ISES Report

Australian Space Forecast Centre
Activities and Future Plans

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IPS Radio and Space Services

There is IPS Space Weather Services Review Underway

- The driver for the review was the Bureau of Meteorology's Munro Review (Option 20) which identified IPS Radio and Space Services to be ceased, reduced or commercialised as a potential savings measure.

- The Space Weather Services reviewers will deliver their report in August 2014.

- Caveat, the ASFC future plans will be influenced by the Space Weather Services Review recommendations and the Bureau of Meteorology's response.

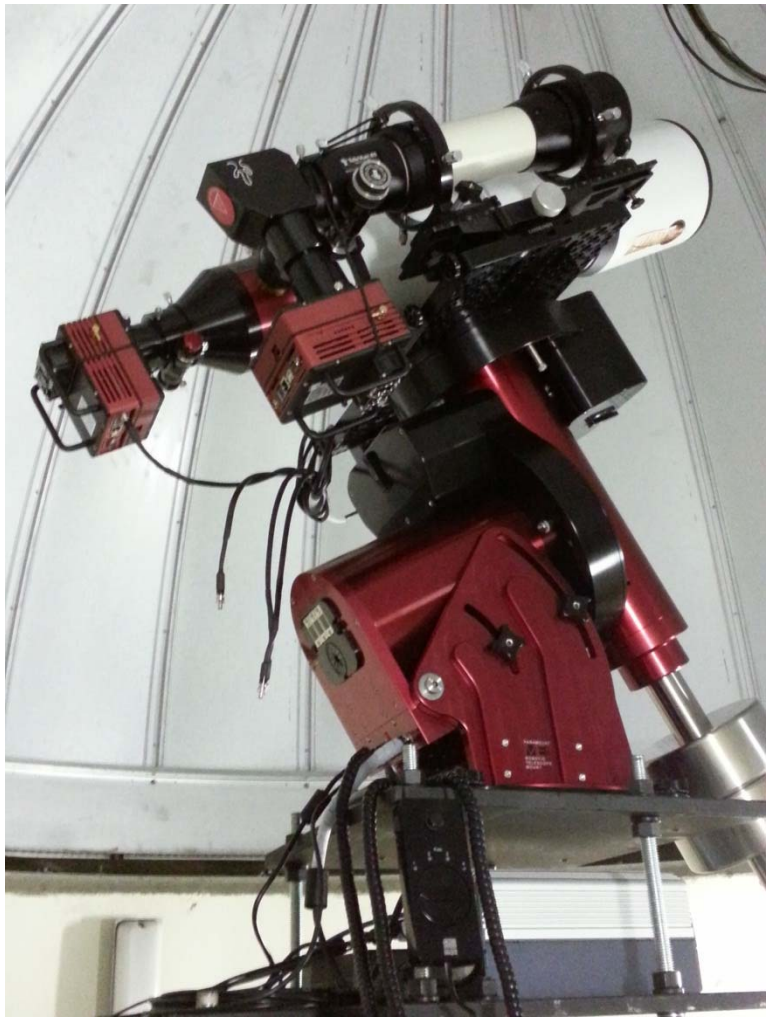
Plans and Improvements Cover

- Learmonth Solar Observatory (LSO)
- Culgoora Solar Observatory (CSO)
- Ionosonde network
- Magnetometer Network
- Australian Space Forecast Centre (ASFC) projects

Learmonth Solar Observatory (LSO)

- Radio systems continue to be upgraded for remote operation by 2016.
- Broadband data links have been upgraded to accommodate remote operation.

Culgoora Solar Observatory (CSO)



- Optical systems continue to be upgraded for remote operation.
- Three new telescopes are being fitted.
  - Lunt with H-alpha filter (656.3nm,152mm)
  - Lunt with Calcium-K filter (393.4nm, 80mm)
  - Televue with a white light filter (85mm)
  - Each telescope will be equipped with an 8 Megapixel SBIG camera (3326 x 2504 pixel array)
  - Positioned by a Paramount ME II tracking mount
- Broadband data links have been upgraded to accommodate remote operation.

Ionosonde Network

Receive antenna at Cocos Island

- IPS has commenced an upgrade of the high-latitude CADI systems to a Linux-based operating system (more stable)
- IPS lost the Christchurch ionosonde this year, however is looking for a new site in cooperation University of Canterbury.
- Most ionosonde sites have now been upgraded to a 4G link for near real-time data delivery.

IPS has a new Ionospheric Scintillation event notification service for the Australian region

Recent Scintillation Events

The following is a list of recent periods of high and sustained ionospheric scintillation as detected in the IPS scintillation monitor network. Note that these are auto-detected and not manually quality controlled.

IPS provides a free email alert service which notifies subscribers of scintillation events as they occur. To subscribe to this service, please visit the Ionospheric Scintillation alert page.

