

Data and Processing Requirements for Solar Proton Events Statistical Modelling

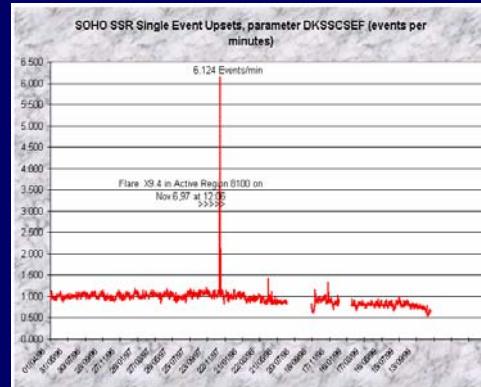
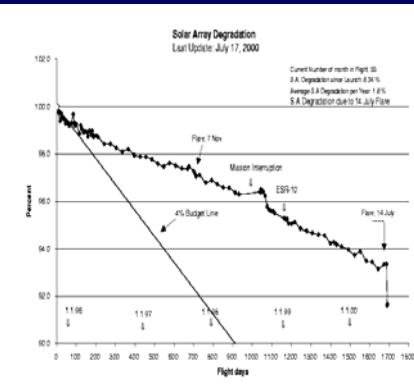
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Examples of Effects of Solar Proton Events



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Examples of Engineering Requirements

- Integrated flux (fluence) over mission duration.
- Peak flux.
- Maximum values.
- Value not to be exceeded at given confidence level (quantile of cumulated probability distribution function).

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1977-1983 Space Missions (King, JSR, 1974)

