Radiation Belt Analyses: needs, data and analysis

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Effects Requirements – What are we looking for?

Dose (TID/TNID)	← total mission fluences (dose rate)
Solar cell degradation:	← total mission fluences
Internal charging	← peak daily/weekly/monthly fluences
Single event effects:	
long term (destructive):	← total mission fluence, probabilities
Short term (SEU, Transients):	← peak fluxes, probabilities
Instrument background/noise:	
Maximum noise levels:	← peak fluxes
Loss of "science"	← duration of "events" ← frequency of "events".
Material Degradation	← total mission fluences ← low energies required (~ 10s keV)

Data Set Requirements

Detector information:

response functions, calibration data, thresholds…

Anisotropy in the environment?

→ Pitch angle or Look direction required

Count rate data, not just calibrated flux data - for validation activities.

Cross Calibration with a "gold standard" instrument

Representative over the full dynamic range of the environment?

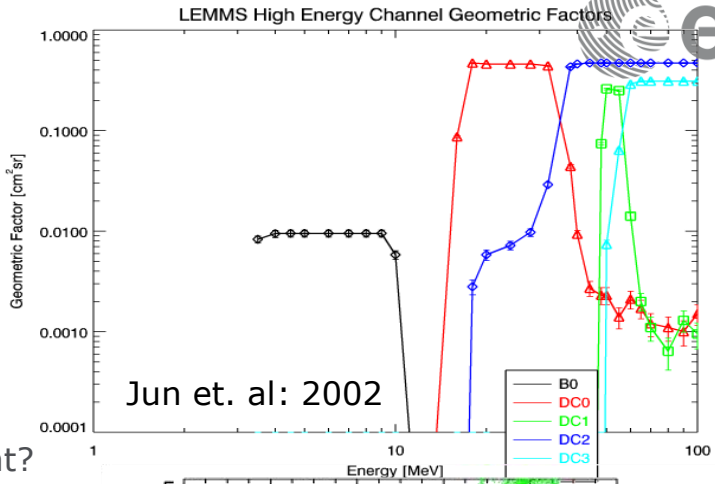
Full coverage of the magnetosphere??? Not really feasible…

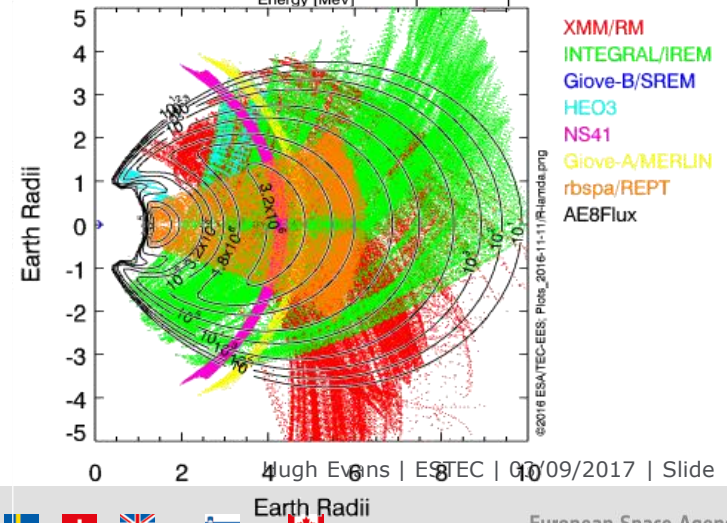
AVAILABILITY??

Ideally automated downloads possible in a convenient data format. API for "favourite" analysis tool (Python, Matlab, IDL, Excel?)

Consistency

stability of data provision is greatly appreciated. Frequent (minor) updates of datasets makes consistent data analysis problematic.





Accessibility: ODI, an Unabashed Advertisement

Purpose: provide a single consistent interface to time series space environment data.