To see the raw data for these events in more detail, please look up the relevant locations and times at the World Data Centre ionospheric scintillation page.

Please contact IPS if you have any questions about these events or have any feedback regarding ionospheric scintillation services.

(last updated 23 Jul 2014 06:40 UT)

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Approximate Start of disturbance              : 07:51UT 08 Jul 2014
Approximate Peak of disturbance               : 08:10UT 08 Jul 2014
Approximate End of disturbance                : 10:33UT 08 Jul 2014
Maximum S4 Index                              : 0.945050
Eightieth percentile of S4 during disturbance : 0.773555
Observed at Sites                             :  Niue
View Details at the WDC

Approximate Start of disturbance              : 07:40UT 06 Jul 2014
Approximate Peak of disturbance               : 07:43UT 06 Jul 2014
Approximate End of disturbance                : 10:40UT 06 Jul 2014
Maximum S4 Index                              : 1.00000
Eightieth percentile of S4 during disturbance : 0.853177
Observed at Sites                             :  Niue
View Details at the WDC

Approximate Start of disturbance              : 10:33UT 04 Jul 2014
Approximate Peak of disturbance               : 10:38UT 04 Jul 2014
Approximate End of disturbance                : 10:50UT 04 Jul 2014
Maximum S4 Index                              : 0.934020
Eightieth percentile of S4 during disturbance : 0.817650
Observed at Sites                             :  Niue
View Details at the WDC

Approximate Start of disturbance              : 14:14UT 30 May 2014
Approximate Peak of disturbance               : 14:14UT 30 May 2014
Approximate End of disturbance                : 14:30UT 30 May 2014
Maximum S4 Index                              : 0.950610
Eightieth percentile of S4 during disturbance : 0.792600
Observed at Sites                             :  Weipa
View Details at the WDC

Approximate Start of disturbance              : 14:59UT 19 May 2014
Approximate Peak of disturbance               : 14:59UT 19 May 2014
Approximate End of disturbance                : 15:06UT 19 May 2014
Maximum S4 Index                              : 1.00000
Eightieth percentile of S4 during disturbance : 0.897200
Observed at Sites                             :  Darwin
View Details at the WDC
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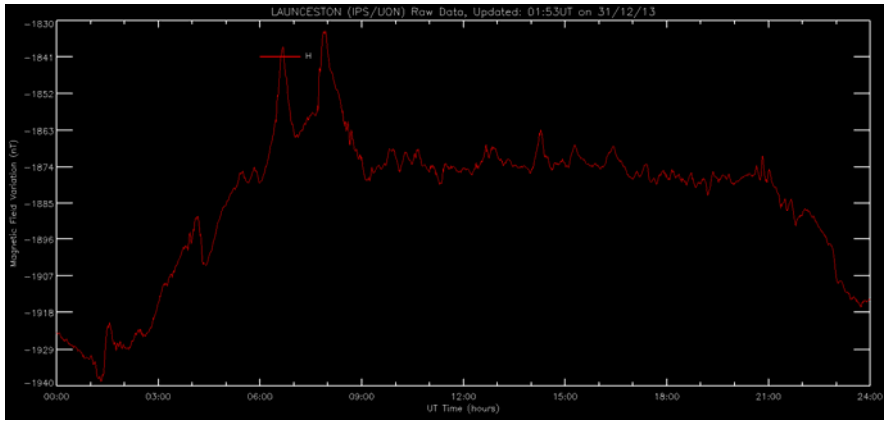
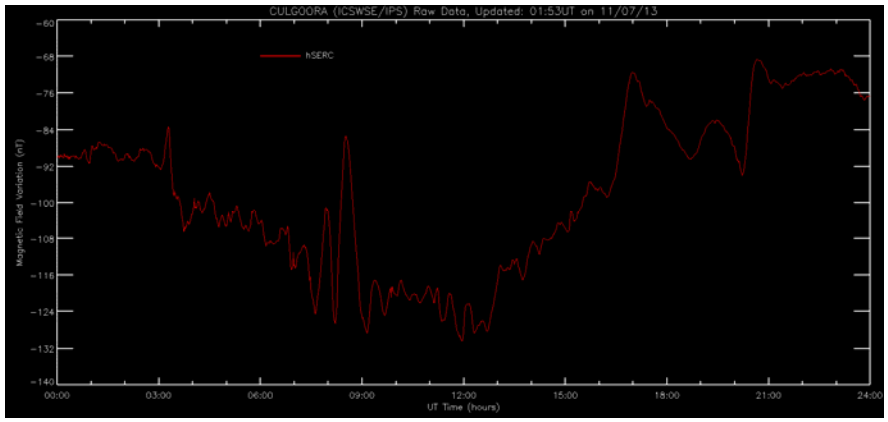
Example output from IPS webpage

- Customers can be notified in near real-time.
- Reports the Start, Peak, and End times
- Maximum S4 index
- and Geographic areas likely to be affected

Magnetometer Network and Services



Launceston raw data



Culgoora raw data

- A new magnetometer has been installed at Launceston, Tasmania (collaboration BoM/IPS and University of Newcastle).
- The SERC MAGDAS unit at Culgoora was upgraded to a MAGDAS-9 .

