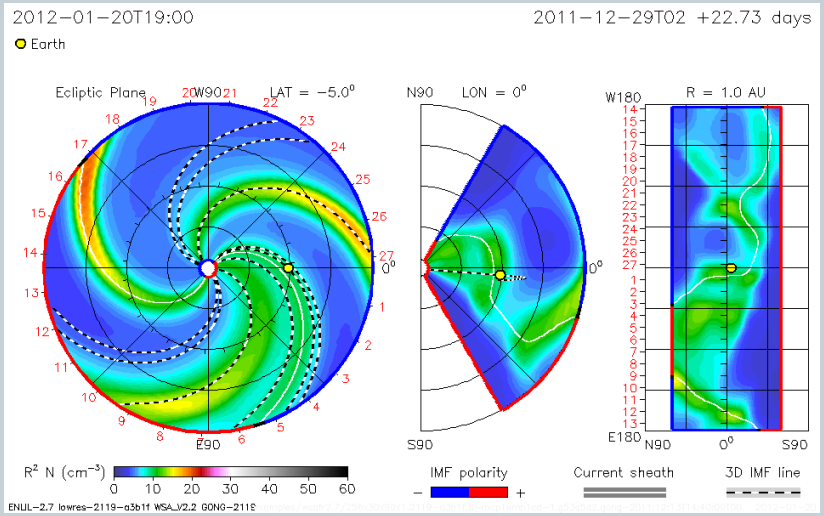



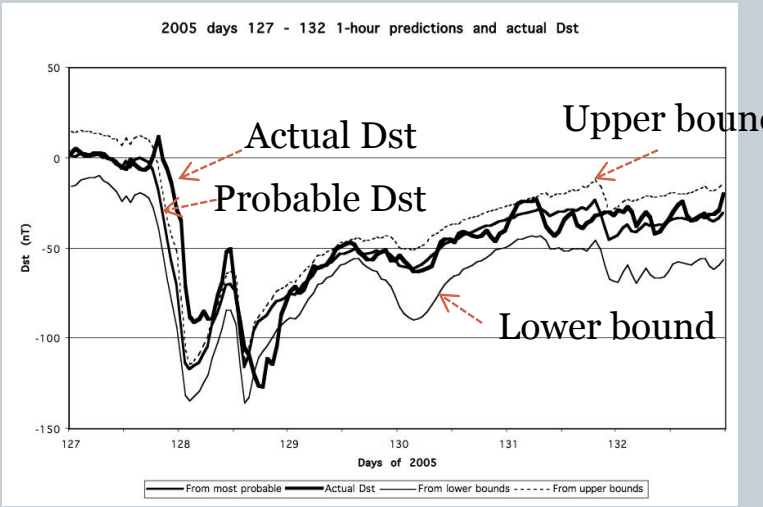
# OPERATIONAL DST



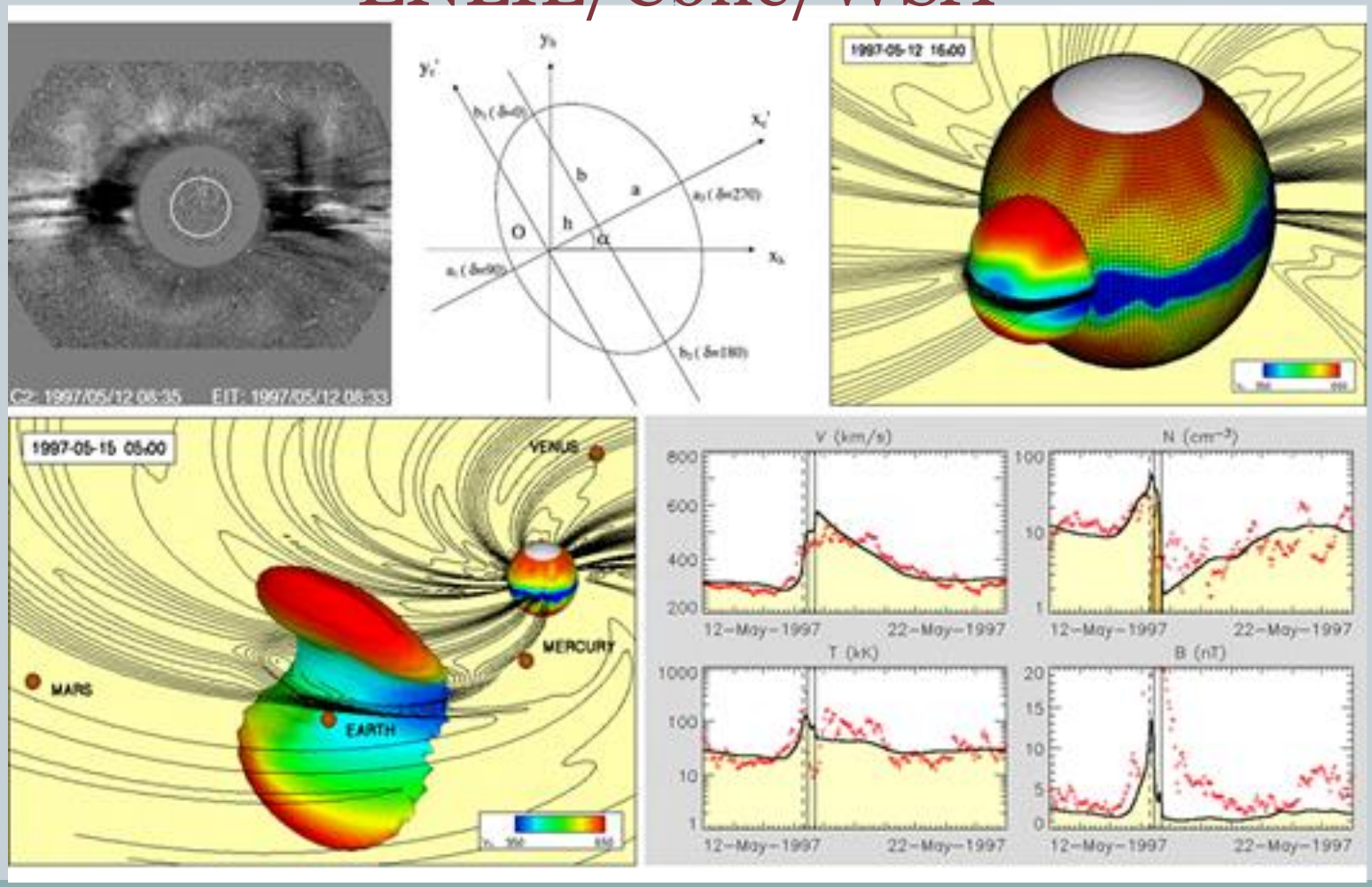
# Dst operational forecasting – Stream A

- ENLIL/Cone/WSA
  - 72-hour forecast of hourly Dst
- Carmel Research Center
  - 1–5 hour forecast of Dst