What is it: MySQL database housing the datasets, providing a set of access tools in Python, IDL, Matlab, Php, Excel…

See: https://spitfire.estec.esa.int/trac/ODI

e.g. Python

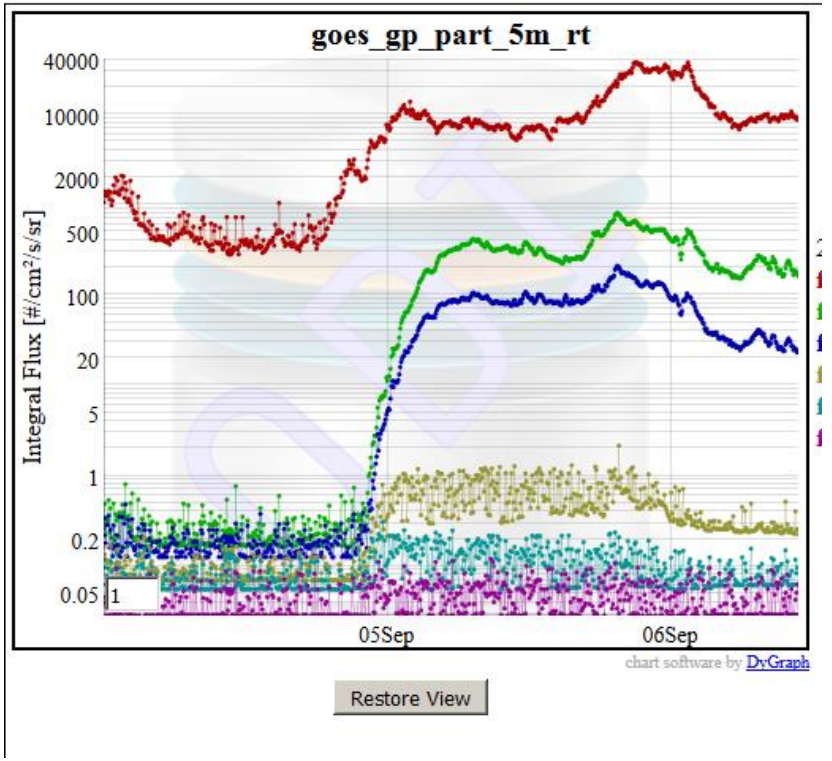
```
odi = odiclient.new_instance()
d = odi.get_dataset('ace_mfi_h0',
START="2017-09-01", END="2017-09-15",
LIMIT=10000)
```

Spitfire is a publicly available installation providing access to the following datasets:

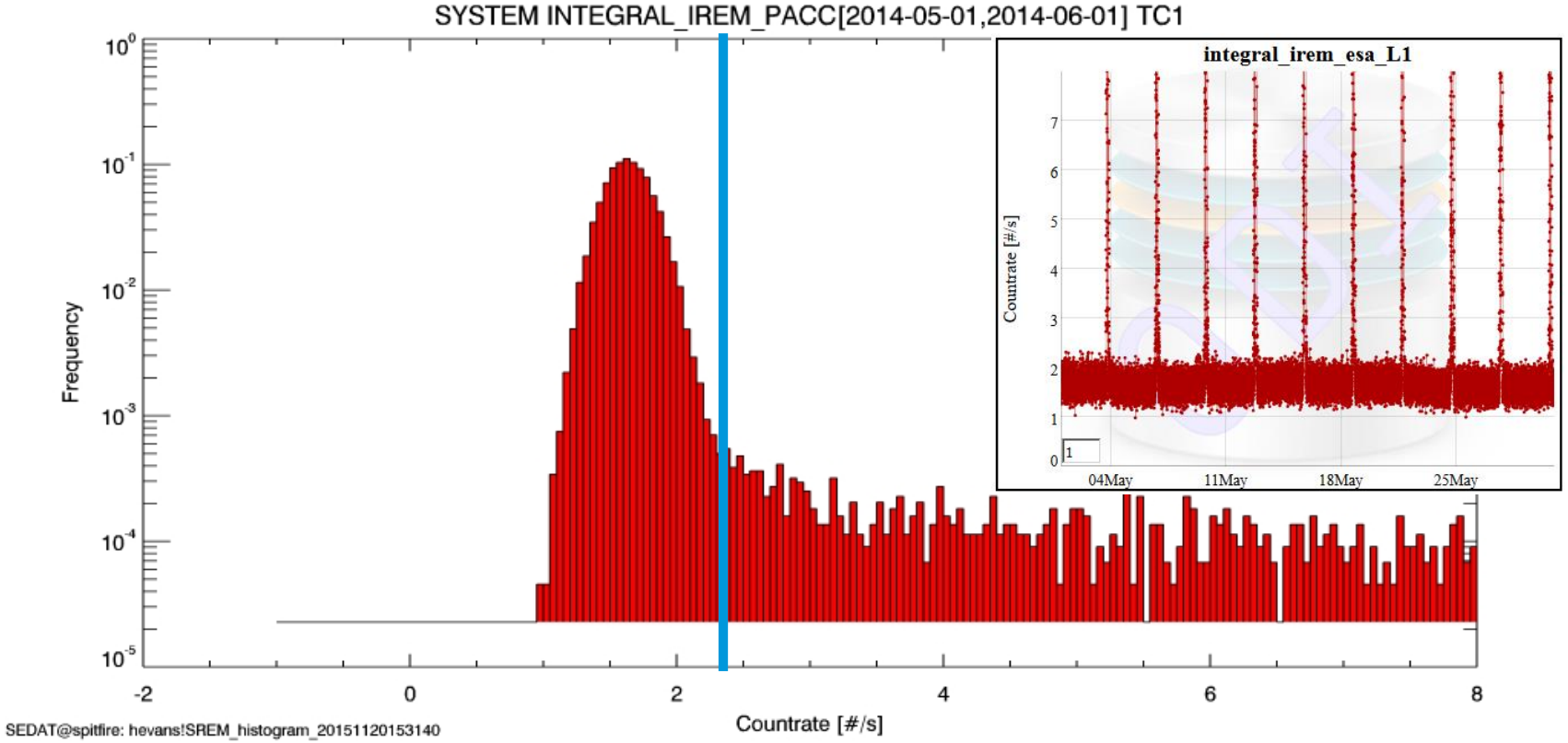
https://spitfire.estec.esa.int/sedat/cgi-public/odi_datasets