IPS has been involved with a study into the impacts of space weather on the Australian power network

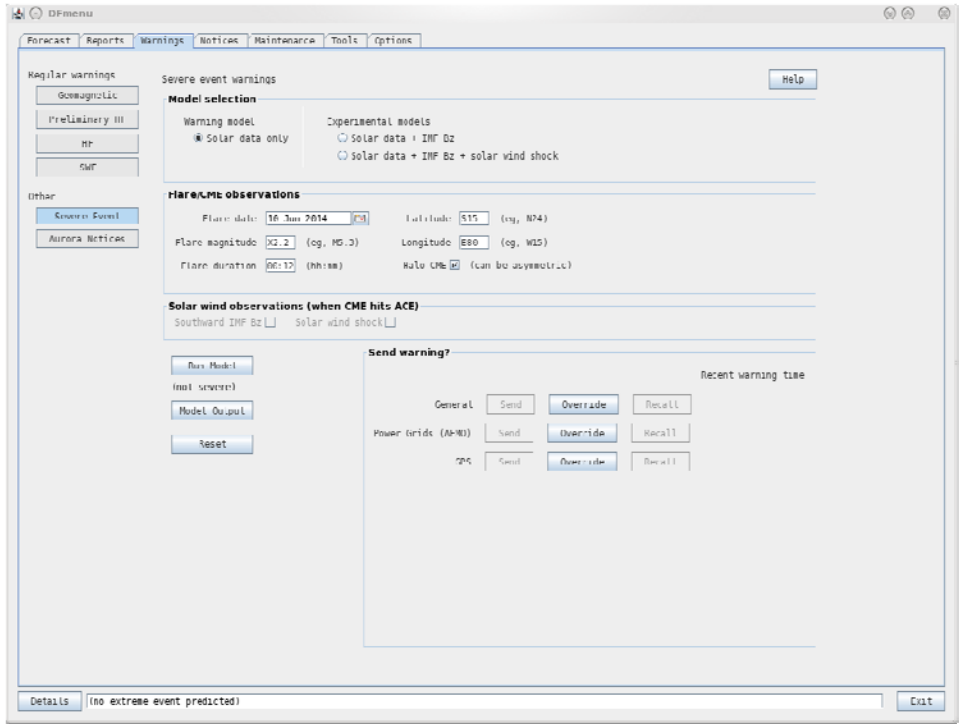
Table 6: SSWS Notifications - Summary of Notifications, timeframes and AEMO Actions

NOTIFICATION from SSWS	ETA (Forecast lead time)	ETD (Warning lead time)	AEMO Actions
Severe Space Weather Watch	12hrs+	TBA	1. Issue a market notice; 2. Increased awareness for next 48 hours 3. Maintain increased awareness of GIC monitored equipment
Short Duration GIC Warning	NOW	30-60 mins.	1. Issue a market notice; 2. Maximise dynamic reactive reserves across the power system; 3. AEMO instruct restoration of transmission outages; 4. Maintain increased awareness for more warnings 24hrs 5. Maintain increased awareness of GIC monitoring equipment
Sustained GIC activity Warning	30-60 mins	6-12 hrs	1. Issue a market notice; 2. Maximise reactive reserves across the power system; 3. Instruct the restoration of transmission outages 4. TNSP may re-rate transformers (possibility of instructing for load shedding) 5. TNSP may advise with the intent to take transformer OOS due high impact of GIC. May have to instruct load shedding to maintain security 6. Maintain increased awareness of GIC monitoring equipment levels 7. Maintain increased awareness & monitor for "Event End"
Severe Space Weather Event End	NOW	NOW	1. Issue market notice; 2. Return power system to normal operations; 3. Maintain increased awareness of GIC monitoring equipment levels 4. Maintain increased awareness and monitor for any further "Warnings" and/or "Cancellations" notices.
Severe Space Weather Cancellation	NOW	NOW	1. Issue market notice; 2. Anticipate event summary from IPS.

