WP6: Forecasts of the radiation belt environment: MLT NARMAX electron flux models

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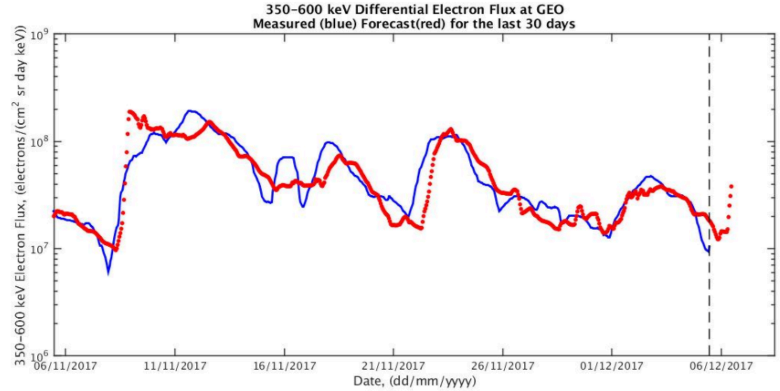
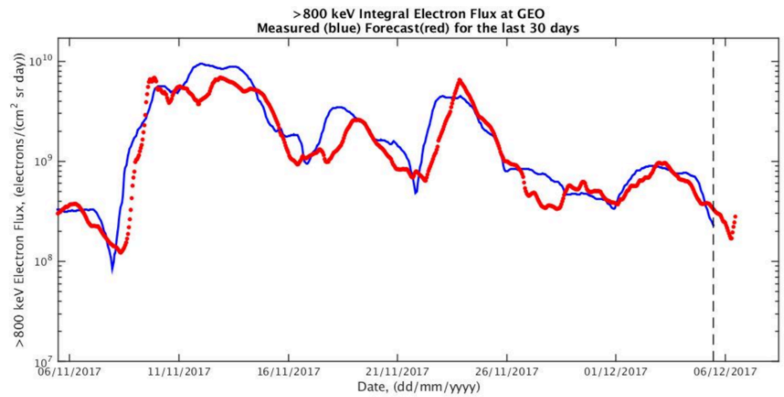
GOES Electron Flux models Models

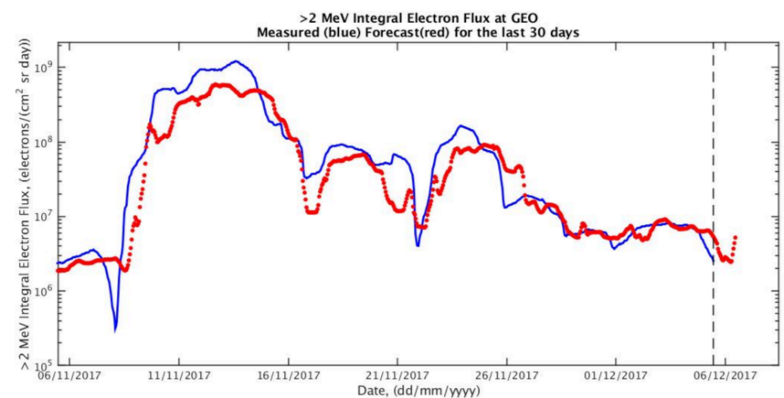
1. 30-50 keV
2. 50-100 keV
3. 100-200 keV
4. 200-350 keV
5. 350-600 keV
6. >800 keV
7. >2 MeV