A variety of dynamic plotting tools that use ODI as the backend are available via

http://space-env.esa.int/index.php/NOAA-daily-plots.html



Background Analysis



Cross Calibration

Protons **can use solar particle events for cross calibration**

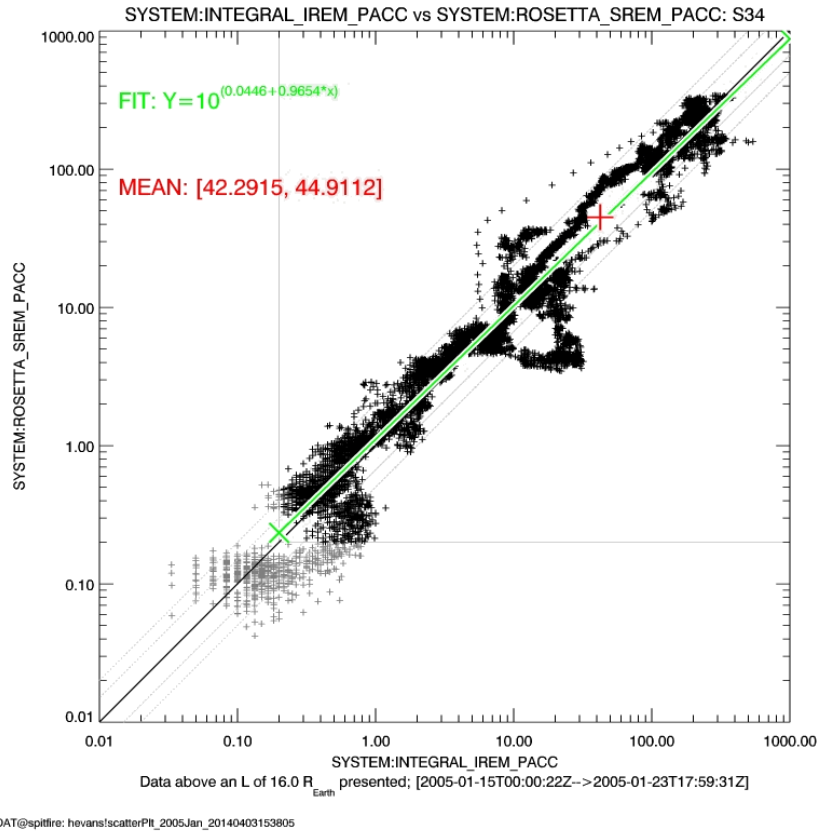
Electrons need to use spacecraft conjunctions:

- How close geographically/magneto-spherically is close enough?
- How close in time is close enough?
- Very Long term averages ?
- Quiet (kp < 2) time comparisons.

How well can we cross calibrate?

< 50%, 20%?? Impacts result reliability.

Gold standard! --- currently can use RBSP to calibrate to a baseline…but what of the future?