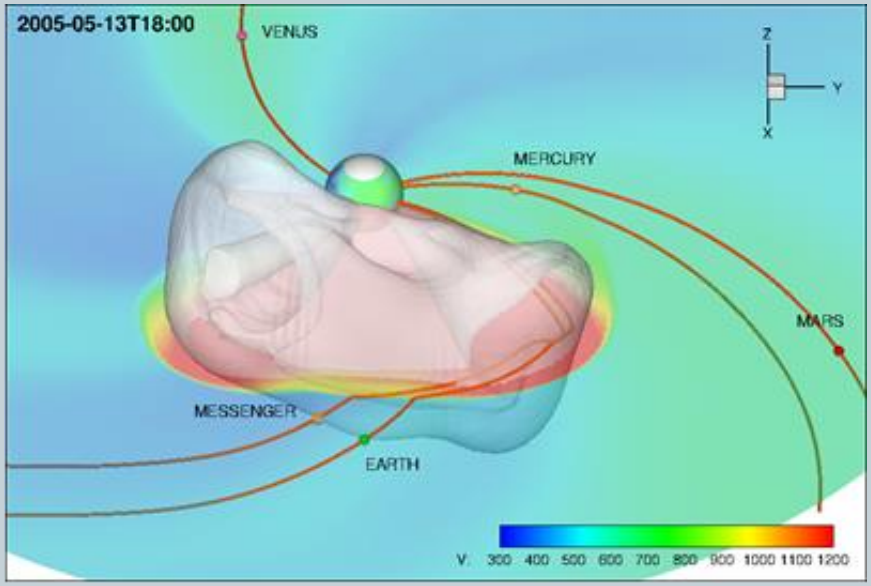



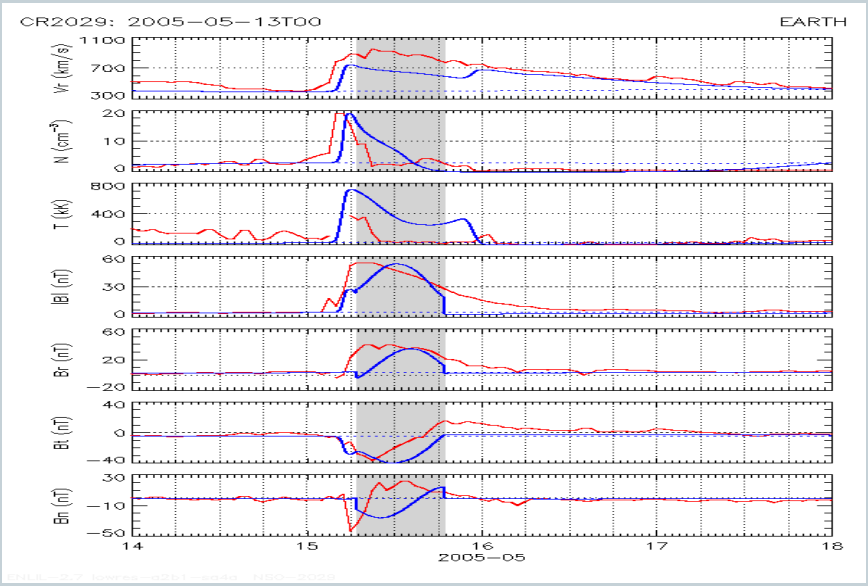
# ENLIL/Cone/WSA



# OPERATIONAL DST

## ENLIL/Rope/WSA

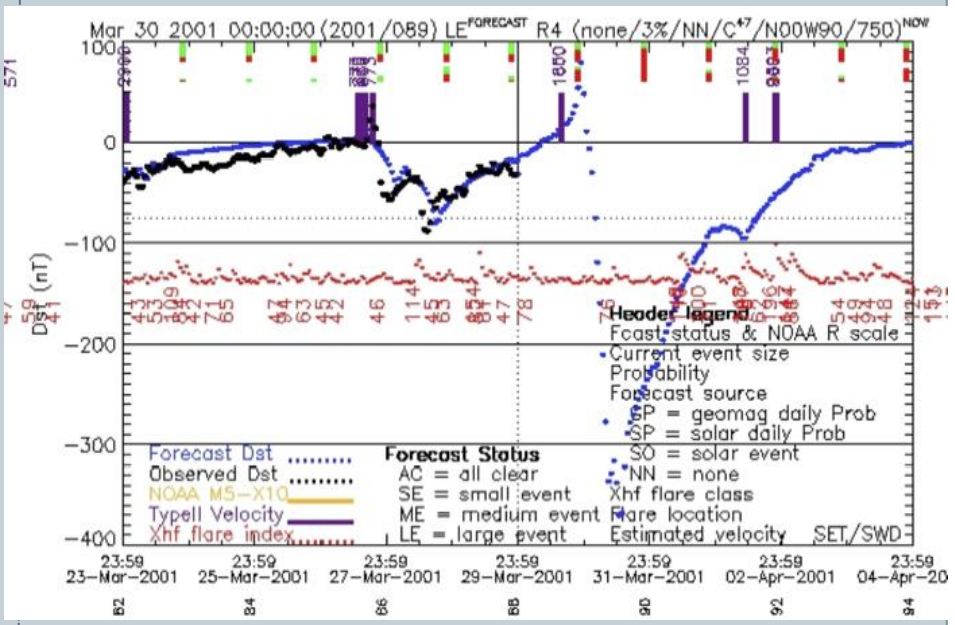


# Dst operational forecasting – Stream B

***Anemomilos***

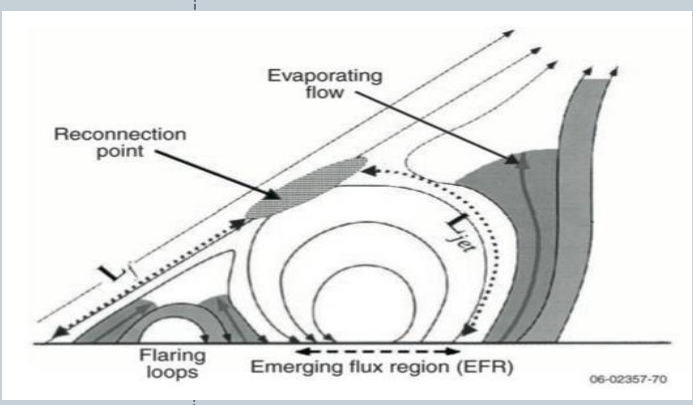
- Greek word for "windmill"
- 6-day forecast of hourly Dst
- data-driven deterministic algorithm
- uses 3 solar observables to simplify cone & identify events