AEMO Power System Security Guidelines for the management of Geomagnetic Storms

- This is in collaboration with state power transmission network service providers (TNSPs) and is coordinated by the Australian Energy Market Operator (AEMO)
- Procedures were established, Section 12 of the Power System Security Guidelines (shown to left).
- Pivotal part of these procedures is the issuing of the "Severe Space Weather" Watch and Warnings by BOM/IPS

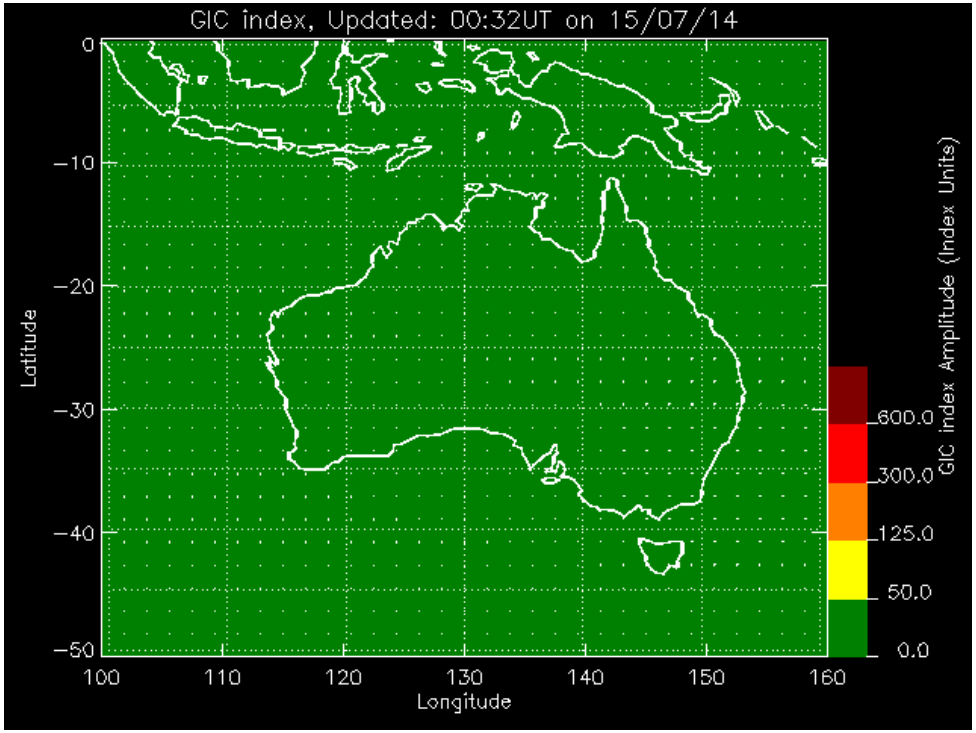
The Severe Space Weather Service has been fully implemented



DFmenu SSWS user interface

- It is based on Generalised Linear Model (study by Terkildsen et al. 2014)
- This Model uses a statistical relationship between severe geomagnetic storms (defined by Dst < -250nT) and parameters of the solar region.
- Model has been integrated into the operational procedures of the Australian Space Forecast Centre.
- User inputs include X-ray flare duration, X-ray flare magnitude, flare location, and whether halo CME associated.
- Optional inputs include whether Bz is south and solar wind shock associated (based on ACE data).

