Operational Dst from real-time data streams and forecast algorithms

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
Operational Dst

Solar irradiances

Solar wind/magnetosphere

Geomorphic ring current index for satellite drag

Thermosphere densities

Photospheric, chromospheric, coronal solar indices for satellite drag

http://sol.spacenvironment.net/~maps/
Operational Dst goals

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

- Dst = -15; ap = 12
- Persistence
- Climatology solar wind templates
- SET: Anemomilos

Stream B
- SWMF
- DMSP
- Kyoto

Stream A
- RDst
- USGS
- CRC
- ACE
- CCMC: ENLIL/CONE/WSA

Hours from current epoch
- -48
- -24
- 0
- +24
- +48
- +72

Mag observatory -> Dst
Solar sources -> Dst

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SWW
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

http://sol.spacenvironment.net/~maps/ SWW
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

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http://sol.spacenvironment.net/~maps/ SWW
Real-time operational Dst

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

**Other sources**
- Rice, UCB, Berkeley, ...
- produce 1-hour Dst

http://sol.spacenvironment.net/~maps/ SWW
Real-time operational Dst

Date: Sat, 21 Apr 2012 14:5

http://sol.spacenvironment.net/~maps/  SWW
**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

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SWW
ENLIL/Cone/WSA

http://sol.spacenvironment.net/~maps/  SWW
Anemomilos

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

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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)
Quantity of ejecta
  ○ individual flare magnitude proxy (Xhf)

Location of ejecta
  ○ flare brightness centroid from SDO/EVE SAM
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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SWW
Anemomilos

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

Relationship between Dst event size, Xhf, and disk longitude
Mean value ratio of forecast to issued

1-σ ratio of forecast to issued

Jan 15 - Jul 17 2001

Mar 01 - Sep 27 2005

1/2/2015