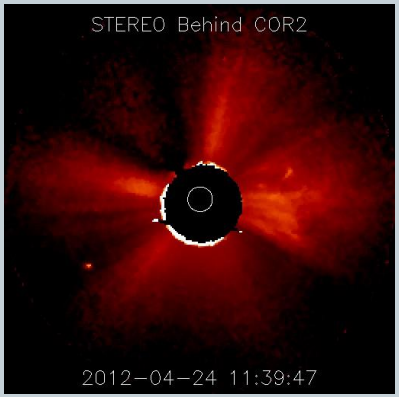


# Anemomilos

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

3 observables needed
- ejecta **speed**
- flare **location**
- ejecta **quantity** (diameter)



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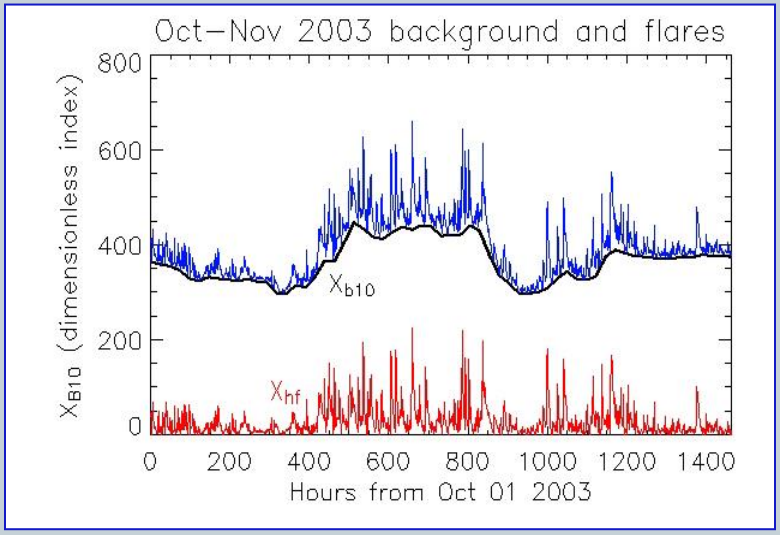
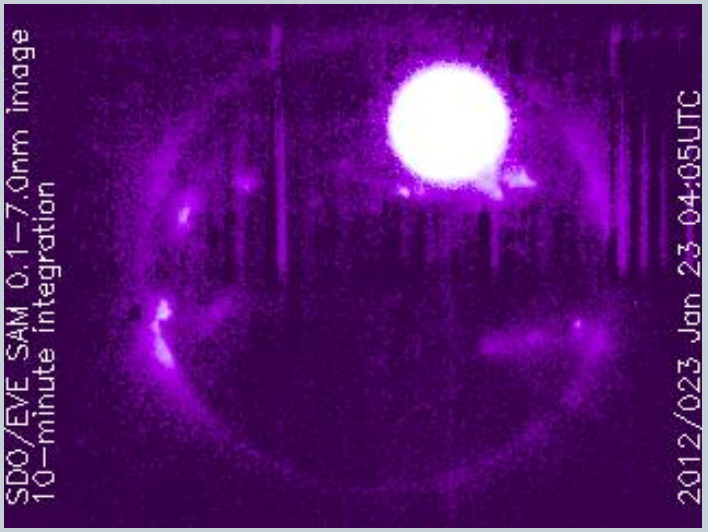
**Quantity** of ejecta
- individual flare magnitude proxy (Xhf)




**Location** of ejecta
- flare brightness centroid from SDO/EVE SAM



# Anemomilos

**Speed** of ejecta

- post-analysis time-of-flight speeds used in 2001 & 2005
- NO DIRECT OBSERVABLES OR PROXIES FOUND YET