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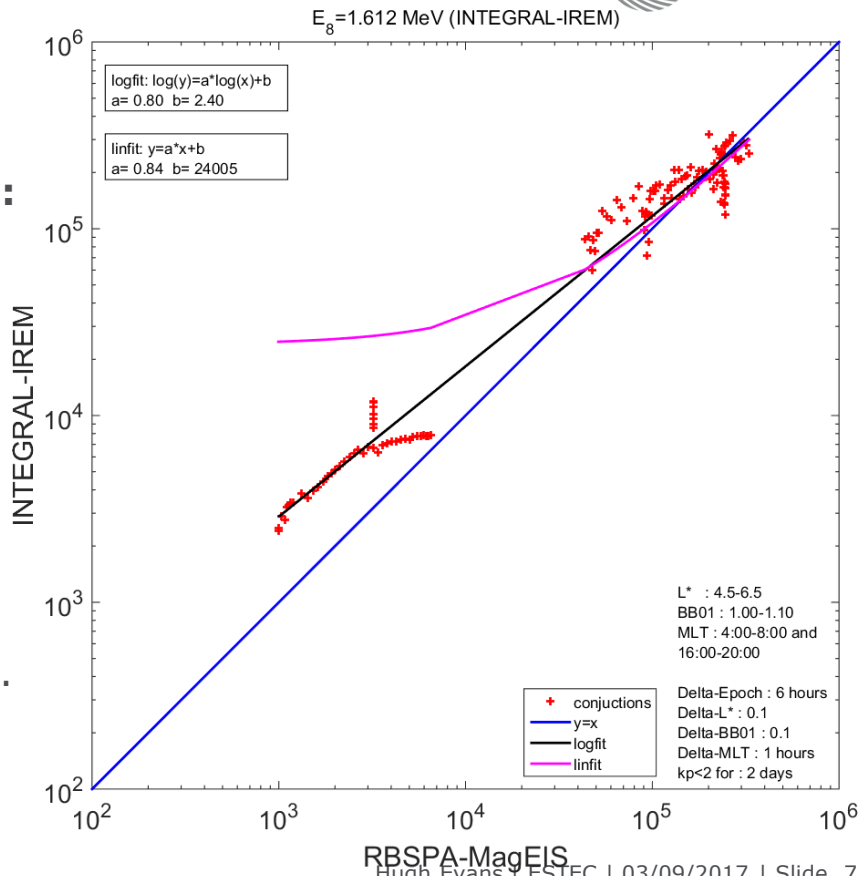
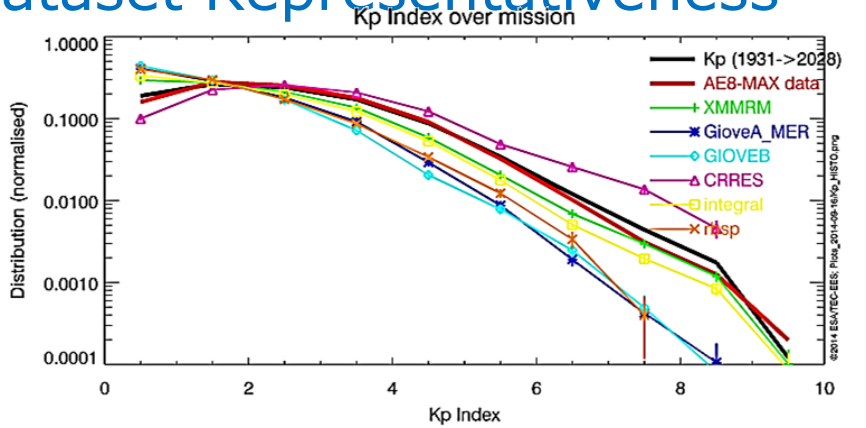