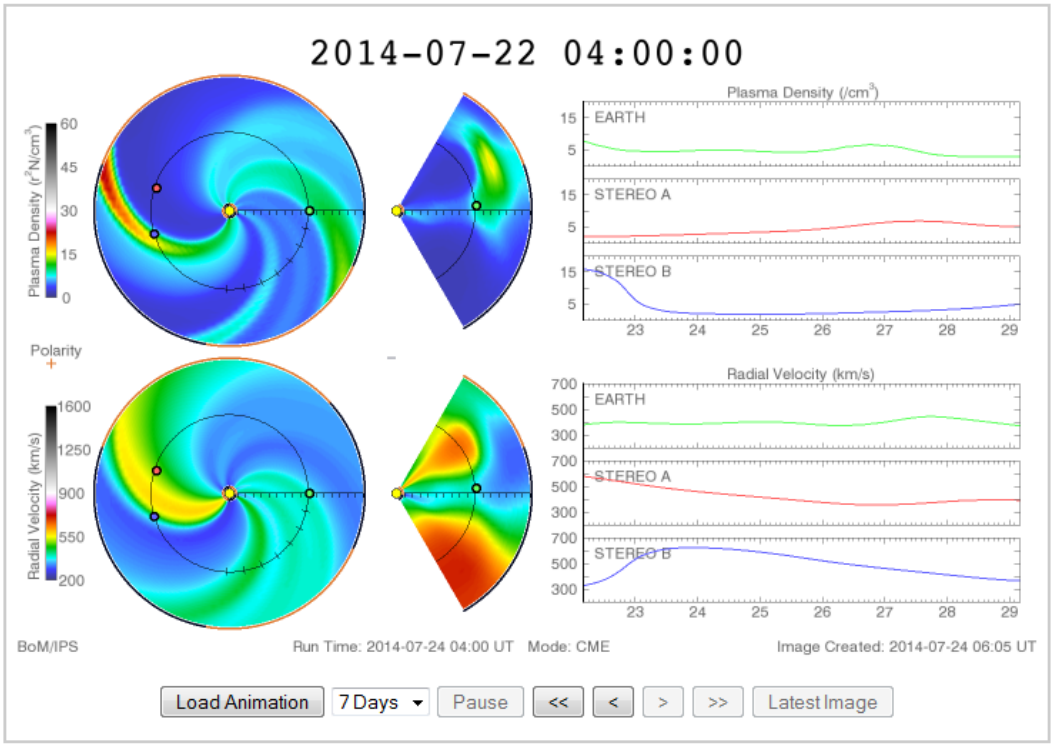
New GIC webpage service

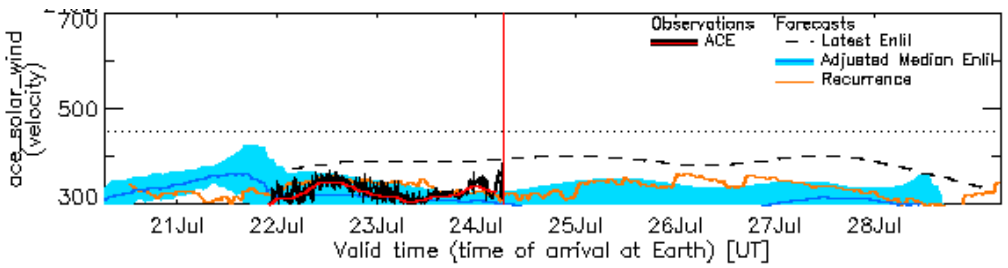


GIC Index Map

- It displays GIC index amplitude as well as vectors indicating direction and magnitude of geo-electric field
- http://www.ips.gov.au/Geophysical/1/2/5

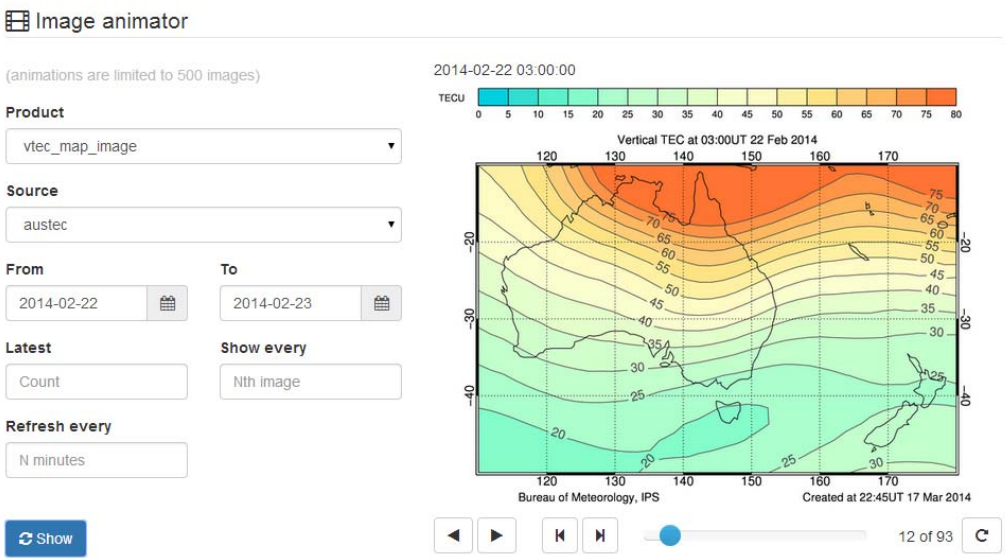
Fully implemented low resolution WSA-Enlil Solar Wind Model courtesy of SWPC/NOAA





- Input parameters are acquired from SWPC CAT tool
- LASCO and STEREO images are automatically downloaded.
- Parameters are entered via DFmenu user interface.
- Enlil model is run via DFmenu user interface.
- Output display shows arrival times of CMEs similar to the SWPC version (shown to left).
- A summary display plots both density and velocity (last 48 runs) and gives median measure rather than just one run.
- IPS is in the process of getting access to the BoM super computer for medium resolution runs.