How to estimate speed

- ✓ Assume 750 km $s^{-1}$
- ✓ Real-time re-analysis
- ? rate change of brightness of flare Xhf index during the rise to peak
- ? other proxies

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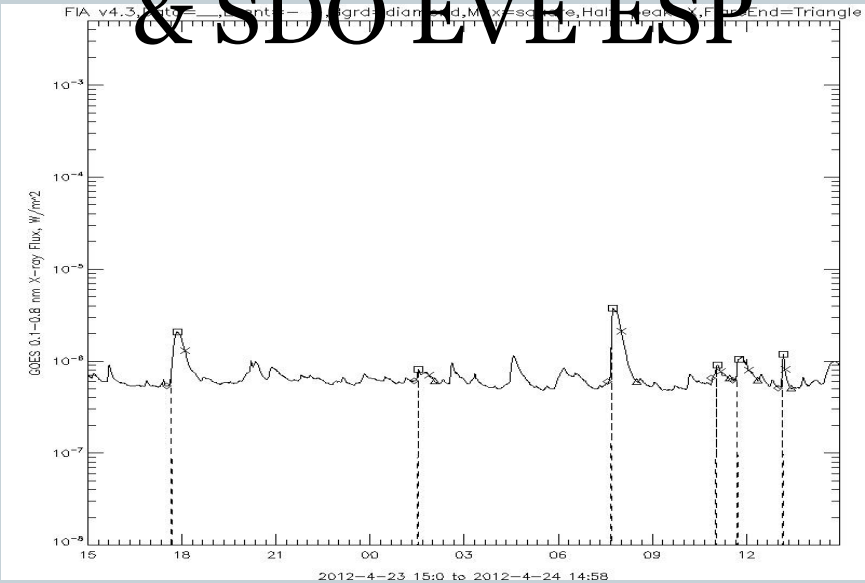
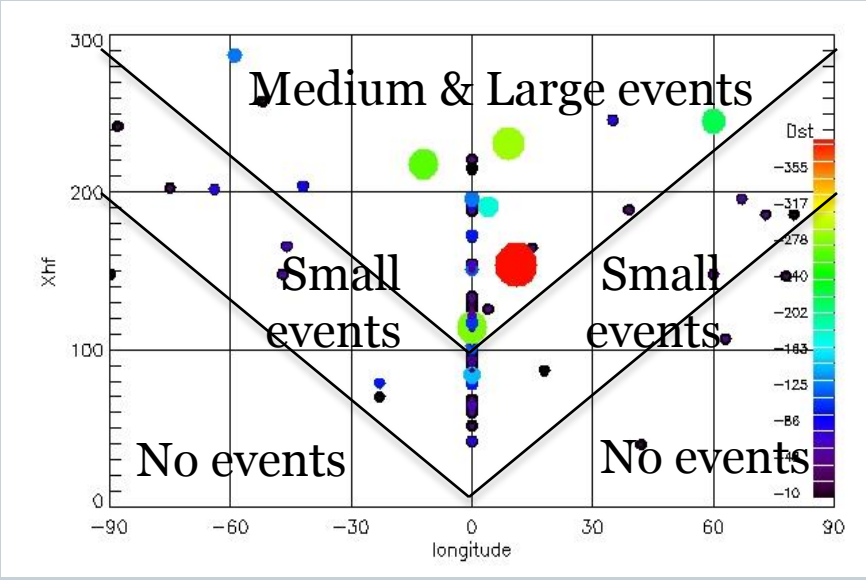
Rate change of flare brightness proxy
- use GOES XRS & SDO EVE ESP