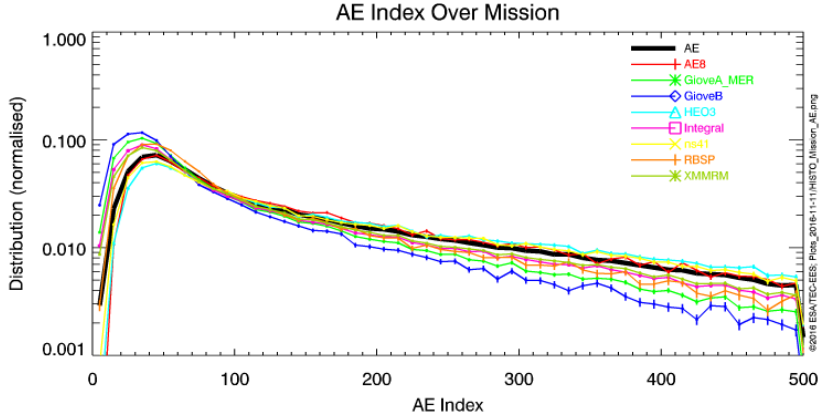
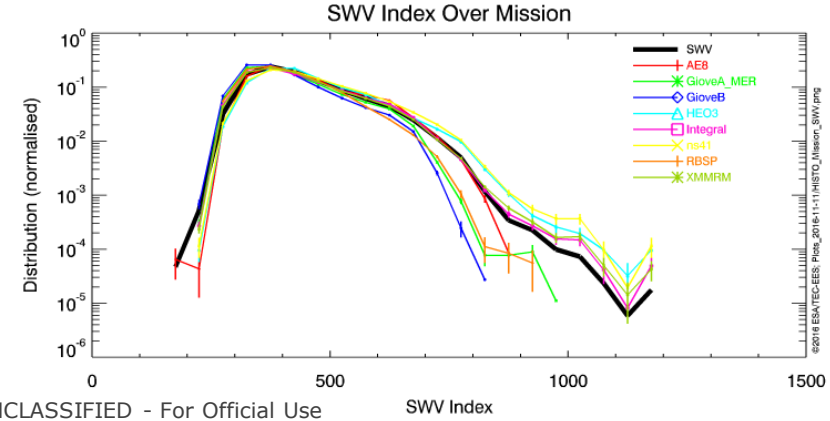
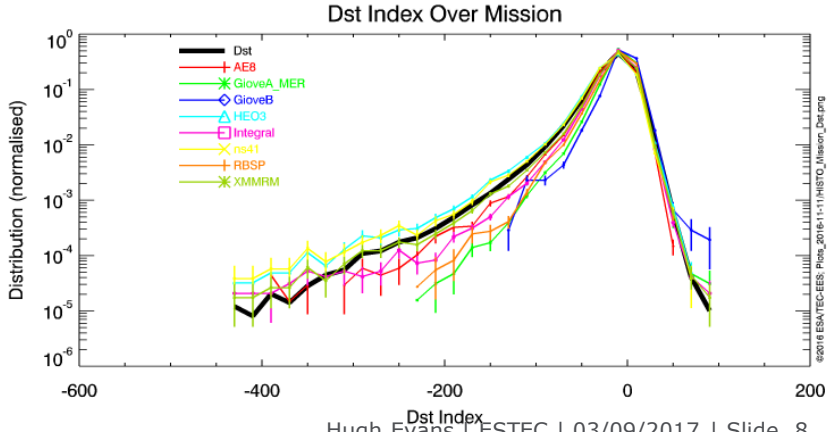