Energy 800keV



Energy 2MeV



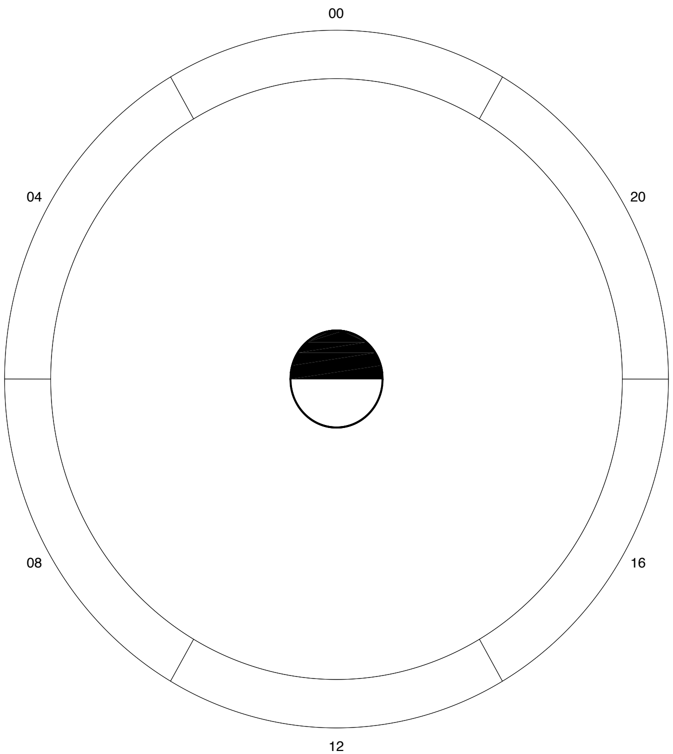
MLT Electron flux models

The spatial variation of the low energy electron flux makes it very difficult to deduce a data based NARMAX model. System identification techniques normally require lots of continuous equally spaced sampled data. However, the satellites that measure the electron fluxes at GEO are sparse. The two GOES spacecraft have orbited the Earth with a separation that has varied between 1 – 4 MLT since 2010, which means they are only at specific MLTs for a short time. Therefore, the data from GOES 13 and 15 were binned by MLT, resulting in a time series for each MLT bin,

which was mostly be empty. The bins selected were:

22-02, 02-06, 06-10, 10-14, 14-18, 18-22 MLT

This was then averaged to get a two hour temporal resolution.



MLT Electron flux models

A NARMAX model was deduced for the electron flux at each MLT, using inputs:

Solar Wind Velocity V

Solar wind density n

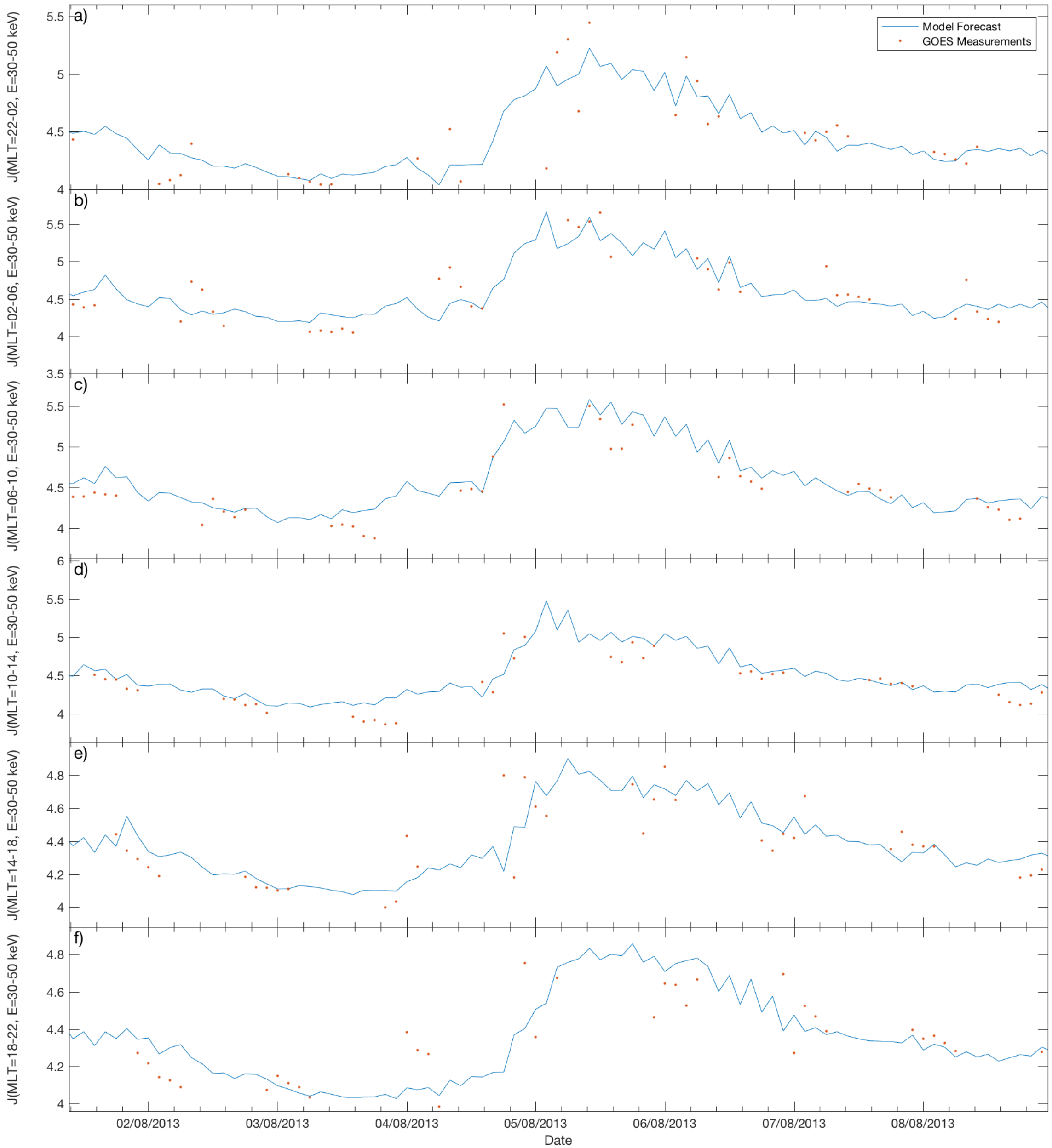
Southward IMF factor

The models were trained on data from 1 January 2011 to 1 March 2013

$$
\begin{aligned}
J(t, MLT) = F[& J(t-24, MLT), J(t-48, MLT), \\
& V(t-2), V(t-6), V(t-10), \ldots V(t-26), \\
& n(t-2), n(t-6), n(t-10), \ldots n(t-26), \\
& B_f(t-2), B_f(t-6), B_f(t-10), \ldots B_f(t-26)]
\end{aligned}
$$

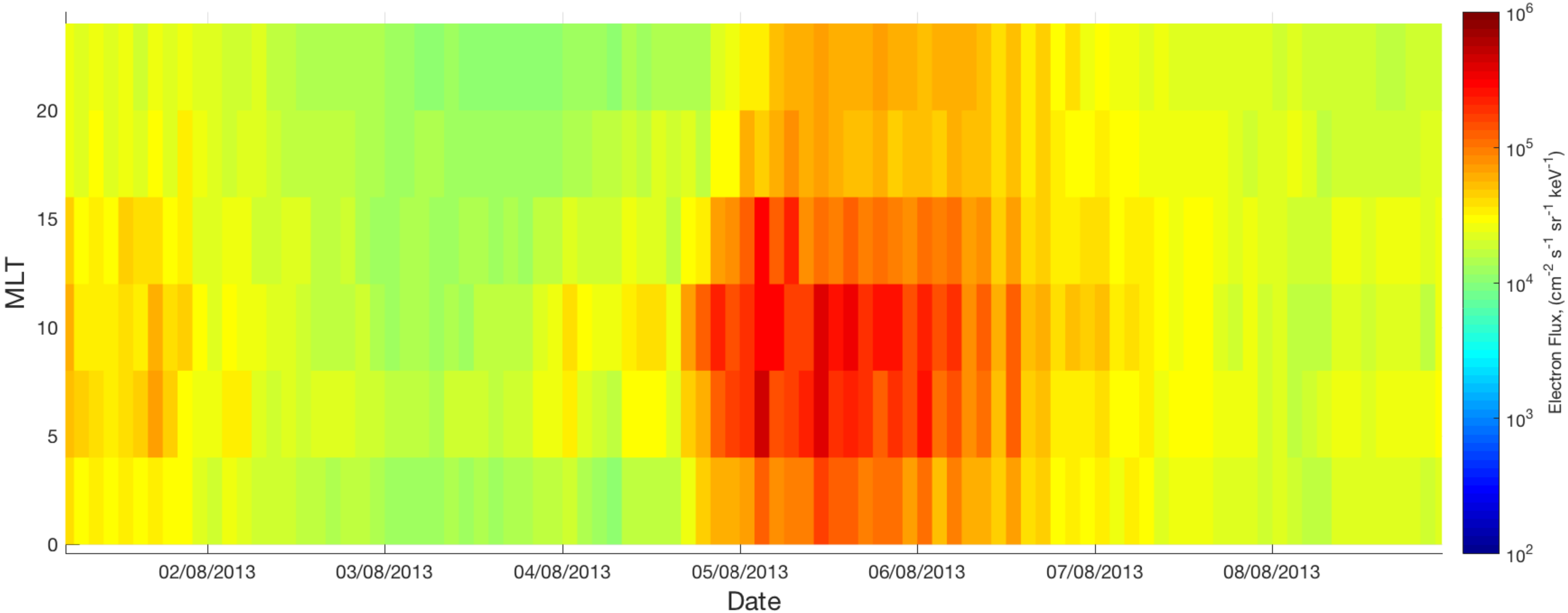
Model Performance

Figure showing the model 2 hour ahead forecast (blue) and measured electron flux (orange).



Model Performance

Figure showing electron flux magnitude in MLT and time.



Model Performance

30-50 keV Electron Flux Model (MLT)	Prediction Efficiency (%)	Correlation Coefficient (%)
22-02	43.65	66.10
02-06	55.67	74.68
06-10	68.38	82.72
10-14	65.13	80.74
14-18	55.20	74.33
18-22	42.29	65.11

Model Performance