Relationship between Dst event size, Xhf, and disk longitude

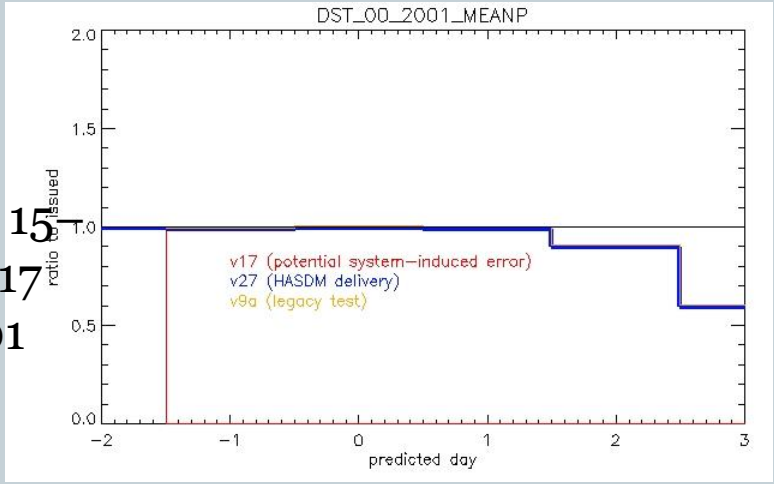


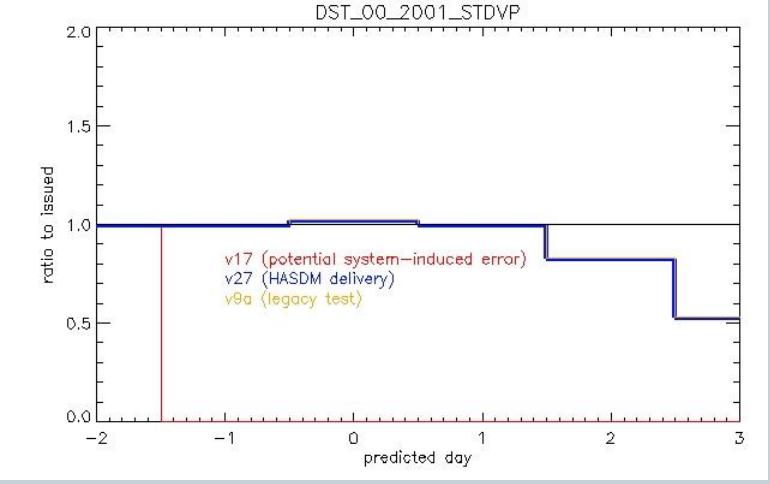
# OPERATIONAL DST

Mean value ratio of forecast to issued

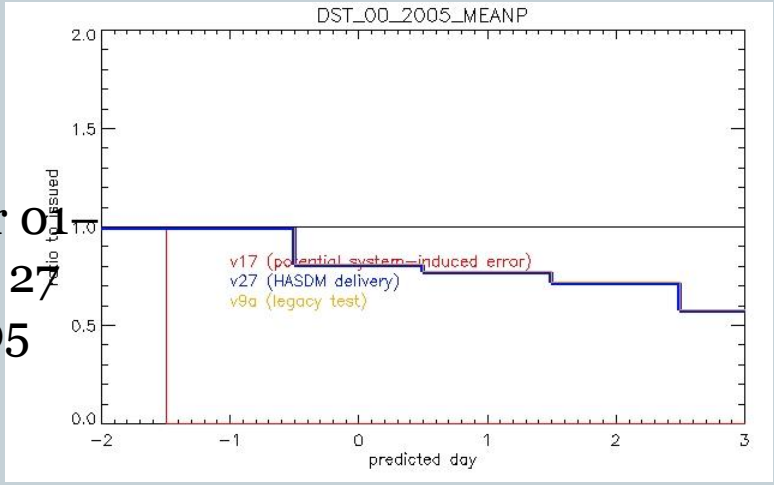