$$f(F) = (1 / \sqrt{2\pi}\sigma) \exp -\frac{1}{2}[(F - \mu) / \sigma]^2$$

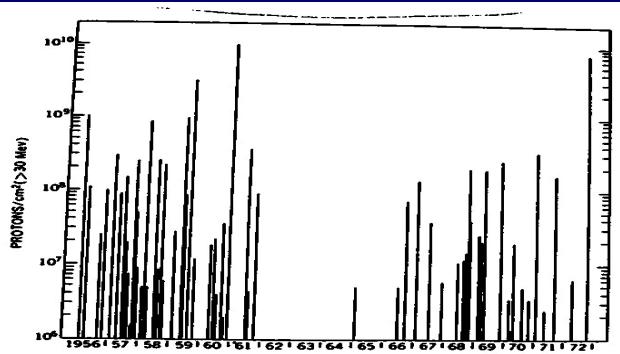


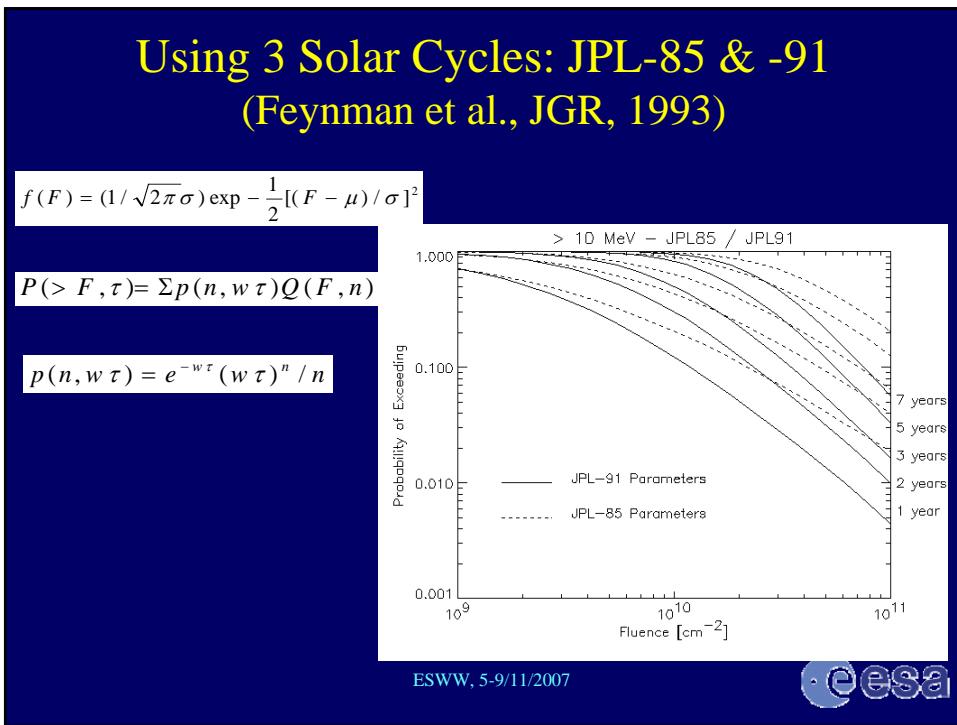
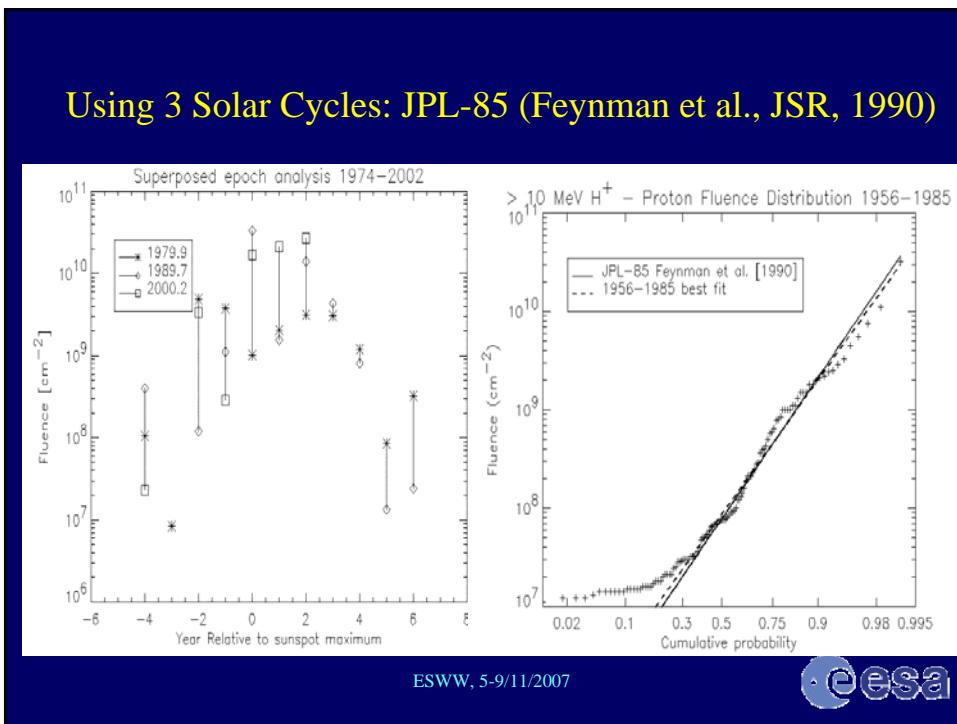
Fig. 1 Event-integrated proton fluxes above 30 Mev for the major solar events of the 19th and 20th solar cycles.

$$P(> F, \tau) = \sum p(n, w \tau) Q(F, n)$$

$$p(n, \tau; N, T) = \frac{(n + N)!}{n! N!} \cdot \frac{(\tau / T)^n}{[1 + (\tau / T)]^{1+n+N}}$$

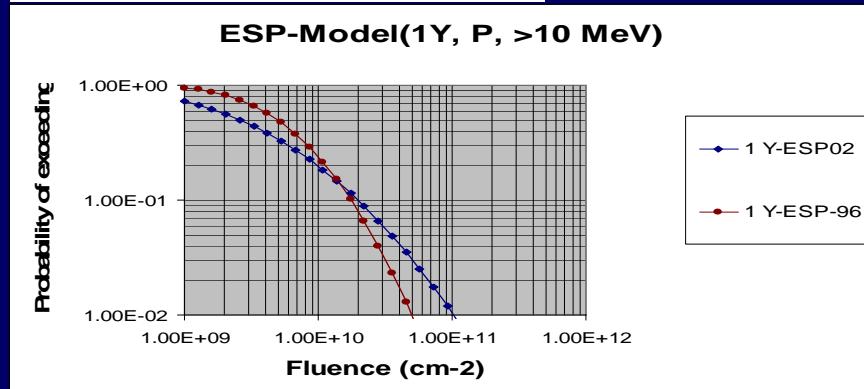
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Using 3 Solar Cycles: ESP 96 & ESP-02 (Xapsos et al., IEEE Trans. Nucl. Sci., 1996 & 2000)