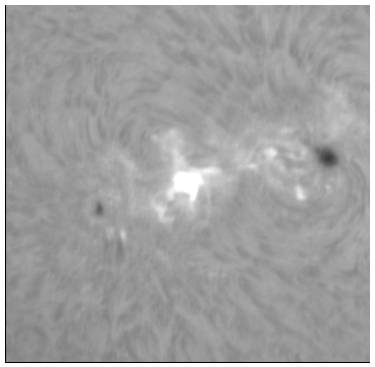
Data Infastructure Project (DIP)

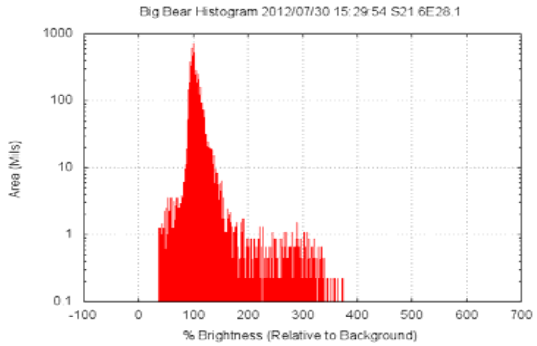


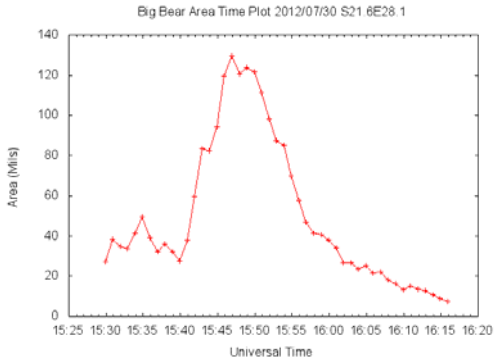
DIP was born out of a desire to make the storing and accessing of data standardised, simpler and quicker than the current IPS file-system.

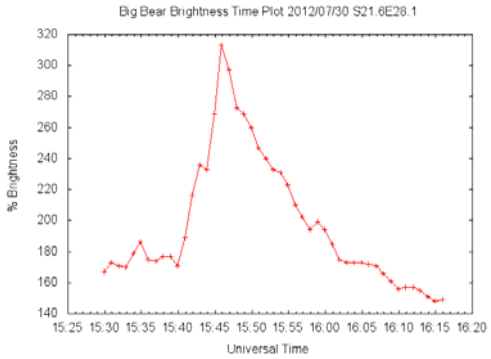
- More than 80 datasets (including some 3rd-party data) are now stored in the database.
- Simple APIs have been developed for fetching and/or updating data from Java, IDL and Unix shell scripts.
- A web-based tool for browsing, charting and exporting the data has been developed.
- Forecast verification software has been migrated to use the database.
- A few old forecaster tools have been redeveloped to use a web-browser UI and data from the database.
- A new web-based animation tool allows easy generation of movies from images stored in the database (including IPS as well as SDO, SOHO, STEREO and GONG images).

