CME Scorecard

Operational specification and forecasting advances for Dst

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Areas of ongoing improvements for operational Dst

Dst forecasting issues

- Customer-driven forecasts
- Operational systems
  - “Stream A” primary forecasts (ENLIL/Rice)
  - “Stream B” backup forecasts (Anemomilos)
- Metrics & CCMC CME Scorecard
1. Customer-driven forecasting

- USAF Space Command requires operational Dst to drive JB2008 thermospheric density model
- Fully redundant systems is a customer requirement:
  ✓ Facilities
  ✓ Servers
  ✓ Algorithms
  ✓ Input data stream sources
  ✓ Output data stream indices
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SET Facilities and Servers

Denver USAF support servers

Logan USAF support servers

Algorithms & Data streams

Algorithm and data stream architecture

Data streams upgrades

2. Operational Dst status

- Primary (stream “A”): ENLIL/Rice Dst forecasts
- Backup (stream “B”): Anemomilos Dst forecasts
- [http://sol.spacenvironment.net/~sam_ops/index.html](http://sol.spacenvironment.net/~sam_ops/index.html)
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Operational Dst requirement: -48 to +72 hours with 3-hour granularity, 3-hour latency

Operational goal achieved: redundant Dst, ±6-days with 1-hour granularity and 1-hour latency

ENLIL/Rice Prime Dst Forecast and ACE Comparison

- ACE near-realtime predictions are plotted here in red
- [http://mms.rice.edu/realtime/forecast.html](http://mms.rice.edu/realtime/forecast.html)
- ENLIL/Rice models under predict but largely in line with the trend and are within acceptable range
- Magnetospheric activity on the New Year’s day is well captured

Credit: R. Bala
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ENLIL/Rice Prime and Anemomilos Secondary

Dst ADVISORY, 04/03 15:00Z, peak 04/05 13:00Z, moderate impact -158nT, NOAA G3, 750k/s, #spacewx http://bit.ly/P8bZX3
\begin{itemize}
\item **Anemomilos** is the Greek word for “windmill”
\item The data-driven deterministic algorithm uses 3 solar observables to identify geoeffective events: \url{http://sol.spacenvironment.net/~sam_ops/index.html}
\item It has a 15-minute cadence, 1-hour time granularity, 144-hour prediction window (+6 days), and 1-hour latency
\item Most flare events above a certain irradiance threshold, occurring within defined solar longitude/latitude regions and having sufficient liftoff velocity of ejected material, will produce a geoeffective Dst perturbation
\end{itemize}

Tobiska et al. \url{http://spacewx.com} \textit{SpaceWeather app}
Anemomilos Basis

Three solar observables are used for operational Dst forecasting: flare magnitude, integrated flare irradiance, and event location

- Magnitude is a proxy for ejecta quantity (mass) and, combined with speed derived from the integrated flare irradiance, represents the kinetic energy
- Speed is estimated as line-of-sight velocity for events within 45° radial of solar disk center
- Solar disk, not limb, observable features are used for predictive techniques based on SDO/EVE/SAM centroid of flare event
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Anemomilos geoeffectiveness of location

Occurrence of Dst vs Xhf in solar latitude & longitude (25 months)

- 2001 (Jan-Jul), 2005 (Mar-Sep), 2011-2012 (Dec-Nov)

Resulting Dst event size can be sorted by Xhf size and flare longitude/latitude

3. Metrics & CME Scorecard

- Metrics – in progress (skill score)
- CME Scorecard value to developer
  - Enables comparison with other forecast methods for identifying strengths and weaknesses
  - Allows a consistent cross-comparison for many methods
  - Enables potential users to identify capabilities of methods
- CME Scorecard suggestions for upgrades
  - Automated download of events from developer sites
  - Skill score table