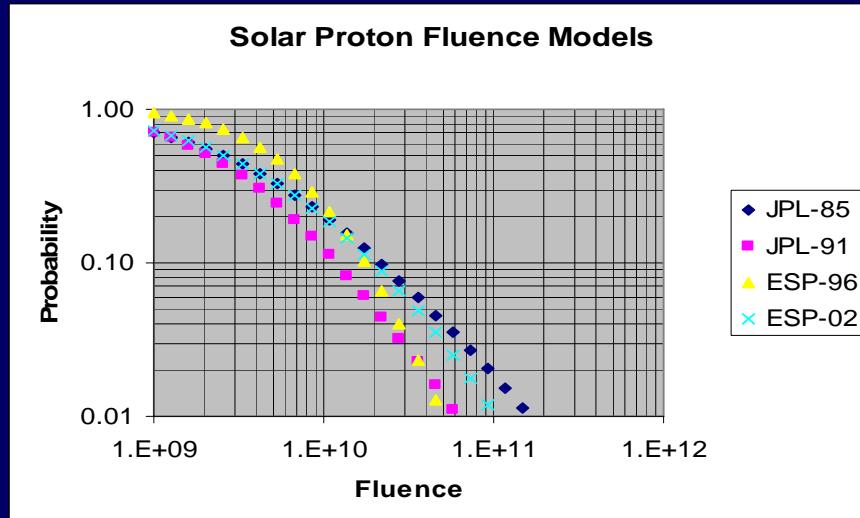
$$f(< F >_{Year}) = (1 / (\sqrt{2\pi} \sigma F)) \exp -\frac{1}{2}[(\ln F - \mu) / \sigma]^2$$



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4 Models !



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Data quality and calibration effects

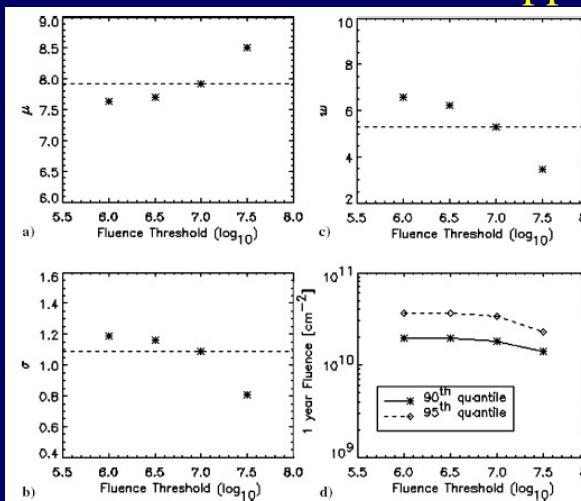
Examples of Possible effects:

1. Event selection criteria (grouping of events)
2. The choice of flux threshold for event identification
3. The choice of fluence threshold for event identification
4. The identification of the high activity part of the solar cycle
5. Parameter fitting procedure of the event intensity distribution
6. Size of the dataset
7. Calibration uncertainty
8. Data gaps
9. Ghost events (glitches, ...)