Environment Uncertainties
Dataset Representativeness

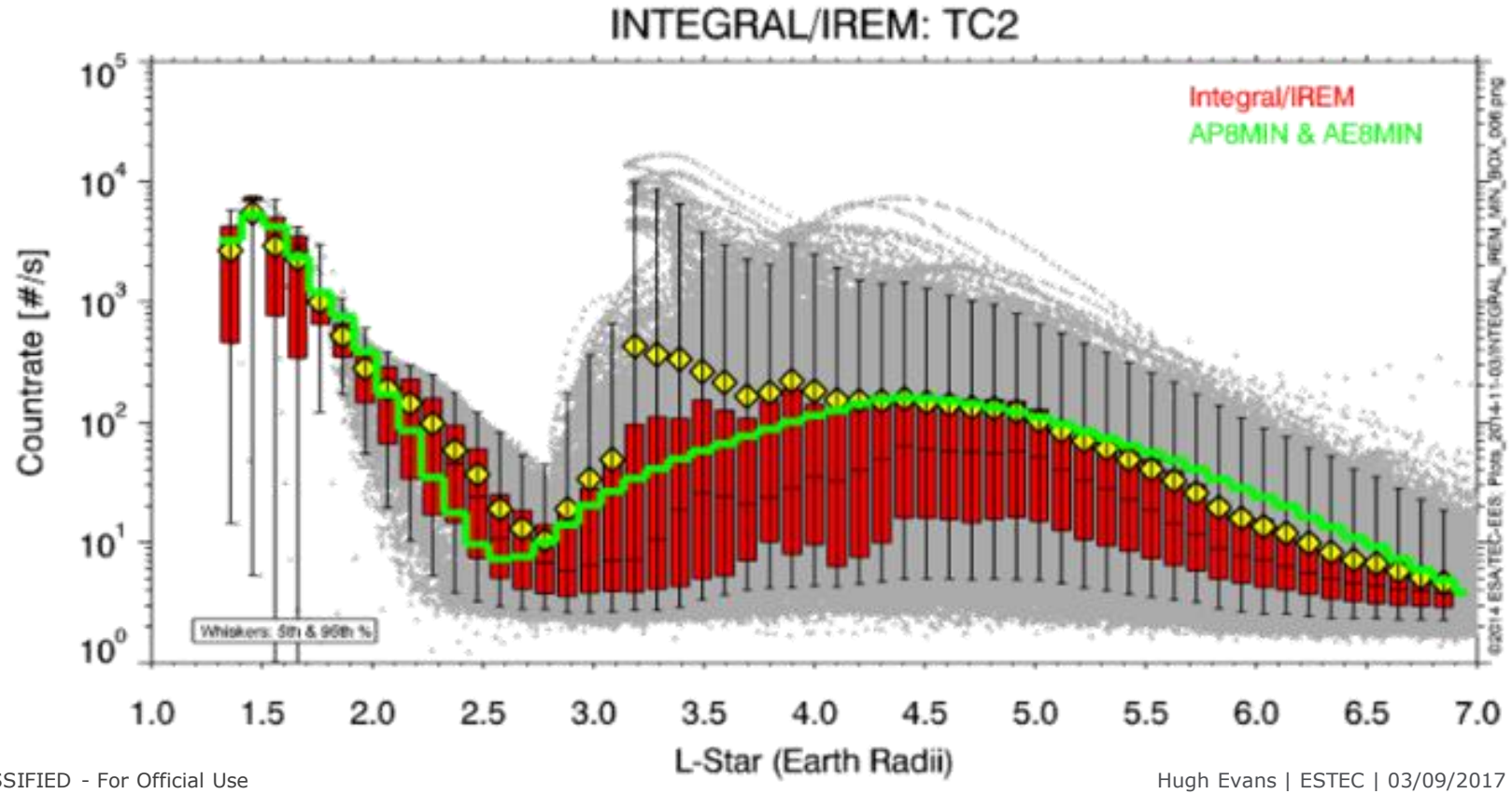




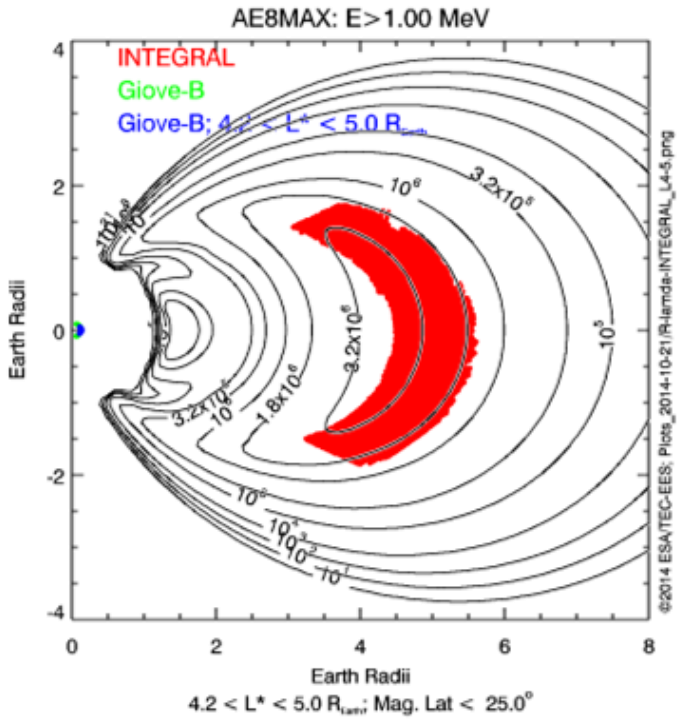


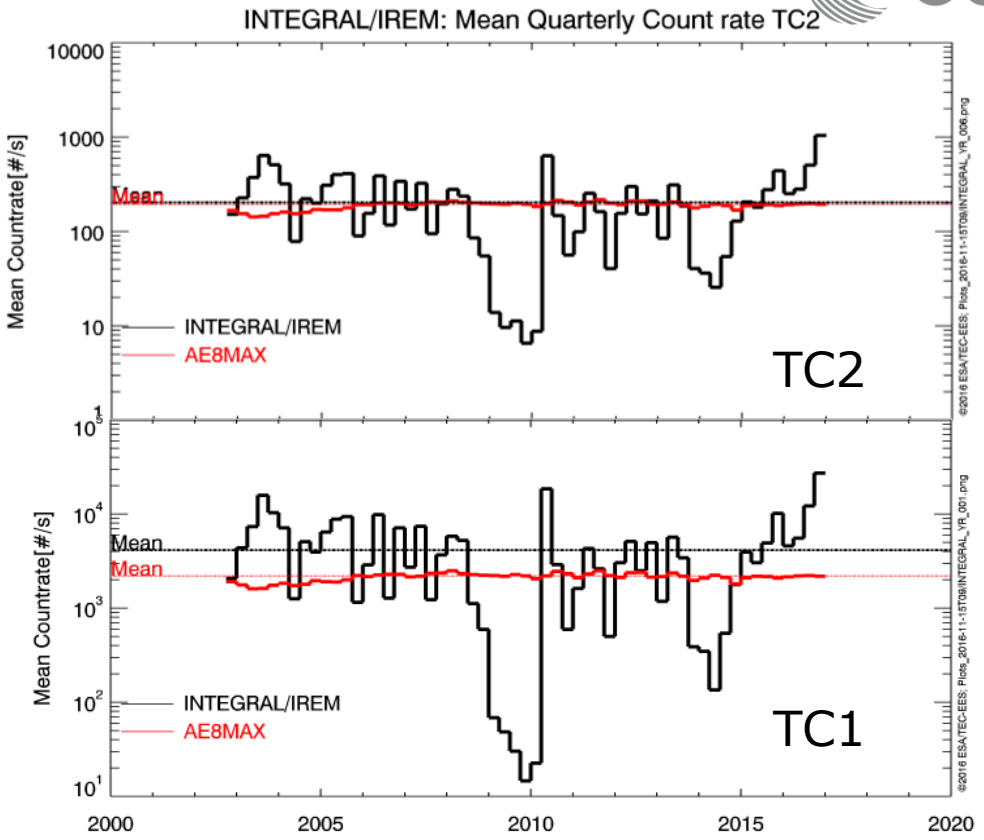


L-Shell Overviews

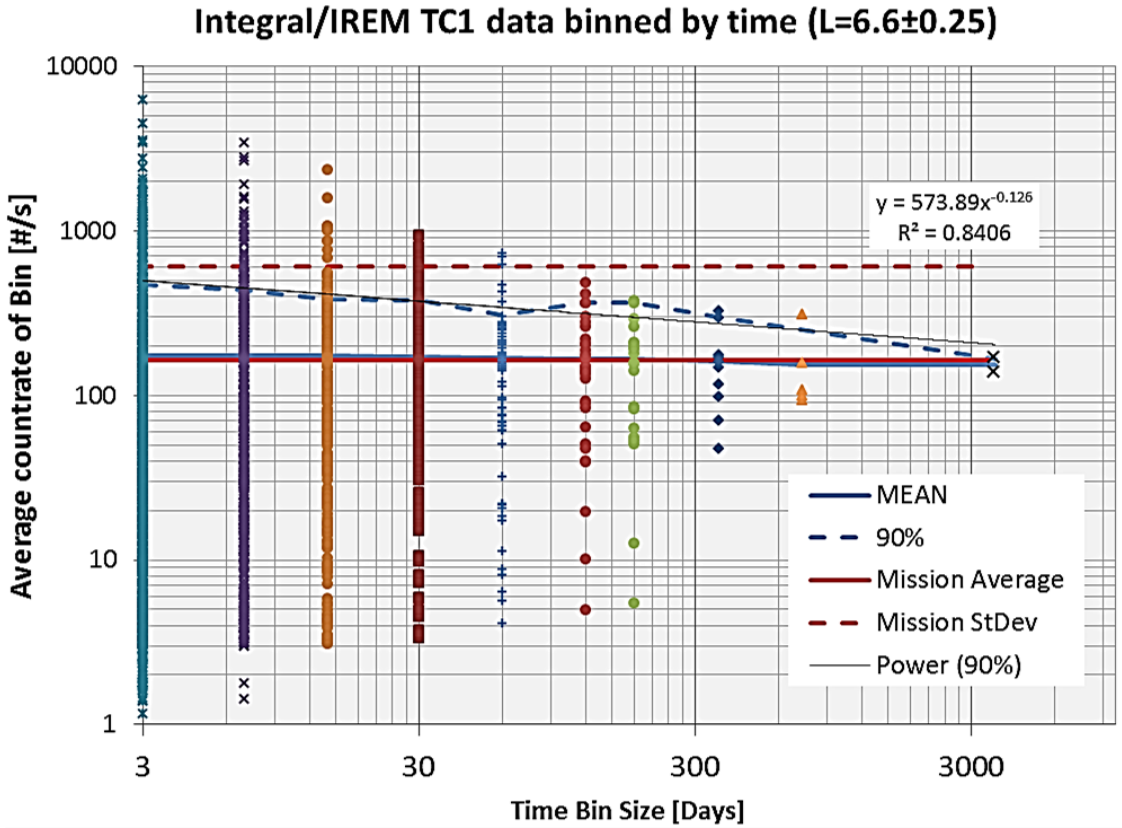


Integral Quarterly Mean Counts
4.2<L*<5.0 ; λ<25°





Confidence levels and Duration