Will soon implement a Automatic Flare Patrol program





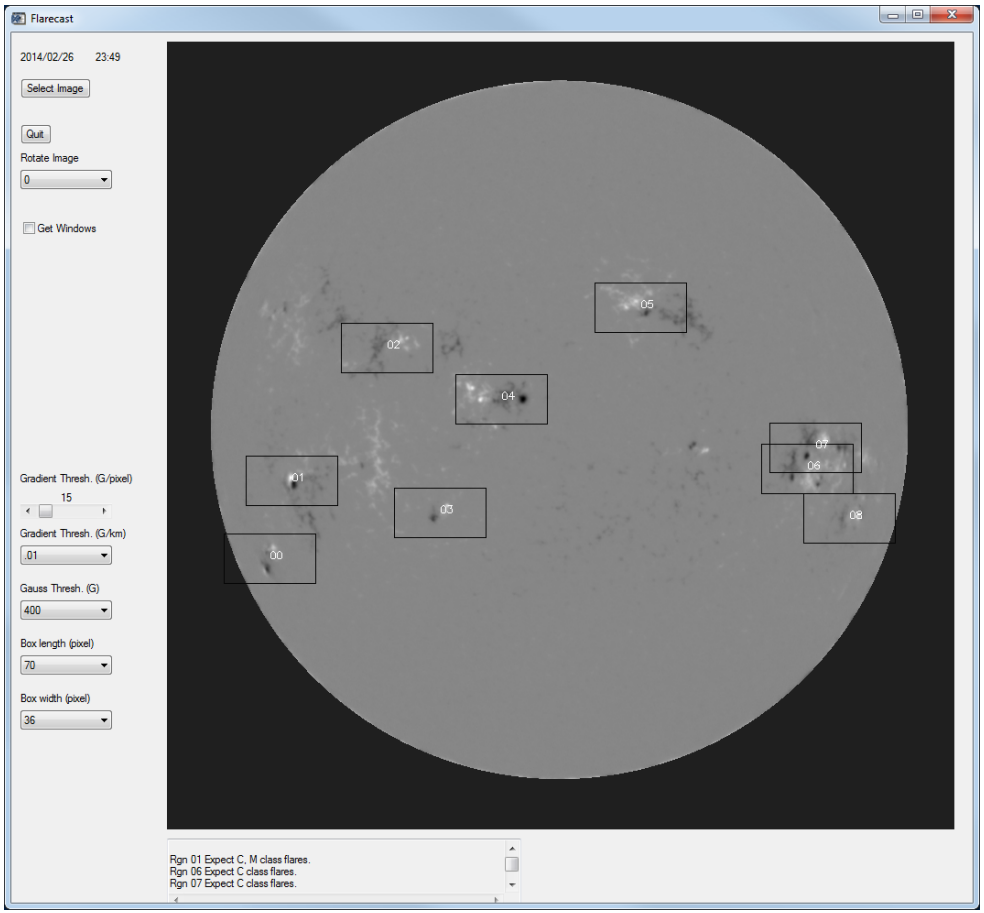




Example outputs

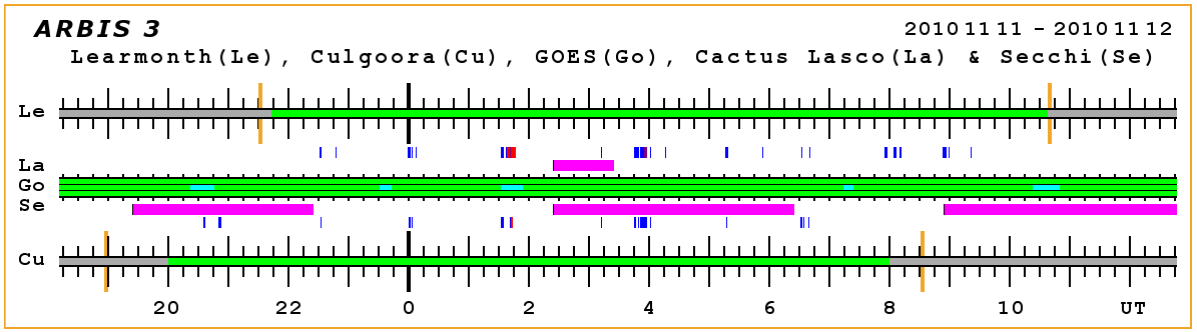
- Acquires Gong H-alpha images (24/7)
- Centres Image and finds limb
- Adjusts image brightness
- Has limb darkening correction
- Histogram analysis
- Provides Flare brightness and area classifications
- And Archives data

Taking steps to Improve the flare prediction software, Flarecast



- This is a flare prediction program uses GONG magnetogram images to analyse neutral line characteristics.
- The plan is to test for additional magnetogram characteristics.
- Include analysis of 2011, 2012, 2013, and 2014 magnetograms.
- Output probabilities for M and X class flares
- Compare output to observed flare activity and provide skill score.

Looking to Improve the Automatic Radio Burst Identification System (ARBIS)



A typical pictorial summary. Orange vertical dashes show sunrise/sunset times. Green color shows available data. For X-rays, green is replaced by aqua, blue and red if peak flux corresponds to C, M and X classes of flares, respectively. Type II and III burst are shown by red and blue vertical dashes between the axes. Purple bands with black left edges correspond to CMEs detected by CACTUS

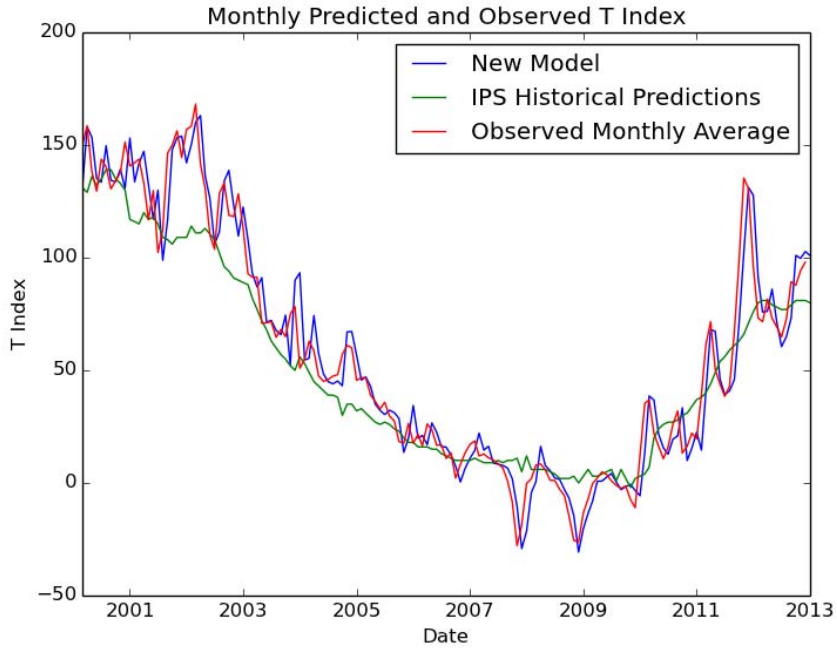
Presently

- Provides type II and type III event email notification service for LSO and CSO
- Pictorial summary

Planned improvements

- Increase coverage to 24/7, add San Vito, Kaena Point, Sagamore Hill SRS data.
- Decrease false alarm rate.