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Effect of threshold on JPL approach

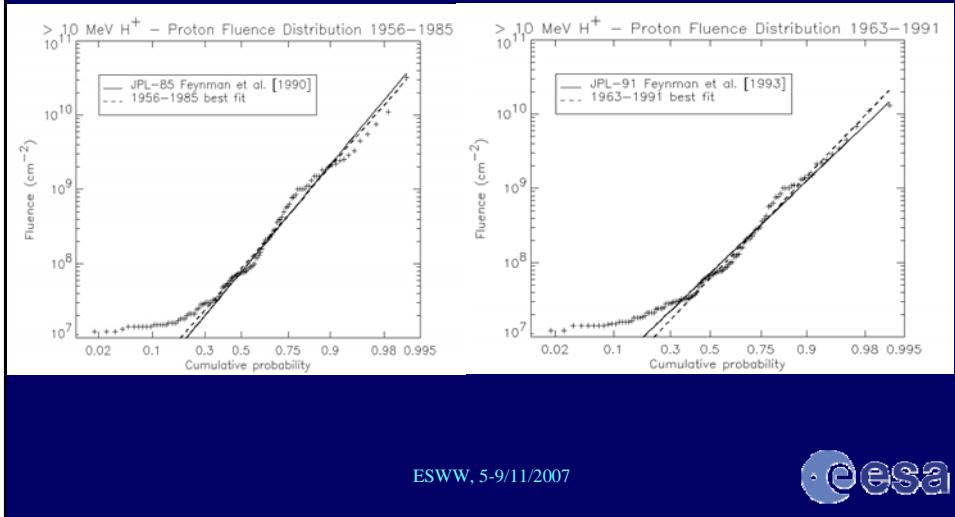


Rosenqvist and Hilgers, GRL, 2003

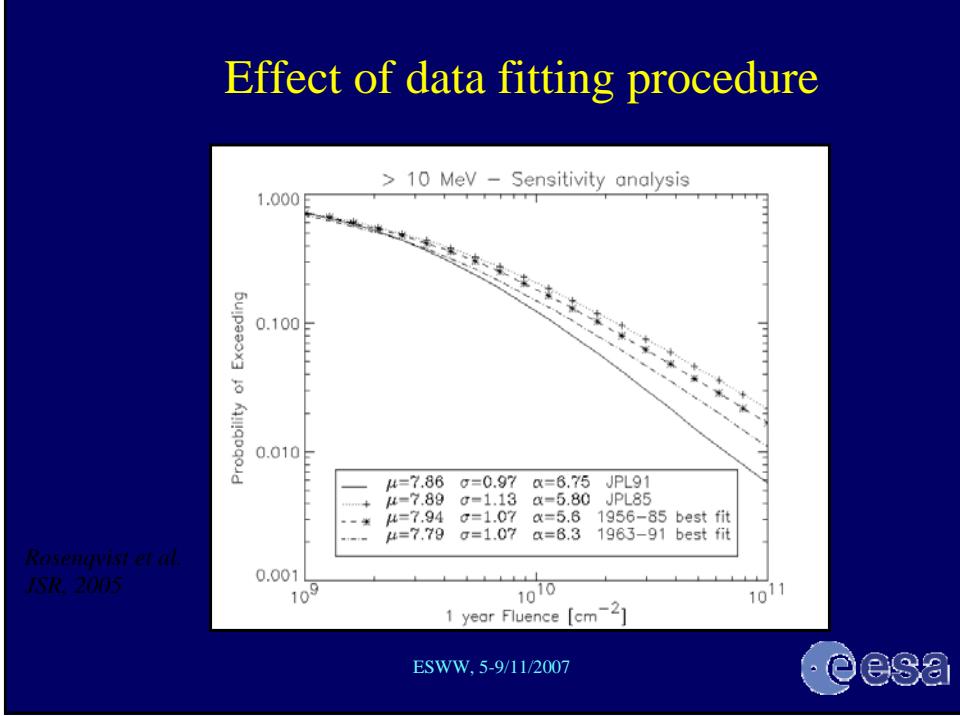
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Effect of data fitting procedure