1-σ ratio of forecast to issued

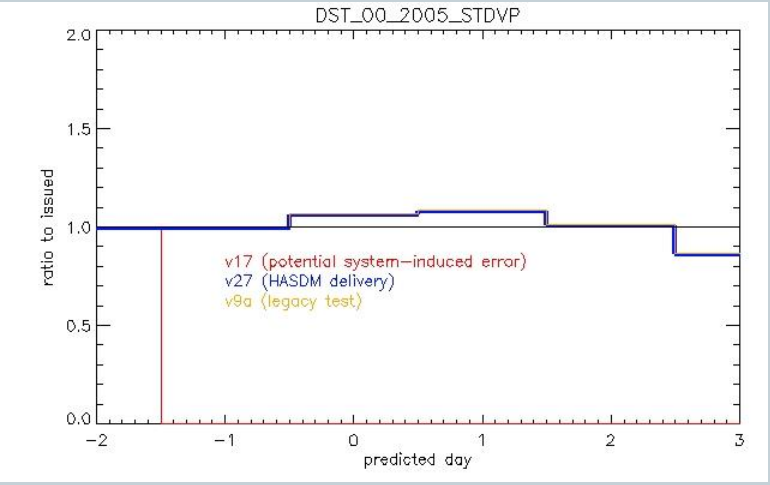
Jan 15 – Jul 17 2001

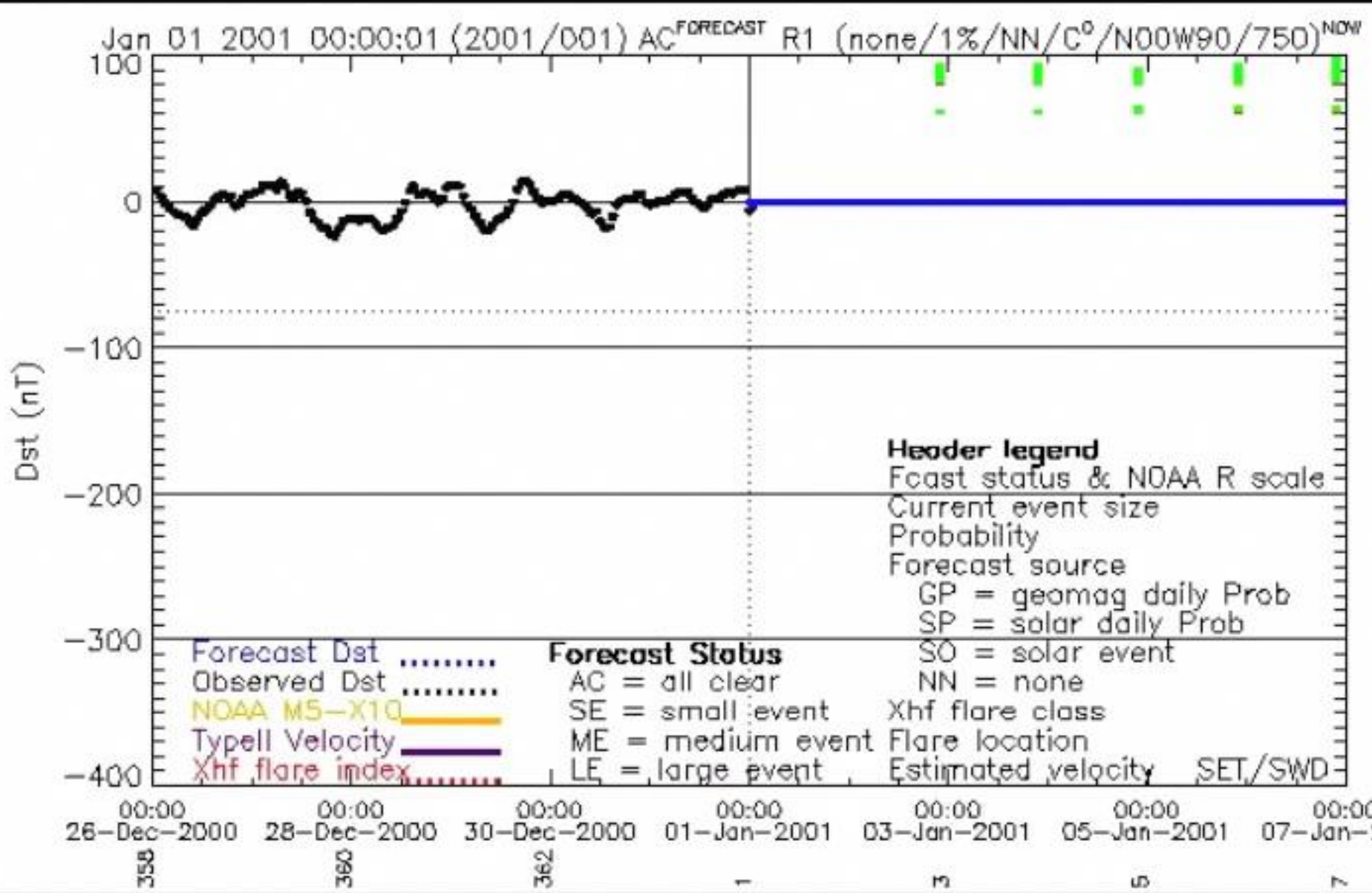



Mar 01 – Sep 27 2005






http://www.youtube.com/watch?v=uz2qe6MIkwo