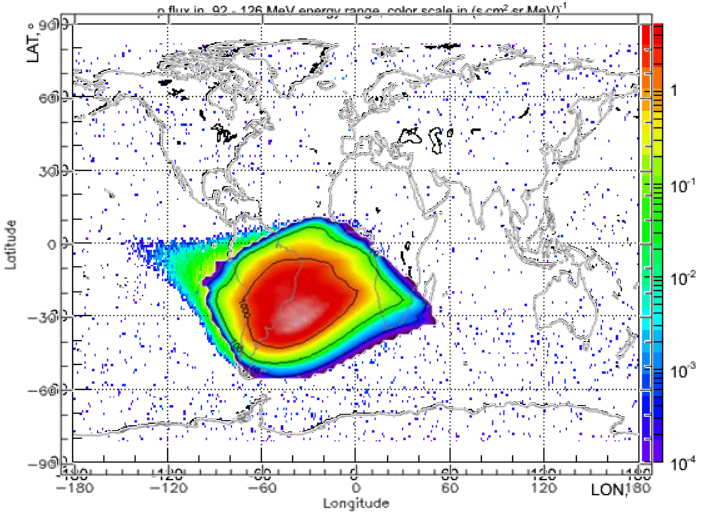


Tricky:
solar cycle and seasonal variations have to be considered as well

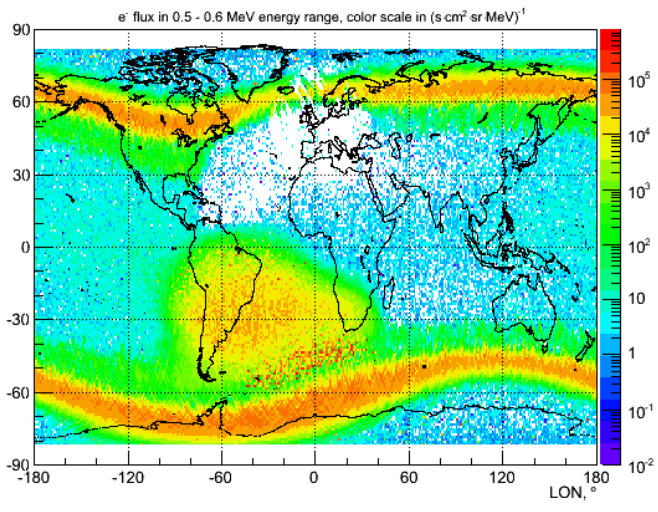
The Trapped Radiation Environment
Inner Belt: SAA

Proba-V/EPT

92 MeV Protons



0.5 MeV electrons



Conclusions

Radiation belt analyses are only as good as the data that goes into them:

- Well calibrated
- Error in calibration and measurements known
- no instrument saturation
- Good particle species discrimination (no contamination)
- Good energy discrimination

- Representative of the long term Magnetospheric state
- Anisotropies considered in the data and model
- Full dynamics of the environment covered
- Full coverage of the magnetosphere required