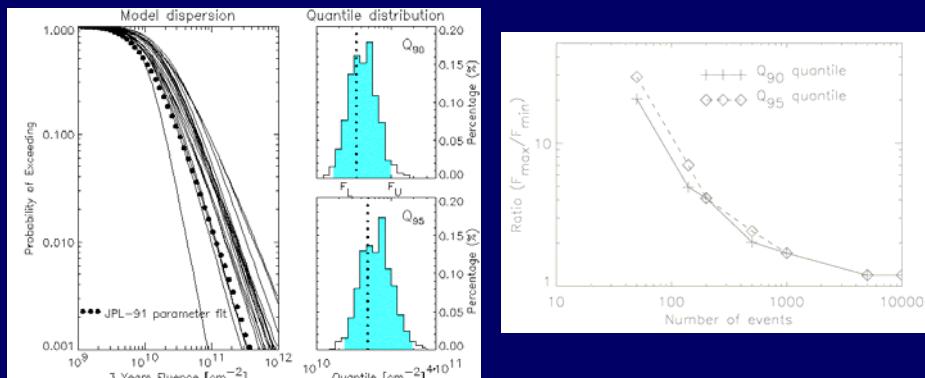


Effect of data fitting procedure



Size of the data set

- Check of models stability through 90th & 95th quantile fluence distribution w.r.t adding more data (left panels) and the size of the sample (right) – Rosenqvist & Hilgers, 2003.

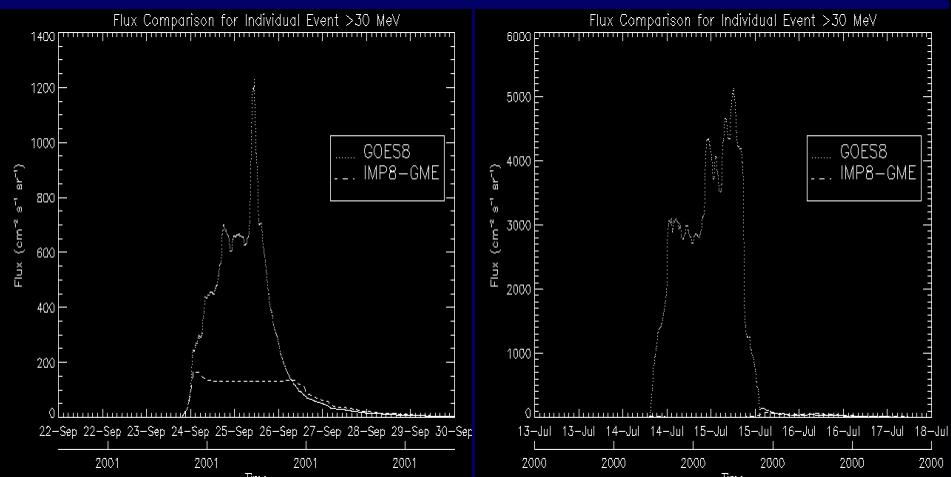


In Rosenqvist and Hilgers, GRL, 2003

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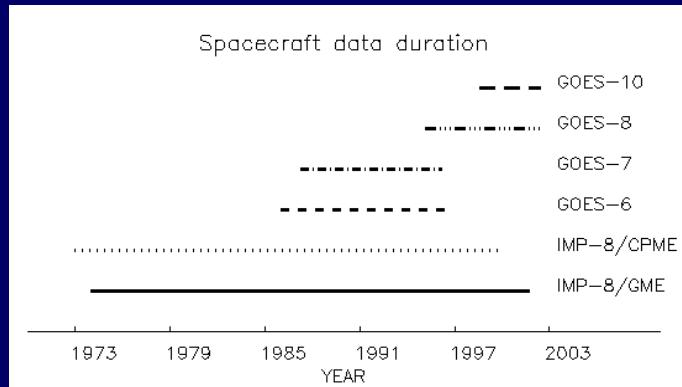
Solar Proton Events Seen by Different Detectors



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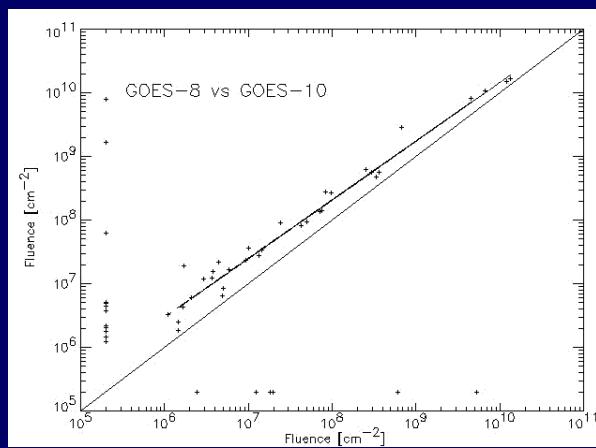
Calibration and data quality