Working on a New T-index Forecast Model



- Older model is based on historical smooth T (similar to smooth sunspot number).
- The current observed regional T index can depart significantly from the monthly predicted value for extended periods.
- The new model will include an auto-regressive prediction using recent daily Aus T values.
- Work is also underway on an ensemble model using both smooth T and the auto-regressive prediction.
- Also an upgraded model may include K indices and 10cm flux as input.
- It will run via a DFmenu calculate button.

Verification of IPS Products

- Presently during monthly meetings if forecasters exceed thresholds related to predictions for Ap (>1 category) and T-index (>20) they give presentation of what took place and why it went wrong.

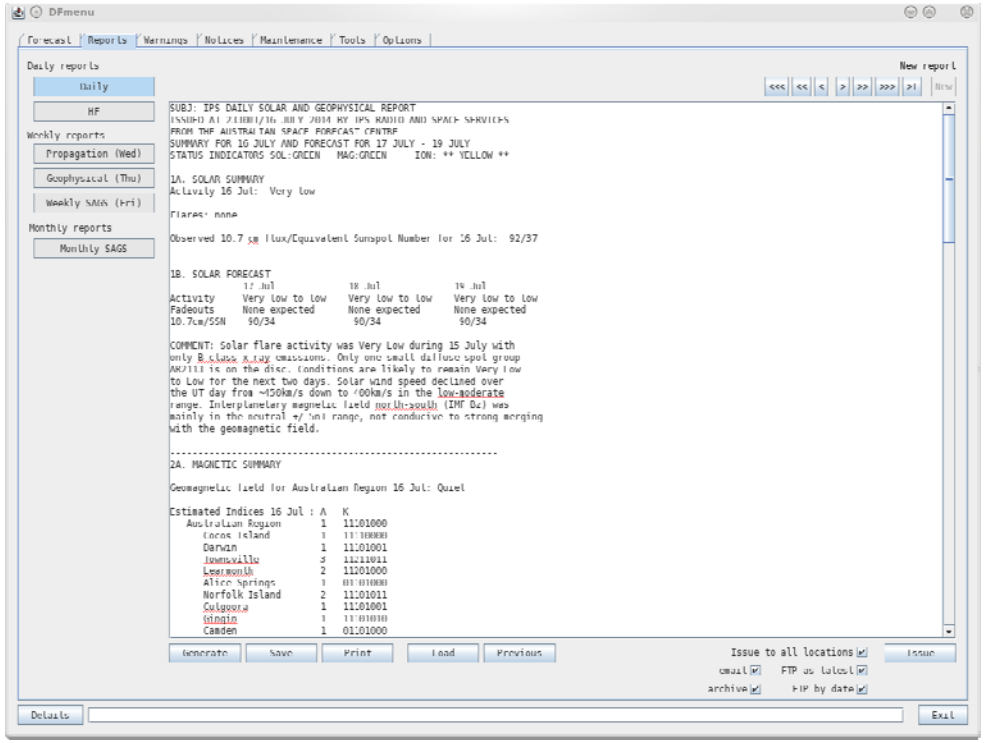
- Various statistical analysis has been carried out on forecasted items shown below (using skill scores and RMSE).

Display	Aus T	Ap	Solar activity	Geomagnetic conditions	Fadeouts	HF conditions
Numerical tabular stats	●	●				
Categorical tabular stats	●	●	●	●	●	●
Error chart	●	●				
Skill chart	●	●				
Conditional quantile plots	●	●				
Threshold skill plots	●	●				
SEDI chart	●	●	●	●	●	

Plan on moving away from Ap to max Kp, as it is hard to verify if Ap errors are due to getting arrival time wrong as opposed to magnitude of impact. Furthermore it is felt max Kp is more useful to the customer. Also moving toward probability forecast for M and X class flares using the Flarecast program (easier to verify).

Thank you

Menu Driven Forecasting Software (DFmenu) Improvements



- The DFmenu aids the duty forecaster with writing, compiling, editing and issuing warnings, as well as daily, weekly and monthly reports.
- Added menu driven capability to run the Severe Space Weather Service model and issue warnings.
- Added menu driven capability to run the WSA-Enlil CME prediction model.
- Added 1-day max Kp forecast support (not issued to public at this time).