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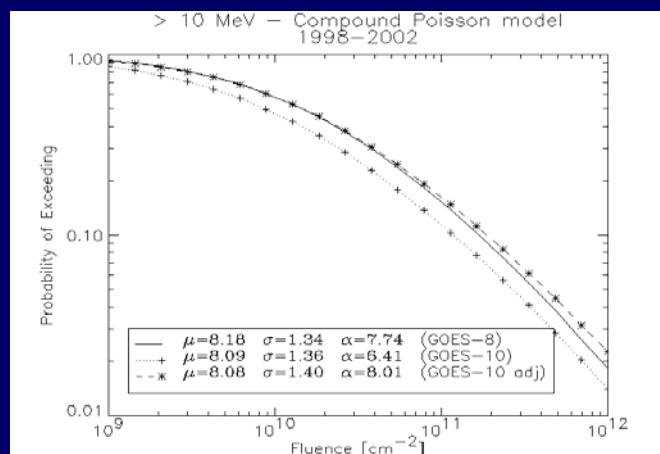
Use of different data sets



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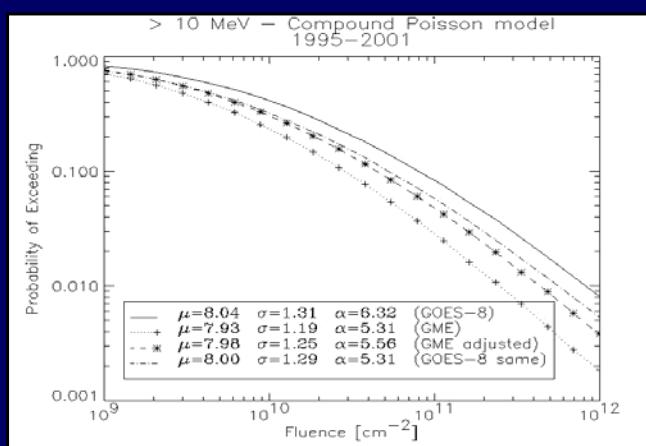
Use of different data sets



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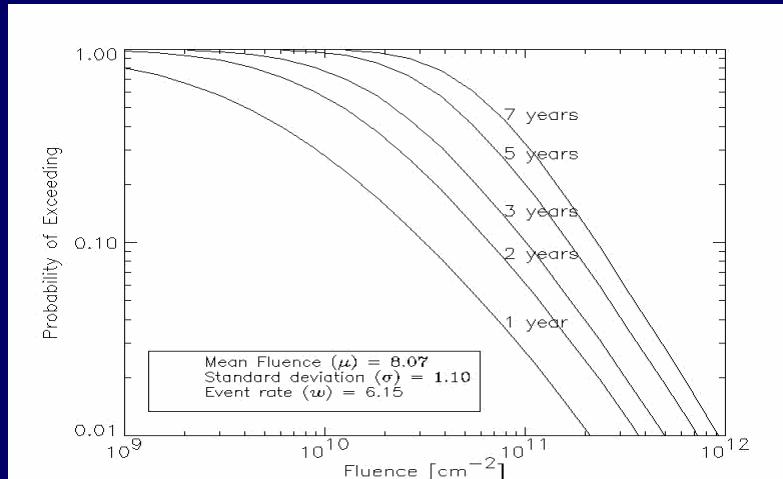
Comparing GOES-8 and IMP-8



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Combining IMP-8 and GOES-8 (>10 MeV) Rosenqvist et al. JSR, 2005.



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Conclusion

- Good predictions require good models, good data and good data processing.
- Models outputs must be compared for validation.
- Parameters of the models should be published.
- Publication of data sources to allow possibility of verification (reference list is in preparation, NWI ISO).
- Comparing several sources helps a lot (this requires to fly several instruments, possibly establishing a ‘reference one’).
- More solar proton data are required to improve the models (duration and energy range e.g. >100 MeV).

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References

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